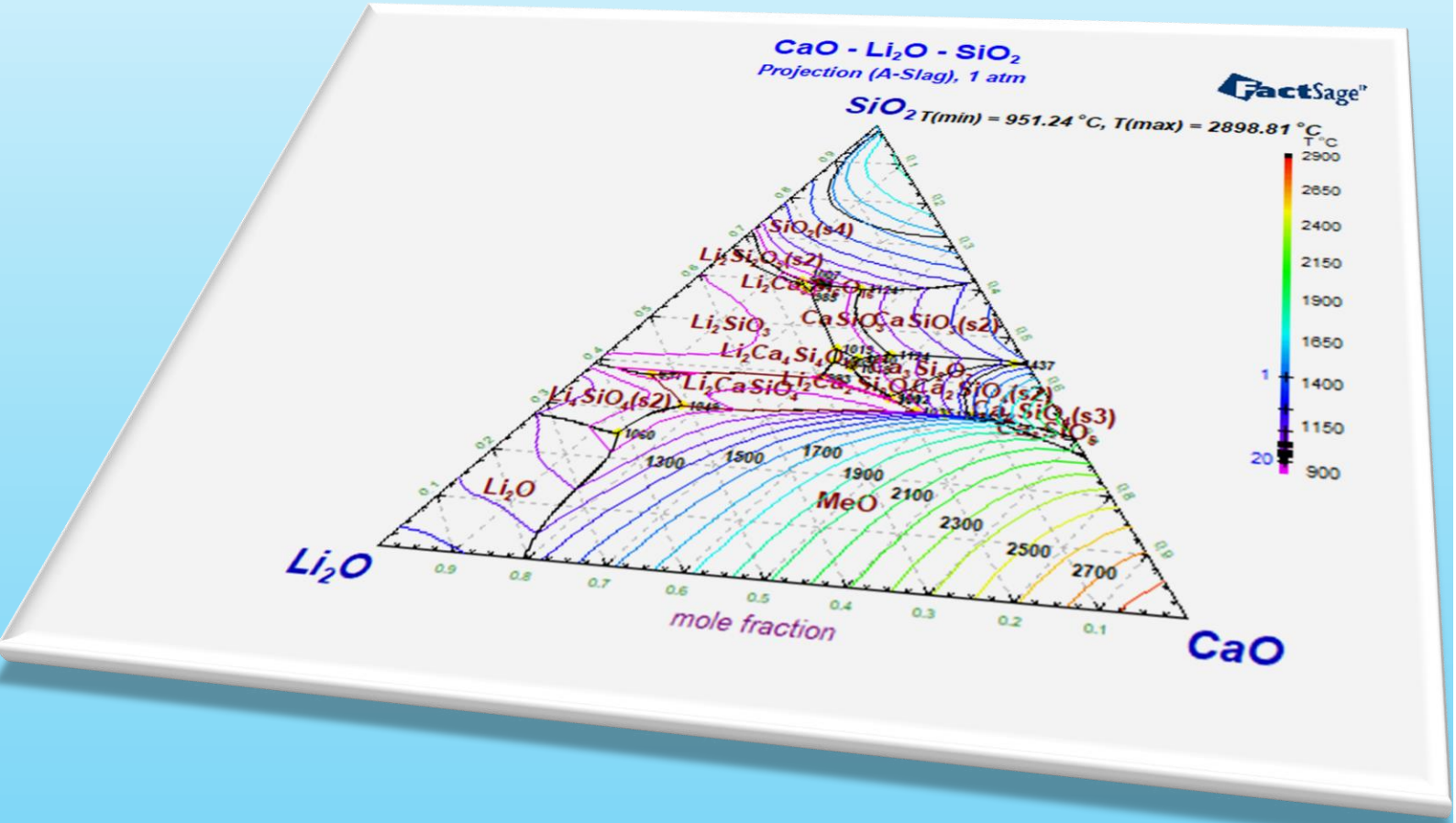
GTT-Technologies

Slagatlas

HotVeGas

Version 16



Introduction

The present collection of phase diagrams for binary, ternary and quaternary sub-systems among the components Al_2O_3-Al_2S_3-CaO-CaF_2-CaS-Cr_2O_3-CrS-FeO-Fe_2O_3-FeS-Li_2O-MgO-MgS-MnO-Mn_2O_3-MnS-K_2O-K_2S-Na_2O-Na_2S-NiO-NiS-P_2O_5-SO_3-SiO_2-SrO-TiO_2-Ti_2O_3-V_2O_3-V_2O_5-ZnO is the result of thermochemical data assessments (Gibbs energies) for the respective phases in each system. These assessments have been carried out in the framework of the HotVeGas project (parts I, II and III) in close collaboration with Forschungszentrum Jülich. The phase diagrams have all been calculated using the method of Zero Fraction Line tracing, in other words, there are no “hand drawn optimal” lines through a set of experimental data points as is still customary in parts the literature. Nevertheless, where available experimental information has been plotted into the calculated diagram. This enables the reader to check at any time on the quality of the data assessments. It must be mentioned especially at this point, that in some cases phase diagrams which have been produced in the classical “by hand” way have been used for controlling the thermochemical data assessments. These cases can usually be recognized from the fact that the “experimental points” follow the lines which have been draw by the classical phase diagram assessor.

The phase diagrams have been reproduced both in terms of mole fraction and weight-percentage axes in order to improve their usability both by thermochemists and users in industrial practice. The experimental points have been plotted into the diagram which uses the axes variables of the respective publication. For binary systems with Fe, which should in general be treated as proper ternary systems, one diagram each for a low (i.e. contact with Fe) and for a high oxygen potential ($p(O_2)$=0.21atm) has been generated. Note, that the diagram for low oxygen potential does not represent a fixed oxygen potential but holds for the Fe-activity fixed to be 1. The oxygen potential thus varies with temperature in these diagrams. The solid phases of Fe dissolve only negligible amounts of O, but the metallic melt takes up increasing amounts of oxygen with increase of temperature. This behavior has been incorporated in the present database. Also, the resulting miscibility gap between liquid metal and liquid oxide (slag) has been fully incorporated. Thus, some of the diagrams with Fe show in the range of the liquid phases a phase boundary (miscibility gap) which is not given in most of the literature phase diagrams.

For ternary systems, in order to give an overview as complete as possible, in most cases a set of phase diagrams has been generated. Isothermal sections for two standard temperatures (500°C and 1000°C) as well as for a temperature just below the liquidus surface are given. In addition, the liquidus surface itself is given, with isotherms in °C. For ternary diagrams too, mole fractions and weight-percentages are used as

axes variables. Also, the experimental information is inserted into the diagrams according to the above-mentioned method.

For quaternary systems, it would be necessary to use a three-dimensional composition tetrahedron. Temperature would then have to be treated as a constant parameter. Since perspective drawings of three-dimensional relationships do not lead to diagrams which can be used for quantitative reading it was decided to use for the present work two-dimensional representations, i.e. sections through the respective quaternary system. Also, it must be said that only a limited number of experimental data is available which permits to show comparisons between calculated and experimental phase boundaries. Thus, the number of quaternary phase diagrams in this Slag Atlas (Schlackenatlas) is at present still limited.

Finally, it should be noted that the HotVeGas project is still ongoing, at present in phase III. While the project is still running there will be changes and additions in the thermochemical database. These will be incorporated into the Slag Atlas in the form of new or modified diagrams in due time. It is thus recommended to keep close contact with GTT if you are interested in the most recent state of the database and the phase diagrams.

Your GTT-Team, June 2020

Einleitung

Die vorliegende Sammlung von Phasendiagrammen zu binären, ternären und quaternären Teilsystemen mit den Komponenten Al_2O_3-Al_2S_3-CaO-CaF_2-CaS-Cr_2O_3-CrS-FeO-Fe_2O_3-FeS-Li_2O-MgO-MgS-MnO-Mn_2O_3-MnS-K_2O-K_2S-Na_2O-Na_2S-NiO-NiS-P_2O_5-SO_3-SiO_2-SrO-TiO_2-Ti_2O_3-V_2O_3-V_2O_5-ZnO ist entstanden als Ergebnis von thermochemischen Datenauswertungen (Gibbs-Energien) zu den einzelnen Phasen in den jeweiligen Systemen. Diese Arbeiten wurden im Rahmen des HotVeGas-Projektes (Teile I, II und III) in enger Zusammenarbeit mit dem Forschungszentrum Jülich durchgeführt. Die Phasendiagramme sind allesamt mit Hilfe der Methode der Zero Phase Fraction Lines berechnet worden, es gibt also keine wie in der Literatur üblichen „von Hand“ eingezeichneten „optimalen“ Linien durch einen Satz von experimentellen Punkten. Dennoch sind experimentelle Informationen, wo vorhanden, in die hier vorliegenden Diagramme mit einbezogen worden. Dadurch ist eine Qualitätskontrolle der berechneten Phasengrenzen jederzeit möglich. Es sei an dieser Stelle aber darauf hingewiesen, dass in einigen Fällen Phasendiagramme, die nach der klassischen „von Hand“-Methode ausgewertet in der Literatur vorlagen, zur Kontrolle der thermochemischen Datenauswertungen genutzt wurden. Diese Fälle sind meist daran zu erkennen, dass die „experimentellen“ Punkte genau den Linien folgen, die der ursprüngliche Phasendiagramm-Auswerter gezeichnet hatte.

Die Phasendiagramme sind zur besseren Nutzbarkeit sowohl durch Thermochemiker als auch durch Anwender aus der industriellen Praxis jeweils mit Molenbruch- und mit Gewichtsprozent-Achsen dargestellt. Die experimentellen Punkte sind jeweils in dem Bild eingetragen, das die Achsen des experimentellen Bildes trägt. Bei binären Systemen mit Eisen, die eigentlich immer als ternäre Systeme betrachtet werden müssen, wurde jeweils ein Bild mit dem hohen ($p(O_2)$=0.21 atm) und niedrigen (Kontakt mit Fe) Sauerstoffpotential berechnet. Man beachte, dass die Bilder niedriges Sauerstoffpotential NICHT für ein fixiertes O-Potential, sondern für die Eisenaktivität 1 erzeugt wurden. Das Sauerstoffpotential variiert also in diesen Bildern. Dazu kommt, dass diese Bilder speziell für hohe Temperaturen oft anders sind als aus der Literatur gewohnt. Die festen Phasen des Eisens lösen vernachlässigbar wenig Sauerstoff, die Schmelze nimmt aber bei steigender Temperatur immer mehr Sauerstoff auf (siehe dazu auch das Fe-O Phasendiagramm). Die entstehende Mischungslücke zwischen der Fe-Metallschmelze und der Oxidschmelze (Schlacke) ist in den vorliegenden Berechnungen vollständig berücksichtigt worden. Daher enthalten einige der Phasendiagramme im Bereich der flüssigen Phase eine Phasengrenze (Mischungslücke), die man aus den bisherigen Veröffentlichungen nicht kennt.

Für die ternären Systeme ist jeweils ein Satz von Bildern erstellt worden, um einen möglichst vollständigen Überblick zu erhalten. So sind die isothermen Schnitte für zwei Standardtemperaturen (500°C und 1000°C) sowie eine Temperatur gerade unterhalb der Liquidusfläche gegeben. Dazu wird auch die Liquidusfläche selbst mit den Isothermen (Temperatur in °C) gegeben. Auch für die ternären Diagramme gilt, dass

sowohl Molenbruch als auch Gewichtsprozent für die Achsen verwendet werden. Auch die experimentellen Punkte sind nach dem schon oben erklärten Verfahren in die Bilder eingetragen worden.

Für quaternäre Systeme benötigt man eigentlich eine dreidimensionale Darstellung in einem Zusammensetzungstetraeder. Dabei wäre dann die Temperatur bereits eine Konstante. Da perspektivische Darstellungen von dreidimensionalen Zusammenhängen aber nicht quantitativ ablesbar sind, werden hier zweidimensionale Darstellungen, also Schnitte durch die quaternären Systeme dargestellt. Es gibt nur eine begrenzte Anzahl von experimentellen Informationen, die es erlauben, Vergleiche zwischen gerechneten und experimentellen Phasengrenzen vorzunehmen. Daher ist die Anzahl der quaternären Phasendiagramme in diesem Schlackenatlas im Augenblick noch eingeschränkt.

Es bleibt anzumerken, dass dieser HotVeGas-Schlackenatlas ein fortlaufendes Projekt ist. Solange es läuft, werden sich Änderungen, speziell aber Ergänzungen ergeben. Diese werden von Zeit zu Zeit in den Atlas ein gepflegt. Rücksprache mit den Editoren bei GTT bezüglich des jeweils neuesten Stands wird daher empfohlen.

Das GTT-Team, Juni 2020

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New systems in GTOX database

(additions to the previous version November 2019, Slagatlas 15.0)

Binary systems

New systems	Reassessed systems
1. *Zn-S*	*Ni-O*
2. Cr_2O_3-TiO_2	Al_2O_3-V_2O_5
3. *CaO-SrO*	*FeO*-V_2O_3
4. Cr_2O_3-*SrO*	SiO_2-V_2O_3
5. *SrO*-TiO_2	*Mg-O*
6. *MnO-SrO*	
7. Mn_2O_3-*SrO*	
8. Cr_2O_3-*NiO*	
9. *Li-O*	
10. Al_2O_3-Li_2O	
11. *CaO*-Li_2O	
12. Fe_2O_3-Li_2O	
13. Li_2O-*MgO*	
14. Li_2O-*MnO*	
15. Li_2O-Mn_2O_3	
16. Li_2O-Na_2O	
17. Li_2O-*NiO*	
18. Li_2O-P_2O_5	
19. Li_2O-SiO_2	
20. Li_2O-*ZnO*	
21. *MnO-NiO*	
22. Mn_2O_3-*NiO*	
23. *NiO*-P_2O_5	

Ternary systems

New systems	Reassessed systems
1. *Cr-Ni-S*	*CaO*-SiO_2-V_2O_3
2. *Fe-Zn-S*	*FeO*-SiO_2-V_2O_3
3. *Mn-Zn-S*	
4. Na_2O-P_2O_5-V_2O_5	
5. Cr_2O_3-*FeO*-TiO_2	
6. *CaO*-Na_2O-V_2O_5	
7. Fe_2O_3-*SrO*-SiO_2	
8. Cr_2O_3-Fe_2O_3-TiO_2	
9. Na_2O-V_2O_5-*ZnO*	

10. $MgO-Na_2O-V_2O_5$	
11. $Cr_2O_3-NiO-TiO_2$	
12. $Cr_2O_3-Fe_2O_3-NiO$	
13. $Al_2O_3-Fe_2O_3-Li_2O$	
14. $Al_2O_3-Li_2O-MgO$	
15. $Al_2O_3-Li_2O-Na_2O$	
16. $Al_2O_3-Li_2O-SiO_2$	
17. $CaO-Li_2O-MgO$	
18. $Li_2O-Na_2O-SiO_2$	
19. $Li_2O-SiO_{-2}ZnO$	
20. $CaO-Li_2O-SiO_2$	
21. $Li_2O-MgO-SiO_2$	
22. $Na_2O-NiO-P_2O_5$	
23. $K_2O-NiO-P_2O_5$	
24. $K_2O-MgO-V_2O_5$	
25. $K_2O-V_2O_5-ZnO$	
26. $CaO-K_2O-V_2O_5$	
27. $Al_2O_3-K_2O-V_2O_5$	
28. Li-Mn-O	
29. $Li_2O-MnO-MnO_2$	
30. Al-Li-O	
31. Li-Ni-O	
32. $Al_2O_3-SiO_2-V_2O_3$	
33. $MgO-SiO_2-V_2O_3$	

Quaternary systems

New systems	Reassessed systems
1. $Al_2O_3-Li_2O-Na_2O-SiO_2$	

For safe calculations in $MeSO_4$-rich subsystems we have introduced an additional liquid phase which contains sulphates and pyrosulphates as well as sulphides and oxides of the same cations (K^{1+}, Na^{1+}, Ca^{2+}, Mg^{2+}, Ni^{2+}, Al^{3+}) The phase name is L_Sulphate. For calculations which only contain the constituents mentioned it is sufficient to use only this phase. If other constituents are to be considered too, the standard Slag phase has to be used simultaneously. Note that the Slag phase itself now only covers sulphates up to certain limit.

The solid solution phases, their description and modelling

System components:

1: Al 2: Ca 3: Cr 4: F 5: Fe 6: K 7: Mg 8: Mn 9: Na
10: Ni 11: O 12: P 13: S 14: Si 15: Sr 16: Ti 17: V 18: Zn
19: Li

	Phase	Name	Model	Description
1.	Al3M_D022	AL3M	SUBL	$(\underline{Al}, Ti)_3 (Ti)$
2.	Alfa	ALFA	SUBL	$(Ca^{+2},\underline{K^{+1}}, Mg^{+2},\underline{Na^{+1}},Va)(\underline{SO_4^{-2}})$
3.	AlPO4-HT	ALPH	SUBL	$(\underline{Al^{+3}},Si^{+4})_1(\underline{P^{5+}},Si^{+4})_1(O^{-2})_4$
4.	AlPO4-MT	ALPM	SUBL	$(\underline{Al^{+3}},Si^{+4})_1(\underline{P^{5+}},Si^{+4})_1(O^{-2})_4$
5.	BCC_A2	BCC	SUBL	$(Al, Ca, \underline{Fe}, O, Si, Sr, \underline{Cr}, P, Mn, S, Zn, Ti, TiO_3, V, VO_3)_1 (Va)_3$
6.	Beta-Alumina	BETA	SUBL	$(Al^{+3})_9(\underline{Na^{+1}}, \underline{K^{+1}}, Li^{+1})_1(O^{-2})_{14}$
7.	Beta-prime	BET2	SUBL	$(\underline{K^{+1}},Na^{+1},Li^{+1})_2 (\underline{Al^{+3}},Va)_2 (Mg^{+2},\underline{Va})_3 (Al_{10}O_{19}^{8-})_1$
8.	Beta-tri	BET3	SUBL	$(Al_{40}Na_4Mg_5O_{70}^{6-}, Al_{40}K_4Mg_5O_{70}^{6-})_1 (O^{-2},Va)_3 (Al^{+3},Na^{+1})_2 (Al^{+3},Mg^{+2})_2$
9.	BETA V-O	BETV	SUBL	$(\underline{V})_1(\underline{O}, Va)_1$
10.	Bixbyte	BIXB	SUBL	$(Fe^{+3}, \underline{Mn^{+3}}, Cr^{+3}, Ti^{+3}, Ni^{+2}, Mn^{+4})_2 (O^{-2})_3$
11.	Brezinaite	BREZ	SUBL	$(\underline{Cr}, Fe, Mn) (Cr)_2 (S)_4$
12.	$12CaO{\cdot}7Al_2O_3$	C12A	SUBL	$(Ca^{+2})_{12} (\underline{Al^{+3}}, Fe^{+3})_{14} (O^{-2})_{33}$

13.	$CaO{\cdot}2Al_2O_3$	C1A2	SUBL	$(Ca^{+2})_1$ $(\underline{Al^{+3}}, Fe^{+3})_4$ $(O^{-2})_7$
14.	$CaO{\cdot}6Al_2O_3$	C1A6	SUBL	$(Ca^{+2})_1$ $(\underline{Al^{+3}}, Fe^{+3})_{12}$ $(O^{-2})_{19}$
15.	C1V1	C1V1	SUBL	$(\underline{Ca}, Mg)$ $(\underline{V})_2(O)_6$
16.	$2CaO{\cdot}Fe_2O_3$	C2F	SUBL	$(Ca^{+2})_2$ $(Al^{+3}, \underline{Fe^{+3}})_2$ $(O^{-2})_5$
17.	$Ca_2P_2O_7$-MT	C2P	SUBL	$(\underline{Ca^{+2}},Mg^{+2})_2(P^{5+})_2$ $(O^{-2})_7$
18.	C2S-C3P	C2SA	SUBL	$(\underline{Ca^{+2}},Cr^{+2}, Mg^{+2},Mn^{+2}, Li_2^{+2})_3(\underline{Ca^{+2}},\underline{Va})_1$ $(\underline{P^{5+}},\underline{Si^{+4}},V^{5+})_2$ $(O^{-2})_8$
19.	α´- Ca_2SiO_4	C2SP	SUBL	$(\underline{Ca^{+2}},Mg^{+2},Fe^{+2},Mn^{+2},Zn^{+2}, Li_2^{+2})_3$ $(\underline{Ca^{+2}}, \underline{Va})_1$ $(\underline{P^{5+}},\underline{Si^{+4}},V^{5+})_2(O^{-2})_8$
20.	$3CaO{\cdot}Al_2O_3$	C3A1	SUBL	$(Ca^{+2})_3$ $(\underline{Al^{+3}}, Fe^{+3})_2$ $(O^{-2})_6$
21.	C3M3P2	C3M3	SUBL	$(\underline{Ca^{+2}},Mg^{+2})_3(Mg^{+2})_3(P^{5+})_4(O^{-2})_{16}$
22.	β-$Ca_3P_2O_8$	C3PL	SUBL	$(\underline{Ca^{+2}},Mg^{+2},Zn^{+2})_3(P^{5+})_2$ $(O^{-2})_8$
23.	α-$Ca_3P_2O_8$	C3PM	SUBL	$(\underline{Ca^{+2}},Mg^{+2},Zn^{+2})_3(P^{5+})_2$ $(O^{-2})_8$
24.	CAF2	CAF2	SUBL	$(Ca^{+2})_1$ $(Al^{+3}, Fe^{+3})_6$ $(O^{-2})_{10}$
25.	$CaO{\cdot}Cr_2O_3$-alpha	CAO1	SUBL	$(Ca^{+2})_1$ $(Al^{+3}, \underline{Cr^{+3}}, Fe^{+3})_2$ $(O^{-2})_4$
26.	$CaO{\cdot}(Al,Cr,Fe)_2O_3$ -beta	CAO2	SUBL	$(Ca^{+2})_1$ $(\underline{Al^{+3}}, \underline{Cr^{+3}}, \underline{Fe^{+3}}))_2$ $(O^{-2})_4$
27.	Oldhamite	CAS	SUBL	$(\underline{Ca},Fe,\underline{Mg}, \underline{Mn}, Cr)$ S

28.	CBCC_A12	CBCC	SUBL	(Cr, Fe, Mg, Mn, V)
29.	Carnegieite	CGKS	SUBL	$(Al^{+3}, Si^{+4})_2 (Va)_1 (Na^{+1}, K^{+1},Va)_1 (O^{-2})_4$
30.	Clinopyroxene	CLIN	SUBL	$(Ca^{+2}, Fe^{+2}, \underline{Mg^{+2}})_1 (Fe^{+2}, \underline{Mg^{+2}})_1 (Si^{+4})_2 (O^{-2})_6$
31.	CMP	CMP	SUBL	$(Ca^{+2},\underline{Mg^{+2}})_1(Ca^{+2})_1(P^{5+})_2(O^{-2})_7$
32.	Cordierite	CORD	SUBL	$(Al_2Si_5O_{18}{}^{10-})_1(Fe^{+2},Mg^{+2},Mn^{+2})_2(\underline{Al^{+3}},Mg^{+2})_1 (\underline{Al^{+3}},Si^{+4})_1$
33.	Corundum	CORU	SUBL	$(\underline{Al^{+3}}, Cr^{+2}, \underline{Cr^{+3}}, \underline{Fe^{+3}}, \underline{Mn^{+3}}, Fe_{0.5}Ti_{0.5}{}^{+3}), Mn_{0.5}Ti_{0.5}{}^{+3}, Ti^{+3}, Mg_{0.5}Ti_{0.5}{}^{+3}, V^{+3}, V^{+4}, Va, Ni_{0.5}Ti_{0.5}{}^{+3})_2 (Cr^{+3}, \underline{Va})_1 (O^{-2})_3$
34.	CUB-A13	CUB	SUBL	(Cr, Fe, Mg, Mn, V)
35.	CZ2P-HT	CZ2P	SUBL	$(\underline{Ca^{+2}},Zn^{+2})_1(\underline{Zn^{+2}}, Ca^{+2})_2(P^{5+})_2(O^{-2})_8$
36.	CrTi-n	CrTi	SUBL	$(TiO_2, Cr_2O_3, Fe_2O_3)(Ti_4O_8)$
37.	D8-2FeZn-gamma	D82	SUBL	$(Fe, Zn)_{0.3}(Fe, Zn)_{0.7}$
38.	Eucryptite-HT	EUCR	SUBL	$(LiAl, Si)(Si)(O)_4$
39.	FCC_A1	FCC	SUBL	$(\underline{Fe}, \underline{Ca}, V, O, Si, Cr, P, Mn, S, Mg, Zn, Al, Ti, \underline{Ni}, Sr)_1 (Va)_1$
40.	$FeNaO_{-2}$delta	FENA	SUBL	$(\underline{Fe^{+3}}, Si^{+4})_1 (\underline{Na^{+1}},Va)_1 (O^{-2})_2$
41.	FeZn-delta	FEZ0	SUBL	$(Fe, Zn)_{0.125}(Fe, Zn)_{0.875}$
42.	FeZn-zeta	FEZ1	SUBL	$(Fe, Zn)_{0.072}(Fe, Zn)_{0.928}$

43.	FeZn4	FEZN	SUBL	$(\underline{Fe}, Zn)_{0.25}(Fe, \underline{Zn})_{0.75}$
44.	Feldspar	FSPA	SUBL	$(Al, Fe)_1(K, Na, Ca)_1 (Al, Si)_3Si_2O_8$
45	GAMMA V-O	GAMV	SUBL	$(\underline{V})_1(\underline{O}, Va)_{0.5}$
46.	Garnet	GARN	SUBL	$(Ca^{+2})_3 (\underline{Al^{+3}},\underline{Cr^{+3}})_2 (Si^{+4})_3 (O^{-2})_{12}$
47.	Glaserite	GLAS	SUBL	$(\underline{K^{+1}}, Na^{+1})_3(Na^{-+1})_1(SO_4^{-2})_2$
48.	Hatrurite	HATR	SUBL	$(\underline{Ca^{+2}},Cr^{+2})_3 (Si^{+4})_1 (O^{-2})_5$
49.	HCP_A3	HCP	SUBL	$(Al, \underline{Ti})_2 (O, Va)$
50.	Hexagonal	HEXA	SUBL	$(Ca^{+2}, \underline{K^{+1}}, Mg^{+2}, \underline{Na^{+1}}, Va, Ni^{+2}, Al^{+3})(S^{-2}, \underline{SO_4^{-2}})$
51.	Sulfide hexagonal	HEXB	SUBL	$(\underline{K^{+1}}, \underline{Na^{+1}})_2(\underline{S^{-2}}, SO_4^{-2})$
52.	High-Sigma	HIGH	SUBL	$(Fe, Mn)_8(Cr)_4(Cr, Fe, Mn)_{18}$
53.	K3P-LT	K3PL	SUBL	$(K_2O)_2(P_2O_5)(K_2O,CaO,K_2CaO_2,MgO,K_2MgO_2)$
54.	K3P-MT	K3PL	SUBL	$(K_2O)_2(P_2O_5)(K_2O,CaO,K_2CaO_2,MgO,K_2MgO_2)$
55.	K3P-HT	K3PL	SUBL	$(K_2O)_2(P_2O_5)(K_2O,CaO,K_2CaO_2,Na_2O,$ $MgO,K_2MgO_2)$
56.	KAF4S3	KAF4	SUBL	$(\underline{Al^{+3}},\underline{Fe^{+3}})_4 (K^{+1})_4 (Si^{+4})_3(O^{-2})_{14}$
57.	Kaliophilite-HT	KALH	SUBL	$(\underline{Al^{+3}},\underline{Fe^{+3}})_2 (K^{+1},Na^{+1})_2 (Si^{+4})_2(O^{-2})_8$

58.	Kaliophilite-LT	KALL	SUBL	$(\underline{Al^{+3}},\underline{Fe^{+3}})_2\ (K^{+1})_2\ (Si^{+4})_2(O^{-2})_8$
59.	K_2MgSiO_4	KMS	SUBL	$(\underline{Mg^{+2}},Si^{+4})_1(Si^{+4})_1\ (\underline{K^{+1}},Va)_2(O^{-2})_4$
60.	$(K,Na)_2CrO_4$-LT	KN21	SUBL	$(\underline{K^{+1}},\underline{Na^{+1}})_2\ (Cr^{6+})(O^{-2})_4$
61.	$(K,Na)_2CrO_4$-HT	KN22	SUBL	$(\underline{K^{+1}},\underline{Na^{+1}})_2\ (Cr^{6+})(O^{-2})_4$
62.	$(K,Na)_2Cr_2O_7$	KN23	SUBL	$(\underline{K^{+1}},\underline{Na^{+1}})_2\ (Cr^{+6})_2(O^{-2})_7$
63.	(K,Na)2P-HT	KN2P	SUBL	$(\underline{K_2O},\underline{Na_2O})_2(P_2O_5)$
64.	(K, Na)2S	KNAS	SUBL	$(\underline{K^{+1}},\underline{Na^{+1}})_2\ (S^{-2},\ SO_4^{-2})$
65.	KP-HT	KP_H	SUBL	$(\underline{K^{+1}},Na^{+1})(P^{+5})(O^{-2})_3$
66.	Li4SiO4-HT	L2SH	SUBL	$(Li_2^{+2})(\ Li_{+2}^{2},Mg^{+2},\ Zn^{+2})(SiO_4^{-4})$
67.	Li4SiO4-LT	L2SL	SUBL	$(Li_2^{+2})(\ Li_2^{+2},\ Zn^{+2})(SiO_4^{-4})$
68.	Langbeinite	LANG	SUBL	$(K^{+1})_2(Ca^{+2},Mg^{+2})_2(SO_4^{-2})_3$
69.	Leucite	LEUC	SUBL	$(\underline{Al^{+3}},\underline{Fe^{+3}})_2\ (K^{+1})_2\ (Si^{+4})_4(O^{-2})_{12}$
70.	LiAlO2-HT	LIAH	SUBL	$(Li,\ Va)(Al,\ Si)O_2$
71.	LiAlO2-LT	LIAL	SUBL	$(Li,\ Va)(Al,\ Si)O_2$
72.	Li2SiO3	LIS	SUBL	$(\underline{Li^{+1}},\ Na^{+1})_2\ (Si^{+4})(O^{-2})_3$

73.	Li-Spinel	LISP	SUBL	$(Al^{+3}, Fe^{+2}, Fe^{+3}, Mg^{+2}, Al_{0.5}Li_{0.5}^{+2}, Fe_{0.5}Li_{0.5}^{+2}, Na_{0.5}Al_{0.5}^{+2})(Al^{+3}, Fe^{+2}, Fe^{+3}, Mg^{+2}, Va)_2(Mg^{+2}, Va)_2(O^{-2})_4$
74.	Lowclinopyroxene	LOWC	SUBL	$(\underline{Ca^{+2}}, Mg^{+2})_1 (Mg^{+2})_1 (Si^{+4})_2 (O^{-2})_6$
75.	Li2Si2O5-HT	LS2H	SUBL	$(\underline{Li^{+1}}, Na^{+1})_2 (Si^{+4})_2(O^{-2})_5$
76.	Li2Si2O5-LT	LS2L	SUBL	$(\underline{Li^{+1}}, Na^{+1})_2 (Si^{+4})_2(O^{-2})_5$
77.	M1V1	M1V1	SUBL	$(Ca, \underline{Mg})(\underline{V})_2(O)_6$
78.	$M_2P_2O_7$	M2P	SUBL	$(Ca^{+2},\underline{Mg^{+2}},\underline{Zn^{+2}})_2(P^{5+})_2 (O^{-2})_7$
79.	M3O5	M3O5	SUBL	$(Fe, Cr)_2(Ti)(O)_5$
80.	$Mg_3P_2O_8$	M3P	SUBL	$(Ca^{+2},\underline{Mg^{+2}},Zn^{+2})_3(P^{5+})_2 (O^{-2})_8$
81.	M4O7	M4O7	SUBL	$(\underline{Ti}, \underline{V})_4(O)_7$
82.	M5O9	M5O9	SUBL	$(\underline{Fe}, \underline{Cr})_2(Ti)_3(O)_9$
83.	M6O11	M6O11	SUBL	$(\underline{Ti}, \underline{V})_6(O)_{11}$
84.	M8O15	M8O15	SUBL	$(\underline{Ti}, \underline{V})_8(O)_{15}$
85.	Melilite	MELM	SUBL	$(Al^{+3}, Mg^{+2})_1 (Al^{+3}, Si^{+4})_1 (Ca_2SiO_7{}^{-6})_1$
86.	MeO	MEO	SUBL	$(Al^{+3},\underline{Ca^{+2}}, \underline{Fe^{+2}}, Fe^{+3}, \underline{Mg^{+2}},Va, Cr^{+3}, \underline{Mn^{+2}}, Mn^{+3}, \underline{Ni^{+2}}, \underline{Sr^{+2}}, Ti^{+4}, V^{+3}, V, V^{+2}, Zn^{+2}, Li_2^{+2}, Li_{0.5}Al_{0.5}^{+2})_1 (O^{-2})_1$
87.	MeS2	MES2	SUBL	$(Fe, Ni) S_2$

88.	MeVO4	MEVO	SUBL	$(Al^{+3}, Fe^{+3})_1(V^{5+})_1(O^{-2})_4$
89.	MgP2O6	MP	SUBL	$(\underline{Mg}^{+2},Zn^{+2})(P^{+5})_2(O^{-2})_6$
90.	Mullite	MULL	SUBL	$(Al^{+3})_1\ (Al^{+3})_1\ (Al^{+3}, Cr^{+3}, \underline{Si^{+4}},Fe^{+3})_1\ (Va, \underline{O^{-2}})_5$
91.	$(Ni, Zn)_3V_2O_8$	M3V	SUBL	$(Ni, Zn)_3V_2O_8$
92.	(K,Na)2C3A5	N2C3	SUBL	$(K^{+1},Na^{+1},Va)_1\ (Ca^{+2},K^{+1},Na^{+1})_1\ (Al^{+3})_2(O^{-2})_4$
93.	N3P-LT	N3PL	SUBL	$(\underline{Na_2O},K_2O)_2(P_2O_5)(Na_2O)$
94.	N3P-HT	N3PH	SUBL	$(\underline{Na_2O},K_2O)_2(P_2O_5)(Na_2O)$
95.	N3P-MT	N3PH	SUBL	$(\underline{Na_2O},K_2O)_2(P_2O_5)(Na_2O)$
96.	Ni3S2-beta	N3S2	SUBL	$(Fe, Ni, Va)_2S$
97.	Na2Si2O5-LT	NA21	SUBL	$(\underline{Na^{+1}}, Li^{+1})_2\ (Si^{+4})_2(O^{-2})_5$
98.	Na2Si2O5-MT	NA22	SUBL	$(\underline{Na^{+1}}, Li^{+1})_2\ (Si^{+4})_2(O^{-2})_5$
99.	Na2Si2O5-HT	NA23	SUBL	$(\underline{Na^{+1}}, Li^{+1})_2\ (Si^{+4})_2(O^{-2})_5$
100.	Na2SiO3	NA24	SUBL	$(\underline{Na^{+1}}, Li^{+1})_2\ (Si^{+4})(O^{-2})_3$
101.	$(K,Na)(Al,Fe)O_2$-HT	NAFH	SUBL	$(\underline{Al^{+3}},\underline{Fe^{+3}}, Si^{+4})_1\ (\underline{K^{+1}},\underline{Na^{+1}},Va)_1\ (O^{-2})_2$
102.	$(K,Na)(Al,Fe)O_2$-LT	NAFL	SUBL	$(\underline{Al^{+3}},\underline{Fe^{+3}}, Si^{+4})_1\ (\underline{K^{+1}},\underline{Na^{+1}},Va)_1\ (O^{-2})_2$

103.	NC2S3	NC2S	SUBL	$(Na^{+1},Va)_2(Ca^{+2},Va)_1(CaNa_2Si_3O_9^{-2})_1$
104.	Nepheline	NEPH	SUBL	$(Al^{+3}, Si^{+4})_2 (Va)_1 (Na^{+1}, K^{+1},Va)_1 (O^{-2})_4$
105.	NiV_2O6	NIV	SUBL	$(\underline{Ni^{+2}}, Zn^{+2})(V^{+5})_2(O^{-2})_6$
106.	NiMnO3	NMO3	SUBL	$(Mn^{+3}, Ni^{+2}, Mn^{+4})_2(O^{-2})_3$
107.	NaPO3-HT	NP_H	SUBL	$(\underline{Na}^{+1}, K^{+1})(P^{+5})(O^{-2})_3$
108.	Na2SO4-LT	NaLT	SUBL	$(\underline{Na}, K)_2 (SO_4)$
109.	Na2SO4-MT	NaMT	SUBL	$(\underline{Na}, K)_2 (SO_4)$
110.	Olivine	OLIV	SUBL	$(\underline{Ca^{+2}},\underline{Fe^{+2}}, \underline{Mg^{+2}},\underline{Mn^{+2}},Zn^{+2})_1(\underline{Ca^{+2}},\underline{Fe^{+2}},\underline{Mg^{+2}}, \underline{Mn^{+2}})_1 (Si^{+4})_1(O^{-2})_4$
111.	Orthopyroxene	ORTH	SUBL	$(\underline{Ca^{+2}}, Mg^{+2}, Fe^{+2})_1 (Mg^{+2})_1 (Si^{+4})_2 (O^{-2})_6$
112.	Pentlandite	PENT	SUBL	$(\underline{Fe}, \underline{Ni})_9 S_8$
113.	Perovskite	PERO	SUBL	$(Ca^{+2})_2(Ti^{+4}, Fe^{+3})_2(O^{-2})_5(O^{-2}, Va)_1$
114.	Protoenstatite	PROE	SUBL	$(Cr^{+2},\underline{Mg^{+2}})_1 (Si^{+4})_1 (O^{-2})_3$
115.	Protopyroxene	PROT	SUBL	$(\underline{Ca^{+2}}, \underline{Mg^{+2}}, Mn^{+2},Fe^{+2},Zn^{+2})_1 (Si^{+4})_1 (O^{-2})_3$
116.	$Sr(Mn,Fe)_{3-\delta}$	PRVS	SUBL	$(Sr^{+2})(\underline{Mn^{+3}}, Mn^{+4},Fe^{+2},Zn^{+2})_1 (Si^{+4})_1 (O^{-2})_3$
117.	PSbrookite	PSBR	SUBL	$(Al, Mg, Fe, Ti, V) (Al, Ti, Fe) (Ti) (O)_5$

118.	Pseudowollastonite	PSWO	SUBL	$(\underline{Ca^{+2}}, Cr^{+2})_1 (Si^{+4})_1 (O^{-2})_3$
119.	K2S2O7-HT	PYRO	SUBL	$(\underline{K^{+1}}, Na^{+1})_2(S_2O_7^{-2})$
120.	Pyrrhotite	PYRR	SUBL	$(\underline{Fe}, \underline{Cr}, Mg, Mn, Ni, Va)(S)$
121.	Rankinite	RANK	SUBL	$(\underline{Ca^{+2}}, Cr^{+2})_3 (Si^{+4})_2 (O^{-2})_7$
122.	Rhodonite	RHOD	SUBL	$(Mg^{+2}, \underline{Mn^{+2}}, Ca^{+2}, Fe^{+2})_1(Si^{+4})_1(O^{-2})_3$
123.	Rutile	RUTI	SUBL	$(Ti, V)_1(O, Va)_2$
124.	Sapphirine	SAPP	SUBL	$(Al_{36}Mg_{14}Si_3O_{80}^{1-2})_1 (Al^{+3}, \underline{Si^{+4}})_3 (Al^{+3}, \underline{Va})_1$
125.	SIGMA	SIGM	SUBL	$(Fe, Mn)_8(Cr)_4(Cr, Fe, Mn)_{18}$
126.	SiO-2HT	SIOH	SUBL	$(Al^{+3}, \underline{Si^{+4}})_1(P^{+5}, \underline{Si^{+4}}, Ti^{+4})_1(O^{-2})_4$
127.	SiO-2MT	SIOM	SUBL	$(Al^{+3}, \underline{Si^{+4}})_1(P^{5+}, \underline{Si^{+4}})_1(O^{-2})_4$
128.	Spinel	SPIN	SUBL	$(Al^{+3}, Cr^{+2}, Cr^{+3}, Fe^{+2}, Fe^{+3}, Mg^{+2}, Mn^{+2}, Zn^{+2}, Ti^{+4}, Ni^{+2})_1(Al^{+3}, Ca^{+2}, Cr^{+3}, Fe^{+2}, Fe^{+3}, Mg^{+2}, Mn^{+2}, Mn^{+3}, Mn^{+4}, Va)_2(Cr^{+2}, Fe^{+2}, Mg^{+2}, Va)_2 (O^{-2})_4$
129.	Spinel Ni_2TiO_4	SPNT	SUBL	$(NiO)_2 (NiO, TiO_2)$
130.	Spodumene	SPOD	SUBL	$(LiAl, Si) (Si)_2(O)_6$
131.	SRMNO3_4H	SRMN	SUBL	$(Sr^{+2})_1(Mn^{+3}, Mn^{+4})_1(O^{-2}, Va)_3$
132.	Ti3O5	T3O5	SUBL	$(\underline{Ti}, V)_3(O)_5$
133.	Ti5O9	T5O9	SUBL	$(\underline{Ti}, V)_5(O)_9$

134.	Tetragonal-Spinel	TETR	SUBL	$(Mn^{+2}, Mn^{+3}, Cr^{+2}, Cr^{+3}, Zn^{+2}, Ti^{+4})_1$ $(Mn^{+2}, Mn^{+3}, Cr^{+3}, Al^{+3}, Fe^{+3}, Va)_2 (O^{-2})_4$
135.	Thiospinel	THIO	SUBL	$(Fe, Mn) (Cr)_2 (S)_4$
136.	Ti3Al	TI3A	SUBL	$(Al, Ti) (Al, Ti) (O, \underline{Va})_2$
137.	TiAl	TIAL	SUBL	$(Al, Ti) (Al, Ti) (O, \underline{Va})_2$
138.	TIOX	TIOX	SUBL	$(Ti^{+2}, Ti^{+3}, Va)(Ti, Va)(O^{-2})$
139.	Titania Spinel	TISP	SUBL	$(Fe^{+2}, Fe^{+3}, Mg^{+2}, Mn^{+2}, Ti^{++4}, Al^{+3})_1(Al^{+3}, Fe^{+2}, Fe^{+3}, Mg^{+2}, Mn^{+2}, Mn^{+3}, Ti^{+3}, Va, V^{+3},)_2(Va)_2 (O^{-2})_4$
140.	V3O5	V3O5	SUBL	$(\underline{V}, Ti)_3(O)_5$
141.	V5O9	V5O9	SUBL	$(\underline{V}, Ti)_5(O)_9$
142.	V-Garnet	VGAR	SUBL	$(Ca, Mg)_{0.5} Ca_{1.5} Mg V_2O_8$
143.	Willemite	WILL	SUBL	$(\underline{Zn}^{+2},Mg^{+2},Fe^{+2})(Si^{+4})_2(O^{-2})_4$
144.	Wollastonite	WOLL	SUBL	$(\underline{Ca^{+2}}, Fe^{+2}, Mg^{+2}, Mn^{+2})_1 (Si^{+4})_1 (O^{-2})_3$
145.	$Zn_3P_2O_8$-HT	Z3PH	SUBL	$(\underline{Zn^{+2}},\underline{Ca^{+2}})_3(P^{+5})_2(O^{-2})_8$
146.	$Zn_3P_2O_8$-LT	Z3PL	SUBL	$(\underline{Zn^{+2}},\underline{Ca^{+2}})_3(P^{+5})_2(O^{-2})_8$
147.	Zincite	ZNO	SUBL	$(Ca^{+2},Cr^{+3},Fe^{+2},Fe^{+3},Mn^{+2},Mn^{+3},Mg^{+2},Va, Zn^{+2})$ (O^{-2})
148.	ZnS-HT	ZNSH	SUBL	$(\underline{Zn}, Fe, Mn)(S)$
149.	ZnS-LT	ZNSL	SUBL	$(\underline{Zn}, Fe, Mn)(S)$

150.	ZnV_2O6	ZNV	SUBL	$(\underline{Zn^{+2}}, Ni^{+2})(V^{+5})_2(O^{-2})_6$
151.	ZnP_2O_6	ZP	SUBL	$(Mg^{+2},\underline{Zn^{+2}})(P^{+5})_2(O^{-2})_6$

Description of oxide melt

1:	**Na_2O**	**2:**	**Al_2O_3**	**3:**	**K_2O**
4:	$KAlO_2$	**5:**	$(K_2Al_4O_7)$:3	**6:**	(K_4Si_2O6):3
7:	$(K_2Si_2O_5)$:2	**8:**	(K_2Si_4O9):3	**9:**	Si_2O_4
10:	$(Si_2Na_8O_8)$:5	**11:**	$(Si_2Na_4O_6)$:3	**12:**	$(Si_2Na_2O_5)$:2
13:	$(Si_2Al_6O_{13})$:4	**14:**	$(Si_2Al_2Na_2O_8)$:3	**15:**	$(Si_6Al_2Na_2O_{16})$:5
16:	$(Al_4Na_2O_7)$:3	**17:**	$NaAlO_2$	**18:**	(KSi_2AlO_6):2
19:	$(K_2Si_2Al_2O_8)$:3	**20:**	Ca_2O_2	**21:**	Mg_2O_2
22:	$CaSiO_3$	**23:**	(Ca_2SiO_4):1.5	**24:**	$SiMgO_3$
25:	$(Si_2Mg_4O_8)$:3	**26:**	$(CaAl_2O_4)$:1.5	**27:**	$(Ca_2Si_4Al_4O_{16})$:5
28:	$(Al_4Mg_2O_8)$:3	**29:**	$(Si_5Al_4Mg_2O_{18})$:5.5	**30:**	$(Ca_3Al_{10}Na_4O_{20})$:8.5
31:	$(Fe_2Si_5Al_4O_{18})$:5.5	**32:**	(Fe_3O_4):1.5	**33:**	Fe_2O_3
34:	Fe_2O_2	**35:**	(Al_2FeO_4):1.5	**36:**	Cr_2O_3
37:	(Cr_2FeO_4):1.5	**38:**	Cr_2O_2	**39:**	$(CaFe_2O_4)$:1.5
40:	$(CrAl_2O_4)$:1.5	**41:**	(Fe_2MgO_4):1.5	**42:**	(Fe_2SiO_4):1.5
43:	$FeNaO_2$	**44:**	$(FeNa_2O_2)$:1.5	**45:**	$FeKO_2$
46:	$(FeSiNa_2O_4)$:2.0	**47:**	$(Na_2Ca_3Si_6O_{16})$:5	**48:**	$FeSiO_3$
49:	$(Fe_2Ca_2Si_4O_{12})$:4	**50:**	$(Fe_2Si_4Mg_2O_{12})$:4	**51:**	CrS
52:	$CrCaO_4$	**53:**	(K_2CrO_4):1.5	**54:**	$(K_2Cr_2O_7)$:2
55:	(Na_2CrO_4):1.5	**56:**	$(K_2Si_5MgO_{12})$:4	**57:**	(K_2SiMgO_4):2
58:	(CaK_2SiO_4):2	**59:**	$(Ca_3Cr_2Si_3O_{12})$:4	**60:**	Ca_2F_4
61:	$CaSiF_2O_2$	**62:**	(Cr_3O_4):1.5	**63:**	P_2O_5
64:	FePO4	**65:**	$(Fe_2P_2O_7)$:2	**66:**	(FeP_2O_6):1.5
67:	$(Fe_3P_2O_8)$:2.5	**68:**	$(Ca_2P_2O_7)$:2	**69:**	(CaP_2O_6):1.5
70:	$(Ca_3P_2O_8)$:2.5	**71:**	$(Mg_2P_2O_7)$:2	**72:**	(MgP_2O_6):1.5
73:	$(Mg_3P_2O_8)$:2.5	**74:**	AlPO4	**75:**	CrPO4
76:	(P_2SiO_7):1.5	**77:**	NaPO3	**78:**	(Na_3PO_4):2
79:	$(Na_4P_2O_7)$:3	**80:**	$(P_2Al_2Mg_3O_{11})$:3.5	**81:**	(Mn_3O_4):1.5
82:	CaS	**83:**	FeS	**84:**	MgS
85:	Al_2S_3	**86:**	SiS_2	**87:**	$CrNaO_2$
88:	(Cr_2MgO_4):1.5	**89:**	MgF_2	**90:**	(Mn_2MgO_4):1.5
91:	MnS	**92:**	Mn_2O_2	**93:**	SO_3
94:	**Mn_2O_3**	95:	**$MnSiO_3$**	96:	**(Mn_2SiO_4)1.5**
97:	(Al_2MnO_4):1.5	**98:**	(Cr_2MnO_4):1.5	**99:**	(Fe_2MnO_4):1.5

100:	**$(Mn_2Al_4Si_5O_{18})$:5.5**	101:	**$(Mn_3Al_2Si_3O_{12})$:4**	102:	**$(MgMnSi_2O_6)$:2**
103:	$(CaMn_2O_4)$:1.5	**104:**	$(Mn_2P_2O_7)$:2	**105:**	$(Mn_3P_2O_8)$:2.5
106:	(MnP_2O_6):1.5	**107:**	$MnPO_4$	**108:**	K_2S
109:	$(KAlS_2)$:2	**110:**	Na_2S	**111:**	$(Ca_9V_6O_{18})$:7.5
112:	$(MnCaSi_2O_6)$:2	**113:**	$(FeMn_2O_4)$:1.5	**114:**	$(NaAlS_2)$:2
115:	(Fe_2CrO_4):1.5	**116:**	(K_2SO_4):1.5	**117:**	(Na_2SO_4):1.5
118:	$CaSO_4$	**119:**	$MgSO_4$	**120:**	$(K_2S_2O_7)$:2
121:	$(Na_2S_2O_7)$:2	**122:**	$CrKO_2$	**123:**	KPO_3
124:	(K_3PO_4):2	**124:**	$(K_4P_2O_7)$:3	**126:**	$MnNaO_2$
127:	$MnKO_2$	**128:**	(Mn_2CrO_4):1.5	**129:**	Fe
130:	Cr	**131:**	Mn	**132:**	$(CaKP_3O_9)$:2.5
133:	$(CaP_2Na_4O_8)$:3.5	**134:**	$(CaPNaO_4)$:1.5	**135:**	(ZnO):0.5
136:	(Zn_2SiO_4):1.5	**137:**	(Al_2ZnO_4):1.5	**138:**	$(Zn_3P_2O_8)$:2.5
139:	$(Zn_2P_2O_7)$:2	**140:**	(ZnP_2O_6):1.5	**141:**	(Fe_2ZnO_4):1.5
142:	Zn	**143:**	(Cr_2ZnO4):1.5	**144:**	$(ZnMn_2O_4)$:1.5
145:	$(KMgPO_4)$:1.5	**146:**	$(KMgP_3O_9)$:2.5	**147:**	$(Na_8Mg_6P_{10}O_{35})$:12
148:	$NiTiO_3$	**149:**	$(Na_4MgP_2O_8)$:3.5	**150:**	S
151:	Al	**152:**	$(KZnPO_4)$:1.5	**153:**	Ti
154:	(Al_2TiO_5):1.5	**155:**	Ti_2O_2	**156:**	Ti_2O_3
157:	Ti_2O_4	**158:**	$MgTiO_3$	**159:**	(Mg_2TiO_4):1.5
160:	$(MgTi_2O_5)$:1.5	**161:**	$(MgTi_2O_4)$:1.5	**162:**	$FeTiO_3$
163:	(Fe_2TiO_5):1.5	**164:**	$(Na_2ZnP_2O_7)$:2.5	**165:**	$(Na_2Zn_5P_4O_{16})$:5.5
166:	Mg	**167:**	Ca	**168:**	(Mn_2TiO_4):1.5
169:	$MnTiO_3$	**170:**	$(MnTi_2O_4)$:1.5	**171:**	(Fe_2TiO_4):1.5
172:	(Zn_2TiO_4):1.5	**173:**	$CaTiO_3$	**174:**	$(Cr_2Ti_2O_7)$:2
175:	V	**176:**	V_2O_2	**177:**	V_2O_3
178:	V_2O_5	**179:**	V_2O_4	**180:**	(MgV_2O_4):1.5
181:	(FeV_2O_4):1.5	**182:**	(MnV_2O_4):1.5	**183:**	(K_4TiO_4):2.5
184:	(Na_4TiO_4):2.5	**185:**	$NiSO_4$	**186:**	NiS
187:	Ni	**188:**	NiO	**189:**	$Al_2(SO_4)_3$:2.5
190:	(TiP_2O_7):1.5	**191:**	$(NiAl_2O_4)$:1.5	**192:**	$(NiFe_2O_4)$:1.5
193:	$(Fe_2S_3O_{12})$:2.5	**194.**	KVO3	**195:**	(K_3VO_4):2
196:	$(K_4V_2O_7)$:2	**197:**	NaVO3	**196:**	(Na_3VO_4):2
199:	$(Na_4V_2O_7)$:2	**200:**	Sr	**201:**	Sr_2O_2
202:	$(Sr_2Fe_2O_5)$:2	**203:**	$(SrAl_2O_4)$:1.5	**204:**	(Sr_3SiO_5):2
205:	(SrP_2O_6):1.5	**206:**	$(Sr_3P_2O_8)$:2.5	**207:**	$(Sr_2P_2O_7)$:2
208:	(Sr_2SiO_4):1.5	**209:**	$SrSiO_3$	**210:**	$NiTiO_3$

211:	$SrCrO_4$	**212:**	(Sr_4Cr_3O12):3.5	**213:**	$SrTiO_3$
214:	$(NiCr_2O_4)$:1.5	**215:**	(Ni_3S_2):2	**216:**	Li_2O
217:	Li	**218:**	$AlLiO_2$	**219:**	$LiMnO_2$
220:	$(NiMn_2O_4)$:1.5	**221:**	(Li_2SiO_3):1.5	**222:**	(Li_4SiO_4):2.5
223:	$(Li_2Si_2O_5)$:2	**224:**	$LiFeO_2$	**225:**	$LiCrO_2$
226:	$(LAlSiO_4)$:1.5	**227:**	$(LAlSi_2O_6)$:2	**228:**	$LiPO_3$
229:	$(Li_4P_2O_7)$:3	**230:**	(Li_3PO_4):2	**231:**	$(Li_2CaSiO4)$:2
232:	$(Li_2MgSiO4)$:2	**233:**	$(Li_2ZnSiO4)$:2	**234:**	(NiP_2O_6):1.5
235:	$(Ni_2P_2O_7)$:2	**236:**	$(Ni_3P_2O_8)$:2.5		

Description of Liquid-Sulphate

Liquid phase containing sulfates, sulfides, and pyrosulfates

1:	**Na_2O**	**2:**	**Al_2O_3**	**3:**	**K_2O**
4:	Ca_2O_2	**5:**	Mg_2O_2	**6:**	CaS
7:	S	**8:**	MgS	**9:**	(Al_2S_3):3
10:	$CaSO_4$	**11:**	(SO_3):0.5	**12:**	Na_2S
13:	K_2S	**14:**	(K_2SO_4):1.5	**15:**	(Na_2SO_4):1.5
16:	$MgSO_4$	**17:**	$(K_2S_2O_7)$:2	**18:**	$(Na_2S_2O_7)$:2
19:	Ni_2O_2	**20:**	$NiSO_4$	**21:**	NiS
22:	$(Al_2(SO_4)_3)$:2.5	**23:**	(Ni_3S_2):25	**24:**	$KAlO_2$
25:	$NaAlO_2$	**26:**	$(Na_2Al_4O_7)$:3		

Description of Liquid metal

1:	**Fe**	2:	**Mn**	3:	**Cr**
4:	P	**5:**	CaS	**6:**	S
7:	FeS	**8:**	MgS	**9:**	Ca
10:	Mg	**11:**	MnS	**12:**	(SiS_2):2
13:	Na_2S	**14:**	K_2S	**15:**	CrS
16:	K	**17:**	Na	**18:**	Al
19:	Ni_2O_2	**20:**	CaO	**21:**	Al_2O_3
22:	Ti	**23:**	C	**24:**	O
25:	PO	**26:**	CrO	**27:**	Cr_2O
28:	MnO	**29:**	MgO	**30:**	V
31:	Sr	**32:**	Ni	**33:**	NiS
34:	(Ni_3S_2):2	**35:**	ZnS	**36:**	Zn
37:	Si	**38:**	Li	**39:**	Li_2O

Stoichiometric phases

ALL compounds

Al_2O_3-CaO-CaF_2-CrO_x-FeO_x-K_2O-Li_2O-MgO-MnO_x-Na_2O-NiO-P_2O_5-SO_3-SiO_2-SrO-TiO_2-Ti_2O_3-VO_x-ZnO-CaS, CrS, FeS, MgS, MnS, NiS, ZnS

1	Li	251	Ca3Si2MgO8_merw	501	CaMnO3
2	Li2O	252	Al2CaSi2O8_Anort	502	Ca2MnO4
3	Li2O2	253	Al2Ca2SiO7_Gehlen	503	CaMn2O4
4	Na	254	Al26Ca20Mg3Si3O68	504	Ca3Mn2O7
5	Na2O_s1(gamma)	255	CaP2O6	505	CaMn3O6
6	Na2O_s2(beta)	256	CaP4O11	506	Ca2Mn3O8
7	Na2O_s3(alpha)	257	Ca2P2O7	507	Ca4Mn3O10
8	Mg_hcp-A3	258	Ca2P2O7(s2)	508	CaMn4O8
9	MgO	259	Ca2P2O7(s3)	509	CaMn7O12
10	F2Mg	260	Ca2P6O17	510	MnTiO3
11	Al	261	Ca3P2O8_beta	511	MnTi2O4_Cubic
12	Al2O3_alpha	262	Ca3P2O8_alpha(s2)	512	MnTi2O4(s2)
13	LiAlO2	263	Ca3P2O8_a(s3)	513	MnTi2O5_Mn-pseudobr
14	LiAlO2(s2)	264	Ca4P2O9	514	Mn2TiO4_Spinel-Tetrag
15	Li5AlO4	265	CaPNaO4	515	Mn2TiO4_Spin-Cub(s2)
16	LiAl5O8	266	CaP2Na2O7_CNP	516	MnV2O4
17	LiAl5O8_Spinel(s2)	267	CaP2Na4O8	517	MnV2O6
18	LiAl11O17	268	CaP2Na6O9	518	Mn2V2O7
19	NaAlO2_LT	269	CaP2Na6O9(s2)	519	Cr3Mn5_CR3MN5
20	NaAlO2_HT(s2)	270	CaP2Na6O9(s3)	520	MnCr2O4()
21	NaAl9O14_beta	271	CaP6Na4O18	521	MnCr2S4
22	Na2Al12O19	272	CaP2MgO7_CMP	522	Fe_bcc_a2
23	Si	273	Ca3P4Mg3O16	523	Fe_fcc_a1(s2)
24	SiO2_quartz_al(s1)	274	Ca5P2SiO12_Silicoc	524	FeO_Wustite
25	SiO2_quartz_b(s2)	275	Ca7P2Si2O16	525	Fe2O3_CORUNDUM
26	SiO2_trid-gam(s3)	276	CaS_Oldhamite	526	Fe3O4_MAGNETITE
27	SiO2_cristo_be(s4)	277	CaSO4	527	LiFeO2
28	SiO2_trid_alp(s5)	278	CaSO4(s2)	528	LiFe5O8
29	SiO2_trid_beta(s6)	279	Na2Ca(SO4)2	529	FeNaO2
30	SiO2_cristo_al(s7)	280	Na6Ca(SO4)4	530	FeNaO2_LT(s2)
31	Li2SiO3	281	CaMg3(SO4)4	531	FeNaO2_HT(s3)

32	Li4SiO4	282	Ca3K4Al10O20	532	FeNaO2_delta(s4)
33	Li4SiO4(s2)	283	CaK2SiO4_	533	FeNa2O2
34	Li2Si2O5	284	CaK4Si3O9	534	FeNa3O3
35	Li2Si2O5(s2)	285	CaK4Si6O15_	535	FeNa4O3
36	Na2SiO3_	286	CaK8Si10O25	536	Fe2Na8O7
37	Na4SiO4_LT	287	Ca2K2Si9O21	537	Fe16Na10O29
38	Na4SiO4_HT(s2)	288	Ca3K2Si6O16	538	Fe2MgO4
39	Na10SiO7_	289	Ca3K2Si6O16(s2)	539	Al2FeO4
40	Na2Si2O5_LT	290	CaKPO4_C2KP	540	Fe2Al2O6
41	Na2Si2O5_MT(s2)	291	CaKP3O9_KC2P	541	FeSi
42	Na2Si2O5_HT(s3)	292	CaK2P2O7_CKP	542	FeSiO3
43	Na6Si2O7_	293	CaK4P2O8	543	Fe2SiO4_FAYALITE
44	Na6Si8O19_	294	CaK4P2O8(s2)	544	FeSiNa2O4
45	MgSiO3_clino	295	CaK4P2O8(s3)	545	Fe2Si2Na2O8
46	MgSiO3_low-cli(s2)	296	CaK6P2O9	546	Fe2Si4Na2O12_Acmite
47	MgSiO3_ortho(s3)	297	CaK6P2O9(s2)	547	Fe2Si6Na2O16
48	MgSiO3_proto(s4)	298	CaK6P2O9_(s3)	548	Fe2Si8Na10O24
49	MgSiO3_woll(s5)	299	K2Ca2(SO4)3	549	Fe8Si5Na12O28
50	Mg2SiO4_forste	300	K2Ca2(SO4)3(s2)	550	Fe2Si5Al4O18
51	Li2MgSiO4_	301	K2Ca2(SO4)3(s3)	551	FeP
52	Na2MgSiO4	302	Ti_hcp-3	552	Fe2P
53	Na2MgSi3O8	303	Ti_bcc-a2(s2)	553	Fe3P
54	Na4Mg2Si3O10	304	TiO_<ALPHA>	554	Fe3P(s2)
55	Na2MgSi4O10	305	TiO2_Rutile	555	FePO4
56	Na2Mg2Si6O15	306	Ti2O3	556	FePO4(s2)
57	Na2Mg5Si12O30	307	Ti2O3(s2)	557	FePO4(s3)
58	LiAlSiO4_Eucryp	308	Ti3O2	558	FeP2O6
59	LiAlSiO4_Eucr(s2)	309	Ti3O5	559	Fe2P2O7
60	LiAlSi2O6_Spod	310	Ti3O5(s2)	560	Fe2P6O18
61	LiAlSi2O6_Spod(s2)	311	Ti4O7	561	Fe3P2O8
62	LiAlSi4O10_Petal	312	Ti5O9	562	Fe4P2O10
63	Na2Al2Si2O8	313	Ti6O11	563	Fe4P6O21
64	NaAlSi3O8_l-alb	314	Ti7O13	564	Fe6P2O14
65	NaAlSi3O8_h-al(s2)	315	Ti8O15	565	Fe7P6O24_W3F2P3
66	Al18Mg7Si3O40	316	Ti9O17	566	Fe10P6O26_W8FP3

67	Al4Mg2Si5O18	317	Ti10O19	567	Fe18P2O24
68	P	318	Ti20O39	568	FeS_TROILITE
69	P_RED(s2)	319	Na2TiO3	569	FeS_TROILITE(s2)
70	P2O5_HEXA	320	Na2TiO3(s2)	570	FeS_Pyrrhotite(s3)
71	P2O5_ORTHOR(s2)	321	Na4TiO4_	571	FeS2_PYRITE
72	P2O5_O'-Phase(s3)	322	Na2Ti2O5	572	Fe7S8
73	LiPO3_	323	(Na2O)(TiO2)3	573	Fe9S10
74	Li3PO4_	324	Na8Ti5O14_	574	Fe10S11
75	Li4P2O7_	325	(Na2O)(TiO2)6	575	Fe11S12
76	Li4P2O7(s2)	326	MgTiO3	576	FeKO2_LT
77	Li5P3O10_	327	Mg2TiO4	577	FeKO2_HT(s2)
78	NaPO3_LT	328	MgTi2O4_Spinel	578	Fe12K2O19
79	NaPO3_HT(s2)	329	MgTi2O5	579	Fe22K2O34
80	Na3PO4_LT	330	TiAl2	580	Fe2K2Si2O8_Kaliophili
81	Na3PO4_MT(s2)	331	Ti8Al17	581	Fe2K2Si2O8_Kaliop(s2)
82	Na3PO4_HT(s3)	332	TiAlO3	582	Fe2K2Si4O12_Iron-Leuc
83	Na2P2O6_LT	333	Al2TiO5	583	Fe2K2Si6O16_Iron-Orth
84	Na2P2O6_HT(s2)	334	TiP2O7	584	Fe4K4Si3O14_K2F2S3
85	Na4P2O7	335	TiP2O7(s2)	585	CaFe2O4_beta
86	Na4P2O7(s2)	336	Ti2P2O9	586	Ca2Fe2O5
87	Na4P2O7(s3)	337	Ti5P4O20	587	Fe3CaO5_CaFe3O5
88	Na4P2O7_S4(s4)	338	K2TiO3_	588	Fe4CaO7
89	Na4P2O7_S5(s5)	339	K4TiO4_	589	Fe5CaO7_CaFe5O7
90	Na4P2O7_S6(s6)	340	K2Ti2O5_	590	Fe9Ca4O17
91	Na4P2O7_S7(s7)	341	K2Ti3O7_	591	Fe17Ca4O29
92	Na5P3O10	342	K4Ti3O8	592	Ca3Fe2Si3O12_Andradit
93	Na5P3O10(s2)	343	K2Ti4O9	593	FeTiO3
94	MgP2O6	344	K2Ti6O13_	594	FeTi2O5_Pseudobrookit
95	Mg2P2O7	345	(K2TiO3)(Na2TiO3)	595	Fe2TiO4_Spinel
96	Mg3P2O8	346	(K2TiO3)2(Na2TiO3)	596	Fe2TiO5_Ferric_Pseudo
97	NaMgPO4_R	347	CaTiO3_CT	597	FeVO4
98	Na4MgP2O8_T2	348	Ca3Ti2O7	598	FeV2O4
99	Na4MgP2O8(s2)	349	Ca5Ti4O13	599	Fe2V4O13
100	Na4MgP2O8(s3)	350	CaSiTiO5_SPHENE	600	NaFeV2O7
101	Na6MgP2O9	351	V	601	NaFe3V4O15

102	Na6MgP2O9(s2)	352	VO	602	Ca6Fe7V3O24
103	Na6MgP2O9(s3)	353	VO2	603	FeCr2S4_Daubreelite
104	NaMgP3O9	354	VO2(s2)	604	Fe2MnO4
105	NaMg4P3O12	355	V2O3	605	Ni_fcc-A1
106	Na2MgP4O12	356	V2O5	606	NiO
107	Na4MgP6O18	357	V3O5	607	NiO(s2)
108	Na8Mg6P10O35	358	V3O5(s2)	608	NiO2
109	AlPO4_LT	359	V3O7	609	LiNiO2
110	AlPO4_MT(s2)	360	V4O7	610	Al2NiO4
111	AlPO4_HT(s3)	361	V5O9	611	Ni2SiO4
112	Al6P2O14	362	V6O11	612	NiP2O6
113	Al2P6O18	363	V6O13	613	Ni2P2O7
114	Na3Al(PO4)2	364	V7O13	614	Ni2P2O7(s2)
115	Na3Al2(PO4)3	365	V8O15	615	Ni3P2O8
116	P2SiO7_lt	366	V52O64_Delta_prim	616	NaNiPO4
117	P2SiO7_mt(s2)	367	NaVO3_	617	NaNiPO4(s2)
118	P2SiO7_ht(s3)	368	NaVO3_(s2)	618	Na4Ni(PO4)2
119	P4Si3O16	369	Na3VO4_	619	NaNi(PO3)3
120	Na5PSi2O9	370	Na4V2O7	620	Na3Ni9(PO4)7
121	Na18P4Si6O31	371	Na5V3O10	621	Na6Ni9(PO4)8
122	Na15P5Si3O26	372	NaV6O15	622	NiS_Millerite
123	P3Si2AlO13	373	Na2V6O15	623	NiS2_Vaesite
124	S1	374	MgV2O4_Spinel	624	Ni3S2_heazlewoodite
125	S2(s2)	375	MgV2O6	625	Ni3S4_thiospinel
126	SO3_	376	Mg2V2O7	626	Ni7S6_
127	Na2S	377	Mg3V2O8	627	Ni9S8_
128	Na2SO4	378	NaMg4V3O12	628	NiSO4
129	Na2SO4(s2)	379	Na6Mg3V4O16_332	629	NiSO4(s2)
130	Na2SO4(s3)	380	AlVO4	630	Na2Ni(SO4)2
131	Na2S2O7	381	NaAlV2O7	631	Na6Ni(SO4)4
132	MgS_Niningerite	382	Si2V_VSi2	632	Na2Ni3S4O16
133	MgSO4	383	Si3V5_V5Si3	633	KNi(PO3)3
134	MgSO4(s2)	384	Si5V6_V6Si5	634	K2Ni(PO3)4
135	Na2Mg(SO4)2	385	KVO3	635	K2Ni(PO3)4(s2)
136	Na2Mg(SO4)2(s2)	386	K3VO4	636	NiCaSi2O6_Ni-clino

137	Na2Mg(SO4)2(s3)	387	K4V2O7	637	NiTiO3
138	Na6Mg(SO4)4	388	K4V2O7(s2)	638	Ni2TiO4
139	Na2Mg3(SO4)4	389	KV3O8	639	NiV2O6
140	AlS_	390	K5V3O10	640	Ni2V2O7
141	Al2S3	391	K3V5O14	641	Ni3V2O8
142	Al2S3(s2)	392	KV6O15	642	Ca5Ni4V6O24
143	Al2(SO4)3	393	K2V8O21	643	Cr2NiO4
144	NaAlS2	394	KNa(VO3)2	644	NiMn2O4
145	Na2Al20S31	395	K2Na(VO3)3	645	Ni6MnO8
146	Na3Al(SO4)3	396	KNa3(VO3)4	646	Fe2NiO4
147	SiS2	397	K2MgV2O7	647	Fe2NiO4(s2)
148	K	398	K2Mg(VO3)4	648	Zn
149	K2O_s1()	399	K2Mg(VO3)4(s2)	649	ZnO
150	K2O_s2()(s2)	400	KAlV2O7	650	Al2ZnO4
151	K2O_s3()(s3)	401	K3Al(VO4)2	651	Zn2SiO4_2ZnO_SiO2
152	KAlO2_LT	402	CaV2O6	652	Li2ZnSiO4
153	KAlO2_HT(s2)	403	Ca2V2O7	653	Na2ZnSiO4
154	KAl9O14_k-beta-al	404	Ca3V2O8	654	Na2ZnSi2O6
155	K2Al12O19_k-be2	405	Ca7V4O17	655	Na2Zn2Si2O7
156	K2SiO3_	406	Ca9V6O18	656	Na4Zn2Si3O10
157	K2Si2O5_LT	407	Ca10V6O19	657	ZnP2O6
158	K2Si2O5_MT(s2)	408	NaCaVO4_121	658	ZnP4O11
159	K2Si2O5_HT(s3)	409	Na3Ca2V3O11	659	Zn2P2O7
160	K2Si4O9_LT	410	NaCa4V3O12	660	Zn2P2O7(s2)
161	K2Si4O9_HT(s2)	411	Na2CaV4O12	661	Zn3P2O8
162	K2MgSiO4_	412	Na2Ca7V8O28	662	Zn3P2O8(s2)
163	K2MgSi3O8_	413	CaMgV2O7	663	NaZnPO4
164	K2MgSi3O8(s2)	414	Ca3V2Si3O12_Gold	664	NaZnPO4(s2)
165	K2MgSi5O12_	415	KCaVO4	665	Na2ZnP2O7
166	K2Mg5Si12O30	416	K2CaV2O7	666	NaZnP3O9
167	K4Mg2Si5O14	417	K4Ca(VO4)2	667	Na2Zn5P4O16
168	K10Mg5Si11O32	418	K2Ca(VO3)4	668	ZnS_Sphalerite
169	KSiAlO4_kalioph	419	K3Ca(VO3)5	669	ZnS_Wurtzite(s2)
170	KSiAlO4_kaliop(s2)	420	K3Ca(VO3)5(s2)	670	KZnPO4_LT
171	KSi2AlO6_leu-LT	421	Ti2VO5_TI2VO5	671	KZnPO4_MT(s2)

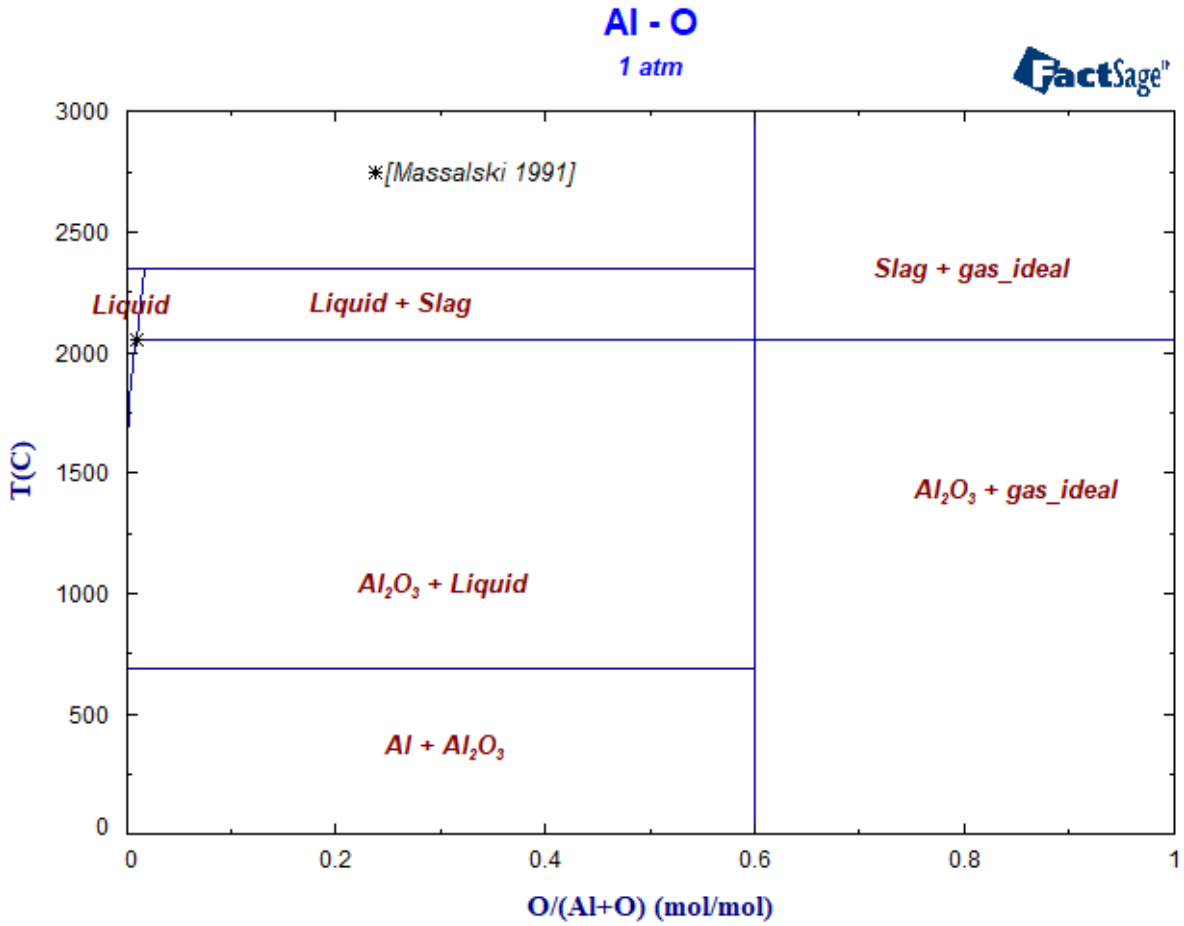
172	KSi2AlO6_le-HT(s2)	422	Cr_BCC-A2	672	KZnPO4_HT(s3)
173	KSi3AlO8	423	CrO2	673	KZn(PO3)3
174	KSi3AlO8_k-fel(s2)	424	CrO3	674	K2ZnP2O7
175	KSi3AlO8_sanid(s3)	425	Cr2O3_Rho	675	K2Zn(PO3)4
176	K4Si3Al4O14	426	LiCrO2	676	K2Zn3(P2O7)2
177	KPO3	427	Li2CrO4	677	KZn4(PO4)3
178	KPO3(s2)	428	Li2CrO4(s2)	678	ZnCa3Al4O10
179	KPO3(s3)	429	Li3CrO4	679	Zn3Ca6Al4O15
180	KPO3_S4(s4)	430	CrNa2O4-LT	680	Ca2ZnSi2O7_Hardystoni
181	K3PO4	431	CrNa2O4-HT(s2)	681	CaZn2P2O8
182	K3PO4(s2)	432	Cr2Na2O4	682	CaZn2P2O8(s2)
183	K3PO4(s3)	433	Cr2Na2O7_	683	CaZn2P2O8(s3)
184	K3PO4_S4(s4)	434	Cr2SiO4	684	ZnTiO3
185	K4P2O7_LT	435	CrPO4	685	Zn2TiO4
186	K4P2O7_MT(s2)	436	Cr6P2O14	686	ZnV2O6
187	K4P2O7__HT(s3)	437	Cr10P2O20	687	Zn2V2O7
188	Na2KP3O9	438	CrS	688	Zn3V2O8
189	K4P2Na2O8	439	CrS(s2)	689	Zn4V2O9
190	KPMgO4	440	'Cr2S2'_Cr1.03S	690	Na2ZnV2O7
191	KMgP3O9_B1	441	Cr2S3	691	K2ZnV2O7
192	KMg4P3O12_J	442	Cr2S3(s2)	692	K2Zn(VO3)4
193	K2MgP2O7_T1	443	Cr3S4	693	Cr2ZnO4
194	K2P4MgO12_B2	444	Cr5S6	694	ZnMn2O4
195	K4P2MgO8	445	Cr7S8	695	Fe2ZnO4_Spinel
196	K4P2MgO8(s2)	446	CrKO2	696	Sr_fcc-a1
197	K4P2MgO8(s3)	447	CrK2O4-LT	697	Sr_bcc-a2(s2)
198	K4P6Mg4O21	448	CrK2O4-HT(s2)	698	SrO_
199	K6MgP2O9	449	CrK3O4	699	SrO2
200	K6MgP2O9(s2)	450	CrK4O4	700	SrAl2O4_(LT)
201	K6MgP2O9(s3)	451	Cr2K2O7_	701	SrAl2O4_(HT)(s2)
202	K2S	452	CrKNaO4	702	SrAl4O7_
203	K2SO4	453	CrCaO4	703	SrAl12O19
204	K2SO4(s2)	454	CaCr2O4_beta	704	Sr3Al2O6_
205	K2S2O7	455	CaCr2O4_alfa(s2)	705	Sr4Al2O7_(LT)
206	K2S2O7(s2)	456	Cr3Ca5O12	706	Sr4Al2O7_(HT)(s2)

207	KNaS	457	Cr4Ca6O16	707	Sr4Al14O25_
208	KNaS2O7	458	Cr13Ca2O20	708	Sr5Al2O8_
209	K2Mg2(SO4)3	459	CrCa4Al6O16	709	SrSiO3_Ps-Wolla
210	KAlS2	460	Cr2Ca6Al4O15	710	Sr2SiO4_beta
211	K2Al8S13	461	CrCaSi4O10_Gillespi	711	Sr2SiO4_alpha'(s2)
212	K2Al20S31	462	Cr2Ca3Si3O12_Uvar	712	Sr2SiO4_alpha(s3)
213	Ca_FCC_A1	463	Cr2TiO5	713	Sr3SiO5_
214	Ca_BCC_A2(s2)	464	Cr2Ti2O7	714	SrP2O6_SP-beta
215	CaO_	465	Cr2Ti4O11	715	SrP2O6_SP-alpha(s2)
216	CaF2	466	Cr2Ti5O13	716	Sr2P2O7_S2P-beta
217	CaMg2	467	Cr2Ti6O15	717	Sr2P2O7_S2P-alpha(s2)
218	CaAl2O4	468	Cr2Ti7O17	718	Sr3P2O8_S3P-alpha
219	CaAl4O7	469	Cr2Ti10O23	719	Sr3P2O8_S3P-beta(s2)
220	CaAl12O19	470	CrVO4	720	Sr3P4O13_Sr3P2O13
221	Ca3Al2O6	471	Cr2V4O13	721	Sr4P2O9_S4P
222	Ca12Al14O33	472	NaCrV2O7	722	SrTiO3
223	Ca4Al6F2O12	473	Mn_cbcc-a12	723	Sr2TiO4
224	Ca12Al14F2O32	474	Mn_cub-a13(s2)	724	SrV2O6
225	Ca3Al16Na2O28	475	Mn_fcc-a1(s3)	725	Sr2V2O7
226	Ca8Al6Na2O18	476	Mn_bcc-a2(s4)	726	Sr3V2O8
227	Sr6Fe2SiO11	477	MnO	727	Sr4V2O9
228	Ca2Al28Mg2O46	478	MnO2	728	SrCrO4
229	Al4Ca3MgO10	479	Mn2O3	729	Sr4Cr3O12
230	CaSiO3_wollaston	480	Mn3O4_Tetr-Spin	730	SrMn3O6
231	CaSiO3_psewo(s2)	481	Mn3O4_CubSpin(s2)	731	Sr2MnO4
232	Ca2SiO4_oliv_gam	482	LiMnO2	732	Sr3Mn2O7
233	Ca2SiO4_al-pr(s2)	483	Li2MnO3	733	Sr4Mn3O10
234	Ca2SiO4_alpha(s3)	484	LiMn2O4	734	Sr7Mn4O15
235	Ca3SiO5_hatrurite	485	Li4Mn5O12	735	SrFe12O19
236	Ca3Si2O7_rankinit	486	Al2MnO4_Galaxite	736	Sr2Fe2O5_Perowskite
237	Li2CaSiO4	487	MnSiO3_RHODONIT	737	Sr2Fe2O6_Perowskite
238	Li2Ca2Si2O7	488	Mn2SiO4_TEPHROIT	738	Sr3Fe2O6
239	Li2Ca3Si6O16	489	Mn7SiO12_Braunite	739	Sr4Fe2O7
240	Li2Ca4Si4O13	490	Mn2Al4Si5O18	740	Sr4Fe6O13
241	Ca4Si2F2O7_Cuspi	491	Mn3Al2Si3O12	741	Sr8Fe6O17

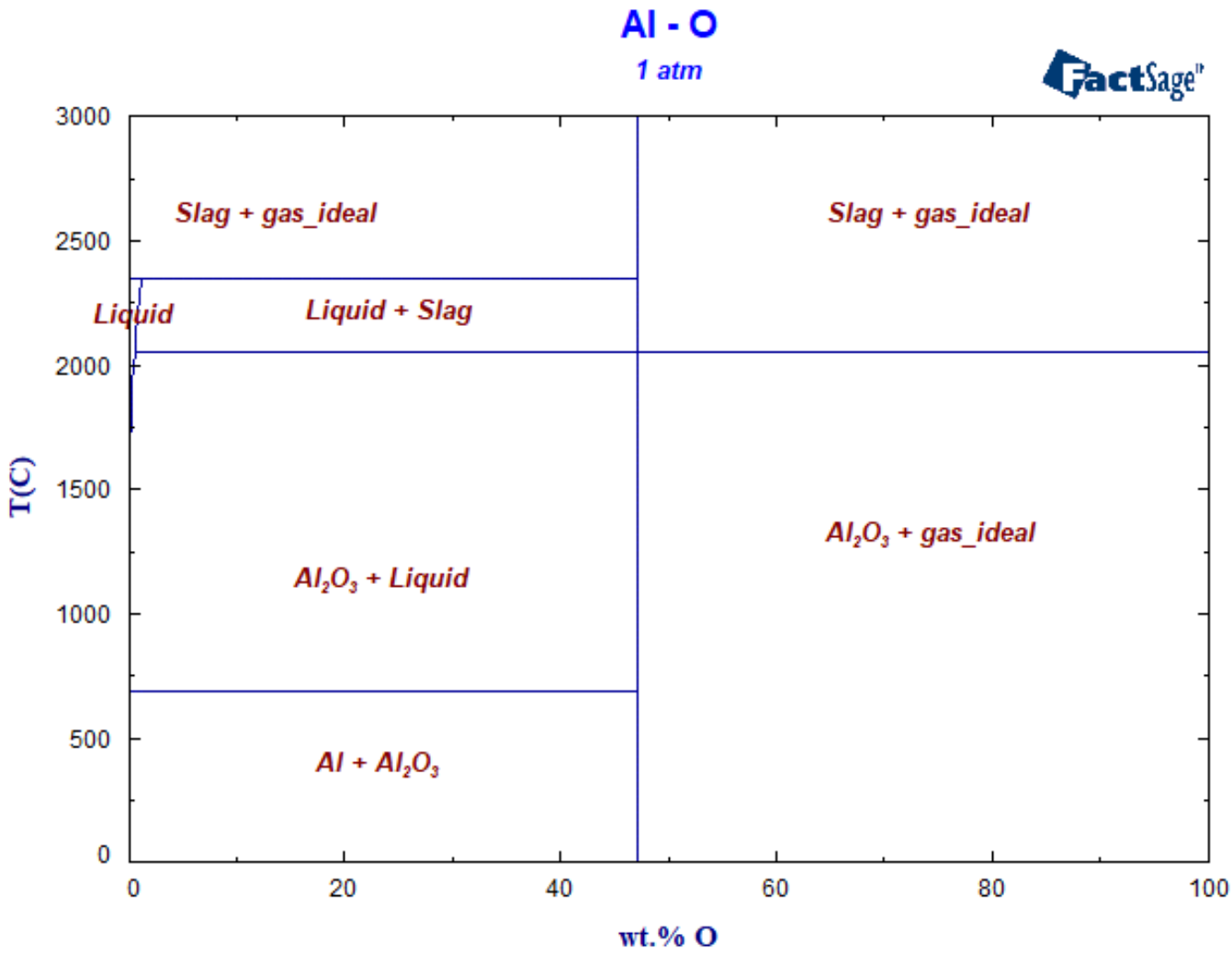
242	Ca5Si2F2O8	492	MnPO4	742	Sr2Fe2SiO7
243	Ca10Si3F2O15	493	MnP2O6	743	Al2MgO4
244	Na2CaSiO4	494	Mn2P2O7	744	Cr2MgO4
245	Na4CaSi3O9	495	Mn2P2O8	745	Cr2FeO4
246	Na2CaSi5O12	496	Mn3P2O8		
247	Na2Ca2Si2O7	497	MnS		
248	Na2Ca2Si3O9	498	MnS2		
249	Na2Ca3Si6O16	499	Mn9SSi3O14		

Binary systems:

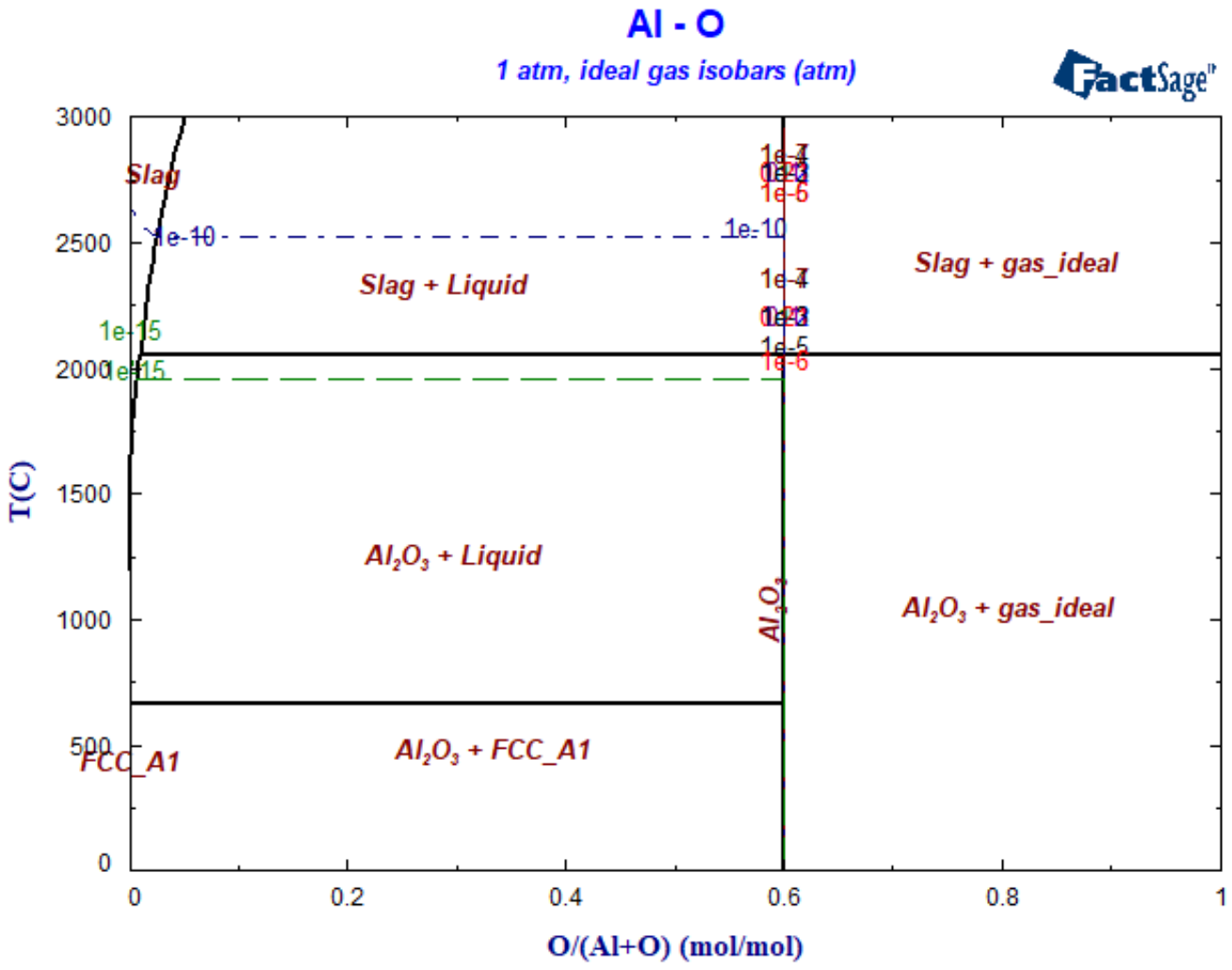
Mole fraction



Weight percent

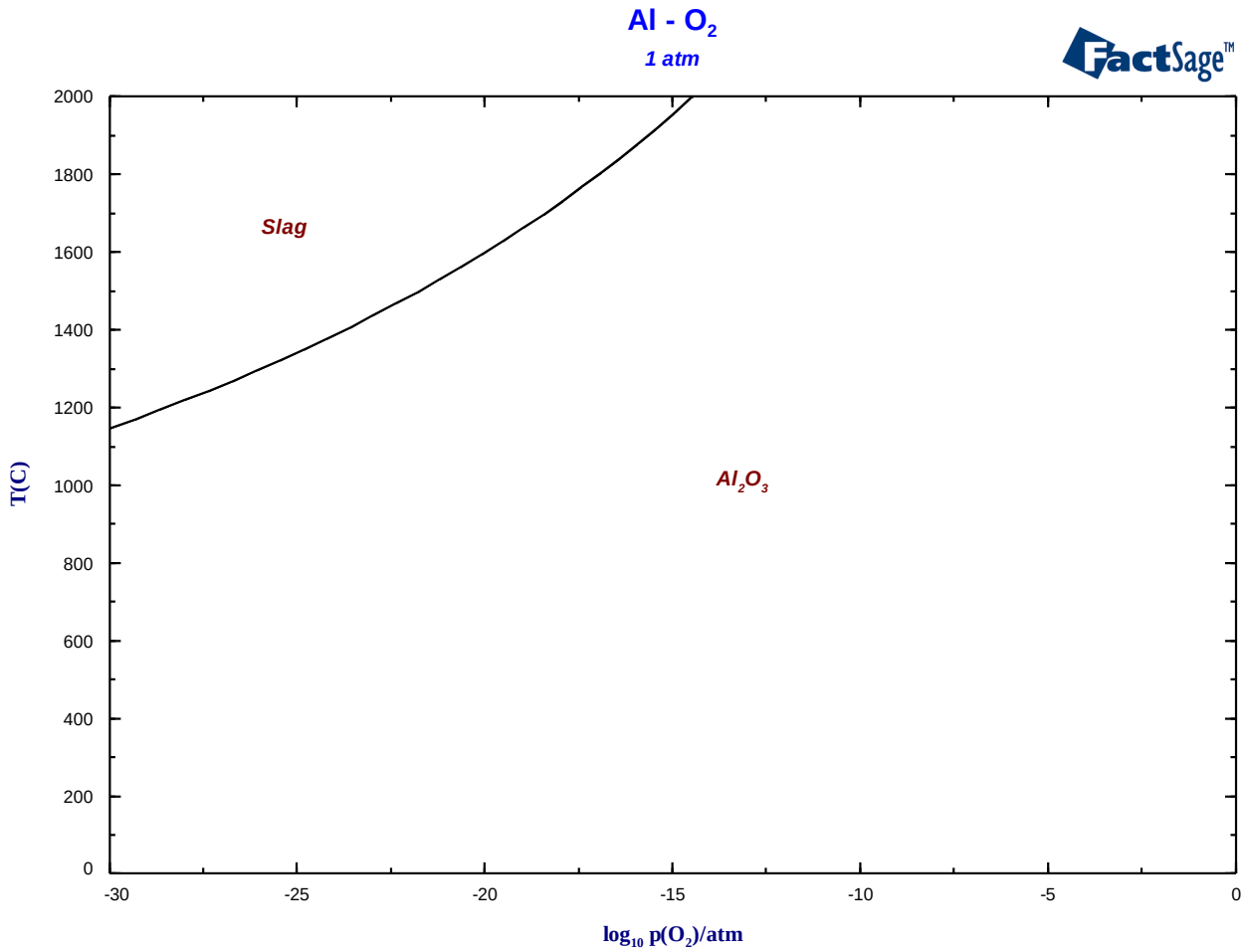


Mole fraction with isobars

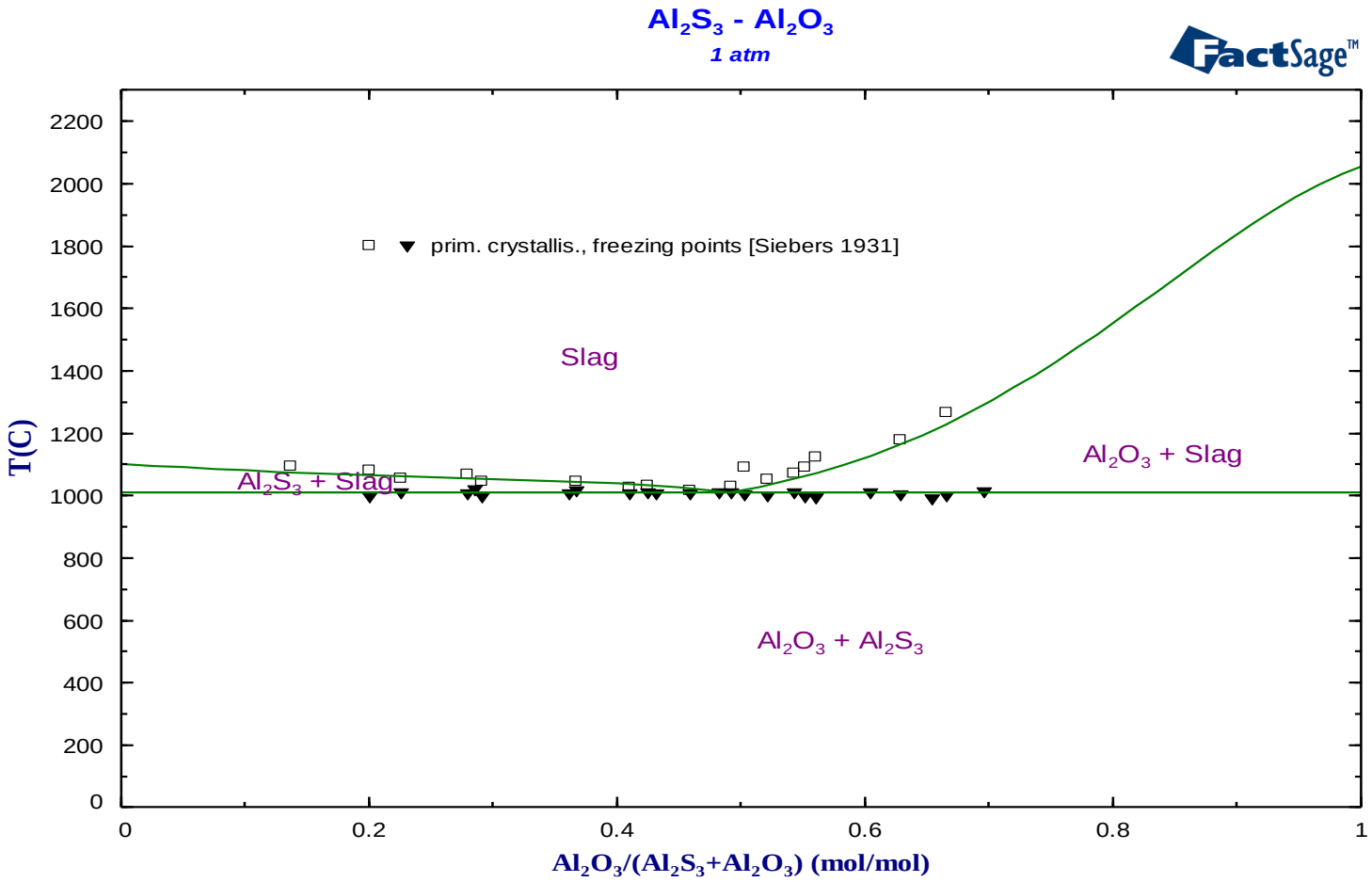


Al-O2,

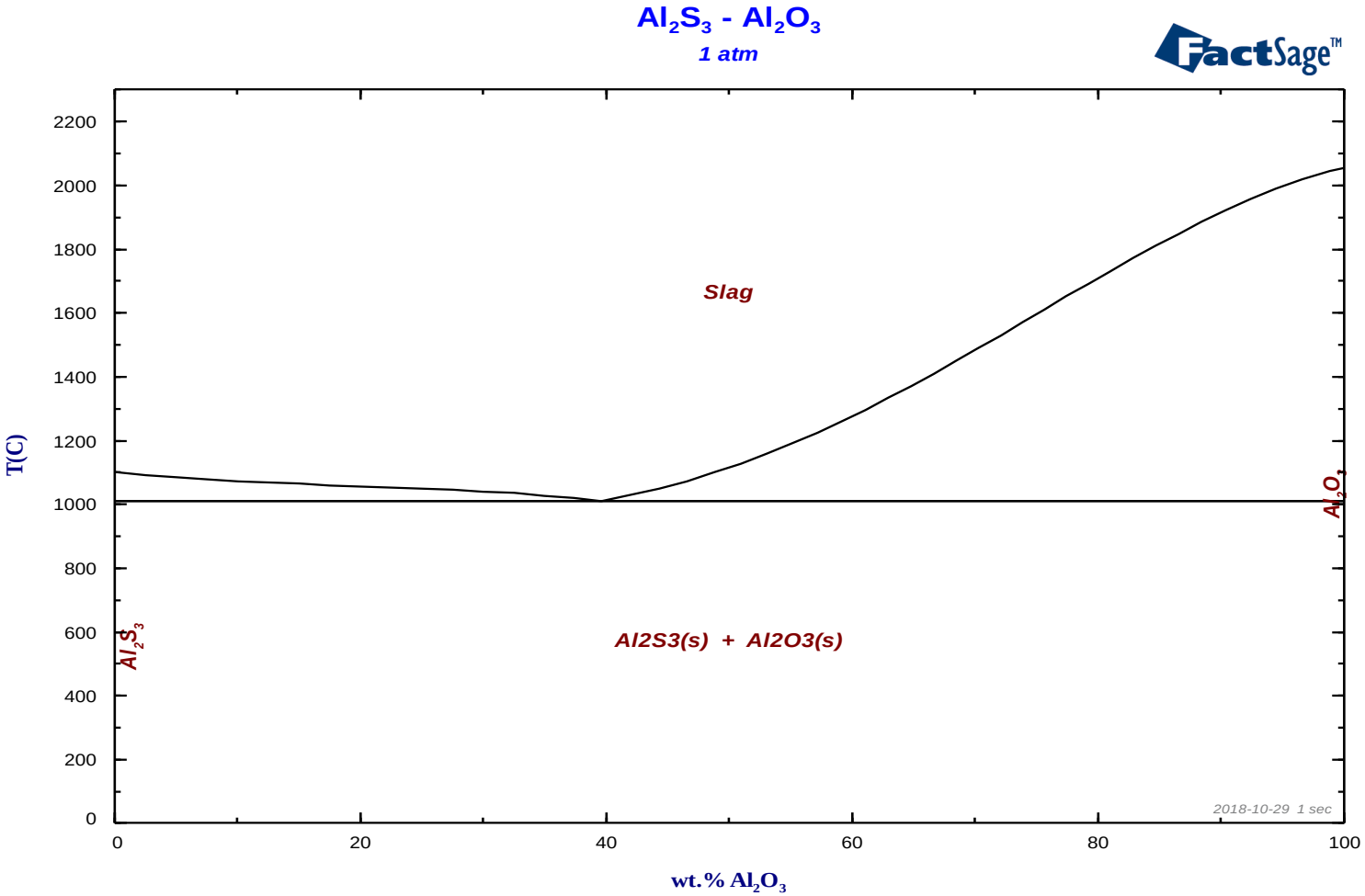
Temperature vs. log P(O2) diagram



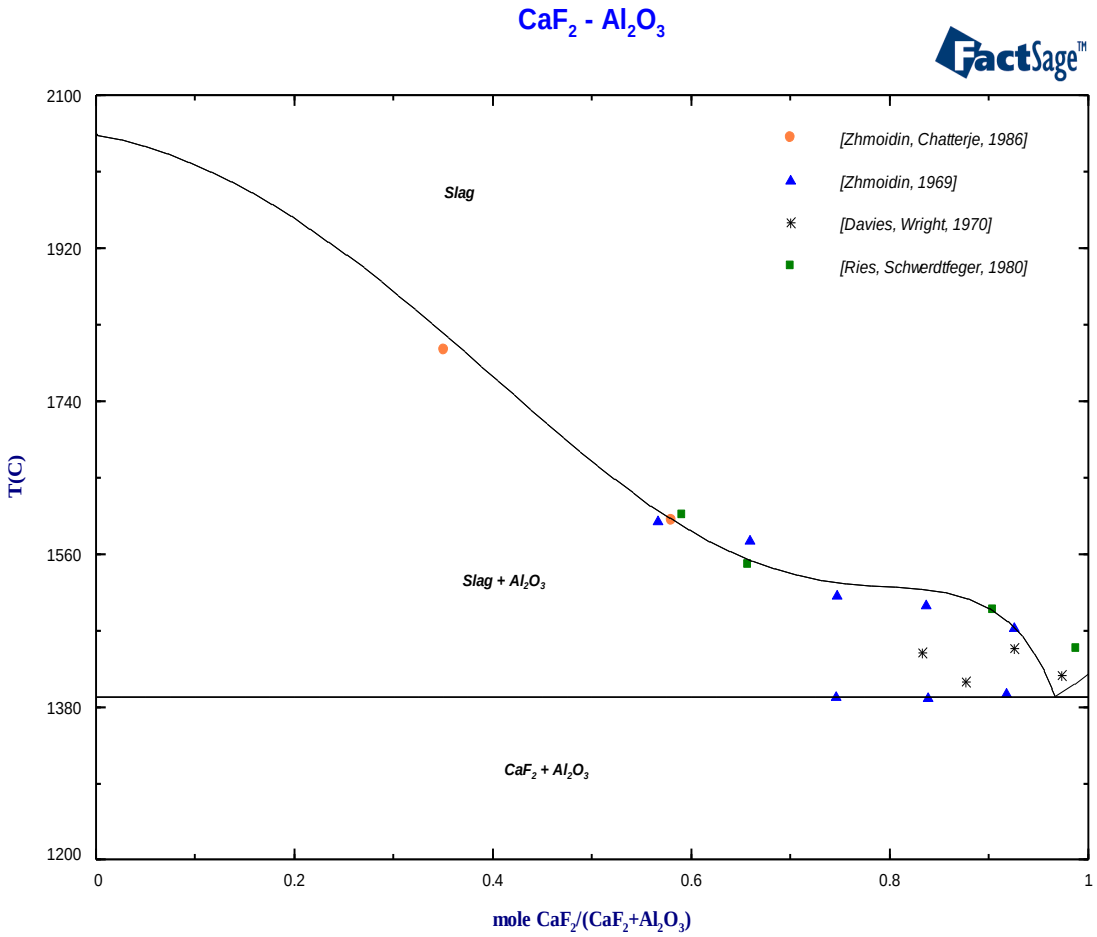
Mole fraction compared with experimental data



Weight percent



Mole fraction



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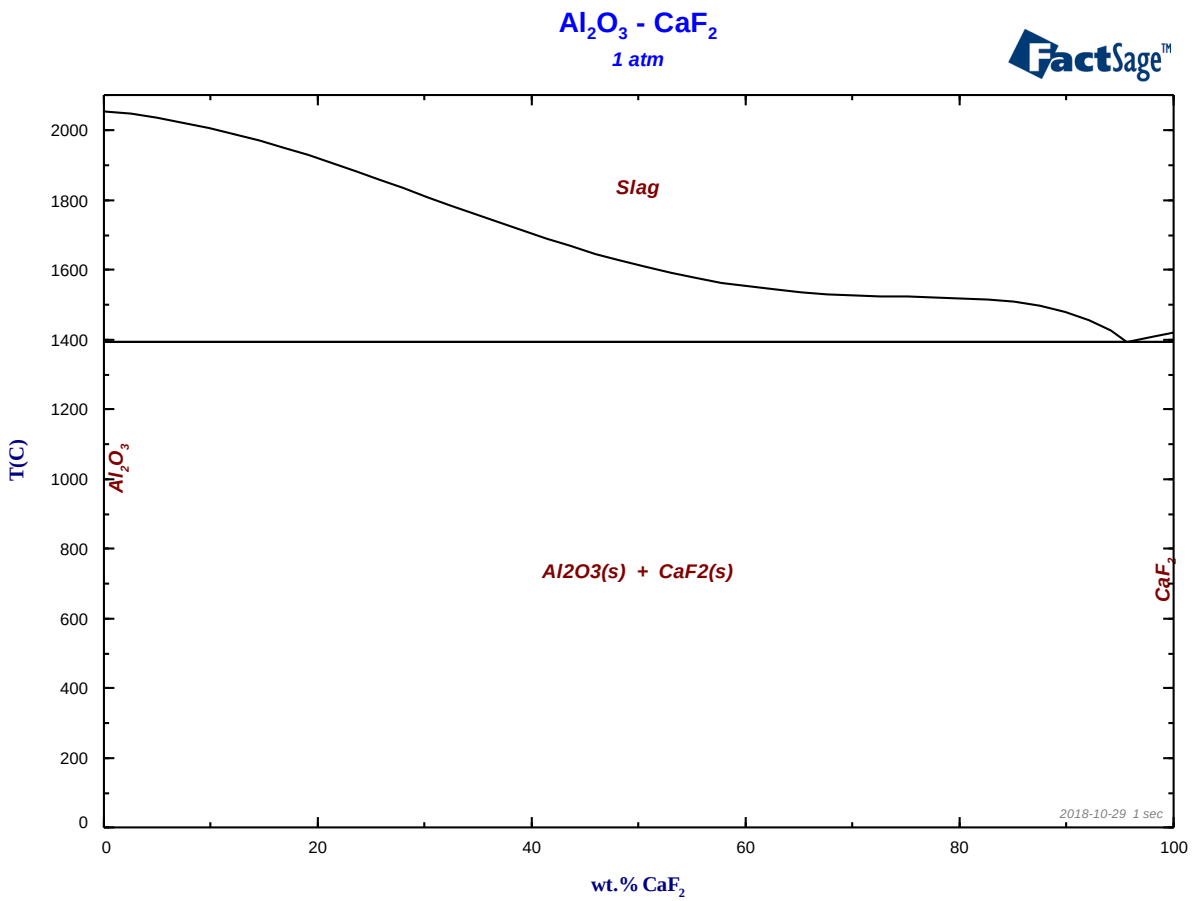
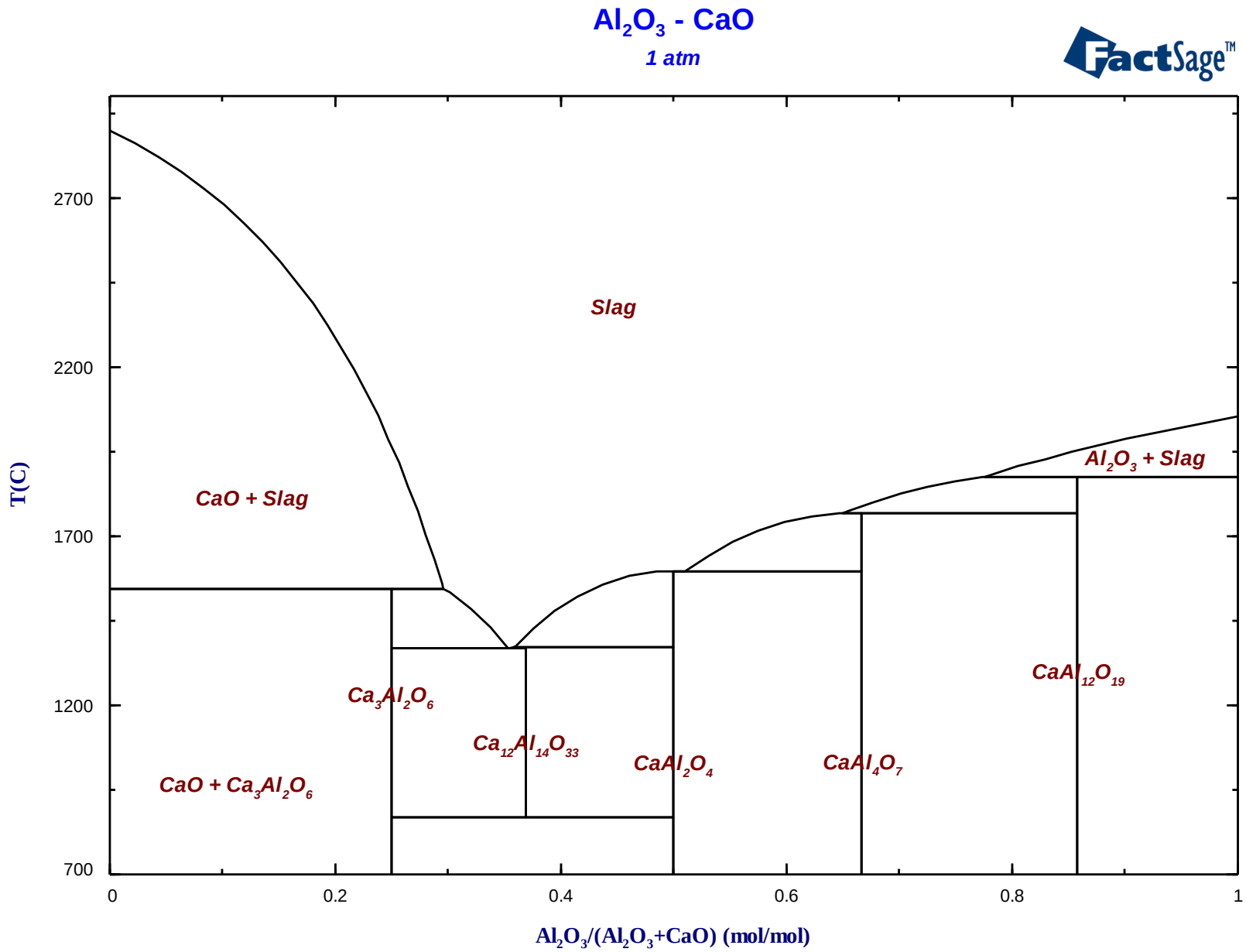
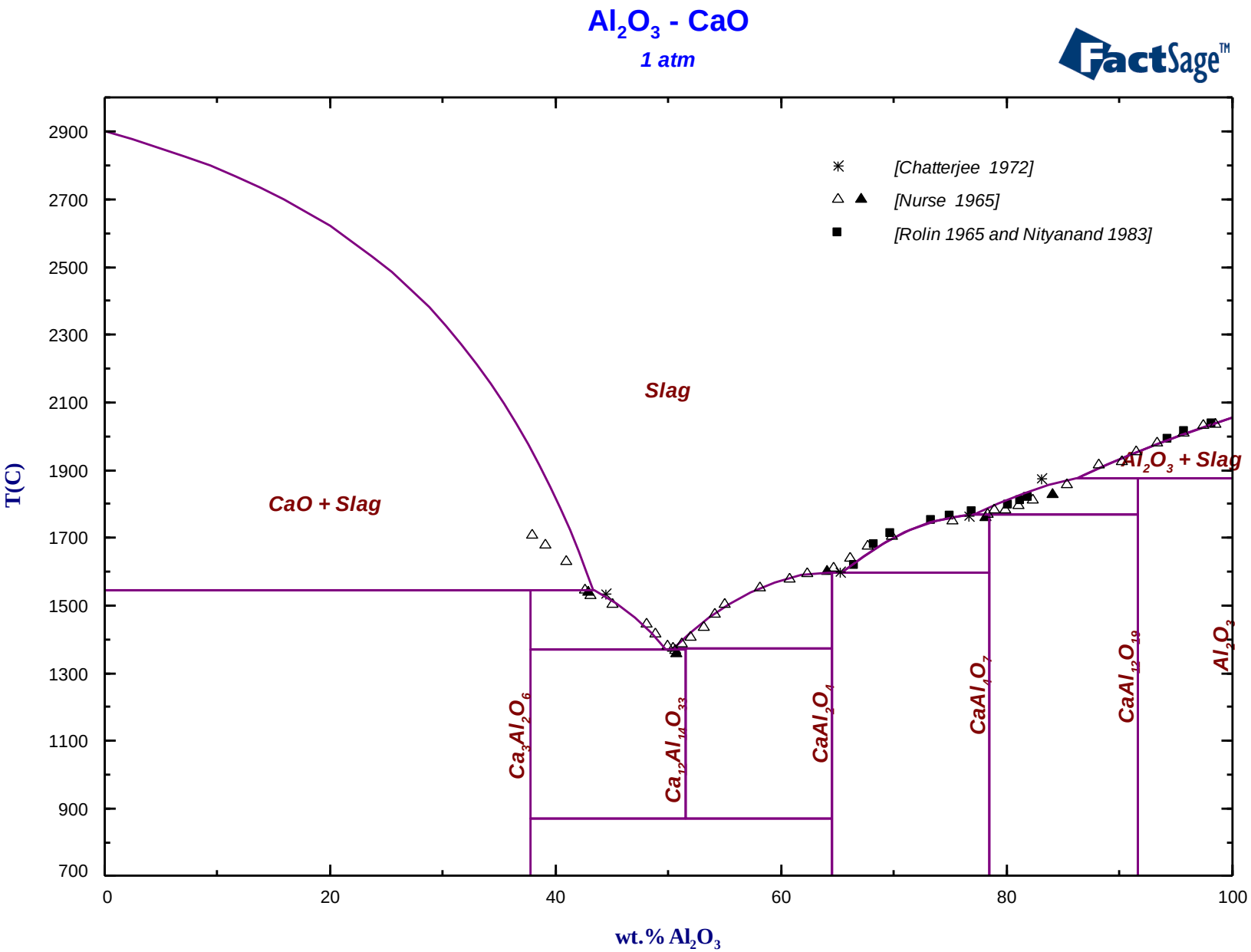


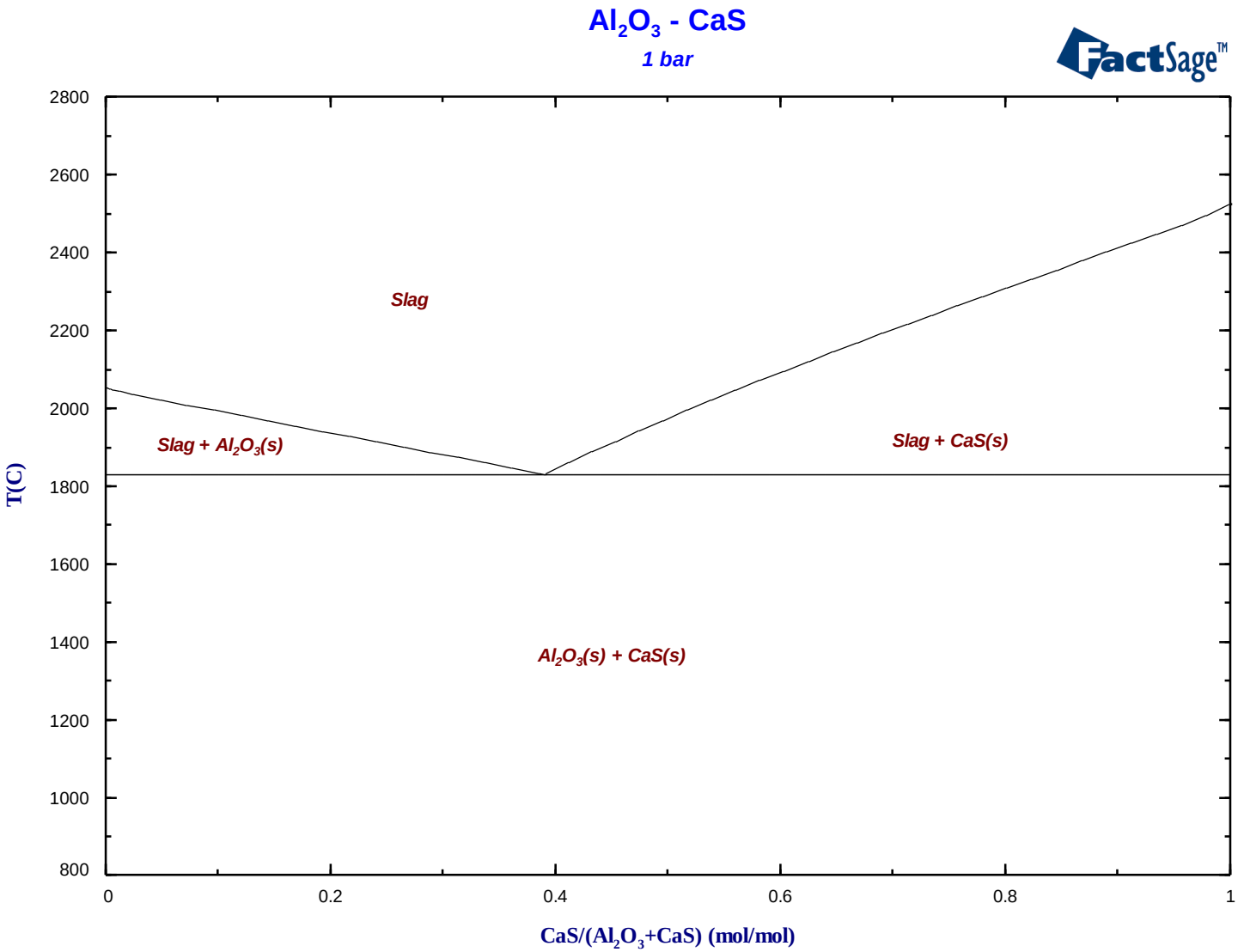
Mole fraction



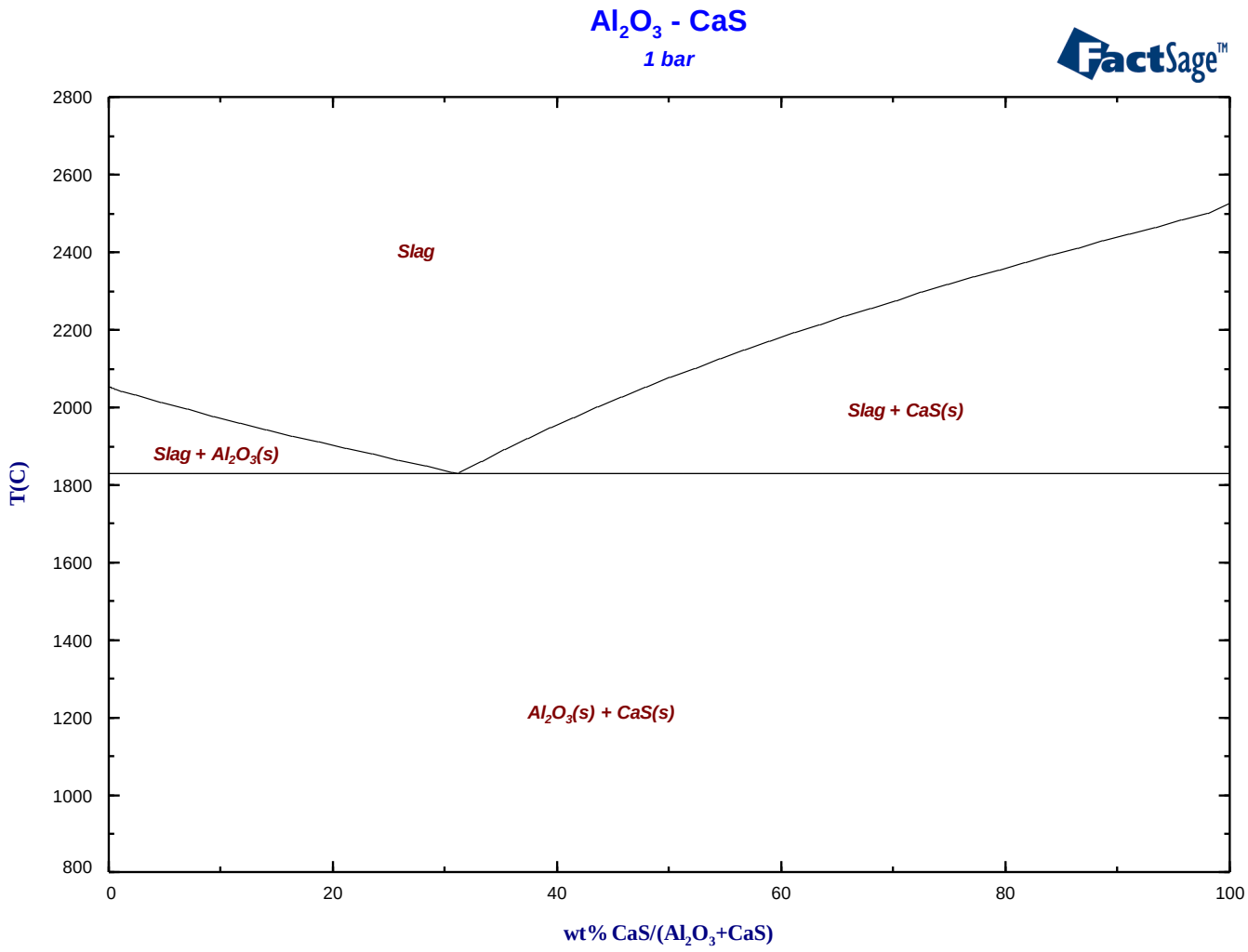
Weight percent
compared with experimental data



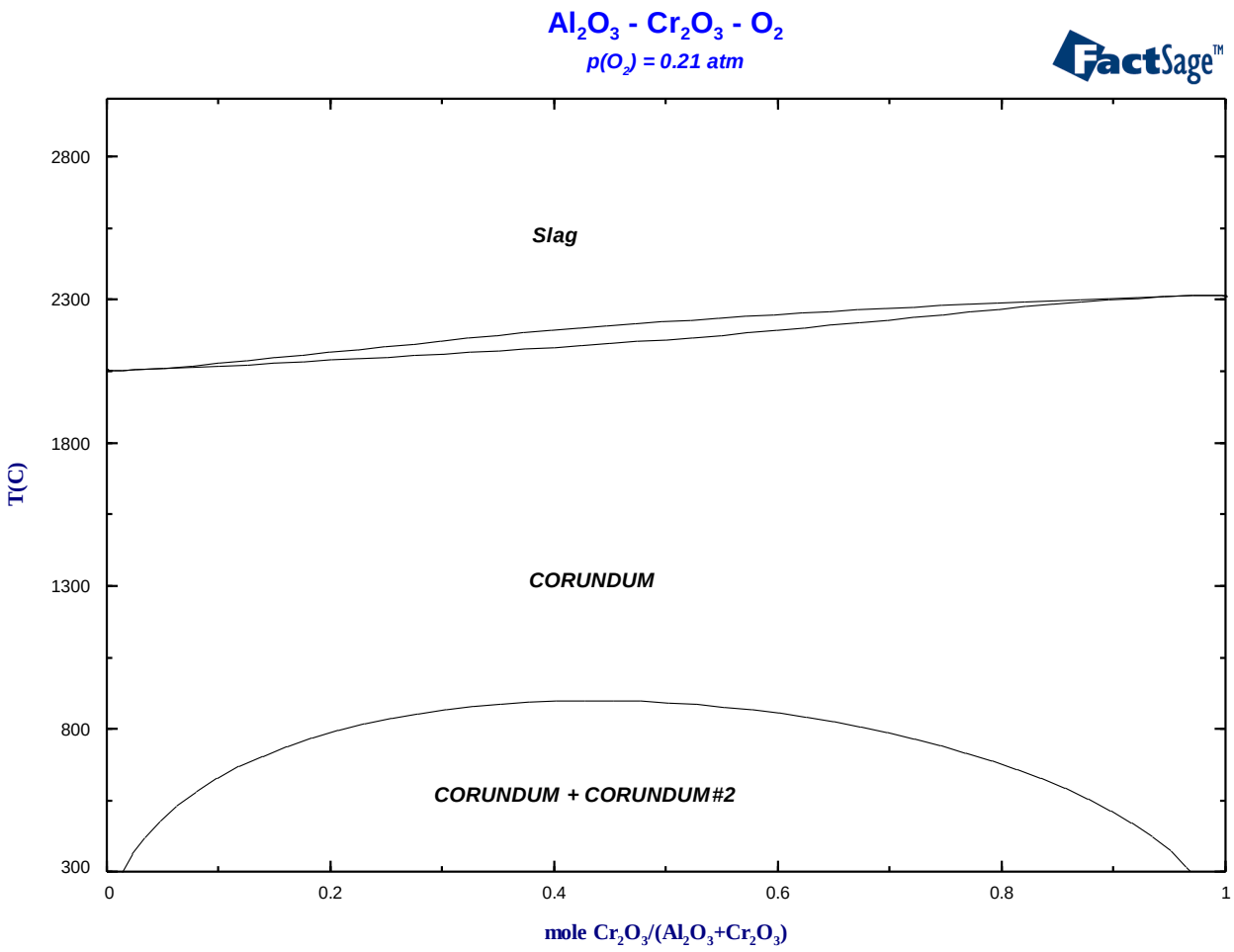
Mole fraction



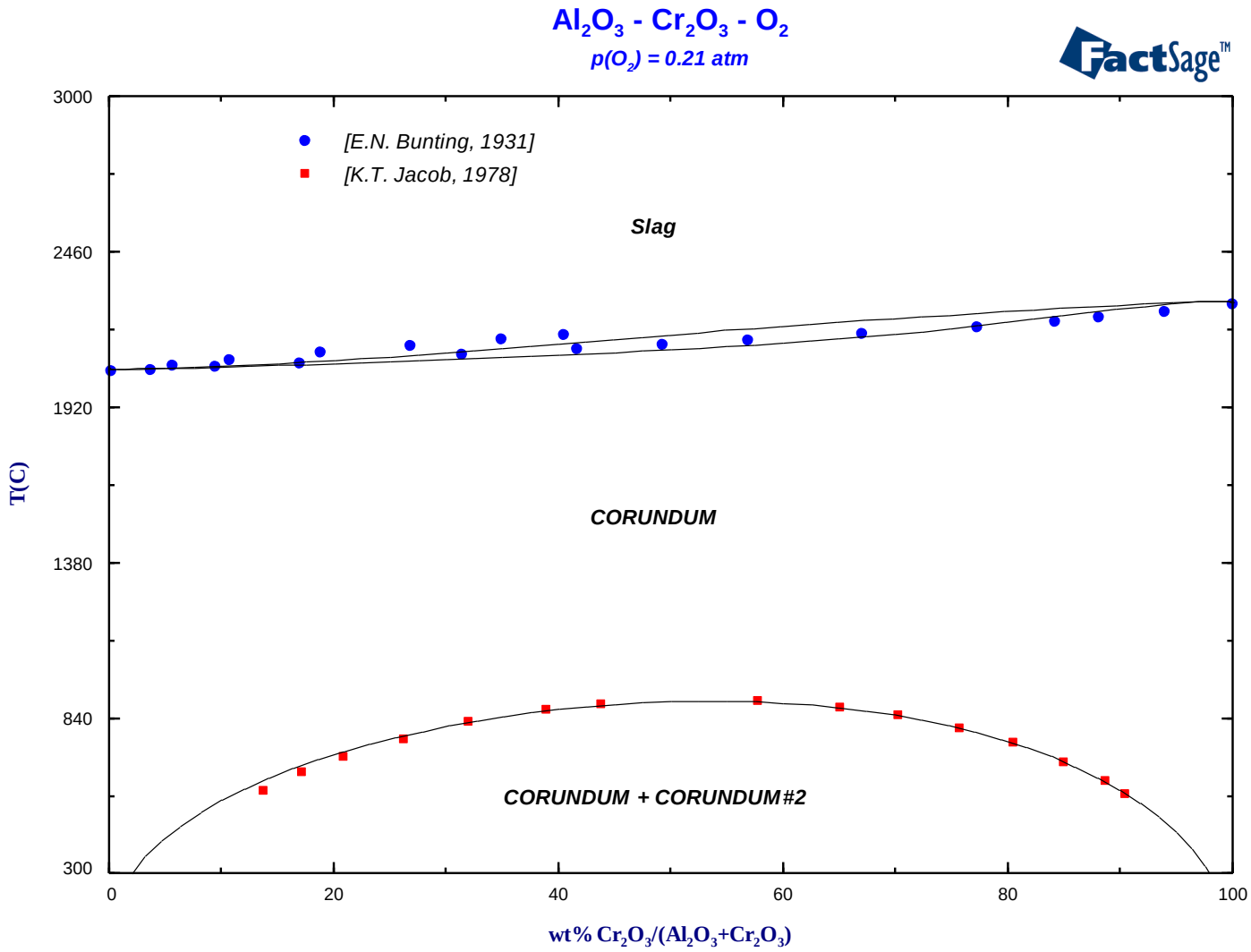
Weight percent



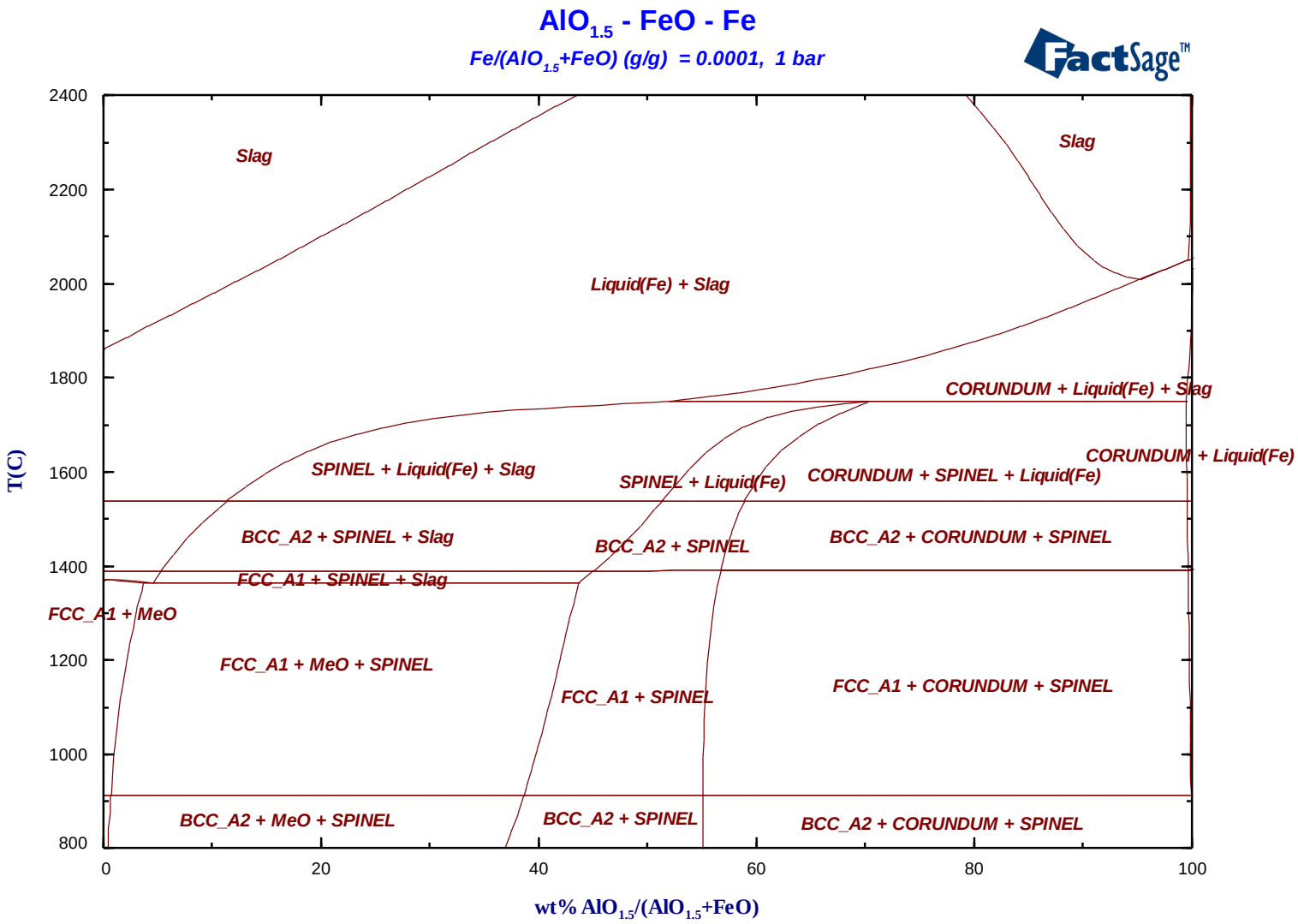
Mole fraction



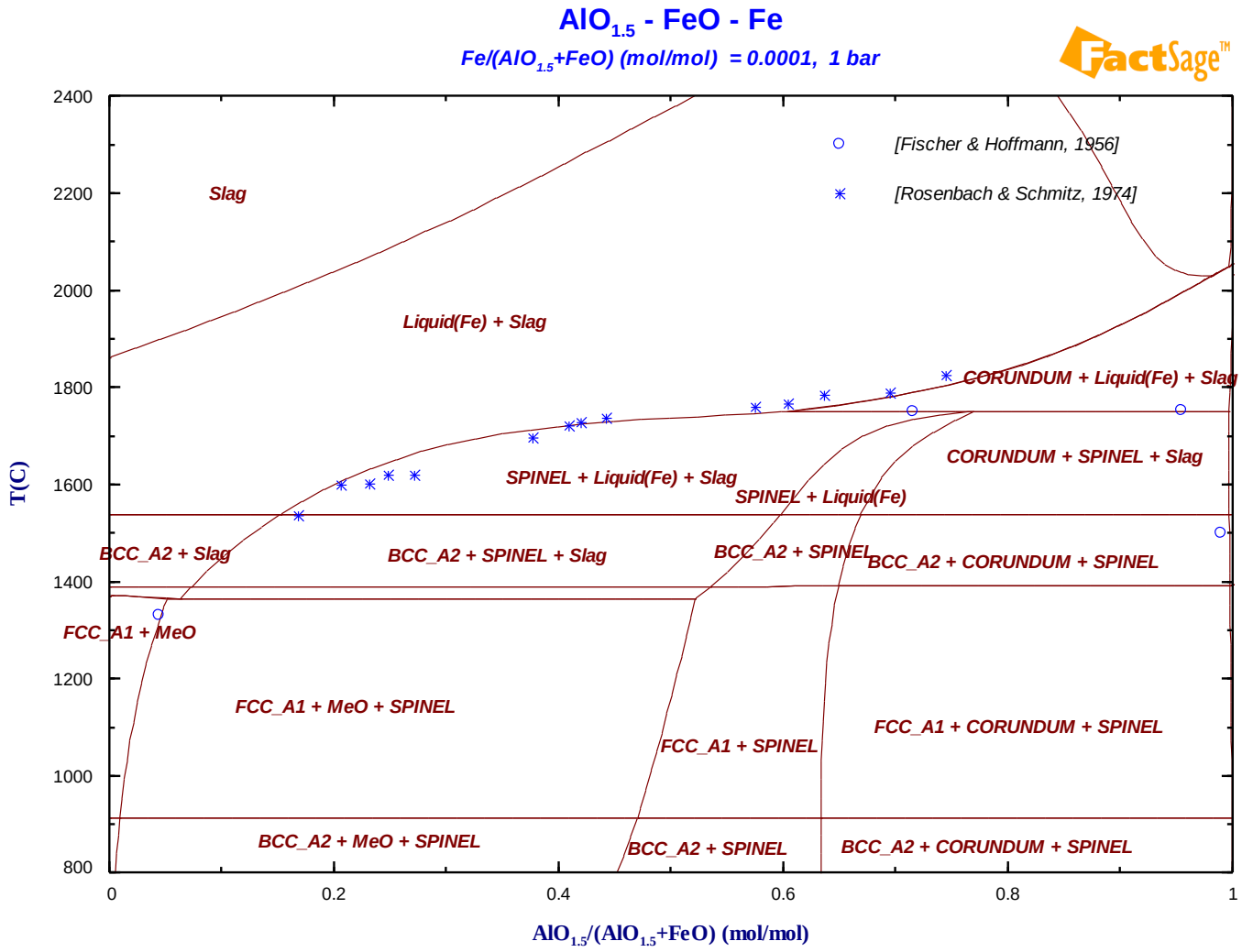
Weight percent compared with experimental data



Mole fraction



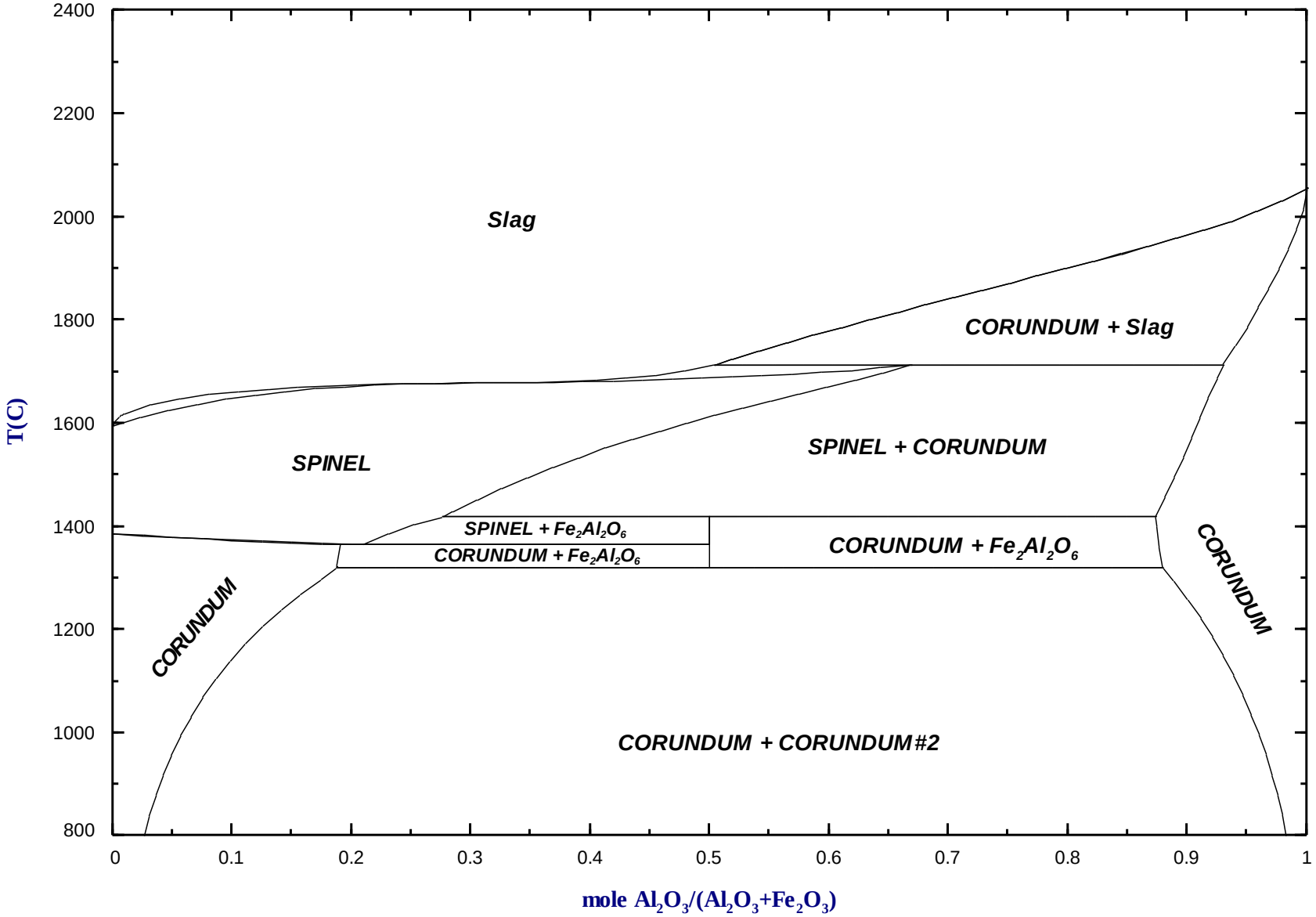
Weight percent compared with experimental data



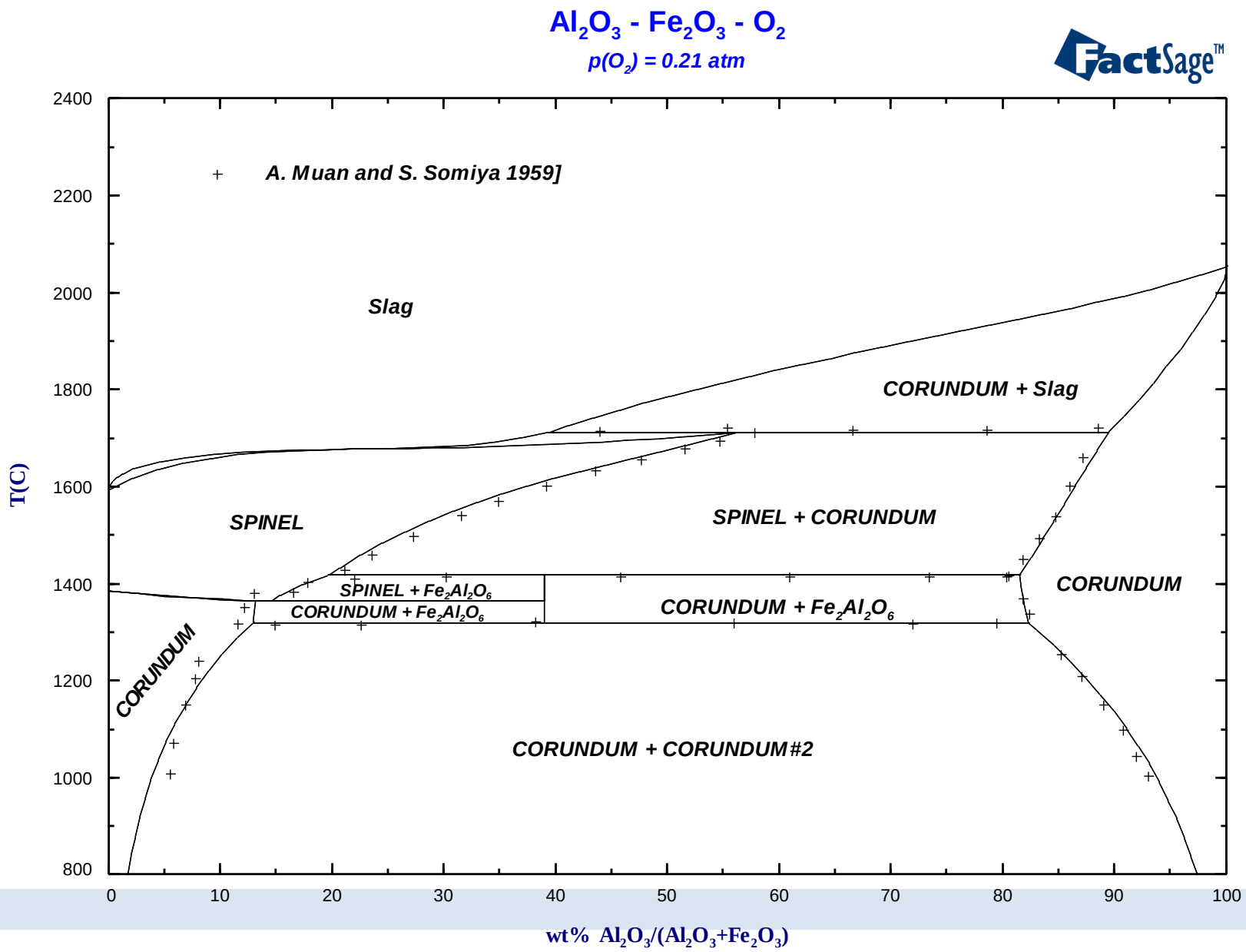
Mole fraction

Al_2O_3 - Fe_2O_3 - O_2

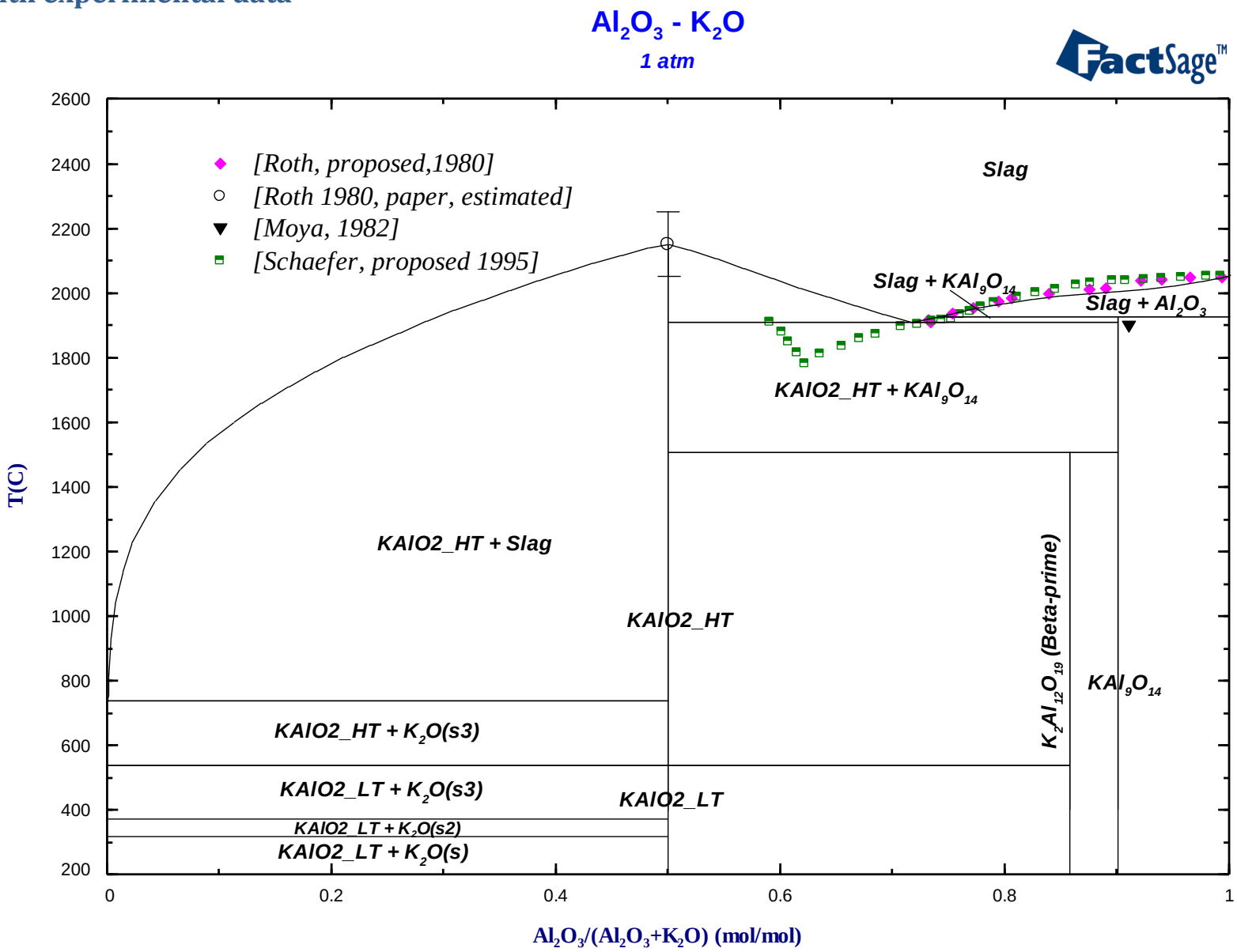
$p(O_2)$ = 0.21 atm



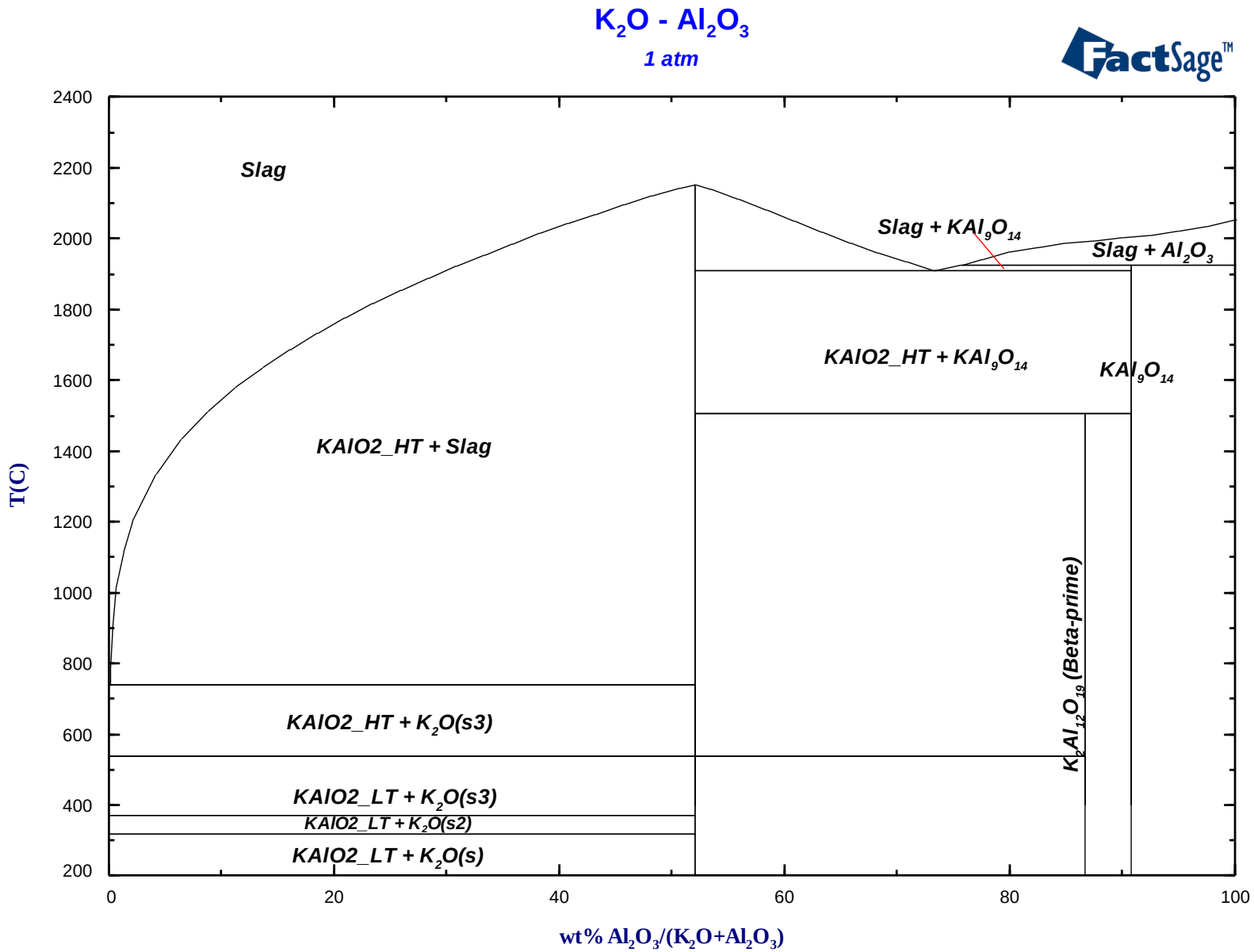
Weight percent
compared with experimental data



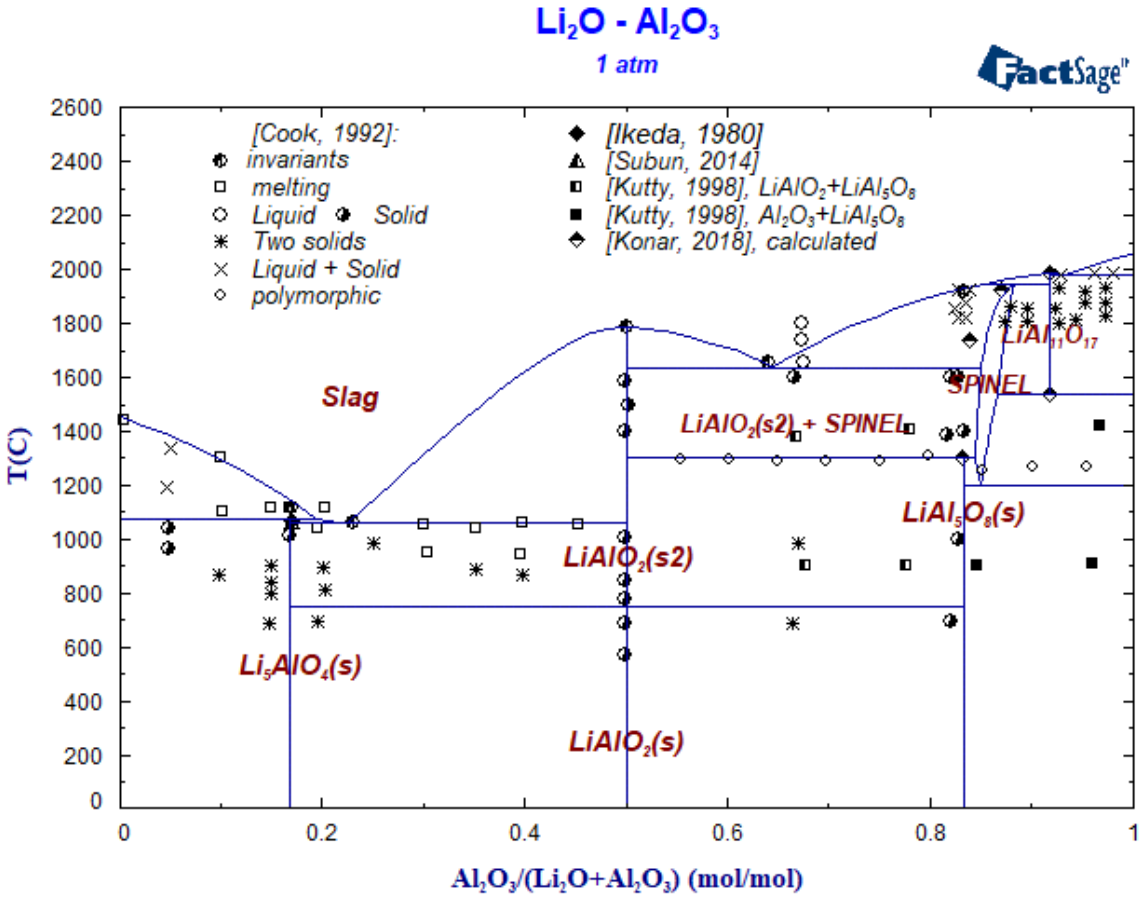
Mole fraction
compared with experimental data



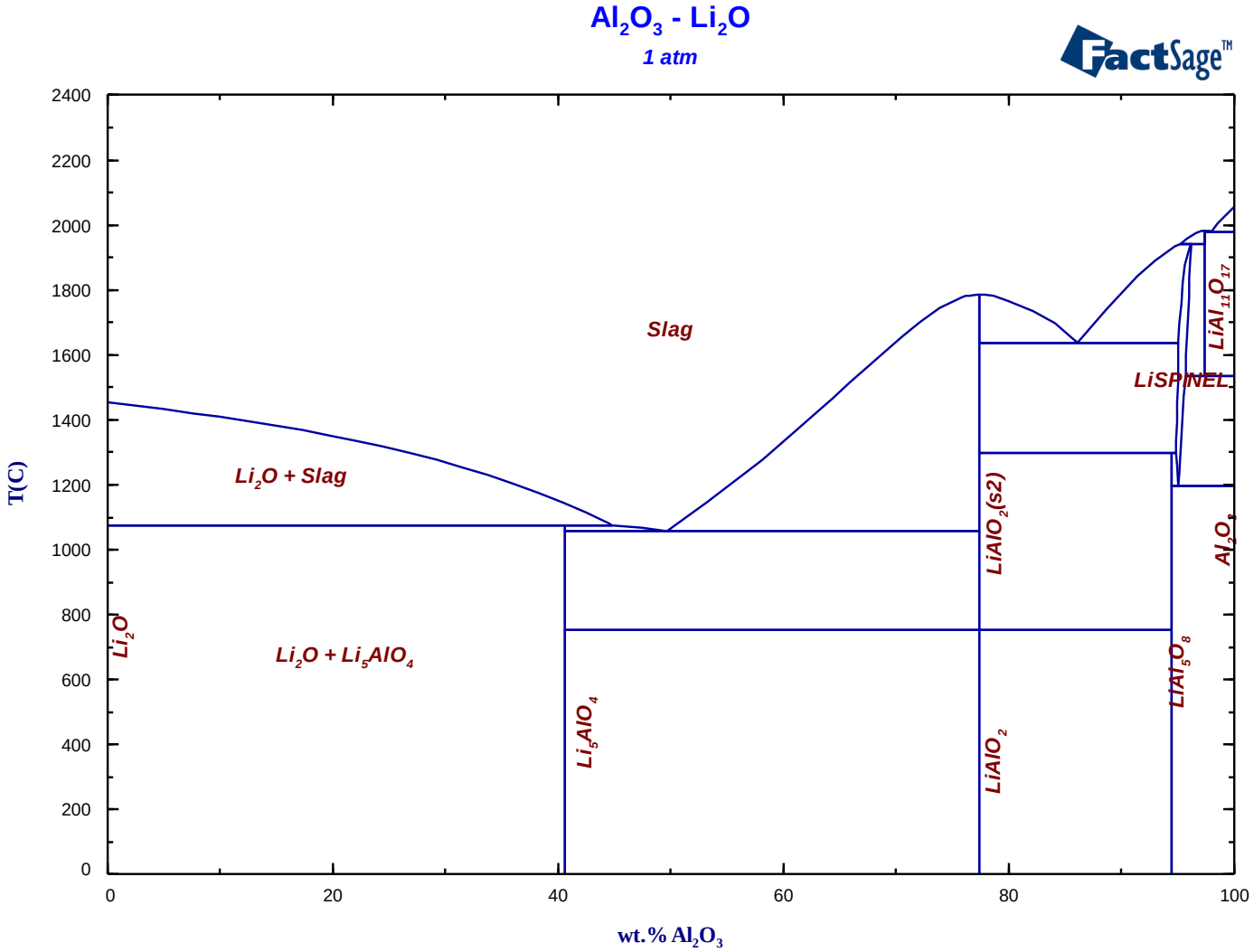
Weight percent



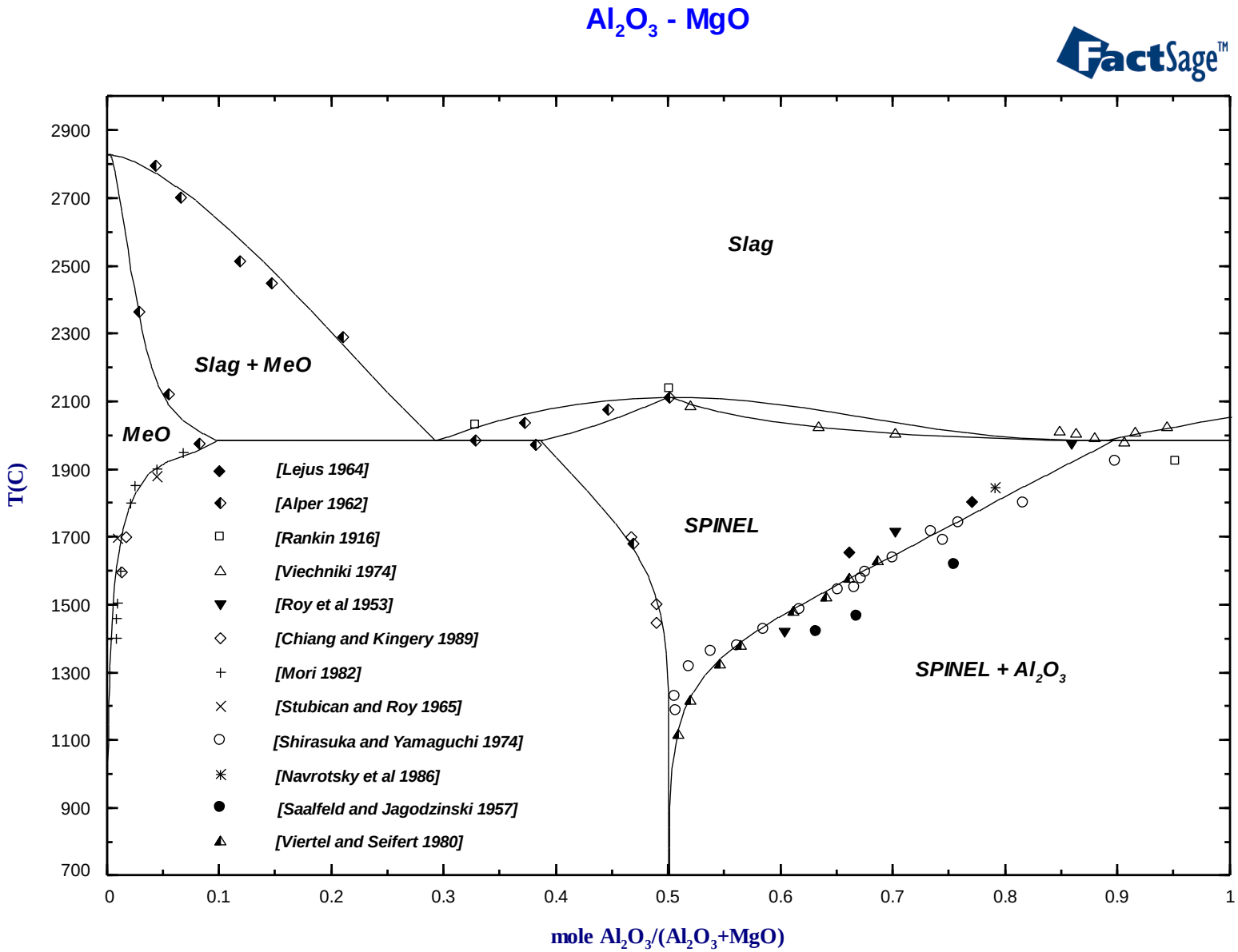
Al2O3-Li2O
Mole fraction
compared with experimental data



Al2O3-Li2O
Weight percent

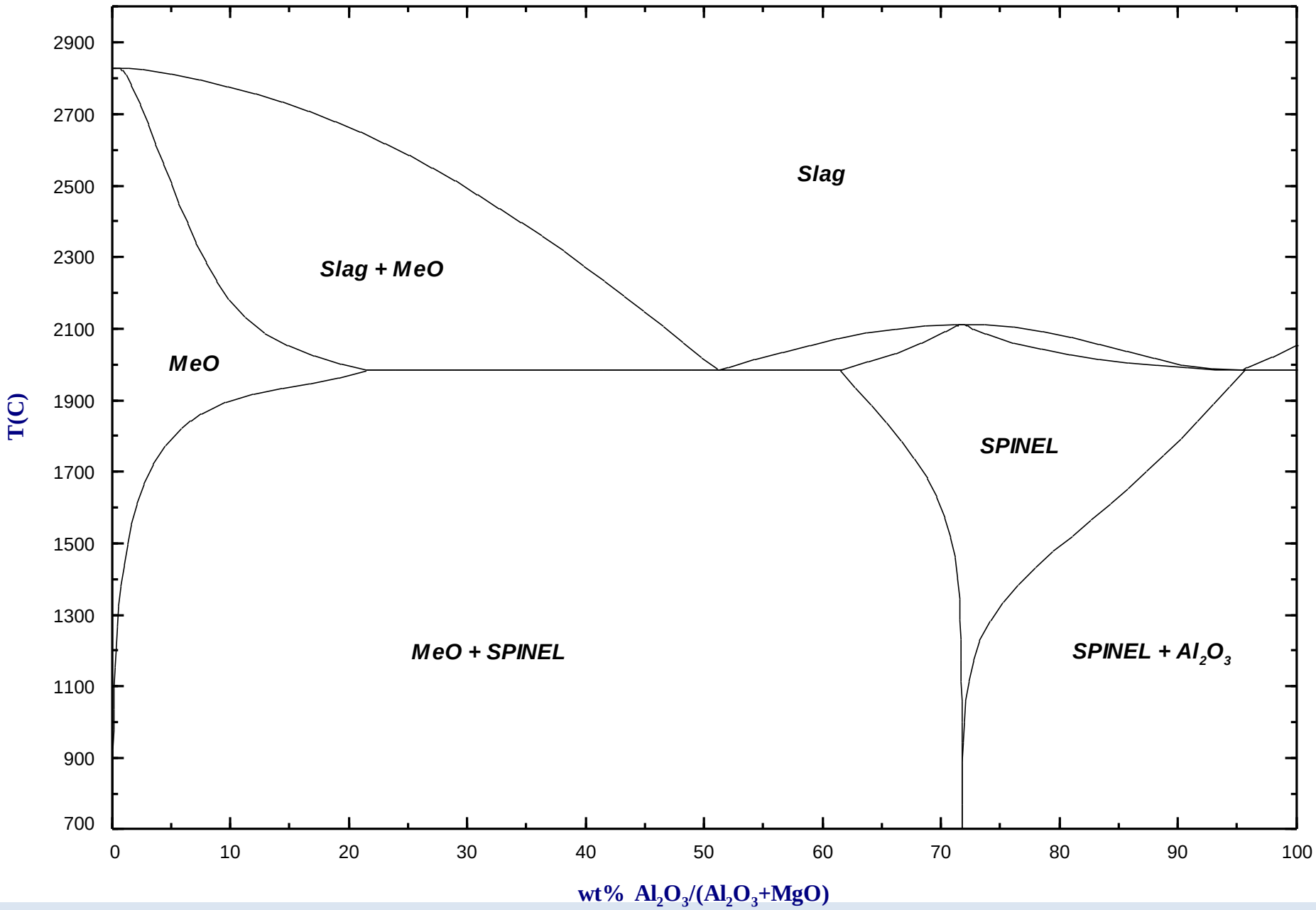


Mole fraction
compared with experimental data

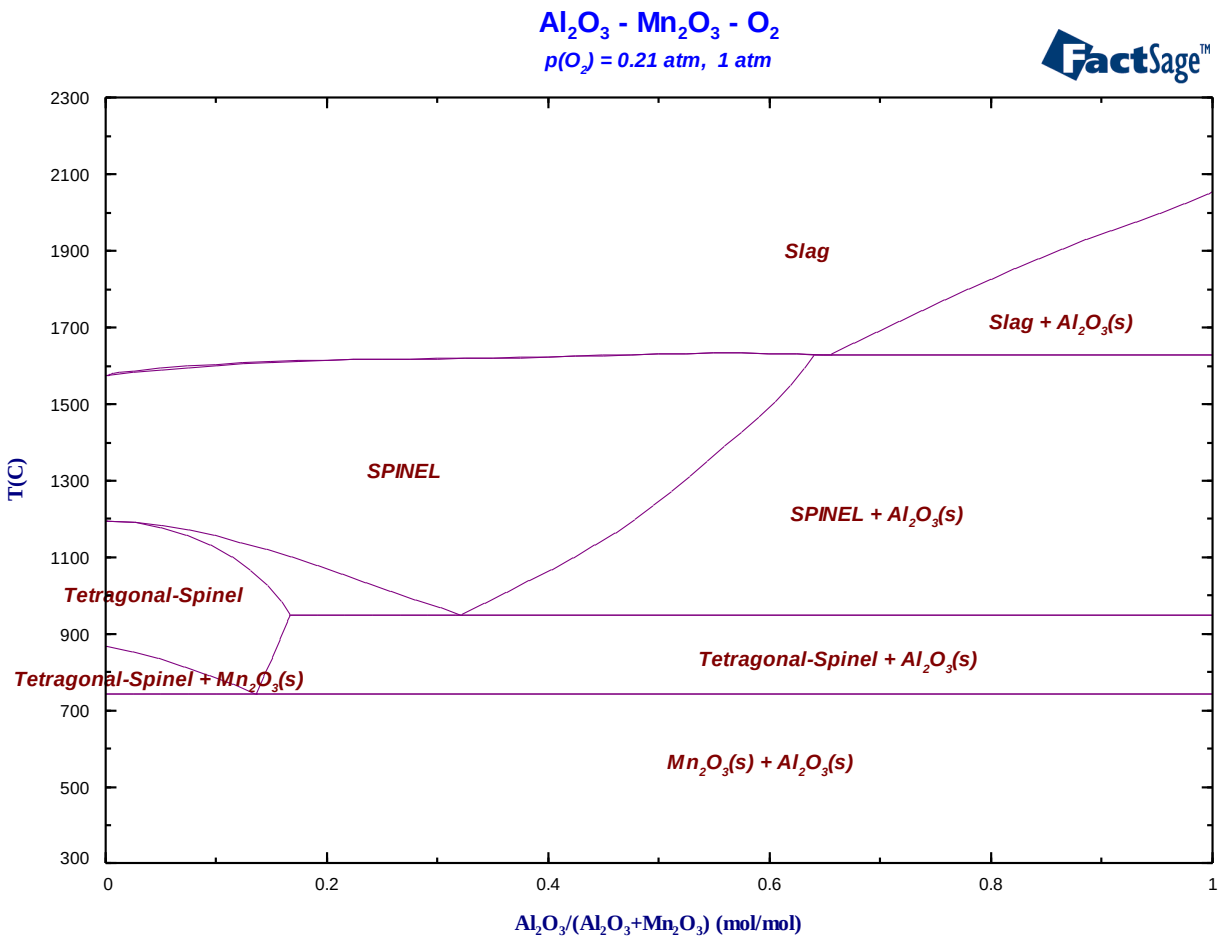


Al_2O_3 - MgO

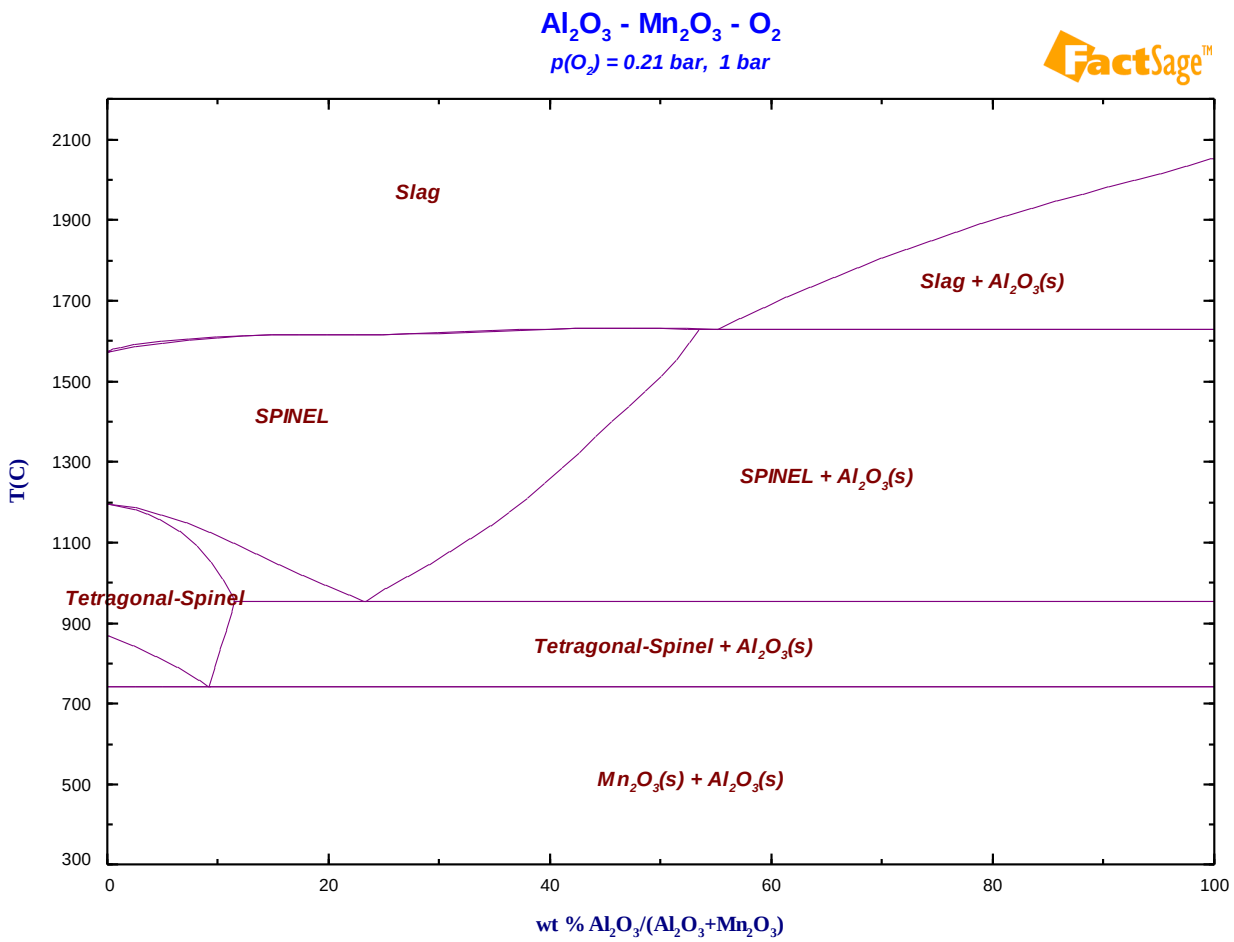
Weight percent



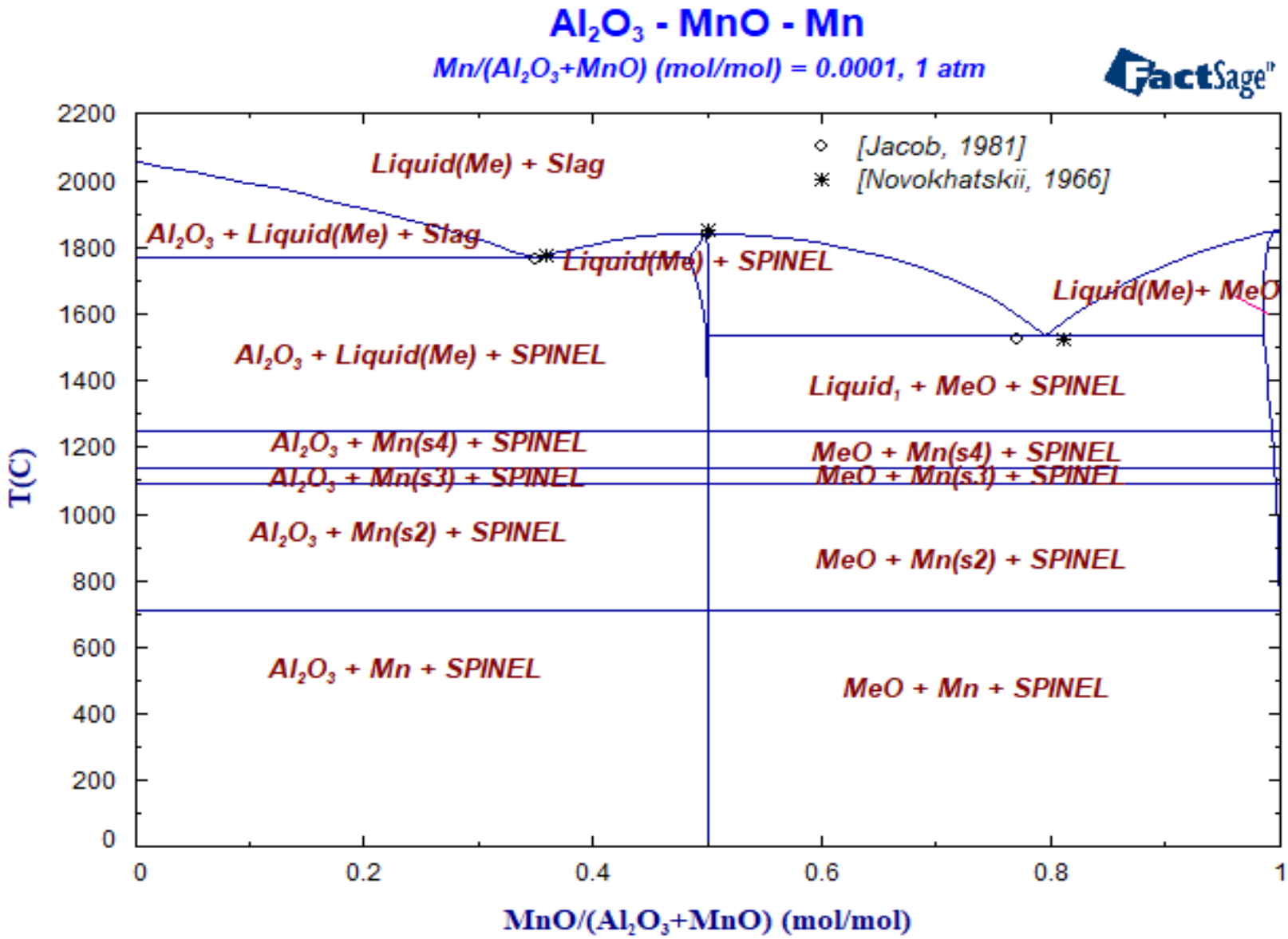
Mole fraction



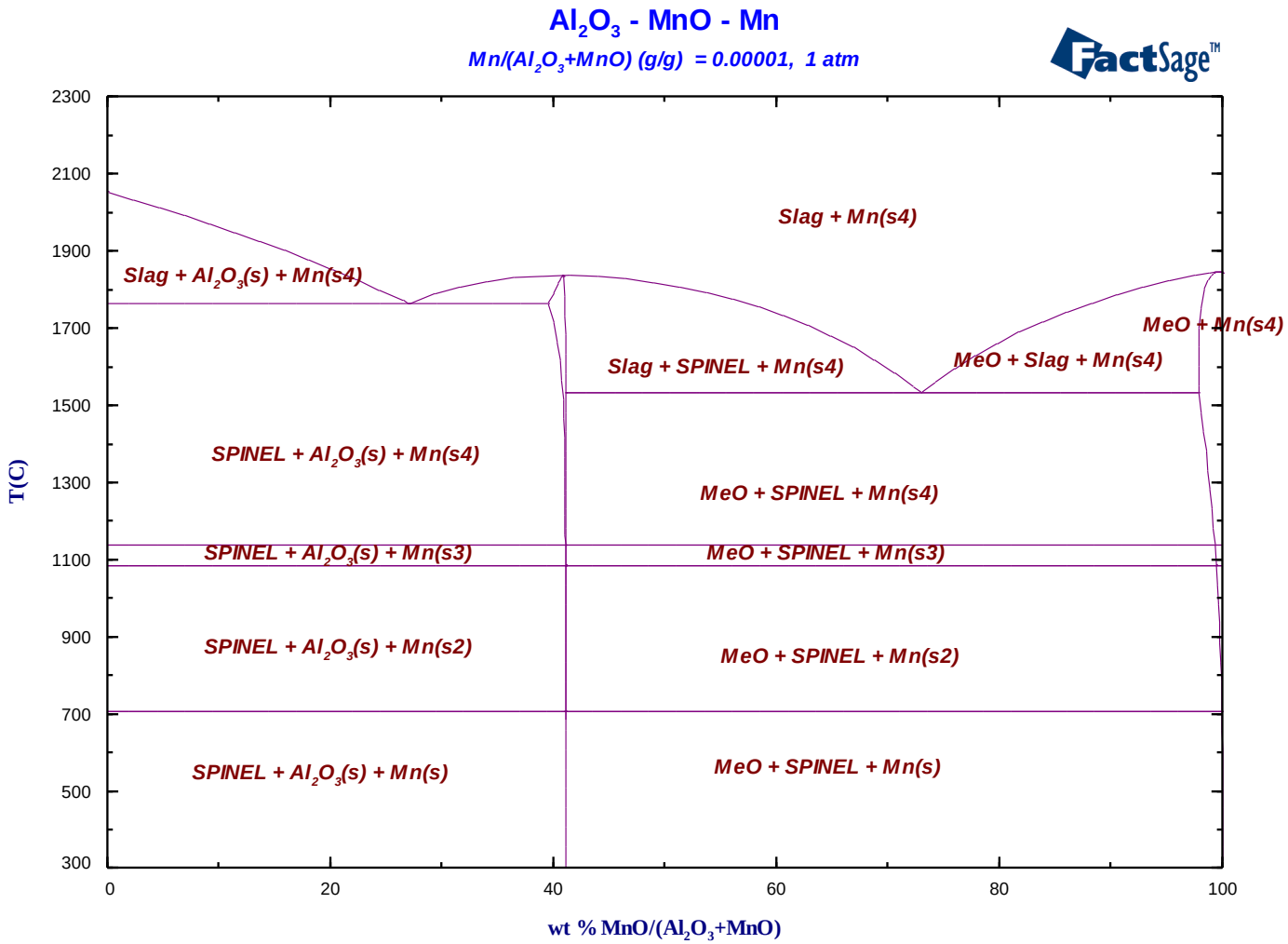
Weight percent



Mole fraction
compared with experimental data

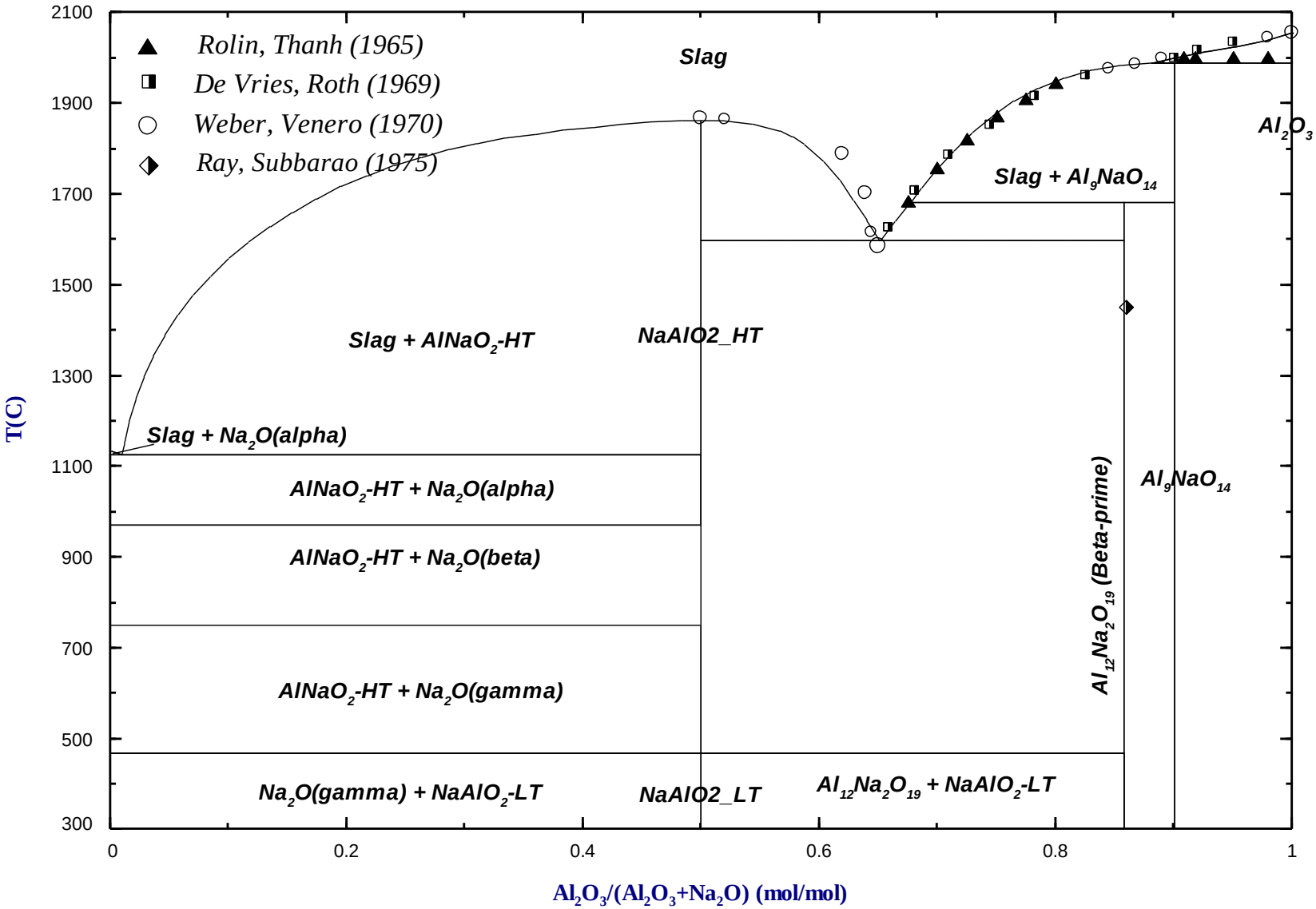


Weight percent

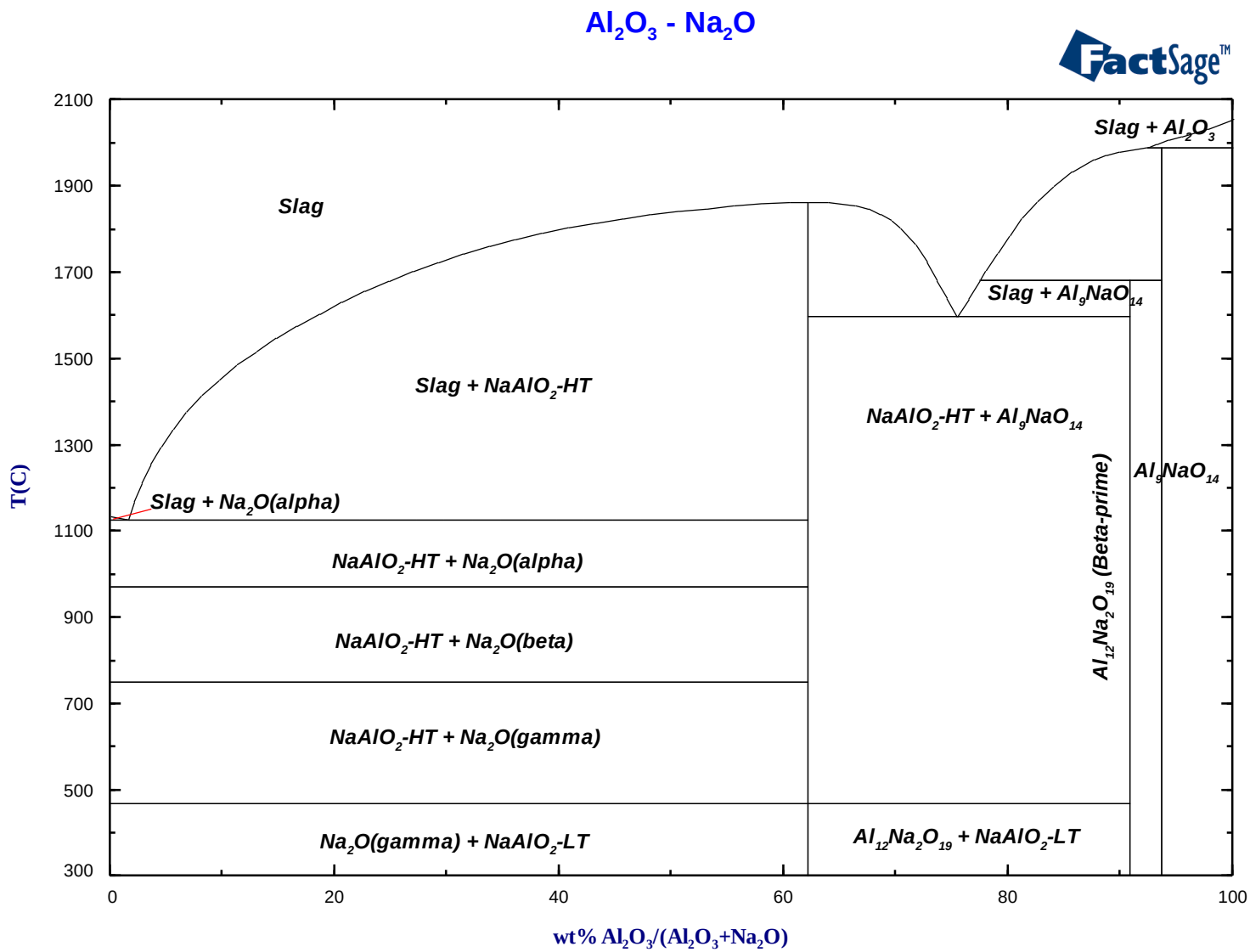


Mole fraction compared with experimental data

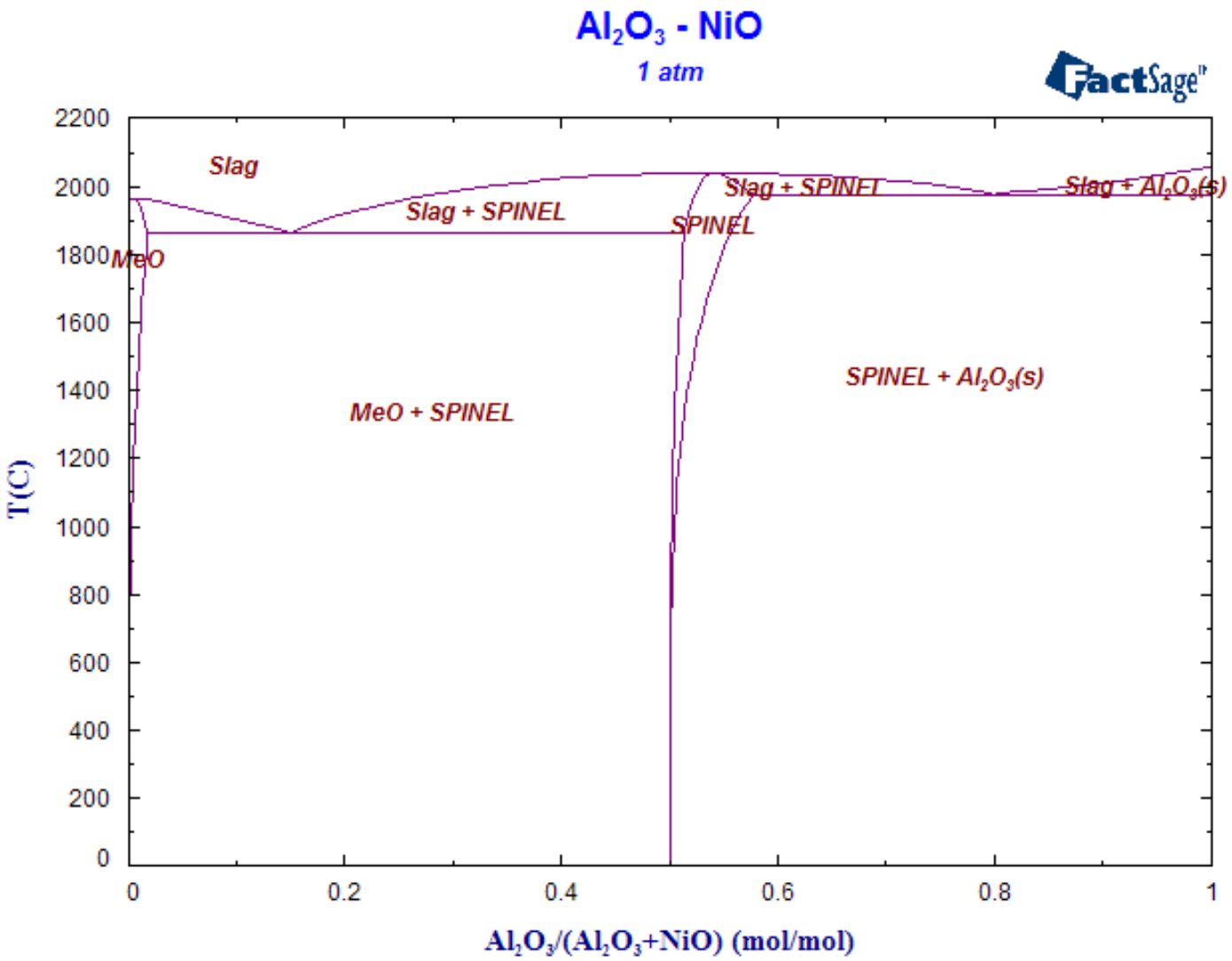
Al_2O_3 - Na_2O



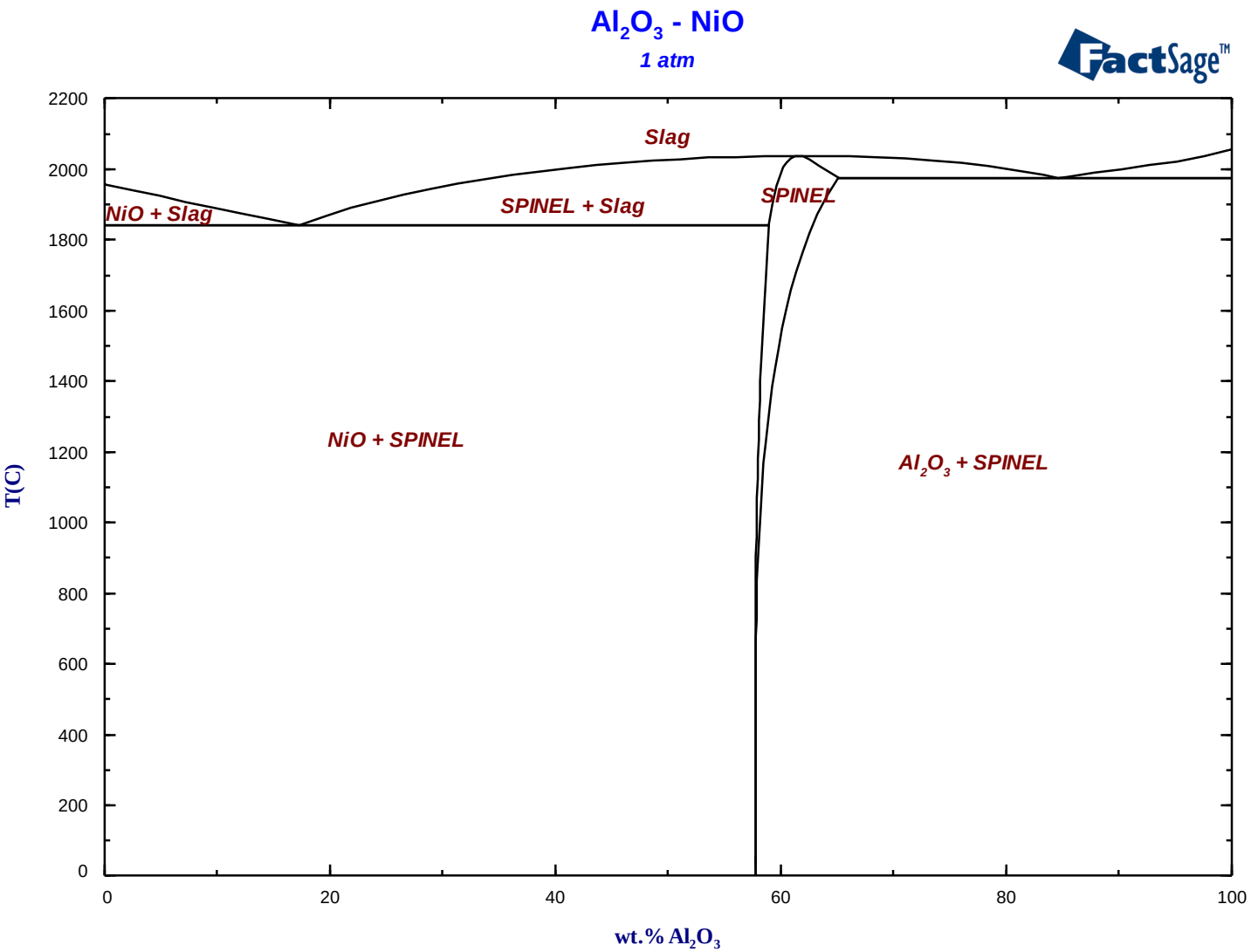
Weight percent



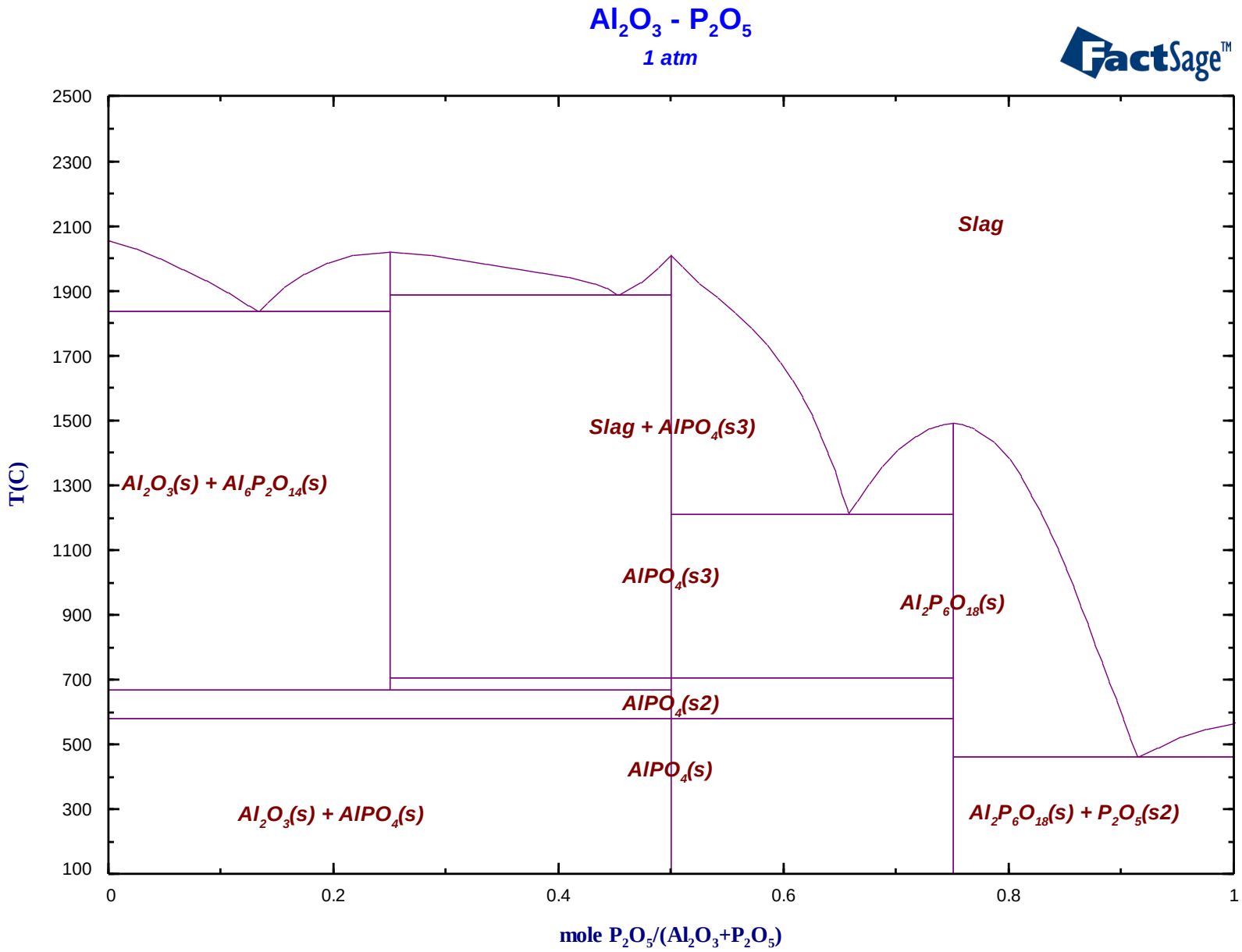
Mole fraction



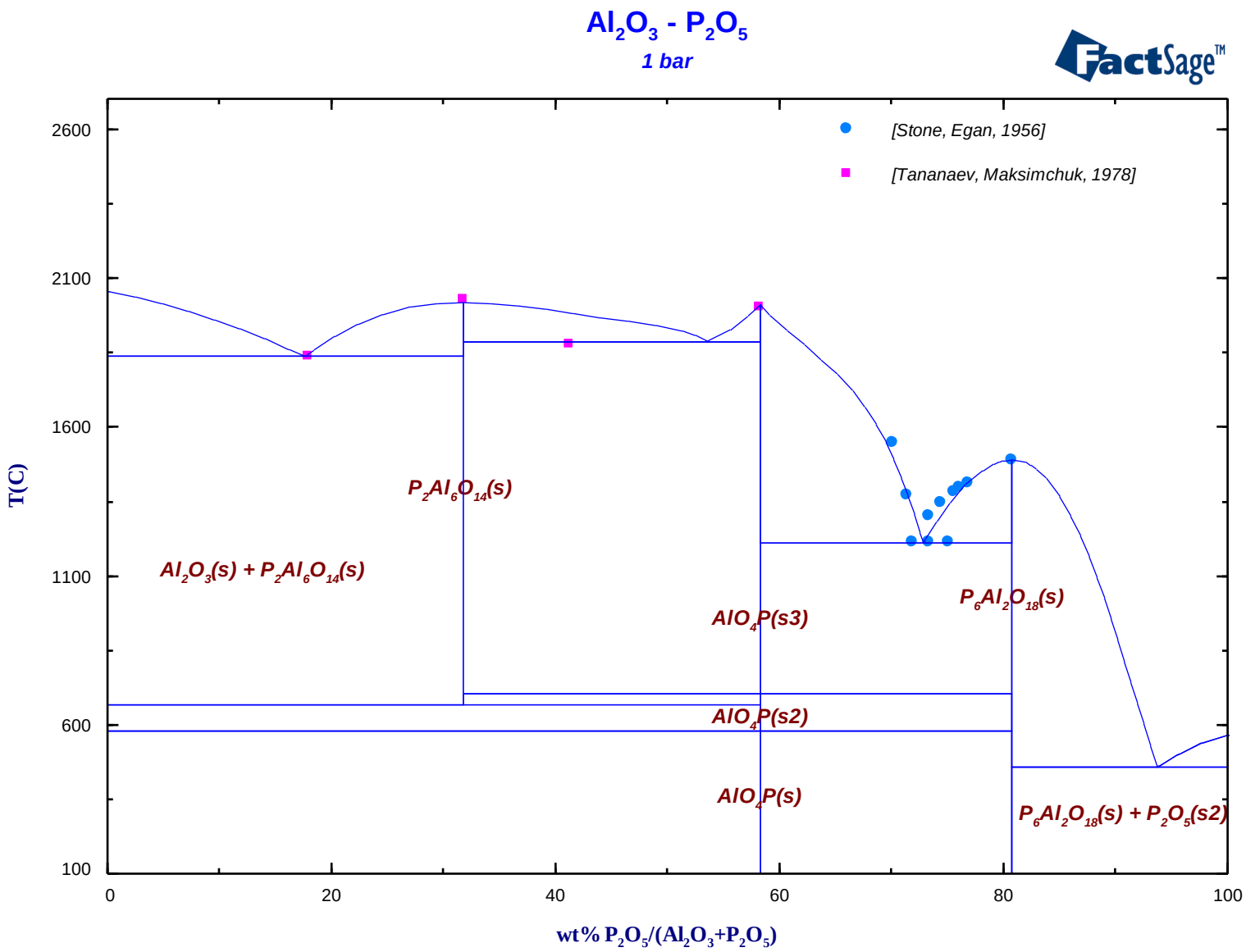
Weight percent



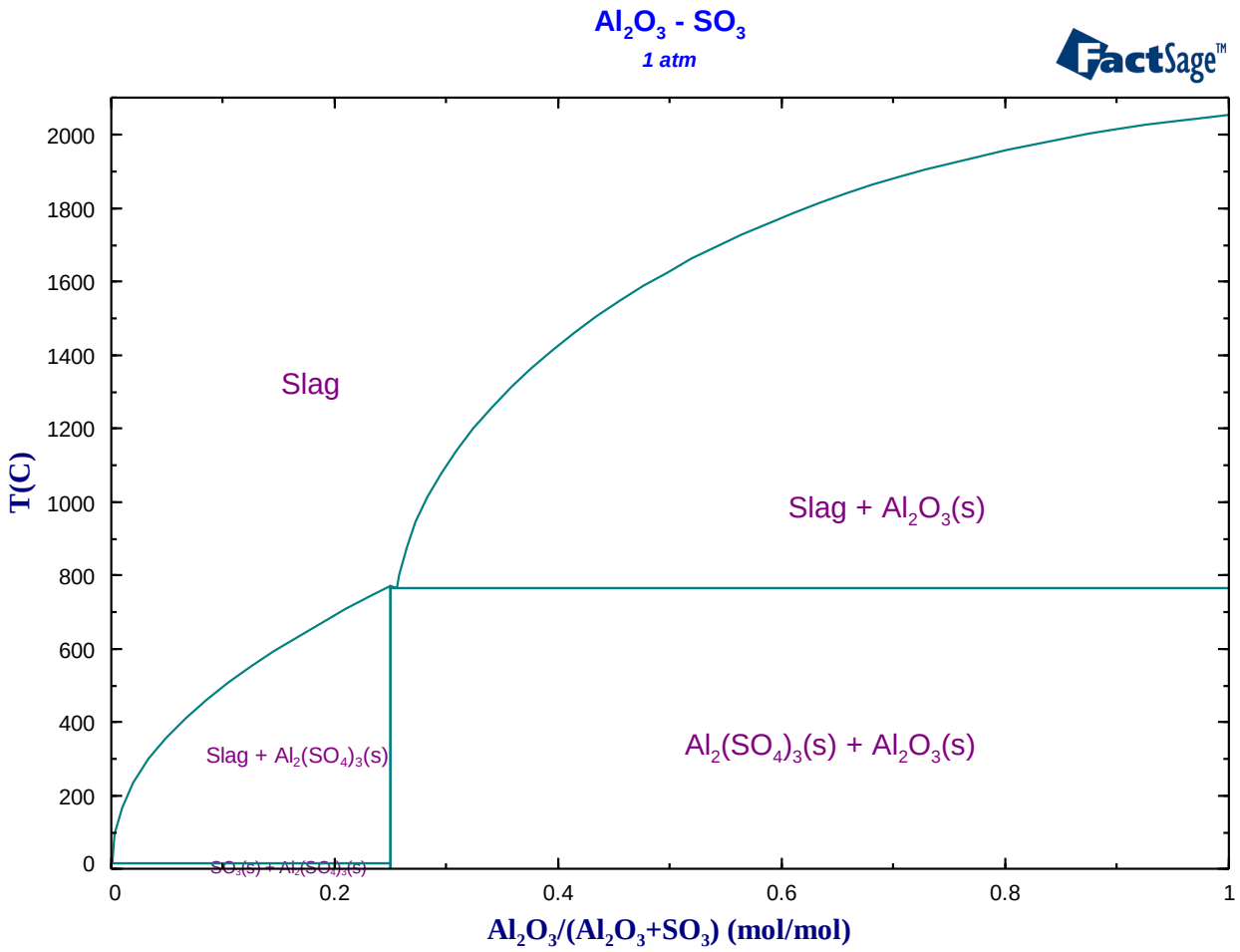
Mole fraction



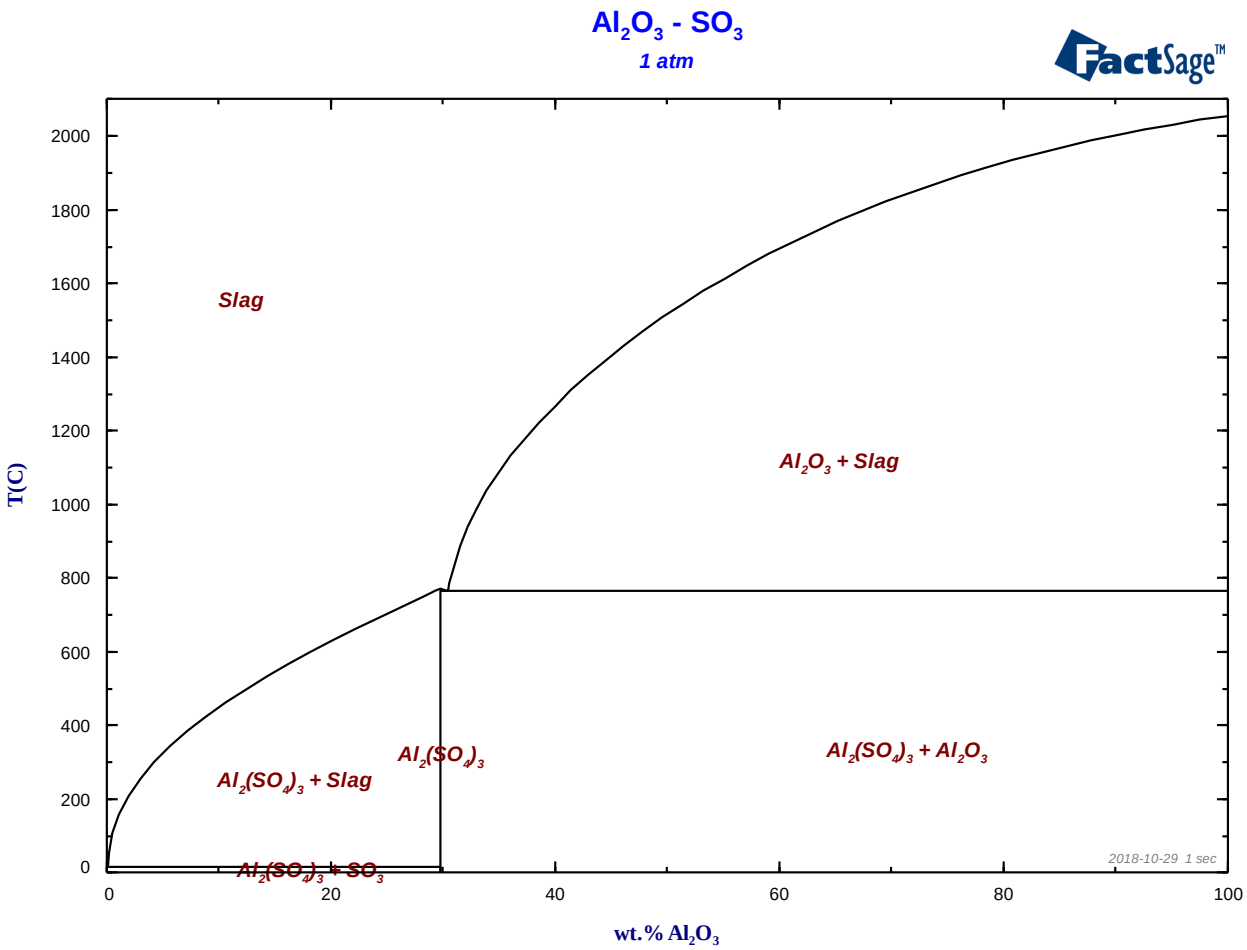
Weight percent, compared with experimental data



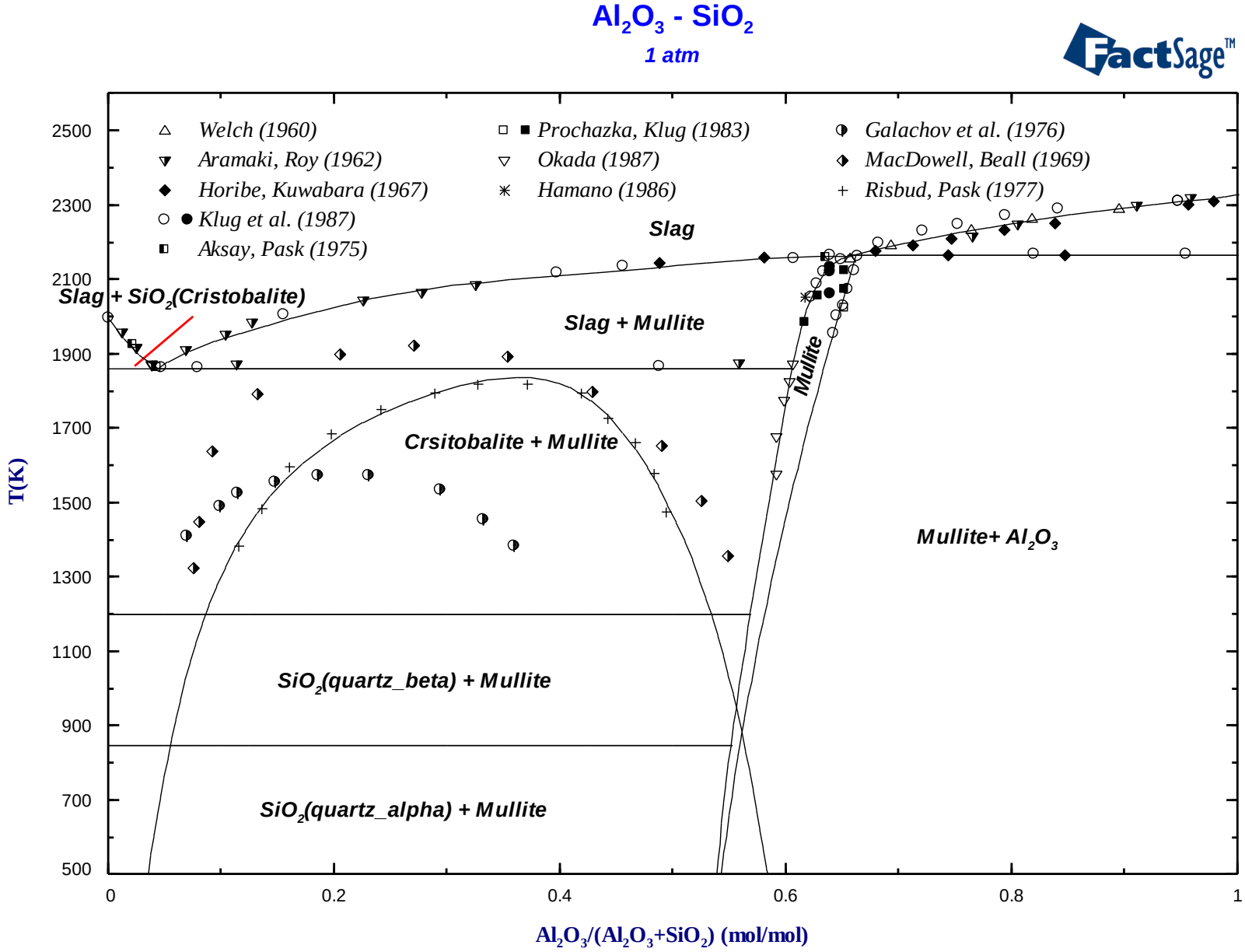
Mole fraction



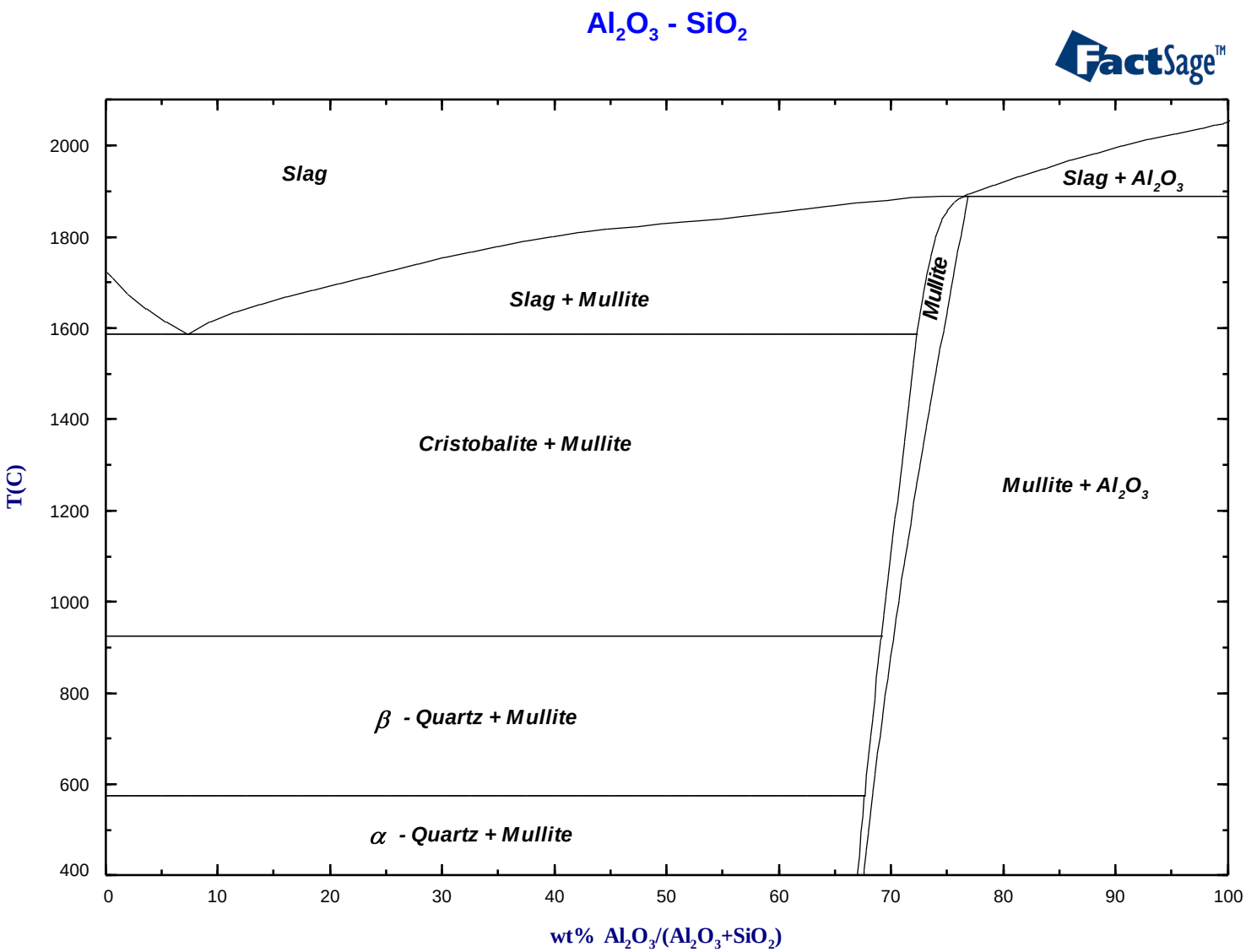
Weight percent



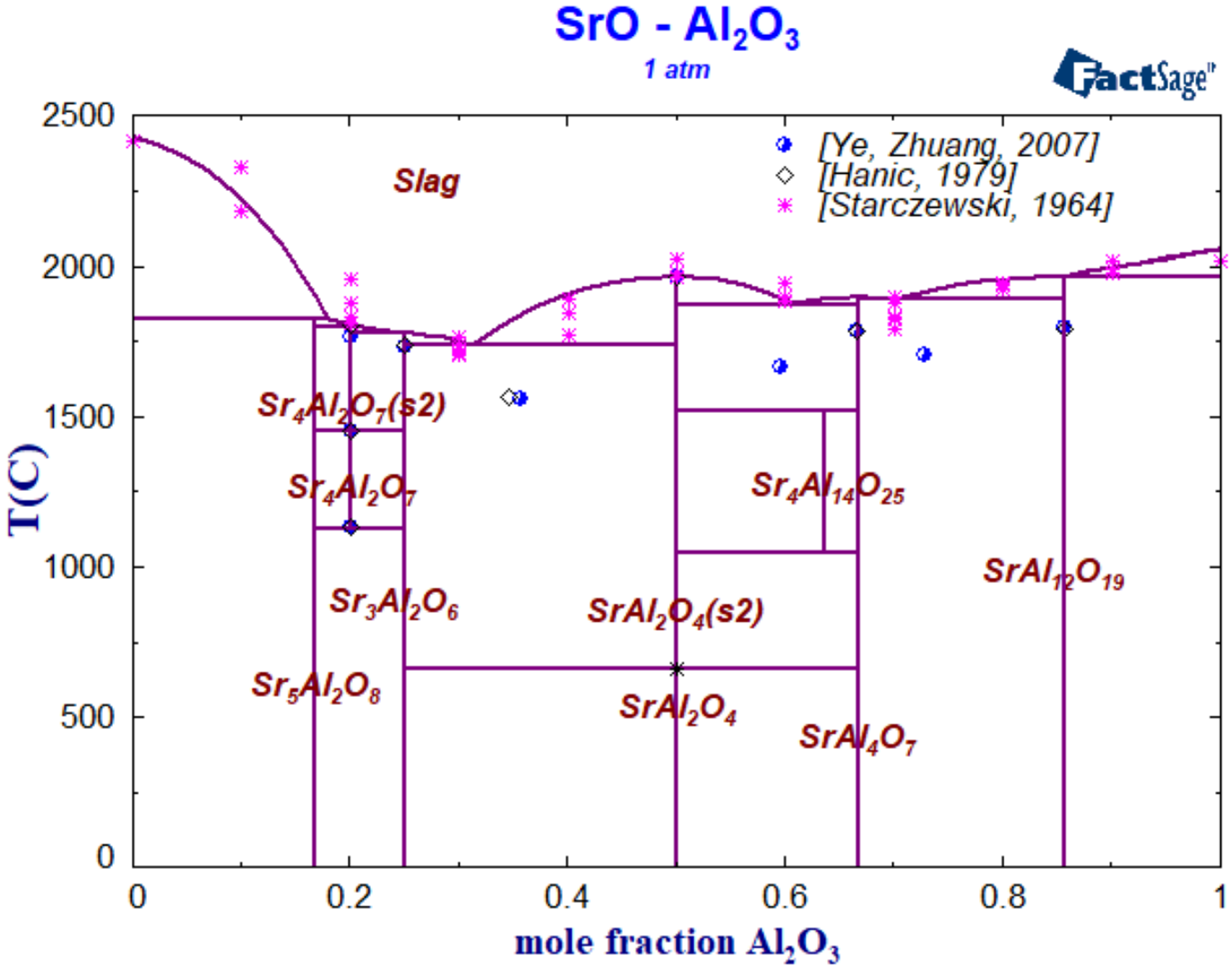
Mole fraction in Kelvin compared with experimental data



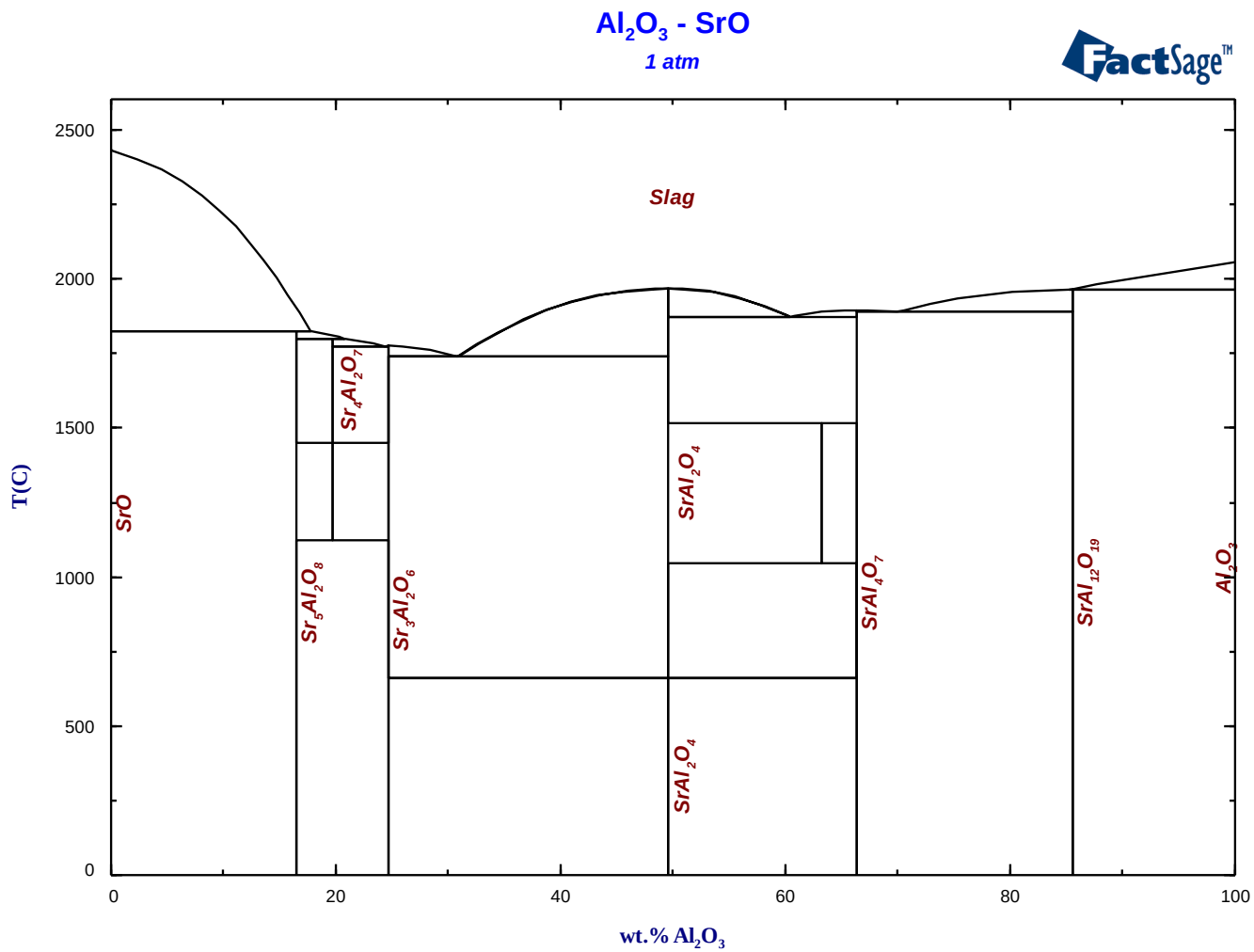
Weight percent



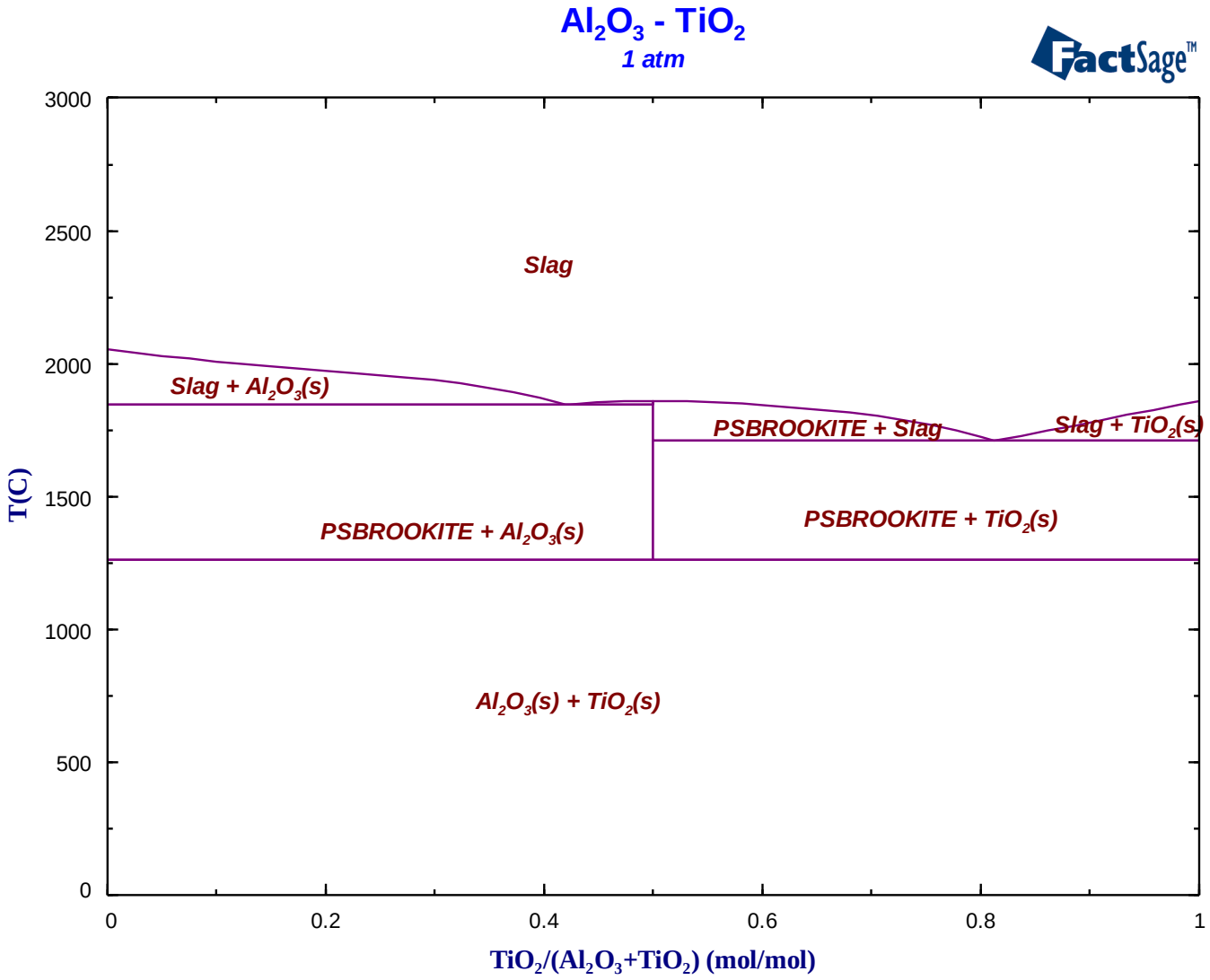
Al2O3-SrO,
Mole fraction compared with experimental data



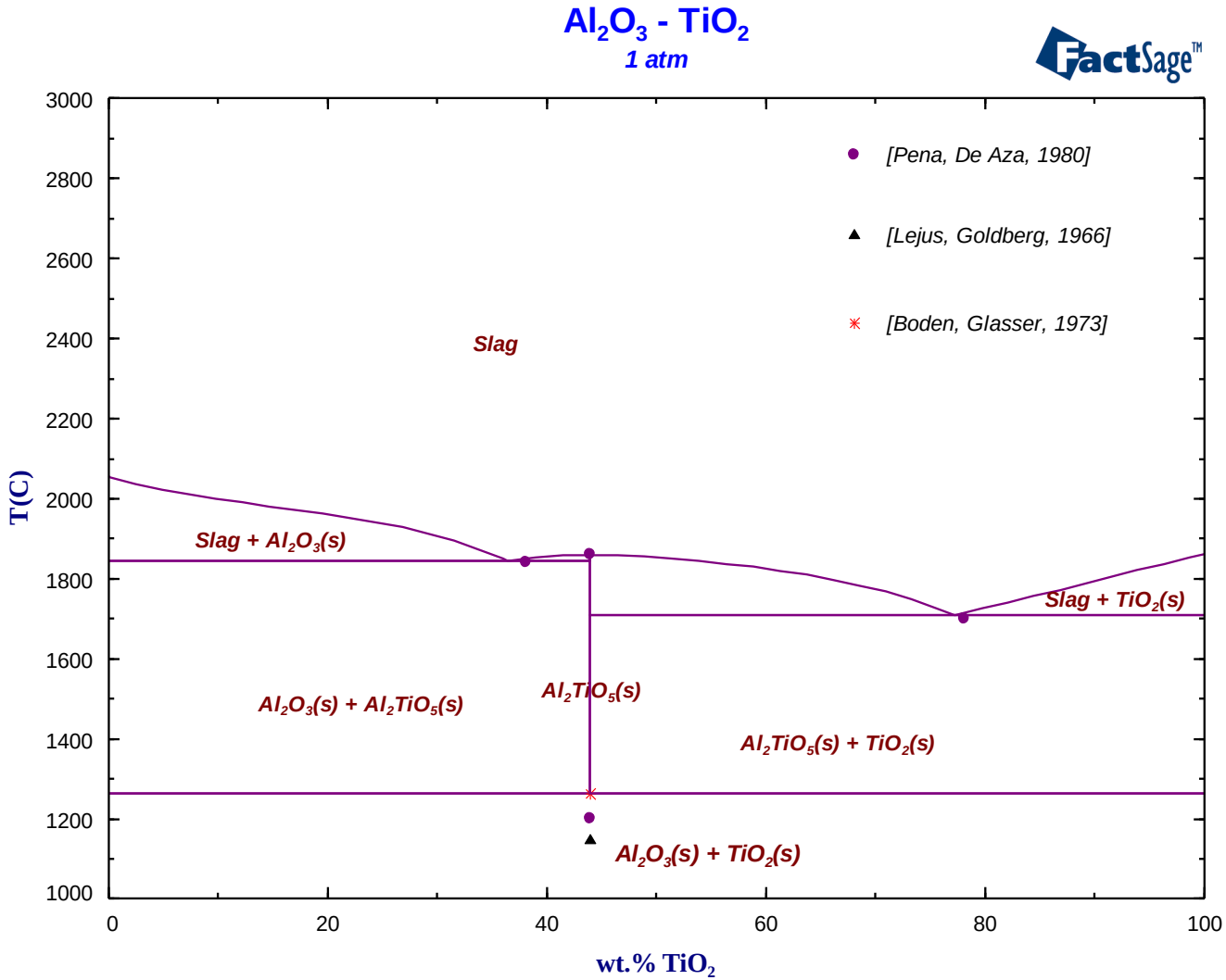
Al2O3-SrO,
Weight percent



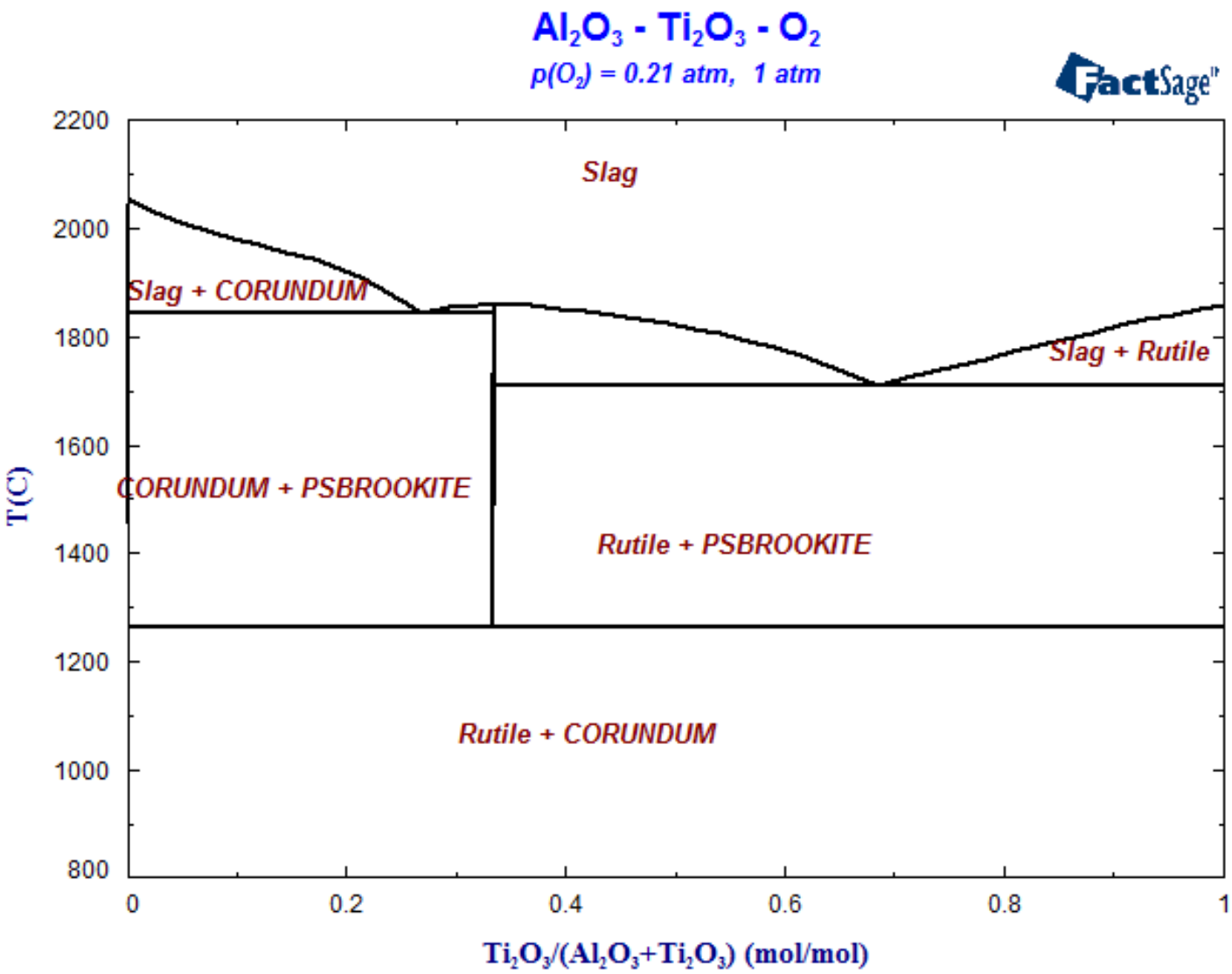
Mole fraction



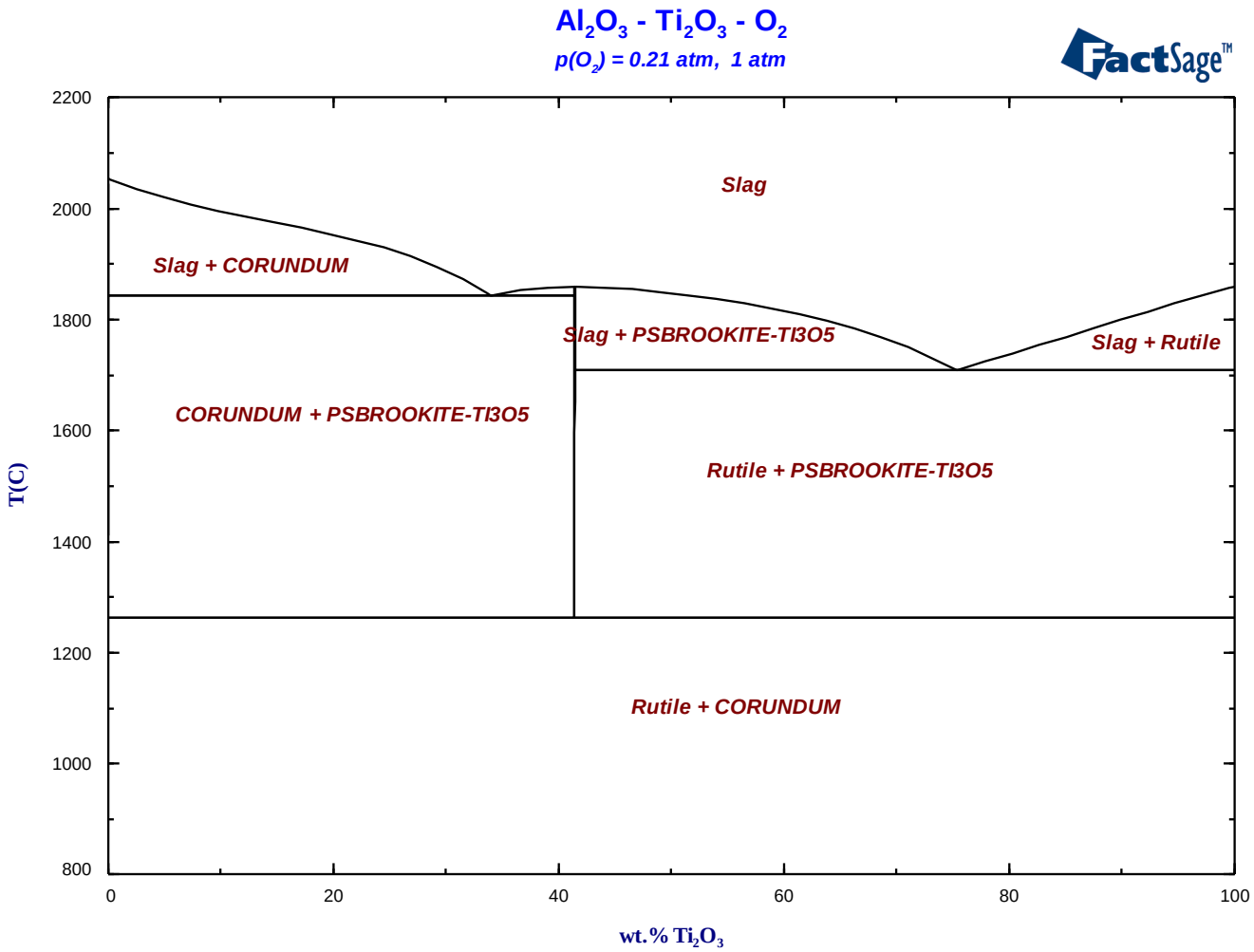
Weight percent
compared with experimental data



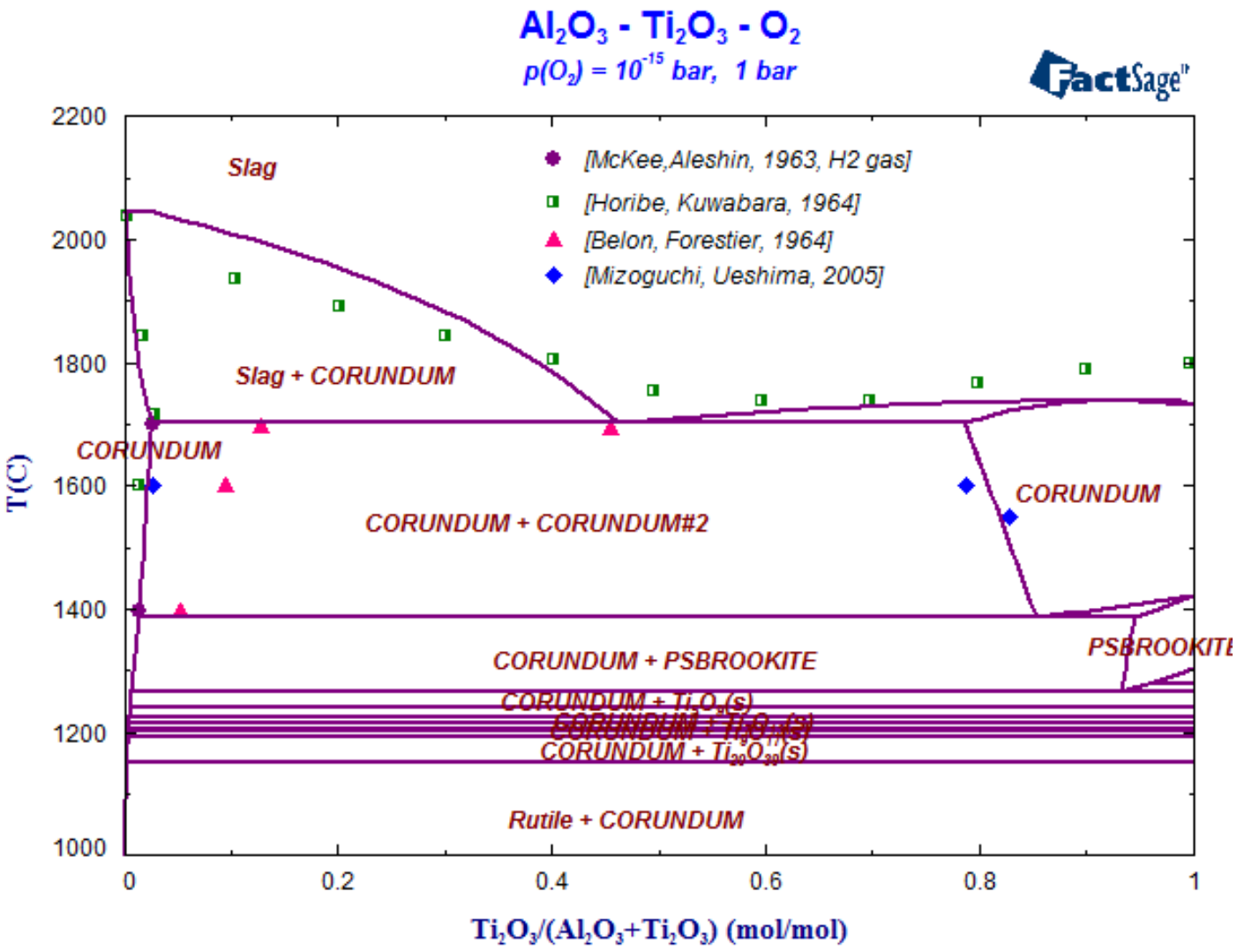
Mole fraction



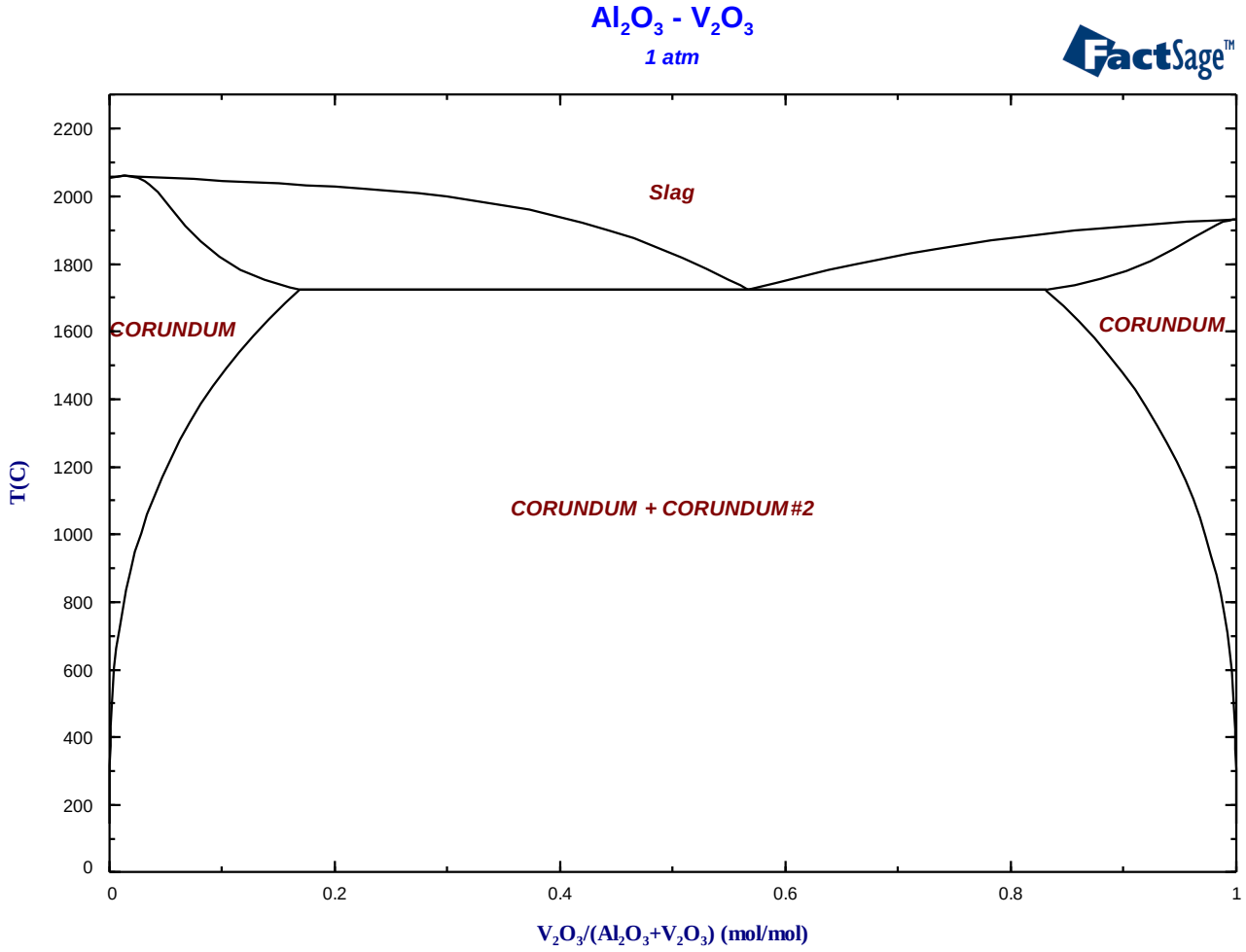
Weight percent



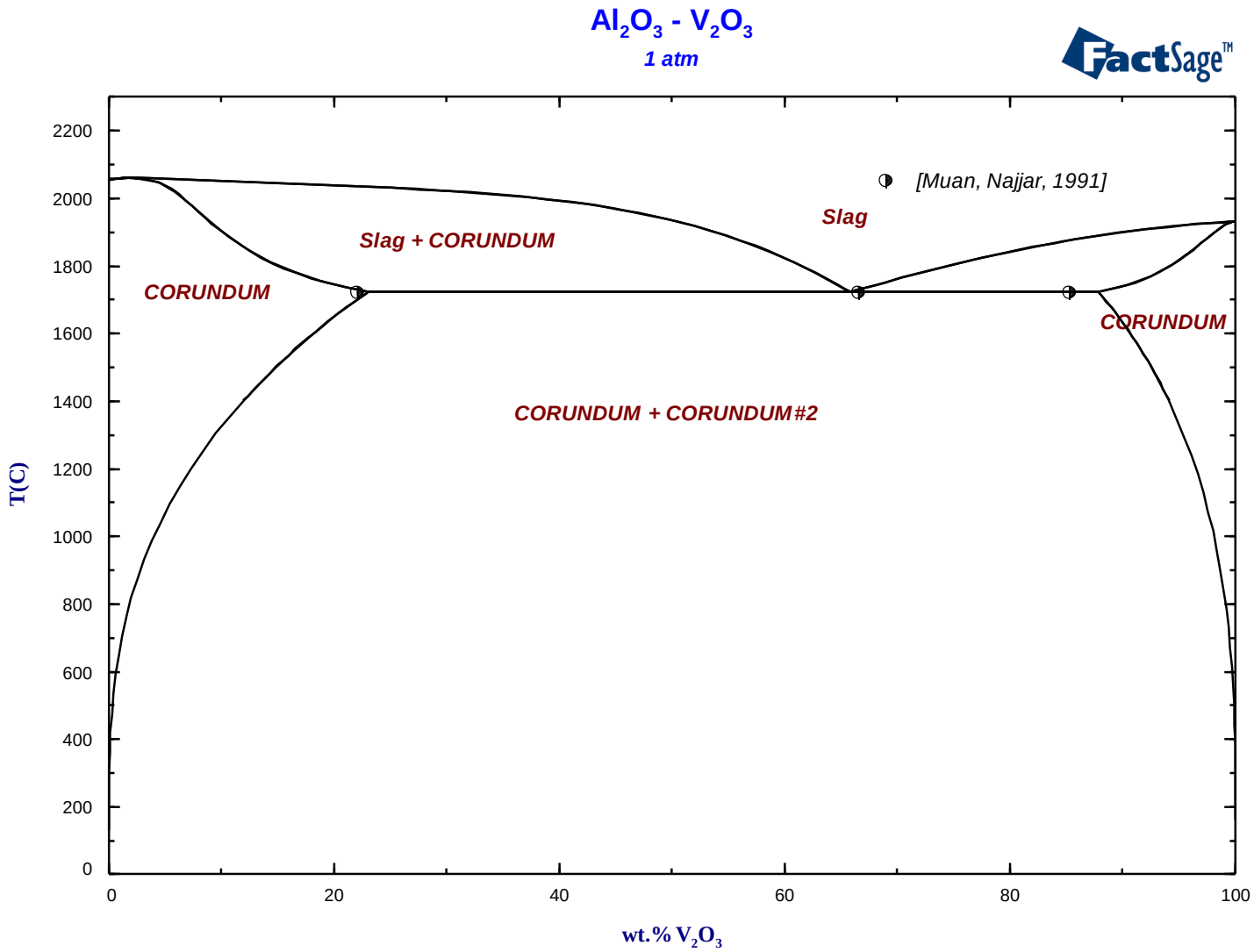
Mole fraction, P(O2)=10^{-15} bar compared with experimental data



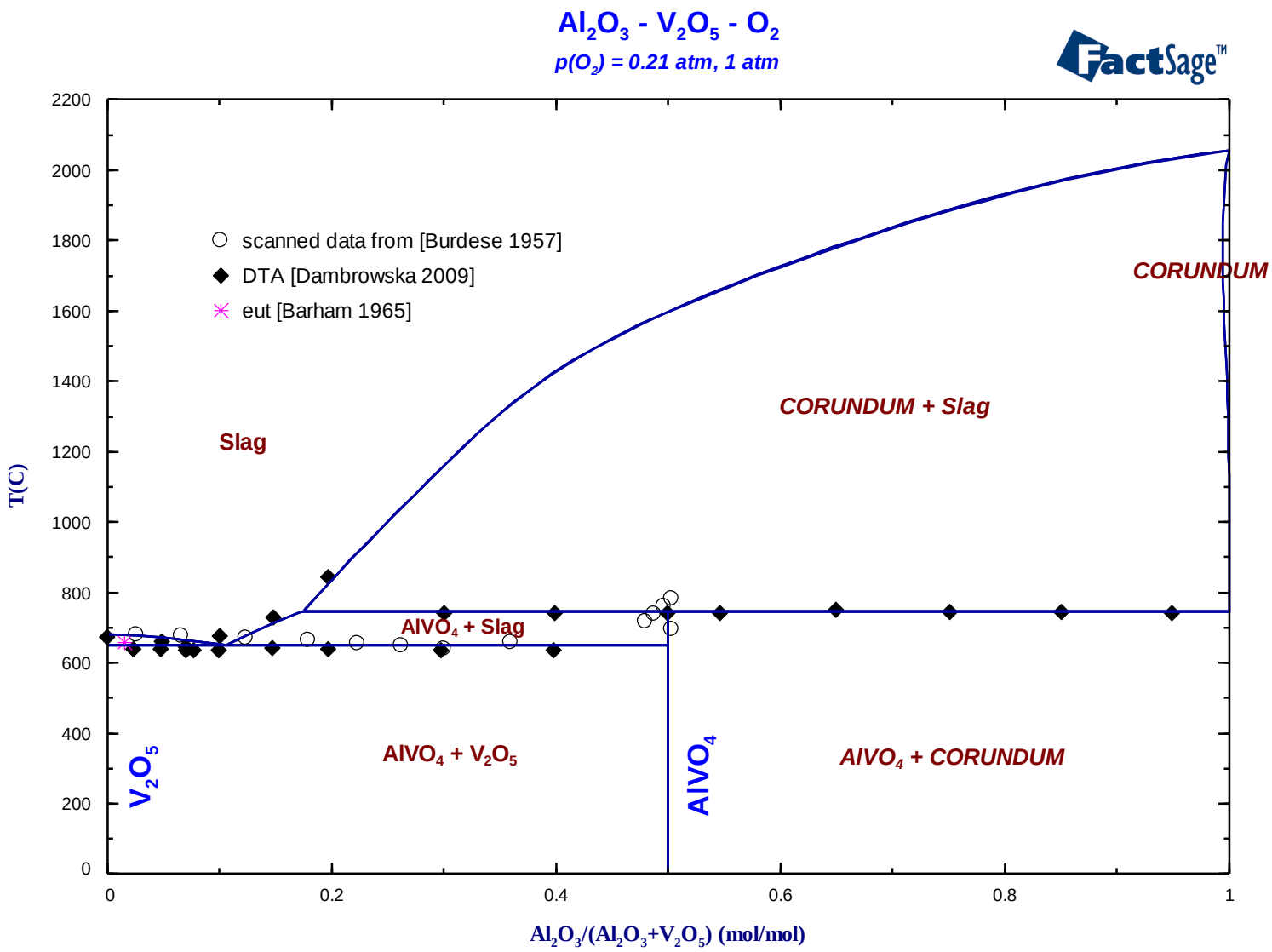
Al2O3-V2O3,
Mole fraction



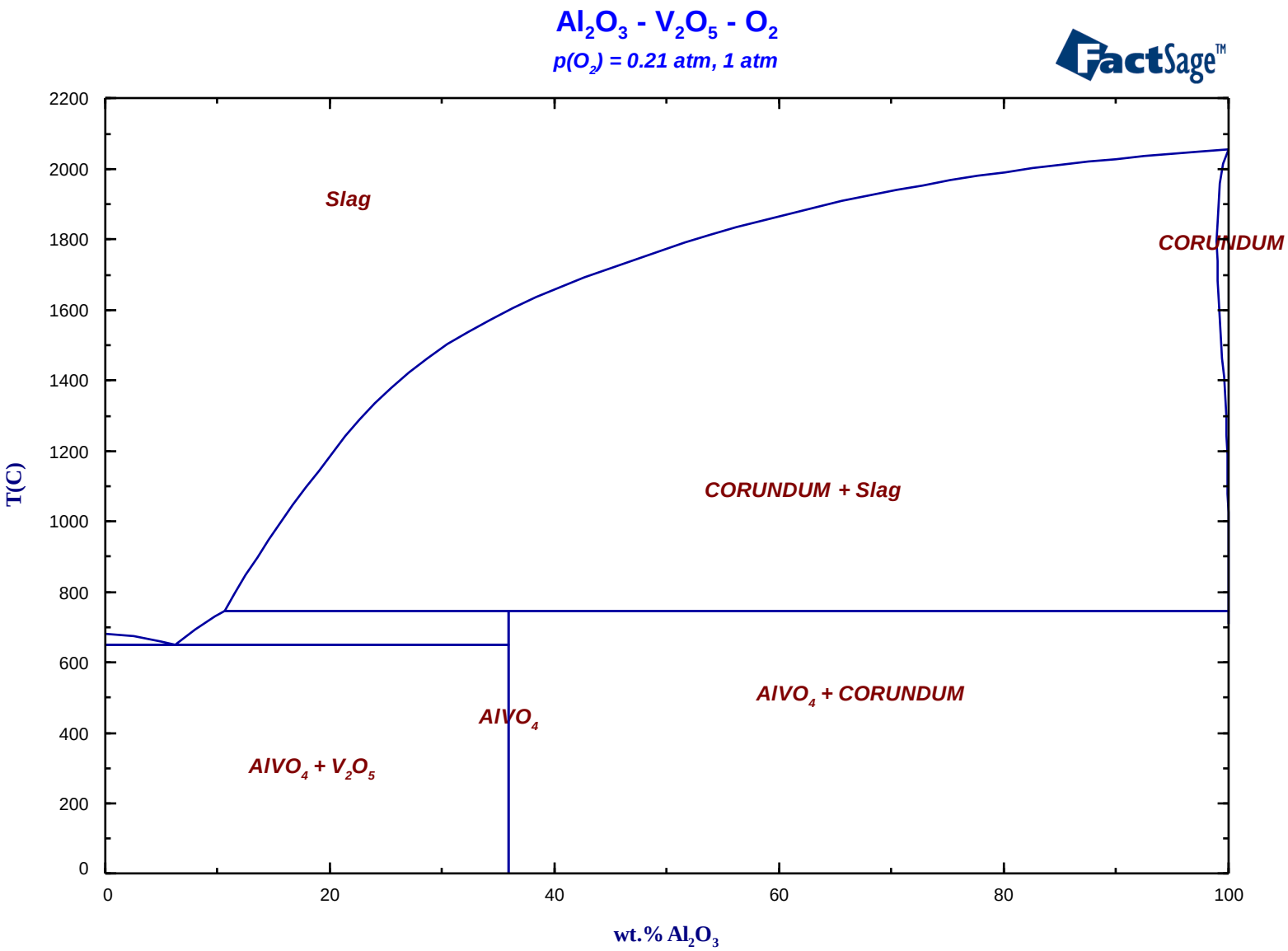
Al2O3-V2O3,
Weight percent



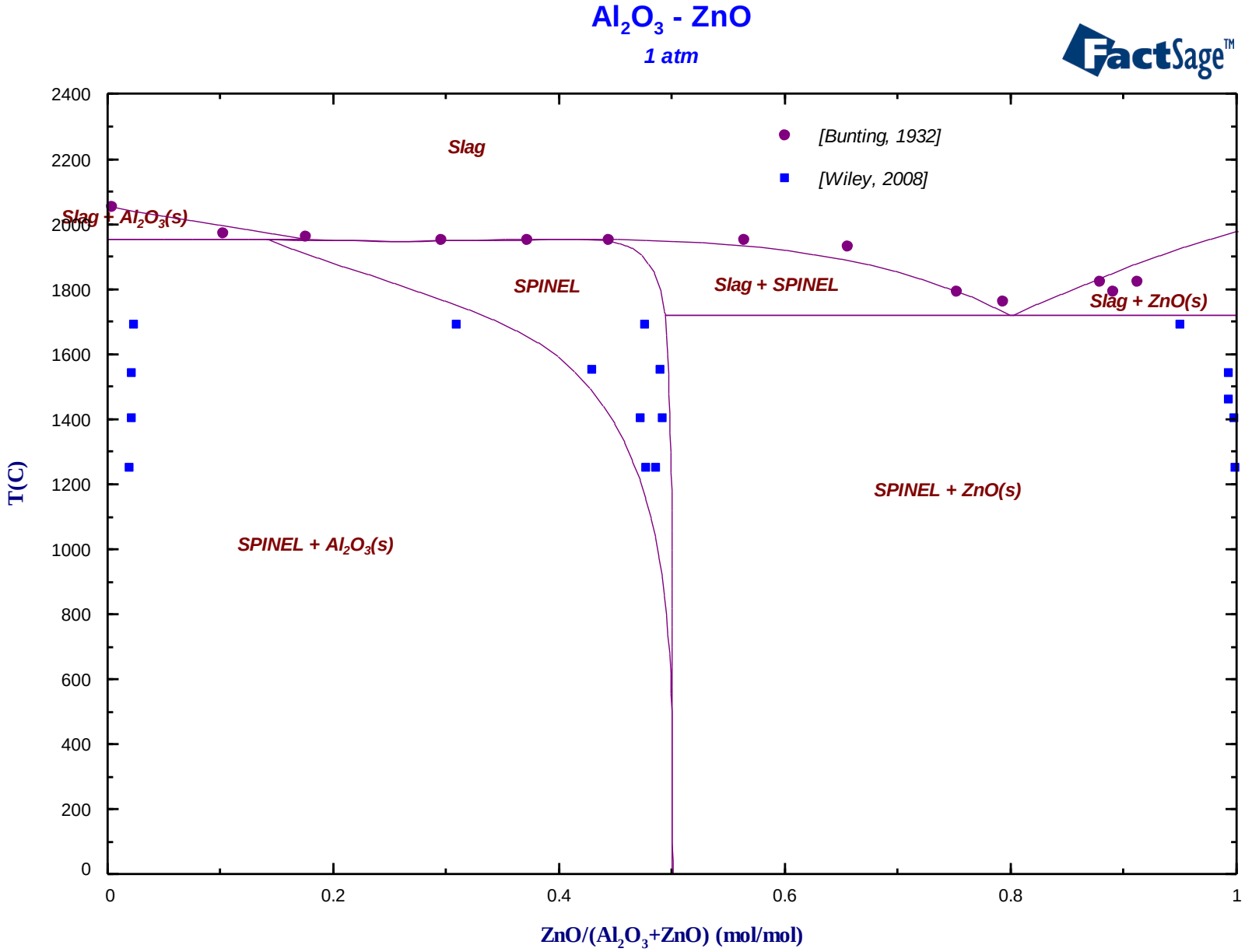
Al2O3-V2O5-O2,
Mole fraction compared with experimental data



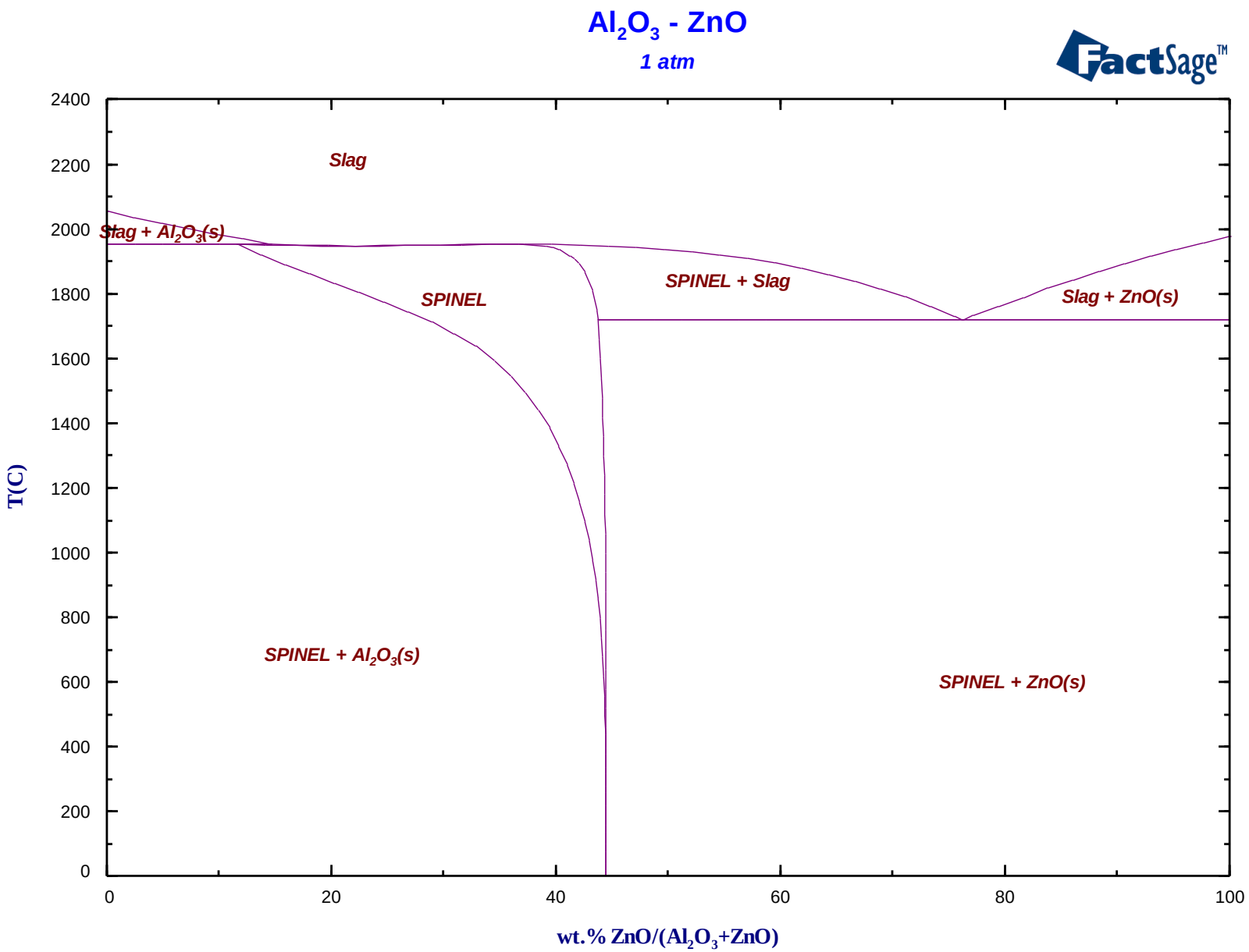
Al2O3-V2O5-O2, Weight percent



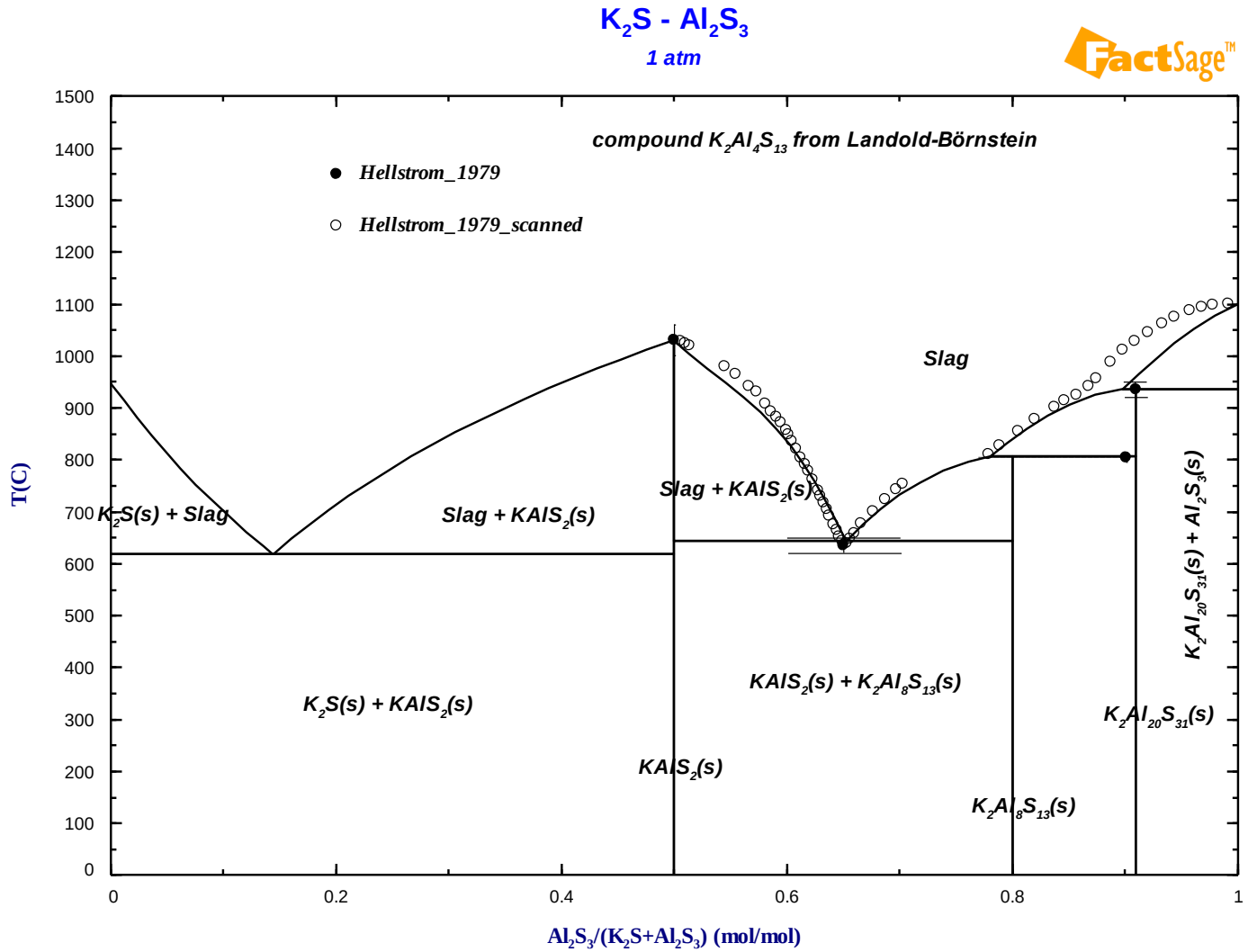
Mole fraction
compared with experimental data



Weight percent



Mole fraction
compared with experimental data



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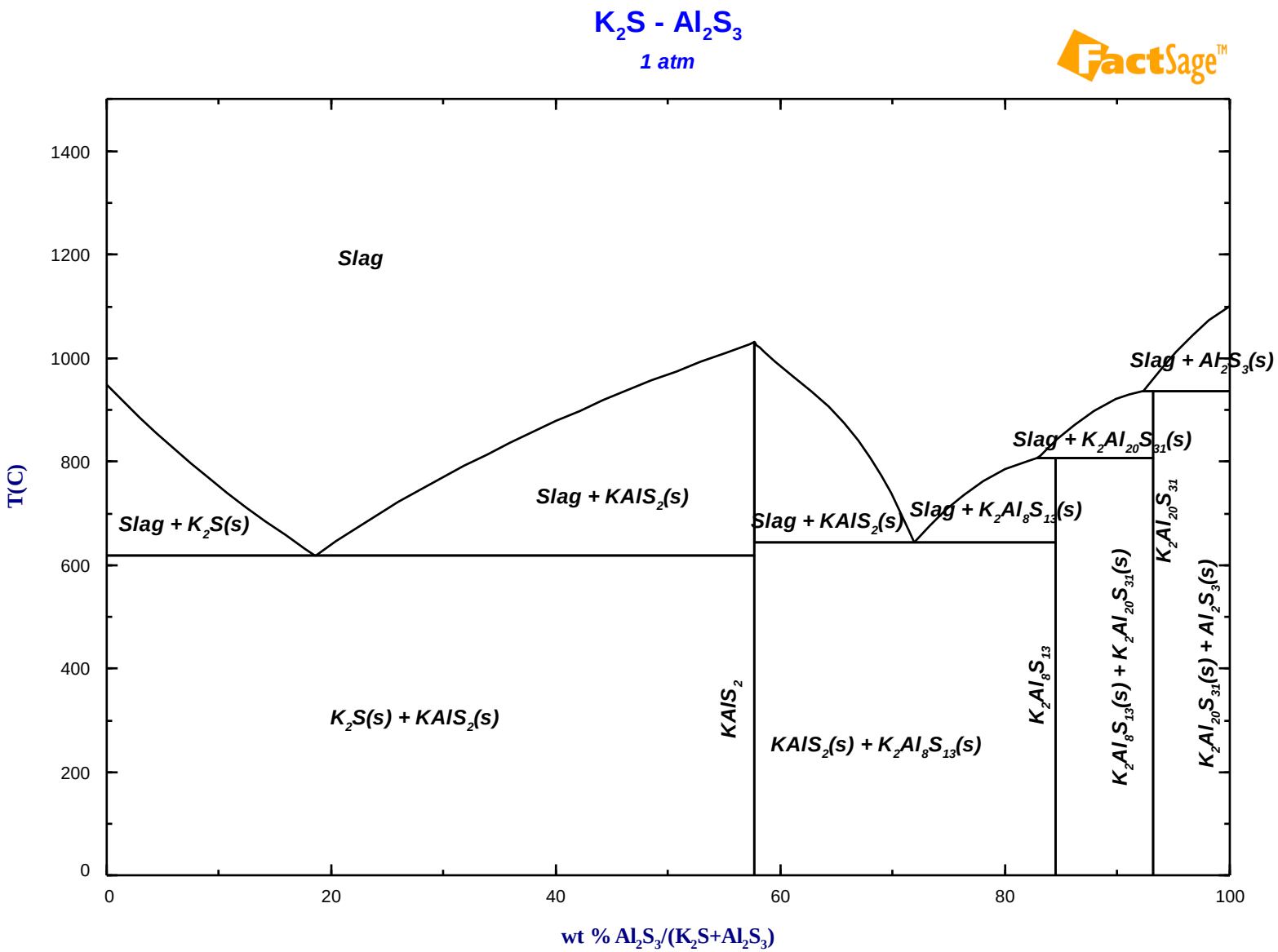
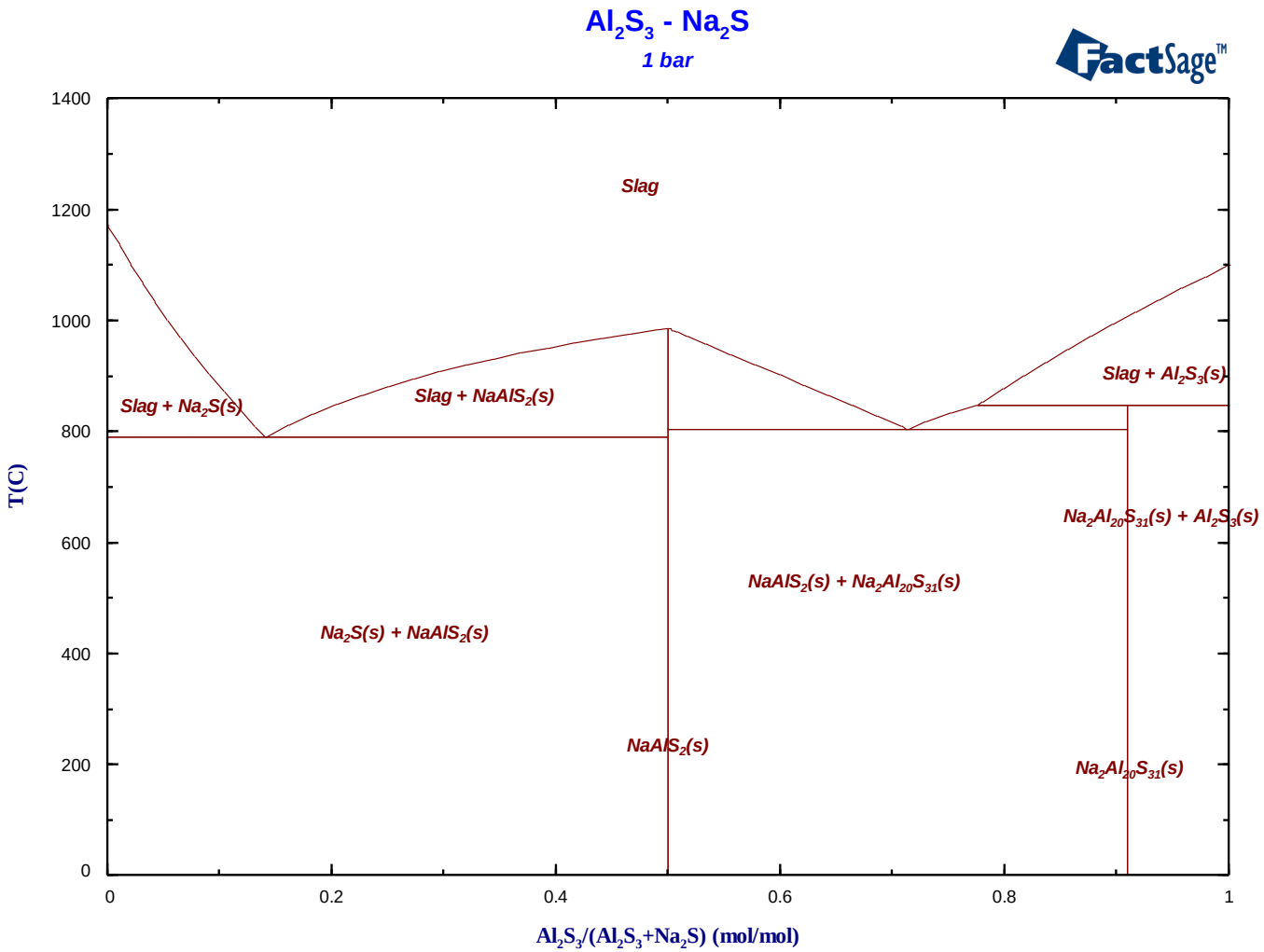
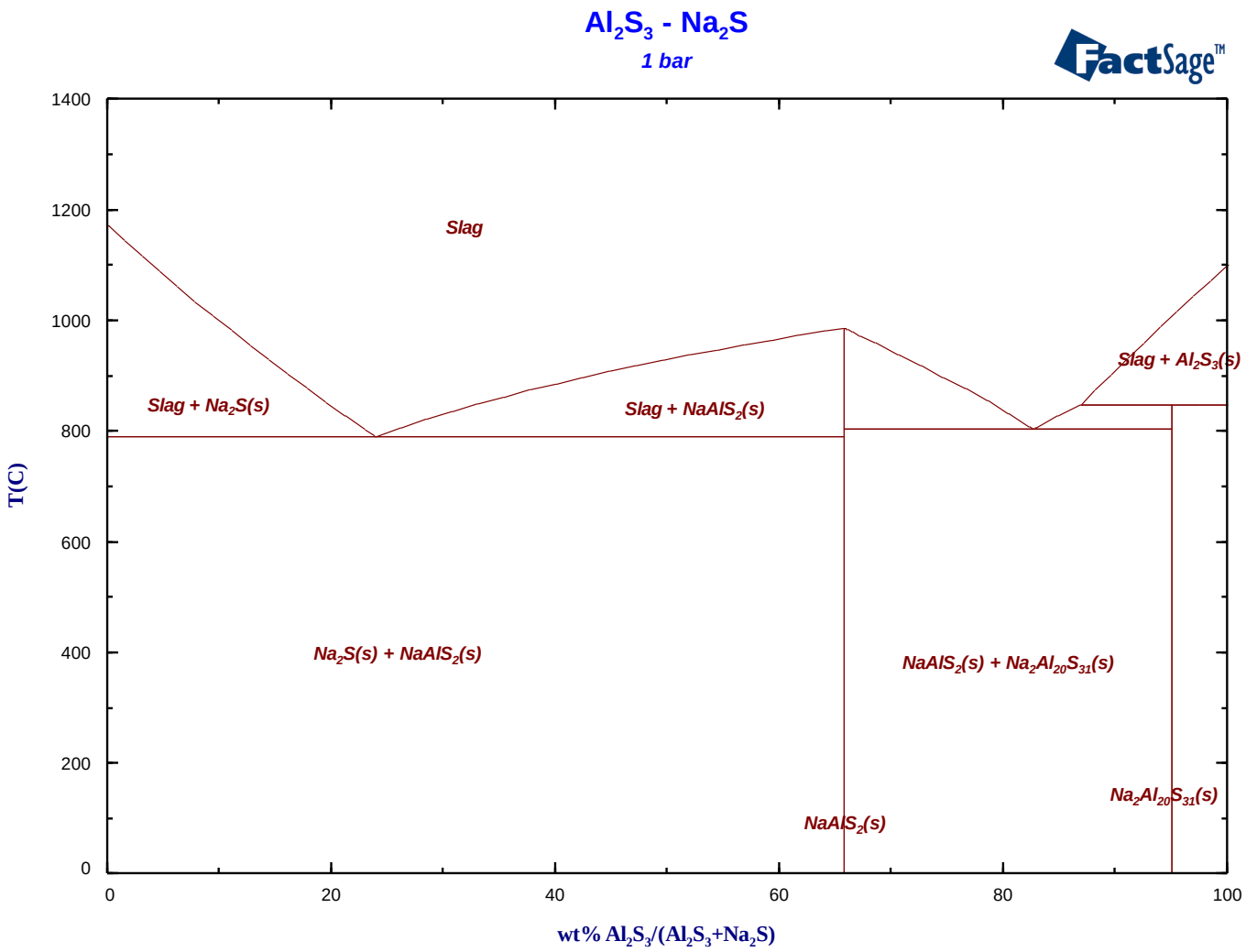


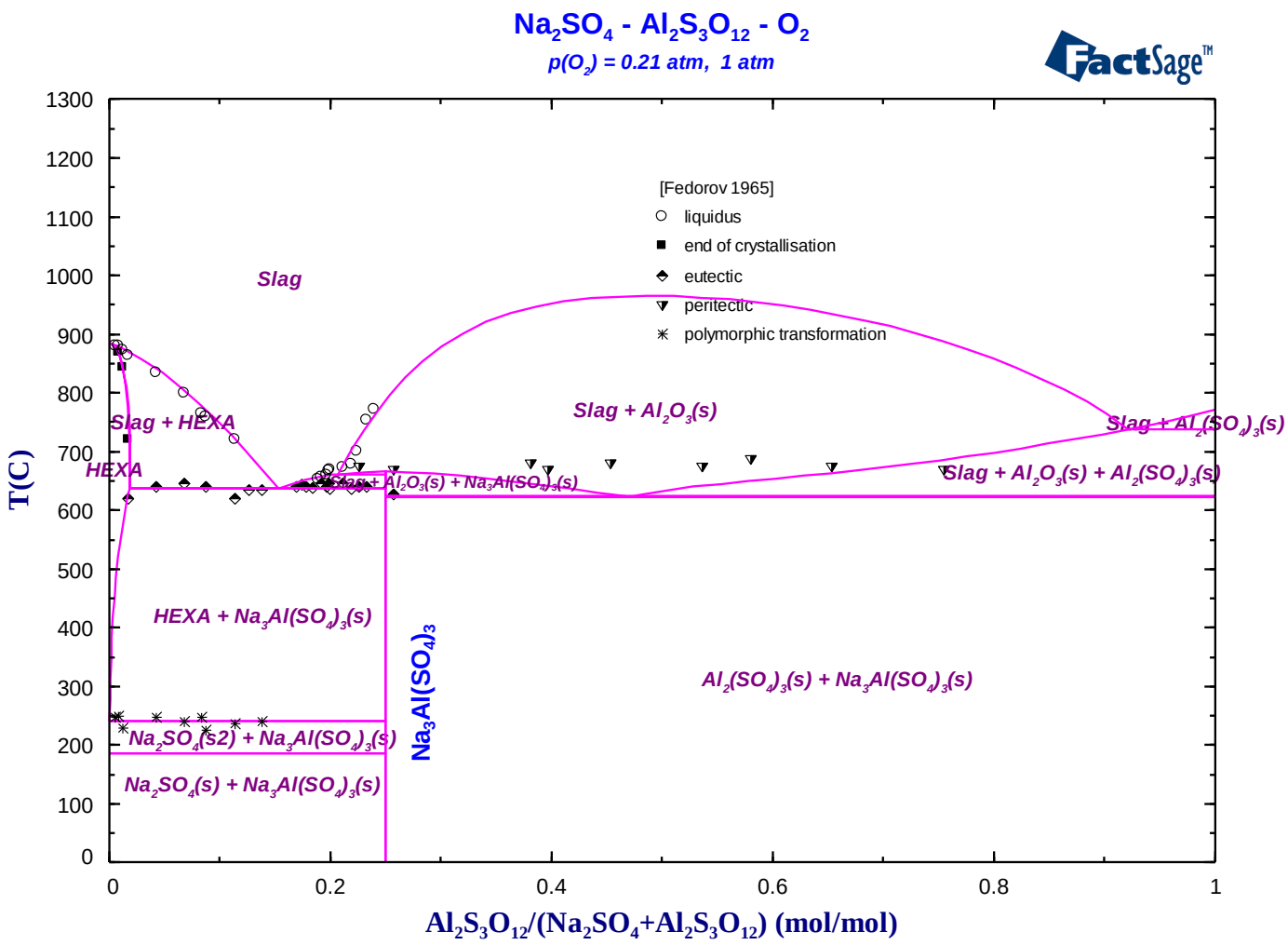
Mole fraction
compared with experimental data



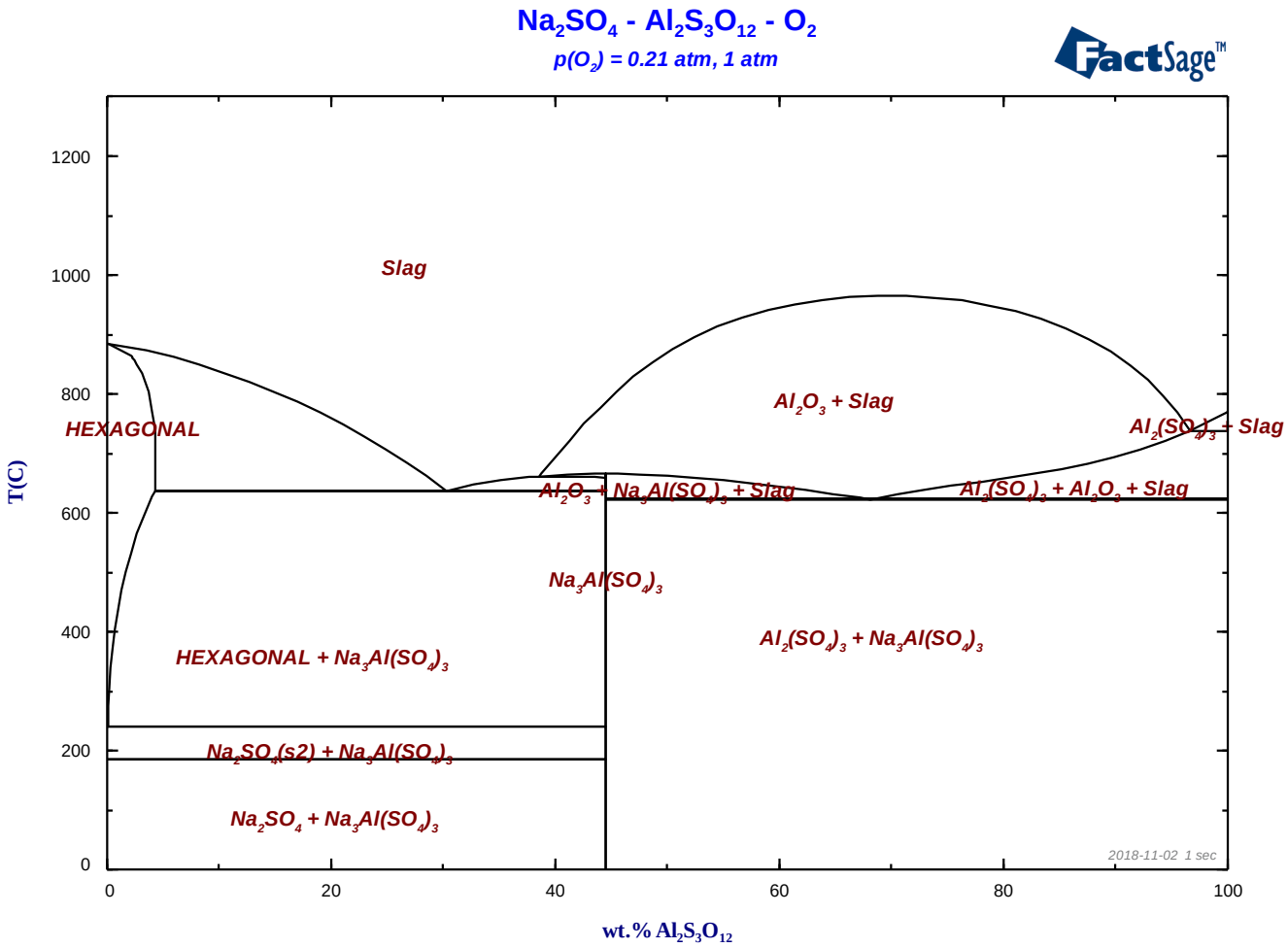
Weight percent



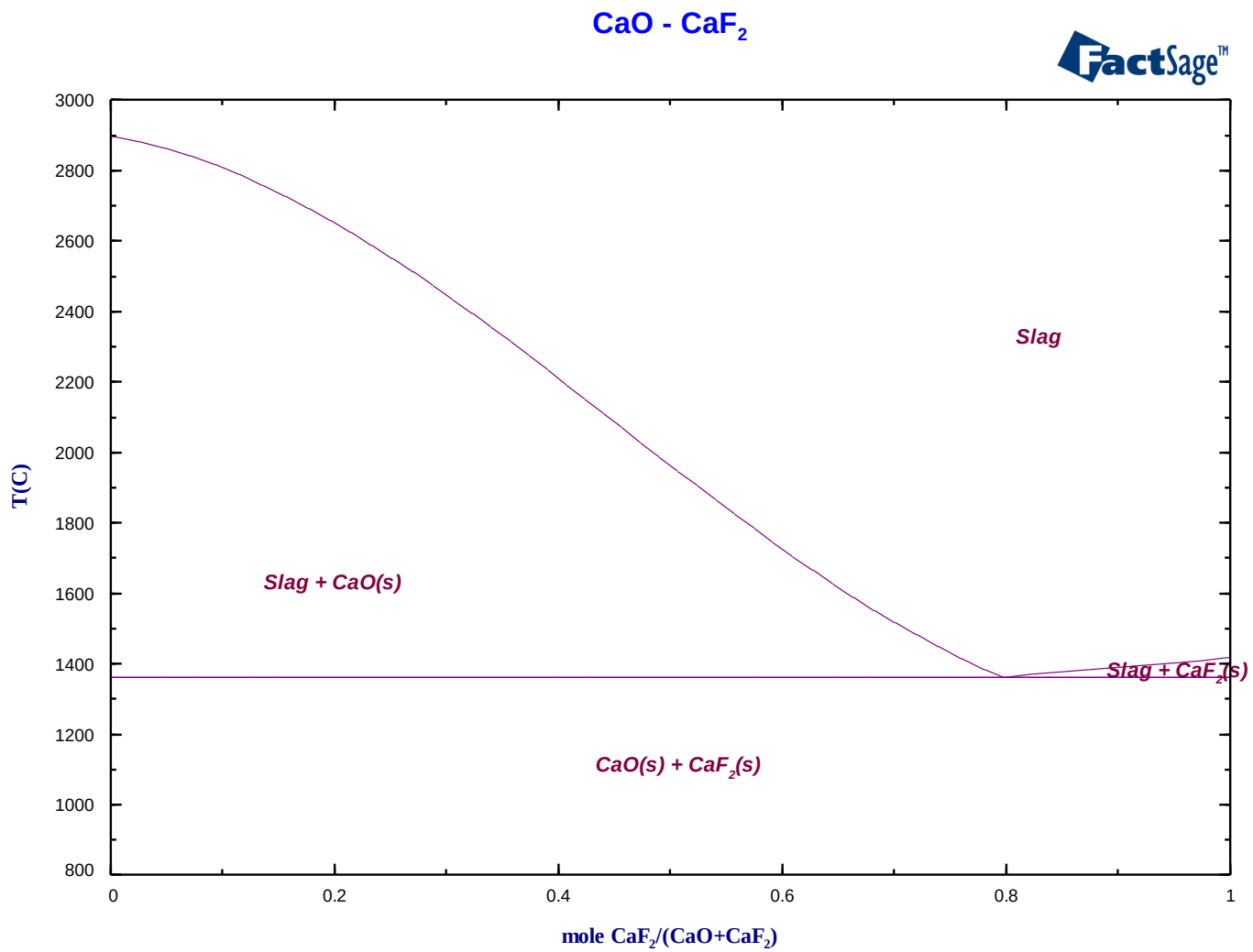
Mole fraction compared with experimental data



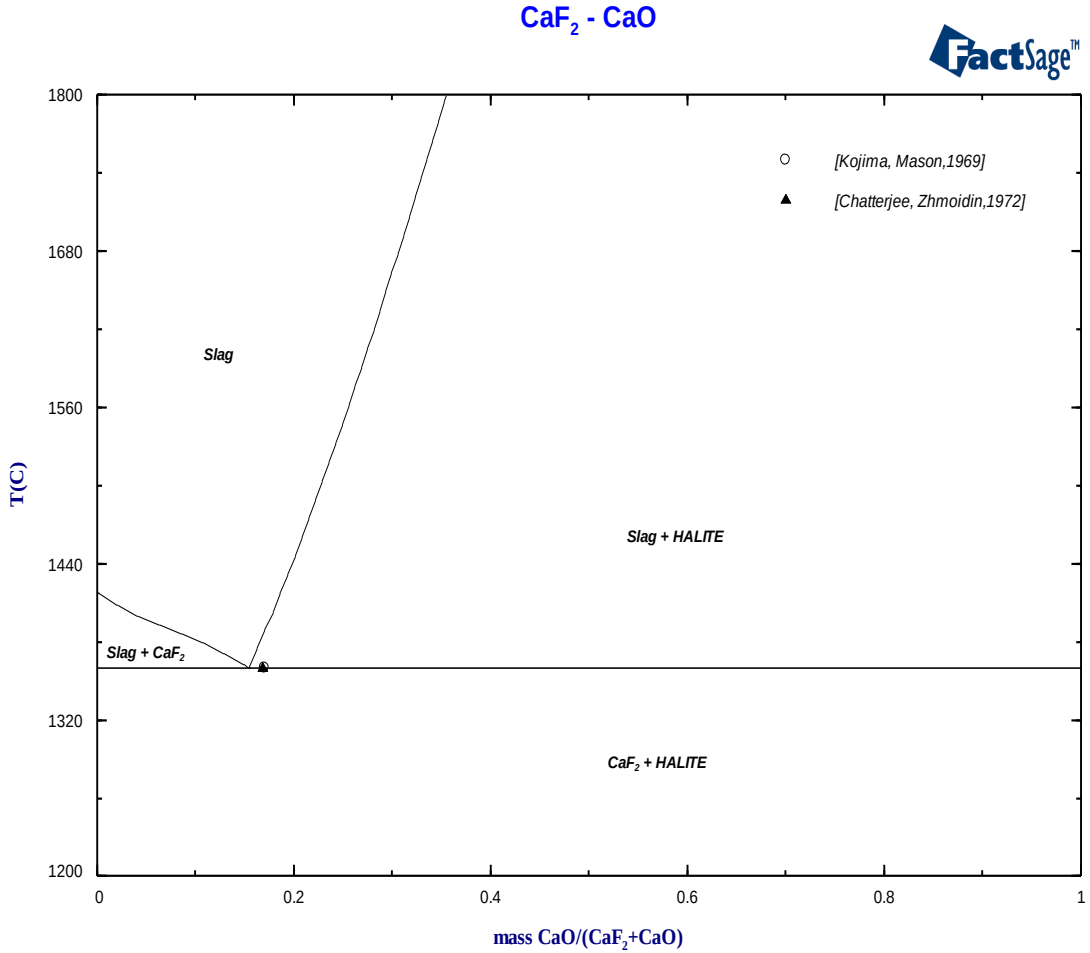
Al2(SO4)3-Na2SO4, Weight percent



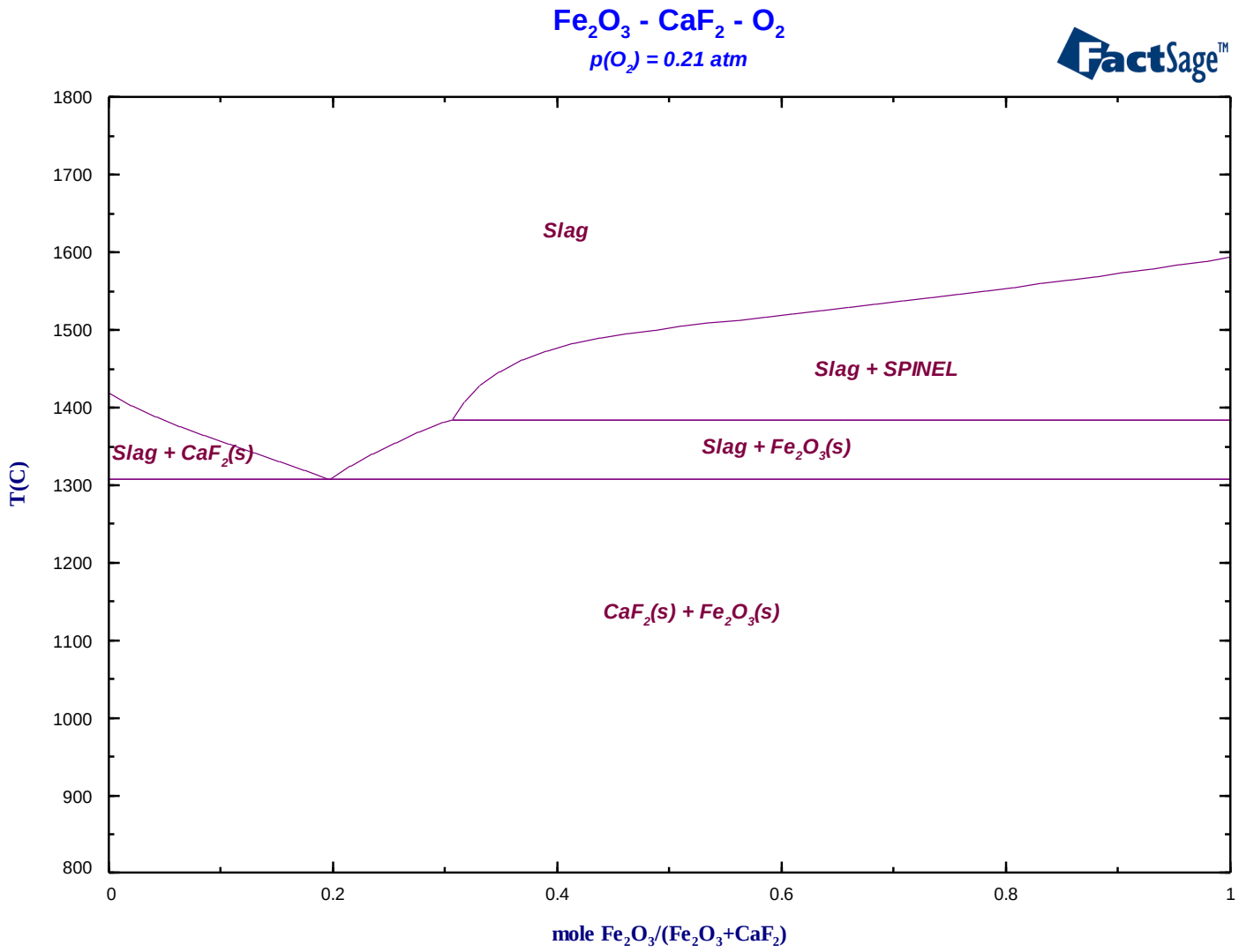
Mole fraction



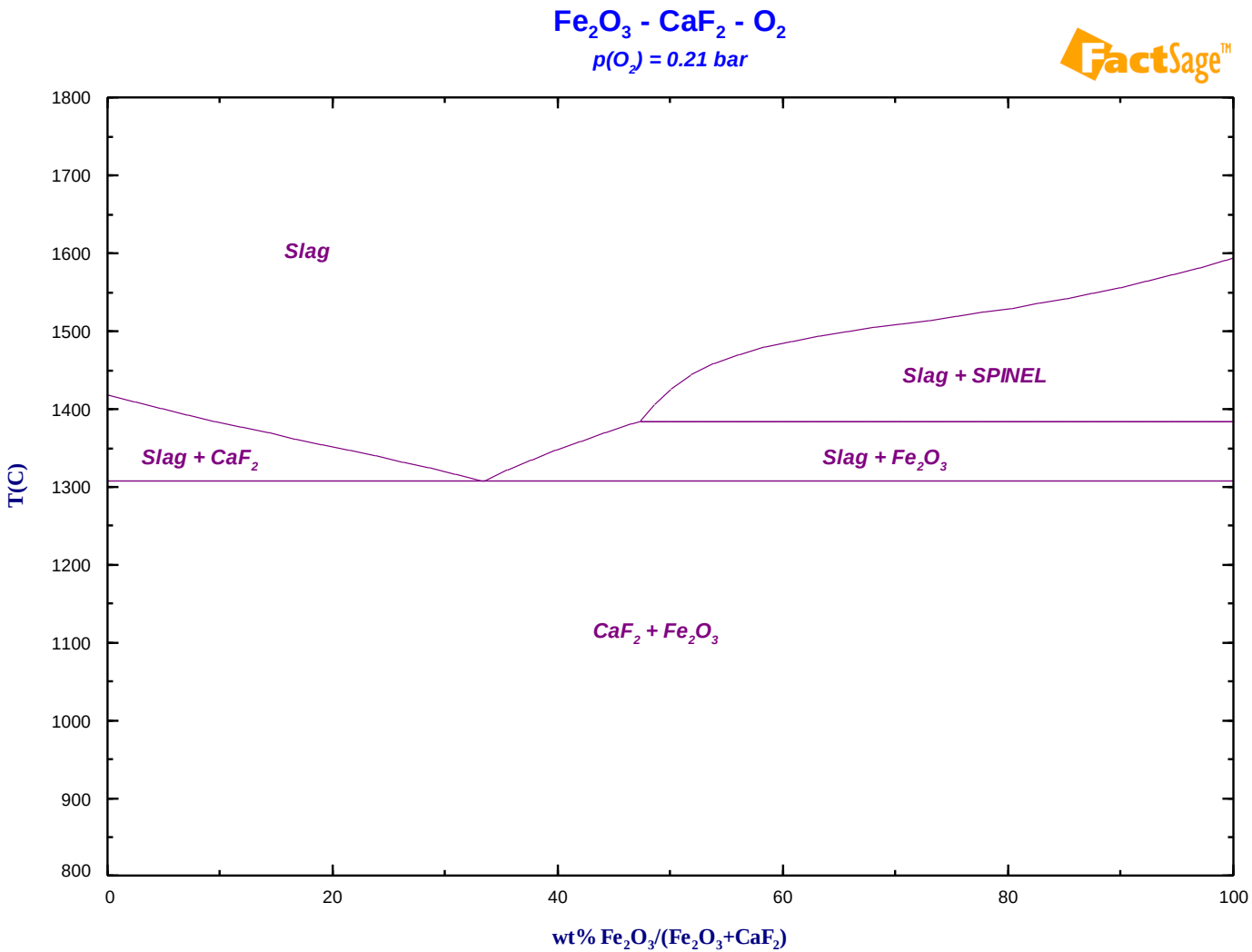
Weight percent
compared with experimental data



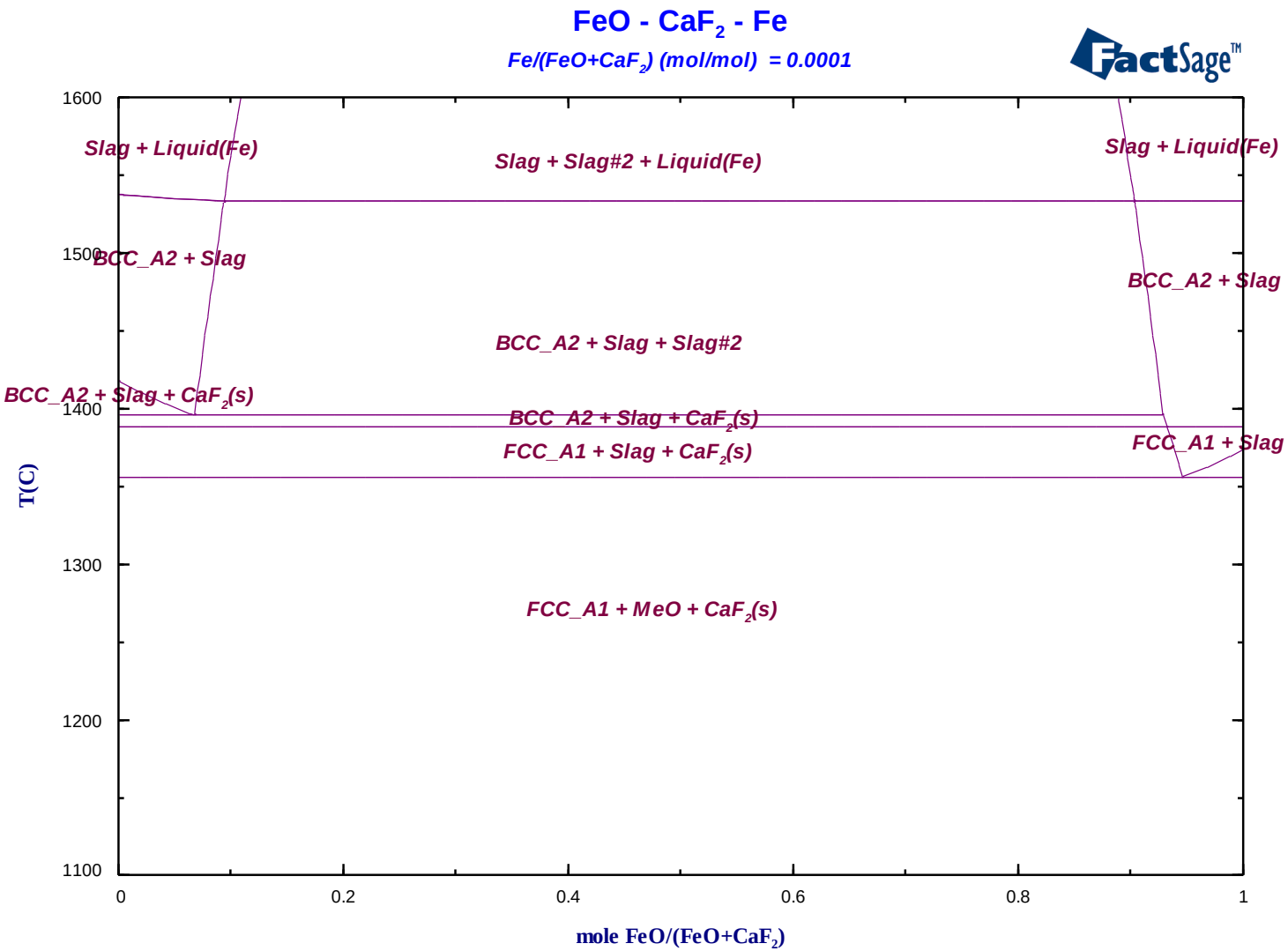
Mole fraction



Weight percent



Mole fraction



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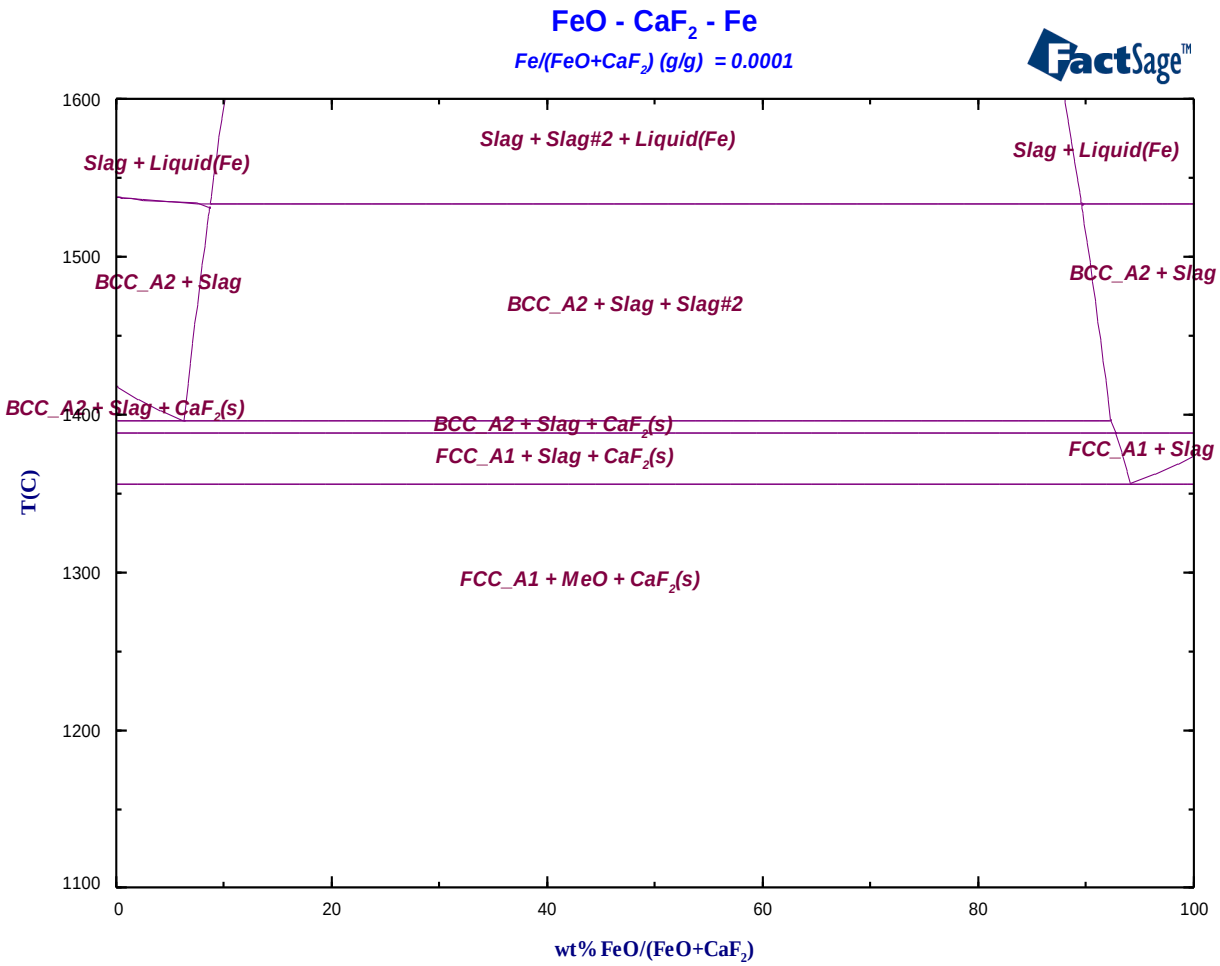
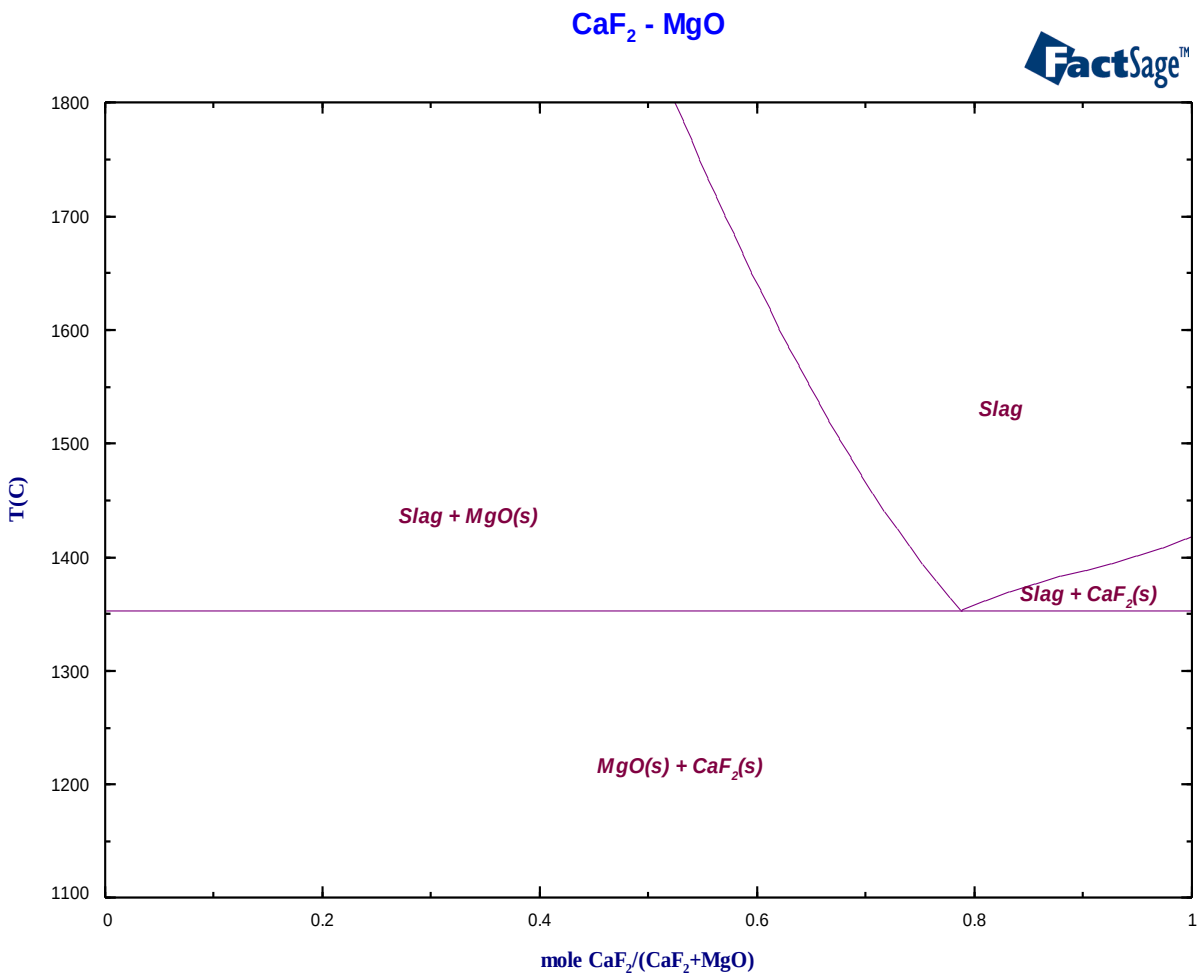


Mole fraction



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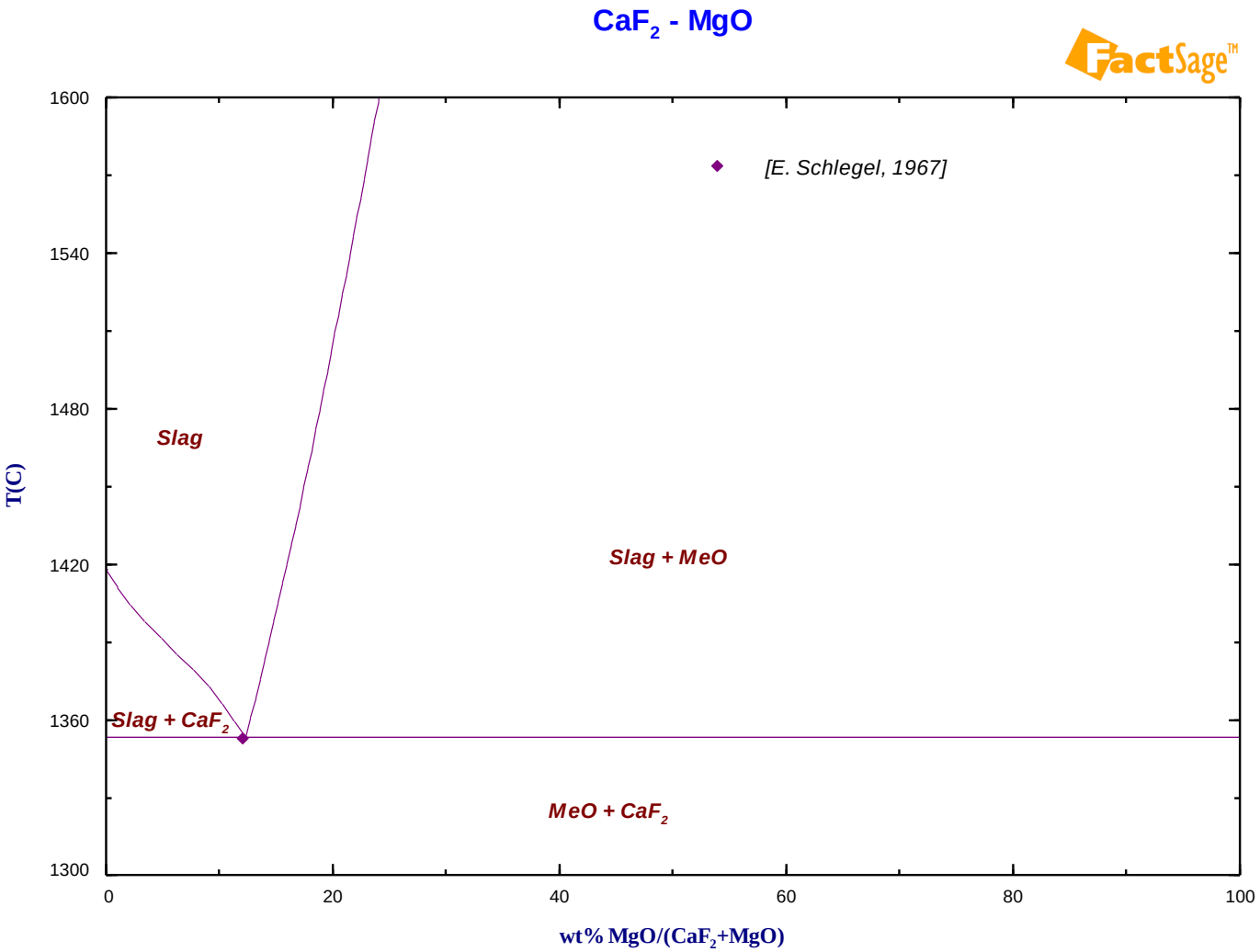
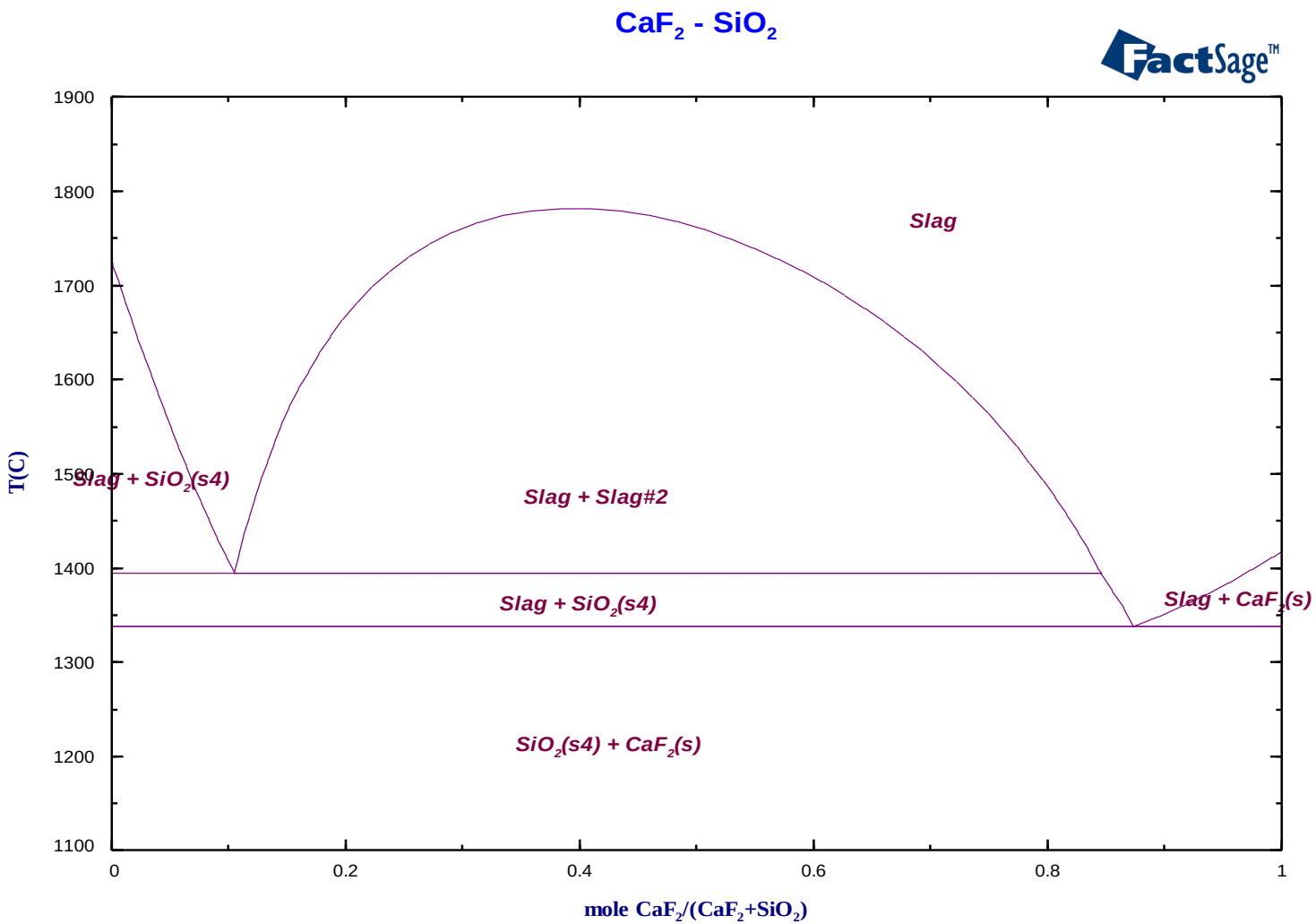
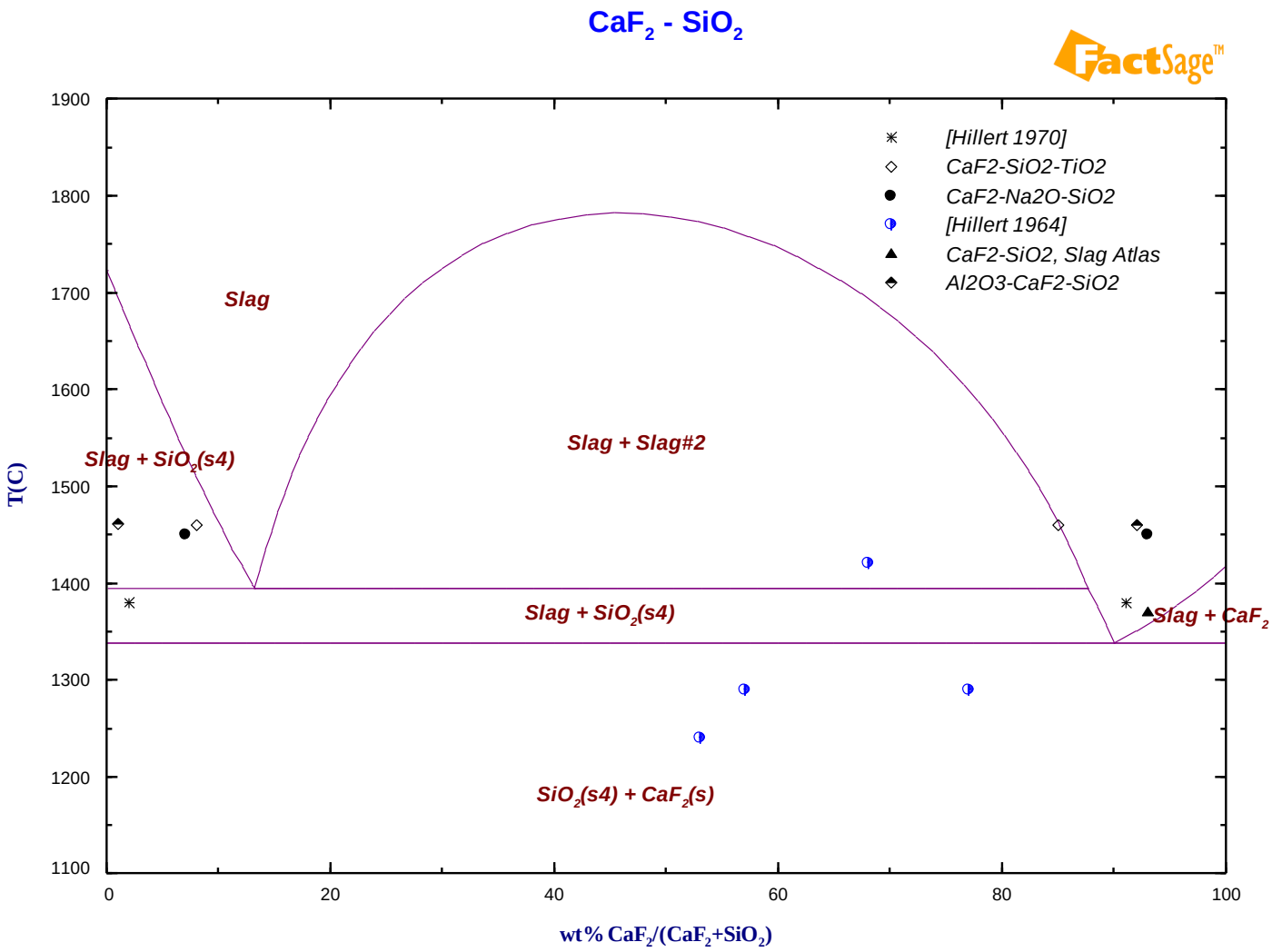


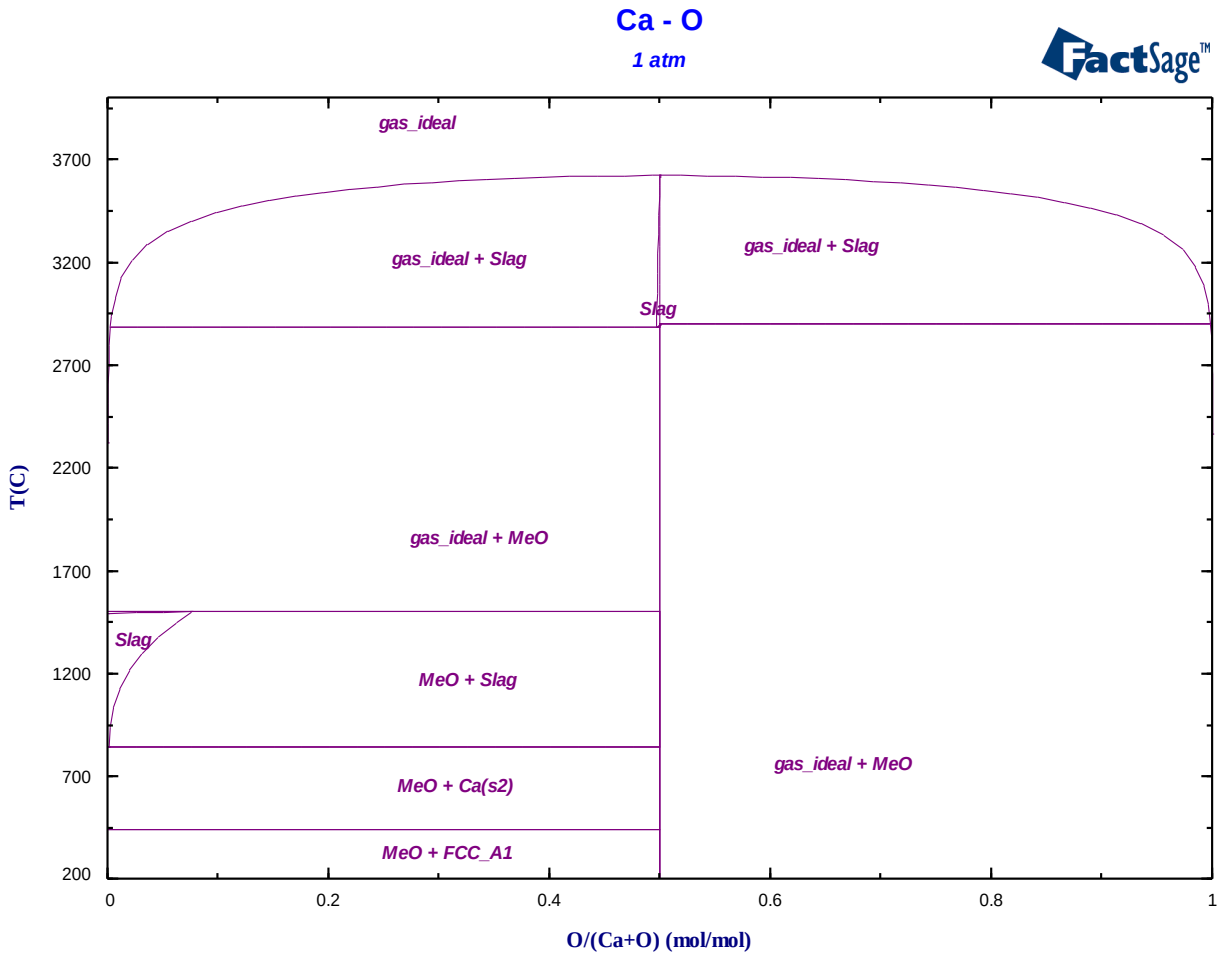
Mole fraction



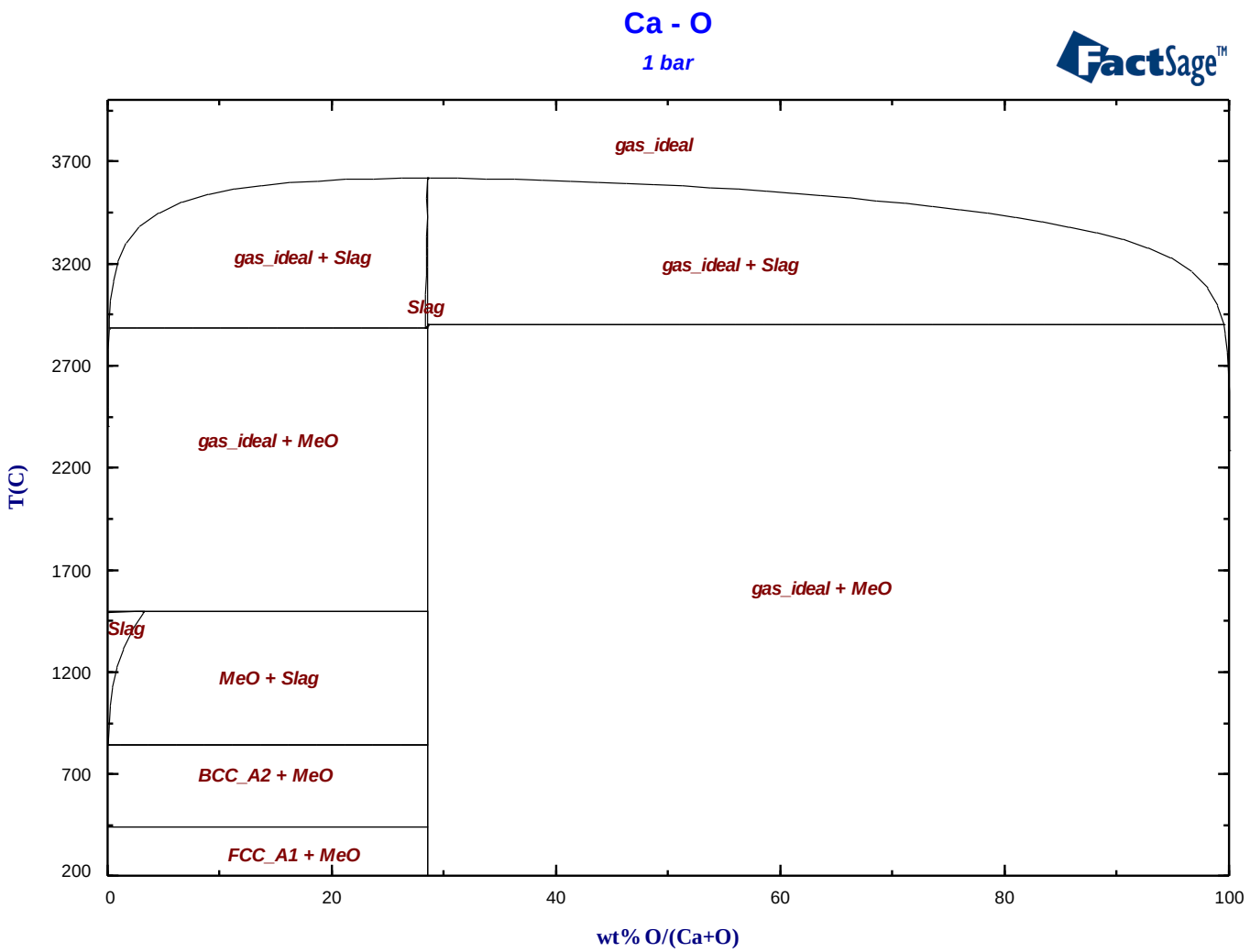
Weight percent
compared with experimental data



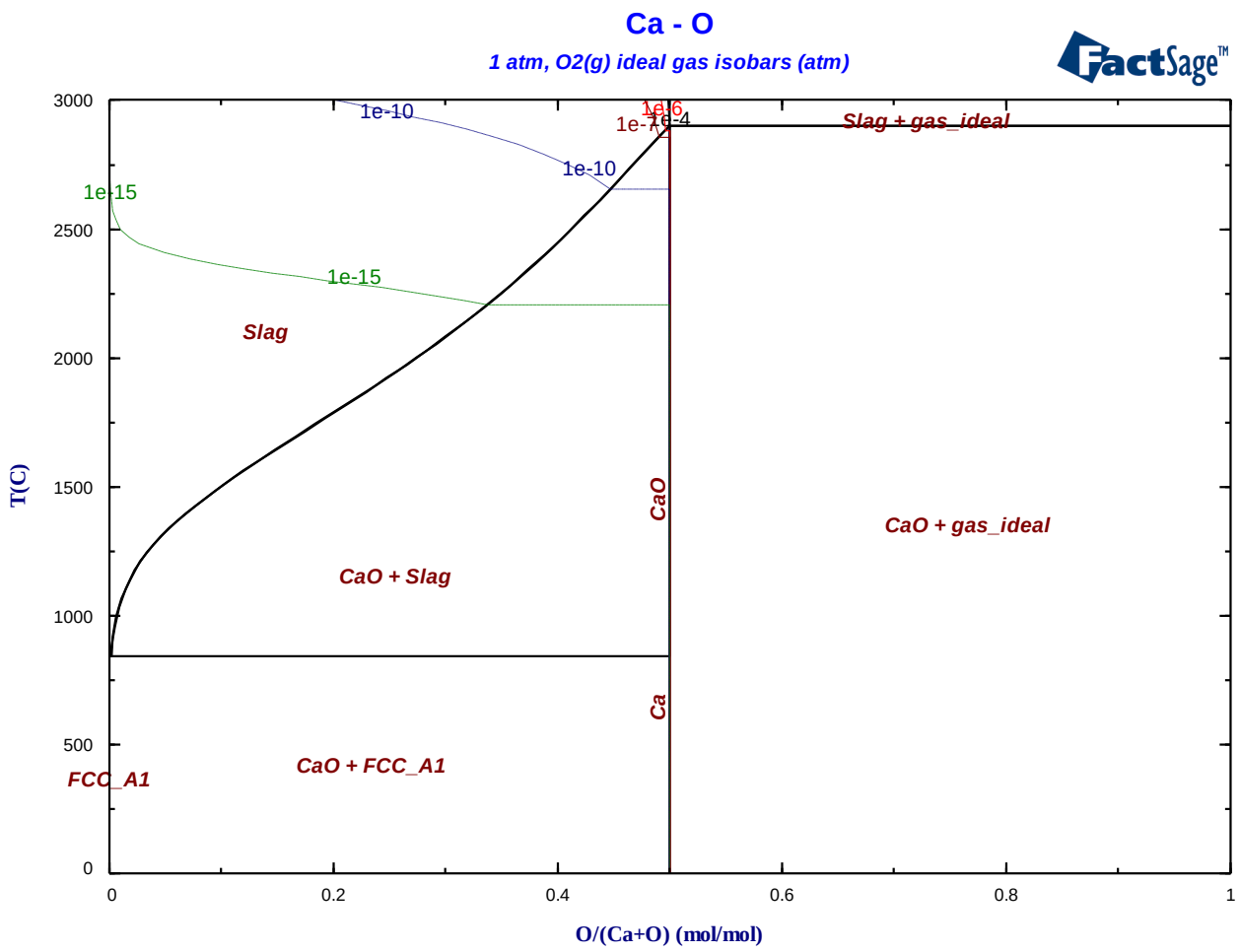
Mole fraction



Weight percent

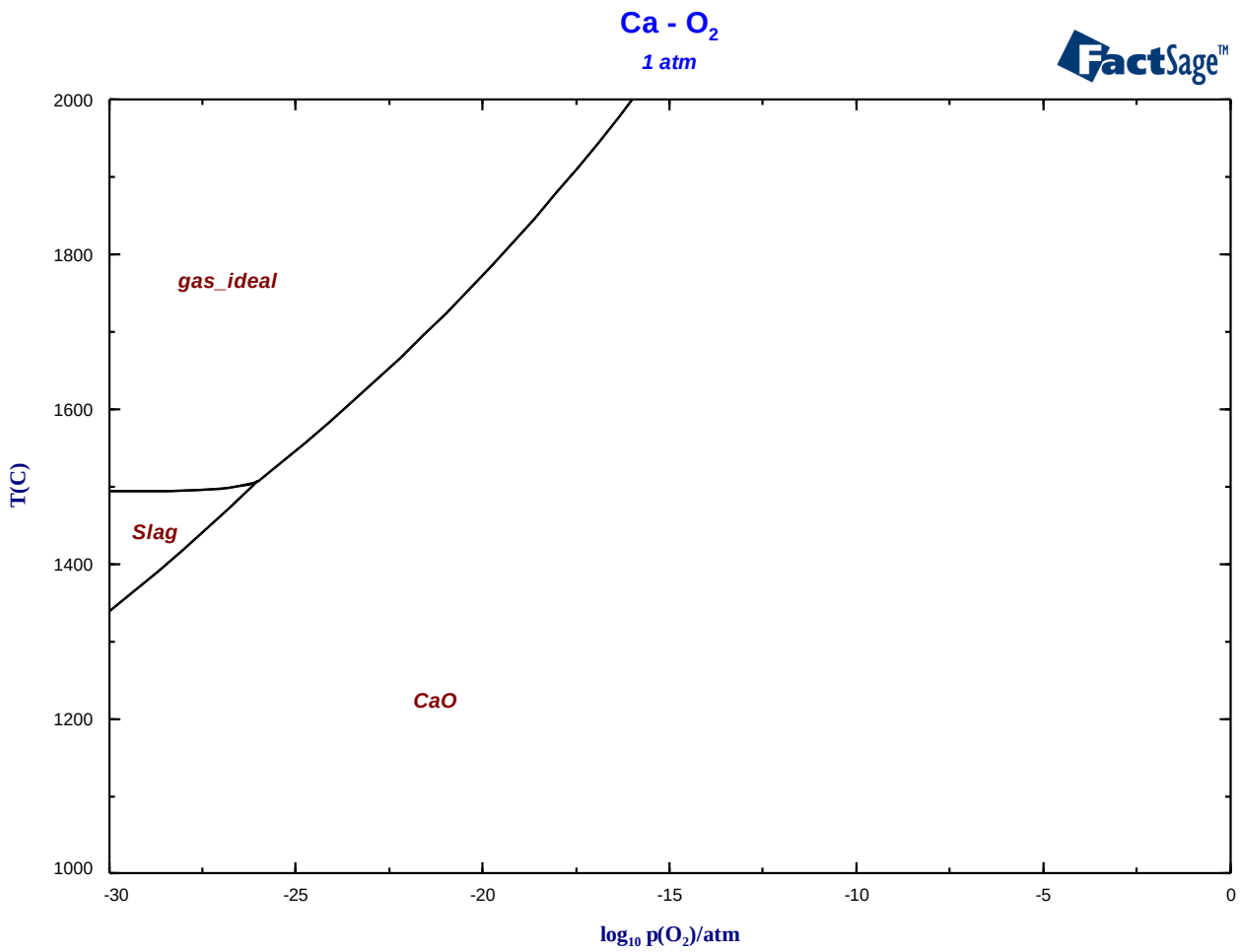


Mole fraction with isobars

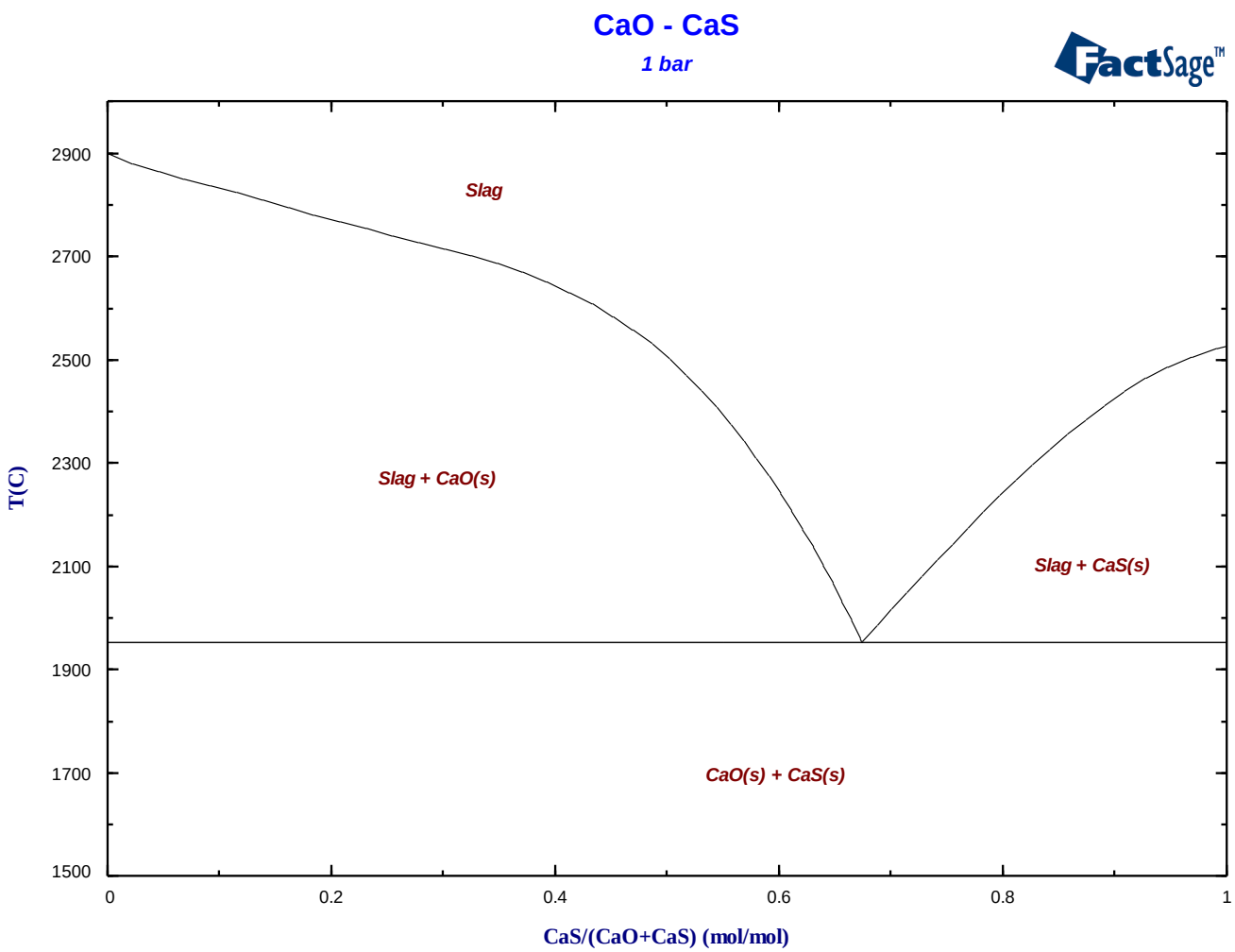


Ca-O2,

Temperature vs. log P(O2) diagram



Mole fraction



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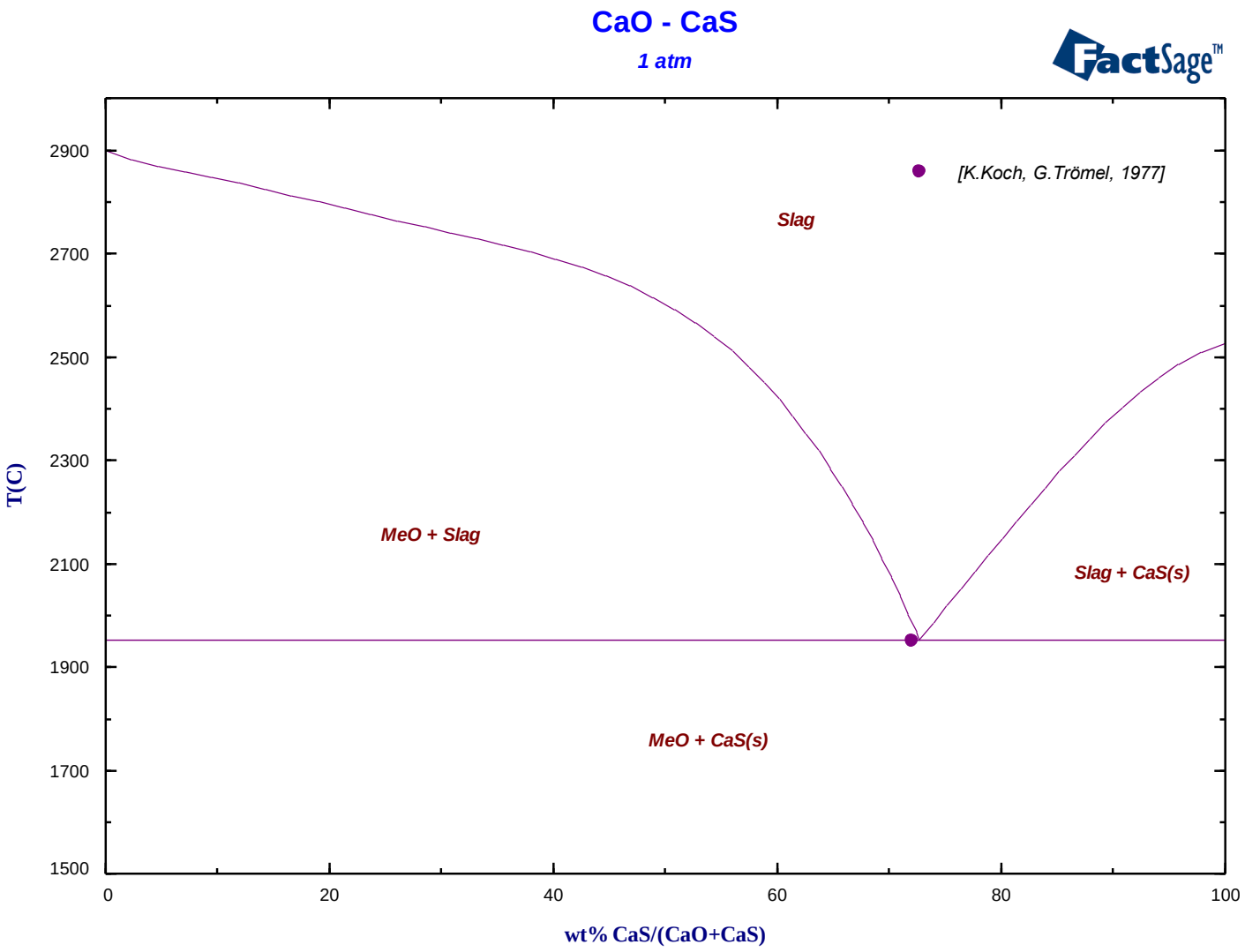
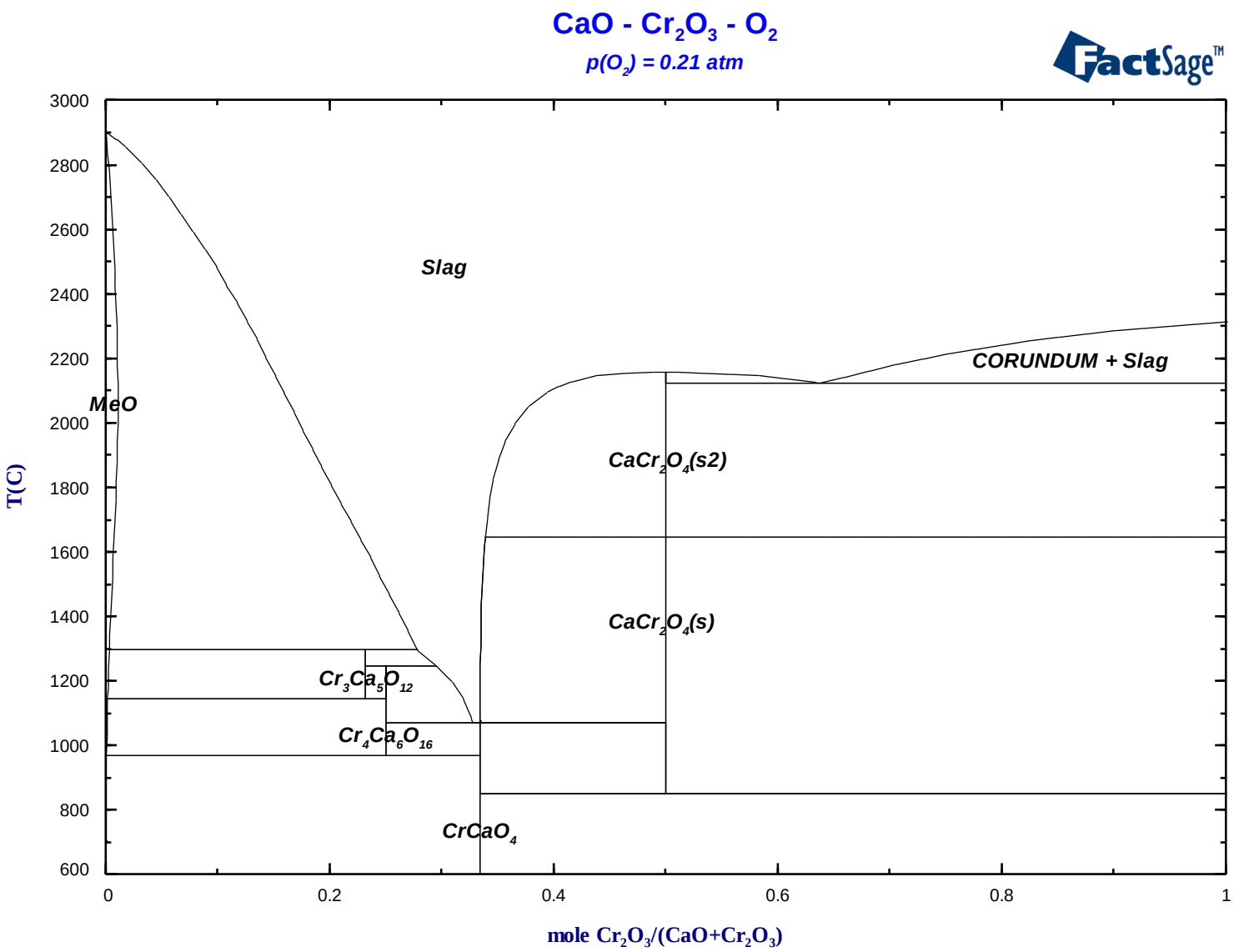
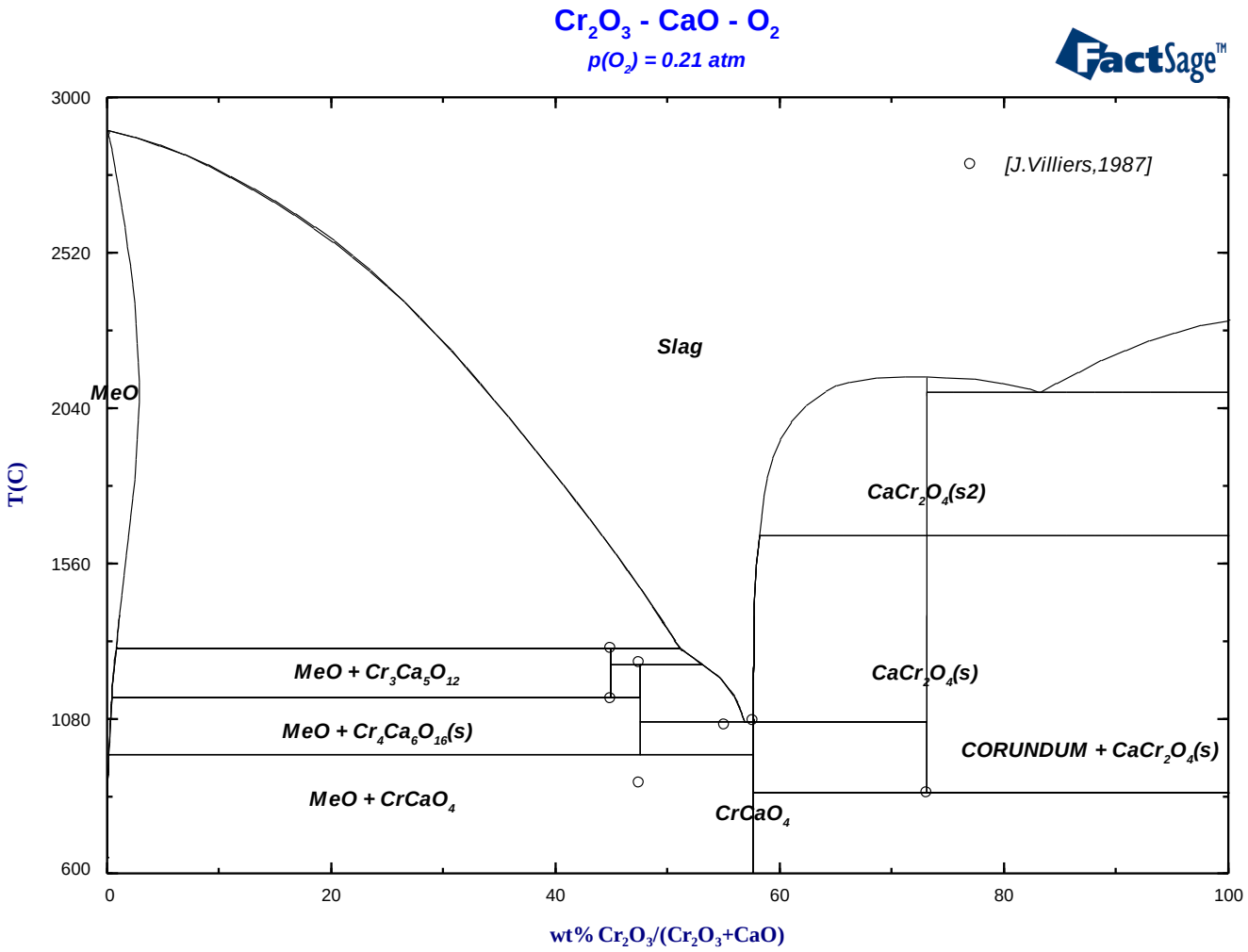


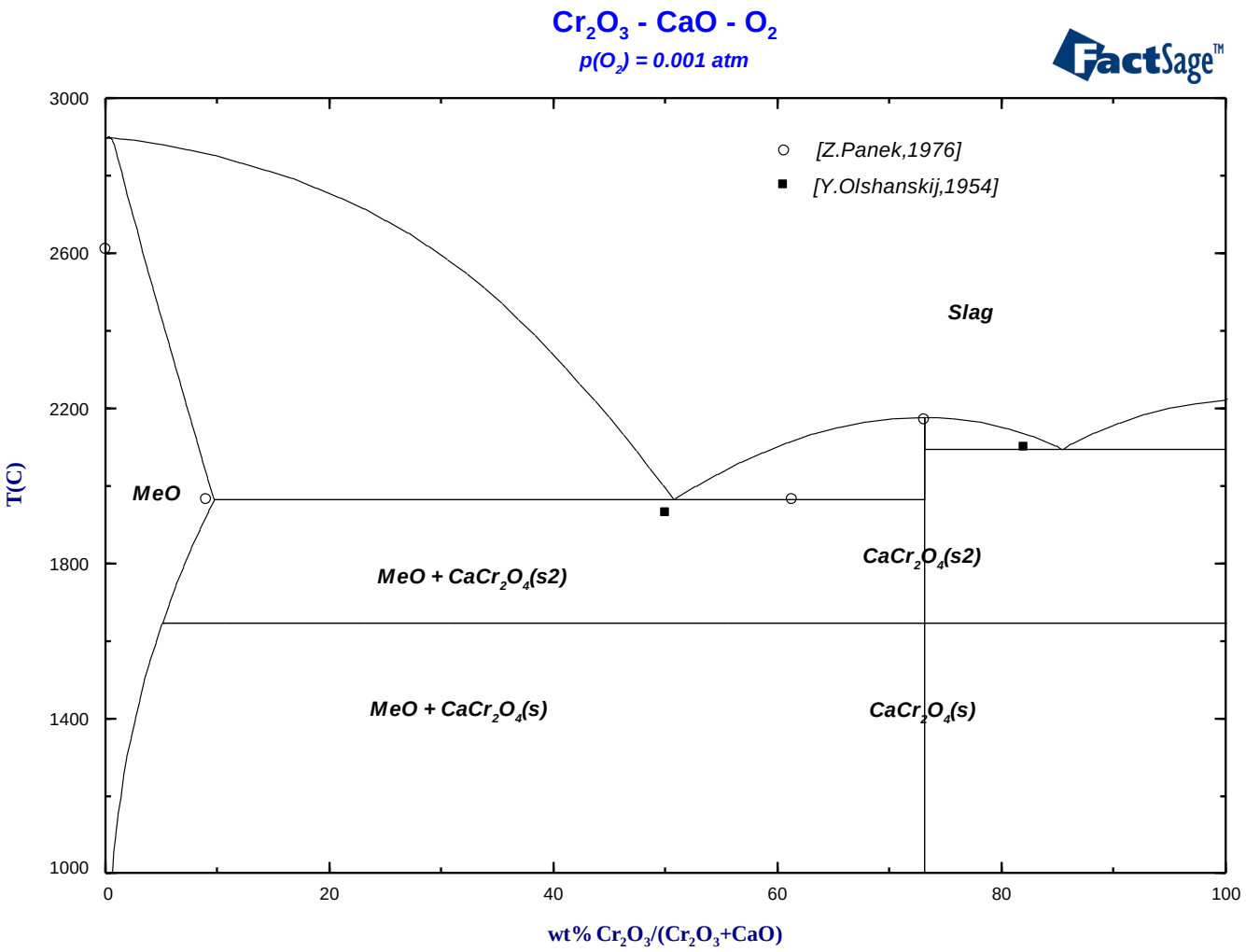
Mole fraction



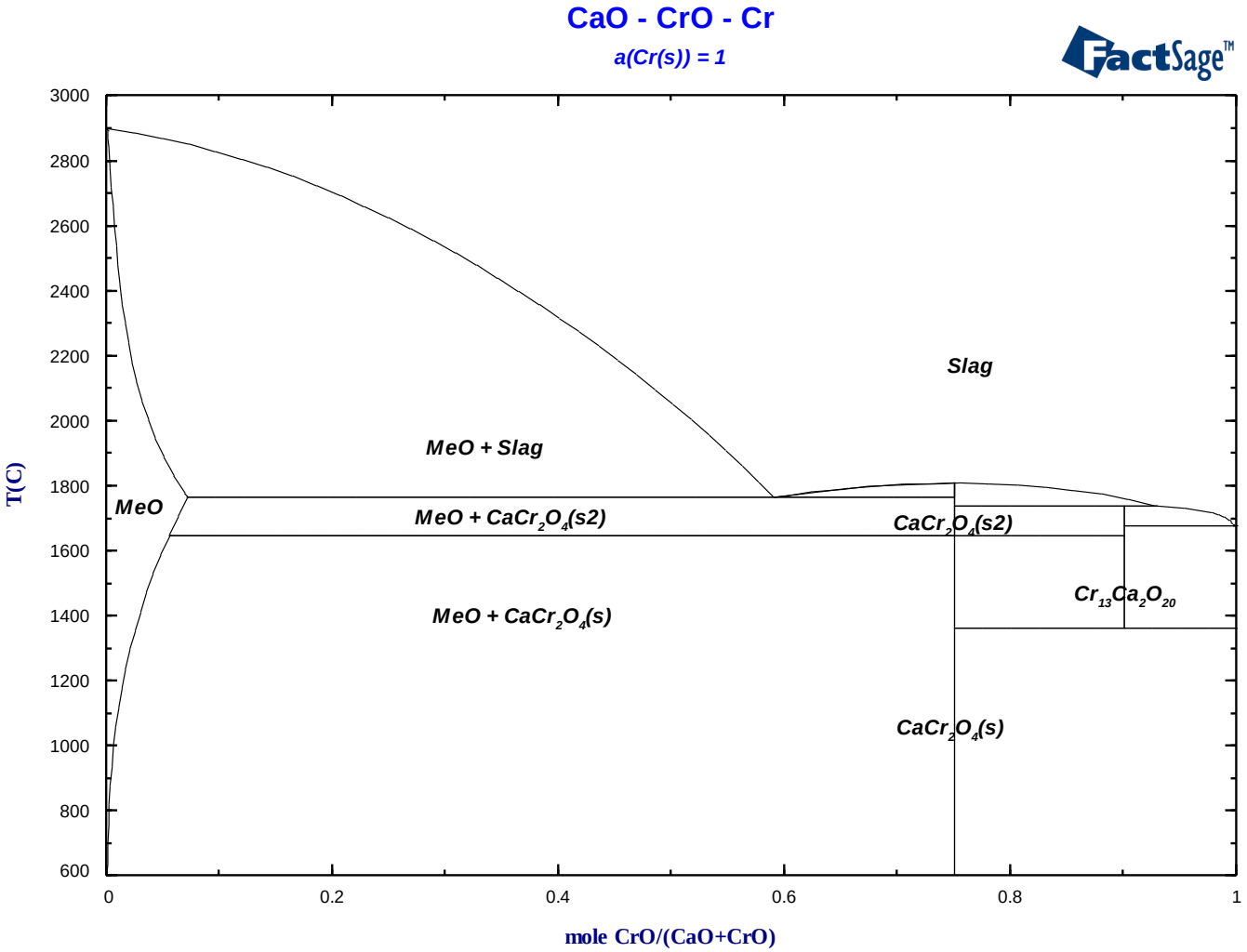
Weight percent
compared with experimental data



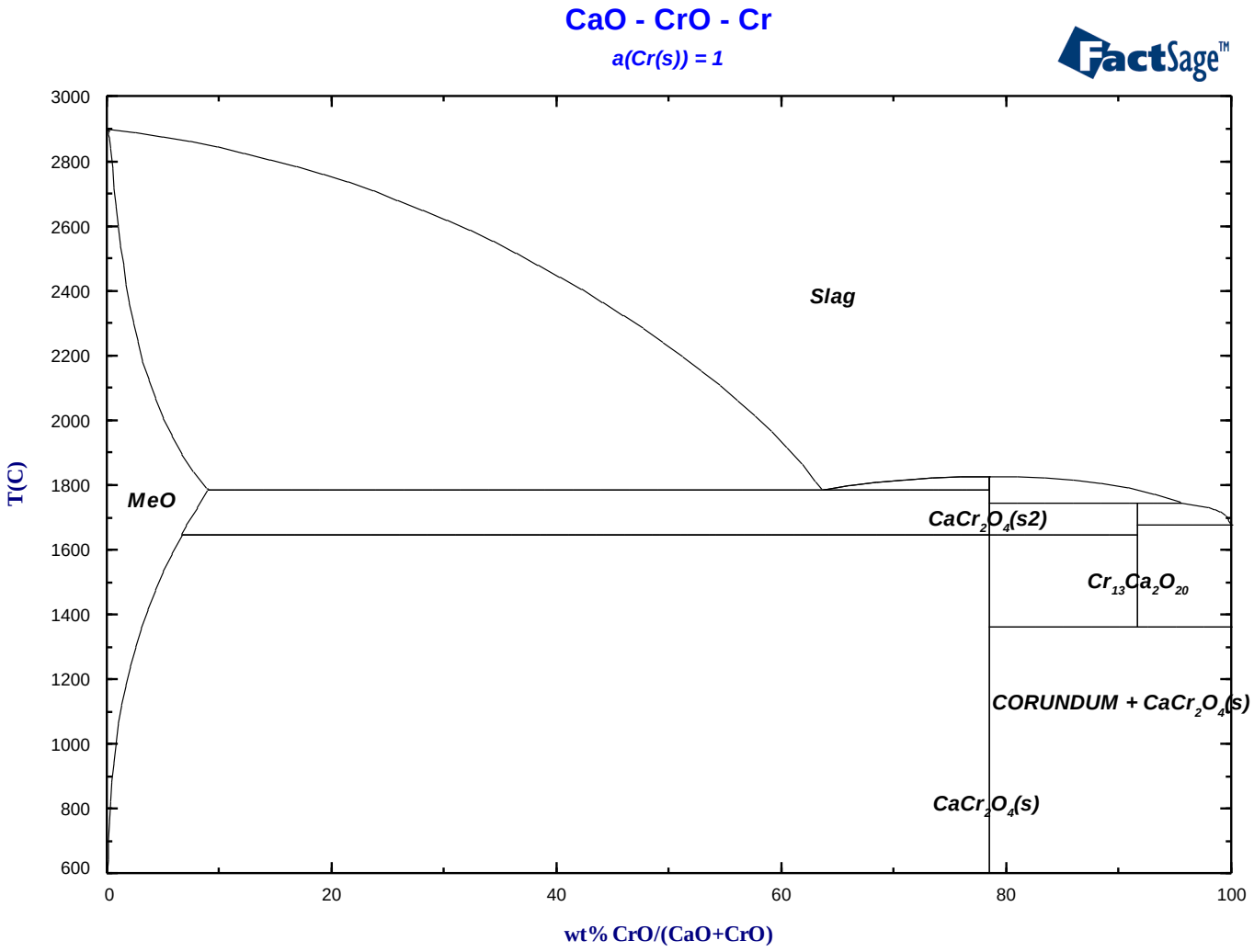
Weight percent
compared with experimental data, $P(O_2)=0.001$ atm



Mole fraction
compared with experimental data



Weight percent



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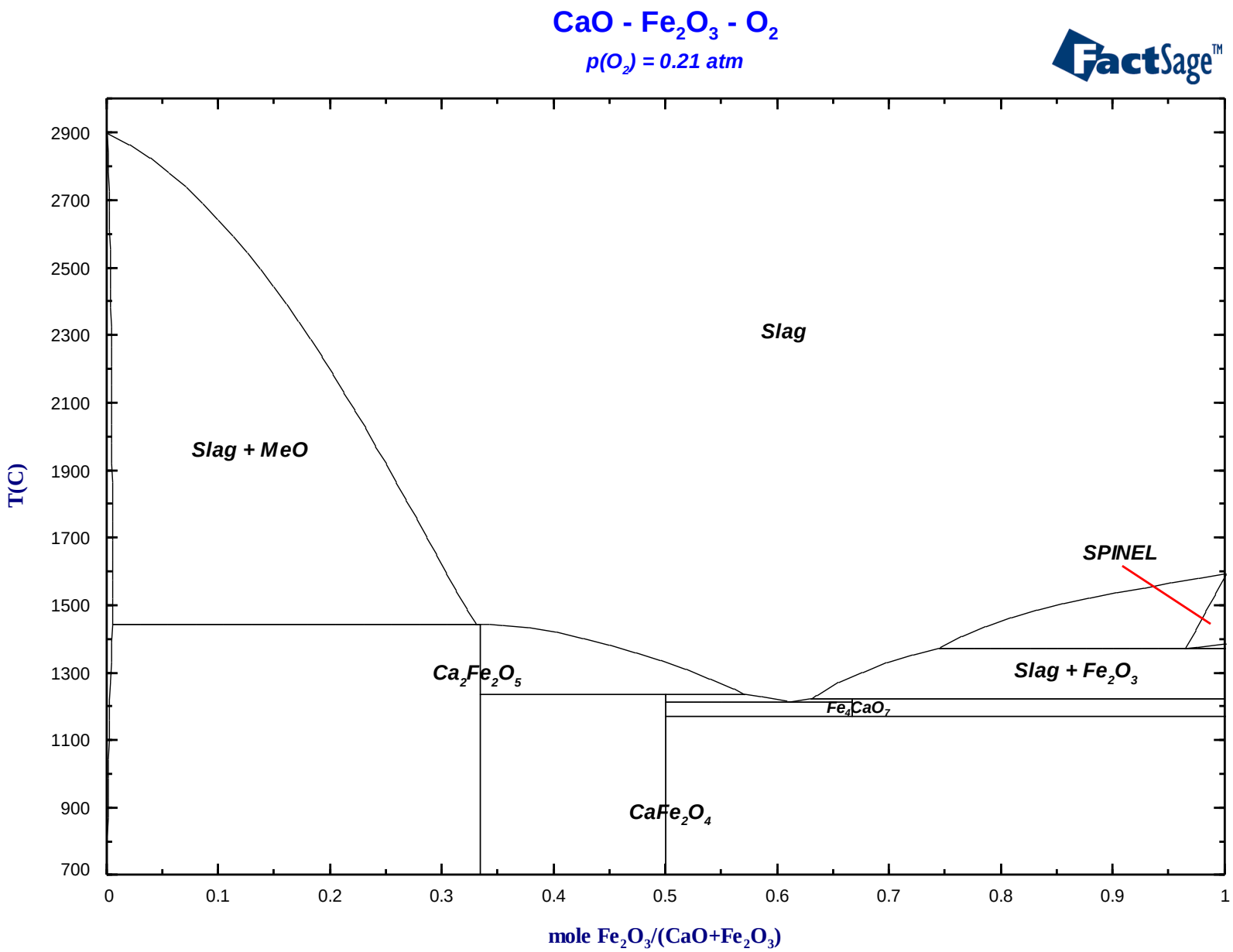

Weight percent
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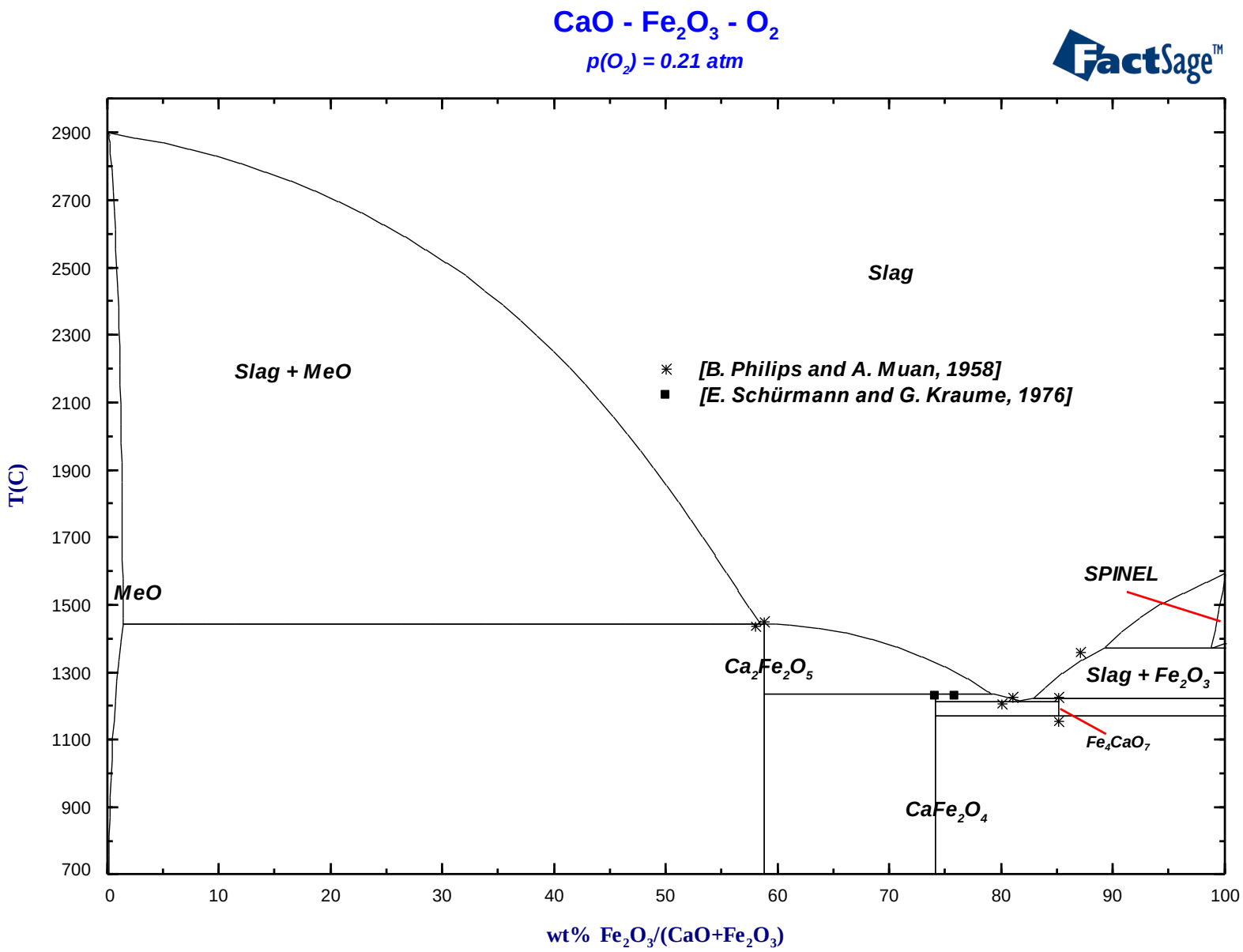
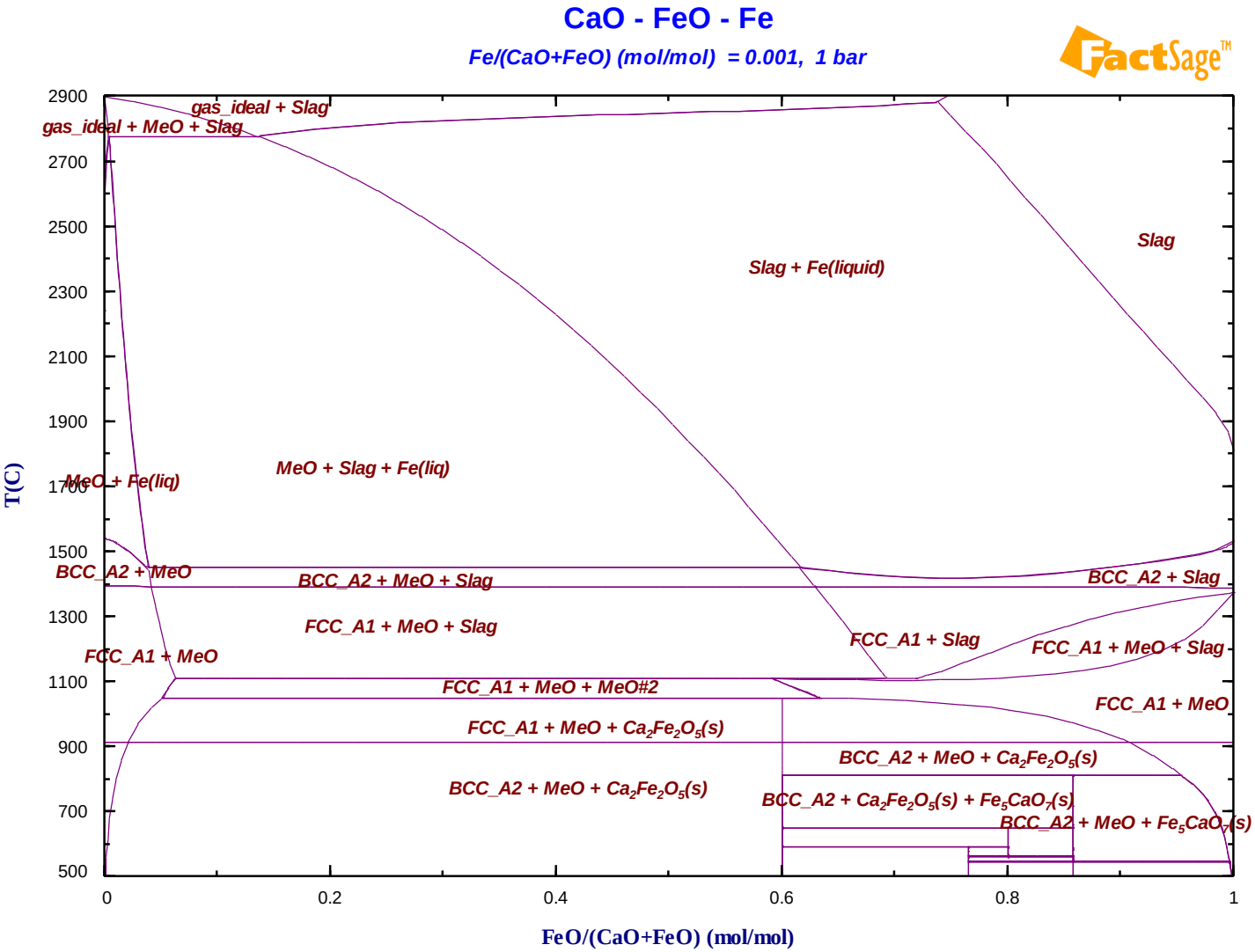
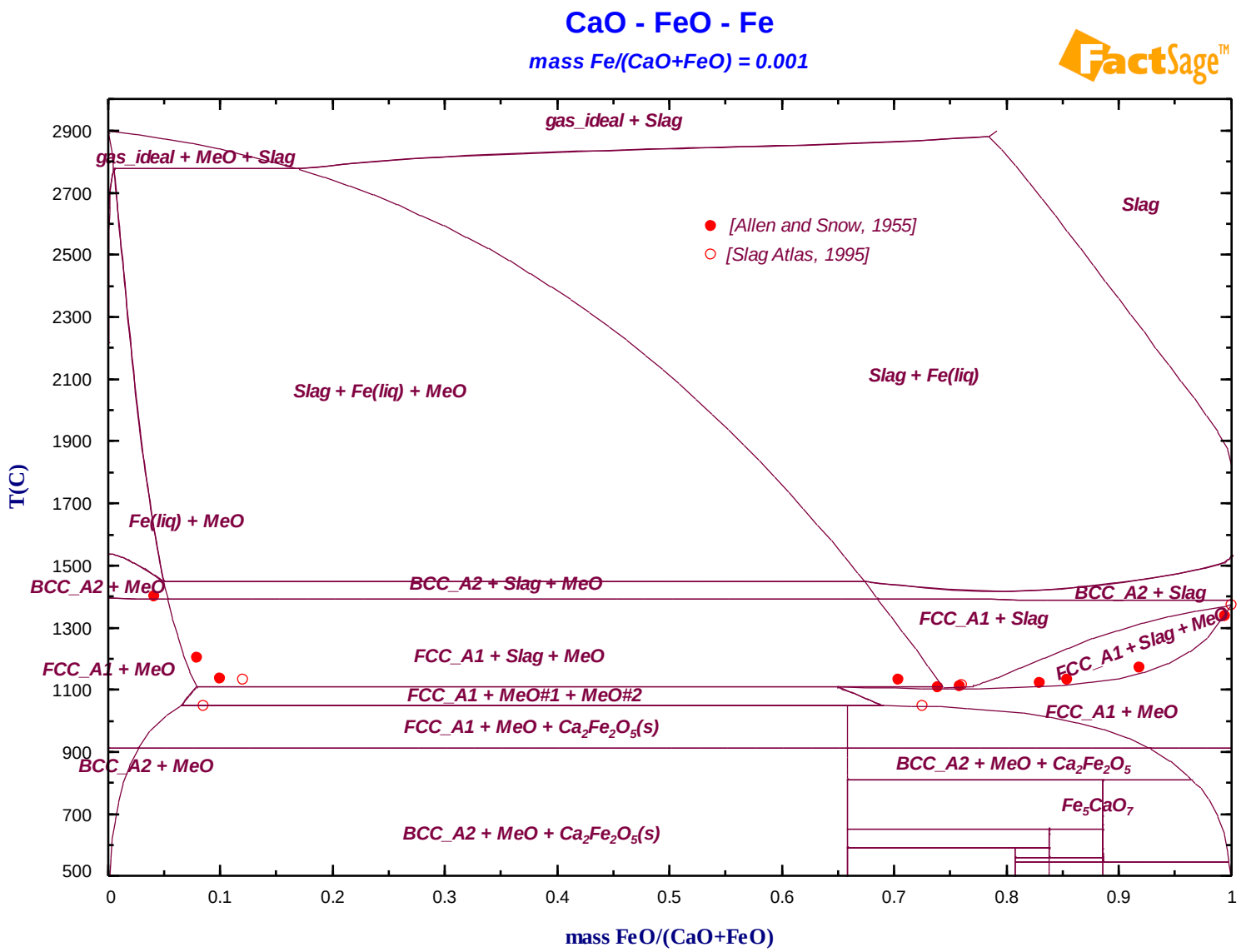


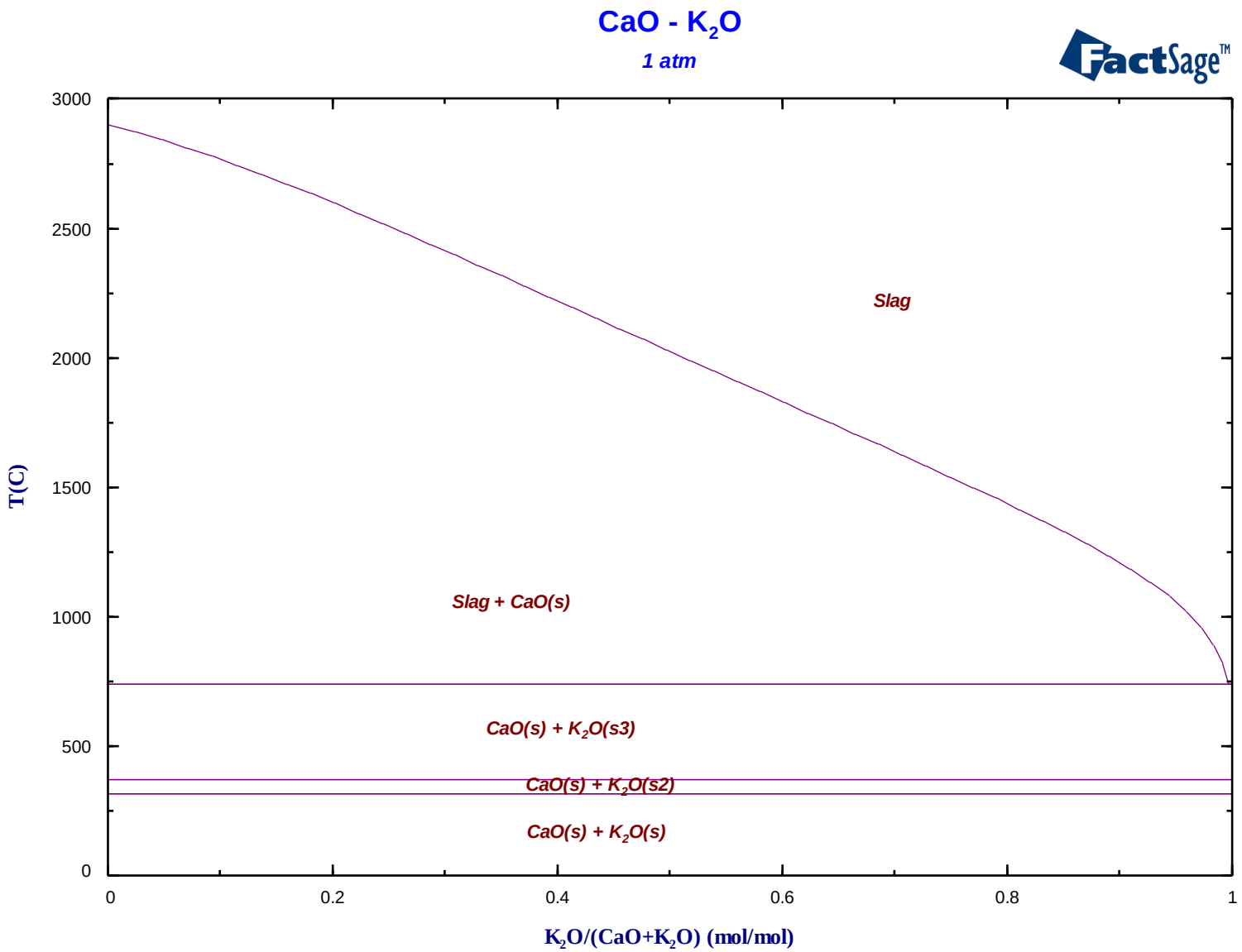
Mole fraction



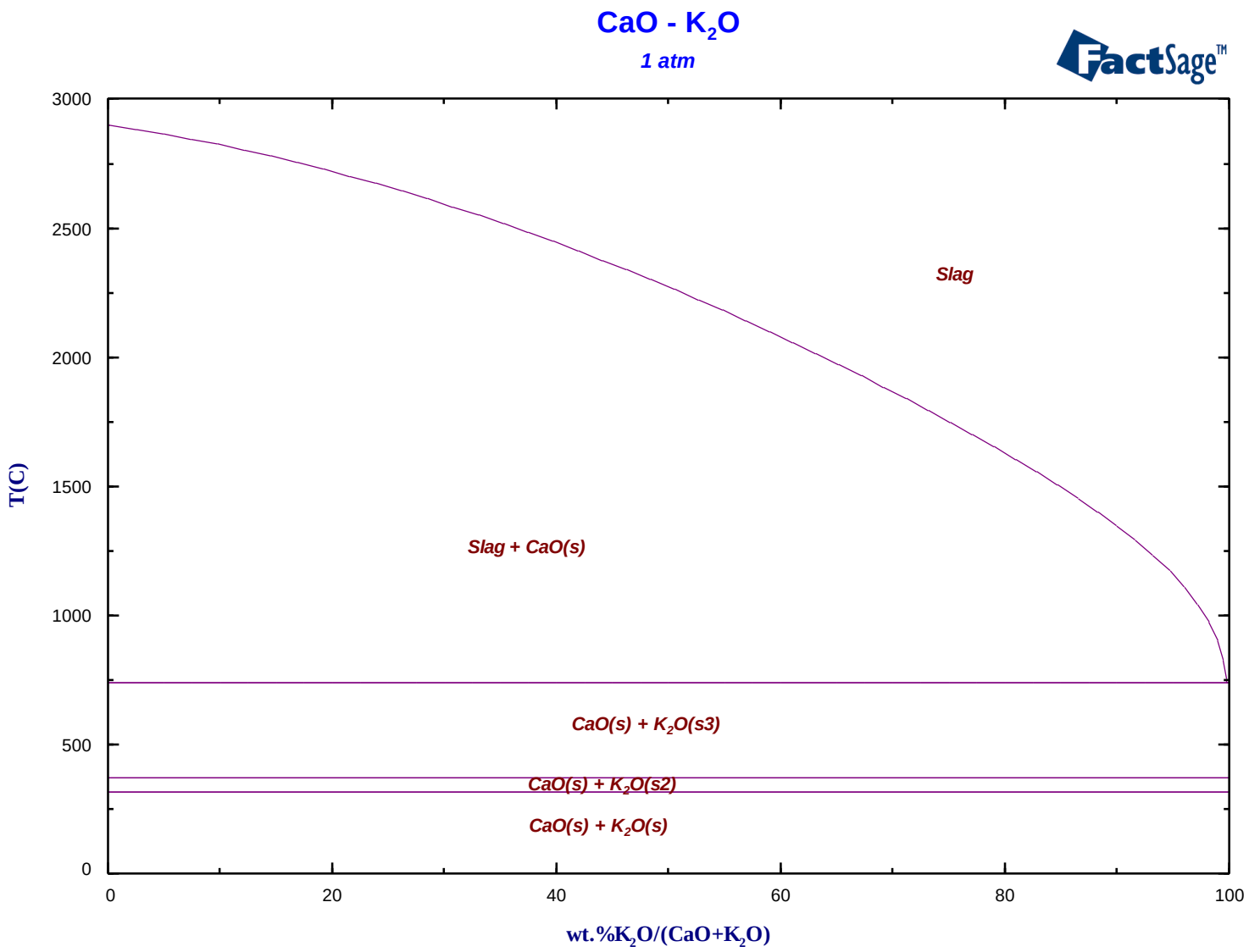
Weight percent
compared with experimental data



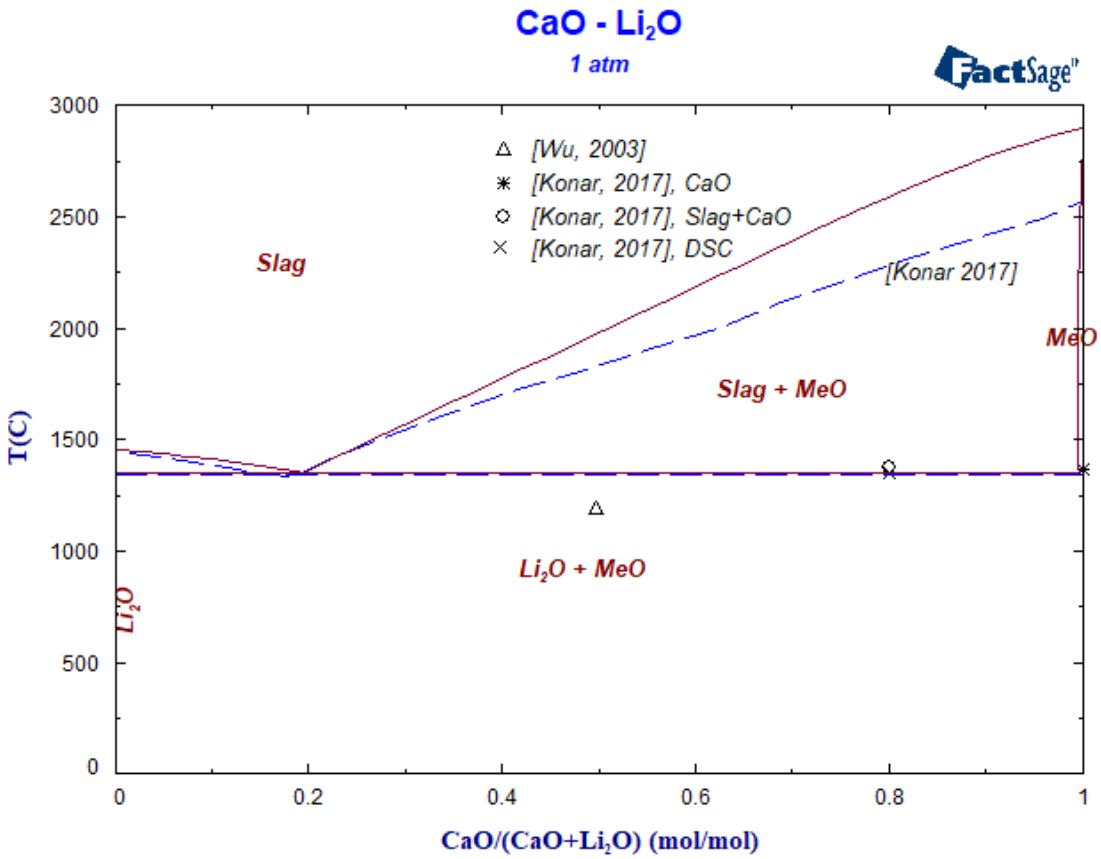
Mole fraction



Weight percent

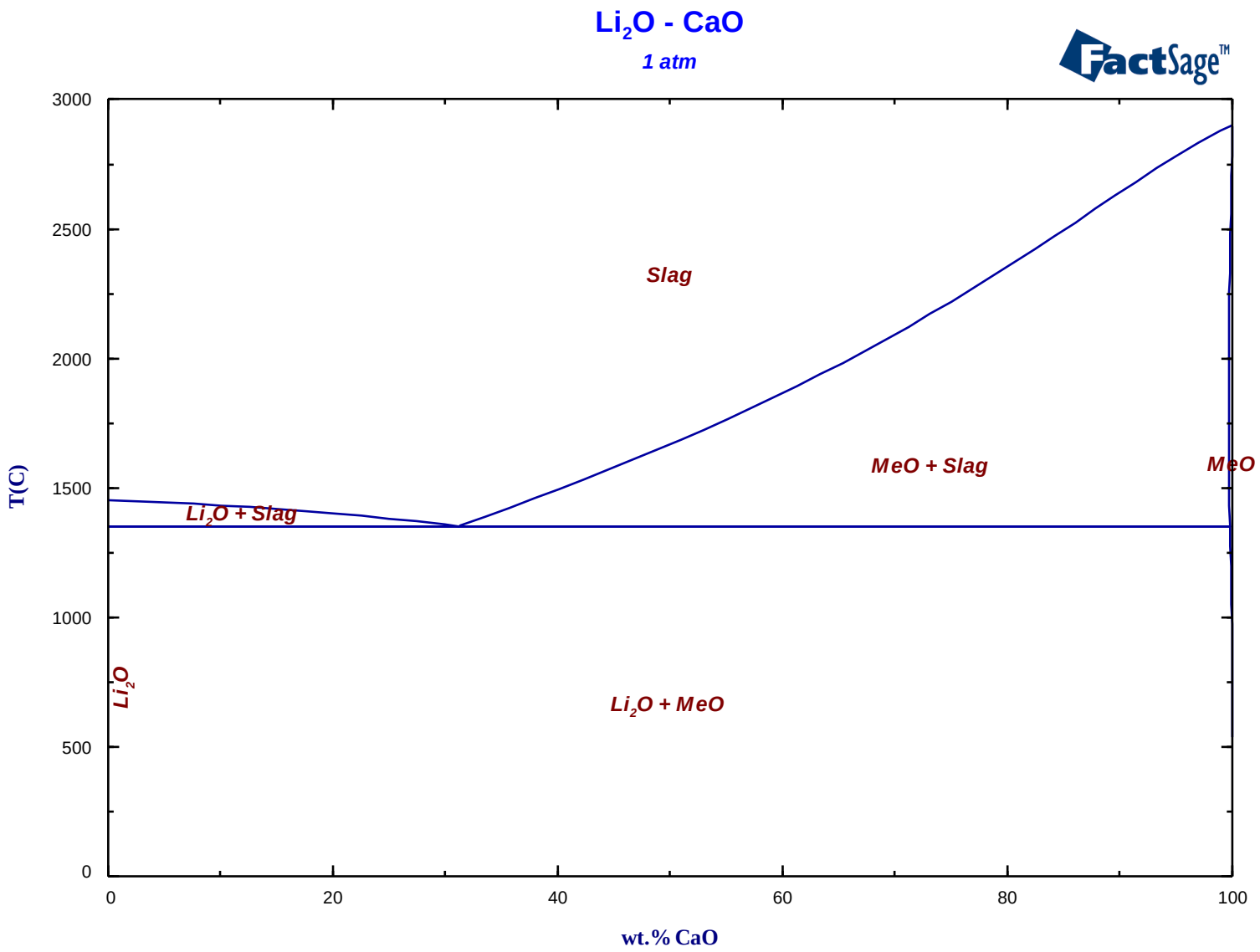


CaO-Li2O,
Mole fraction

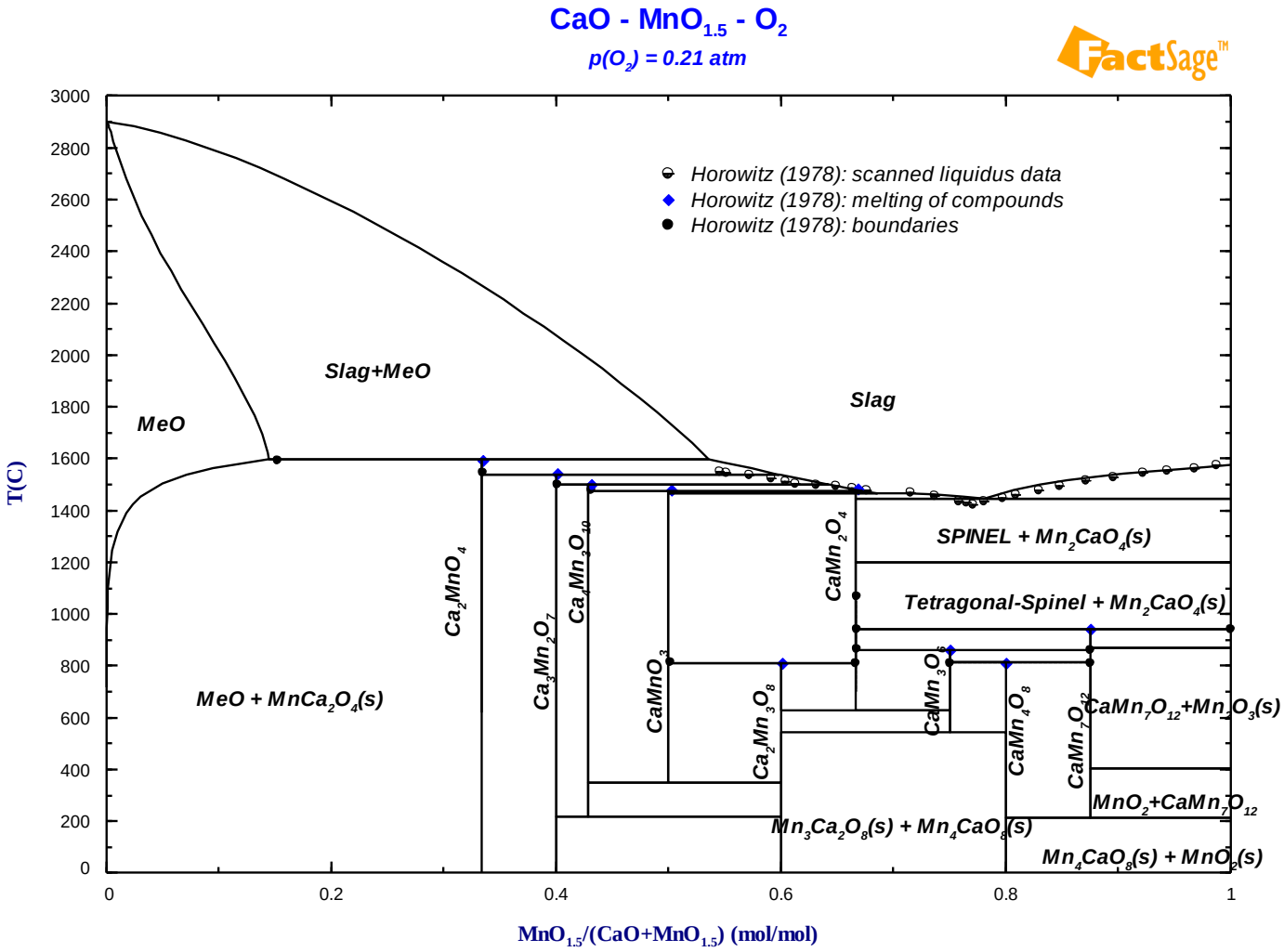


Slag	*(CaO, Li_2O)*	This work
MeO	*(Ca^{+2}, Li_2^{+2}, Va)(O^{-2})*	This work

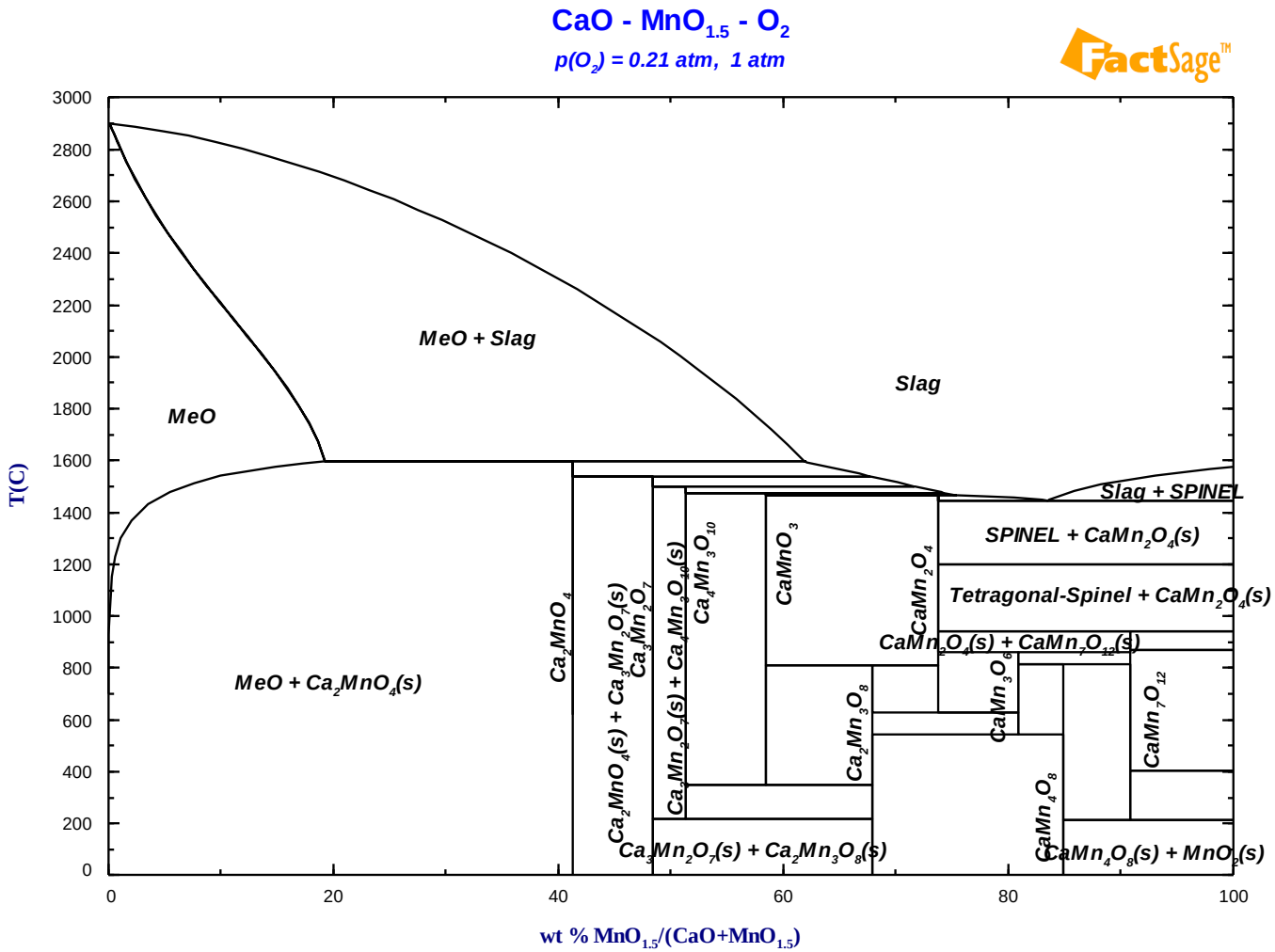
CaO-Li2O,
Weight percent



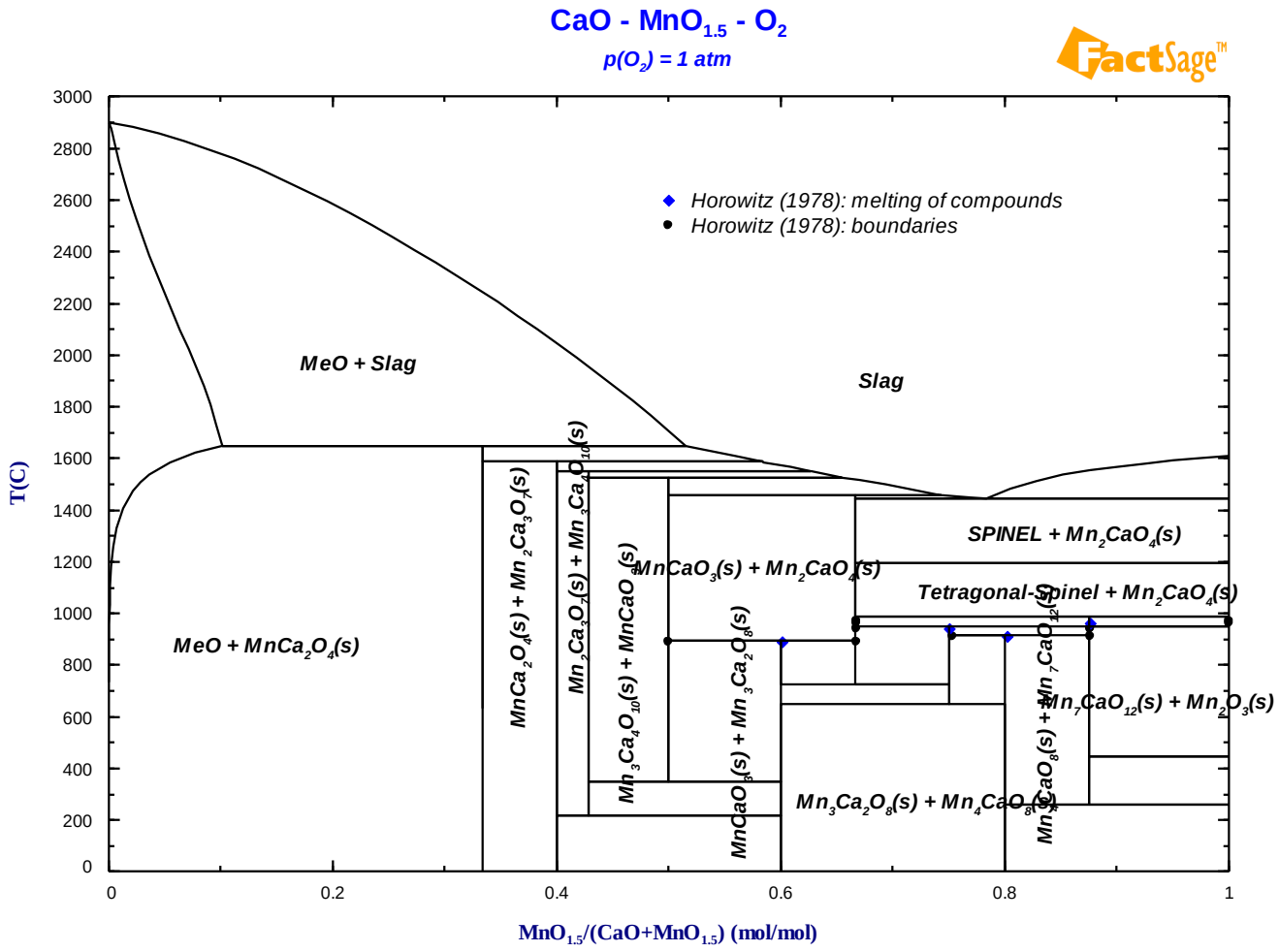
Mole fraction compared with experimental data



Weight percent



Mole fraction compared with experimental data



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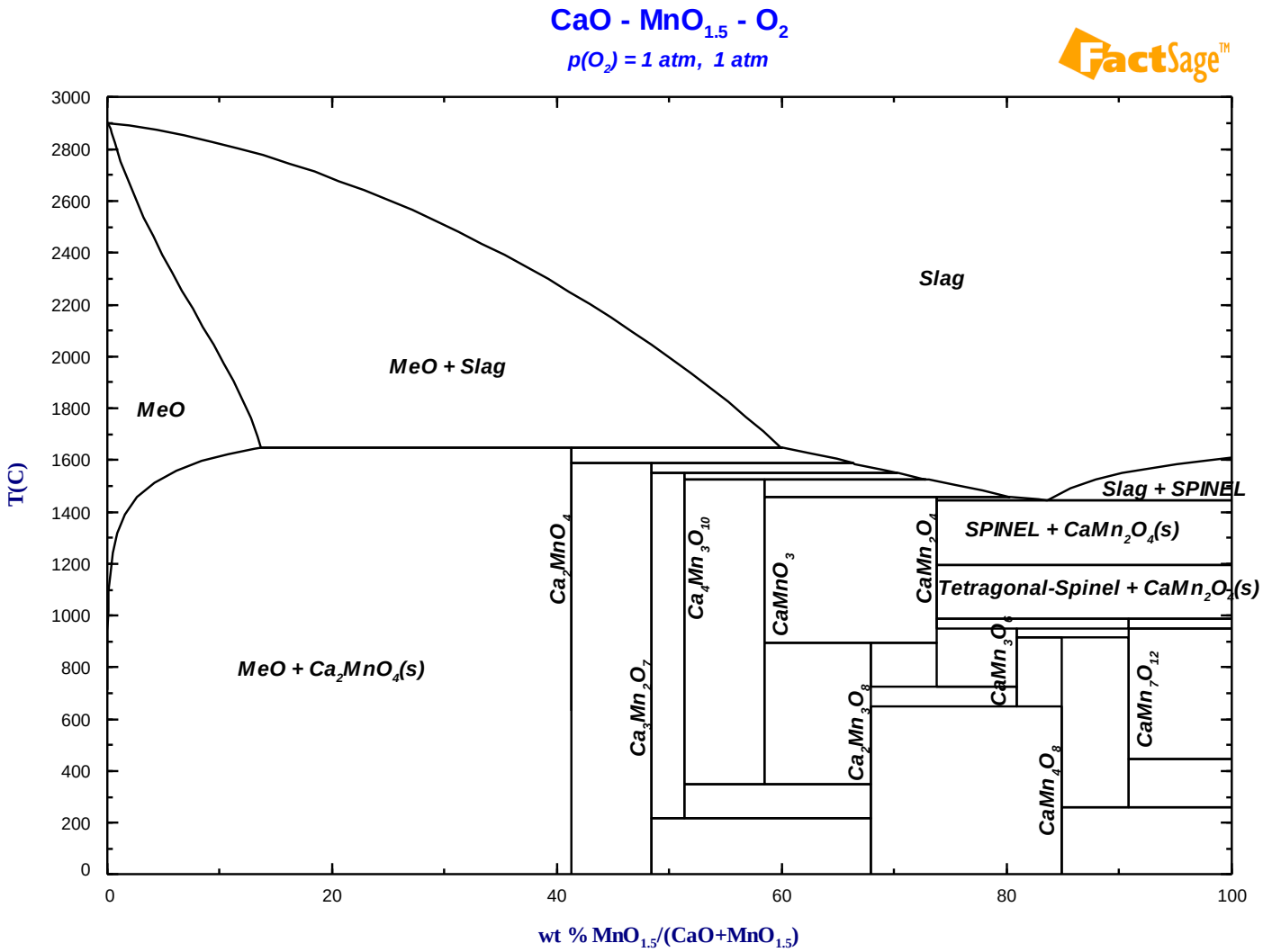
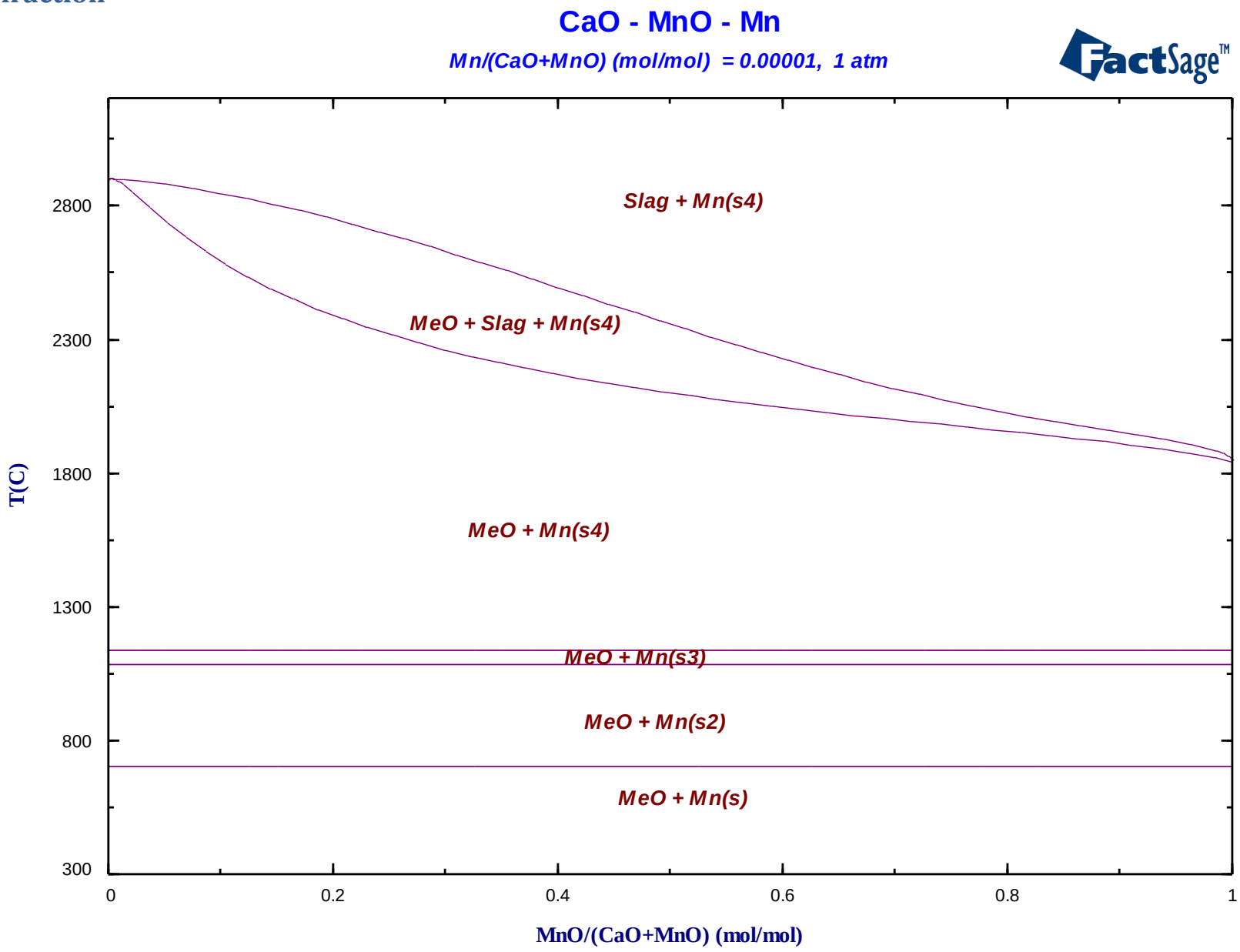
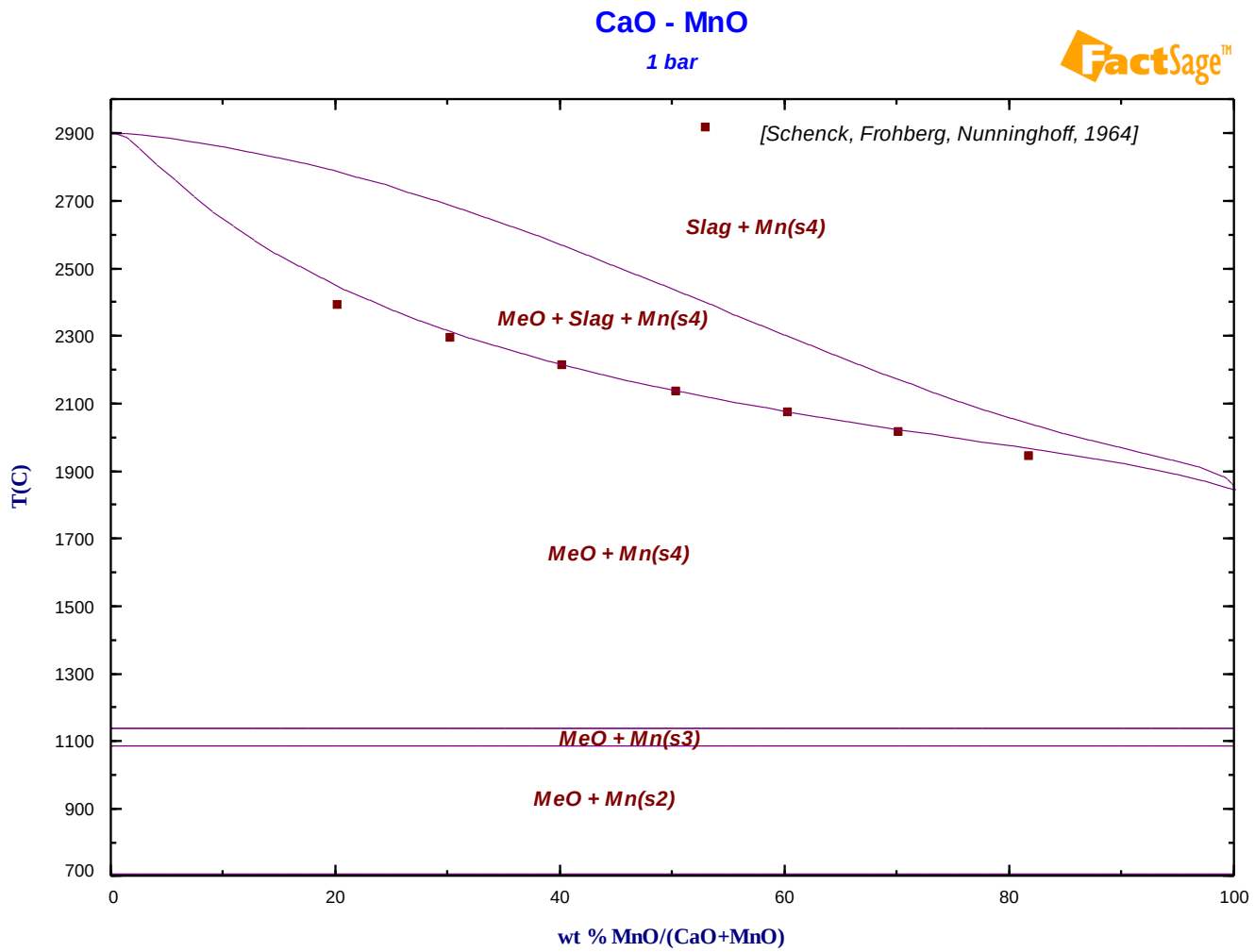


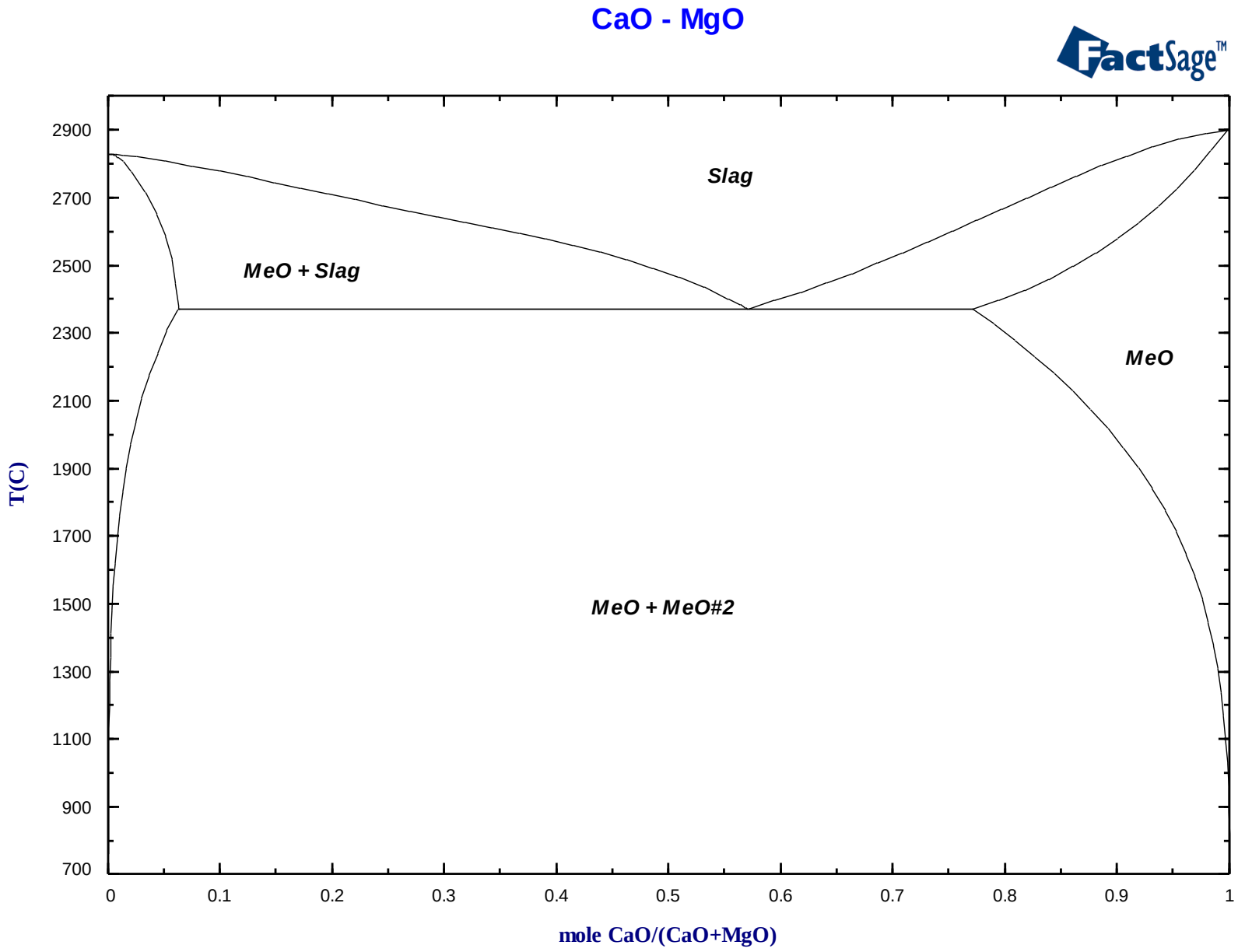
Mole fraction



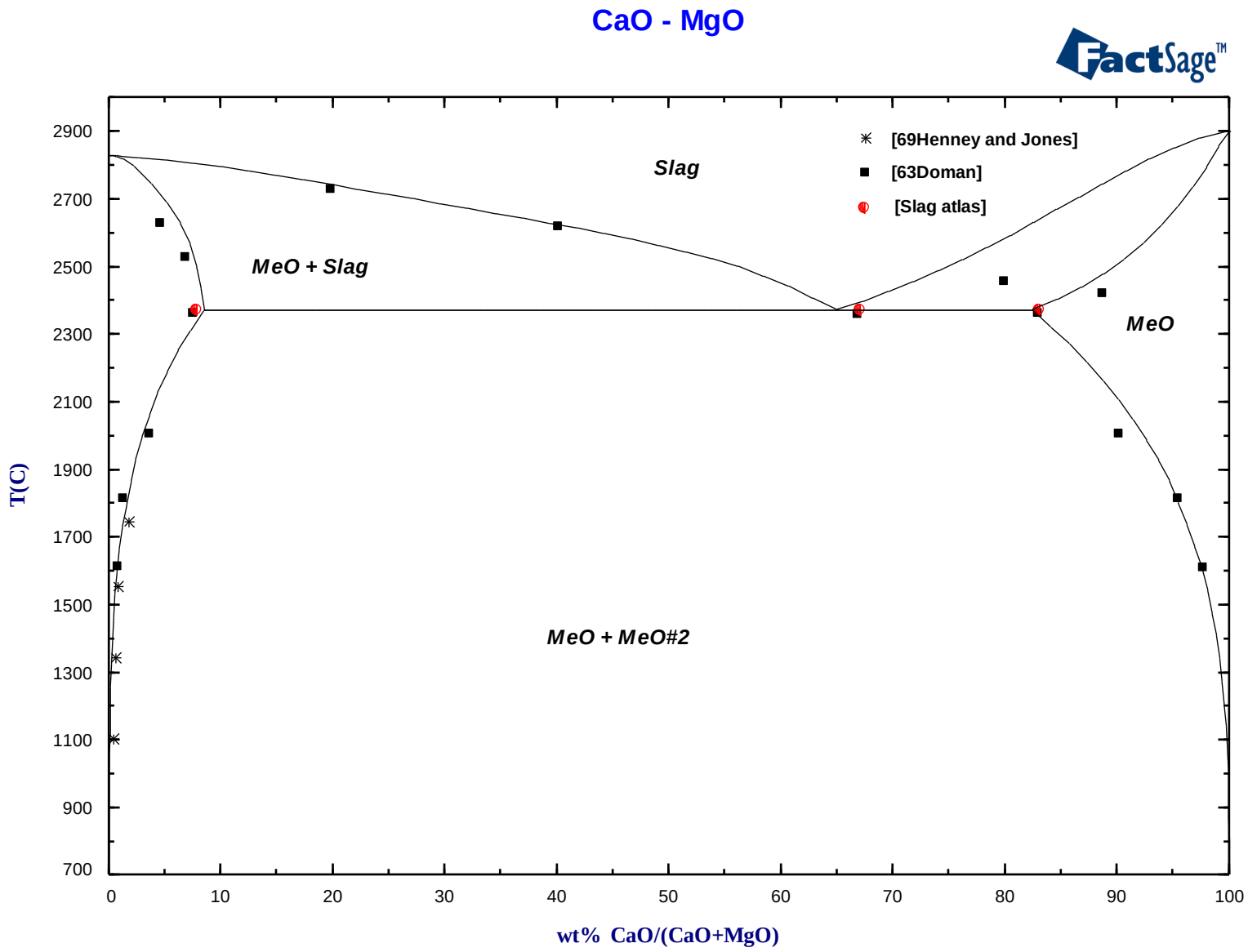
Weight percent
compared with experimental data



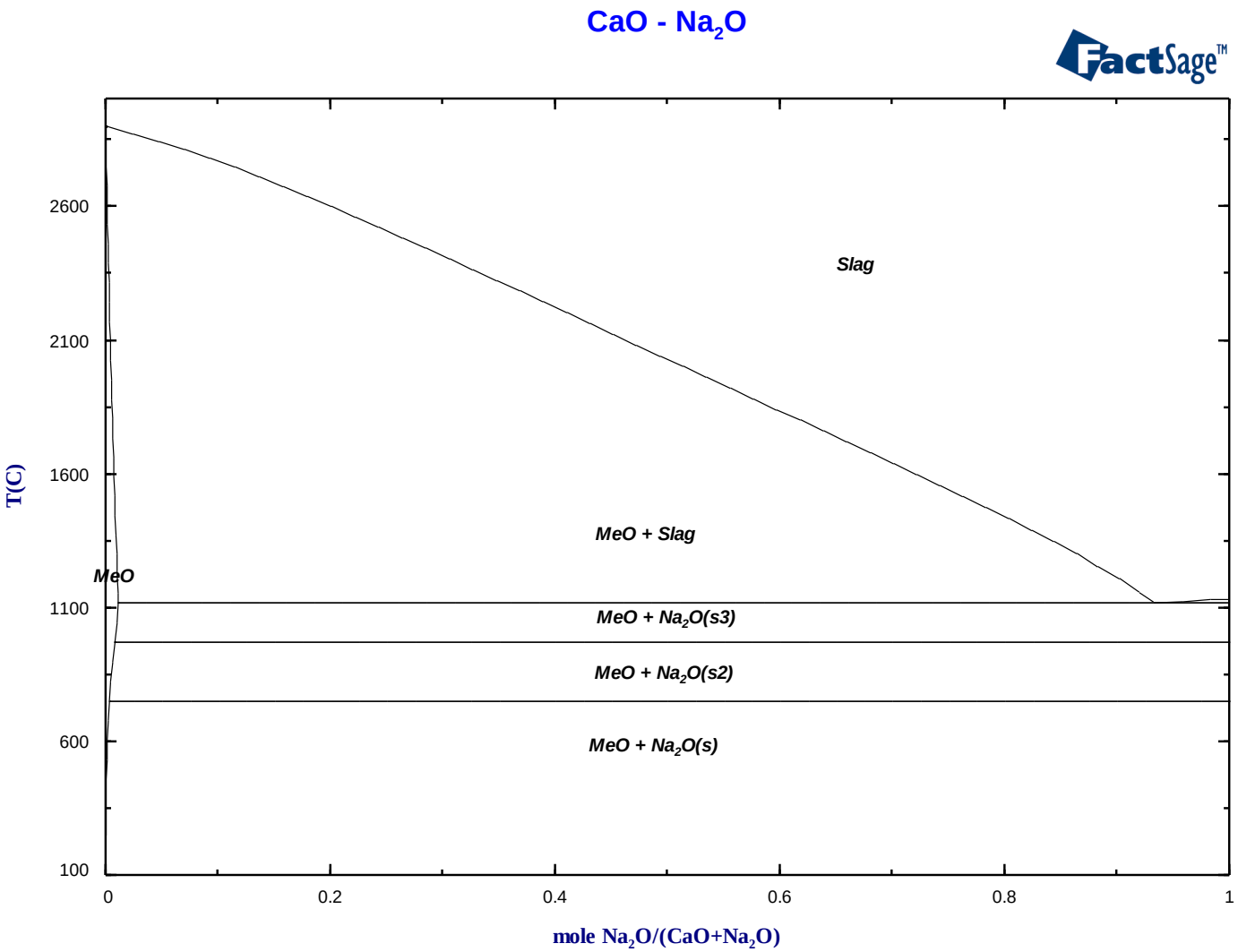
Mole fraction



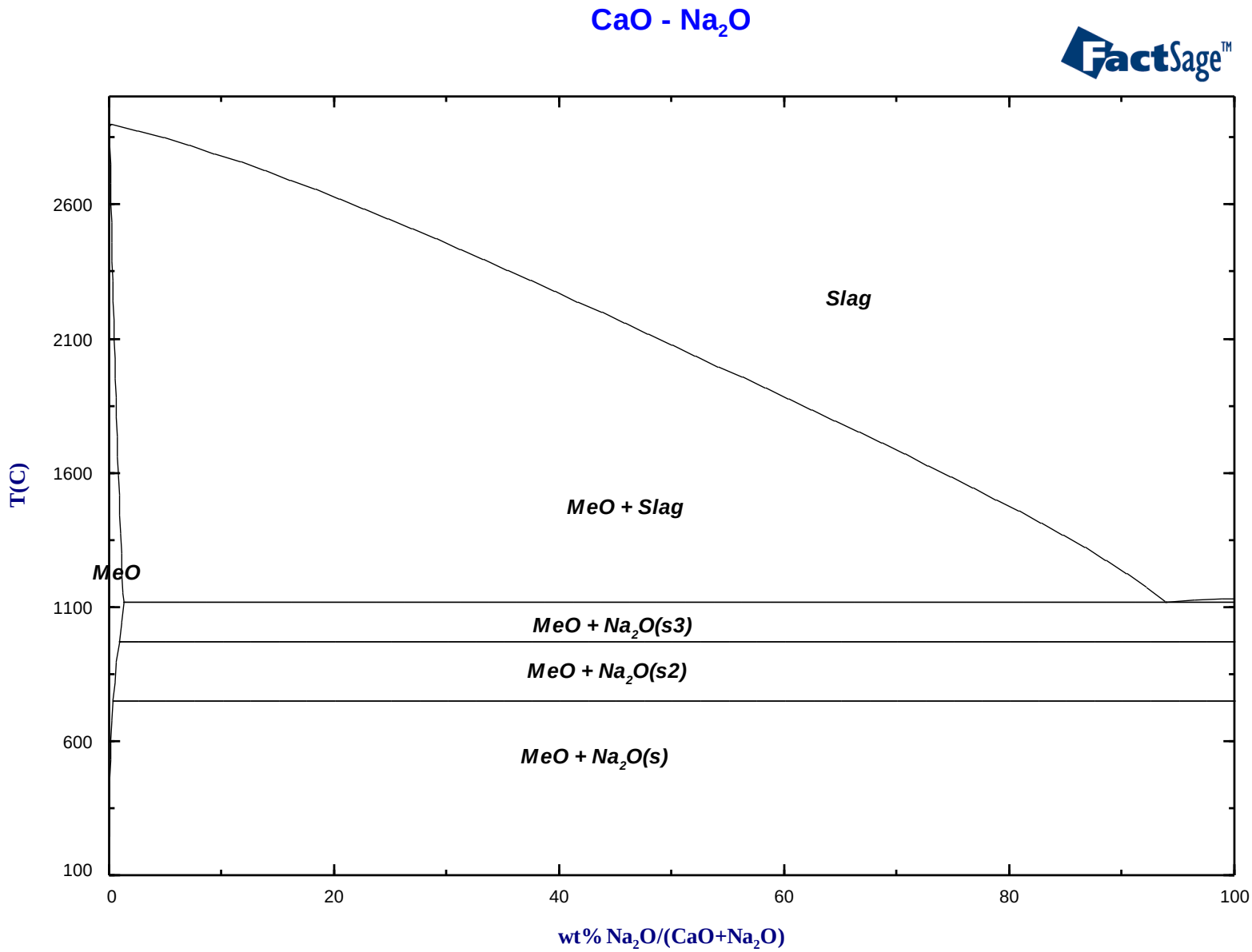
Weight percent
compared with experimental data



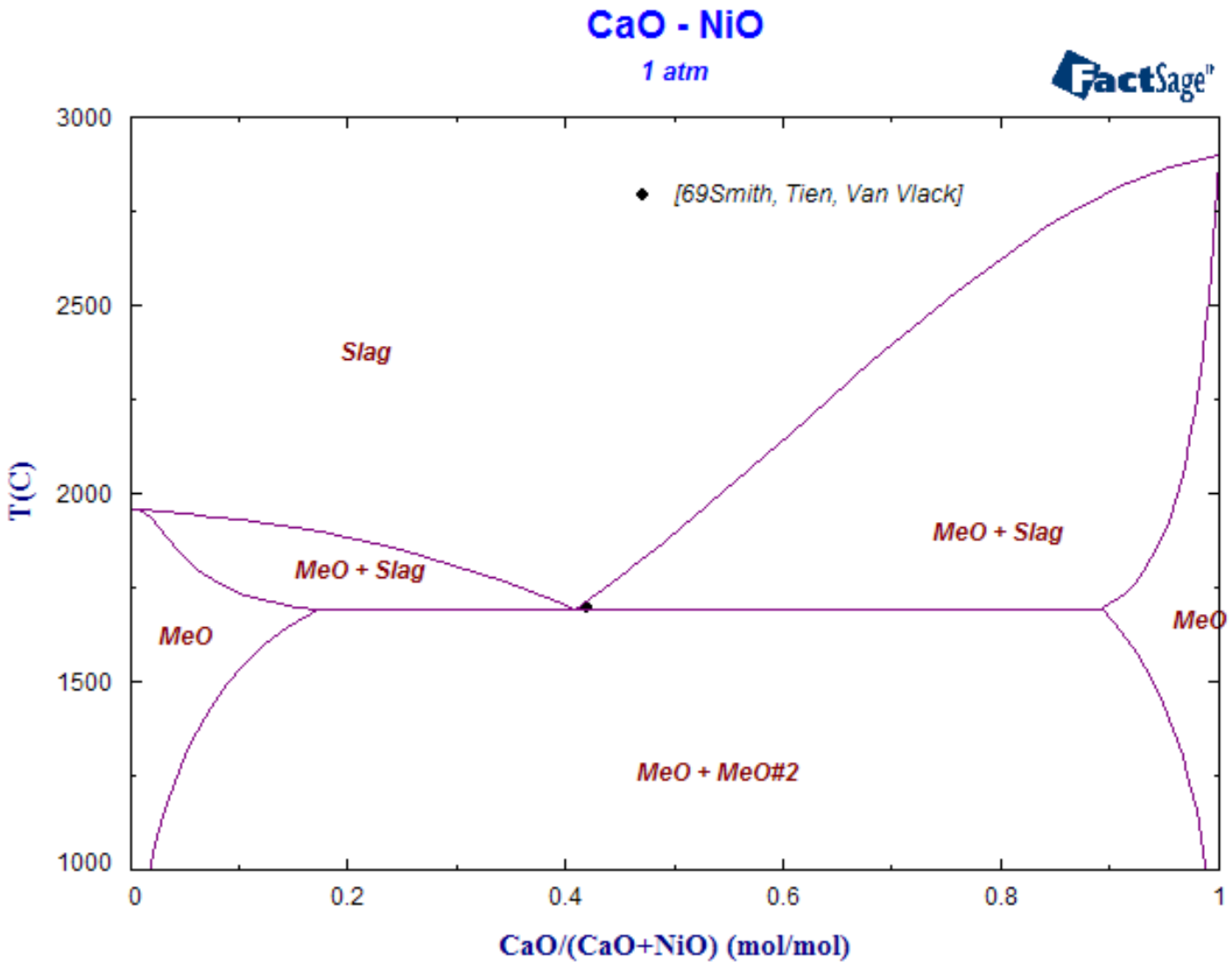
Mole fraction



CaO-Na2O,
Weight percent



Mole fraction



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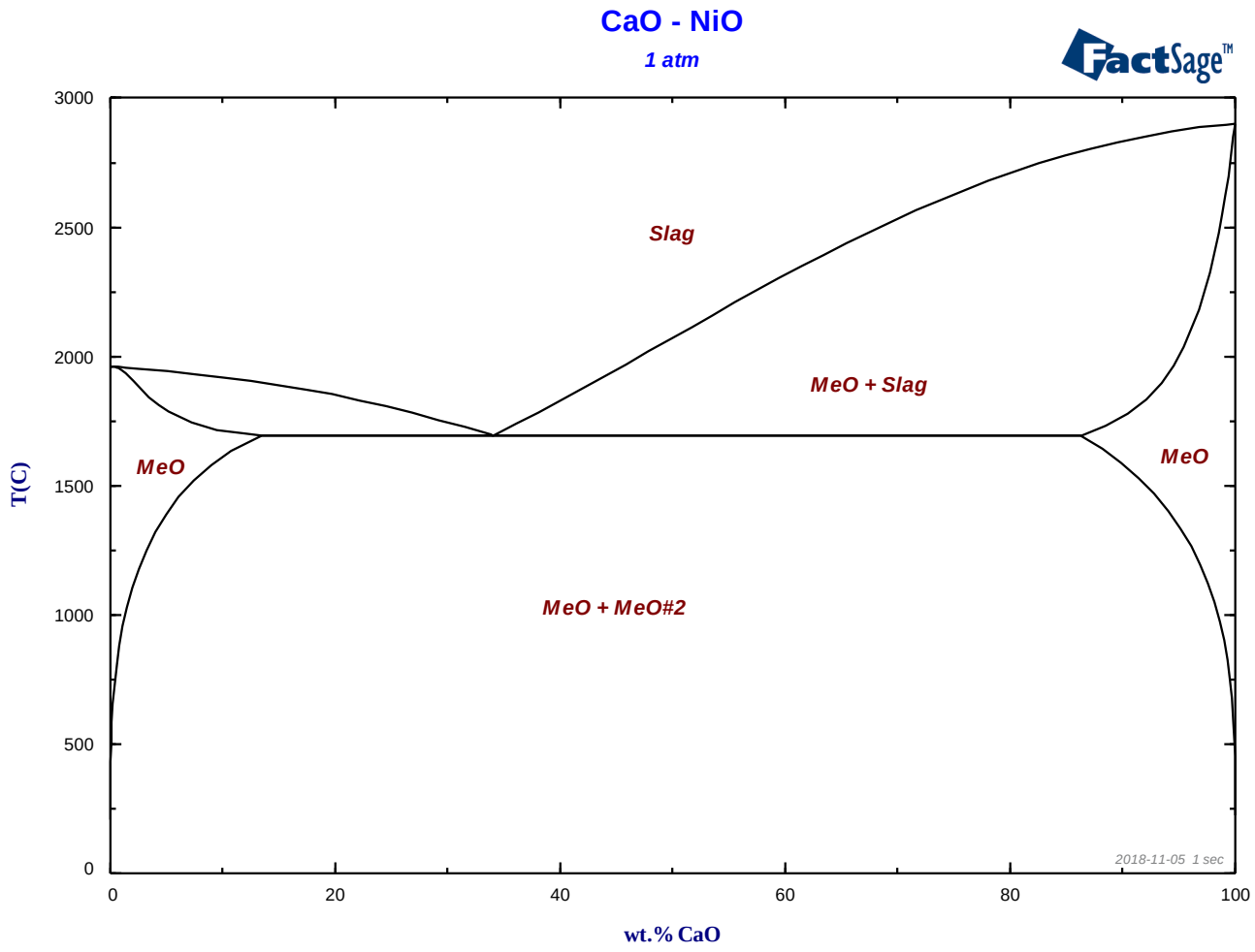
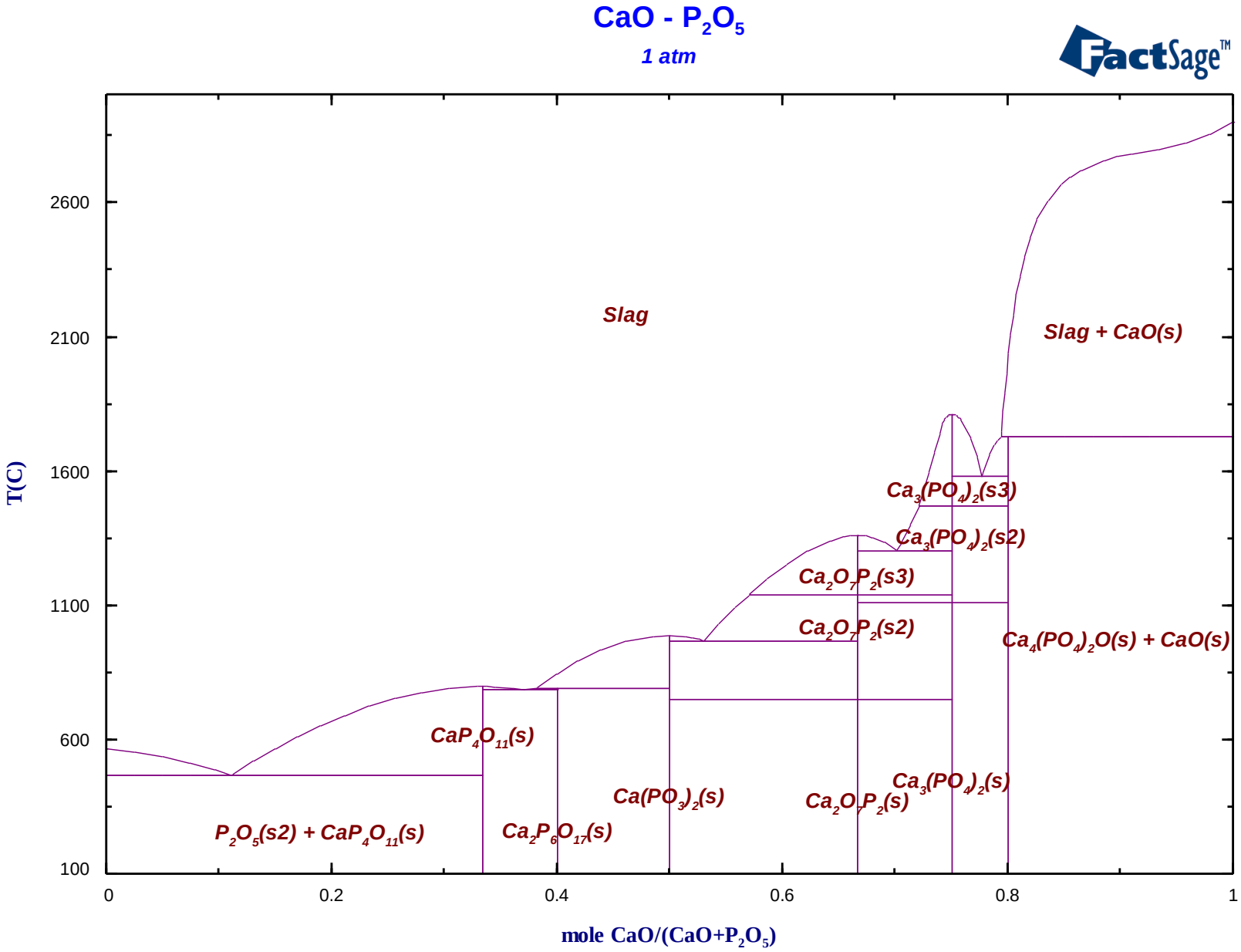
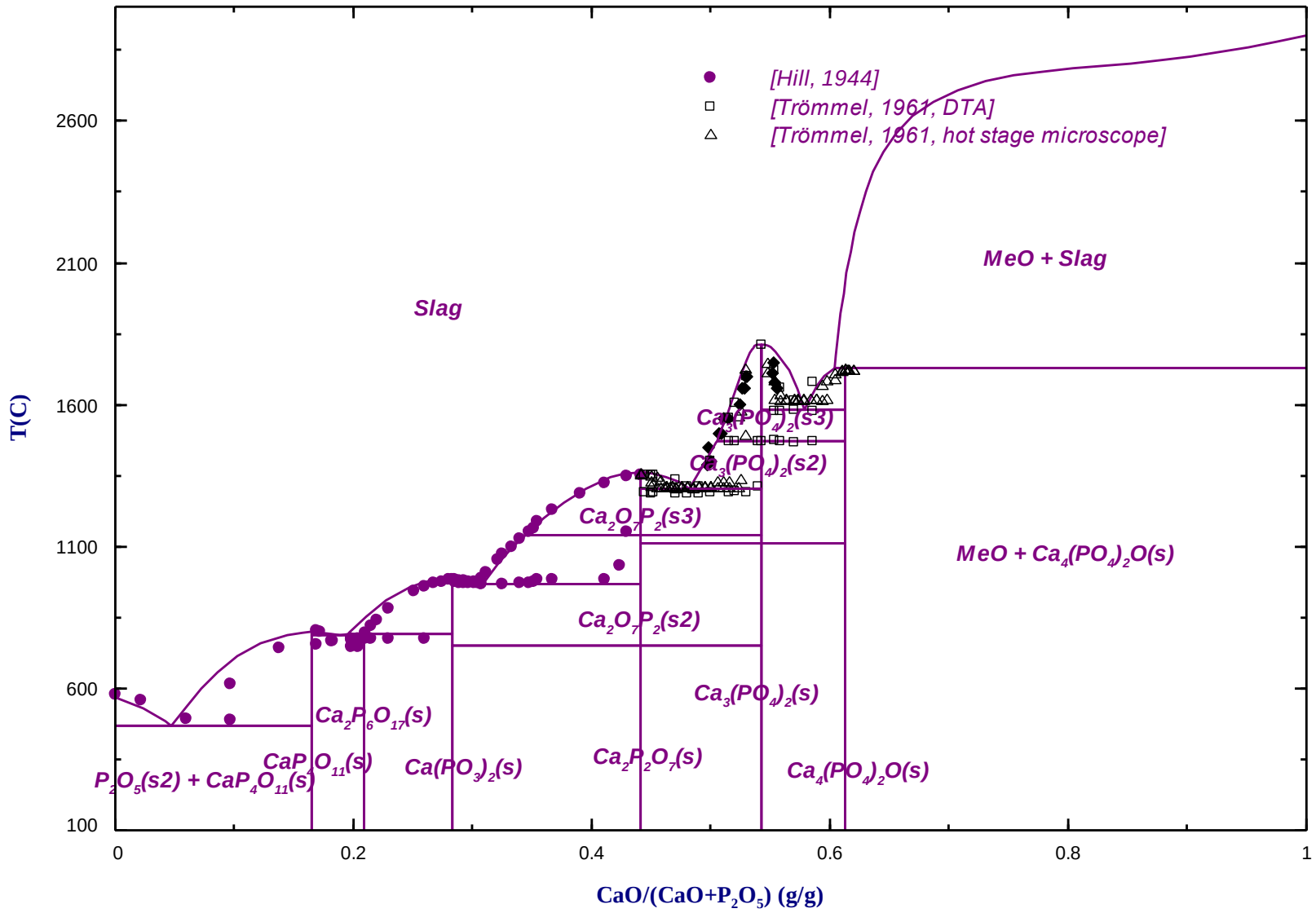


Mole fraction

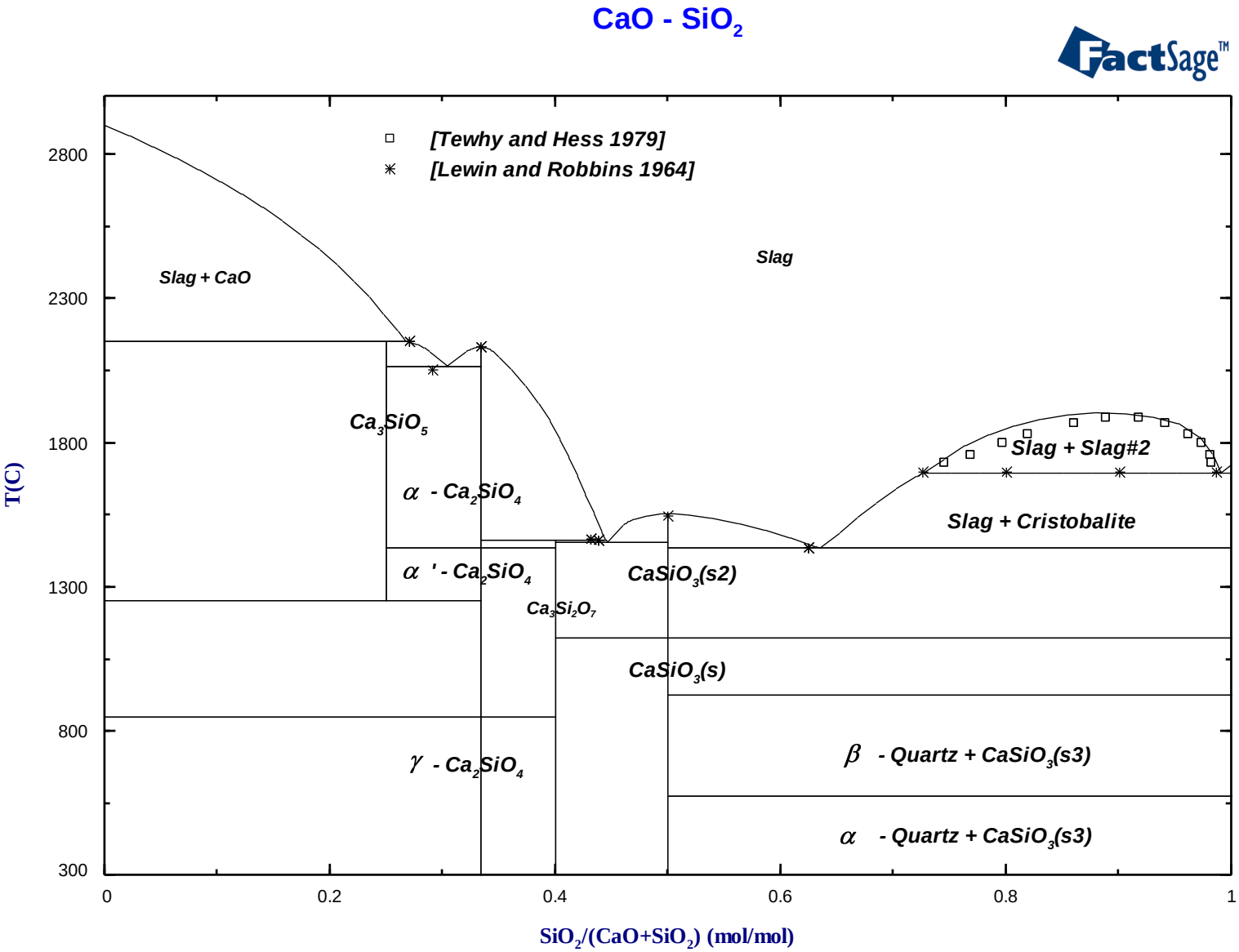


Weight percent compared with experimental data

$CaO - P_2O_5$

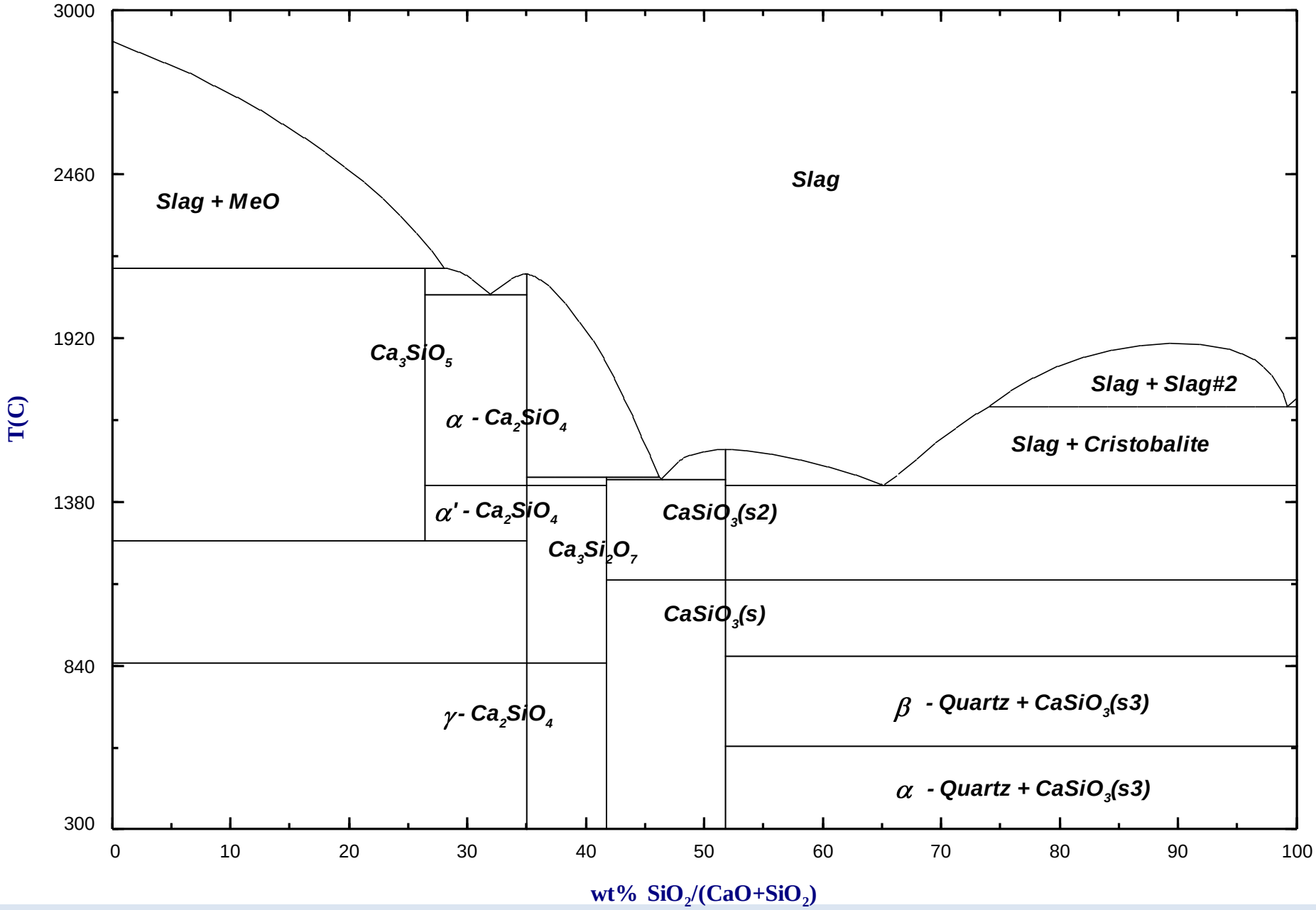


Mole fraction
compared with experimental data

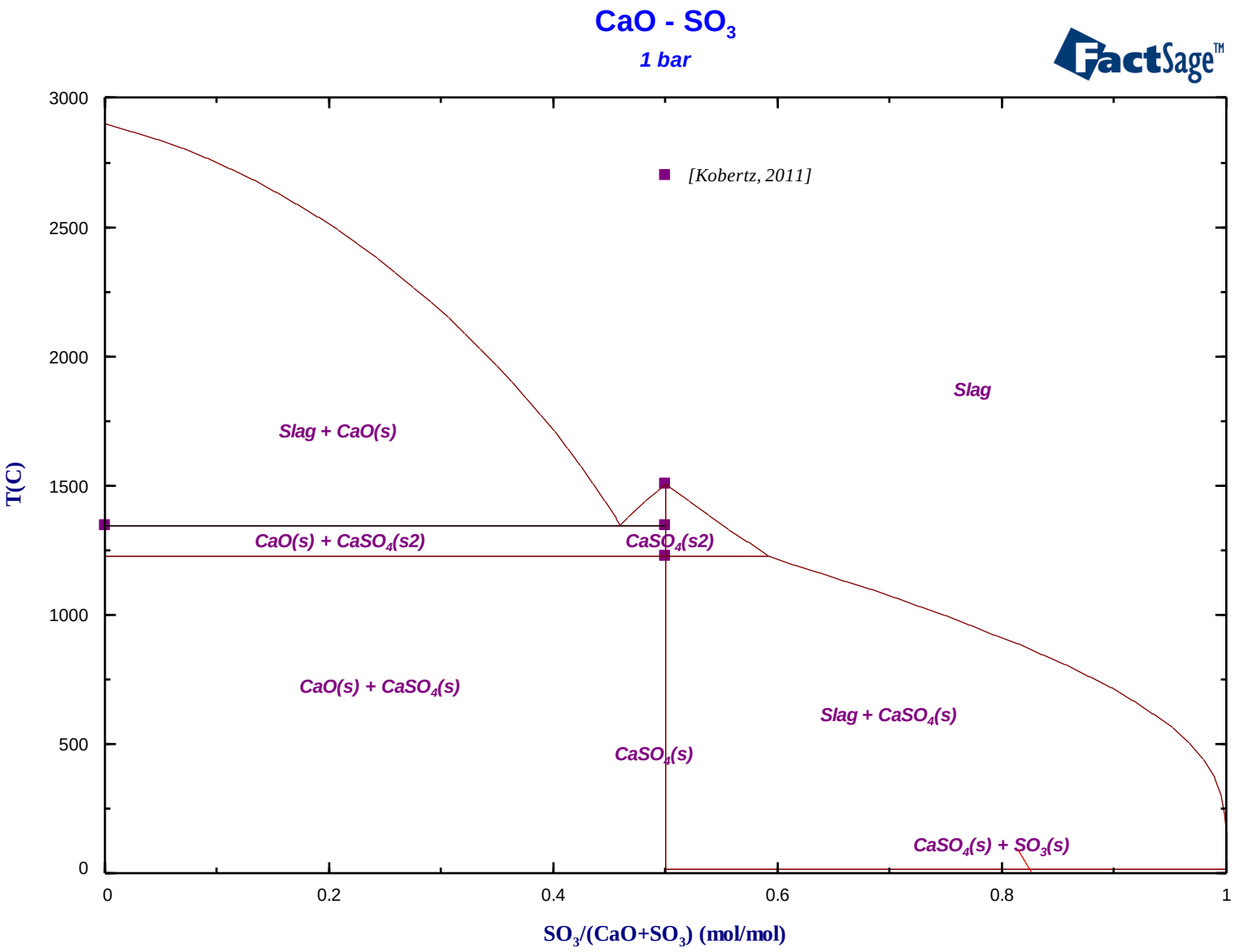


CaO - SiO_2

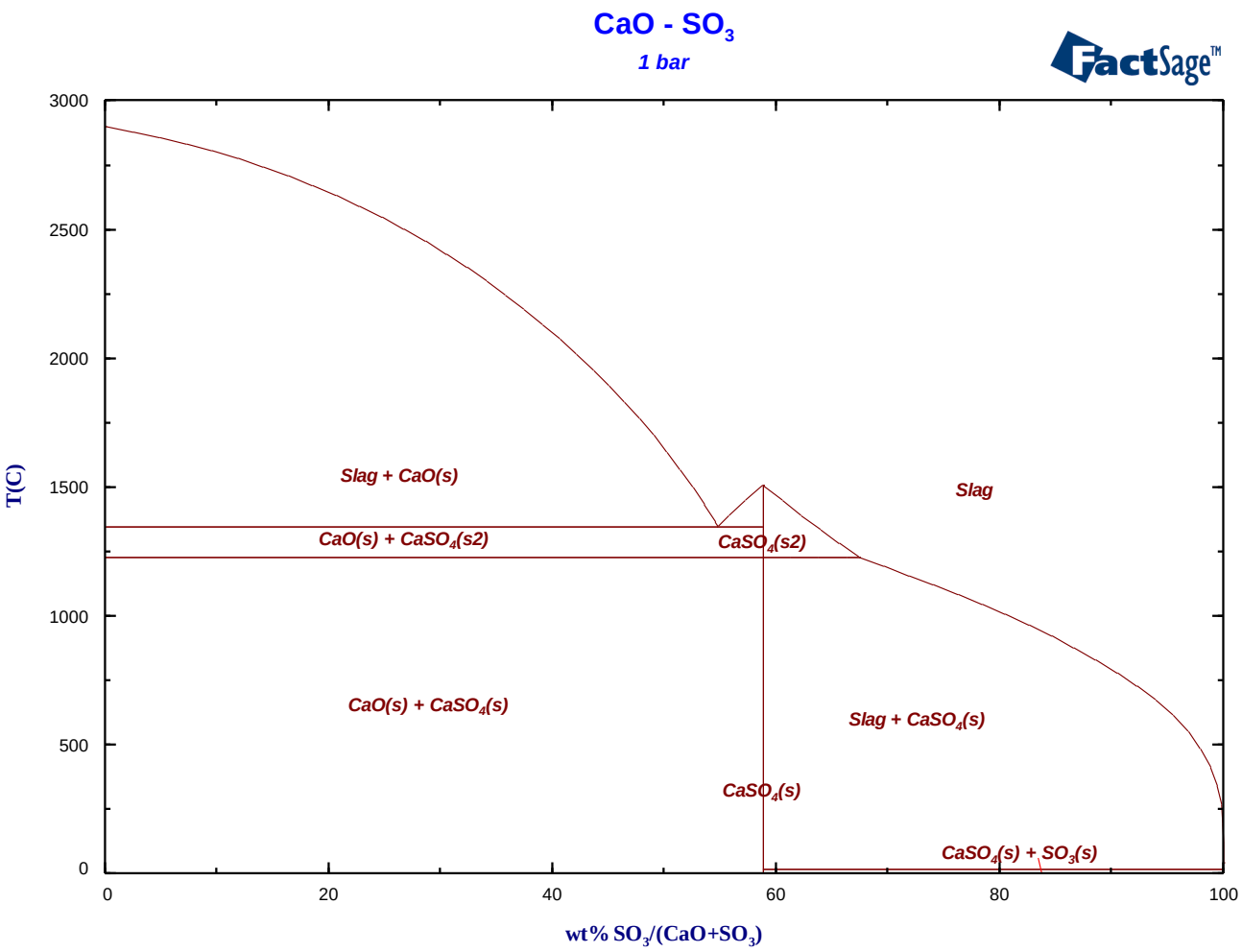
Weight percent



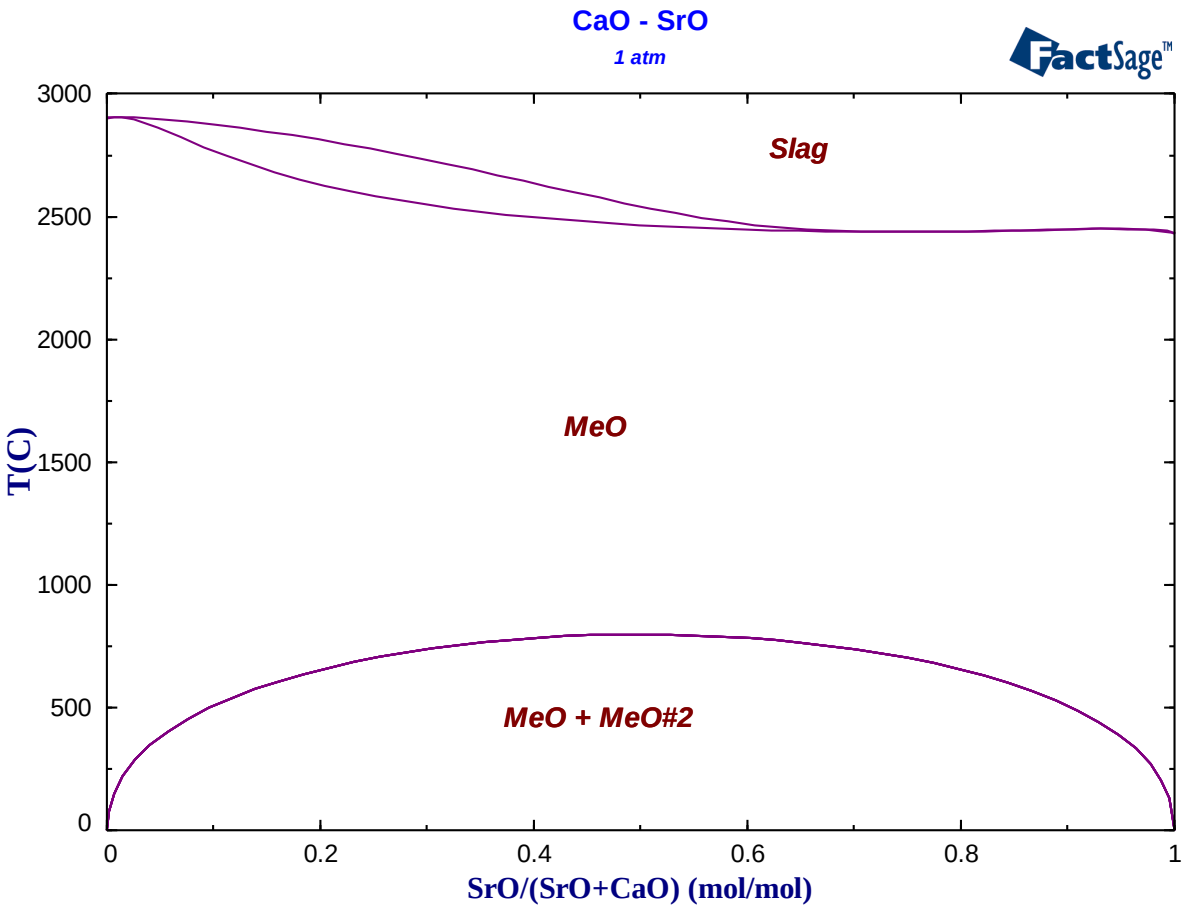
Mole fraction
compared with experimental data



Weight percent



Mole fraction



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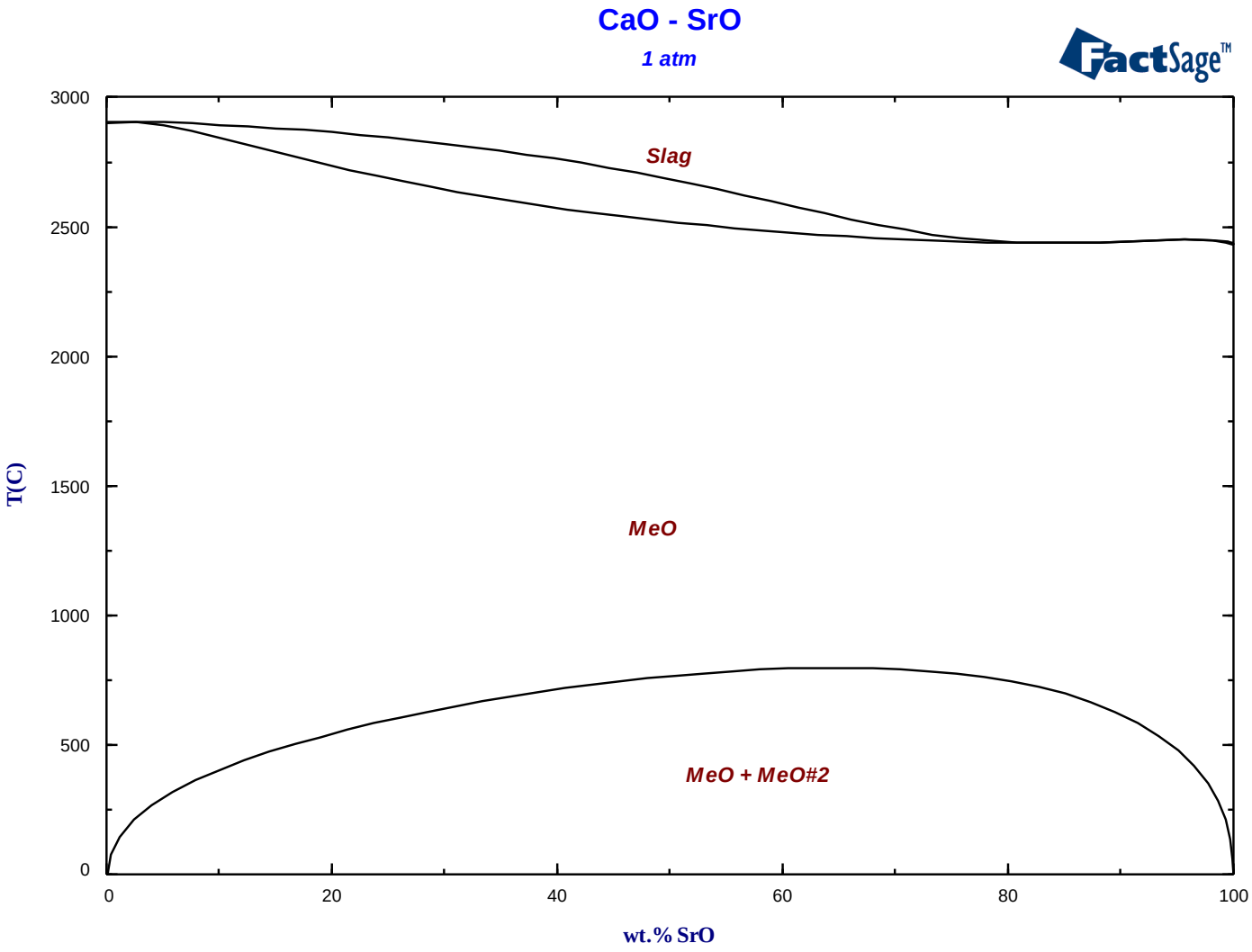
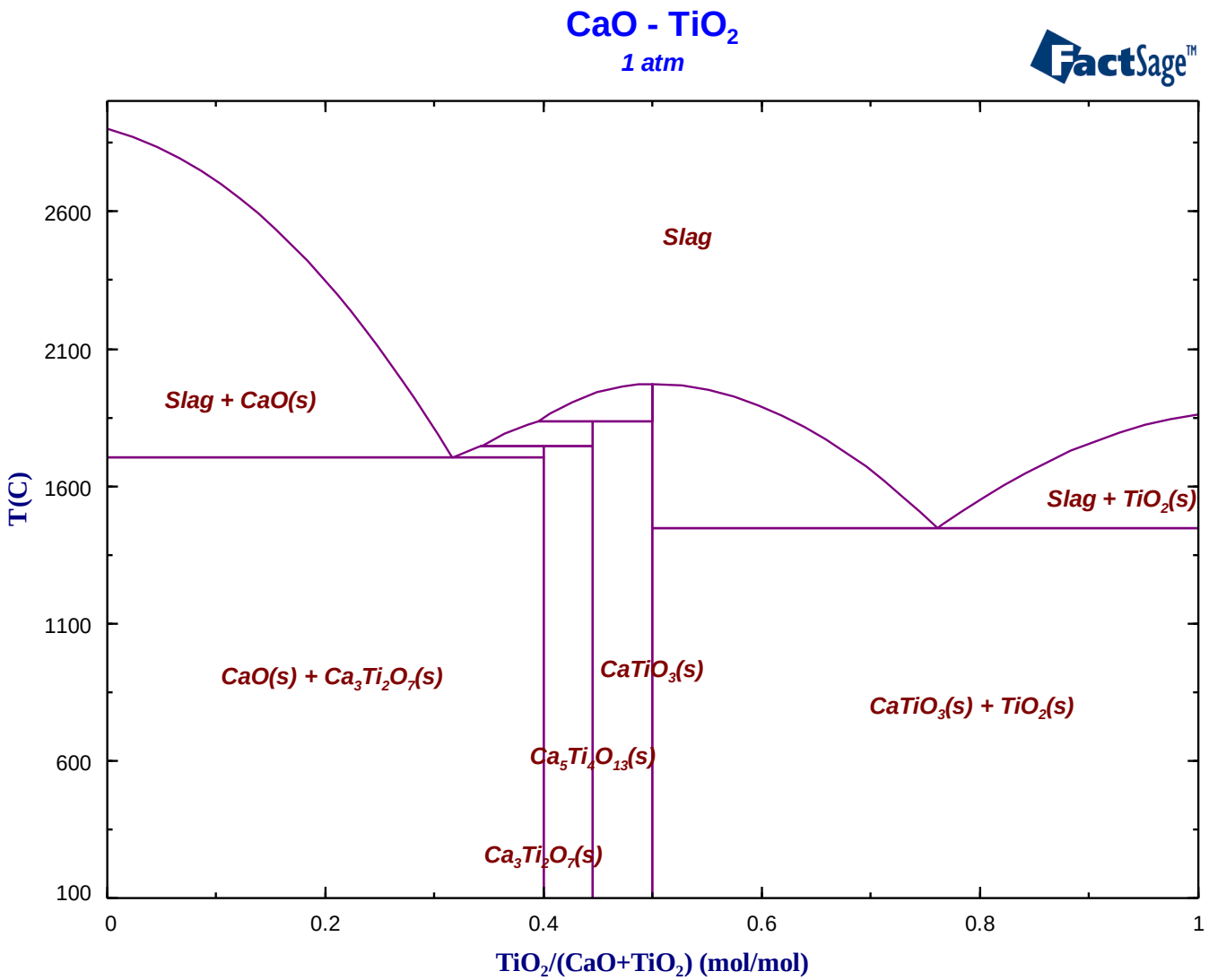
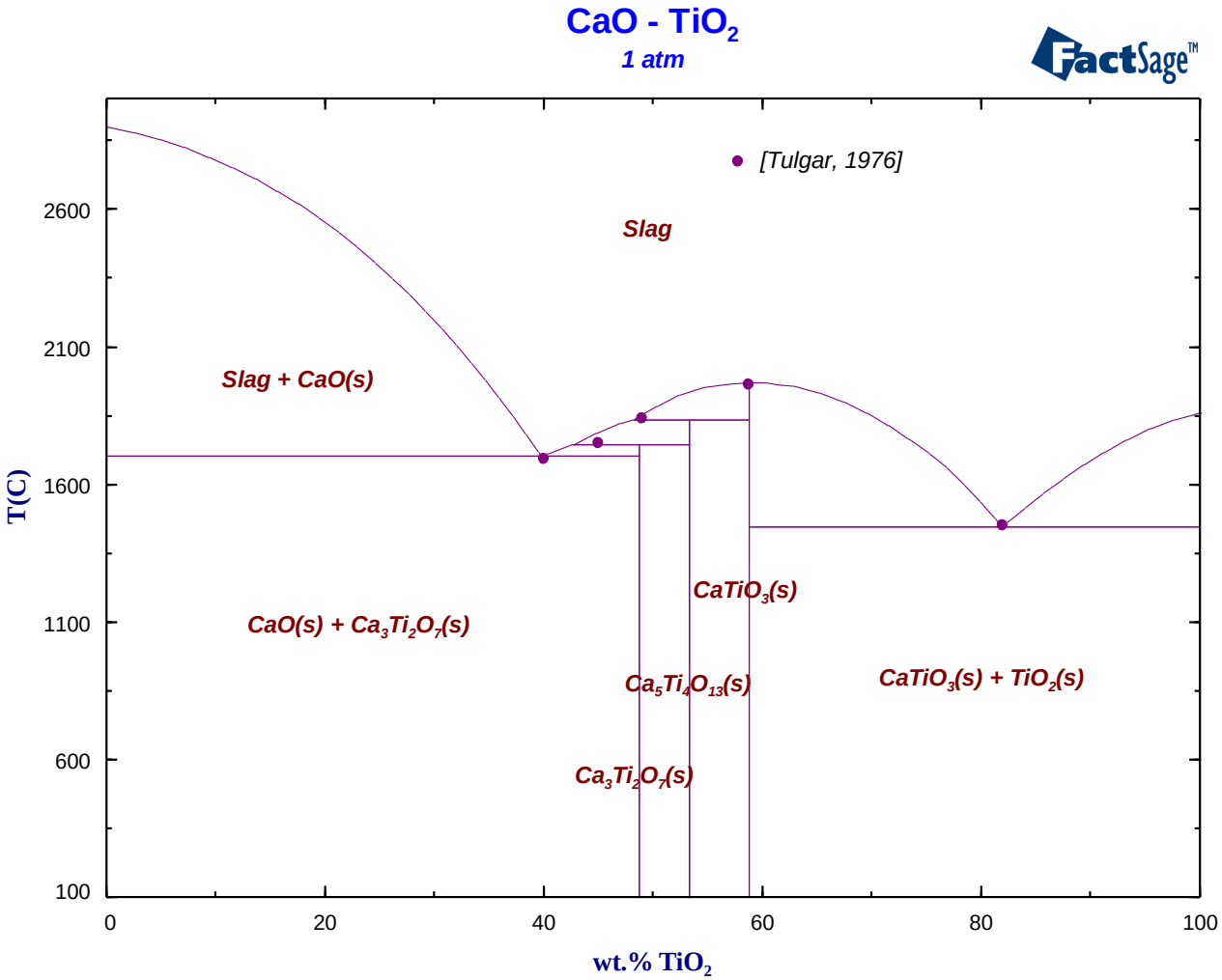


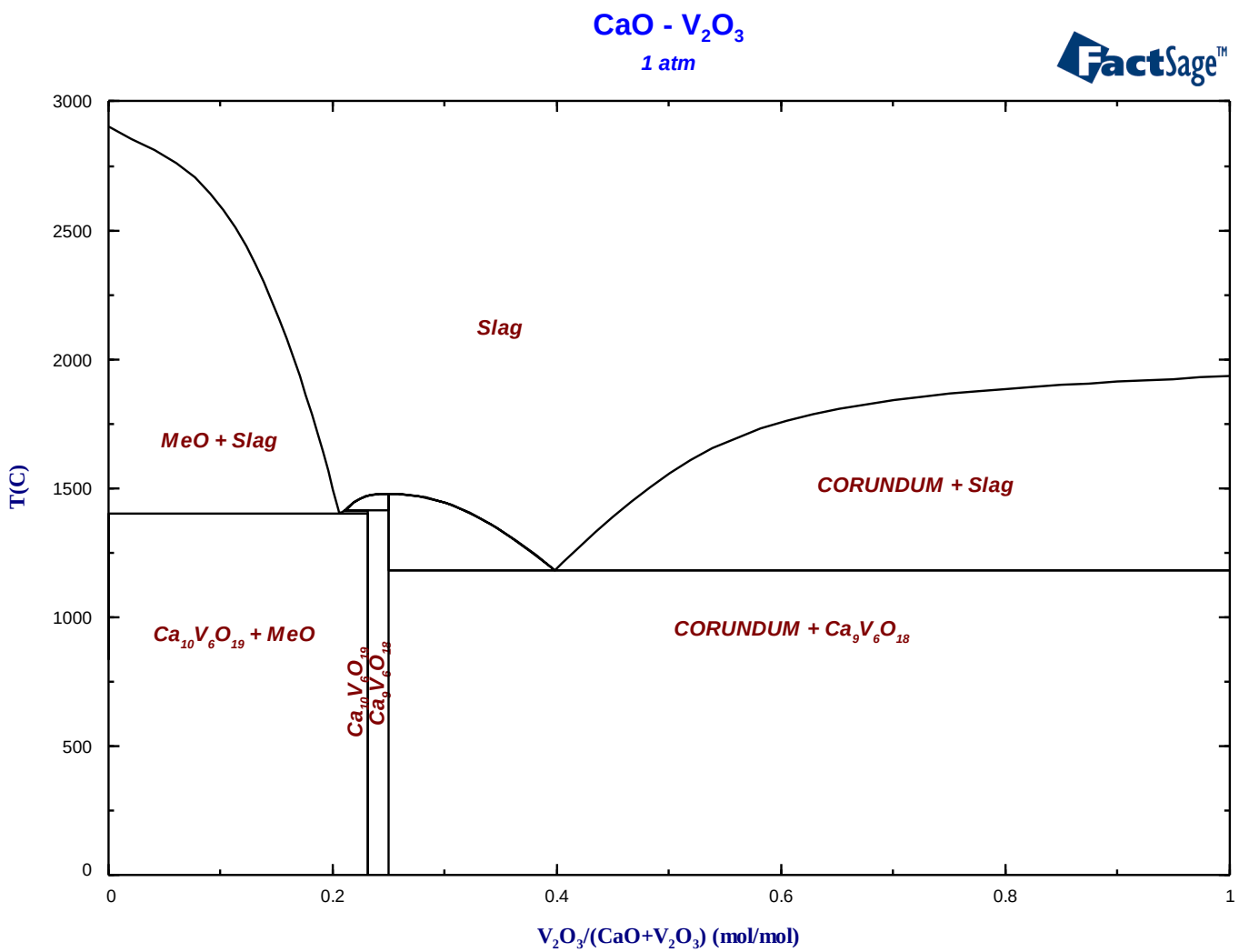
Mole fraction



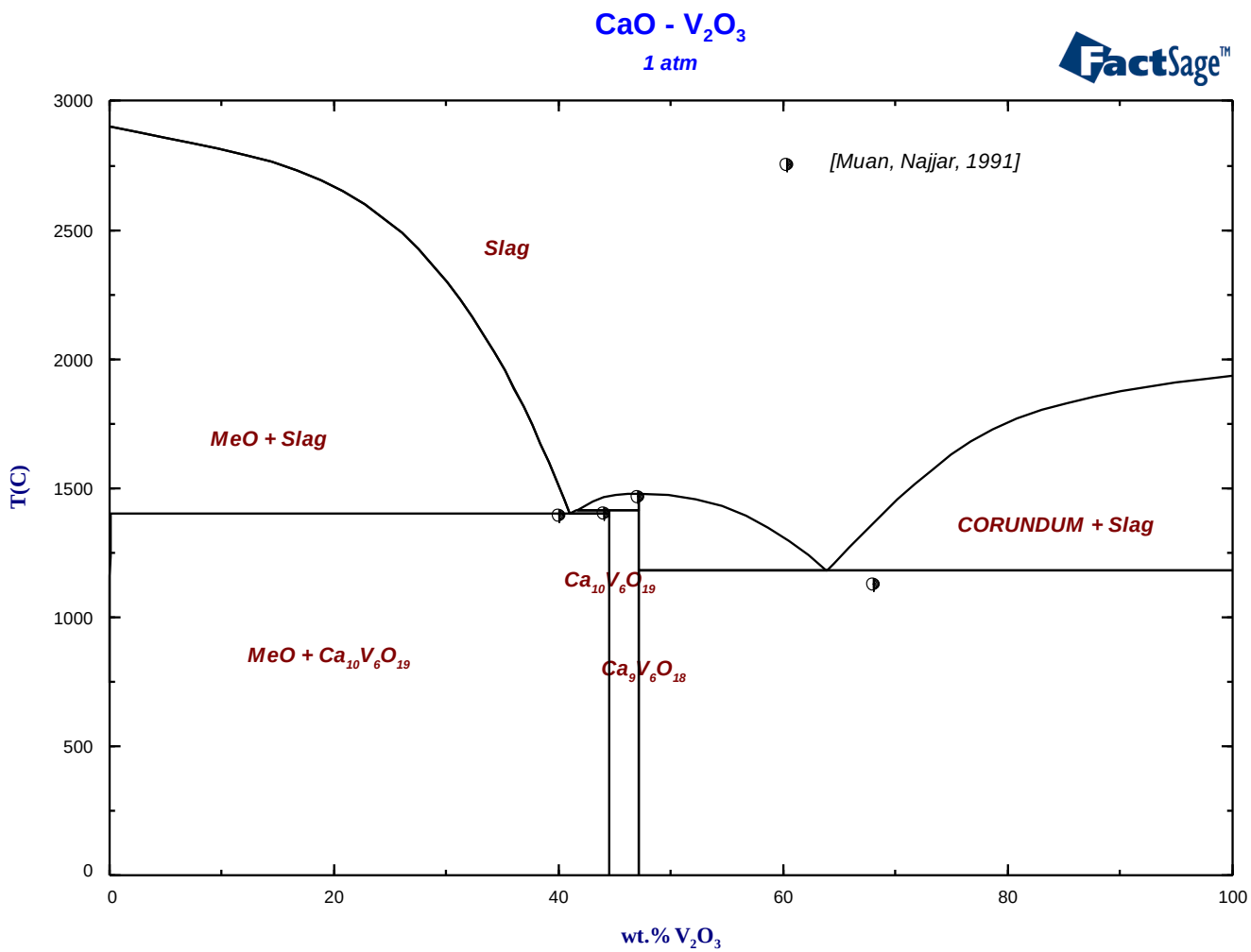
Weight percent compared with experimental data



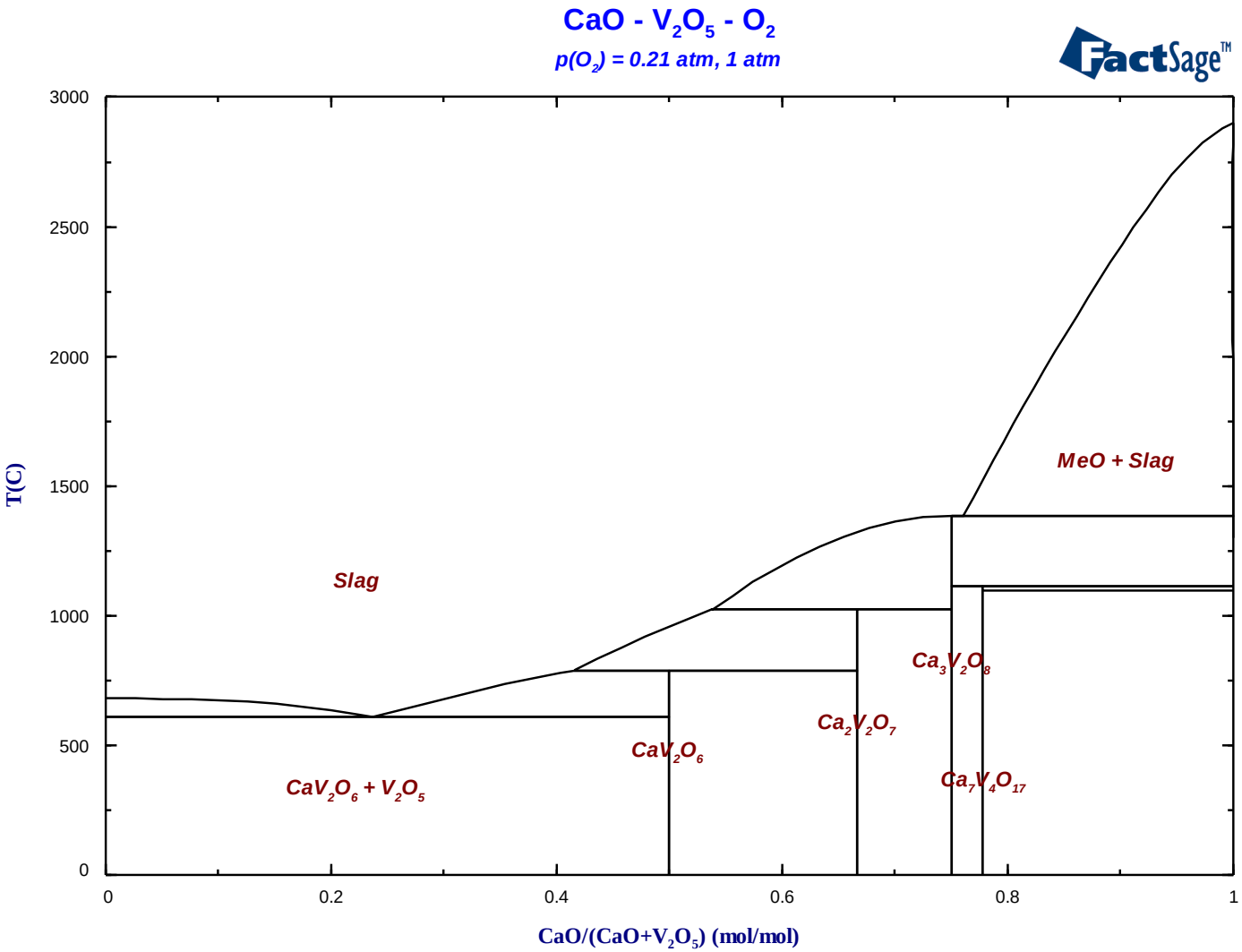
CaO-V2O3,
Mole fraction



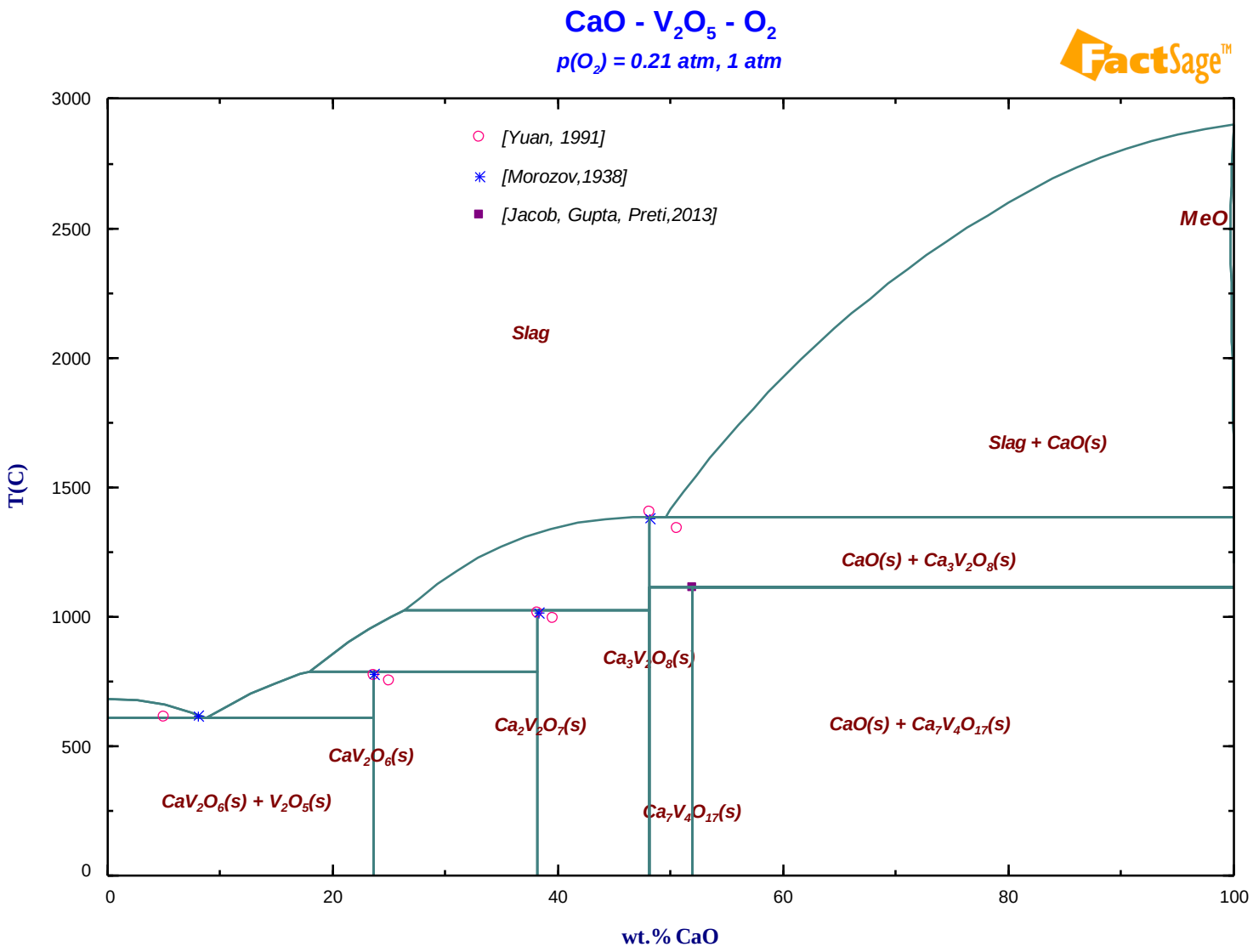
CaO-V2O3,
Weight percent compared with experimental data



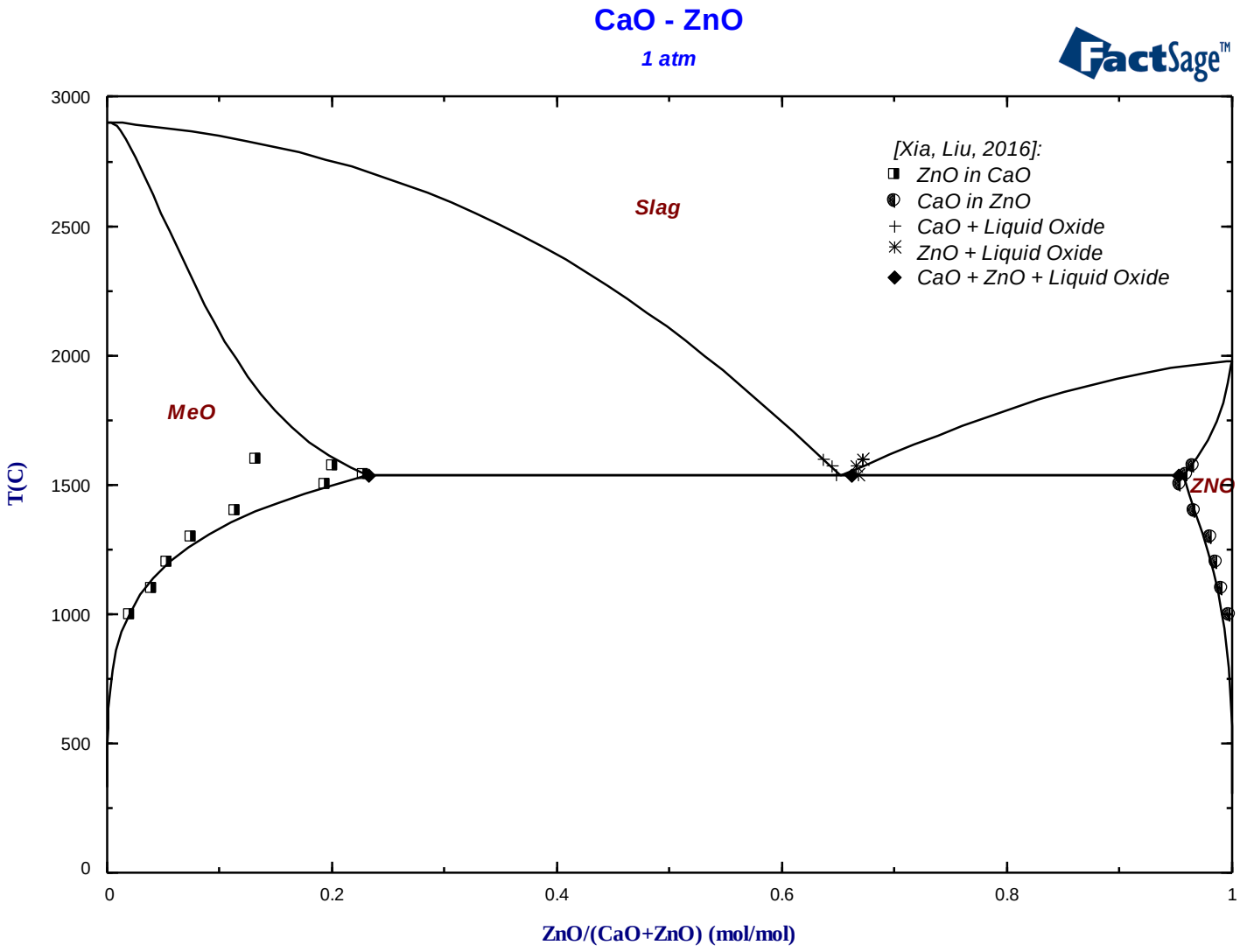
CaO-V2O5-O2,
Mole fraction



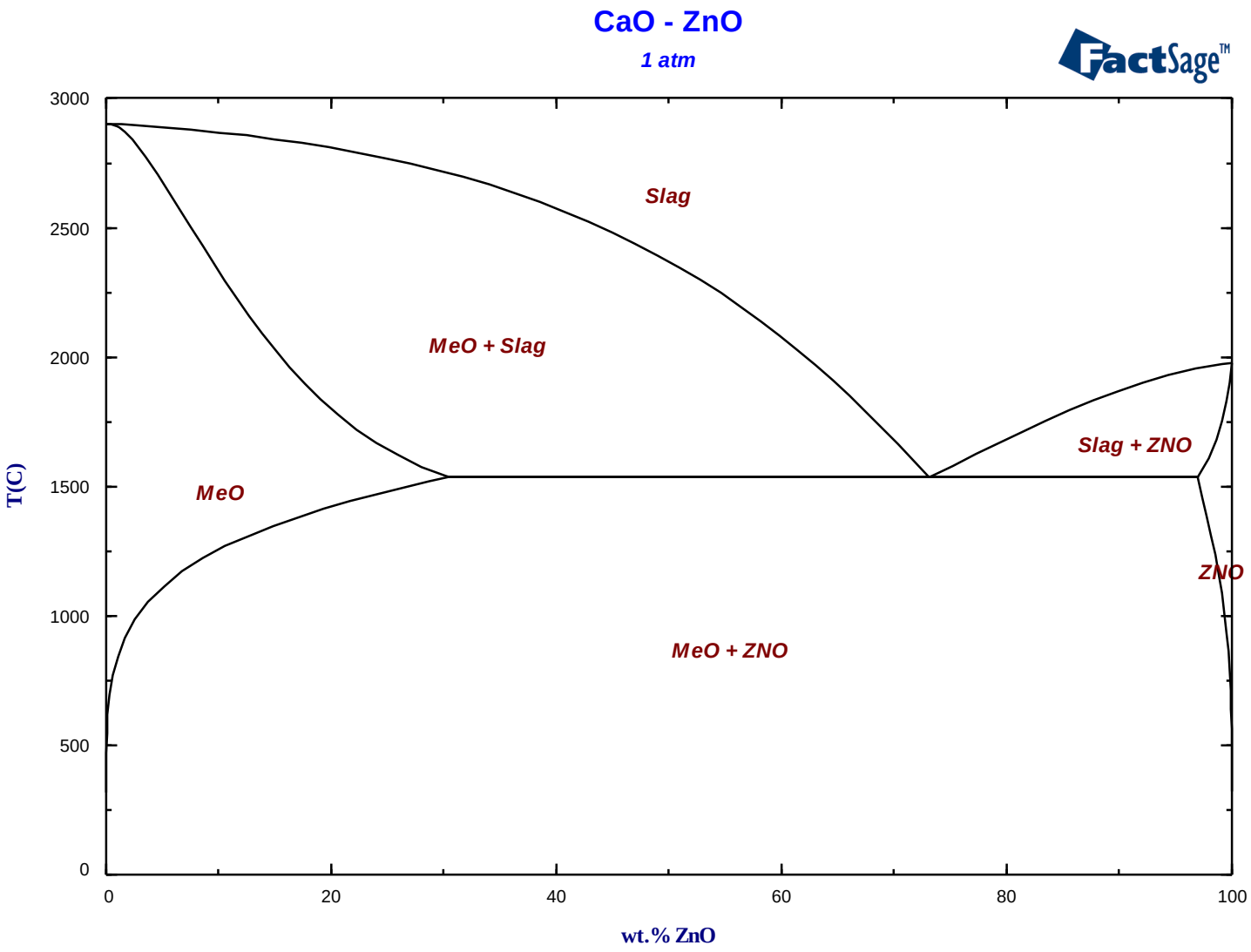
CaO-V2O5-O2,
Weight percent compared with experimental data



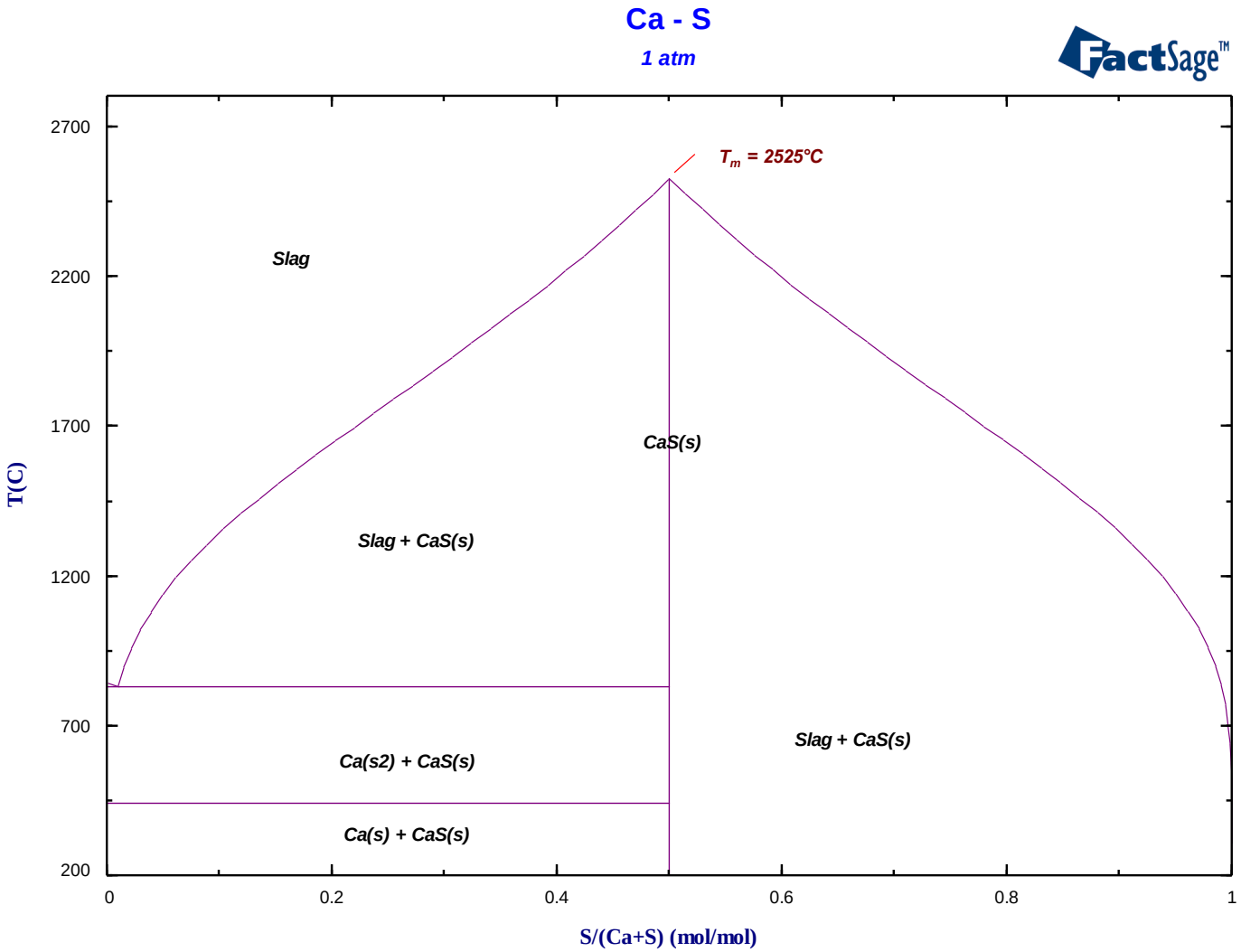
Mole fraction



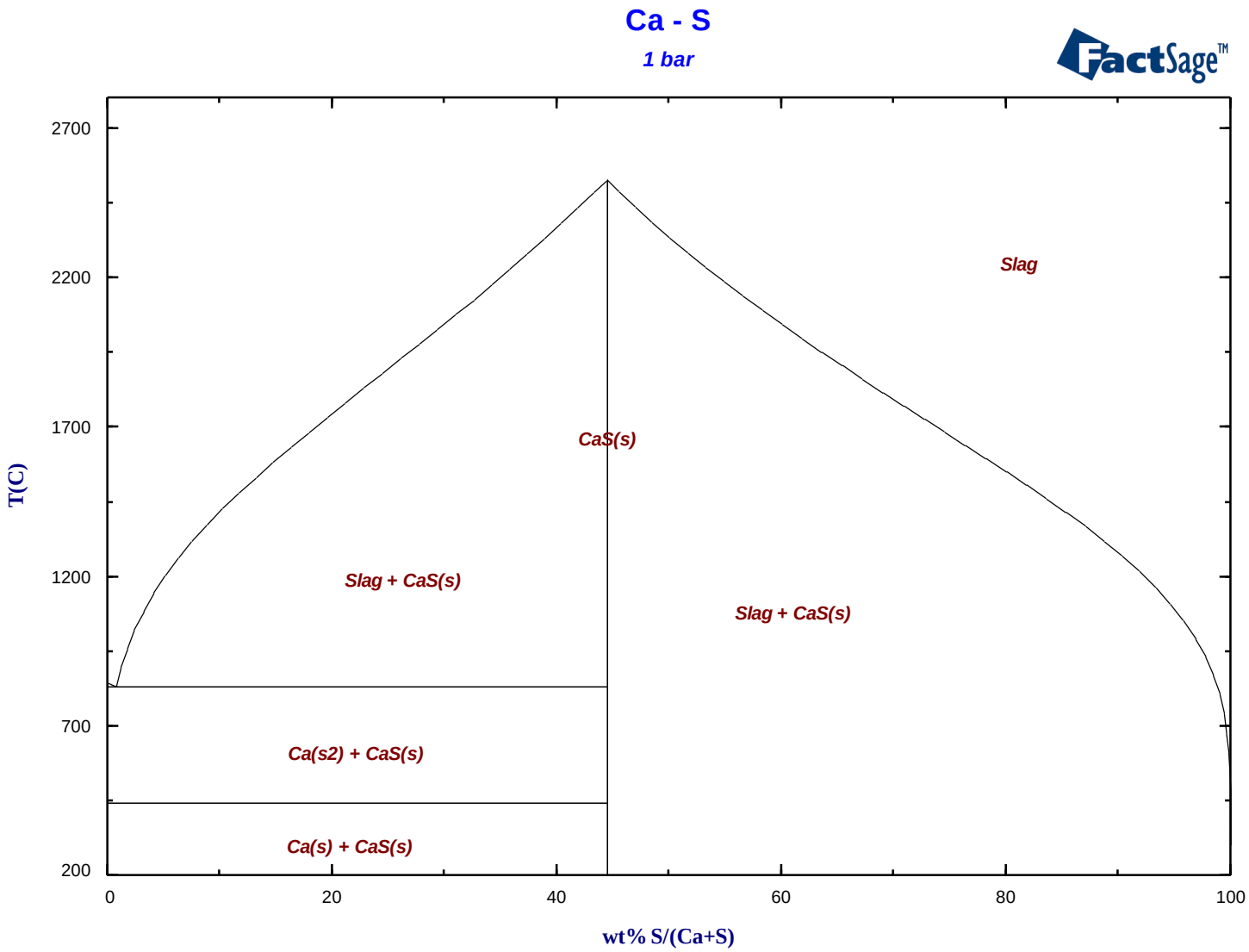
Weight percent



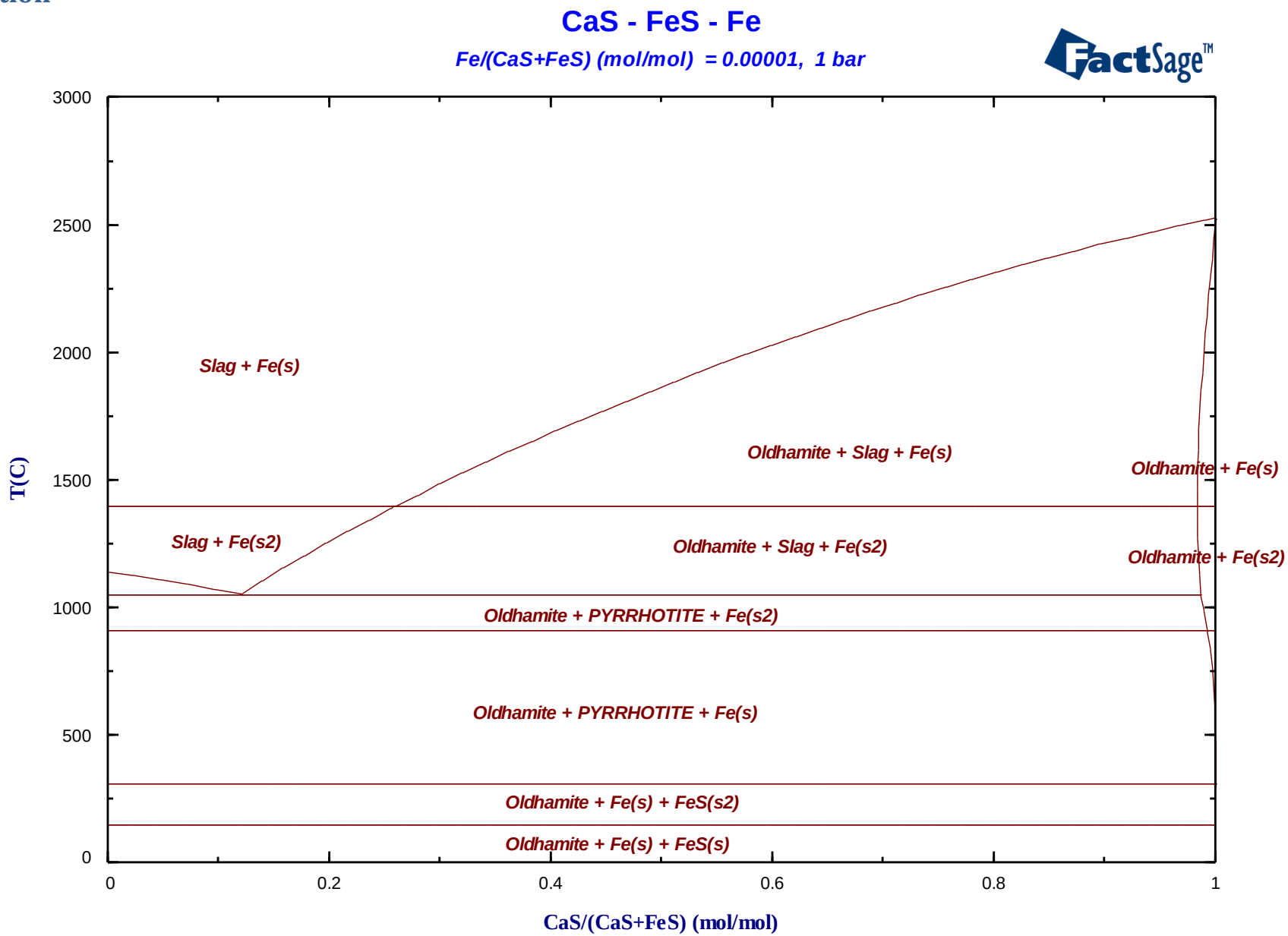
Mole fraction



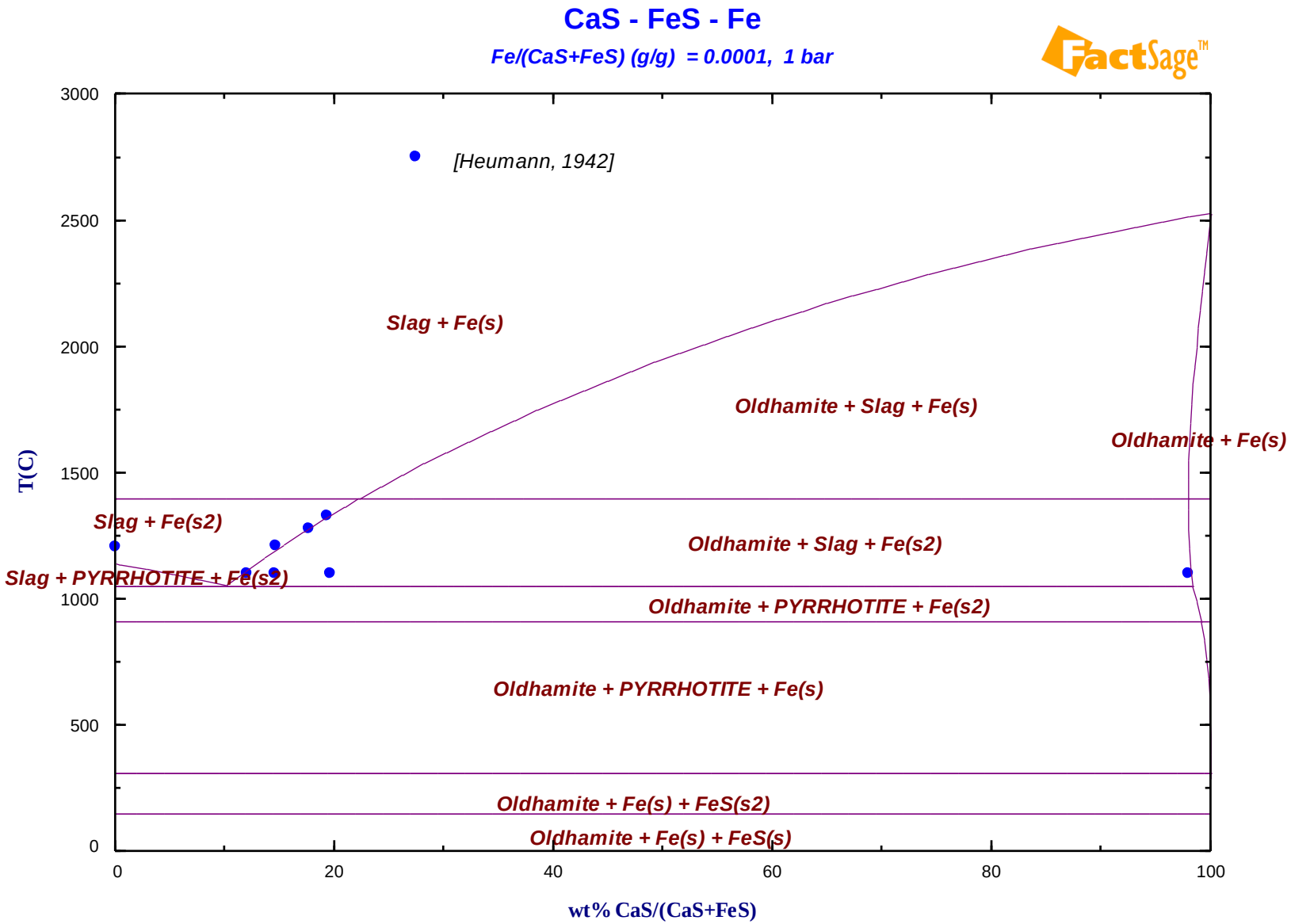
Weight percent



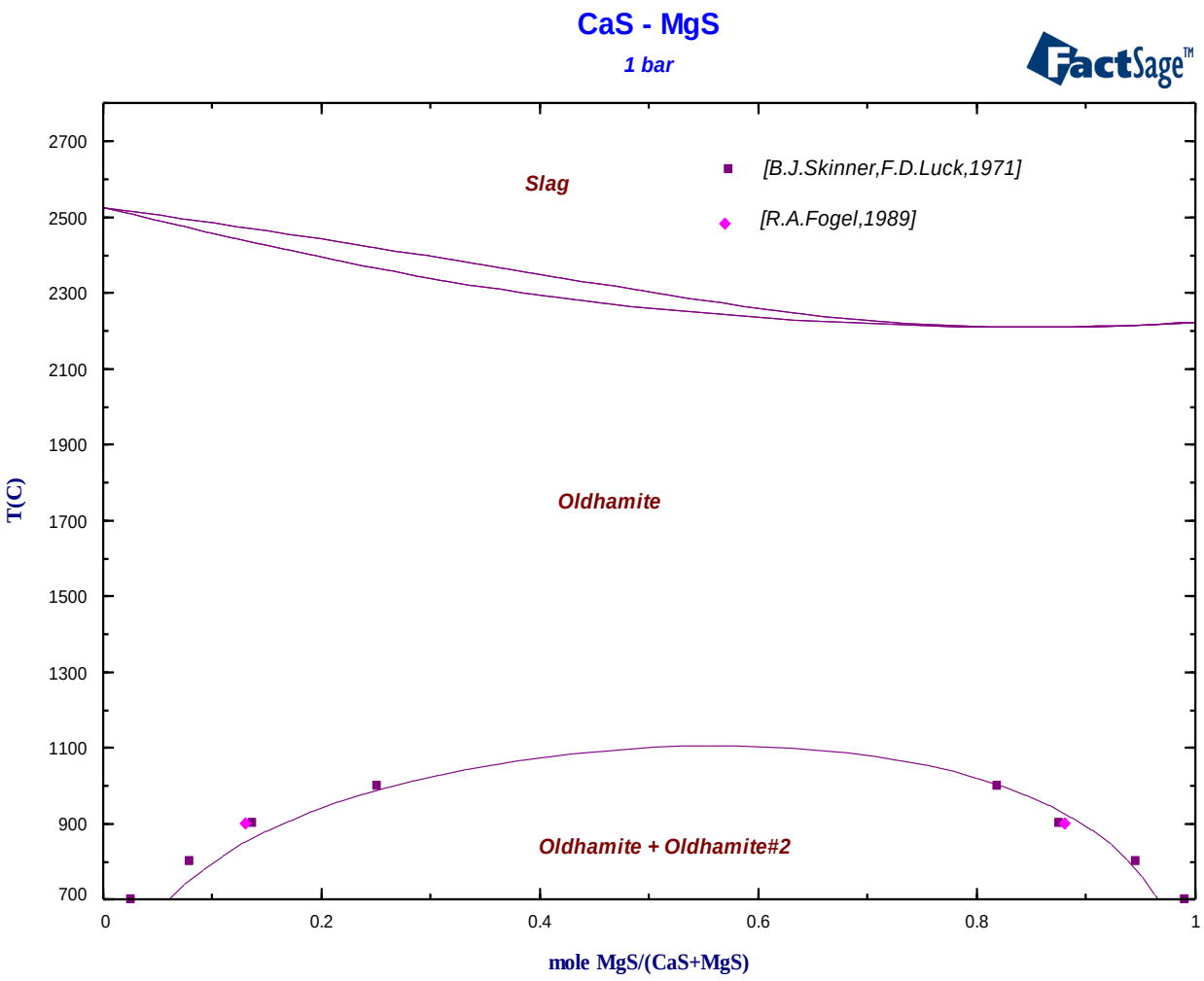
Mole fraction



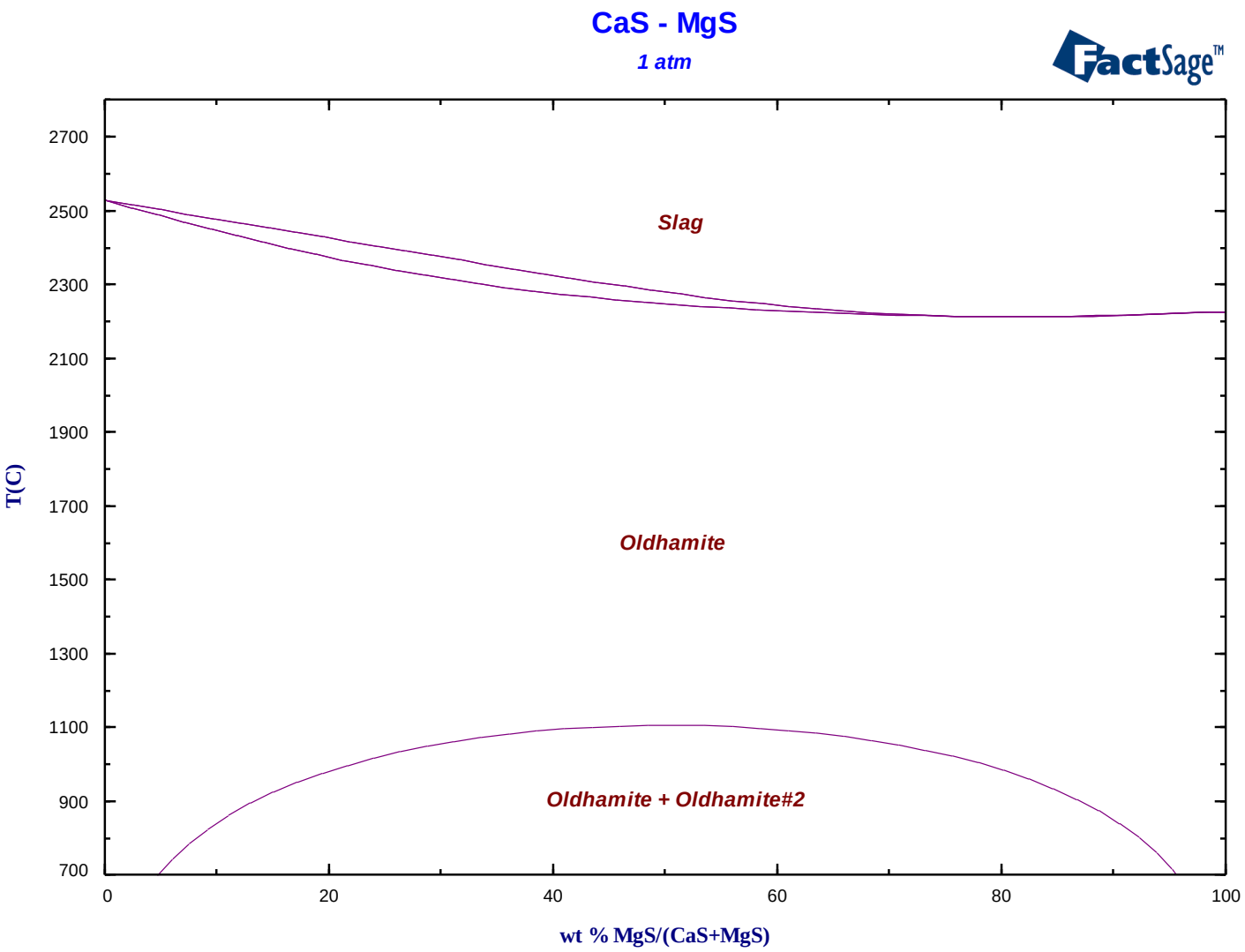
Weight percent
compared with experimental data



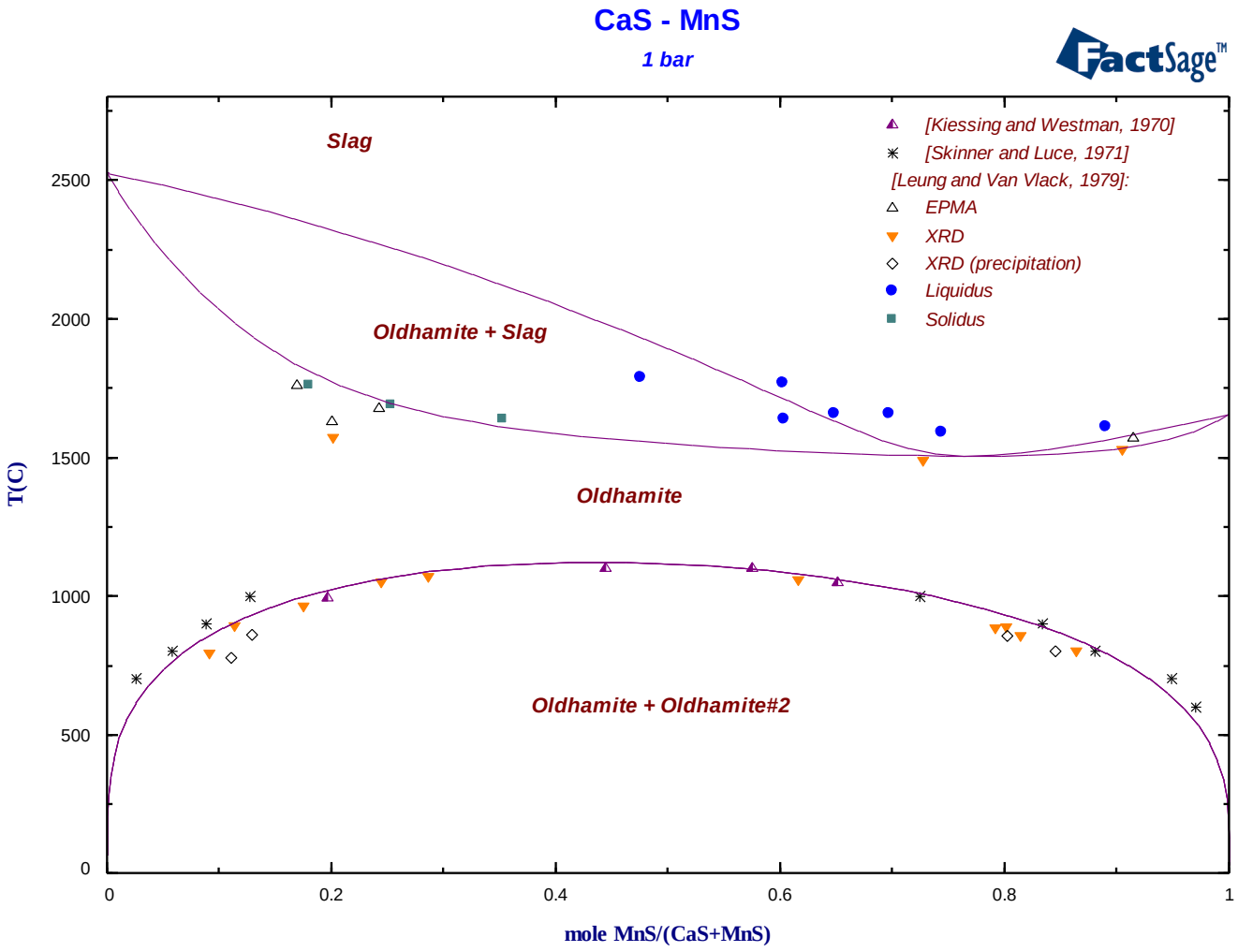
Mole fraction
compared with experimental data



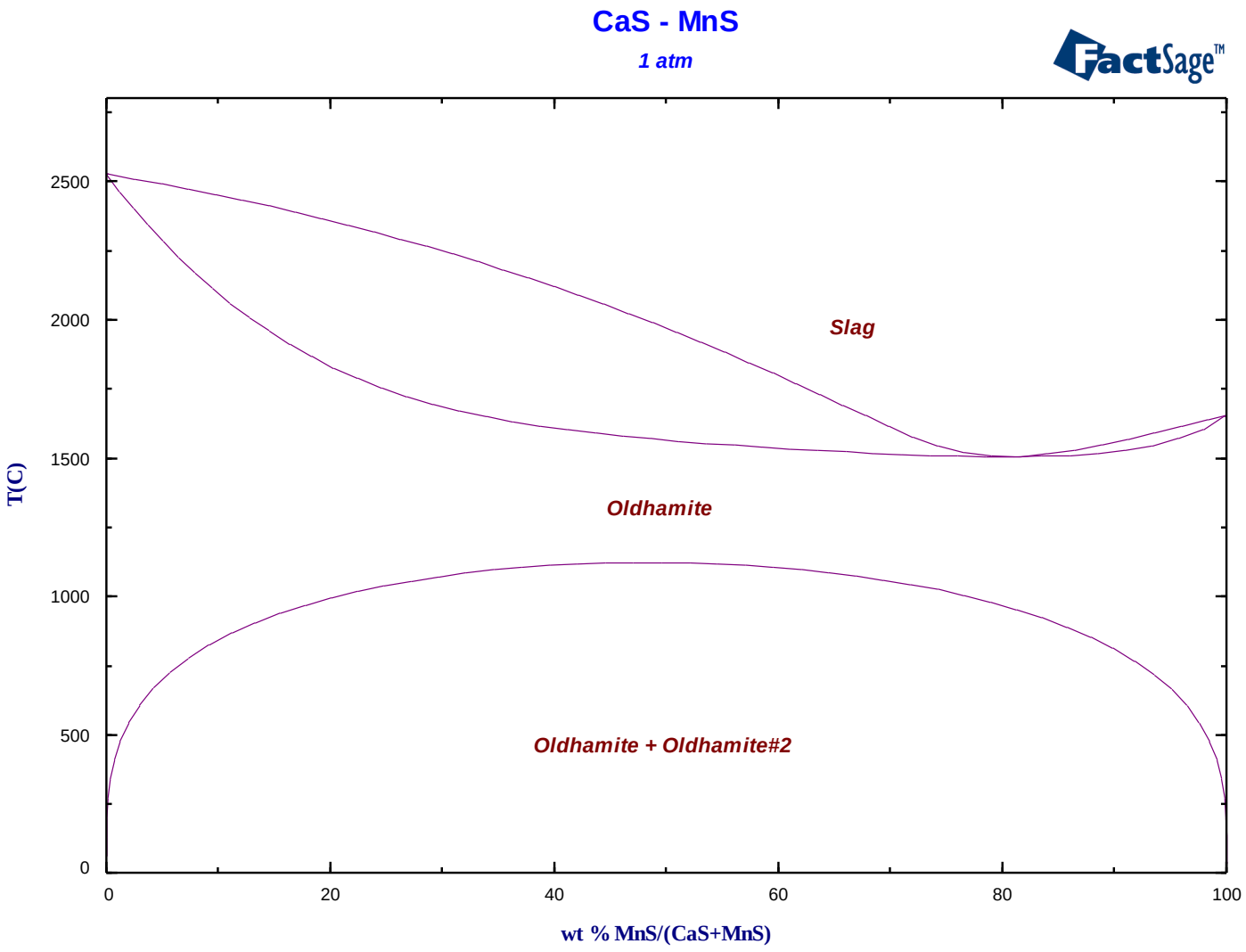
Weight percent



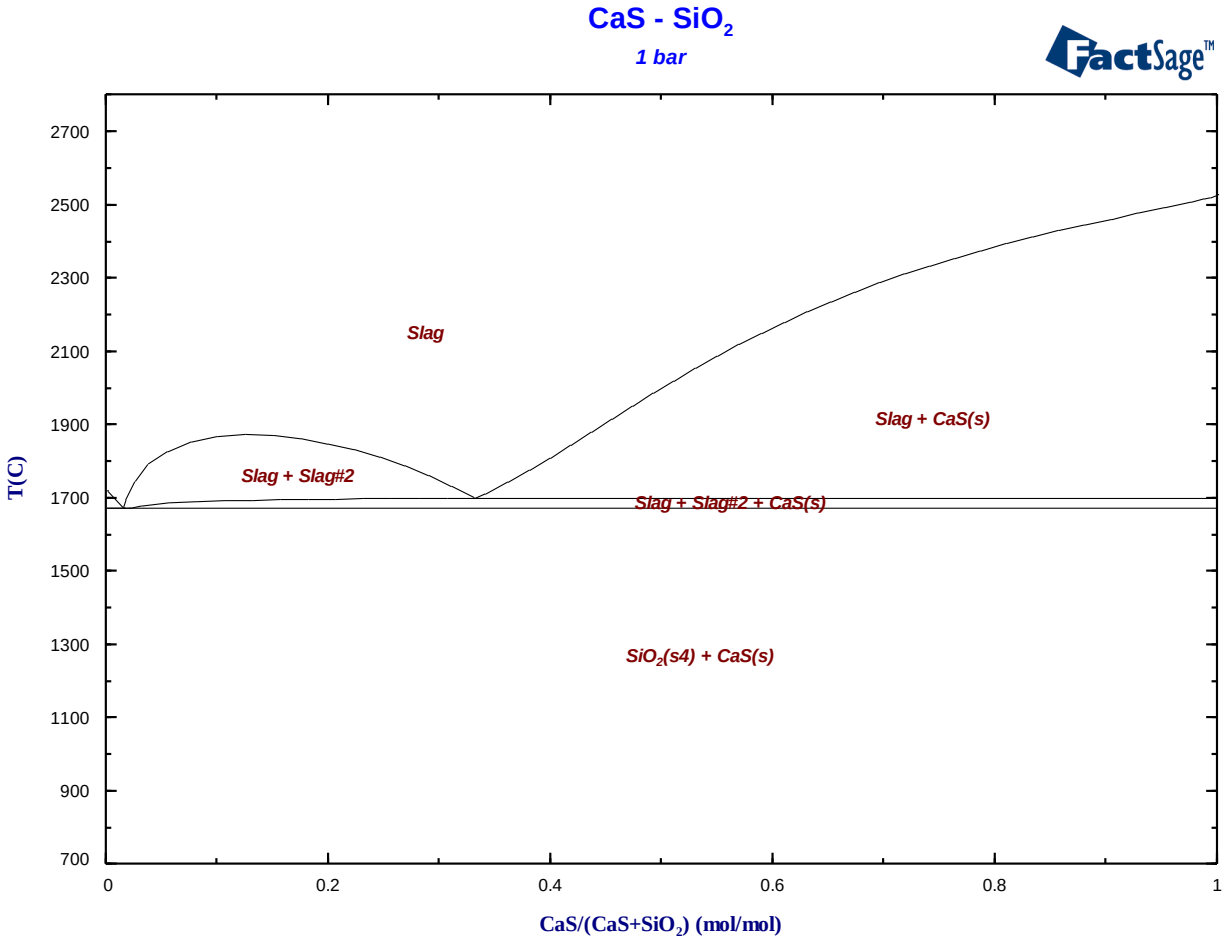
Mole fraction
compared with experimental data



Weight percent



Mole fraction



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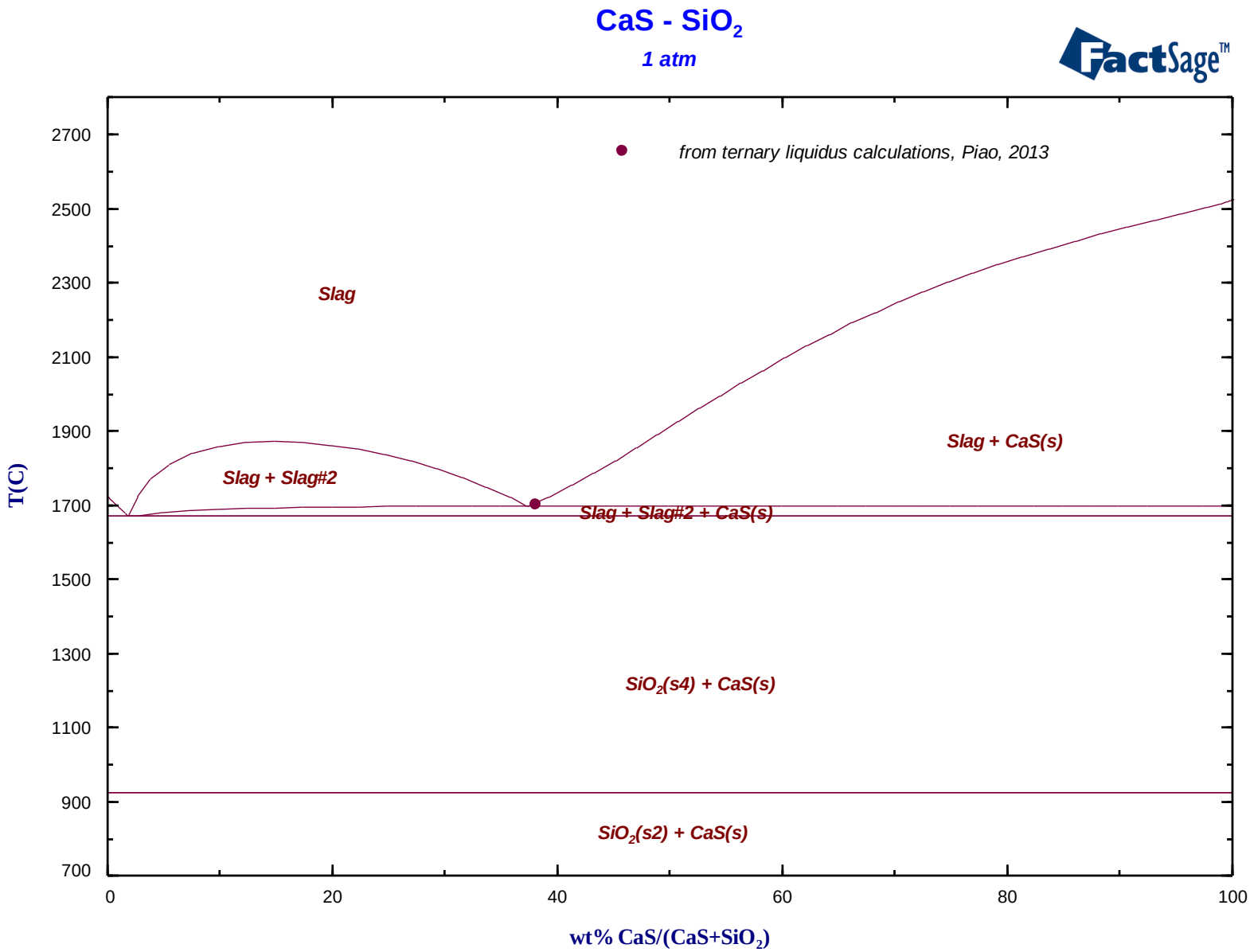
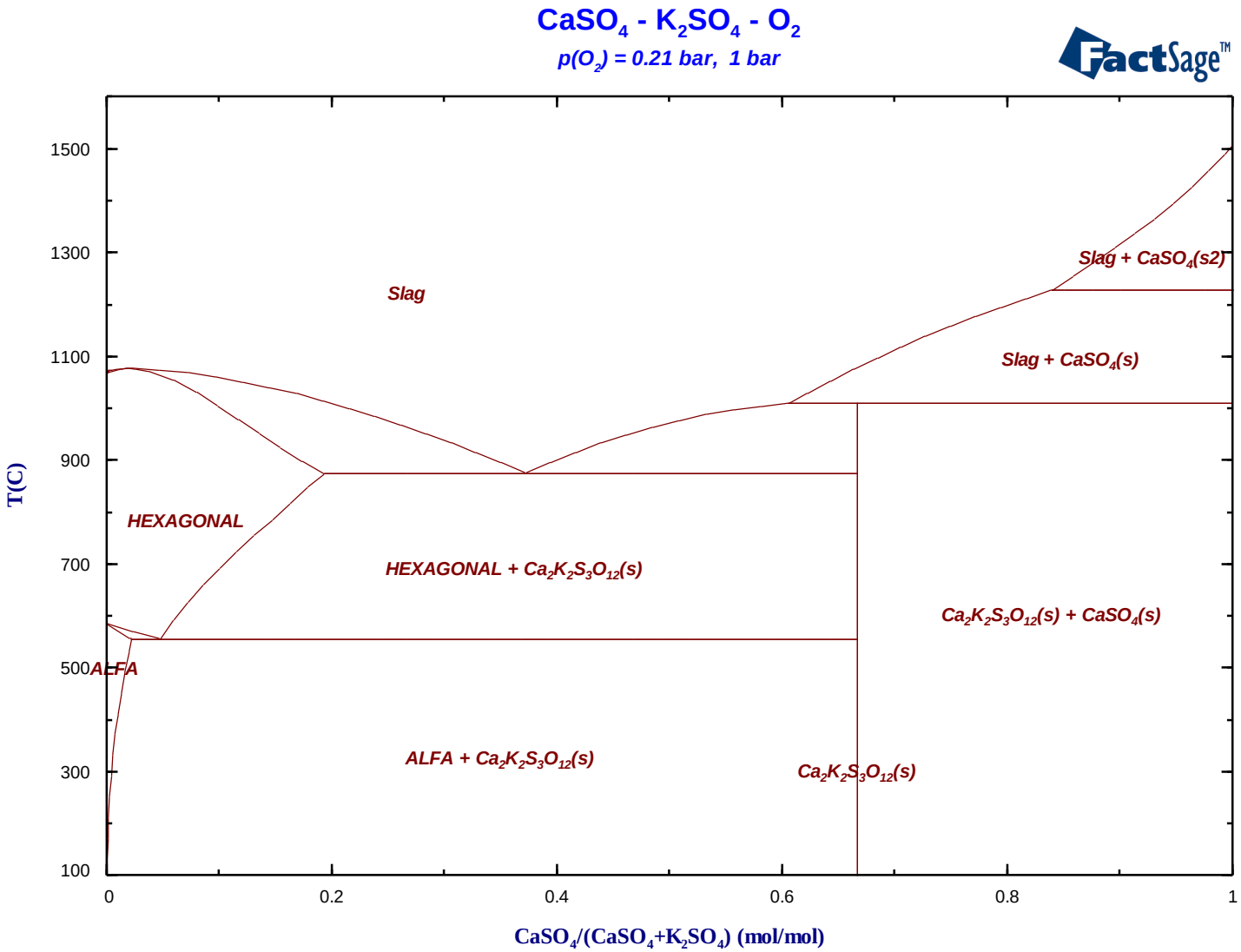
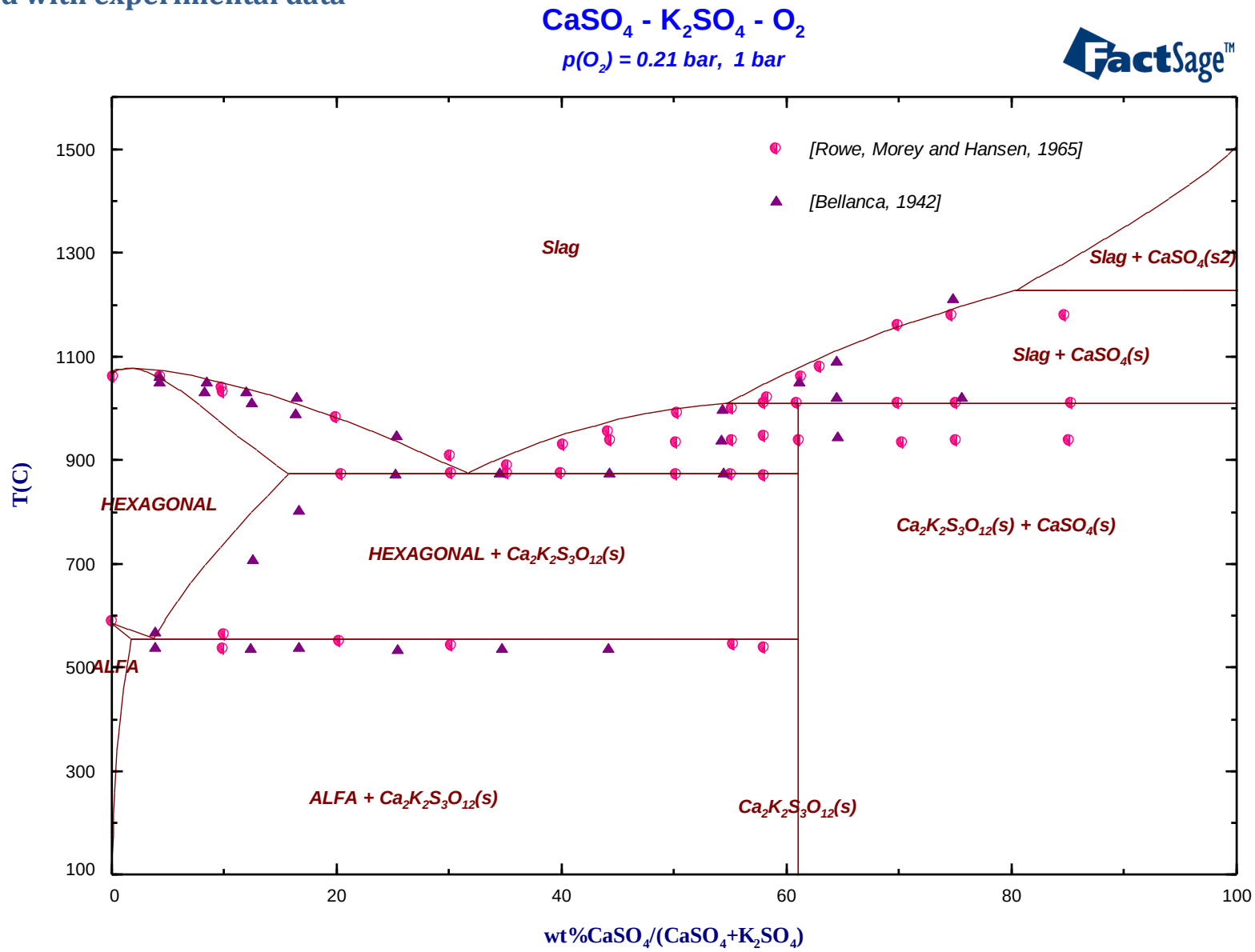


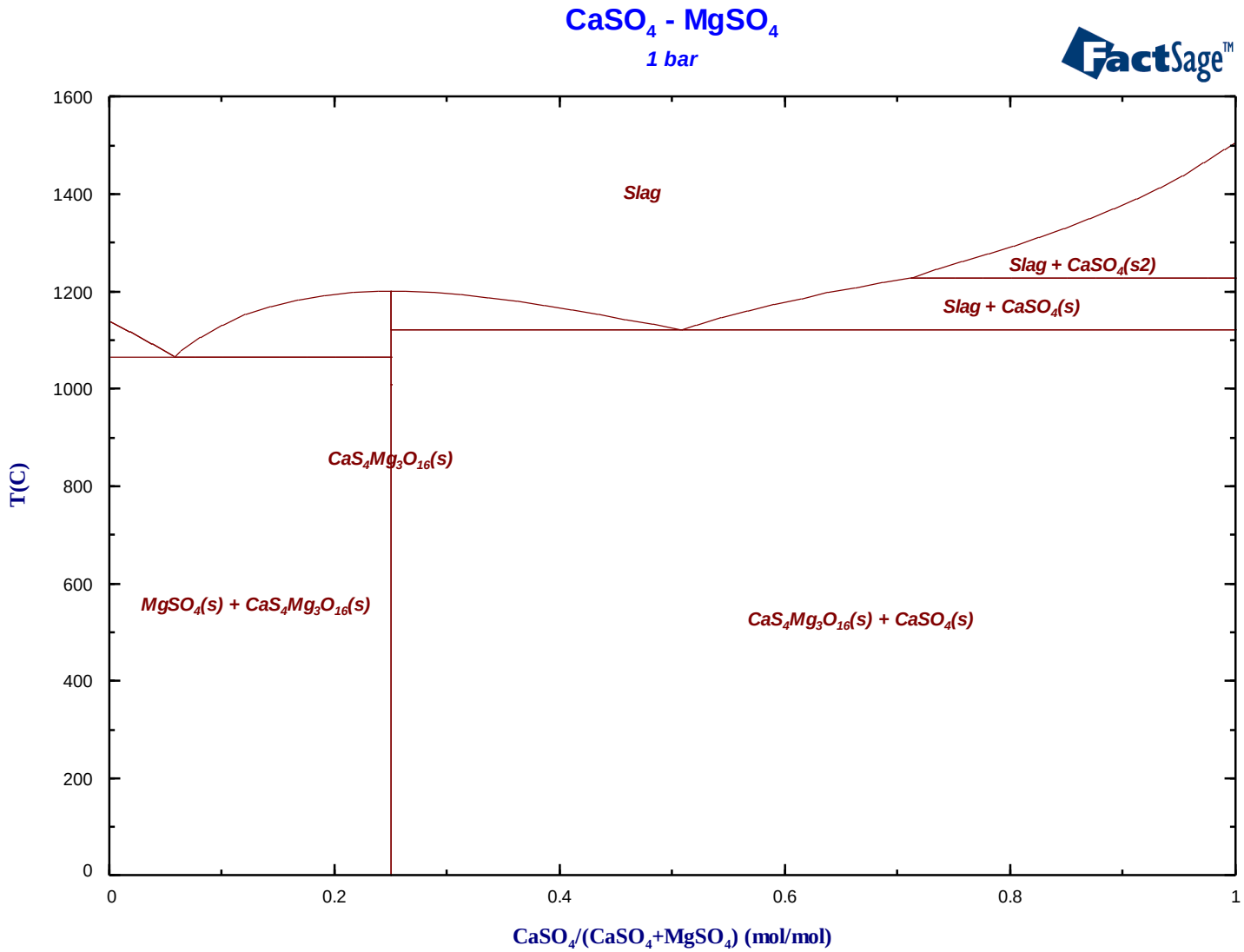
Mole fraction



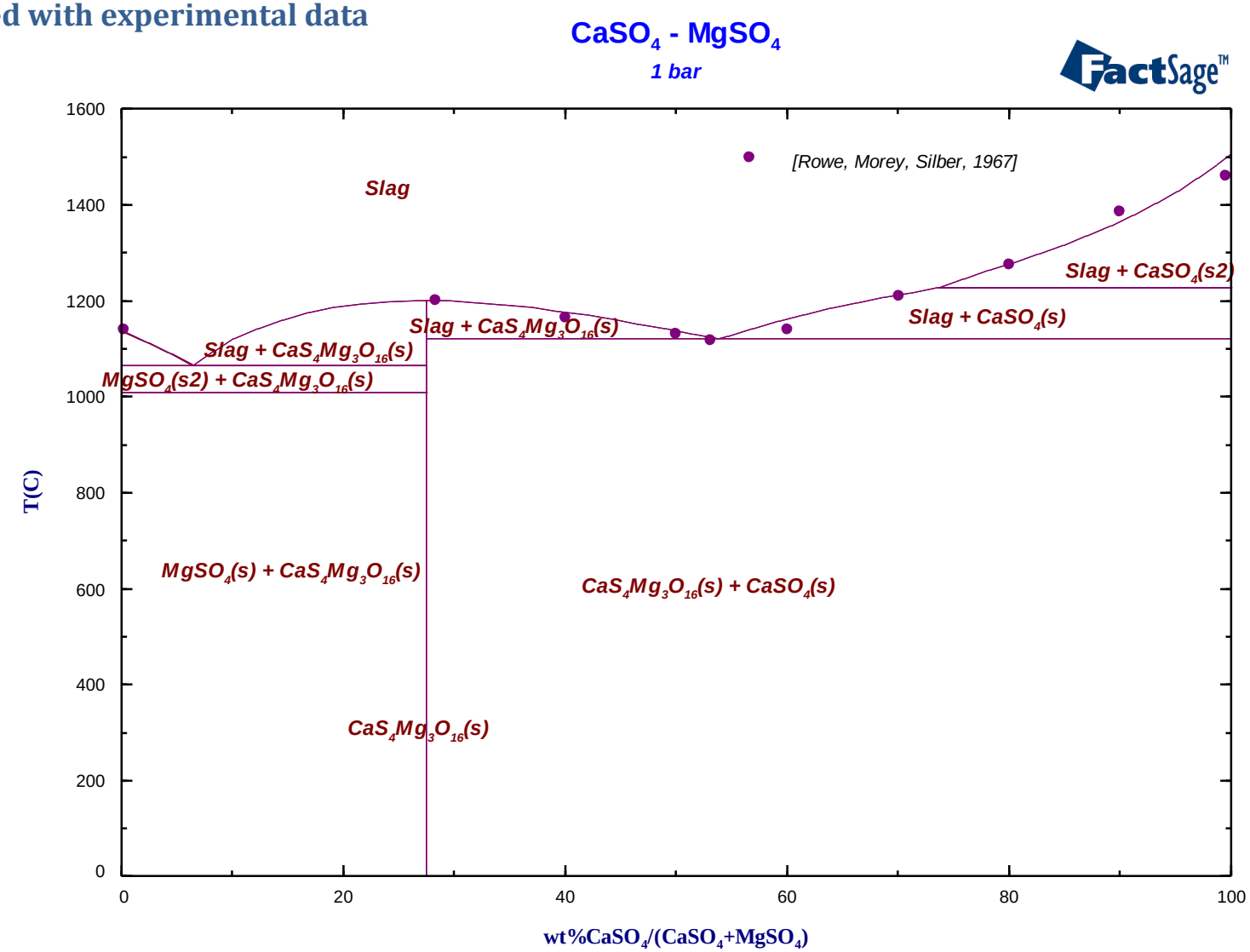
Weight percent
compared with experimental data



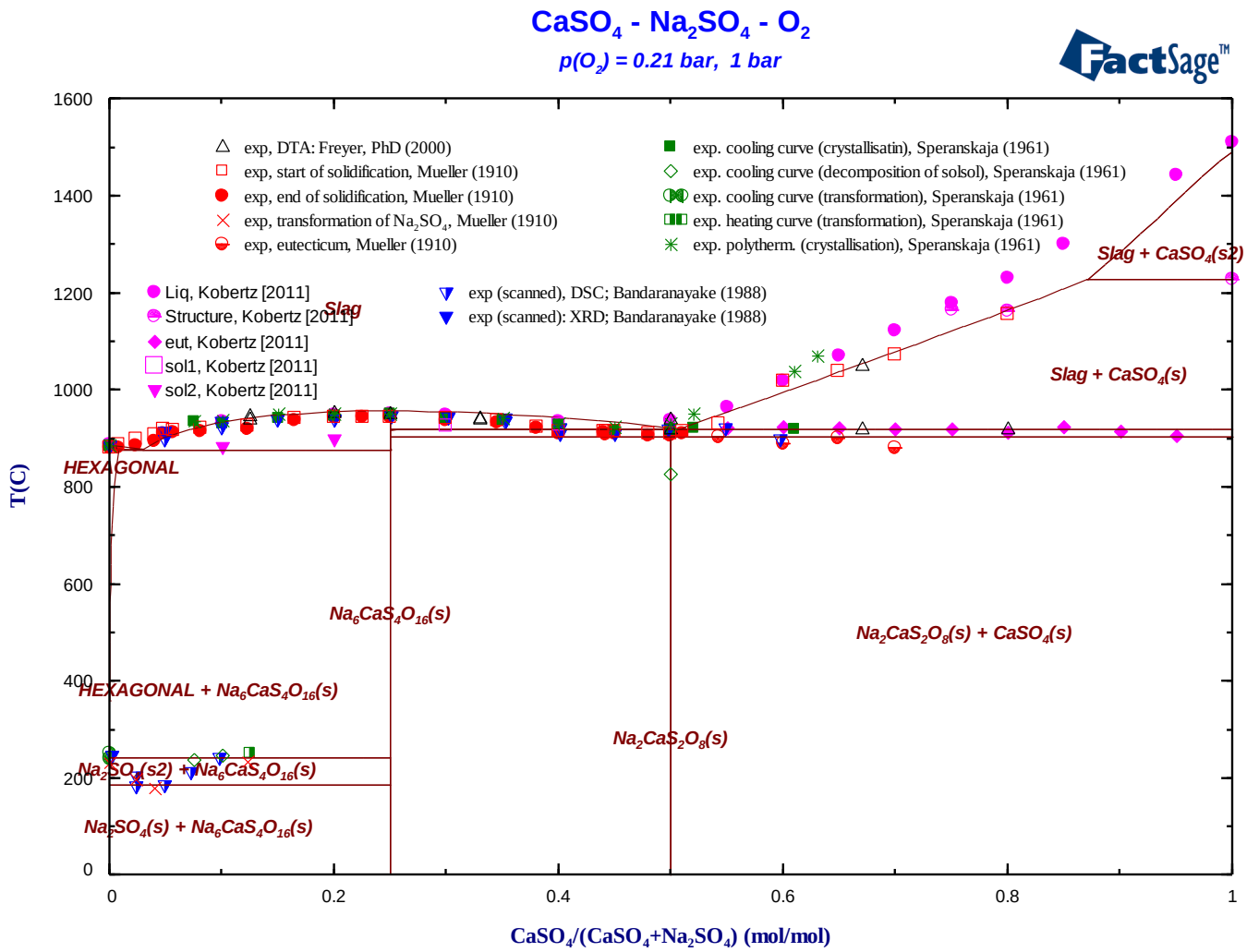
Mole fraction



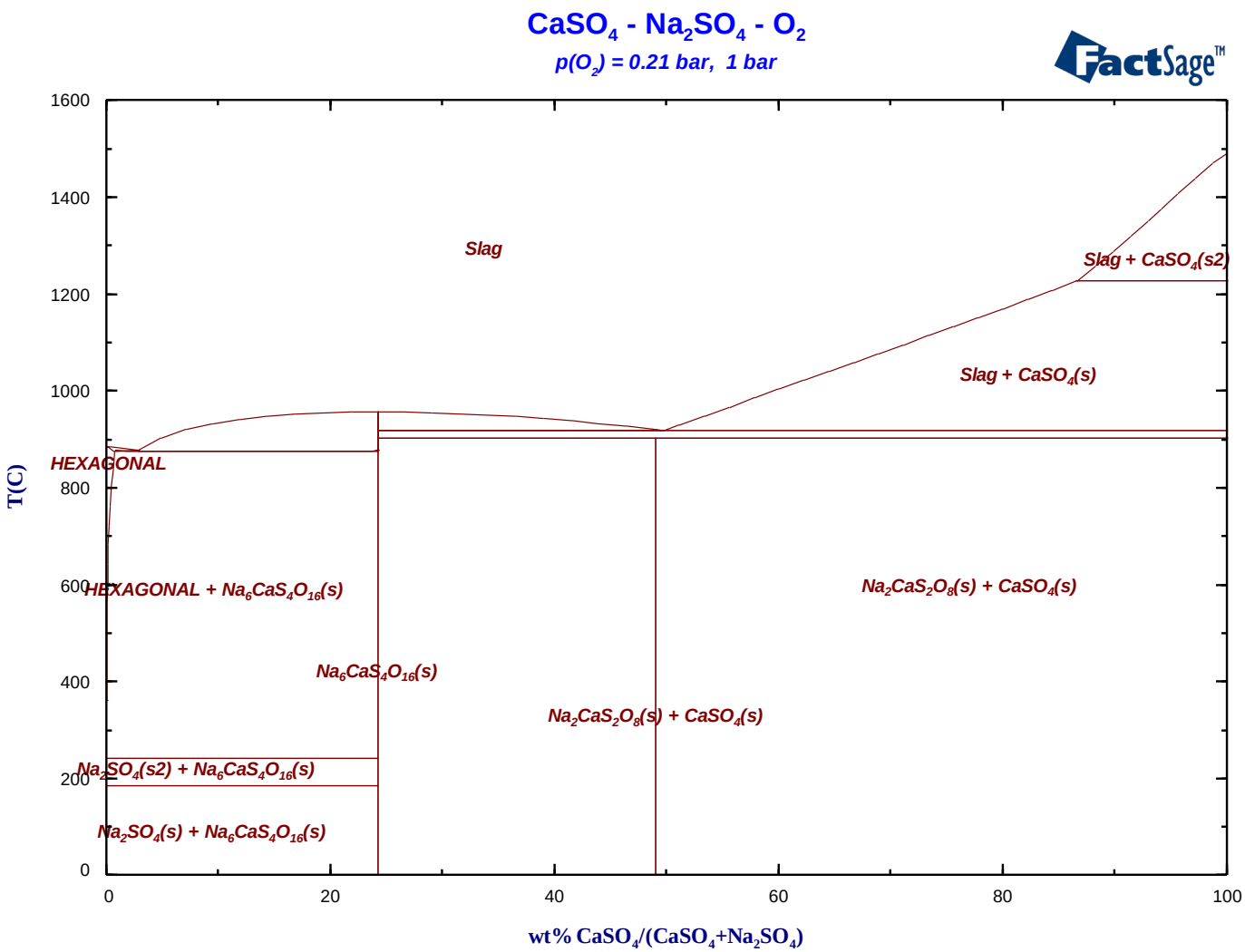
Weight percent
compared with experimental data



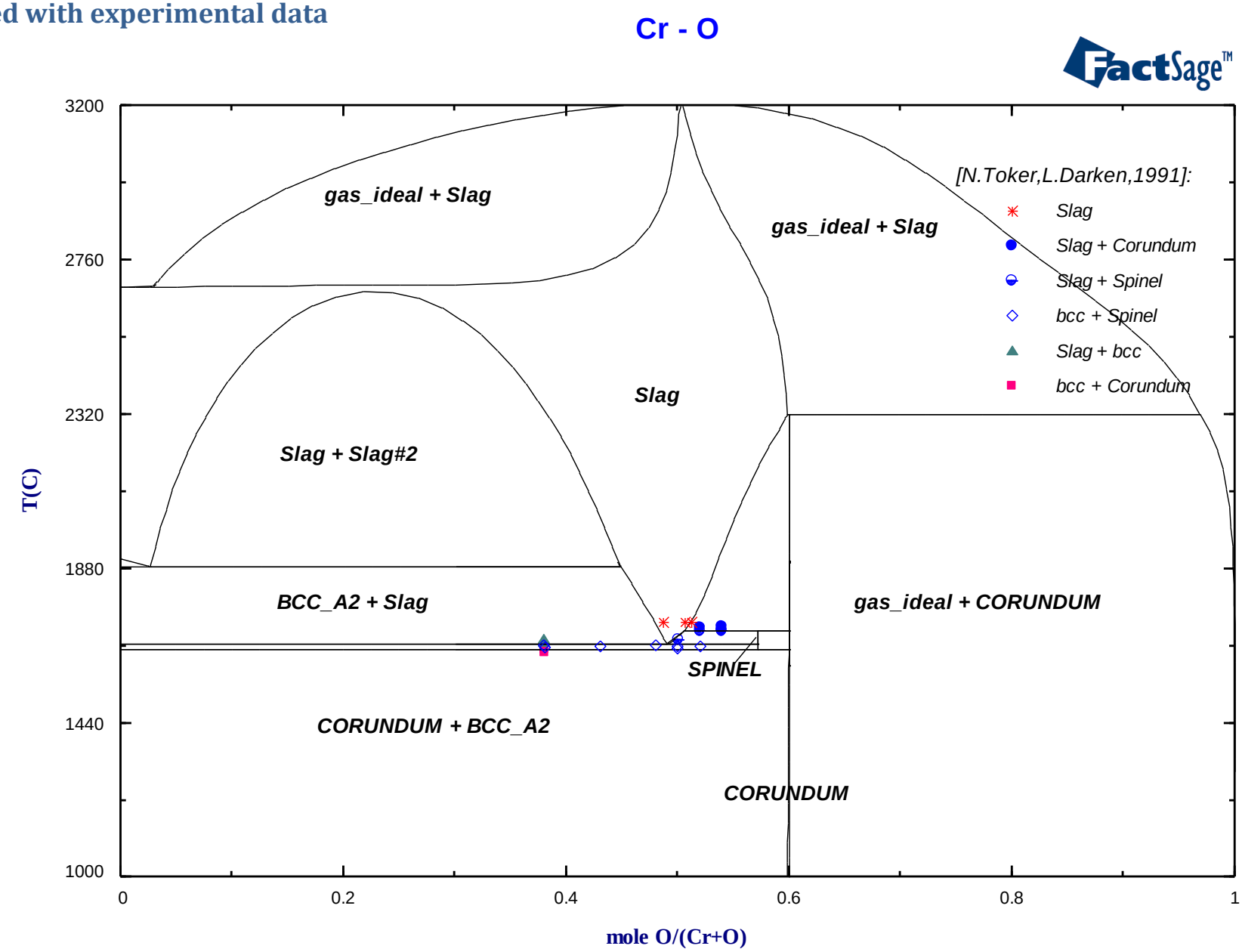
Mole fraction
compared with experimental data



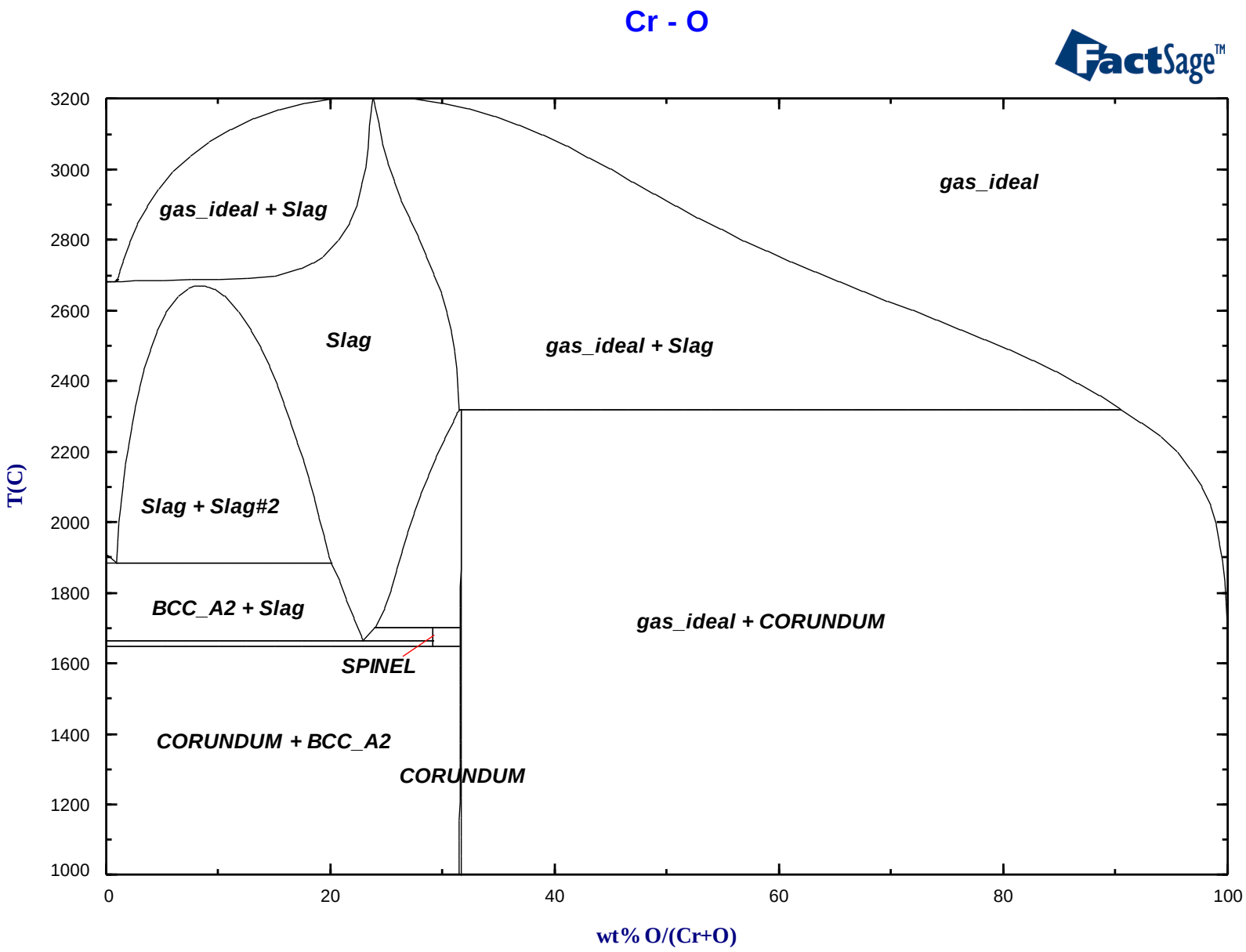
Weight percent



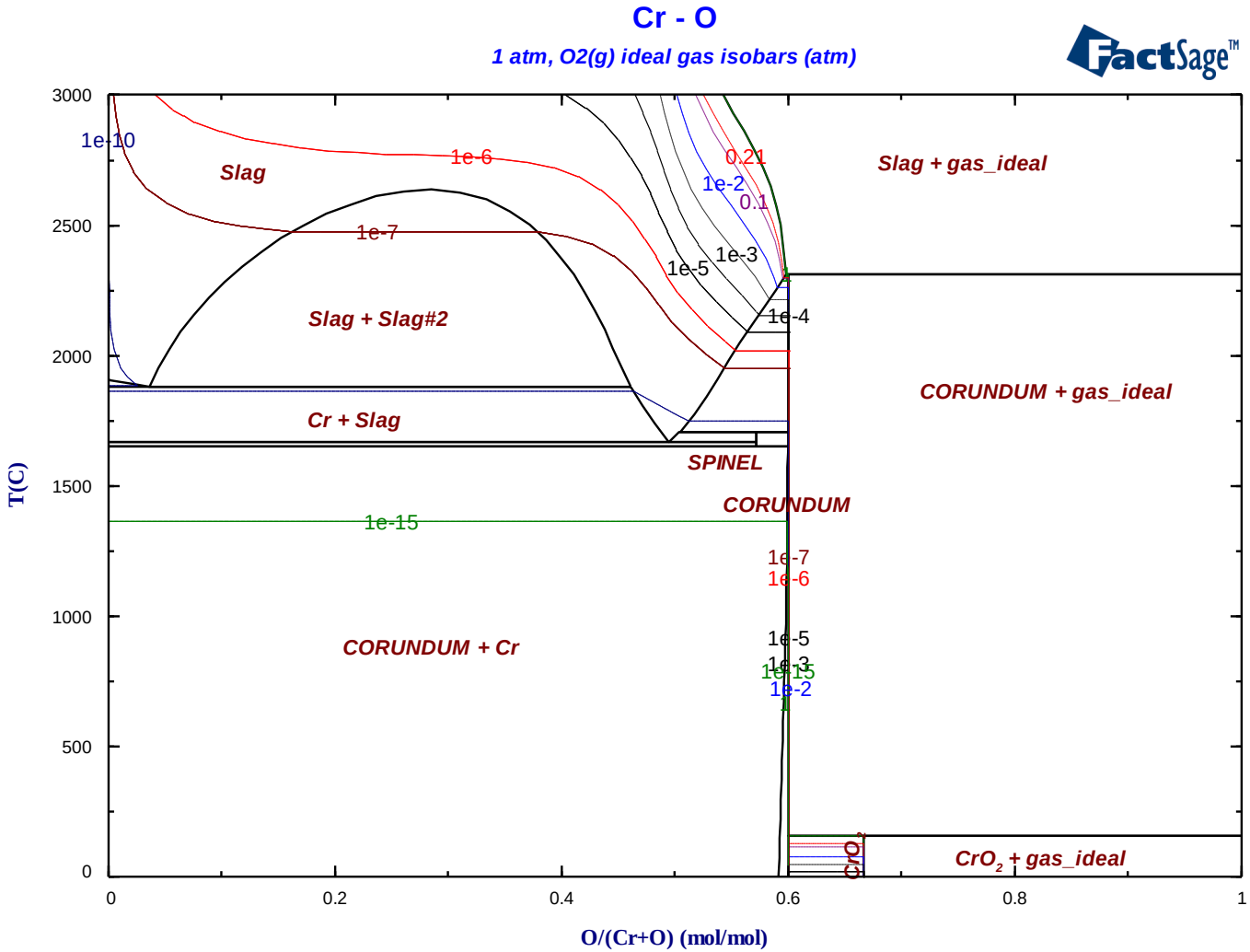
Mole fraction
compared with experimental data



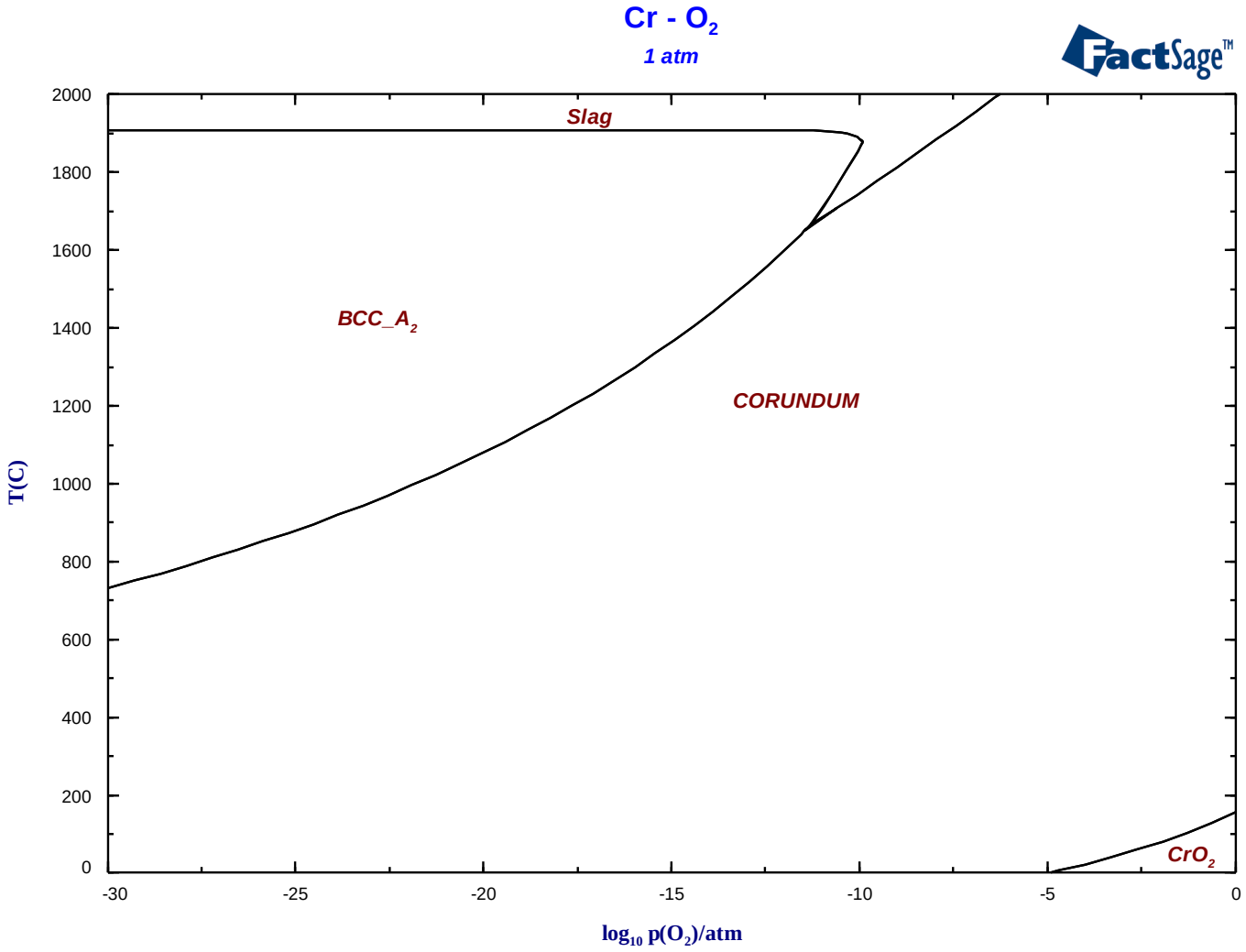
Weight percent



Mole fraction with isobars



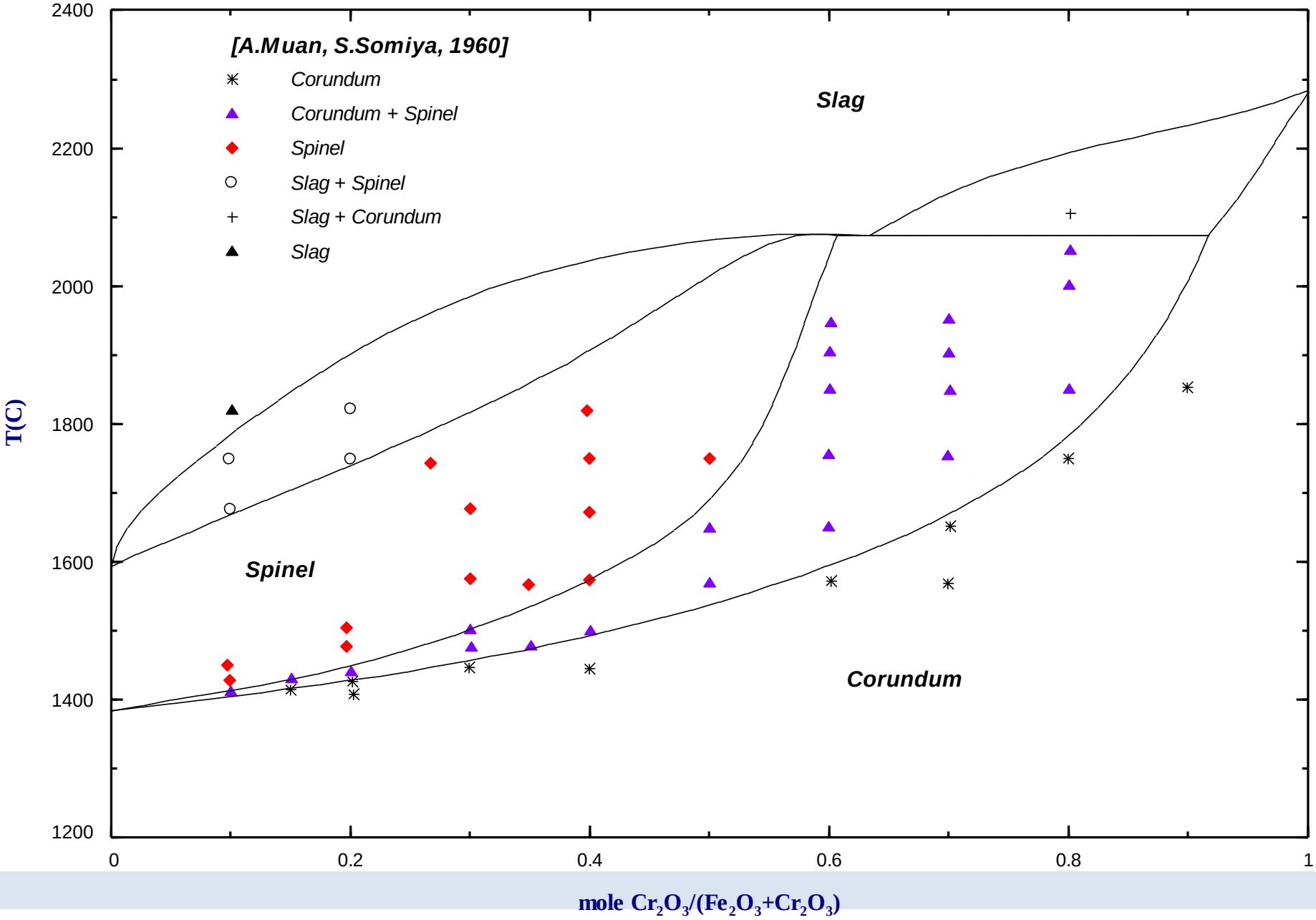
Cr-O2,
Temperature vx. log P(O2) diagram



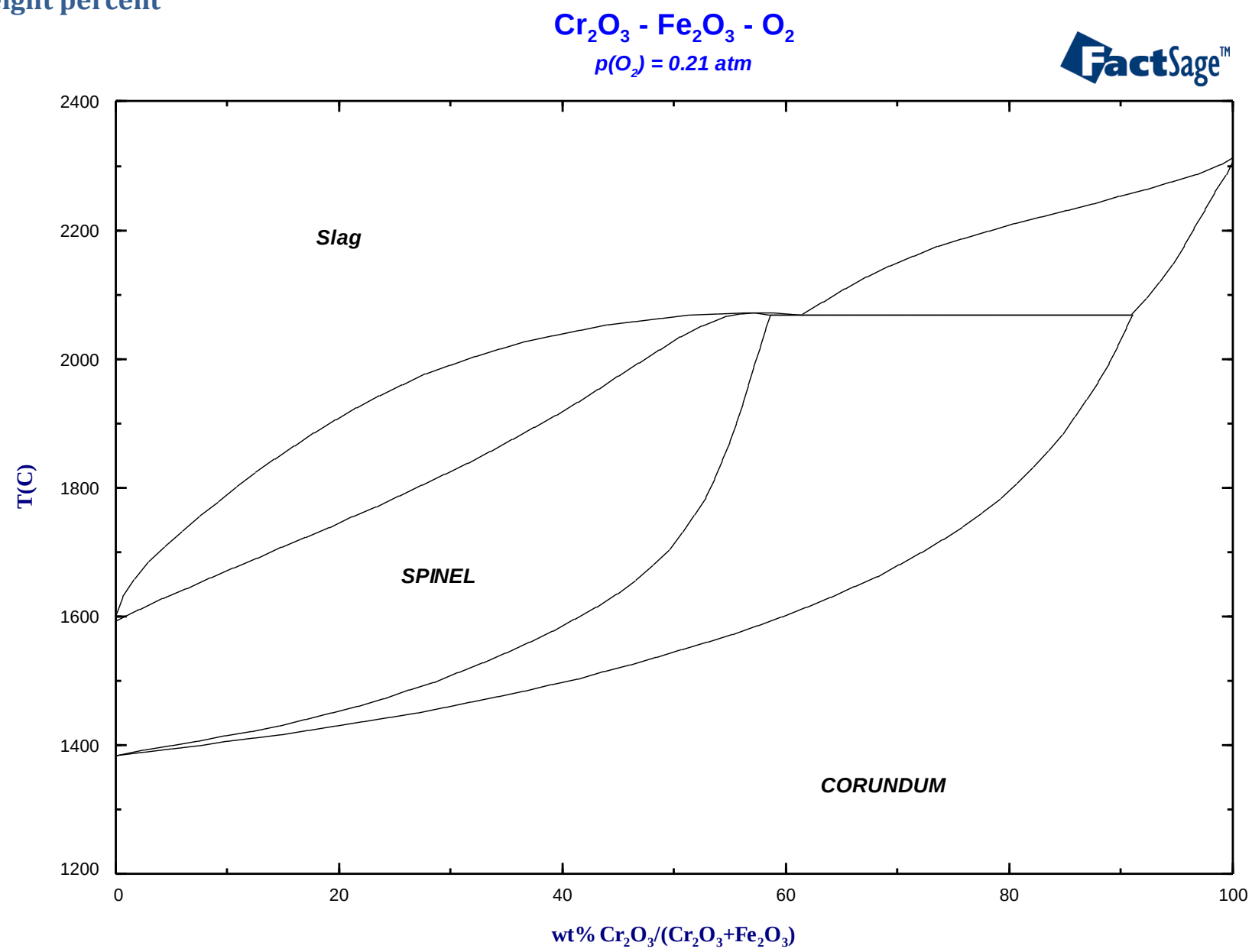
Mole fraction compared with experimental data

Fe_2O_3 - Cr_2O_3 - O_2

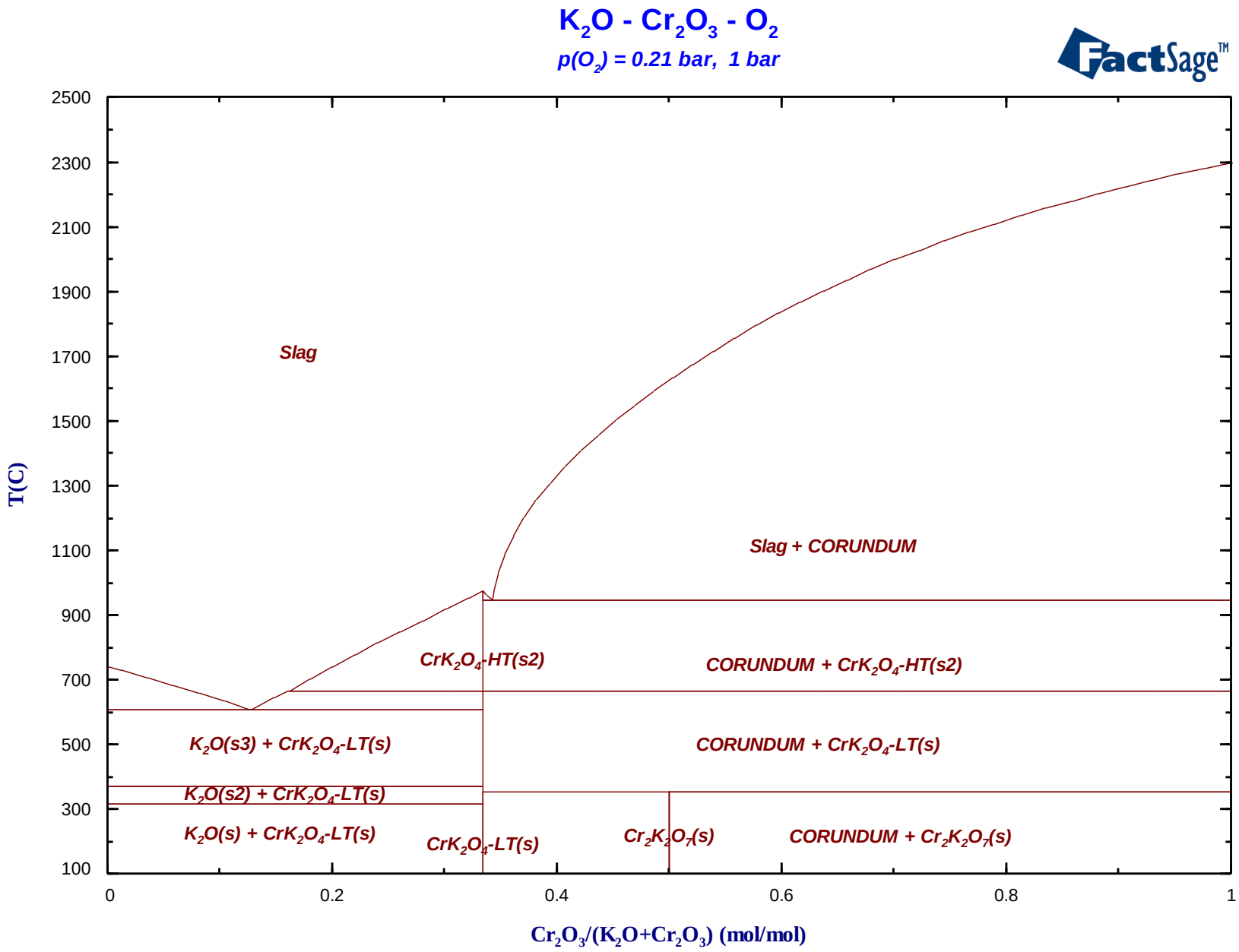
$p(O_2)$ = 0.21 atm



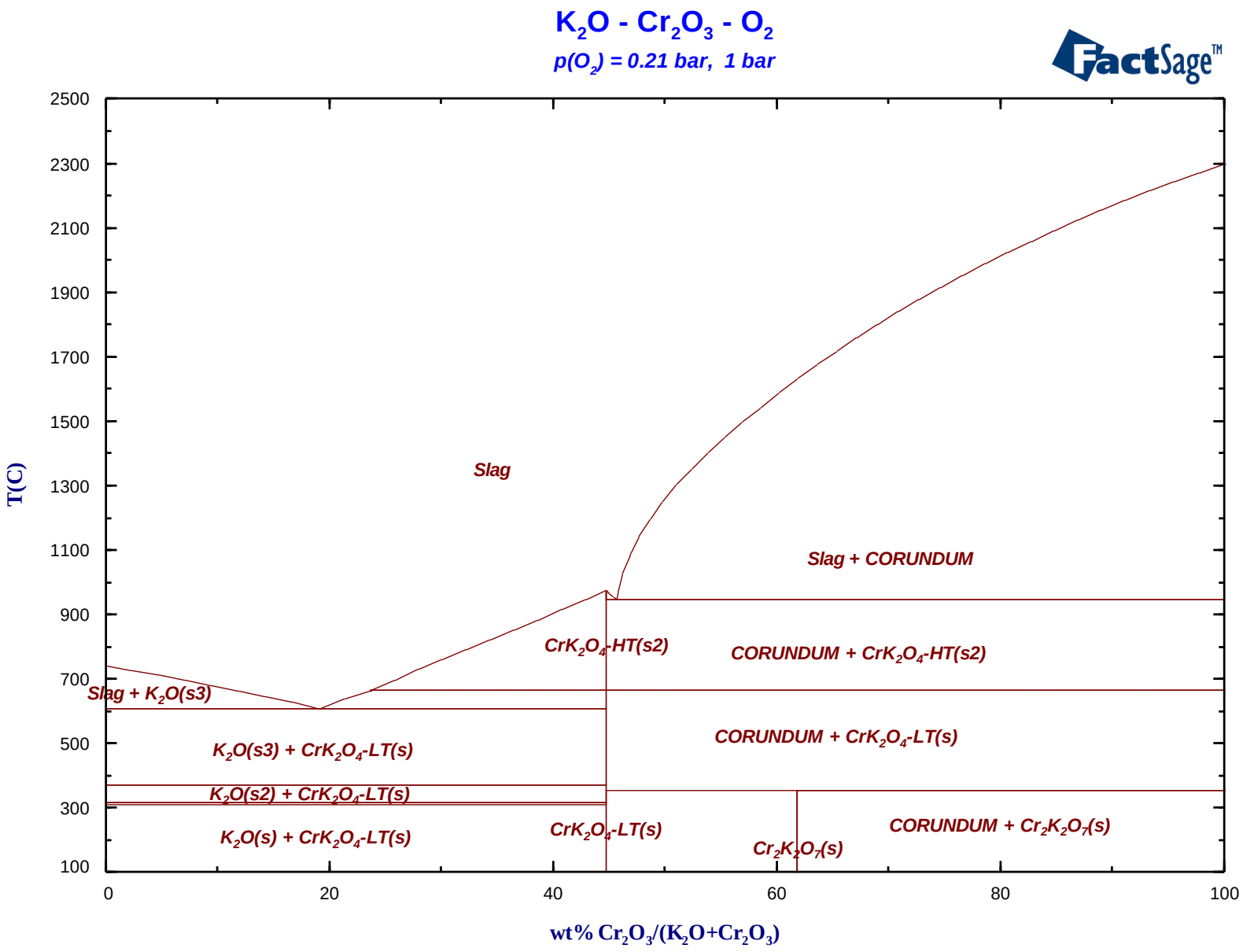
Weight percent



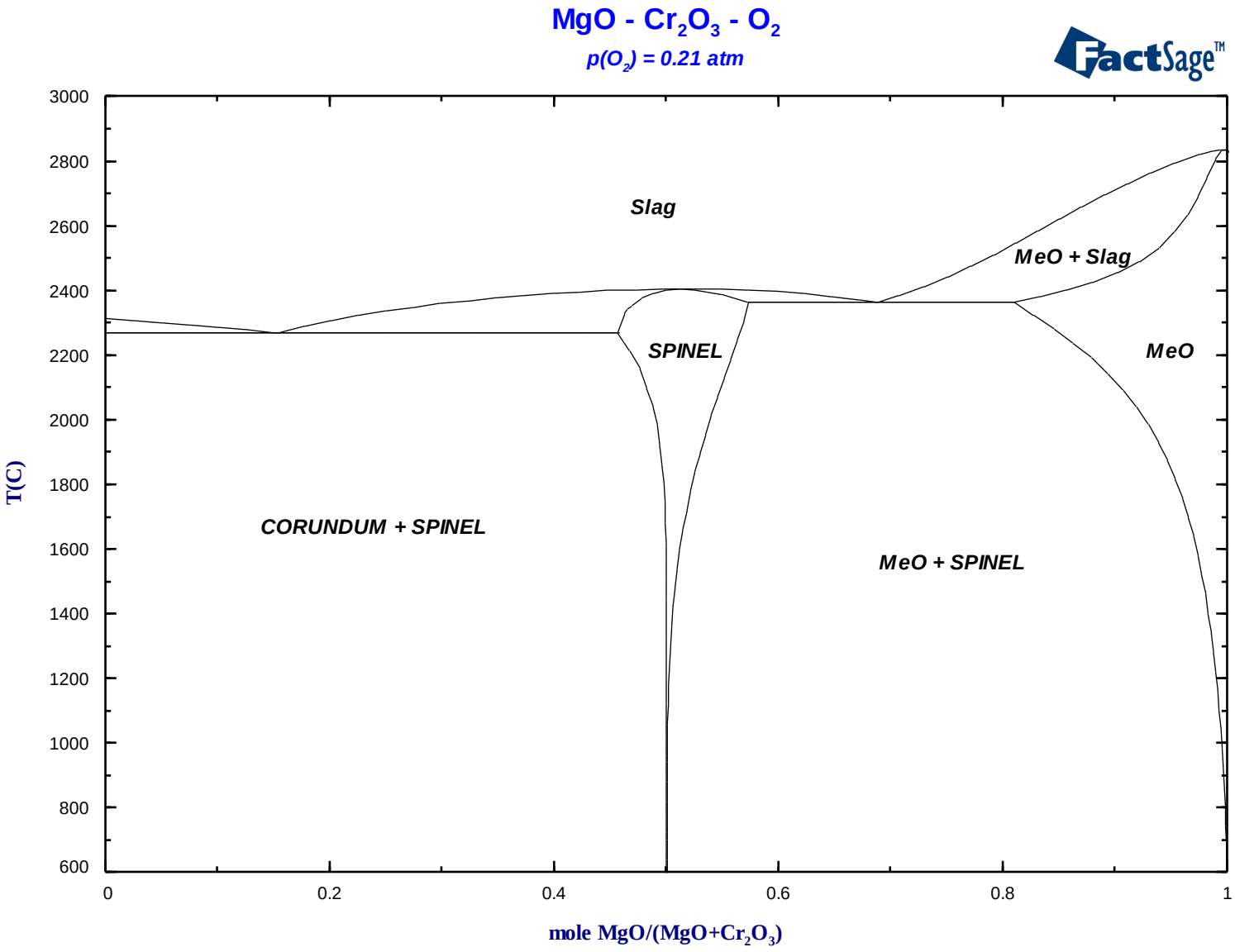
Mole fraction



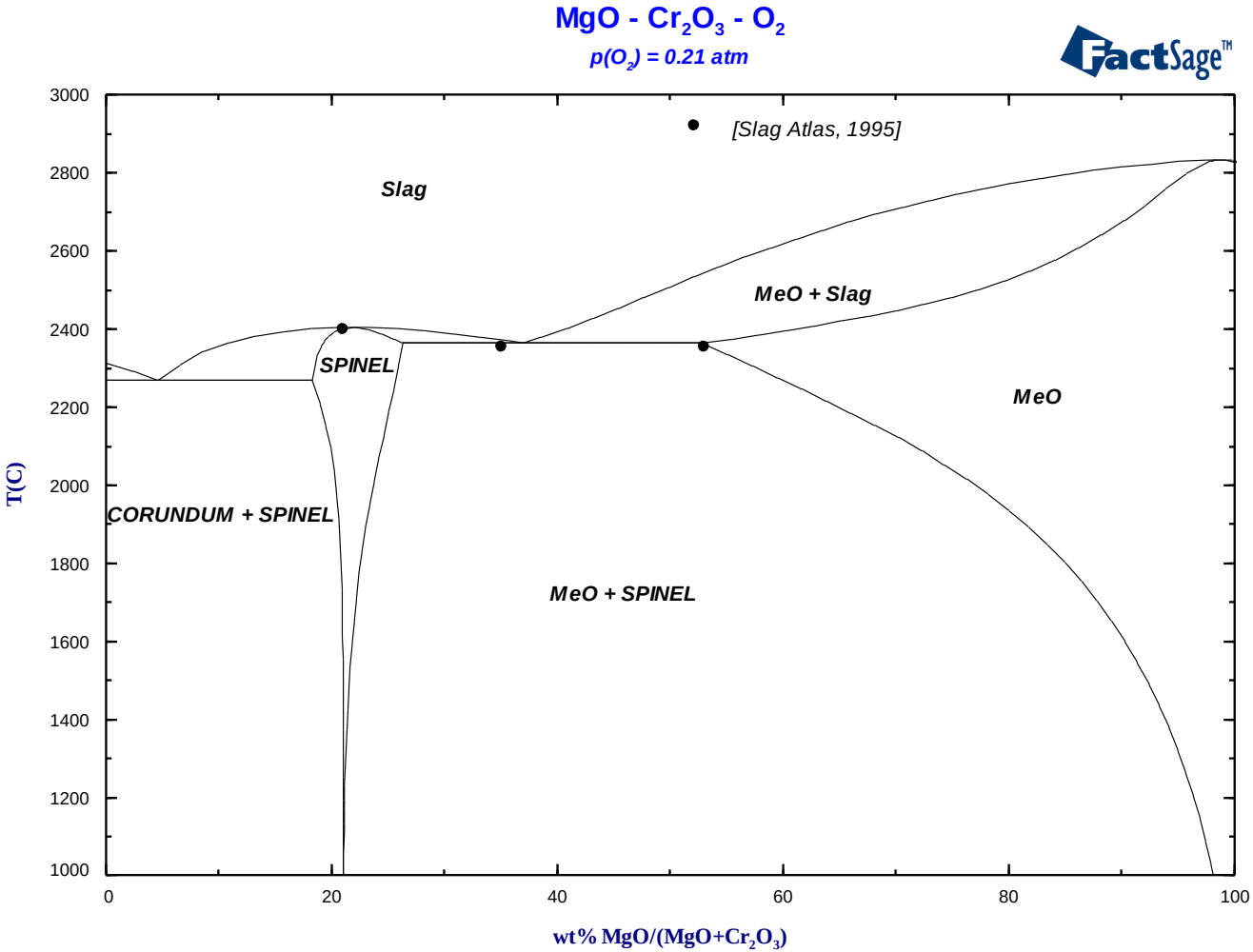
Weight percent



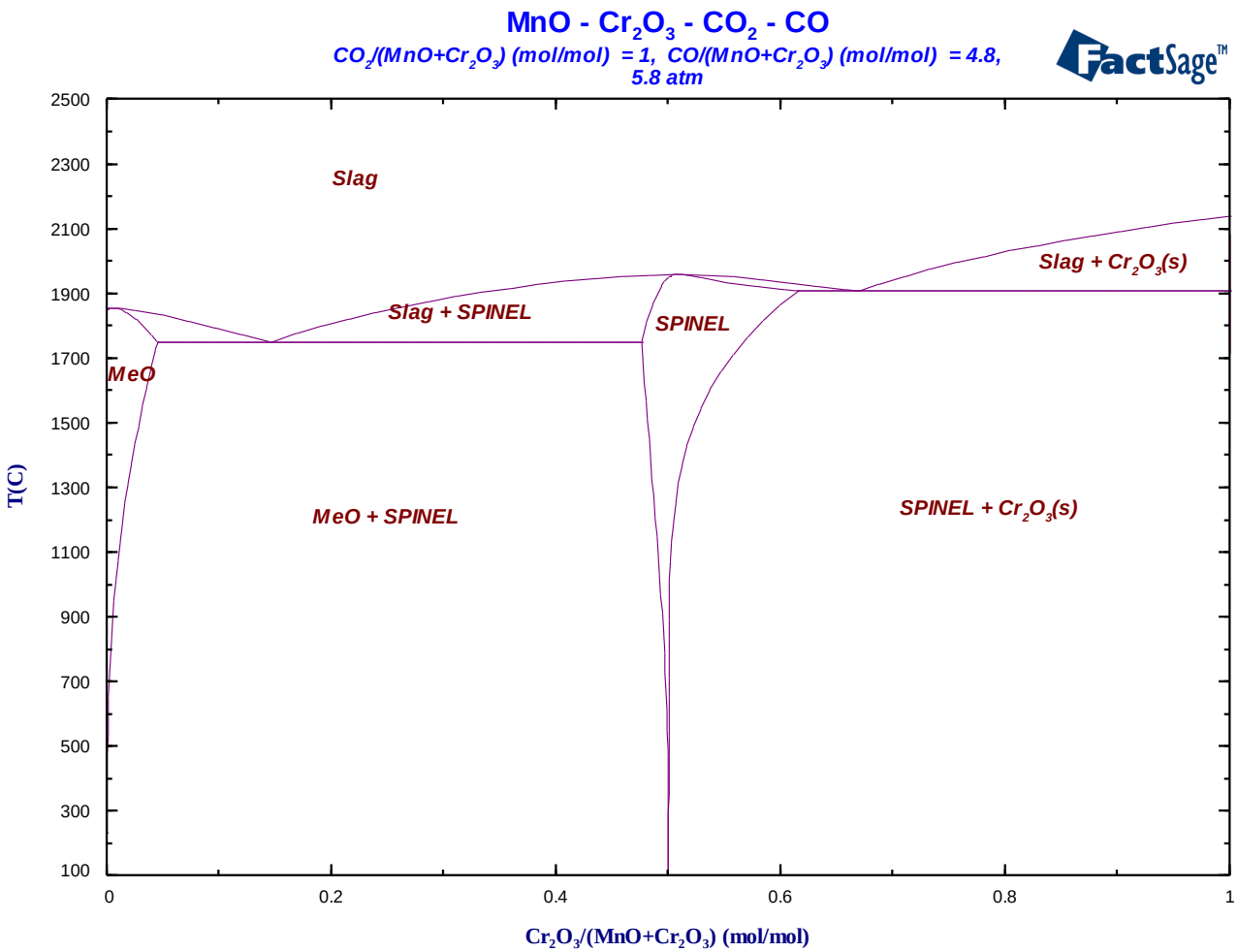
Mole fraction



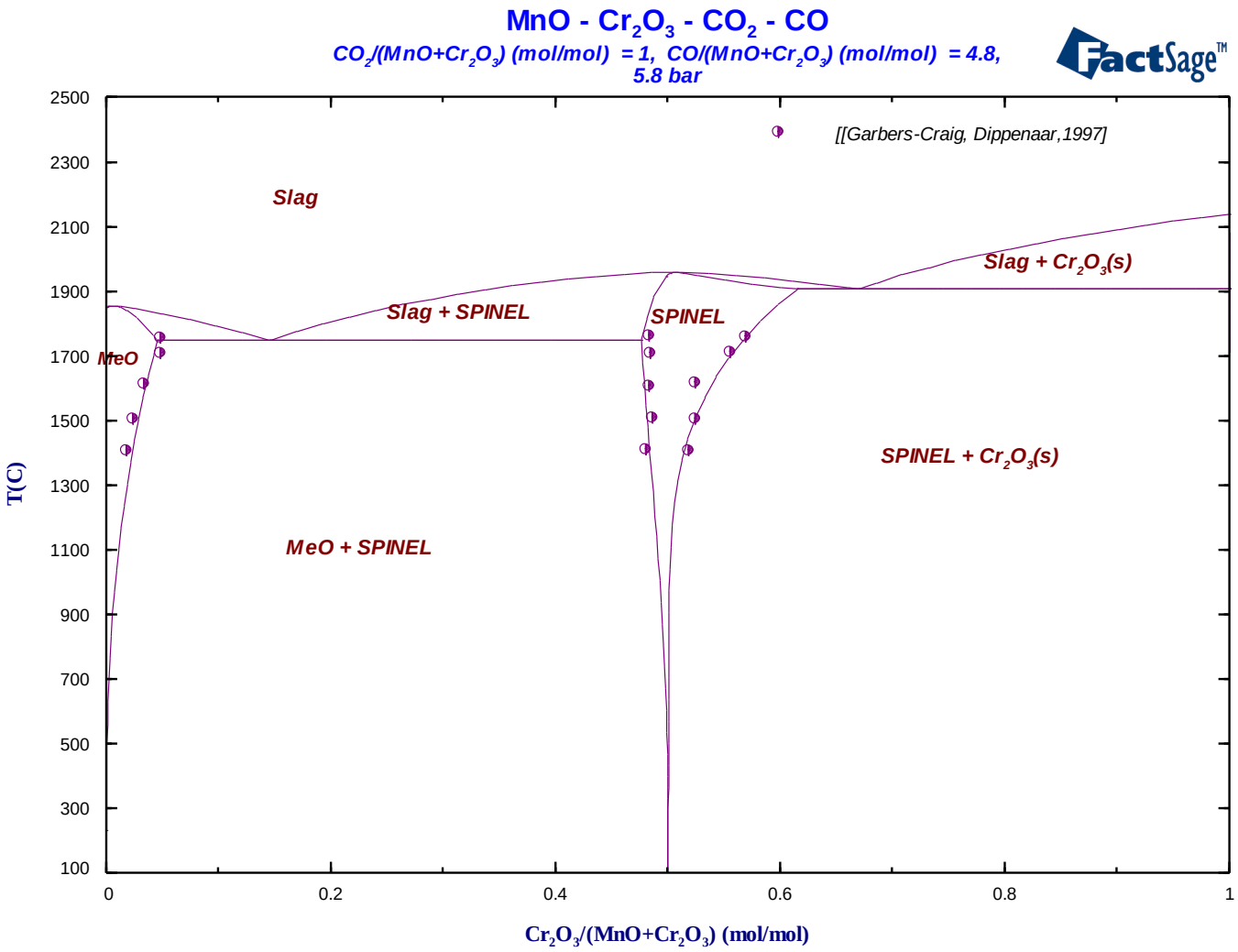
Weight percent
compared with experimental data



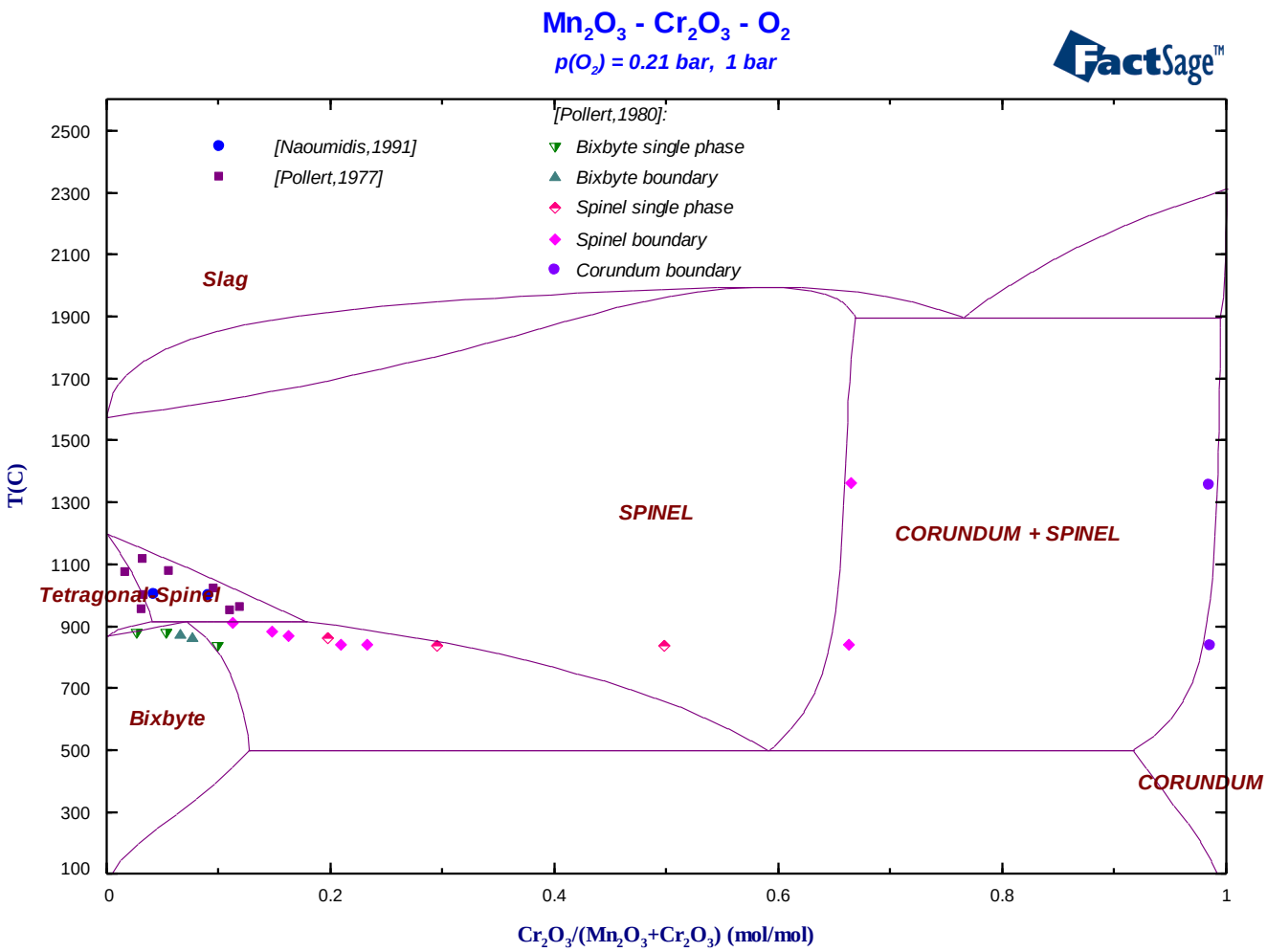
Mole fraction



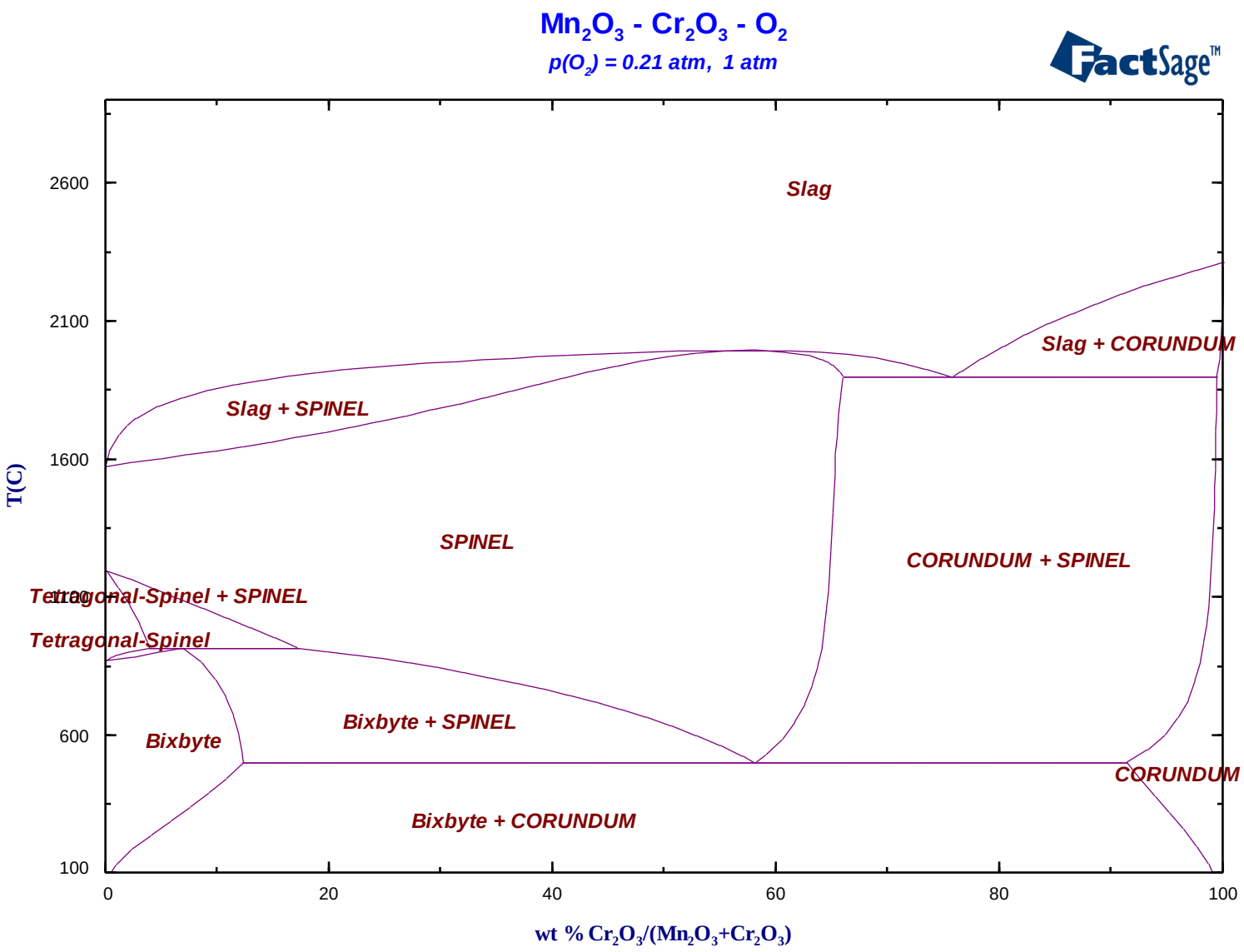
Weight percent
compared with experimental data



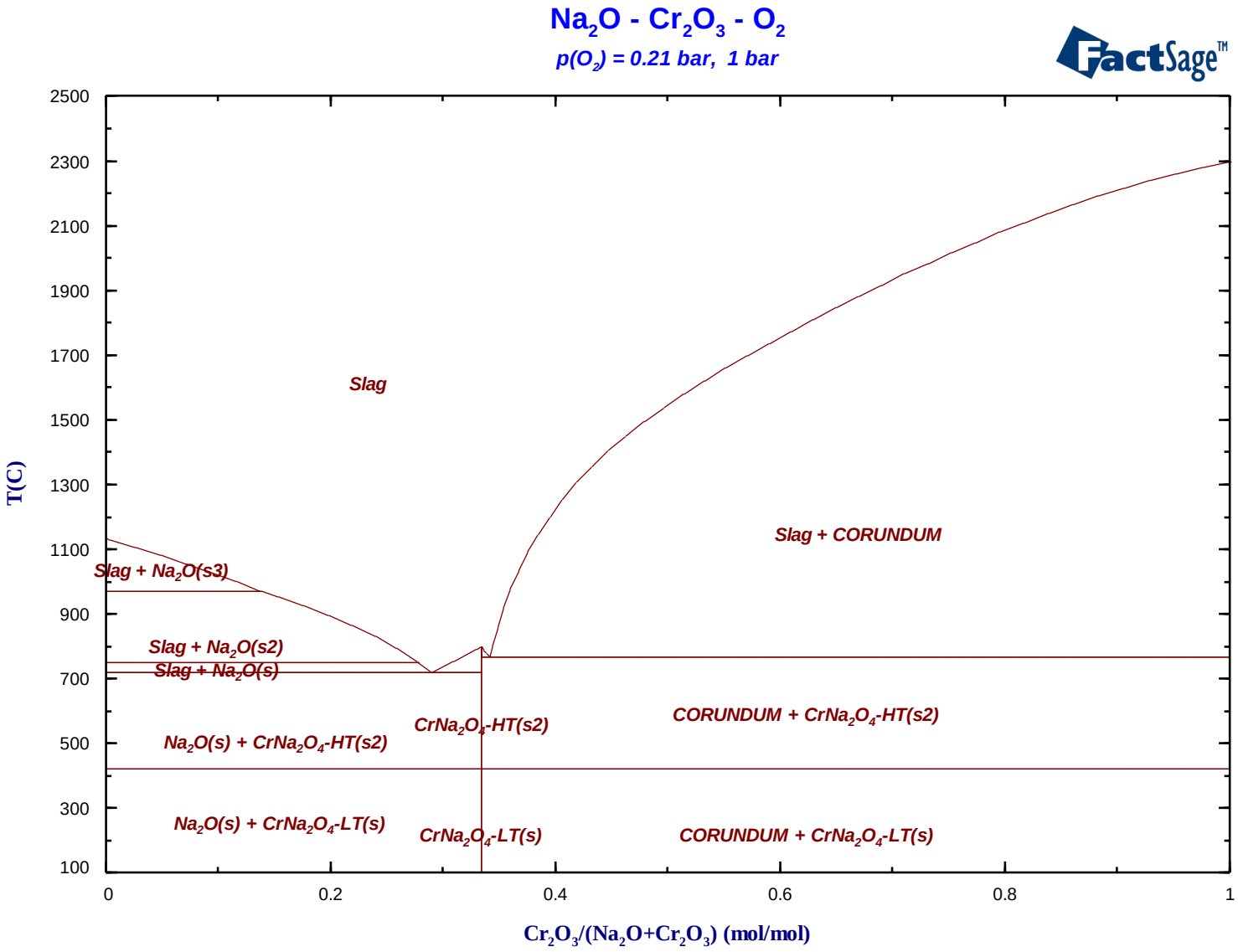
Mole fraction
compared with experimental data



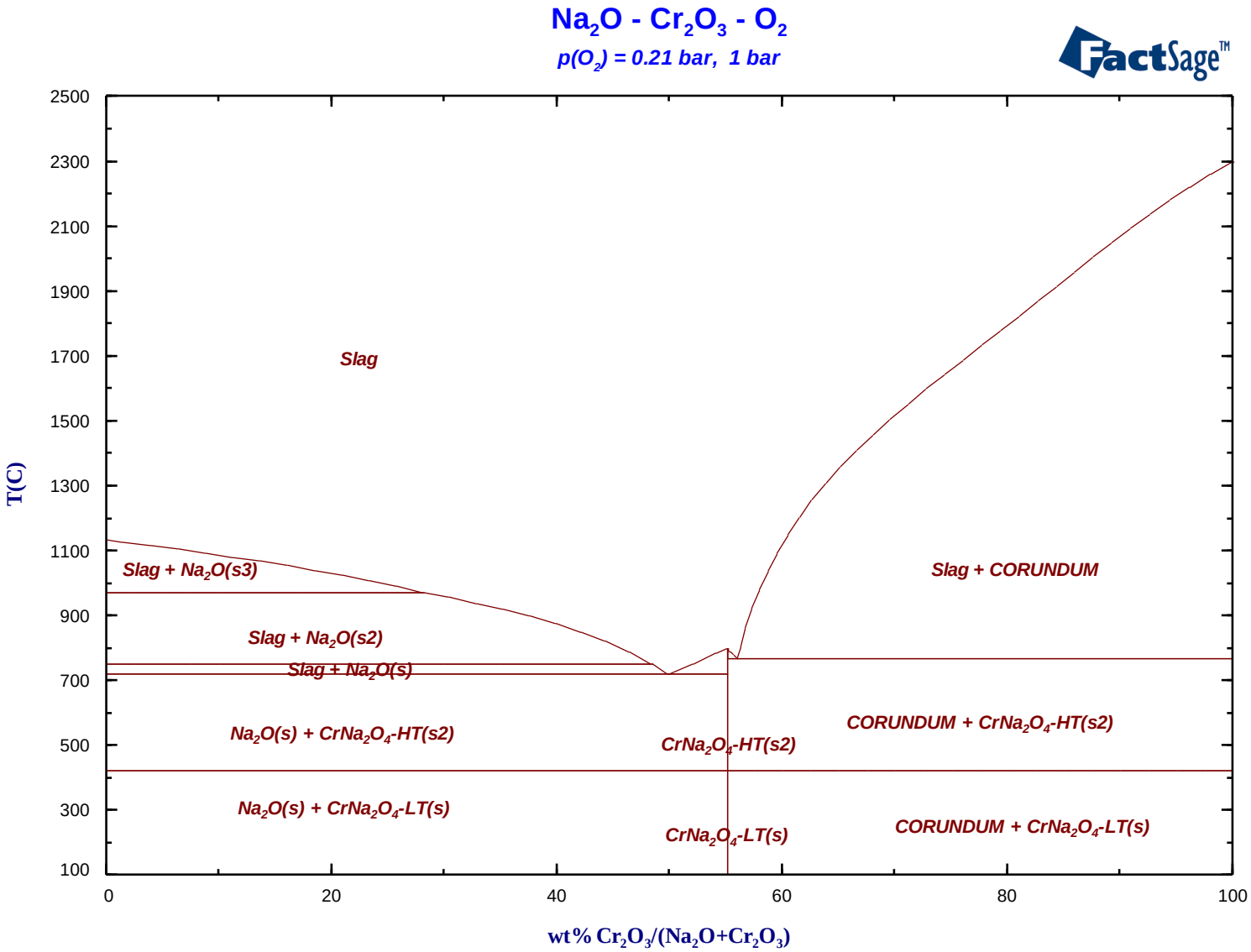
Weight percent

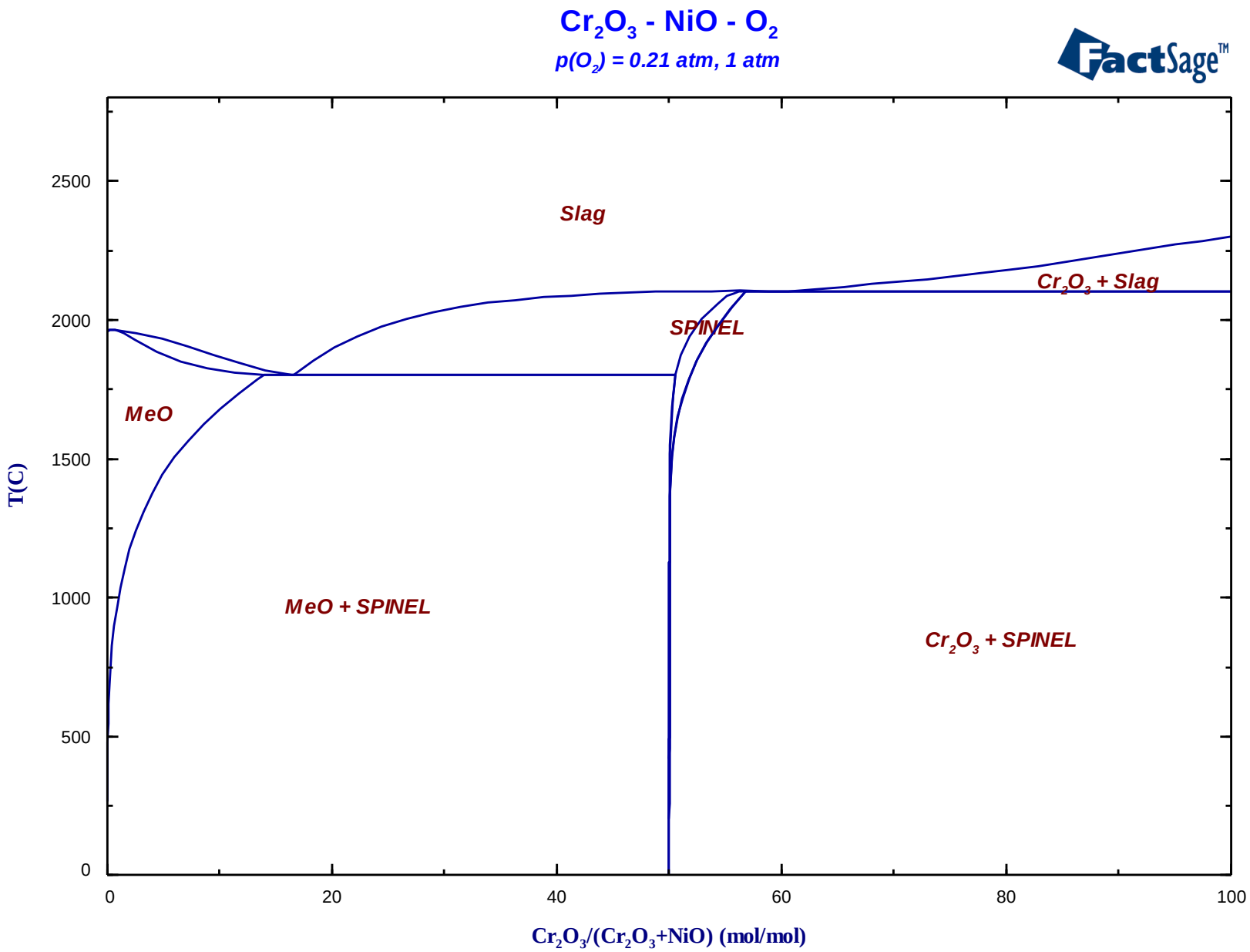


Mole fraction

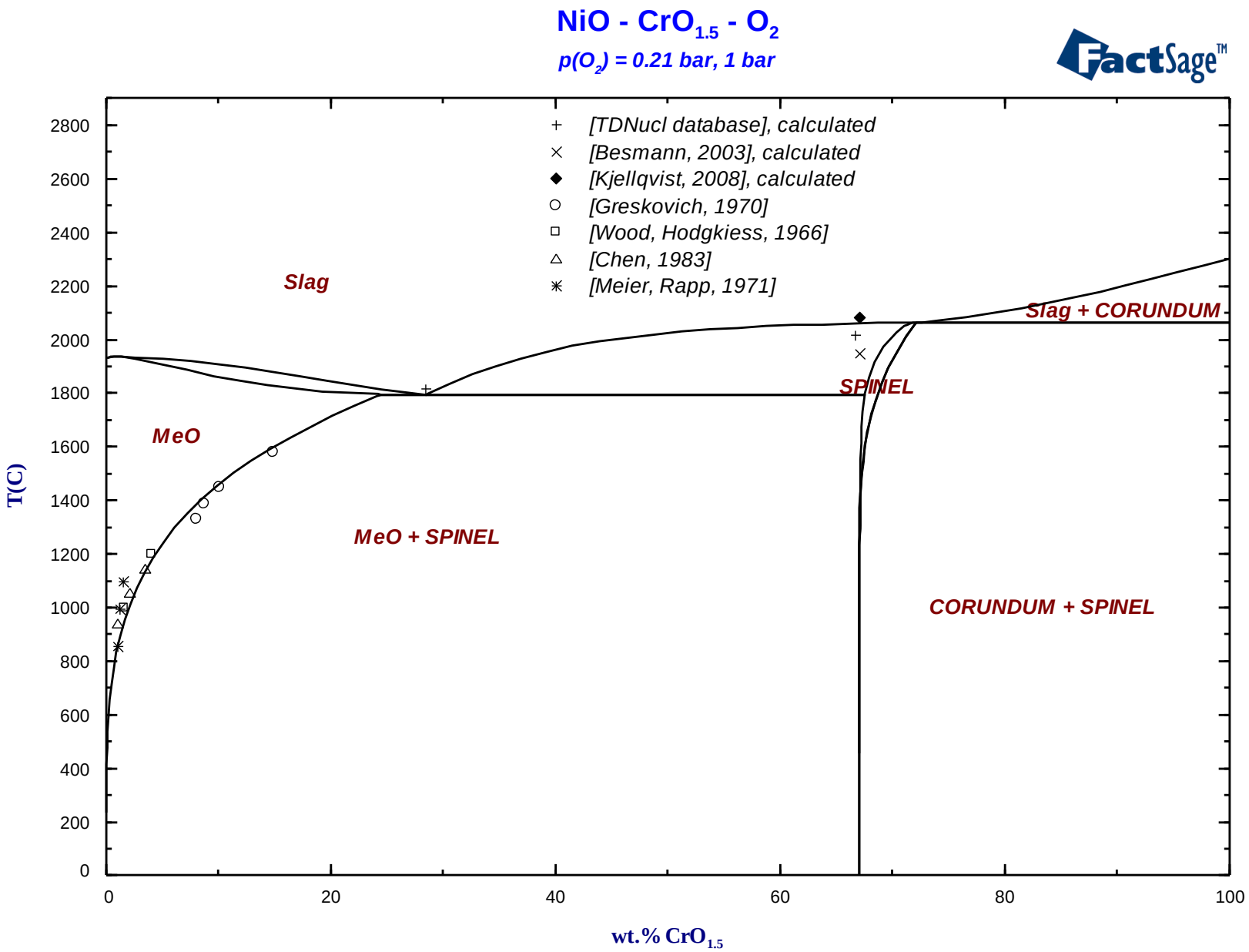


Weight percent

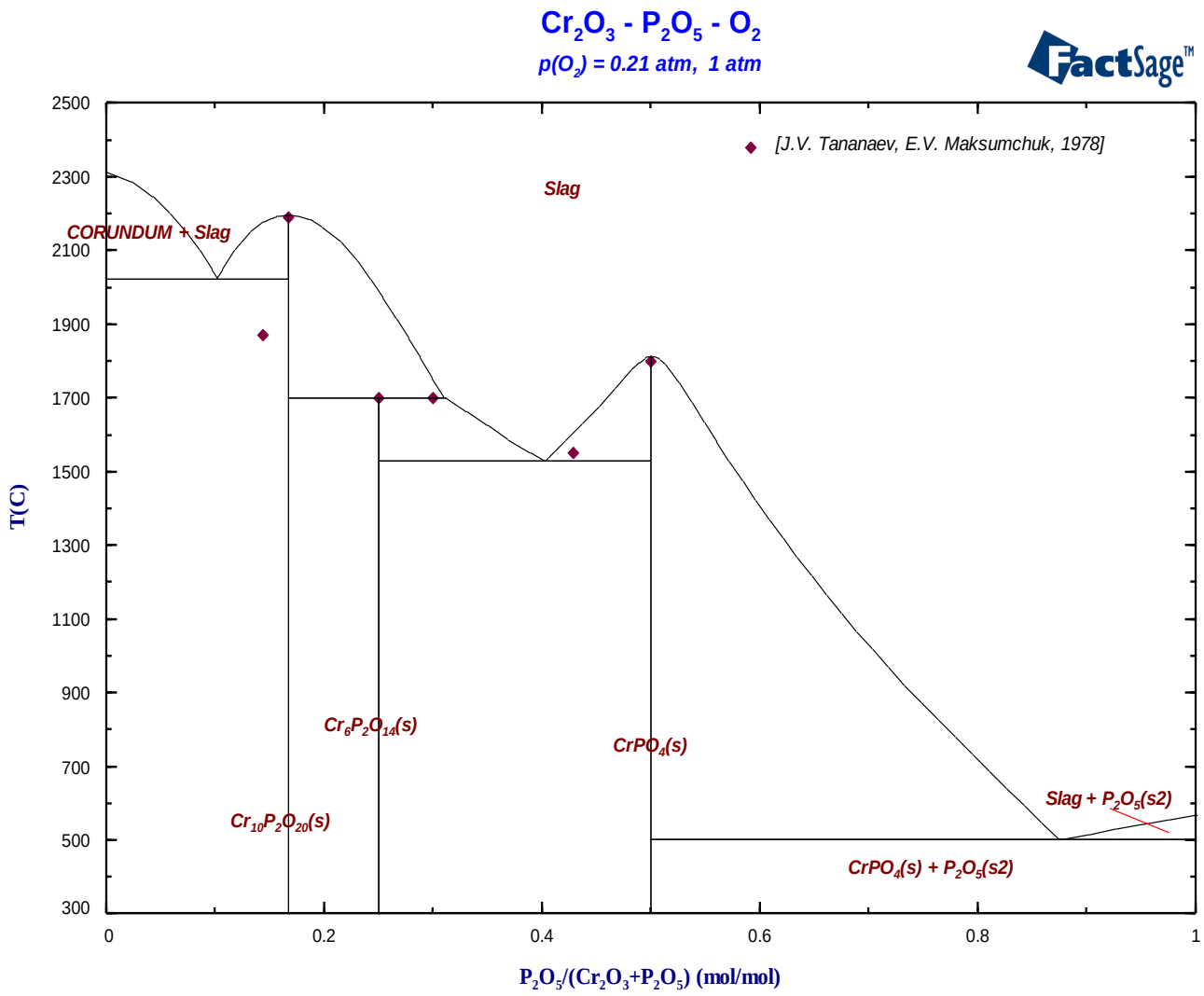



Cr2O3 - NiO - O2
p(O2) = 0.21 atm, 1 atm
FactSage™
Slag
Cr2O3 + Slag
SPINEL
MeO
MeO + SPINEL
Cr2O3 + SPINEL
T(C)
2500
2000
1500
1000
500
0
0
20
40
60
80
100
Cr2O3/(Cr2O3+NiO) (mol/mol)

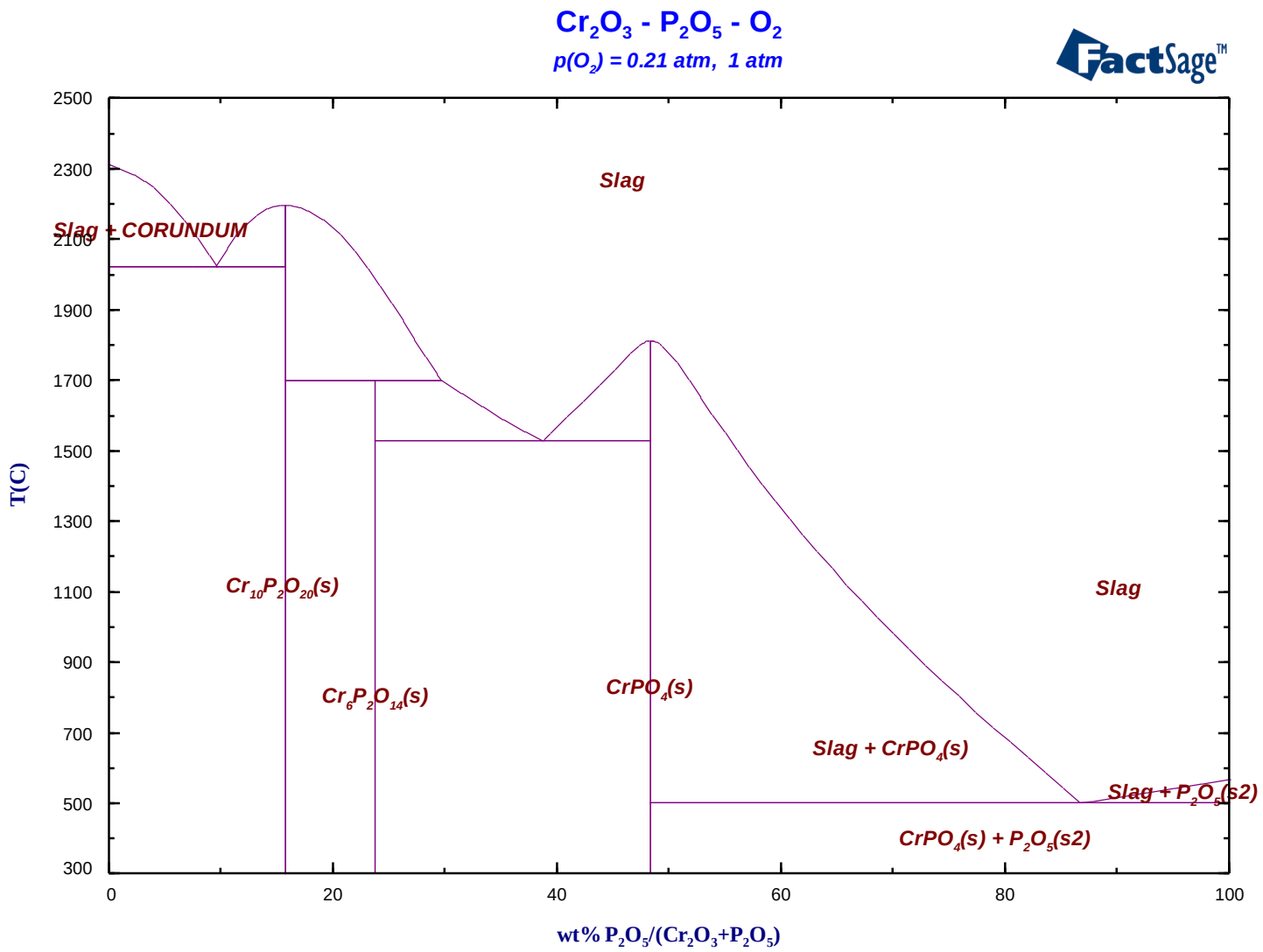
Weight percent compared with experimental data



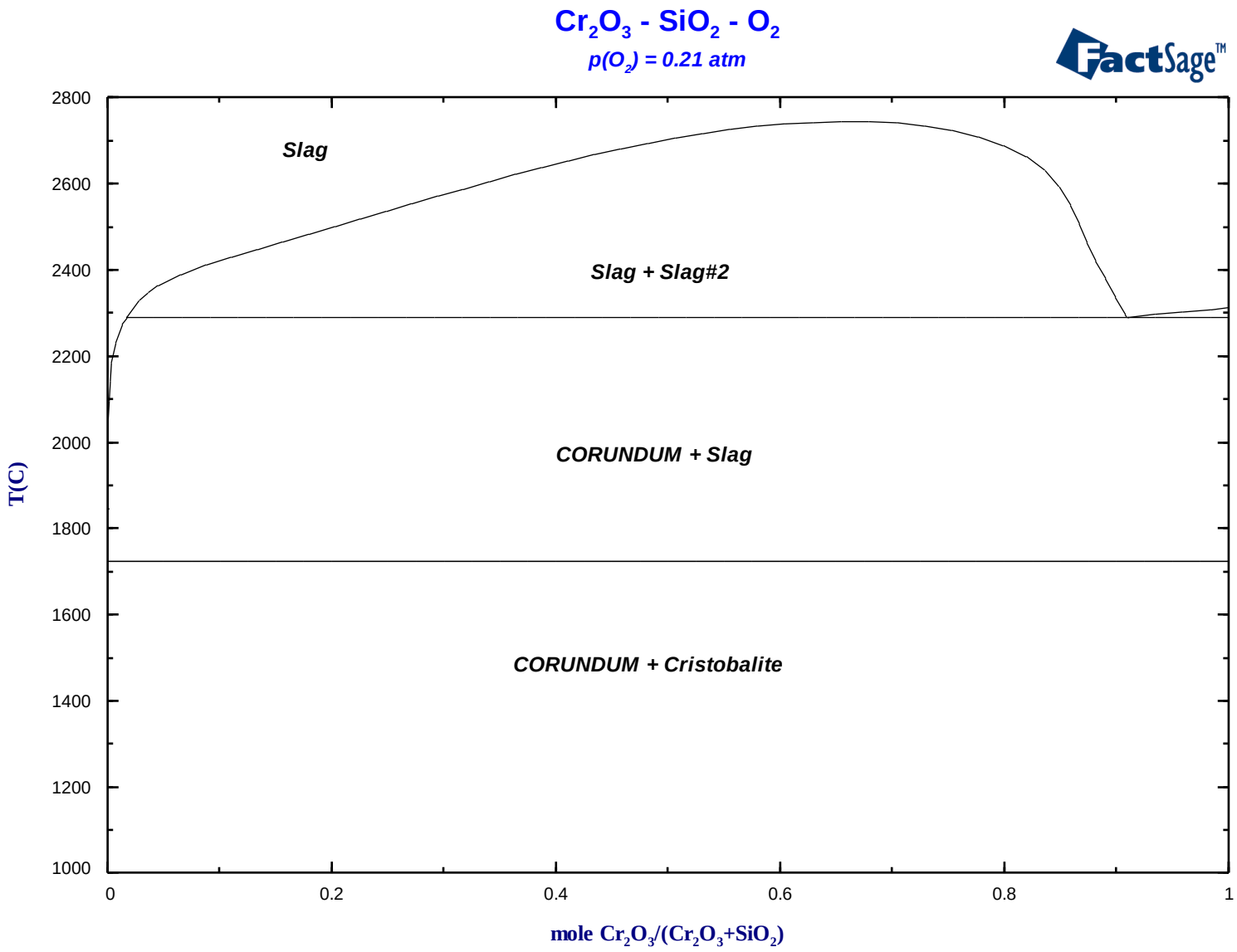
Mole fraction
compared with experimental data



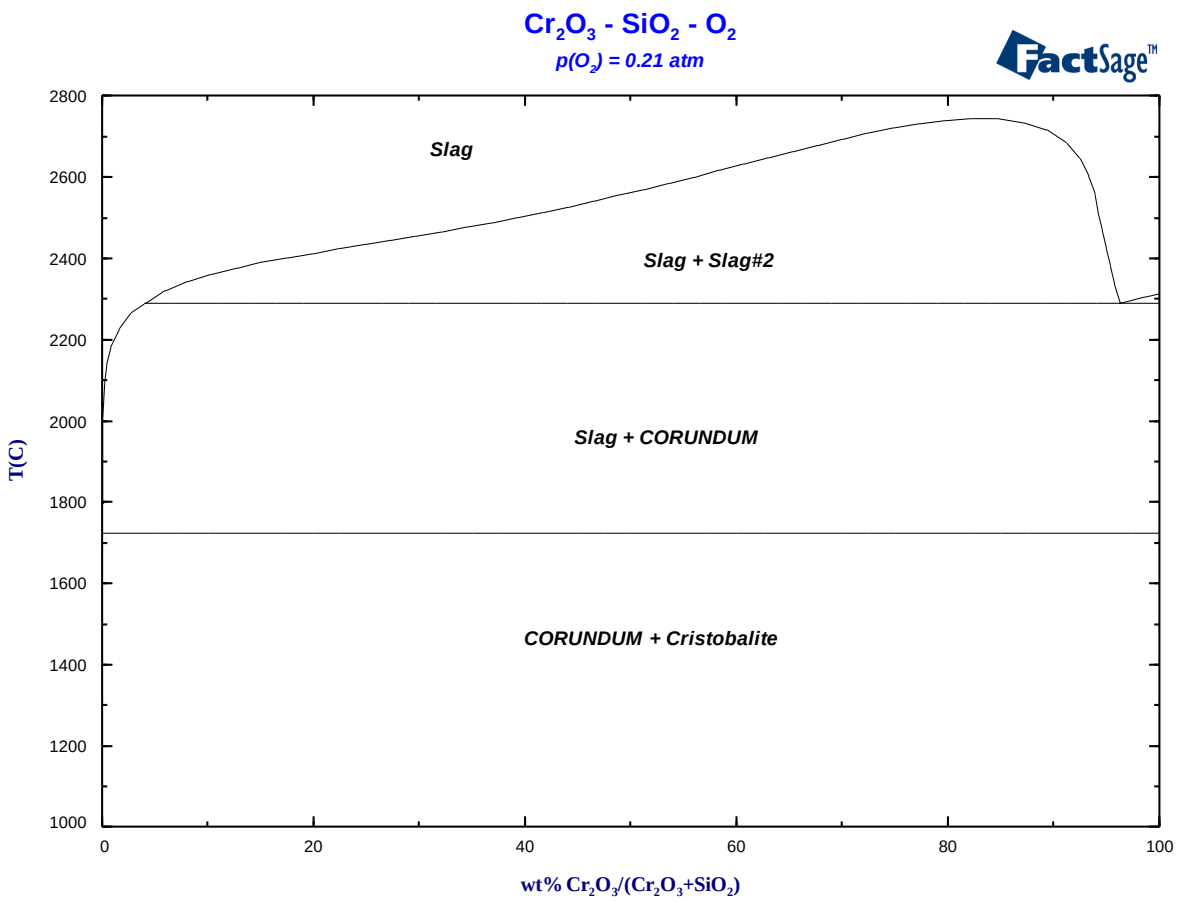
Weight percent



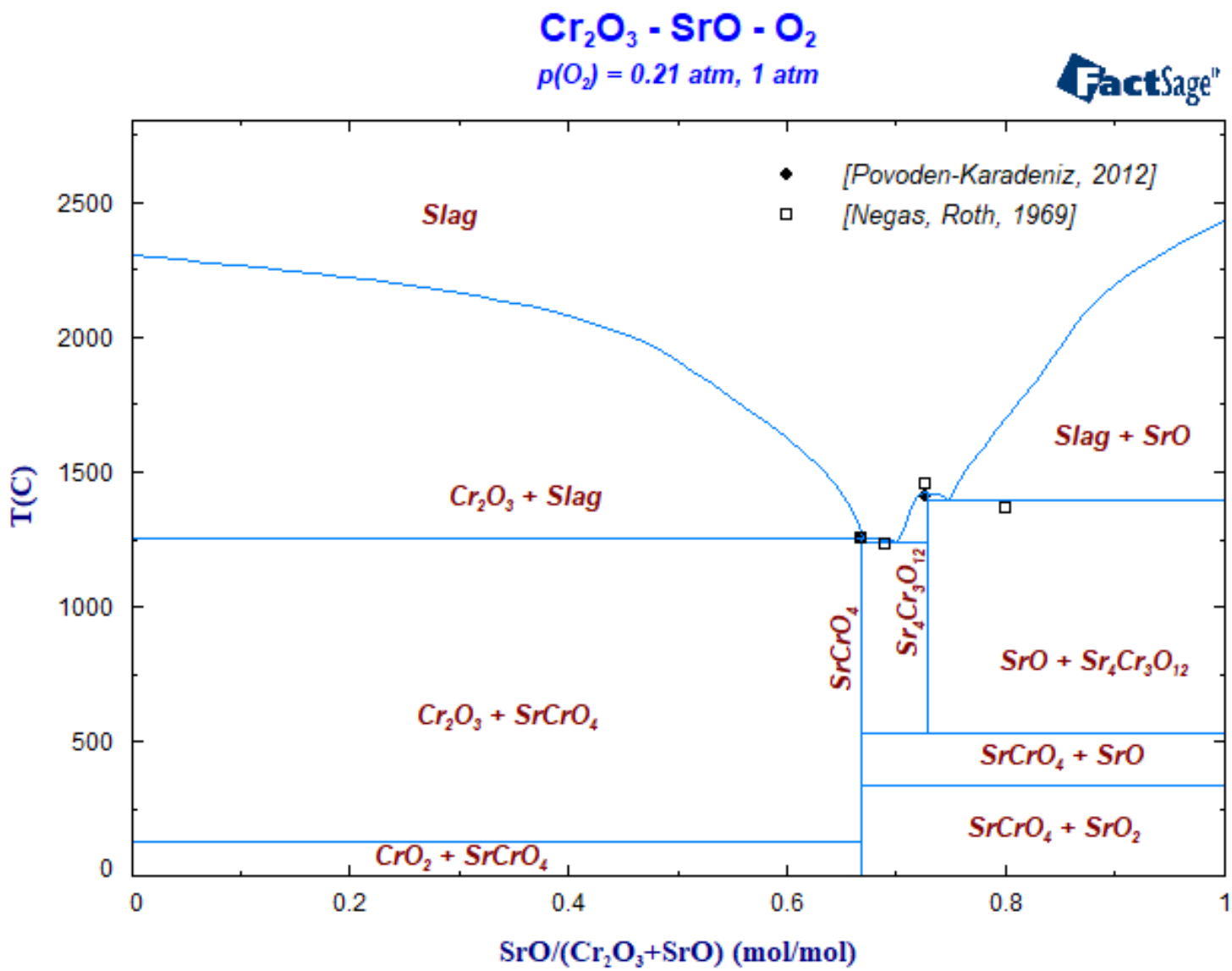
Mole fraction



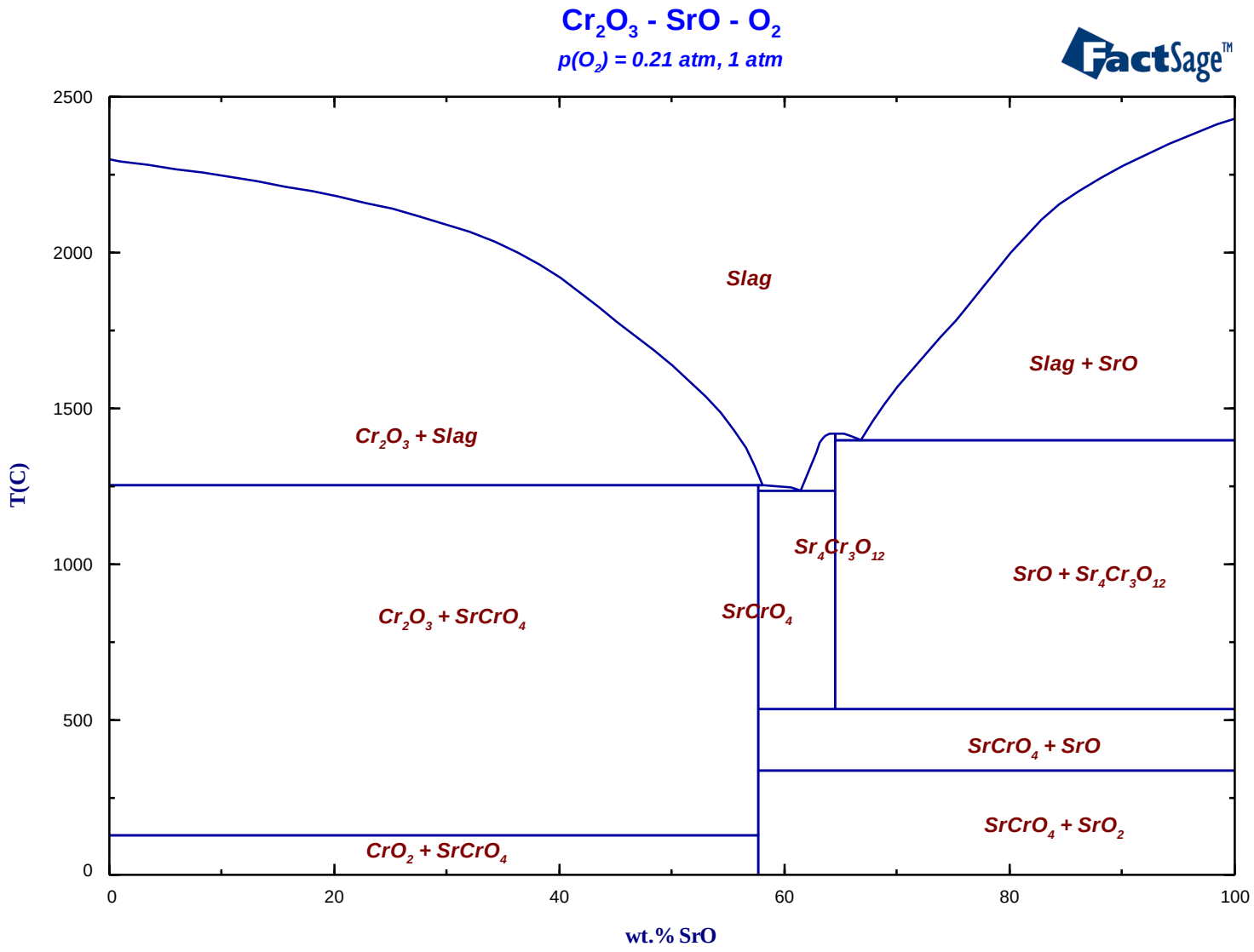
Weight percent



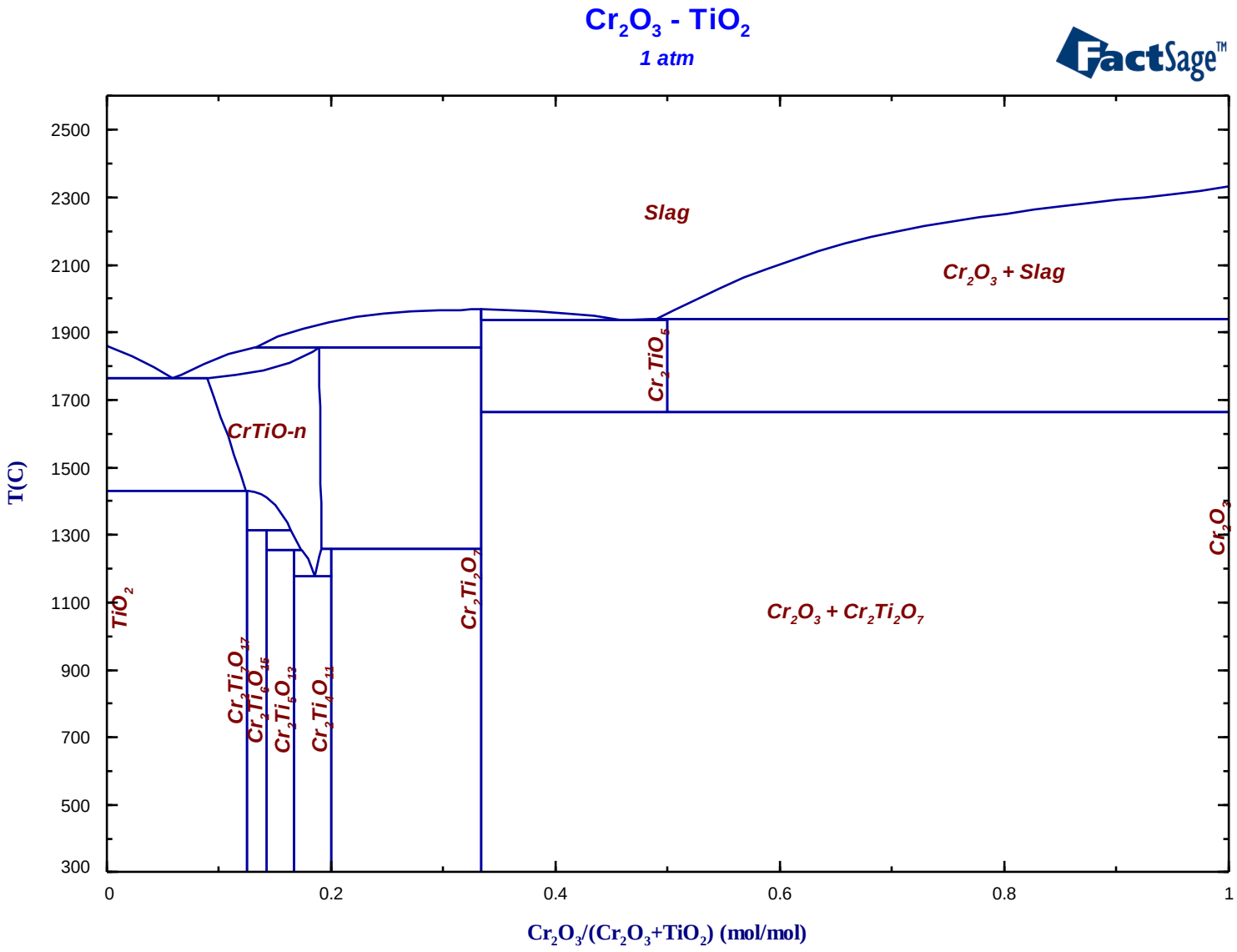
Cr2O3-SrO,
Mole fraction compared with experimental data



Cr2O3-SrO,
Weight percent

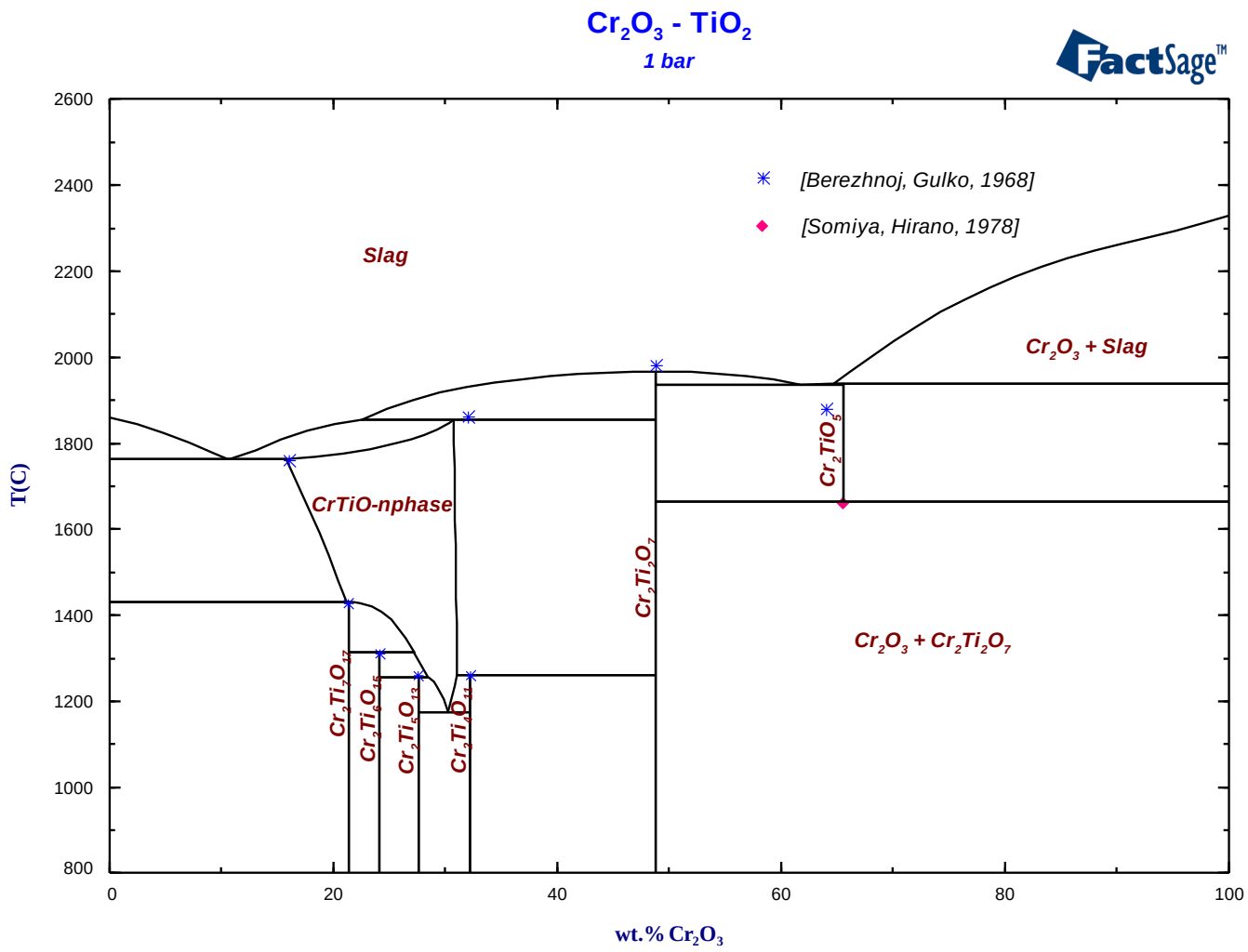


Cr2O3-TiO2,
Mole fraction



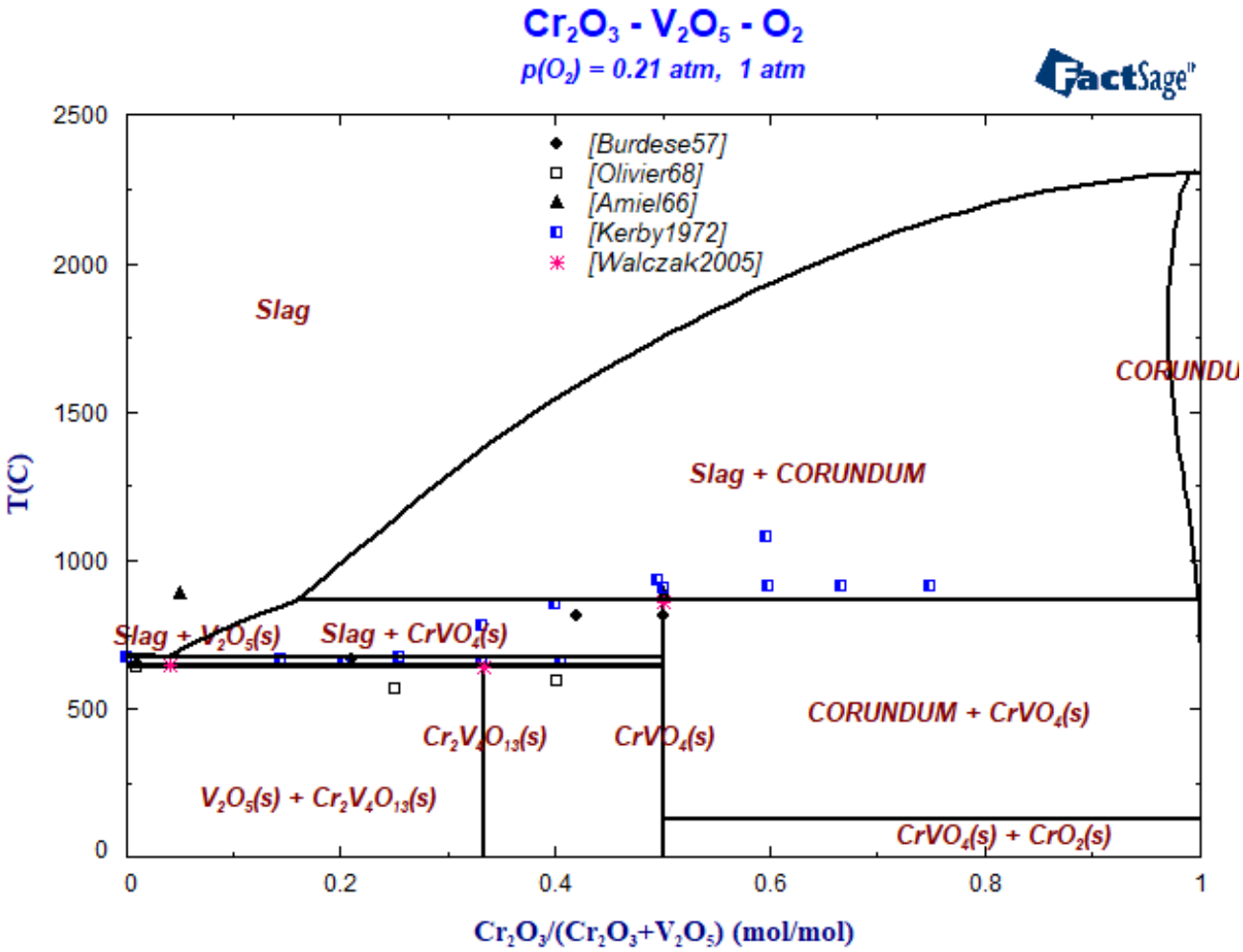
Cr2O3-TiO2,

Weight percent compared with experimental data



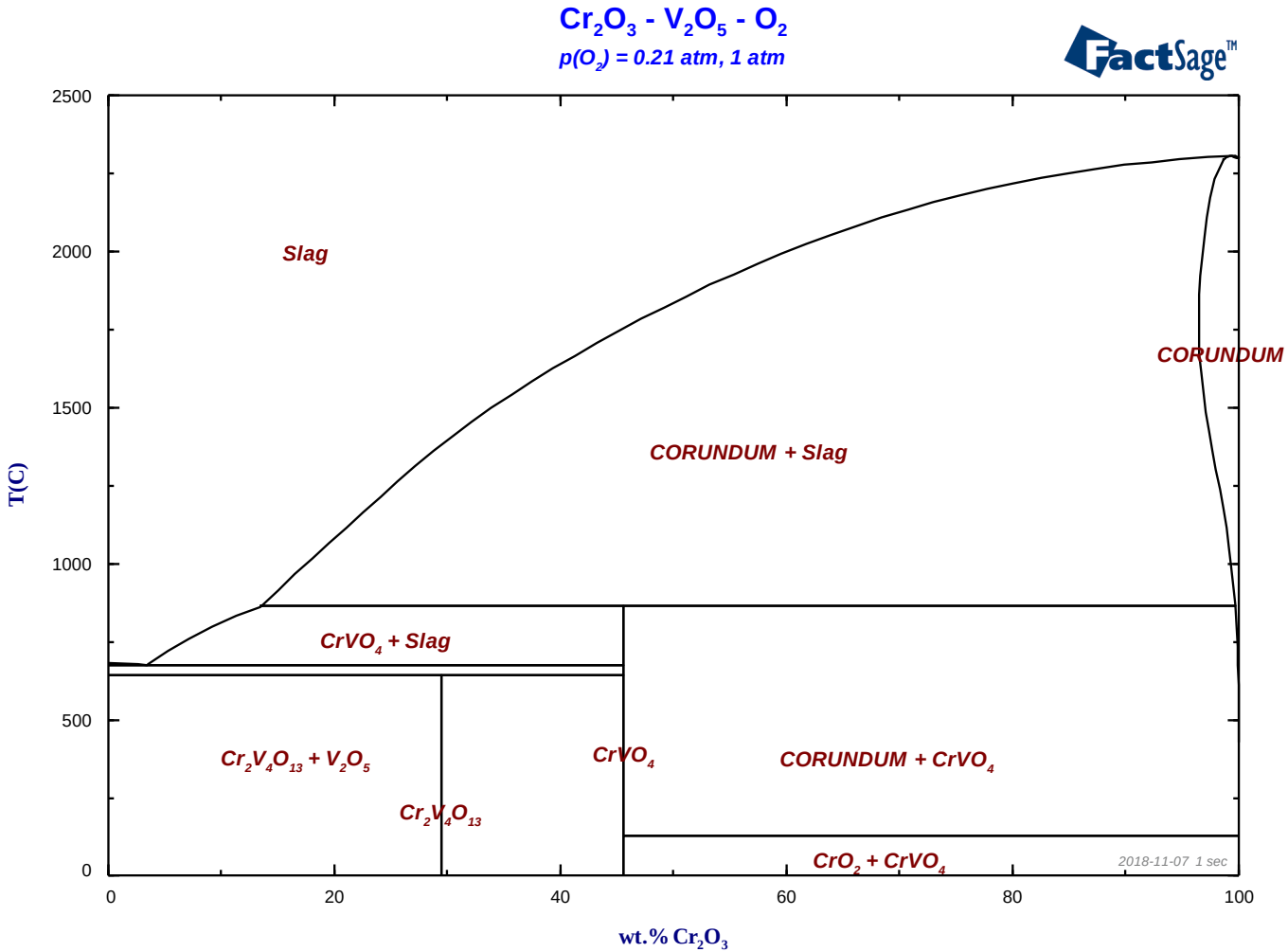
Cr2O3-V2O5-O2,

Mole fraction compared with experimental data

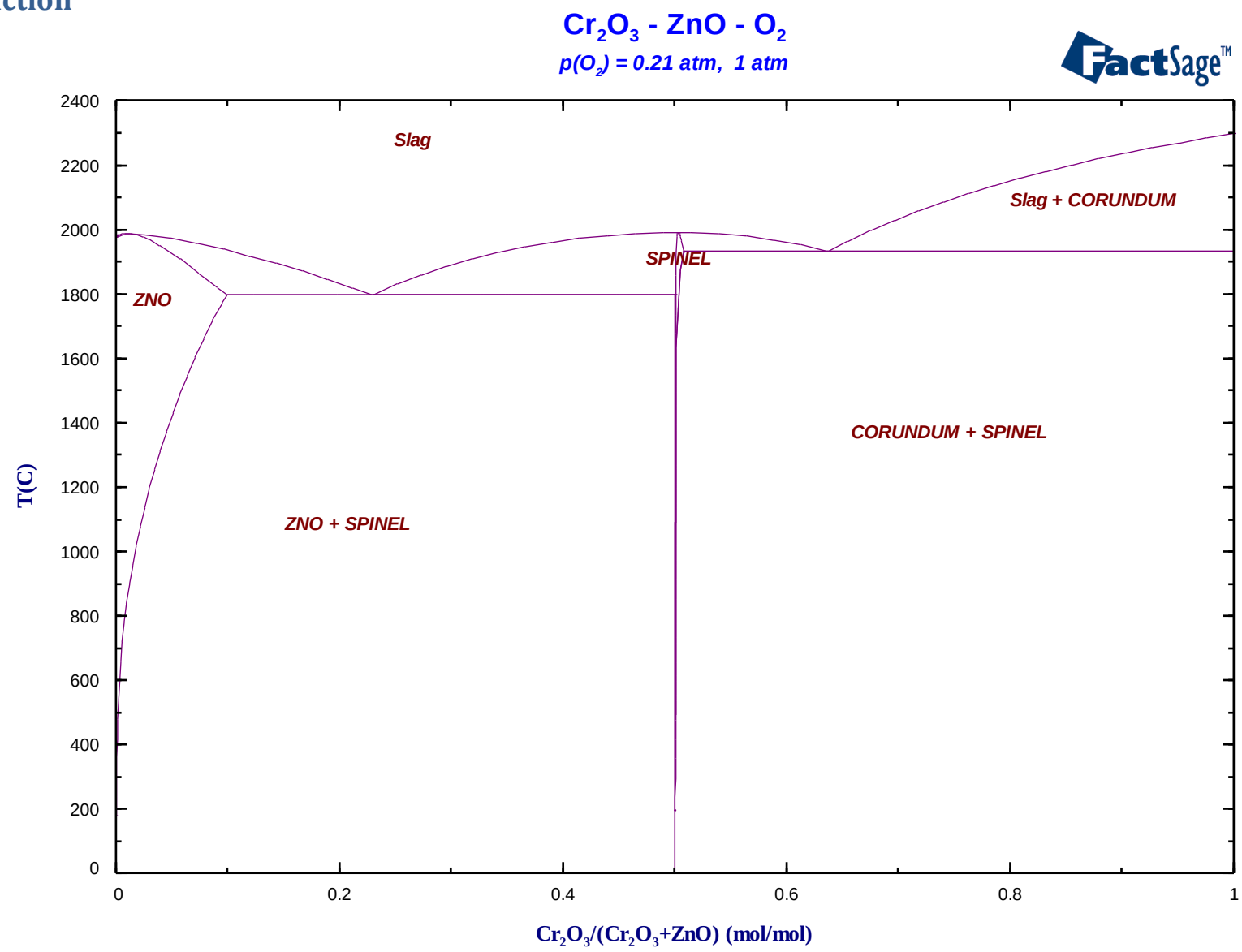


Cr2O3-V2O5-O2,

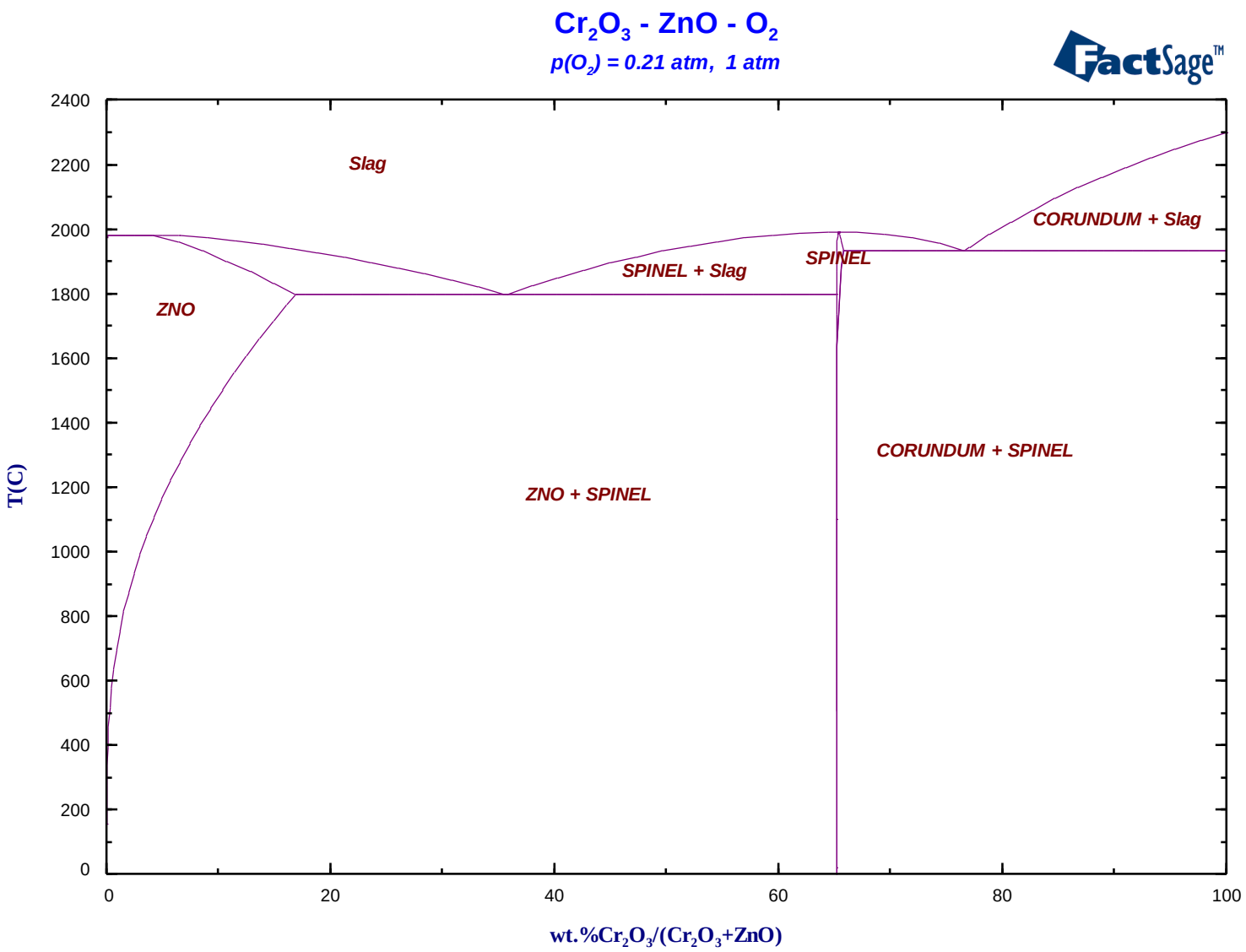
Weight percent



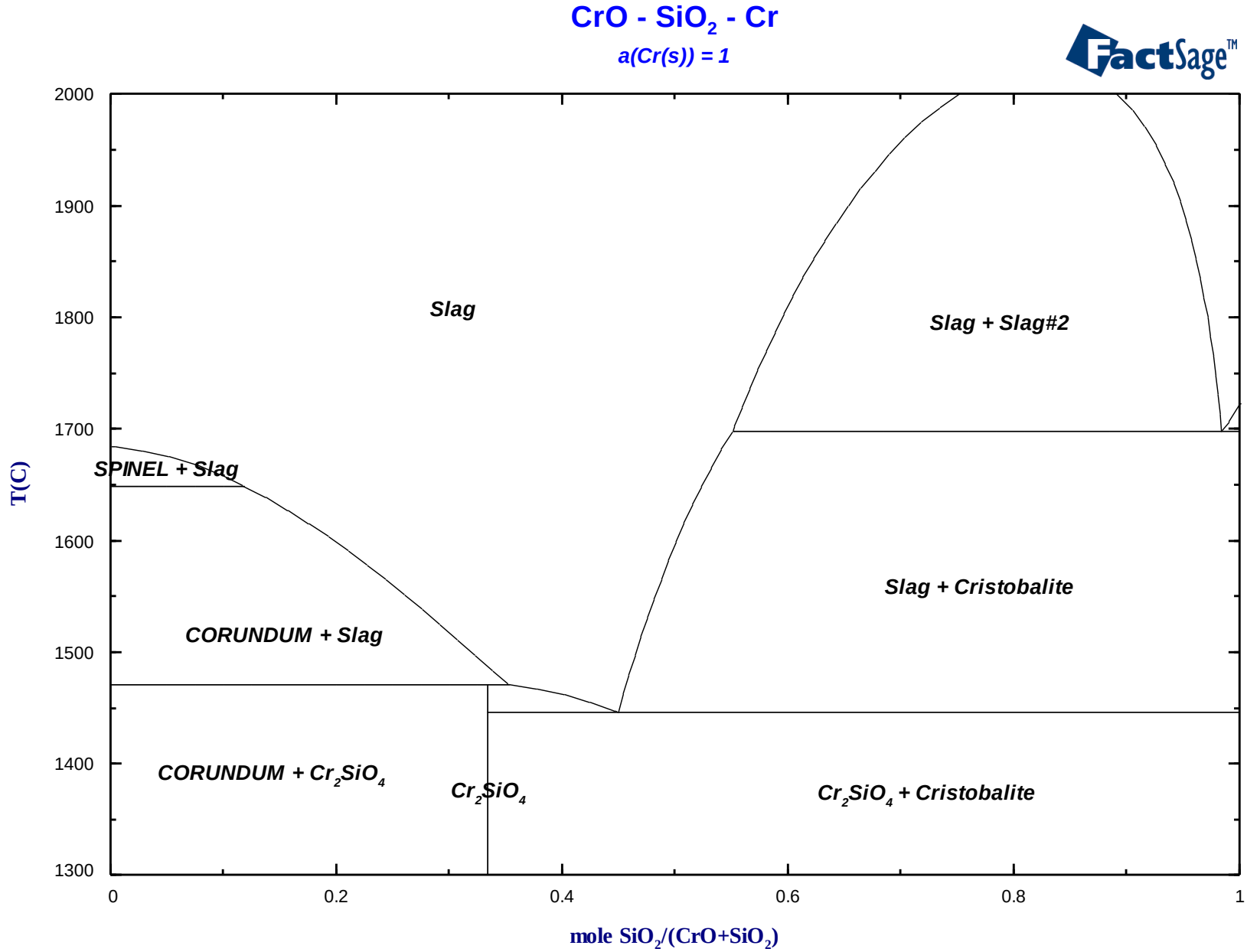
Mole fraction



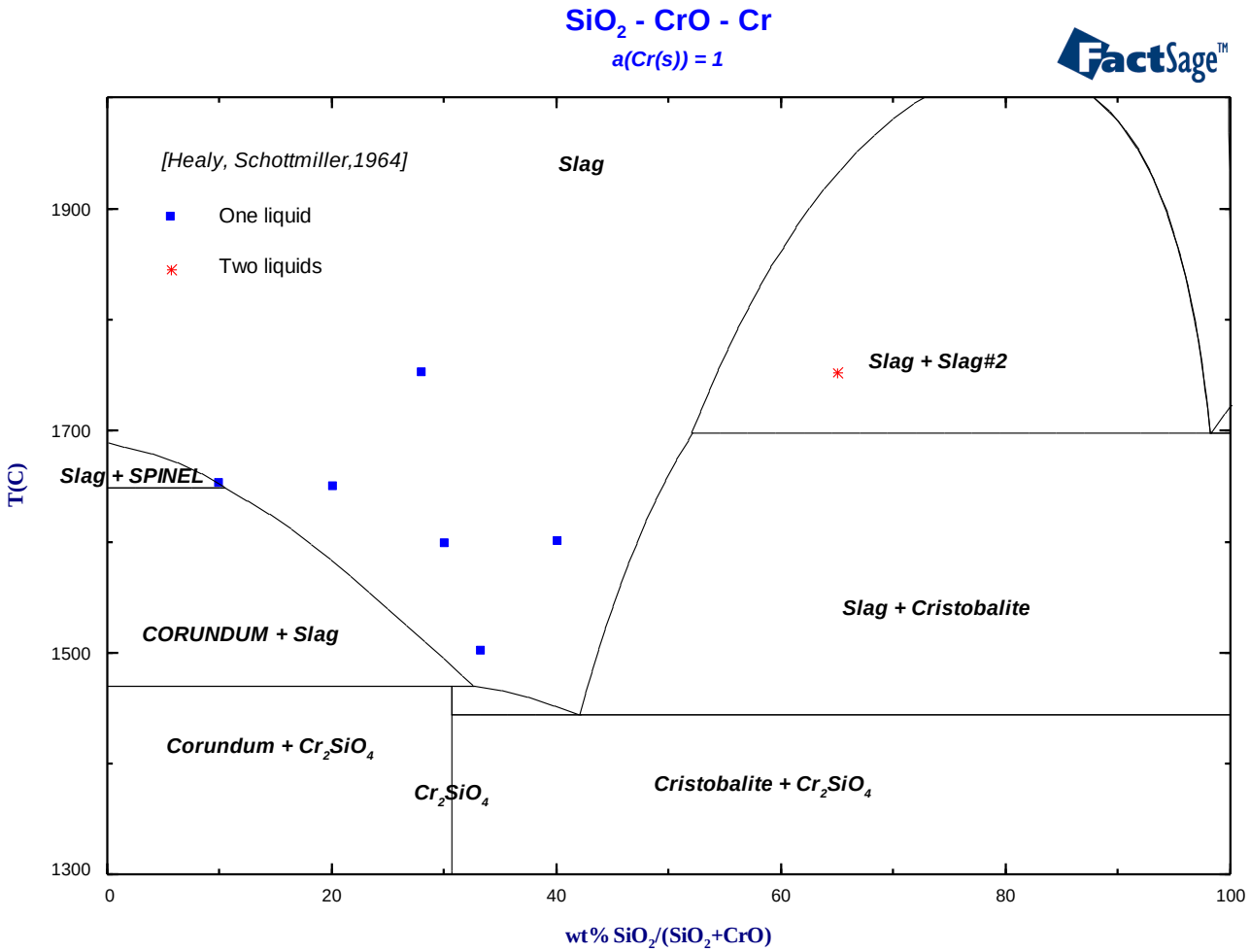
Weight percent



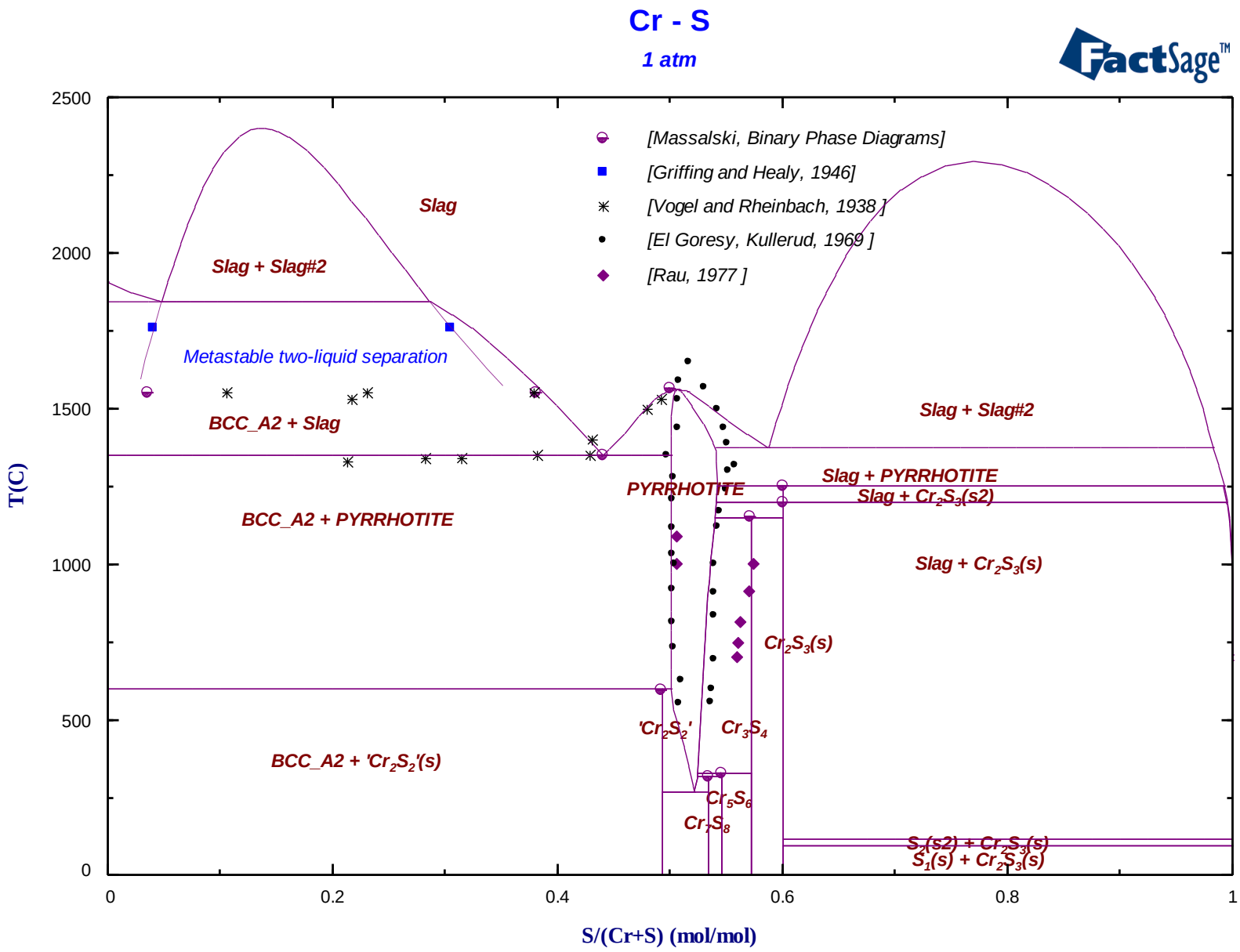
Mole fraction



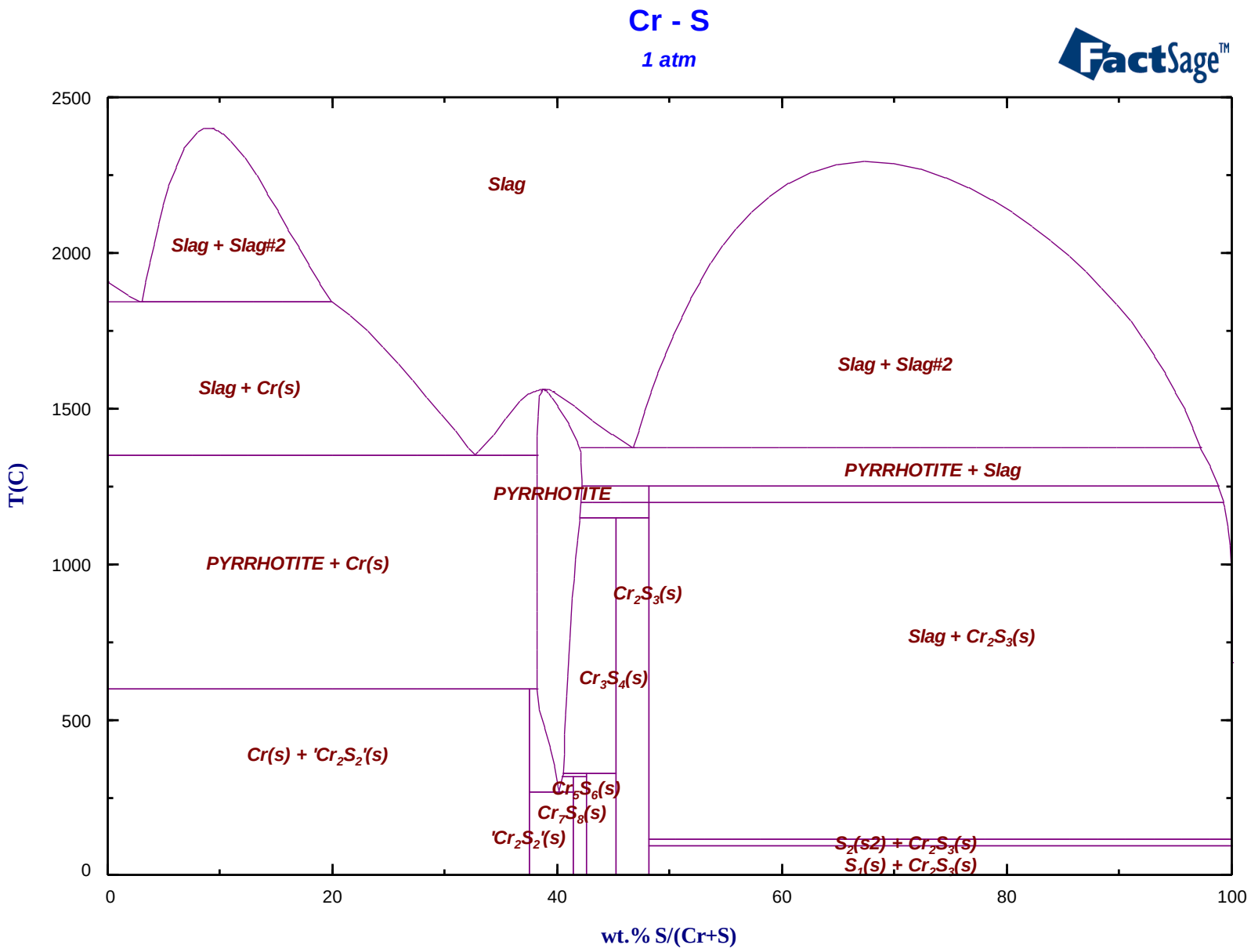
Weight percent
compared with experimental data



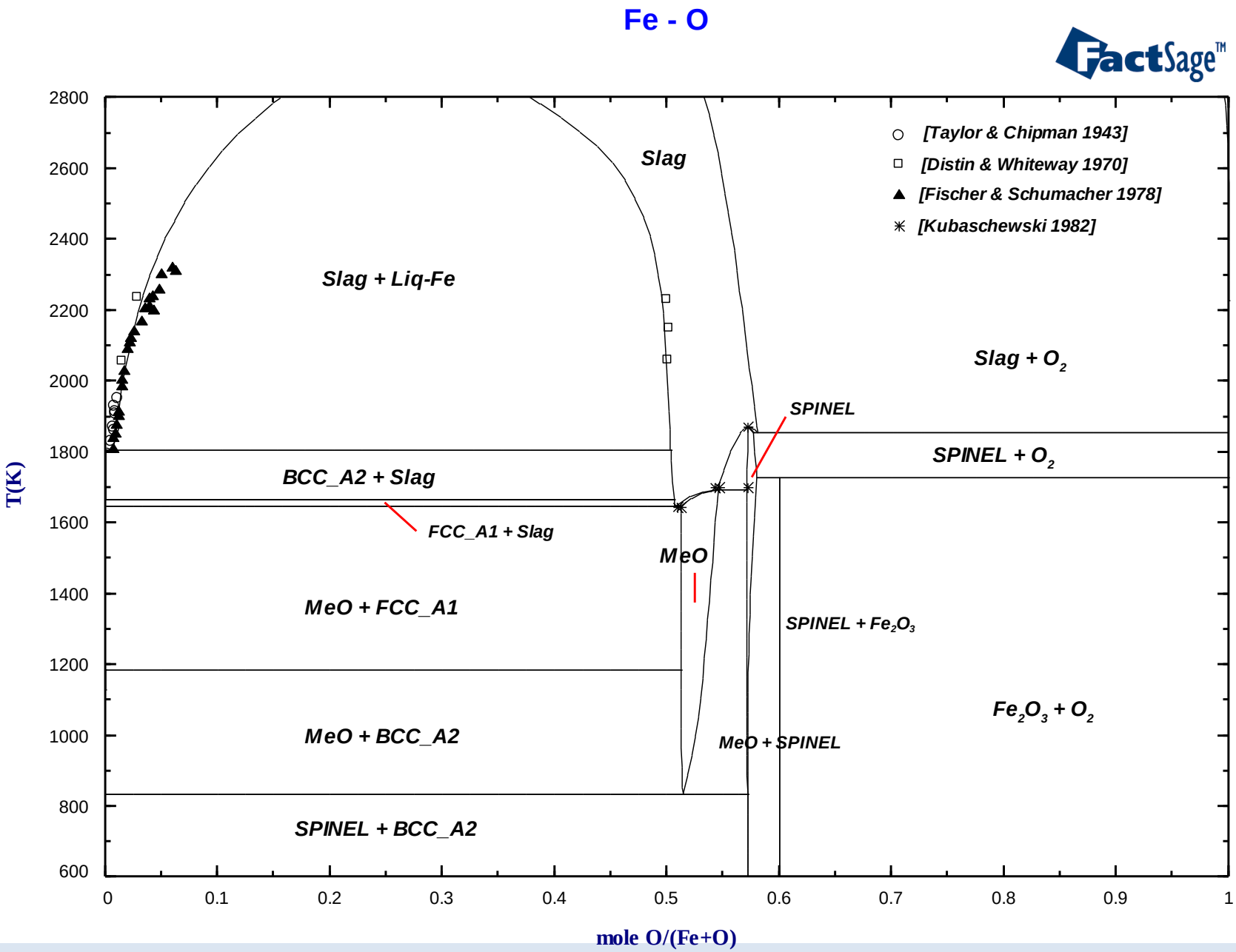
Mole fraction
compared with experimental data



Weight percent

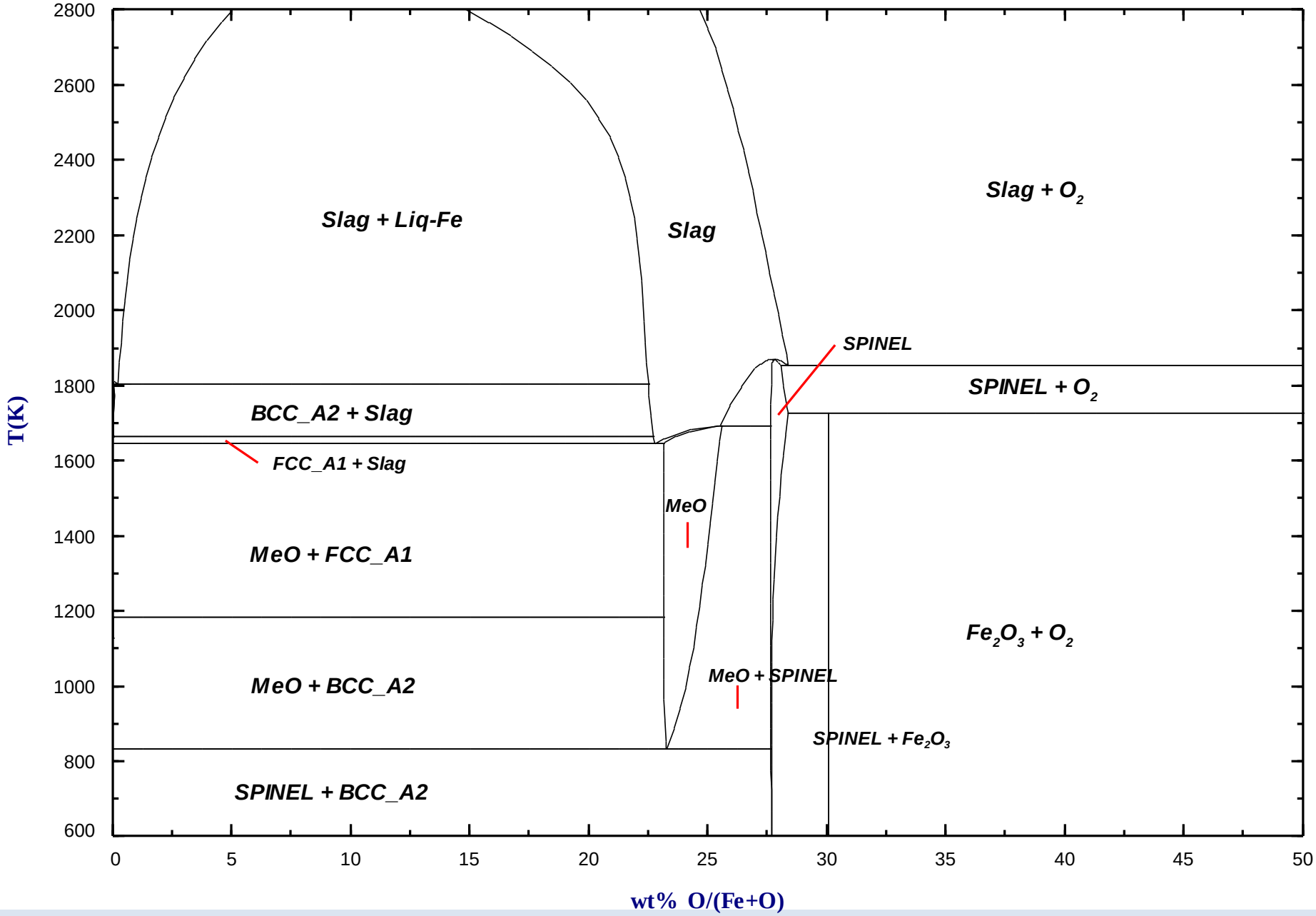


Mole fraction in Kelvin compared with experimental data

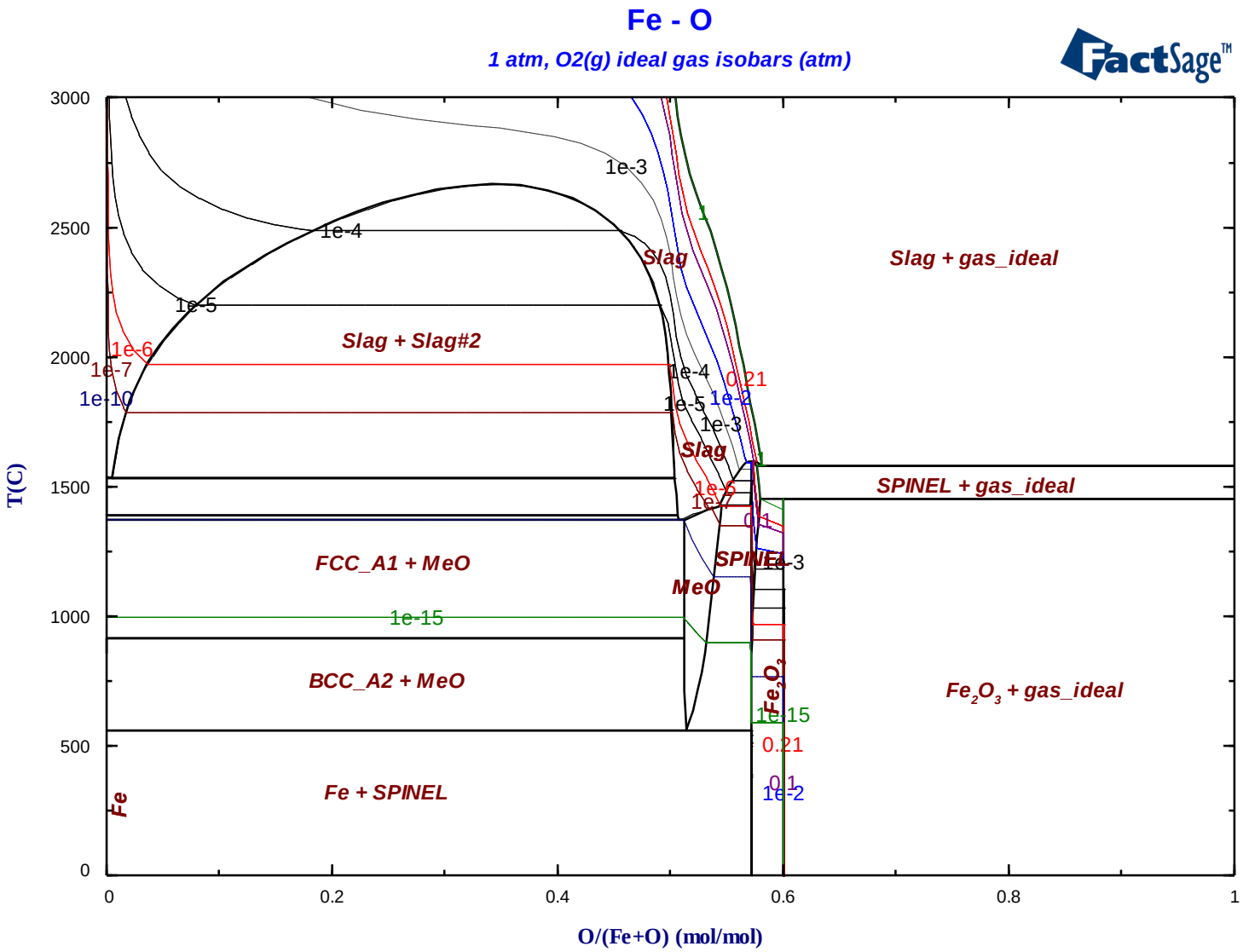


Fe - O

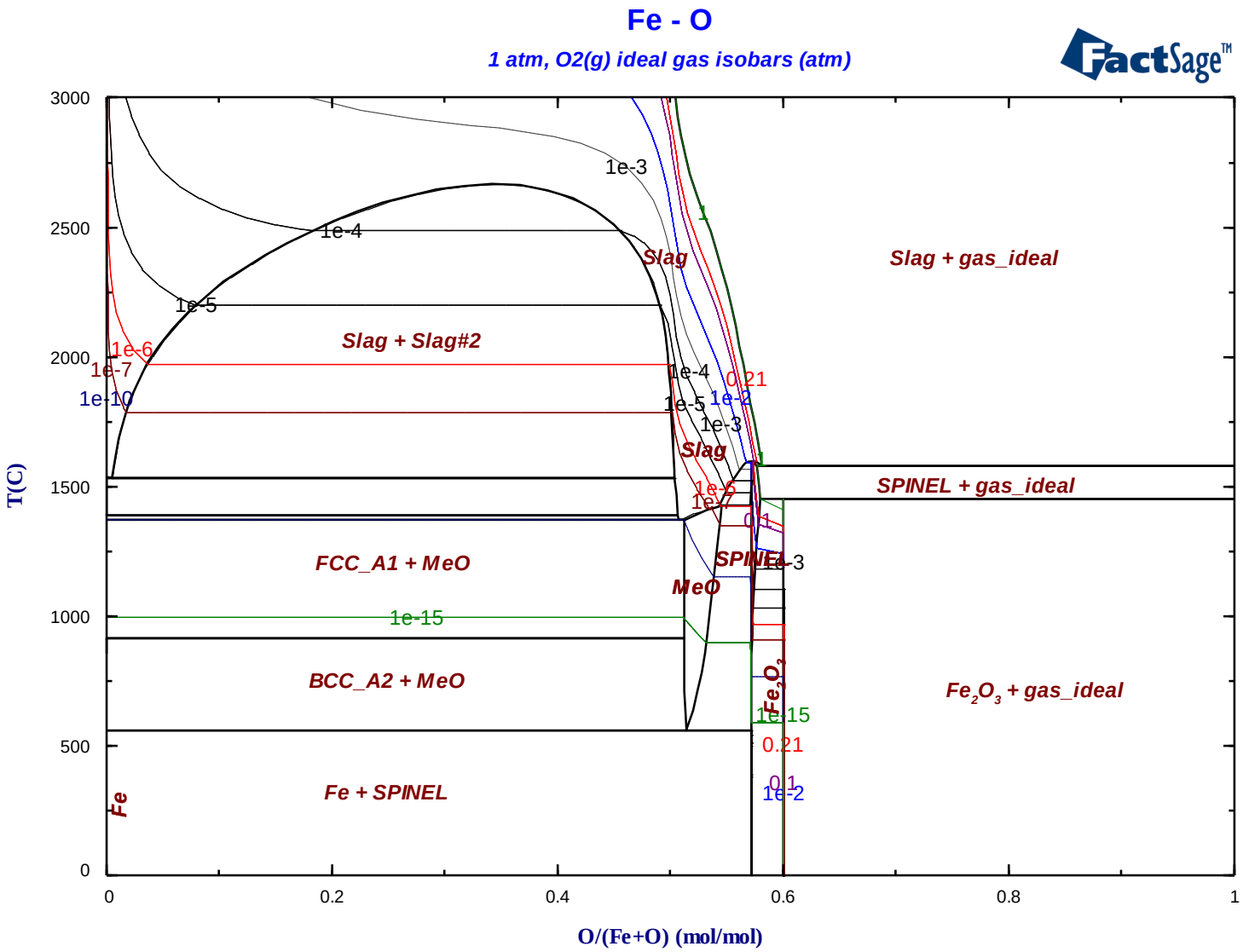
Weight percent in Kelvin



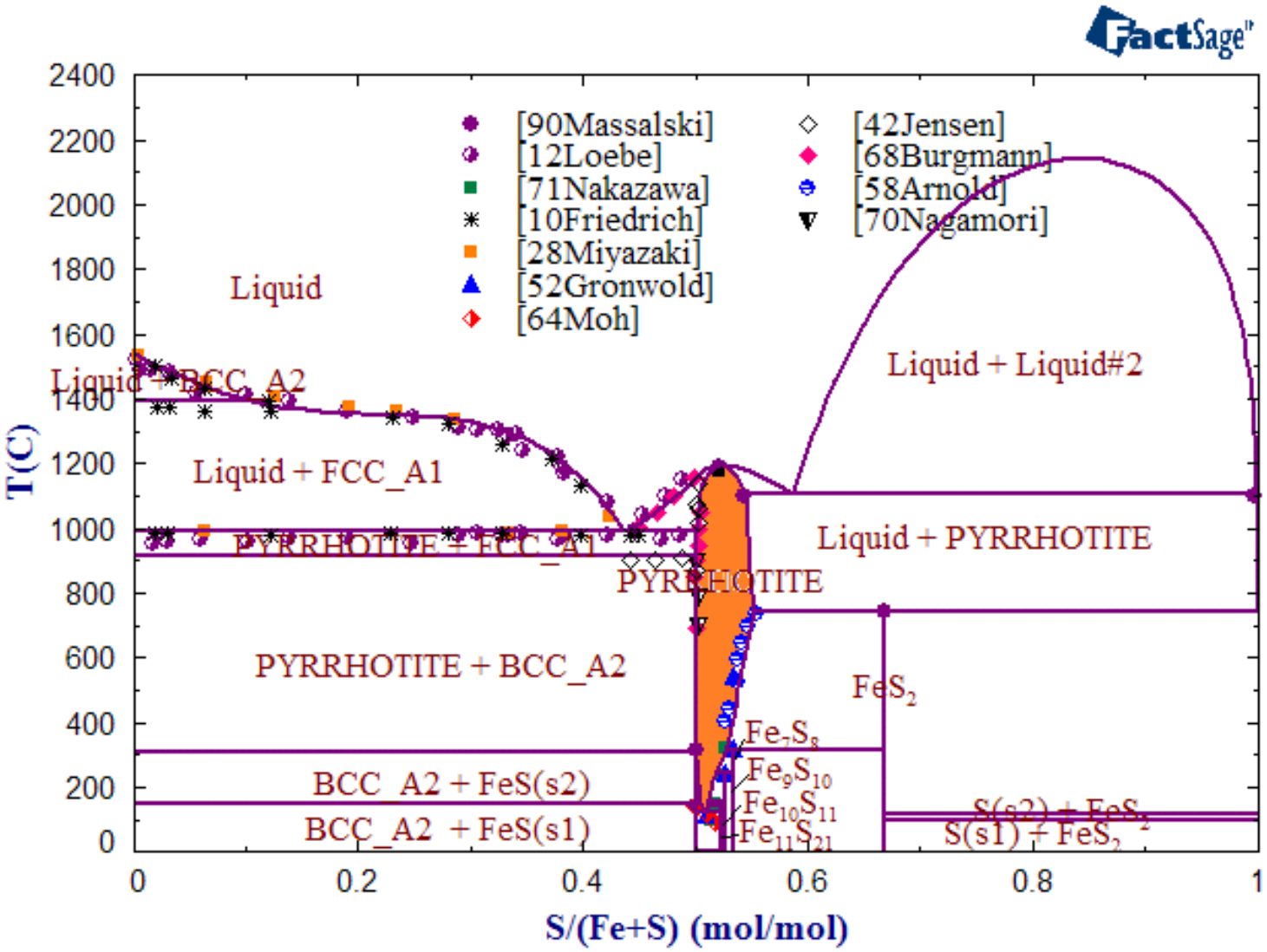
Mole fraction with isobars



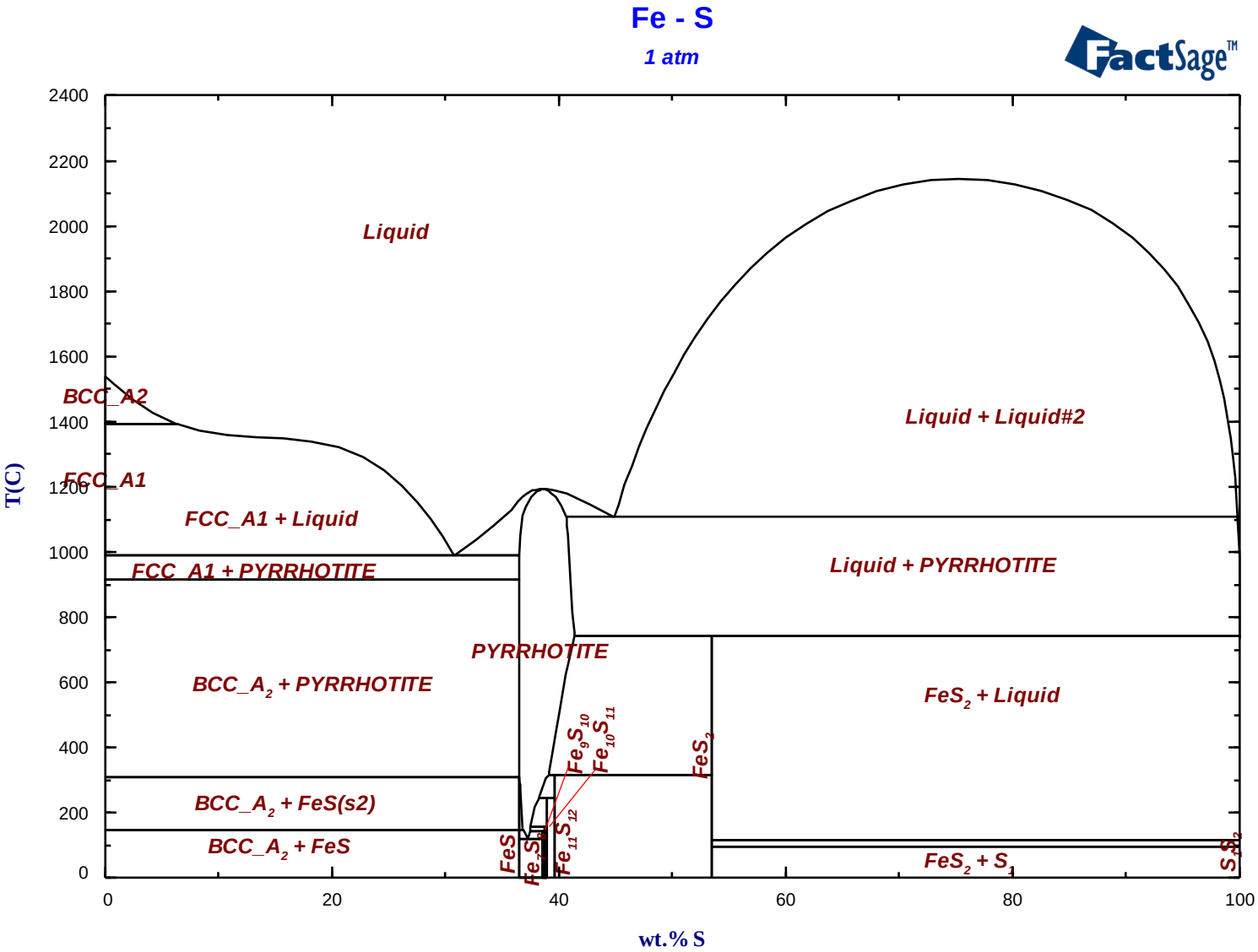
Fe-O2,
Temeprature vs. log P(O2) diagram



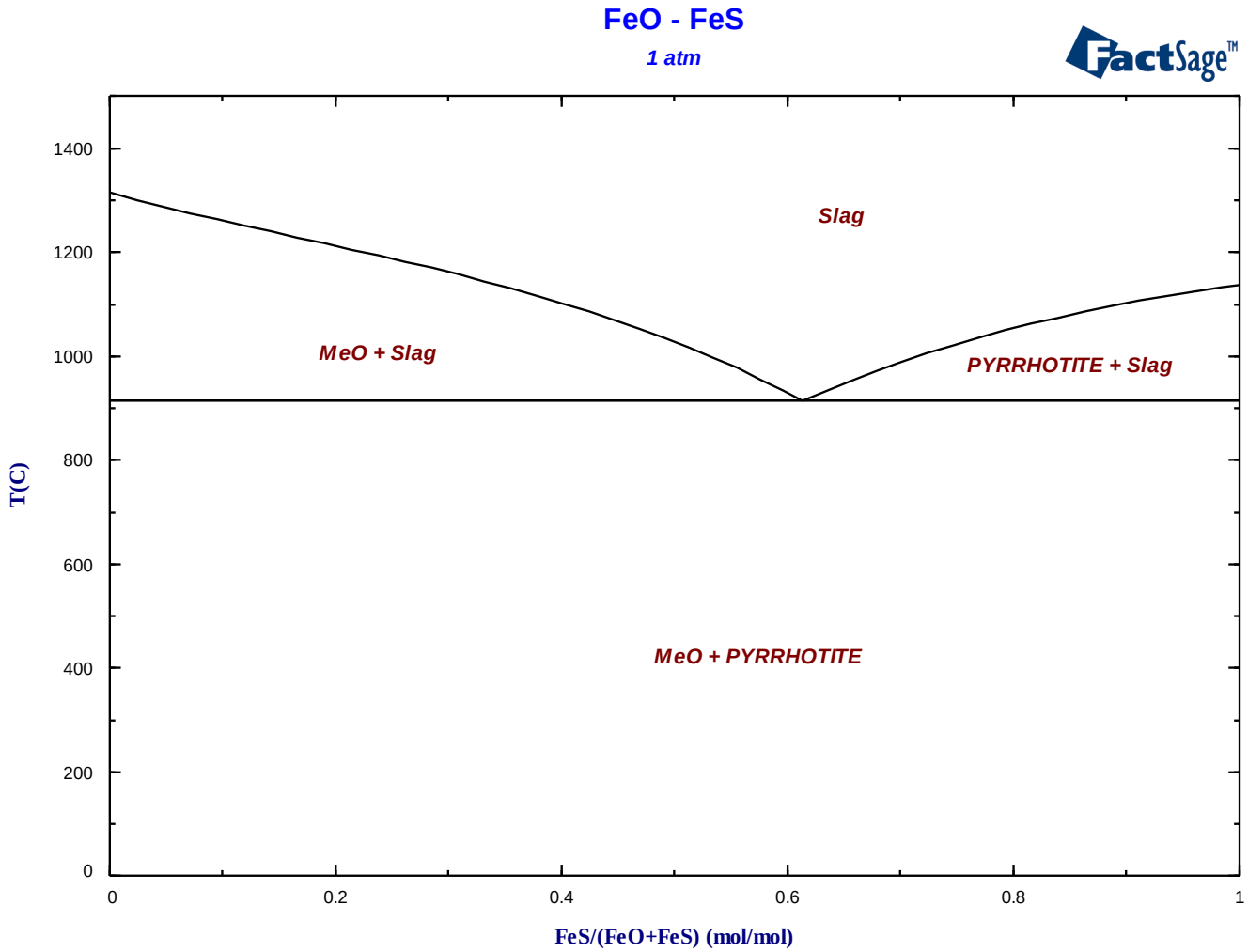
Mole fraction compared with experimental data



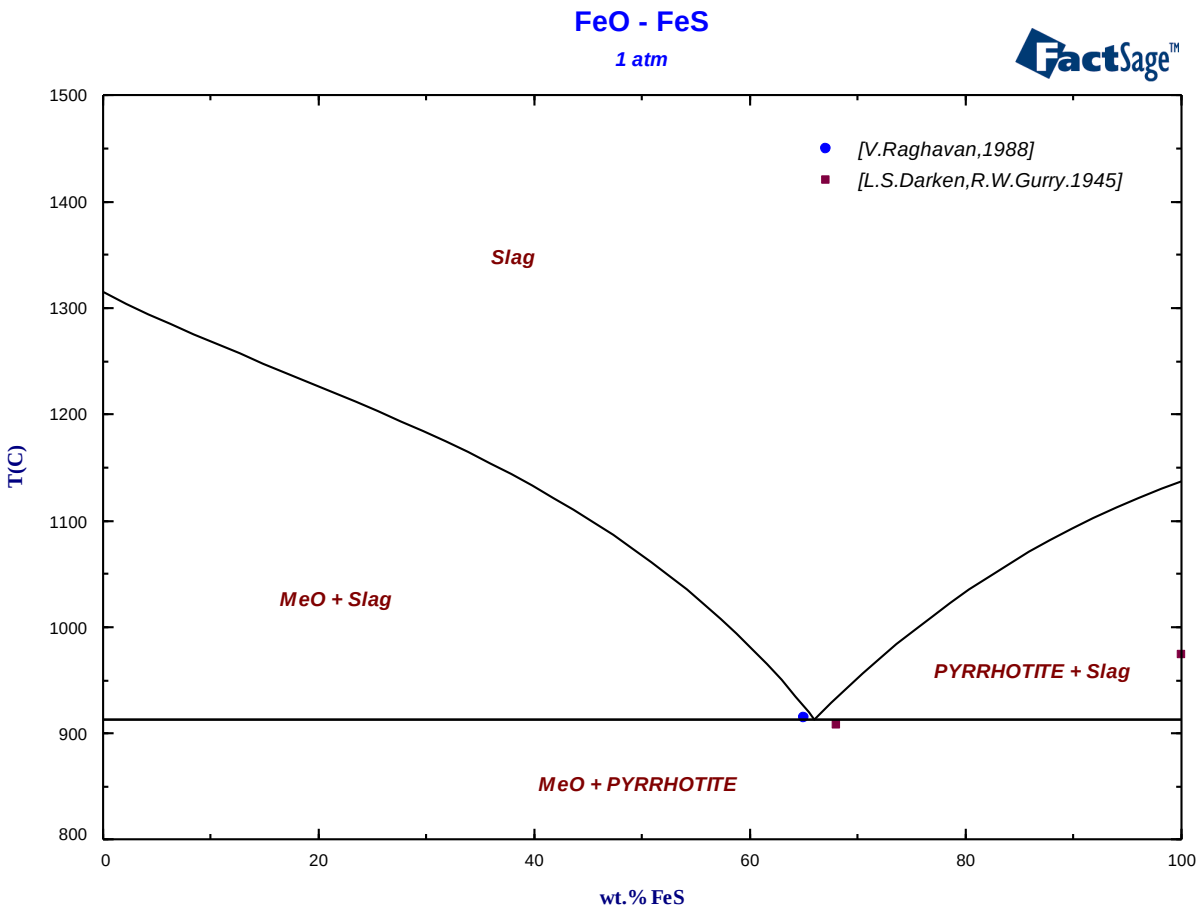
Weight percent



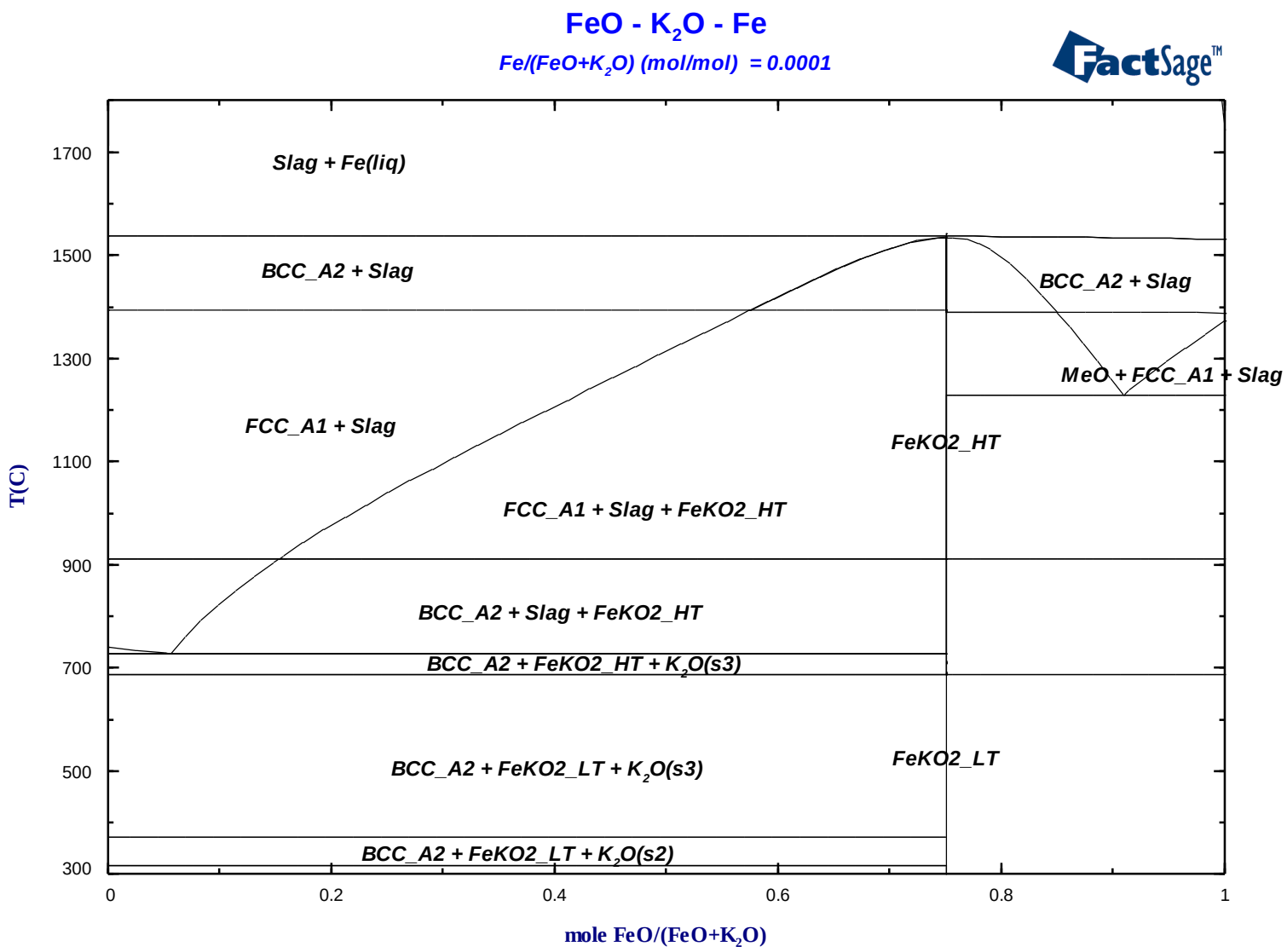
Mole fraction



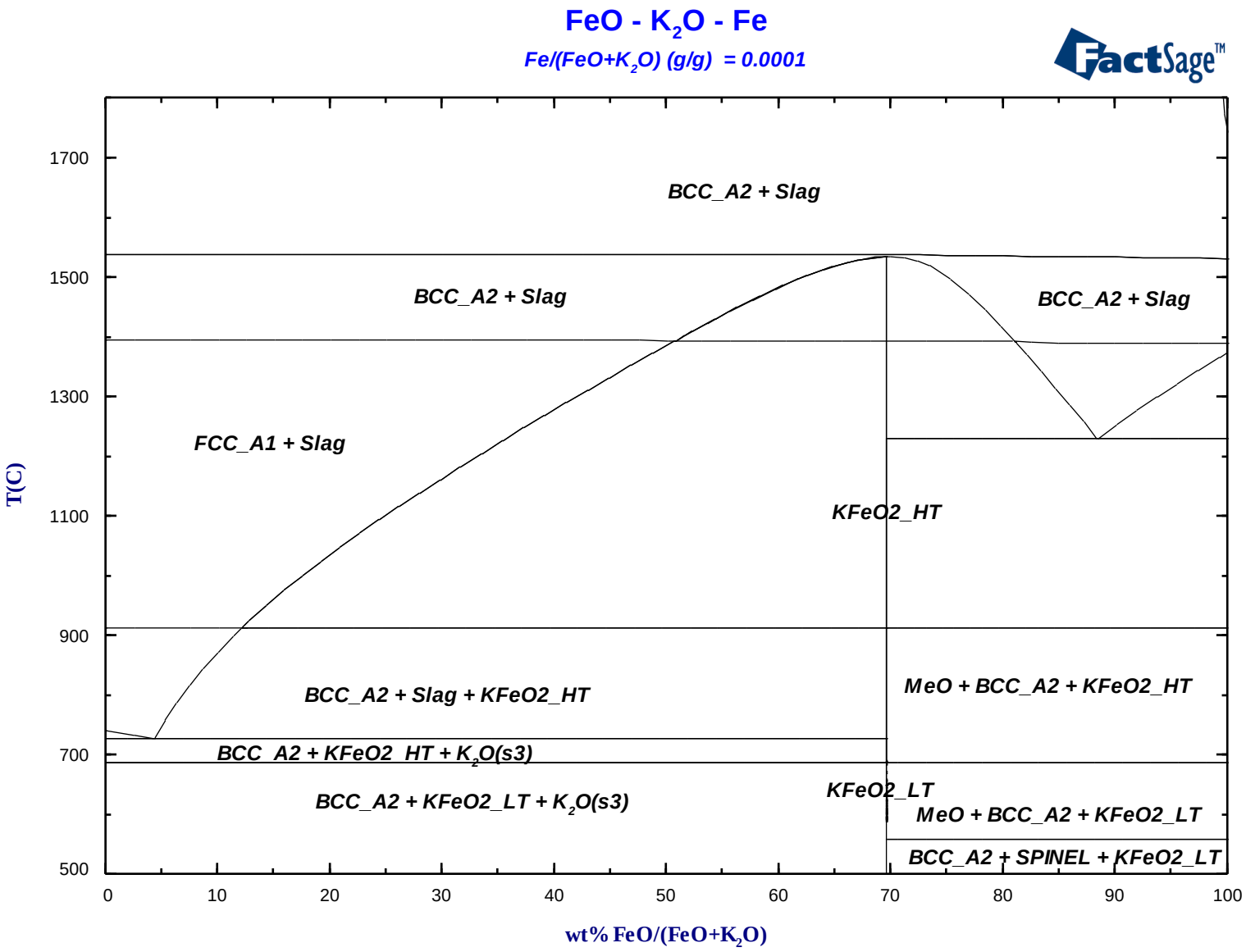
Weight percent



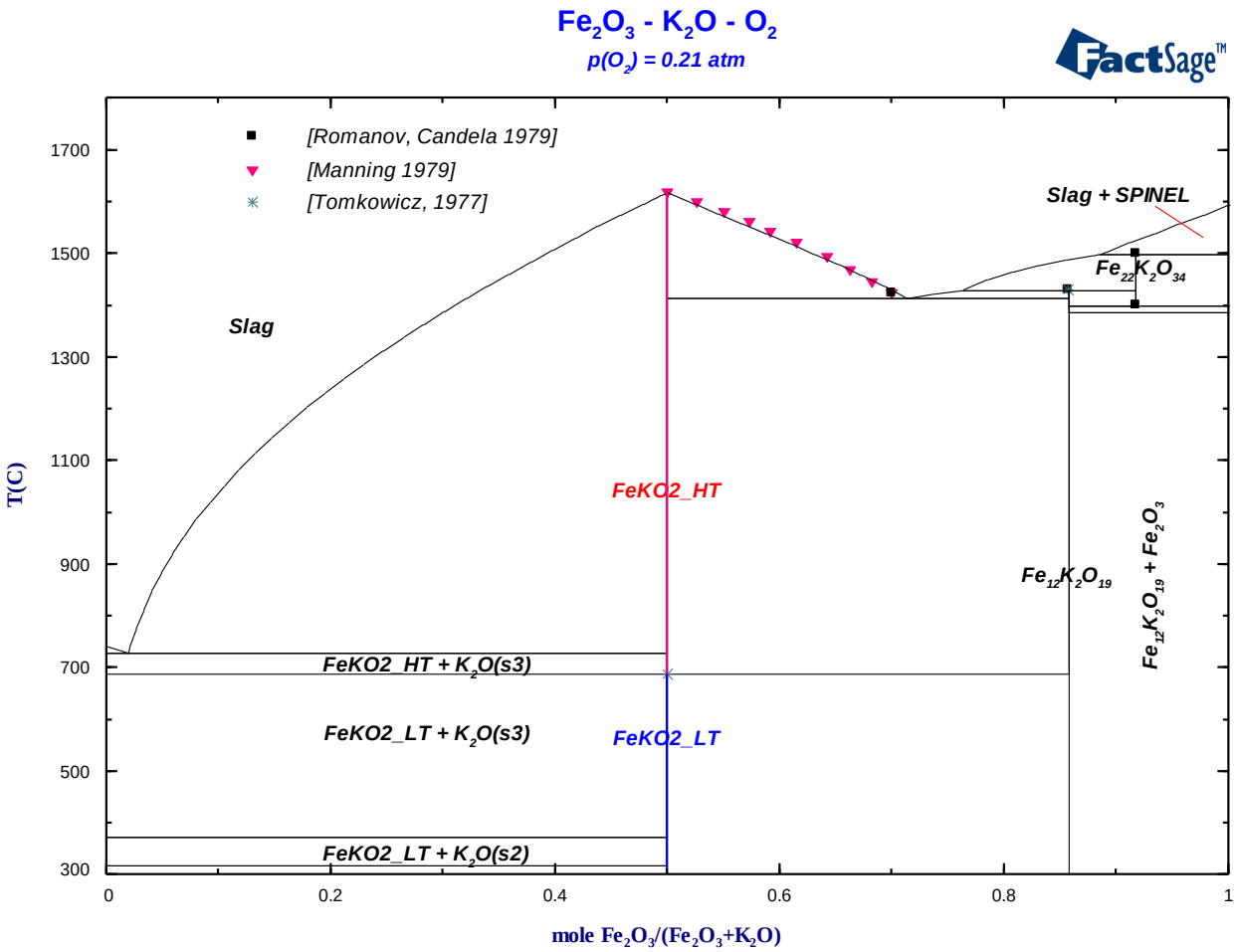
Mole fraction



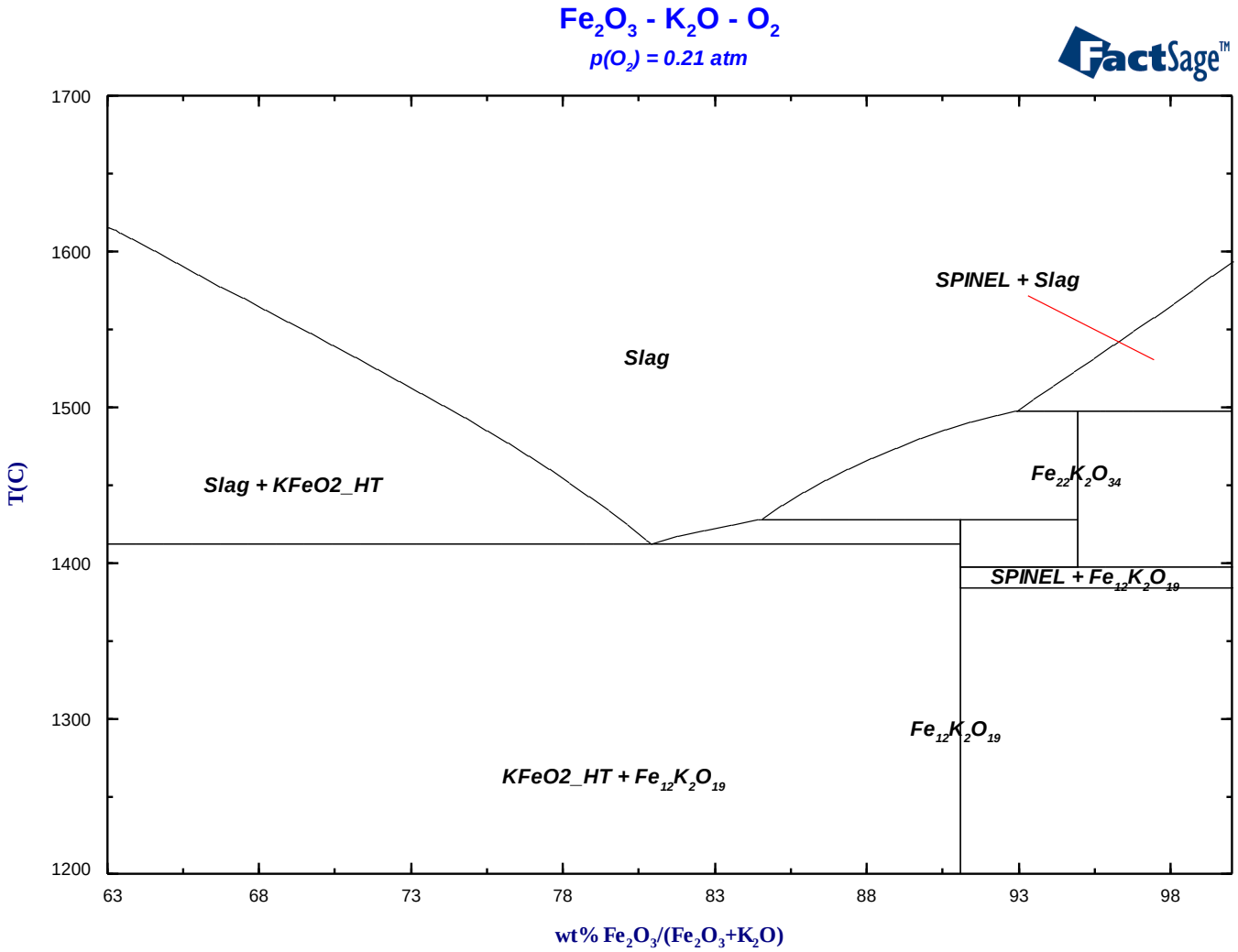
Weight percent



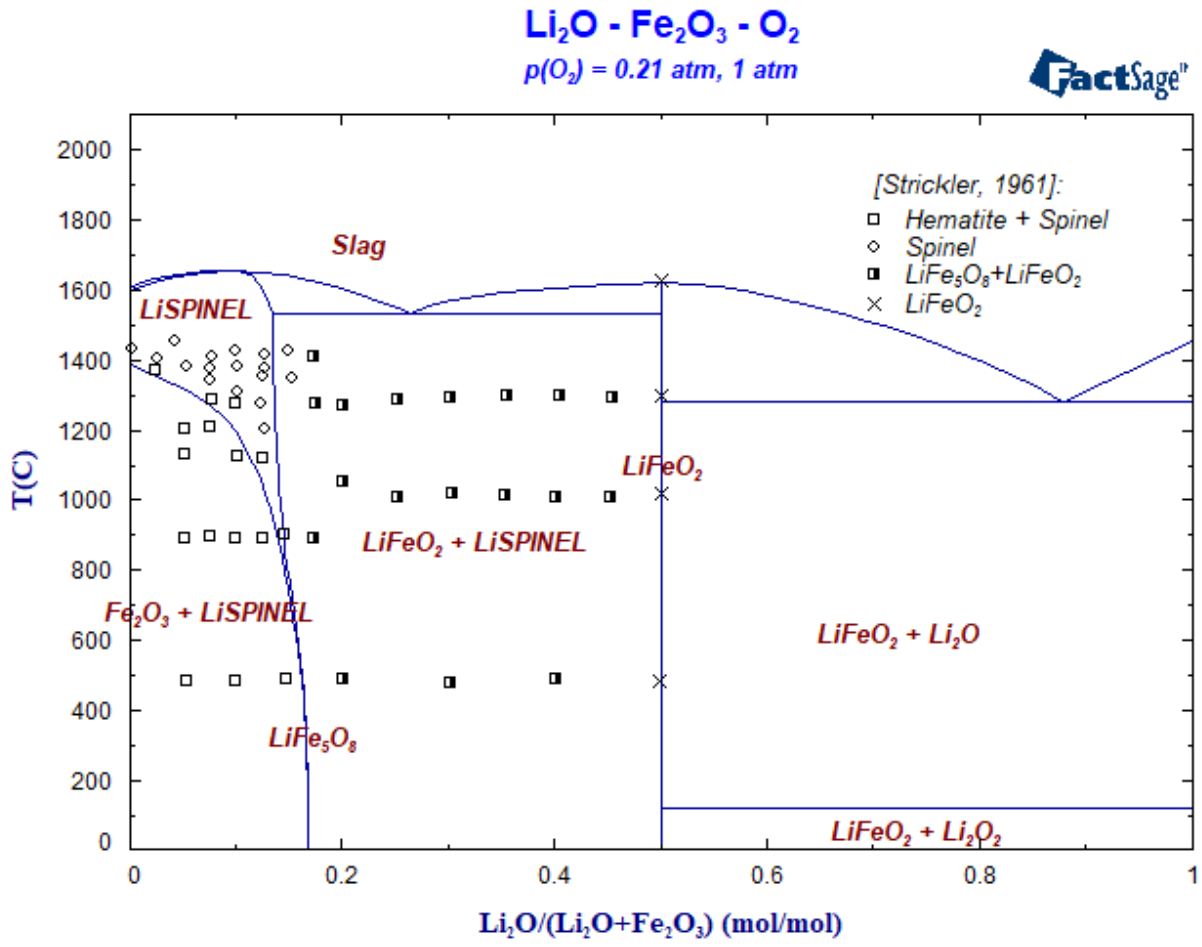
Mole fraction
compared with experimental data



Weight percent

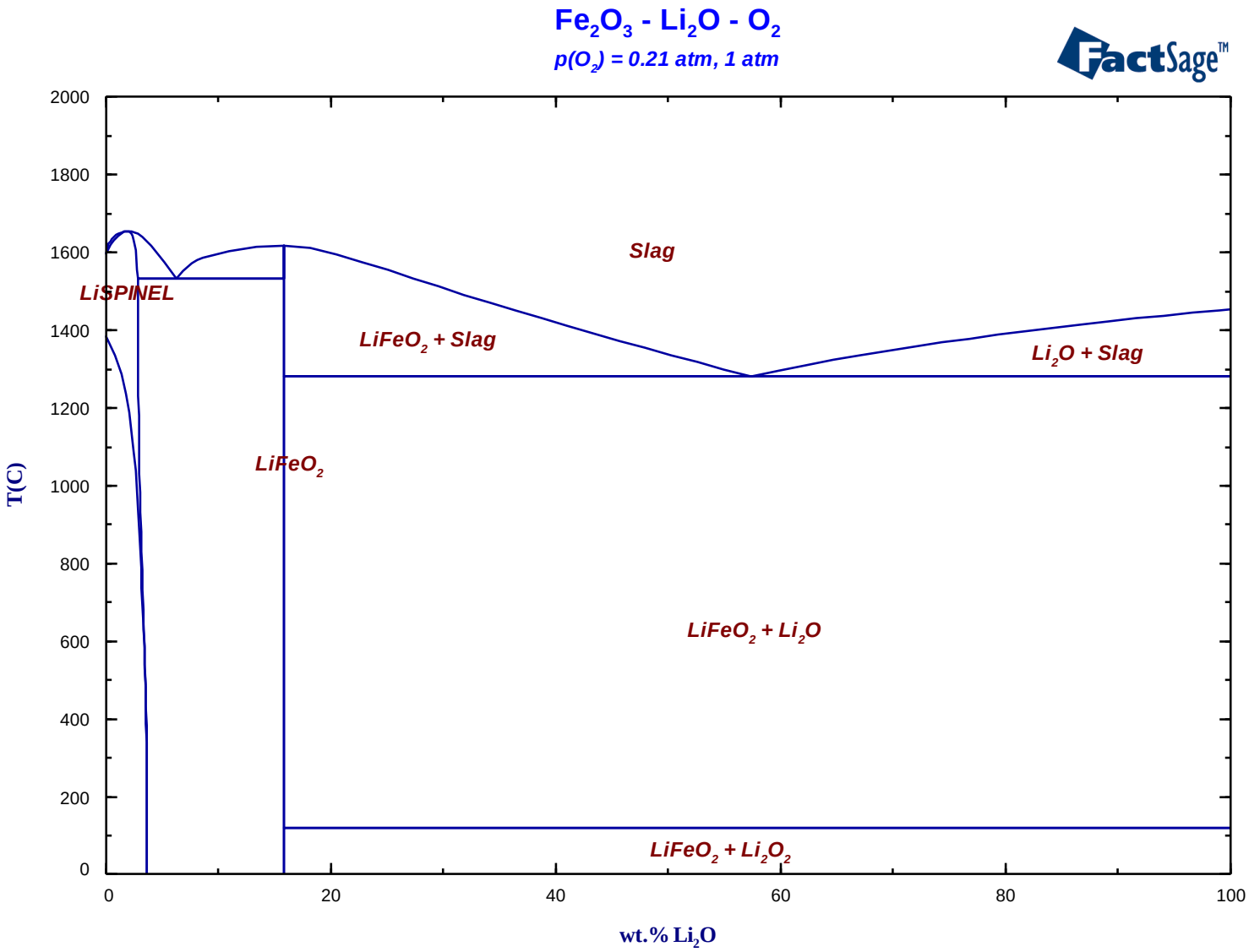

Fe2O3 - K2O - O2
p(O2) = 0.21 atm
FactSage™
1700
1600
1500
1400
1300
1200
T(C)
63
68
73
78
83
88
93
98
wt% Fe2O3/(Fe2O3+K2O)
SPINEL + Slag
Slag
Slag + KFeO2_HT
Fe22K2O34
SPINEL + Fe12K2O19
Fe12K2O19
KFeO2_HT + Fe12K2O19

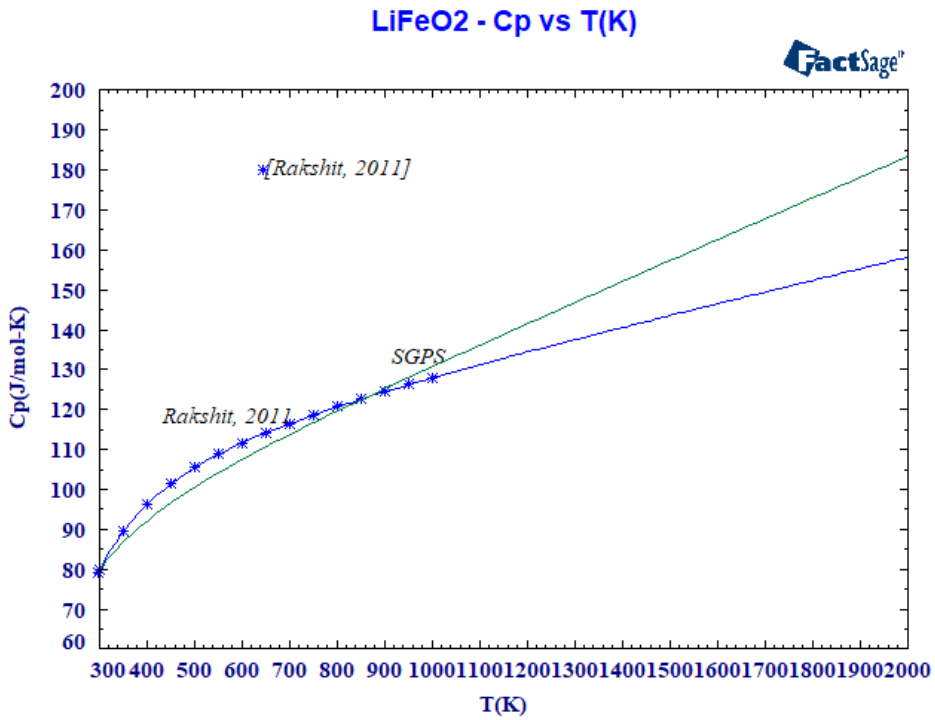
Fe2O3-Li2O-O2,
Mole fraction compared with experimental data

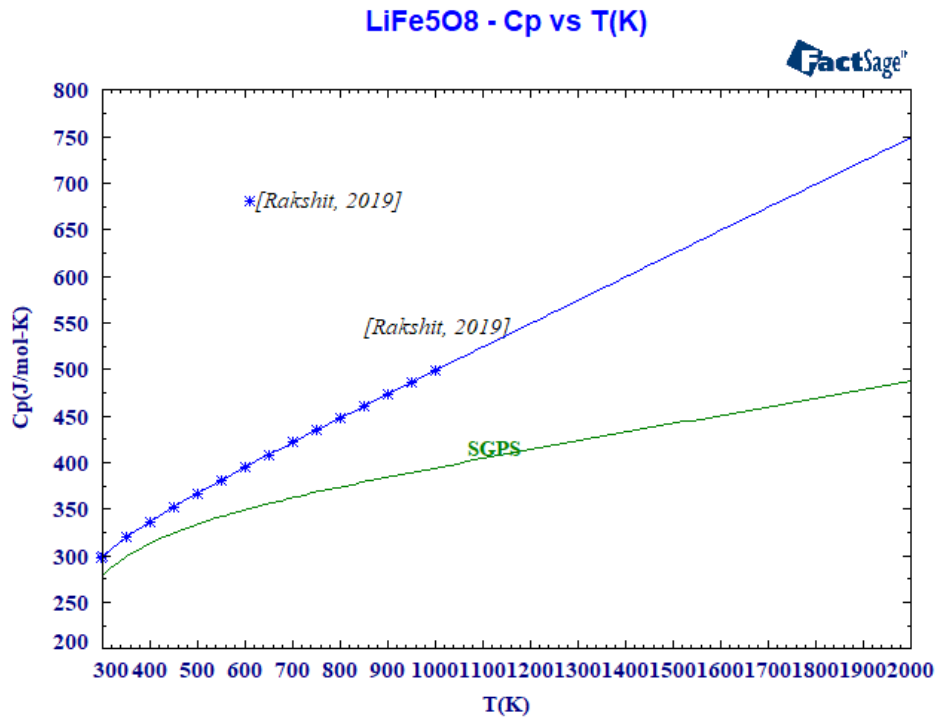


Slag	$(Fe_2O_2, Fe_2O_3, Fe_3O_4, LiFeO_2, Li_2O)$	This work
Li-Spinel	$(Fe^{+2},Fe^{+3},Fe_{0.5}Li_{0.5}^{+2})\ (Fe^{+2},Fe^{+3},Va)_2(Va)_2(O^{-2})_4$	This work
$LiFeO_2$	stoichiometric	Rakshit 2011
$LiFe_5O_8$	stoichiometric	Rakshit 2011

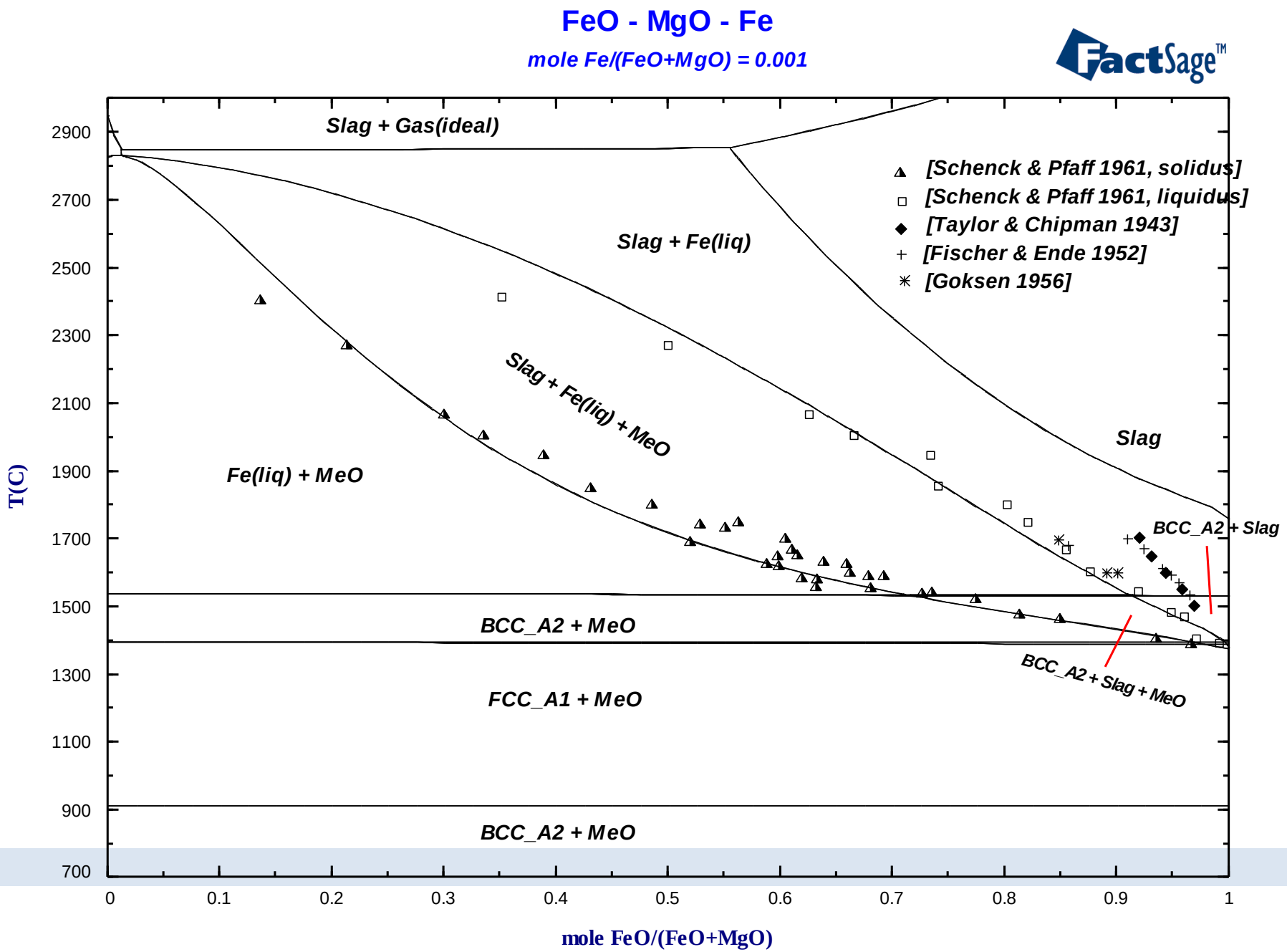
Fe2O3-Li2O-O2,
Weight percent




LiFeO2 - Cp vs T(K)
FactSage
[Rakshit, 2011]
SGPS
Rakshit, 2011
Cp(J/mol-K)
T(K)


LiFe5O8 - Cp vs T(K)
FactSage
[Rakshit, 2019]
[Rakshit, 2019]
SGPS
Cp(J/mol-K)
T(K)

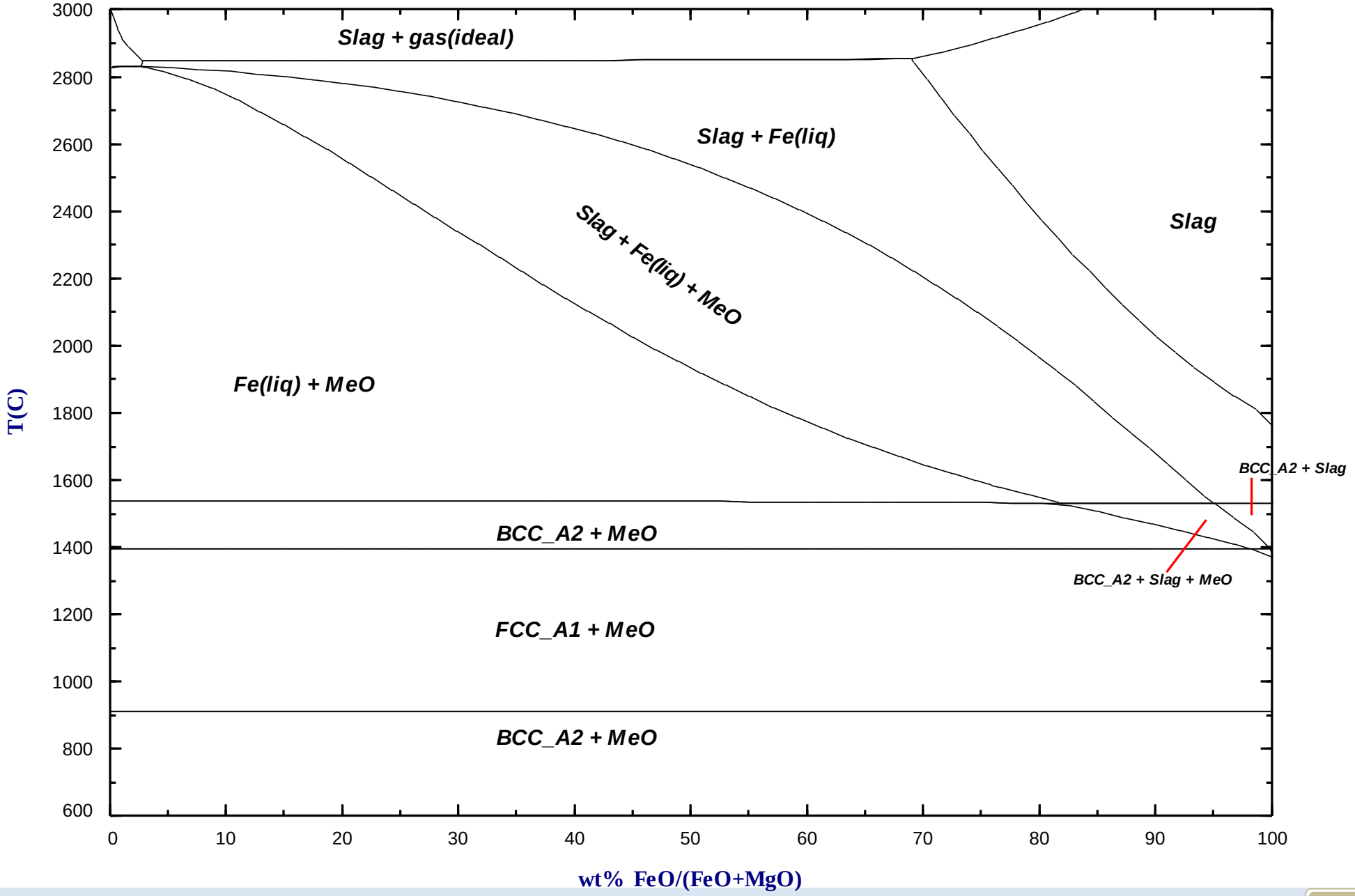
Mole fraction
compared with experimental data



FeO - MgO - Fe

Weight percent

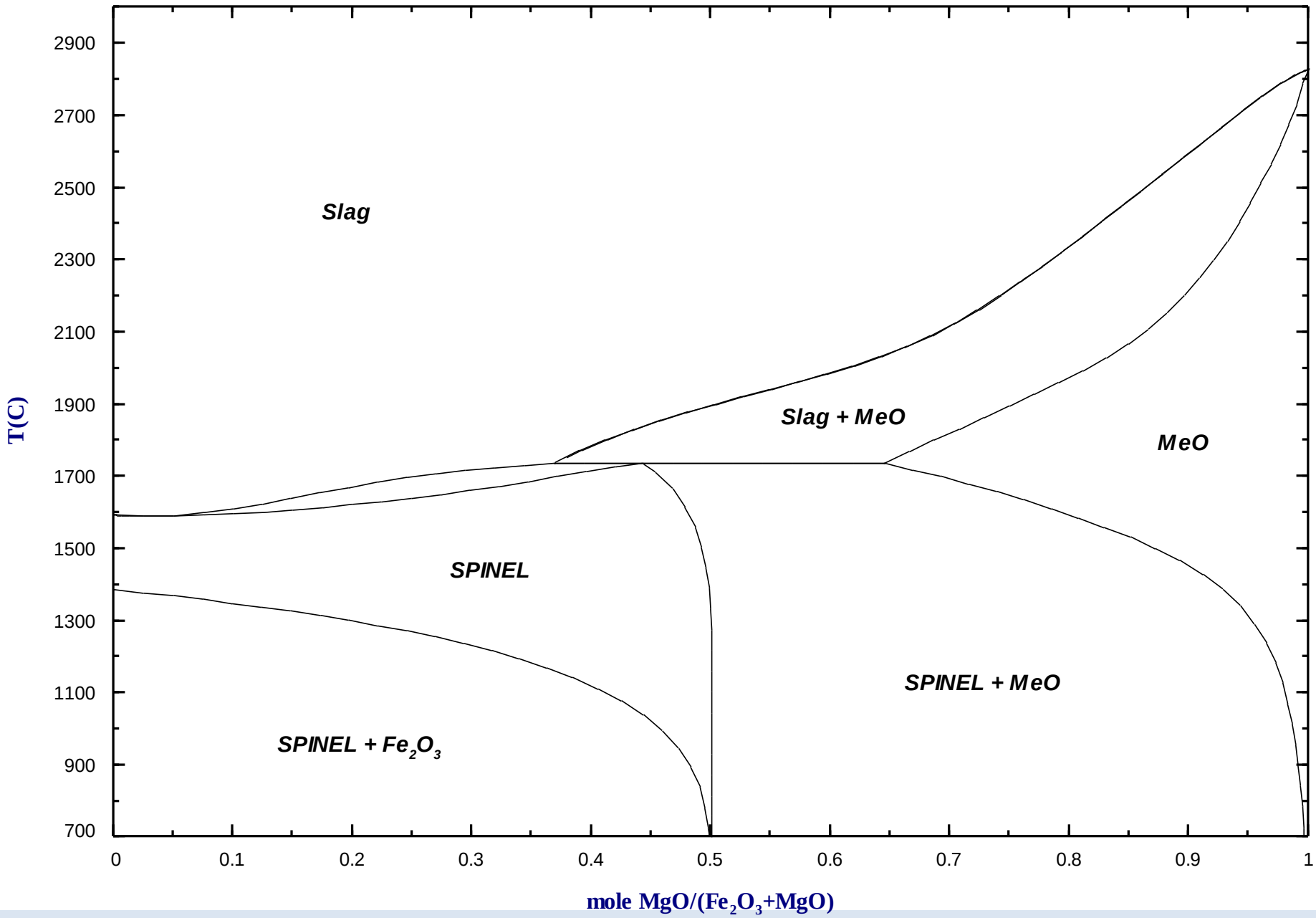
wt% Fe/(FeO+MgO) = 0.001



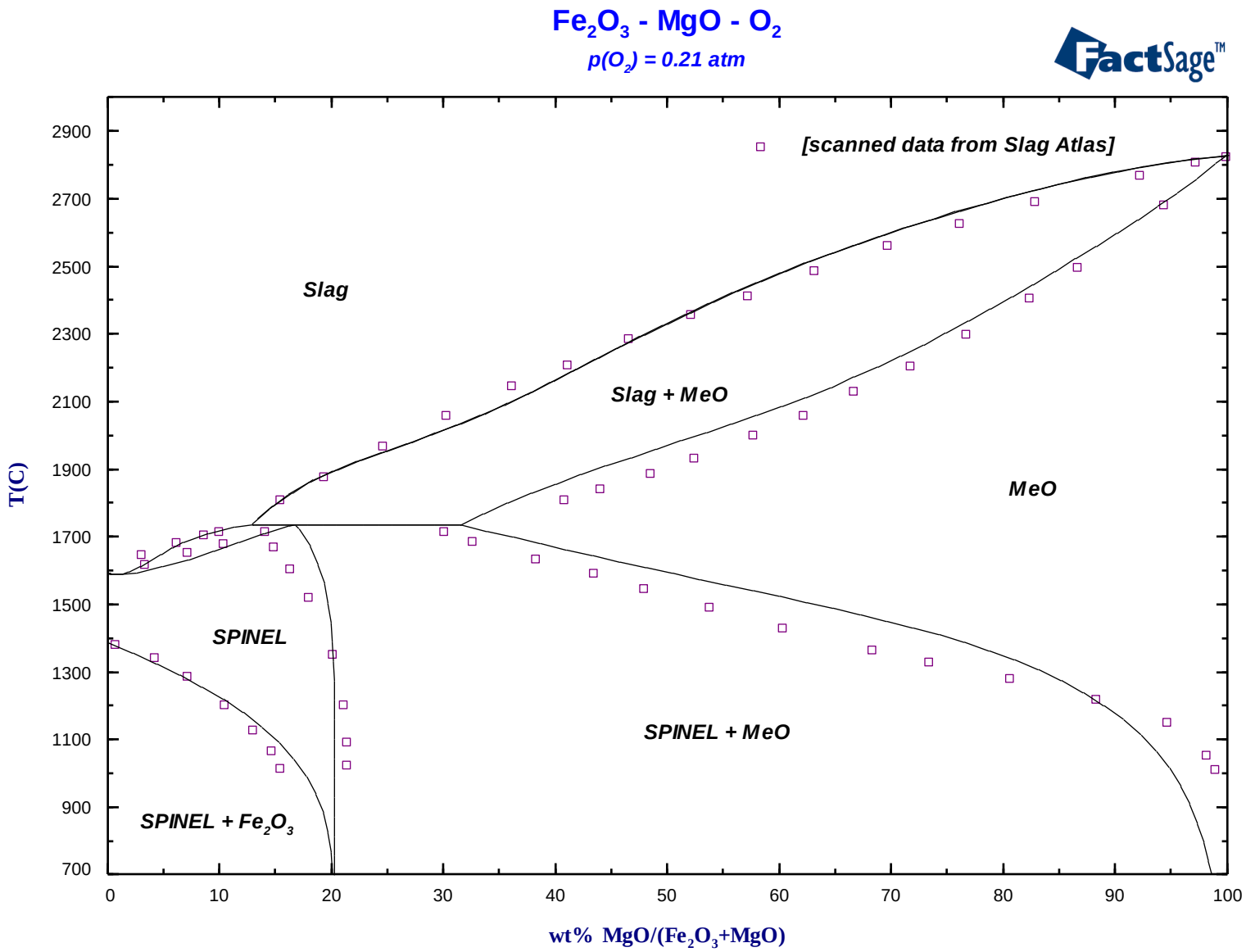
Fe_2O_3 - MgO - O_2

$p(O_2)$ = 0.21 atm

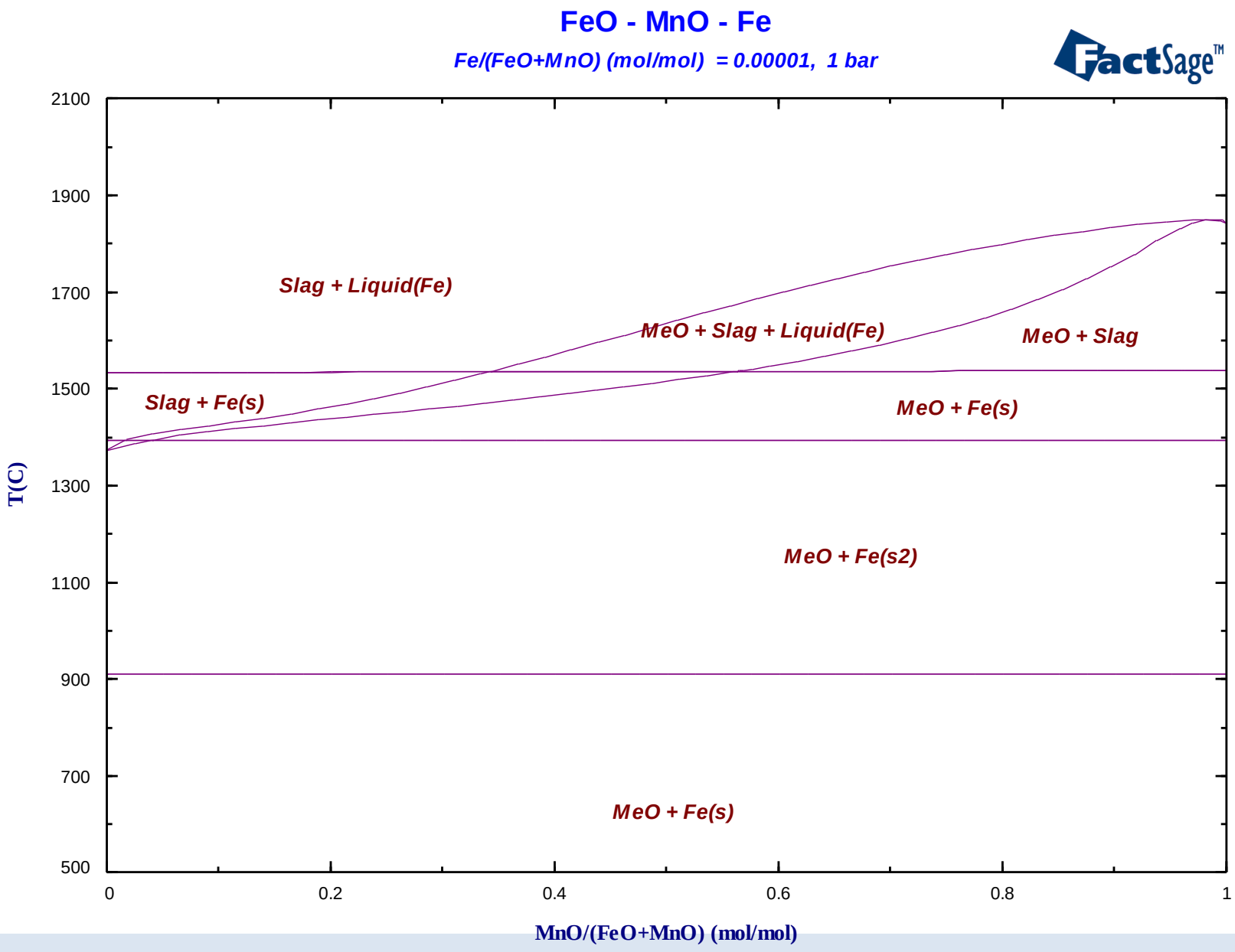
Mole fraction



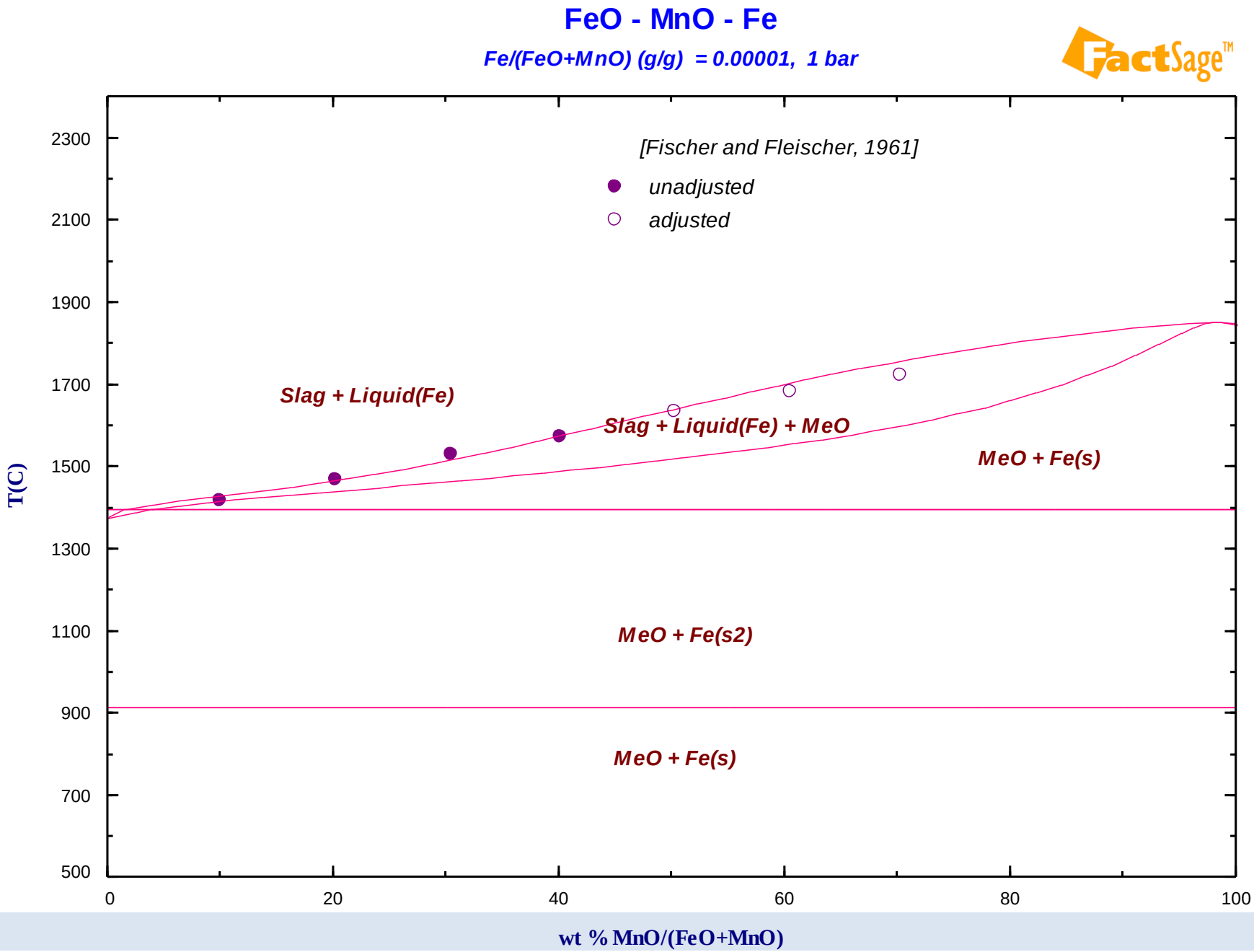
Weight percent
compared with experimental data



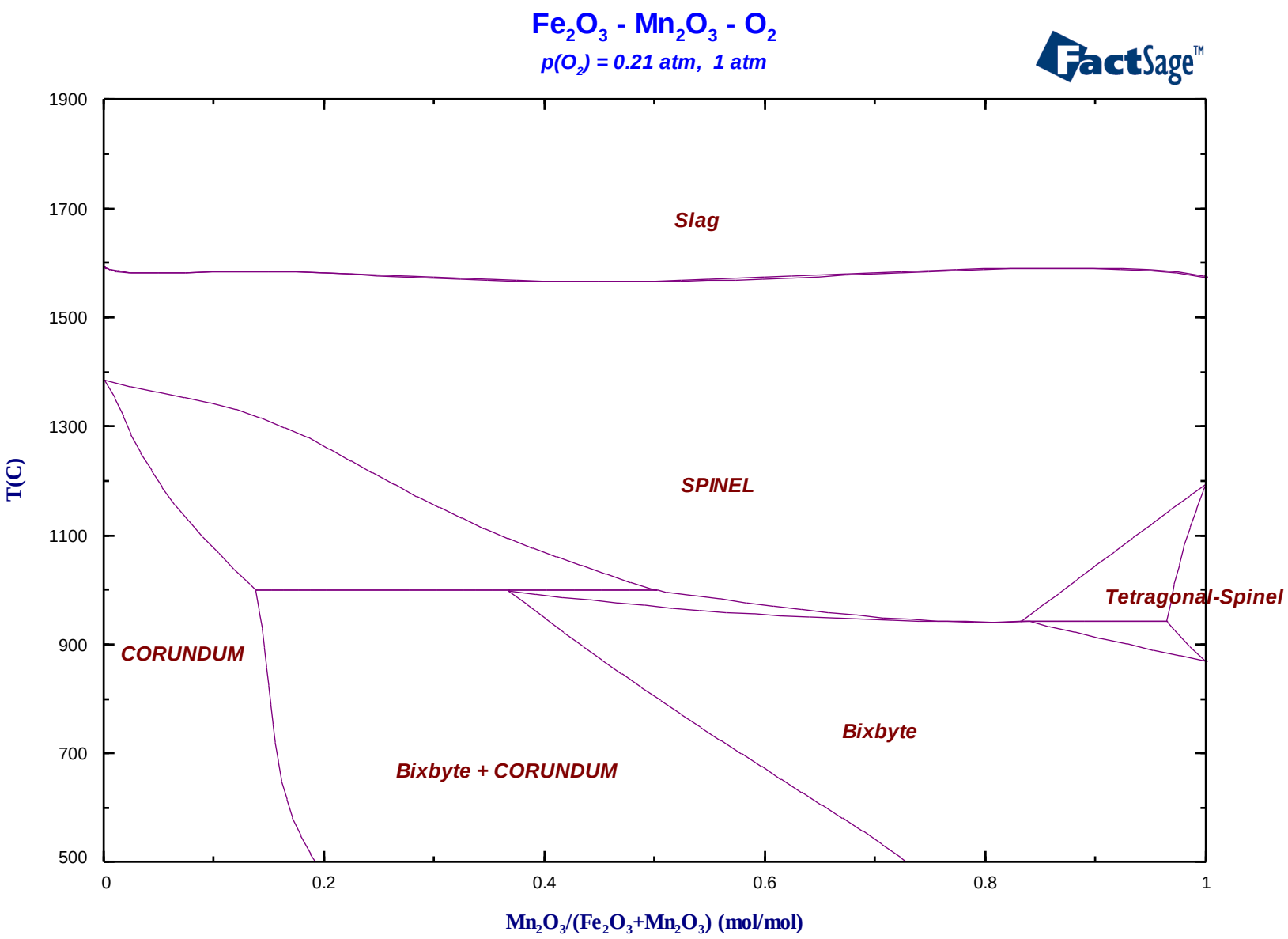
Mole fraction



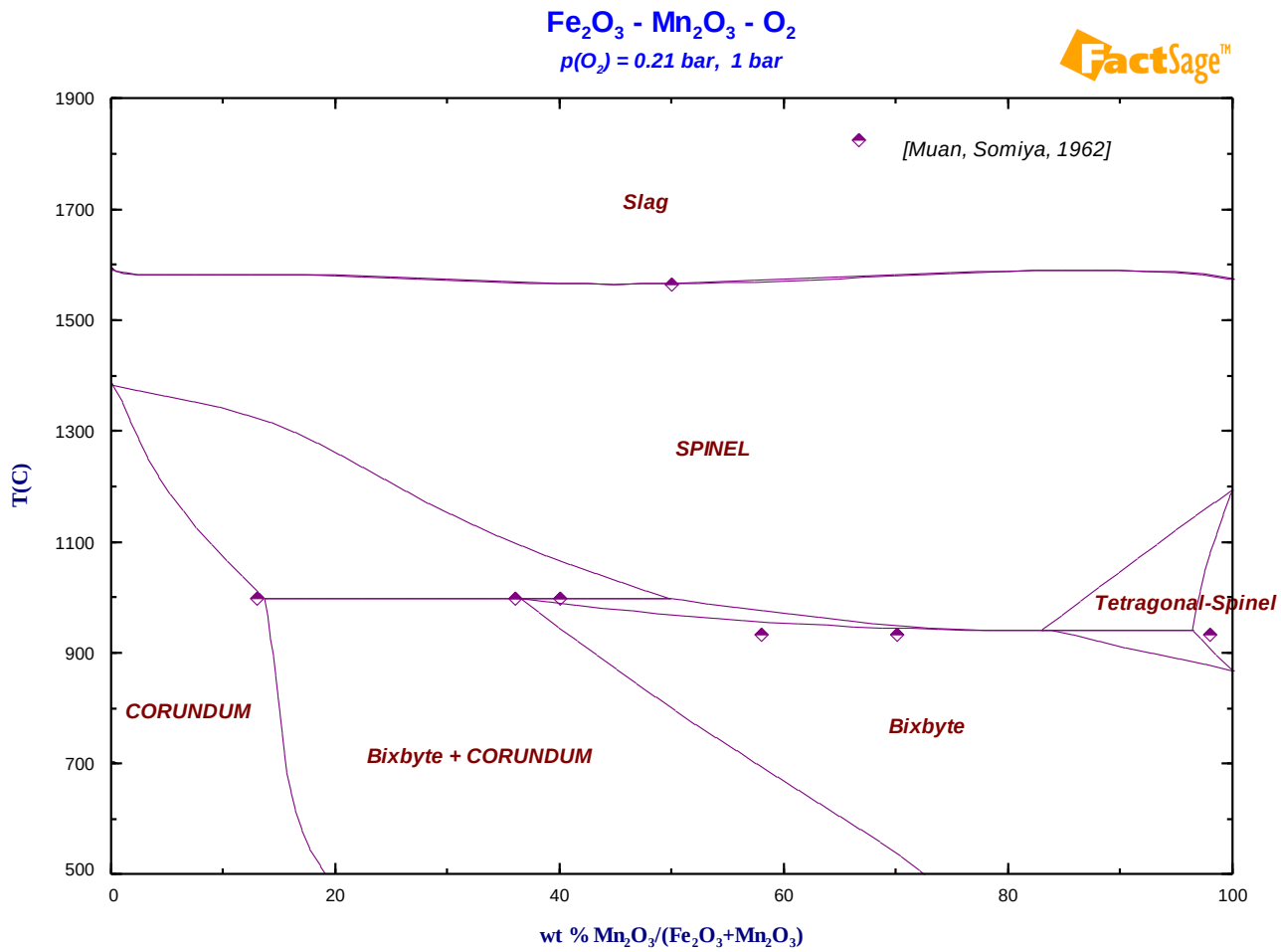
Weight percent
compared with experimental data



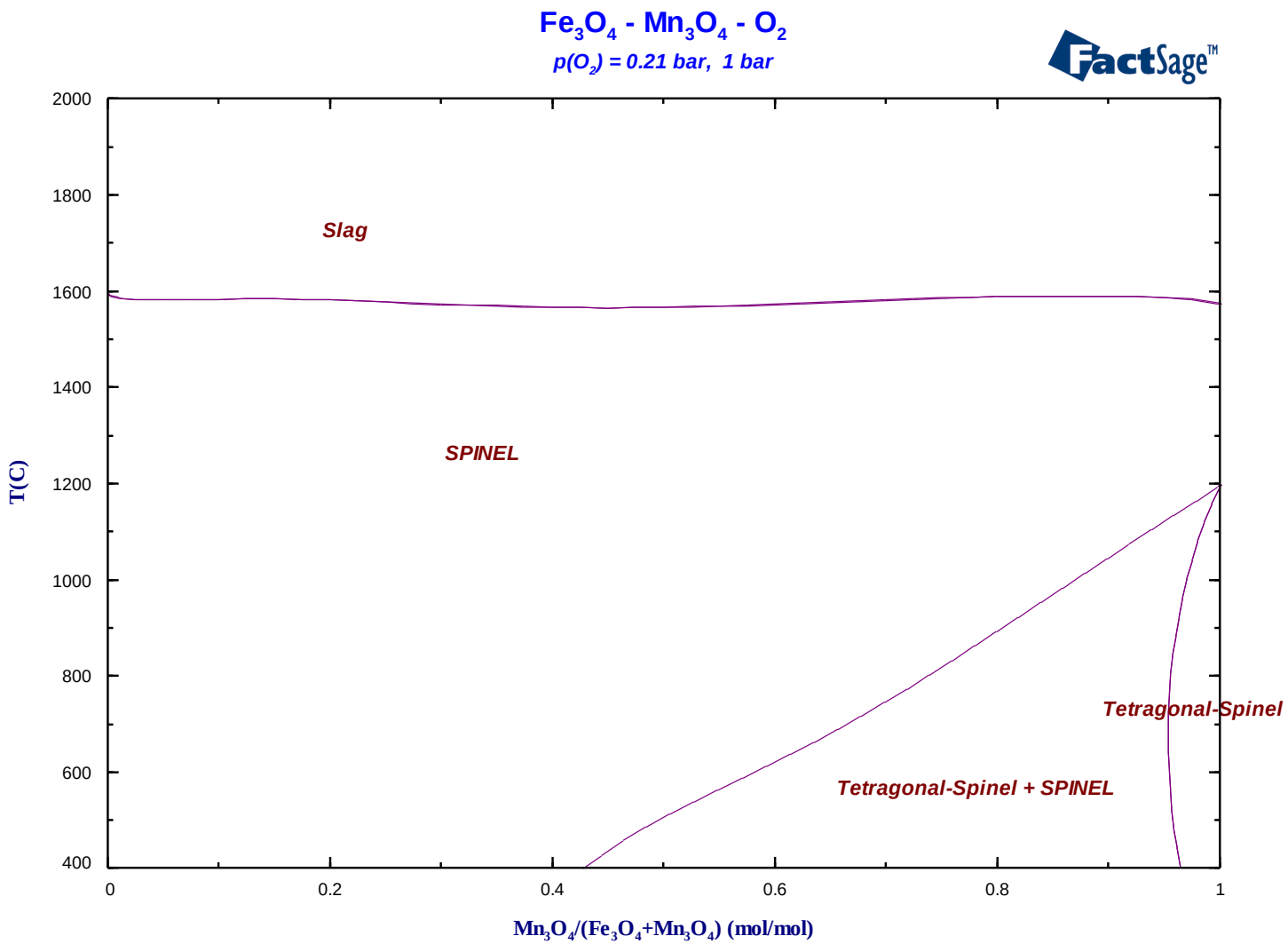
Mole fraction



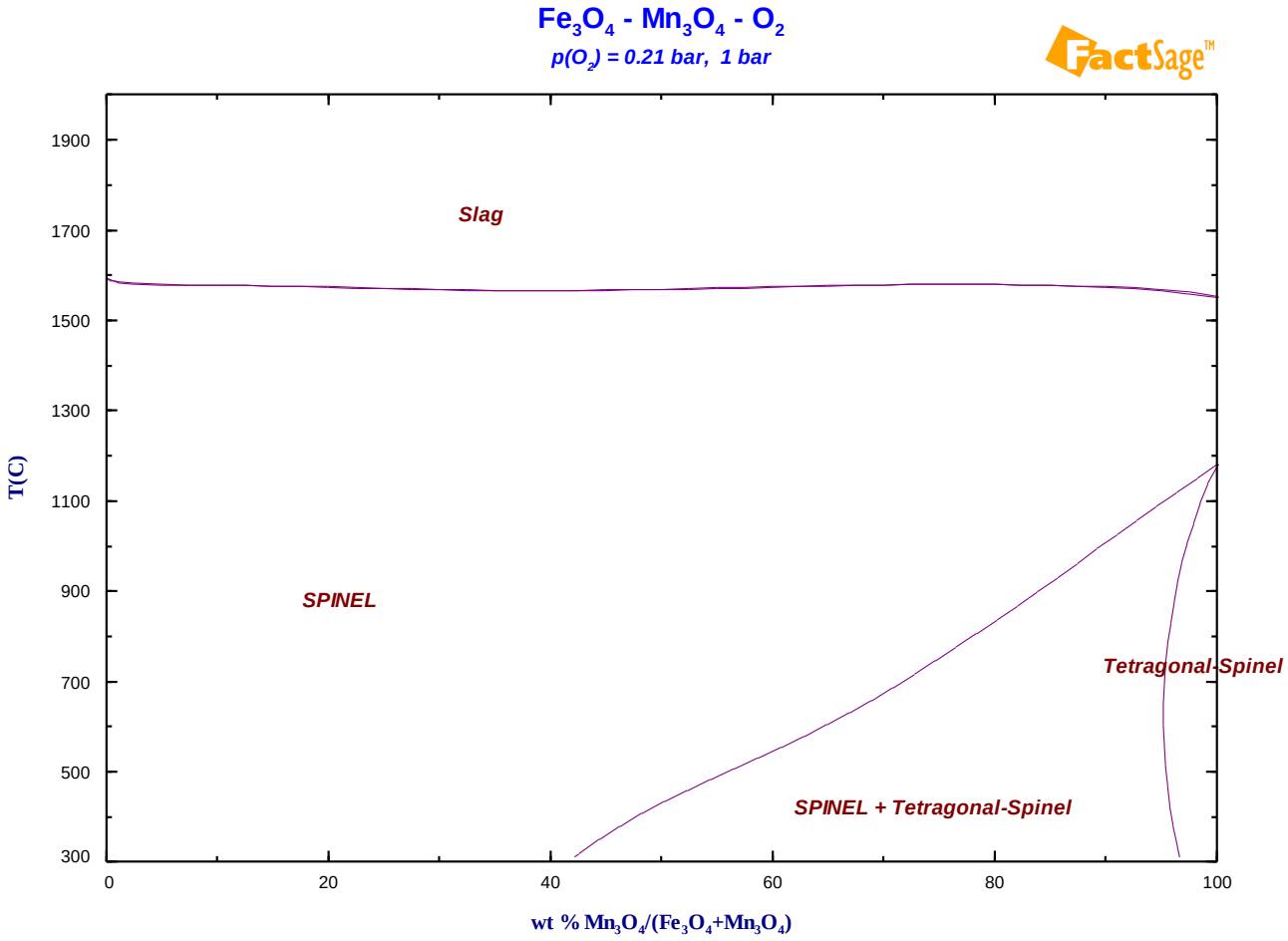
Weight percent
compared with experimental data



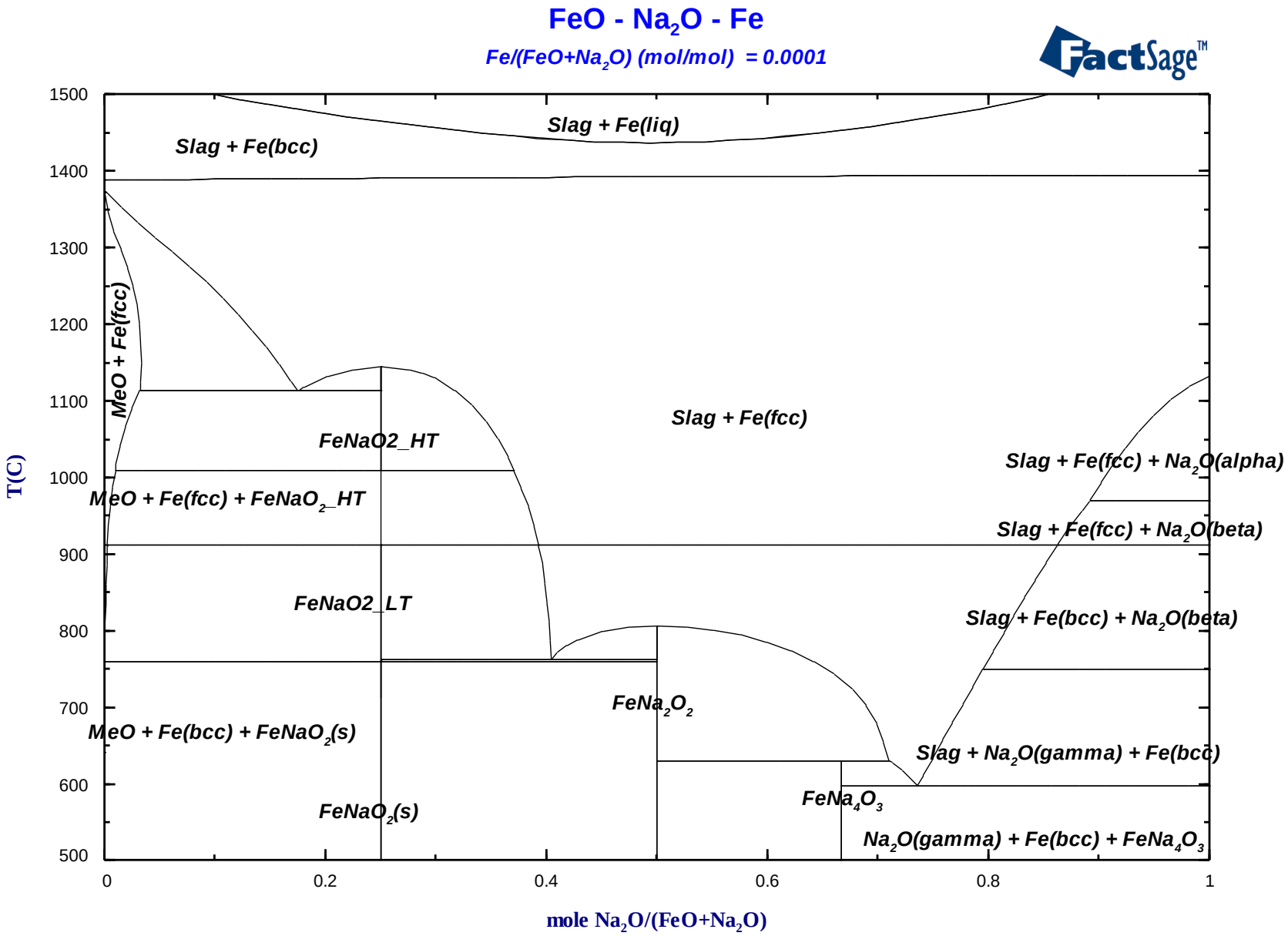
Mole fraction



Weight percent

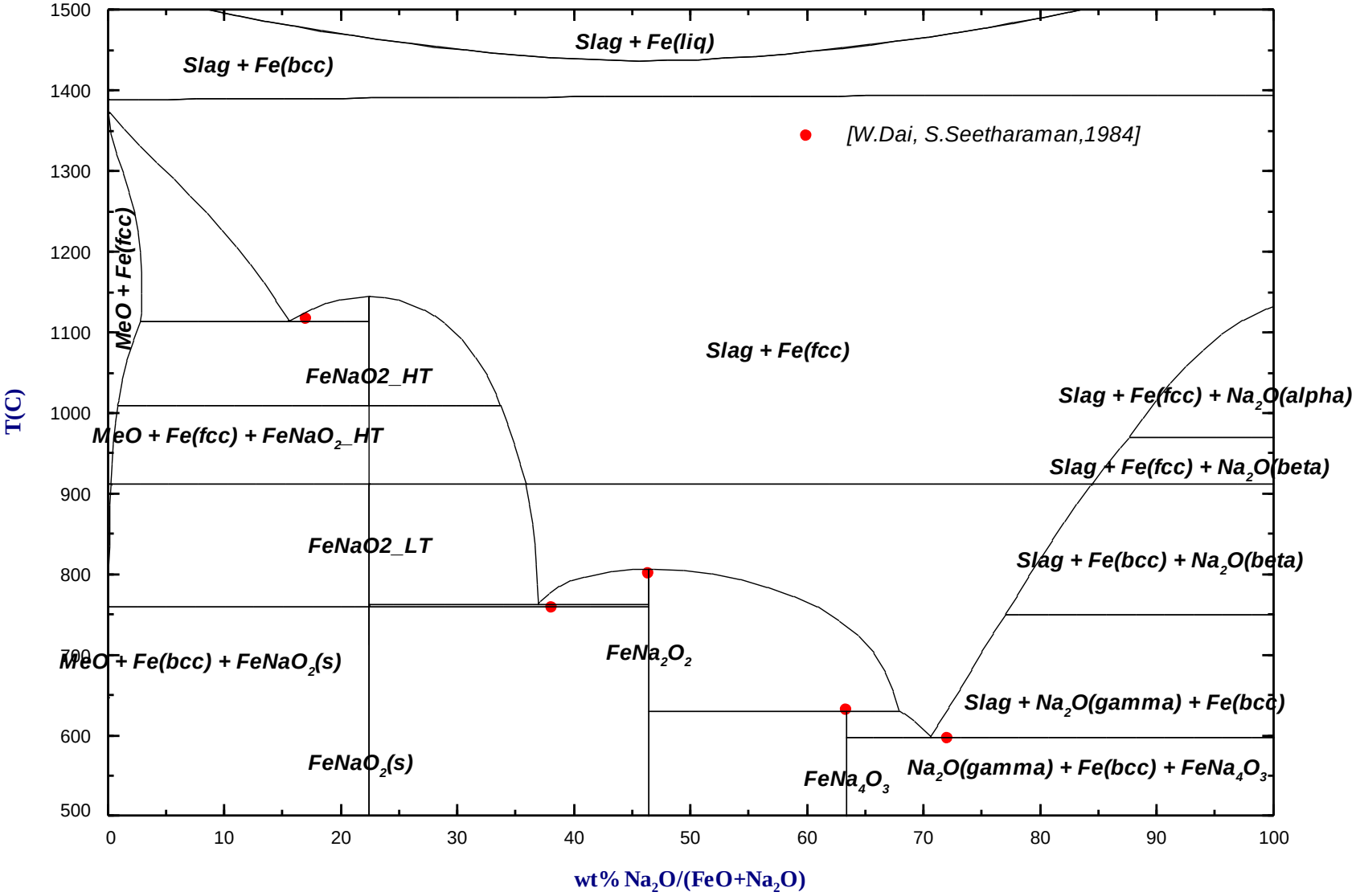


Mole fraction

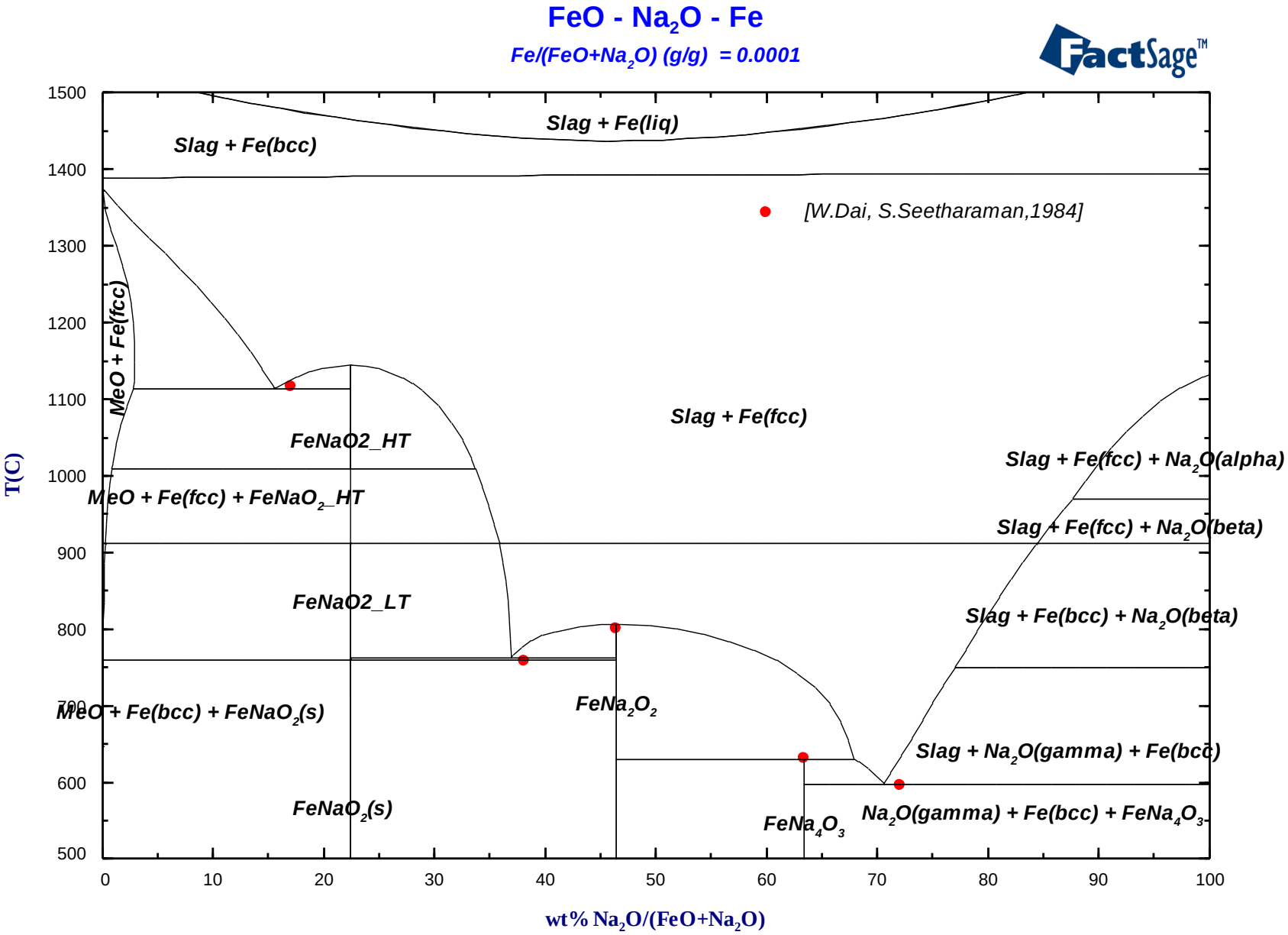


FeO - Na_2O - Fe

Fe/(FeO+Na_2O) (g/g) = 0.0001

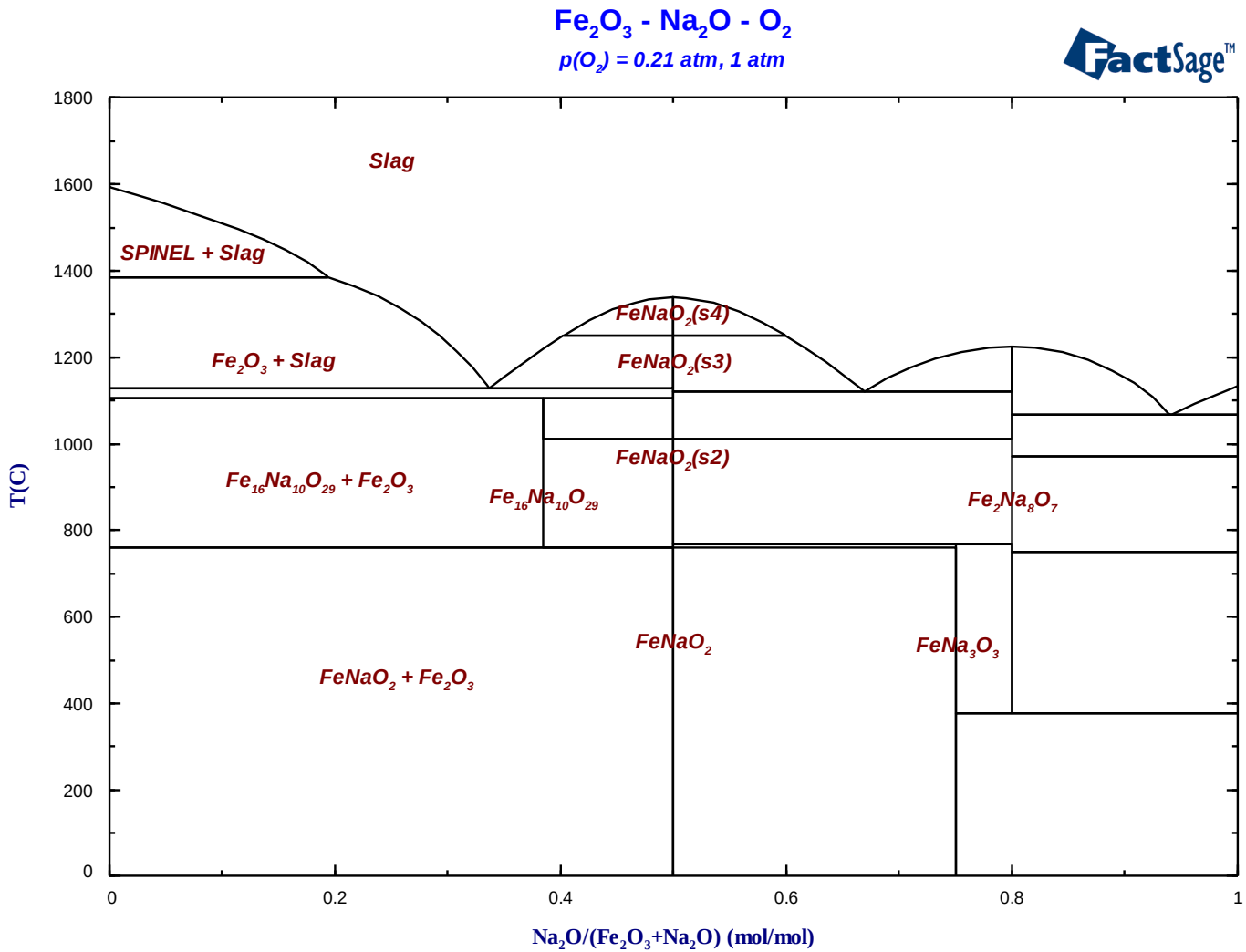


Weight percent
compared with experimental data

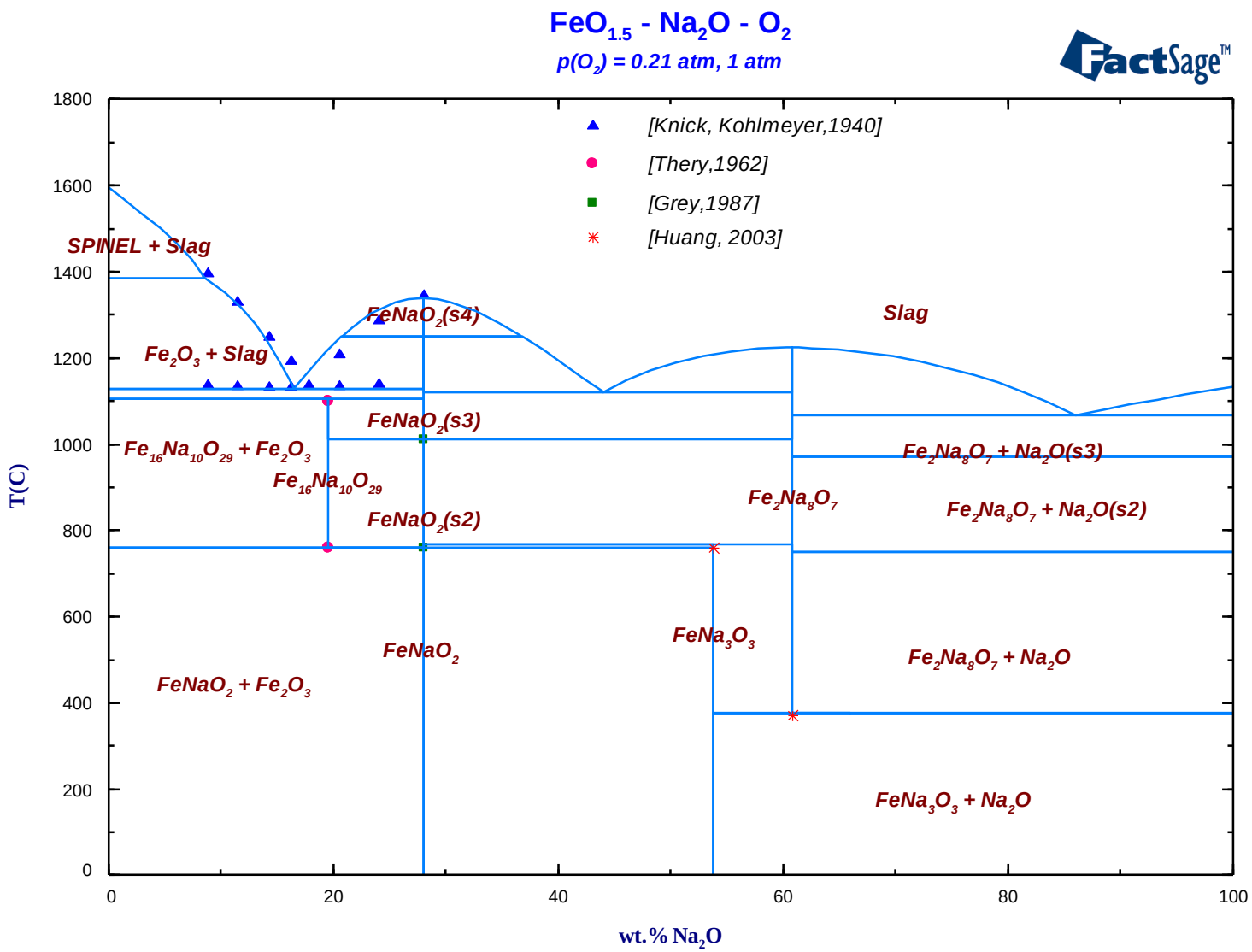


Fe2O3-Na2O-O2,

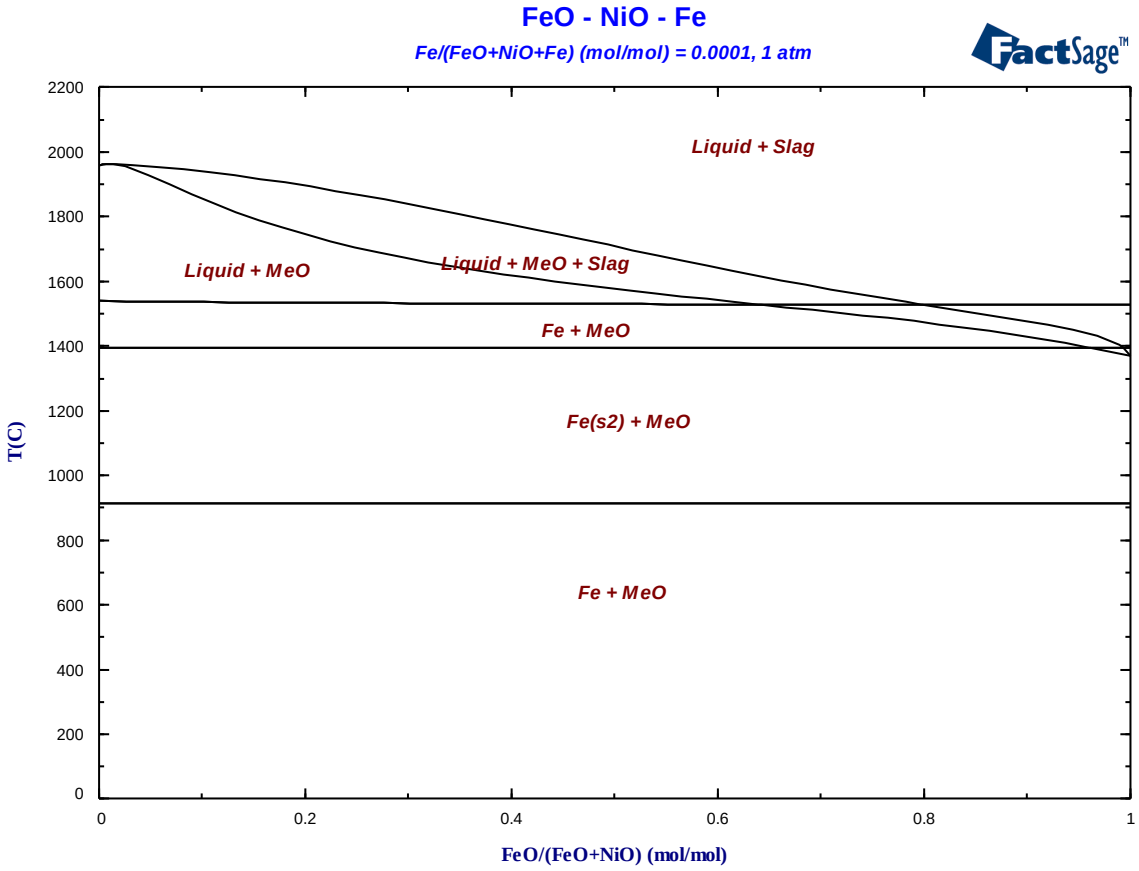
Mole fraction



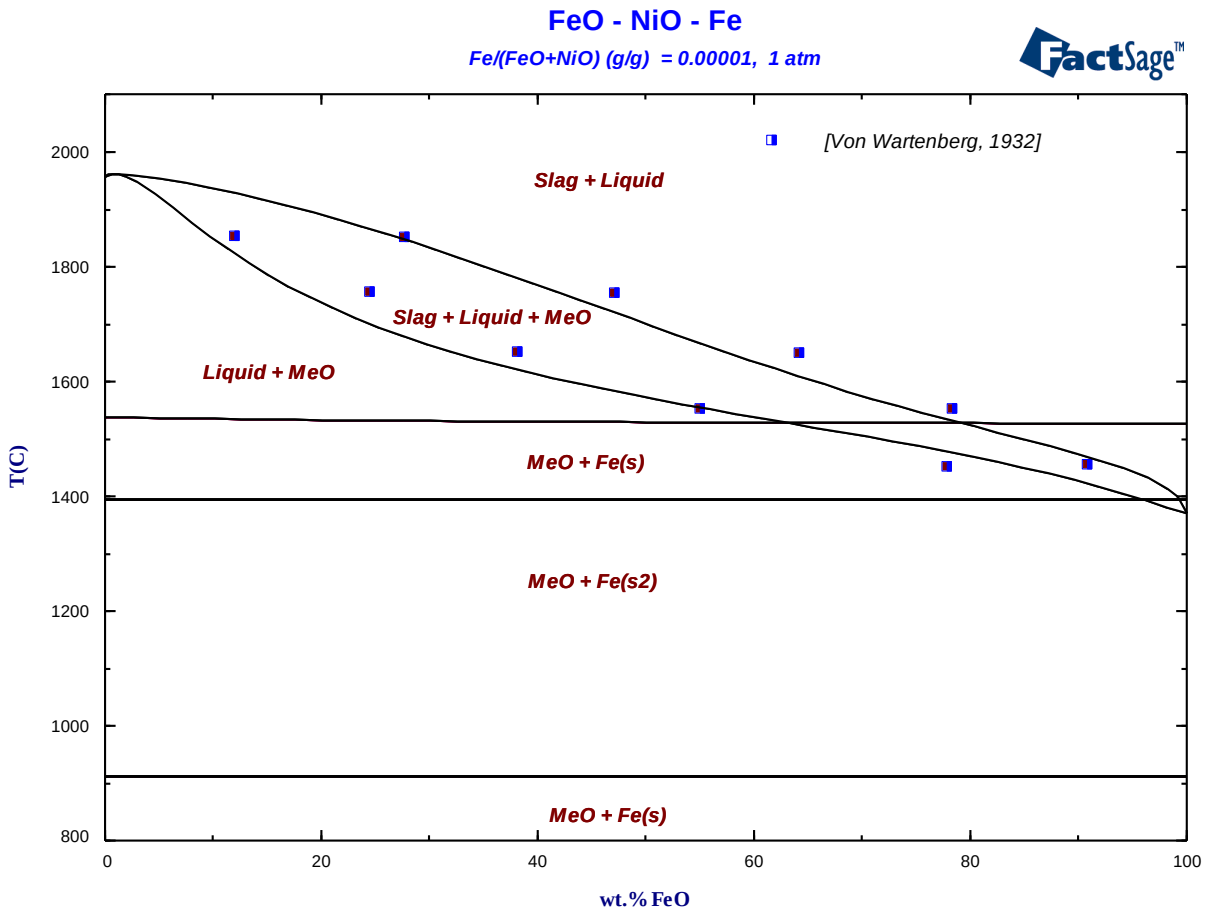
Fe2O3-Na2O-O2,
Weight percent
compared with experimental data



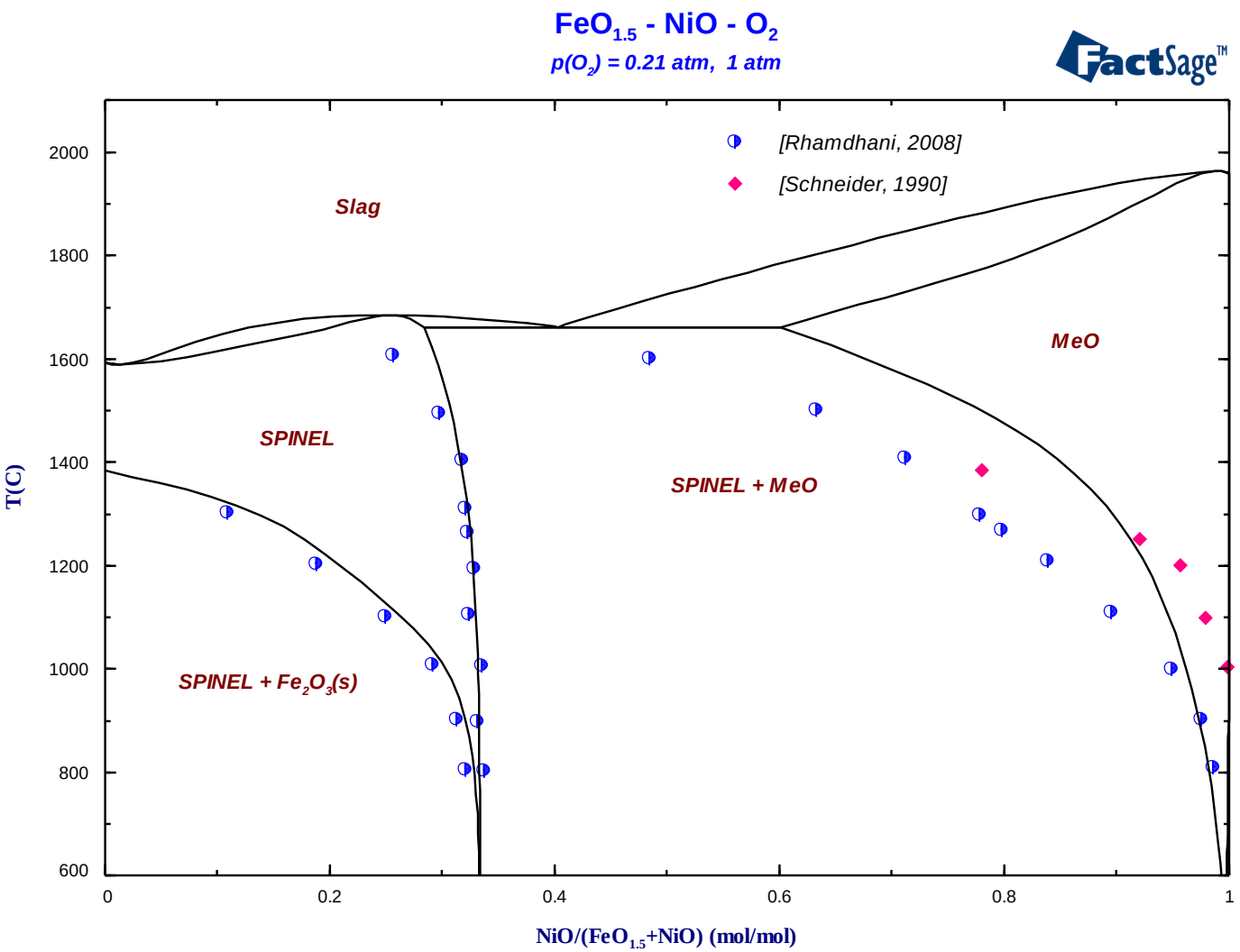
Mole fraction



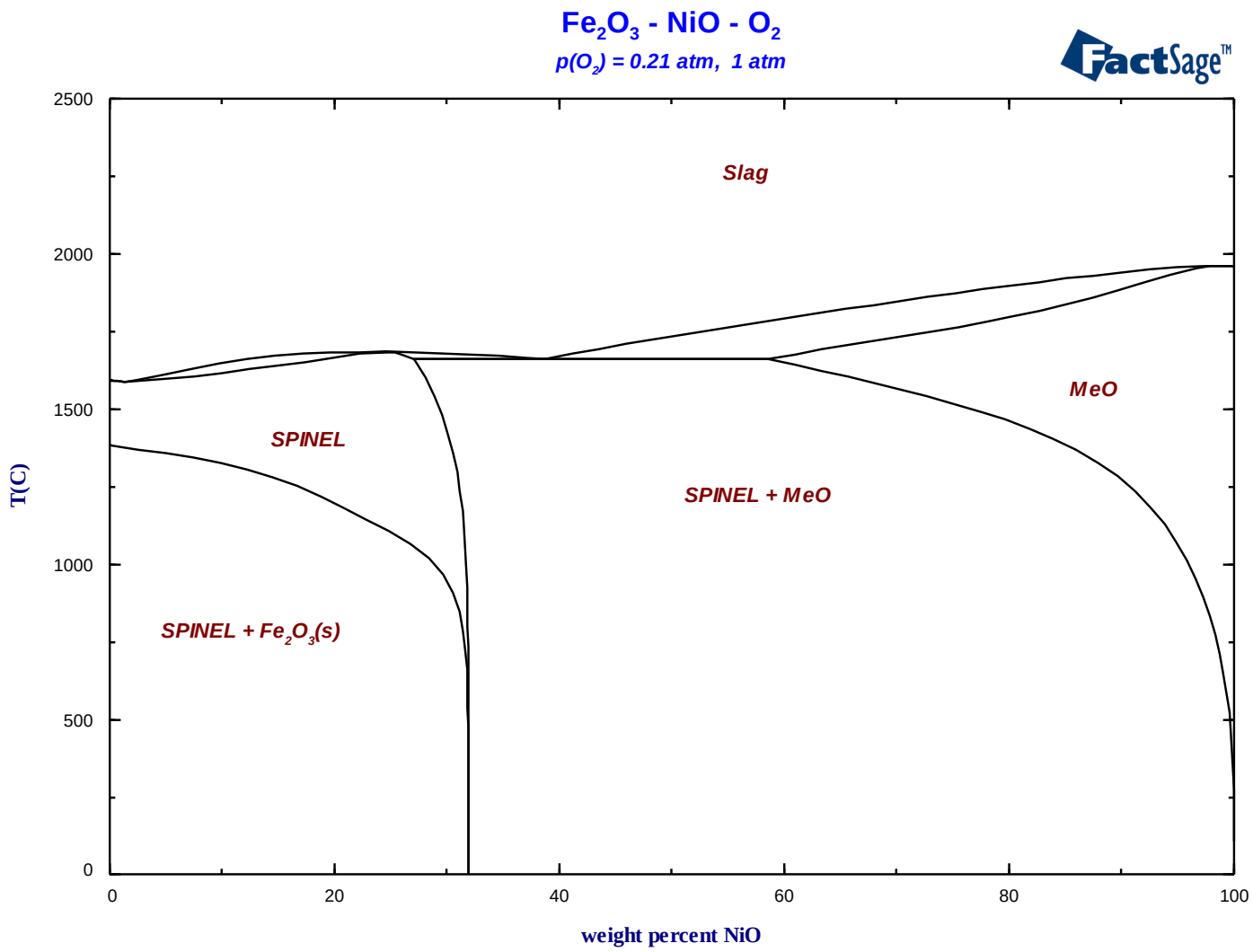
Weight percent compared with experimental data



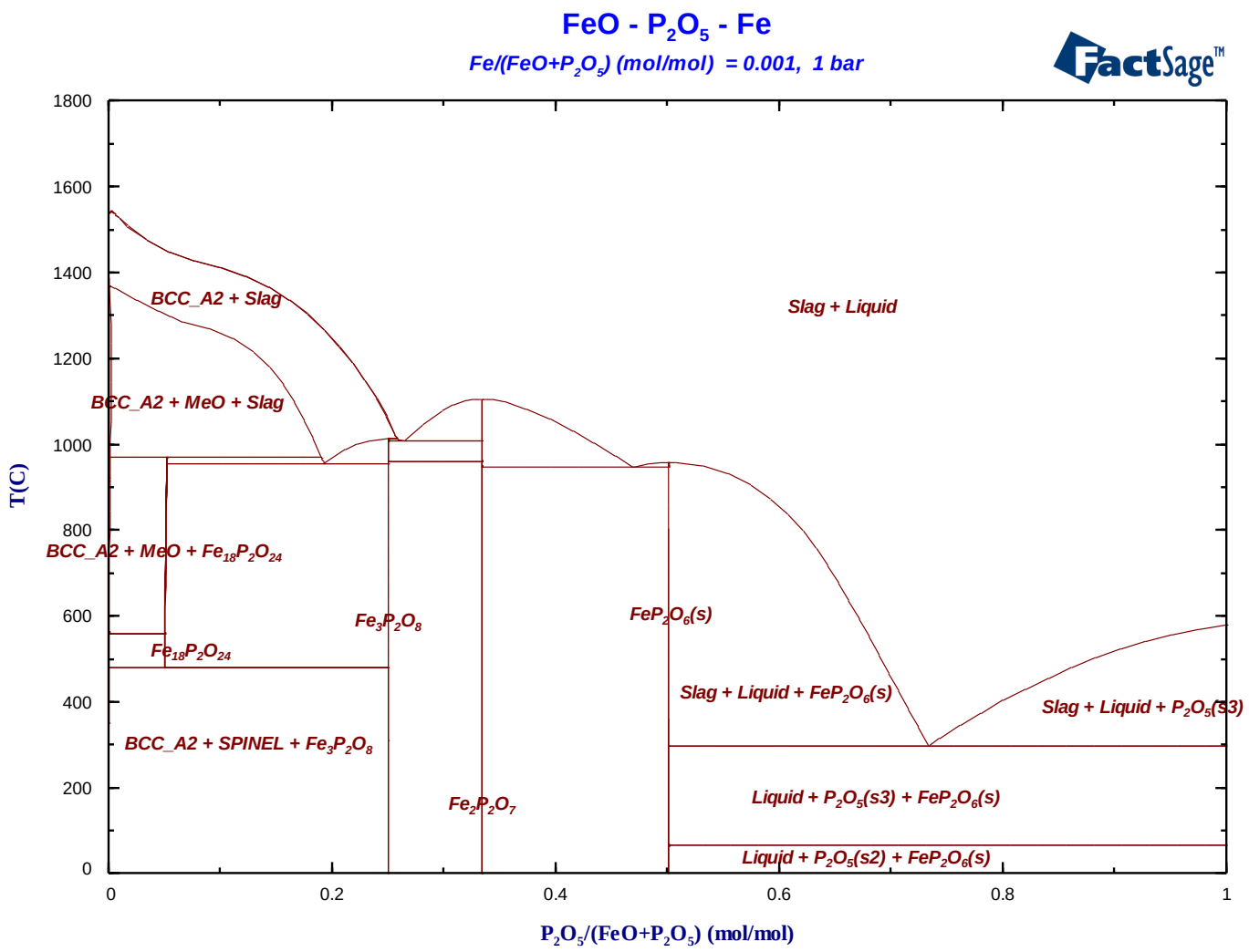
Mole fraction compared with experimental data



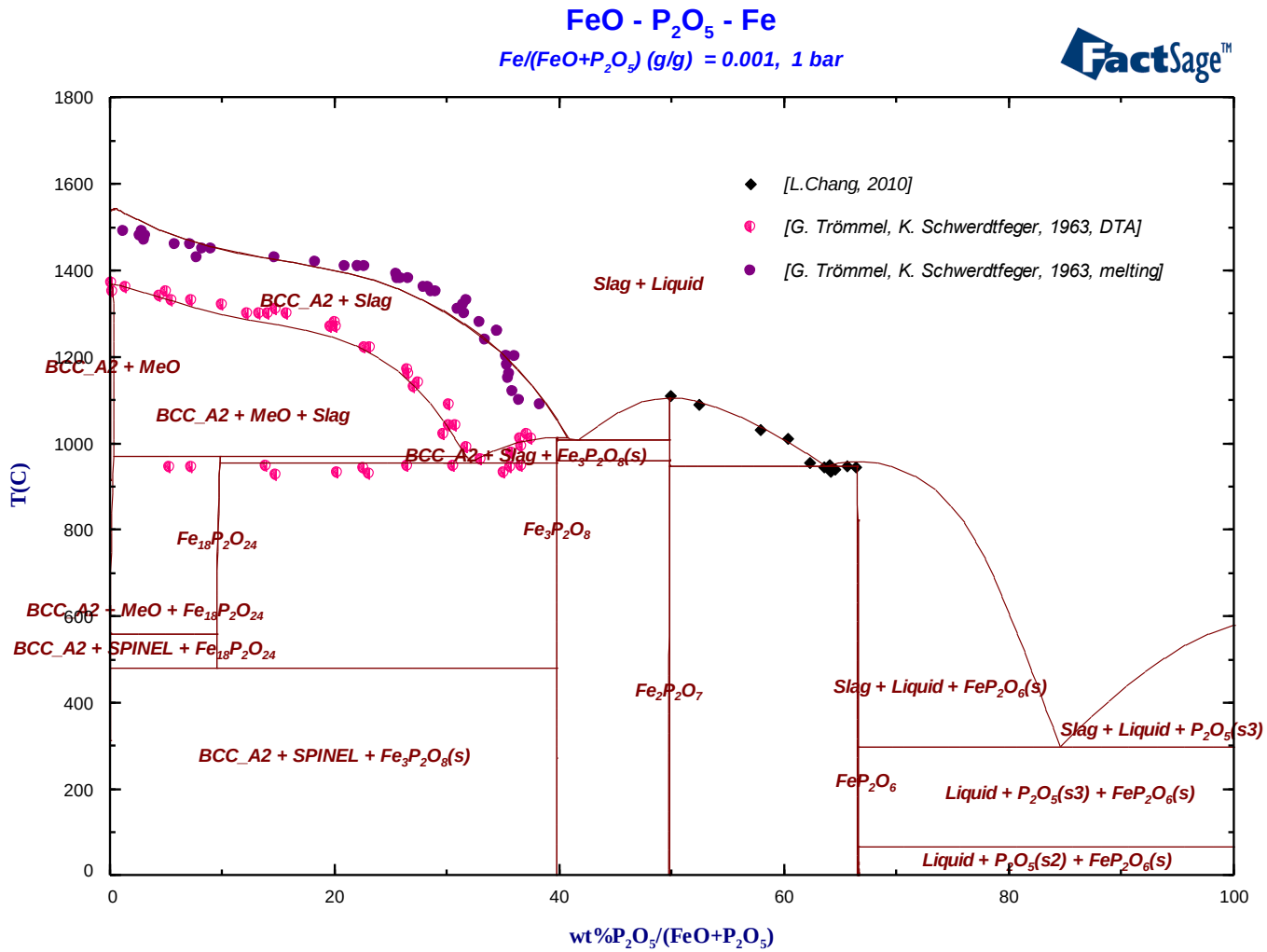
Weight percent



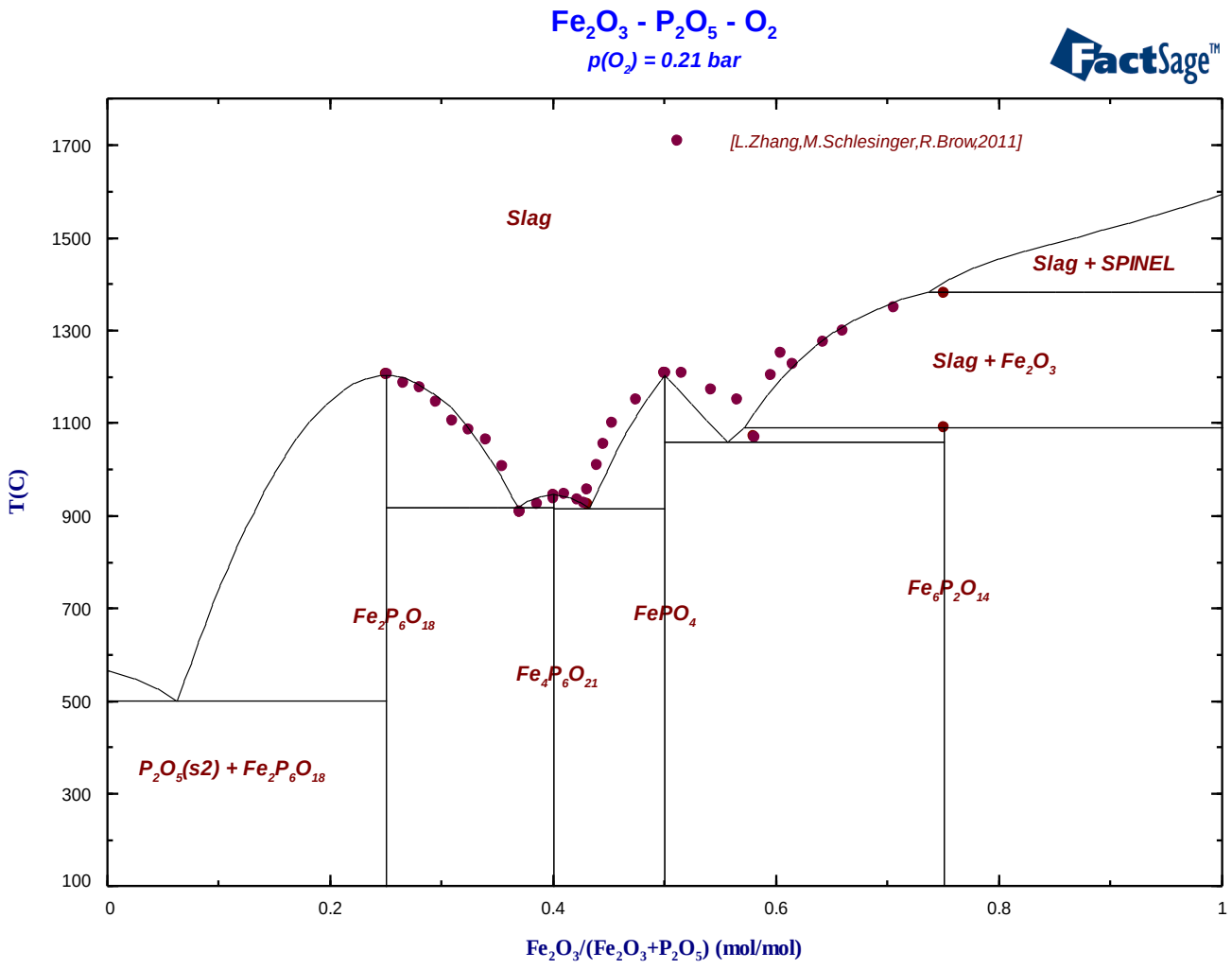
Mole fraction



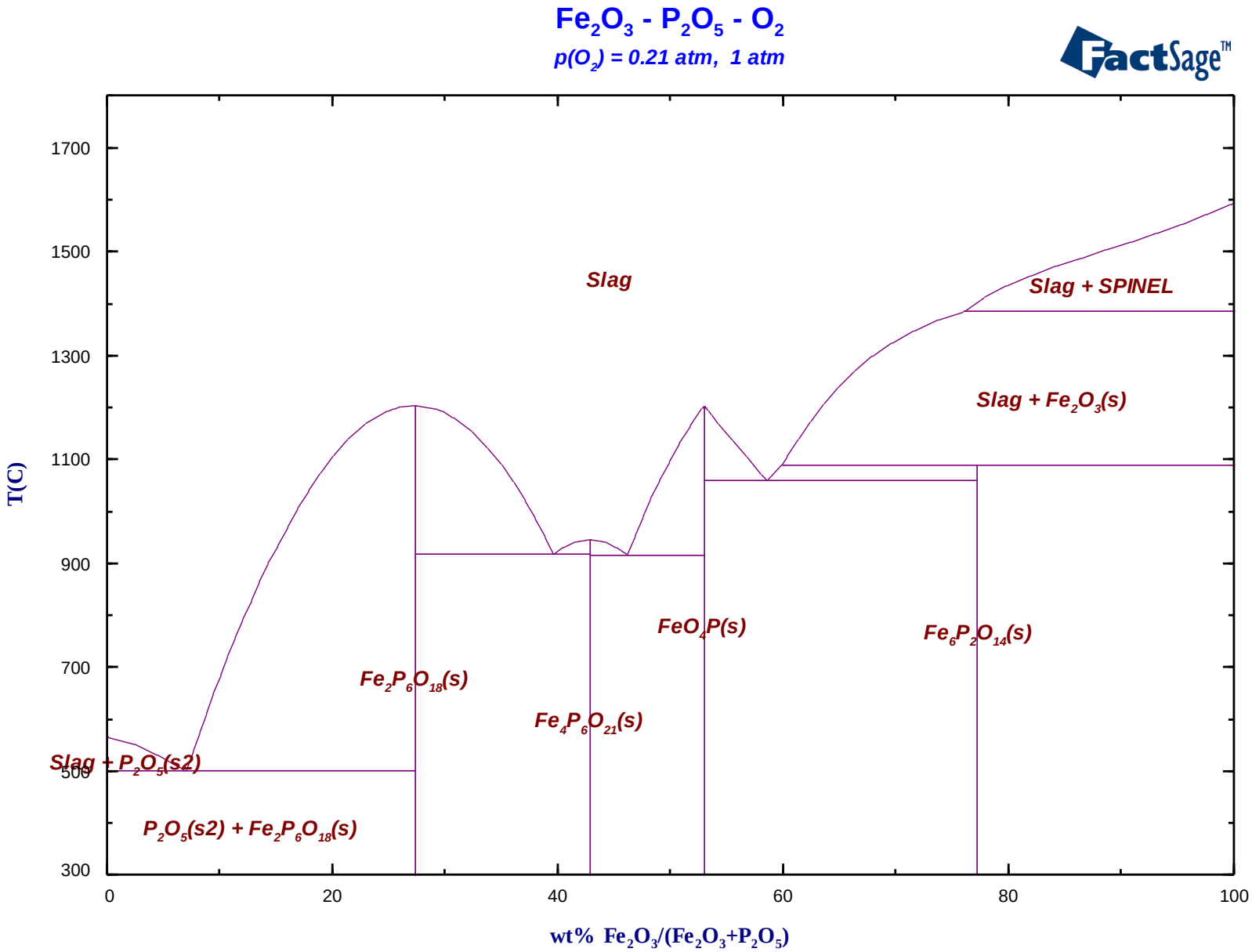
Weight percent
compared with experimental data



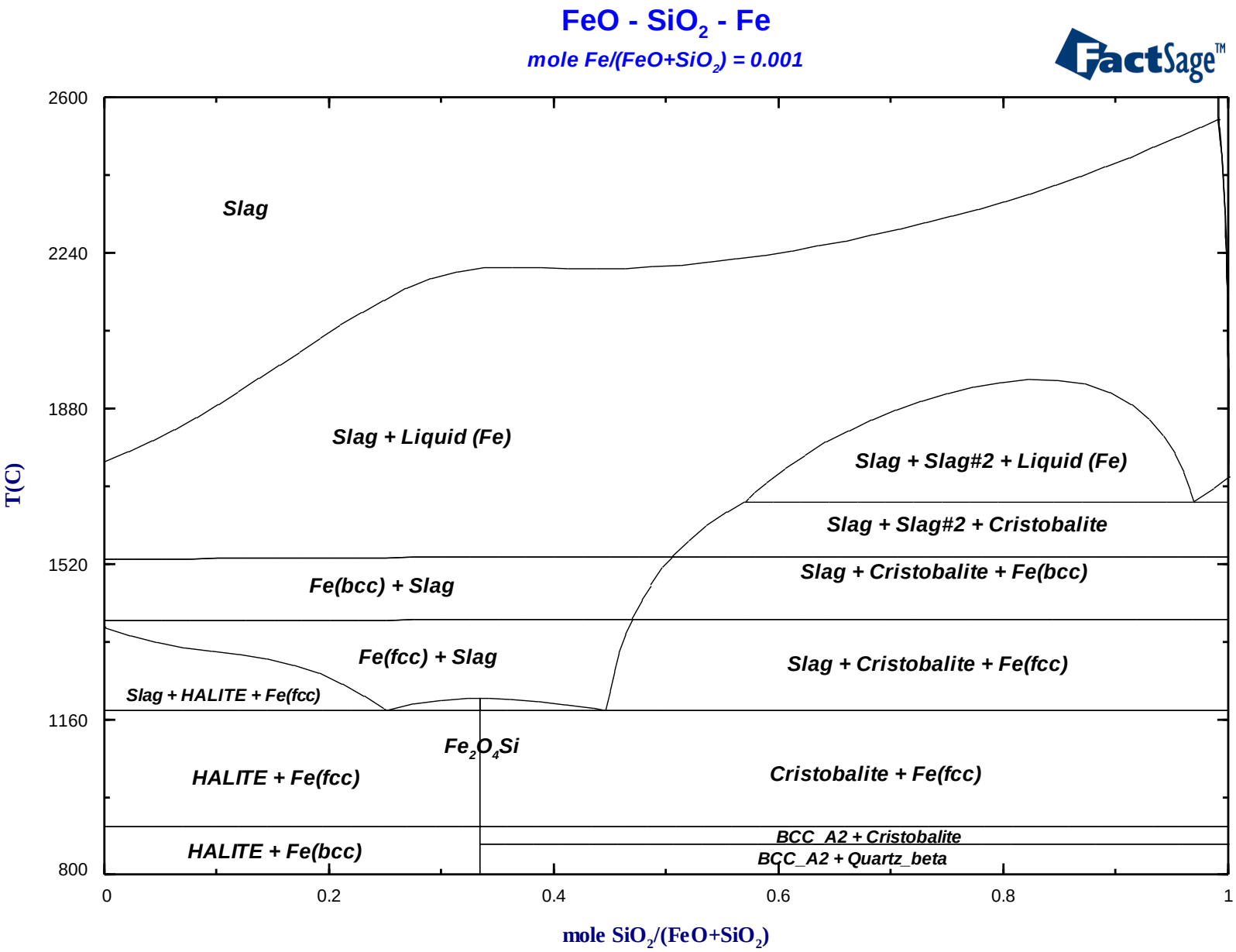
Mole fraction



Weight percent



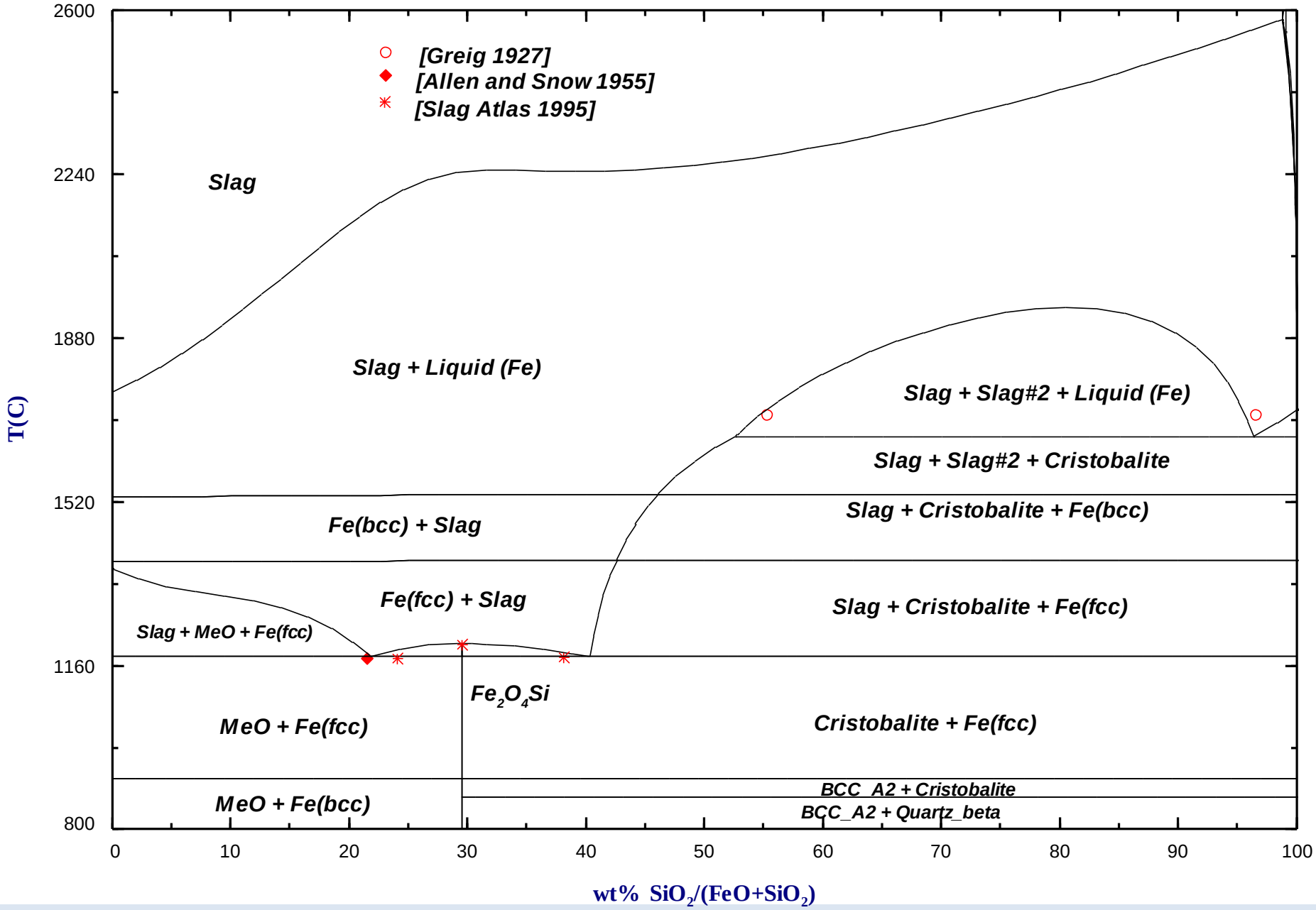
Mole fraction



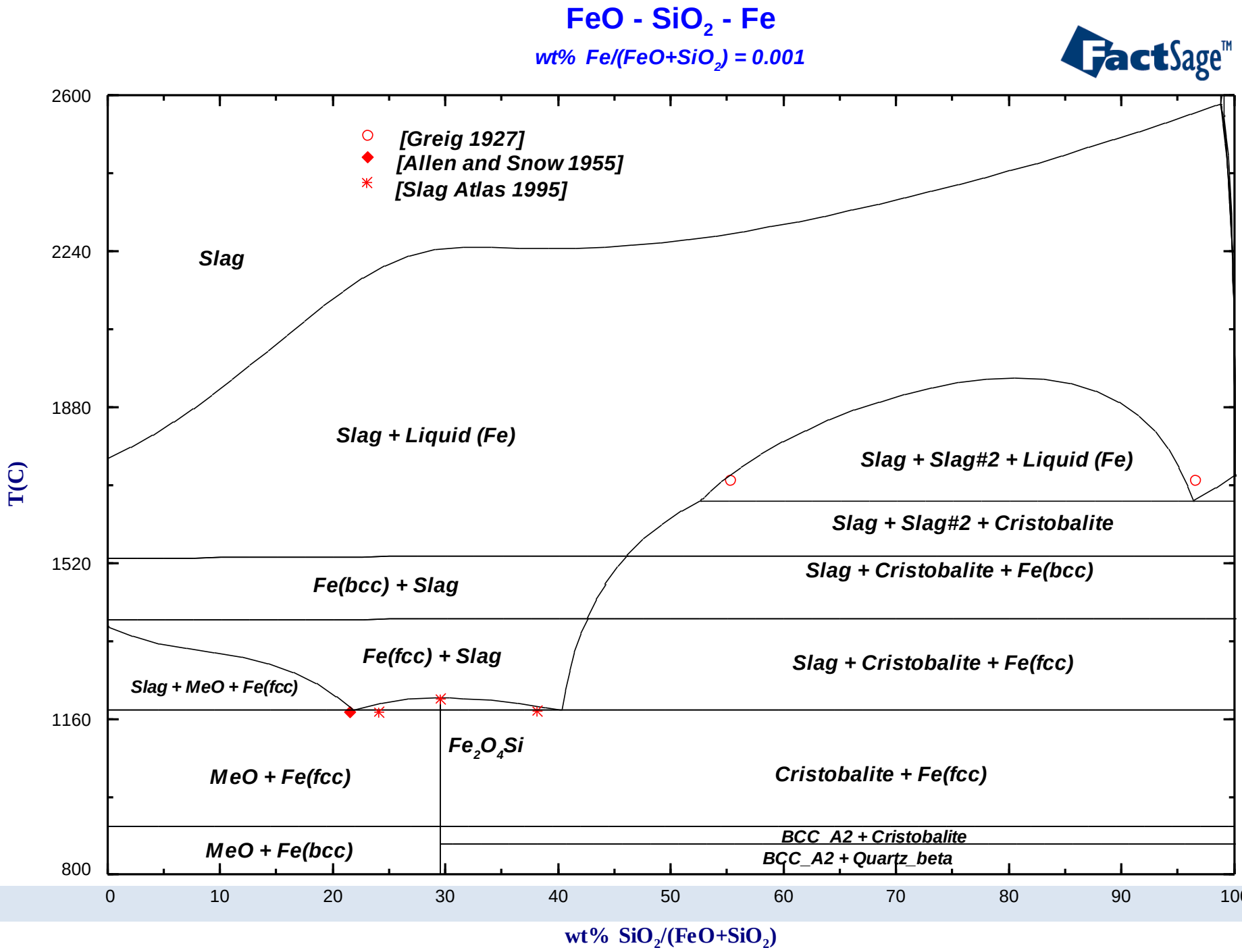
Weight percent
compared with experimental data

FeO - SiO_2 - Fe

wt% Fe/(FeO+SiO_2) = 0.001



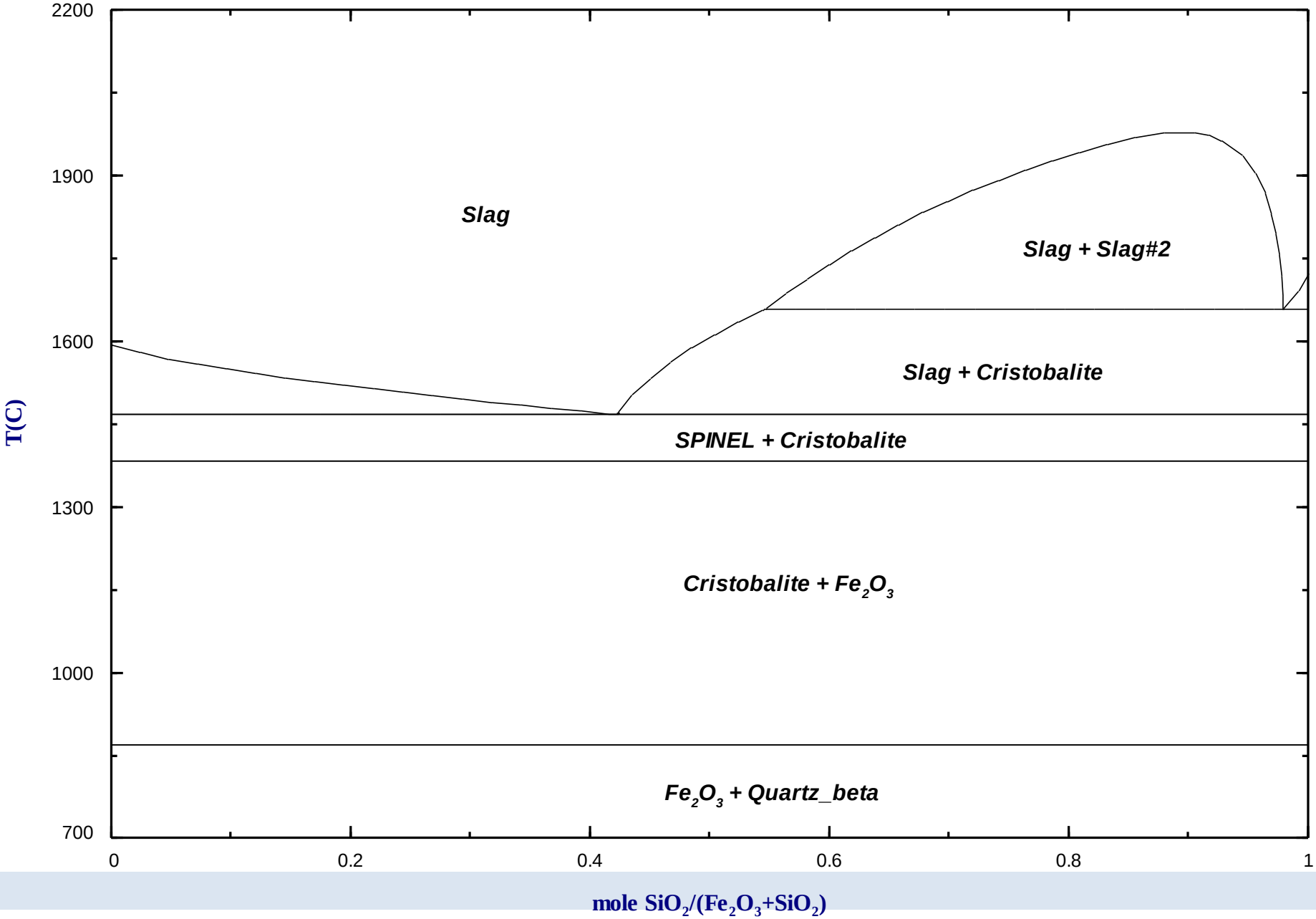
Weight percent



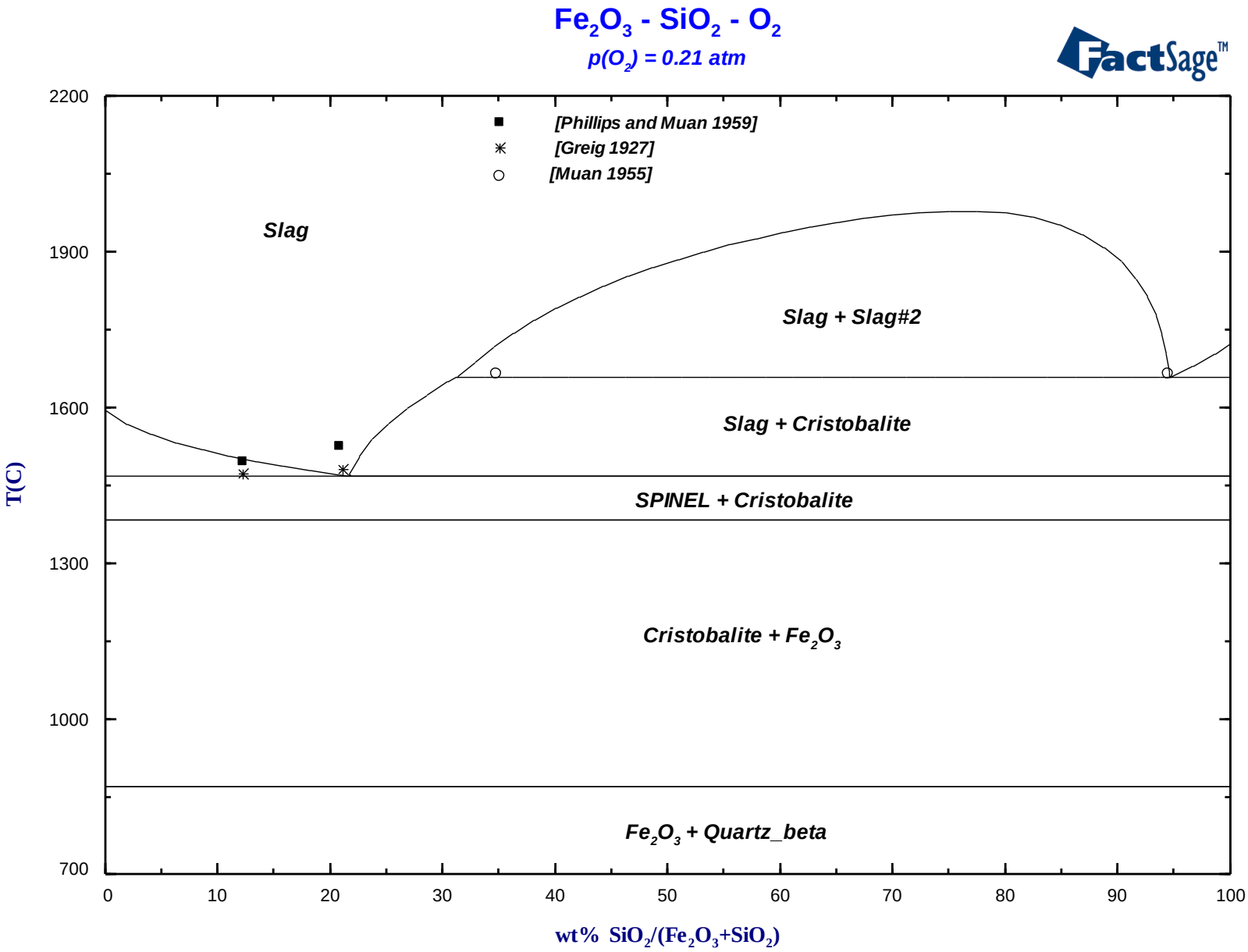
Mole fraction

Fe_2O_3 - SiO_2 - O_2

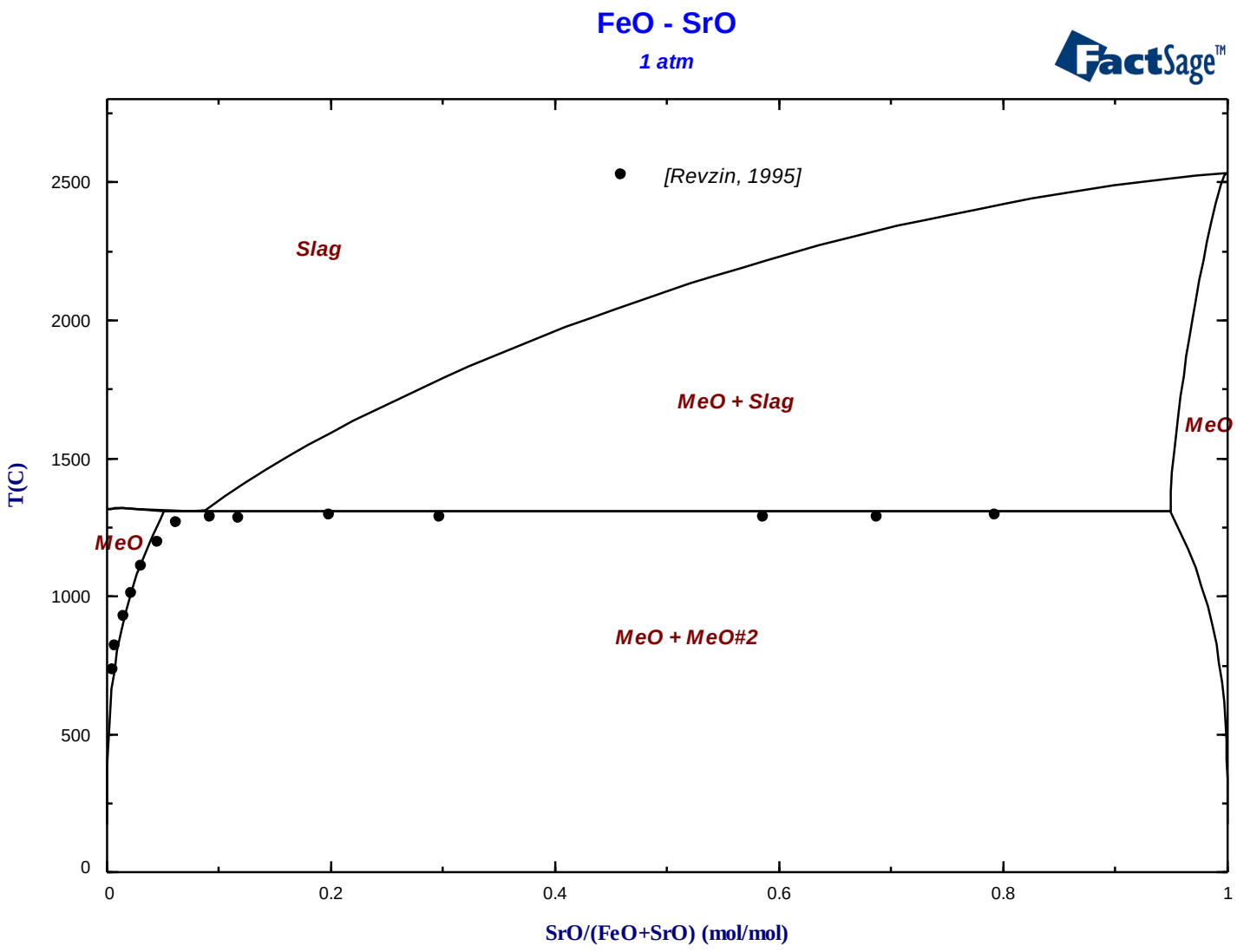
$p(O_2)$ = 0.21 atm



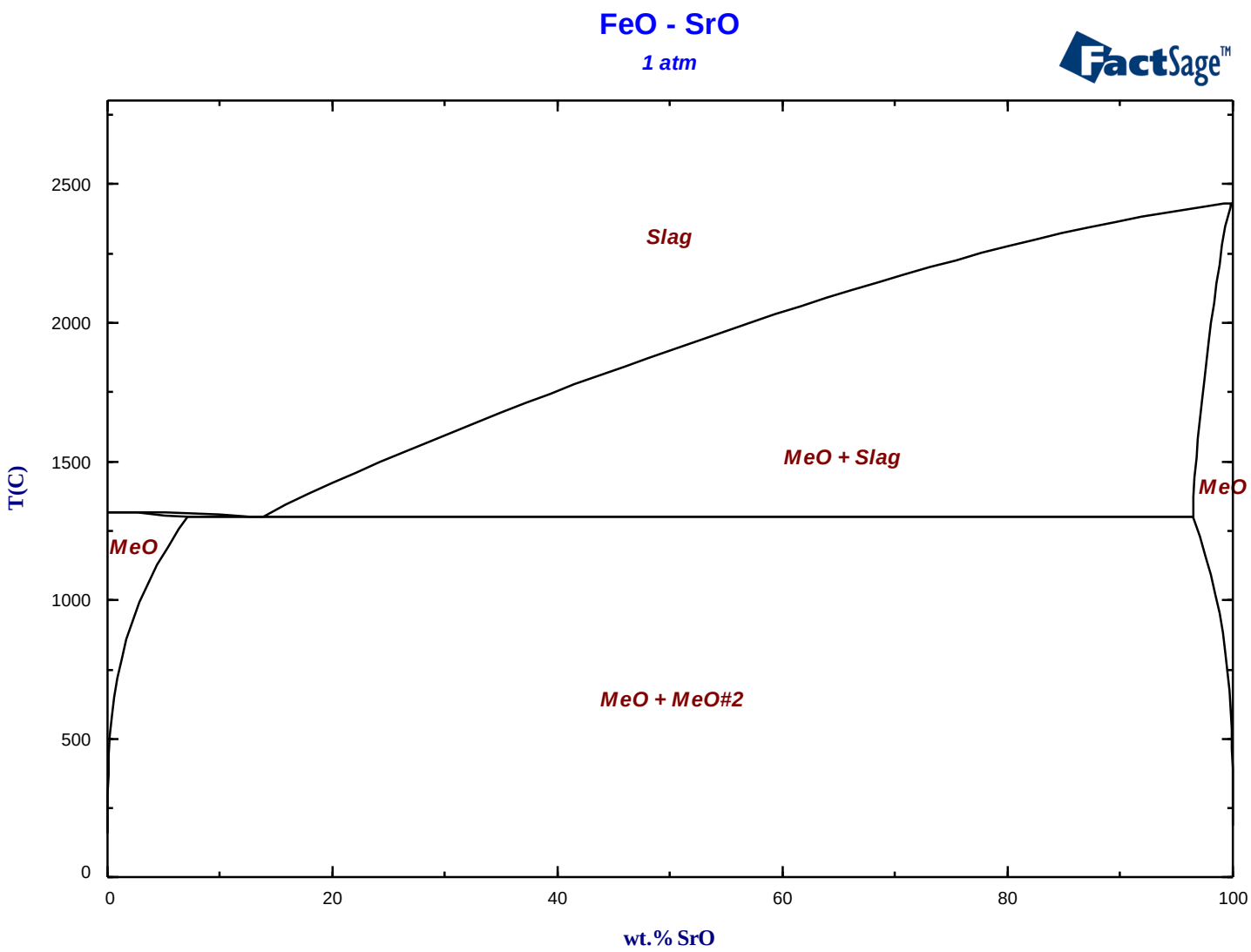
Weight percent
compared with experimental data



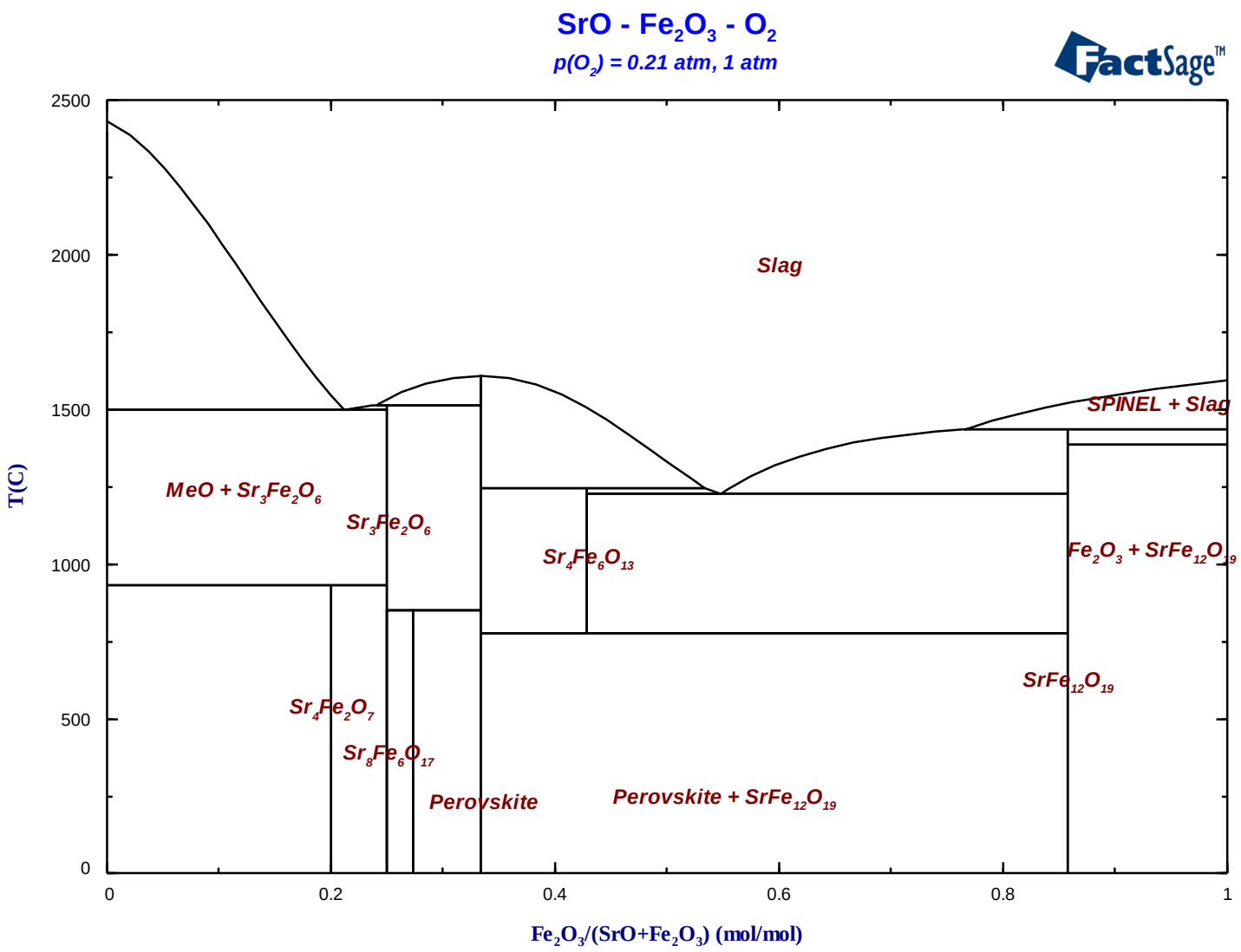
Mole fraction compared with experimental data



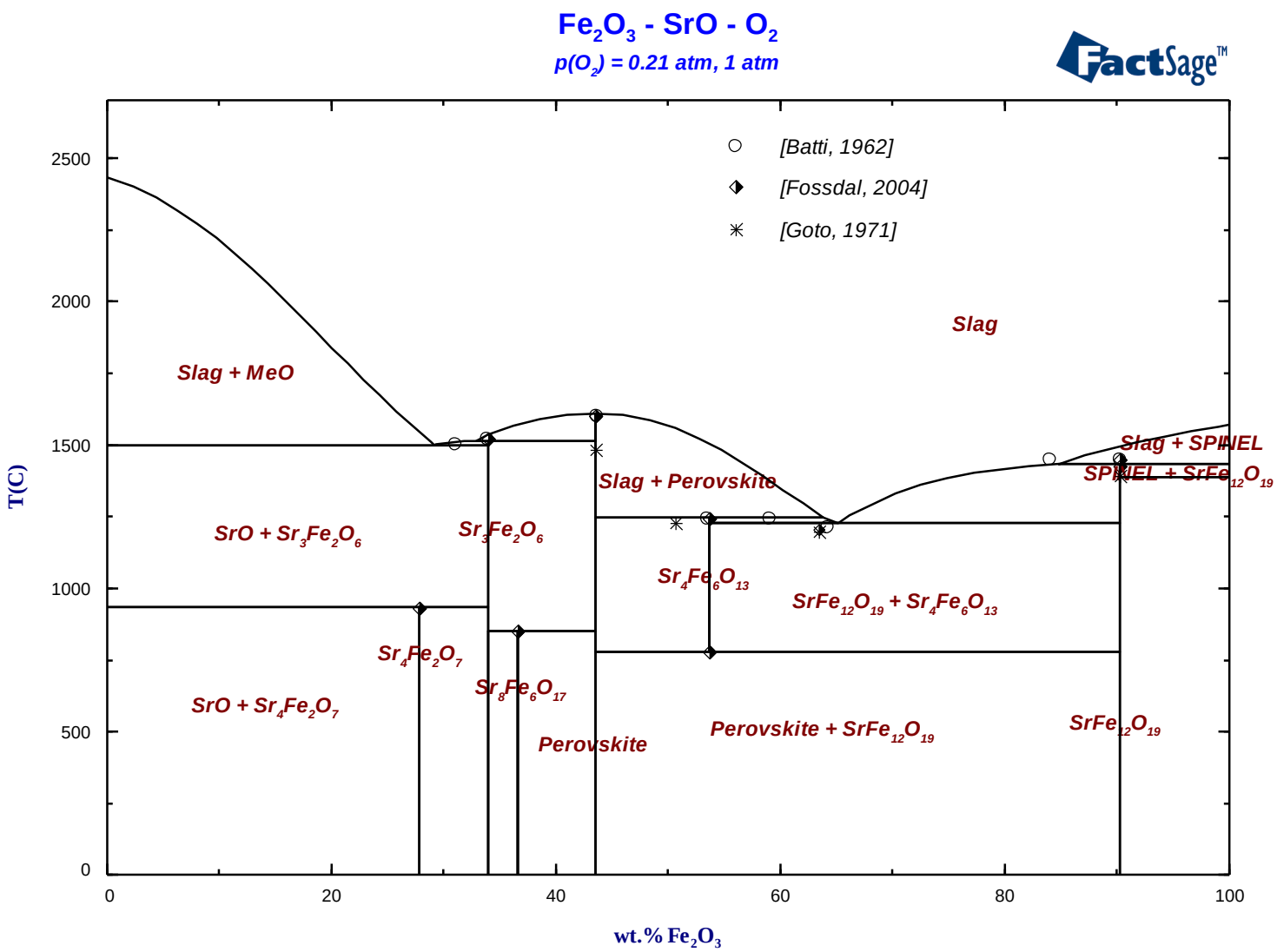
Weight percent



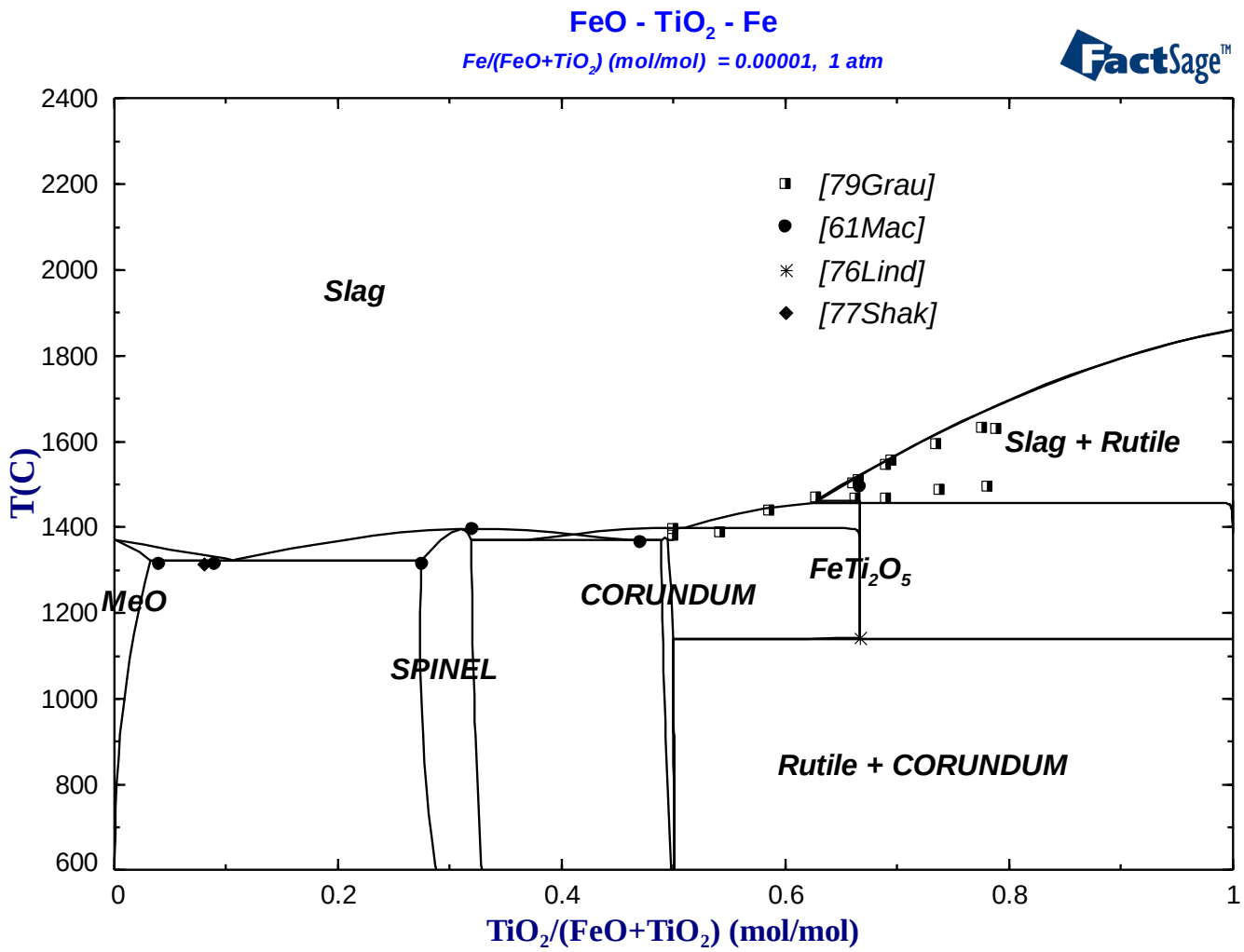
Mole fraction



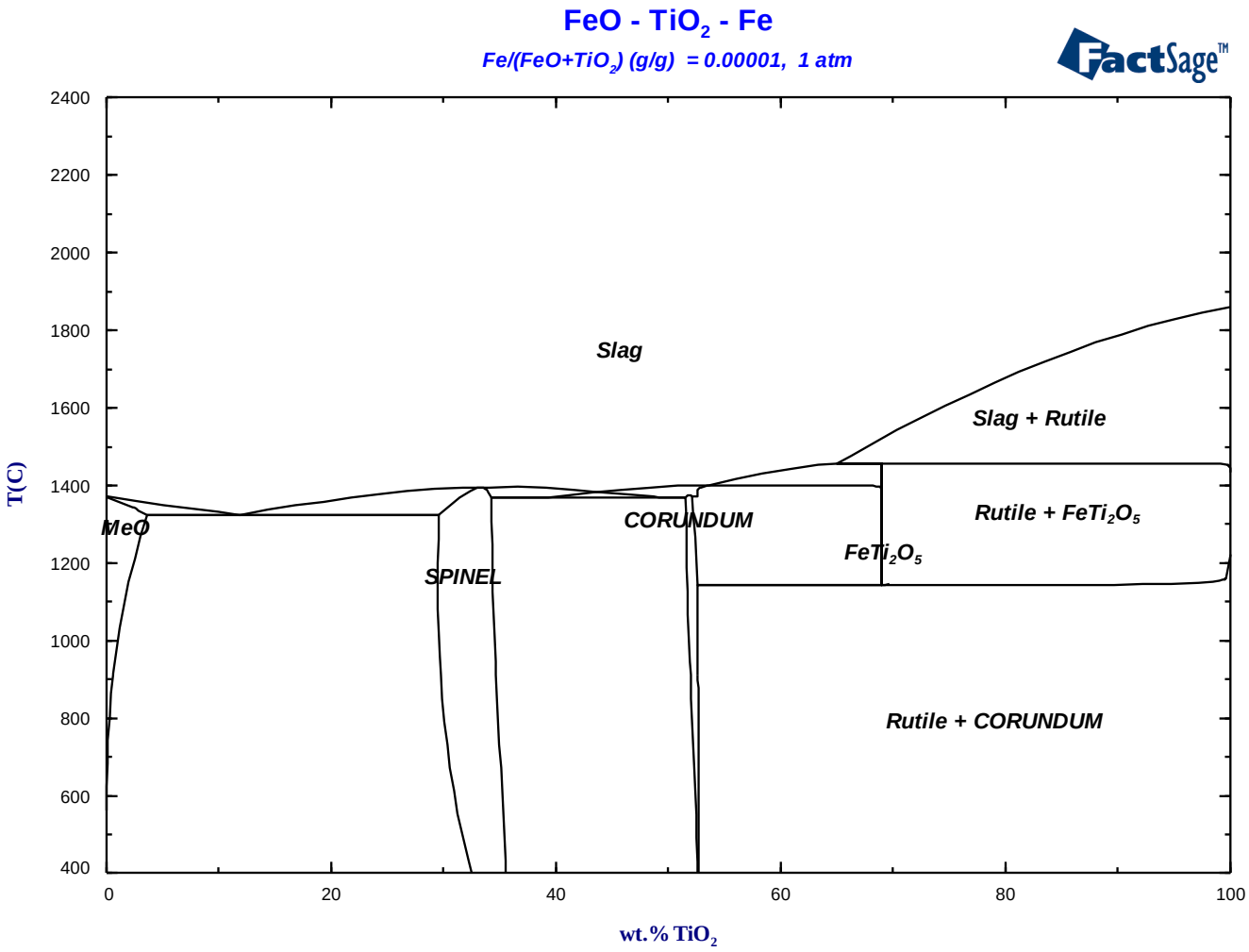
Weight percent compared with experimental data



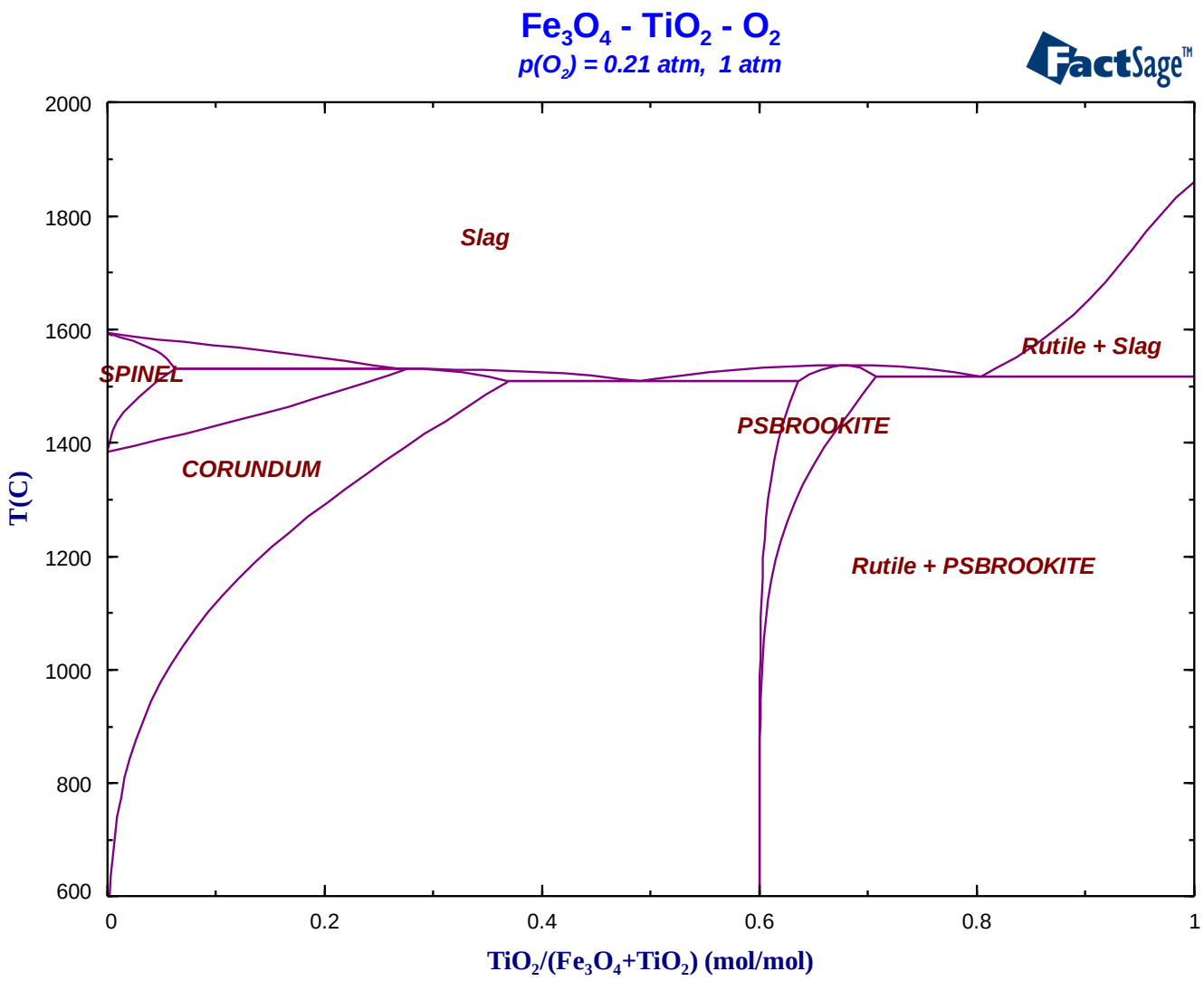
Mole fraction



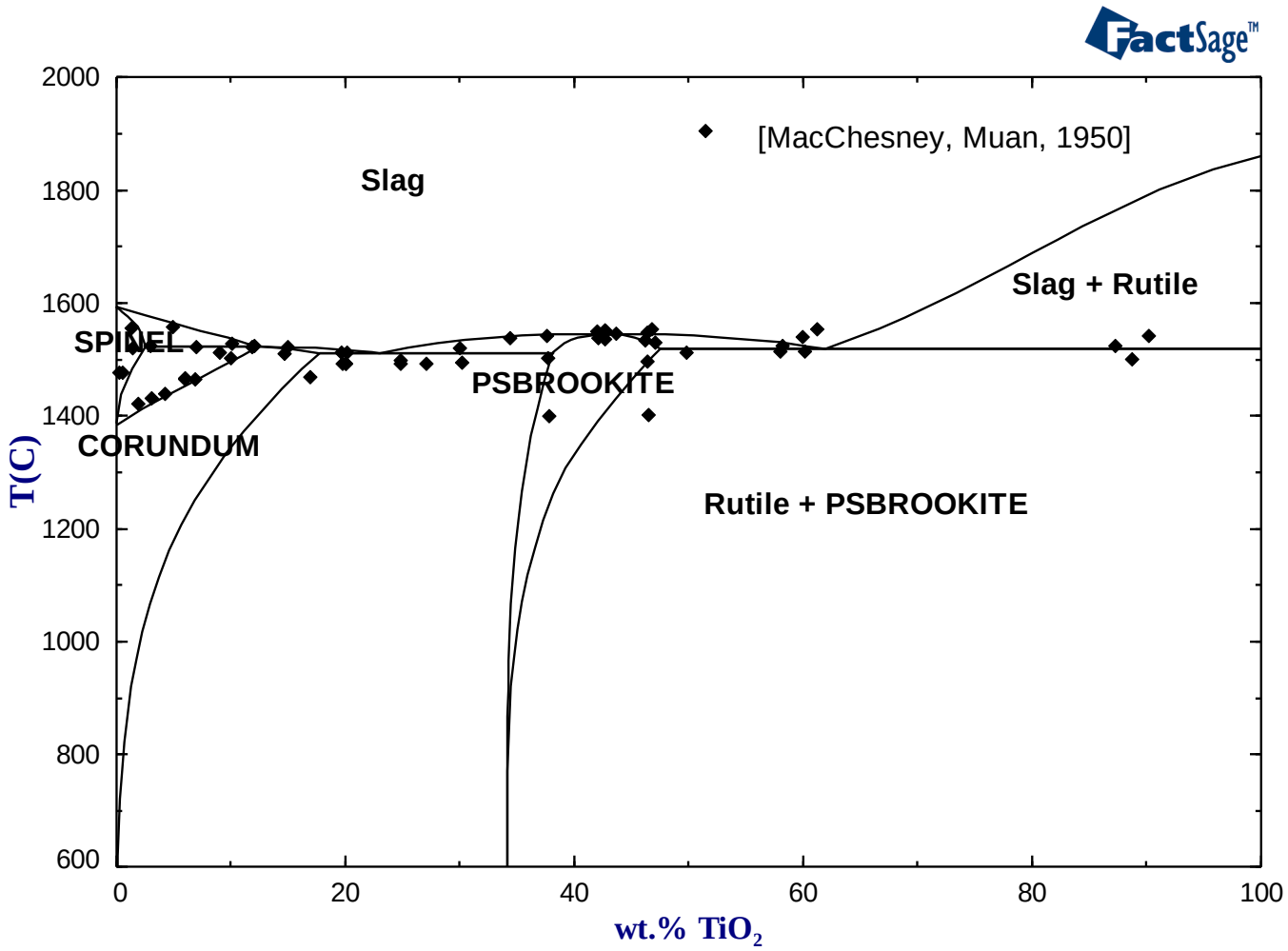
Weight percent



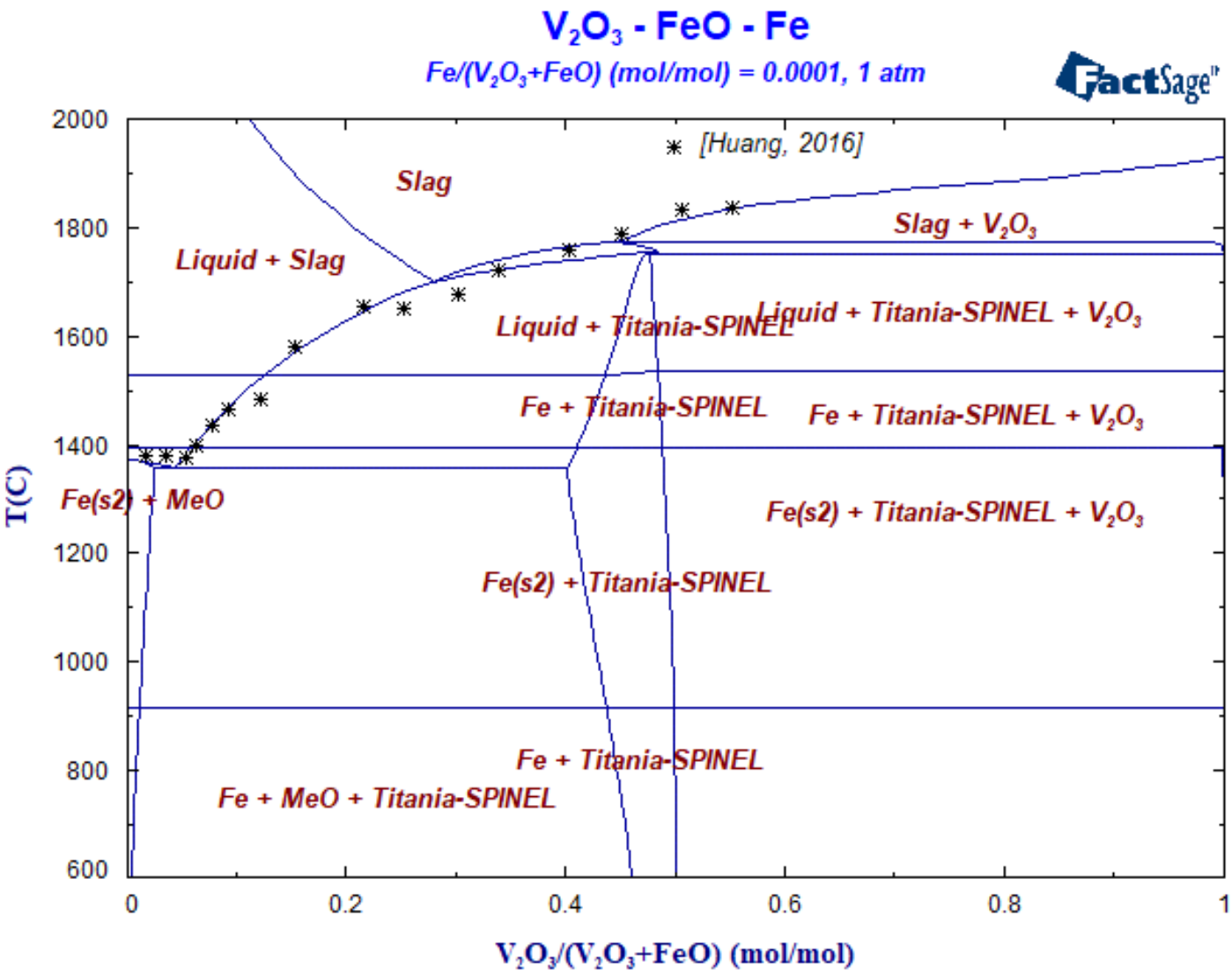
Mole fraction



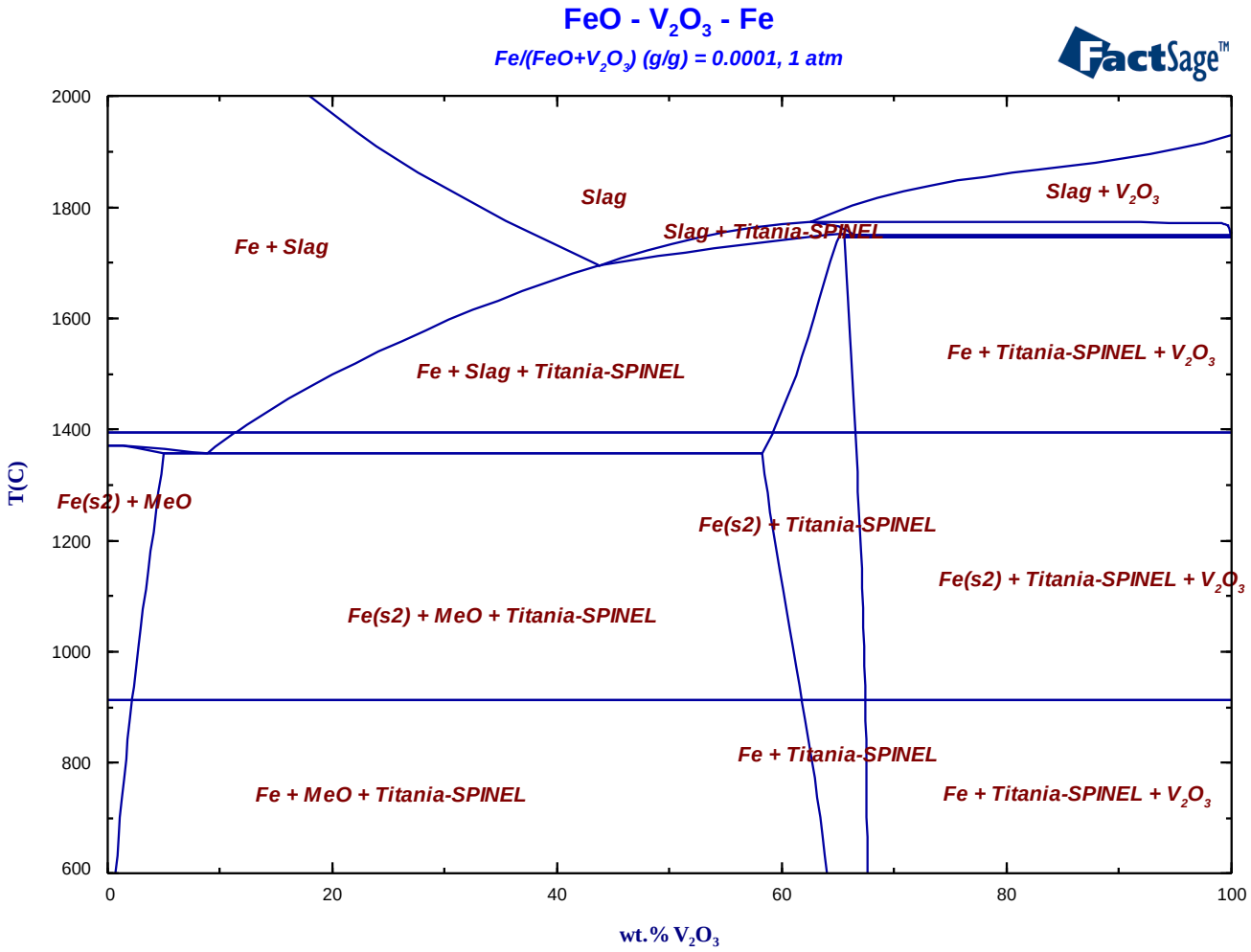
Fe3O4-TiO2-O2,
Weight percent compared with experimental data



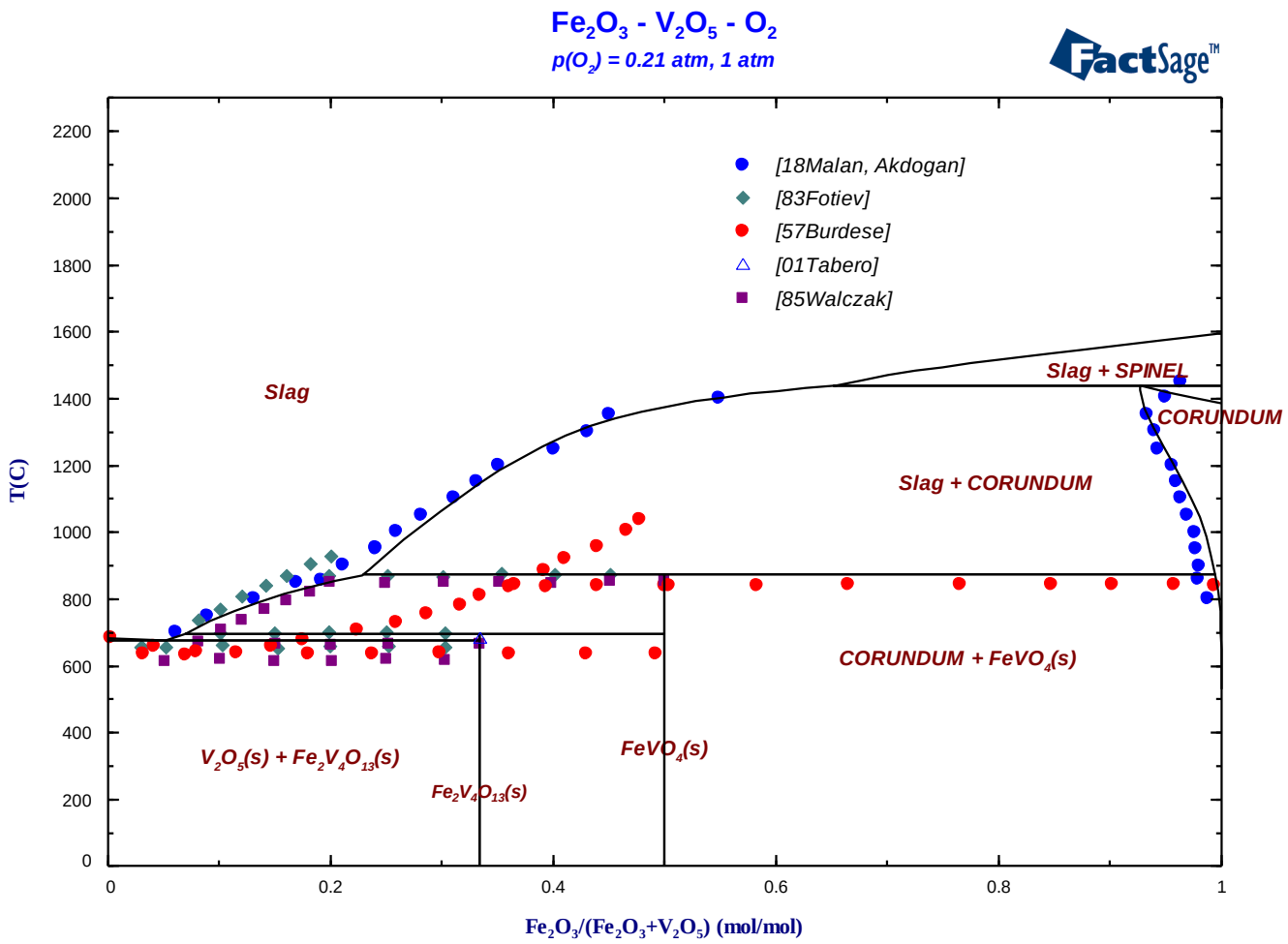
FeO-V2O3-Fe,
Mole fraction compared with experimental daza



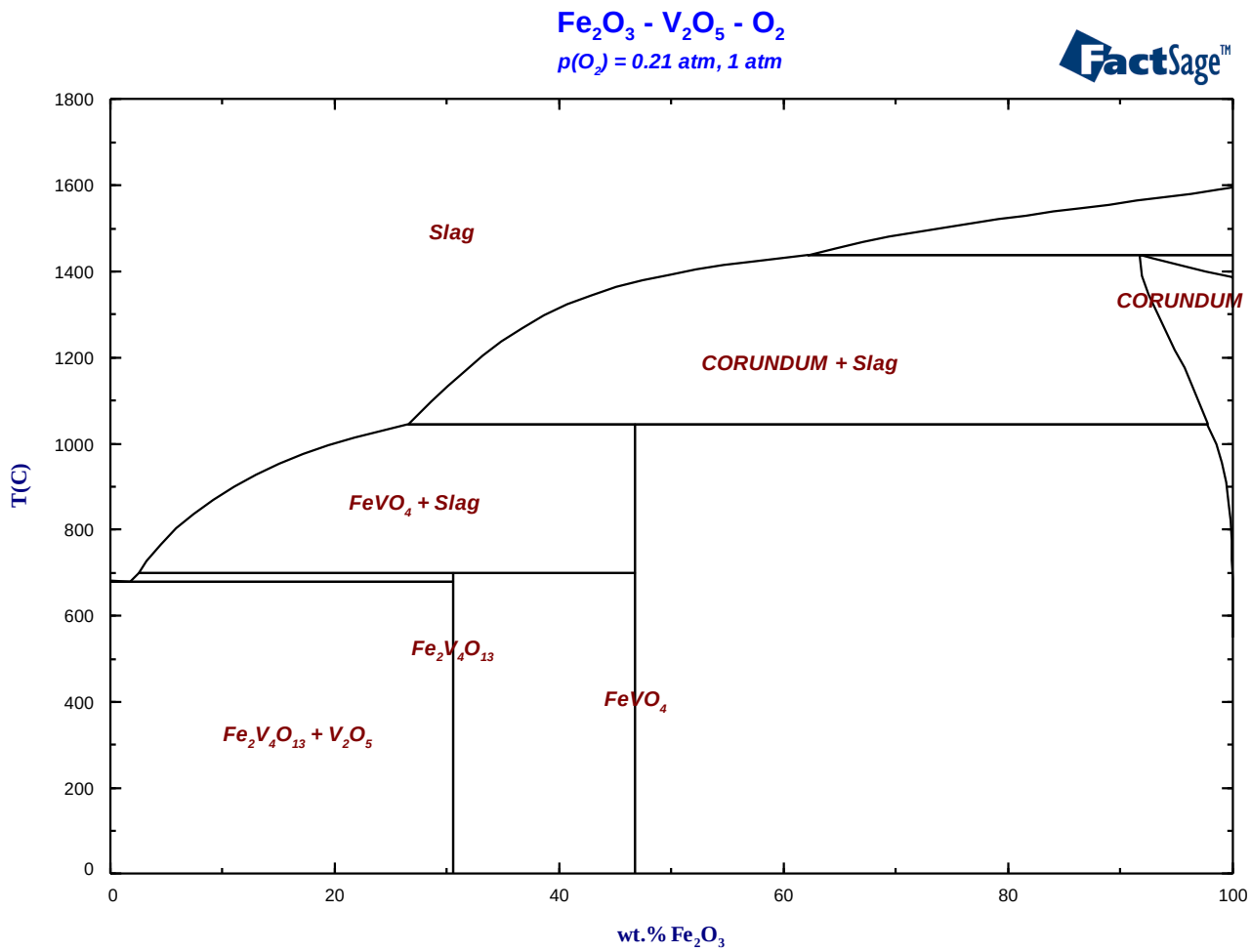
FeO-V2O3-Fe,
Weight percent



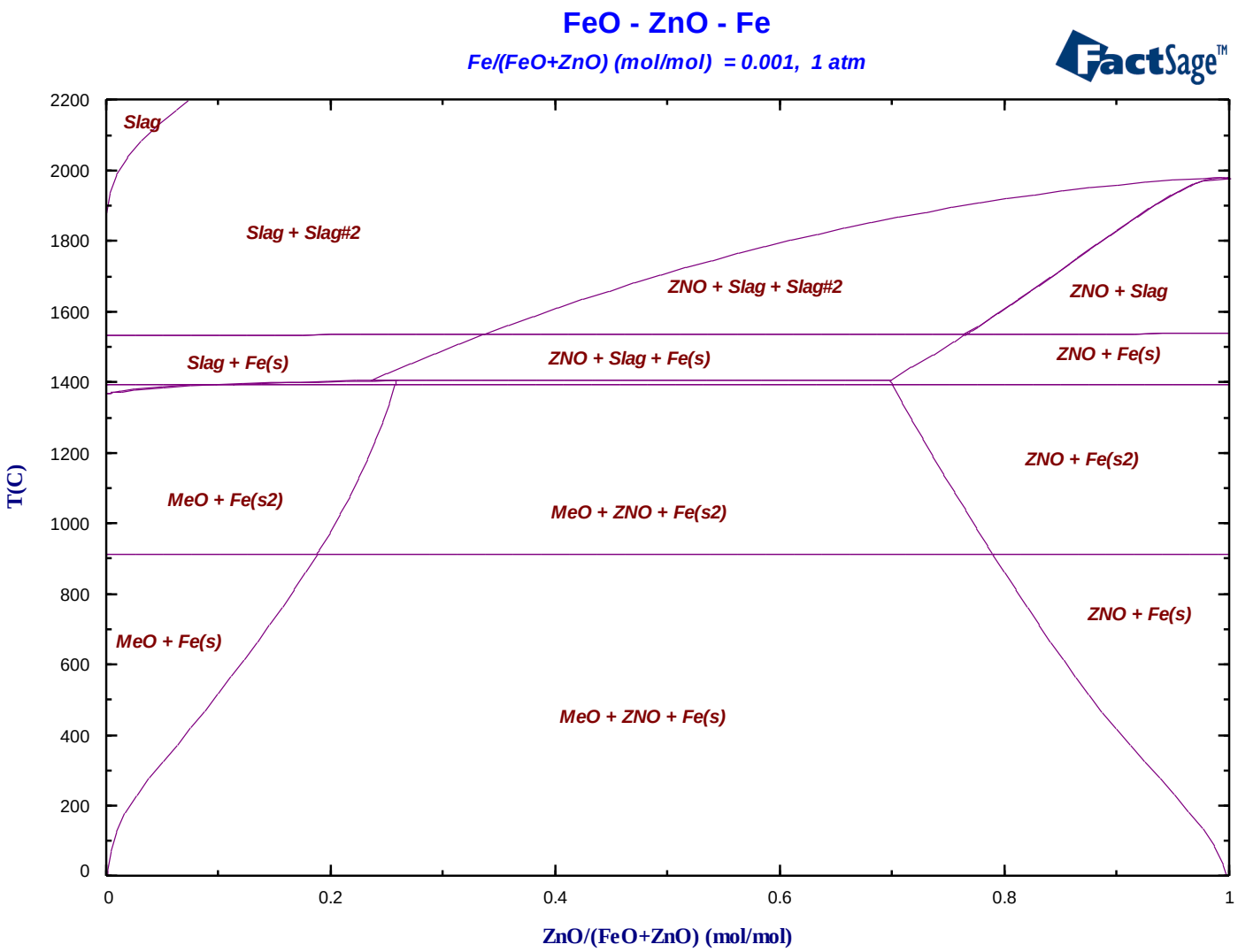
Fe2O3-V2O5-O2,
Mole fraction compared with experimental data



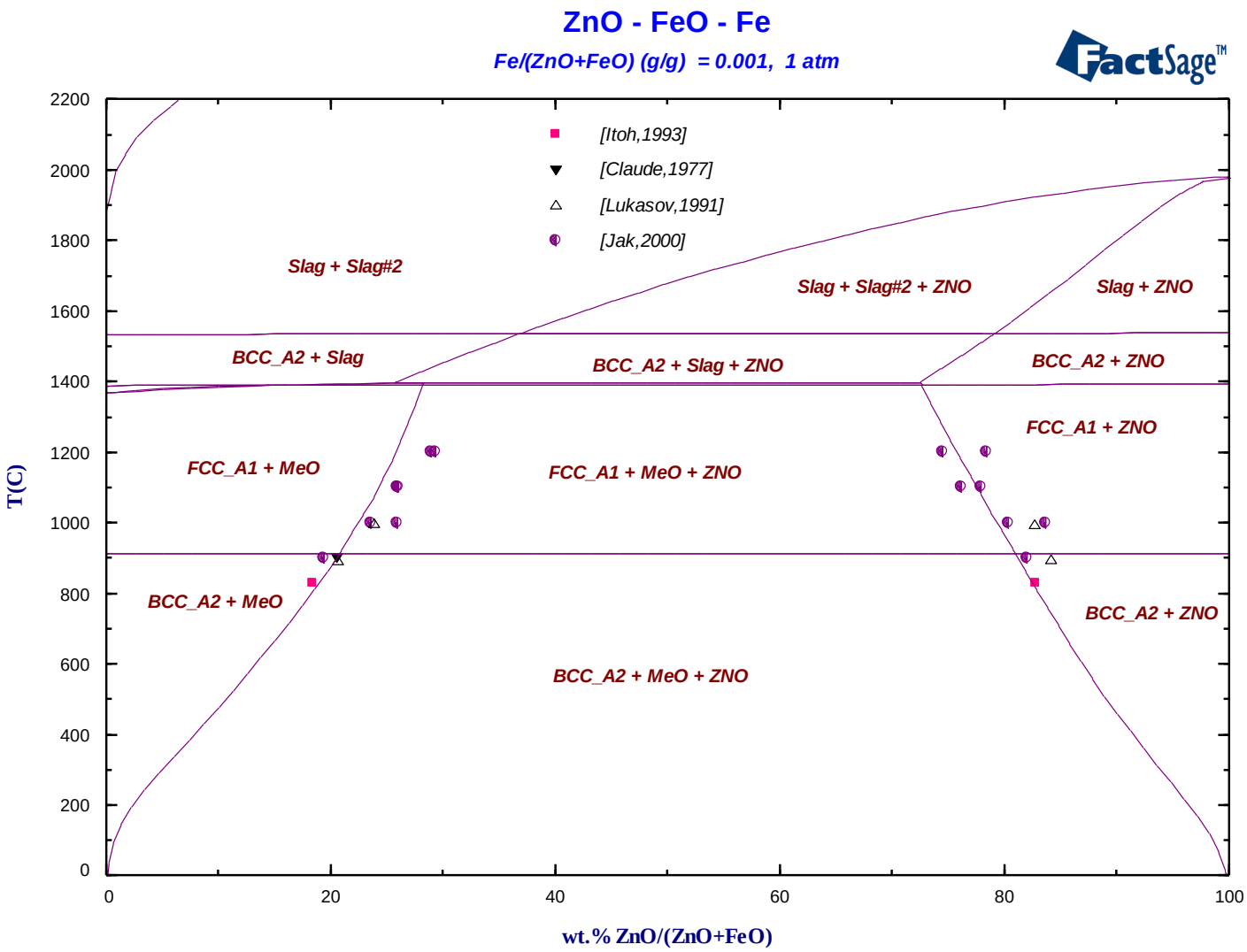
Fe2O3-V2O5-O2,
Weight percent



Mole fraction



Weight percent
compared with experimental data

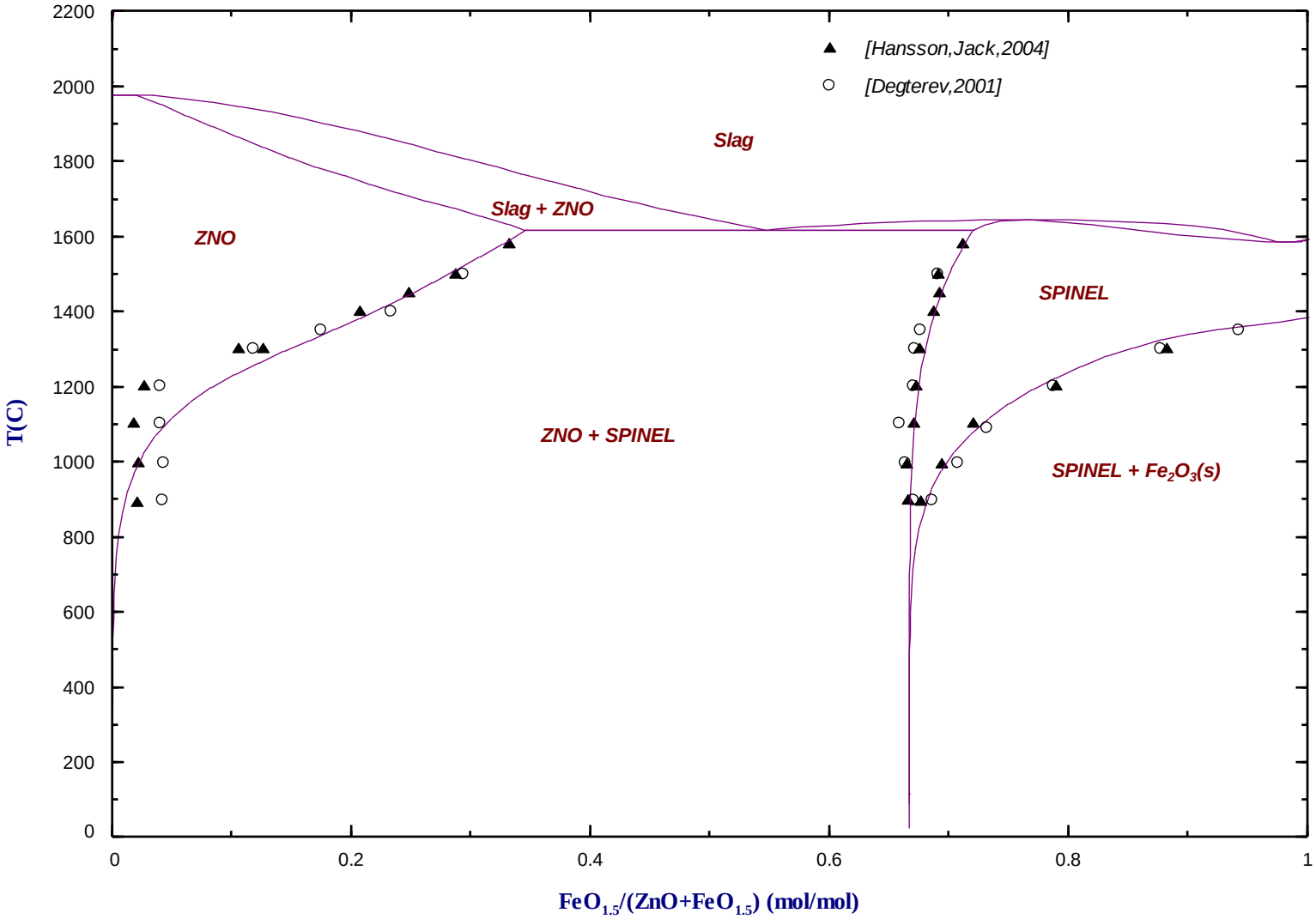


Mole fraction experimental data

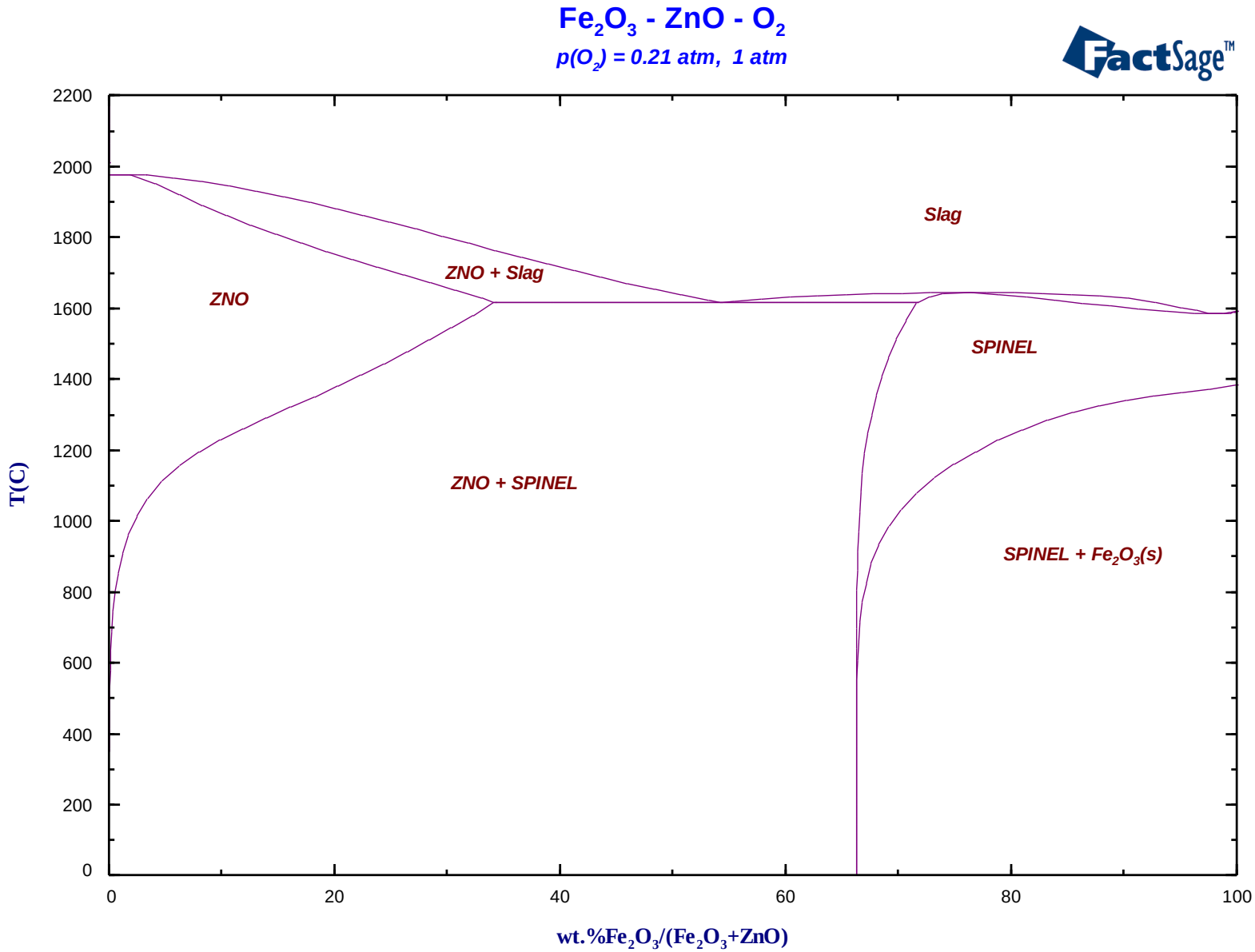
compared with

$ZnO - FeO_{1.5} - O_2$

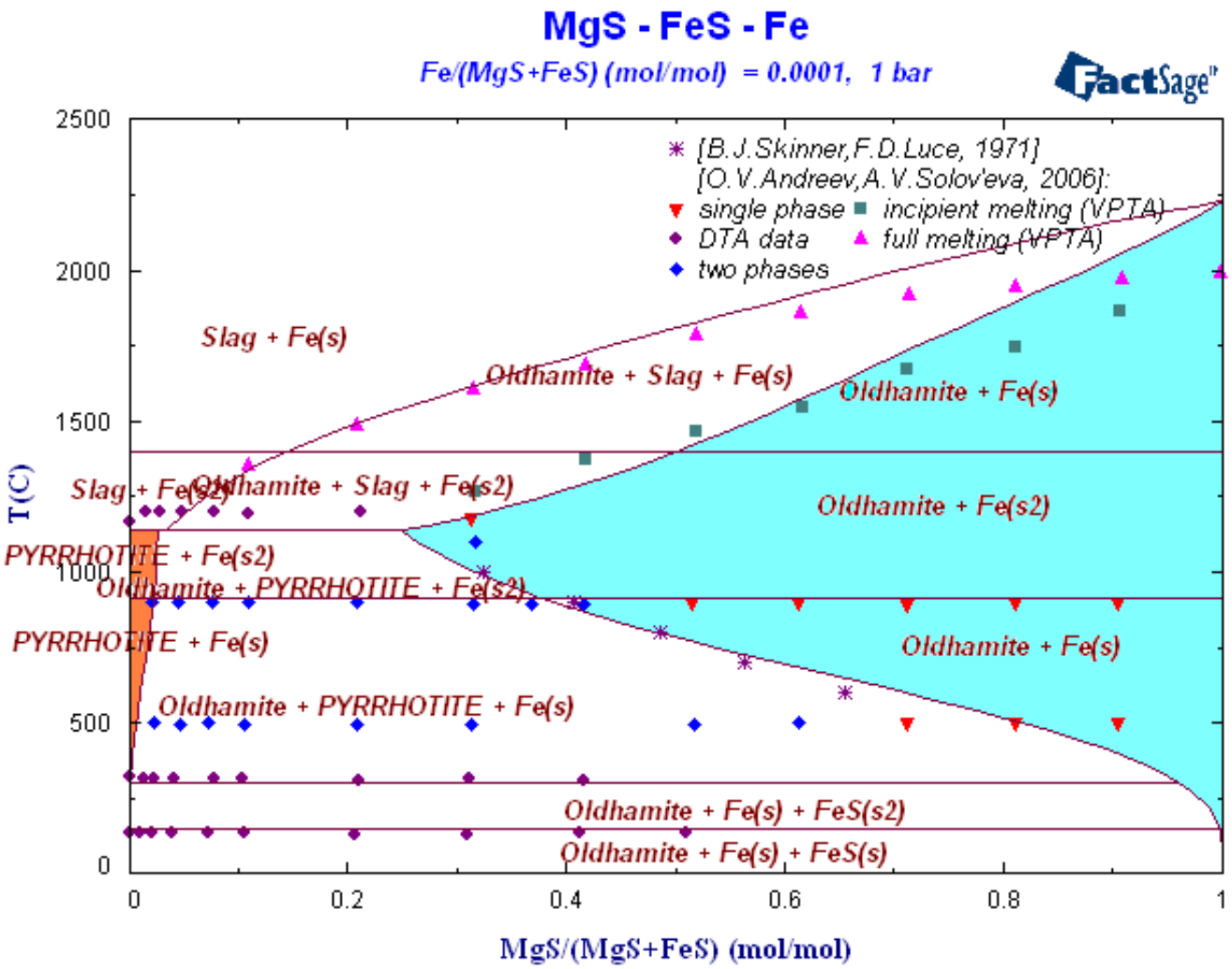
$p(O_2)$ = 0.21 atm, 1 atm



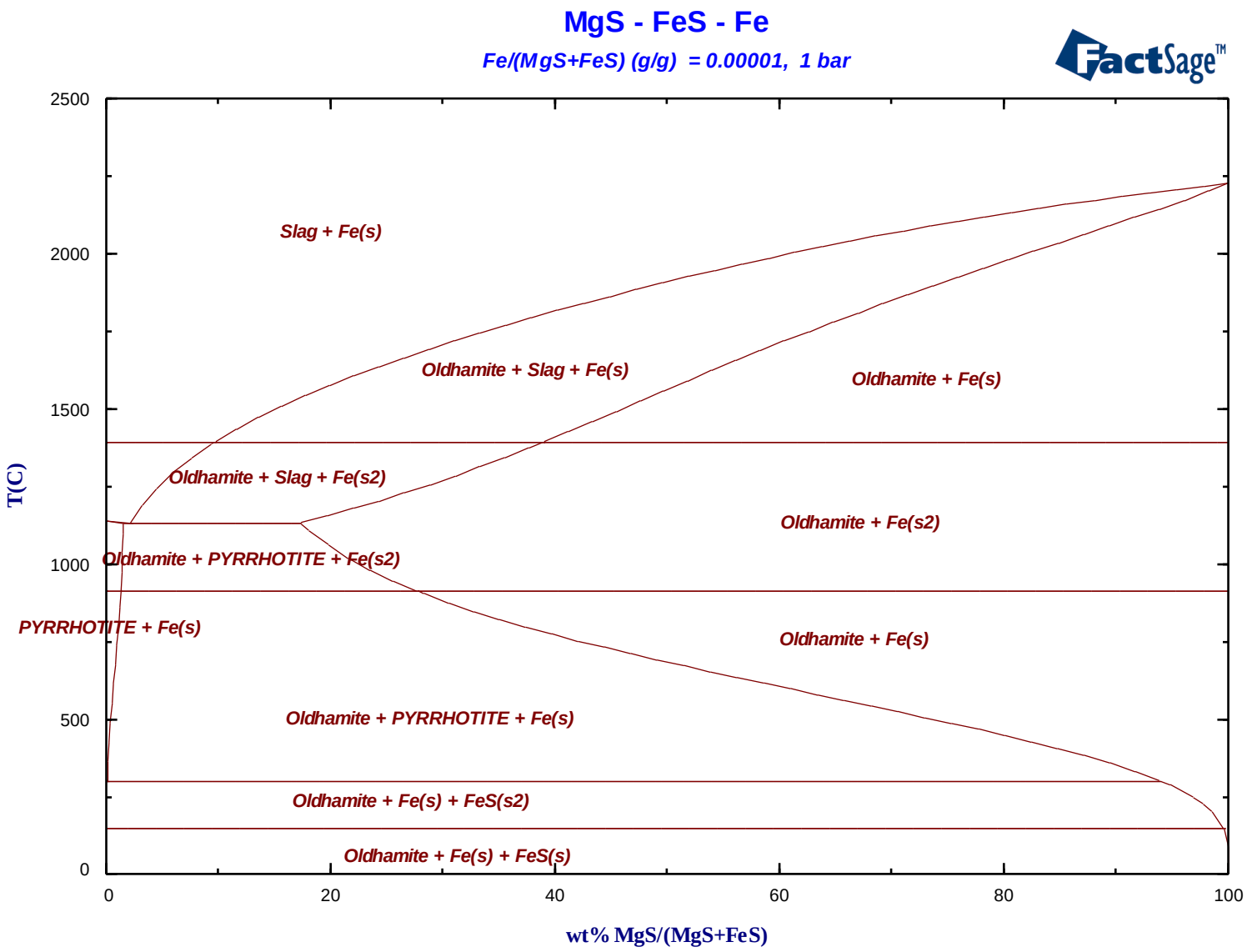
Weight percent



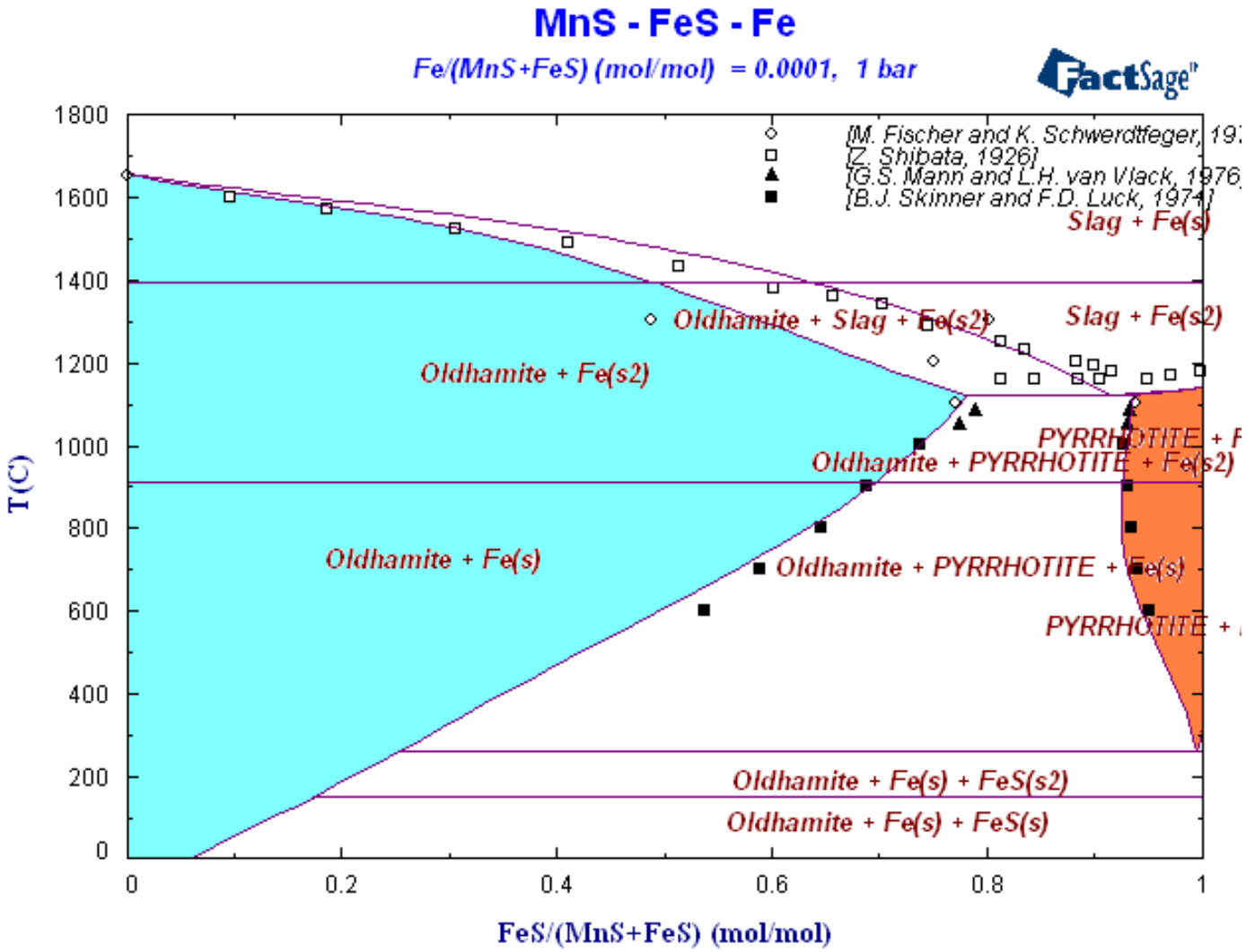
Mole fraction
compared with experimental data



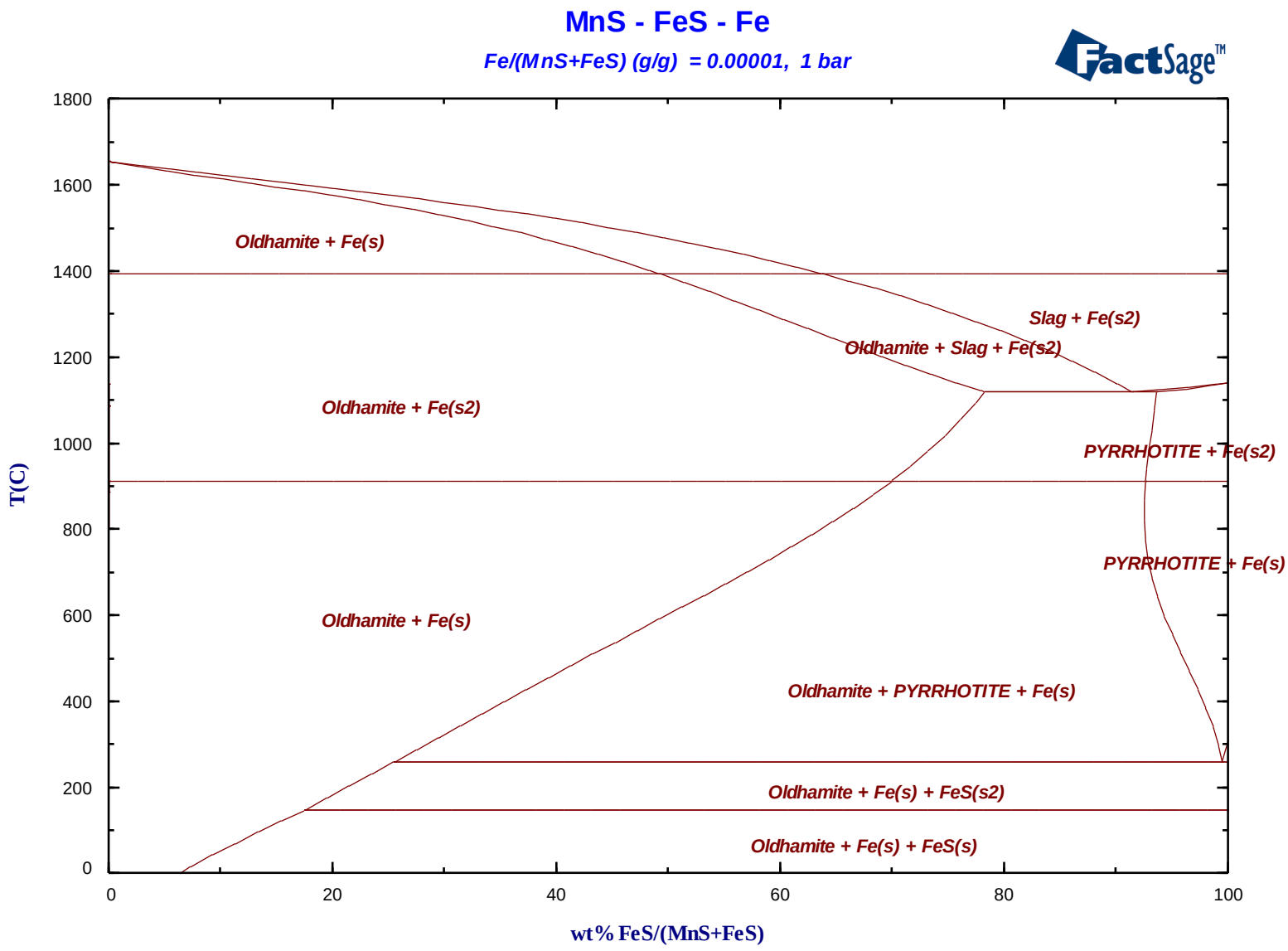
Weight percent

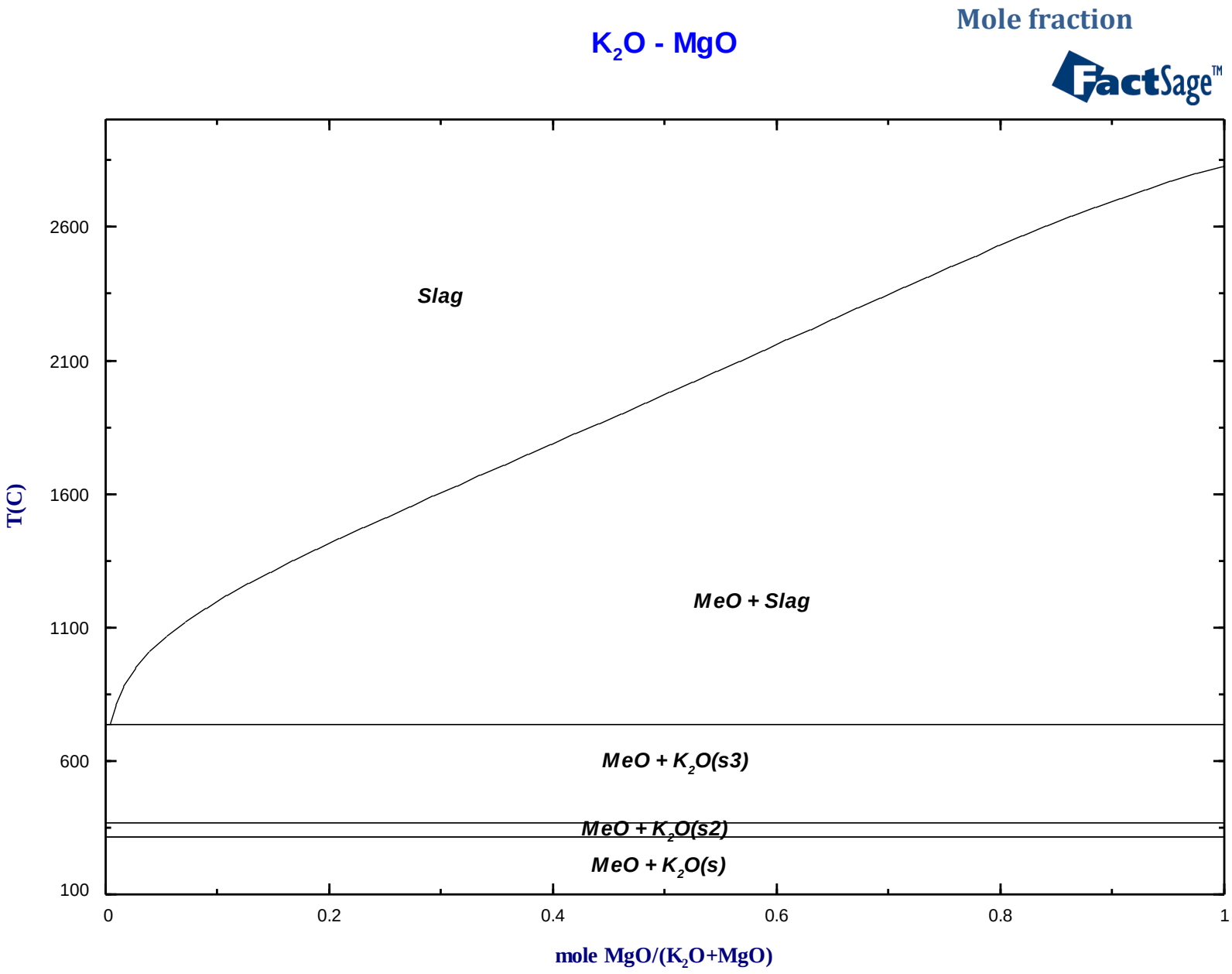


Mole fraction
compared with experimental data

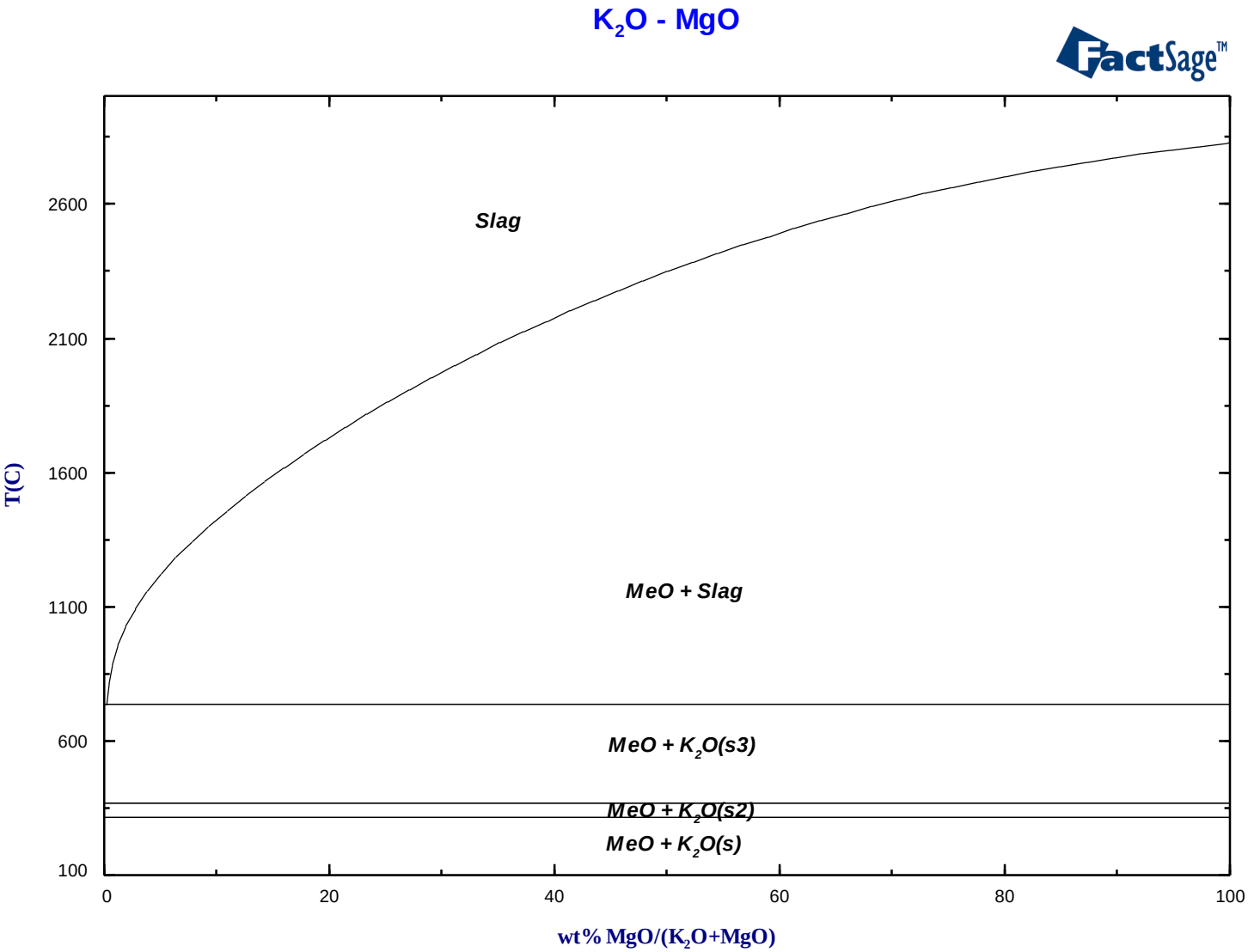


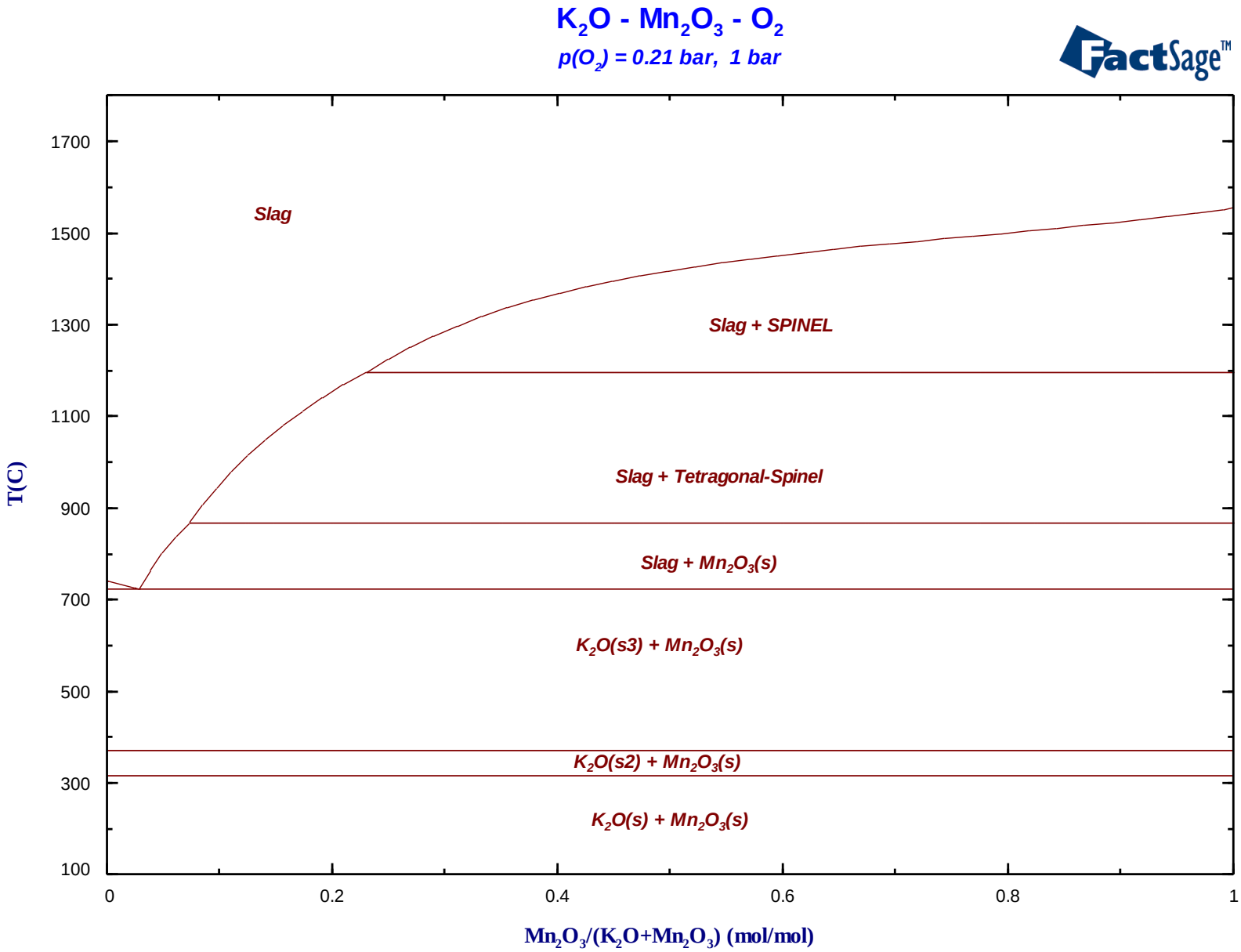
Weight percent



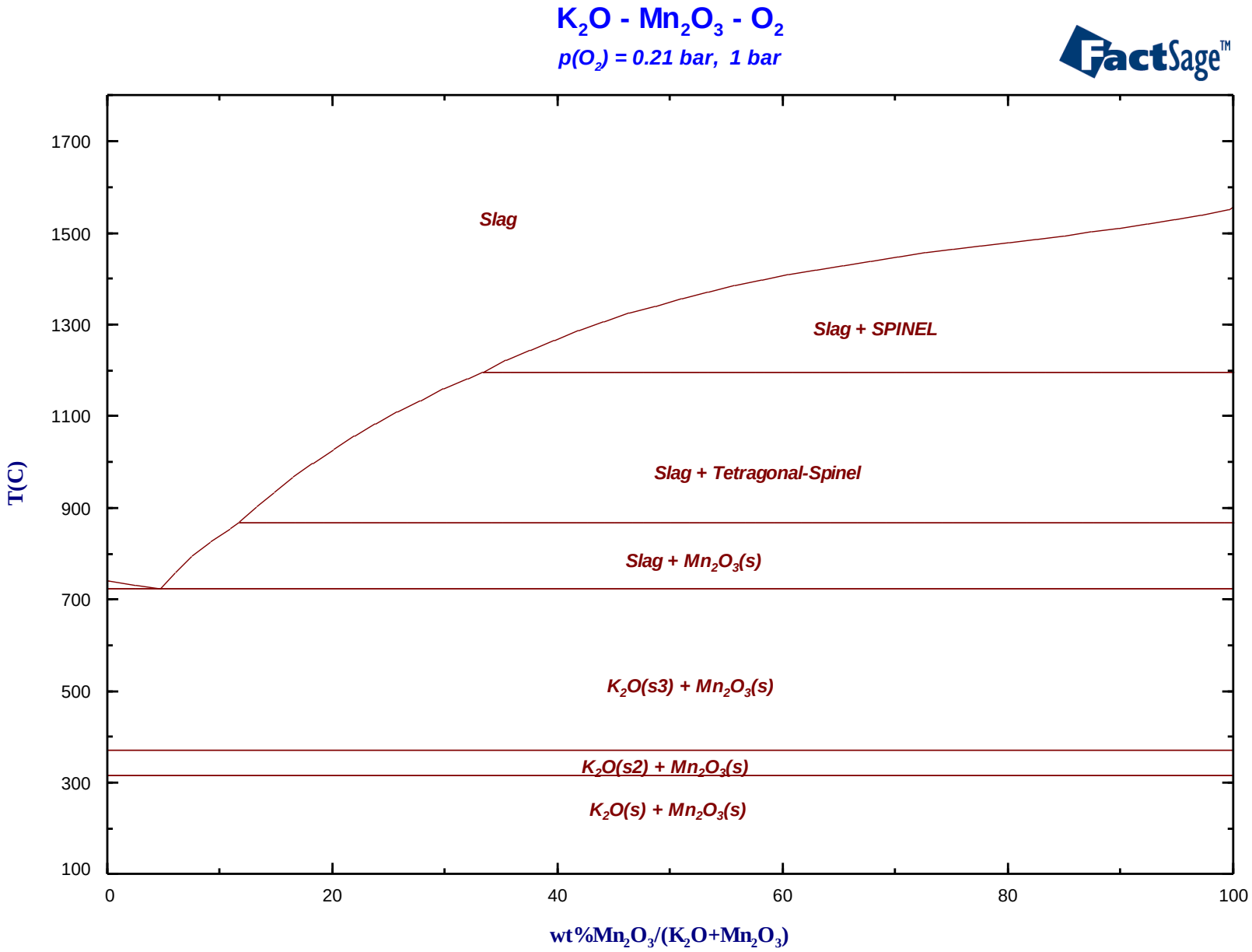

Mole fraction
K2O - MgO
FactSage™
Slag
MeO + Slag
MeO + K2O(s3)
MeO + K2O(s2)
MeO + K2O(s)
T(C)
2600
2100
1600
1100
600
100
0
0.2
0.4
0.6
0.8
1
mole MgO/(K2O+MgO)

Weight percent



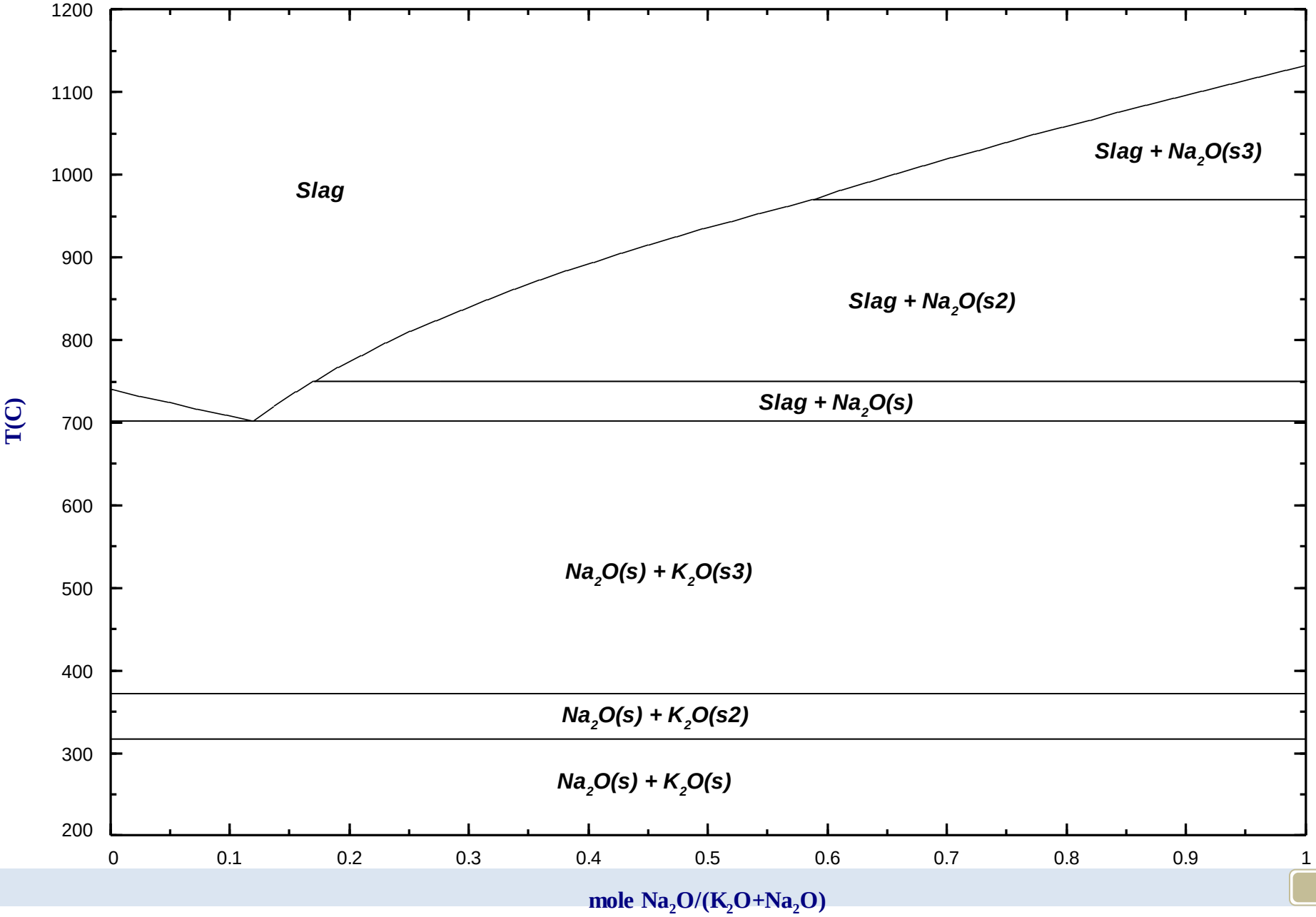

K2O - Mn2O3 - O2
p(O2) = 0.21 bar, 1 bar
FactSage™
Slag
Slag + SPINEL
Slag + Tetragonal-Spinel
Slag + Mn2O3(s)
K2O(s3) + Mn2O3(s)
K2O(s2) + Mn2O3(s)
K2O(s) + Mn2O3(s)
T(C)
1700
1500
1300
1100
900
700
500
300
100
0
0.2
0.4
0.6
0.8
1
Mn2O3/(K2O+Mn2O3) (mol/mol)

Weight percent



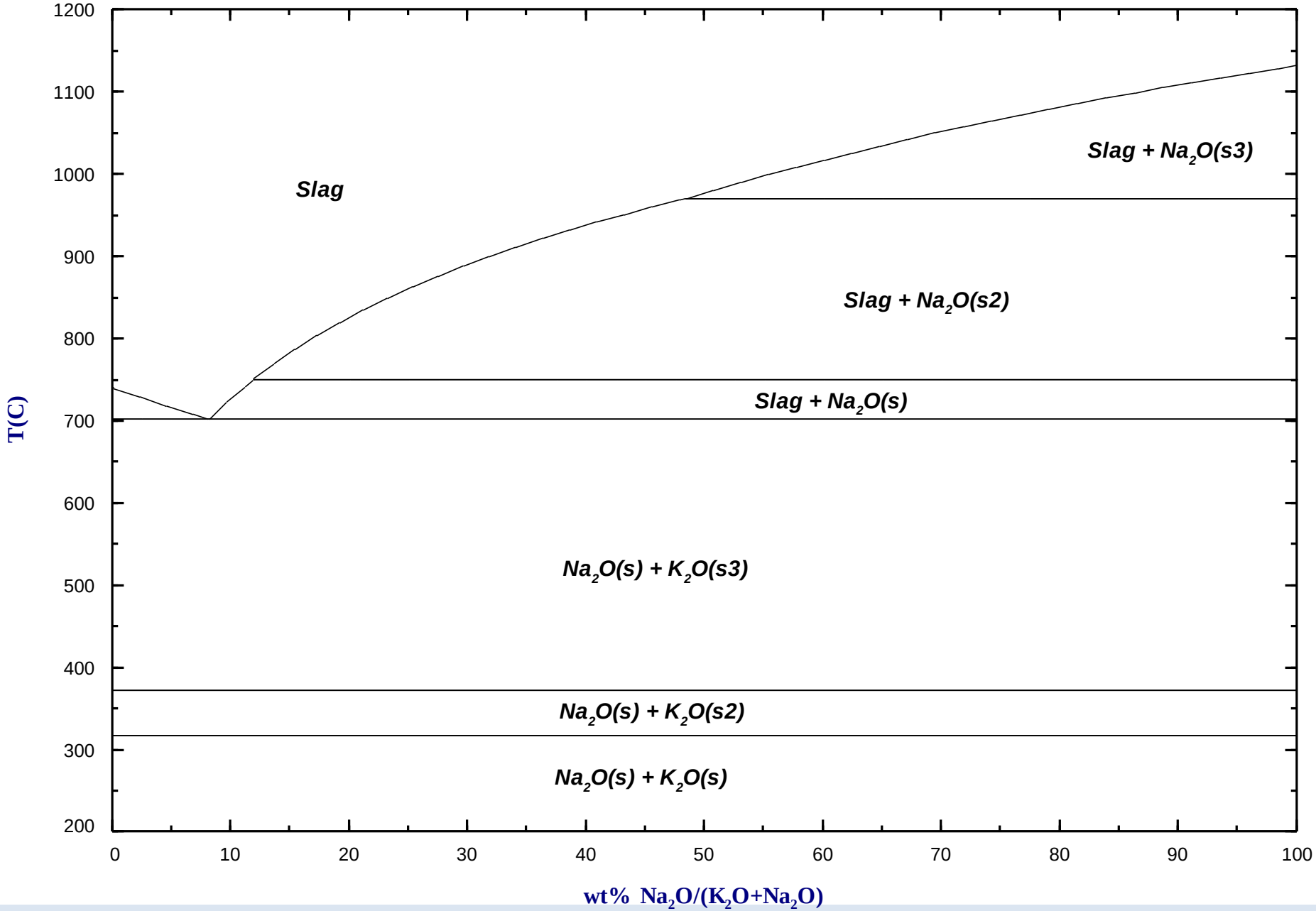
Mole fraction

K_2O - Na_2O

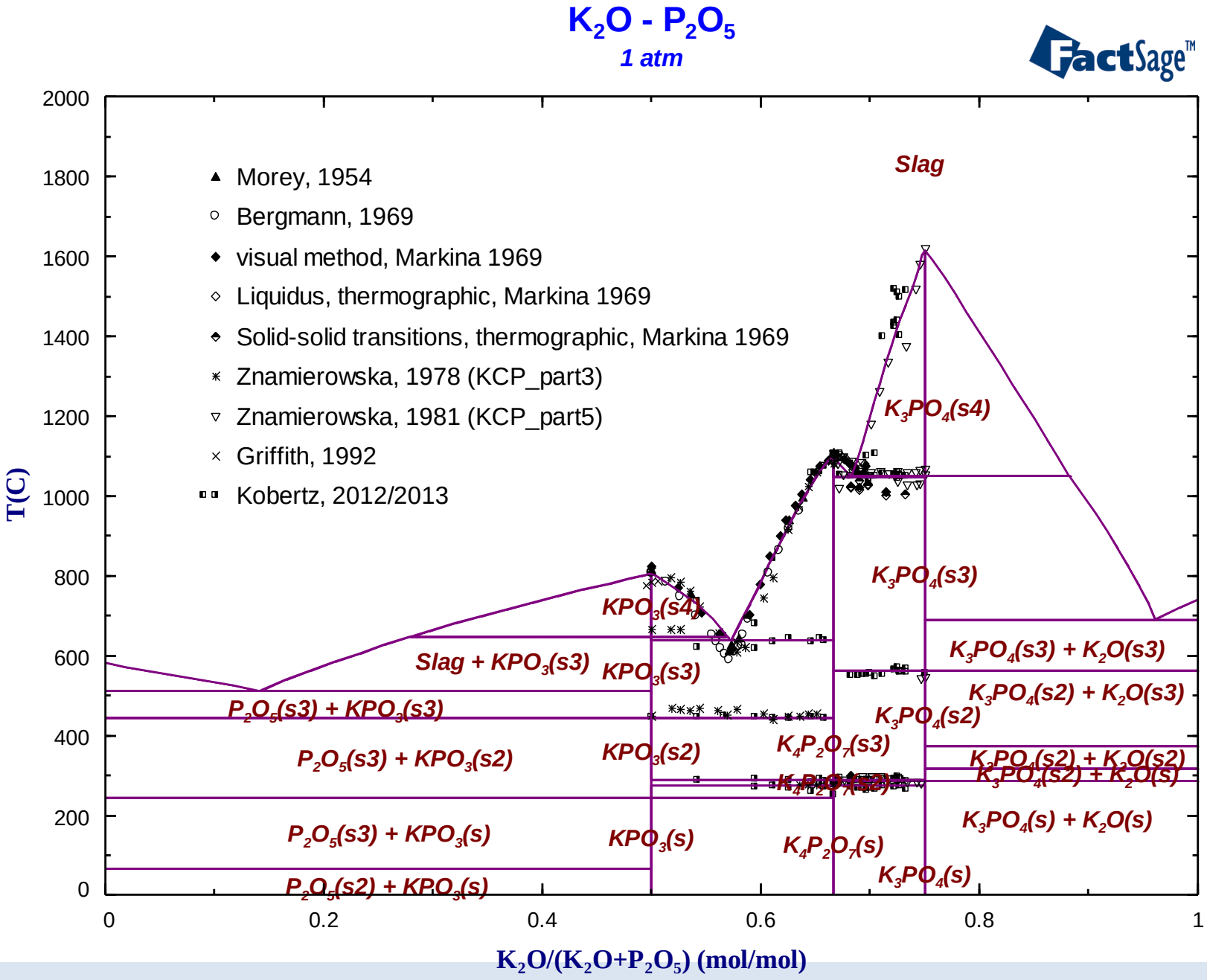


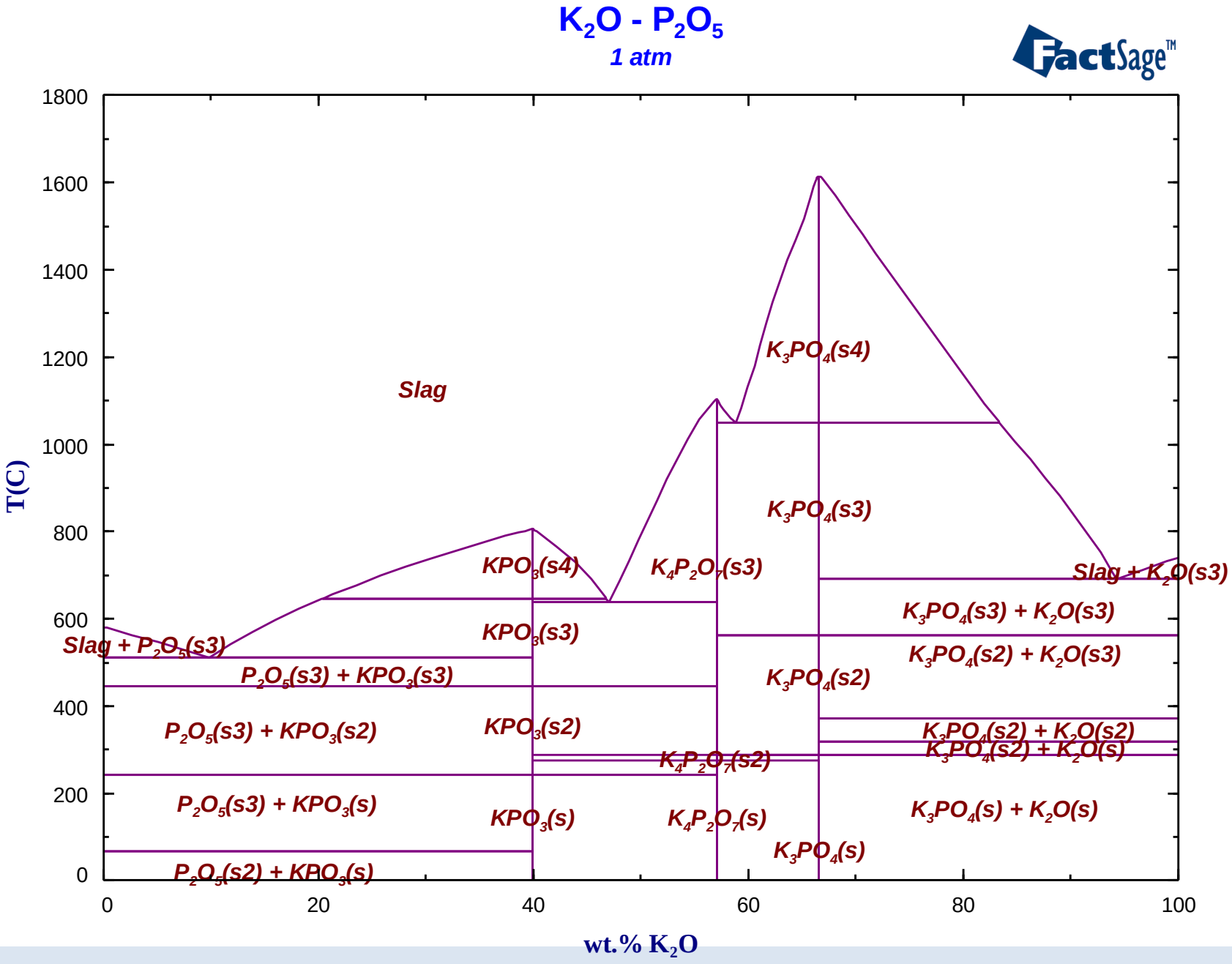
K_2O - Na_2O

Weight percent



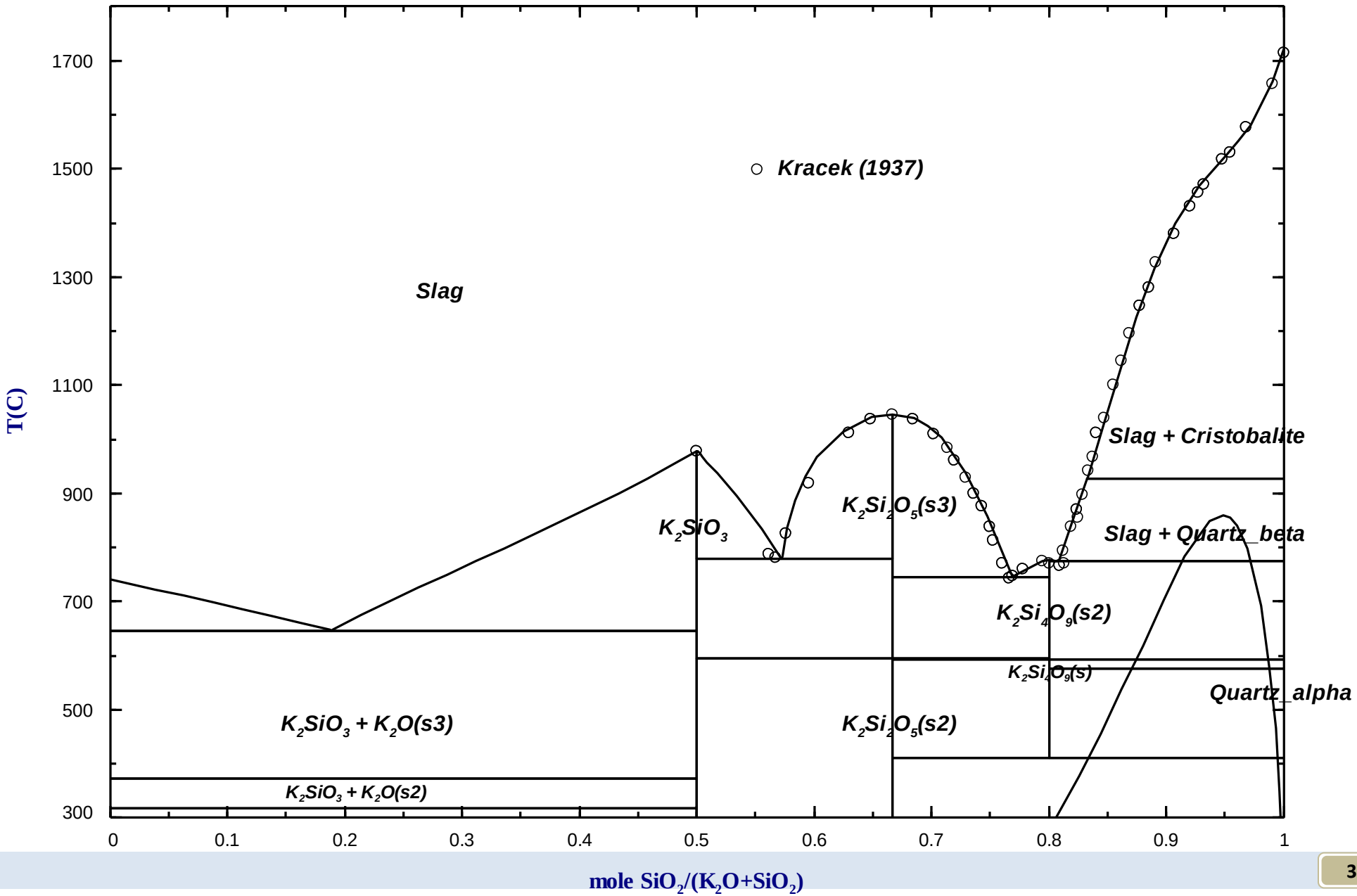
Mole fraction
compared with experimental data



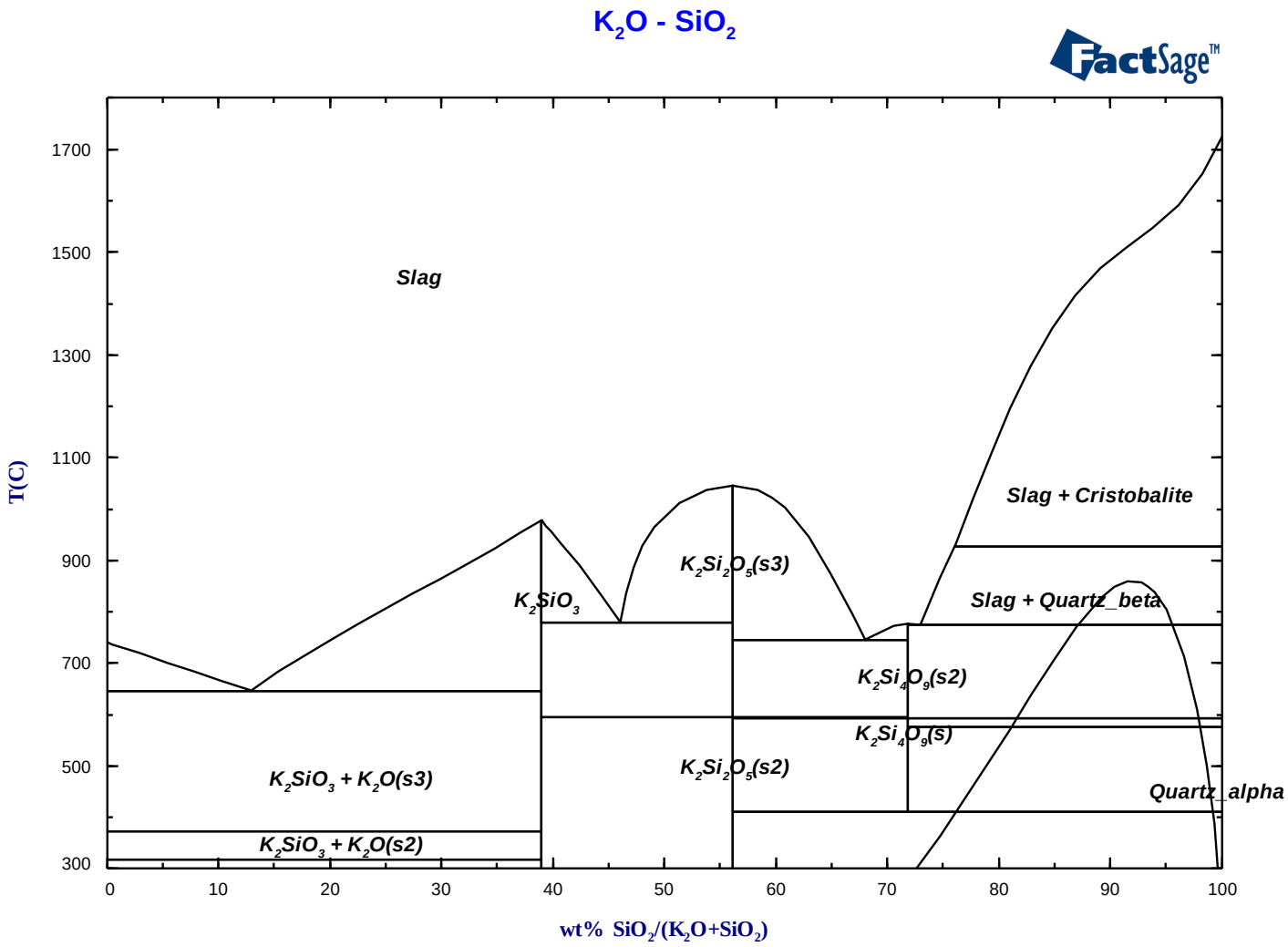

K2O - P2O5
1 atm
FactSage™
T(C)
wt.% K2O
Slag
K3PO4(s4)
K3PO4(s3)
KPO3(s4)
K4P2O7(s3)
Slag + K2O(s3)
K3PO4(s3) + K2O(s3)
KPO3(s3)
Slag + P2O5(s3)
K3PO4(s2) + K2O(s3)
P2O5(s3) + KPO3(s3)
K3PO4(s2)
P2O5(s3) + KPO3(s2)
KPO3(s2)
K3PO4(s2) + K2O(s2)
K3PO4(s2) + K2O(s)
K4P2O7(s2)
P2O5(s3) + KPO3(s)
KPO3(s)
K4P2O7(s)
K3PO4(s) + K2O(s)
K3PO4(s)
P2O5(s2) + KPO3(s)

Mole fraction compared with experimental data

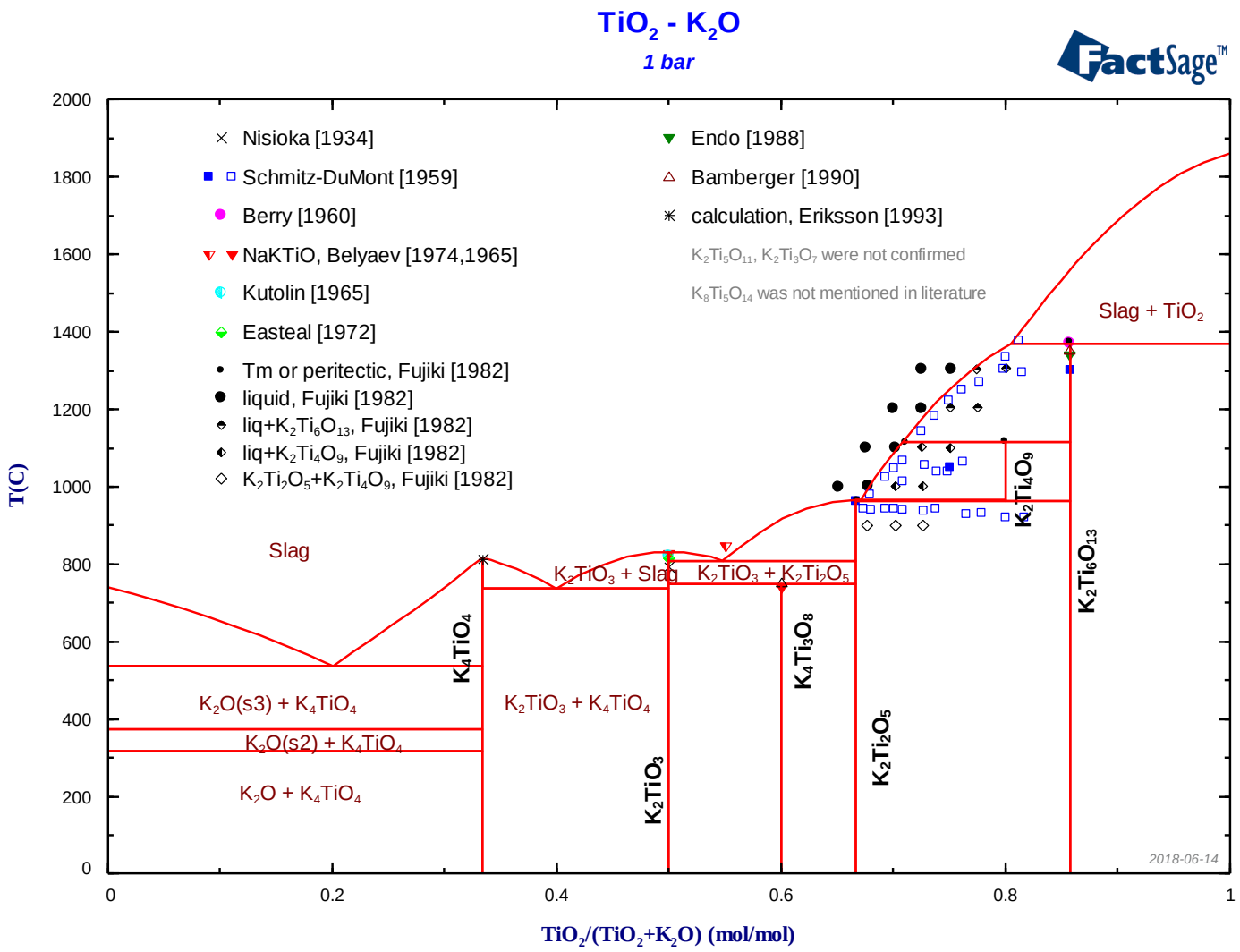
K_2O - SiO_2



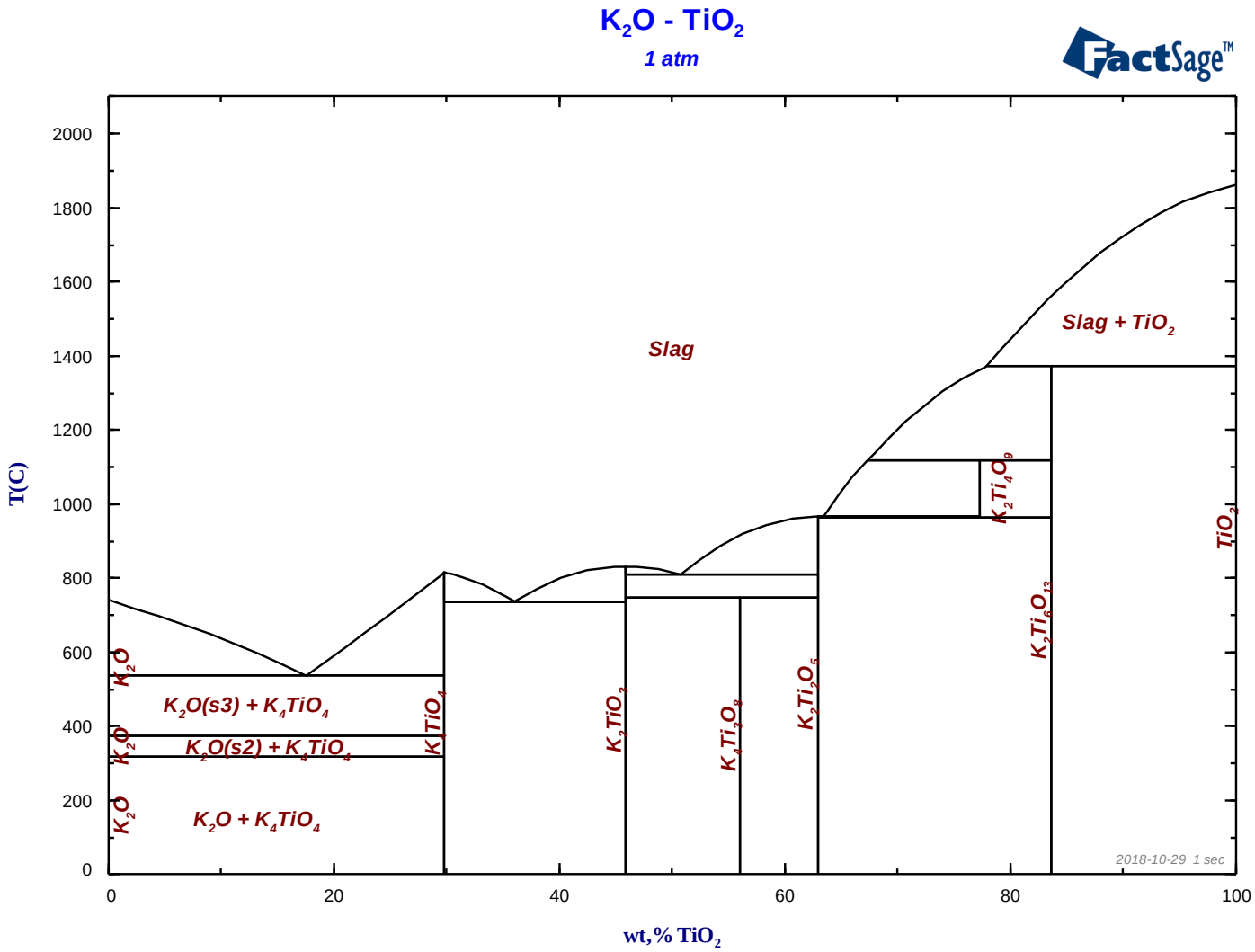
Weight percent



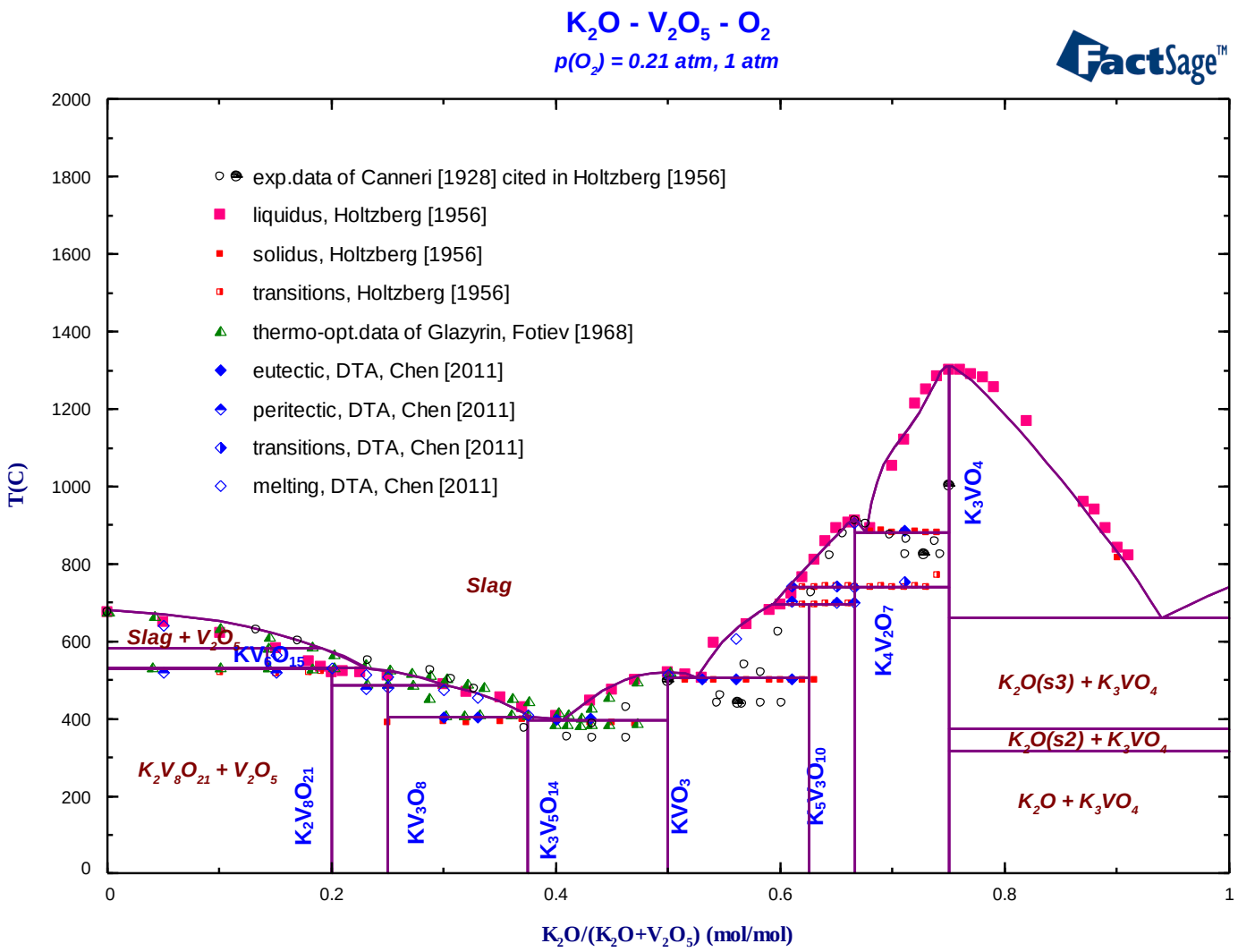
Mole fraction
compared with experimental data



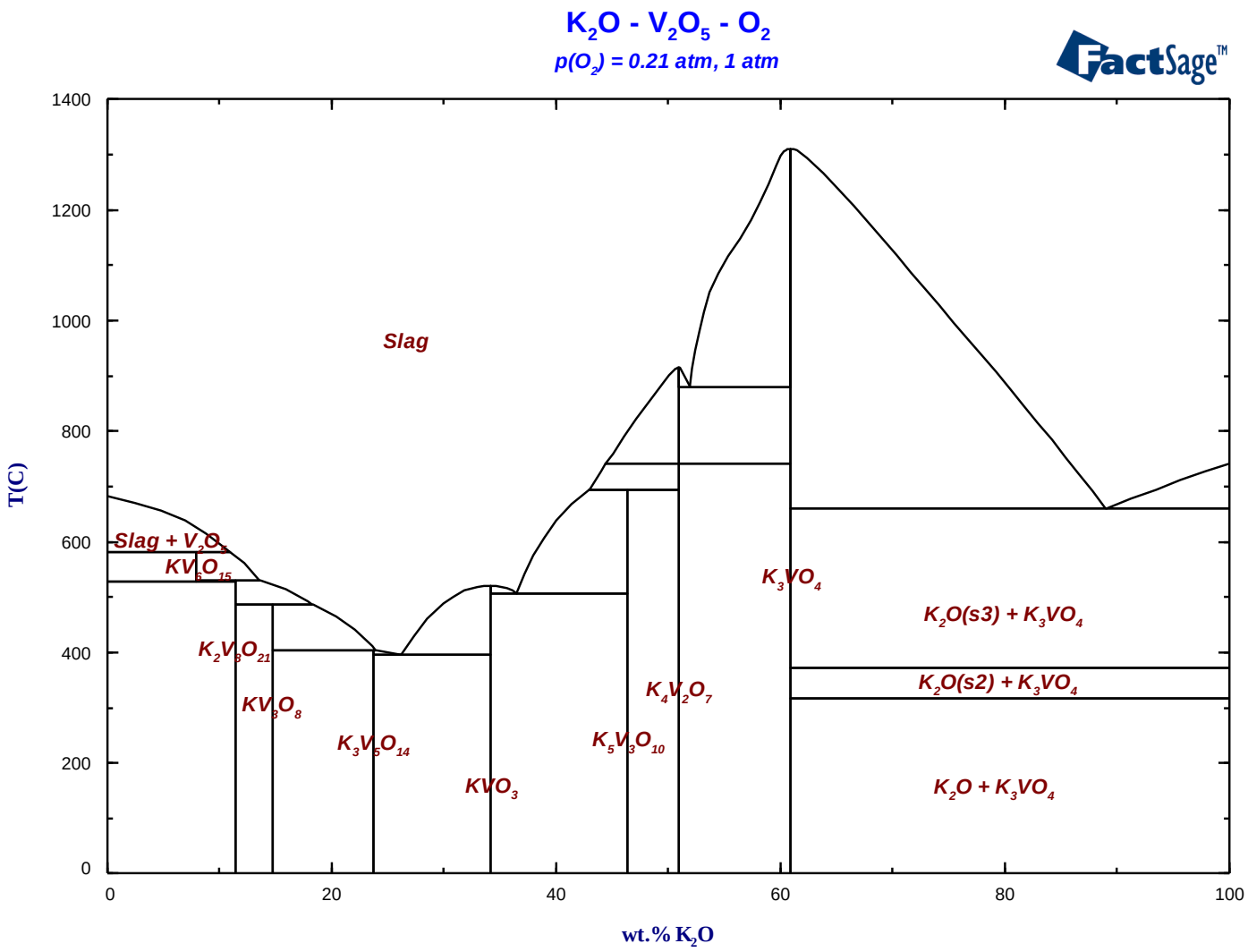
Weight percent



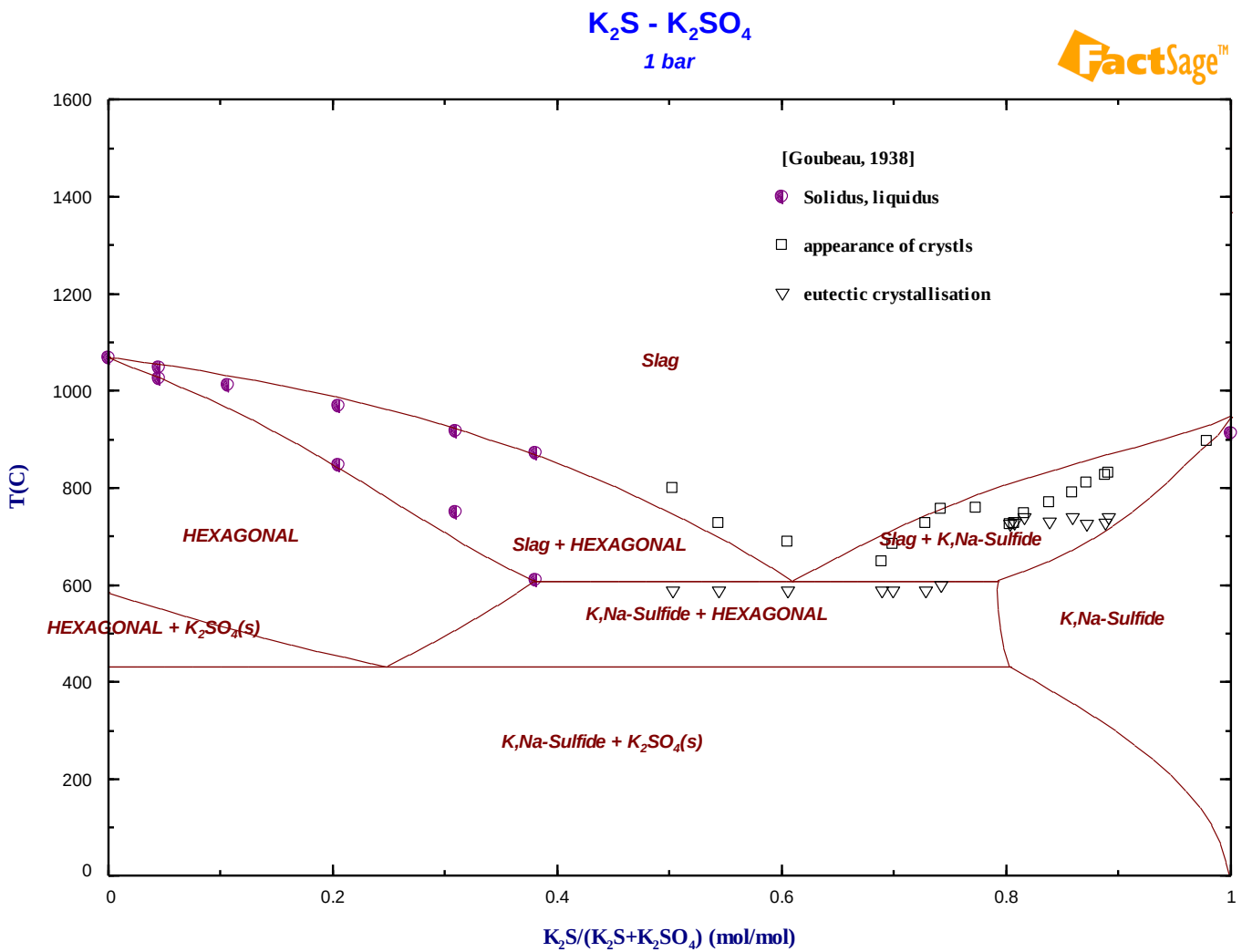
K2O-V2O5,
Mole fraction
compared with experimental data



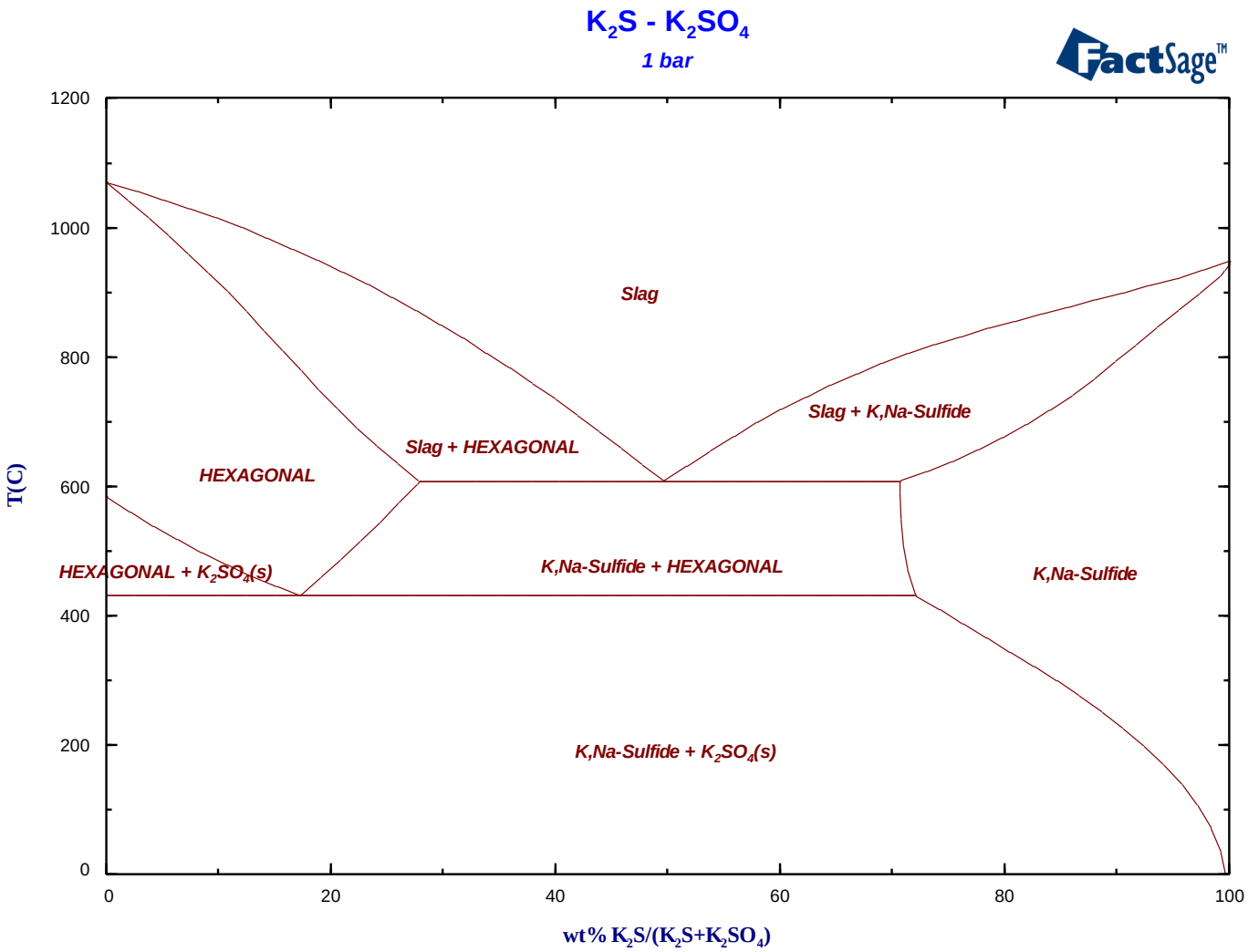
K2O-V2O5,
Weight percent



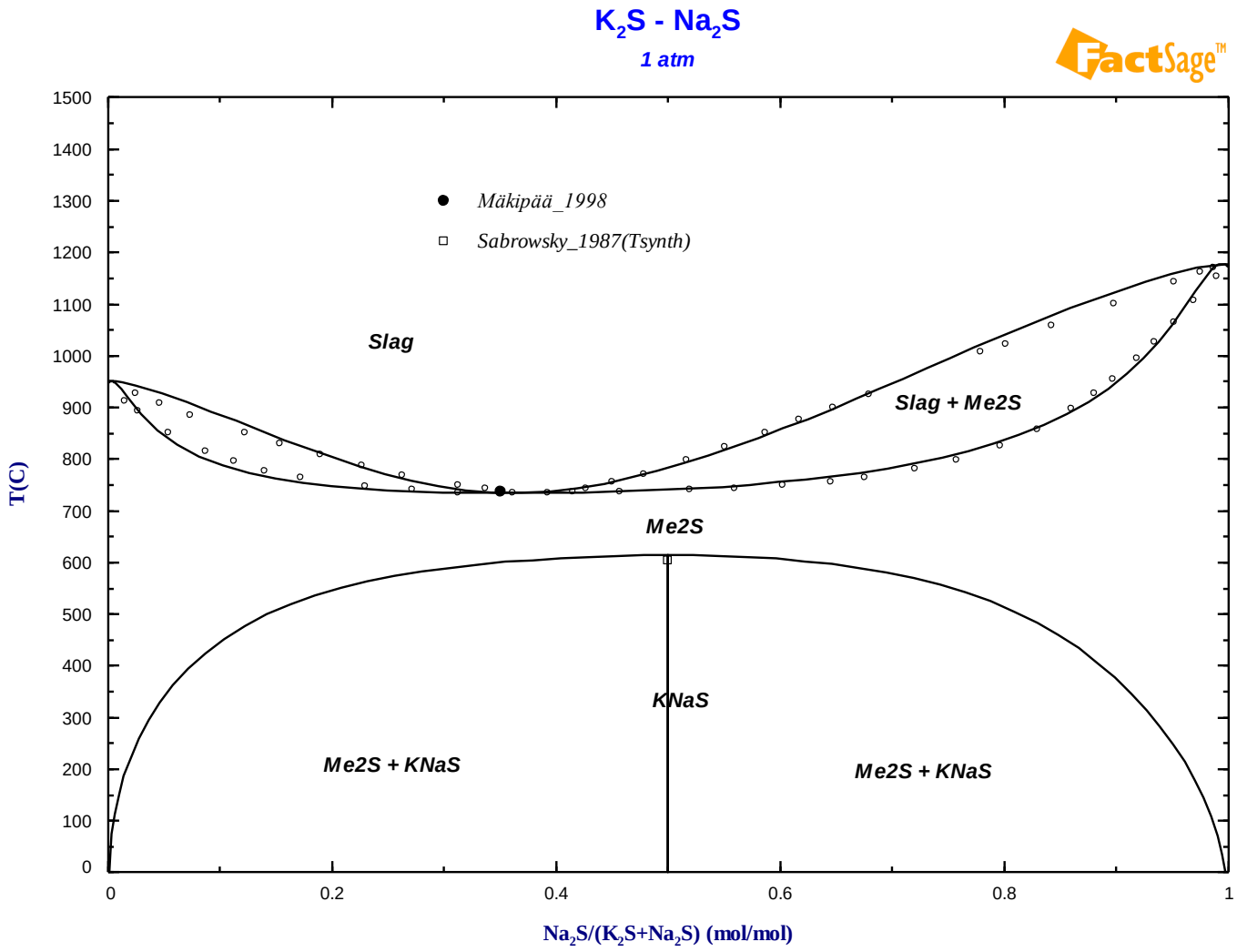
Mole fraction
compared with experimental data

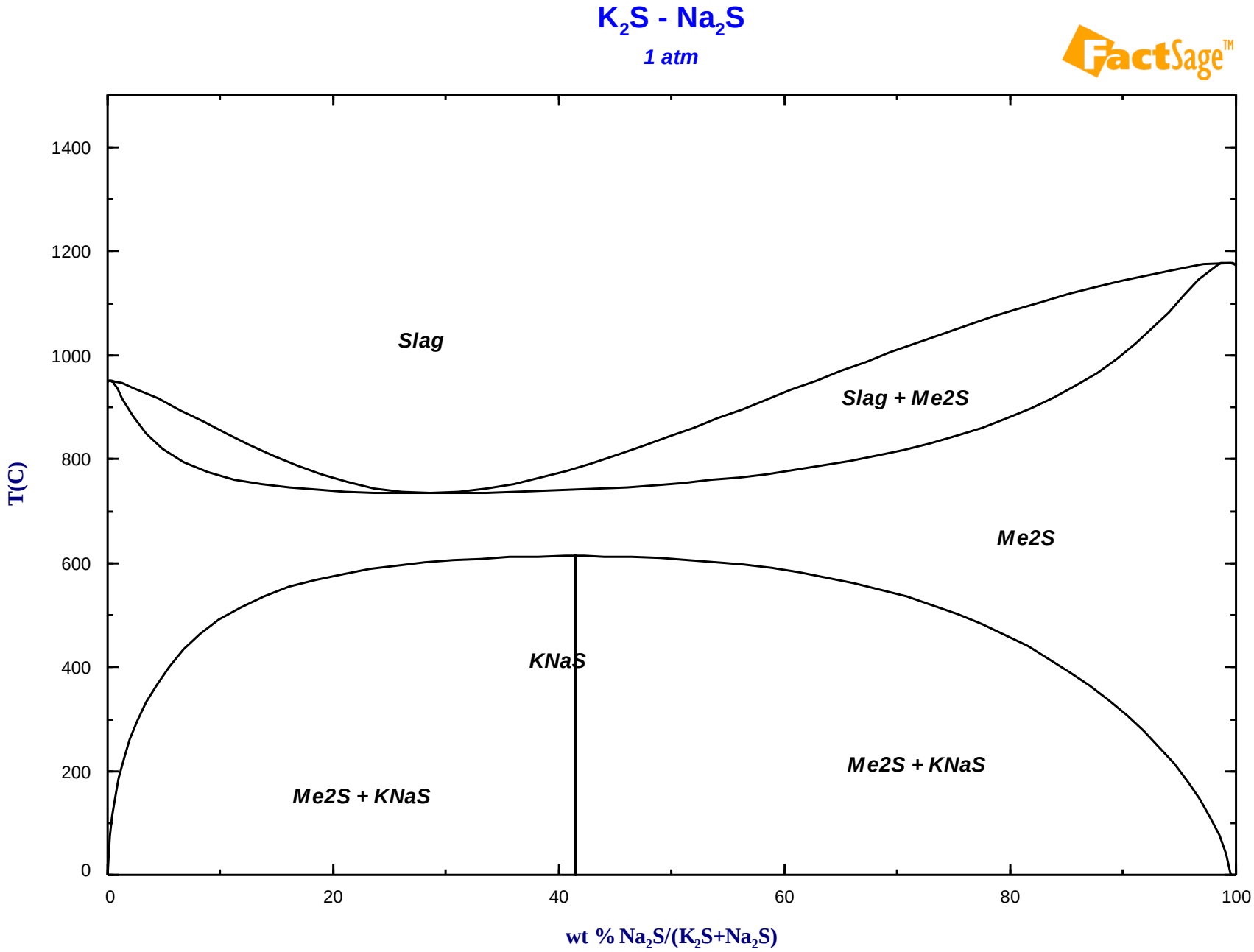


Weight percent

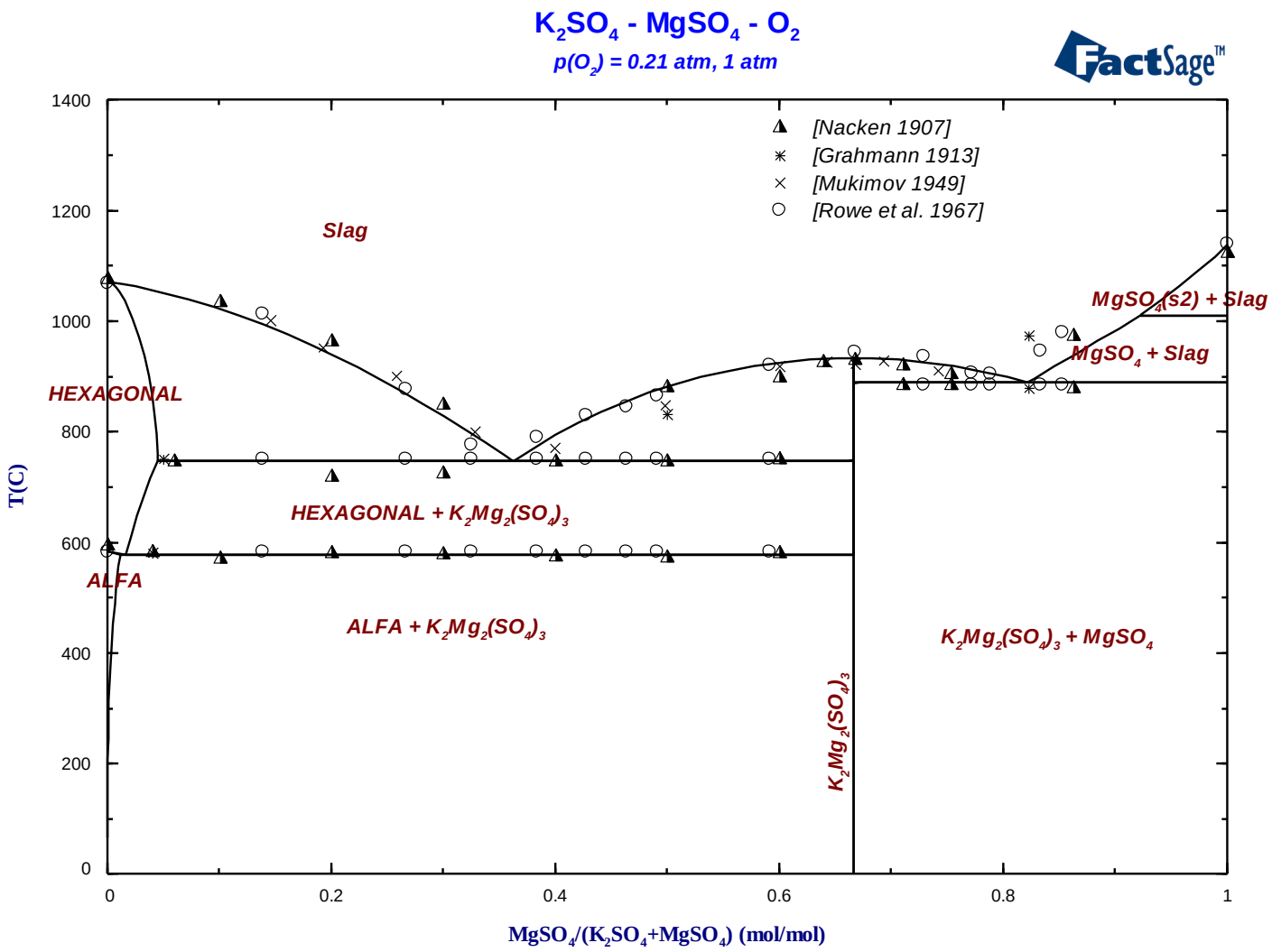


Mole fraction
compared with experimental data

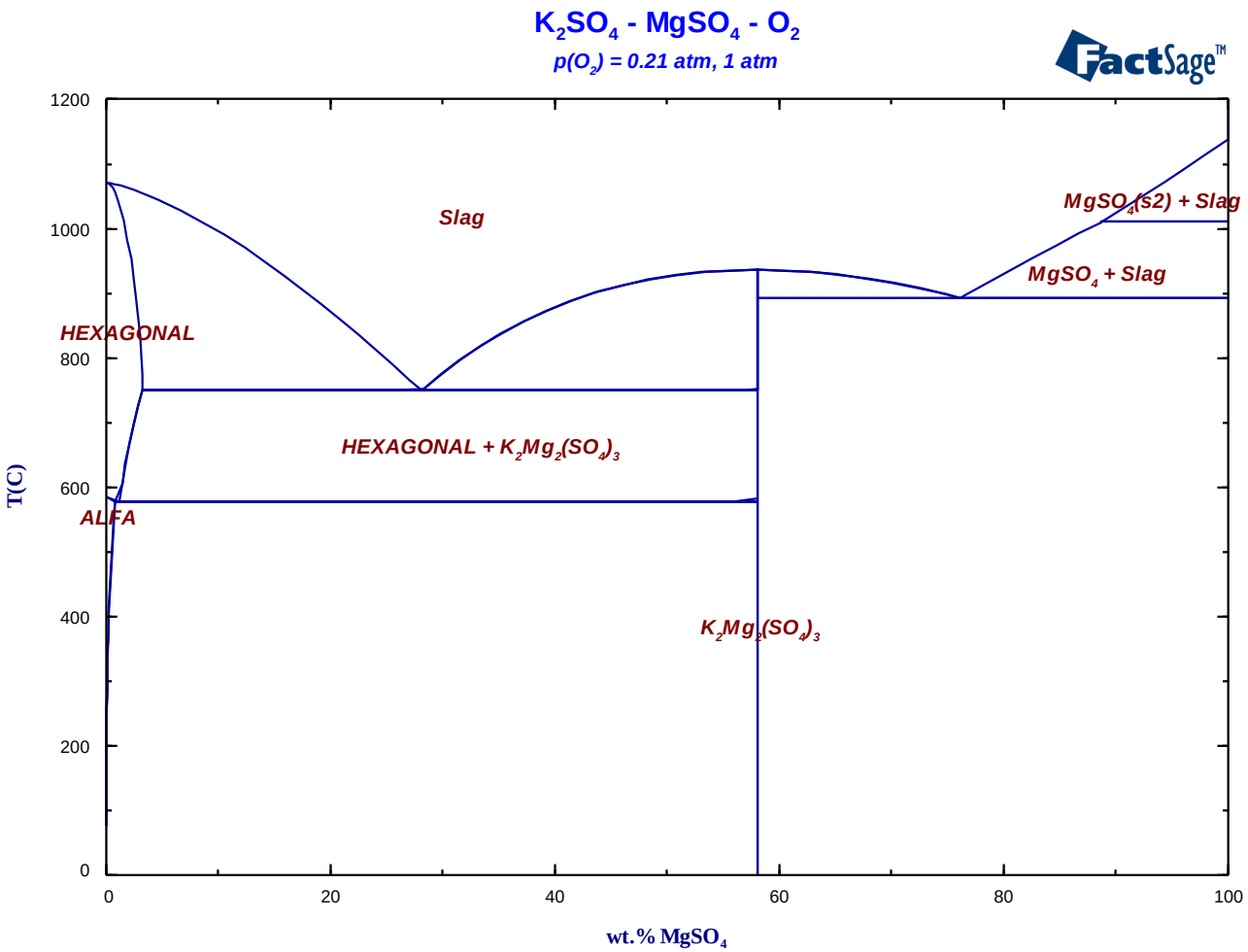



K2S - Na2S
1 atm
FactSage™
Slag
Slag + Me2S
Me2S
KNaS
Me2S + KNaS
Me2S + KNaS
T(C)
1400
1200
1000
800
600
400
200
0
0
20
40
60
80
100
wt % Na2S/(K2S+Na2S)

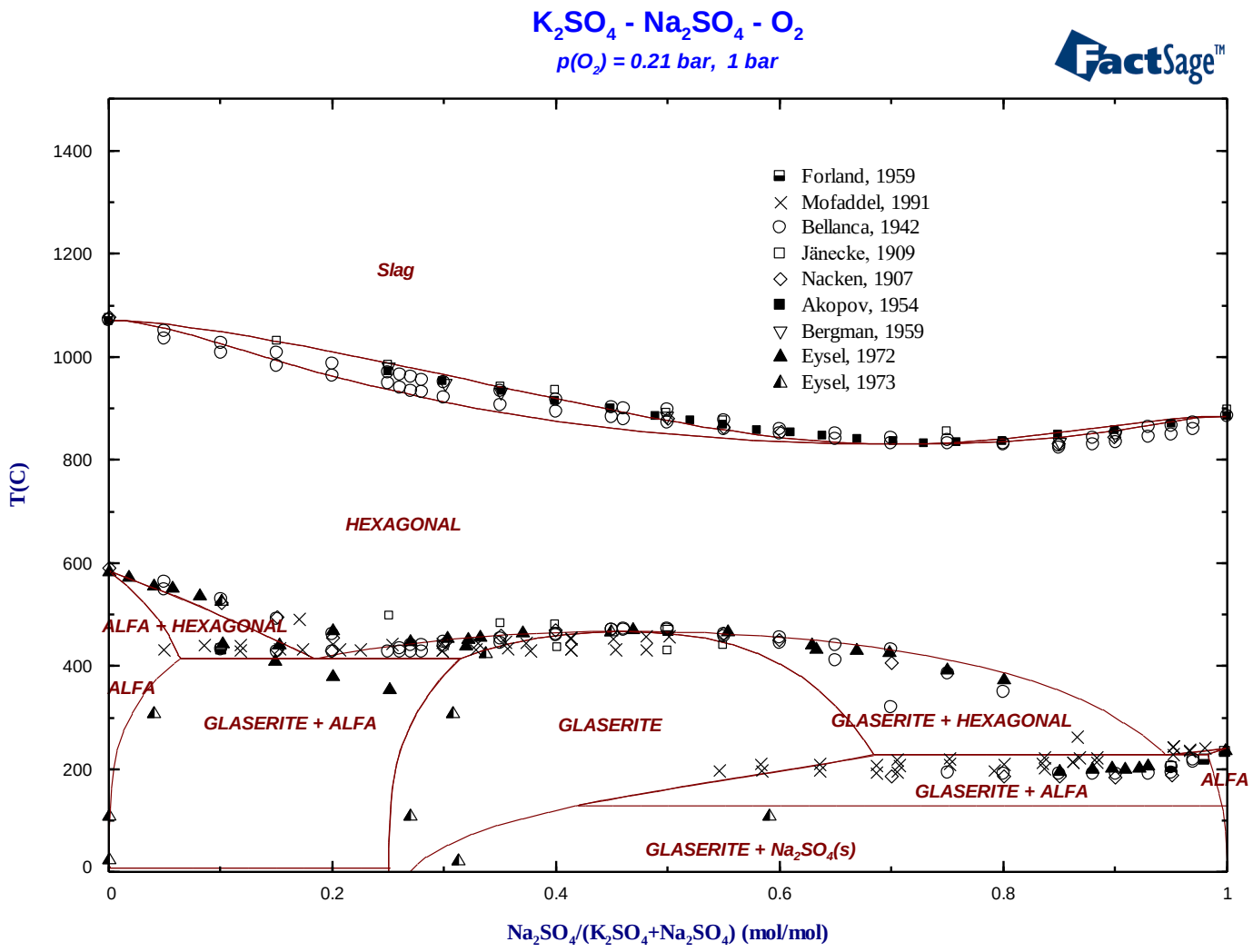
Mole fraction compared with experimental data



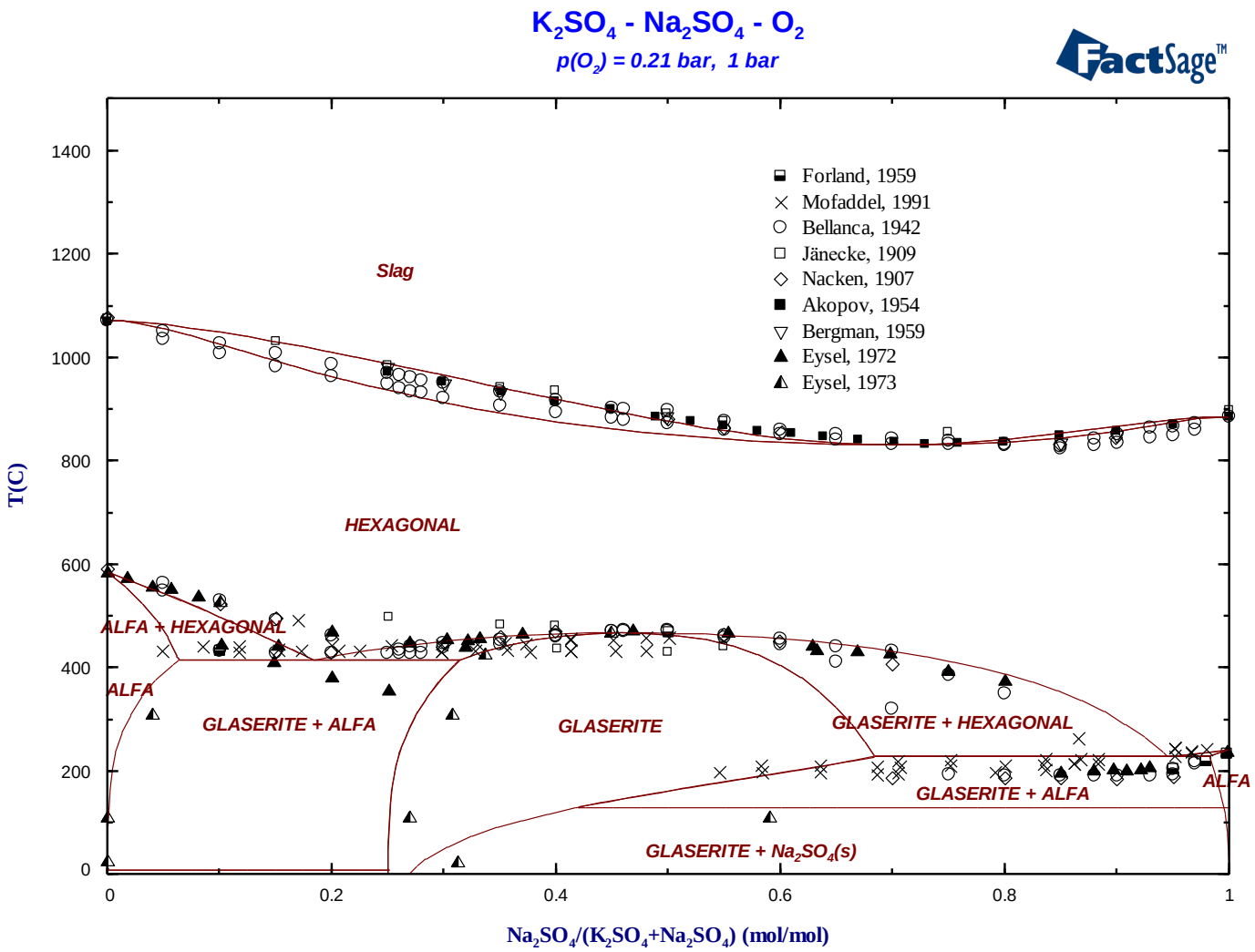
Weight percent



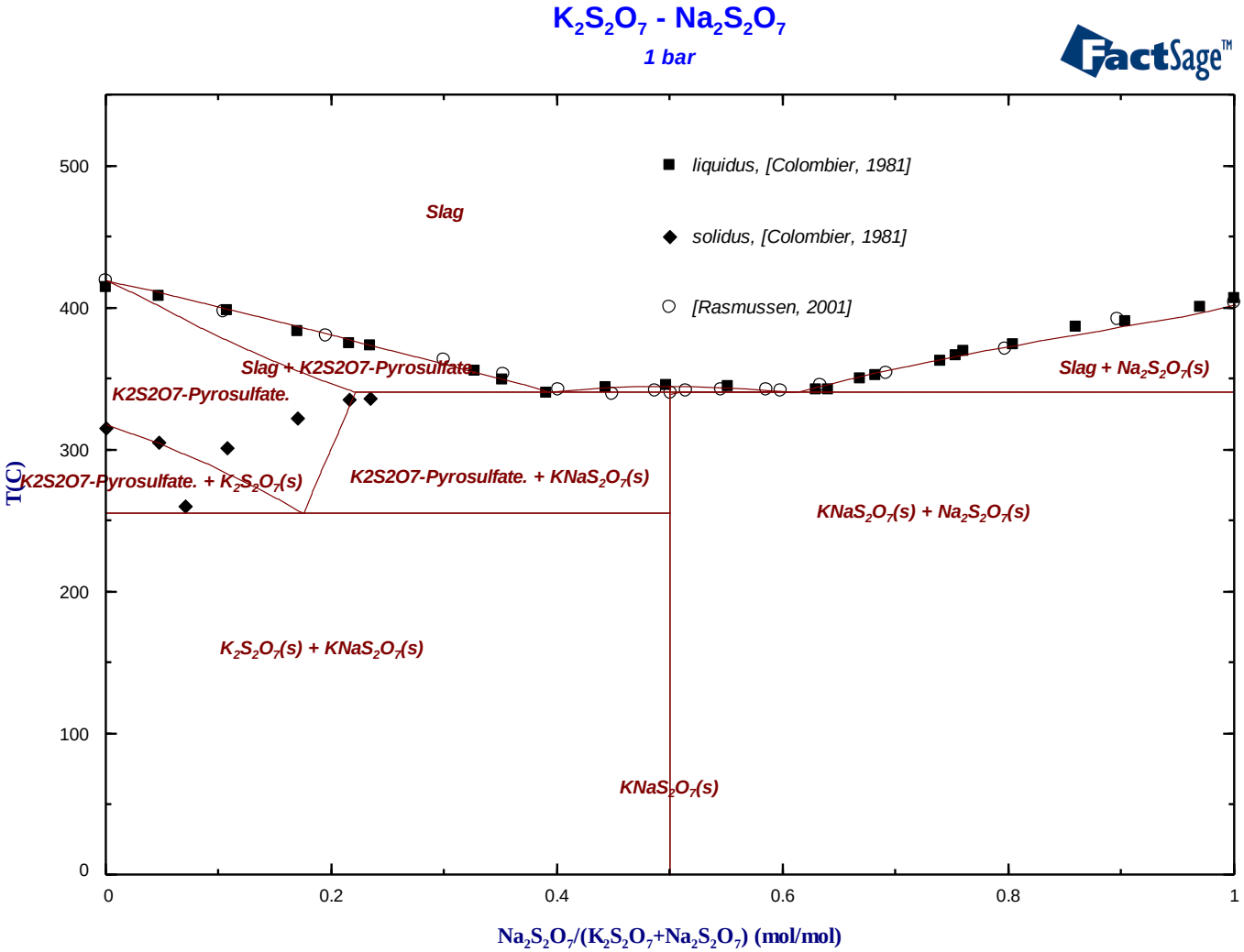
Mole fraction
compared with experimental data



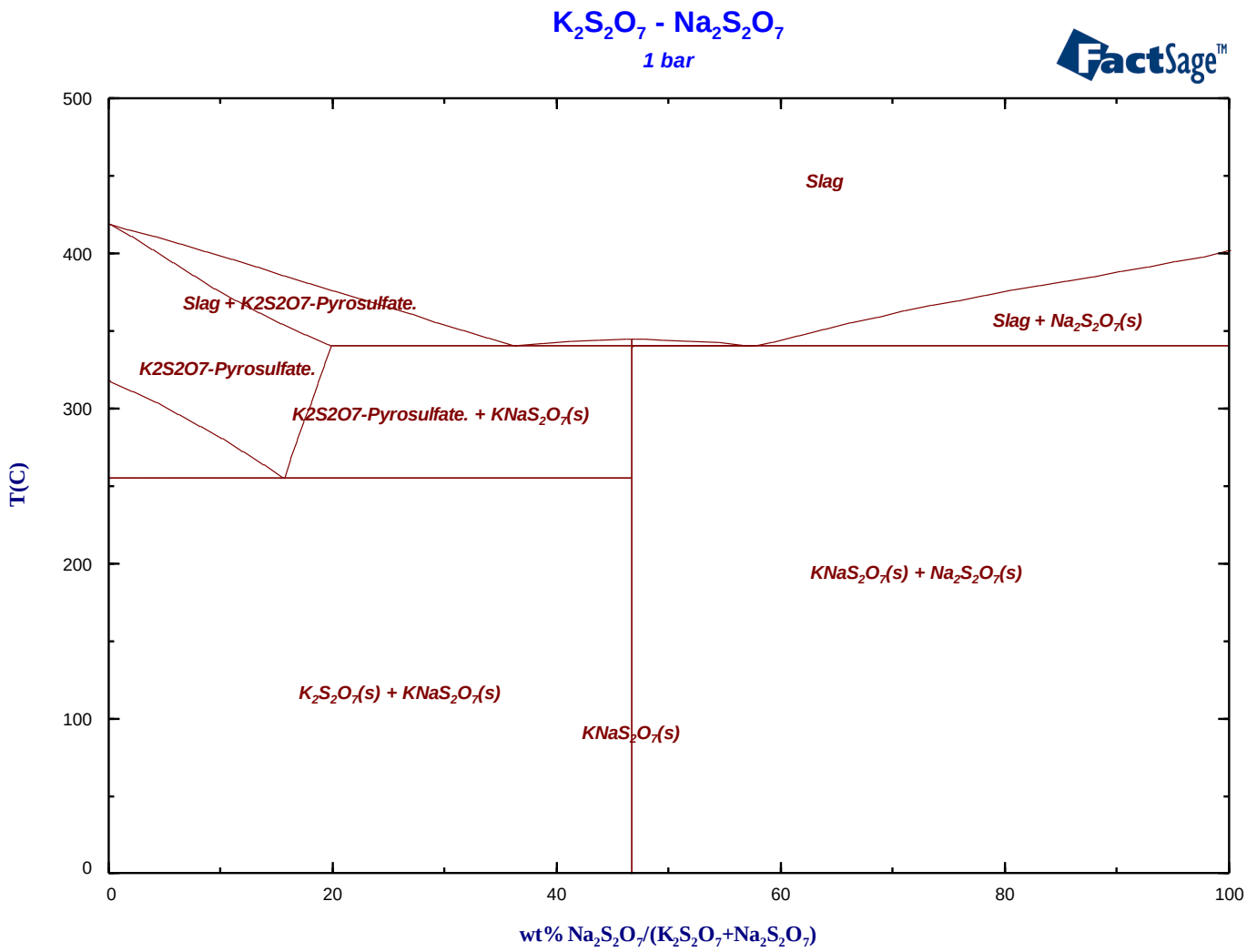
Weight percent



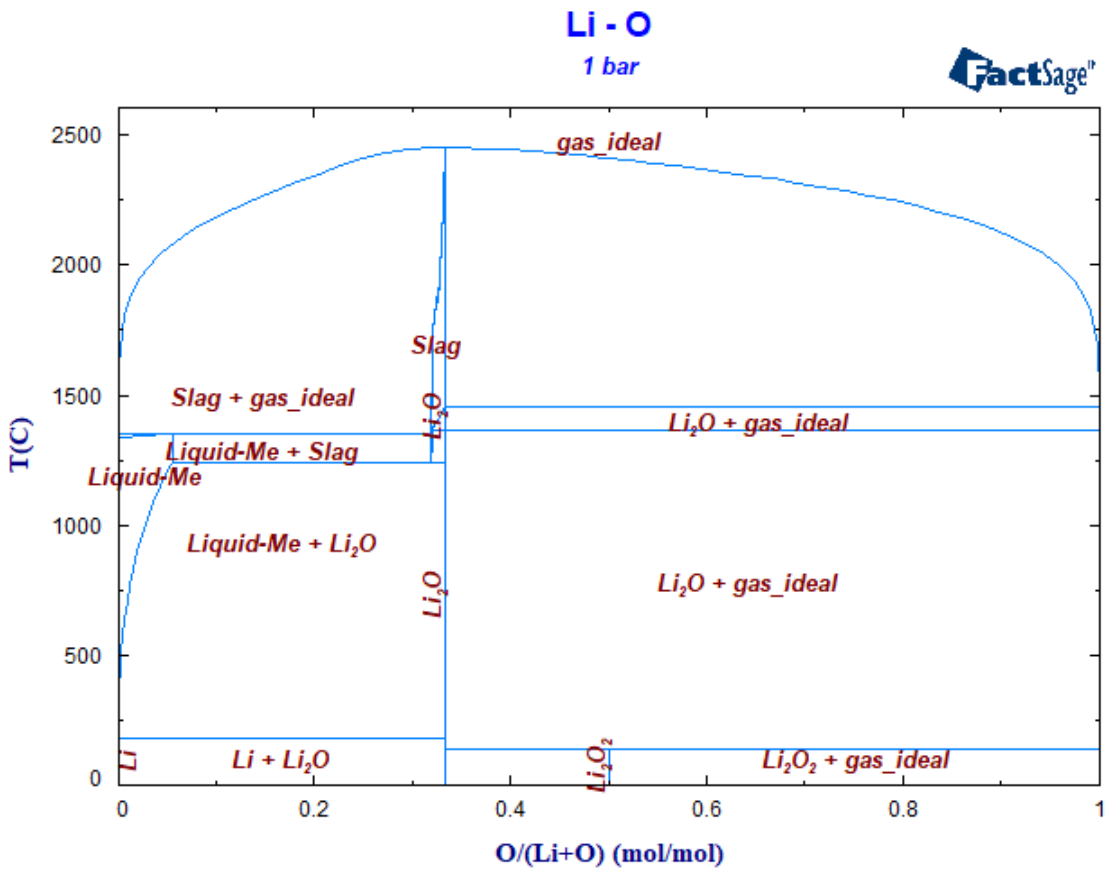
Mole fraction
compared with experimental data



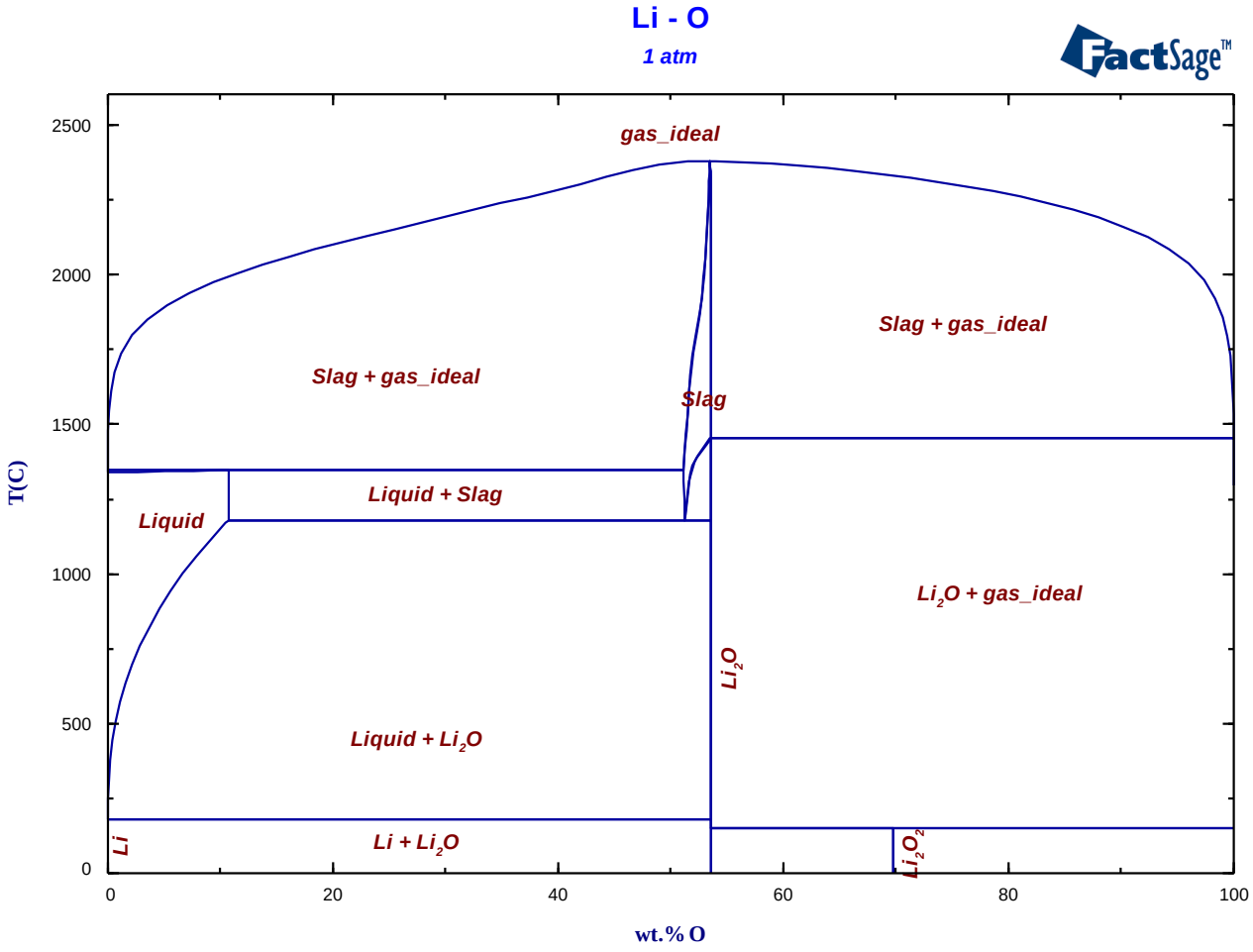
Weight percent



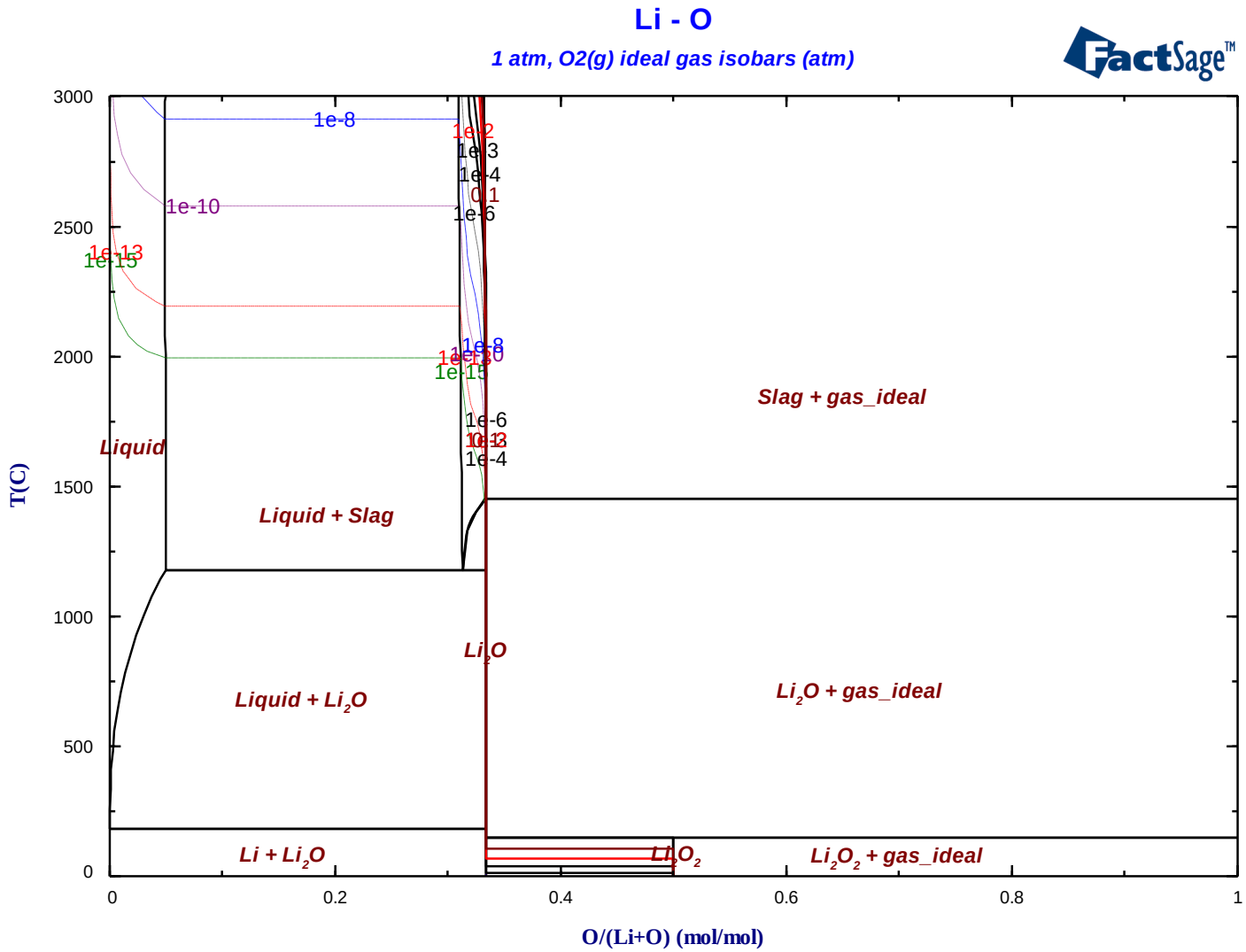
Li-O,
Mole fraction



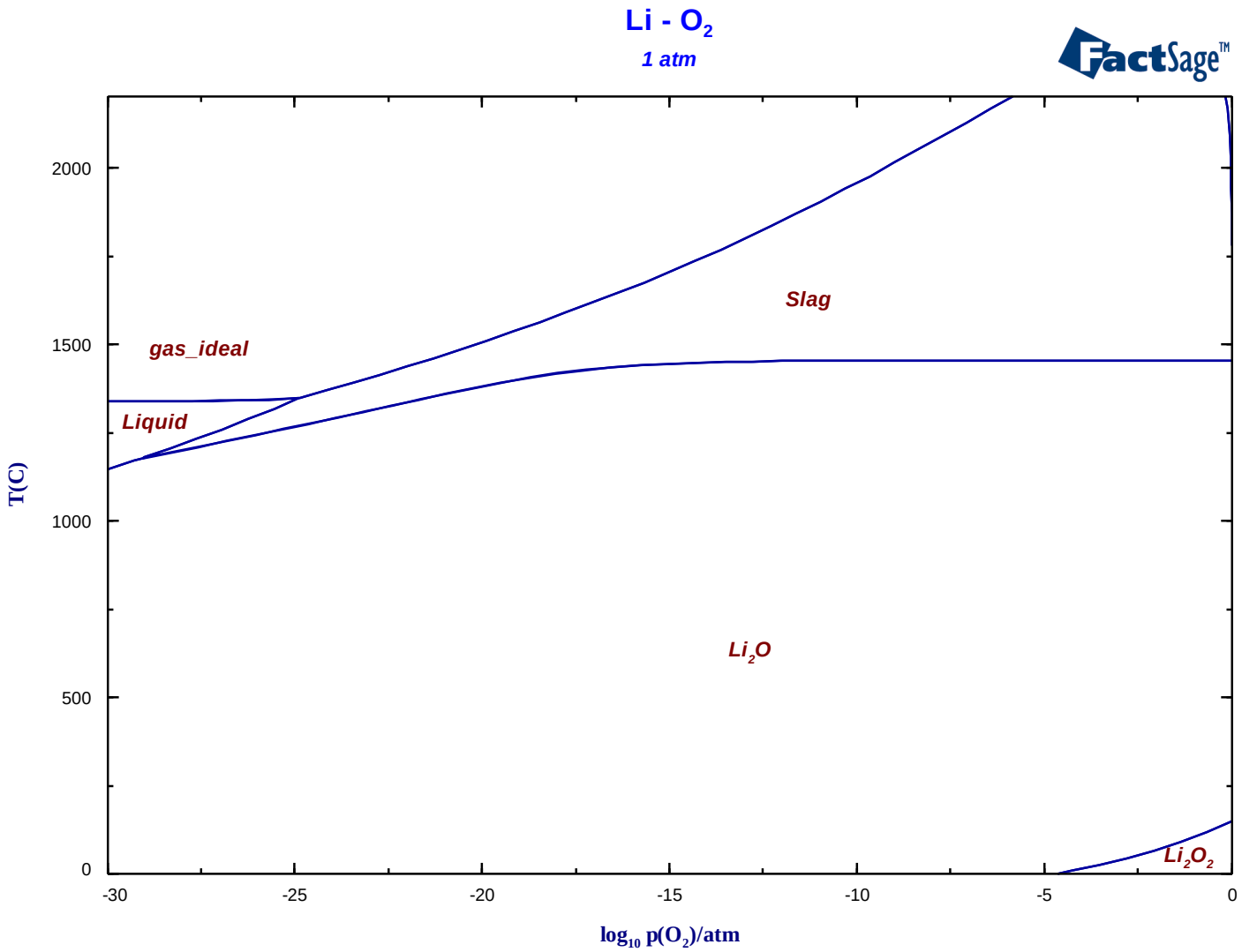
Li-O,
Weight percent



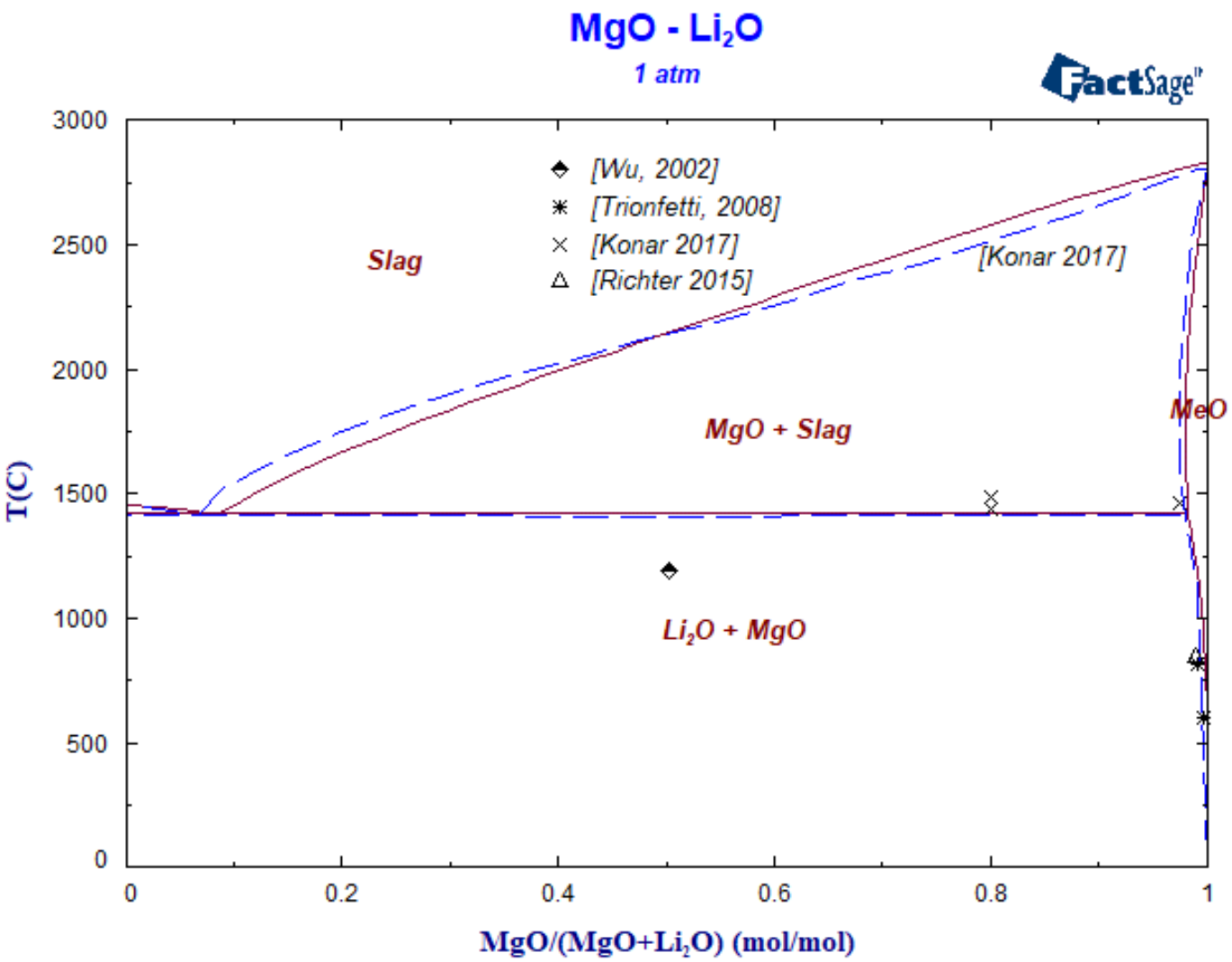
Li-O,
Mole fraction with isobars



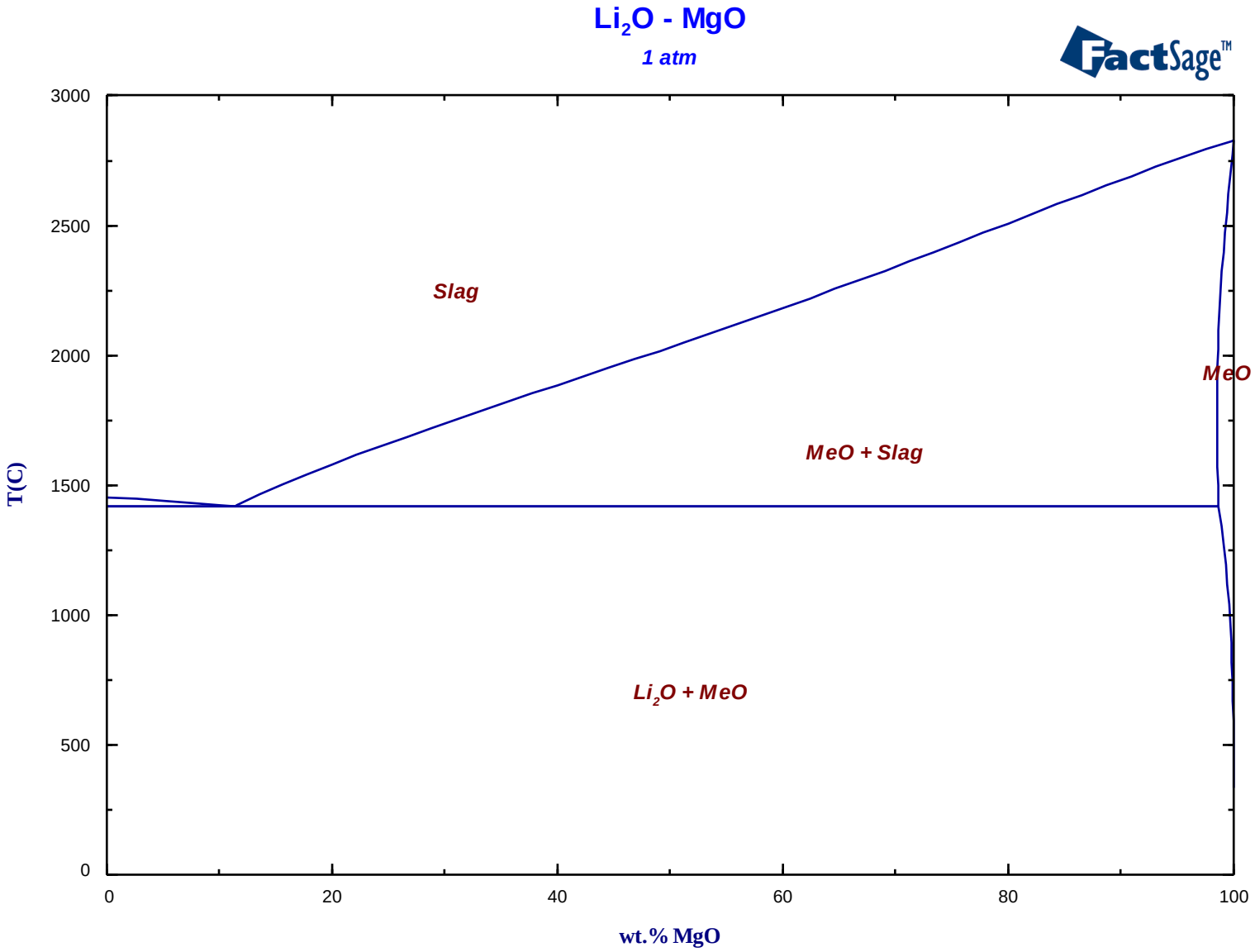
Li-O,
Temperature vs. log P(O2) diagram



Li2O-MgO,
Mole fraction



Li2O-MgO,
Weight percent



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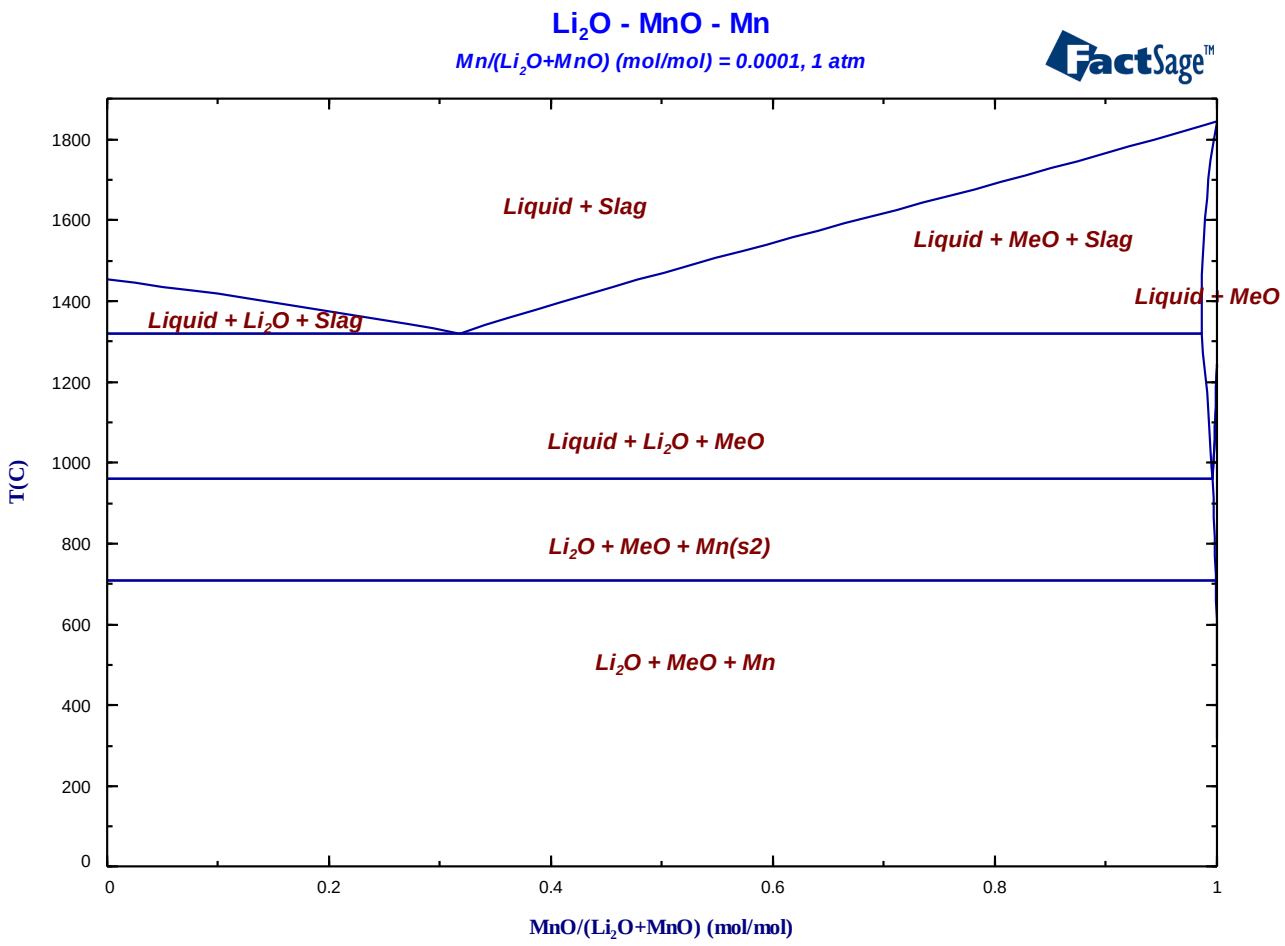

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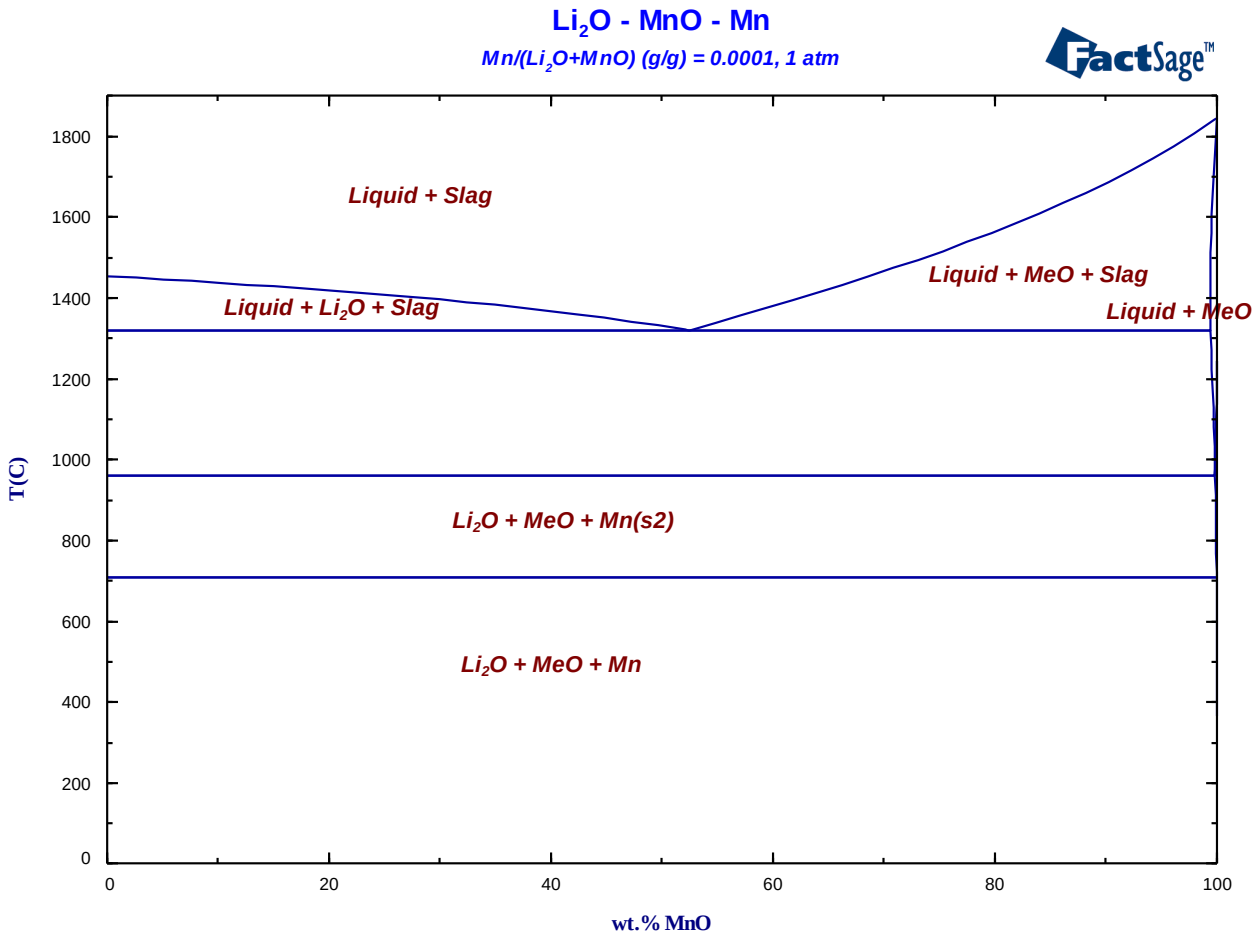

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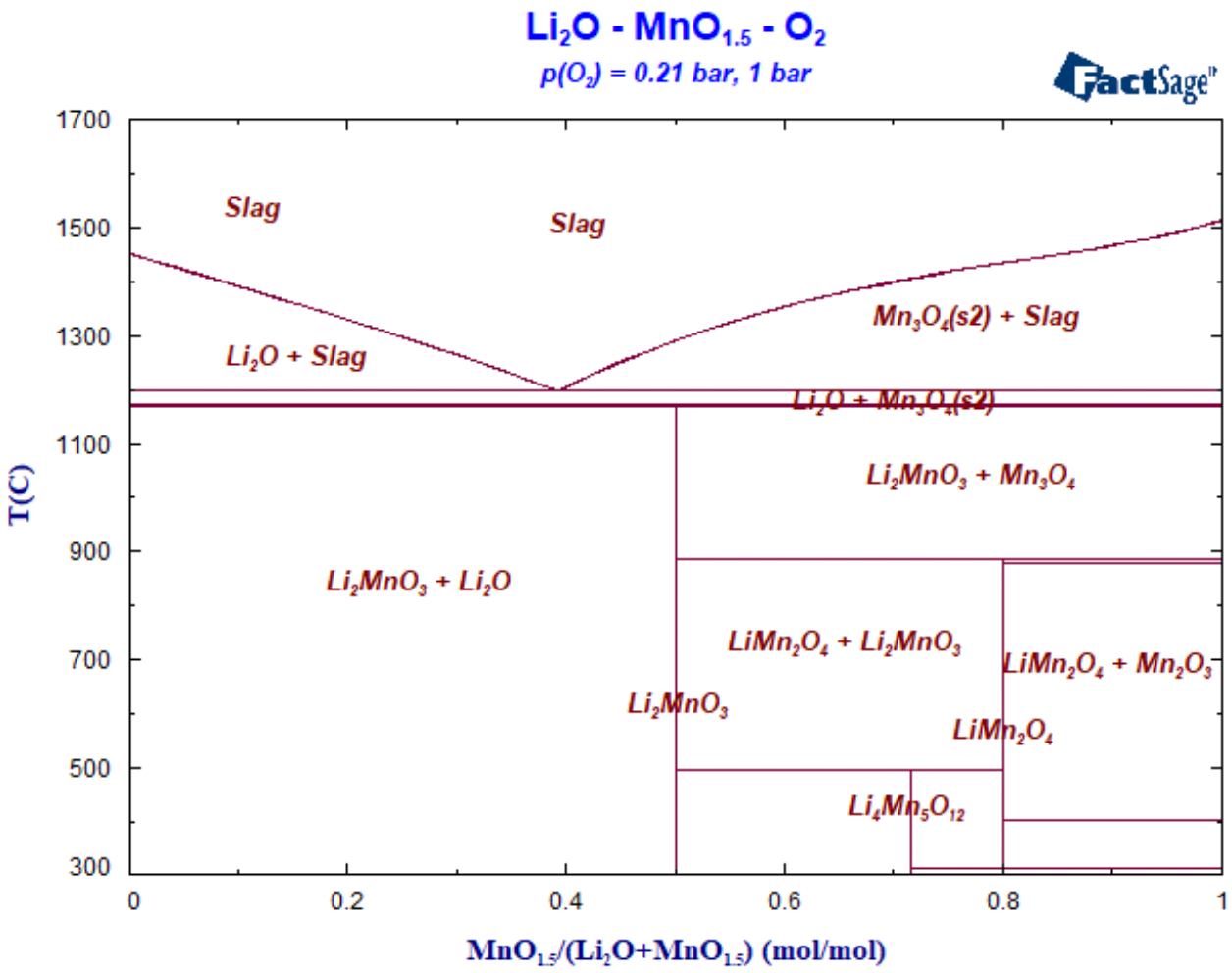

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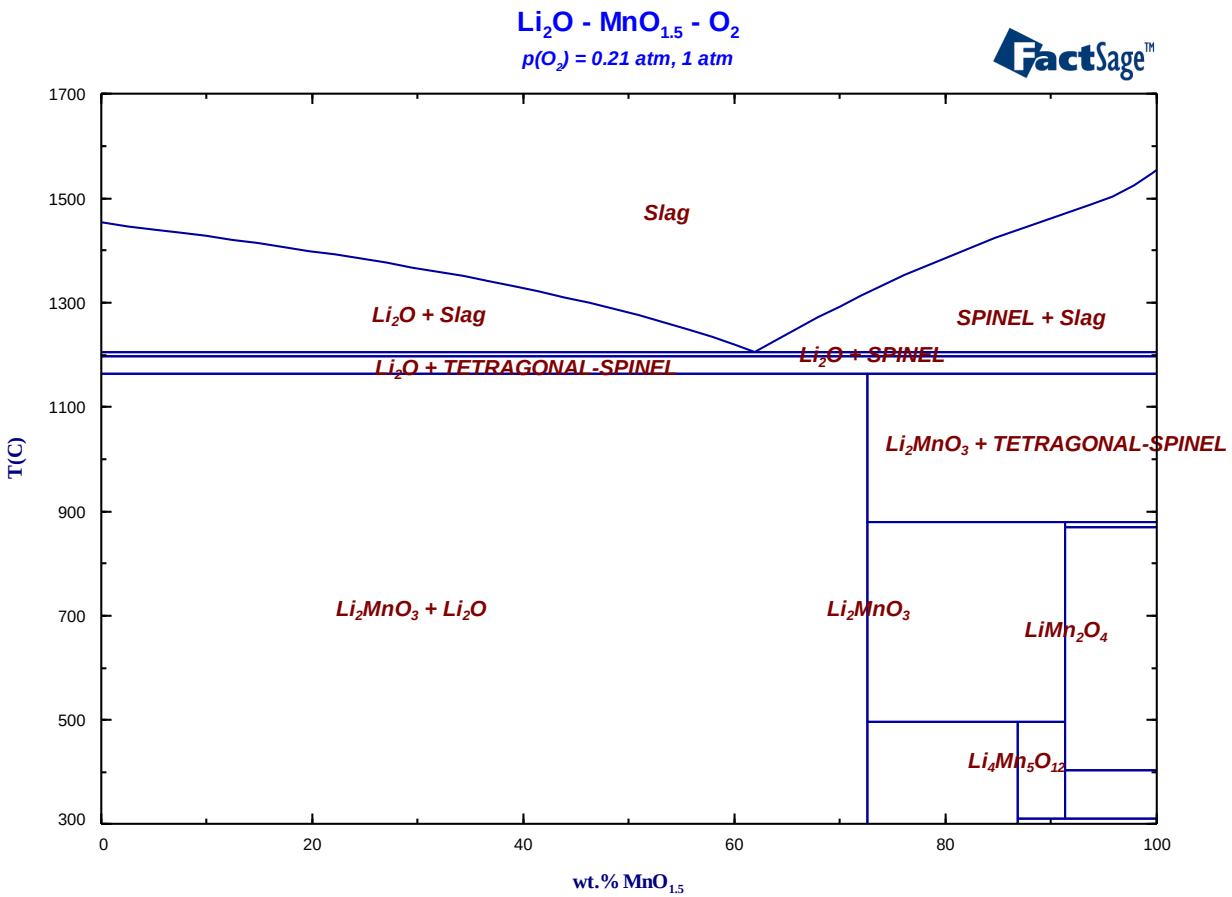

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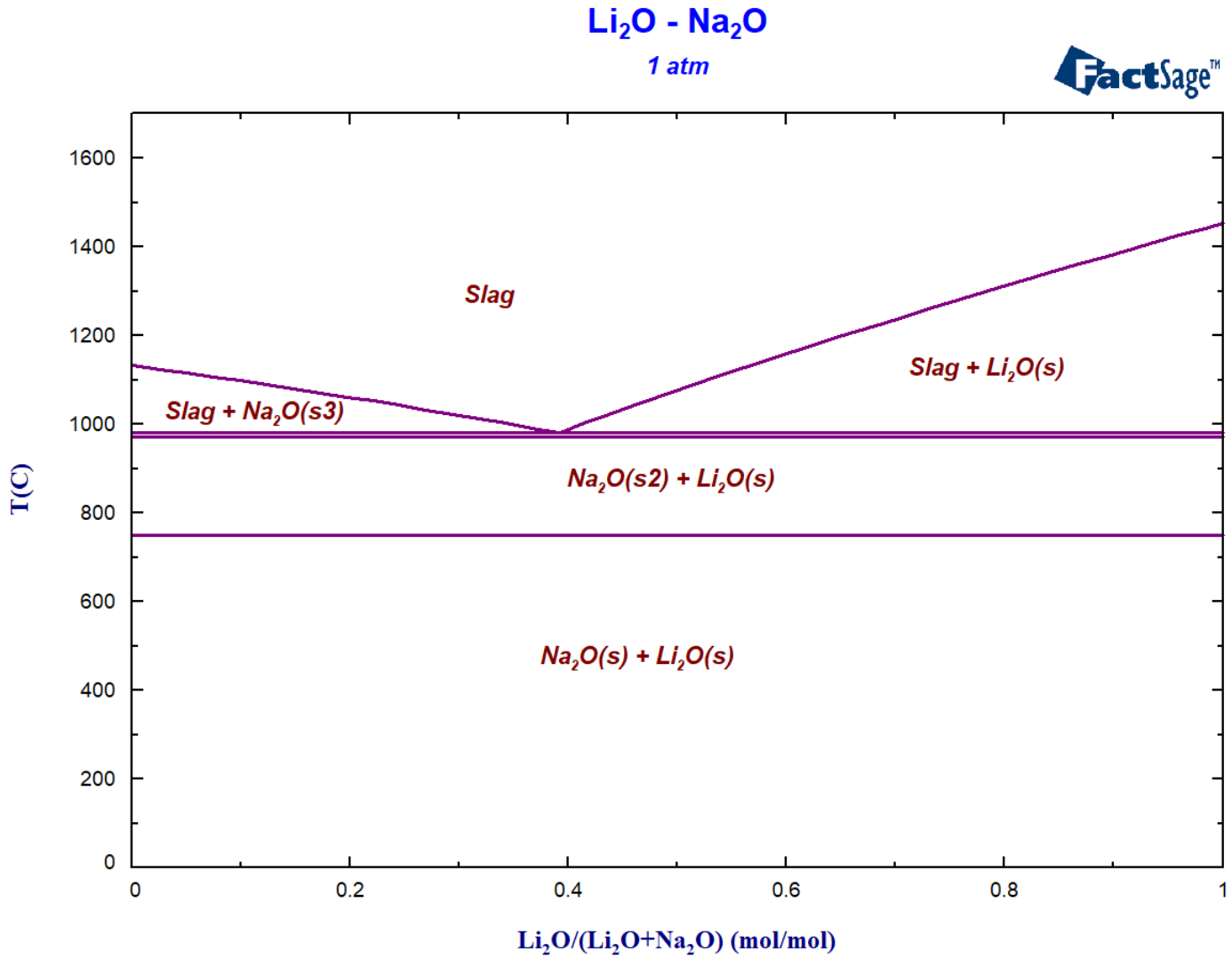

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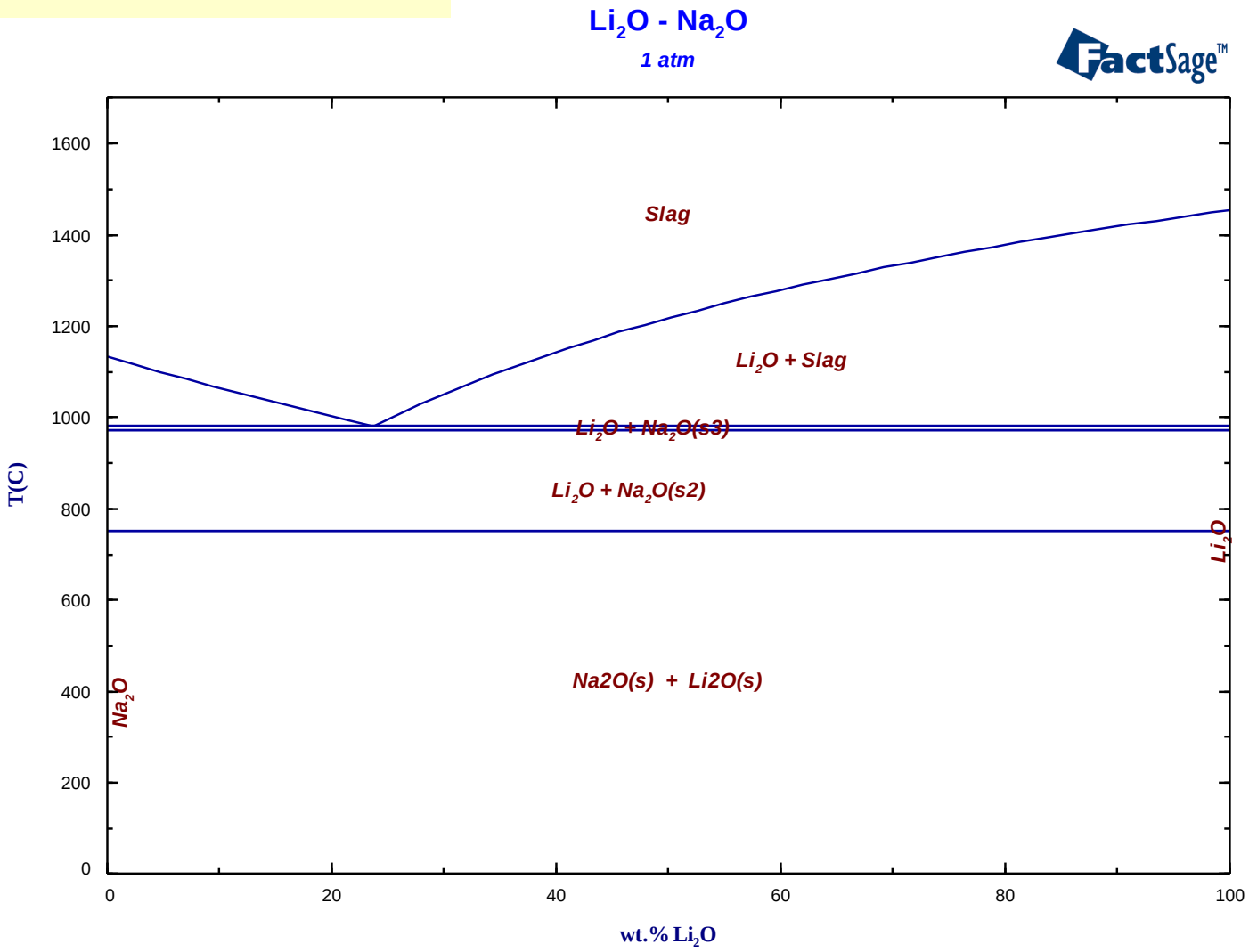

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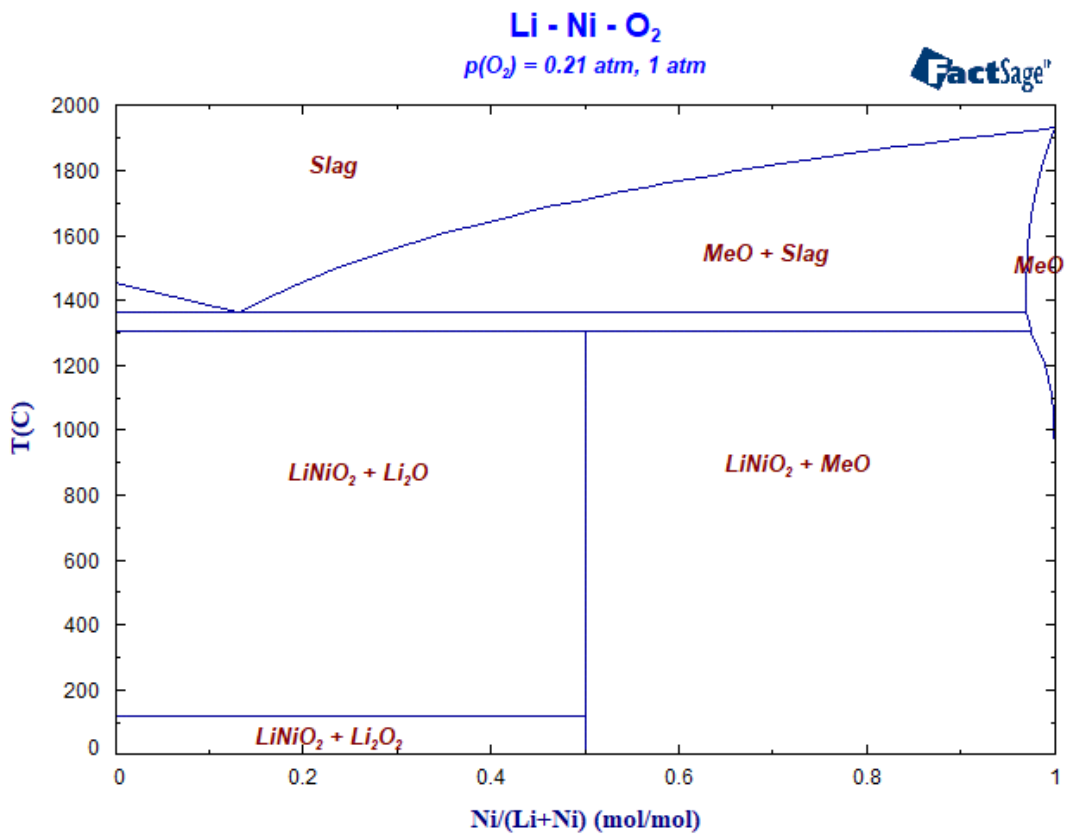

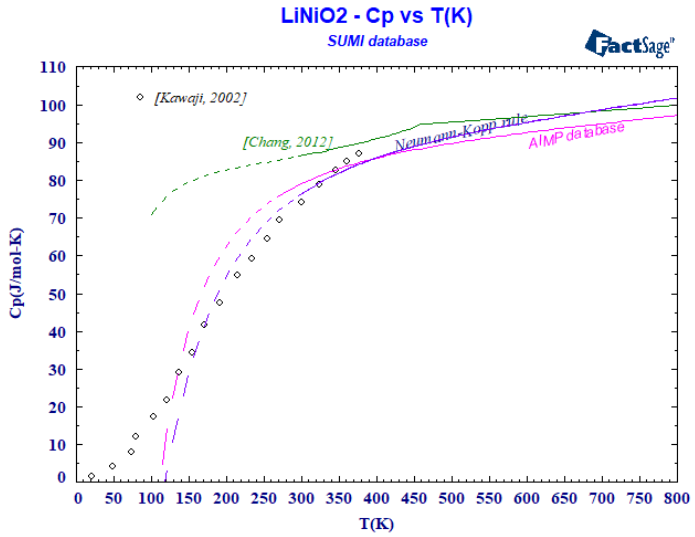

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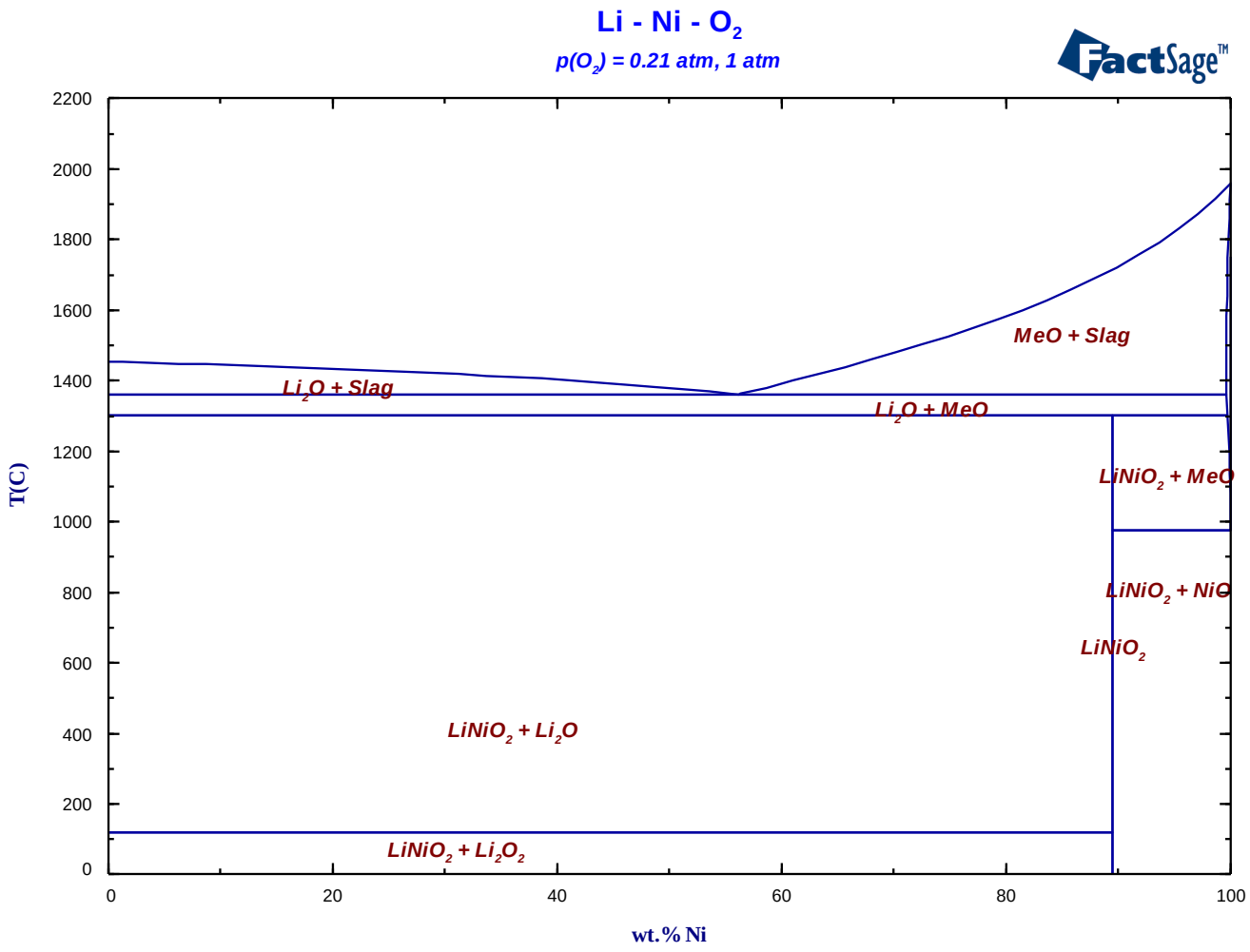
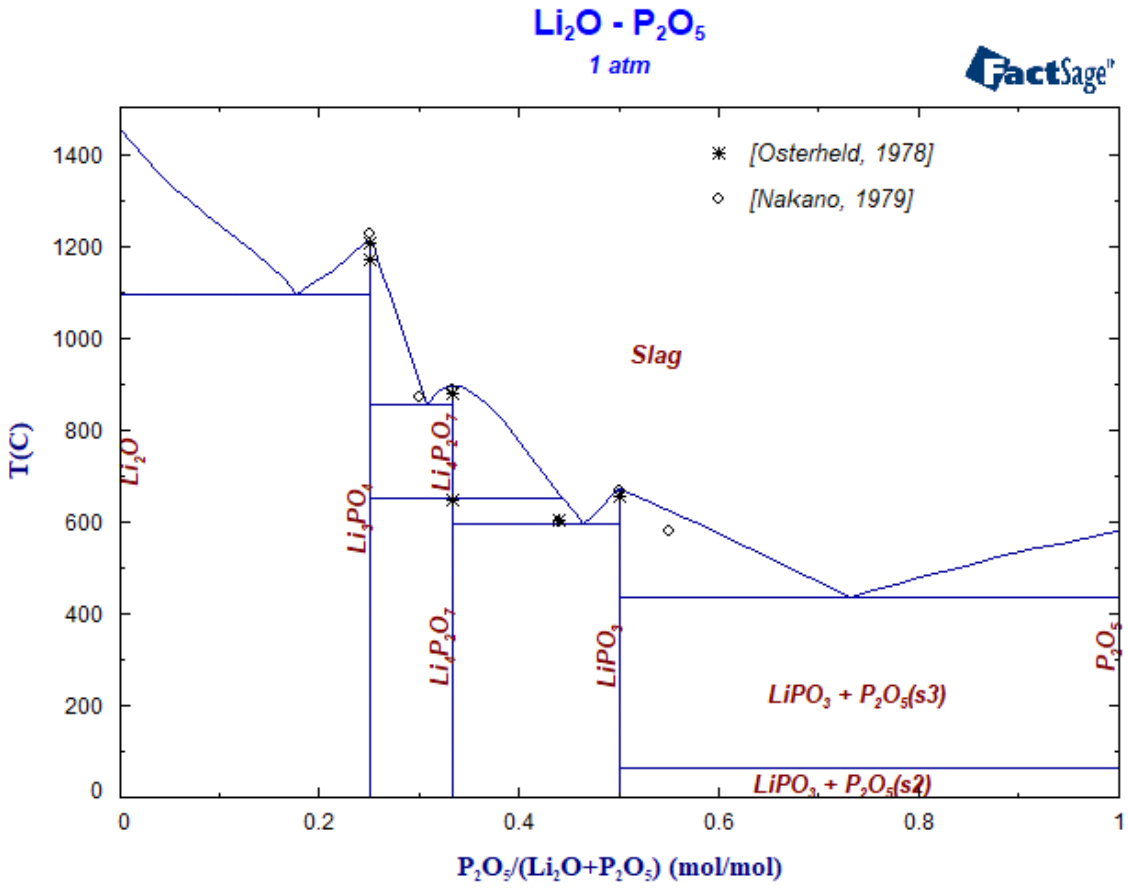
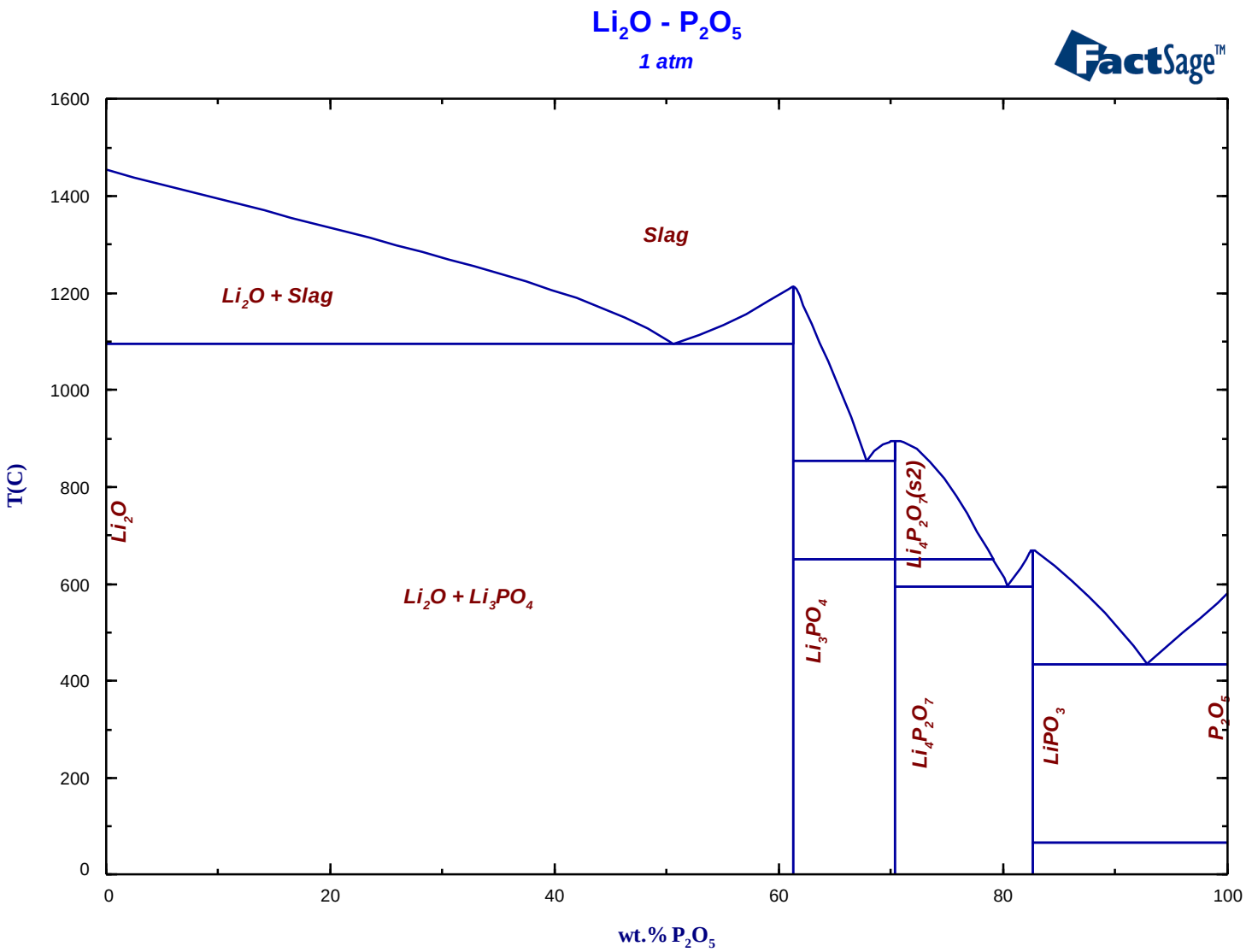


Li2O-P2O5,
Mole fraction compared with experimental data

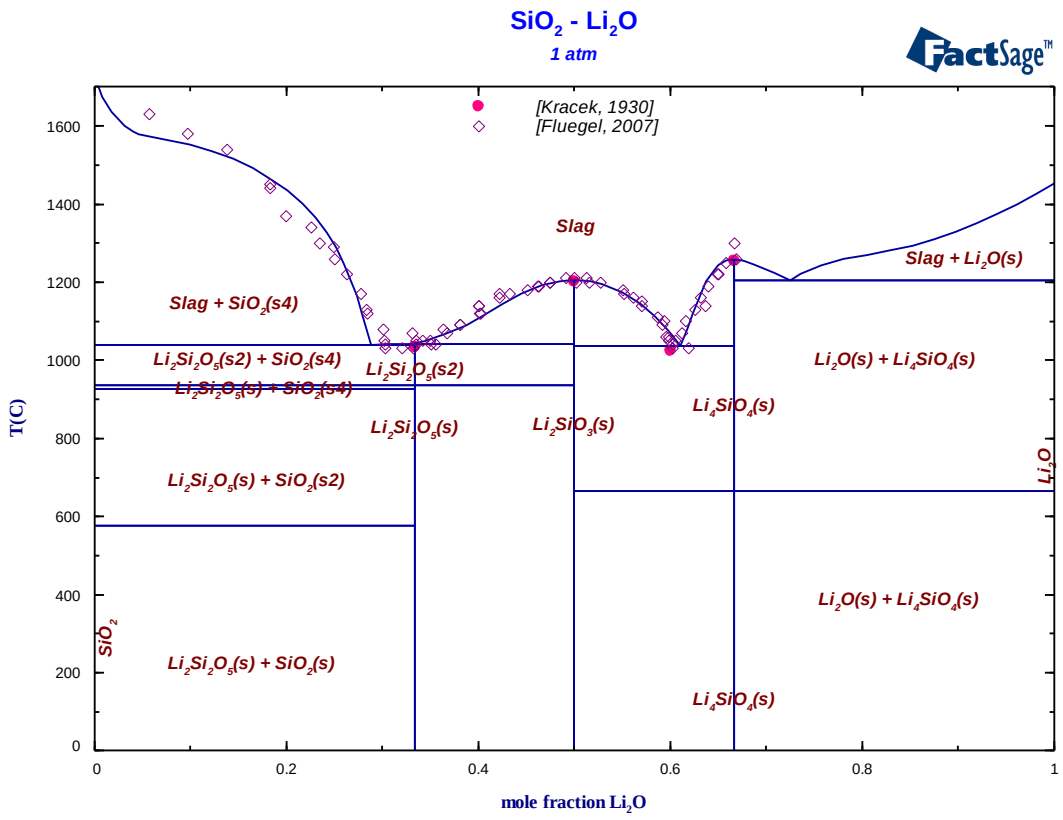


Slag	***(Li_2O, P_2O_5, $LiPO_3$, $Li_4P_2O_7$, Li_3PO_4)***	This work using [Jin, 2019]
$LiPO_3$	***stoichiometric***	[Jin, 2019]
$Li_4P_2O_7$	***stoichiometric***	[Jin, 2019]
Li_3PO_4	***stoichiometric***	[Jin, 2019]

Li2O-P2O5,
Weight percent

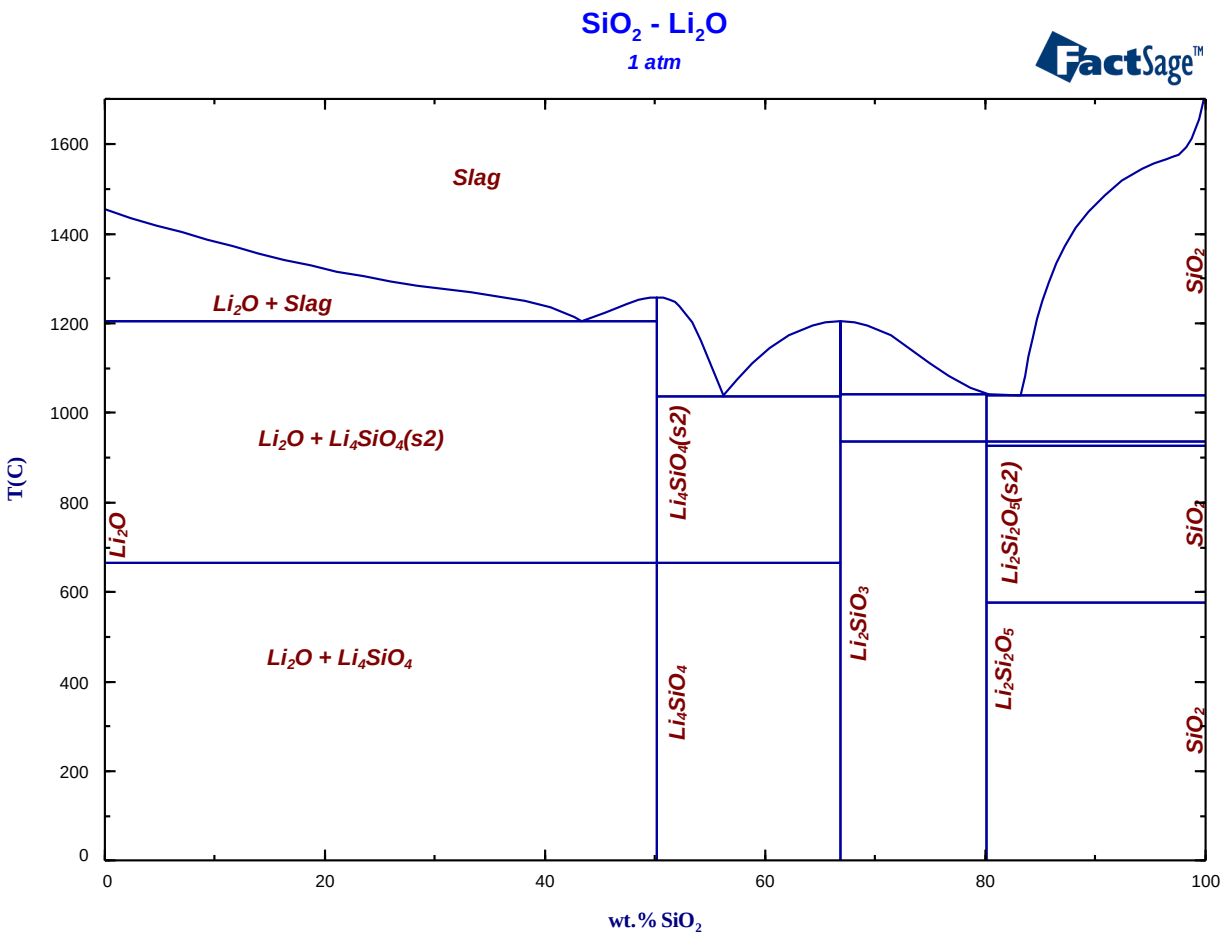


Li2O-SiO2,
Mole fraction compared with experimental data



$Li_4SO_4(s) \rightarrow Li_4SiO_4(s2)$, H_{tr}=900 J/mol [2000Kleykamp]

Li2O-SiO2,
Weight percent



Li2O-ZnO,
Mole fraction

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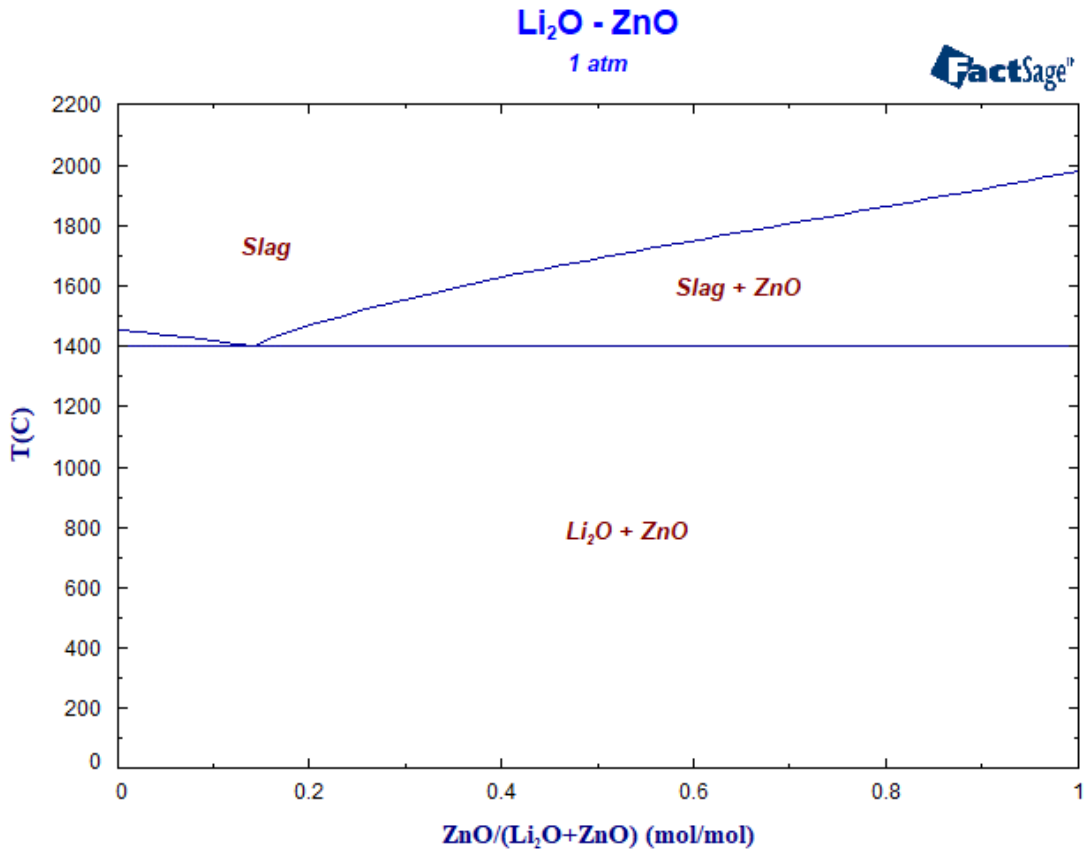

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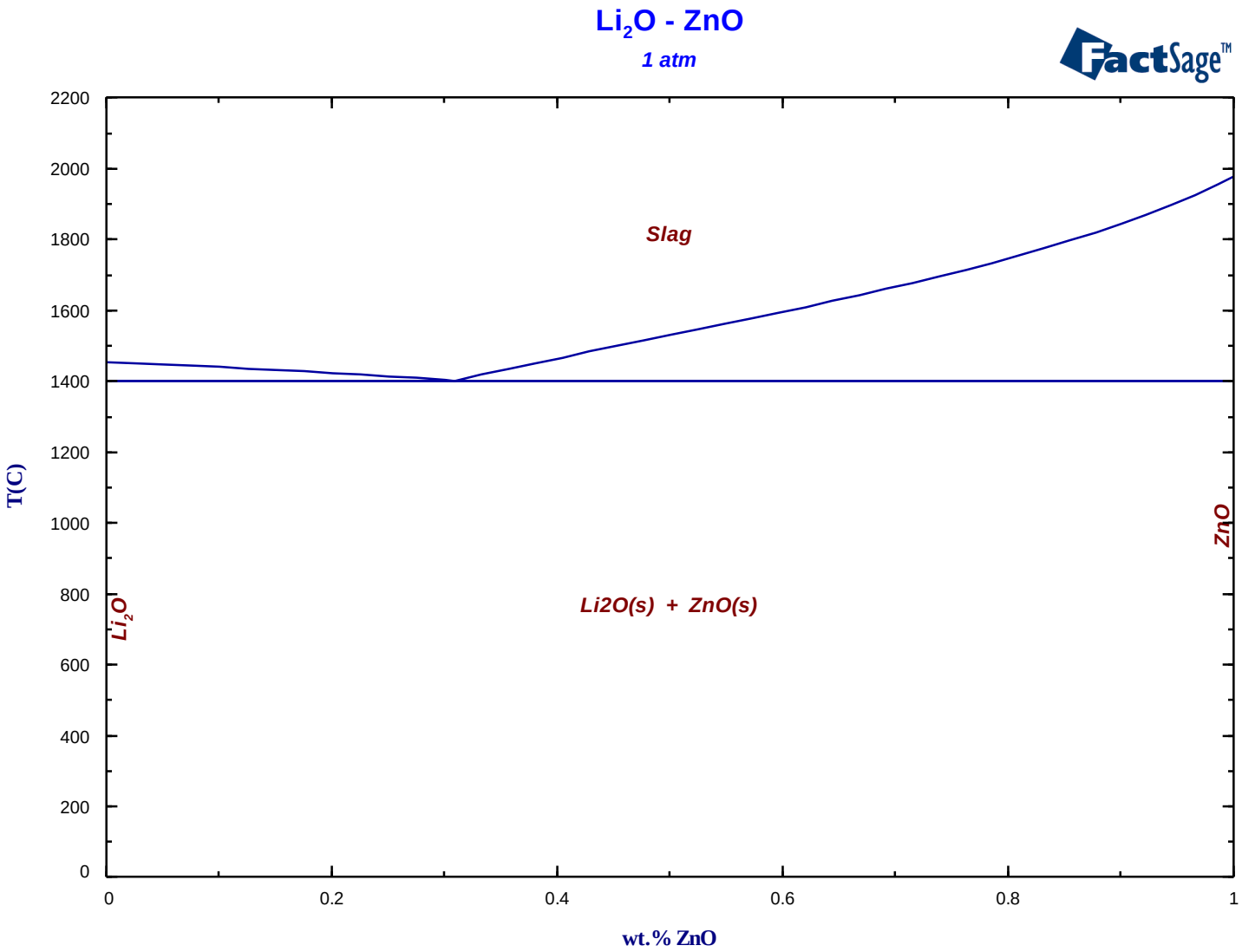
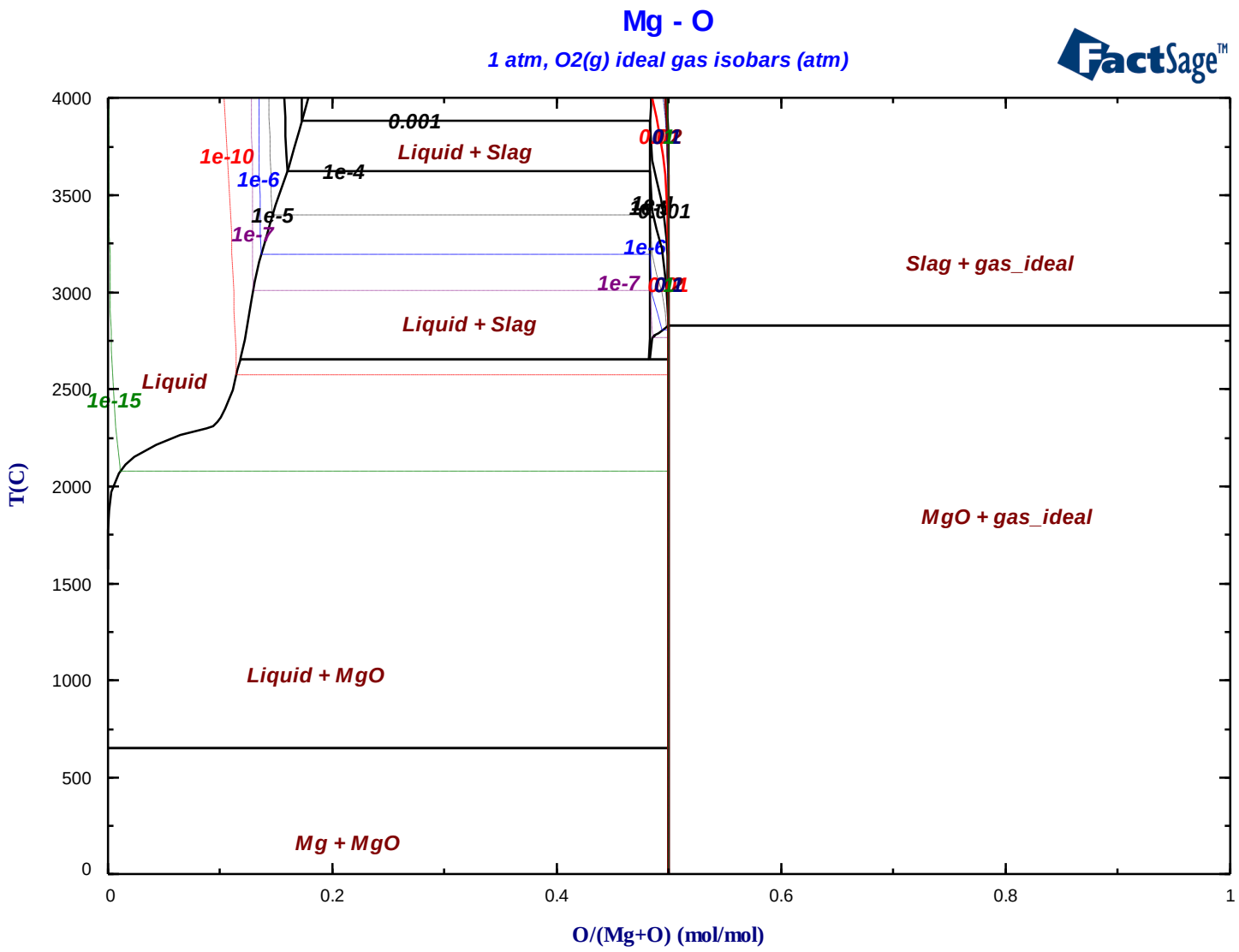
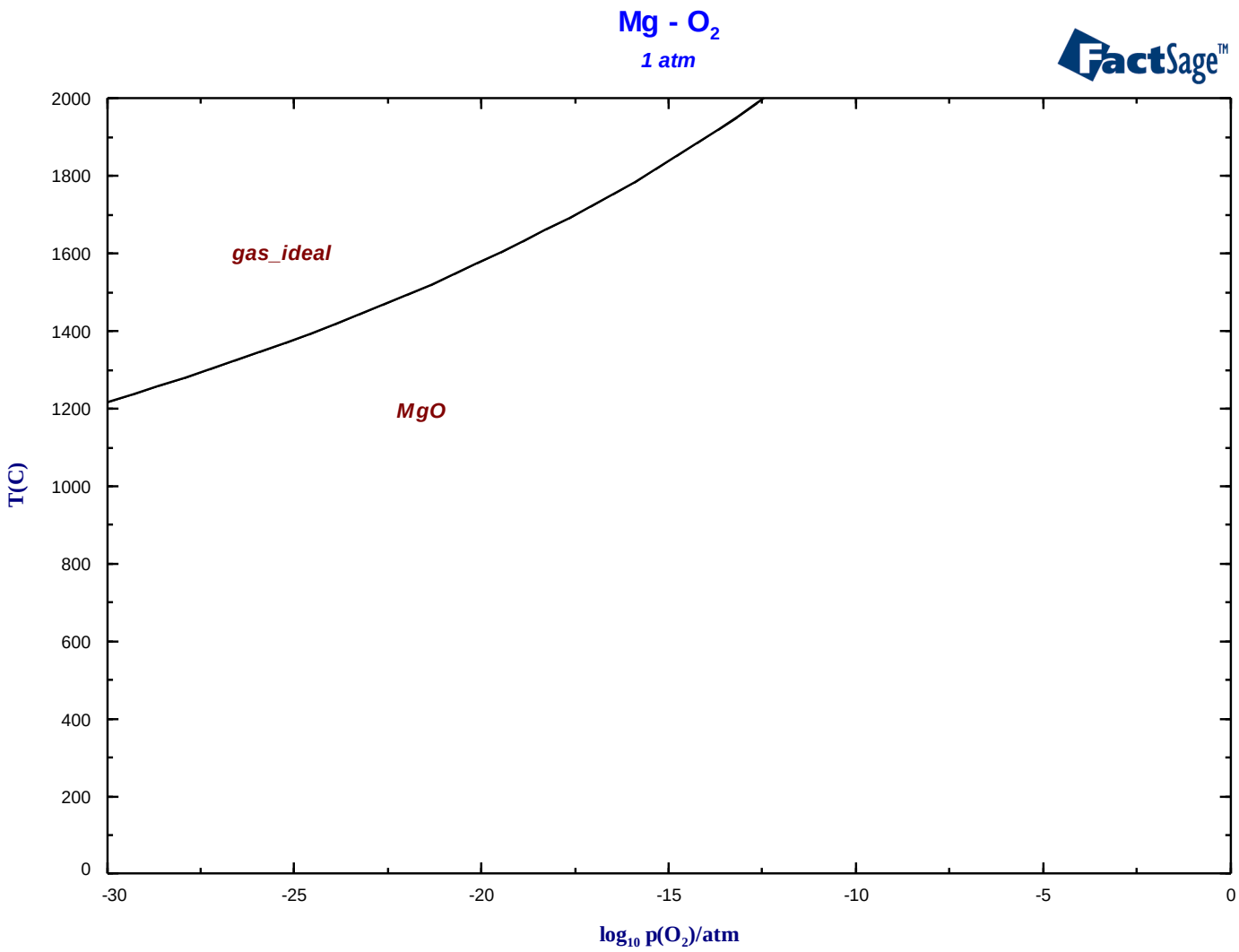


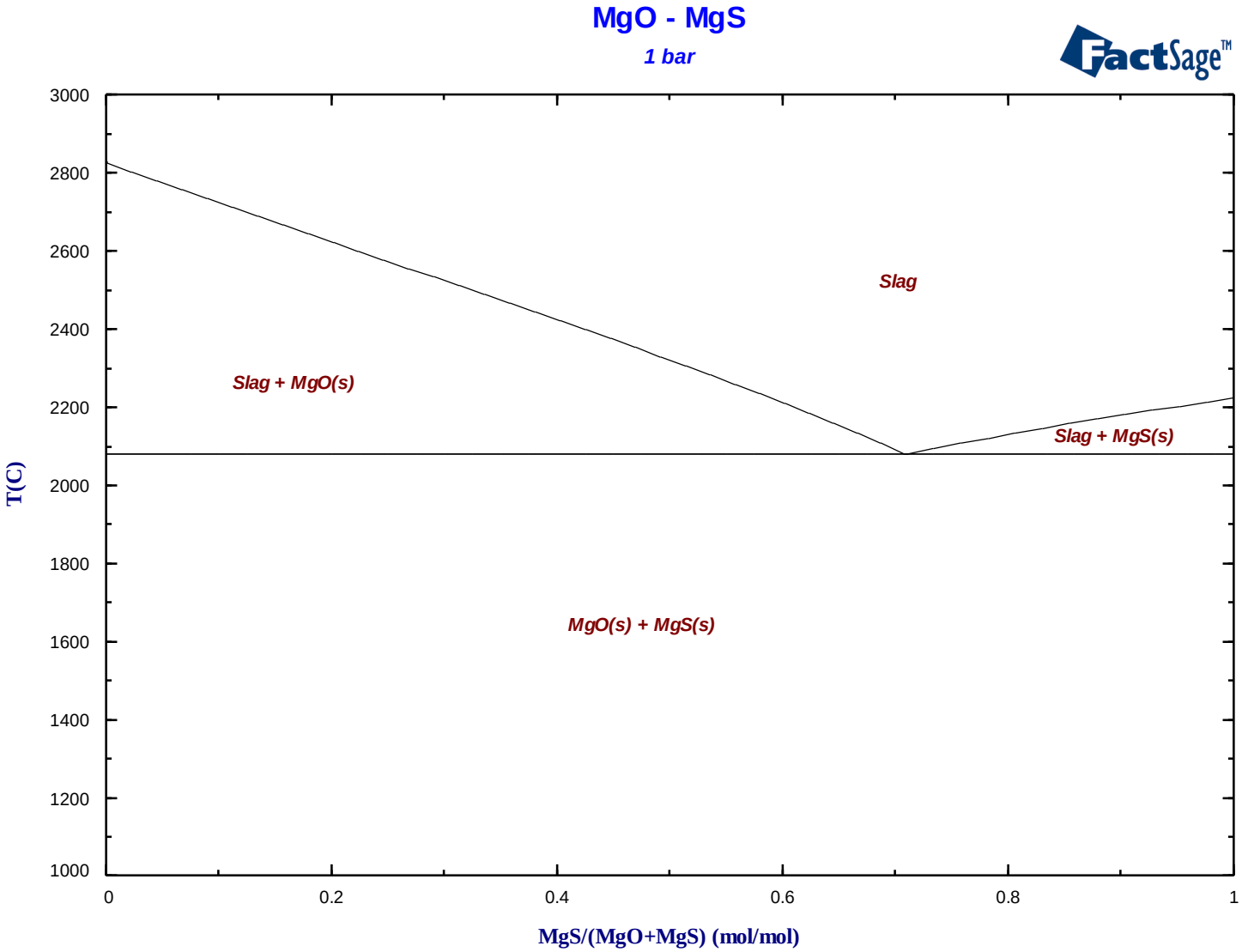
Mg-O,
Mole fraction with isobars



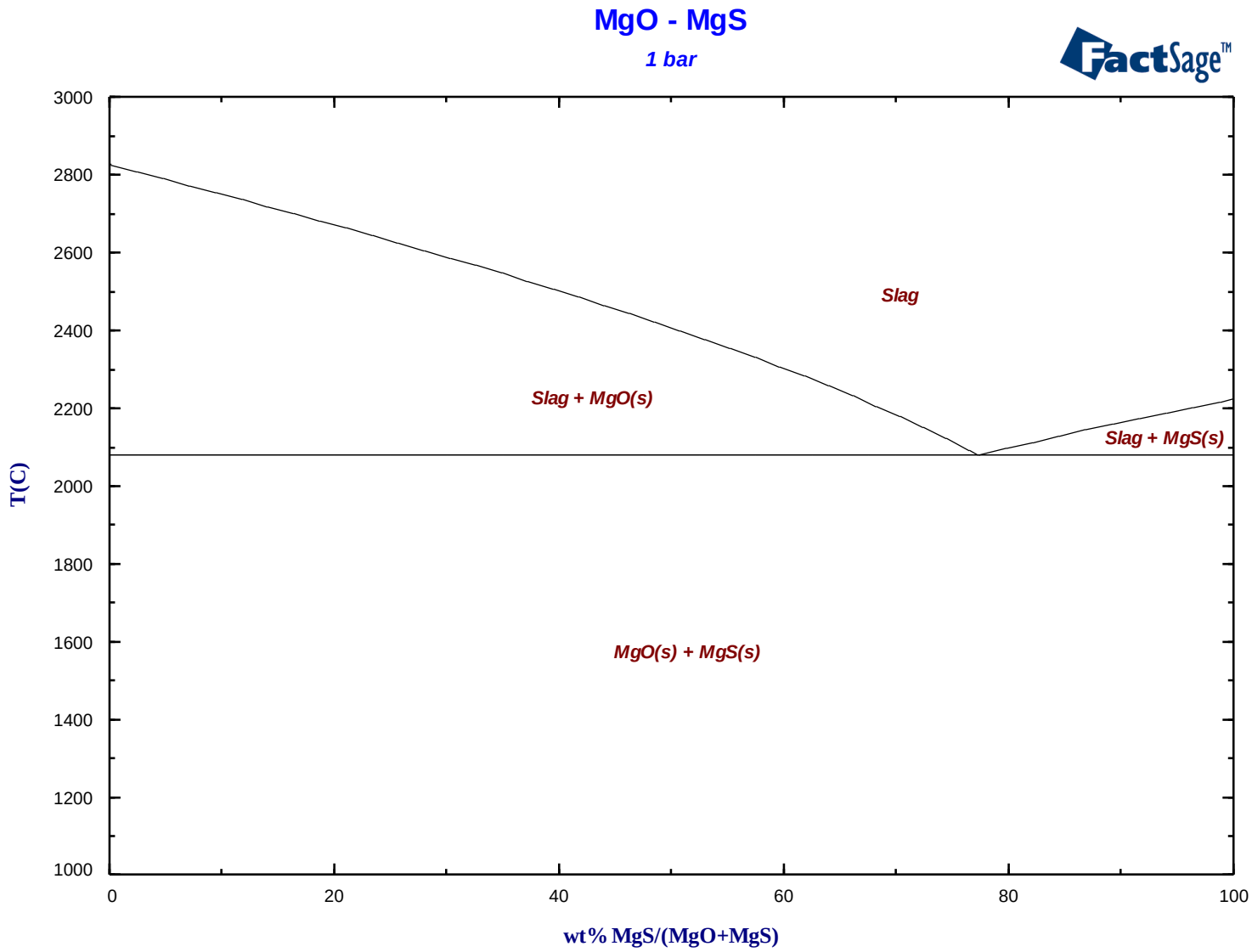
Mg-O,
Temperature vs. log P(O2) diagram



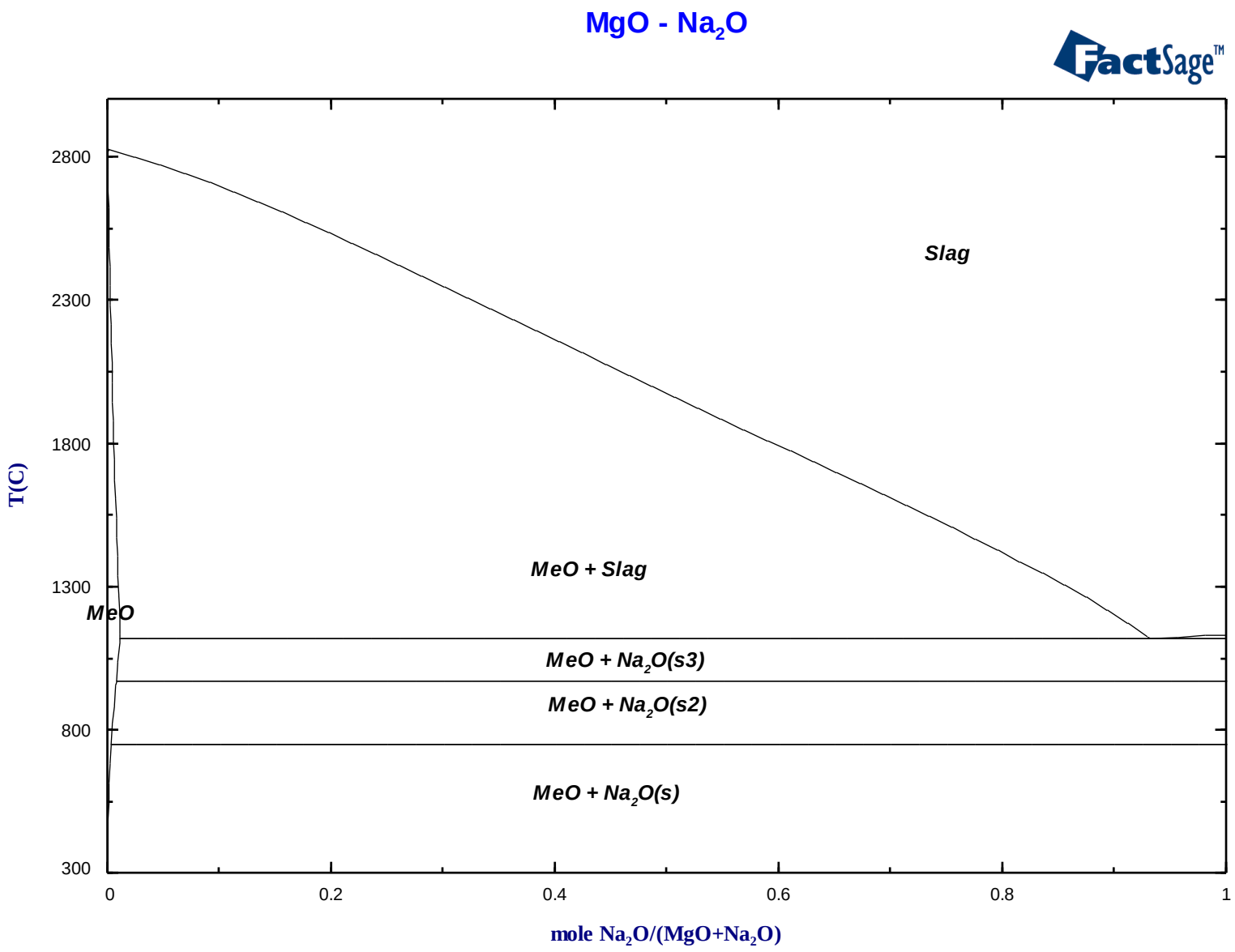
Mole fraction

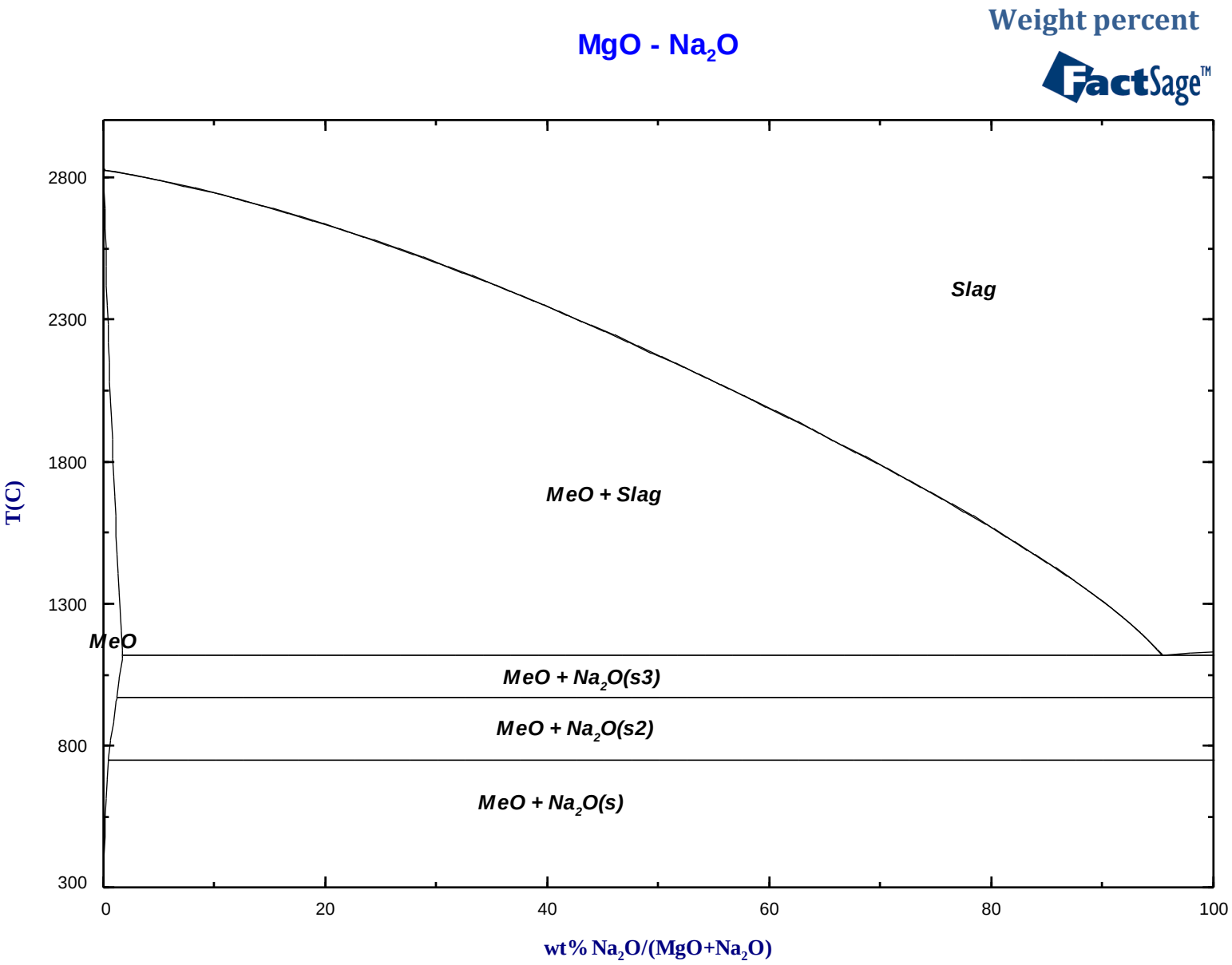


Weight percent



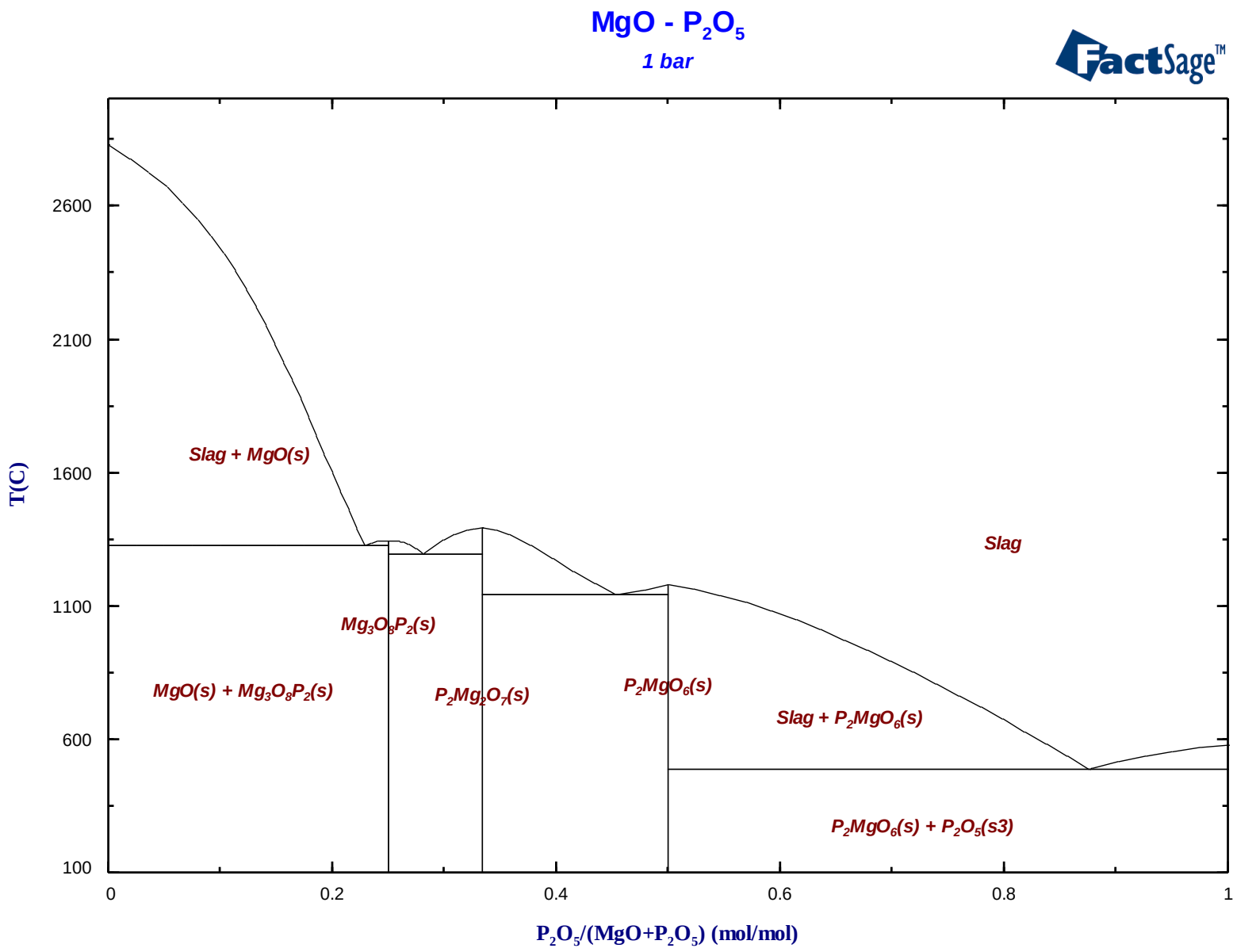
Mole fraction



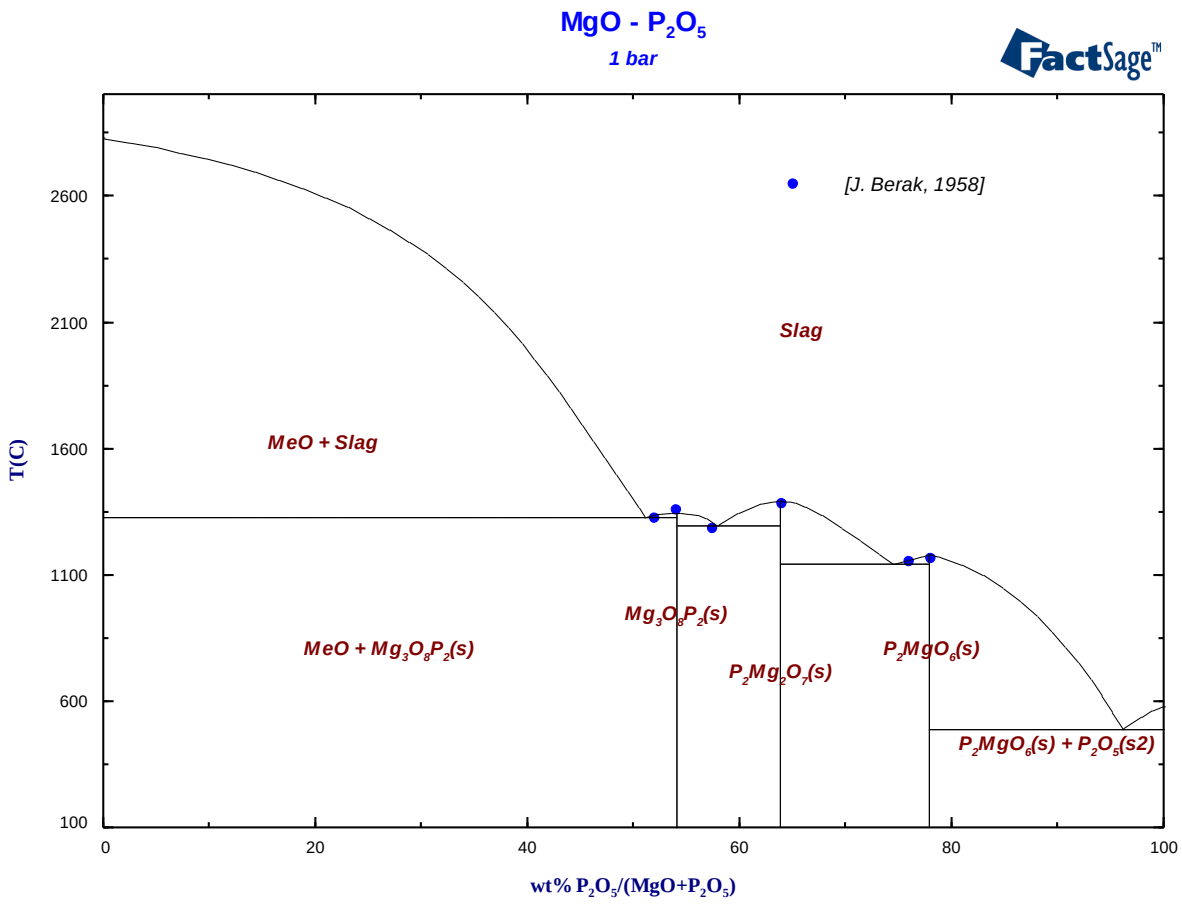


Weight percent
MgO - Na2O
FactSage™
Slag
MeO + Slag
MeO
MeO + Na2O(s3)
MeO + Na2O(s2)
MeO + Na2O(s)
T(C)
2800
2300
1800
1300
800
300
0
20
40
60
80
100
wt% Na2O/(MgO+Na2O)

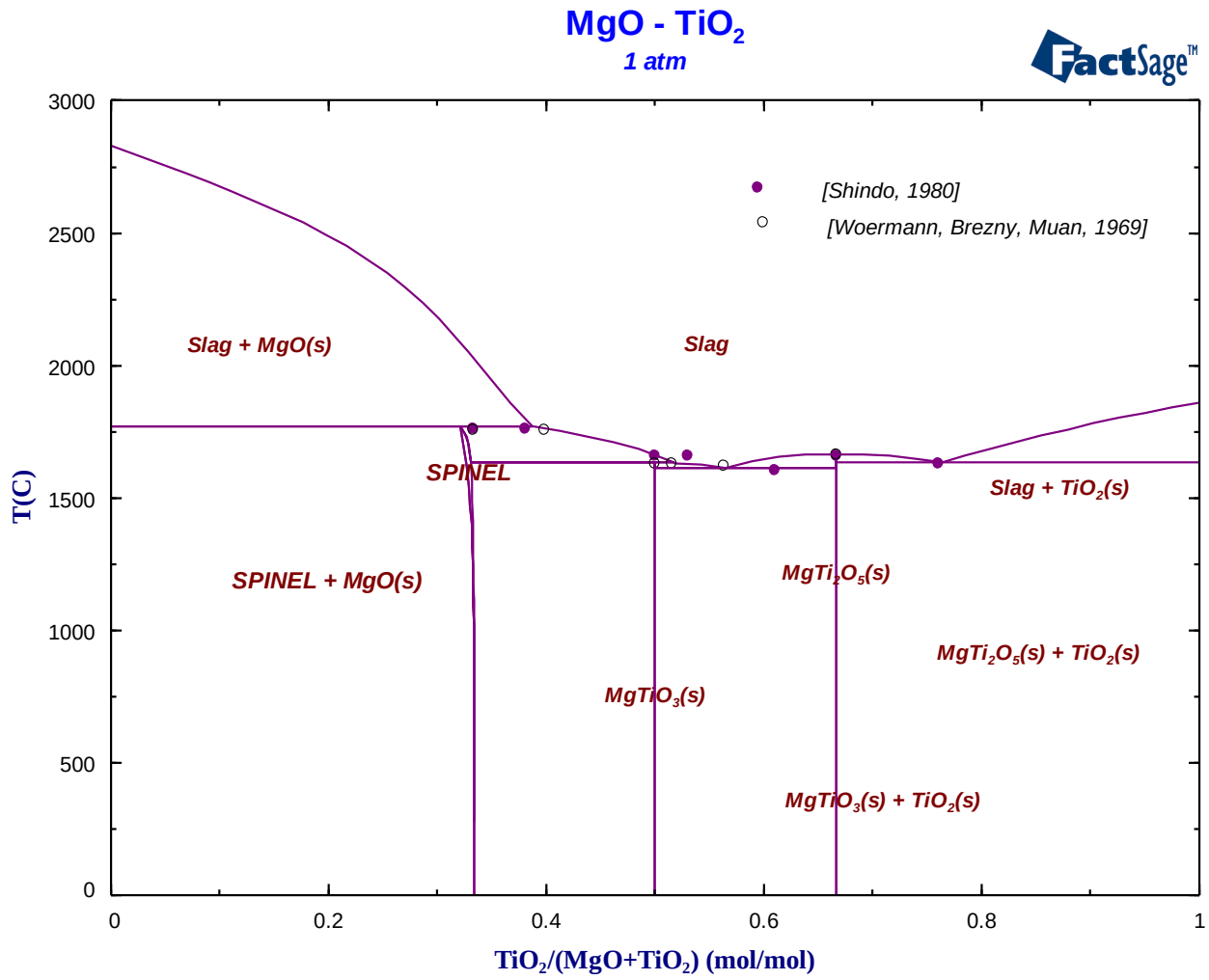
Mole fraction



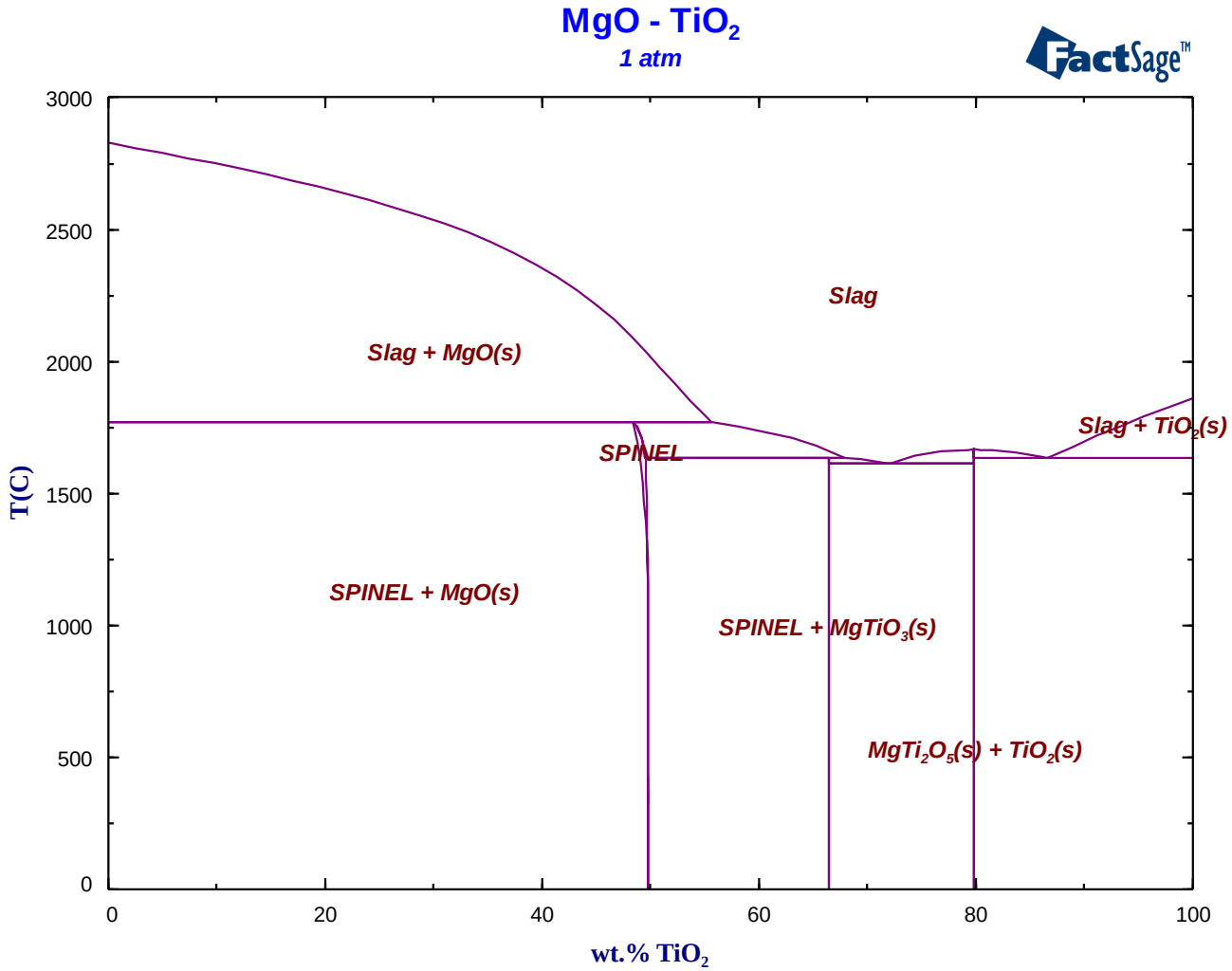
Weight percent



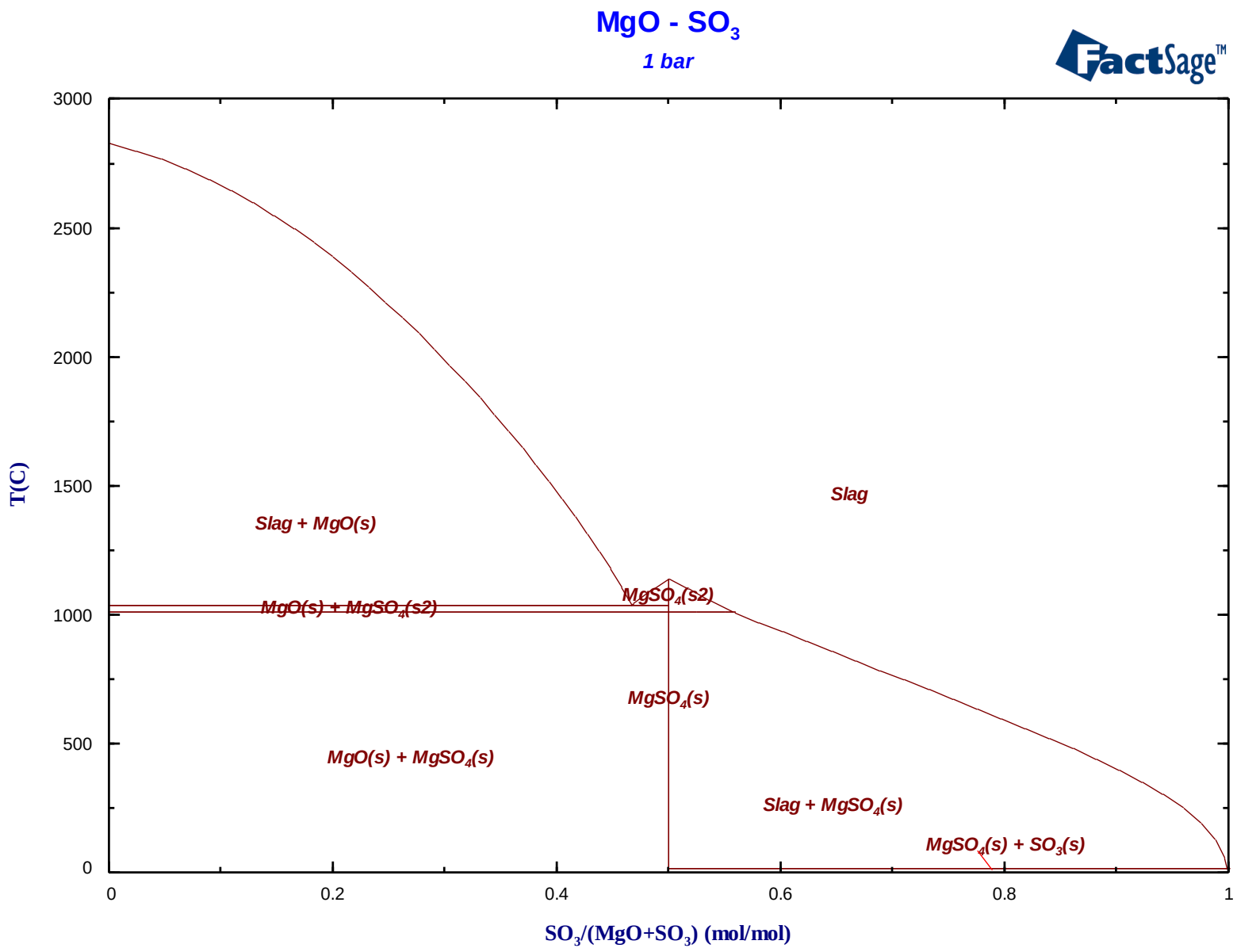
Mole fraction compared with experimental data



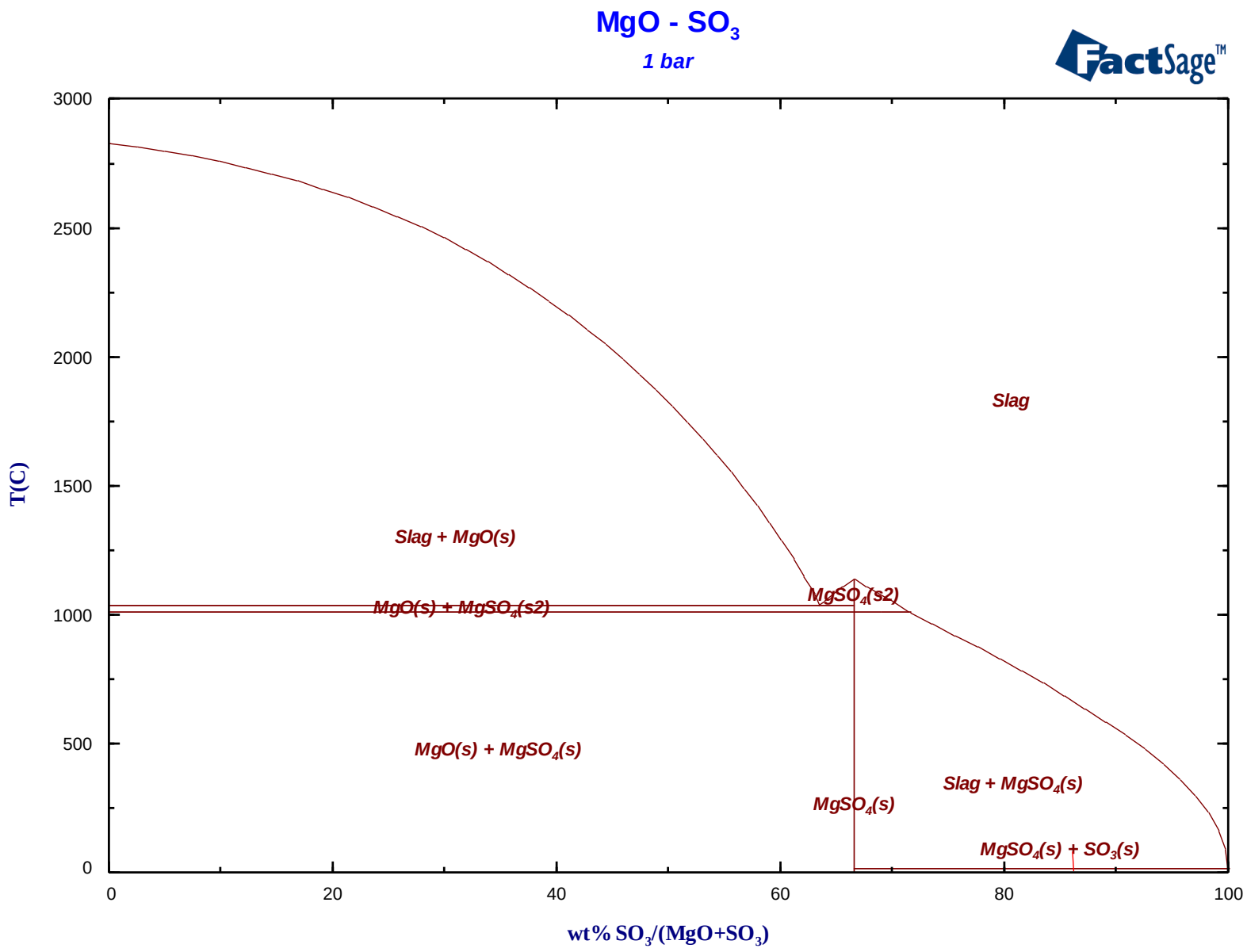
Weight percent



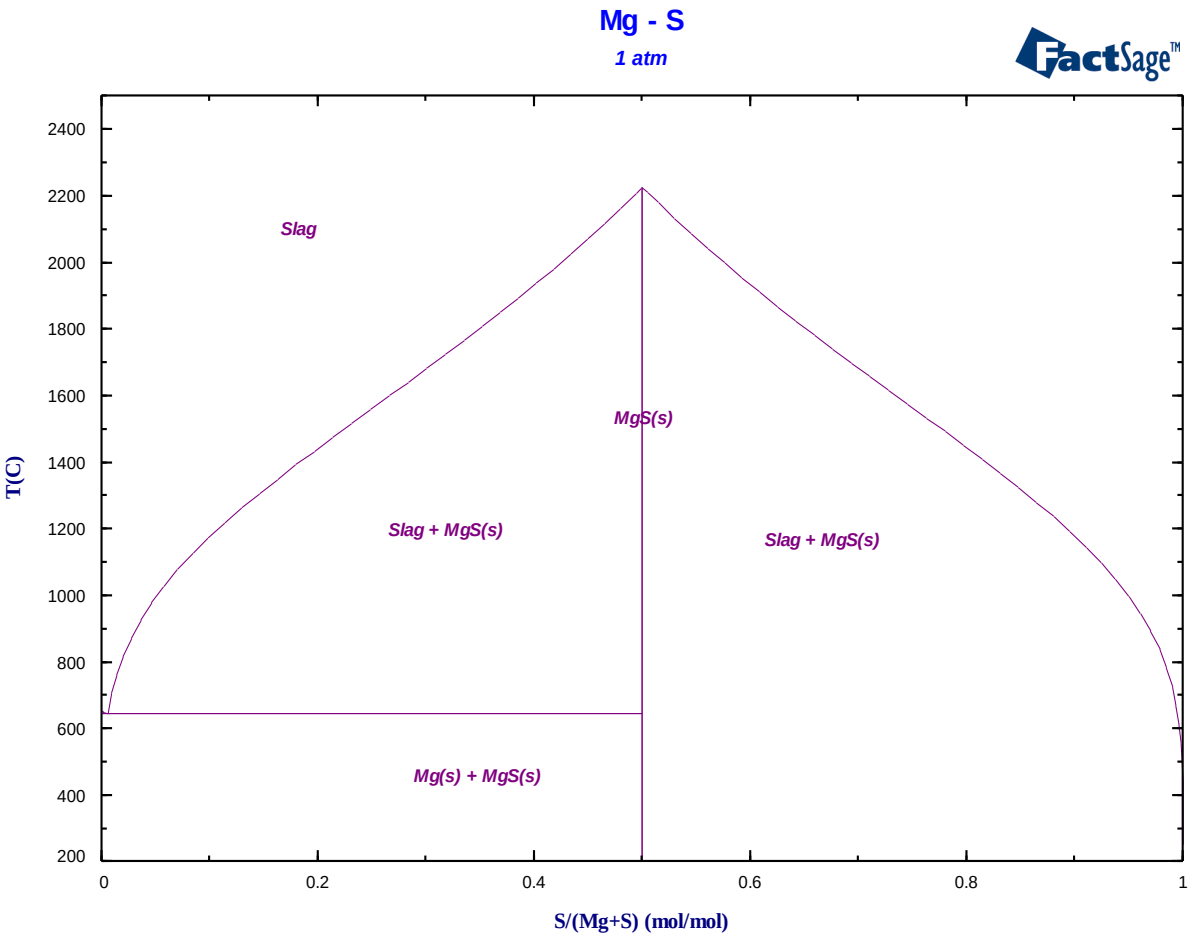
Mole fraction



Weight percent



Mole fraction



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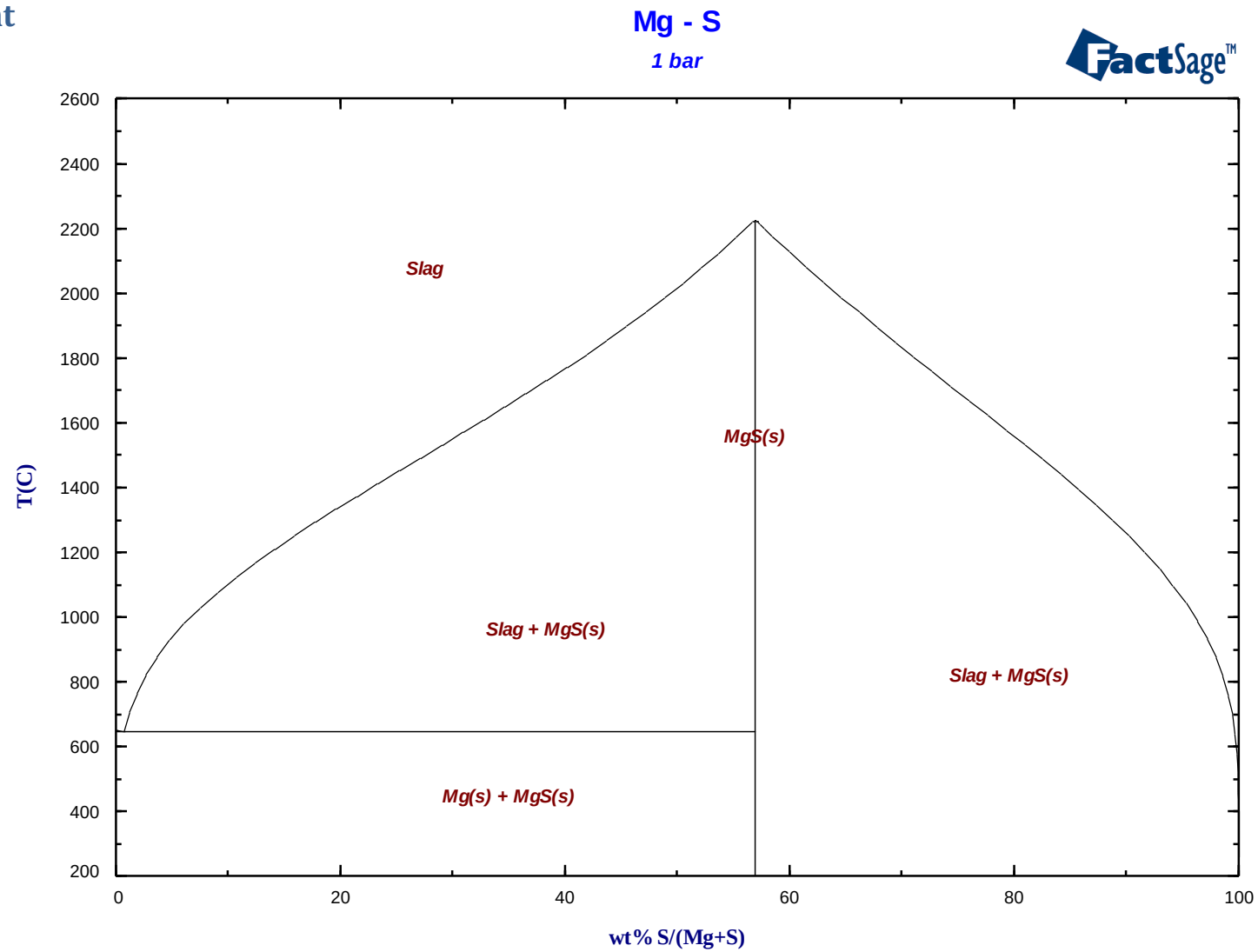
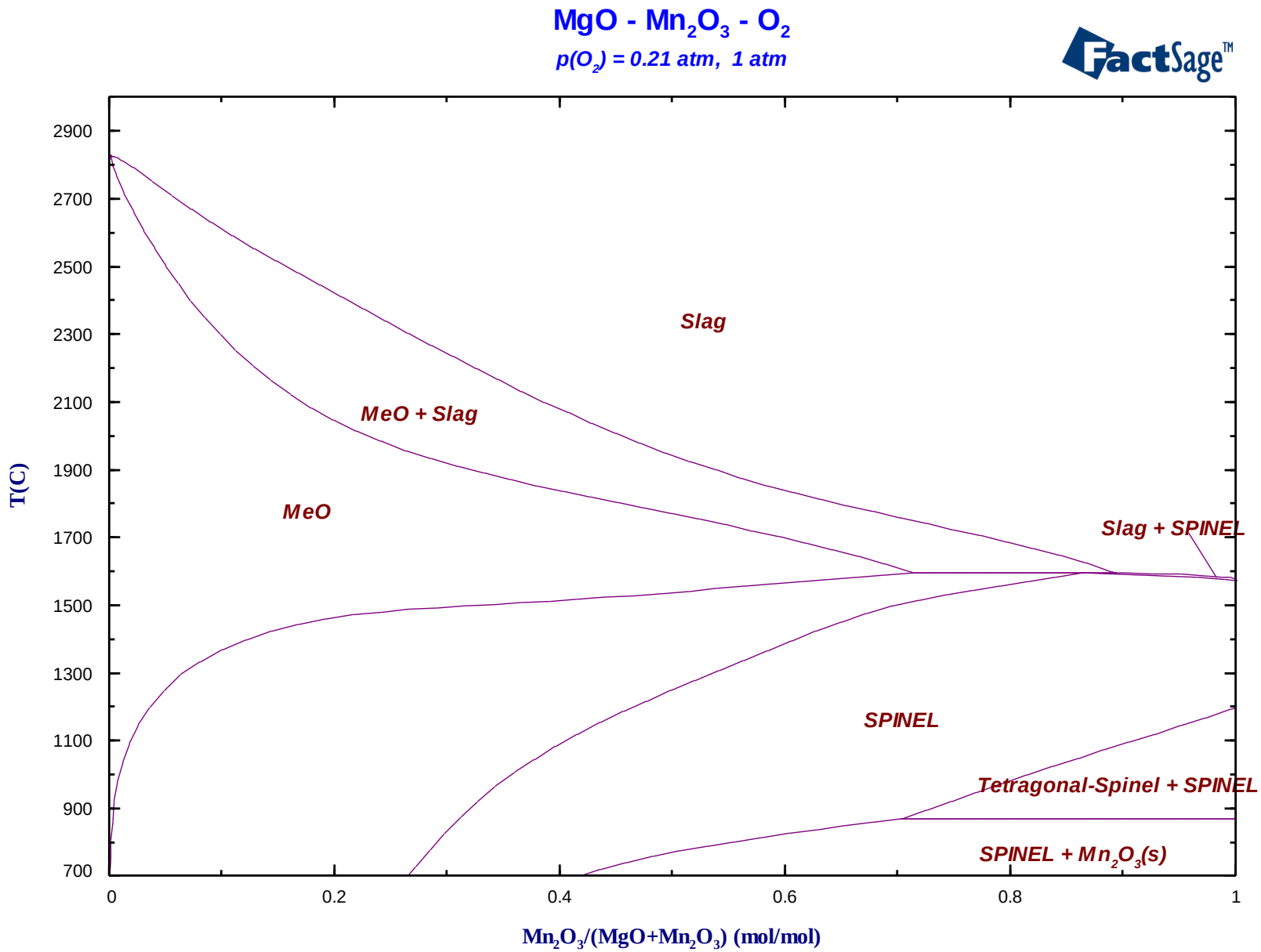
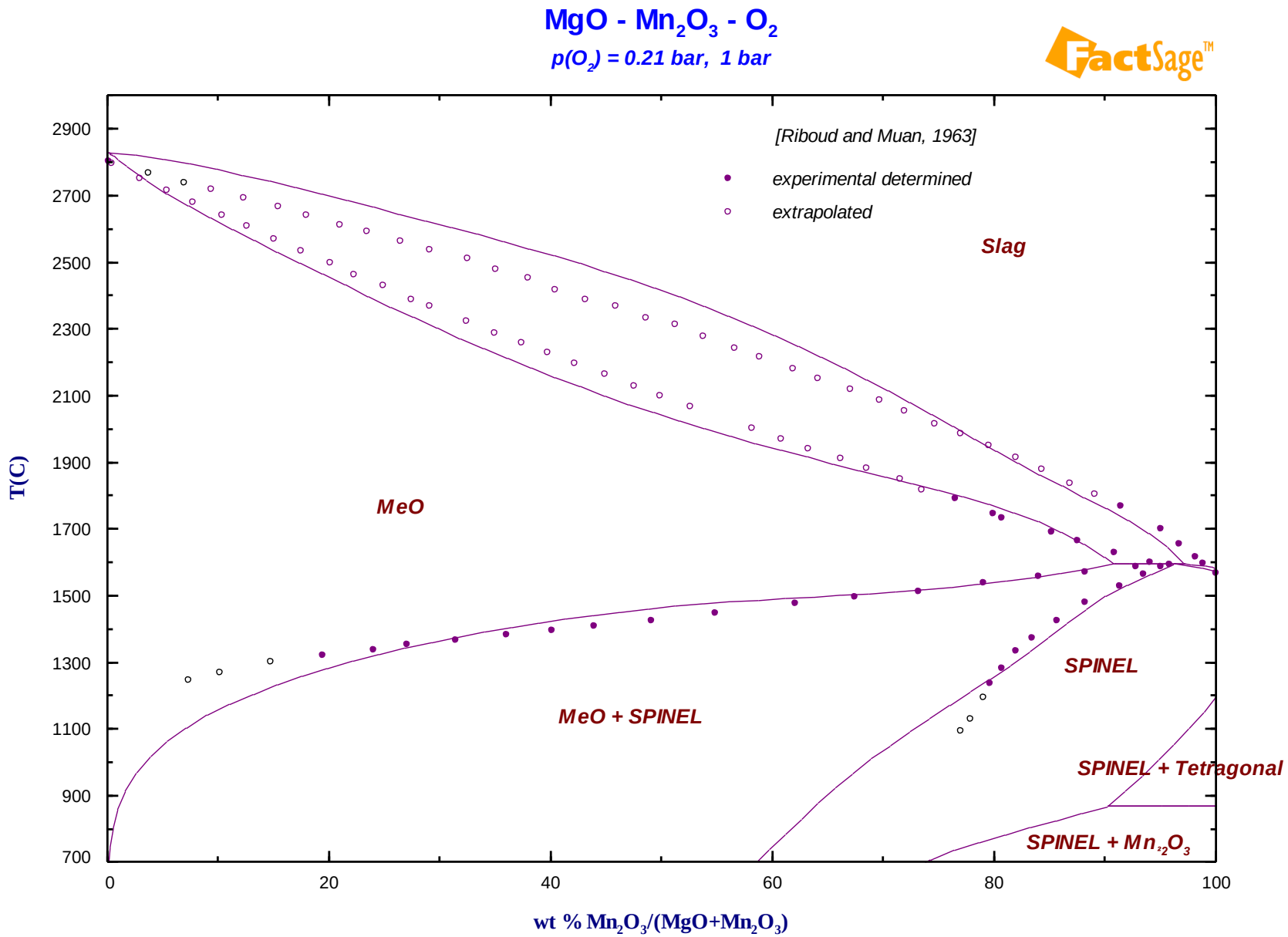


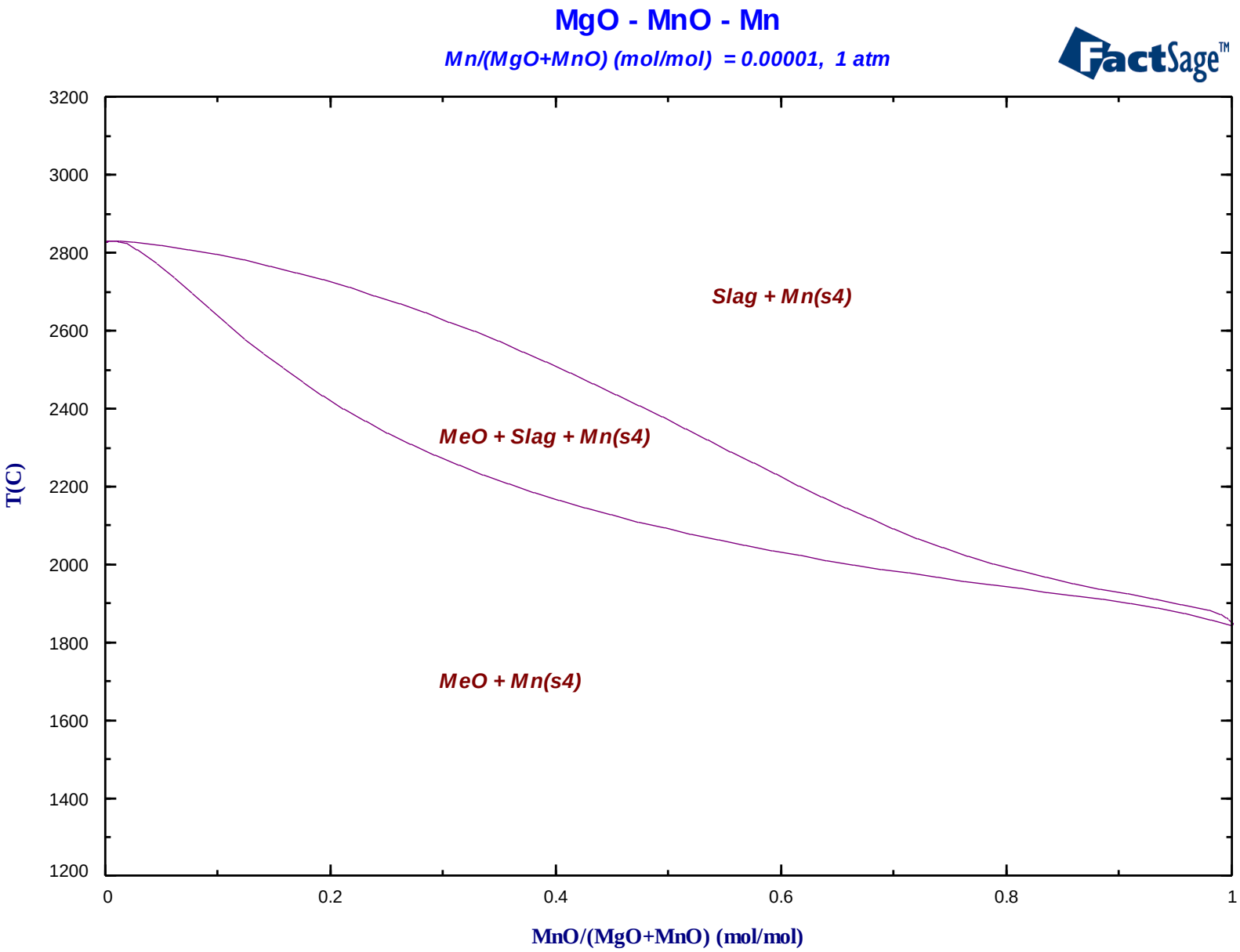
Mole fraction



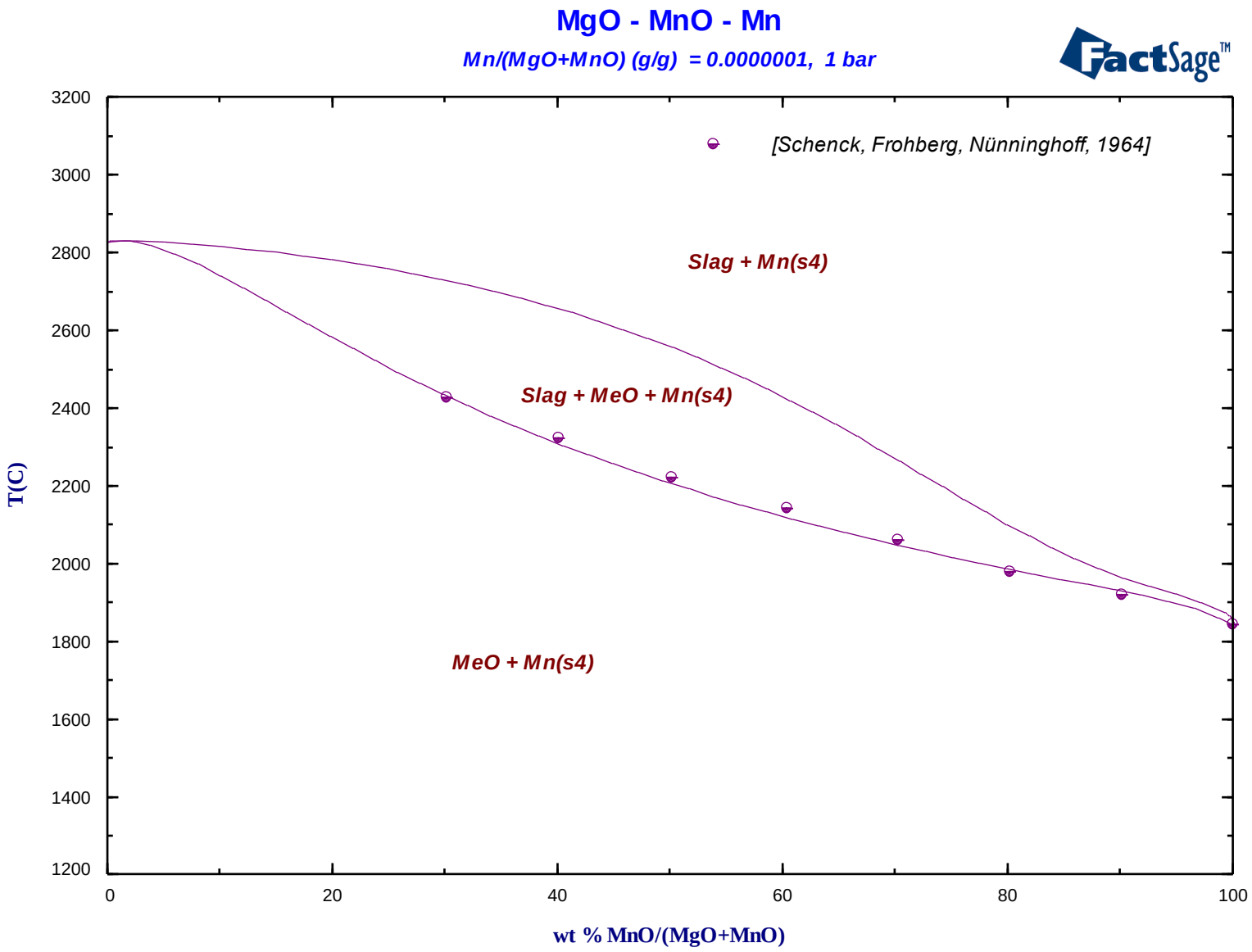
Weight percent
compared with experimental data



Mole fraction



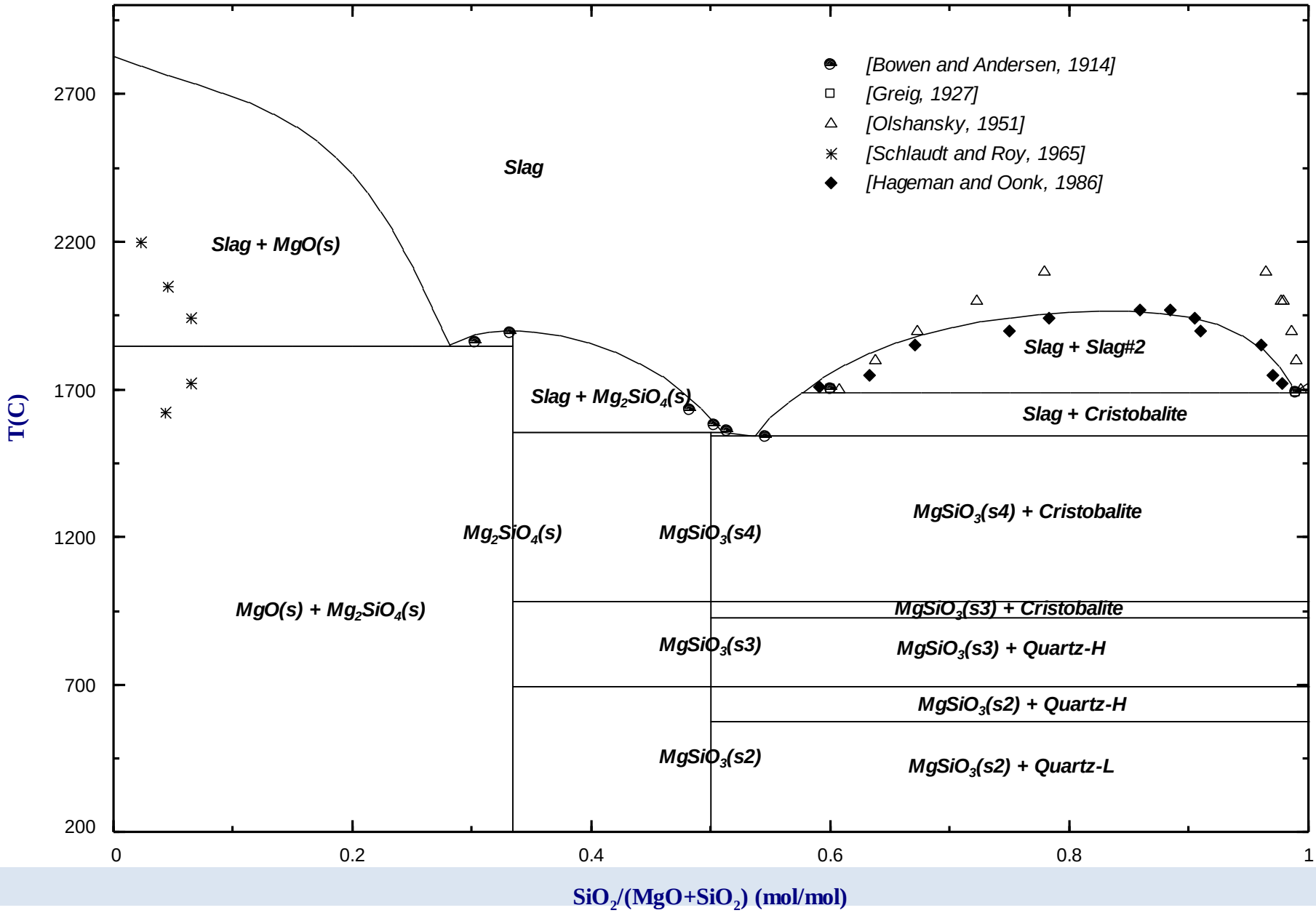
Weight percent
compared with experimental data



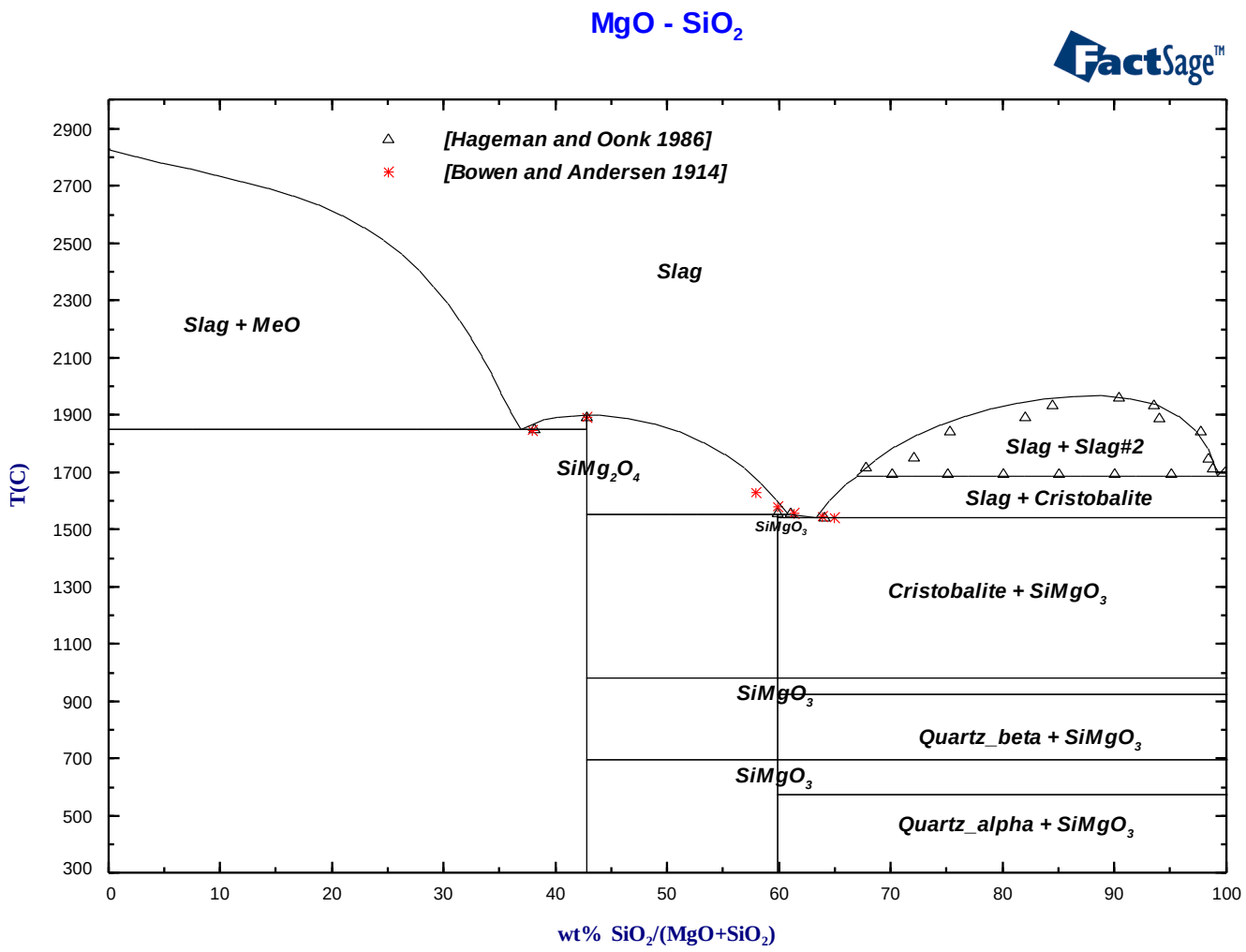
Mole fraction compared with experimental data

$MgO - SiO_2$

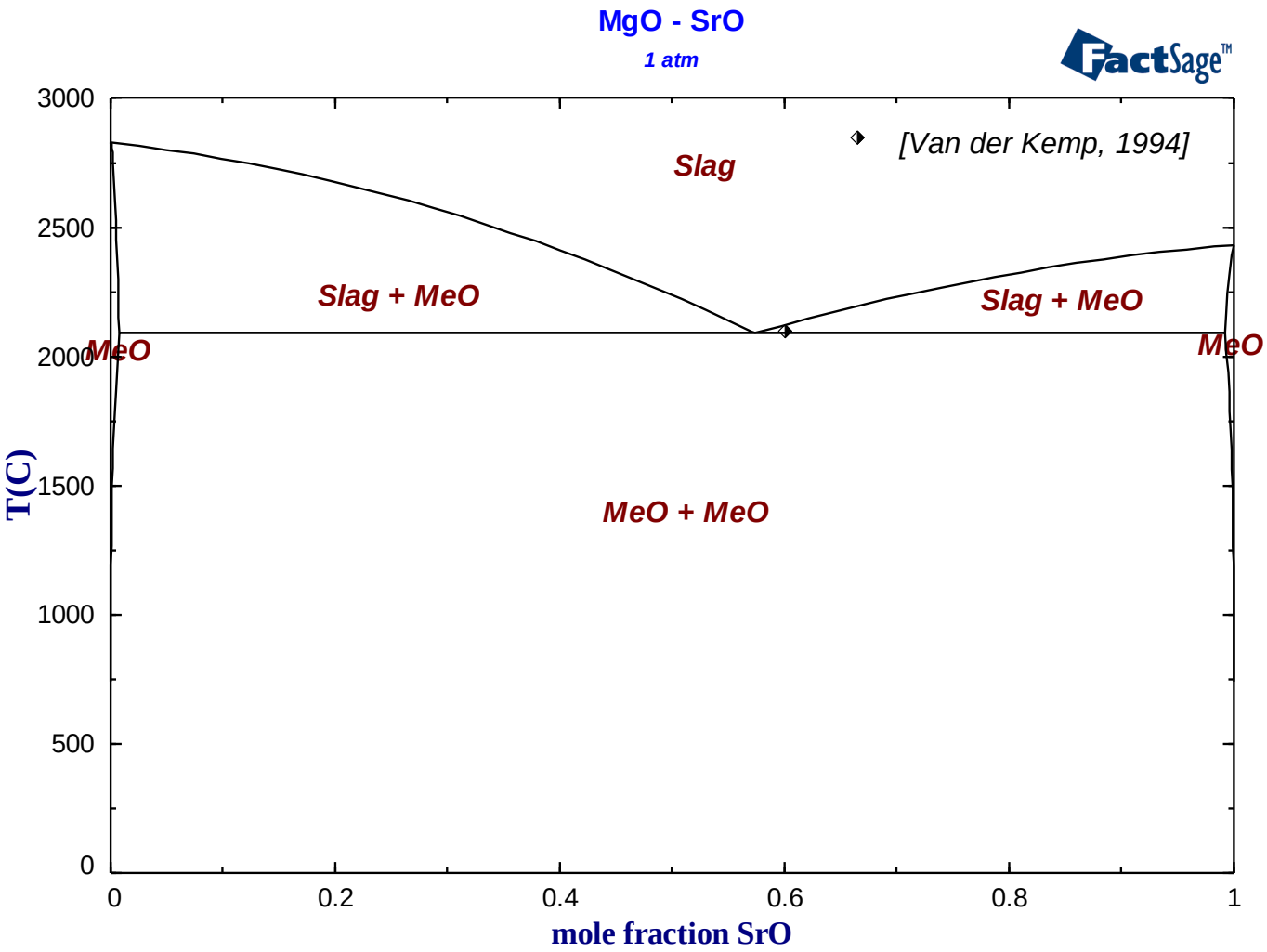
1 bar



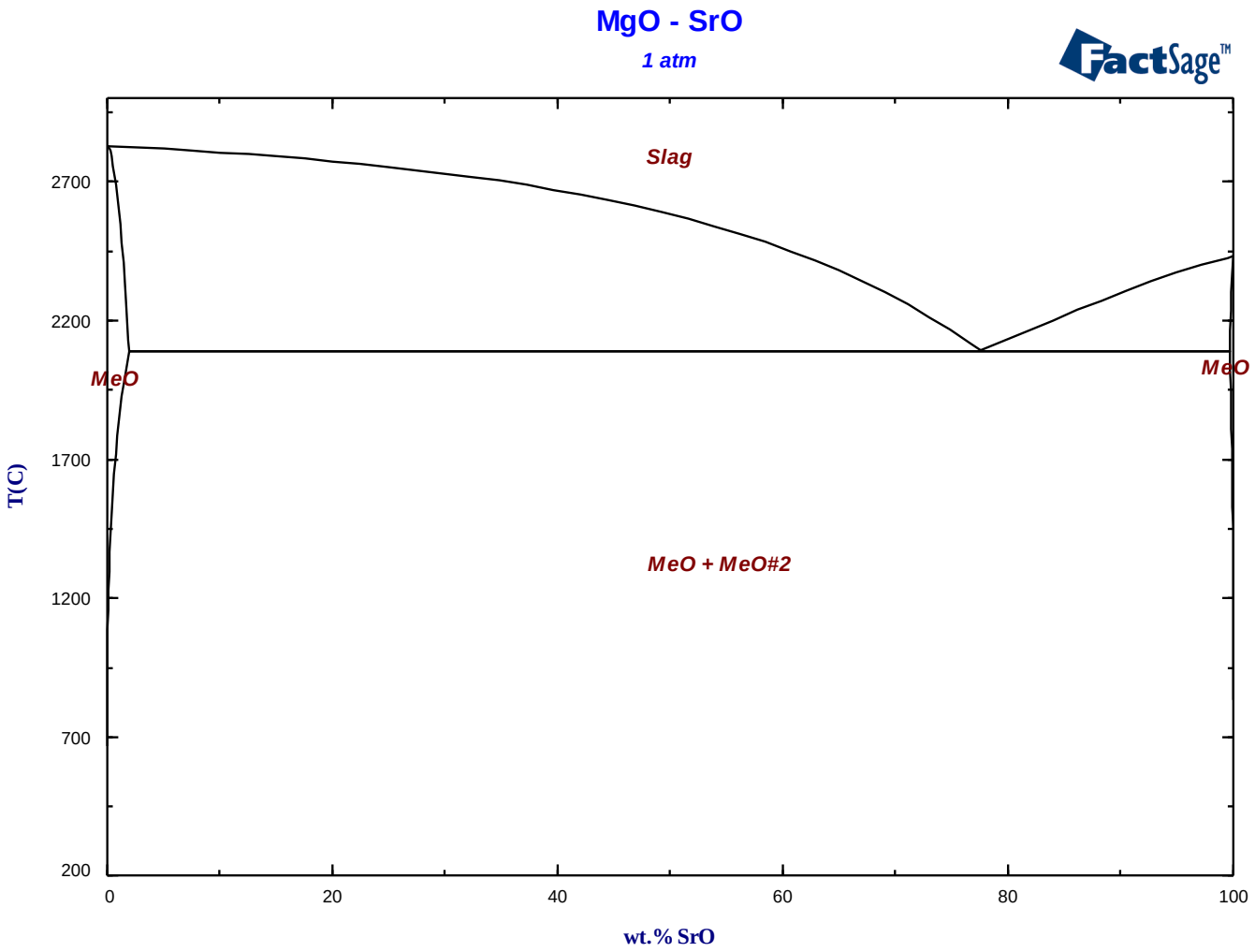
Weight percent
compared with experimental data



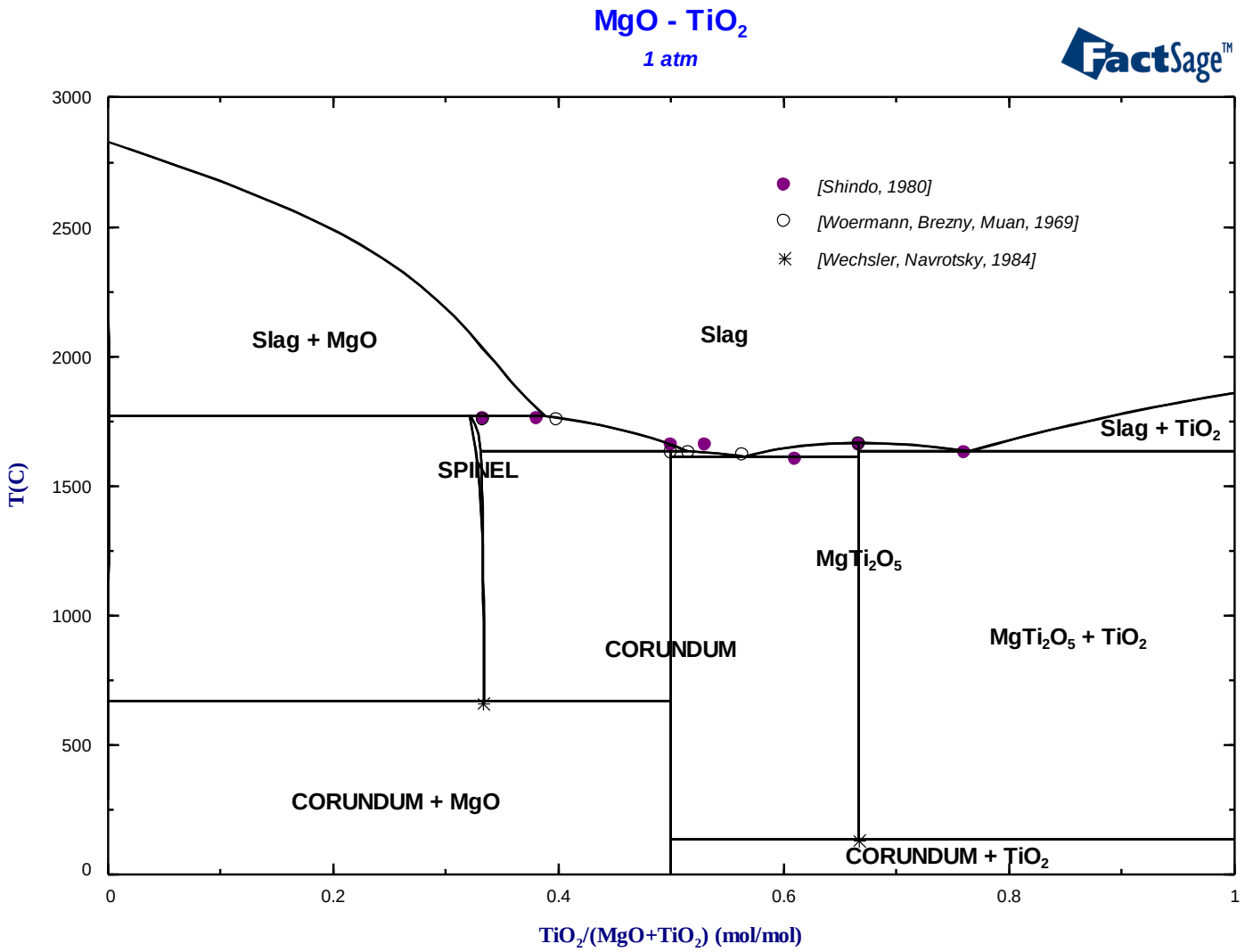
Mole fraction compared with experimental data



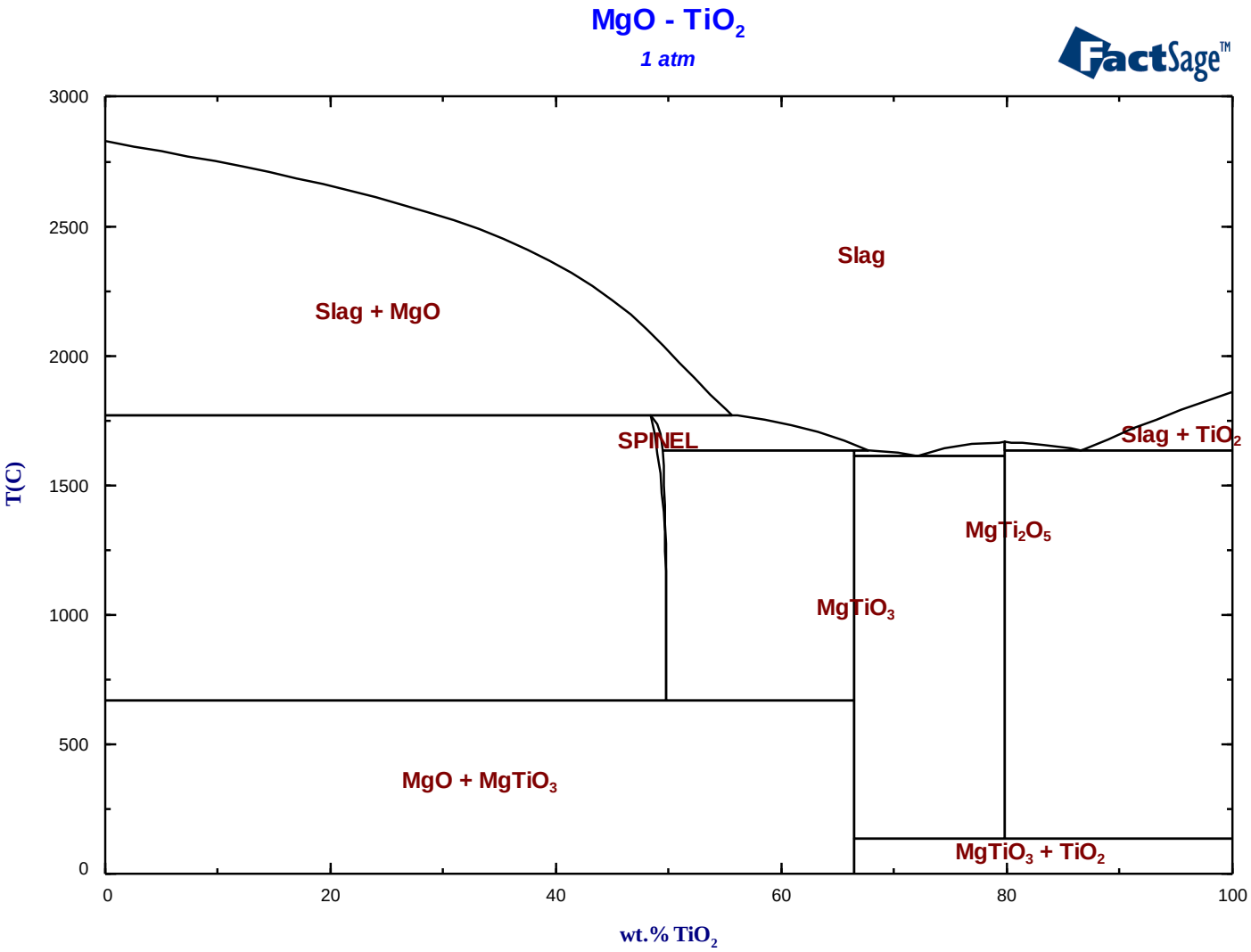
MgO-SrO
Weight percent



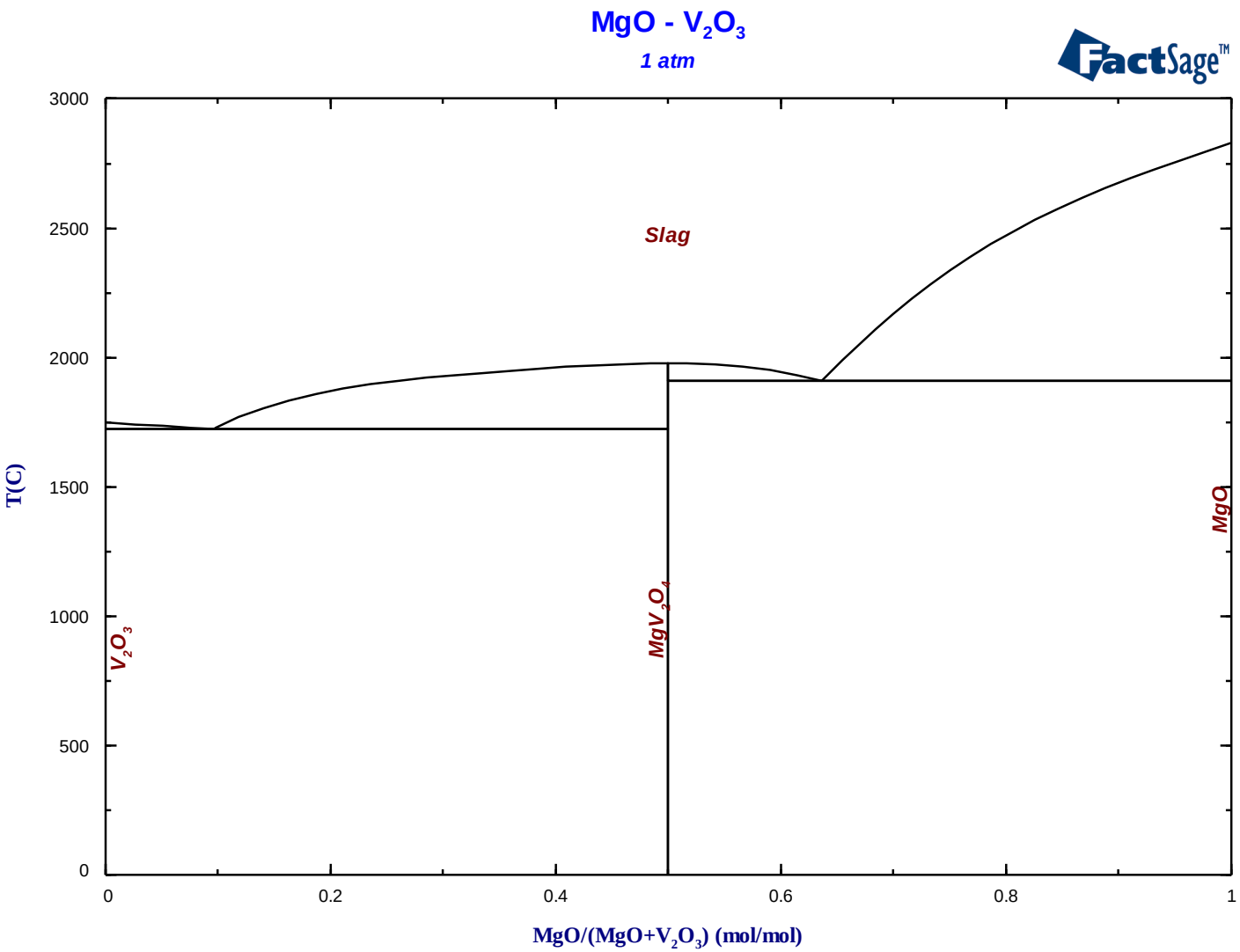
MgO-TiO2, Mole fraction compared with experimental data



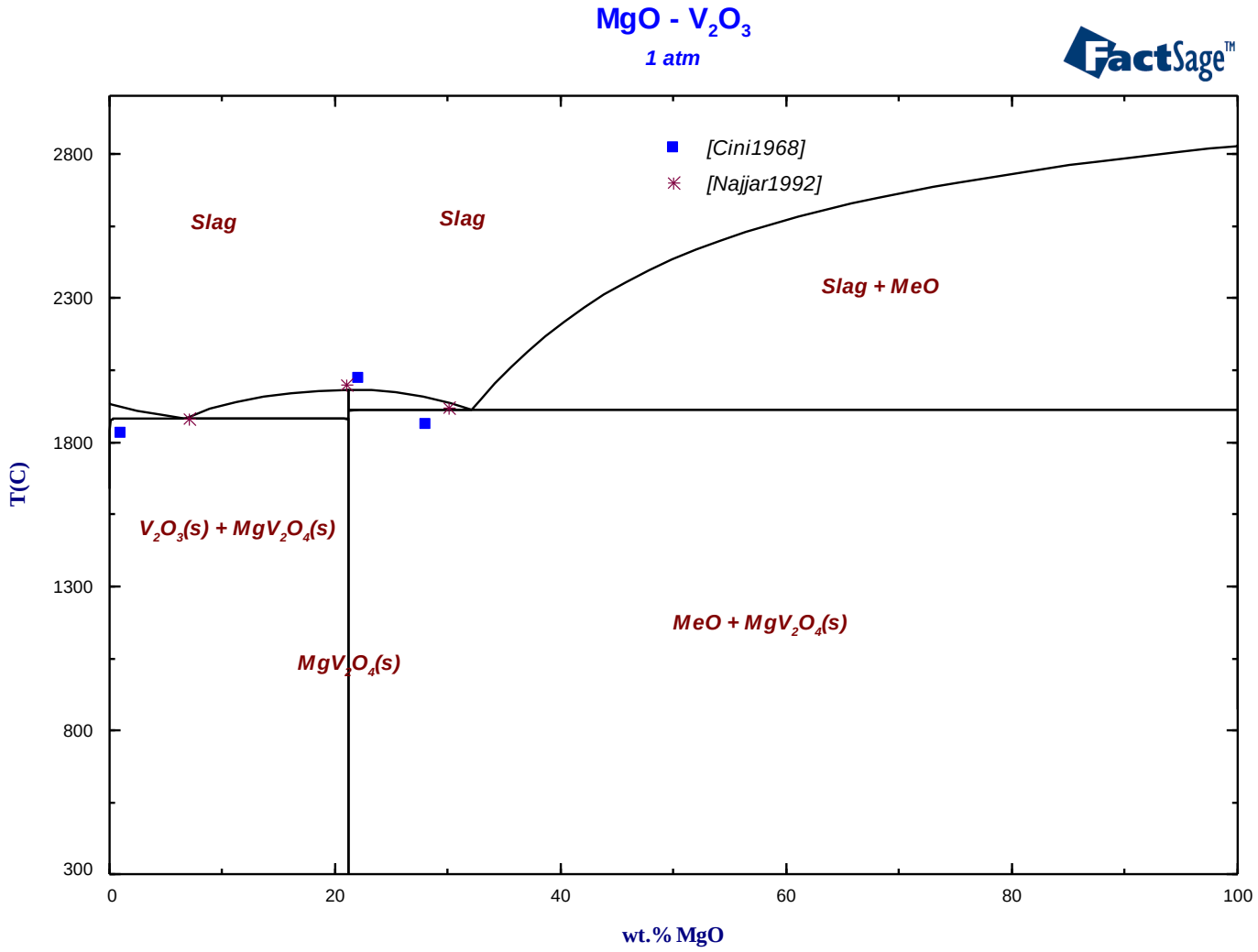
MgO-TiO2, Weight percent



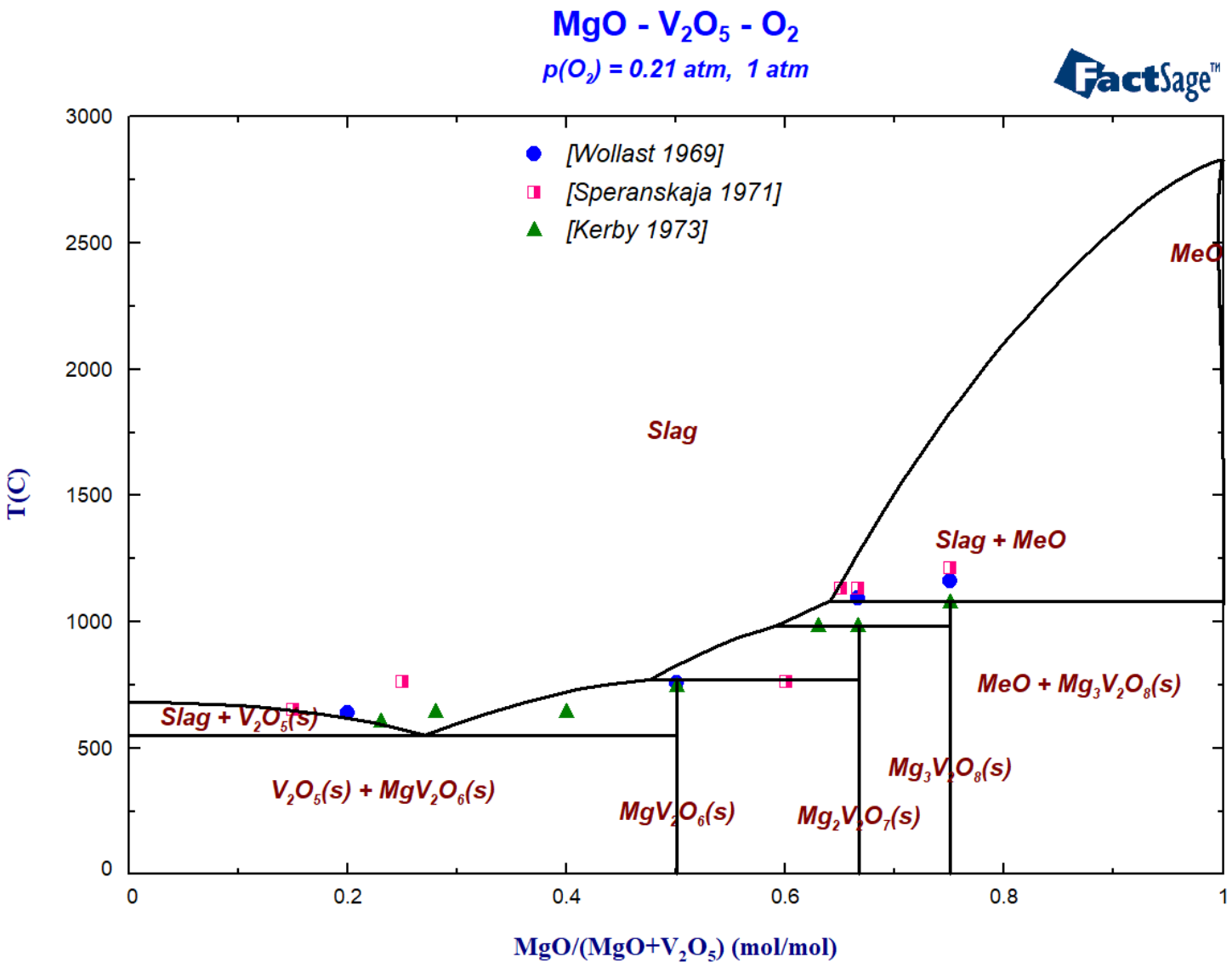
MgO-V2O3,
Mole fraction



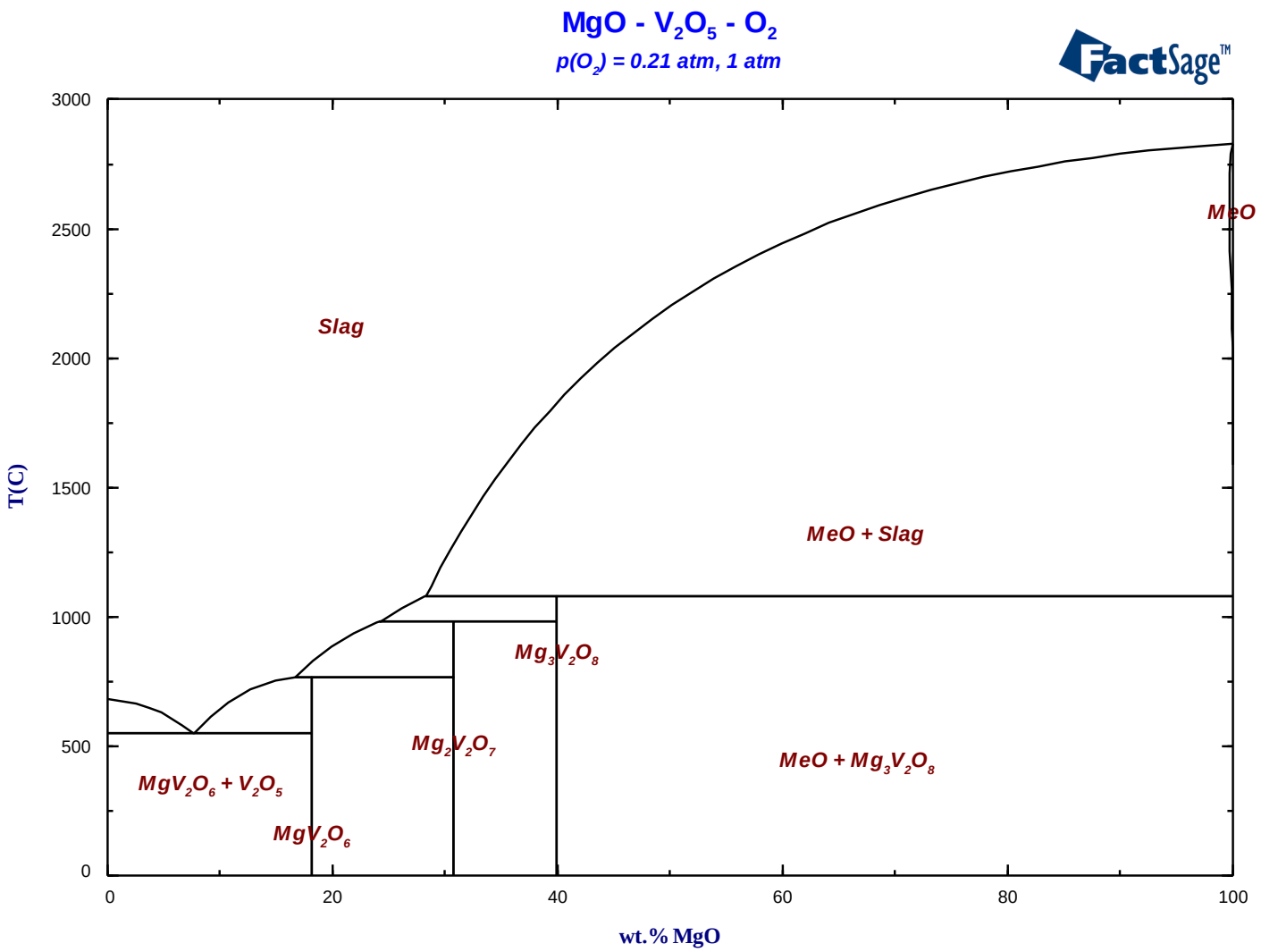
MgO-V2O3,
Weight percent compared with experimental data



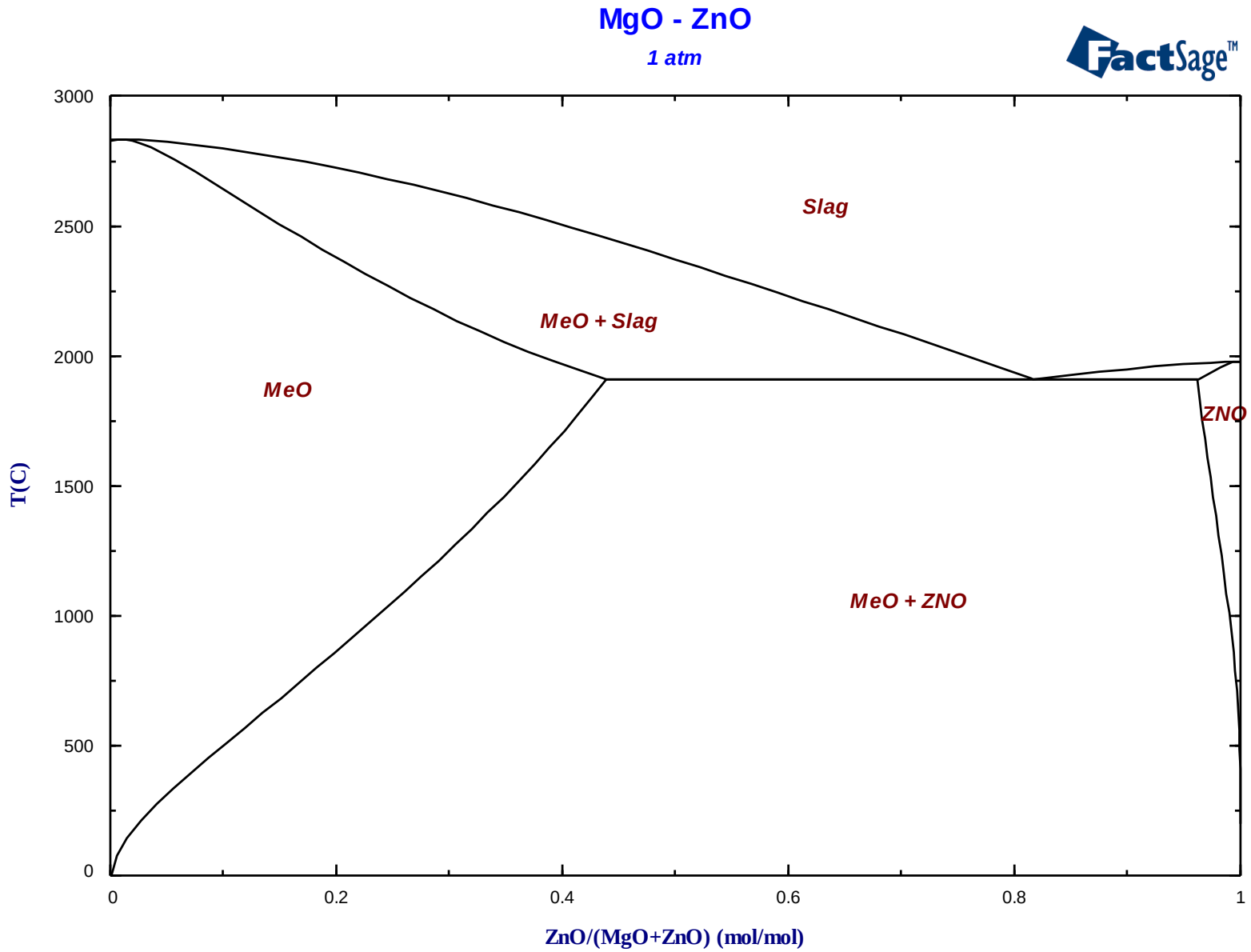
MgO-V2O5-O2,
Mole fraction compared with experimental data



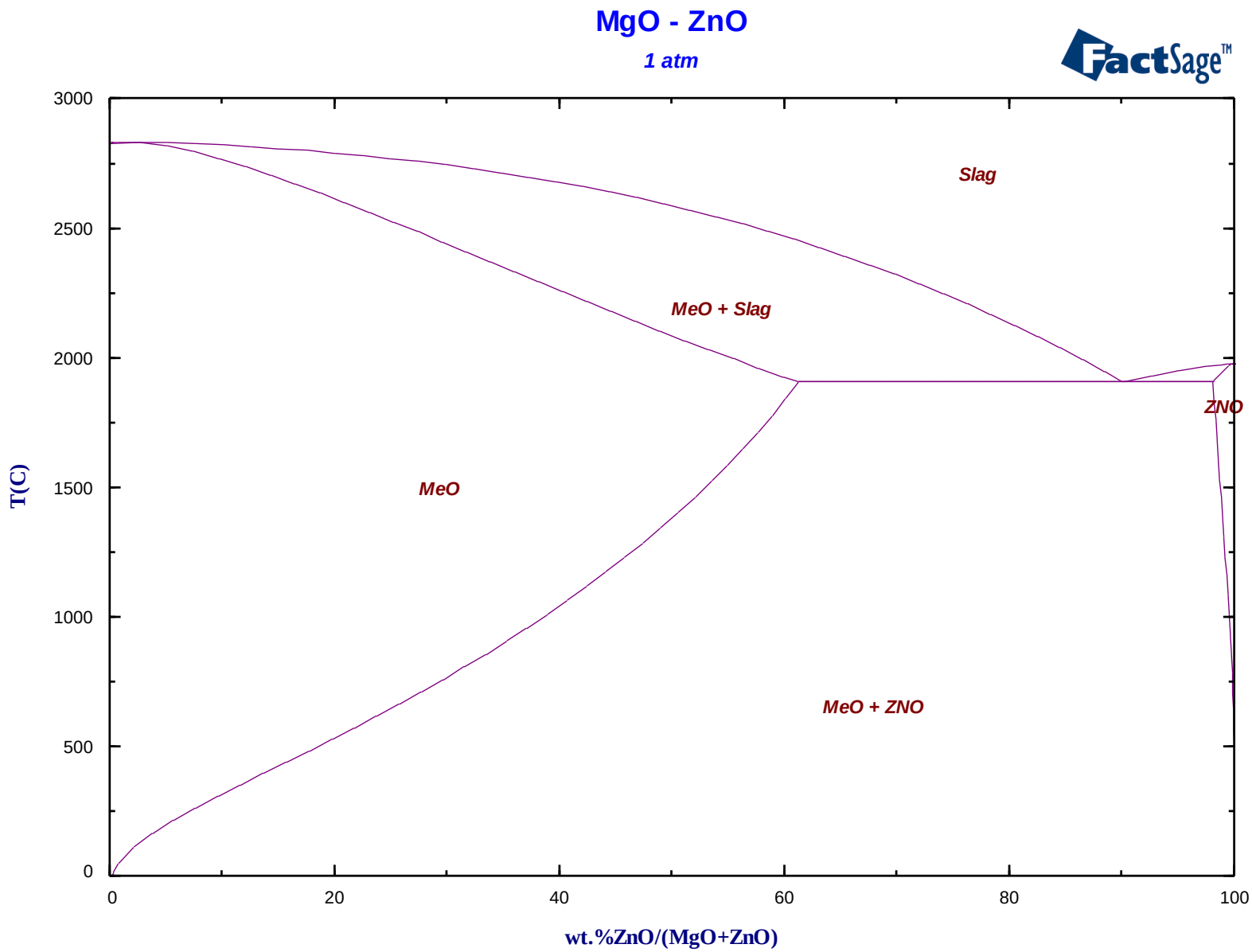
MgO-V2O5-O2,
Weight percent



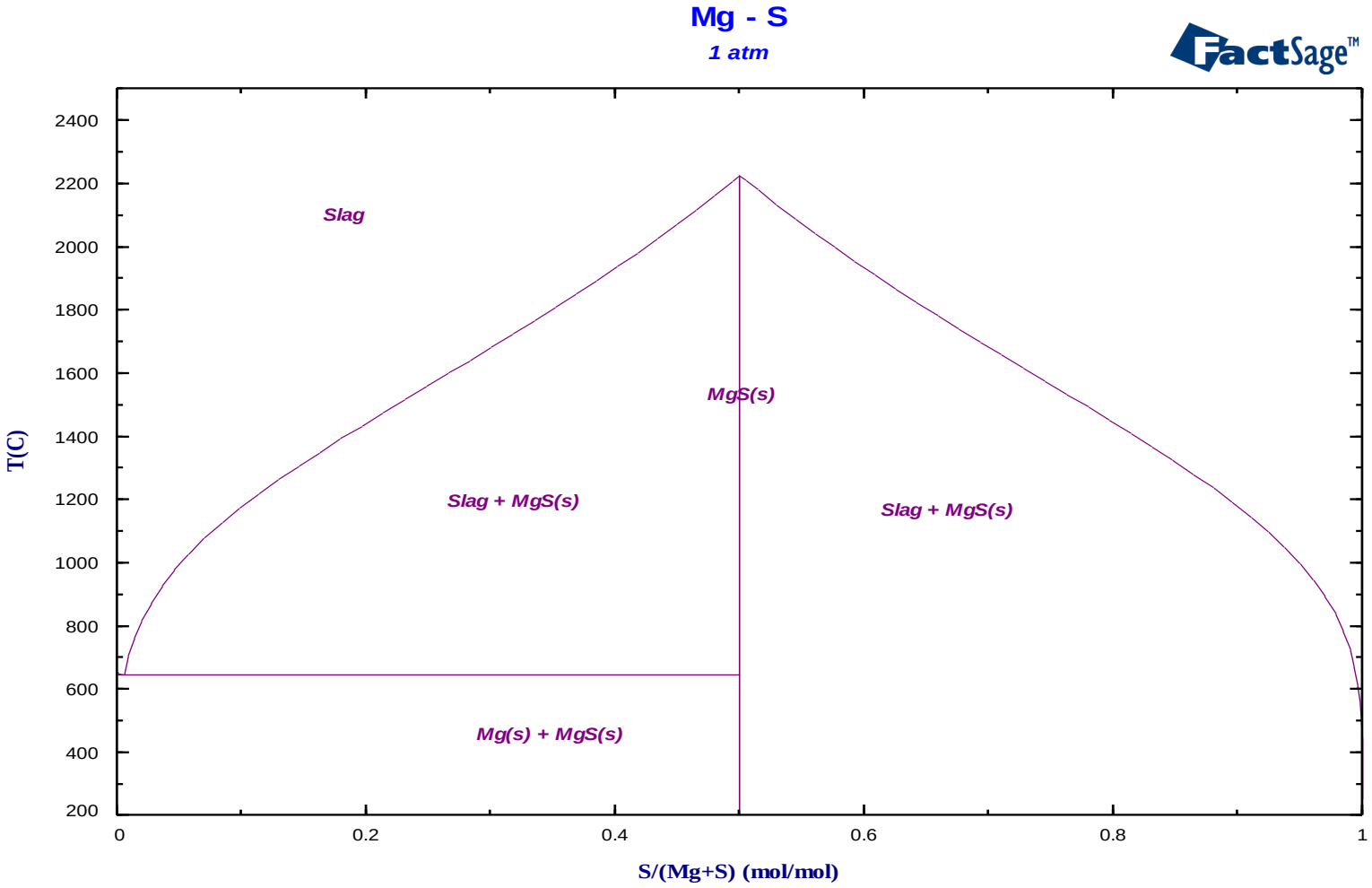
Mole fraction



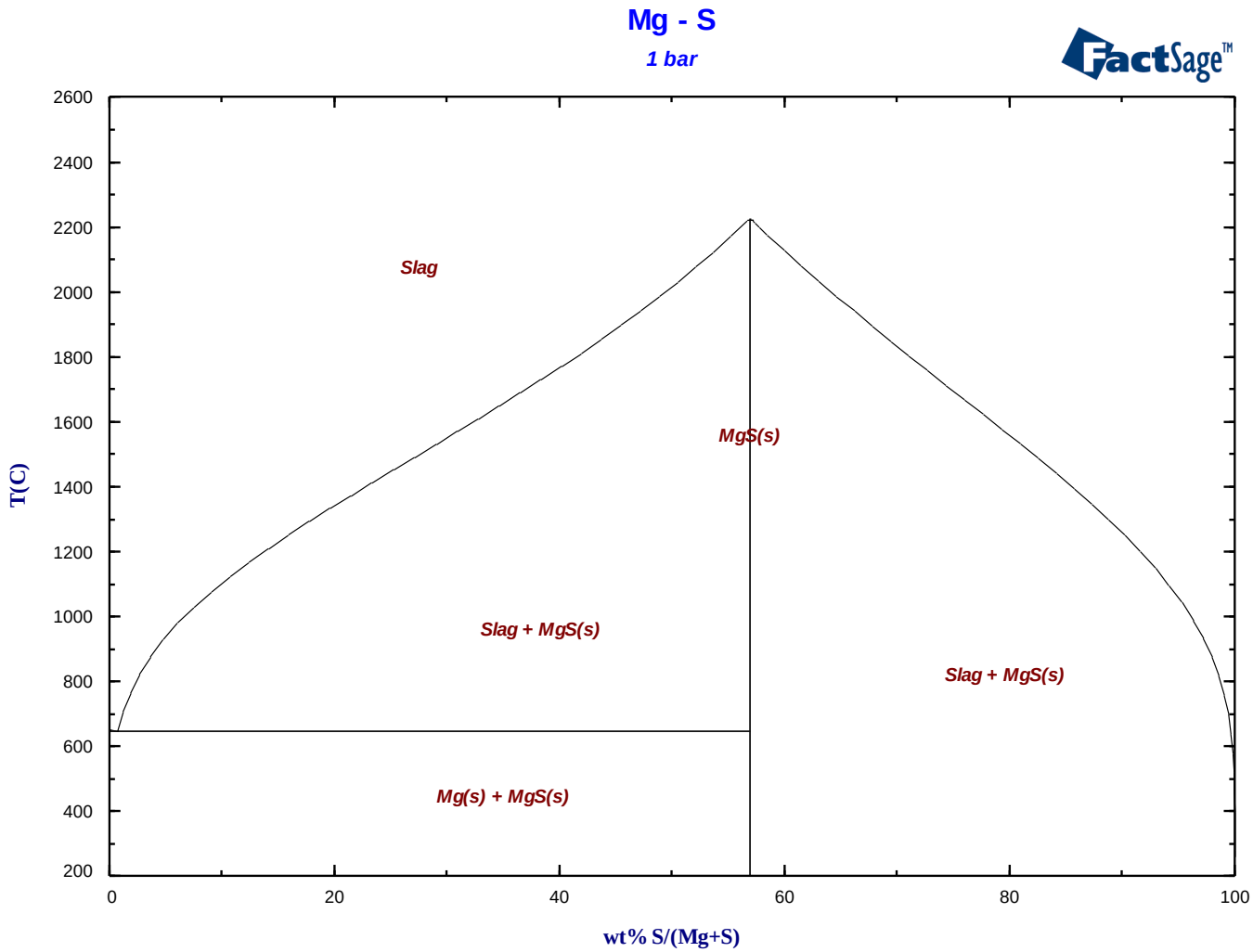
Weight percent



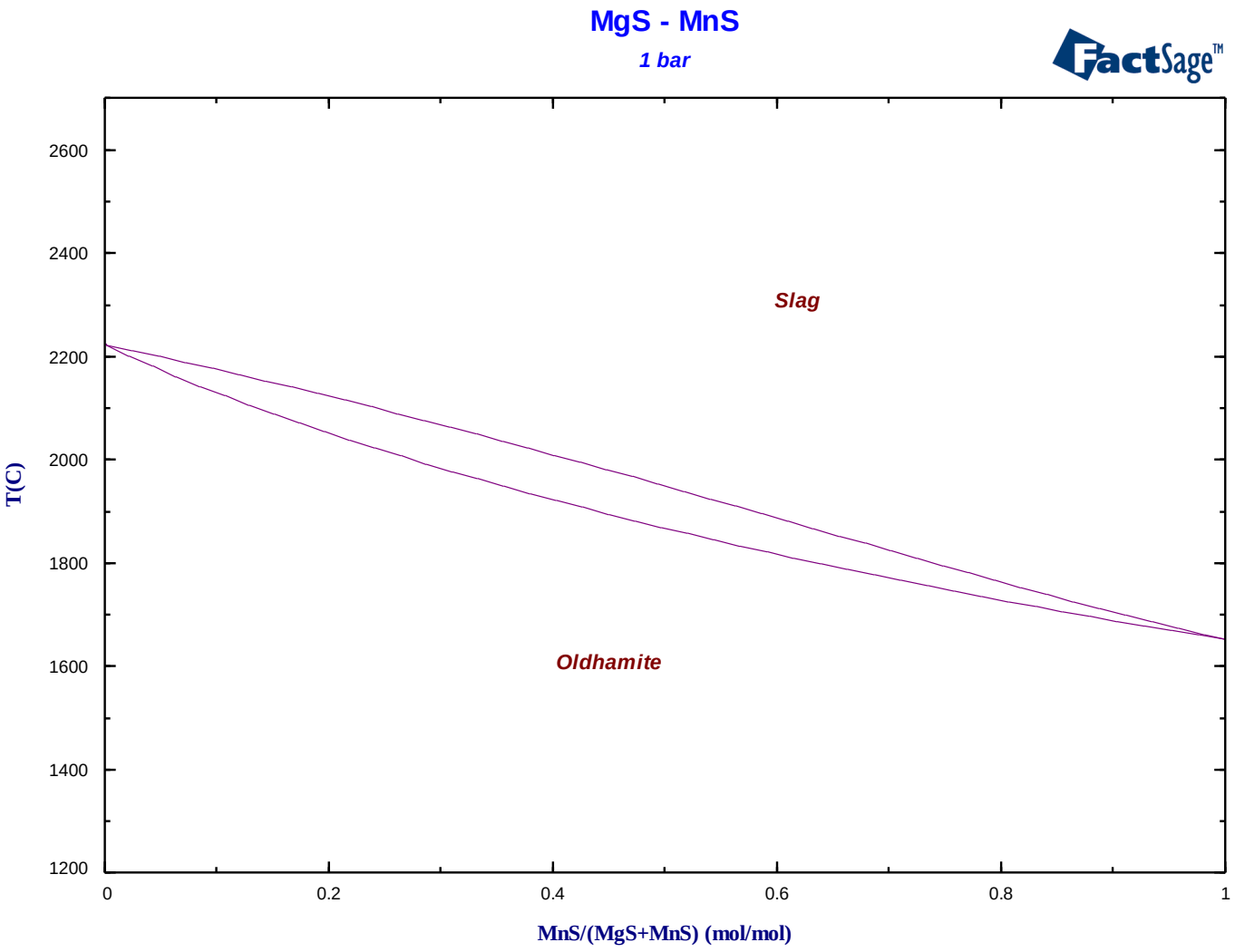
Mole fraction



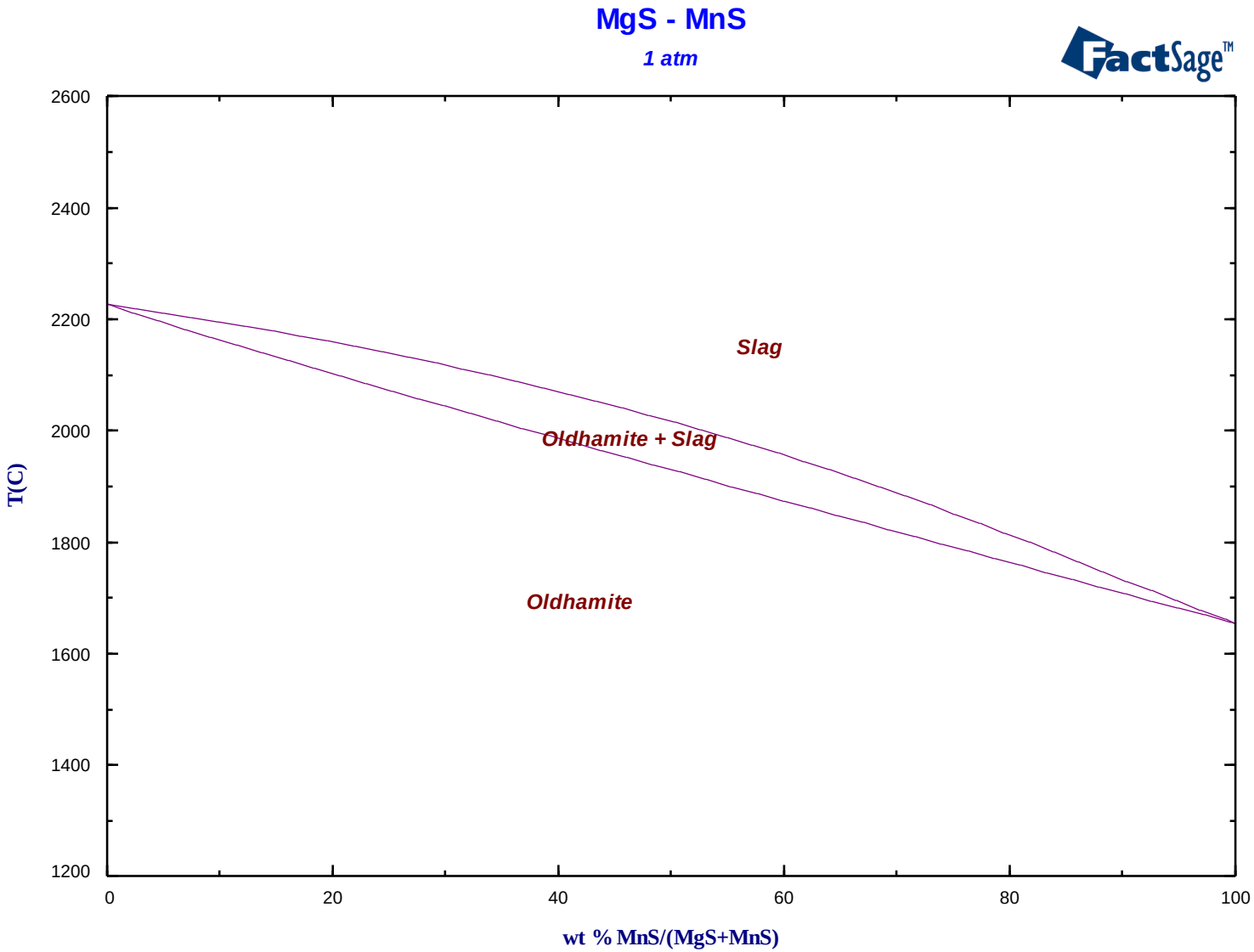
Weight percent



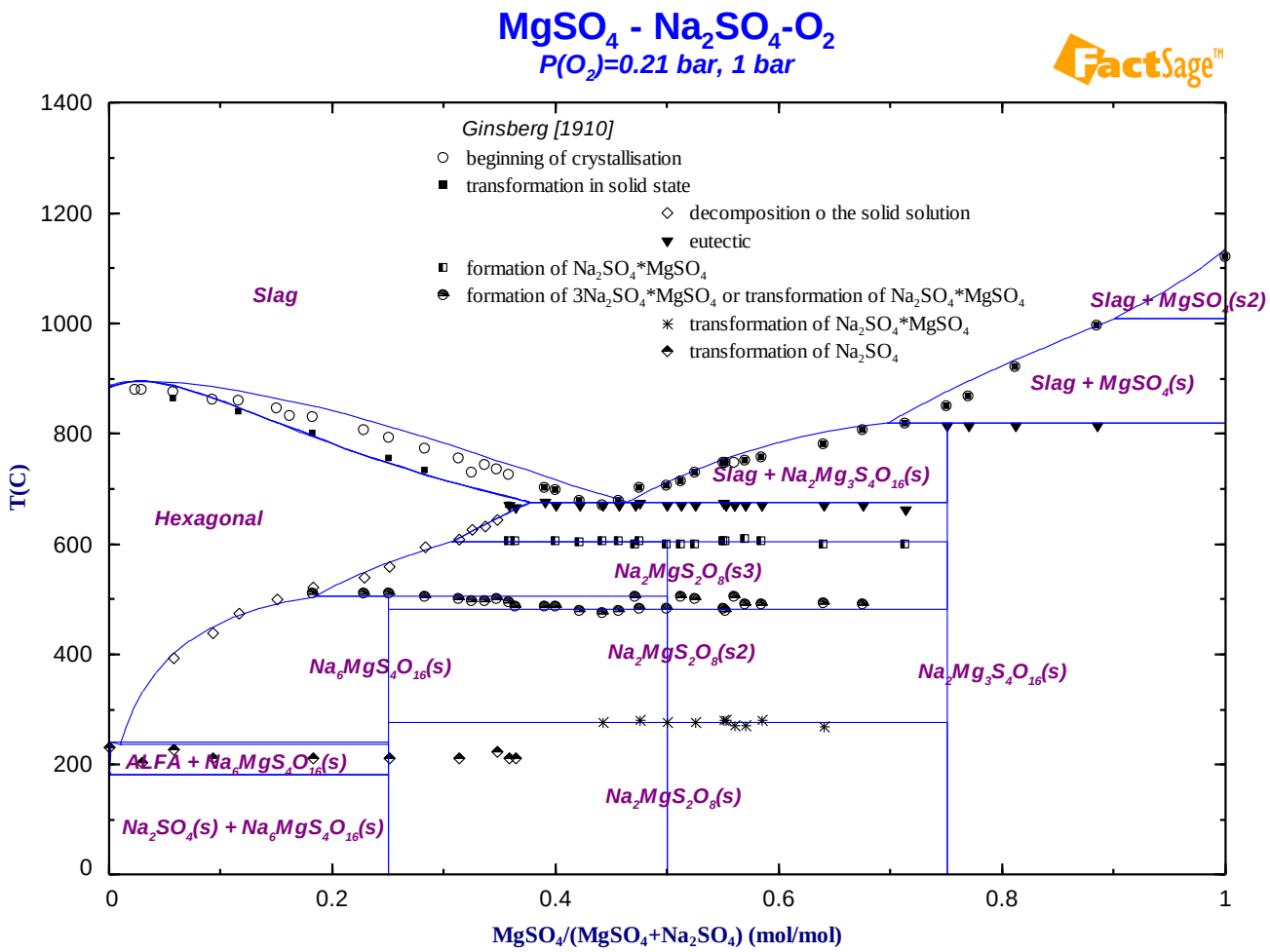
Mole fraction



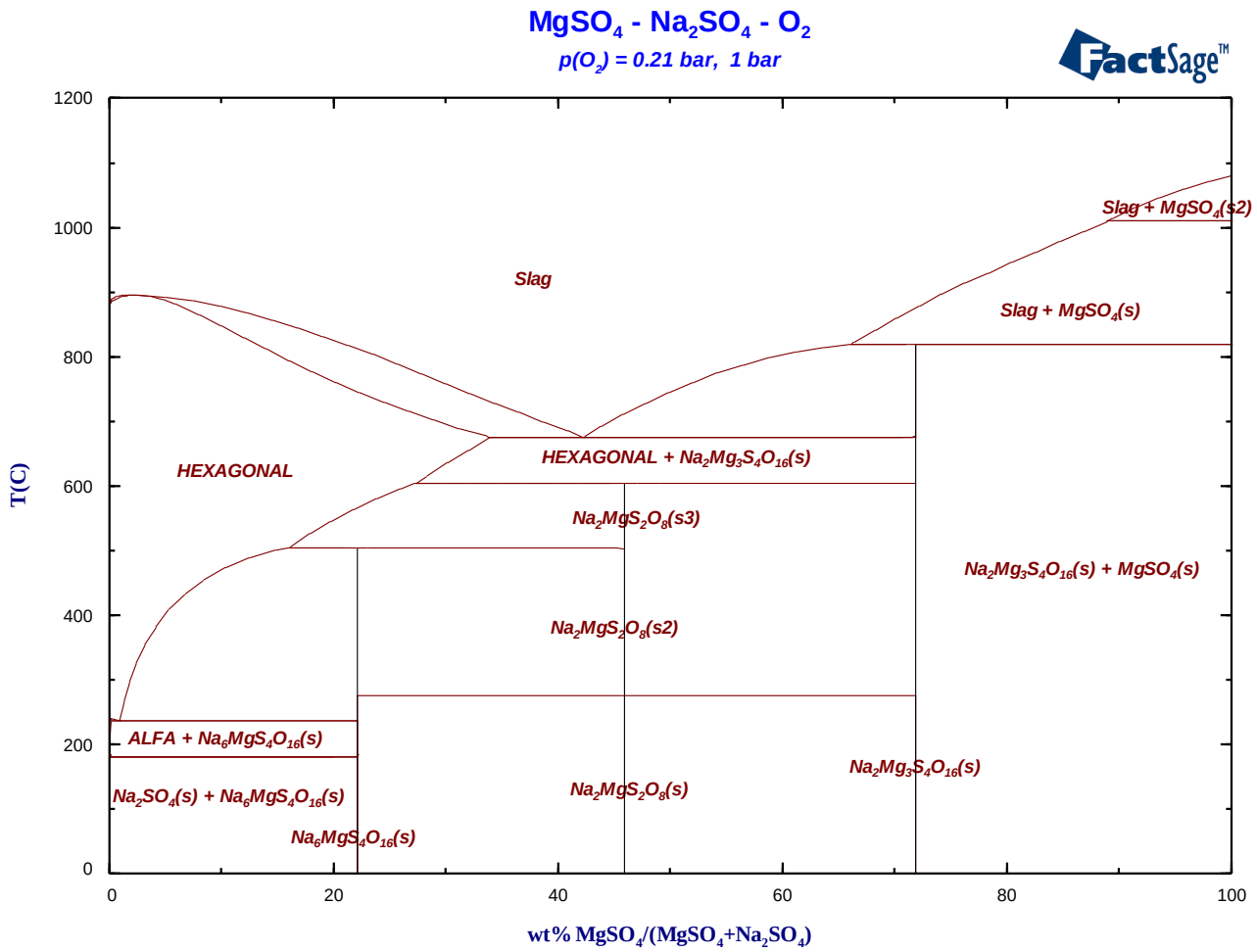
Weight percent



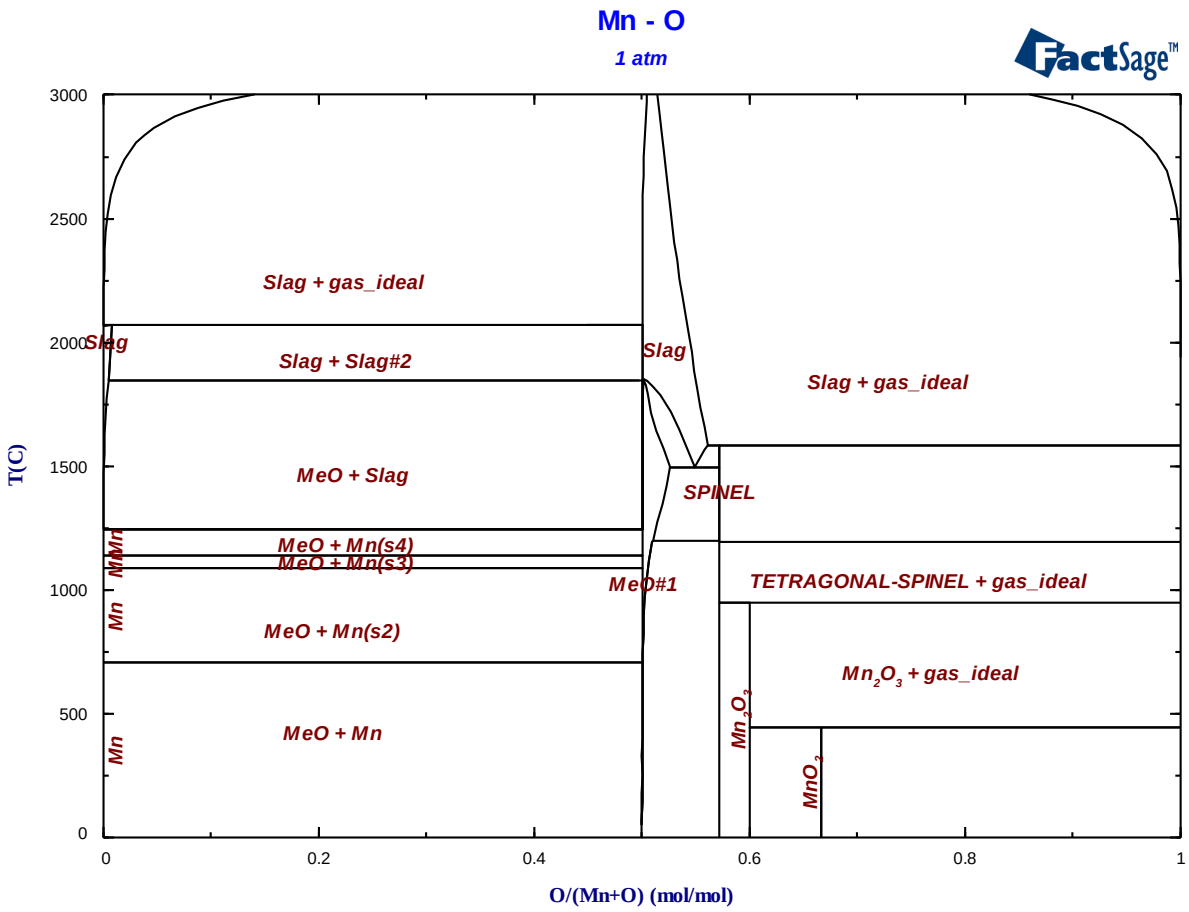
Mole fraction
compared with experimental data



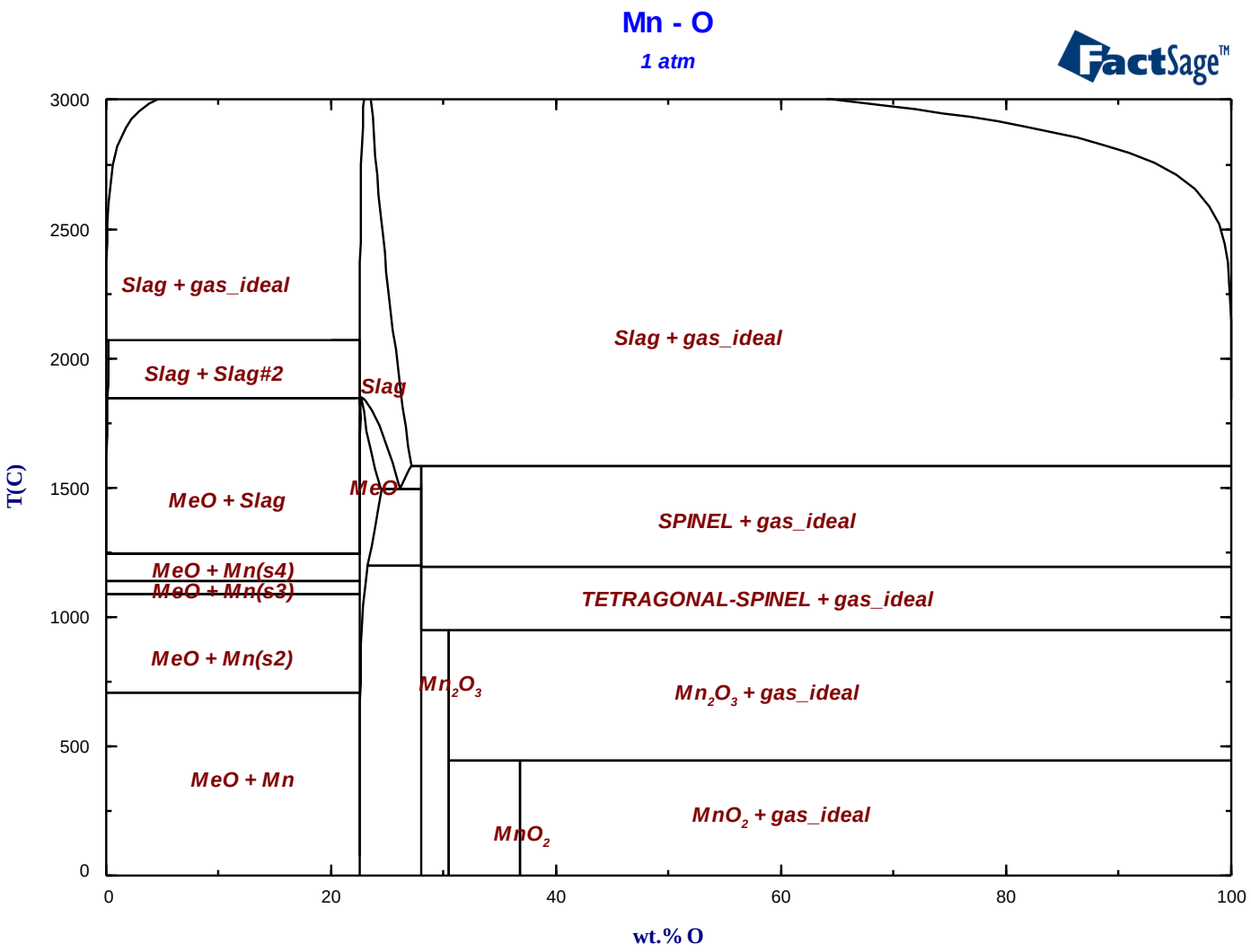
Weight percent



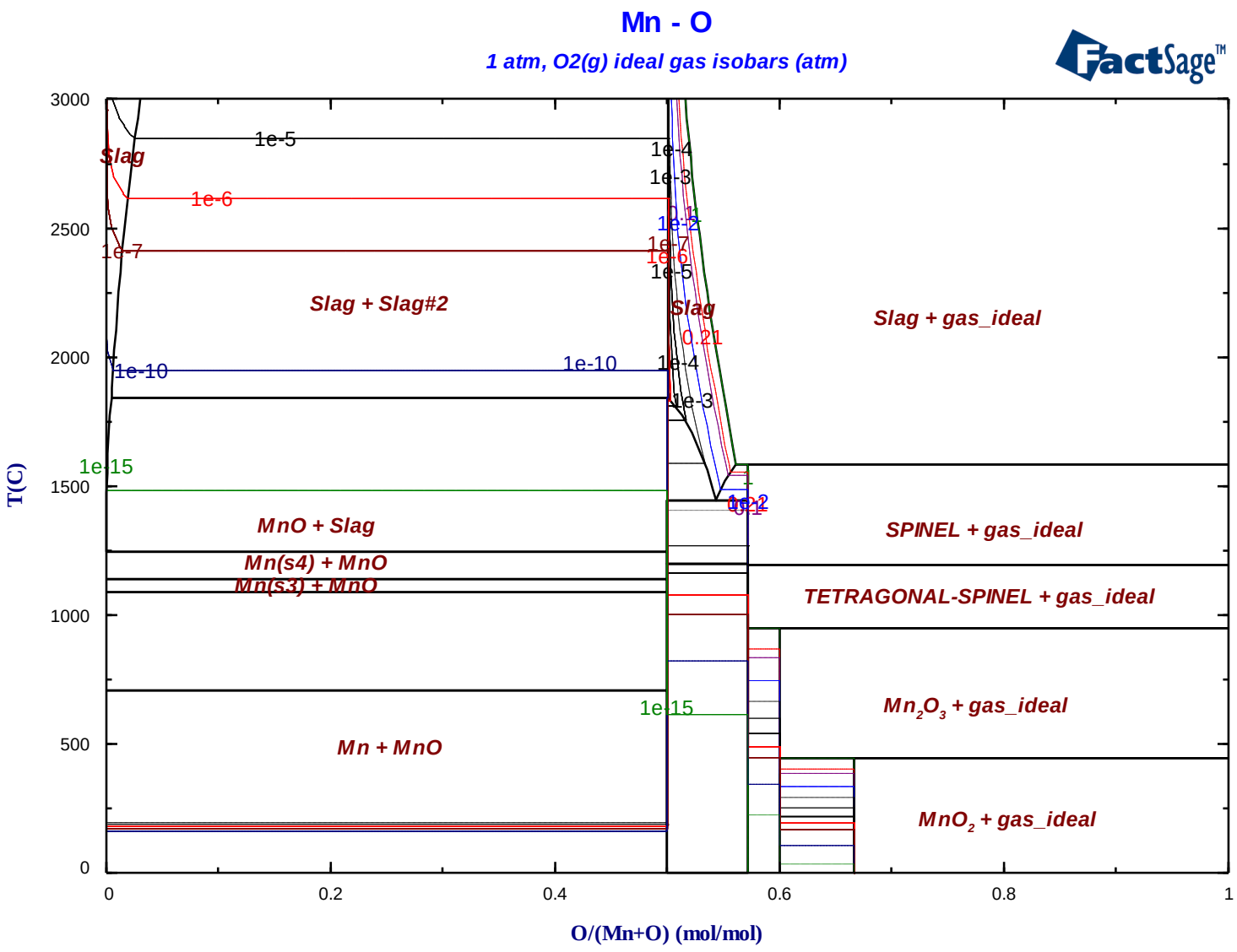
Mole fraction



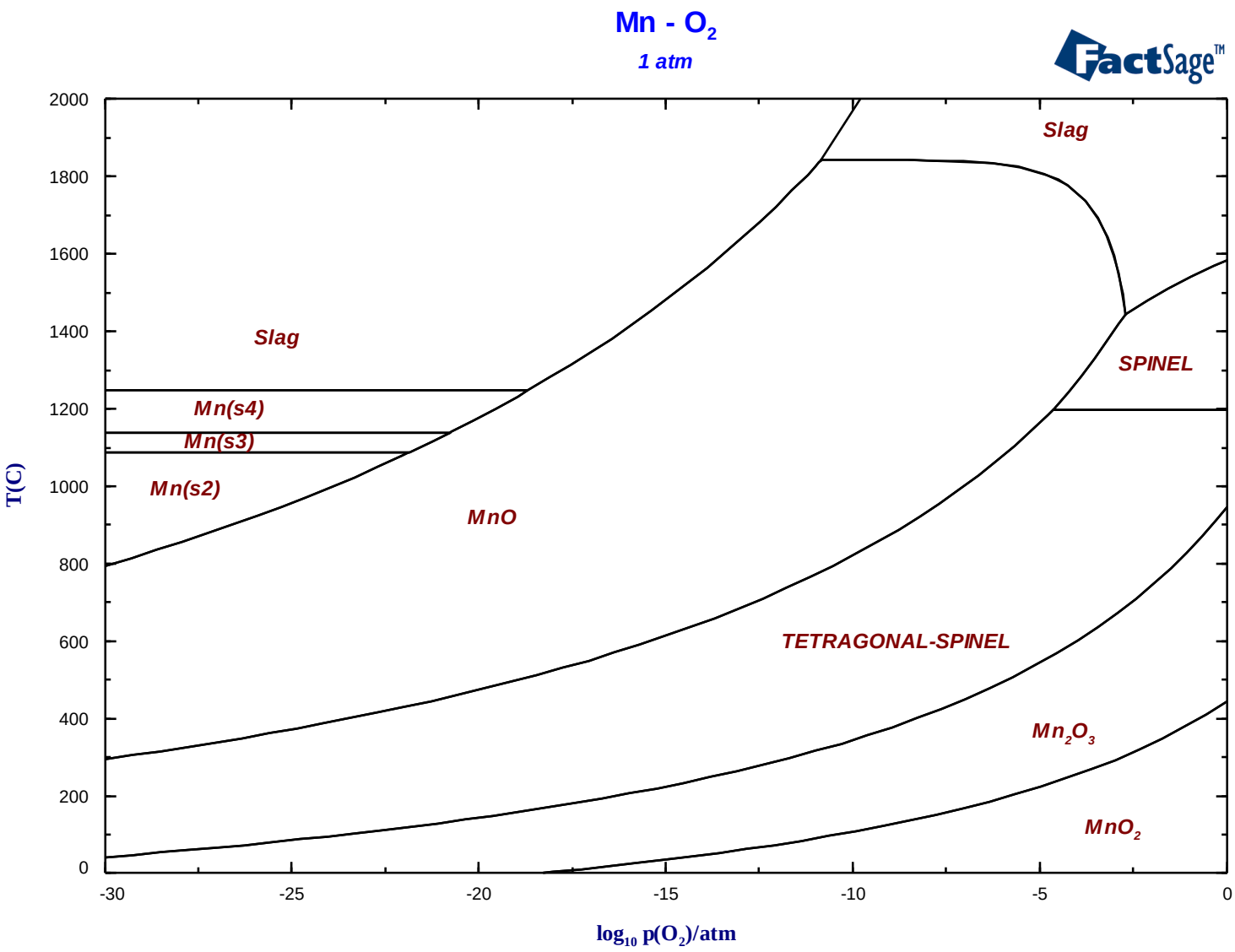
Weight percent



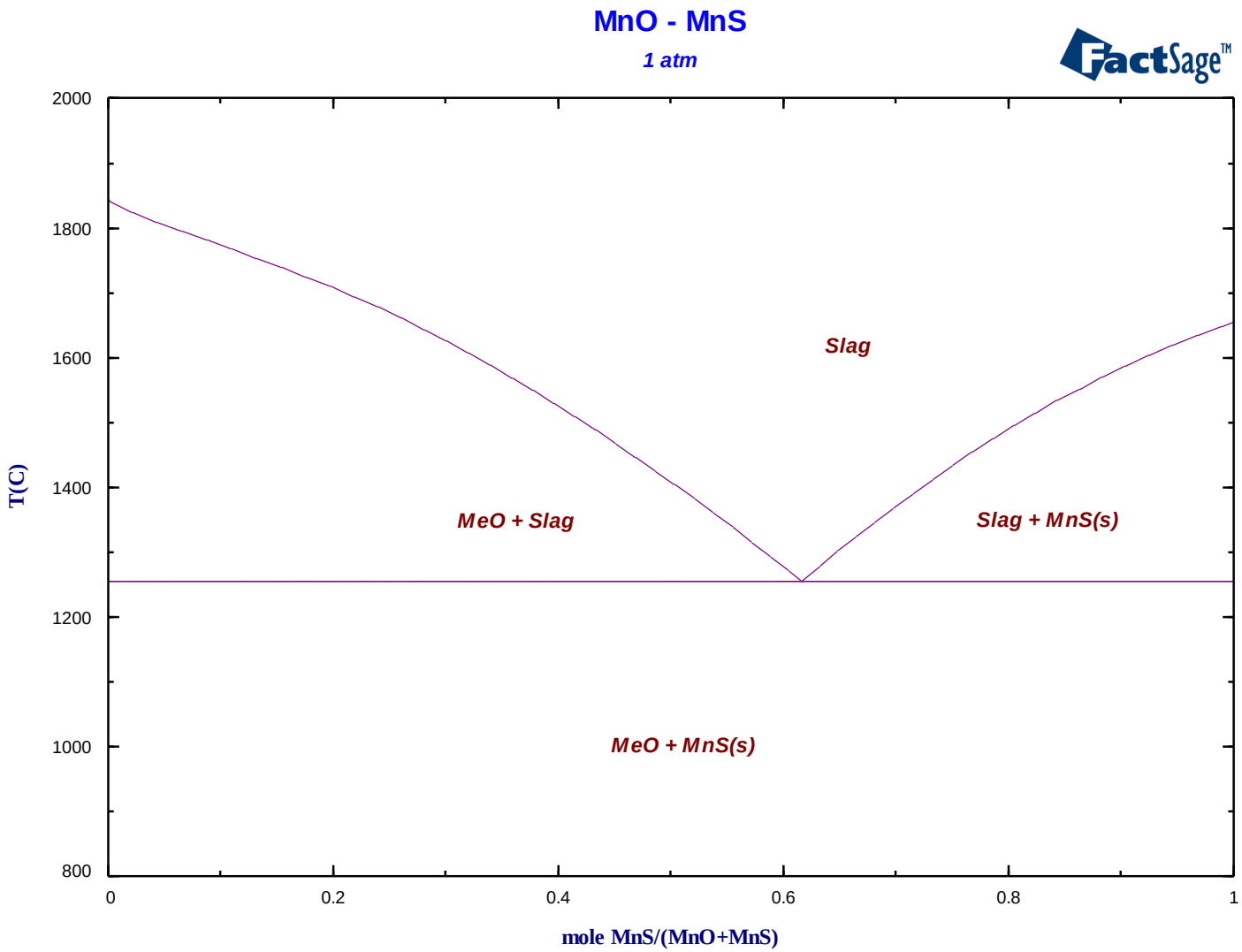
Mn-O,
Mole fraction with isobars



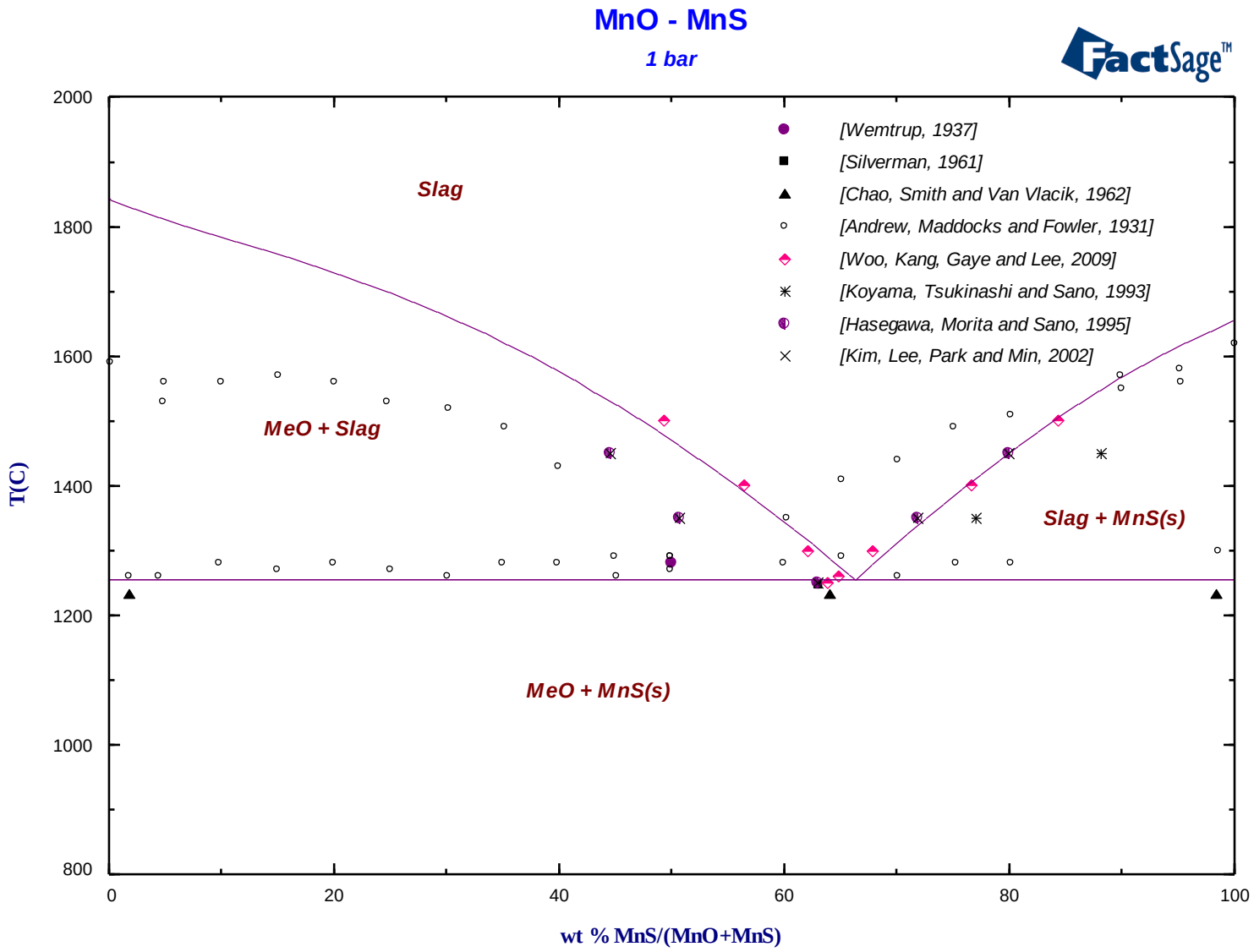
Mn-O2,
Temperature vs. log P(O2) diagram



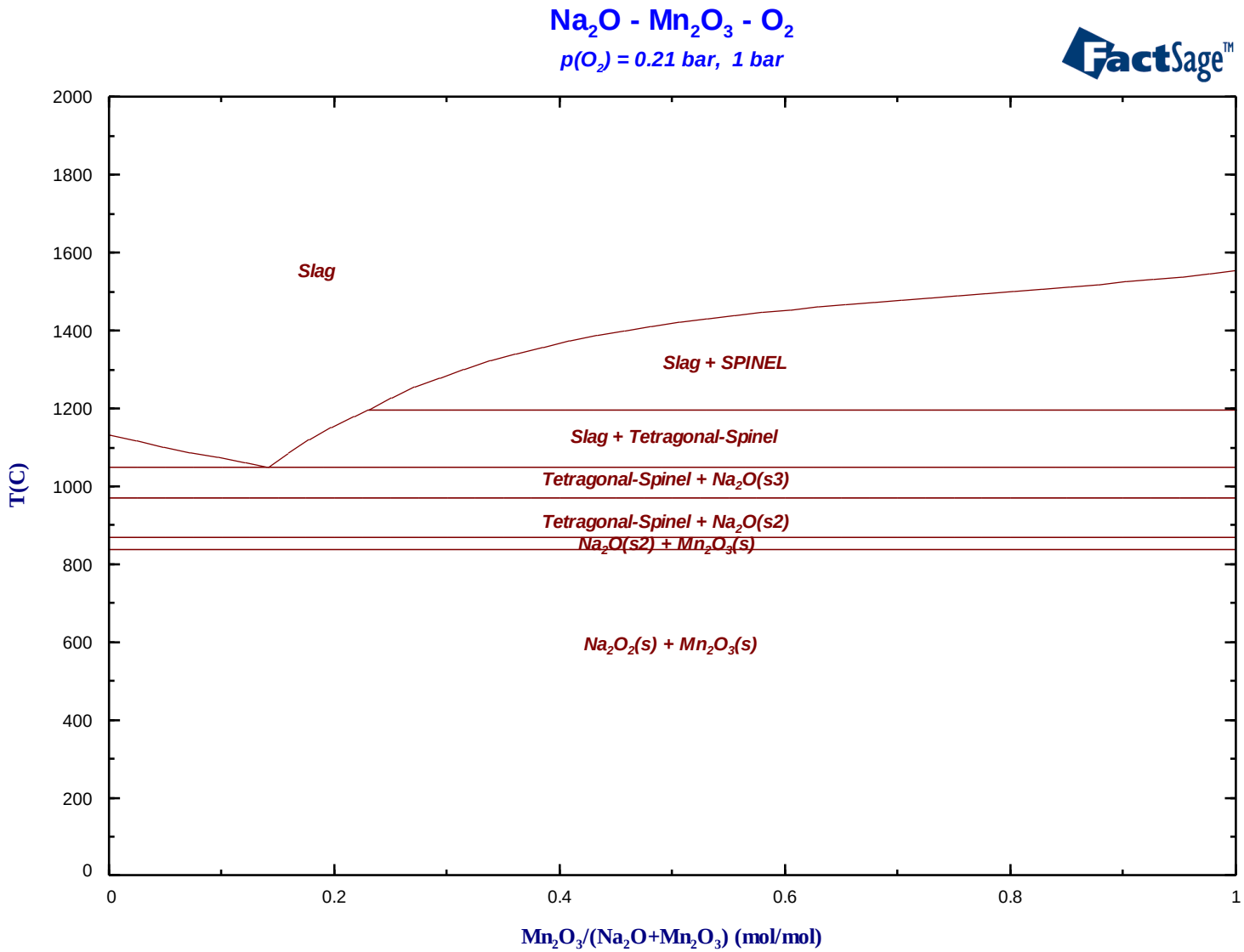
Mole fraction



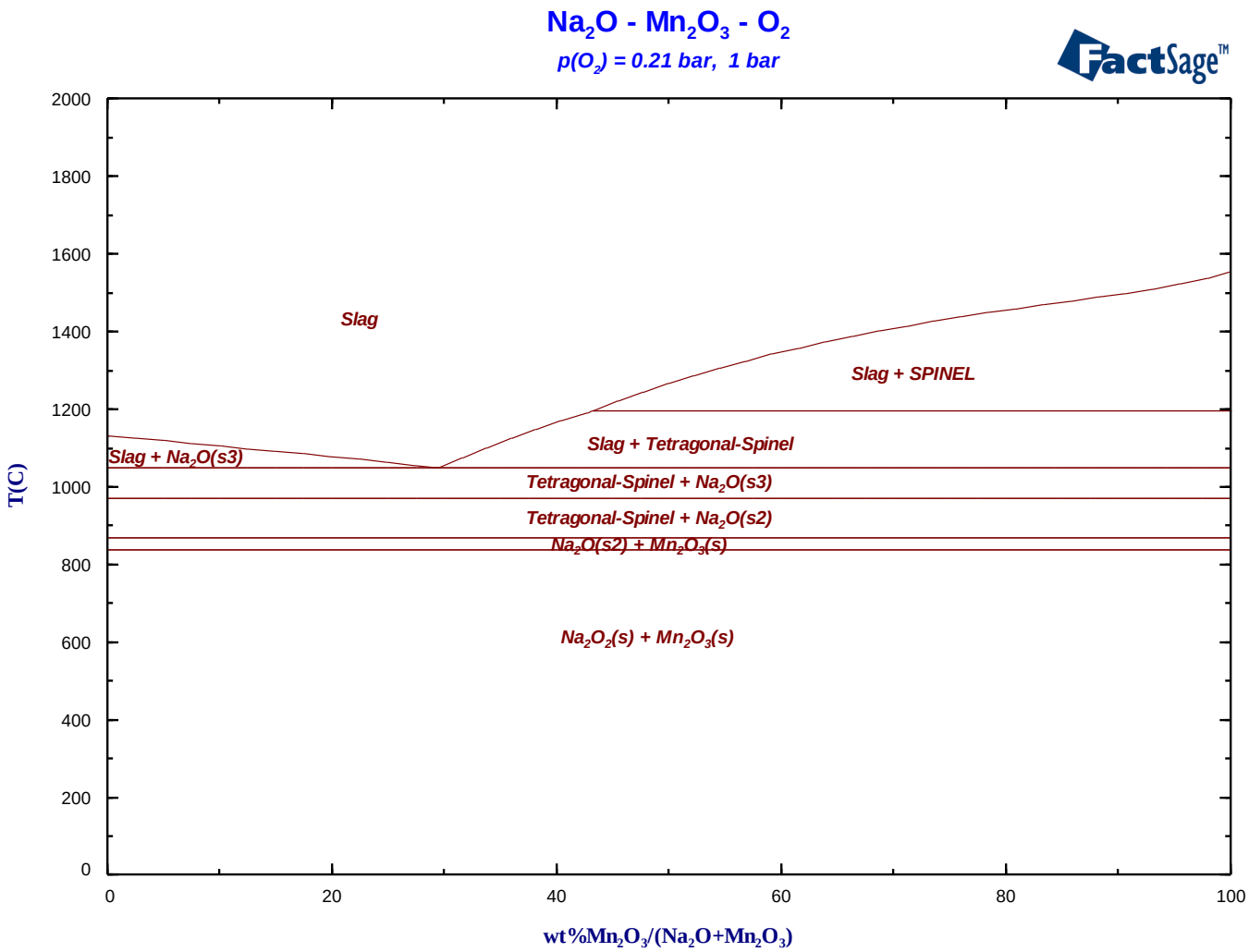
Weight percent compared with experimental data



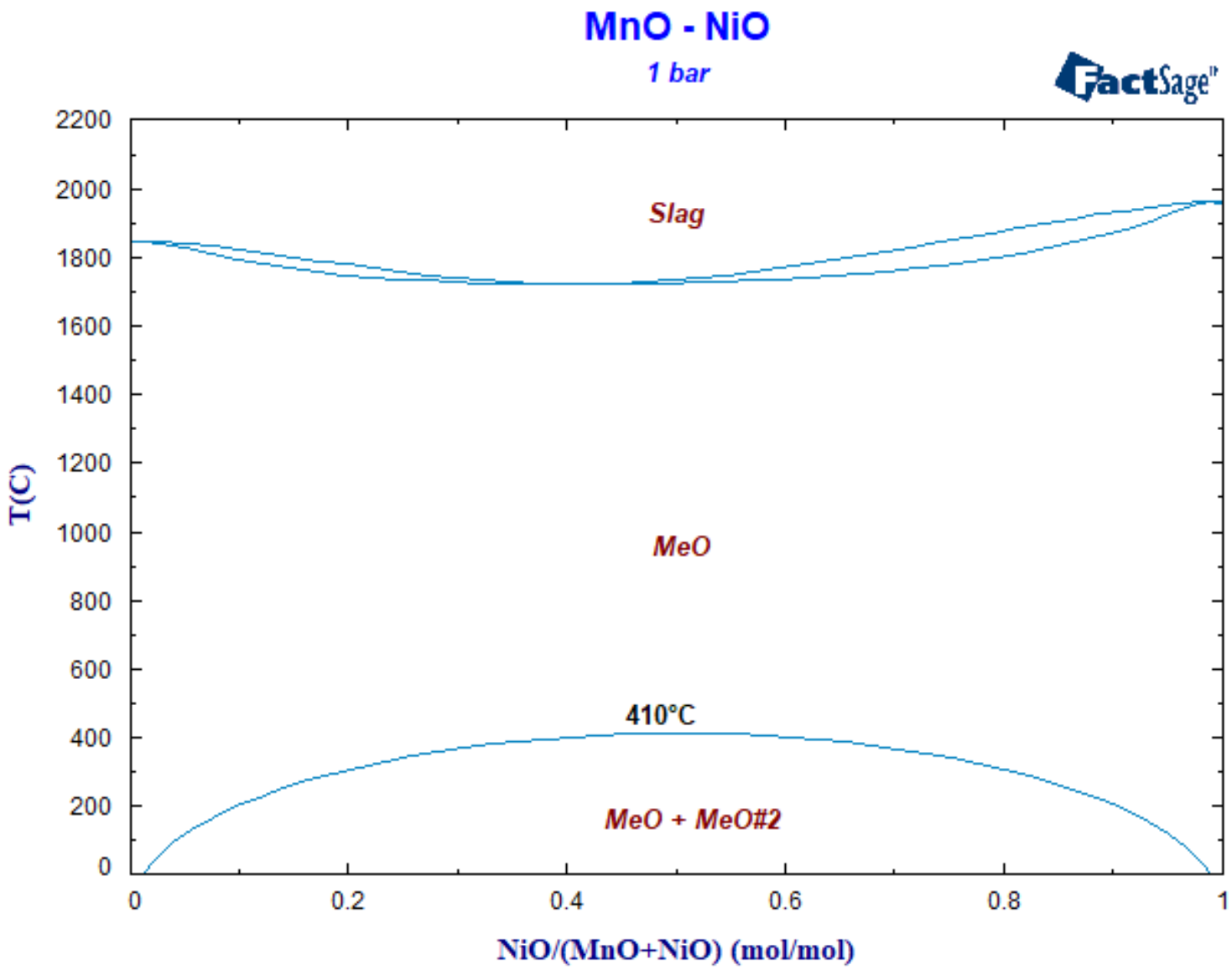
Mole fraction



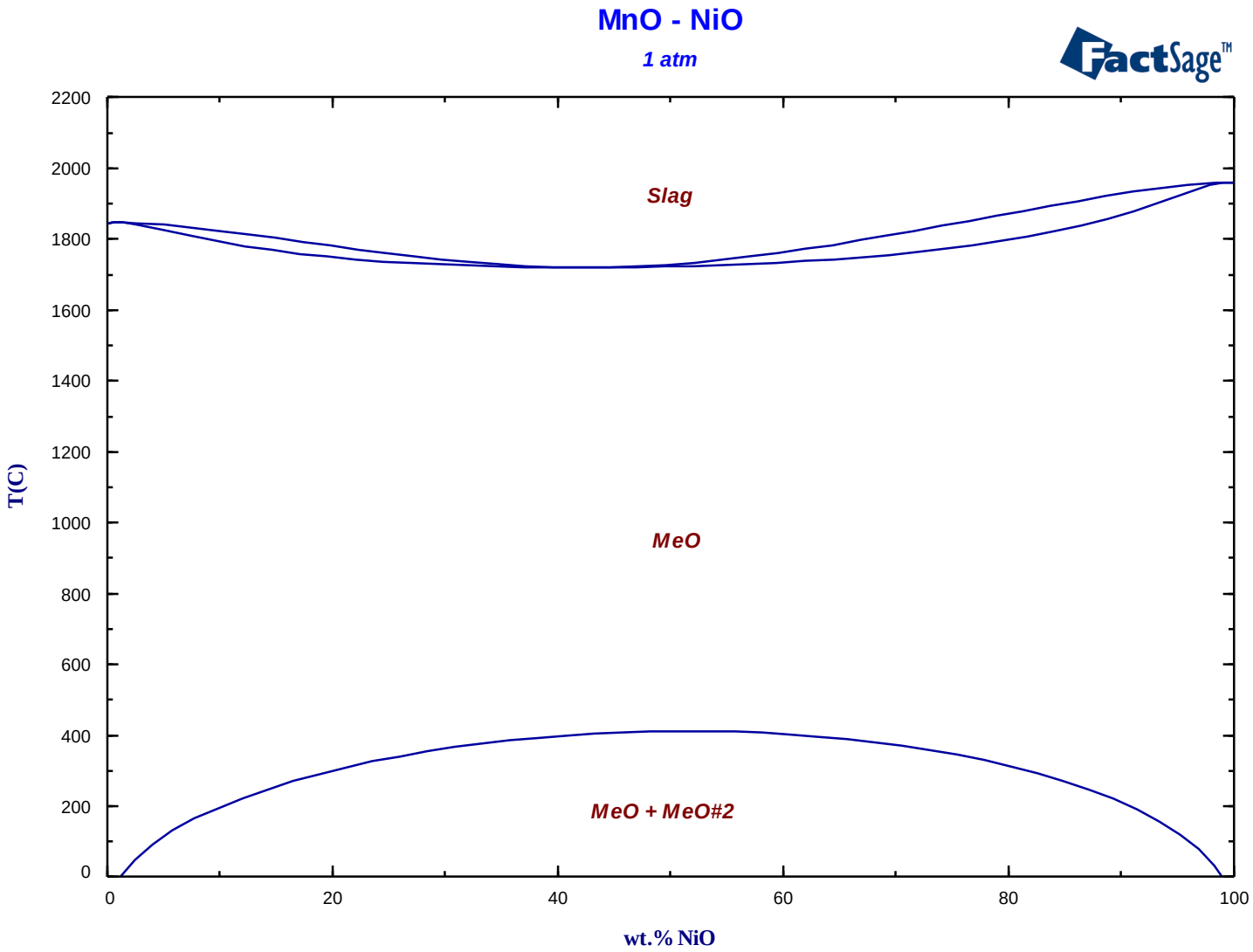
Weight percent



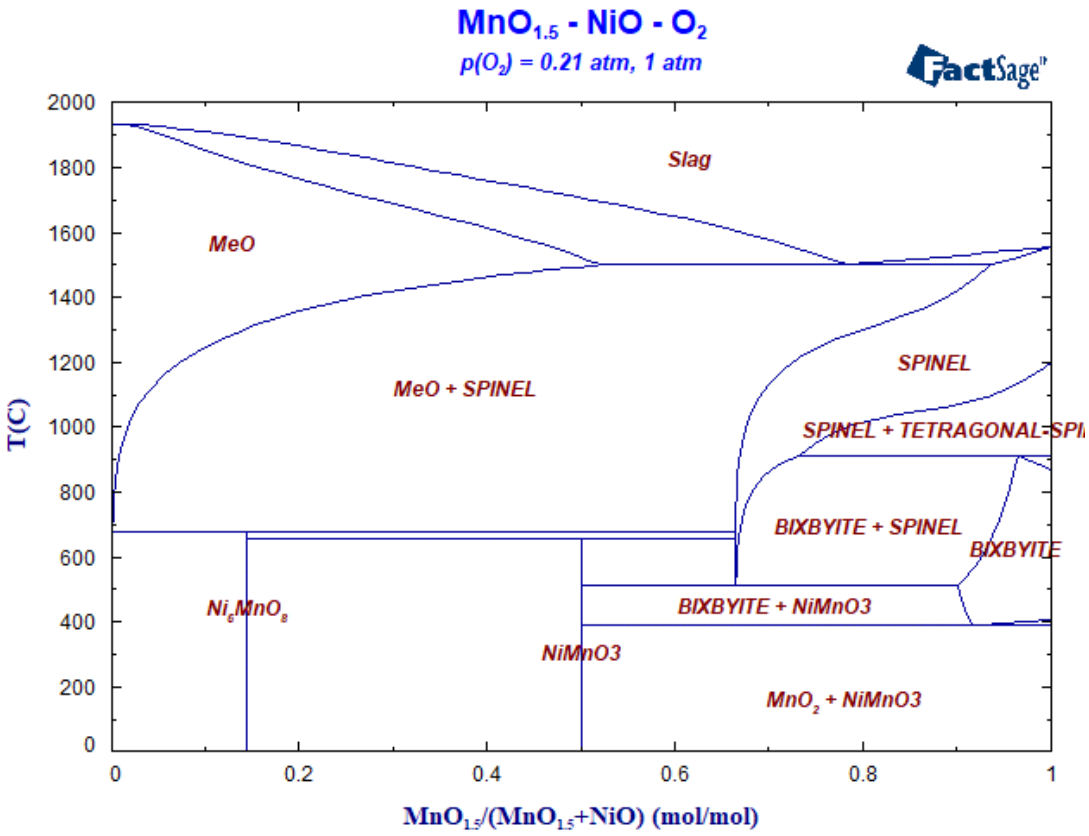
MnO-NiO,
Mole fraction



MnO-NiO,
Weight percent

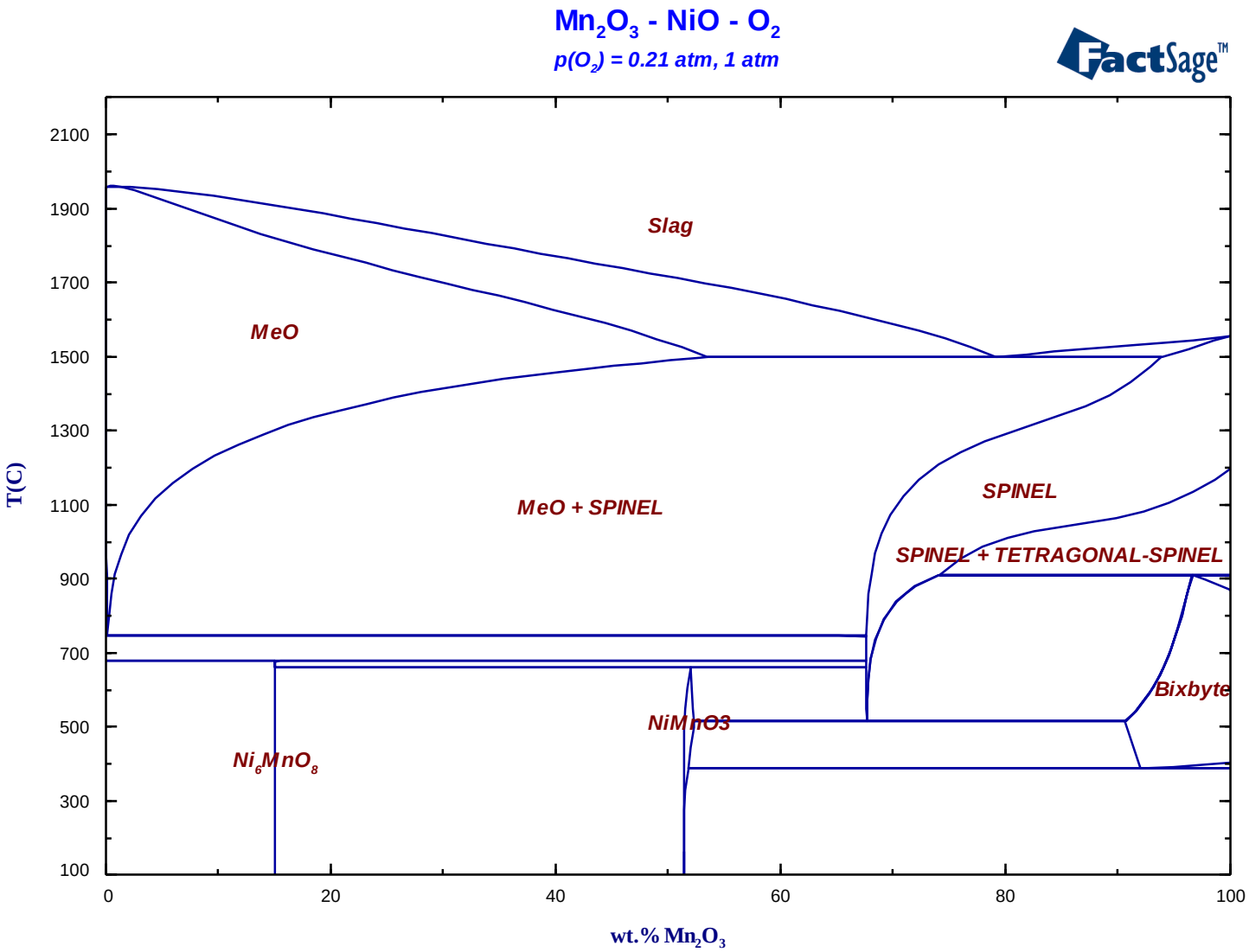


Mn2O3-NiO-O2,
Mole fraction

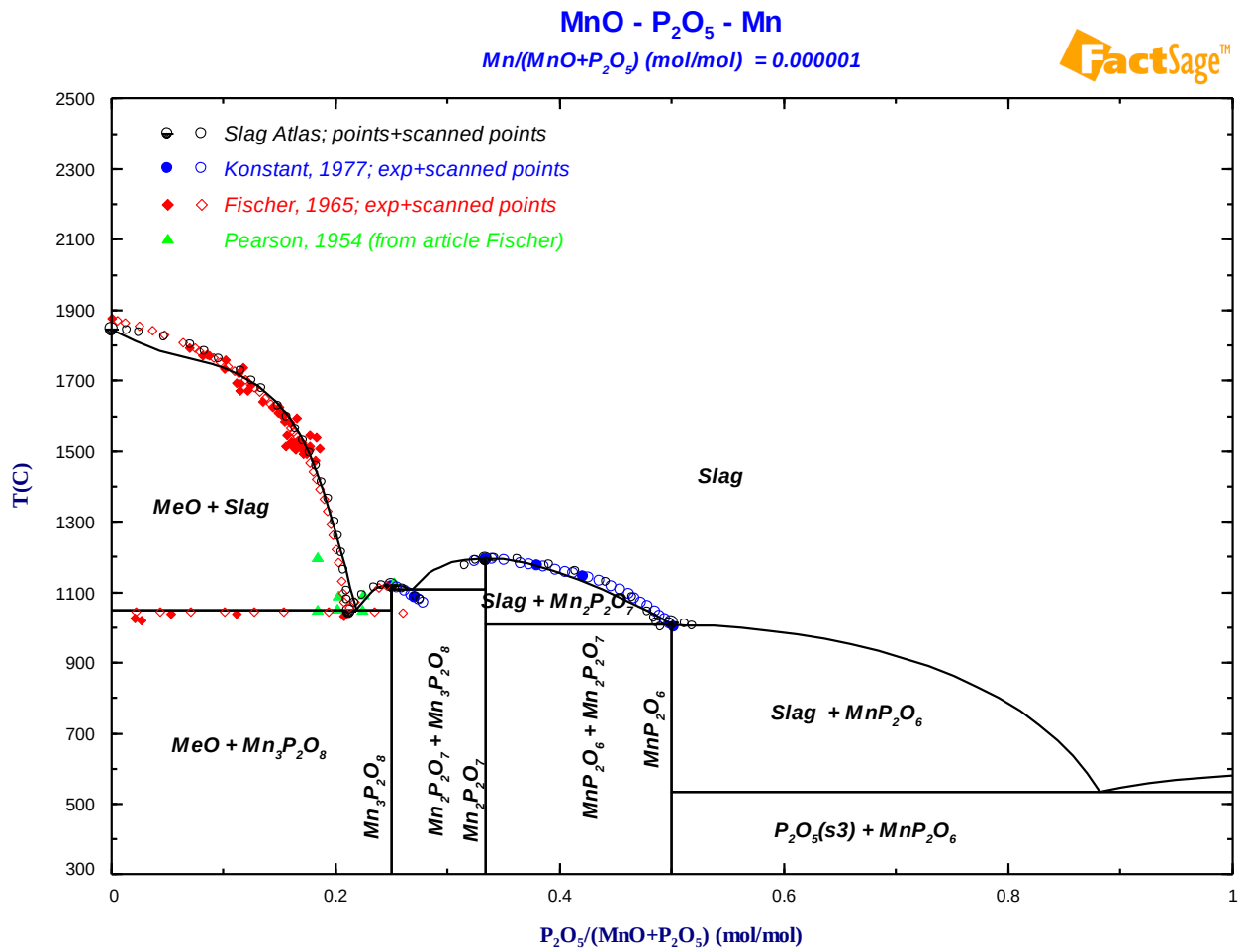


Slag	$(Mn_2O_2, Mn_2O_3, Mn_3O_4, Ni_2O_2, NiMn_2O_4)$	This work
MeO	$(Mn^{+2}, Mn^{+3}, Va, Ni^{+2})(O^{-2})$	[Kjellqvist2010]
Spinel	$(Mn^{+2}, Ni^{+2})\ (Mn^{+2}, Mn^{+3}, Mn^{+4}, Va)_2\ (Va)_2(O^{-2})_4$	This work
Bixbyite	$(Mn^{+2}, Mn^{+4}, Ni^{+2})_2\ (O^{-2})_3$	[Kjellqvist2010]
$NiMnO_3$	$(Mn^{+3}, Mn^{+4}, Ni^{+2})_2(O^{-2})_3$	[Kjellqvist2010]
Ni_6MnO_8	*stoichiometric*	[Kjellqvist2010]

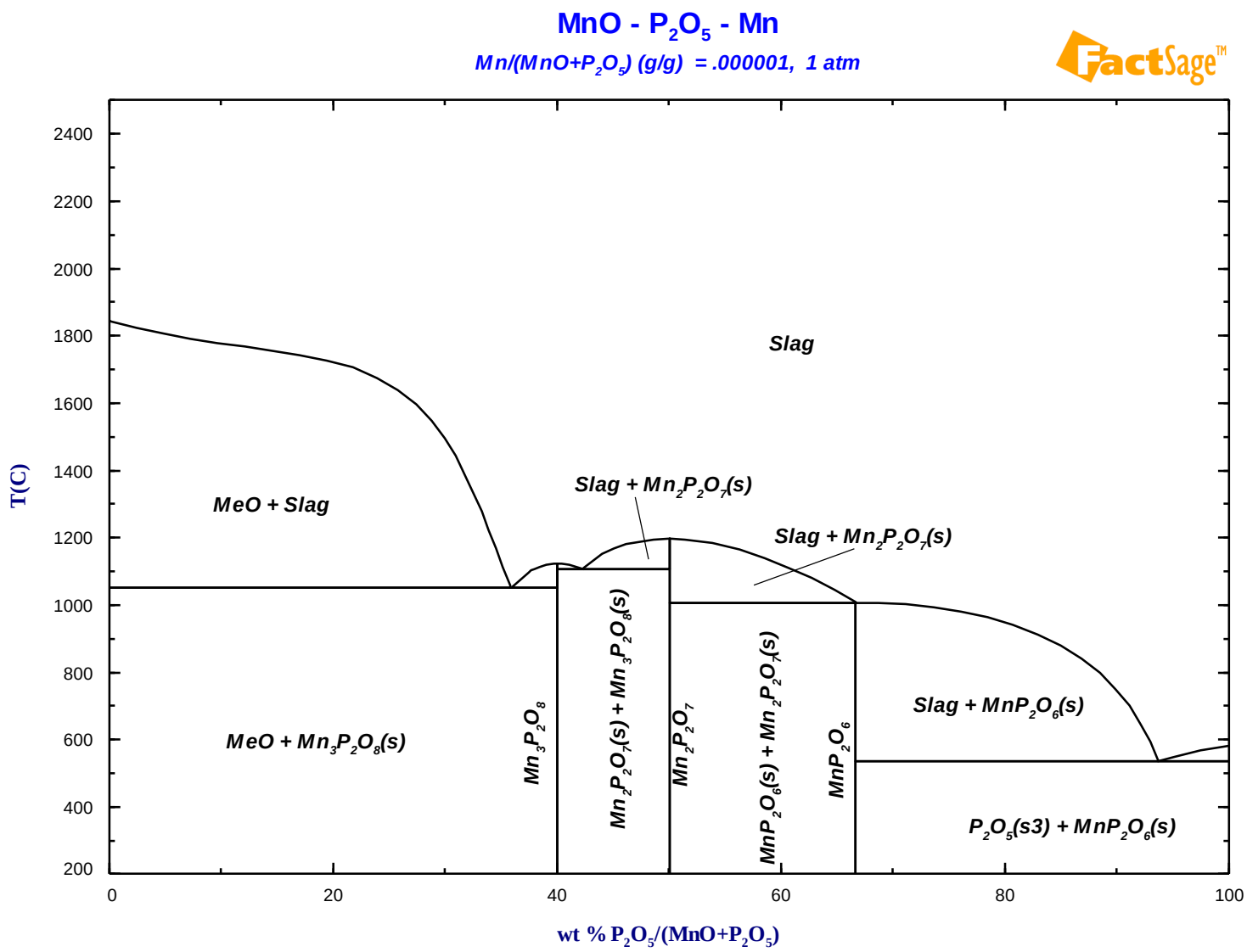
Mn2O3-NiO-O2, Weight percent



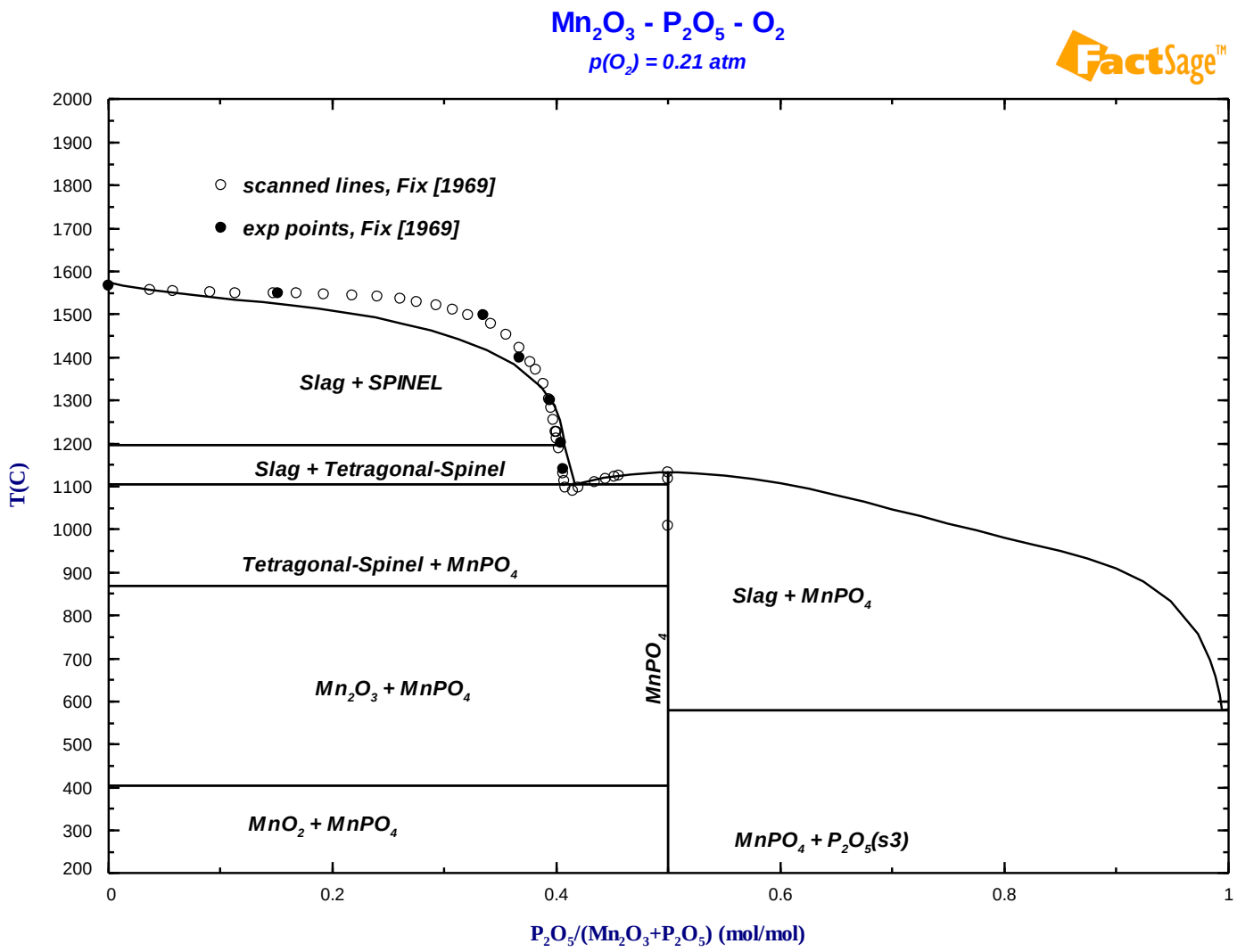
Mole fraction compared with experimental data



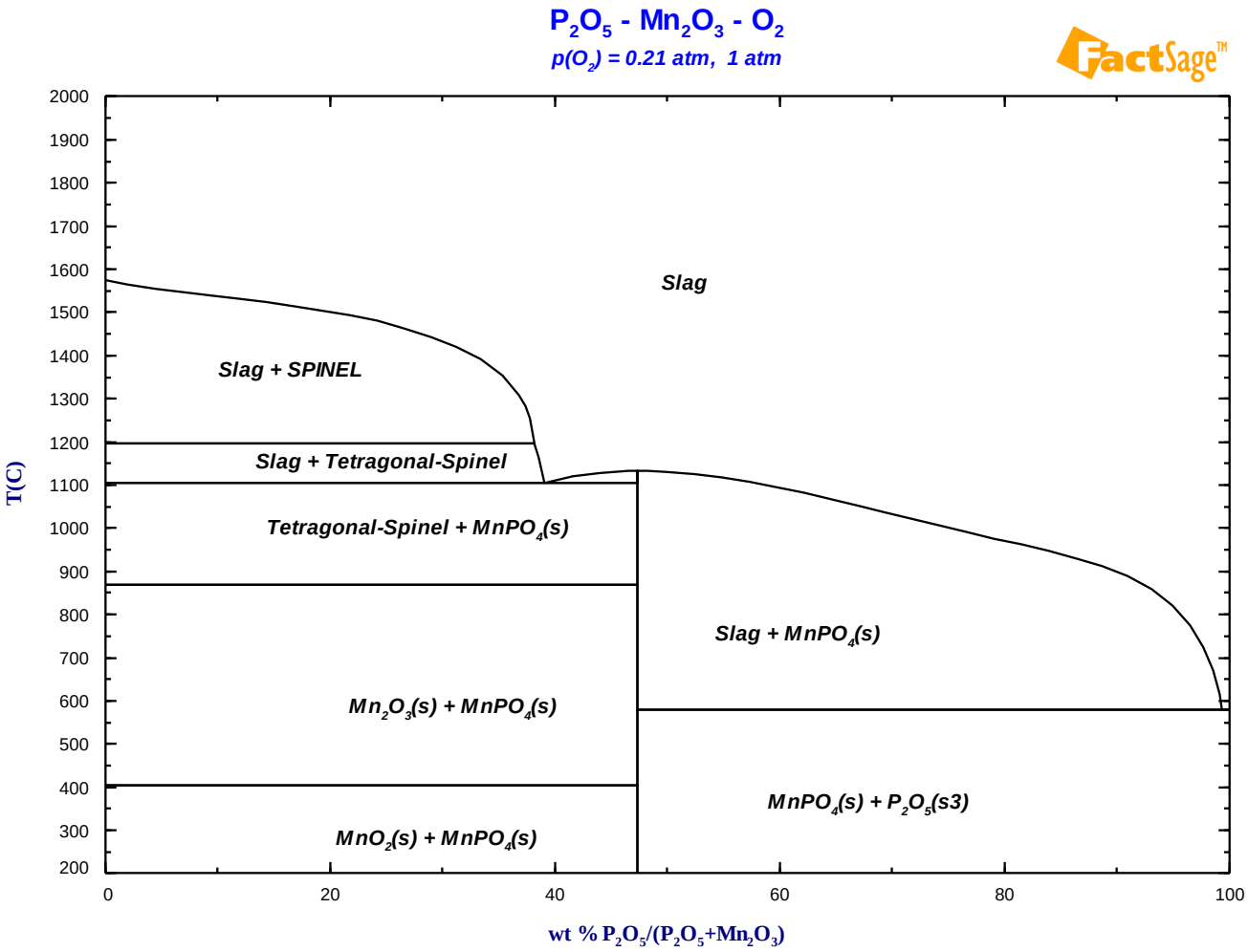
Weight percent



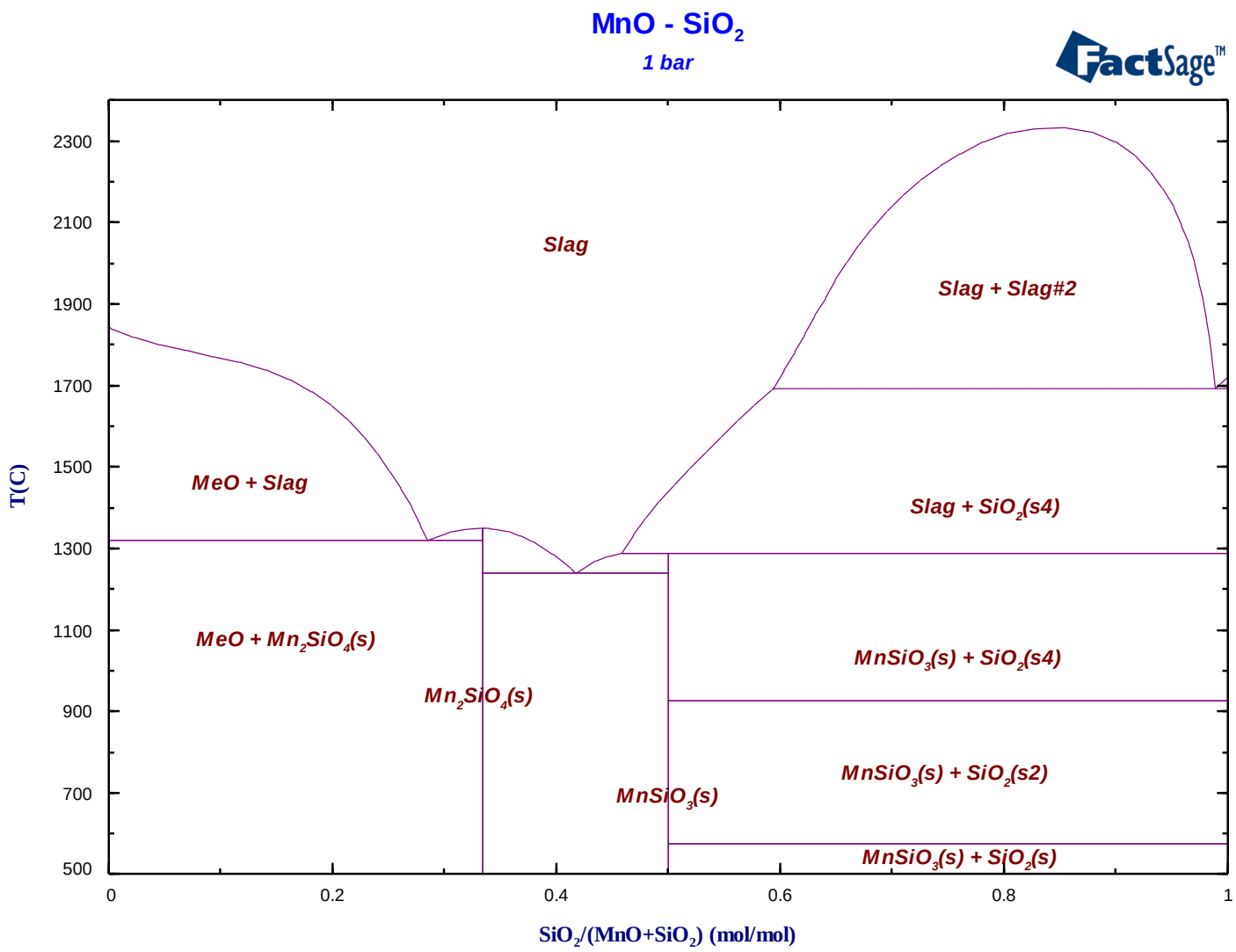
Mole fraction compared with experimental data



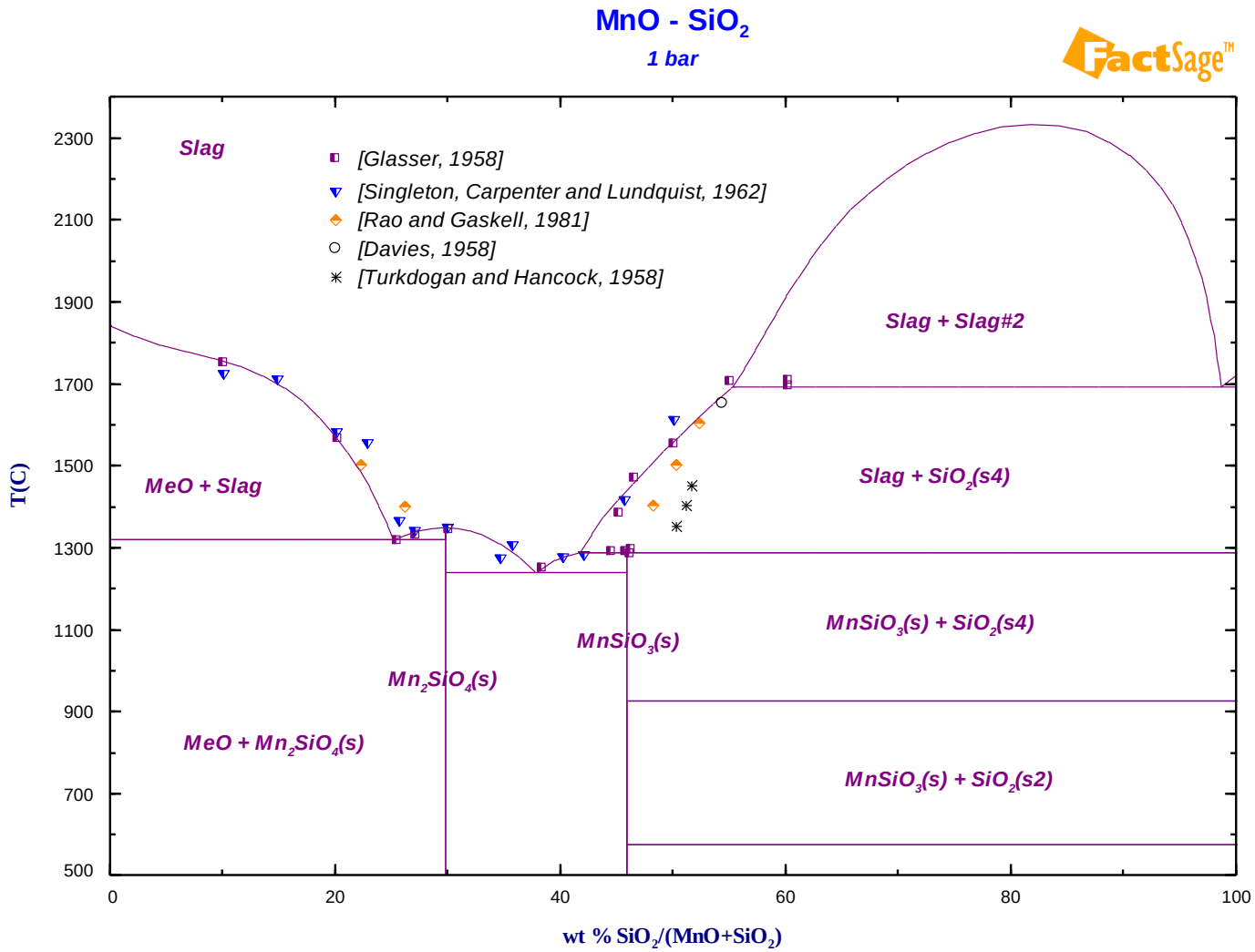
Weight percent



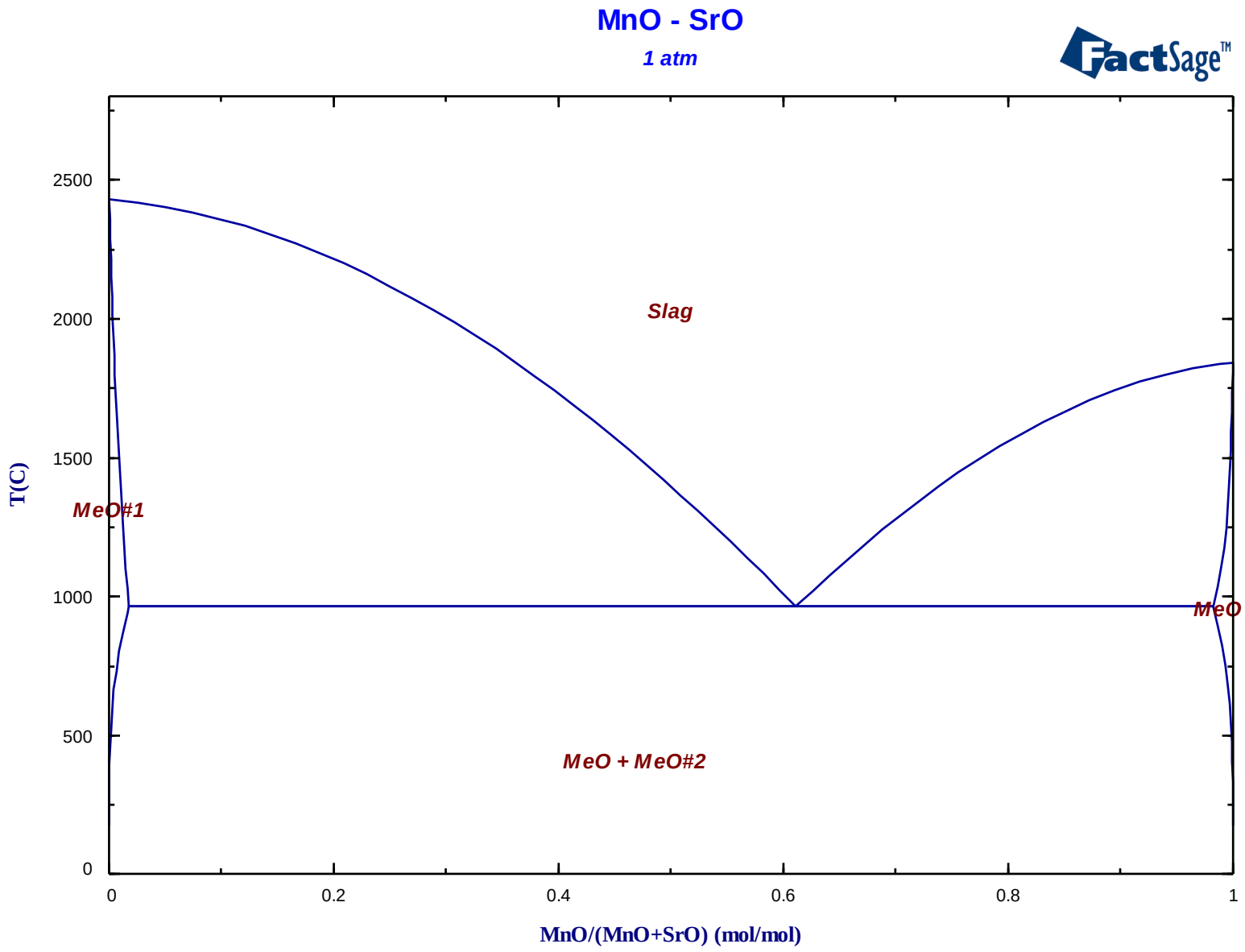
Mole fraction



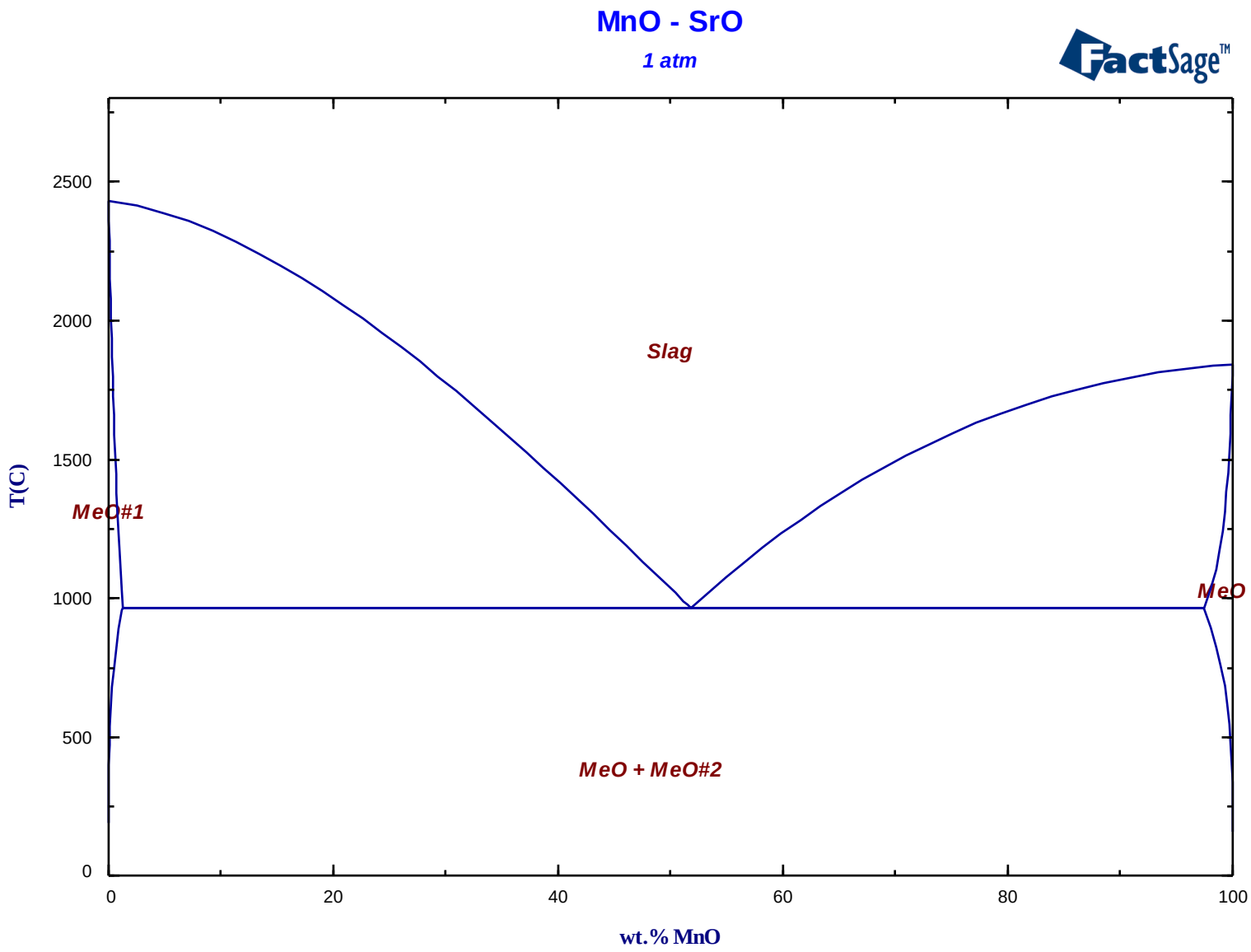
Weight percent compared with experimental data



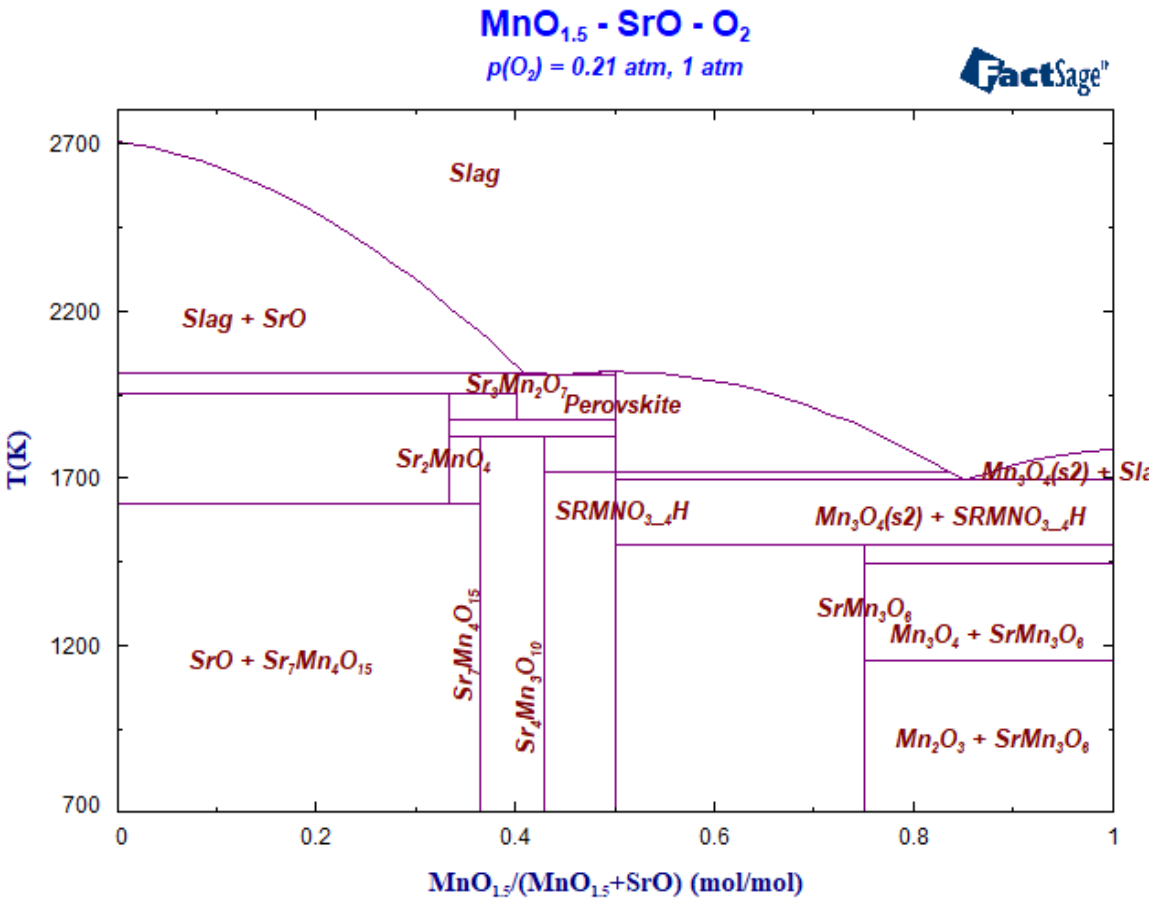
MnO-SrO,
Mole fraction



MnO-SrO,
Weight percent

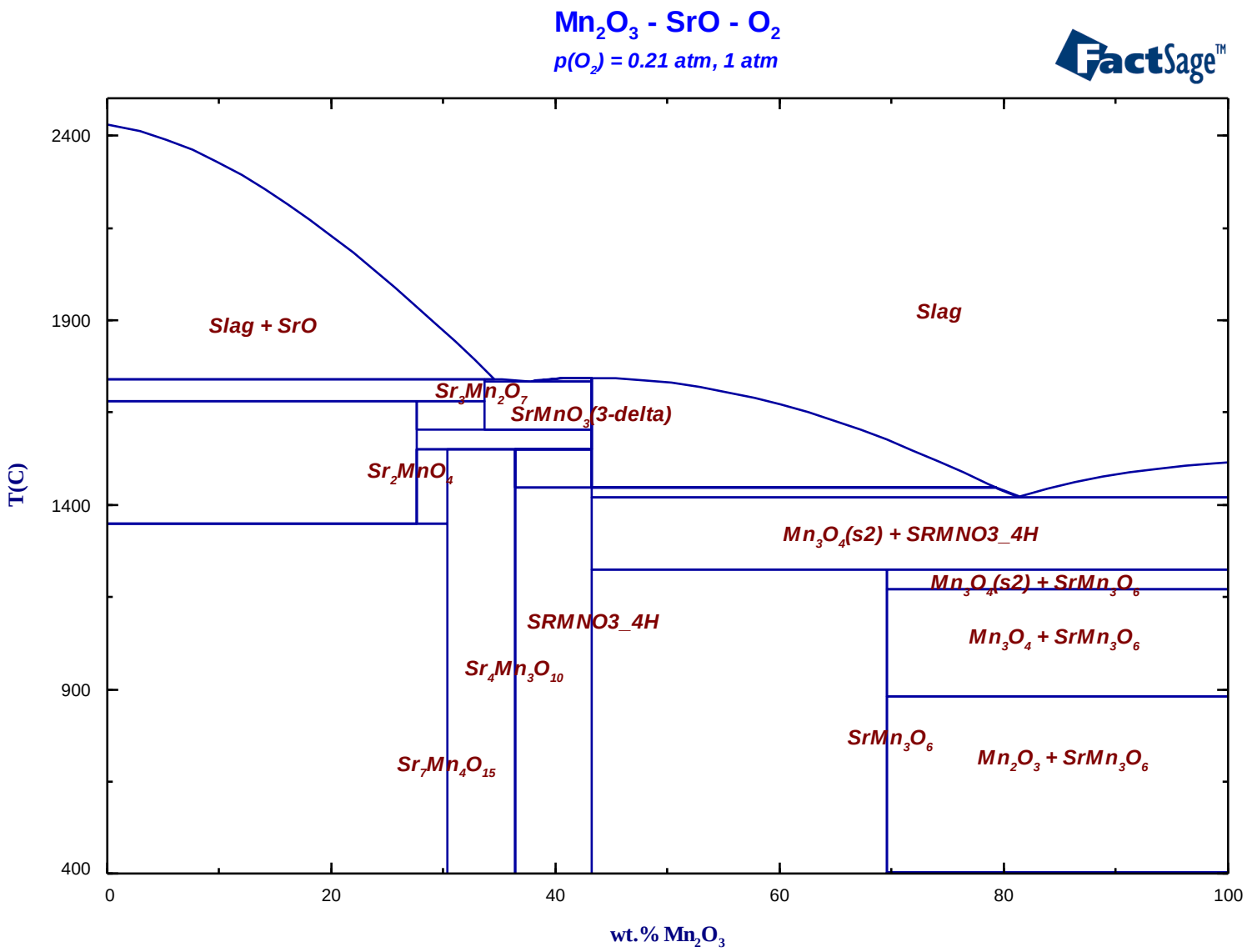


Mn2O3-SrO-O2,
Mole fraction

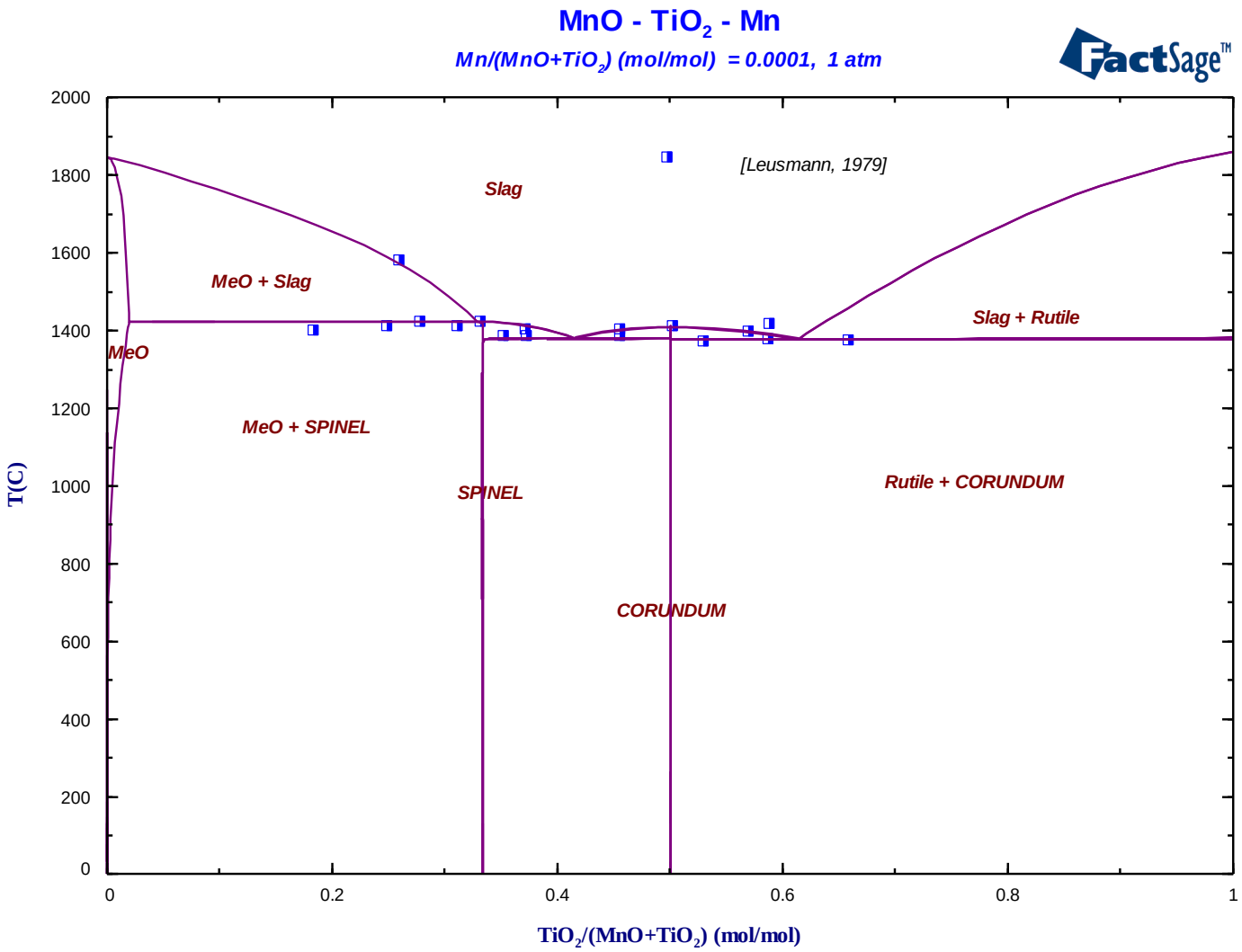


Slag	$(Mn_2O_2, Mn_2O_3, Mn_3O_4, Sr_2O_2)$	[Grundy2004]*
Perovskite	$(Sr^{+2})(Mn^{+3},Mn^{+4})(O^{-2},Va)_3$	[Grundy2004]
SrMnO3_4H	$(Sr^{+2})(Mn^{+3},Mn^{+4})(O^{-2},Va)_3$	[Grundy2004]
Sr_2MnO_4	stoichiometric	[Grundy2004]
$Sr_7Mn_4O_{15}$	stoichiometric	[Grundy2004]
$Sr_3Mn_2O_7$	stoichiometric	[Grundy2004]
$Sr_4Mn_3O_{10}$	stoichiometric	[Grundy2004]
$SrMn_3O_6$	stoichiometric	[Grundy2004]*

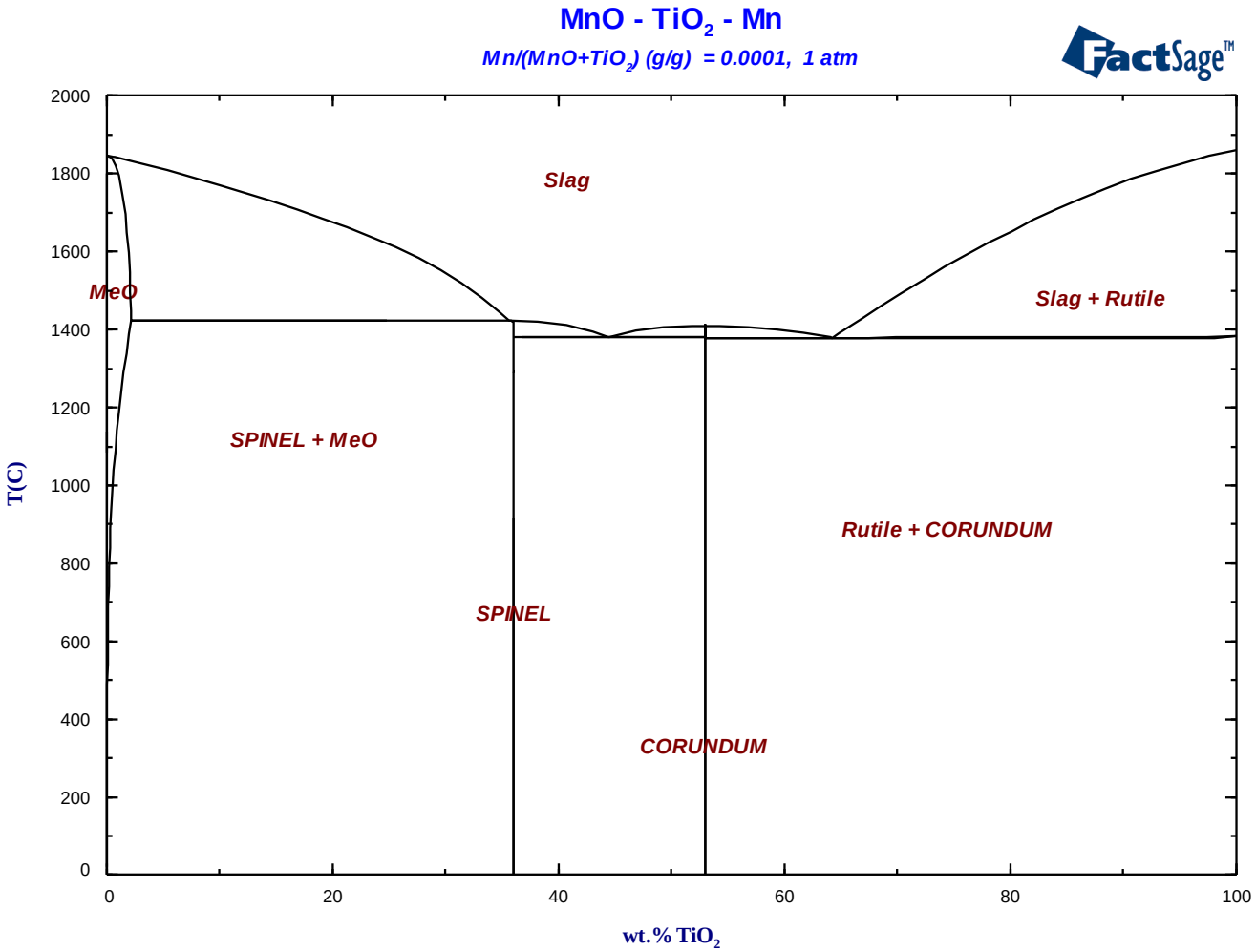
Mn2O3-SrO-O2,
Weight percent



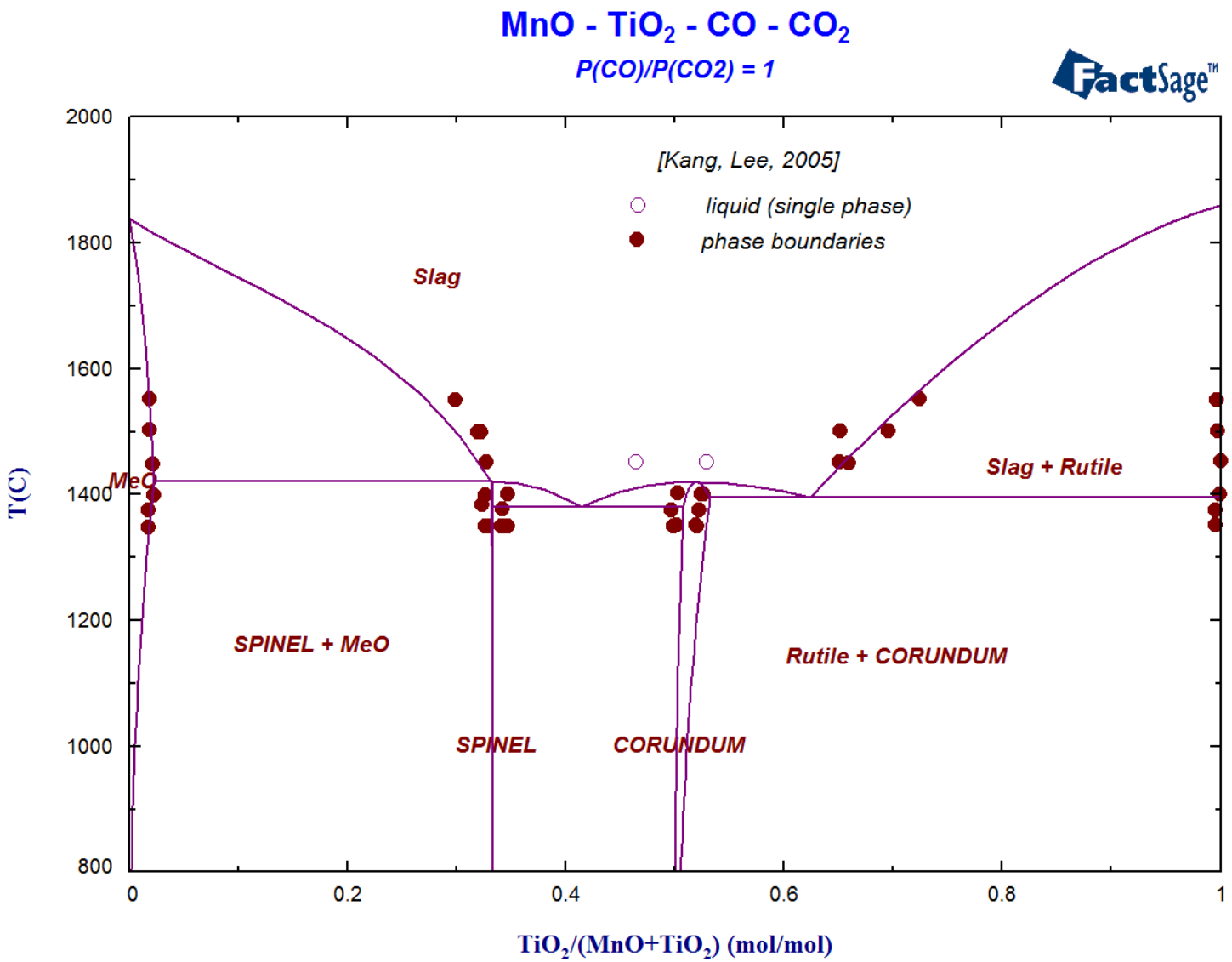
Mole fraction compared with experimental data



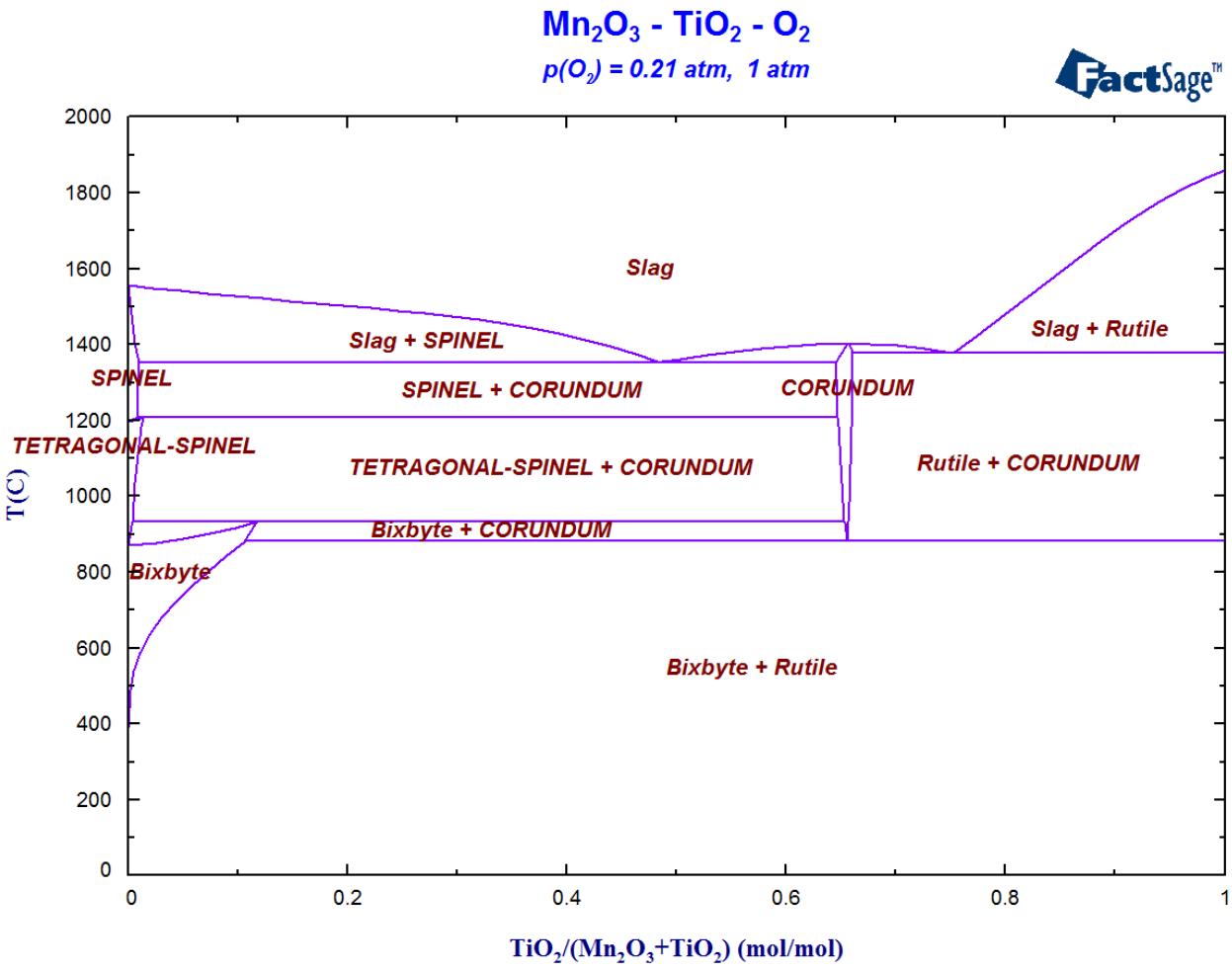
MnO-TiO2-Mn,
Weight percent



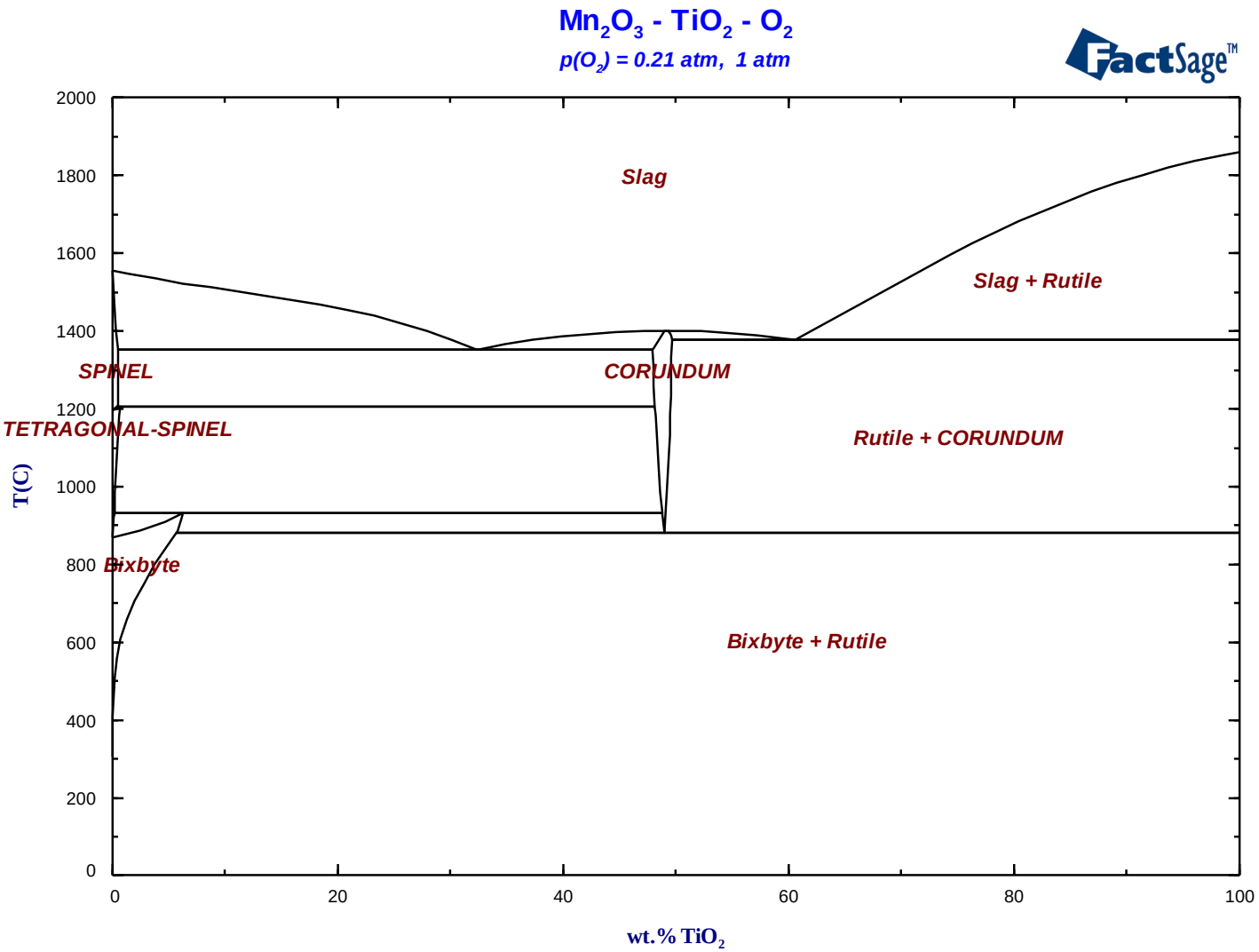
Mole fraction, P(CO)/P(CO2)=1, compared with experimental data



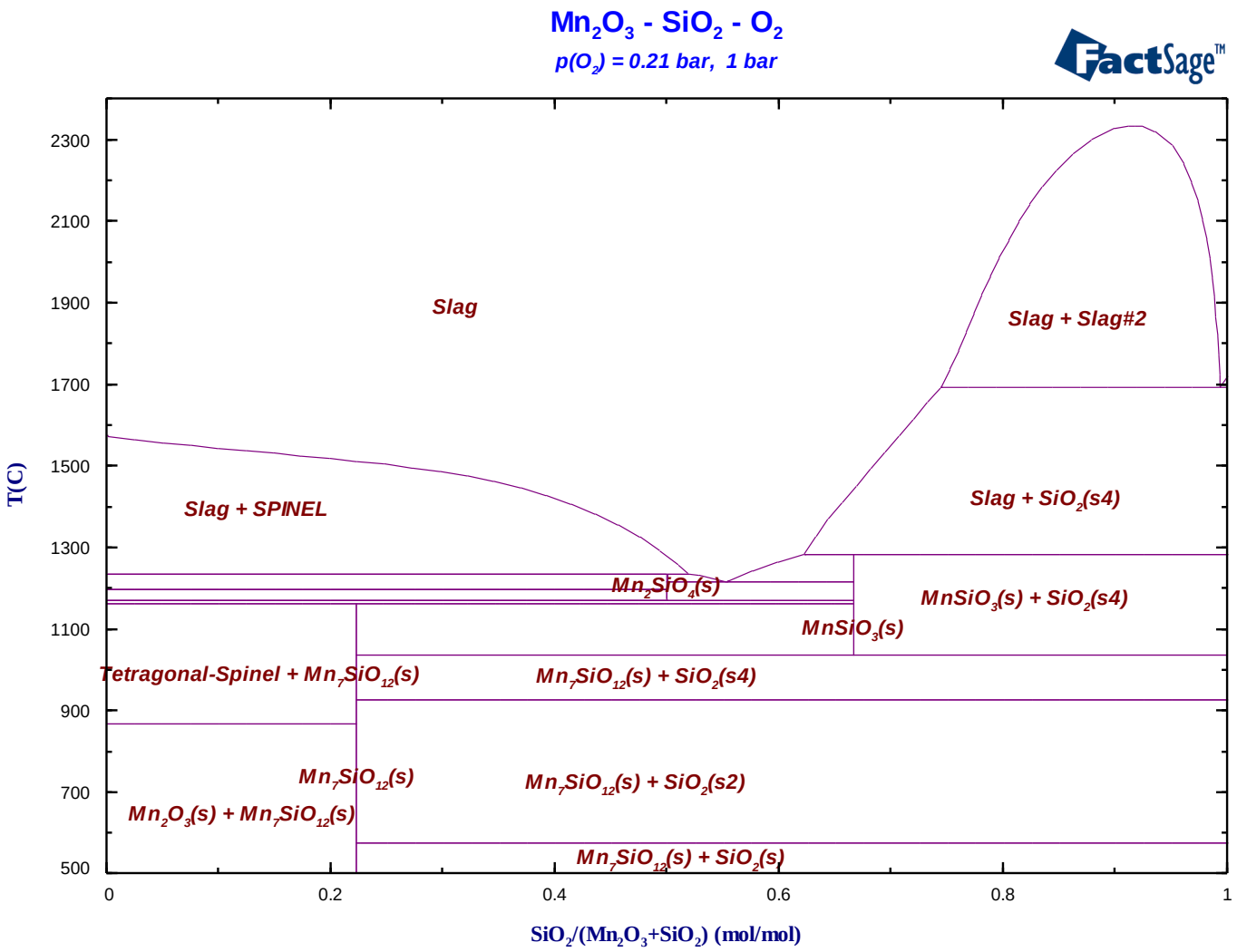
Mole fraction,



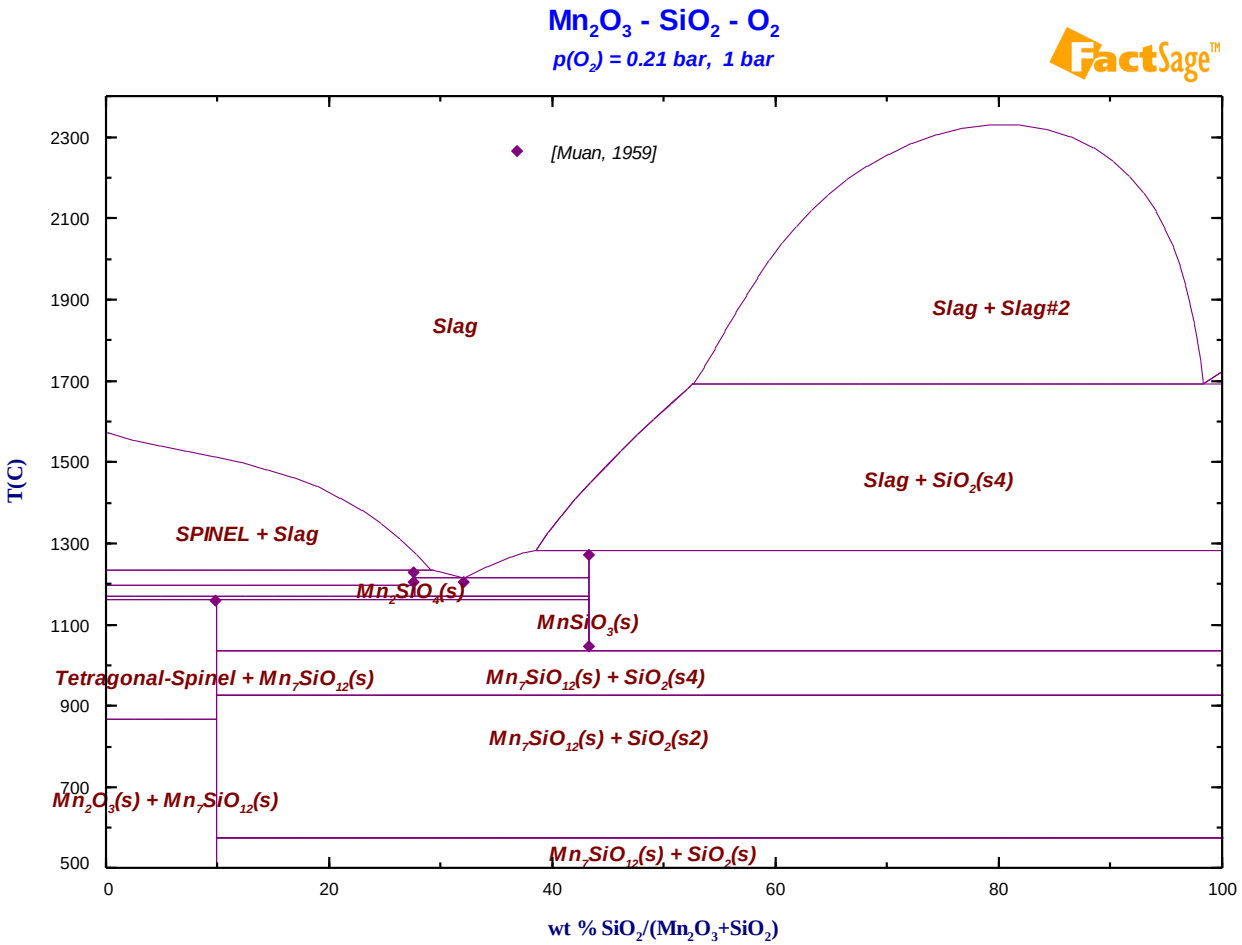
Weight percent,



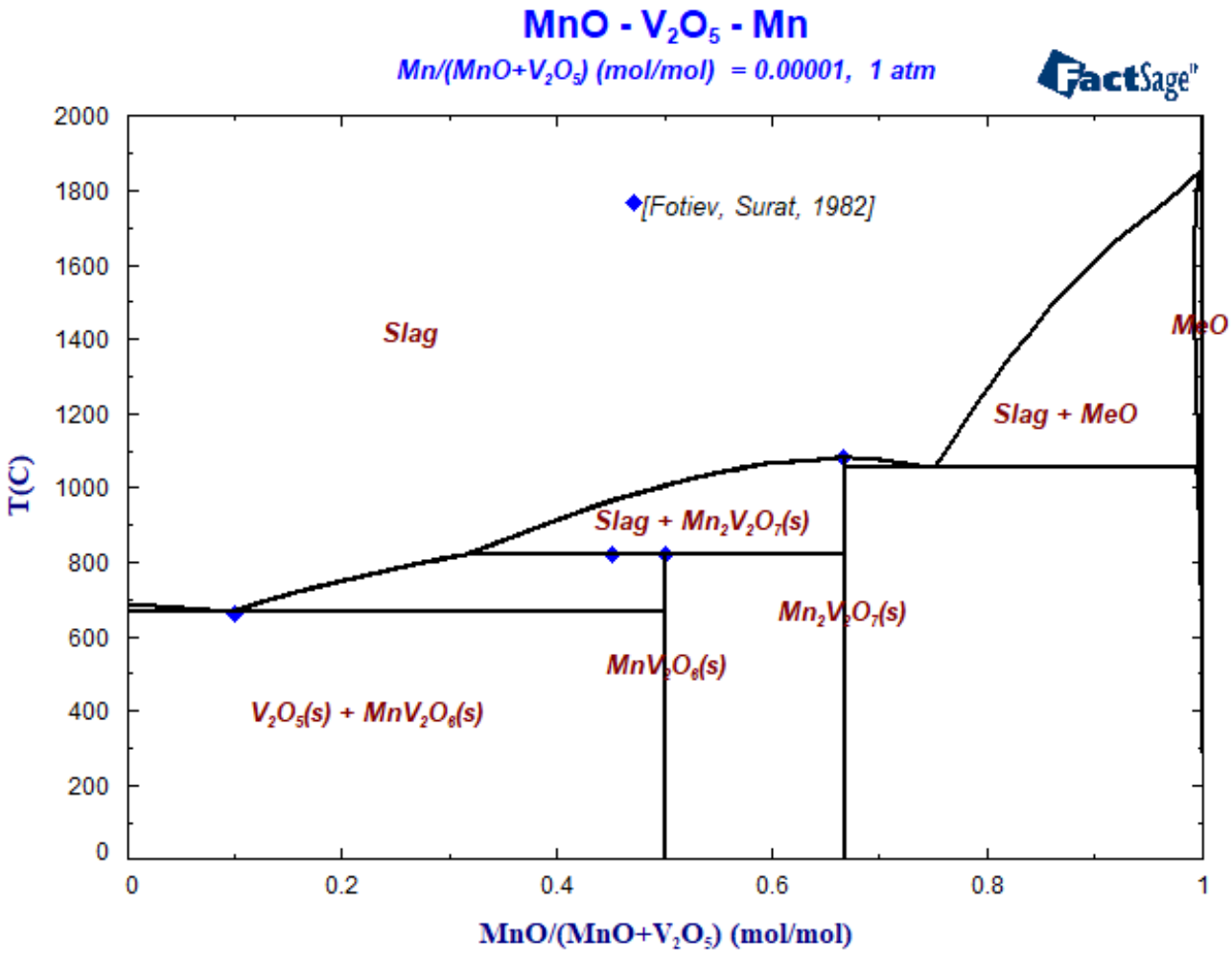
Mole fraction



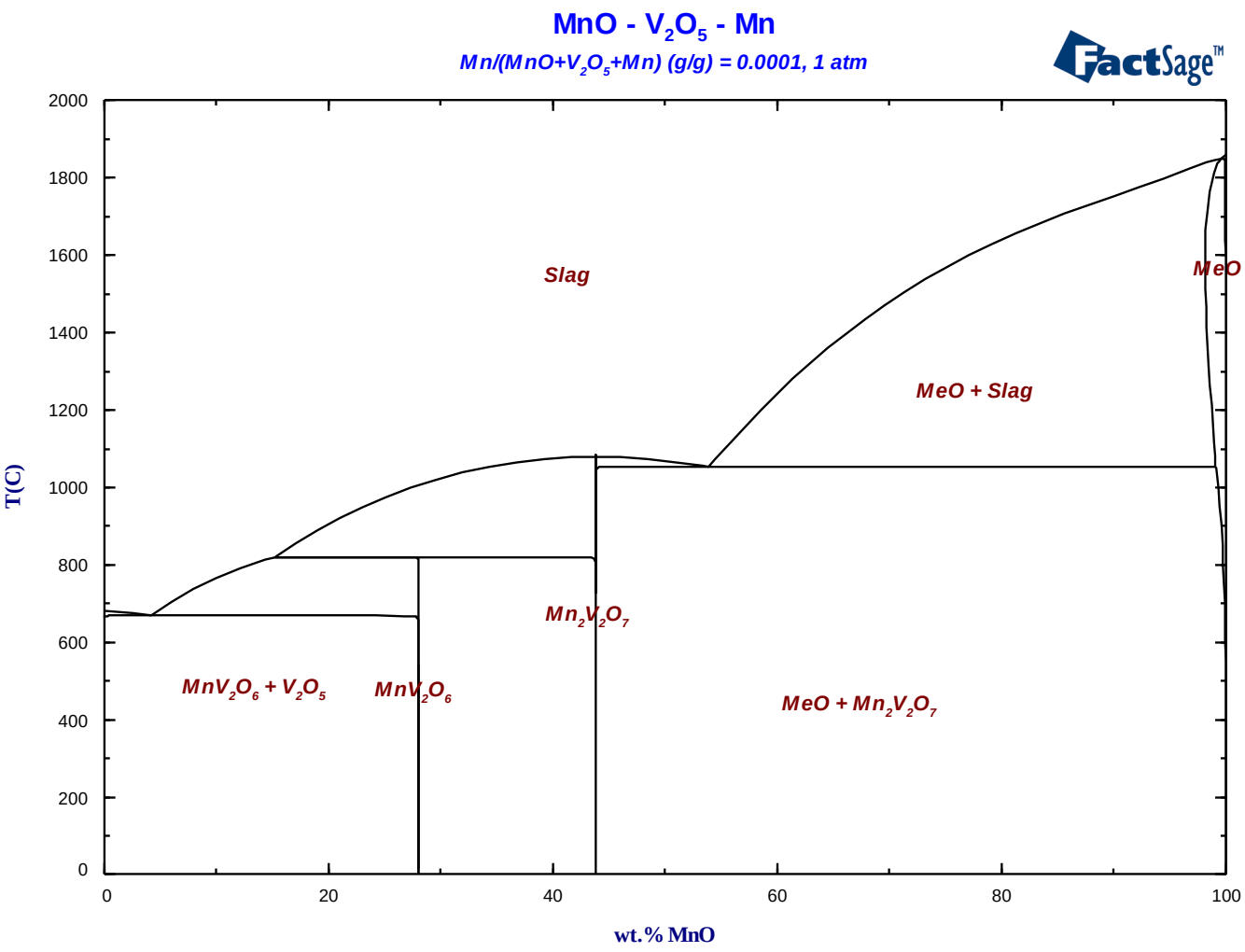
Weight percent compared with experimental data



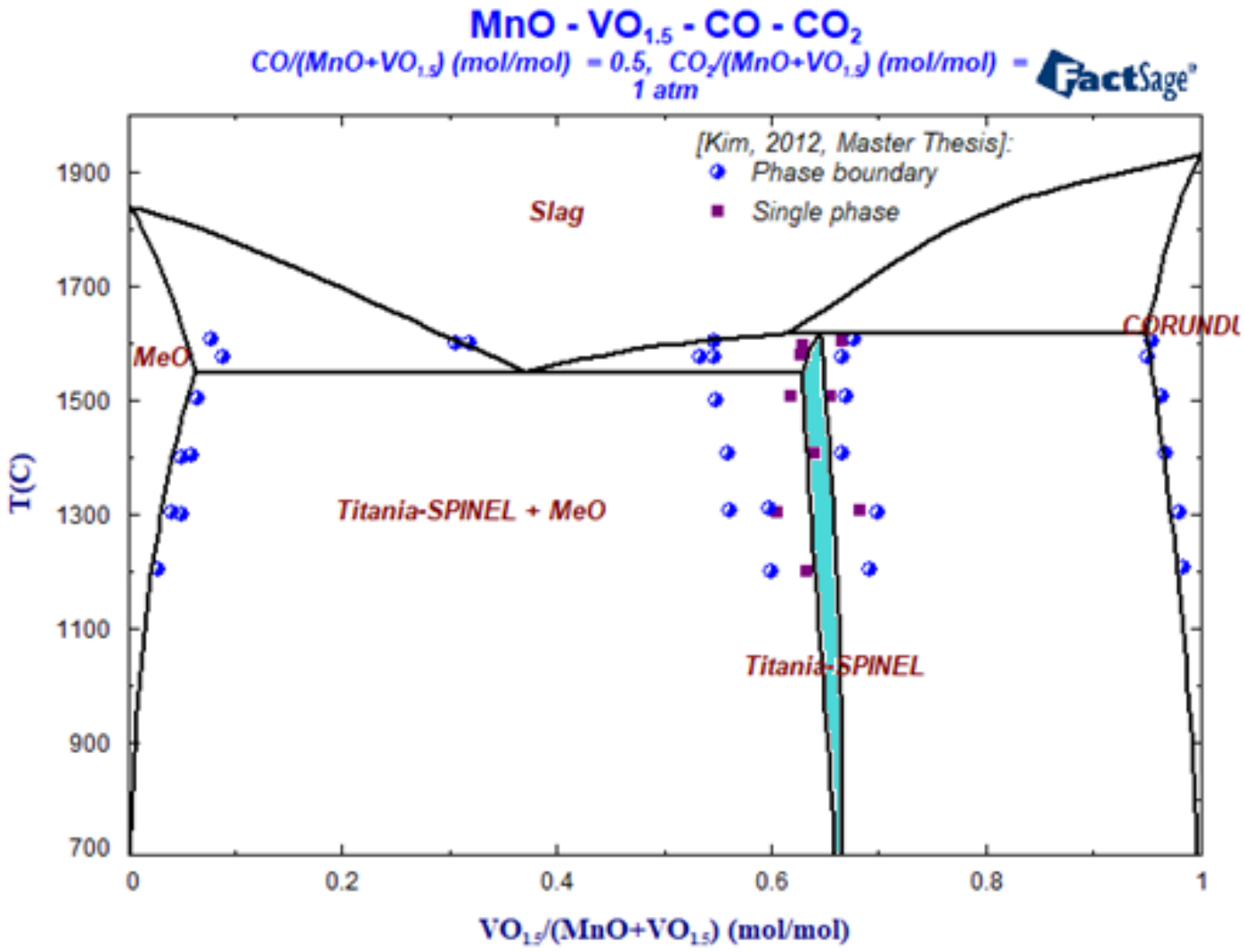
MnO-V2O5-Mn
Mole fraction
compared with experimental data



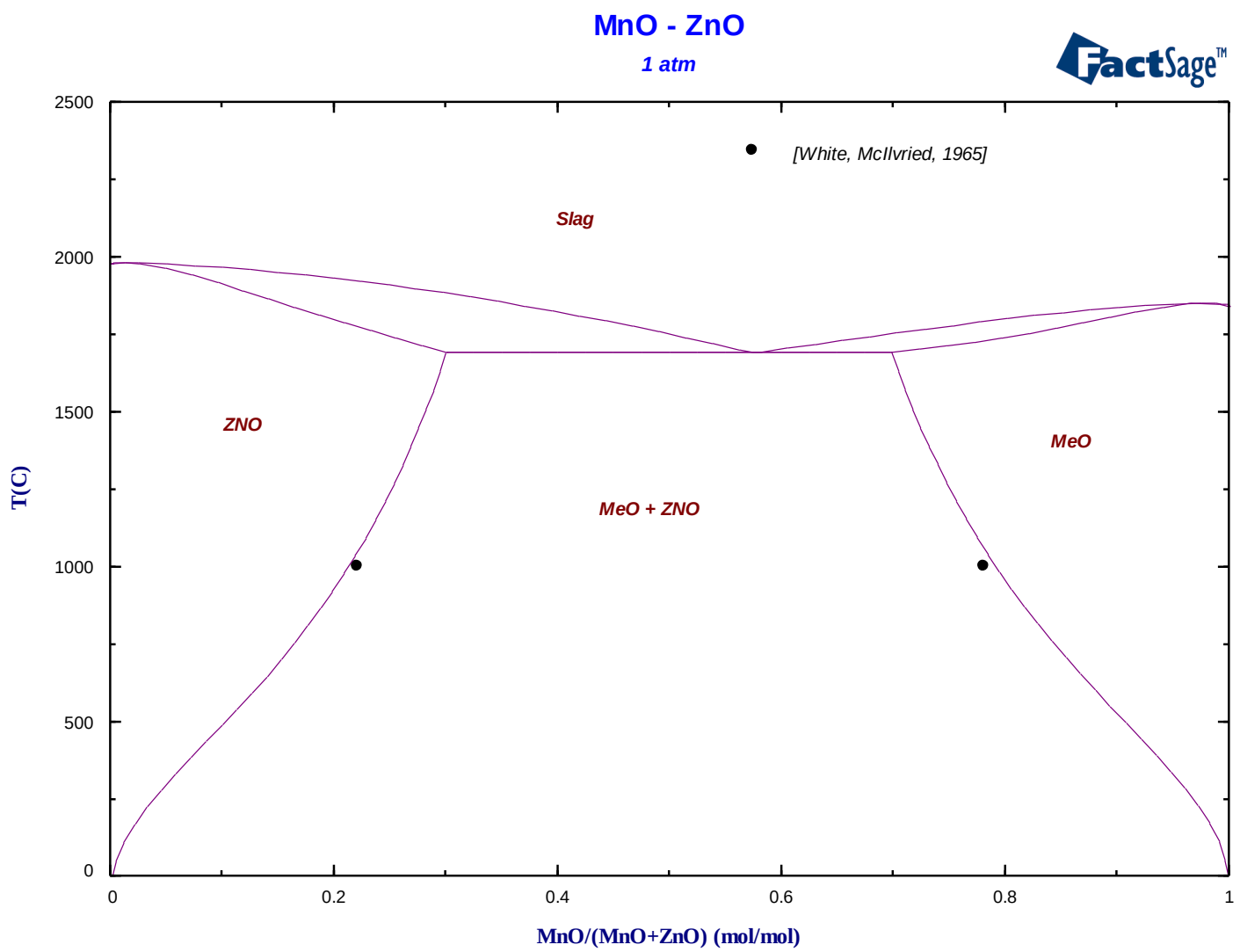
MnO-V2O5-Mn
Weight percent



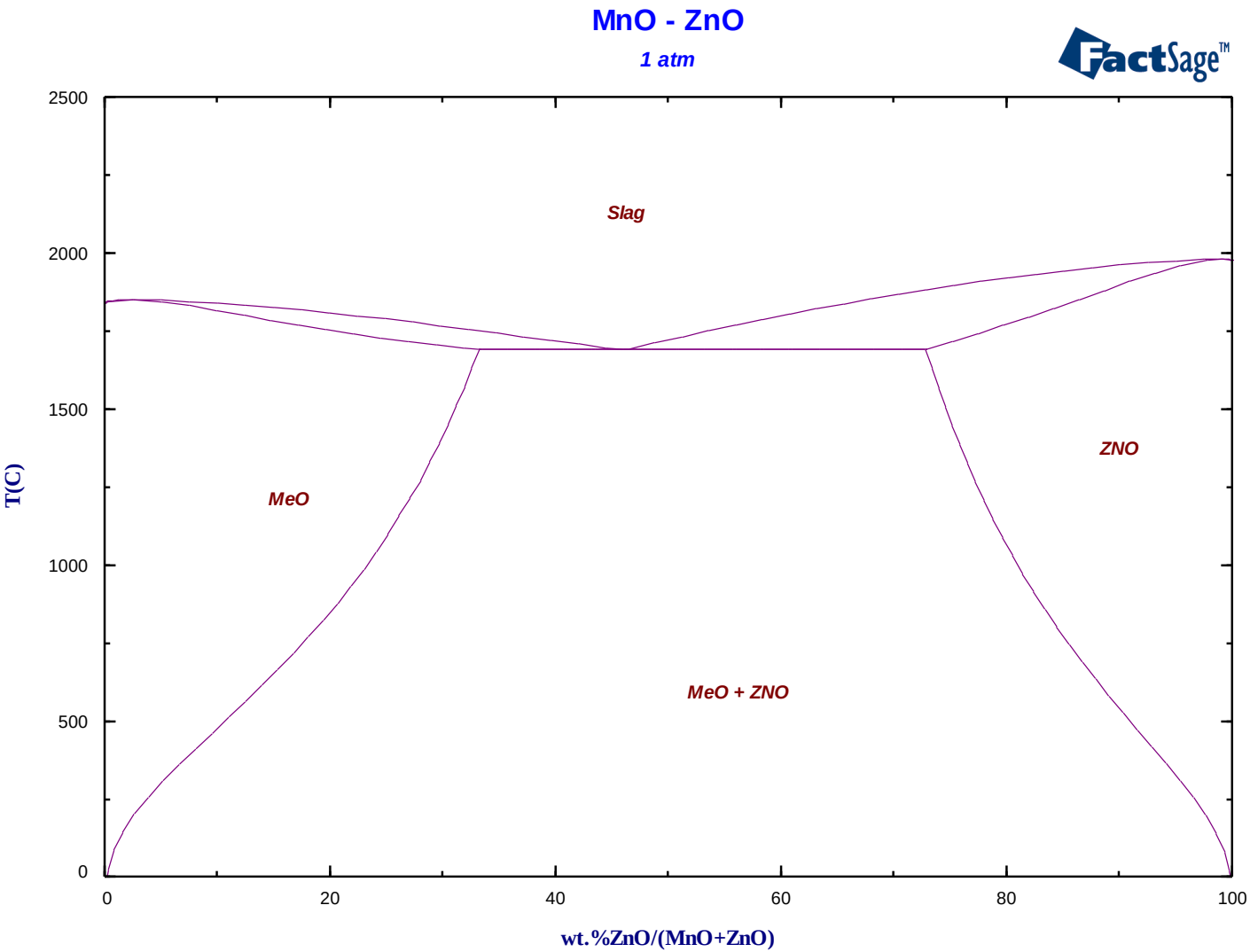
MnO-V2O3, CO/CO2=1
Mole fraction compared with experimental data

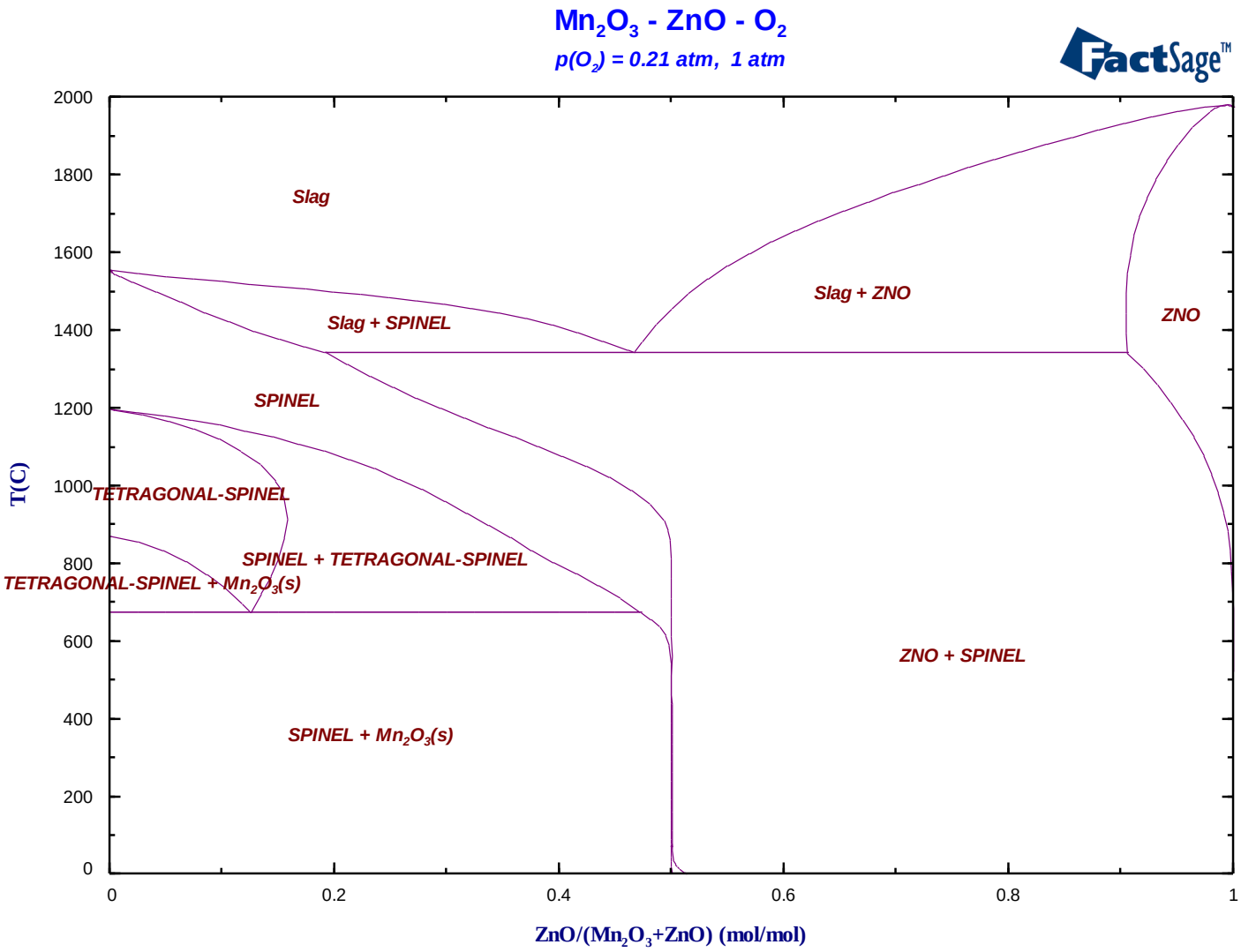


MnO-ZnO,
Mole fraction
compared with experimental data



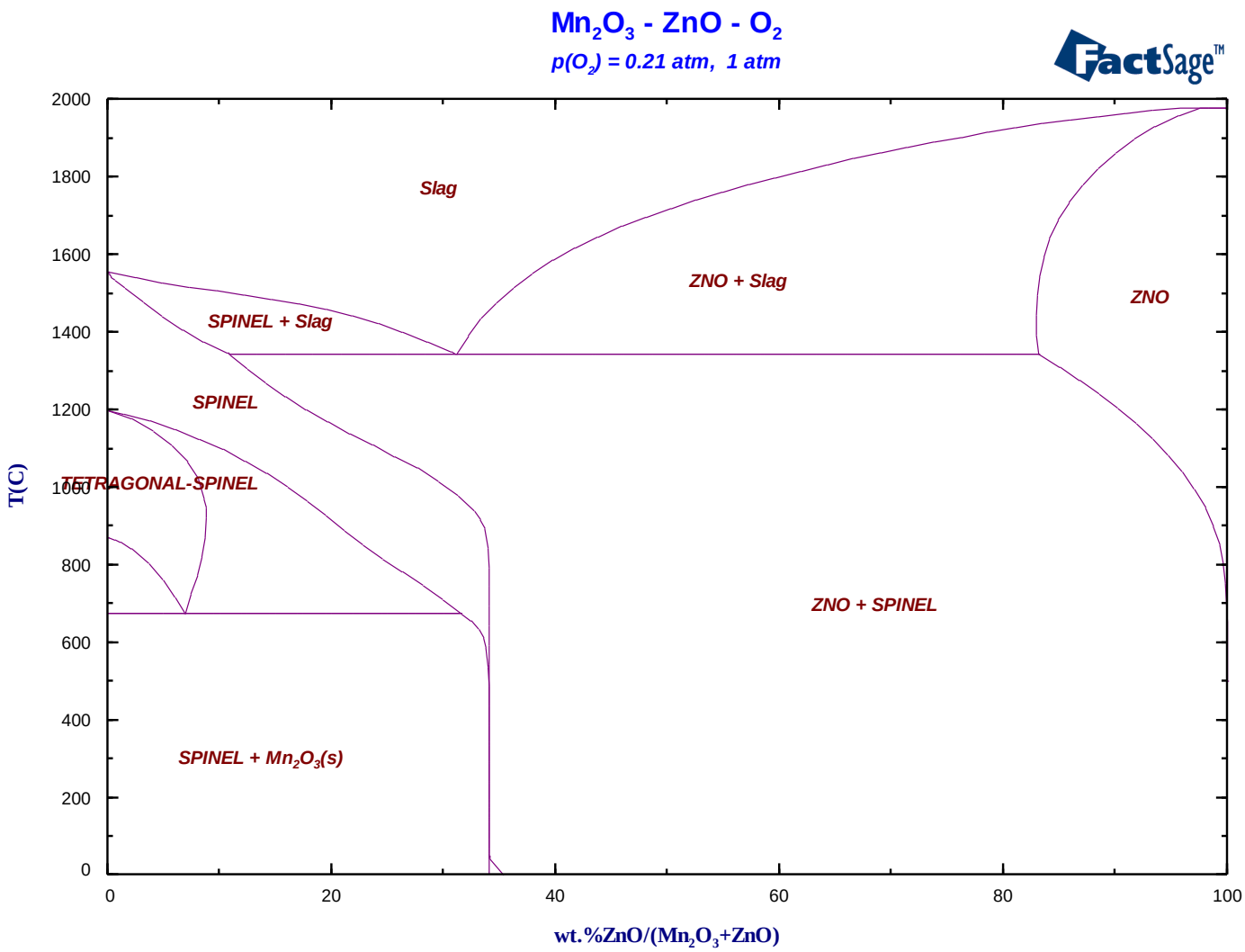
MnO-ZnO
Weight percent



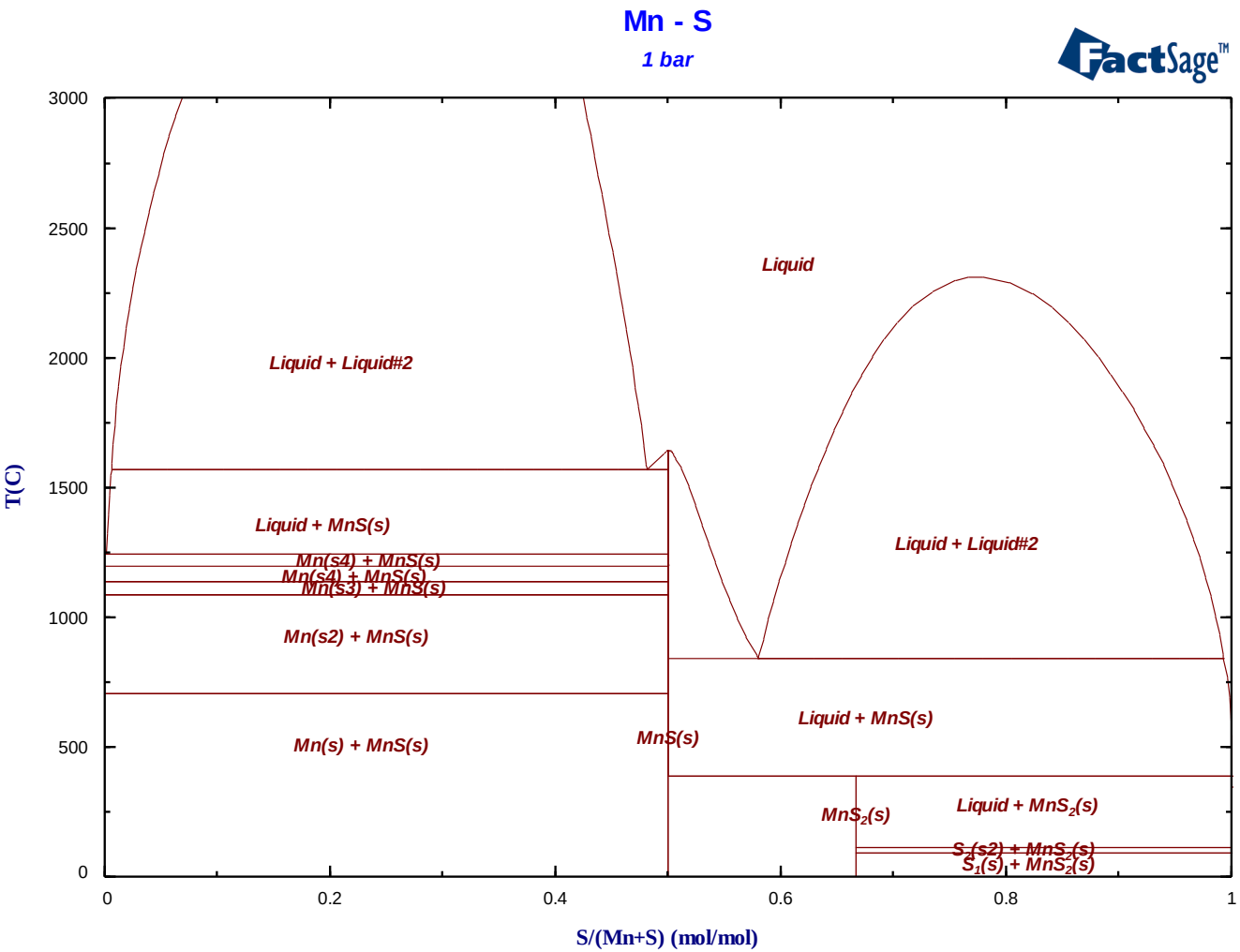

Mn2O3 - ZnO - O2
p(O2) = 0.21 atm, 1 atm
FactSage™
Slag
Slag + SPINEL
Slag + ZNO
ZNO
SPINEL
TETRAGONAL-SPINEL
SPINEL + TETRAGONAL-SPINEL
TETRAGONAL-SPINEL + Mn2O3(s)
ZNO + SPINEL
SPINEL + Mn2O3(s)
T(C)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
0.2
0.4
0.6
0.8
1
ZnO/(Mn2O3+ZnO) (mol/mol)

Mn2O3-ZnO-O2,

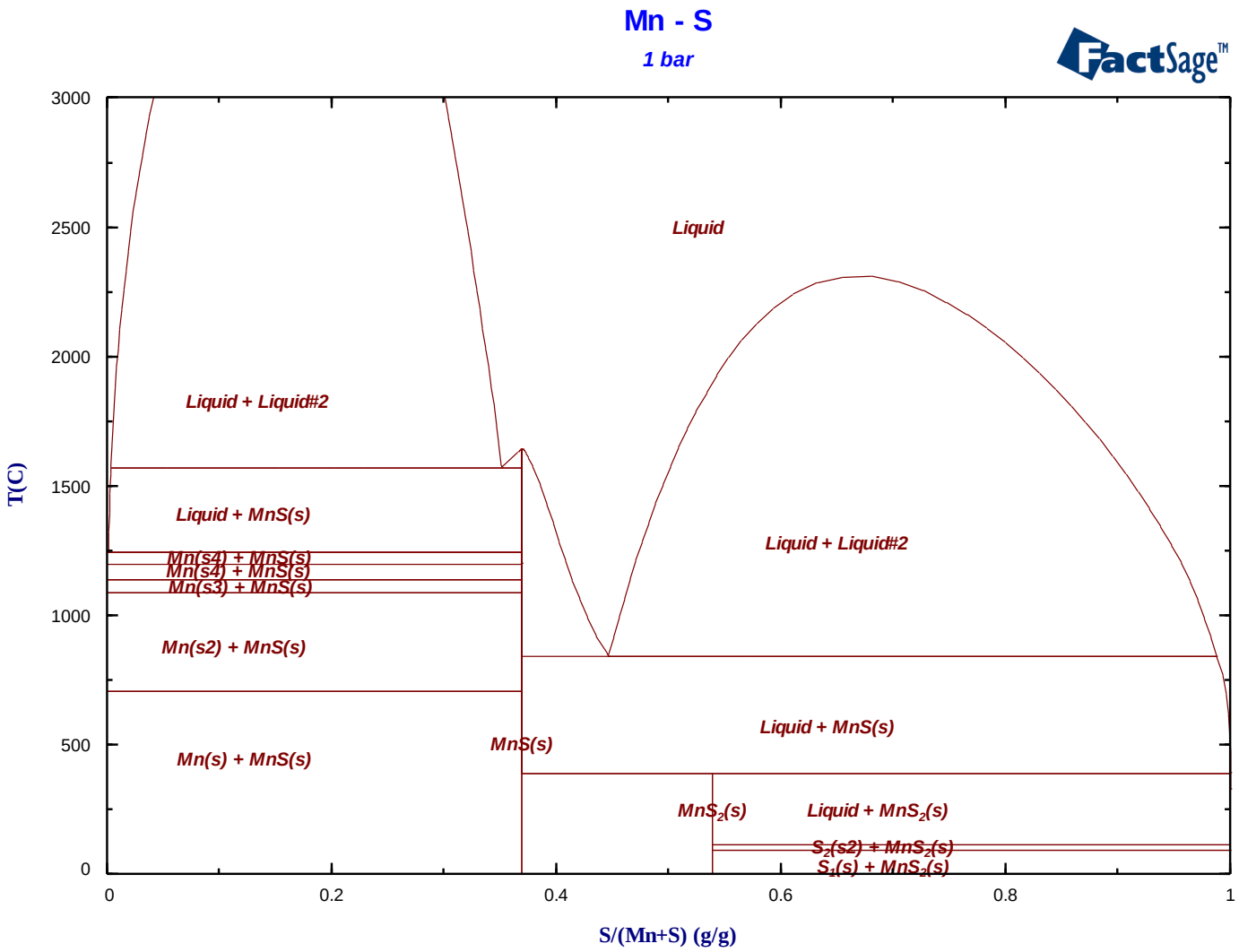
Weight percent



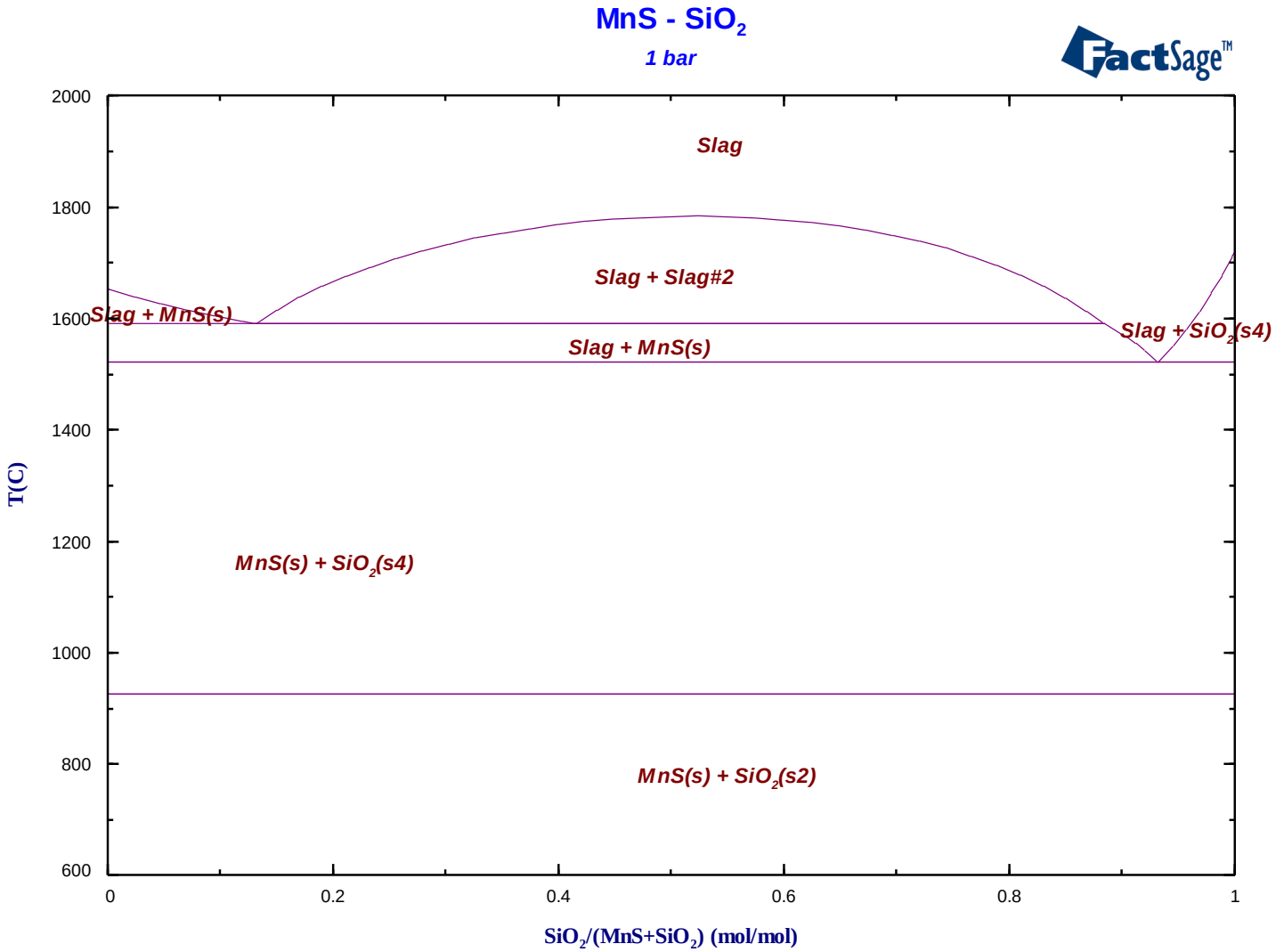
Mn-S,
Mole fraction



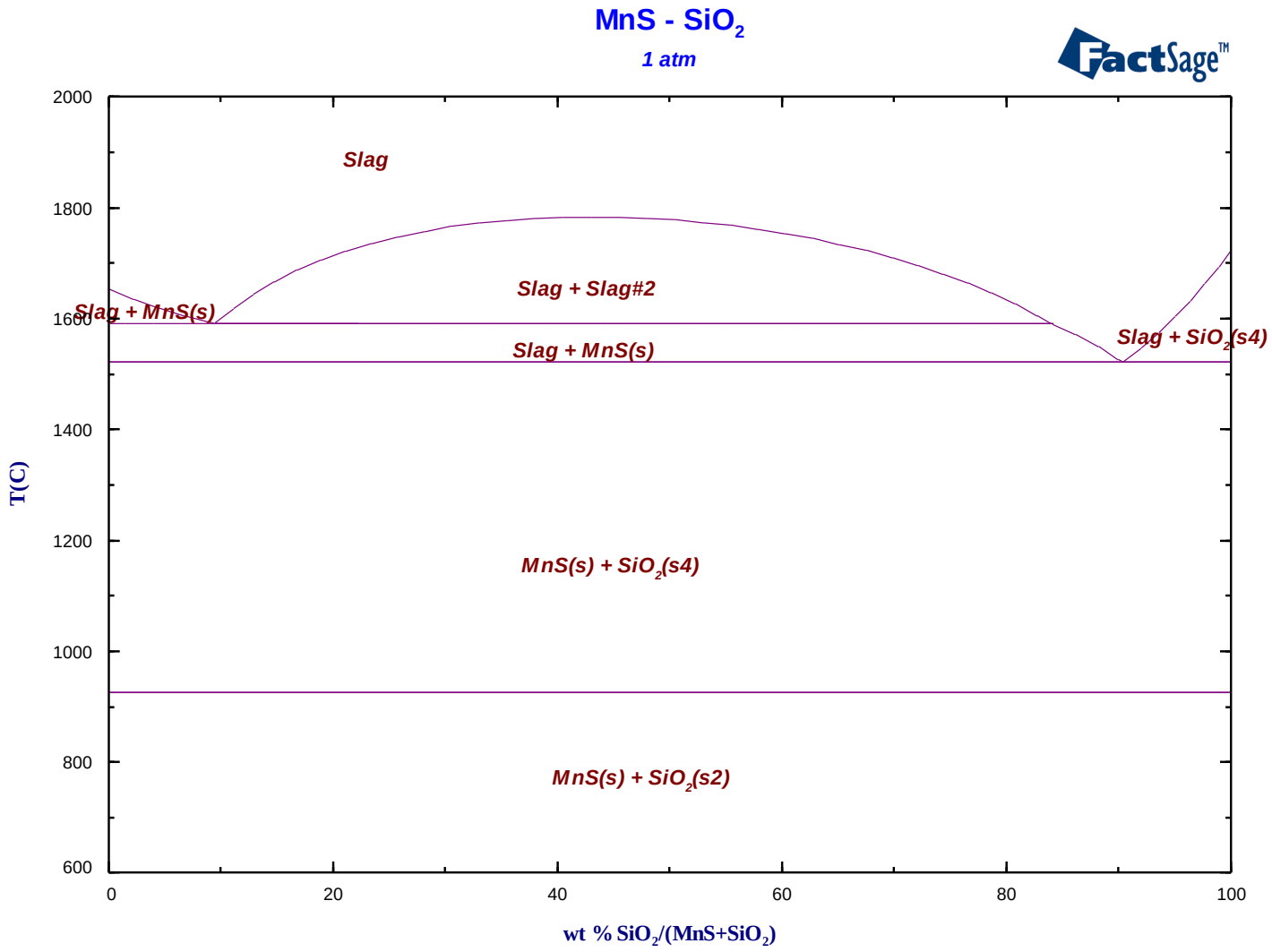
Weight percent



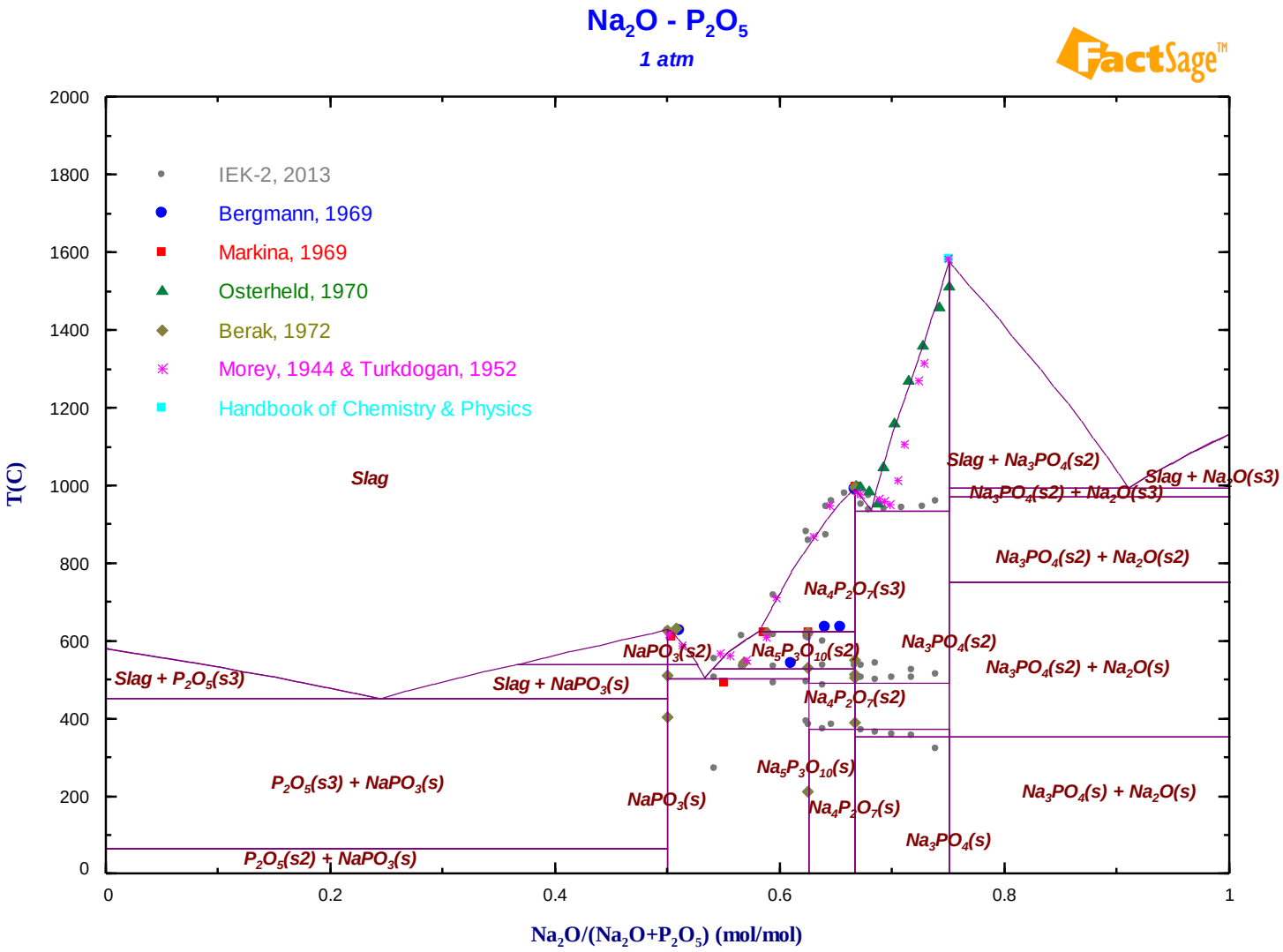
Mole fraction



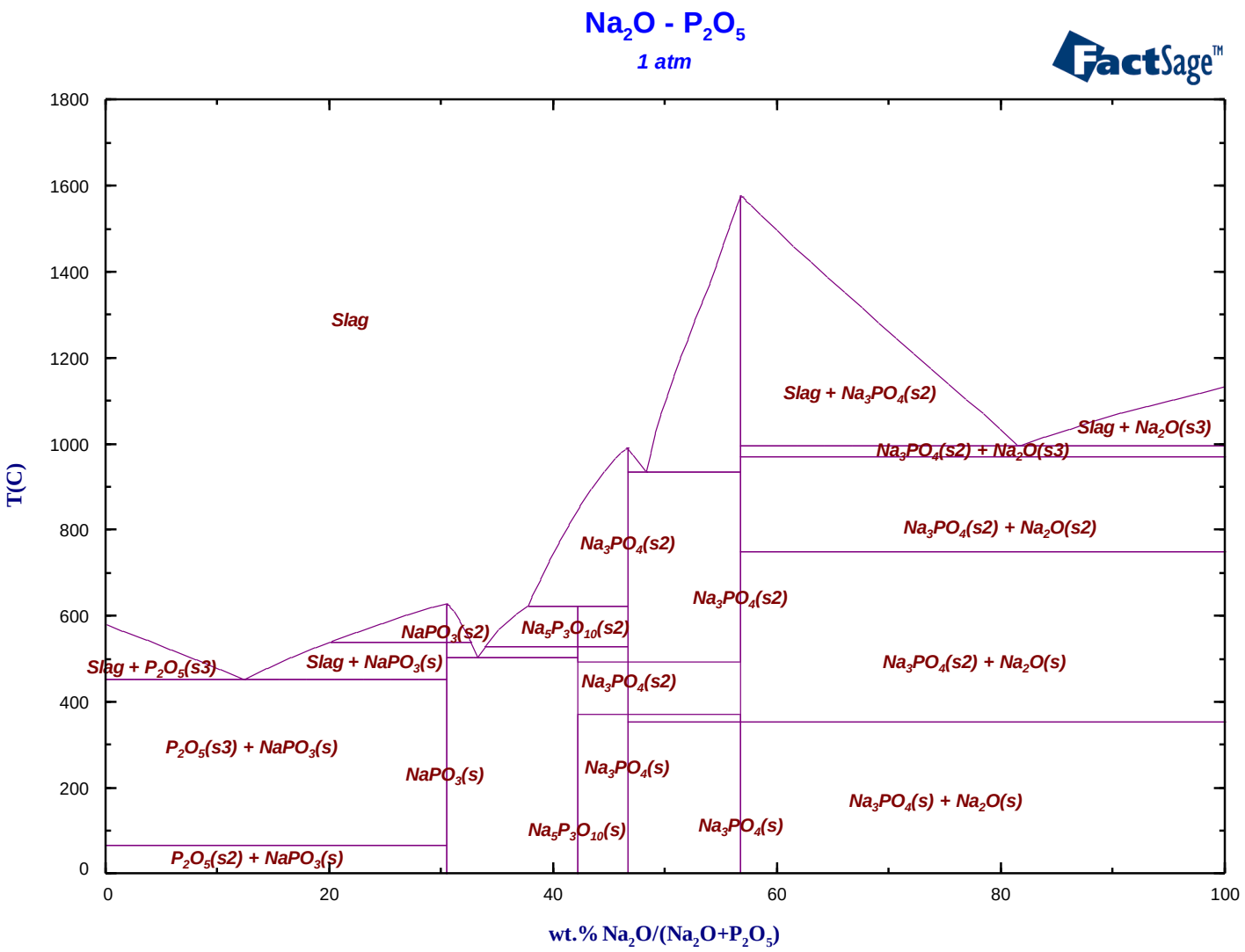
Weight percent



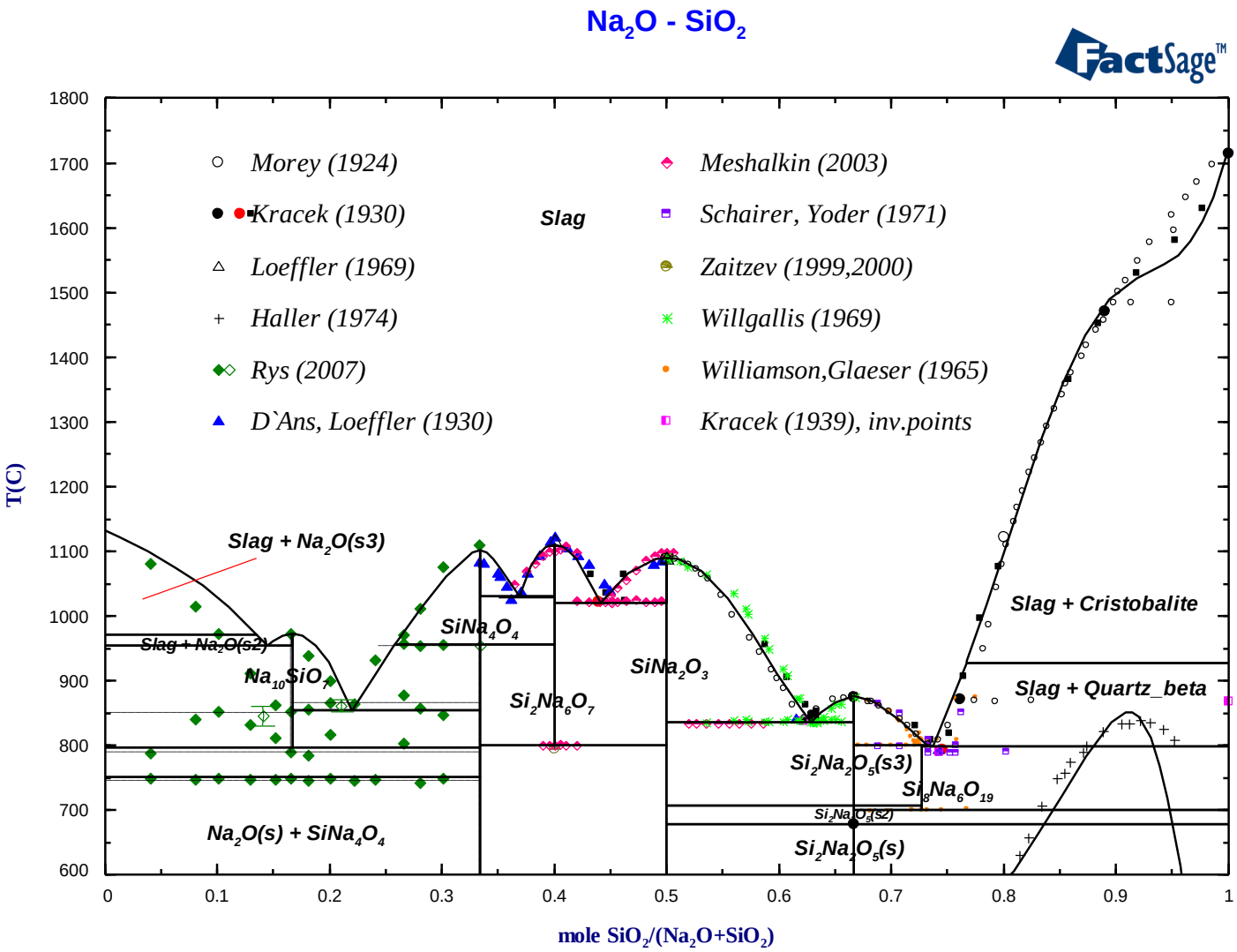
Mole fraction
compared with experimental data



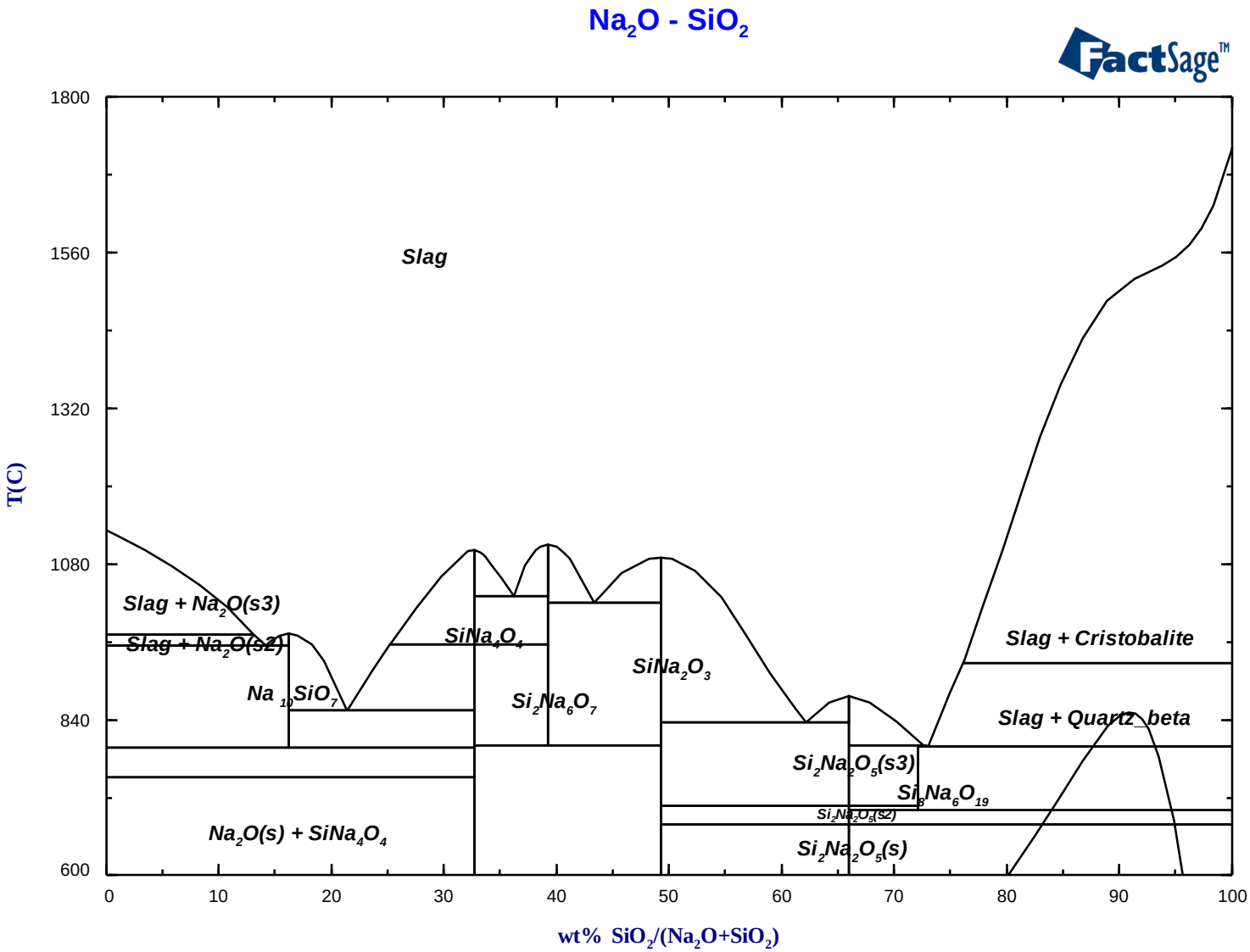
Weight percent



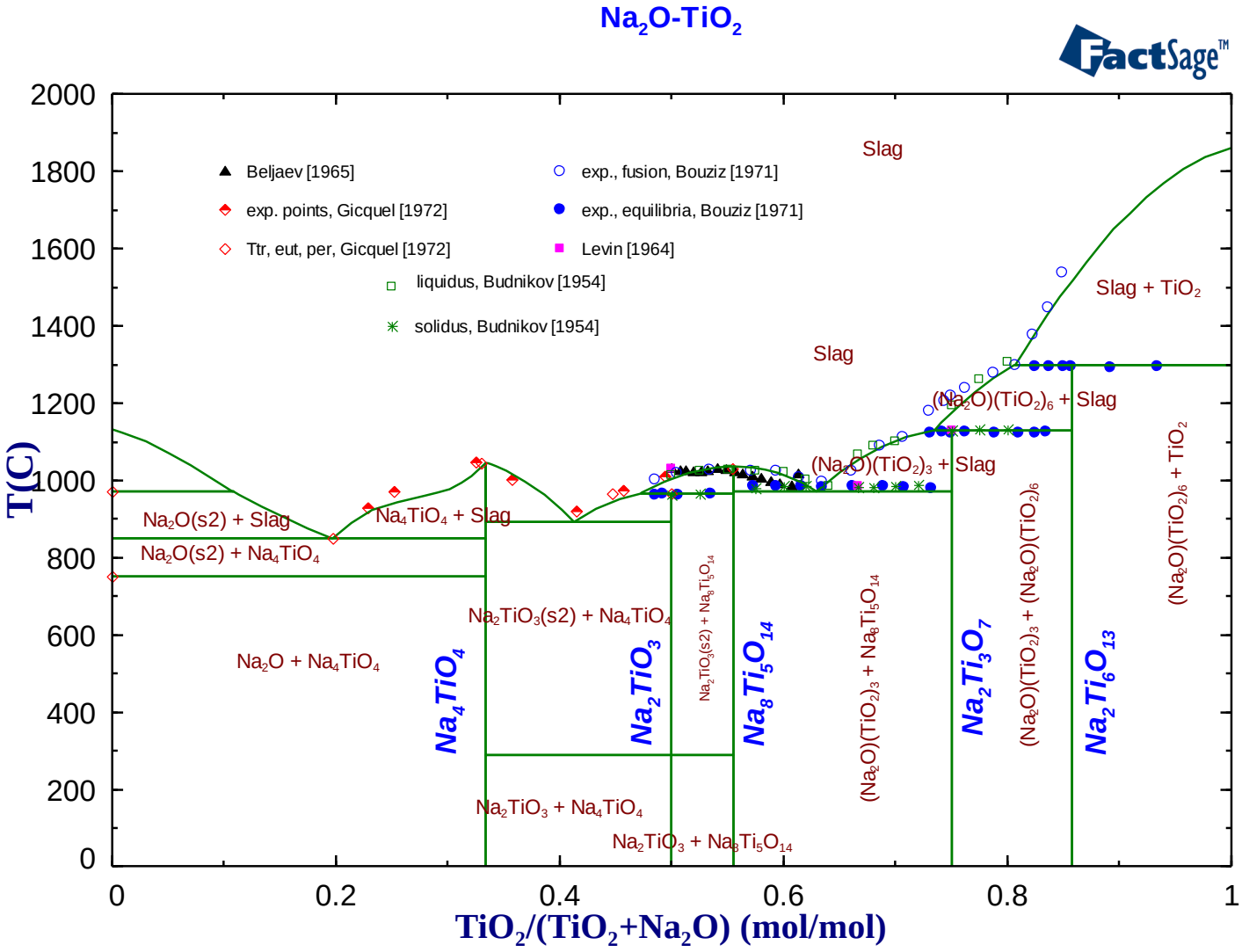
Mole fraction
compared with experimental data



Weight percent



Mole fraction
compared with experimental data



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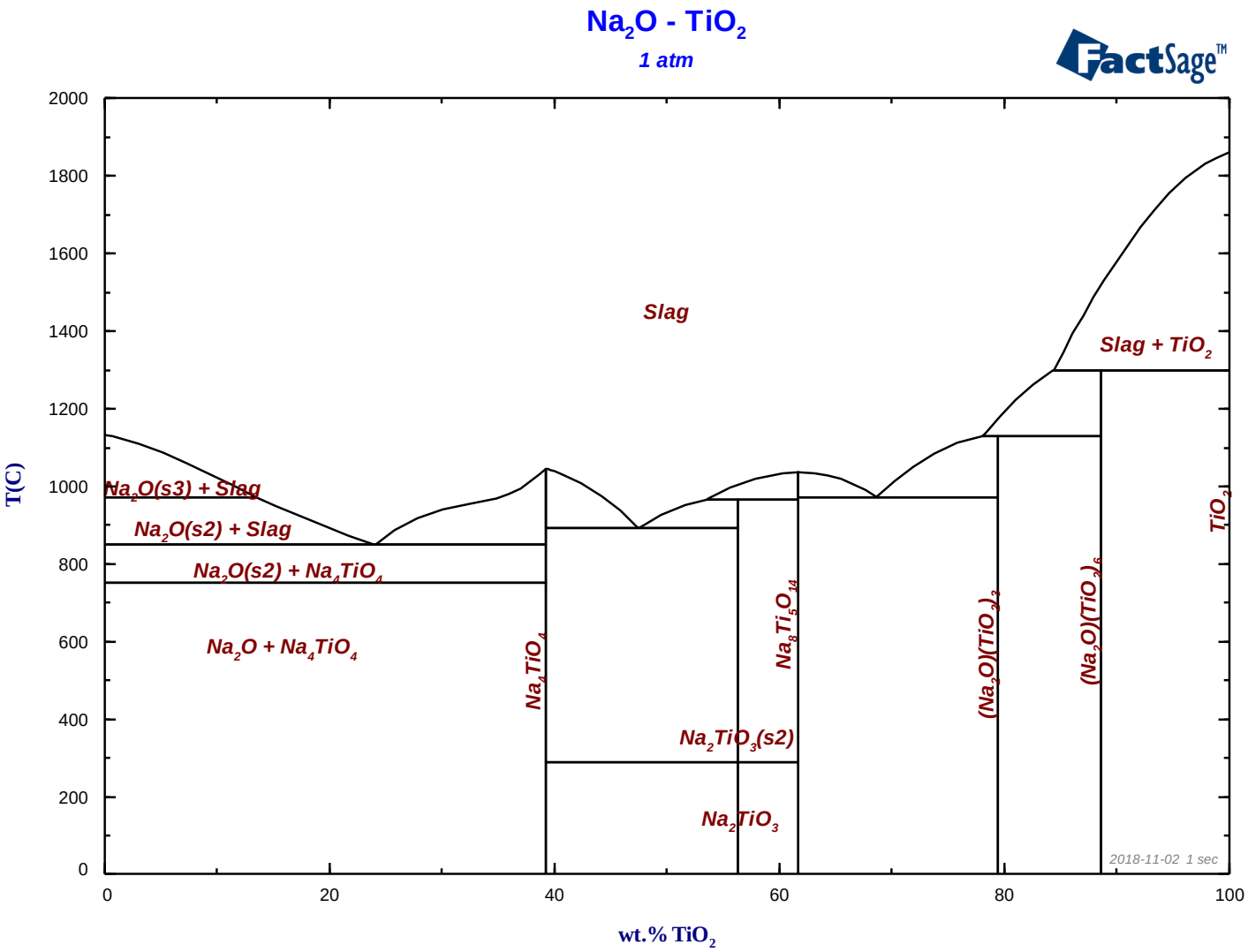
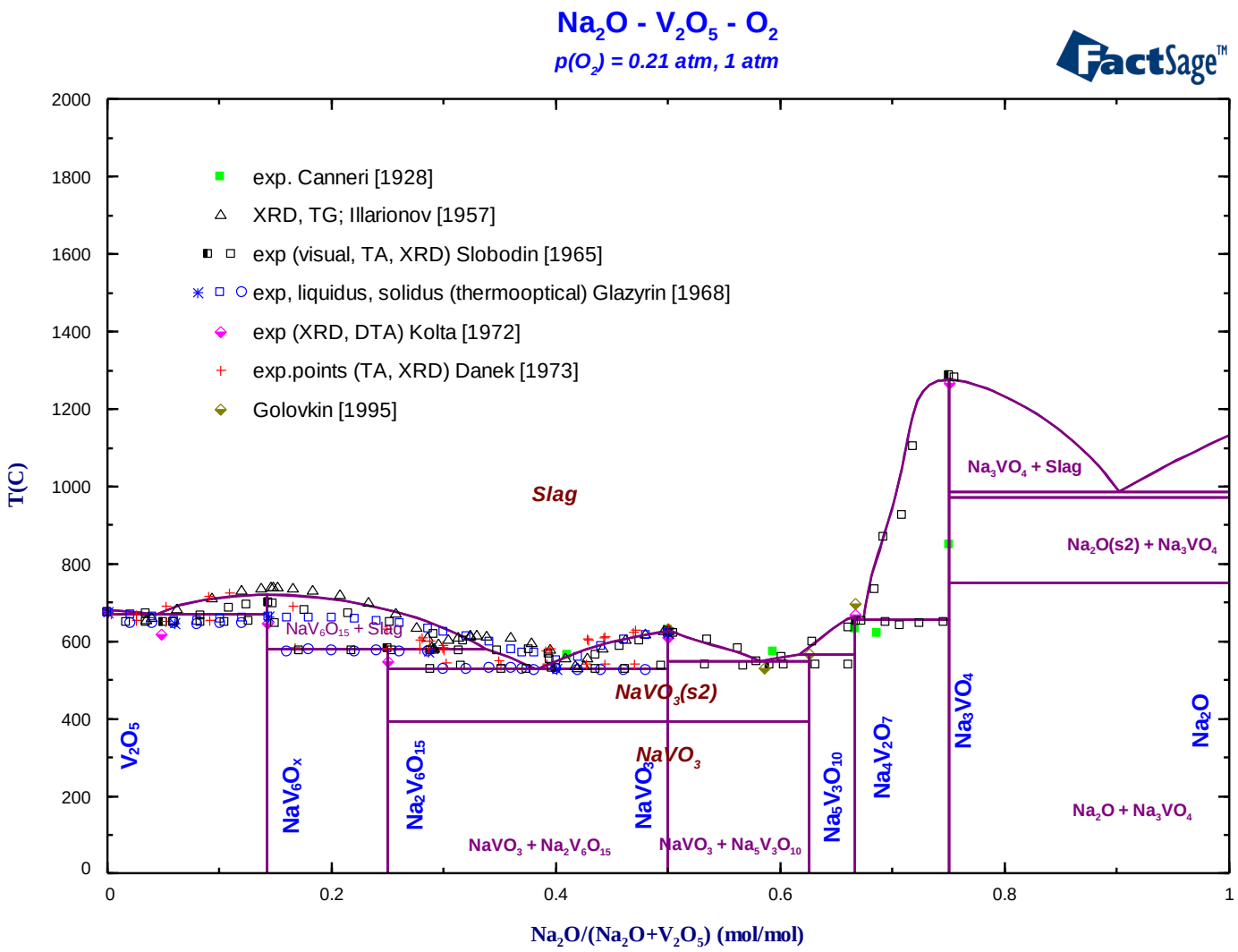
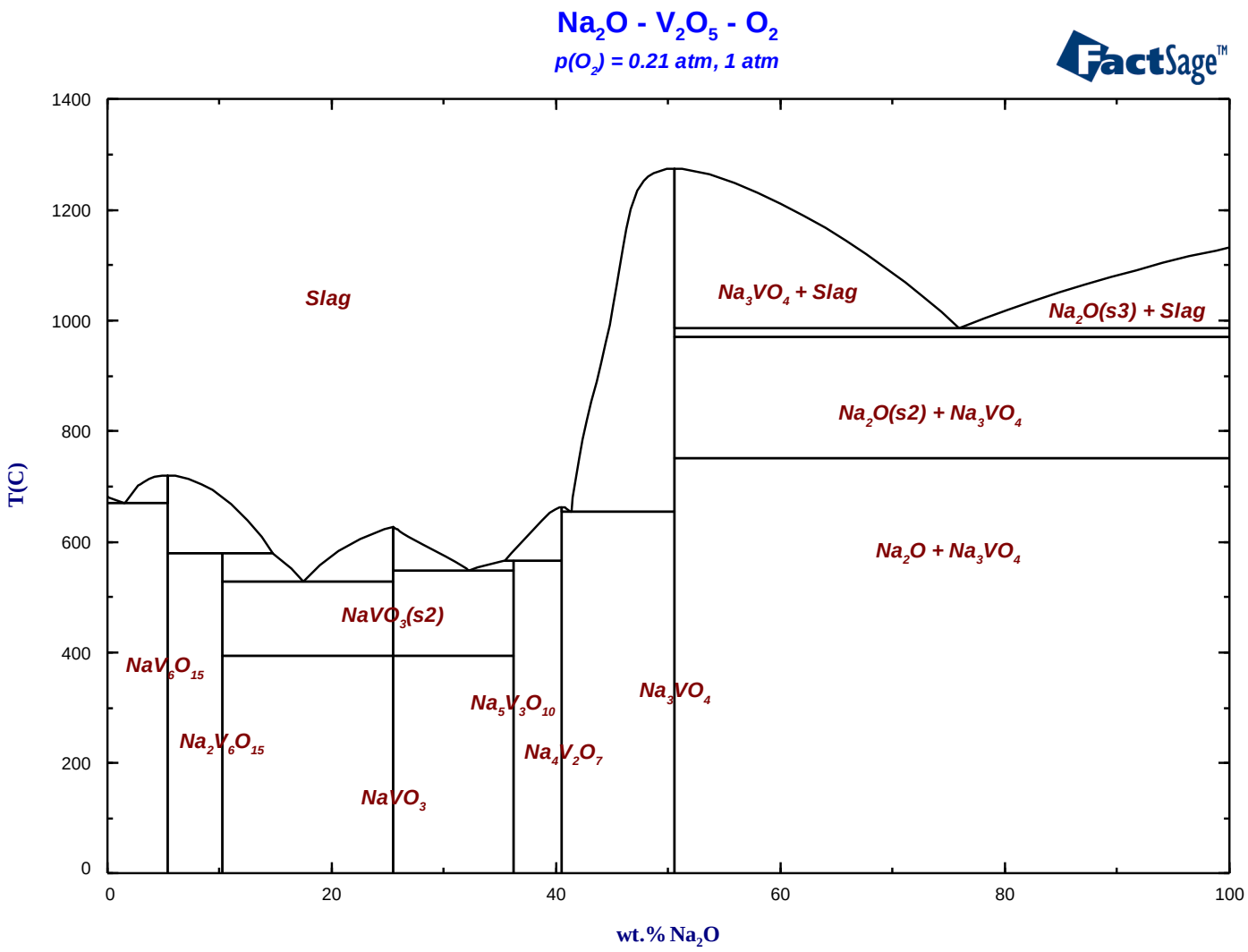


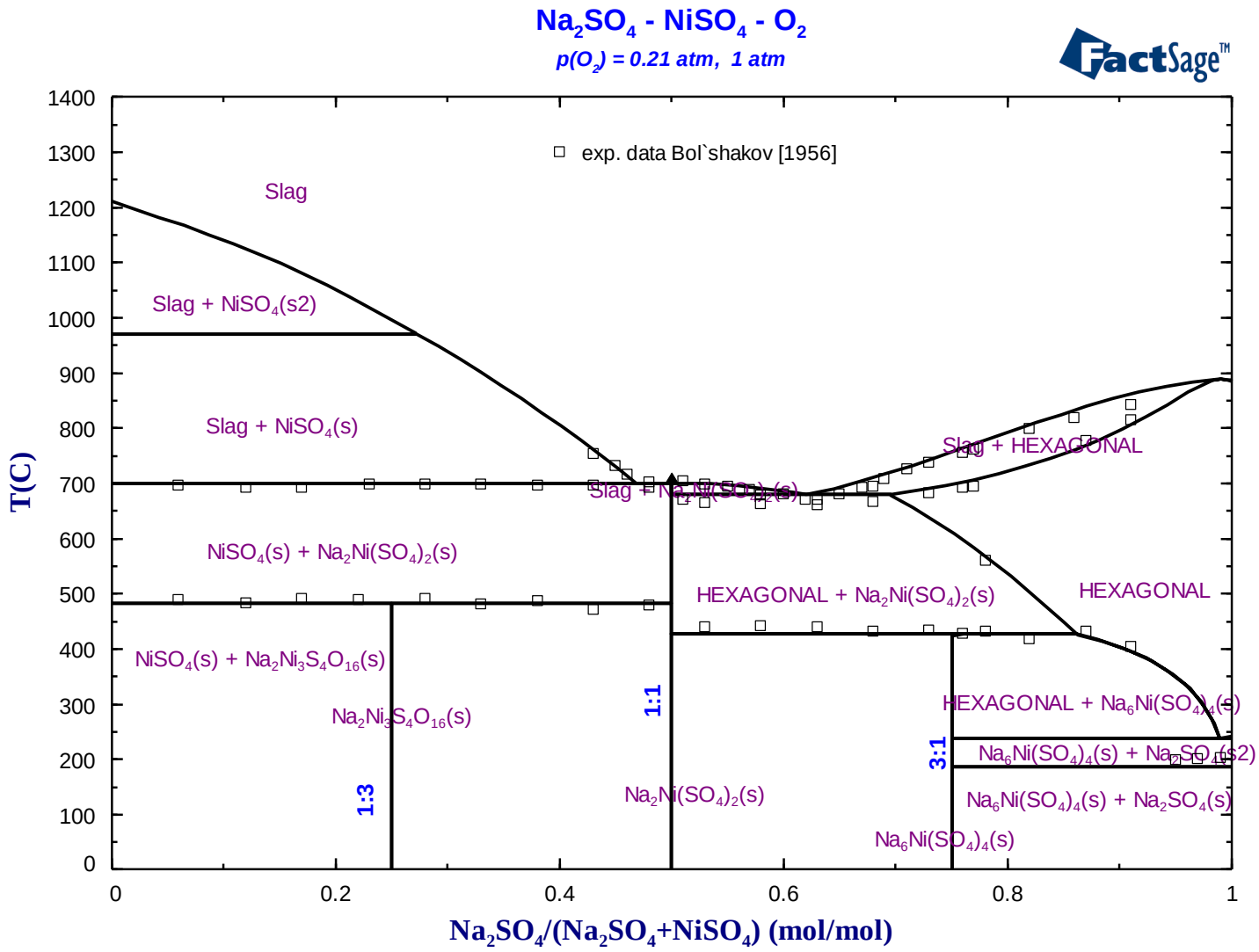
Na2O-V2O5,
Mole fraction
compared with experimental data



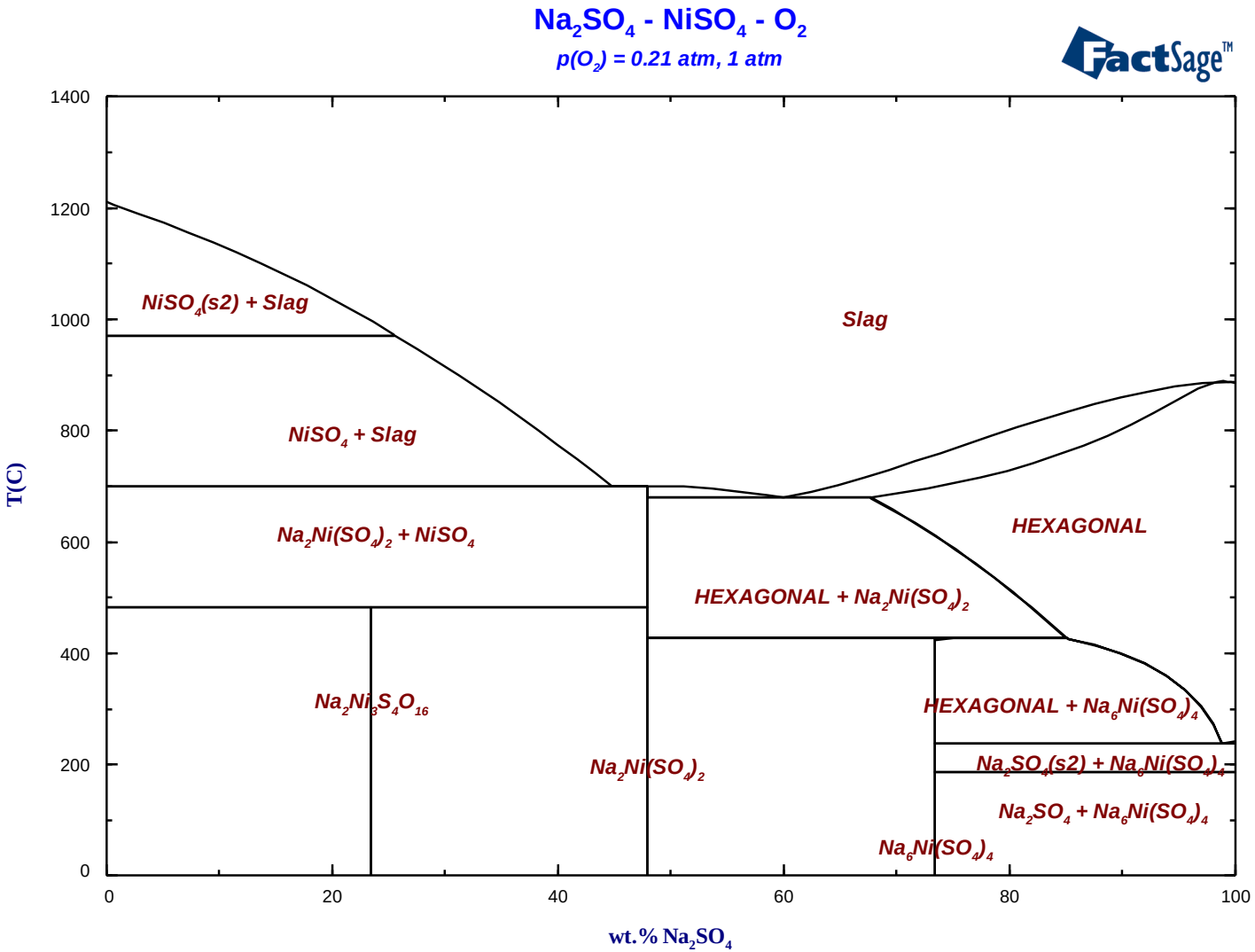
Na2O-V2O5,
Weight percent



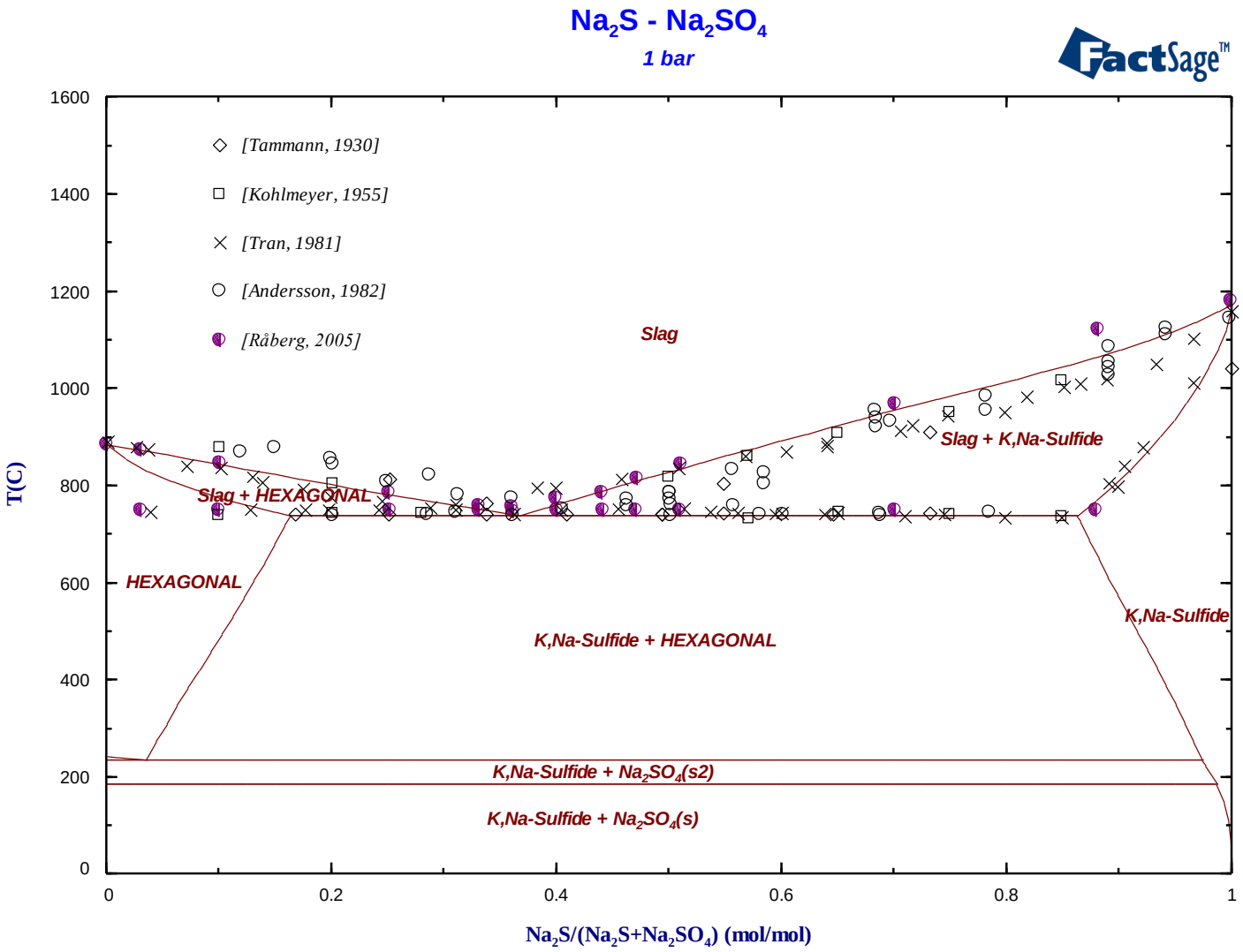
Na2SO4-NiSO4,
Mole fraction
compared with experimental data



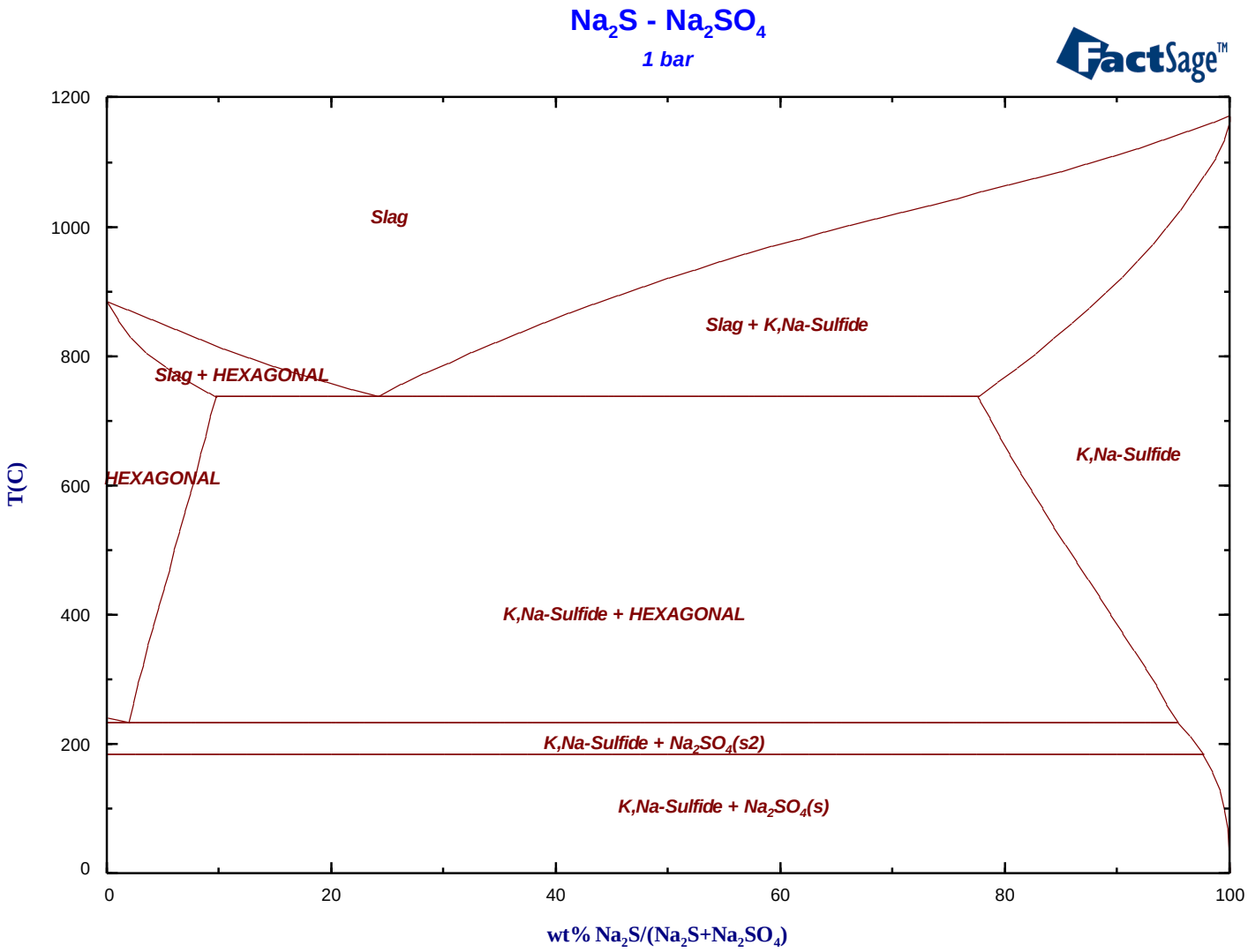
Na2SO4-NiSO4,
Weight percent



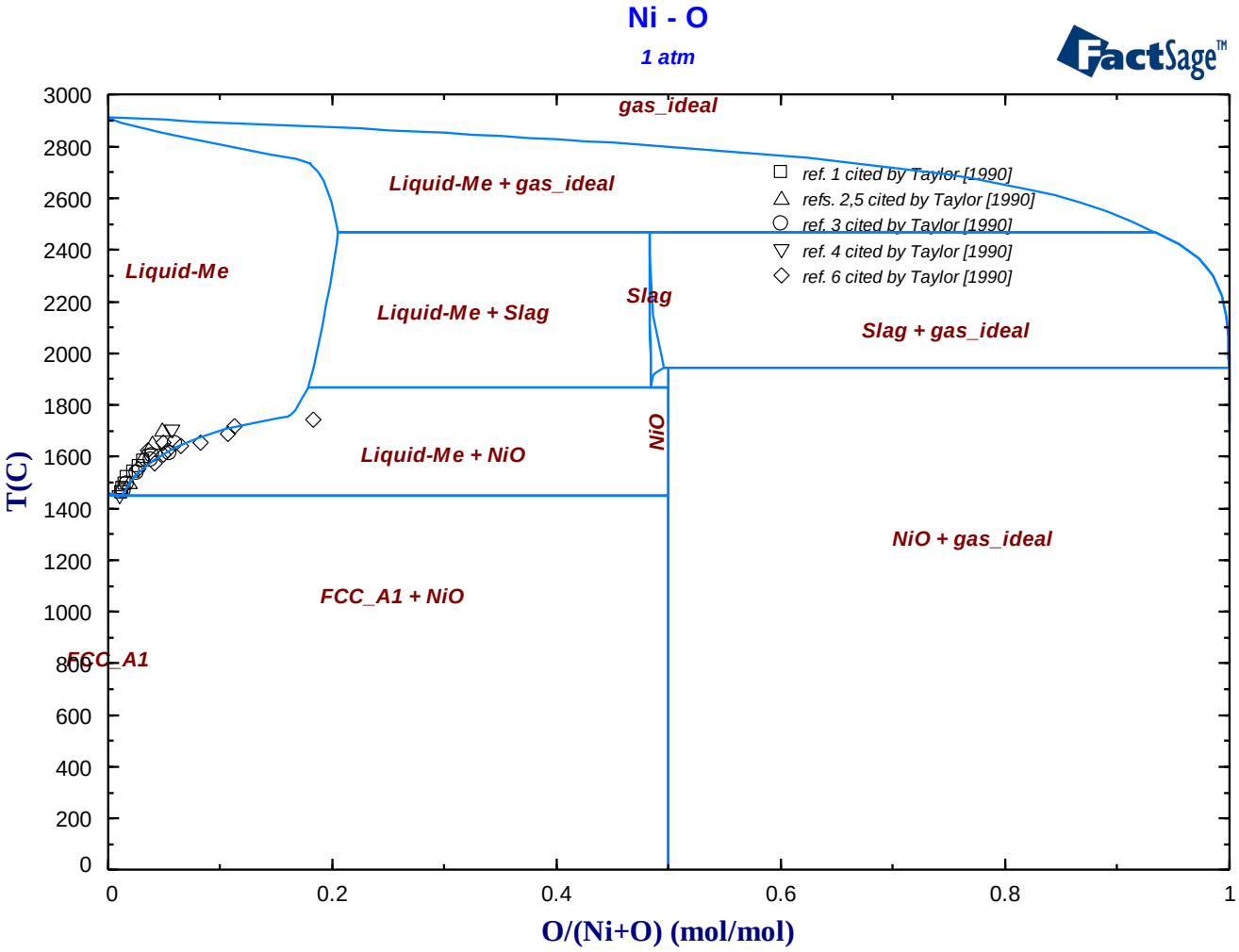
Mole fraction
compared with experimental data



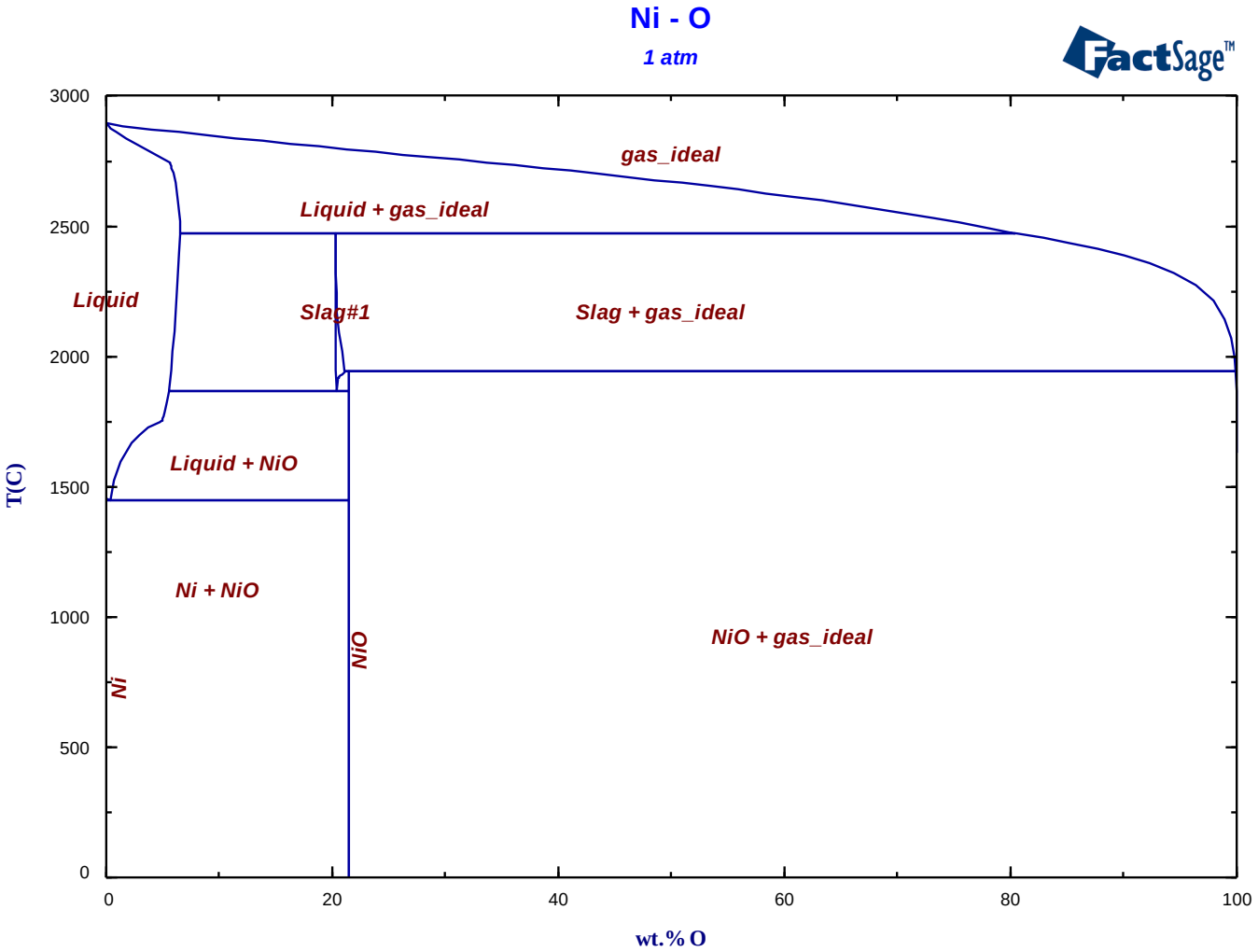
Weight percent



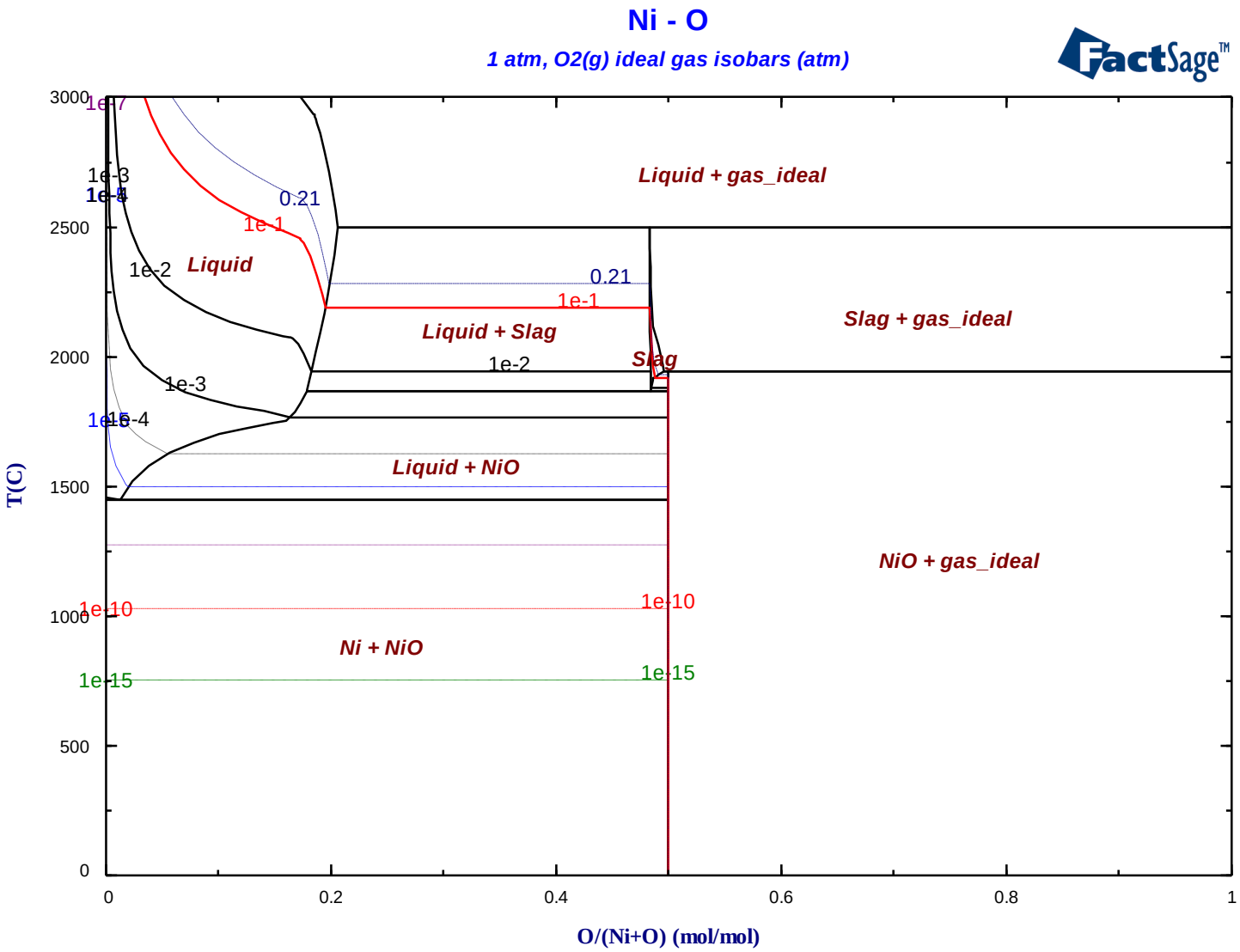
Mole fraction
compared with experimental data



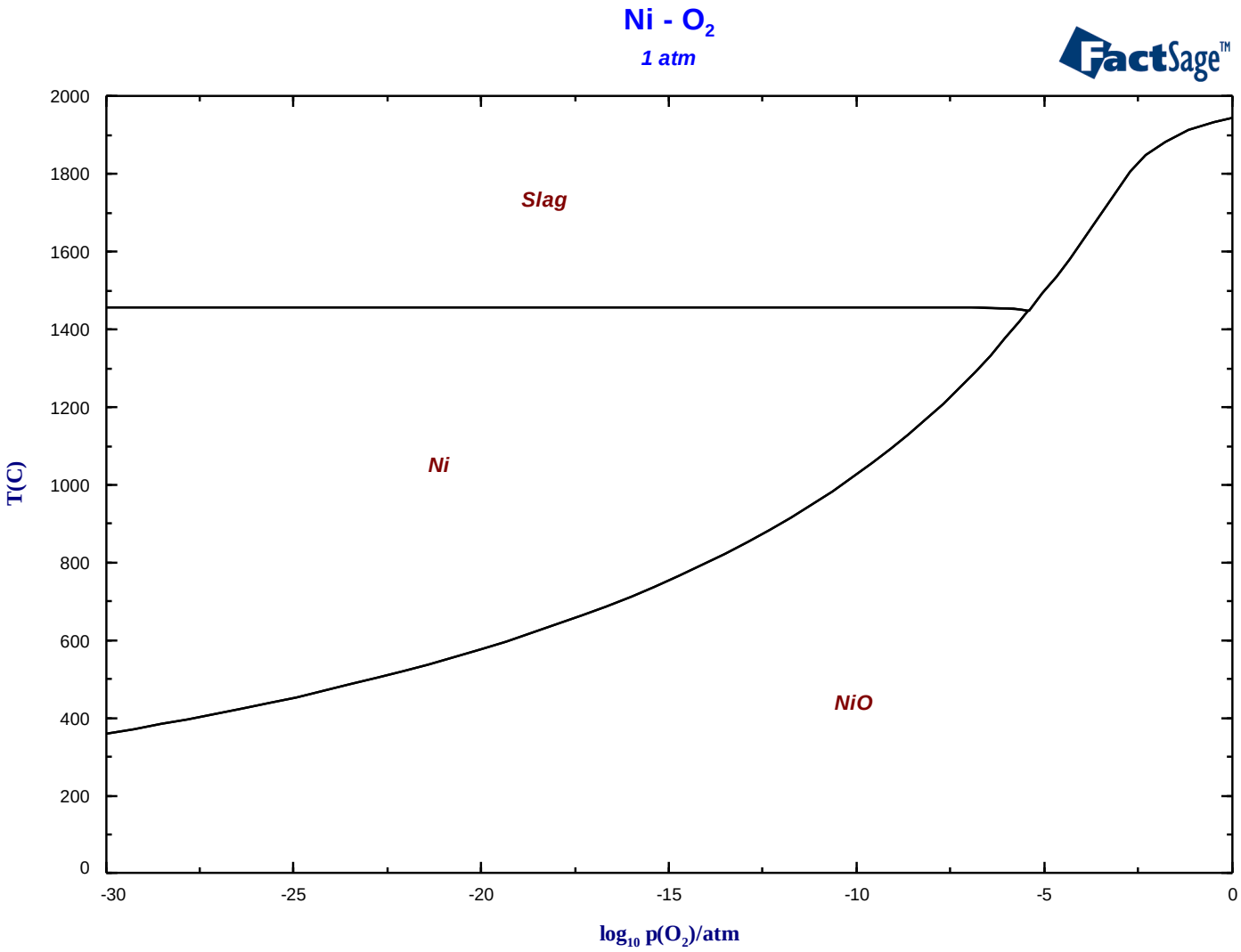
Weight percent



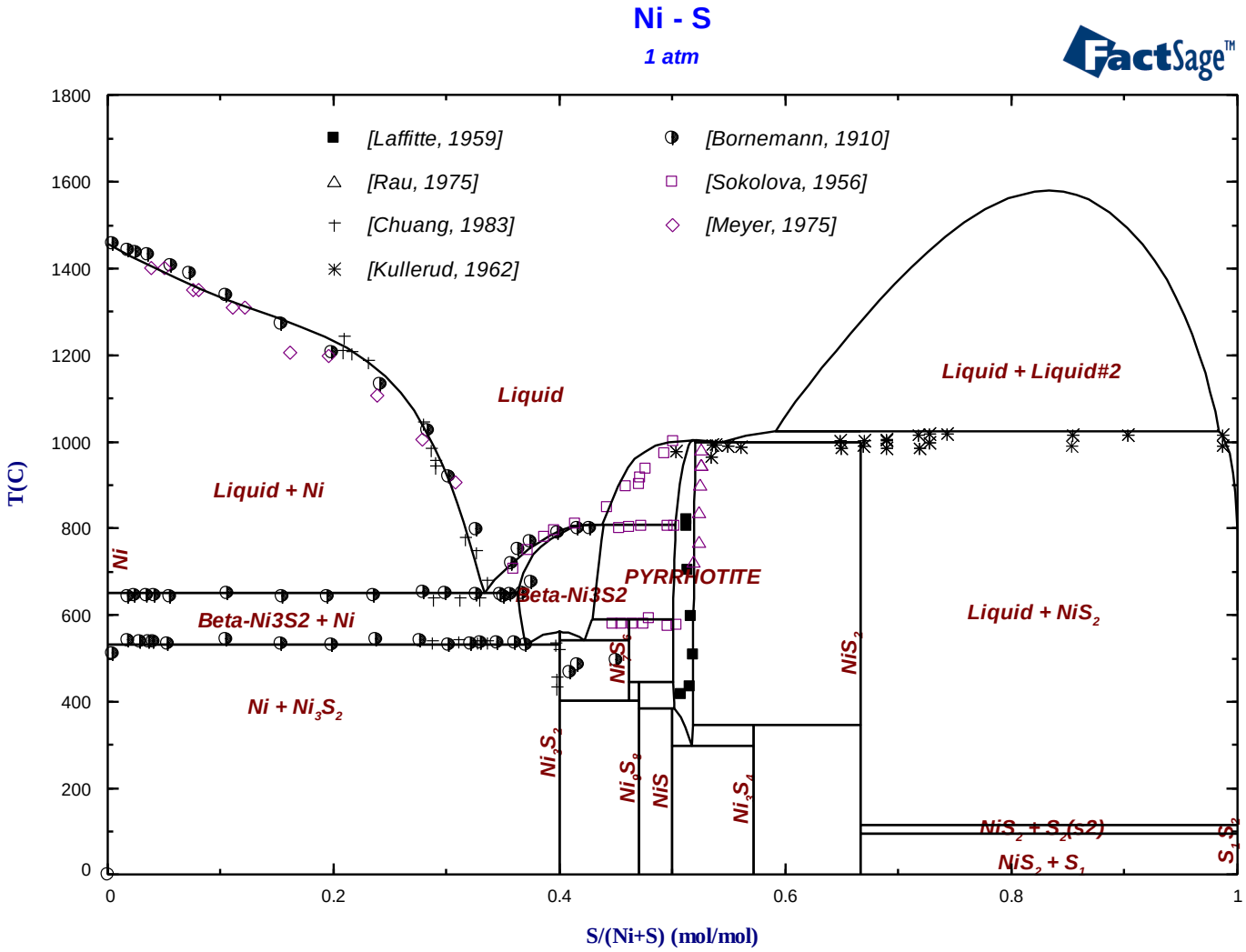
Ni-O,
Mole fraction with isobars



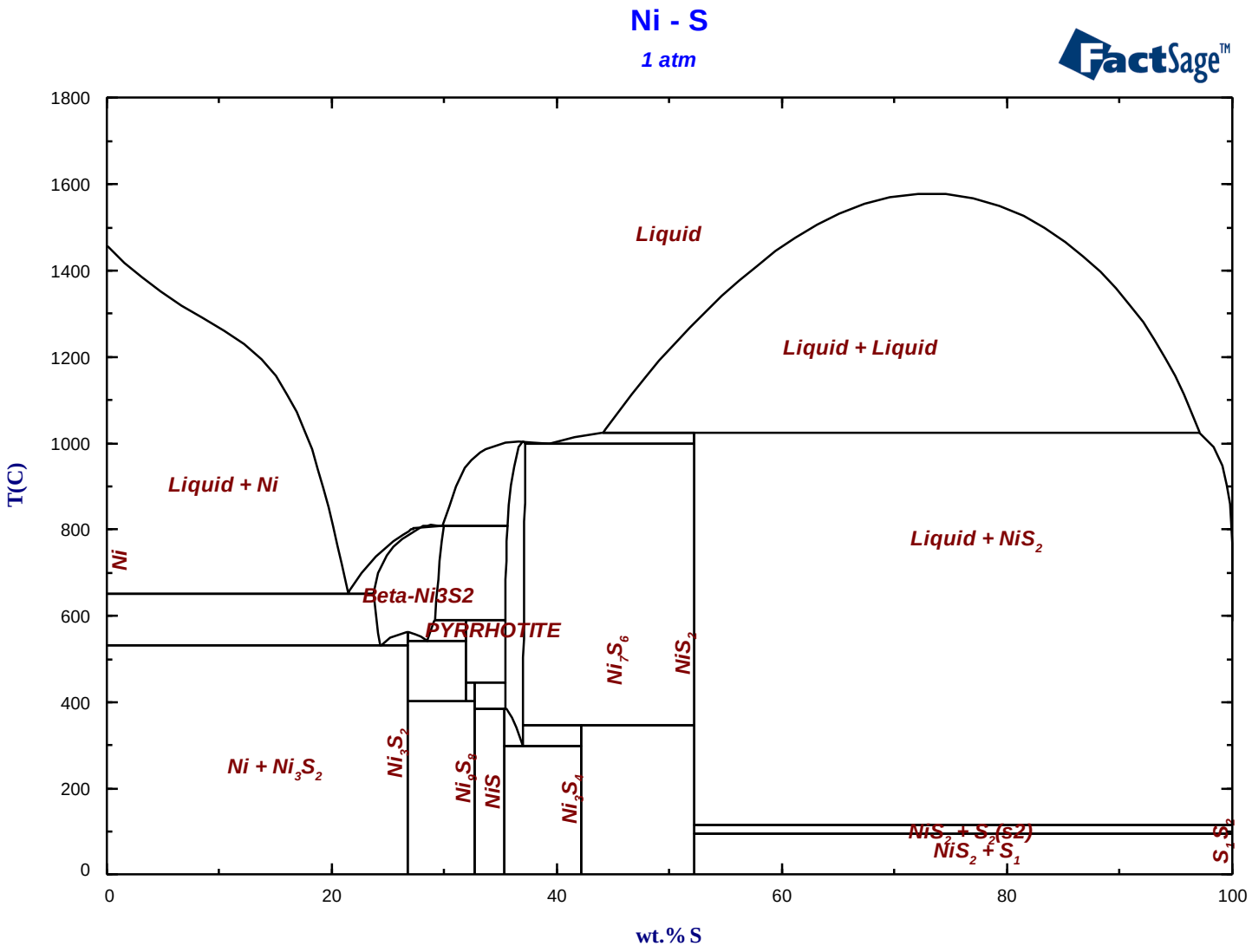
Ni-O,
Temperature vs. log P(O2) diagram



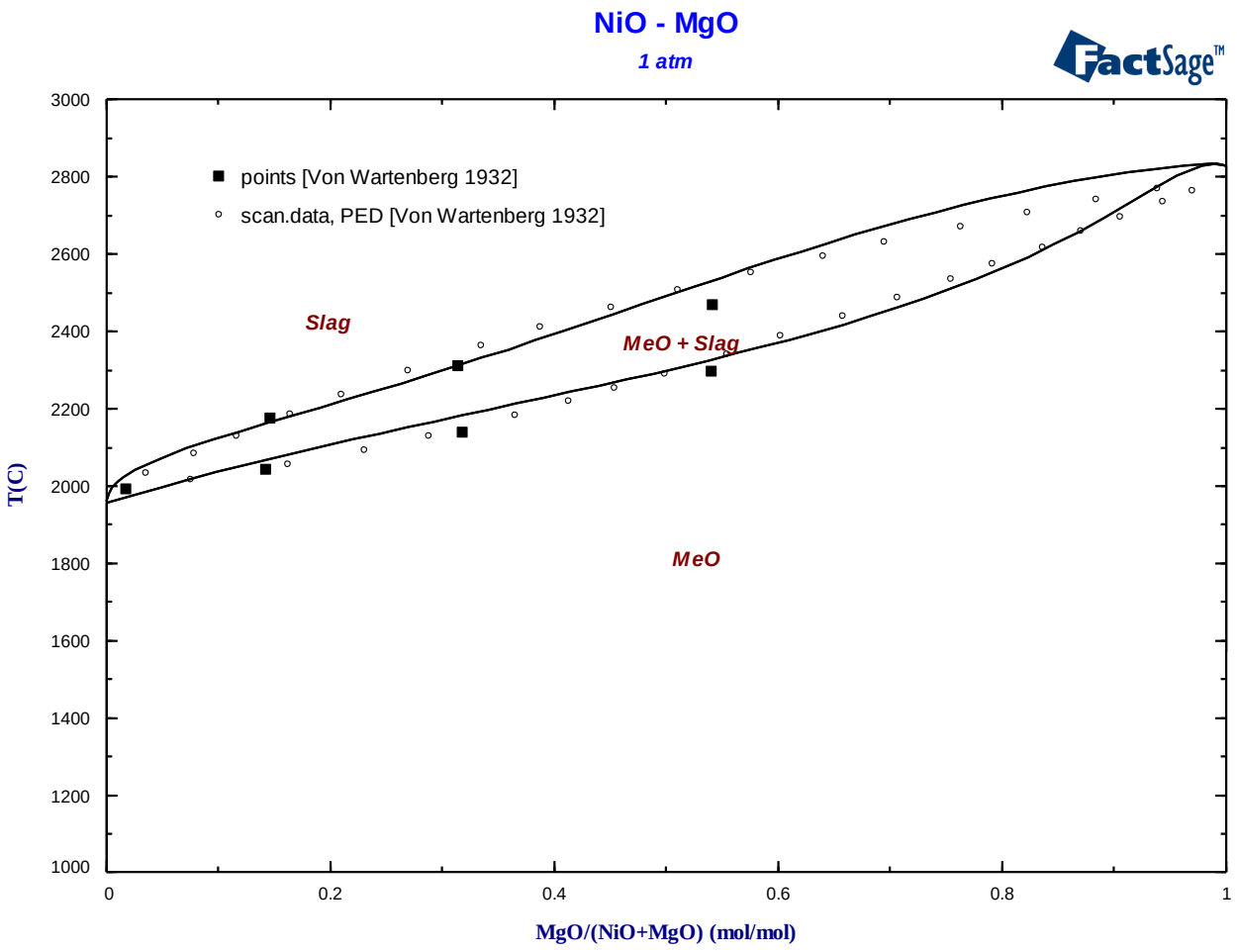
Mole fraction
compared with experimental data



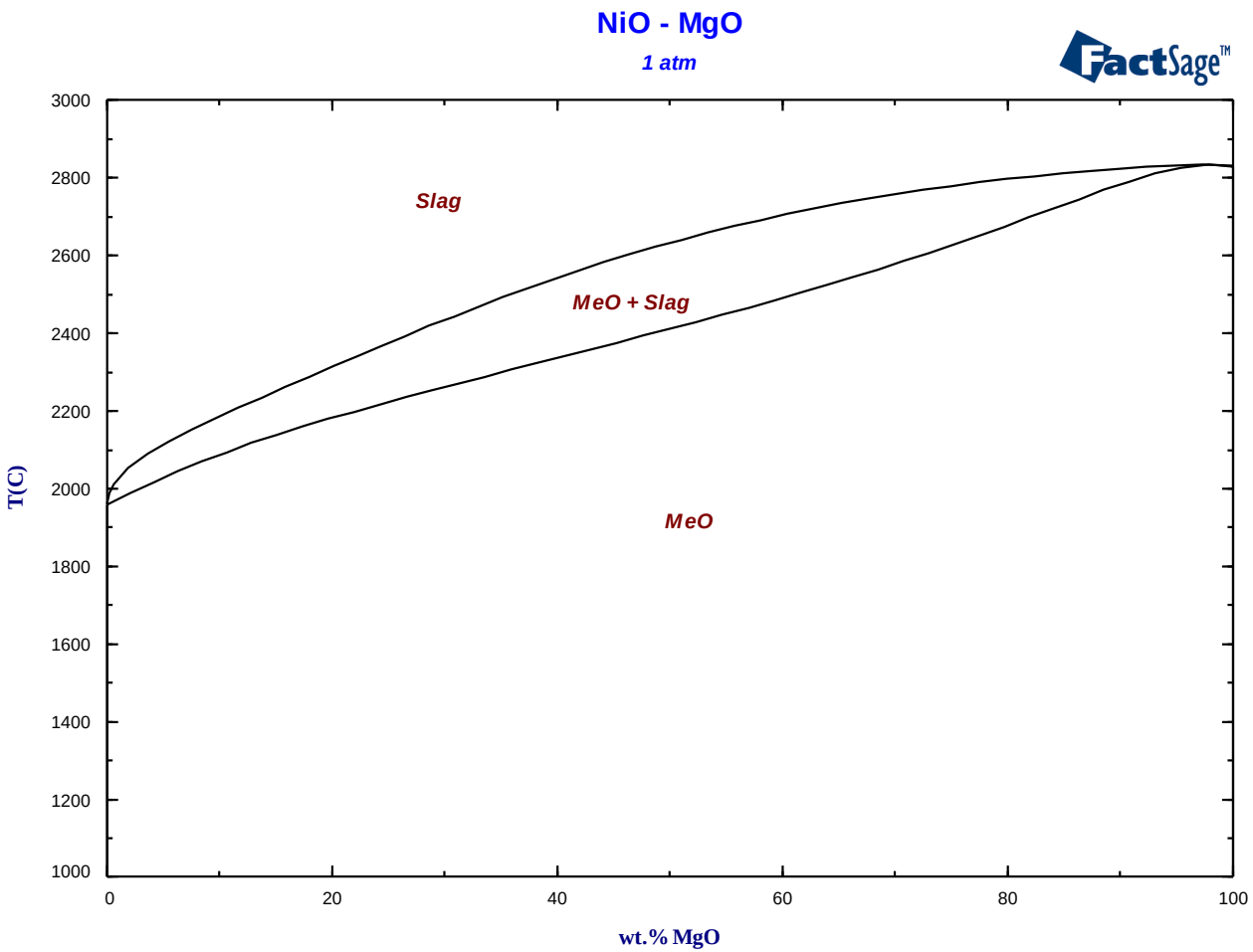
Ni-S,
Weight percent



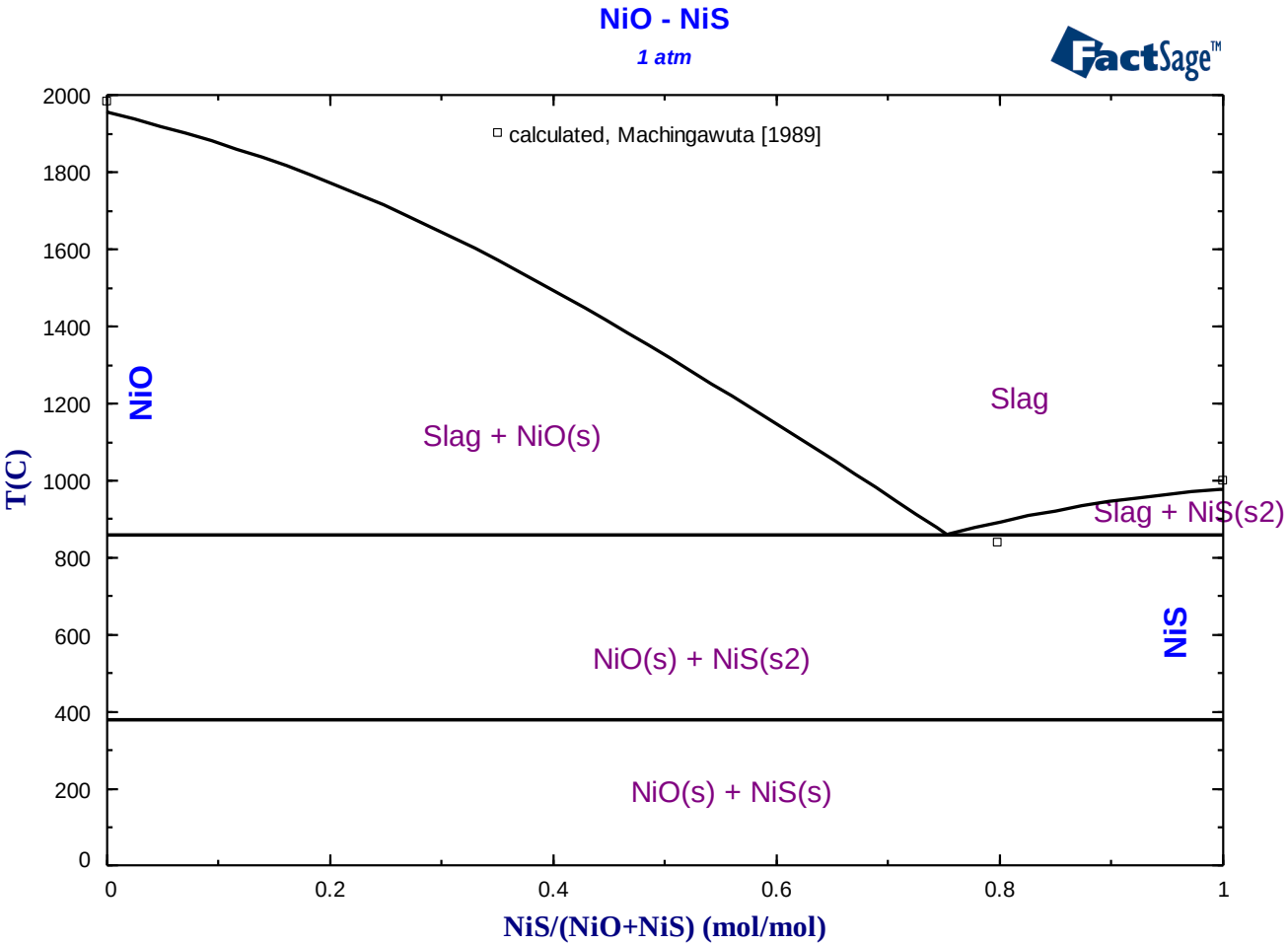
NiO-MgO,
Mole fraction compared with experimental data



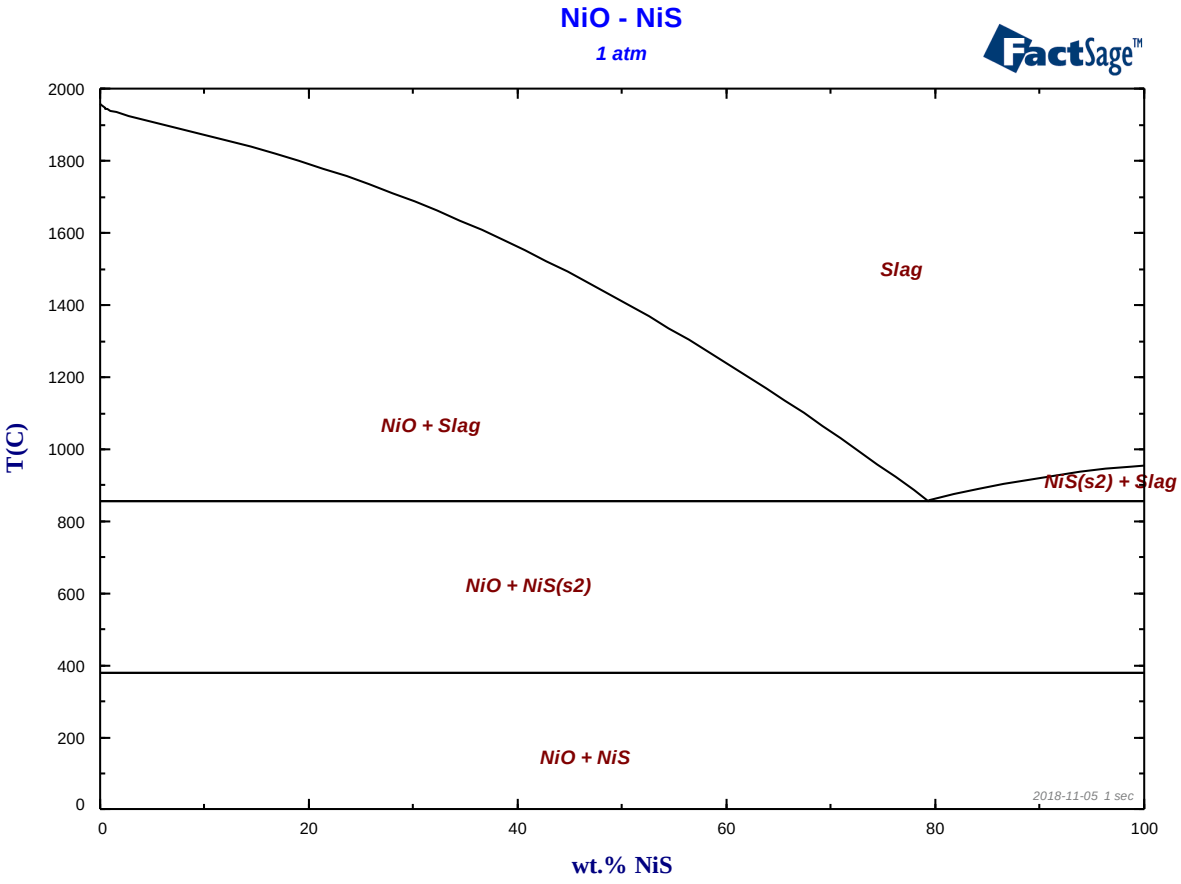
NiO-MgO,
Weight percent



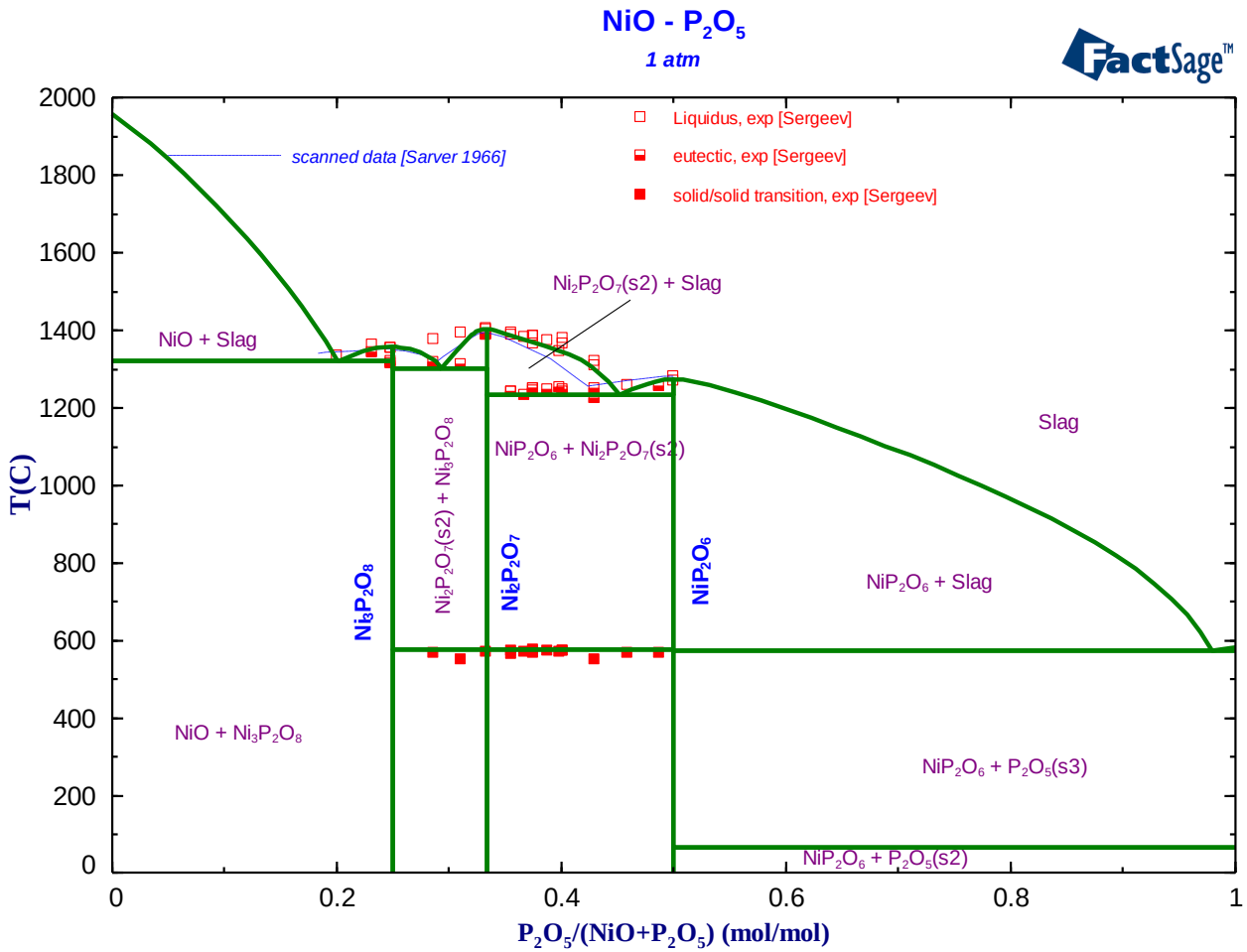
Mole fraction



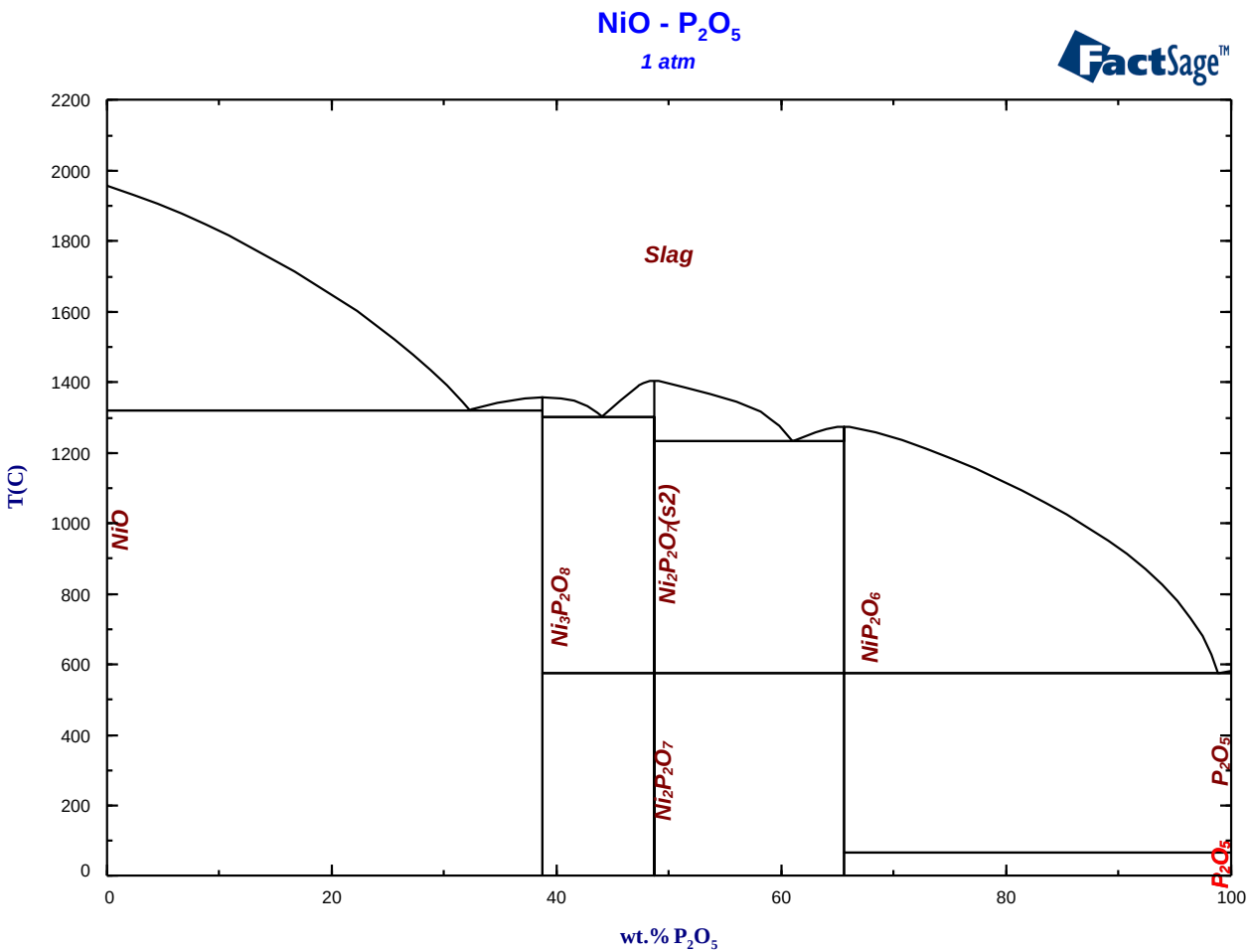
Weight fraction



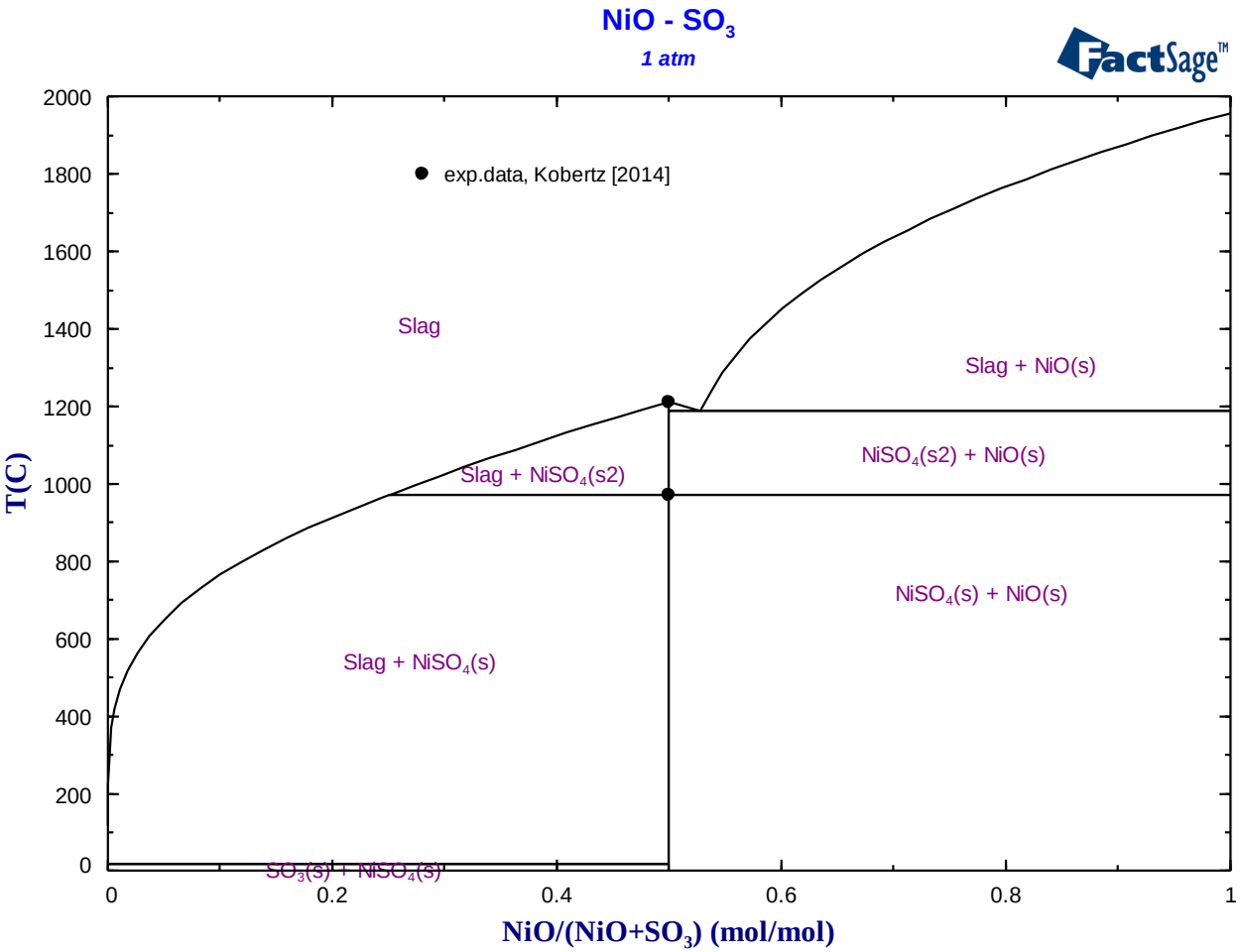
NiO-P2O5,
Mole fraction compared with experimental data



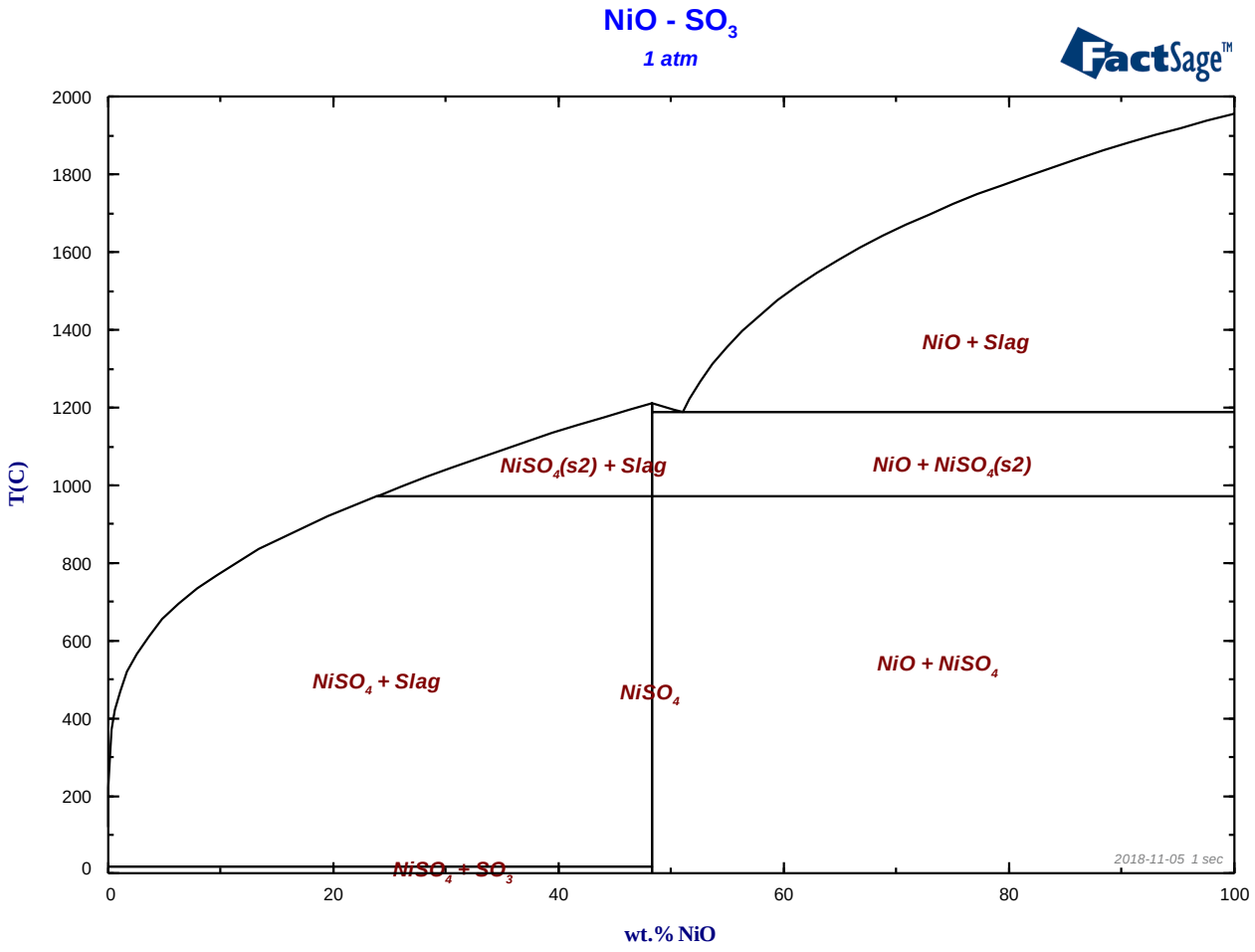
NiO-P2O5,
Weight percent



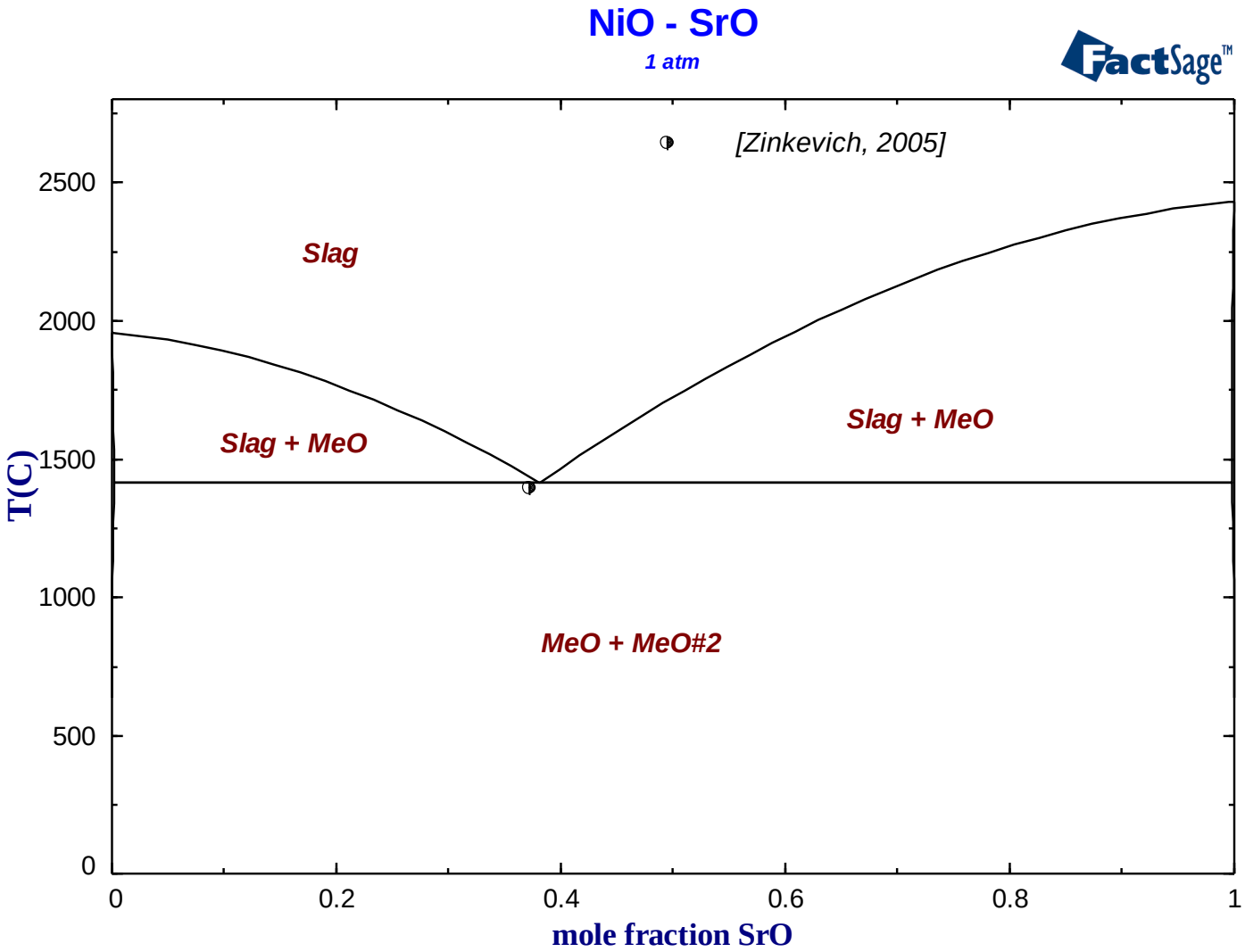
Mole fraction compared with experimental data



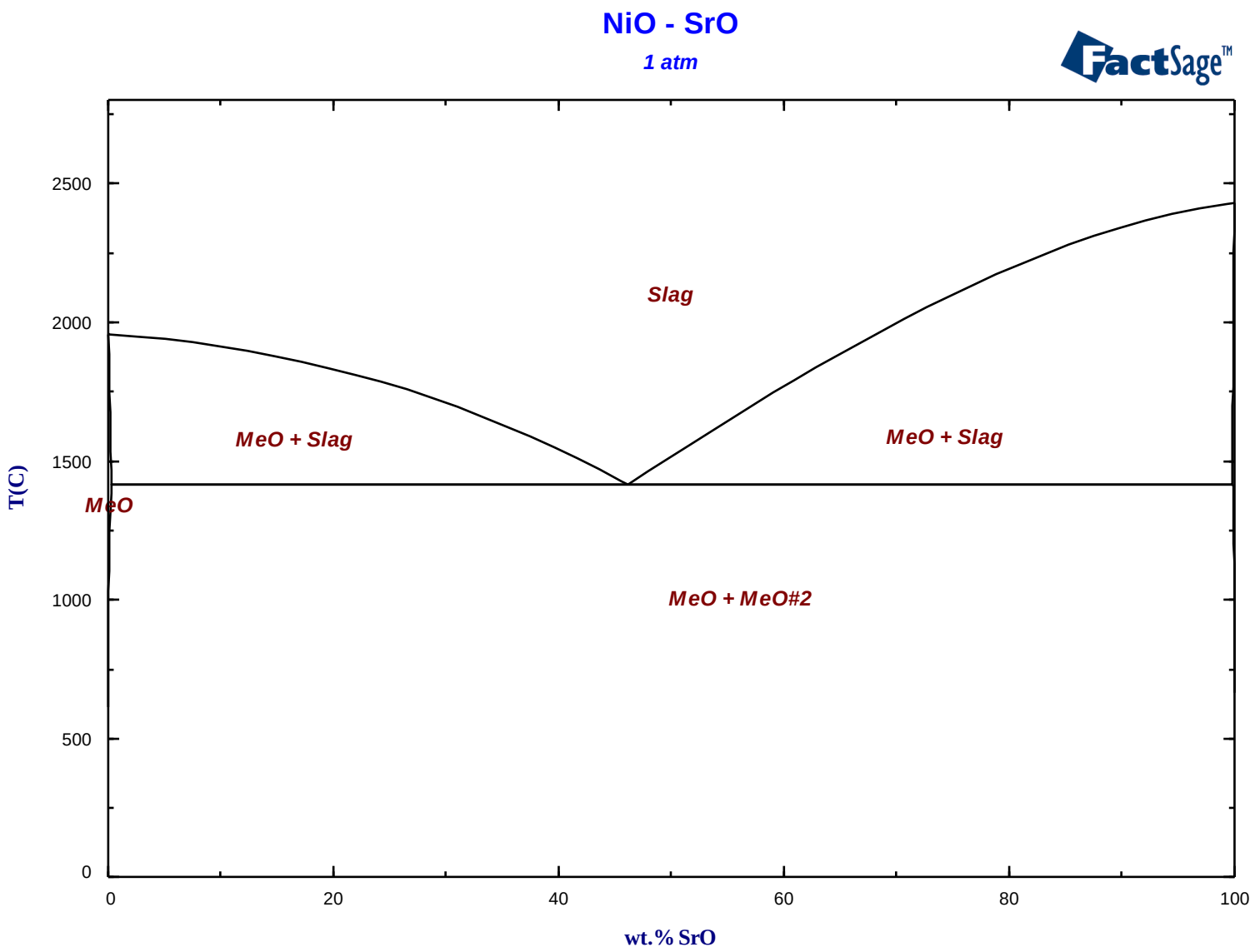
Weight fraction



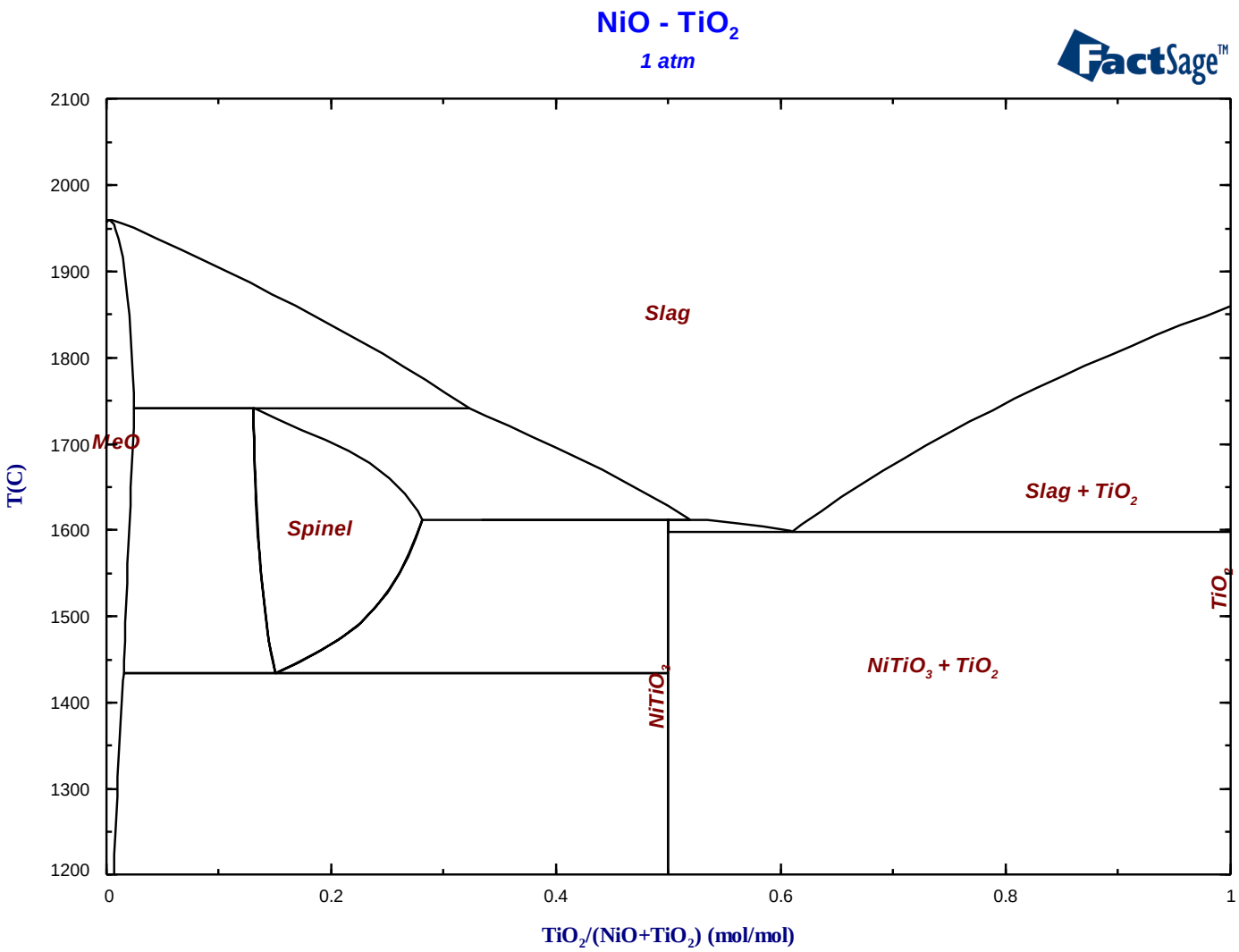
NiO-SrO,
Mole fraction compared with experimental data



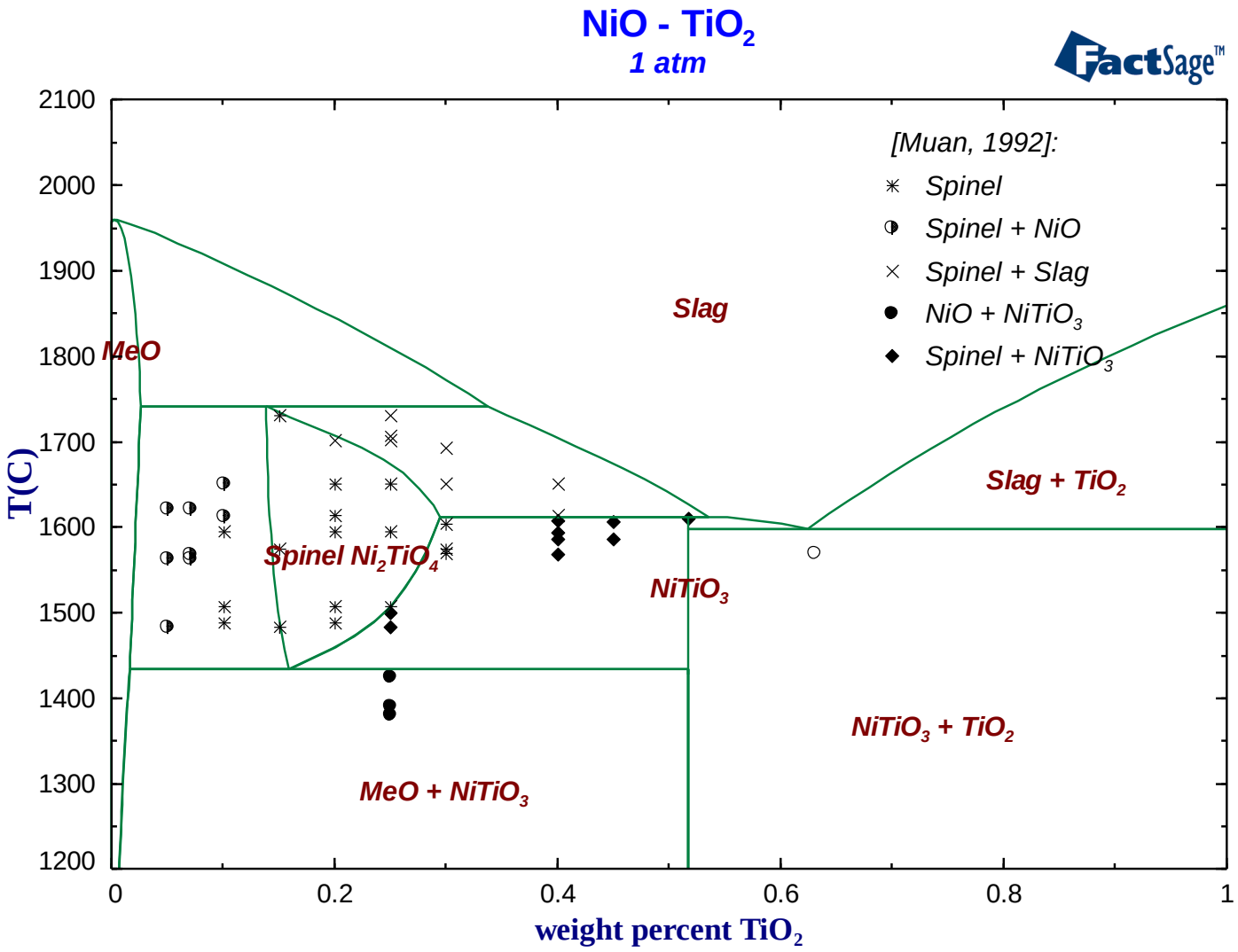
NiO-SrO,
Weight percent



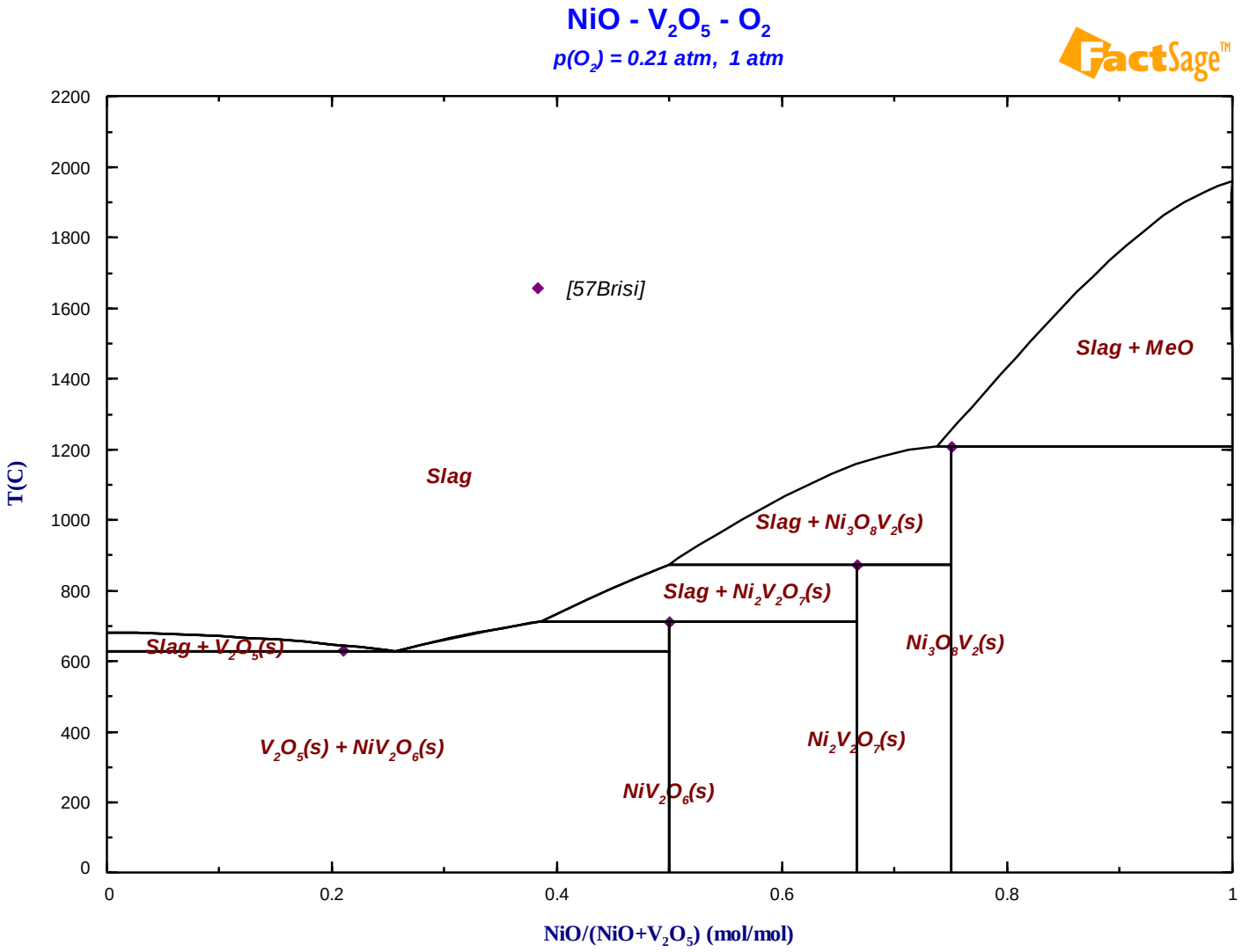
NiO-TiO2,
Mole fraction



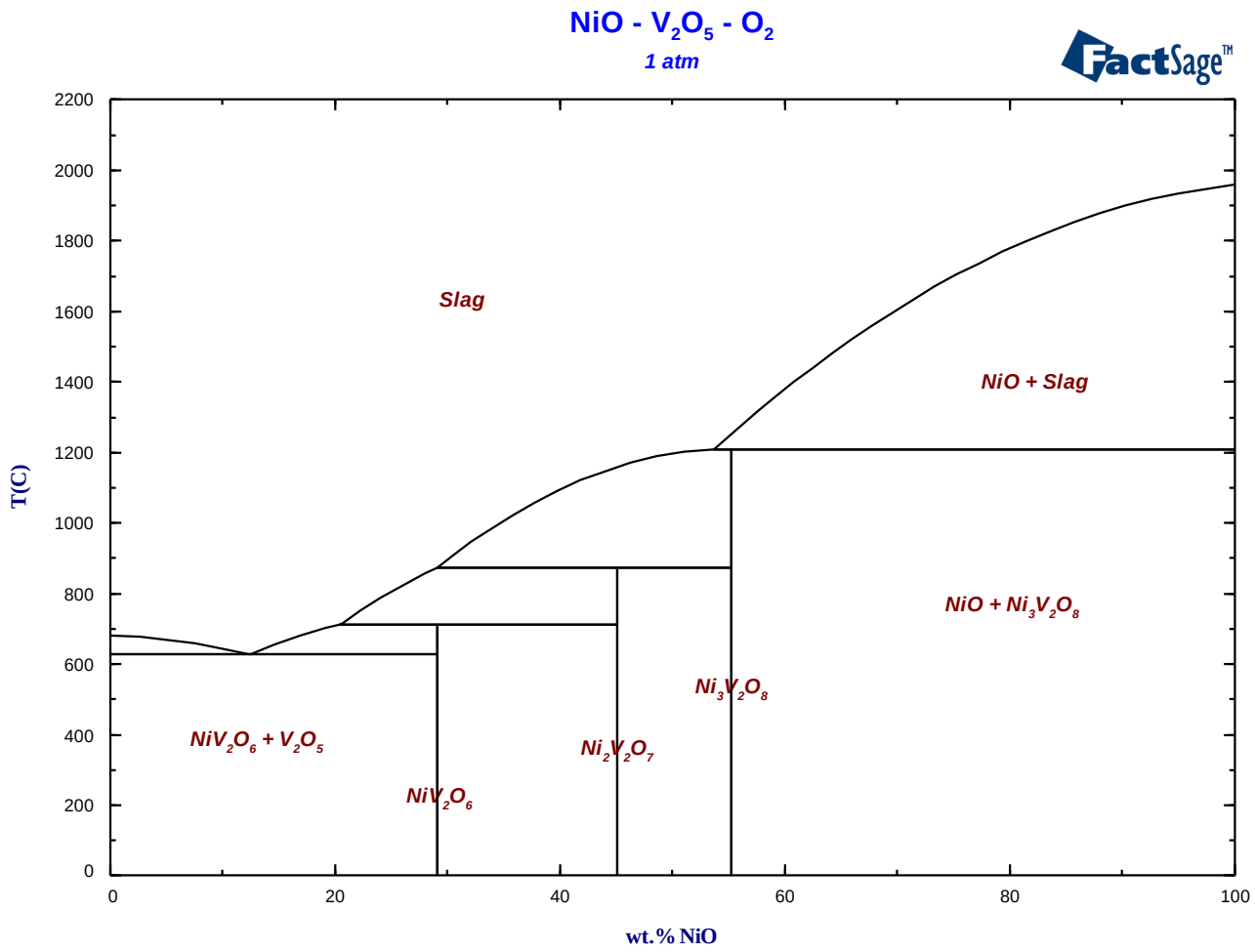
NiO-TiO2,
Weight percent compared with experimental data



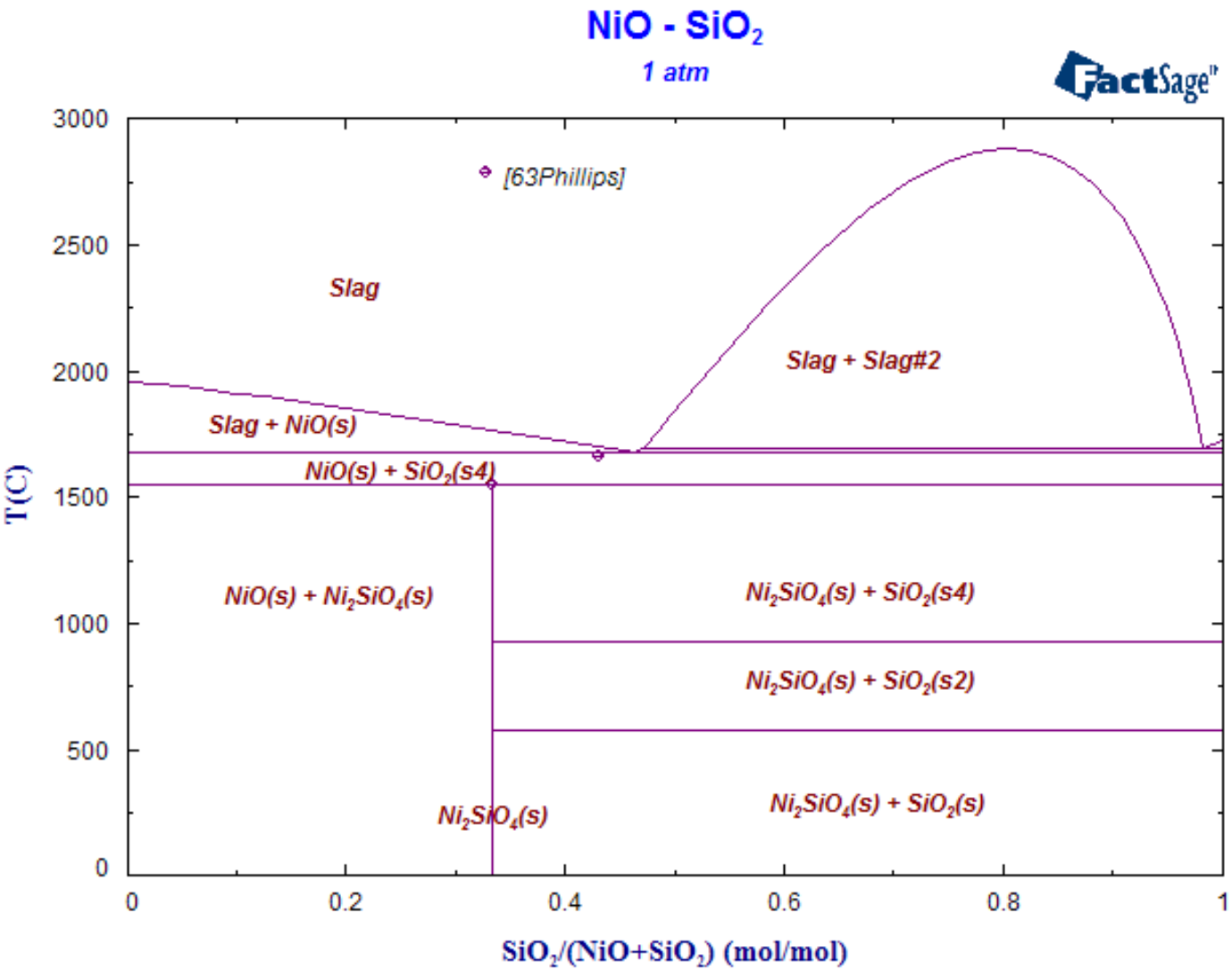
NiO-V2O5-O2,
Mole fraction compared with experimental data



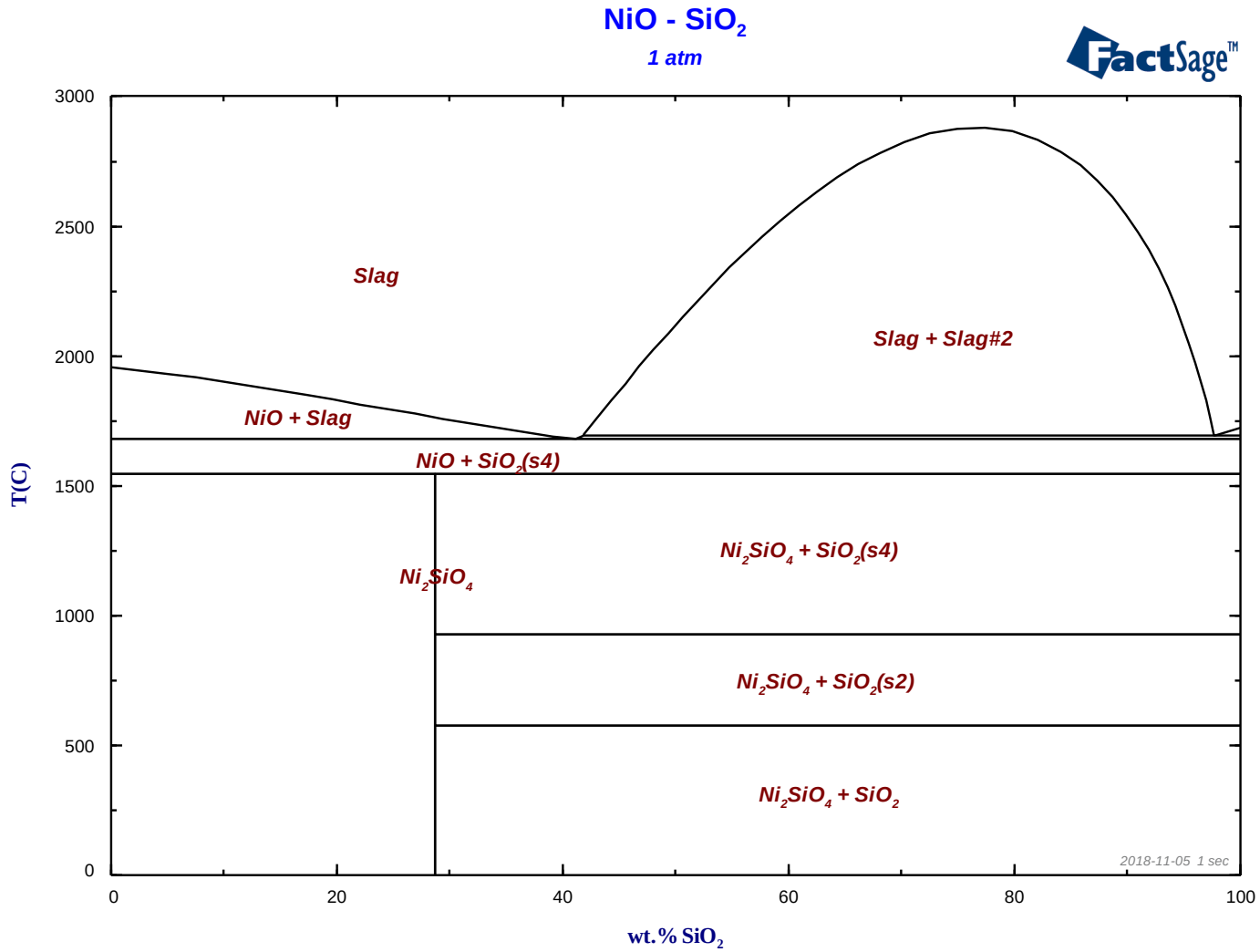
NiO-V2O5-O2,
Weight percent



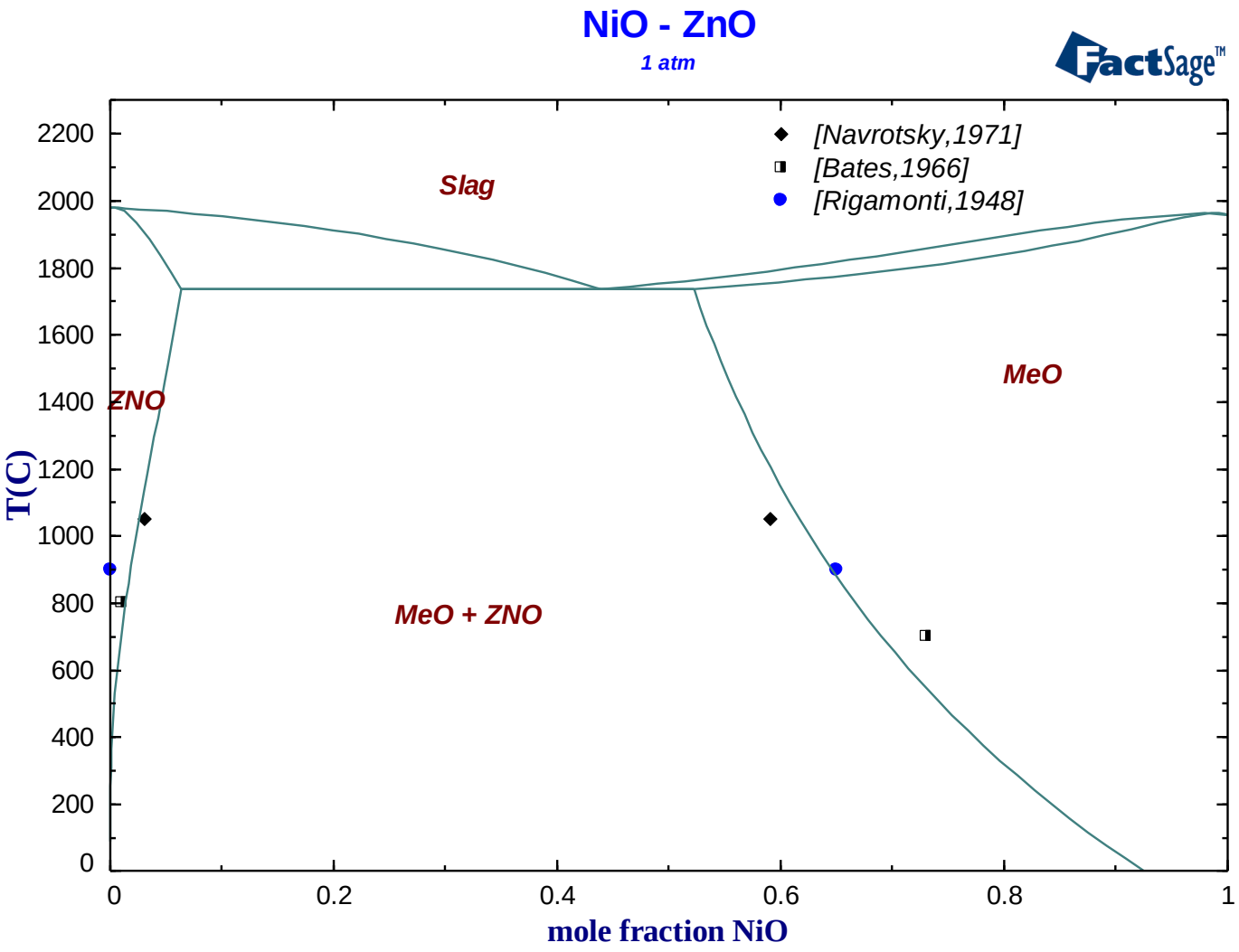
Mole fraction compared with experimental data



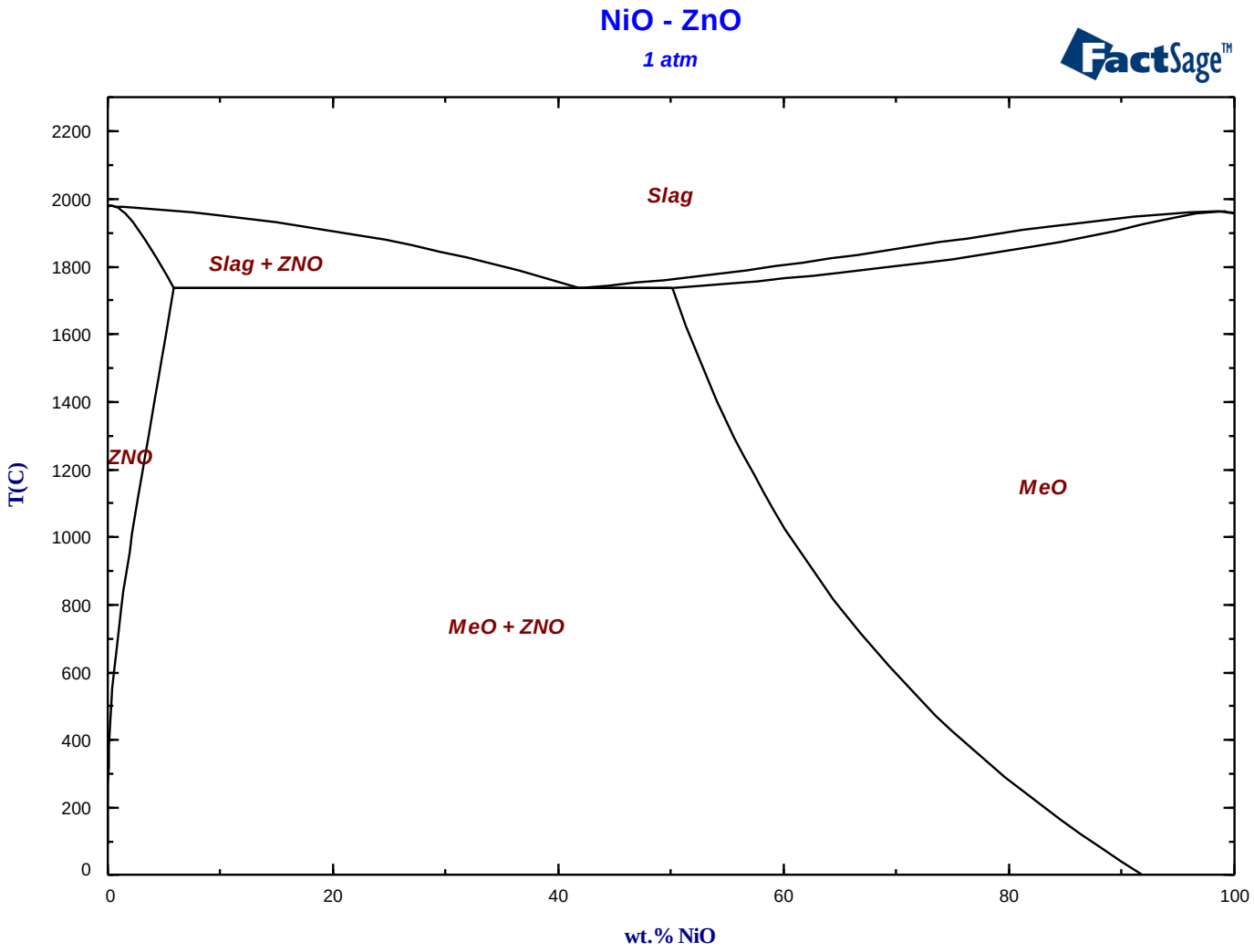
Weight percent



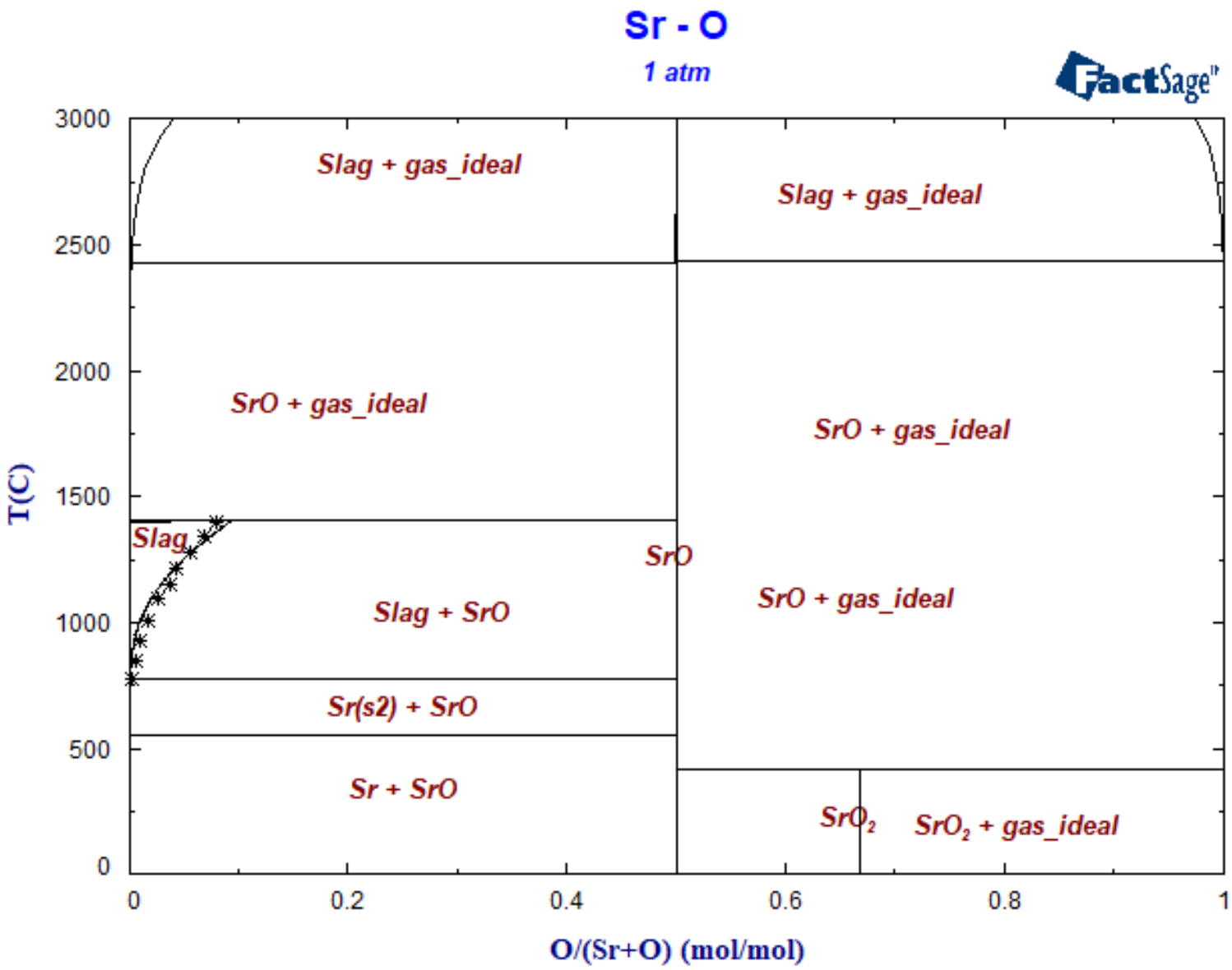
NiO-ZnO,
Mole fraction compared with experimental data



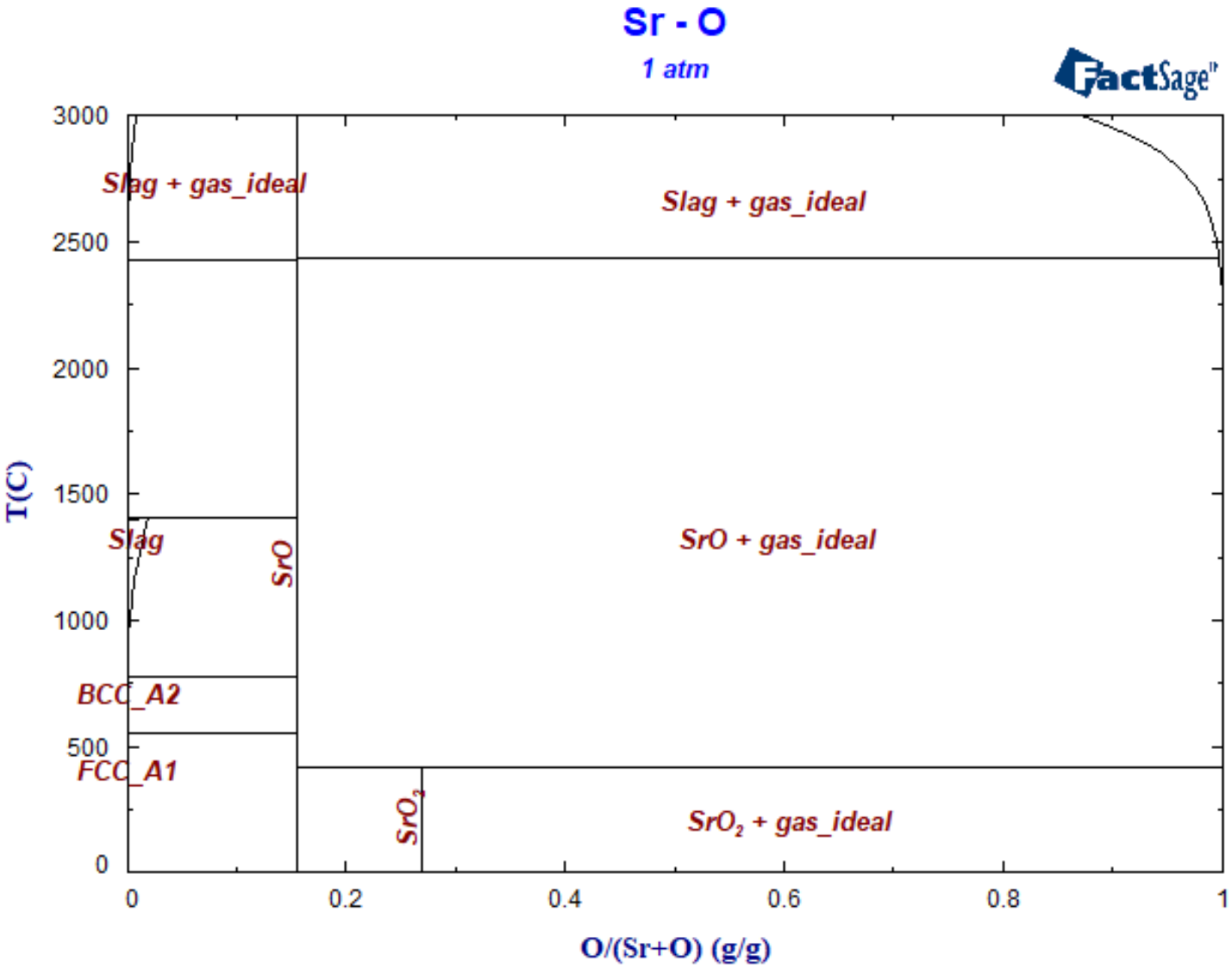
NiO-ZnO,
Weight percent



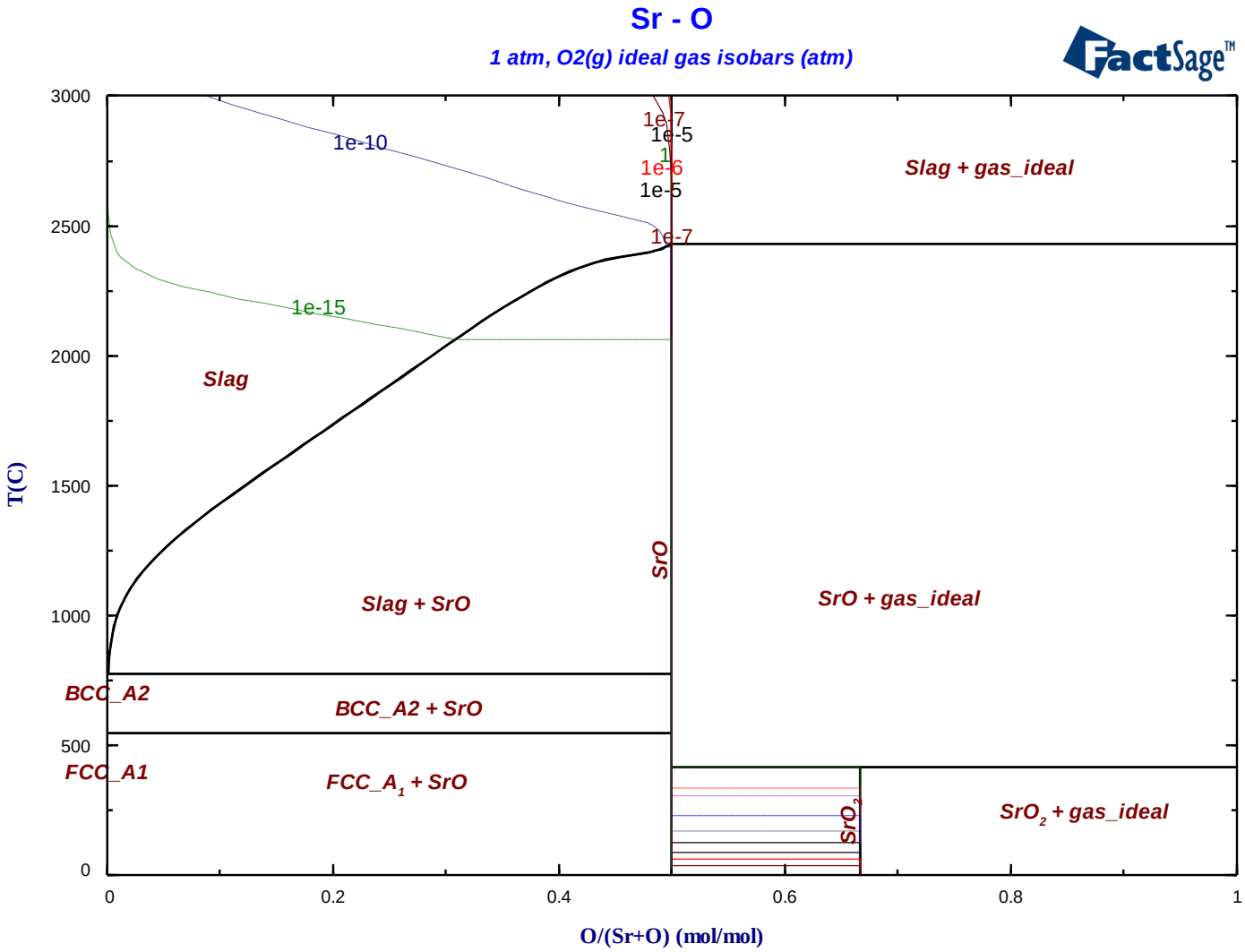
Mole fraction
compared with experimental data



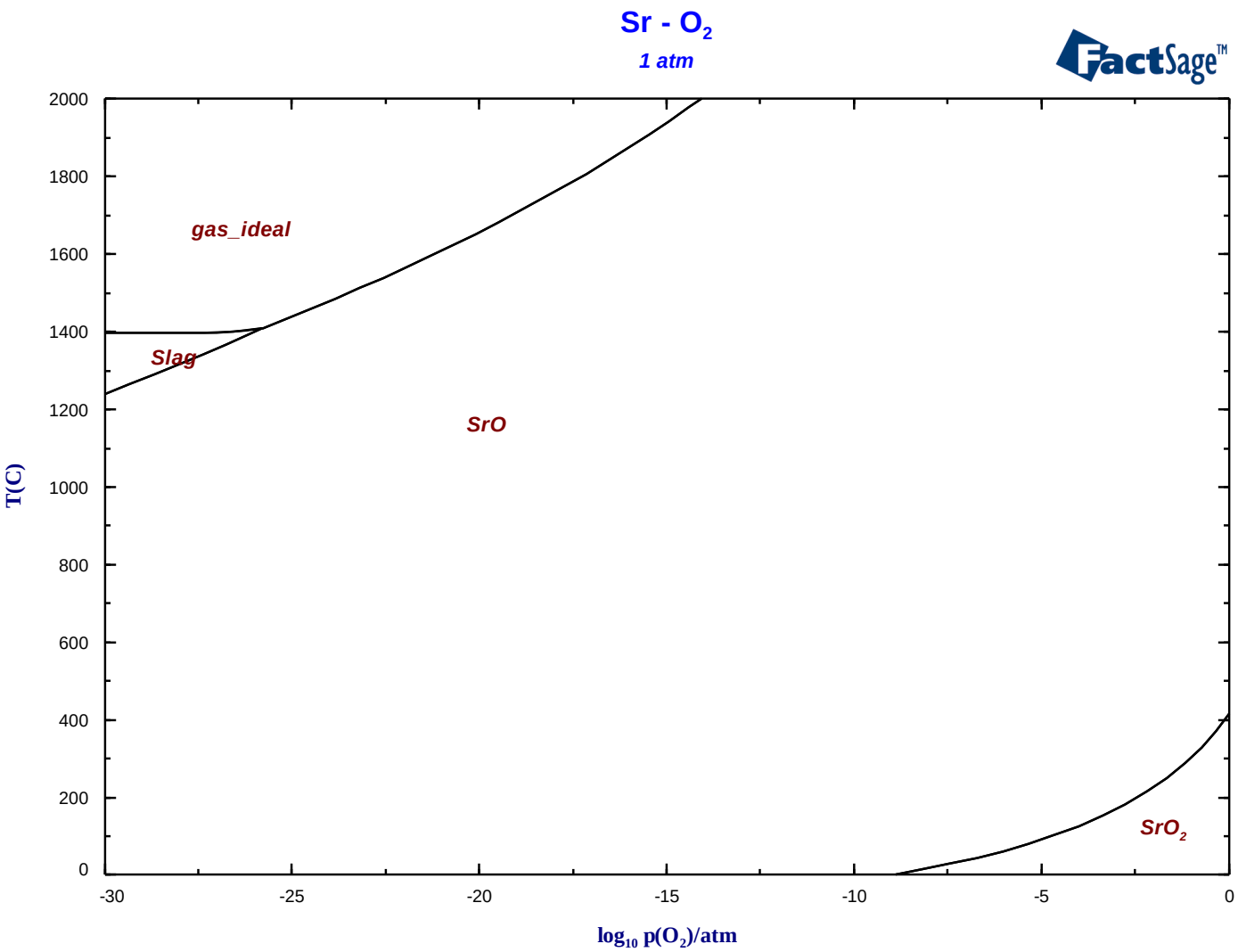
Weight percent



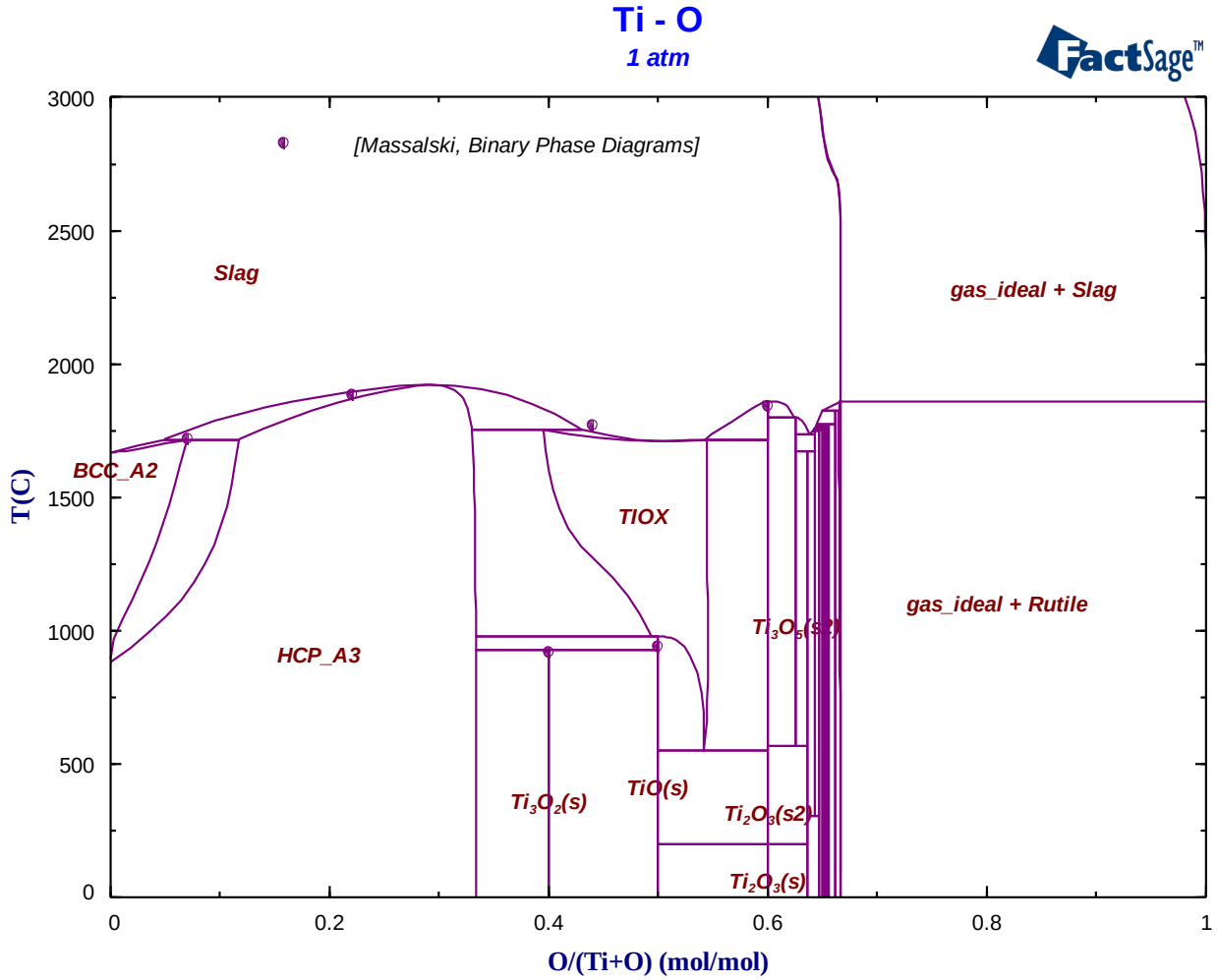
Mole fraction with isobars



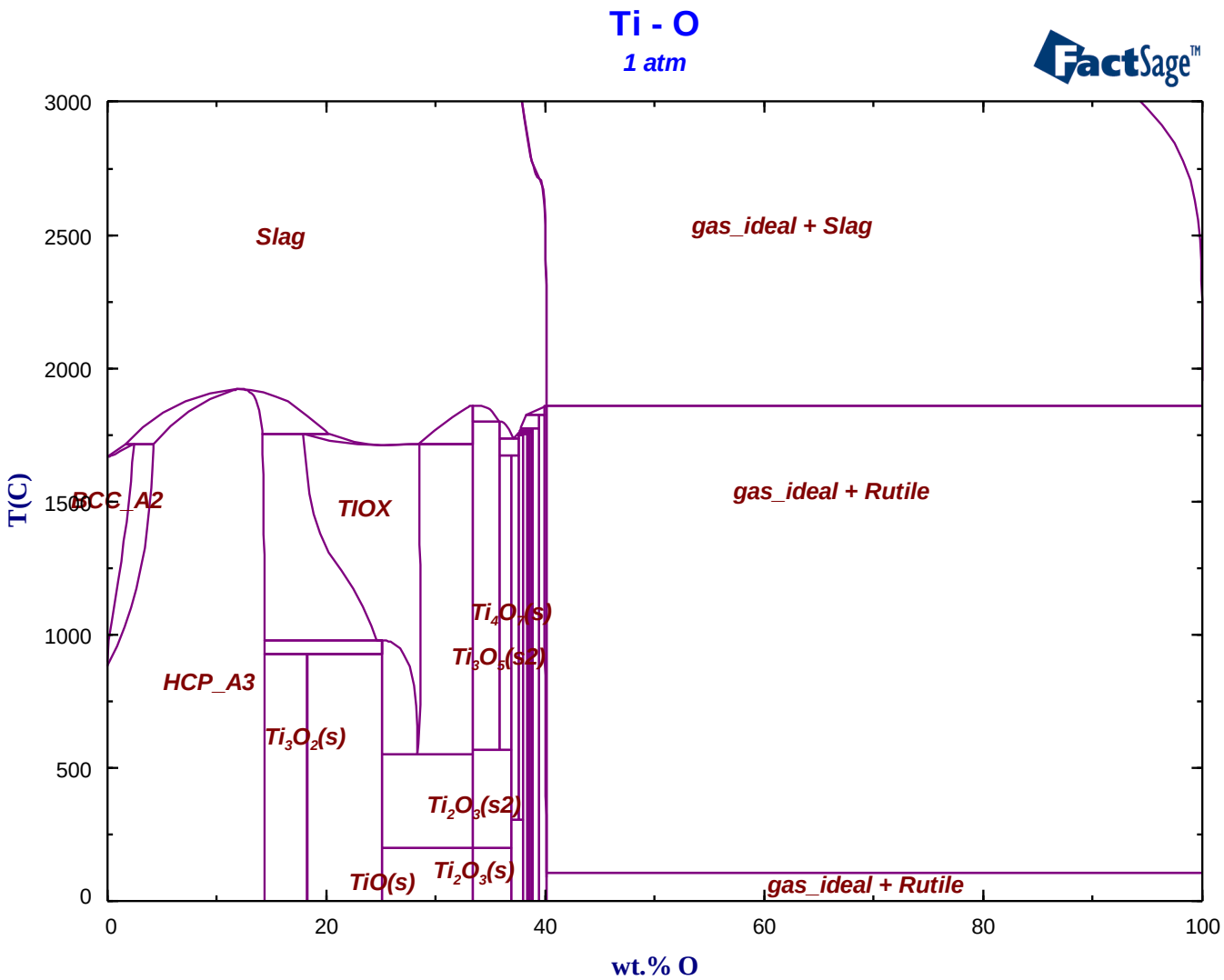
O2-Sr,
Temperature vs. log P(O2) diagram



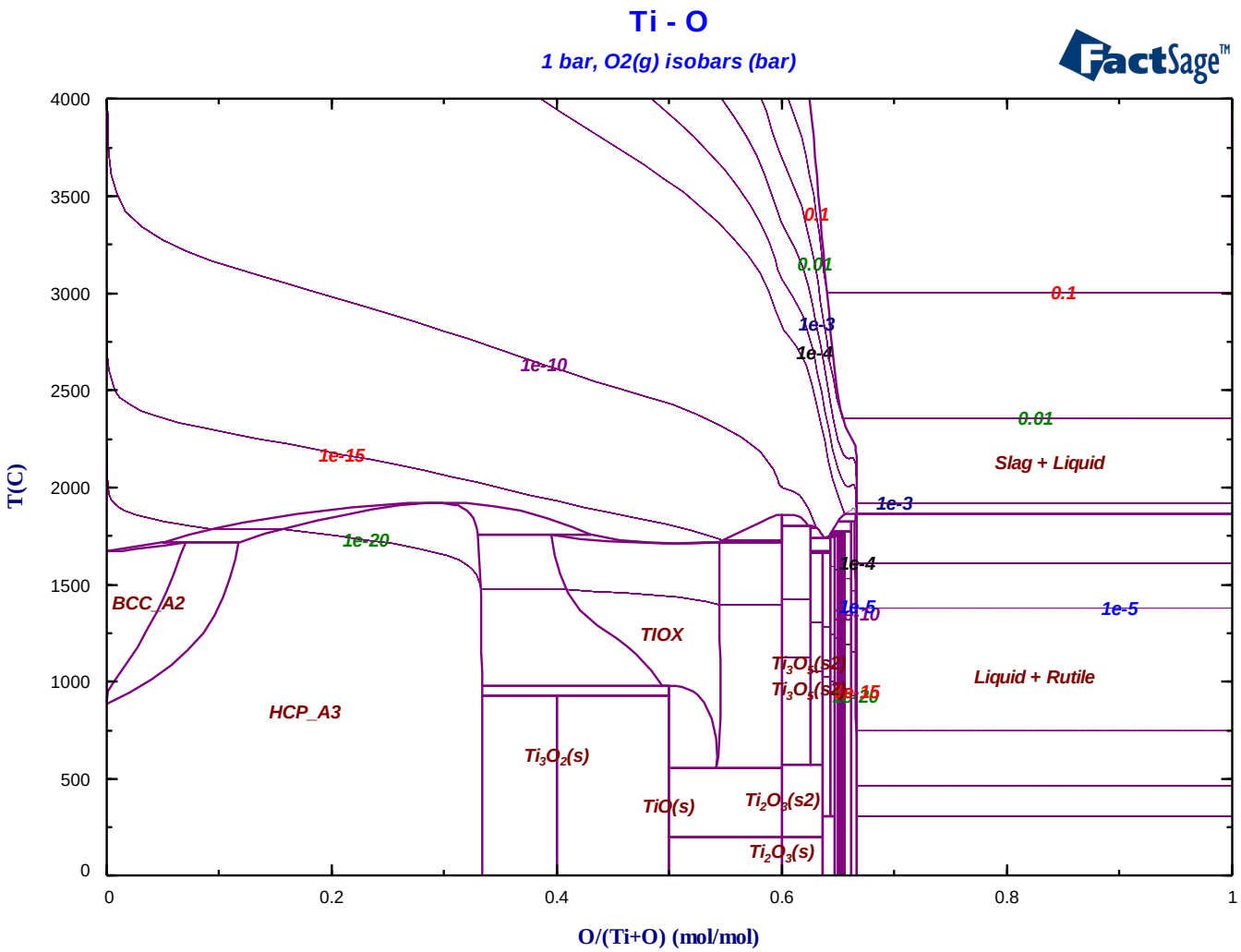
Mole fraction
compared with experimental data



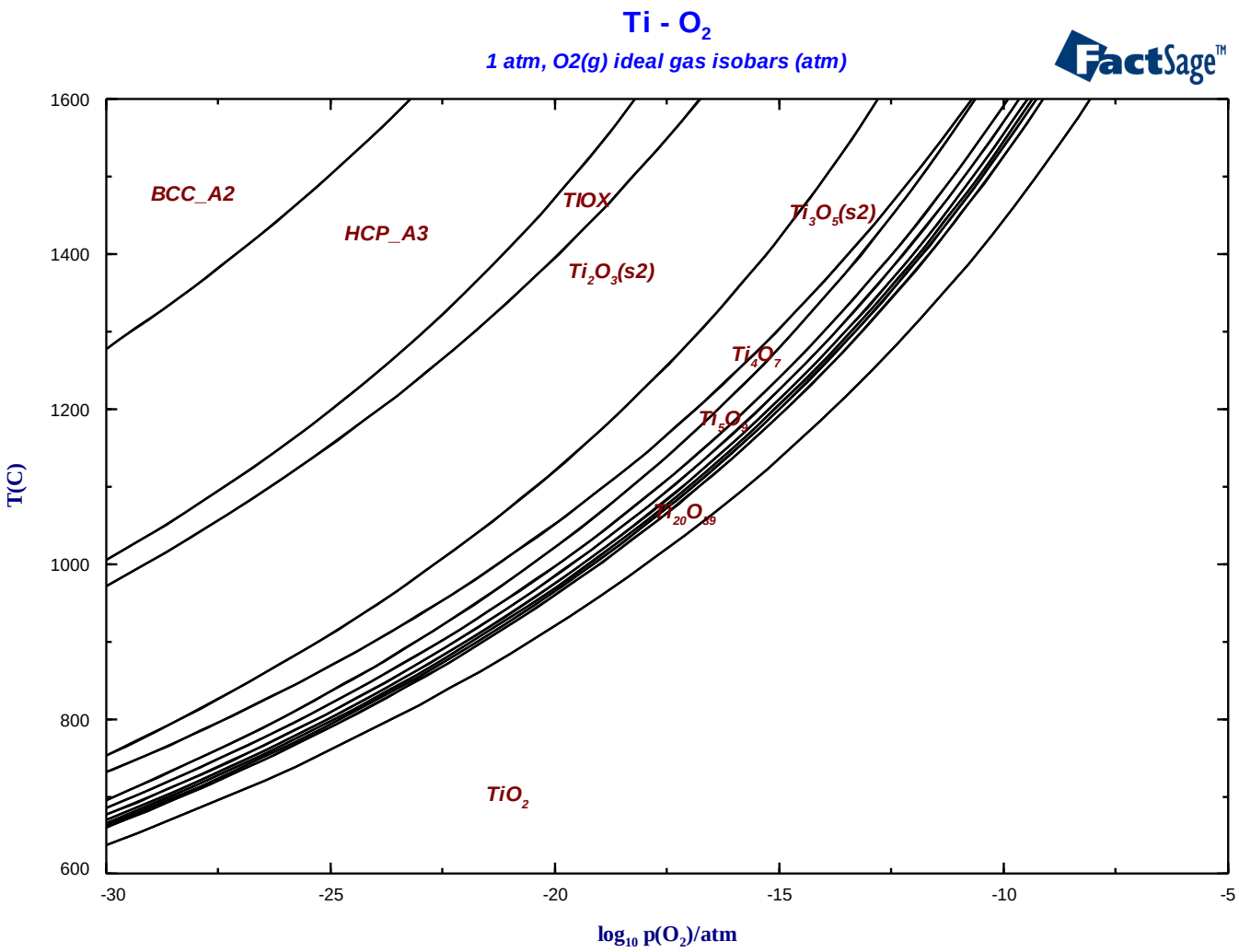
Weight percent



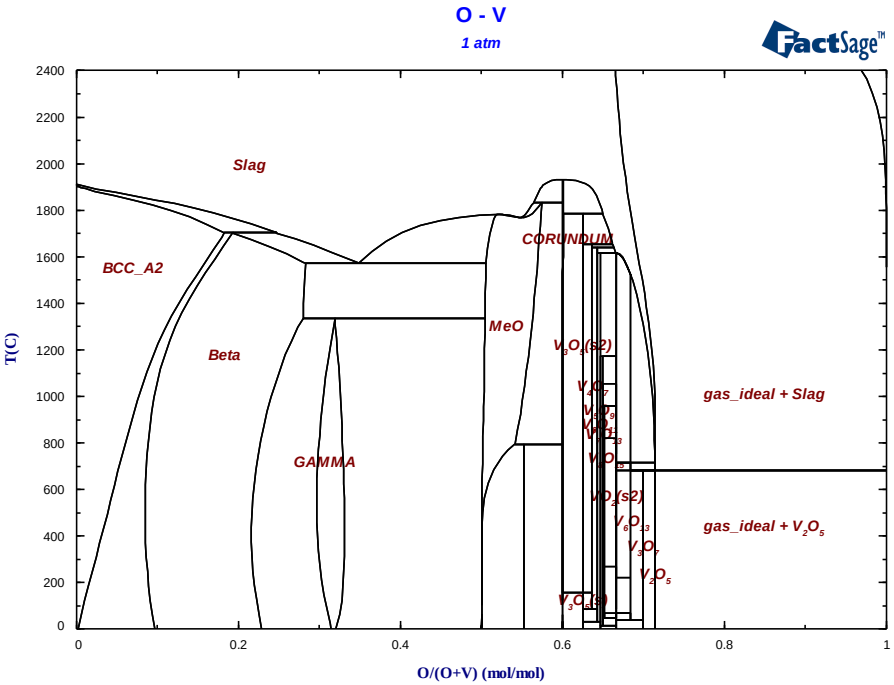
O-Ti,
Mole fraction with isobars



O2-Ti,
Temperature vs. log P(O2) diagram

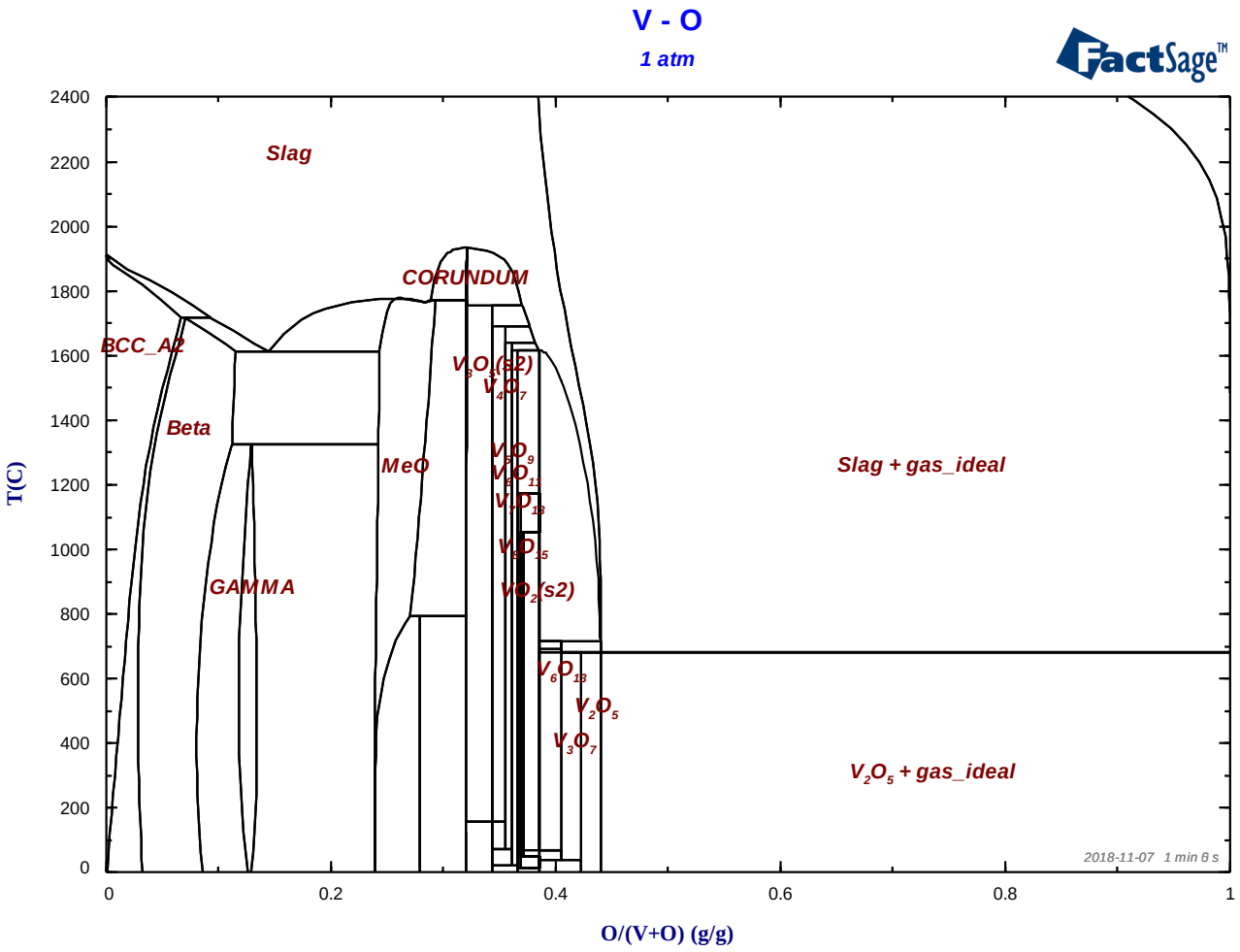


O-V,
Mole fraction

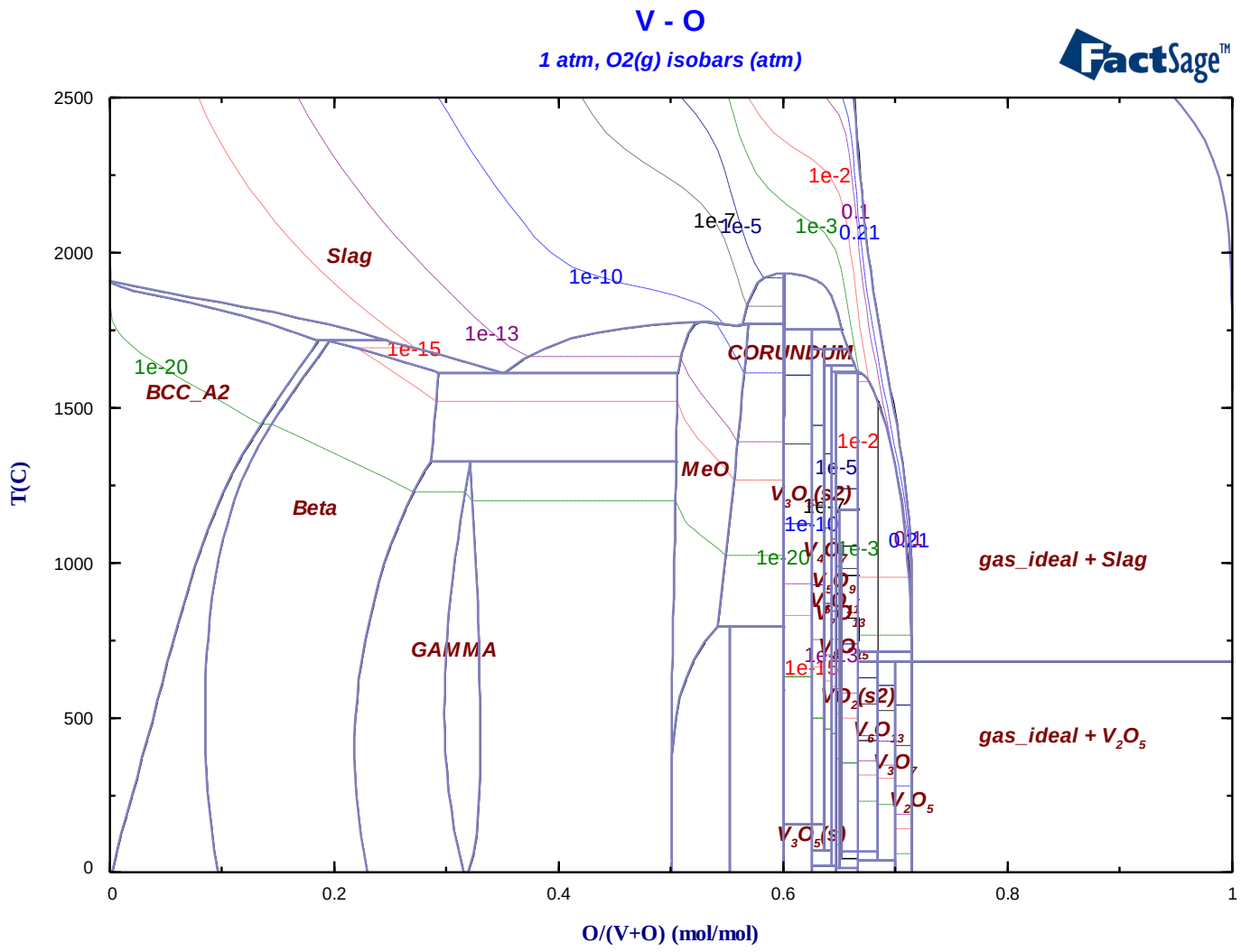


Phase	Description	Used data
Slag	(V, V_2O_2, V_2O_3, V_2O_4, V_2O_5)	Present work
Bcc-A2	(V, O, VO_3)(Va)$_3$	Present work
Beta	(V)(O, Va)	[Yang15]
Gamma	(V)(O, Va)$_{0.5}$	[Yang15]
MeO	(V^{+2}, V^{+3},V)(O^{-2})	Present work
Corundum	(V^{+4},V^{+3}, Va)$_2$(O^{-2})$_3$	Present work
VO, VO_2, V_2O_3, V_2O_5, V_3O_5,	stoichiometric	[Yang15]
V_3O_7, V_4O_7, V_5O_9, V_6O_{11},	stoichiometric	[Yang15]
V_6O_{13},V_7O_{13},V_8O_{15}, $V_{52}O_{64}$	stoichiometric	[Yang15]
	stoichiometric	[Yang15]

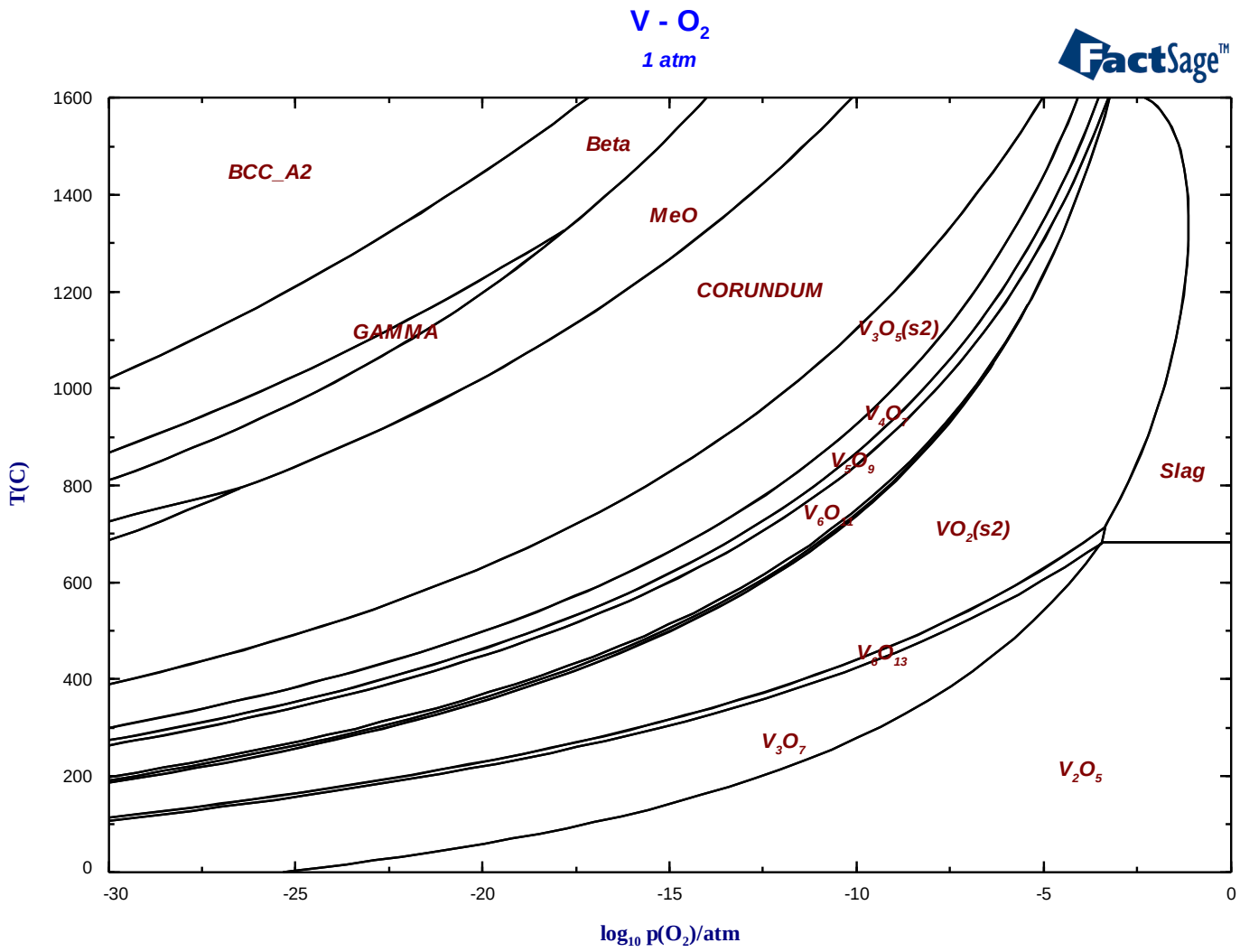
O-V,
Weight percent



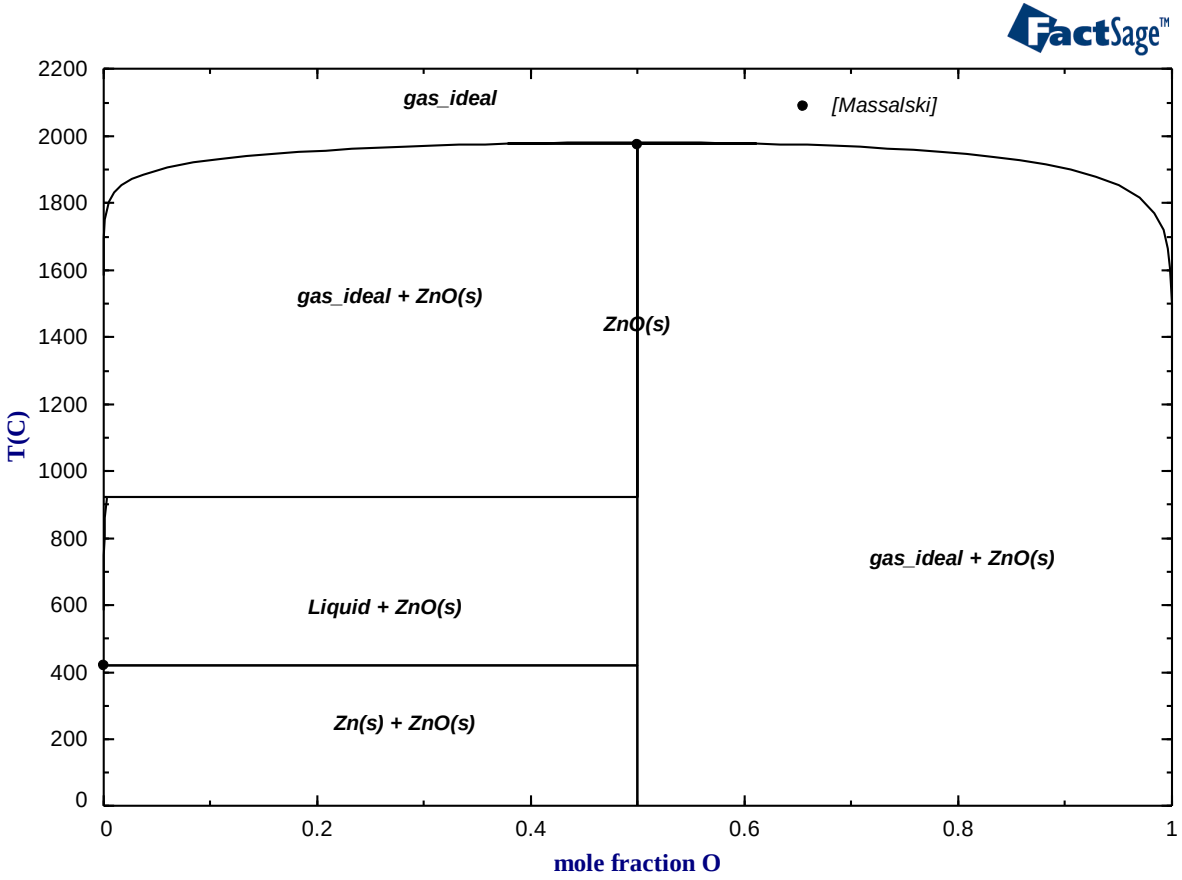
O-V,
Mole fraction with isobars



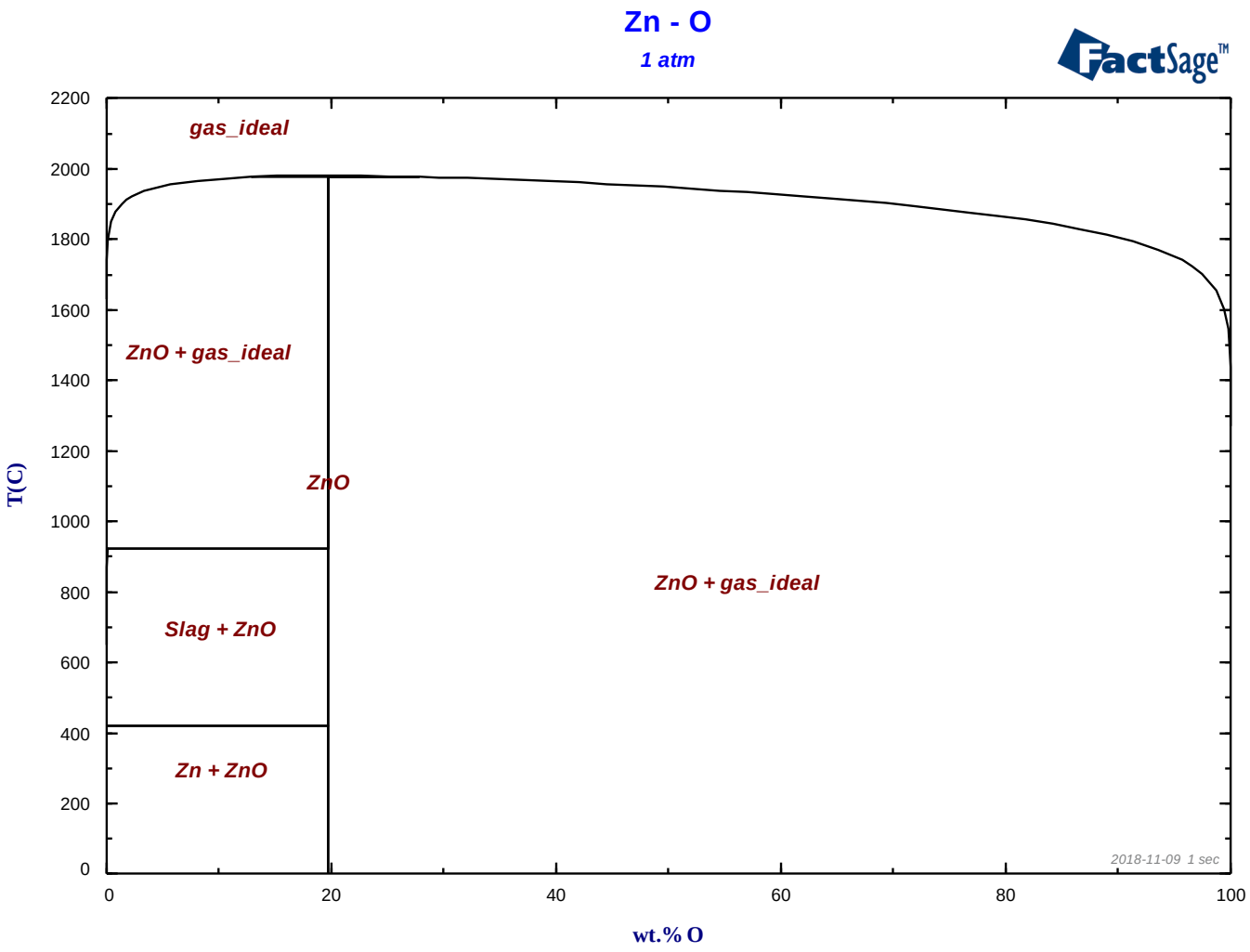
O2-V,
Temperature vs. log P(O2) diagram



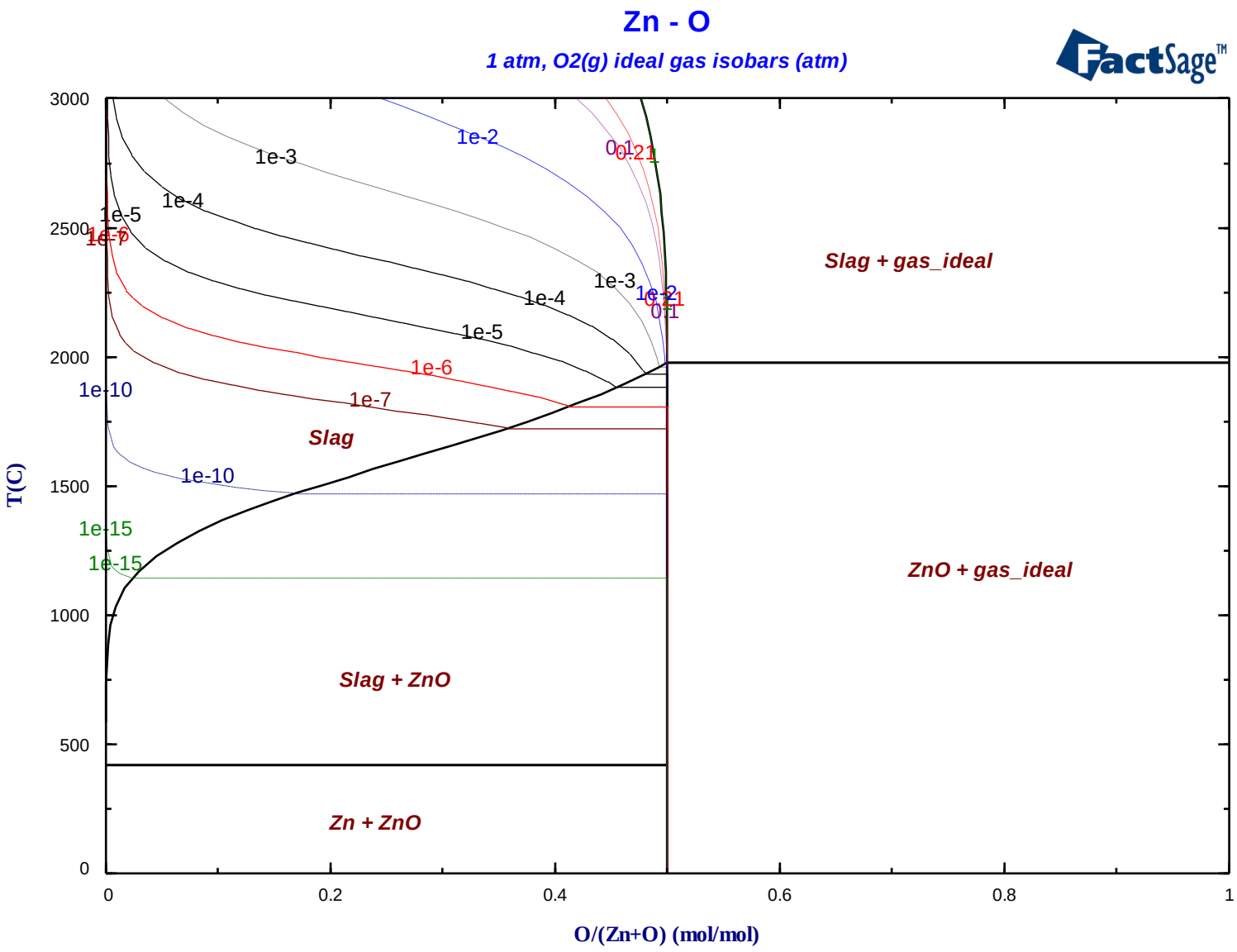
O-Zn,
Mole fraction



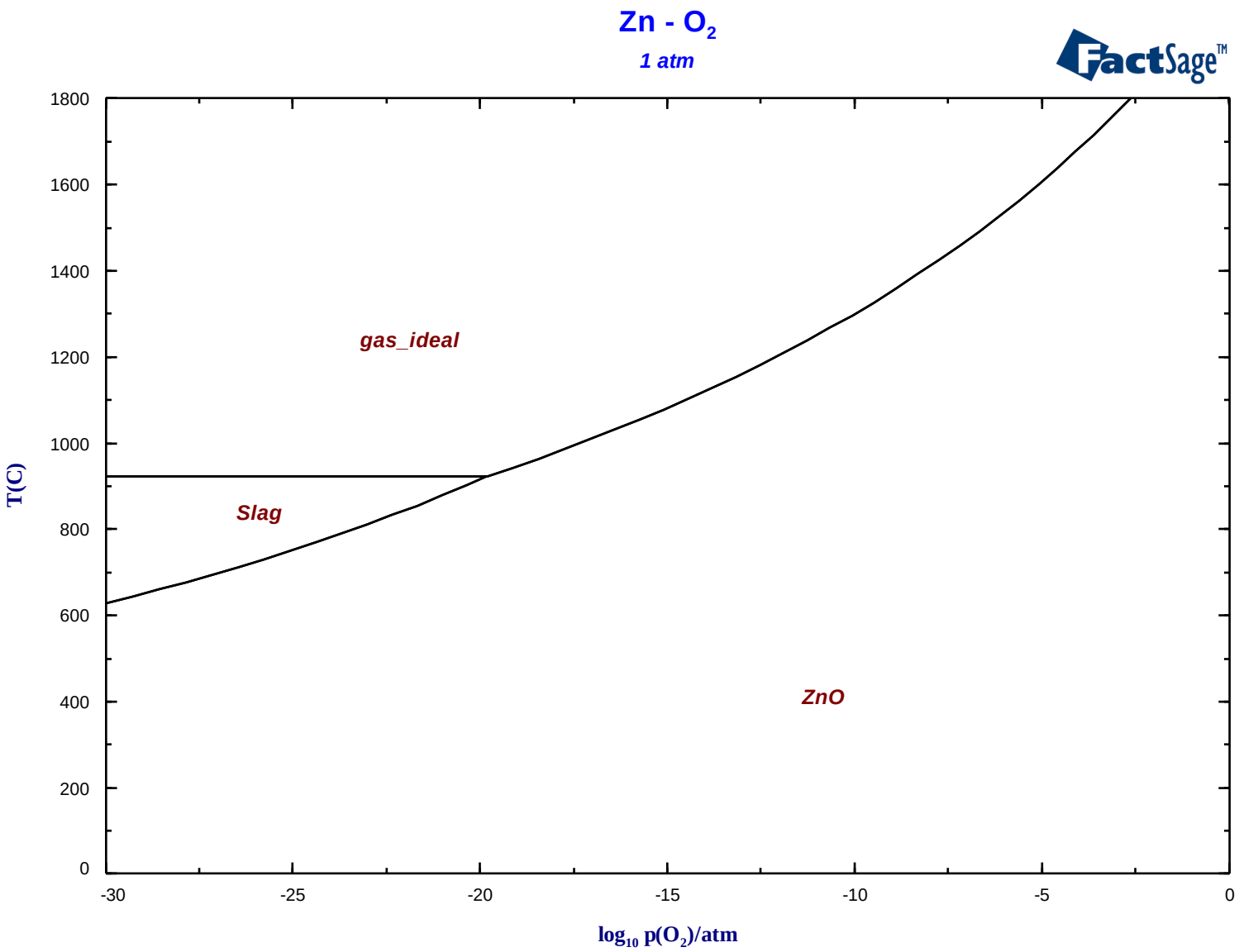
O-Zn,
Weight percent



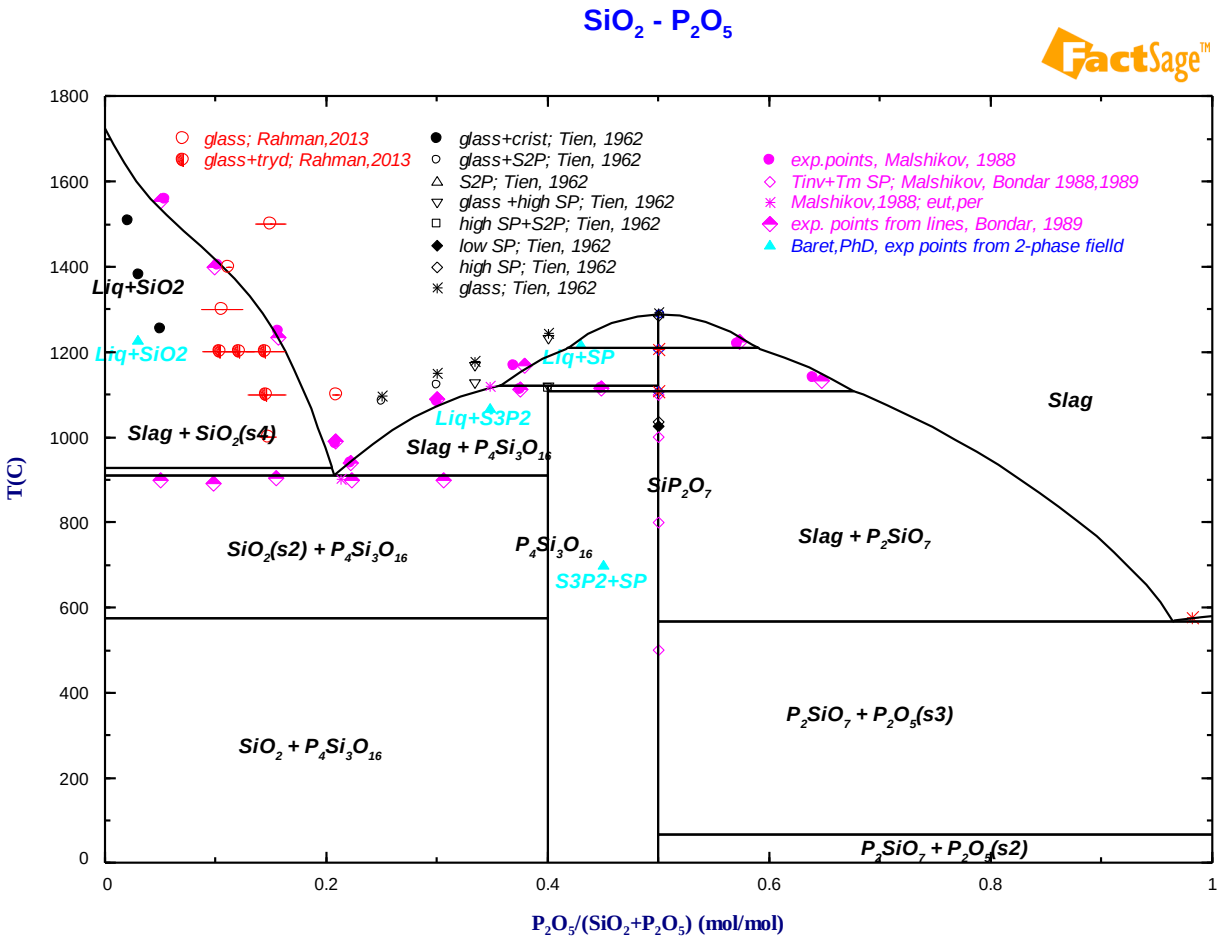
O-Zn,
Mole fraction with isobars



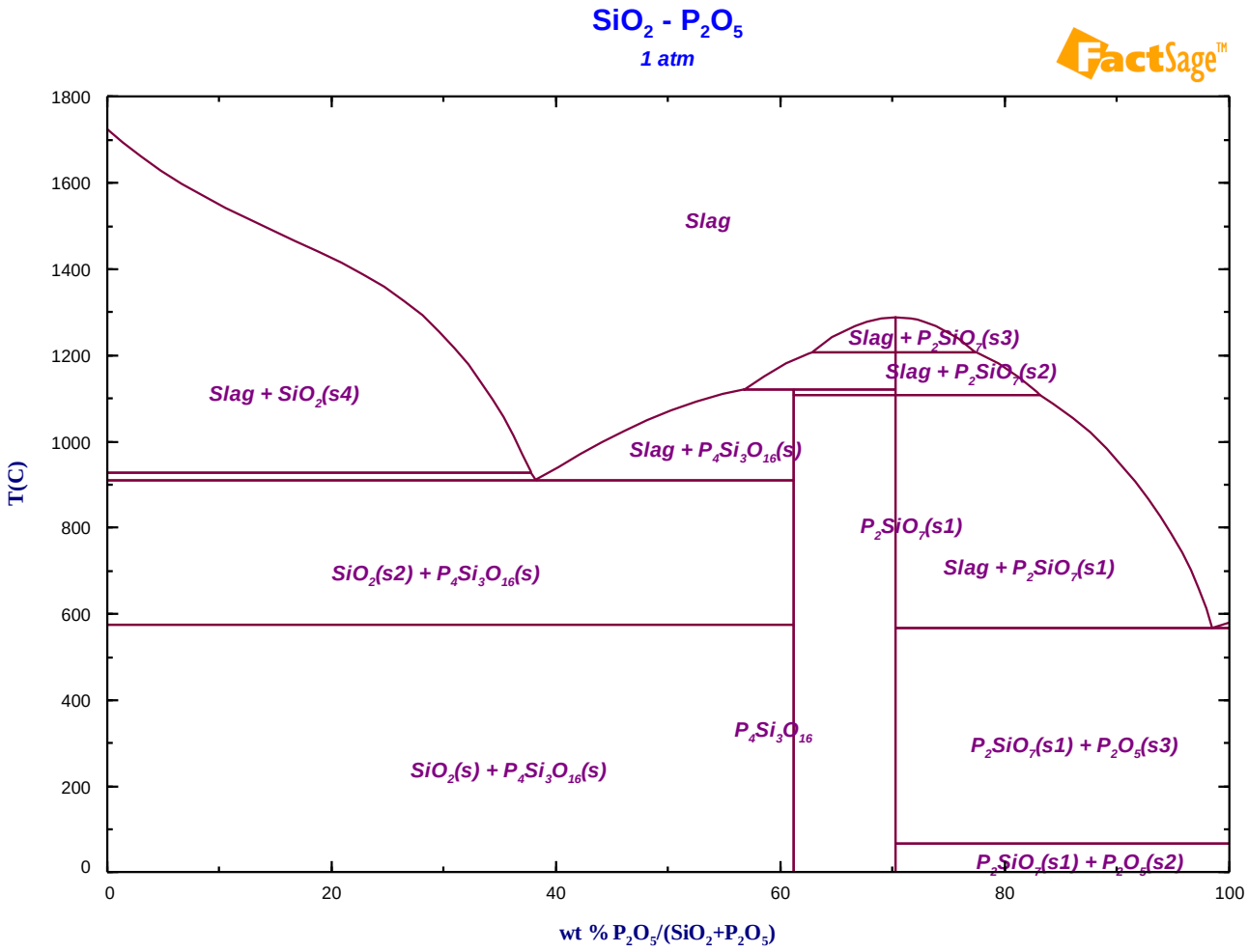
O2-Zn,
Temperature vs. log P(O2) diagram



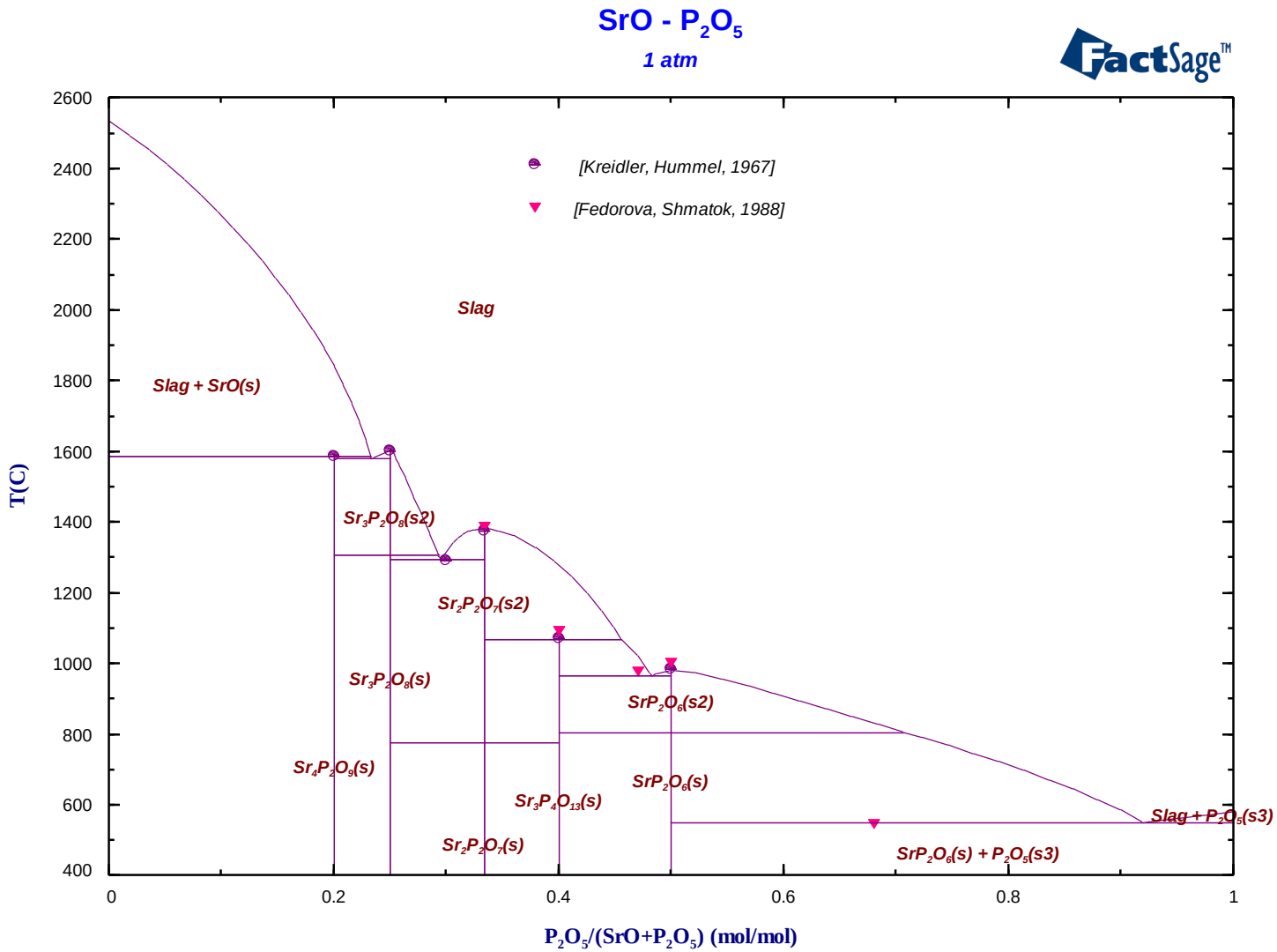
Mole fraction
compared with experimental data



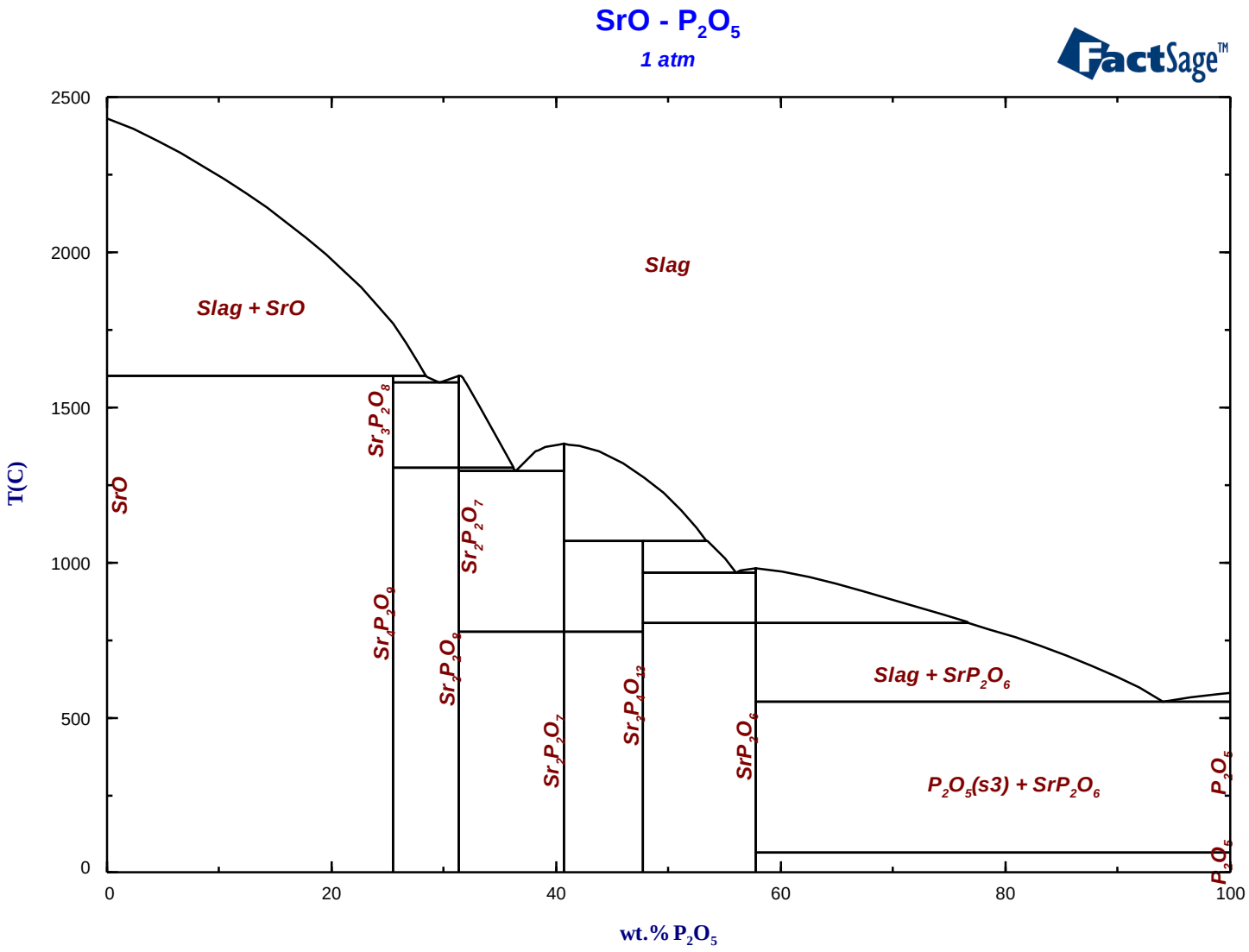
Weight percent



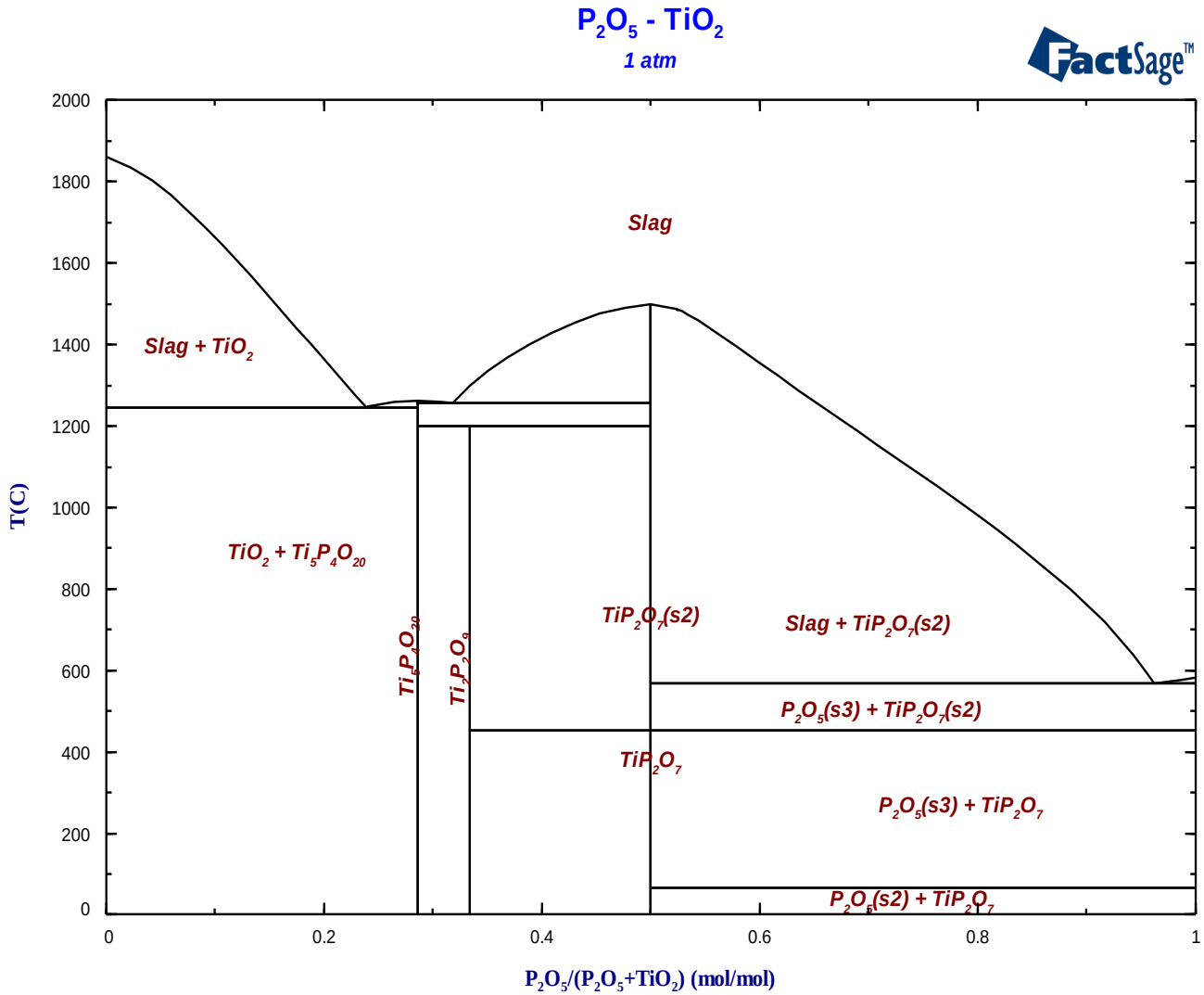
Mole fraction
compared with experimental data



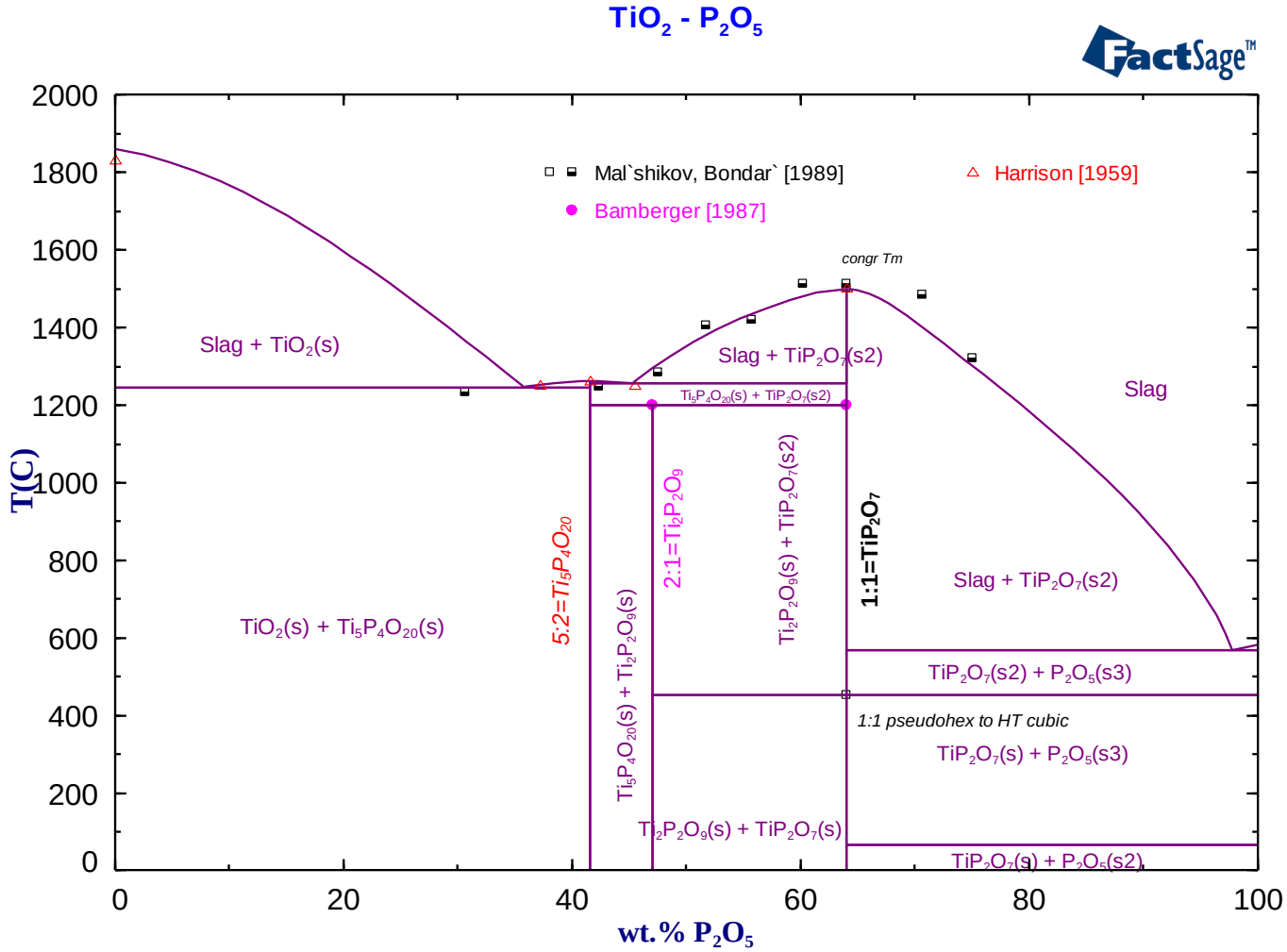
Weight percent



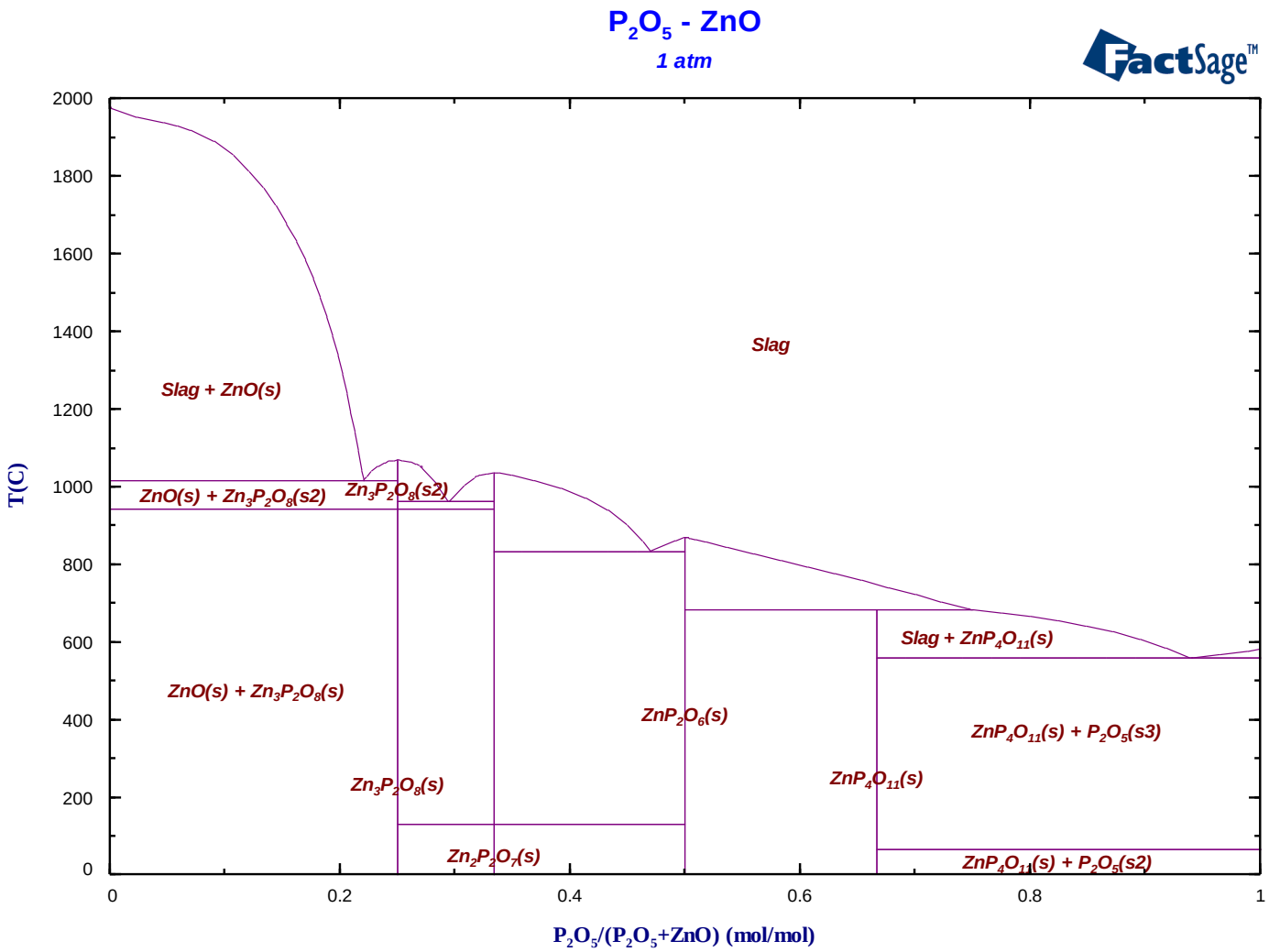
Mole fraction



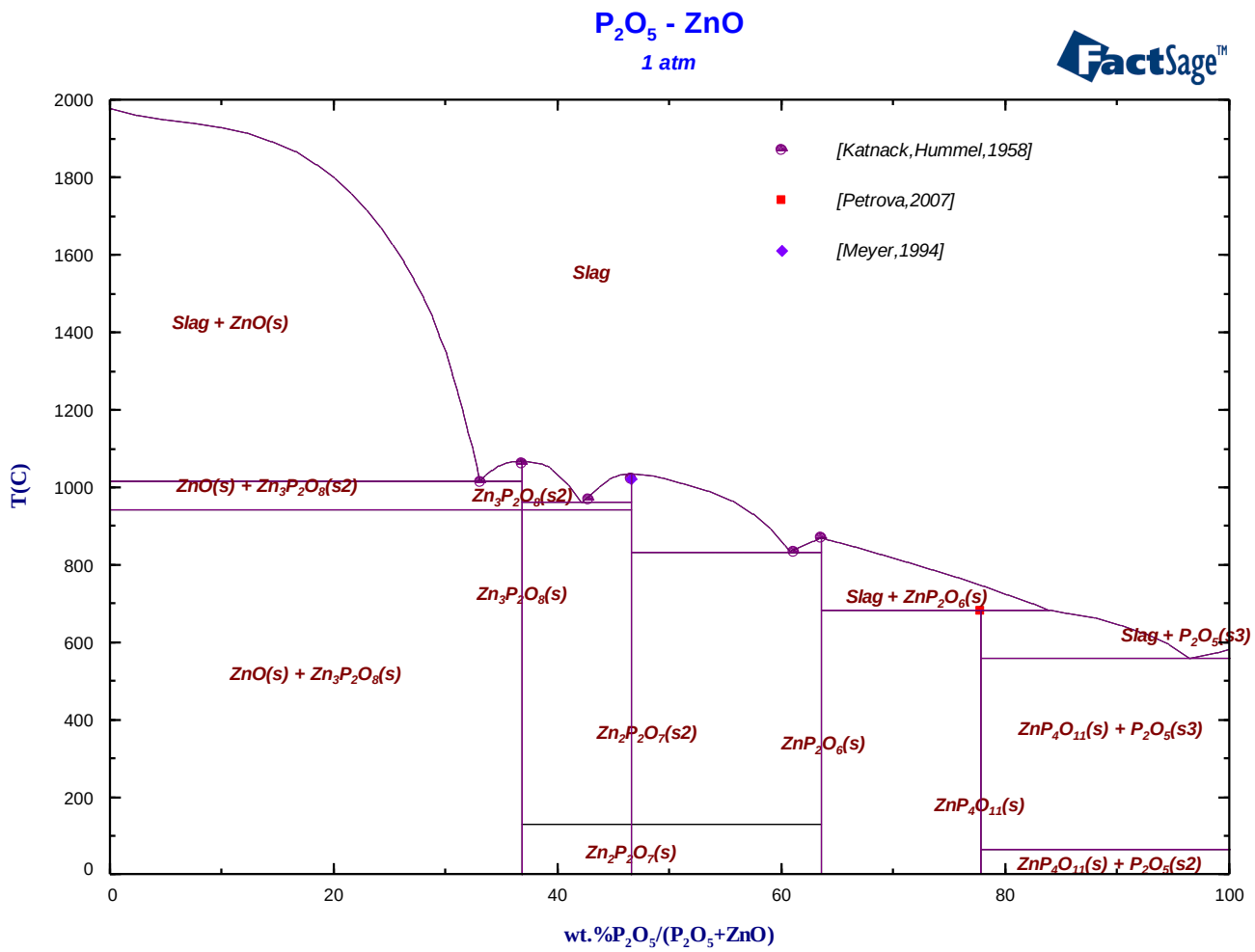
Weight percent
compared with experimental data



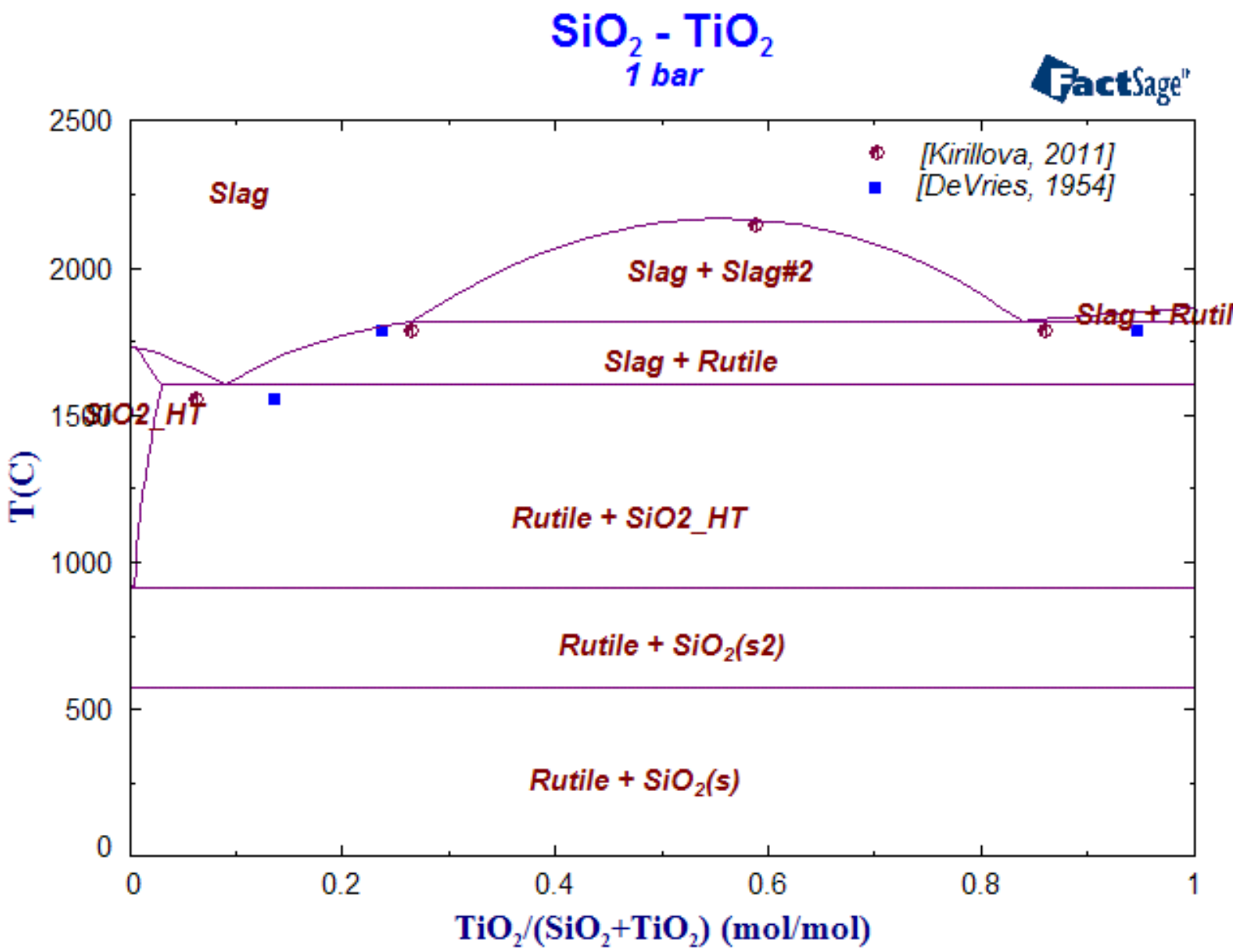
Mole fraction



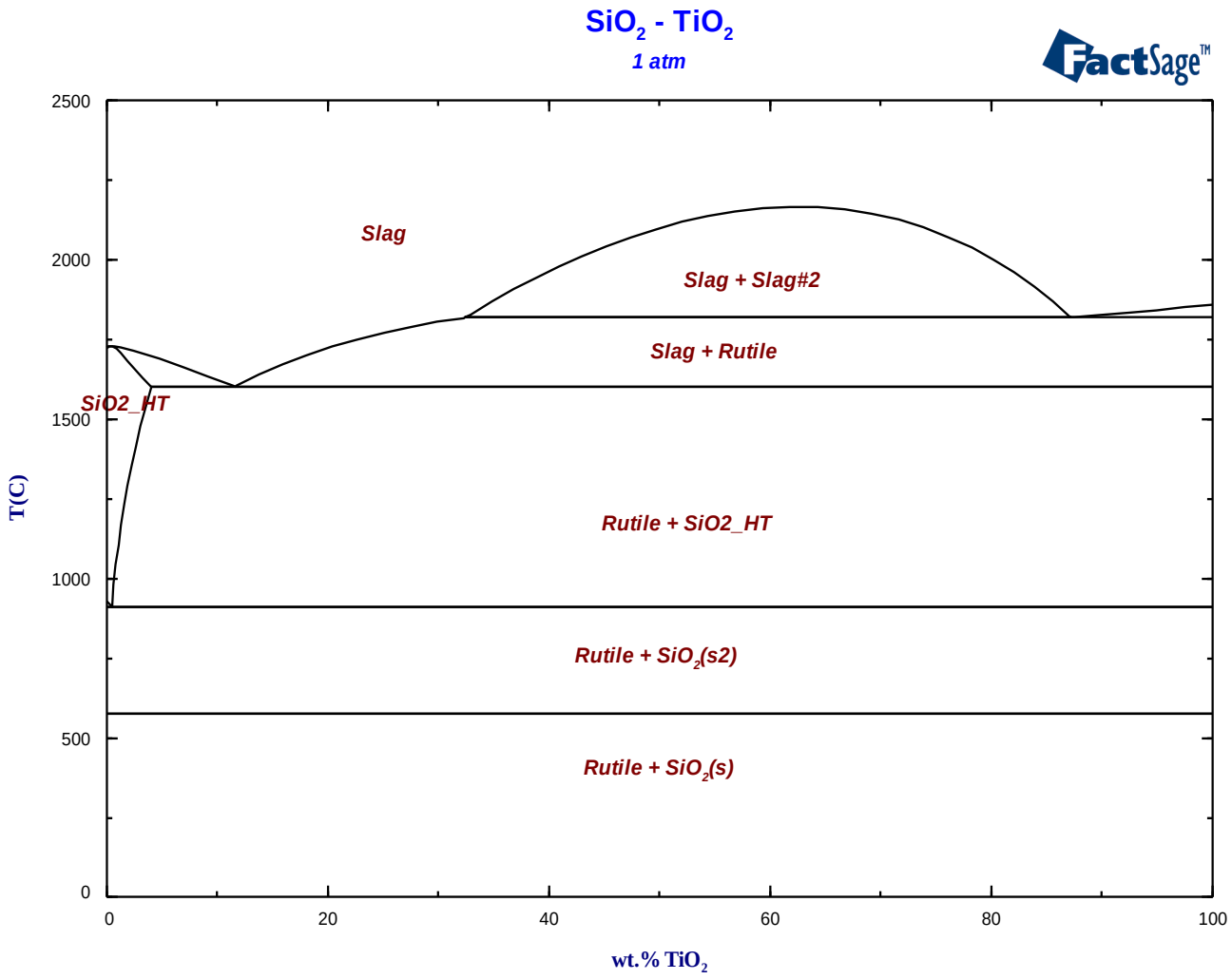
Weight percent
compared with experimental data



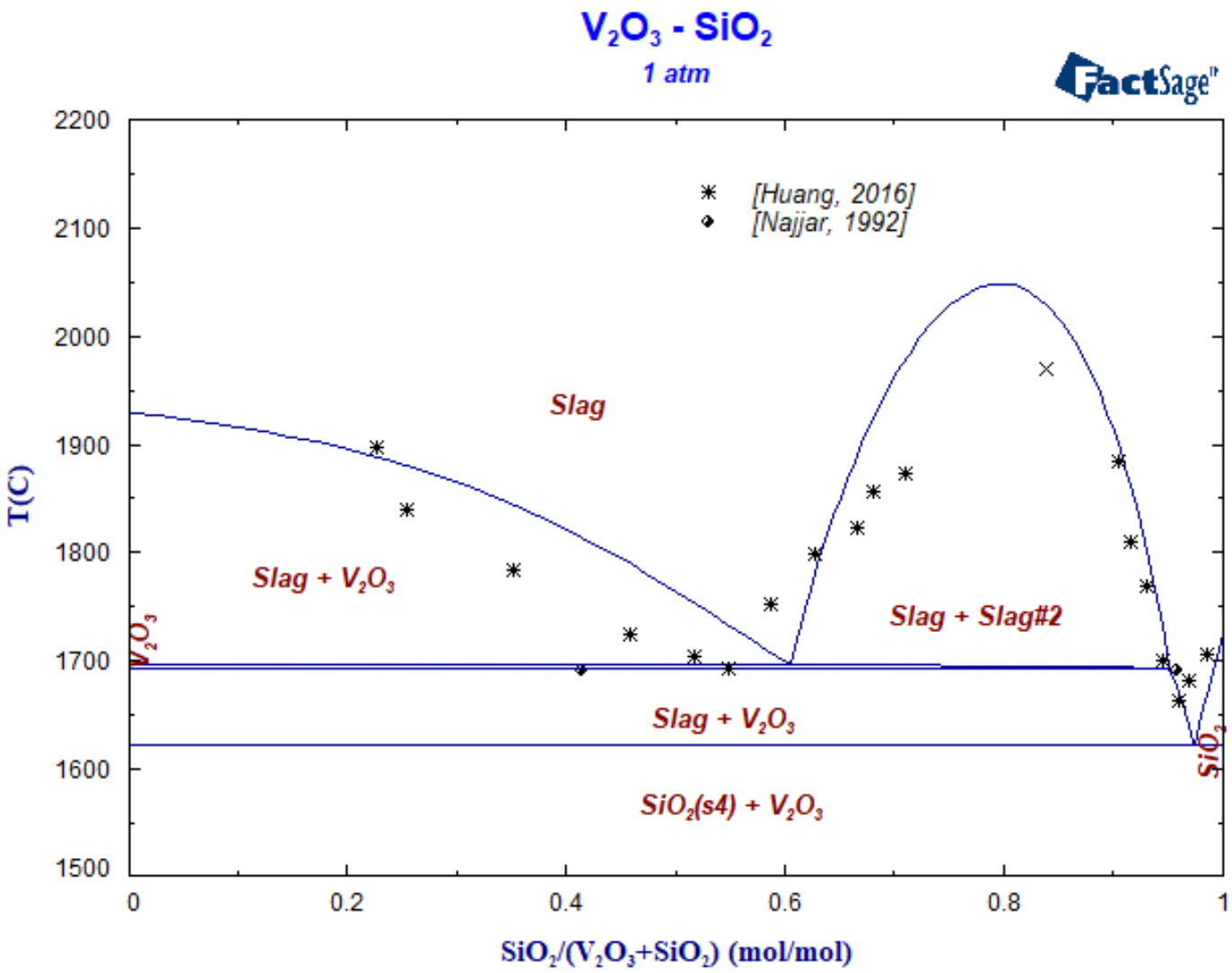
Mole fraction compared with experimental data



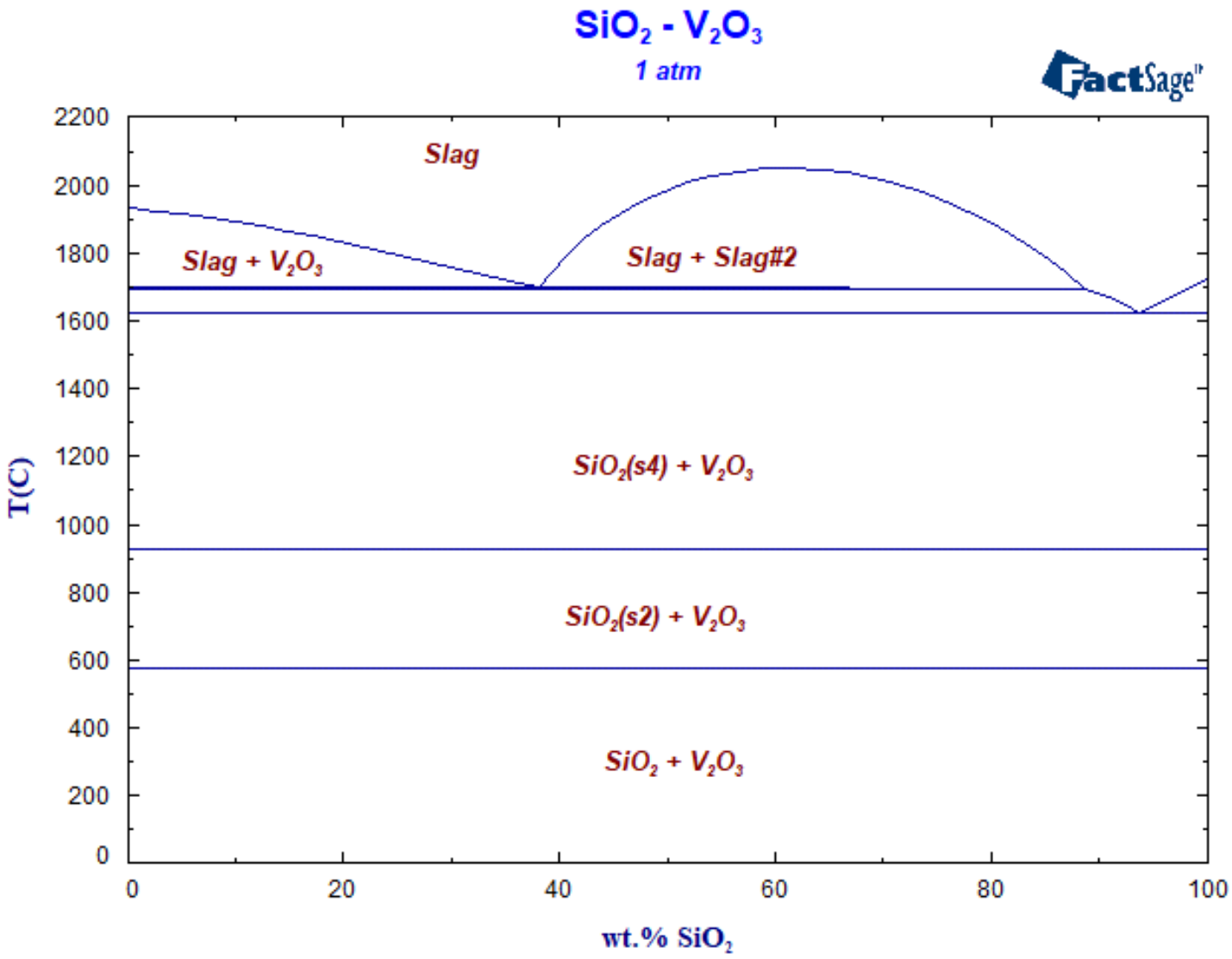
Weight percent



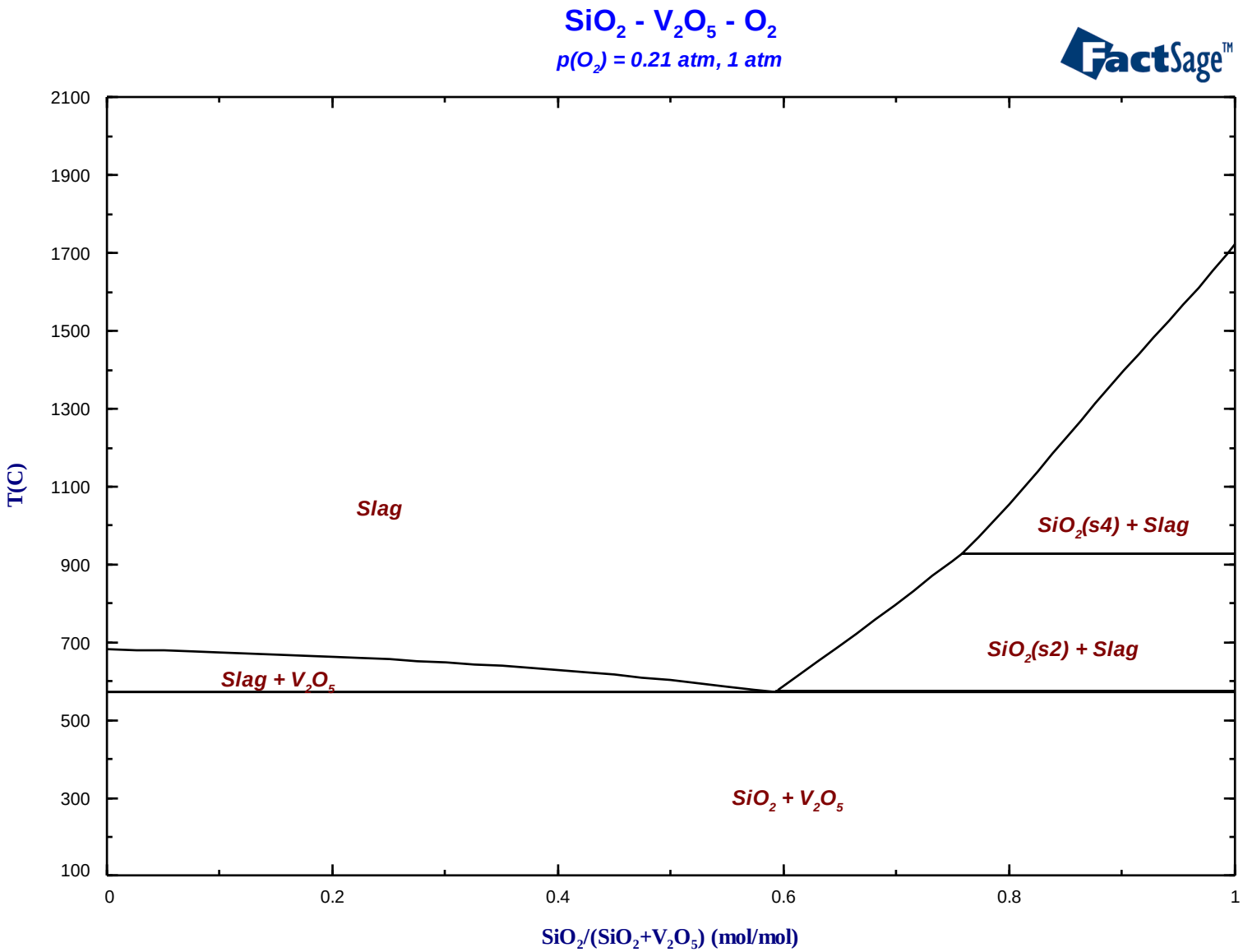
SiO2-V2O3,
Mole fraction compared with experimental data



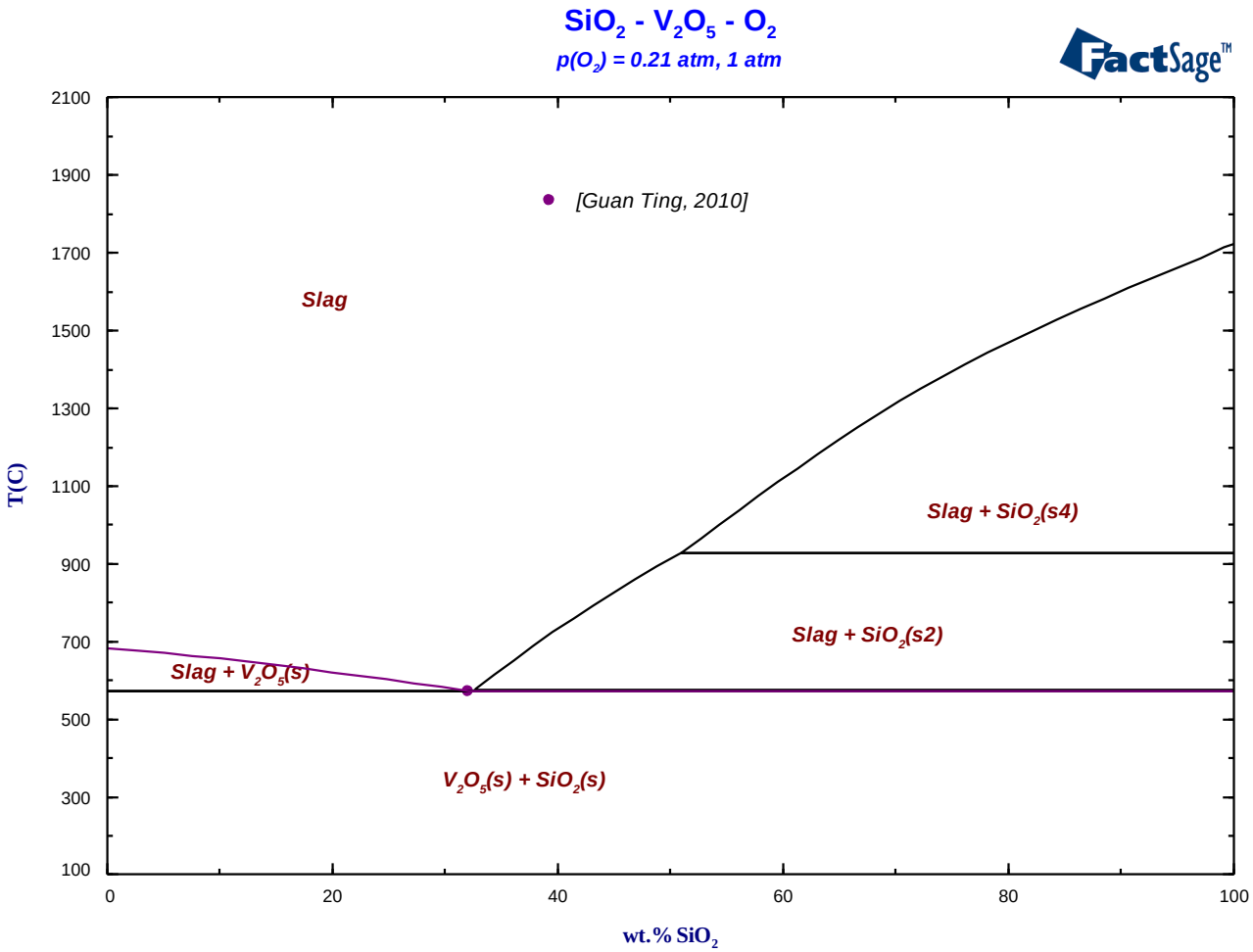
SiO2-V2O3,
Weight percent



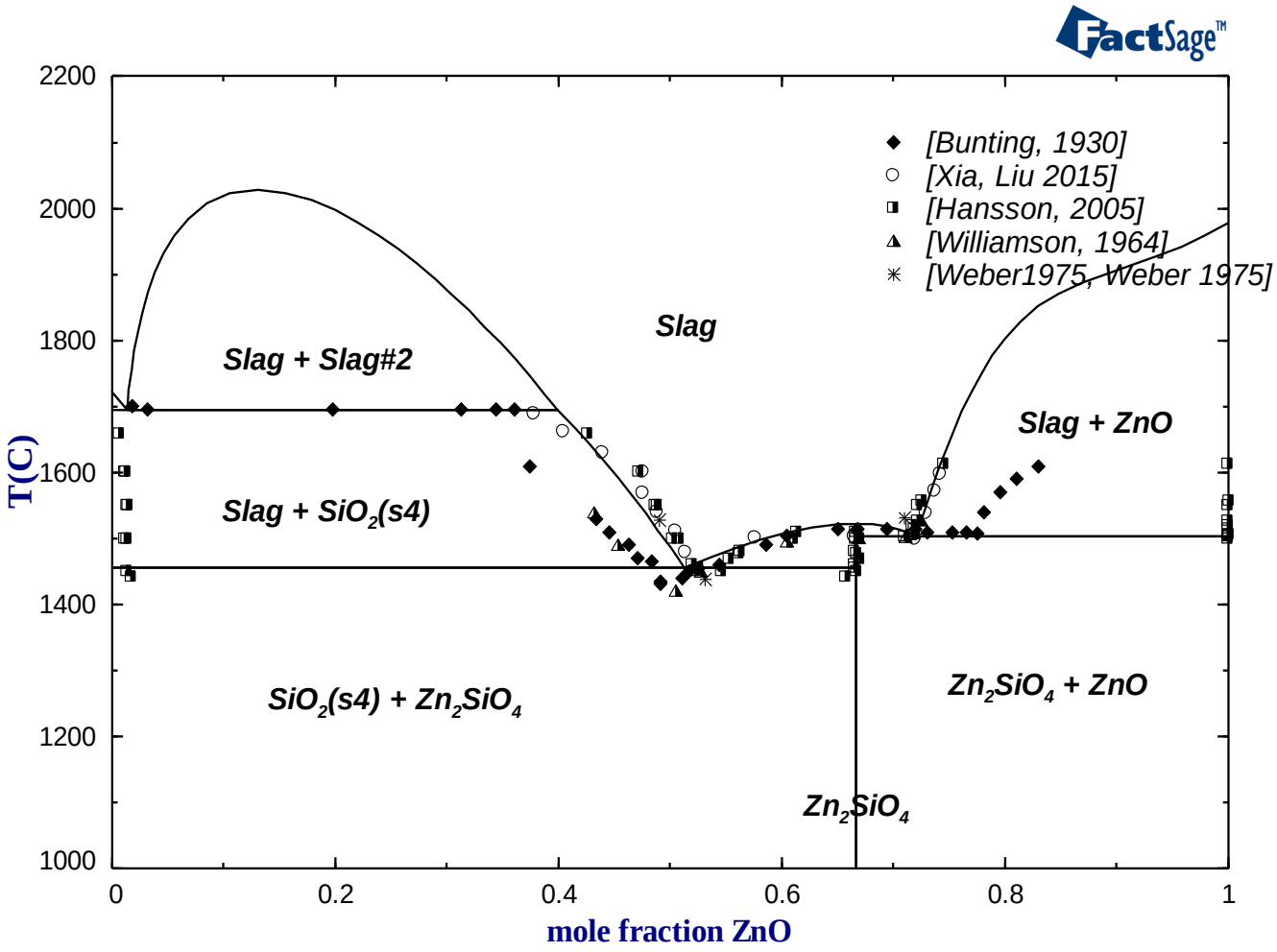
SiO2-V2O5-O2,
Mole fraction



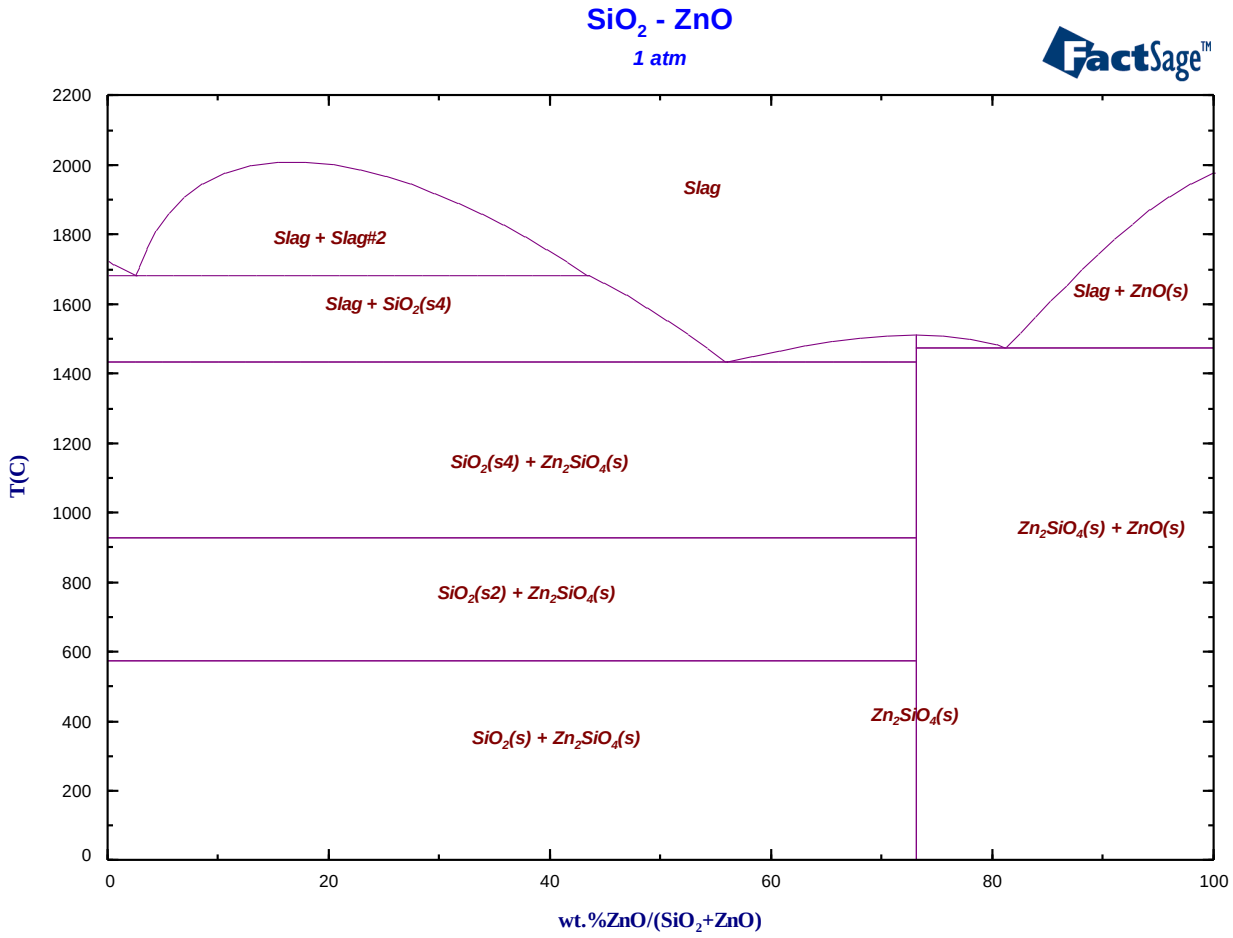
SiO2-V2O5-O2,
Weight percent compared with experimental data



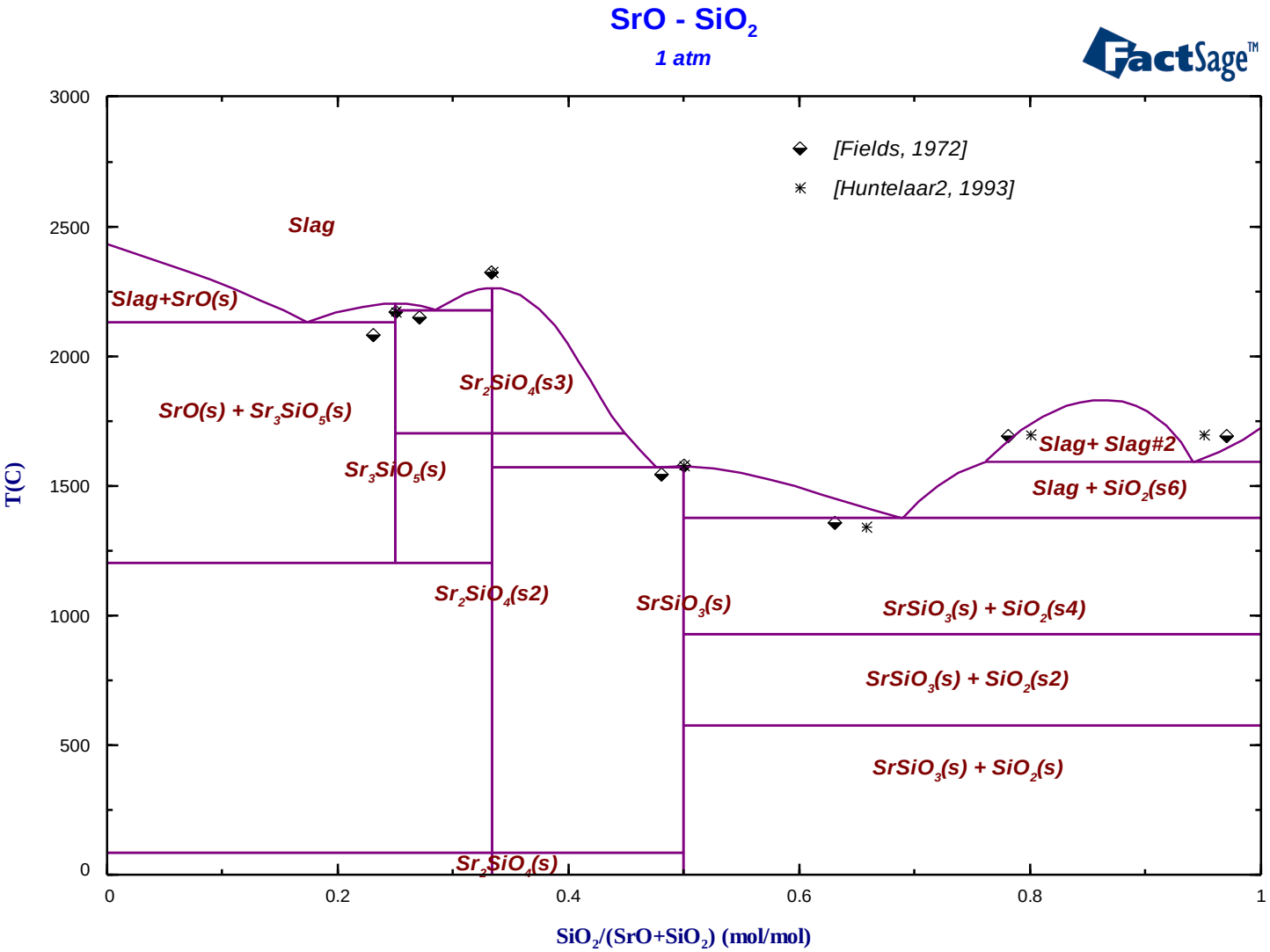
Mole fraction
compared with experimental data



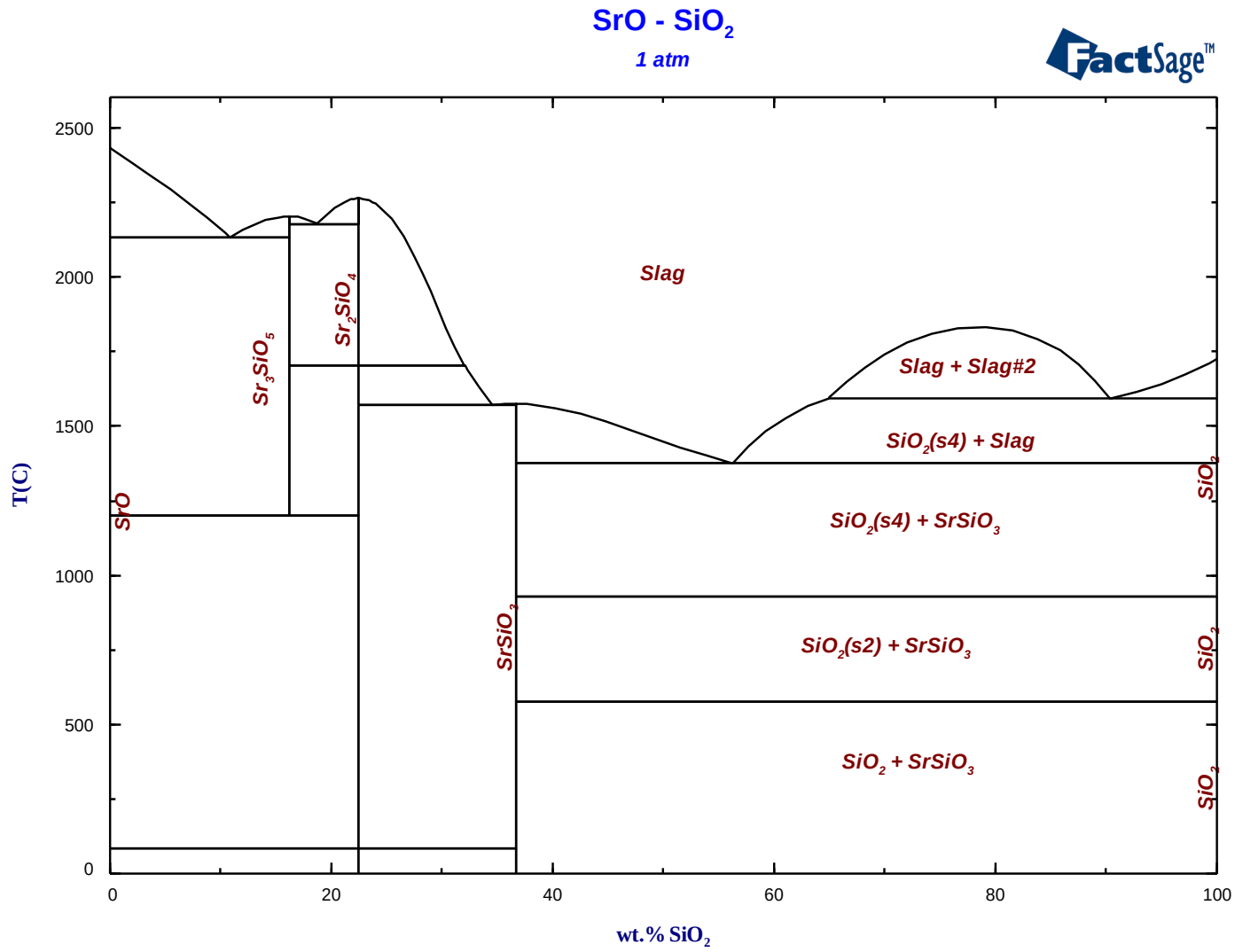
Weight percent



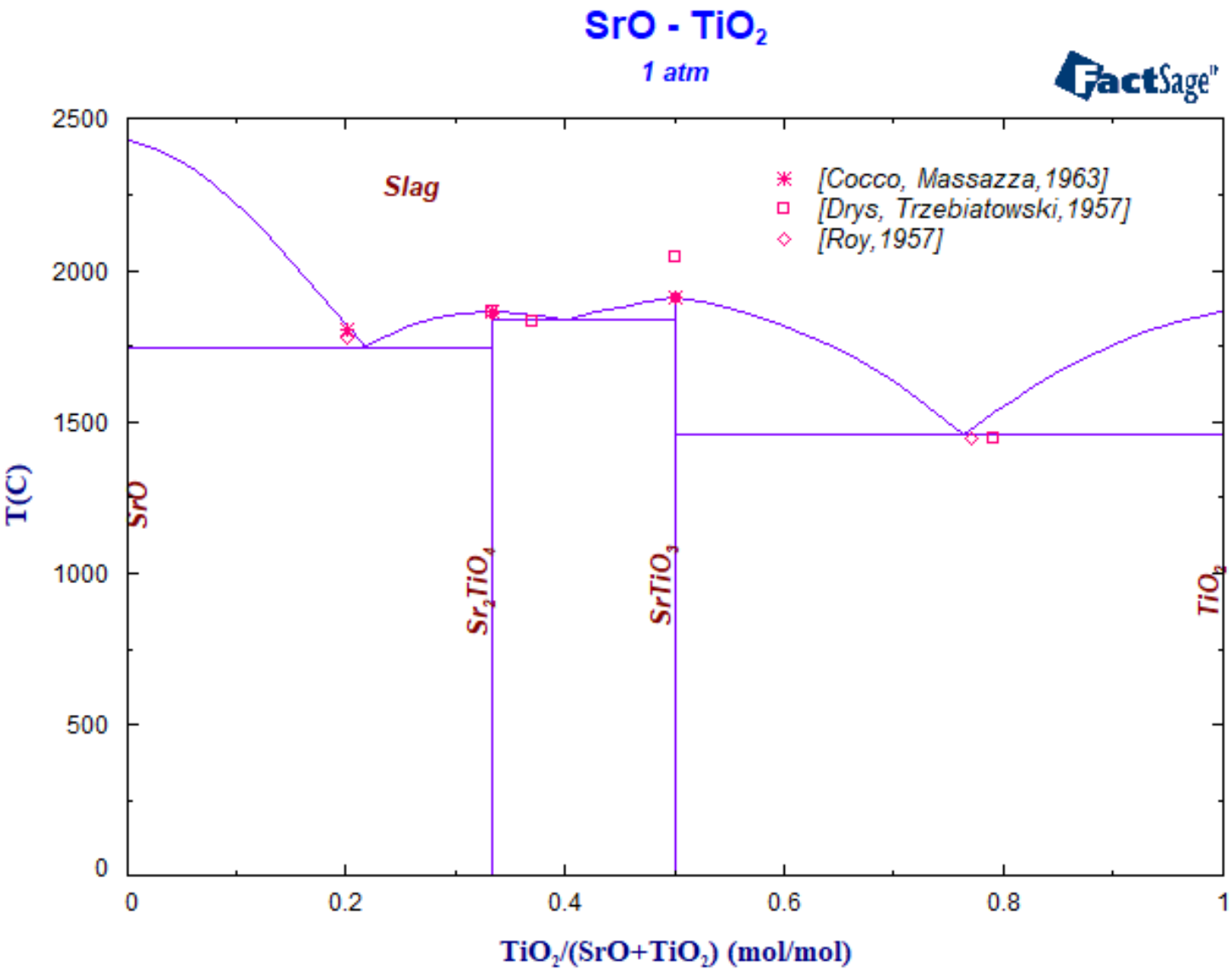
SrO-SiO2,
Mole fraction compared with experimental data



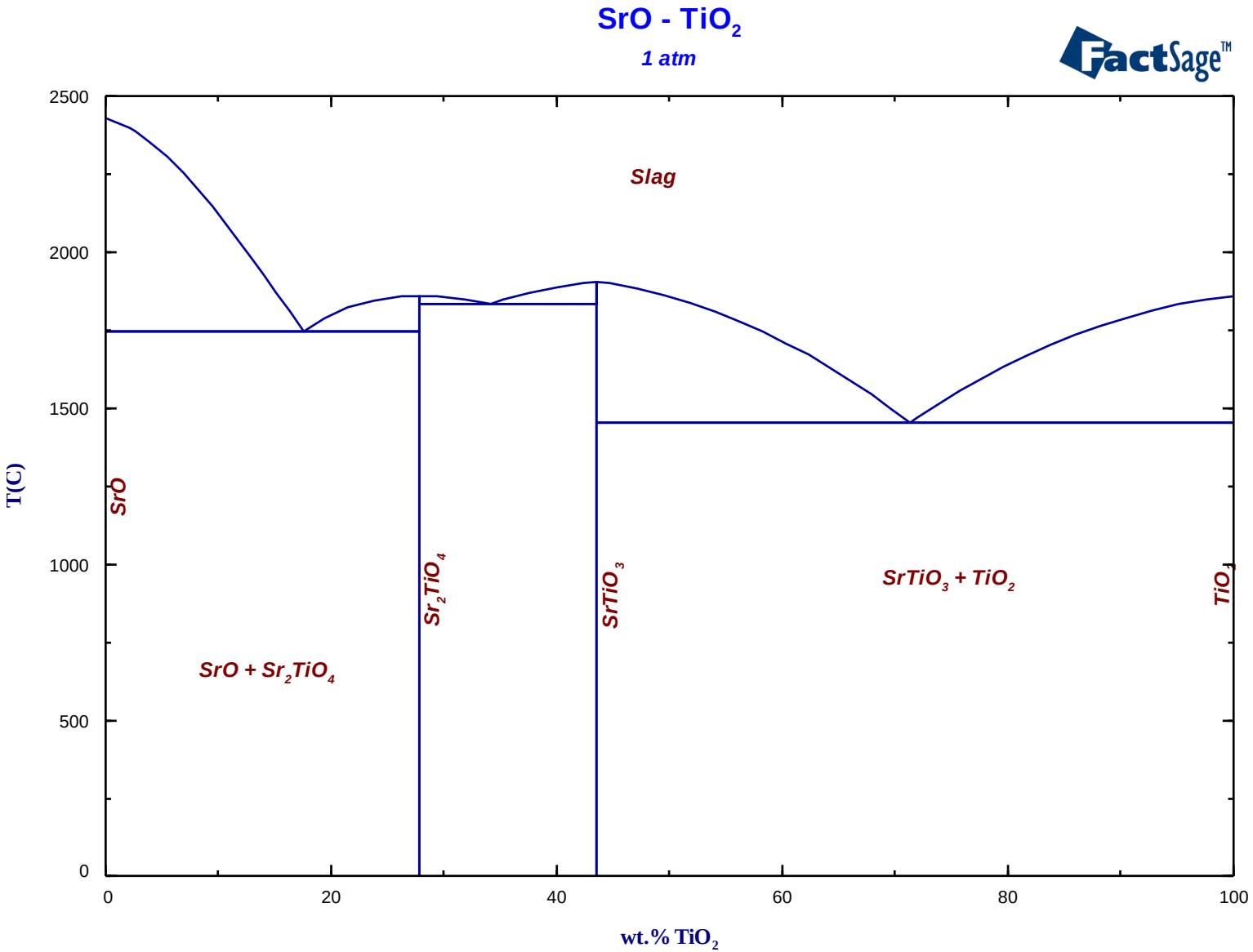
SrO-SiO2,
Weight percent



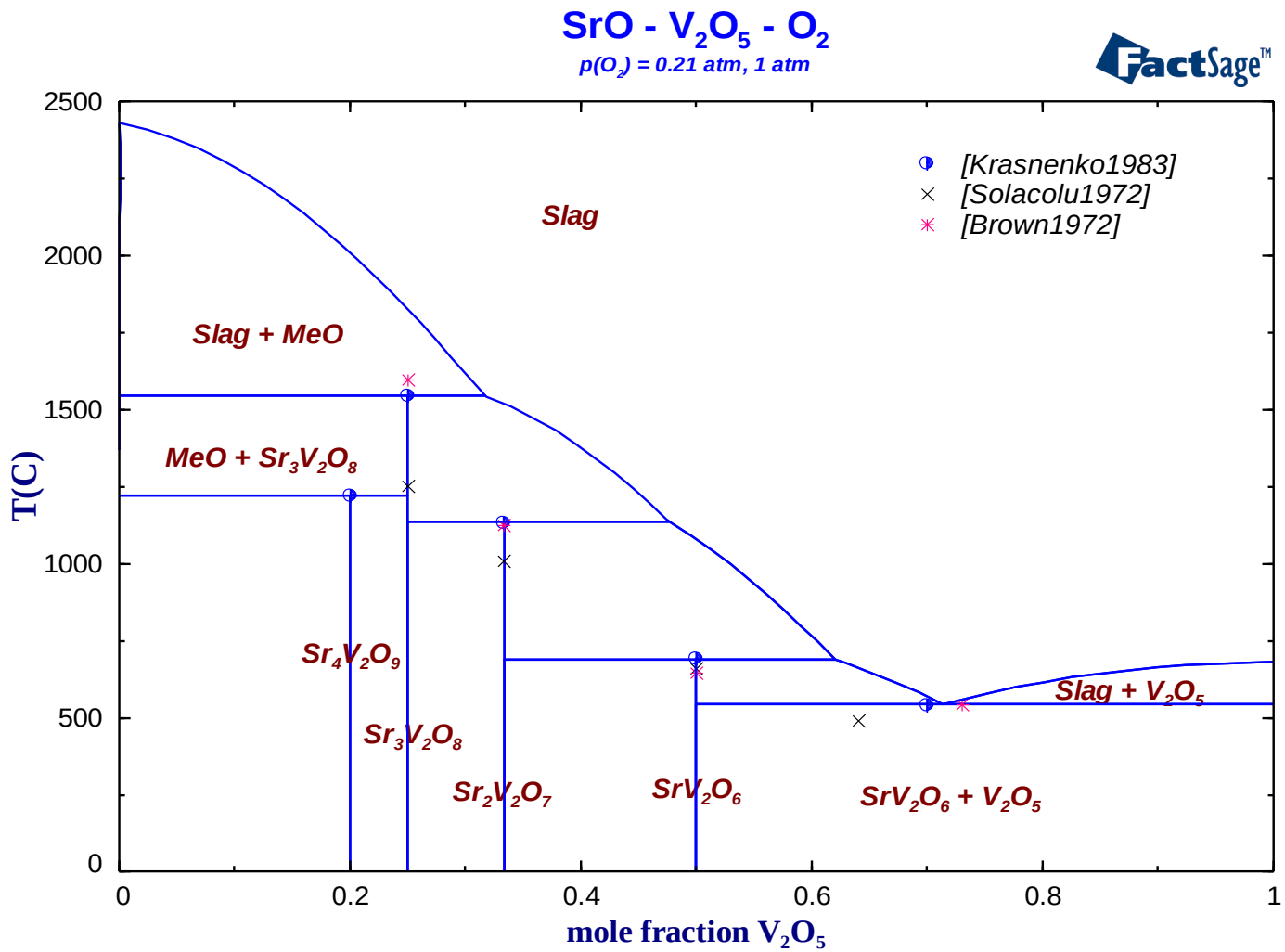
SrO-TiO2,
Mole fraction compared with experimental data



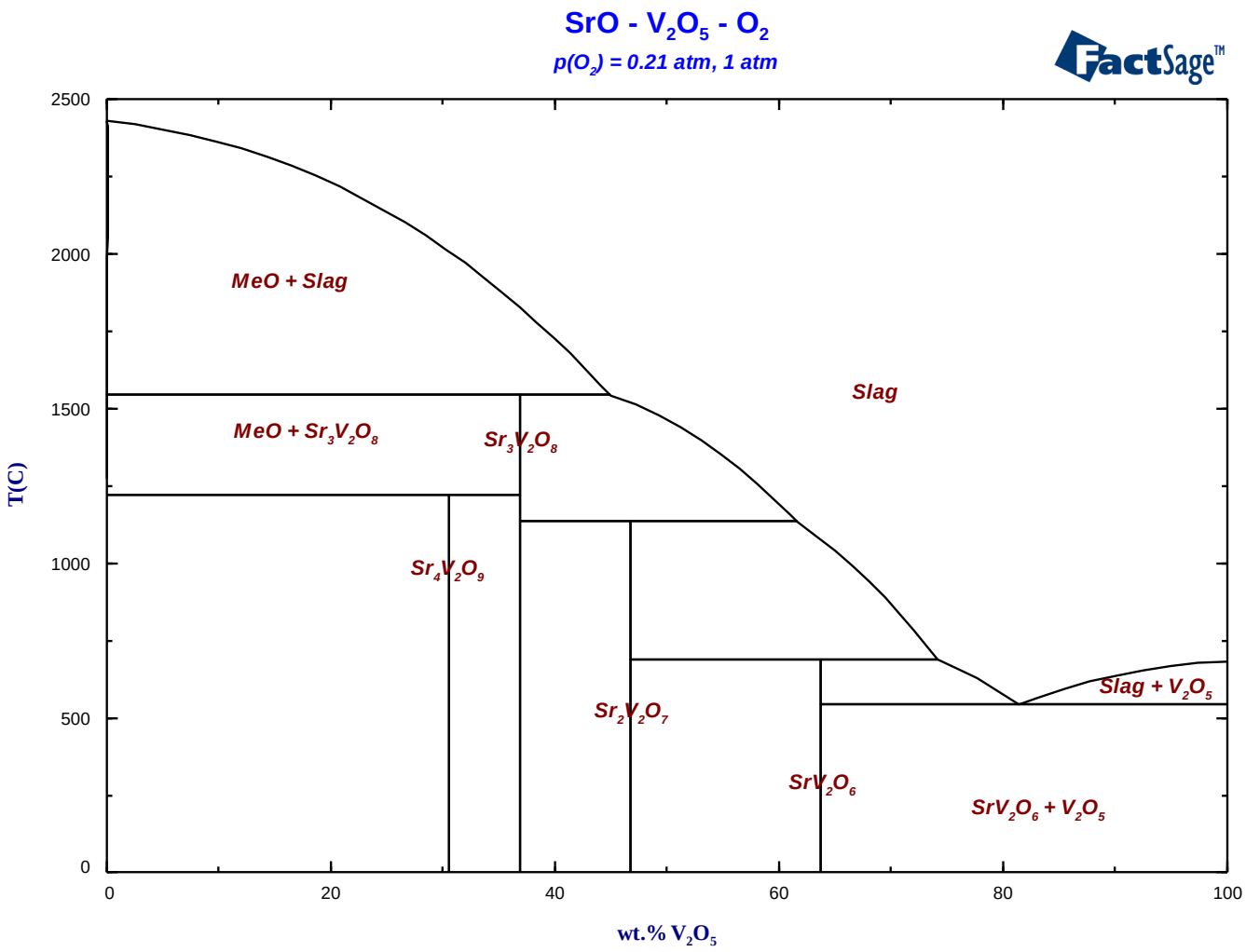
SrO-TiO2,
Weight percent



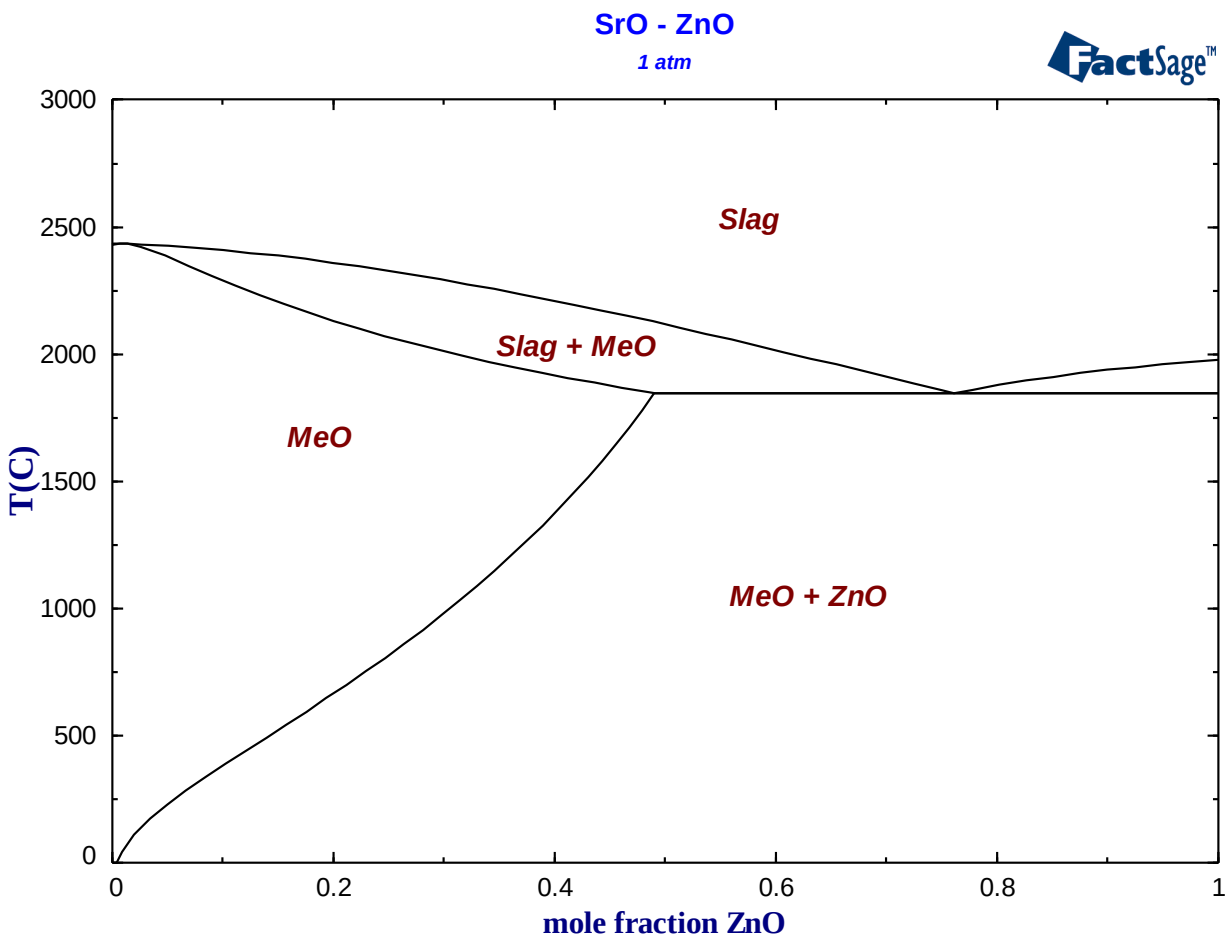
SrO-V2O5-O2,
Mole fraction compared with experimental data



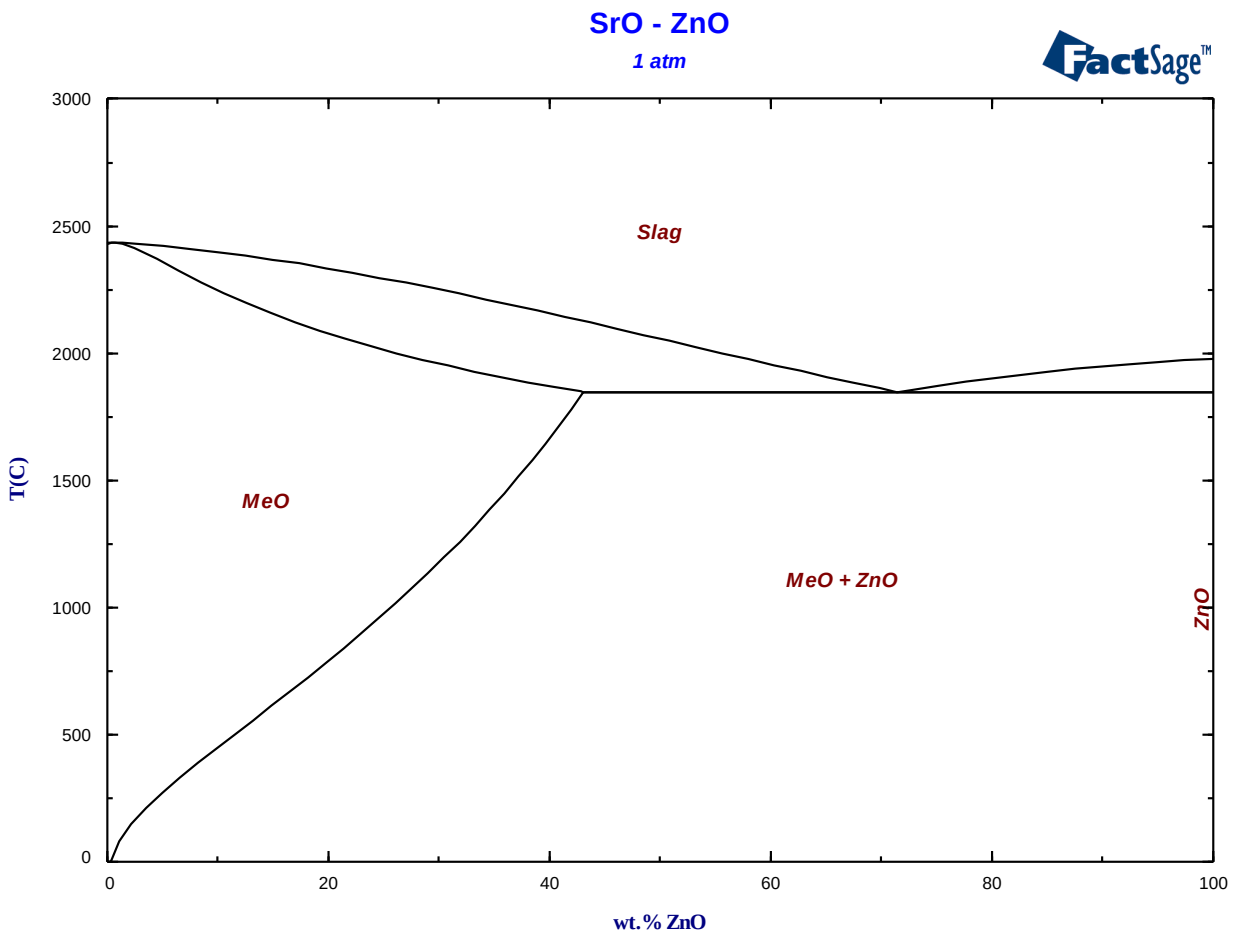
SrO-V2O5-O2,
Weight percent



SrO-ZnO,
Mole fraction

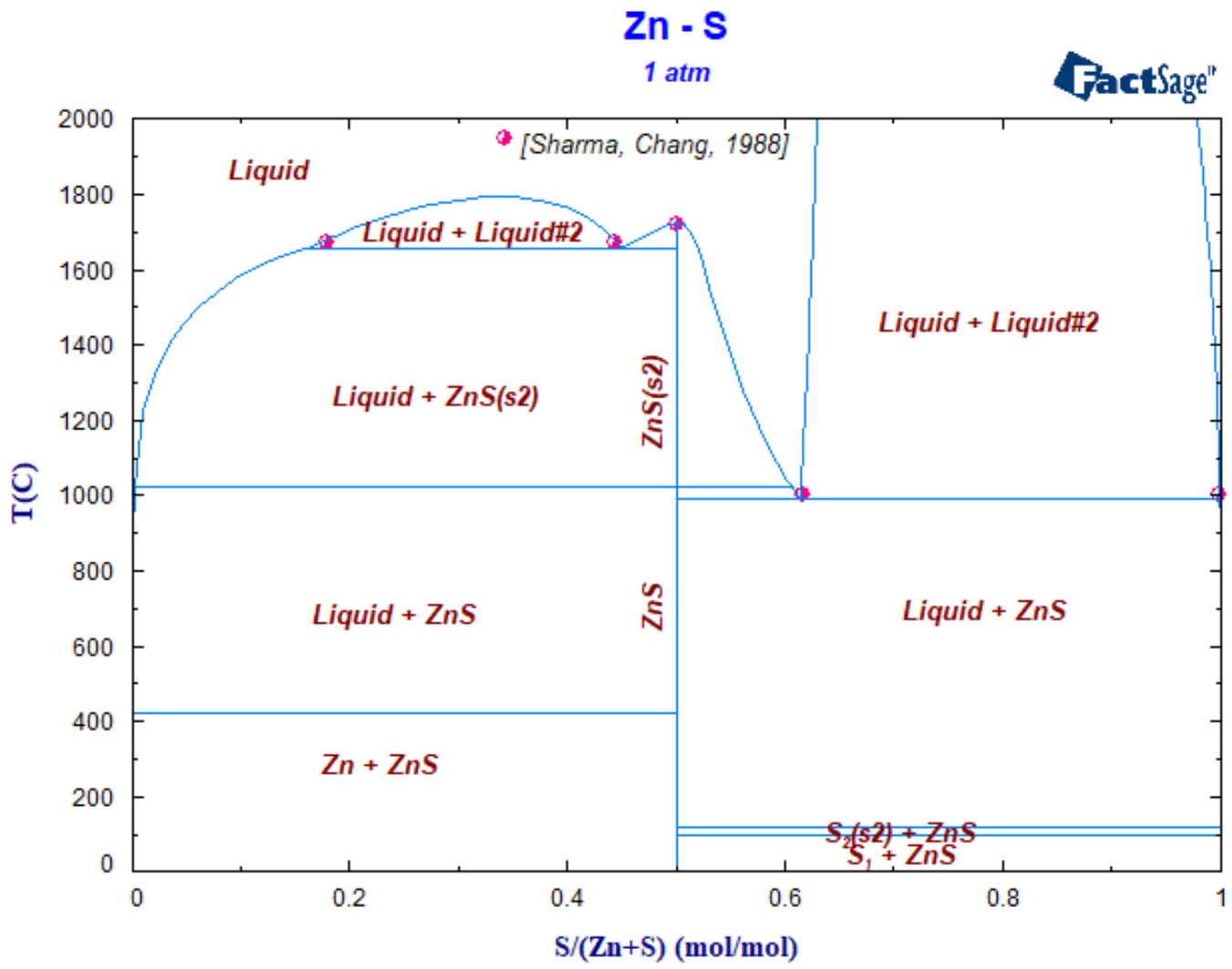


SrO-ZnO,
Weight percent

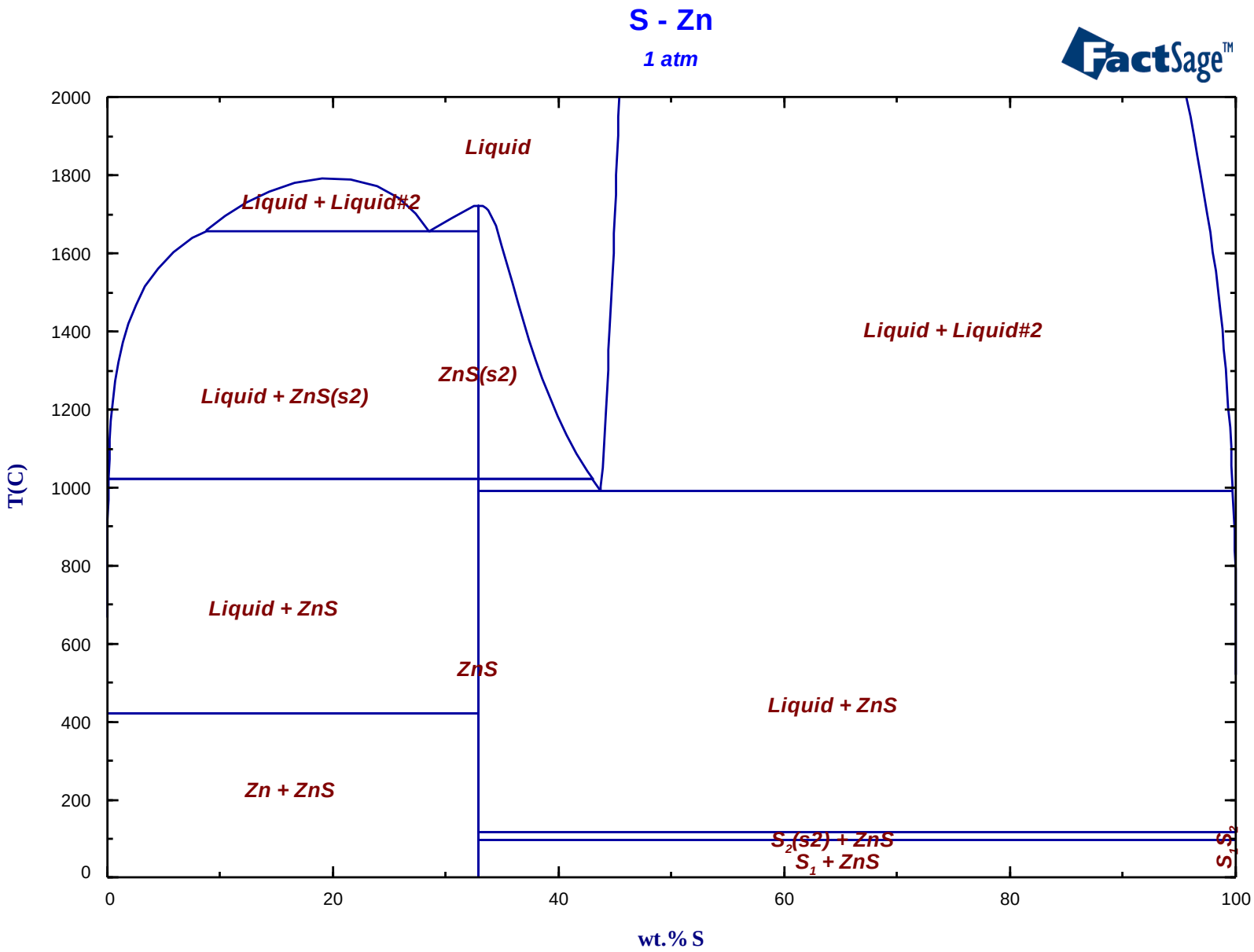


S-Zn,

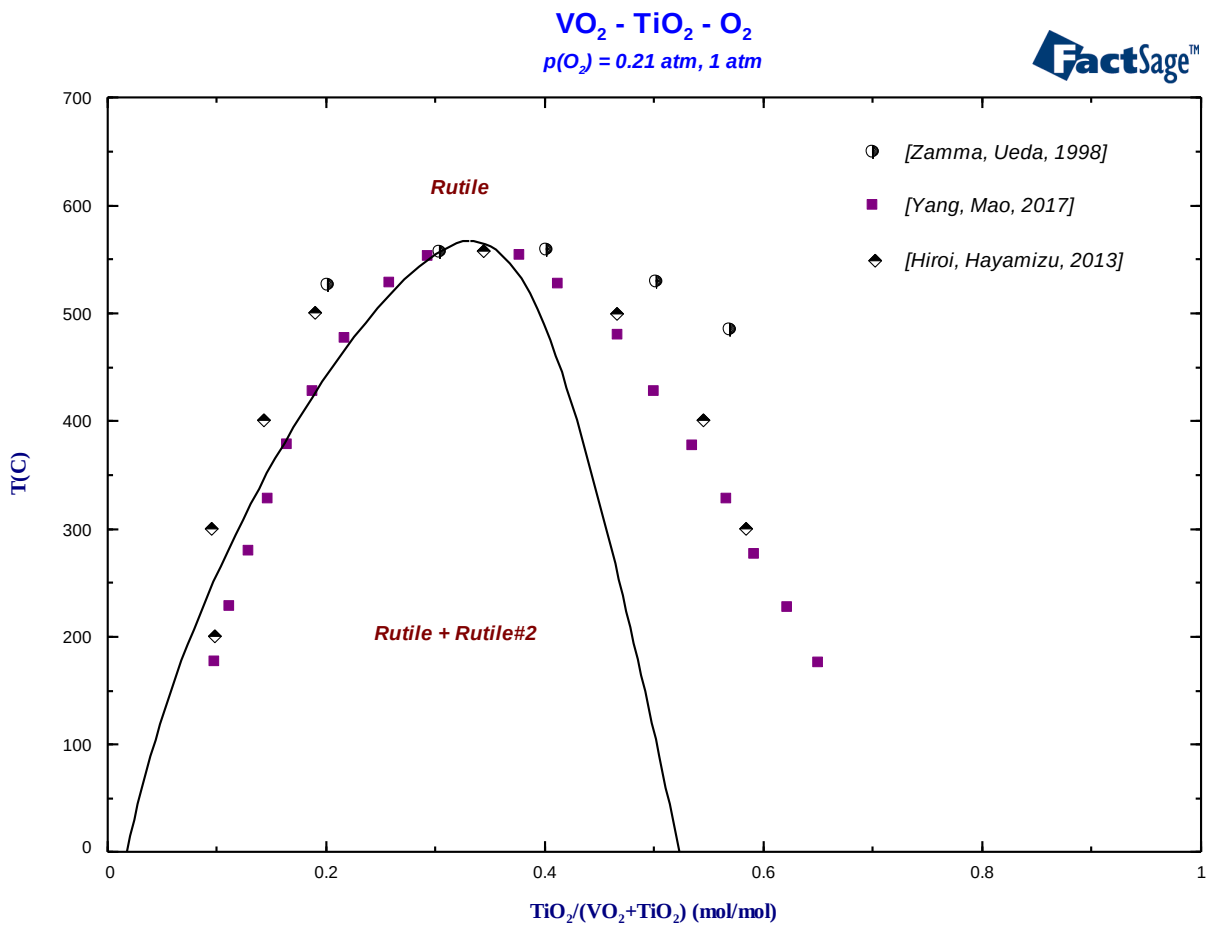
Mole fraction compared with experimental data



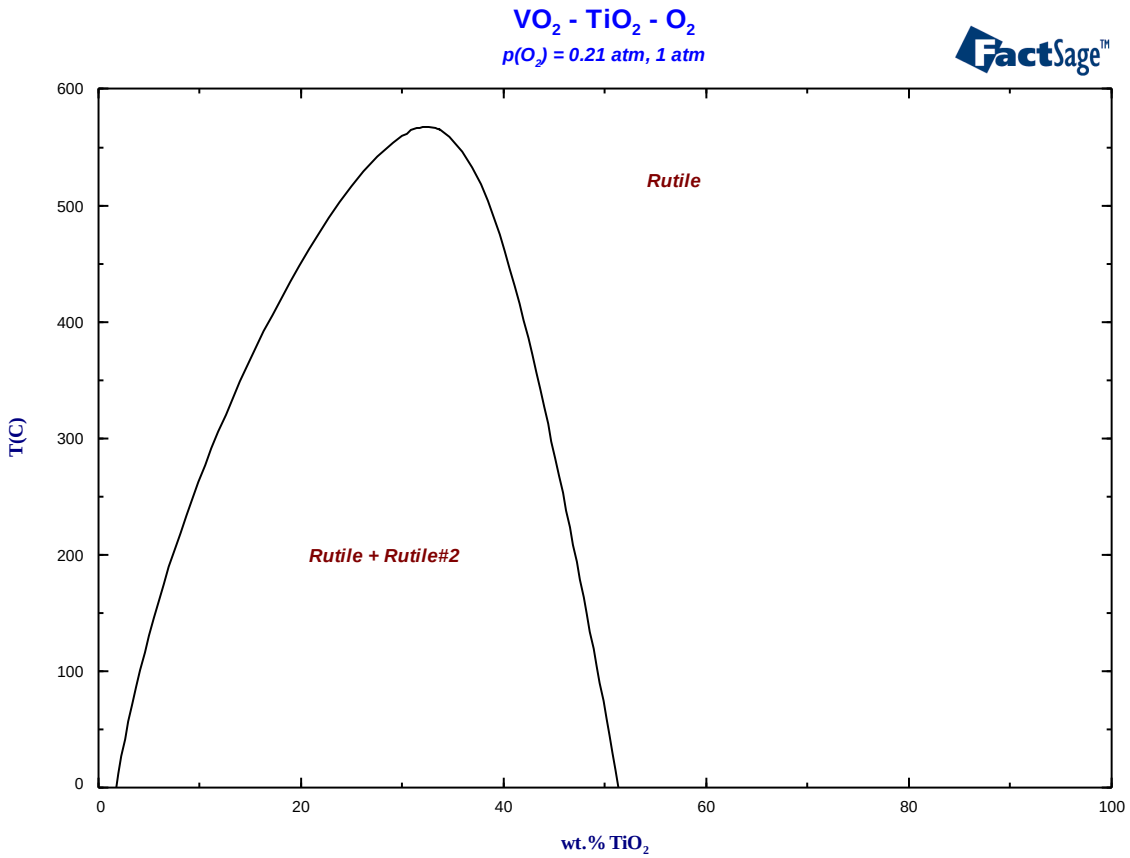
S-Zn,
Weight percent



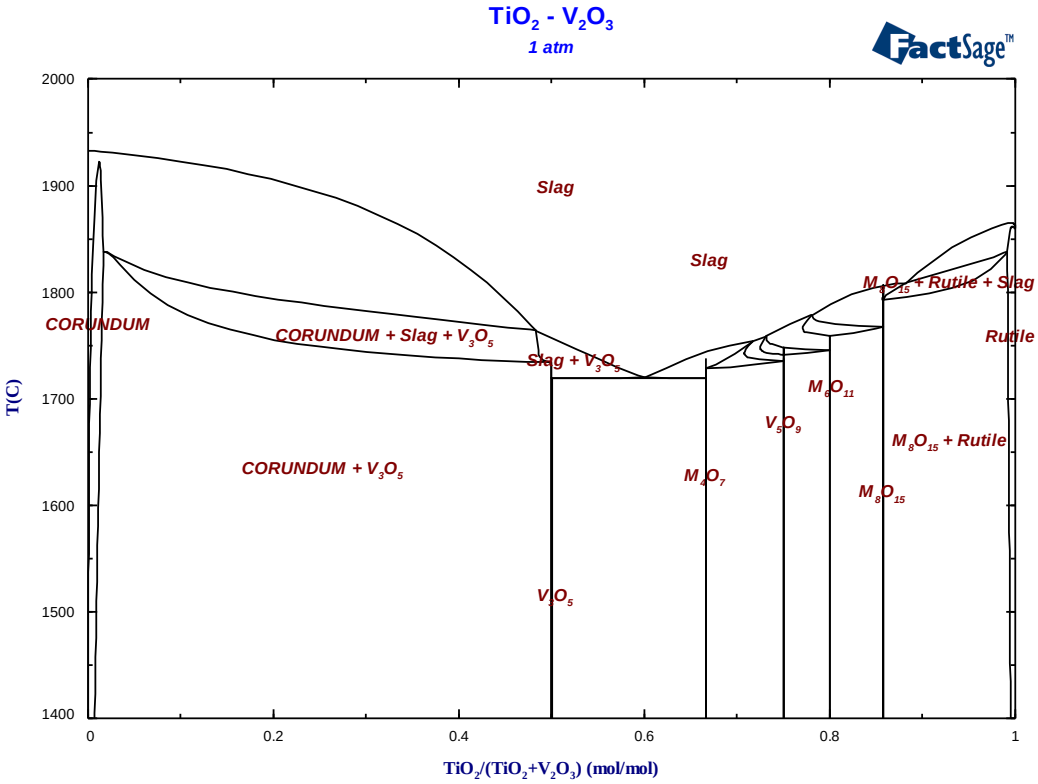
TiO2-VO2,
Mole fraction compared with experimental data



TiO2-VO2,
Weight percent

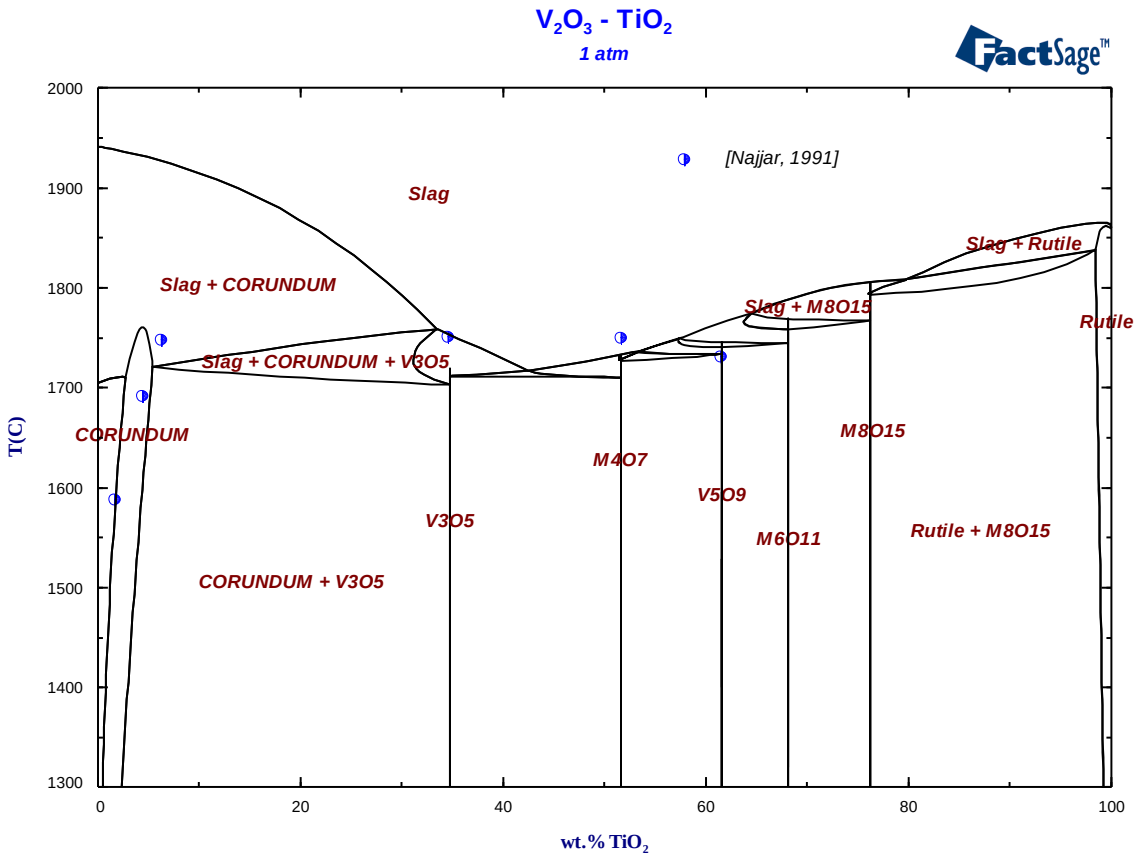


TiO2-V2O3, Mole fraction

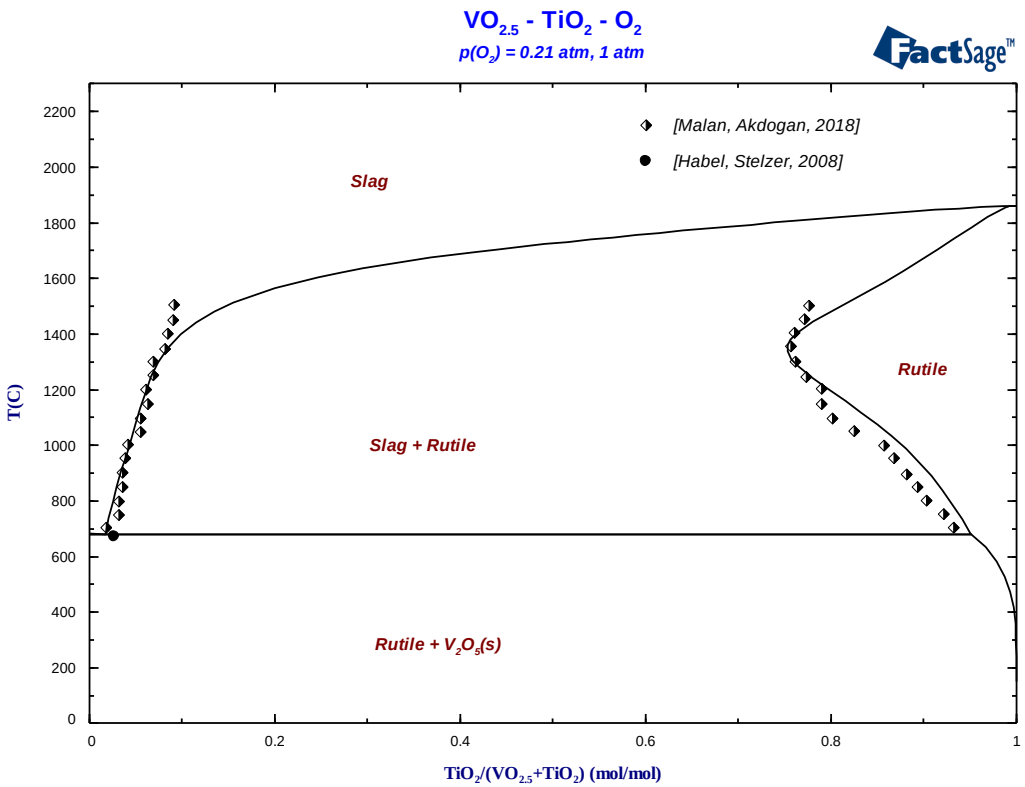


Phase	Description	Used data
Corundum	$(Ti^{+3}, V^{+3}, V^{+4})_2 (Va)_1 (O^{-2})_3$	Present work
Pseudobrookite	$(Ti, V)_1 (Ti)_1 (Ti)_1 (O)_5$	Present work
Rutile	$(Ti, V) (O, Va)_2$	[Yang17], present work
V_3O_5	$(Ti, \underline{V})_3 (O)_5$	[Yang17]
M_4O_7	$(Ti, V)_4 (O)_7$	[Yang17]
V_5O_9	$(Ti, \underline{V})_5 (O)_9$	[Yang17]
M_6O_{11}	$(Ti, V)_6 (O)_{11}$	[Yang17]
M_8O_{15}	$(Ti, V)_8 (O)_{15}$	[Yang17]

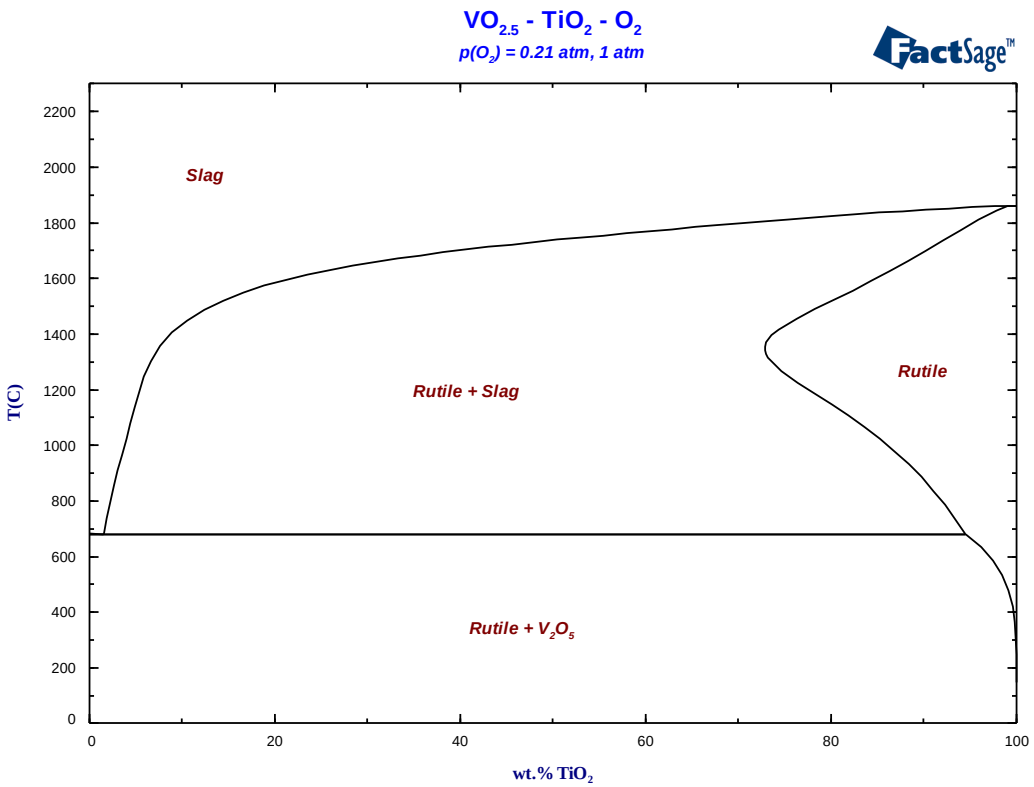
TiO2-V2O3,
Wight percent compared with experimental data



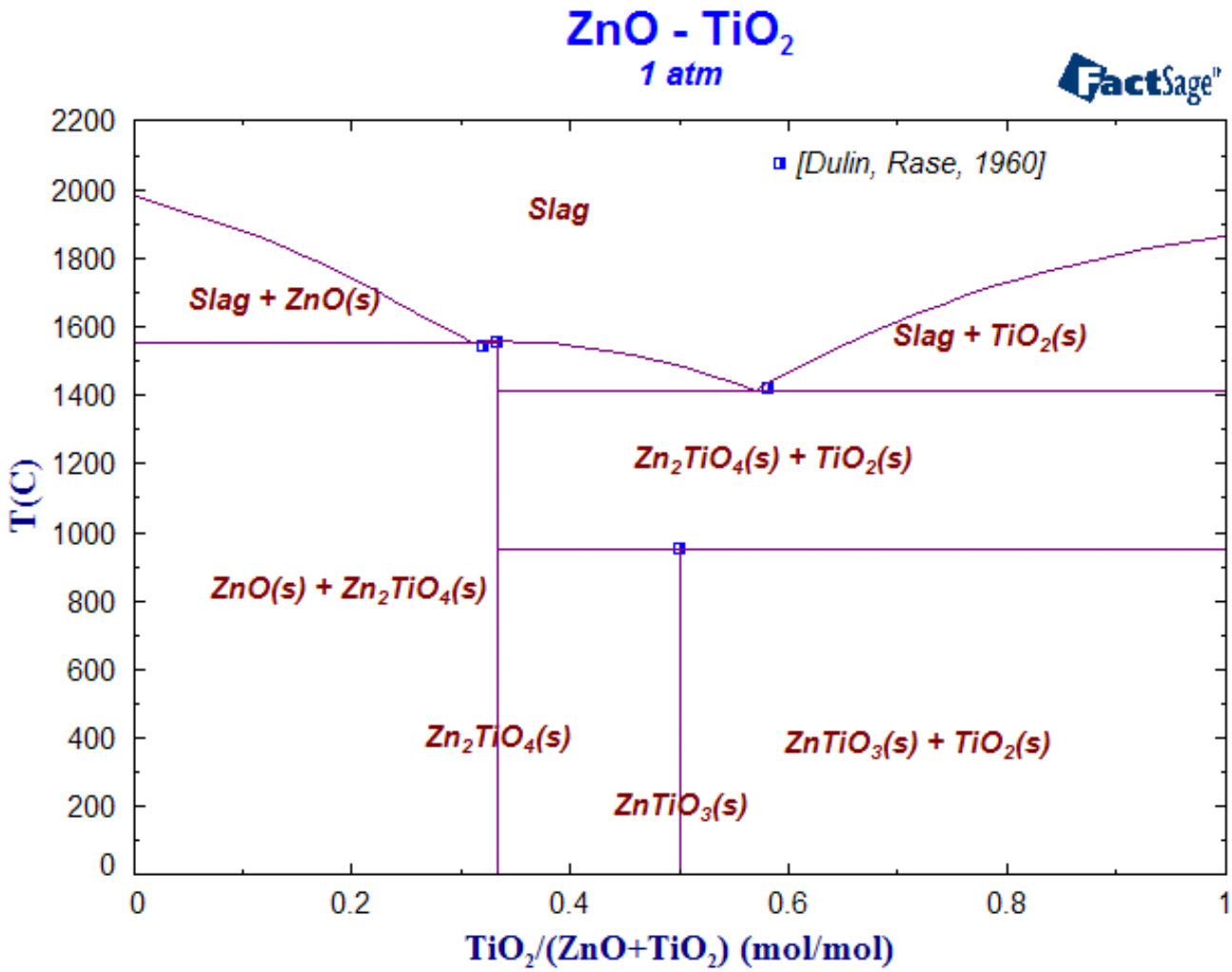
TiO2-V2O5-O2,
Mole fraction compared with experimental data



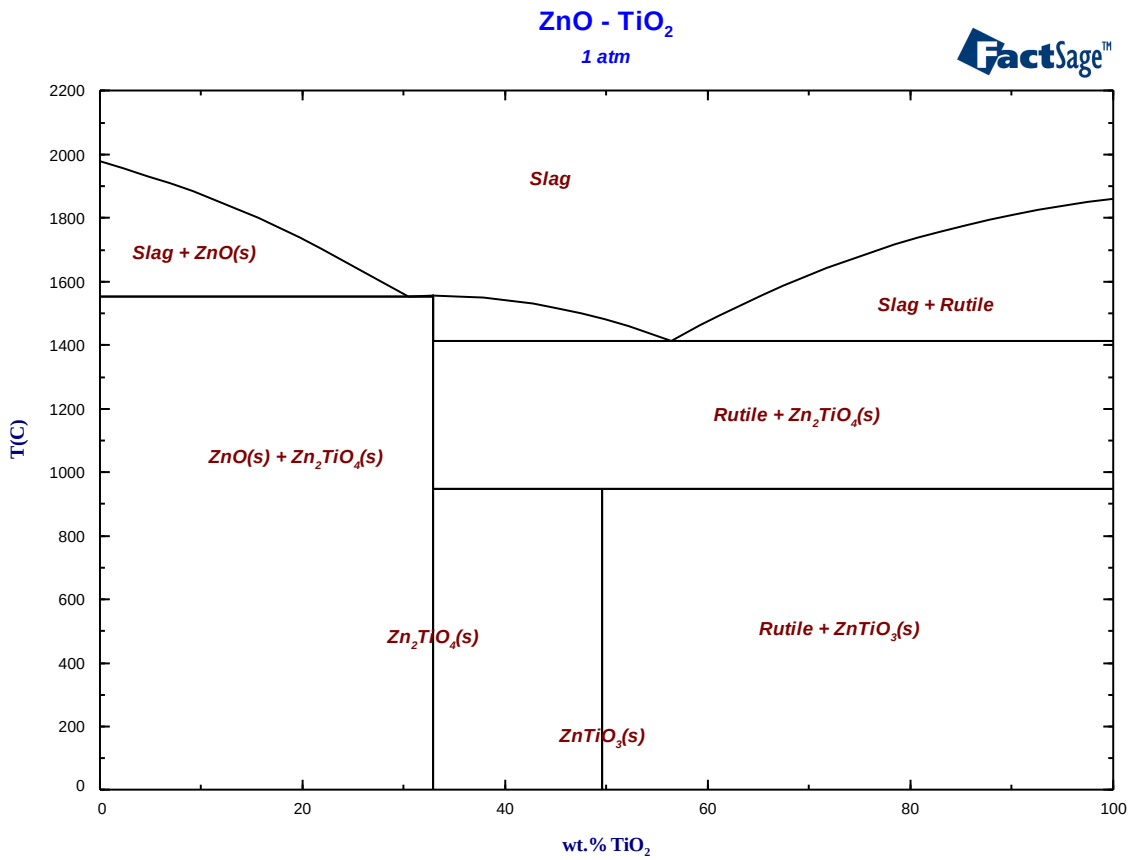
TiO2-V2O5-O2, Weight percent



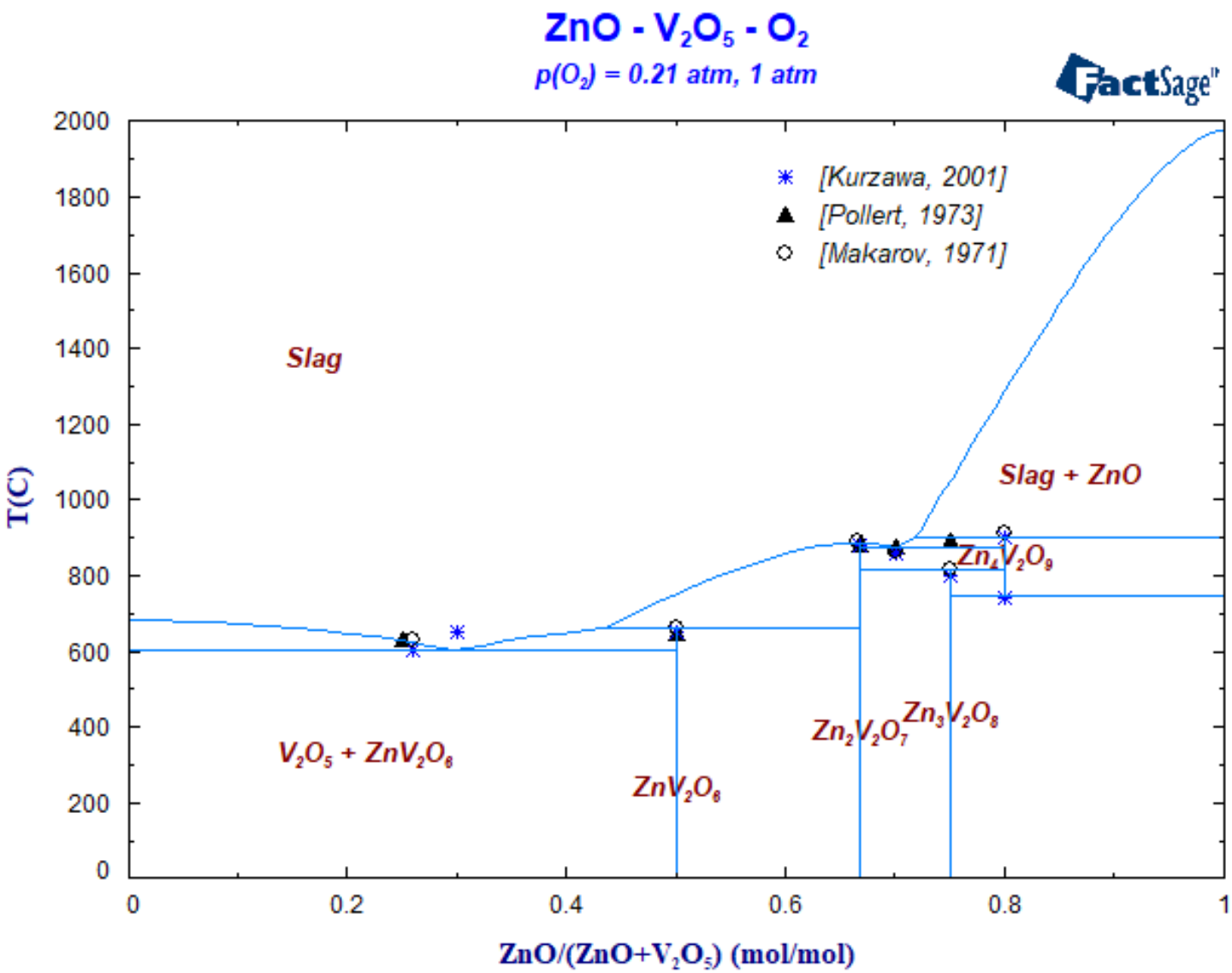
Mole fraction
compared with experimental data

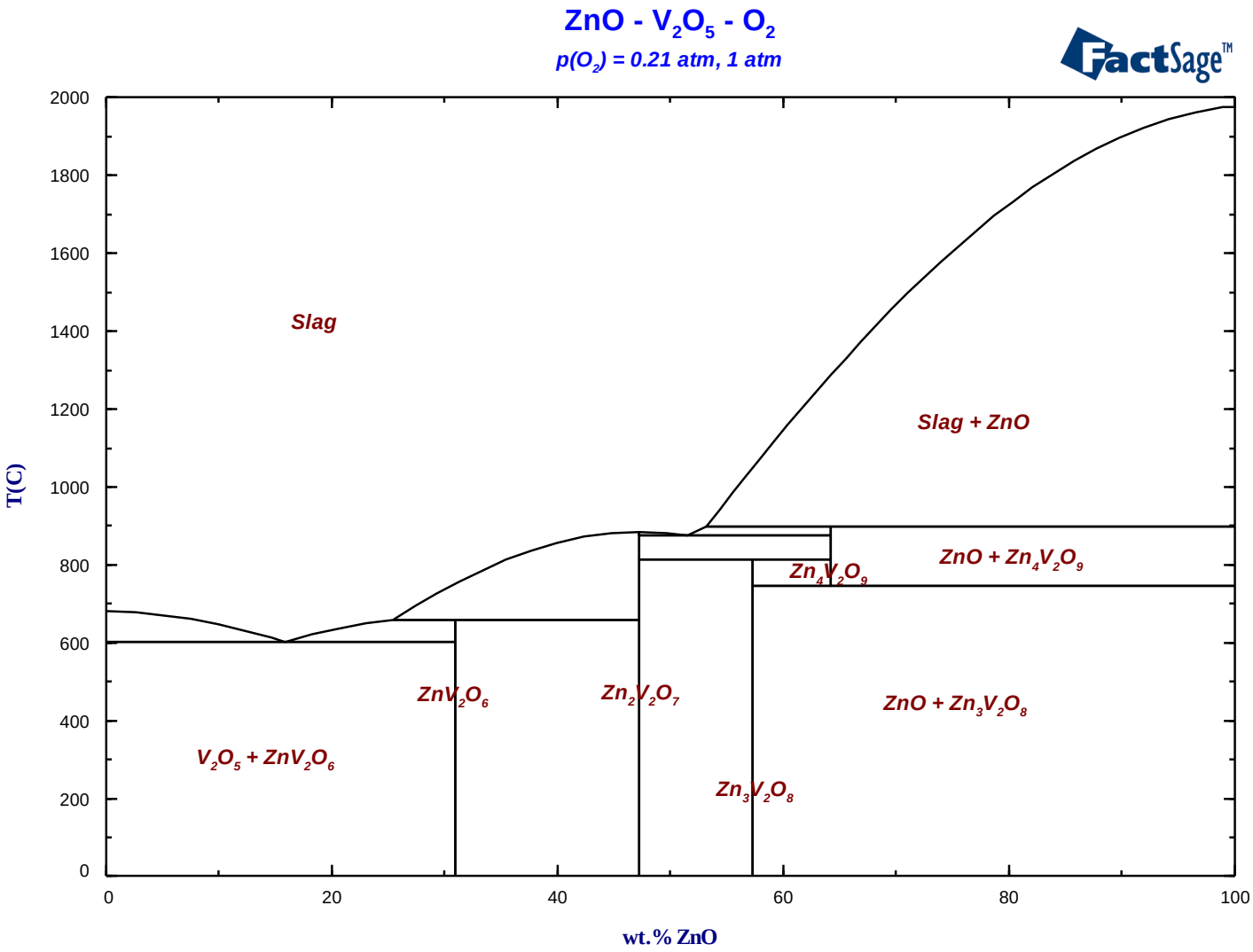


Weight percent



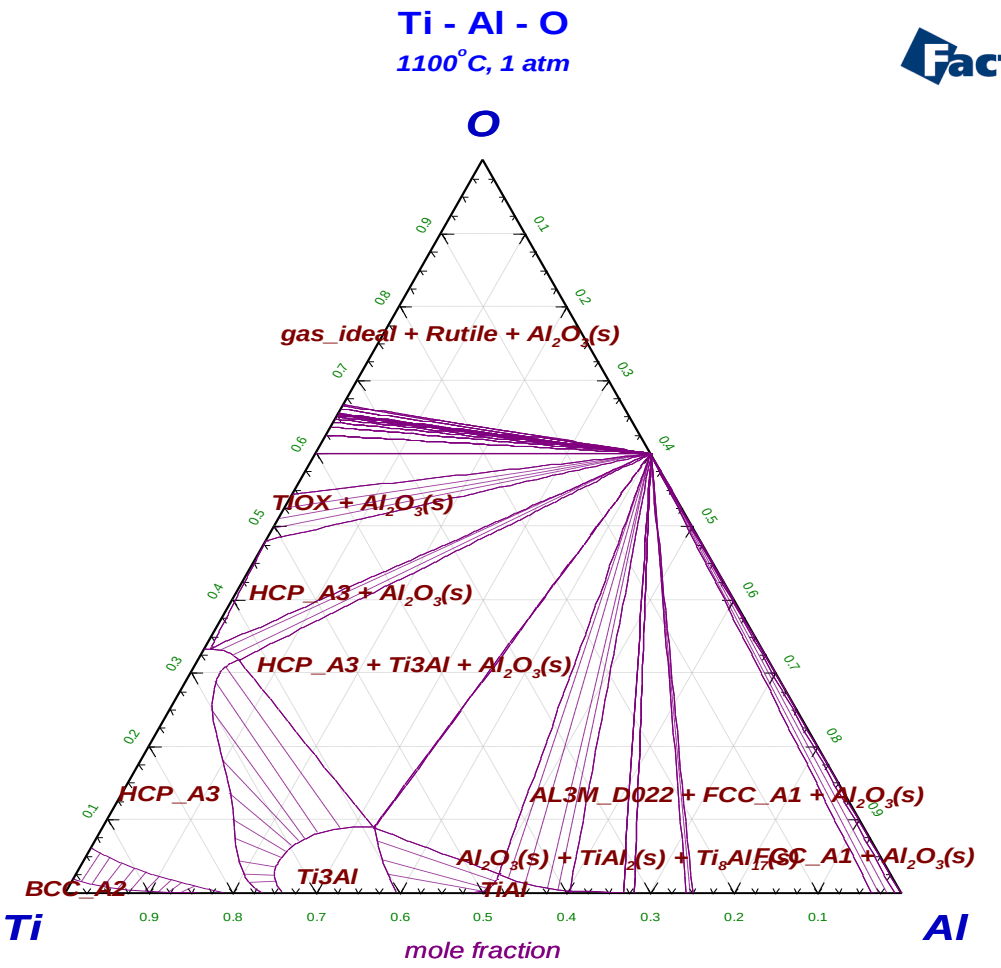
V2O5-ZnO-O2,
Mole fraction
compared with experimental data

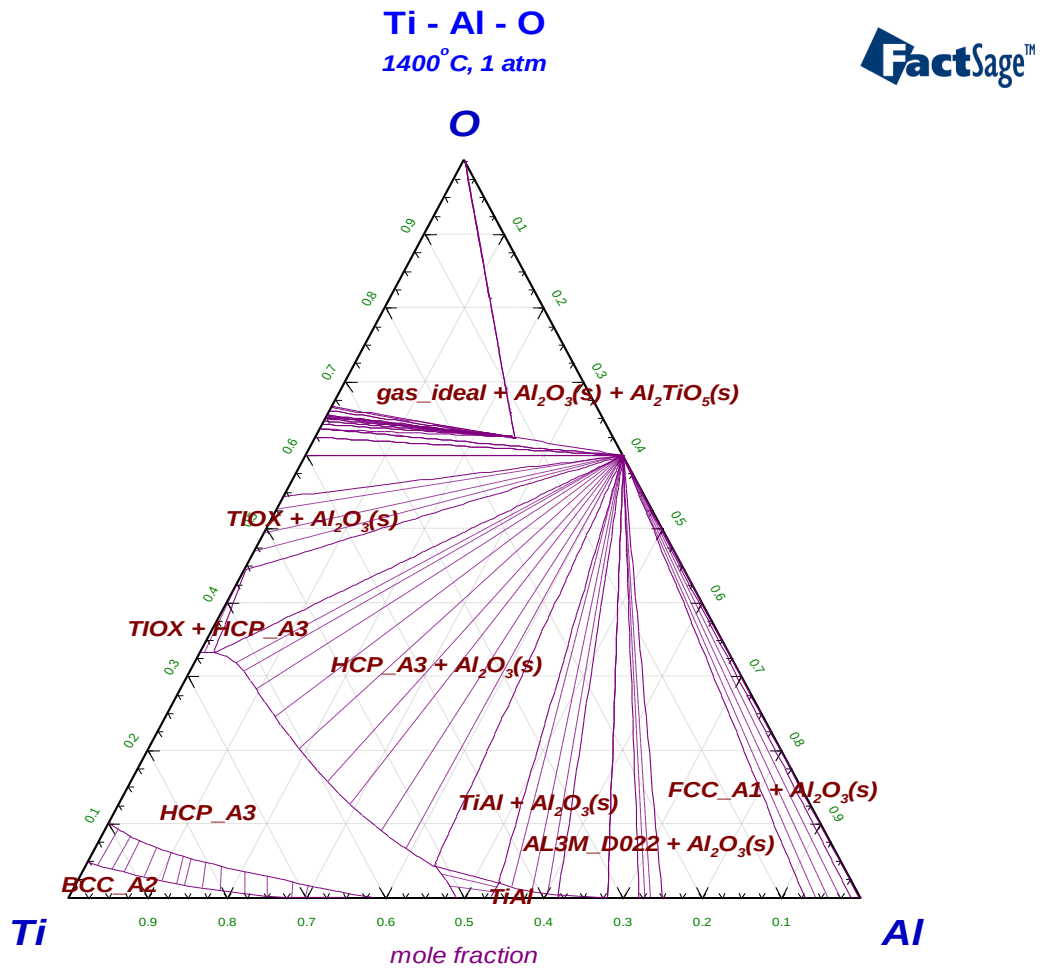



ZnO - V2O5 - O2
p(O2) = 0.21 atm, 1 atm
FactSage™
Slag
Slag + ZnO
ZnO + Zn4V2O9
Zn4V2O9
ZnV2O6
Zn2V2O7
ZnO + Zn3V2O8
V2O5 + ZnV2O6
Zn3V2O8
T(C)
wt.% ZnO
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
20
40
60
80
100

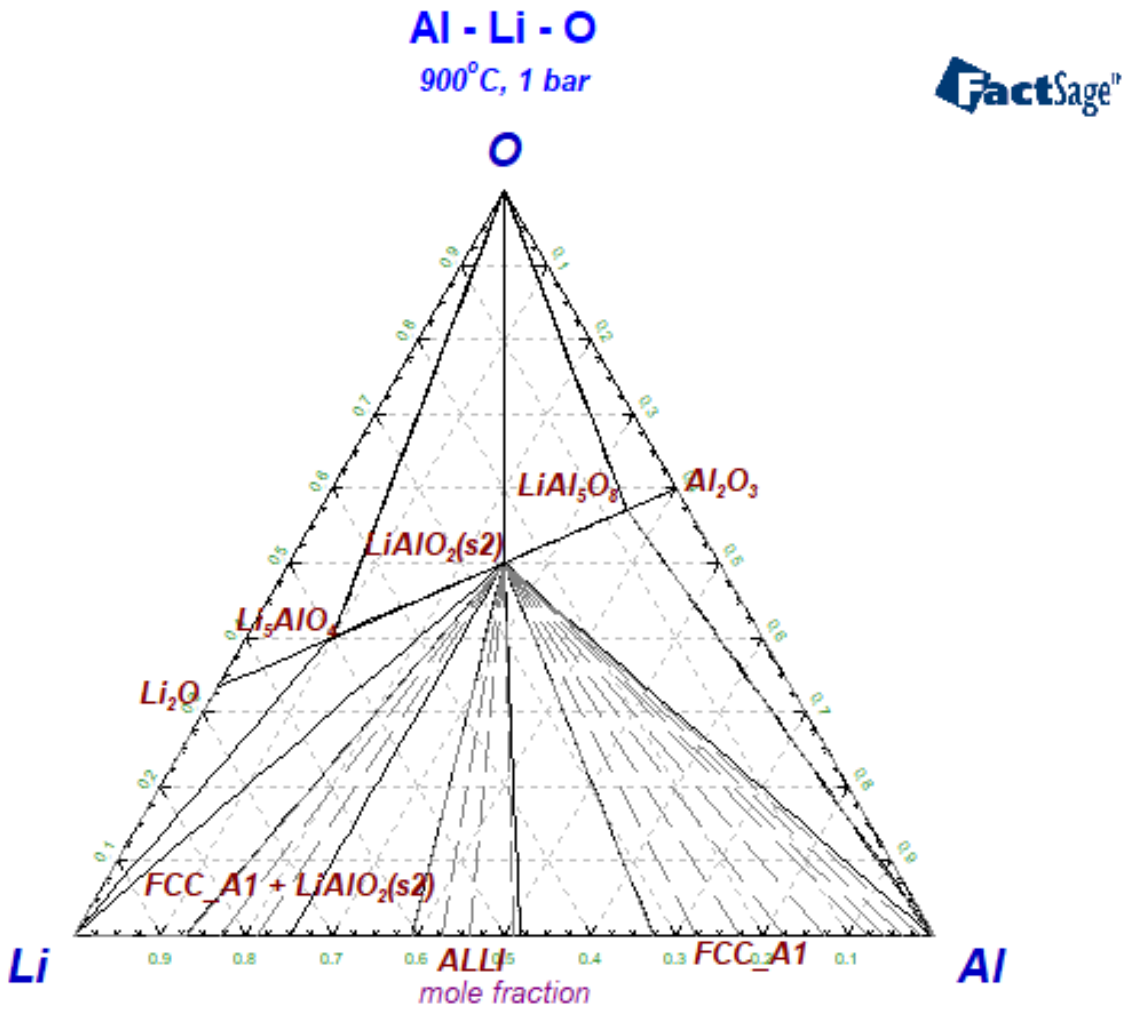
Ternary systems:

Mole fraction 1100°C

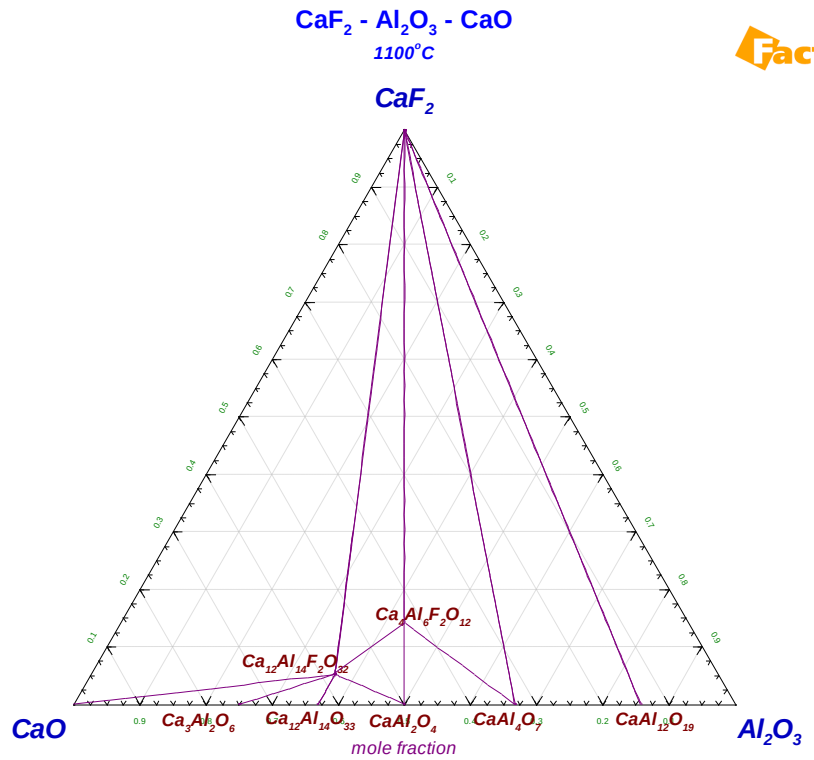



Ti - Al - O
1400°C, 1 atm
O
gas_ideal + Al2O3(s) + Al2TiO5(s)
TIOX + Al2O3(s)
TIOX + HCP_A3
HCP_A3 + Al2O3(s)
HCP_A3
TiAl + Al2O3(s)
FCC_A1 + Al2O3(s)
AL3M_D022 + Al2O3(s)
BCC_A2
TiAl
Ti
Al
mole fraction

Al-Li-O, Mole fraction, 900°C



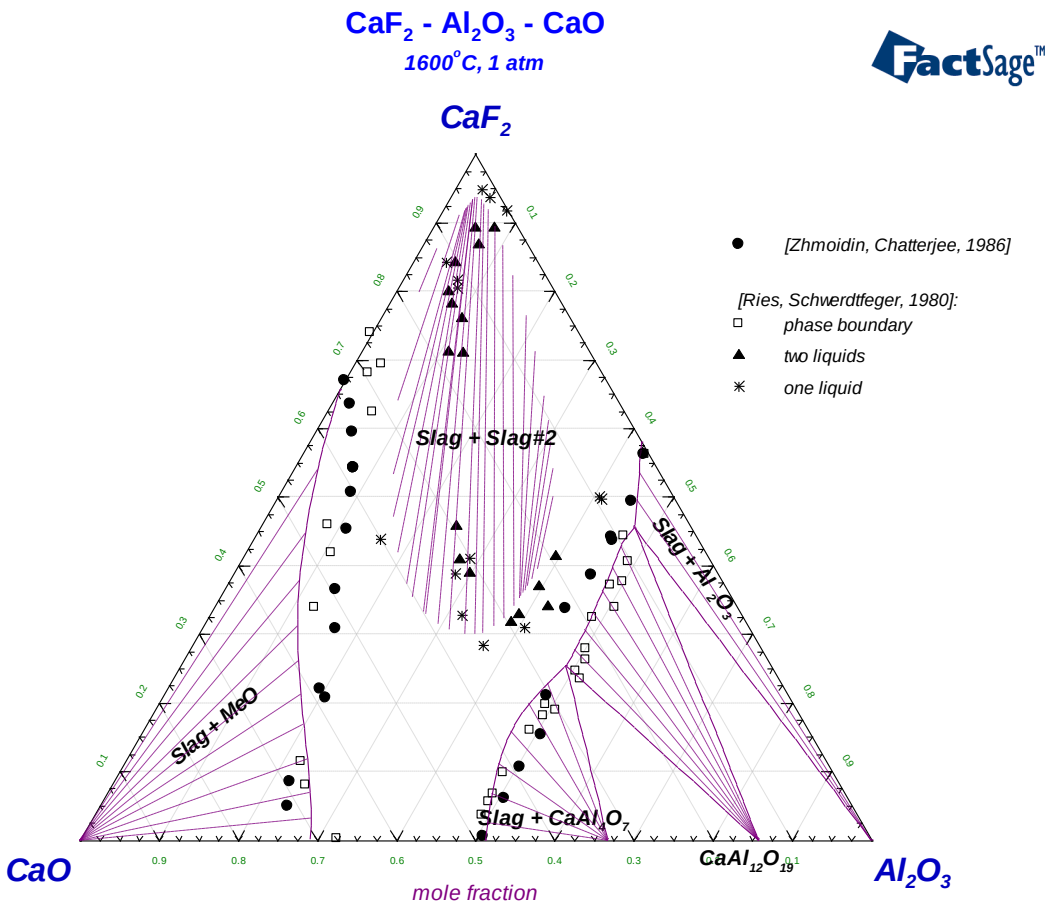
Al2O3-CaF2-CaO,
Mole fraction, 1100°C



Name	Phase	Description
C3A3F	$3CaO\ 3Al_2O_3\ CaF_2$	$Ca_4Al_6F_2O_{12}$
C11A7F	$11CaO\ 7Al_2O_3\ CaF_2$	$Ca_{12}Al_{14}F_2O_{32}$

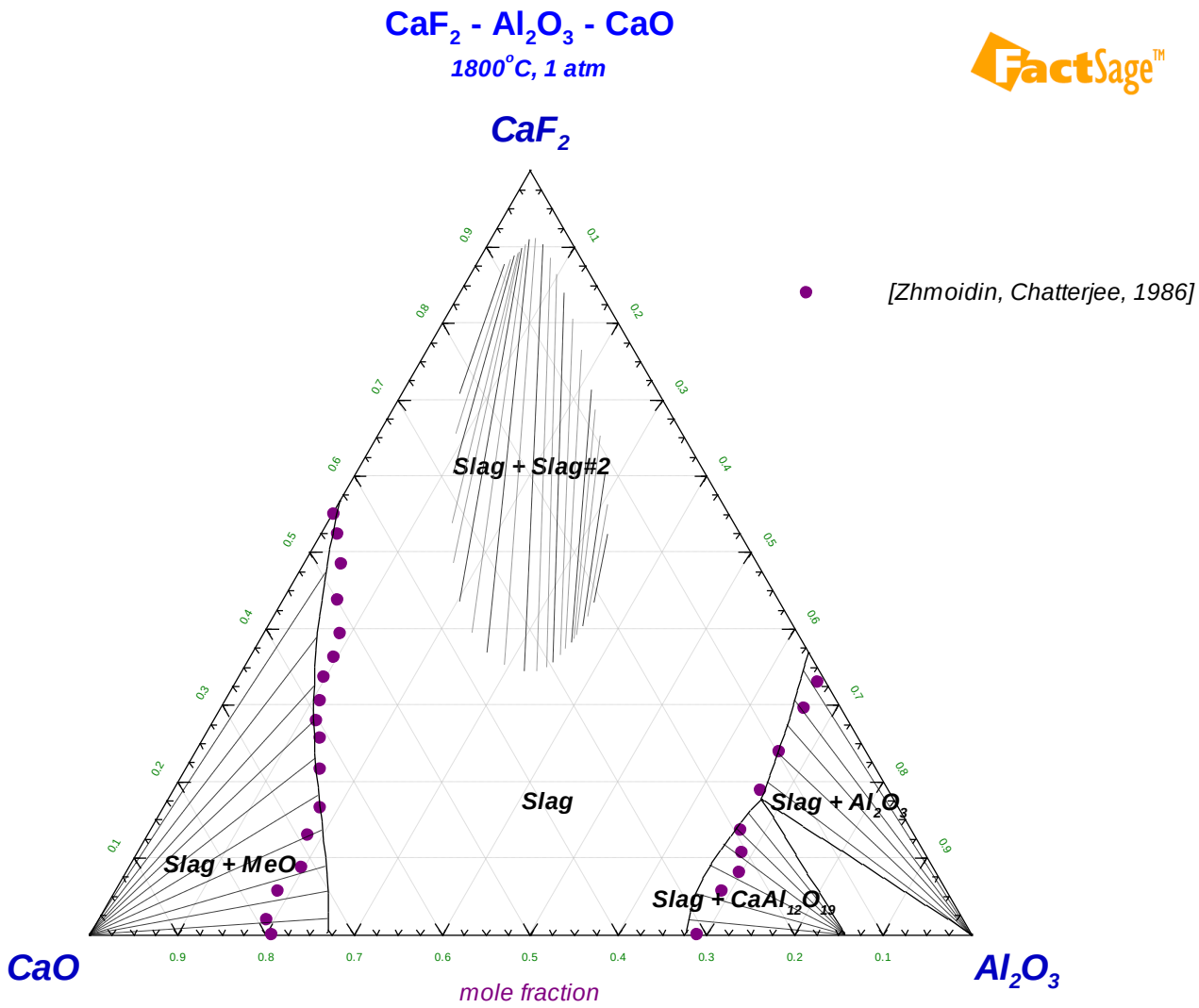
Al2O3-CaF2-CaO,

Mole fraction, 1600°C



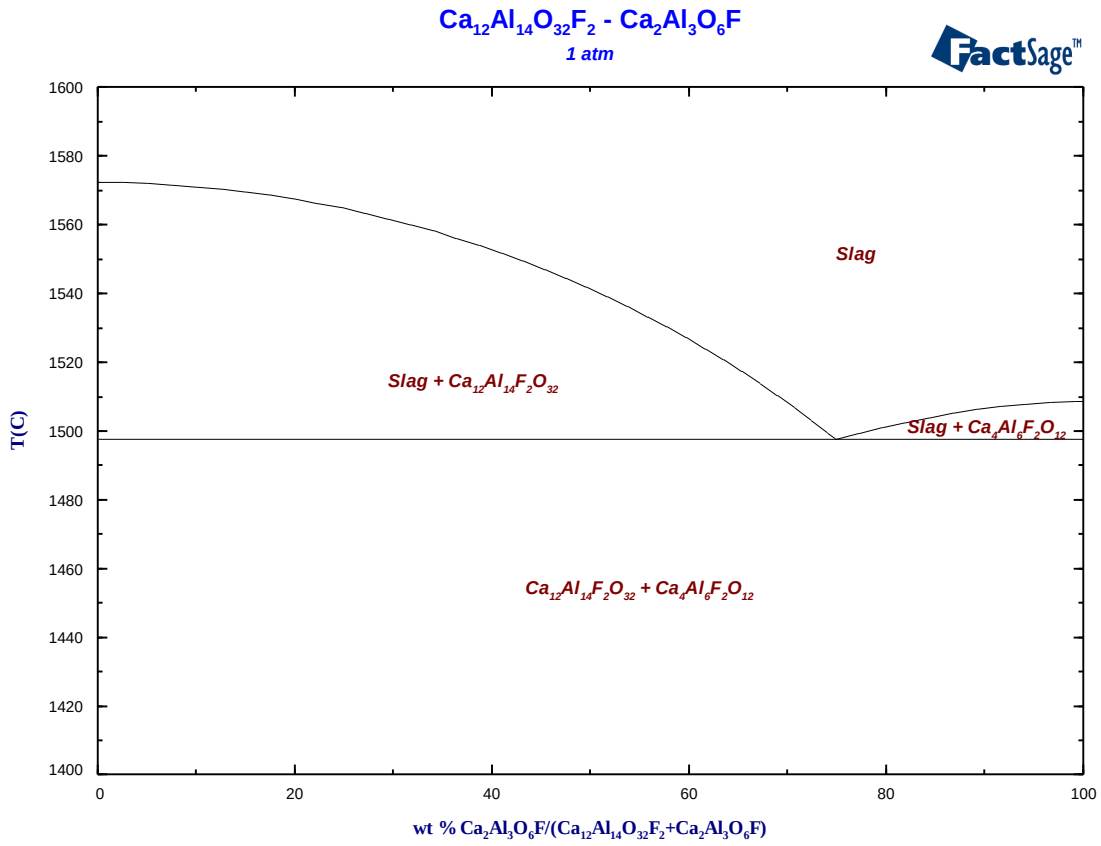
Al2O3-CaF2-CaO,

Mole fraction, 1800°C



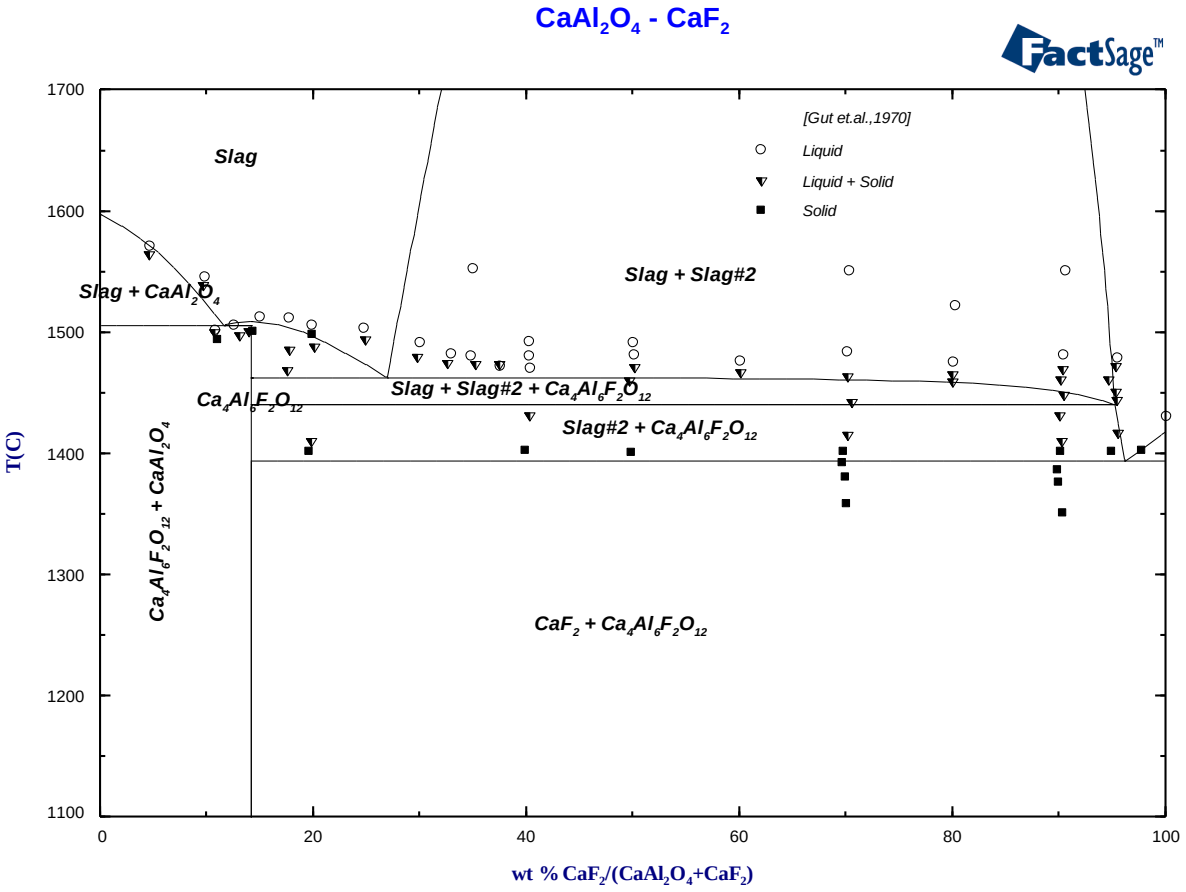
Al2O3-CaF2-CaO,

Weight percent, Isopleth C11A7F-C3A3F



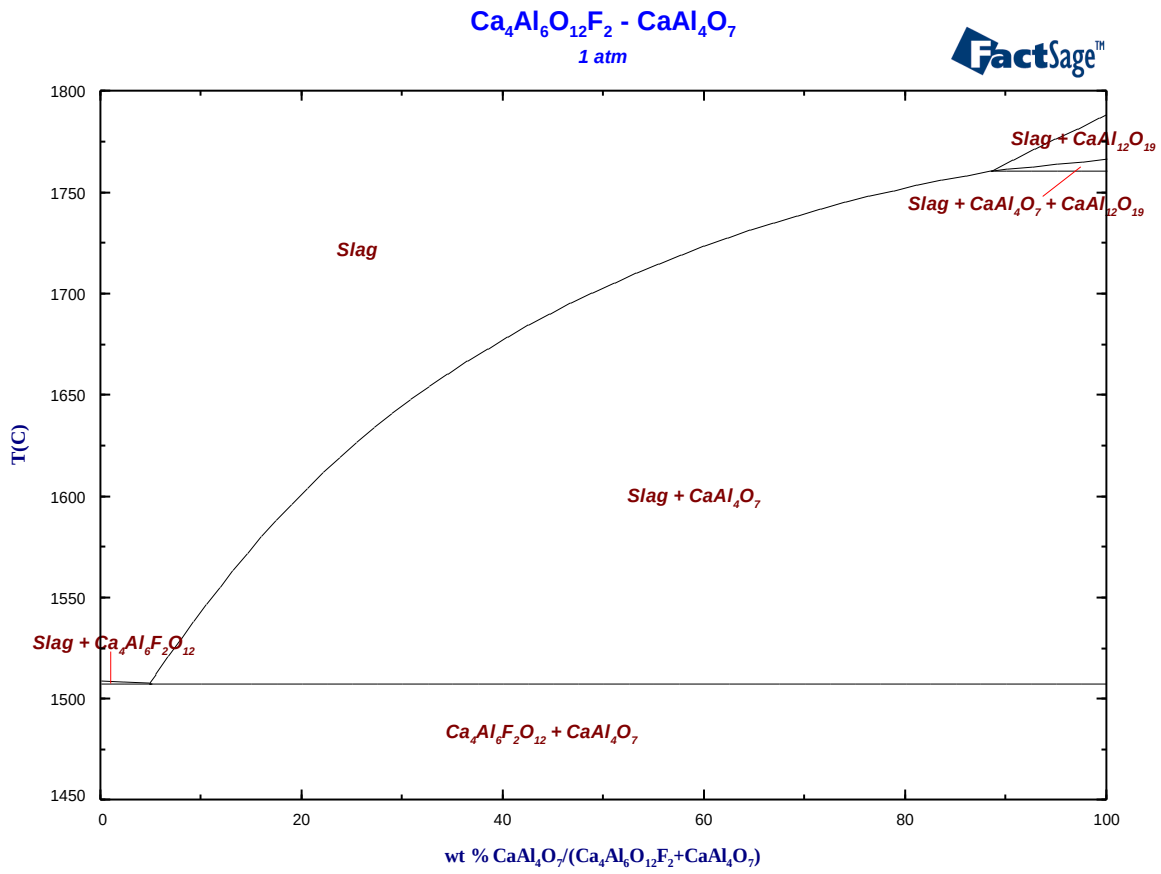
Al2O3-CaF2-CaO,

Weight percent, Isopleth C3A3F-CaAl4O7

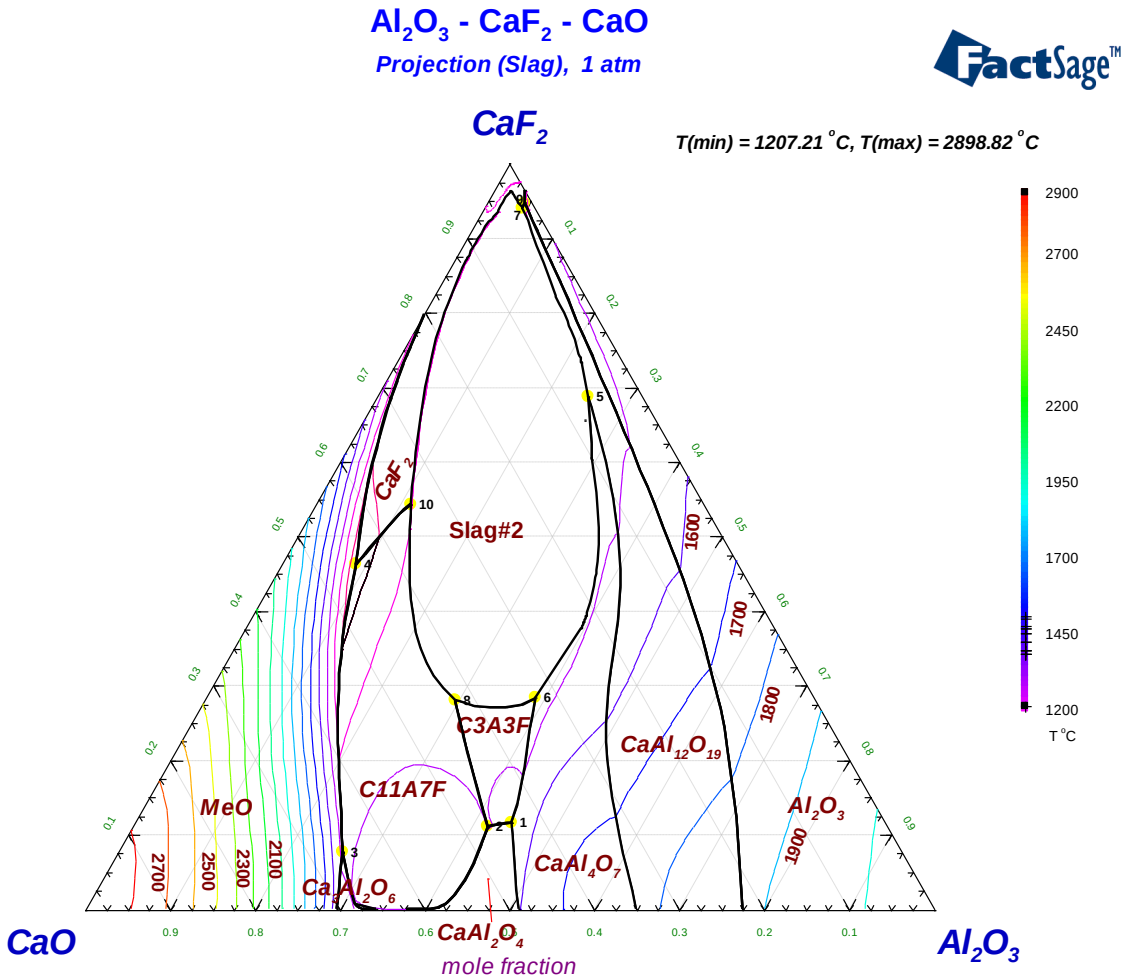


Al2O3-CaF2-CaO,

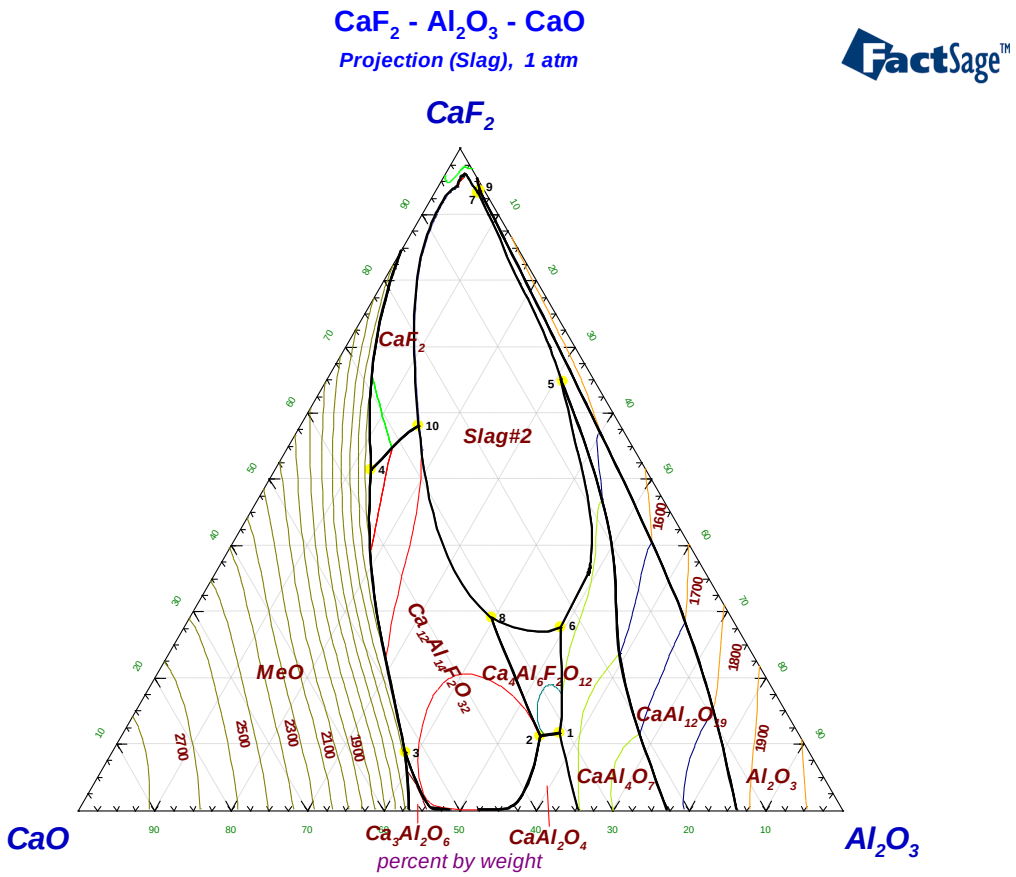
Weight percent, Isopleth C3A3F-CaAl4O7



Mole fraction
Liquidussurface



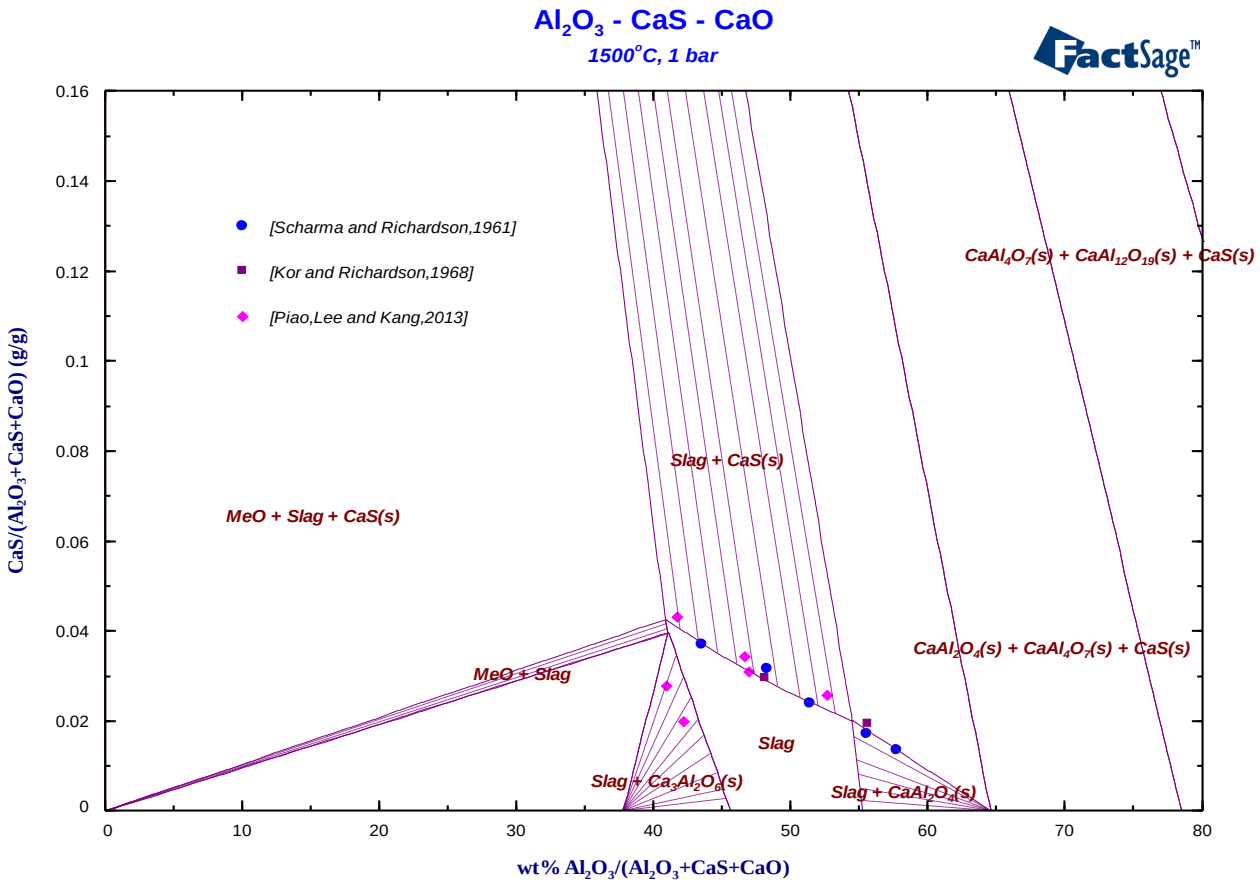
Weight percent
Liquidussurface



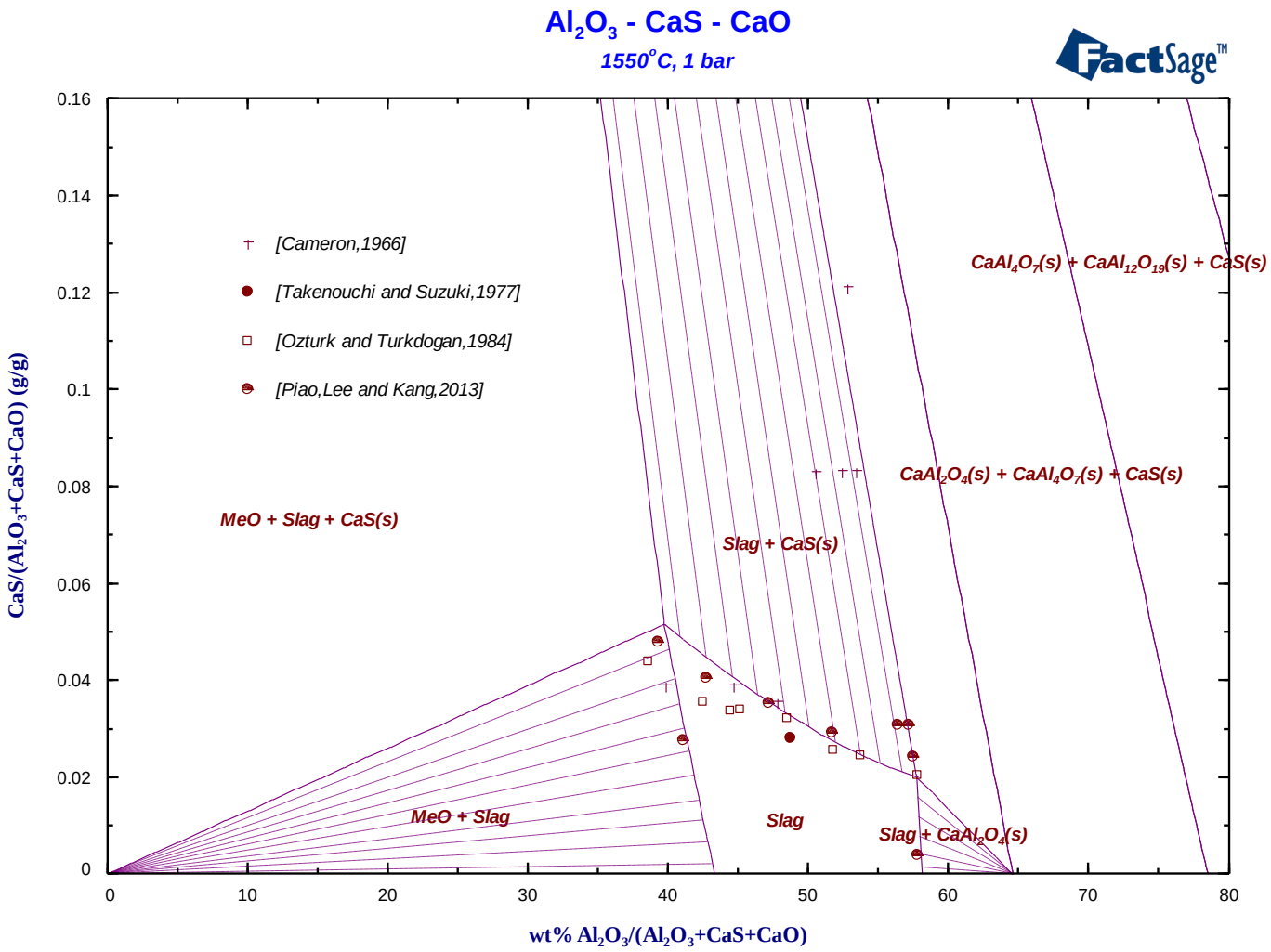
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction					Weight percent				
	A = CaF2, B = CaO, C = Al2O3					A = CaF2, B = CaO, C = Al2O3				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: Ca4Al6F2O12 / CaAl2O4 / CaAl4O7	1:	0.11717	0.43892	0.44390	1506.26	1:	11.577	31.147	57.276	1505.52
2: Ca12Al14F2O32 / Ca4Al6F2O12 / CaAl2O4	2:	0.11168	0.47000	0.41832	1497.18	2:	11.218	33.908	54.874	1497.16
3: Ca12Al14F2O32 / Ca3Al2O6 / MeO	3:	0.07792	0.65849	0.26359	1471.69	3:	8.705	52.838	38.457	1471.69
4: Ca12Al14F2O32 / CaF2 / MeO	4:	0.46309	0.44949	0.08742	1207.59	4:	51.448	35.868	12.683	1207.27
5: CaAl12O19 / CaAl4O7 / Slag#2	5:	0.68884	0.06304	0.24812	1464.03	5:	65.098	4.279	30.622	1464.03
6: Ca4Al6F2O12 / CaAl4O7 / Slag#2	6:	0.28382	0.32789	0.38829	1450.10	6:	27.652	22.945	49.404	1450.04
7: Al2O3 / CaAl12O19 / CaF2	7:	0.94688	0.00839	0.04473	1382.79	7:	93.628	0.596	5.776	1382.79
8: Ca12Al14F2O32 / Ca4Al6F2O12 / Slag#2	8:	0.28174	0.42396	0.29429	1419.42	8:	29.028	31.374	39.598	1419.42
9: Al2O3 / CaAl12O19 / CaF2_s1(s)	9:	0.95183	0.02687	0.02131	1419.41	9:	95.283	1.932	2.785	1419.42
10: Ca12Al14F2O32 / CaF2 / Slag#2	10:	0.54344	0.34462	0.11194	1392.11	10:	57.988	26.412	15.599	1392.18

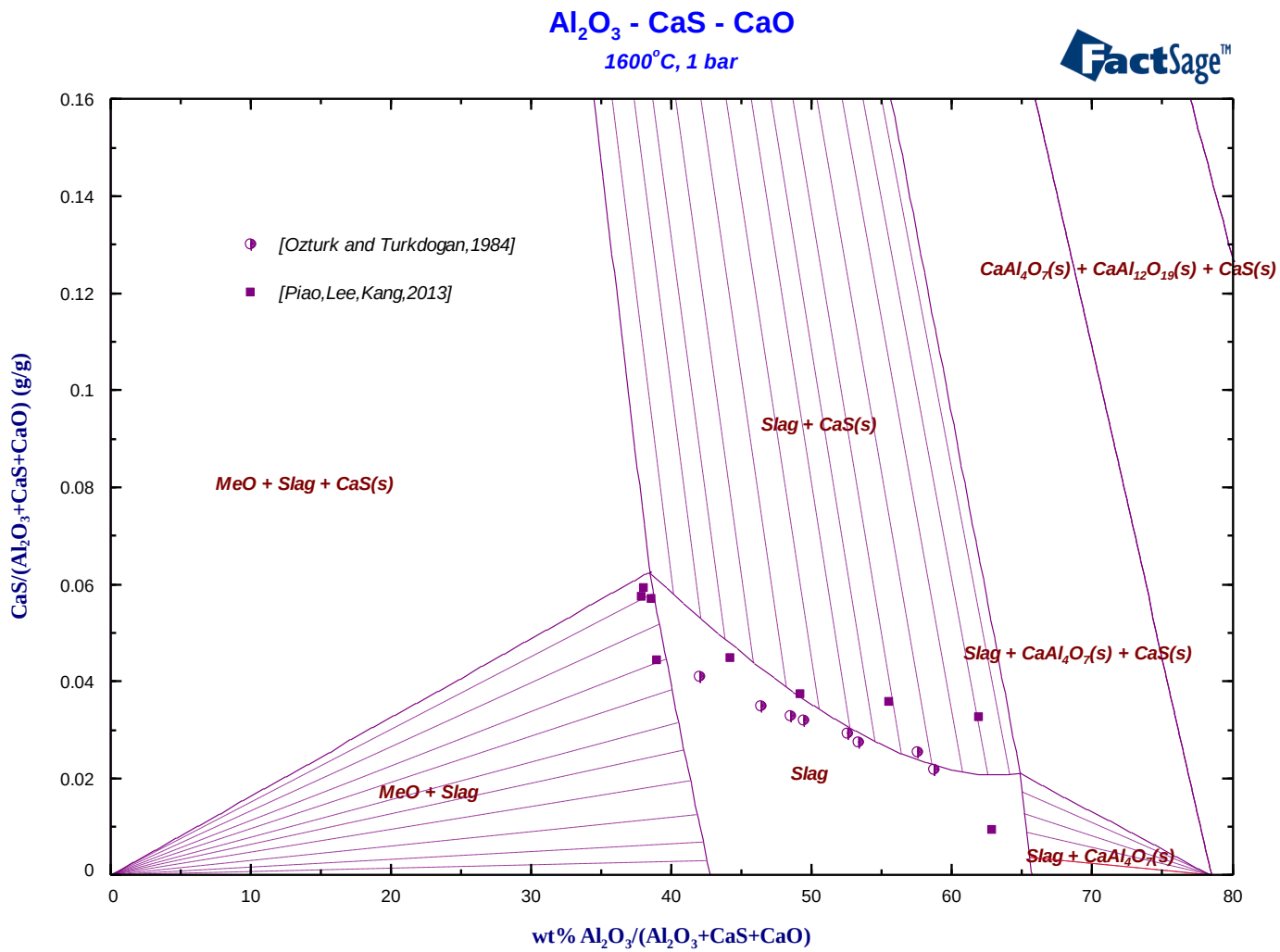
Al2O3-CaO-CaS,
Weight percent, 1500°C



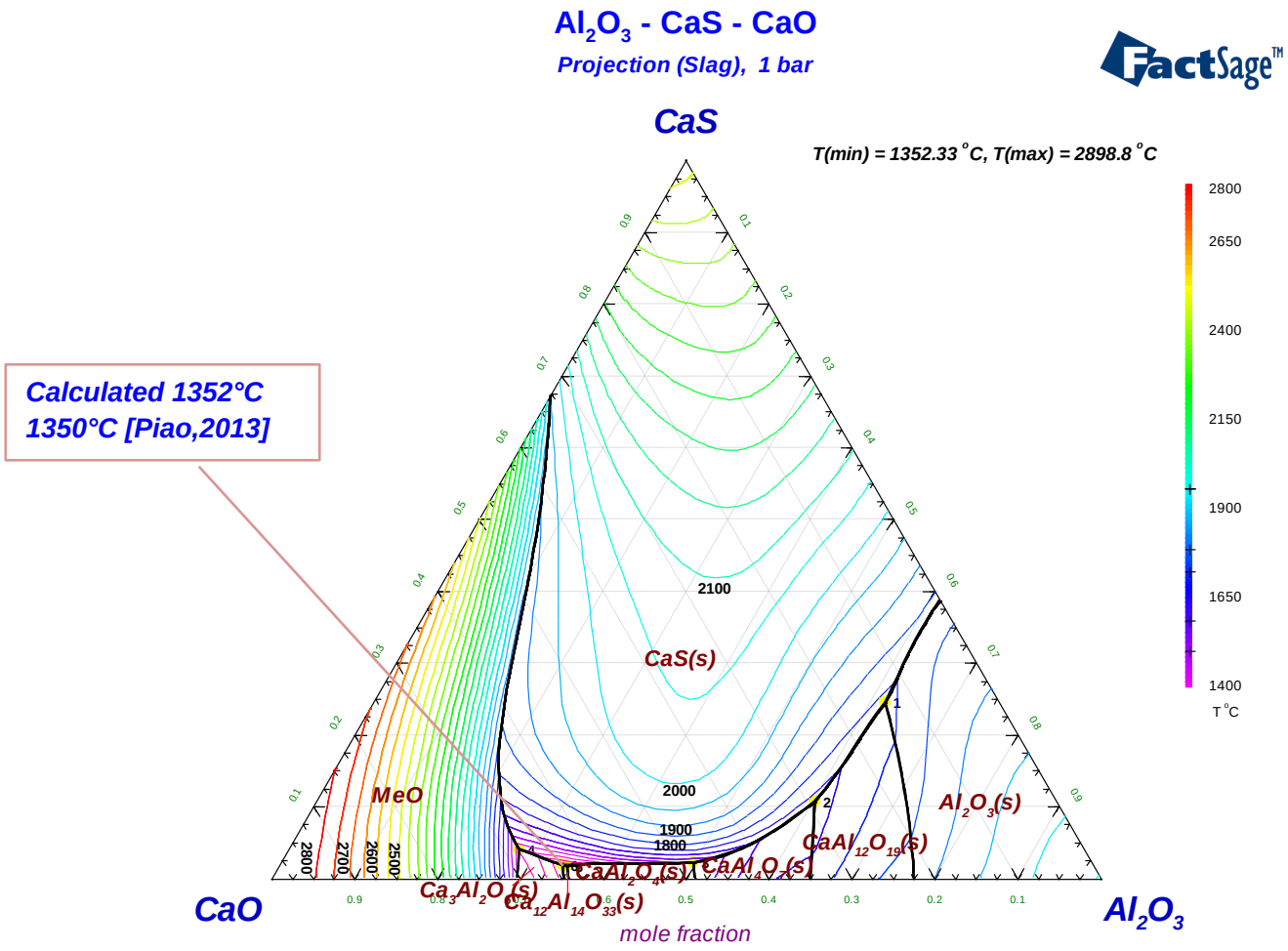
Al2O3-CaO-CaS,
Weight percent, 1550°C



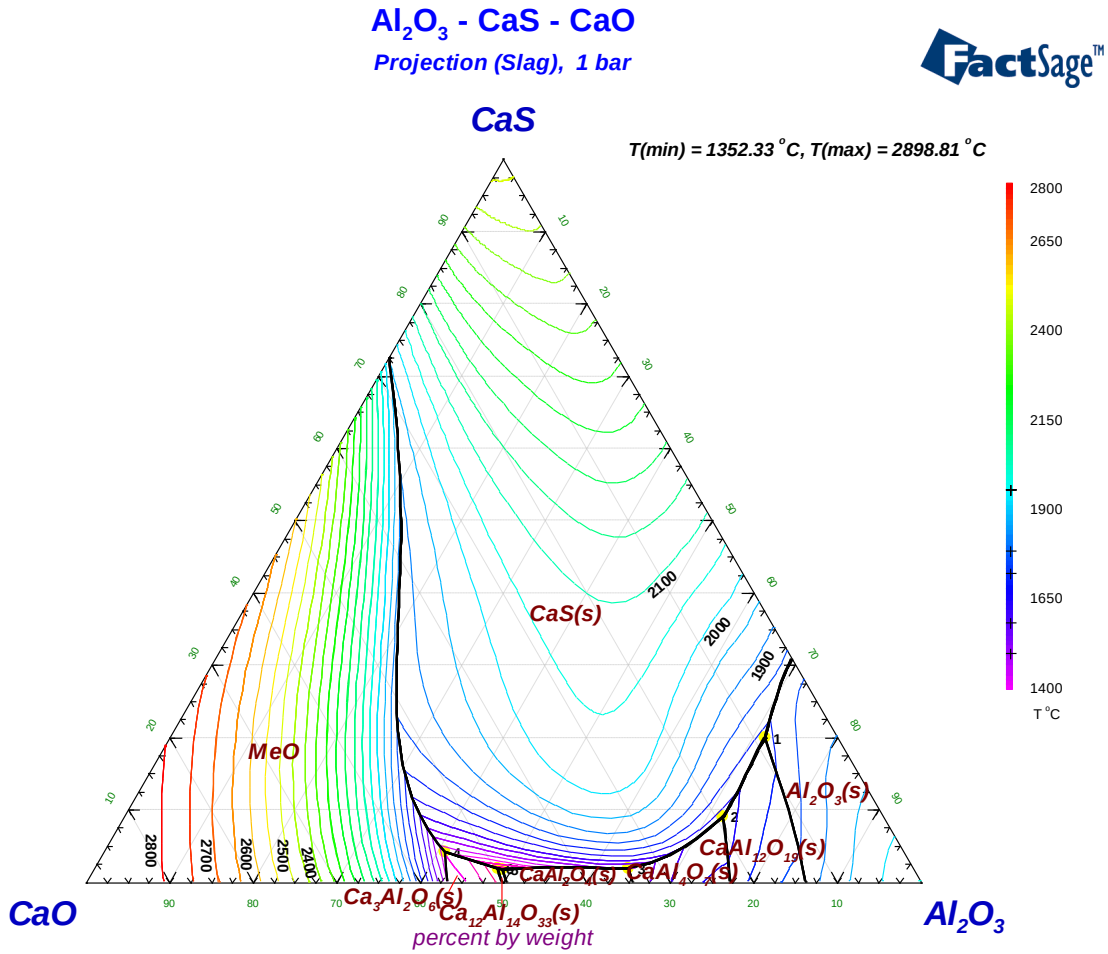
Al2O3-CaO-CaS,
Weight percent, 1600°C



Mole fraction, Liquidussurface



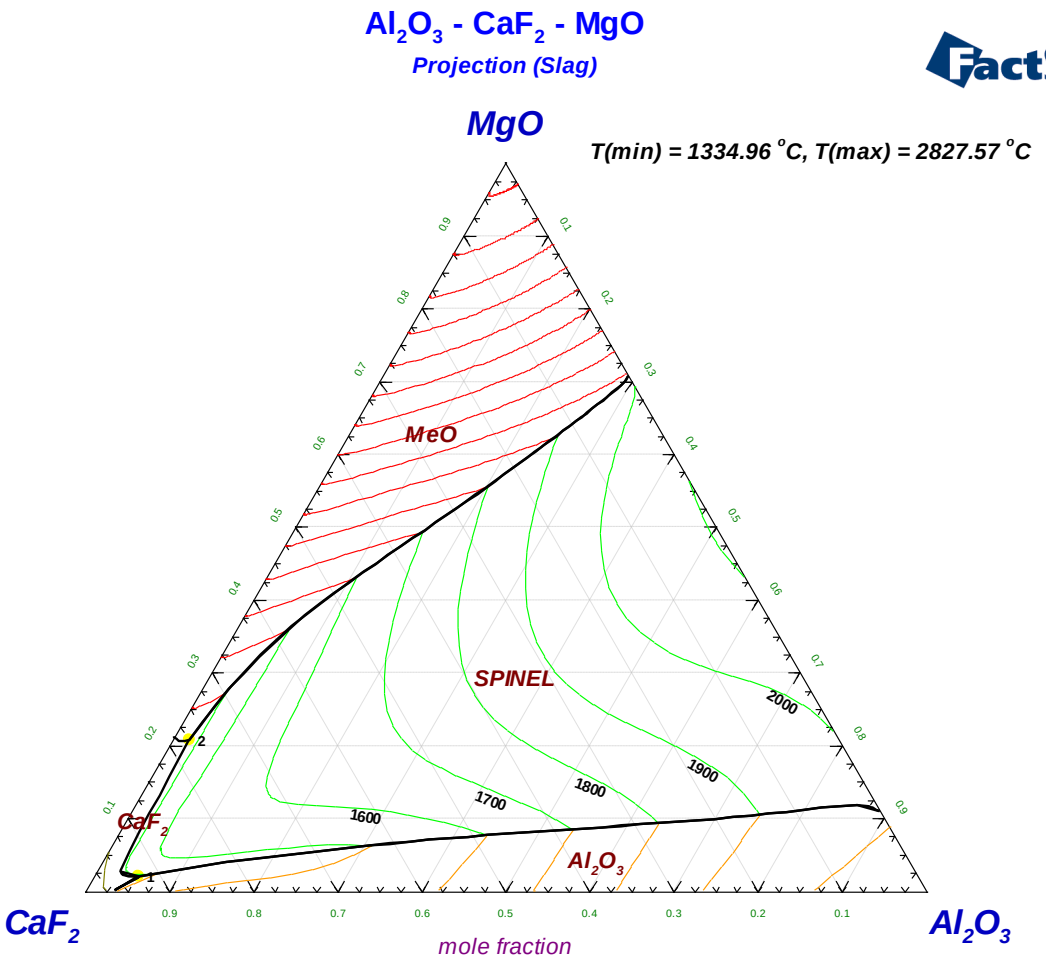
Weight percent, Liquidussurface



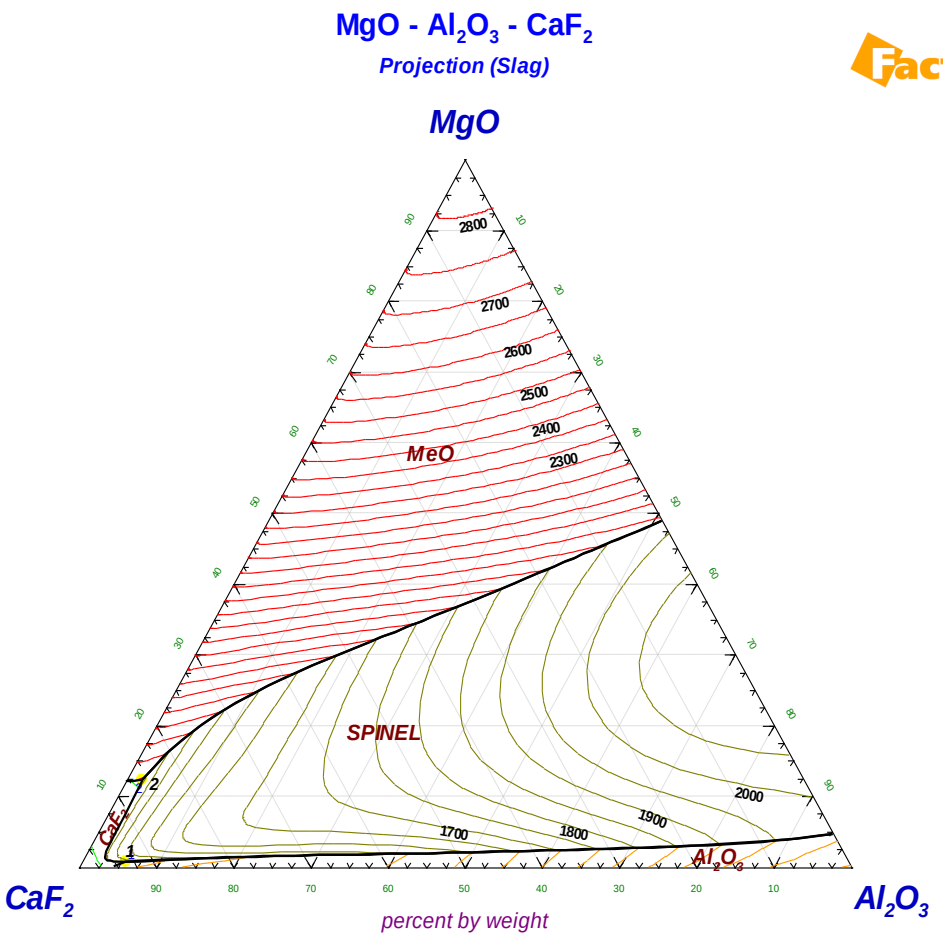
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction					Weight percent				
	A = CaS, B = CaO, C = Al2O3					A = CaS, B = CaO, C = Al2O3				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: Al2O3(s) / CaAl12O19(s) / CaS(s)	1:	0.24431	0.13697	0.61872	1781.23	1:	19.940	8.689	71.370	1781.23
2: CaAl12O19(s) / CaAl4O7(s) / CaS(s)	2:	0.10698	0.29108	0.60194	1721.60	2:	9.036	19.110	71.854	1721.60
3: CaAl2O4(s) / CaAl4O7(s) / CaS(s)	3:	0.02132	0.47996	0.49872	1582.21	3:	1.939	33.940	64.121	1582.21
4: Ca3Al2O6(s) / CaS(s) / MeO	4:	0.04058	0.68075	0.27866	1497.45	4:	4.212	54.915	40.873	1497.43
5: Ca12Al14O33(s) / CaAl2O4(s) / CaS(s)	5:	0.01767	0.63453	0.34780	1369.73	5:	1.763	49.202	49.035	1355.04
6: Ca12Al14O33(s) / Ca3Al2O6(s) / CaS(s)	6:	0.01811	0.63938	0.34251	1352.33	6:	1.813	49.740	48.447	1352.33

Mole fraction, Liquidussurface



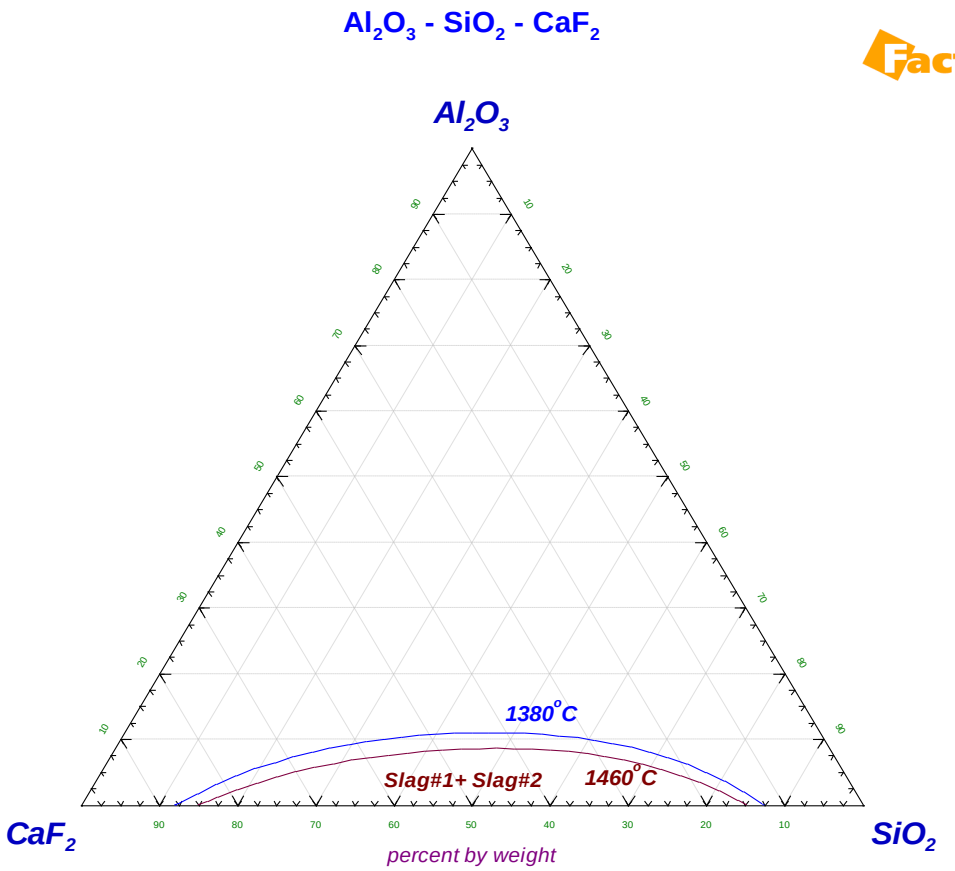
Weight percent, Liquidussurface



Invariant equilibria on the liquidus surface

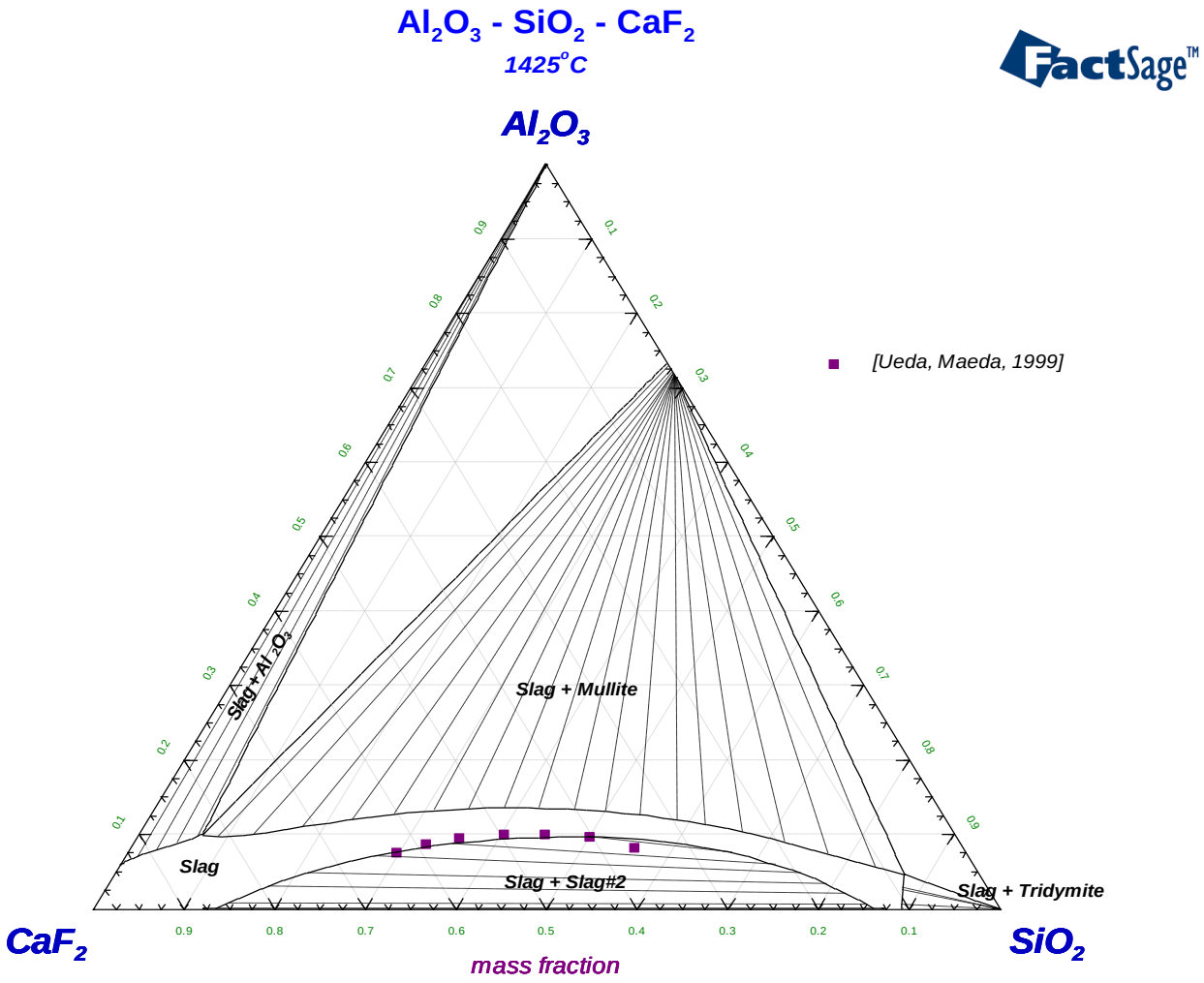
Intersections with slag	Mole fraction					Weight percent				
	A = MgO, B = CaF2, C = Al2O3					A = MgO, B = CaF2, C = Al2O3				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: Al2O3 / CaF2 / SPINEL	1:	0.02010	0.92632	0.05358	1368.36	1:	1.031	92.018	6.951	1368.36
2: CaF2 / MeO / SPINEL	2:	0.20745	0.77272	0.01982	1334.96	2:	11.824	85.317	2.858	1334.96

Weight percent,
Liquidus lines at 1380°C and 1460°C



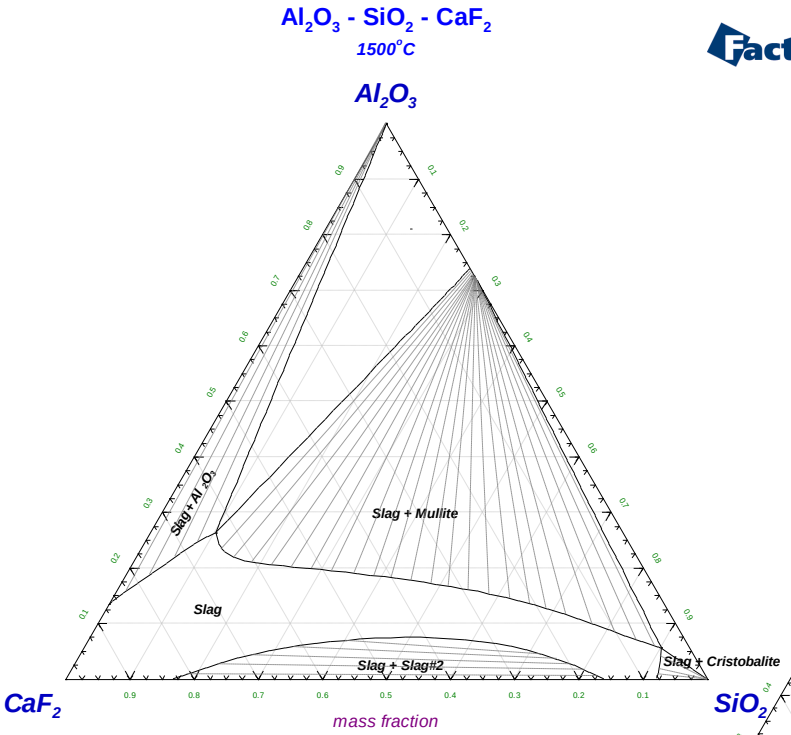
Al2O3-CaF2-SiO2,

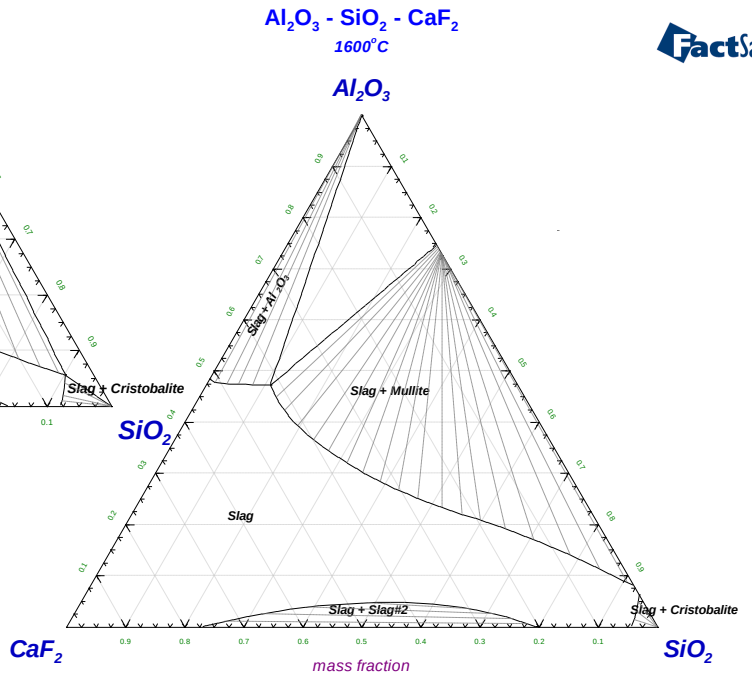
Weight percent 1425°C

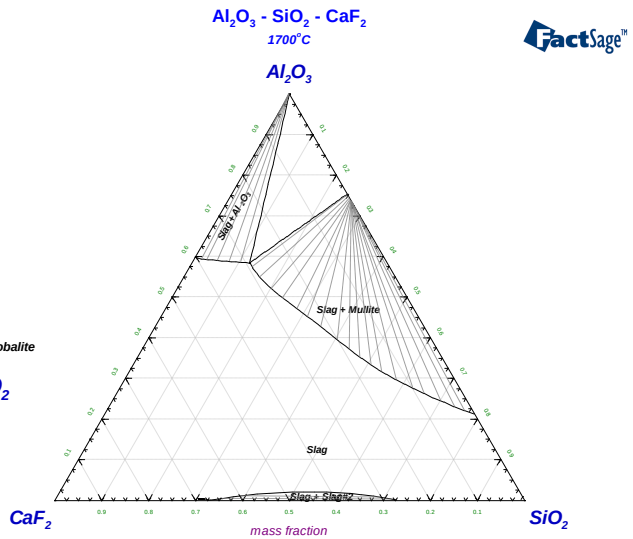


Al2O3-CaF2-SiO2,

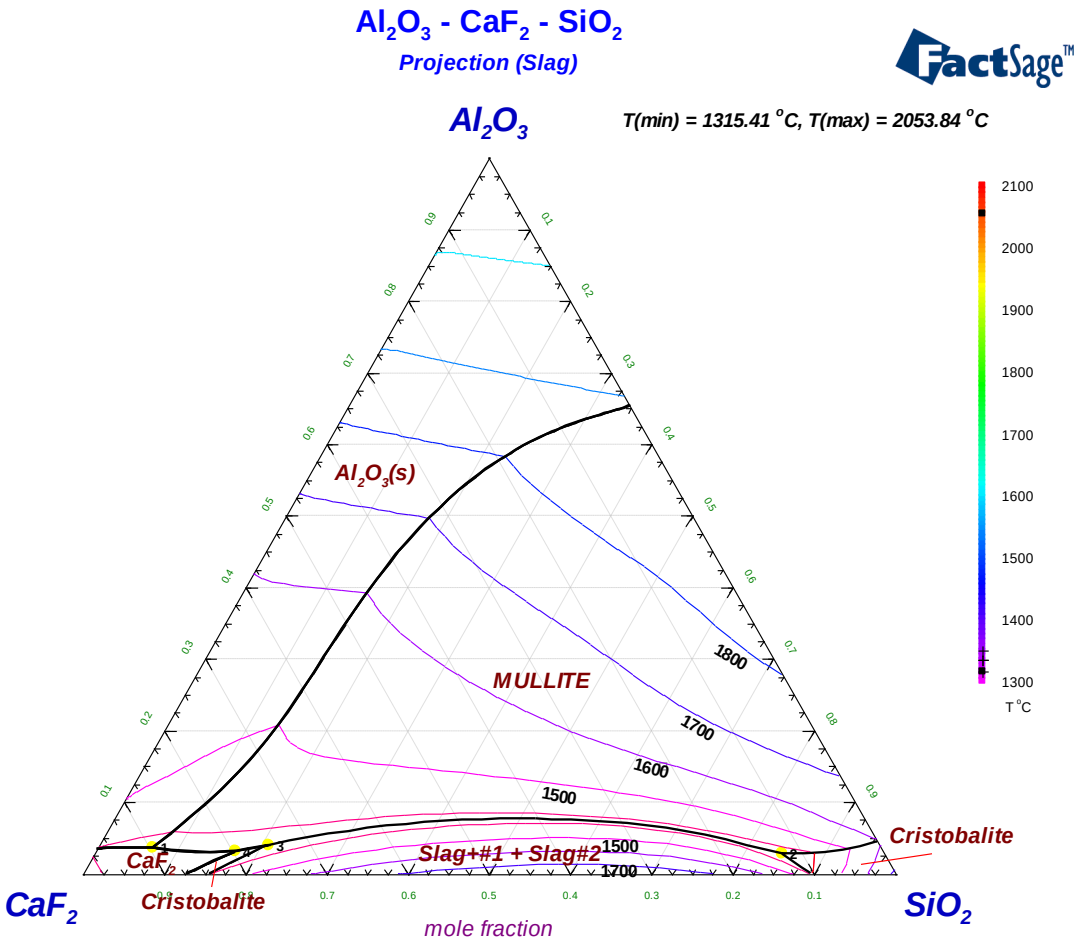
Weight percent 1500°C, 1600°C and 1700°C



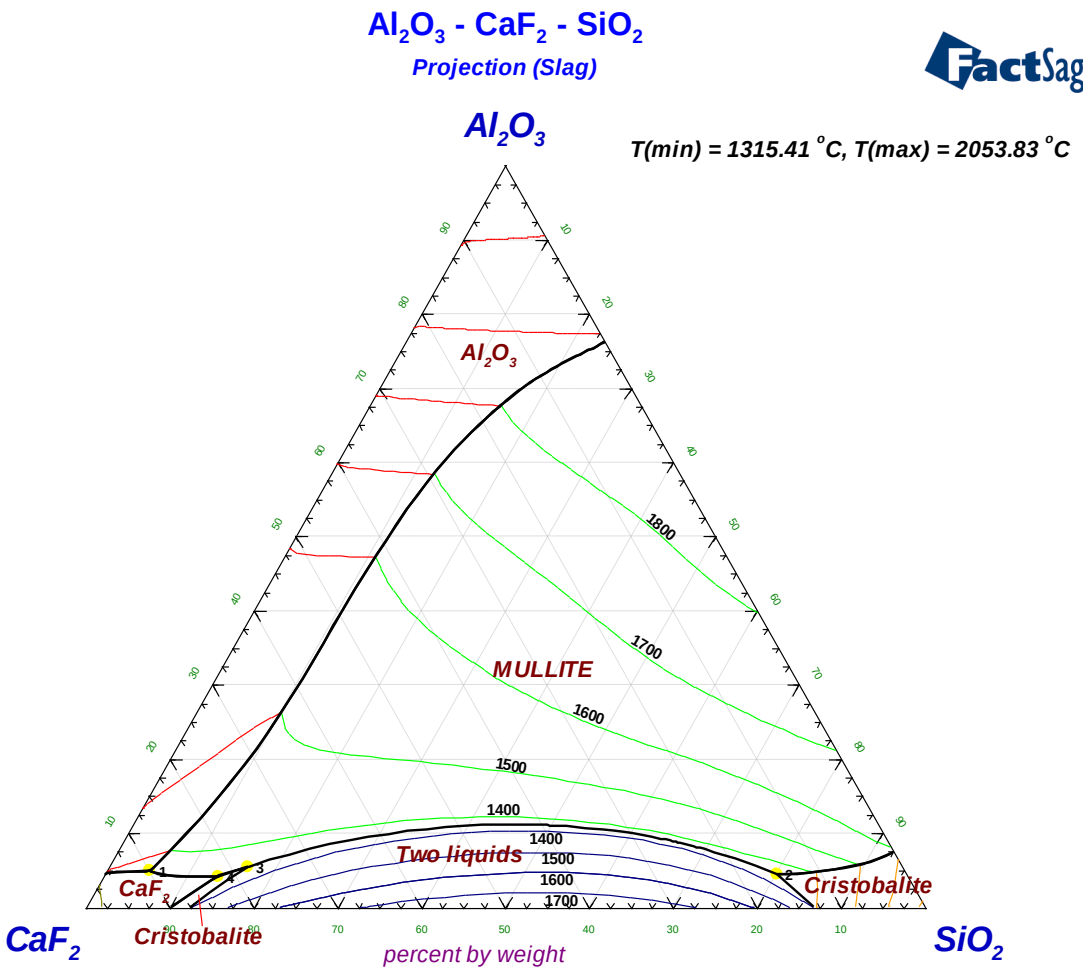




Mole fraction, Liquidussurface



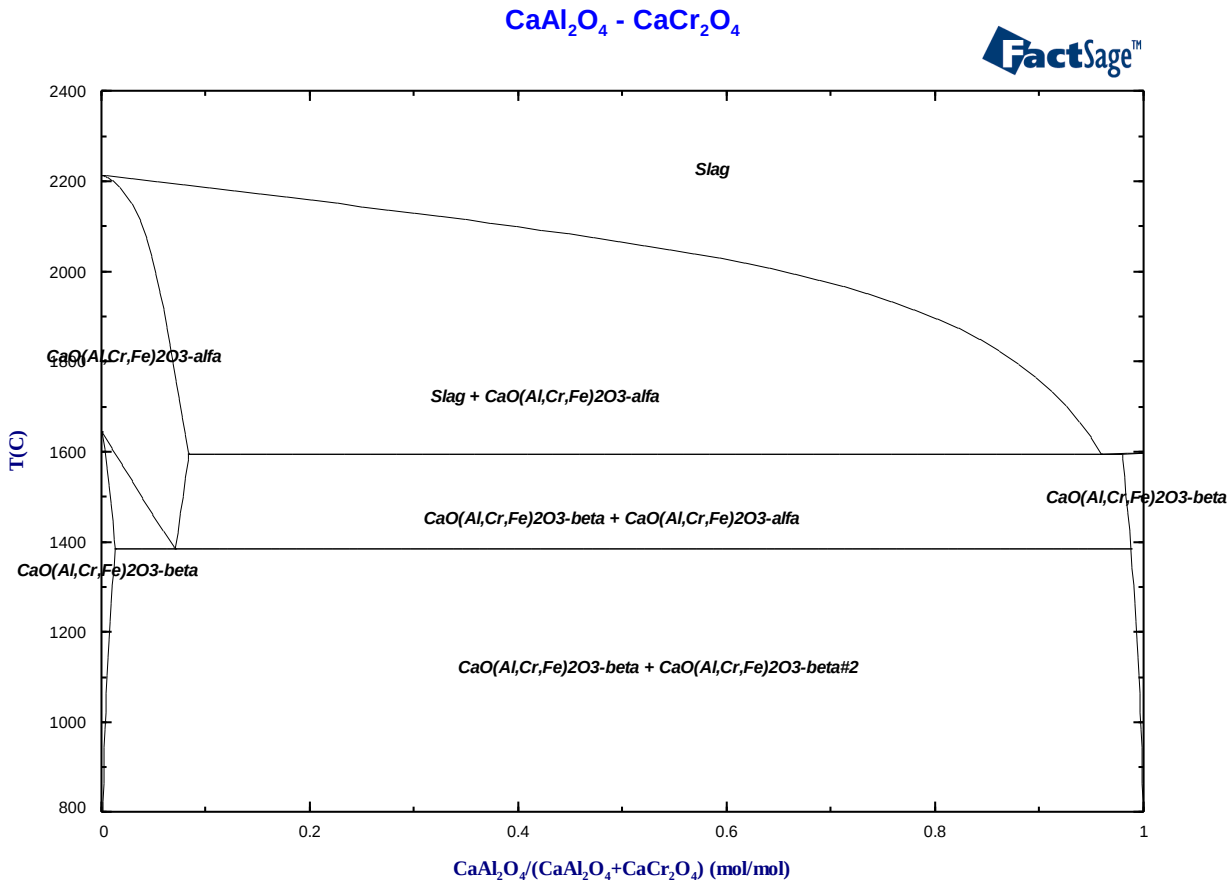
Weight percent, Liquidussurface



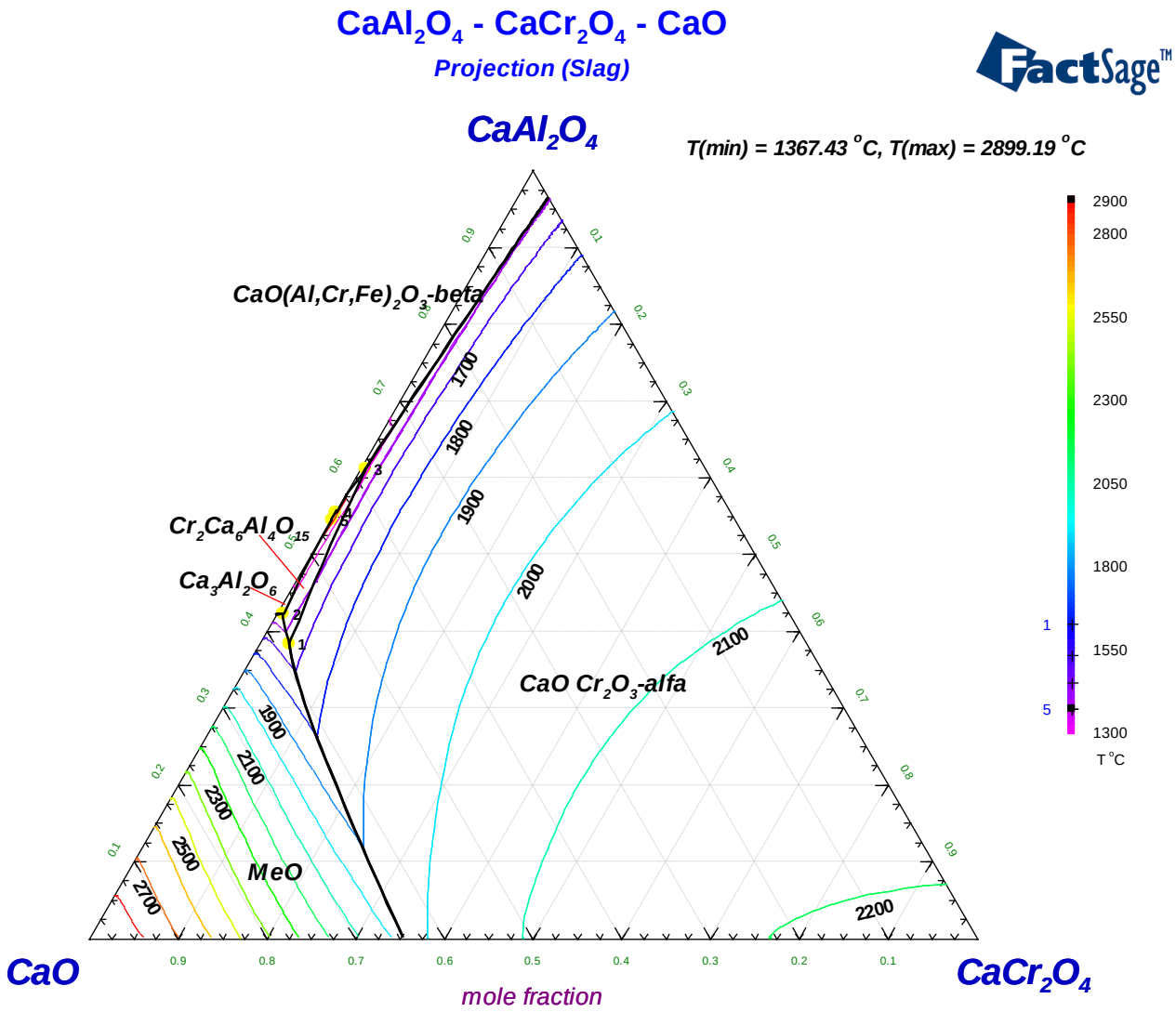
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction				Weight percent			
	A = Al2O3, B = CaF2, C = SiO2				A = Al2O3, B = CaF2, C = SiO2			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1. Al2O3 / CaF2 / MULLITE	1: 0.03733	0.89529	0.06738	1349.38	1. 4.896	89.898	5.207	1349.38
2. MULLITE / Slag#2 / Cristobalite	2: 0.02809	0.12530	0.84661	1334.46	2. 4.509	15.403	80.088	1334.48
3. MULLITE / Cristobalite / Slag#2	3: 0.04019	0.75217	0.20765	1334.46	3. 5.441	77.990	16.569	1334.46
4. CaF2 / MULLITE / Cristobalite	4: 0.03122	0.79700	0.17177	1315.42	4. 4.204	82.168	13.629	1315.41

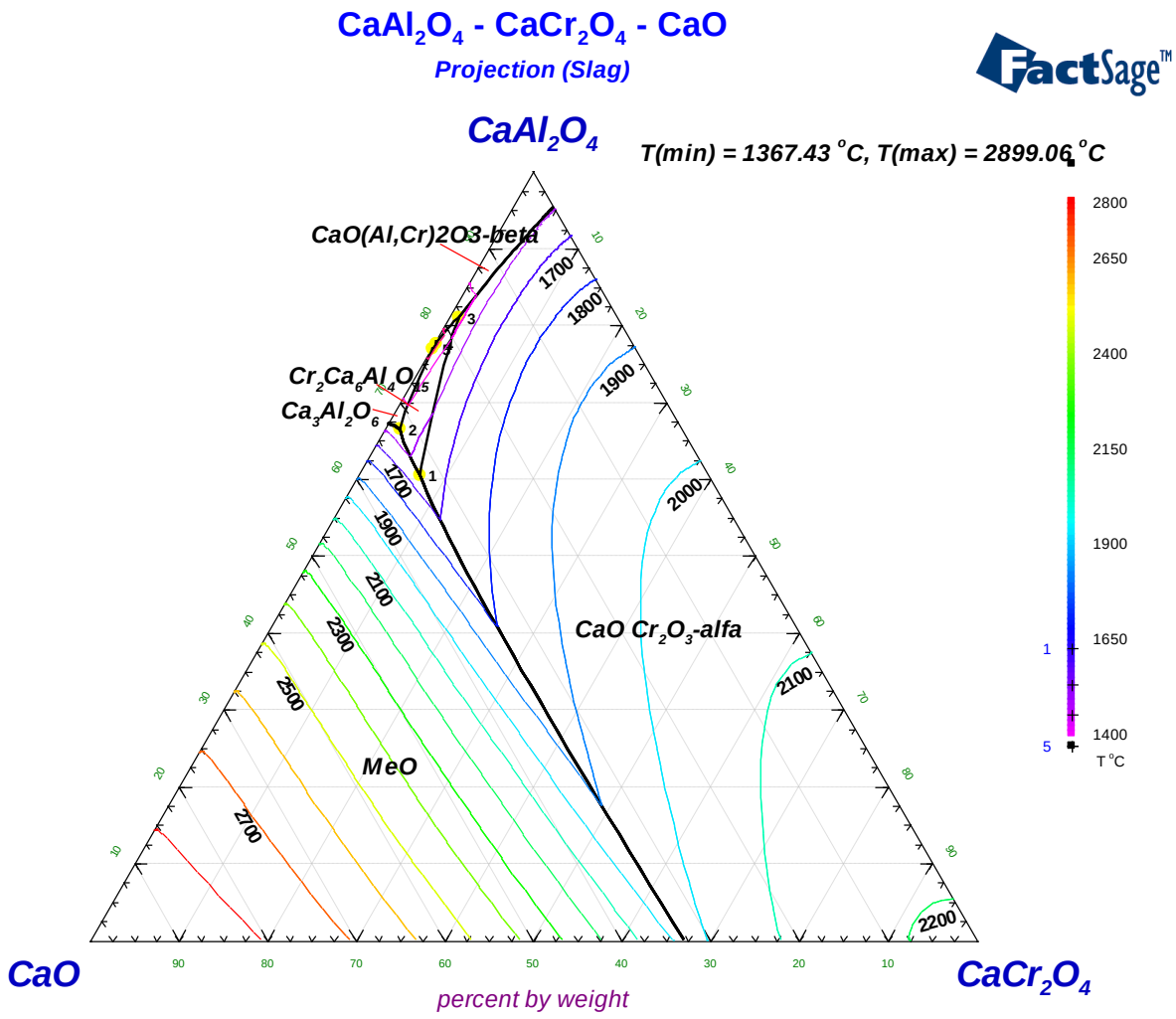
Al2O3-CaO-Cr2O3,
Mole fraction, Isopleth CaAl2O4-CaCr2O4



Mole fraction, Liquidussurface

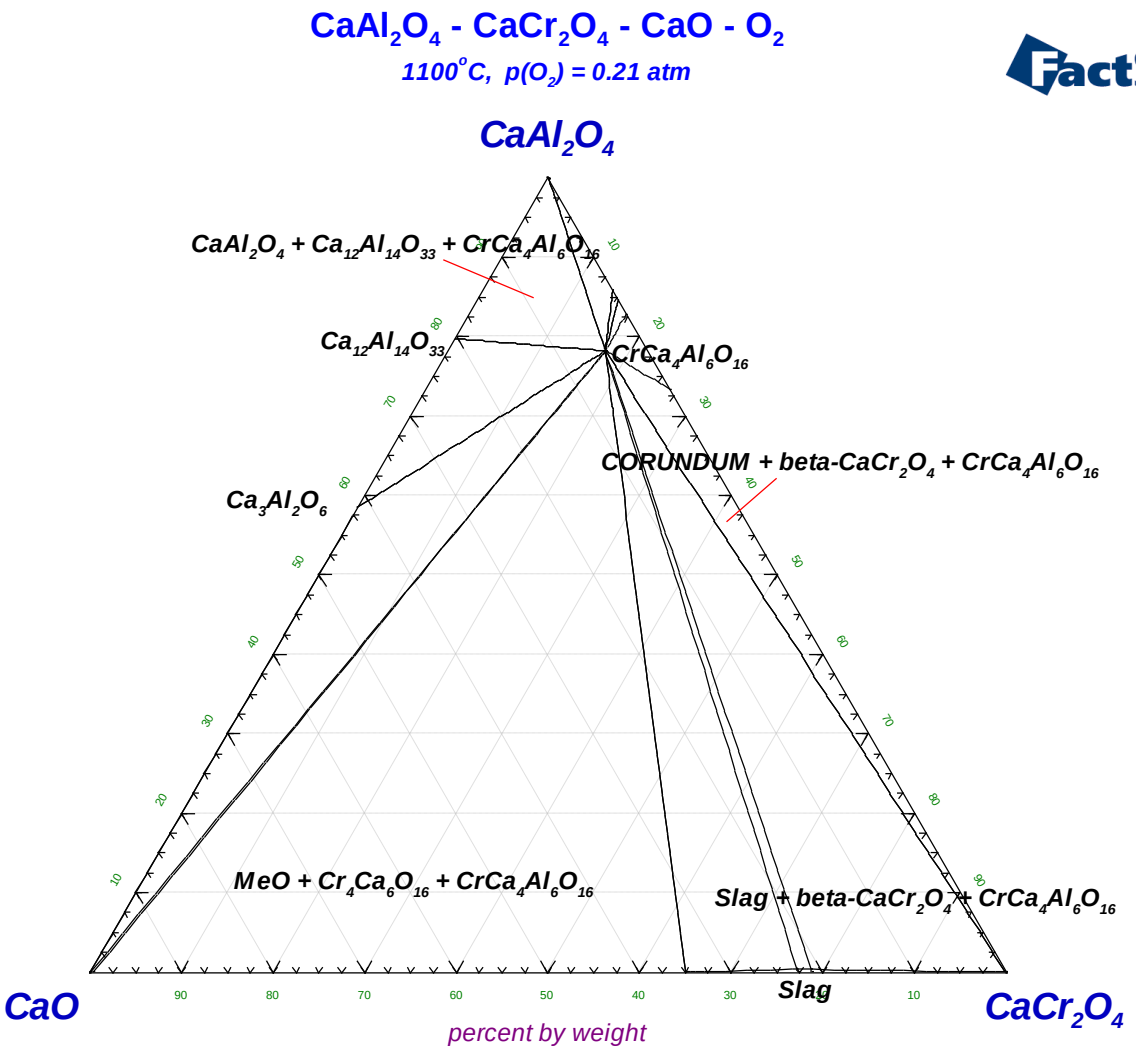


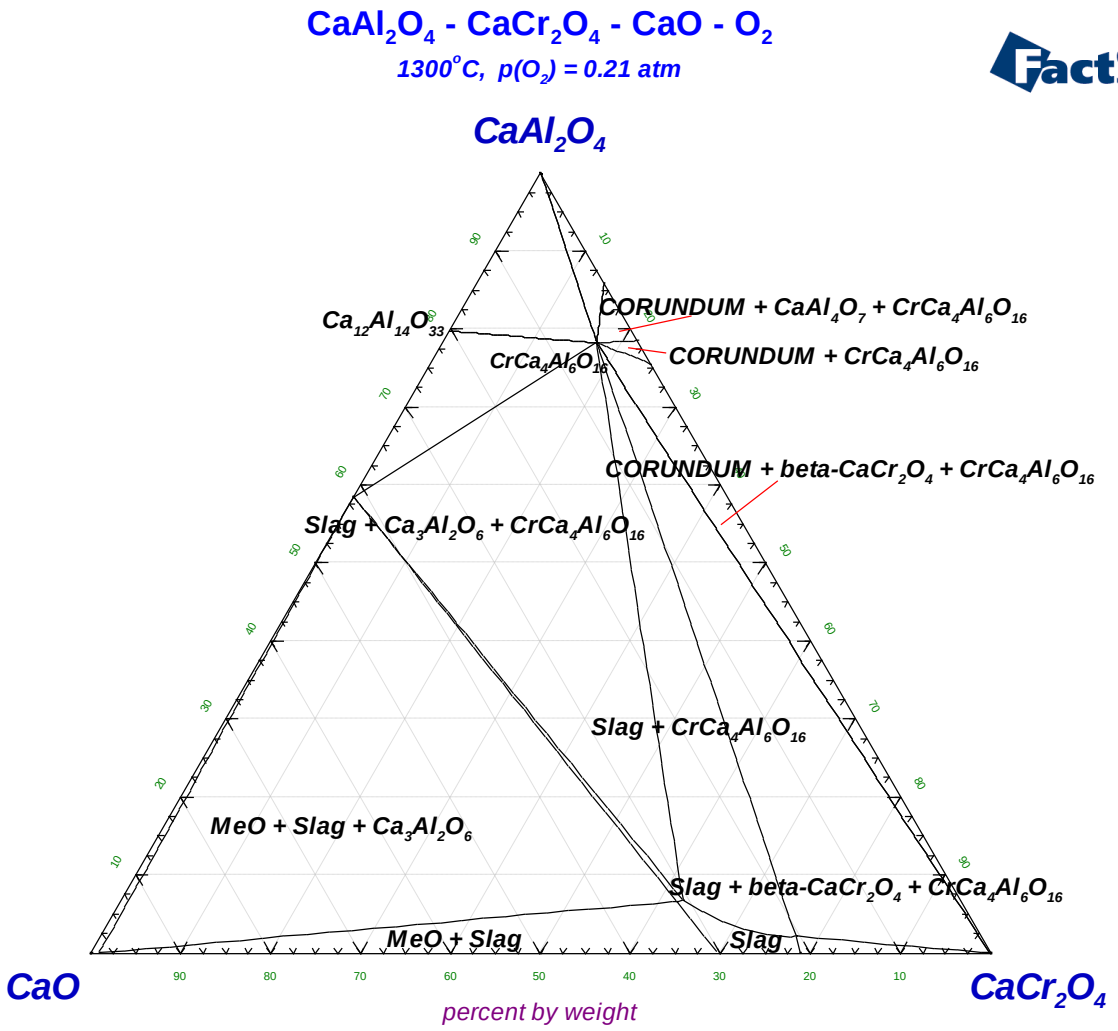
Weight percent, Liquidussurface

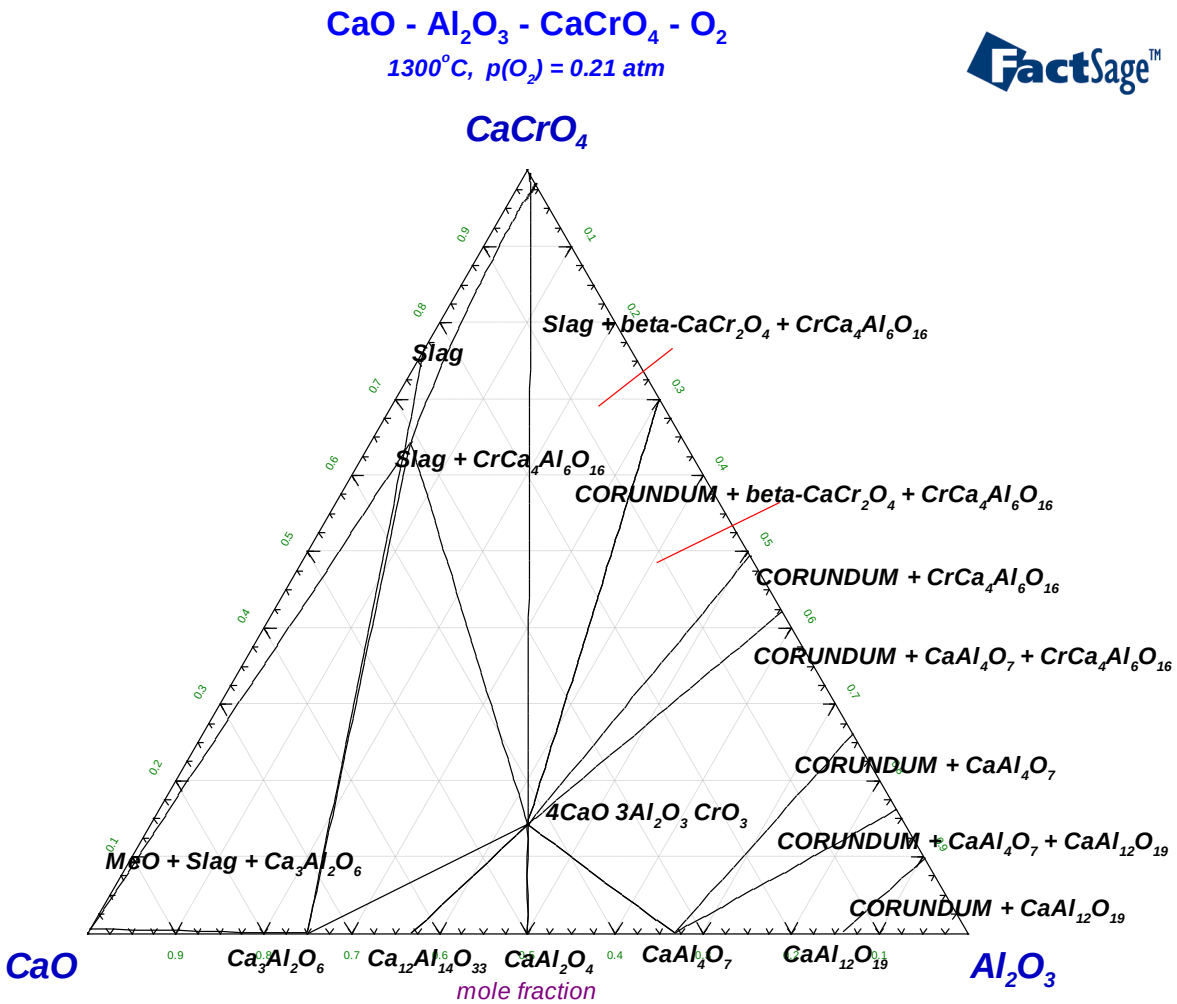


Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction				Weight percent			
	A = CaAl2O4, B = CaO, C = CaCr2O4				A = CaAl2O4, B = CaO, C = CaCr2O4			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: CaO Cr2O3-alfa / Cr2Ca6Al4O15 / MeO	1: 0.38421	0.58226	0.03353	1626.17	1: 60.510	32.538	6.952	1626.17
2: Ca3Al2O6 / Cr2Ca6Al4O15 / MeO	2: 0.42206	0.56991	0.00803	1530.04	2: 66.481	31.853	1.666	1529.92
3: $CaOCr_2O_3$-alfa/ $CaO(Al,Cr)_2O_3$-beta/$Cr_2Ca_6Al_4O_{15}$	3: 0.61156	0.38219	0.00624	1449.05	3: 80.959	17.953	1.088	1449.12
4: Ca12Al14O33 / $CaO(Al,Cr)_2O_3$-beta /$Cr_2Ca_6Al_4O_{15}$	4: 0.55411	0.44475	0.00114	1369.09	4: 77.670	22.121	0.210	1369.09
5: Ca12Al14O33 / Ca3Al2O6 / Cr2Ca6Al4O15	5: 0.54476	0.45421	0.00103	1367.45	5: 77.021	22.787	0.192	1367.43


CaAl2O4 - CaCr2O4 - CaO - O2
1100°C, p(O2) = 0.21 atm
CaAl2O4
CaAl2O4 + Ca12Al14O33 + CrCa4Al6O16
Ca12Al14O33
CrCa4Al6O16
CORUNDUM + beta-CaCr2O4 + CrCa4Al6O16
Ca3Al2O6
MeO + Cr4Ca6O16 + CrCa4Al6O16
Slag + beta-CaCr2O4 + CrCa4Al6O16
Slag
CaO
CaCr2O4
percent by weight

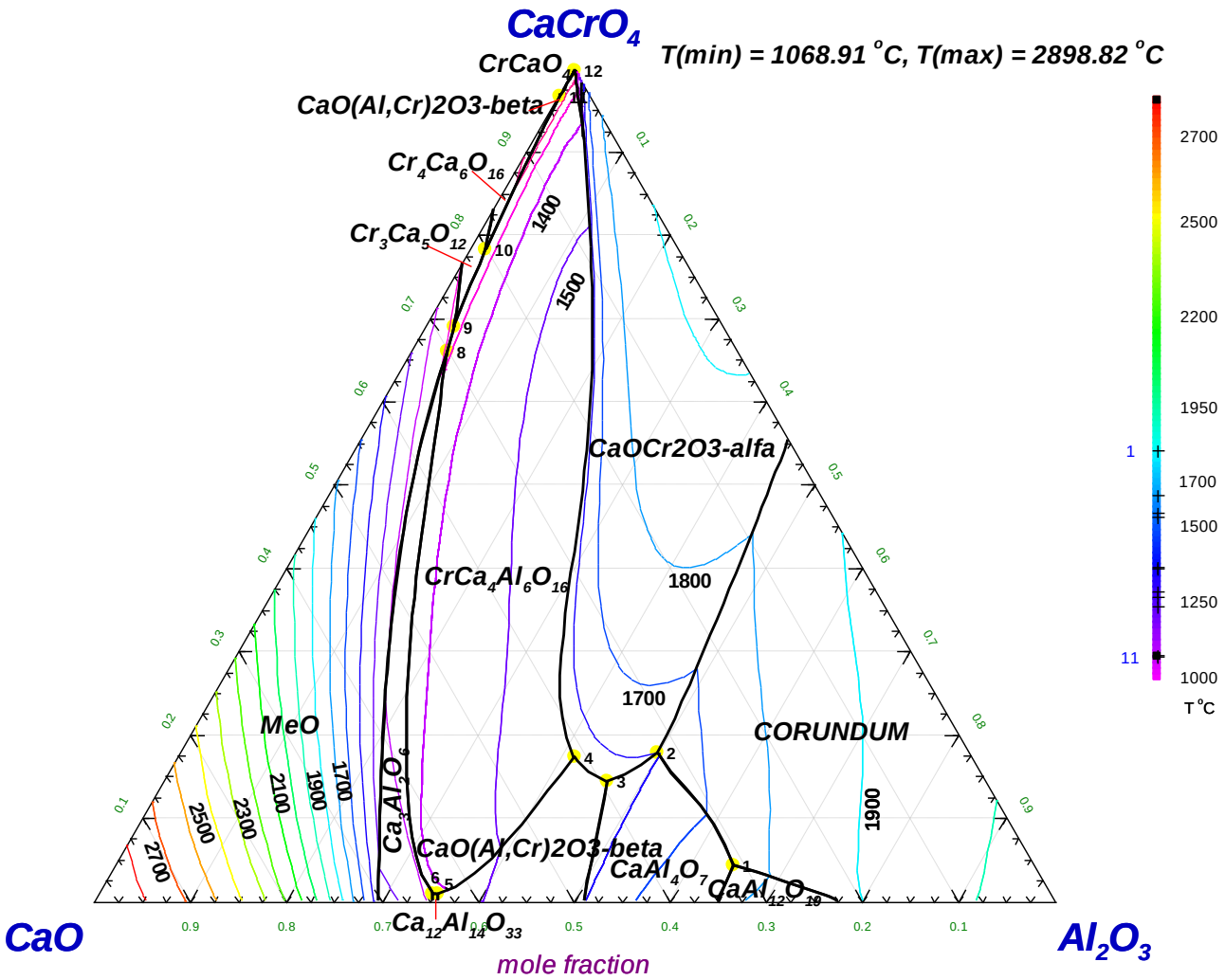

CaAl2O4 - CaCr2O4 - CaO - O2
1300°C, p(O2) = 0.21 atm
CaAl2O4
Ca12Al14O33
CORUNDUM + CaAl4O7 + CrCa4Al6O16
CrCa4Al6O16
CORUNDUM + CrCa4Al6O16
CORUNDUM + beta-CaCr2O4 + CrCa4Al6O16
Slag + Ca3Al2O6 + CrCa4Al6O16
Slag + CrCa4Al6O16
MeO + Slag + Ca3Al2O6
Slag + beta-CaCr2O4 + CrCa4Al6O16
MeO + Slag
Slag
CaO
CaCr2O4
percent by weight


CaO - Al2O3 - CaCrO4 - O2
1300°C, p(O2) = 0.21 atm
FactSage™
CaCrO4
Slag + beta-CaCr2O4 + CrCa4Al6O16
Slag
Slag + CrCa4Al6O16
CORUNDUM + beta-CaCr2O4 + CrCa4Al6O16
CORUNDUM + CrCa4Al6O16
CORUNDUM + CaAl4O7 + CrCa4Al6O16
CORUNDUM + CaAl4O7
4CaO 3Al2O3 CrO3
CORUNDUM + CaAl4O7 + CaAl12O19
MgO + Slag + Ca3Al2O6
CORUNDUM + CaAl12O19
CaO
Ca3Al2O6
Ca12Al14O33
CaAl2O4
CaAl4O7
CaAl12O19
Al2O3
mole fraction

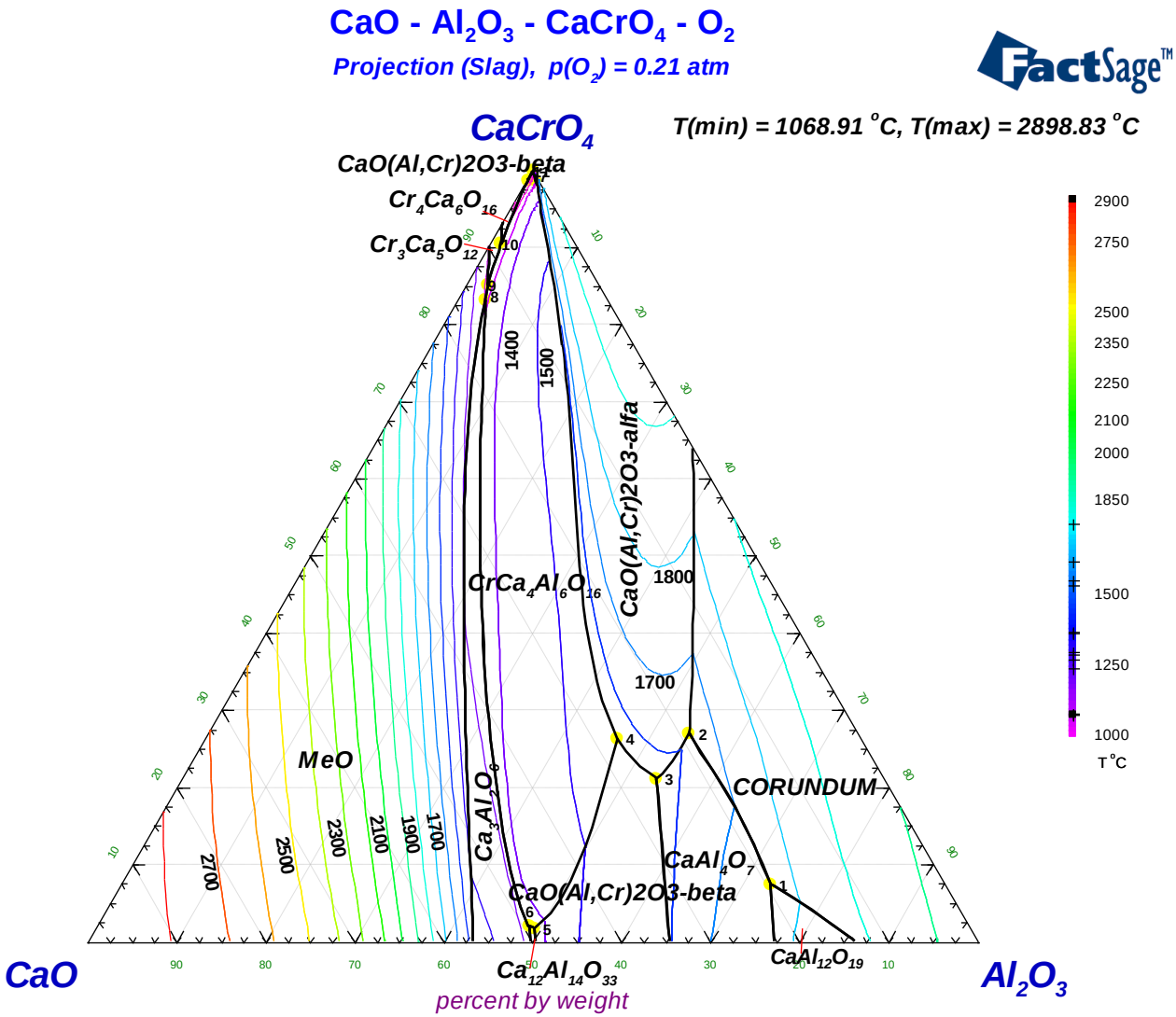
Mole fraction, Liquidussurface

$CaO - Al_2O_3 - CaCrO_4 - O_2$

Projection (Slag), $p(O_2) = 0.21$ atm



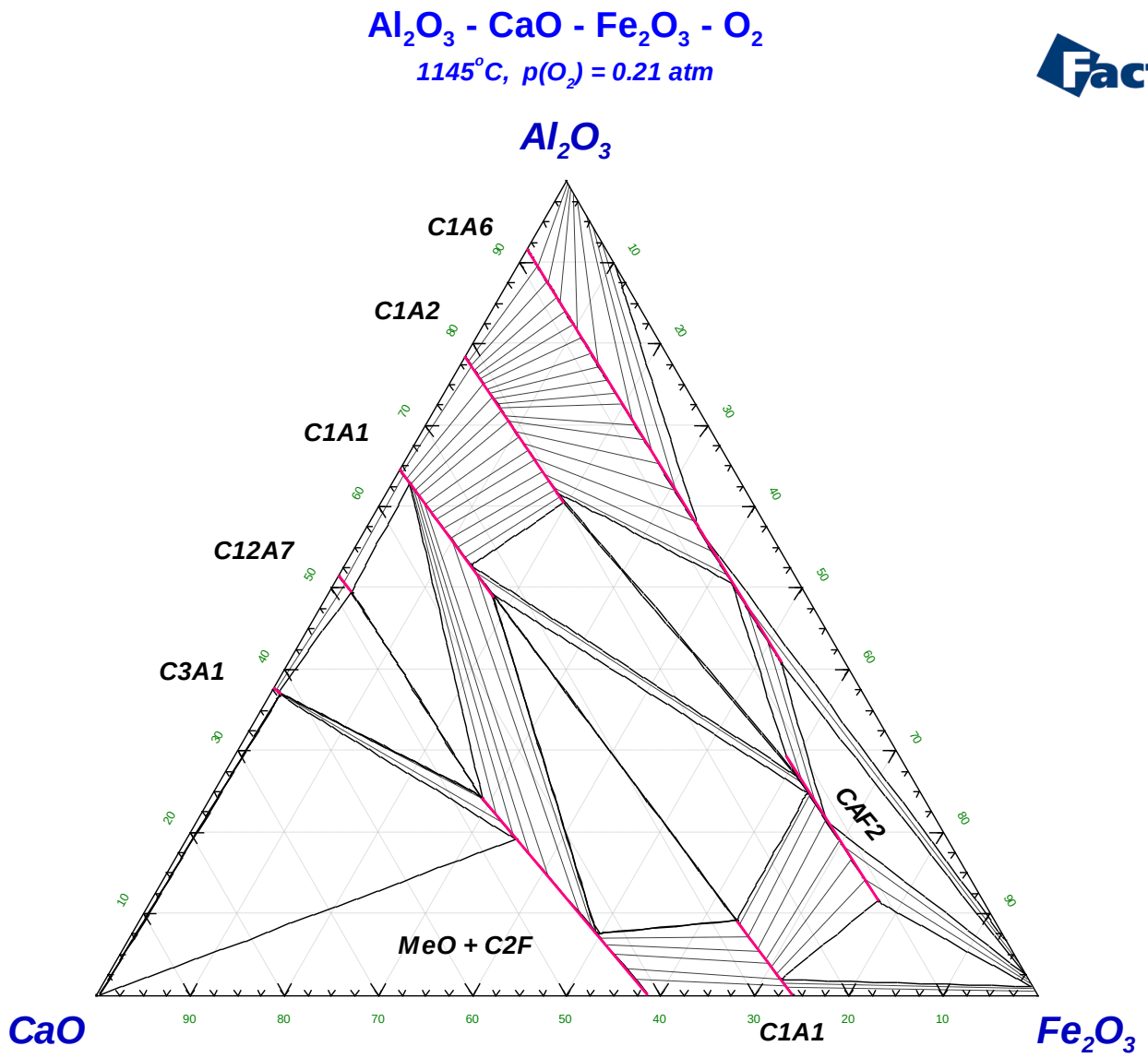
Weight percent, Liquidussurface



Invariant equilibria on the liquidus surface

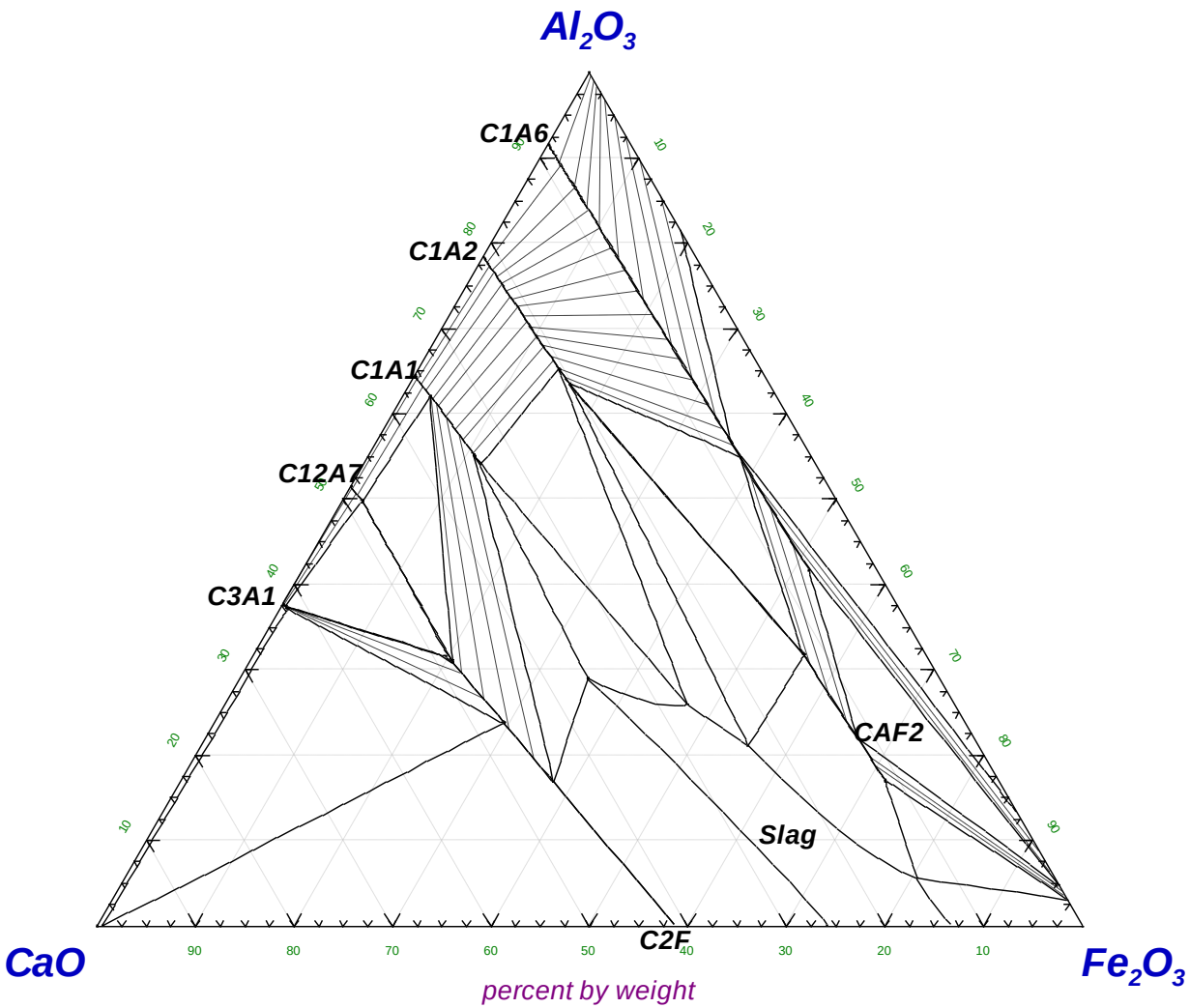
Intersections with slag	Mole fraction					Weight percent				
	A = CaCrO4, B = CaO, C = Al2O3					A = CaCrO4, B = CaO, C = Al2O3				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: CORANDUM / CaAl12O19 / CaAl4O7	1:	0.04282	0.31255	0.64463	1747.59	1:	7.431	19.488	73.081	1747.59
2: CORANDUM / CaAl4O7 / CaO(Al,Cr)2O3-alfa	2:	0.16630	0.32332	0.51038	1613.12	2:	27.001	18.862	54.137	1613.11
3: CaAl4O7 /CaO Cr_2O_3-alfa/CaO(Al,Cr,Fe)$_2$O$_3$-beta	3:	0.12175	0.40829	0.46996	1548.14	3:	21.157	25.492	53.352	1548.14
4: CaO Cr2O3-alfa / CaO(Al,Cr)$_2$O$_3$-beta/CrCa4Al6O16	4:	0.15151	0.43869	0.40980	1528.74	4:	26.265	27.325	46.410	1528.74
5: Ca12Al14O33 / CaO(Al,Cr)2O3-beta / CrCa4Al6O16	5:	0.00831	0.63813	0.35356	1362.92	5:	1.773	48.932	49.294	1362.91
6: Ca12Al14O33 / Ca3Al2O6 / CrCa4Al6O16	6:	0.00947	0.64269	0.34784	1359.73	6:	2.026	49.380	48.594	1359.73
7: CaO Cr2O3-alfa / CaO(Al,Cr)$_2$O$_3$-beta/CrCa4Al6O16	7:	0.97496	0.00905	0.01599	1290.72	7:	98.615	0.329	1.057	1290.72
8: Ca3Al2O6 / CrCa4Al6O16 / MeO	8:	0.65996	0.30233	0.03771	1280.73	8:	83.200	13.694	3.106	1280.73
9: Cr3Ca5O12(s1) / CrCa4Al6O16 / MeO	9:	0.68999	0.27968	0.03033	1265.10	9:	85.153	12.402	2.446	1265.10
10: Cr3Ca5O12(s1) / Cr4Ca6O16(s1) / CrCa4Al6O16	10:	0.78248	0.20073	0.01679	1234.91	10:	90.400	8.332	1.267	1234.91
11: CaO(Al,Cr)2O3-beta / CrCa4Al6O16 / CrCaO4(s1)	11:	0.99731	0.00054	0.00215	1071.49	11:	99.840	0.019	0.141	1071.49
12: Cr4Ca6O16(s1) / CrCa4Al6O16 / CrCaO4(s1)	12:	0.96581	0.03221	0.00198	1068.92	12:	98.685	1.183	0.132	1068.97

Weight percent 1145 C°



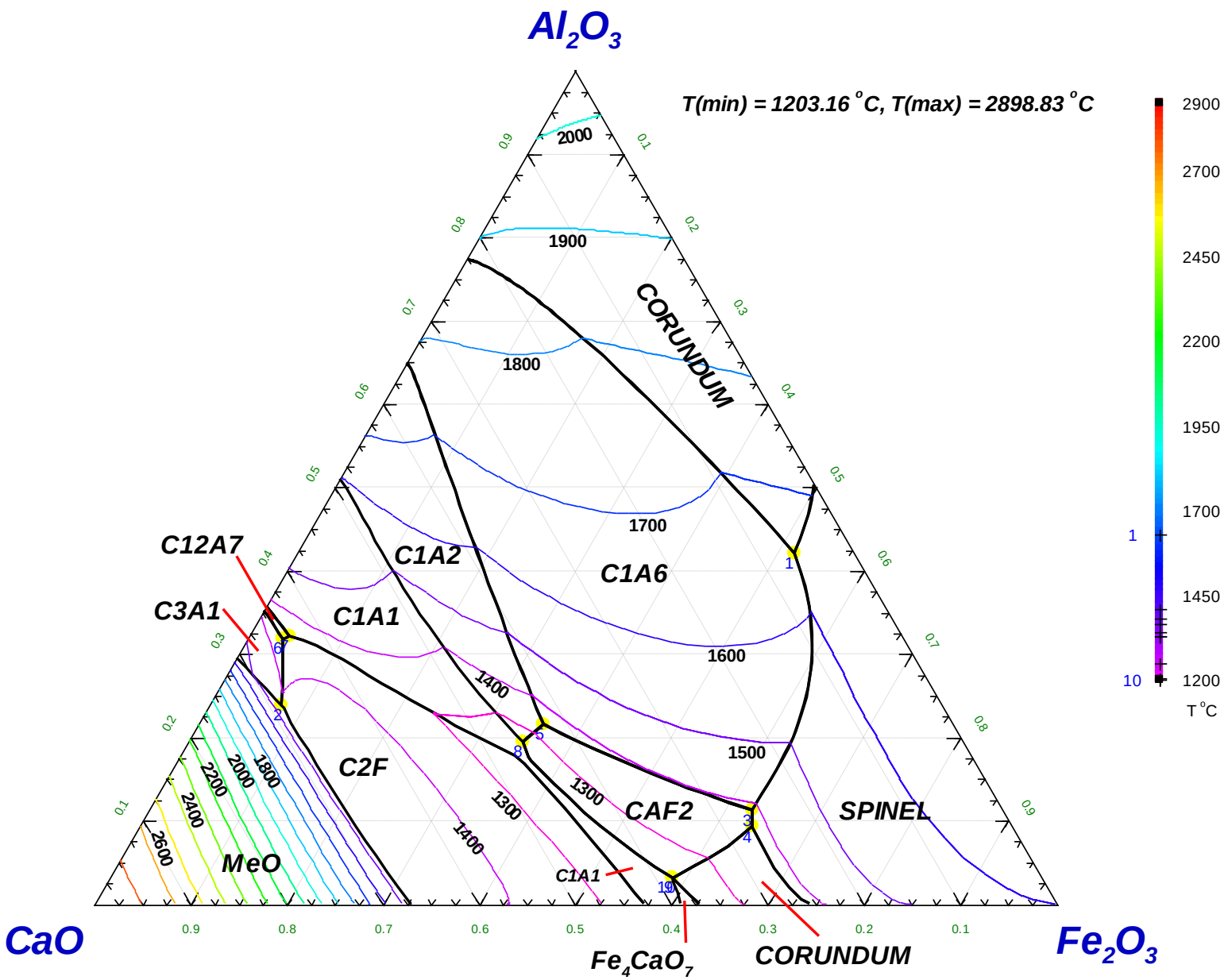
Al_2O_3 - CaO - Fe_2O_3 - O_2

1330°C, $p(O_2)$ = 0.21 atm



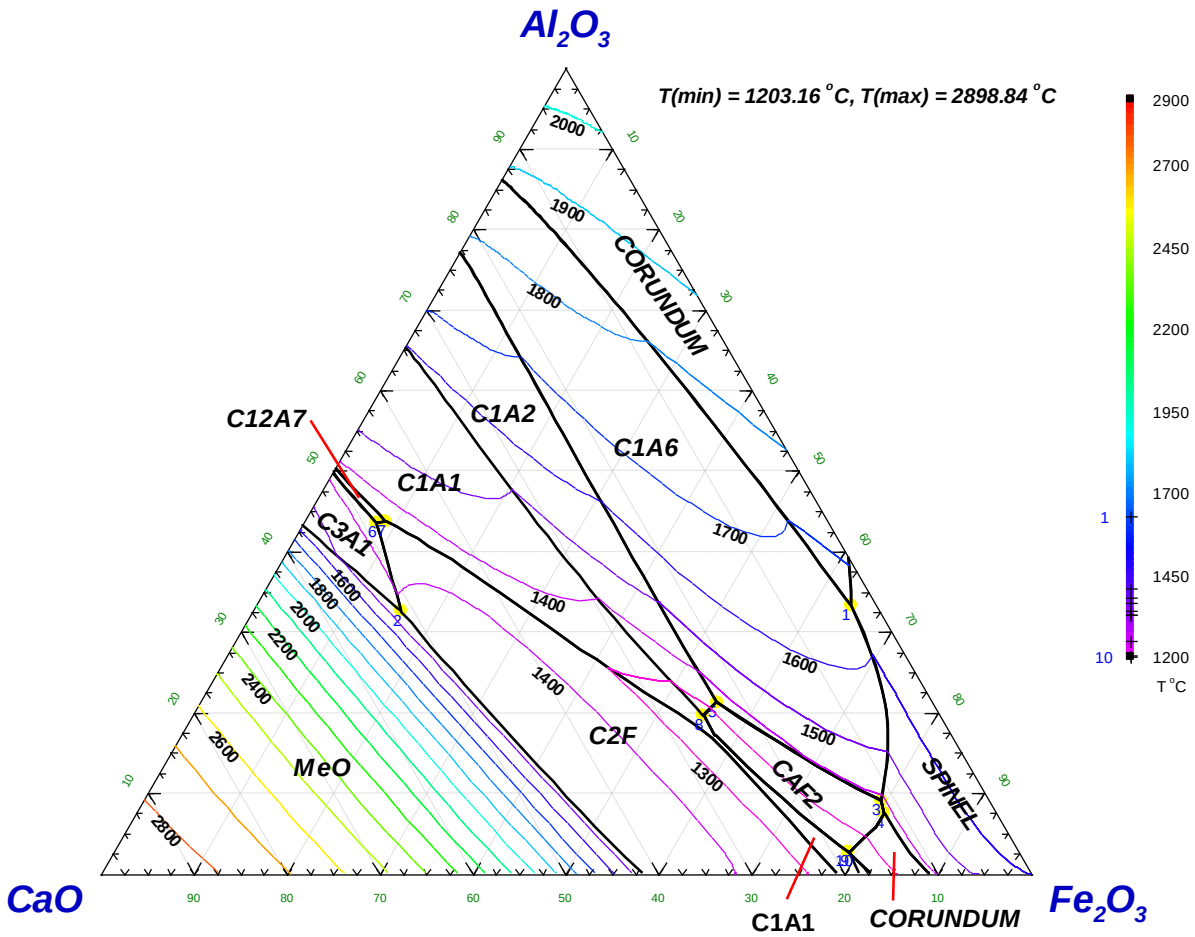
Al_2O_3 - CaO - Fe_2O_3 - O_2

Projection (Slag), $p(O_2)$ = 0.21 atm



Al_2O_3 - CaO - Fe_2O_3 - O_2

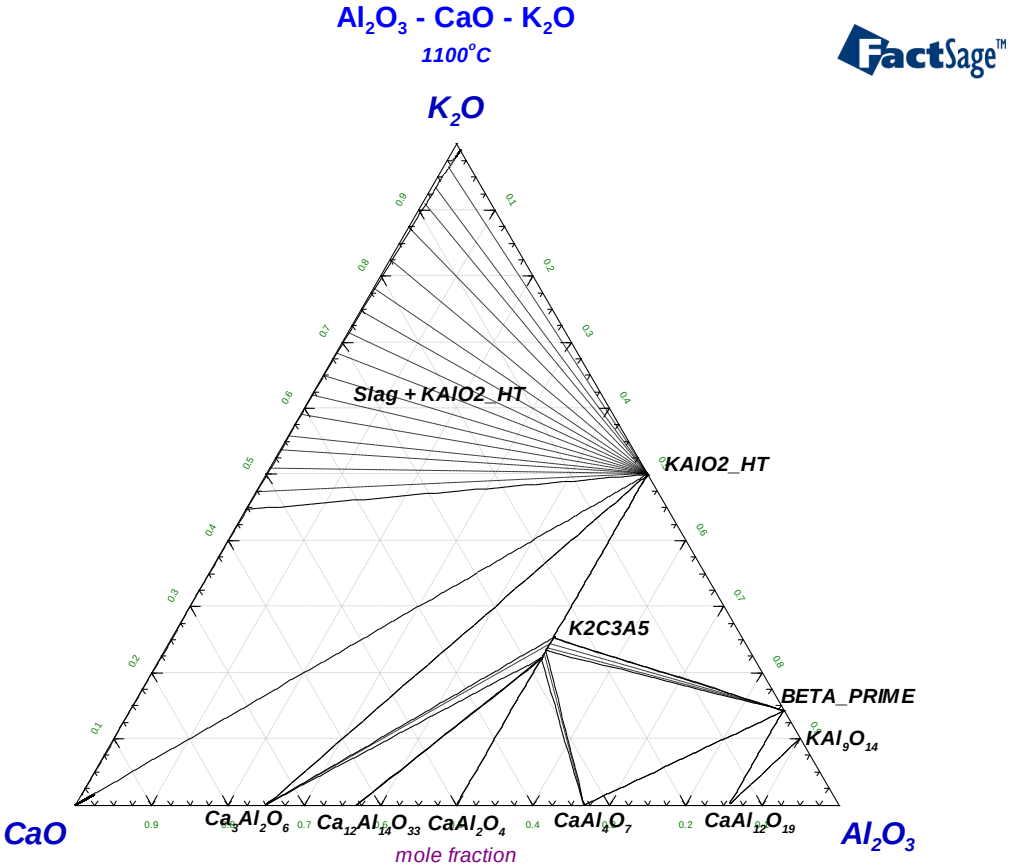
Projection (Slag), $p(O_2)$ = 0.21 atm



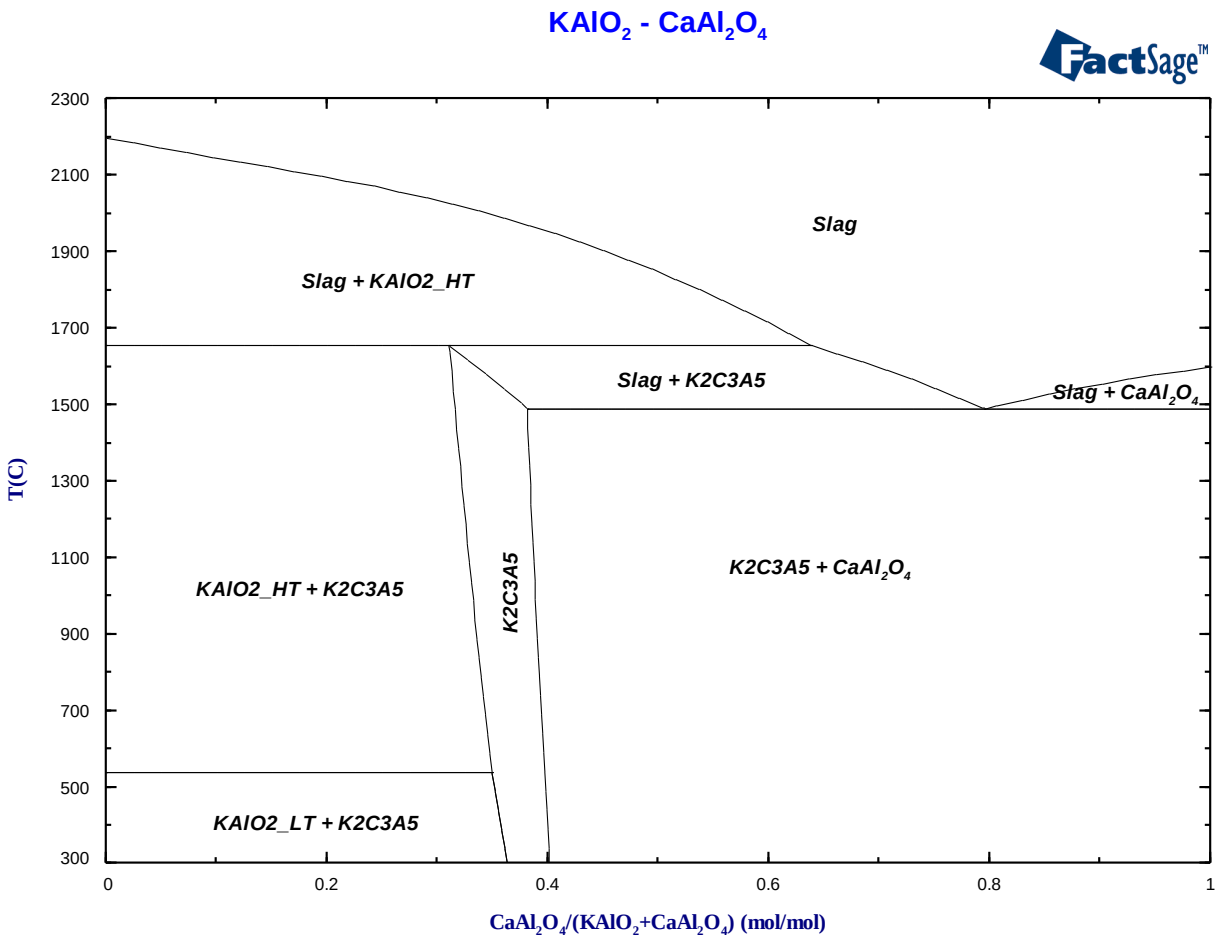
Invariant equilibria on the liquidus surface

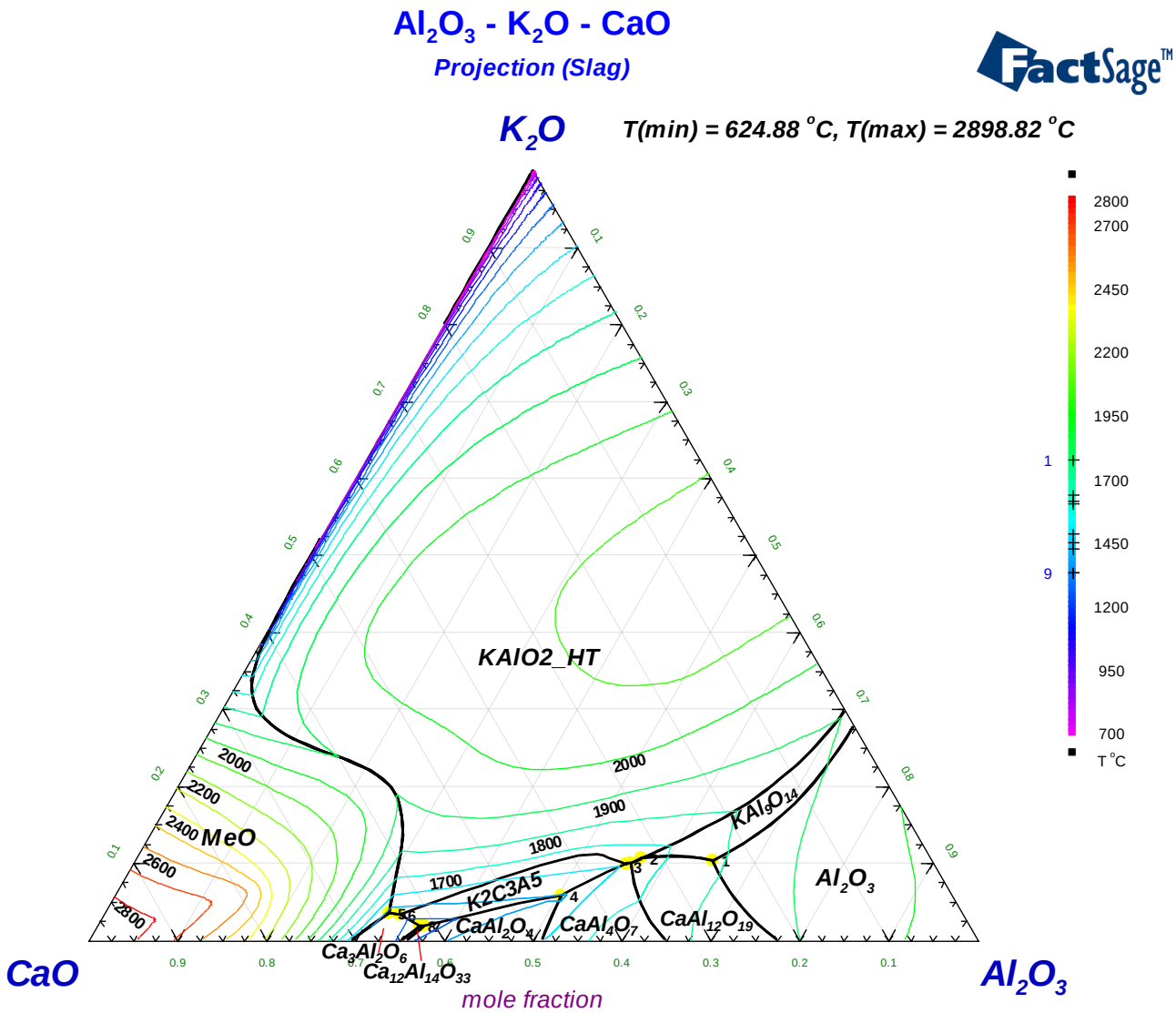
Intersections with slag	Mole fraction				Weight percent			
	A = Al2O3, B = CaO, C = Fe2O3				A = Al2O3, B = CaO, C = Fe2O3			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: C1A6 / CORANDUM / SPINEL	1: 0.42158	0.06187	0.51655	1628.43	1: 33.336%	2.691%	63.973%	1628.43
2: C2F / C3A1 / MeO	2: 0.23914	0.68577	0.07509	1407.02	2: 32.584%	51.392%	16.024%	1407.01
3: C1A6 / CAF2 / SPINEL	3: 0.1125	0.25993	0.62757	1382.25	3: 9.084%	11.544%	79.372%	1382.25
4: CAF2 / CORANDUM#1 / SPINEL	4: 0.09303	0.26949	0.63749	1365.51	4: 7.504%	11.956%	80.540%	1365.52
5: C1A2 / C1A6 / CAF2	5: 0.2159	0.42508	0.35902	1339.33	5: 21.335%	23.102%	55.564%	1339.33
6: C12A7 / C2F / C3A1	6: 0.31806	0.64507	0.03687	1331.06	6: 43.535%	48.561%	7.904%	1331.06
7: C12A7 / C1A1 / C2F	7: 0.32241	0.6363	0.04129	1330.4	7: 43.744%	47.482%	8.774%	1330.4
8: C1A1 / C1A2 / CAF2	8: 0.19482	0.45724	0.34794	1247.25	8: 19.654%	25.370%	54.976%	1247.25
9: CAF2 / CORANDUM / Fe4CaO7	9: 0.03121	0.38302	0.58576	1203.54	9: 2.692%	18.171%	79.137%	1203.54
10: C1A1 / CAF2 / Fe4CaO7	10: 0.03153	0.38367	0.58481	1203.16	10: 2.721%	18.215%	79.064%	1203.16

Al2O3-CaO-K2O,
Mole fraction 1100°C

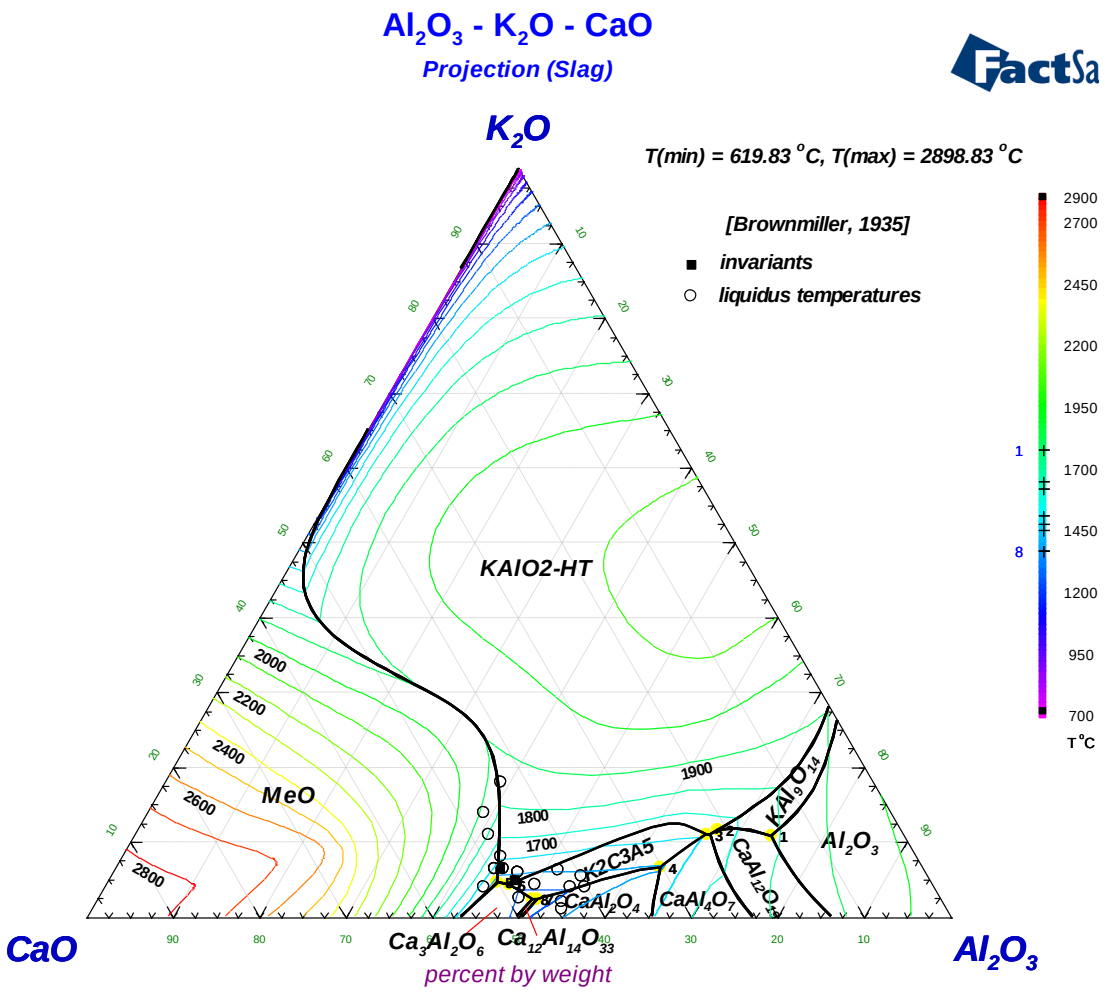


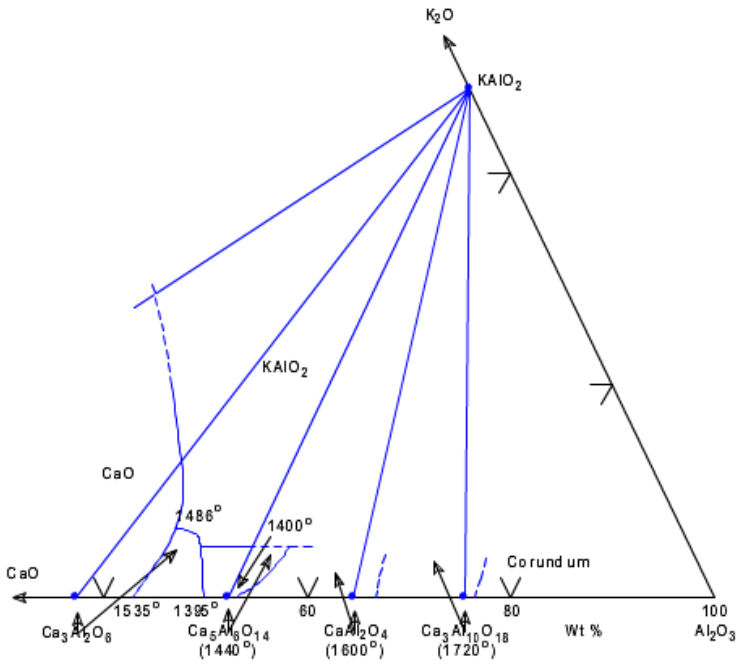
Isopleth KAlO2-CaAl2O4
(proposed calculation)




Al2O3 - K2O - CaO
Projection (Slag)
FactSage™
K2O
T(min) = 624.88 °C, T(max) = 2898.82 °C
KAlO2_HT
MeO
K2C3A5
KAl9O14
CaAl2O4
CaAl4O7
CaAl12O19
Al2O3
Ca3Al2O6
Ca12Al14O33
2000
2200
2400
2600
2800
1900
1800
1700
CaO
Al2O3
mole fraction
2800
2700
2450
2200
1950
1700
1450
1200
950
700
T °C

Weight percent
compared with experimental data
Liquidussurface





L. T. Brownmiller, Am. J. Sci., 229(29) [171] 260-277 (1935).

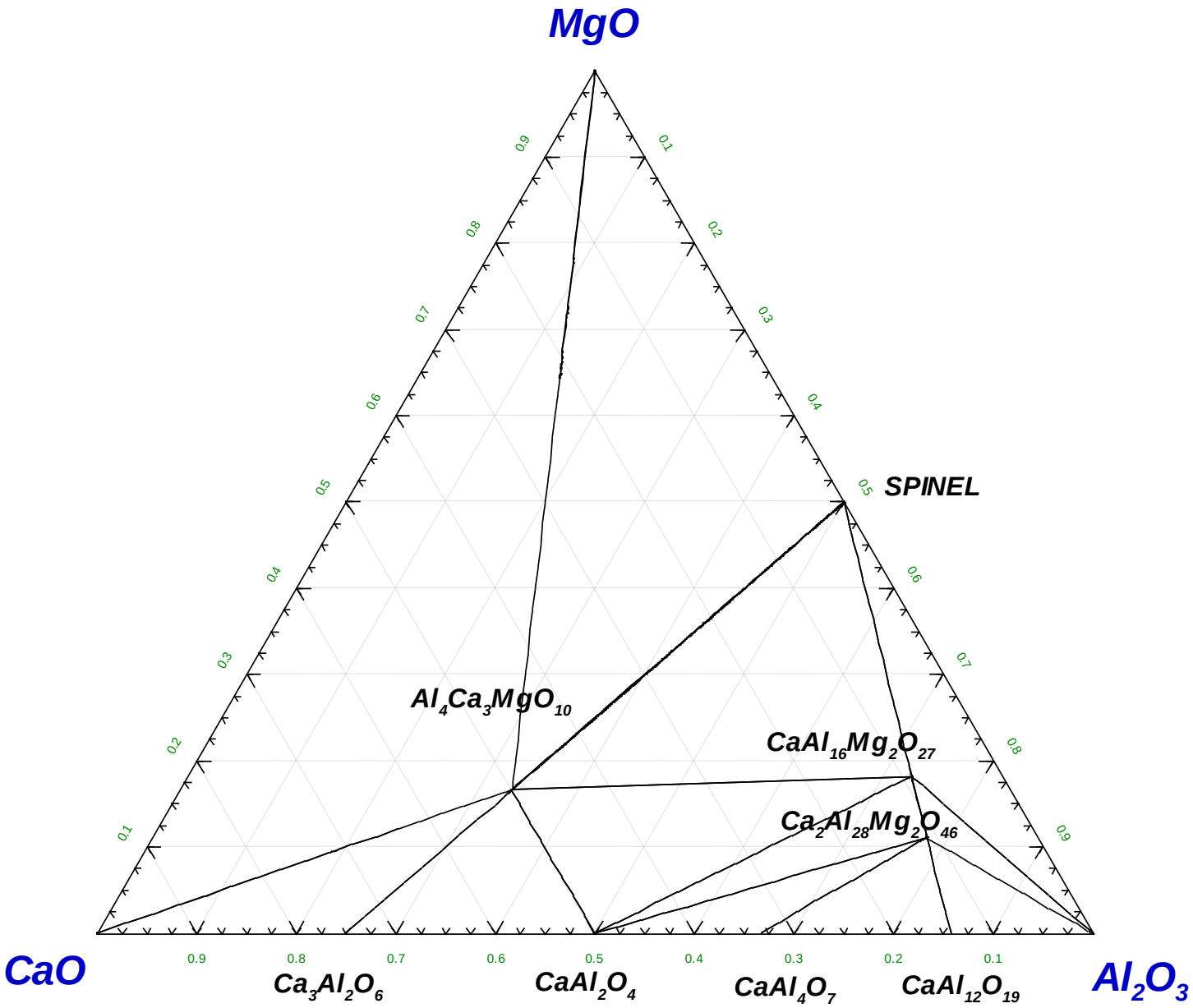
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction					Weight percent				
	A = K2O, B = CaO, C = Al2O3					A = K2O, B = CaO, C = Al2O3				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: Al2O3 / CaAl12O19 / KAl9O14	1:	0.10355	0.24536	0.65109	1779.63	1:	10.850	15.305	73.845	1779.59
2: KAlO2_HT / CaAl12O19 / KAl9O14	2:	0.10619	0.32463	0.56919	1637.27	2:	11.598	21.108	67.294	1637.27
3: K2C3A5 / KAlO2_HT / CaAl4O7	4:	0.09934	0.34581	0.55486	1605.84	3:	10.967	22.728	66.306	1605.83
4: K2C3A5 / CaAl2O4 / CaAl4O7	5:	0.05728	0.43905	0.50367	1488.48	4:	6.631	30.257	63.112	1488.48
5: KAlO2_HT / Ca3Al2O6 / MeO	6:	0.03540	0.64447	0.32013	1450.15	5:	4.624	50.114	45.261	1450.16
6: K2C3A5 / KAlO2_HT / Ca3Al2O6	7:	0.03352	0.63357	0.33291	1424.91	6:	4.348	48.917	46.735	1424.93
7: K2C3A5 / Ca12Al14O33 / CaAl2O4	8:	0.01875	0.61255	0.36870	1334.03	7:	2.396	46.602	51.002	1334.03
8: K2C3A5 / Ca12Al14O33 / Ca3Al2O6	9:	0.01849	0.61799	0.36351	1332.16	8:	2.371	47.175	50.454	1332.16

Al_2O_3 - CaO - MgO

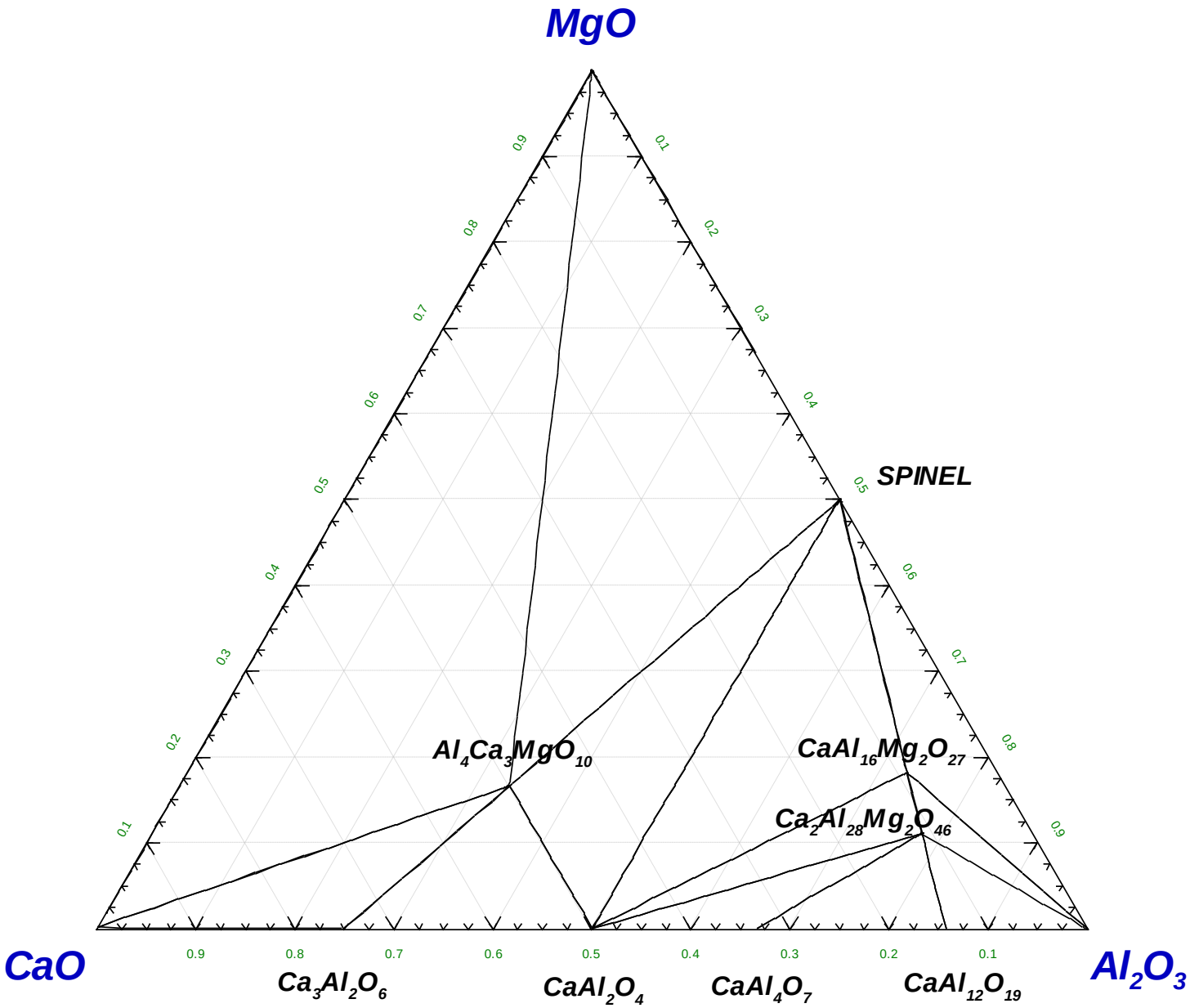
500°C

Al2O3-CaO-MgO,
Mole fraction



Al_2O_3 - CaO - MgO

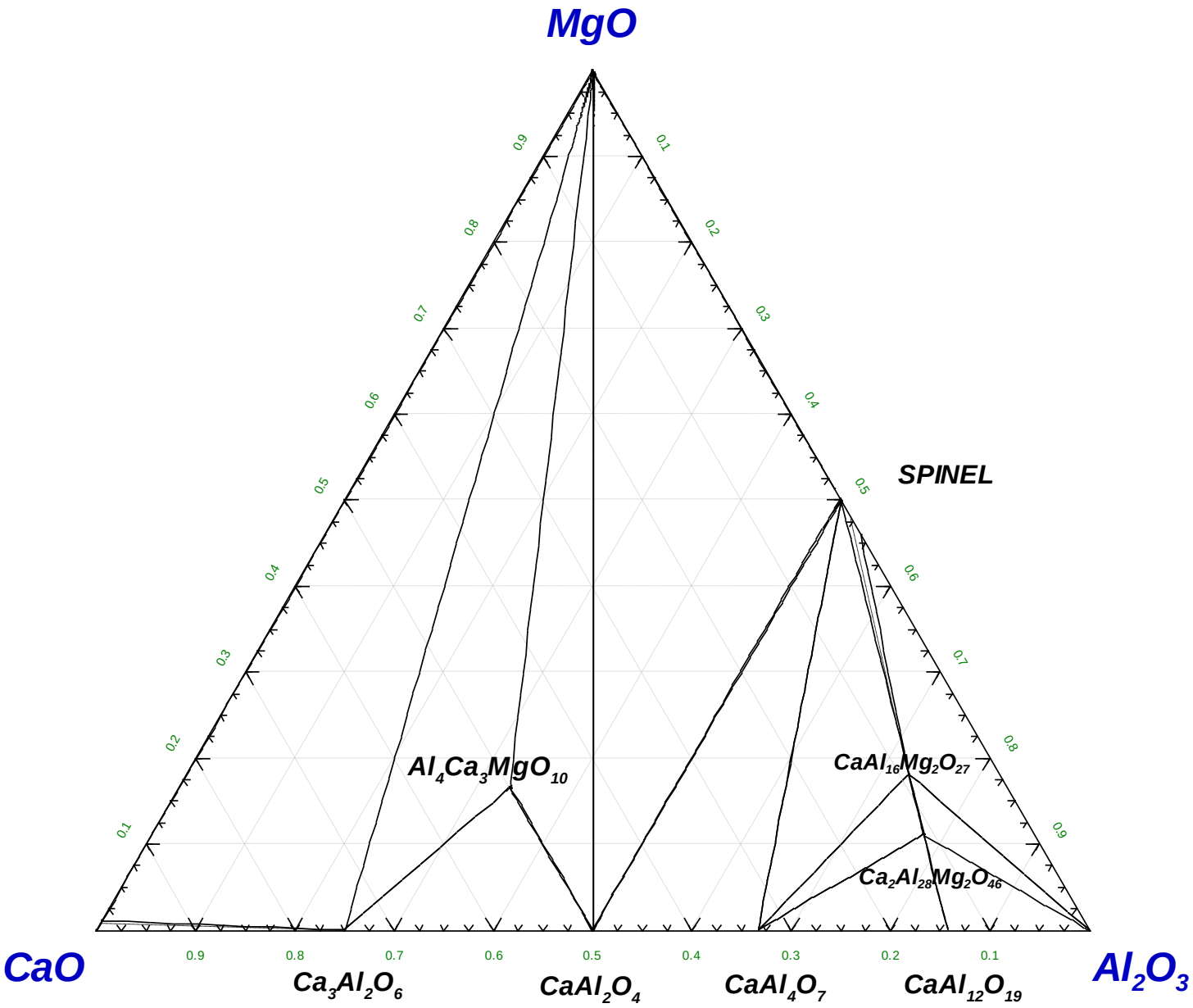
1000°C



Mole fraction
kurz unterhalb Liquidussurface

Al_2O_3 - CaO - MgO

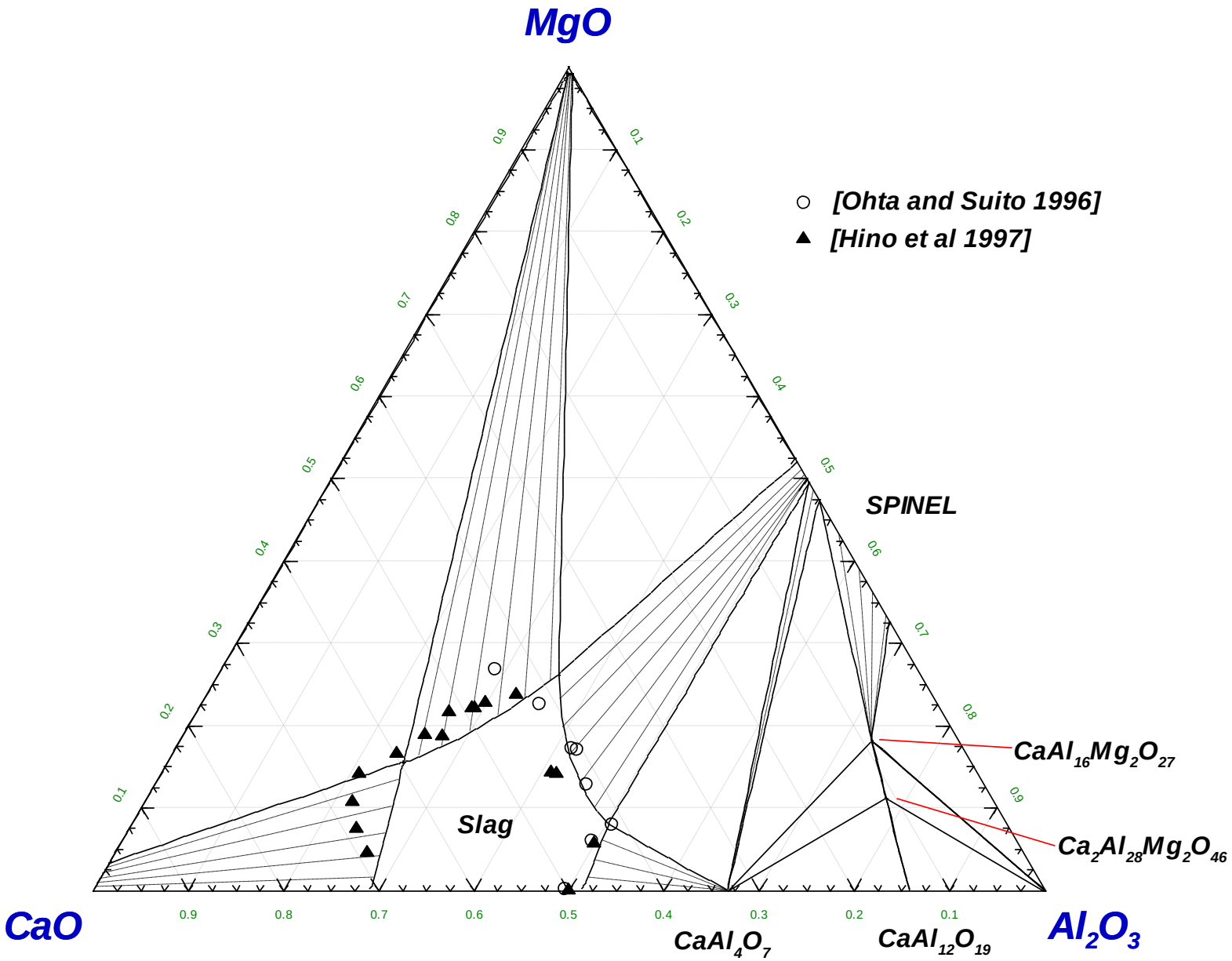
1320°C



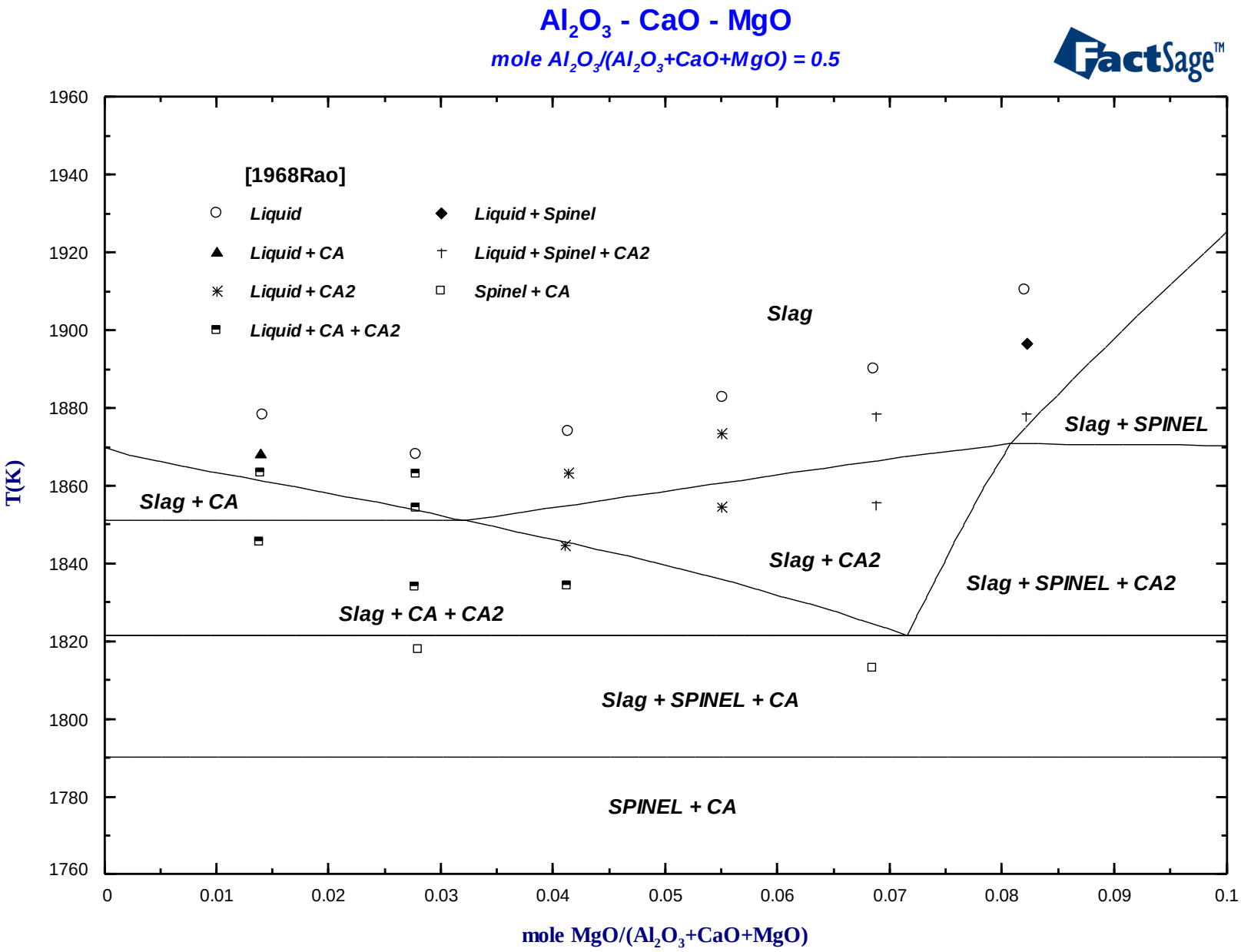
Mole fraction
compared with experimental data

Al_2O_3 - CaO - MgO

1600°C

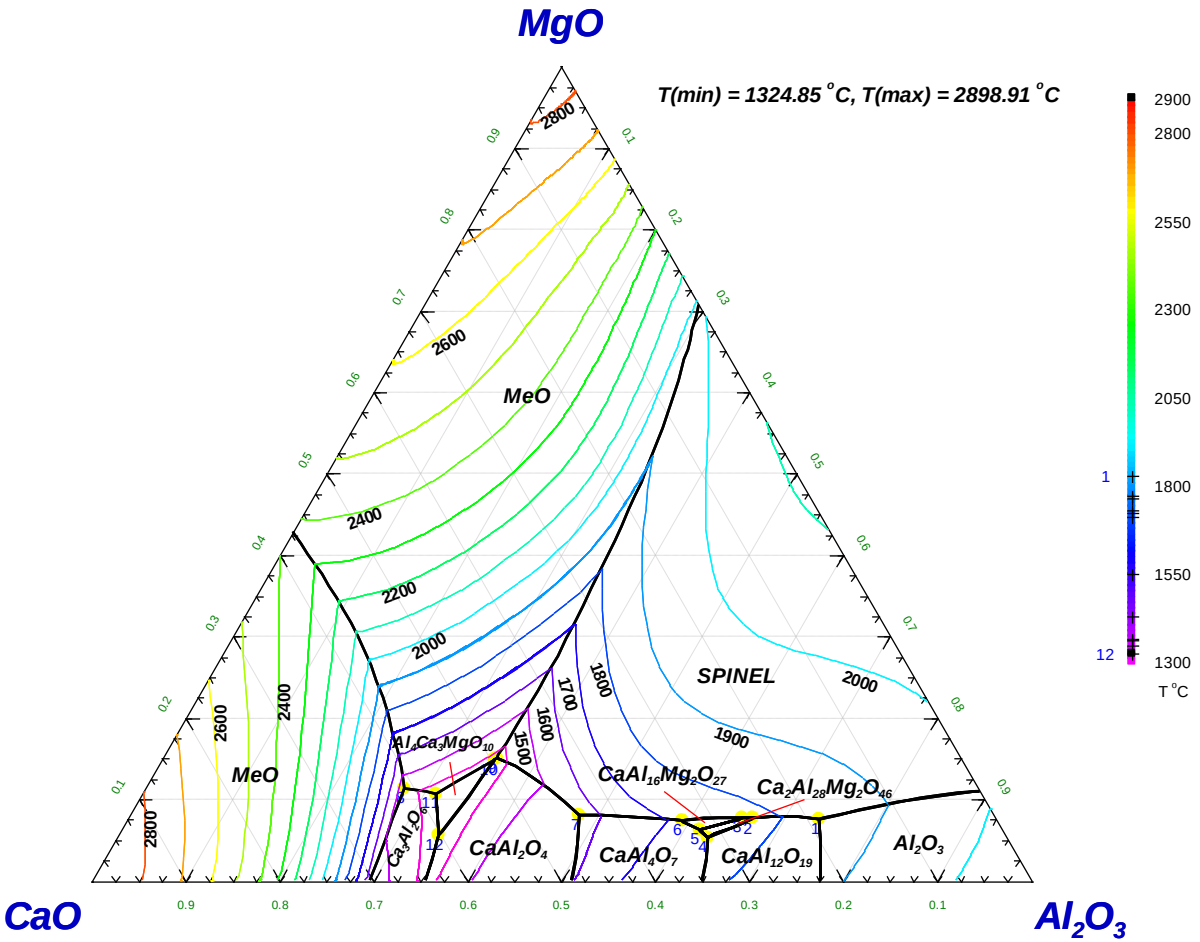


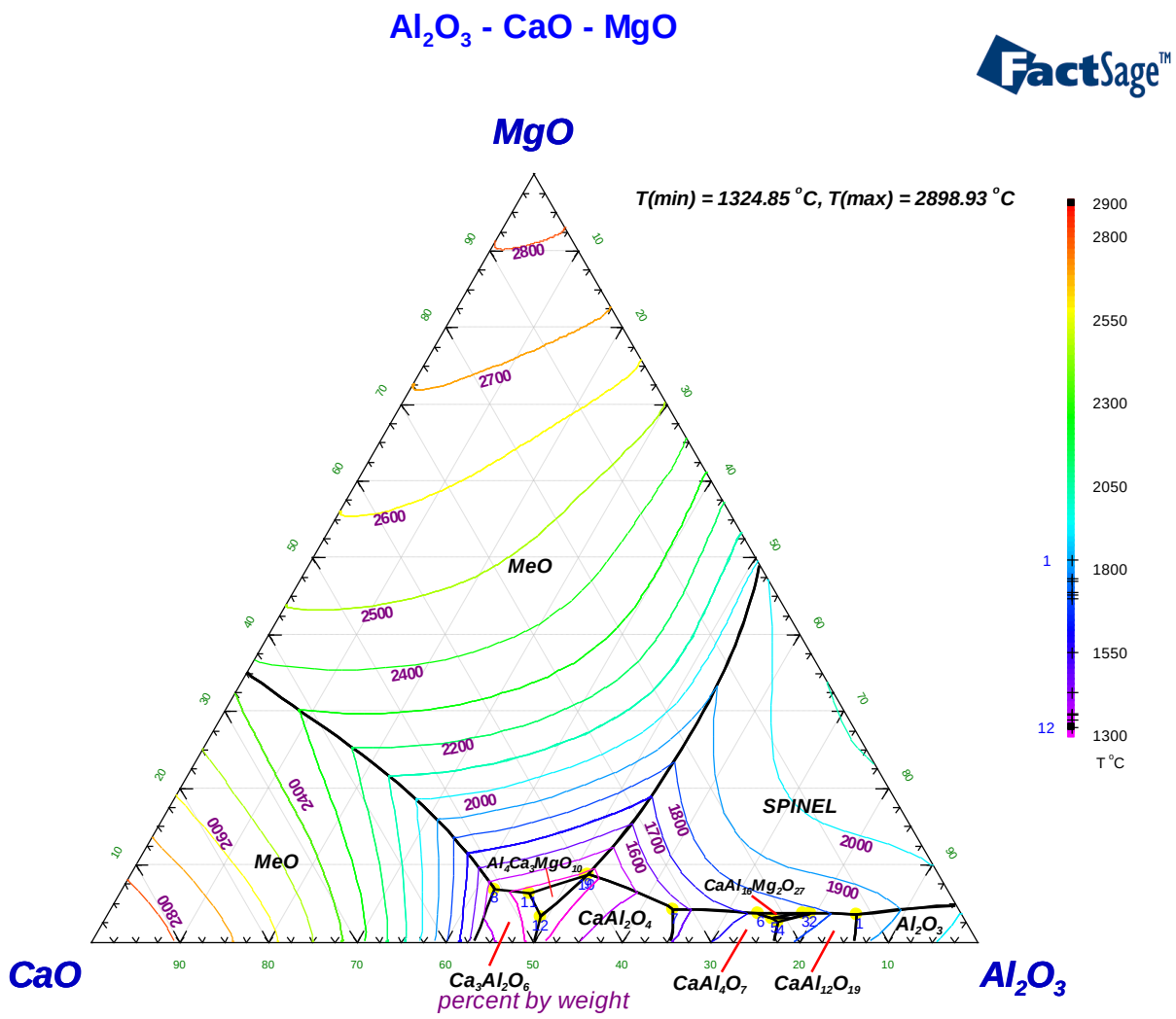
Mole fraction in Kelvin x(Al2O3)=0.5 compared with experimental data



Mole fraction
Liquidussurface

Al_2O_3 - CaO - MgO

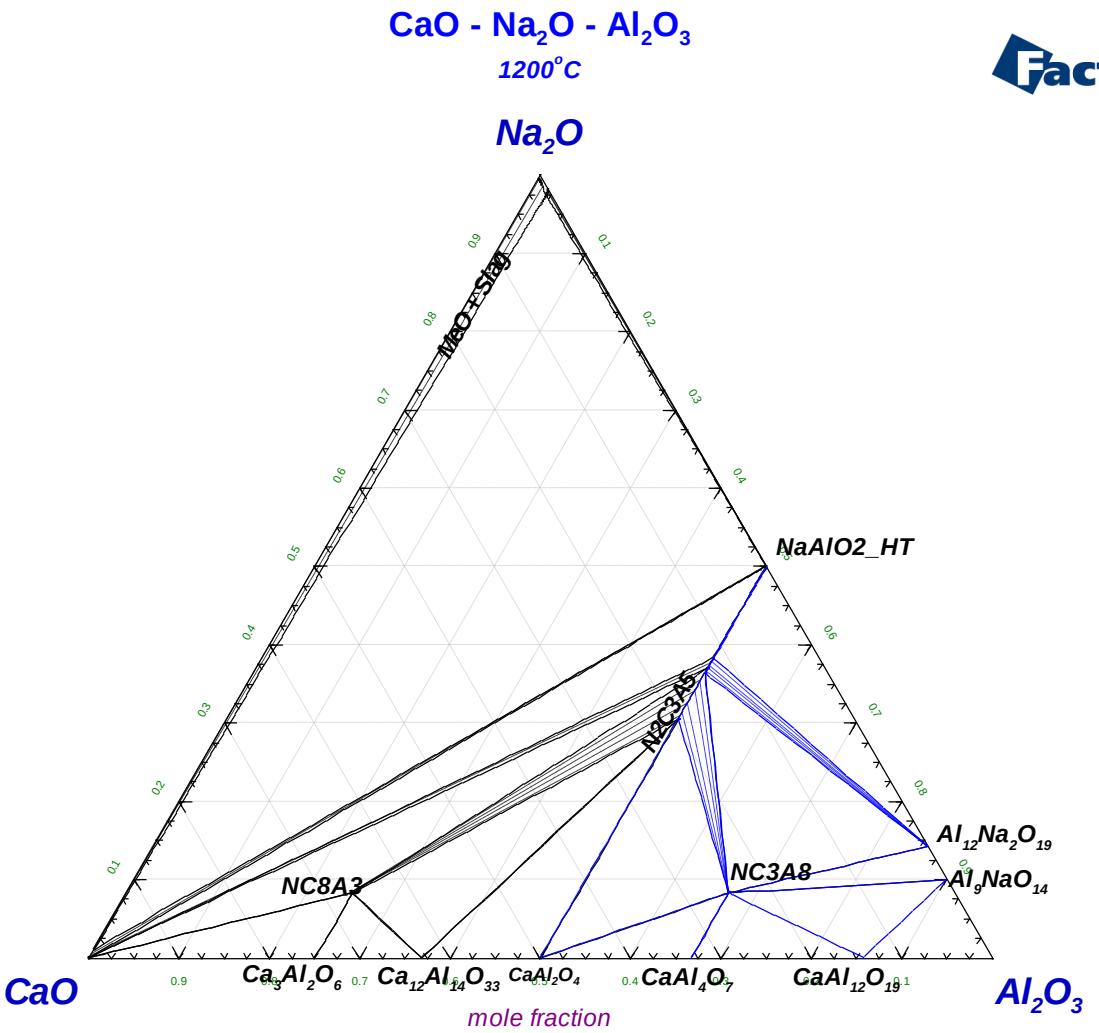



Al_2O_3 - CaO - MgO
MgO
T(min) = 1324.85 °C, T(max) = 2898.93 °C
2900
2800
2550
2300
2050
1800
1550
1300
T °C
MeO
SPINEL
$Al_4Ca_4MgO_{10}$
$CaAl_{16}Mg_2O_{27}$
$CaAl_2O_4$
Al_2O_3
CaO
$Ca_3Al_2O_6$
$CaAl_4O_7$
$CaAl_{12}O_{19}$
percent by weight

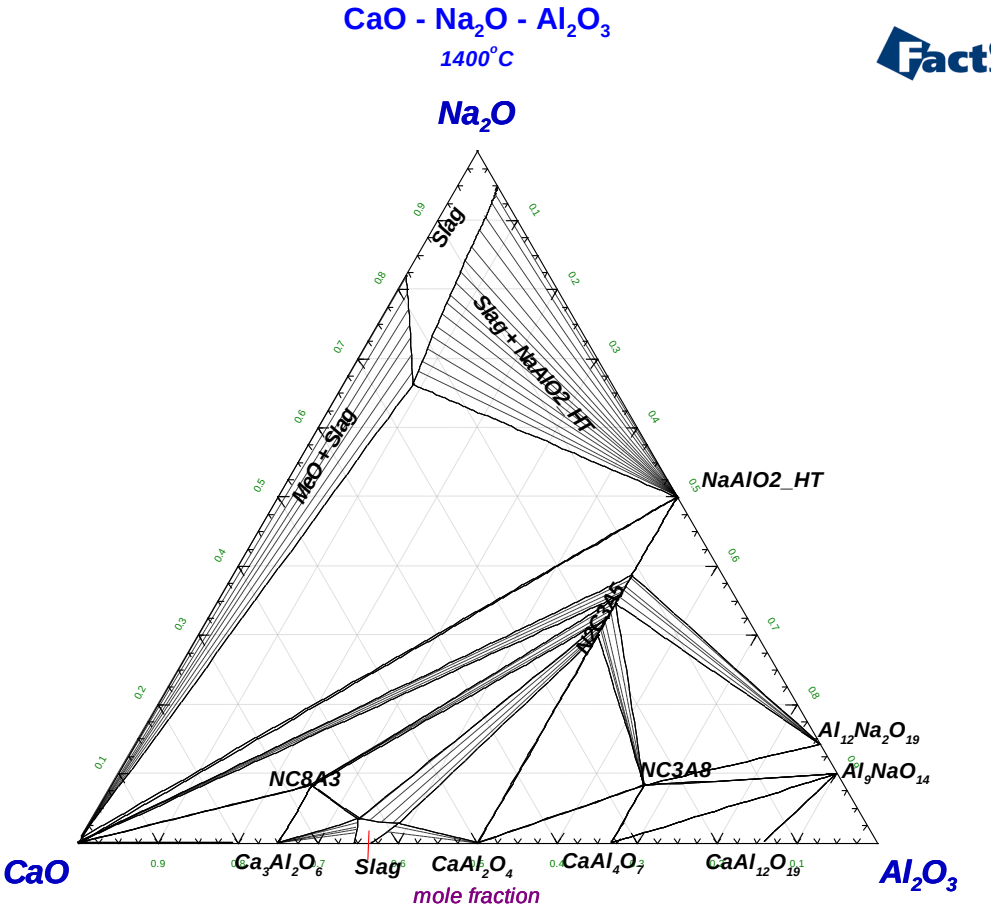
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction					Weight percent				
	A = MgO, B = CaO, C = Al2O3					A = MgO, B = CaO, C = Al2O3				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: Al2O3 / CaAl12O19 / SPINEL	1:	0.07555	0.18763	0.73682	1827.87	1:	3.433%	11.863%	84.704%	1827.87
2: Ca2Al28Mg2O46 / CaAl12O19 / SPINEL	2:	0.07657	0.25793	0.6655	1772.88	2:	3.613%	16.936%	79.451%	1772.88
3: Ca2Al28Mg2O46 / CaAl16Mg2O27 / SPINEL	3:	0.07694	0.26956	0.65349	1764.58	3:	3.655%	17.816%	78.529%	1764.58
4: Ca2Al28Mg2O46 / CaAl12O19 / CaAl4O7	4:	0.05328	0.31763	0.62909	1731.22	4:	2.553%	21.179%	76.267%	1731.22
5: Ca2Al28Mg2O46 / CaAl16Mg2O27 / CaAl4O7	5:	0.06226	0.32169	0.61605	1723.93	5:	3.010%	21.640%	75.350%	1723.93
6: CaAl16Mg2O27 / CaAl4O7 / SPINEL	6:	0.07375	0.33466	0.59159	1709.75	6:	3.622%	22.870%	73.507%	1709.75
7: CaAl2O4 / CaAl4O7 / SPINEL	7:	0.08027	0.44014	0.47958	1548.46	7:	4.212%	32.131%	63.657%	1548.46
8: Ca3Al2O6 / MEO#1 / MEO#2	8:	0.11323	0.60997	0.2768	1429.61	8:	6.812%	51.059%	42.129%	1429.62
9: CaAl2O4 / MEO#1 / SPINEL	9:	0.15073	0.49357	0.35569	1364.86	9:	8.676%	39.529%	51.795%	1364.86
10: Al4Ca3MgO10 / CaAl2O4 / MEO#1	10:	0.14828	0.49727	0.35445	1362.05	10:	8.537%	39.835%	51.628%	1362.05
11: Al4Ca3MgO10 / Ca3Al2O6 / MEO#1	11:	0.10668	0.58044	0.31288	1345.09	11:	6.254%	47.344%	46.402%	1345.09
12: Al4Ca3MgO10 / Ca3Al2O6 / CaAl2O4	12:	0.05684	0.60158	0.34158	1324.85	12:	3.233%	47.612%	49.155%	1324.85

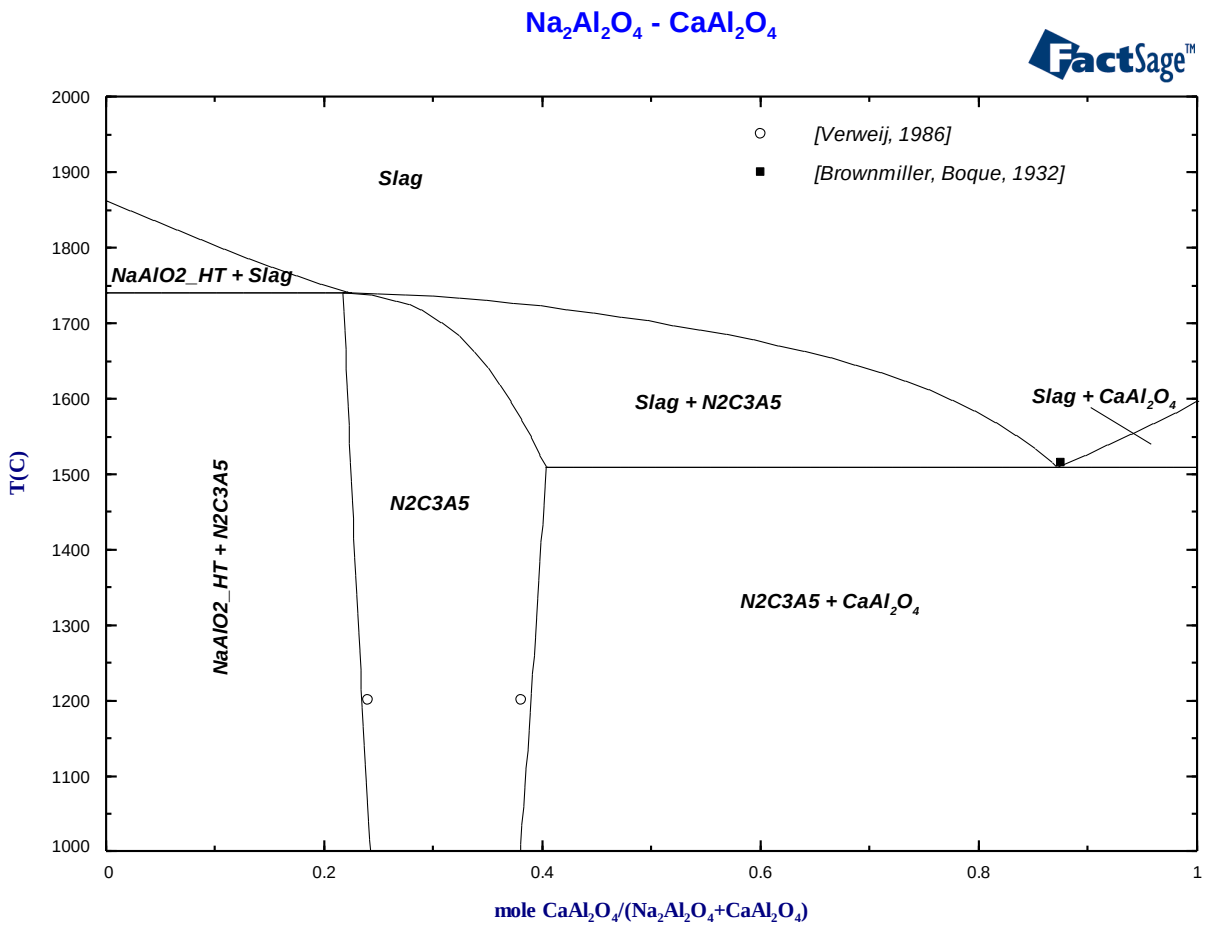
Mole fraction 1200°C



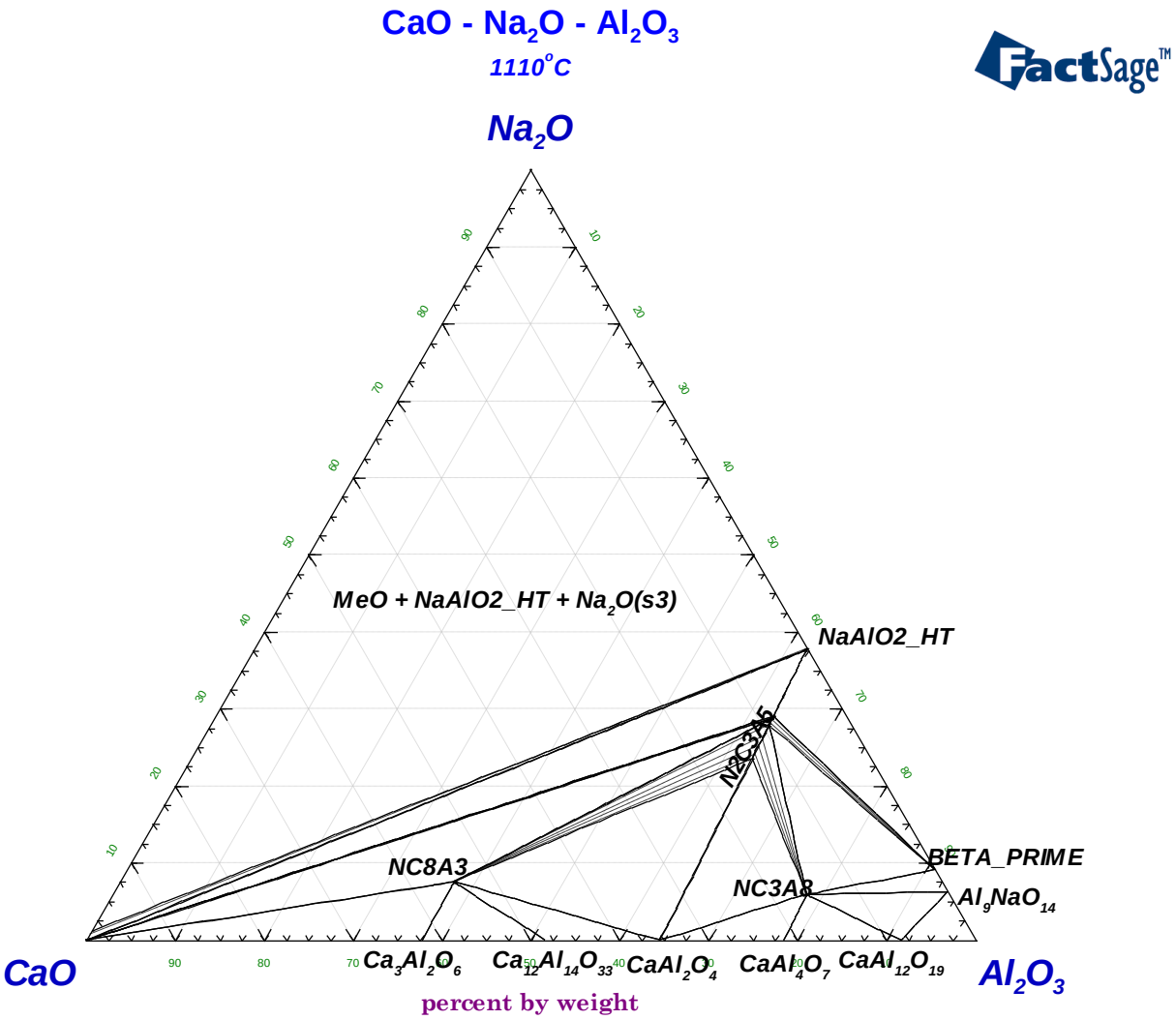
Al2O3-CaO-Na2O,
Mole fraction 1400°C



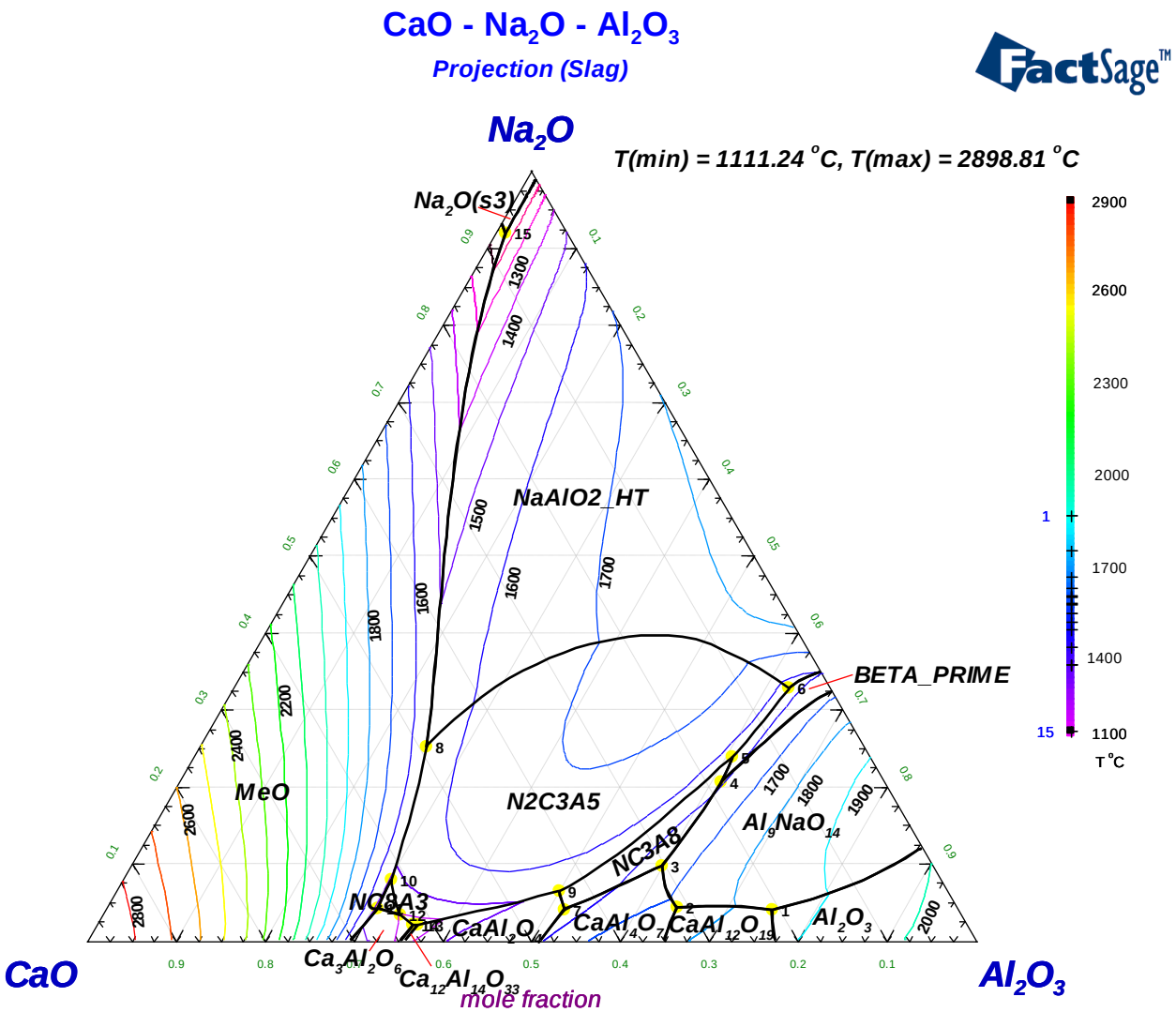
Mole fraction
compared with experimental data

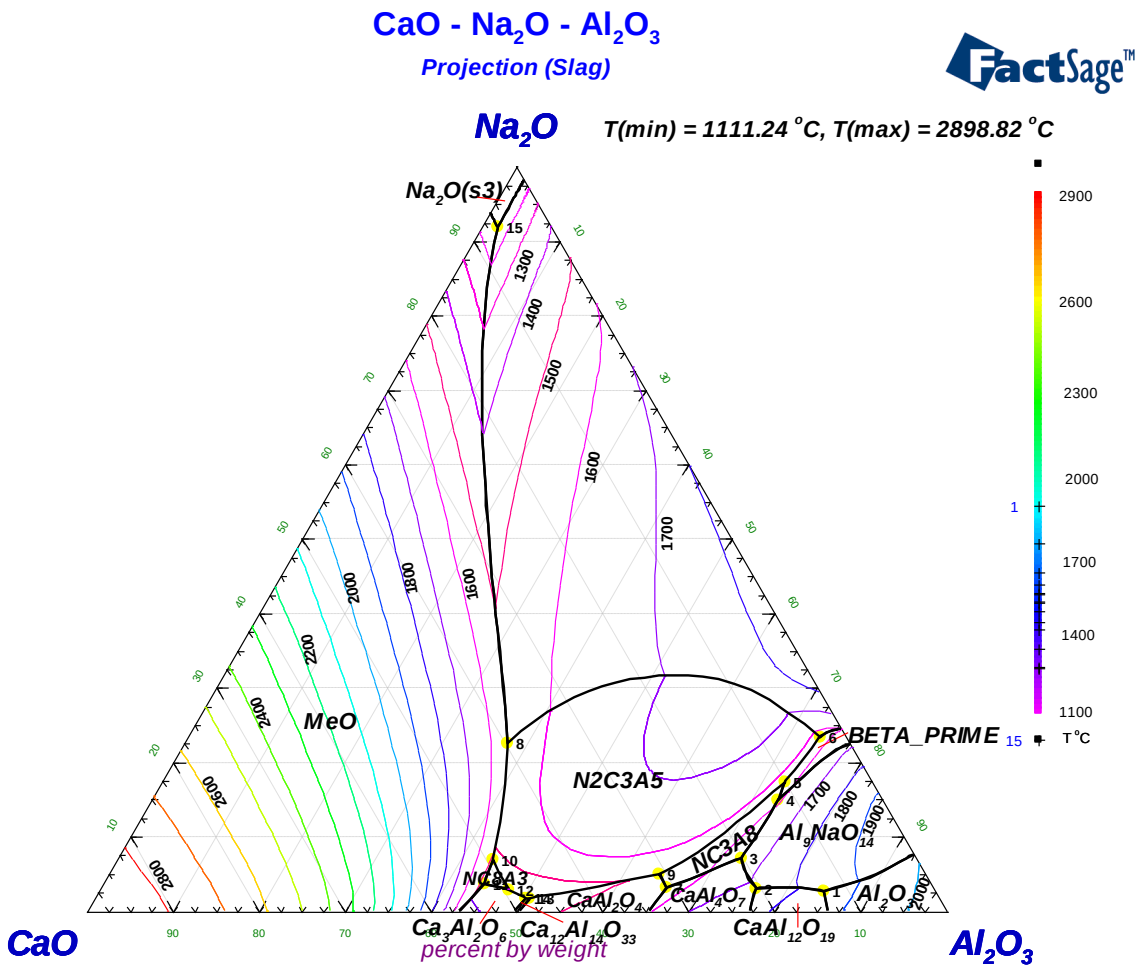


Weight percent
kurz unterhalb Liquidussurface



Mole fraction
Liquidussurface

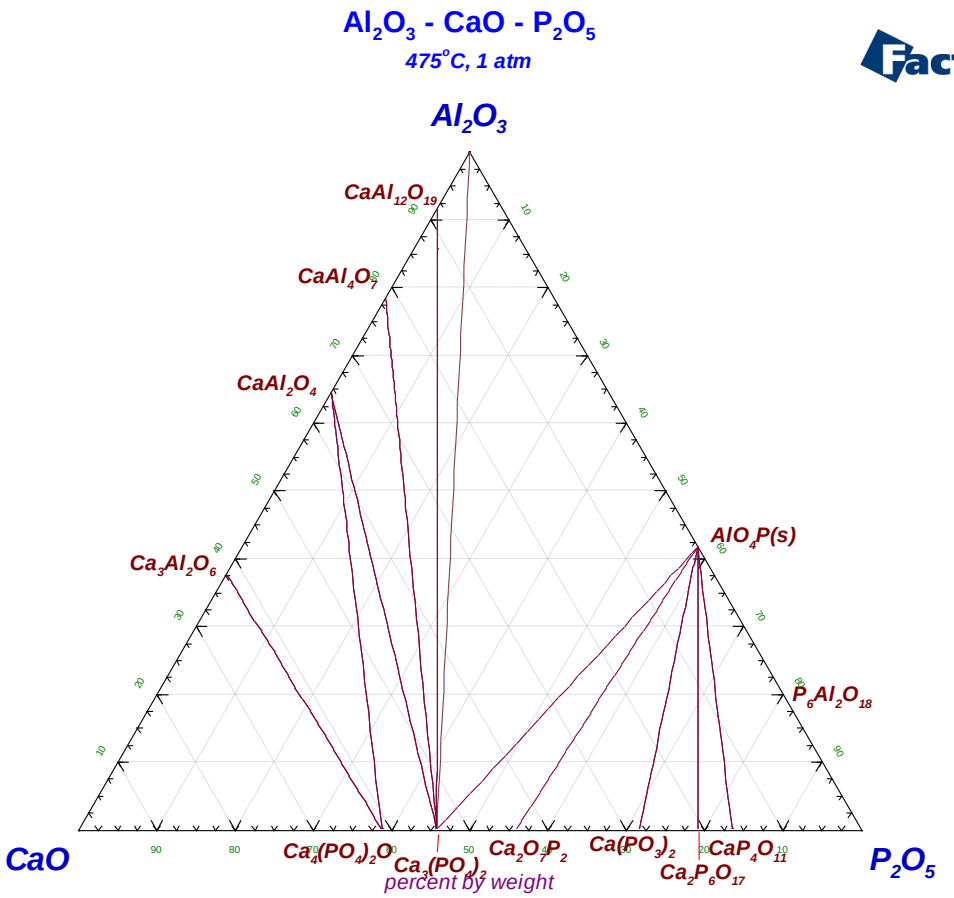



CaO - Na2O - Al2O3
Projection (Slag)
FactSage™
Na2O
T(min) = 1111.24 °C, T(max) = 2898.82 °C
Na2O(s3)
MeO
N2C3A5
BETA_PRIME
NC3A3
NC3A8
Al9NaO14
CaAl2O4
CaAl4O7
Al2O3
Ca3Al2O6
Ca12Al14O33
CaAl12O19
CaO
Al2O3
percent by weight
T °C
2900
2600
2300
2000
1700
1400
1100

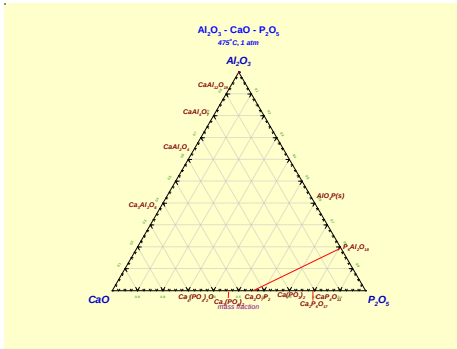
Invariant equilibria on the liquidus surface

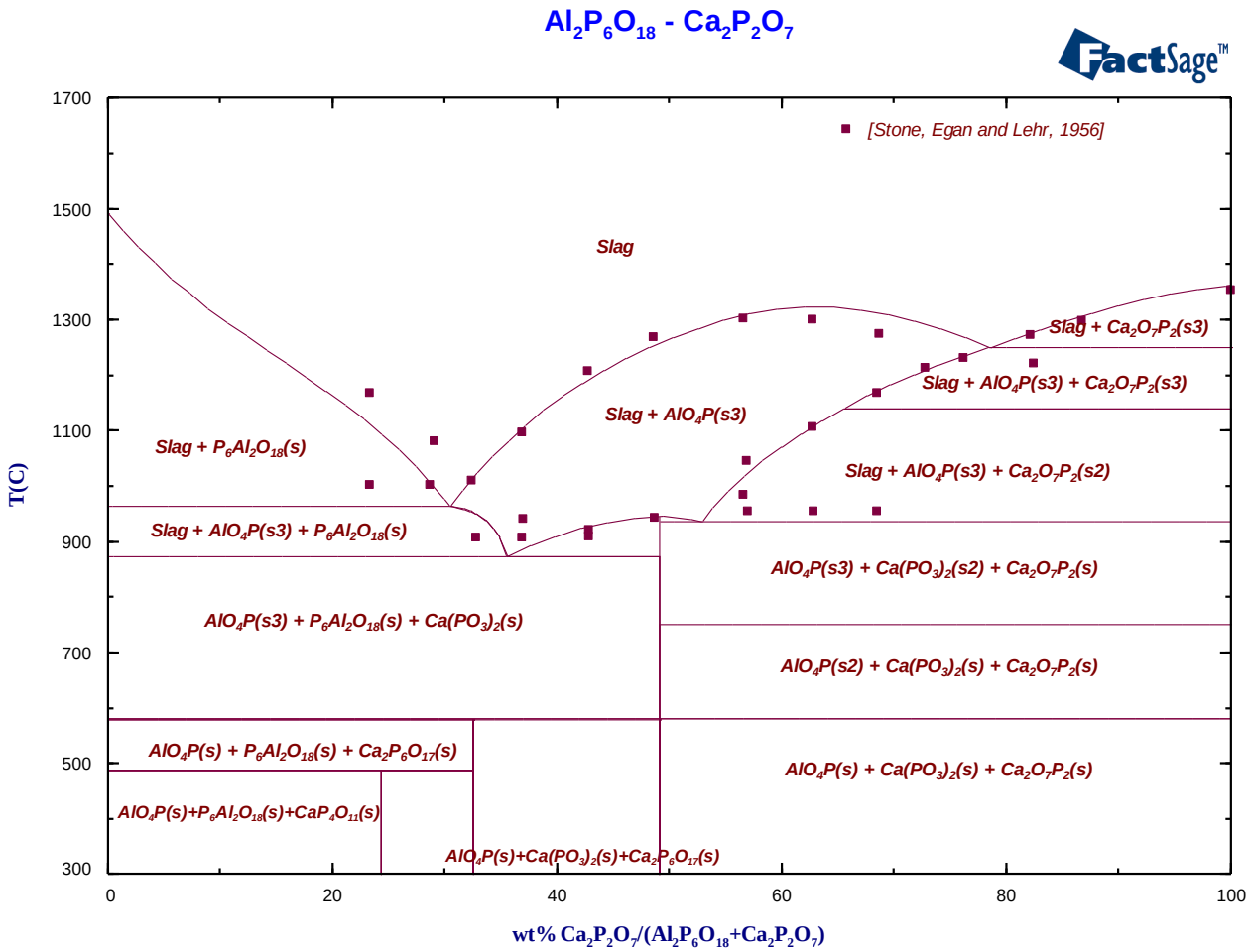
Intersections with slag	Mole fraction				Weight percent			
	A = Na2O, B = CaO, C = Al2O3				A = Na2O, B = CaO, C = Al2O3			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: Al2O3 / Al9NaO14 / CaAl12O19	1: 0.04008	0.20896	0.75095	1838.57	1: 2.737	12.910	84.353	1838.57
2: Al9NaO14 / CaAl12O19 / CaAl4O7	2: 0.04273	0.31481	0.64247	1718.43	2: 3.086	20.573	76.341	1718.43
3: Al9NaO14 / Ca3Al16Na2O28 / CaAl4O7	3: 0.09709	0.30394	0.59897	1629.53	3: 7.153	20.259	72.589	1629.53
4: Al9NaO14/BETA_PRIME / Ca3Al16Na2O28	4: 0.20582	0.18337	0.61081	1591.94	4: 14.952	12.052	72.996	1591.94
5: N2C3A5 / BETA_PRIME / Ca3Al16Na2O28	5: 0.23811	0.15464	0.60725	1566.19	5: 17.292	10.161	72.547	1566.19
6: N2C3A5 / NaAlO2_HT / BETA_PRIME	6: 0.32787	0.04627	0.62586	1562.66	6: 23.431	2.992	73.578	1562.66
7: Ca3Al16Na2O28 / CaAl2O4 / CaAl4O7	7: 0.04072	0.44244	0.51684	1541.33	7: 3.154	31.001	65.846	1541.32
8: N2C3A5 / NaAlO2_HT / MeO	8: 0.25182	0.49223	0.25595	1535.19	8: 22.519	39.827	37.654	1535.19
9: N2C3A5 / Ca3Al16Na2O28 / CaAl2O4	9: 0.06411	0.43676	0.49913	1509.59	9: 5.007	30.863	64.129	1509.59
10: N2C3A5 / Ca8Al6Na2O18 / MeO	10: 0.07879	0.61861	0.30259	1477.32	10: 6.934	49.257	43.808	1477.32
11: Ca3Al2O6 / Ca8Al6Na2O18 / MeO	11: 0.04173	0.65207	0.30620	1451.31	11: 3.675	51.961	44.364	1451.45
12: N2C3A5 / Ca3Al2O6 / Ca8Al6Na2O18	12: 0.03382	0.63117	0.33501	1393.63	12: 2.925	49.400	47.674	1393.63
13: N2C3A5 / Ca12Al14O33 / CaAl2O4	13: 0.02041	0.61787	0.36171	1334.80	13: 1.738	47.598	50.664	1334.79
14: N2C3A5 / Ca12Al14O33 / Ca3Al2O6	14: 0.02054	0.62282	0.35664	1332.17	14: 1.755	48.132	50.113	1332.16
15: NaAlO2_HT / MeO / Na2O(s3)	15: 0.91919	0.06967	0.01115	1111.24	15: 91.868	6.300	1.833	1111.24

Al2O3-CaO-P2O5,
Weight percent 475°C



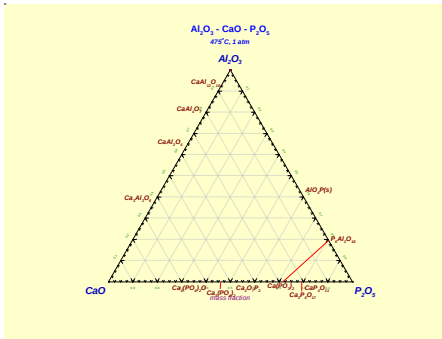
Weight percent, Isopleth Al2P6O18-Ca2P2O7 compared with experimental data

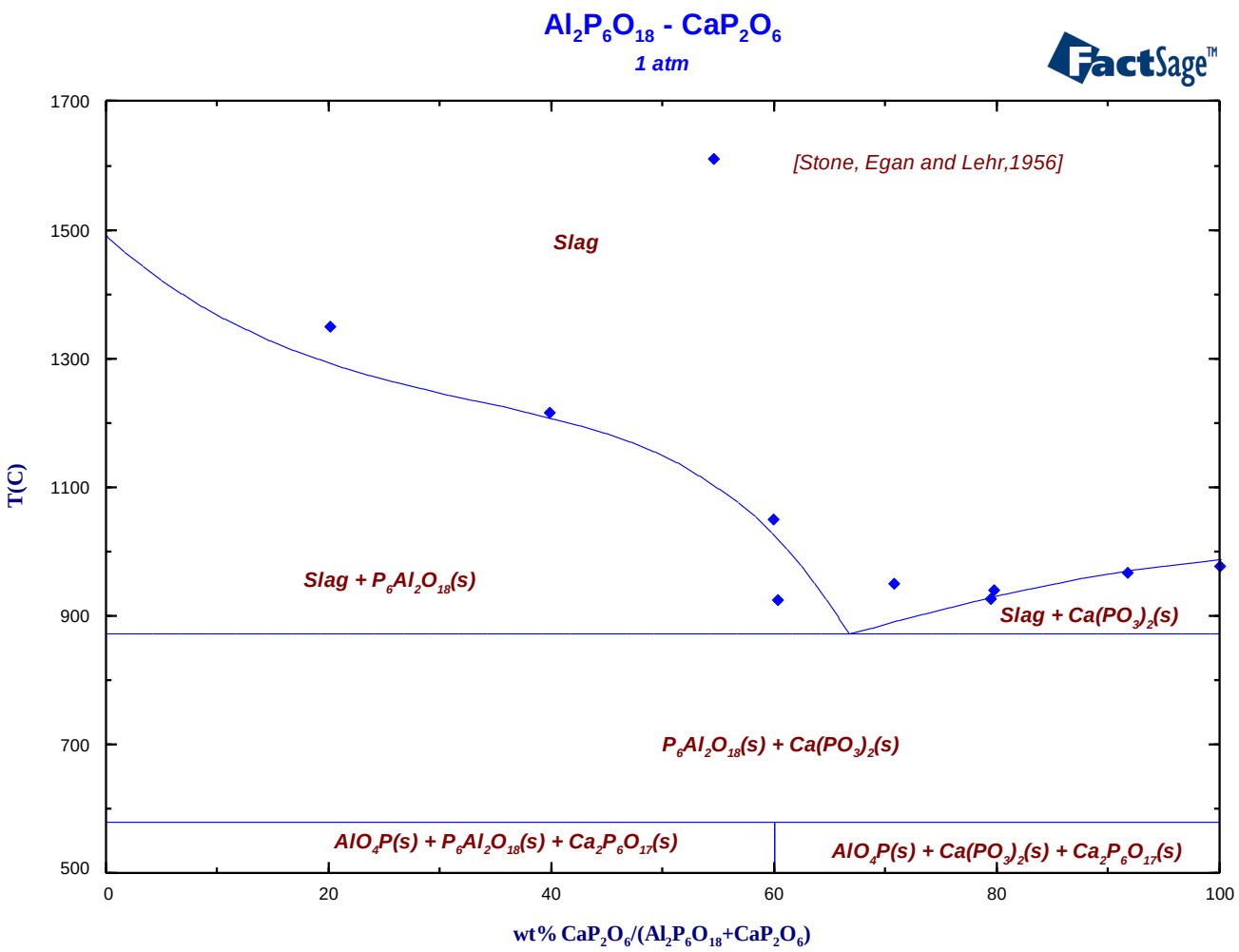




Al2O3-CaO-P2O5,

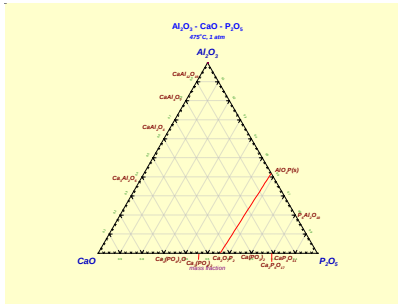
Weight percent, Isopleth Al2P6O18-CaP2O6

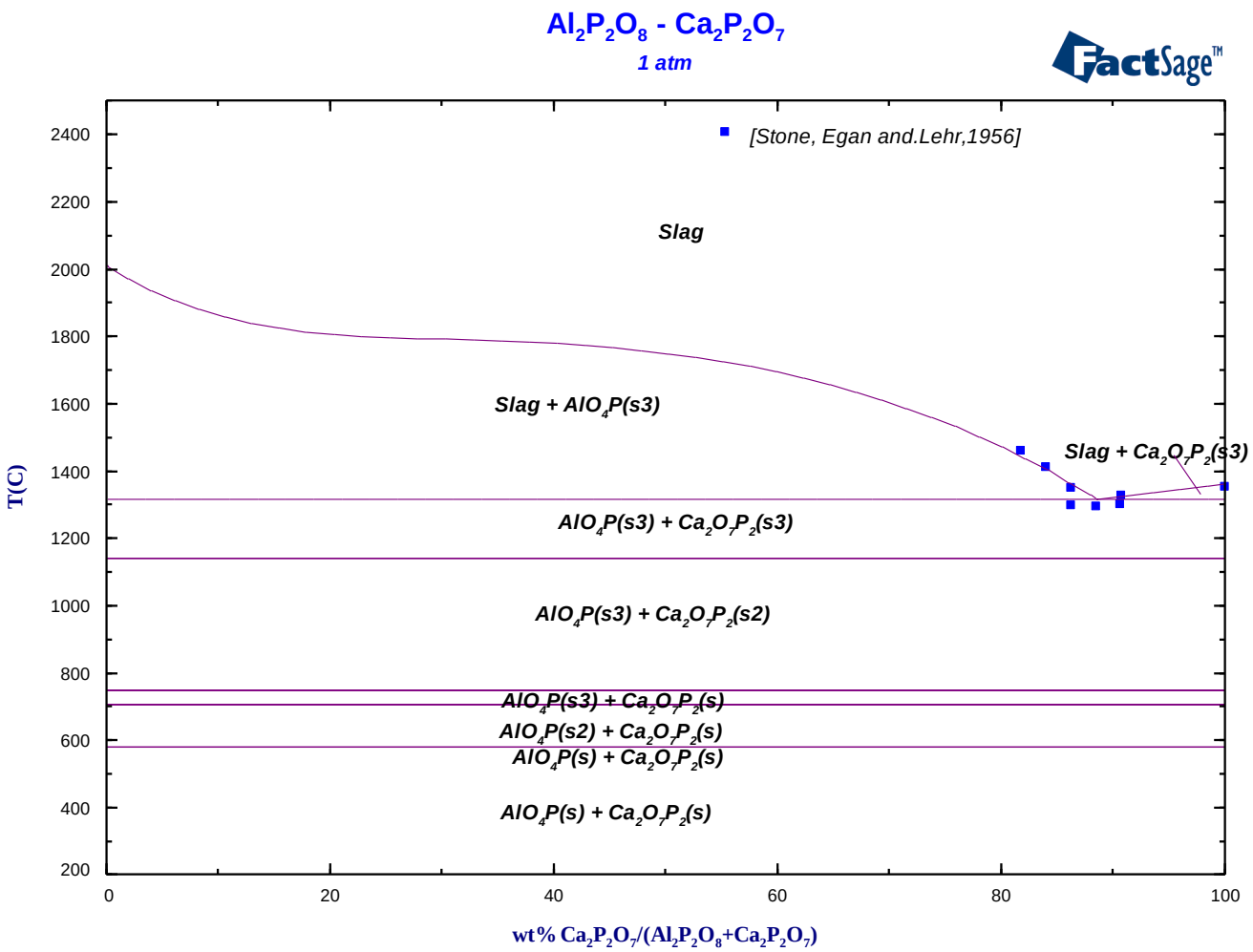




Al2O3-CaO-P2O5,

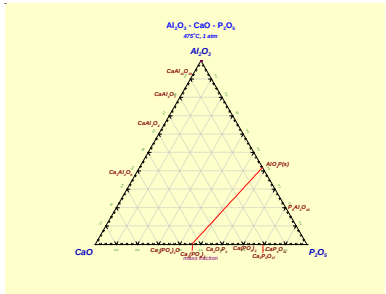
Weight percent, Isopleth Al2P2O8-Ca2P2O7

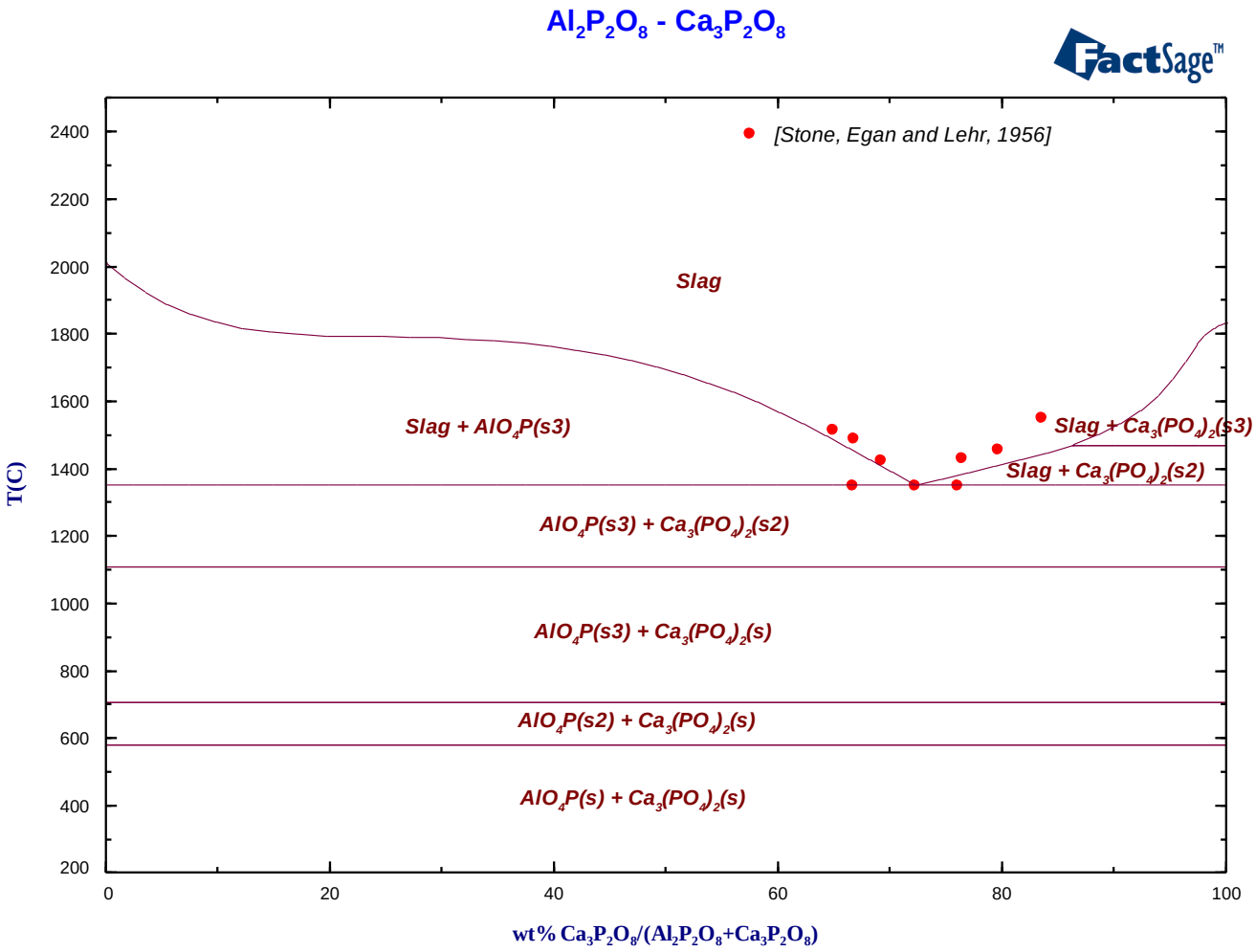




Al2O3-CaO-P2O5,

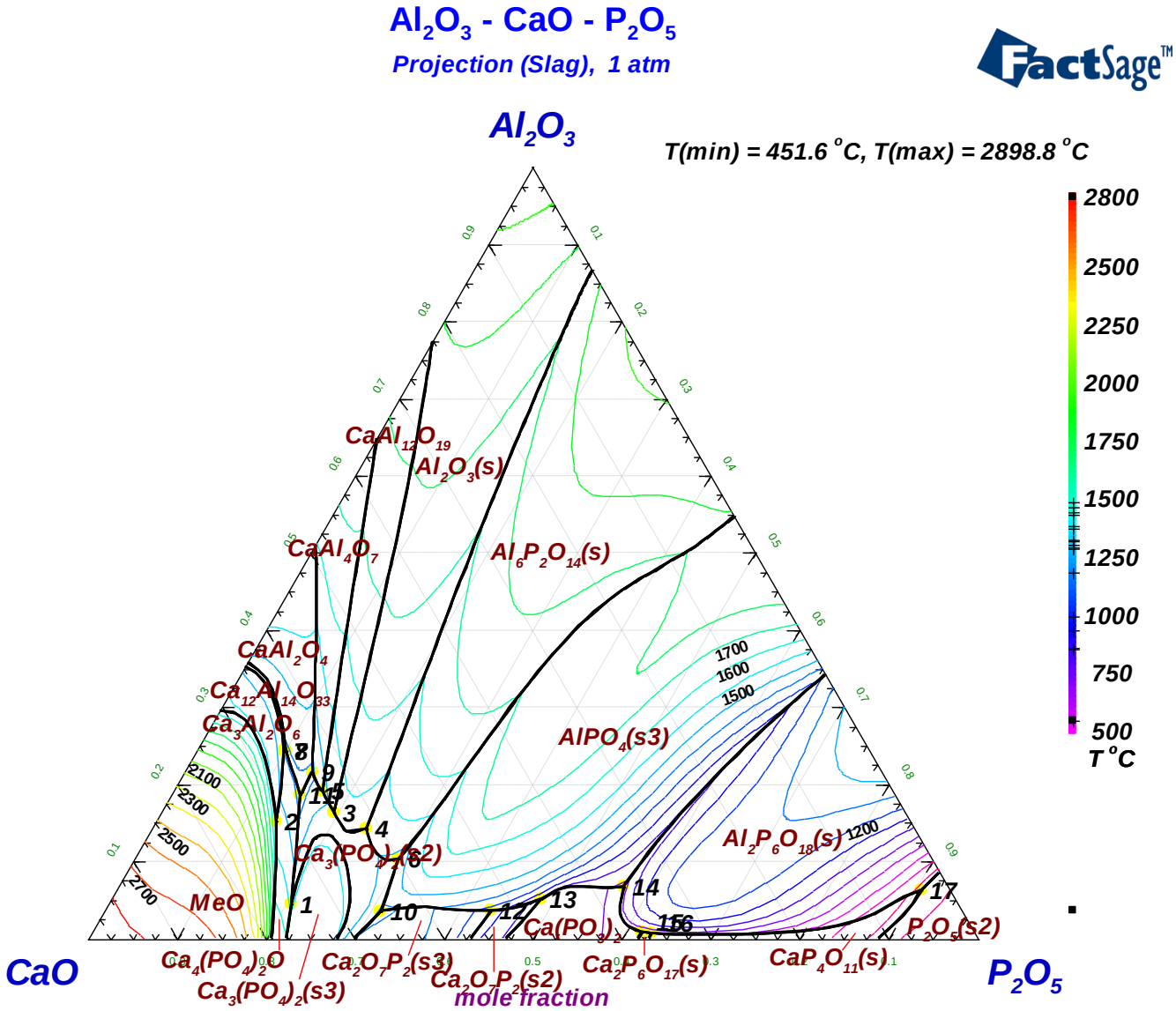
Weight percent, Isopleth Al2P2O8-Ca3P2O8



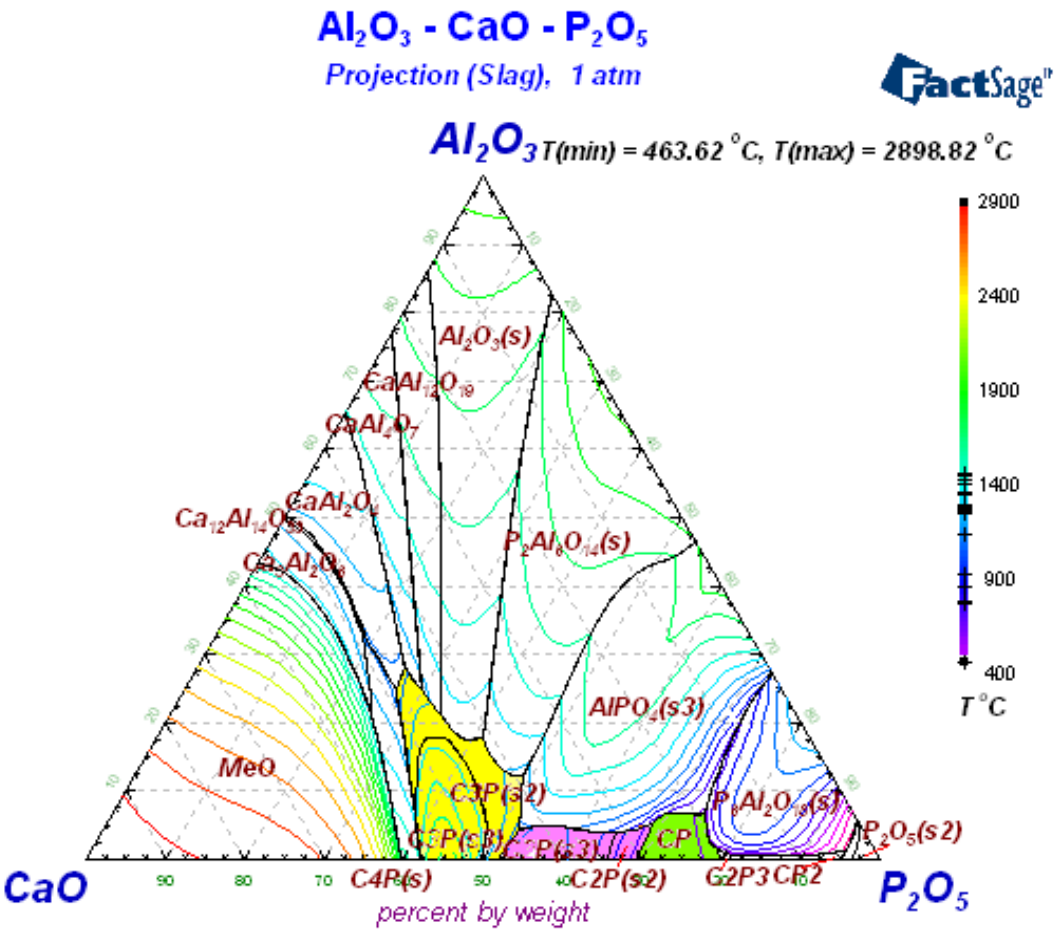


Al2O3-CaO-P2O5,

Mole fraction Liquidussurface



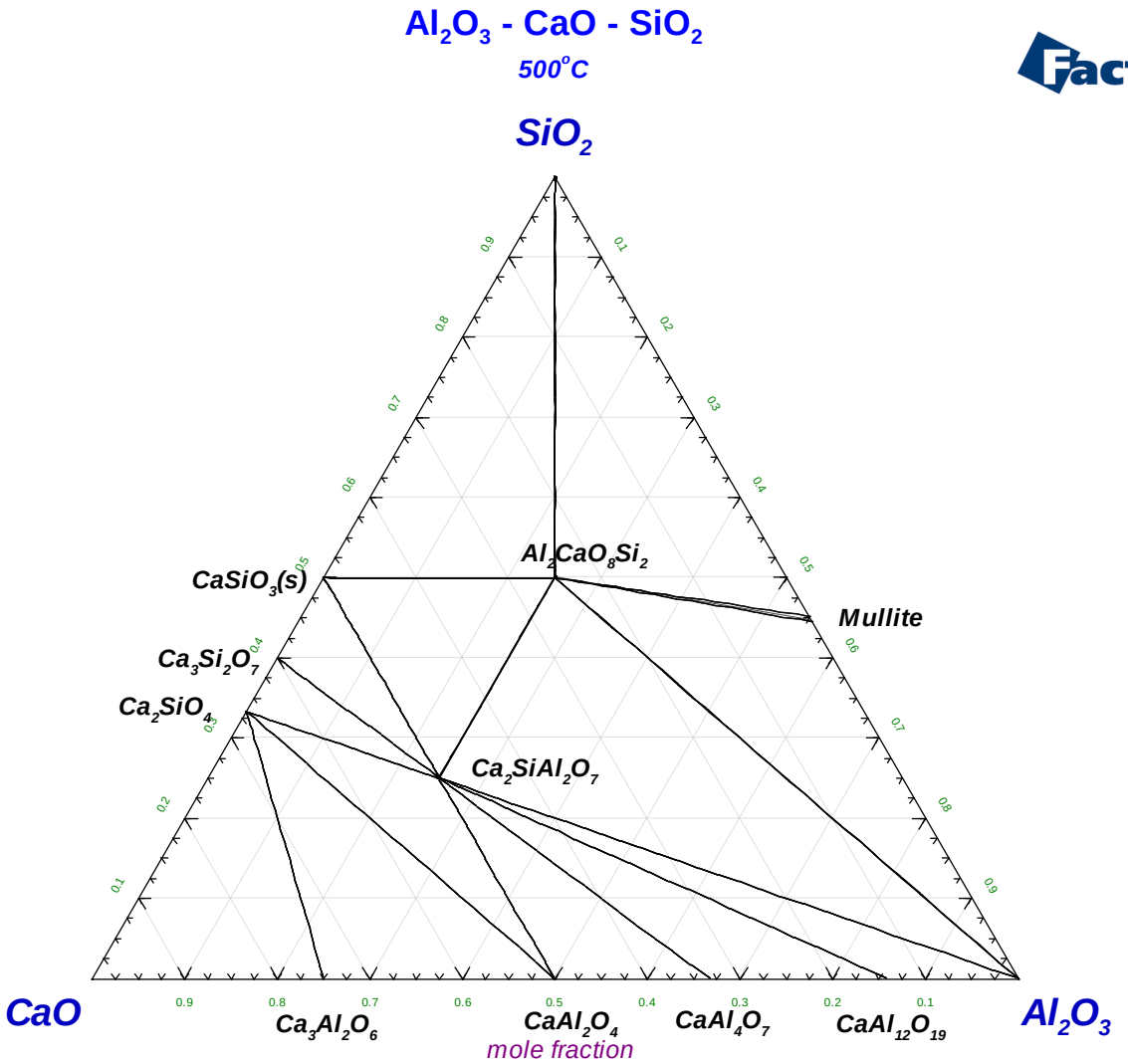
Weight percent
Liquidussurface

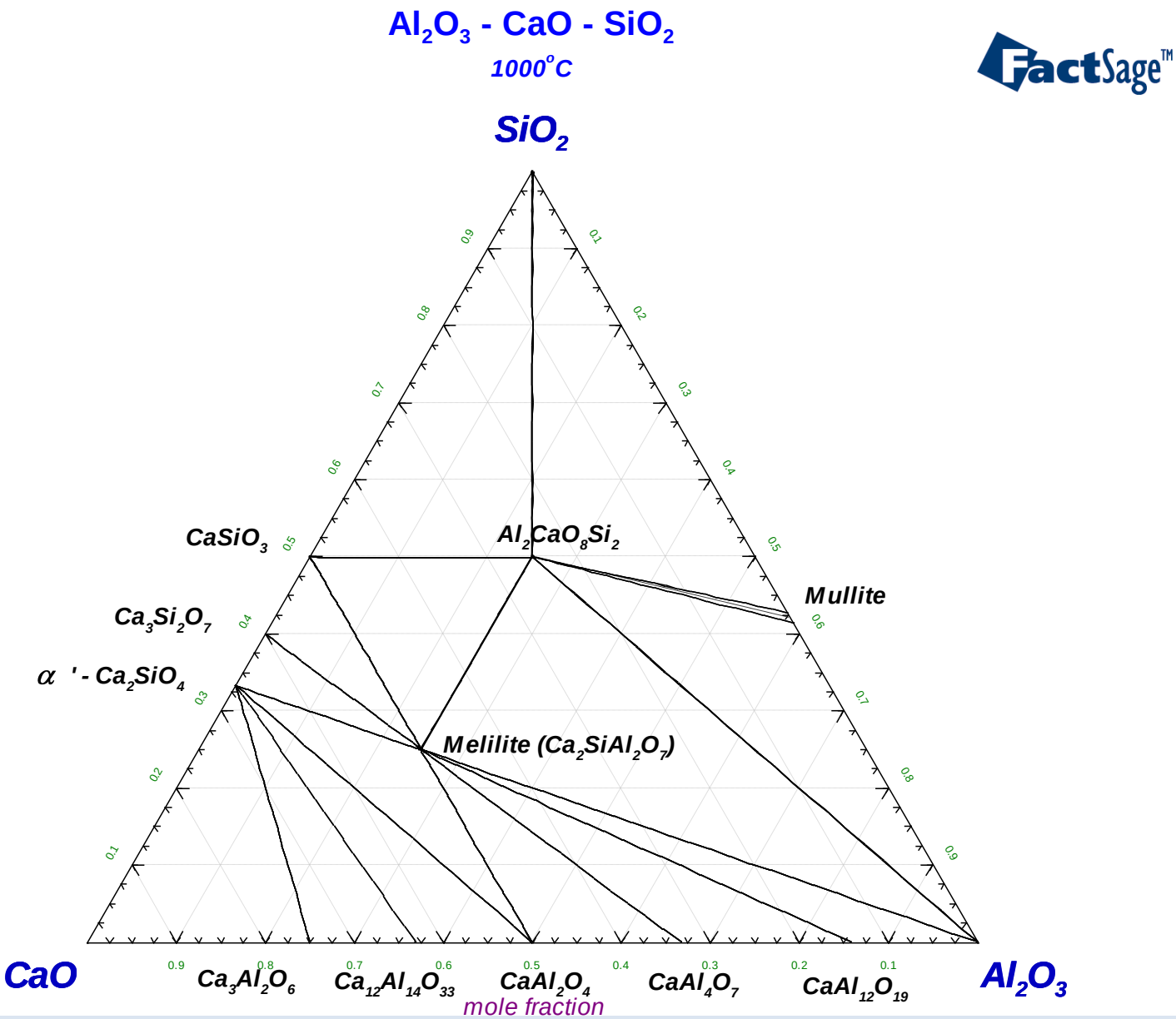


Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction				Weight percent			
	A = Al2O3, B = CaO, C = P2O5				A = Al2O3, B = CaO, C = P2O5			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: Ca3(PO4)2(s2) / Ca3(PO4)2(s3) / Ca4(PO4)2O	1: 0.04444	0.74979	0.20577	1469.84	1. 6.715	55.215	38.070	1469.86
2: Ca3Al2O6 / Ca4(PO4)2O / MeO	2: 0.15169	0.71287	0.13544	1450.85	2. 21.095	53.461	25.444	1450.85
3: Al2O3 / Ca3(PO4)2(s2) / CaAl12O19	3: 0.16406	0.64167	0.19427	1428.38	3. 21.110	44.674	34.216	1428.38
4: Al2O3 / Al6P2O14 / Ca3(PO4)2(s2)	4: 0.14256	0.61578	0.24165	1414.59	4. 17.700	41.240	41.060	1414.59
5: Ca3(PO4)2(s2) / CaAl12O19 / CaAl4O7	5: 0.19145	0.64047	0.16808	1364.58	5. 24.847	45.198	29.955	1364.58
6: Al6P2O14 / AlPO4(s3) / Ca3(PO4)2(s2)	6: 0.10324	0.59947	0.29729	1352.01	6. 12.254	38.859	48.887	1352.01
7: Ca12Al14O33 / Ca3Al2O6 / Ca4(PO4)2O	7: 0.24348	0.65776	0.09875	1296.74	7. 33.052	48.656	18.292	1296.74
8: Ca12Al14O33 / Ca4(PO4)2O / CaAl2O4	8: 0.24289	0.65639	0.10072	1289.77	8. 32.890	48.465	18.645	1289.77
9: Ca3(PO4)2(s2) / CaAl2O4 / CaAl4O7	9: 0.21610	0.64030	0.14360	1274.52	9. 28.304	45.786	25.910	1274.52
10: AlPO4(s3) / Ca2O7P2(s3) / Ca3(PO4)2(s2)	10: 0.03579	0.65297	0.31124	1263.12	10. 4.338	43.314	52.348	1263.12
11: Ca3(PO4)2(s2) / Ca4(PO4)2O / CaAl2O4	11: 0.18632	0.66825	0.14542	1257.98	11. 24.822	48.542	26.635	1257.98
12: AlPO4(s3) / Ca2O7P2(s2) / Ca2O7P2(s3)	12: 0.03623	0.52920	0.43457	1139.85	12. 3.887	31.214	64.899	1139.85
13: AlPO4(s3) / Ca(PO3)2(s) / Ca2O7P2(s2)	13: 0.05097	0.46554	0.48349	936.53	13. 5.204	26.121	68.675	936.53
14: Al2P6O18 / AlPO4(s3) / Ca(PO3)2(s)	14: 0.06834	0.36332	0.56834	872.28	14. 6.641	18.765	74.595	872.28
15: Al2P6O18 / Ca(PO3)2(s) / Ca2P6O17	15: 0.00885	0.37302	0.61813	787.04	15. 0.790	19.124	80.086	787.04
16: Al2P6O18 / Ca2P6O17 / CaP4O11	16: 0.00704	0.36282	0.63014	782.43	16. 0.617	18.443	80.941	782.43
17: Al2P6O18 / CaP4O11 / P2O5(s2)	17: 0.06290	0.03225	0.90485	463.62	17. 1.165	3.808	95.027	463.62

Mole fraction

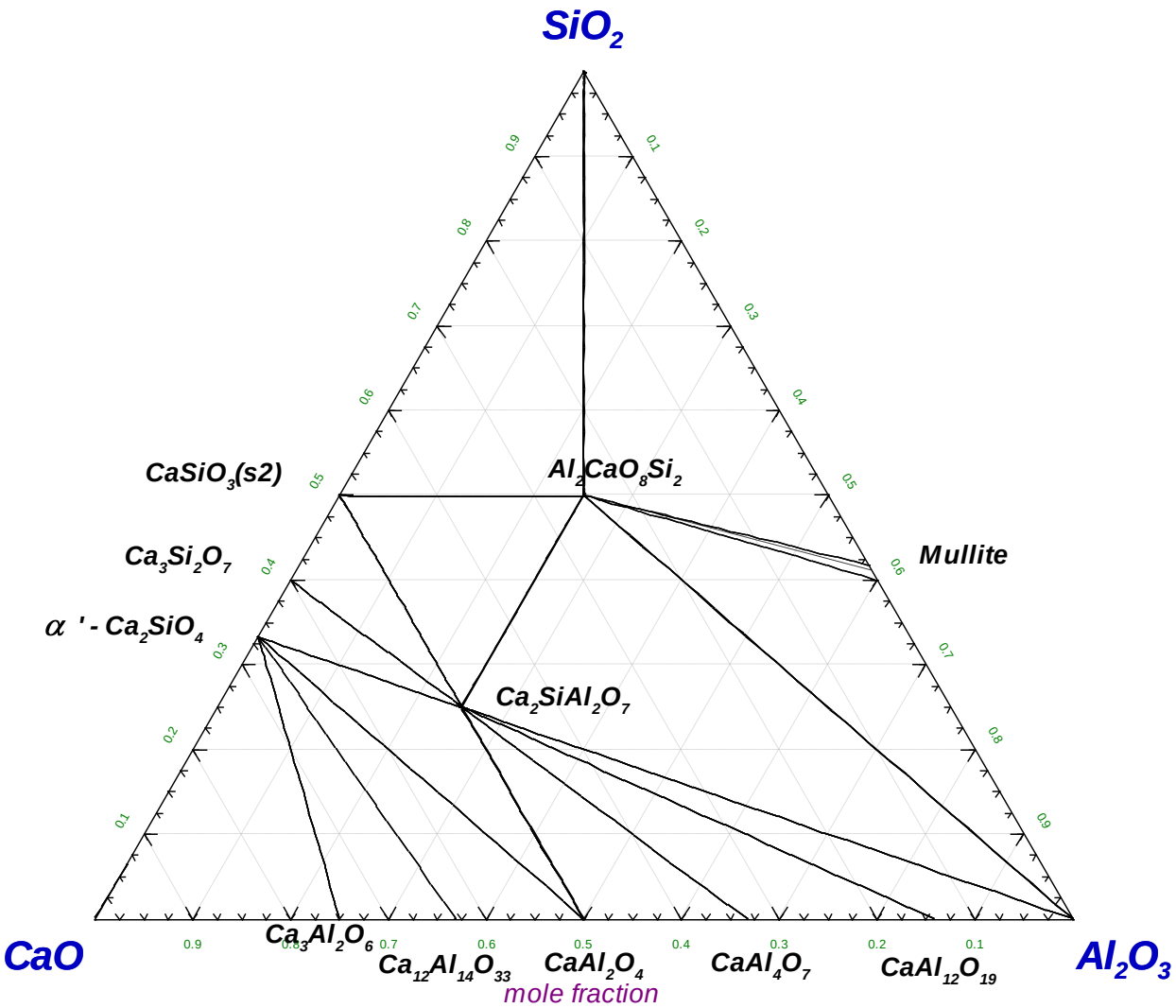



Al_2O_3 - CaO - SiO_2
1000°C
SiO_2
$CaSiO_3$
$Al_2CaO_8Si_2$
Mullite
$Ca_3Si_2O_7$
α '- Ca_2SiO_4
Melilite ($Ca_2SiAl_2O_7$)
CaO
$Ca_3Al_2O_6$
$Ca_{12}Al_{14}O_{33}$
$CaAl_2O_4$
$CaAl_4O_7$
$CaAl_{12}O_{19}$
Al_2O_3
mole fraction

Mole fraction
kurz unterhalb Liquidussurface

Al_2O_3 - CaO - SiO_2

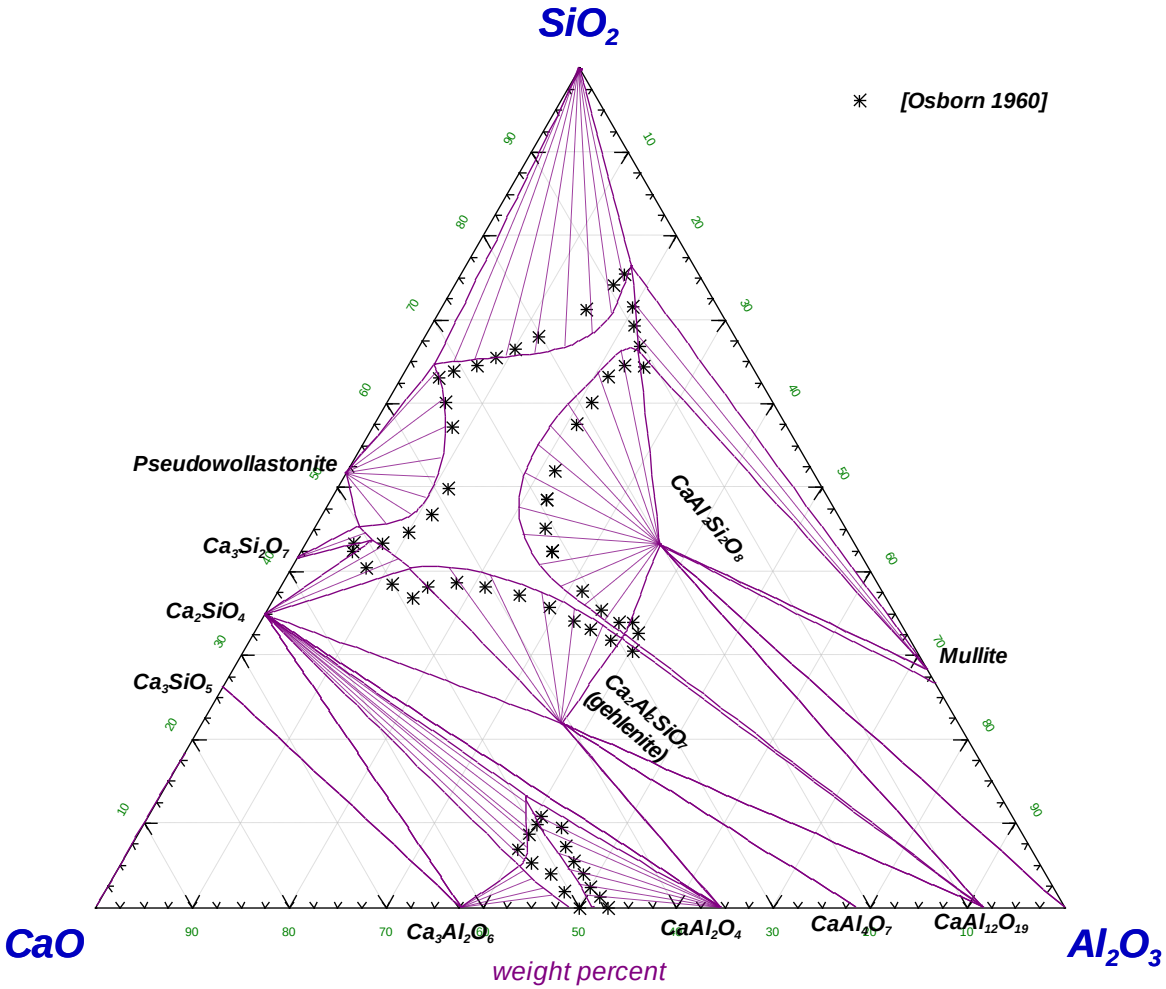
1185°C



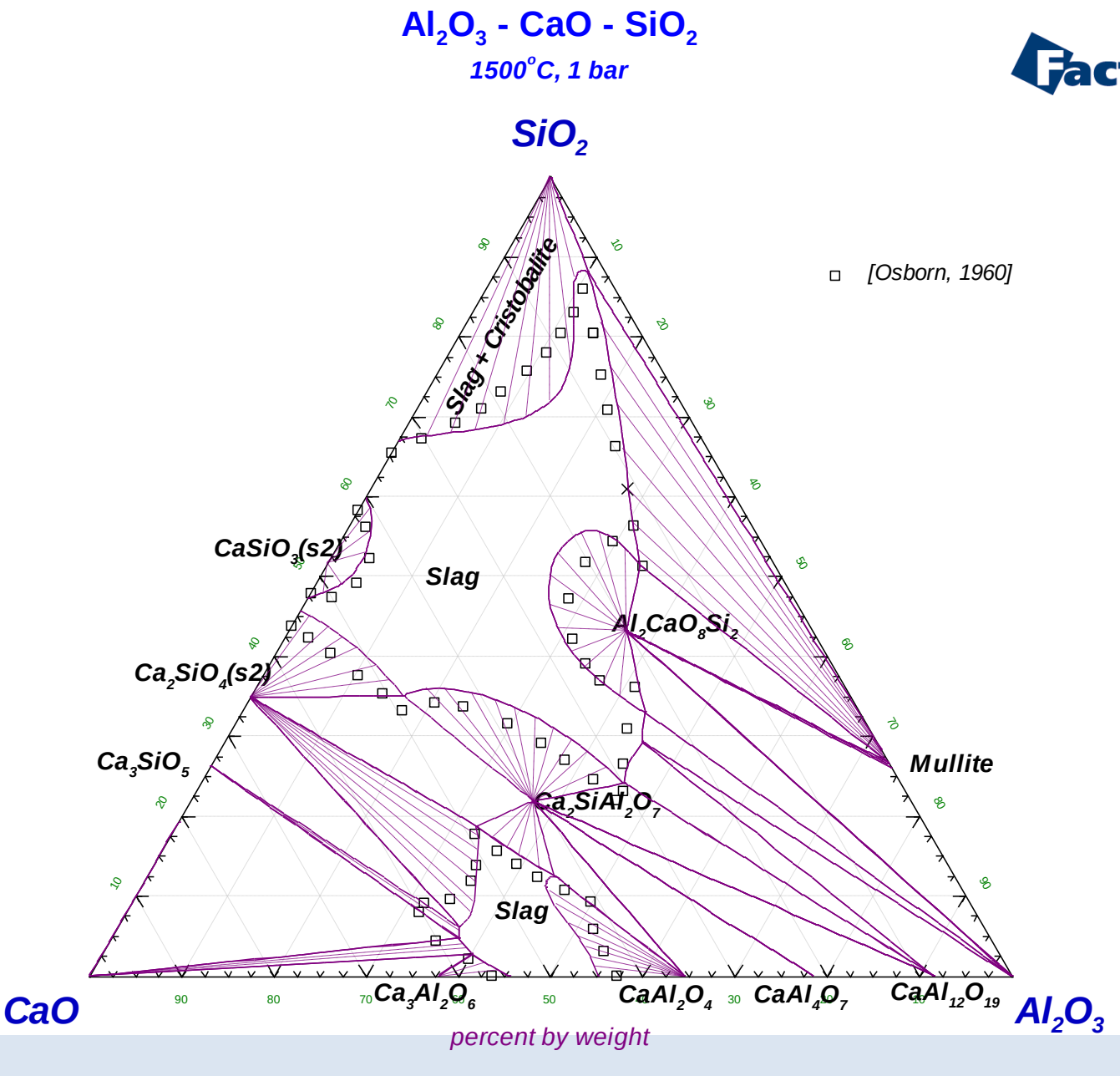
Weight percent
compared with experimental data

Al_2O_3 - CaO - SiO_2

1400°C



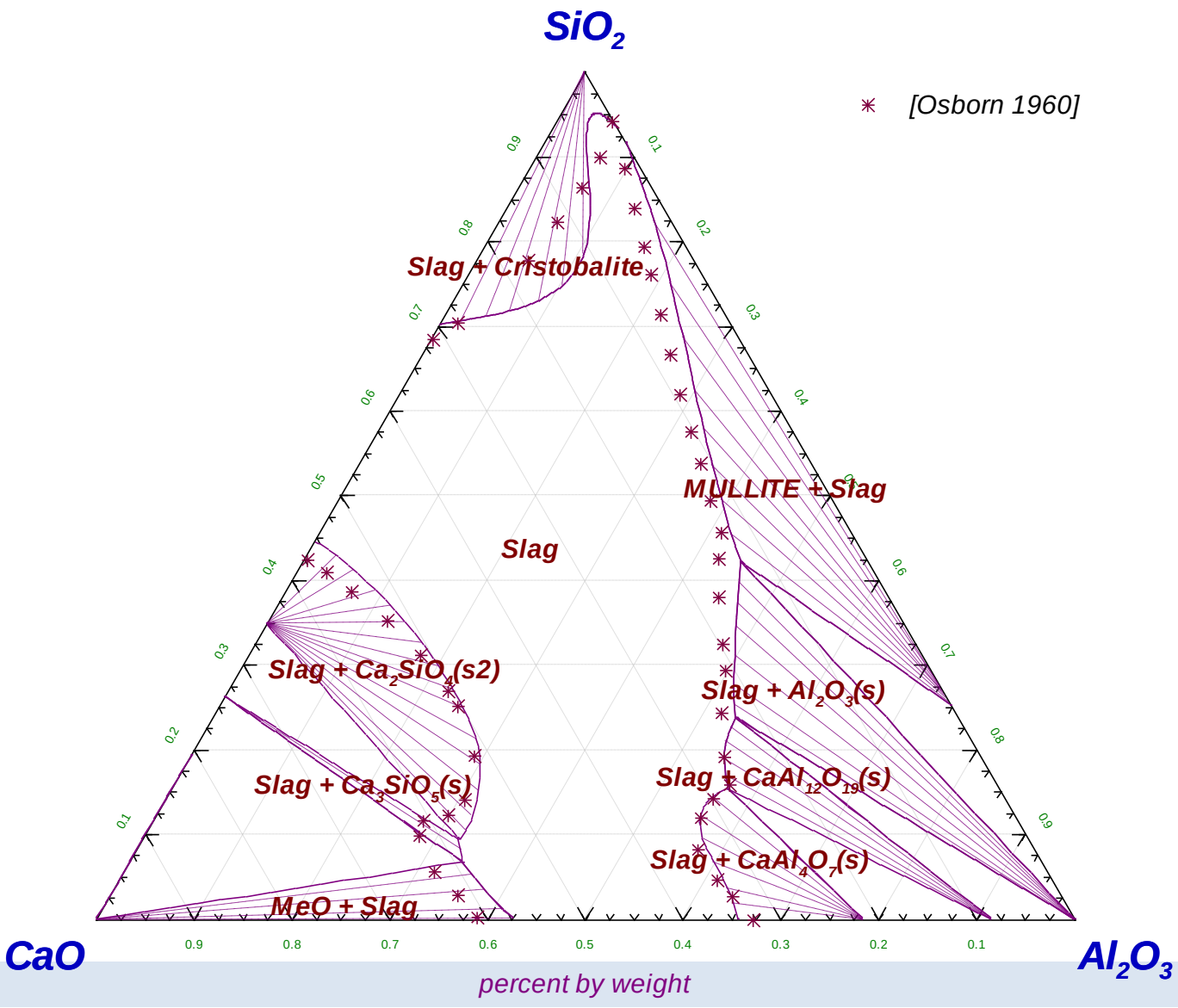
Weight percent
compared with experimental data



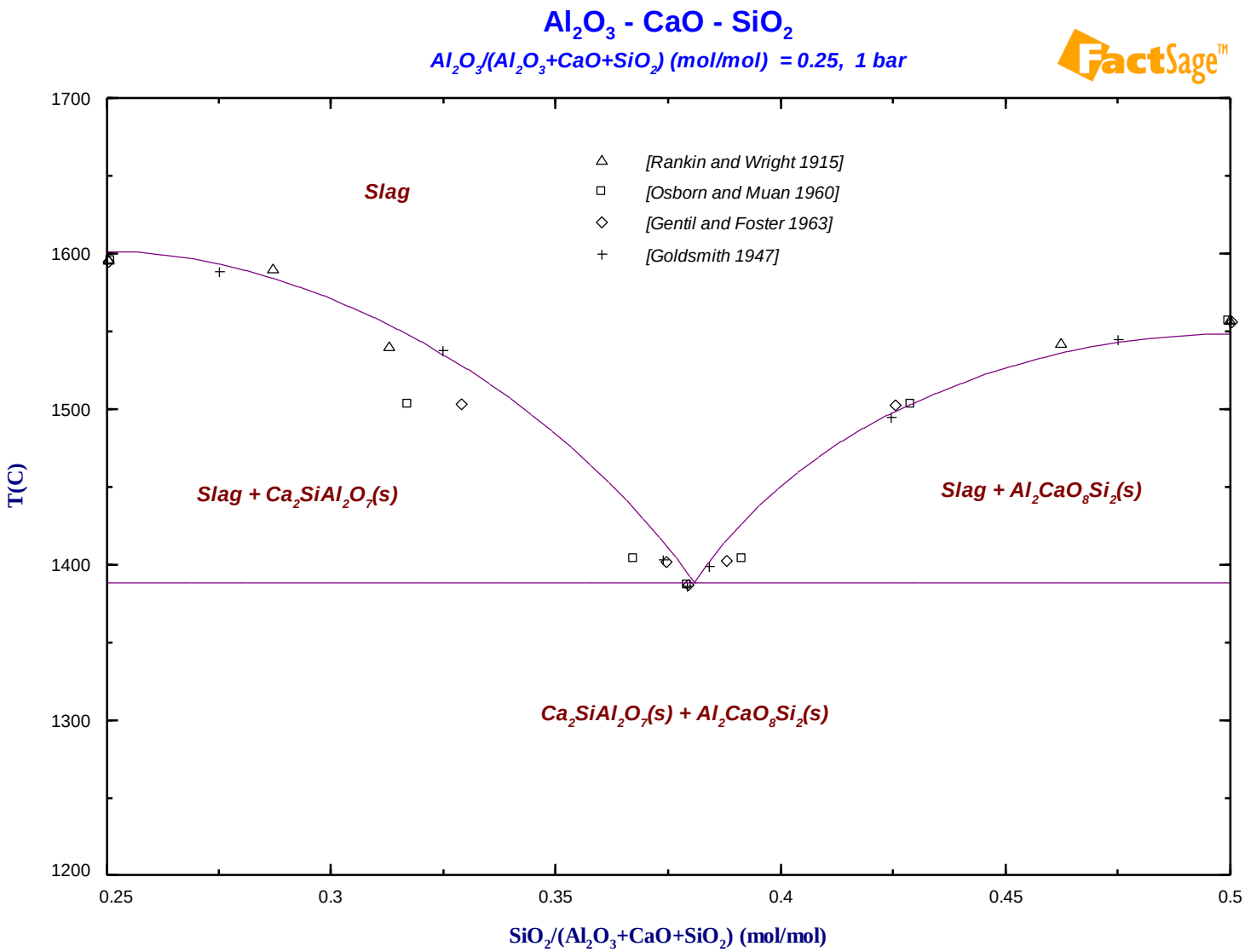
Weight percent
compared with experimental data

Al_2O_3 - CaO - SiO_2

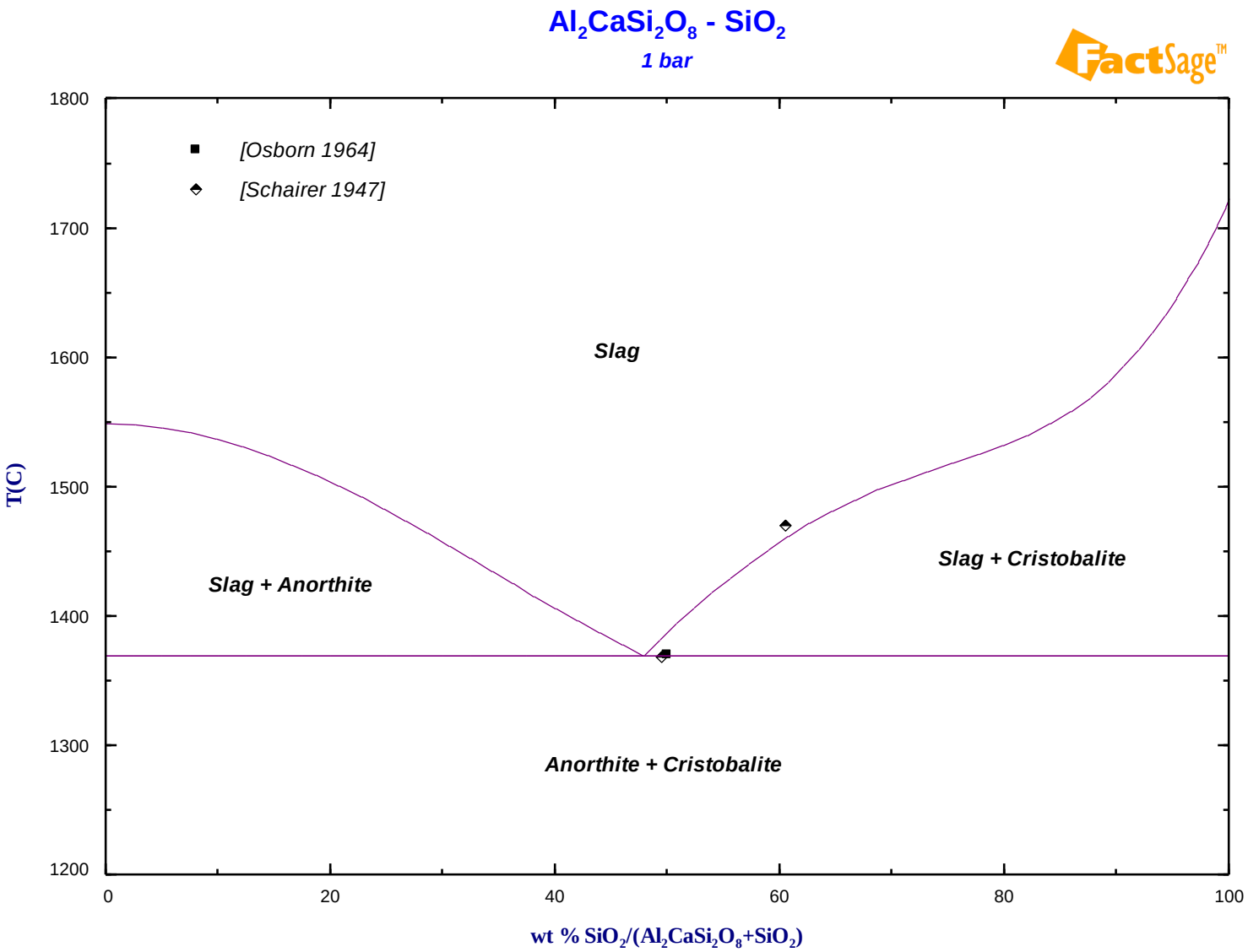
1600°C, 1 bar



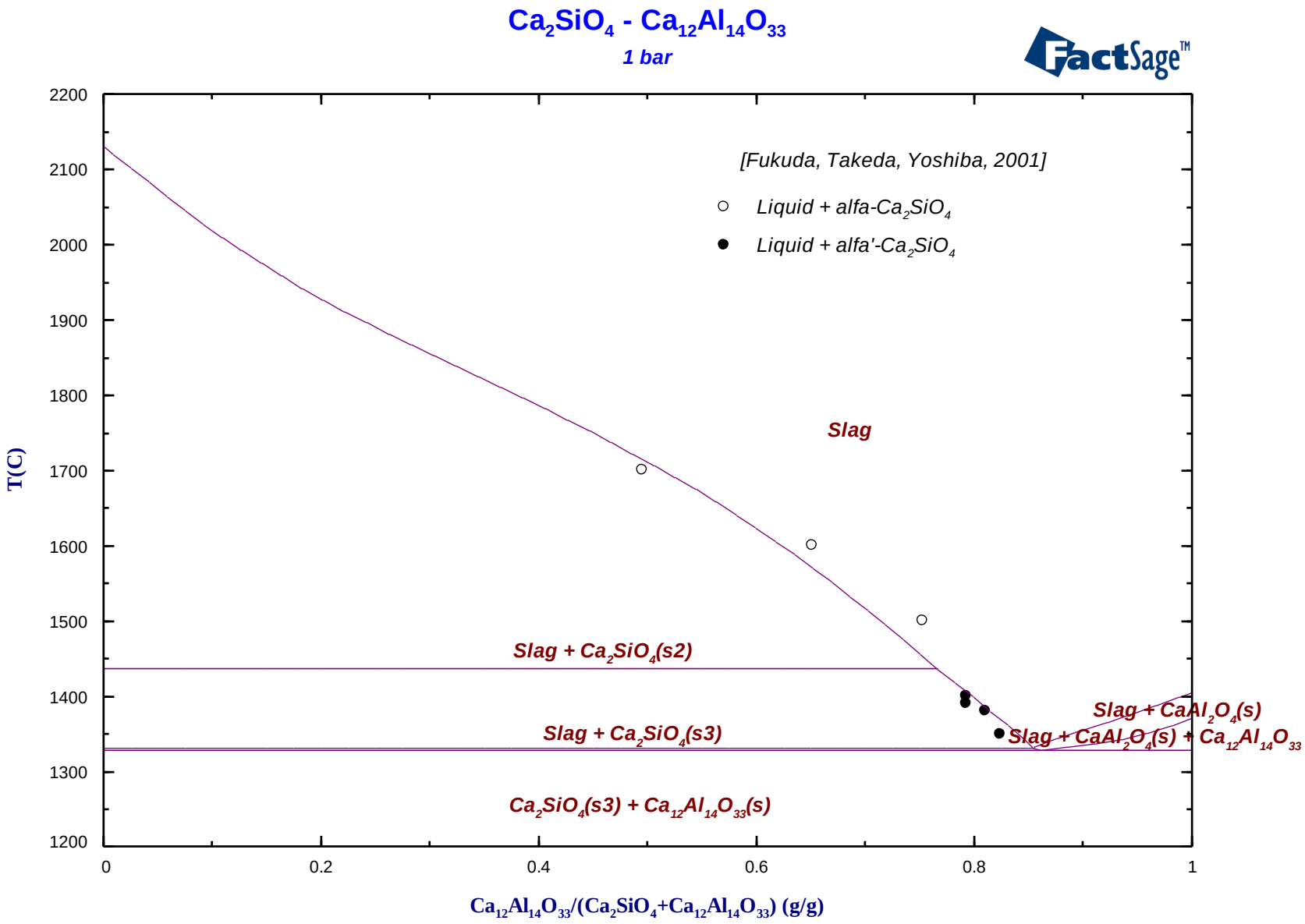
Mole fraction x(Al2O3)=0,25 compared with experimental data



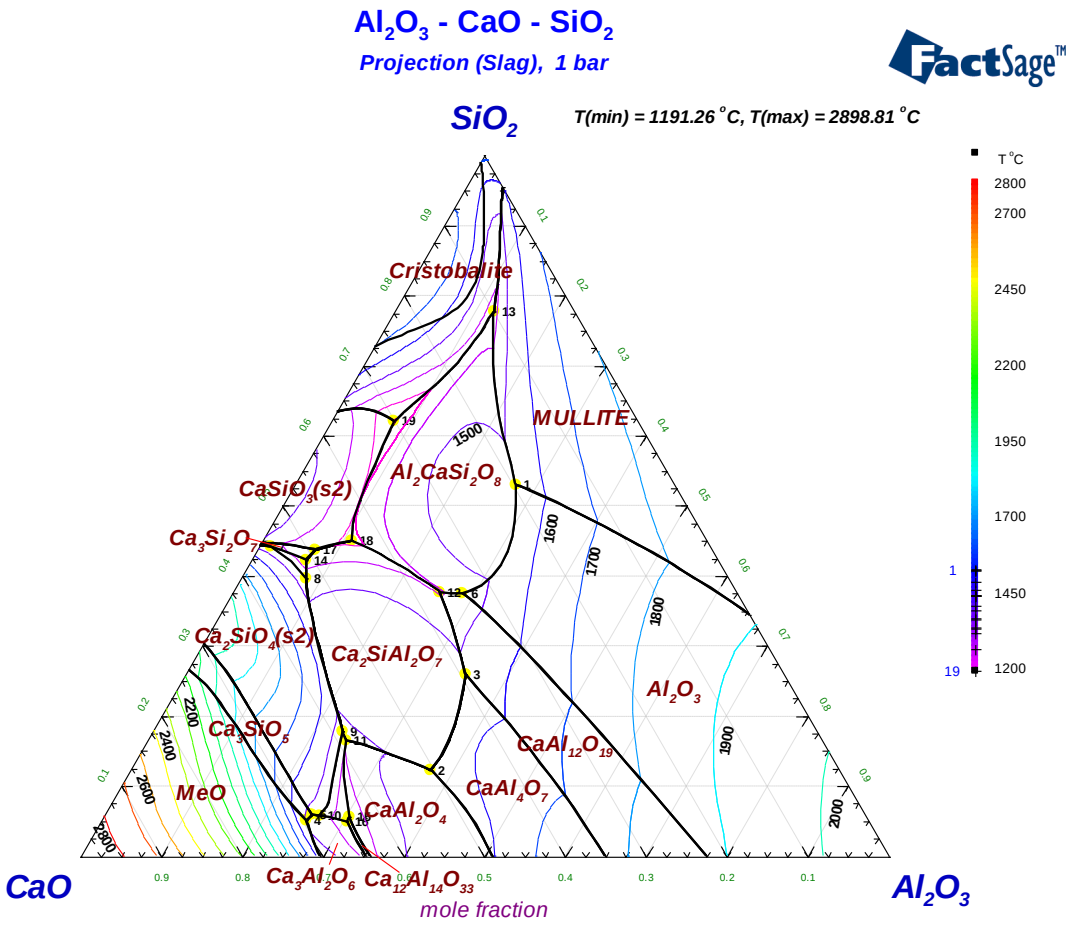
Weight percent
compared with experimental data

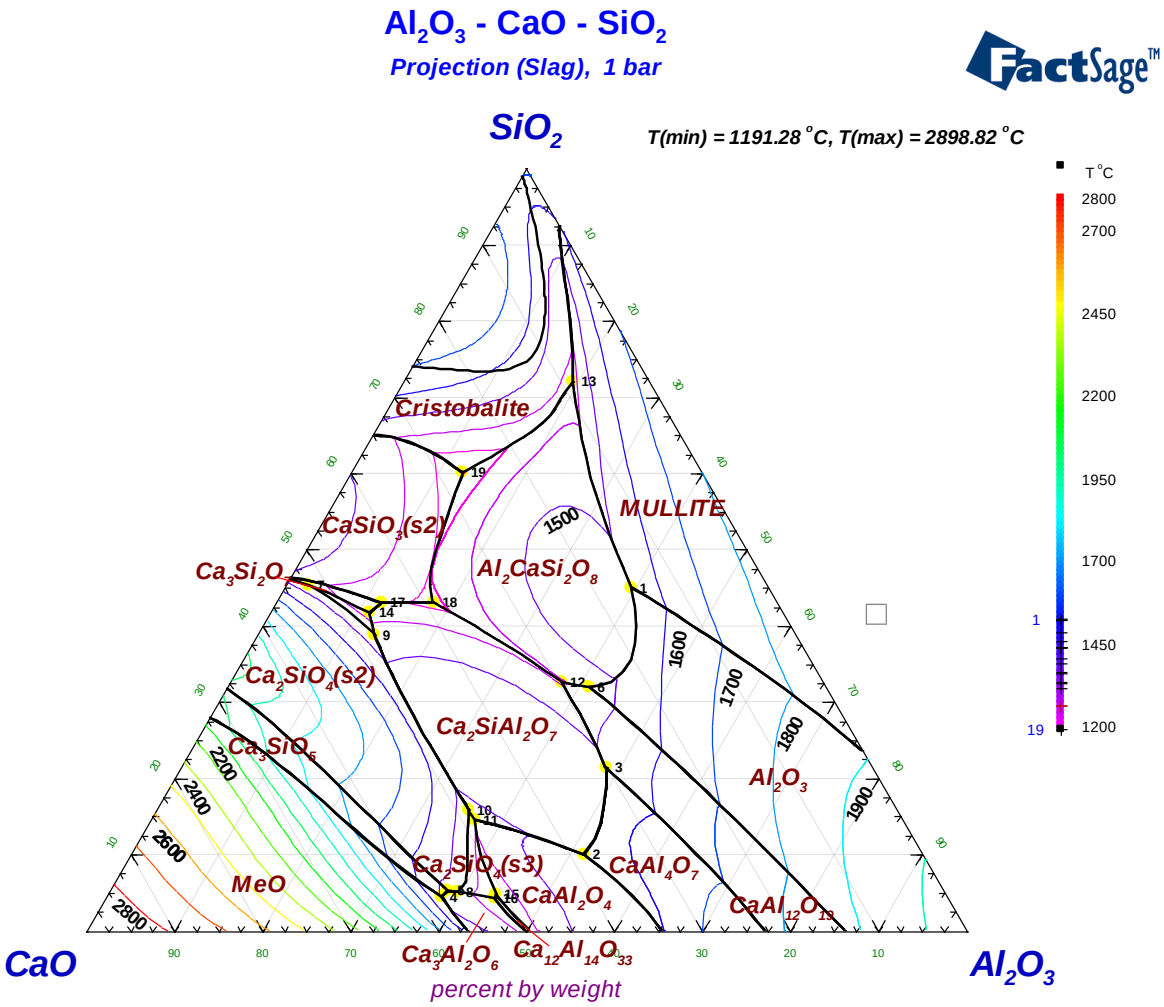


Weight percent Ca2SiO4-Ca12Al14O33 compared with experimental data



Mole fraction
Liquidussurface

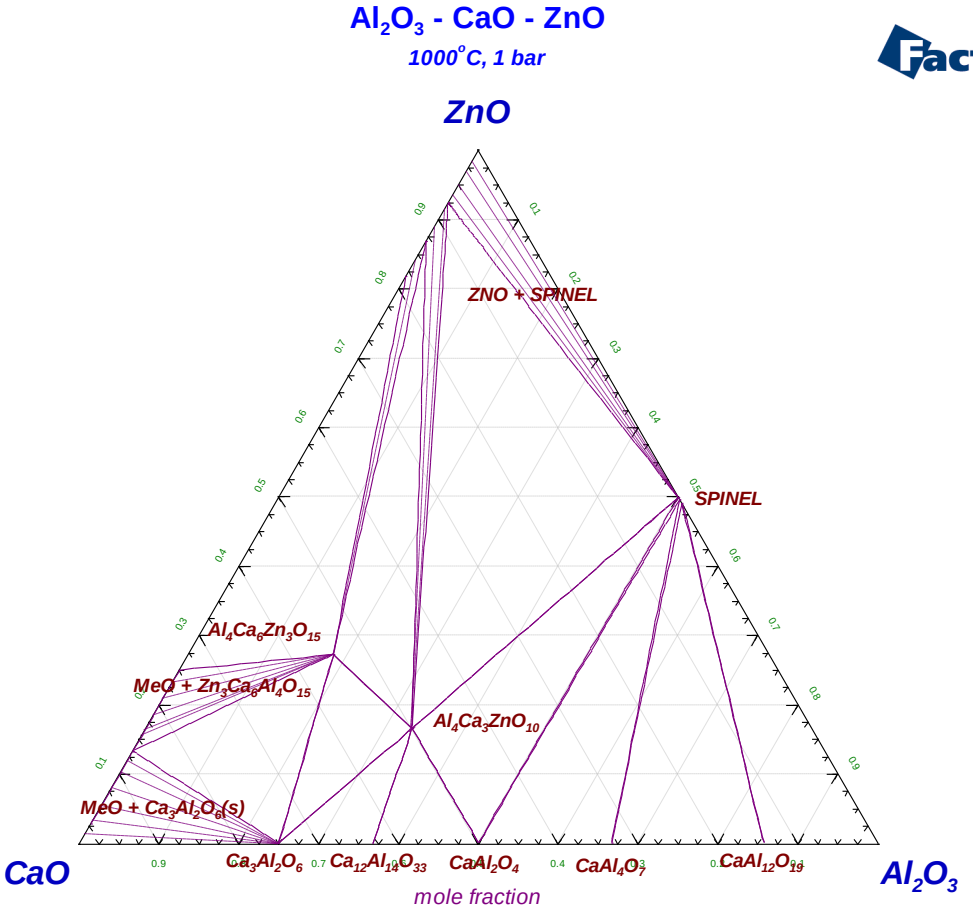



Al2O3 - CaO - SiO2
Projection (Slag), 1 bar
FactSage™
SiO2
T(min) = 1191.28 °C, T(max) = 2898.82 °C
T °C
2800
2700
2450
2200
1950
1700
1450
1200
Cristobalite
MULLITE
CaSiO3(s2)
Ca3Si2O7
Al2CaSi2O8
Ca2SiO4(s2)
Ca2SiAl2O7
Ca3SiO5
Al2O3
Ca2SiO4(s3)
CaAl4O7
CaAl2O4
CaAl12O19
MeO
Ca3Al2O6
Ca12Al14O33
1500
1600
1700
1800
1900
2200
2400
2500
2800
CaO
Al2O3
percent by weight

Invariant equilibria on the liquidus surface

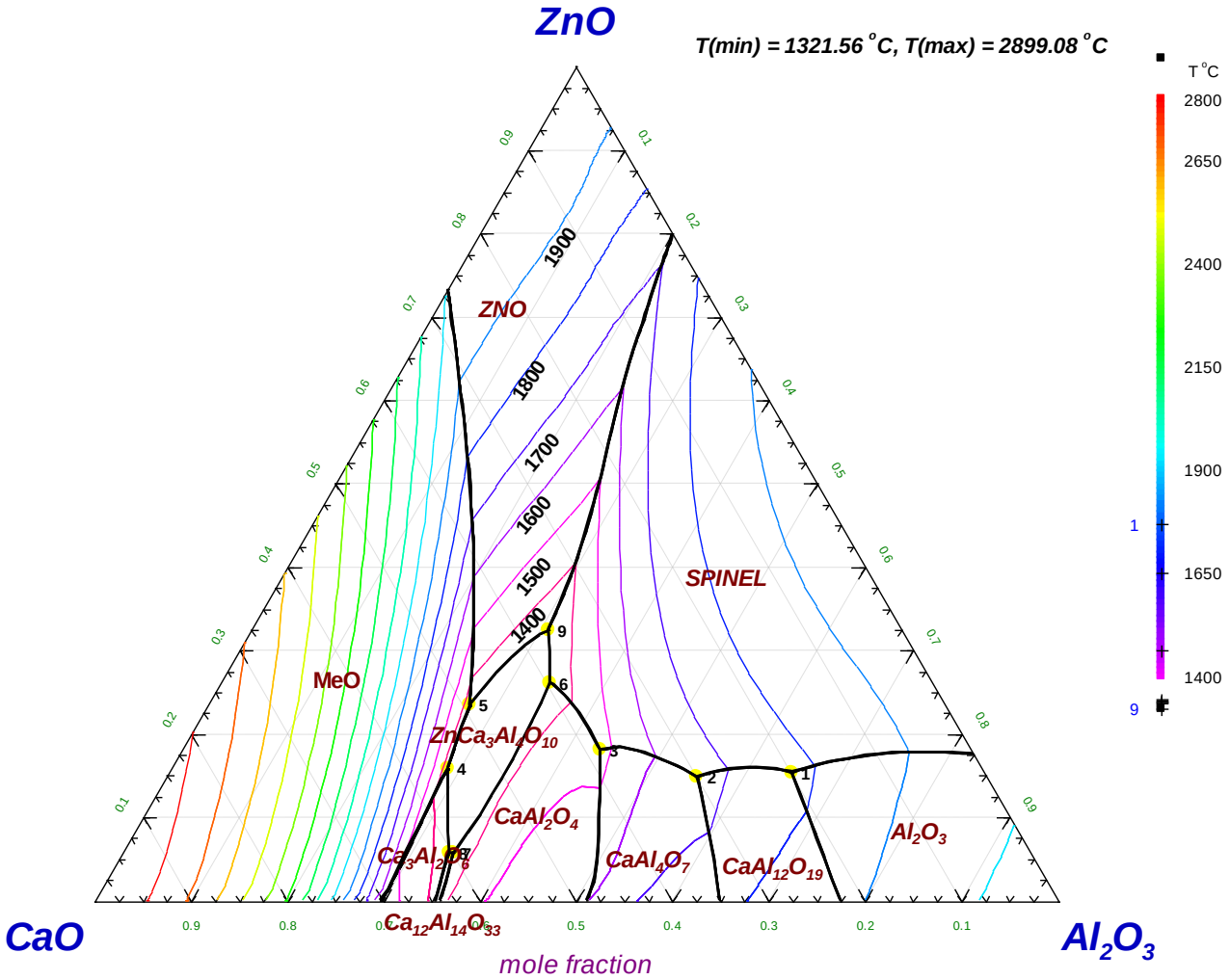
Intersections with slag	Mole fraction A = SiO2, B = CaO, C = Al2O3				Weight percent A = SiO2, B = CaO, C = Al2O3			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: Al2CaSi2O8 / Al2O3 / MULLITE	1: 0.53016	0.19613	0.27371	1522.84	1: 45.017	15.543	39.440	1522.84
2: Ca2SiAl2O7 / CaAl2O4 / CaAl4O7	2: 0.12311	0.50502	0.37187	1520.16	2: 10.046	38.461	51.493	1520.18
3: Ca2SiAl2O7 / CaAl12O19 / CaAl4O7	3: 0.25986	0.39392	0.34621	1518.99	3: 21.387	30.259	48.354	1518.99
4: Ca3Al2O6 / Ca3SiO5 / MeO	4: 0.05097	0.69506	0.25397	1484.01	4: 4.508	57.374	38.117	1483.98
5: Ca2SiO4(s2) / Ca3Al2O6 / Ca3SiO5	5: 0.05915	0.68373	0.25712	1458.08	5: 5.218	56.292	38.489	1457.91
6: Al2CaSi2O8 / Al2O3 / CaAl12O19	6: 0.37610	0.33887	0.28503	1439.36	6: 31.980	26.892	41.128	1439.36
7: Ca2SiO4(s2) / Ca2SiO4(s3) / Ca3Si2O7	7: 0.44186	0.54377	0.01437	1436.73	7: 45.377	52.119	2.505	1436.74
8: Ca2SiAl2O7 / Ca2SiO4(s2) / Ca2SiO4(s3)	8: 0.39705	0.52296	0.07999	1436.73	8: 5.119	55.270	39.610	1436.73
9: Ca2SiAl2O7 / Ca2SiO4(s2) / Ca2SiO4(s3)	9: 0.17838	0.58610	0.23552	1436.73	9: 38.893	47.810	13.297	1436.73
10: Ca2SiO4(s2) / Ca2SiO4(s3) / Ca3Al2O6	10: 0.05839	0.67540	0.26621	1436.73	10: 15.854	48.622	35.524	1436.73
11: Ca2SiAl2O7 / Ca2SiO4(s3) / CaAl2O4	11: 0.16487	0.58942	0.24571	1405.49	11: 14.565	48.599	36.836	1405.49
12: Al2CaO8Si2 / Ca2SiAl2O7 / CaAl12O19	12: 0.37749	0.36681	0.25570	1388.25	12: 32.719	29.672	37.609	1388.23
13: Al2CaSi2O8 / MULLITE / Cristobalite	13: 0.77700	0.10020	0.12279	1364.64	13: 72.018	8.668	19.314	1364.64
14: Ca2SiAl2O7 / Ca2SiO4(s3) / Ca3Si2O7	14: 0.42300	0.50934	0.06766	1360.06	14: 41.749	46.918	11.333	1360.05
15: Ca12Al14O33 / Ca2SiO4(s3) / CaAl2O4	15: 0.05610	0.63973	0.30417	1331.21	15: 4.798	51.060	44.142	1331.21
16: Ca12Al14O33 / Ca2SiO4(s3) / Ca3Al2O6	16: 0.05021	0.64497	0.30482	1330.35	16: 4.294	51.474	44.232	1330.35
17: Ca2SiAl2O7 / Ca3Si2O7 / CaSiO3(s2)	17: 0.43796	0.49015	0.07188	1314.96	17: 43.047	44.964	11.990	1314.96
18: Al2CaSi2O8 / Ca2SiAl2O7 / CaSiO3(s2)	18: 0.45111	0.43833	0.11056	1262.21	18: 43.052	39.042	17.906	1262.21
19: Al2CaSi2O8 / CaSiO3(s2) / Cristobalite	19: 0.62137	0.30113	0.07750	1191.26	19: 60.098	27.182	12.719	1191.37

Mole fraction 1000°C



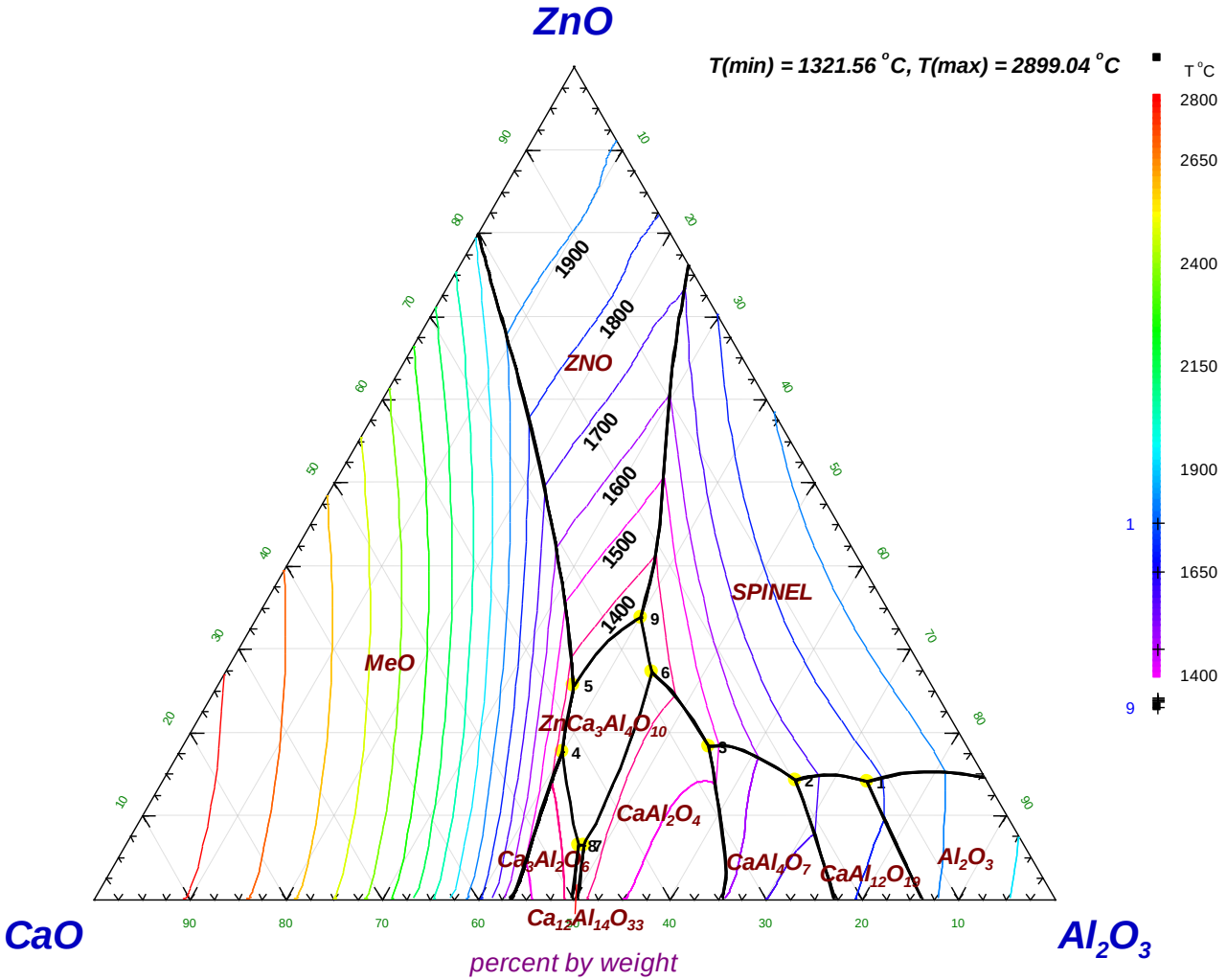
Al_2O_3 - CaO - ZnO

Projection (Slag), 1 atm



Al_2O_3 - CaO - ZnO

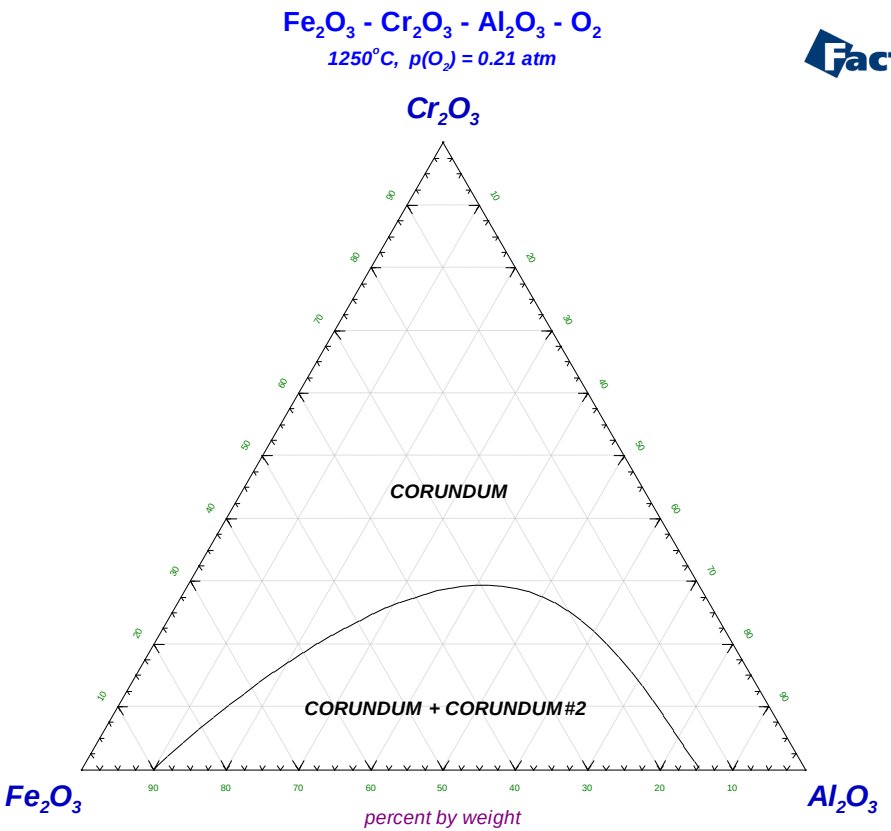
Projection (Slag), 1 atm

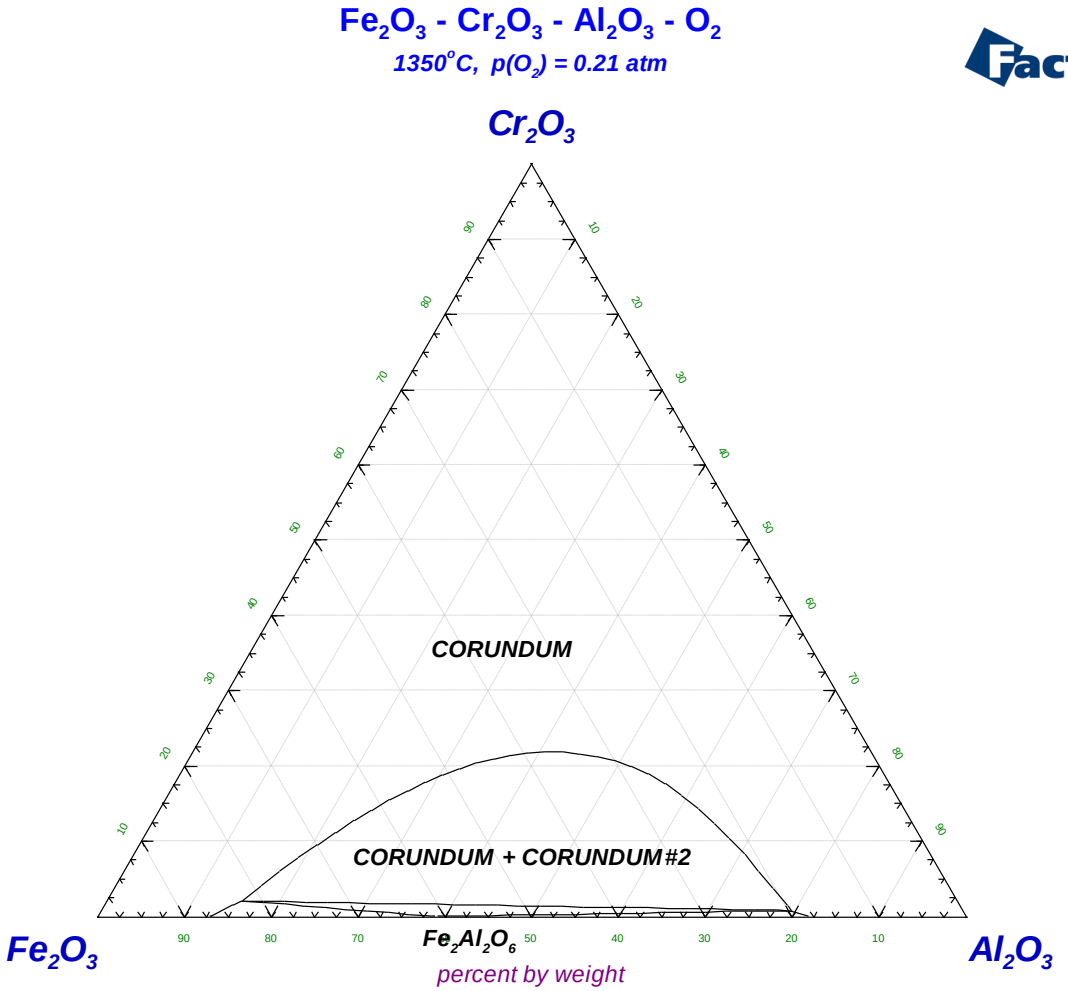


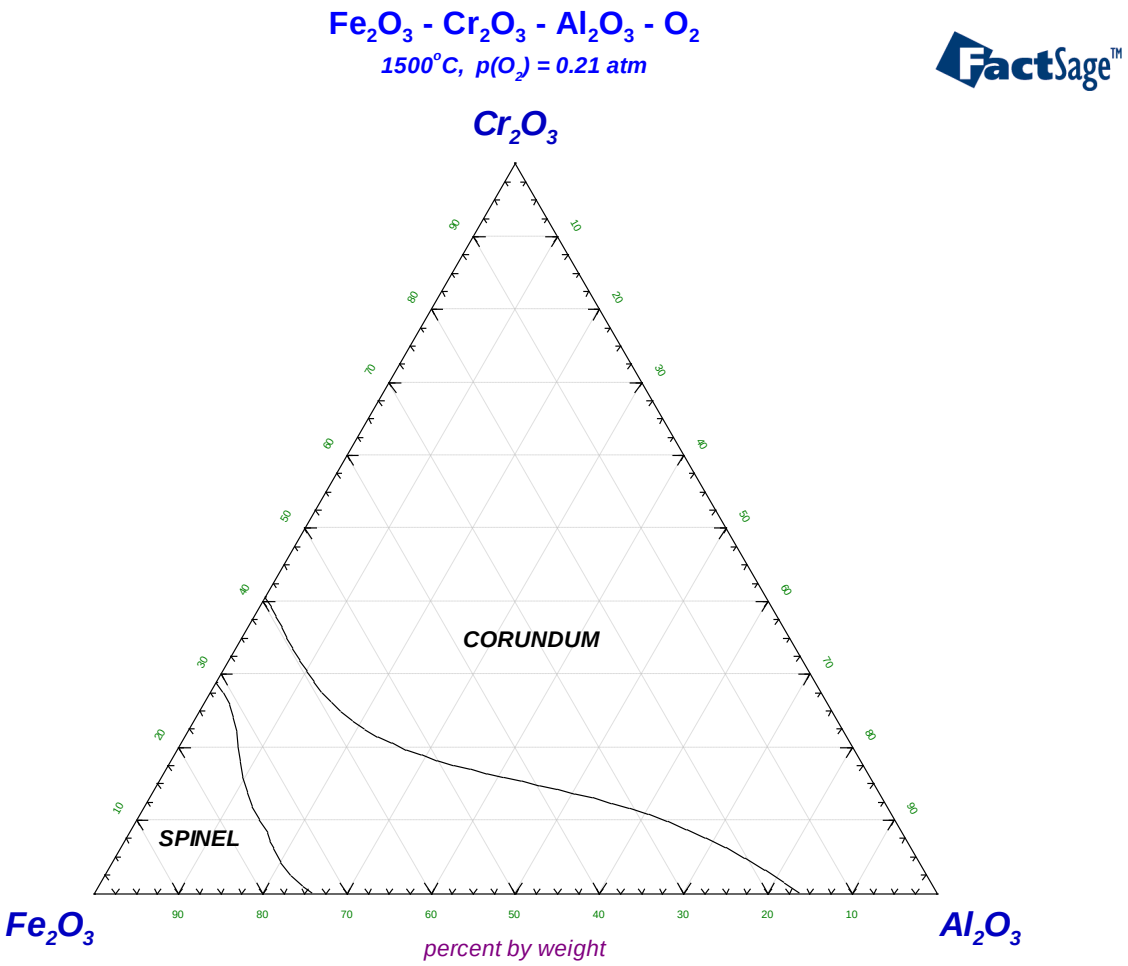
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction					Weight percent				
	A = ZnO, B = CaO, C = Al2O3					A = ZnO, B = CaO, C = Al2O3				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: Al2O3 / CaAl12O19 / SPINEL	1:	0.15446	0.19876	0.64678	1769.91	1:	14.019	12.431	73.550	1769.88
2: CaAl12O19 / CaAl4O7 / SPINEL	2:	0.14927	0.29983	0.55090	1651.56	2:	14.269	19.750	65.981	1651.56
3: CaAl2O4 / CaAl4O7 / SPINEL	3:	0.18097	0.38510	0.43393	1464.53	3:	18.280	26.804	54.916	1464.53
4: Ca3Al2O6 / MeO / ZnCa3Al4O10	4:	0.15911	0.55398	0.28691	1345.91	4:	17.673	42.400	39.927	1345.91
5: MeO / ZNO / ZnCa3Al4O10	5:	0.23458	0.49392	0.27150	1340.98	5:	25.634	37.193	37.172	1340.99
6: CaAl2O4 / SPINEL / ZnCa3Al4O10	6:	0.26219	0.39593	0.34189	1340.04	6:	27.216	28.320	44.464	1340.09
7: Ca12Al14O33 / CaAl2O4 / ZnCa3Al4O10	7:	0.05804	0.59834	0.34362	1338.04	7:	..6.443	45.767	47.790	1338.04
8: Ca12Al14O33 / Ca3Al2O6 / ZnCa3Al4O10	8:	0.05804	0.60340	0.33856	1335.82	8:	6.463	46.302	47.235	1335.82
9: SPINEL / ZNO / ZnCa3Al4O10	9:	0.32507	0.36656	0.30837	1321.56	9:	33.721	26.202	40.078	1321.56

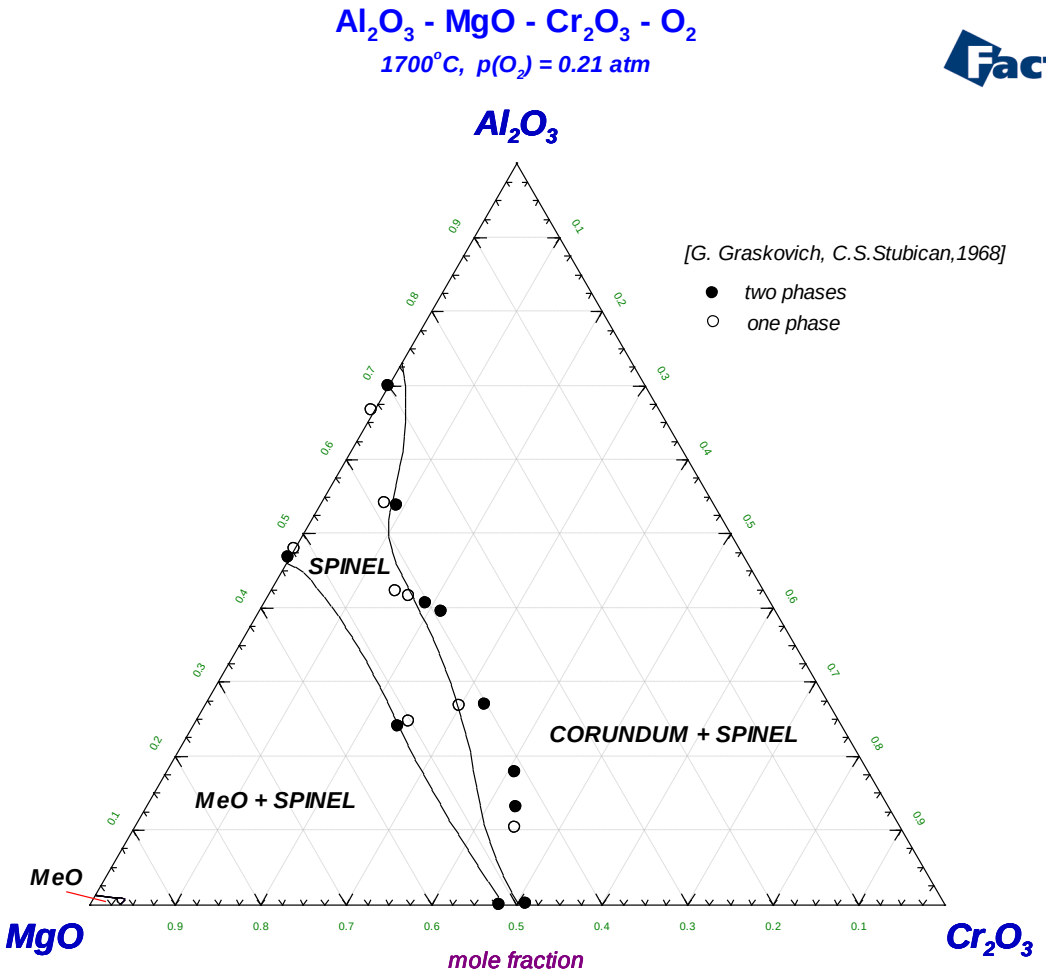
Al2O3-Cr2O3-Fe2O3,
Weight percent 1250°C



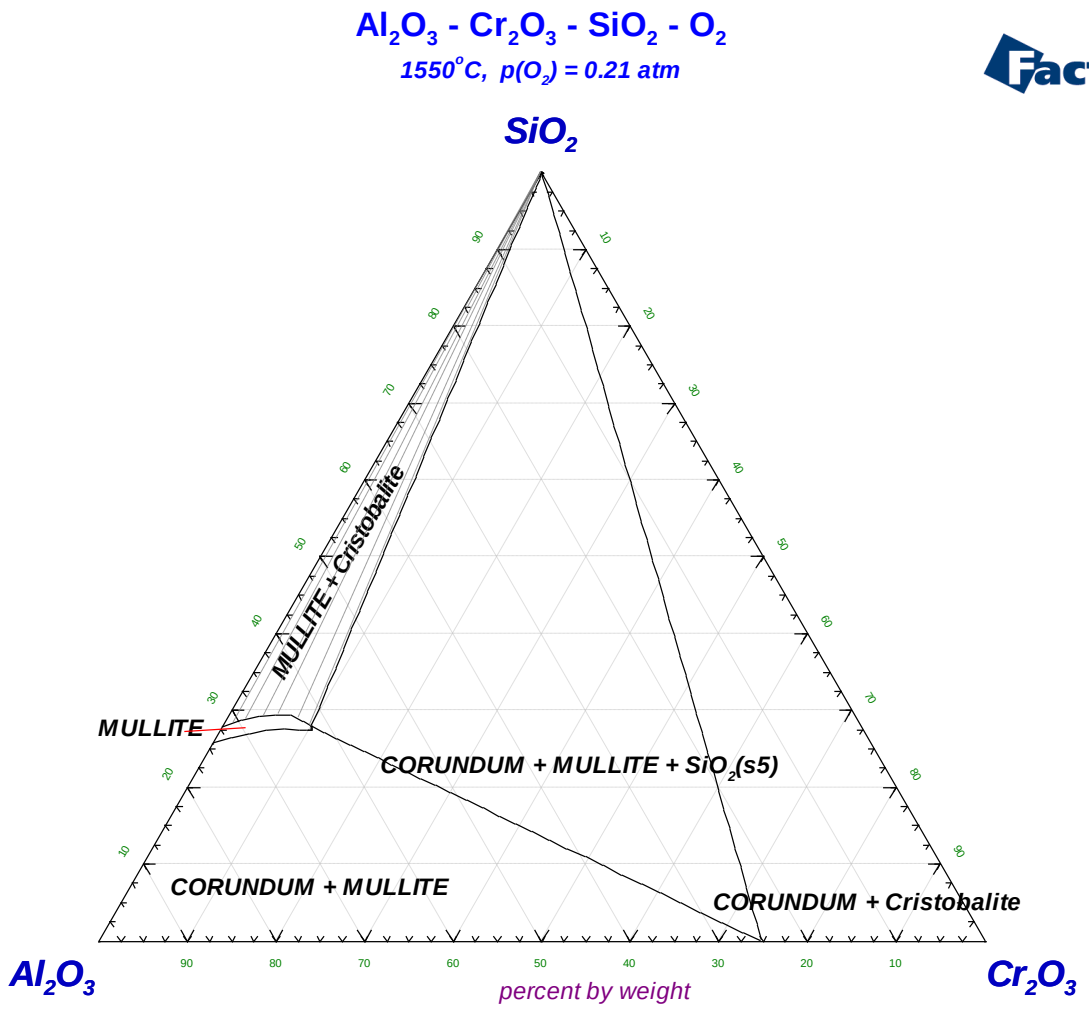

Fe_2O_3 - Cr_2O_3 - Al_2O_3 - O_2
1350°C, $p(O_2)$ = 0.21 atm
Cr_2O_3
CORUNDUM
CORUNDUM + CORUNDUM#2
$Fe_2Al_2O_6$
Fe_2O_3
Al_2O_3
percent by weight


Fe_2O_3 - Cr_2O_3 - Al_2O_3 - O_2
1500°C, $p(O_2)$ = 0.21 atm
Cr_2O_3
CORUNDUM
SPINEL
Fe_2O_3
Al_2O_3
90
80
70
60
50
40
30
20
10
percent by weight

Al2O3-Cr2O3-MgO,
Mole fraction 1700°C

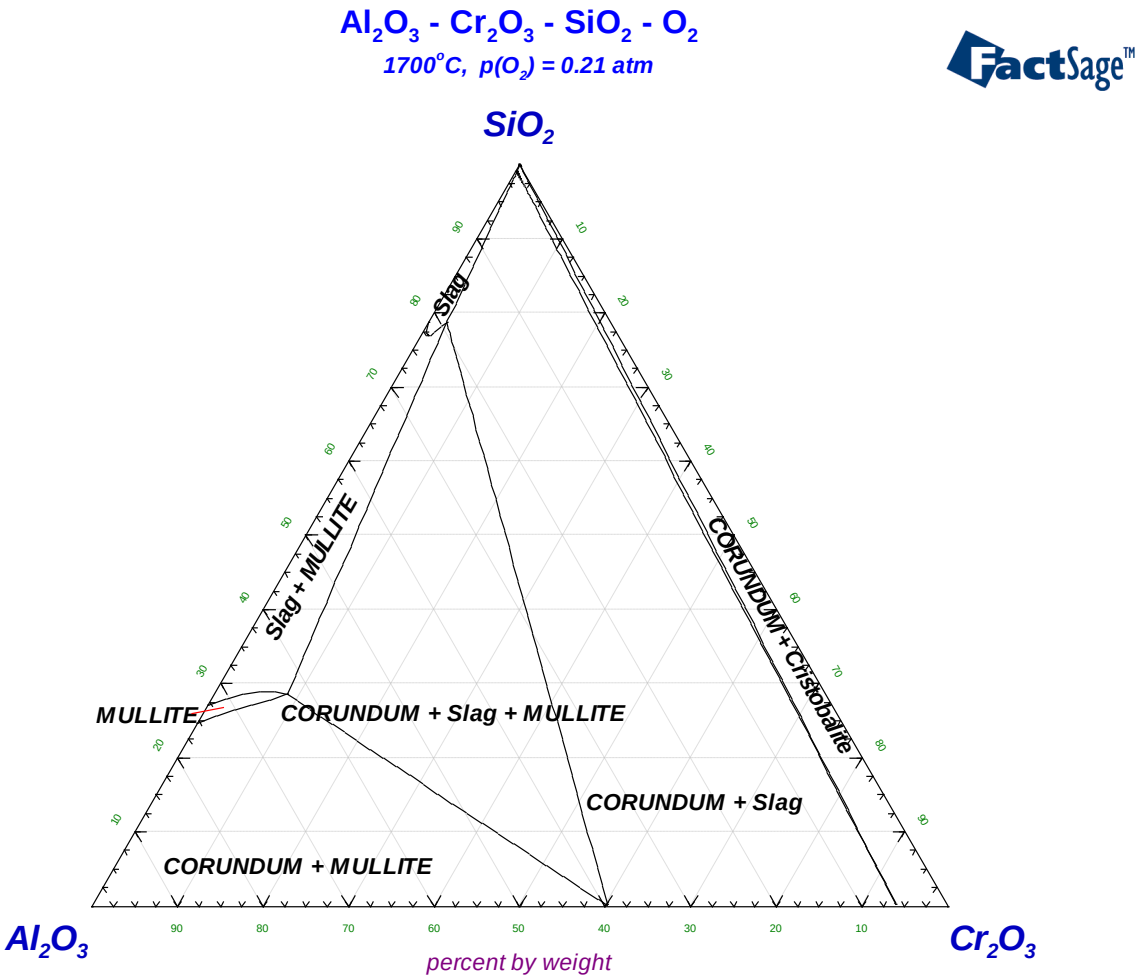


Al2O3-Cr2O3-SiO2,
Weight percent 1550°C



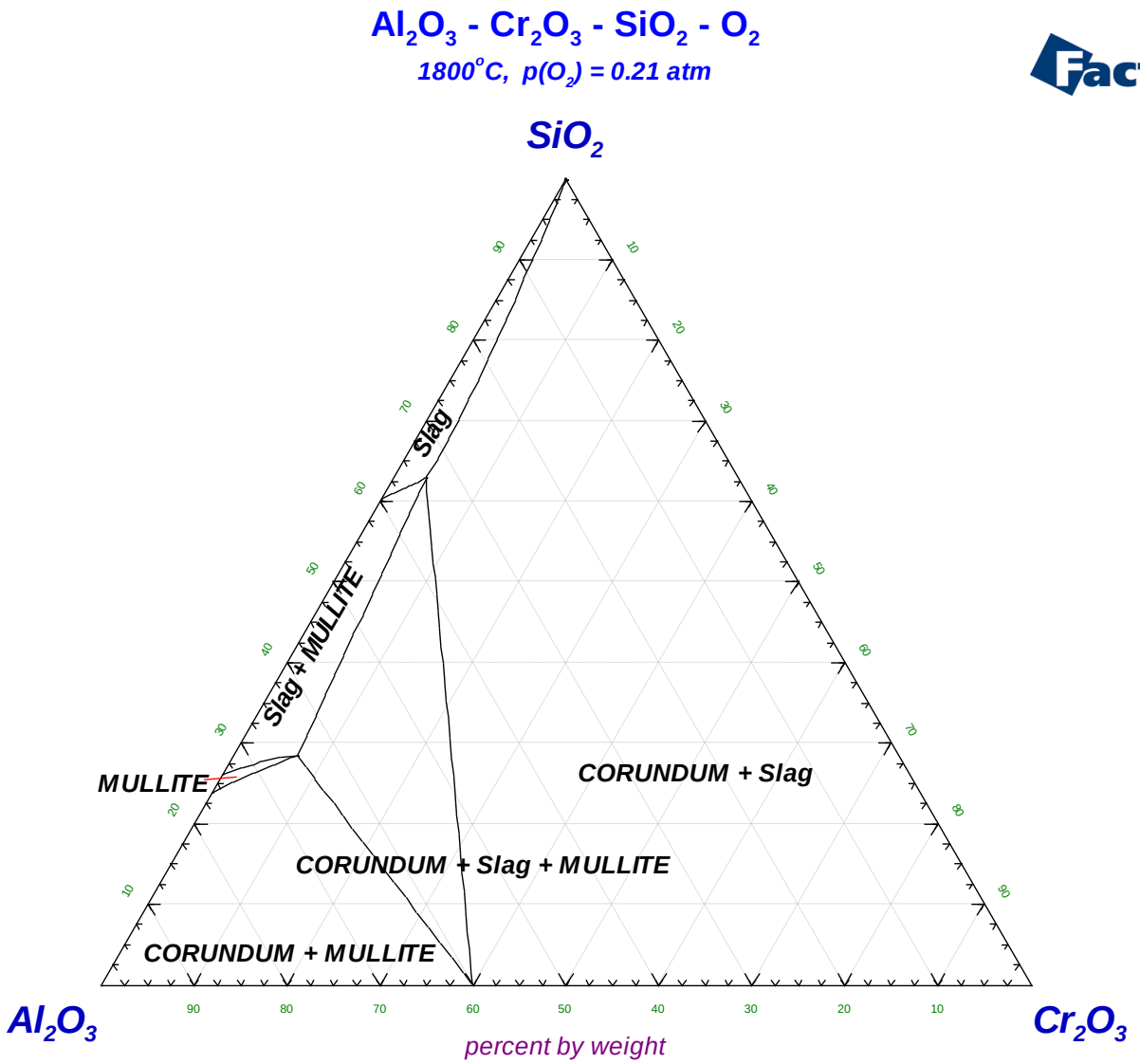
Al2O3-Cr2O3-SiO2,

Weight percent 1700°C



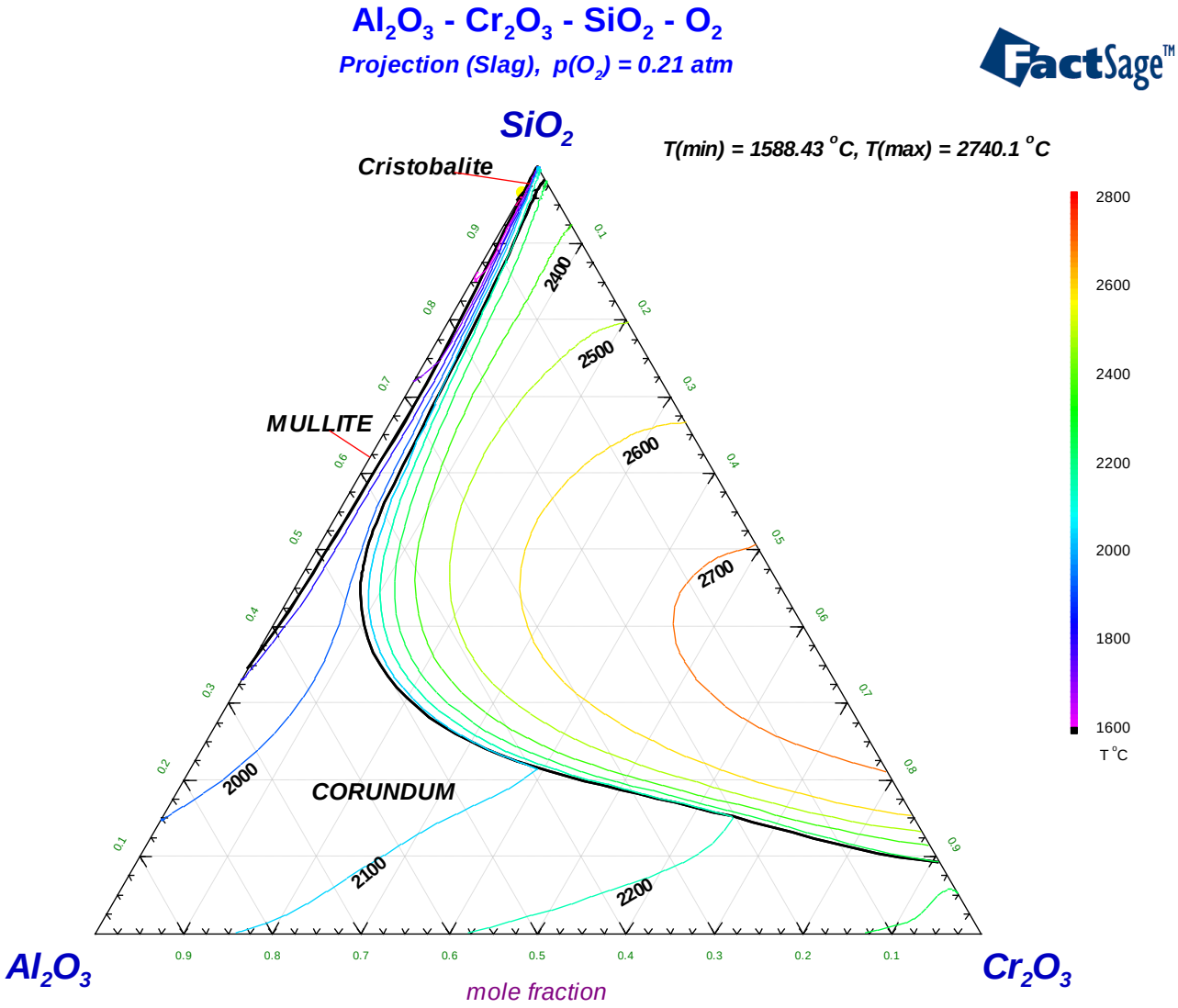
Al2O3-Cr2O3-SiO2,

Weight percent 1800°C

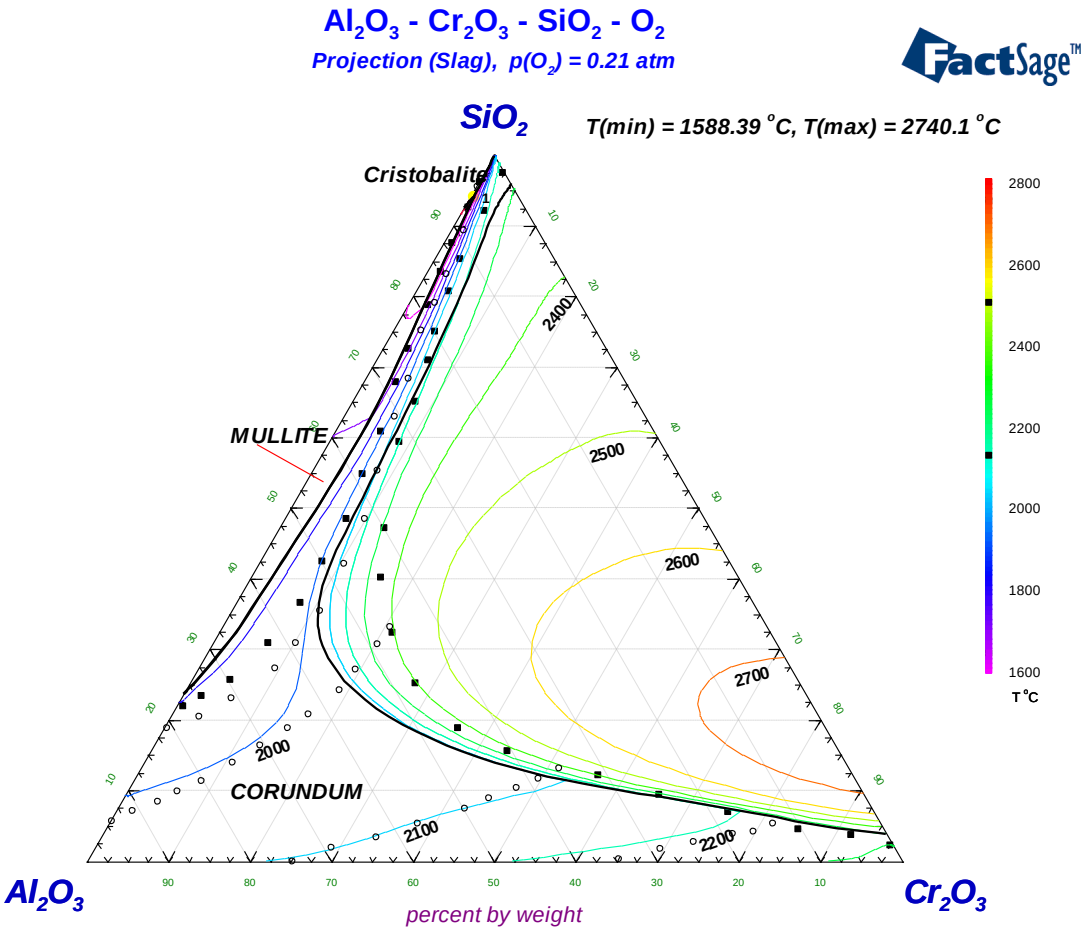


Al2O3-Cr2O3-SiO2,

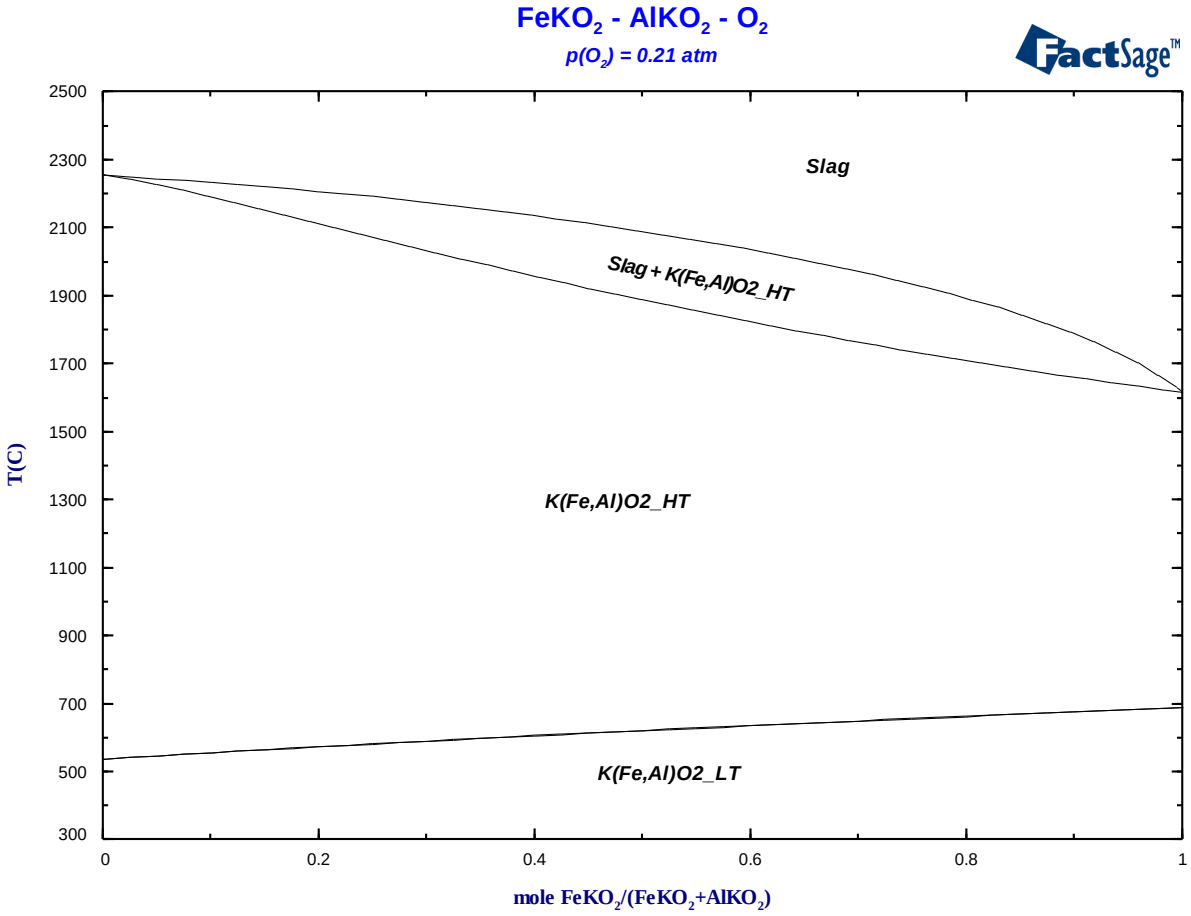
Mole fraction
Liquidussurface



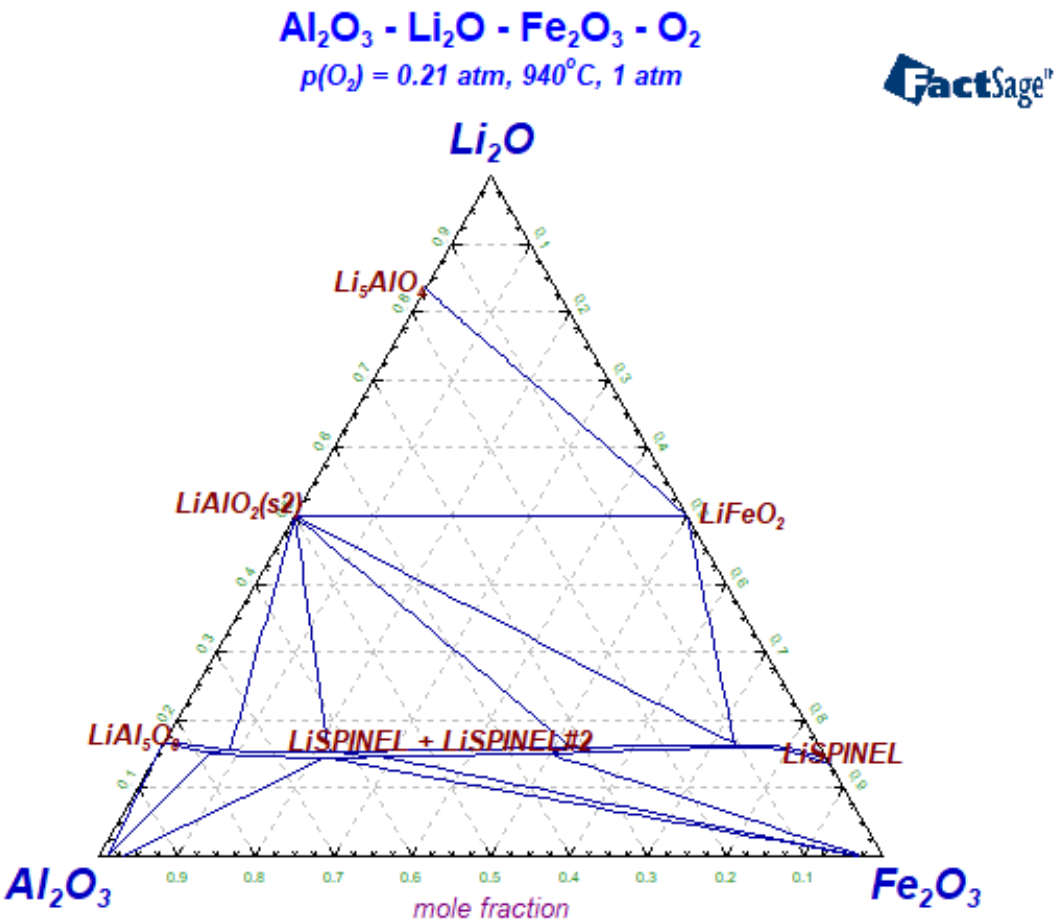
Weight percent
Liquidussurface compared with experimental data



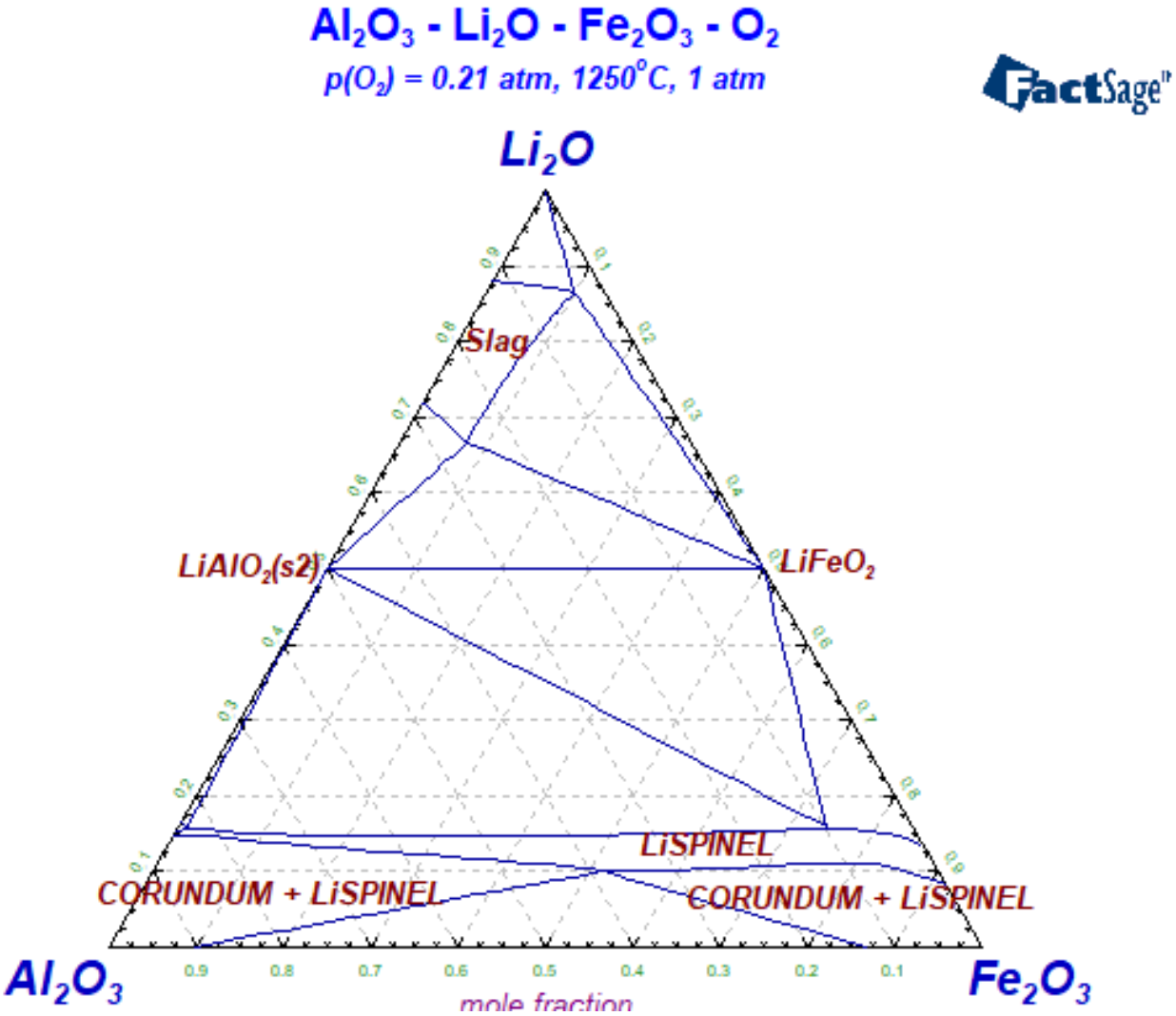
Isopleth FeKO2-AlKO2

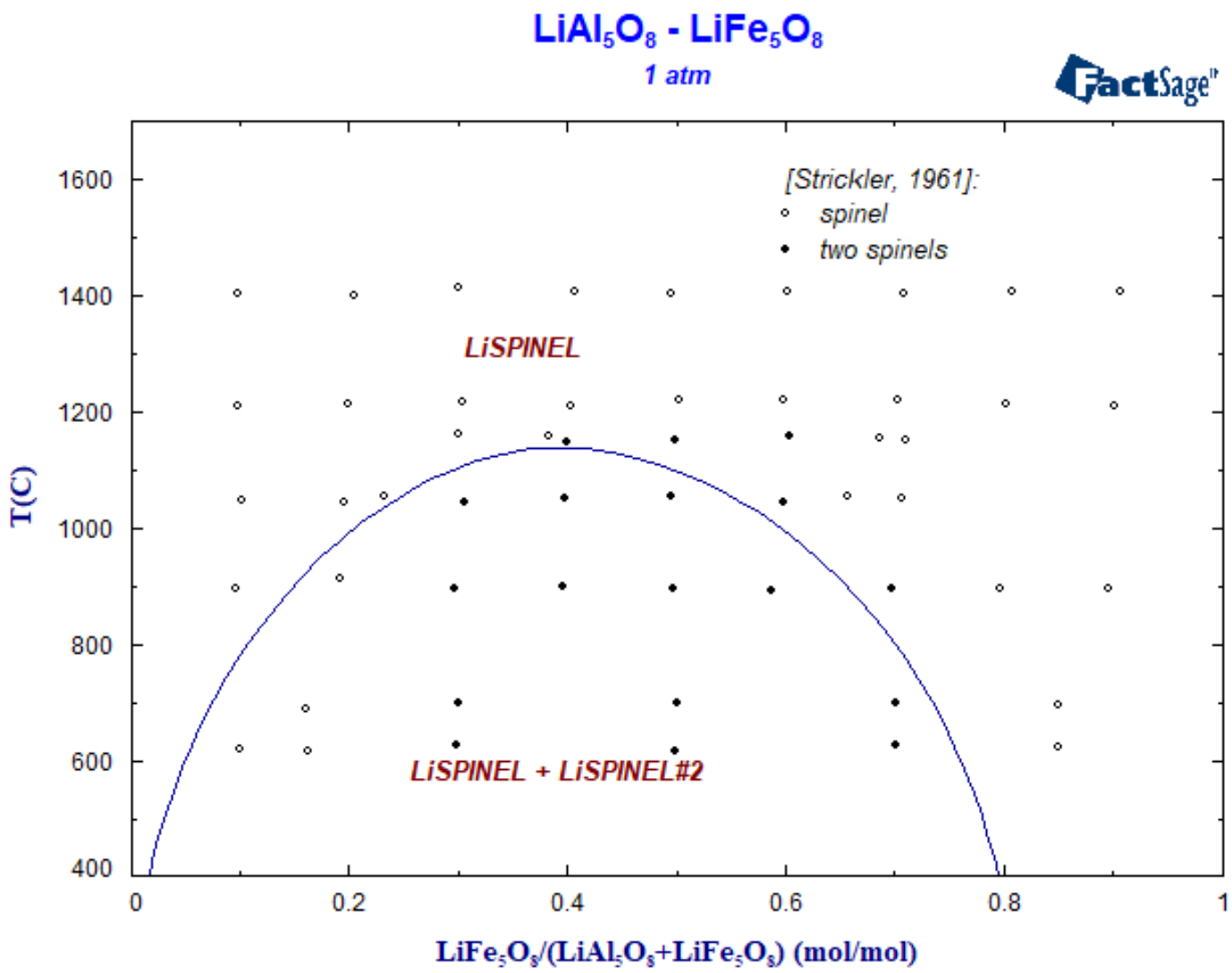


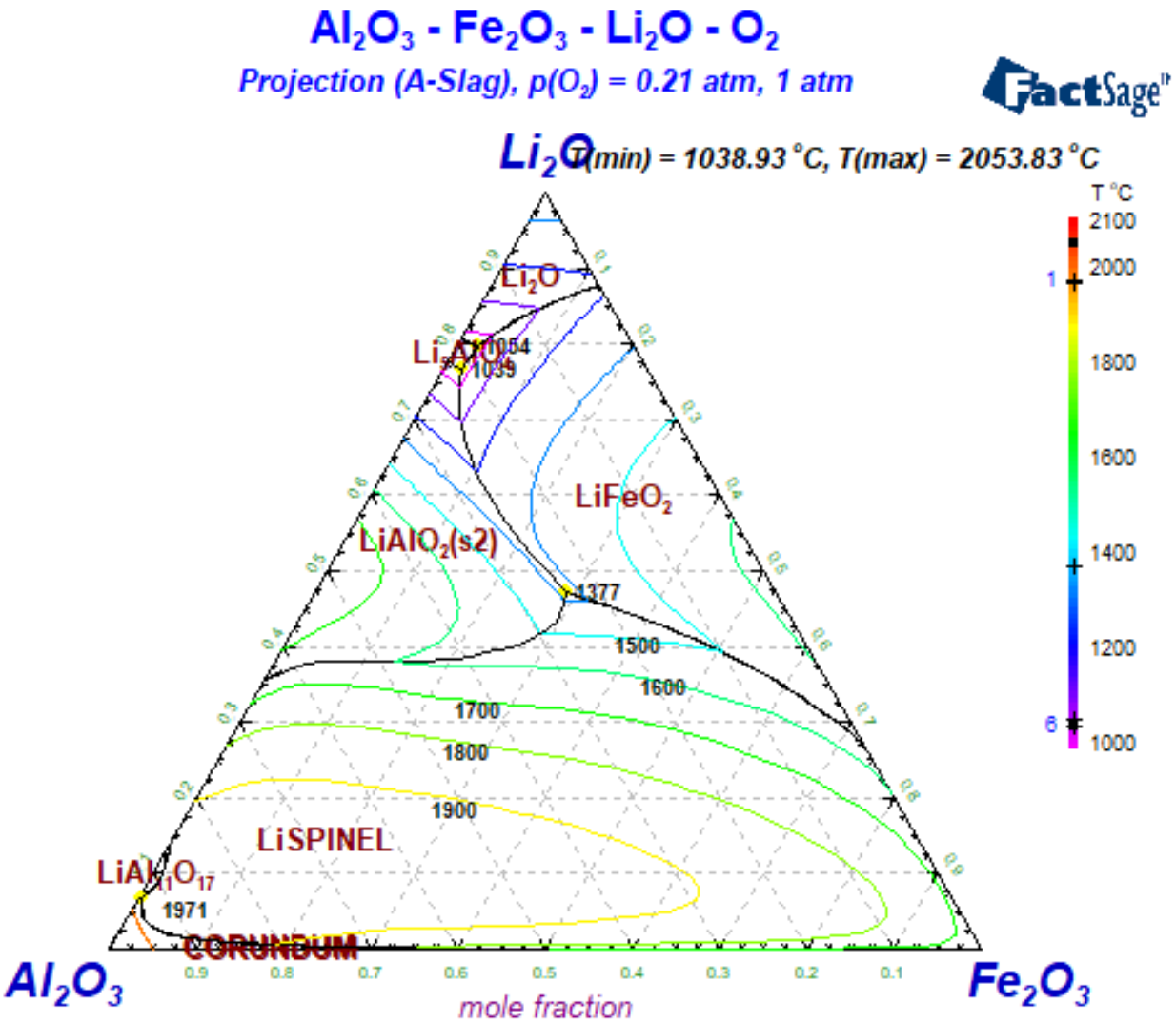
Al2O3-Fe2O3-Li2O,
Mole fraction 940°C

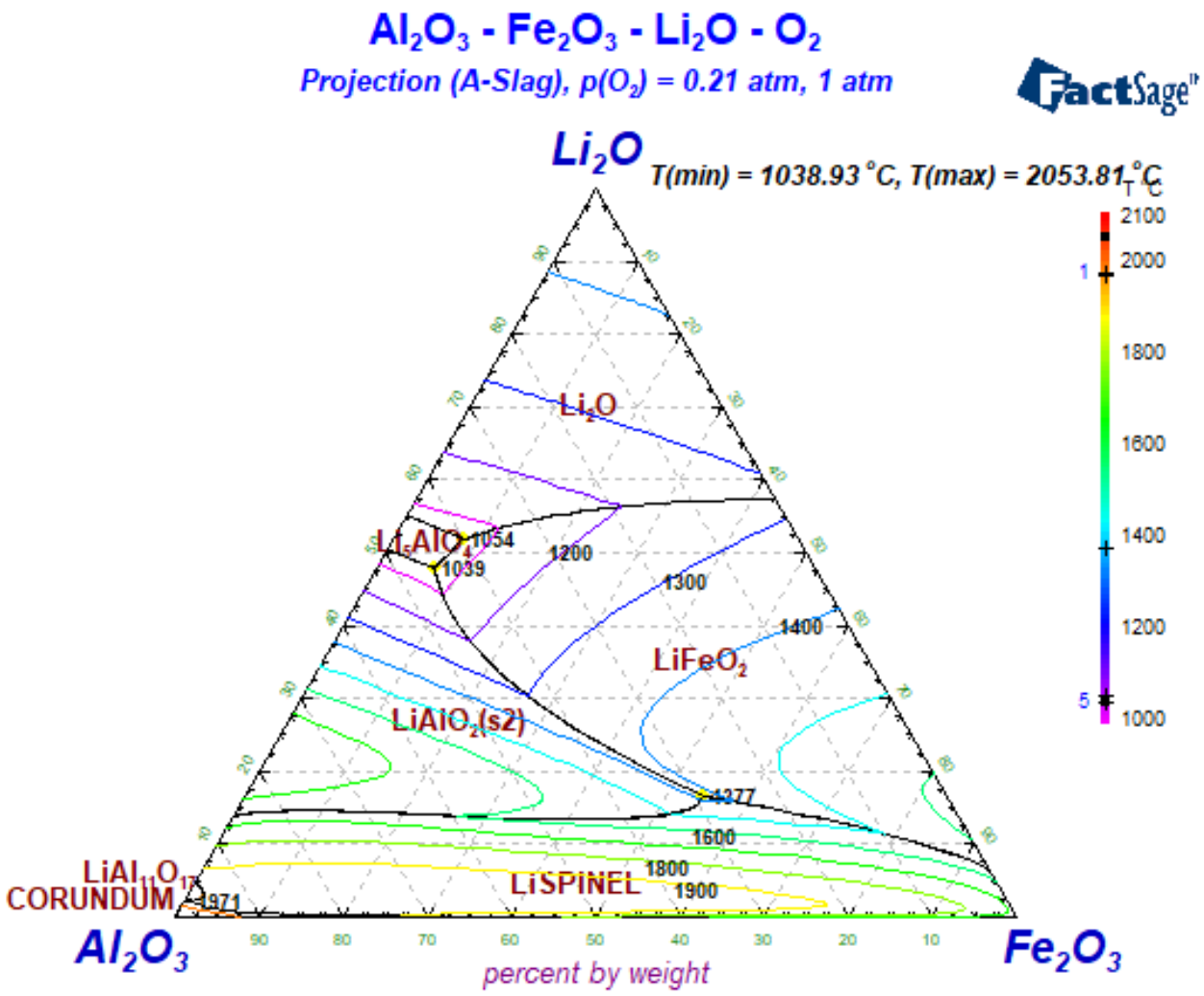


Al2O3-Fe2O3-Li2O,
Mole fraction 1250°C




LiAl5O8 - LiFe5O8
1 atm
FactSage
[Strickler, 1961]:
spinel
two spinels
LiSPINEL
LiSPINEL + LiSPINEL#2
T(C)
1600
1400
1200
1000
800
600
400
0
0.2
0.4
0.6
0.8
1
LiFe5O8/(LiAl5O8+LiFe5O8) (mol/mol)

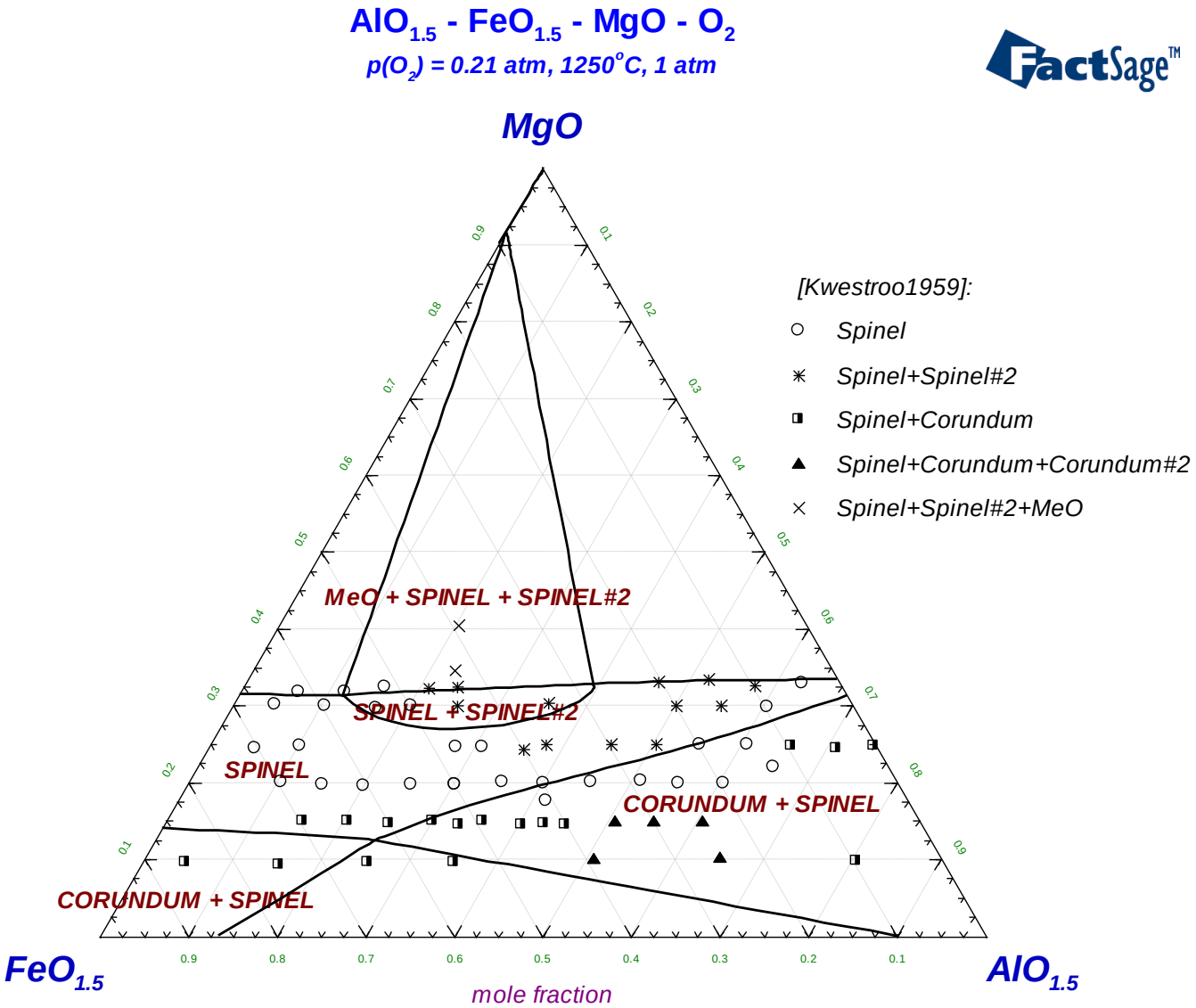

Al_2O_3 - Fe_2O_3 - Li_2O - O_2
Projection (A-Slag), $p(O_2)$ = 0.21 atm, 1 atm
FactSage
Li_2O
T(min) = 1038.93 °C, T(max) = 2053.83 °C
T °C
2100
2000
1800
1600
1400
1200
1000
Li_2O
Li_5AlO_4
1054
1035
$LiFeO_2$
$LiAlO_2$(s2)
1377
1500
1600
1700
1800
1900
LiSPINEL
$LiAl_{11}O_{17}$
1971
CORUNDUM
Al_2O_3
Fe_2O_3
mole fraction

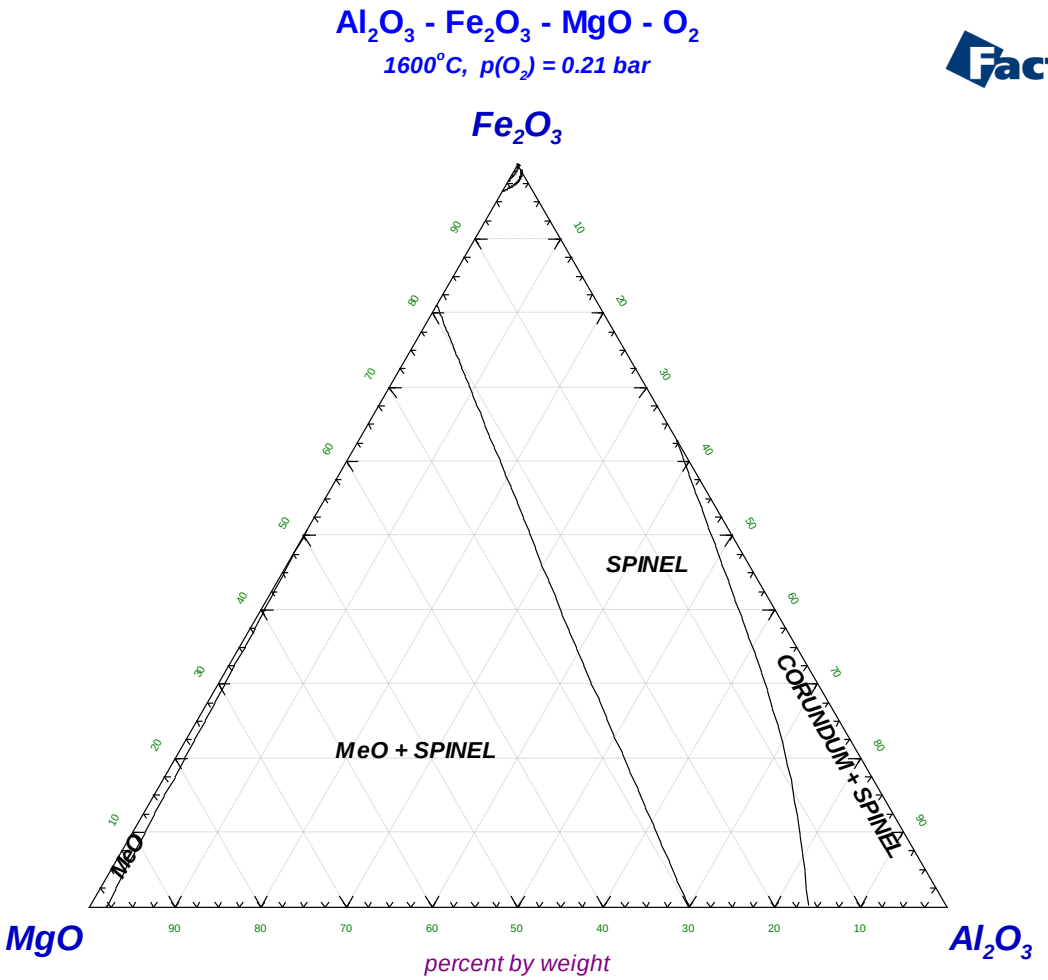

Al2O3 - Fe2O3 - Li2O - O2
Projection (A-Slag), p(O2) = 0.21 atm, 1 atm
FactSage
Li2O
T(min) = 1038.93 °C, T(max) = 2053.81 °C
T °C
2100
2000
1800
1600
1400
1200
1000
Li2O
Li5AlO4
1054
1039
1200
1300
1400
LiFeO2
LiAlO2(s2)
1277
1600
1800
1900
LiSPINEL
LiAl11O17
CORUNDUM
1971
Al2O3
Fe2O3
90
80
70
60
50
40
30
20
10
percent by weight

Invariant equilibria on the liquidus surface

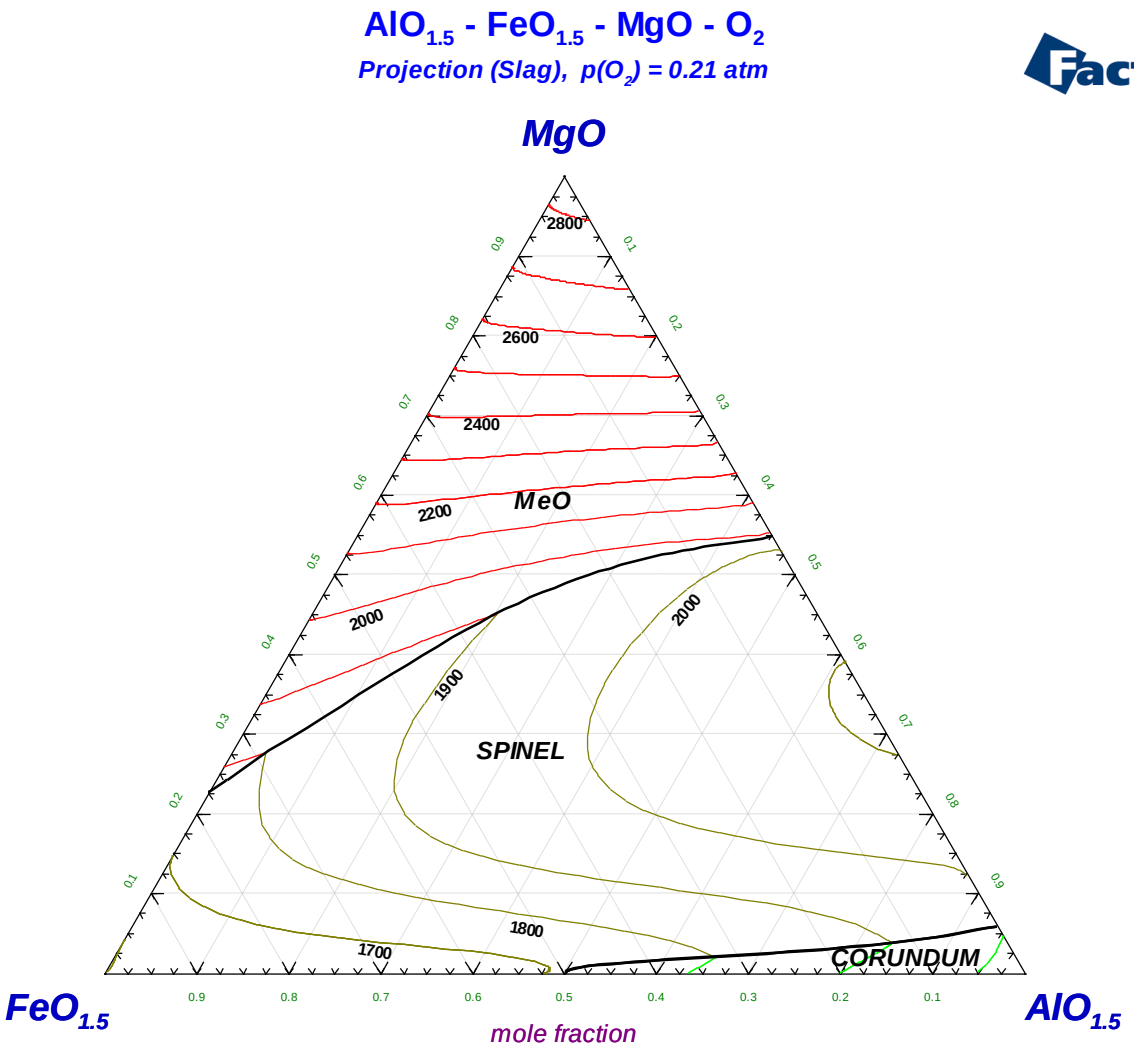
Intersections with slag	Mole fraction				Weight percent			
	A = Li2O, B = Al2O3, C = Fe2O3				A = Li2O, B = Al2O3, C = Fe2O3			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1. CORUNDUM / LiAl11O17 / LiSPINEL	0.06779	0.92777	0.00444	1970.95	2.081	97.191	0.728	1970.95
2. LiAlO2(s2) / LiFeO2 / LiSPINEL	0.47119	0.24033	0.28848	1376.93	16.633	28.948	54.419	1376.91
3. Li2O / Li5AlO4 / LiFeO2	0.79642	0.17973	0.02385	1053.58	51.811	39.896	8.293	1053.58
4. Li5AlO4 / LiAlO2(s2) / LiFeO2	0.76726	0.21234	0.02041	1038.93	47.928	45.259	6.813	1038.93

Al2O3-Fe2O3-MgO, Mole fraction 1250°C

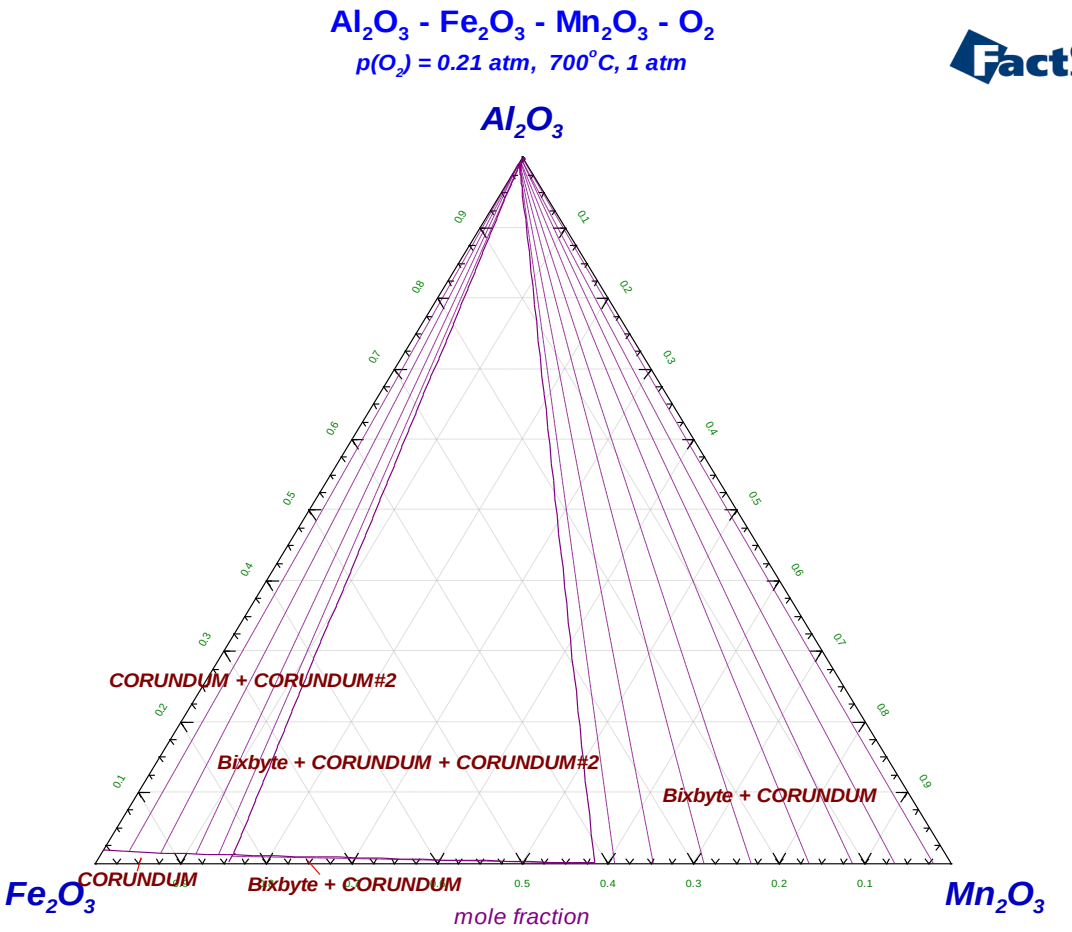


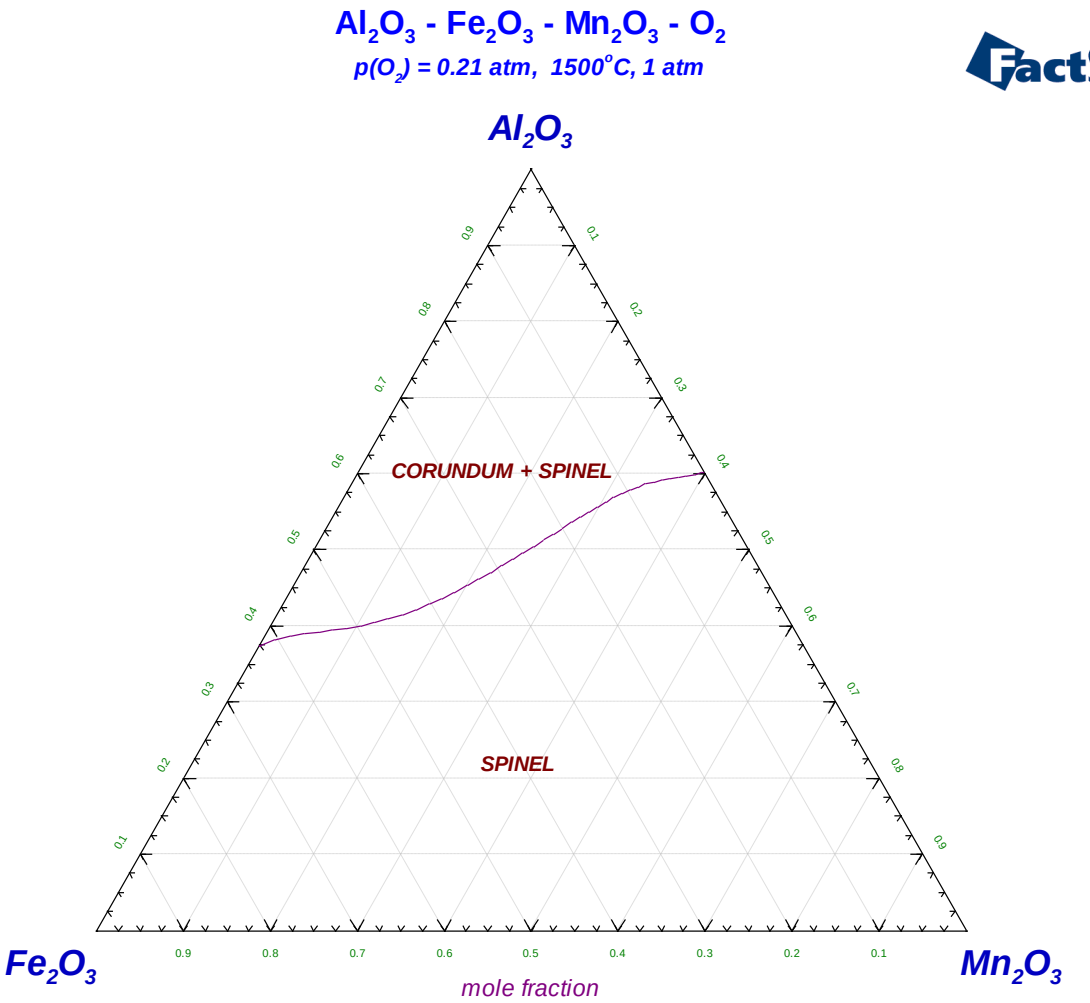

Al_2O_3 - Fe_2O_3 - MgO - O_2
1600°C, $p(O_2)$ = 0.21 bar
Fe_2O_3
SPINEL
MeO + SPINEL
CORUNDUM + SPINEL
MeO
MgO
Al_2O_3
percent by weight

Mole fraction
Liquidussurface

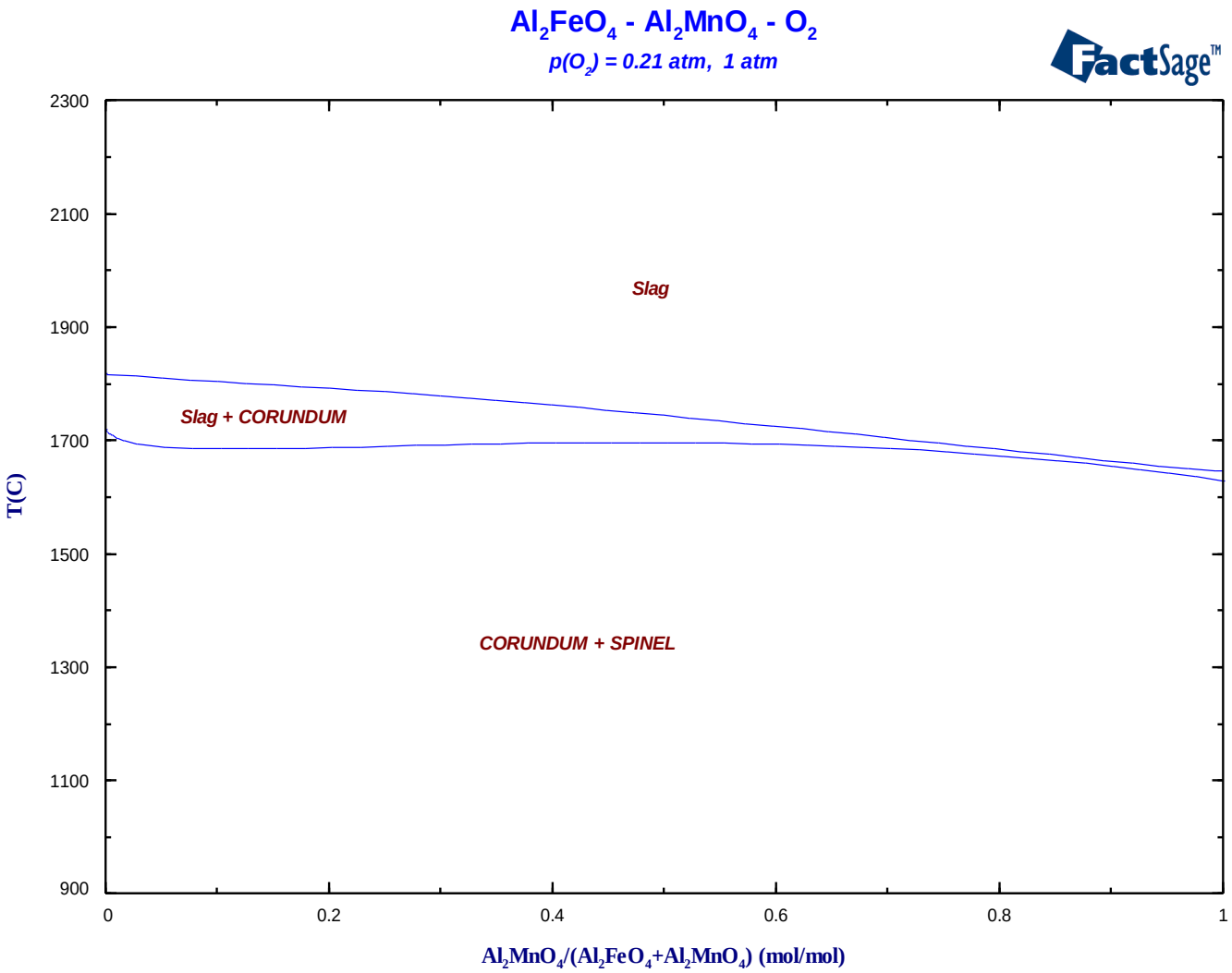


Mole fraction, 700°C

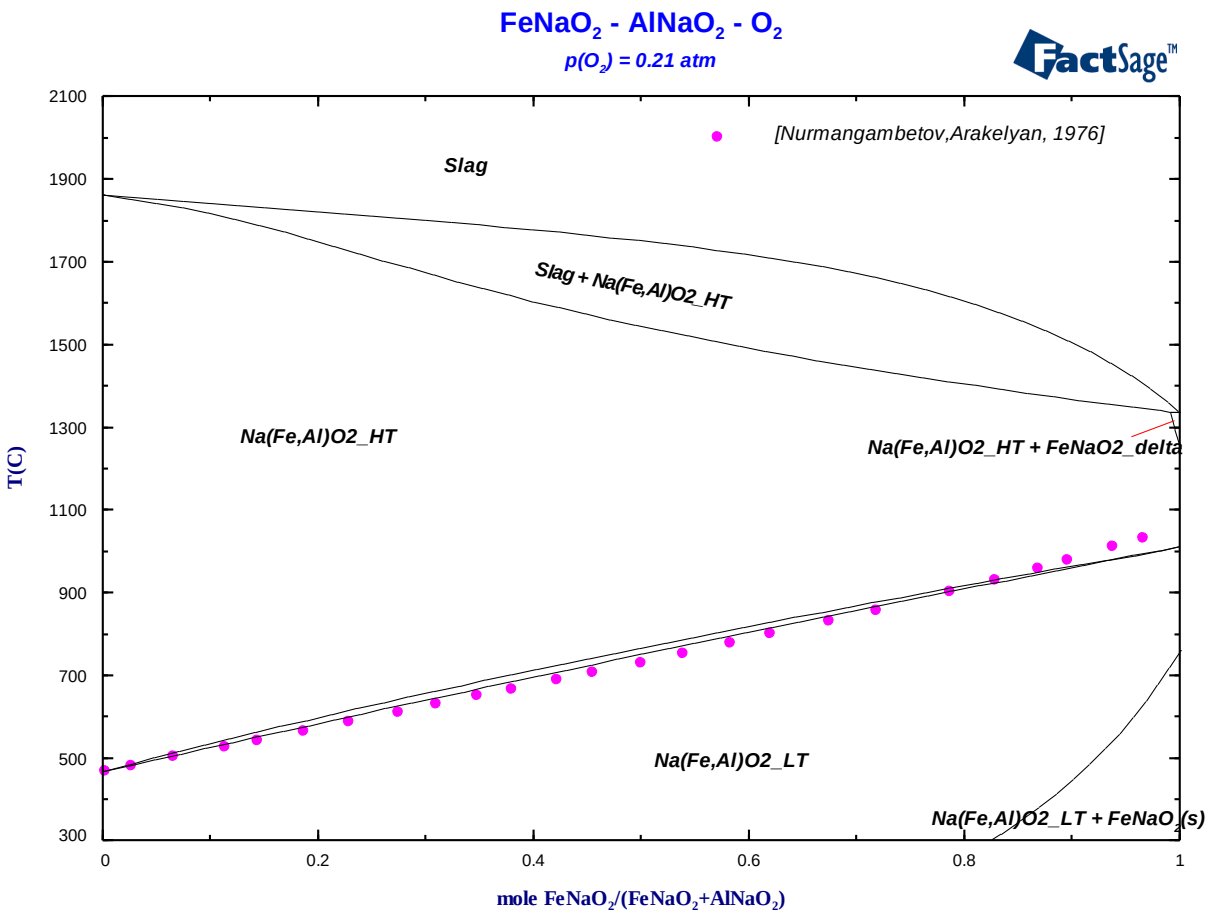



Al_2O_3 - Fe_2O_3 - Mn_2O_3 - O_2
$p(O_2)$ = 0.21 atm, 1500°C, 1 atm
Al_2O_3
CORUNDUM + SPINEL
SPINEL
Fe_2O_3
Mn_2O_3
mole fraction

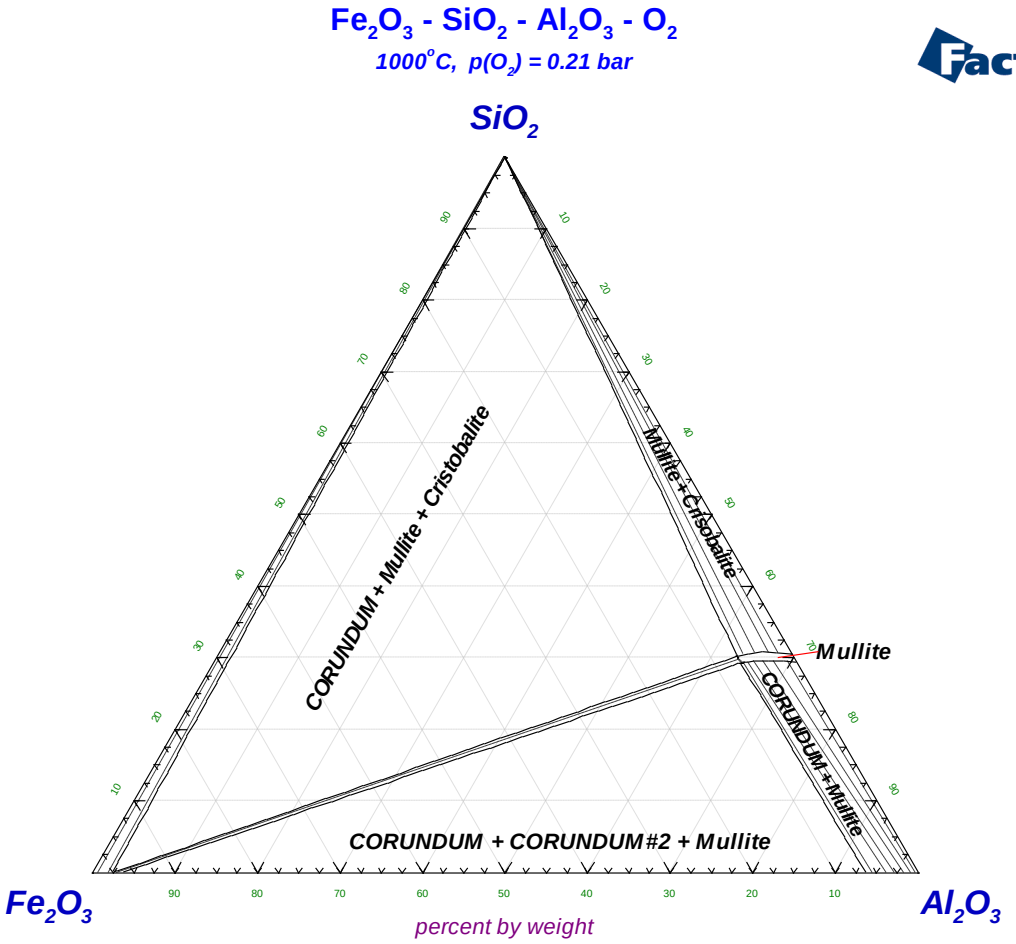
Mole fraction, Isopleth Al2FeO4-Al2MnO4

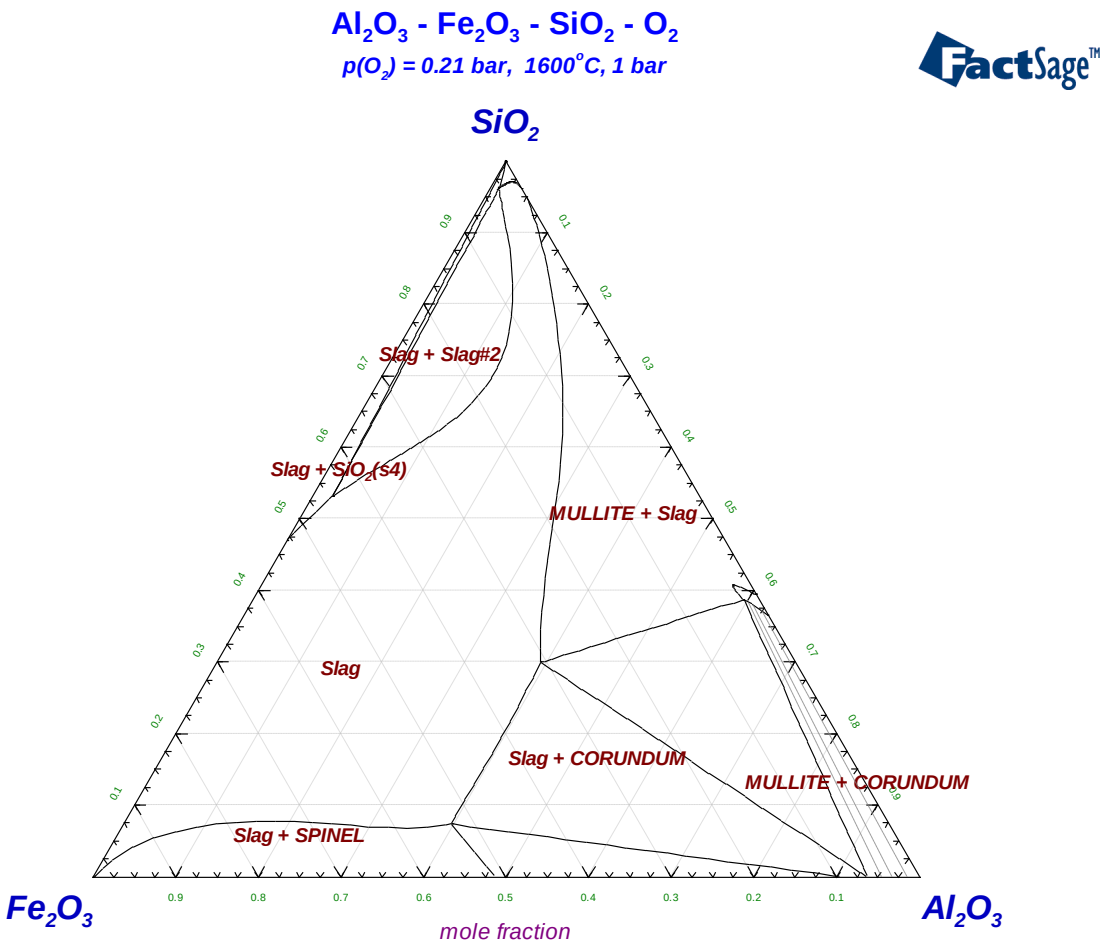


Isopleth FeNaO2-AlNaO2
compared with experimental data

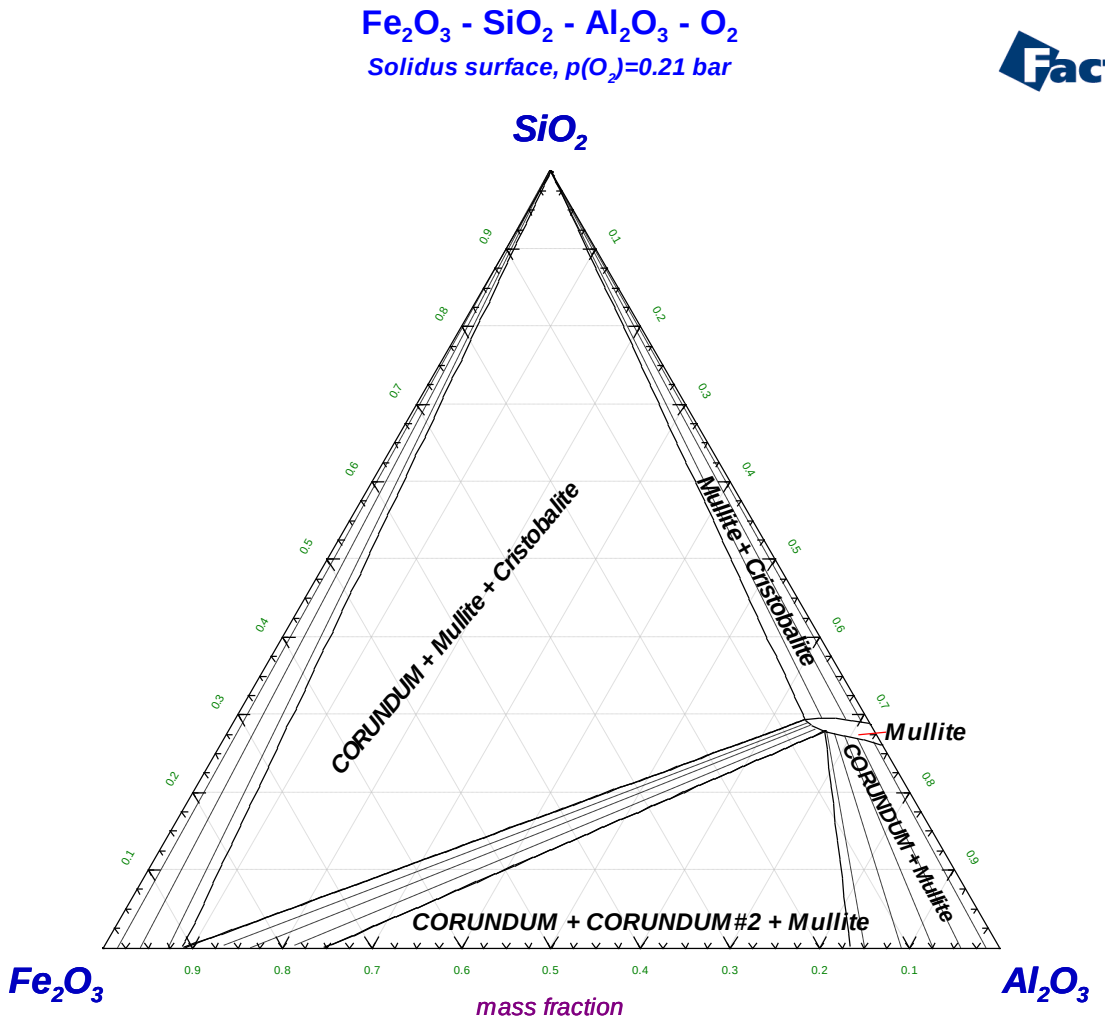


Al2O3-Fe2O3-SiO2,
Weight percent 1000°C



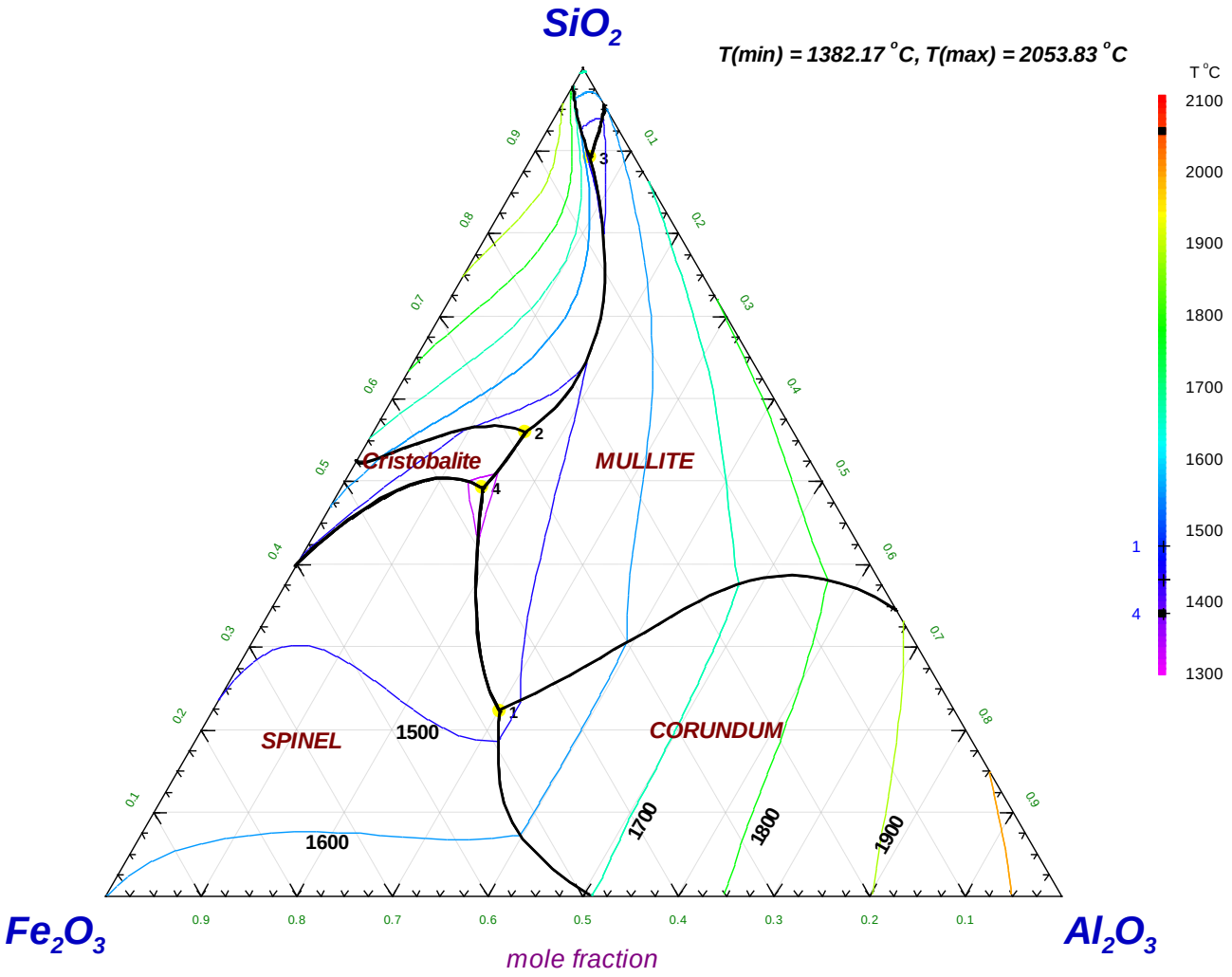

Al_2O_3 - Fe_2O_3 - SiO_2 - O_2
$p(O_2)$ = 0.21 bar, 1600°C, 1 bar
SiO_2
Slag + Slag#2
Slag + SiO_2(S4)
MULLITE + Slag
Slag
Slag + CORUNDUM
MULLITE + CORUNDUM
Slag + SPINEL
Fe_2O_3
Al_2O_3
mole fraction

Weight percent
Solidusfläche

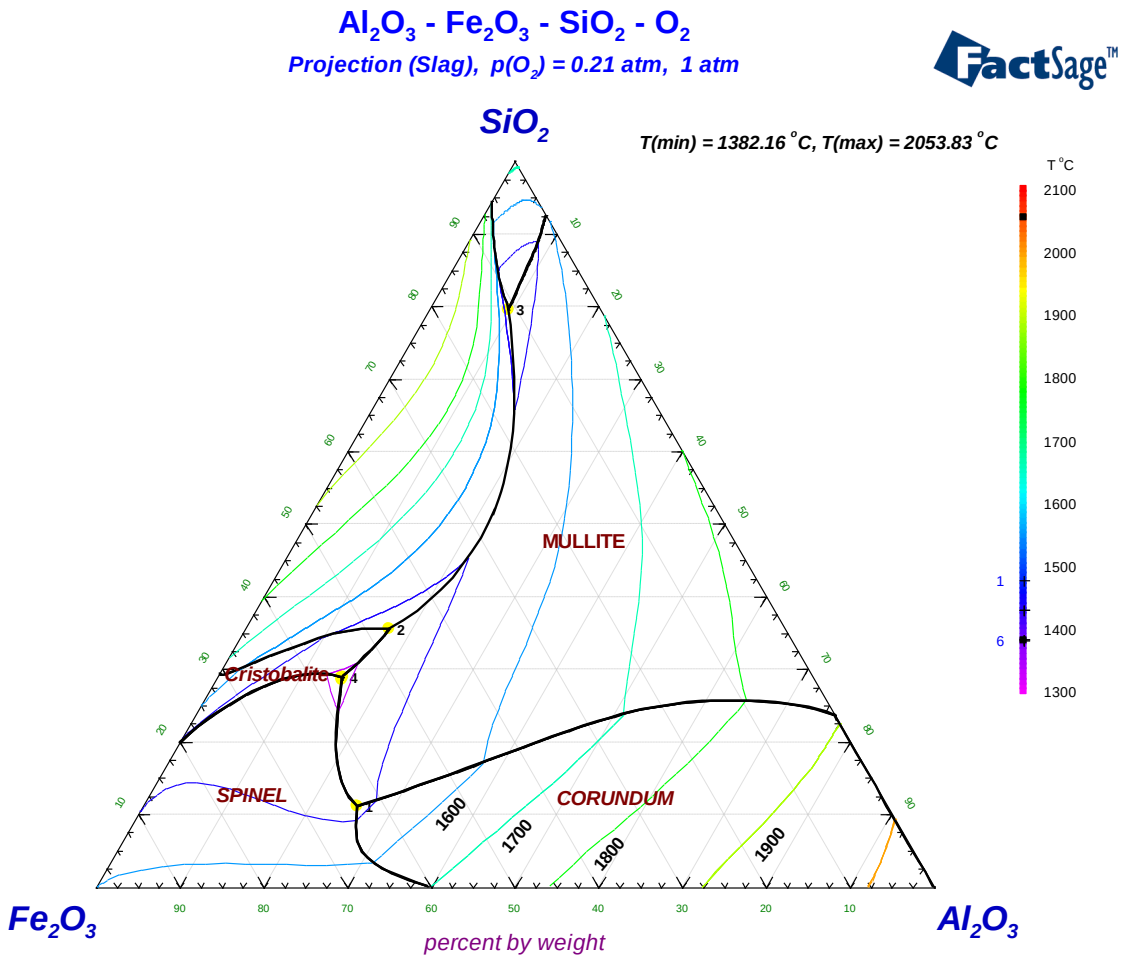


Al_2O_3 - Fe_2O_3 - SiO_2 - O_2

Projection (Slag), $p(O_2)$ = 0.21 atm, 1 atm



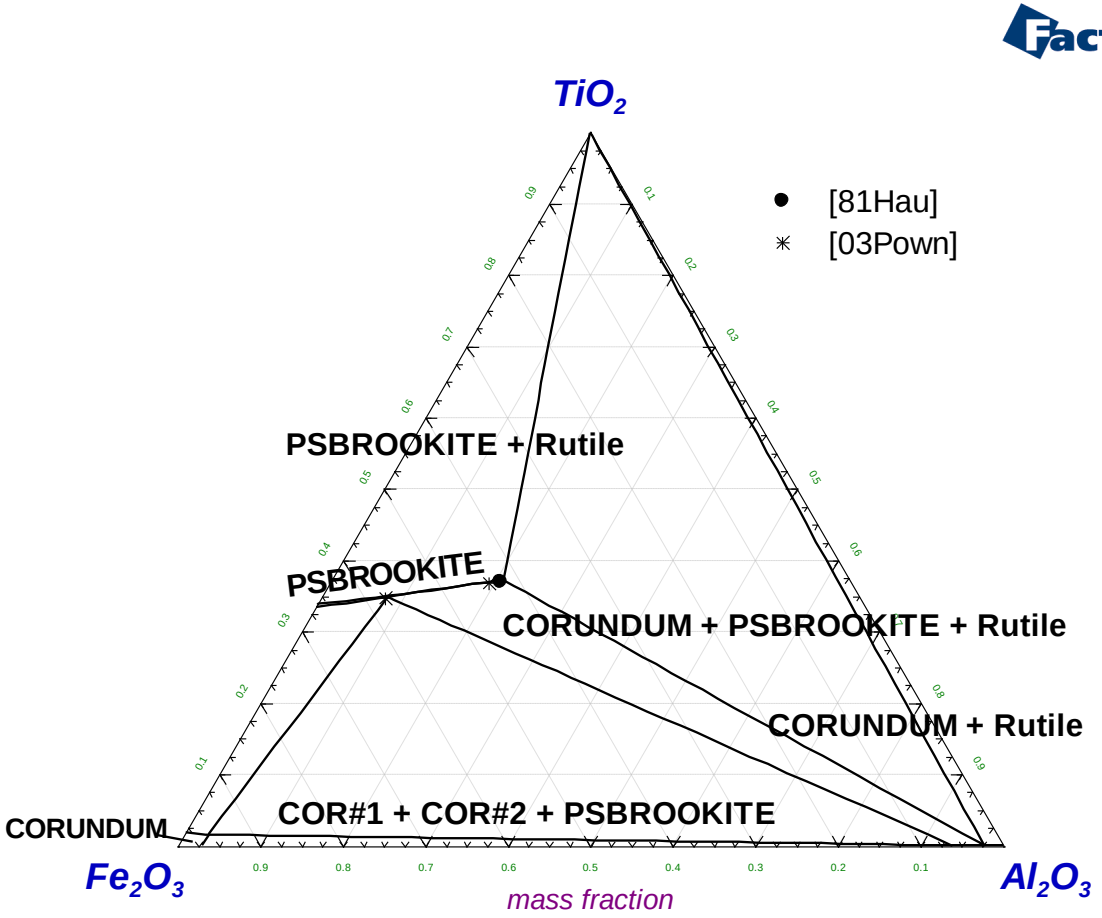
Weight percent
Liquidussurface



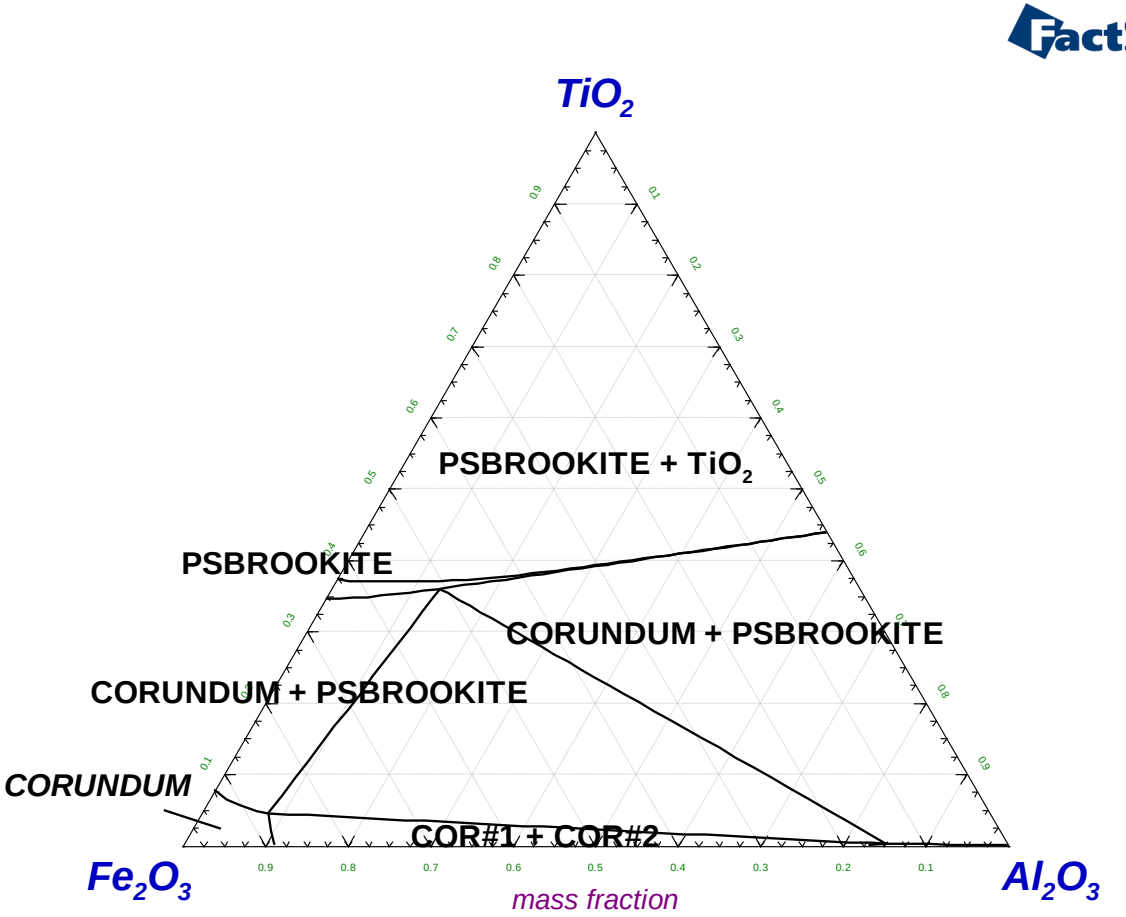
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction					Weight percent				
	A = SiO2, B = Fe2O3, C = Al2O3					A = SiO2, B = Fe2O3, C = Al2O3				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: CORUNDUM / MULLITE / SPINEL	1:	0.22299	0.47567	0.30135	1477.07	1.	11.157	63.255	25.587	1477.07
2: MULLITE / Cristobalite / Slag#2	2:	0.55976	0.28040	0.15985	1430.14	2.	35.512	47.279	17.209	1430.09
3: MULLITE / Cristobalite / Slag#2	3:	0.89153	0.04602	0.06245	1430.08	3.	79.614	10.922	9.464	1430.09
4: CORUNDUM / SPINEL / Cristobalite	4:	0.49217	0.35950	0.14833	1382.83	4.	28.963	56.225	14.812	1382.83

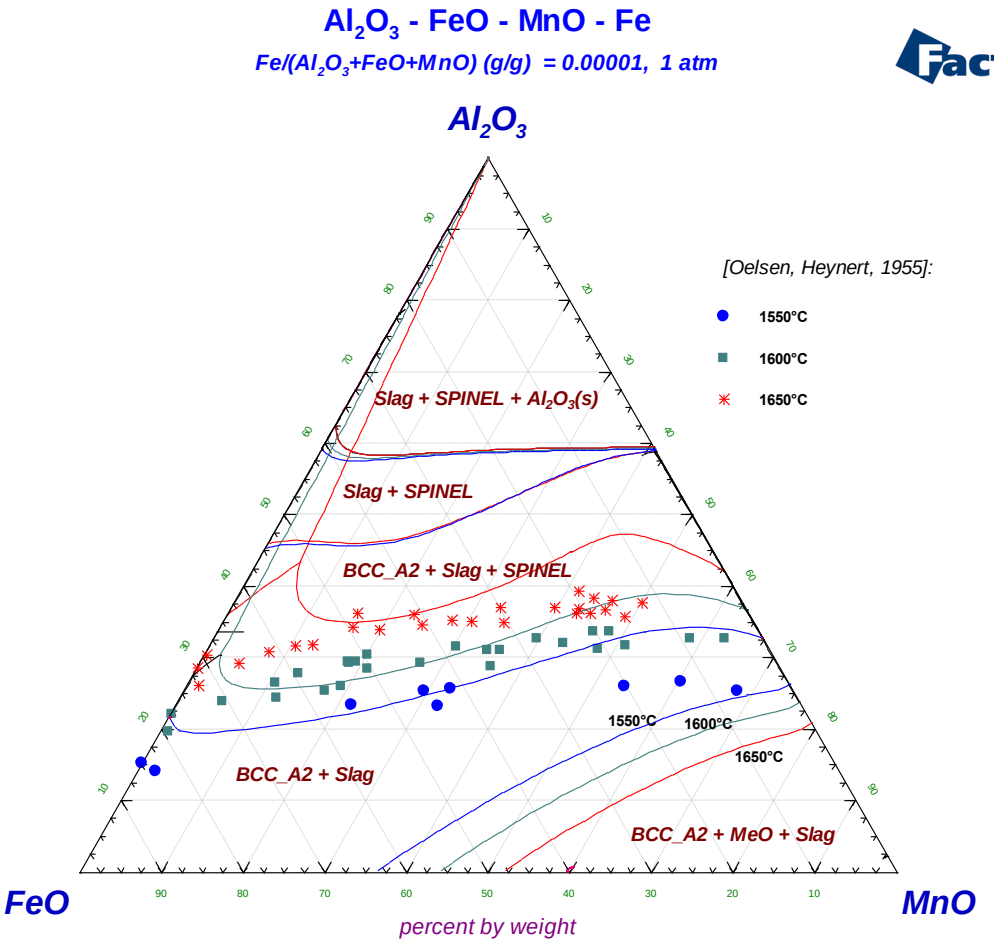
Al2O3-Fe2O3-TiO2,
Weight percent 1000°C



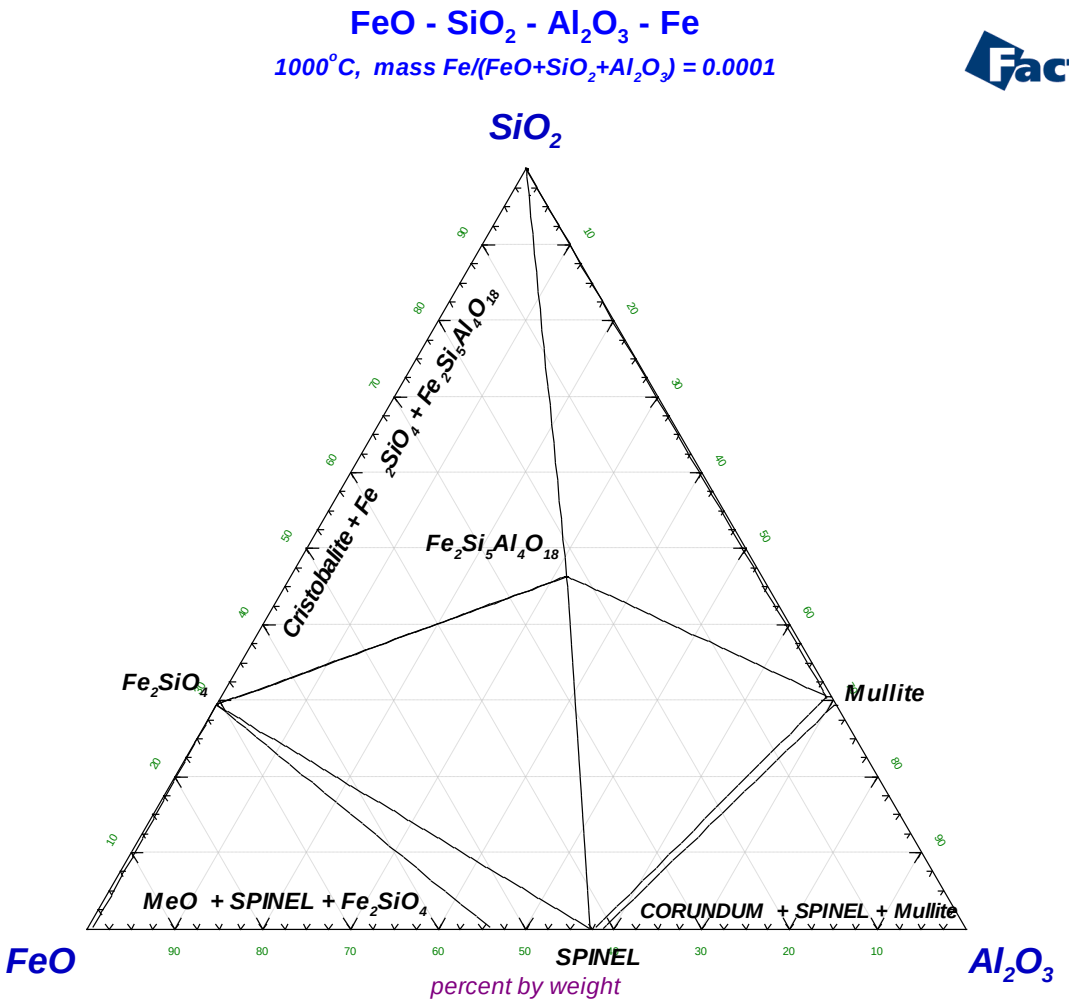
Al2O3-Fe2O3-TiO2,
Weight percent 1300°C

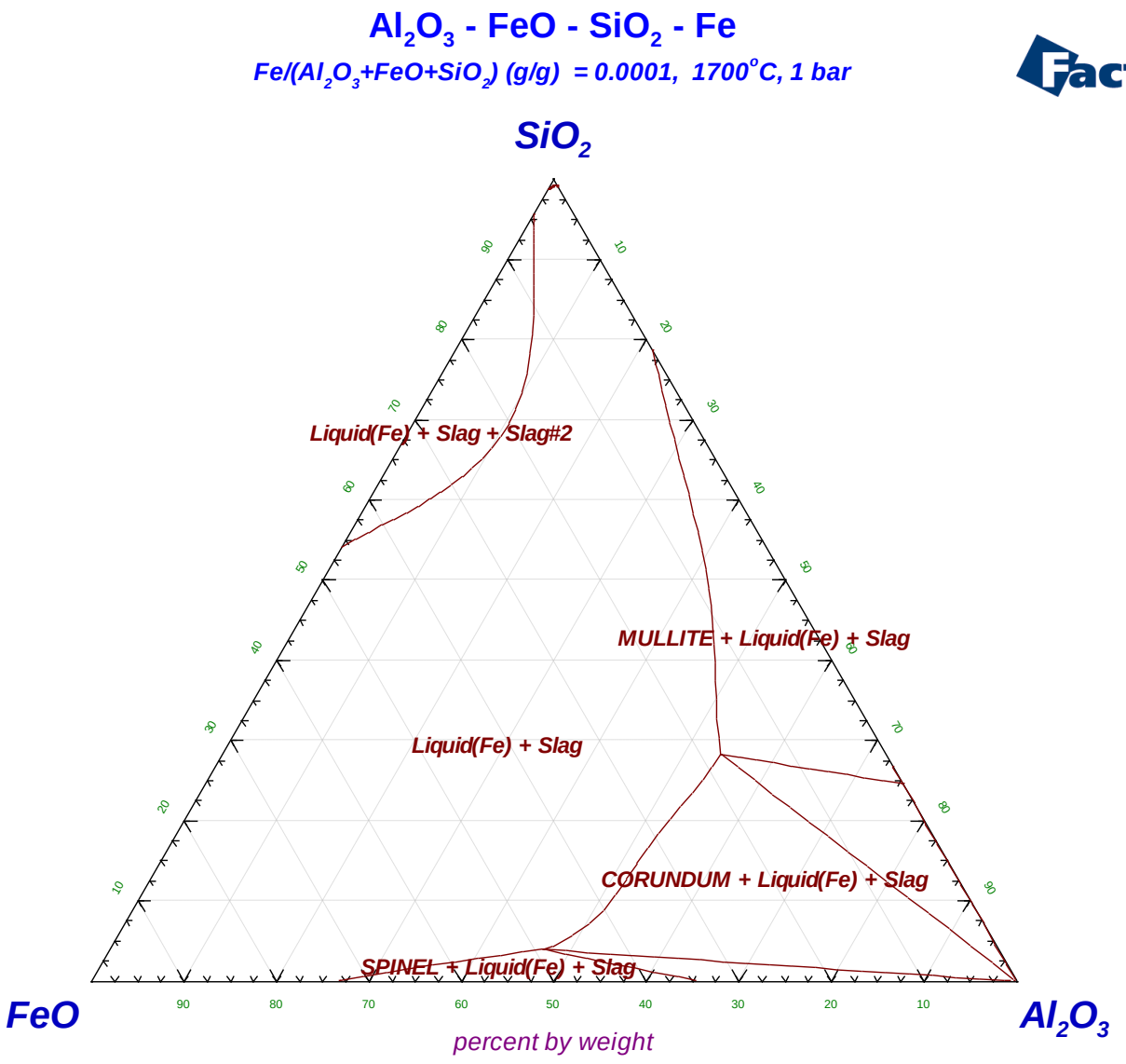


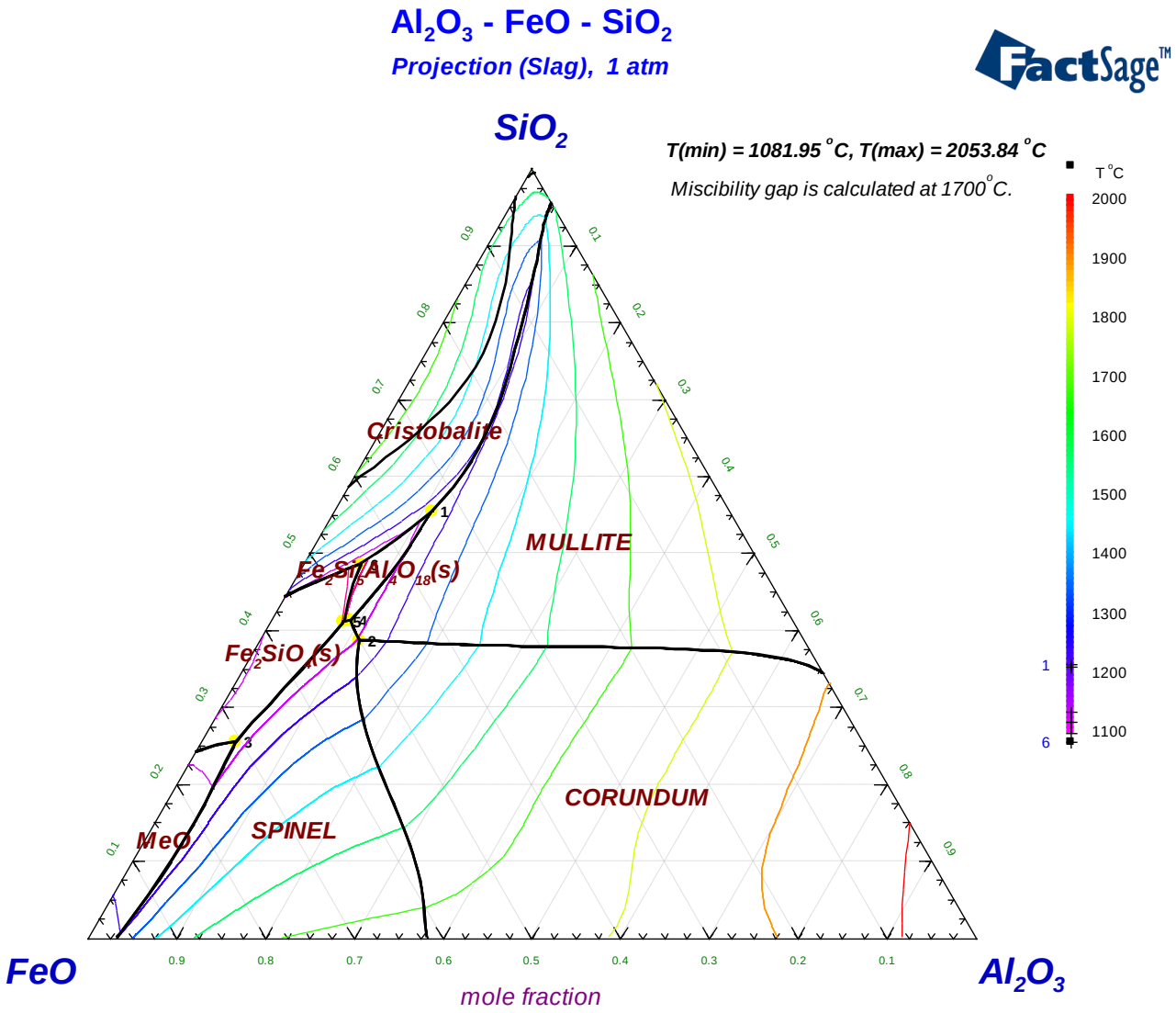
Weight percent, Liquid lines at 1550, 1600 and 1650°C



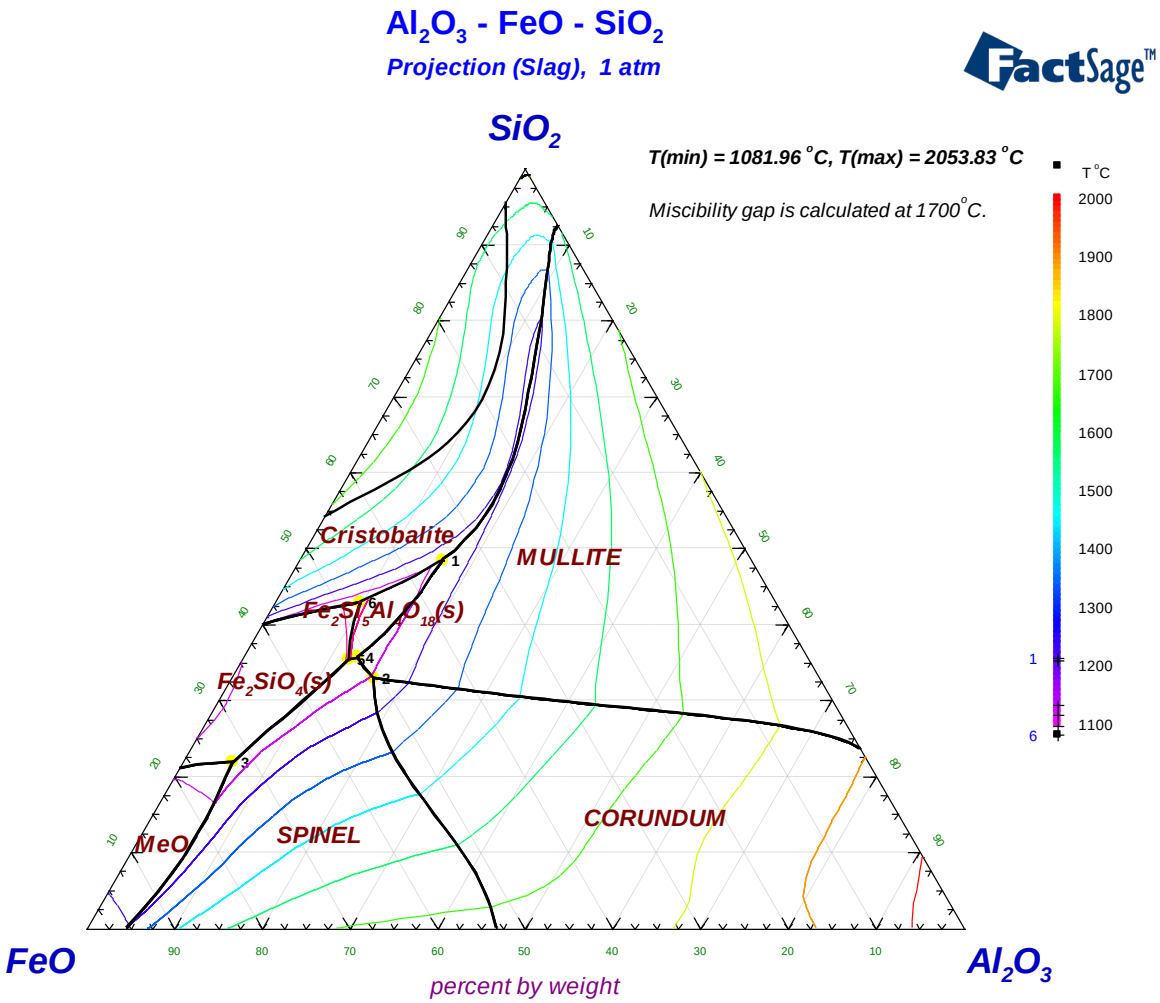
Al2O3-FeO-SiO2,
Weight percent 1000°C




Al_2O_3 - FeO - SiO_2 - Fe
$Fe/(Al_2O_3+FeO+SiO_2)$ (g/g) = 0.0001, 1700°C, 1 bar
SiO_2
Liquid(Fe) + Slag + Slag#2
MULLITE + Liquid(Fe) + Slag
Liquid(Fe) + Slag
CORUNDUM + Liquid(Fe) + Slag
SPINEL + Liquid(Fe) + Slag
FeO
Al_2O_3
percent by weight


Al2O3 - FeO - SiO2
Projection (Slag), 1 atm
FactSage™
SiO2
T(min) = 1081.95 °C, T(max) = 2053.84 °C
Miscibility gap is calculated at 1700°C.
T °C
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
Cristobalite
MULLITE
Fe2Si4Al4O18(s)
Fe2SiO4(s)
MeO
SPINEL
CORUNDUM
FeO
Al2O3
mole fraction

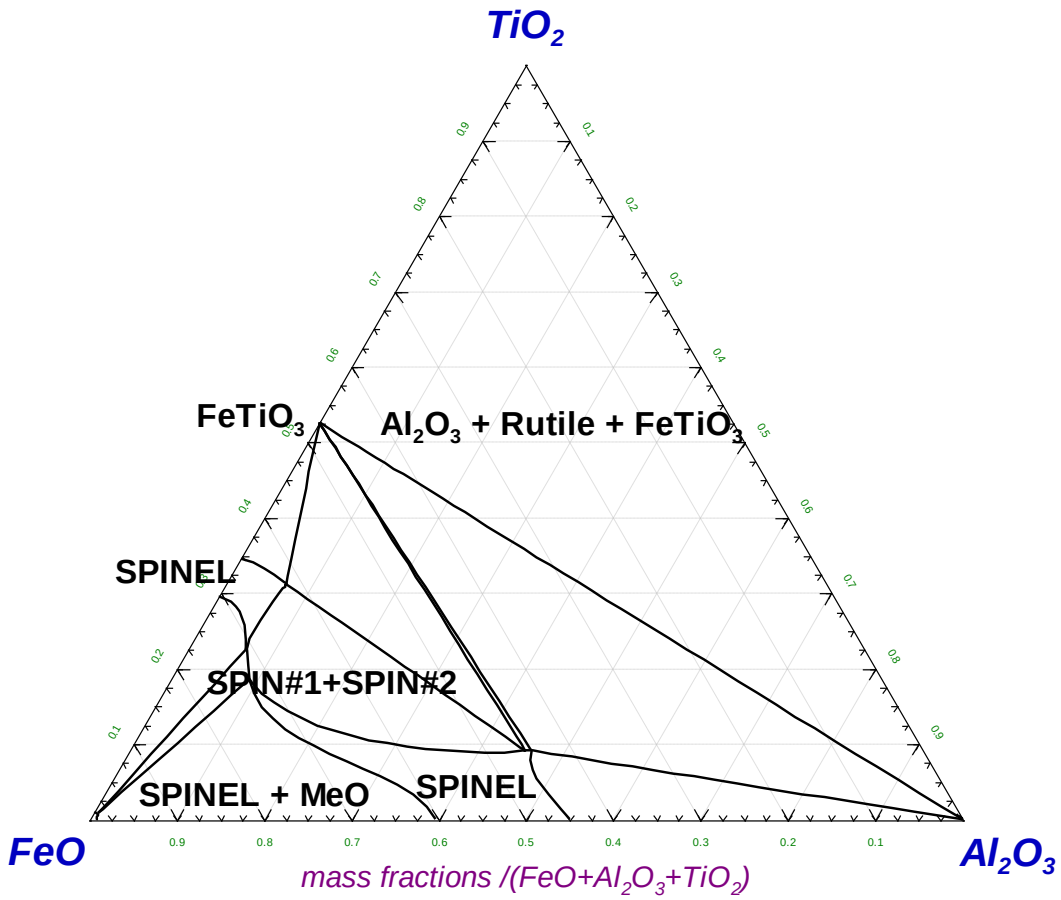
Weight percent
Liquidussurface



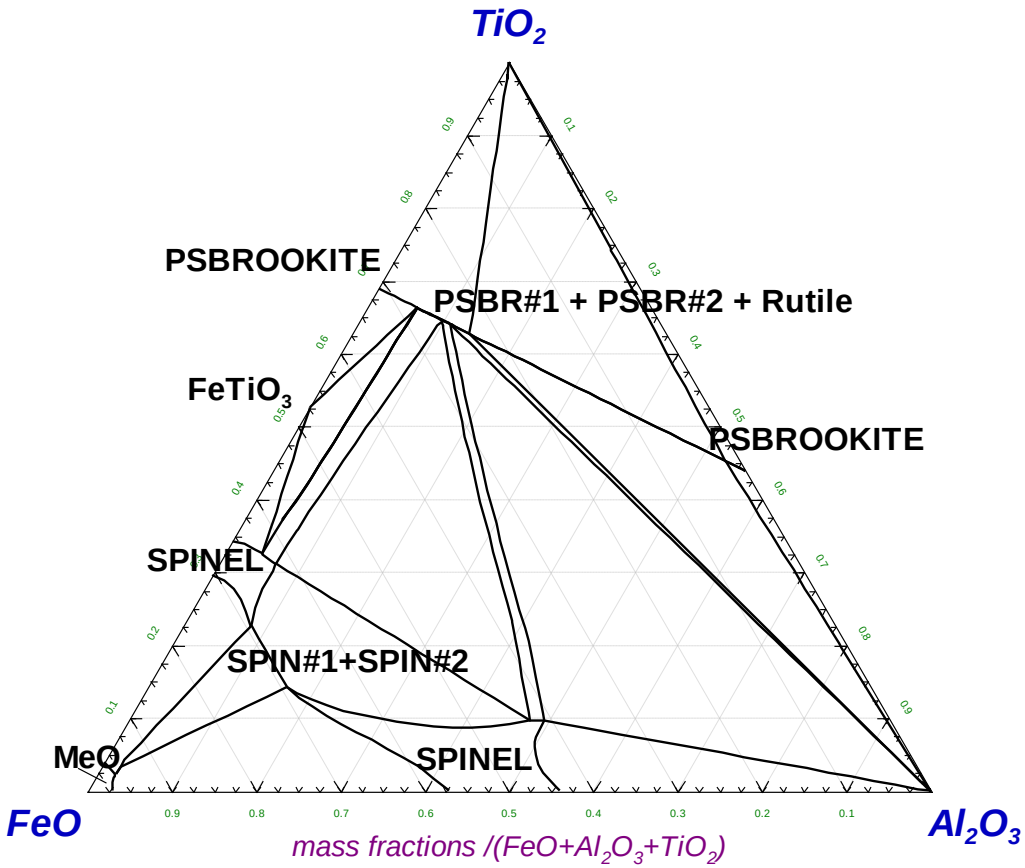
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction					Weight percent				
	A = SiO2, B = FeO, C = Al2O3					A = SiO2, B = FeO, C = Al2O3				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: Fe2Si5Al4O18 / MULLITE / Cristobalite	1:	0.55412	0.33569	0.11019	1213.12	1:	48.050	35.133	16.367	1213.12
2: CORUNDUM / MULLITE / SPINEL	2:	0.38735	0.50009	0.11256	1208.53	2:	32.929	50.834	16.237	1208.54
3: Fe2SiO4(s) / MeO / SPINEL	3:	0.25469	0.70595	0.03937	1131.37	3:	21.850	72.419	5.731	1131.37
4: Fe2Si5Al4O18 / MULLITE / SPINEL	4:	0.41365	0.49720	0.08915	1114.58	4:	35.677	51.275	13.048	1114.58
5: Fe2Si5Al4O18 / Fe2SiO4(s) / SPINEL	5:	0.41056	0.50653	0.08292	1096.96	5:	35.487	52.351	12.162	1096.96
6: Fe2Si5Al4O18 / Fe2SiO4(s) / Cristobalite	6:	0.48676	0.44861	0.06463	1081.97	6:	42.968	47.351	9.681	1081.96

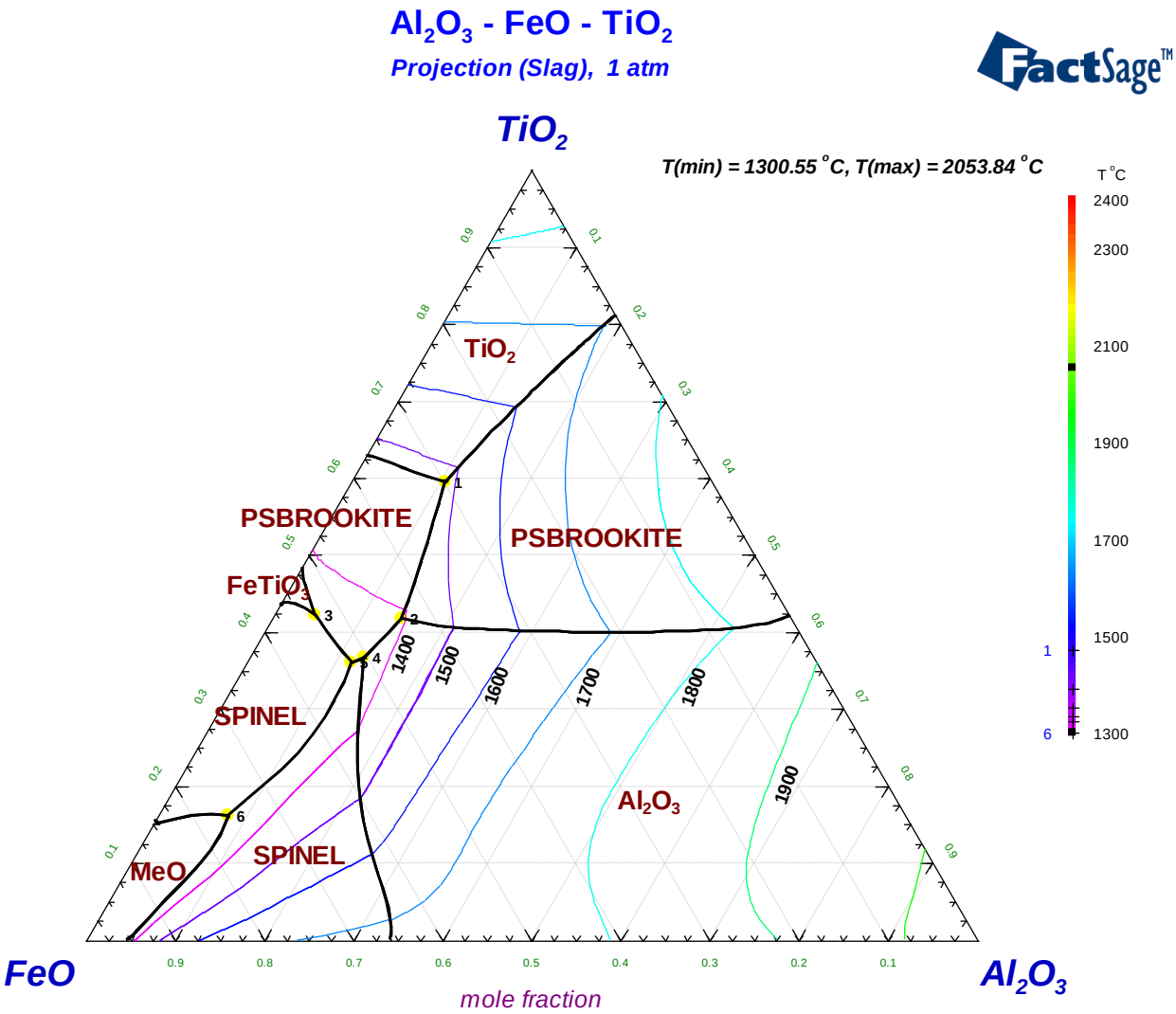
Al2O3-FeO-TiO2,
Weight percent 1000°C

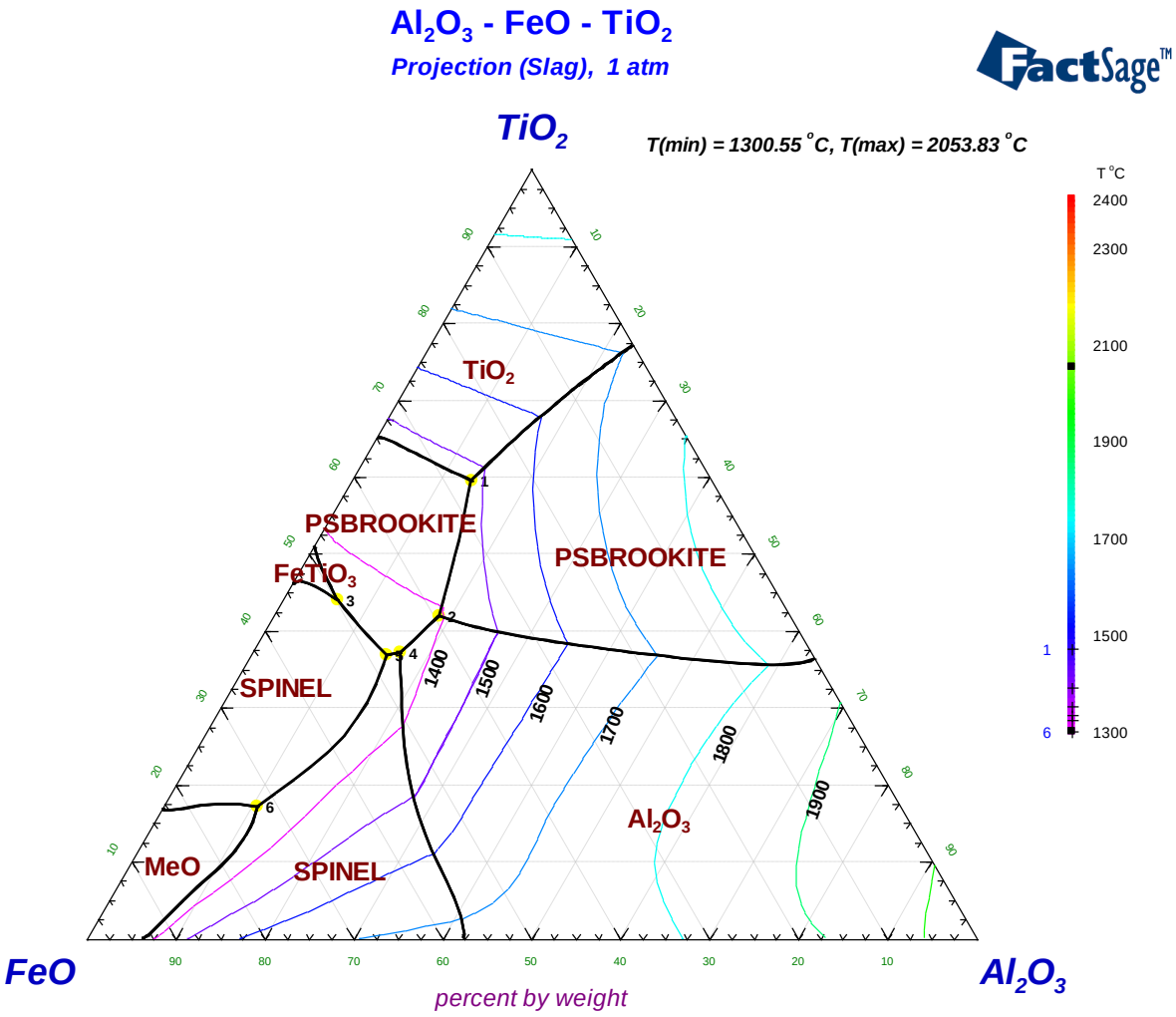


Al2O3-FeO-TiO2,
Weight percent 1300°C



Al2O3-FeO-TiO2,
Mole fraction, Liquidus surface

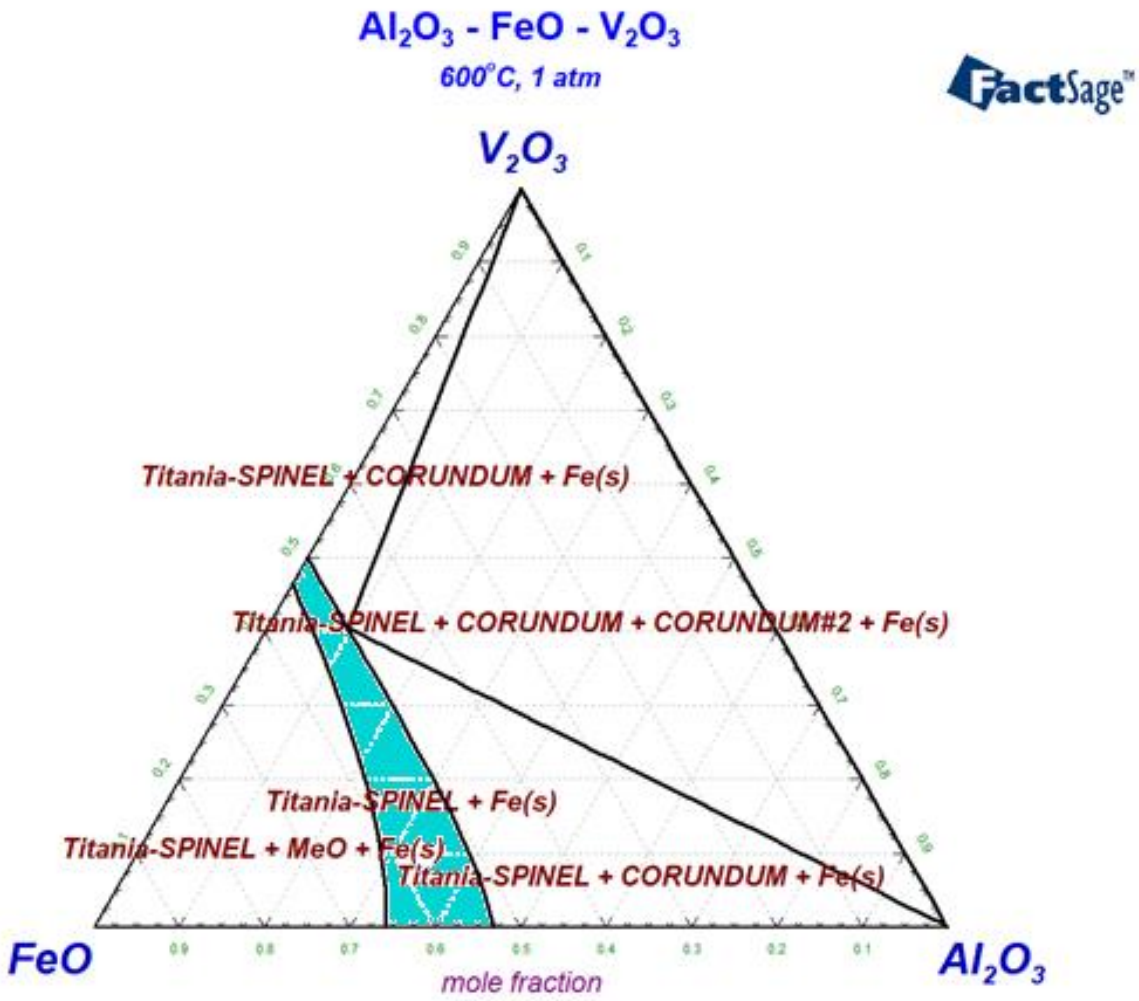


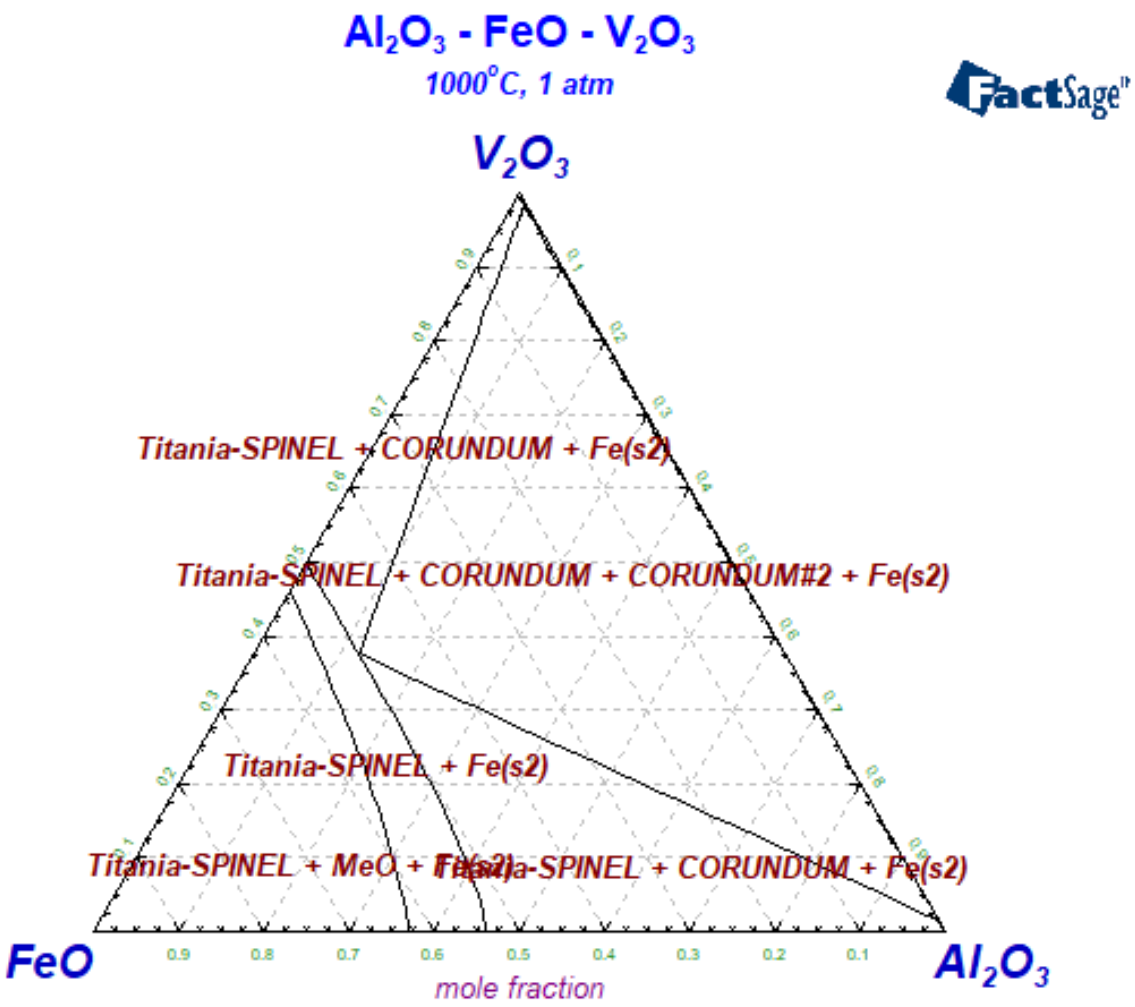

Al2O3 - FeO - TiO2
Projection (Slag), 1 atm
FactSage™
TiO2
T(min) = 1300.55 °C, T(max) = 2053.83 °C
T °C
2400
2300
2100
1900
1700
1500
1300
TiO2
PSBROOKITE
PSBROOKITE
FeTiO3
SPINEL
SPINEL
MeO
Al2O3
1400
1500
1600
1700
1800
1900
FeO
Al2O3
percent by weight

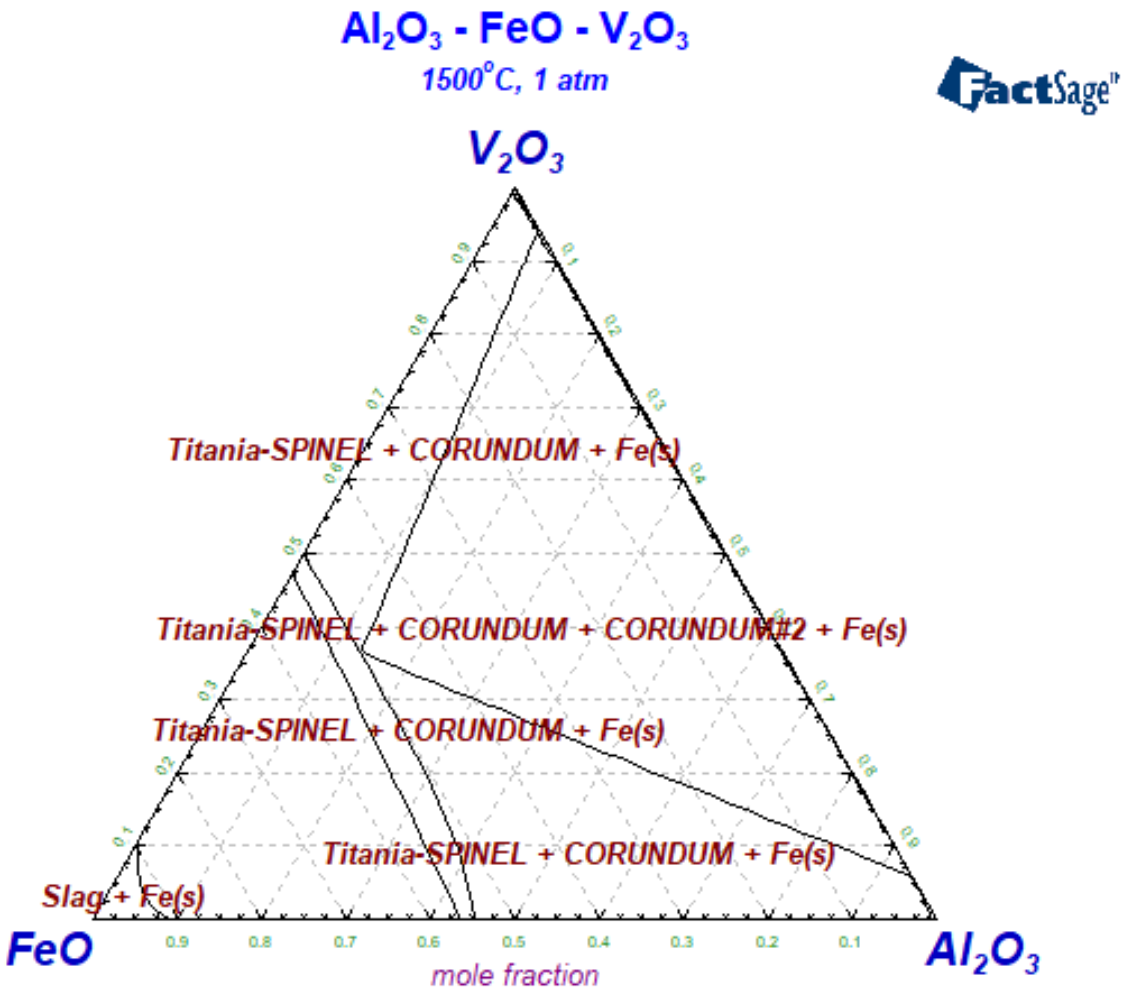
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction					Weight percent				
	A = TiO2, B = FeO, C = Al2O3					A = TiO2, B = FeO, C = Al2O3				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: PSBROOKITE#1 / PSBROOKITE-#2 / TiO2	1:	0.59524	0.29964	0.10512	1472.17	1:	59.584	26.982	13.433	1472.17
2: Al2O3 / PSBROOKITE-#1/ PSBROOKITE#2	2:	0.41815	0.43669	0.14516	1391.23	2:	41.971	39.429	18.600	1391.22
3: FeTiO3 / PSBROOKITE#1 / SPINEL#1	3:	0.42291	0.53137	0.04572	1351.77	3:	44.087	49.829	6.085	1351.77
4: Al2O3 / PSBROOKITE#1 / SPINEL#1	4:	0.36671	0.50471	0.12859	1335.52	4:	37.233	46.098	16.668	1335.52
5: PSBROOKITE#1 / SPINEL#1 / SPINEL#2	5:	0.36118	0.52154	0.11727	1323.74	5:	36.853	47.871	15.276	1323.74
6: MeO / SPINEL#1 / SPINEL#2	6:	0.16218	0.75957	0.07825	1300.55	6:	17.155	72.277	10.568	1300.55

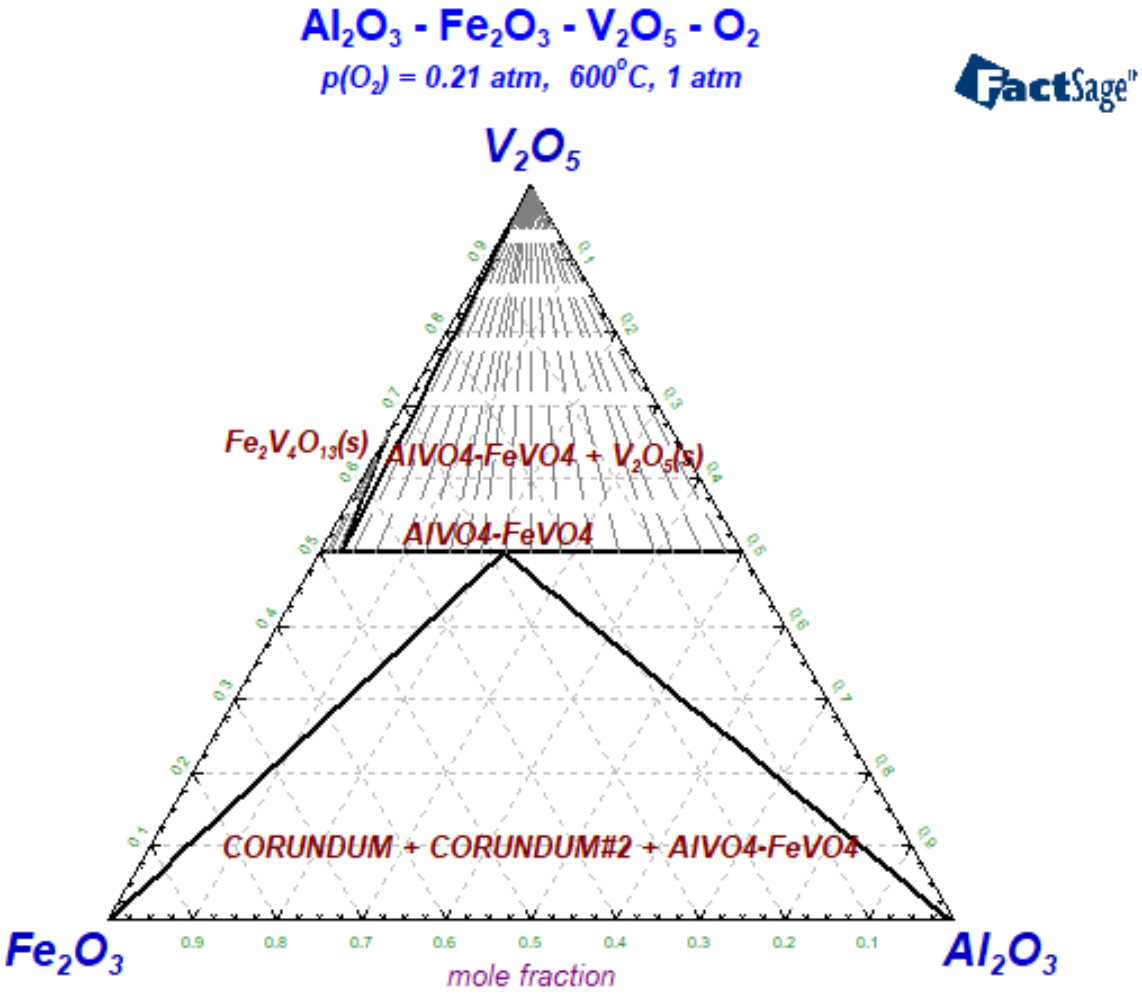
Al2O3-FeO-V2O3,
Mole fraction 600°C



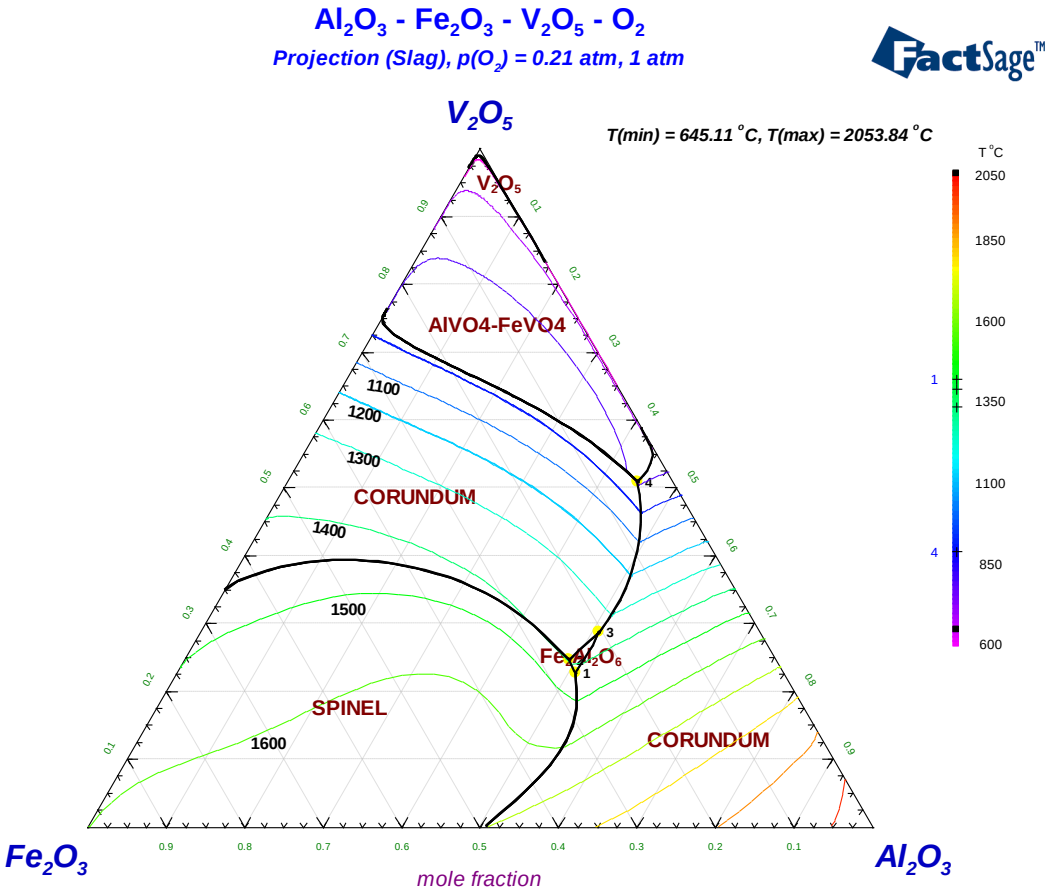

Al_2O_3 - FeO - V_2O_3
1000°C, 1 atm
FactSage
V_2O_3
Titania-SPINEL + CORUNDUM + Fe(s2)
Titania-SPINEL + CORUNDUM + CORUNDUM#2 + Fe(s2)
Titania-SPINEL + Fe(s2)
Titania-SPINEL + MeO + Fe(s2)
Titania-SPINEL + CORUNDUM + Fe(s2)
FeO
Al_2O_3
0.9 0.8 0.7 0.6 0.5 0.4 0.3 0.2 0.1
mole fraction

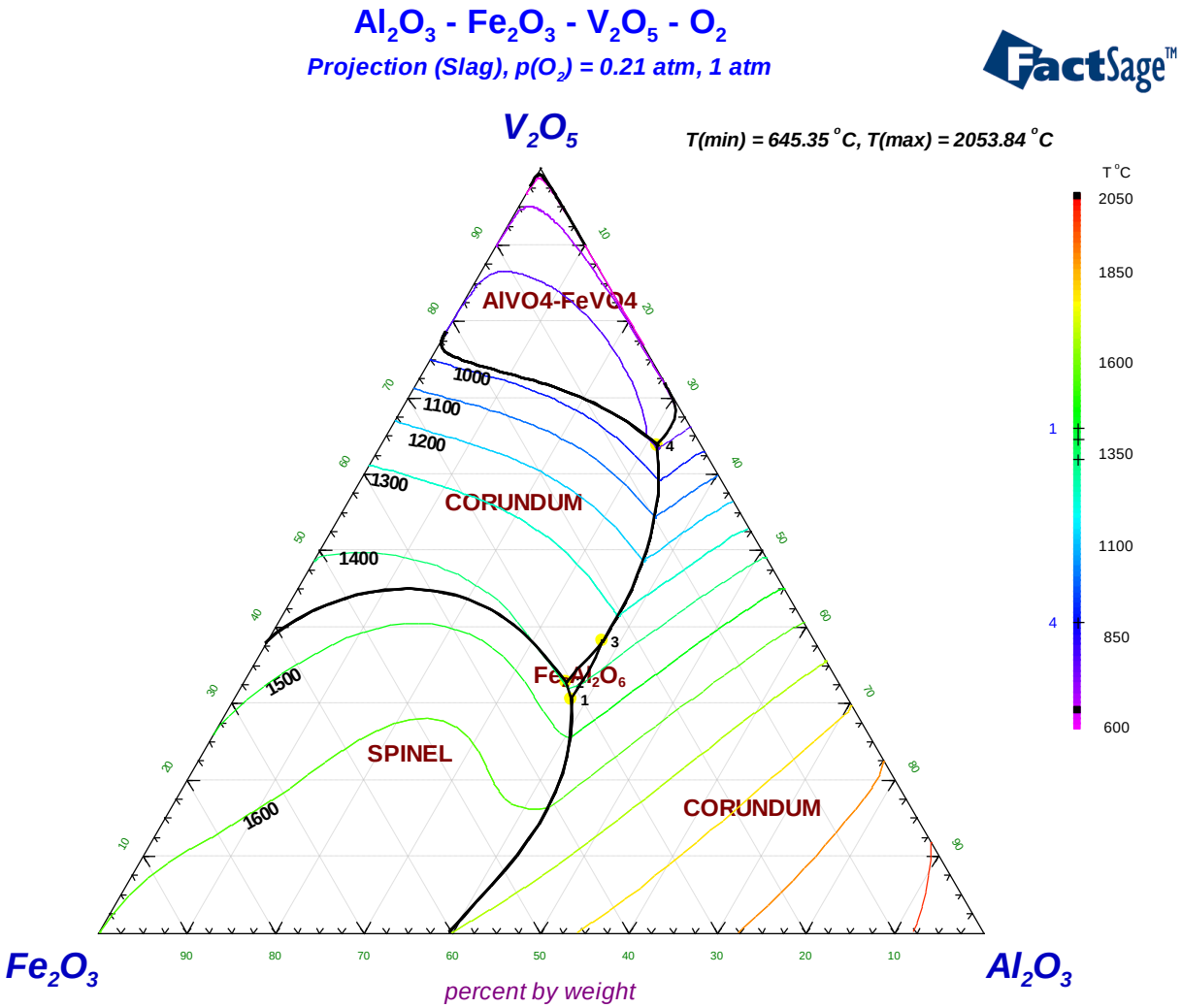

Al_2O_3 - FeO - V_2O_3
1500°C, 1 atm
FactSage
V_2O_3
Titania-SPINEL + CORUNDUM + Fe(s)
Titania-SPINEL + CORUNDUM + CORUNDUM#2 + Fe(s)
Titania-SPINEL + CORUNDUM + Fe(s)
Titania-SPINEL + CORUNDUM + Fe(s)
Slag + Fe(s)
FeO
Al_2O_3
0.9 0.8 0.7 0.6 0.5 0.4 0.3 0.2 0.1
mole fraction

Al2O3-Fe2O3-V2O5, Mole fraction 600°C



Al2O3-Fe2O3-V2O5,
Mole fraction, Liquidus surface

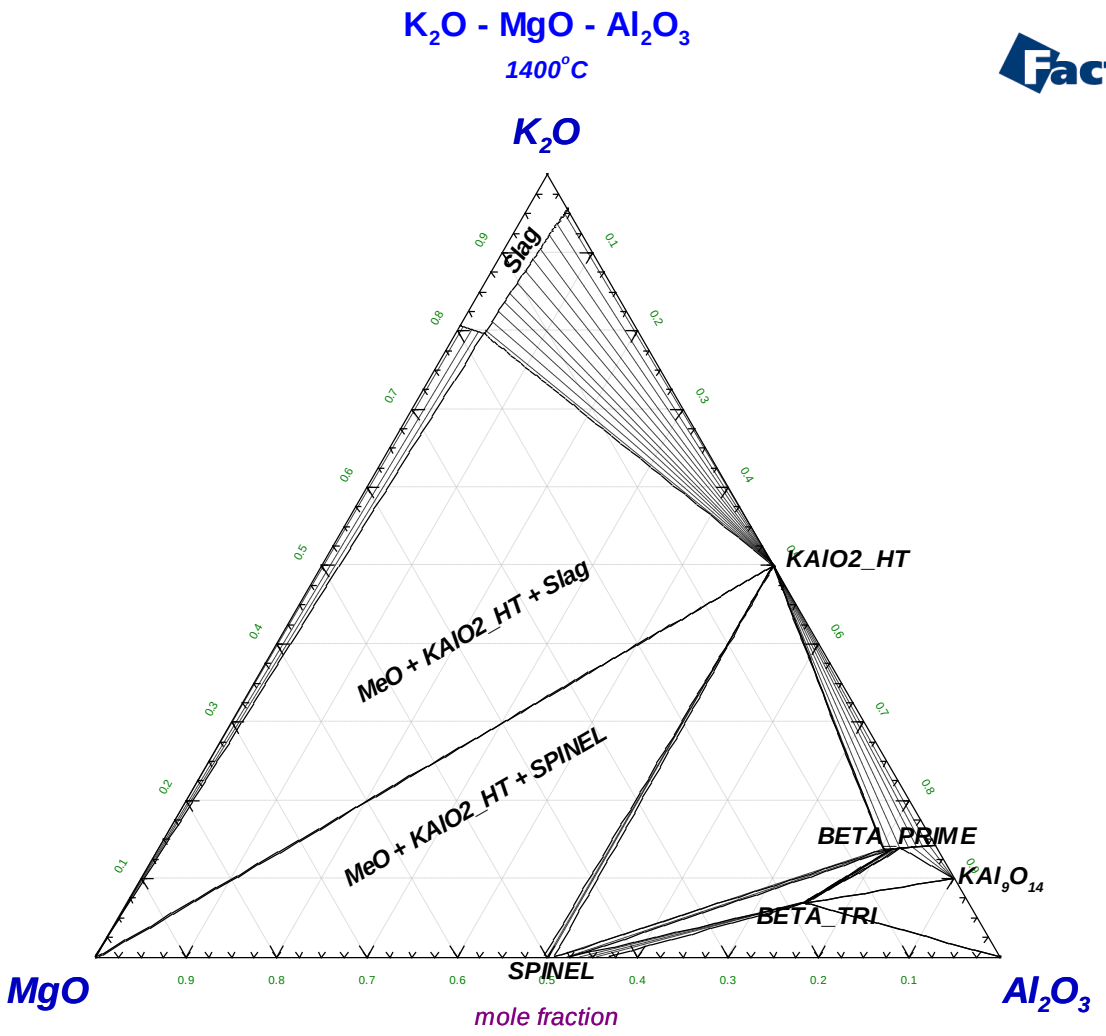



Al_2O_3 - Fe_2O_3 - V_2O_5 - O_2
Projection (Slag), $p(O_2)$ = 0.21 atm, 1 atm
FactSage™
V_2O_5
T(min) = 645.35 °C, T(max) = 2053.84 °C
T °C
2050
1850
1600
1350
1100
850
600
AlVO4-FeVO4
1000
1100
1200
1300
1400
1500
1600
CORUNDUM
SPINEL
$FeAl_2O_6$
CORUNDUM
1
3
4
Fe_2O_3
Al_2O_3
percent by weight

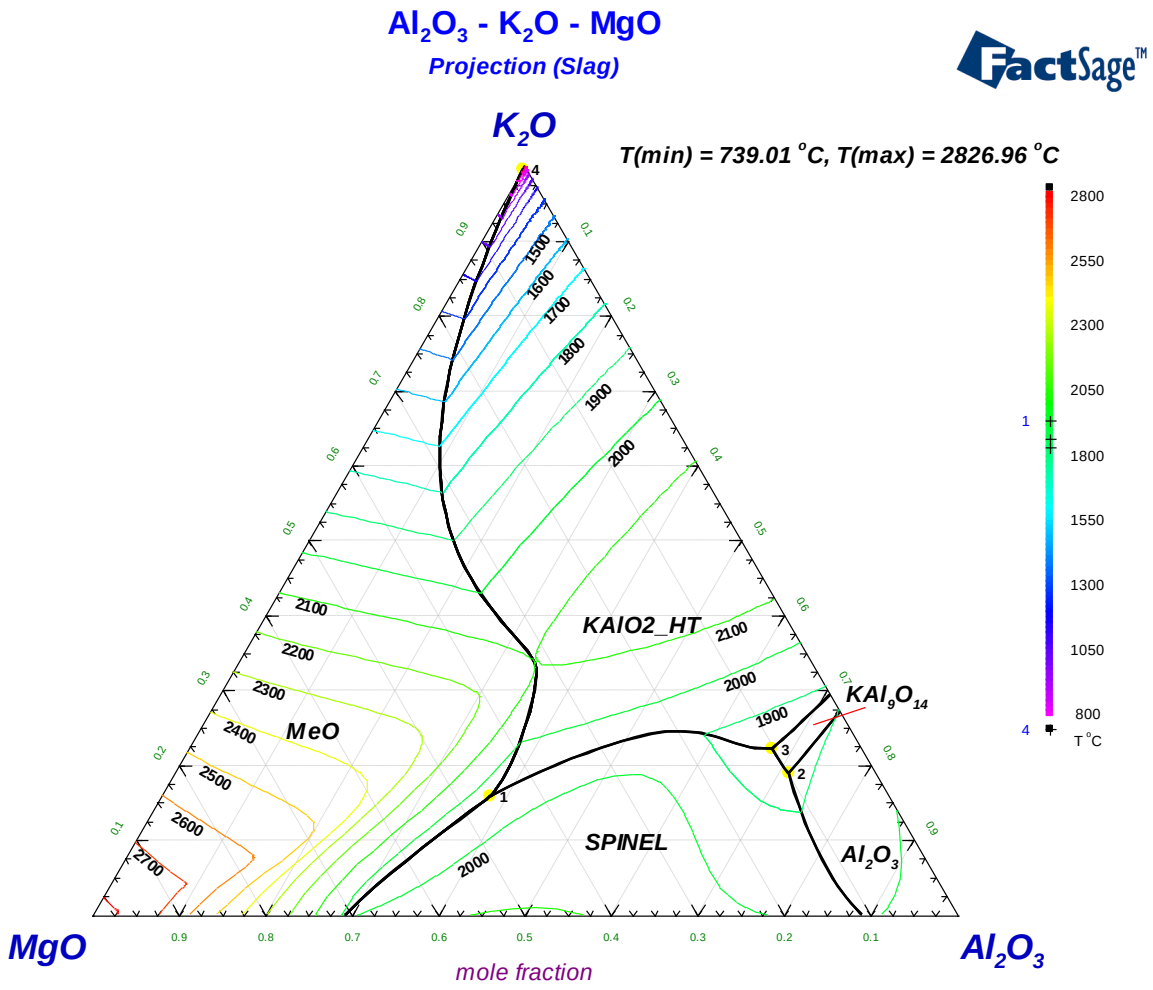
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction					Weight percent				
	A = V2O5, B = Fe2O3, C = Al2O3					A = V2O5, B = Fe2O3, C = Al2O3				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1. CORUNDUM#1 / Fe2Al2O6 / SPINEL	1:	0.22783	0.26439	0.50778	1417.82	1:	30.597	31.175	38.229	1417.91
2. CORUNDUM#1 / Fe2Al2O6 / SPINEL	2:	0.24692	0.26249	0.49059	1388.31	2:	32.817	30.630	36.553	1388.31
3. CORUNDUM#1 / CORUND#2 /Fe2Al2O6	3:	0.28690	0.20427	0.50883	1334.99	3:	38.173	23.871	37.956	1335.05
4. MeVO4 / CORUNDUM#1 / CORUNDUM#2	4:	0.50959	0.04459	0.44582	887.95	4:	63.805	4.902	31.293	887.91

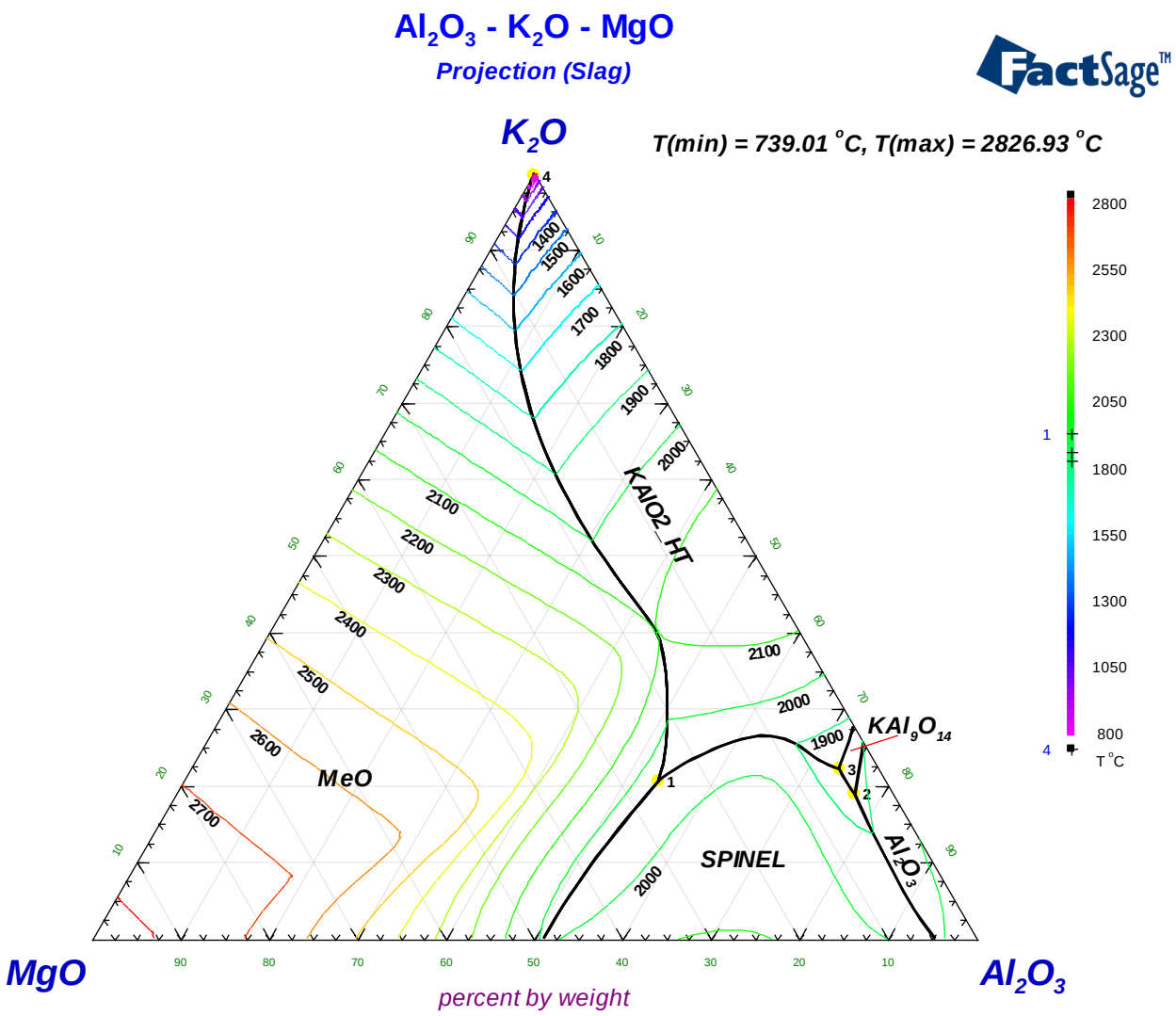
Al2O3-K2O-MgO,
Mole fraction 1400°C



Mole fraction
Liquidussurface



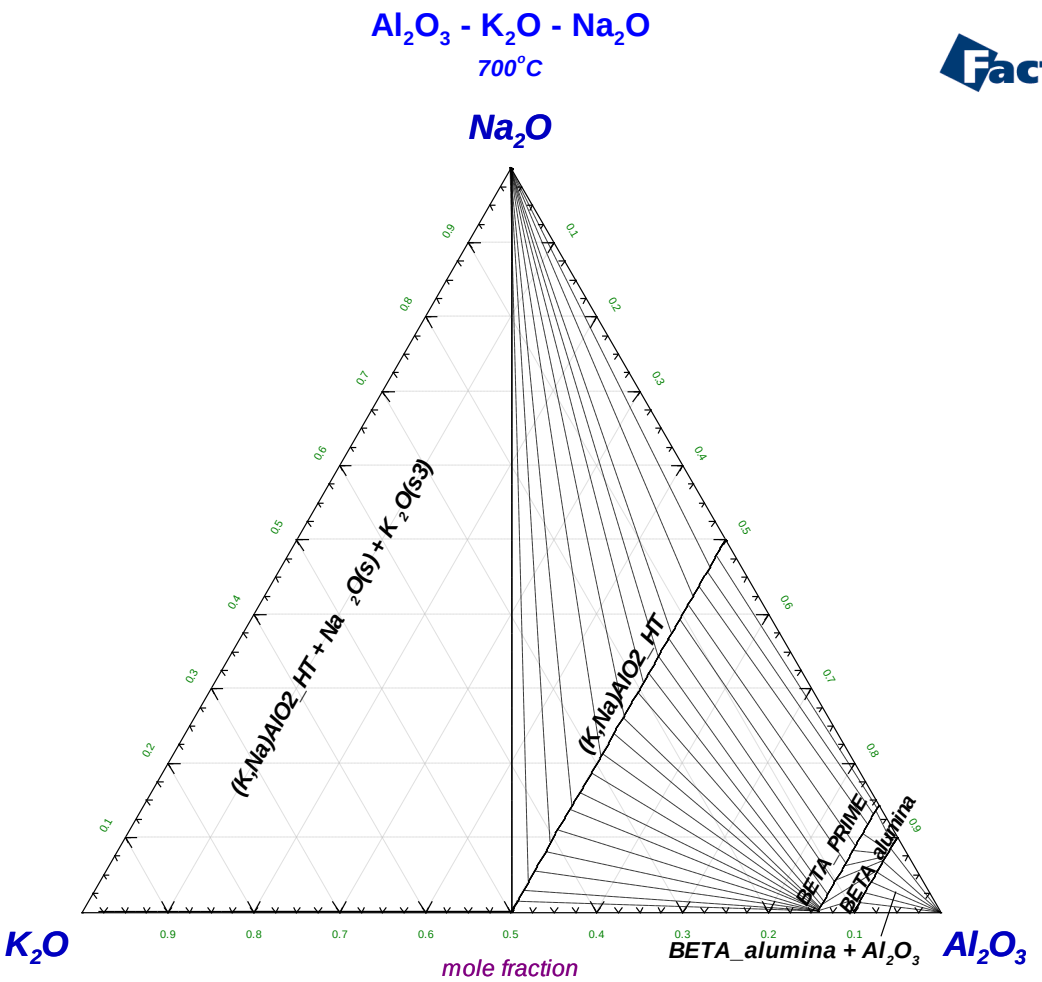
Weight percent
Liquidussurface



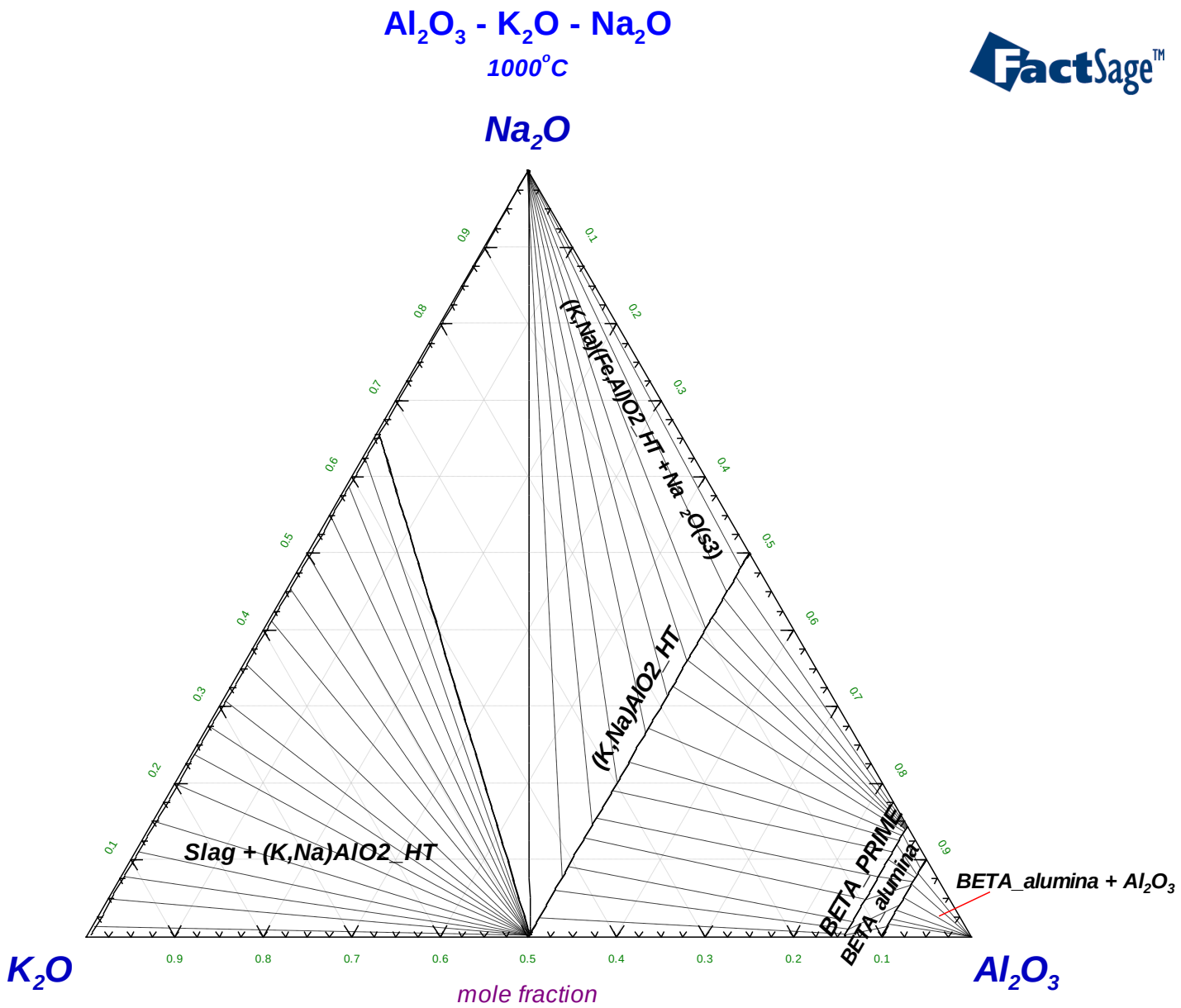
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction				Weight percent			
	A = K2O, B = MgO, C = Al2O3				A = K2O, B = MgO, C = Al2O3			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: KAlO2_HT / MeO / SPINEL	1: 0.15875	0.46023	0.38101	1927.44	1: 20.668	25.638	53.694	1927.44
2: Al2O3 / KAl9O14 / SPINEL	2: 0.18928	0.10031	0.71041	1860.24	2: 18.906	4.287	76.807	1860.26
3: KAlO2_HT / KAl9O14 / SPINEL	3: 0.22214	0.10247	0.67539	1826.71	3: 22.279	4.397	73.323	1826.71
4: KAlO2_HT / K2O(s3) / MeO	4: 0.99578	0.00388	0.00034	739.01	4: 99.797	0.166	0.037	739.01

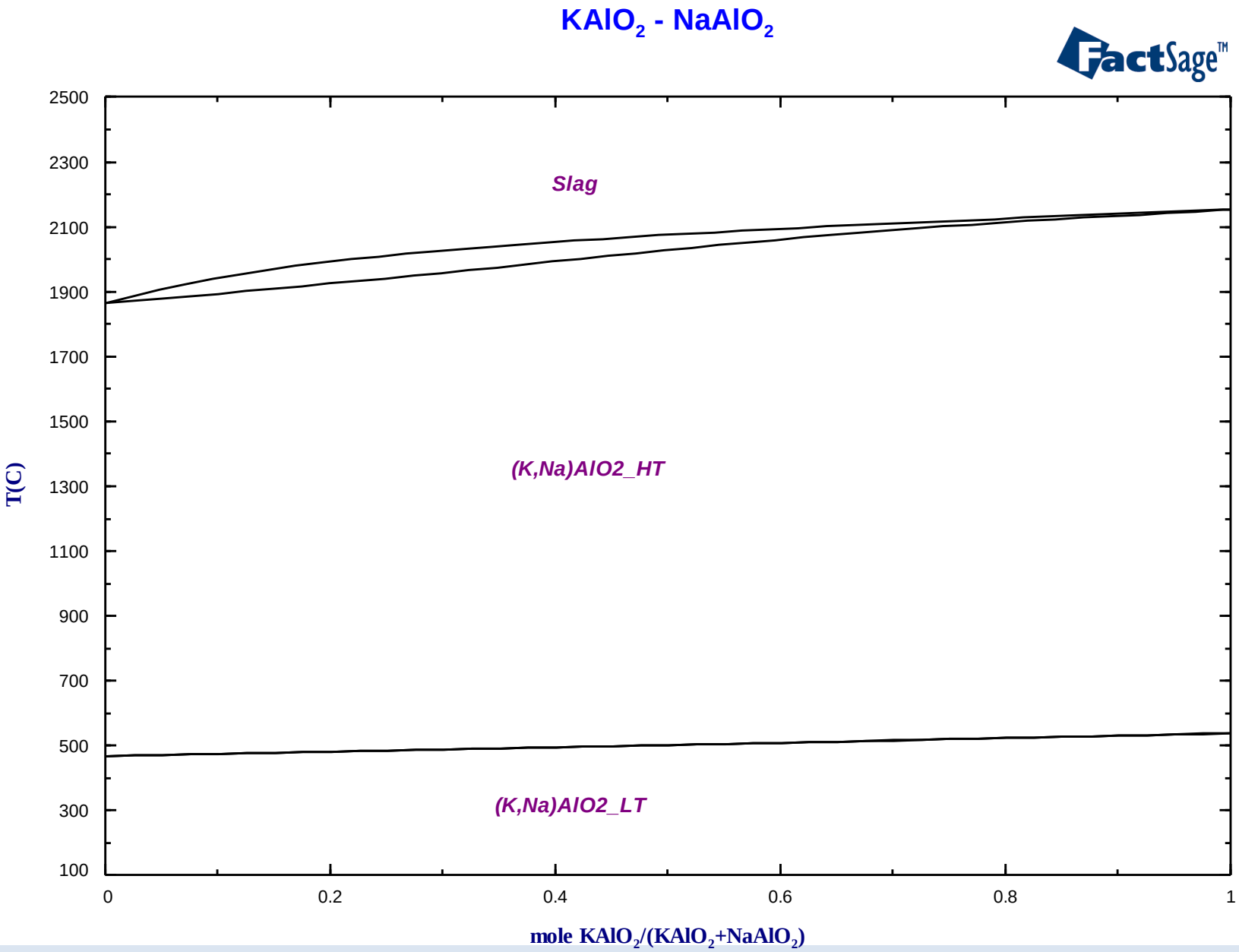
Mole fraction
(proposed calculation)



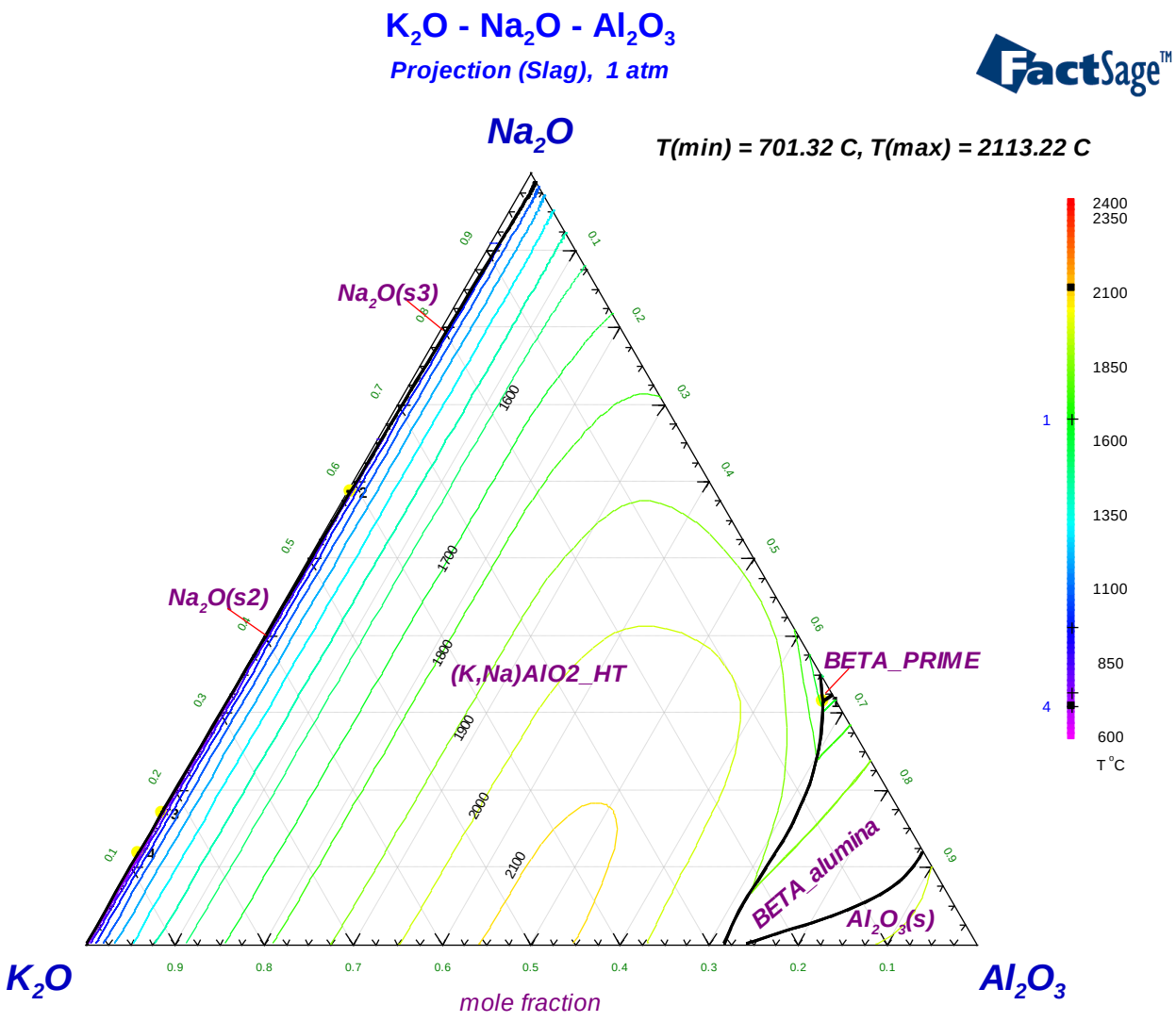
Mole fraction
(proposed calculation)



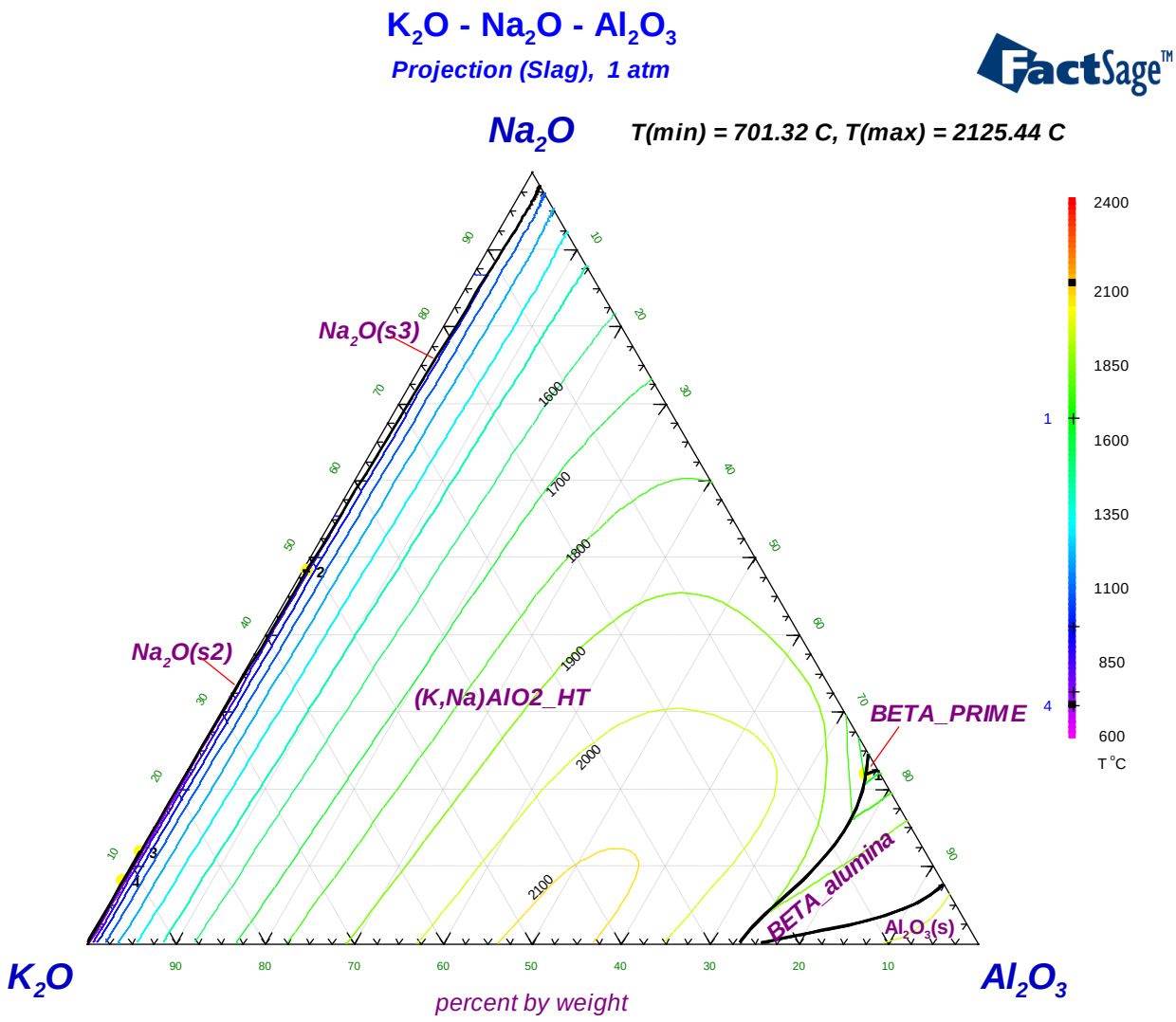
Isopleth AlKO2-AlNaO2
(proposed calculation)



Mole fraction
Liquidussurface
(proposed calculation)



Weight percent
Liquidussurface
(proposed calculation)



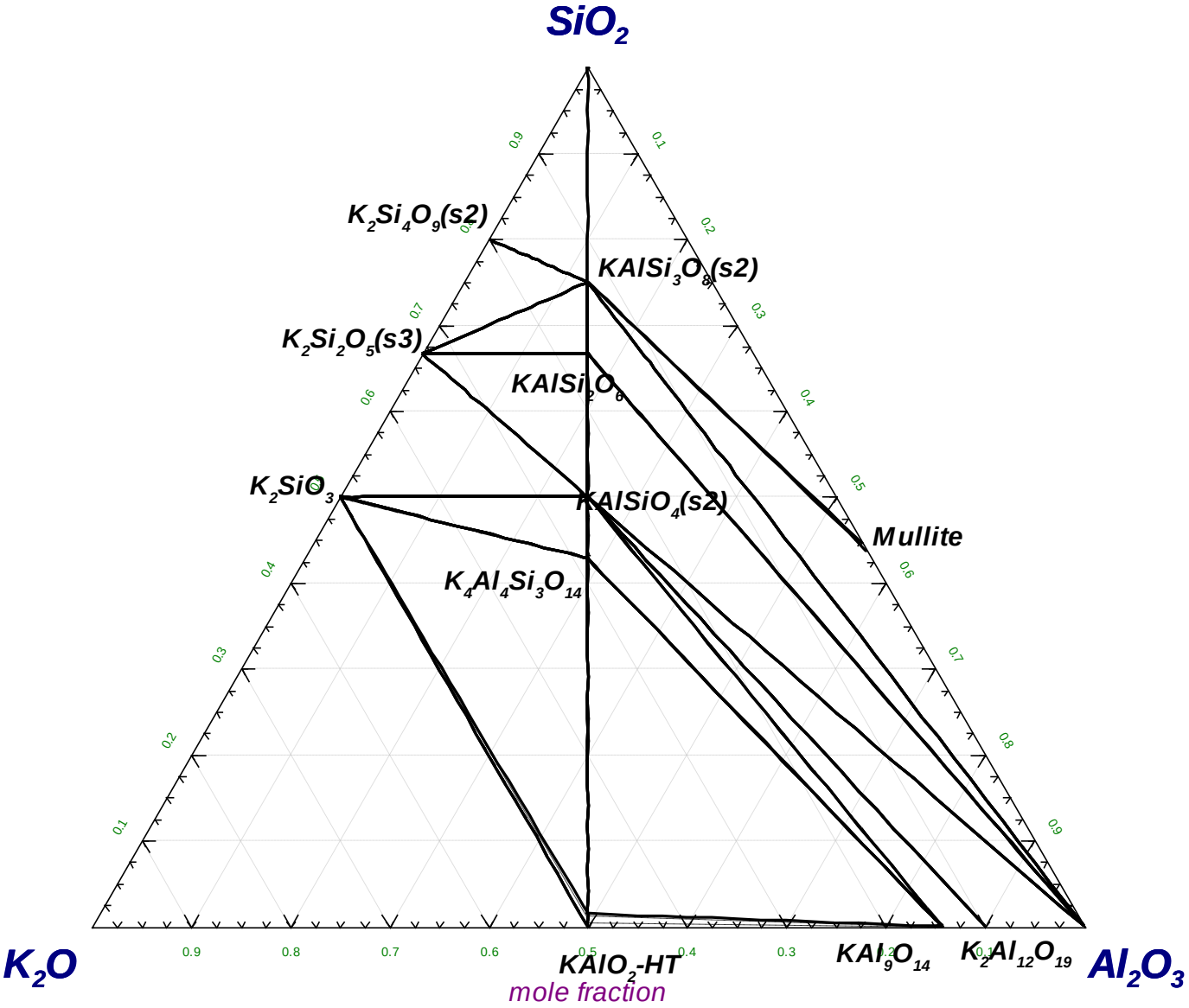
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction					Weight percent				
	A = Na2O, B = K2O, C = Al2O3					A = Na2O, B = K2O, C = Al2O3				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: (K,Na)AlO2_HT / BETA_PRIME /BETA_alumina	1:	0.31467	0.01467	0.67066	1670.31	1:	21.848	1.548	76.604	1670.29
2: (K,Na)AlO2_HT / Na2O(s2) / Na2O(s3)	2:	0.58745	0.40834	0.00422	970.05	2:	48.351	51.079	0.571	970.05
3: (K,Na)AlO2_HT / Na2O(s) / Na2O(s2)	3:	0.16996	0.82952	0.00052	750.05	3:	11.873	88.068	0.059	750.05
4: (K,Na)AlO2_HT / K2O(s3) / Na2O(s)	4:	0.11848	0.88123	0.00029	701.32	4:	8.125	91.843	0.032	701.32

Mole fraction

Al_2O_3 - K_2O - SiO_2

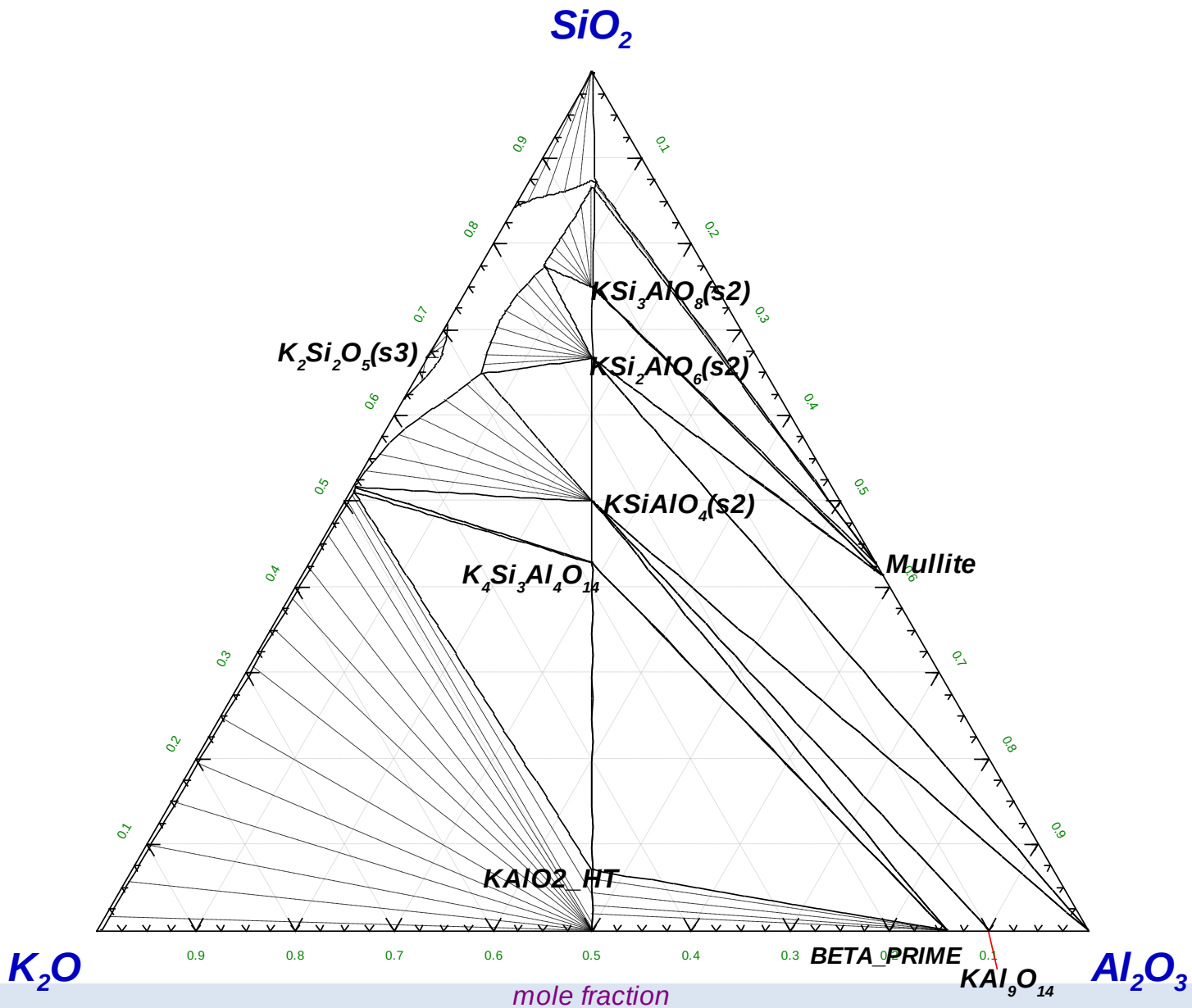
645°C



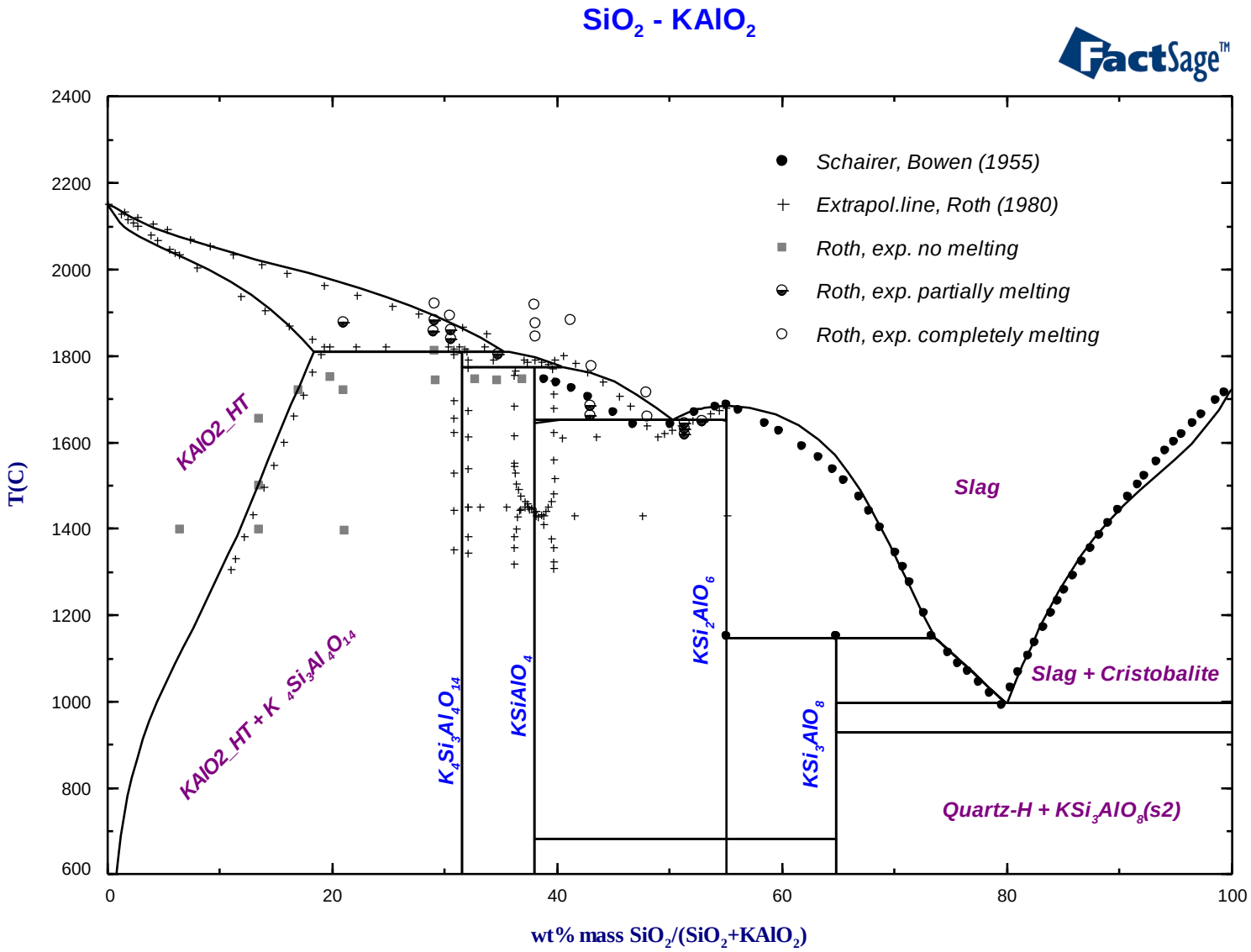
Mole fraction
kurz unterhalb Liquidussurface

Al_2O_3 - K_2O - SiO_2

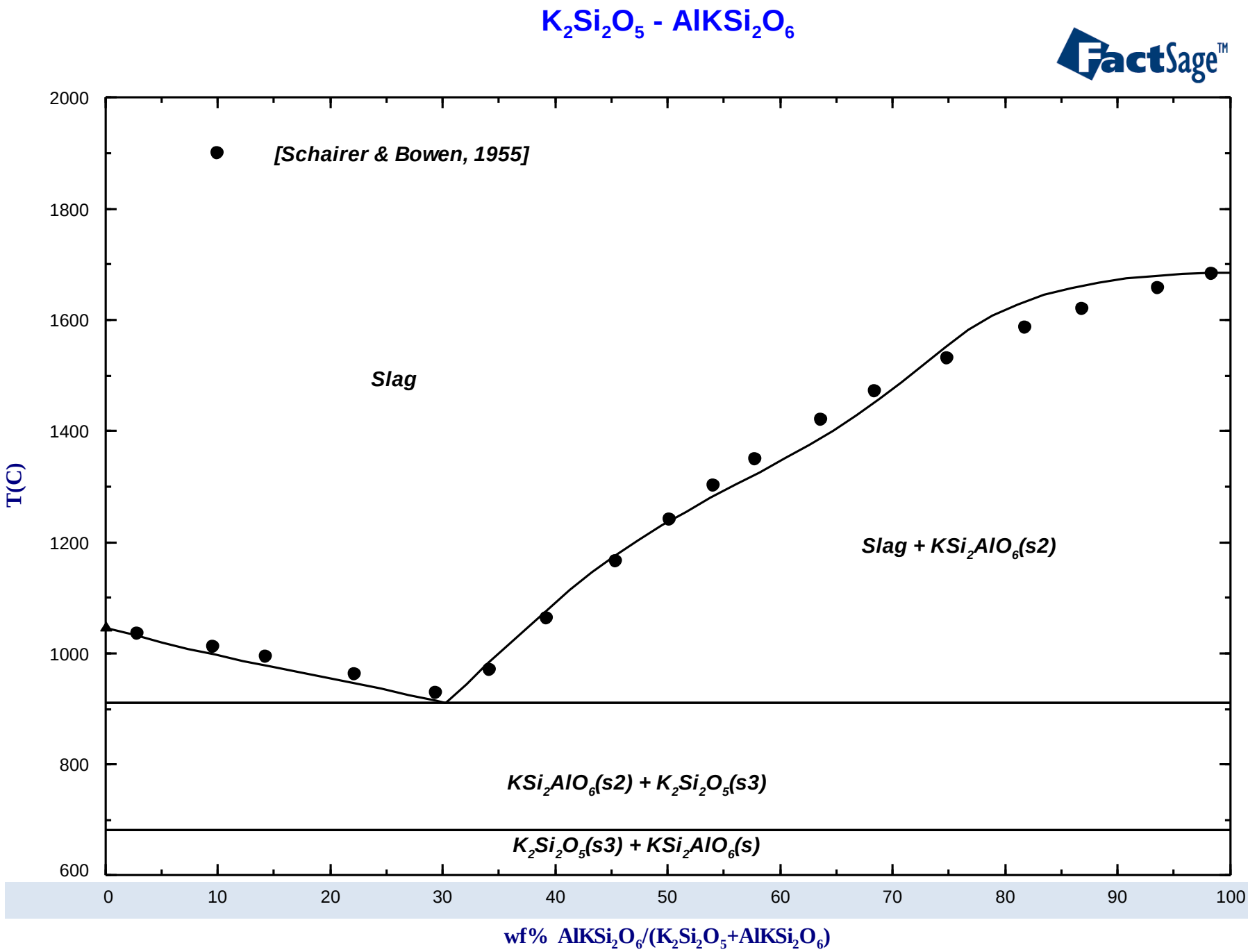
1000°C



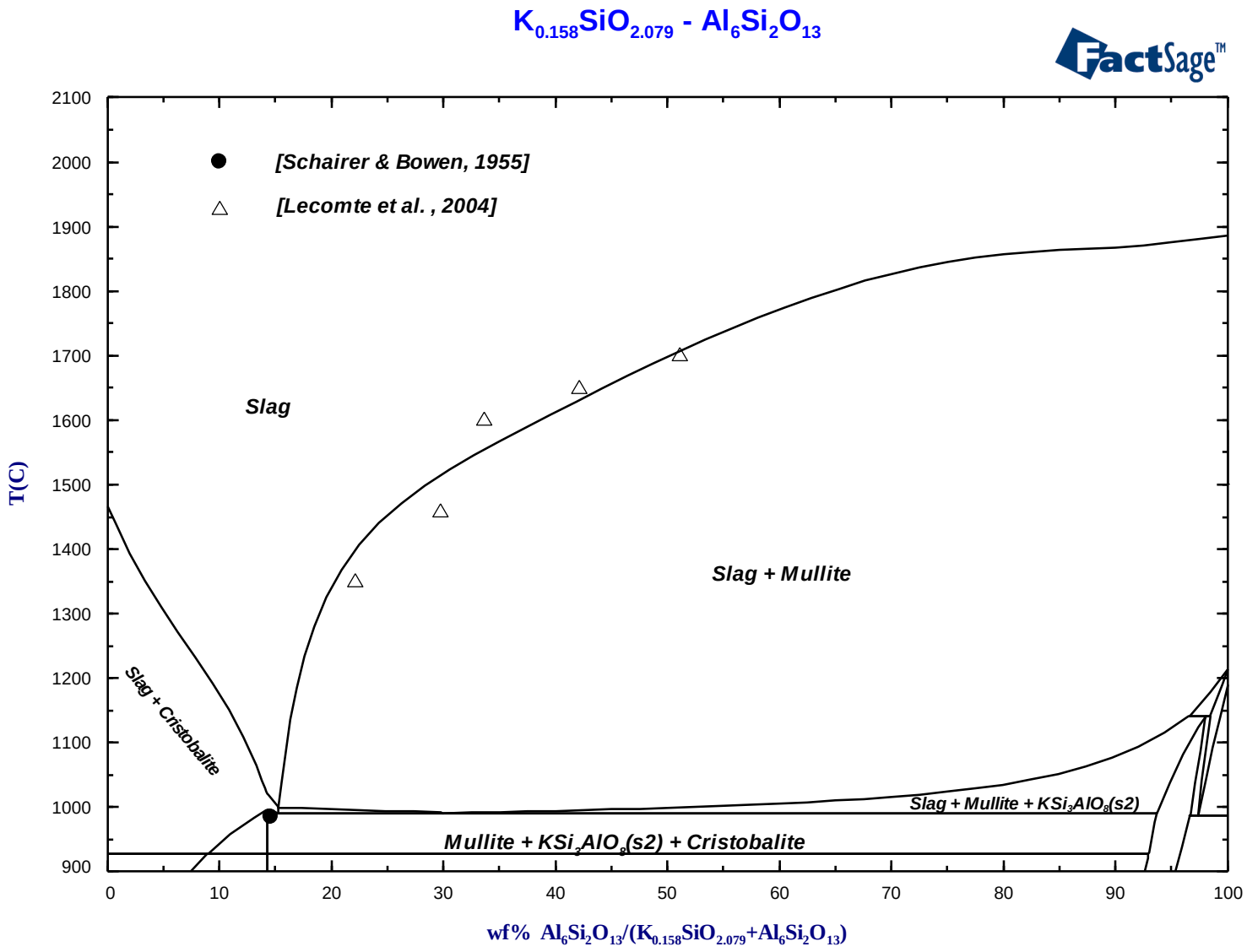
Weight percent
compared with experimental data



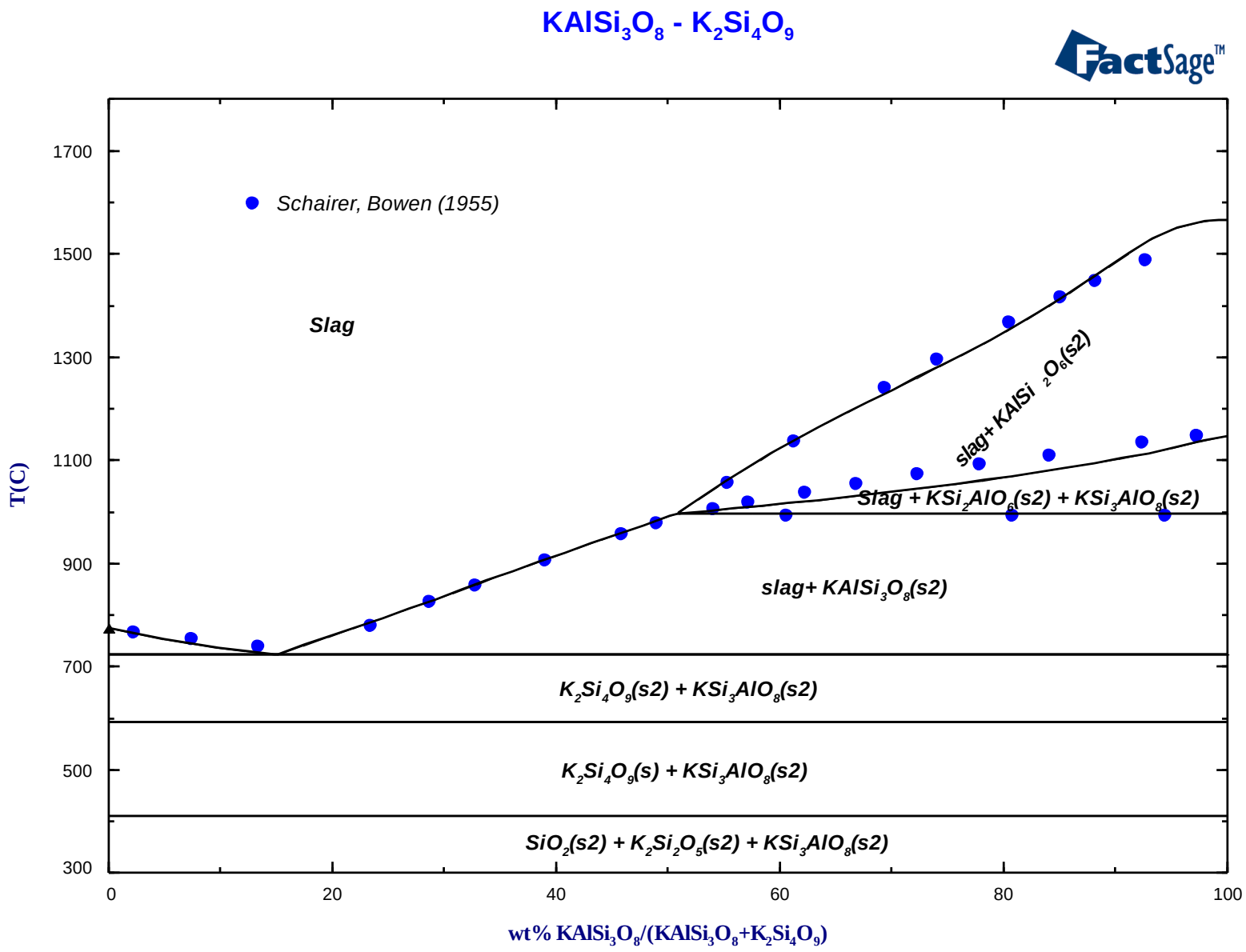
Weight percent
compared with experimental data



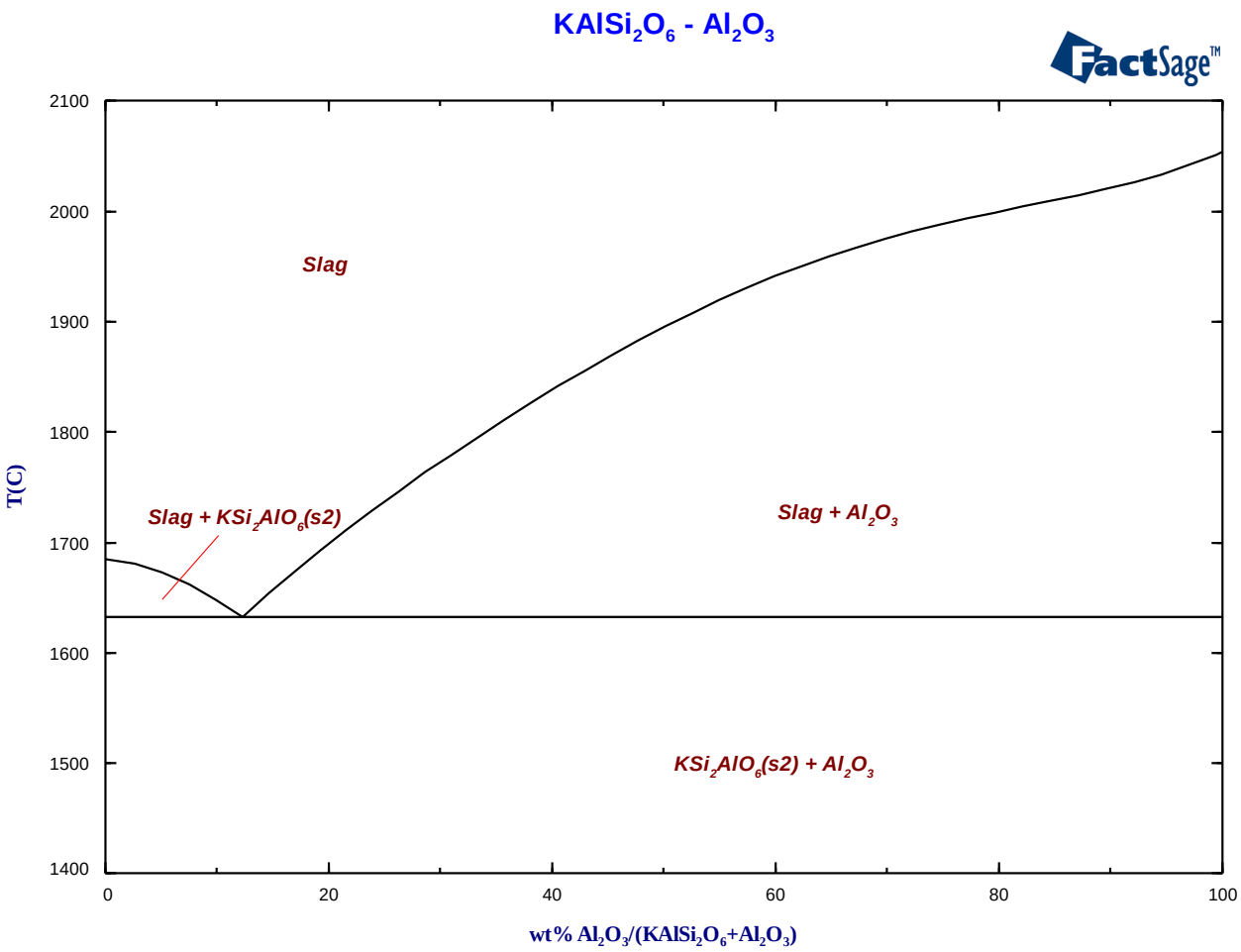
Weight percent K16SiO2-Al6Si2O13 compared with experimental data



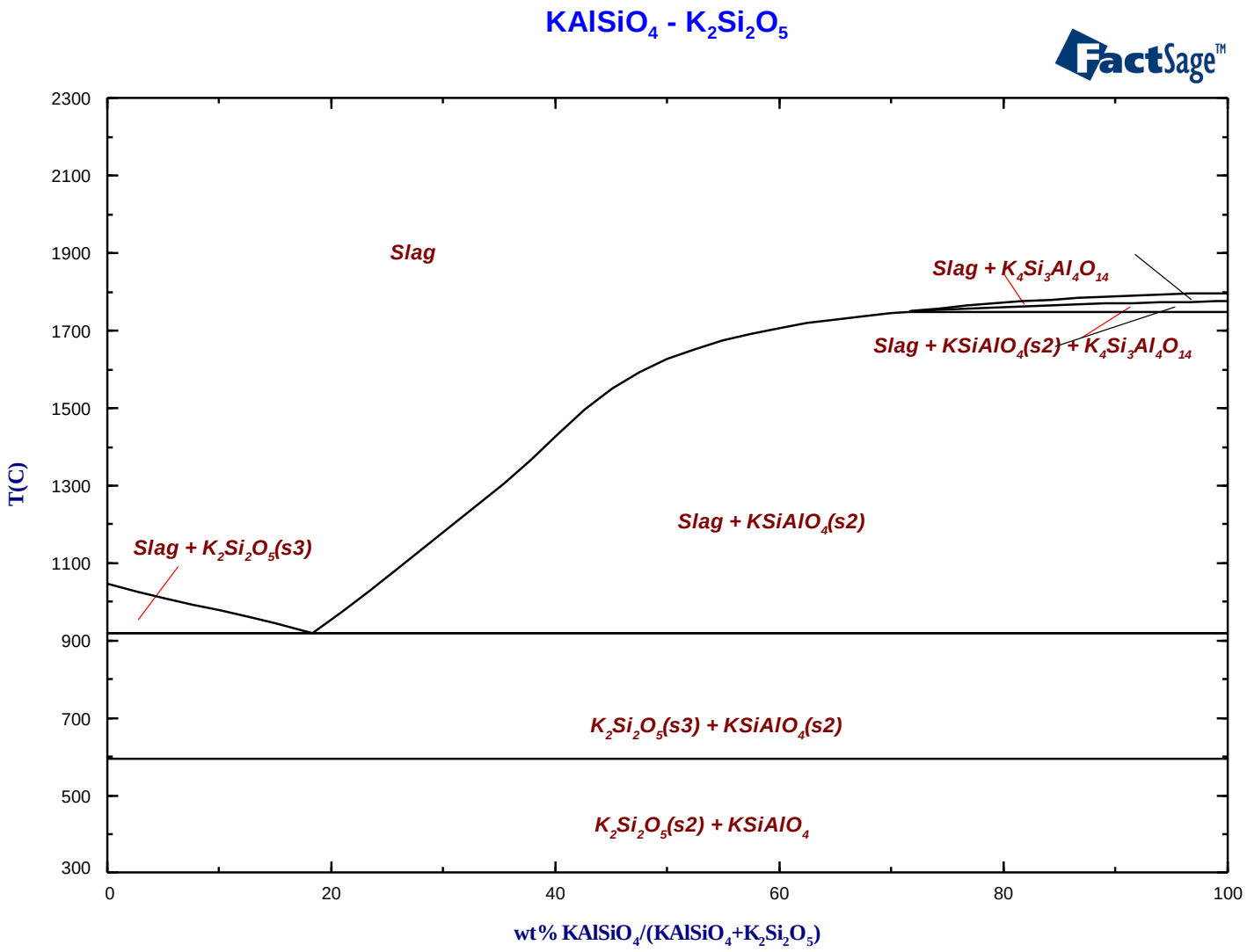
Weight percent KAlSi3O8-K2Si4O9 compared with experimental data

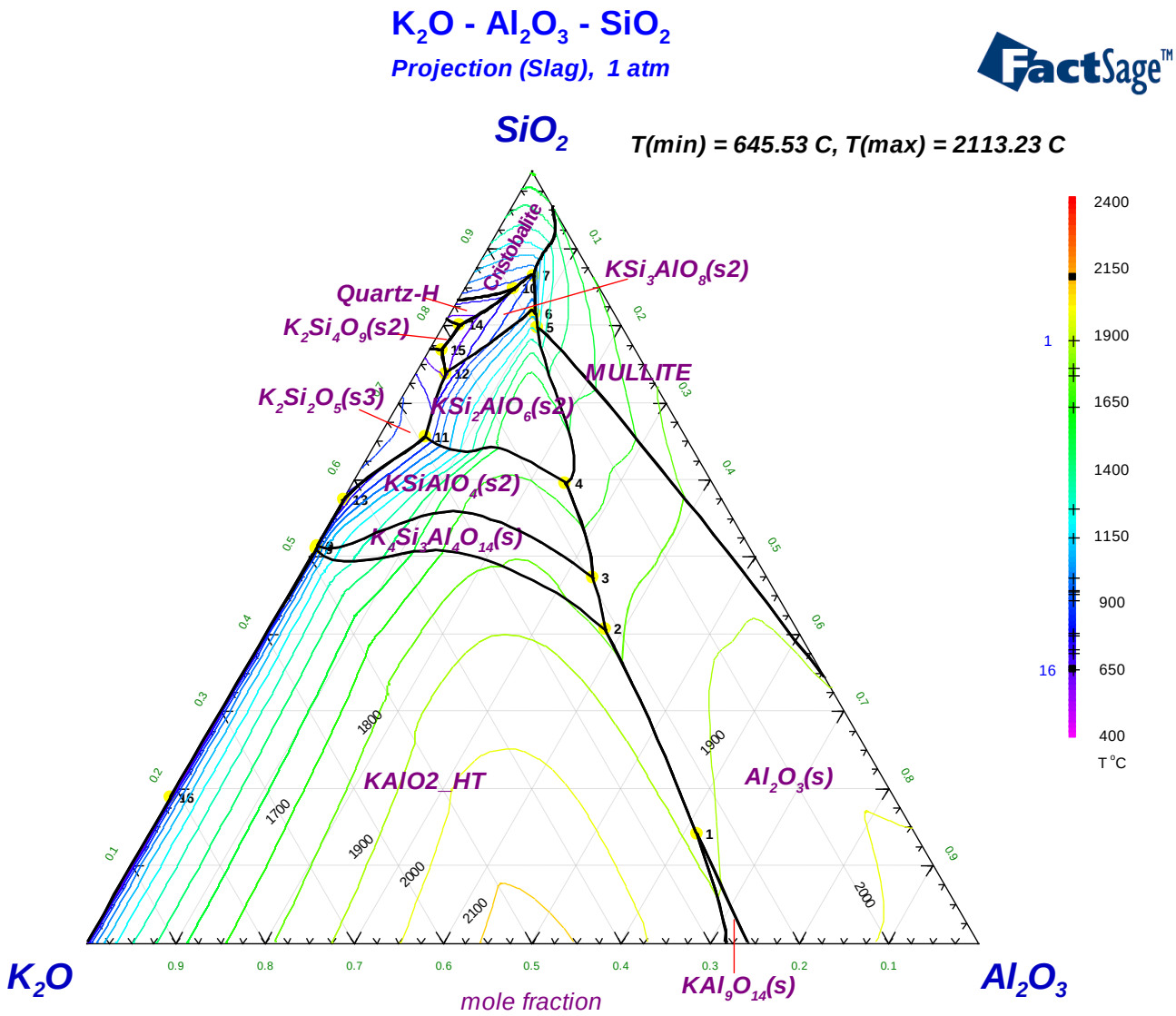


Weight percent KAlSi2O6-Al2O3



Weight percent KAlSiO4-K2Si2O5

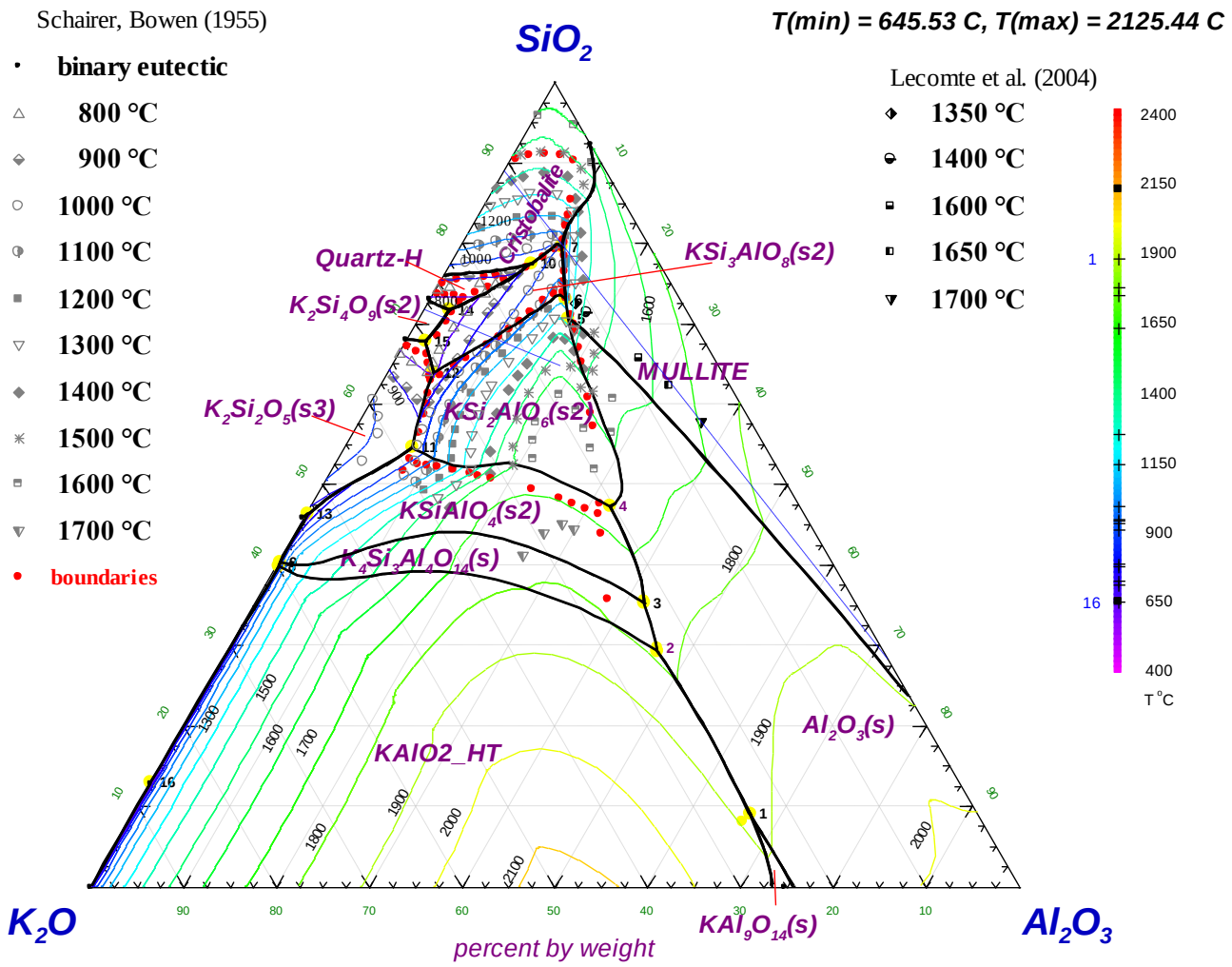



K2O - Al2O3 - SiO2
Projection (Slag), 1 atm
FactSage™
SiO2
T(min) = 645.53 C, T(max) = 2113.23 C
Cristobalite
Quartz-H
K2Si4O9(s2)
KSi3AlO8(s2)
MULLITE
K2Si2O5(s3)
KSi2AlO6(s2)
KSiAlO4(s2)
K4Si3Al4O14(s)
KAlO2_HT
Al2O3(s)
KAl9O14(s)
K2O
Al2O3
mole fraction
T °C
2400
2150
1900
1650
1400
1150
900
650
400

Weight percent
Liquidussurface
compared with experimental data

K_2O - Al_2O_3 - SiO_2

Projection (Slag), 1 atm

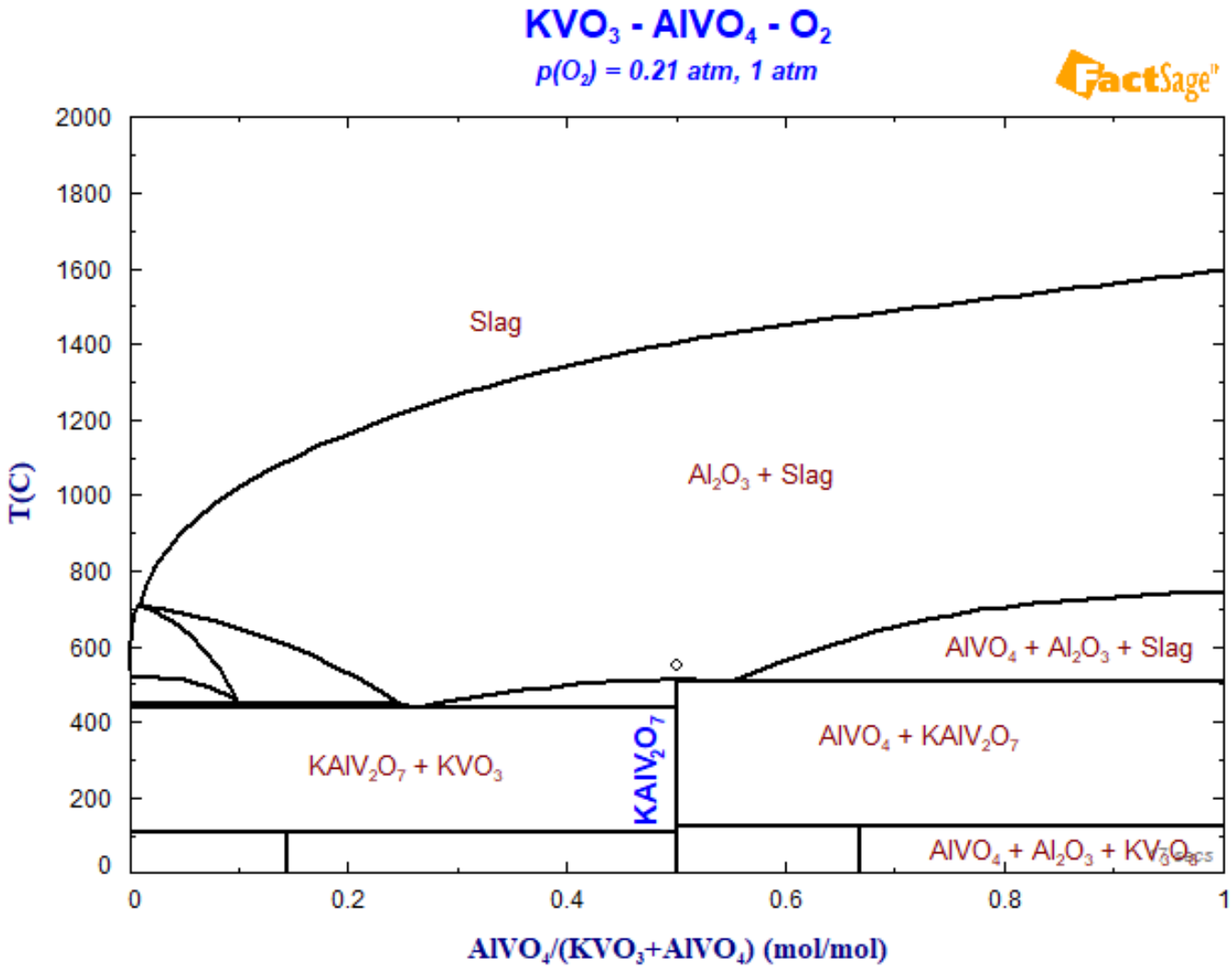


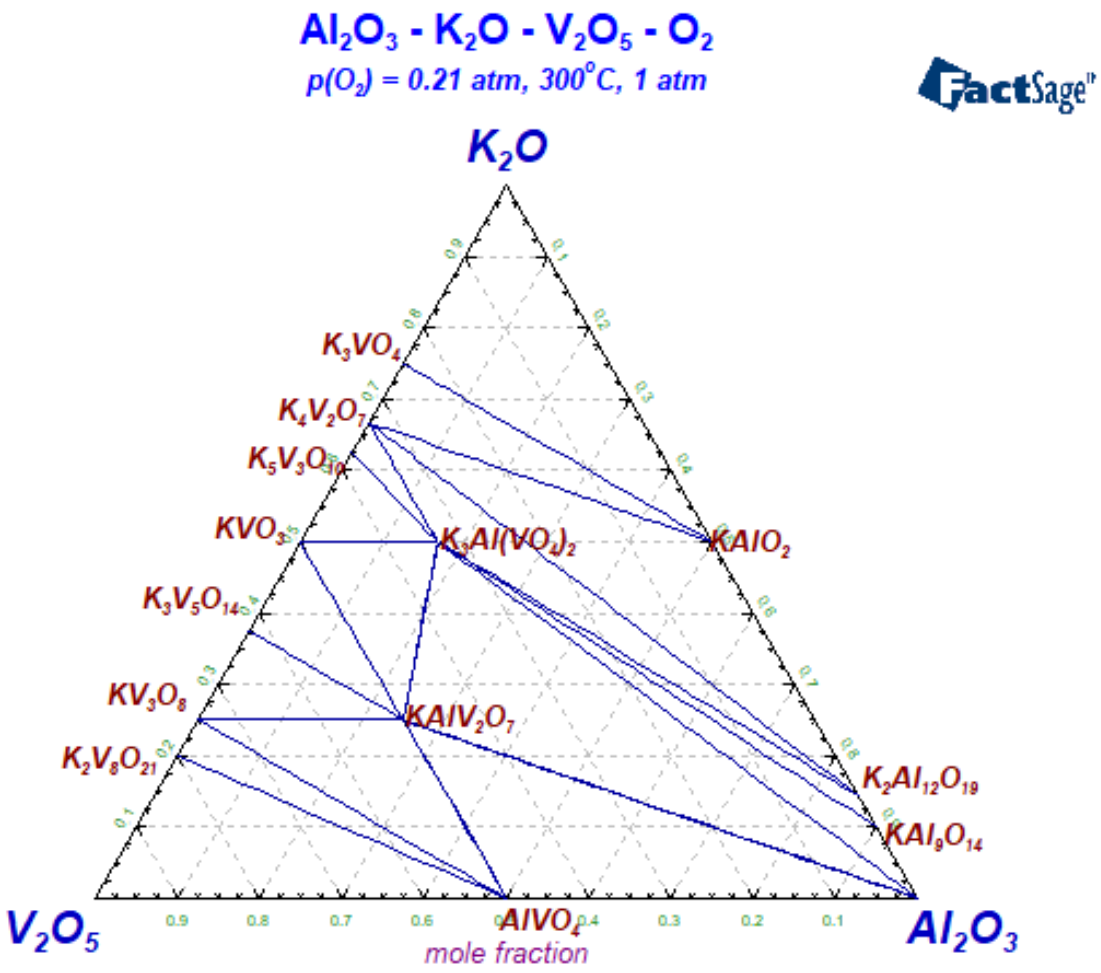
Invariant equilibria on the liquidus surface

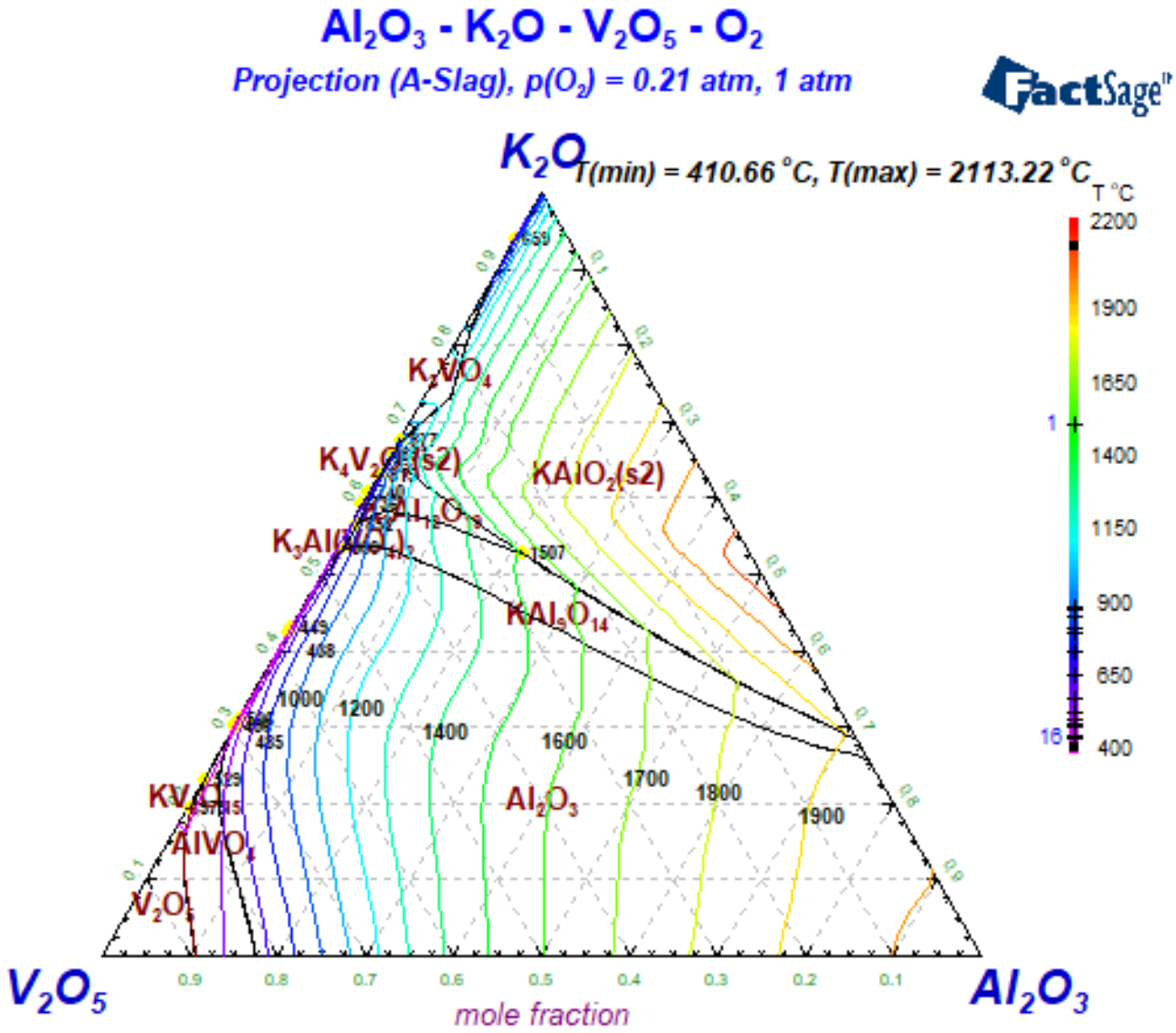
Intersections with slag	Mole fraction					Weight percent				
	A = SiO2, B = K2O, C = Al2O3					A = SiO2, B = K2O, C = Al2O3				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: KAlO2_HT / Al2O3 / KAl9O14	1:	0.14105	0.24440	0.61455	1878.21	1:	9.001	24.450	66.549	1878.21
2: KAlO2_HT / Al2O3 / K4Si3Al4O14	2:	0.40623	0.21465	0.37912	1774.47	2:	29.308	24.277	46.415	1774.47
3: Al2O3 / K4Si3Al4O14 / KSiAlO4(s2)	3:	0.47271	0.19506	0.33223	1745.79	3:	35.216	22.782	42.002	1745.79
4: Al2O3 / KSi2AlO6(s2) / KSiAlO4(s2)	4:	0.59587	0.16407	0.24006	1627.43	4:	47.274	20.407	32.320	1627.43
5: Al2O3 / KSi2AlO6(s2) / Mullite	5:	0.79740	0.09494	0.10766	1248.86	5:	70.632	13.184	16.184	1248.86
6: KSi2AlO6(s2) / KSi3AlO8(s2) / Mullite	6:	0.81549	0.08804	0.09646	1140.76	6:	72.995	12.354	14.651	1140.76
7: KSi3AlO8(s2) / Mullite / Cristobalite	7:	0.86446	0.06523	0.07031	990.50	7:	79.598	9.416	10.986	990.50
8: KAlO2_HT / K2SiO3 / K4Si3Al4O14	8:	0.50994	0.48728	0.00277	943.82	8:	39.884	59.748	0.368	943.91
9: K2SiO3 / K4Si3Al4O14 / KSiAlO4(s2)	9:	0.51420	0.48369	0.00211	936.46	9:	40.295	59.424	0.281	936.46
10: KSi3AlO8(s2) / Cristobalite / Quartz-H	10:	0.84731	0.09637	0.05633	926.28	10:	77.453	13.810	8.737	926.28
11: K2Si2O5(s3) / KSi2AlO6(s2) / KSiAlO4(s2)	11:	0.65595	0.29192	0.05213	906.12	11:	54.568	38.072	7.359	906.12
12: K2Si2O5(s3) / KSi2AlO6(s2) / KSi3AlO8(s2)	12:	0.73761	0.22816	0.03423	784.22	12:	63.952	31.012	5.037	784.22
13: K2Si2O5(s3) / K2SiO3 / KSiAlO4(s2)	13:	0.57466	0.42314	0.00220	771.36	13:	46.278	53.422	0.301	771.36
14: K2Si4O9(s2) / KSi3AlO8(s2) / Quartz	14:	0.80026	0.18122	0.01851	722.05	14:	71.722	25.462	2.816	722.06
15: K2Si2O5(s3) / K2Si4O9(s2) / KSi3AlO8(s2)	15:	0.76817	0.21697	0.01486	706.83	15:	67.768	30.007	2.225	706.83
16: KAlO2_HT / K2O(s3) / K2SiO3	16:	0.18802	0.81185	0.00013	645.53	16:	12.869	87.115	0.015	645.74

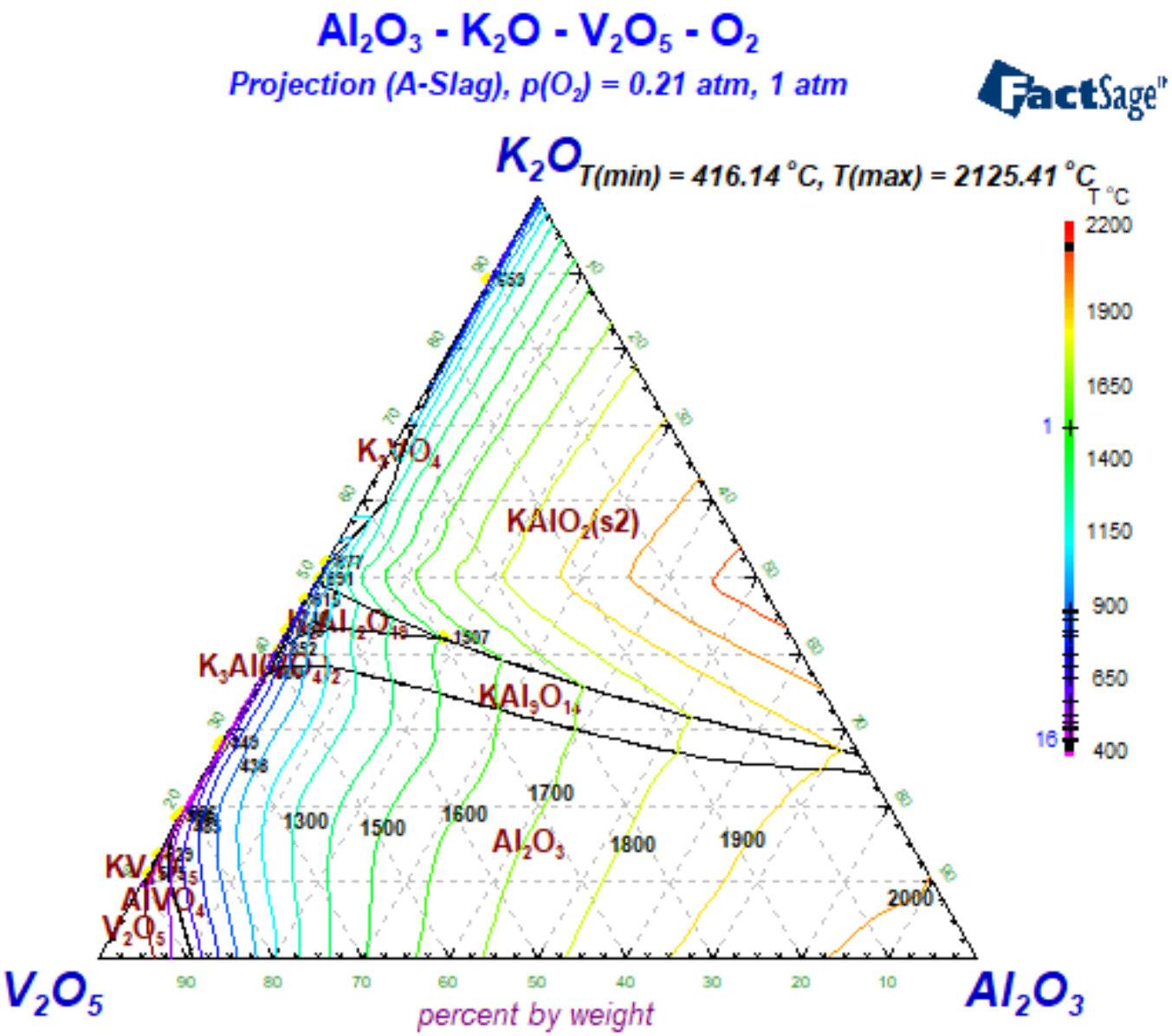
Al2O3-K2O-V2O5,

Al2O3-K2O-V2O5, Mole fraction, Isopleth AlVO4-KVO3




Al2O3 - K2O - V2O5 - O2
p(O2) = 0.21 atm, 300°C, 1 atm
FactSage
K2O
K3VO4
K4V2O7
K5V3O10
KVO3
K3Al(VO4)2
KAlO2
K3V5O14
KV3O8
KAlV2O7
K2V8O21
K2Al12O19
KAl9O14
V2O5
AlVO4
Al2O3
mole fraction

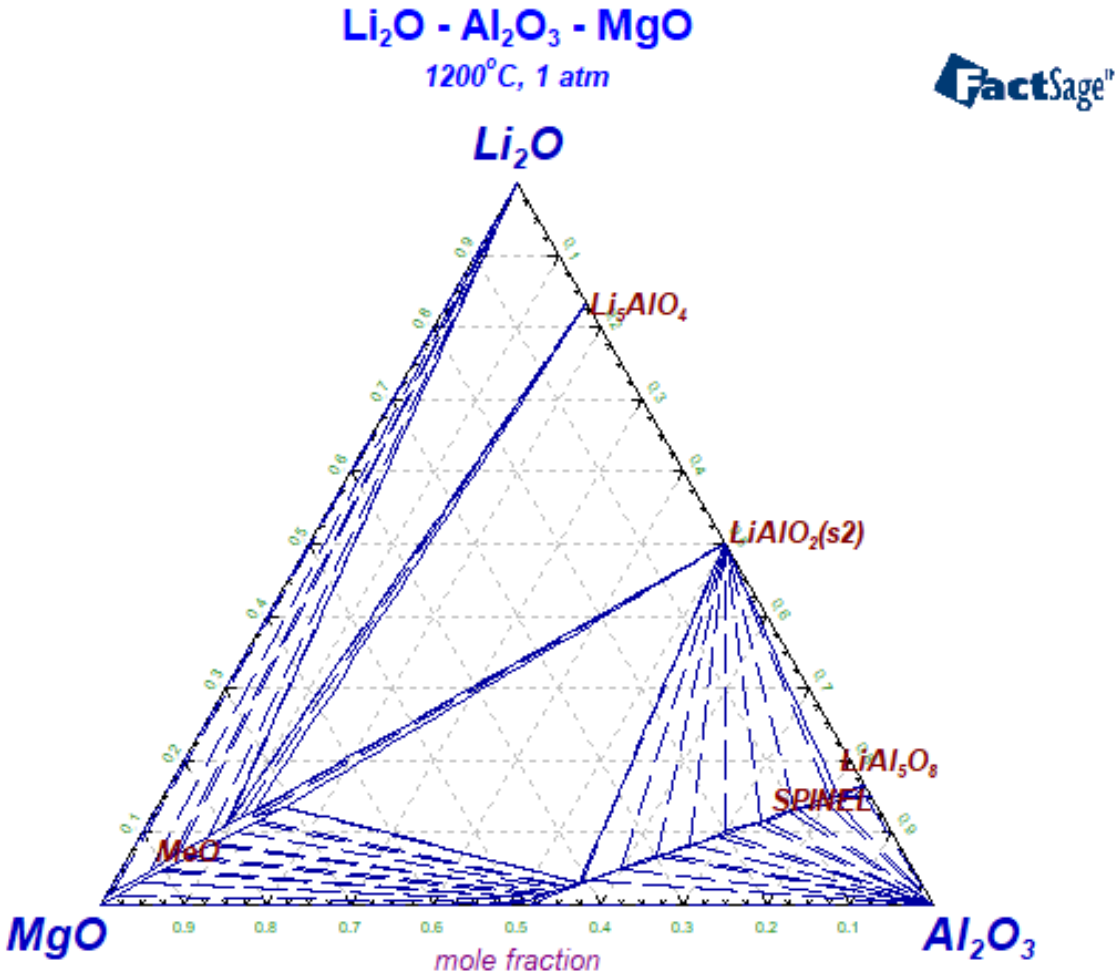

Al2O3 - K2O - V2O5 - O2
Projection (A-Slag), p(O2) = 0.21 atm, 1 atm
FactSage
K2O
T(min) = 410.66 °C, T(max) = 2113.22 °C
T °C
2200
1900
1650
1400
1150
900
650
400
K3VO4
K4V2O7(s2)
KAlO2(s2)
Al12O19
K3Al(VO4)2
KAl5O14
KV3O8
AlVO4
V2O5
Al2O3
1000
1200
1400
1600
1700
1800
1900
V2O5
Al2O3
mole fraction

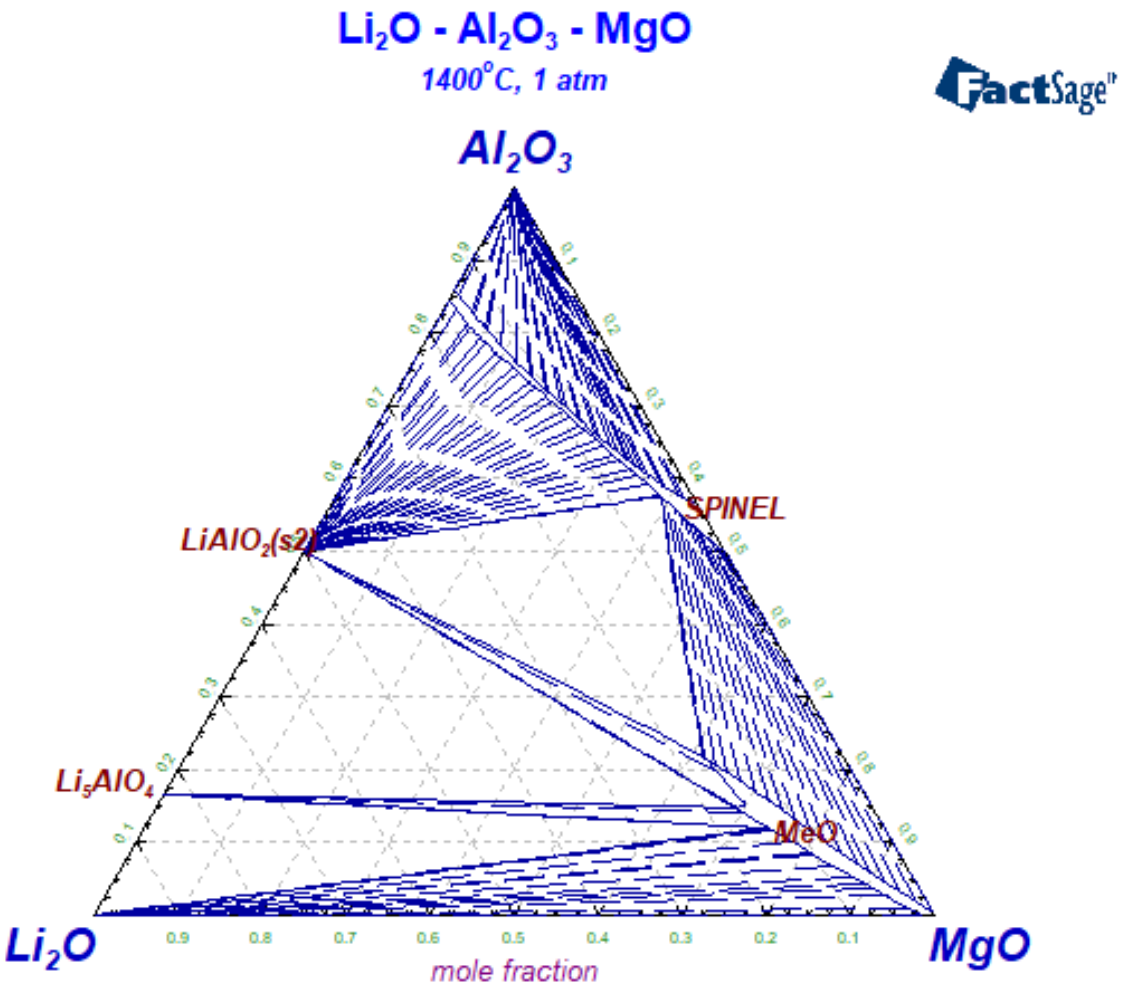

Al2O3 - K2O - V2O5 - O2
Projection (A-Slag), p(O2) = 0.21 atm, 1 atm
FactSage
K2O
T(min) = 416.14 °C, T(max) = 2125.41 °C
T °C
2200
1900
1650
1400
1150
900
650
400
K3VO4
KAlO2(s2)
KAl9O14
Al2O3
1300
1500
1600
1700
1800
1900
2000
V2O5
Al2O3
percent by weight

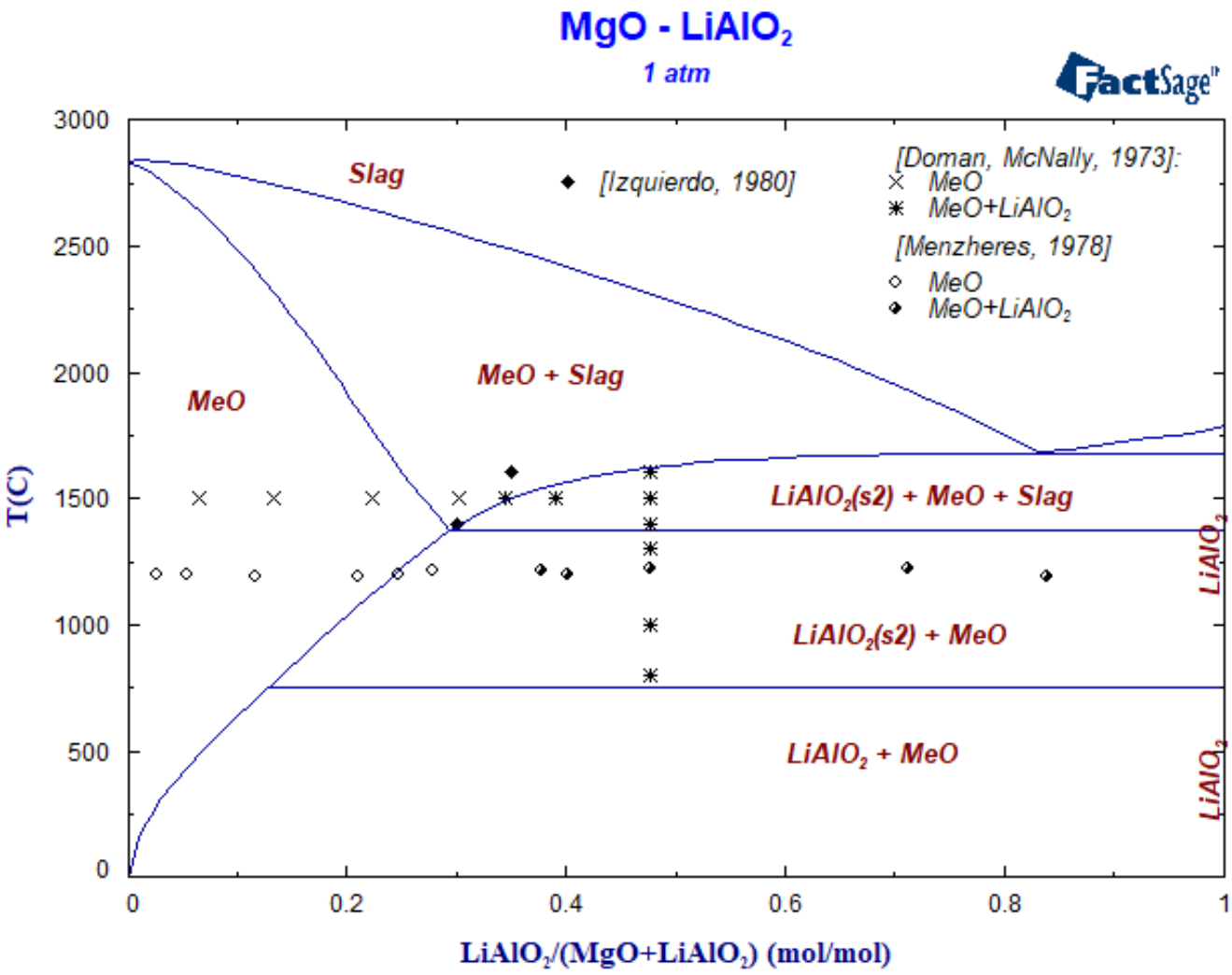
Invariant equilibria on the liquidus surface

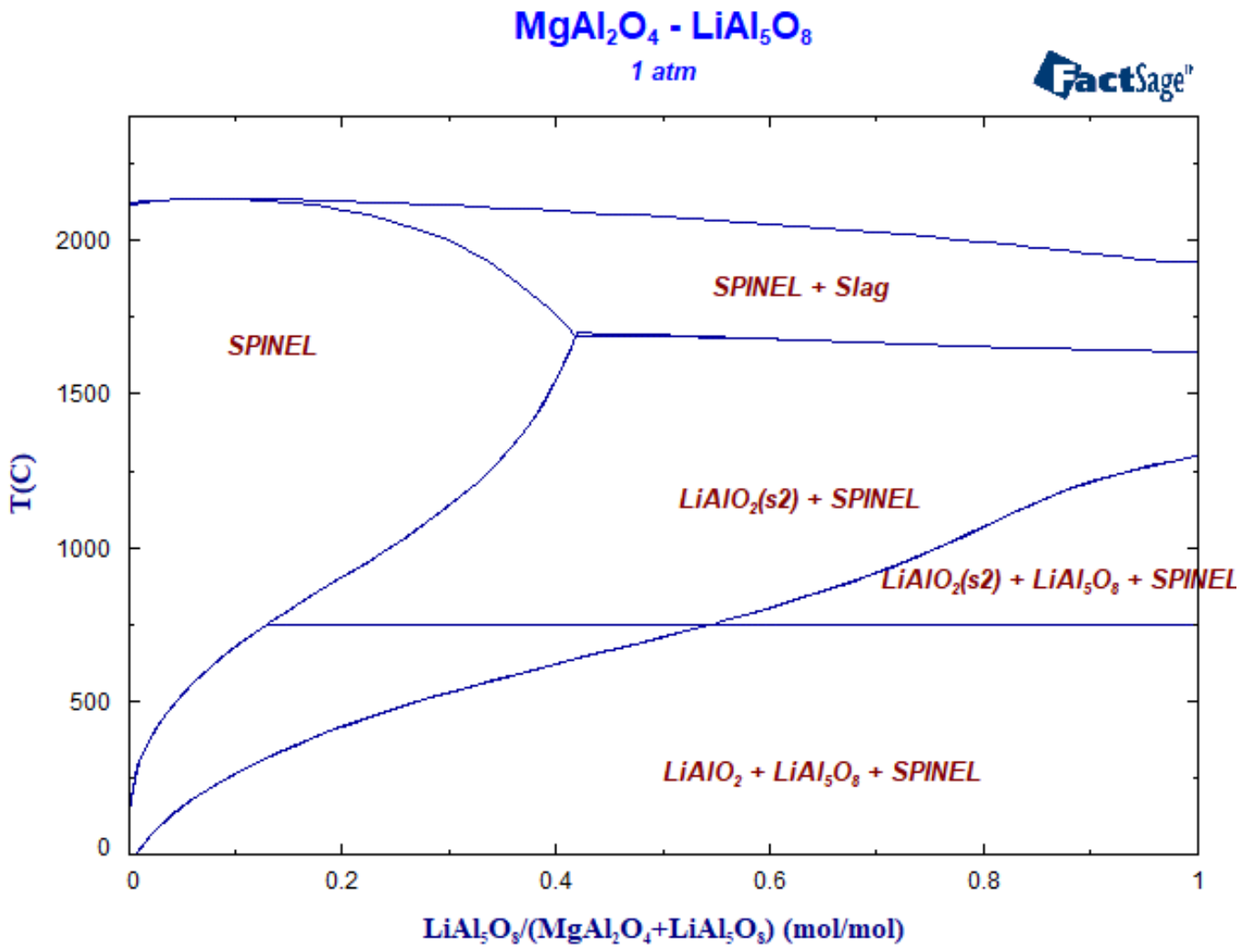
Intersections with slag	Mole fraction A = K2O, B = V2O5, C = Al2O3				Weight percent A = K2O, B = V2O5, C = Al2O3			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1. K2Al12O19 / KAl9O14 / KAlO2_HT(s2)	0.52702	0.25861	0.21437	1507.10	41.880	39.680	18.440	1507.09
2. K2Al12O19 / K4V2O7(s2) / KAlO2_HT(s2)	0.65573	0.34099	0.00329	891.45	49.764	49.966	0.270	891.45
3. K3VO4 / K4V2O7(s2) / KAlO2_HT(s2)	0.67528	0.32244	0.00228	877.40	51.932	47.878	0.190	877.29
4. K2Al12O19 / K3Al(VO4)2 / KAl9O14	0.56500	0.42770	0.00731	852.42	40.394	59.041	0.565	852.42
5. K2Al12O19 / K3Al(VO4)2 / K4V2O7(s2)	0.62996	0.36874	0.00130	815.12	46.894	53.001	0.105	815.12
6. Al2O3 / K3Al(VO4)2 / KAl9O14	0.53250	0.45910	0.00840	799.99	37.288	62.075	0.637	799.99
7. K3Al(VO4)2 / K4V2O7 / K4V2O7(s2)	0.60691	0.39299	0.00010	740.03	44.435	55.557	0.008	740.00
8. K3Al(VO4)2 / K4V2O7 / K5V3O10	0.59261	0.40737	0.00002	735.63	42.967	57.031	0.002	693.20
9. K2O(s3) / K3VO4 / KAlO2_HT(s2)	0.93946	0.06038	0.00016	659.31	88.945	11.038	0.017	659.31
10.AlVO4 / KV6O15 / V2O5	0.19175	0.80240	0.00585	575.19	10.973	88.664	0.362	575.25
11.AlVO4 / K2V8O21 / KV6O15	0.23110	0.76764	0.00127	528.99	13.478	86.442	0.080	528.99
12.Al2O3 / AlVO4 / KAlV2O7	0.31023	0.68903	0.00074	505.74	18.899	81.052	0.049	505.72
13.AlVO4 / K2V8O21 / KV3O8	0.30121	0.69841	0.00038	486.33	18.254	81.721	0.025	486.34
14.AlVO4 / KAlV2O7 / KV3O8	0.30435	0.69527	0.00037	484.56	18.477	81.499	0.025	484.56
15.Al2O3 / K3Al(VO4)2 / KVO3	0.42992	0.57001	0.00008	449.47	28.088	71.907	0.005	449.48
16.Al2O3 / KAlV2O7 / KVO3_S1(s)	0.42463	0.57531	0.00006	438.48	27.653	72.342	0.004	438.48

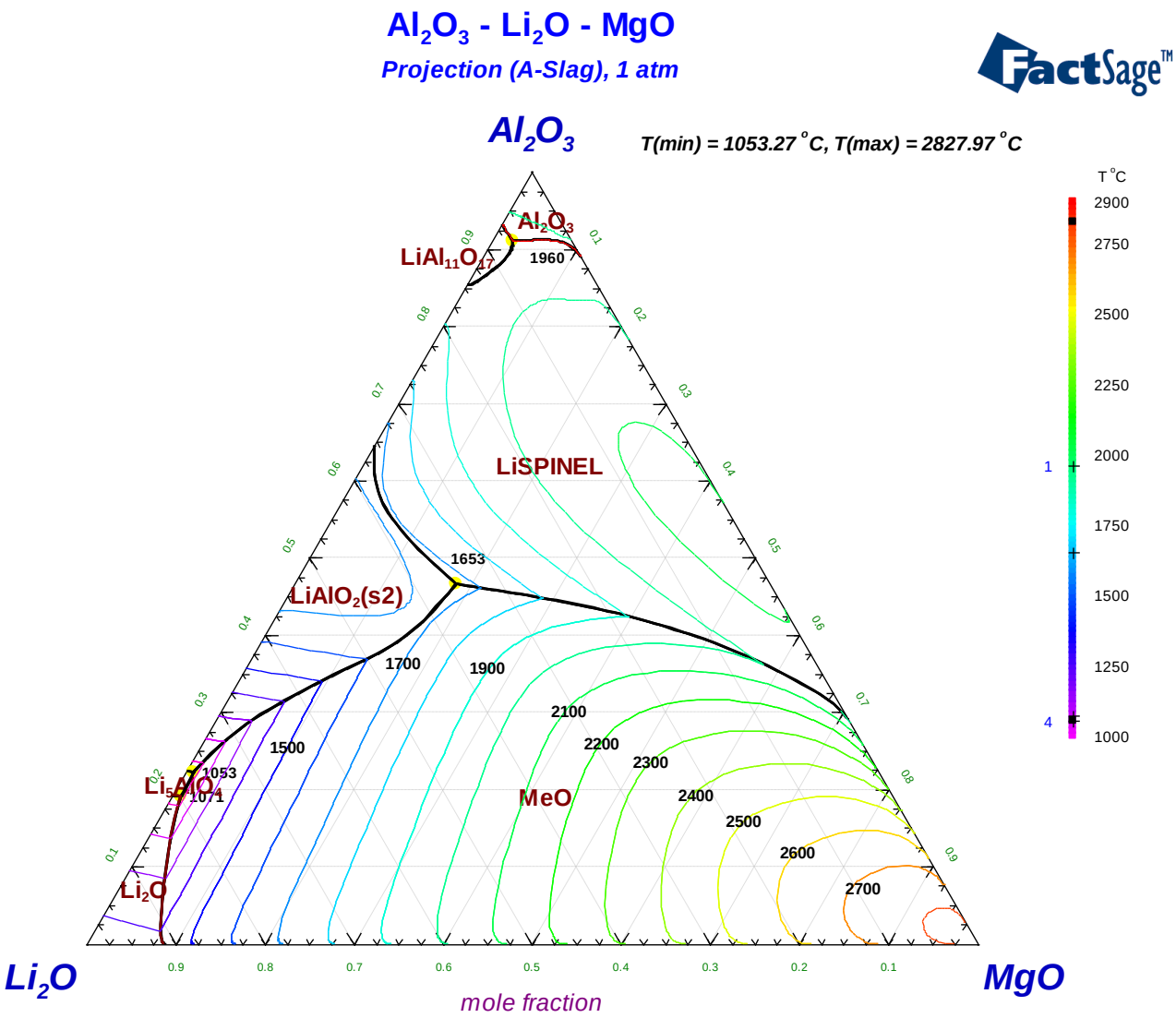
Al2O3-Li2O-MgO,
Mole fraction 1200°C

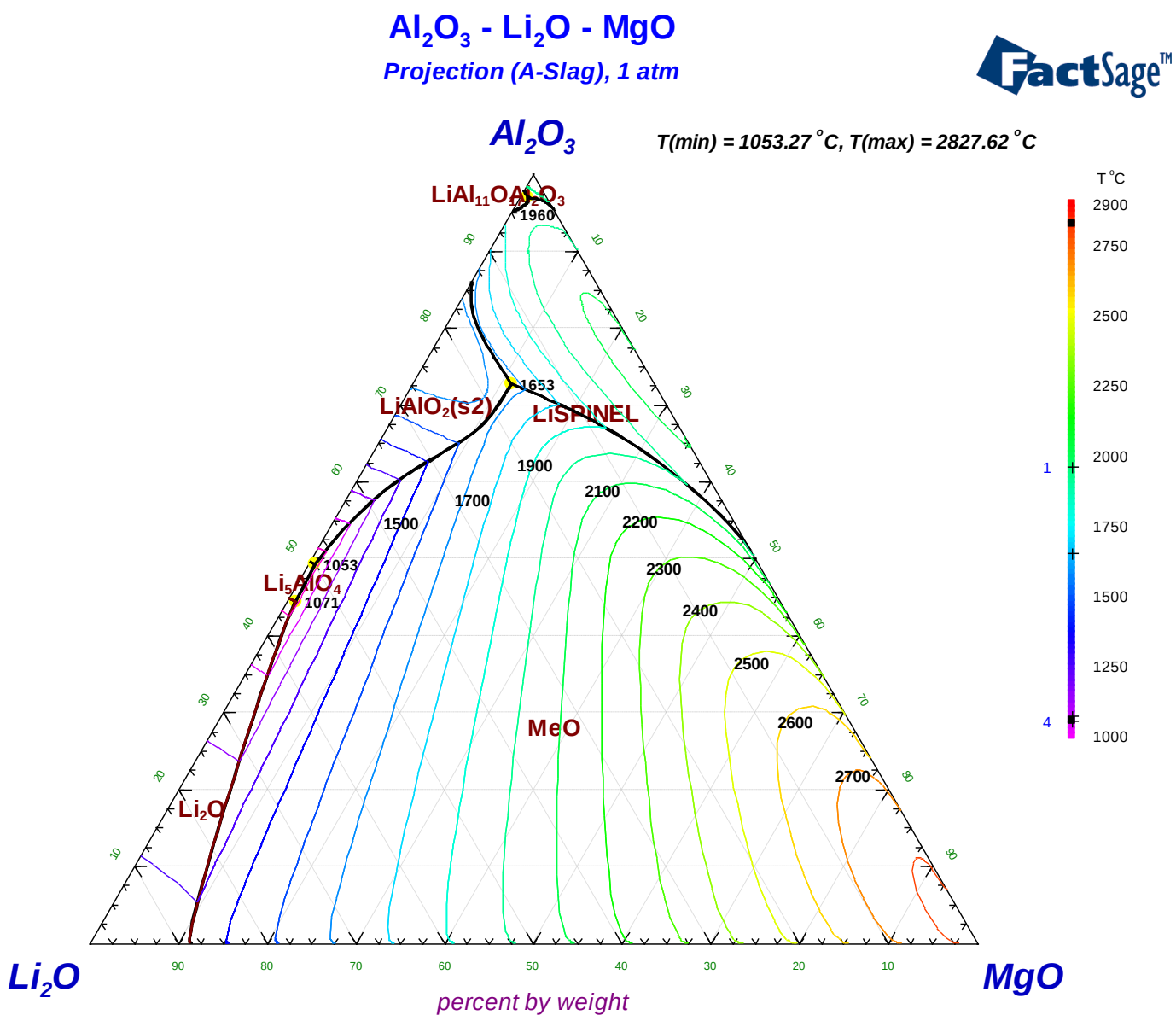



Li2O - Al2O3 - MgO
1400°C, 1 atm
FactSage
Al2O3
SPINEL
LiAlO2(s2)
Li5AlO4
MeO
Li2O
MgO
mole fraction


MgO - LiAlO2
1 atm
FactSage
Slag
[Izquierdo, 1980]
[Doman, McNally, 1973]:
MeO
MeO+LiAlO2
[Menzheres, 1978]
MeO
MeO+LiAlO2
MeO
MeO + Slag
LiAlO2(s2) + MeO + Slag
LiAlO2(s2) + MeO
LiAlO2 + MeO
LiAlO2
LiAlO2
T(C)
3000
2500
2000
1500
1000
500
0
0
0.2
0.4
0.6
0.8
1
LiAlO2/(MgO+LiAlO2) (mol/mol)


MgAl2O4 - LiAl5O8
1 atm
FactSage
SPINEL + Slag
SPINEL
LiAlO2(s2) + SPINEL
LiAlO2(s2) + LiAl5O8 + SPINEL
LiAlO2 + LiAl5O8 + SPINEL
T(C)
2000
1500
1000
500
0
0
0.2
0.4
0.6
0.8
1
LiAl5O8/(MgAl2O4+LiAl5O8) (mol/mol)

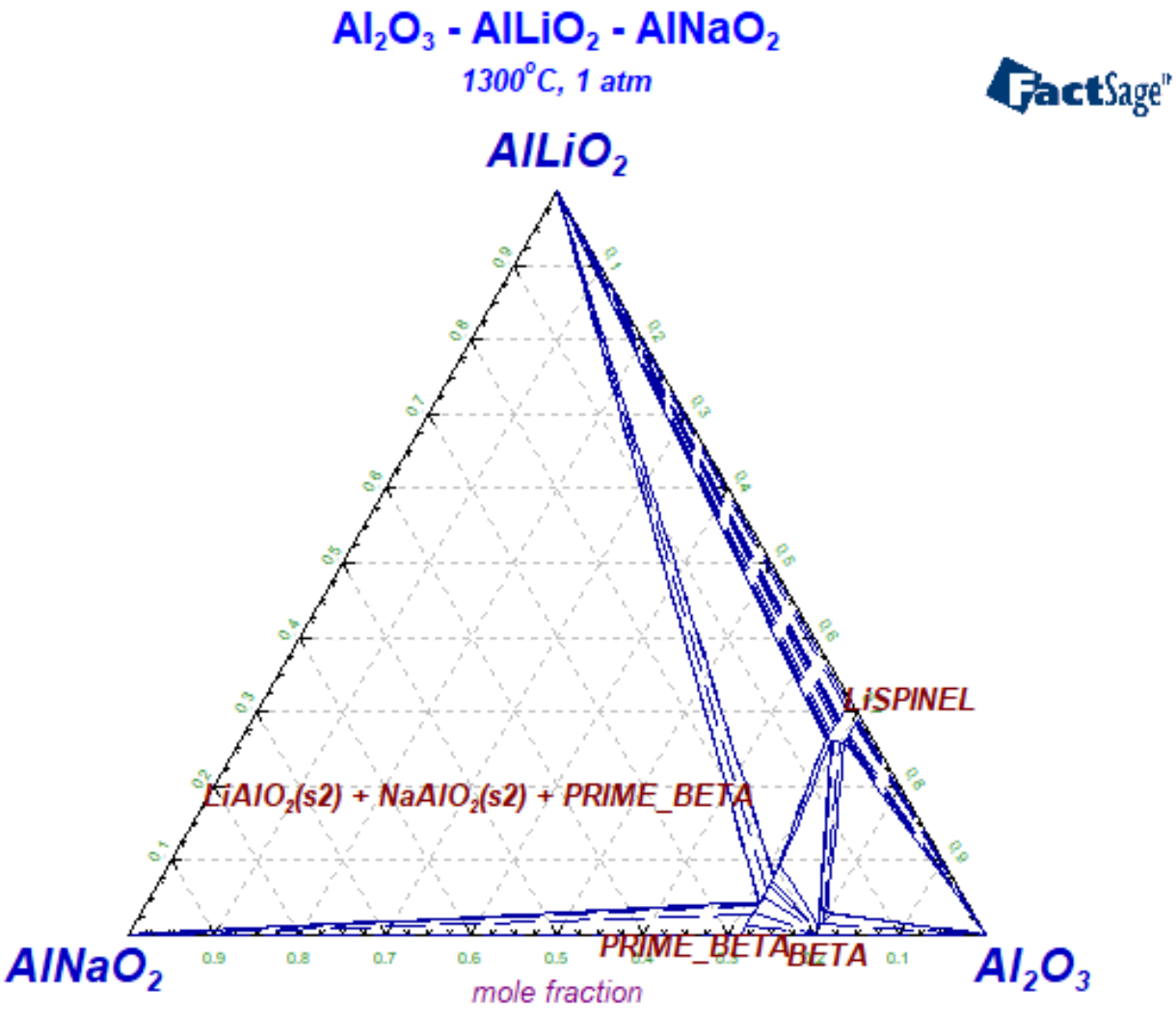

Al2O3 - Li2O - MgO
Projection (A-Slag), 1 atm
FactSage™
Al2O3
T(min) = 1053.27 °C, T(max) = 2827.97 °C
T °C
2900
2750
2500
2250
2000
1750
1500
1250
1000
1
4
Al2O3
LiAl11O17
1960
LiSPINEL
1653
LiAlO2(s2)
1700
1900
2100
2200
2300
2400
2500
2600
2700
1500
1053
Li5AlO4
1071
MeO
Li2O
Li2O
MgO
mole fraction

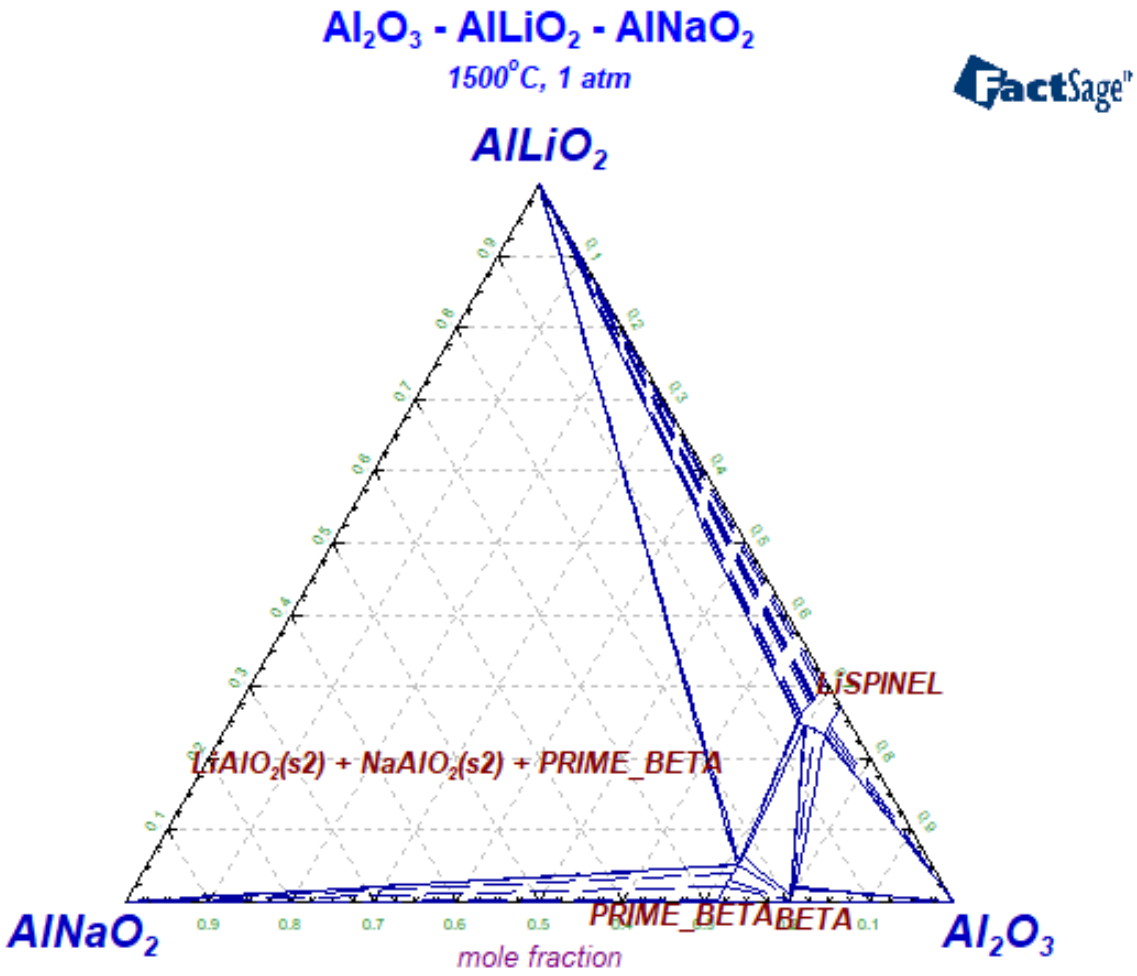

Al2O3 - Li2O - MgO
Projection (A-Slag), 1 atm
FactSage™
Al2O3
T(min) = 1053.27 °C, T(max) = 2827.62 °C
T °C
2900
2750
2500
2250
2000
1750
1500
1250
1000
LiAl11O17Al2O3
1960
1653
LiAlO2(S2)
LiSPINEL
1900
1700
1500
2100
2200
2300
2400
2500
2600
2700
1053
Li5AlO4
1071
MeO
Li2O
Li2O
MgO
percent by weight

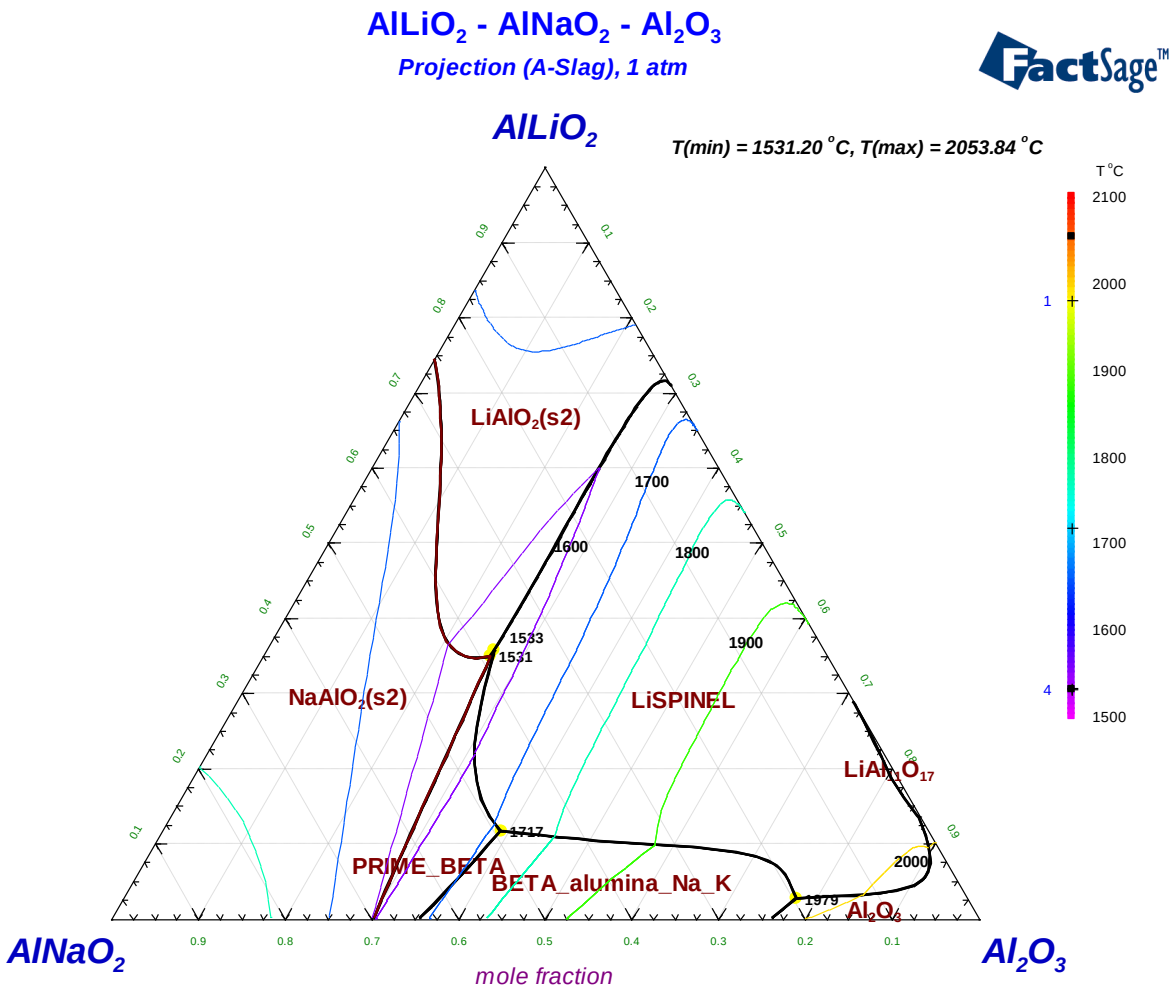
Invariant equilibria on the liquidus surface

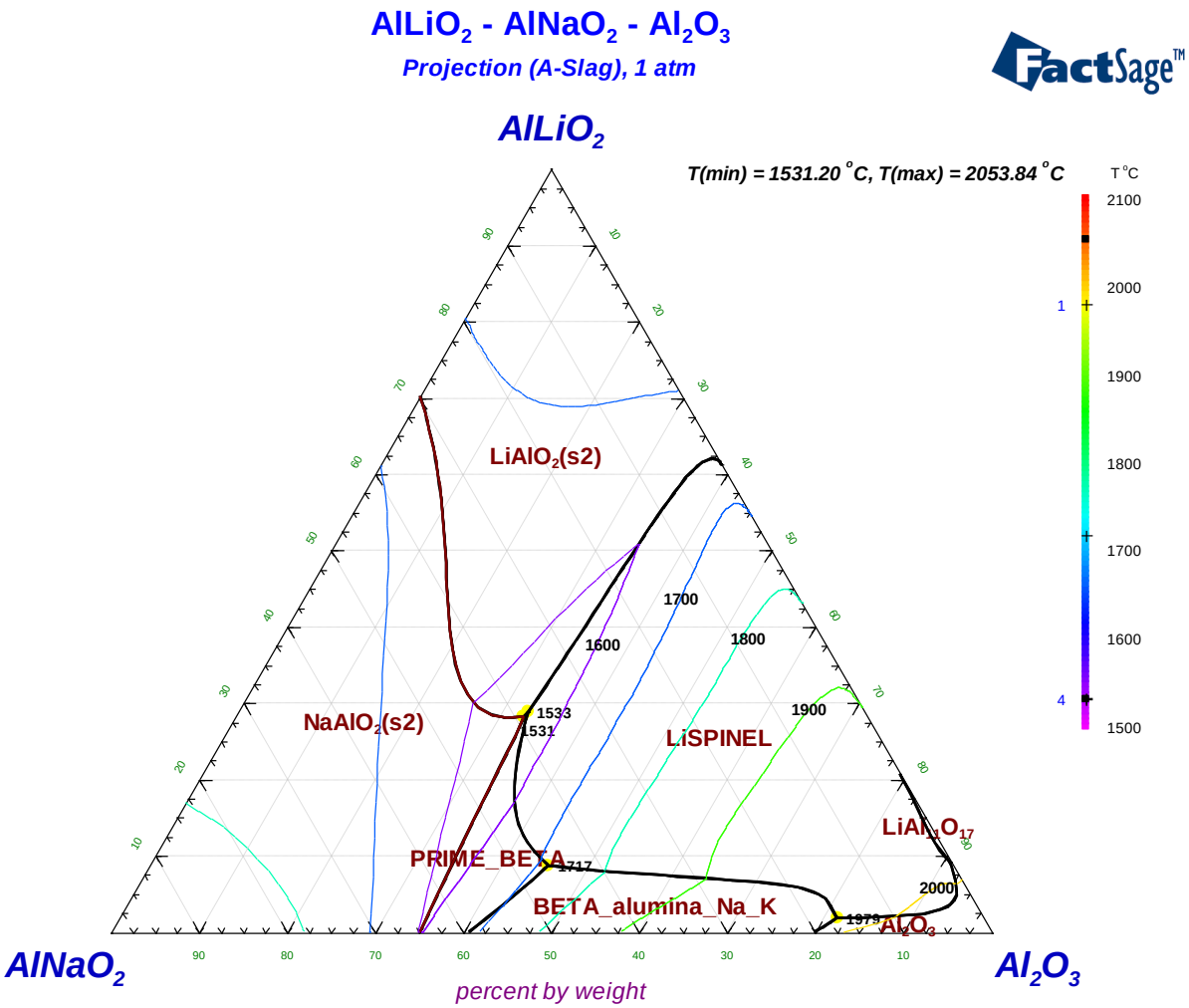
Intersections with slag	Mole fraction				Weight percent			
	A = Al2O3, B = Li2O, C = MgO				A = Al2O3, B = Li2O, C = MgO			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1. Al2O3 / LiAl11O17 / LiSPINEL	0.91110	0.06682	0.02208	1960.47	96.986	2.085	0.929	1960.47
2. LiAlO2(s2) / LiSPINEL / MeO	0.46637	0.35160	0.18204	1652.81	72.715	16.066	11.220	1652.81
3. Li2O / Li5AlO4 / MeO	0.19070	0.79865	0.01065	1071.03	44.455	54.564	0.981	1070.96
4. Li5AlO4 / LiAlO2(s2) / MeO	0.22220	0.76870	0.00911	1053.27	49.259	49.943	0.798	1053.27

Al2O3-Li2O-Na2O,
Mole fraction 1300°C




Al_2O_3 - $AlLiO_2$ - $AlNaO_2$
1500°C, 1 atm
FactSage
$AlLiO_2$
LiSPINEL
$LiAlO_2$(s2) + $NaAlO_2$(s2) + PRIME_BETA
PRIME_BETA
BETA
$AlNaO_2$
Al_2O_3
mole fraction


AlLiO2 - AlNaO2 - Al2O3
Projection (A-Slag), 1 atm
FactSage™
AlLiO2
T(min) = 1531.20 °C, T(max) = 2053.84 °C
T °C
2100
2000
1900
1800
1700
1600
1500
1
4
LiAlO2(s2)
NaAlO2(s2)
LiSPINEL
LiAl5O17
PRIME_BETA
BETA_alumina_Na_K
Al2O3
1700
1600
1800
1900
1533
1531
1717
2000
1979
AlNaO2
Al2O3
mole fraction

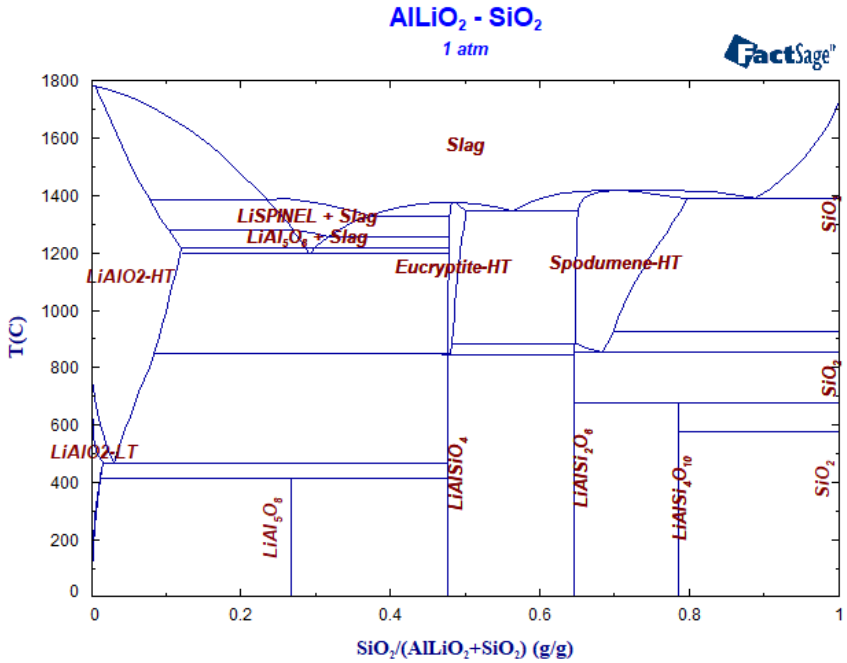

AlLiO2 - AlNaO2 - Al2O3
Projection (A-Slag), 1 atm
FactSage™
AlLiO2
T(min) = 1531.20 °C, T(max) = 2053.84 °C
T °C
2100
2000
1900
1800
1700
1600
1500
LiAlO2(s2)
NaAlO2(s2)
LiSPINEL
PRIME_BETA
BETA_alumina_Na_K
LiAl5O17
Al2O3
1700
1600
1800
1900
1533
1531
1717
2000
1979
AlNaO2
Al2O3
percent by weight

Invariant equilibria on the liquidus surface

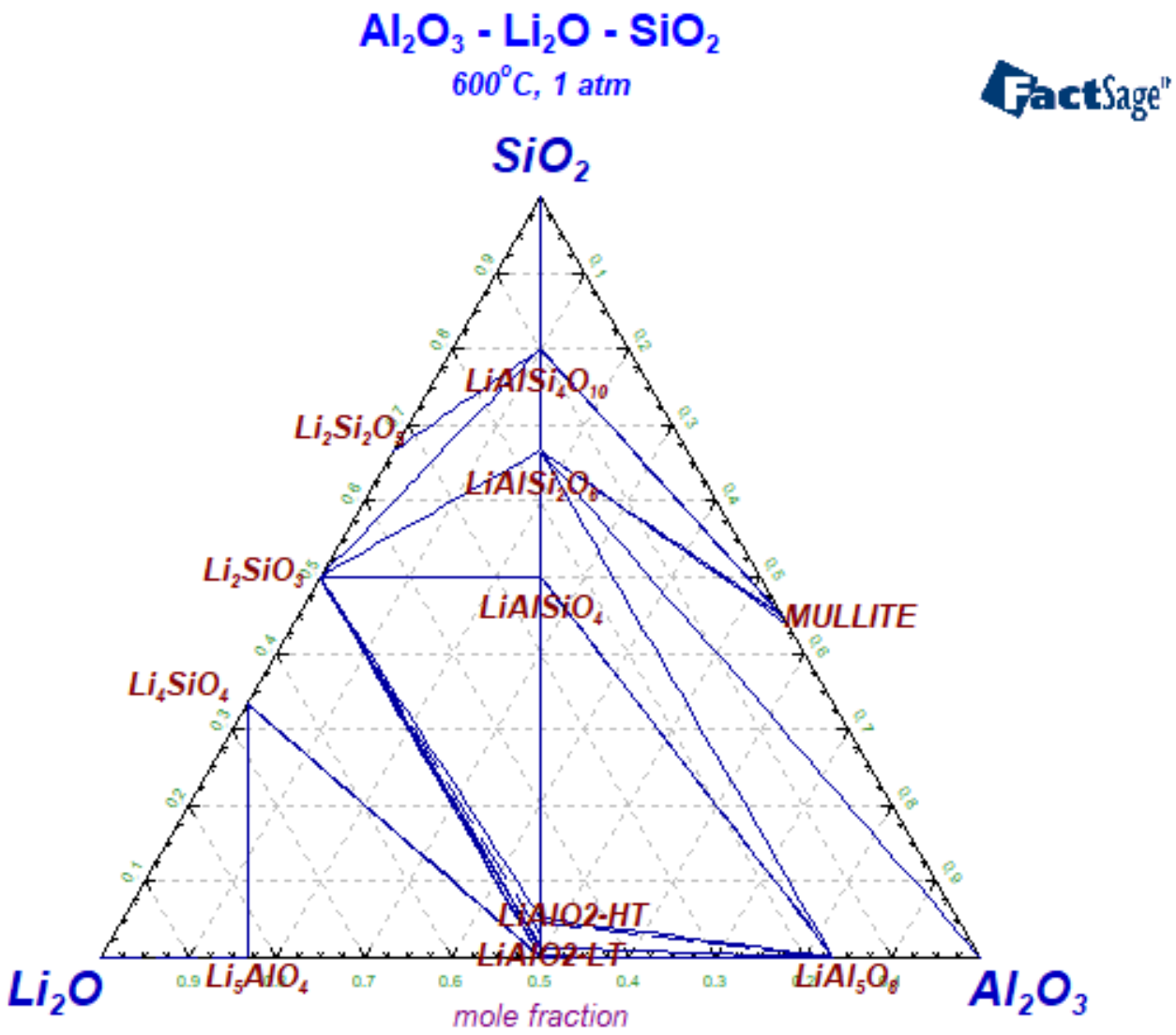
Intersections with slag	Mole fraction				Weight percent			
	A = AlLiO2, B = AlNaO2, C = Al2O3				A = AlLiO2, B = AlNaO2, C = Al2O3			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1. Al2O3 / BETA_alumina / LiSPINEL	0.02727	0.19648	0.77625	1979.36	1.852	16.595	81.553	1979.36
2. BETA_alumina / LiSPINEL / PRIME_BETA	0.11678	0.49239	0.39083	1717.06	8.757	45.913	45.330	1717.06
3. LiAlO2(s2) / LiSPINEL / PRIME_BETA	0.35697	0.38007	0.26296	1532.80	28.874	38.227	32.898	1532.79
4. LiAlO2(s2) / NaAlO2(s2) / PRIME_BETA	0.34938	0.38824	0.26238	1531.21	28.222	38.996	32.782	1531.20

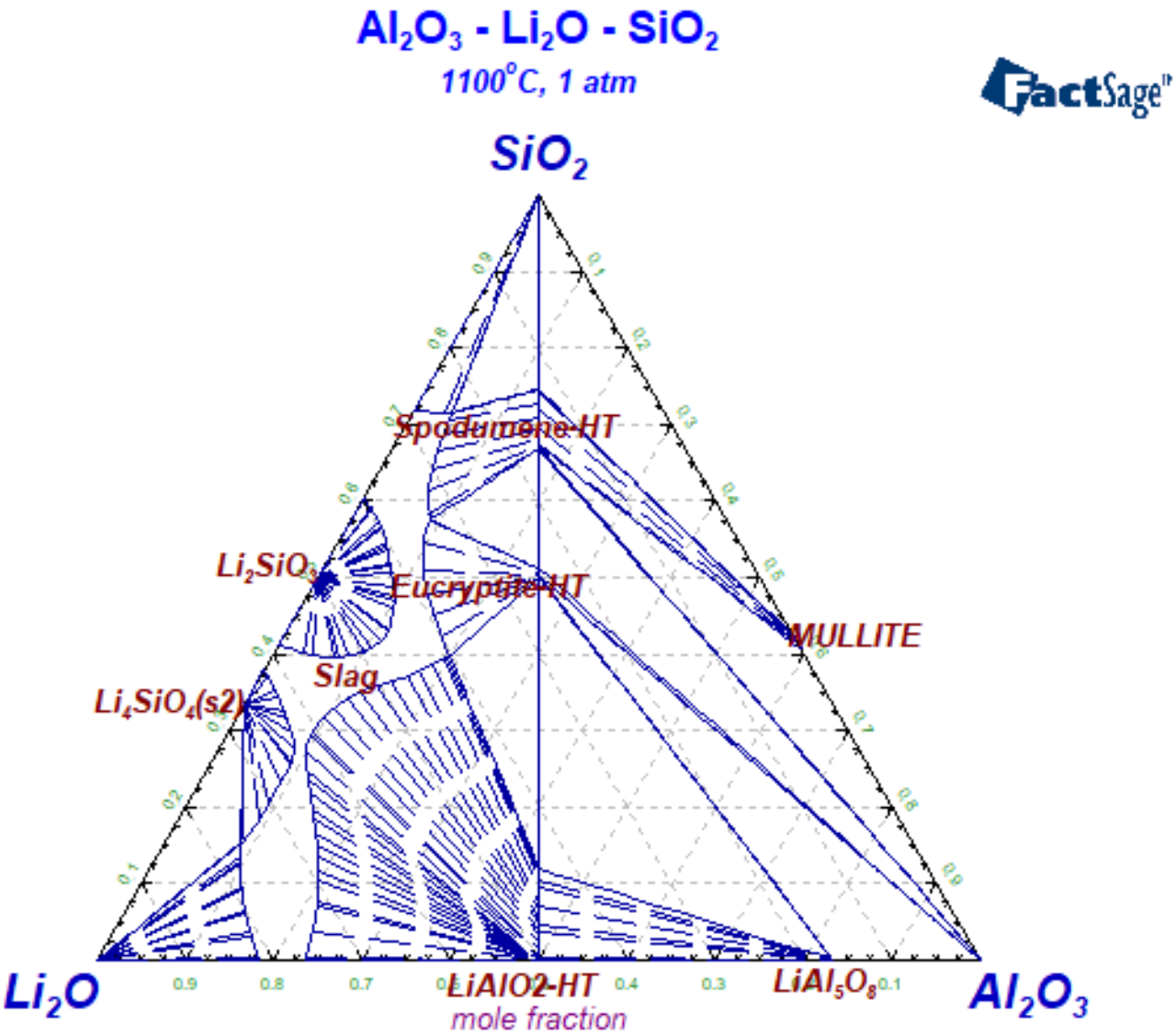
Al2O3-Li2O-SiO2,
Weight fraction, AlLiO2-SiO2

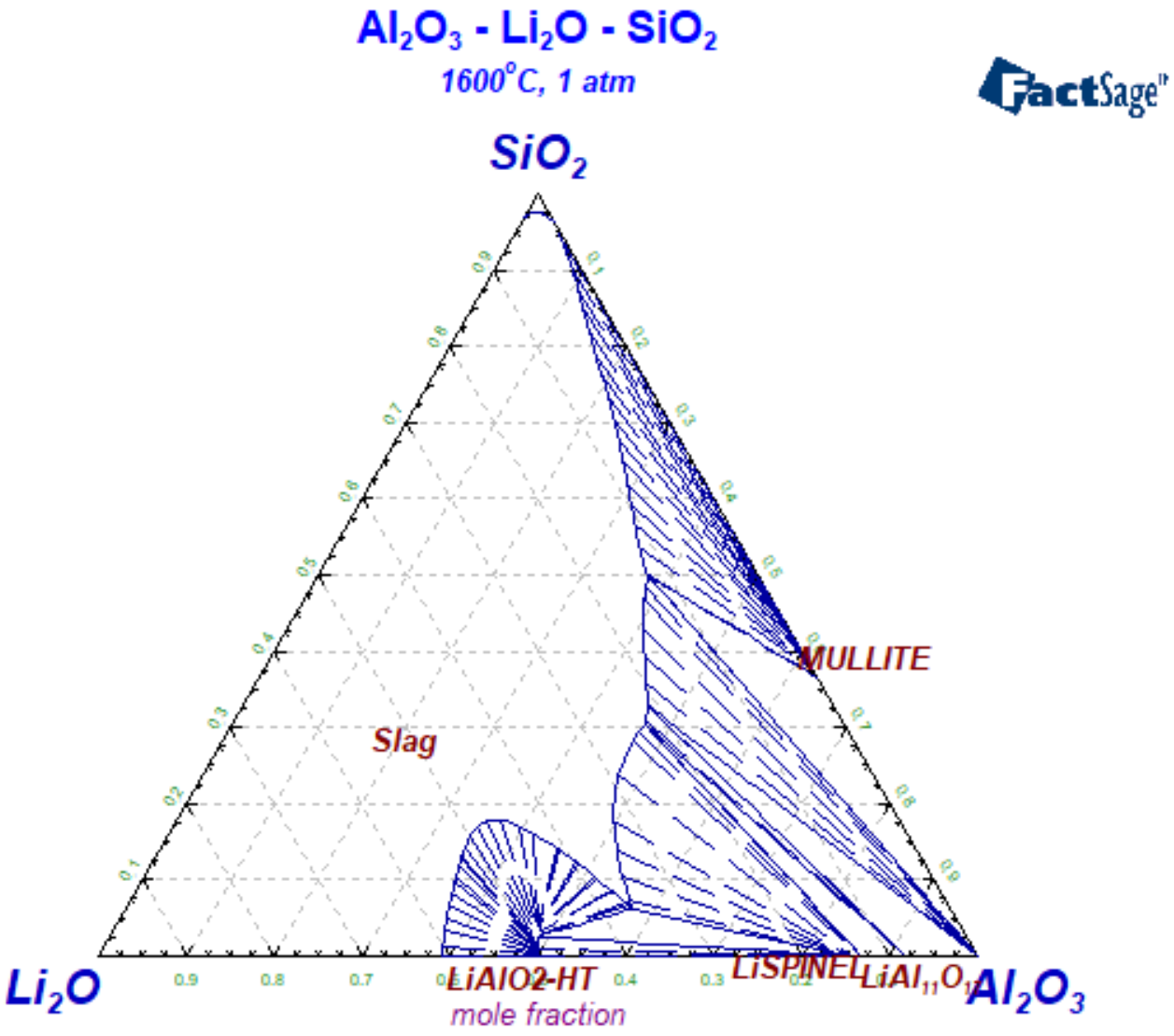
**** The data [2018Konar] were slightly changed according to assessed before binary systems.***

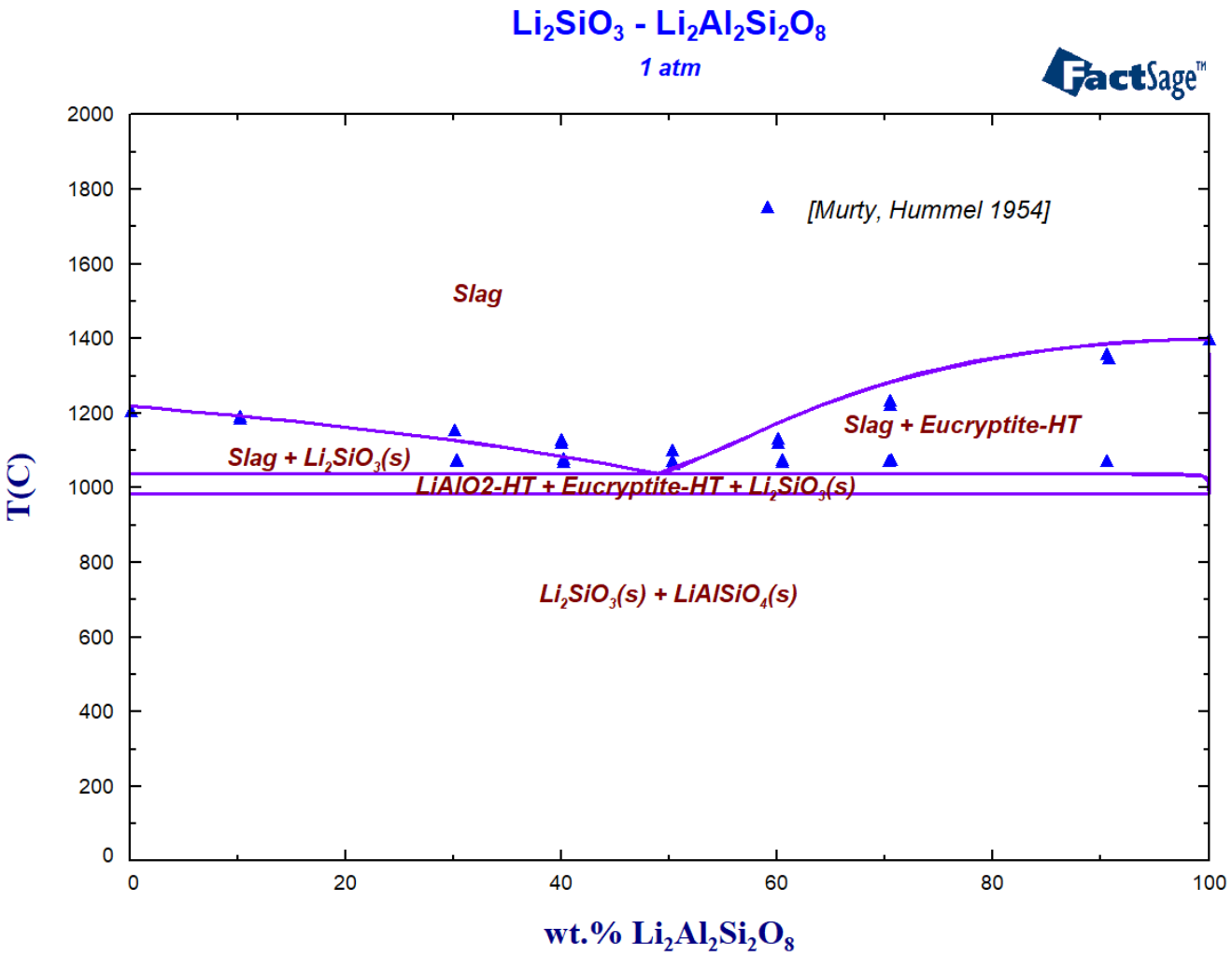


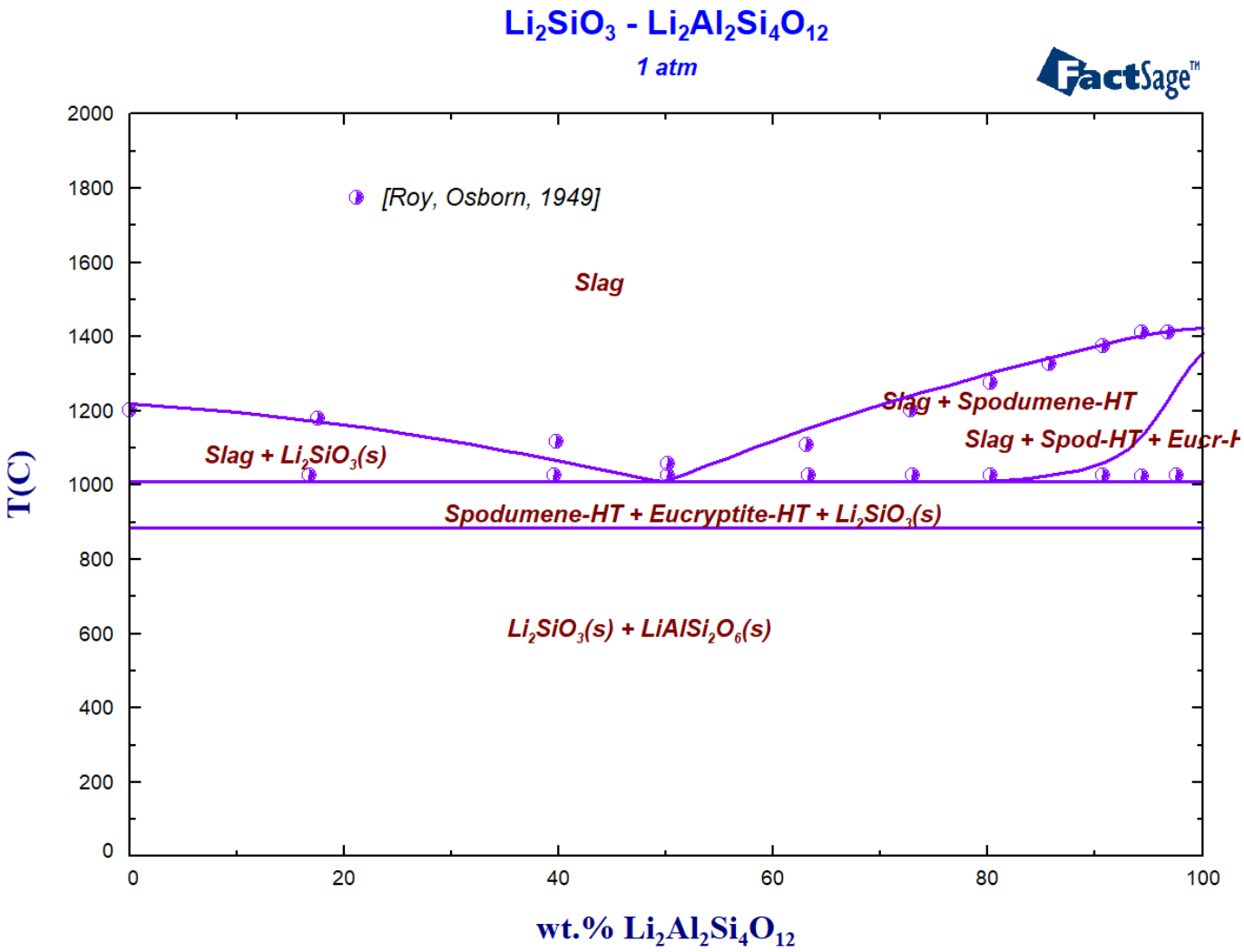
Slag	(Al_2O_3, Li_2O, SiO_2, Li_2SiO_3, Li_2SiO_3, $LiAlO_2$, $Li_2Si_2O_5$, $LiAlSiO_4$, $LiAl_2Si_2O_6$)	GTT
$LiAlO_2$-HT	(Li, Va)(Al, Si)$(O)_2$	[2018Konar]*
$LiAlO_2$-LT	(LiAl, Si)$(O)_2$	[2018Konar]*
Eucryptite-HT	(LiAl, Si)(Si)$(O)_4$	[2018Konar]*
Spodumene-HT	(LiAl, Si)$(Si)_2(O)_6$	[2018Konar]*
LiAlSiO4(s1)	stoichiometric	[2018Konar]*
$LiAlSi_2O_6$(s1)	stoichiometric	[2018Konar]*
$LiAlSi_4O_{10}$	stoichiometric	[2018Konar]*

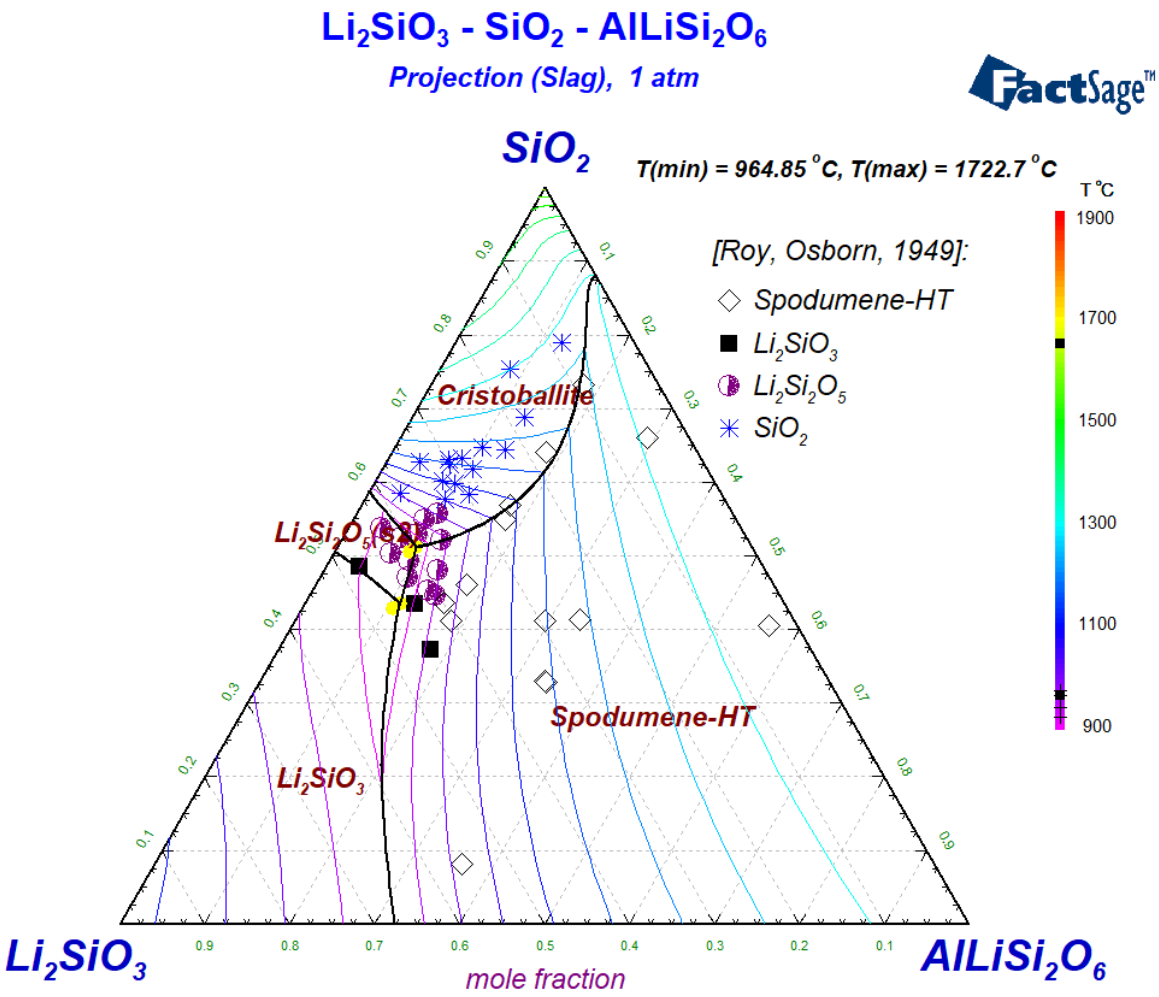

Al2O3 - Li2O - SiO2
600°C, 1 atm
FactSage
SiO2
LiAlSi4O10
Li2Si2O5
LiAlSi2O6
Li2SiO3
LiAlSiO4
MULLITE
Li4SiO4
LiAlO2-HT
LiAlO2-LT
Li2O
Li5AlO4
LiAl5O8
Al2O3
mole fraction


Al_2O_3 - Li_2O - SiO_2
1100°C, 1 atm
FactSage
SiO_2
Spodumene-HT
Li_2SiO_3
Eucryptite-HT
MULLITE
Slag
Li_4SiO_4(s2)
Li_2O
LiAlO2-HT
$LiAl_5O_8$
Al_2O_3
mole fraction

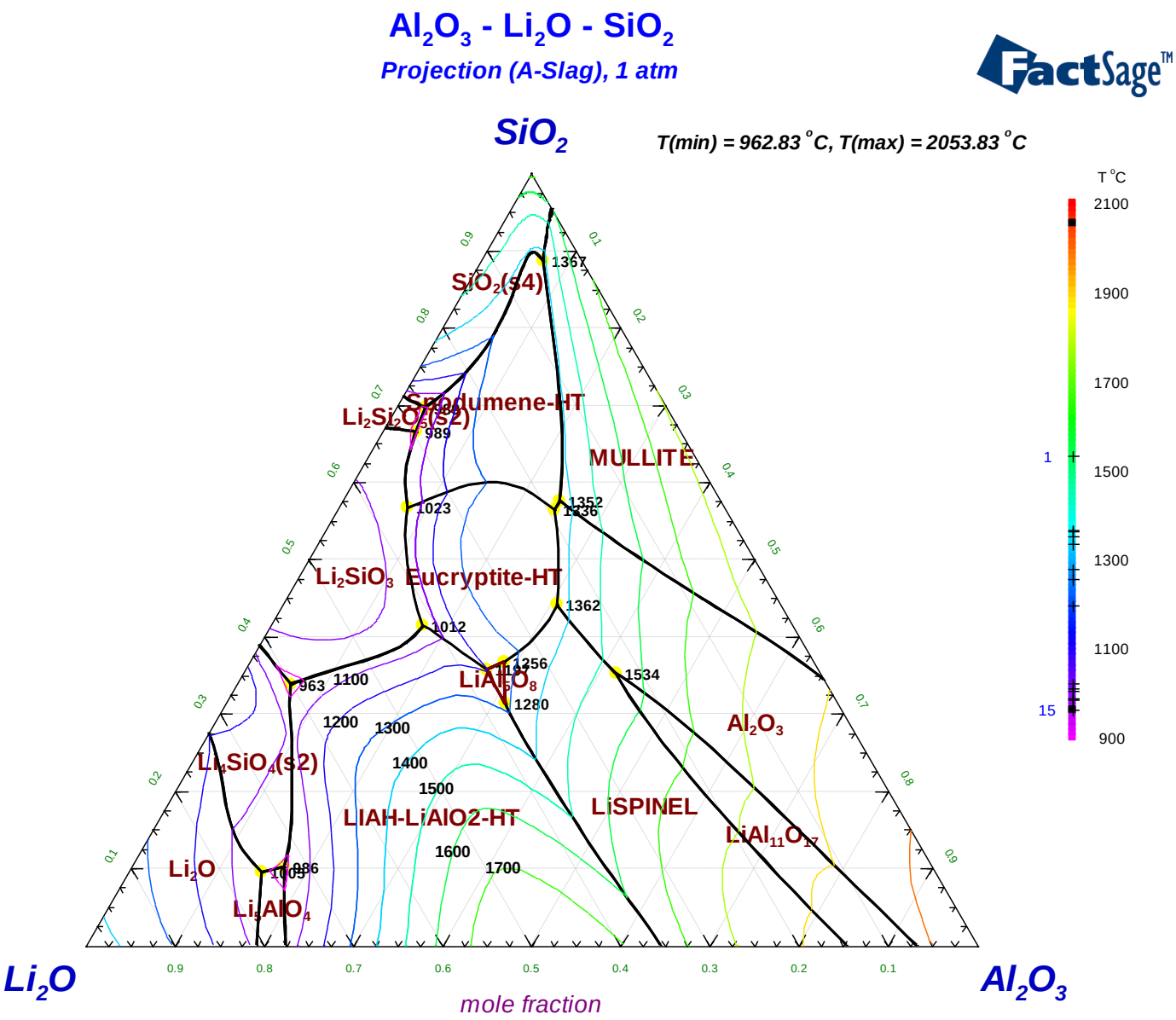

Al_2O_3 - Li_2O - SiO_2
1600°C, 1 atm
FactSage
SiO_2
MULLITE
Slag
Li_2O
LiAlO2-HT
LiSPINEL
$LiAl_{11}O_{17}$
Al_2O_3
mole fraction

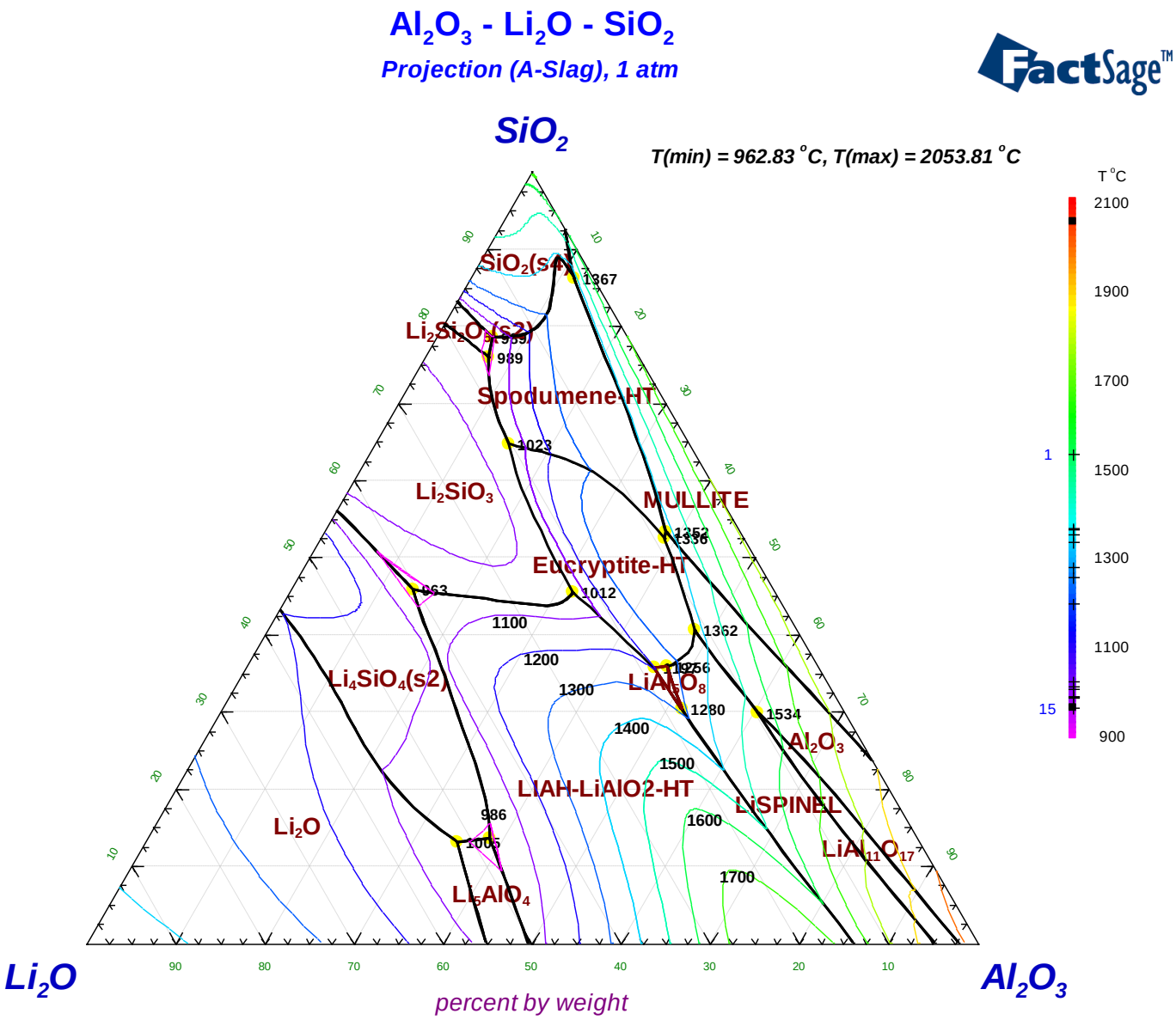

Li2SiO3 - Li2Al2Si2O8
1 atm
FactSage™
[Murty, Hummel 1954]
Slag
Slag + Eucryptite-HT
Slag + Li2SiO3(s)
LiAlO2-HT + Eucryptite-HT + Li2SiO3(s)
Li2SiO3(s) + LiAlSiO4(s)
T(C)
wt.% Li2Al2Si2O8
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
20
40
60
80
100


Li2SiO3 - Li2Al2Si4O12
1 atm
FactSage™
[Roy, Osborn, 1949]
Slag
Slag + Spodumene-HT
Slag + Spod-HT + Eucr-H
Slag + Li2SiO3(s)
Spodumene-HT + Eucryptite-HT + Li2SiO3(s)
Li2SiO3(s) + LiAlSi2O6(s)
T(C)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
20
40
60
80
100
wt.% Li2Al2Si4O12


Li2SiO3 - SiO2 - AlLiSi2O6
Projection (Slag), 1 atm
FactSage
SiO2
T(min) = 964.85 °C, T(max) = 1722.7 °C
T °C
1900
1700
1500
1300
1100
900
[Roy, Osborn, 1949]:
Spodumene-HT
Li2SiO3
Li2Si2O5
SiO2
Cristoballite
Li2Si2O5(s2)
Spodumene-HT
Li2SiO3
Li2SiO3
AlLiSi2O6
mole fraction

Al2O3-Li2O-SiO2,
Mole fraction, Liquidussurface

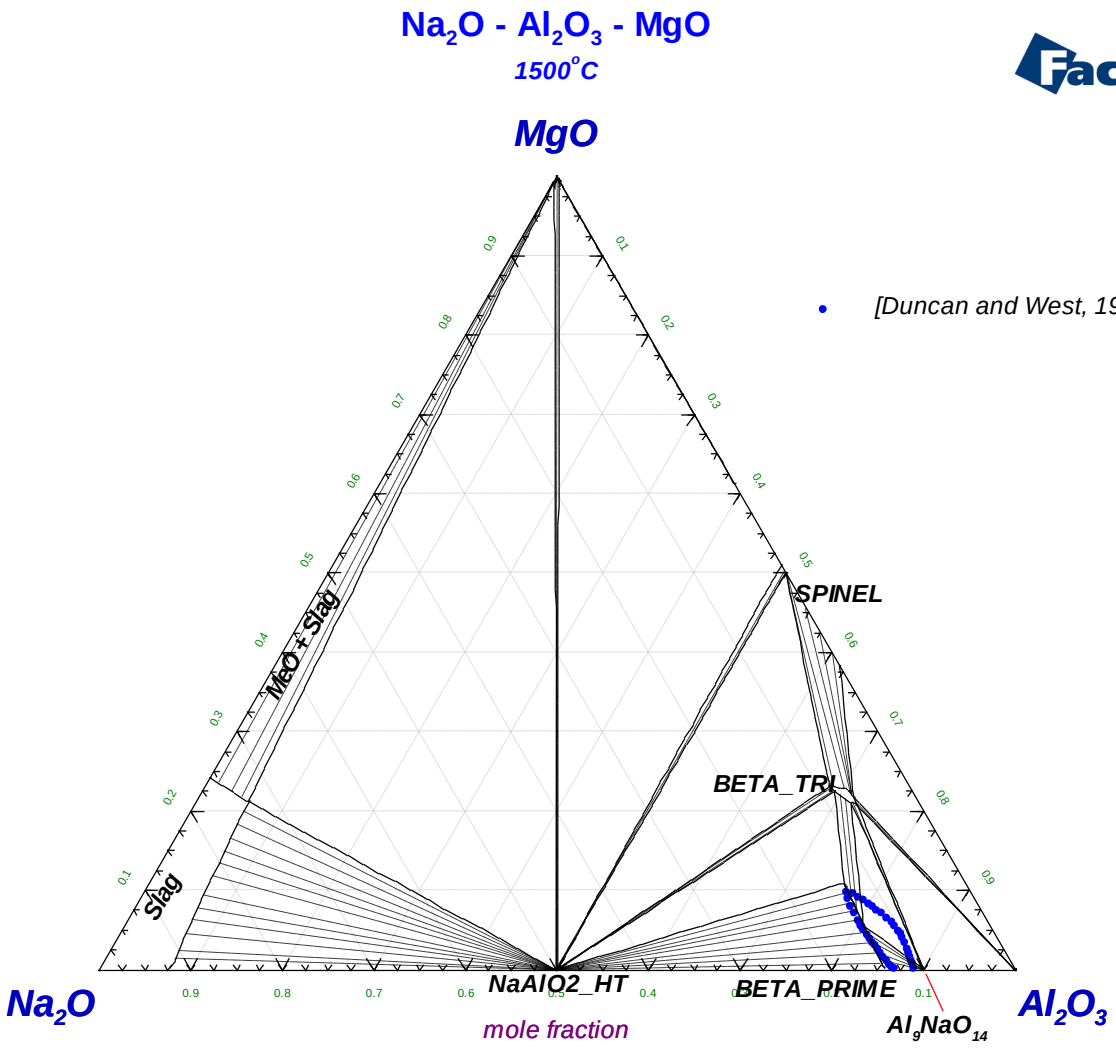



Al2O3 - Li2O - SiO2
Projection (A-Slag), 1 atm
FactSage™
SiO2
T(min) = 962.83 °C, T(max) = 2053.81 °C
T °C
2100
1900
1700
1500
1300
1100
900
1
15
SiO2(s4)
1367
Li2Si2O5(s2)
989
Spodumene-HT
1023
Li2SiO3
MULLITE
1352
1336
Eucryptite-HT
1012
1100
1362
1200
1300
Li4SiO4(s2)
LiAl5O8
1280
1534
1400
Al2O3
1500
LIAH-LiAlO2-HT
LiSPINEL
1600
Li2O
986
1005
LiAl11O17
1700
Li5AlO4
Li2O
Al2O3
percent by weight

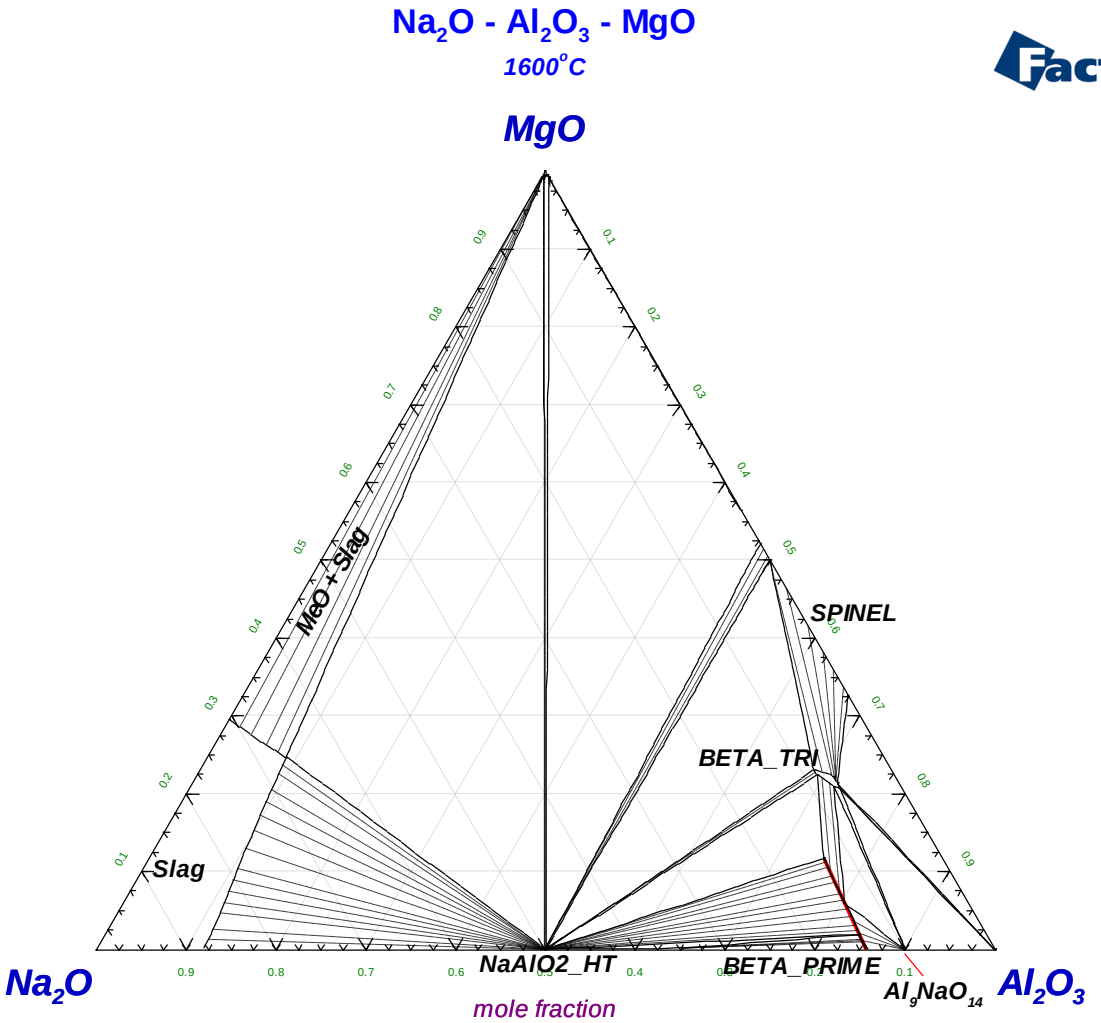
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction A = SiO2, B = Li2O, C = Al2O3				Weight percent A = SiO2, B = Li2O, C = Al2O3			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1. Al2O3 / LiAl11O17 / LiSPINEL	0.35255	0.22901	0.41844	1533.68	29.966	9.680	60.354	1533.67
2. MULLITE / SiO2(s4) / Spodumene-HT	0.88609	0.04392	0.06999	1366.66	86.305	2.128	11.568	1366.66
3. Al2O3 / Eucryptite-HT / LiSPINEL	0.44205	0.25016	0.30779	1362.31	40.601	11.427	47.973	1362.31
4. Al2O3 / MULLITE / Spodumene-HT	0.57610	0.17972	0.24418	1351.53	53.350	8.277	38.373	1351.53
5. Al2O3 / Eucryptite-HT / Spodumene-HT	0.56419	0.19164	0.24418	1335.79	52.538	8.875	38.587	1335.79
6. LiAlO2-HT / LiAl5O8(s) / LiSPINEL	0.31315	0.37295	0.31389	1279.76	30.365	17.985	51.650	1279.76
7. Eucryptite-HT / LiAl5O8 / LiSPINEL	0.36721	0.34722	0.28557	1256.12	35.843	16.855	47.302	1256.13
8. Eucryptite-HT / LiAlO2-HT / LiAl5O8	0.35770	0.37128	0.27102	1197.46	35.689	18.423	45.888	1197.45
9. Eucryptite-HT / Li2SiO3/ Spodumene-HT	0.56708	0.35525	0.07767	1023.32	64.768	20.178	15.054	1023.32
10.Eucryptite-HT / LiAlO2-HT / Li2SiO3	0.41421	0.41513	0.17065	1012.18	45.505	22.681	31.815	1012.18
11.Li2O / Li4SiO4(s2) / Li5AlO4	0.09521	0.75527	0.14953	1004.85	13.140	51.840	35.020	1004.84
12.Li2Si2O5(s2) / Li2SiO3 / Spodumene-HT	0.66588	0.29689	0.03723	989.33	75.952	16.841	7.207	989.33
13.Li2Si2O5(s2) / SiO2(s4)/ Spodumene-HT	0.69699	0.27026	0.03275	988.94	78.581	15.153	6.266	988.90
14.LiAlO2-HT / Li4SiO4(s2) / Li5AlO4	0.10209	0.72692	0.17099	986.08	13.544	47.961	38.495	986.07
15.LiAlO2-HT / Li2SiO3 / Li4SiO4(s2)	0.33873	0.60101	0.06026	963.01	45.781	40.398	13.821	962.83

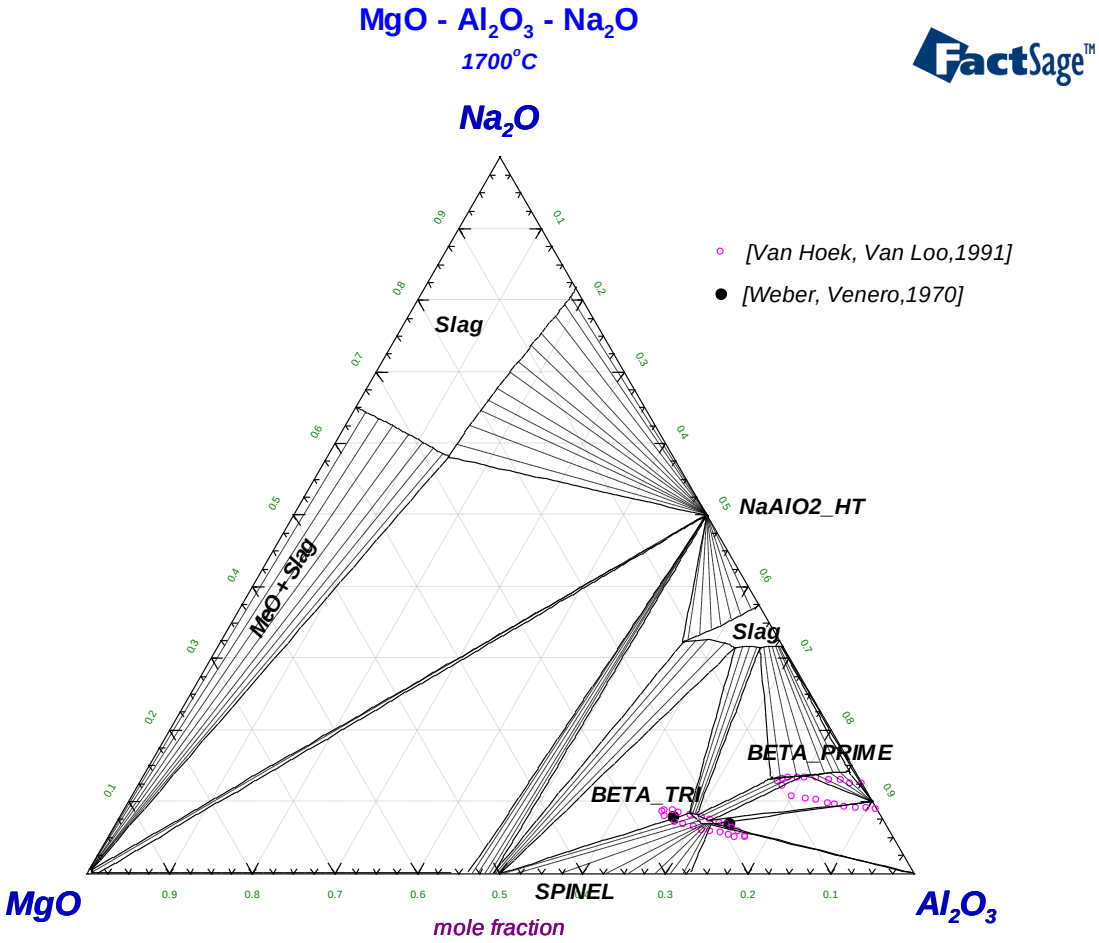
Al2O3-MgO-Na2O,
Mole fraction 1500C°

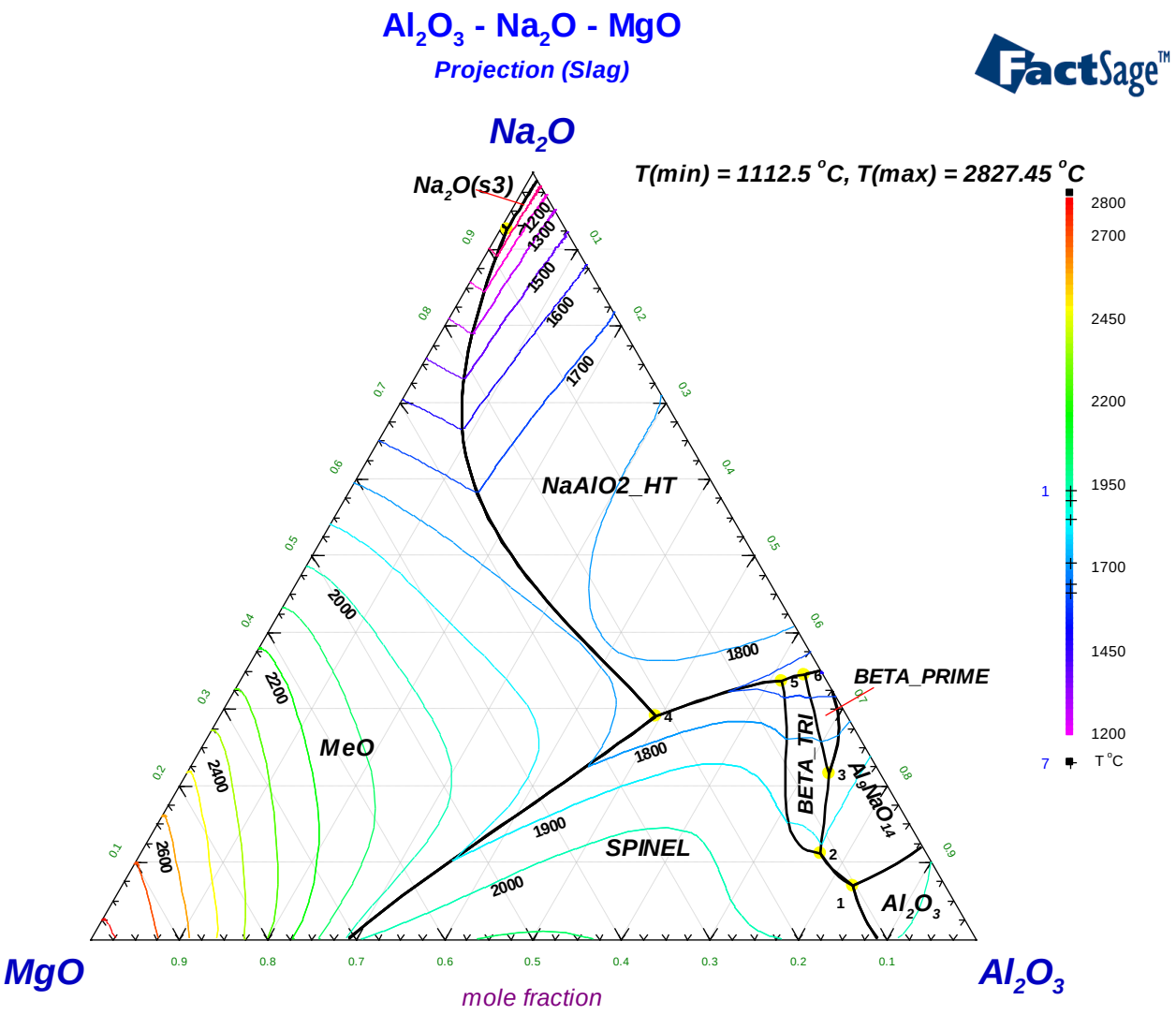


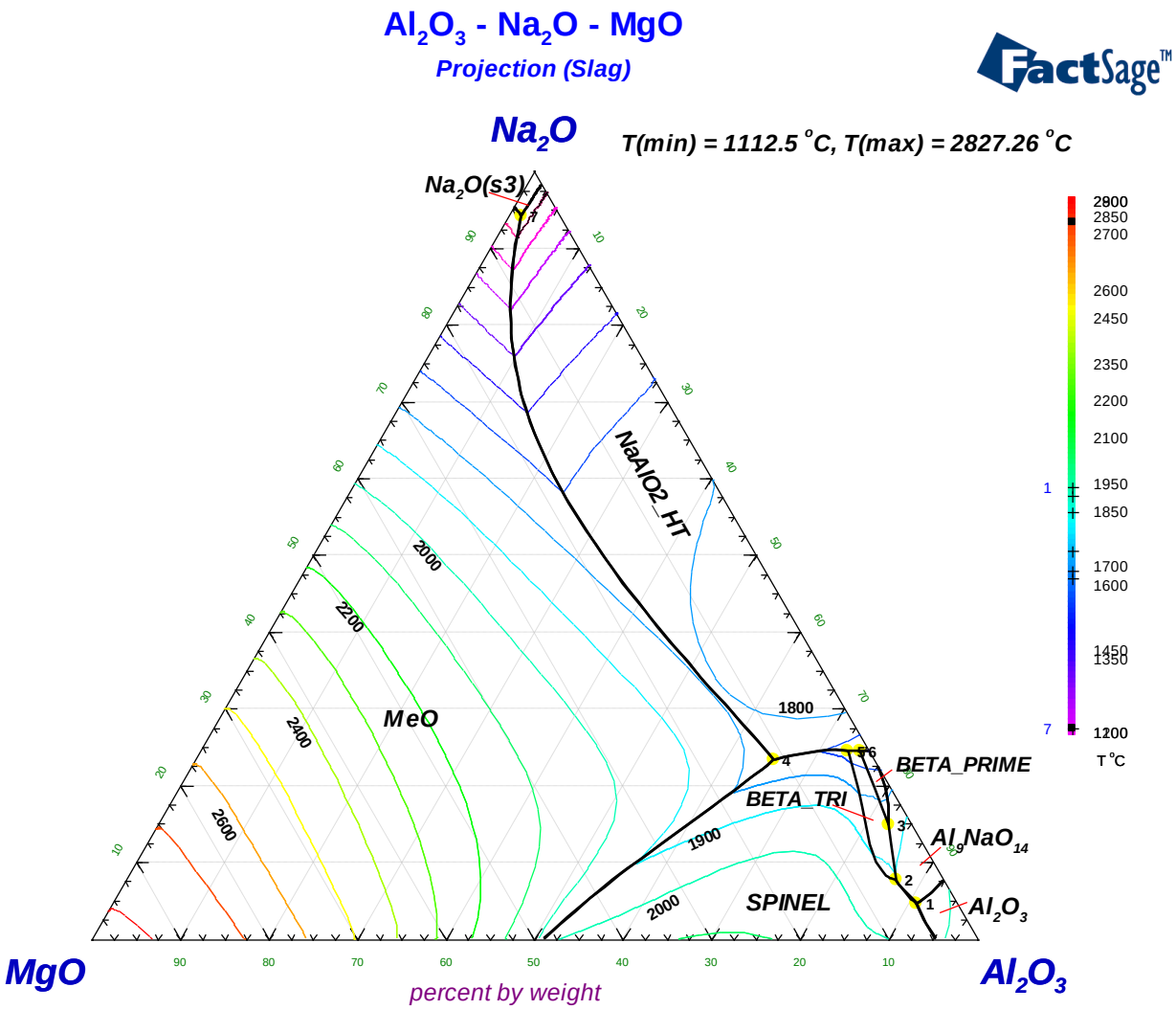
- *[Duncan and West, 1988]*


Na2O - Al2O3 - MgO
1600°C
MgO
MgO + Slag
SPINEL
BETA_TRI
Slag
NaAlO2_HT
BETA_PRIME
Al9NaO14
Na2O
Al2O3
mole fraction

Mole fraction
compared with experimental data



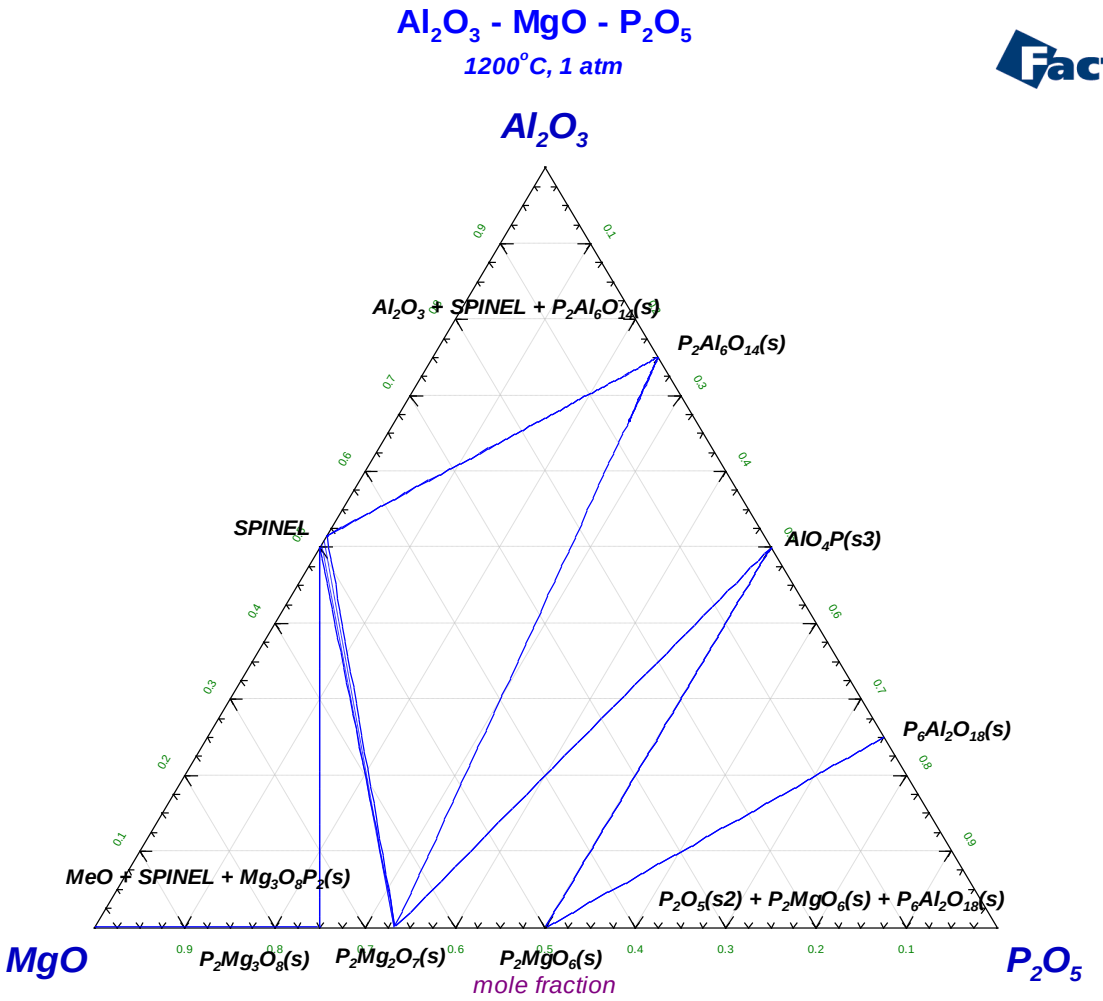

Al2O3 - Na2O - MgO
Projection (Slag)
Na2O
T(min) = 1112.5 °C, T(max) = 2827.45 °C
Na2O(s3)
NaAlO2_HT
MeO
SPINEL
BETA_PRIME
BETA_TRI
Al9NaO14
Al2O3
MgO
Al2O3
mole fraction
T °C

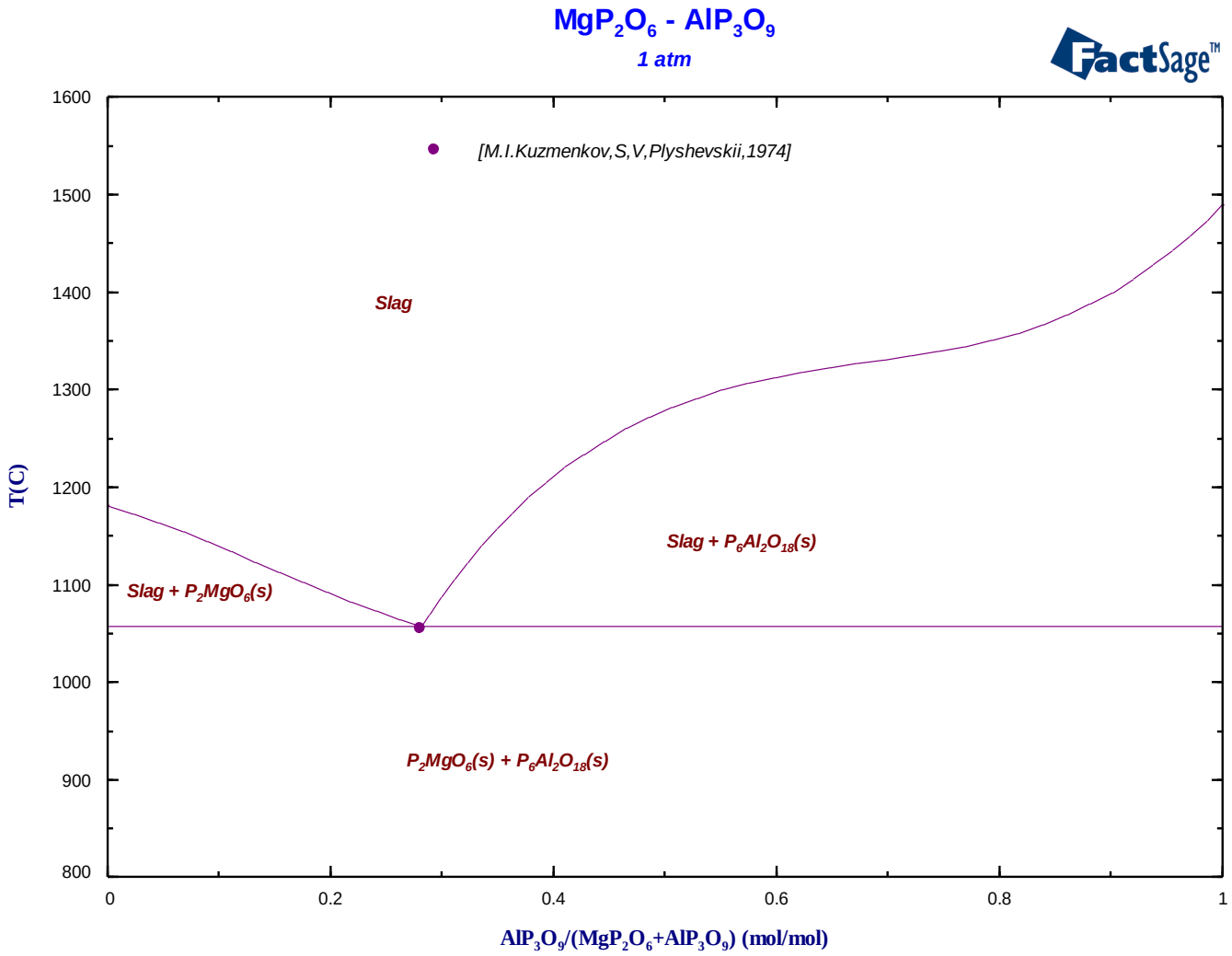

Al_2O_3 - Na_2O - MgO
Projection (Slag)
FactSage™
Na_2O
T(min) = 1112.5 °C, T(max) = 2827.26 °C
$Na_2O(s3)$
NaAlO2_HT
MeO
BETA_PRIME
BETA_TRI
Al_9NaO_{14}
Al_2O_3
SPINEL
2000
2200
2400
2600
1800
1900
2000
2900
2850
2700
2600
2450
2350
2200
2100
1950
1850
1700
1600
1450
1350
1200
T °C
MgO
Al_2O_3
percent by weight

Invariant equilibria on the liquidus surface

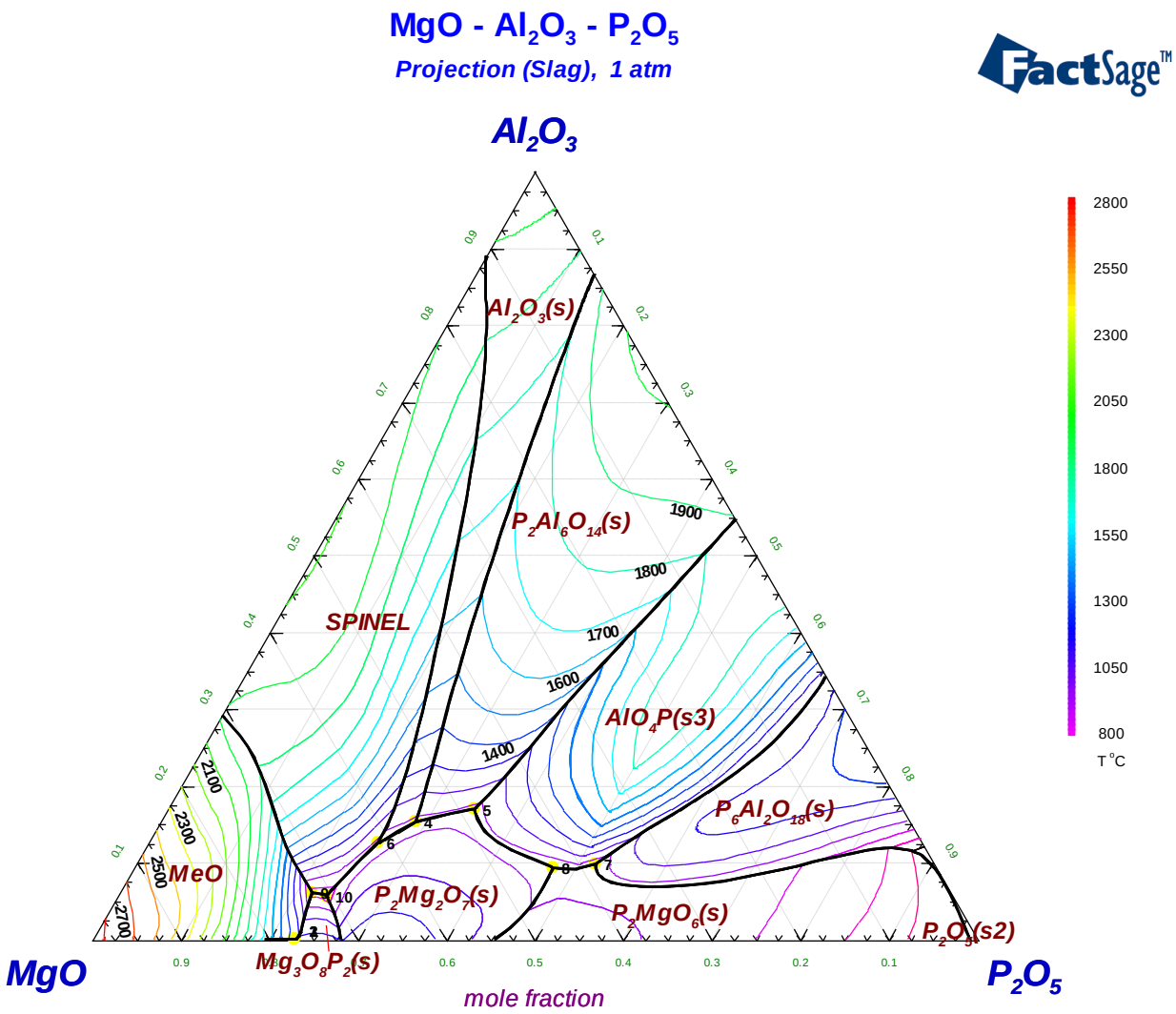
Intersections with slag	Mole fraction					Weight percent				
	A = Na2O, B = MgO, C = Al2O3					A = Na2O, B = MgO, C = Al2O3				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: Al2O3 / Al9NaO14 / SPINEL	1:	0.06955	0.10358	0.82687	1929.66	1:	4.646	4.499	90.856	1929.65
2: Al9NaO14 / BETA_TRI / SPINEL	2:	0.11216	0.11863	0.76921	1902.44	2:	7.710	5.303	86.987	1902.42
3: Al9NaO14 / BETA_PRIME / BETA_TRI	3:	0.21624	0.05686	0.72690	1845.13	3:	14.923	2.552	82.525	1845.12
4: NaAlO2_HT / MeO / SPINEL	4:	0.29019	0.21570	0.49411	1714.47	4:	23.340	11.282	65.378	1714.47
5: NaAlO2_HT / BETA_TRI / SPINEL	5:	0.33676	0.04998	0.61327	1648.37	5:	24.436	2.358	73.206	1648.40
6: NaAlO2_HT / BETA_PRIME / BETA_TRI	6:	0.34459	0.02010	0.63531	1623.05	6:	24.564	0.932	74.504	1623.08
7: NaAlO2_HT / MeO / Na2O(s3)	7:	0.92649	0.06510	0.00841	1112.50	7:	94.284	4.308	1.408	1112.50

Al2O3-MgO-P2O5,
Mole fraction 1200°C

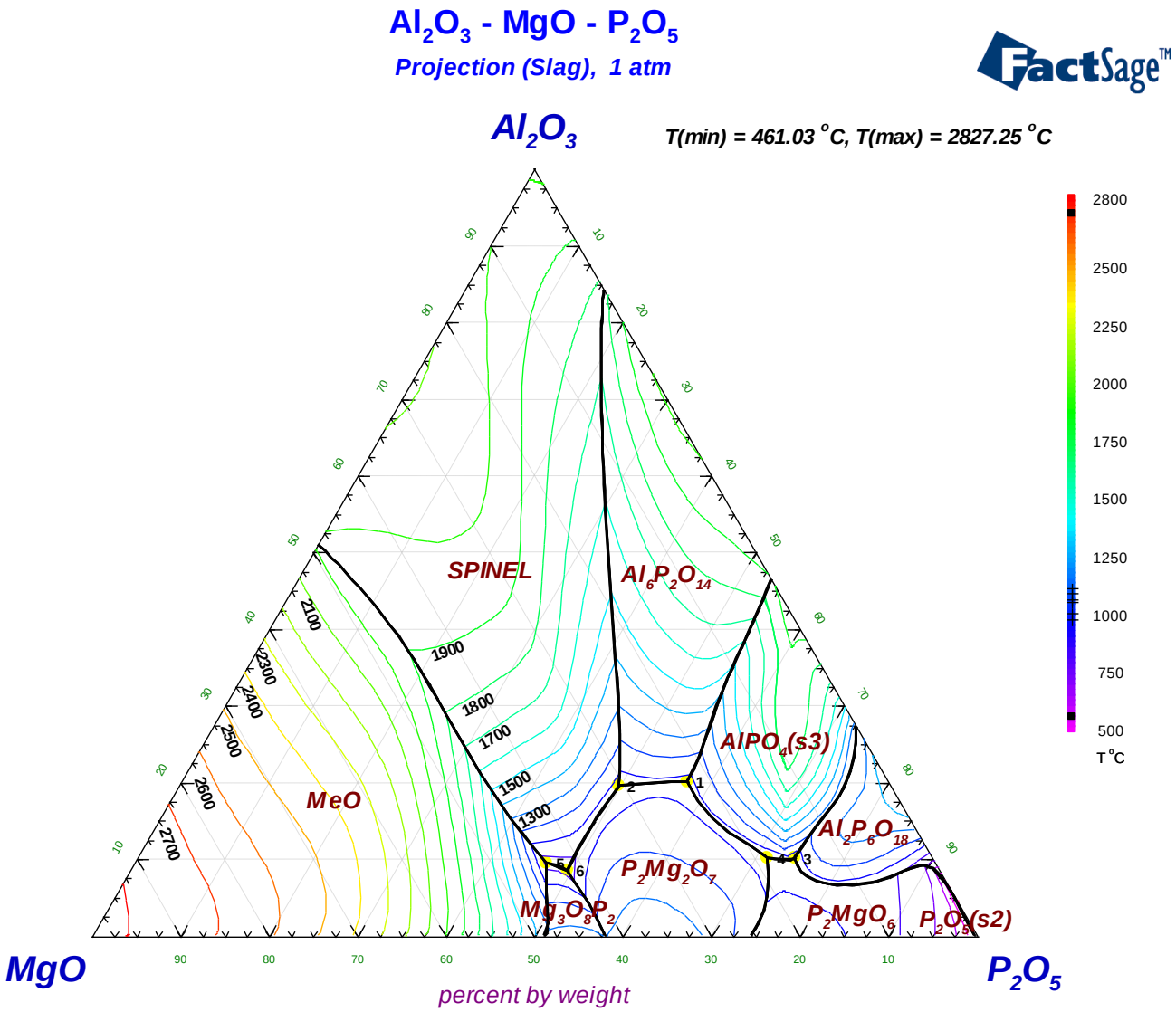



MgP2O6 - AlP3O9
1 atm
FactSage™
[M.I.Kuzmenkov,S,V,Plyshevskii,1974]
Slag
Slag + P6Al2O18(s)
Slag + P2MgO6(s)
P2MgO6(s) + P6Al2O18(s)
T(C)
1600
1500
1400
1300
1200
1100
1000
900
800
0
0.2
0.4
0.6
0.8
1
AlP3O9/(MgP2O6+AlP3O9) (mol/mol)

Mole fraction, Liquidussurface



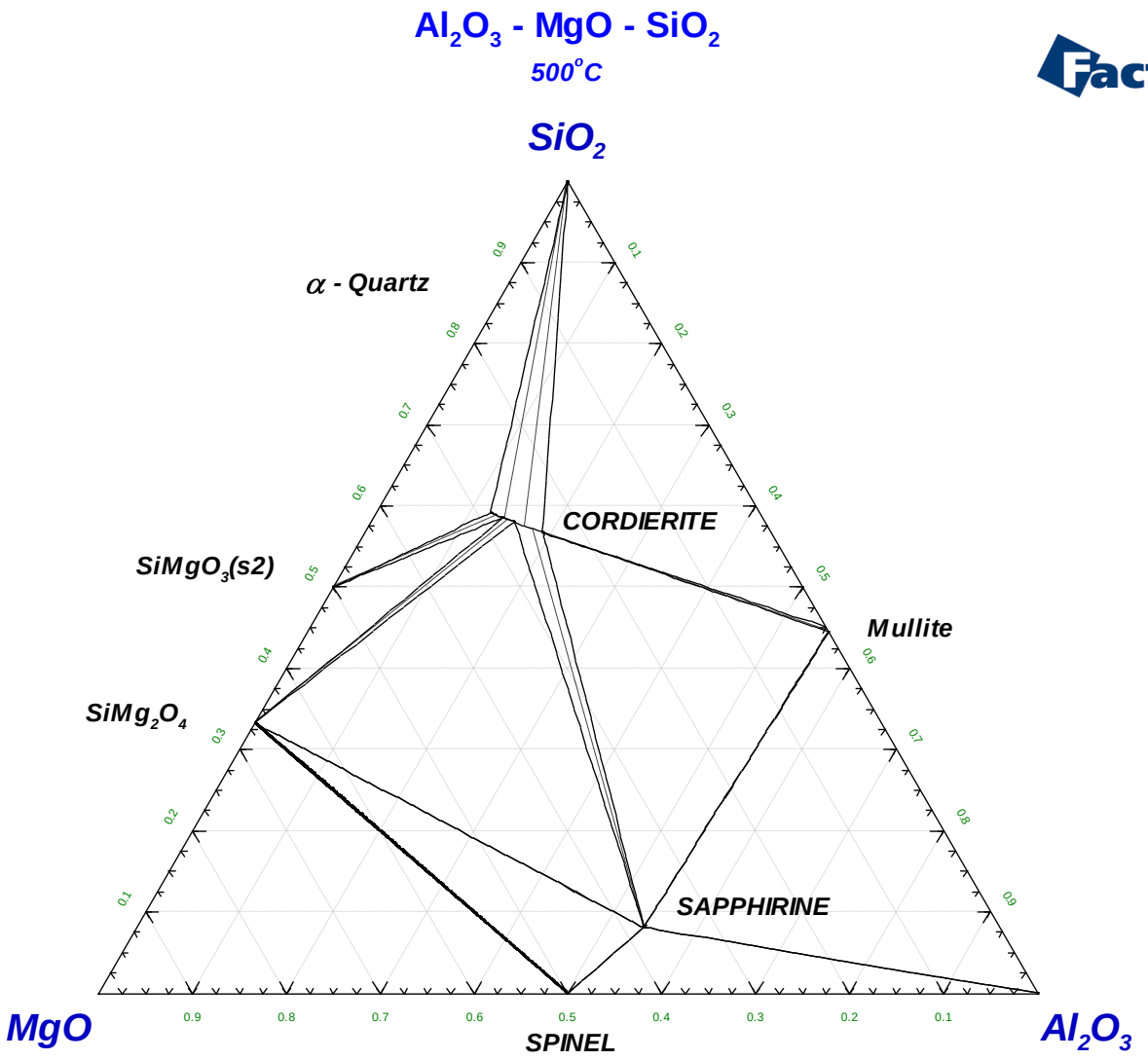
Weight percent, Liquidussurface



Invariant equilibria on the liquidus surface

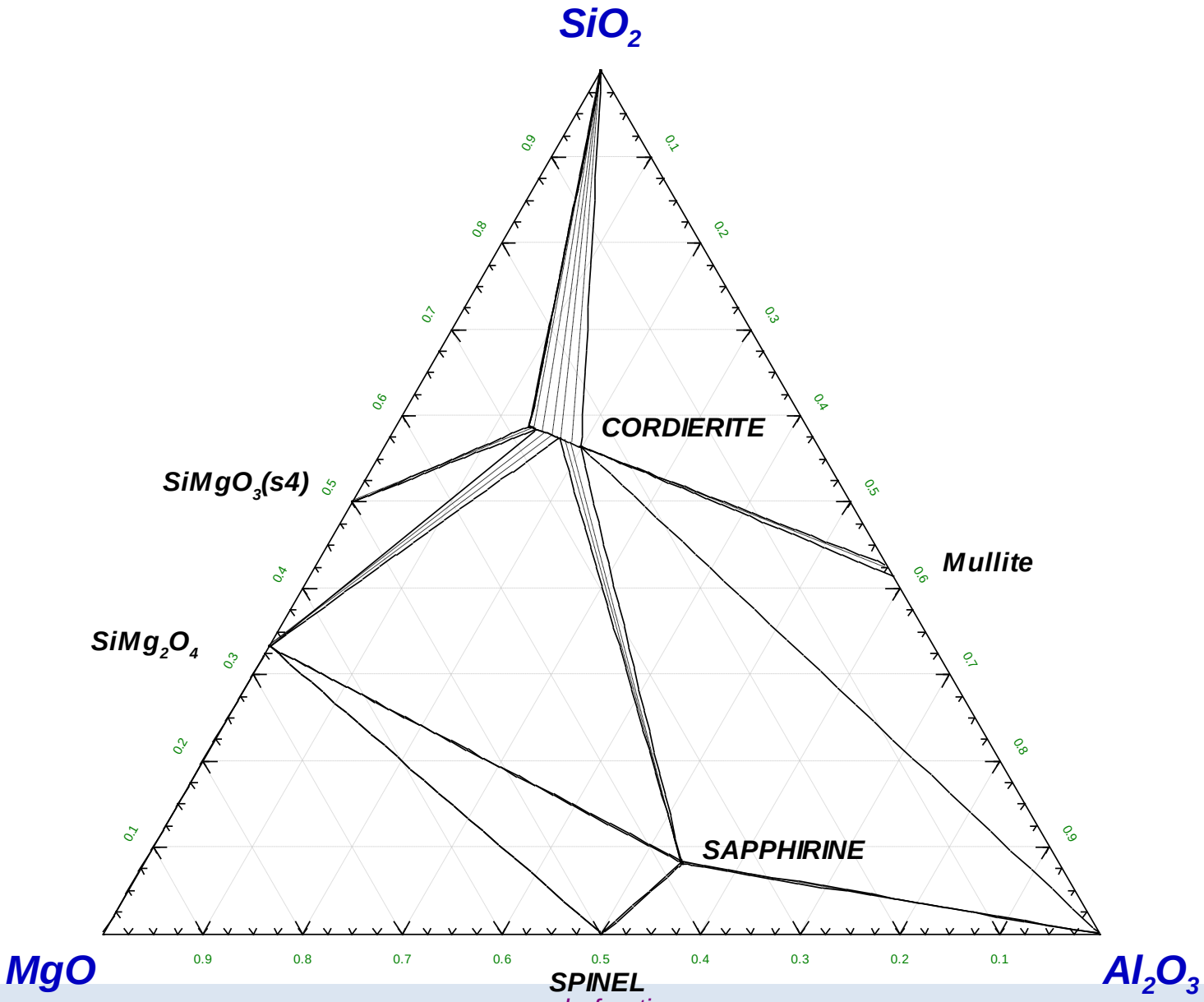
Intersections with slag	Mole fraction					Weight percent				
	A = Al2O3, B = MgO, C = P2O5					A = Al2O3, B = MgO, C = P2O5				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: Al6P2O14 / AlPO4(s3) / P2Mg2O7	1:	0.17009	0.48372	0.34619	1066.24	1:	20.171	22.675	57.154	1066.22
2: Al6P2O14 / P2Mg2O7 / SPINEL	2:	0.14716	0.58387	0.26897	1044.20	2:	19.559	30.675	49.767	1044.16
3: Al2P6O18 / AlPO4(s3) / P2MgO6	3:	0.09839	0.38238	0.51924	1010.65	3:	10.118	15.544	74.338	1010.90
4: AlPO4(s3) / P2Mg2O7 / P2MgO6	4:	0.09410	0.43286	0.47304	1002.27	4:	10.187	18.523	71.290	1002.26
5: MeO / Mg3O8P2 / SPINEL	5:	0.06151	0.72072	0.21776	948.18	5:	9.470	43.859	46.671	948.03
6: Mg3O8P2/ P2Mg2O7 / SPINEL	6:	0.05645	0.70688	0.23667	921.57	6:	8.485	41.996	49.519	921.54

Mole fraction



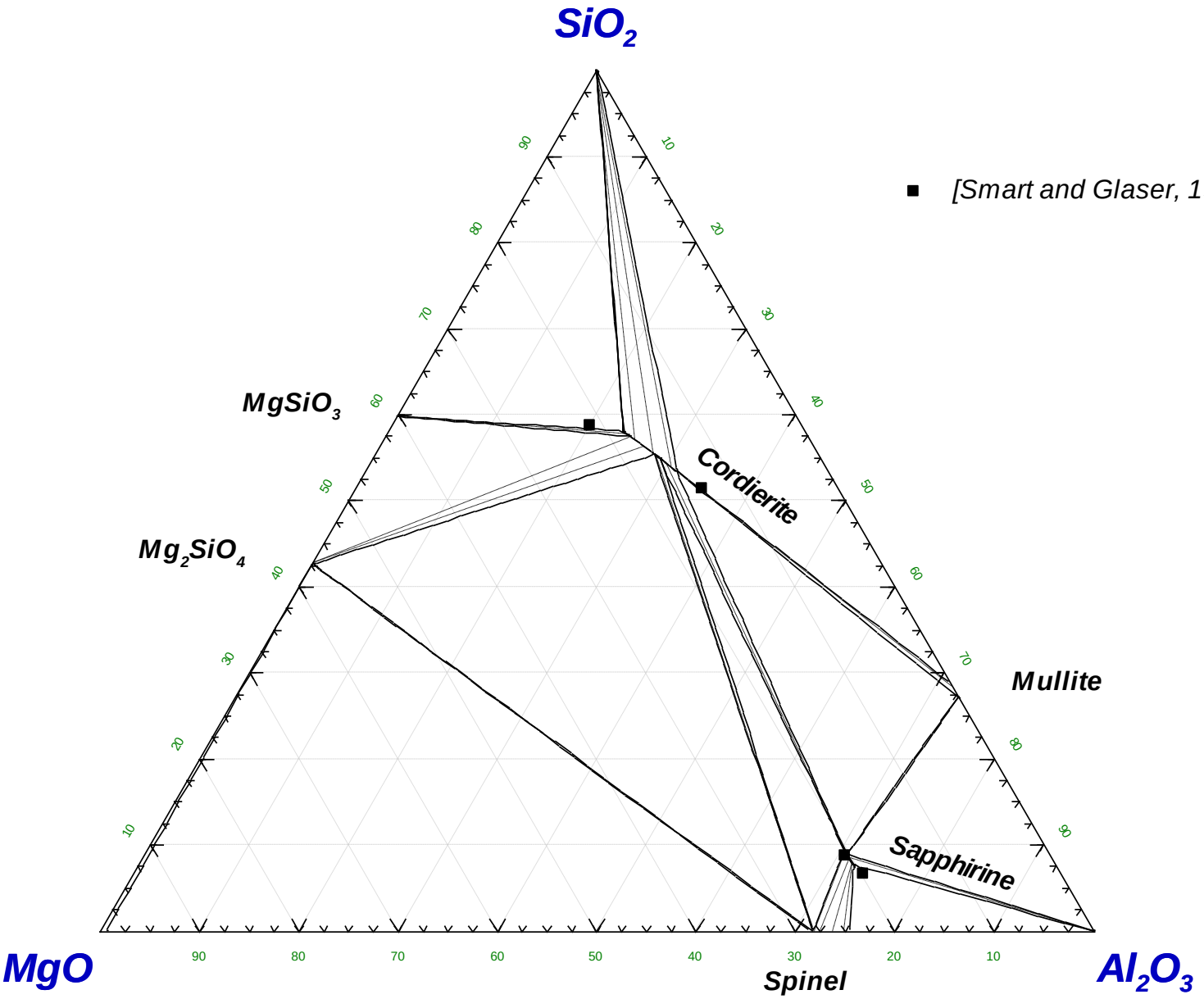
Al_2O_3 - MgO - SiO_2

1000°C



Al_2O_3 - MgO - SiO_2

1350°C

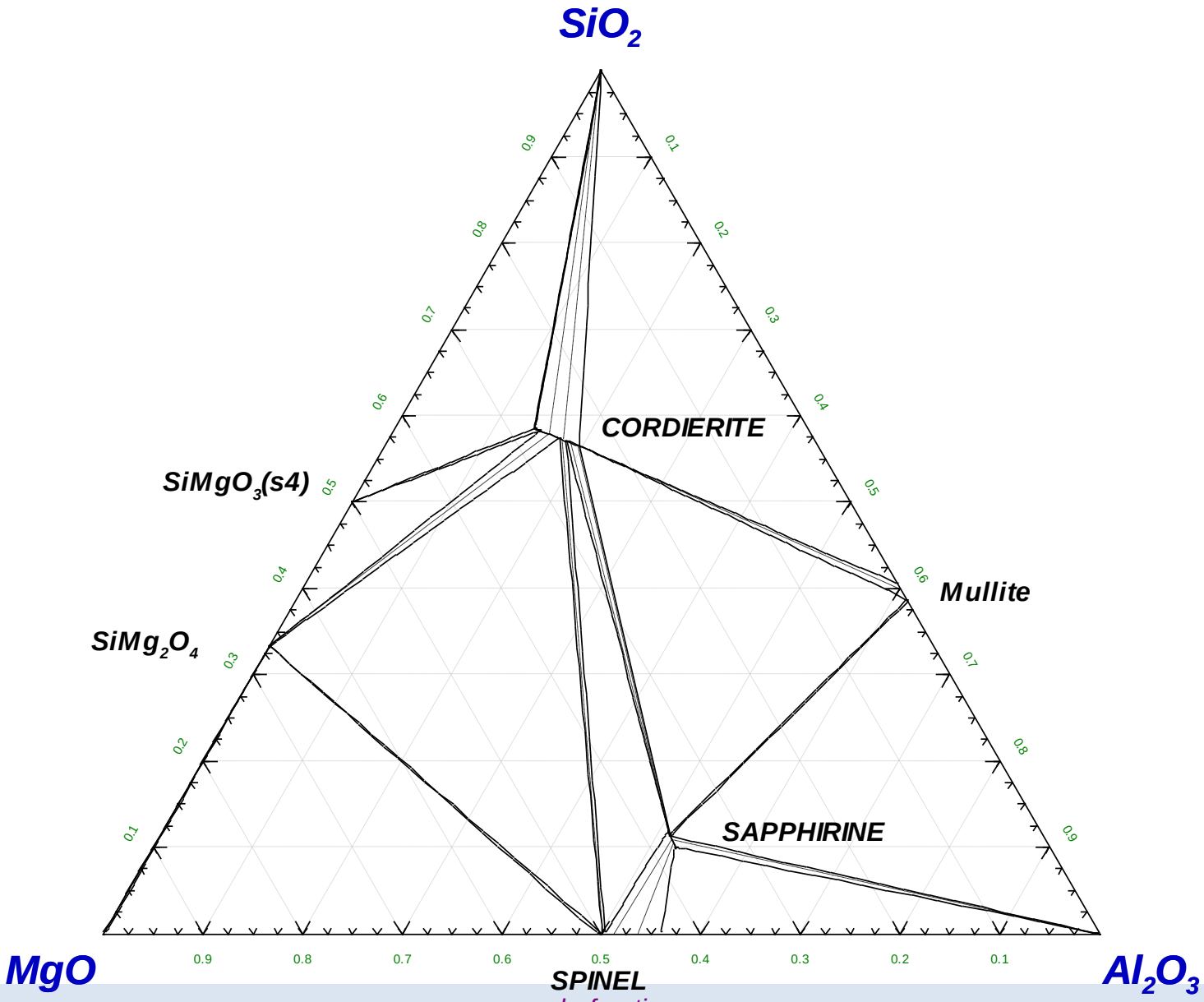


- *[Smart and Glaser, 1981]*

Mole fraction
kurz unterhalb Liquidussurface

Al_2O_3 - MgO - SiO_2

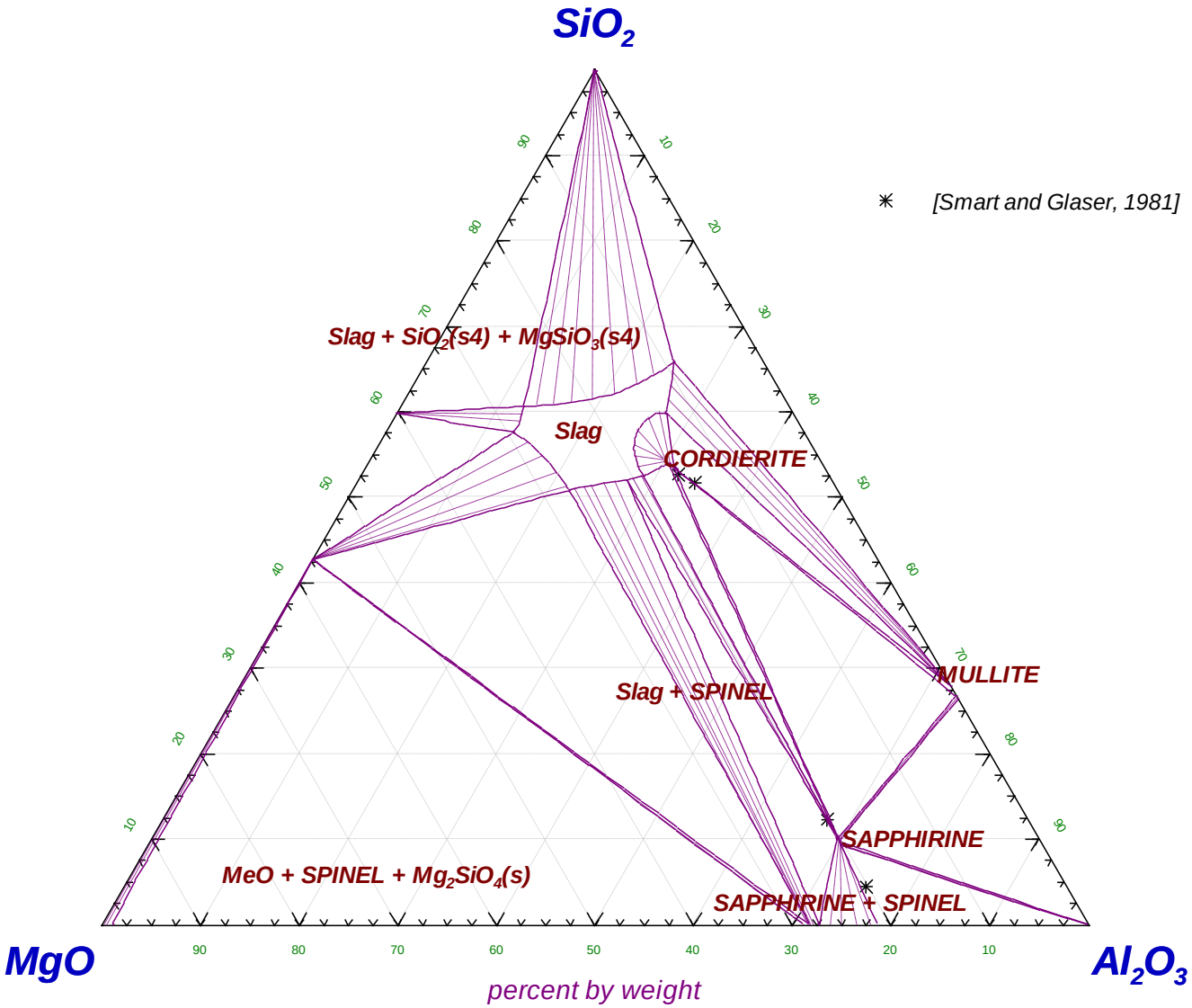
1380°C



Weight percent
compared with experimental data

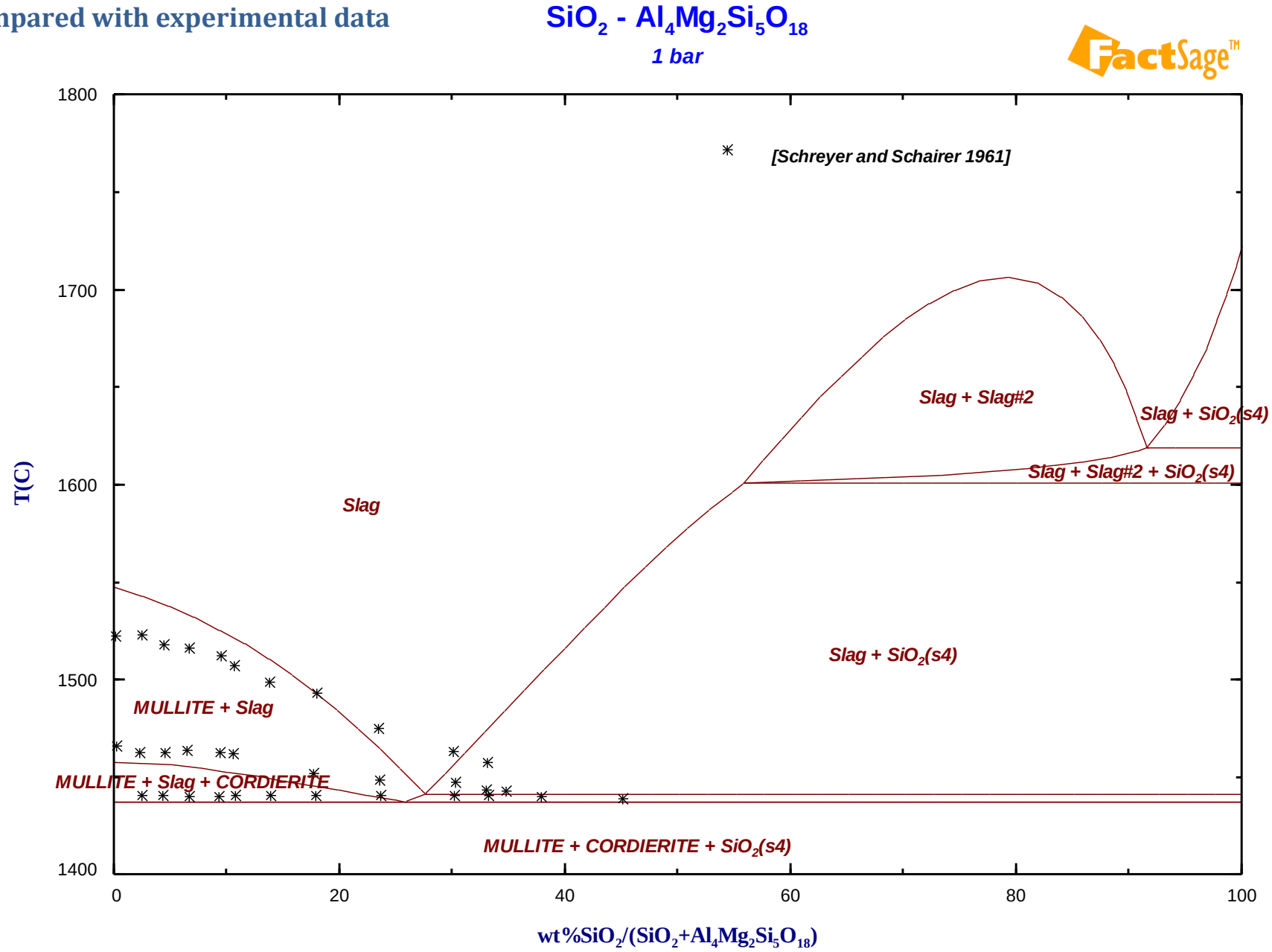
Al_2O_3 - SiO_2 - MgO

1450°C



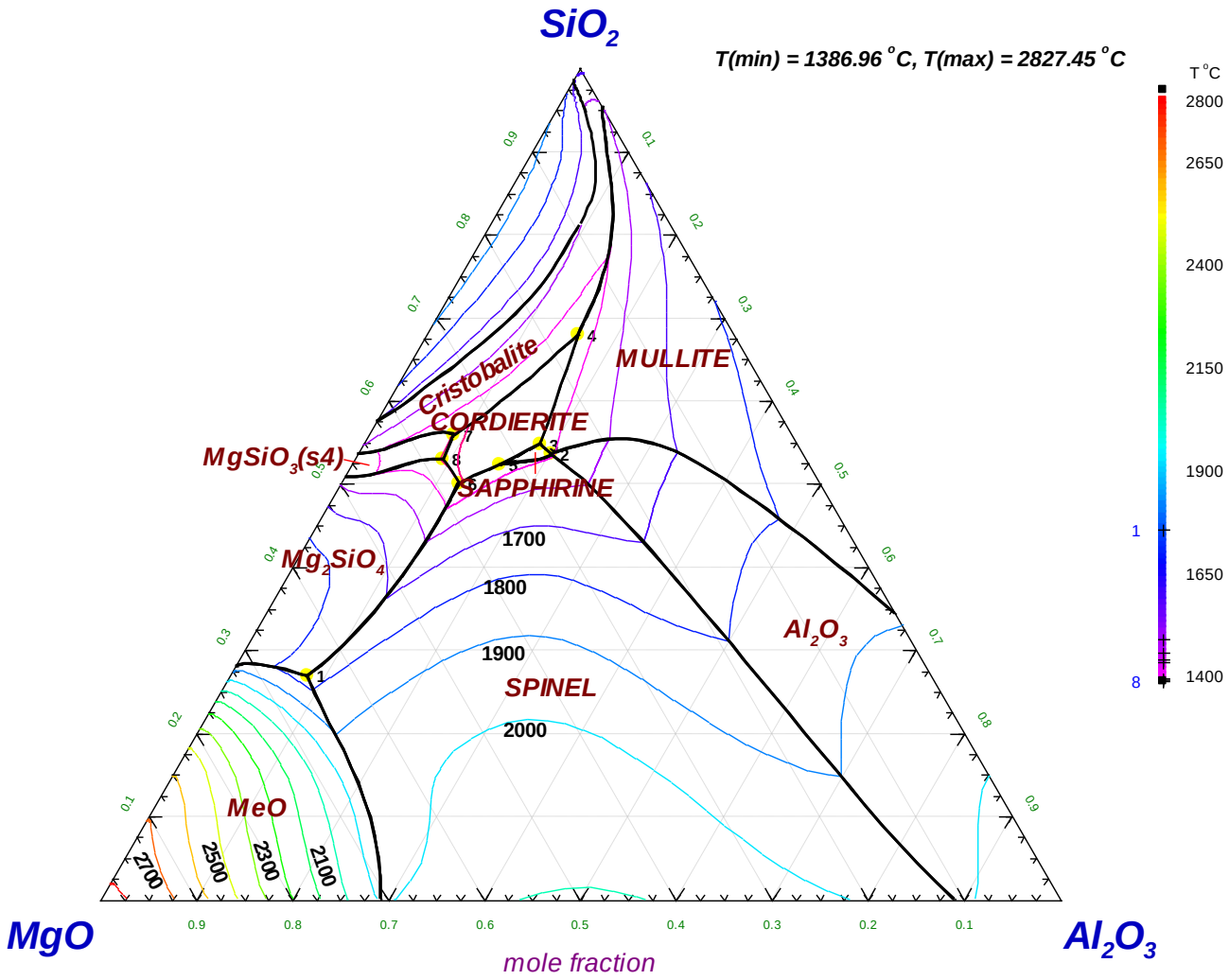
✳ *[Smart and Glaser, 1981]*

Weight percent
compared with experimental data



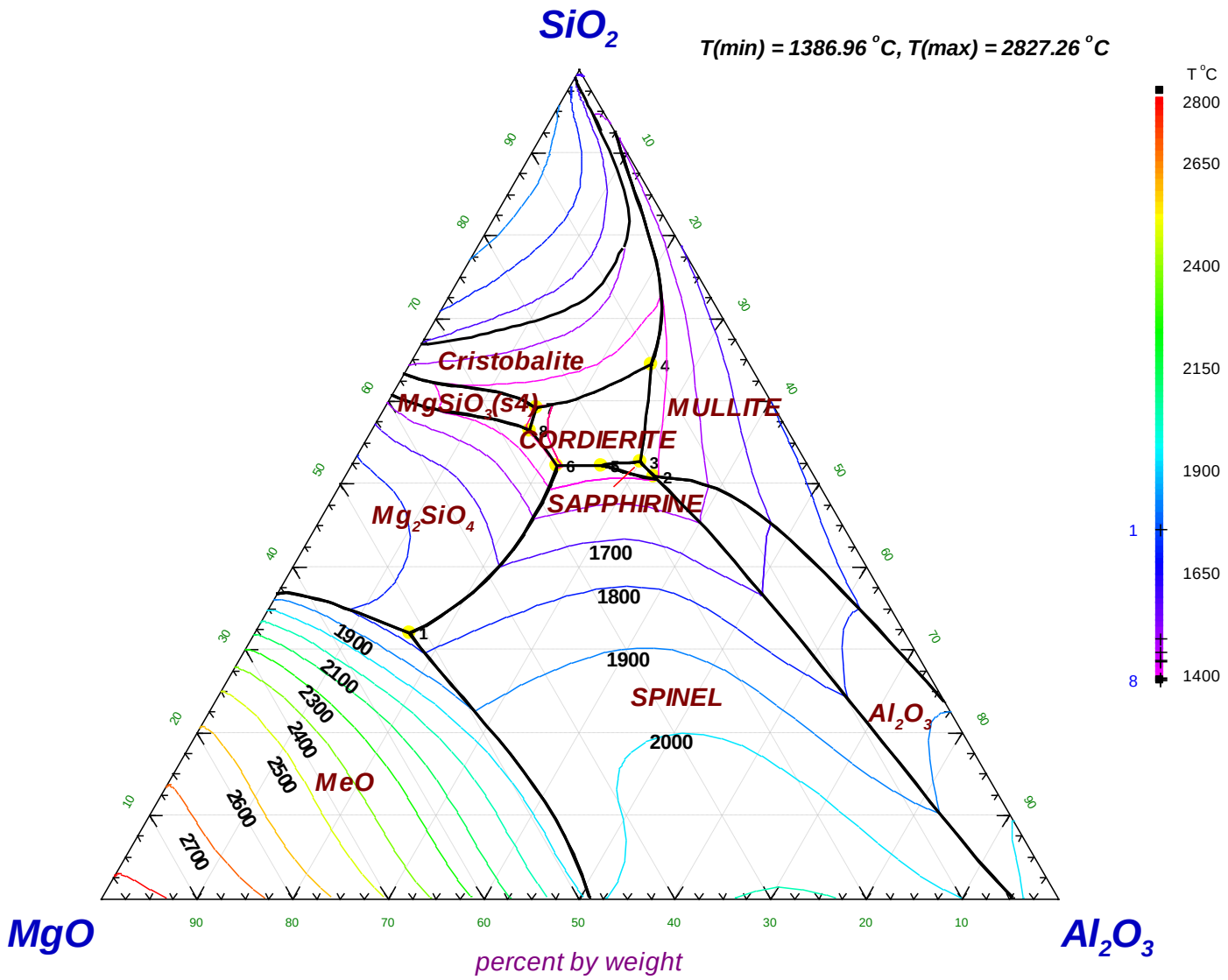
Al_2O_3 - MgO - SiO_2

Projection (Slag), 1 bar



Al_2O_3 - MgO - SiO_2

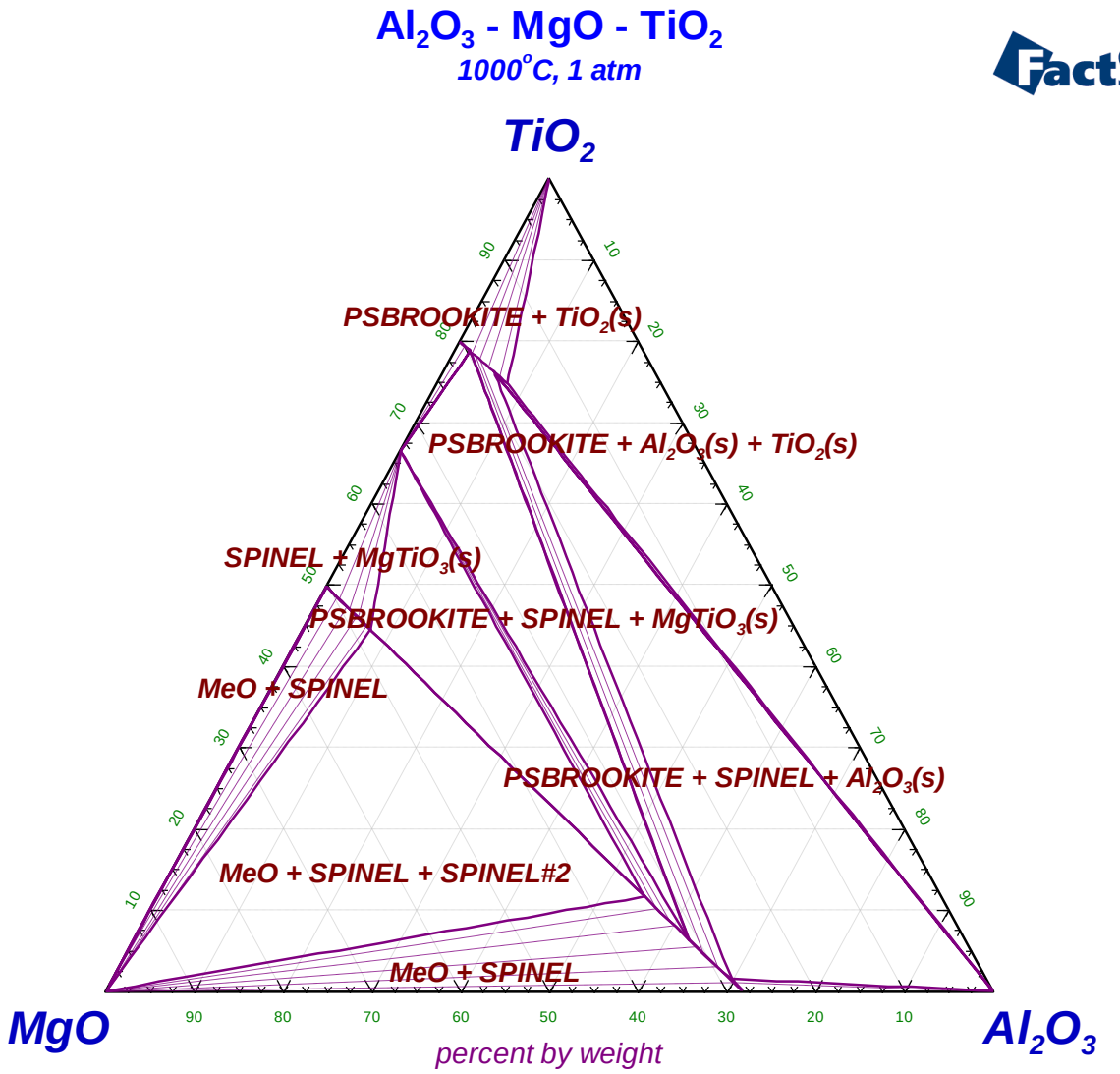
Projection (Slag), 1 bar

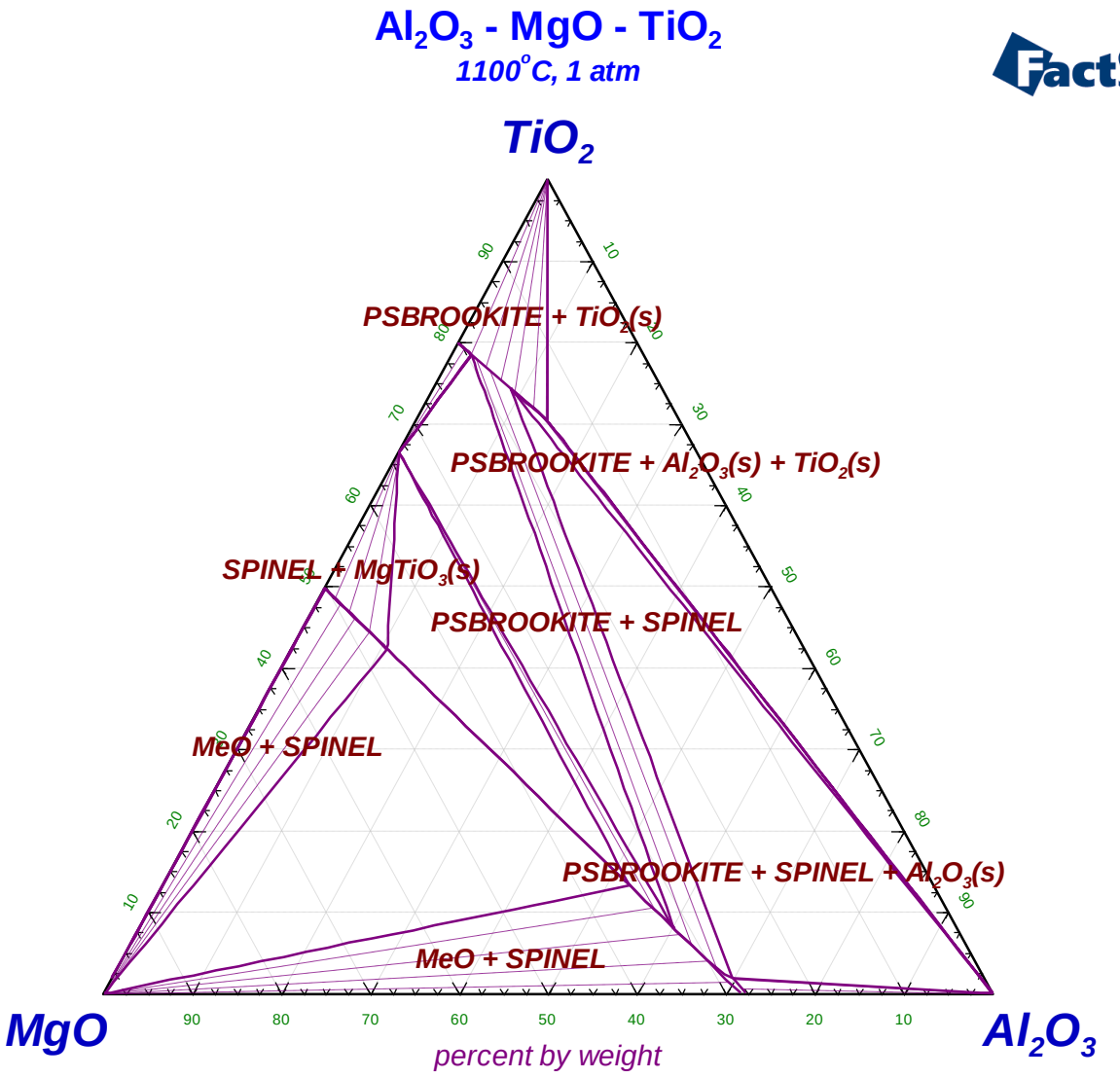


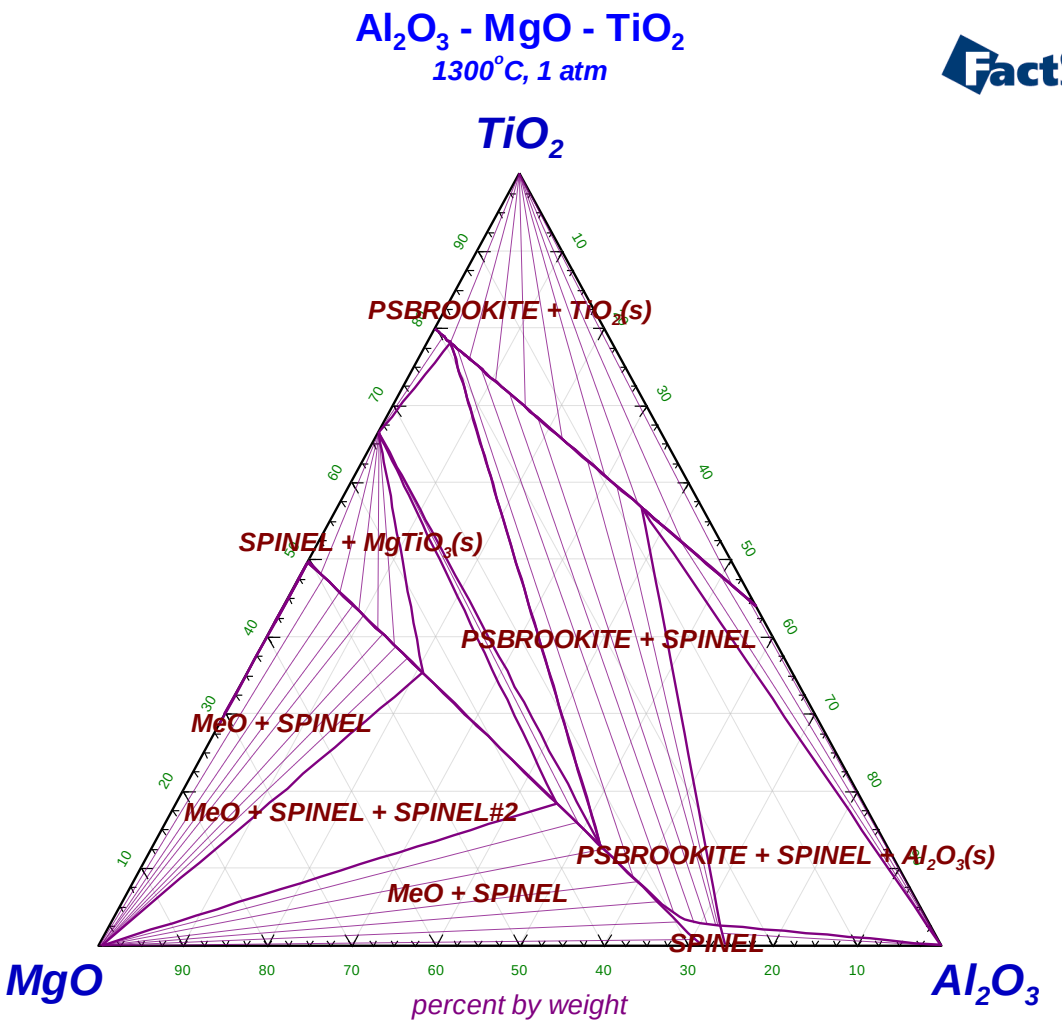
Invariant equilibria on the liquidus surface

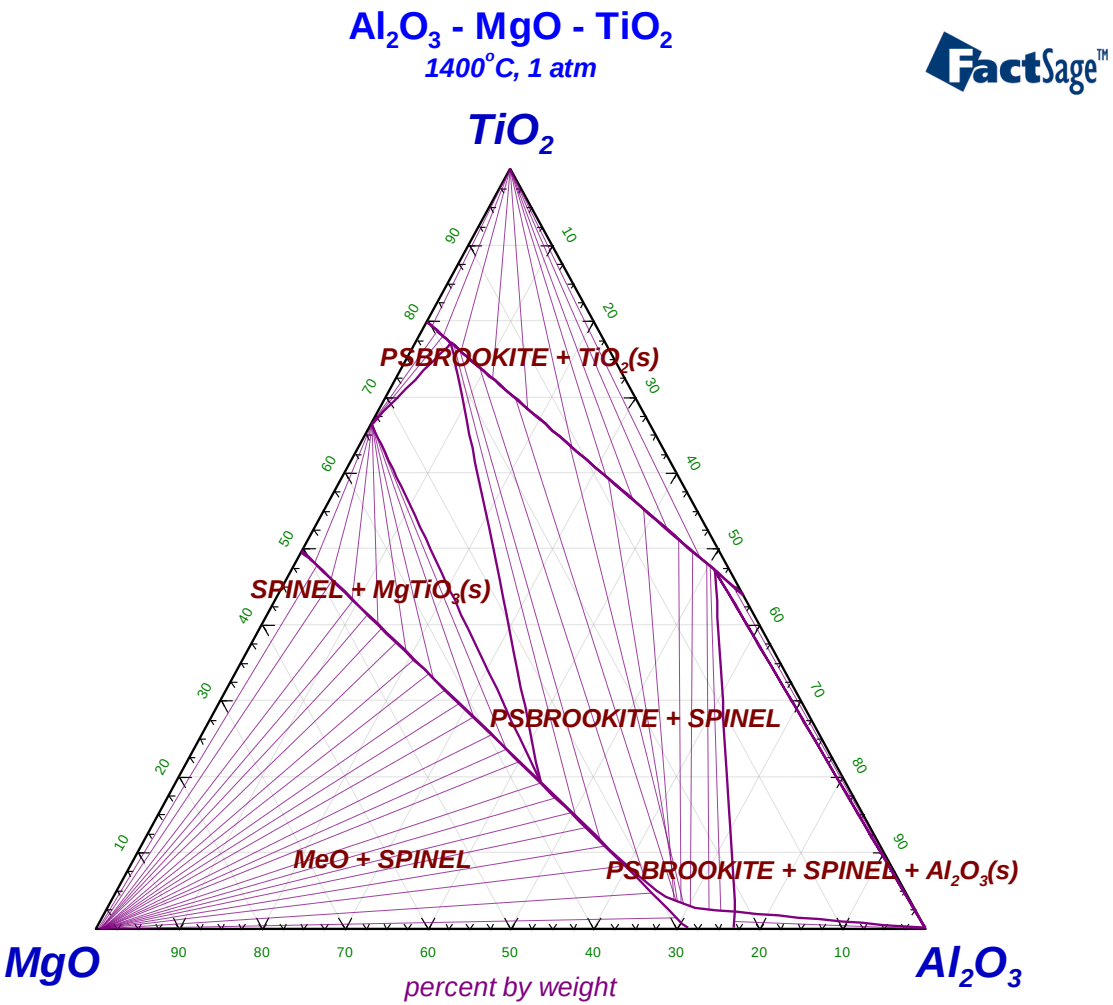
Intersections with slag	Mole fraction					Weight percent				
	A = SiO2, B = MgO, C = Al2O3					A = SiO2, B = MgO, C = Al2O3				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: MeO / Mg2SiO4 / SPINEL	1:	0.26930	0.64991	0.08079	1756.15	1:	31.968	51.757	16.275	1756.13
2: Al2O3 / MULLITE / SAPPHIRINE	2:	0.53688	0.26184	0.20129	1491.43	2:	50.298	16.927	32.775	1491.43
3: CORDIERITE / MULLITE / SAPPHIRINE	3:	0.54774	0.26831	0.18396	1455.85	3:	52.392	17.455	30.152	1455.85
4: CORDIERITE / MULLITE / Cristobalite	4:	0.67960	0.16281	0.15758	1437.46	4:	64.065	10.454	25.480	1437.46
5: CORDIERITE / SAPPHIRINE / SPINEL	5:	0.52318	0.32235	0.15447	1433.65	5:	52.194	21.615	26.192	1433.65
6: CORDIERITE / Mg2SiO4 / SPINEL	6:	0.50121	0.37611	0.12268	1395.32	6:	52.194	26.169	21.637	1395.32
7: CORDIERITE / MgSiO3(s4) / Cristobalite	7:	0.55983	0.35135	0.08881	1389.58	7:	59.443	24.637	15.920	1389.58
8: CORDIERITE / Mg2SiO4 / MgSiO3(s4)	8:	0.53043	0.37749	0.09207	1386.96	8:	56.625	26.750	16.626	1386.96

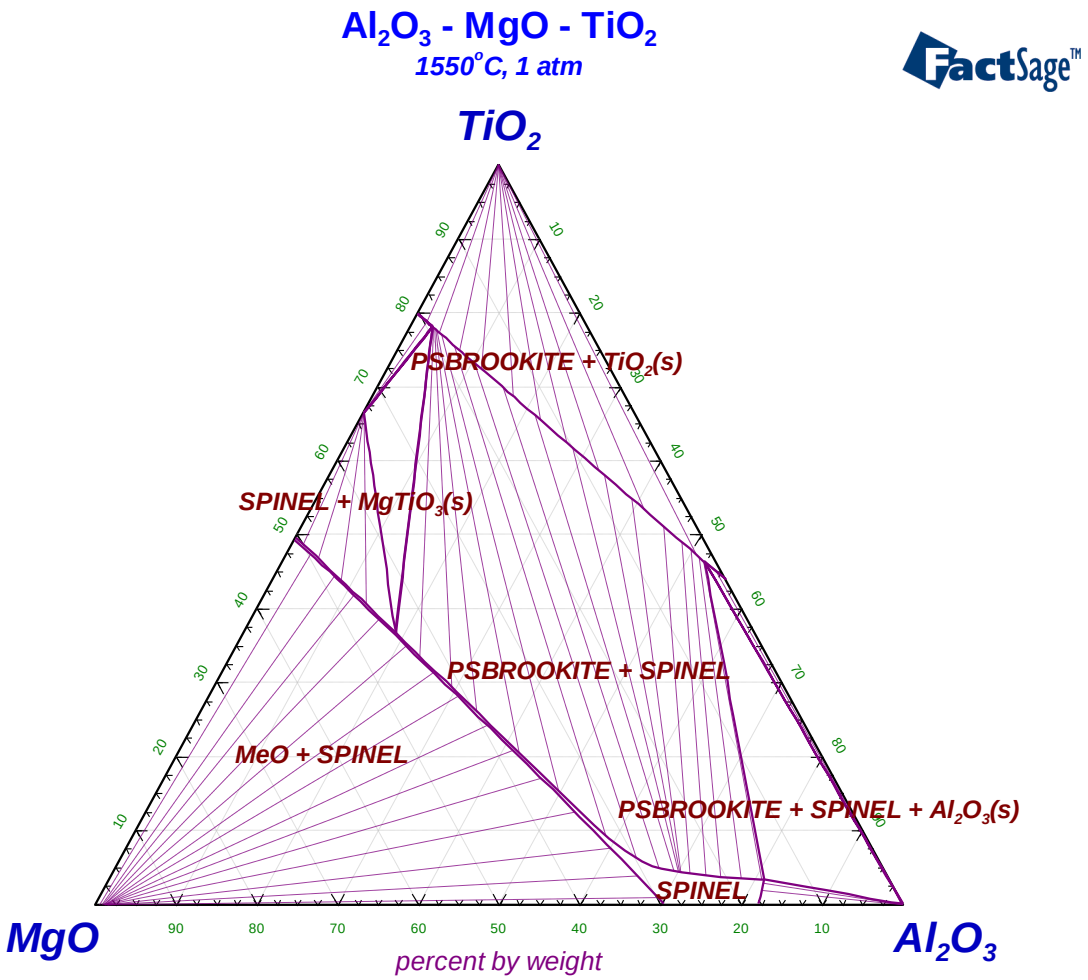
Al2O3-MgO-TiO2,
Weight percent 1000C°



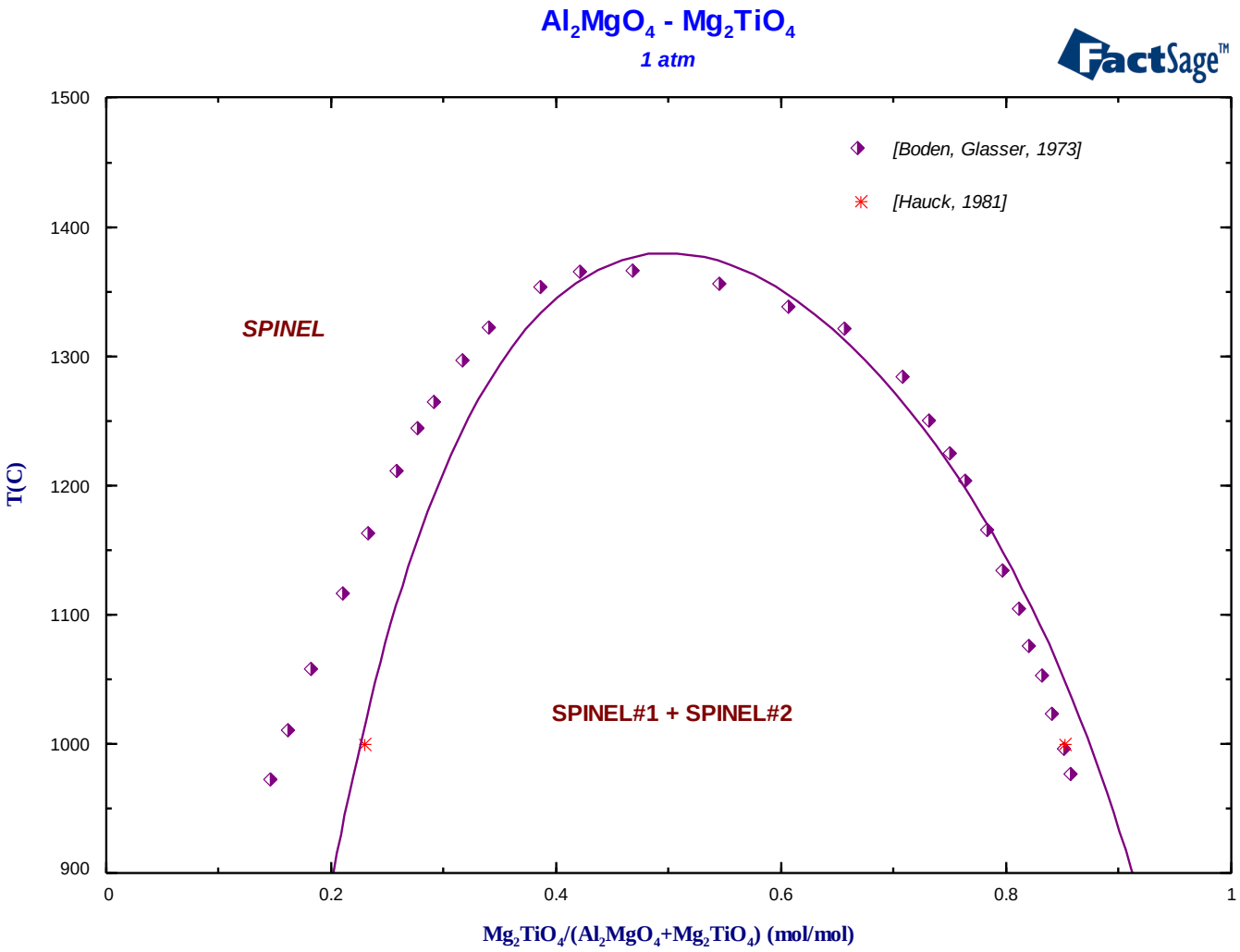

Al2O3 - MgO - TiO2
1100°C, 1 atm
TiO2
PSBROOKITE + TiO2(s)
PSBROOKITE + Al2O3(s) + TiO2(s)
SPINEL + MgTiO3(s)
PSBROOKITE + SPINEL
MeO + SPINEL
PSBROOKITE + SPINEL + Al2O3(s)
MeO + SPINEL
MgO
Al2O3
percent by weight


Al2O3 - MgO - TiO2
1300°C, 1 atm
TiO2
PSBROOKITE + TiO2(s)
SPINEL + MgTiO3(s)
PSBROOKITE + SPINEL
MeO + SPINEL
MeO + SPINEL + SPINEL#2
PSBROOKITE + SPINEL + Al2O3(s)
MeO + SPINEL
SPINEL
MgO
Al2O3
percent by weight

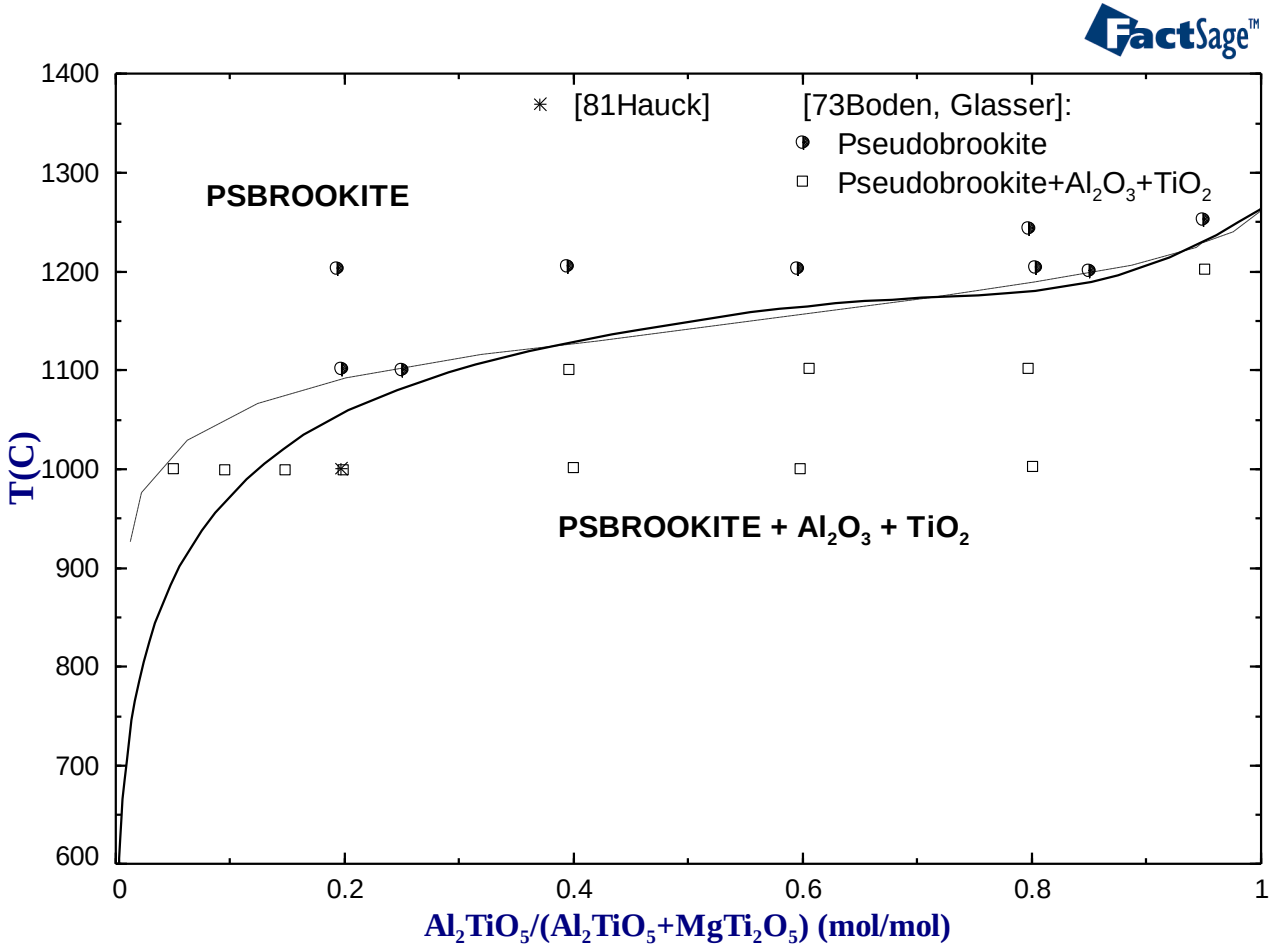

Al2O3 - MgO - TiO2
1400°C, 1 atm
FactSage™
TiO2
PSBROOKITE + TiO2(s)
SPINEL + MgTiO3(s)
PSBROOKITE + SPINEL
MeO + SPINEL
PSBROOKITE + SPINEL + Al2O3(s)
MgO
Al2O3
percent by weight


Al_2O_3 - MgO - TiO_2
1550°C, 1 atm
TiO_2
PSBROOKITE + TiO_2(s)
SPINEL + $MgTiO_3$(s)
PSBROOKITE + SPINEL
MeO + SPINEL
PSBROOKITE + SPINEL + Al_2O_3(s)
SPINEL
MgO
Al_2O_3
90 80 70 60 50 40 30 20 10
percent by weight

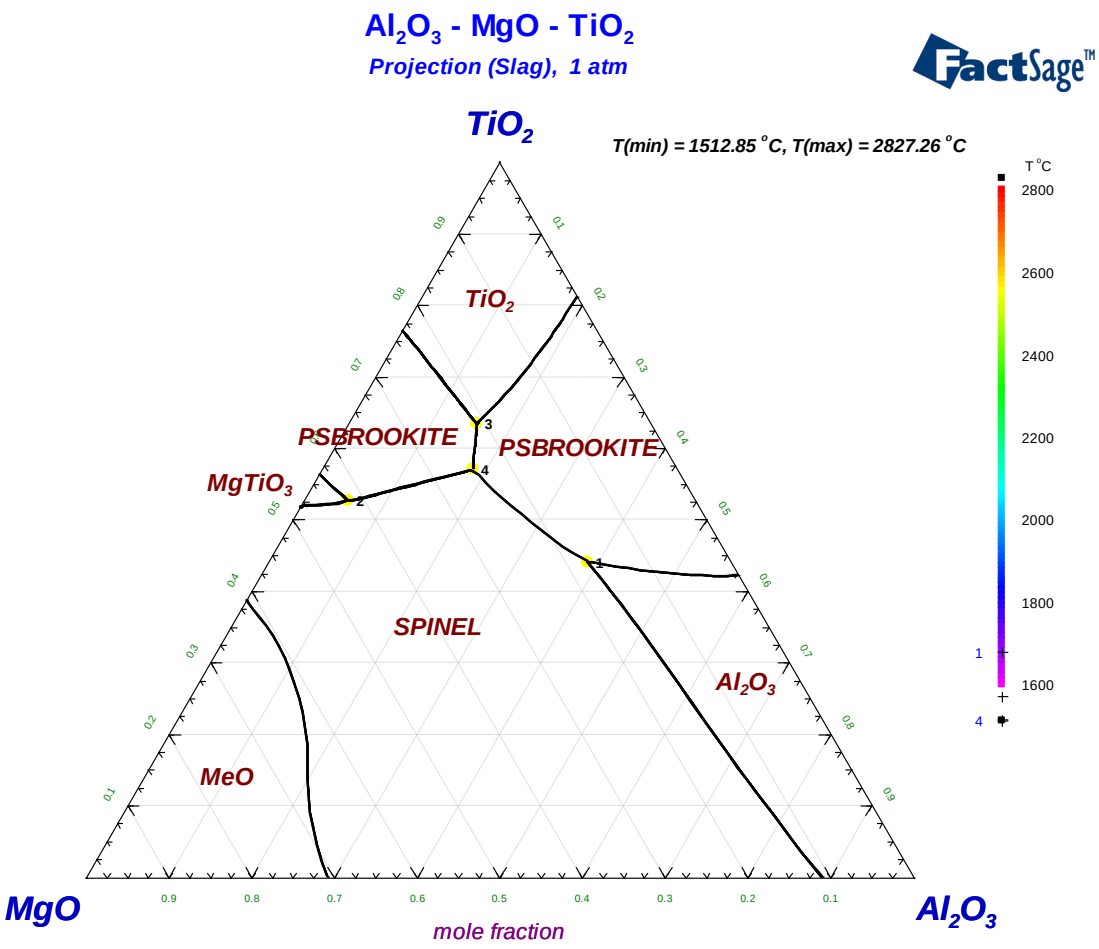
Isopleth Al2MgO4-Mg2TiO4, Mole fraction compared with experimental data



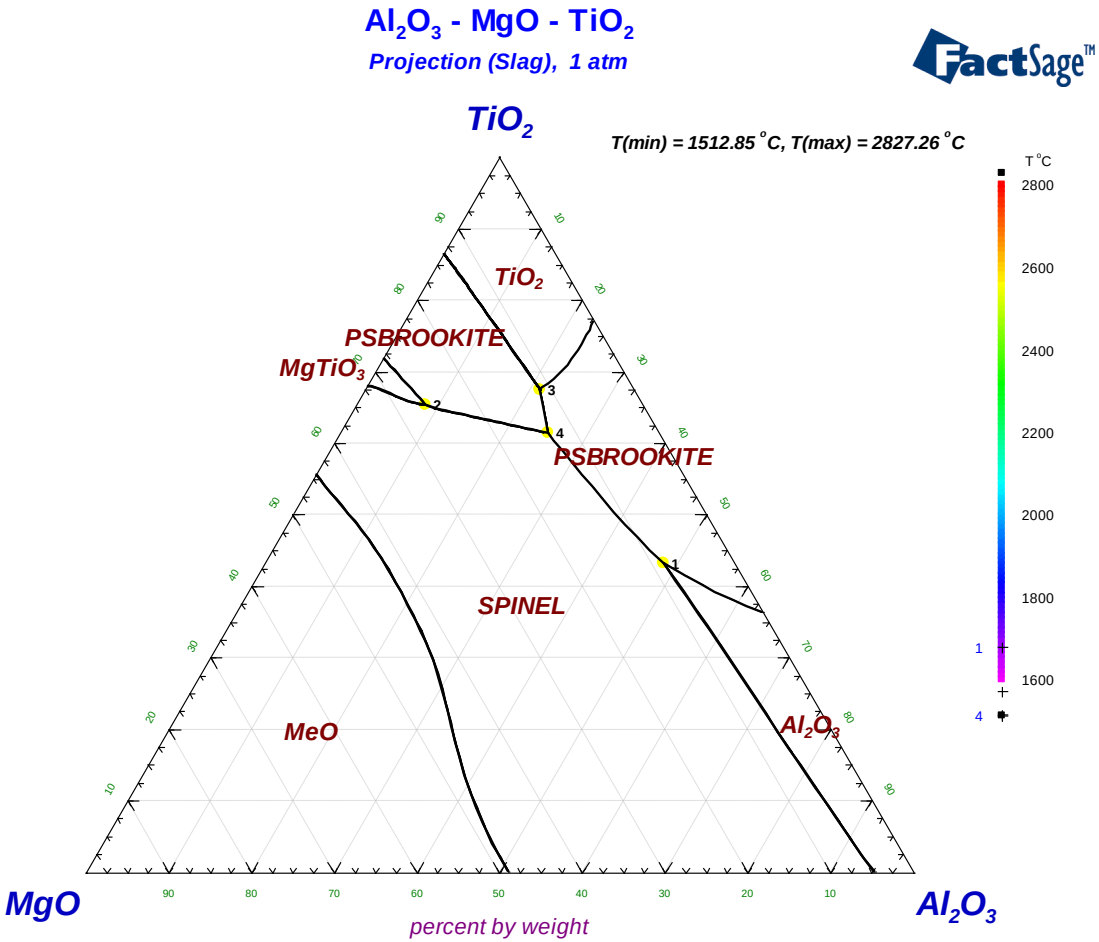
Isopleth Al2TiO5-MgTi2O5, Mole fraction compared with experimental data



Mole fraction
Liquidussurface



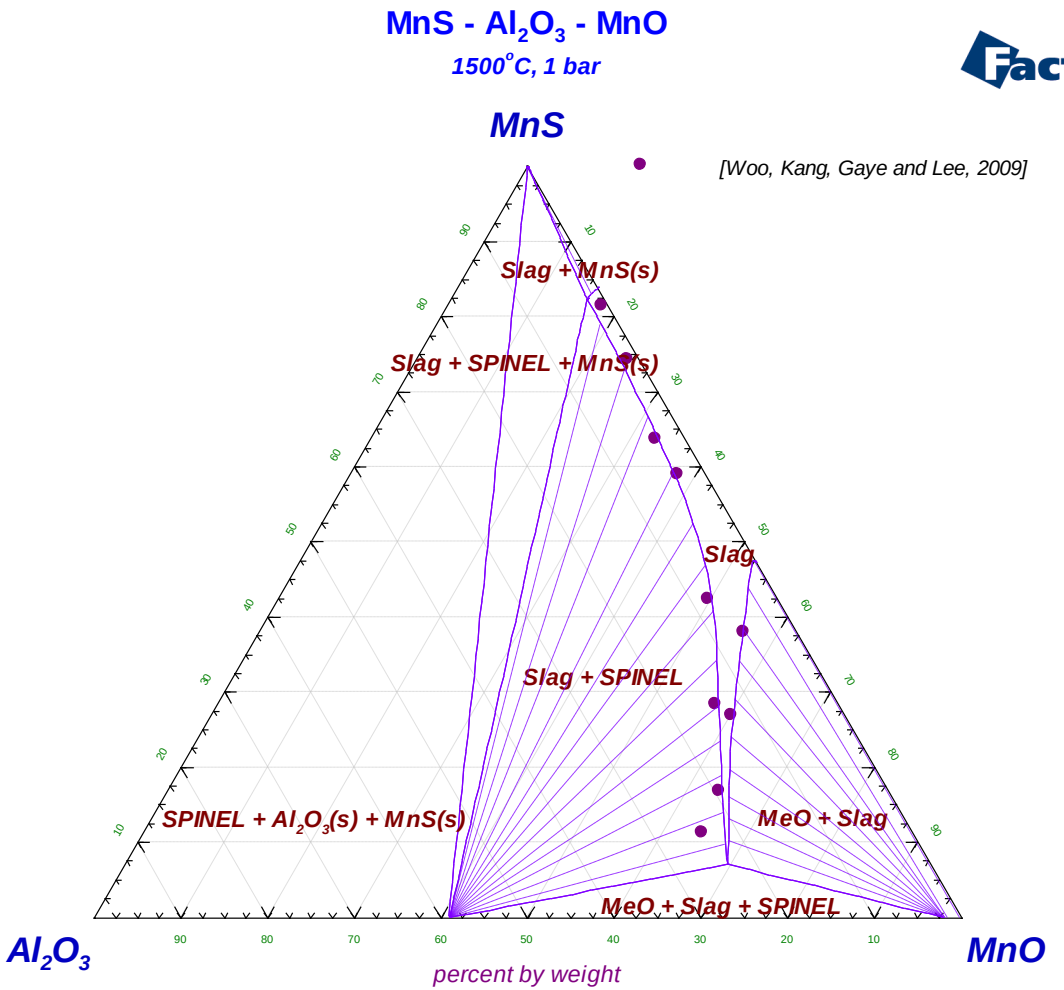
Weight percent
Liquidussurface



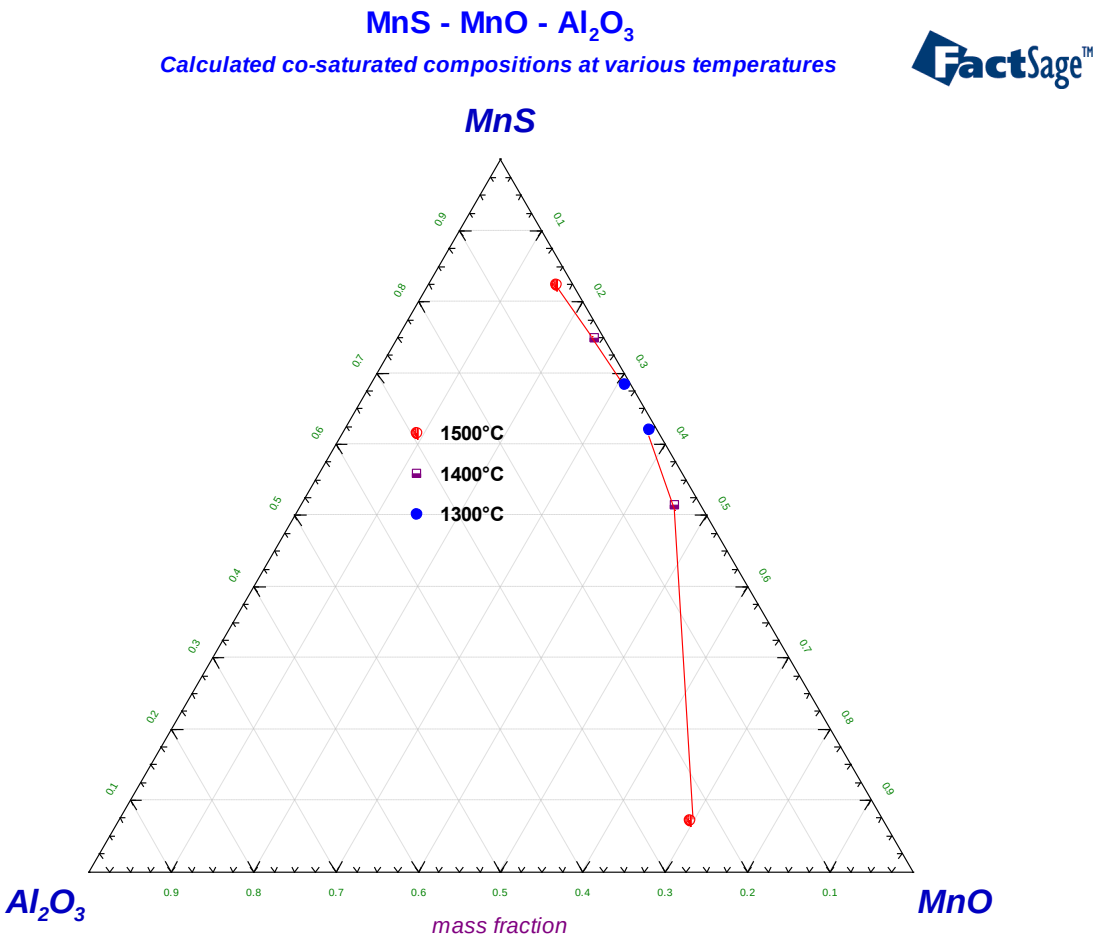
Invariant equilibria on the liquidus surface

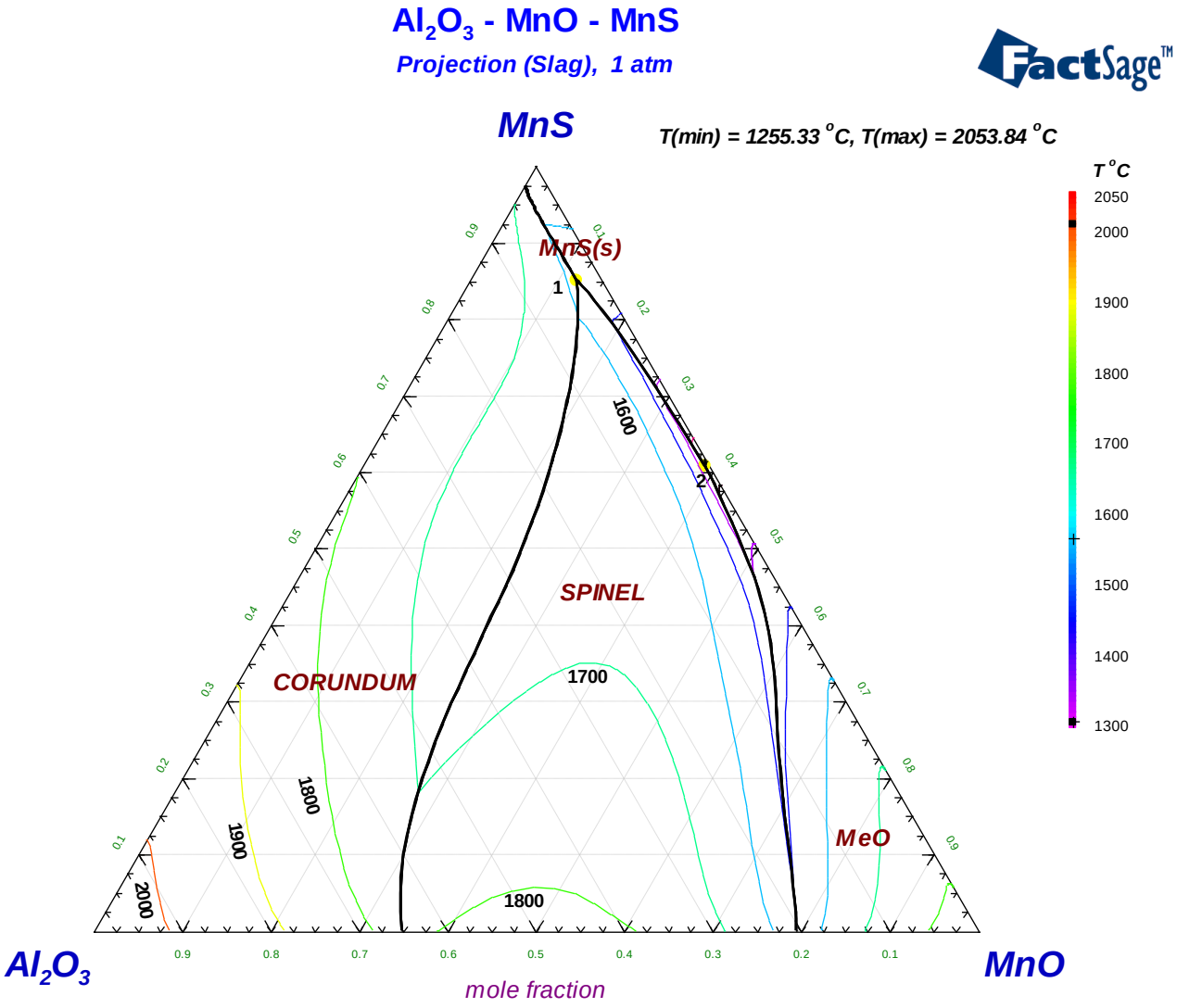
Intersections with slag	Mole fraction					Weight percent				
	A = TiO2, B = MgO, C = Al2O3					A = TiO2, B = MgO, C = Al2O3				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: Al2O3 / PSBROOKITE#1 / SPINEL	1:	0.44114	0.17297	0.38590	1679.22	1:	43.203	8.549	48.249	1679.22
2: MgTiO3 / PSBROOKITE#1 / SPINEL	2:	0.52729	0.41980	0.05290	1572.79	2:	65.365	26.262	8.372	1572.79
3: PSBROOKITE#1 / PSBROOKITE#2 / TiO2	3:	0.63434	0.21062	0.15504	1515.44	3:	67.586	11.325	21.089	1515.45
4: PSBROOKITE#1 / PSBRKITE#2 / SPINEL	4:	0.57079	0.24651	0.18270	1512.85	4:	61.479	13.399	25.122	1512.85

Al2O3-MnO-MnS,
Weight percent,

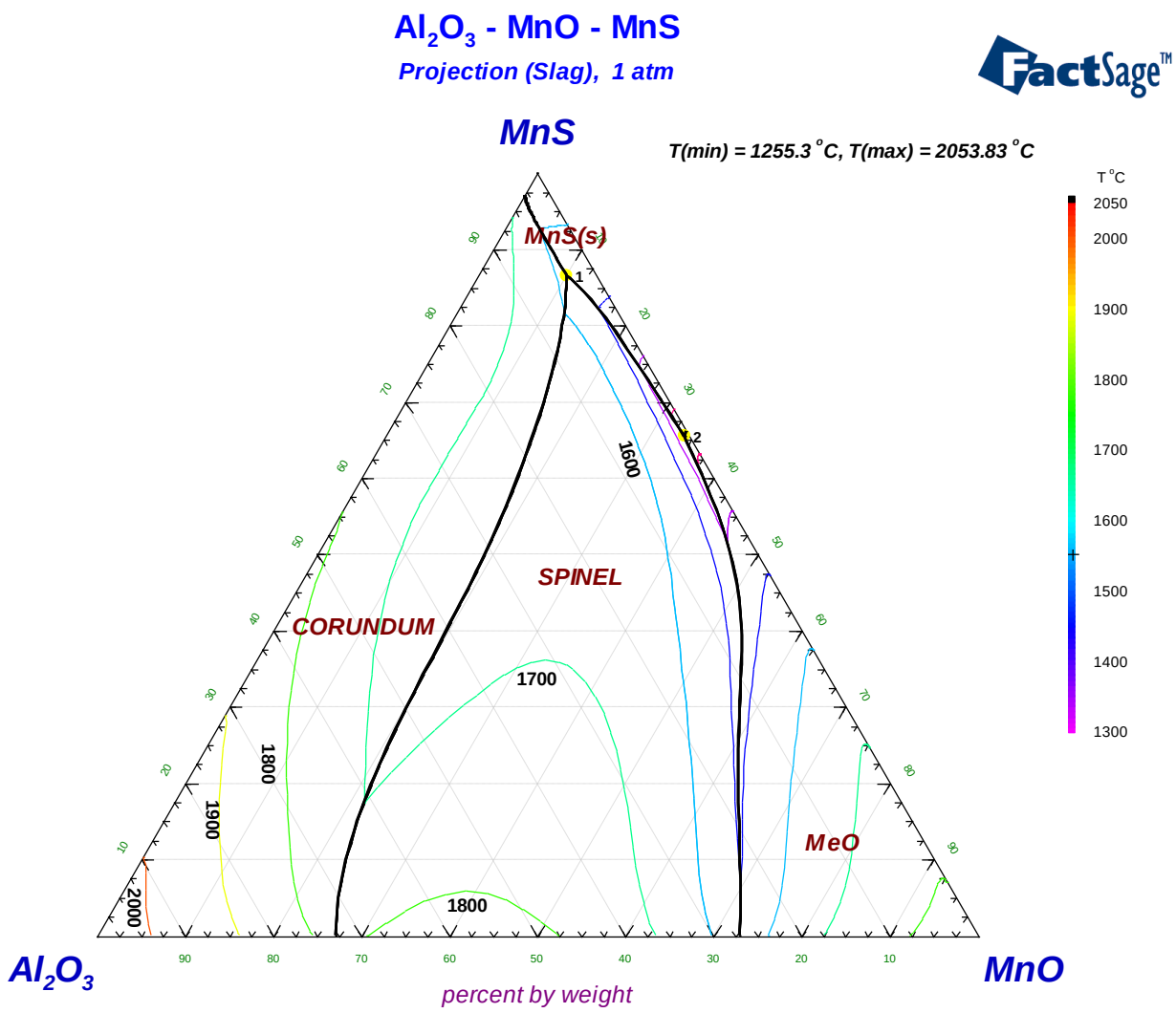


Weight percent,
Co-saturated compositions at various temperatures




Al2O3 - MnO - MnS
Projection (Slag), 1 atm
MnS
T(min) = 1255.33 °C, T(max) = 2053.84 °C
T °C
2050
2000
1900
1800
1700
1600
1500
1400
1300
MnS(s)
1
2
1600
SPINEL
1700
CORUNDUM
1800
1900
2000
1800
MeO
Al2O3
MnO
mole fraction

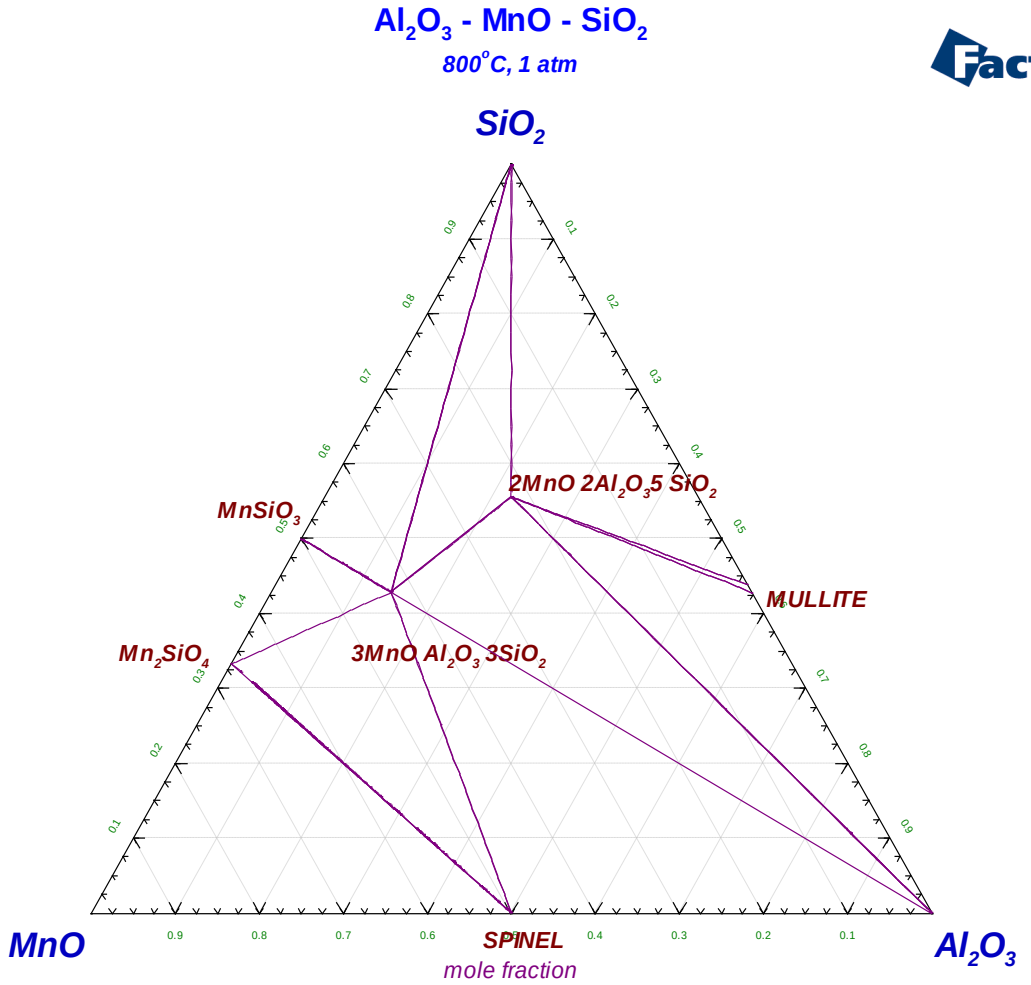
Weight percent, Liquidussurface

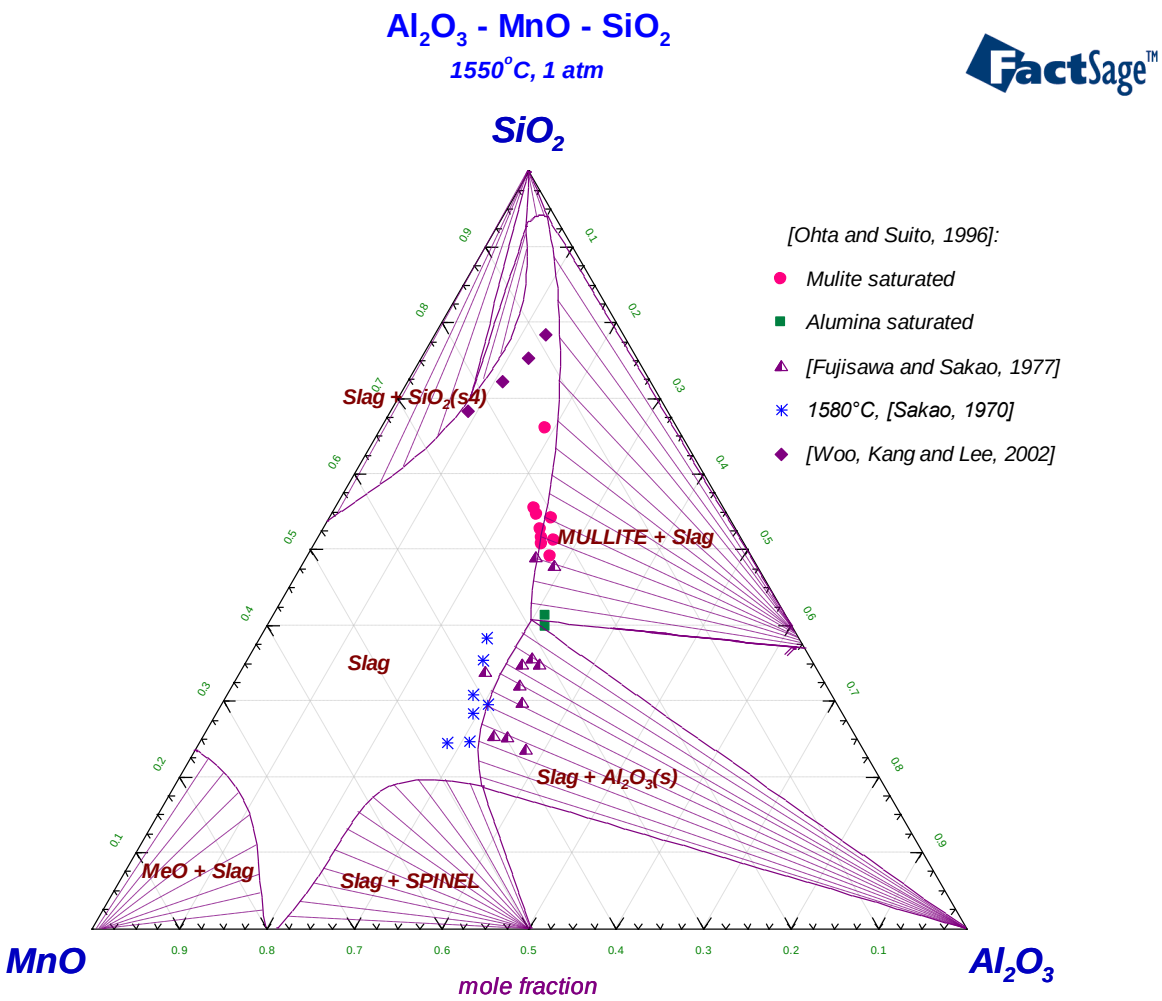


Invariant equilibria on the liquidus surface

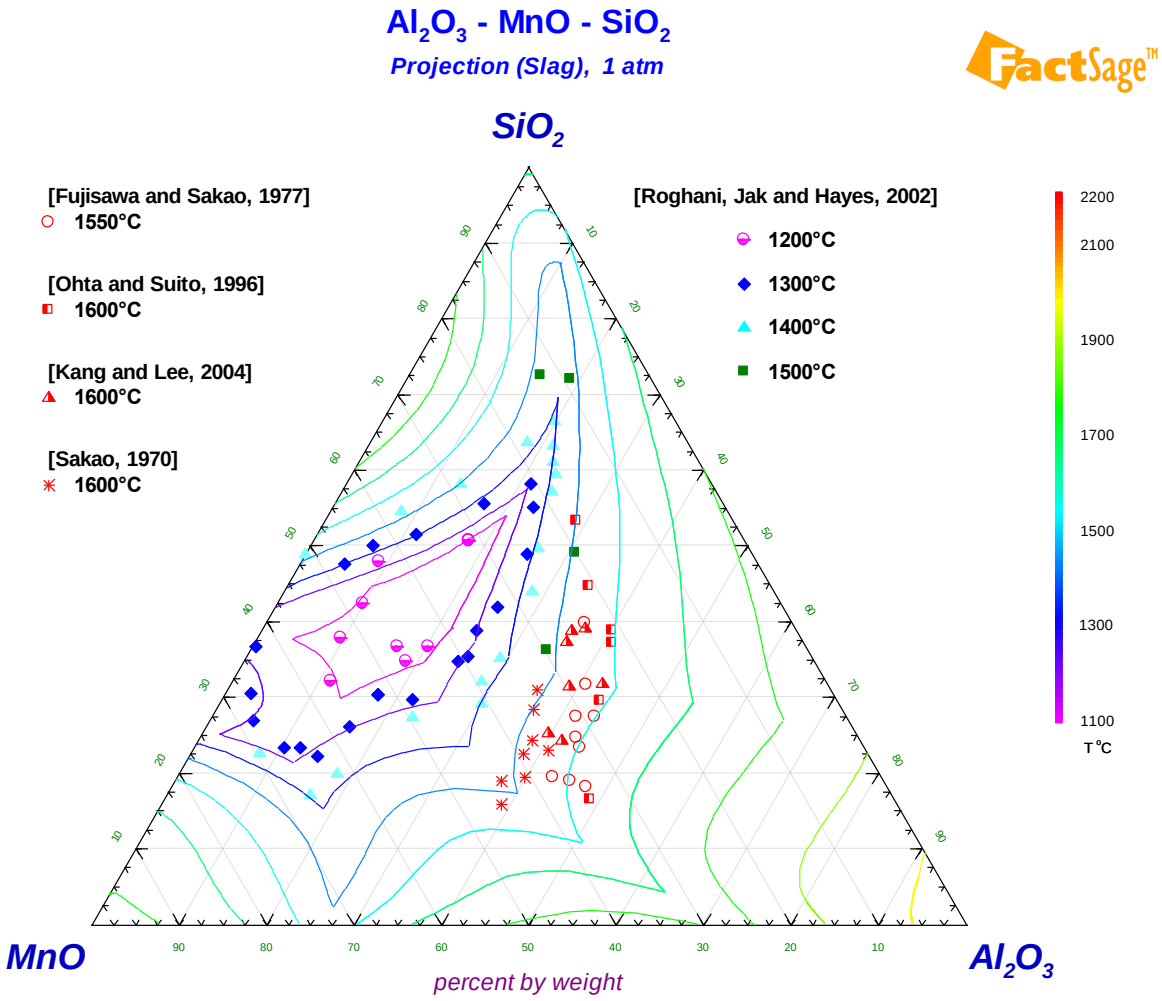
Intersections with slag	Mole fraction				Weight percent			
	A = MnS, B = Al2O3, C = MnO				A = MnS, B = Al2O3, C = MnO			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: SPINEL / CORANDUM / MnS(s)	1: 0.85118	0.02860	0.12022	1551.15	1: 86.615	3.411	9.974	1551.15
2: SPINEL / MeO / MnS(s)	2: 0.60909	0.00452	0.38639	1256.39	2: 0.65.534	0.570	33.896	1256.39

Mole fraction 800°C

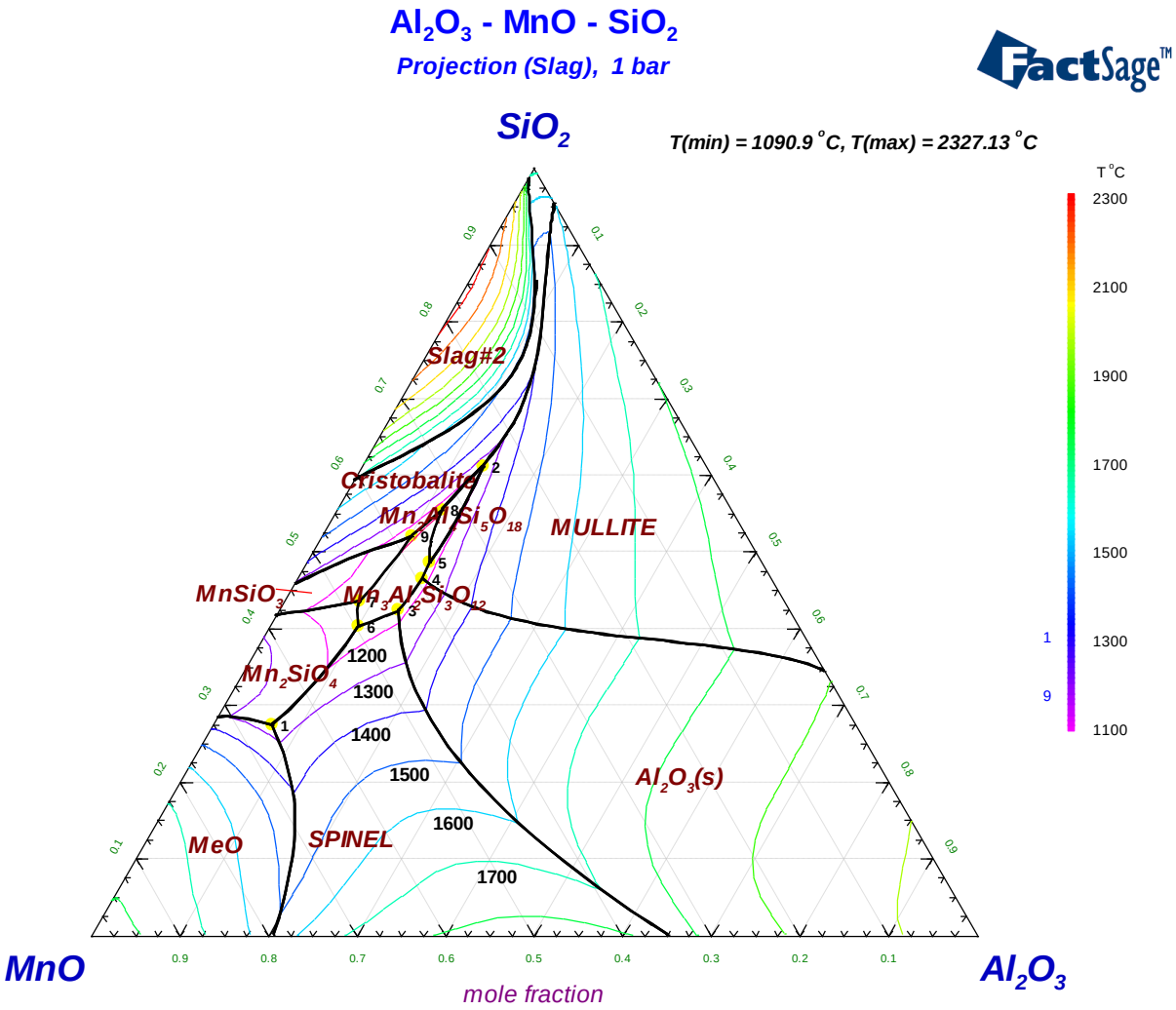


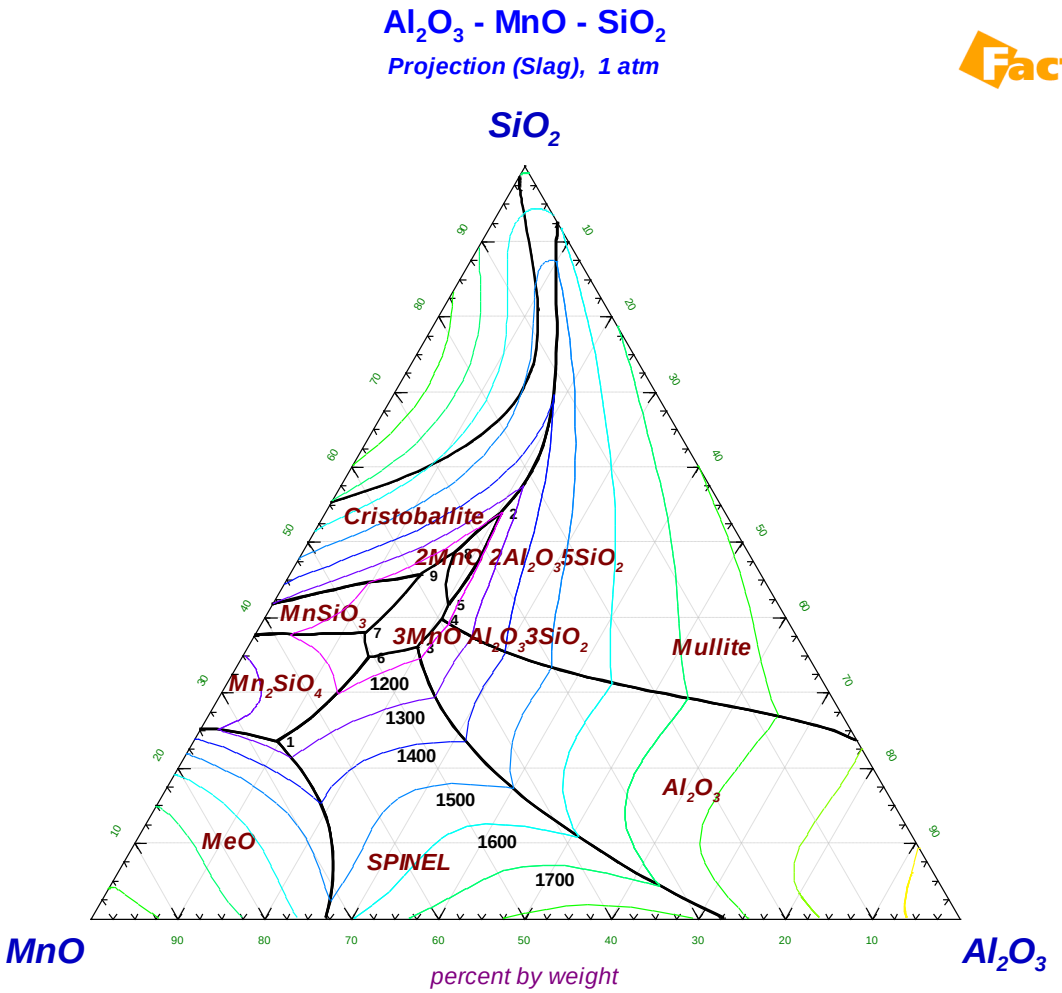

Al_2O_3 - MnO - SiO_2
1550°C, 1 atm
SiO_2
[Ohta and Suito, 1996]:
Mulite saturated
Alumina saturated
[Fujisawa and Sakao, 1977]
1580°C, [Sakao, 1970]
[Woo, Kang and Lee, 2002]
Slag + SiO_2(s4)
MULLITE + Slag
Slag
Slag + Al_2O_3(s)
MeO + Slag
Slag + SPINEL
MnO
Al_2O_3
mole fraction

Weight percent, Liquid lines compared with experimental data



Mole fraction
Liquidussurface



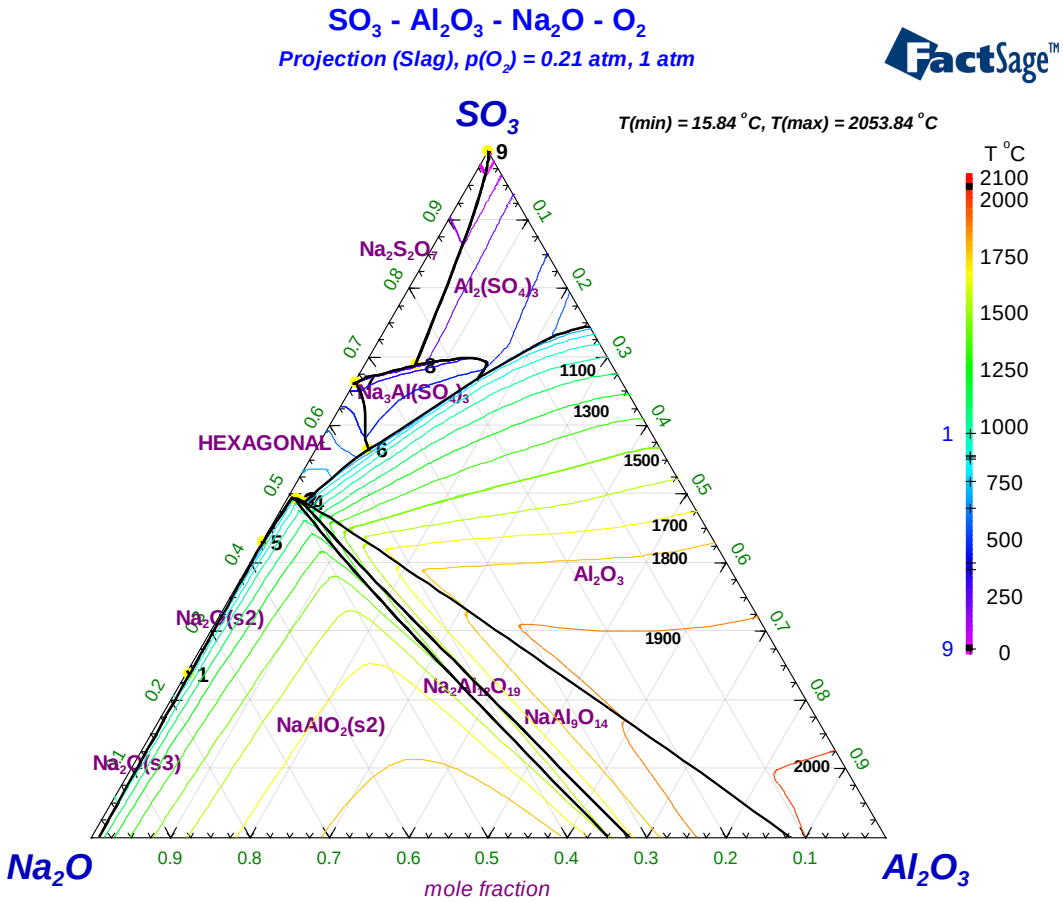

Al_2O_3 - MnO - SiO_2
Projection (Slag), 1 atm
SiO_2
Cristobalite
$2MnO\cdot 2Al_2O_3\cdot 5SiO_2$
$MnSiO_3$
$3MnO\cdot Al_2O_3\cdot 3SiO_2$
Mullite
Mn_2SiO_4
1200
1300
1400
1500
1600
1700
Al_2O_3
MeO
SPINEL
MnO
Al_2O_3
percent by weight

Invariant equilibria on the liquidus surface

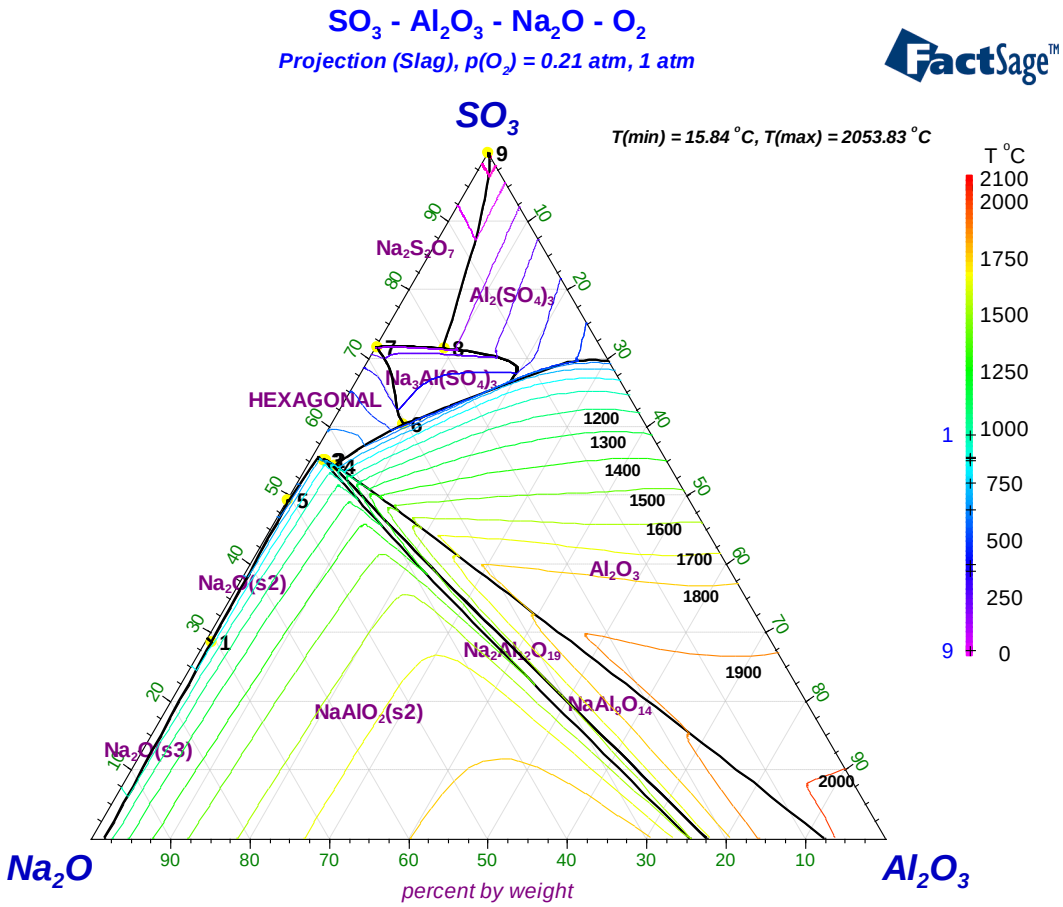
Intersections with slag	Mole fraction					Weight percent				
	A = SiO2, B = MnO, C = Al2O3					A = SiO2, B = MnO, C = Al2O3				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: MeO / Mn2SiO4(s) / SPINEL	1:	0.27470	0.65867	0.06662	1243.54	1.	23.571	66.727	9.701	1243.54
2: MULLITE / Mn2Al4Si5O18(s) / Cristobalite	2:	0.61217	0.25146	0.13637	1191.89	2.	53.878	25.847	20.275	1191.10
3: Al2O3(s) / Mn3Al2Si3O12(s) / SPINEL	3:	0.42369	0.44064	0.13567	1163.44	3.	36.087	44.305	19.609	1163.43
4: Al2O3(s) / MULLITE / Mn3Al2Si3O12(s)	4:	0.46511	0.39314	0.14176	1155.56	4.	39.769	39.665	20.567	1155.51
5: MULLITE /Mn2Al4Si5O18(s)/Mn3Al2Si3O12	5:	0.48642	0.37413	0.13945	1145.09	5.	41.776	37.903	20.321	1145.02
6: Mn2SiO4(s) / Mn3Al2Si3O12(s) / SPINEL	6:	0.40232	0.49743	0.10025	1128.31	6.	34.691	50.640	14.669	1128.31
7: Mn2SiO4(s) / Mn3Al2Si3O12(s) / MnSiO3(s)	7:	0.43532	0.47953	0.08515	1107.48	7.	37.987	49.403	12.610	1107.48
8: Mn2Al4Si5O18/ Mn3Al2Si3O12 / Cristobalite	8:	0.55535	0.32631	0.11834	1096.18	8.	48.691	33.707	17.602	1095.96
9: Mn3Al2Si3O12(s) / MnSiO3(s) / Cristobalite	9:	0.52098	0.37746	0.10156	1090.90	9.	45.754	39.110	15.136	1090.85

Al2O3-Na2O-SO3,

Mole fraction, Liquidussurface

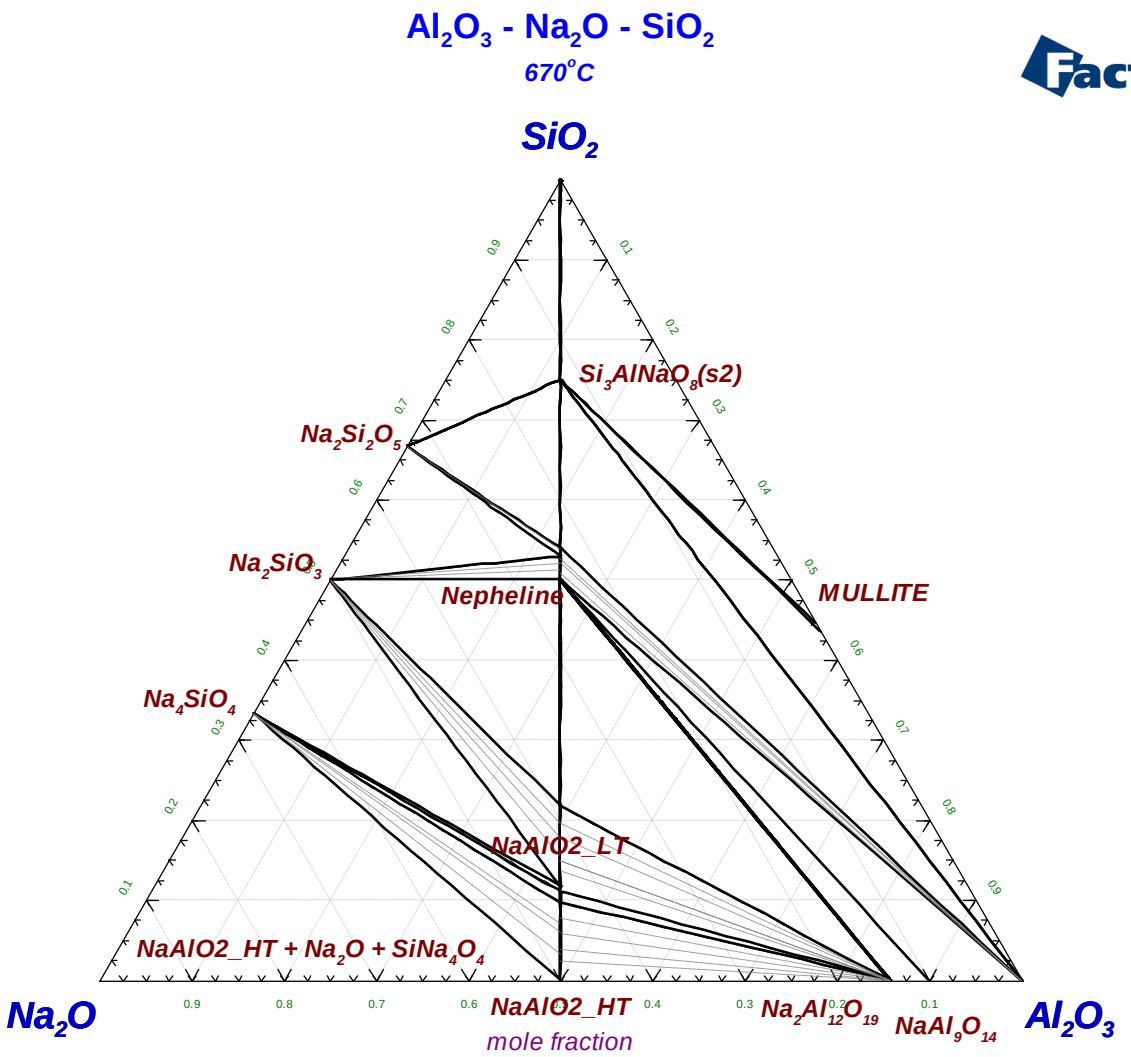


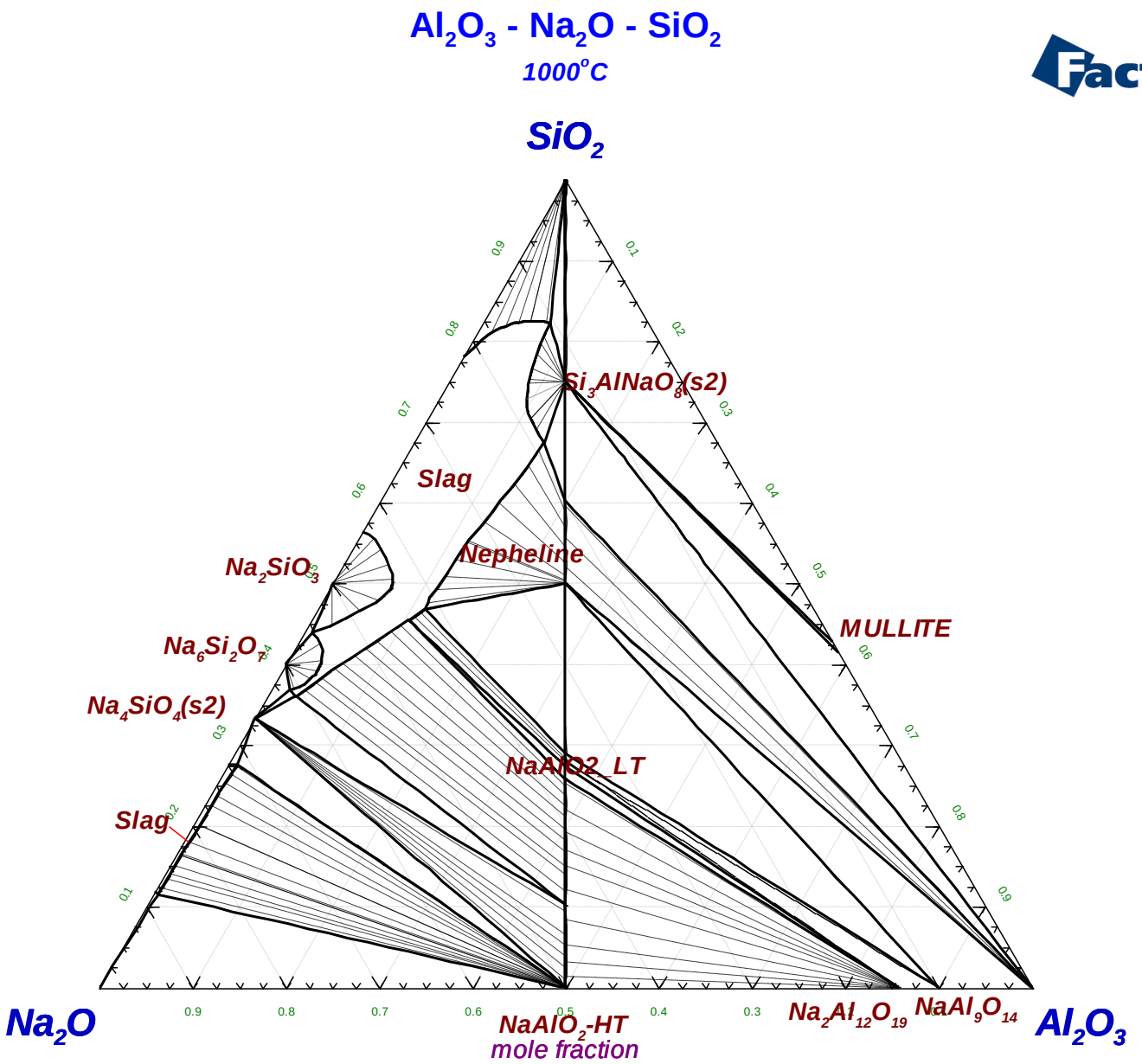
Weight percent, Liquidussurface



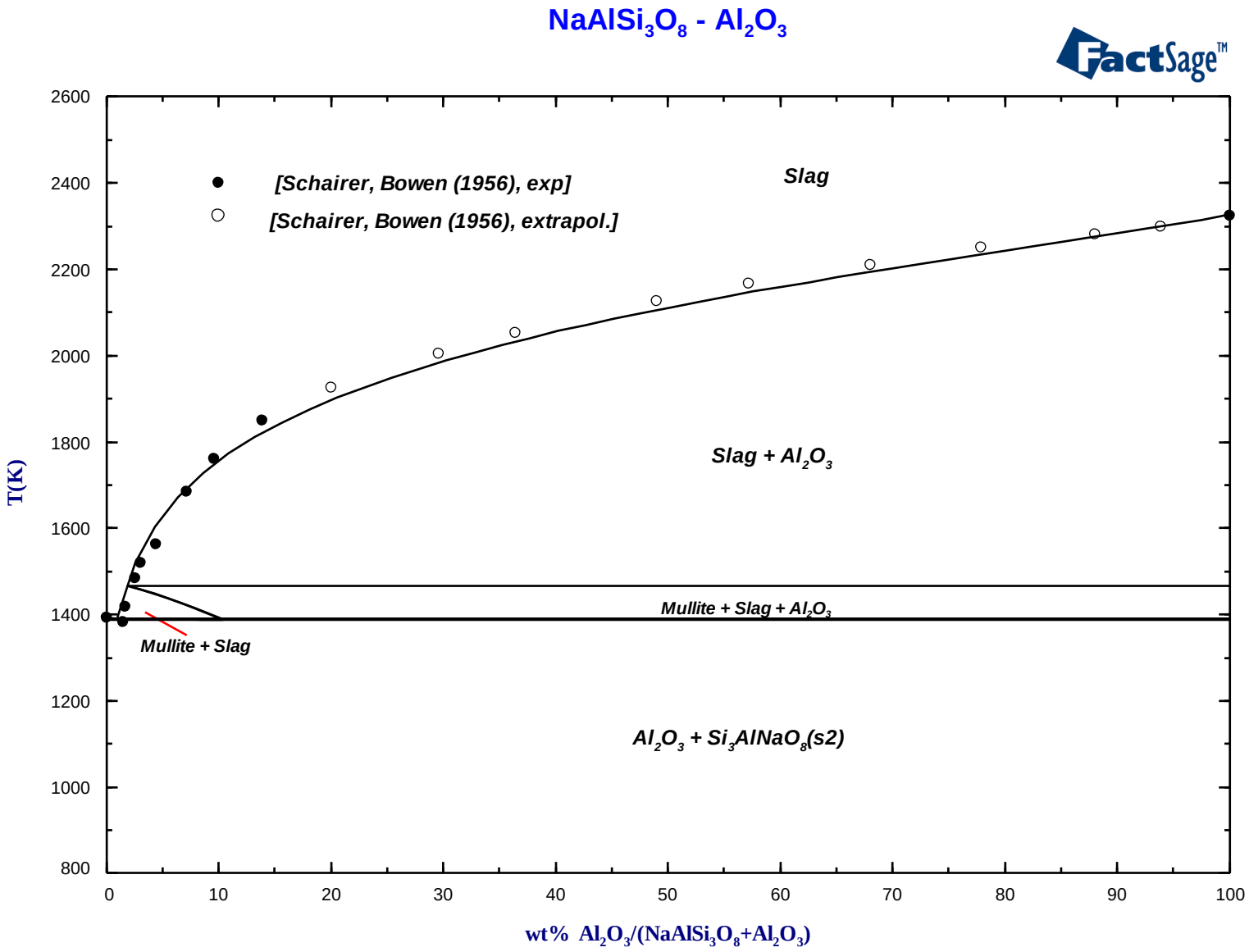
Intersections with slag	Mole fraction				Weight percent			
	A = SO3, B = Na2O, C = Al2O3				A = SO3, B = Na2O, C = Al2O3			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: Na2O(s2) / Na2O(s3) / NaAlO2_HT	1: 0.23775	0.75670	0.00555	970.25	1: 28.624	70.525	0.851	970.05
2. HEXAGONAL / Na2Al12O19 / NaAl9O14	2: 0.49258	0.49367	0.01375	869.36	2: 55.207	42.831	1.963	869.36
3. HEXAGONAL / Na2Al12O19 / NaAlO2_HT	3: 0.49069	0.49672	0.01259	866.27	3: 55.057	43.144	1.799	866.27
4. Al2O3 / HEXAGONAL / NaAl9O14	4: 0.48713	0.48716	0.02571	857.51	4: 54.307	42.043	3.650	857.51
5. Na2O(s2) / Na2SO4(s3) / NaAlO2_HT	5: 0.42893	0.56921	0.00186	756.55	5: 49.193	50.536	0.271	756.55
6. Al2O3 / HEXAGONAL / Na3Al(SO4)3	6: 0.56504	0.36758	0.06737	636.39	6: 60.407	30.421	9.173	636.39
7. HEXAGONAL / Na2S2O7 / Na3Al(SO4)3	7: 0.66179	0.33564	0.00258	394.65	7: 71.553	28.093	0.355	394.70
8. Al2(SO4)3 / Na2S2O7 / Na3Al(SO4)3	8: 0.68748	0.24587	0.06665	365.50	8: 71.412	19.771	8.818	365.50
9. Al2(SO4)3 / Na2S2O7 / SO3	9: 0.99921	0.00017	0.00062	15.84	9: 99.908	0.013	0.079	15.84

Mole fraction kurz unterhalb Liquidussurface

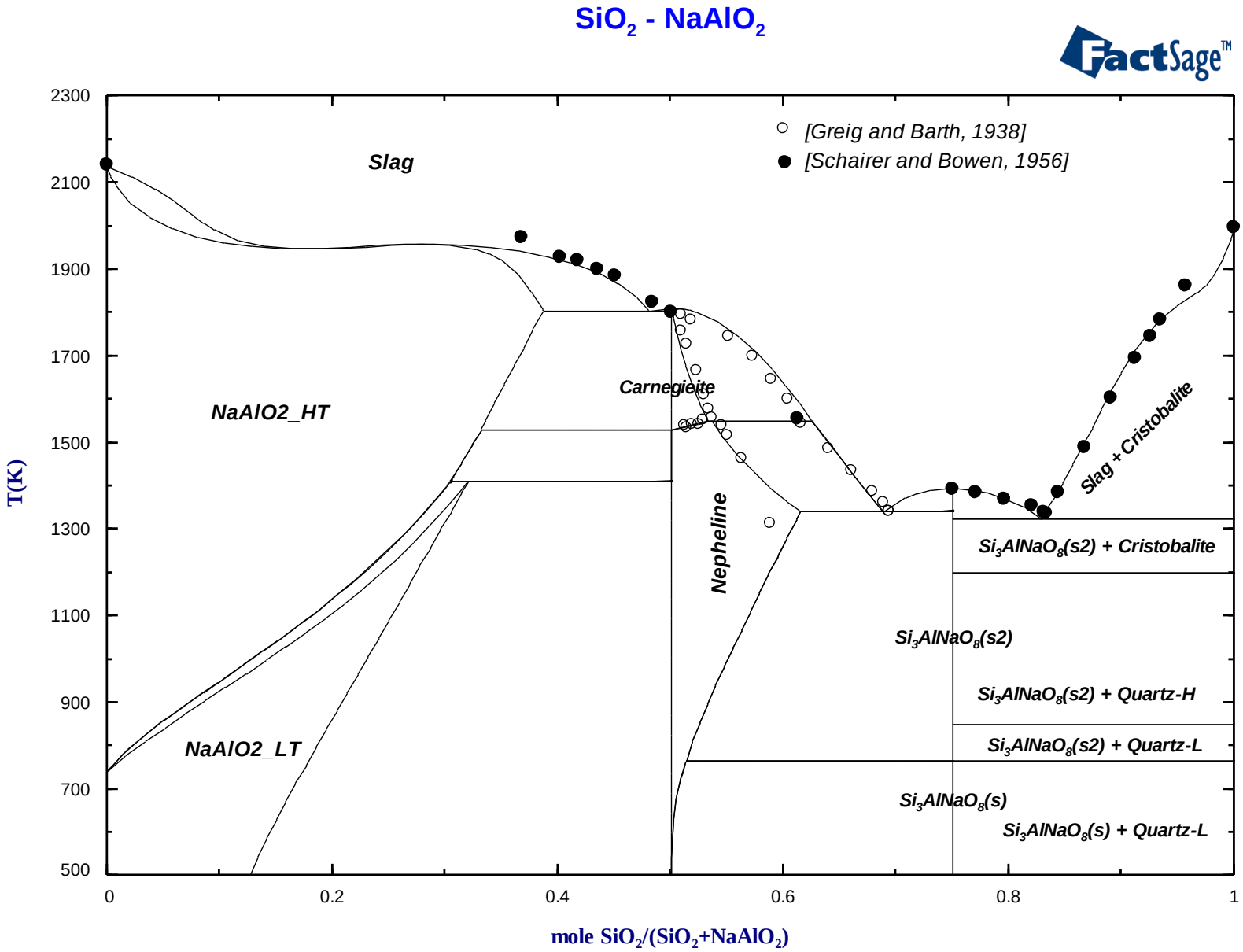



Al_2O_3 - Na_2O - SiO_2
1000°C
SiO_2
Si_3AlNaO_8(s2)
Slag
Nepheline
Na_2SiO_3
$Na_6Si_2O_7$
Na_4SiO_4(s2)
MULLITE
NaAlO2_LT
Slag
Na_2O
$NaAlO_2$-HT
$Na_2Al_{12}O_{19}$
$NaAl_9O_{14}$
Al_2O_3
mole fraction

Weight percent in K
compared with experimental data

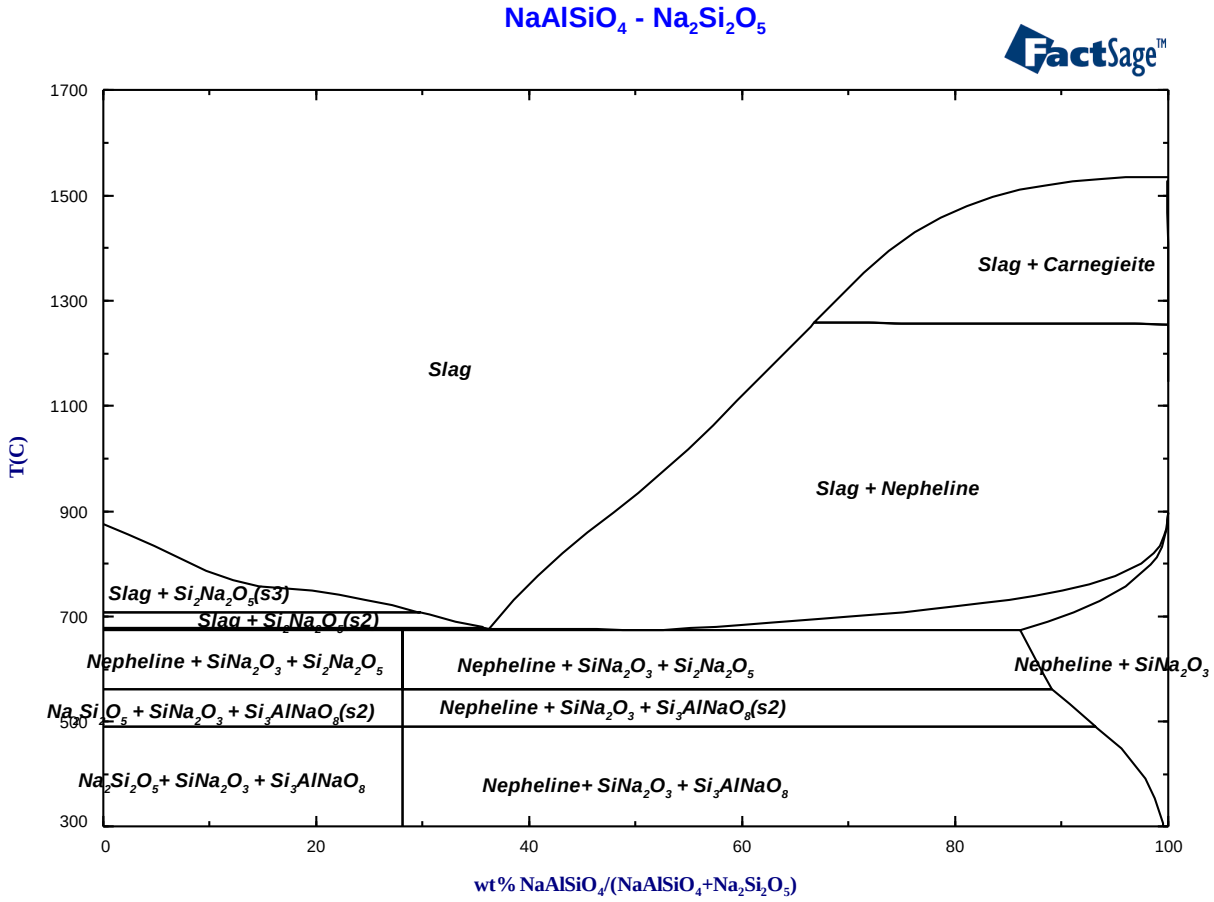


Mole fraction in Kelvin compared with experimental data



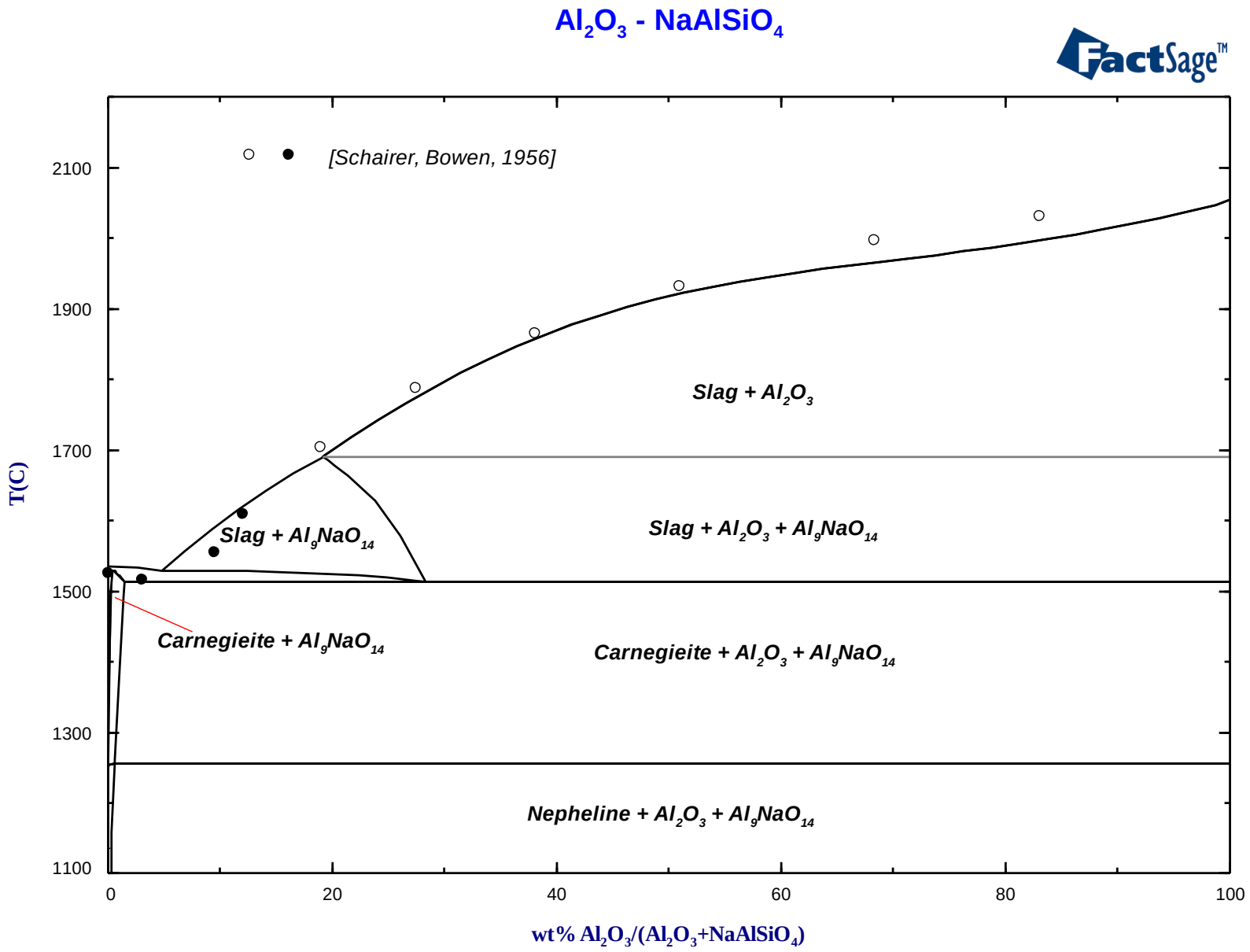
Al2O3-Na2O-SiO2,

Weight percent Na2Si2O5-AlNaSiO4



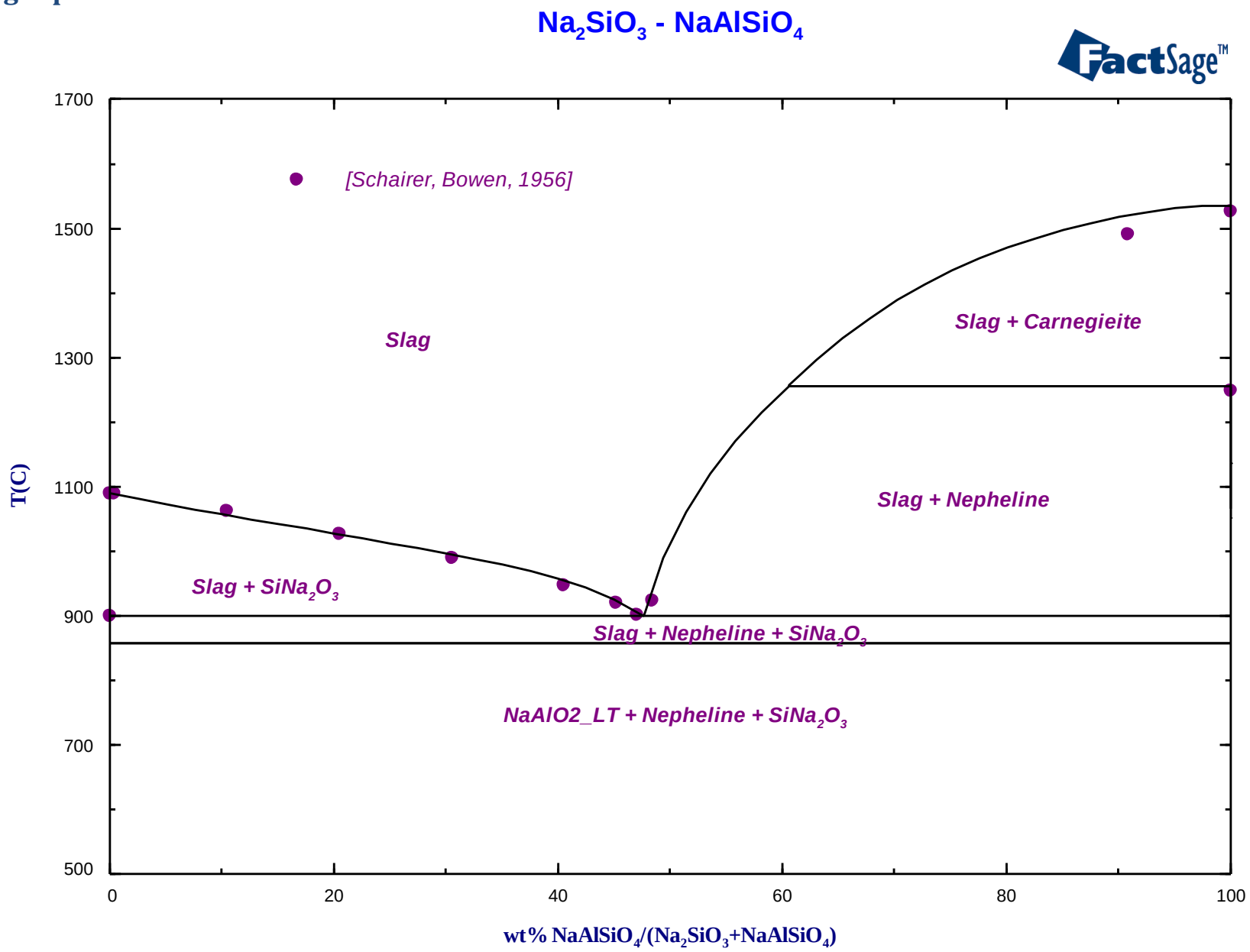
Al2O3-Na2O-SiO2,

Weight percent Al2O3-AlNaSiO4



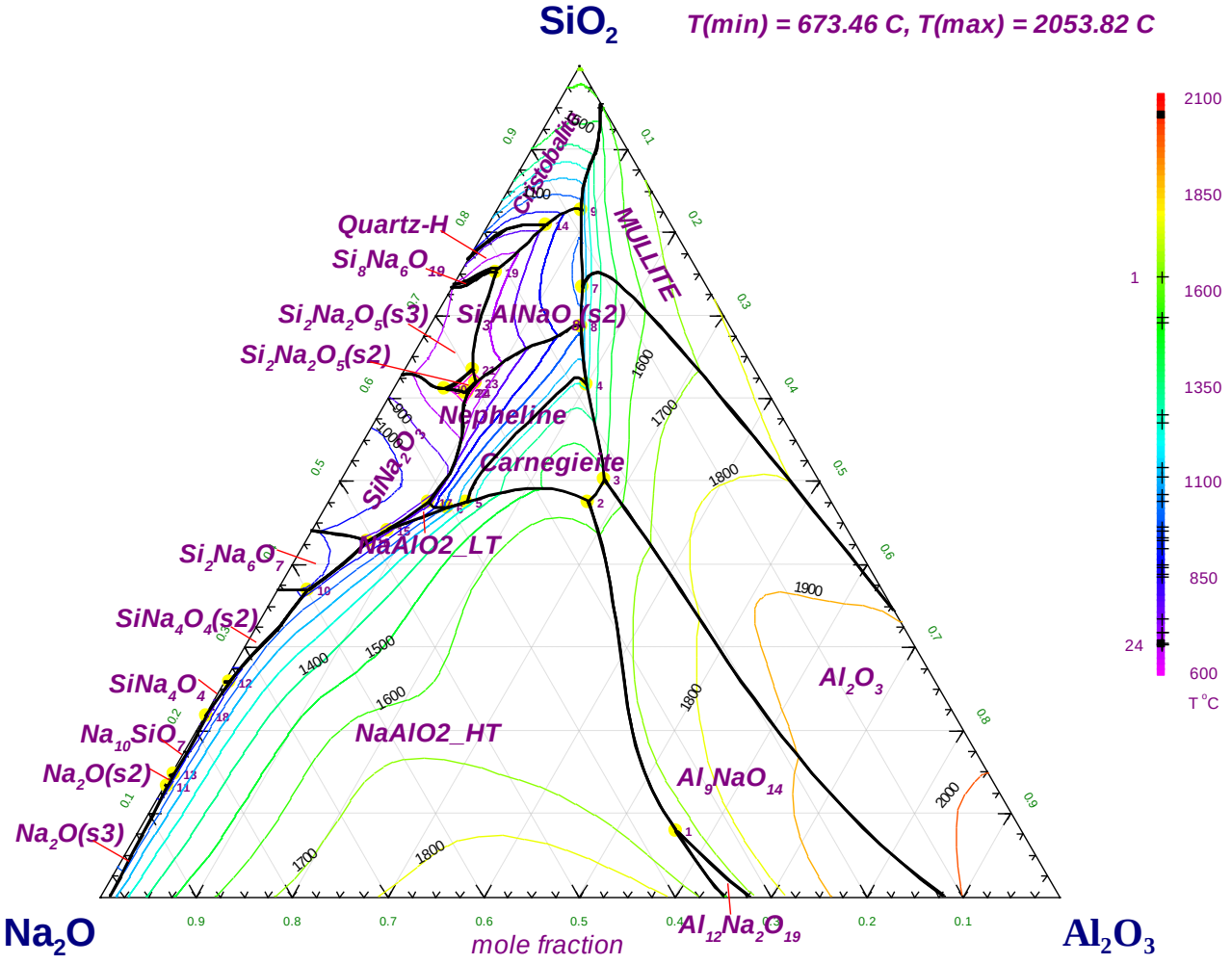
Al2O3-Na2O-SiO2,

Weight percent Na2SiO3-AlNaSiO4

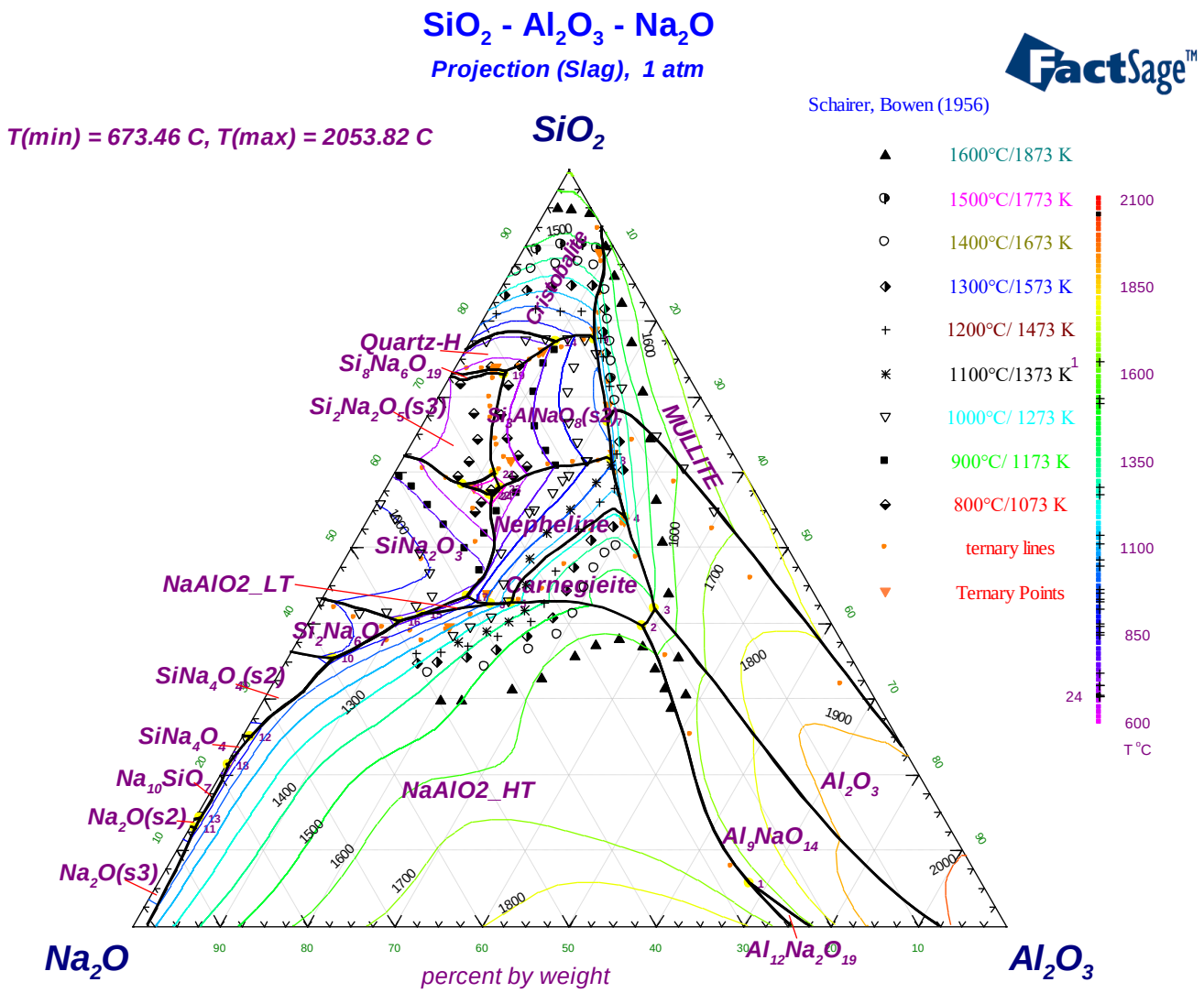


SiO_2 - Al_2O_3 - Na_2O

Projection (Slag), 1 atm



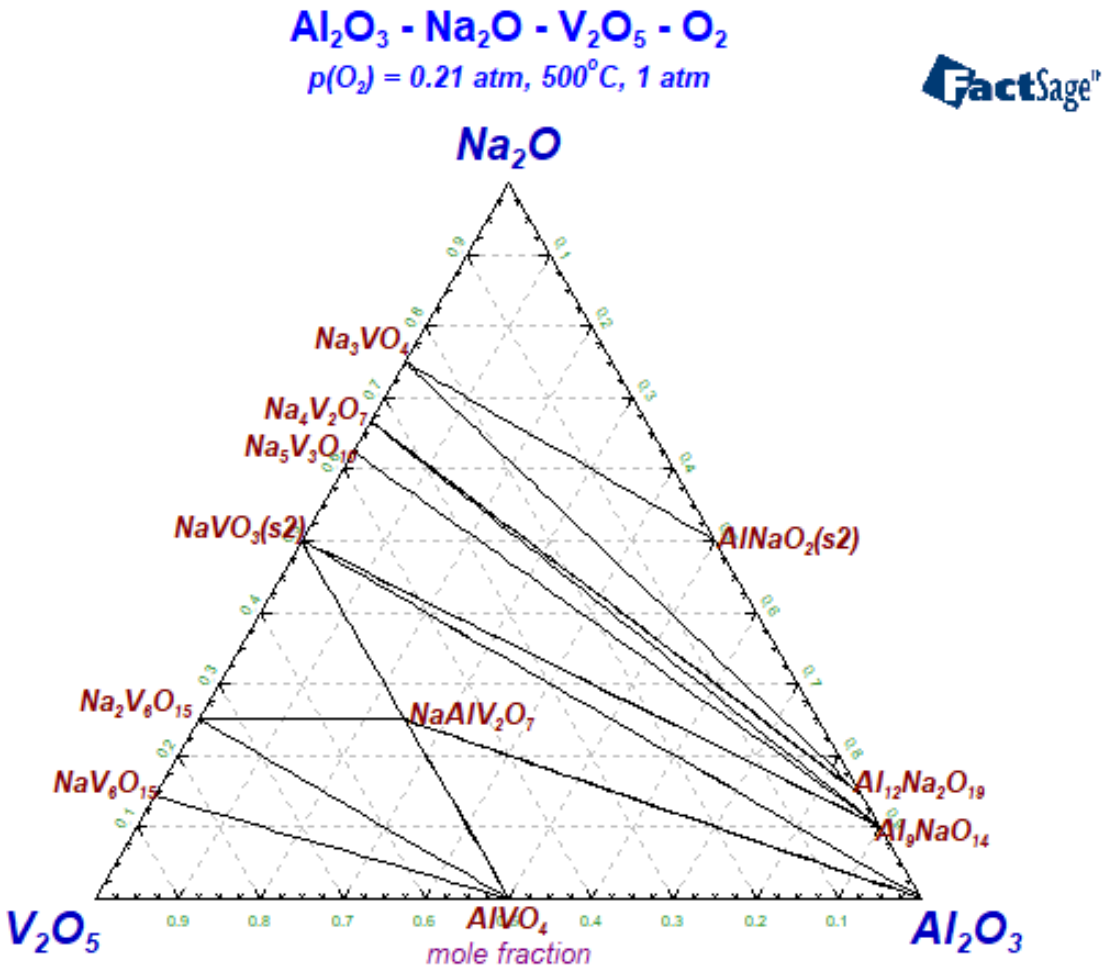
Weight percent
Liquidussurface
compared with experimental data



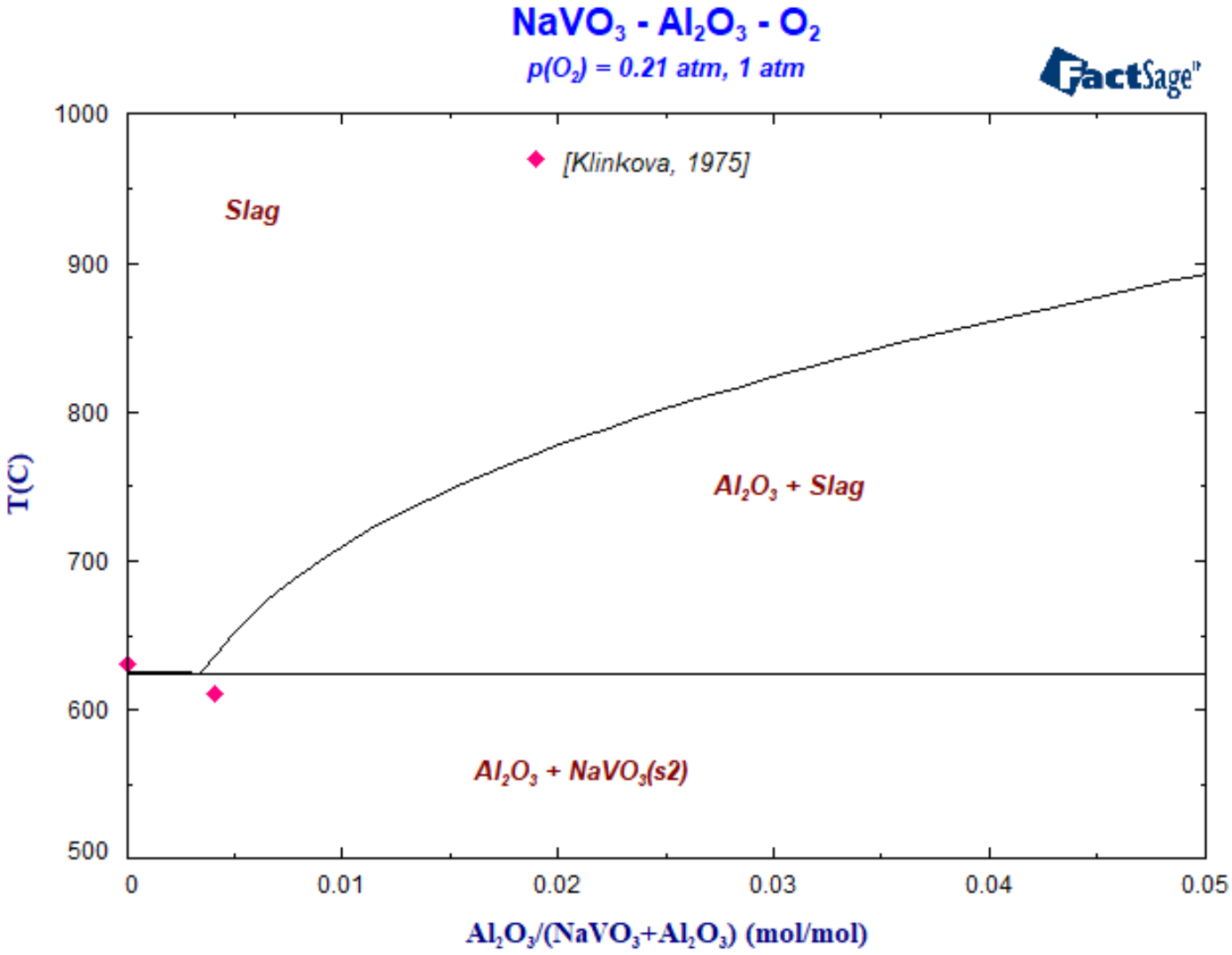
Invariant equilibria on the liquidus surface

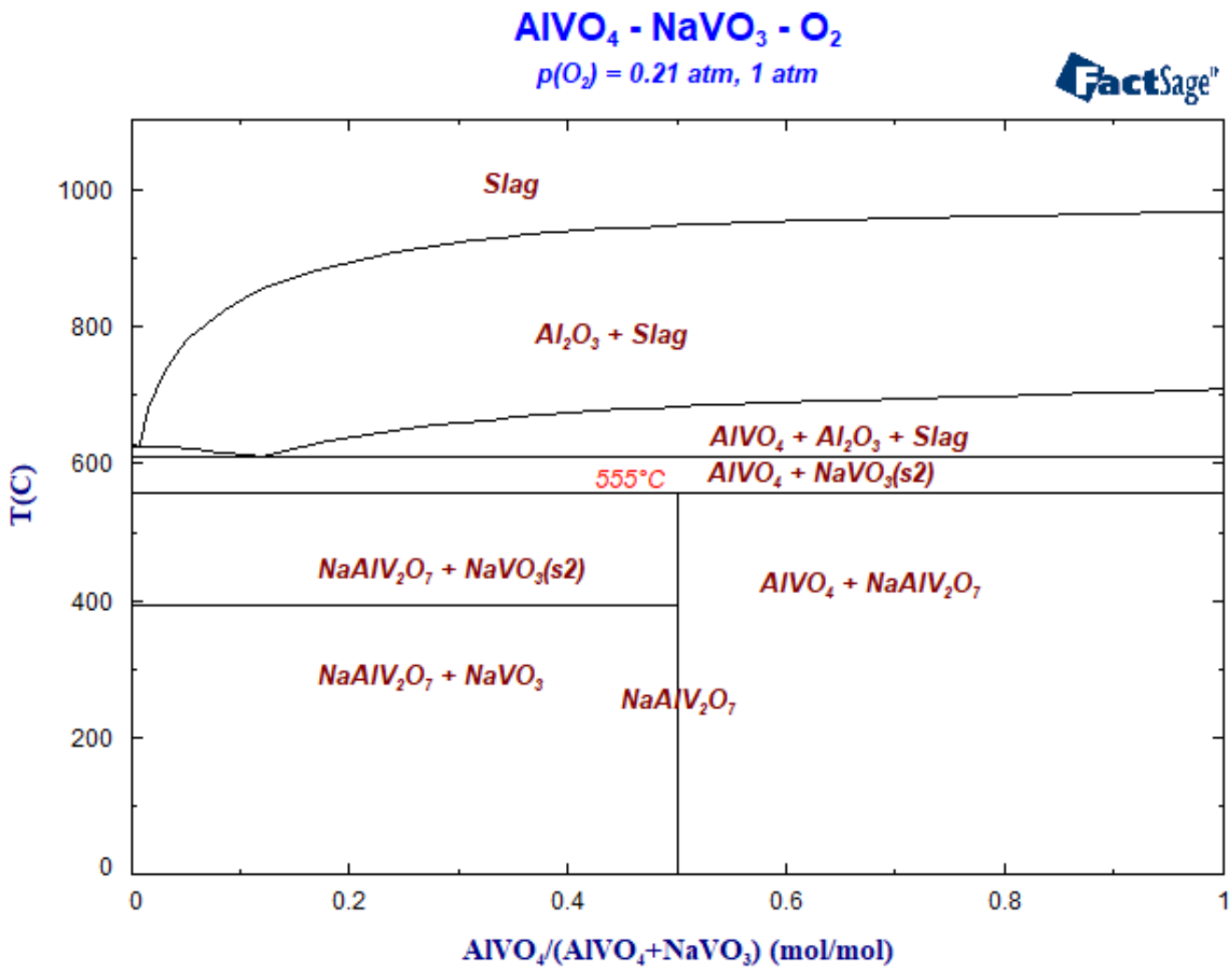
Intersections with slag	Mole fraction					Weight percent				
	A = SiO2, B = Na2O, C = Al2O3					A = SiO2, B = Na2O, C = Al2O3				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: NaAlO2_HT / Al12Na2O19 / Al9NaO14	1:	0.07904	0.35961	0.56135	1635.44	1:	5.635	26.448	67.917	1635.44
2: NaAlO2_HT / Al9NaO14 / Carnegieite	2:	0.47531	0.25265	0.27204	1527.43	2:	39.690	21.762	38.548	1527.52
3: Al2O3 / Al9NaO14 / Carnegieite	3:	0.50191	0.22302	0.27507	1513.34	3:	41.870	19.191	38.939	1513.33
4: Al2O3 / Nepheline / Carnegieite	4:	0.61706	0.18390	0.19903	1275.10	4:	53.915	16.575	29.511	1275.10
5: NaAlO2_HT / Nepheline / Carnegieite	5:	0.47506	0.37976	0.14517	1254.27	5:	42.677	35.192	22.131	1254.25
6: NaAlO2_HT / NaAlO2_LT / Nepheline	6:	0.46891	0.40262	0.12847	1135.85	6:	42.542	37.680	19.778	1135.85
7: Al2O3 / MULLITE / Si3AlNaO8(s2)	7:	0.73308	0.13030	0.13662	1113.74	7:	66.684	12.226	21.089	1113.74
8: Al2O3 / Nepheline / Si3AlNaO8(s2)	8:	0.68690	0.15485	0.15824	1065.25	8:	61.596	14.324	24.080	1065.22
9: MULLITE / Si3AlNaO8(s2) / Cristobalite	9:	0.82633	0.08521	0.08846	1048.31	9:	77.638	8.259	14.103	1047.91
10: NaAlO2_HT / Si2Na6O7 / SiNa4O4(s2)	10:	0.36814	0.59931	0.03256	981.91	10:	35.344	59.353	5.304	981.91
11: NaAlO2_HT / Na2O(s2) / Na2O(s3)	11:	0.13261	0.86305	0.00434	970.05	11:	12.872	86.413	0.715	970.10
12: NaAlO2_HT / SiNa4O4(s2) / SiNa4O4(s)	12:	0.25743	0.73623	0.00634	954.75	12:	25.051	73.902	1.047	954.75
13: NaAlO2_HT / Na10SiO7 / Na2O(s2)	13:	0.14709	0.84917	0.00374	947.32	13:	14.289	85.094	0.617	947.32
14: Si3AlNaO8(s2) / Cristobalite / Quartz_H	14:	0.80861	0.13030	0.06108	926.28	14:	77.255	12.842	9.903	926.28
15: NaAlO2_HT / NaAlO2_LT / SiNa2O3	15:	0.44121	0.47948	0.07931	883.04	15:	41.219	46.207	12.574	883.21
16: NaAlO2_HT / Si2Na6O7 / SiNa2O3	16:	0.42716	0.50753	0.06531	877.08	16:	40.240	49.319	10.441	877.07
17: NaAlO2_LT / Nepheline / SiNa2O3	17:	0.47424	0.41964	0.10612	856.75	17:	43.620	39.816	16.564	856.75
18: NaAlO2_HT / Na10SiO7 / SiNa4O4	18:	0.21799	0.77984	0.00217	850.13	18:	21.245	78.397	0.358	850.13
19: Si2Na2O5(s3) / Si3AlNaO8(s2) / Si8Na6O19	19:	0.75226	0.21050	0.03724	740.89	19:	72.852	21.028	6.120	740.90
20: Si2Na2O5(s3) / Si2Na2O5(s2) / SiNa2O3	20:	0.61107	0.33553	0.05341	706.86	20:	58.319	33.032	8.649	706.86
21: Si2Na2O5(s3)/ Si2Na2O5(s2) / Si3AlNaO8(s2)	21:	0.63436	0.29392	0.07173	706.86	21:	59.887	28.622	11.491	706.84
22: Si2Na2O5 / Si2Na2O5(s2) / SiNa2O3	22:	0.60692	0.31578	0.07729	677.84	22:	57.051	30.620	12.329	677.84
23: Nepheline / Si2Na2O5 / Si3AlNaO8(s2)	23:	0.61802	0.29929	0.08269	676.53	23:	57.918	28.932	13.150	676.53
24: Nepheline / Si2Na2O5 / SiNa2O3	24:	0.60592	0.31364	0.08043	673.54	24:	56.843	30.352	12.805	673.46

Al2O3-Na2O-V2O5, Mole fraction 500°C

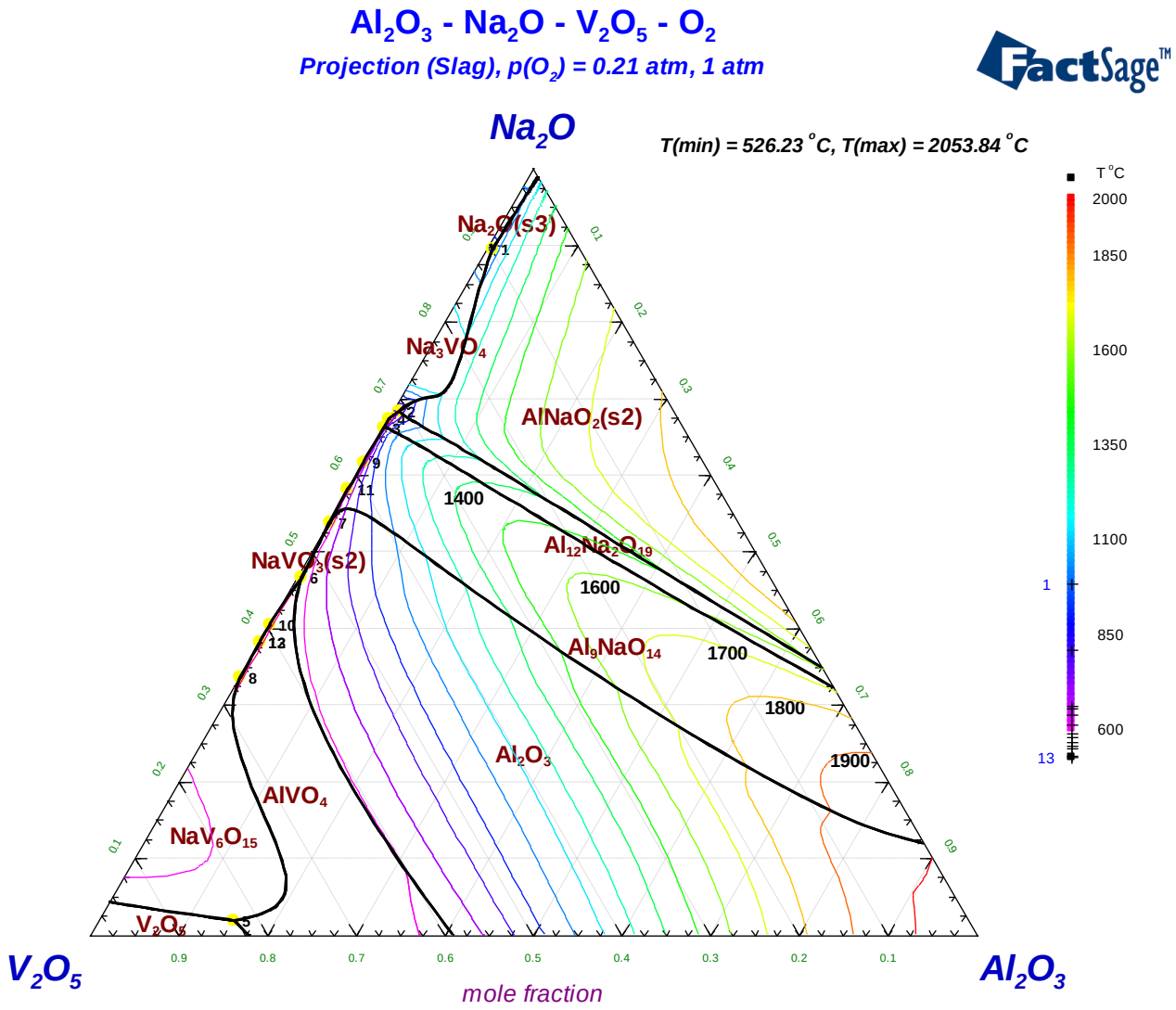


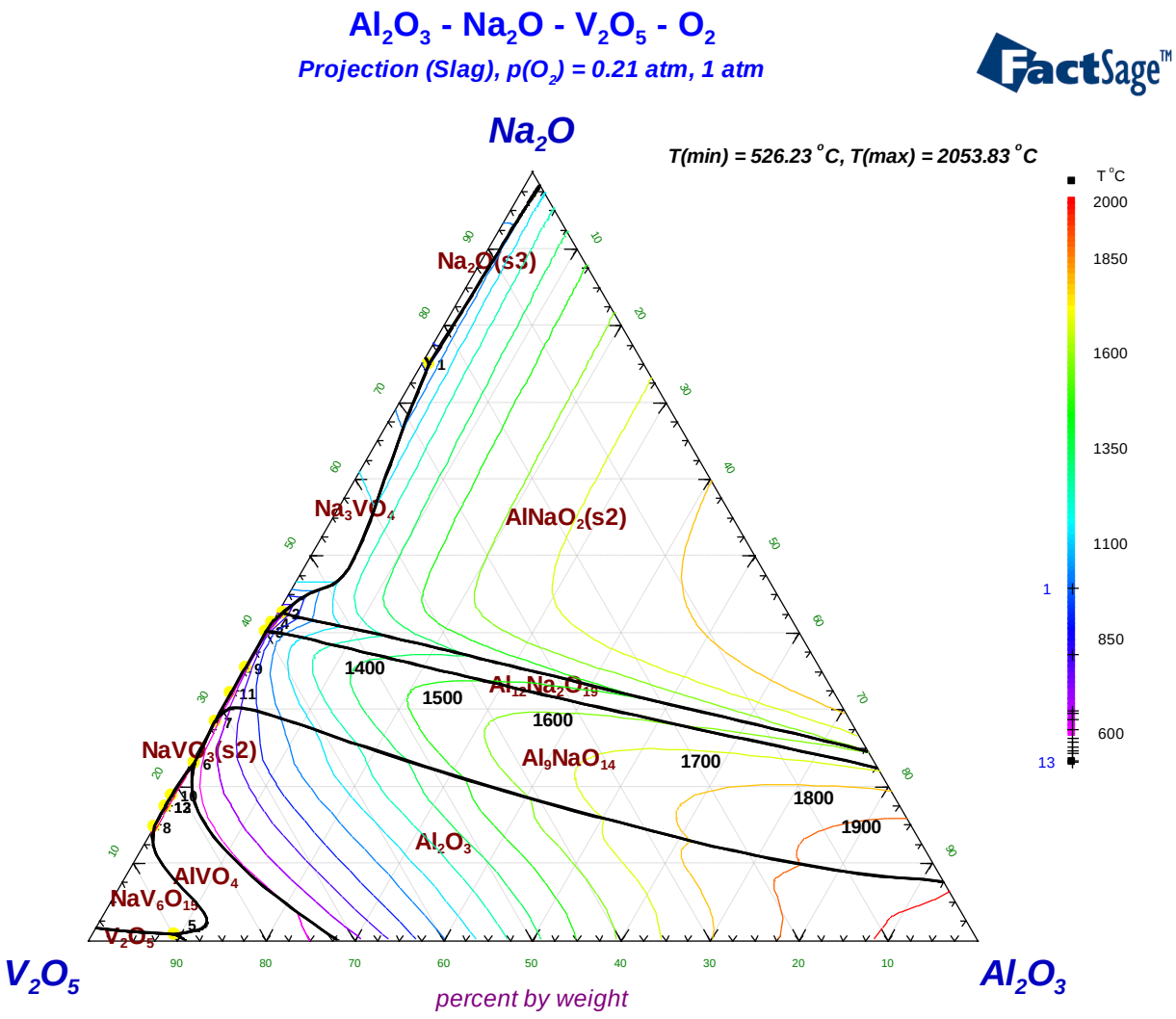
Al2O3-Na2O-V2O5, Mole fraction, Isopleth Al_2O_3-$NaVO_3$





T_m of $NaAlV_2O_7$ is unknown, over 550°C [Fotiev 1983].

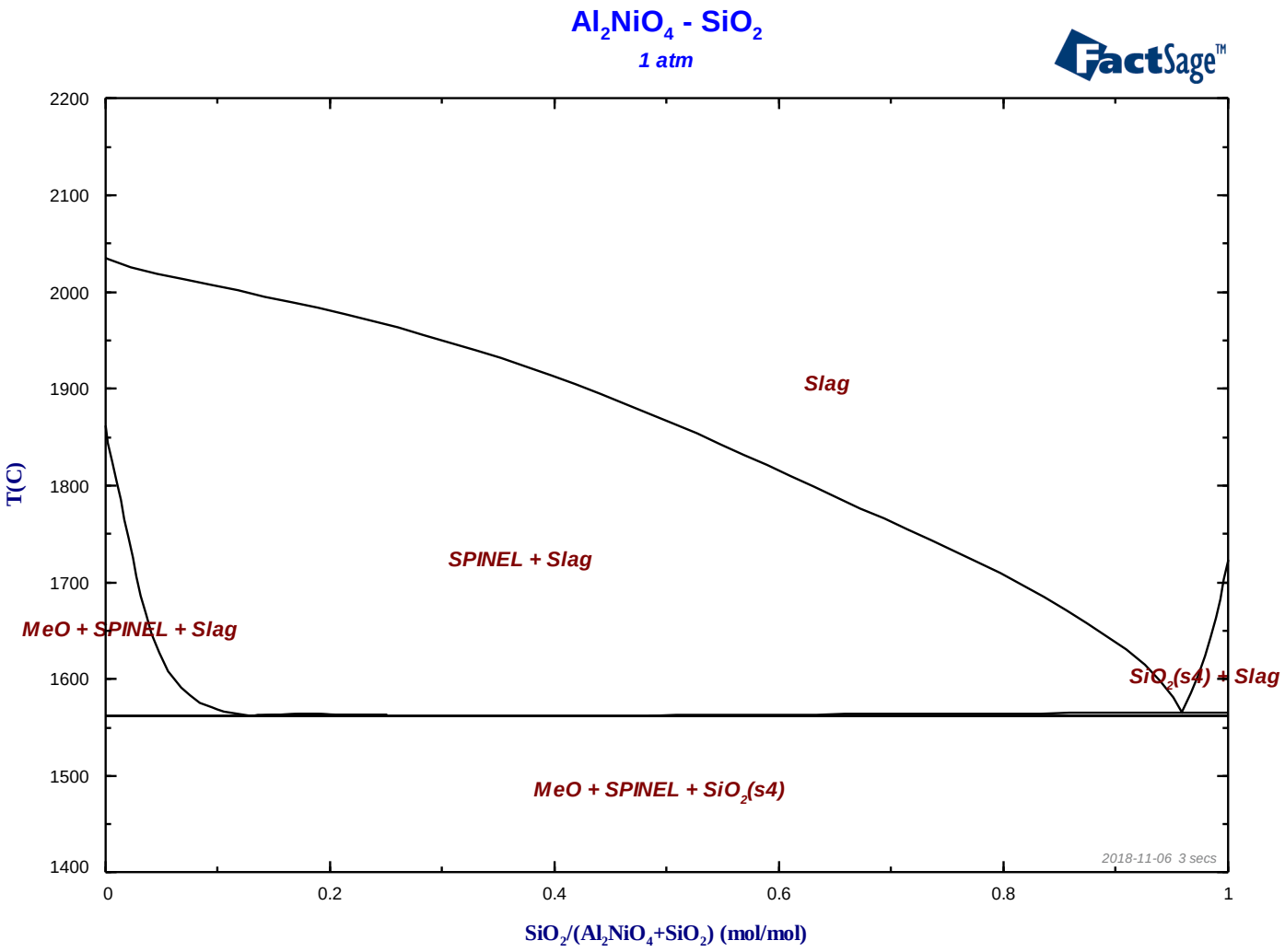

Al2O3 - Na2O - V2O5 - O2
Projection (Slag), p(O2) = 0.21 atm, 1 atm
FactSage™
Na2O
T(min) = 526.23 °C, T(max) = 2053.84 °C
T °C
2000
1850
1600
1350
1100
850
600
Na2O(s3)
Na3VO4
AlNaO2(s2)
Al12Na2O19
Al9NaO14
NaVO3(s2)
Al2O3
AlVO4
NaV6O15
V2O5
1400
1600
1700
1800
1900
V2O5
Al2O3
mole fraction


Al_2O_3 - Na_2O - V_2O_5 - O_2
Projection (Slag), $p(O_2)$ = 0.21 atm, 1 atm
FactSage™
Na_2O
T(min) = 526.23 °C, T(max) = 2053.83 °C
T °C
2000
1850
1600
1350
1100
850
600
$Na_2O(s3)$
Na_3VO_4
$AlNaO_2(s2)$
$Al_{12}Na_2O_{19}$
Al_9NaO_{14}
$NaVO_3(s2)$
Al_2O_3
$AlVO_4$
NaV_6O_{15}
V_2O_5
1400
1500
1600
1700
1800
1900
V_2O_5
Al_2O_3
percent by weight

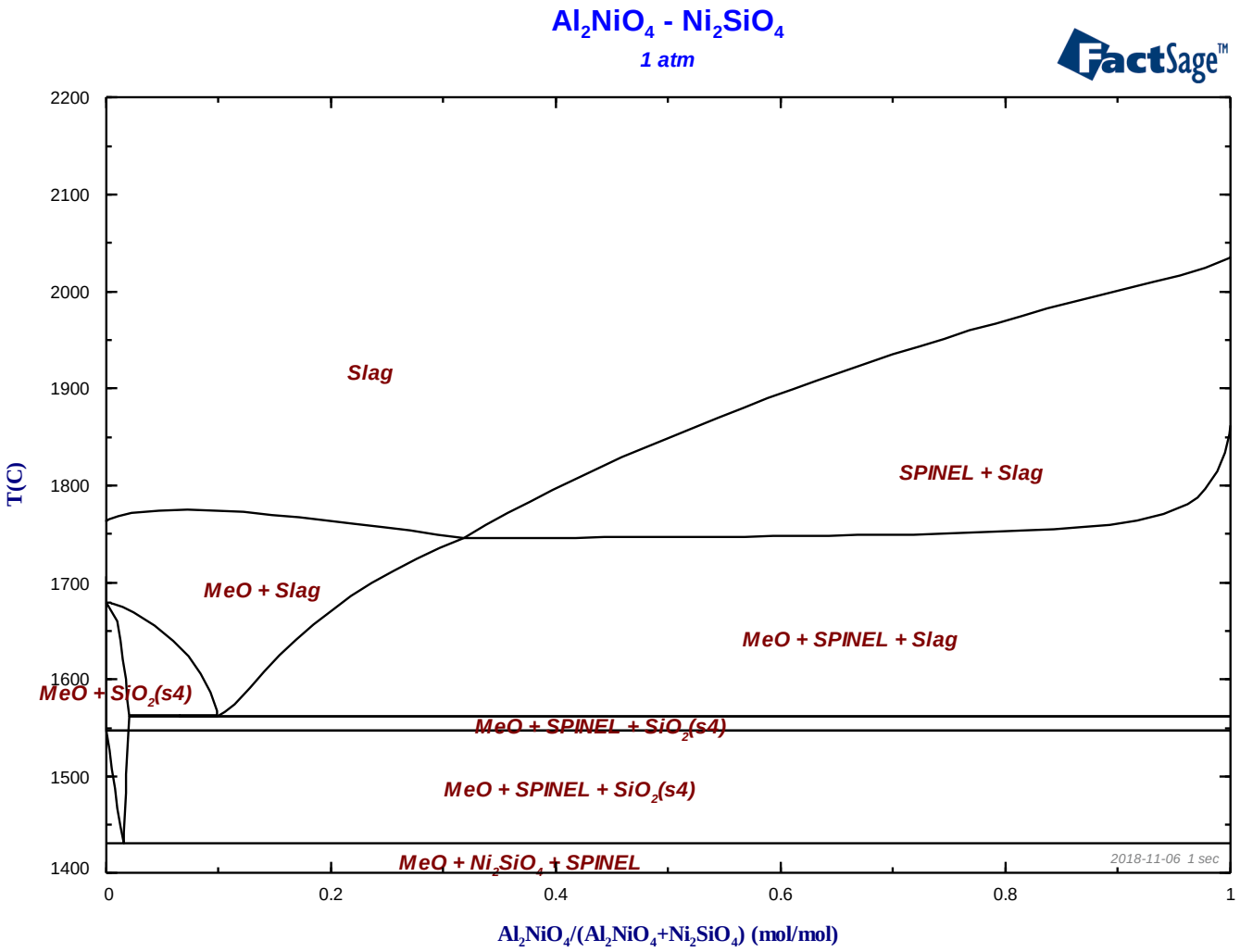
Invariant equilibria on the liquidus surface

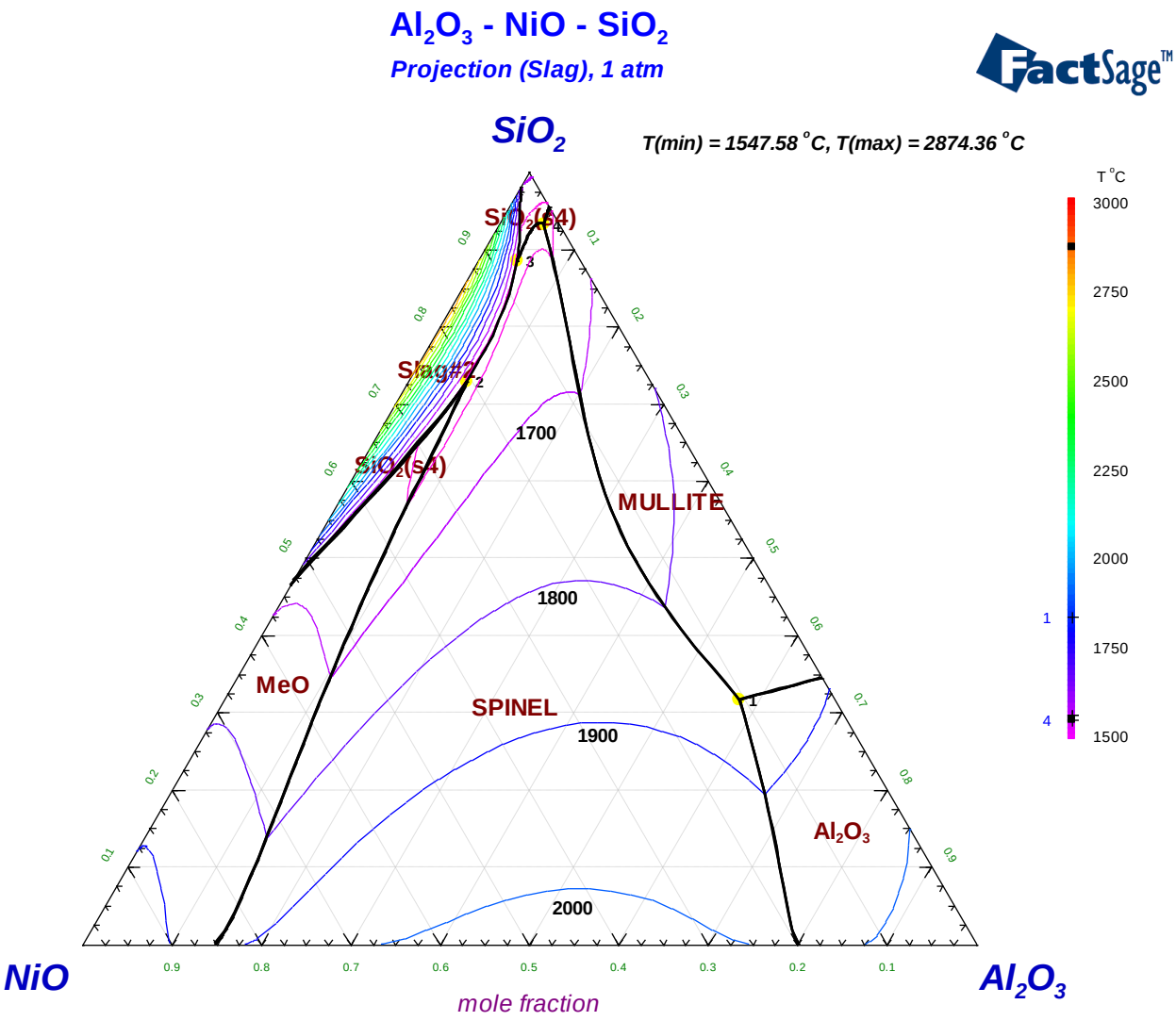
Intersections with slag	Mole fraction					Weight percent				
	A = Na2O, B = V2O5, C = Al2O3					A = Na2O, B = V2O5, C = Al2O3				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: AlNaO2(s2) / Na2O(s3) / Na3VO4	1:	0.89537	0.09806	0.00656	981.14	1:	74.993	24.102	0.904	981.14
2: Al12Na2O19 / AlNaO2(s2) / Na3VO4	2:	0.68336	0.31017	0.00647	808.42	2:	42.597	56.739	0.664	809.08
3: Al12Na2O19 / Al9NaO14 / Na4V2O7	3:	0.66268	0.33711	0.00021	659.32	3:	40.107	59.872	0.021	659.34
4: Al12Na2O19 / Na3VO4 / Na4V2O7	4:	0.67385	0.32557	0.00058	652.94	4:	41.335	58.606	0.059	652.75
5: AlVO4 / NaV6O15 / V2O5	5:	0.01911	0.82842	0.15248	637.59	5:	0.707	90.006	9.287	637.59
6: Al2O3 / AlVO4 / NaVO3(s2)	6:	0.46580	0.52852	0.00569	609.78	6:	22.990	76.549	0.462	609.78
7: Al2O3 / Al9NaO14 / NaVO3(s2)	7:	0.53853	0.46039	0.00109	589.08	7:	28.473	71.432	0.095	589.09
8: AlVO4 / Na2V6O15 / NaV6O15	8:	0.33588	0.66259	0.00153	578.13	8:	14.714	85.176	0.110	578.13
9: Al9NaO14 / Na4V2O7 / Na5V3O10	9:	0.61654	0.38338	0.00008	564.36	9:	35.398	64.594	0.008	564.38
10: AlVO4 / NaAlV2O7 / NaVO3(s2)	10:	0.40504	0.59458	0.00038	555.01	10:	18.835	81.136	0.029	555.01
11: Al9NaO14 / Na5V3O10 / NaVO3(s2)	11:	0.58186	0.41797	0.00017	546.70	11:	32.170	67.815	0.015	546.70
12: AlVO4 / Na2V6O15 / NaAlV2O7	12:	0.38161	0.61828	0.00010	527.46	12:	17.376	82.616	0.008	527.45
13: Na2V6O15 / NaAlV2O7 / NaVO3(s2)	13:	0.38243	0.61748	0.00009	526.23	13:	17.426	82.567	0.007	526.23

Mole fraction, Isopleth NiAl2O4-SiO2

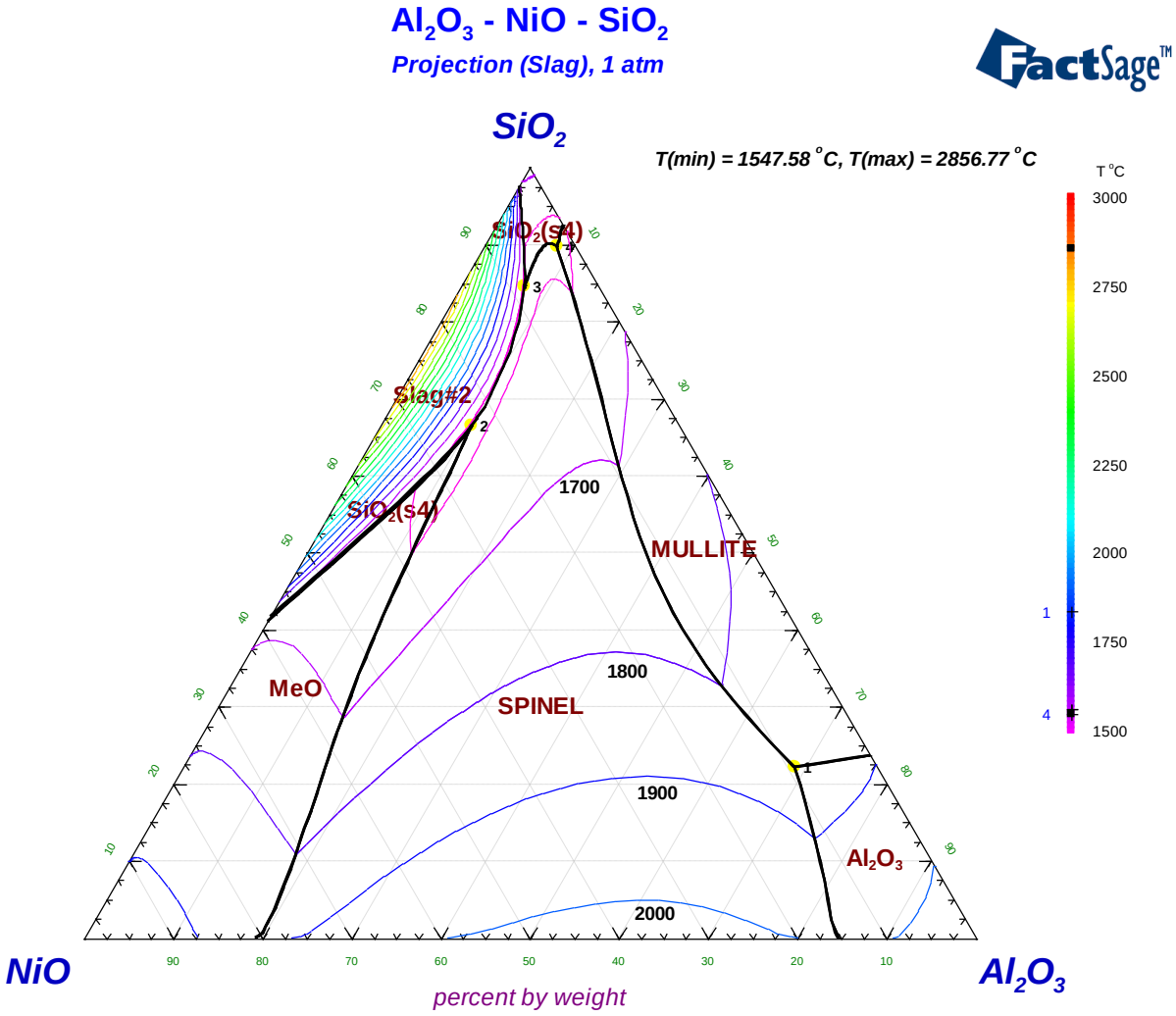


Mole fraction, Isopleth NiAl2O4-Ni2SiO4




Al2O3 - NiO - SiO2
Projection (Slag), 1 atm
FactSage™
SiO2
T(min) = 1547.58 °C, T(max) = 2874.36 °C
T °C
3000
2750
2500
2250
2000
1750
1500
SiO2(S4)
Slag#2
SiO2(S4)
MULLITE
MeO
SPINEL
Al2O3
1700
1800
1900
2000
NiO
Al2O3
mole fraction

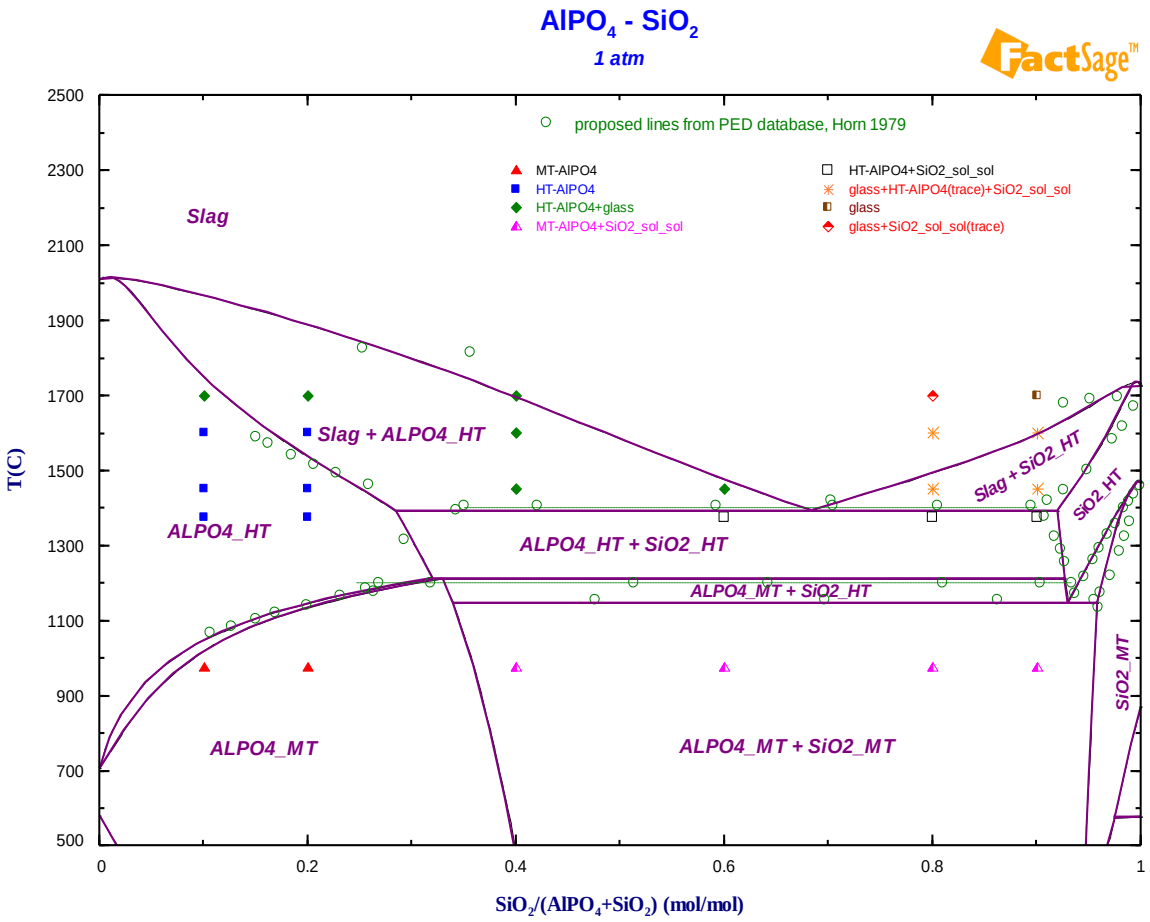
Weight percent, Liquidus surface



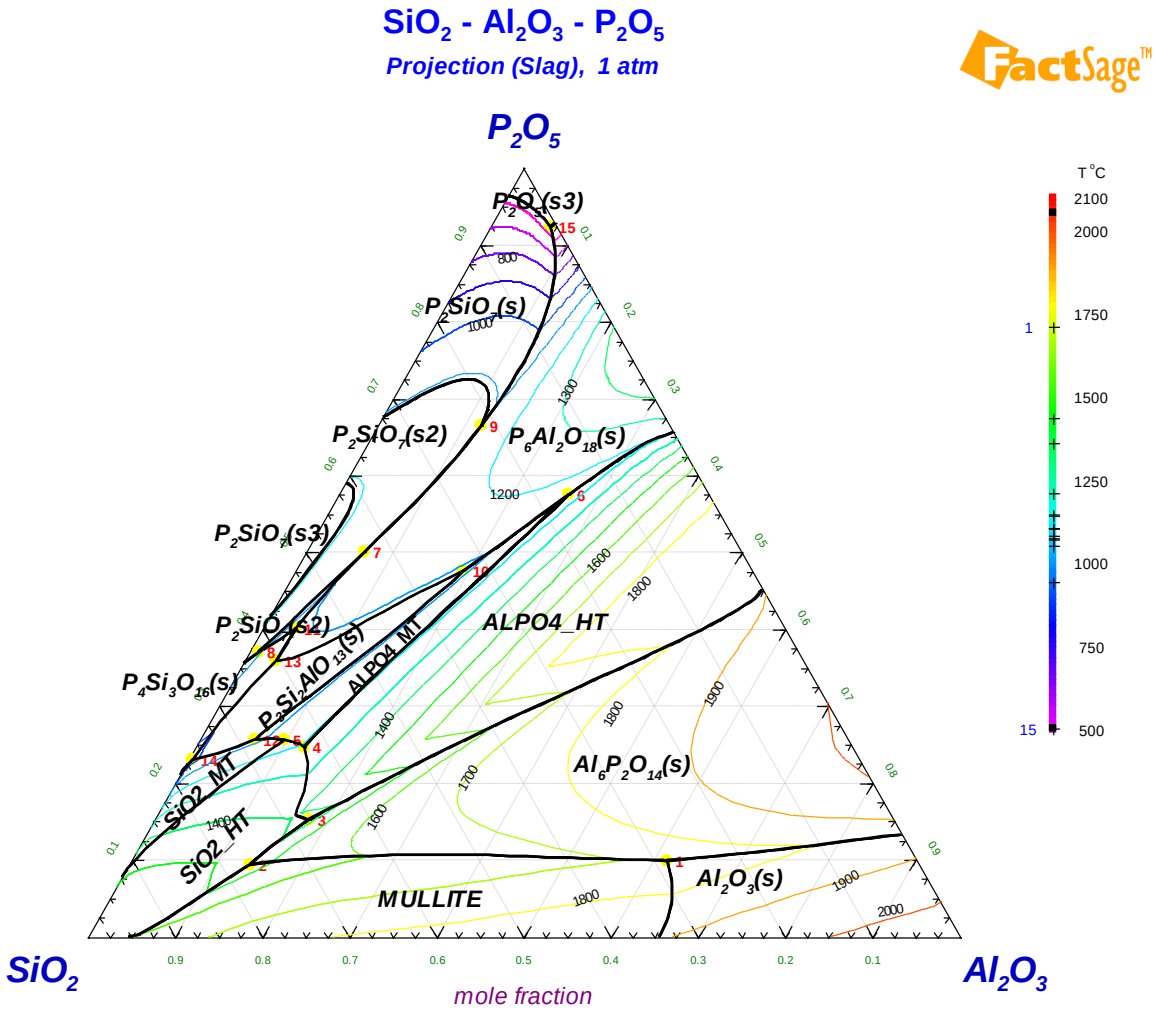
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction					Weight percent				
	A = SiO2, B = NiO, C = Al2O3					A = SiO2, B = NiO, C = Al2O3				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1 Al2O3 / MULLITE / SPINEL	1:	0.31666	0.10609	0.57726	1837.07	1:	22.173	9.234	68.593	1837.07
2. MeO / SiO2(s4) / Slag#2	2:	0.72872	0.20527	0.06601	1562.08	2:	66.495	23.285	10.221	1562.08
3. MeO / SiO2(s4) / Slag#2	3:	0.88580	0.07008	0.04411	1562.07	3:	84.541	8.315	7.144	1562.08
4. MULLITE / SPINEL / SiO2(s4)	4:	0.93279	0.01723	0.04998	1547.60	4:	89.776	2.061	8.163	1547.59

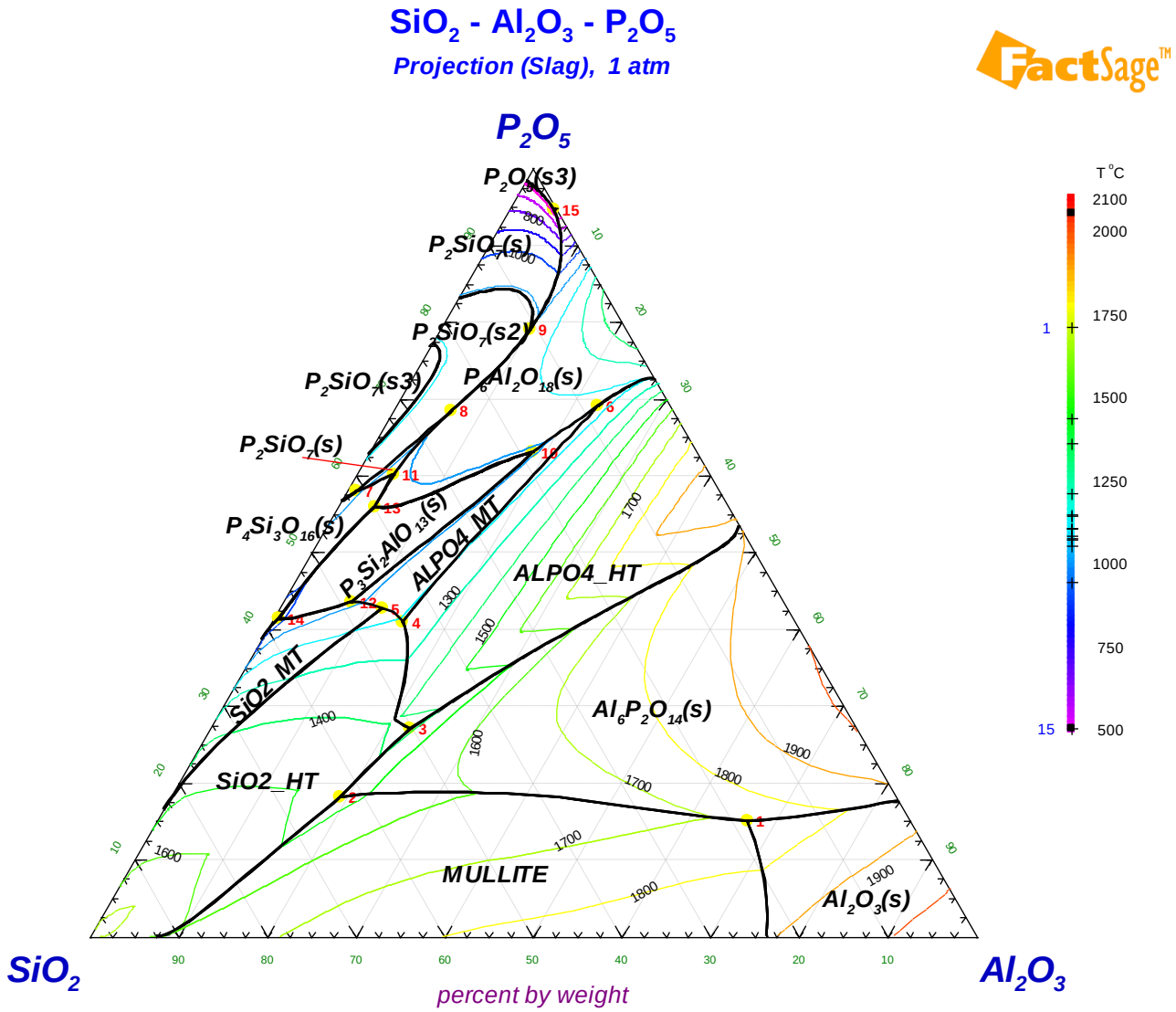
Al2O3-P2O5-SiO2,
Mole fraction, Isopleth AlPO4-SiO2
compared with experimental data



Mole fraction
Liquidussurface



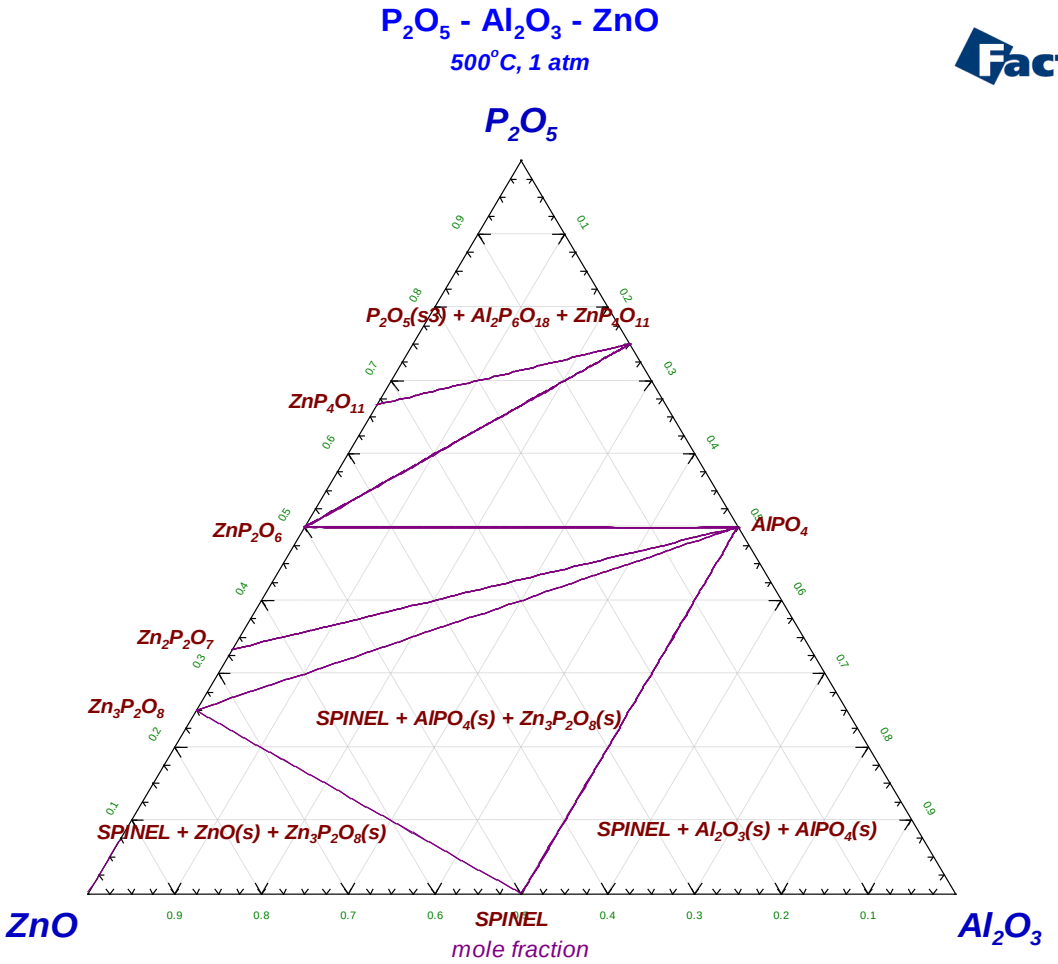
Weight percent, Liquidussurface

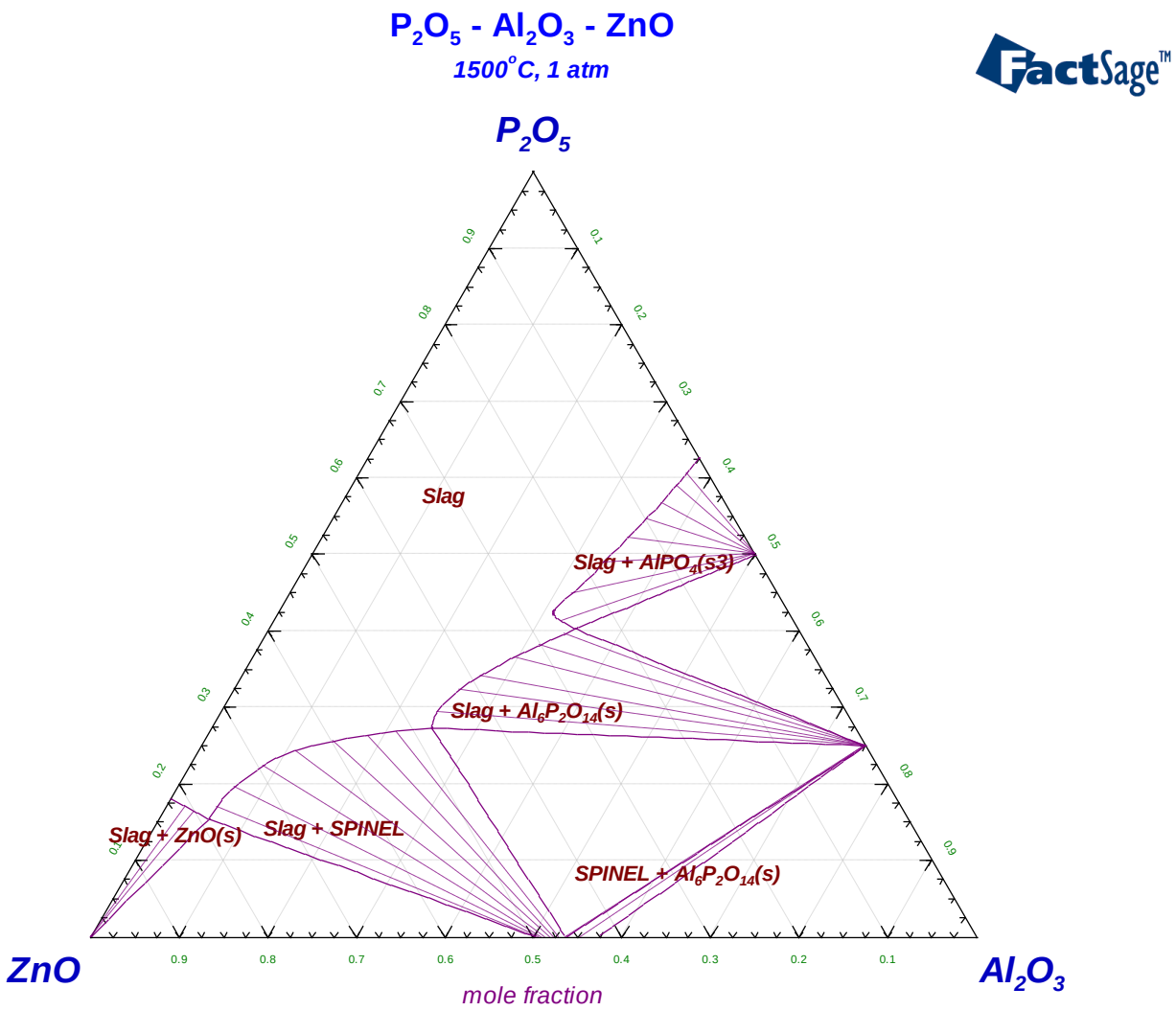


Invariant equilibria on the liquidus surface

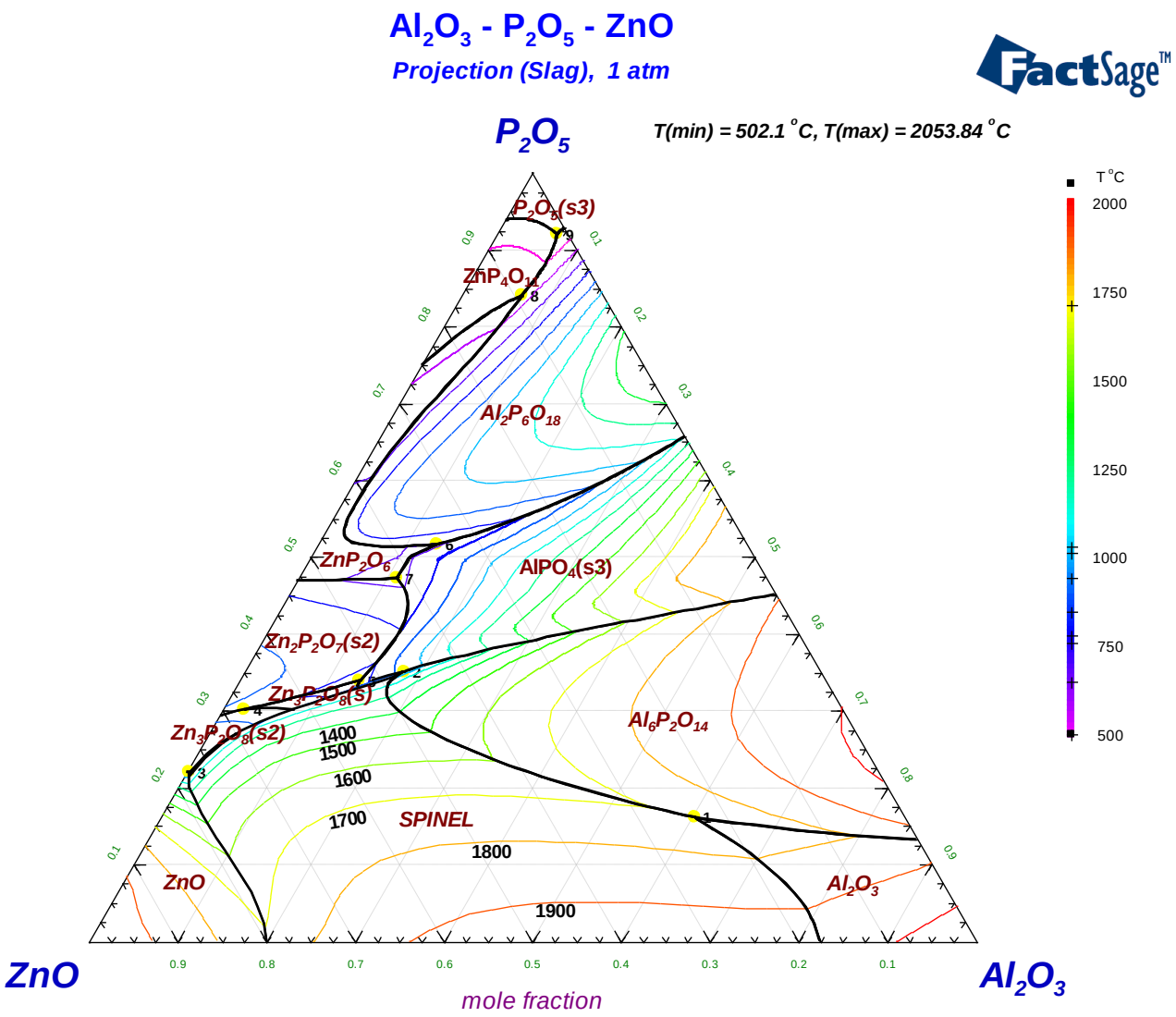
Intersections with slag	Mole fraction				Weight percent			
	A = P2O5, B = SiO2, C = Al2O3				A = P2O5, B = SiO2, C = Al2O3			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: Al2O3 / Al6P2O14 / MULLITE	1: 0.09930	0.28633	0.61437	1713.71	1: 15.005	18.313	66.682	1713.71
2: Al6P2O14 / MULLITE / SiO2_HT	2: 0.09426	0.76757	0.13818	1438.99	2: 18.182	62.673	19.146	1438.99
3: ALPO4_HT / Al6P2O14 / SiO2_HT	3: 0.15263	0.67025	0.17713	1363.07	3: 27.082	50.342	22.576	1363.07
4: ALPO4_HT / ALPO4_MT / SiO2_HT	4: 0.24719	0.62871	0.12409	1212.35	4: 41.031	44.174	14.796	1211.90
5: ALPO4_MT / SiO2_HT / SiO2_MT	5: 0.25660	0.64630	0.09709	1147.36	5: 42.773	45.602	11.626	1147.35
6: ALPO4_HT / ALPO4_MT / P6Al2O18	6: 0.57563	0.16021	0.26416	1145.80	6: 69.087	8.139	22.774	1145.80
7: P2SiO7(s1) / P2SiO7(s2) / P6Al2O18	7: 0.50067	0.43266	0.06666	1106.85	7: 57.986	40.930	1.084	1106.85
8: P2SiO7(s1) / P2SiO7(s2) / P4Si3O16	8: 0.37126	0.61908	0.00966	1106.85	8: 68.426	25.029	6.545	1106.85
9: P2SiO7(s1) / P2SiO7(s2) / P6Al2O18	9: 0.66526	0.21631	0.11843	1106.85	9: 79.020	10.876	10.104	1106.85
10: ALPO4_MT / P3Si2AlO13 / P6Al2O18	10: 0.47613	0.33117	0.19270	1083.41	10: 63.086	18.574	18.340	1083.41
11: P2SiO7(s1) / P4Si3O16 / P6Al2O18	11: 0.40127	0.56064	0.03809	1076.64	11: 60.256	35.636	4.109	1076.64
12: ALPO4_MT / P3Si2AlO13 / SiO2_MT	12: 0.25710	0.68001	0.06289	1074.50	12: 43.568	48.777	7.655	1074.50
13: P3Si2AlO13 / P4Si3O16 / P6Al2O18	13: 0.35908	0.60446	0.03646	1053.34	13: 56.007	39.908	4.084	1053.35
14: P3Si2AlO13 / P4Si3O16 / SiO2_MT	14: 0.23087	0.76482	0.00431	945.70	14: 41.396	58.049	0.555	945.63
15: P2O5(s3) / P2SiO7(s1) / P6Al2O18	15: 0.92442	0.00686	0.06872	503.77	15: 94.649	0.297	5.054	503.77

Al2O3-P2O5-ZnO,
Mole fraction, 500°C000°C

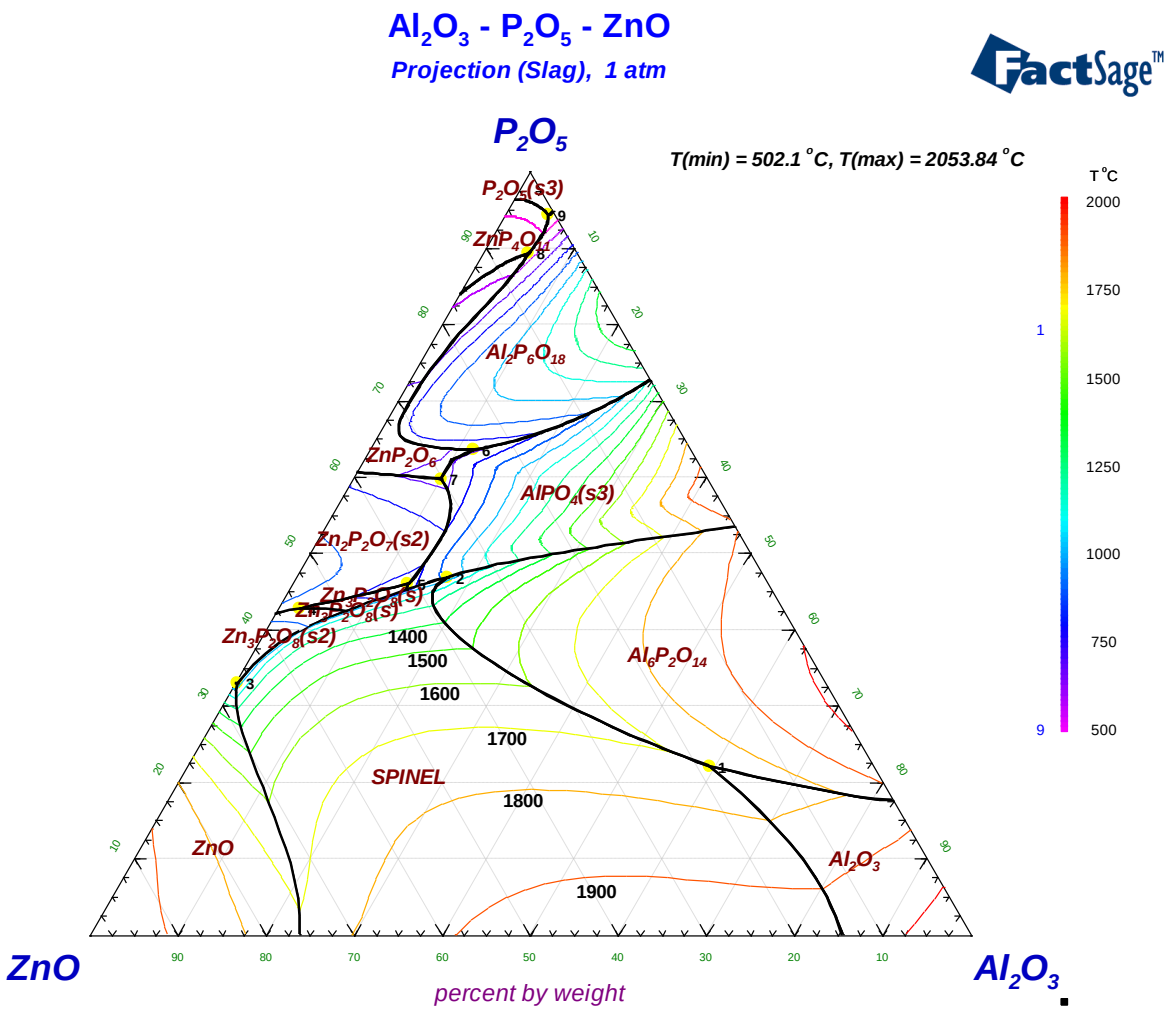



P2O5 - Al2O3 - ZnO
1500°C, 1 atm
P2O5
Slag
Slag + AlPO4(s3)
Slag + Al6P2O14(s)
Slag + ZnO(s)
Slag + SPINEL
SPINEL + Al6P2O14(s)
ZnO
Al2O3
mole fraction

Mole fraction, Liquidusfläche



Weight percent, Liquidusfläche

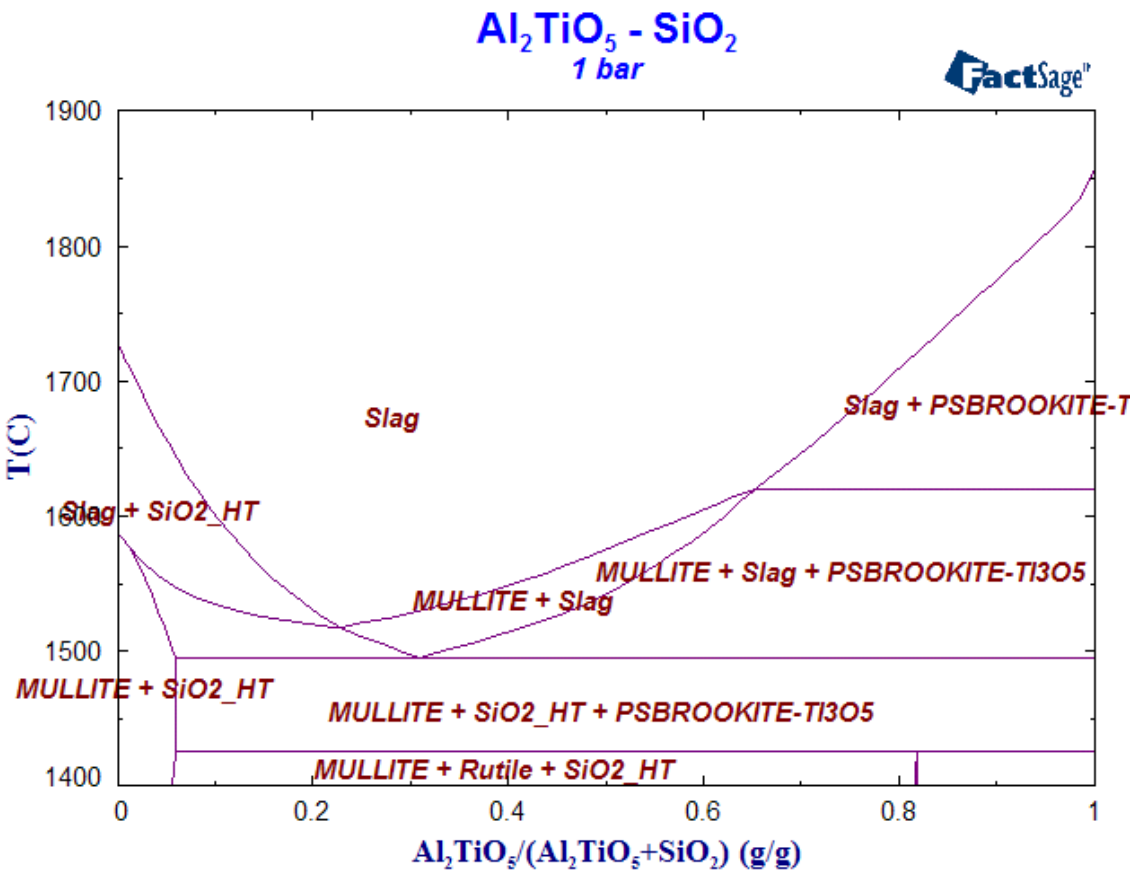


Invariant equilibria on the liquidus surface

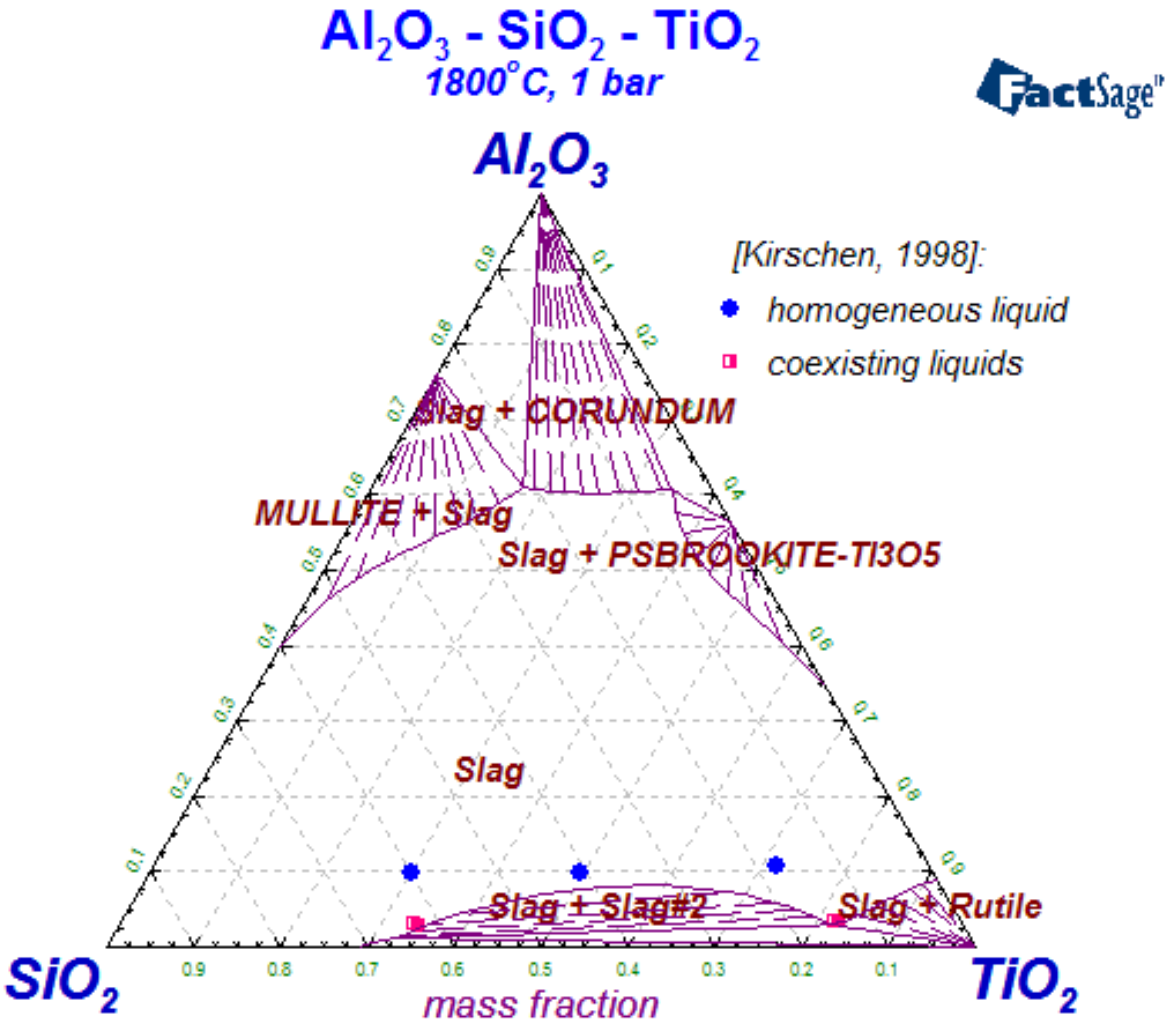
Intersections with slag	Mole fraction				Weight percent			
	A = P2O5, B = ZnO, C = Al2O3				A = P2O5, B = ZnO, C = Al2O3			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: Al2O3 / Al6P2O14 / SPINEL	1: 0.16134	0.23631	0.60235	1711.99	1: 22.116	18.572	59.312	1711.99
2: Al6P2O14 / AlPO4_HT(s3) / SPINEL	2: 0.35132	0.46954	0.17914	1030.66	2: 46.893	35.931	17.176	1030.66
3: SPINEL / Zn3P2O8(s2) / ZnO	3: 0.22022	0.77711	0.00267	1012.31	3: 32.983	66.730	0.287	1012.31
4: Zn2P2O7(s2) / Zn3P2O8(s1) / Zn3P2O8(s2)	4: 0.30179	0.67381	0.02439	941.85	4: 42.770	54.747	2.483	941.85
5: AlPO4_HT(s3) / Zn2P2O7(s2) / Zn3P2O8(s1)	5: 0.33904	0.52568	0.13528	847.71	5: 45.965	40.860	13.175	847.71
6: Al2P6O18 / AlPO4_HT(s3) / ZnP2O6	6: 0.51669	0.34973	0.13358	780.18	6: 63.541	24.658	11.800	780.18
7: AlPO4_HT(s3) / Zn2P2O7(s2) / ZnP2O6	7: 0.47283	0.41678	0.11040	758.37	7: 59.770	30.205	10.025	758.38
8: Al2P6O18 / ZnP2O6 / ZnP4O11	8: 0.84063	0.09155	0.06782	649.99	8: 89.254	5.573	5.172	649.99
9: Al2P6O18 / P2O5(s3) / ZnP4O11	9: 0.92069	0.01222	0.06709	502.10	9: 94.344	0.718	4.938	502.10

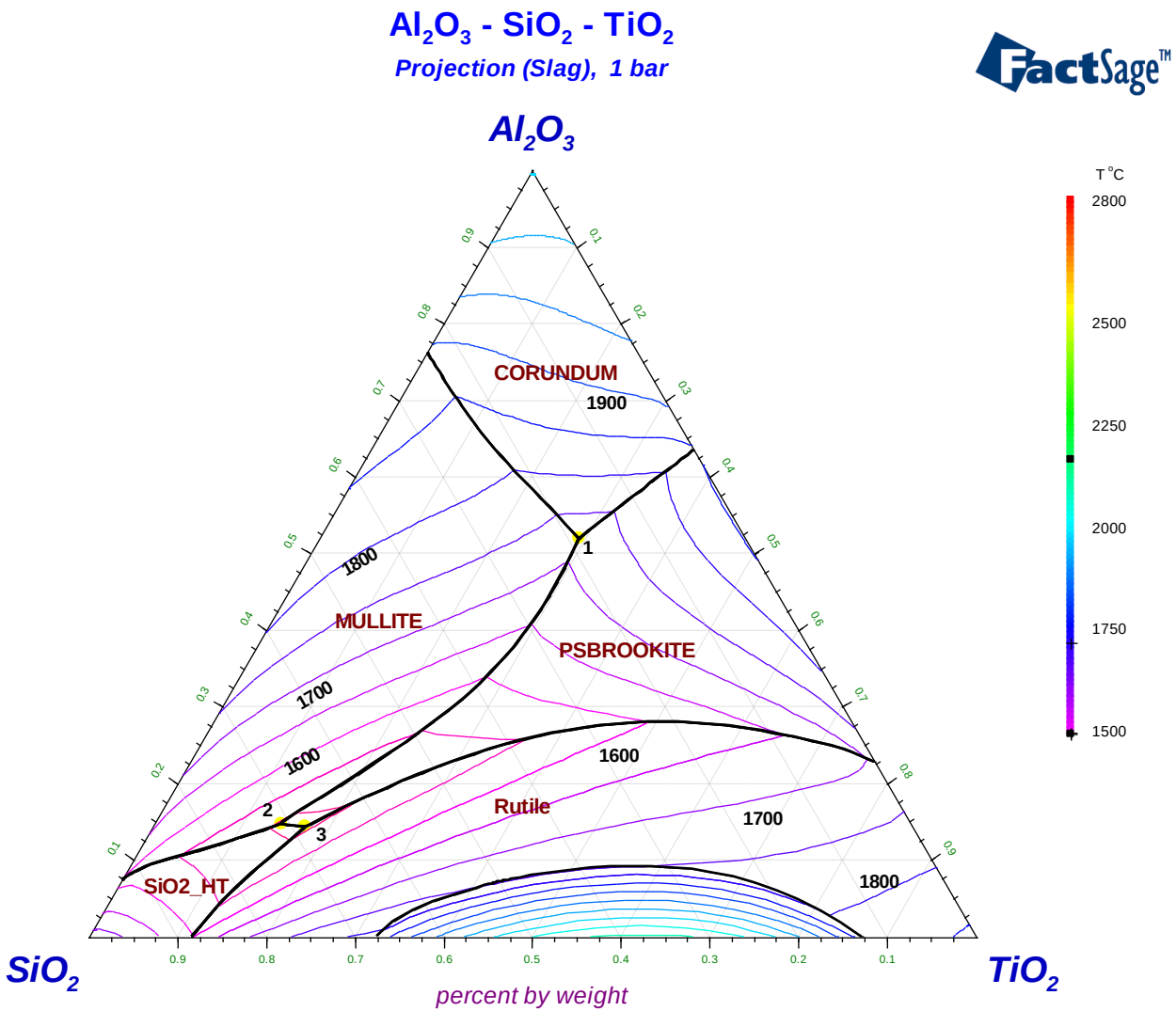
Al2O3-SiO2-TiO2,

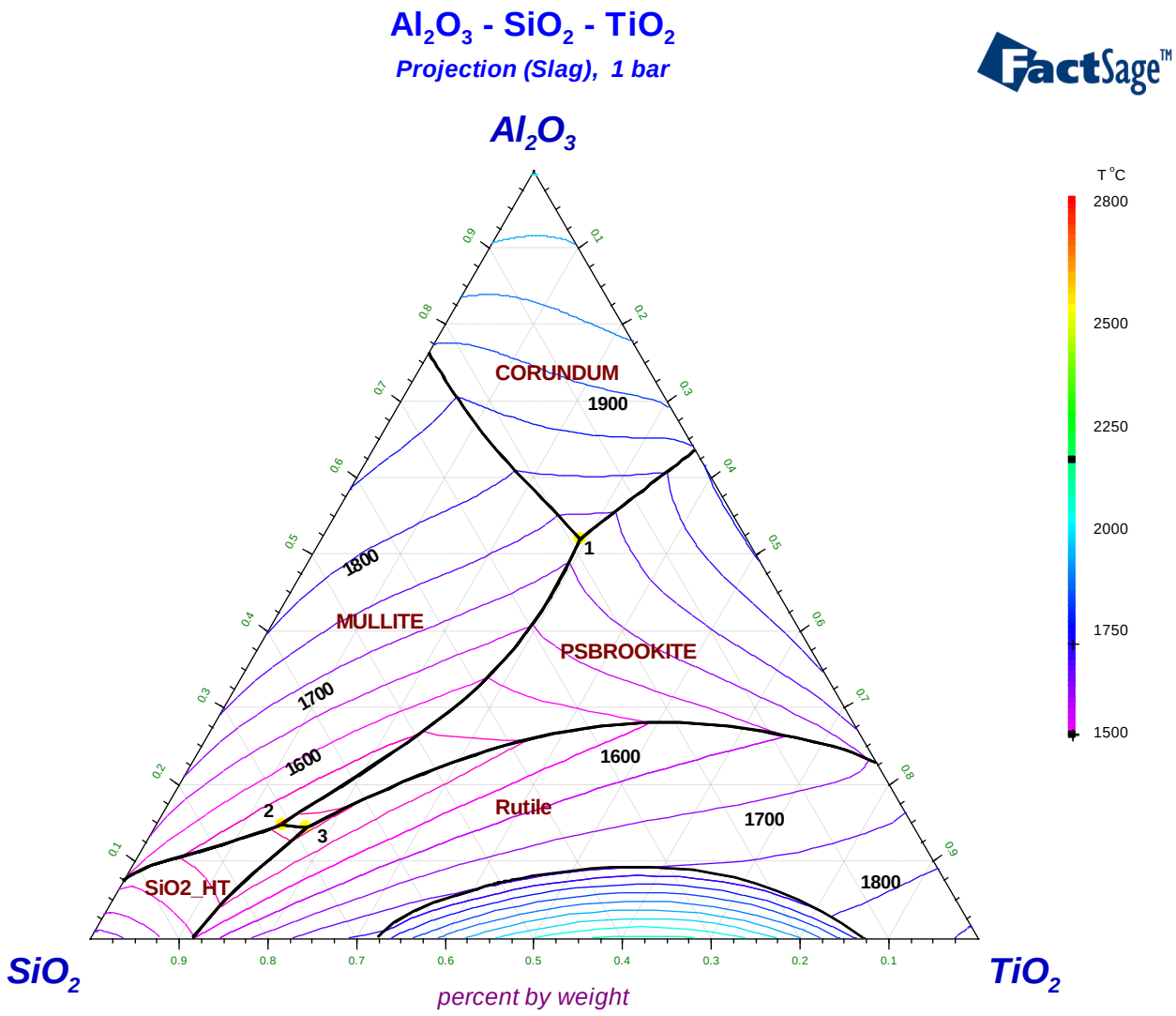
Al2O3-SiO2-TiO2,
Weight fraction, Isopleth section Al2TiO5-SiO2



Al2O3-SiO2-TiO2,
Weight fraction, 1800°C



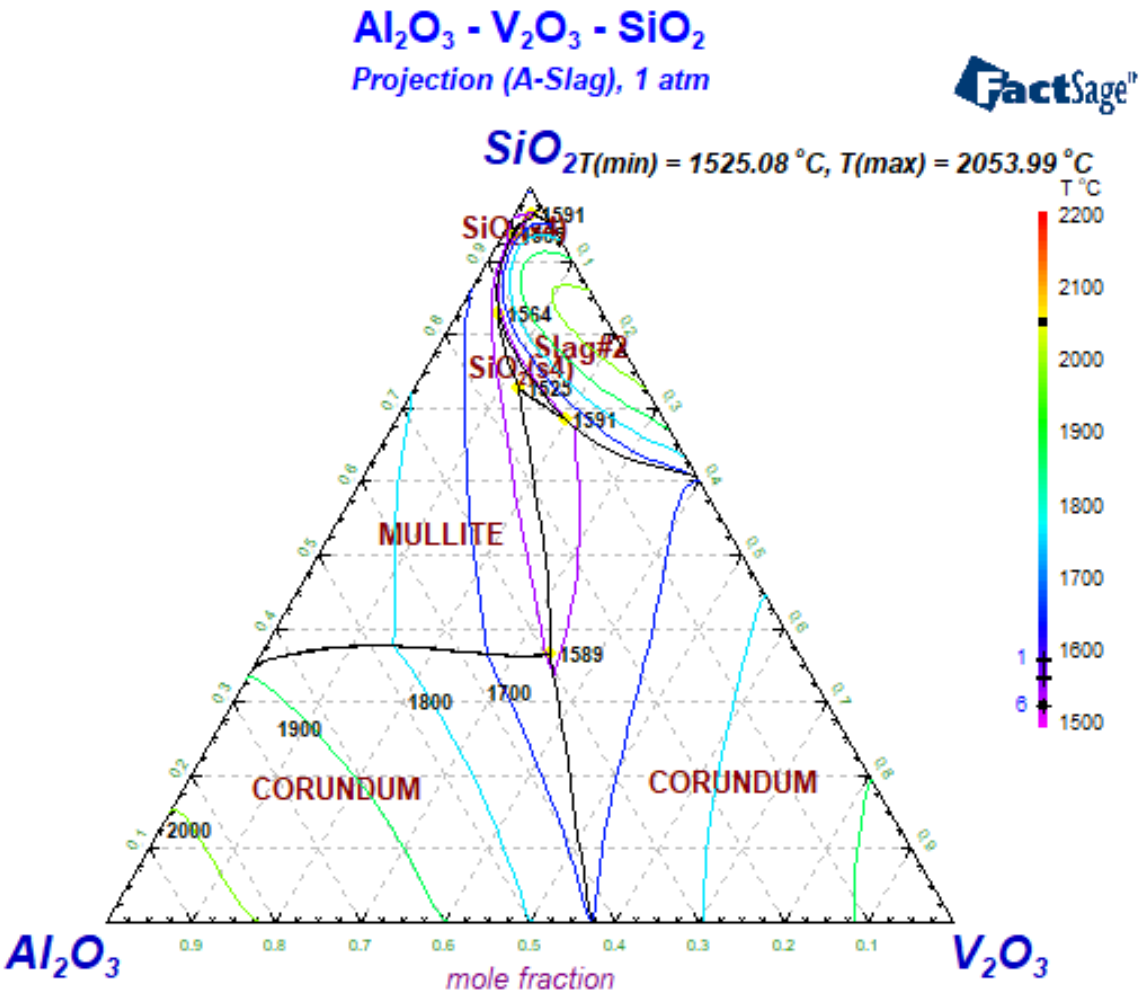

Al2O3 - SiO2 - TiO2
Projection (Slag), 1 bar
FactSage™
Al2O3
SiO2
TiO2
percent by weight
T °C
2800
2500
2250
2000
1750
1500
CORUNDUM
1900
1800
MULLITE
PSBROOKITE
1700
1600
Rutile
SiO2_HT
1
2
3

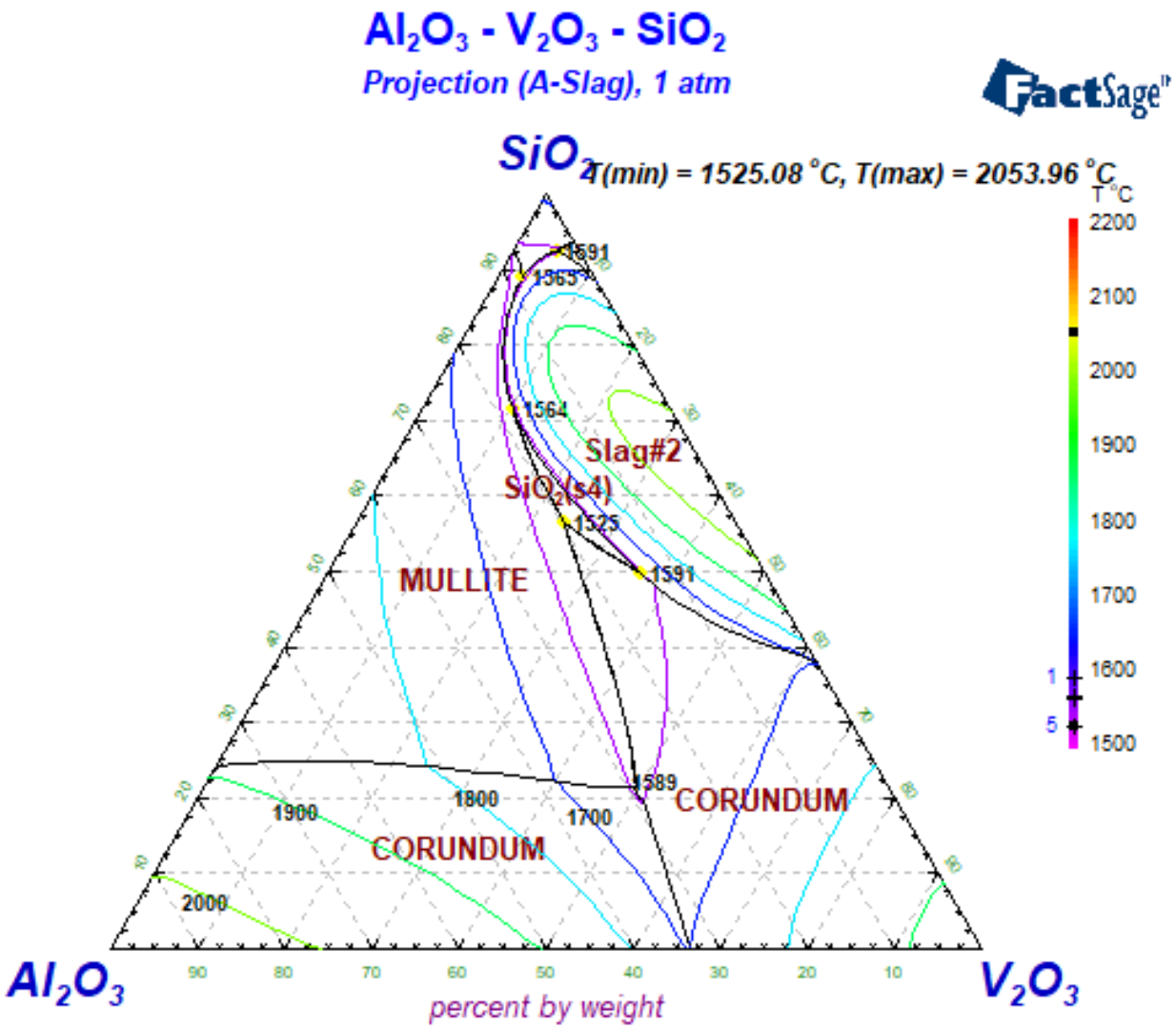

Al2O3 - SiO2 - TiO2
Projection (Slag), 1 bar
Al2O3
SiO2
TiO2
percent by weight
T °C
2800
2500
2250
2000
1750
1500
CORUNDUM
1900
1800
MULLITE
1700
1600
PSBROOKITE
Rutile
SiO2_HT
1
2
3

Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction				Weight percent			
	A = P2O5, B = ZnO, C = Al2O3				A = P2O5, B = ZnO, C = Al2O3			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: Al2O3 / Al6P2O14 / SPINEL	1: 0.16134	0.23631	0.60235	1711.99	1: 22.116	18.572	59.312	1711.99
2: Al6P2O14 / AlPO4_HT(s3) / SPINEL	2: 0.35132	0.46954	0.17914	1030.66	2: 46.893	35.931	17.176	1030.66
3: SPINEL / Zn3P2O8(s2) / ZnO	3: 0.22022	0.77711	0.00267	1012.31	3: 32.983	66.730	0.287	1012.31
4: Zn2P2O7(s2) / Zn3P2O8(s1) / Zn3P2O8(s2)	4: 0.30179	0.67381	0.02439	941.85	4: 42.770	54.747	2.483	941.85
5: AlPO4_HT(s3) / Zn2P2O7(s2) / Zn3P2O8(s1)	5: 0.33904	0.52568	0.13528	847.71	5: 45.965	40.860	13.175	847.71
6: Al2P6O18 / AlPO4_HT(s3) / ZnP2O6	6: 0.51669	0.34973	0.13358	780.18	6: 63.541	24.658	11.800	780.18
7: AlPO4_HT(s3) / Zn2P2O7(s2) / ZnP2O6	7: 0.47283	0.41678	0.11040	758.37	7: 59.770	30.205	10.025	758.38
8: Al2P6O18 / ZnP2O6 / ZnP4O11	8: 0.84063	0.09155	0.06782	649.99	8: 89.254	5.573	5.172	649.99
9: Al2P6O18 / P2O5(s3) / ZnP4O11	9: 0.92069	0.01222	0.06709	502.10	9: 94.344	0.718	4.938	502.10

Al2O3-SiO2-V2O3,
Mole fraction, Liquidus surface

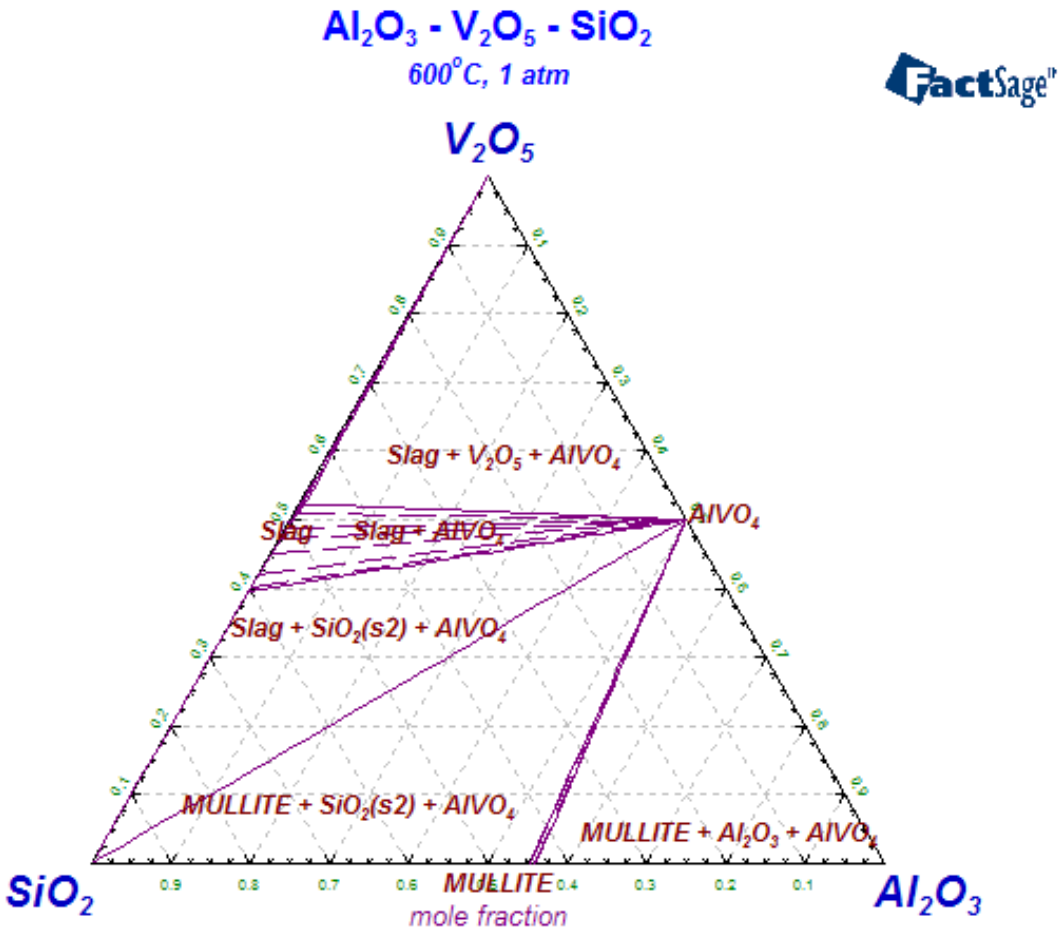



Al2O3 - V2O3 - SiO2
Projection (A-Slag), 1 atm
FactSage
SiO2
T(min) = 1525.08 °C, T(max) = 2053.96 °C
T °C
2200
2100
2000
1900
1800
1700
1600
1500
1591
1563
1564
Slag#2
SiO2(s4)
1525
1591
MULLITE
1589
CORUNDUM
1900
1800
1700
CORUNDUM
2000
Al2O3
V2O3
90
80
70
60
50
40
30
20
10
percent by weight

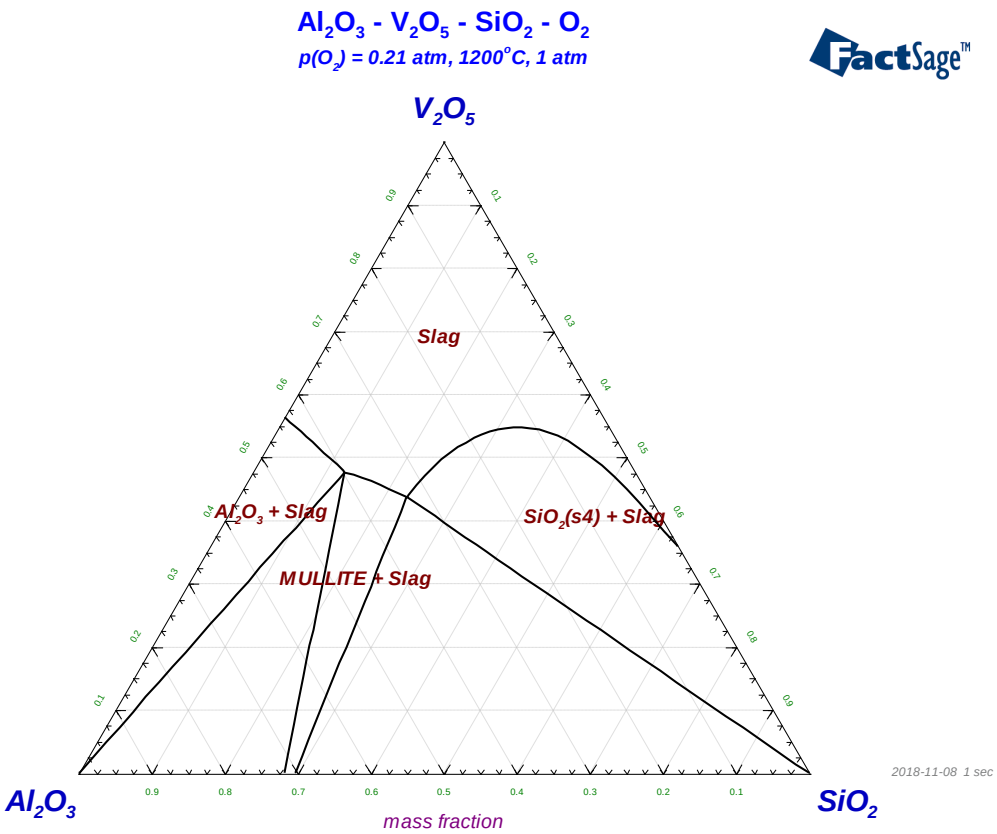
Invariant equilibria on the liquidus surface

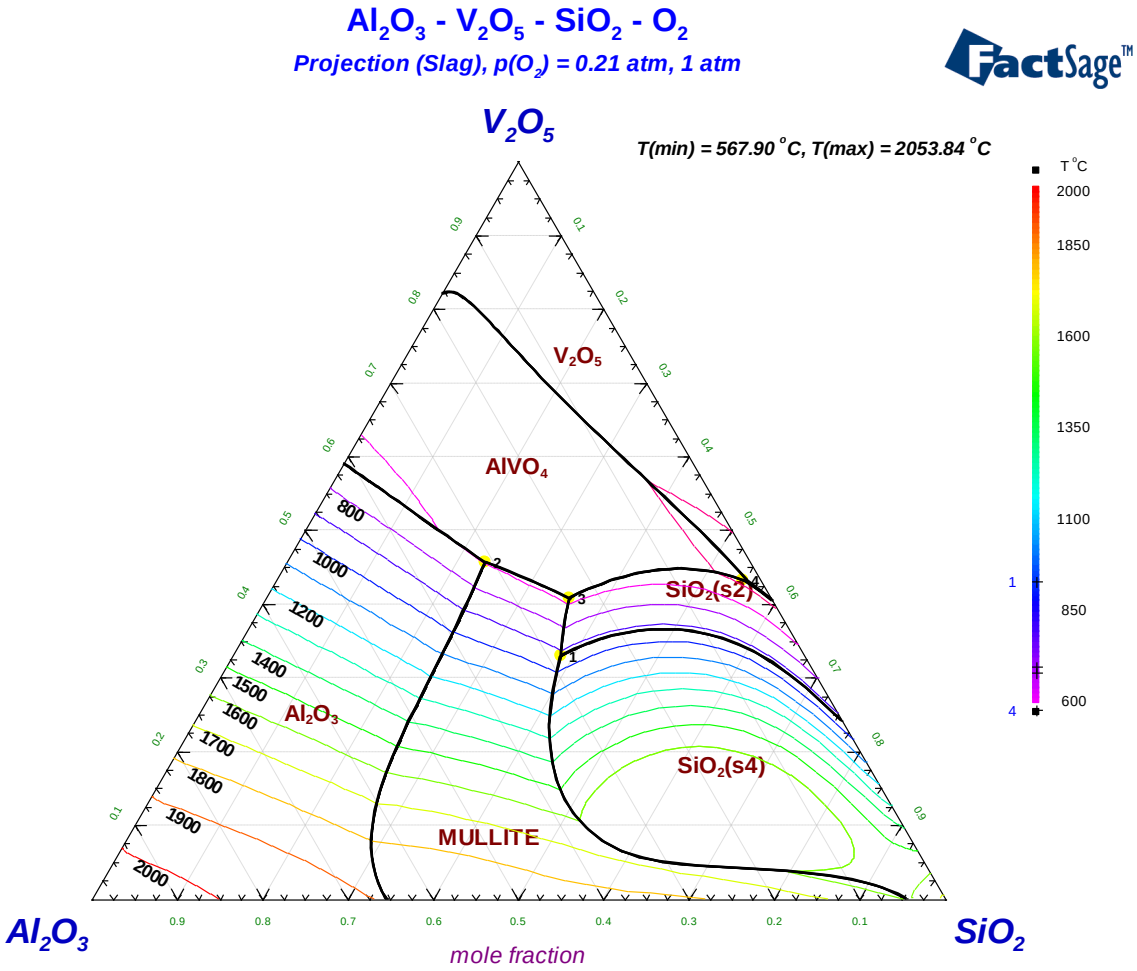
Intersections with slag	Mole fraction				Weight percent			
	A = SiO2, B = Al2O3, C = V2O3				A = SiO2, B = Al2O3, C = V2O3			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1. CORUNDUM#1 / SiO2(s4) / Slag#2	0.96332	0.01569	0.02099	1591.22	92.422	2.555	5.023	1591.22
2. CORUNDUM#1 / SiO2(s4) / Slag#2	0.68442	0.11615	0.19943	1590.56	49.632	14.293	36.076	1590.56
3. CORUNDUM#1 / CORUNDUM#2 / MULLITE	0.36561	0.29371	0.34069	1589.03	21.044	28.869	50.081	1589.03
4. MULLITE / SiO2(s4) / Slag#2	0.93714	0.05102	0.01183	1564.51	88.977	8.221	2.802	1564.51
5. MULLITE / SiO2(s4) / Slag#2	0.82866	0.12281	0.04852	1563.63	71.553	17.996	10.451	1563.63
6. CORUNDUM#1 / MULLITE / SiO2(s4)	0.72698	0.14977	0.12326	1525.08	56.416	19.723	23.861	1525.08

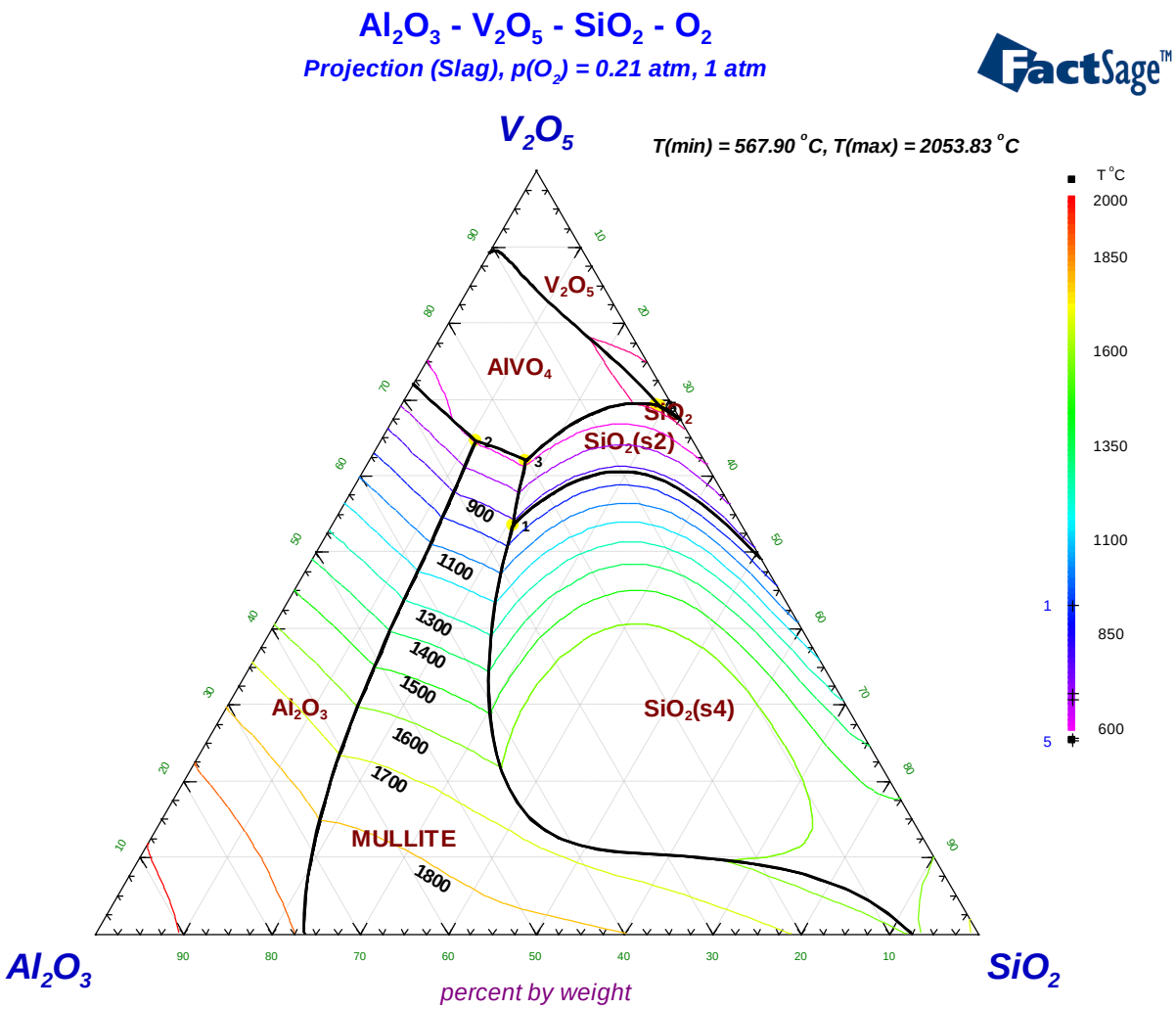
Al2O3-SiO2-V2O5,
Mole fraction, 600°C



Al2O3-SiO2-V2O5,
Mole fraction, 1200°C



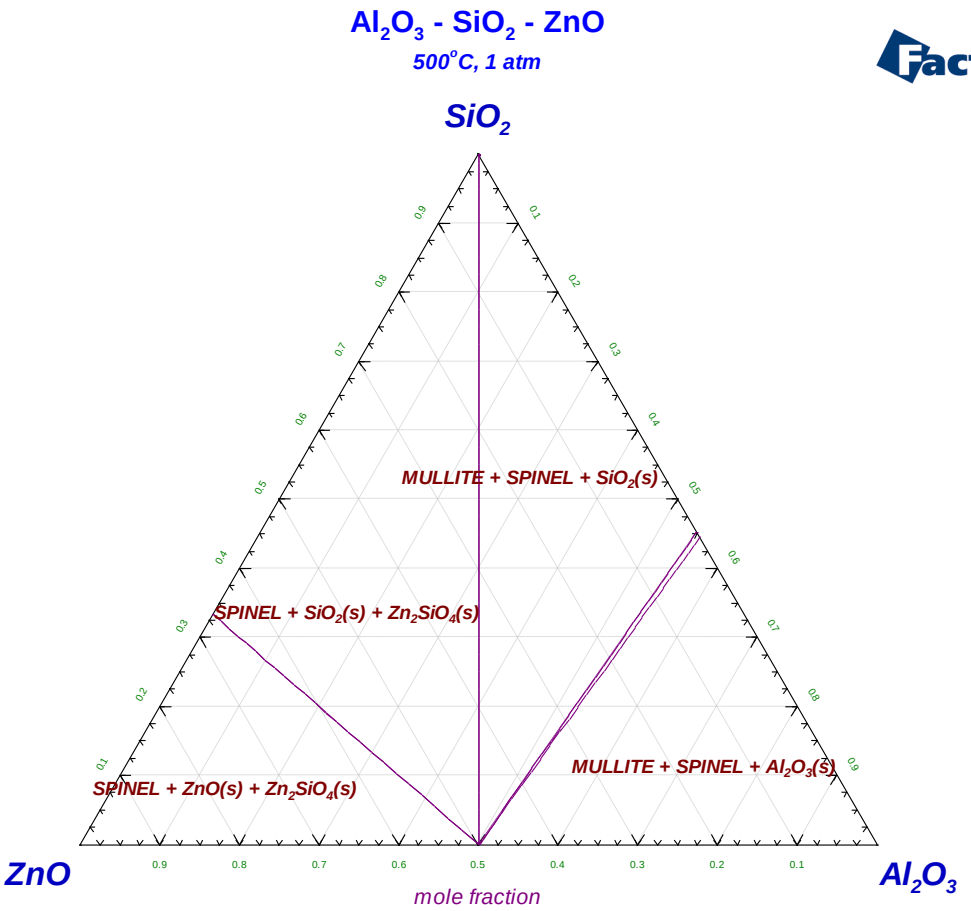

Al_2O_3 - V_2O_5 - SiO_2 - O_2
Projection (Slag), p(O_2) = 0.21 atm, 1 atm
FactSage™
V_2O_5
T(min) = 567.90 °C, T(max) = 2053.84 °C
T °C
2000
1850
1600
1350
1100
850
600
V_2O_5
$AlVO_4$
SiO_2(s2)
Al_2O_3
SiO_2(s4)
MULLITE
800
1000
1200
1400
1500
1600
1700
1800
1900
2000
Al_2O_3
SiO_2
mole fraction


Al_2O_3 - V_2O_5 - SiO_2 - O_2
Projection (Slag), $p(O_2)$ = 0.21 atm, 1 atm
FactSage™
V_2O_5
T(min) = 567.90 °C, T(max) = 2053.83 °C
T °C
2000
1850
1600
1350
1100
850
600
V_2O_5
$AlVO_4$
SiO_2
SiO_2(s2)
SiO_2(s4)
Al_2O_3
MULLITE
900
1100
1300
1400
1500
1600
1700
1800
Al_2O_3
SiO_2
percent by weight

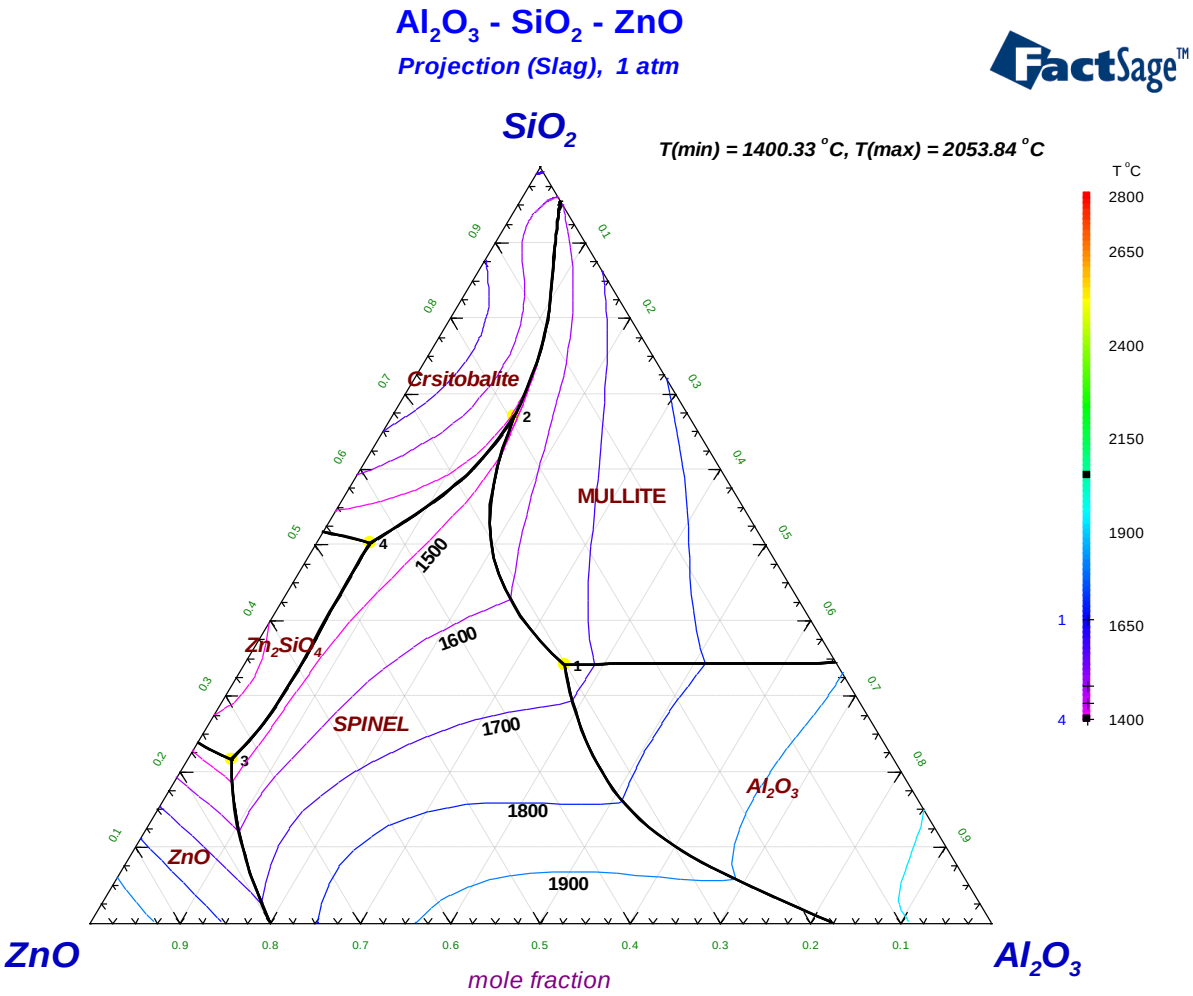
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction					Weight percent				
	A = V2O5, B = Al2O3, C = SiO2					A = V2O5, B = Al2O3, C = SiO2				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1. MULLITE / SiO2(s4) / SiO2(s2)	1:	0.32976	0.28562	0.38463	926.32	1:	53.451	25.954	20.596	926.28
2. Al2O3 / AlVO4 / MULLITE	2:	0.45721	0.31052	0.23227	693.69	2:	64.576	24.587	10.837	693.69
3. AlVO4 / MULLITE / SiO2(s2)	3:	0.40836	0.23626	0.35537	676.19	3:	62.041	20.123	17.836	676.24
4. AlVO4 / SiO2(s) / SiO2(s2)	4:	0.43271	0.02024	0.54705	574.85	4:	69.258	1.816	28.925	574.85

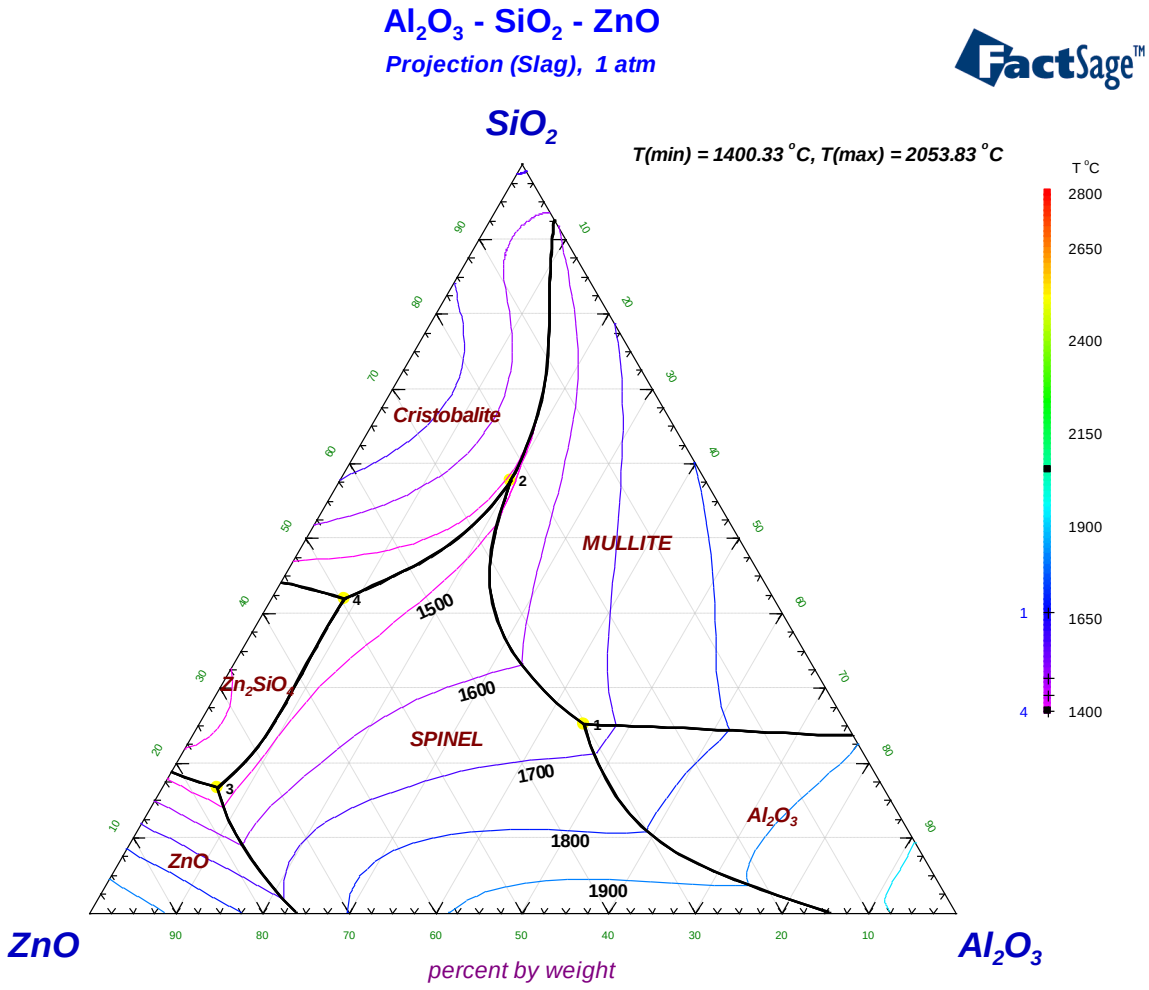
Al2O3-SiO2-ZnO,
Mole fraction, 500°C



Mole fraction, Liquidussurface



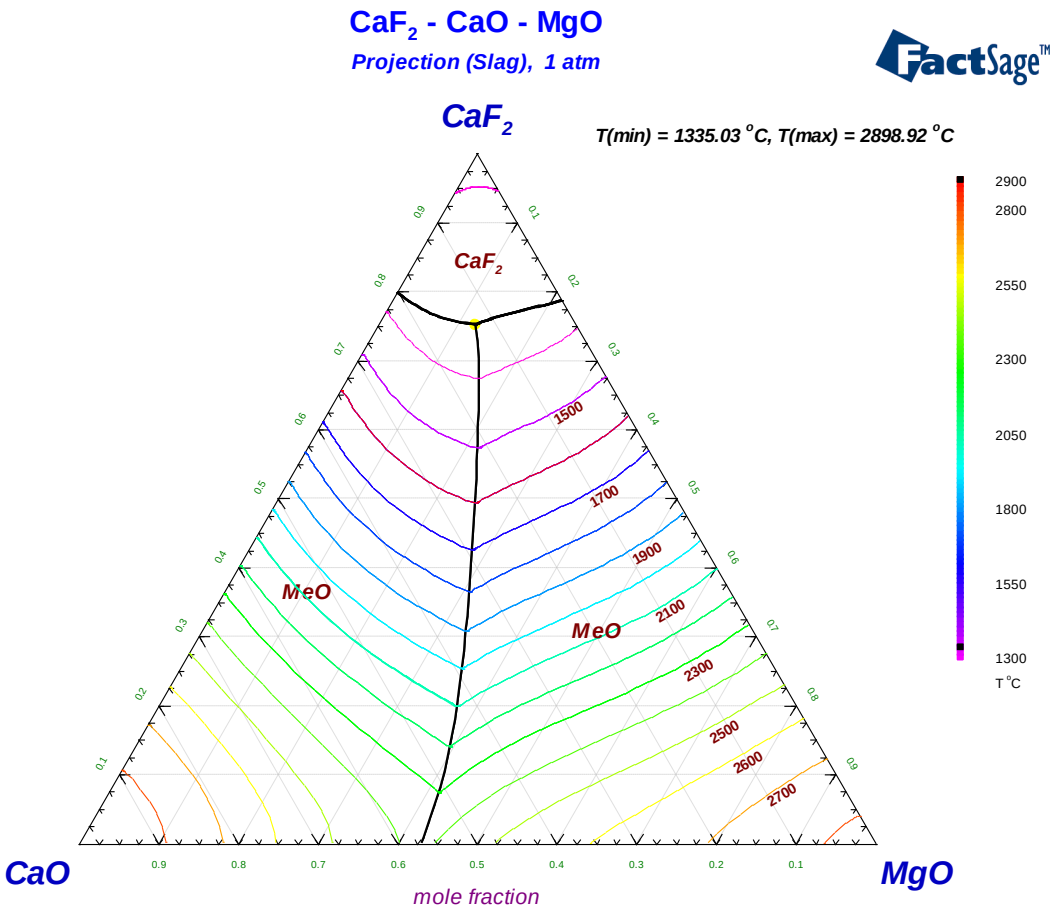
Weight percent,
Liquidussurface compared with experimental data



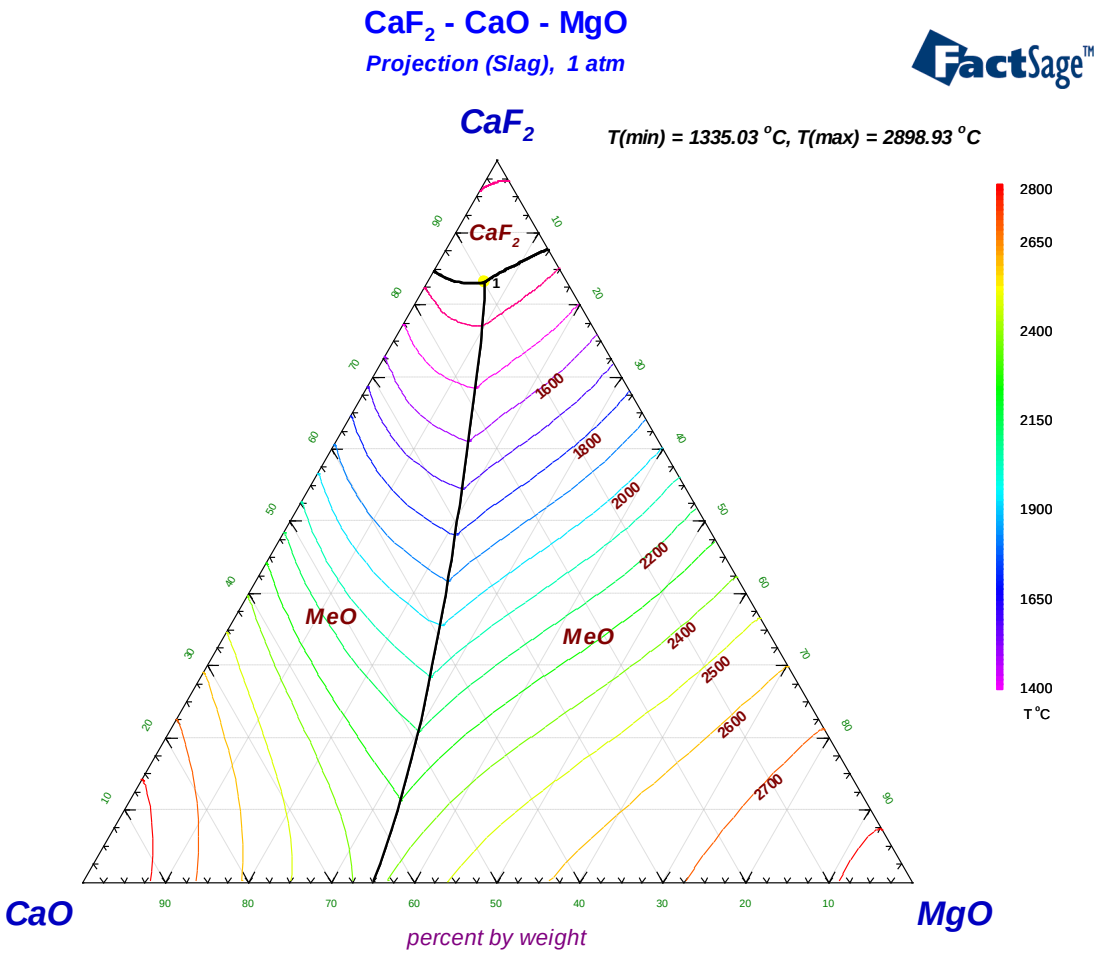
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction					Weight percent				
	A = SiO2, B = ZnO, C = Al2O3					A = SiO2, B = ZnO, C = Al2O3				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: Al2O3 / MULLITE / SPINEL	1:	0.34089	0.30263	0.35648	1666.73	1:	25.145	30.234	44.621	1666.76
2: MULLITE / SPINEL / Cristobalite	2:	0.67093	0.19296	0.13611	1489.49	2:	57.677	22.467	19.856	1489.49
3: SPINEL / Zn2SiO4 / ZnO	3:	0.21583	0.73471	0.04946	1442.46	3:	16.668	76.850	6.482	1442.46
4: SPINEL / Cristobalite / Zn2SiO4	4:	0.50218	0.43796	0.05986	1400.33	4:	41.956	49.557	8.487	1400.33

Mole fraction, Liquidussurface



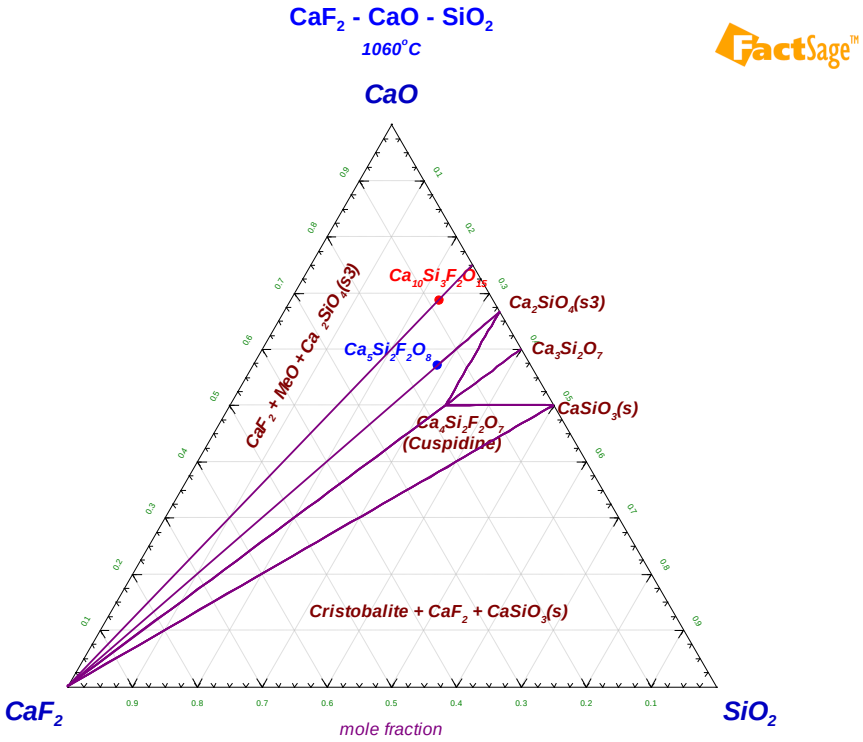
Weight percent, Liquidussurface



Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction				Weight percent			
	A = CaF2, B = CaO, C = MgO				A = CaF2, B = CaO, C = MgO			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: CaF2 / MeO#1 / MeO#2	1: 0.75238	0.12573	0.12189	1335.03	1.0.83080	0.09972	0.06948	1335.03

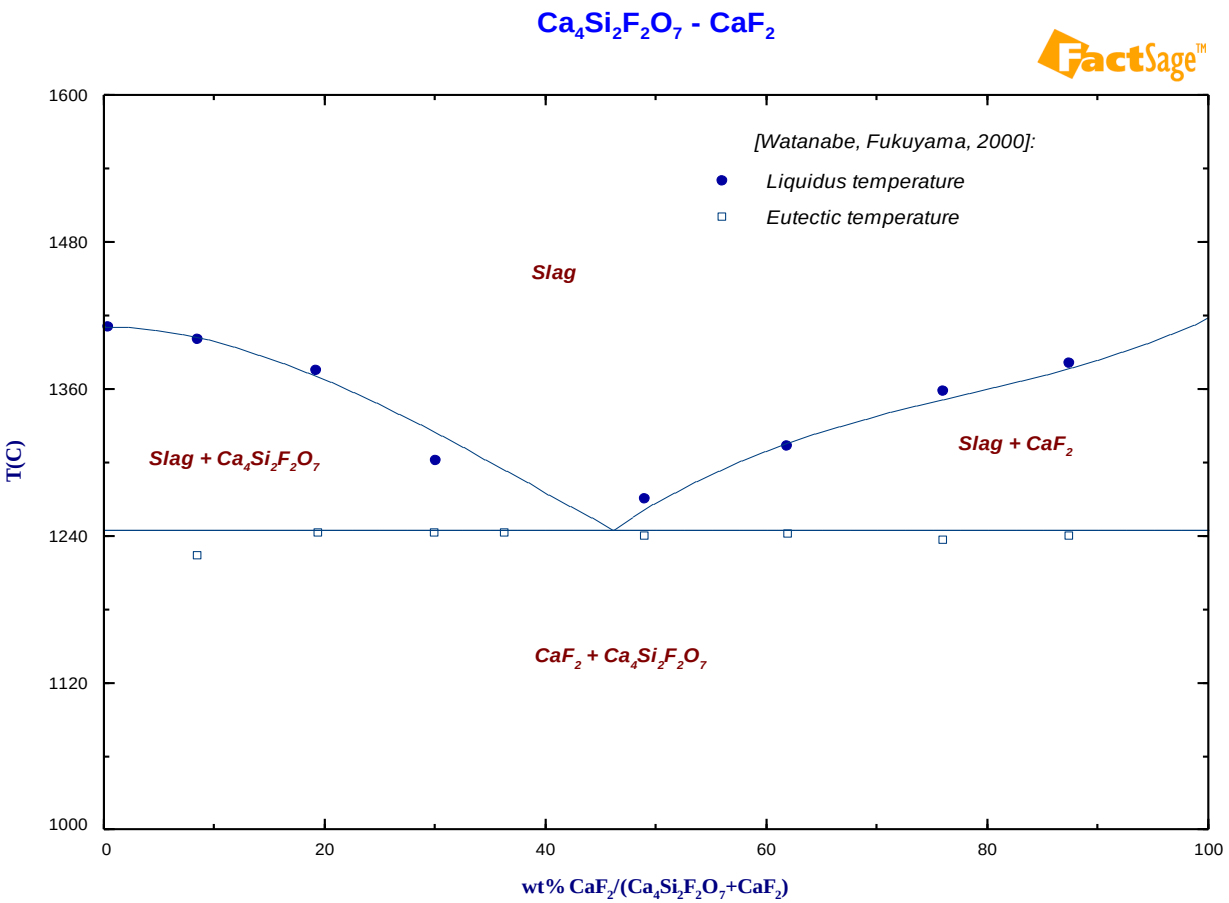
CaF2-CaO-SiO2,
Mole fraction 1060°C



Name	Phase	Used data	Description
C3S2F Cuspidine	$3CaO\ 2SiO_2\ CaF_2$	Heat of formation [Fukuyama, Tabata,2003]	$Ca_4Si_2F_2O_7$
C4S2F	$4CaO\ 2SiO_2\ CaF_2$		$Ca_5Si_2F_2O_8$
C9S3F	$9CaO\ 3SiO_2\ CaF_2$		$Ca_{10}Si_3F_2O_{15}$

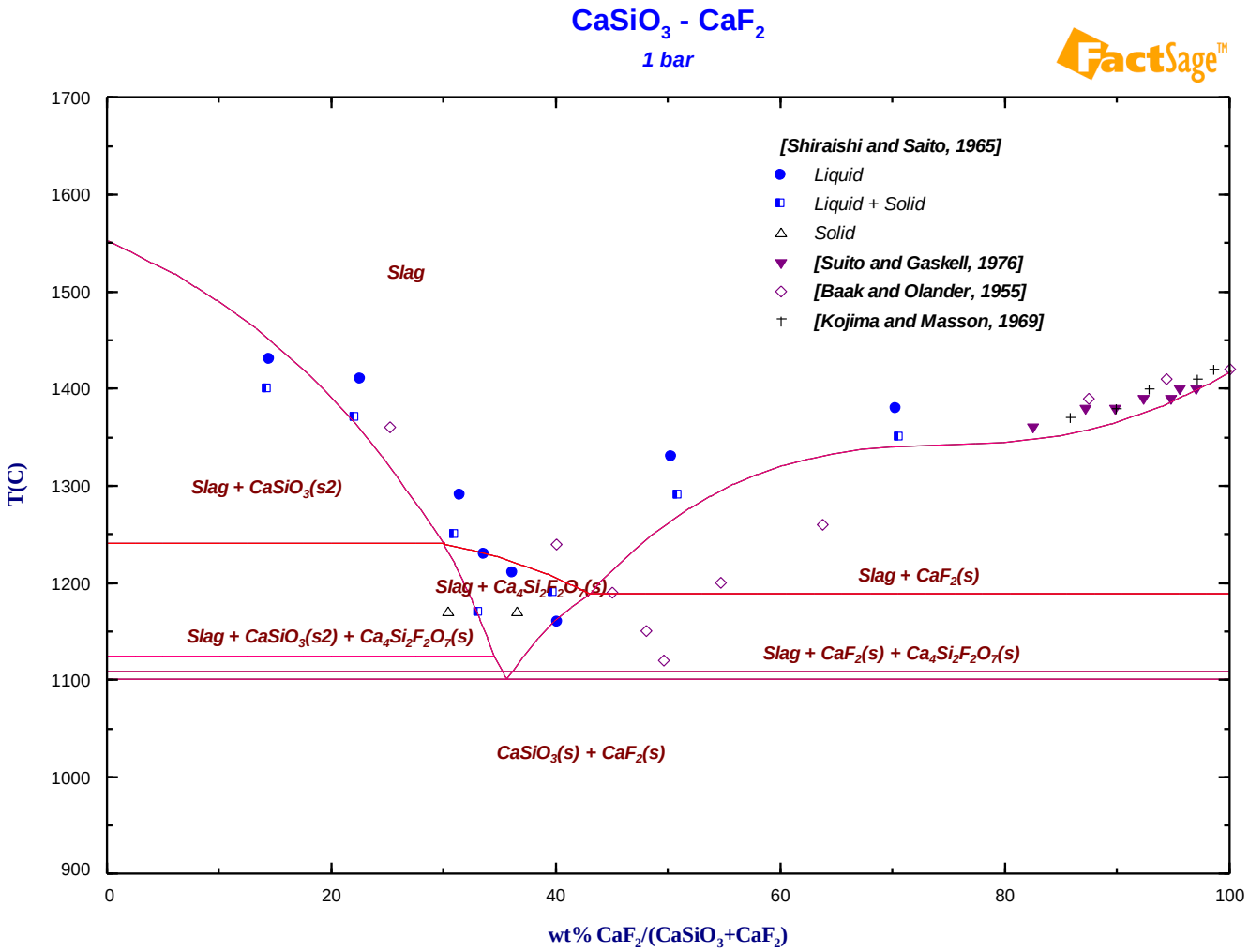
CaF2-CaO-SiO2,

Weight percent, Isopleth Cuspidine-CaF2



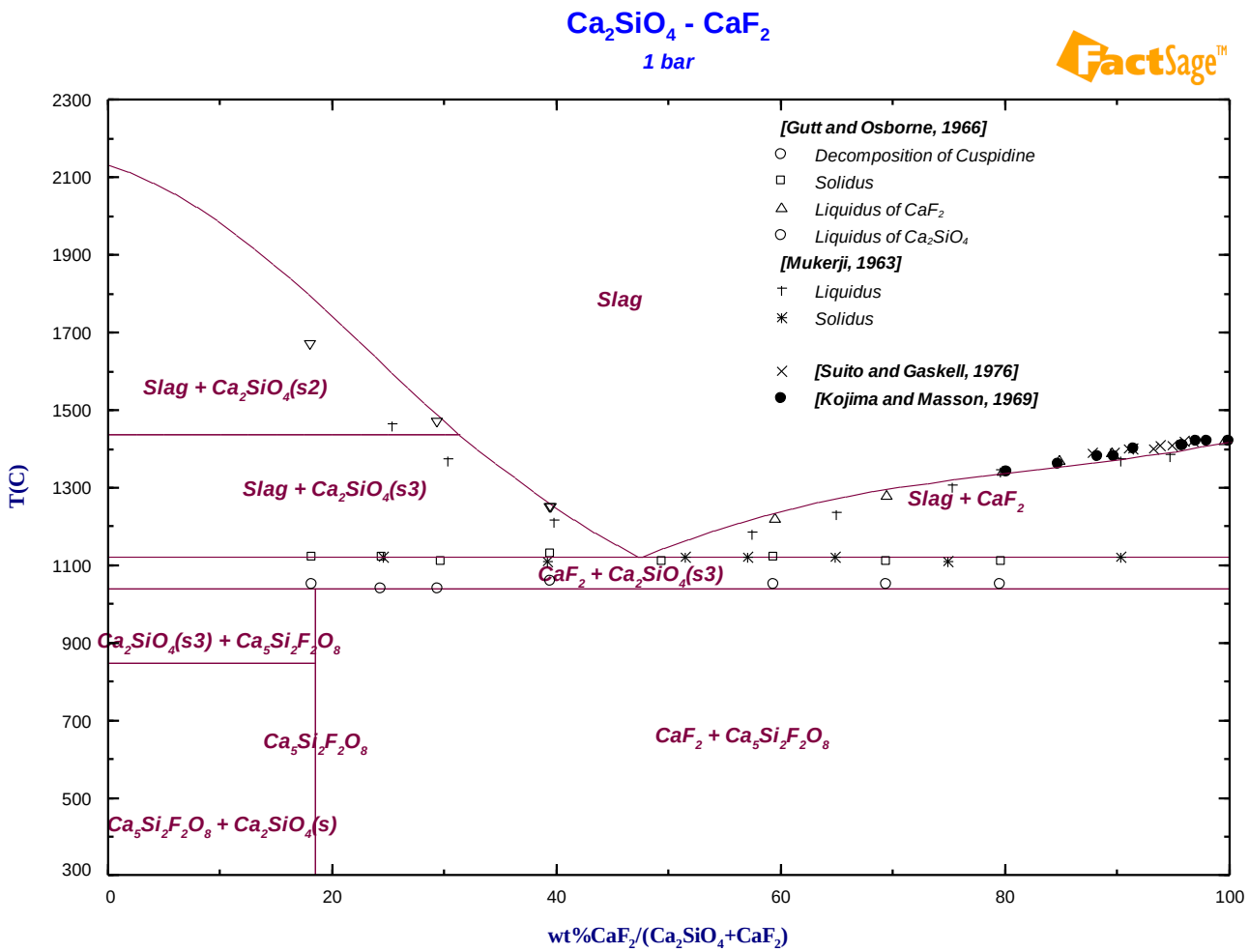
CaF2-CaO-SiO2,

Weight percent, Isopleth CaSiO3-CaF2

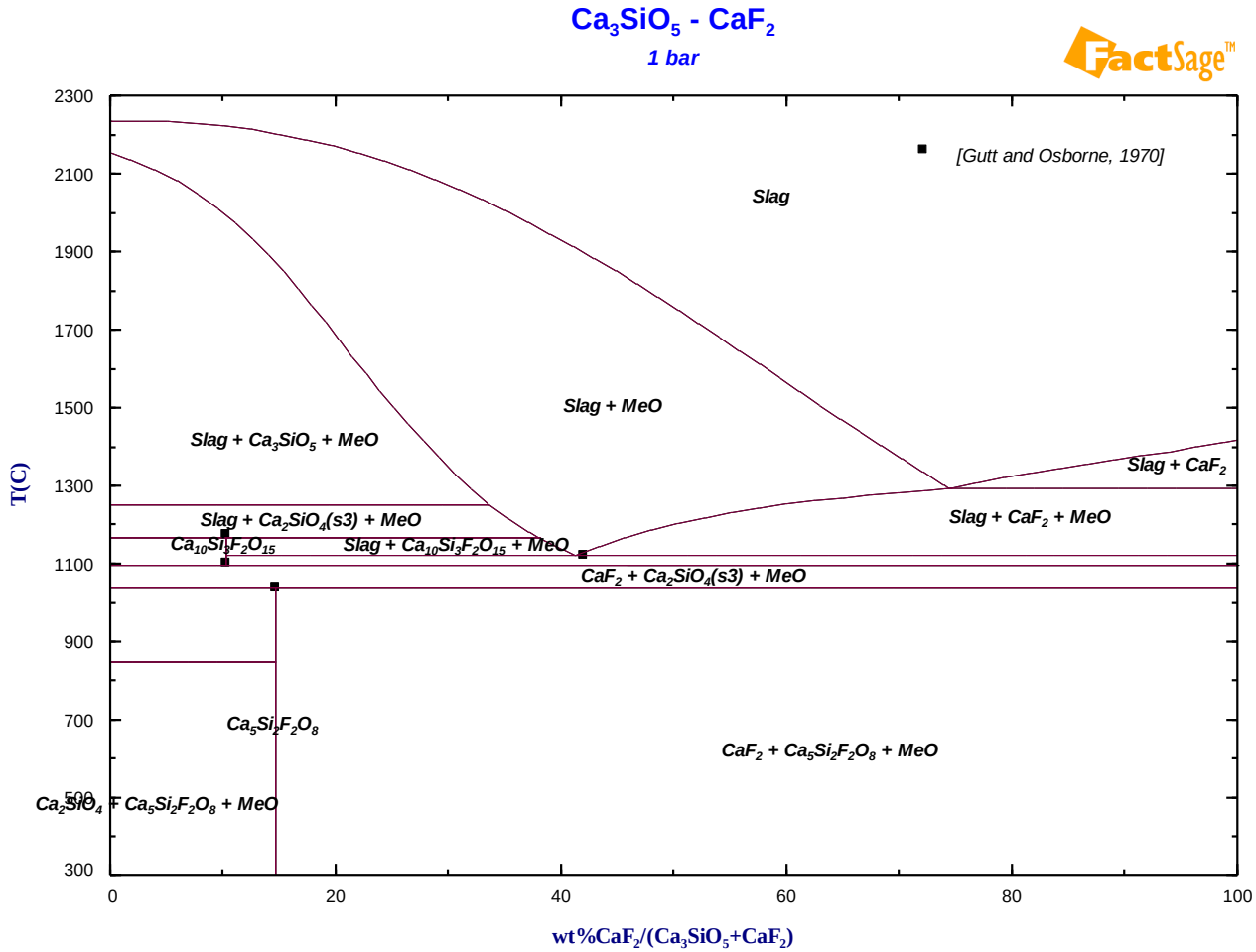


CaF2-CaO-SiO2,

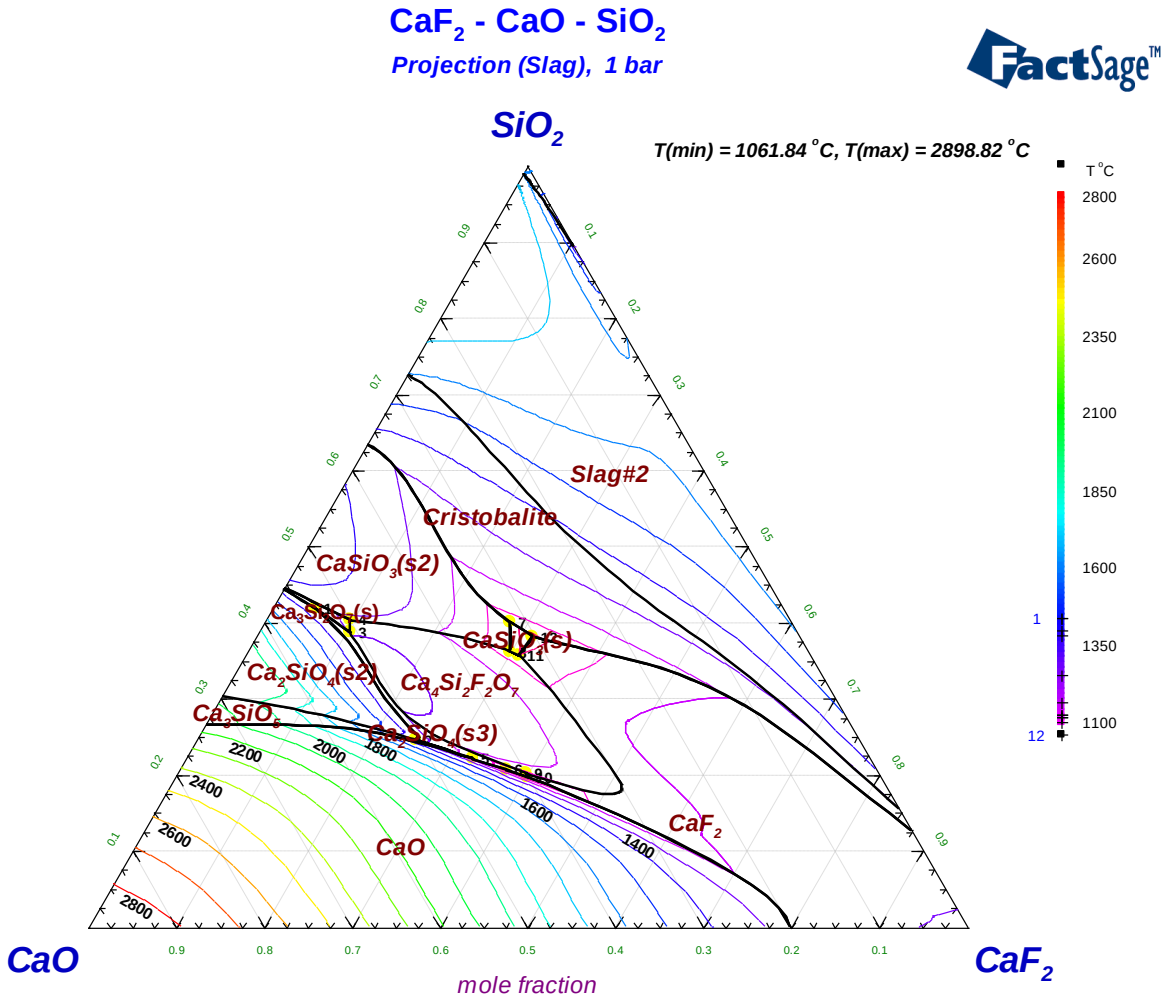
Weight percent, Isopleth Ca2SiO4-CaF2



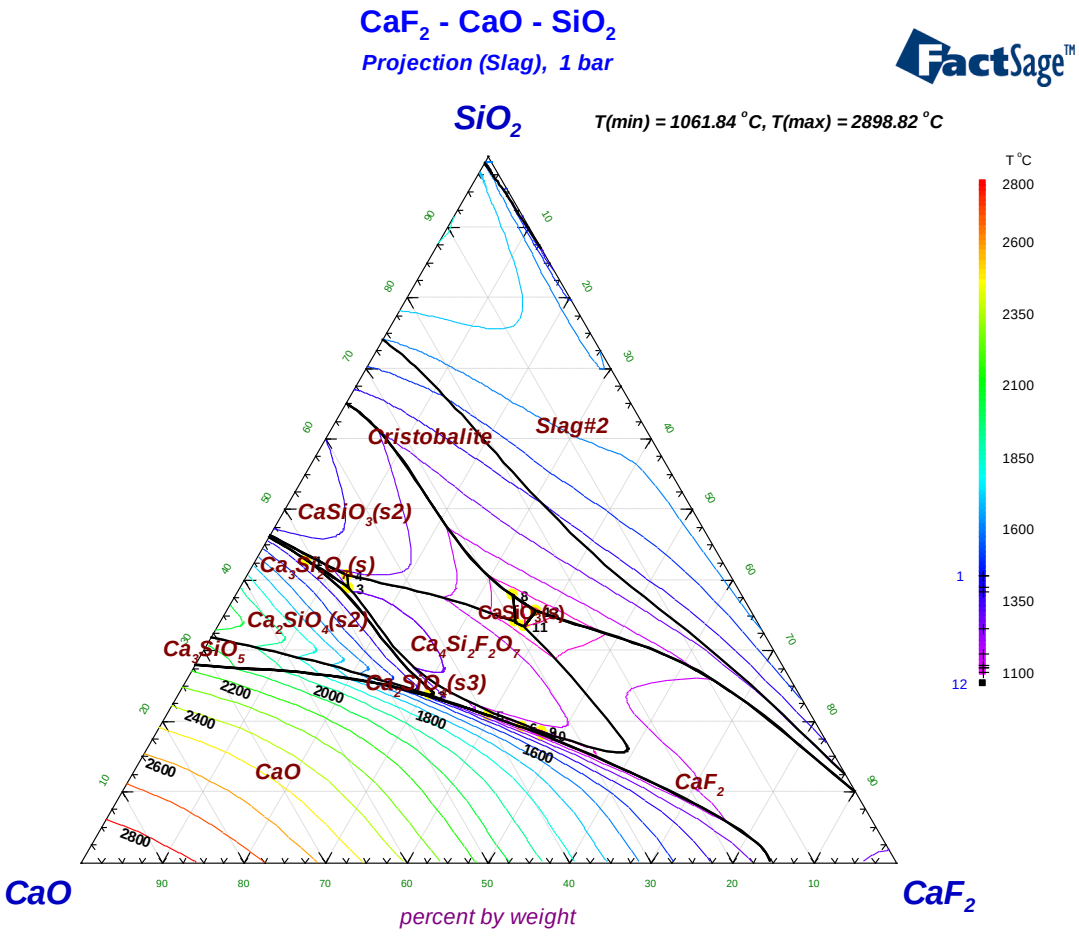
Weight percent,, Isopleth Ca3SiO5-CaF2



Mole fraction, Liquidussurface



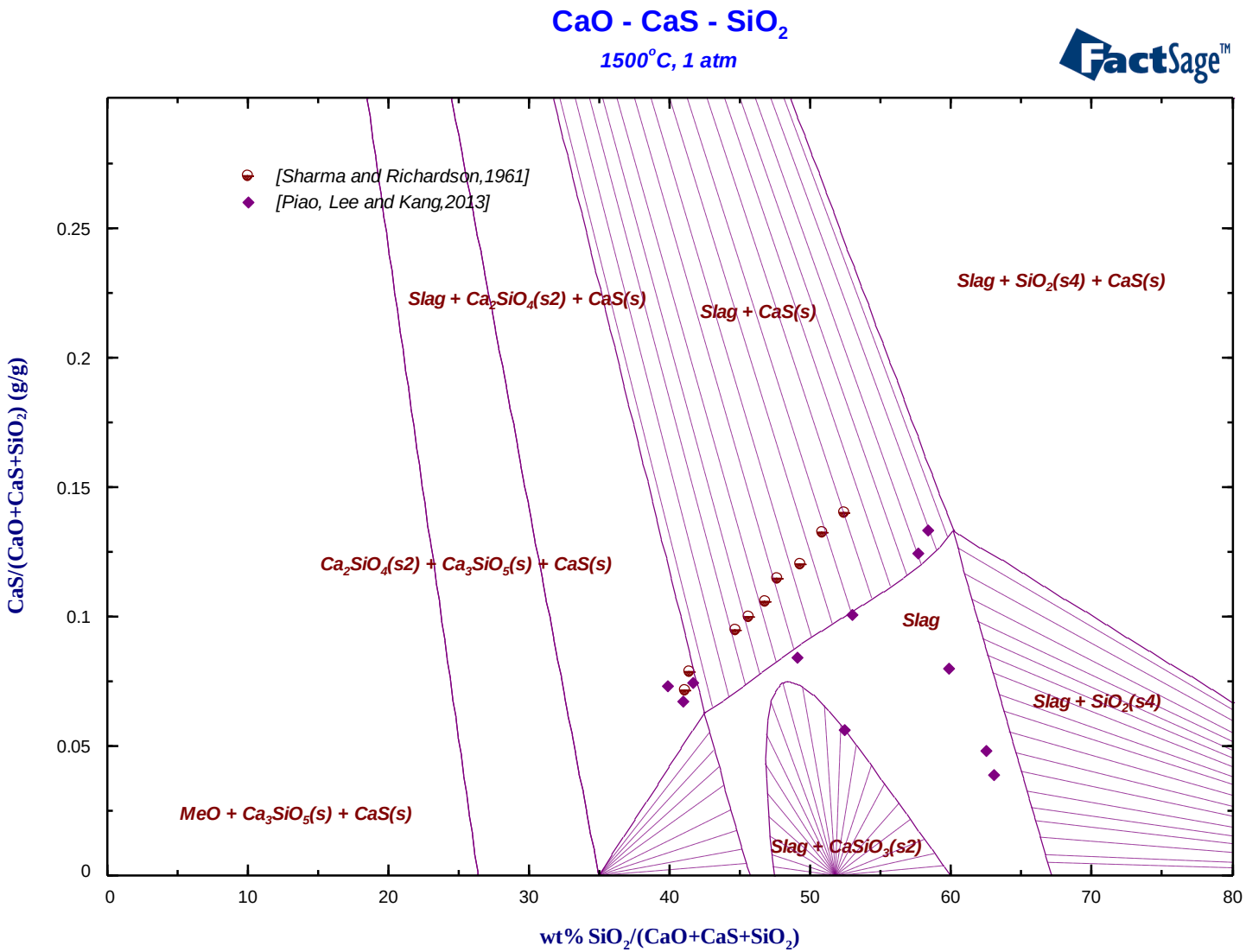
Weight percent, Liquidussurface

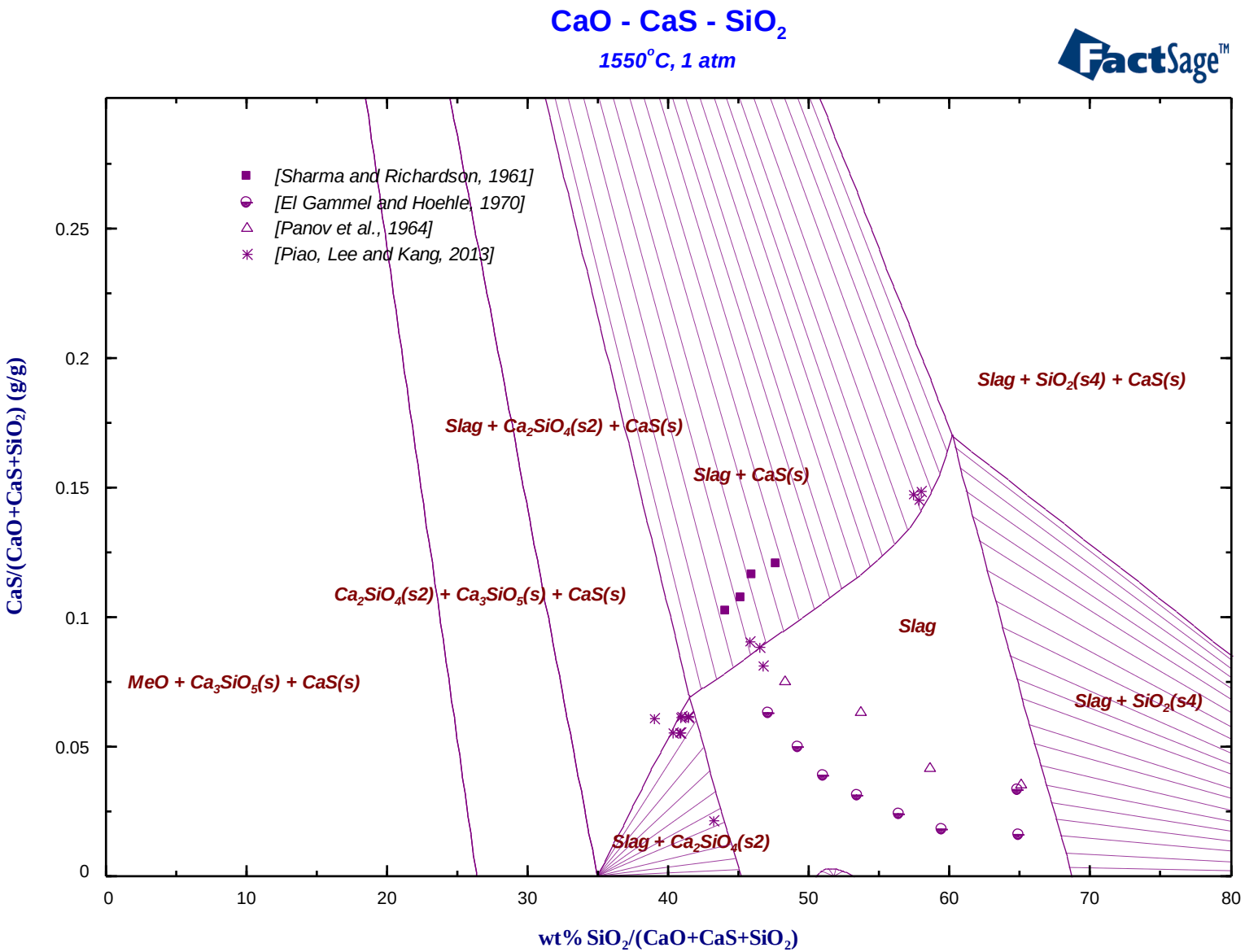


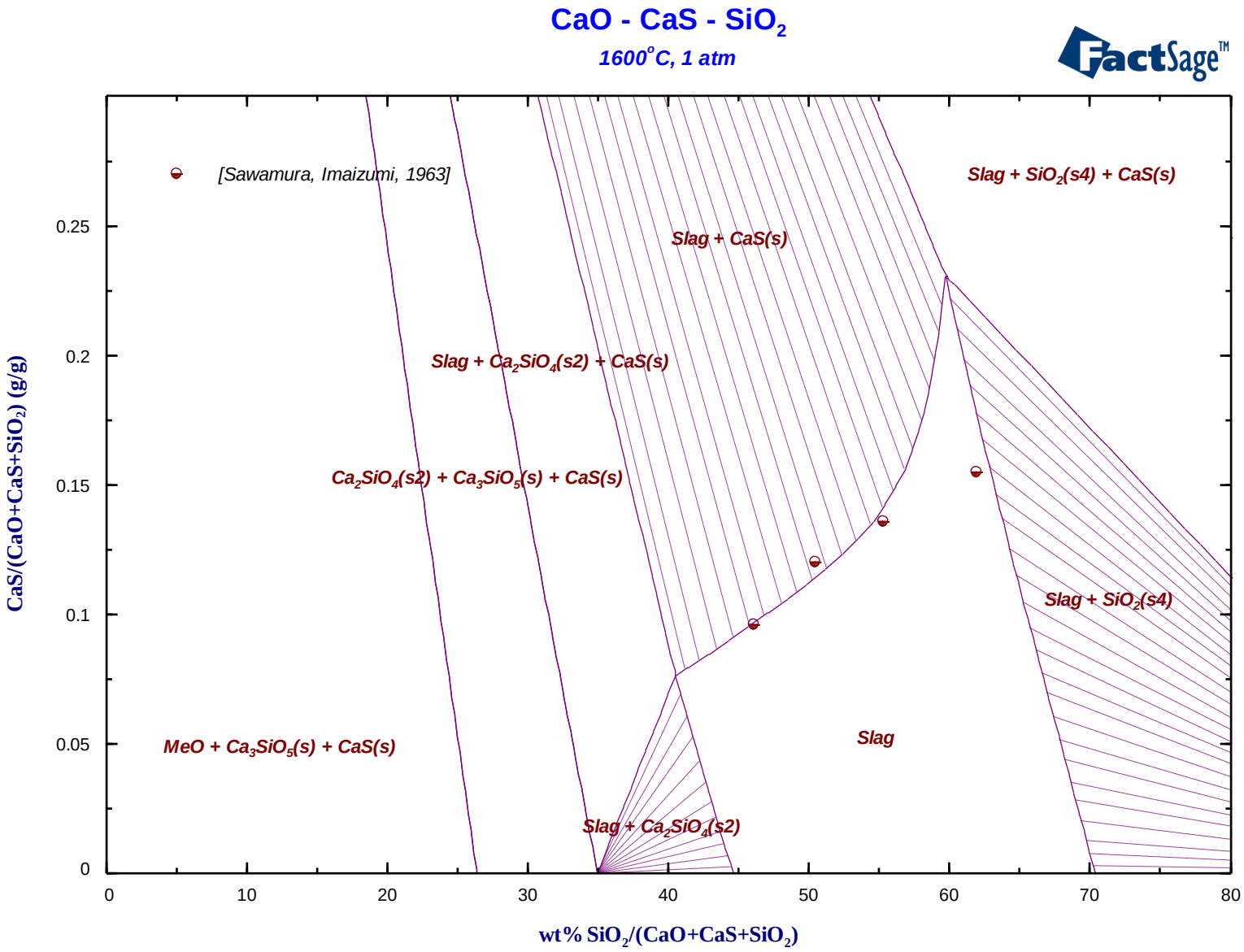
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction				Weight percent			
	A = SiO2, B = CaO, C = CaF2				A = SiO2, B = CaO, C = CaF2			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: Ca2SiO4(s2) / Ca2SiO4(s3) / Ca3Si2O7	1: 0.41903	0.53323	0.04774	1436.73	1: 42.814	50.849	6.337	1436.73
2: Ca2SiO4(s2) / Ca2SiO4(s3) / Ca3SiO5	2: 0.24620	0.50516	0.24865	1436.73	2: 23.655	45.300	31.044	1436.73
3: Ca2SiO4(s3) / Ca3Si2O7 / Ca4Si2F2O7	3: 0.38799	0.50883	0.10319	1396.24	3: 38.917	47.634	13.449	1396.24
4: Ca3Si2O7 / Ca4Si2F2O7 / CaSiO3(s2)	4: 0.40396	0.50079	0.09526	1379.72	4: 40.594	46.968	12.438	1379.72
5: Ca2SiO4(s3) / Ca3SiO5 / CaO	5: 0.22157	0.45206	0.32637	1251.47	5: 20.755	39.520	39.725	1251.53
6: Ca10Si3F2O15 / Ca2SiO4(s3) / CaO	6: 0.20708	0.42144	0.37148	1165.48	6: 19.119	36.315	44.567	1165.48
7: CaSiO3(s2) / CaSiO3 / Cristobalite	7: 0.40134	0.32017	0.27848	1124.14	7: 34.042	29.711	36.247	1124.14
8: Ca4Si2F2O7 / CaSiO3(s2) / CaSiO3(s)	8: 0.36304	0.33949	0.29748	1124.13	8: 37.790	28.137	34.073	1124.13
9: Ca2SiO4(s3) / Ca4Si2F2O7 / CaF2	9: 0.20207	0.40057	0.39736	1118.36	9: 18.500	34.228	47.272	1118.37
10: Ca10Si3F2O15 / Ca2SiO4(s3) / CaF2	10: 0.19763	0.40165	0.40072	1118.32	10: 18.079	34.291	47.631	1118.33
11: Ca4Si2F2O7 / CaF2 / CaSiO3(s)	11: 0.35785	0.33125	0.31090	1100.34	11: 33.412	28.867	37.721	1100.34
12: CaF2 / CaSiO3(s) / Cristobalite	12: 0.38264	0.30355	0.31381	1061.84	12: 35.637	26.386	37.978	1061.84

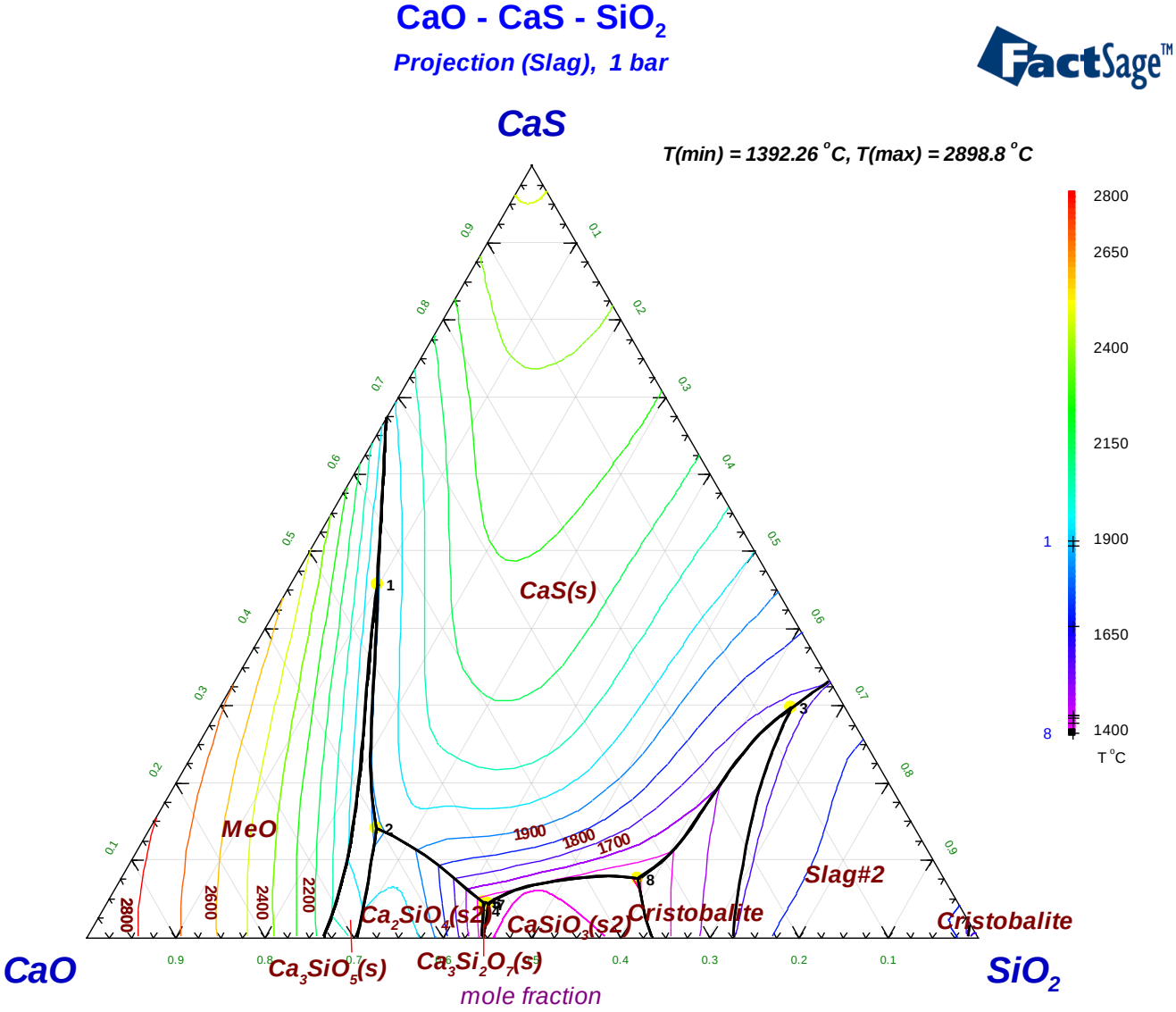
CaO-CaS-SiO2,
Weight percent 1500°C



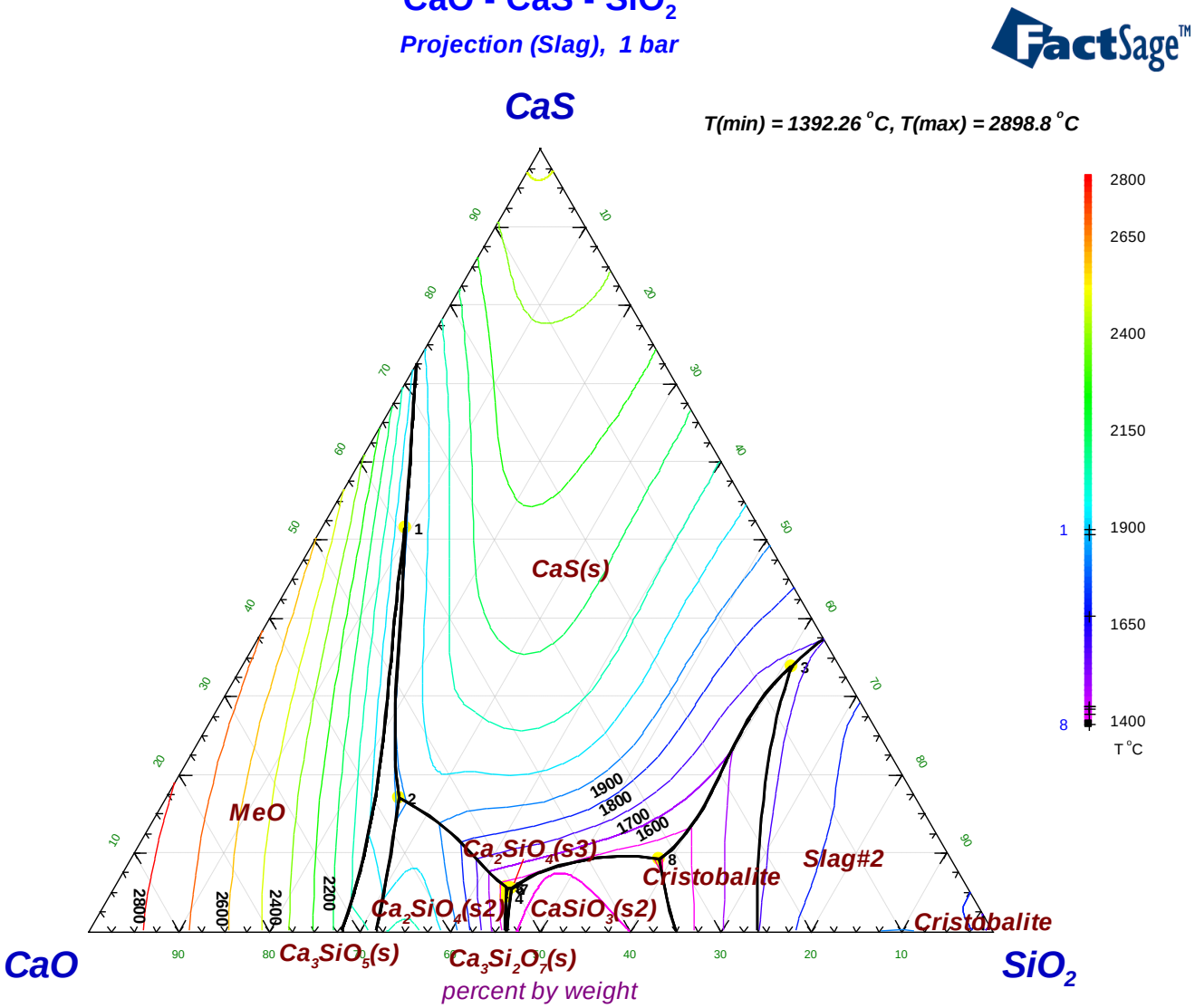

CaO - CaS - SiO2
1550°C, 1 atm
FactSage™
[Sharma and Richardson, 1961]
[El Gammel and Hoehle, 1970]
[Panov et al., 1964]
[Piao, Lee and Kang, 2013]
Slag + SiO2(s4) + CaS(s)
Slag + Ca2SiO4(s2) + CaS(s)
Slag + CaS(s)
Ca2SiO4(s2) + Ca3SiO5(s) + CaS(s)
Slag
MeO + Ca3SiO5(s) + CaS(s)
Slag + SiO2(s4)
Slag + Ca2SiO4(s2)
CaS/(CaO+CaS+SiO2) (g/g)
wt% SiO2/(CaO+CaS+SiO2)
0
0.05
0.1
0.15
0.2
0.25
0
10
20
30
40
50
60
70
80


CaO - CaS - SiO2
1600°C, 1 atm
FactSage™
[Sawamura, Imaizumi, 1963]
Slag + SiO2(s4) + CaS(s)
Slag + CaS(s)
Slag + Ca2SiO4(s2) + CaS(s)
Ca2SiO4(s2) + Ca3SiO5(s) + CaS(s)
Slag + SiO2(s4)
Slag
MeO + Ca3SiO5(s) + CaS(s)
Slag + Ca2SiO4(s2)
CaS/(CaO+CaS+SiO2) (g/g)
wt% SiO2/(CaO+CaS+SiO2)
0
0.05
0.1
0.15
0.2
0.25
0
10
20
30
40
50
60
70
80

Mole fraction, Liquidussurface



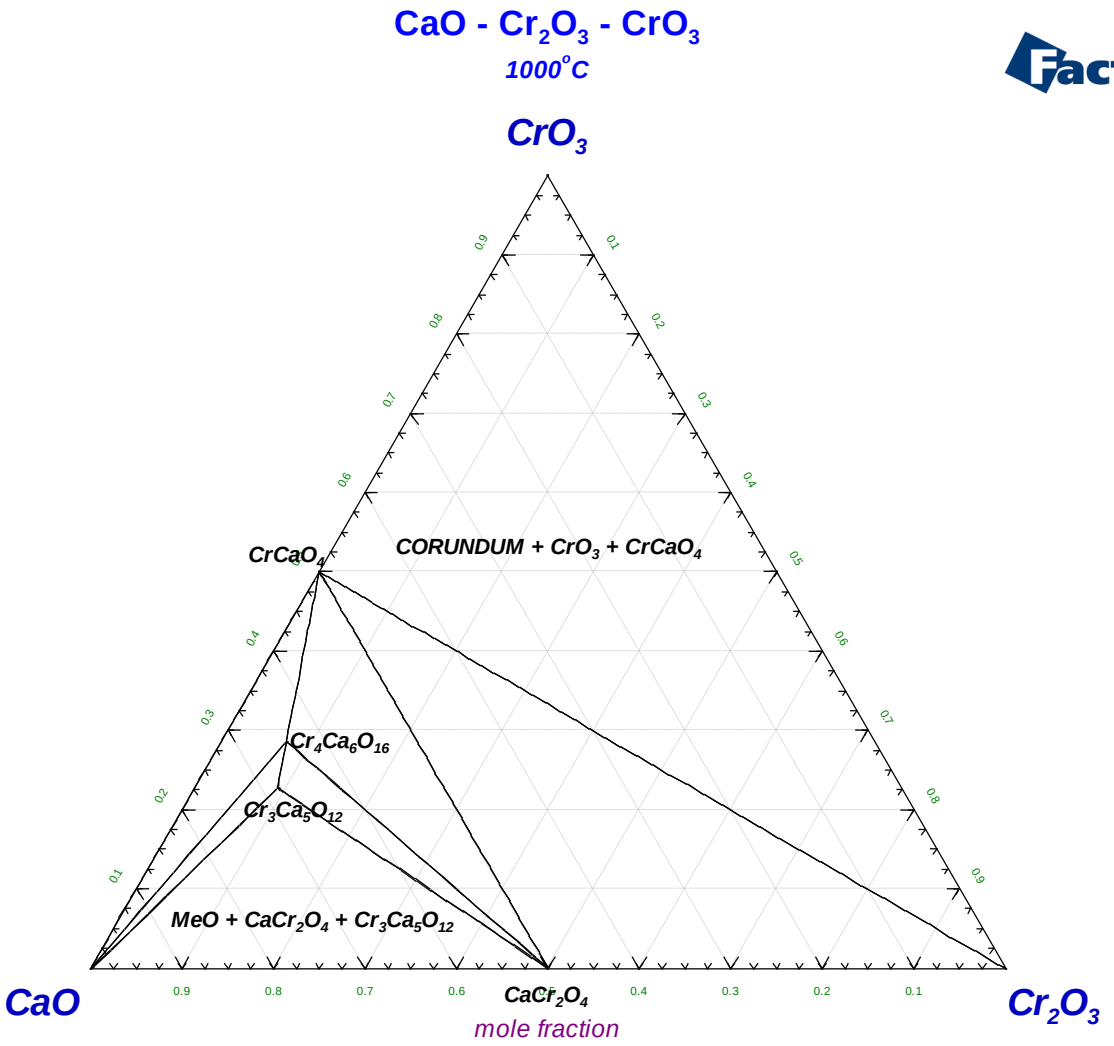
Weight percent, Liquidussurface



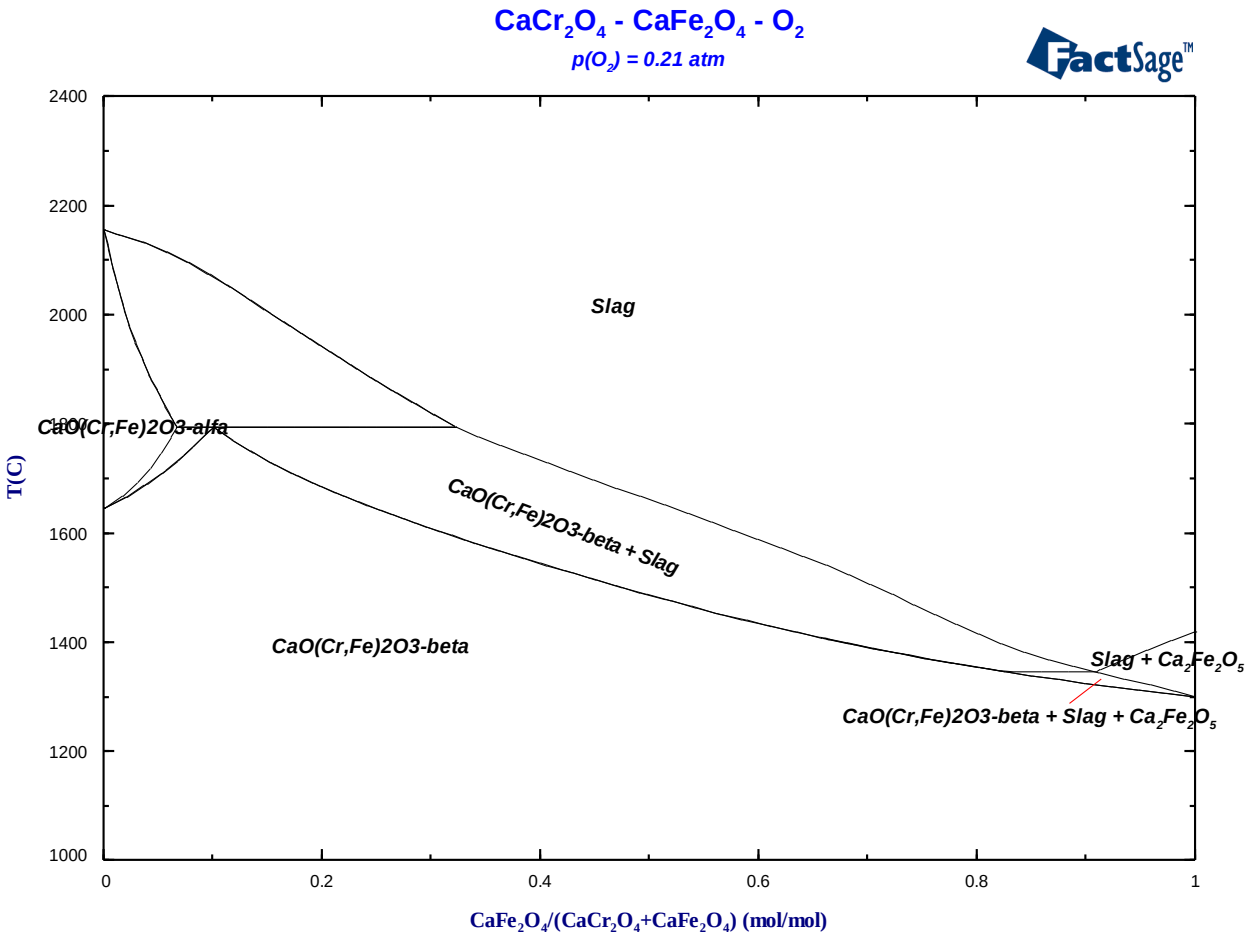
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction				Weight percent			
	A = CaS, B = CaO, C = SiO2				A = CaS, B = CaO, C = SiO2			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: Ca3SiO5(s) / CaS(s) / MeO	1: 0.45650	0.44518	0.09832	1894.20	1: 51.615	39.126	9.259	1894.19
2: Ca2SiO4(s2) / Ca3SiO5(s) / CaS(s)	2: 0.14051	0.60451	0.25499	1882.72	2: 17.078	57.111	25.811	1882.72
3: CaS(s) / Cristobalite / Slag#2	3: 0.29675	0.05991	0.64334	1671.99	3: 33.755	5.297	60.947	1671.99
4: Ca2SiO4(s2) / Ca2SiO4(s3) / Ca3Si2O7(s)	4: 0.03518	0.53631	0.42851	1436.73	4: 4.349	51.533	44.118	1436.73
5: Ca2SiO4(s2) / Ca2SiO4(s3) / CaS(s)	5: 0.04493	0.53135	0.42373	1436.73	5: 5.540	50.937	43.523	1436.73
6: Ca2SiO4(s3) / Ca3Si2O7(s) / CaS(s)	6: 0.04439	0.53085	0.42475	1430.84	6: 5.475	50.893	43.631	1430.83
7: Ca3Si2O7(s) / CaS(s) / CaSiO3(s2)	7: 0.04380	0.52629	0.42991	1416.81	7: 5.401	50.447	44.152	1416.80
8: CaS(s) / CaSiO3(s2) / Cristobalite	8: 0.07630	0.34222	0.58148	1392.26	8: 9.230	32.182	58.588	1392.39

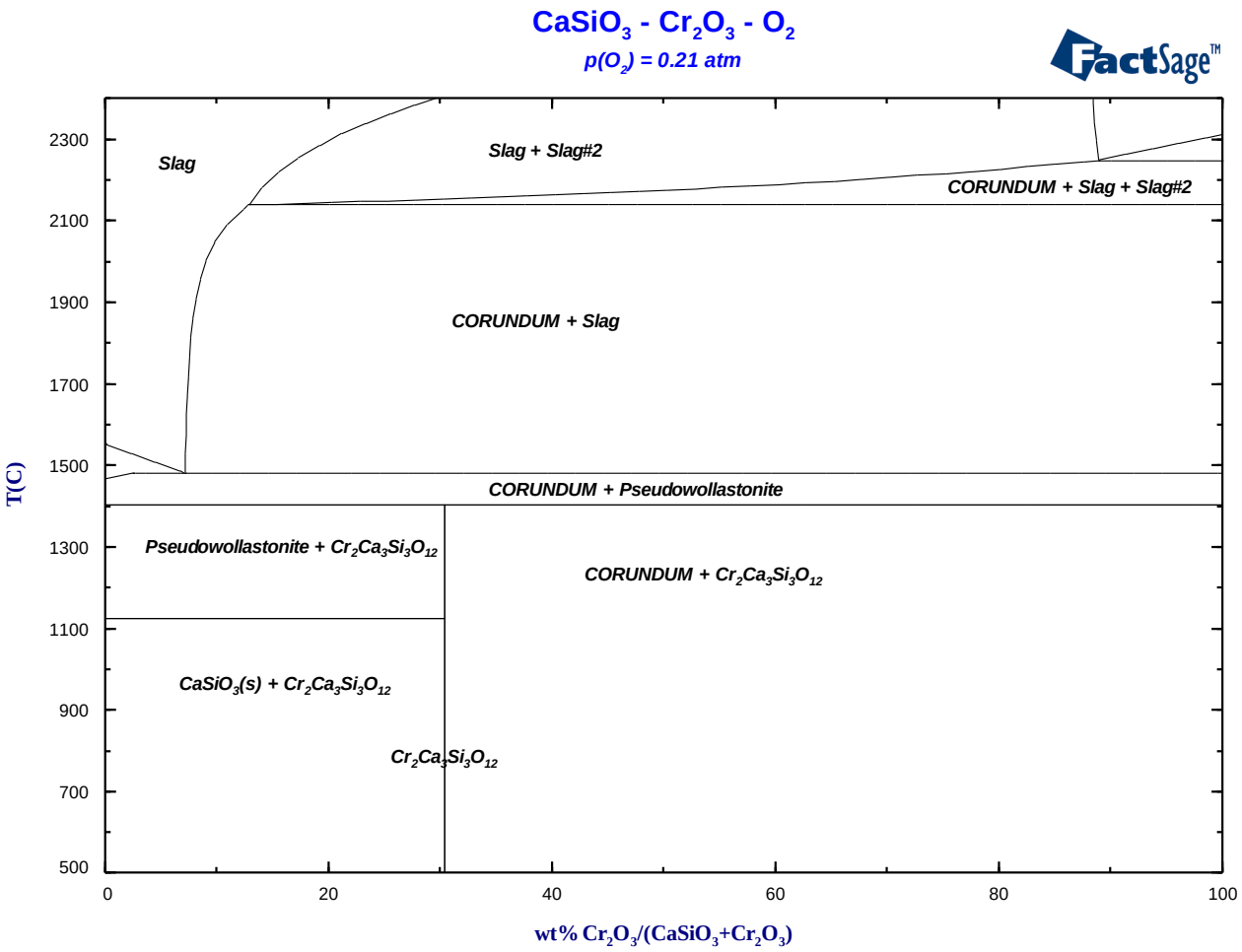
CaO-Cr2O3-CrO,
Mole fraction 1000°C



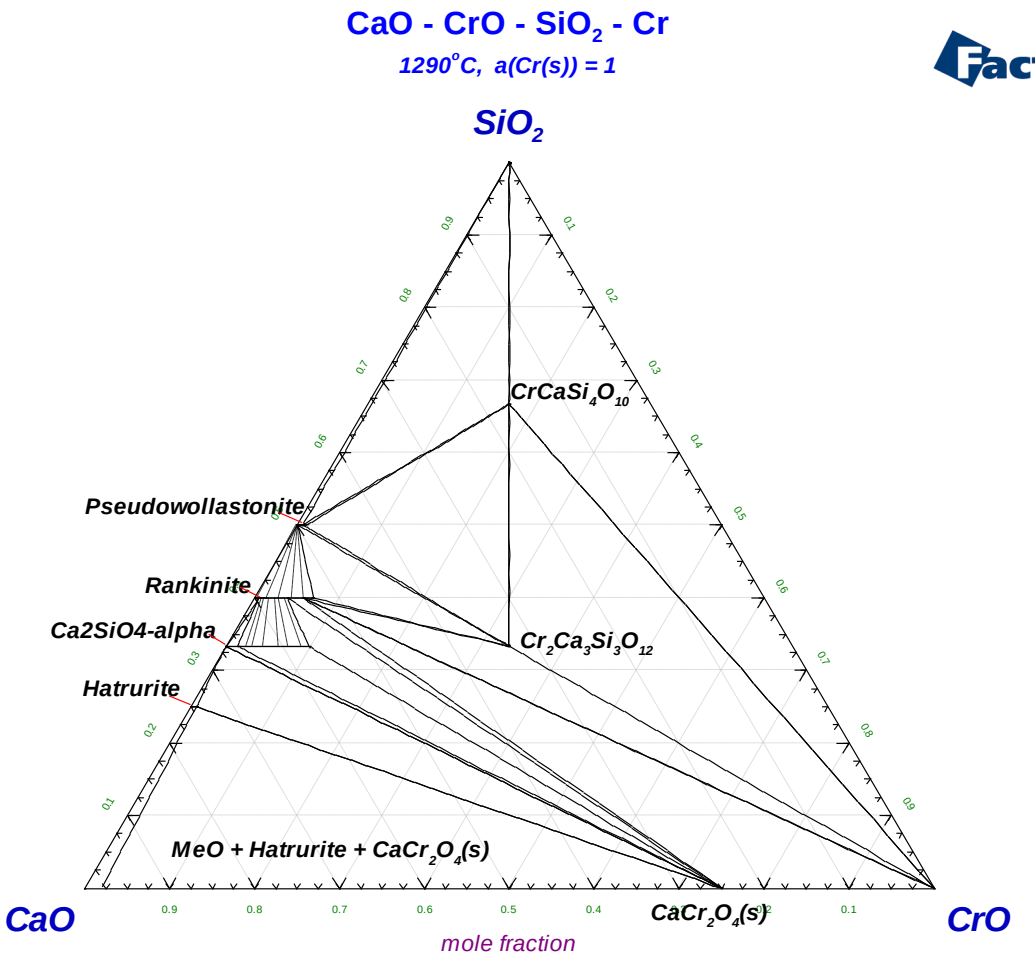
Mole fraction CaCr2O4-CaFe2O4-O2



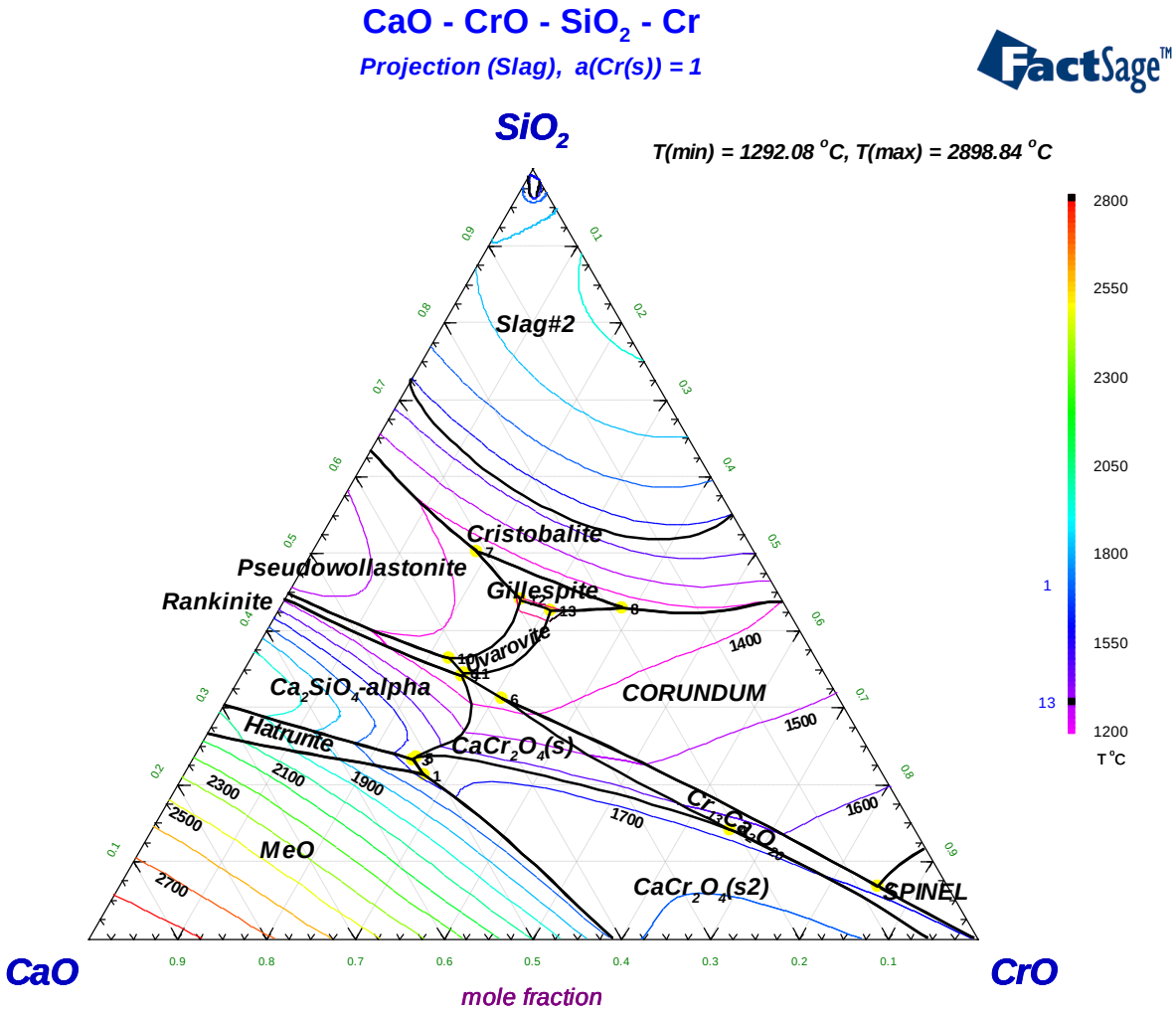
Weight percent CaSiO3-Cr2O3 an der Luft



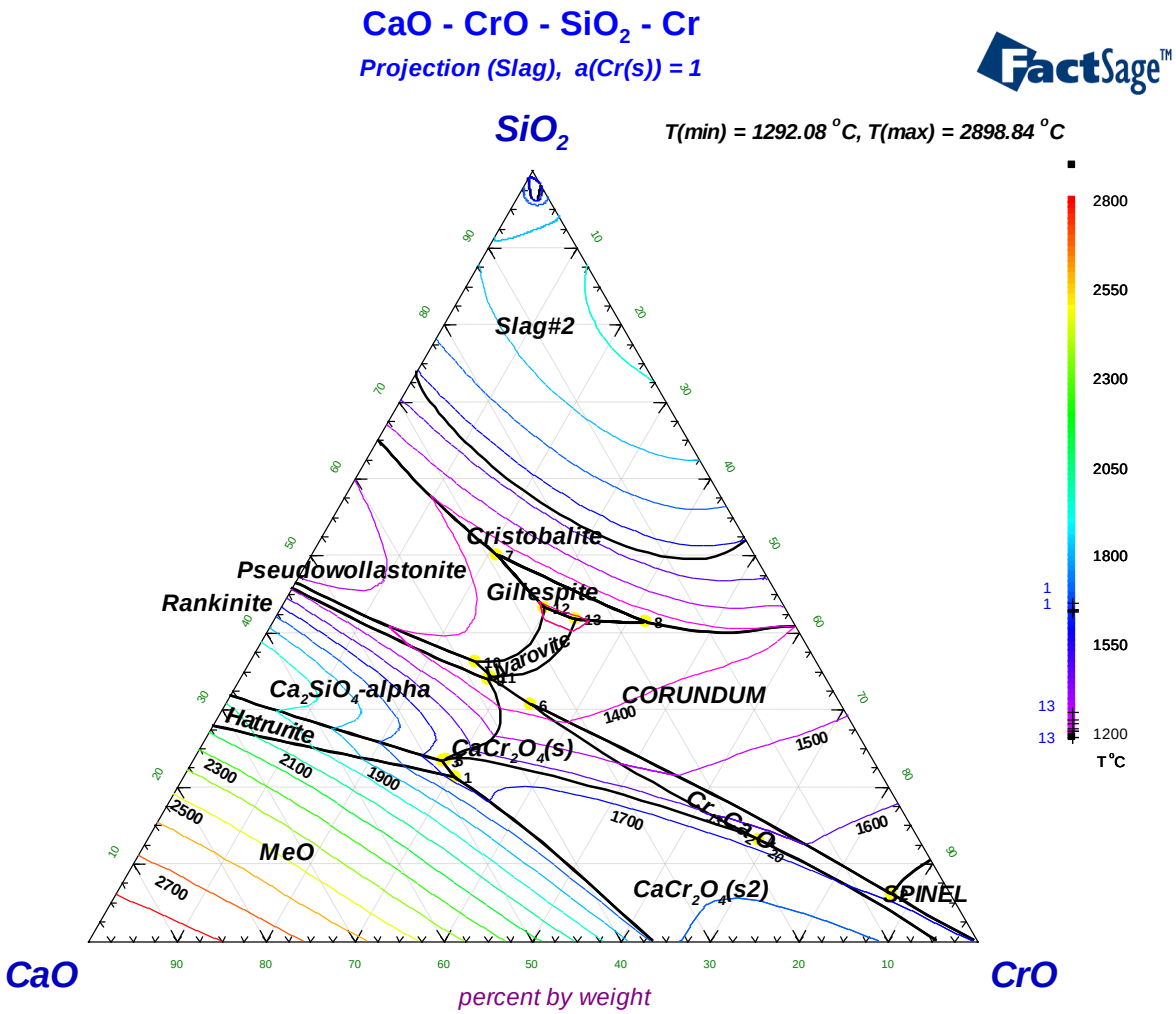
CaO-CrO-SiO2,
Mole fraction 1290°C



Mole fraction
Liquidussurface



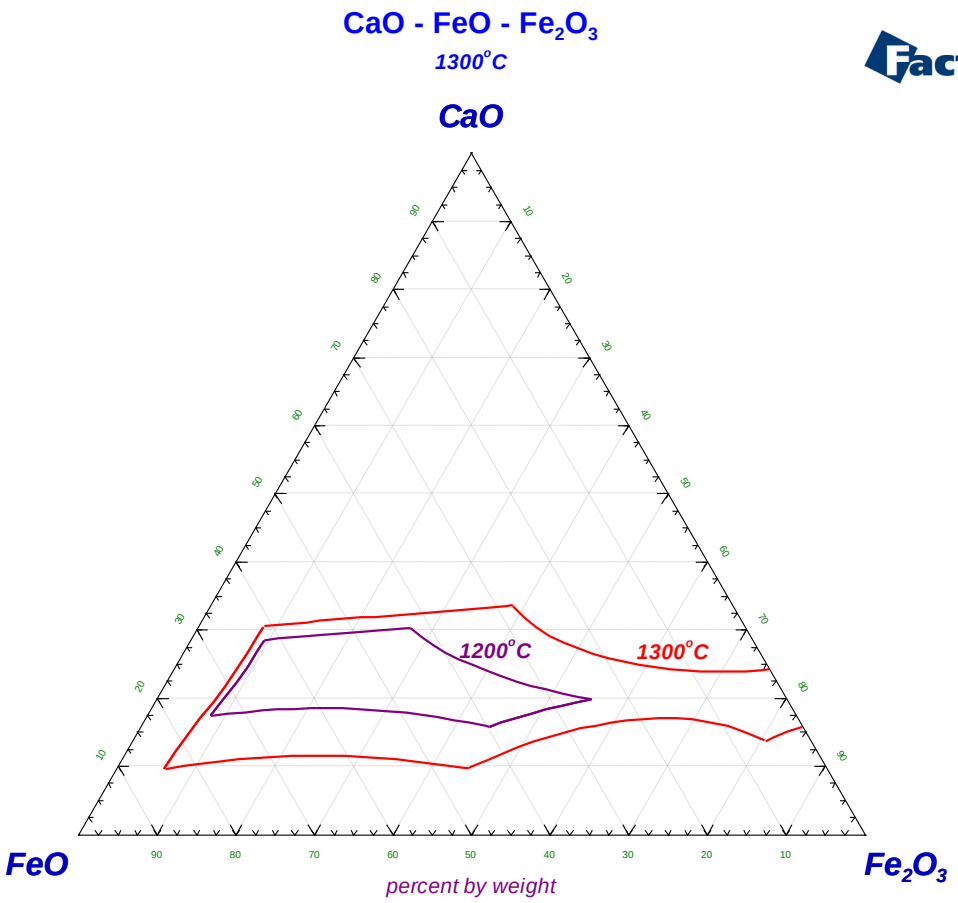
Weight percent
Liquidussurface

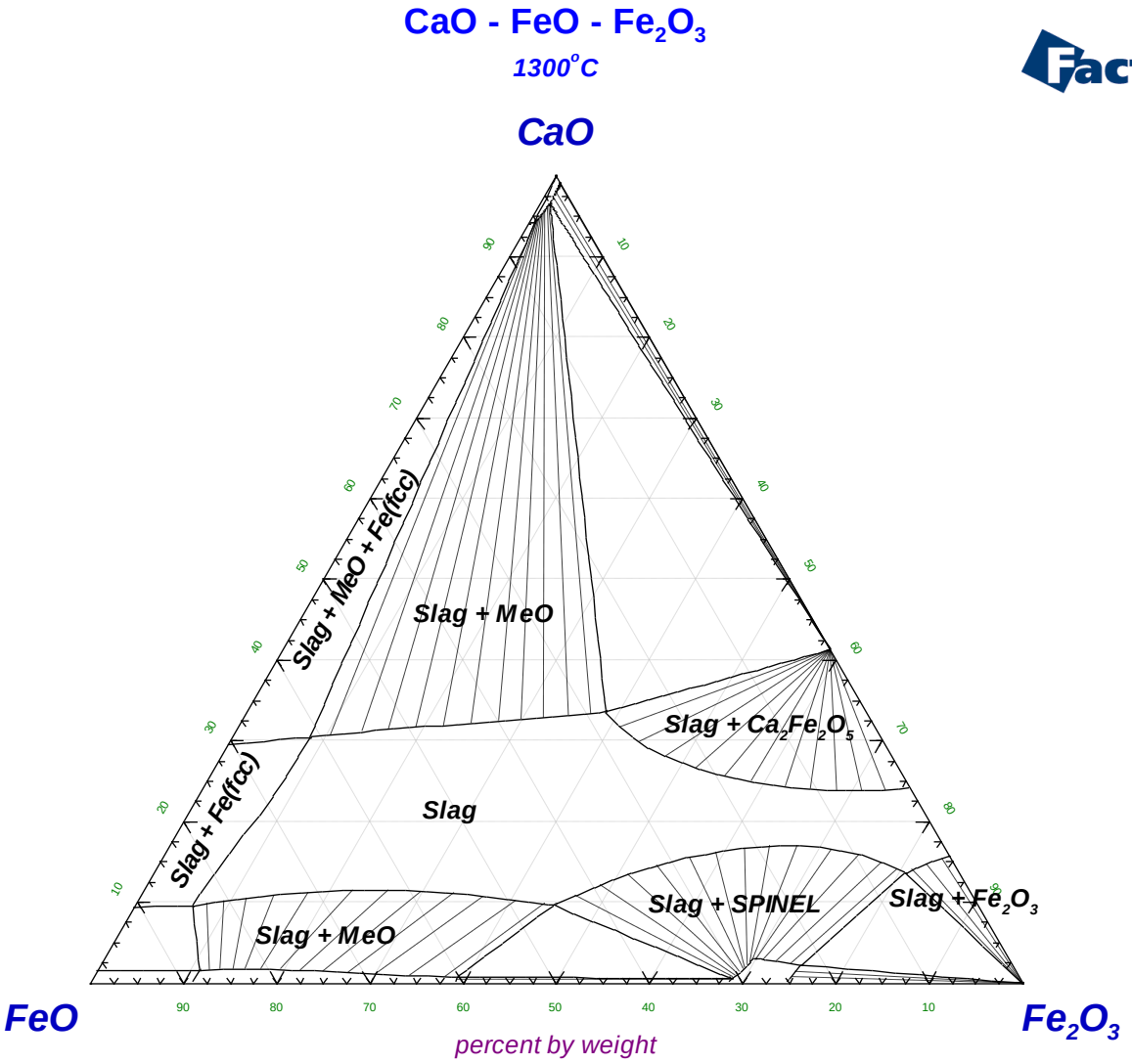


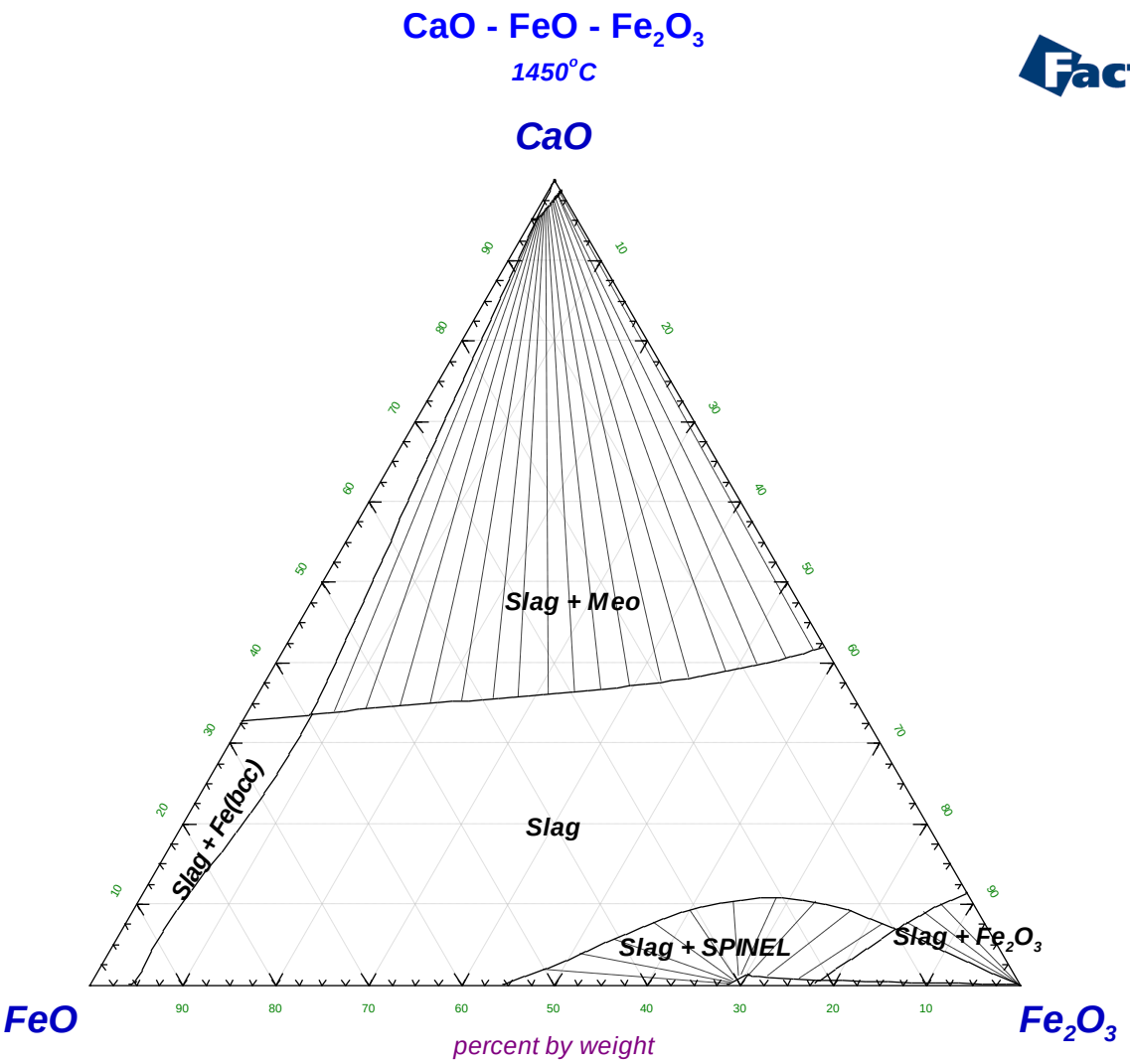
Invariant equilibria on the liquidus surface

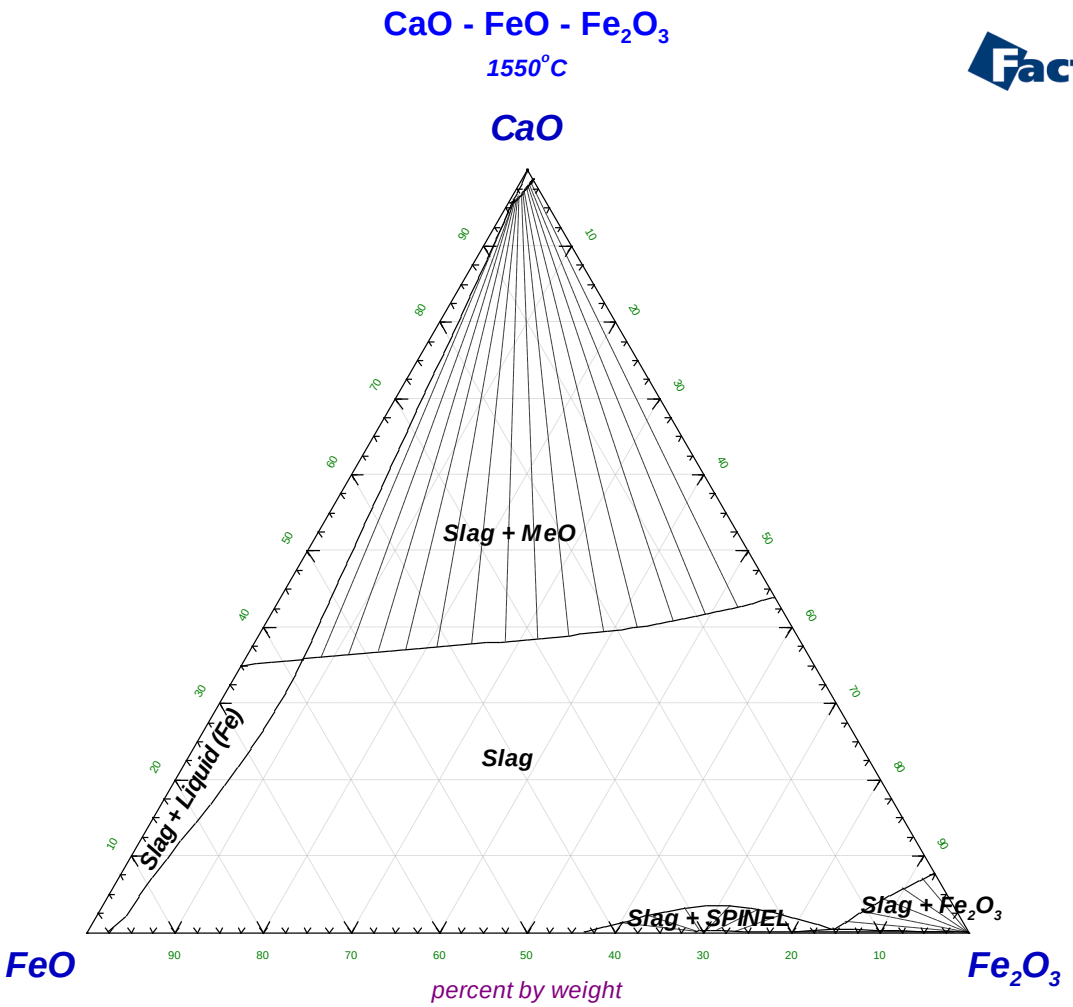
Intersections with slag	Mole fraction				Weight percent			
	A = SiO2, B = CaO, C = CrO				A = SiO2, B = CaO, C = CrO			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: Hatrurite / CaCr2O4(s2) / MeO	1: 0.21280	0.51626	0.27095	1669.01	1: 21.253	48.123	30.624	1669.01
2: Ca2SiO4-alfa / Hatrurite / CaCr2O4(s2)	2: 0.06777	0.07753	0.85470	1648.85	2: 6.120	6.535	87.346	1648.85
3: CORANDUM / Cr13Ca2O20 / SPINEL	3: 0.23253	0.51835	0.24912	1647.33	3: 23.294	48.464	28.242	1647.33
4: Ca2SiO4-alfa / CaCr2O4(s2) / CaCr2O4(s)	4: 0.14124	0.20663	0.65213	1644.87	4: 13.175	17.988	68.837	1644.87
5: CaCr2O4(s2) / CaCr2O4(s) / Cr13Ca2O20	5: 0.23583	0.51242	0.25175	1644.85	5: 23.607	47.874	28.519	1644.85
6: CORANDUM / CaCr2O4(s) / Cr13Ca2O20	6: 0.31234	0.37853	0.30913	1362.11	6: 30.759	34.791	34.451	1362.11
7: CORANDUM / Gillespite / Cristobalite	7: 0.50300	0.31114	0.18586	1340.39	7: 50.114	28.931	20.955	1340.39
8: Pseudowollastonite / Gillespite / Cristobalite	8: 0.42975	0.18372	0.38652	1327.91	8: 41.376	16.509	42.114	1327.91
9: CORANDUM / CaCr2O4(s) / Rankinite	9: 0.34071	0.40975	0.24954	1314.98	9: 33.884	38.032	28.084	1314.98
10: CORANDUM / Uvarovite / Rankinite	10: 0.36312	0.41094	0.22594	1307.61	10: 36.227	38.264	25.509	1307.61
11: Pseudowollastonite / Uvarovite / Rankinite	11: 0.34552	0.40484	0.24964	1306.56	11: 34.350	37.563	28.086	1306.56
12: CORANDUM / Uvarovite / Gillespite	12: 0.43958	0.29364	0.26678	1292.24	12: 43.286	26.986	29.728	1292.23
13: Pseudowollastonite / Uvarovite / Gillespite	13: 0.42659	0.26624	0.30717	1291.86	13: 41.712	24.297	33.991	1291.86

CaO-Fe2O3-FeO,
Weight percent
Liquidus lines at 1200° and 1300°C



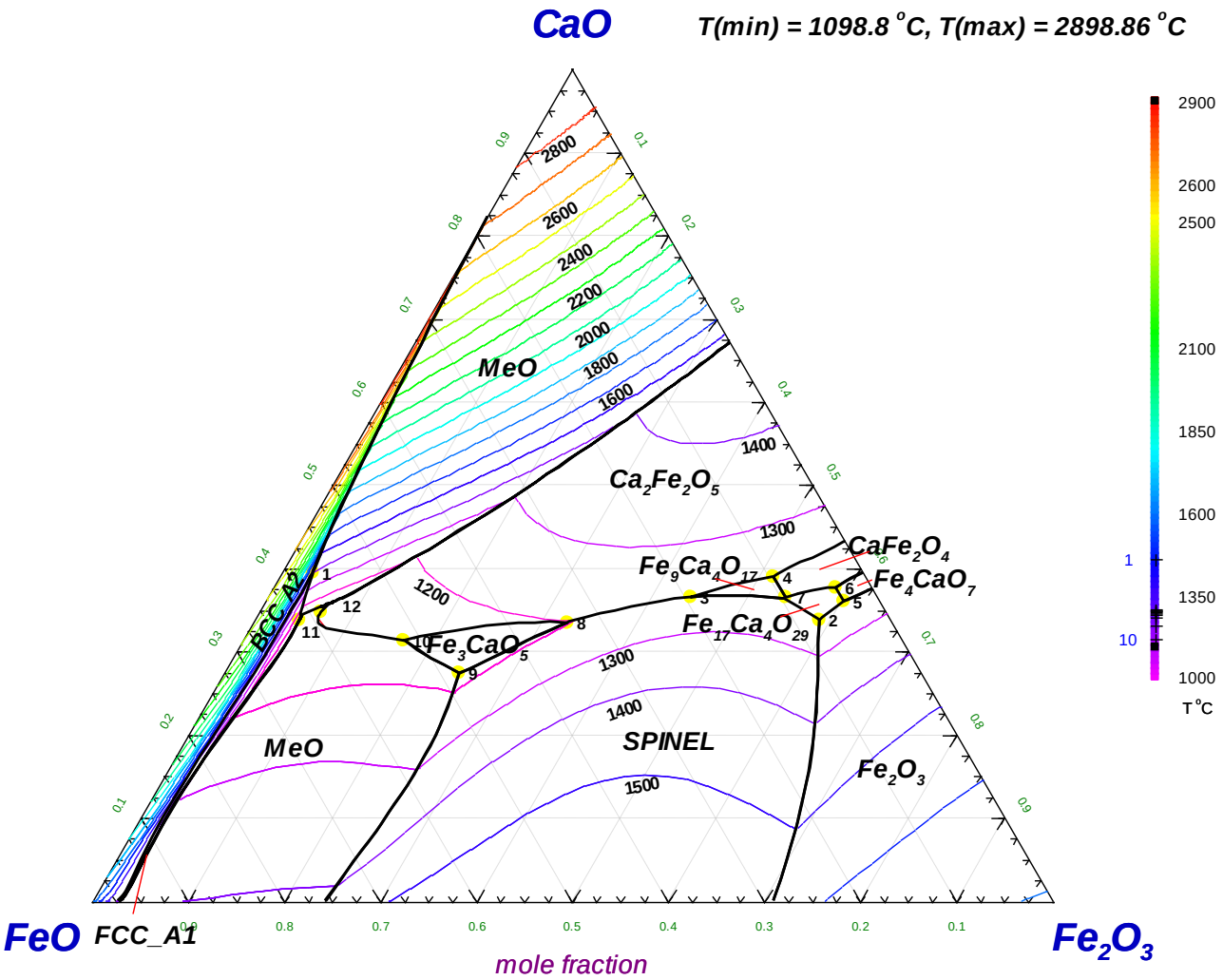

CaO - FeO - Fe2O3
1300°C
CaO
Slag + MeO + Fe(fcc)
Slag + MeO
Slag + Ca2Fe2O5
Slag + Fe(fcc)
Slag
Slag + SPINEL
Slag + Fe2O3
Slag + MeO
FeO
Fe2O3
90
80
70
60
50
40
30
20
10
percent by weight


CaO - FeO - Fe2O3
1450°C
CaO
Slag + Meo
Slag + Fe(bcc)
Slag
Slag + SPINEL
Slag + Fe2O3
FeO
Fe2O3
90
80
70
60
50
40
30
20
10
percent by weight

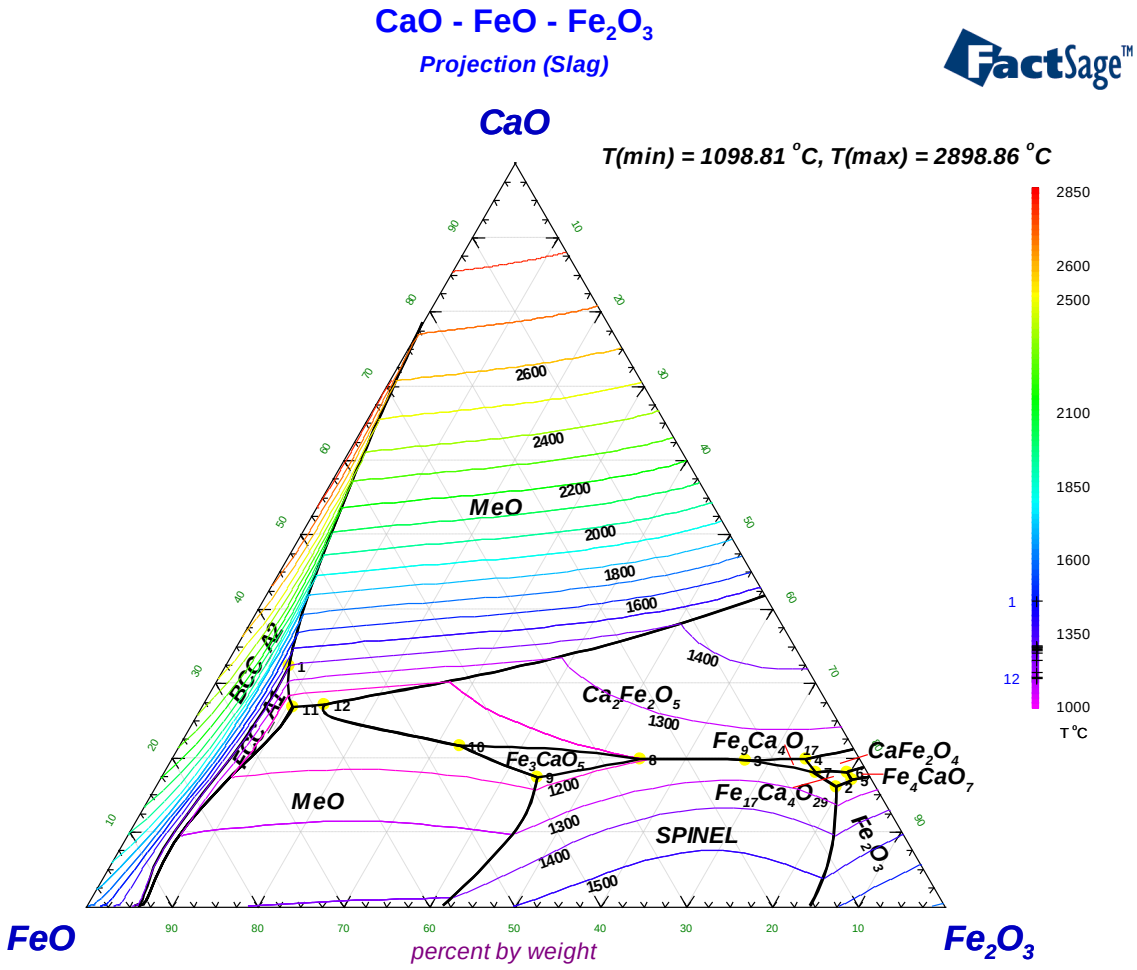

CaO - FeO - Fe2O3
1550°C
CaO
Slag + MeO
Slag
Slag + Liquid (Fe)
Slag + SPINEL
Slag + Fe2O3
FeO
Fe2O3
90
80
70
60
50
40
30
20
10
percent by weight

$CaO - FeO - Fe_2O_3$

Projection (Slag)



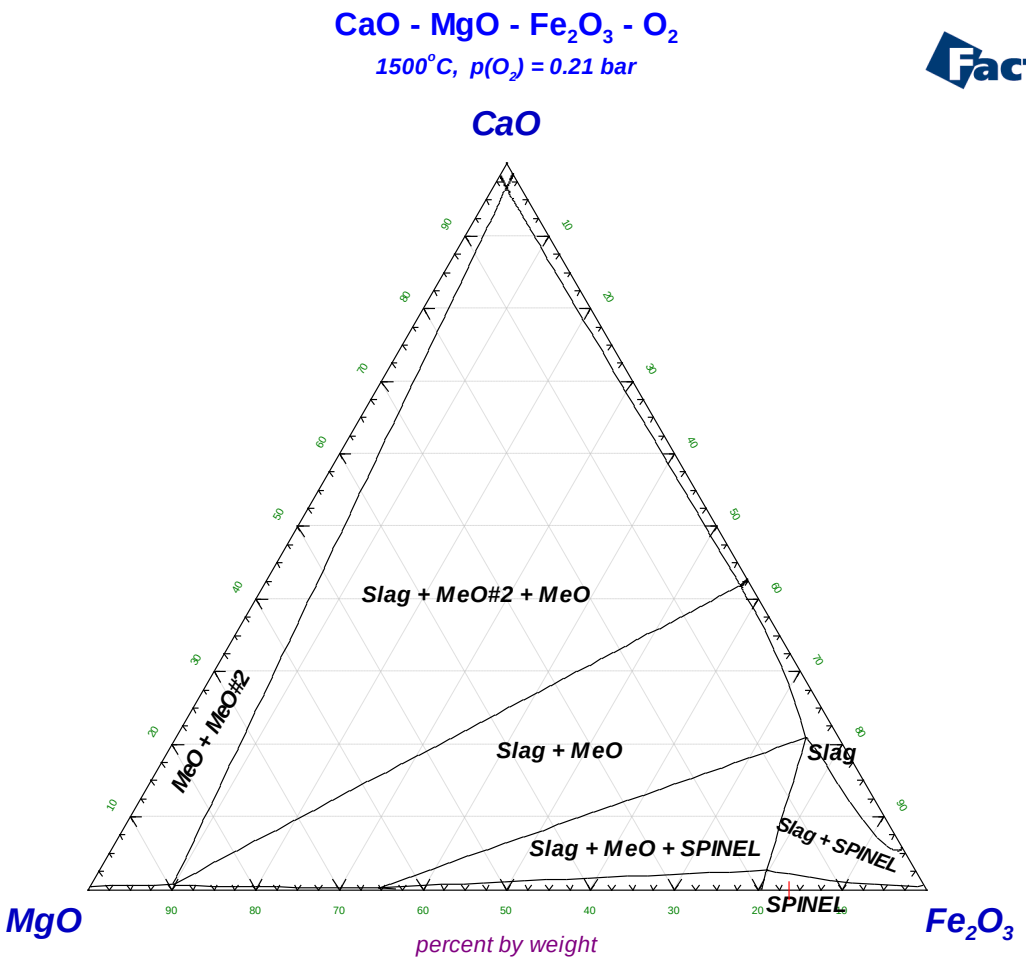
Weight percent
Liquidussurface



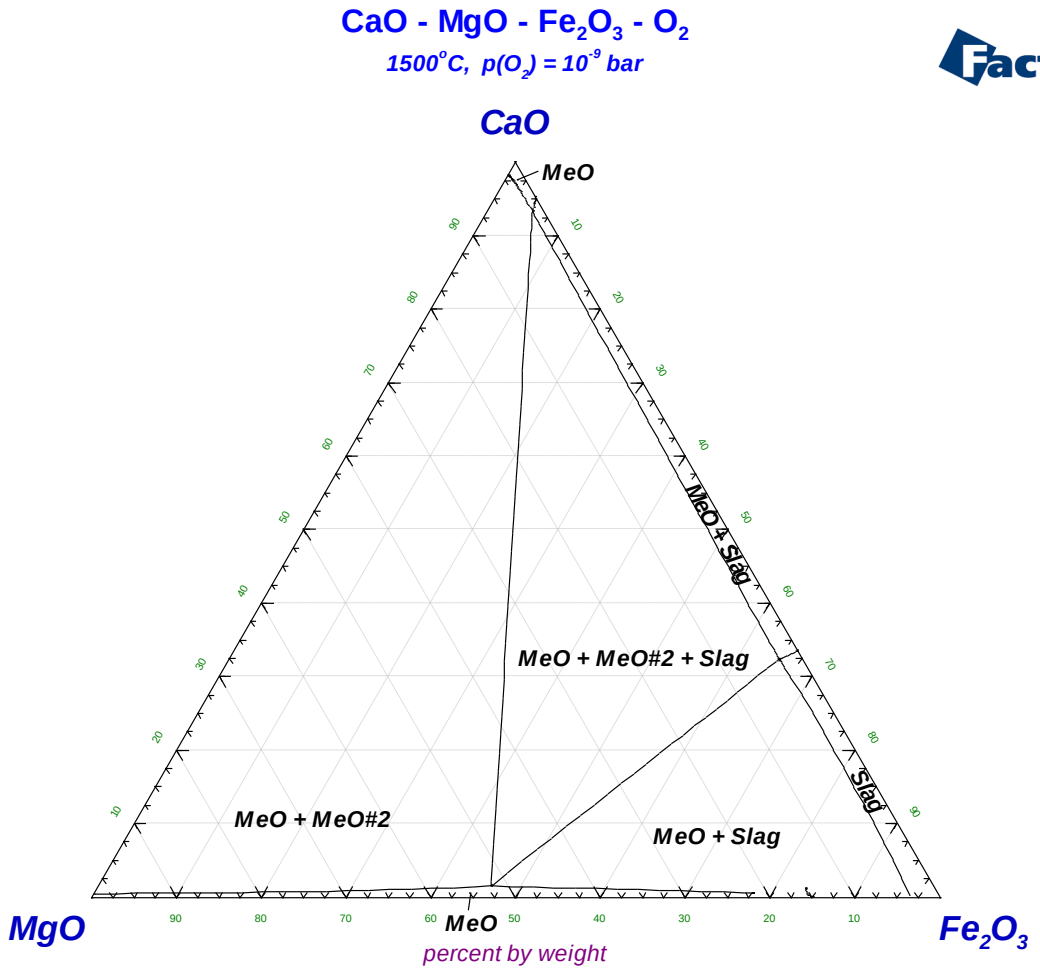
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction				Weight percent			
	A = CaO, B = FeO, C = Fe2O3				A = CaO, B = FeO, C = Fe2O3			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: BCC_A2 / FCC_A1 / MeO	1: 0.39484	0.57296	0.03221	1391.92	1: 32.348	60.138	7.514	1391.92
2: Fe17Ca4O29 / Fe2O3 / SPINEL	2: 0.33854	0.07381	0.58765	1224.51	2: 16.071	4.489	79.440	1224.52
3: Ca2Fe2O5 / Fe9Ca4O17 / SPINEL	3: 0.36595	0.19383	0.44023	1219.06	3: 19.592	13.295	67.114	1219.06
4: Ca2Fe2O5 / CaFe2O4 / Fe9Ca4O17	4: 0.39077	0.09564	0.51358	1218.86	4: 19.778	6.202	74.020	1218.86
5: Fe17Ca4O29 / Fe2O3 / Fe4CaO7	5: 0.36043	0.03701	0.60257	1217.33	5: 16.971	2.232	80.796	1217.33
6: CaFe2O4 / Fe17Ca4O29 / Fe4CaO7	6: 0.37746	0.03704	0.58549	1209.38	6: 18.042	2.268	79.690	1209.38
7: CaFe2O4 / Fe17Ca4O29 / Fe9Ca4O17	7: 0.36518	0.09451	0.54031	1205.53	7: 18.034	5.980	75.986	1205.53
8: Ca2Fe2O5 / Fe3CaO5 / SPINEL	8: 0.33539	0.33777	0.32684	1197.17	8: 19.742	25.473	54.785	1197.17
9: Fe3CaO5 / MeO / SPINEL	9: 0.27427	0.48029	0.24544	1171.44	9: 17.266	38.736	43.998	1171.44
10: Ca2Fe2O5 / Fe3CaO5 / MeO	10: 0.31373	0.51832	0.16795	1127.31	10: 21.547	45.606	32.847	1127.31
11: FCC_A1 / MeO#1 / MeO#2	11: 0.33718	0.61552	0.04730	1109.39	11: 26.752	62.563	10.685	1109.38
12: Ca2Fe2O5 / MeO#1 / MeO#2	12: 0.34774	0.58776	0.06450	1104.16	12: 27.074	58.627	14.299	1104.15

CaO-Fe2O3-MgO,
Weight percent 1500°C

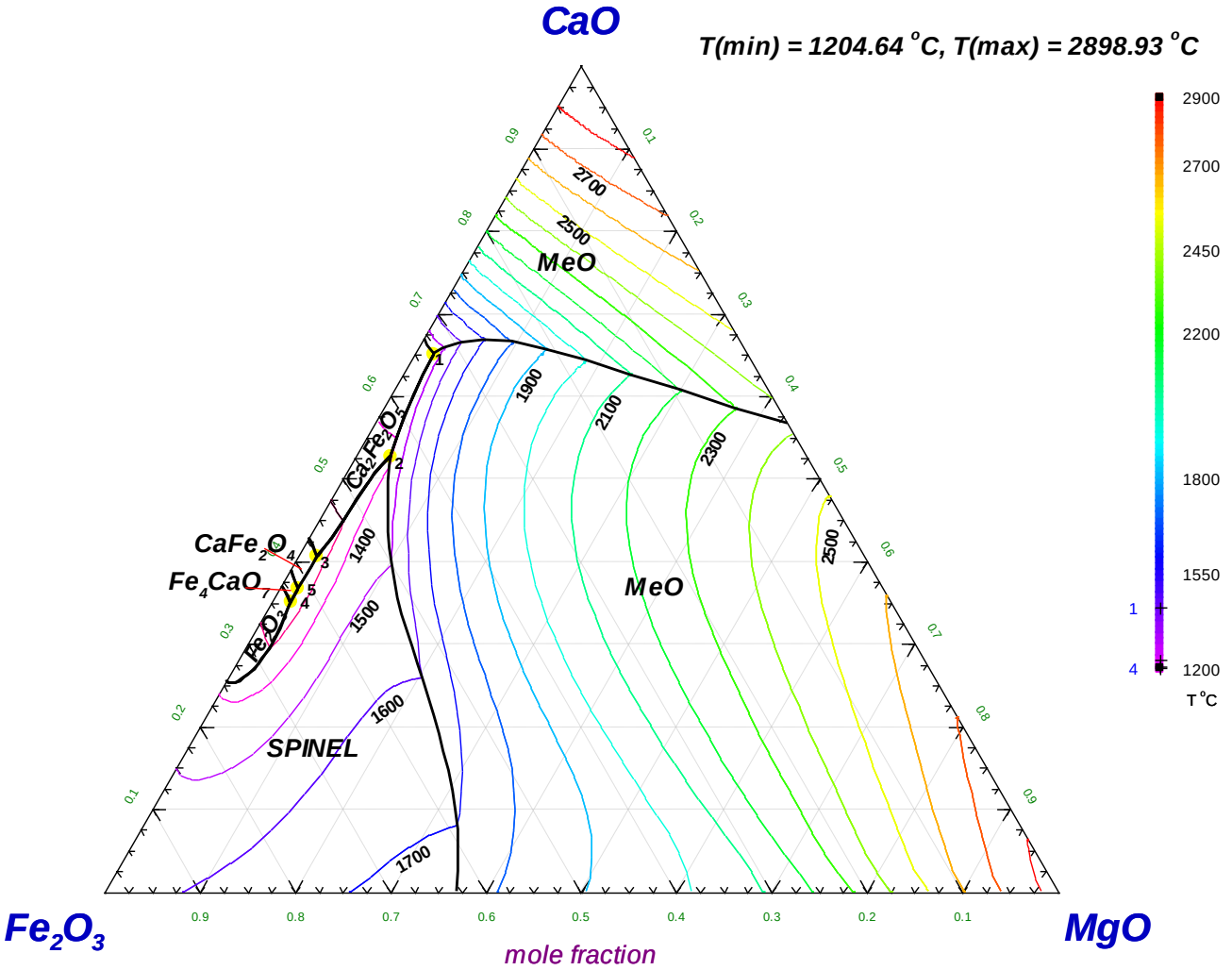


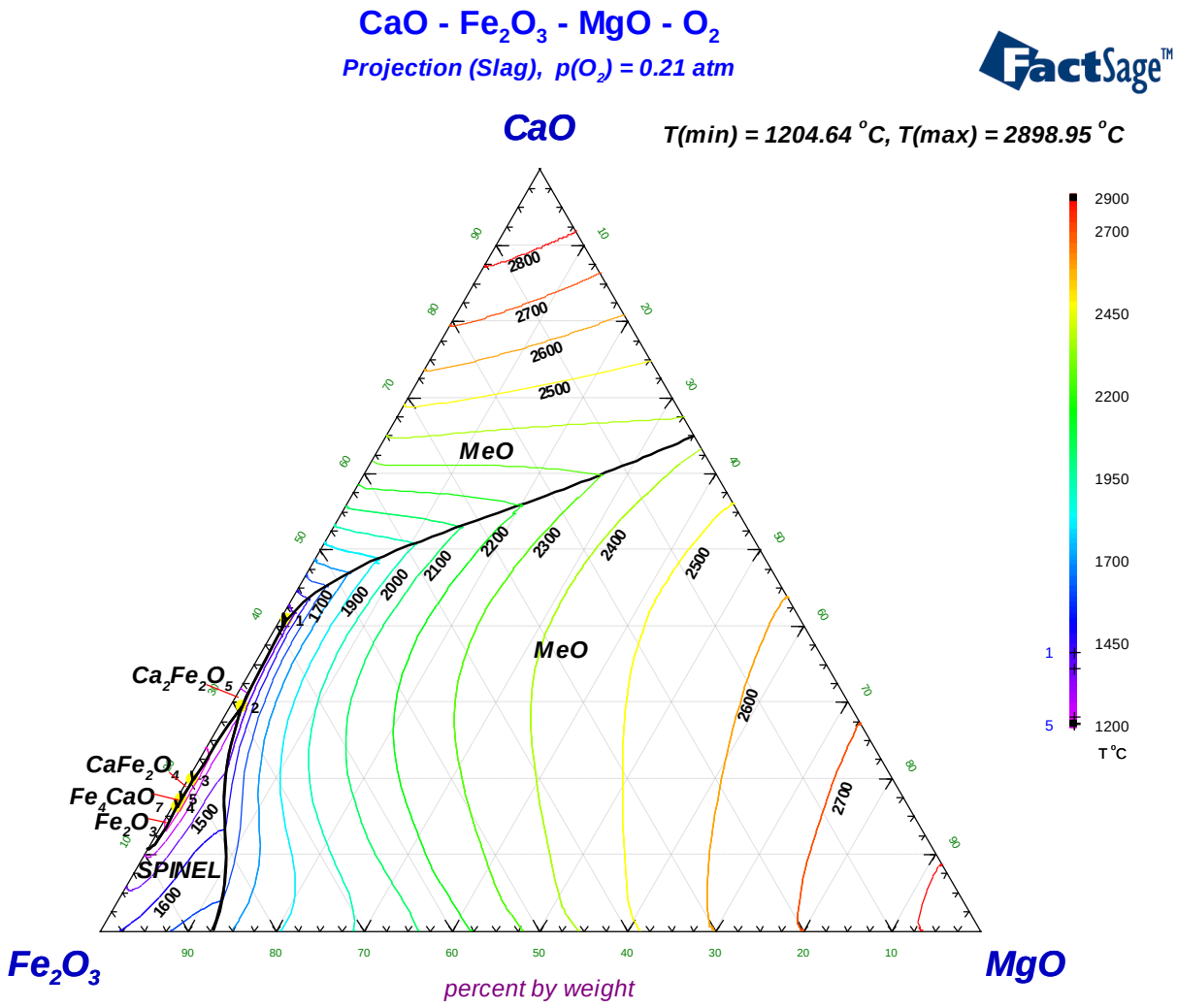
Weight percent
$P(O_2)=10^{-9}$ bar



$CaO - Fe_2O_3 - MgO - O_2$

Projection (Slag), $p(O_2) = 0.21$ atm

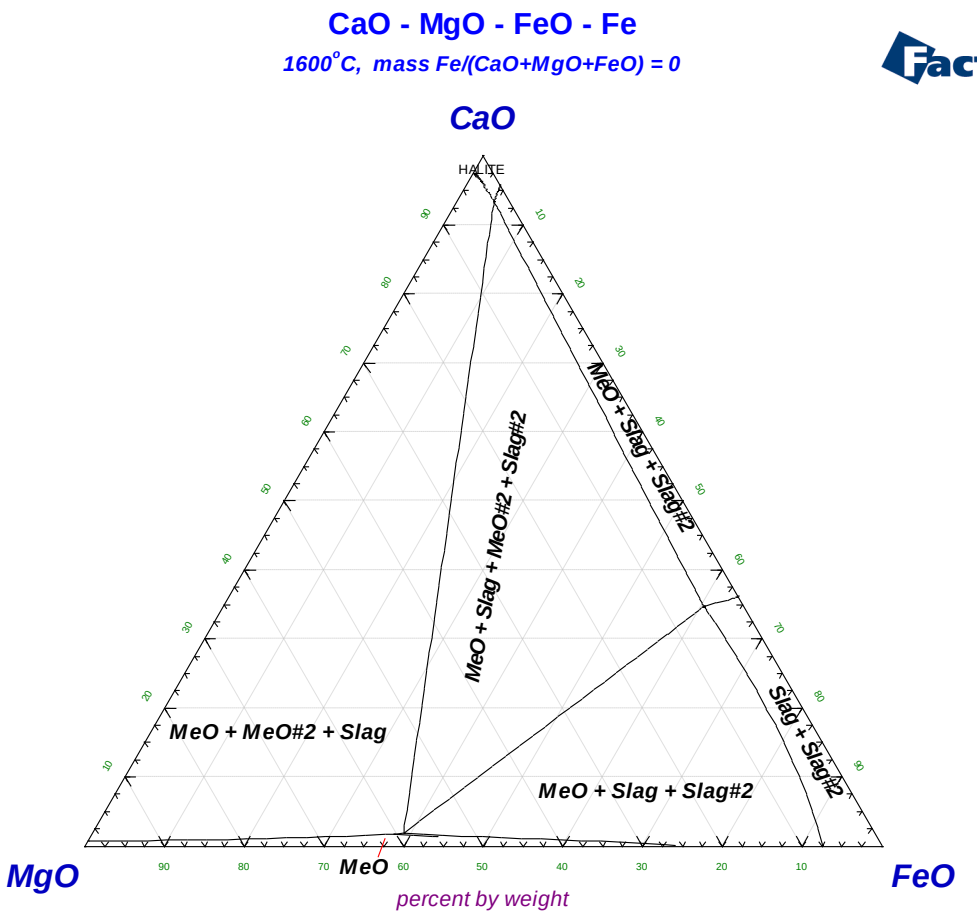



CaO - Fe2O3 - MgO - O2
Projection (Slag), p(O2) = 0.21 atm
FactSage™
CaO
T(min) = 1204.64 °C, T(max) = 2898.95 °C
MeO
MeO
Ca2Fe2O5
CaFe2O4
Fe4CaO7
Fe2O3
SPINEL
Fe2O3
MgO
percent by weight
T °C
2900
2700
2450
2200
1950
1700
1450
1200

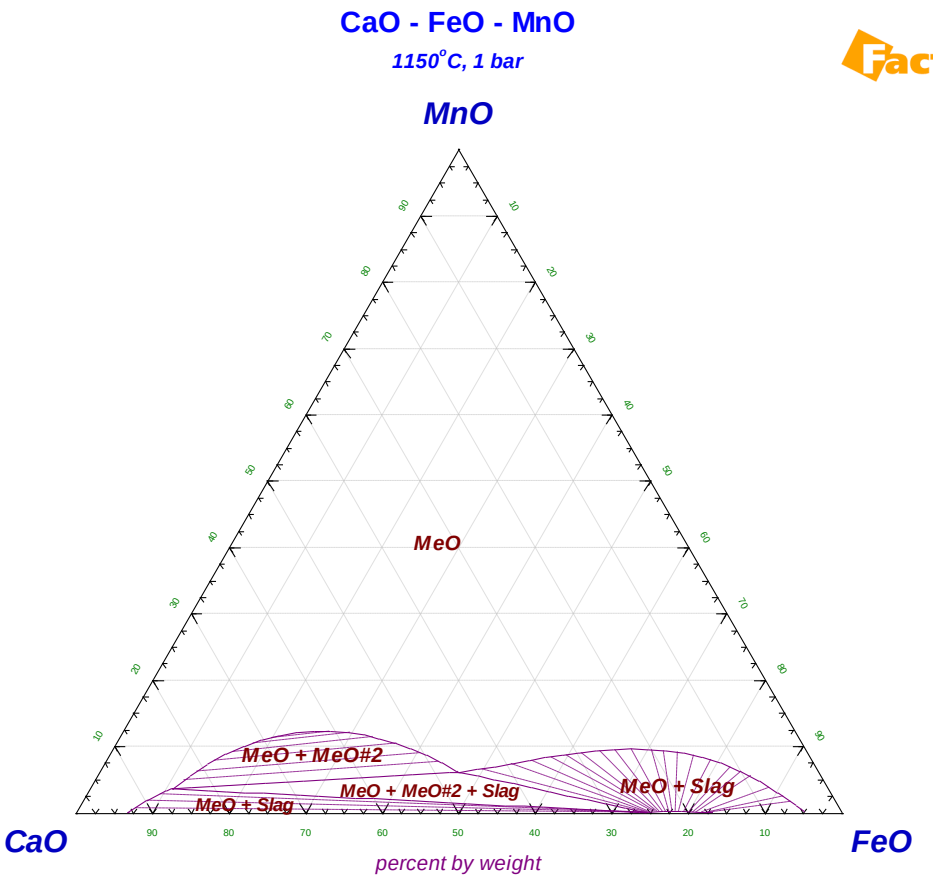
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction				Weight percent			
	A = CaO, B = Fe2O3, C = MgO				A = CaO, B = Fe2O3, C = MgO			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: Ca2Fe2O5 / MeO#1 / MeO#2	1: 0.65110	0.32930	0.0196	1437.05	1: 40.758	58..369	0.873	1437.05
2: Ca2Fe2O5 / MeO#1 / SPINEL	2: 0.52689	0.43652	0.03659	1386.85	2: 29.333	69.203	1.464	1386.85
3: Ca2Fe2O5 / CaFe2O4 / SPINEL	3: 0.40569	0.57383	0.02048	1227.52	3: 19.746	79.537	0.716	1227.52
4: Fe2O3 / Fe4CaO7 / SPINEL	4: 0.35081	0.62940	0.01980	1210.53	4: 16.261	83.079	0.660	1210.53
5: CaFe2O4 / Fe4CaO7 / SPINEL	5: 0.36683	0.61377	0.01941	1204.64	5: 17.234	82.111	0.655	1204.64

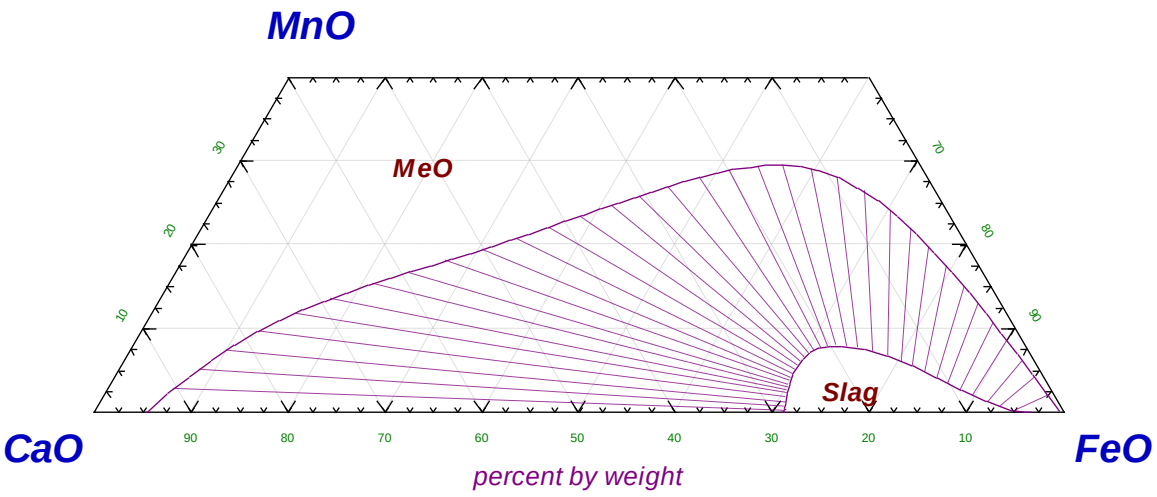
CaO-FeO-MgO,
Weight percent 1600°C

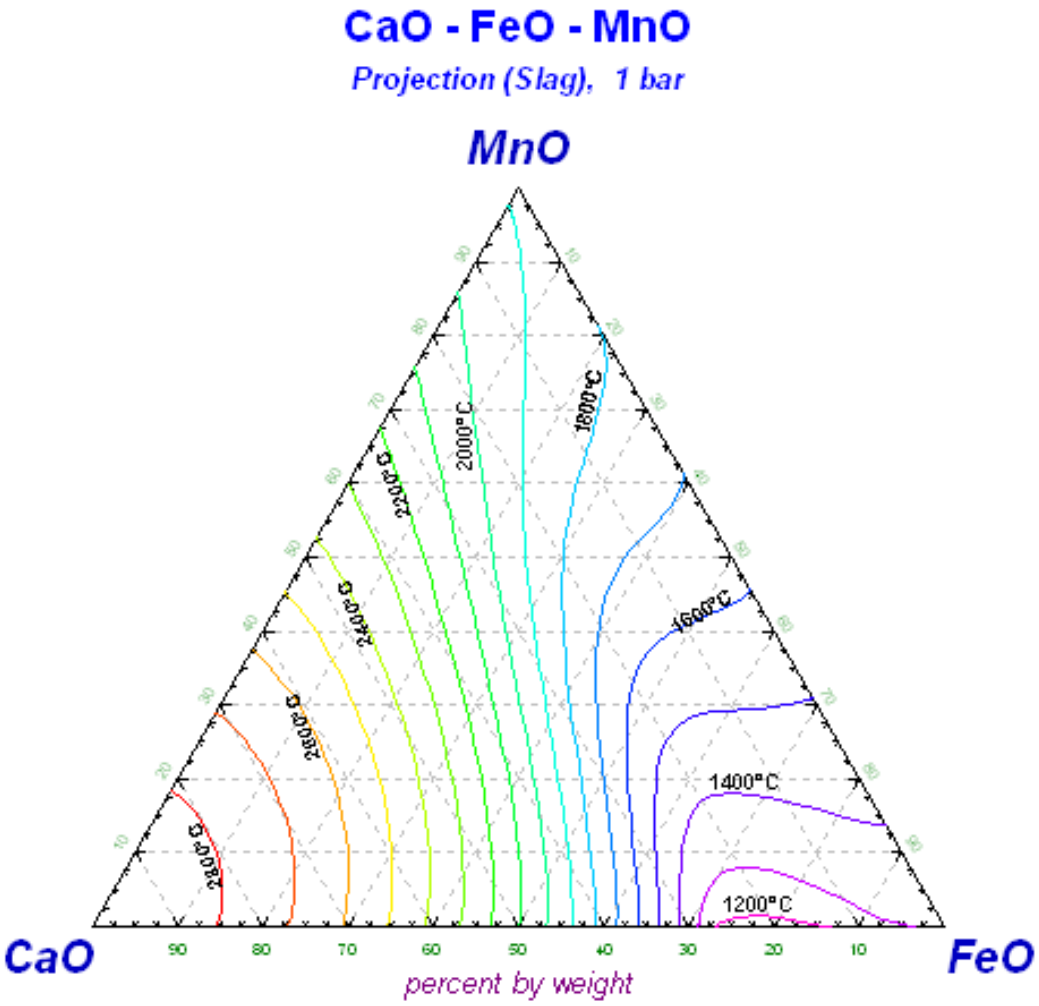


Weight percent 1150°C

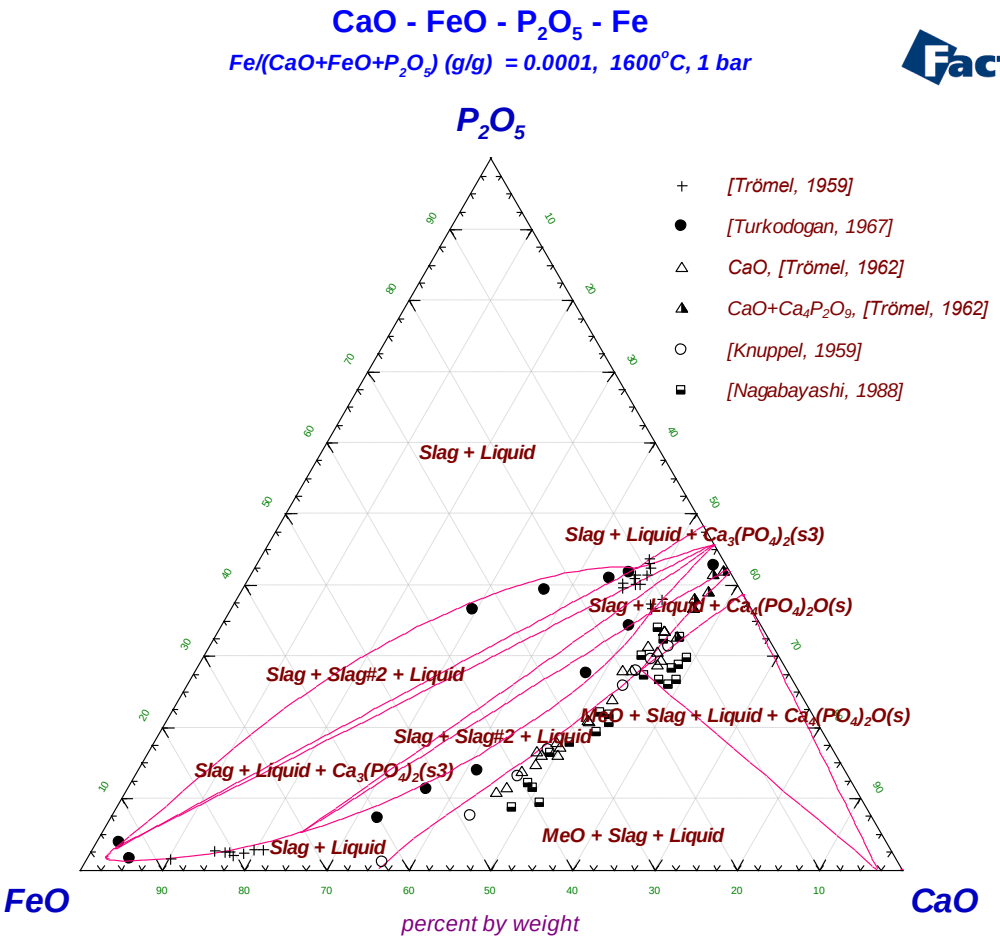


Weight percent 1350°C

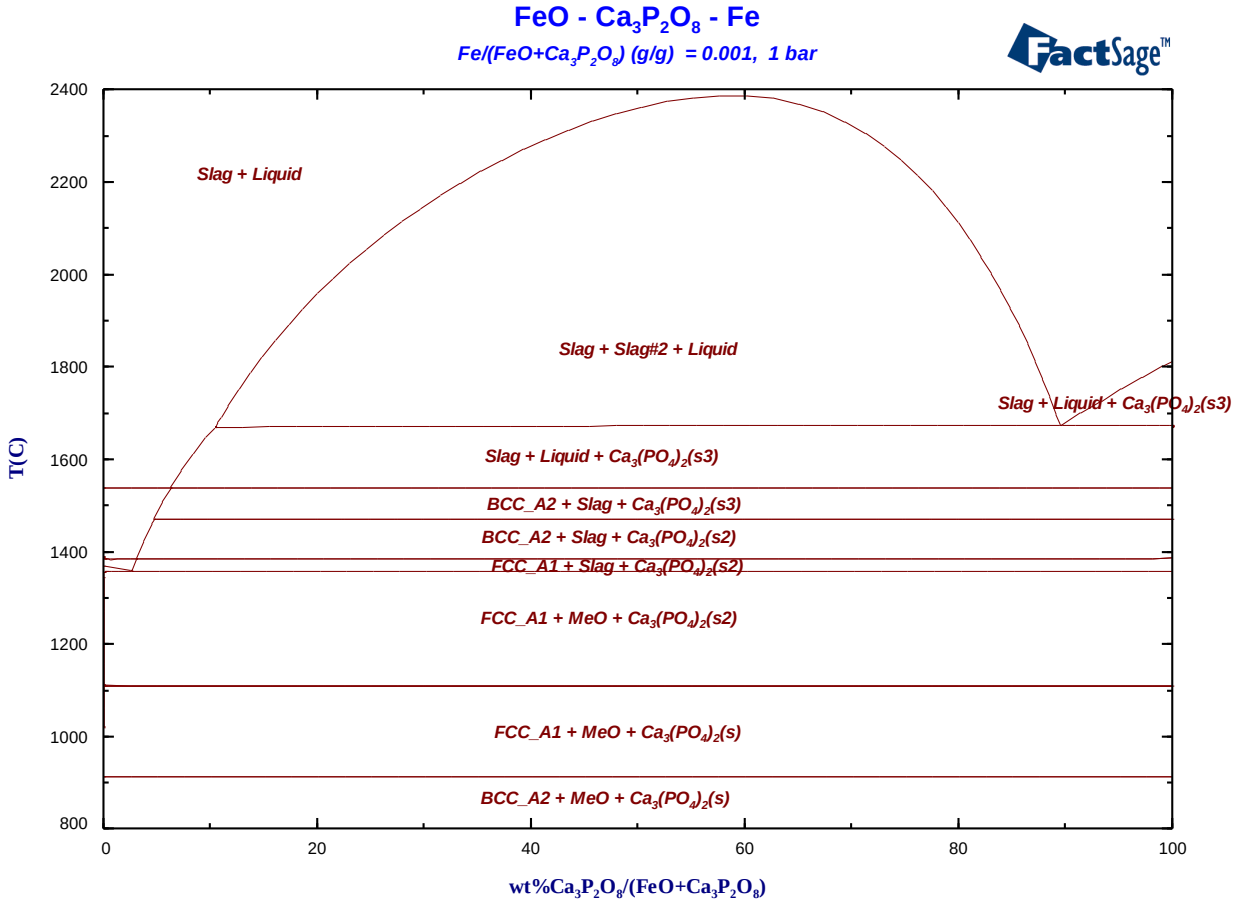



CaO - FeO - MnO
Projection (Slag), 1 bar
MnO
CaO
FeO
percent by weight
90
80
70
60
50
40
30
20
10
1600°C
2000°C
2200°C
2400°C
2600°C
2800°C
1600°C
1400°C
1200°C

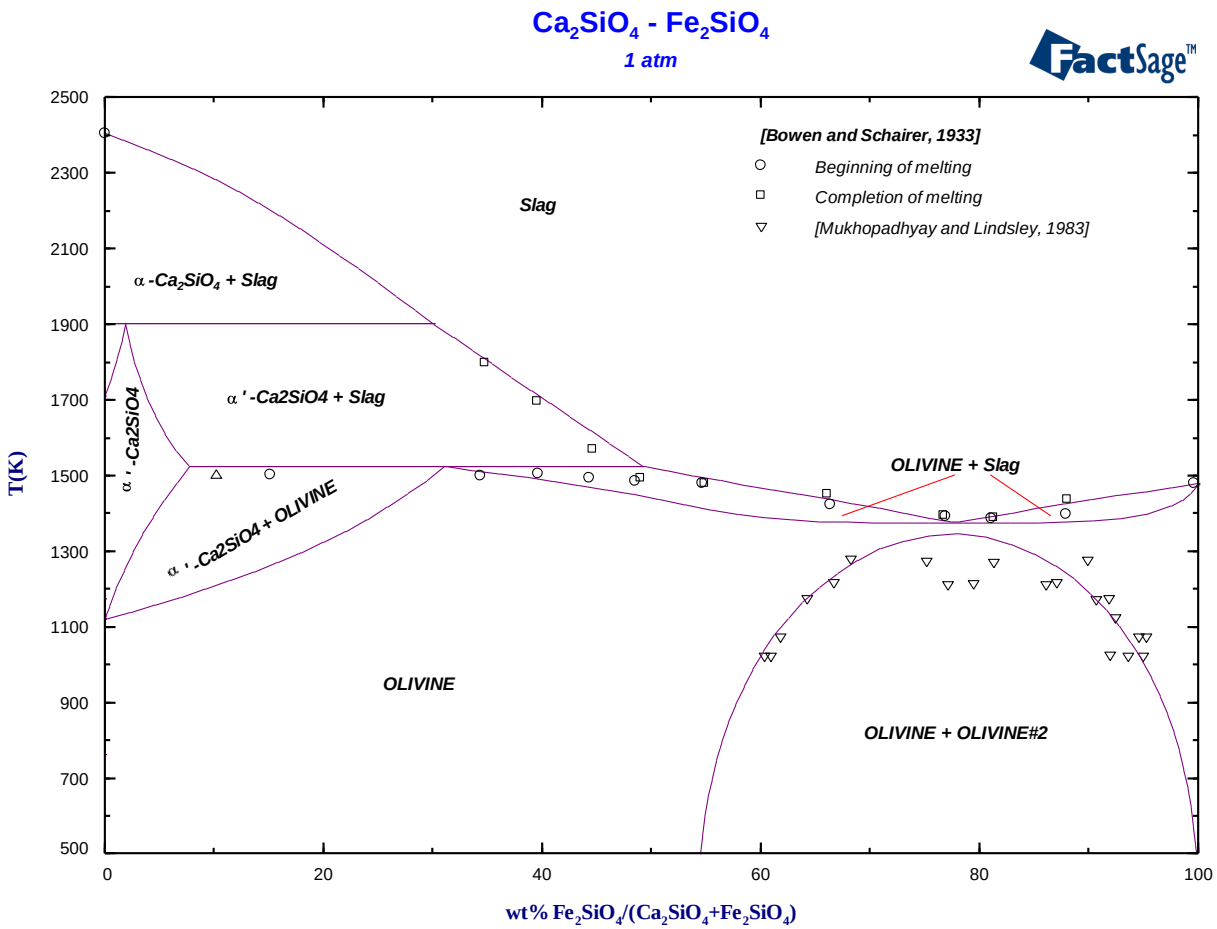
Weight percent, Isothermal section at 1600°C



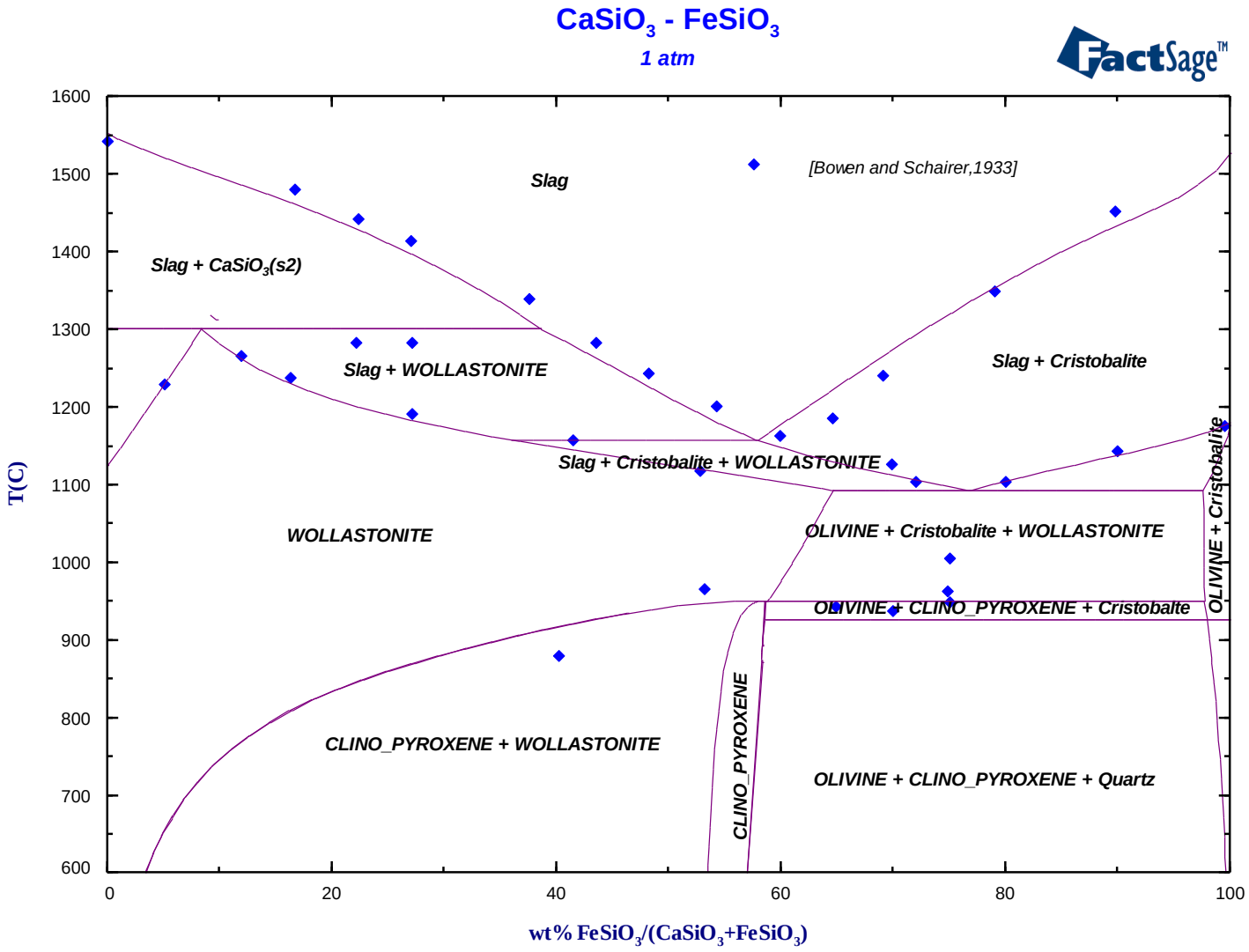
Weight percent, Isopleth section at Ca3P2O8-FeO



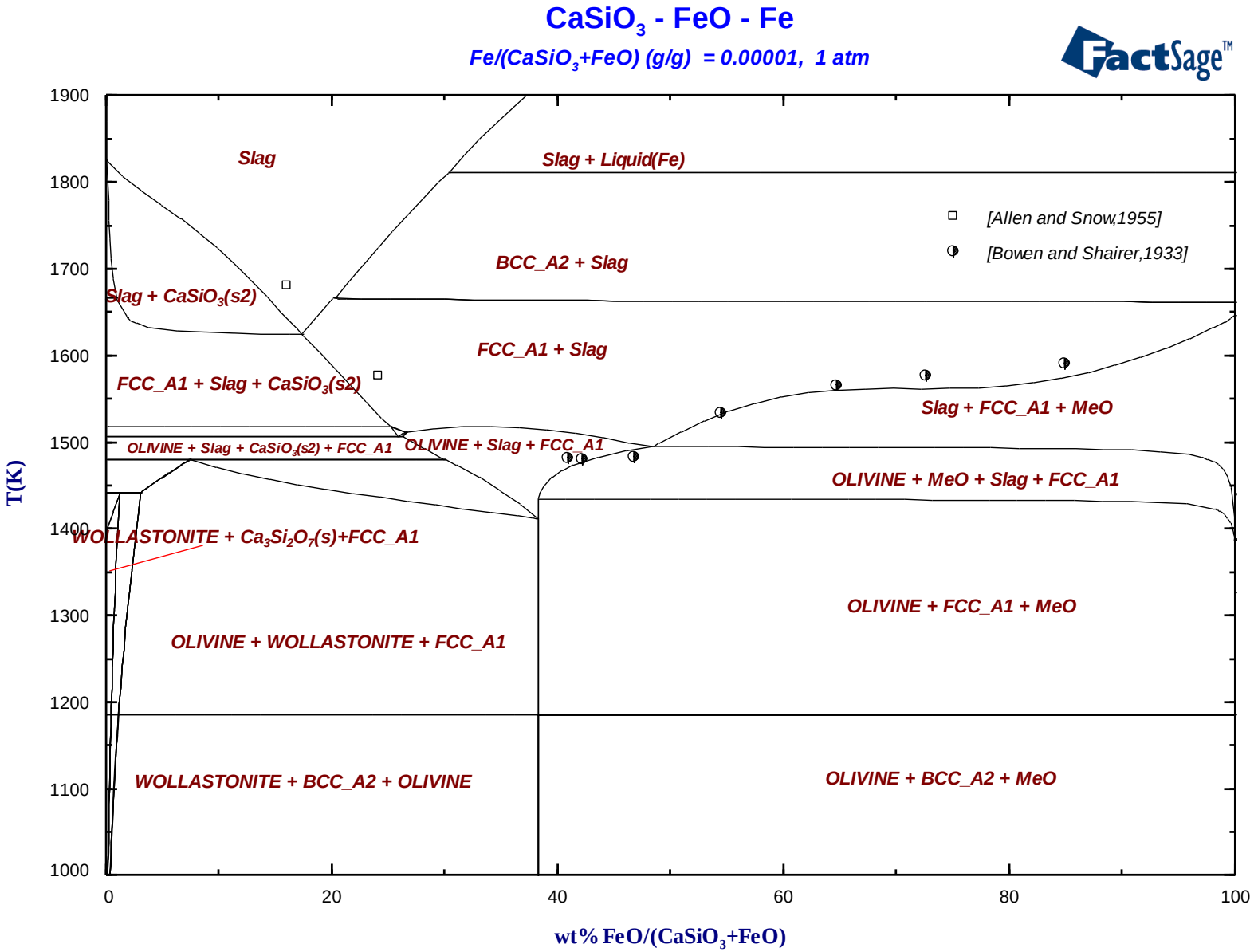
Weight percent in Kelvin compared with experimental data



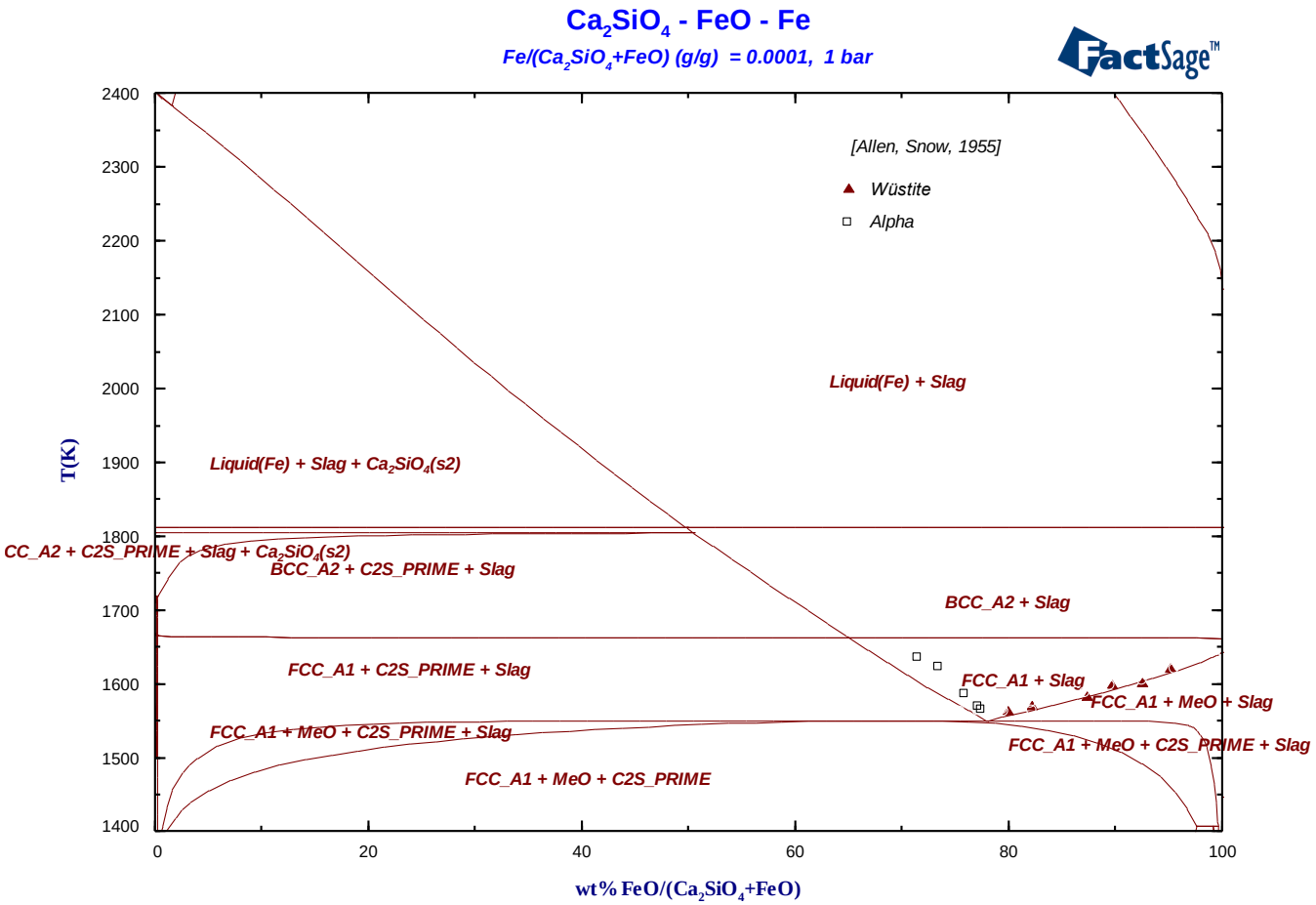
Weight percent
compared with experimental data



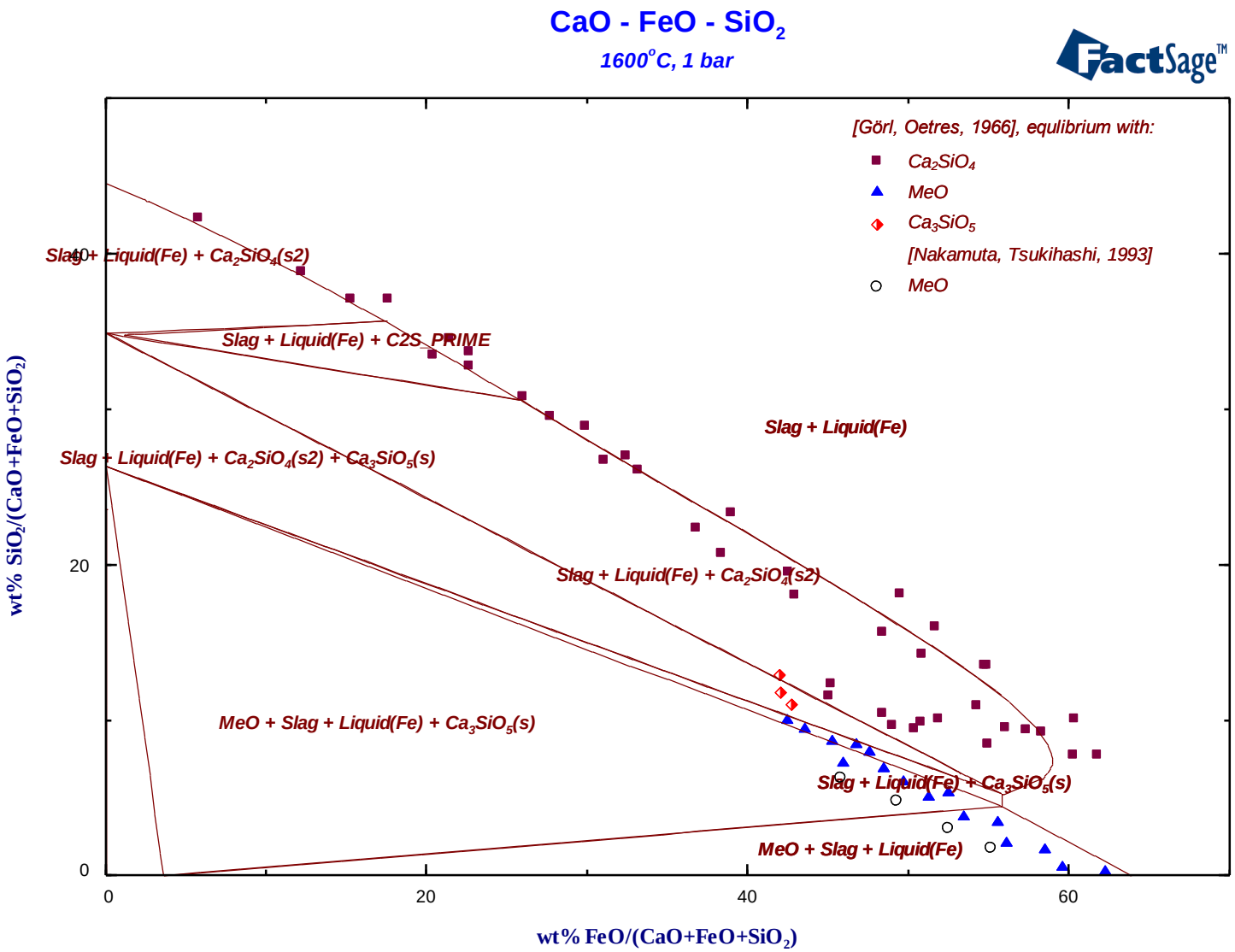
Weight percent
compared with experimental data



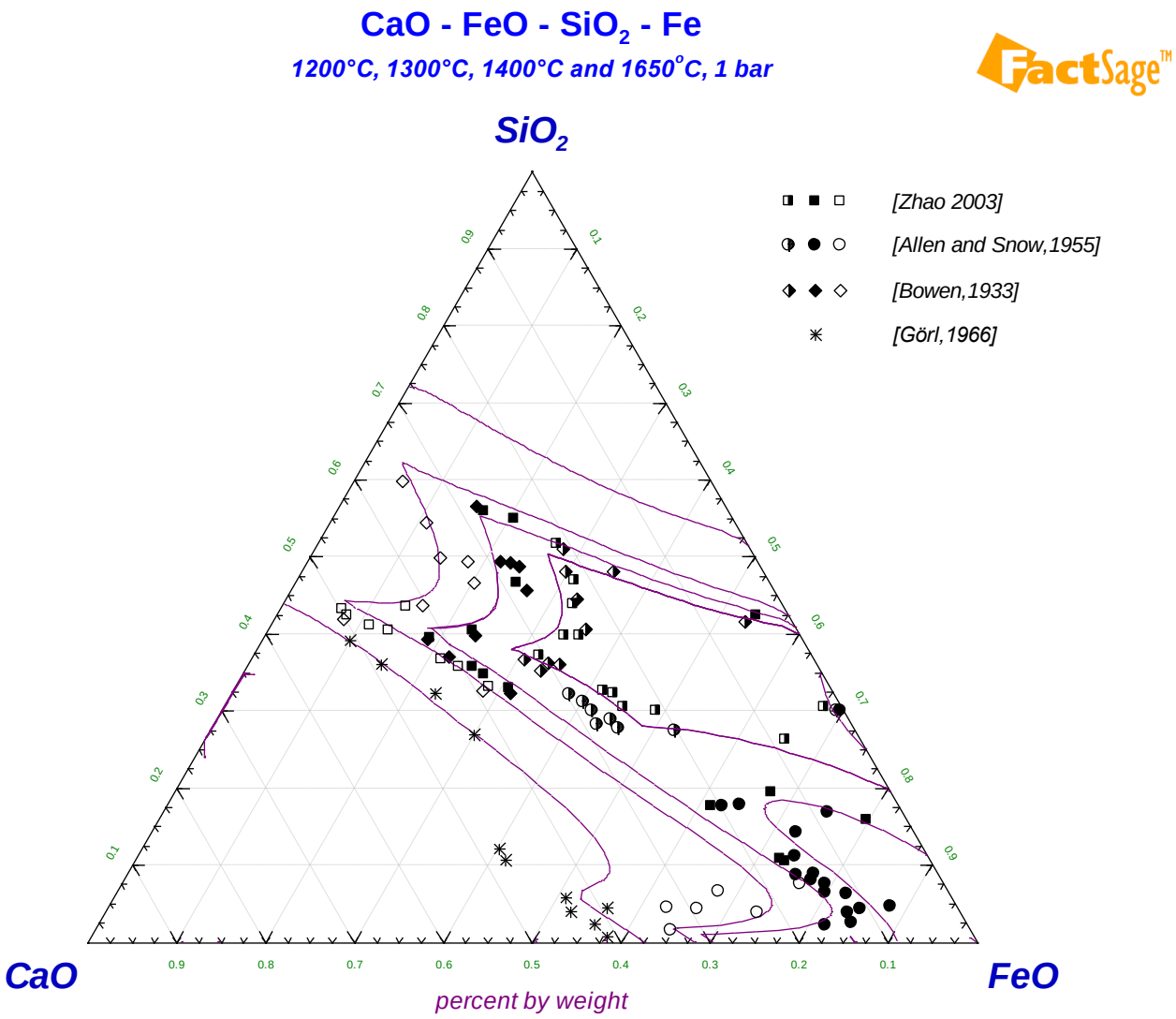
Weight percent
compared with experimental data



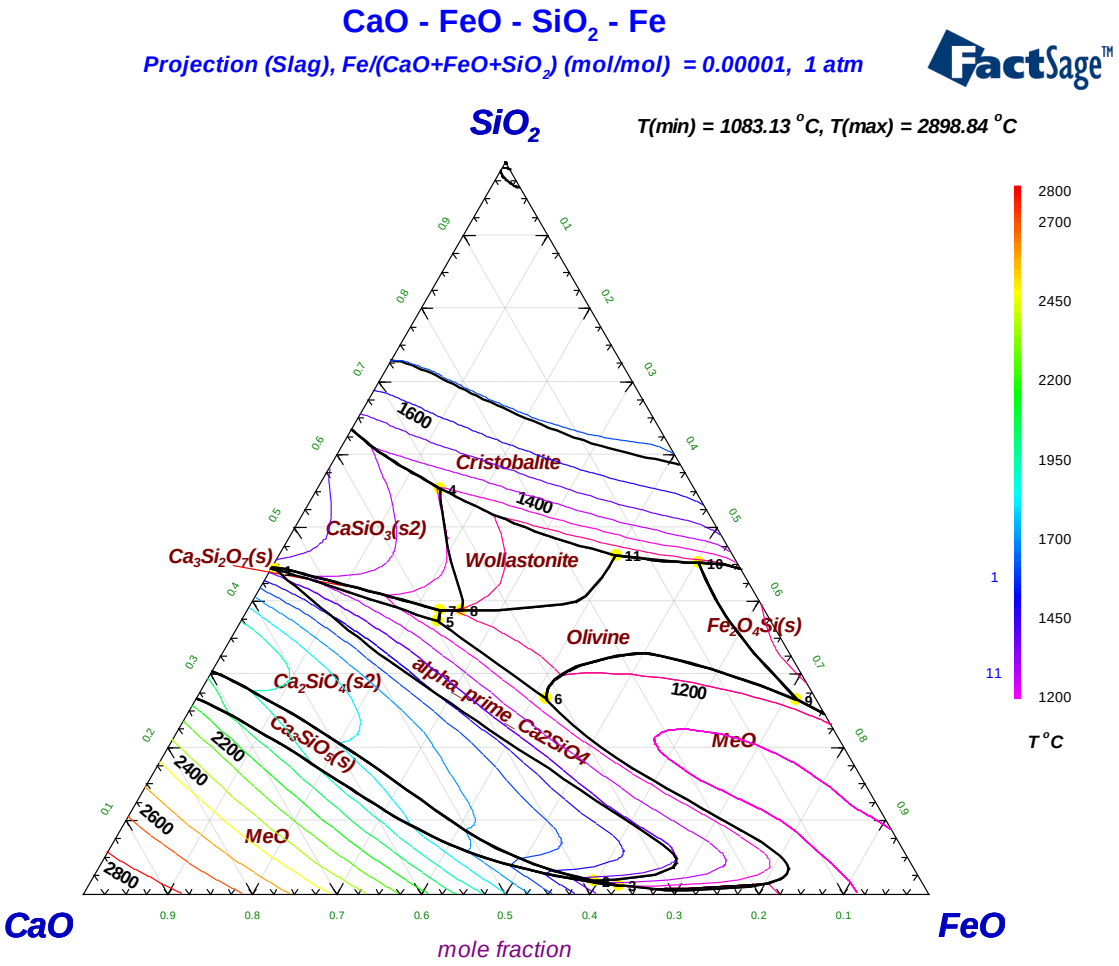
Weight percent
compared with experimental data



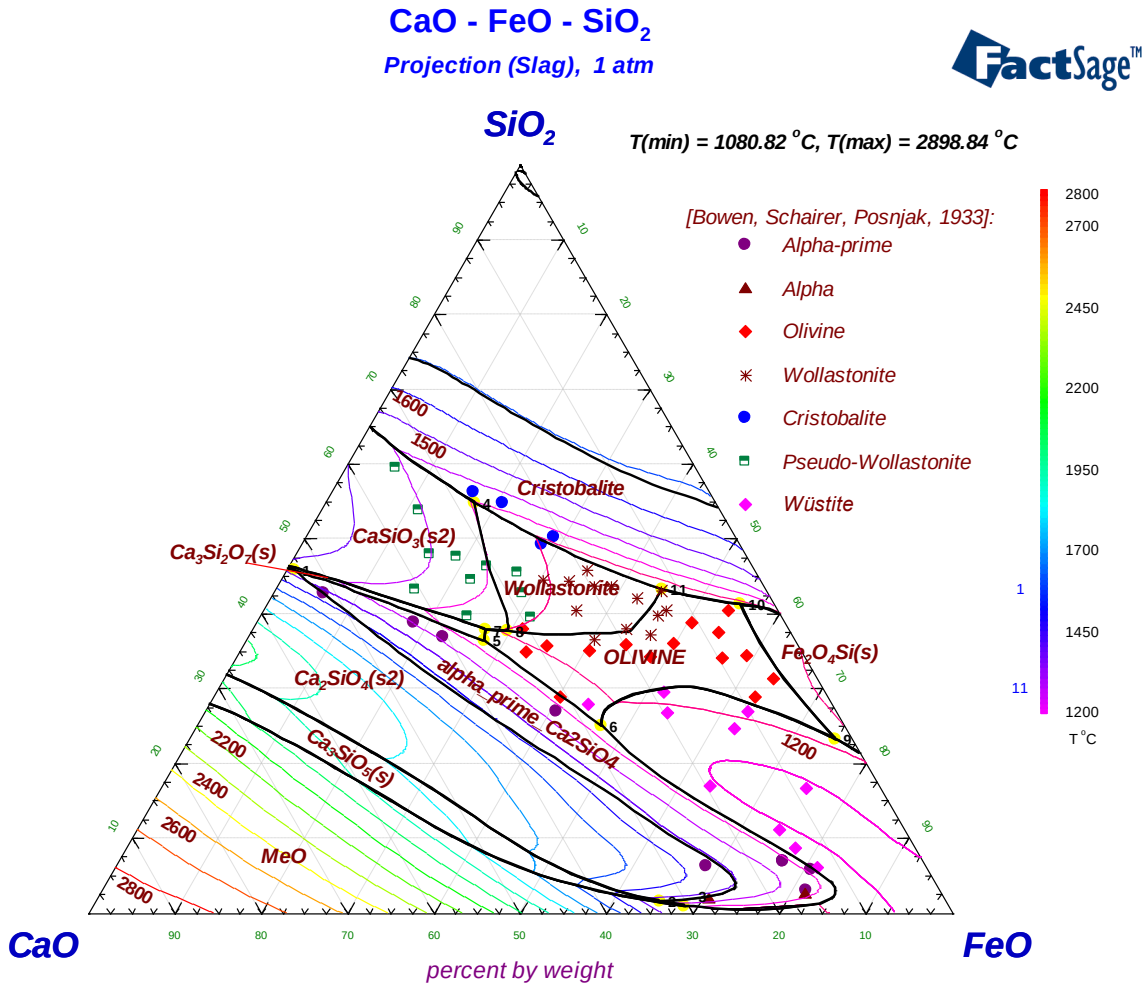
CaO-FeO-SiO2,
Weight percent
Liquiduslines 1200°C, 1300°C, 1400°C, 1650°C



Mole fraction
Liquidussurface



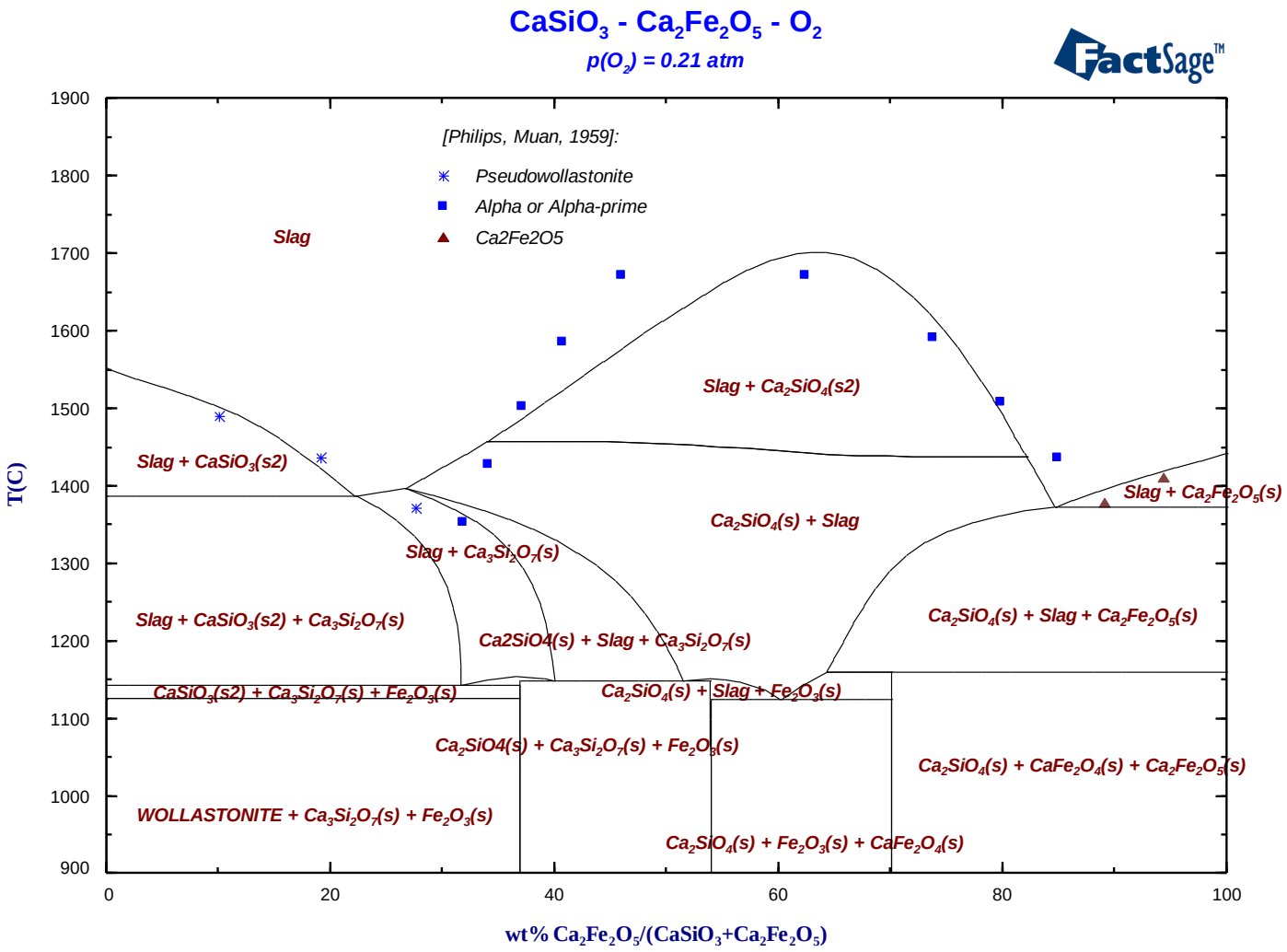
Weight percent,
Liquidussurface compared with experimental data

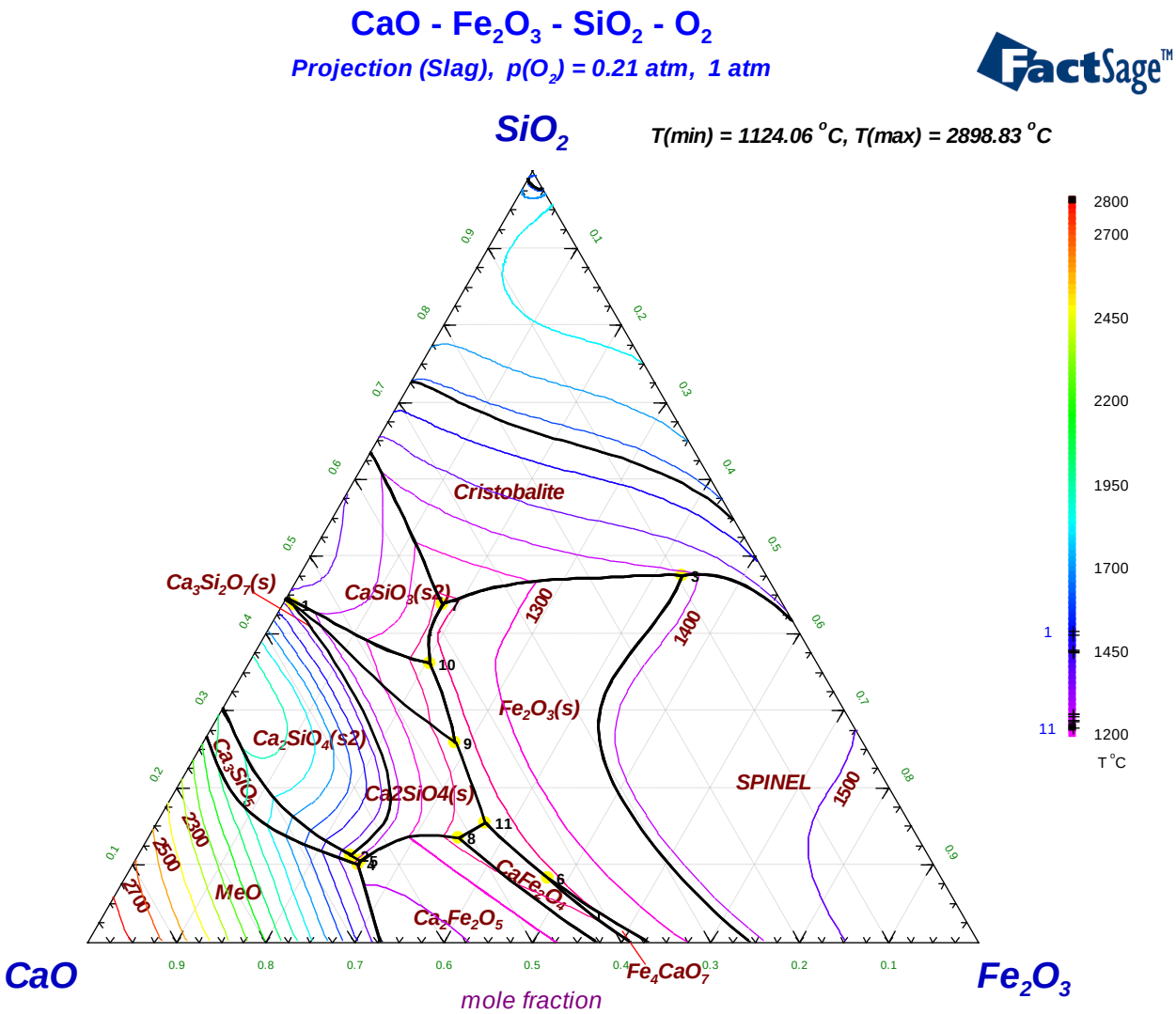


Invariant equilibria on the liquidus surface

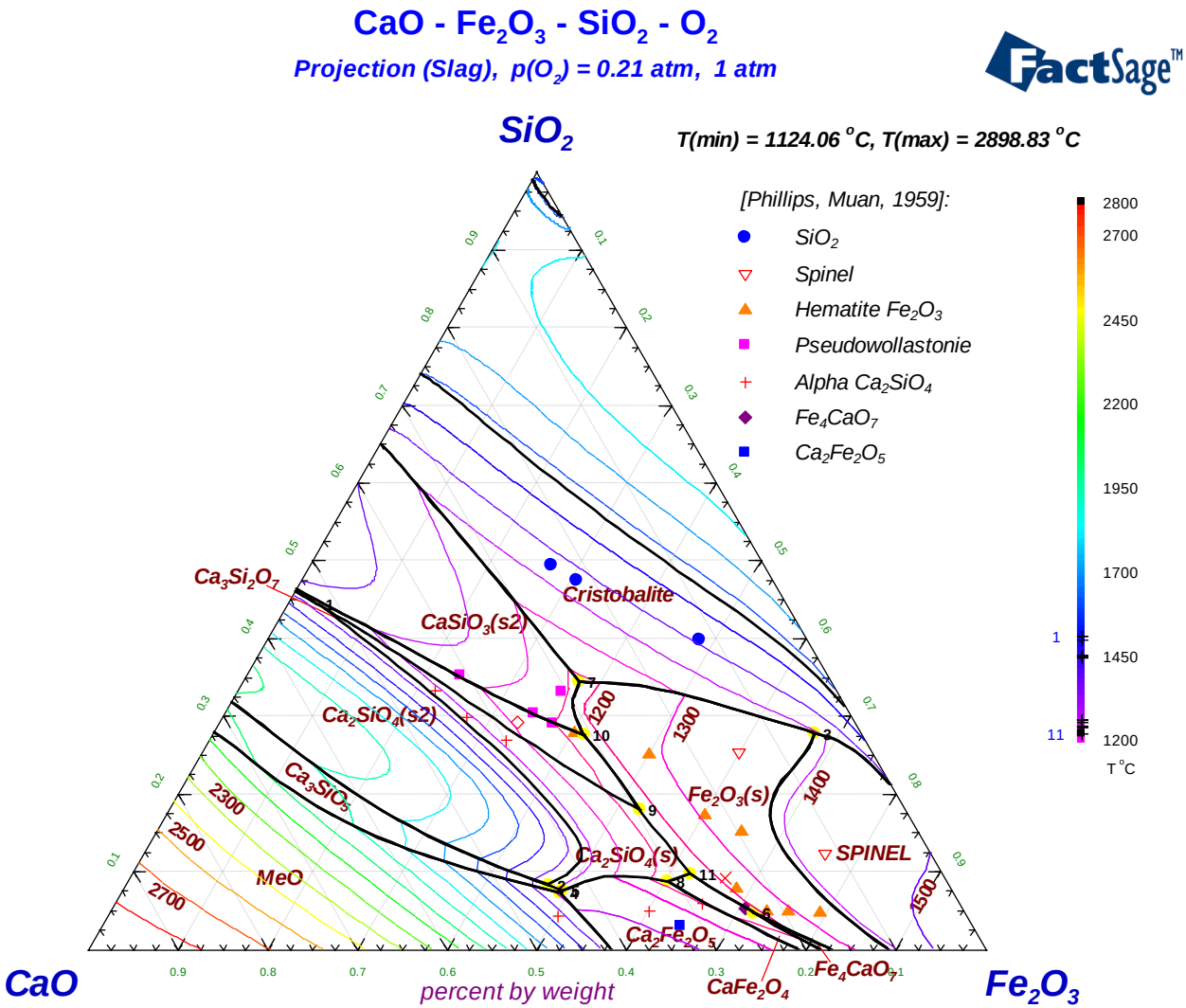
Intersections with slag	Mole fraction				Weight percent			
	A = SiO2, B = CaO, C = FeO				A = SiO2, B = CaO, C = FeO			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: Ca2SiO4(s2) / Ca3Si2O7 / Ca2SiO4(s)	1: 0.44200	0.55074	0.00726	1453.63	1: 45.818	53.282	0.900	1453.63
2: Ca2SiO4(s2) / Ca3SiO5 / Ca2SiO4(s)	2: 0.01768	0.38654	0.59578	1446.89	2: 1.621	33.072	65.307	1446.87
3: Ca3SiO5 / MeO / Ca2SiO4(s)	3: 0.01072	0.35915	0.63012	1324.28	3: 0.976	30.490	68.534	1324.28
4: CaSiO3(s2) / Cristobalite / Wollastonite	4: 0.55324	0.30080	0.14596	1291.12	4: 54.858	27.837	17.305	1291.12
5: Ca3Si2O7 / OLIVINE / Ca2SiO4(s)	5: 0.37134	0.39363	0.23503	1241.52	5: 36.415	36.026	27.558	1241.52
6: MeO / OLIVINE / Ca2SiO4(s)	6: 0.26565	0.31864	0.41571	1235.49	6: 25.058	28.053	46.889	1235.50
7: Ca3Si2O7 / CaSiO3(s2) / OLIVINE	7: 0.38681	0.38346	0.22974	1212.26	7: 37.945	35.108	26.948	1212.31
8: CaSiO3(s2) / OLIVINE / Wollastonite	8: 0.38652	0.35891	0.25457	1193.46	8: 37.676	32.652	29.672	1193.46
9: Fe2O4Si / Me / OLIVINE	9: 0.26483	0.02241	0.71276	1163.82	9: 23.271	1.838	74.891	1163.83
10: Fe2O4Si / OLIVINE / Cristobalite	10: 0.45140	0.04541	0.50319	1147.05	10: 41.206	3.869	54.925	1147.05
11: OLIVINE / Cristobalite / Wollastonite	11: 0.46202	0.13756	0.40042	1092.45	11: 43.212	12.008	44.780	1092.44

CaO-Fe2O3-SiO2,
Weight percent
compared with experimental data




CaO - Fe2O3 - SiO2 - O2
Projection (Slag), p(O2) = 0.21 atm, 1 atm
FactSage™
SiO2
T(min) = 1124.06 °C, T(max) = 2898.83 °C
Cristobalite
Ca3Si2O7(s)
CaSiO3(s2)
Fe2O3(s)
Ca2SiO4(s2)
Ca3SiO5
Ca2SiO4(s)
SPINEL
MeO
CaFe2O4
Ca2Fe2O5
Fe4CaO7
1300
1400
1500
2300
2500
2700
CaO
Fe2O3
mole fraction
T °C
2800
2700
2450
2200
1950
1700
1450
1200

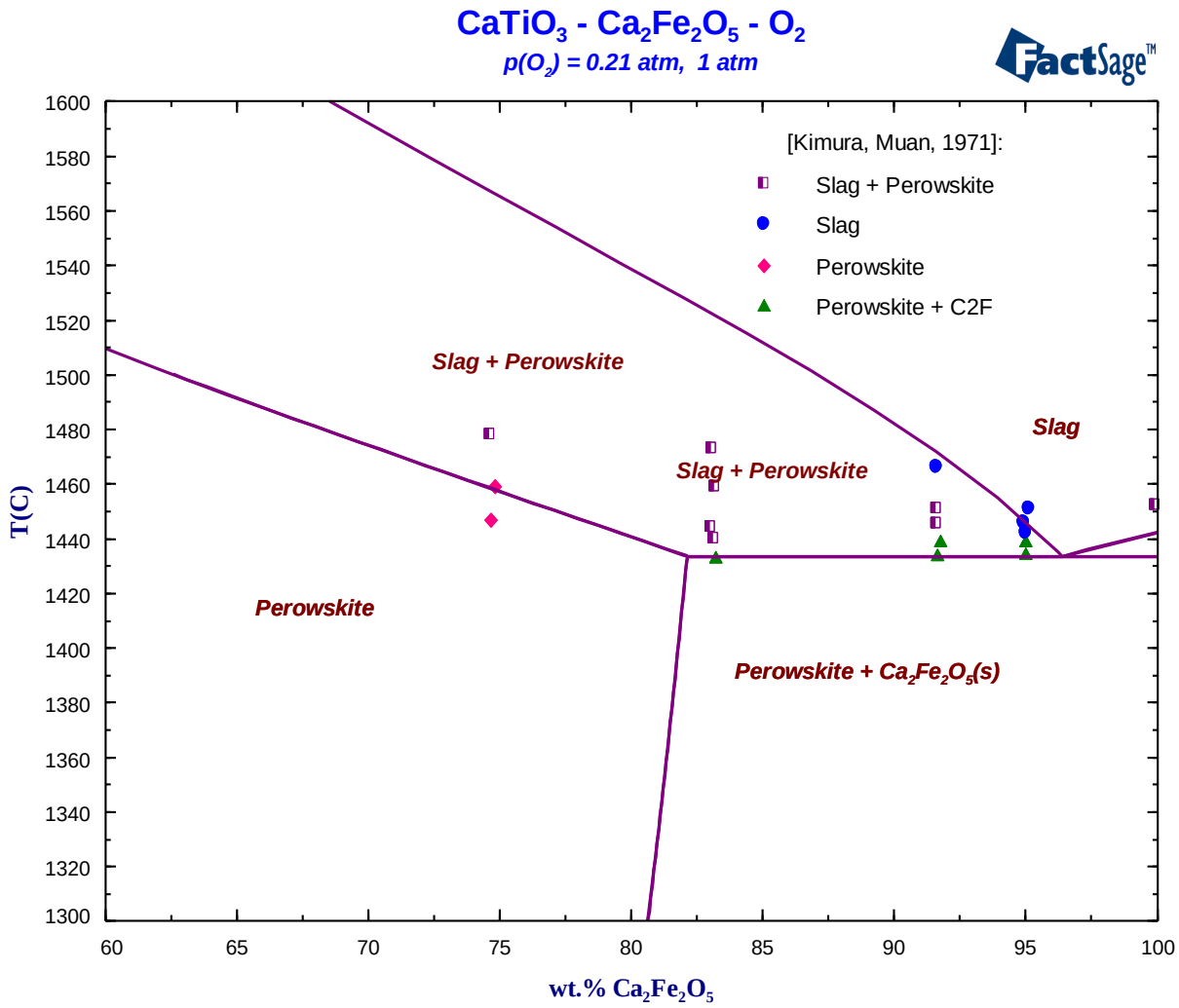
Weight percent,
Liquidussurface compared with experimental data

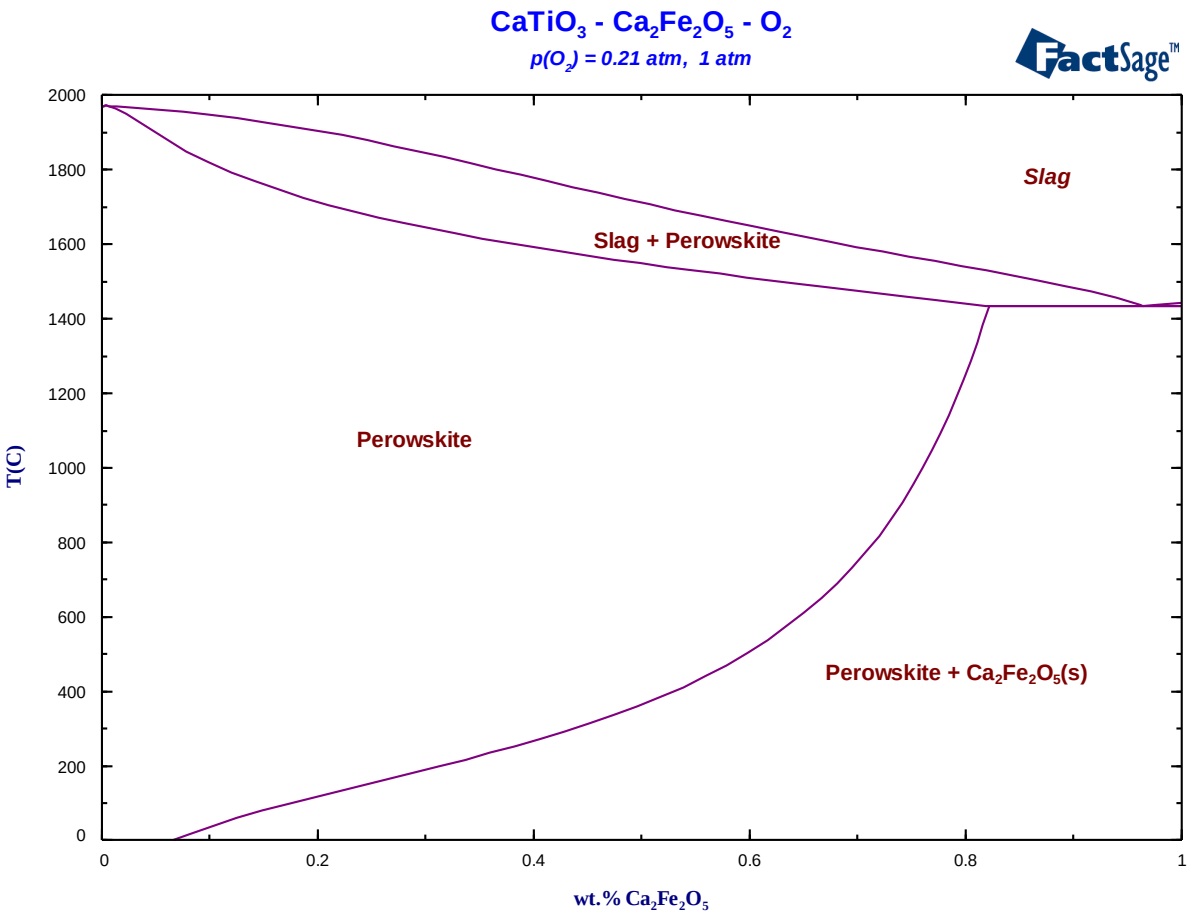


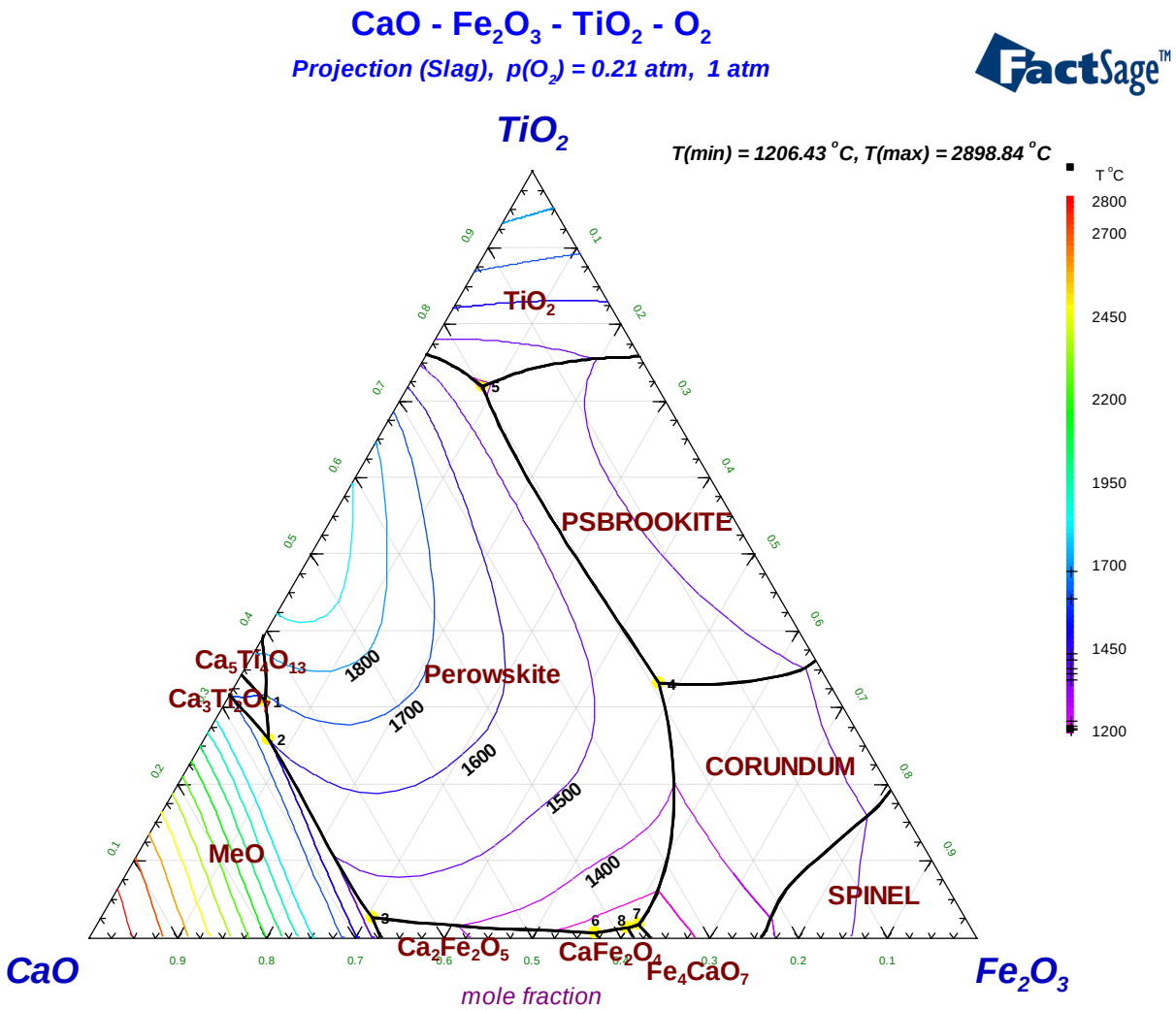
Invariant equilibria on the liquidus surface

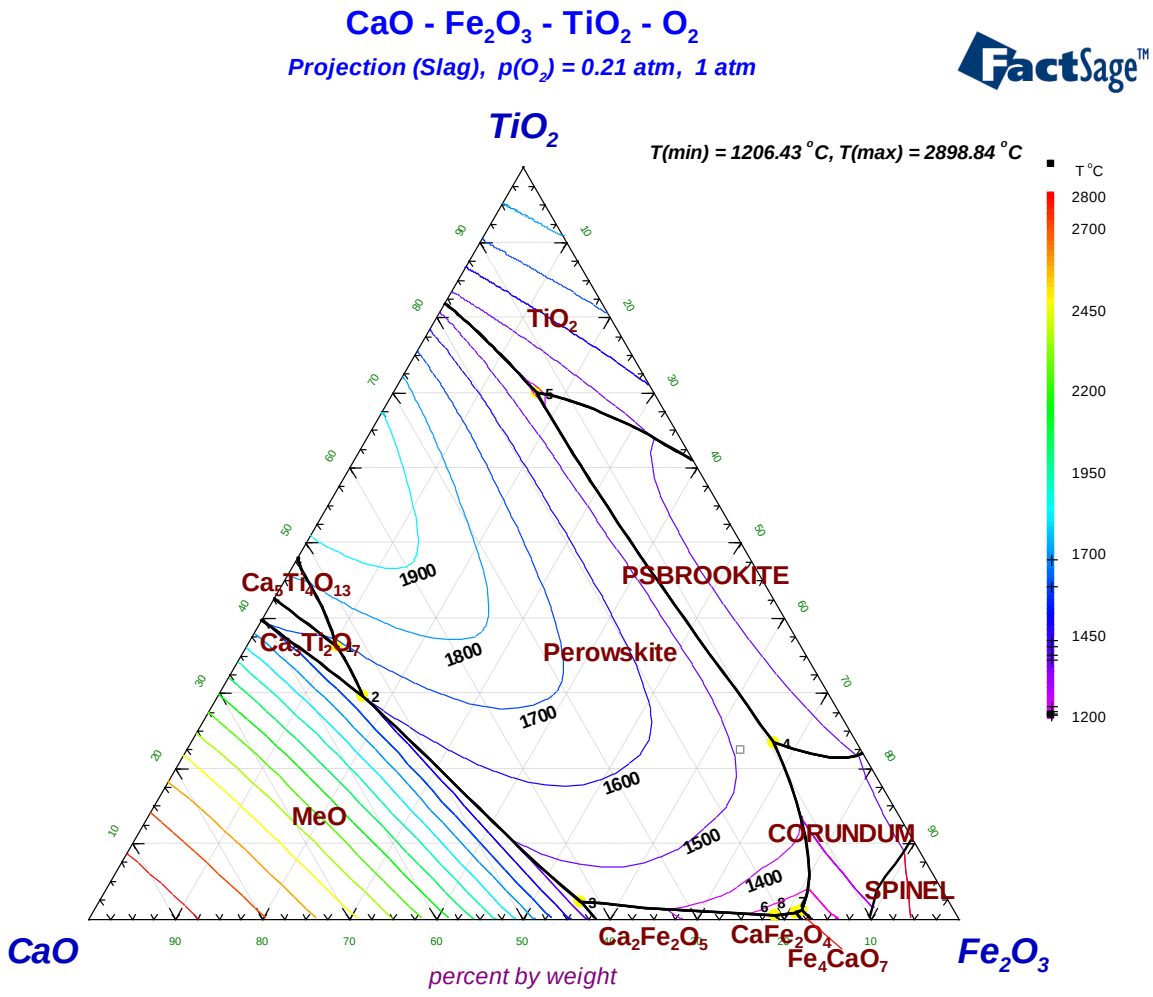
Intersections with slag	Mole fraction				Weight percent			
	A = SiO2, B = CaO, C = Fe2O3				A = SiO2, B = CaO, C = Fe2O3			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: Ca2SiO4(s2) / Ca3Si2O7 / Ca2SiO4(s)	1: 0.43684	0.55077	0.01239	1446.29	1: 44.403	52.250	3.347	1446.29
2: Ca2SiO4(s2) / Ca3SiO5 / Ca2SiO4(s)	2: 0.11227	0.64722	0.24051	1436.92	2: 8.283	44.562	47.156	1436.92
3: Fe2O3 / SPINEL / Cristobalite	3: 0.47545	0.09376	0.43079	1384.11	3: 27.839	5.124	67.037	1384.11
4: Ca2Fe2O5 / Ca3SiO5 / MeO	4: 0.09961	0.64586	0.25452	1381.65	4: 7.224	43.717	49.059	1381.65
5: Ca2Fe2O5 / Ca3SiO5 / Ca2SiO4(s)	5: 0.10463	0.64092	0.25445	1378.08	5: 7.587	43.375	49.038	1378.08
6: CaSiO3(s2) / Fe2O3 / Cristobalite	6: 0.08271	0.44141	0.47588	1168.83	6: 4.701	23.415	71.884	1168.83
7: CaFe2O4_beta / Fe2O3 / Fe4CaO7	7: 0.43802	0.38216	0.17981	1168.80	7: 34.420	28.028	37.553	1168.80
8: Ca2Fe2O5 / CaFe2O4_beta / Ca2SiO4(s)	8: 0.13460	0.51526	0.35014	1160.07	8: 8.706	31.105	60.189	1160.07
9: Ca3Si2O7 / Fe2O3 / Ca2SiO4(s)	9: 0.25846	0.45703	0.28450	1148.22	9: 17.935	29.598	52.467	1148.21
10: Ca3Si2O7 / CaSiO3(s2) / Fe2O3	10: 0.36137	0.43431	0.20432	1142.56	10: 27.591	30.948	41.461	1142.59
11: CaFe2O4_beta(s) / Fe2O3 / Ca2SiO4(s)	11: 0.15385	0.47534	0.37081	1124.06	11: 9.719	28.025	62.256	1124.06

CaO-Fe2O3-TiO2,
Weight percent CaTiO3-Ca2Fe2O5
compared with experimental data




CaTiO3 - Ca2Fe2O5 - O2
p(O2) = 0.21 atm, 1 atm
FactSage™
Slag
Slag + Perowskite
Perowskite
Perowskite + Ca2Fe2O5(s)
T(C)
wt.% Ca2Fe2O5
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
0.2
0.4
0.6
0.8
1

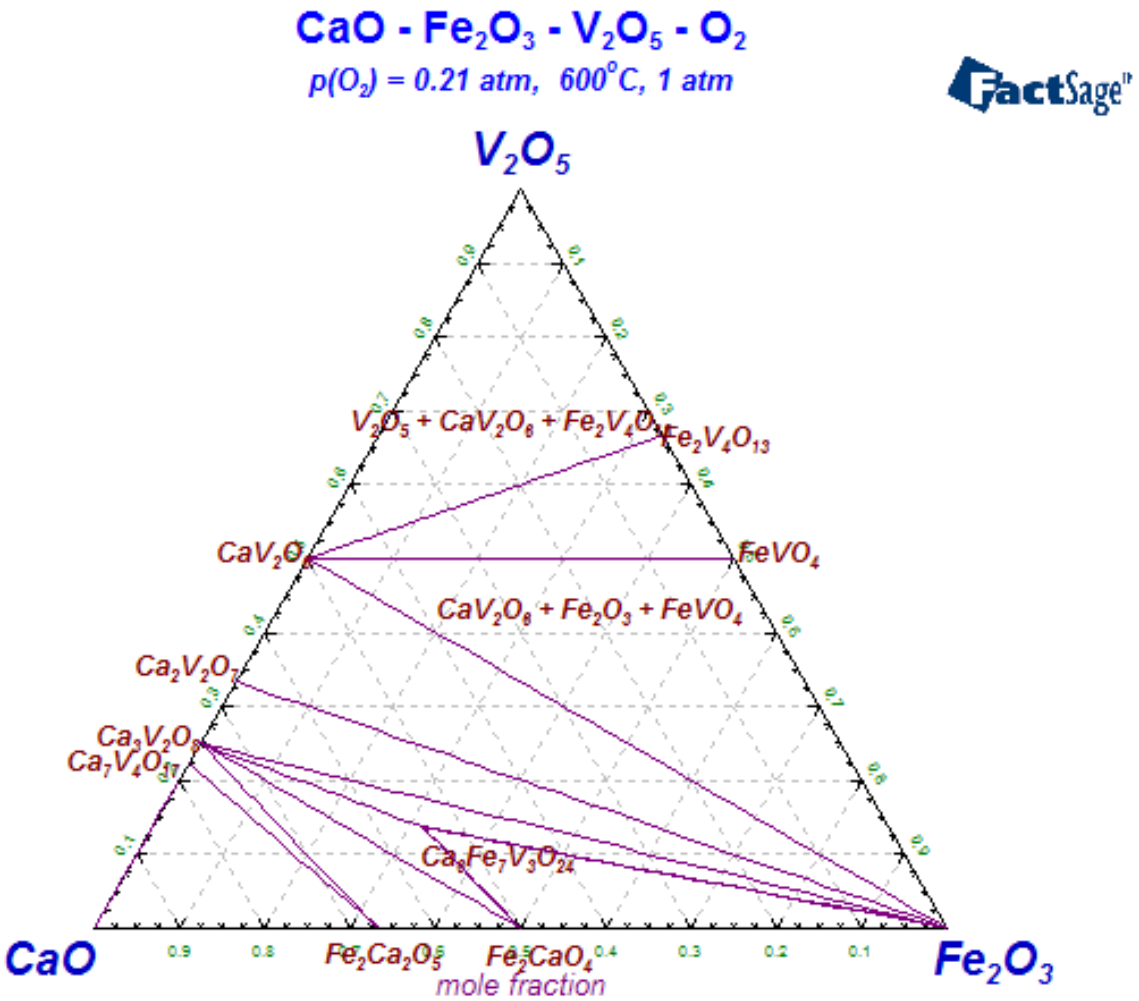

CaO - Fe2O3 - TiO2 - O2
Projection (Slag), p(O2) = 0.21 atm, 1 atm
FactSage™
TiO2
T(min) = 1206.43 °C, T(max) = 2898.84 °C
T °C
2800
2700
2450
2200
1950
1700
1450
1200
TiO2
PSBROOKITE
Perowskite
CORUNDUM
SPINEL
MeO
Ca5Ti4O13
Ca3Ti2O7
Ca2Fe2O5
CaFe2O4
Fe4CaO7
1800
1700
1600
1500
1400
1
2
3
4
5
6
7
8
CaO
Fe2O3
mole fraction


CaO - Fe2O3 - TiO2 - O2
Projection (Slag), p(O2) = 0.21 atm, 1 atm
FactSage™
TiO2
T(min) = 1206.43 °C, T(max) = 2898.84 °C
T °C
2800
2700
2450
2200
1950
1700
1450
1200
TiO2
PSBROOKITE
Ca5Ti4O13
Ca3Ti2O7
Perowskite
1900
1800
1700
1600
1500
1400
MeO
CORUNDUM
SPINEL
Ca2Fe2O5
CaFe2O4
Fe4CaO7
CaO
Fe2O3
percent by weight

Invariant equilibria on the liquidus surface

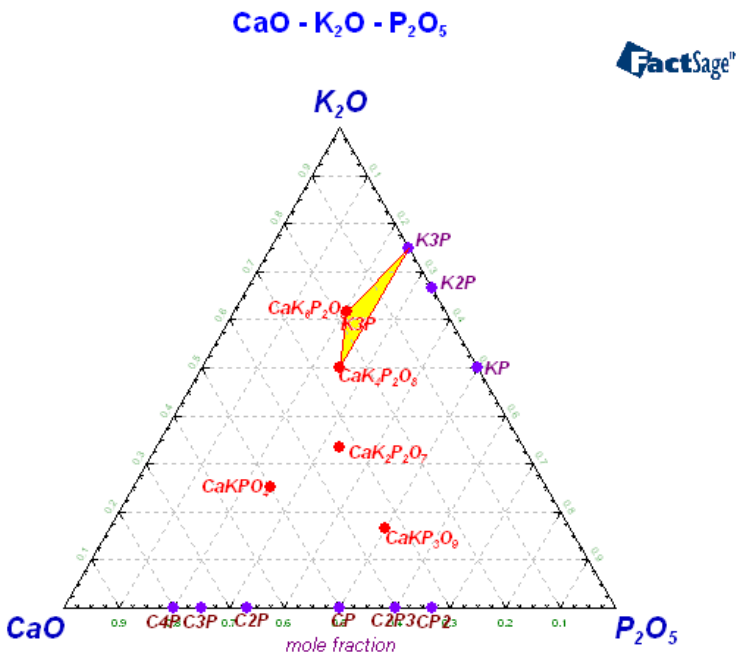
Intersections with slag	Mole fraction					Weight percent				
	A = TiO2, B = CaO, C = Fe2O3					A = TiO2, B = CaO, C = Fe2O3				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: Ca3Ti2O7 / Ca5Ti4O13 / Perowskite	1:	0.30835	0.64708	0.04457	1683.94	1:	36.199	53.338	10.463	1683.94
2: Ca3Ti2O7 / MeO#1 / Perowskite	2:	0.25823	0.66809	0.07368	1601.50	2:	29.524	53.632	16.844	1601.50
3: Ca2Fe2O5 / MeO#1 / Perowskite	3:	0.02512	0.66746	0.30742	1433.02	3:	2.266	42.280	55.454	1433.03
4: CORUNDUM / PSBROOKITE / Perowskite	4:	0.33163	0.19114	0.47723	1414.75	4:	23.354	9.451	67.195	1414.75
5: PSBROOKITE / Perowskite / TiO2	5:	0.71854	0.19638	0.08508	1388.05	5:	69.996	13.432	16.572	1388.05
6: Ca2Fe2O5 / CaFe2O4 / Perowskite	6:	0.00017	0.24183	0.75800	1355.27	6:	0.427	20.782	78.791	1231.38
7: CORUNDUM / Fe4CaO7 / Perowskite	7:	0.01640	0.37153	0.61207	1210.11	7:	1.093	17.379	81.529	1210.07
8: CaFe2O4 / Fe4CaO7 / Perowskite	8:	0.01178	0.38608	0.60214	1206.44	8:	0.792	18.232	80.975	1206.43

CaO-Fe2O3-V2O5,
Mole fraction, 600°C

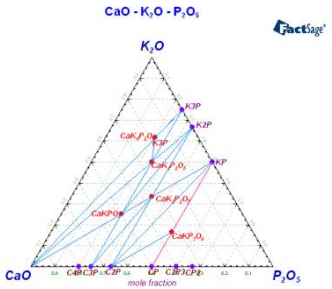


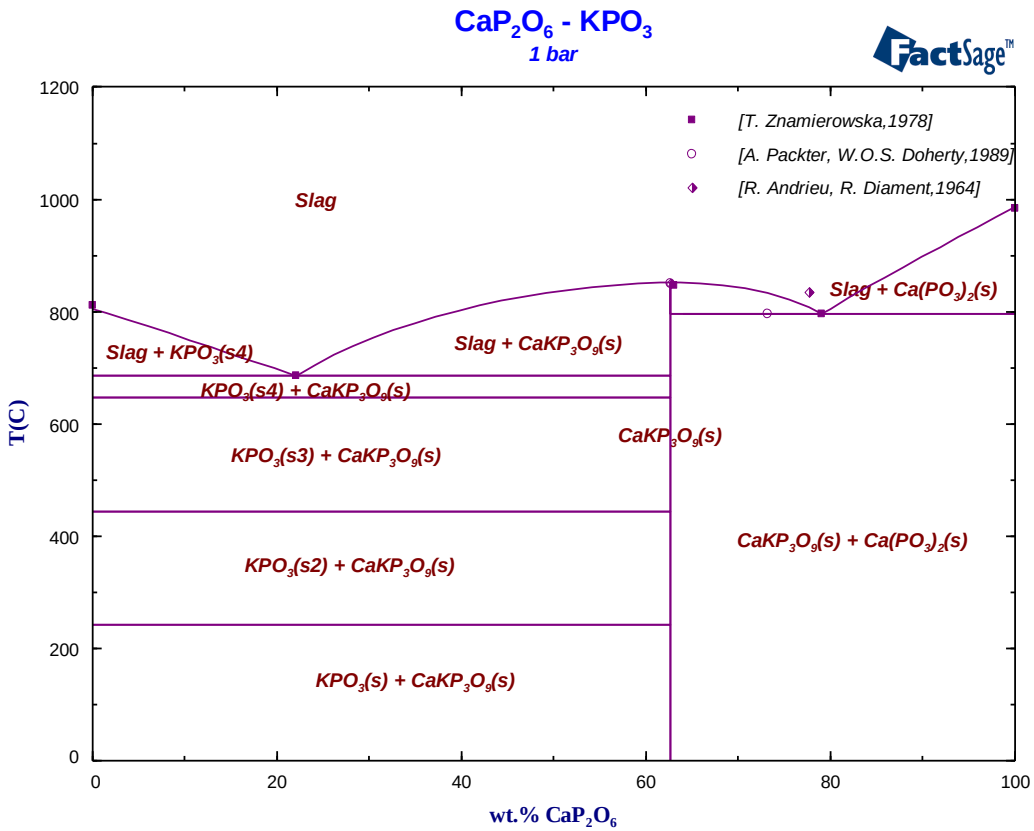
Ternary phases

Phase	Description	Used data
CKP	$CaK_2P_2O_7$	GTT
C2KP3	$CaKP_3O_9$	GTT
C2KP	$CaKPO_4$	GTT
K3P-LT	$(K_2O)_2(P_2O_5)(K_2O,CaO,K_2CaO_2)$	$CaK_4P_2O_8$(s1)-GTT $CaK_6P_2O_9$(s1)-GTT K_3PO_4(s1) IEK-2
K3P-MT	$(K_2O)_2(P_2O_5)(K_2O,CaO,K_2CaO_2)$	$CaK_4P_2O_8$(s2) GTT $CaK_6P_2O_9$(s2) GTT K_3PO_4(s2) IEK-2
	H_{tr} (s1→s2) is proposed to be equal to K_3PO_4	
K3P-HT	$(K_2O)_2(P_2O_5)(K_2O,CaO,K_2CaO_2)$	$CaK_4P_2O_8$(s3) GTT $CaK_6P_2O_9$(s3) GTT K_3PO_4(s3) IEK-2
	H_{tr} (s2→s3) is proposed to be equal to K_3PO_4	

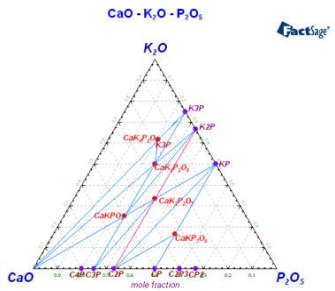


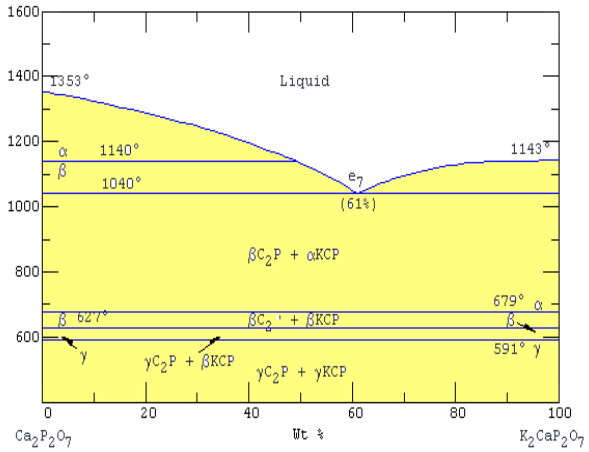
Weight percent, Isopleth CaP2O6-KPO3



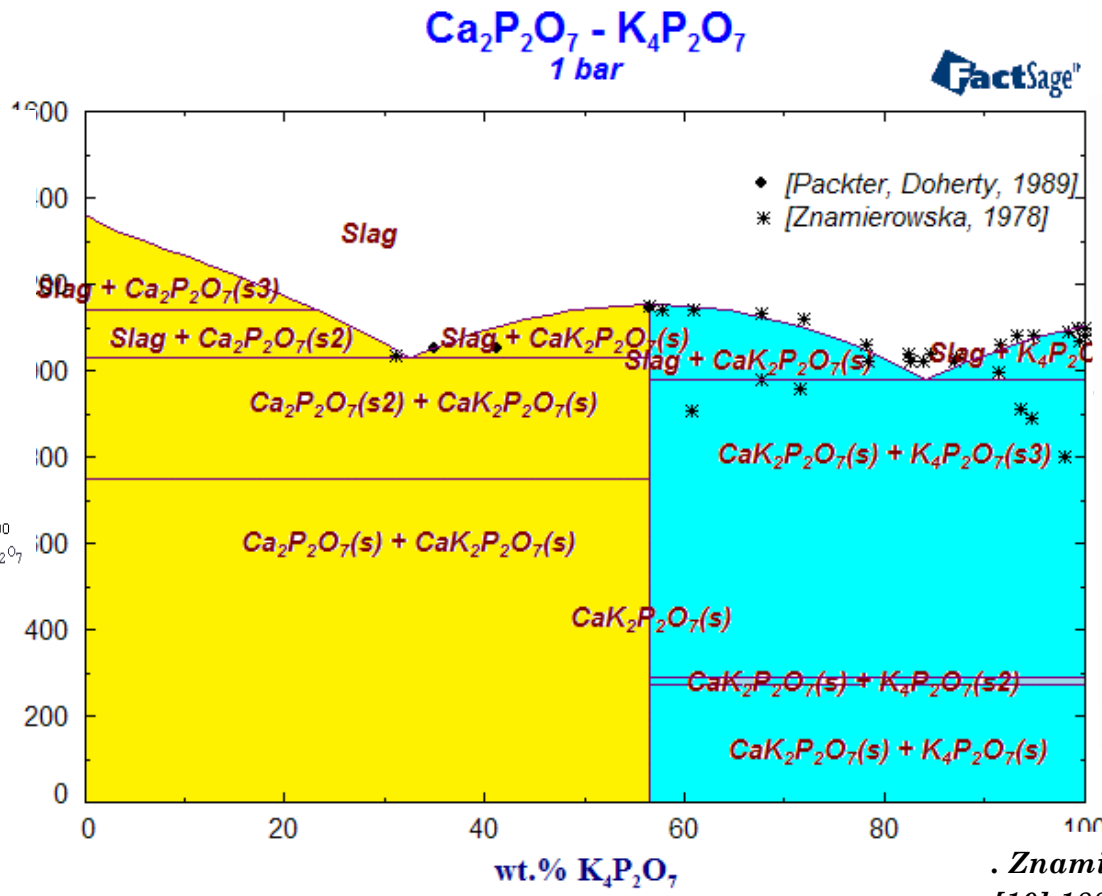


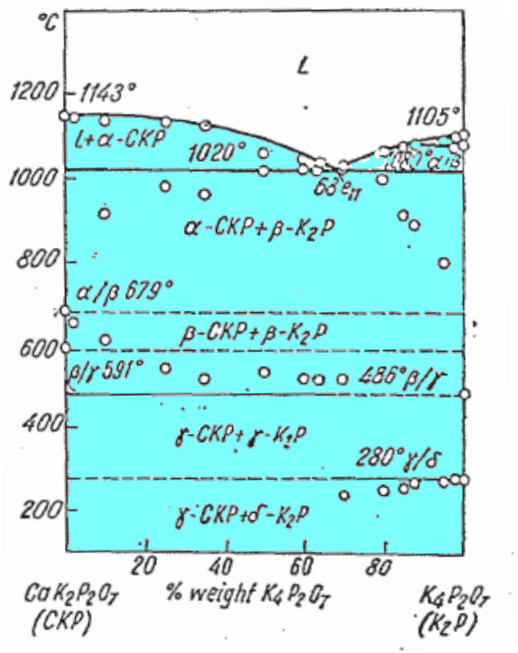
Weight percent, Isopleth Ca2P2O7-K4P2O7





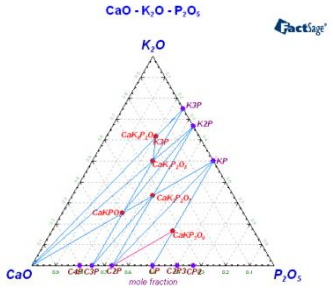
T. Znamierowska, Pol. J. Chem., 52 [6] 1127-1134 (1978).

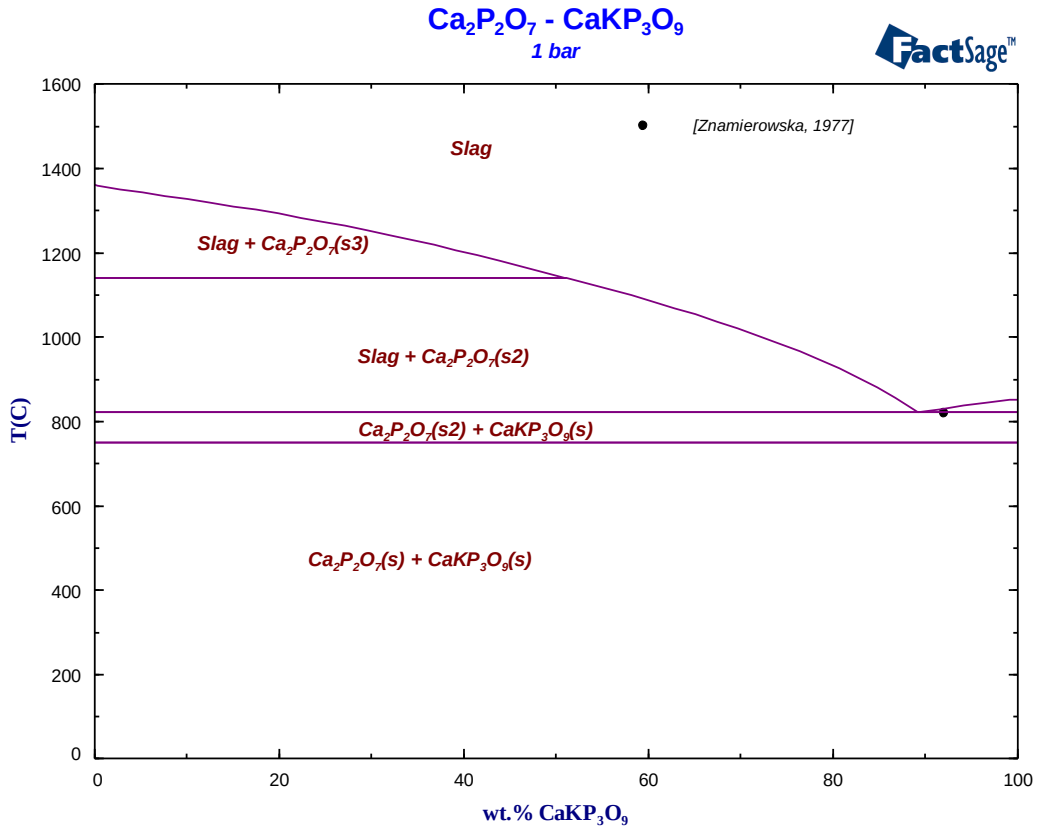




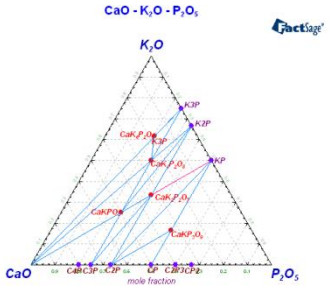
. Znamierowska, Pol. J. Chem., 52 [10] 1889-1895 (1978).

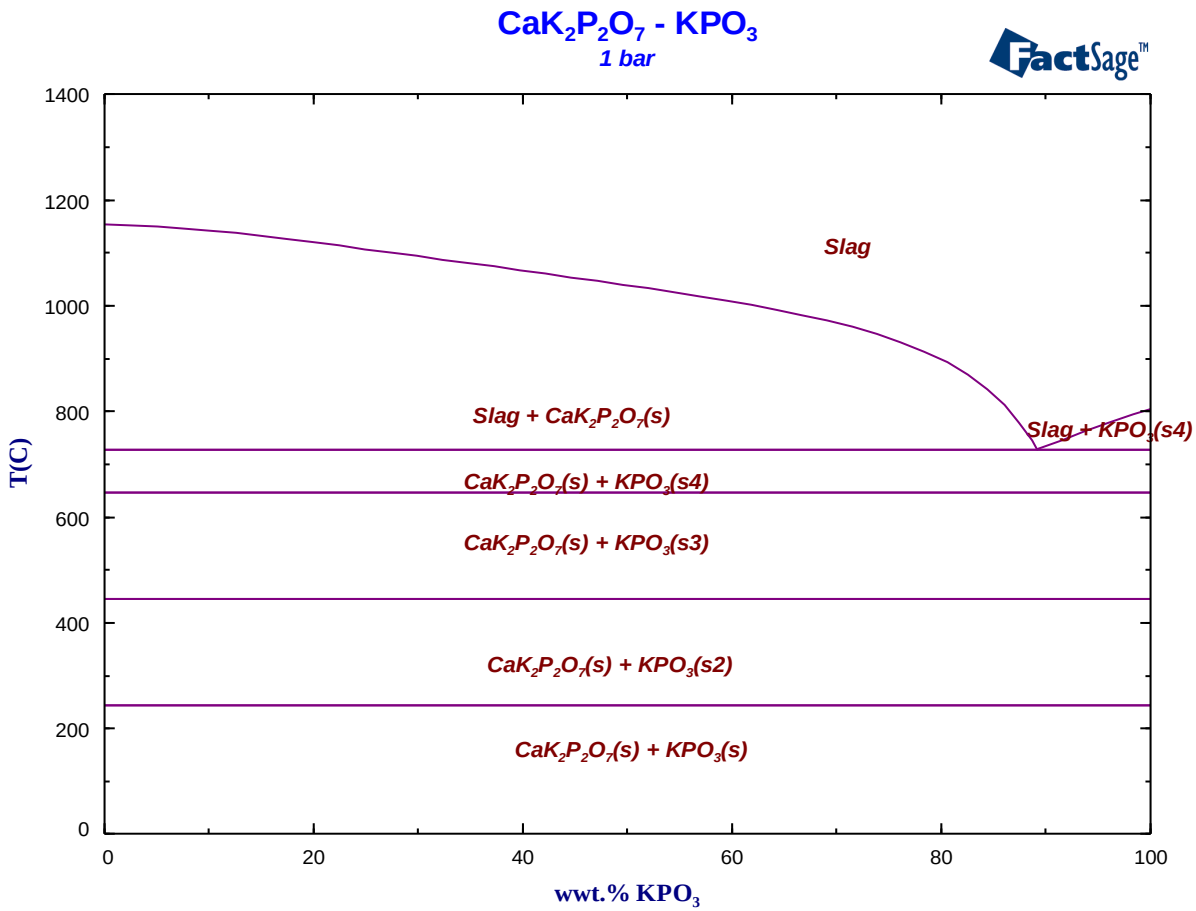
Weight percent, Isopleth Ca2P2O7-CaKP3O9



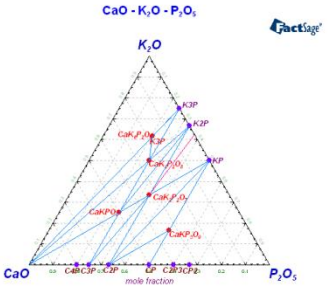


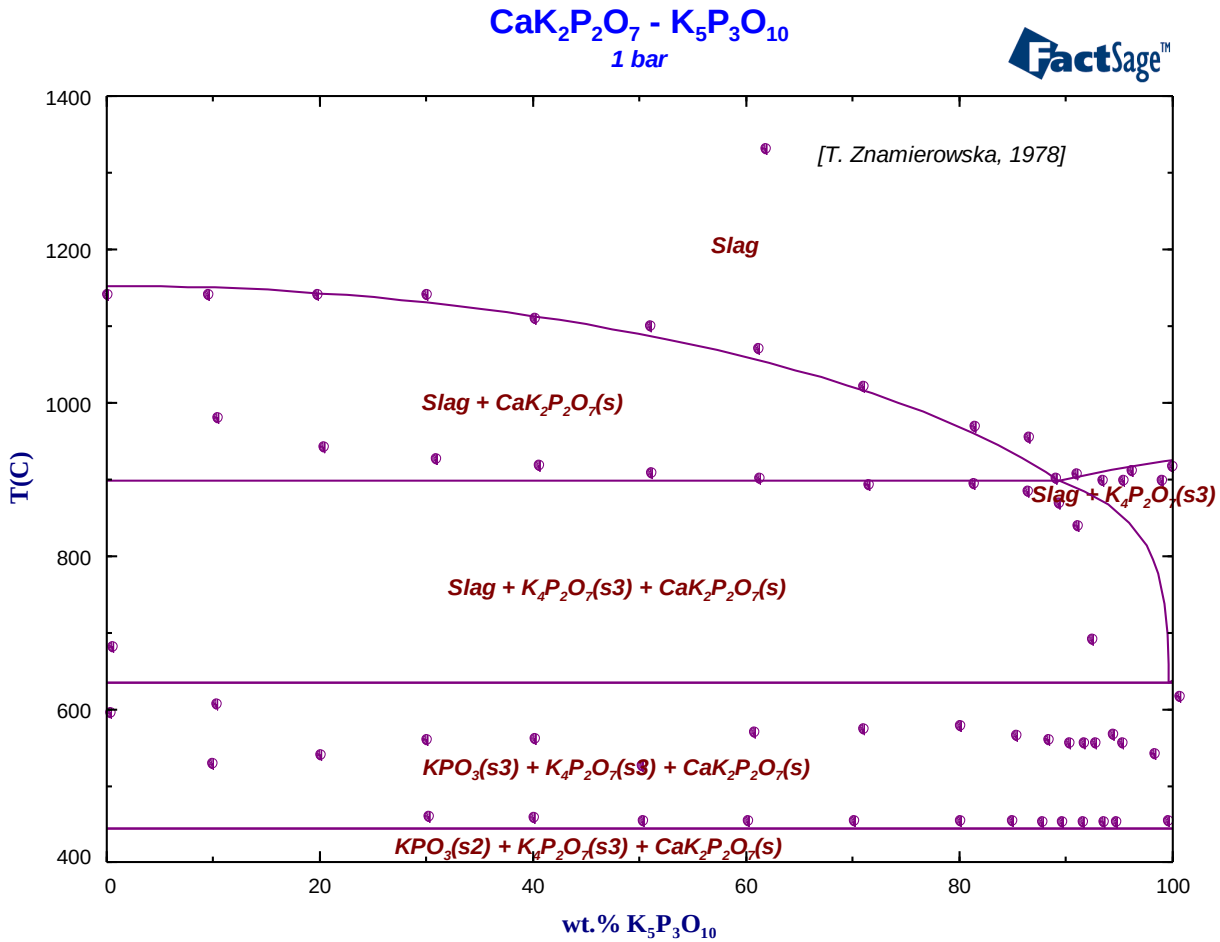
Weight percent, Isopleth K2CaP2O7-KPO3



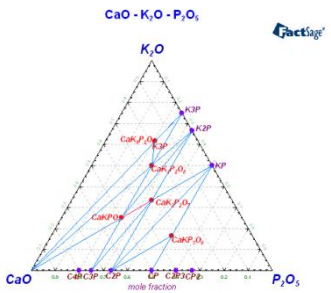


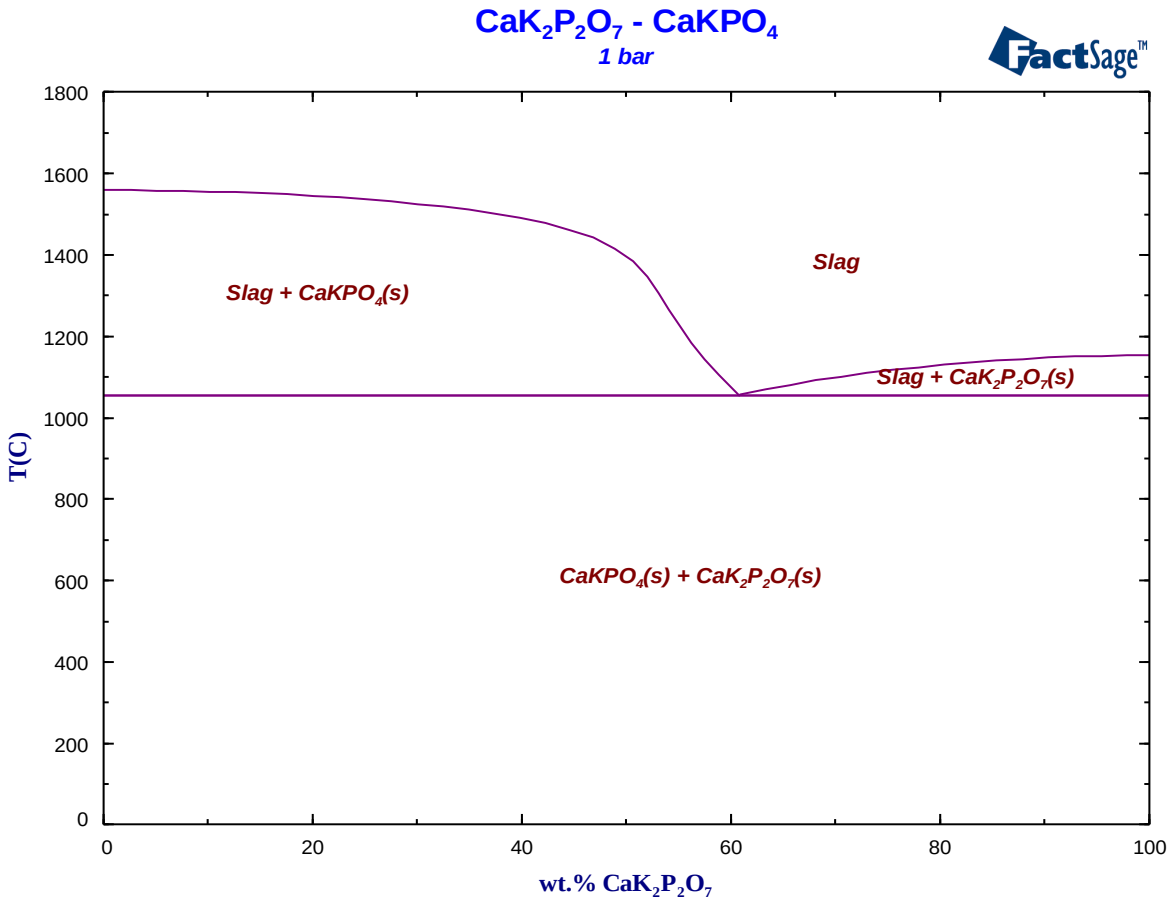
Weight percent, Isopleth K2CaP2O7-K5P3O10



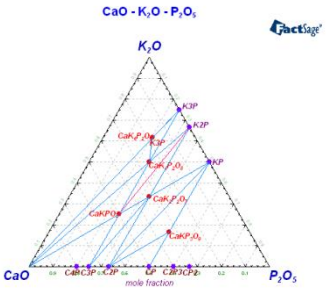


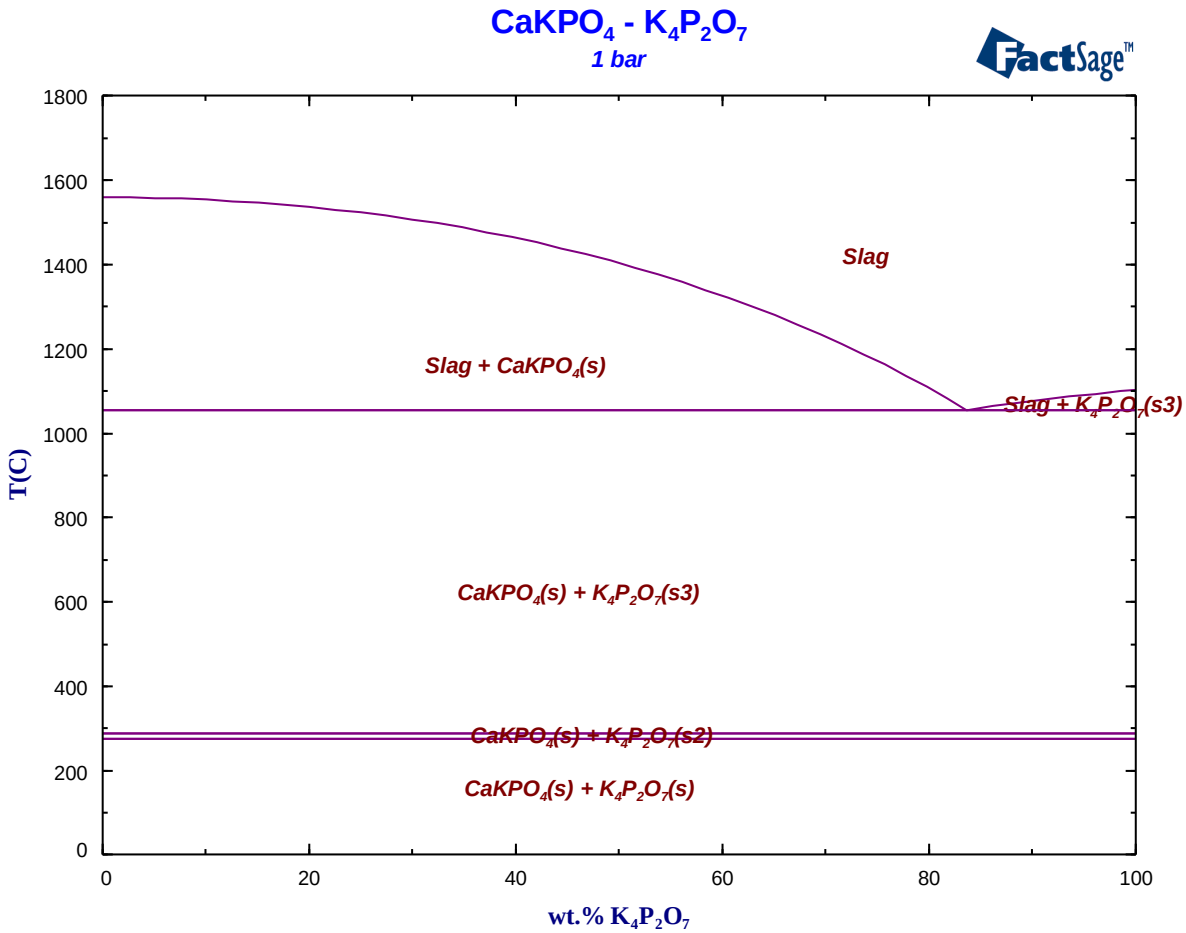
Weight percent, Isopleth CaKPO4-CaK2P2O7



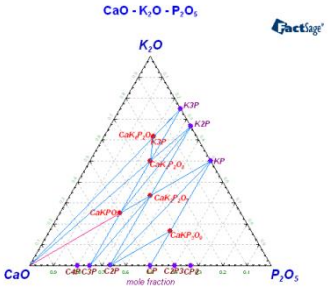


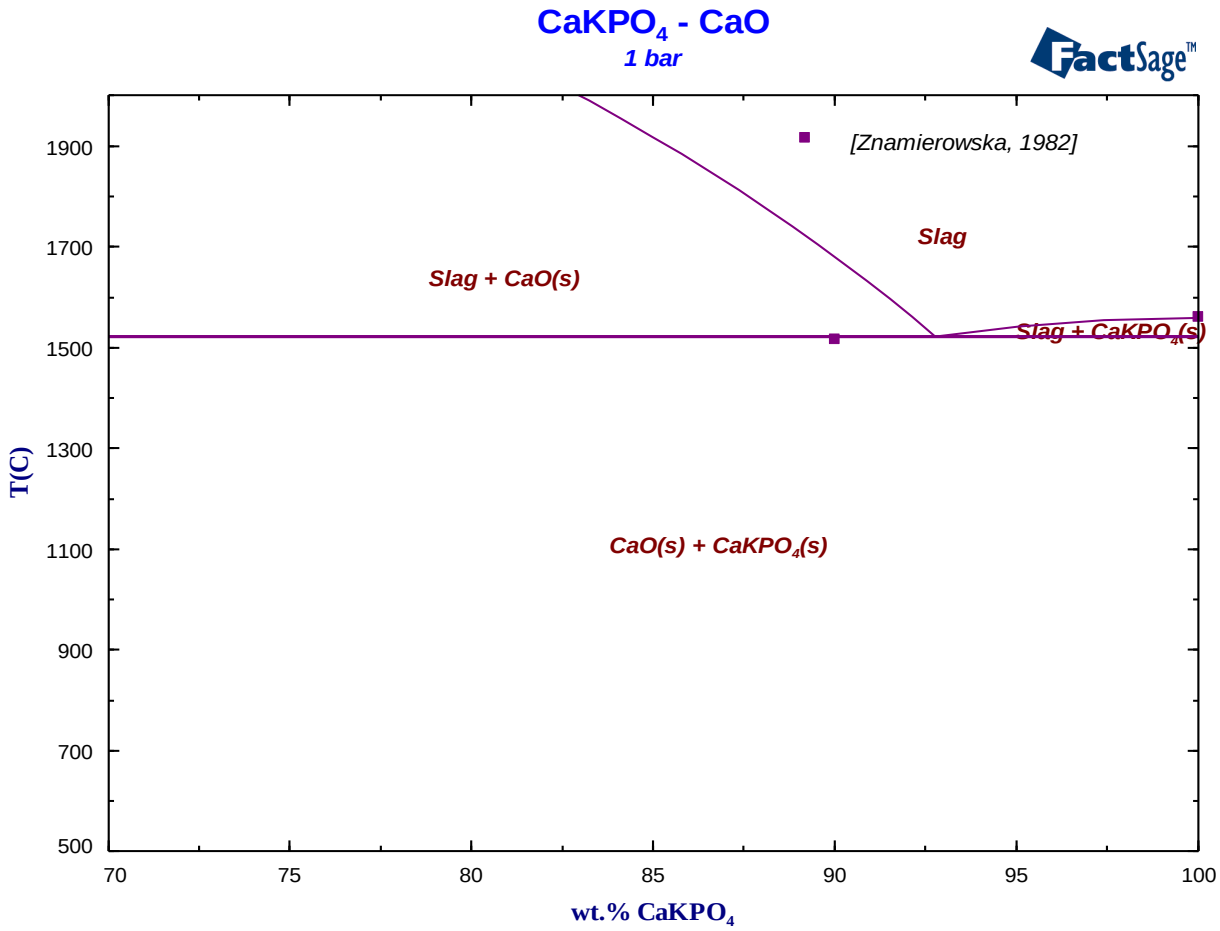
Weight percent, Isopleth CaKPO4-K4P2O7



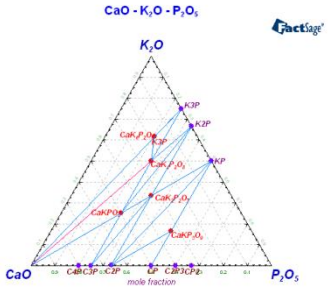


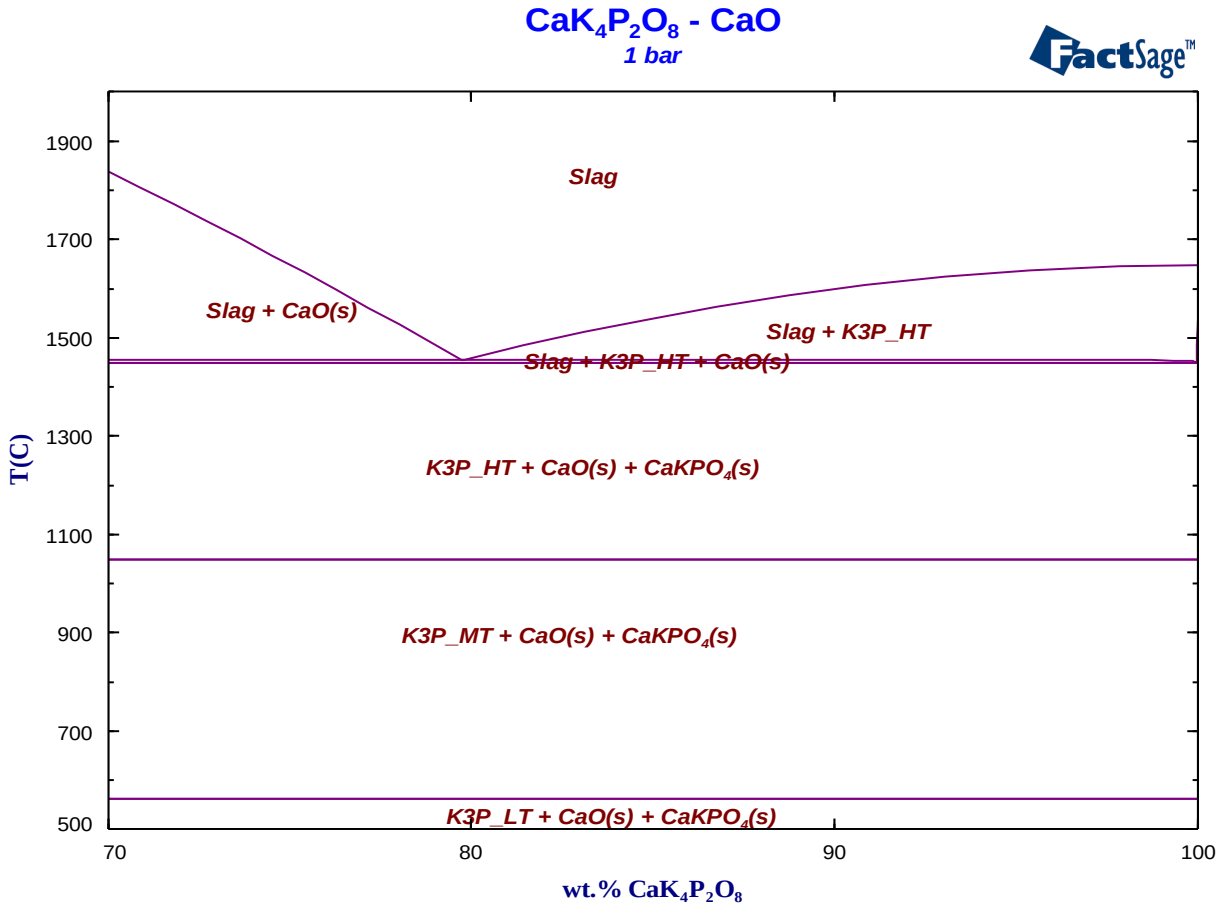
Weight percent, Isopleth CaO-CaKPO4



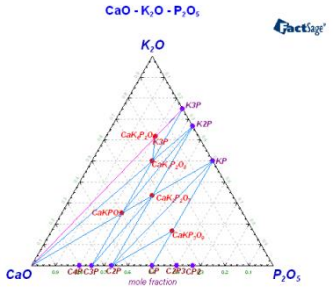


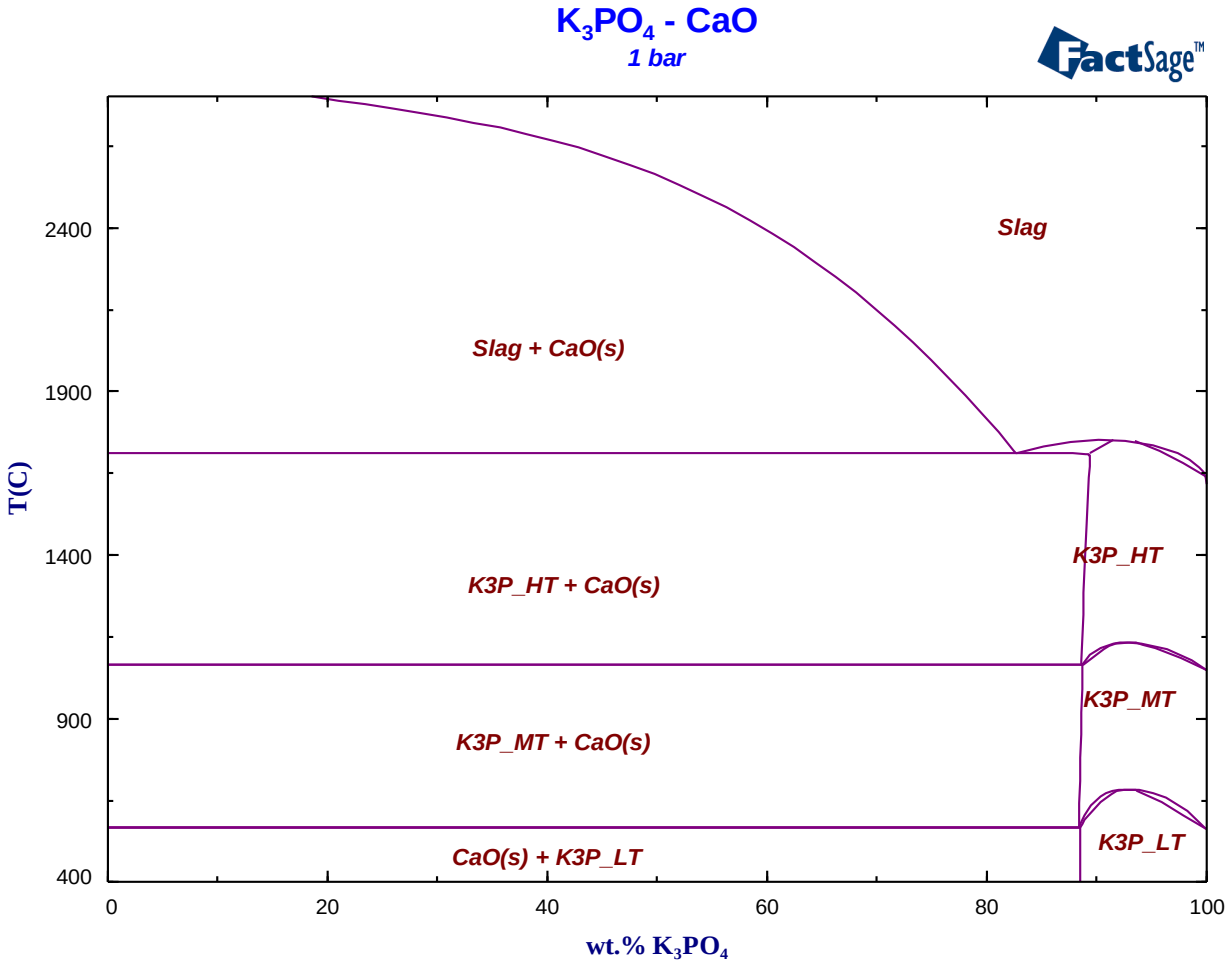
Weight percent, Isopleth CaO-K4CaP2O8

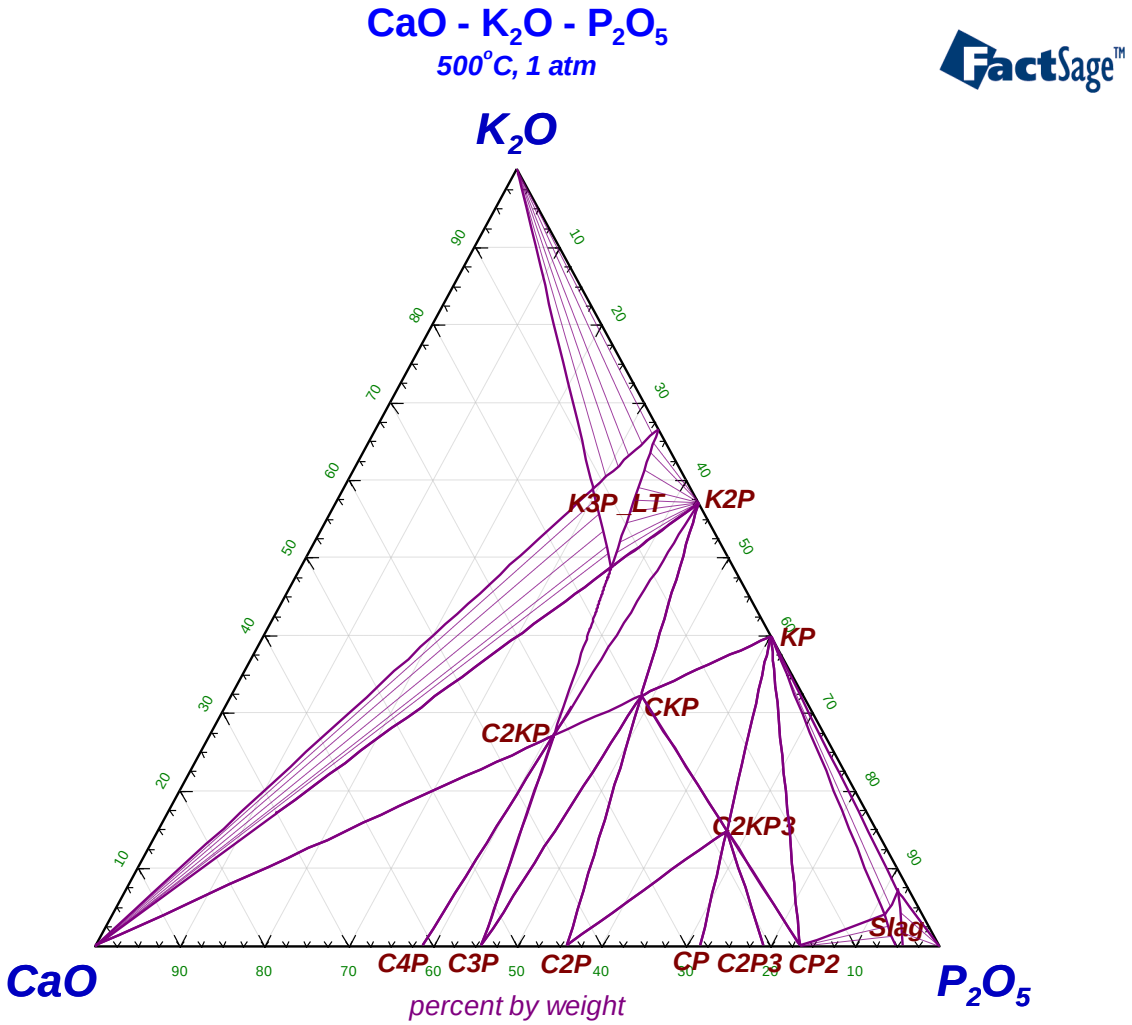


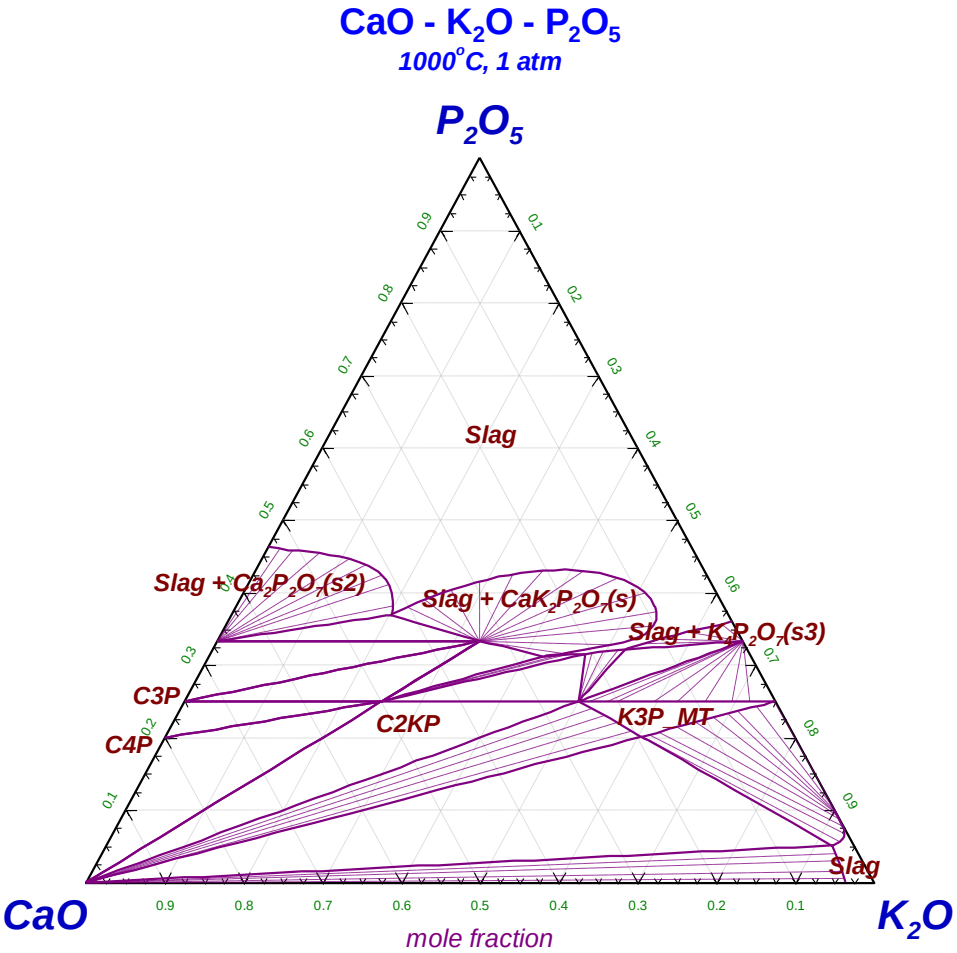


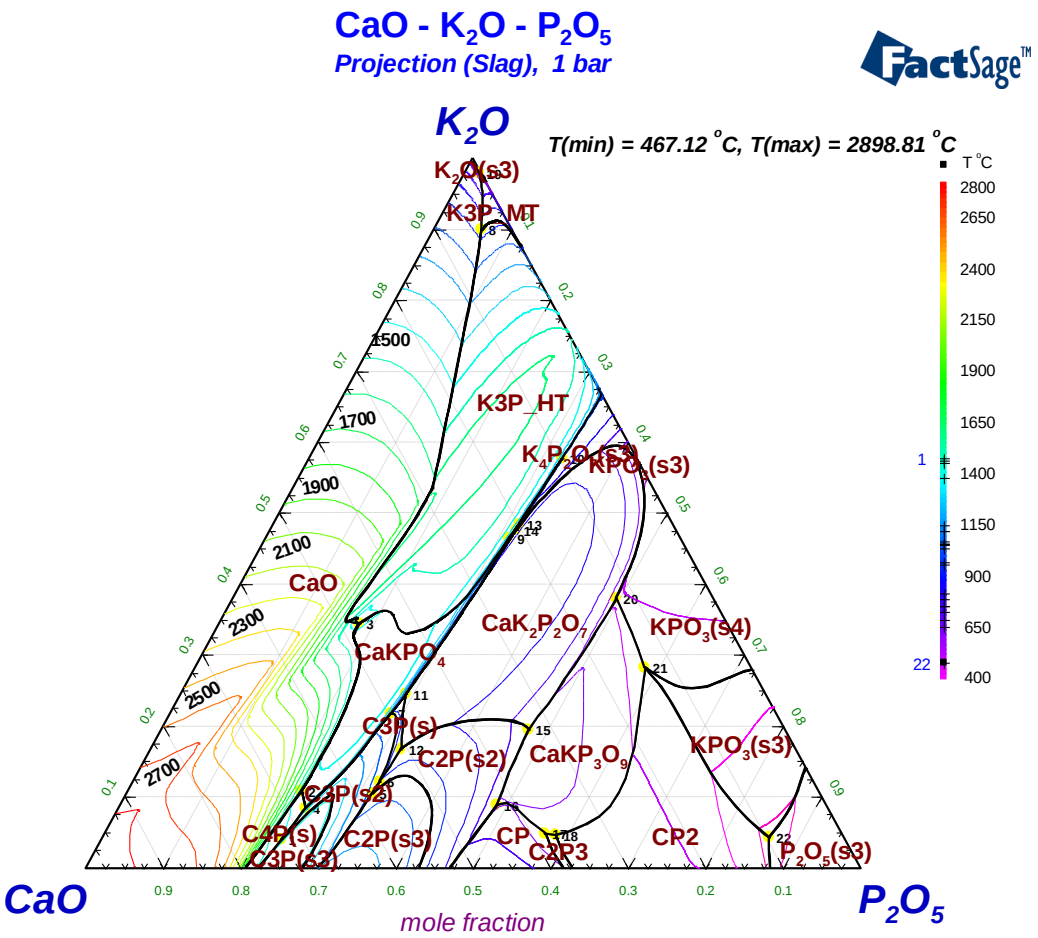
Weight percent, Isopleth CaO-K3PO4

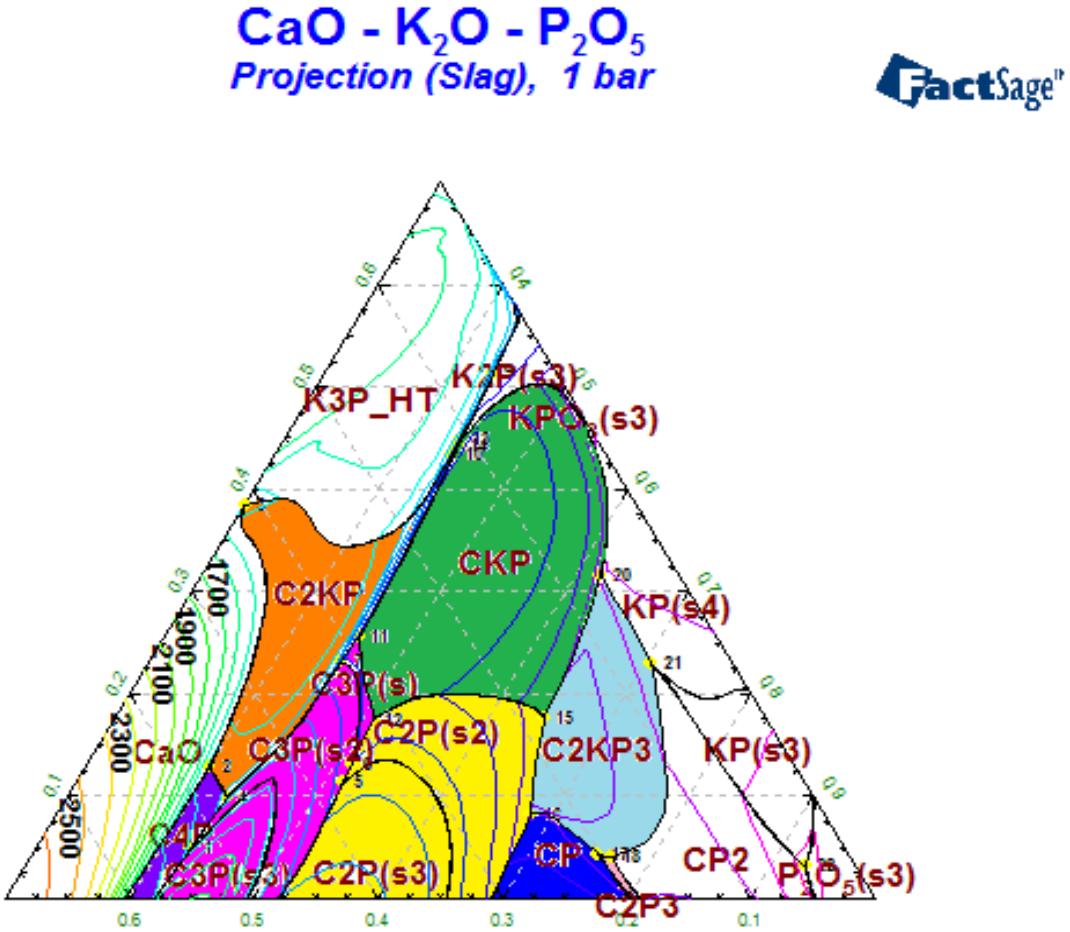





CaO - K2O - P2O5
500°C, 1 atm
K2O
CaO
P2O5
K3P_LT
K2P
KP
CKP
C2KP
C2KP3
Slag
C4P
C3P
C2P
CP
C2P3
CP2
percent by weight


CaO - K2O - P2O5
1000°C, 1 atm
P2O5
Slag
Slag + Ca2P2O7(s2)
Slag + CaK2P2O7(s)
Slag + K4P2O7(s3)
C3P
C4P
C2KP
K3P_MT
Slag
CaO
K2O
mole fraction


CaO - K2O - P2O5
Projection (Slag), 1 bar
FactSage™
K2O
T(min) = 467.12 °C, T(max) = 2898.81 °C
T °C
2800
2650
2400
2150
1900
1650
1400
1150
900
650
400
K2O(s3)
K3P_MT
K3P_HT
K4P2O7(s3)
KPO3(s3)
CaO
CaKPO4
CaK2P2O7
KPO3(s4)
C3P(s)
C2P(s2)
CaKP3O9
KPO3(s3)
C3P(s2)
C4P(s)
C3P(s3)
C2P(s3)
CP
C2P3
CP2
P2O5(s3)
1500
1700
1900
2100
2300
2500
2700
CaO
P2O5
mole fraction


CaO - K2O - P2O5
Projection (Slag), 1 bar
FactSage
K3P_HT
K2P(s3)
KPO3(s3)
CKP
C2KP
KP(s4)
C3P(s)
C2P(s2)
C2KP3
KP(s3)
CaO
C3P(s2)
C4P
C3P(s3)
C2P(s3)
CP
CP2
P2O5(s3)
C2P3
2500
2300
2100
1900
1700
0.6
0.5
0.4
0.3
0.2
0.1

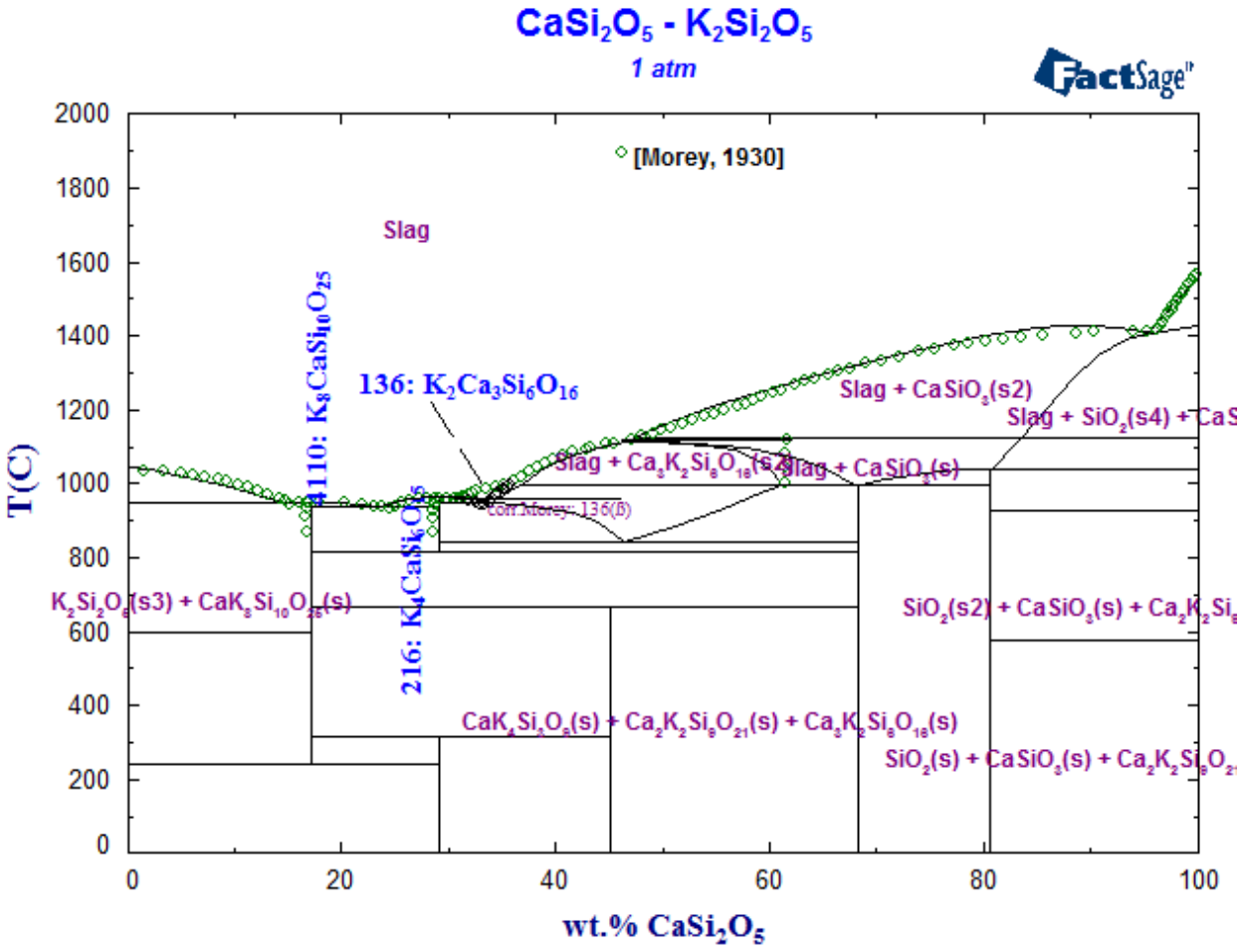
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction				Weight percent			
	A = K2O, B = CaO, C = P2O5				A = K2O, B = CaO, C = P2O5			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: Ca3(PO4)2(s2) / Ca3(PO4)2(s3) / C4P	1: 0.03976	0.72781	0.23243	1469.85	1: 4.830	52.628	42.542	1469.85
2: Ca4(PO4)2O / CaKPO4 / CaO	2: 0.10822	0.66763	0.22415	1453.98	2: 12.830	47.123	40.046	1454.00
3: CaKPO4 / CaO / K3P_HT	3: 0.34448	0.47583	0.17969	1446.83	3: 38.338	31.526	30.136	1446.83
4: Ca3(PO4)2(s2) / Ca4(PO4)2O / CaKPO4	4: 0.08431	0.67391	0.24177	1370.87	4: 9.921	47.209	42.870	1370.87
5: Ca2P2O7(s2) / Ca2P2O7(s3) / Ca3(PO4)2(s2)	5: 0.10439	0.57859	0.31702	1139.85	5: 11.267	37.176	51.558	1139.85
6: Ca2P2O7(s2) / Ca3(PO4)2(s2) / Ca3(PO4)2(s)	6: 0.12152	0.55996	0.31851	1110.28	6: 12.999	35.659	51.342	1109.85
7: Ca3(PO4)2(s2) / Ca3(PO4)2(s) / CaKPO4	7: 0.21811	0.49726	0.28463	1110.28	7: 23.129	31.391	45.480	1109.85
8: CaO / K3P_HT / K3P_MT	8: 0.89964	0.03972	0.06064	1062.11	8: 88.664	2.331	9.006	1062.11
9: CaKPO4 / K3P_HT / K3P_MT	9: 0.46483	0.22107	0.31410	1048.15	9: 51.276	5.059	43.665	1048.11
10: K3P_HT / K3P_MT / K4P2O7(s3)	10: 0.57775	0.09575	0.32650	1048.10	10: 43.452	12.303	44.245	1048.10
11: Ca3(PO4)2(s) / CaK2P2O7 / CaKPO4	11: 0.24458	0.46479	0.29063	1043.91	11: 25.497	28.846	45.657	1043.91
12: Ca2P2O7(s2) / Ca3(PO4)2(s) / CaK2P2O7	12: 0.16732	0.50958	0.32310	1025.51	12: 17.473	31.681	50.846	1025.41
13: CaKPO4 / K3P_MT / K4P2O7(s3)	13: 0.48526	0.19745	0.31729	961.10	13: 44.893	10.874	44.233	961.13
14: CaK2P2O7 / CaKPO4 / K4P2O7(s3)	14: 0.47591	0.20700	0.31710	947.69	14: 44.189	11.442	44.368	947.69
15: Ca2P2O7(s2) / CaK2P2O7 / CaKP3O9	15: 0.19514	0.33074	0.47412	808.66	15: 17.636	17.795	64.569	808.66
16: Ca(PO3)2(s) / Ca2P2O7(s2) / CaKP3O9	16: 0.08818	0.42557	0.48625	781.98	16: 8.208	23.584	68.208	781.84
17: Ca(PO3)2(s) / Ca2P6O17 / CaKP3O9	17: 0.04882	0.38266	0.56852	745.52	17: 4.308	20.101	75.592	745.52
18: Ca2P6O17 / CaKP3O9 / CaP4O11	18: 0.04672	0.37033	0.58295	744.42	18: 4.078	19.244	76.678	744.42
19: CaO / K2O(s3) / K3P_MT	19: 0.97885	0.00277	0.01838	715.74	19: 97.090	0.164	2.747	715.74
20: CaK2P2O7 / CaKP3O9 / KPO3(s4)	20: 0.37982	0.12565	0.49453	678.34	20: 31.656	6.234	62.109	678.33
21: CaKP3O9 / KPO3(s3) / KPO3(s4)	21: 0.28308	0.13690	0.58002	645.90	21: 22.855	6.580	70.565	645.90
22: CaP4O11 / KPO3(s3) / P2O5(s3)	22: 0.04325	0.09684	0.85991	467.12	22: 3.096	4.128	92.776	467.13

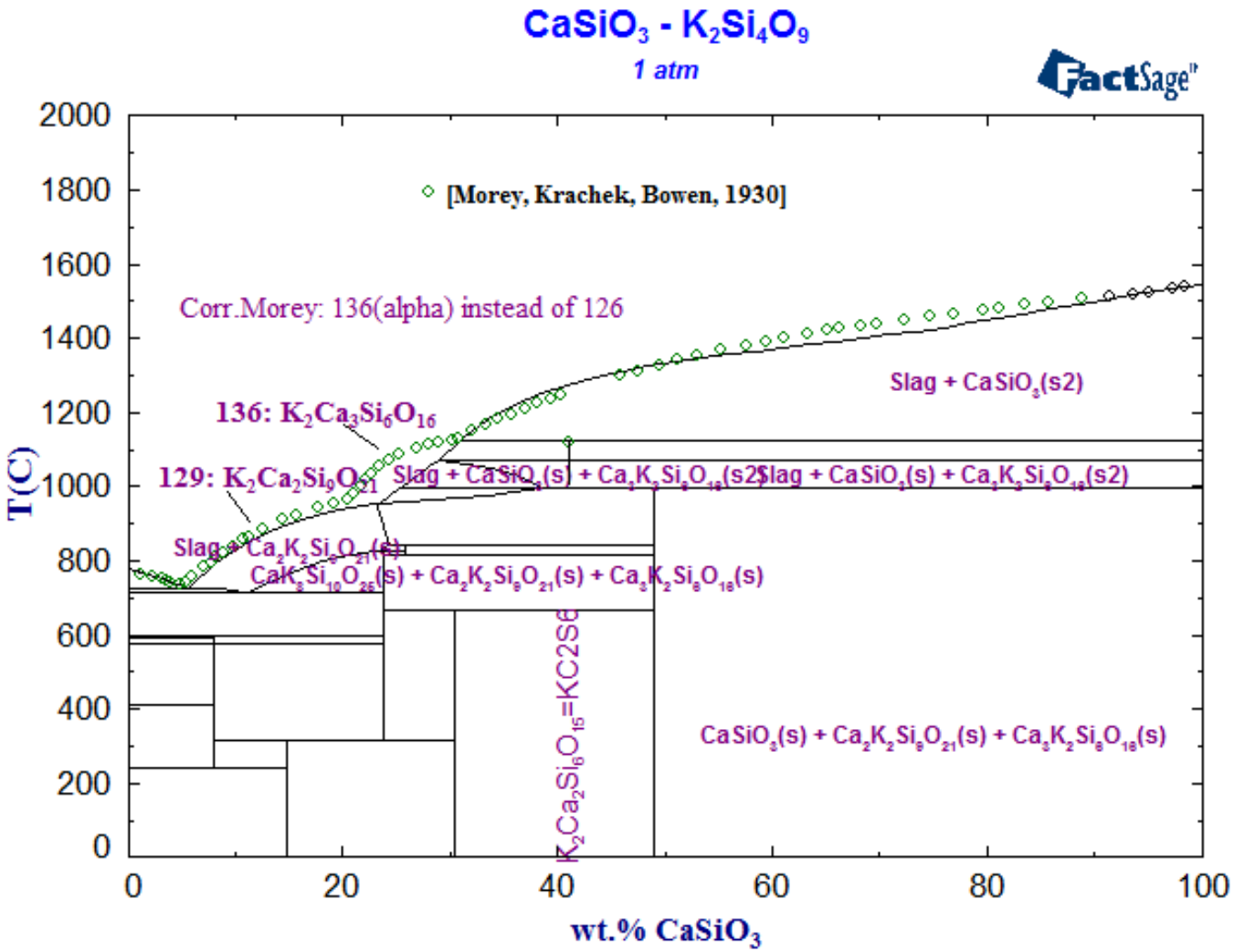
Ternary phases in $CaO-K_2O-SiO_2$ system

Phase	Description	Formel
KCS(111)	stoichiometric	K_2CaSiO_4
K_2CS_3 (213)	stoichiometric	$K_4CaSi_3O_9$
K_2CS_6 (216)	stoichiometric	$K_4CaSi_6O_{15}$
K_4CS_{10} (4110)	stoichiometric	$K_8CaSi_{10}O_{25}$
KC_2S_9 (129)	stoichiometric	$K_2Ca_2Si_9O_{21}$
KC_3S_6 (136-HT)	stoichiometric	$K_2Ca_3Si_6O_{16}$ (α, HT)
KC_3S_6 (136-LT)	stoichiometric	$K_2Ca_3Si_6O_{16}$ (β, LT)

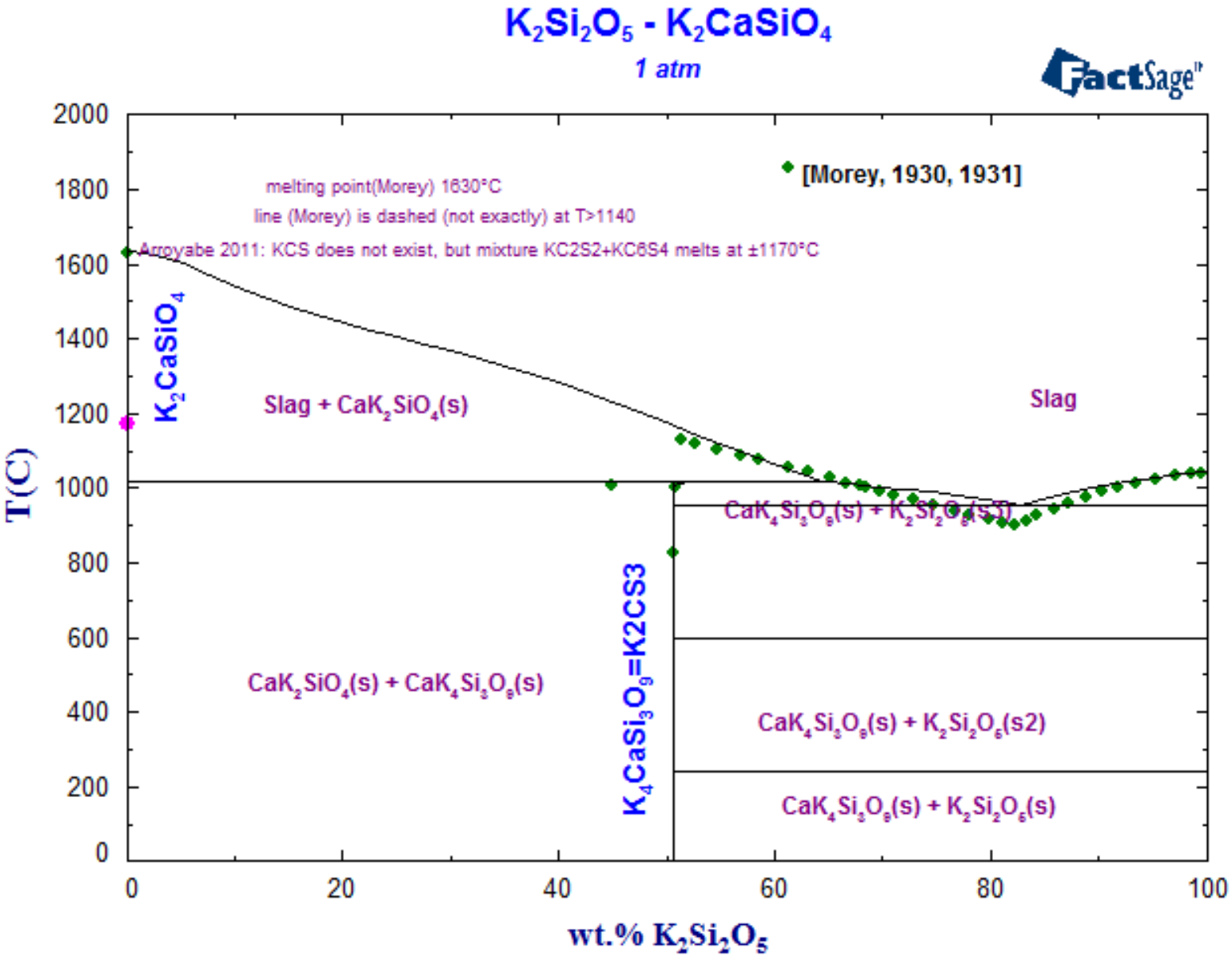
CaO-K2O-SiO2,
Weight percent
Isopleth CaSi2O5-K2Si2O5



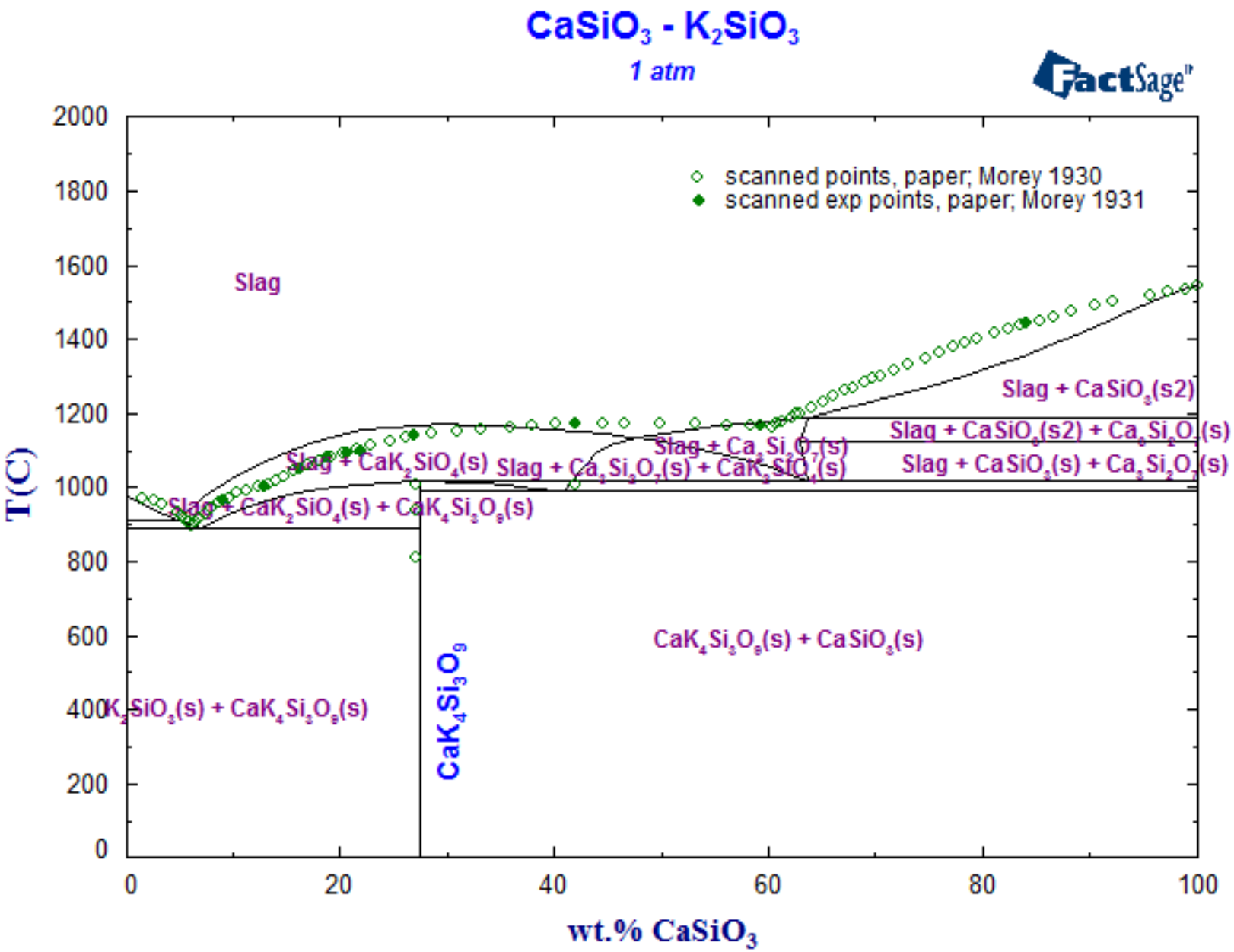
Isopleth CaSiO3-K2Si4O9
compared with experimental data

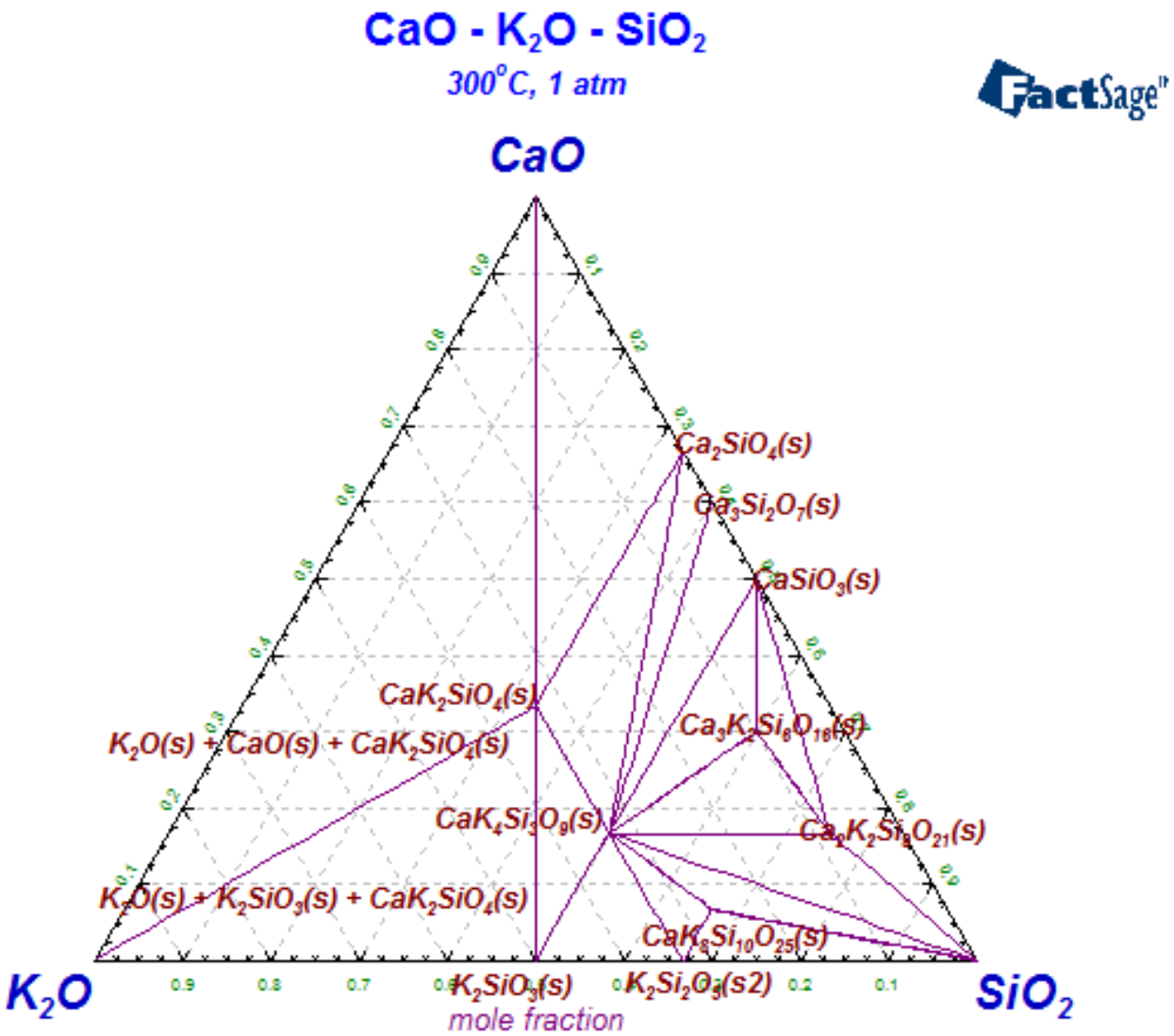


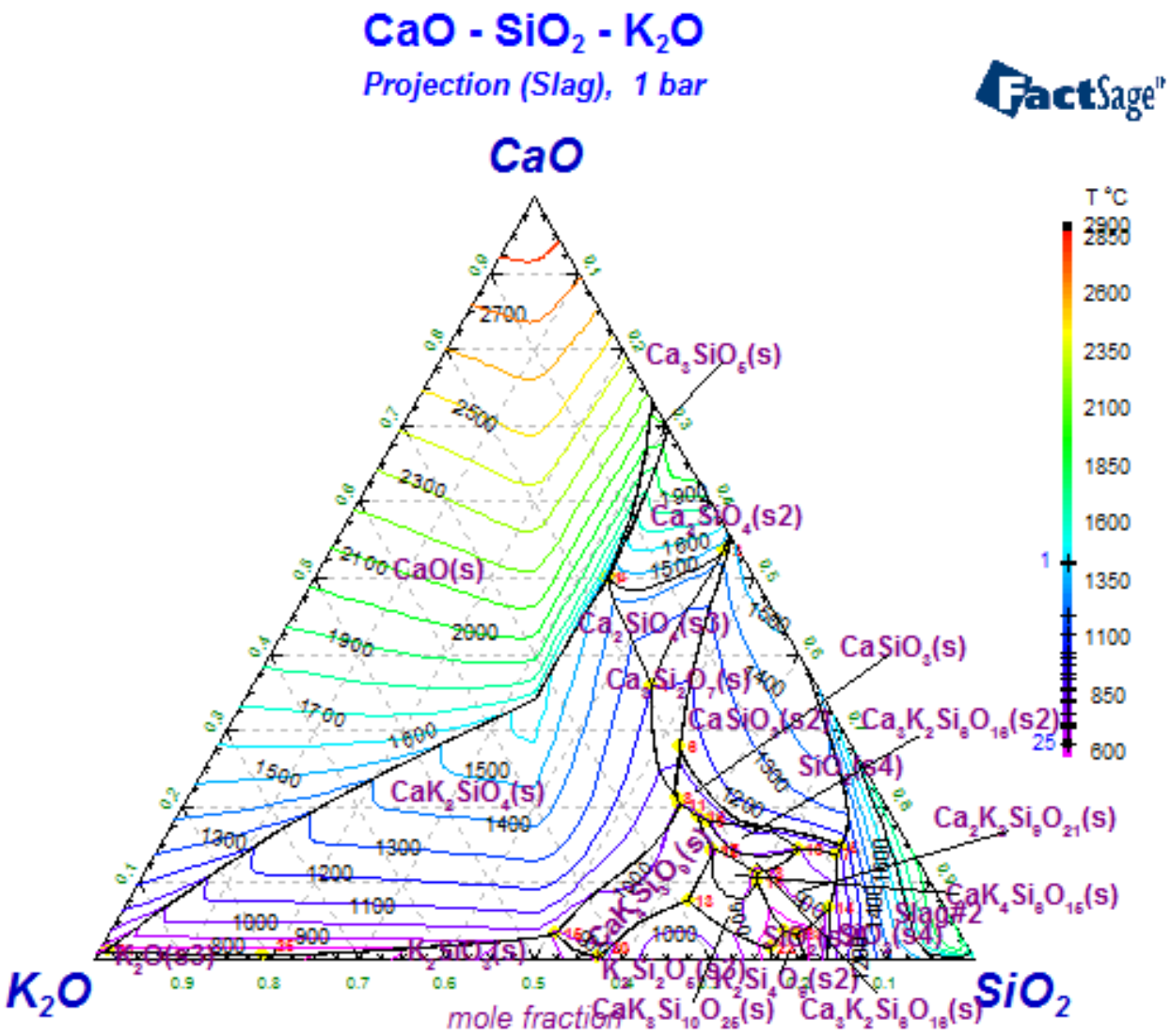
Isopleth K2Si2O5-K2CaSiO4
compared with experimental data



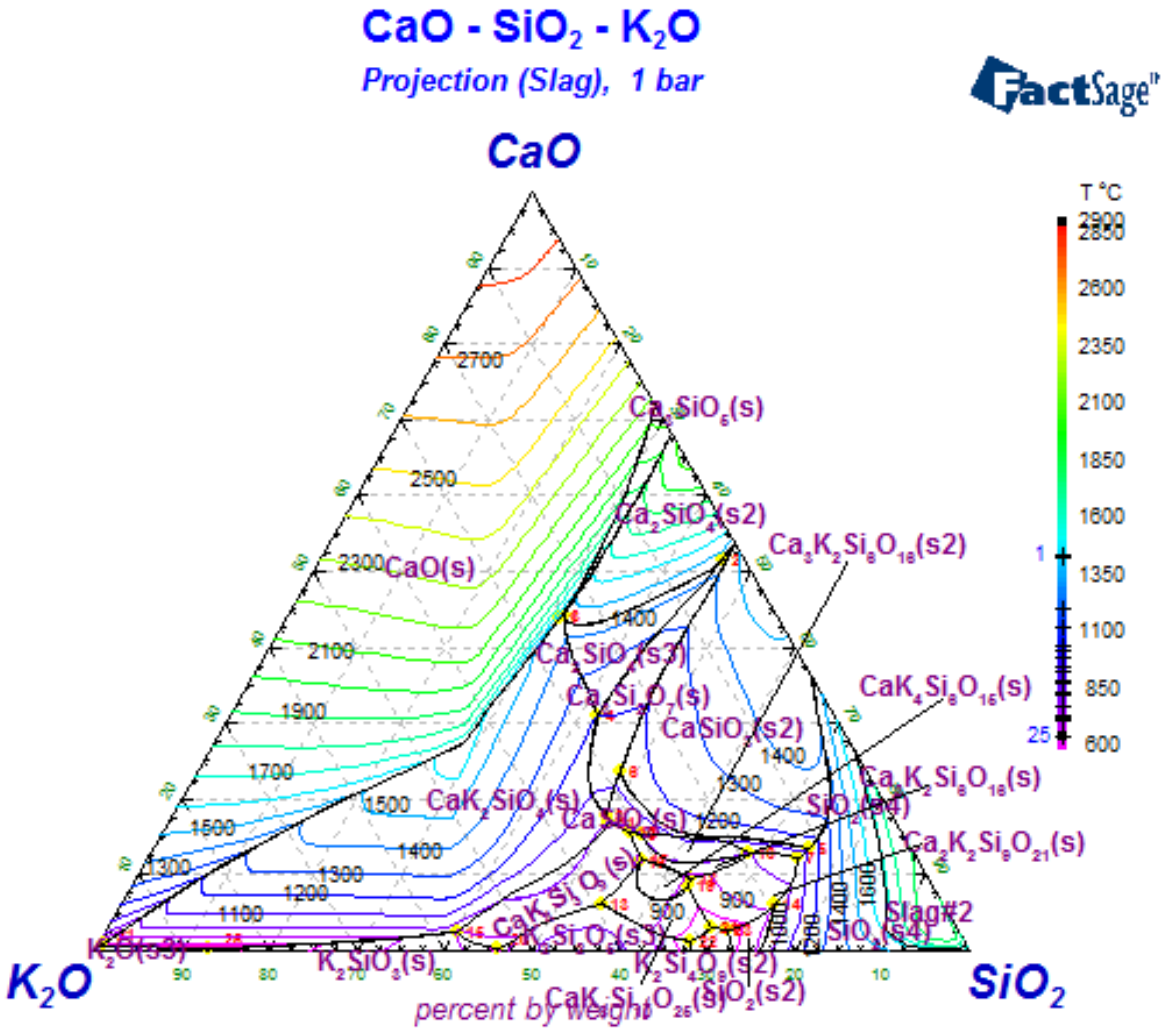
Isopleth CaSiO3-K2SiO3
compared with experimental data




CaO - K2O - SiO2
300°C, 1 atm
FactSage
CaO
Ca2SiO4(s)
Ca3Si2O7(s)
CaSiO3(s)
CaK2SiO4(s)
K2O(s) + CaO(s) + CaK2SiO4(s)
Ca3K2Si6O18(s)
CaK4Si3O9(s)
Ca2K2Si8O21(s)
K2O(s) + K2SiO3(s) + CaK2SiO4(s)
CaK8Si10O25(s)
K2O
K2SiO3(s)
K2Si2O5(s2)
SiO2
mole fraction


CaO - SiO2 - K2O
Projection (Slag), 1 bar
FactSage
CaO
K2O
SiO2
mole fraction
T °C
Ca3SiO5(s)
Ca2SiO4(s2)
CaO(s)
Ca2SiO4(s3)
Ca3Si2O7(s)
CaSiO3(s)
CaSiO3(s2)
Ca3K2Si6O18(s2)
SiO2(s4)
CaK2SiO4(s)
Ca2K2Si6O21(s)
CaK4Si6O16(s)
Slag#2
K2O(s3)
K2SiO3(s)
K2Si2O5(s2)
K2Si4O9(s2)
CaK6Si10O25(s)
Ca3K2Si6O18(s)

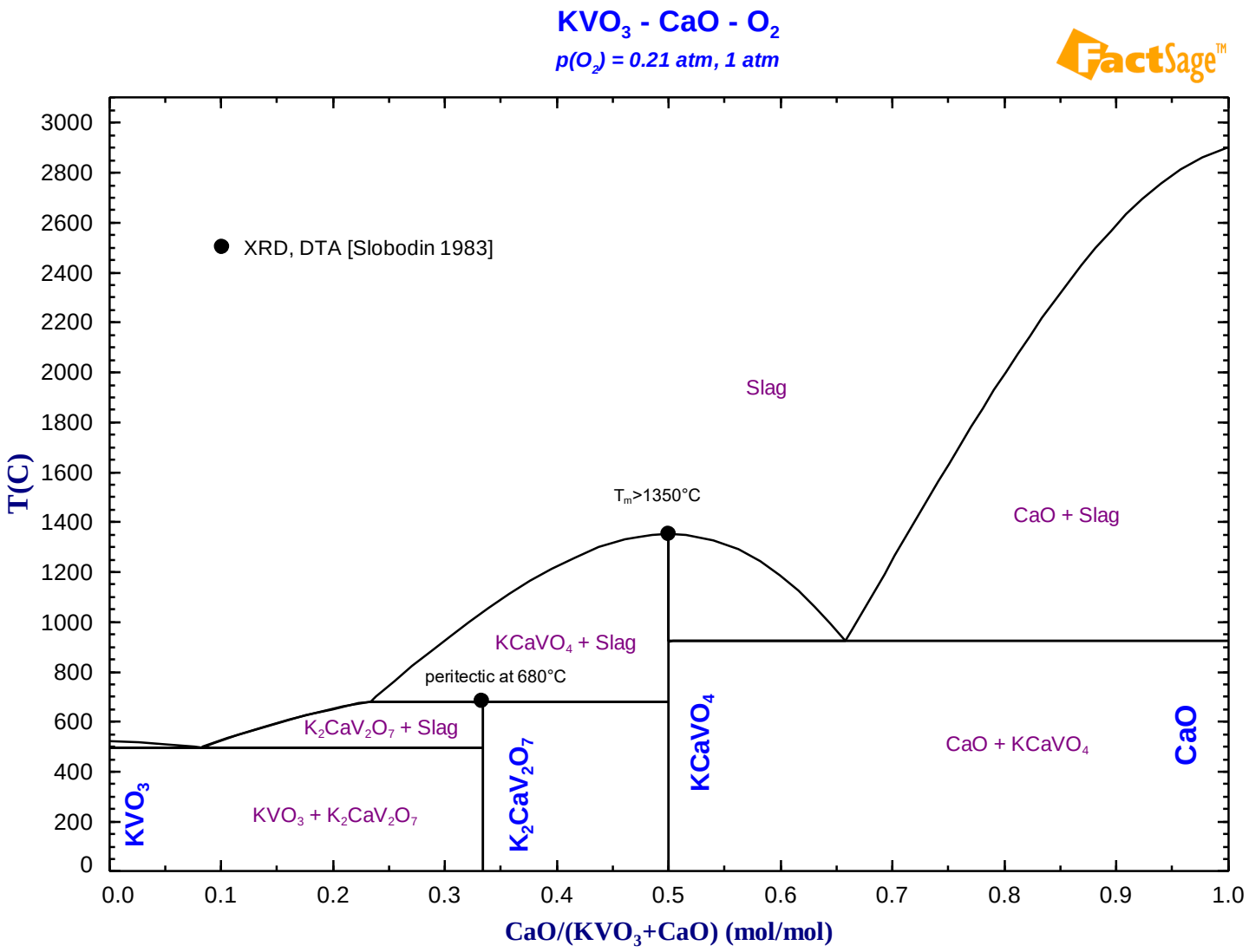
Weight percent
Liquidussurface

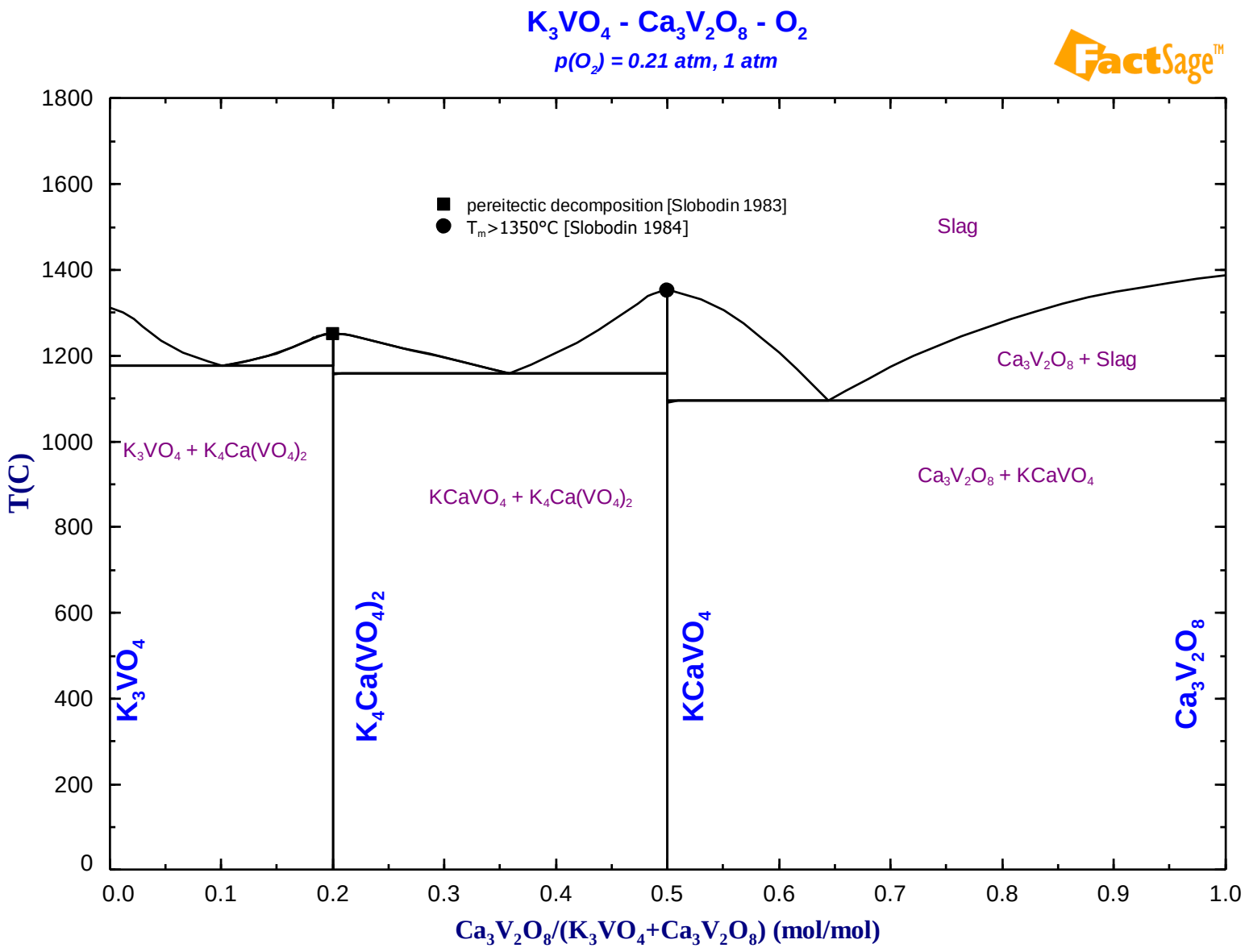


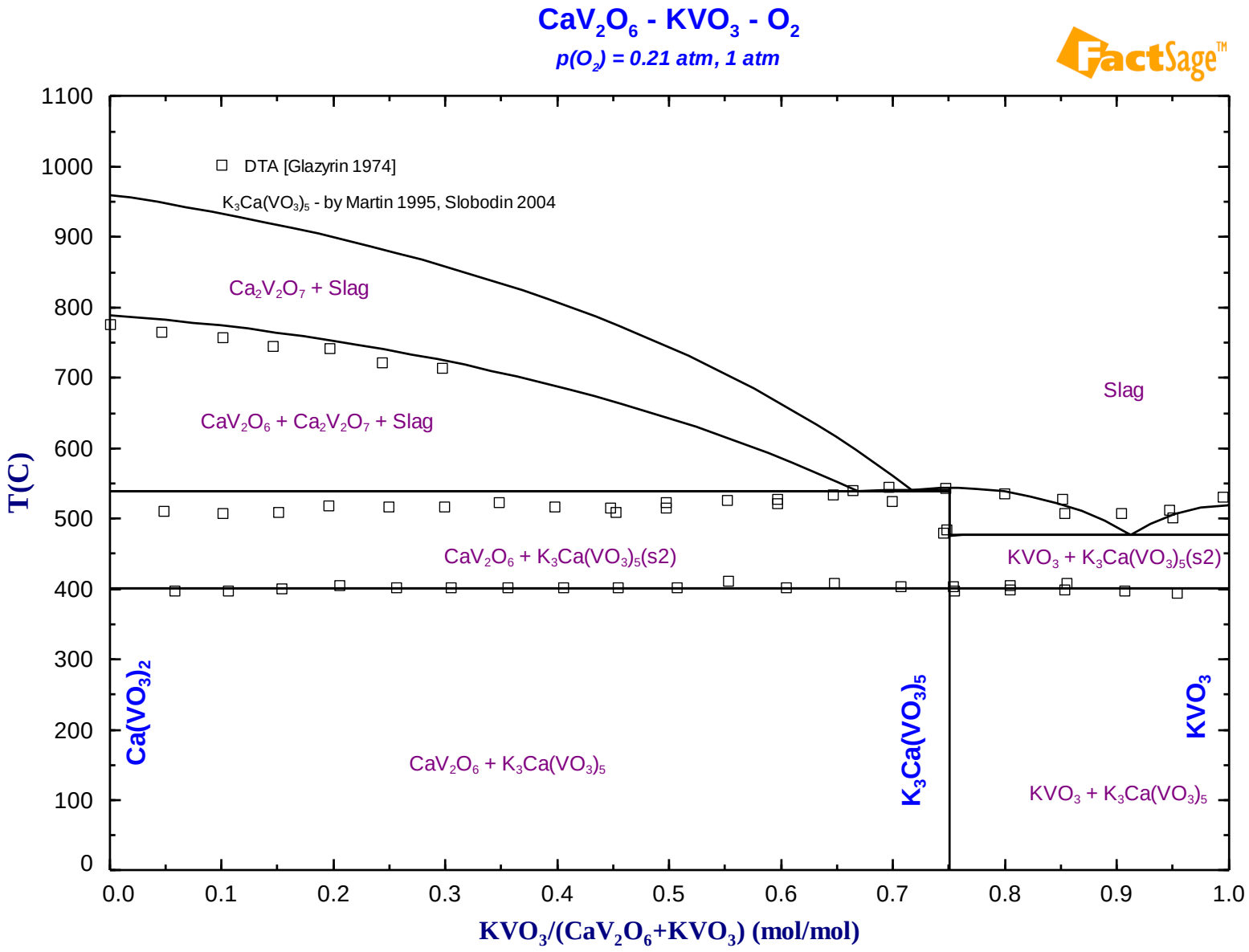
Invariant equilibria on the liquidus surface

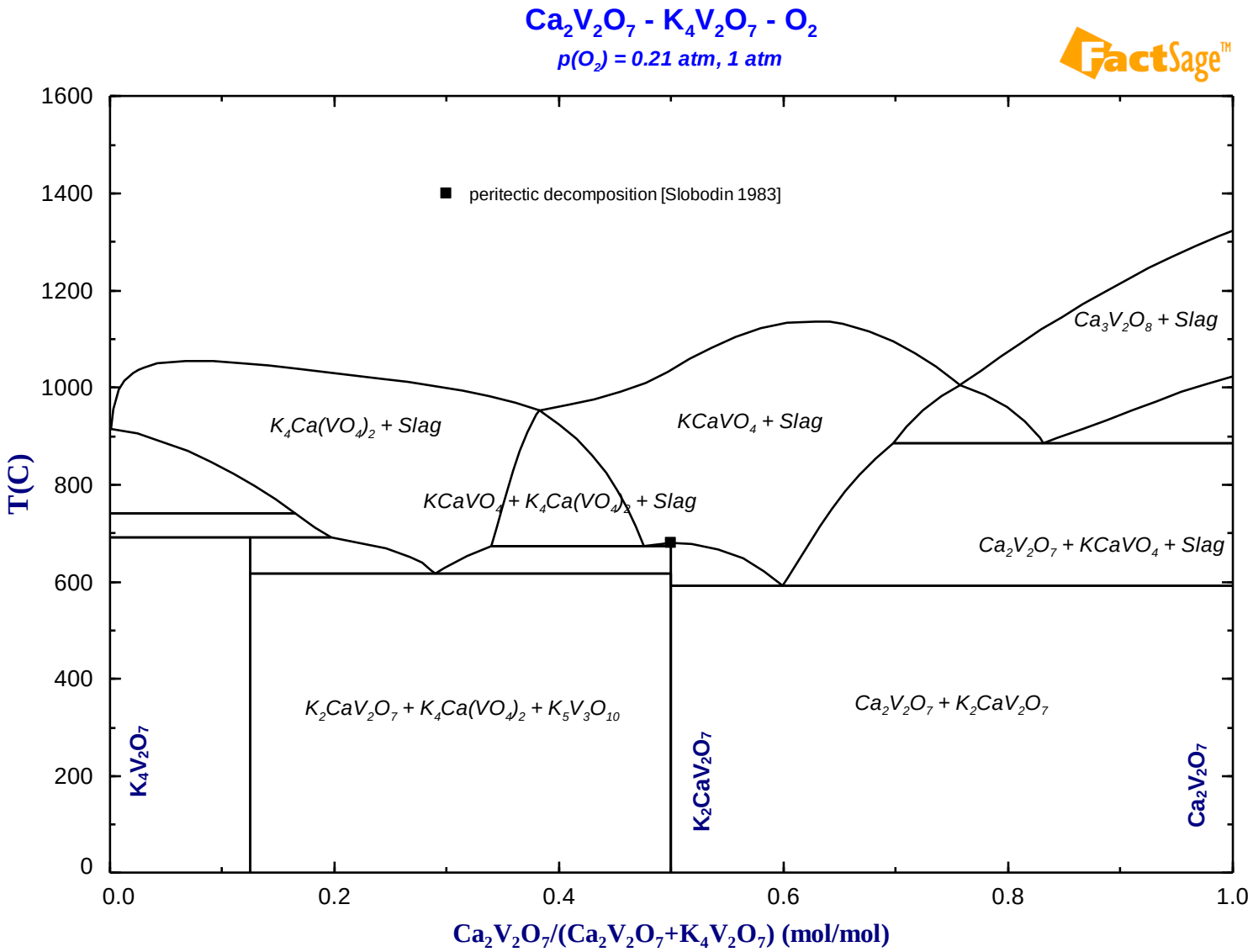
Intersections with slag	Mole fraction					Weight percent				
	A = CaO, B = K2O, C = SiO2					A = CaO, B = K2O, C = SiO2				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: Ca3SiO5(s) / CaK2SiO4(s) / CaO(s)	1:	0.49849	0.16927	0.33224	1440.92	1:	43.773	24.968	31.259	1440.82
2: Ca2SiO4(s2) / Ca2SiO4(s3) / Ca3Si2O7(s)	2:	0.53832	0.01458	0.44710	1436.73	2:	51.669	2.351	45.980	1436.73
3: Ca2SiO4(s3) / Ca3SiO5(s) / CaK2SiO4(s)	3:	0.50279	0.16383	0.33338	1430.70	3:	44.291	24.242	31.466	1430.50
4: Ca2SiO4(s3) / Ca3Si2O7(s) / CaK2SiO4(s)	4:	0.35854	0.18717	0.45430	1198.90	4:	30.917	27.110	41.973	1198.90
5: CaSiO3(s2) / CaSiO3(s) / SiO2(s4)	5:	0.14837	0.07670	0.77494	1124.23	5:	13.396	11.633	74.971	1124.28
6: Ca3Si2O7(s) / CaSiO3(s2) / CaSiO3(s)	6:	0.27754	0.19537	0.52709	1124.13	6:	23.712	28.037	48.251	1124.13
7: Ca2K2Si9O21(s) / CaSiO3(s) / SiO2(s4)	7:	0.13628	0.08964	0.77408	1039.73	7:	12.209	13.489	74.302	1039.73
8: Ca3Si2O7(s) / CaK2SiO4(s) / CaSiO3(s)	8:	0.21285	0.23262	0.55453	1016.54	8:	17.770	32.623	49.607	1016.56
9: Ca3K2Si6O16(s2) /Ca3K2Si6O16/ CaSiO3(s)	9:	0.18151	0.21167	0.60681	993.85	9:	15.289	29.948	54.763	993.99
10: Ca2K2Si9O21 / Ca3K2Si6O16 / CaSiO3(s)	10:	0.14460	0.12792	0.72749	993.62	10:	12.700	18.872	68.429	993.85
11: CaK2SiO4 / CaK4Si3O9 / CaSiO3(s)	11:	0.20190	0.23333	0.56476	988.37	11:	16.840	32.690	50.470	988.37
12: Ca3K2Si6O16 / CaK4Si3O9 / CaSiO3(s)	12:	0.18558	0.21997	0.59445	946.93	12:	15.569	30.998	53.433	946.79
13: CaK4Si3O9 / CaK8Si10O25 / K2Si2O5(s3)	13:	0.07687	0.28704	0.63610	928.84	13:	6.196	38.865	54.938	928.84
14: Ca2K2Si9O21 / SiO2(s4) / SiO2(s2)	14:	0.06814	0.13167	0.80019	926.29	14:	5.942	19.288	74.769	926.29
15: CaK2SiO4 / CaK4Si3O9 / K2SiO3	15:	0.03322	0.45986	0.50693	889.03	15:	2.463	57.268	40.269	889.02
16: CaK4Si3O9 / CaK4Si6O15 / CaK8Si10O25	16:	0.13983	0.22747	0.63270	884.35	16:	11.654	31.845	56.500	884.34
17: Ca3K2Si6O16 / CaK4Si3O9 / CaK4Si6O15	17:	0.14276	0.22521	0.63203	881.00	17:	11.914	31.571	56.515	881.00
18: Ca2K2Si9O21 / Ca3K2Si6O16 /CaK4Si6O15	18:	0.11191	0.19132	0.69677	840.13	18:	9.485	27.239	63.276	838.37
19: Ca2K2Si9O21 / CaK4Si6O15 /CaK8Si10O25	19:	0.10123	0.19602	0.70274	824.81	19:	8.554	27.822	63.623	824.81
20: CaK4Si3O9 / K2Si2O5(s3) / K2SiO3(s)	20:	0.00197	0.42688	0.57116	775.46	20:	0.148	53.874	45.979	775.33
21: CaK2SiO4 / CaO(s) / K2O(s3)	21:	0.01259	0.97819	0.00922	733.34	21:	0.756	98.651	0.593	733.44
22: CaK8Si10O25 / K2Si2O5(s3) / K2Si4O9(s2)	22:	0.01399	0.22545	0.76056	727.23	22:	1.159	31.359	67.482	727.23
23: Ca2K2Si9O21 / K2Si4O9(s2) / SiO2(s2)	23:	0.03178	0.18596	0.78226	725.44	23:	2.688	26.420	70.892	725.44
24: Ca2K2Si9O21 / CaK8Si10O25 /K2Si4O9(s2)	24:	0.03628	0.19791	0.76582	714.21	24:	3.050	27.953	68.996	714.21
25: CaK2SiO4 / K2O(s3) / K2SiO3(s)	25:	0.00405	0.80597	0.18998	643.34	25:	0.259	86.705	13.036	643.34

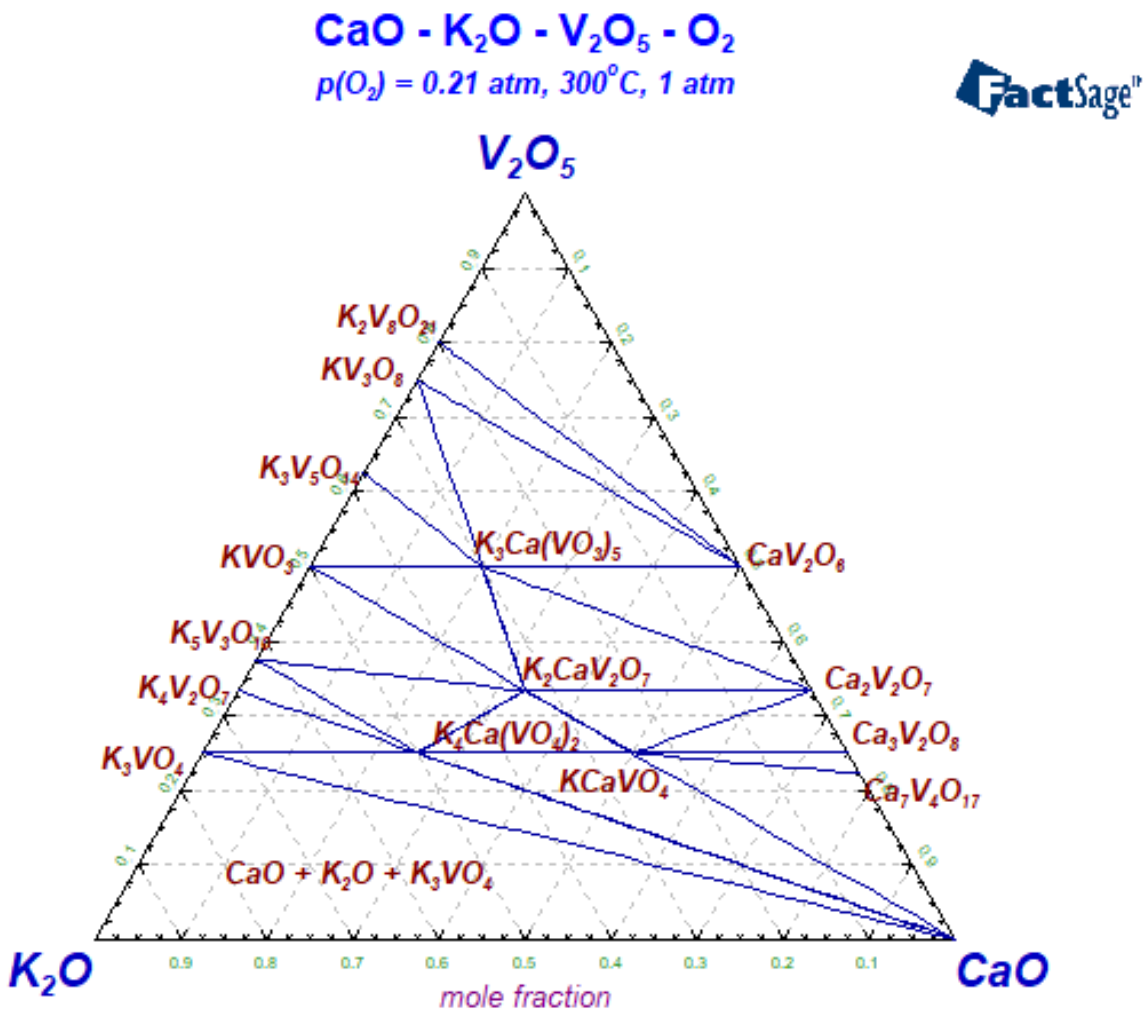
CaO-K2O-V2O5,
Mole fraction, Isopleth CaO-KVO3



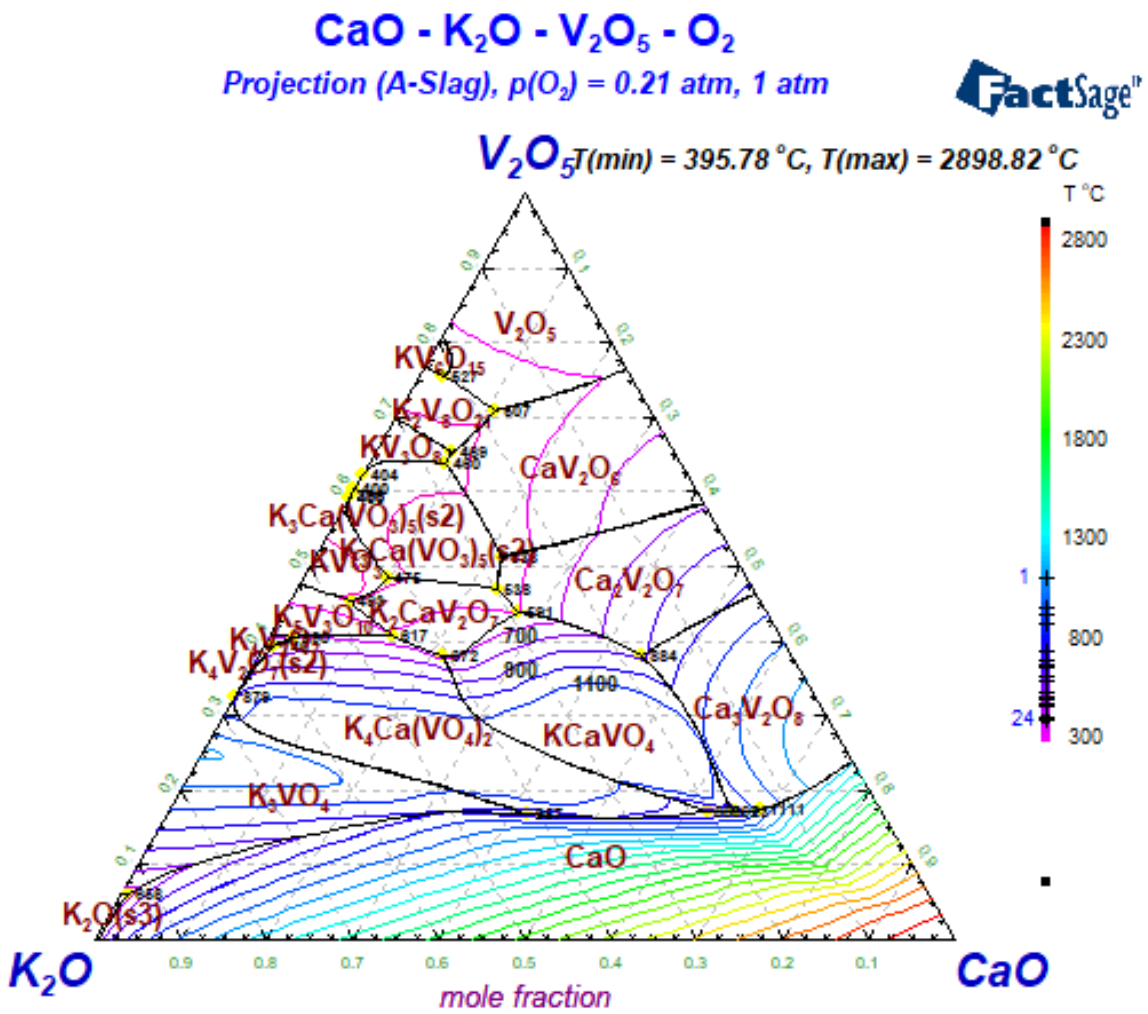

K3VO4 - Ca3V2O8 - O2
p(O2) = 0.21 atm, 1 atm
FactSage™
pereitectic decomposition [Slobodin 1983]
Tm>1350°C [Slobodin 1984]
Slag
Ca3V2O8 + Slag
K3VO4 + K4Ca(VO4)2
KCaVO4 + K4Ca(VO4)2
Ca3V2O8 + KCaVO4
K3VO4
K4Ca(VO4)2
KCaVO4
Ca3V2O8
T(C)
1800
1600
1400
1200
1000
800
600
400
200
0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Ca3V2O8/(K3VO4+Ca3V2O8) (mol/mol)

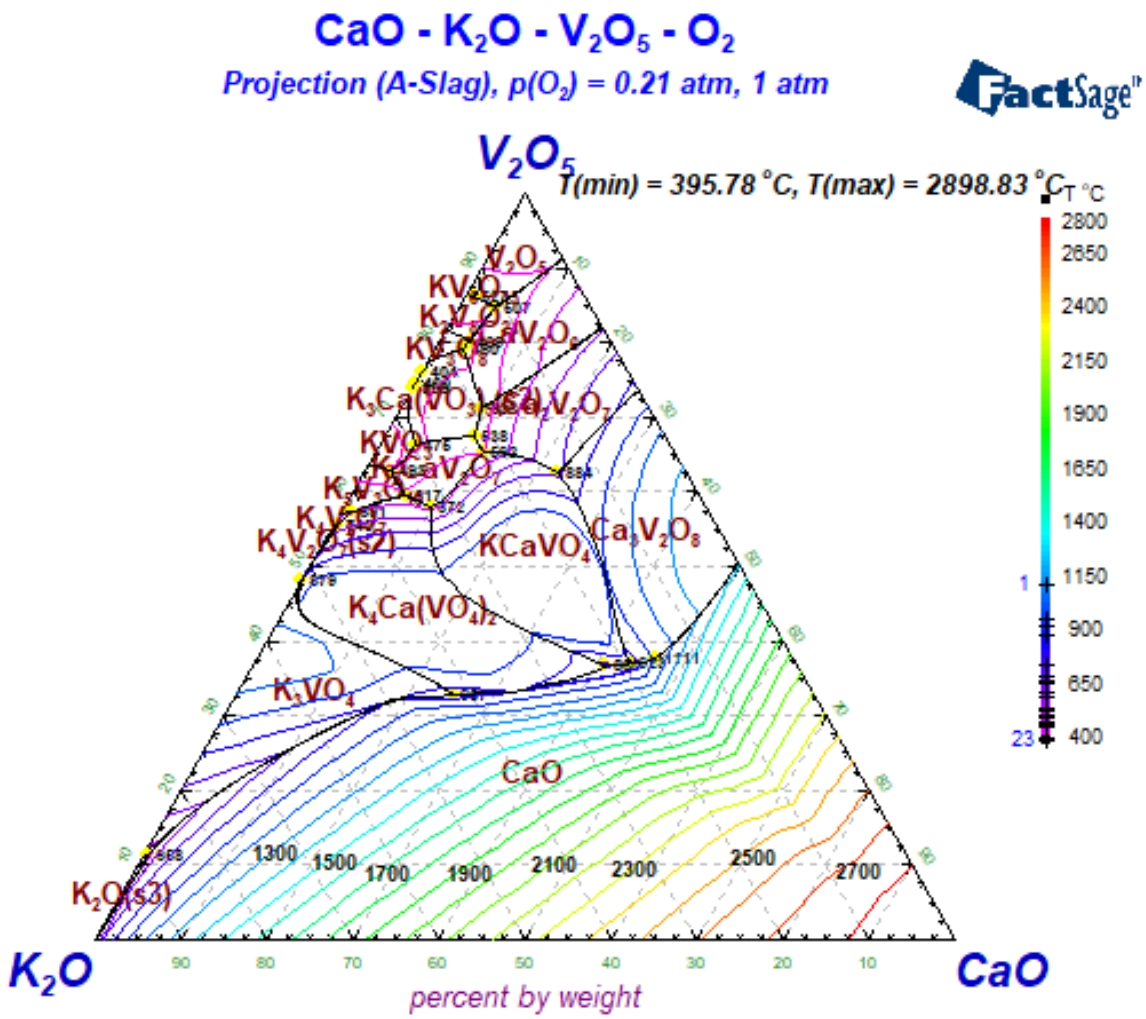

CaV2O6 - KVO3 - O2
p(O2) = 0.21 atm, 1 atm
FactSage™
DTA [Glazyrin 1974]
K3Ca(VO3)5 - by Martin 1995, Slobodin 2004
Ca2V2O7 + Slag
CaV2O6 + Ca2V2O7 + Slag
Slag
CaV2O6 + K3Ca(VO3)5(s2)
KVO3 + K3Ca(VO3)5(s2)
Ca(VO3)2
CaV2O6 + K3Ca(VO3)5
K3Ca(VO3)5
KVO3
KVO3 + K3Ca(VO3)5
T(C)
KVO3/(CaV2O6+KVO3) (mol/mol)
0
100
200
300
400
500
600
700
800
900
1000
1100
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0


Ca2V2O7 - K4V2O7 - O2
p(O2) = 0.21 atm, 1 atm
FactSage™
peritectic decomposition [Slobodin 1983]
K4Ca(VO4)2 + Slag
KCaVO4 + Slag
Ca3V2O8 + Slag
KCaVO4 + K4Ca(VO4)2 + Slag
Ca2V2O7 + KCaVO4 + Slag
K2CaV2O7 + K4Ca(VO4)2 + K5V3O10
Ca2V2O7 + K2CaV2O7
K4V2O7
K2CaV2O7
Ca2V2O7
T(C)
1600
1400
1200
1000
800
600
400
200
0
0.0
0.2
0.4
0.6
0.8
1.0
Ca2V2O7/(Ca2V2O7+K4V2O7) (mol/mol)


CaO - K2O - V2O5 - O2
p(O2) = 0.21 atm, 300°C, 1 atm
FactSage
V2O5
K2V8O21
KV3O8
K3V5O14
KVO3
K3Ca(VO3)5
CaV2O6
K5V3O16
K2CaV2O7
Ca2V2O7
K4V2O7
K4Ca(VO4)2
Ca3V2O8
K3VO4
KCaVO4
Ca7V4O17
CaO + K2O + K3VO4
K2O
CaO
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
mole fraction

CaO-K2O-V2O5,
Mole fraction, Liquidus surface

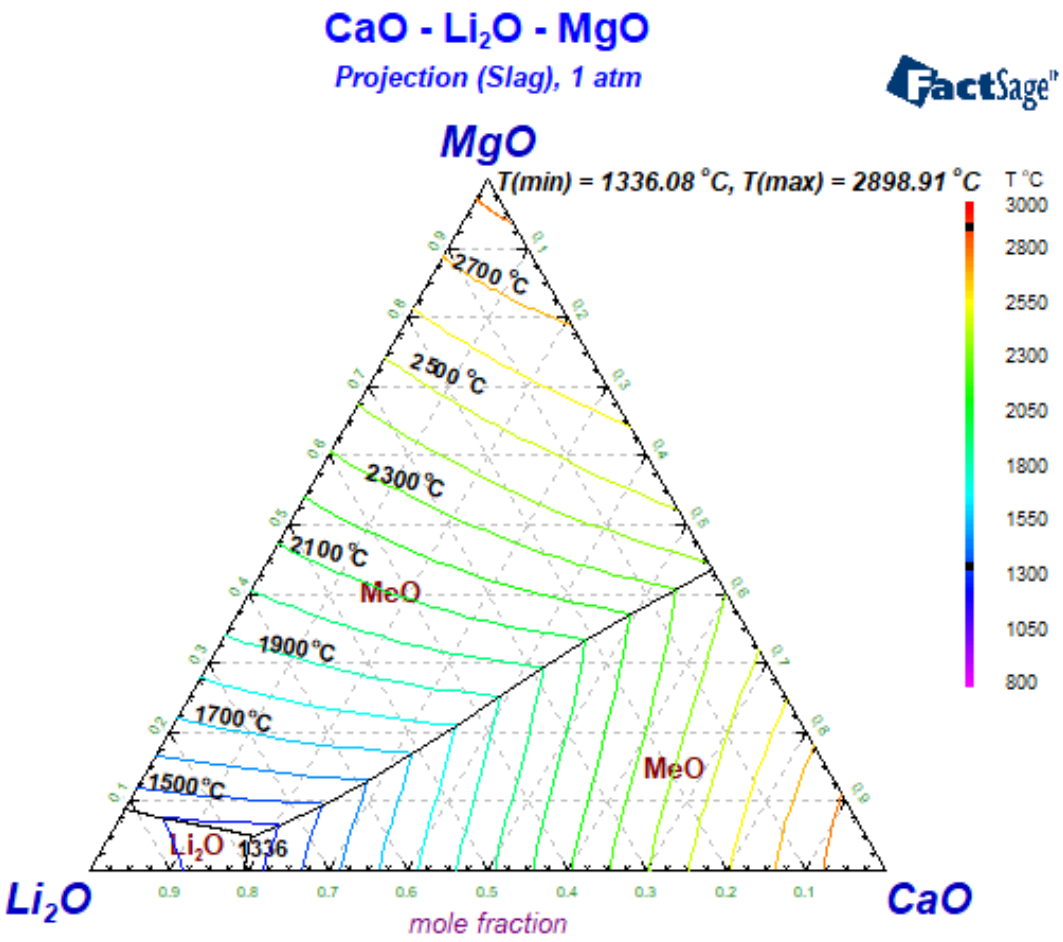


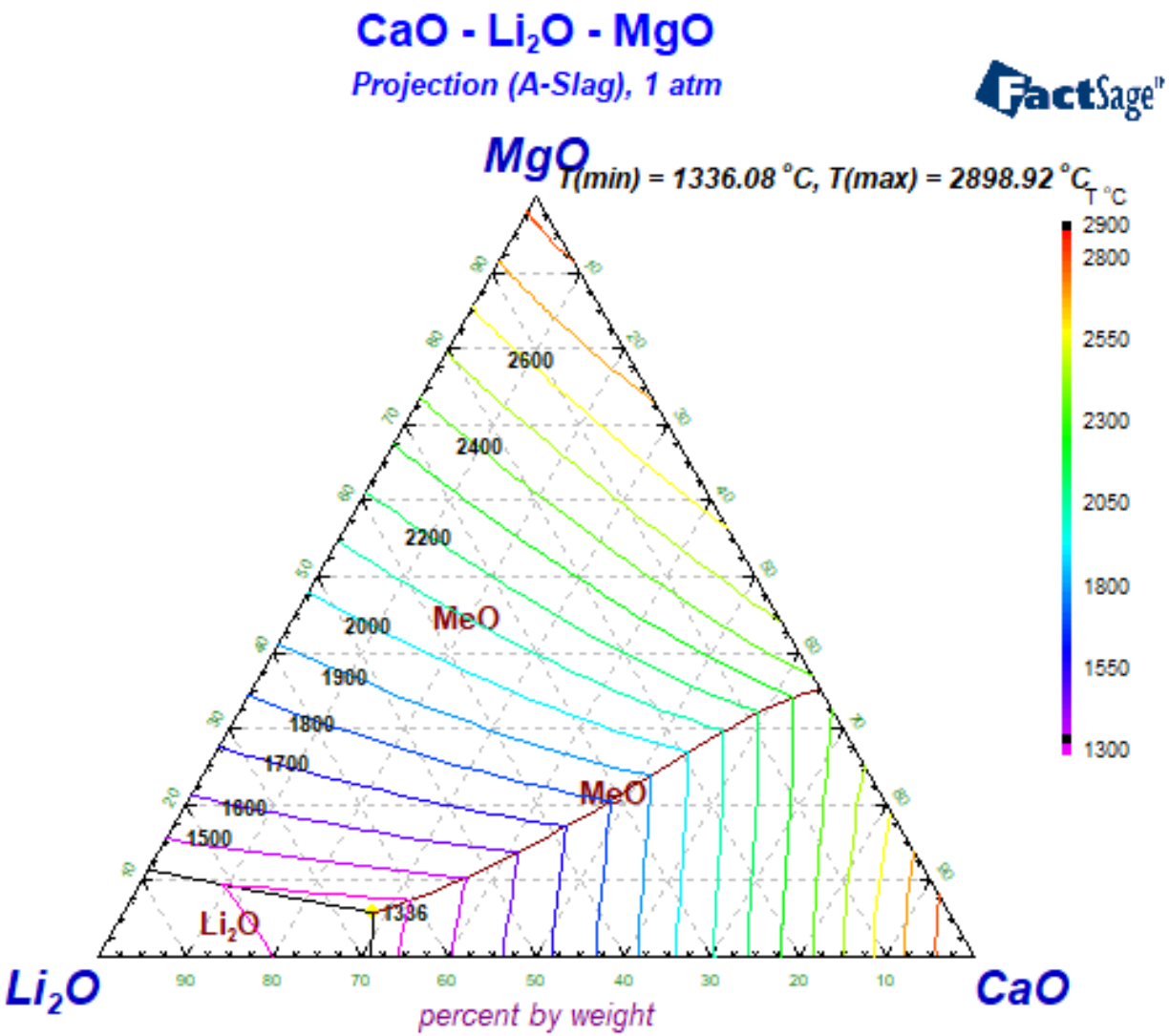

CaO - K2O - V2O5 - O2
Projection (A-Slag), p(O2) = 0.21 atm, 1 atm
FactSage
V2O5
T(min) = 395.78 °C, T(max) = 2898.83 °C
T °C
2800
2650
2400
2150
1900
1650
1400
1150
900
650
400
KCaVO4
Ca3V2O8
K4Ca(VO4)2
K3VO4
CaO
K2O(s3)
1300
1500
1700
1900
2100
2300
2500
2700
K2O
CaO
percent by weight

Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction A = V2O5, B = K2O, C = CaO				Weight percent A = V2O5, B = K2O, C = CaO			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1. Ca3V2O8 / Ca7V4O17 / CaO	0.17301	0.14023	0.68676	1110.90	37.827	15.878	46.295	1110.93
2. CaO / K3VO4 / K4Ca(VO4)2	0.16760	0.41419	0.41821	956.89	32.795	41.974	25.231	956.89
3. Ca3V2O8/Ca7V4O17 / KCaVO4	0.17250	0.17008	0.65742	922.51	37.234	19.013	43.753	922.50
4. Ca2V2O7 / Ca3V2O8/ KCaVO4	0.37949	0.17499	0.44551	884.14	62.470	14.919	22.612	884.13
5. CaO / K4Ca(VO4)2 / KCaVO4	0.17222	0.20217	0.62561	880.11	36.657	22.287	41.056	880.11
6. K3VO4/K4Ca(VO4)2/K4V2O7(s2)	0.32390	0.67591	0.00019	879.30	48.056	51.936	0.009	879.30
7. K4Ca(VO4)2/ K4V2O7/K4V2O7(s2)	0.39176	0.59704	0.01120	740.00	55.615	43.895	0.490	740.00
8. K4Ca(VO4)2 / K4V2O7/ K5V3O10	0.40577	0.56585	0.02837	689.85	57.347	41.417	1.236	690.70
9. K2CaV2O7 /K4Ca(VO4)2 / KCaVO4	0.38031	0.40624	0.21345	671.85	57.928	32.047	10.025	671.88
10.CaO/ K2O(s3) / K3VO4	0.06124	0.93026	0.00849	658.22	11.224	88.296	00.480	658.22
11.K2CaV2O7/ K4Ca(VO4)2/ K5V3O10	0.40707	0.45053	0.14240	616.99	59.487	34.097	6.416	616.99
12.Ca2V2O7 / K2CaV2O7 / KCaVO4	0.43938	0.28867	0.27195	591.46	65.313	22.223	12.464	591.53
13.Ca2V2O7/CaV2O6/K3Ca(VO3)5(s2)	0.51305	0.27059	0.21636	538.04	71.267	19.467	9.267	538.04
14.Ca2V2O7/K2CaV2O7/ K3Ca(VO3)5(s2)	0.47004	0.29804	0.23191	537.94	67.544	22.181	10.275	537.96
15.K2V8O21/ KV6O15 / V2O5	0.75584	0.21722	0.02694	527.30	86.220	12.833	0.947	527.30
16.CaV2O6 / K2V8O21 / V2O5	0.70910	0.17981	0.11108	506.60	84.772	11.133	4.094	506.60
17.K2CaV2O7 / K5V3O10 / KVO3	0.45466	0.47593	0.06940	493.13	62.925	34.113	2.961	493.13
18.K2CaV2O7 / K3Ca(VO3)5(s2) / KVO3	0.48600	0.41736	0.09663	474.84	66.398	29.531	4.071	474.84
19.CaV2O6 / K2V8O21 / KV3O8	0.65274	0.25750	0.08976	469.38	80.211	16.388	3.401	469.37
20.CaV2O6 / K3Ca(VO3)5(s2) / KV3O8	0.63891	0.27293	0.08816	460.04	79.128	17.506	3.366	460.04
21.K3Ca(VO3)5(s2) / K3V5O14 / KV3O8	0.62194	0.37768	0.00038	403.72	76.063	23.922	0.014	403.72
22.K3Ca(VO3)5/K3Ca(VO3)5(s2)/K3V5O14	0.60328	0.39654	0.00018	400.01	74.598	25.395	0.007	400.01
23.K3Ca(VO3)5 / K3V5O14 / KVO3	0.59378	0.40610	0.00012	395.78	73.840	26.155	0.005	395.78

CaO-Li2O-MgO,
Mole fraction, Liquidus surface

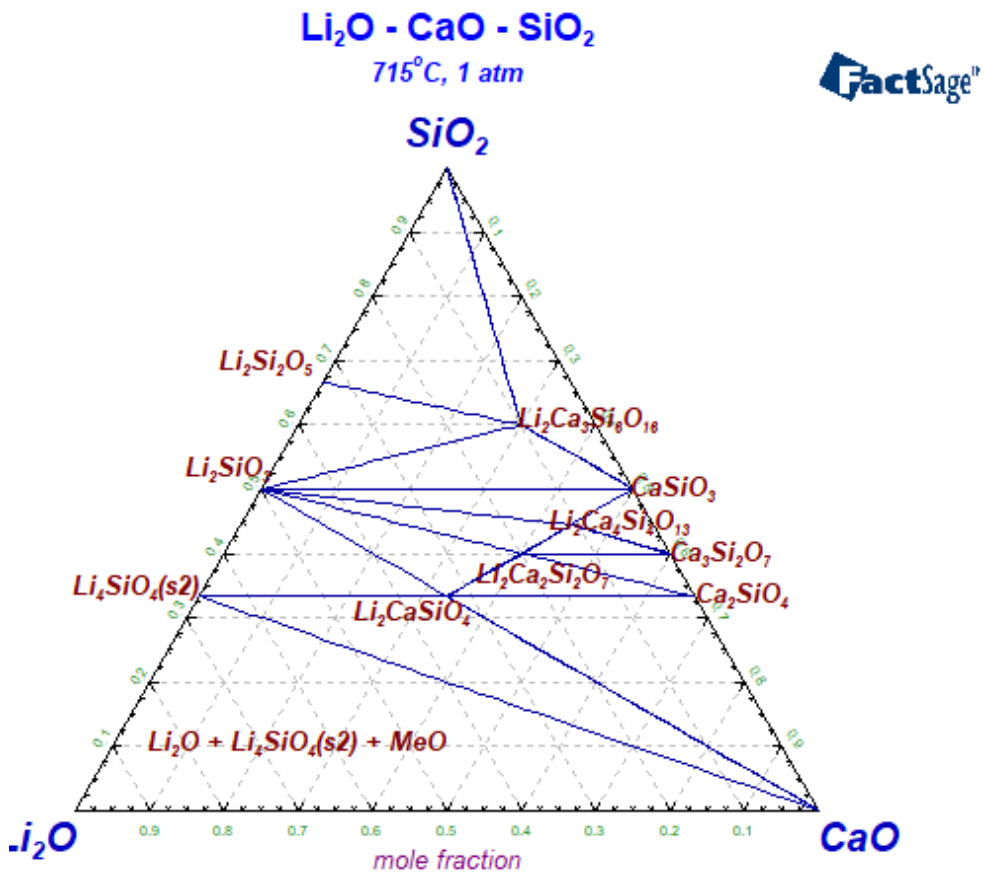



CaO - Li2O - MgO
Projection (A-Slag), 1 atm
FactSage
MgO
T(min) = 1336.08 °C, T(max) = 2898.92 °C
T °C
2900
2800
2550
2300
2050
1800
1550
1300
2600
2400
2200
2000
1900
1800
1700
1600
1500
1336
MeO
MeO
Li2O
Li2O
CaO
90
80
70
60
50
40
30
20
10
percent by weight

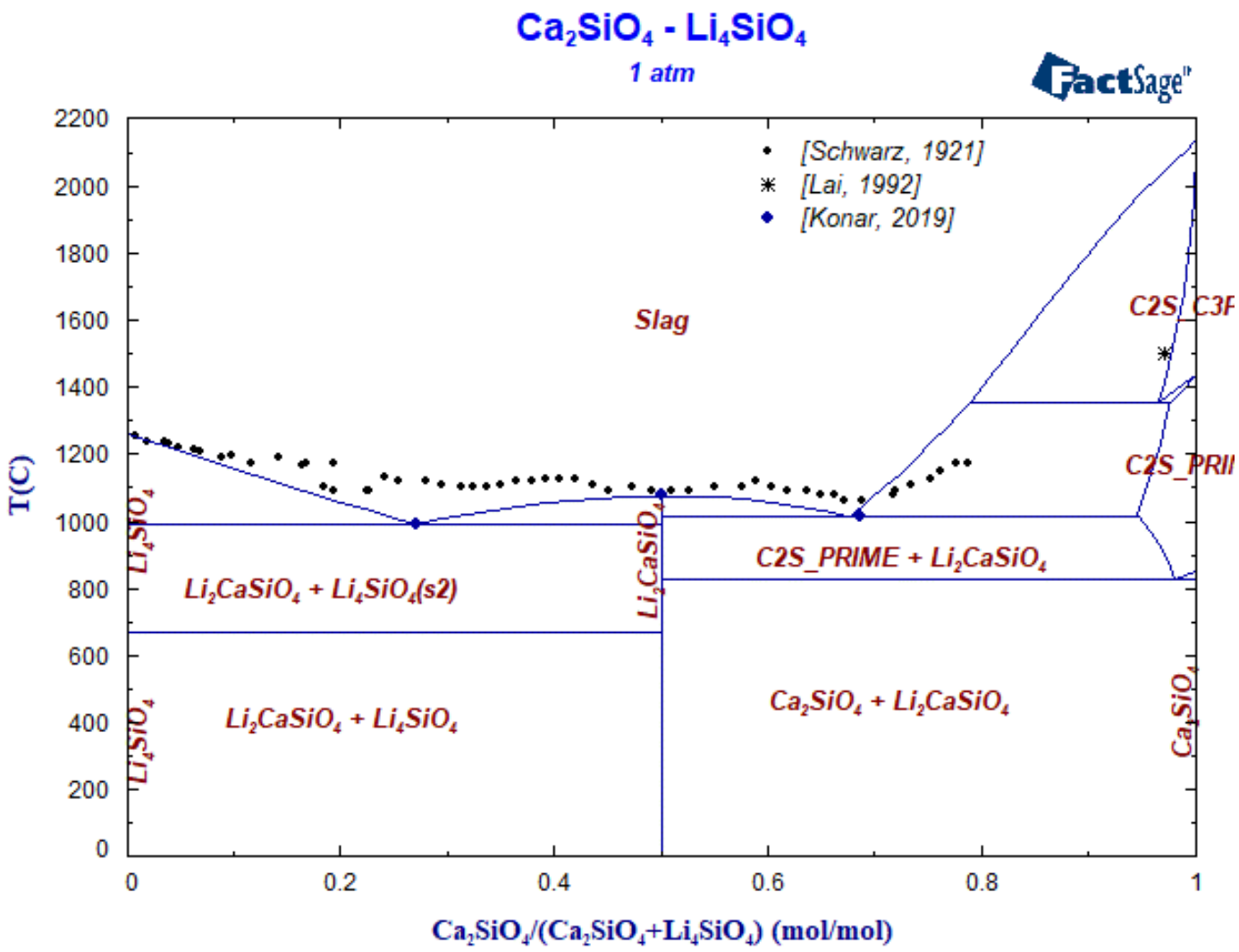
Invariant equilibria on the liquidus surface

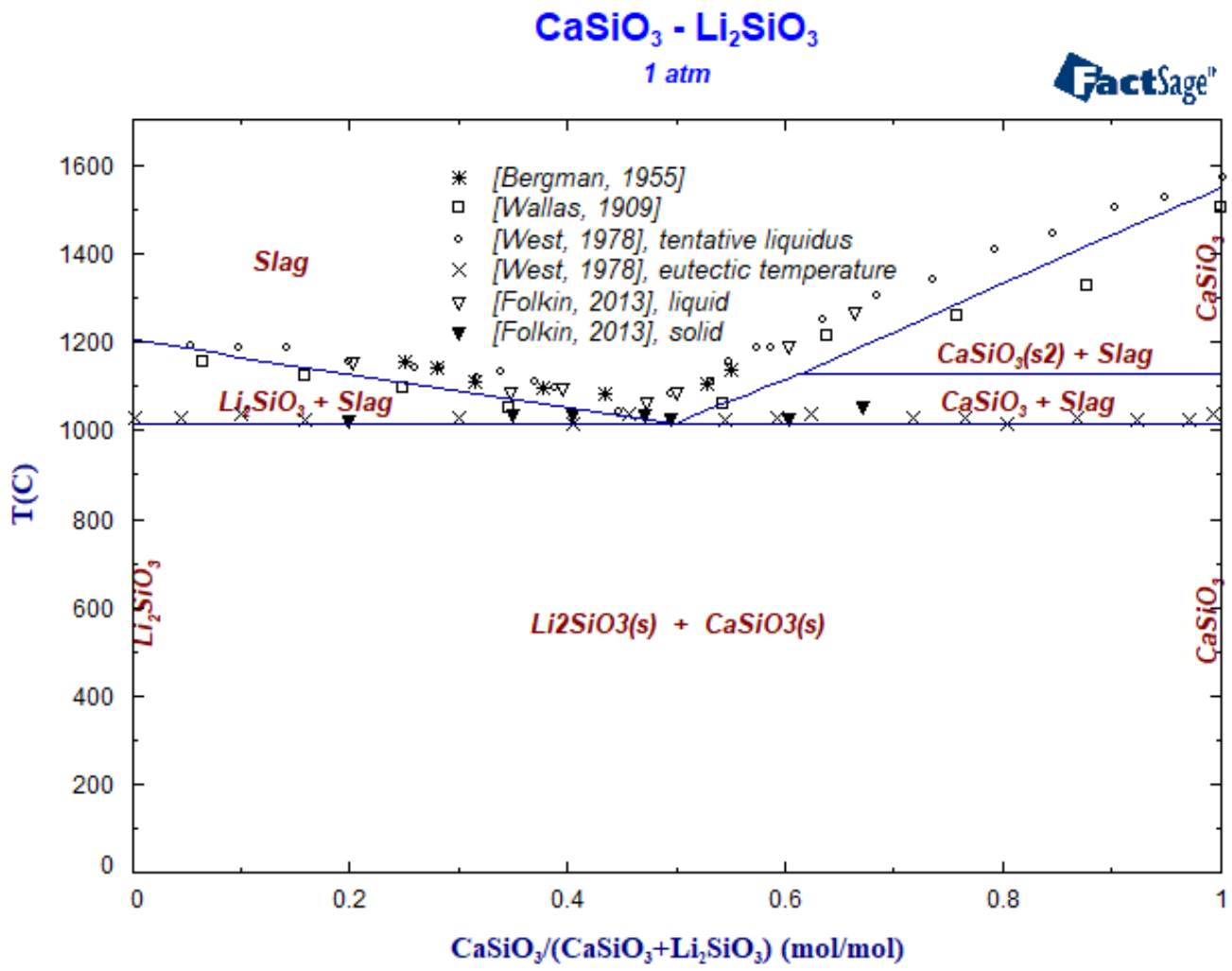
Intersections with slag	Mole fraction				Weight percent			
	A = MgO, B = Li2O, C = CaO				A = MgO, B = Li2O, C = CaO			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: Li2O / MeO#1 / MeO#2	0.05038	0.77082	0.17880	1336.08	5.787	65.640	28.573	1336.08

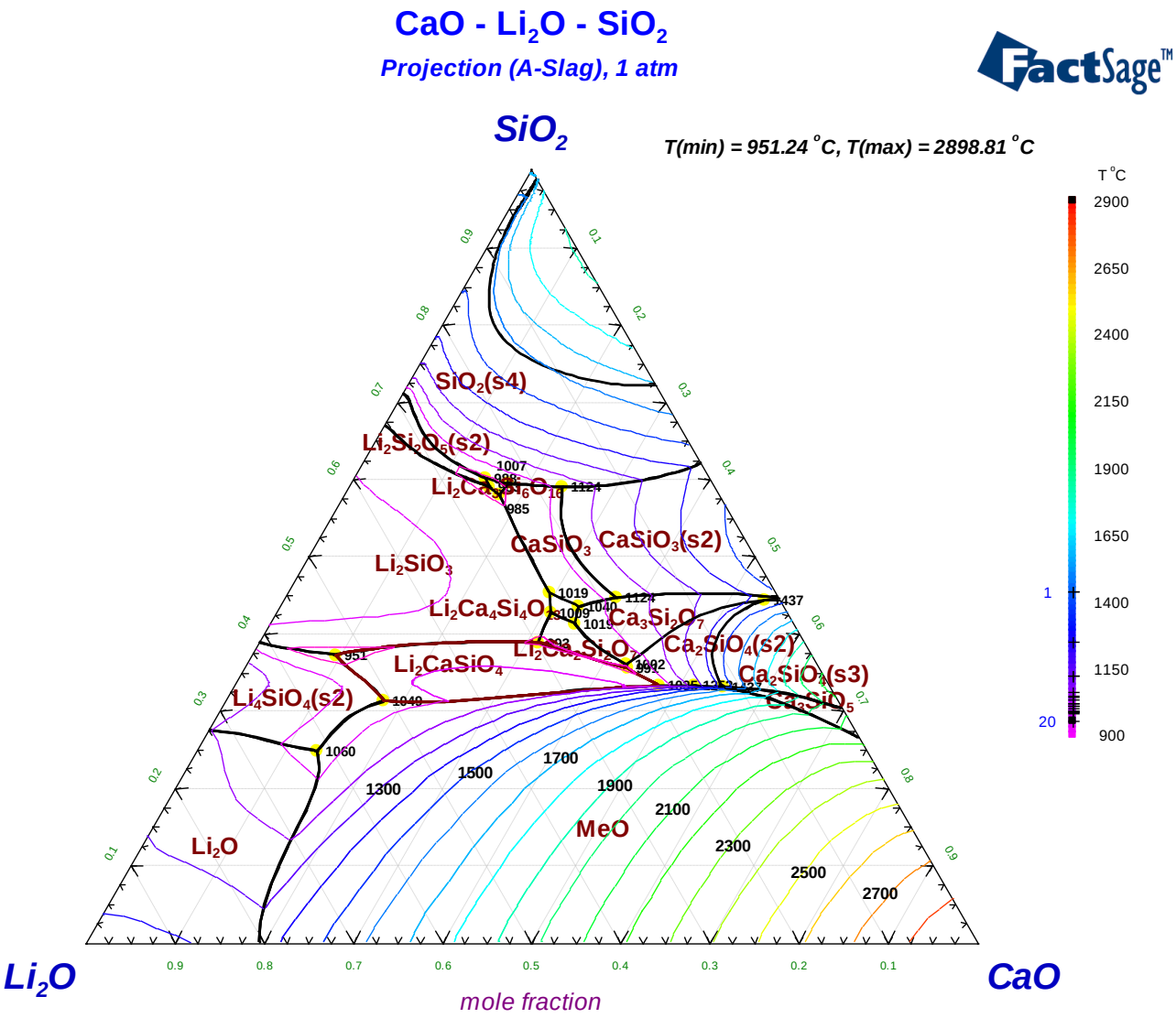
CaO-Li2O-SiO2, Mole fraction, 715°C

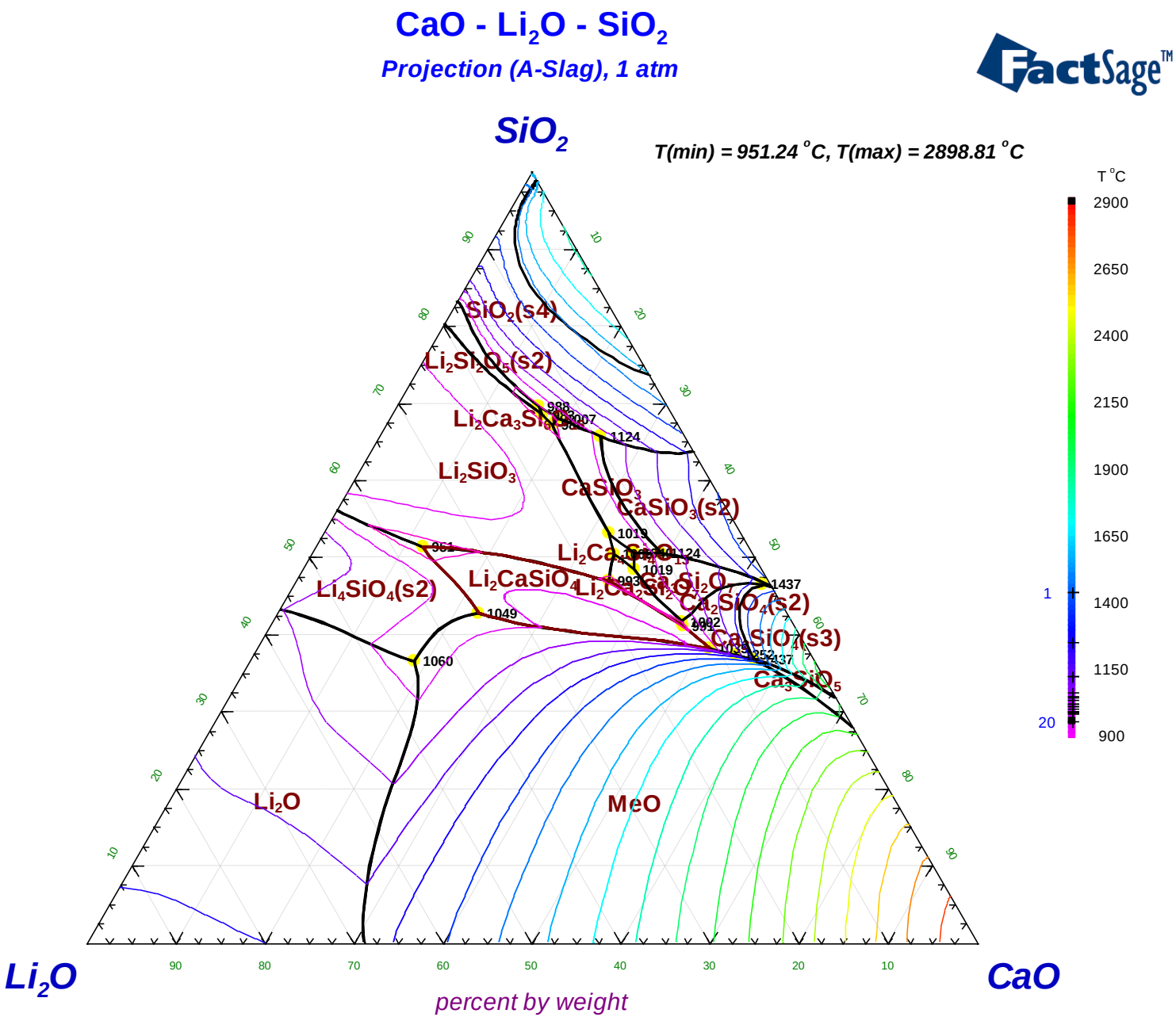


Slag	*(CaO, Li_2O, SiO_2, Li_2SiO_3, Li_2SiO_3,*	This work
	$Li_2Si_2O_5$, $CaSiO_3$, Ca_2SiO_4, Li_2CaSiO_4)	This work
C2S-C3P	*$(\underline{Ca^{+2}}, Li_2^{+2})_3(\underline{Ca^{+2}}, Va)(Si^{+4})_2(O^{-2})_8$*	This work
C2S-prime	*$(\underline{Ca^{+2}}, Li_2^{+2})_3(\underline{Ca^{+2}}, Va)(Si^{+4})_2(O^{-2})_8$*	This work
Li_2CaSiO_4	***stoichiometric***	ΔH_f from oxides [Konar2017]
$Li_2Ca_2Si_2O_7$	***stoichiometric***	This work
$Li_2Ca_4Si_4O_{13}$	***stoichiometric***	This work
$Li_2Ca_3Si_6O_{16}$	***stoichiometric***	This work


Ca2SiO4 - Li4SiO4
1 atm
FactSage
[Schwarz, 1921]
[Lai, 1992]
[Konar, 2019]
Slag
C2S_C3F
C2S_PRI
C2S_PRIME + Li2CaSiO4
Li2CaSiO4 + Li4SiO4(s2)
Li2CaSiO4 + Li4SiO4
Ca2SiO4 + Li2CaSiO4
Li4SiO4
Li2CaSiO4
Ca2SiO4
T(C)
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
0.2
0.4
0.6
0.8
1
Ca2SiO4/(Ca2SiO4+Li4SiO4) (mol/mol)


CaSiO3 - Li2SiO3
1 atm
FactSage
[Bergman, 1955]
[Wallas, 1909]
[West, 1978], tentative liquidus
[West, 1978], eutectic temperature
[Folkin, 2013], liquid
[Folkin, 2013], solid
Slag
Li2SiO3 + Slag
CaSiO3(s2) + Slag
CaSiO3 + Slag
Li2SiO3(s) + CaSiO3(s)
Li2SiO3
CaSiO3
CaSiO3
T(C)
1600
1400
1200
1000
800
600
400
200
0
0
0.2
0.4
0.6
0.8
1
CaSiO3/(CaSiO3+Li2SiO3) (mol/mol)

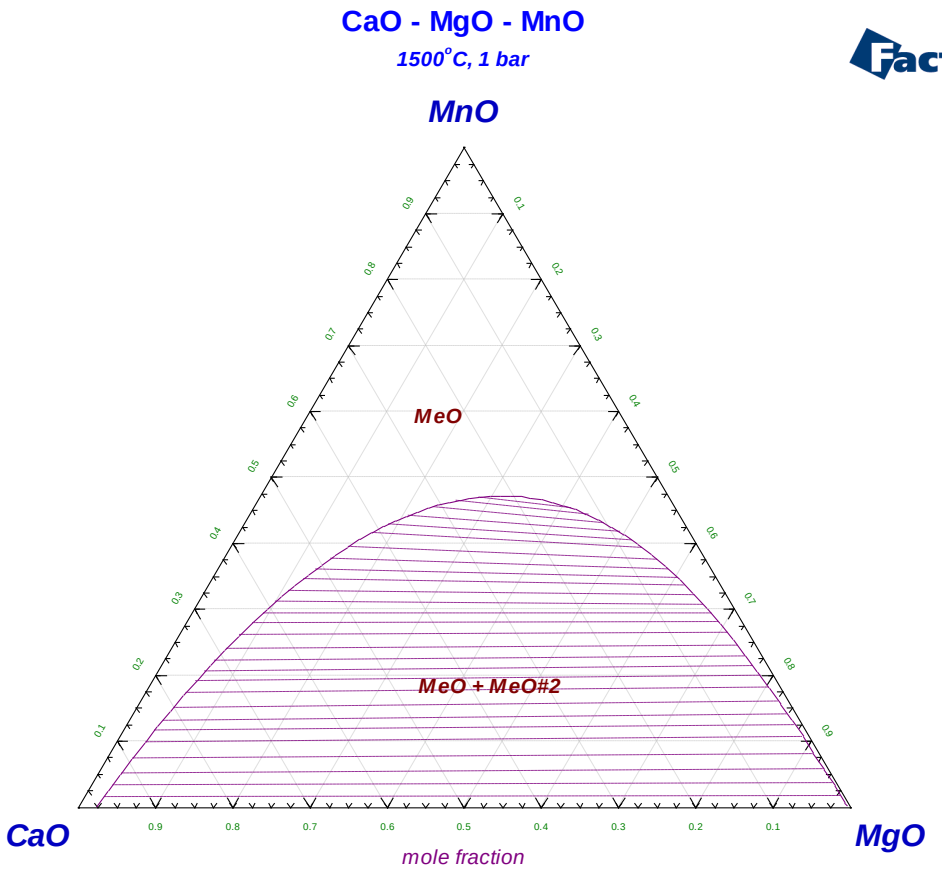

CaO - Li2O - SiO2
Projection (A-Slag), 1 atm
FactSage
SiO2
T(min) = 951.24 °C, T(max) = 2898.81 °C
T °C
2900
2650
2400
2150
1900
1650
1400
1150
900
SiO2(s4)
Li2Si2O5(s2)
Li2Ca3Si6O18
CaSiO3
CaSiO3(s2)
Li2SiO3
Li2Ca4Si4O12
Ca3Si2O7
Ca2SiO4(s2)
Li2Ca2Si2O7
Li2CaSiO4
Ca2SiO4(s3)
Ca3SiO5
Li4SiO4(s2)
Li2O
MeO
1300
1500
1700
1900
2100
2300
2500
2700
Li2O
CaO
mole fraction


CaO - Li2O - SiO2
Projection (A-Slag), 1 atm
SiO2
T(min) = 951.24 °C, T(max) = 2898.81 °C
T °C
2900
2650
2400
2150
1900
1650
1400
1150
900
SiO2(s4)
Li2Si2O5(s2)
Li2Ca3SiO6
Li2SiO3
CaSiO3
CaSiO3(s2)
Li2Ca2SiO4
Li4SiO4(s2)
Li2CaSiO4
Ca2SiO4(s2)
Ca3SiO5(s3)
Ca3SiO5
Li2O
MeO
1124
1019
1437
951
1049
1060
Li2O
CaO
percent by weight

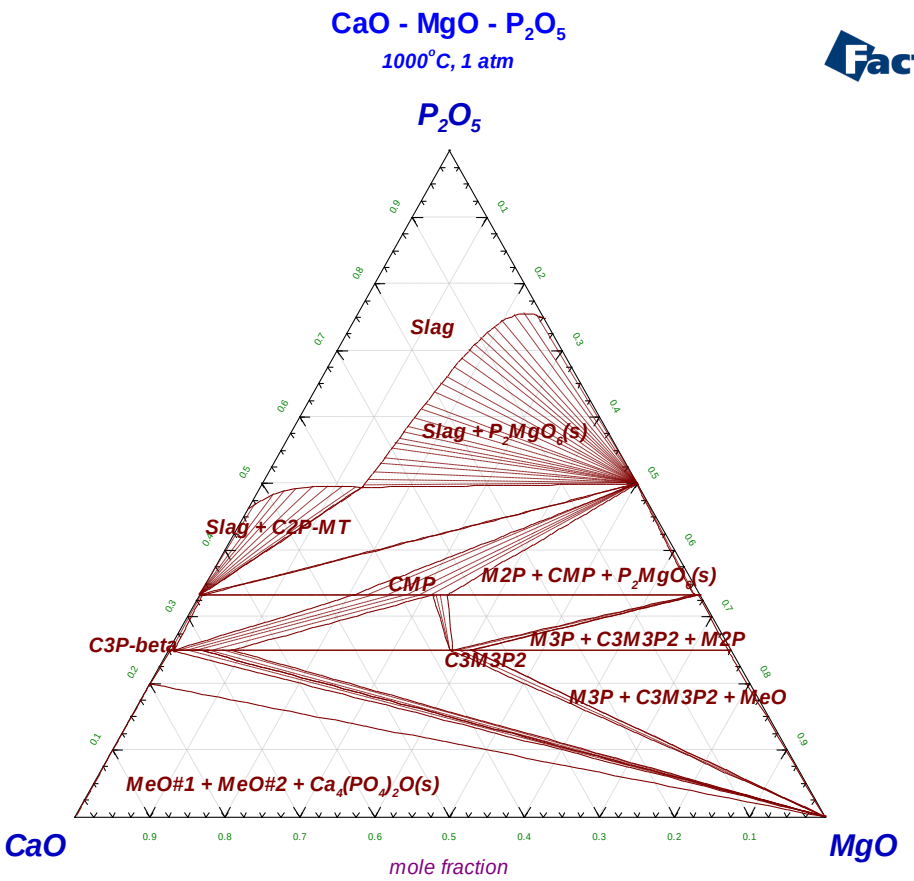
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction A = SiO2, B = Li2O, C = CaO				Weight percent A = SiO2, B = Li2O, C = CaO			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1. Ca2SiO4(s3) / Ca2SiO4(s2) / Ca3Si2O7	0.44363	0.01649	0.53989	1436.75	46.418	0.858	52.724	1436.73
2. Ca2SiO4(s3) / Ca2SiO4(s2) / Ca3SiO5	0.33180	0.11945	0.54875	1436.73	36.729	6.576	56.695	1436.73
3. Ca2SiO4(s2) / Ca3SiO5 / MeO	0.33234	0.15052	0.51714	1251.59	37.348	8.412	54.239	1251.56
4. Ca3Si2O7 / CaSiO3(s2) / CaSiO3	0.44732	0.18086	0.37181	1124.14	65.677	9.405	24.918	1124.15
5. CaSiO3(s2) / CaSiO3 / SiO2(s4)	0.59016	0.16993	0.23991	1124.13	50.586	10.172	39.242	1124.14
6. Li2O / Li4SiO4(s2) / MeO	0.24888	0.61609	0.13503	1059.87	36.530	44.973	18.497	1059.87
7. Li2CaSiO4 / Li4SiO4(s2) / MeO	0.31293	0.50918	0.17789	1049.15	42.740	34.585	22.675	1049.15
8. Ca3Si2O7 / CaSiO3 / Li2Ca4Si4O13	0.43579	0.22869	0.33552	1040.36	50.516	13.184	36.300	1040.36
9. Ca2SiO4(s2) / Li2CaSiO4 / MeO	0.33283	0.19103	0.47614	1035.11	38.158	10.892	50.949	1035.11
10.Ca3Si2O7/ Li2Ca2Si2O7 / Li2Ca4Si4O13	0.41340	0.24490	0.34170	1019.25	48.401	14.260	37.339	1019.24
11.CaSiO3 / Li2Ca4Si4O13 / Li2SiO3	0.45336	0.25305	0.29359	1019.04	53.135	14.750	32.115	1019.06
12.Li2Ca2Si2O7 / Li2Ca4Si4O13/ Li2SiO3	0.42715	0.26438	0.30847	1008.91	50.459	15.532	34.010	1008.90
13.CaSiO3 / Li2Ca3Si6O16 / SiO2(s4)	0.59446	0.22857	0.17696	1007.36	68.071	13.017	18.912	1007.36
14.Ca2SiO4(s2) / Ca3Si2O7 / Li2Ca2Si2O7	0.36008	0.21355	0.42637	1001.60	41.665	12.289	46.046	1001.59
15.Li2Ca2Si2O7 / Li2CaSiO4 / Li2SiO3	0.38917	0.29774	0.31309	992.50	46.919	17.852	35.229	992.50
16.Ca2SiO4(s2)/ Li2Ca2Si2O7 / Li2CaSiO4	0.35528	0.21470	0.43002	990.81	41.149	12.367	46.484	990.81
17.Li2Ca3Si6O16 / Li2Si2O5(s2)/SiO2(s4)	0.60159	0.25021	0.14820	987.74	69.601	14.397	16.002	987.75
18.CaSiO3 / Li2Ca3Si6O16 / Li2SiO3	0.58100	0.24554	0.17346	985.47	67.167	14.117	18.716	985.47
19.Li2Ca3Si6O16 / Li2Si2O5(s2)/ Li2SiO3	0.59065	0.25181	0.15754	983.38	68.448	14.512	17.039	983.38
20.Li2CaSiO4 / Li2SiO3 / Li4SiO4(s2)	0.37294	0.53356	0.09350	951.24	51.401	36.572	12.027	951.25

Mole fraction 1500C°

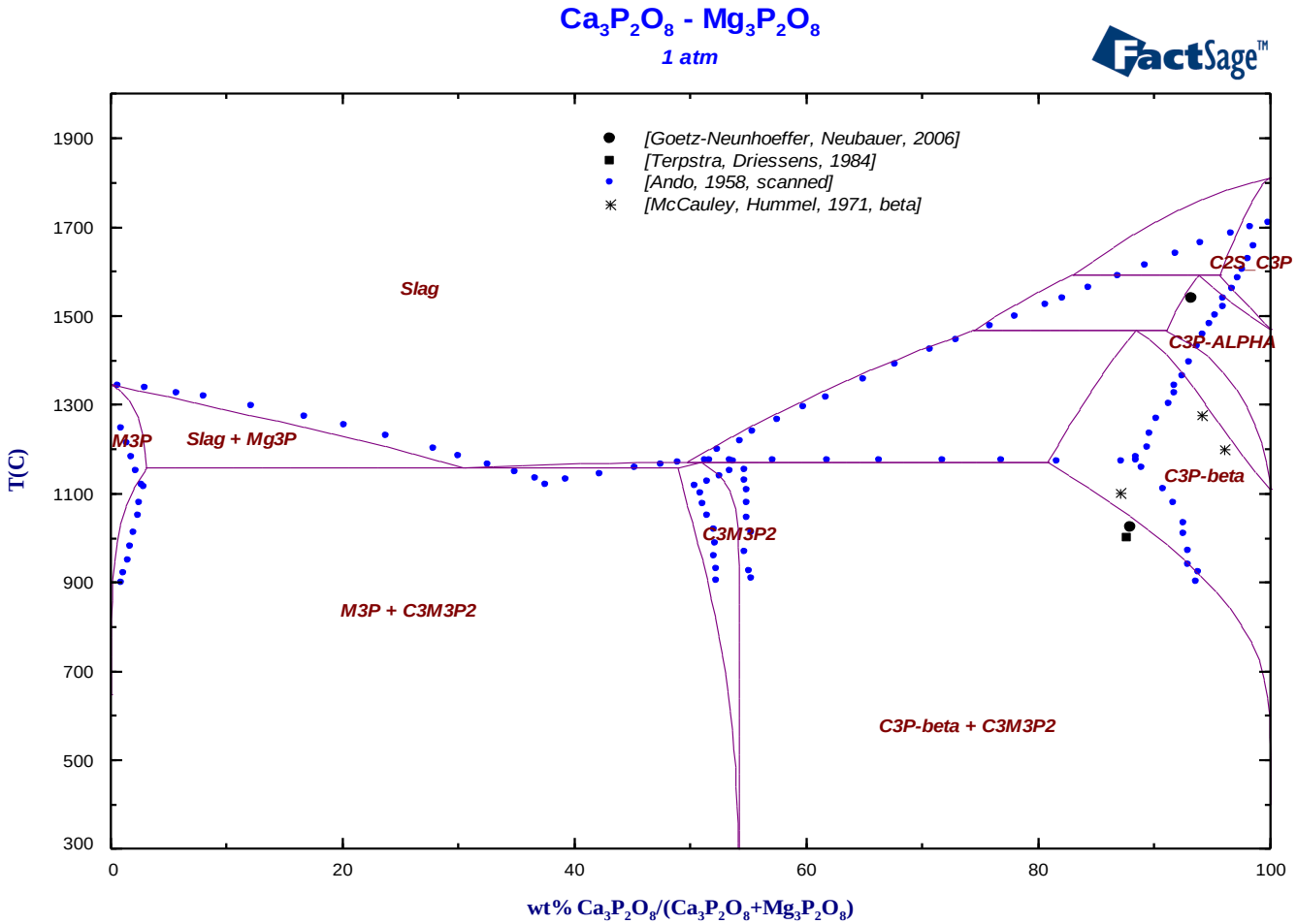


Mole fraction 1000°C



CaO-MgO-P2O5,

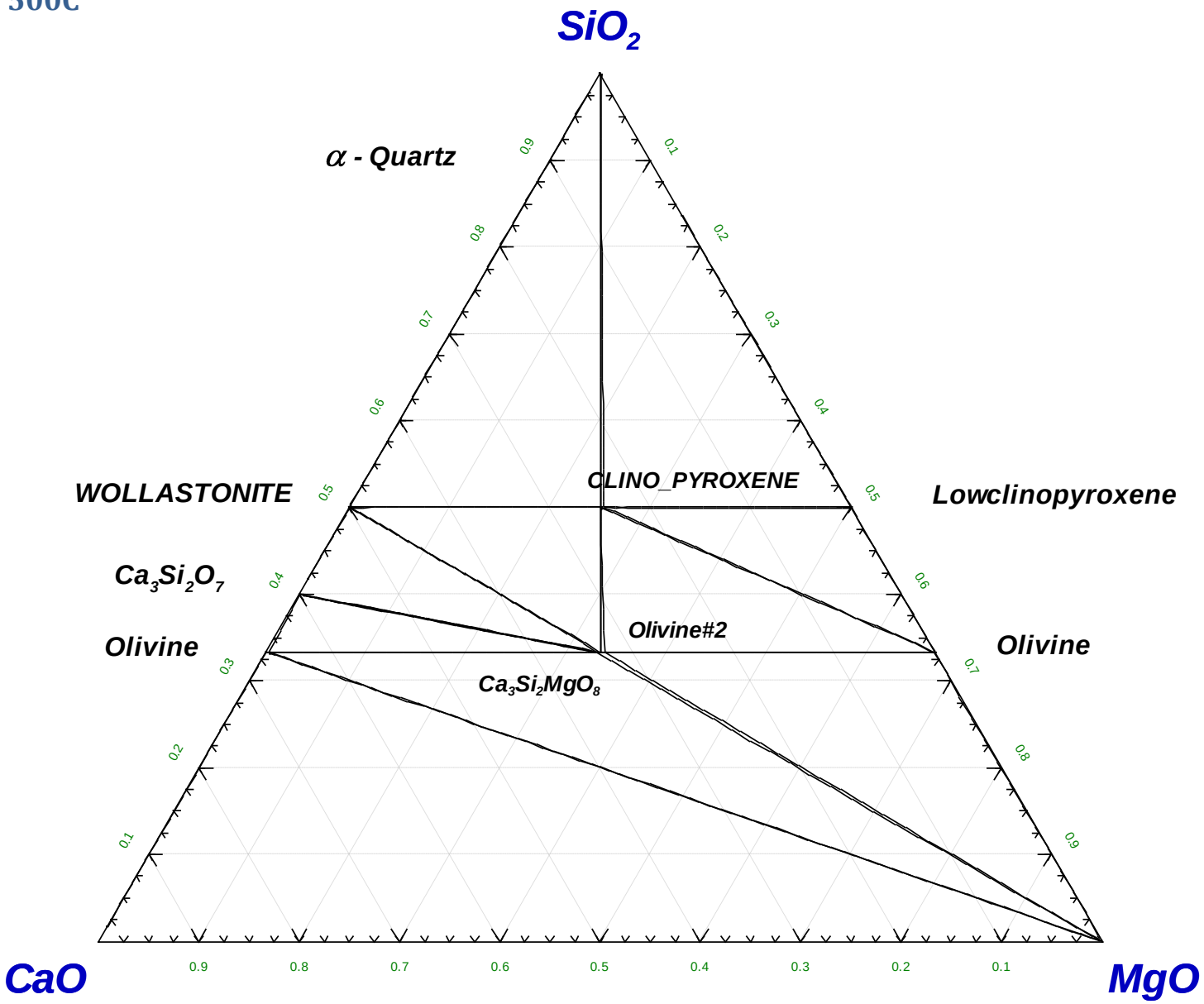
Weight percent, Isopleth Ca3P2O8-Mg3P2O8

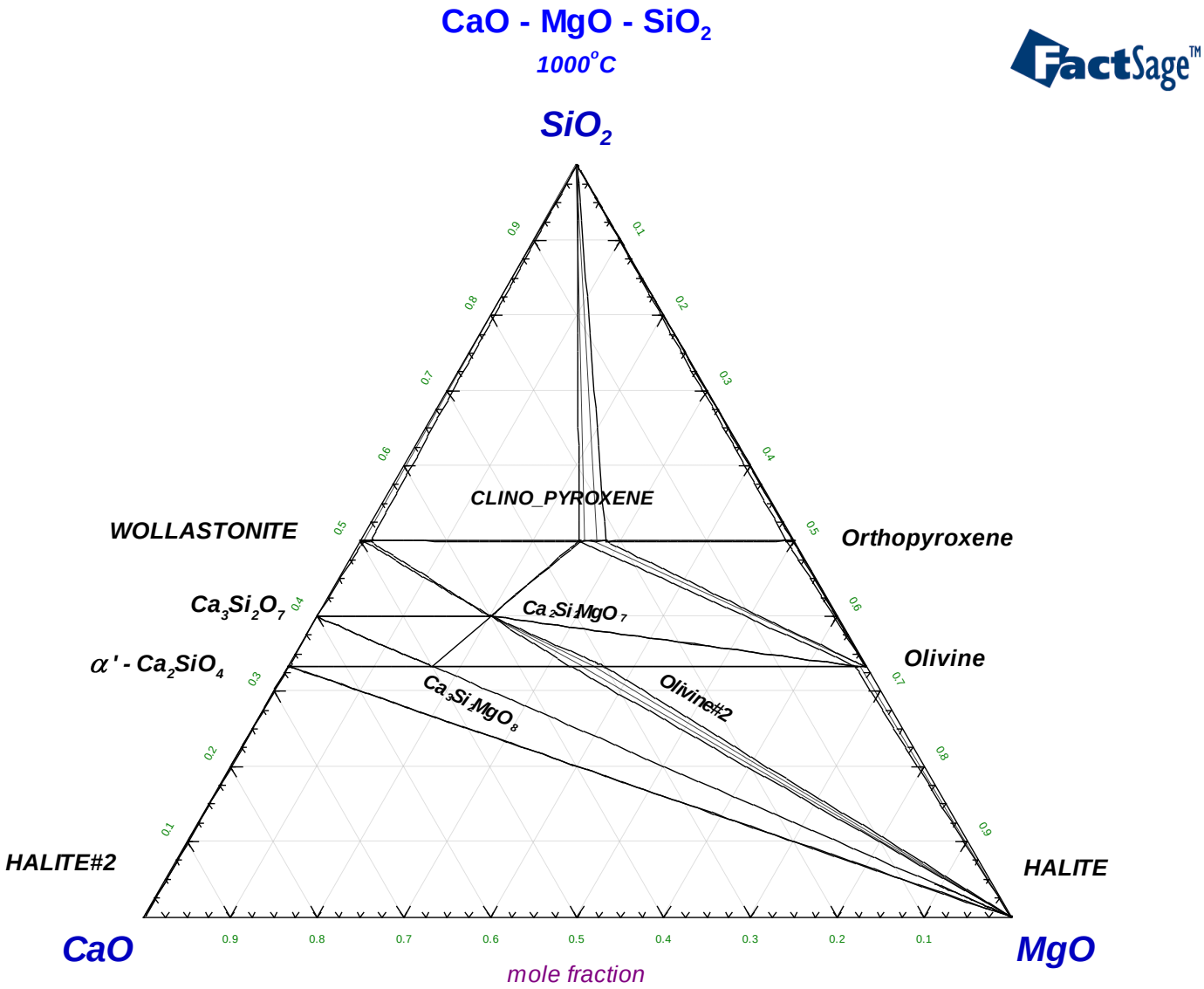


$CaO - MgO - SiO_2$

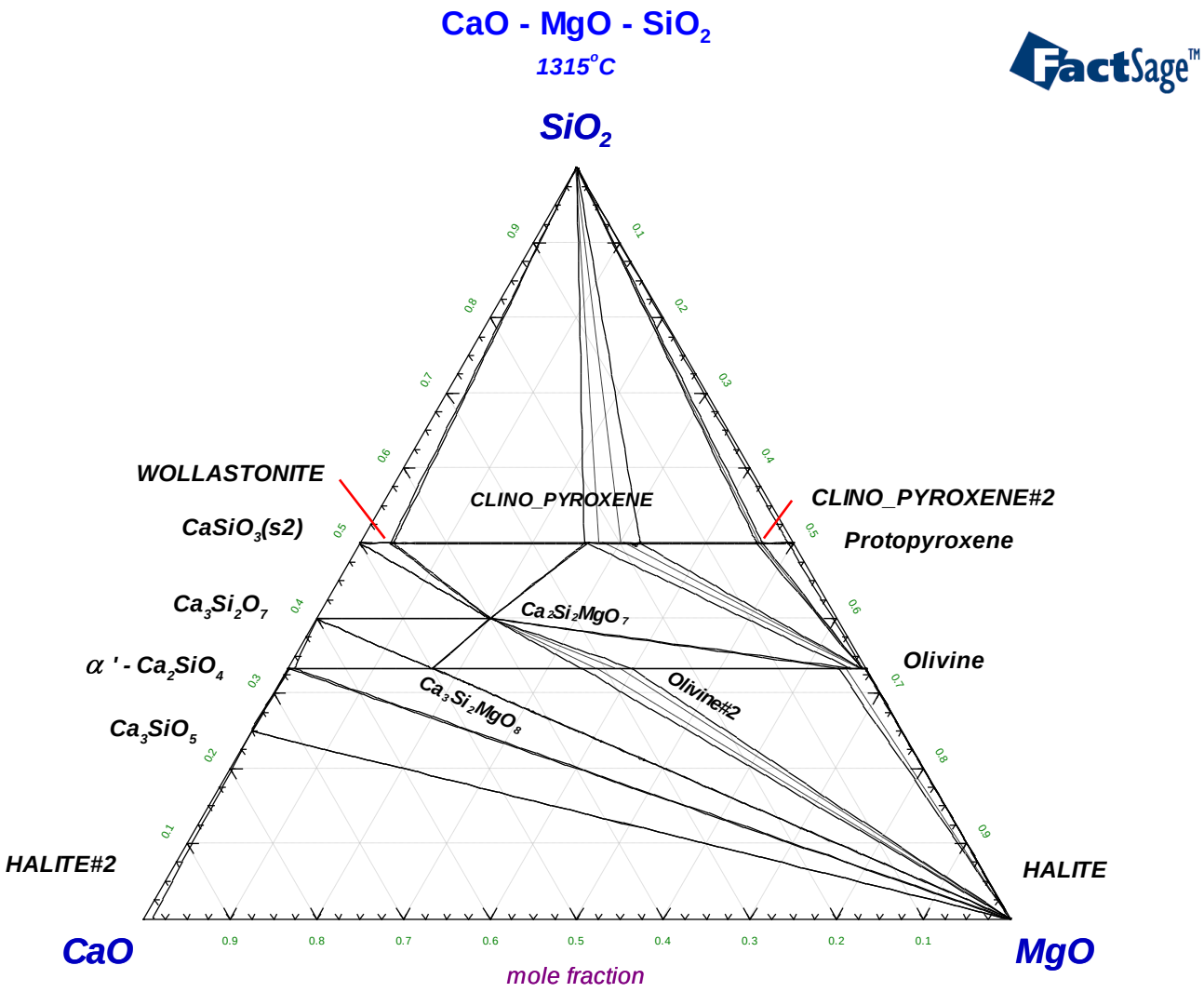
500°C

CaO-MgO-SiO2,
Mole fraction 500C°



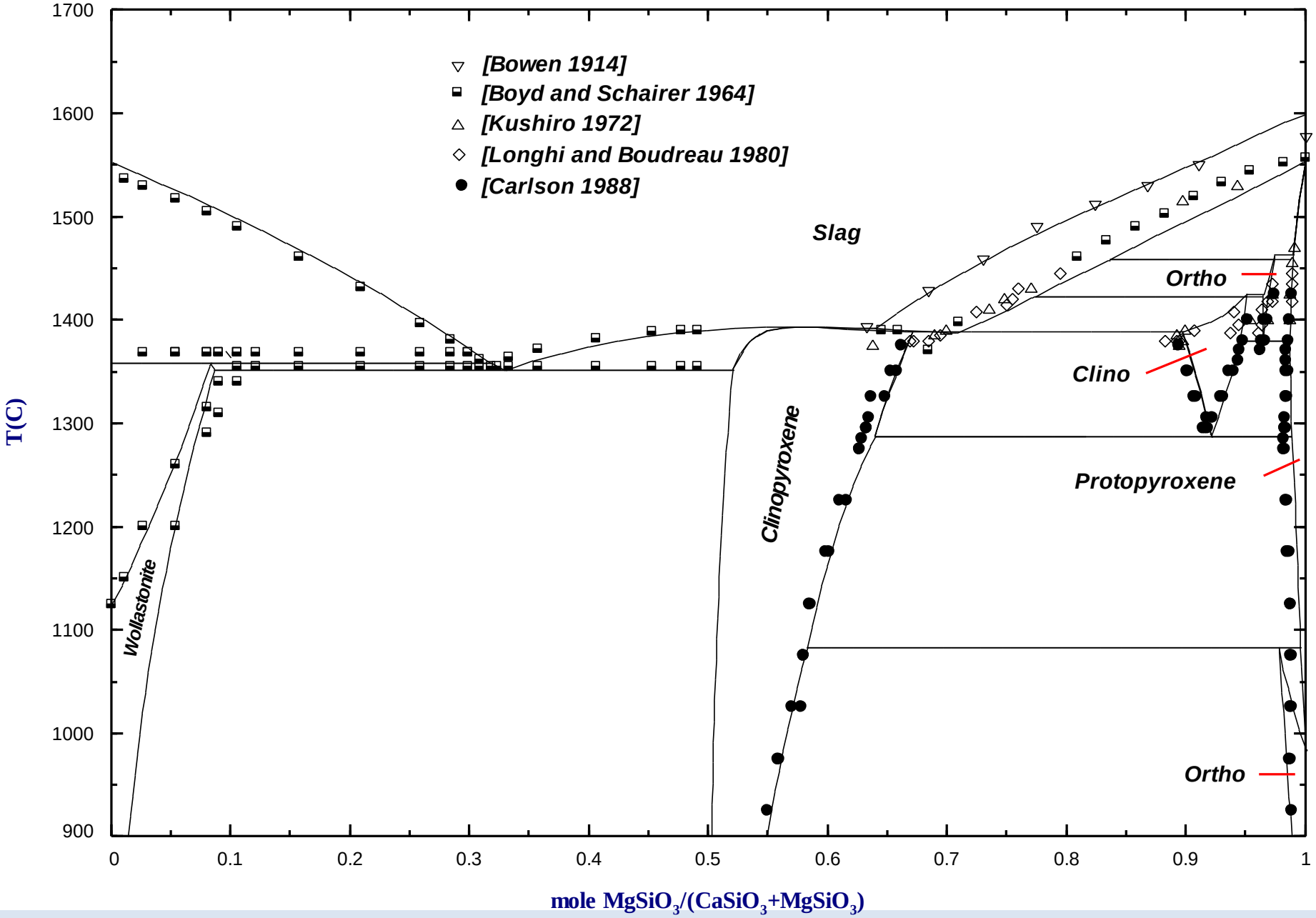

CaO - MgO - SiO2
1000°C
SiO2
CLINO_PYROXENE
WOLLASTONITE
Orthopyroxene
Ca3Si2O7
Ca2SiMgO7
α' - Ca2SiO4
Olivine
Olivine#2
Ca3SiMgO8
HALITE#2
HALITE
CaO
MgO
mole fraction

Mole fraction
kurz unterhalb Liquidussurface

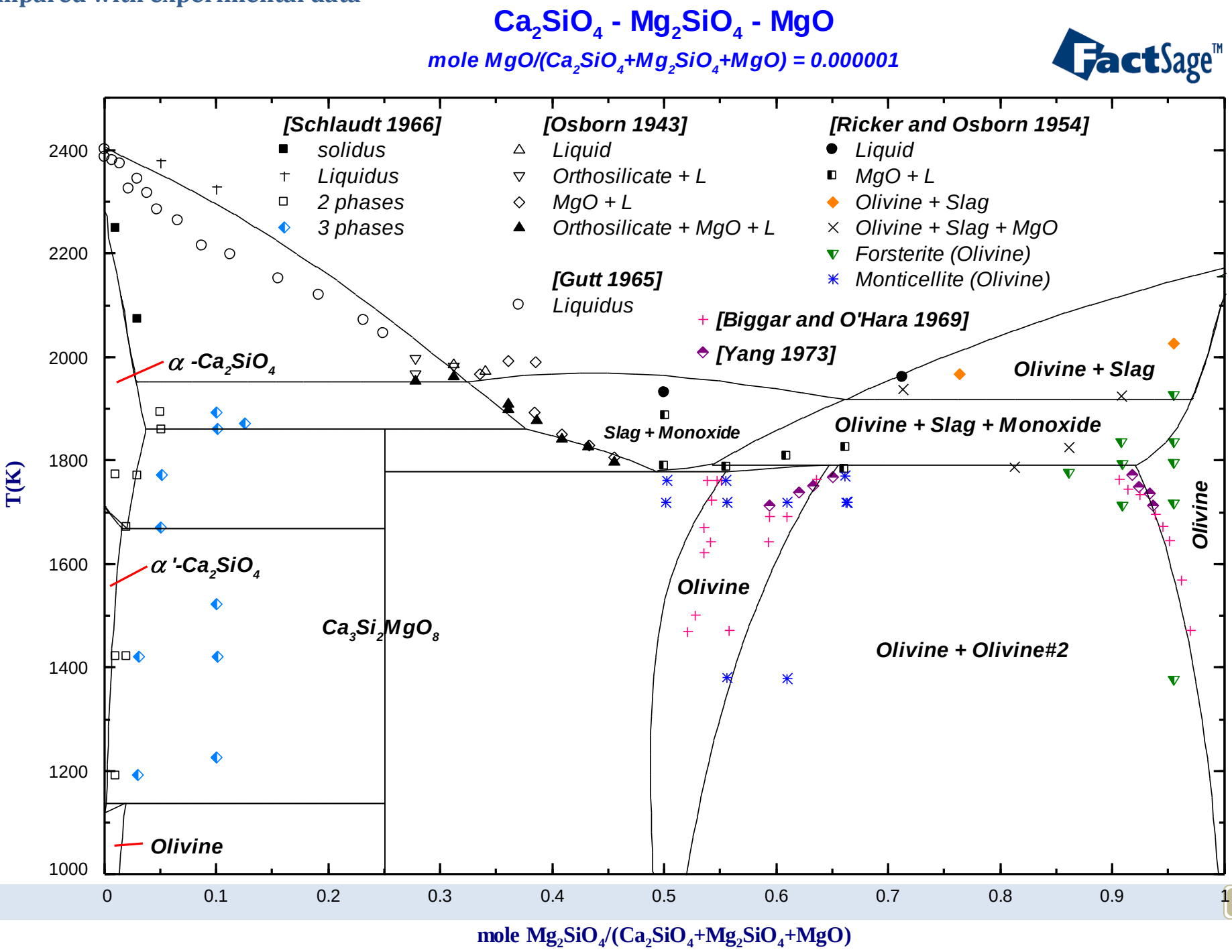


Mole fraction
compared with experimental data

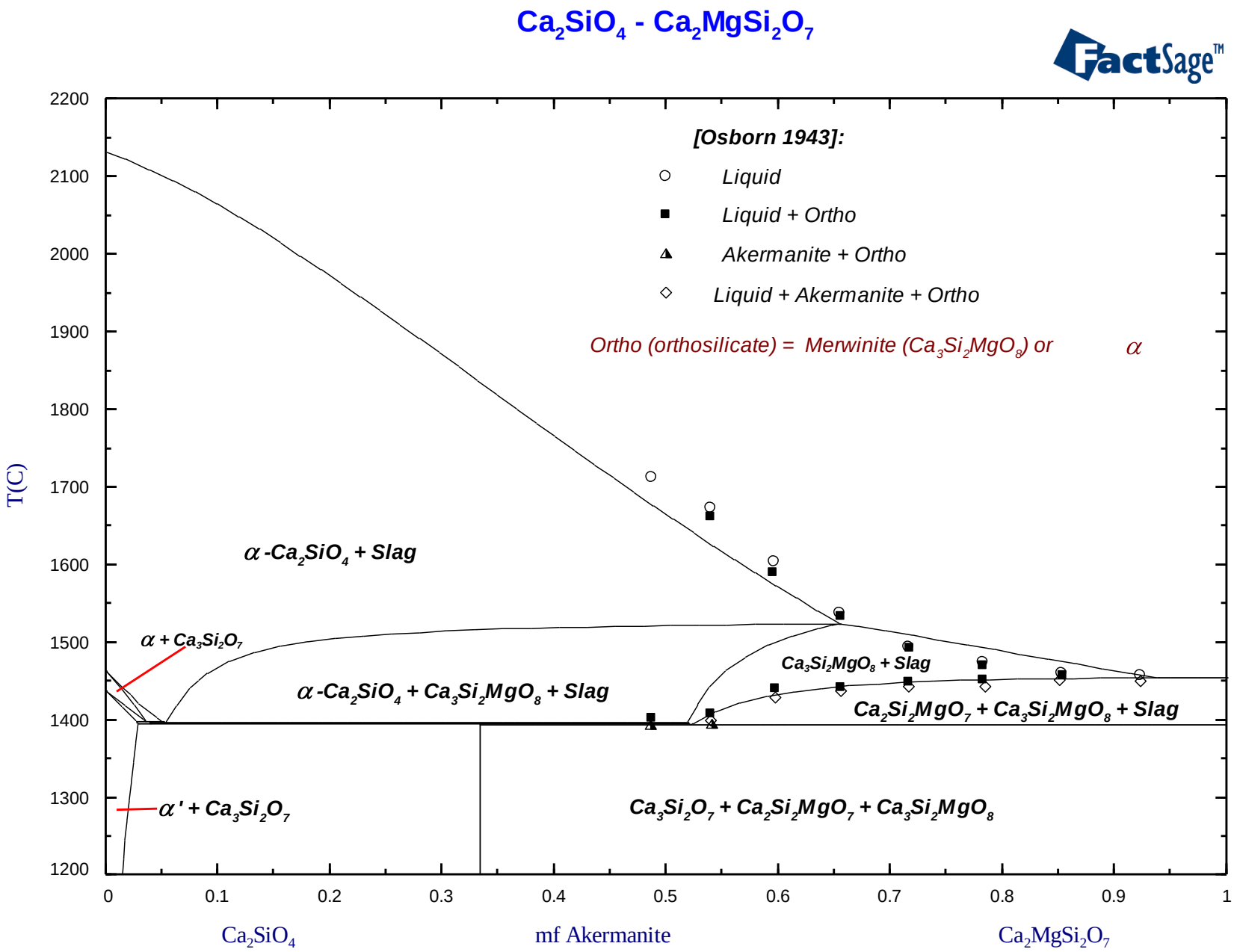
$CaSiO_3$ - $MgSiO_3$



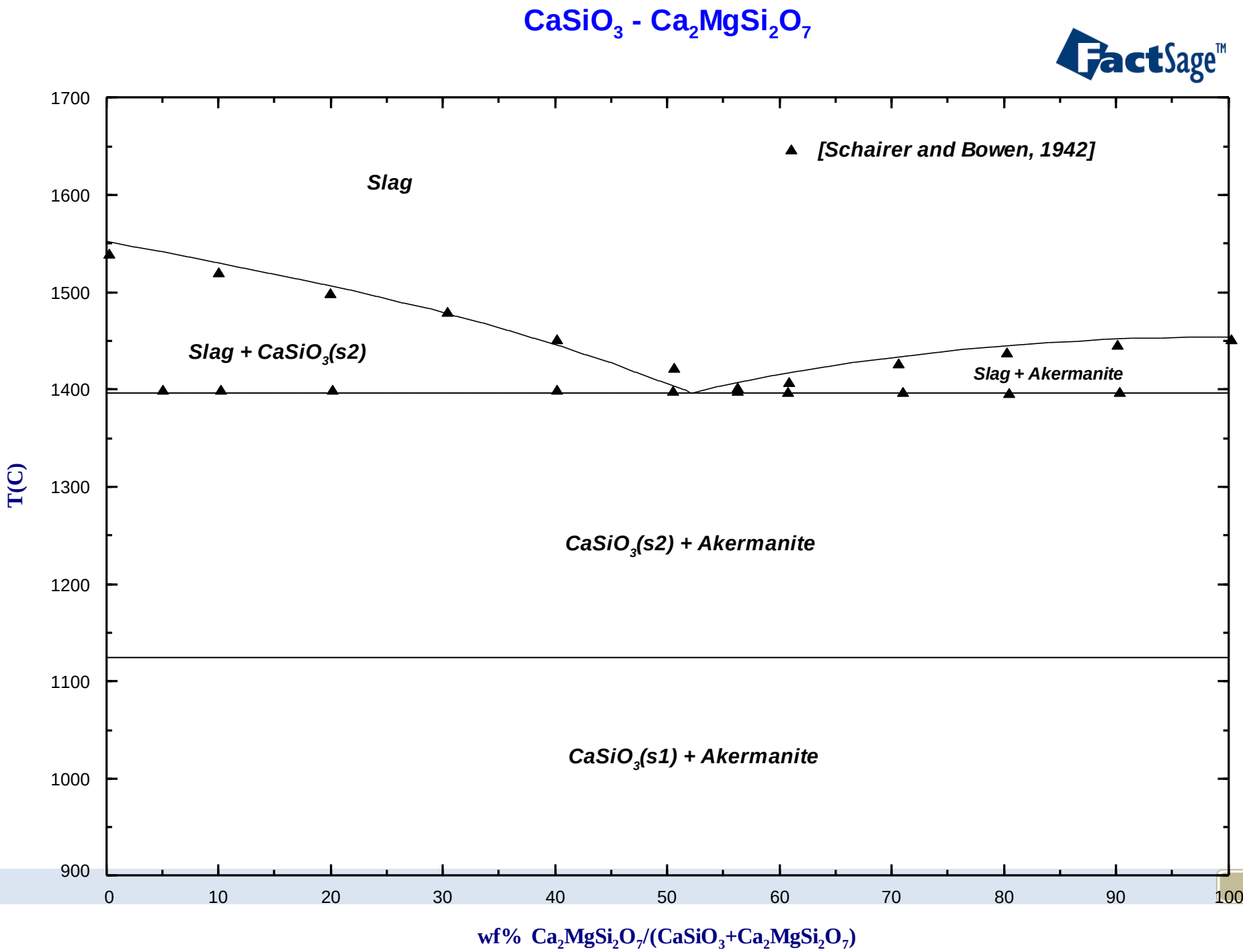
Mole fraction in Kelvin Ca2SiO4-Mg2SiO4 compared with experimental data

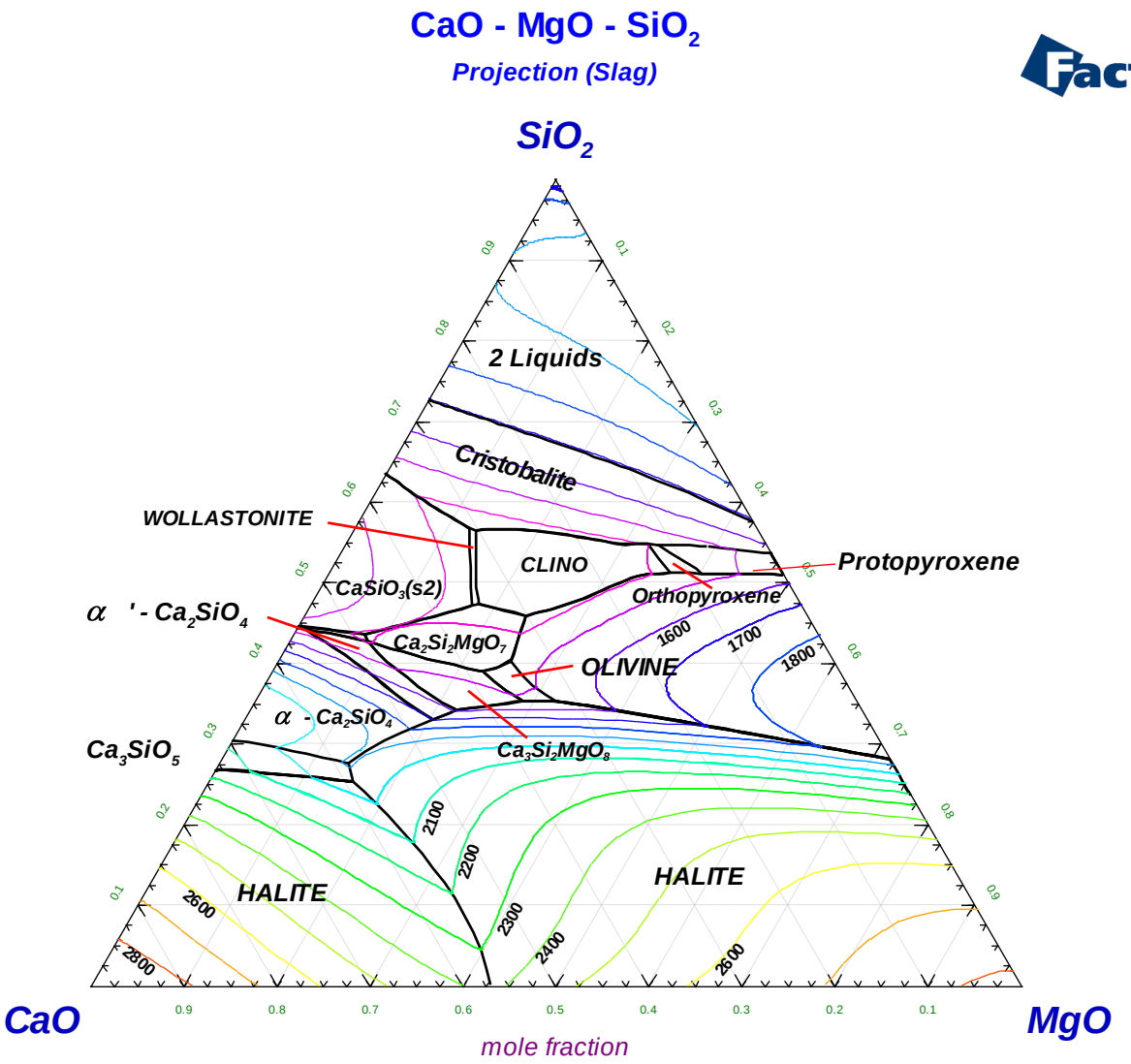


Mole fraction Ca2SiO4-Akermanite compared with experimental data

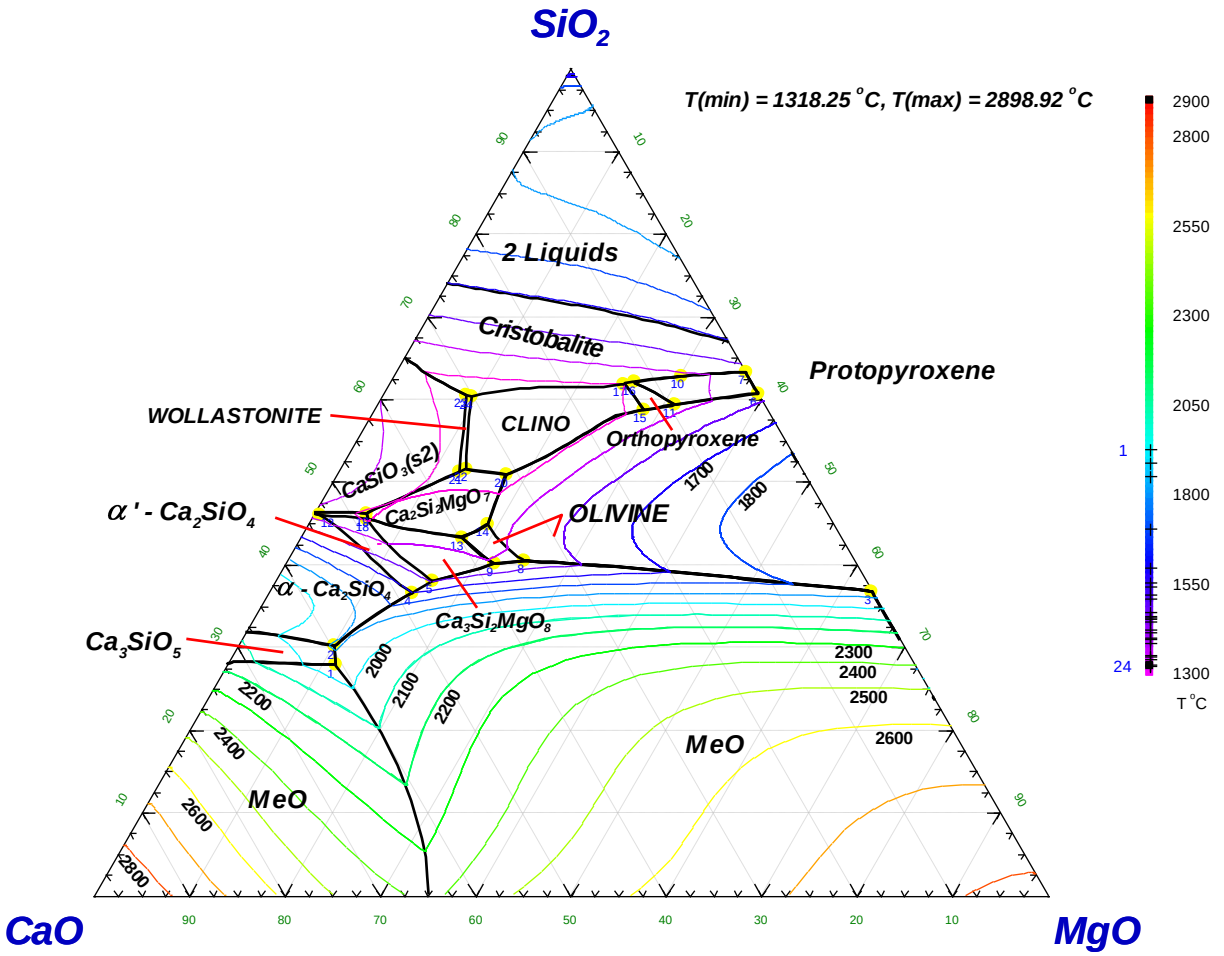


Weight percent CaSiO3-Akermanite compared with experimental data




CaO - MgO - SiO2
Projection (Slag)
SiO2
2 Liquids
Cristobalite
WOLLASTONITE
CLINO
Protopyroxene
CaSiO3(s2)
Orthopyroxene
α '- Ca2SiO4
Ca2Si2MgO7
OLIVINE
1600
1700
1800
α - Ca2SiO4
Ca3SiO5
Ca3Si2MgO8
2100
2200
2300
2400
2500
2600
2800
HALITE
HALITE
CaO
MgO
mole fraction

$CaO - MgO - SiO_2$

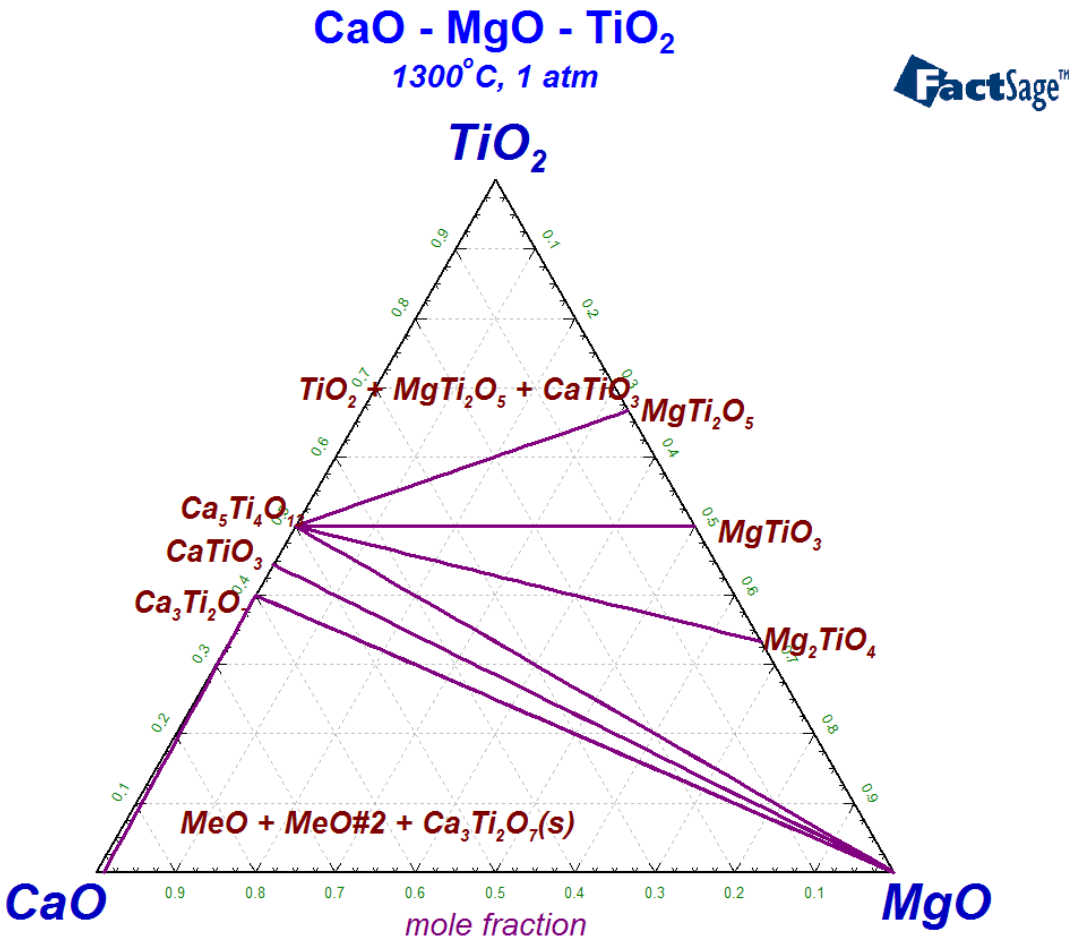

SiO2
T(min) = 1318.25 °C, T(max) = 2898.92 °C
2 Liquids
Cristobalite
Protopyroxene
WOLLASTONITE
CLINO
Orthopyroxene
CaSiO3(s2)
Ca2Si2MgO7
α ' - Ca2SiO4
OLIVINE
α - Ca2SiO4
Ca3Si2MgO8
Ca3SiO5
MeO
MeO
CaO
MgO
2900
2800
2550
2300
2050
1800
1550
1300
T °C

Invariant equilibria on the liquidus surface

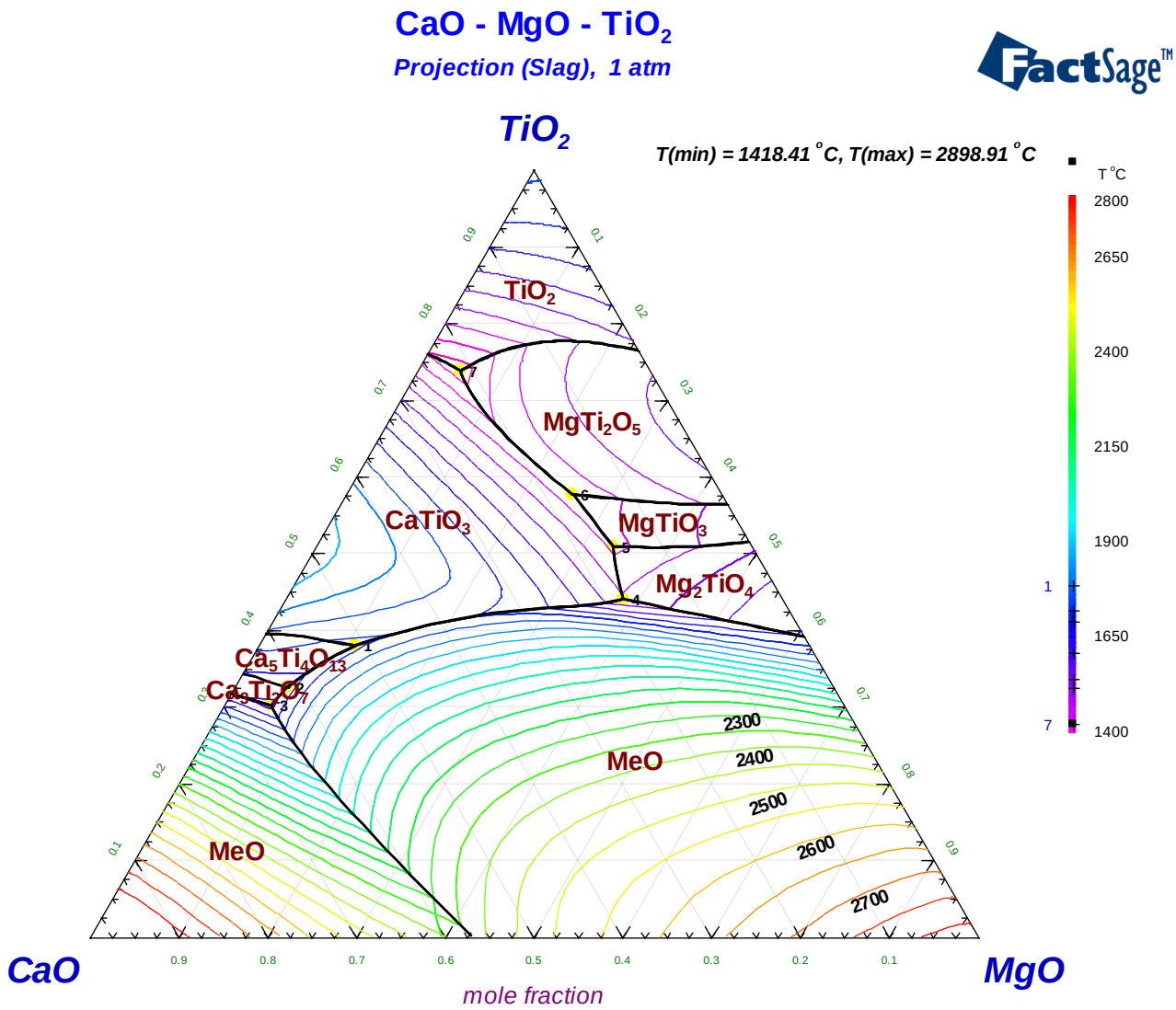
Intersections with slag	Mole fraction					Weight percent				
	A = SiO2, B = CaO, C = MgO					A = SiO2, B = CaO, C = MgO				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: Ca3SiO5 / MeO#1 / MeO#2	1:	0.25442	0.59149	0.15409	1924.86	1:	27.996	60.659	11.345	1924.86
2: Ca2SiO4(s2) / Ca3SiO5 / MeO#1	2:	0.27589	0.58505	0.13907	1887.55	2:	30.145	59.662	10.193	1887.56
3: Ca2SiO4(s2) / MeO#1 / α′-Ca2SiO4	3:	0.33028	0.46700	0.20272	1702.33	3:	36.611	48.315	15.074	1702.30
4: Ca3Si2MgO8 / MeO#1 / α′-Ca2SiO4	4:	0.34167	0.43702	0.22131	1594.20	4:	38.048	45.421	16.531	1594.20
5: Ca3Si2MgO8 / MeO#1 / OLIVINE	5:	0.35342	0.35844	0.28814	1506.32	5:	40.105	37.962	21.933	1506.32
6: OLIVINE / Orthopyroxene / Protopyroxene	6:	0.51129	0.08747	0.40123	1458.54	6:	59.309	9.470	31.221	1458.55
7: Ca2SiO4(s2) / Ca3Si2O7 / α′-Ca2SiO4	7:	0.44218	0.54871	0.00911	1455.64	7:	46.041	53.323	0.636	1455.64
8: Ca2Si2MgO7 / Ca3Si2MgO8 / OLIVINE	8:	0.38978	0.38323	0.22699	1450.83	8:	43.322	39.754	16.924	1450.83
9: CLINO_pyroxene/ OLIVINE / Orthopyroxene	9:	0.51149	0.12058	0.36793	1422.77	9:	58.736	12.923	28.341	1422.76
10: Orthopyroxene / Protopyroxene / Cristobalite	10:	0.54736	0.11657	0.33607	1412.37	10:	62.087	12.341	25.572	1412.37
11: CLINO_pyroxene/ Orthopyroxene / Cristobalite	11:	0.54747	0.12712	0.32540	1399.80	11:	61.903	13.416	24.681	1399.80
12: Ca3Si2MgO8 / Ca3Si2O7 / α′-Ca2SiO4	12:	0.42789	0.48967	0.08244	1394.87	12:	45.511	48.608	5.882	1394.87
13: Ca2Si2MgO7 / Ca3Si2O7 / CaSiO3(s2)	13:	0.43564	0.48707	0.07729	1382.81	13:	46.242	48.254	5.504	1382.81
14: CLINO_PYROXENE / Ca2Si2MgO7 / OLIVINE	14:	0.45913	0.30197	0.23890	1350.28	14:	50.946	31.272	17.782	1350.27
15: Ca2Si2MgO7 / CaSiO3(s2) / WOLLASTONITE	15:	0.47119	0.35406	0.17475	1345.80	15:	51.280	35.963	12.758	1345.80
16: CLINO_pyroxene/ Ca2Si2MgO7/WOLLASTONITE	16:	0.47270	0.34601	0.18130	1339.54	16:	51.535	35.207	13.259	1339.54
17: CaSiO3(s2) / Cristobalite / WOLLASTONITE	17:	0.56852	0.30871	0.12277	1325.18	17:	60.545	30.684	8.771	1325.18
18: CLINO_pyroxene/ Cristobalite / WOLLASTONITE	18:	0.56494	0.30314	0.13191	1317.86	18:	60.334	30.216	9.450	1317.86

CaO-MgO-TiO2,

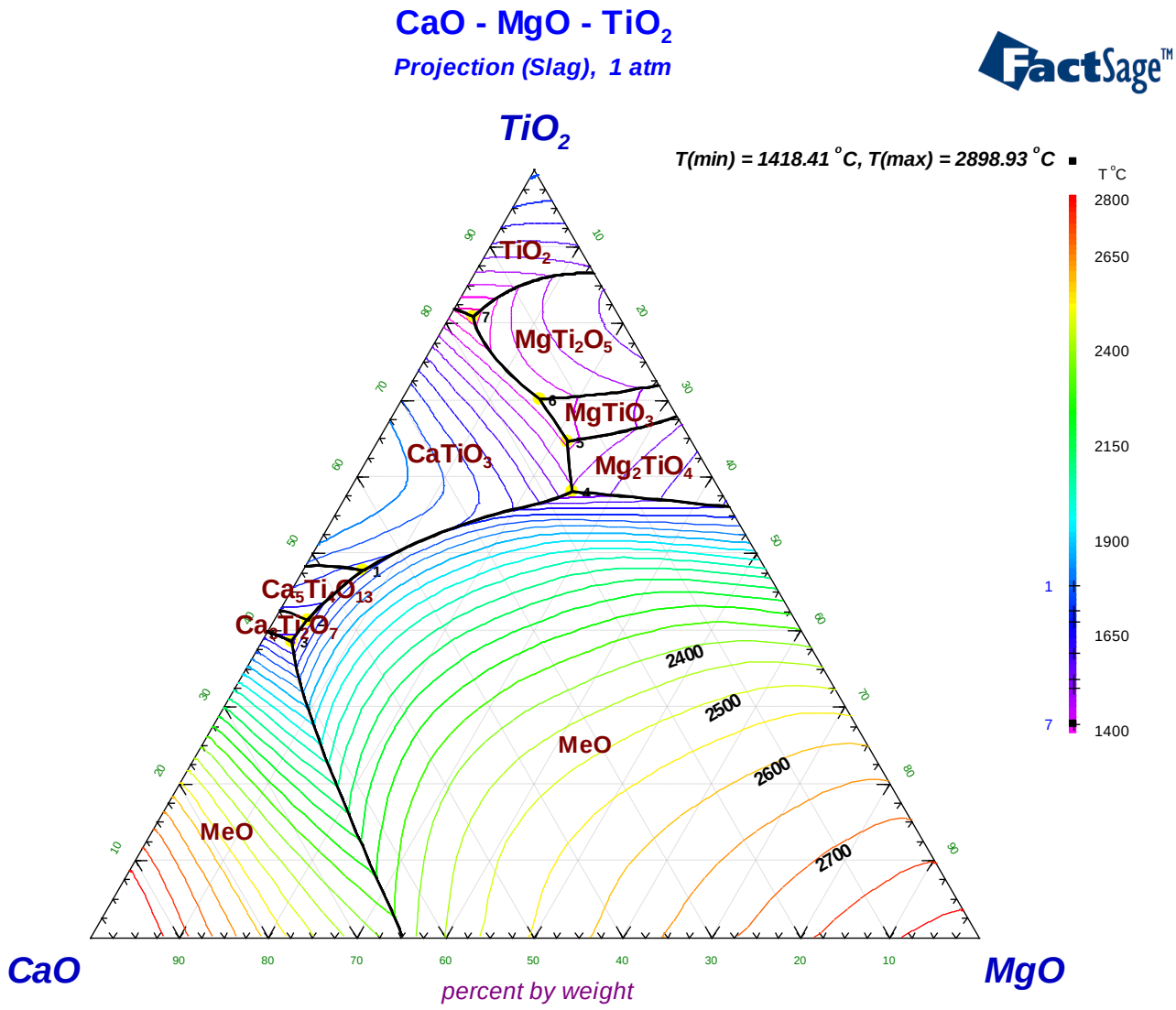
CaO-MgO-TiO2,
Mole fraction, 1300°C



CaO-MgO-TiO2,
Mole fraction, Liquidus surface



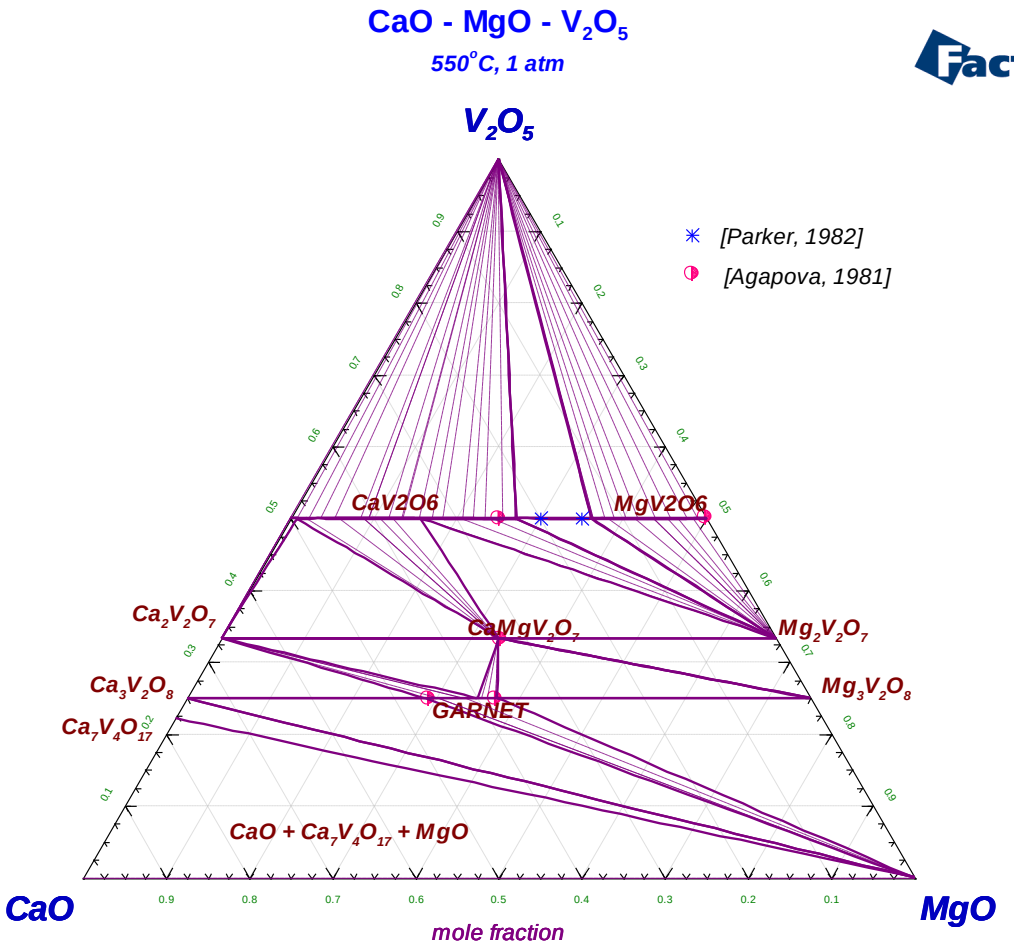
CaO-MgO-TiO2,
Weight percent, Liquidus surface

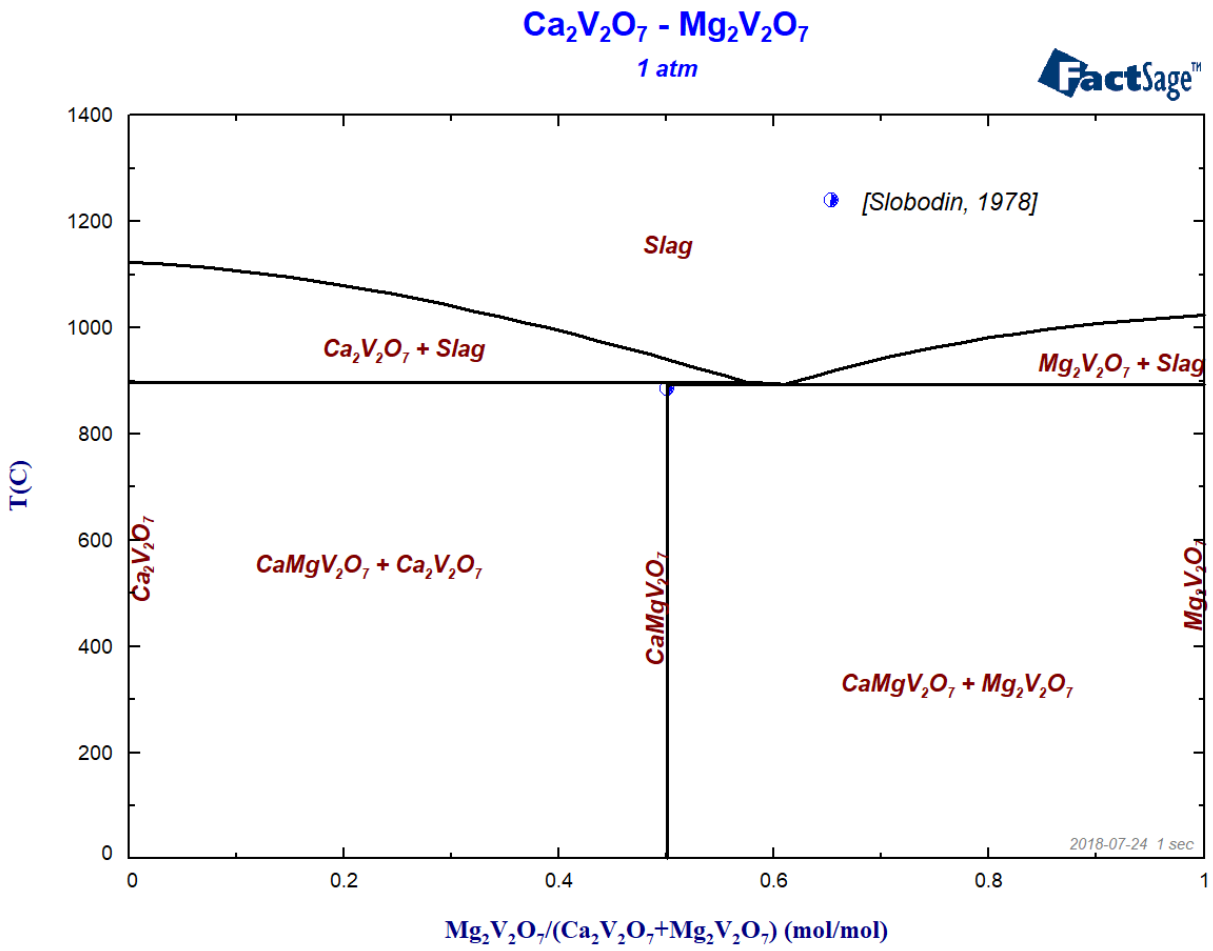


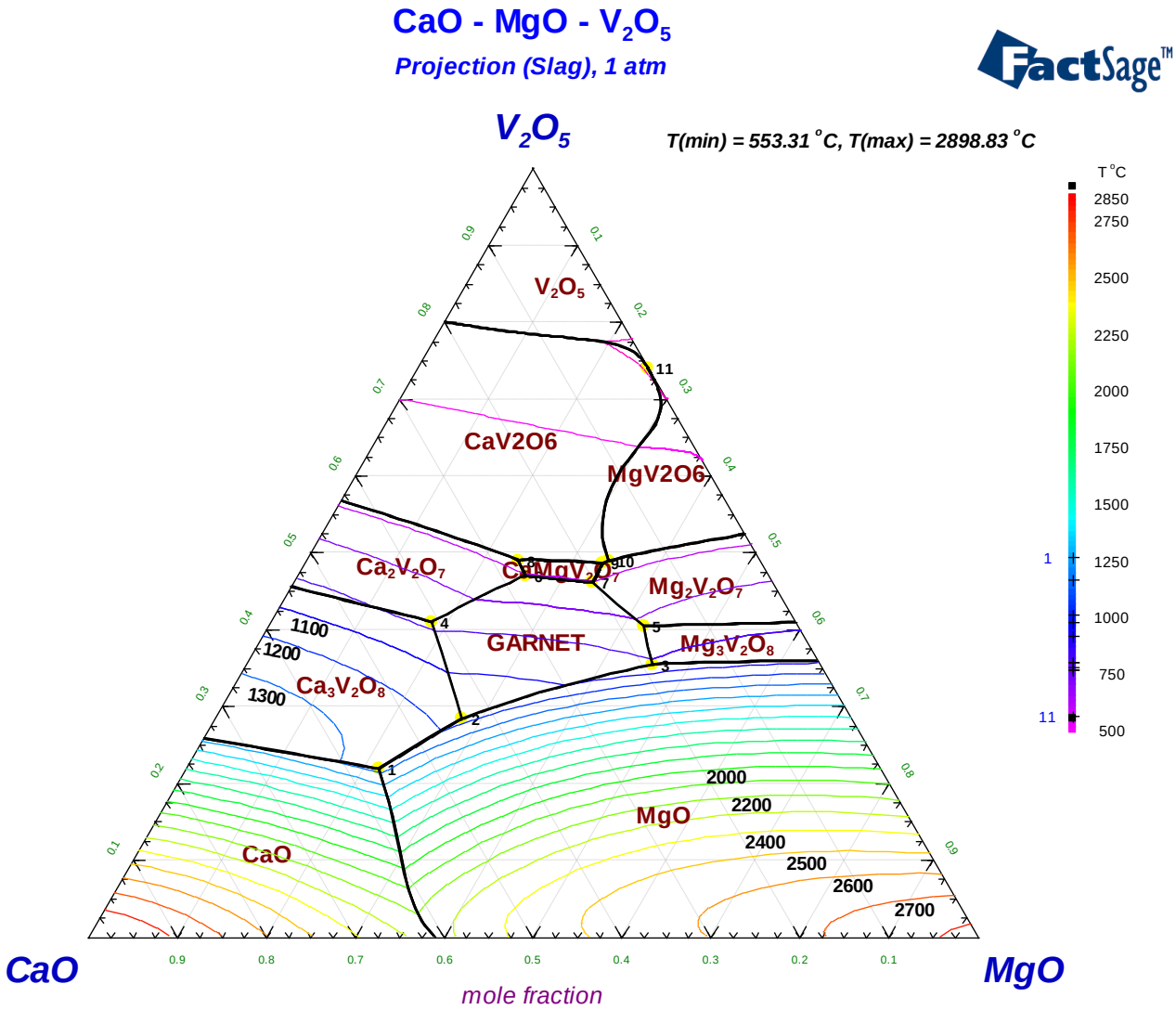
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction					Weight percent				
	A = TiO2, B = CaO, C = MgO					A = TiO2, B = CaO, C = MgO				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: Ca5Ti4O13 / CaTiO3 / MeO#1	1:	0.37949	0.51204	0.10847	1781.15	1:	47.809	45.295	6.896	1781.15
2: Ca3Ti2O7 / Ca5Ti4O13 / MeO#1	2:	0.32561	0.61511	0.05927	1718.32	2:	41.351	54.850	3.799	1718.32
3: Ca3Ti2O7 / MeO#1 / MeO#2	3:	0.30141	0.64570	0.05289	1687.60	3:	38.570	58.014	3.416	1687.61
4: CaTiO3 / MeO#1 / Mg2TiO4	4:	0.44008	0.17921	0.38071	1606.29	4:	58.055	16.599	25.345	1606.29
5: CaTiO3 / Mg2TiO4 / MgTiO3	5:	0.50904	0.15577	0.33519	1536.80	5:	64.634	13.888	21.478	1536.81
6: CaTiO3 / MgTi2O5 / MgTiO3	6:	0.57755	0.16770	0.25475	1513.84	6:	70.103	14.292	15.605	1513.84
7: CaTiO3 / MgTi2O5 / TiO2	7:	0.73814	0.21371	0.04815	1418.41	7:	80.892	16.445	2.663	1418.41

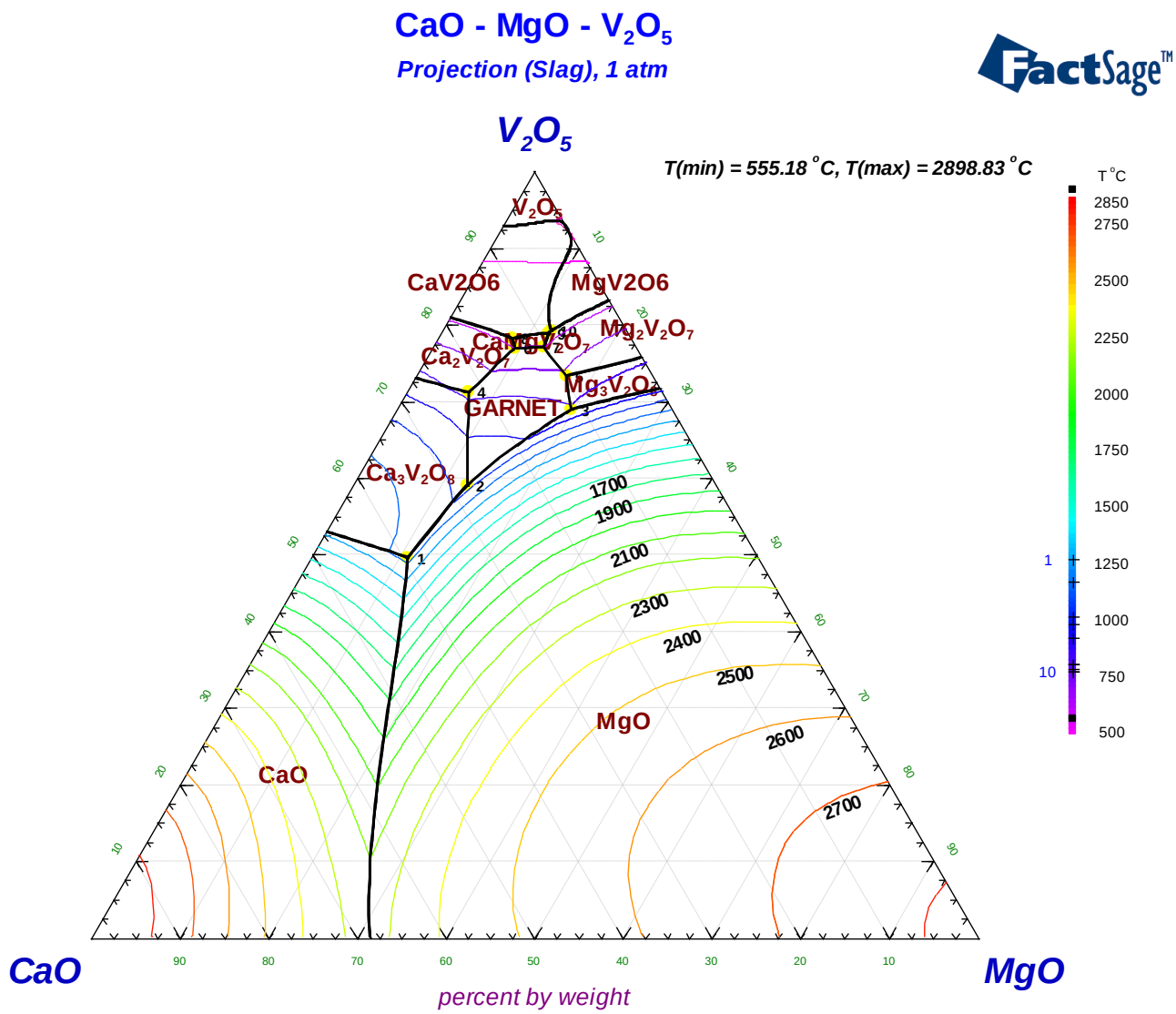
CaO-MgO-V2O5,
Mole fraction, 550°C




Ca2V2O7 - Mg2V2O7
1 atm
FactSage™
[Slobodin, 1978]
Slag
Ca2V2O7 + Slag
Mg2V2O7 + Slag
CaMgV2O7 + Ca2V2O7
CaMgV2O7 + Mg2V2O7
Ca2V2O7
CaMgV2O7
Mg2V2O7
2018-07-24 1 sec
T(C)
1400
1200
1000
800
600
400
200
0
0
0.2
0.4
0.6
0.8
1
Mg2V2O7/(Ca2V2O7+Mg2V2O7) (mol/mol)


CaO - MgO - V2O5
Projection (Slag), 1 atm
FactSage™
V2O5
T(min) = 553.31 °C, T(max) = 2898.83 °C
T °C
2850
2750
2500
2250
2000
1750
1500
1250
1000
750
500
V2O5
CaV2O6
MgV2O6
Ca2V2O7
CaMgV2O7
Mg2V2O7
GARNET
Mg3V2O8
Ca3V2O8
CaO
MgO
1100
1200
1300
2000
2200
2400
2500
2600
2700
CaO
MgO
mole fraction

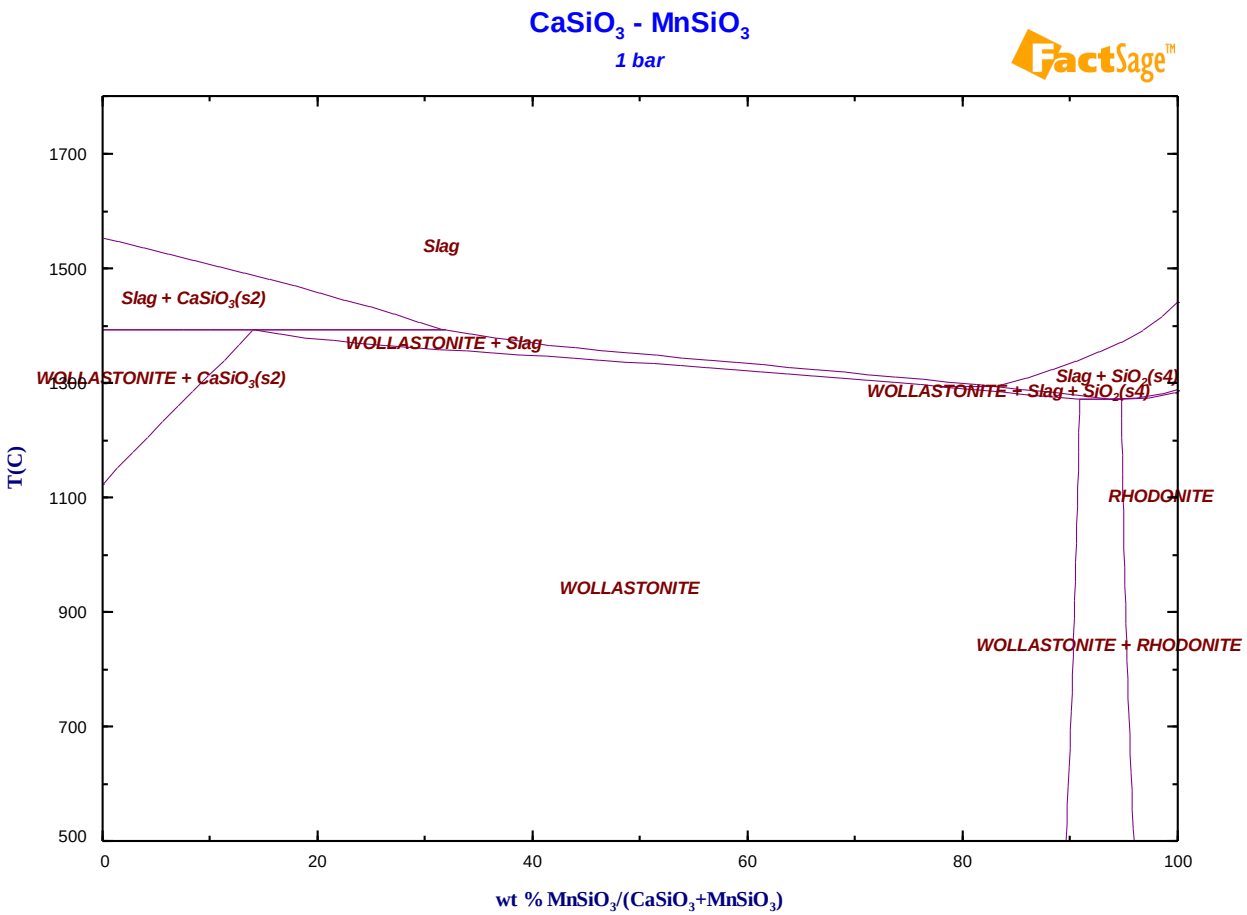
CaO-MgO-V2O5,
Weight percent, Liquidus surface



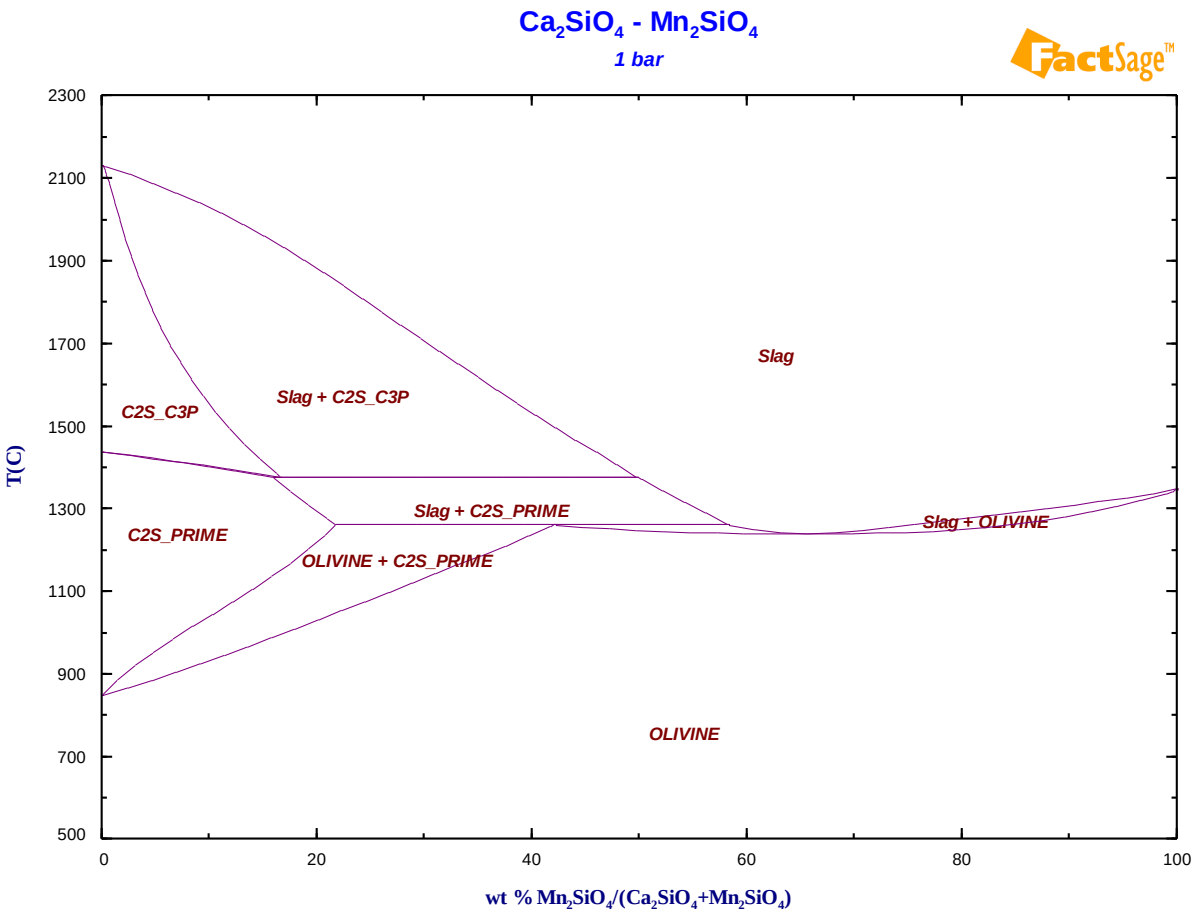
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction				Weight percent			
	A = V2O5, B = CaO, C = MgO				A = V2O5, B = CaO, C = MgO			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: Ca3V2O8 / CaO / MgO	1: 0.21897	0.56392	0.21711	1262.81	1: 49.658	39.431	10.911	1262.81
2. Ca3V2O8 / GARNET / MgO	2: 0.28401	0.43707	0.27892	1163.09	2: 59.098	28.041	12.861	1163.09
3. GARNET / Mg3V2O8 / MgO	3: 0.35498	0.18779	0.45723	1011.72	3: 69.036	11.260	19.704	1011.72
4. Ca2V2O7 / Ca3V2O8 / GARNET	4: 0.41020	0.40800	0.18180	975.04	4: 71.181	21.828	6.991	975.03
5. GARNET / Mg2V2O7 / Mg3V2O8	5: 0.40497	0.17273	0.42230	915.02	5: 73.390	9.651	16.959	915.02
6. Ca2V2O7 / CaMgV2O7 / GARNET	6: 0.47054	0.27301	0.25645	802.45	6: 76.943	13.764	9.293	802.45
7. CaMgV2O7 / GARNET / Mg2V2O7	7: 0.46128	0.20181	0.33691	801.96	7: 77.116	10.402	12.481	801.96
8. Ca2V2O7 / CaMgV2O7 / CaV2O6	8: 0.49014	0.27121	0.23865	776.68	8: 78.216	13.344	8.439	776.68
9. CaMgV2O7 / CaV2O6 / Mg2V2O7	9: 0.48611	0.17813	0.33576	766.21	9: 78.986	8.924	12.090	766.20
10. CaV2O6 / Mg2V2O7 / MgV2O6	10: 0.48880	0.17016	0.34105	765.70	10: 79.243	8.505	12.252	765.70

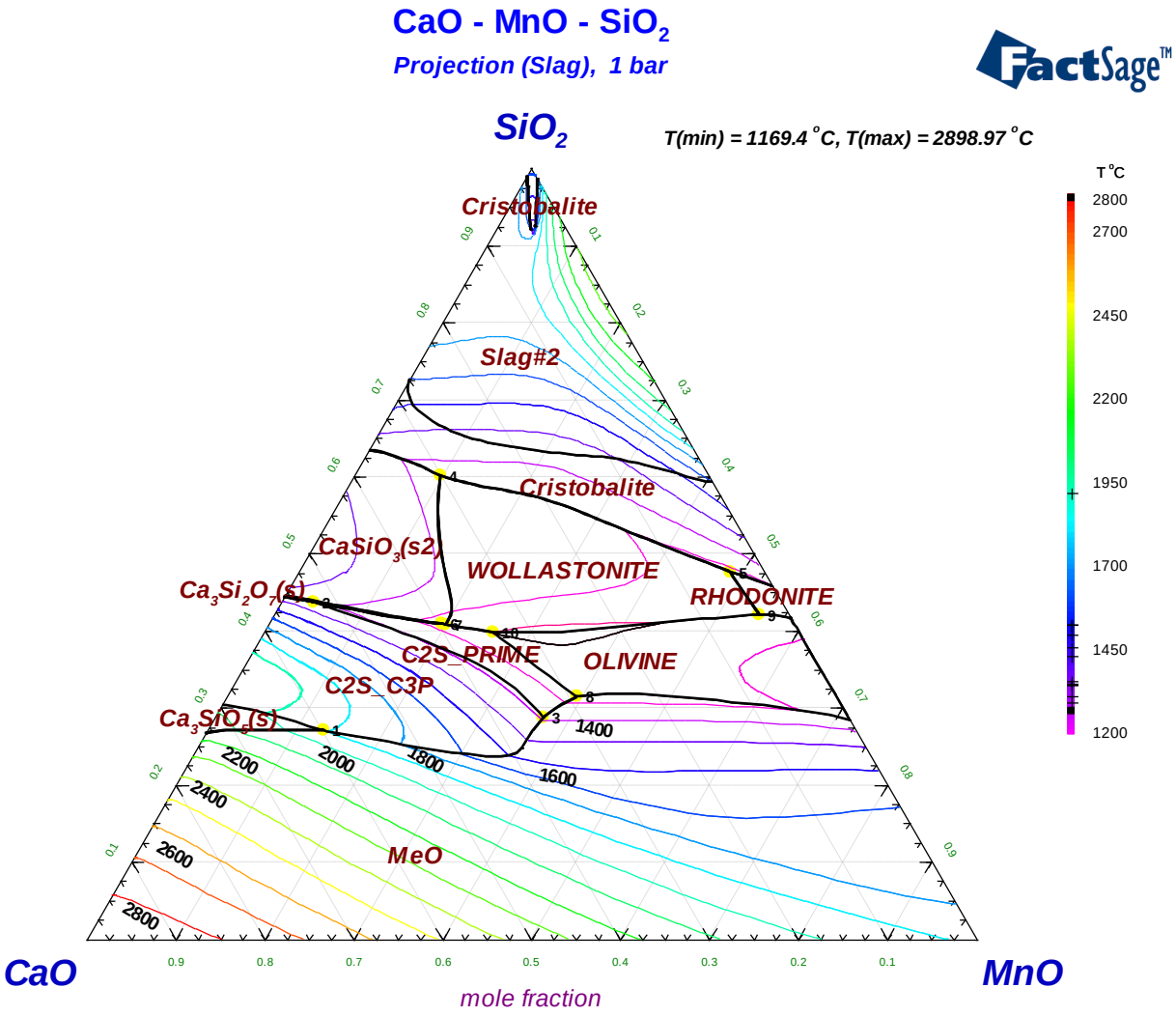
Weight percent, Metasilicate section CaSiO3-MnSiO3



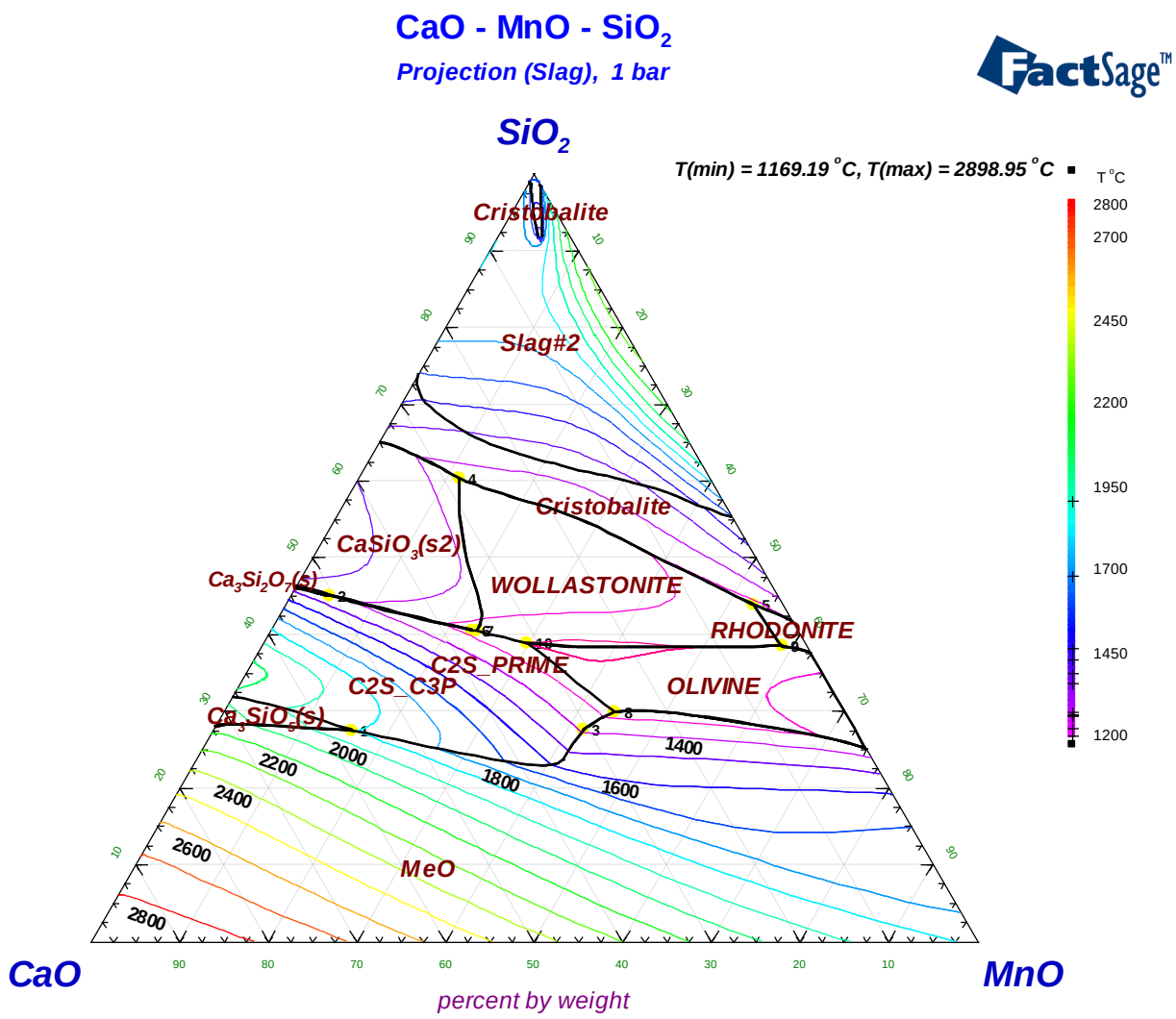
Weight percent, Orthosilicate section Ca2SiO4-Mn2SiO4



Mole fraction, Liquidussurface



Weight percent, Liquidussurface

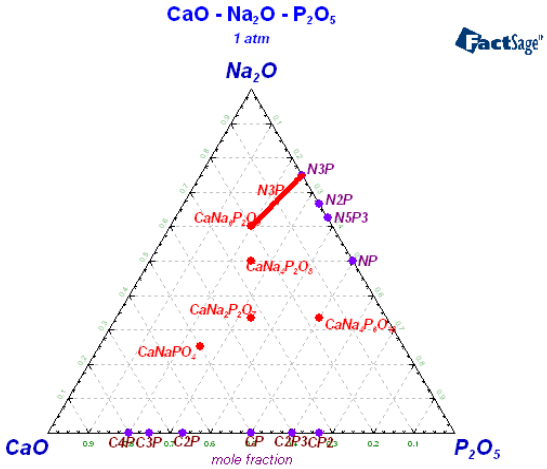


Invariant equilibria on the liquidus surface

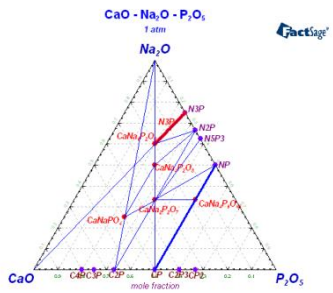
Intersections with slag	Mole fraction					Weight percent				
	A = SiO2, B = CaO, C = MnO					A = SiO2, B = CaO, C = MnO				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: C2S_C3P / Ca3SiO5(s) / MeO	1:	0.27068	0.59839	0.13093	1904.47	1:	27.515	0.56.772	15.713	1904.47
2: C2S_C3P / C2S_PRIME / Ca3Si2O7(s)	2:	0.43714	0.52677	0.03609	1427.68	2:	45.001	0.50.612	4.387	1427.68
3: C2S_C3P / C2S_PRIME / MeO	3:	0.28781	0.34234	0.36985	1385.84	3:	27.568	0.30.605	41.826	1385.84
4: CaSiO3(s2) / Cristobalite / WOLLASTONITE	4:	0.60150	0.30210	0.09640	1355.37	4:	60.315	0.28.272	11.413	1355.39
5: RHODONITE / Cristobalite / WOLLASTONITE	5:	0.47700	0.03849	0.48452	1270.42	5:	43.965	0.03.311	52.725	1270.42
6: C2S_PRIME / Ca3Si2O7(s) / CaSiO3(s2)	6:	0.40901	0.39608	0.19490	1262.96	6:	40.545	0.36.645	22.811	1262.96
7: C2S_PRIME / CaSiO3(s2) / WOLLASTONITE	7:	0.40835	0.39211	0.19954	1257.45	7:	40.435	0.36.238	23.327	1257.45
8: C2S_PRIME / MeO / OLIVINE	8:	0.31455	0.29158	0.39387	1256.49	8:	29.909	0.25.876	44.215	1256.48
9: OLIVINE / RHODONITE / WOLLASTONITE	9:	0.42143	0.03307	0.54550	1219.20	9:	38.440	0.02.816	58.744	1219.20
10: C2S_PRIME / OLIVINE / WOLLASTONITE	10:	0.39801	0.34397	0.25802	1198.27	10:	38.881	0.31.361	29.758	1198.27

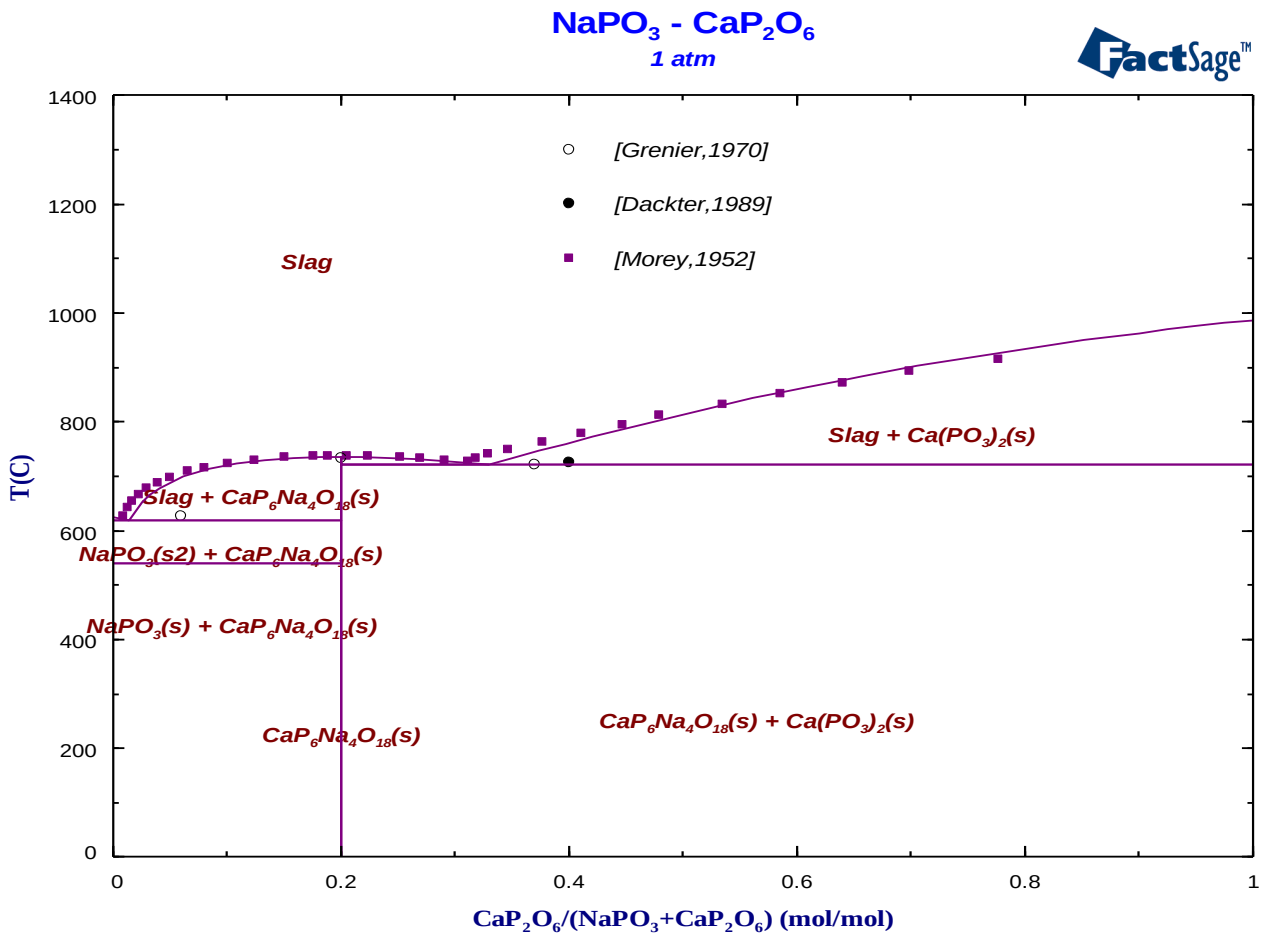
Ternary phases in $CaO-Na_2O-P_2O_5$ system

Phase	Description	Used data
CNP	$CaNa_2P_2O_7$	GTT
C2NP	$CaNaPO_4$	GTT
CN2P	$CaNa_4P_2O_8$	GTT
CN2P3	$CaNa_4P_6O_{18}$	GTT
N3P-LT	$(Na_2O)_2(P_2O_5)(Na_2O,Na_2CaO_2)$	$CaNa_6P_2O_9$(s1) GTT Na_3PO_4(s1) IEK-2
N3P-MT	$(Na_2O)_2(P_2O_5)(Na_2O,Na_2CaO_2)$	$CaNa_6P_2O_9$(s2) GTT Na_3PO_4(s2) IEK-2
N3P-HT	$(Na_2O)_2(P_2O_5)(Na_2O,Na_2CaO_2)$	$CaNa_6P_2O_9$(s3) GTT Na_3PO_4(s3) IEK-2
	H_{tr} (s1→s2→s3) is proposed to be equal to Na_3PO_4	

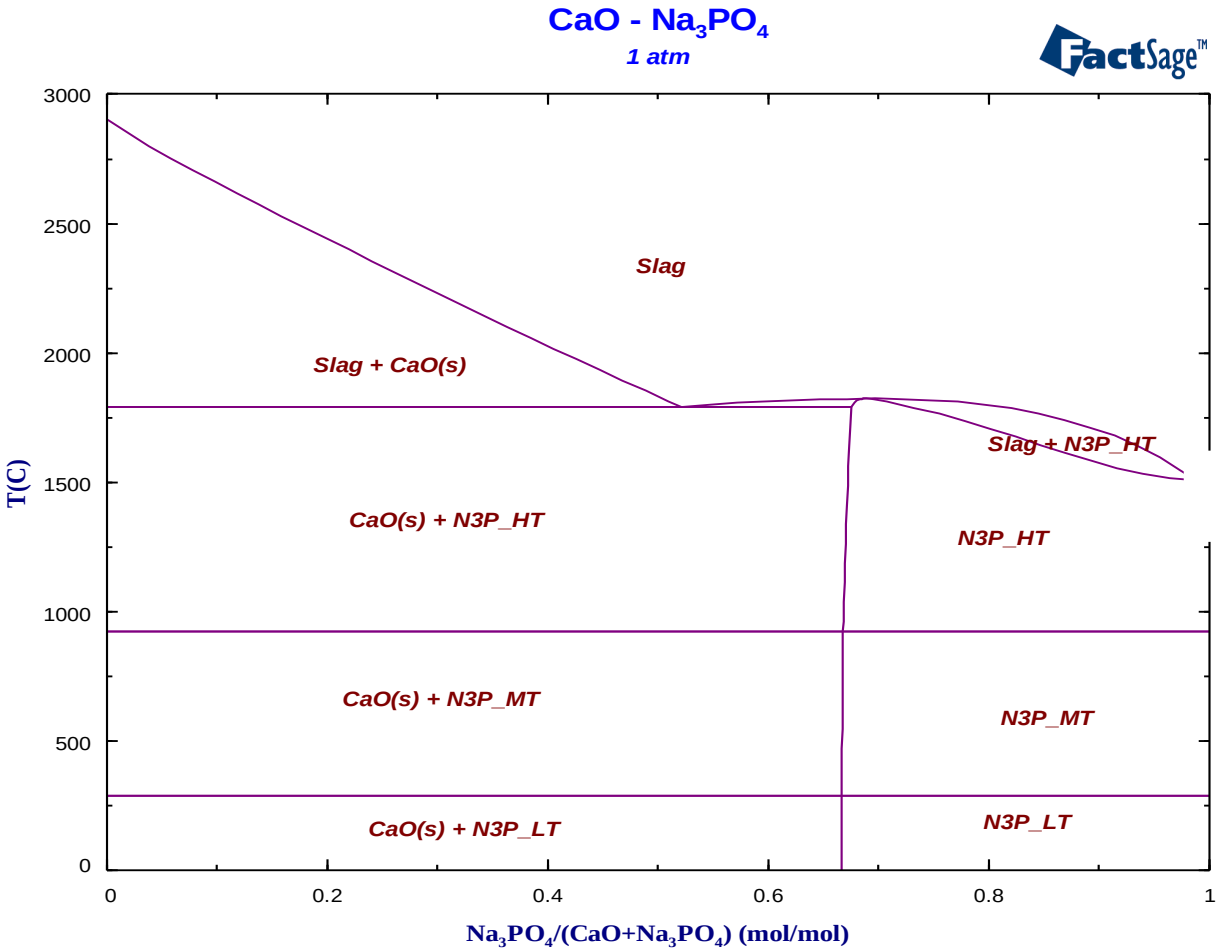


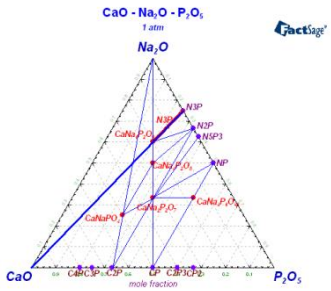
Mole fraction, Isopleth CaP2O6-NaPO3



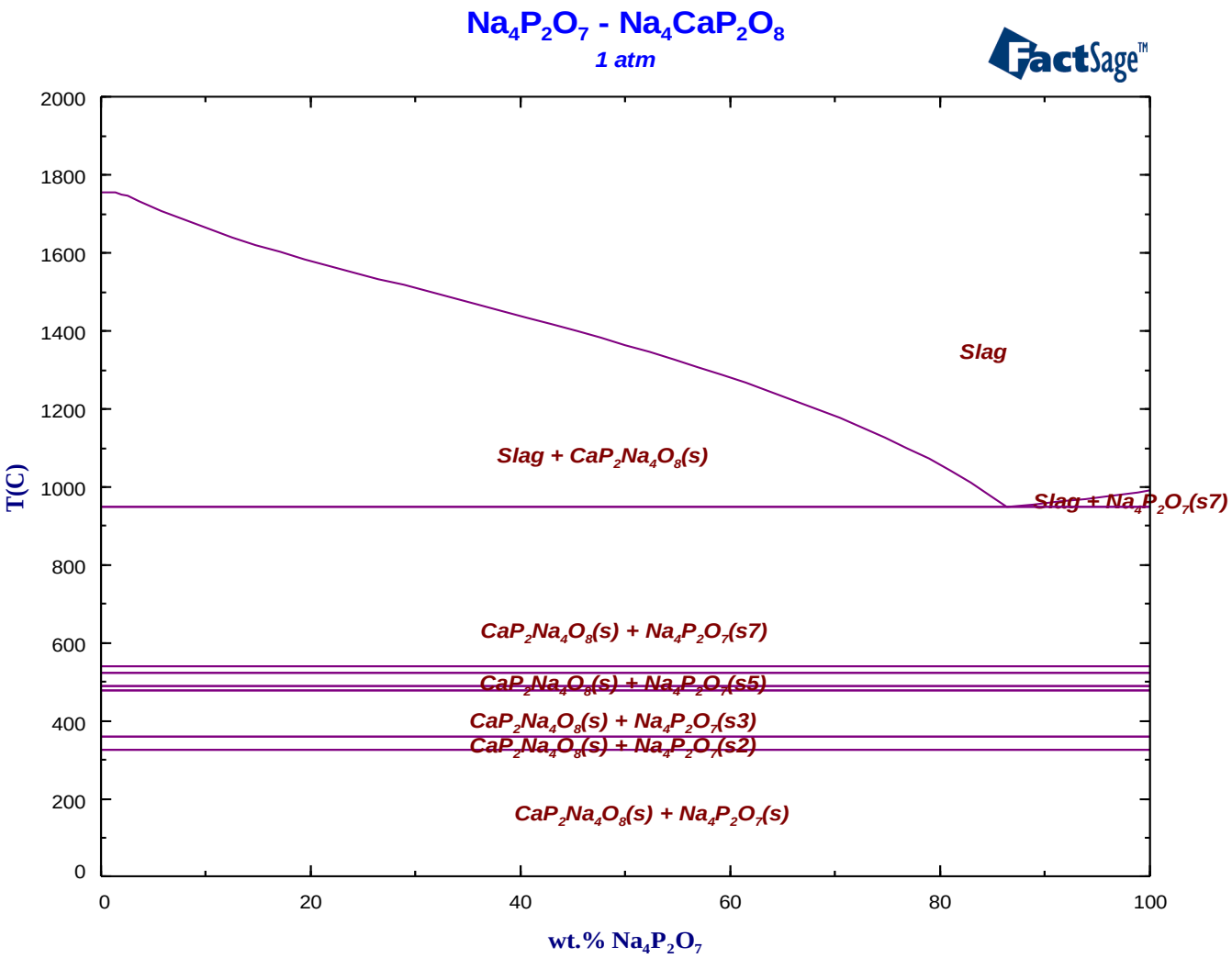


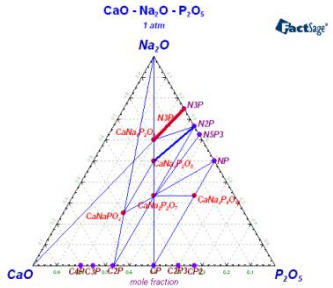
Mole fraction, Isopleth CaO-Na3PO4



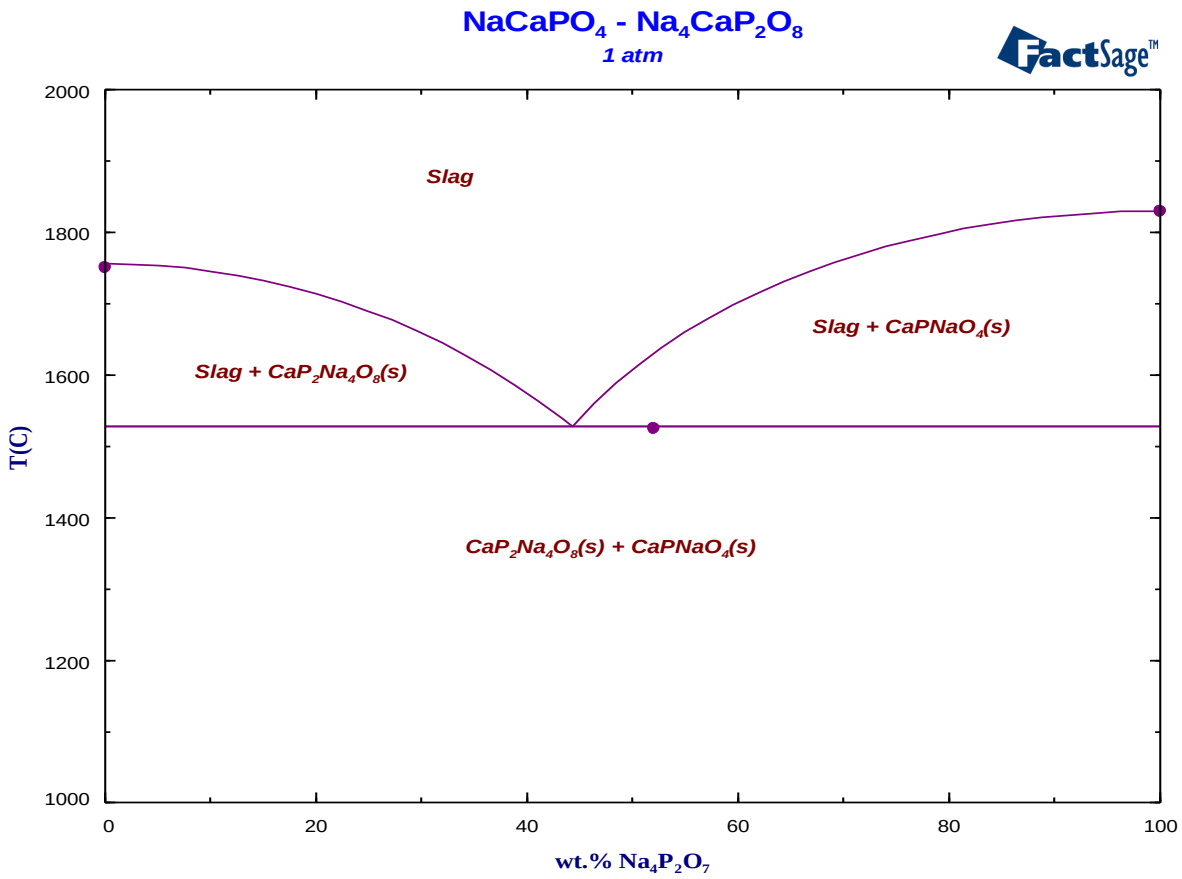


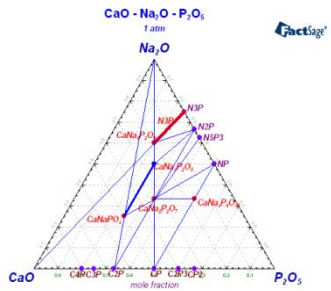
Weight percent, Isopleth Na4CaP2O8-Na4P2O7



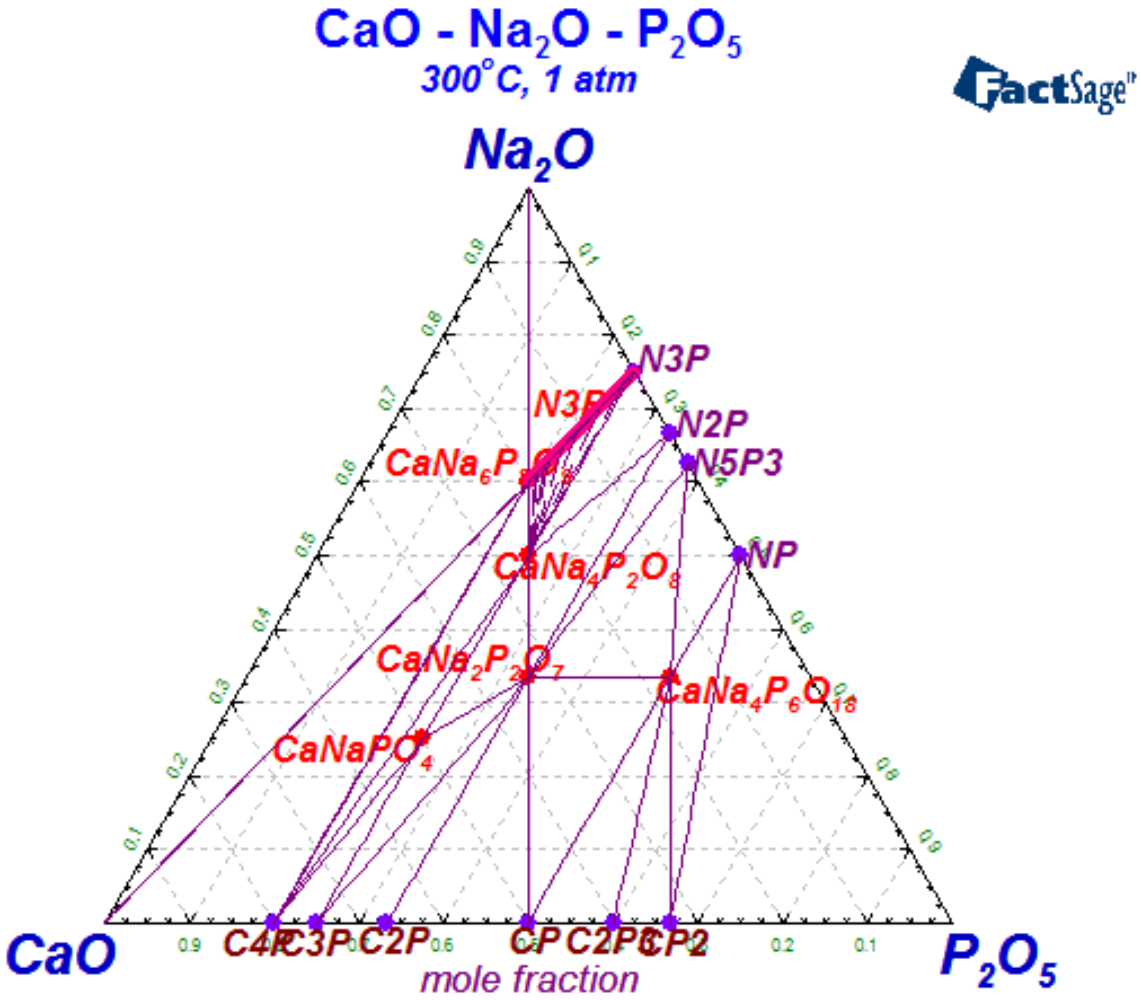


Weight percent, Isopleth NaCaPO4-Na4CaP2O8

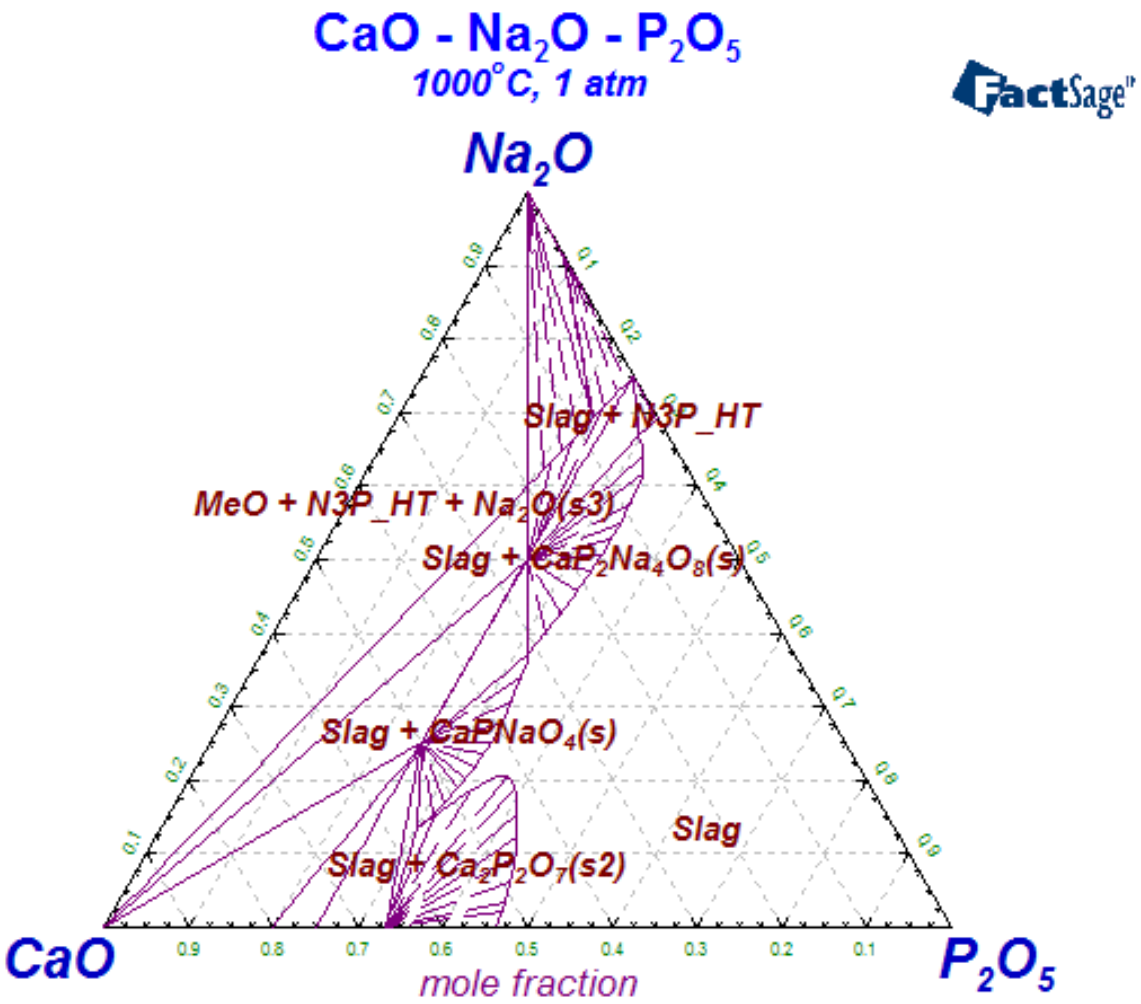


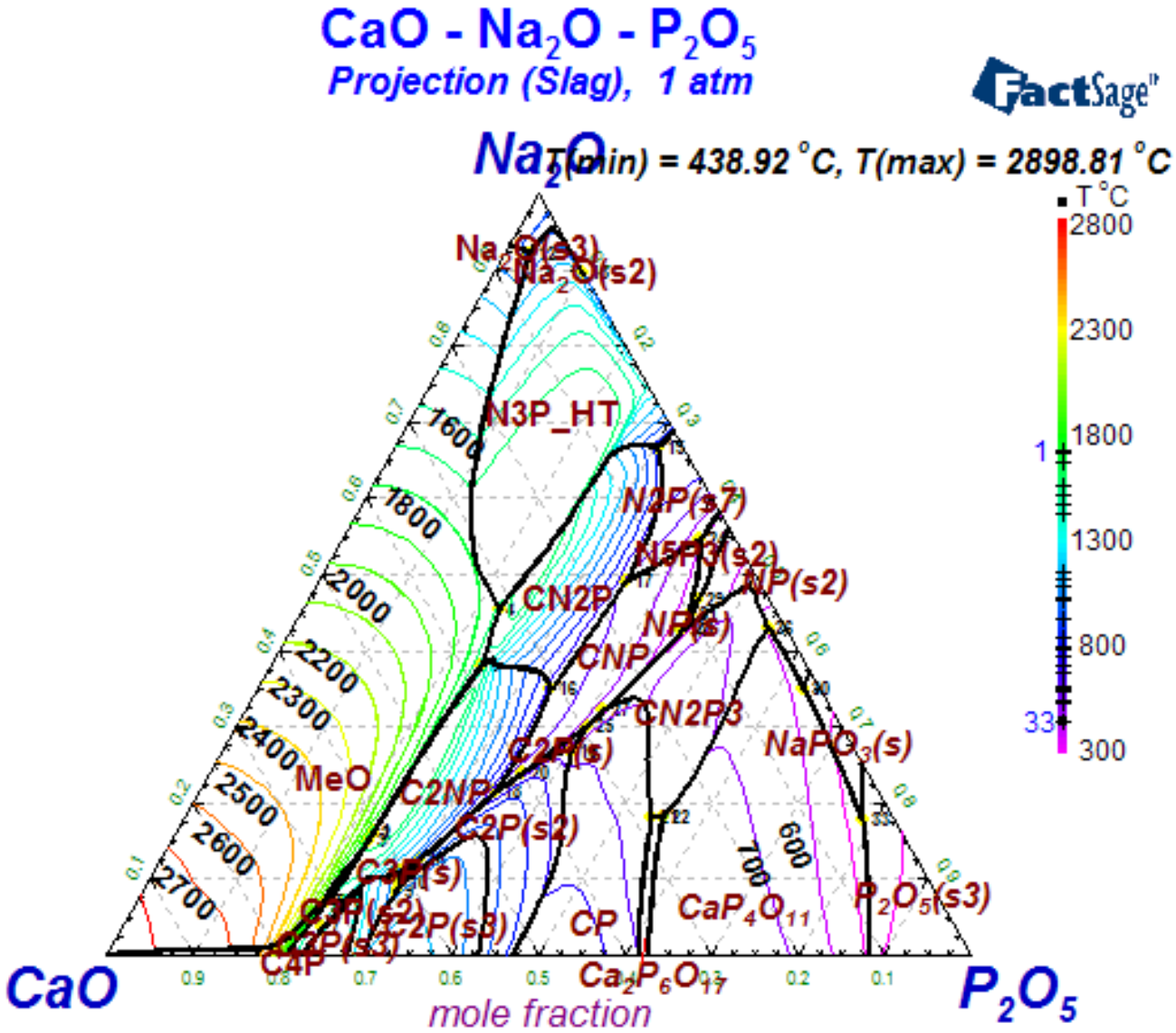


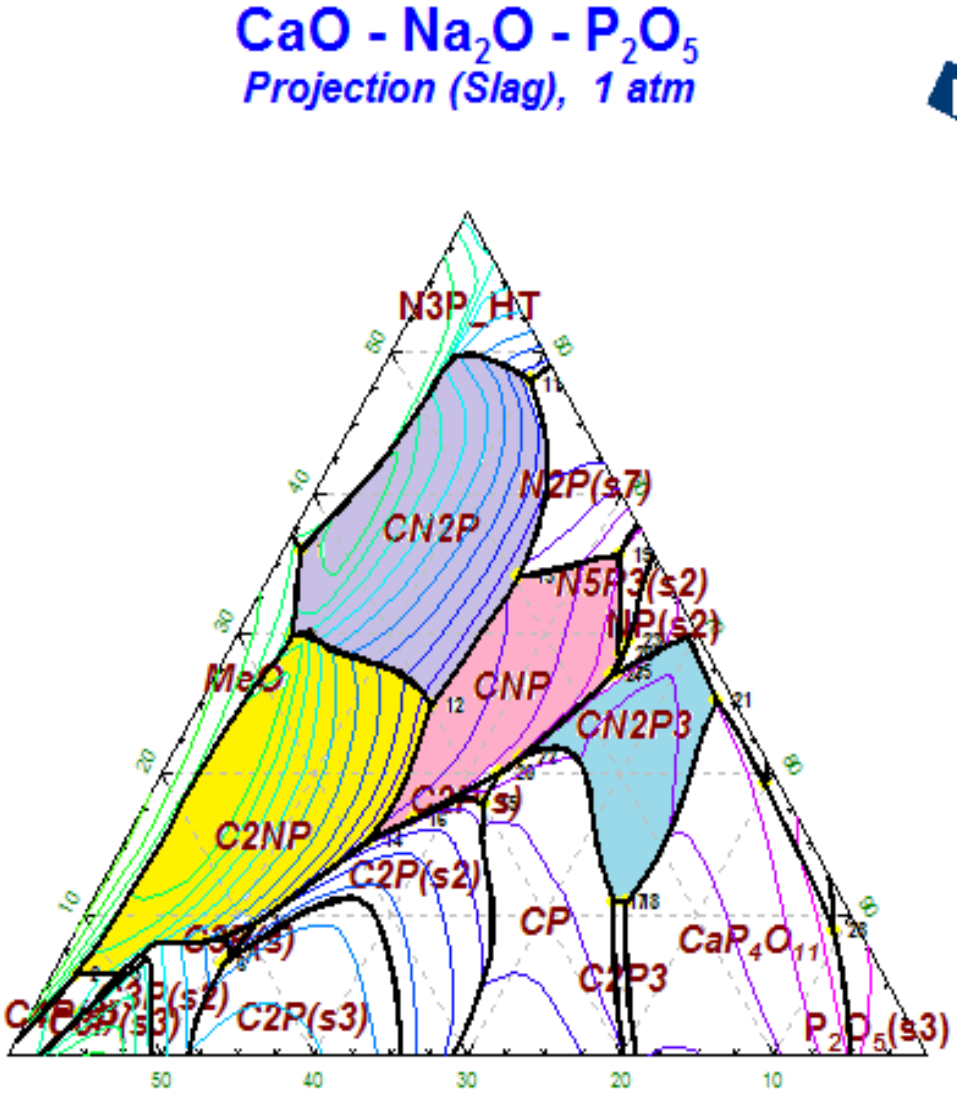
Mole fraction, 300°C



Mole fraction, 1000°C




CaO - Na2O - P2O5
Projection (Slag), 1 atm
FactSage
T(min) = 438.92 °C, T(max) = 2898.81 °C
T °C
2800
2300
1800
1300
800
300
Na2O
CaO
P2O5
mole fraction
Na2O(s3)
Na2O(s2)
N3P_HT
N2P(s7)
N5P3(s2)
NP(s2)
NP(s)
CN2P
CNP
CN2P3
NaPO3(s)
C2P(s)
MeO
C2NP
C2P(s2)
C3P(s)
C2P(s3)
CP
CaP4O11
P2O5(s3)
C4P
Ca2P6O17
1600
1800
2000
2200
2300
2400
2500
2600
2700
600
700

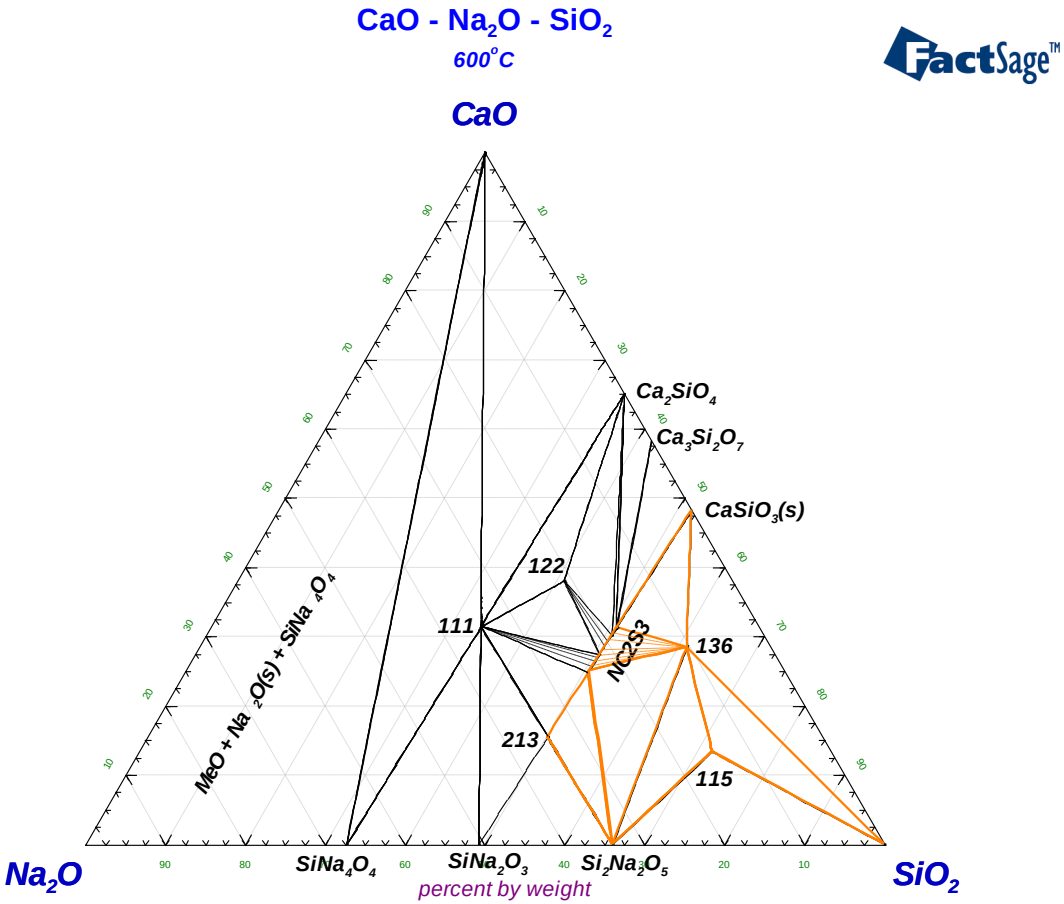

CaO - Na2O - P2O5
Projection (Slag), 1 atm
FactSage
N3P_HT
N2P(s7)
CN2P
N5P3(s2)
NP(s2)
MeO
CNP
CN2P3
C2NP
C2P(s2)
CP
CaP4O11
C2P3
C2P(s3)
P2O5(s3)
50
40
30
20
10

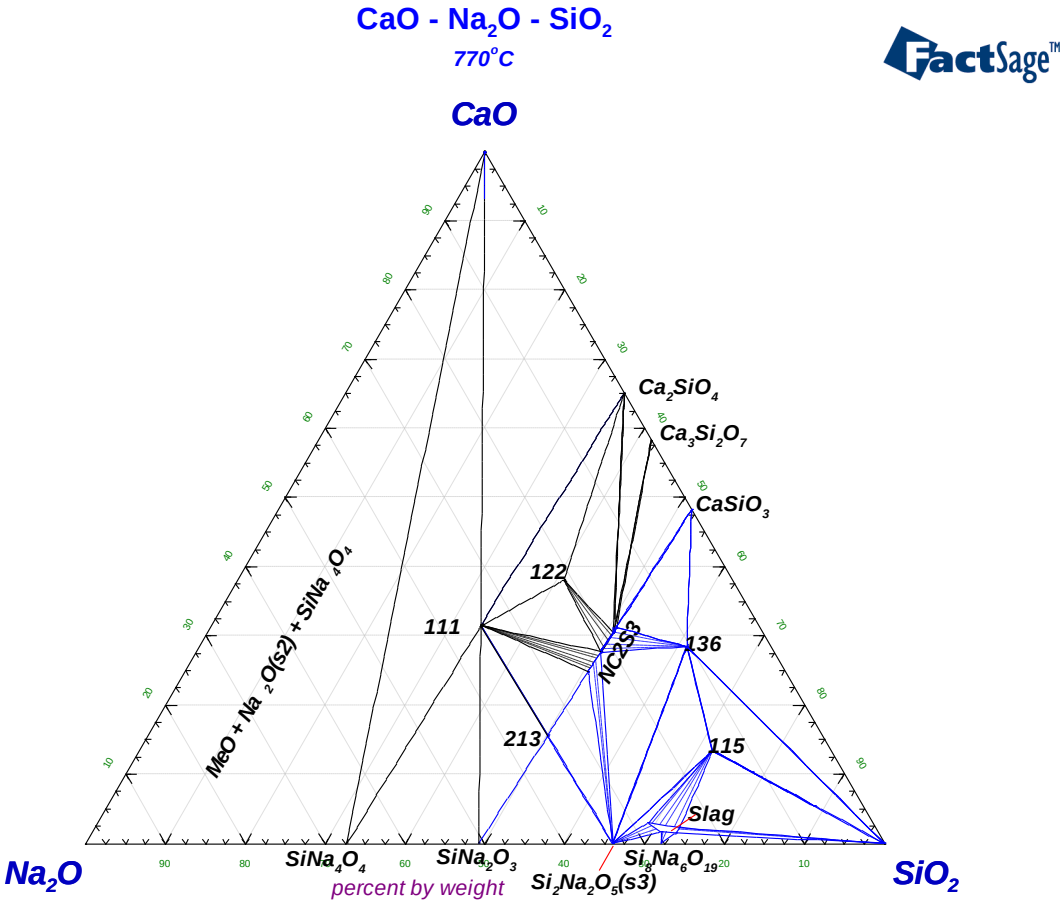
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction					Weight percent				
	A = Na2O, B = CaO, C = P2O5					A = Na2O, B = CaO, C =P2O5				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: CaP2Na4O8 / MeO / N3P_HT	1:	0.45421	0.31892	0.22687	1668.21	1:	35.982	22.859	41.159	1668.21
2: Ca4P2O9 / CaPNaO4 / MeO	2:	0.06961	0.70894	0.22146	1556.21	2:	5.714	52.653	41.633	1556.21
3: CaP2Na4O8 / CaPNaO4 / MeO	3:	0.38047	0.37551	0.24401	1505.46	3:	29.746	26.563	43.691	1505.46
4: Ca3P2O8(s2) / Ca3P2O8(s3) / Ca4P2O9(s)	4:	0.03523	0.73153	0.23324	1469.84	4:	2.861	53.755	43.383	1469.85
5: Ca3P2O8(s2) / Ca4P2O9(s) / CaPNaO4(s)	5:	0.07119	0.68769	0.24113	1422.60	5:	5.715	49.951	44.333	1422.38
6: Ca2P2O7(s2) / Ca2P2O7(s3) / Ca3P2O8(s2)	6:	0.08370	0.62337	0.29292	1139.89	6:	6.348	42.775	50.877	1139.89
7: Ca2P2O7(s2) / Ca3P2O8(s2) / Ca3P2O8(s)	7:	0.09324	0.61279	0.29397	1109.89	7:	7.059	41.973	50.968	1109.85
8: Ca3P2O8(s2) / Ca3P2O8(s) / CaPNaO4(s)	8:	0.10973	0.60386	0.28640	1109.85	8:	8.364	41.643	49.993	1109.22
9: MeO / N3P_HT / Na2O(s3)	9:	0.92202	0.04960	0.02838	1079.78	9:	89.352	4.349	6.300	1079.78
10: Ca2P2O7(s2) / Ca3P2O8(s) / CaPNaO4(s)	10:	0.12407	0.57649	0.29945	1006.32	10:	9.318	39.175	51.507	1006.32
11: CaP2Na4O8(s) / N3P_HT / N3P_MT	11:	0.66708	0.02832	0.30460	922.40	11:	47.981	1.843	50.176	922.41
12: CaP2Na2O7(s) / CaP2Na4O8(s) / CaPNaO4(s)	12:	0.34983	0.31084	0.33933	835.23	12:	24.843	19.972	55.186	835.23
13: CaP2Na2O7(s) / CaP2Na4O8(s) / Na4P2O7(s7)	13:	0.49156	0.15293	0.35551	786.82	13:	34.039	9.582	56.380	786.89
14: Ca2P2O7(s2) / CaP2Na2O7(s) / CaPNaO4(s)	14:	0.21464	0.44358	0.34178	779.80	14:	15.345	28.694	55.961	779.80
15: Ca(PO3)2(s) / Ca2P2O7(s) / Ca2P2O7(s2)	15:	0.26531	0.32987	0.40481	749.85	15:	17.796	20.019	62.185	749.88
16: Ca2P2O7(s) / Ca2P2O7(s2) / CaP2Na2O7(s)	16:	0.23938	0.39837	0.36225	749.85	16:	16.746	25.216	58.038	749.86
17: Ca(PO3)2(s) / Ca2P6O17(s) / CaP6Na4O18(s)	17:	0.18162	0.27772	0.54067	701.97	17:	10.868	15.036	74.096	702.06
18: Ca2P6O17(s) / CaP4O11(s) / CaP6Na4O18(s)	18:	0.18203	0.26564	0.55234	701.70	18:	10.788	14.244	74.968	701.70
19: CaP2Na2O7(s) / Na4P2O7(s7) / Na5P3O10(s2)	19:	0.54496	0.04044	0.41460	602.23	19:	35.593	2.390	62.017	602.26
20: Ca(PO3)2(s) / Ca2P2O7(s) / CaP2Na2O7(s)	20:	0.30025	0.29468	0.40507	598.65	20:	20.089	17.839	62.071	598.65
21: CaP4O11(s) / CaP6Na4O18(s) / NaPO3(s2)	21:	0.43009	0.01999	0.54993	589.27	21:	25.186	1.059	73.755	589.28
22: Ca(PO3)2(s) / CaP2Na2O7(s) / CaP6Na4O18(s)	22:	0.32083	0.26398	0.41519	578.11	22:	21.239	15.812	62.949	578.11
23: Na5P3O10(s2) / NaPO3(s2) / NaPO3(s)	23:	0.43036	0.11390	0.45574	539.41	23:	29.532	4.763	65.705	539.40
24: CaP4O11(s) / NaPO3(s2) / NaPO3(s)	24:	0.46518	0.08291	0.45190	539.40	24:	19.275	0.910	79.815	539.40
25: CaP6Na4O18(s) / NaPO3(s2) / NaPO3(s)	25:	0.34962	0.01824	0.63215	539.40	25:	27.287	6.534	66.179	539.40
26: CaP2Na2O7(s) / Na5P3O10(s2) / NaPO3(s)	26:	0.44789	0.10064	0.45146	532.93	26:	28.476	5.789	65.735	532.92
27: CaP2Na2O7(s) / CaP6Na4O18(s) / NaPO3(s)	27:	0.42501	0.12284	0.45215	529.30	27:	27.042	7.072	65.887	529.30
28: CaP4O11(s) / NaPO3(s) / P2O5(s3)	28:	0.17699	0.03672	0.78629	438.92	28:	8.801	1.652	89.547	438.92

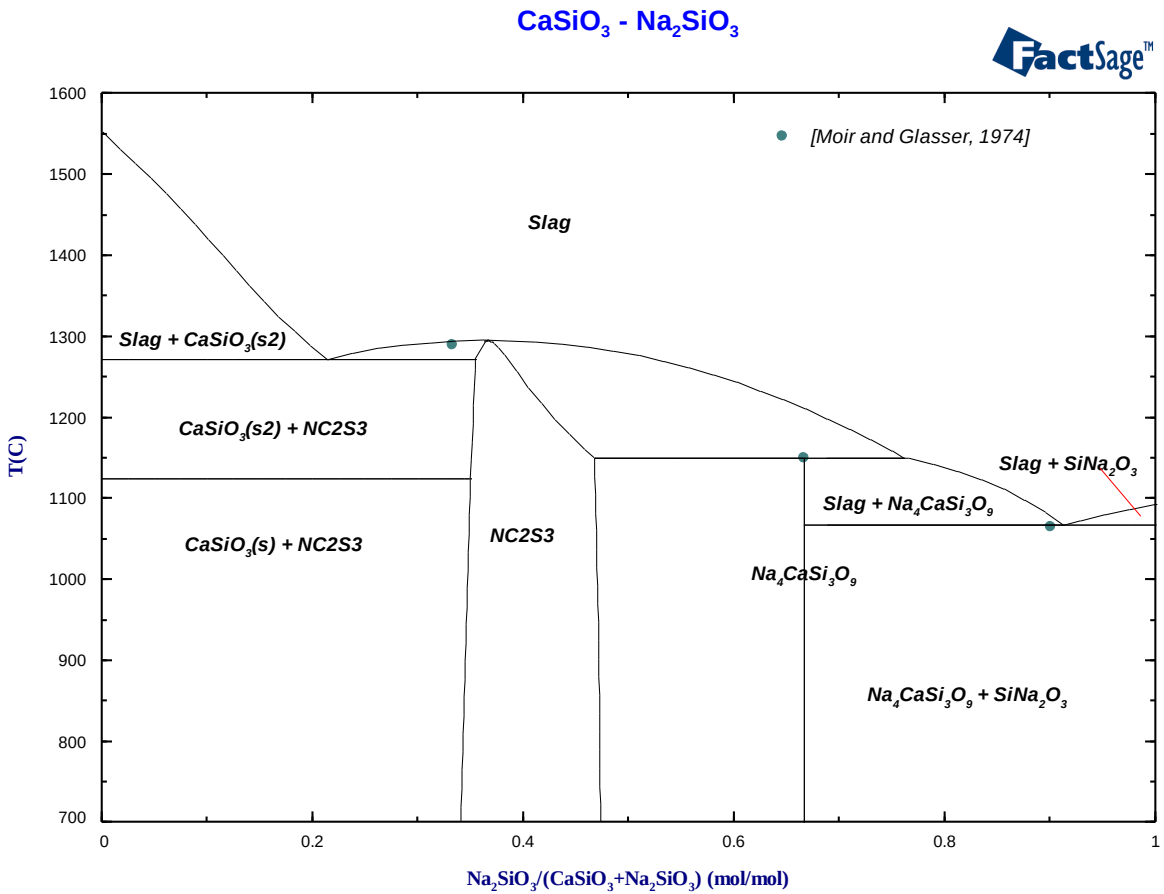
Ternary phases in $CaO-Na_2O-SiO_2$ system

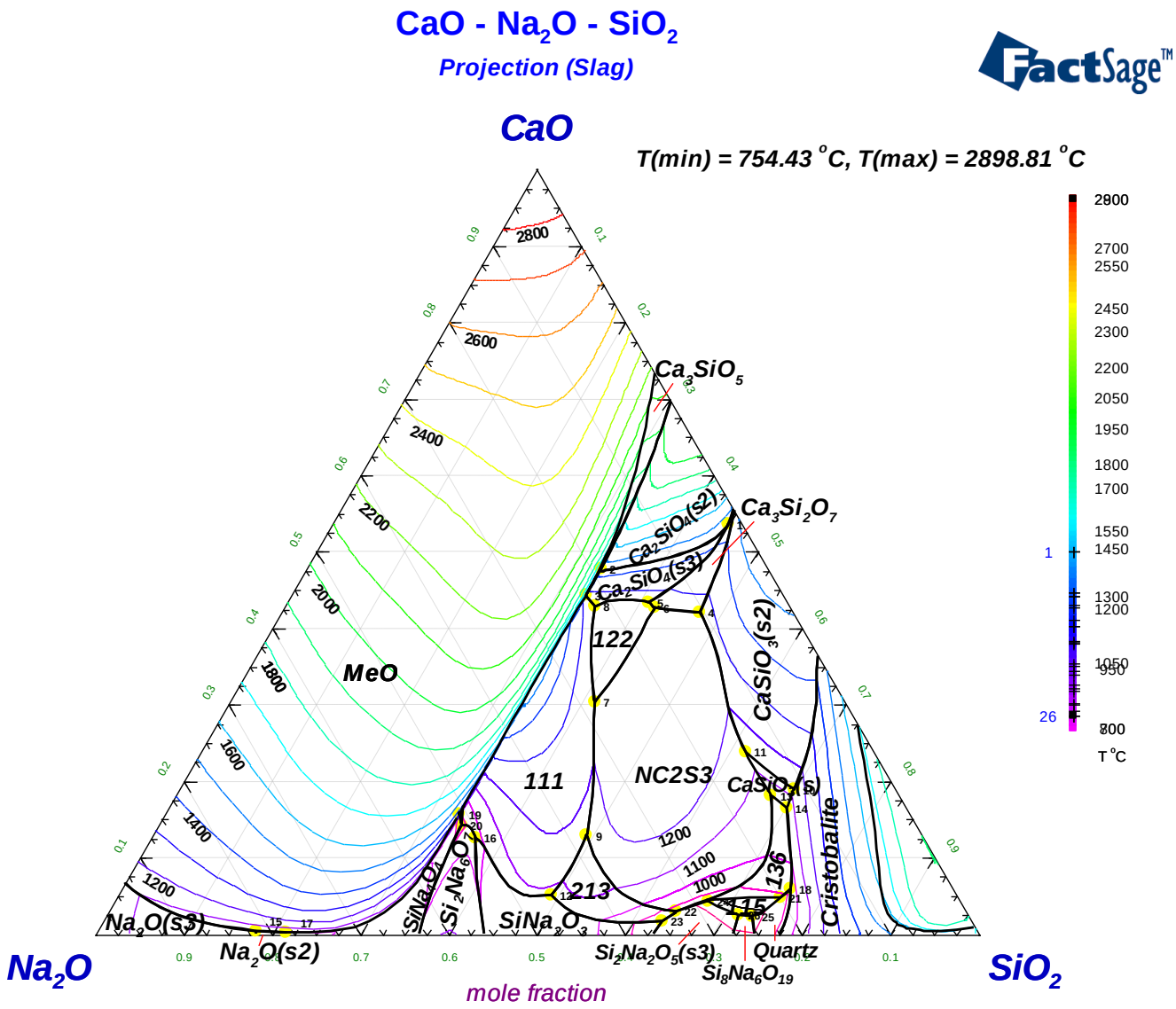
Phase	Description	Formel
111	stoichiometric	Na_2CaSiO_4
115	stoichiometric	$Na_2CaSi_5O_{12}$
122	stoichiometric	$Na_2Ca_2Si_2O_7$
136	stoichiometric	$Na_2Ca_3Si_6O_{16}$
213	stoichiometric	$Na_4CaSi_3O_9$
NC2S3	Solid solution phase	$(Na^{1+},Va)_2(Ca^{2+},Va)(CaNa_2Si_3O_9^{2-})$


CaO - Na2O - SiO2
600°C
CaO
Ca2SiO4
Ca3Si2O7
CaSiO3(s)
122
111
NC2S3
136
213
115
MeO + Na 2O(s) + SiNa 4O4
Na2O
SiNa4O4
SiNa2O3
Si2Na2O5
SiO2
percent by weight

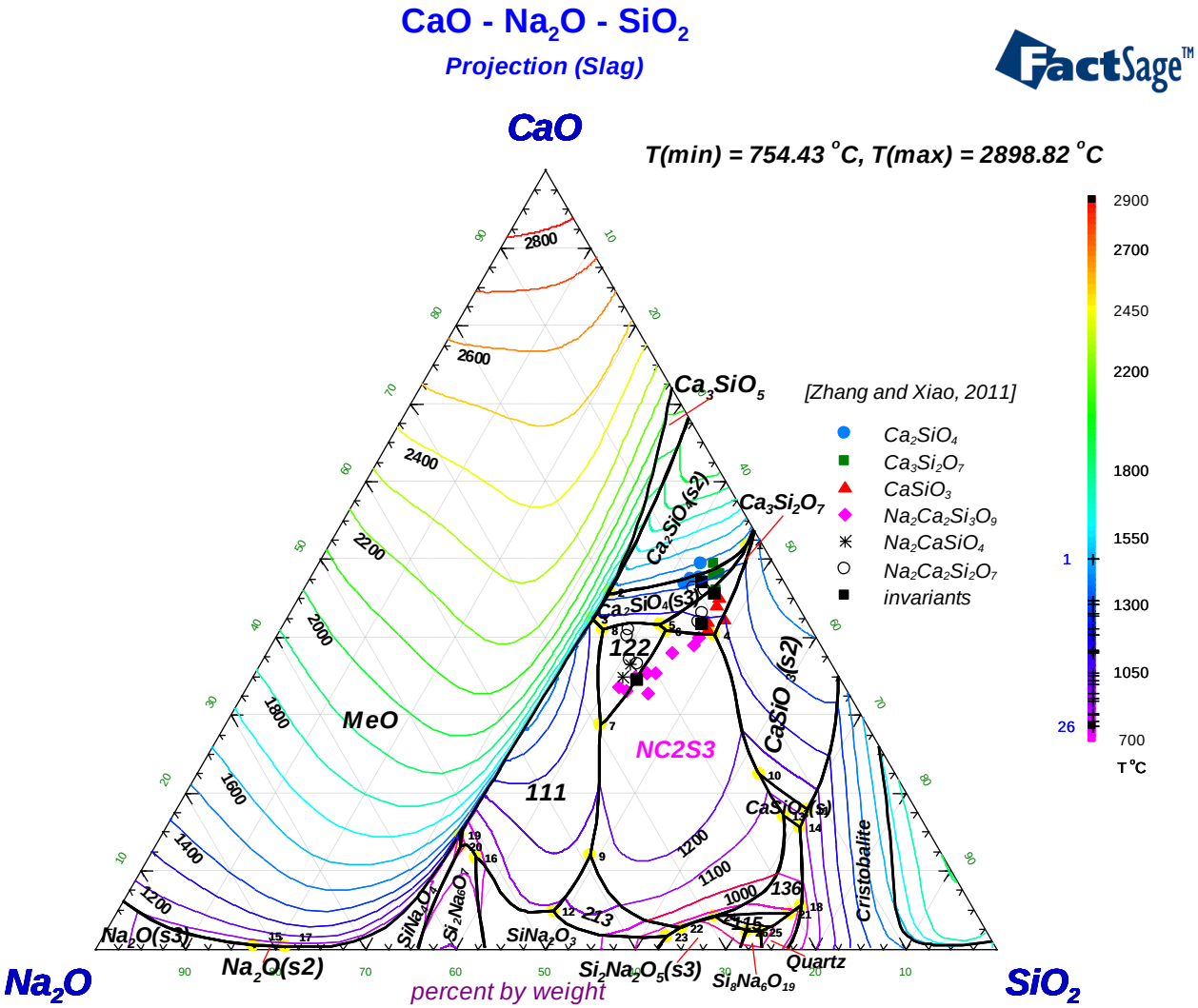

CaO - Na2O - SiO2
770°C
CaO
Na2O
SiO2
Ca2SiO4
Ca3Si2O7
CaSiO3
122
111
136
NC2S3
213
115
Slag
MeO + Na2O(s2) + SiNa4O4
SiNa4O4
SiNa2O3
Si8Na6O19
Si2Na2O5(s3)
percent by weight

Orthosilicate isopleth compared with experimental data




CaO - Na2O - SiO2
Projection (Slag)
FactSage™
CaO
T(min) = 754.43 °C, T(max) = 2898.81 °C
Ca3SiO5
Ca3Si2O7
Ca2SiO4(s2)
Ca2SiO4(s3)
122
MeO
CaSiO3(s2)
111
NC2S3
CaSiO3(s)
Cristobalite
213
136
115
Na2O(s3)
Na2O(s2)
Si2Na6O7
Si2Na6O
SiNa2O3
Si2Na2O5(s3)
Quartz
Si8Na6O19
Na2O
SiO2
mole fraction
T °C

Weight percent,
Liquidussurface compared with experimental data

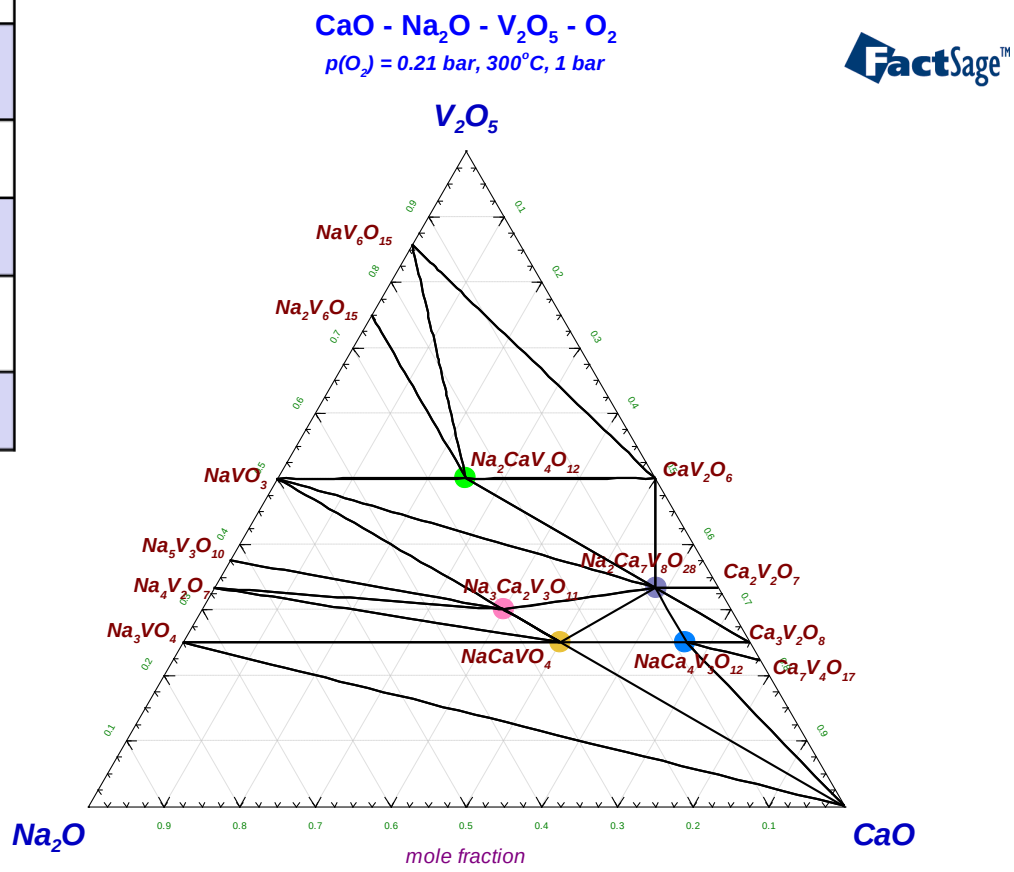


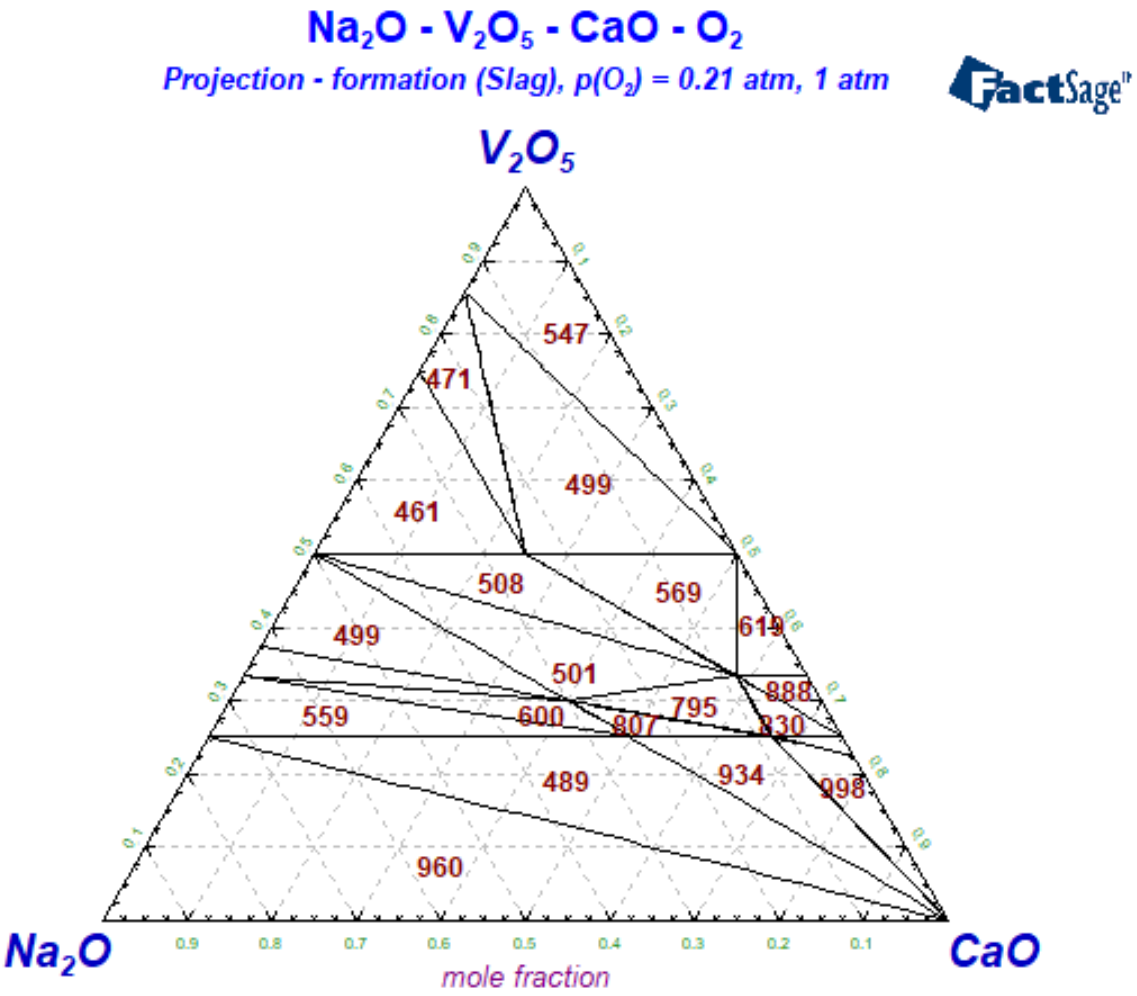
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction A = CaO, B = Na2O, C = SiO2				Weight percent A = CaO, B = Na2O, C = SiO2			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: Ca2SiO4(s2) / Ca2SiO4(s3) / Ca3Si2O7	1: 0.53623	0.01517	0.44860	1436.73	1: 51.877	1.622	46.500	1436.73
2: Ca2SiO4(s2) / Ca2SiO4(s3) / Ca3SiO5	2: 0.47778	0.18892	0.33330	1436.73	2: 45.778	20.006	34.216	1436.73
3: Ca3SiO5 / CaSiNa2O4 / MeO	3: 0.44357	0.22269	0.33374	1267.19	3: 42.354	23.501	34.145	1267.19
4: Ca3Si2O7 / CaSiO3(s2) / NC2S3	4: 0.42136	0.10464	0.47400	1264.36	4: 40.326	11.068	48.606	1264.36
5: Ca2Si2Na2O7 / Ca2SiO4(s3) / Ca3Si2O7	5: 0.43429	0.15633	0.40938	1251.09	5: 41.531	16.523	41.946	1251.10
6: Ca2Si2Na2O7 / Ca3Si2O7 / NC2S3	6: 0.42715	0.15303	0.41981	1248.38	6: 40.833	16.168	42.999	1248.38
7: Ca2Si2Na2O7 / CaSiNa2O4 / NC2S3	7: 0.30413	0.28280	0.41307	1215.96	7: 28.711	29.508	41.782	1215.96
8: Ca2Si2Na2O7 / Ca2SiO4(s3) / CaSiNa2O4	8: 0.42938	0.21913	0.35149	1203.83	8: 40.965	23.106	35.929	1203.83
9: CaSiNa2O4 / NC2S3 / Na4CaSi3O9	9: 0.12899	0.37915	0.49186	1149.07	9: 11.999	38.980	49.022	1149.07
10: CaSiO3(s2) / CaSiO3(s) / Cristobalite	10: 0.18958	0.11433	0.69609	1124.45	10: 22.463	15.050	62.487	1124.14
11: CaSiO3(s2) / CaSiO3(s) / NC2S3	11: 0.23796	0.14425	0.61779	1124.13	11: 17.856	11.901	70.244	1124.13
12: CaSiNa2O4 / Na4CaSi3O9 / SiNa2O3	12: 0.05171	0.45761	0.49068	1065.43	12: 4.774	46.692	48.535	1065.39
13: CaSiO3(s) / NC2S3 / Na2Ca3Si6O16	13: 0.18146	0.14394	0.67460	1059.27	13: 17.065	14.961	67.974	1059.27
14: CaSiO3(s) / Na2Ca3Si6O16 / Cristobalite	14: 0.16476	0.13421	0.70103	1055.21	14: 15.481	13.938	70.580	1055.21
15: MeO / Na2O(s2) / Na2O(s3)	15: 0.00471	0.81632	0.17897	970.05	15: 0.428	82.119	17.453	970.05
16: CaSiNa2O4 / Si2Na6O7 / SiNa2O3	16: 0.12623	0.50643	0.36733	957.78	16: 11.693	51.849	36.458	957.78
17: MeO / Na2O(s2) / SiNa4O4	17: 0.00221	0.78294	0.21485	937.28	17: 0.202	78.828	20.970	937.28
18: Na2Ca3Si6O16 / Cristobalite / Quartz	18: 0.05884	0.18303	0.75813	926.29	18: 5.481	18.845	75.674	926.28
19: CaSiNa2O4 / MeO / SiNa4O4	19: 0.15779	0.50873	0.33348	883.13	19: 14.647	52.188	33.165	885.22
20: CaSiNa2O4 / Si2Na6O7 / SiNa4O4	20: 0.14199	0.51492	0.34309	864.64	20: 13.163	52.758	34.078	864.65
21: Na2Ca3Si6O16 / Na2CaSi5O12 / Quartz	21: 0.04770	0.20087	0.75144	857.44	21: 4.437	20.655	74.907	857.45
22: NC2S3 / Na4CaSi3O9 / Si2Na2O5(s3)	22: 0.02951	0.32739	0.64310	807.32	22: 2.732	33.491	63.777	807.32
23: Na4CaSi3O9 / Si2Na2O5(s3) / SiNa2O3	23: 0.01751	0.34996	0.63253	800.16	23: 1.618	35.747	62.635	800.16
24: Na2Ca3Si6O16 / Na2CaSi5O12 / Si2Na2O5(s3)	24: 0.04391	0.28419	0.67189	772.05	24: 4.074	29.140	66.786	772.05
25: Na2CaSi5O12 / Si8Na6O19 / Quartz	25: 0.02297	0.24441	0.73263	754.81	25: 2.131	25.057	72.813	754.81
26: Na2CaSi5O12 / Si2Na2O5(s3) / Si8Na6O19	26: 0.02446	0.25922	0.71633	754.43	26: 2.268	26.565	71.167	754.43

CaO-Na2O-V2O5, Mole fraction, 300°

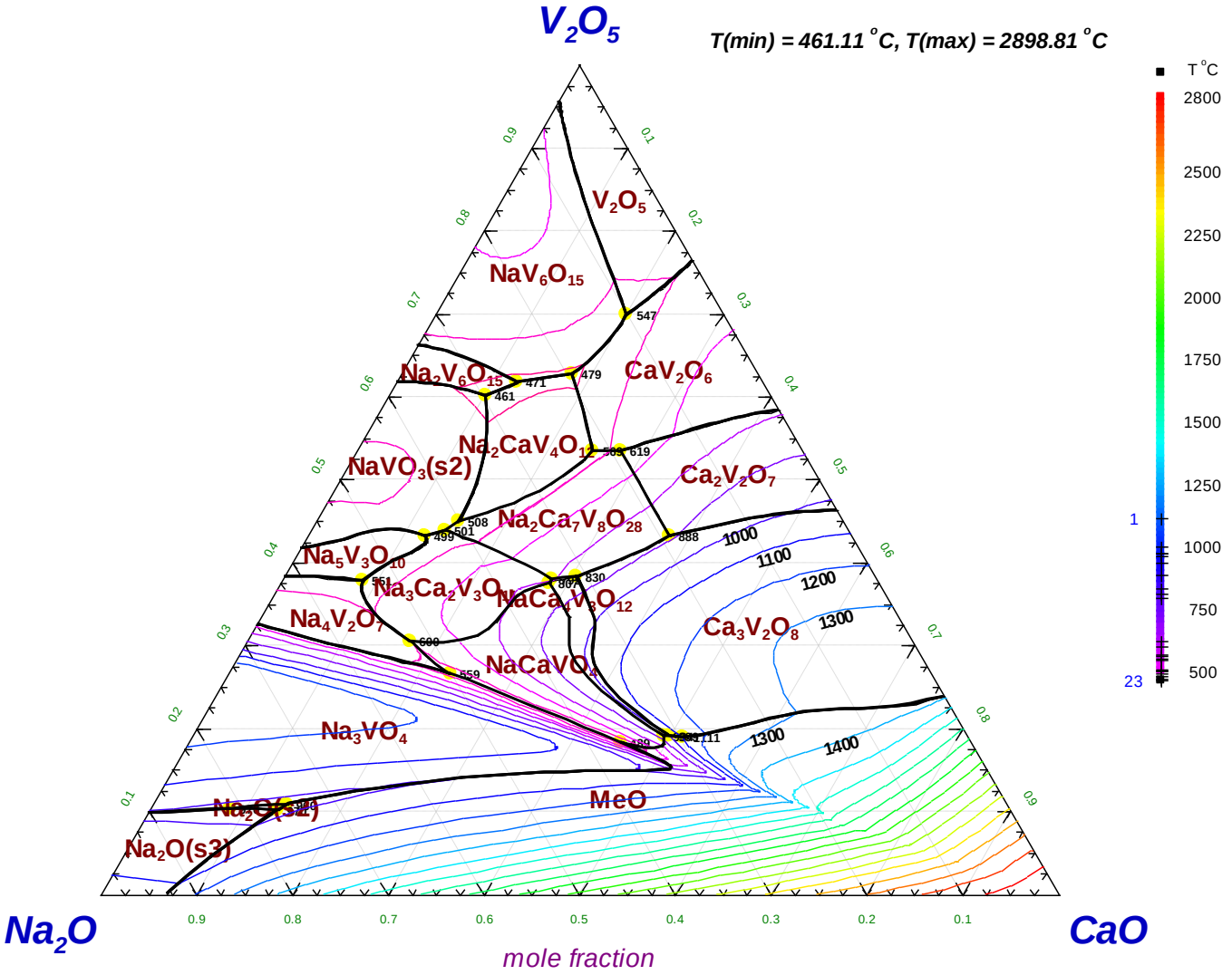
Phase	N:C:V	Experiment	Calculated
$Na_2CaV_4O_{12}$	112	570[Slobodin 2000] 550 [Krasnenko1987]	569
$Na_3Ca_2V_3O_{11}$	343		807
$NaCaVO_4$	121	~1000	934
$Na_2Ca_7V_8O_{28}$	174	~880 [Krasnenko1987]	888
$NaCa_4V_3O_{12}$	183	~1000	999



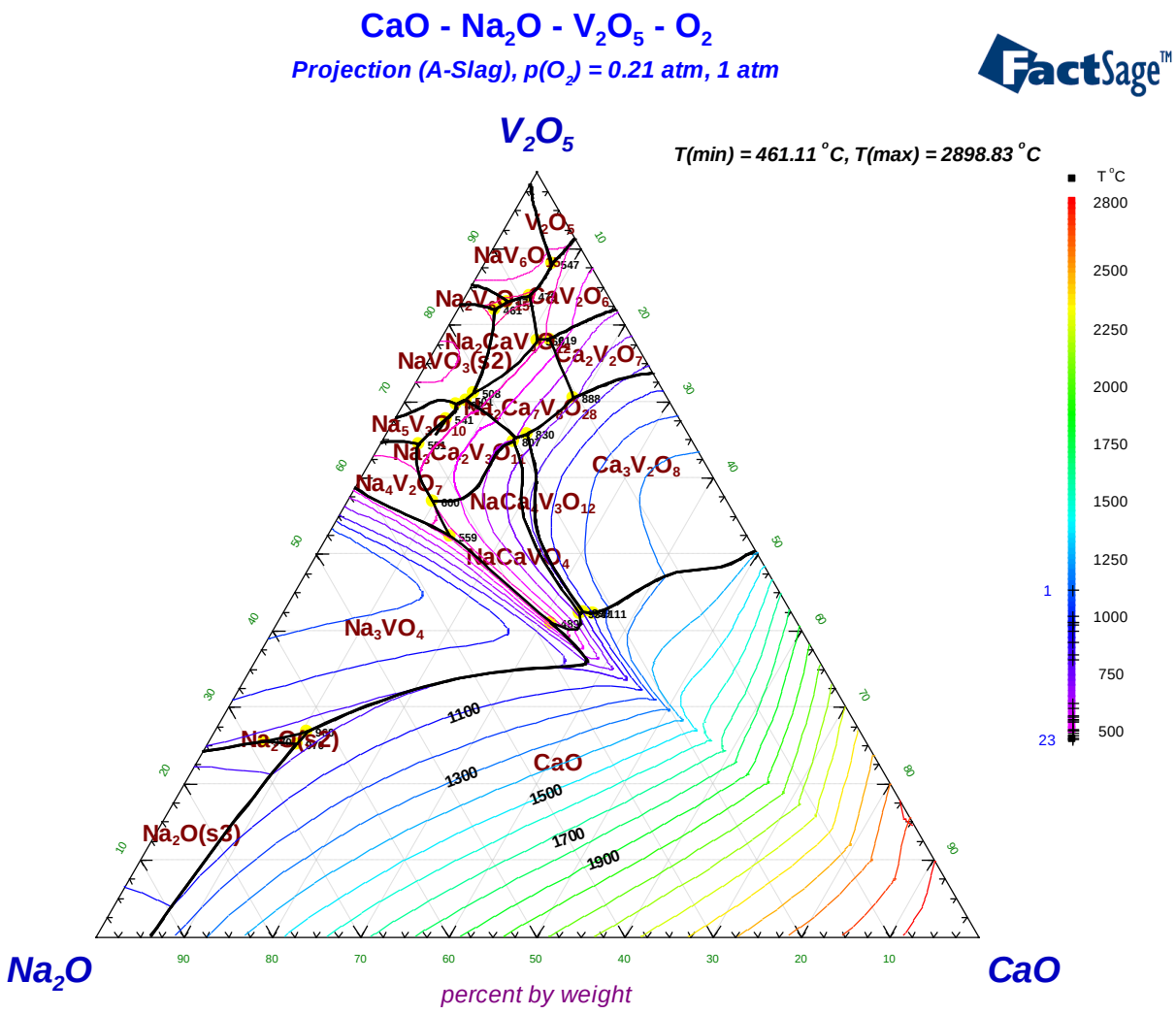

Na2O - V2O5 - CaO - O2
Projection - formation (Slag), p(O2) = 0.21 atm, 1 atm
FactSage
V2O5
547
471
499
461
508
569
619
499
501
888
795
559
600
807
830
489
934
998
960
Na2O
CaO
mole fraction

$CaO - Na_2O - V_2O_5 - O_2$

Projection (A-Slag), $p(O_2)$ = 0.21 atm, 1 atm



CaO-Na2O-V2O5, Weight percent, Liquidus surface

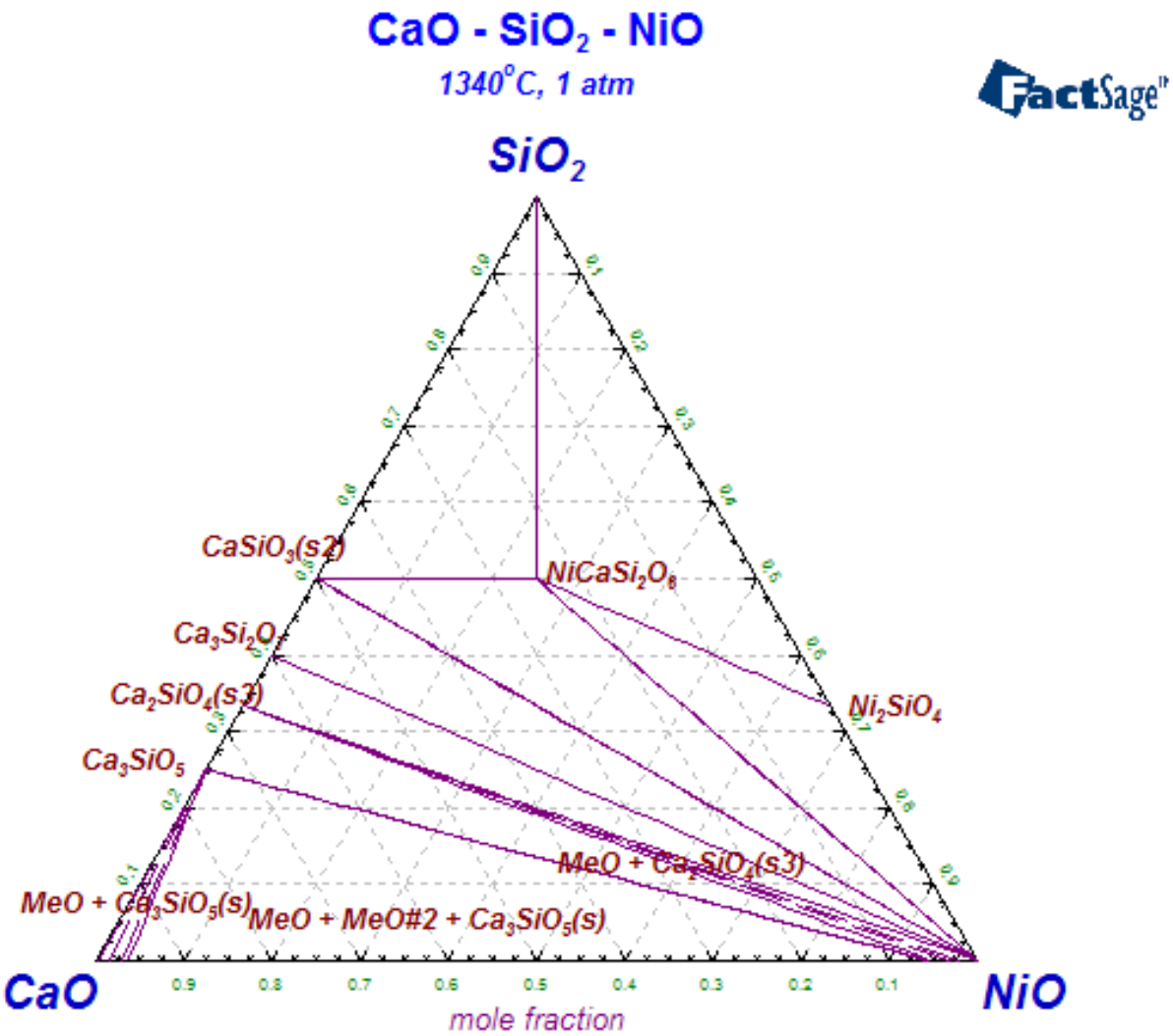


Invariant equilibria on the liquidus surface

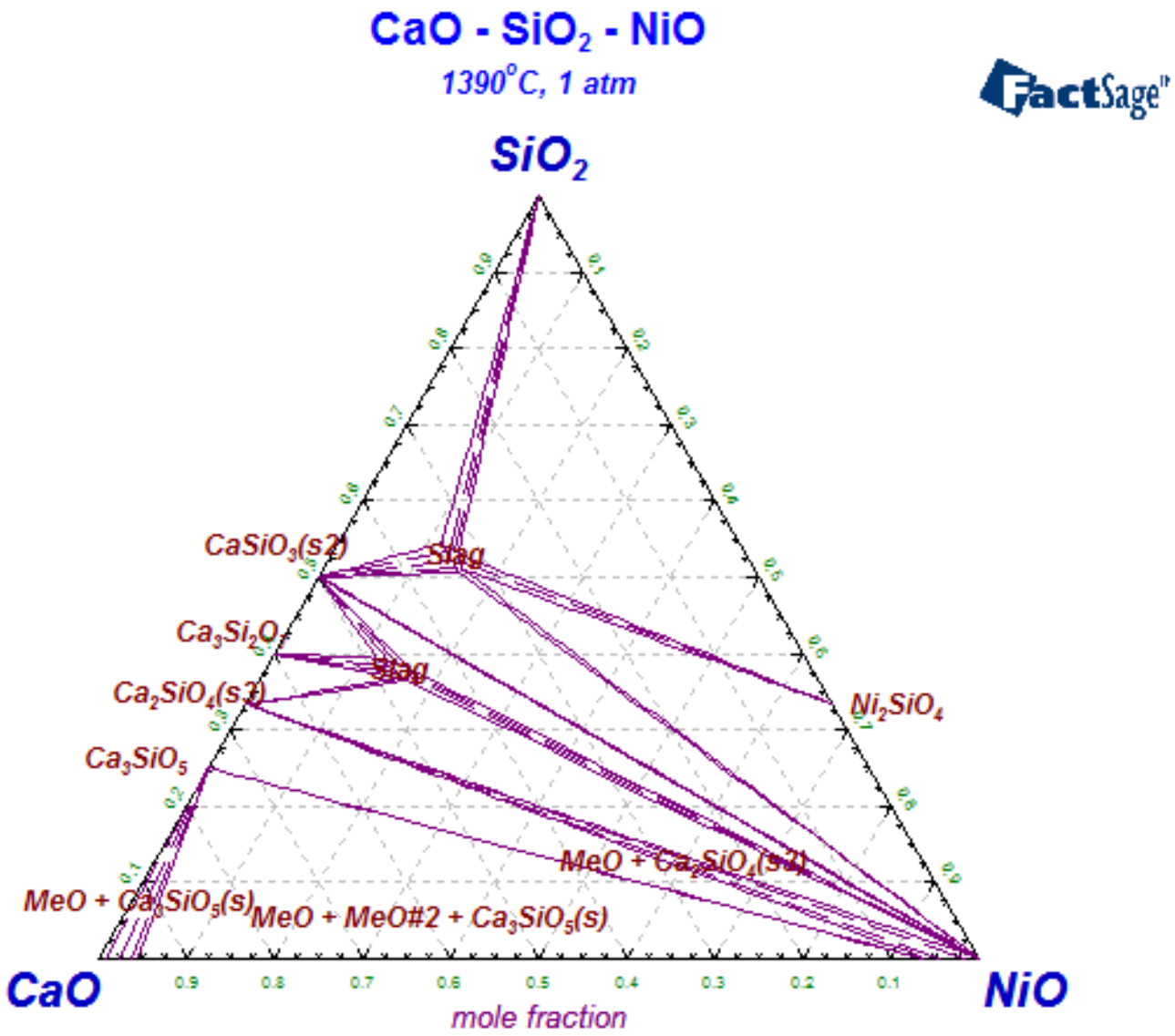
Intersections with slag	Mole fraction A = V2O5, B = Na2O, C = CaO X(A) X(B) X(C) T(C)	Weight percent A = V2O5, B = Na2O, C = CaO W(A) W(B) W(C) T(C)
1. Ca3V2O8 / Ca7V4O17 / MeO	1: 0.19031 0.29627 0.51342 1111.04	1: 42.332 22.457 35.212 1110.99
2.Ca3V2O8 / Ca7V4O17 / NaCa4V3O12	2: 0.19172 0.31082 0.49747 999.04	2: 42.508 23.484 34.008 999.02
3. Na2O(s2) / Na2O(s3) / Na3VO4	3: 0.10387 0.81282 0.08332 970.05	3: 25.227 64.605 10.168 970.06
4. MeO / Na2O(s2) / Na2O(s3)	4: 0.10181 0.76510 0.13310 970.05	4: 25.549 68.132 6.319 970.05
5. MeO / Na2O(s2) / Na3VO4	5: 0.10905 0.75062 0.14032 959.78	5: 26.721 62.677 10.601 959.78
6. MeO / NaCa4V3O12_183 / NaCaVO4_121	6: 0.19060 0.31629 0.49311 934.32	6: 42.317 23.929 33.754 934.32
7. Ca2V2O7 / Ca3V2O8 / Na2Ca7V8O28_174	7: 0.43213 0.18995 0.37792 888.03	7: 70.450 10.553 18.997 888.05
8. Ca3V2O8/Na2Ca7V8O28_174/NaCa4V3O12	8: 0.38393 0.31104 0.30503 829.65	8: 65.745 18.150 16.105 829.65
9. Na3Ca2V3O11 / NaCa4V3O12 / NaCaVO4	9: 0.37475 0.34397 0.28128 807.38	9: 64.758 20.255 14.987 807.38
10.Na2Ca7V8O28/ Na3Ca2V3O11/NaCa4V3O12	10:0.38020 0.33876 0.28104 794.92	10: 78.168 9.450 12.383 619.04
11.Ca2V2O7 / CaV2O6 / Na2Ca7V8O28_174	11:0.53518 0.18985 0.27497 619.05	11: 56.892 33.296 9.812 600.29
12.Na3Ca2V3O11 / Na4V2O7 / NaCaVO4_121	12:0.30517 0.52412 0.17071 600.29	12: 78.009 10.878 11.112 568.95
13.CaV2O6 / Na2Ca7V8O28 / Na2CaV4O12	13:0.53441 0.21869 0.24690 568.95	13: 52.369 33.605 14.026 559.43
14.Na3VO4 / Na4V2O7 / NaCaVO4_121	14:0.26654 0.50192 0.23154 559.44	14: 64.390 31.199 4.411 550.81
15.Na3Ca2V3O11 / Na4V2O7 / Na5V3O10	15:0.37821 0.53776 0.08404 550.81	15: 87.953 4.316 7.731 547.12
16.CaV2O6 / NaV6O15 / V2O5	16:0.69975 0.10076 0.19950 547.12	16: 67.670 26.412 5.918 540.67
17.Na2Ca7V8O28 / Na2CaV4O12 / NaVO3(s2)	17:0.44996 0.40082 0.14922 507.94	17: 71.134 21.593 7.273 508.04
18.Na2Ca7V8O28 / Na3Ca2V3O11 / NaVO3(s2)	18:0.43896 0.42087 0.14016 500.55	18: 70.167 22.925 6.908 500.55
19.Na3Ca2V3O11 / Na5V3O10 / NaVO3(s2)	19:0.43252 0.44481 0.12267 499.10	19: 69.546 24.372 6.082 499.10
20.MeO / Na3VO4 / NaCaVO4	20:0.18323 0.36475 0.45202 488.52	20: 41.001 27.814 31.186 488.53
21.CaV2O6 / Na2CaV4O12 / NaV6O15	21:0.62721 0.19439 0.17839 478.53	21: 83.801 8.851 7.349 478.53
22.Na2CaV4O12 / Na2V6O15 / NaV6O15	22:0.61745 0.25657 0.12598 470.56	22: 83.022 11.756 5.223 470.56
23.Na2CaV4O12 / Na2V6O15 / NaVO3(s2)	23:0.60170 0.29744 0.10087 461.11	23: 81.958 13.806 4.236 461.11

CaO-NiO-SiO2,

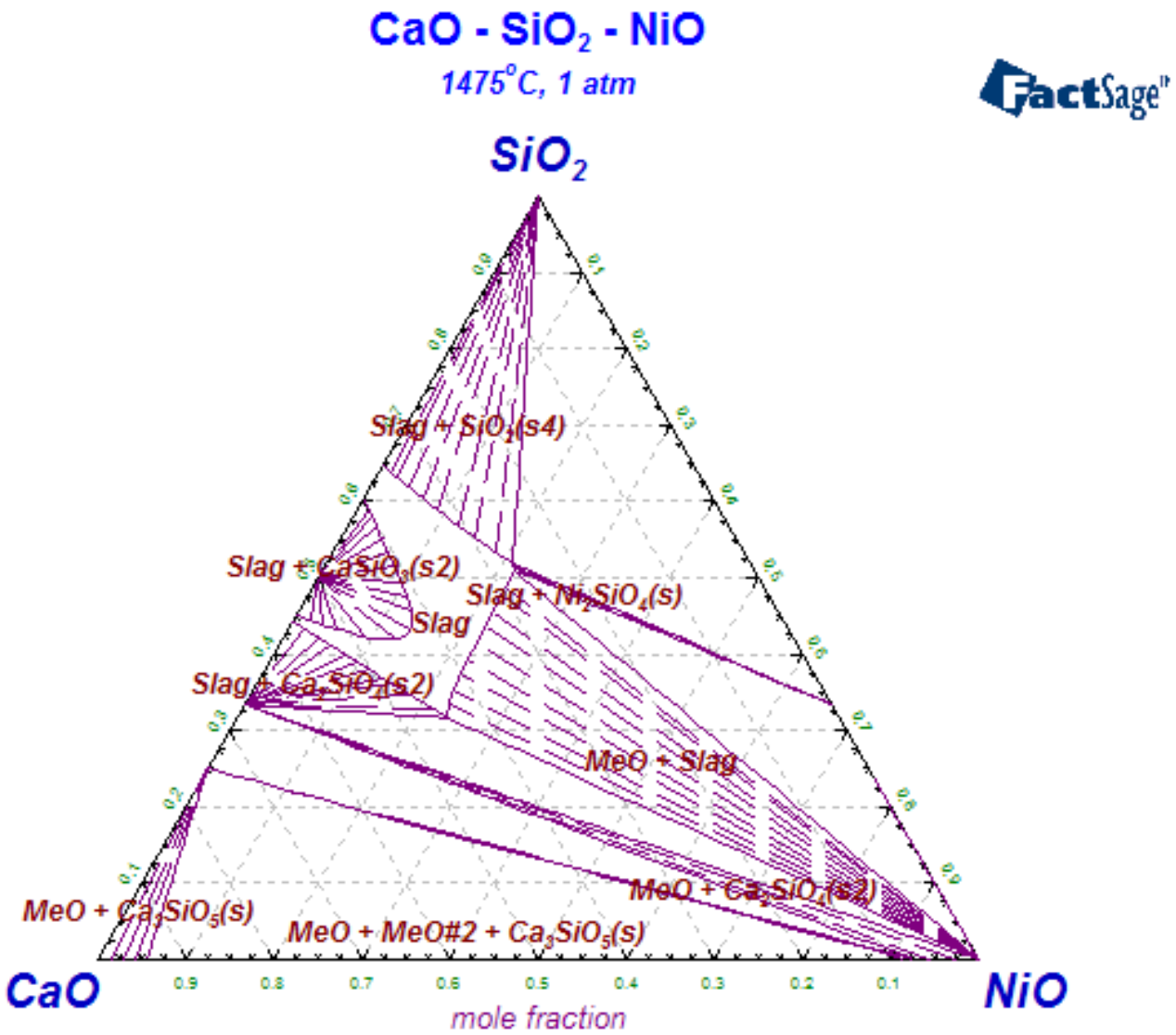
Mole fraction 1340°C



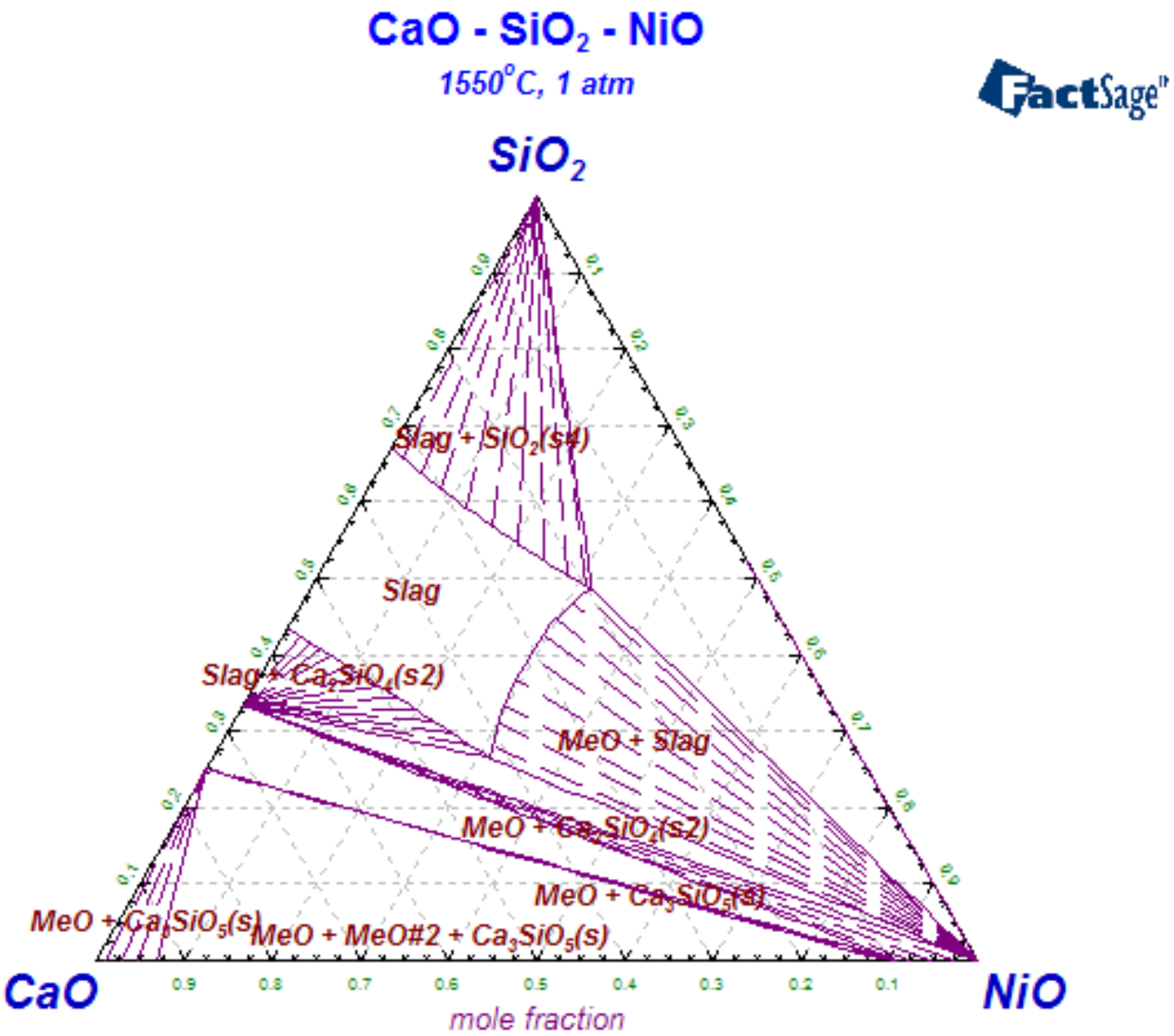
Mole fraction 1390°C

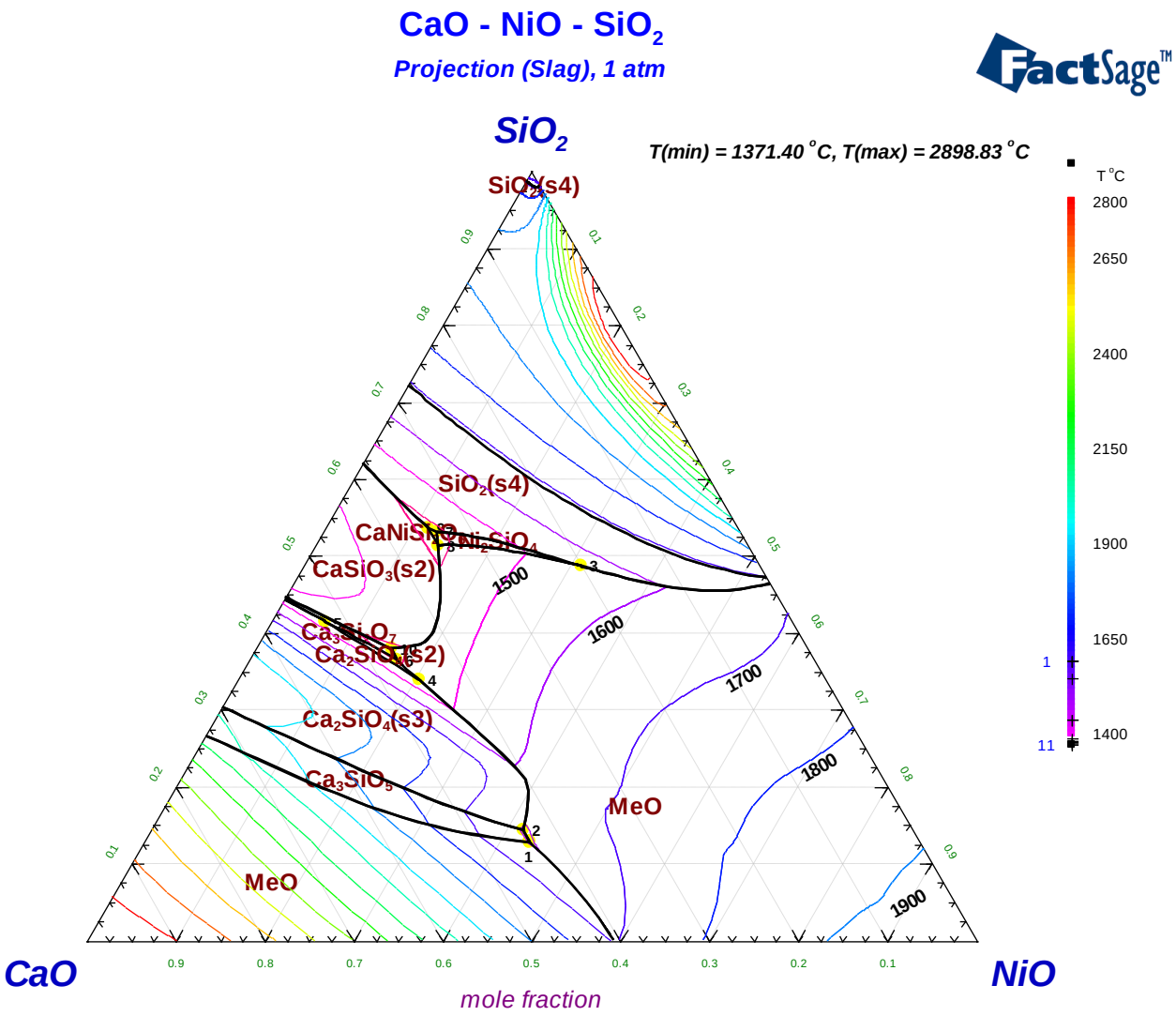


Mole fraction 1475°C

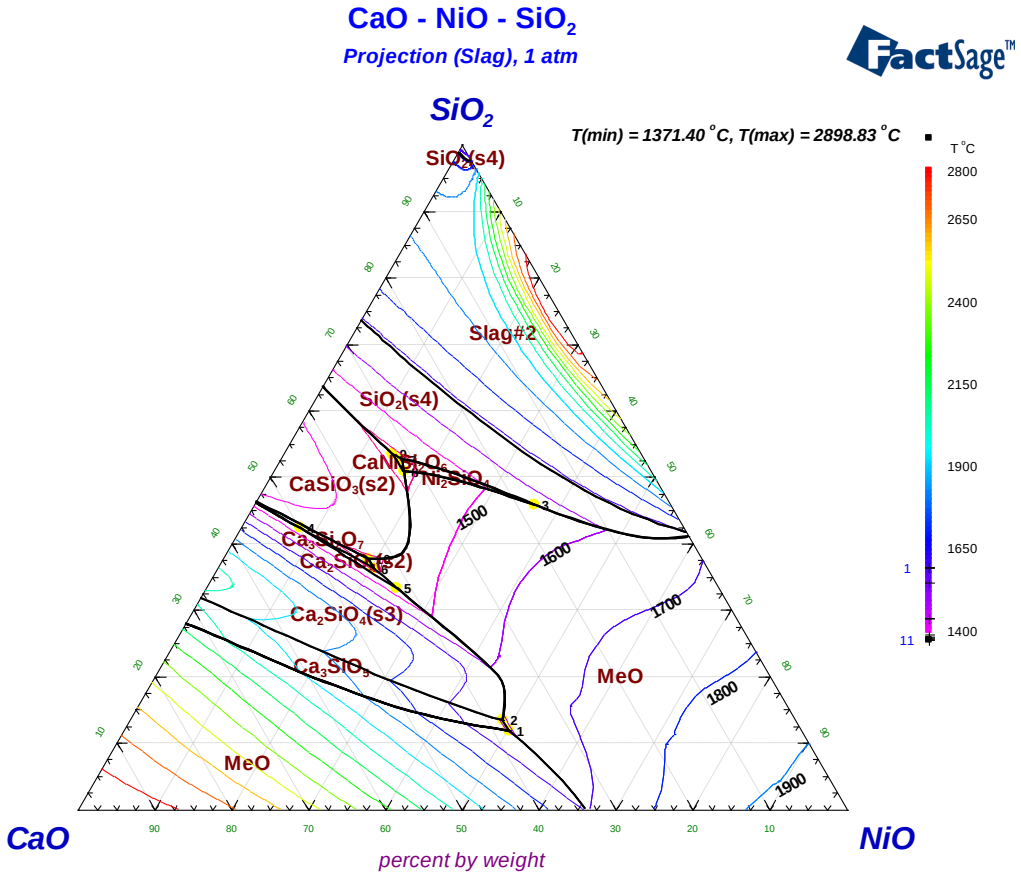


Mole fraction 1550°C




CaO - NiO - SiO2
Projection (Slag), 1 atm
FactSage™
SiO2
T(min) = 1371.40 °C, T(max) = 2898.83 °C
T °C
2800
2650
2400
2150
1900
1650
1400
SiO2(s4)
SiO2(s4)
CaNiSiO3
Ni2SiO4
CaSiO3(s2)
Ca3Si2O7
Ca2SiO4(s2)
Ca2SiO4(s3)
Ca3SiO5
MeO
MeO
1500
1600
1700
1800
1900
CaO
NiO
mole fraction

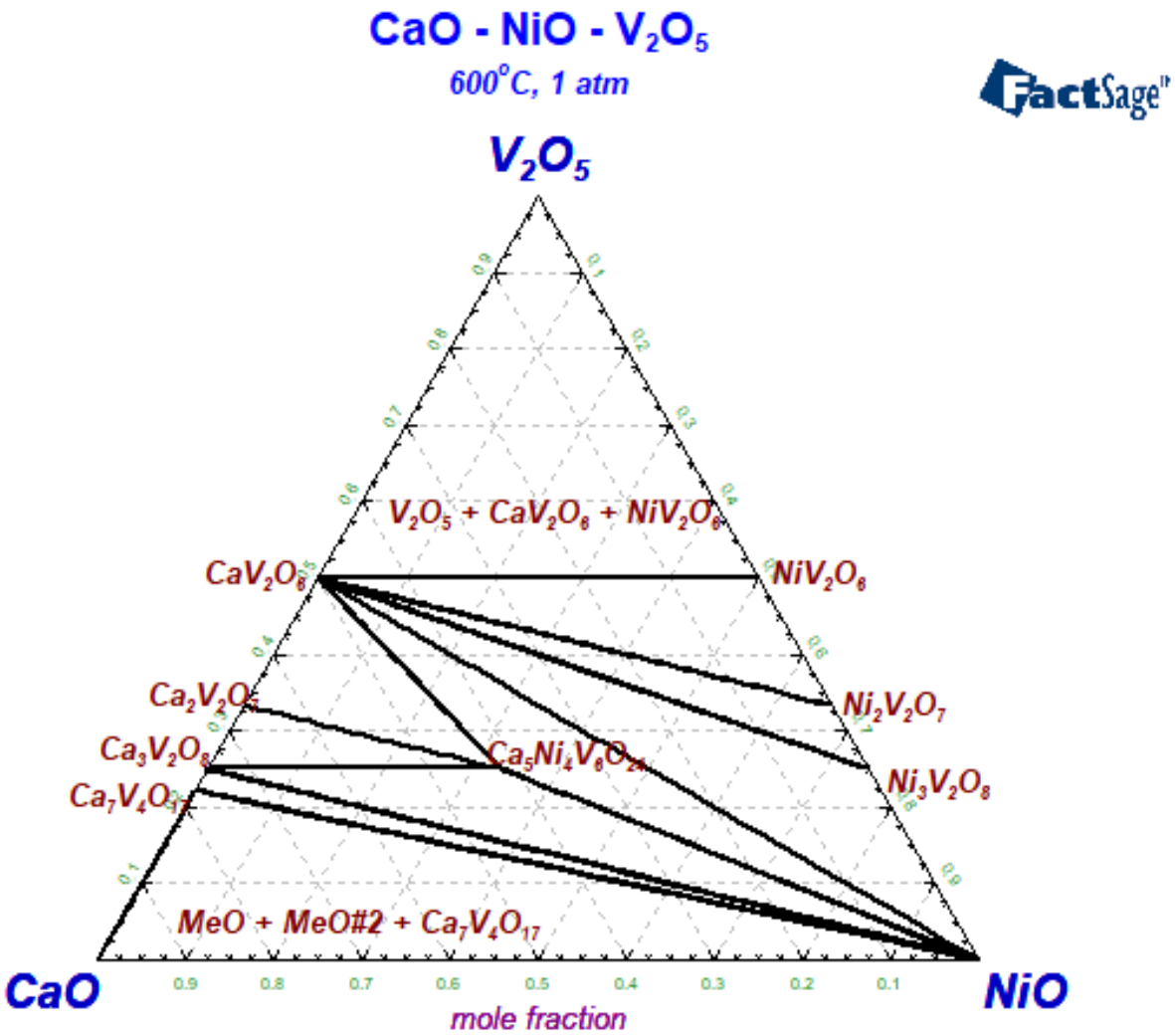
Weight percent, Liquiudussurface



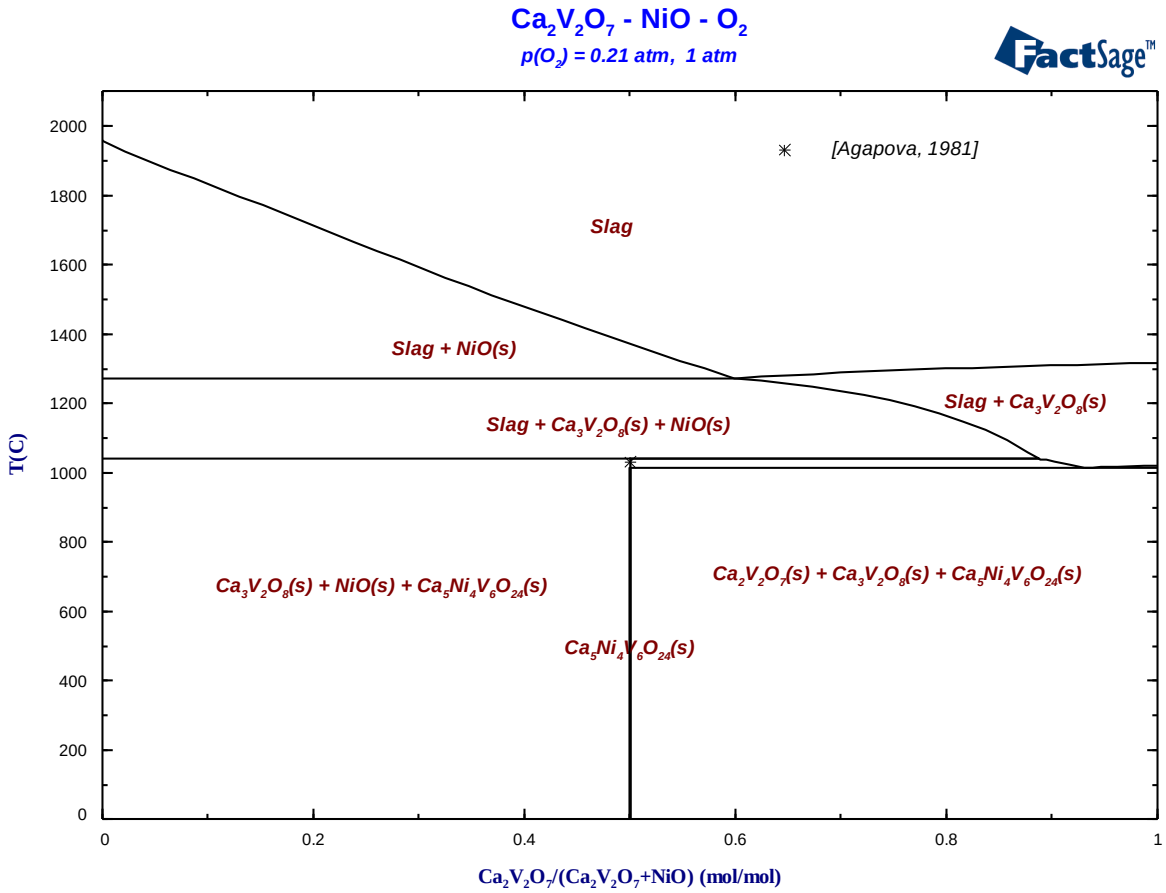
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction					Weight percent				
	A = SiO2, B = CaO, C = NiO					A = SiO2, B = CaO, C = NiO				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: Ca3SiO5 / MeO#1 / MeO#2	1:	0.12901	0.43797	0.43302	1593.43	1:	12.002	37.986	50.012	1593.43
2: Ca2SiO4(s3) / Ca3SiO5 / MeO#1	2:	0.14353	0.43757	0.41889	1592.33	2:	13.381	38.072	48.546	1592.29
3: MeO#1 / Ni2SiO4 / SiO2(s4)	3:	0.48708	0.20080	0.31211	1546.59	3:	45.843	17.639	36.518	1546.58
4: Ca2SiO4(s3) / Ca2SiO4(s2) / MeO#1	4:	0.33933	0.45712	0.20355	1436.73	4:	42.393	49.972	7.635	1436.73
5: Ca2SiO4(s3) / Ca2SiO4(s2) / Ca3Si2O7	5:	0.41530	0.52453	0.06017	1436.73	5:	33.300	41.868	24.833	1436.73
6: Ca2SiO4(s2) / Ca3Si2O7 / MeO#1	6:	0.36614	0.46849	0.16538	1387.96	6:	36.288	43.336	20.376	1387.96
7: CaNiSi2O6 / Ni2SiO4 / SiO2(s4)	7:	0.53154	0.34059	0.12788	1381.30	7:	52.712	31.523	15.765	1381.30
8: CaNiSi2O6 / CaSiO3(s2) / MeO#1	8:	0.51419	0.34801	0.13780	1378.61	8:	50.895	32.149	16.956	1378.61
9: CaNiSi2O6 / CaSiO3(s2) / SiO2(s4)	9:	0.53741	0.34806	0.11452	1376.08	9:	53.493	32.335	14.171	1376.08
10: Ca3Si2O7 / CaSiO3(s2) / MeO#1	10:	0.37990	0.46765	0.15244	1371.40	10:	37.768	43.392	18.840	1371.40

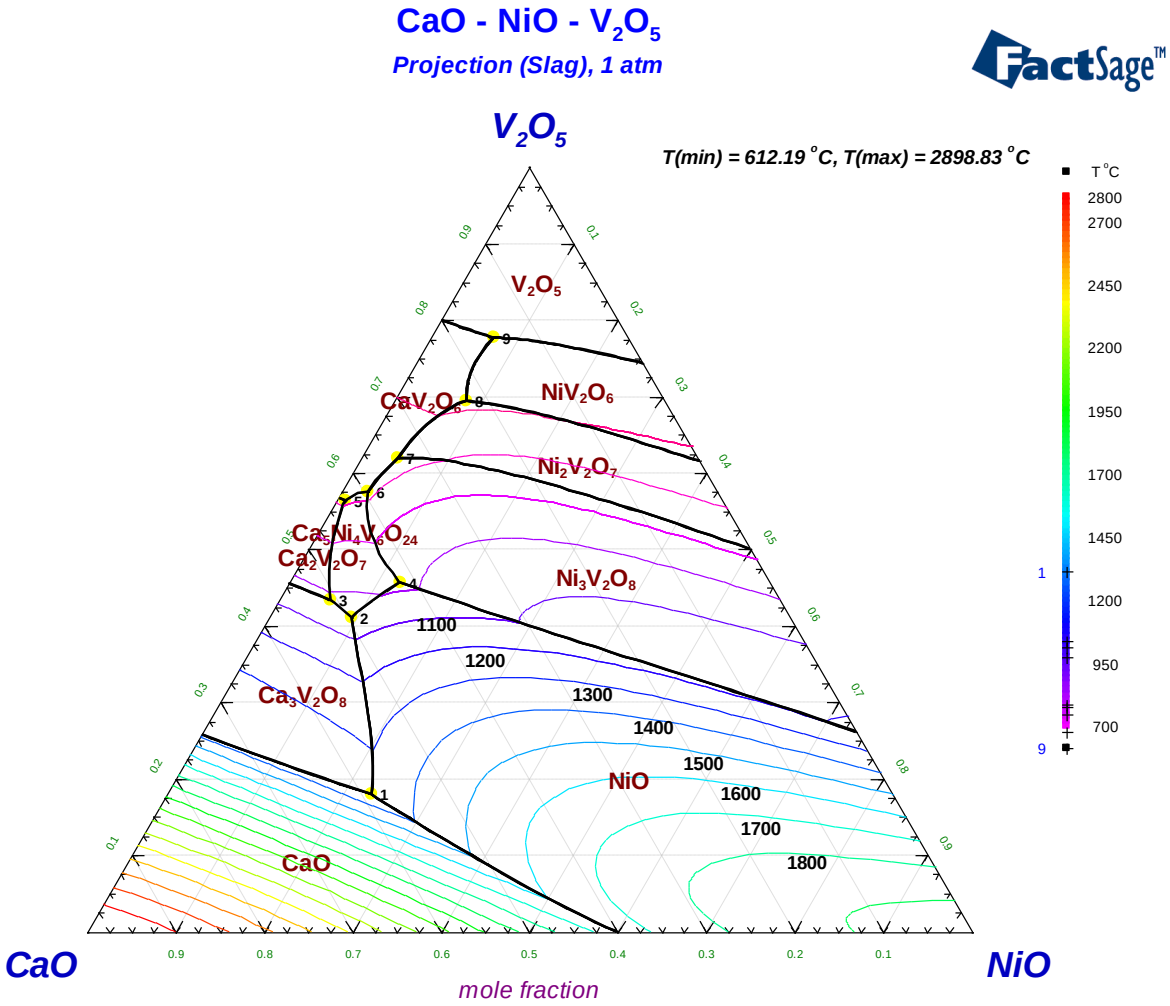
Mole fraction 600°C

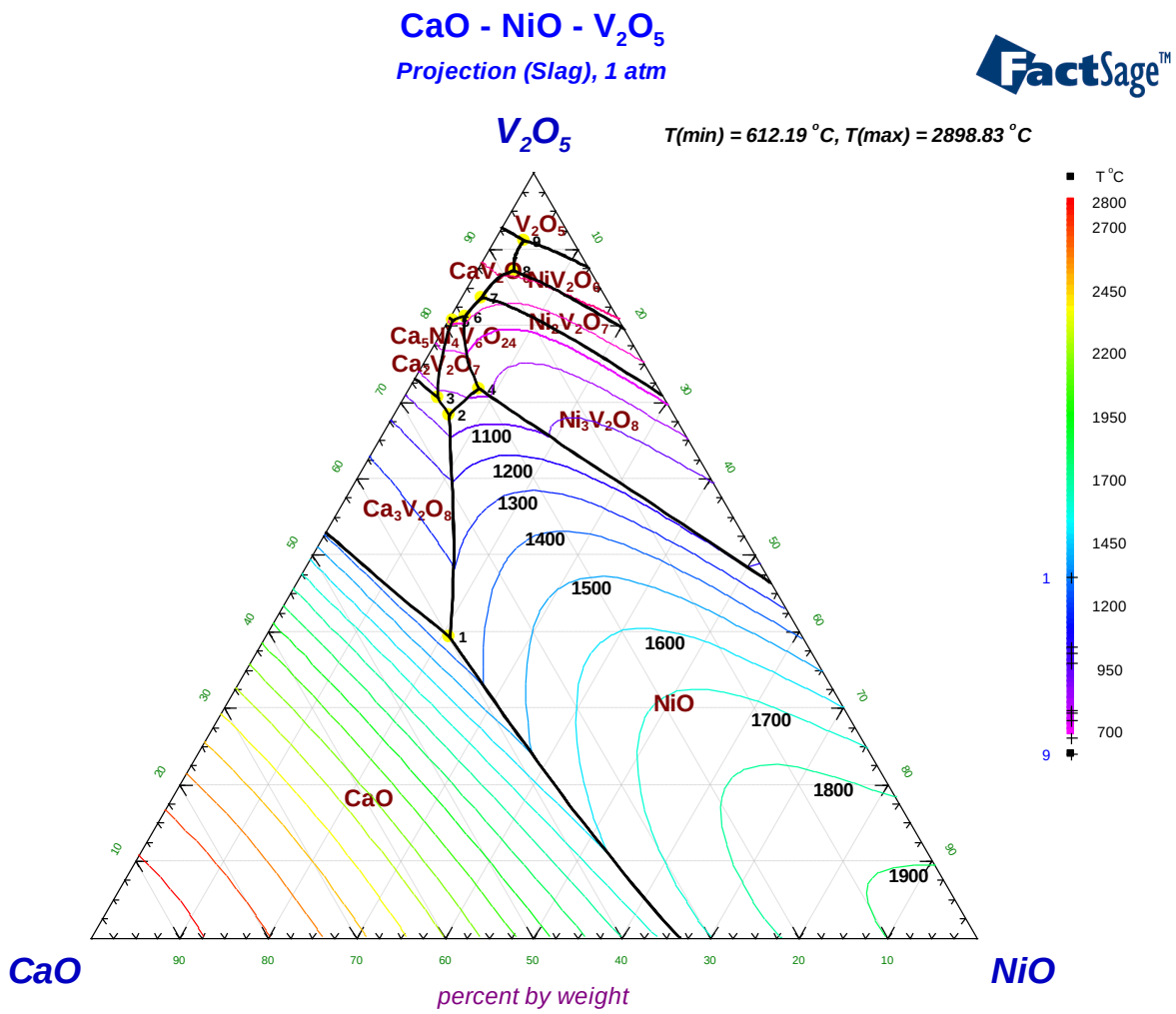


CaO-NiO-V2O5,
Mole fraction , Isopleth Ca2V2O7-NiO-O2



CaO-NiO-V2O5,
Mole fraction , Liquidus surface

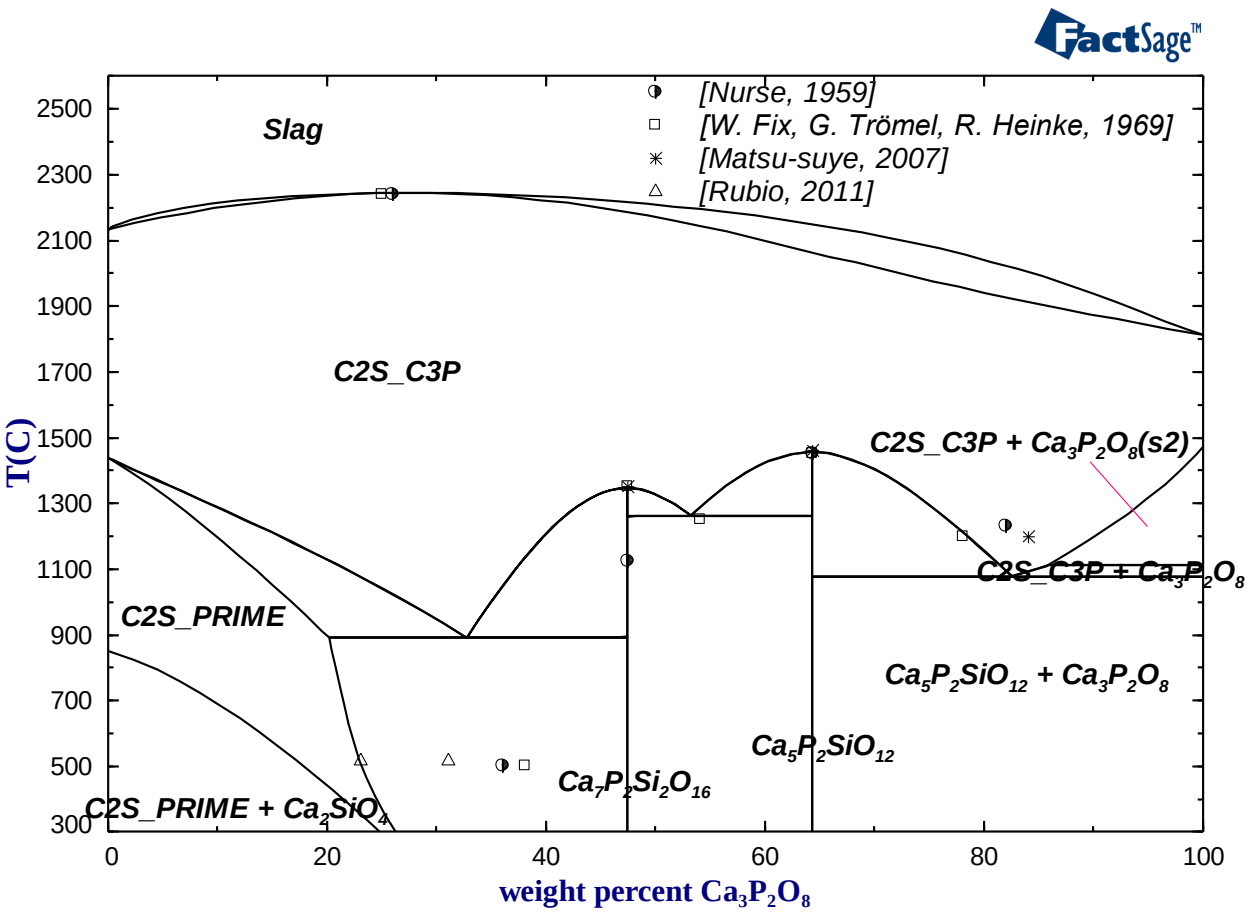



CaO - NiO - V2O5
Projection (Slag), 1 atm
V2O5
T(min) = 612.19 °C, T(max) = 2898.83 °C
T °C
2800
2700
2450
2200
1950
1700
1450
1200
950
700
V2O5
CaV2O6
NiV2O6
Ni2V2O7
Ca5Ni4V6O24
Ca2V2O7
Ni3V2O8
Ca3V2O8
NiO
CaO
1100
1200
1300
1400
1500
1600
1700
1800
1900
CaO
NiO
percent by weight

Invariant equilibria on the liquidus surface

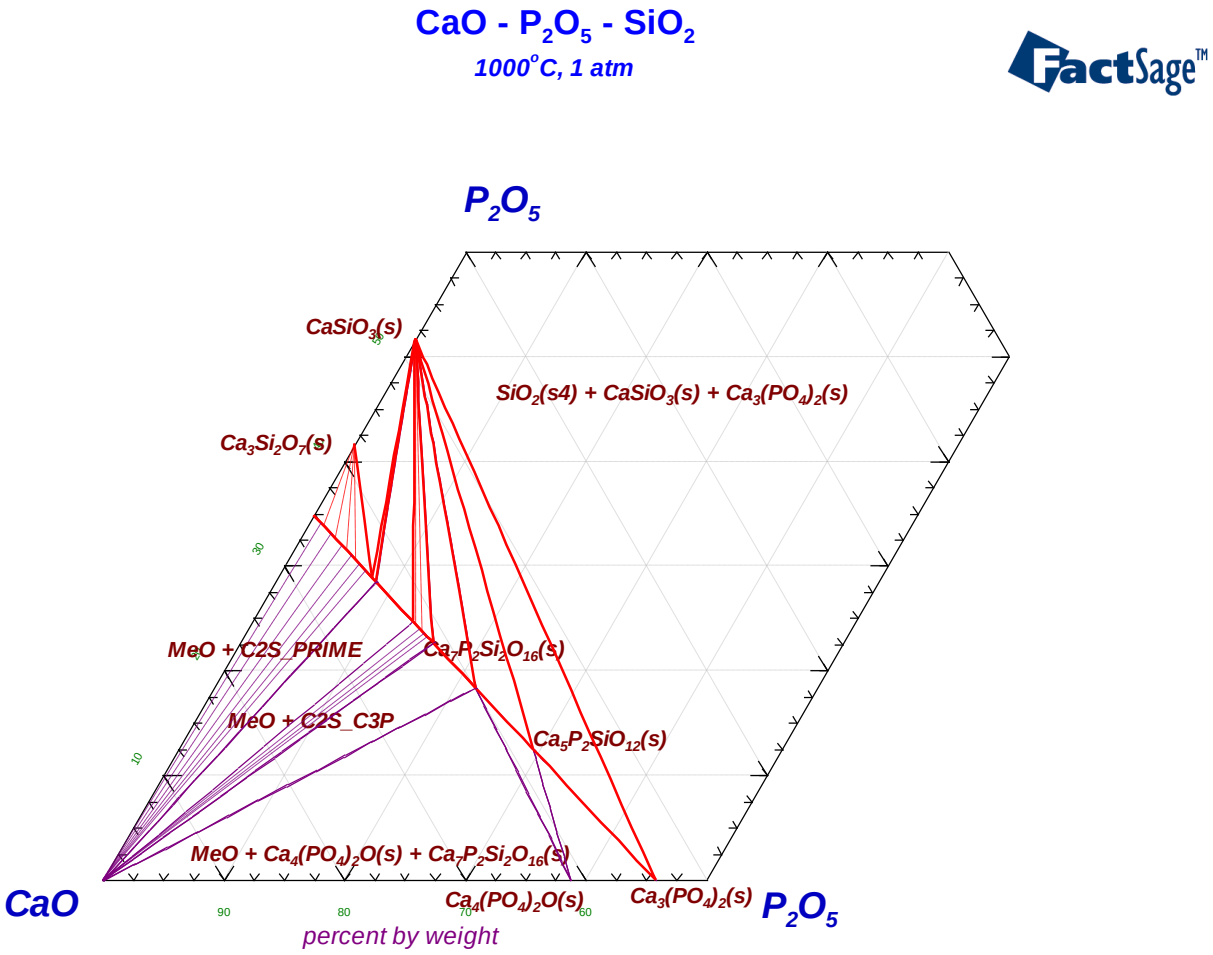
Intersections with slag	Mole fraction				Weight percent			
	A = V2O5, B = CaO, C = NiO				A = V2O5, B = CaO, C = NiO			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1. Ca3V2O8 / CaO / NiO	1: 0.17929	0.58879	0.23192	1312.72	1: 39.313	39.805	20.883	1312.72
2. Ca3V2O8 / Ca5Ni4V6O24 / NiO	2: 0.41099	0.49543	0.09358	1038.57	2: 68.252	25.367	6.382	1038.57
3. Ca2V2O7 / Ca3V2O8 / Ca5Ni4V6O24	3: 0.43340	0.50795	0.05866	1013.54	3: 70.575	25.503	3.923	1013.55
4. Ca5Ni4V6O24 / Ni3V2O8 / NiO	4: 0.45682	0.41818	0.12500	971.48	4: 71.704	20.238	8.058	971.48
5. Ca2V2O7 / Ca5Ni4V6O24 / CaV2O6	5: 0.56458	0.42647	0.00895	784.42	5: 80.684	18.791	0.525	784.43
6. Ca5Ni4V6O24 / CaV2O6 / Ni3V2O8	6: 0.57630	0.39443	0.02927	774.92	6: 81.177	17.130	1.693	774.97
7. CaV2O6 / Ni2V2O7 / Ni3V2O8	7: 0.62013	0.33839	0.04148	746.34	7: 83.632	14.071	2.298	746.33
8. CaV2O6 / Ni2V2O7 / NiV2O6	8: 0.69469	0.22424	0.08107	676.84	8: 87.150	8.674	4.176	676.84
9. CaV2O6 / NiV2O6 / V2O5	9: 0.77707	0.15222	0.07071	612.19	9: 91.094	5.502	3.404	612.19

CaO-P2O5-SiO2,
Weight percent



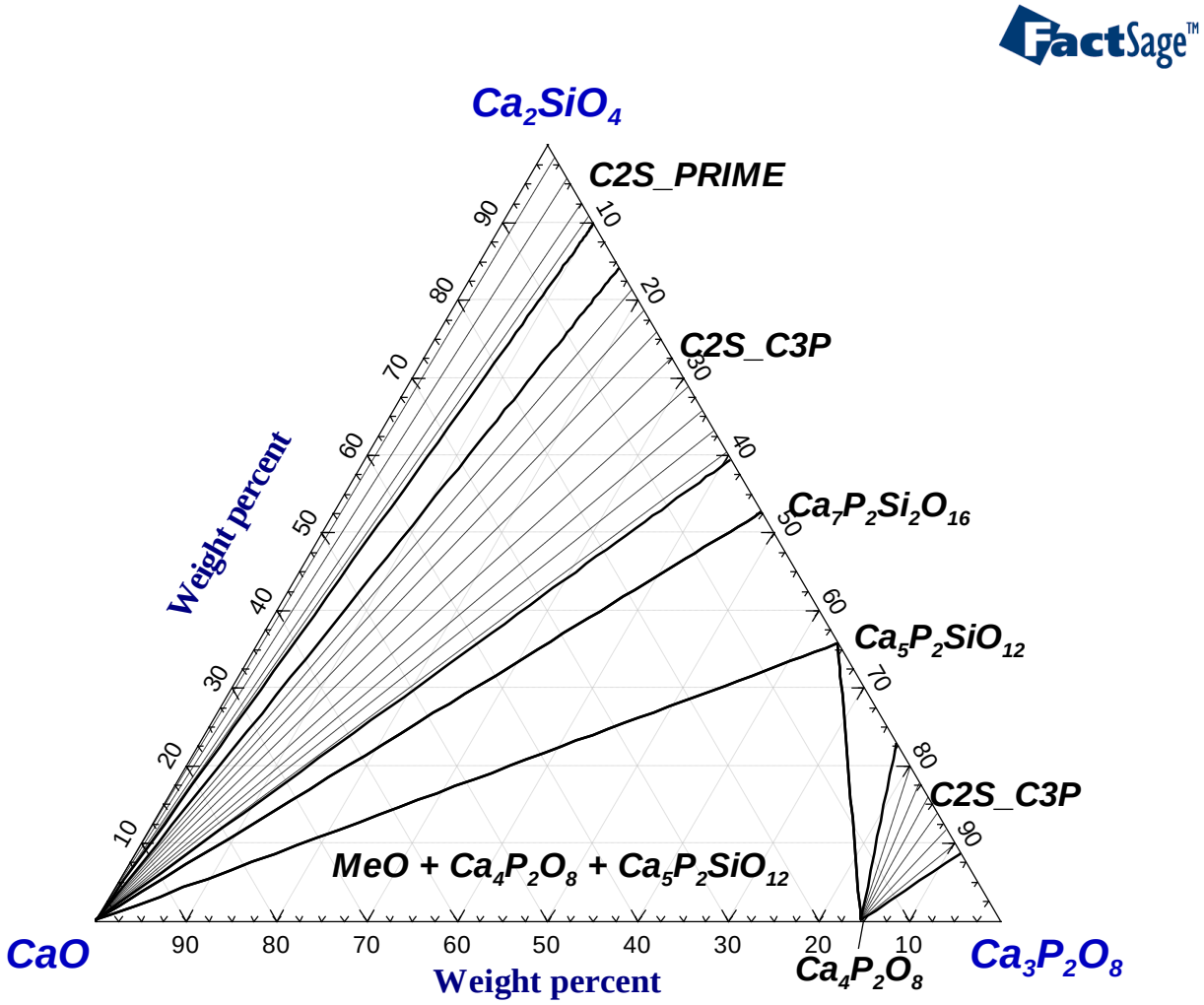
CaO-P2O5-SiO2,

Weight percent, 1000°C



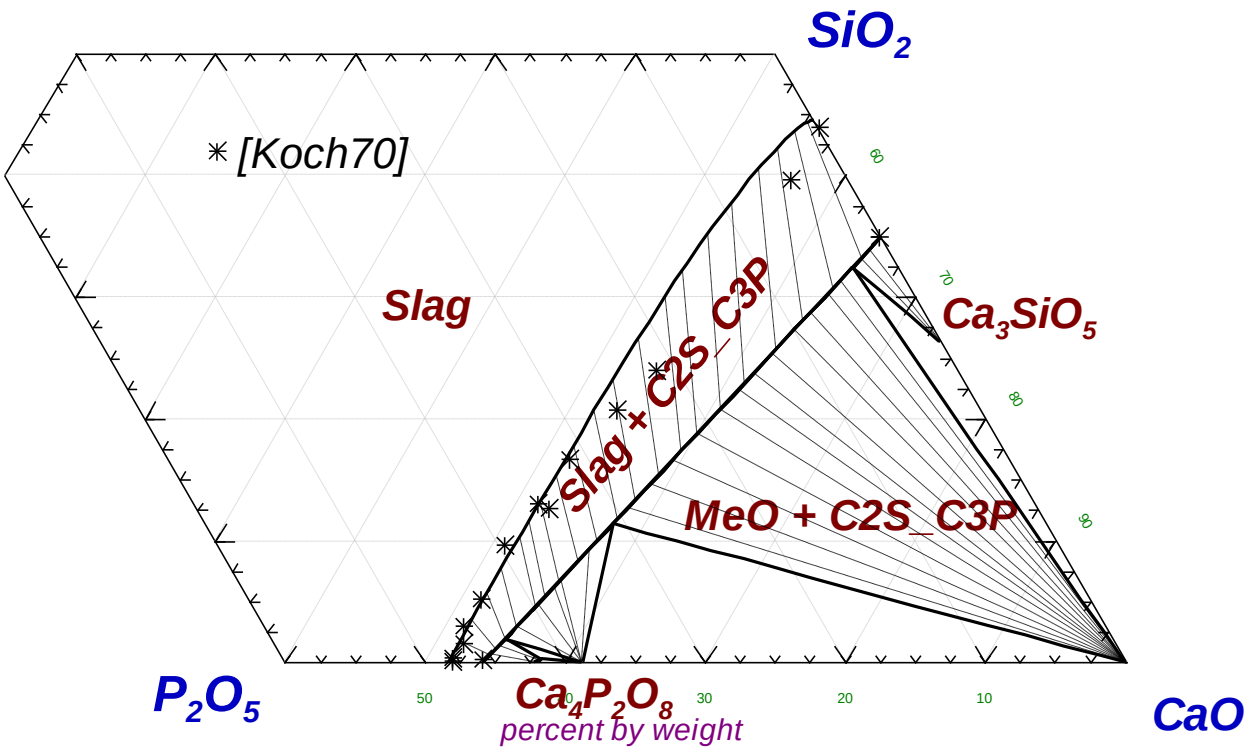
CaO-P2O5-SiO2,

Weight percent, 1225°C



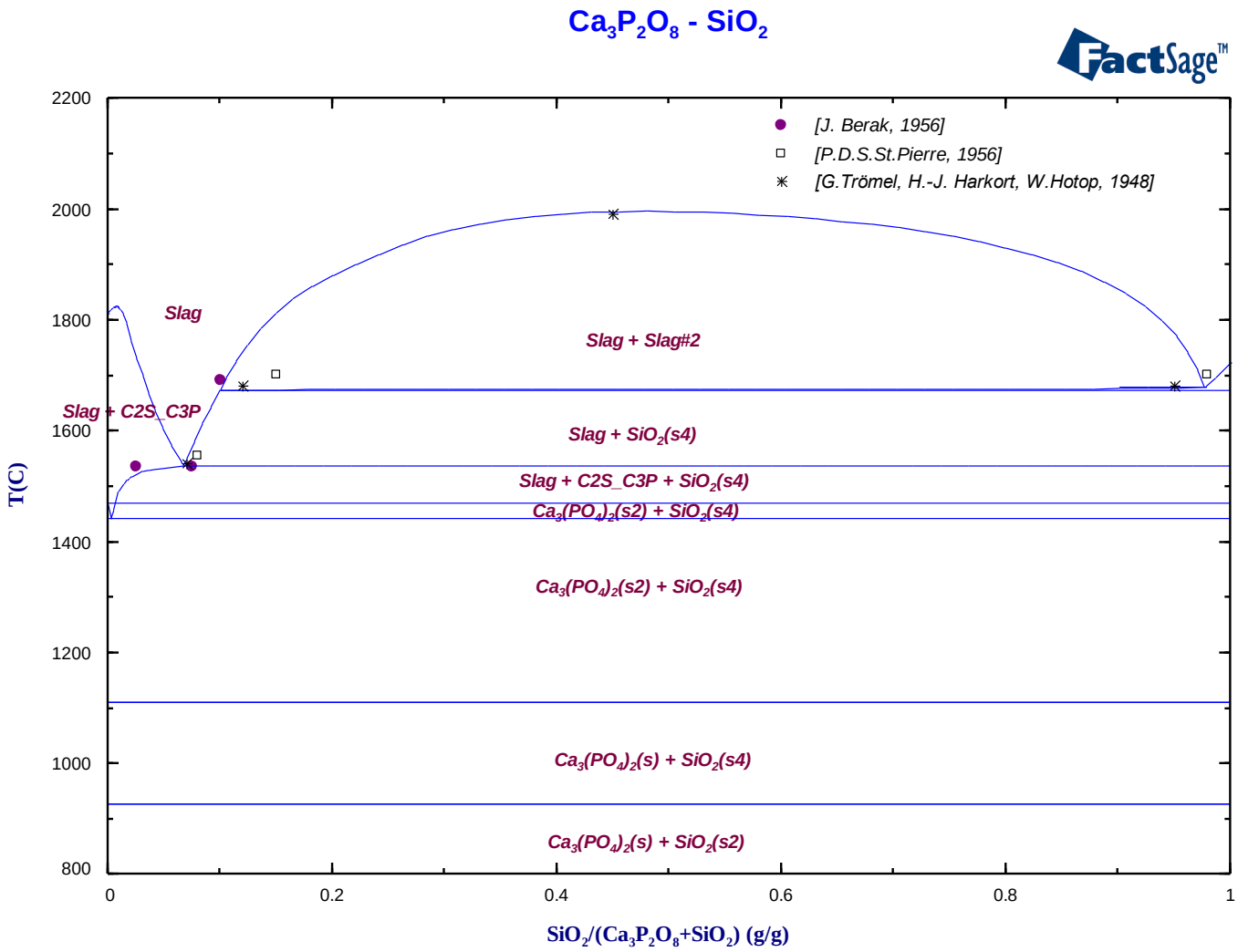
CaO-P2O5-SiO2,

Weight percent, 1600°C

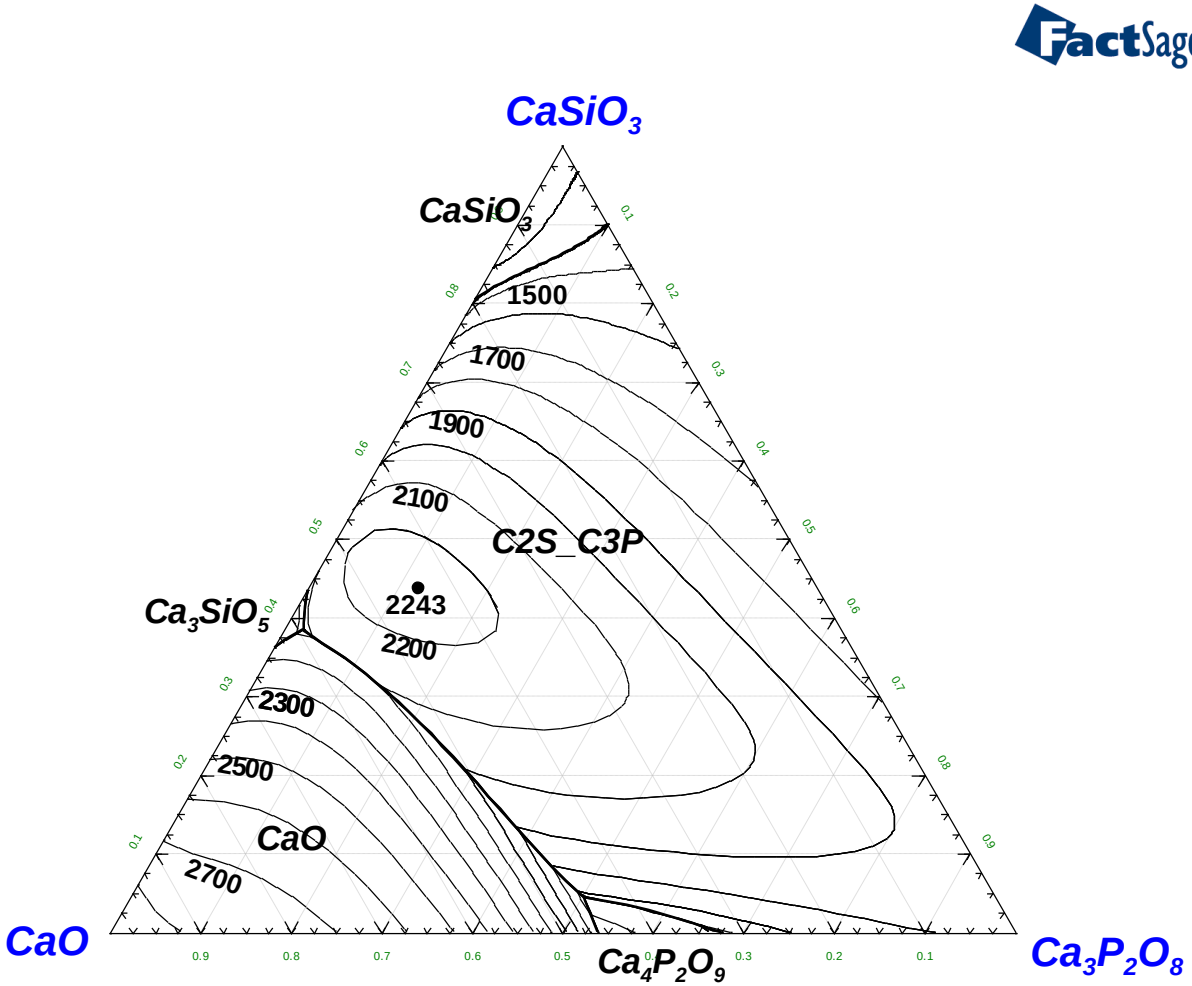


CaO-P2O5-SiO2,

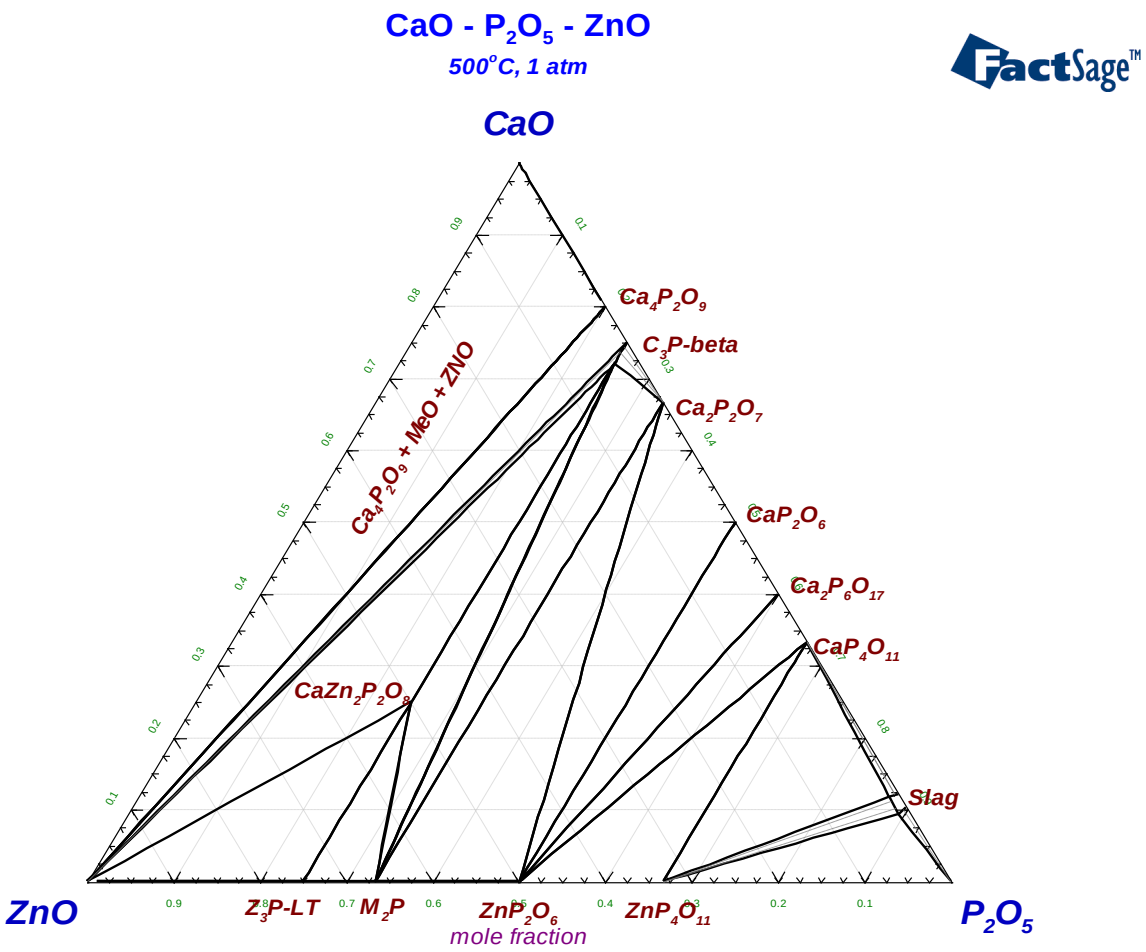
Weight percent, Isopleth Ca3P2O8-SiO2



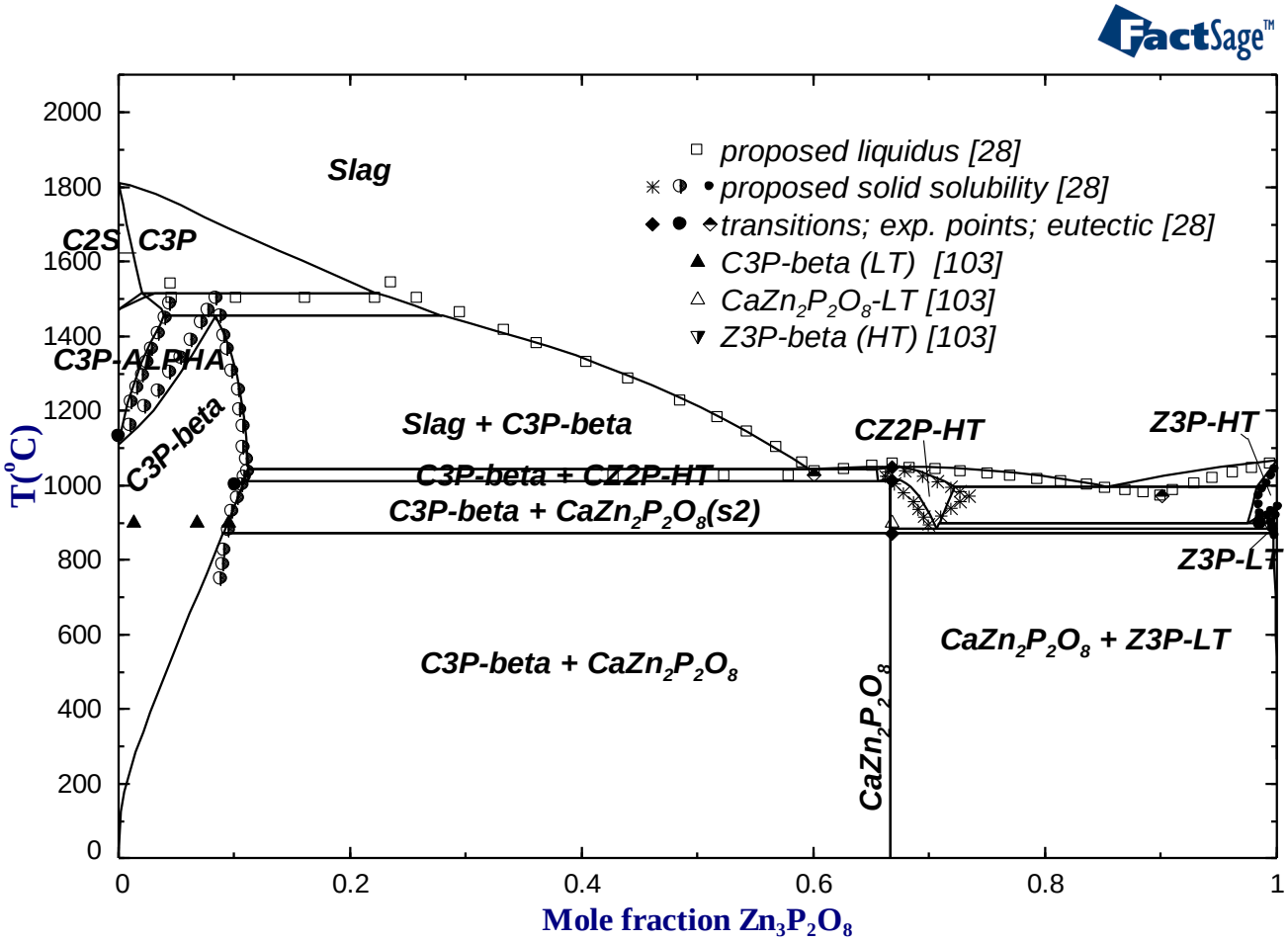
Weight percent,
Liquidussurface in CaO-corner



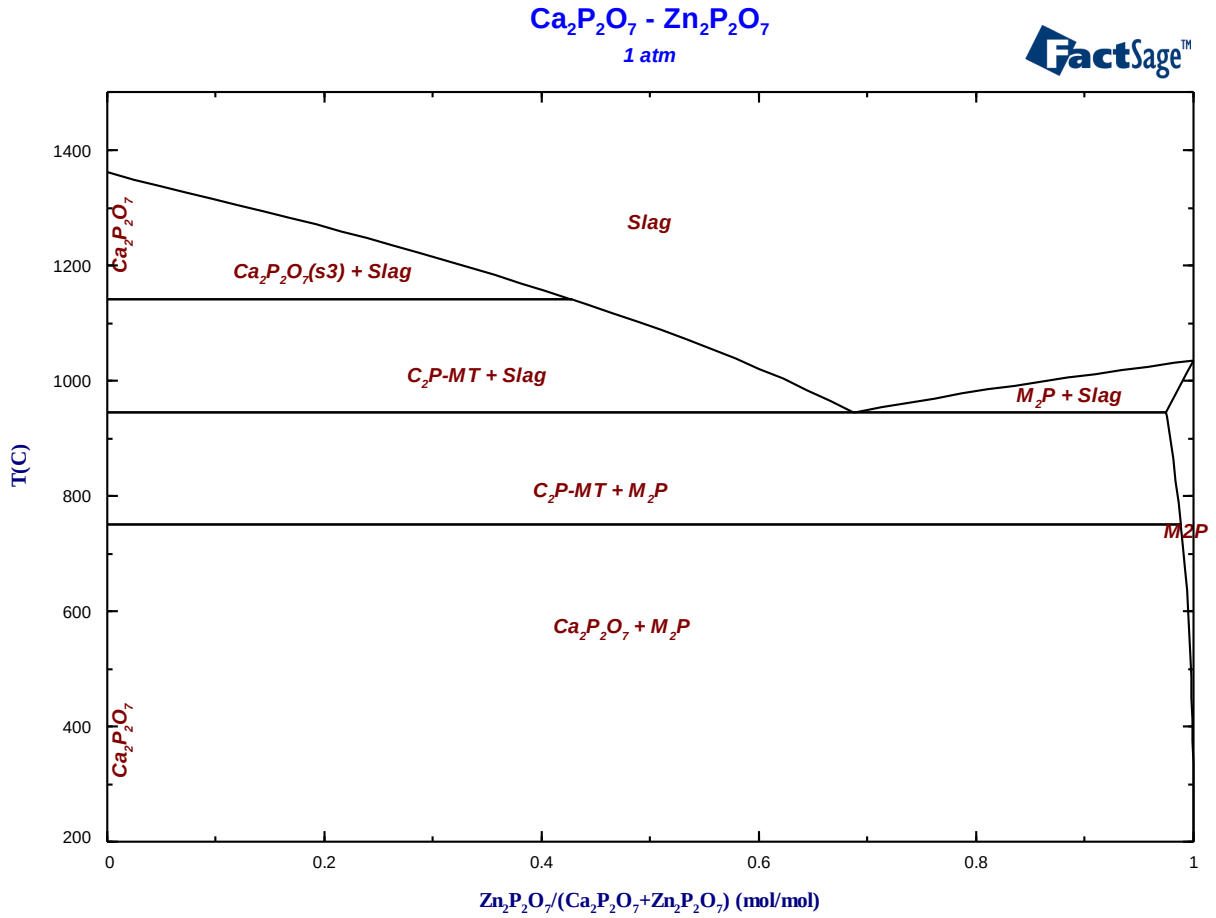
CaO-P2O5-ZnO,
Mole fraction 500°C



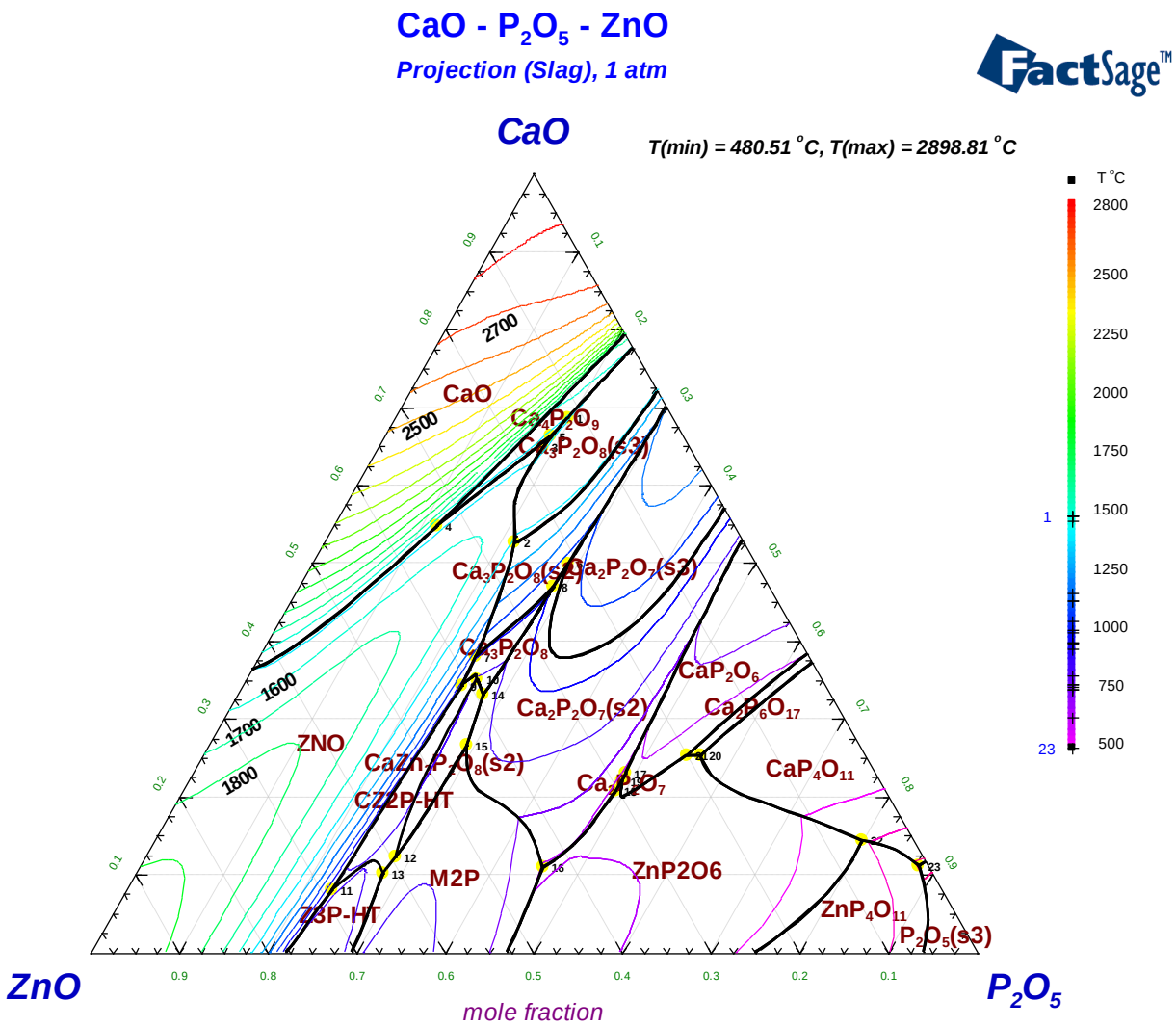
Mole fraction, Isopleth section Ca3P2O8-Zn3P2O8



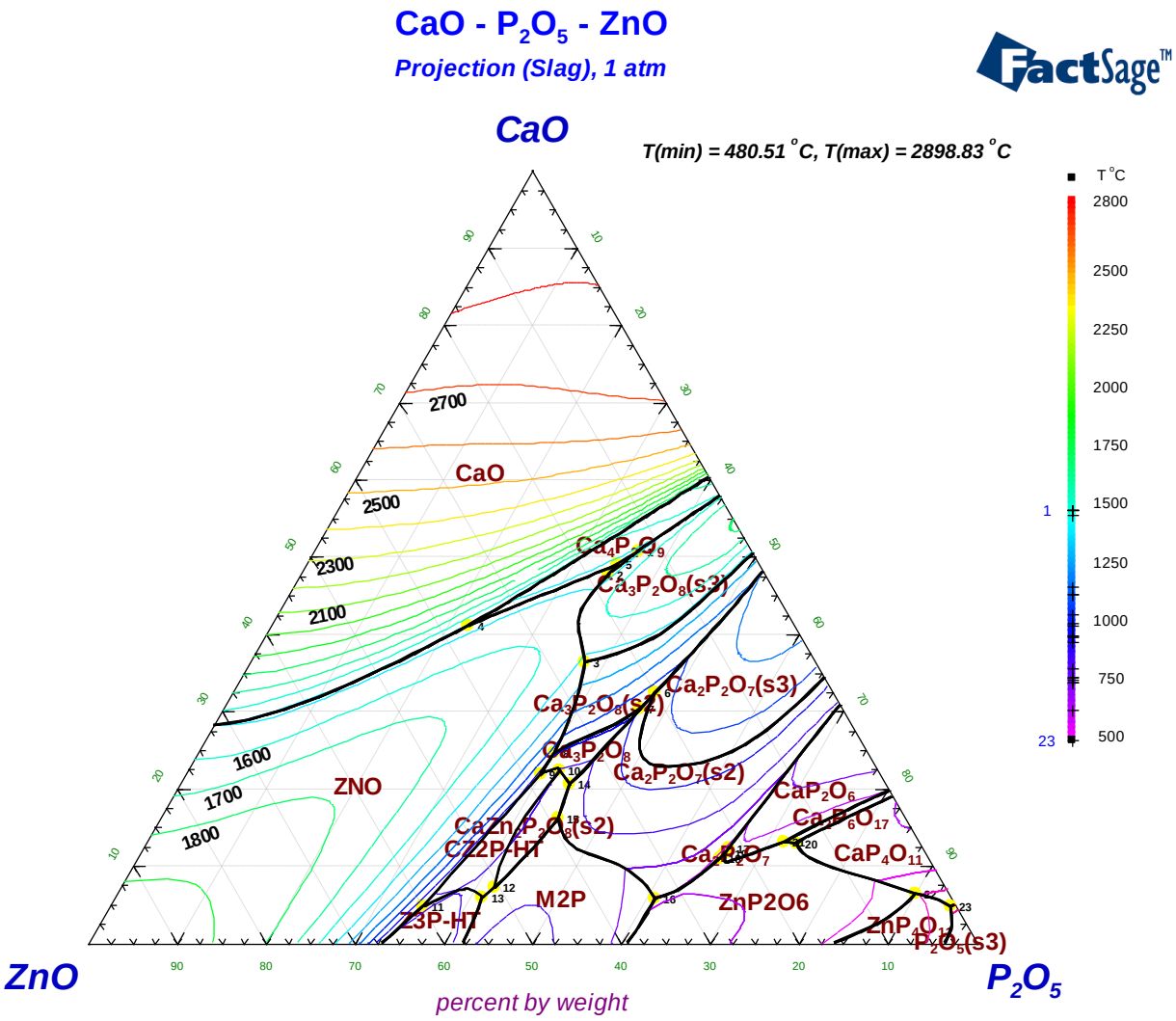
Mole fraction, Isopleth section Ca2P2O7-Zn2P2O7



Mole fraction, Liquidussurface



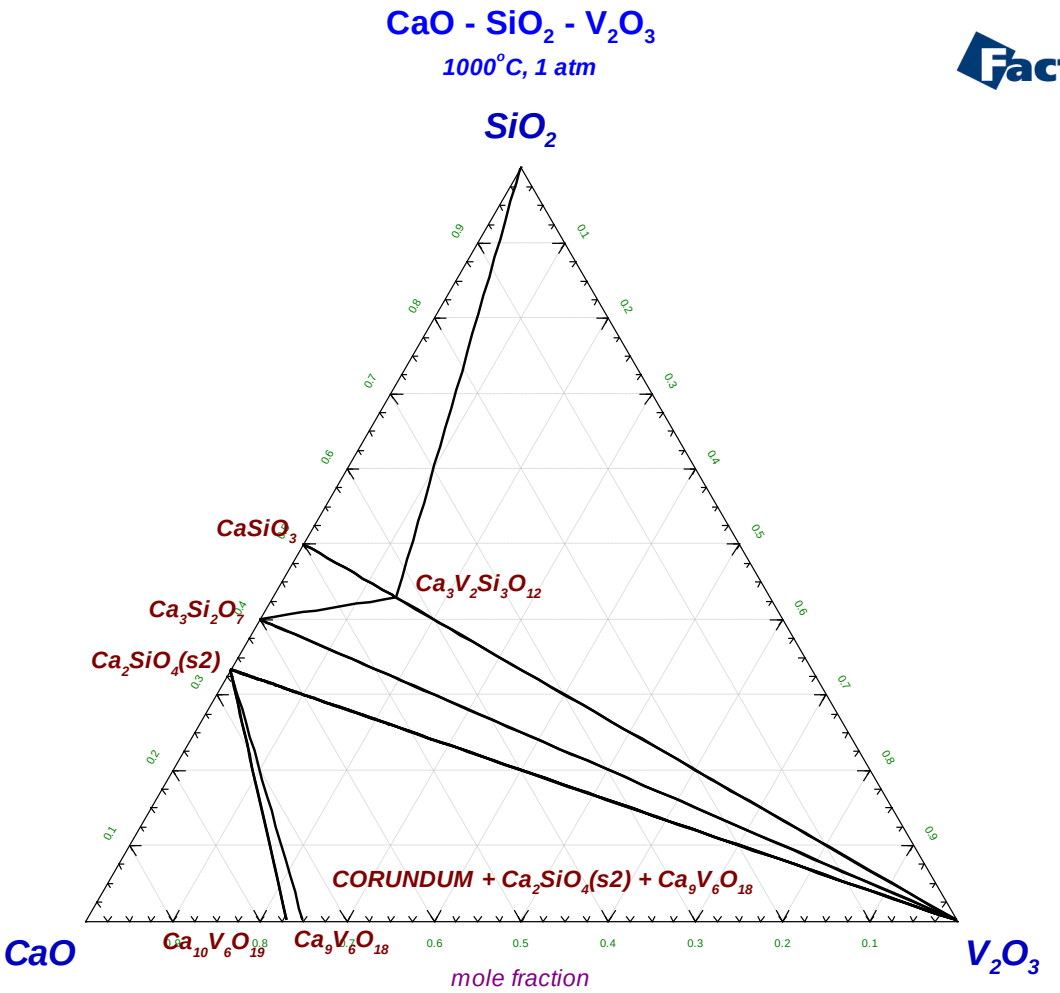
Weight percent, Liquidussurface

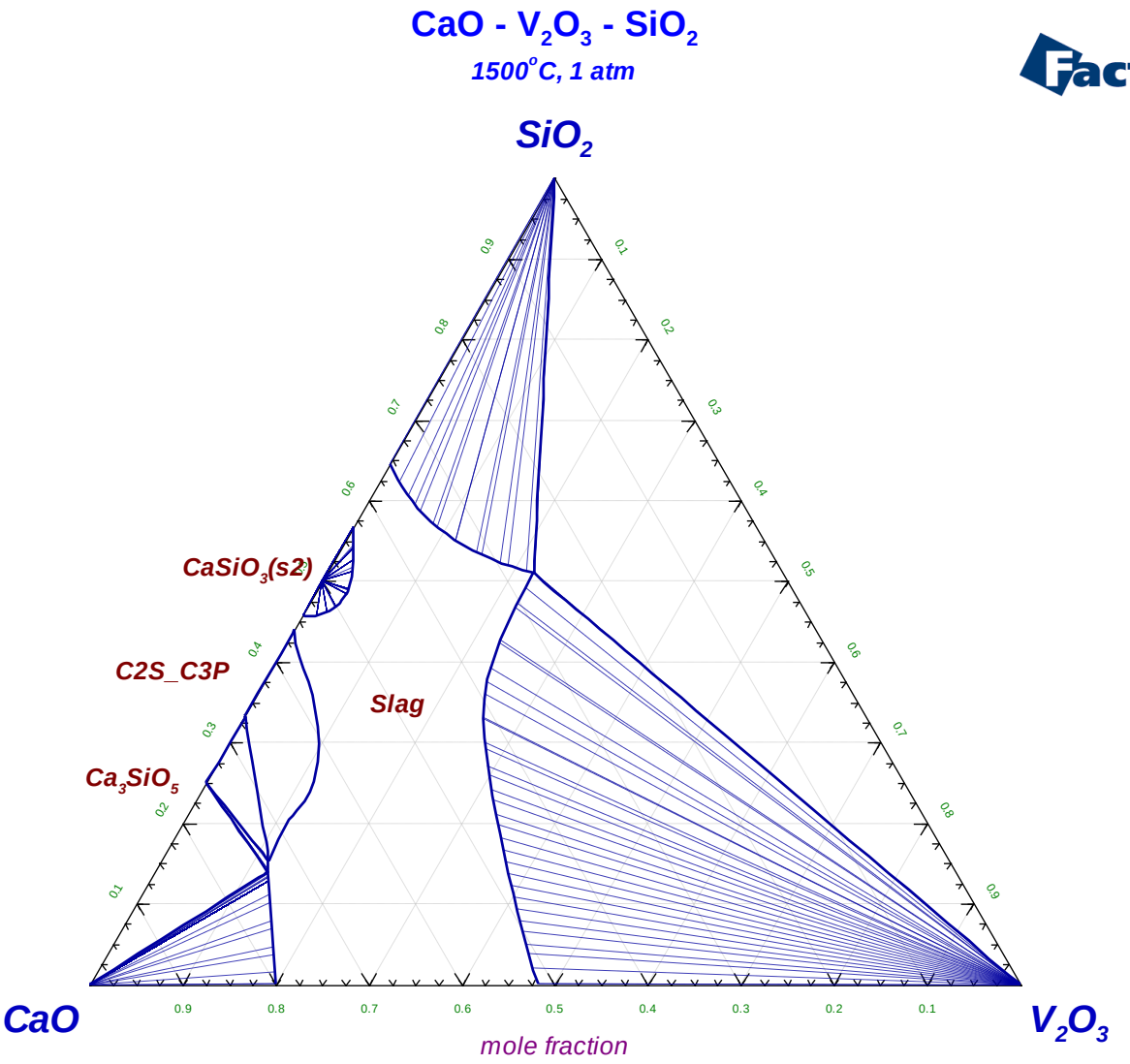


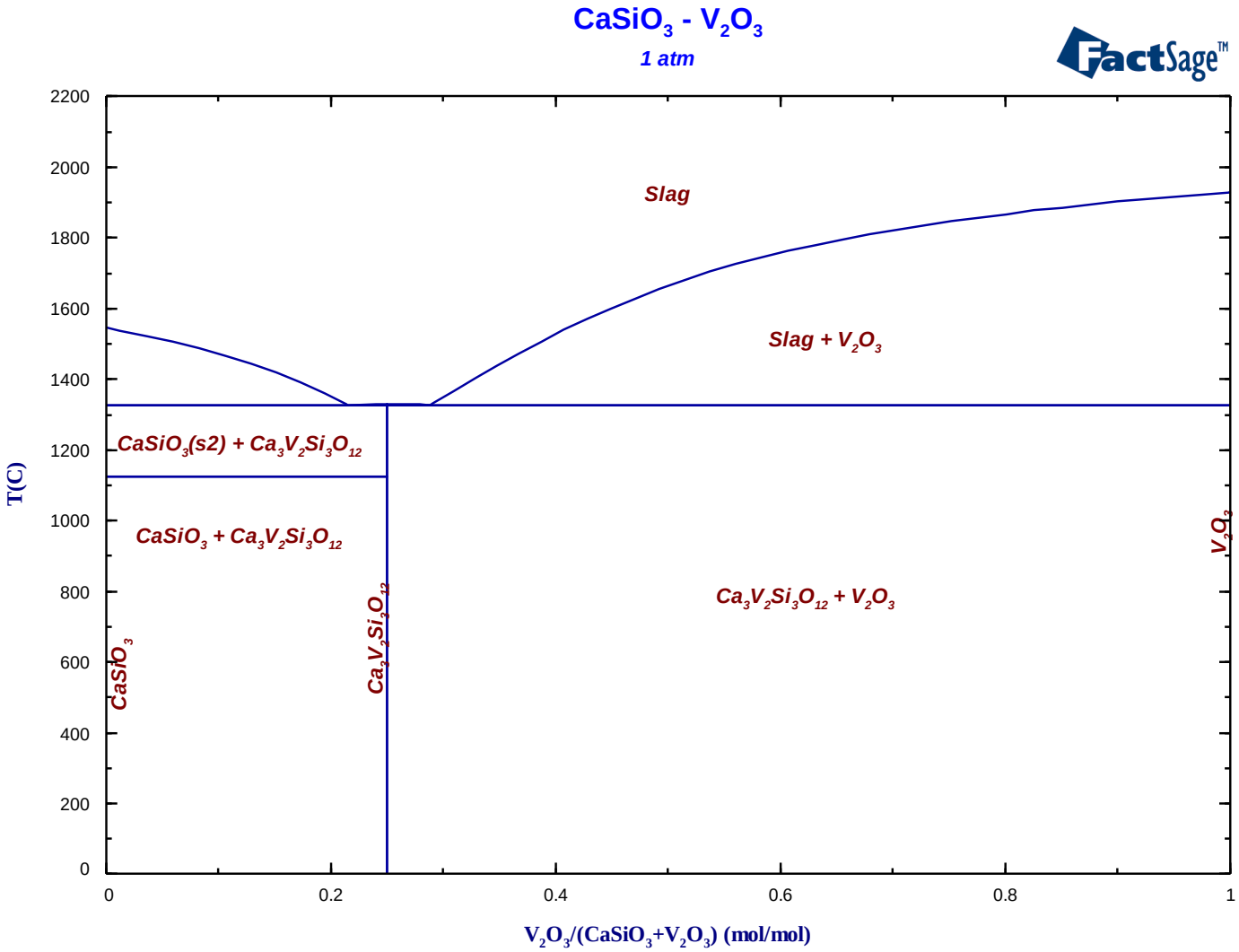
Invariant equilibria on the liquidus surface

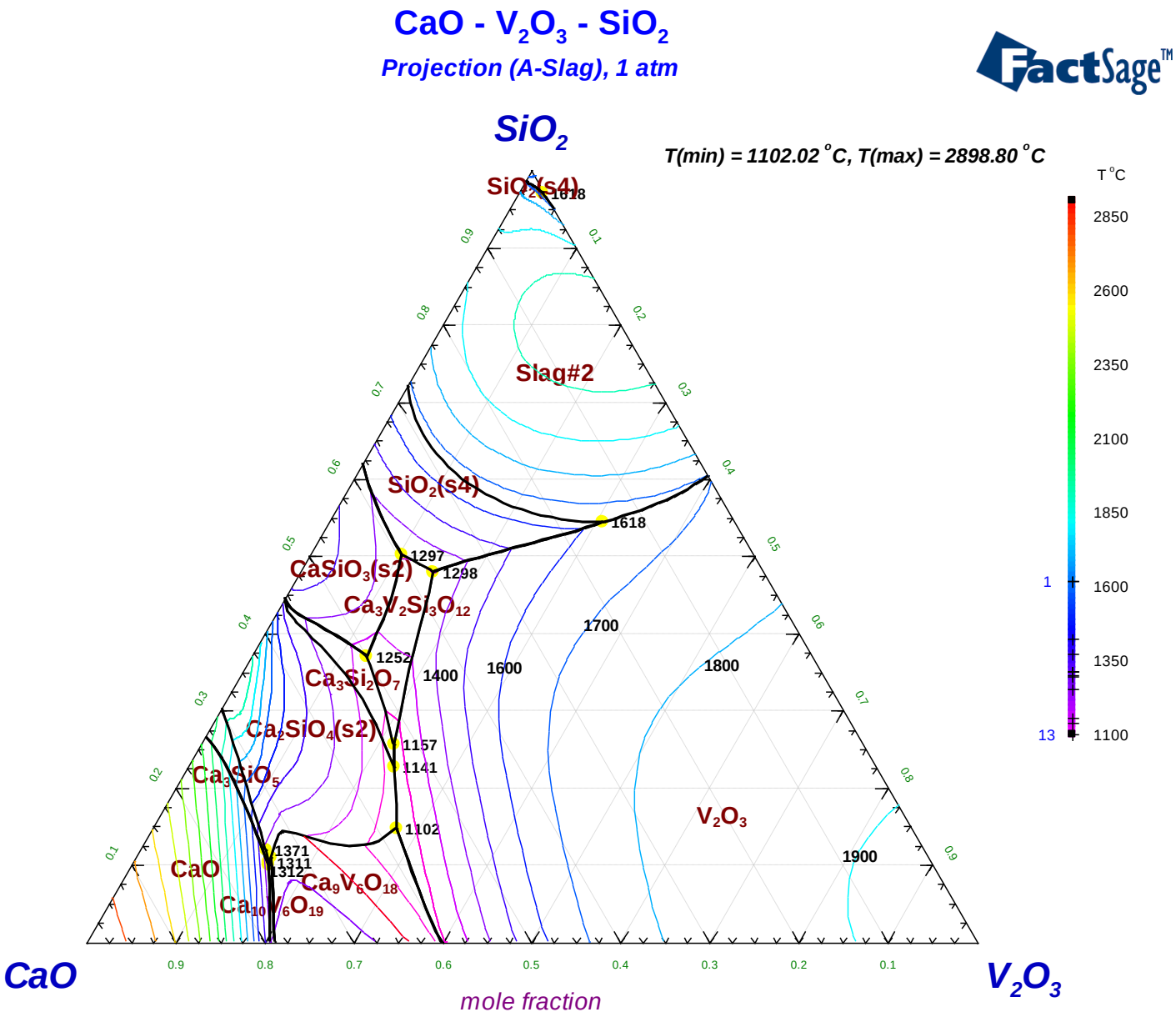
Intersections with slag	Mole fraction					Weight percent				
	A = CaO, B = ZnO, C = P2O5					A = CaO, B = ZnO, C = P2O5				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1. Ca3P2O8(s2) / Ca3P2O8_(s3) / Ca4P2O9	1:	0.68683	0.11828	0.19489	1469.86	1:	50.809	12.698	36.493	1469.85
2. Ca3P2O8(s2) / Ca3P2O8(s3) / ZNO	2:	0.52642	0.25804	0.21554	1469.85	2:	47.757	17.560	4.683	1469.85
3. Ca3P2O8(s2) / Ca3P2O8(s3) / ZNO	3:	0.64923	0.16450	0.18627	1469.85	3:	36.393	25.888	37.719	1469.85
4. Ca4P2O9 / CaO(s) / ZNO	4:	0.54743	0.33582	0.11676	1469.14	4:	41.151	36.634	22.216	1469.14
5. Ca3P2O8(s2) / Ca4P2O9(s) / ZNO	5:	0.66394	0.14863	0.18743	1447.11	5:	49.033	15.929	35.038	1447.09
6. Ca2P2O7(s2) / Ca2P2O7(s3) / Ca3P2O8(s2)	6:	0.49921	0.21150	0.28929	1139.86	6:	32.451	19.951	47.598	1139.85
7. Ca3P2O8(s2) / Ca3P2O8(s) / ZNO	7:	0.38058	0.37491	0.24451	1109.86	7:	30.379	22.697	46.924	1109.85
8. Ca2P2O7(s2) / Ca3P2O8(s2) / Ca3P2O8(s)	8:	0.47058	0.24227	0.28716	1109.85	8:	24.656	35.248	40.097	1109.83
9. CZ2P-HT / Ca3P2O8(s) / ZNO	9:	0.34316	0.41017	0.24666	1021.54	9:	21.959	38.089	39.952	1021.50
10. CZ2P-HT / Ca3P2O8(s) / CaZn2P2O8(s2)	10:	0.35138	0.38792	0.26070	984.49	10:	22.321	35.760	41.919	984.48
11. CZ2P-HT / Z3P-HT / ZNO	11:	0.08031	0.68771	0.23198	973.24	11:	4.822	59.922	35.256	973.25
12. CZ2P-HT / CaZn2P2O8(s2) / M2P	12:	0.12341	0.59385	0.28274	931.23	12:	7.256	50.667	42.077	931.23
13. CZ2P-HT / M2P / Z3P-HT	13:	0.10174	0.61937	0.27889	927.12	13:	5.962	52.671	41.367	927.13
14. Ca2P2O7(s2) / Ca3P2O8(s) / CaZn2P2O8(s2)	14:	0.33064	0.39174	0.27762	923.42	14:	20.641	35.490	43.869	923.42
15. Ca2P2O7(s2) / CaZn2P2O8(s2) / M2P	15:	0.26558	0.44293	0.29149	903.65	15:	16.133	39.046	44.821	903.65
16. Ca2P2O7(s2) / M2P / ZnP2O6	16:	0.10949	0.43537	0.45515	788.08	16:	5.783	33.369	60.848	787.98
17. Ca2P2O7(s) / Ca2P2O7(s2) / CaP2O6(s)	17:	0.23037	0.28101	0.48862	749.85	17:	12.286	21.750	65.964	749.88
18. Ca2P2O7(s) / Ca2P2O7(s2) / ZnP2O6	18:	0.20751	0.30434	0.48815	749.85	18:	11.009	23.433	65.557	749.85
19. Ca2P2O7(s) / CaP2O6_S1(s) / ZnP2O6	19:	0.22043	0.29027	0.48930	740.36	19:	11.724	22.404	65.872	740.36
20. Ca2P6O17(s) / CaP4O11(s) / ZnP2O6	20:	0.25314	0.18534	0.56152	729.02	20:	13.025	13.839	73.136	729.02
21. Ca2P6O17(s) / CaP2O6(s) / ZnP2O6	21:	0.25289	0.20089	0.54622	727.10	21:	13.123	15.128	71.748	727.09
22. CaP4O11(s) / ZnP2O6 / ZnP4O11(s)	22:	0.14346	0.05803	0.79851	607.11	22:	6.379	3.745	89.876	607.11
23. CaP4O11(s) / P2O5(s3) / ZnP4O11(s)	23:	0.11208	0.00927	0.87865	480.52	23:	4.770	0.573	94.657	480.52

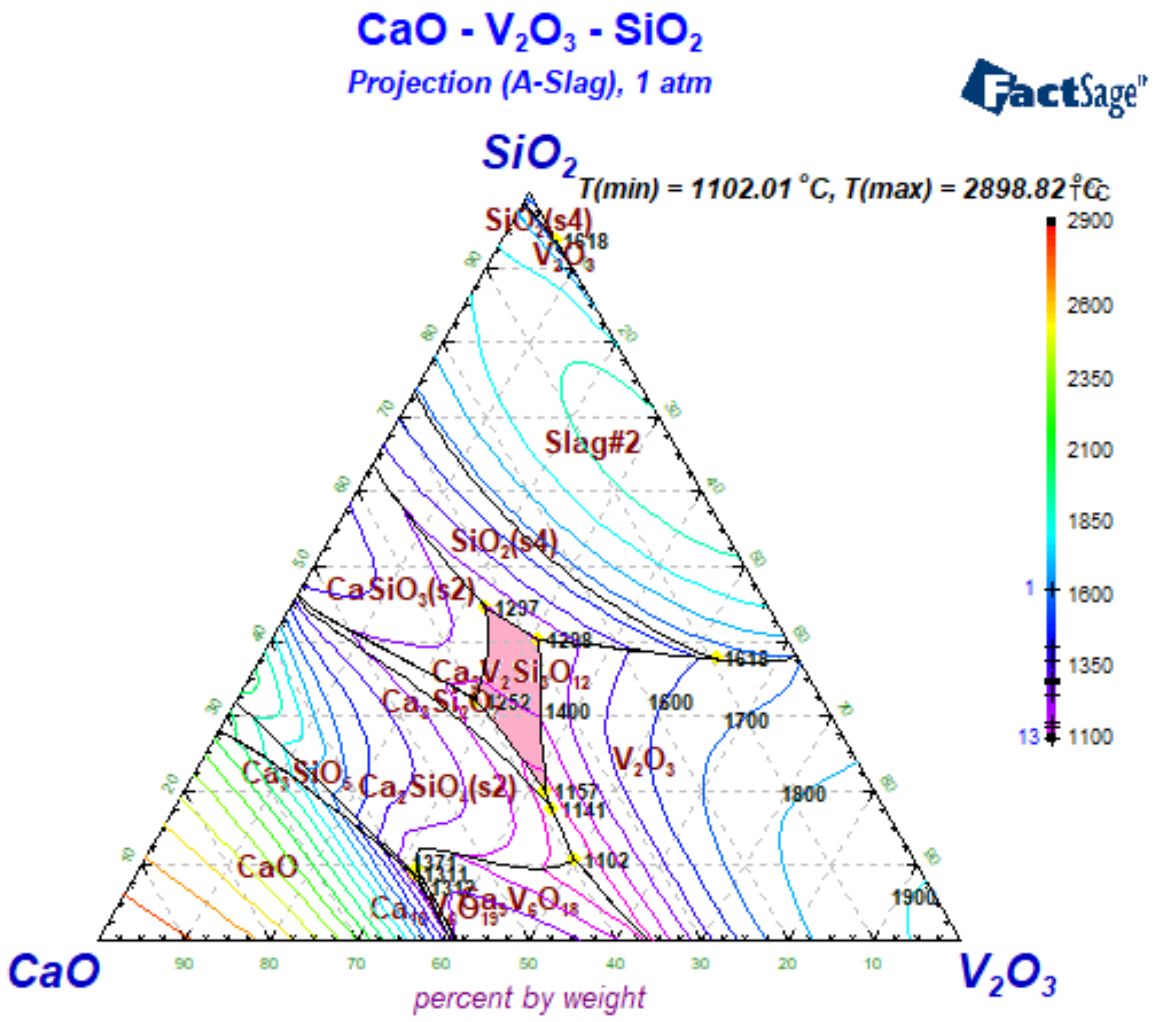
CaO-SiO2-V2O3,
Mole fraction 1000°C




CaO - V2O3 - SiO2
1500°C, 1 atm
SiO2
CaSiO3(s2)
C2S_C3P
Slag
Ca3SiO5
CaO
V2O3
mole fraction


CaSiO3 - V2O3
1 atm
FactSage™
Slag
Slag + V2O3
CaSiO3(s2) + Ca3V2Si3O12
CaSiO3 + Ca3V2Si3O12
Ca3V2Si3O12 + V2O3
CaSiO3
Ca3V2Si3O12
V2O3
T(C)
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
0.2
0.4
0.6
0.8
1
V2O3/(CaSiO3+V2O3) (mol/mol)


CaO - V2O3 - SiO2
Projection (A-Slag), 1 atm
FactSage™
SiO2
T(min) = 1102.02 °C, T(max) = 2898.80 °C
T °C
2850
2600
2350
2100
1850
1600
1350
1100
1
13
SiO2(s4)
1618
Slag#2
SiO2(s4)
1618
1297
1298
CaSiO3(s2)
Ca3V2Si3O12
1700
1252
1400
1600
1800
Ca3Si2O7
Ca2SiO4(s2)
1157
1141
Ca3SiO5
V2O3
1102
1900
1371
1311
1312
CaO
Ca9V6O18
Ca10V6O19
CaO
V2O3
mole fraction

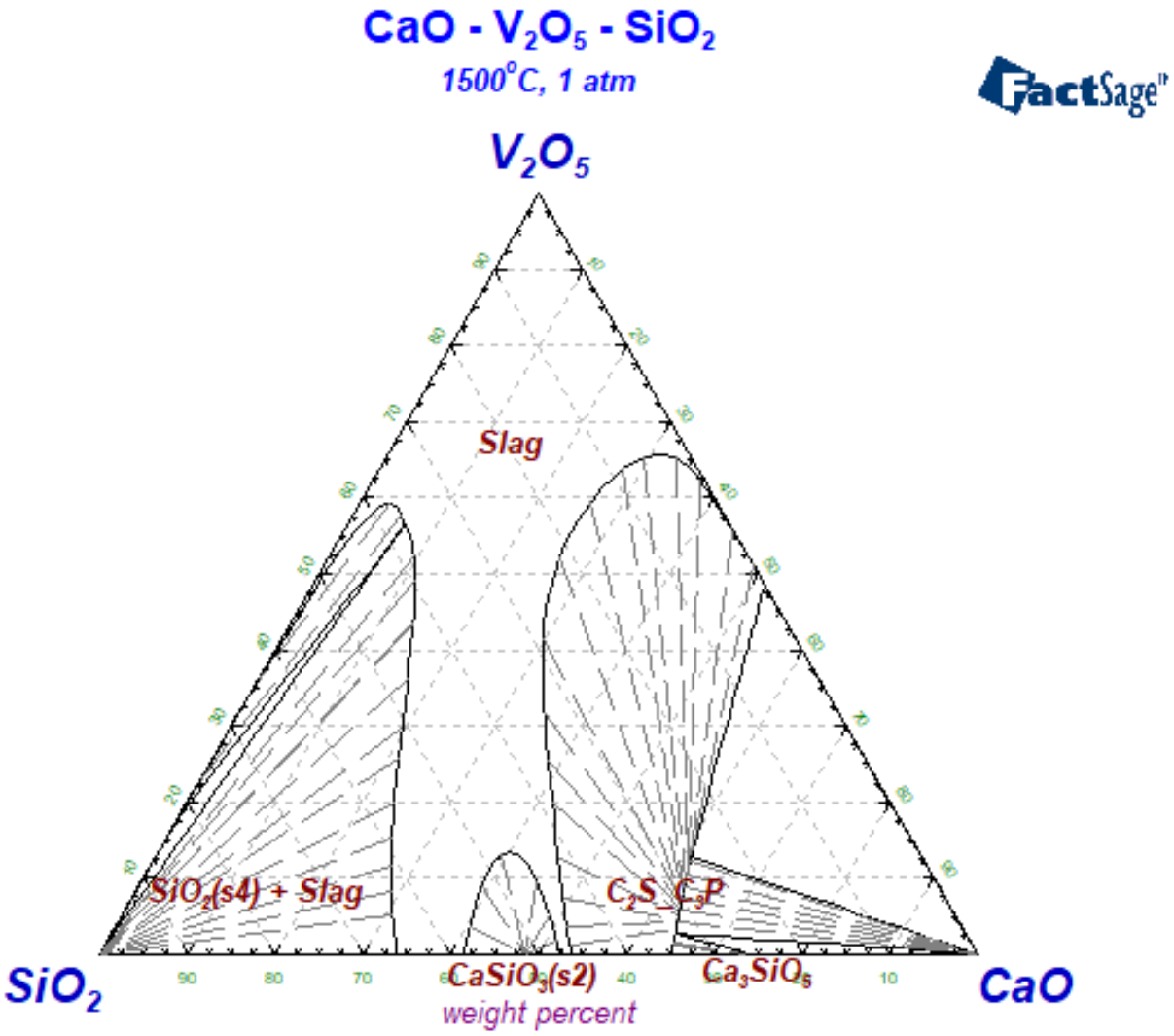


$Ca_3V_2Si_3O_{12}$- Vanadium Garnet or Goldmanite, calculated T_m=1329°C

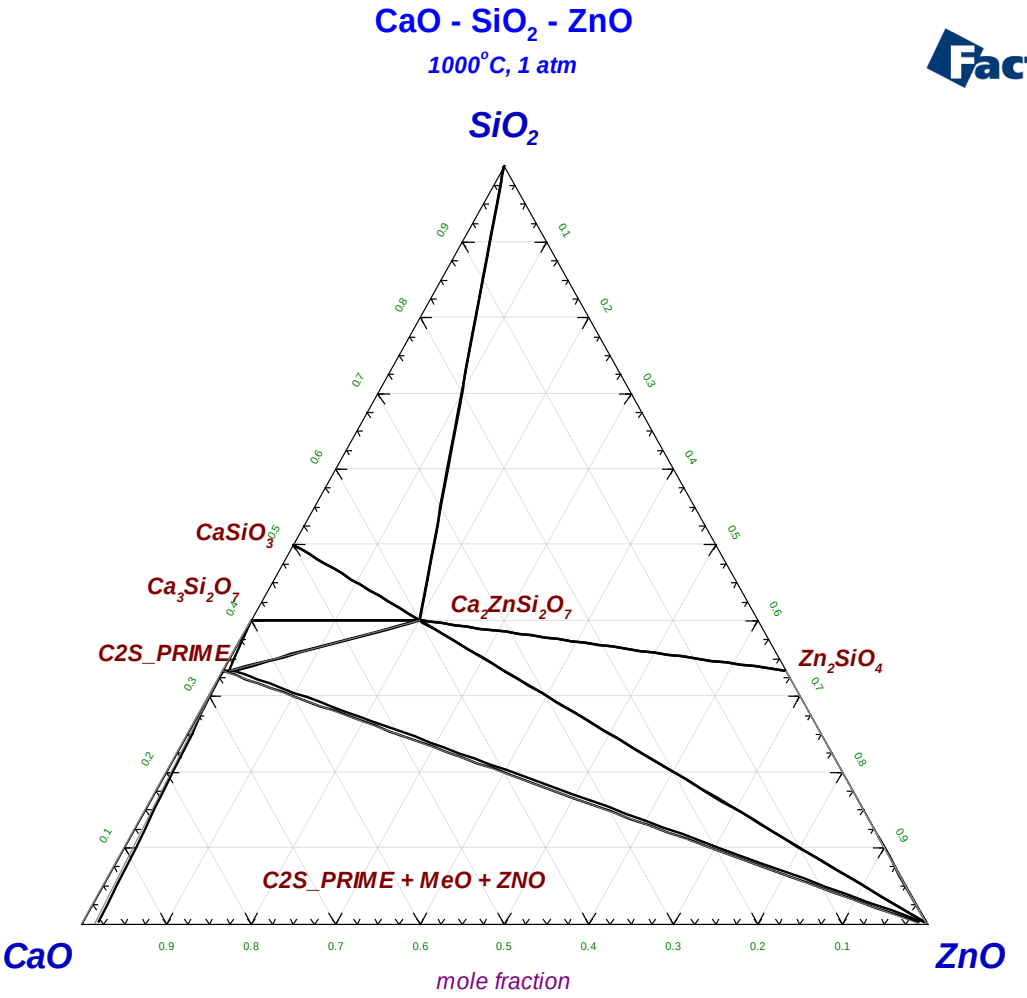
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction				Weight percent			
	A = SiO2, B = CaO, C = V2O3				A = SiO2, B =CaO, C = V2O3			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1. SiO2(s4) / Slag#2 / V2O3	0.97139	0.00215	0.02646	1617.64	37.571	9.514	52.915	1617.69
2. SiO2(s4) / Slag#2 / V2O3	0.54469	0.14778	0.30753	1617.56	93.457	0.193	6.350	1617.64
3. Ca10V6O19 / Ca2SiO4(s2) / Ca9V6O18	0.12052	0.73875	0.14073	1371.09	10.380	59.384	30.236	1371.09
4. Ca10V6O19 / Ca3SiO5 / CaO	0.10015	0.74556	0.15429	1312.31	8.481	58.927	32.592	1312.31
5. Ca10V6O19 / Ca2SiO4(s2) / Ca3SiO5	0.10372	0.74335	0.15293	1310.82	8.797	58.846	32.357	1310.82
6. Ca3V2Si3O12 / SiO2(s4) / V2O3	0.48033	0.36995	0.14971	1298.06	40.058	28.796	31.146	1298.06
7. Ca3V2Si3O12 / CaSiO3(s2) / SiO2(s4)	0.50209	0.39524	0.10267	1296.91	44.548	32.729	22.723	1296.97
8. Ca3Si2O7 / Ca3V2Si3O12 / CaSiO3(s2)	0.37128	0.49934	0.12939	1252.45	32.005	40.173	27.822	1252.45
9. Ca3Si2O7 / Ca3V2Si3O12 / V2O3	0.25677	0.52671	0.21651	1156.63	19.929	38.153	41.918	1156.64
10.Ca2SiO4(s2) / Ca3Si2O7 / V2O3	0.22747	0.54122	0.23131	1140.91	17.369	38.570	44.060	1140.91
11.Ca2SiO4(s2) / Ca9V6O18 / V2O3	0.14806	0.57795	0.27398	1102.02	10.800	39.346	49.854	1102.01

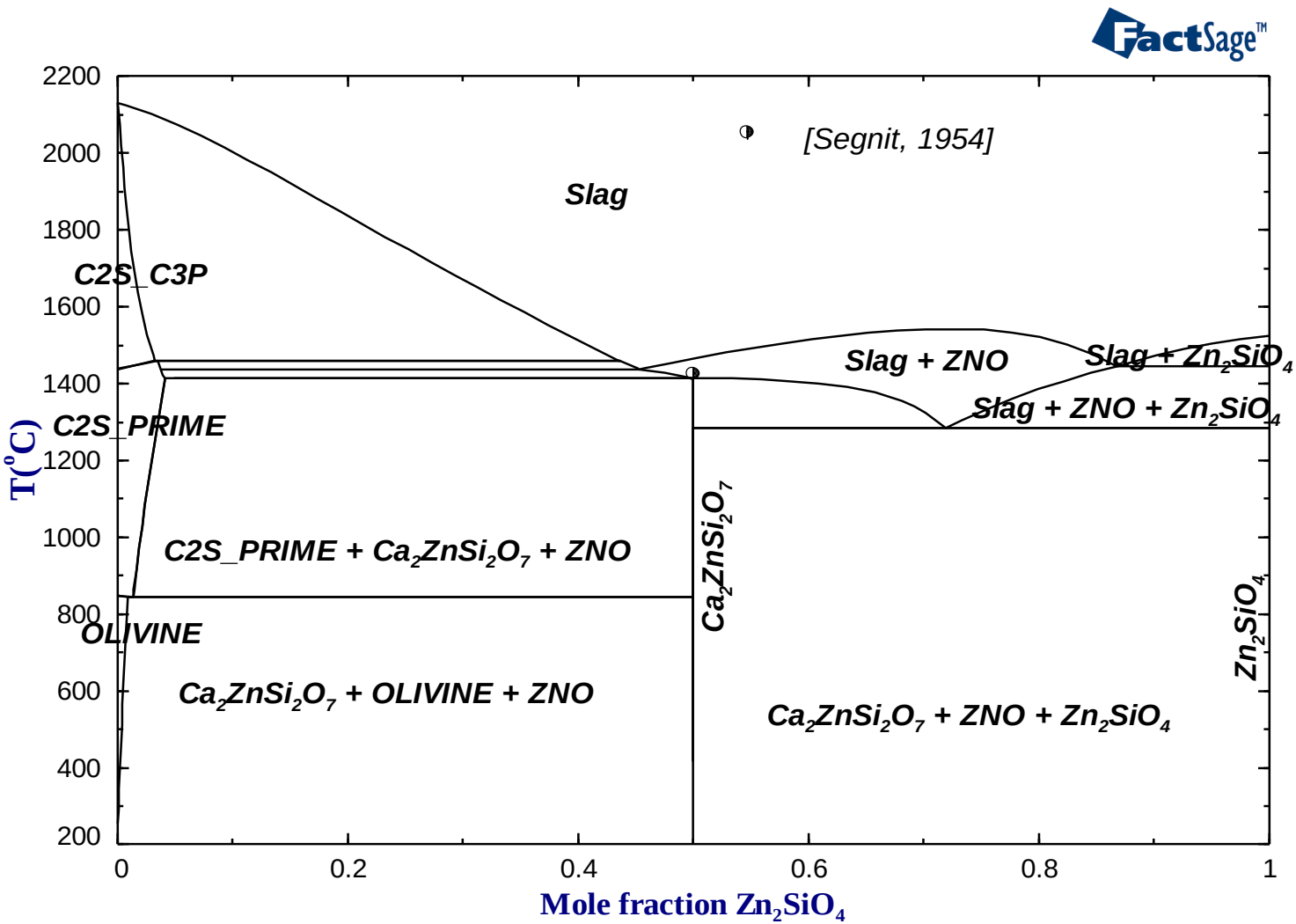
CaO-SiO2-V2O5,
Mole fraction 1500°C



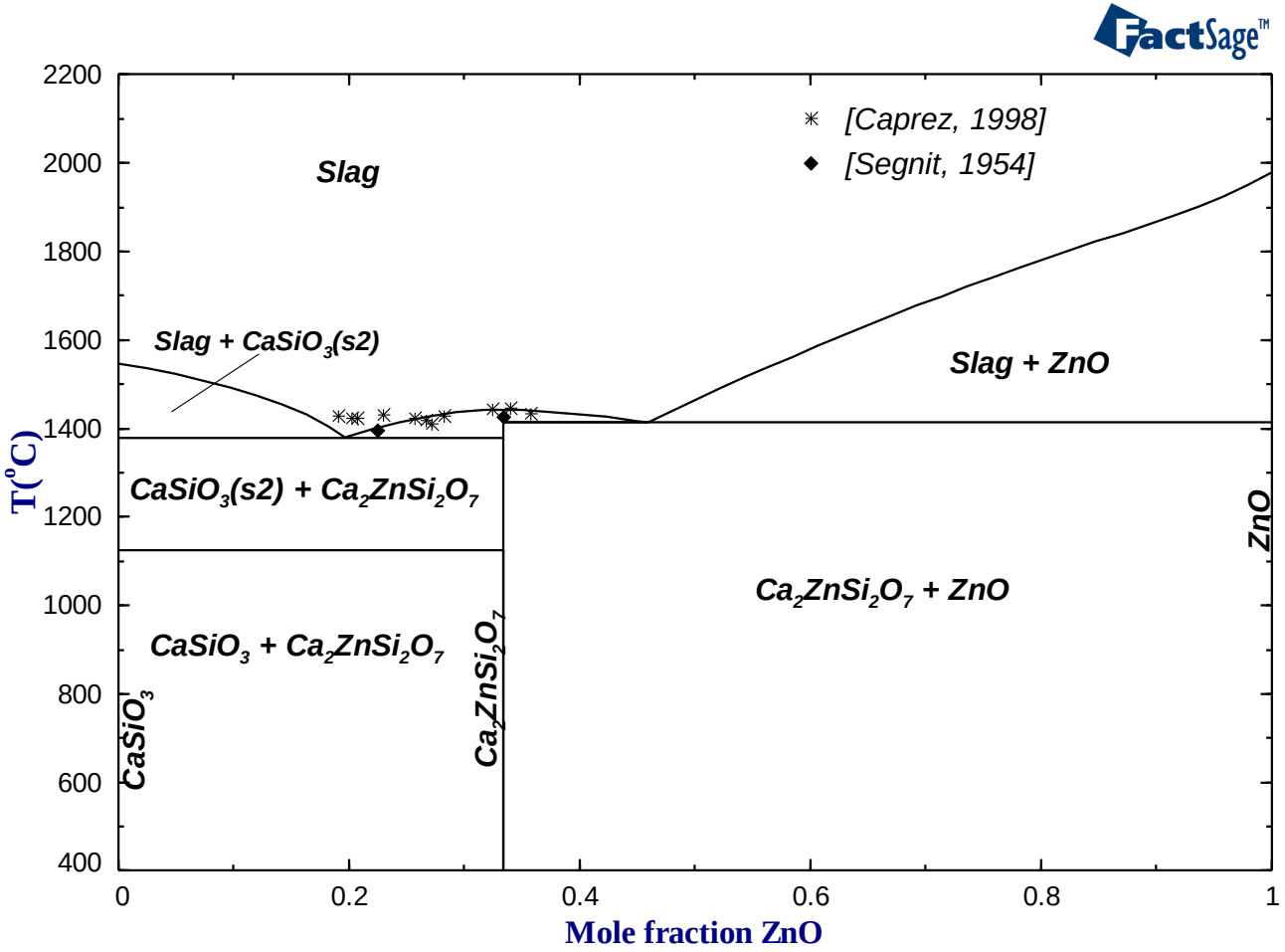
Mole fraction 1000°C



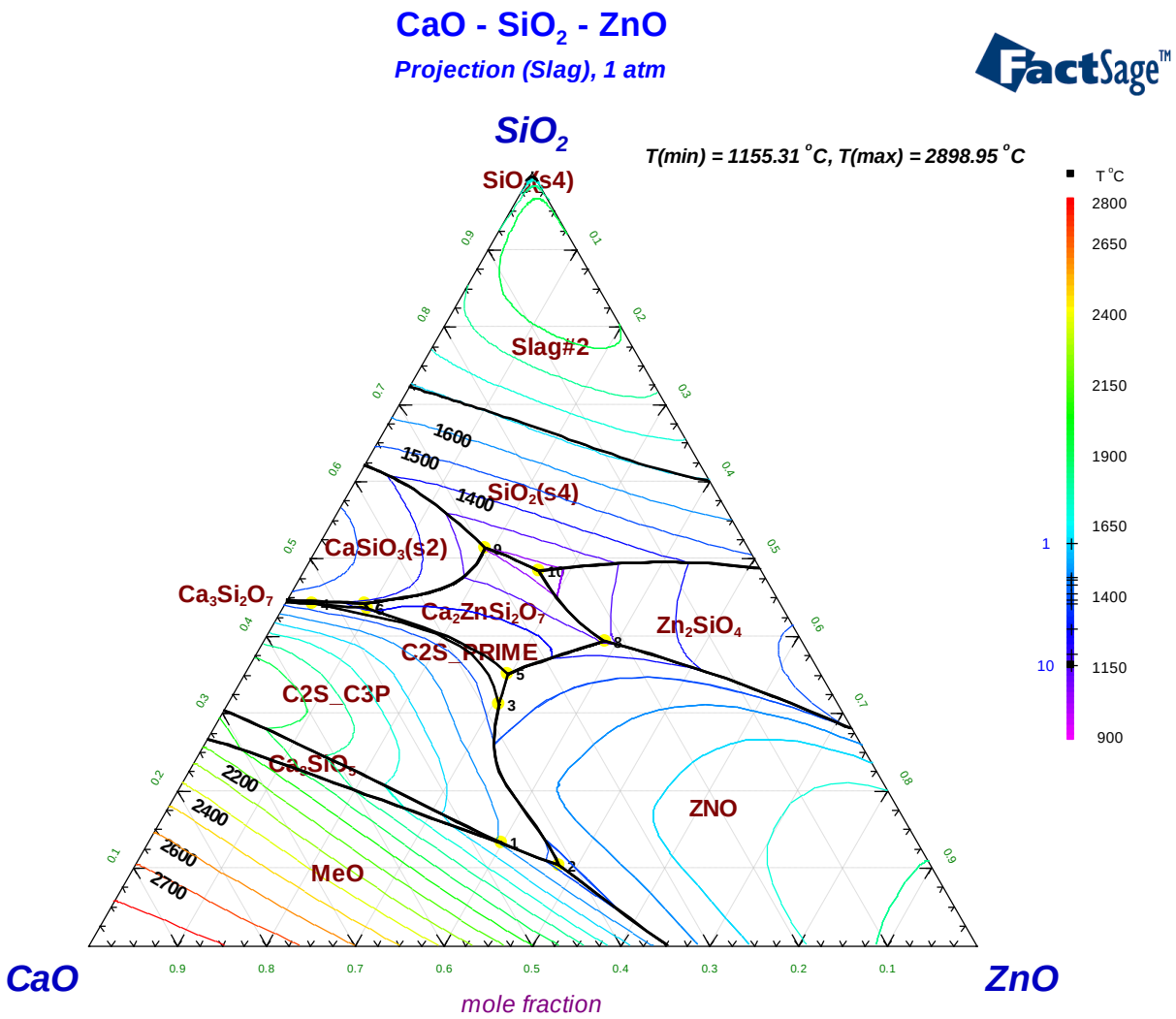
Mole fraction
Isopleth section Ca2SiO4-Zn2SiO4



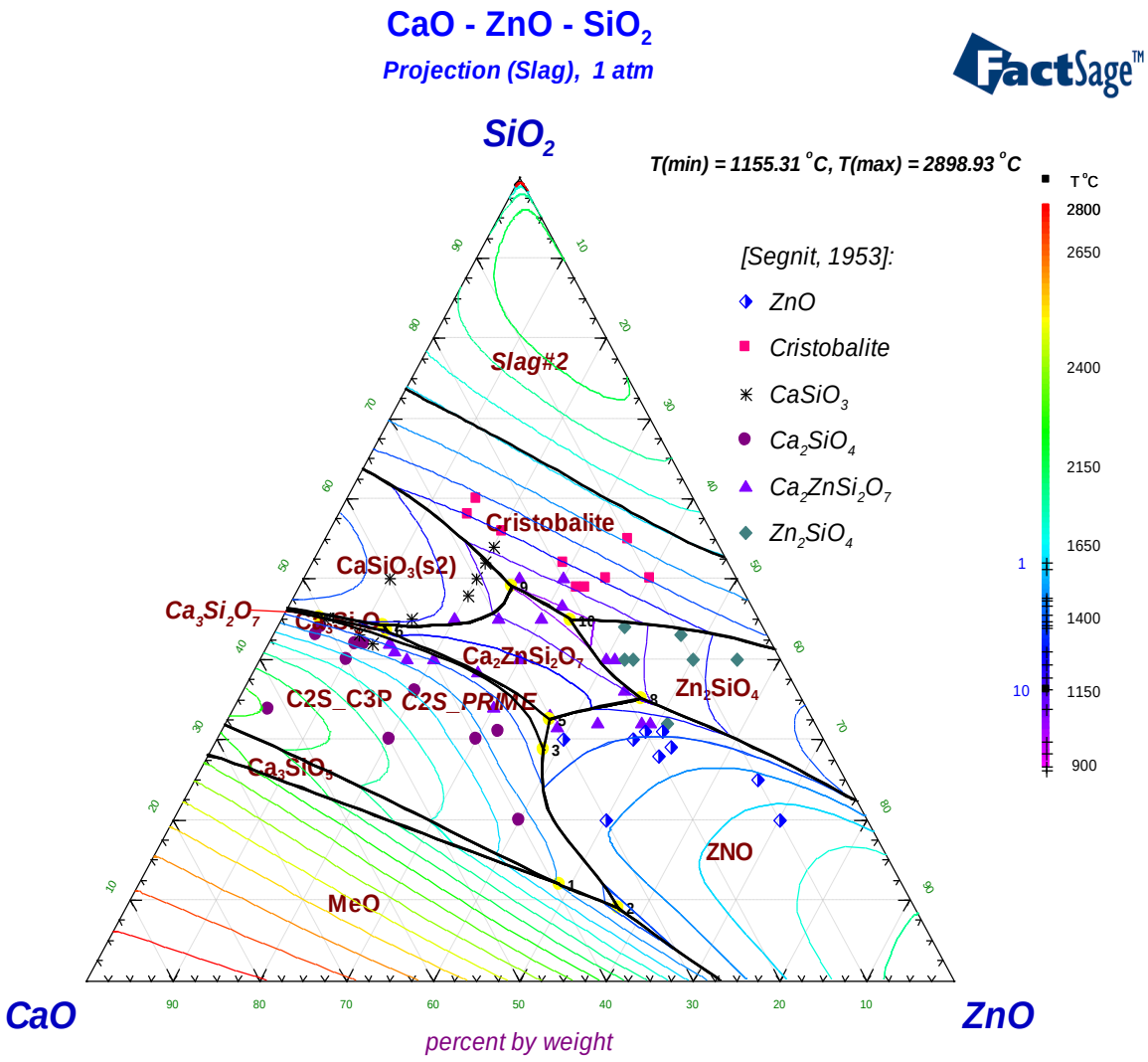
Mole fraction
Isopleth section CaSiO3-ZnO



Mole fraction
Liquidussurface



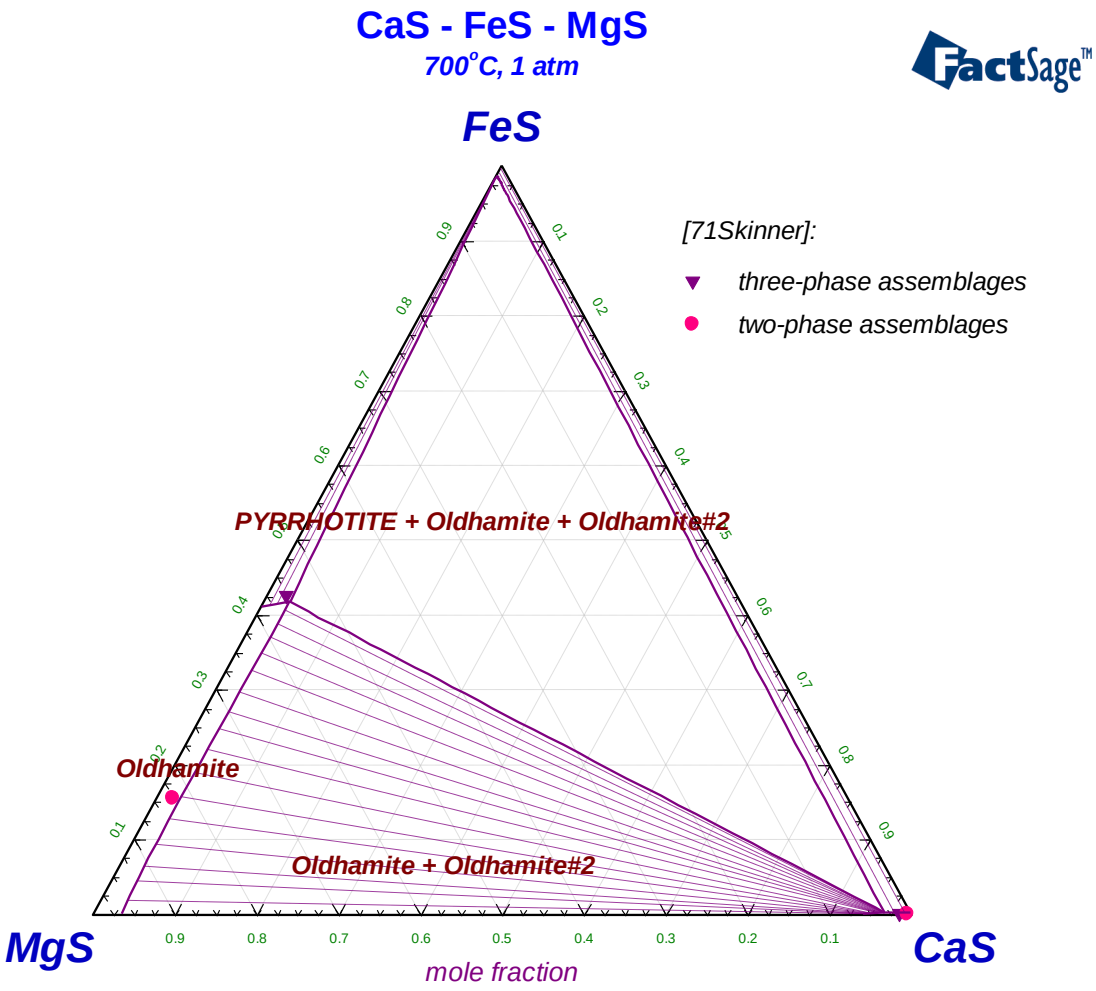
Weight percent
Liquidussurface compared with experimental data

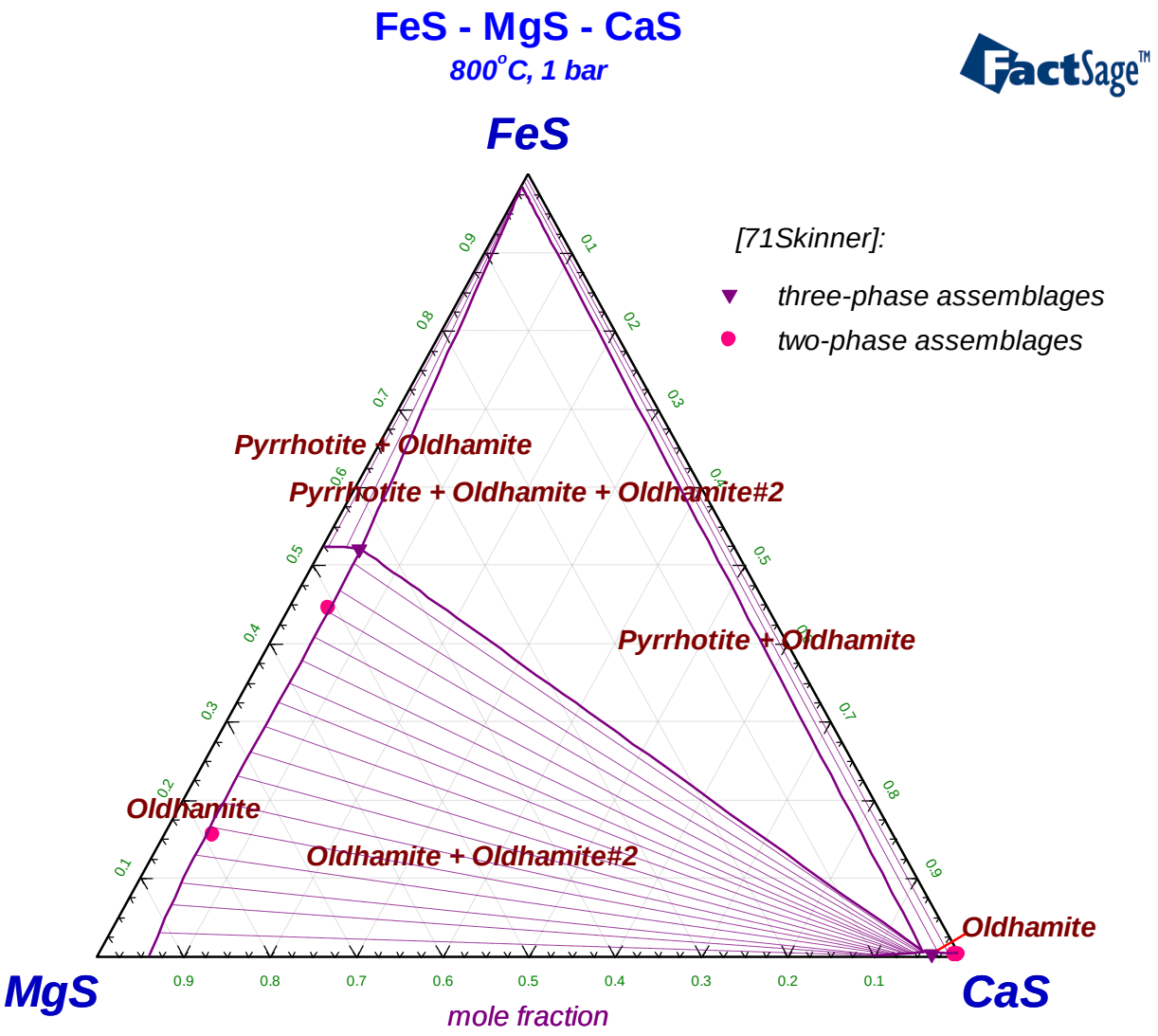


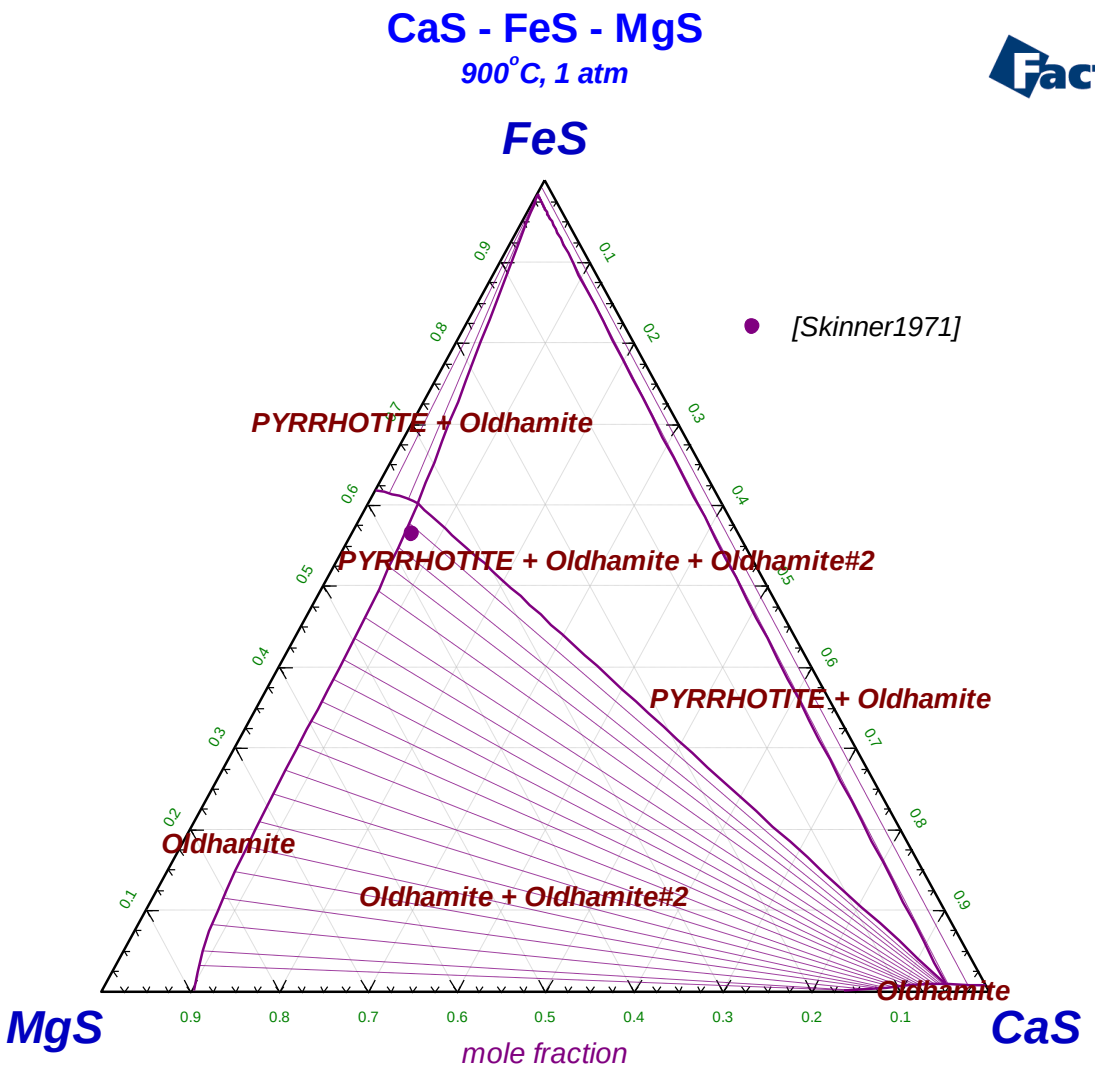
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction					Weight percent				
	A = SiO2, B = CaO, C = ZnO					A = SiO2, B = CaO, C = ZnO				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: C2S_C3P / Ca3SiO5 / MeO	1:	0.13224	0.46891	0.39886	1588.77	1:	11.912	39.423	48.665	1588.77
2: C2S_C3P / MeO / ZNO	2:	0.10277	0.41797	0.47926	1470.14	2:	8.999	34.160	56.841	1470.14
3: C2S_C3P / C2S_PRIME / ZNO	3:	0.31127	0.38169	0.30704	1457.53	3:	28.732	32.882	38.386	1457.54
4: C2S_C3P / C2S_PRIME / Ca3Si2O7	4:	0.44149	0.52716	0.03135	1440.21	4:	45.237	50.413	4.350	1440.20
5: C2S_PRIME / Ca2ZnSi2O7 / ZNO	5:	0.35104	0.35173	0.29723	1412.54	5:	32.447	30.343	37.210	1412.52
6: C2S_PRIME / Ca2ZnSi2O7 / Ca3Si2O7	6:	0.43610	0.46794	0.09596	1388.23	6:	43.488	43.551	12.961	1388.23
7: Ca2ZnSi2O7 / Ca3Si2O7 / CaSiO3(s2)	7:	0.44191	0.46756	0.09053	1375.09	7:	44.151	43.598	12.251	1375.05
8: Ca2ZnSi2O7 / ZNO / Zn2SiO4	8:	0.39347	0.22135	0.38518	1283.39	8:	35.076	18.417	46.507	1283.39
9: Ca2ZnSi2O7 / CaSiO3(s2) / SiO2(s4)	9:	0.51419	0.29591	0.18990	1195.06	9:	49.084	26.363	24.552	1195.06
10: Ca2ZnSi2O7 / SiO2(s4) / Zn2SiO4	10:	0.48417	0.25009	0.26575	1155.31	10:	44.934	21.662	33.404	1155.31

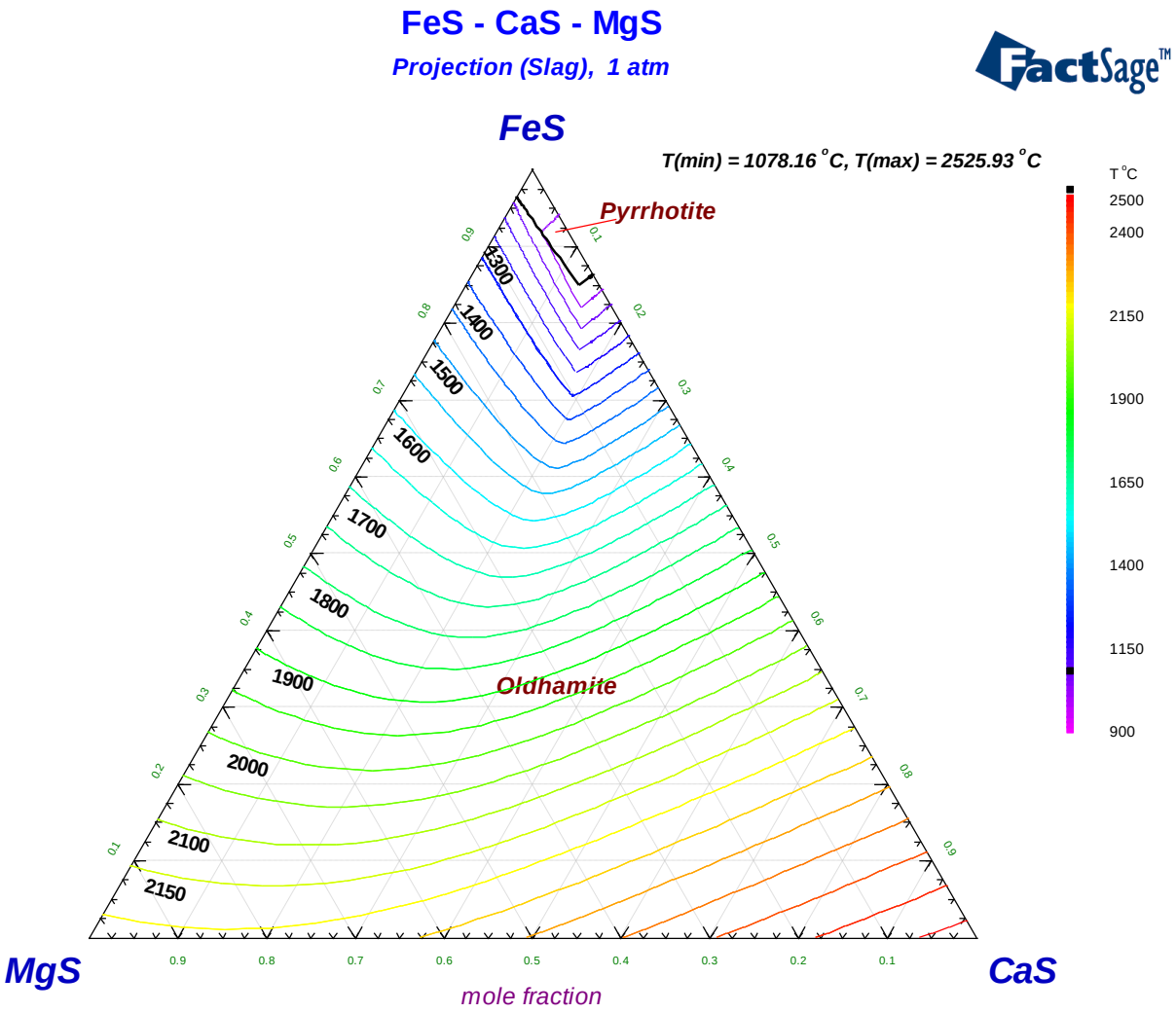
CaS-FeS-MgS,
Mole fraction 700°C



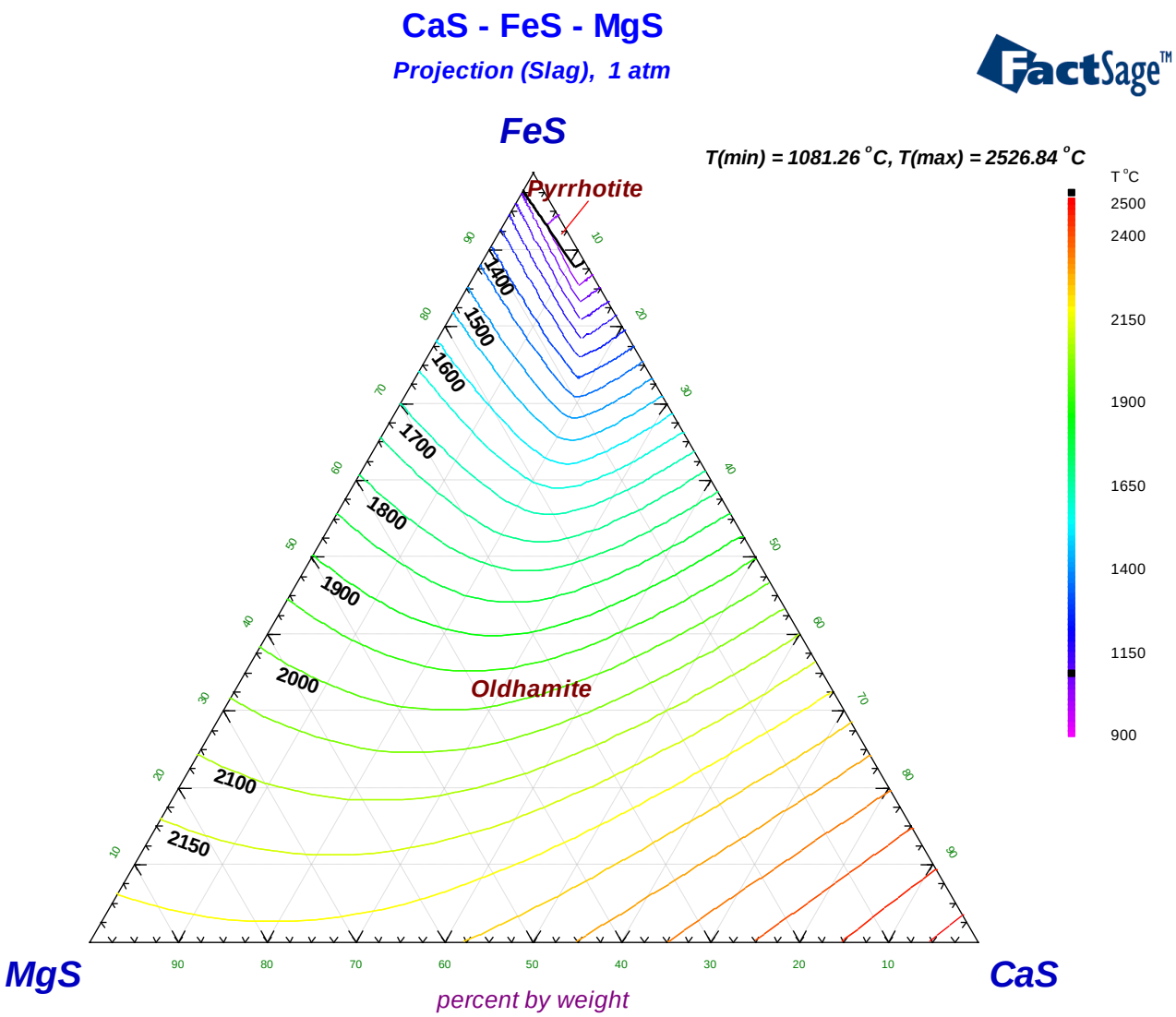

FeS - MgS - CaS
800°C, 1 bar
FeS
[71Skinner]:
three-phase assemblages
two-phase assemblages
Pyrrhotite + Oldhamite
Pyrrhotite + Oldhamite + Oldhamite#2
Pyrrhotite + Oldhamite
Oldhamite
Oldhamite + Oldhamite#2
Oldhamite
MgS
CaS
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
mole fraction


CaS - FeS - MgS
900°C, 1 atm
FeS
[Skinner1971]
PYRRHOTITE + Oldhamite
PYRRHOTITE + Oldhamite + Oldhamite#2
PYRRHOTITE + Oldhamite
Oldhamite
Oldhamite + Oldhamite#2
Oldhamite
MgS
CaS
mole fraction

Mole fraction, Liquidussurface



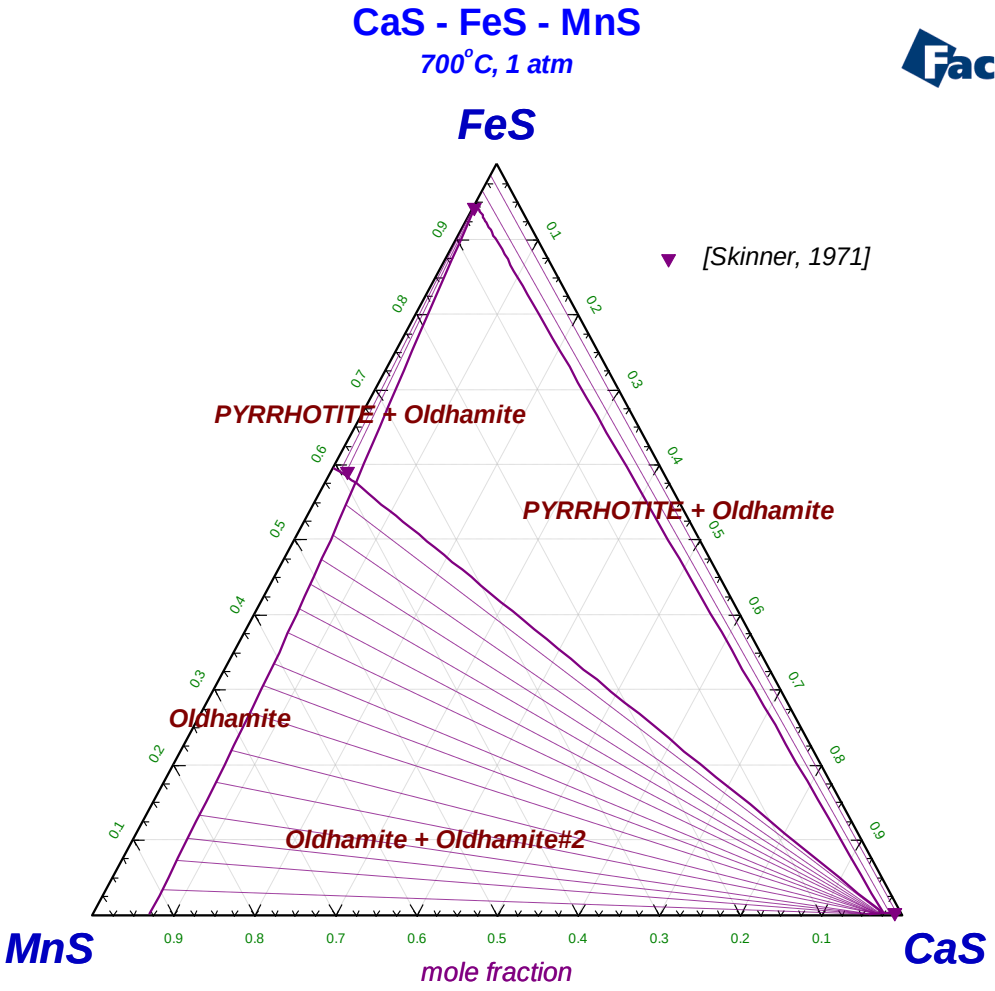
Weight percent, Liquidussurface

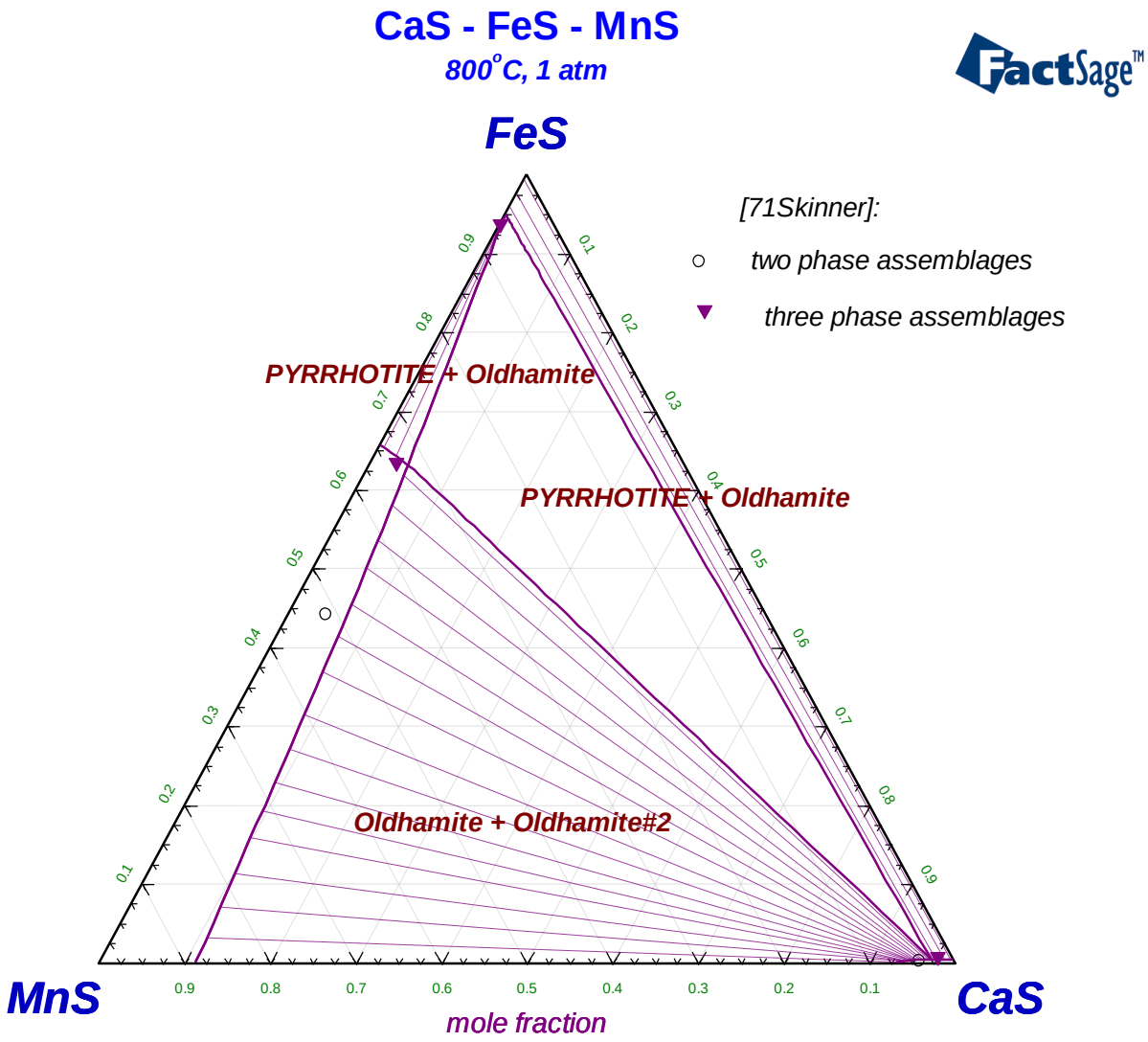


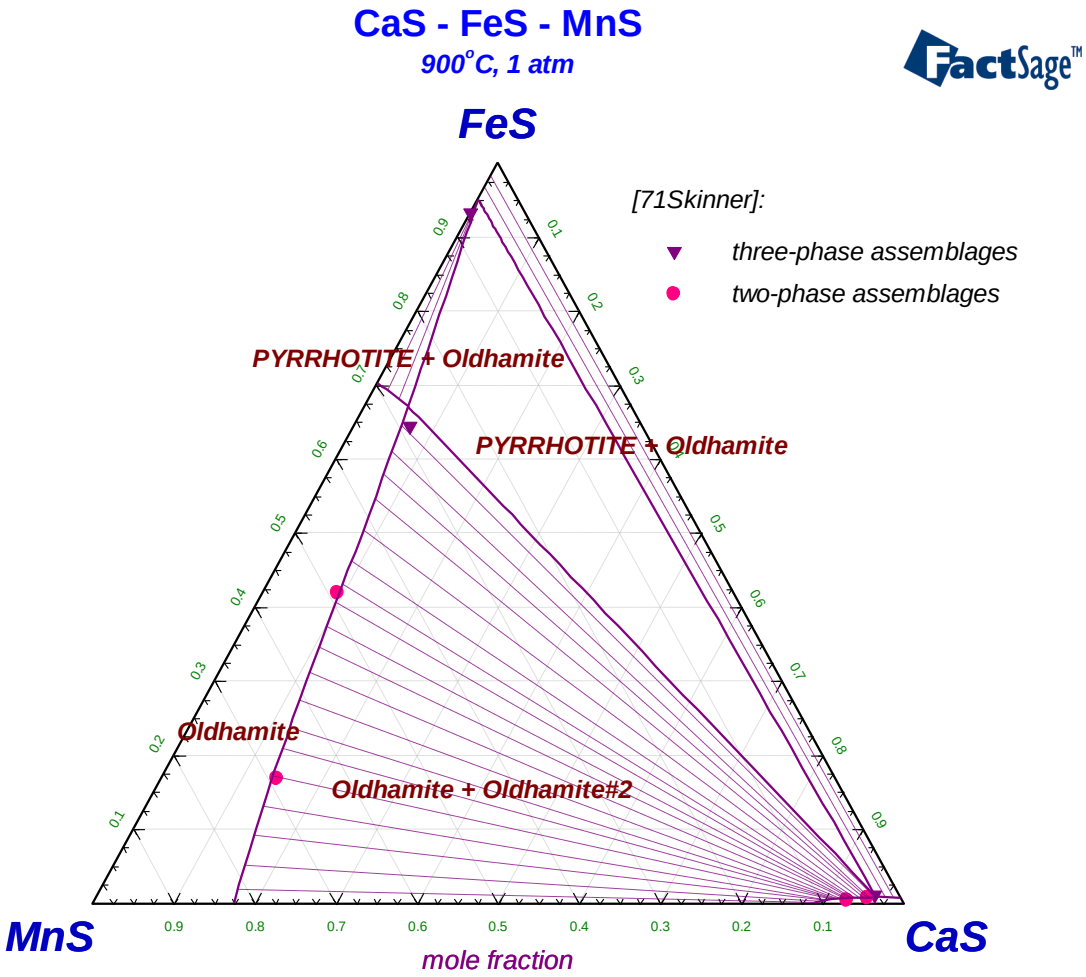
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction				Weight percent			
	A = FeS, B = MgS, C = CaS				A = FeS, B = MgS, C = CaS			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
Niningerite / Oldhamite / Troilite-HT	0.87924	0.00761	0.11315	1113.77	89.996	0.500	9.504	1113.77

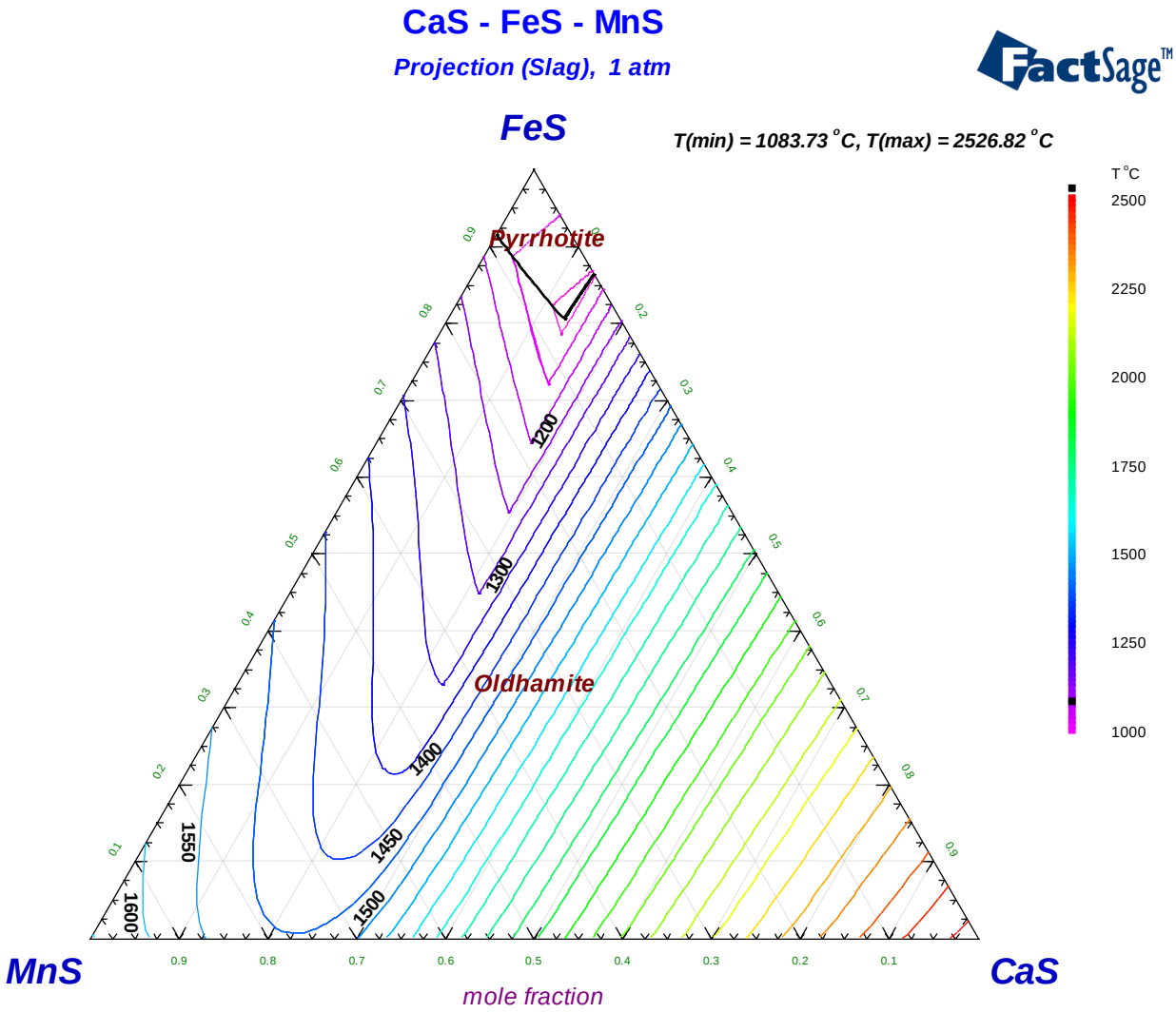
CaS-FeS-MnS,
Mole fraction 700°C



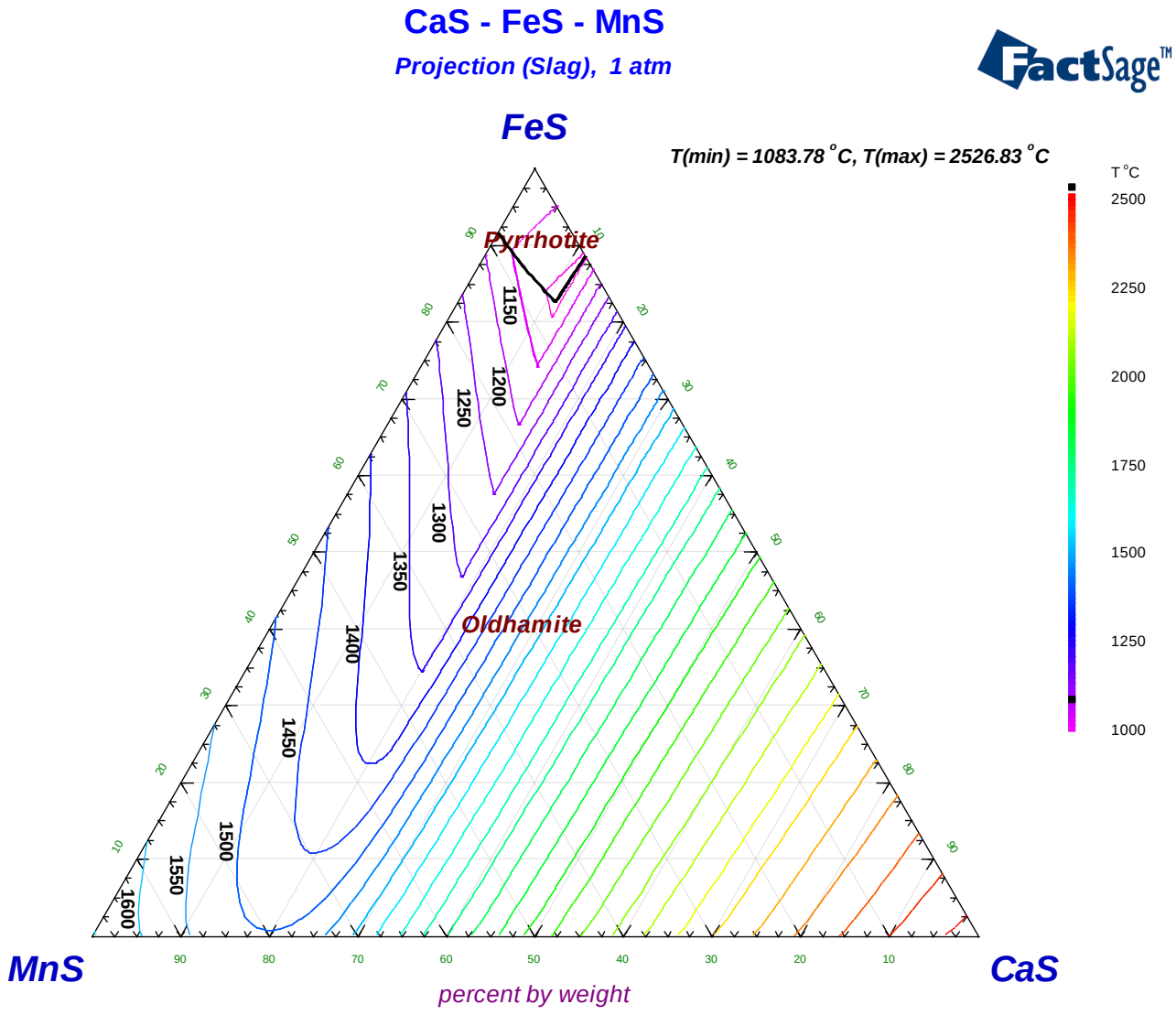

CaS - FeS - MnS
800°C, 1 atm
FeS
[71Skinner]:
two phase assemblages
three phase assemblages
PYRRHOTITE + Oldhamite
PYRRHOTITE + Oldhamite
Oldhamite + Oldhamite#2
MnS
CaS
mole fraction


CaS - FeS - MnS
900°C, 1 atm
FeS
[71Skinner]:
three-phase assemblages
two-phase assemblages
PYRRHOTITE + Oldhamite
PYRRHOTITE + Oldhamite
Oldhamite
Oldhamite + Oldhamite#2
MnS
CaS
mole fraction

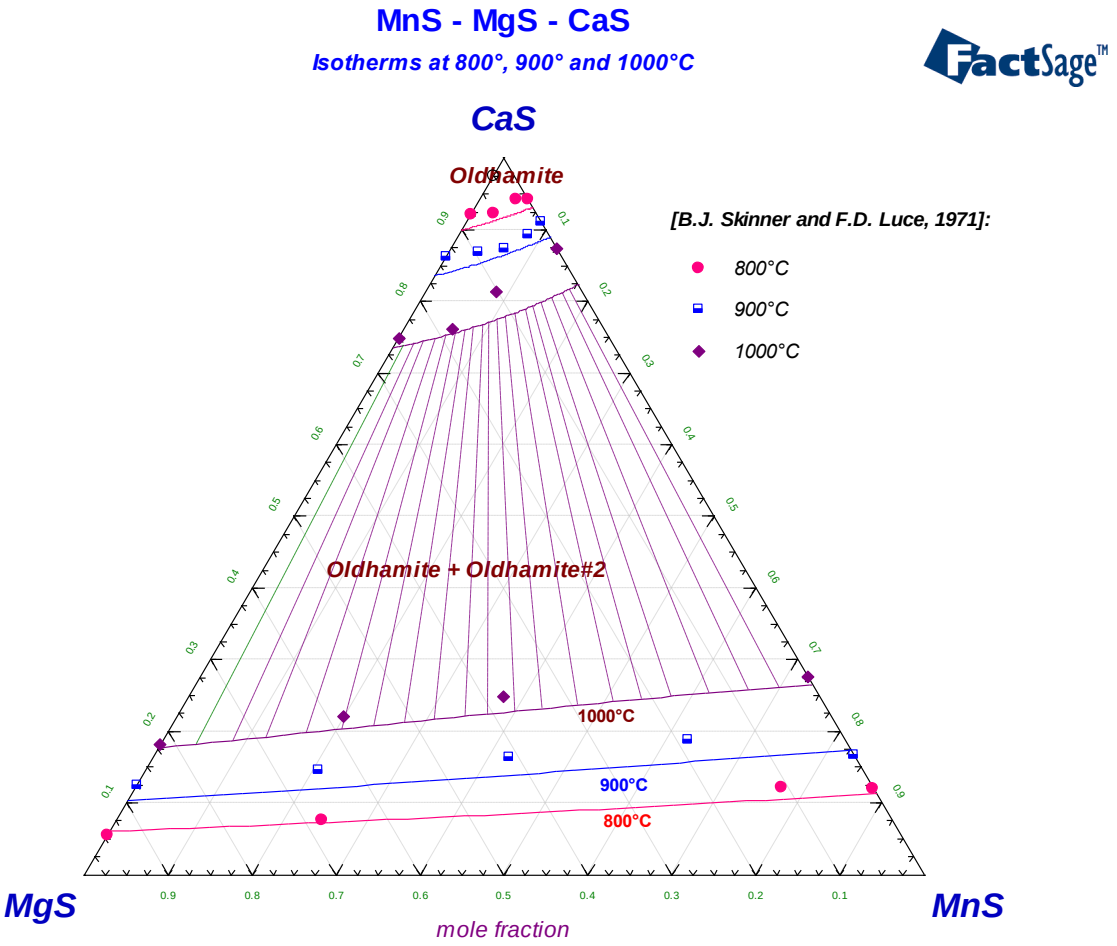
Mole fraction, Liquidussurface

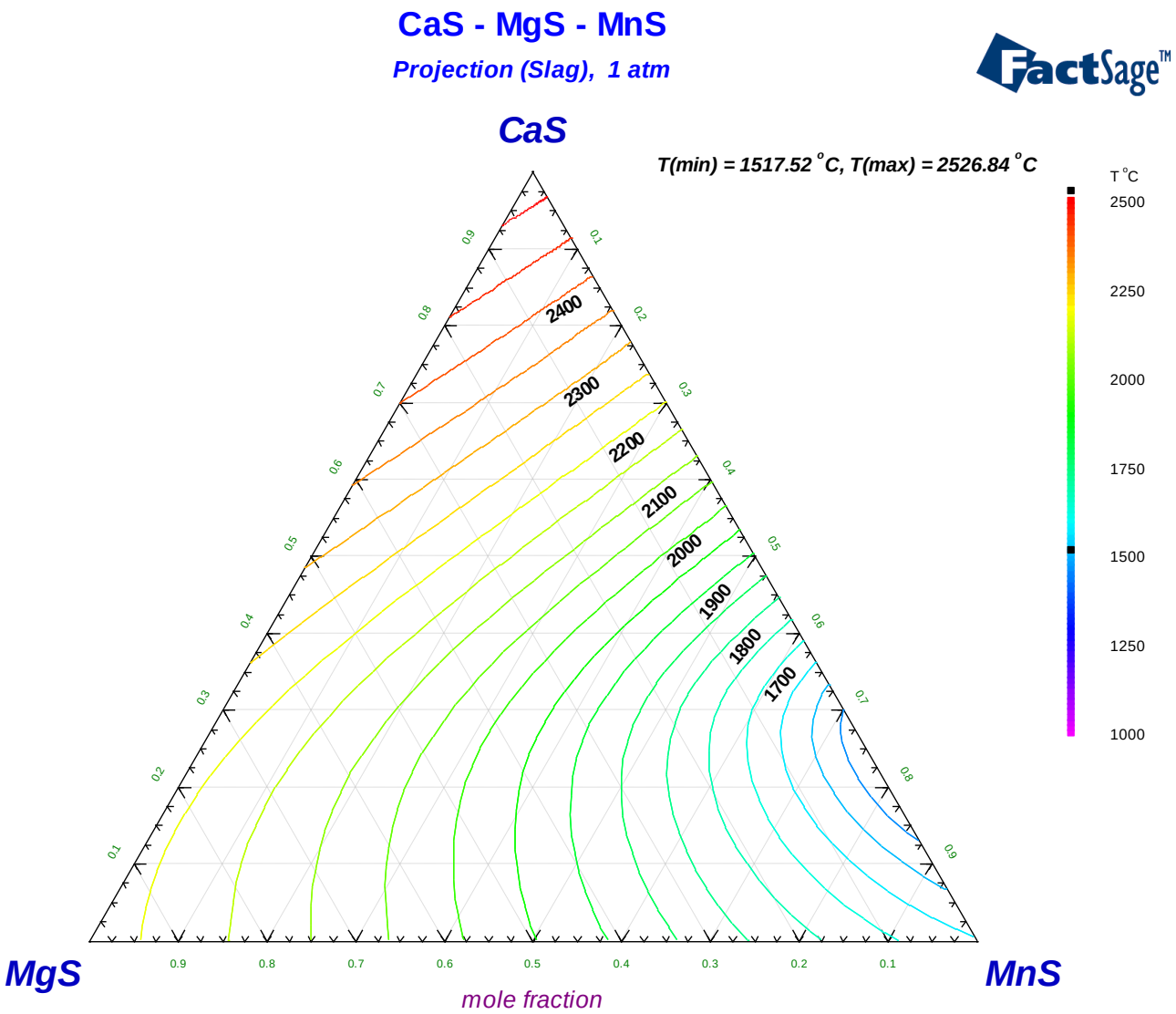


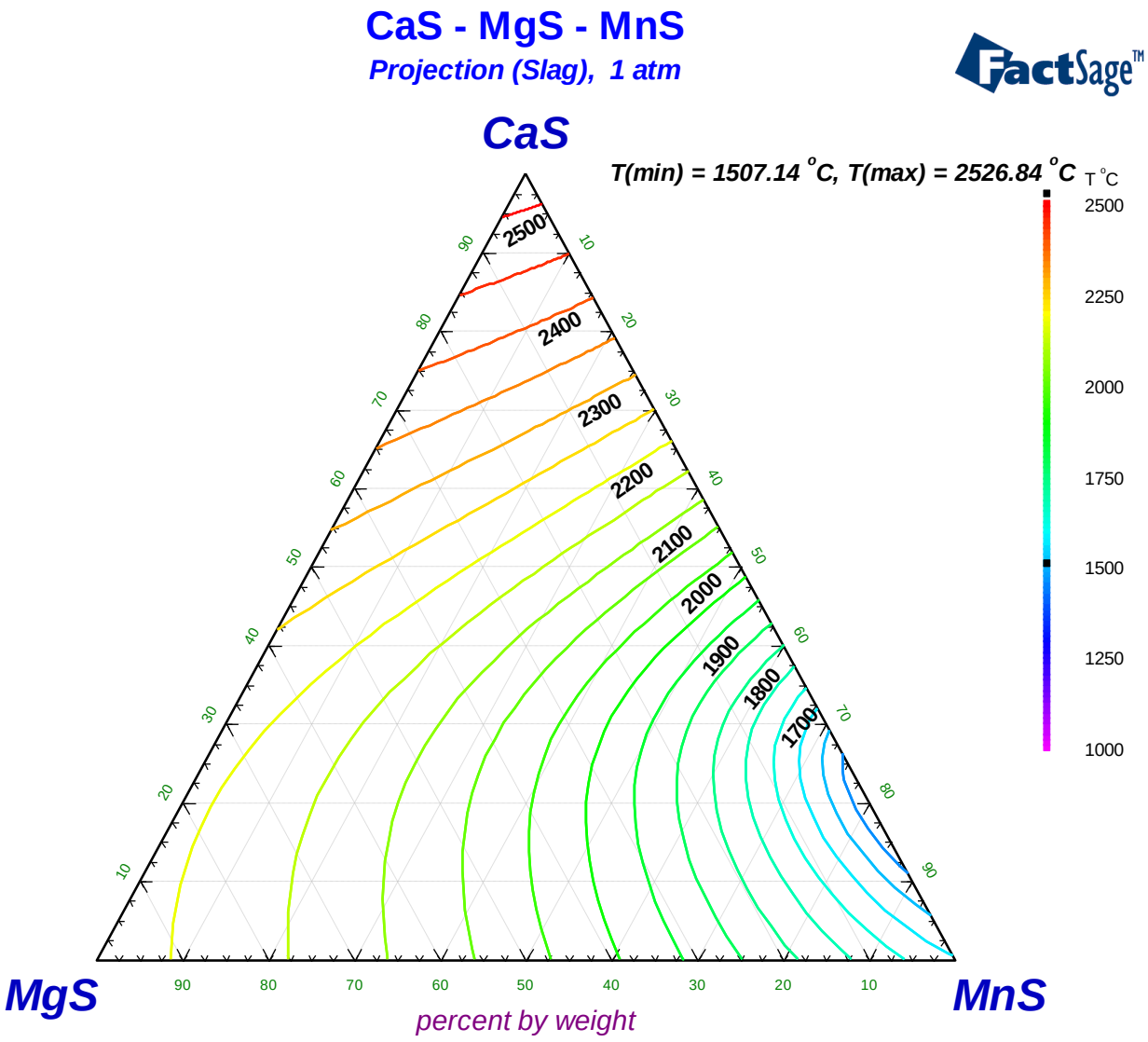
Weight percent, Liquidussurface



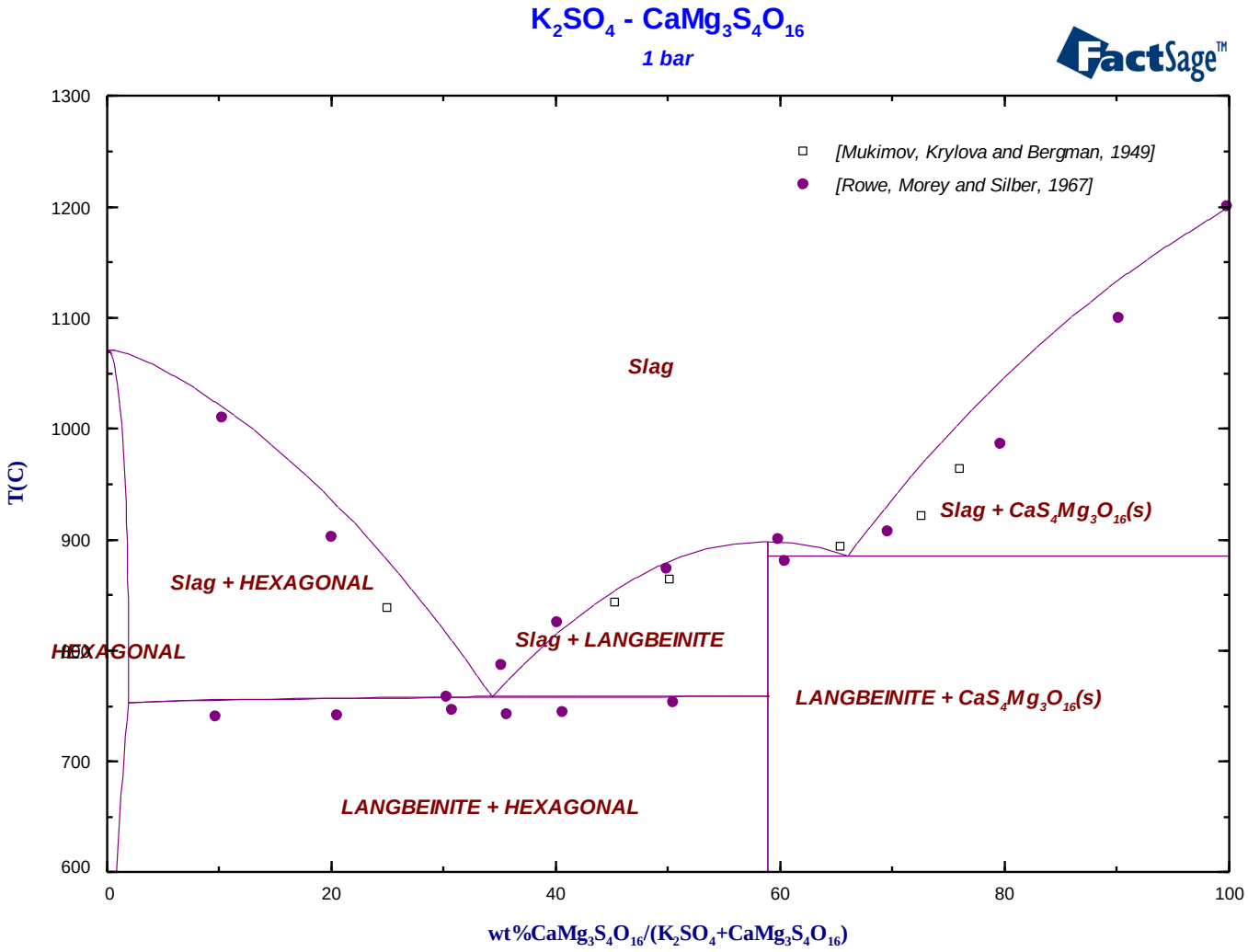
Mole fraction, Isotherms 800°, 900 and 1000°C



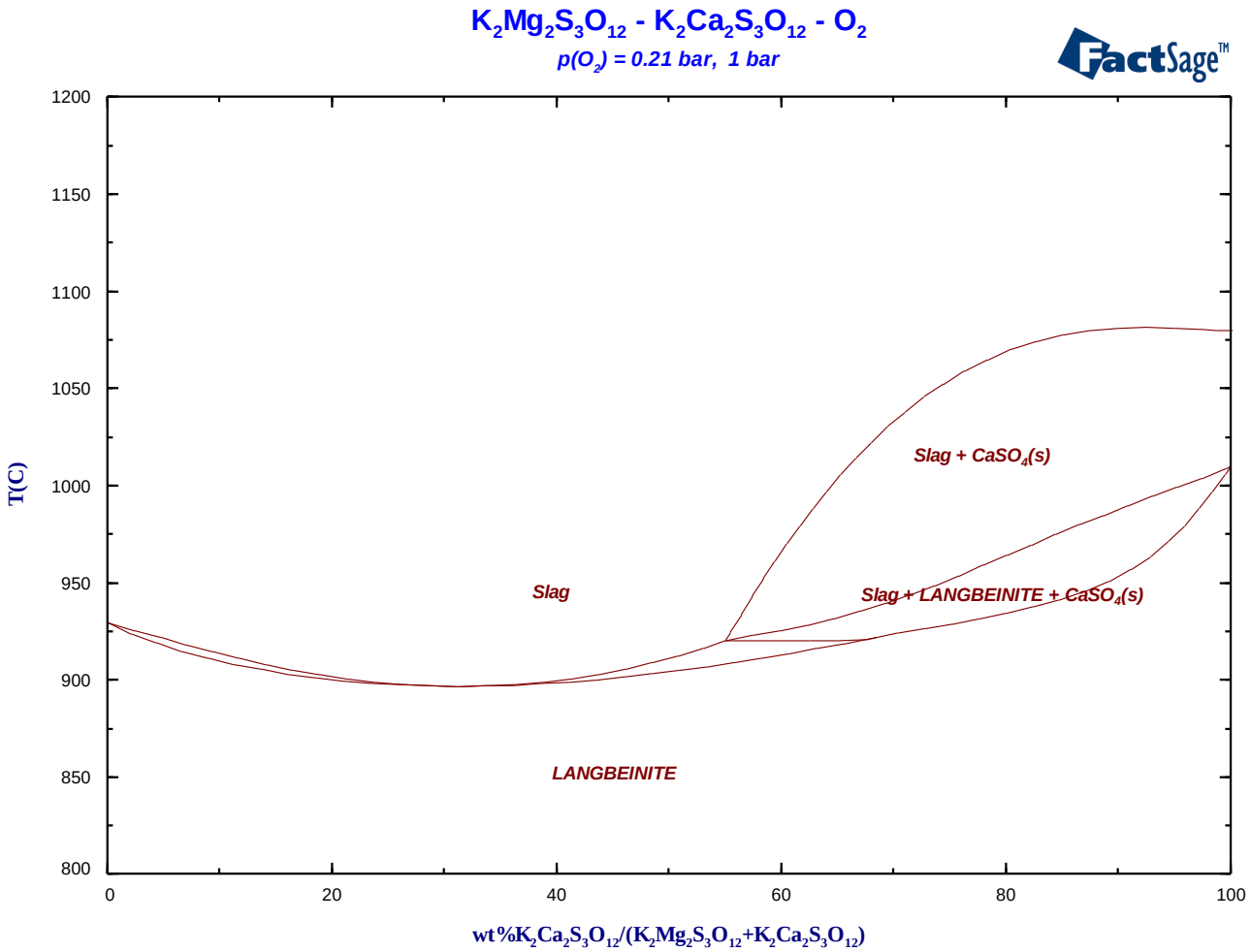

CaS - MgS - MnS
Projection (Slag), 1 atm
CaS
T(min) = 1517.52 °C, T(max) = 2526.84 °C
T °C
2500
2250
2000
1750
1500
1250
1000
2400
2300
2200
2100
2000
1900
1800
1700
MgS
MnS
mole fraction


CaS - MgS - MnS
Projection (Slag), 1 atm
FactSage™
CaS
T(min) = 1507.14 °C, T(max) = 2526.84 °C
T °C
2500
2250
2000
1750
1500
1250
1000
2500
2400
2300
2200
2100
2000
1900
1800
1700
MgS
MnS
percent by weight

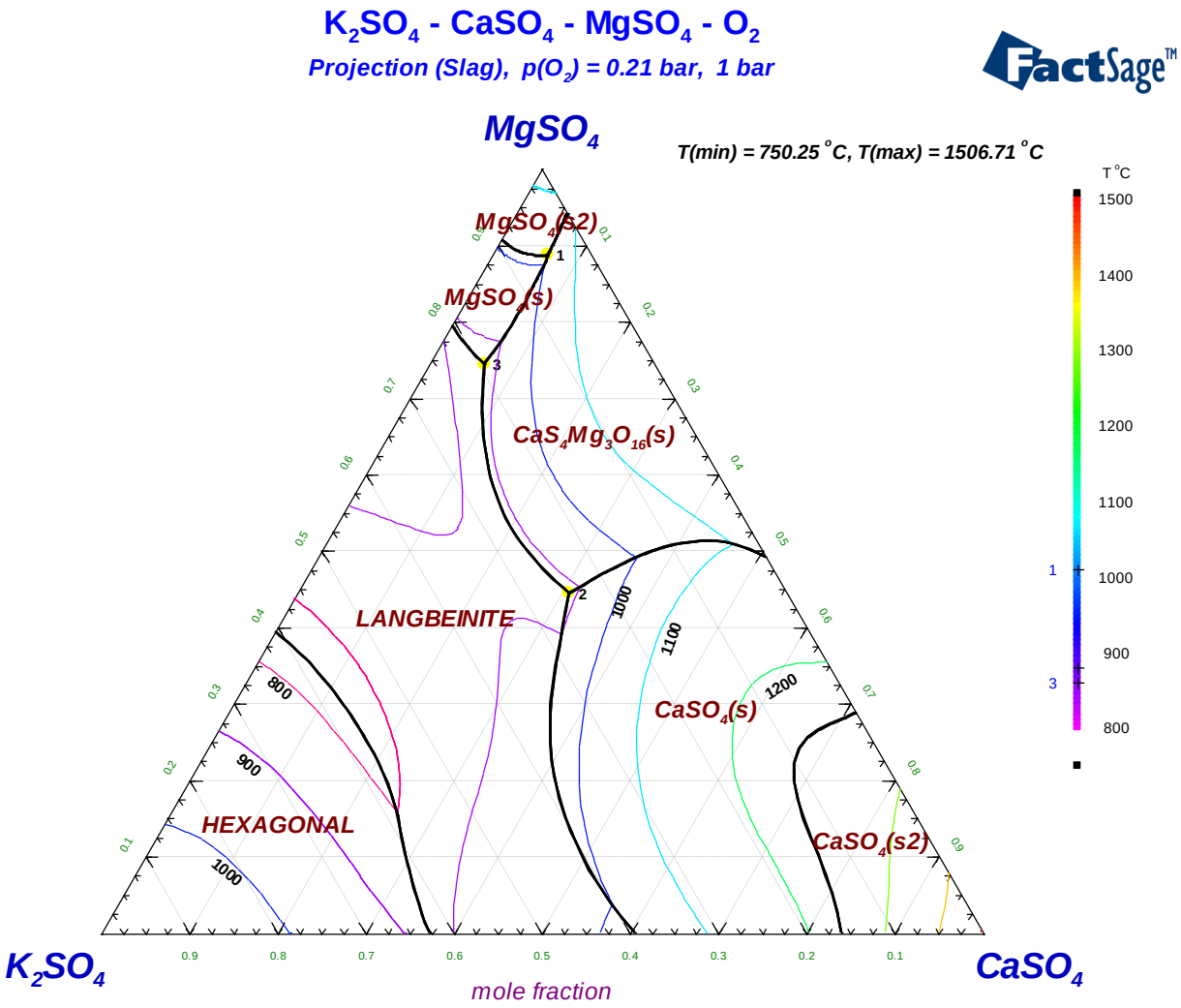
Weight percent K2SO4-CaMg3S4O16 compared with experimental data



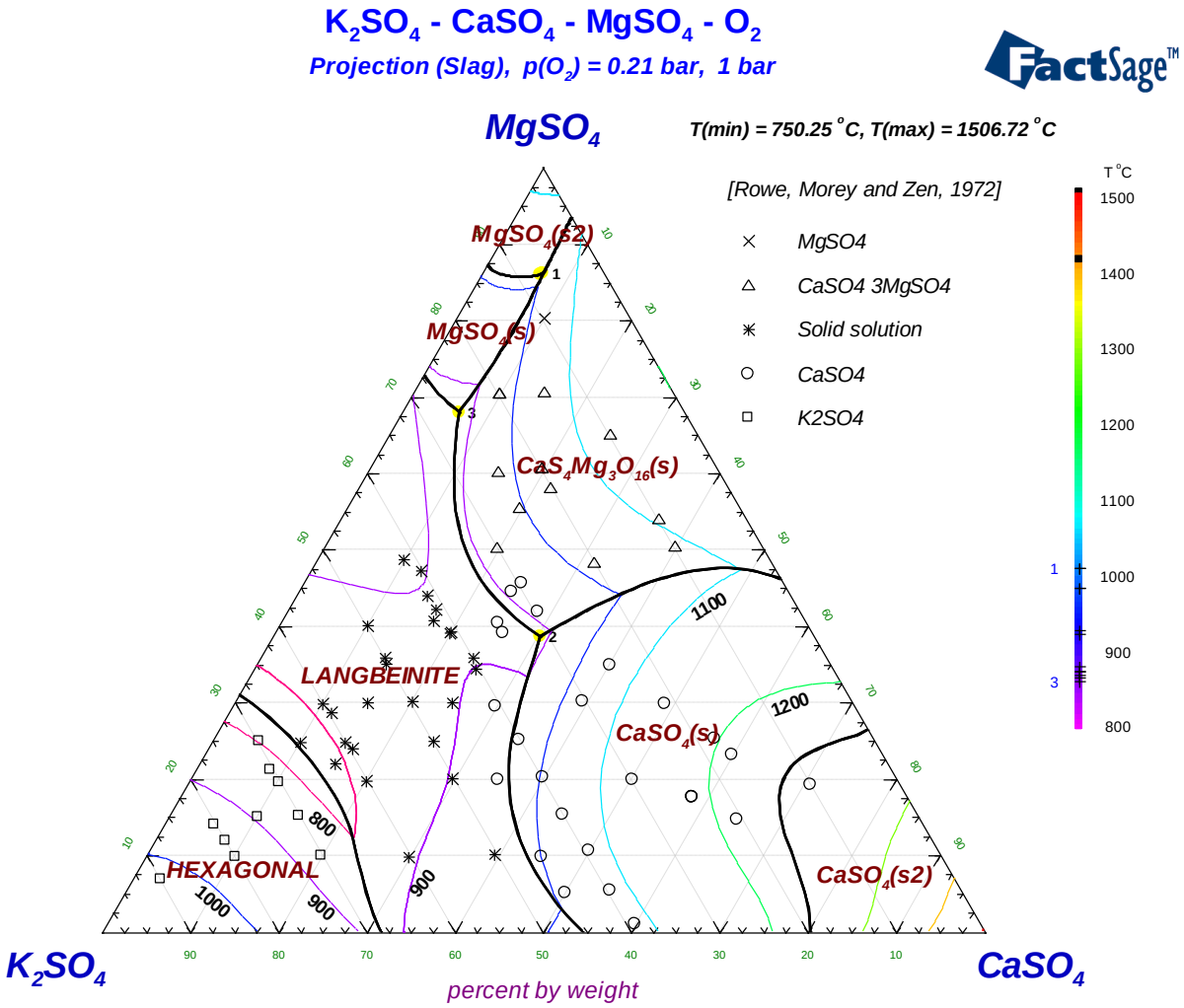
Weight percent K2Mg2S3O12-K2Ca2S3O12



Mole fraction, Liquidussurface



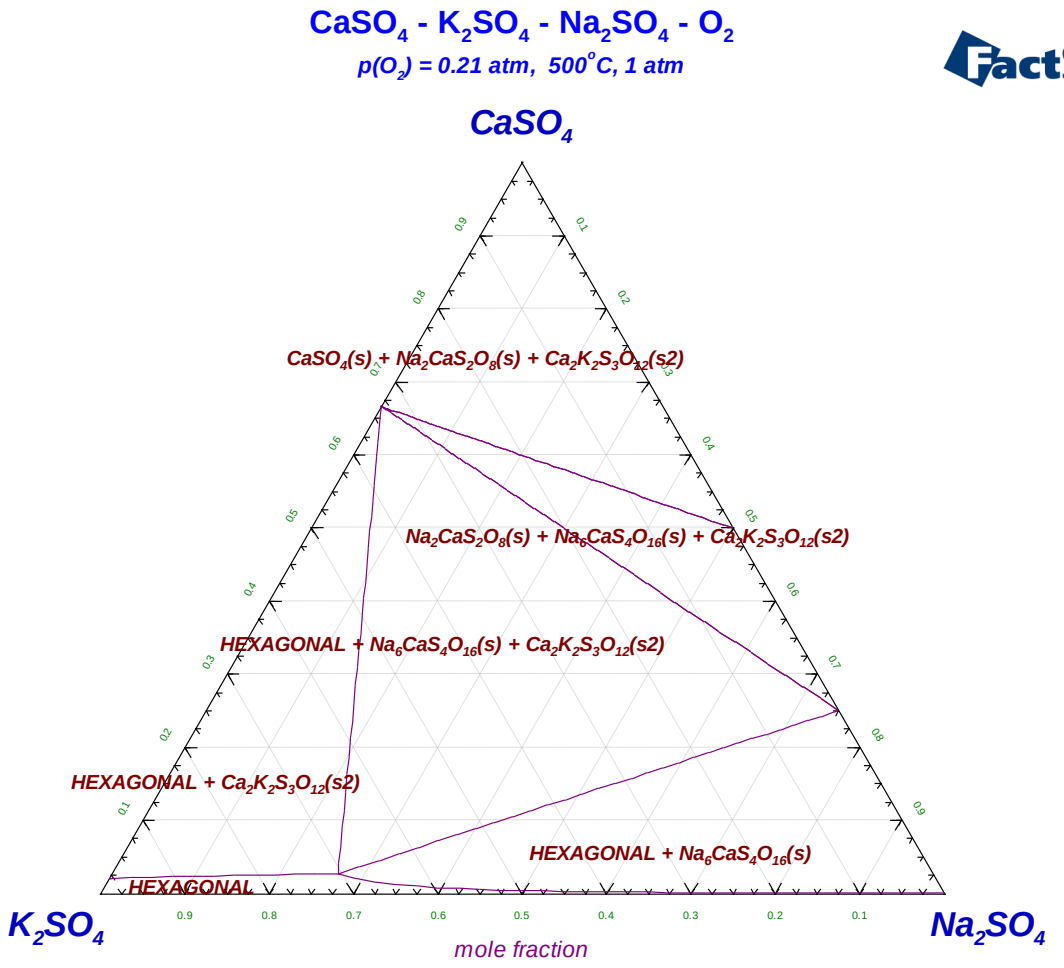
Weight percent, Liquidussurface compared with experimental data

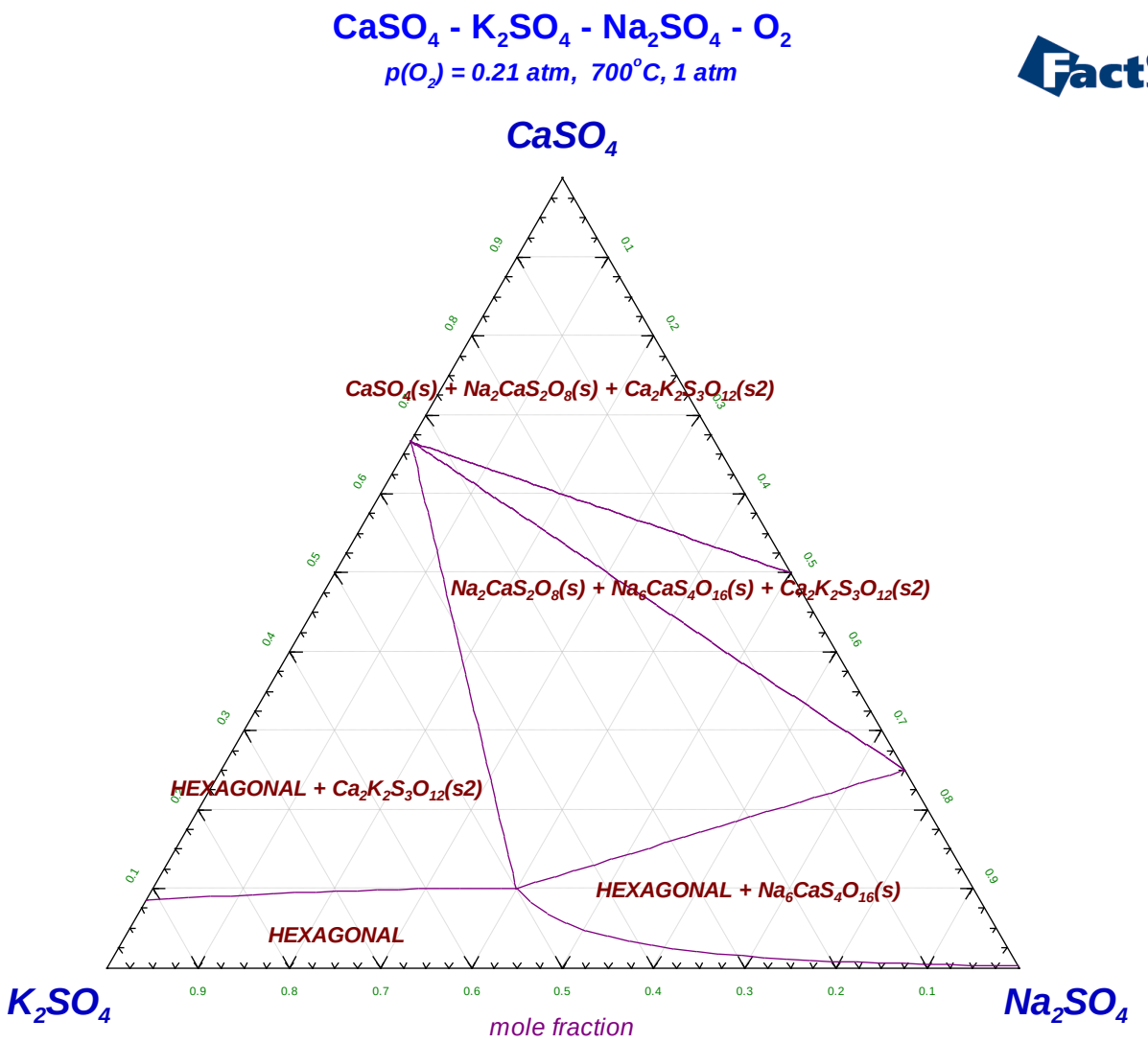


Invariant equilibria on the liquidus surface

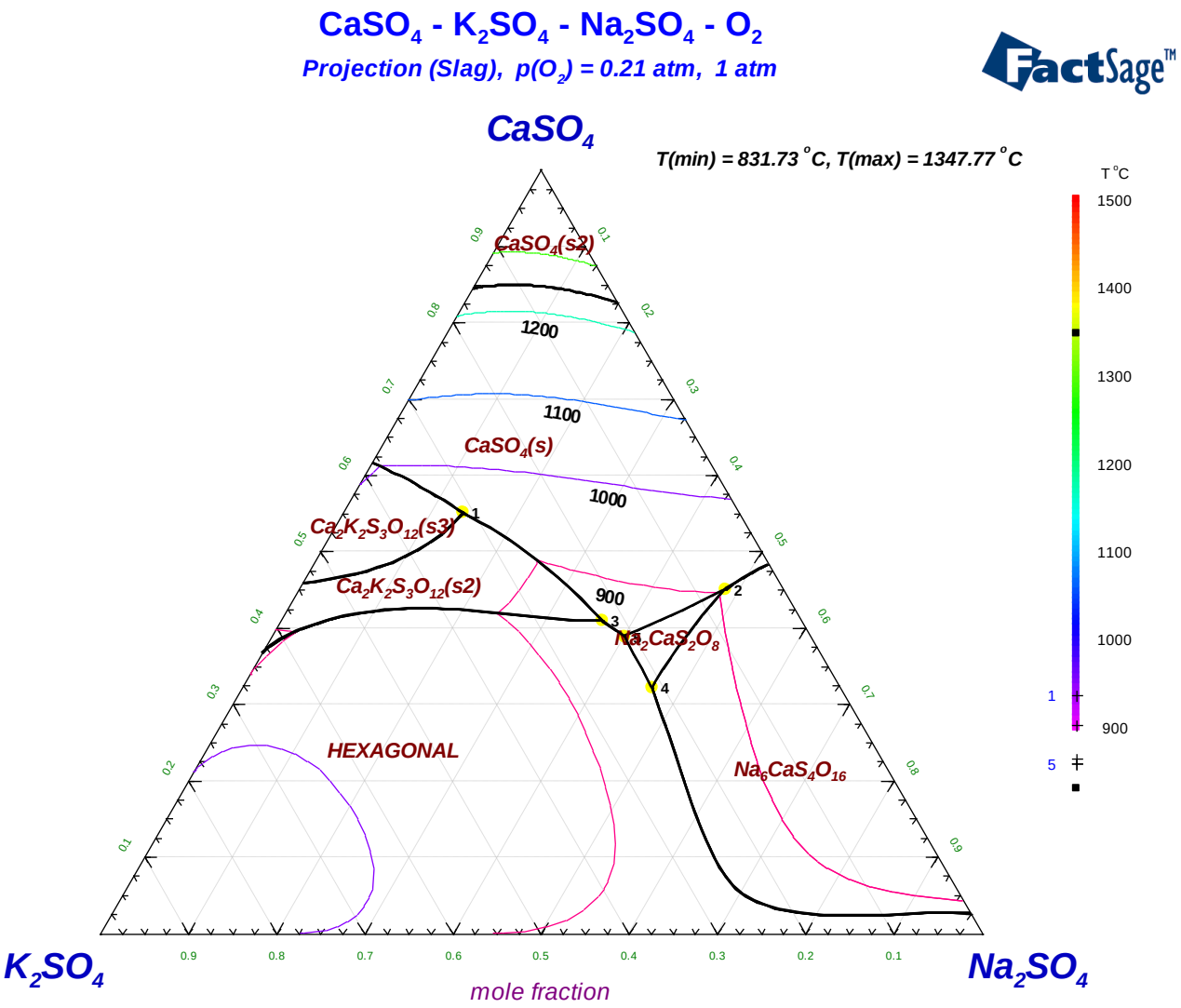
Intersections with slag	Mole fraction					Weight percent				
	A = MgSO4, B = K2SO4, C = CaSO4					A = MgSO4, B = K2SO4, C = CaSO4				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: CaS4Mg3O16(s) / MgSO4(s1) / MgSO4(s2)	1:	0.88774	0.04926	0.06300	1009.85	1:	86.163	6.921	6.916	1009.85
2: CaS4Mg3O16(s) / CaSO4(s) / LANGBEINITE	2:	0.44528	0.24643	0.30830	879.95	2:	38.695	31.003	30.302	879.95
3: CaS4Mg3O16(s) / LANGBEINITE / MgSO4(s1)	3:	0.74495	0.19289	0.06216	859.13	3:	68.062	25.514	6.424	859.13

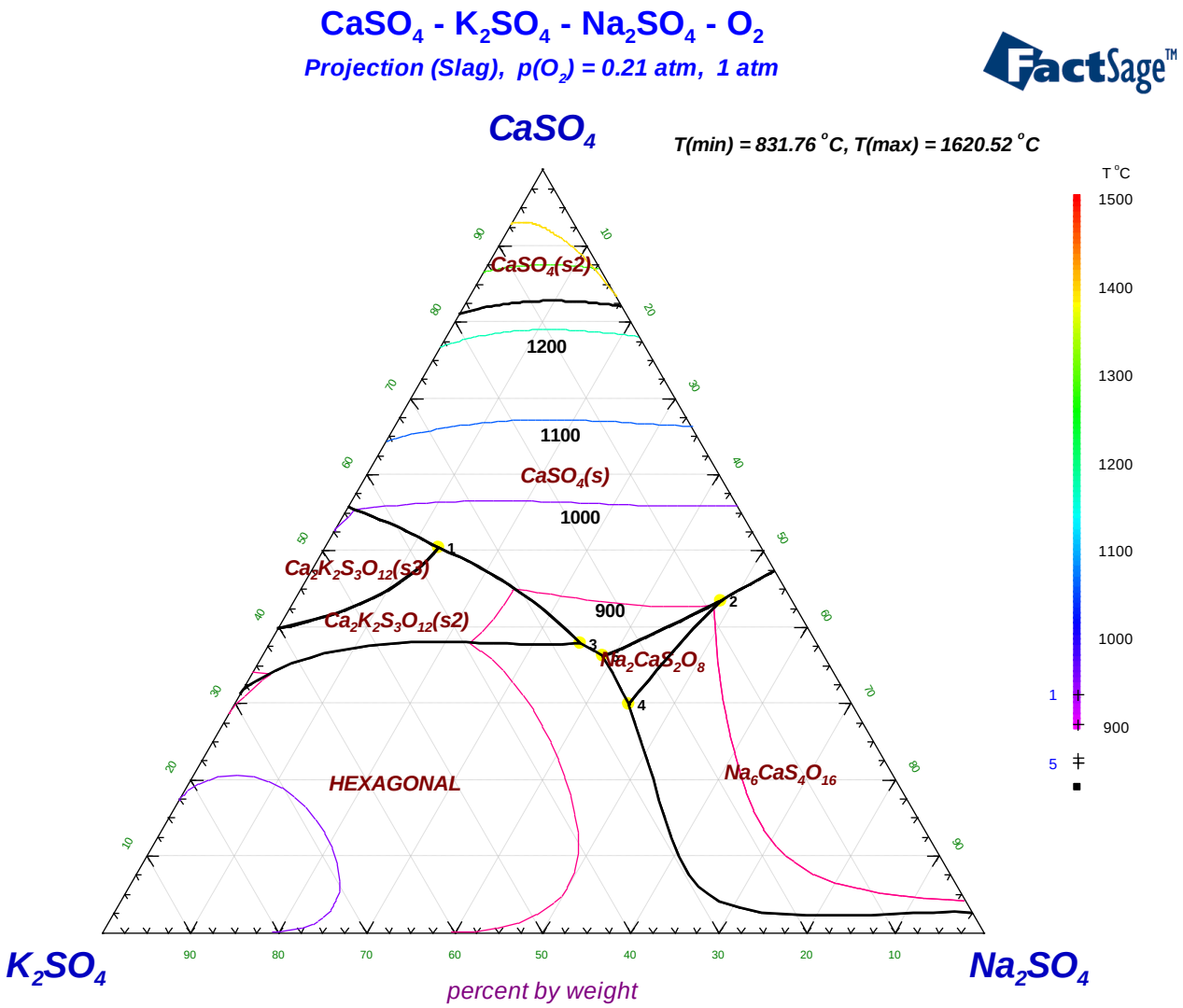
Mole fraction 500°C




CaSO4 - K2SO4 - Na2SO4 - O2
p(O2) = 0.21 atm, 700°C, 1 atm
CaSO4
CaSO4(s) + Na2CaS2O8(s) + Ca2K2S3O12(s2)
Na2CaS2O8(s) + Na6CaS4O16(s) + Ca2K2S3O12(s2)
HEXAGONAL + Ca2K2S3O12(s2)
HEXAGONAL + Na6CaS4O16(s)
HEXAGONAL
K2SO4
Na2SO4
mole fraction

Mole fraction, Liquidussurface

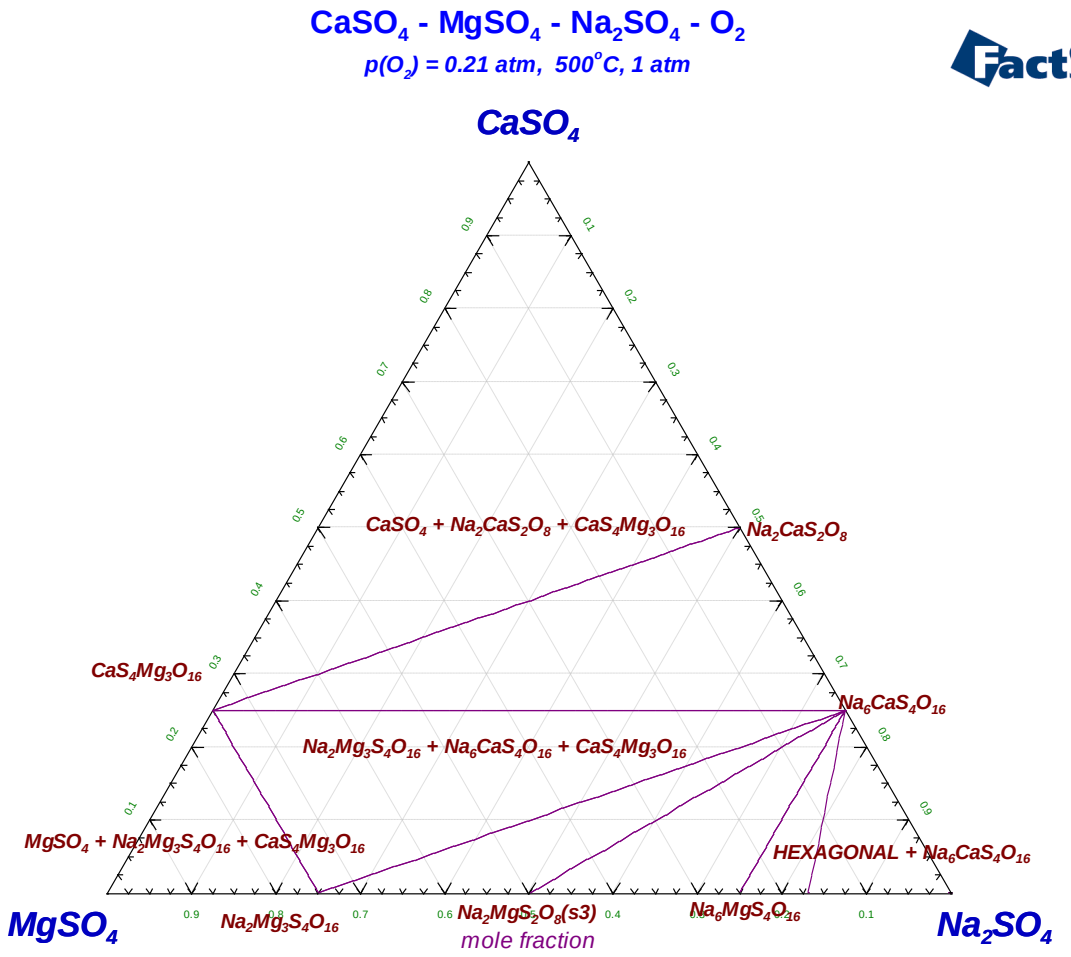


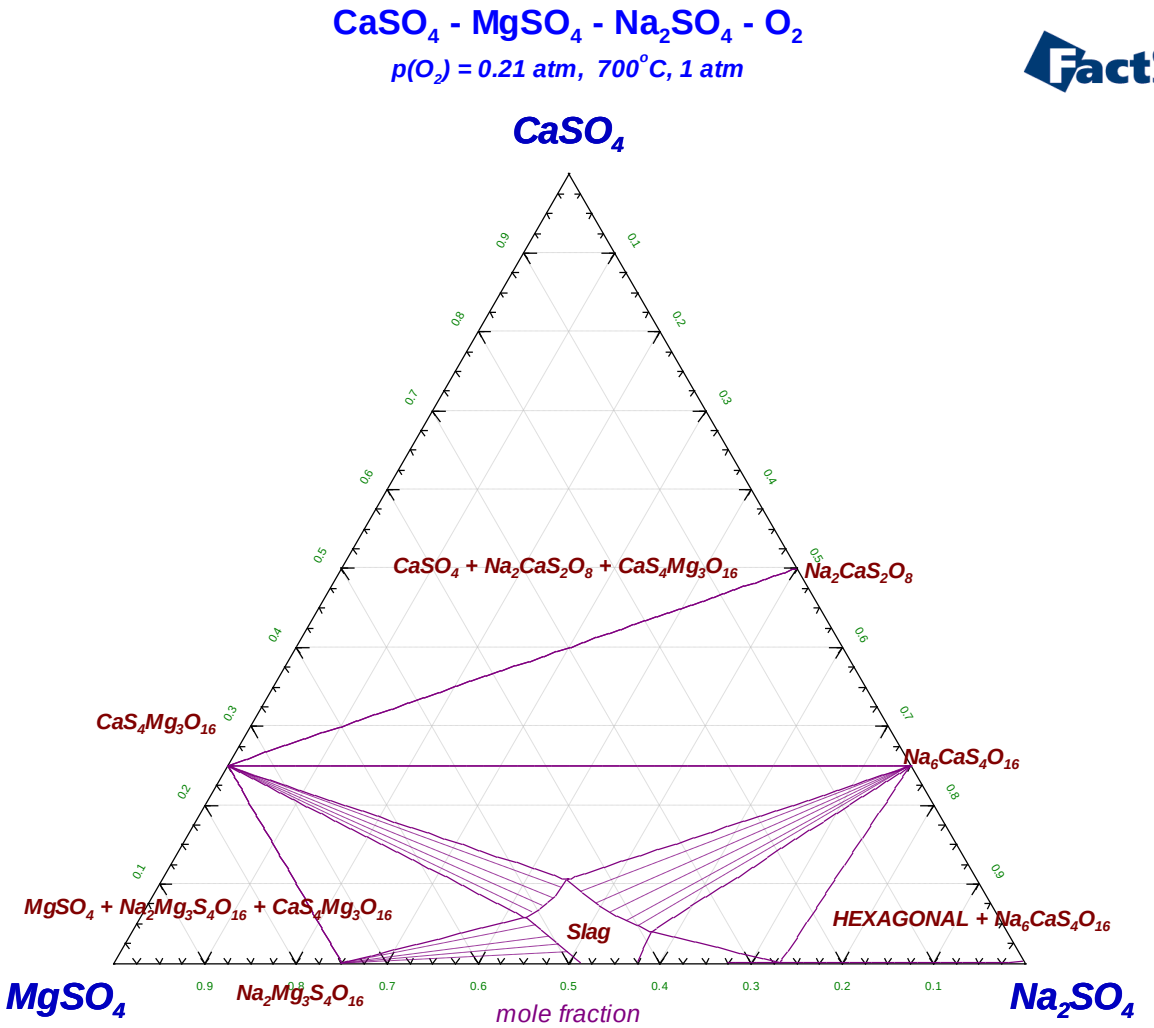

CaSO4 - K2SO4 - Na2SO4 - O2
Projection (Slag), p(O2) = 0.21 atm, 1 atm
FactSage™
CaSO4
T(min) = 831.76 °C, T(max) = 1620.52 °C
T °C
1500
1400
1300
1200
1100
1000
900
CaSO4(s2)
1200
1100
CaSO4(s)
1000
Ca2K2S3O12(s3)
Ca2K2S3O12(s2)
900
Na2CaS2O8
HEXAGONAL
Na6CaS4O16
1
2
3
4
K2SO4
Na2SO4
percent by weight

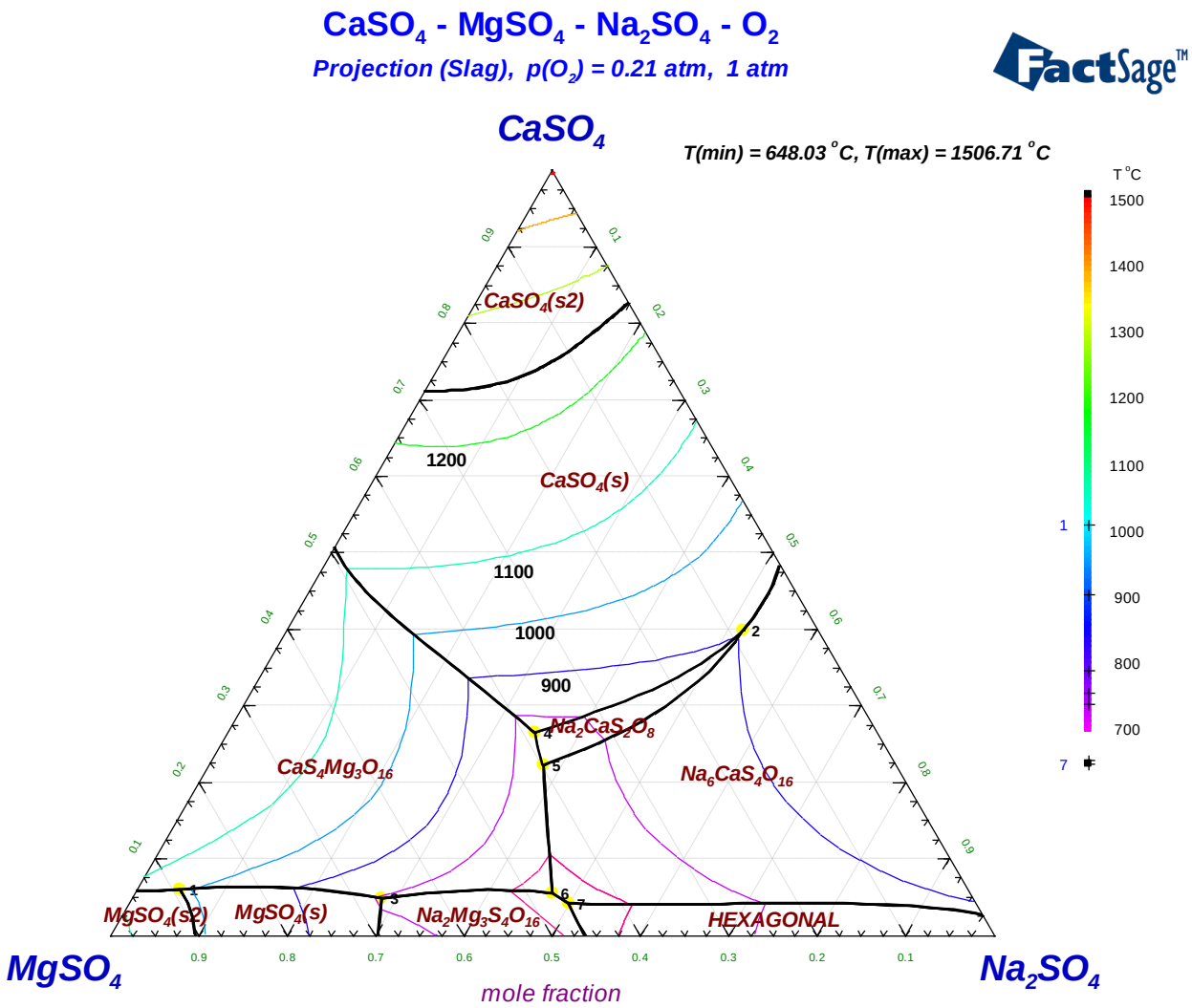
Invariant equilibria on the liquidus surface

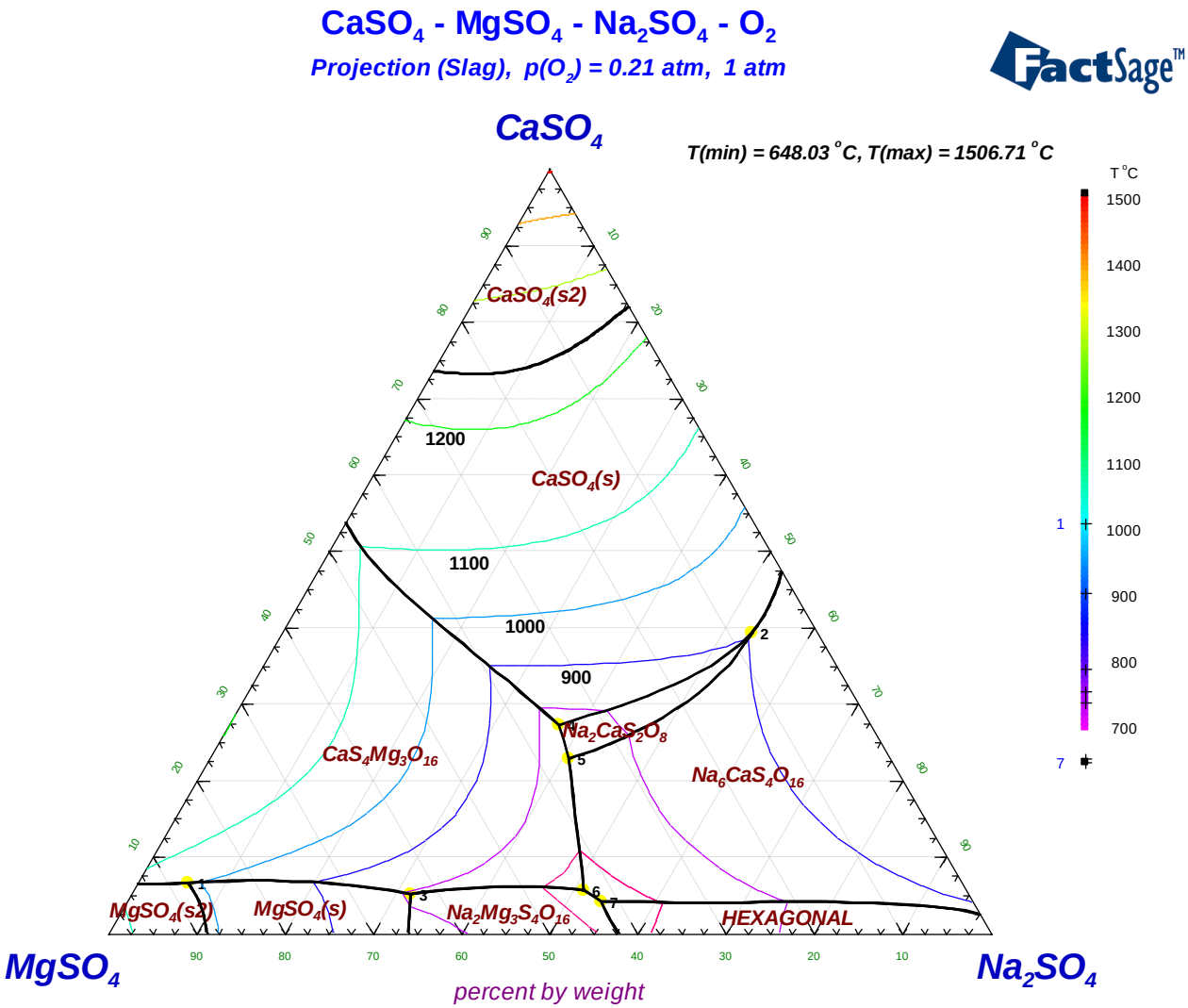
Intersections with slag	Mole fraction					Weight percent				
	A = CaSO4, B = K2SO4, C = Na2SO4					A = CaSO4, B = K2SO4, C = Na2SO4				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: Ca2K2S3O12(s2) / Ca2K2S3O12(s3) / CaSO4(s)	1:	0.55058	0.31303	0.13638	936.85	1:	50.348	36.640	13.012	936.85
2: CaSO4(s) / Na2CaS2O8 / Na6CaS4O16	2:	0.45104	0.06551	0.48345	902.85	2:	43.399	8.068	48.534	902.85
3: Ca2K2S3O12(s2) / CaSO4(s) / HEXAGONAL	3:	0.40895	0.22566	0.36539	864.74	3:	37.900	26.769	35.331	864.73
4: HEXAGONAL / Na2CaS2O8 / Na6CaS4O16	4:	0.32220	0.21305	0.46475	860.12	4:	29.839	25.255	44.906	860.12
5: CaSO4(s) / HEXAGONAL / Na2CaS2O8	5:	0.38925	0.21063	0.40013	859.23	5:	36.165	25.049	38.787	859.23

Mole fraction 500°C




CaSO4 - MgSO4 - Na2SO4 - O2
p(O2) = 0.21 atm, 700°C, 1 atm
CaSO4
CaSO4 + Na2CaS2O8 + CaS4Mg3O16
Na2CaS2O8
CaS4Mg3O16
Na6CaS4O16
MgSO4 + Na2Mg3S4O16 + CaS4Mg3O16
Slag
HEXAGONAL + Na6CaS4O16
MgSO4
Na2Mg3S4O16
mole fraction
Na2SO4

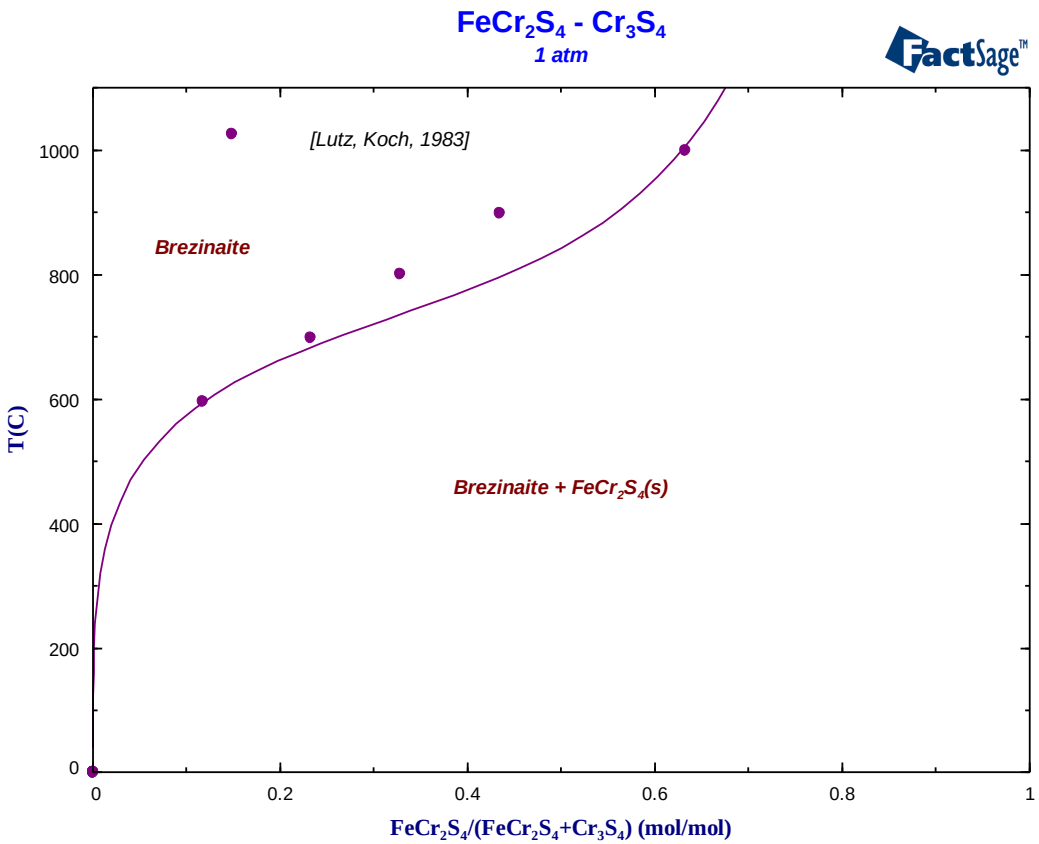

CaSO4 - MgSO4 - Na2SO4 - O2
Projection (Slag), p(O2) = 0.21 atm, 1 atm
FactSage™
CaSO4
T(min) = 648.03 °C, T(max) = 1506.71 °C
T °C
1500
1400
1300
1200
1100
1000
900
800
700
CaSO4(s2)
CaSO4(s)
1200
1100
1000
900
Na2CaS2O8
CaS4Mg3O16
Na6CaS4O16
MgSO4(s2)
MgSO4(s)
Na2Mg3S4O16
HEXAGONAL
MgSO4
Na2SO4
mole fraction


CaSO4 - MgSO4 - Na2SO4 - O2
Projection (Slag), p(O2) = 0.21 atm, 1 atm
FactSage™
CaSO4
T(min) = 648.03 °C, T(max) = 1506.71 °C
T °C
1500
1400
1300
1200
1100
1000
900
800
700
CaSO4(s2)
CaSO4(s)
1200
1100
1000
900
CaS4Mg3O16
Na2CaS2O8
Na6CaS4O16
MgSO4(s2)
MgSO4(s)
Na2Mg3S4O16
HEXAGONAL
MgSO4
Na2SO4
percent by weight

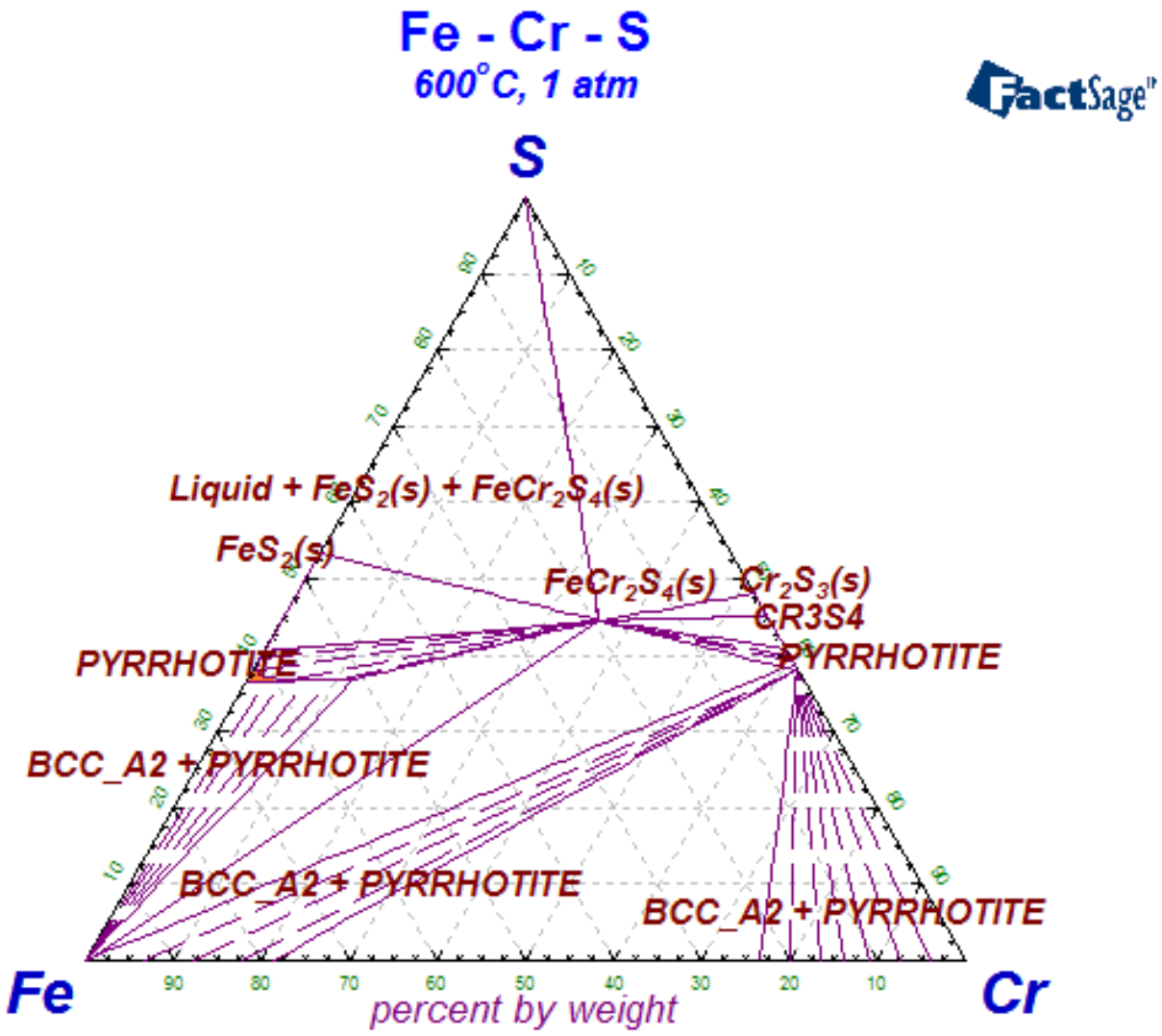
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction					Weight percent				
	A = CaSO4, B = MgSO4, C = Na2SO4					A = CaSO4, B = MgSO4, C = Na2SO4				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: CaS4Mg3O16 / MgSO4(s) / MgSO4(s2)	1:	0.05918	0.89109	0.04973	1009.85	1:	6.583	87.645	5.772	1009.84
2: CaSO4 / Na2CaS2O8 / Na6CaS4O16	2:	0.39780	0.08512	0.51708	902.85	2:	39.287	7.432	53.281	902.85
3: CaS4Mg3O16 / MgSO4(s) / Na2Mg3S4O16	3:	0.04846	0.66823	0.28331	788.60	3:	5.184	63.198	31.619	788.60
4: CaS4Mg3O16 / CaSO4 / Na2CaS2O8	4:	0.26482	0.38704	0.34814	755.16	4:	27.294	35.269	37.437	755.11
5: CaS4Mg3O16 / Na2CaS2O8 / Na6CaS4O16	5:	0.22165	0.39894	0.37941	737.89	5:	22.845	36.354	40.801	737.88
6: CaS4Mg3O16 / Na2Mg3S4O16 / Na6CaS4O16	6:	0.05464	0.47236	0.47300	653.12	6:	5.658	43.243	51.099	653.12
7: HEXAGONAL / Na2Mg3S4O16 / Na6CaS4O16	7:	0.04100	0.46084	0.49816	648.03	7:	4.235	42.083	53.682	648.03

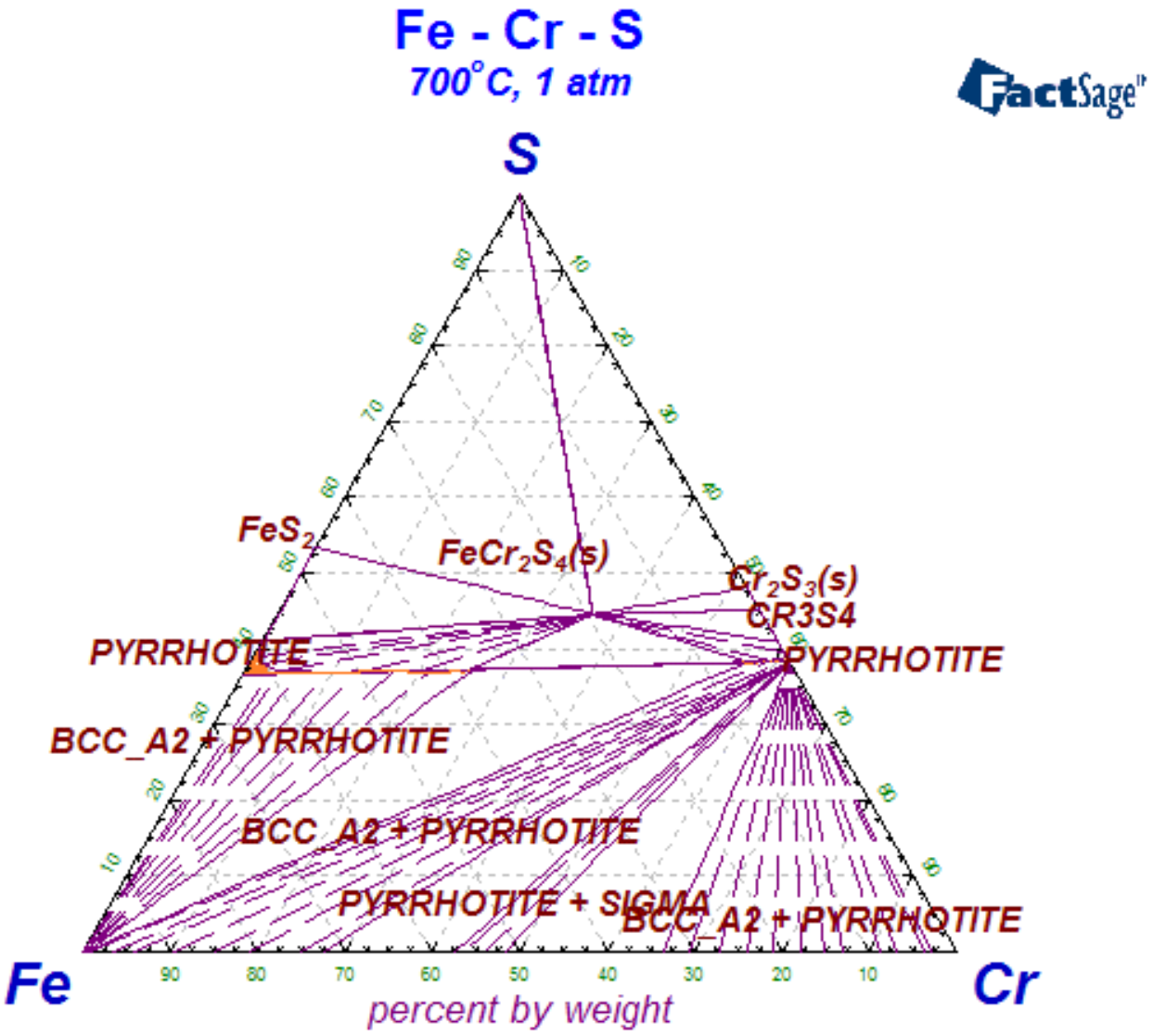
Mole fraction Cr2FeS4-Cr3S4



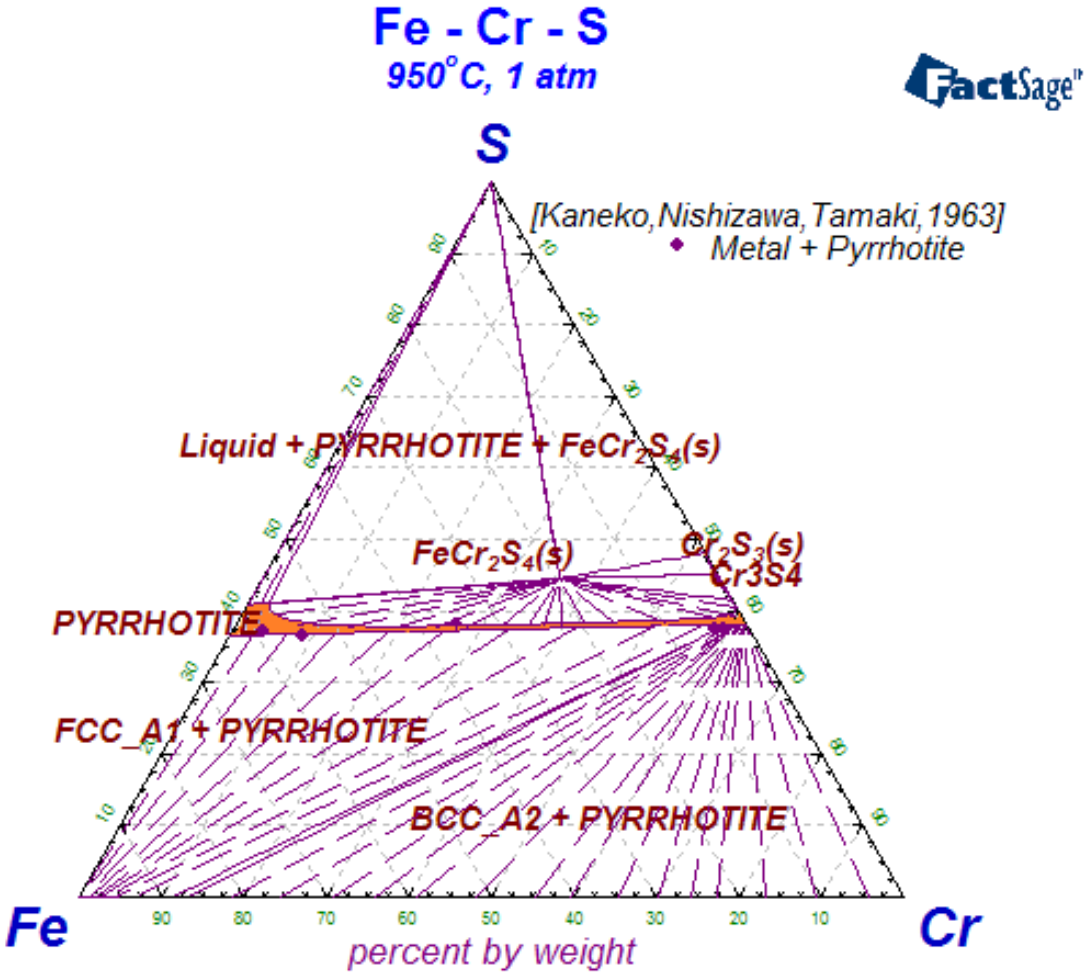
Weight percent



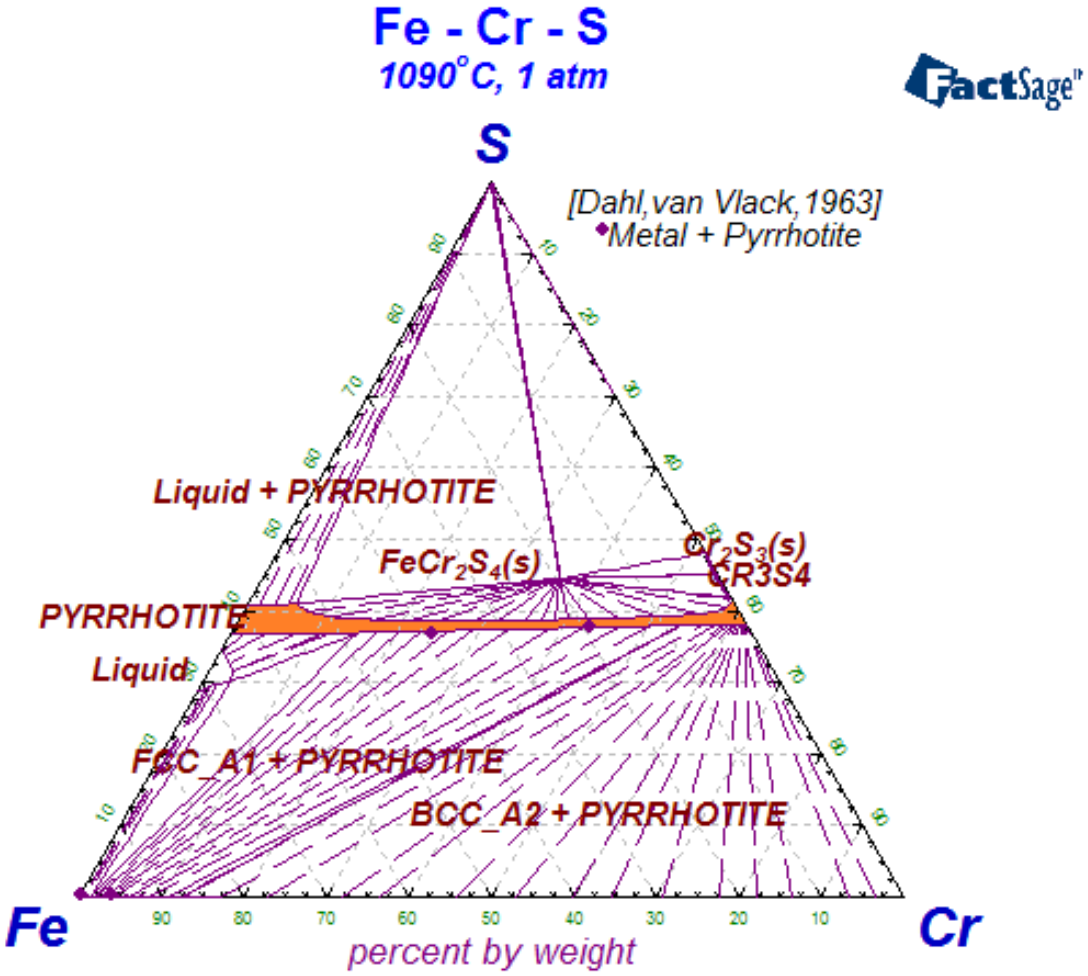
Weight percent

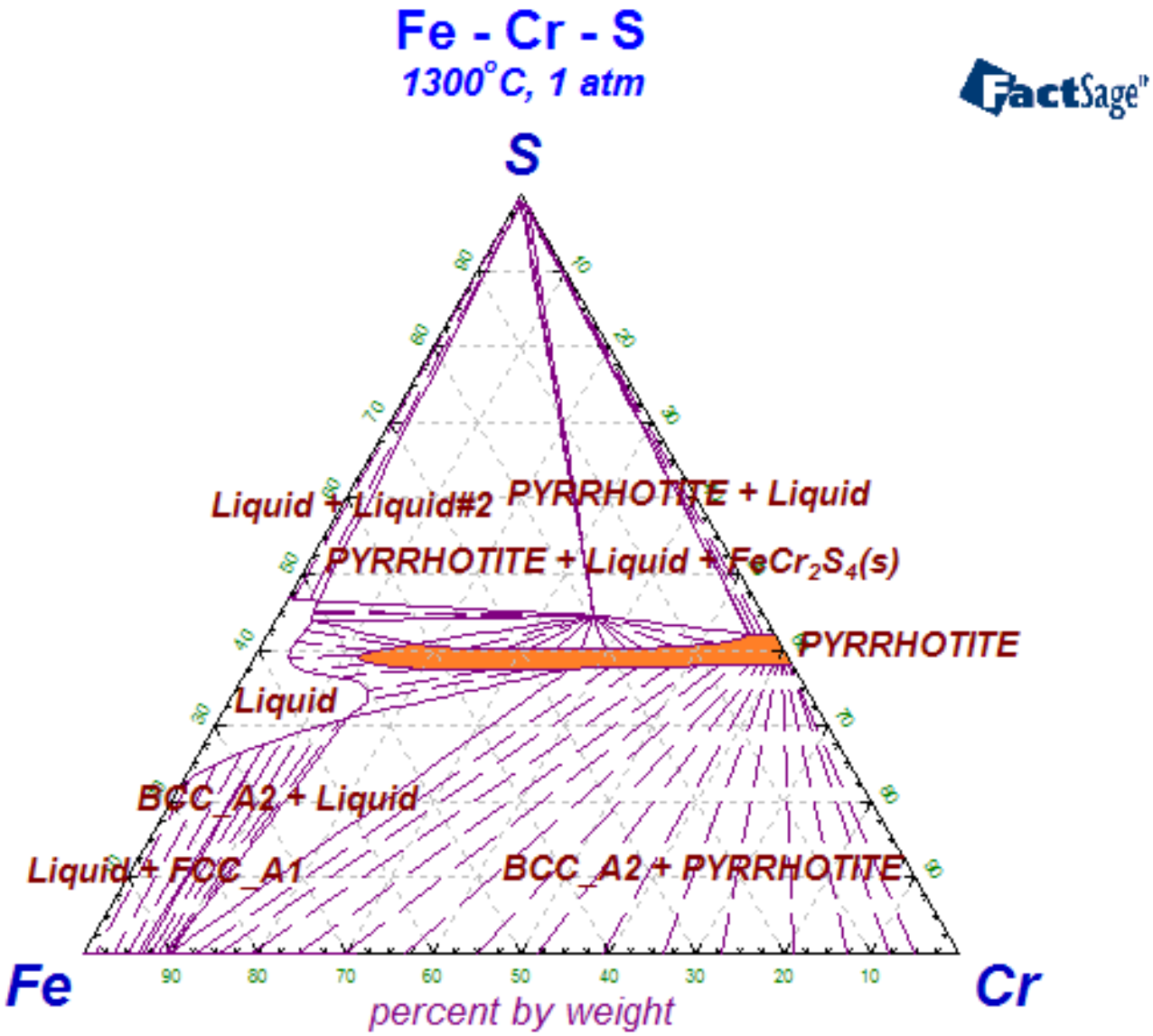


Weight percent 950°C

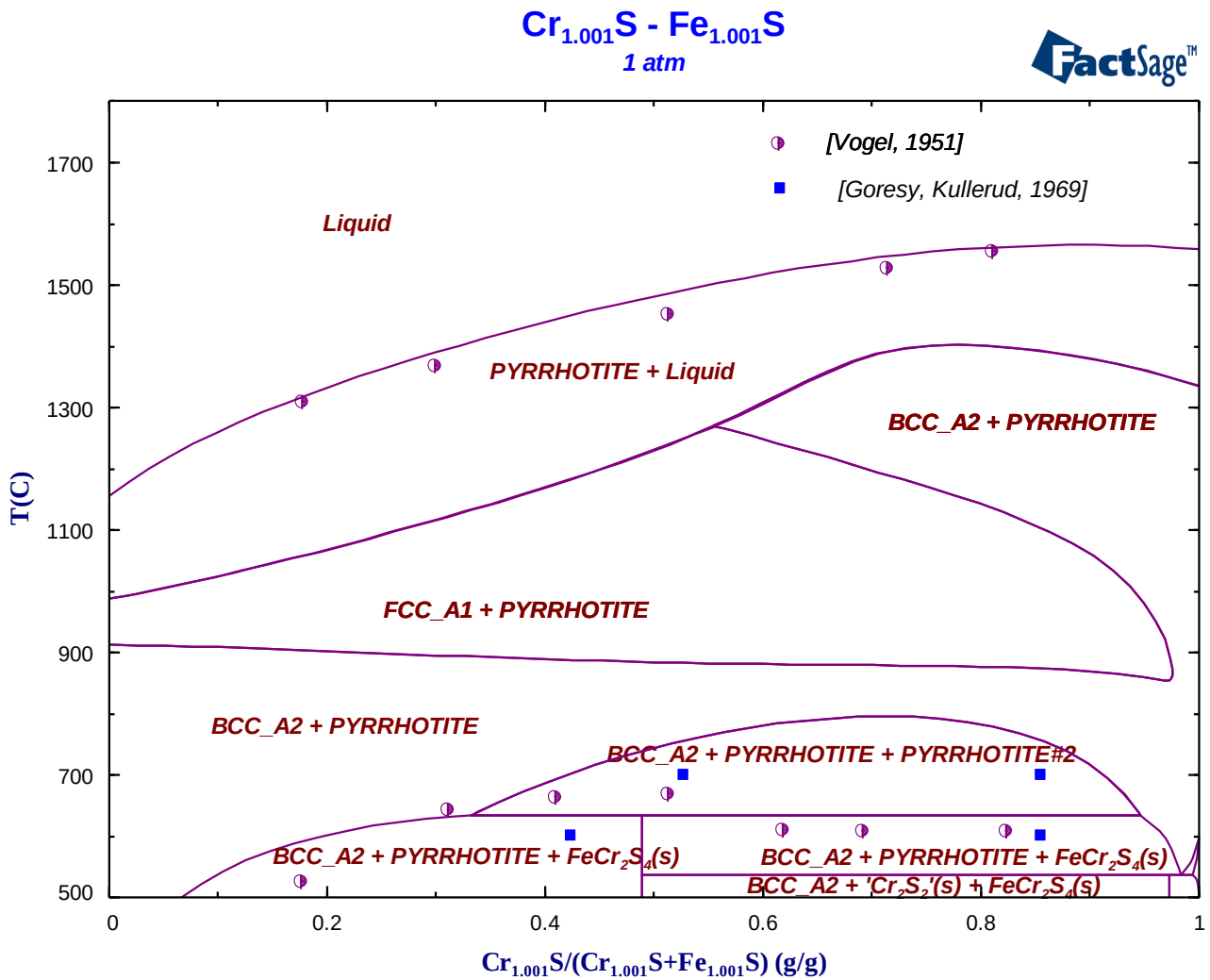


Weight percent 1090°C



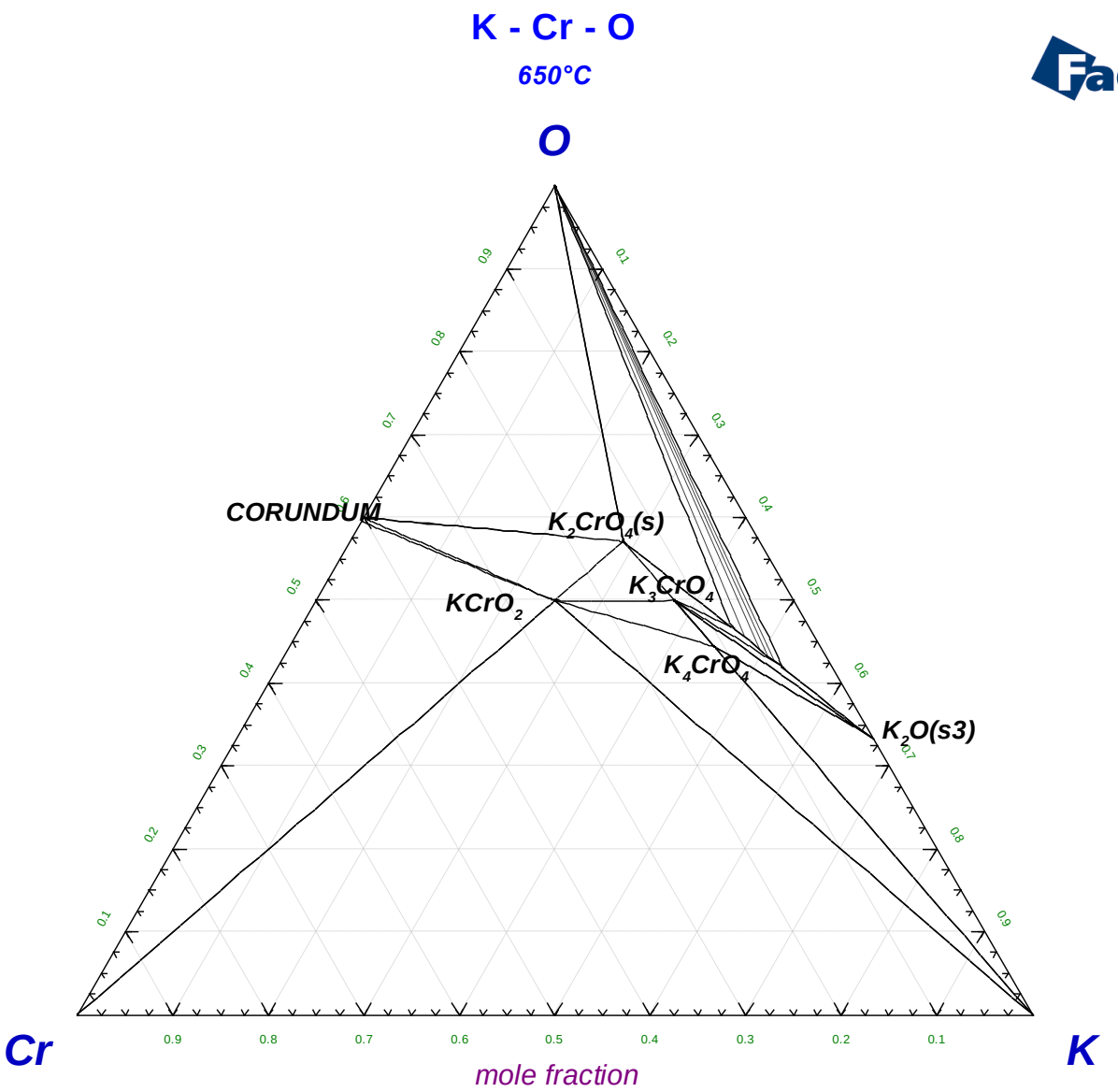

Fe - Cr - S
1300°C, 1 atm
FactSage
S
Liquid + Liquid#2
PYRRHOTITE + Liquid
PYRRHOTITE + Liquid + FeCr2S4(s)
PYRRHOTITE
Liquid
BCC_A2 + Liquid
Liquid + FCC_A1
BCC_A2 + PYRRHOTITE
Fe
Cr
90
80
70
60
50
40
30
20
10
percent by weight

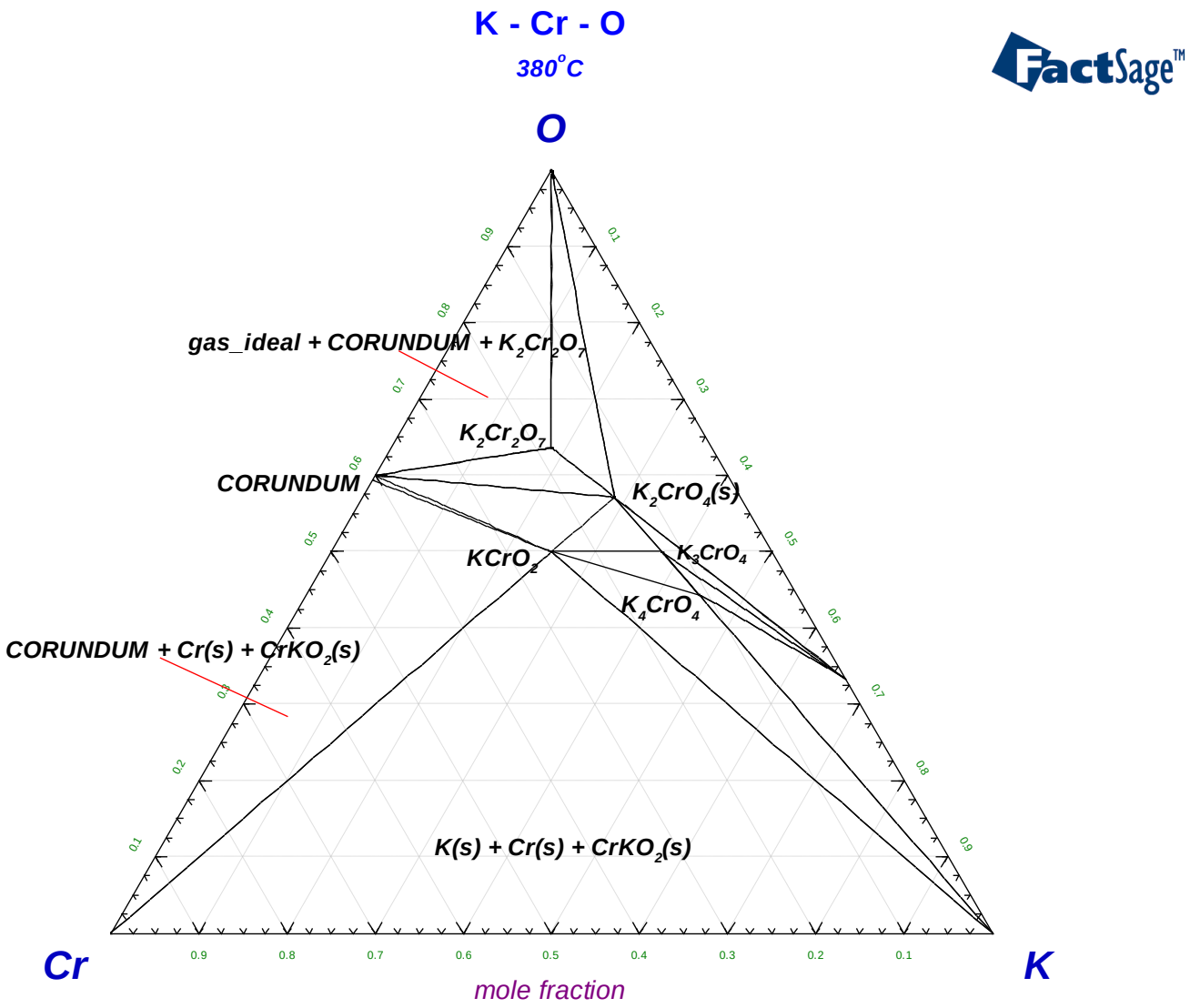
Cr-Fe-S,
Weight percent, isopleth section at ~50 mol% S



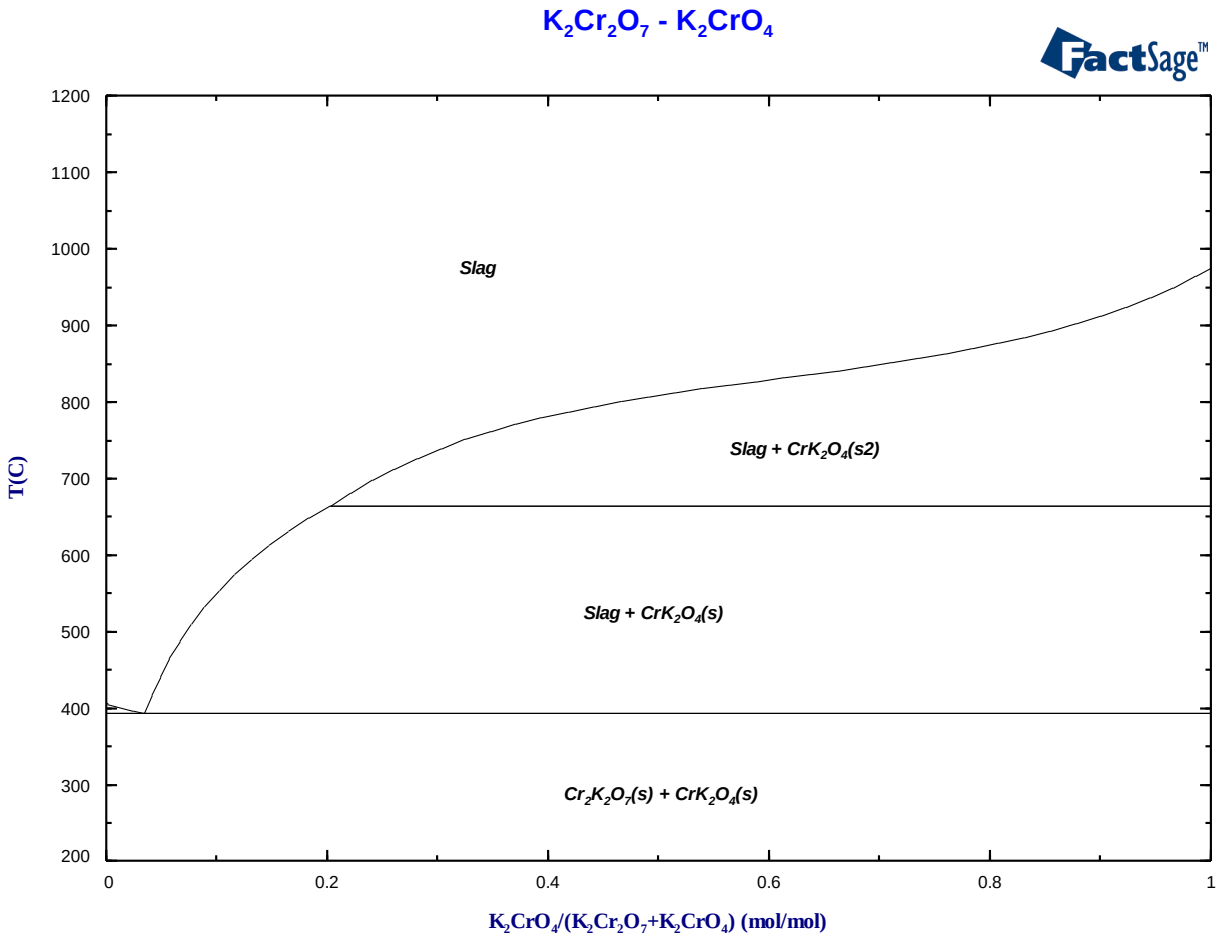
Cr-K-O,

Cr-K-O, Mole fraction 650°C

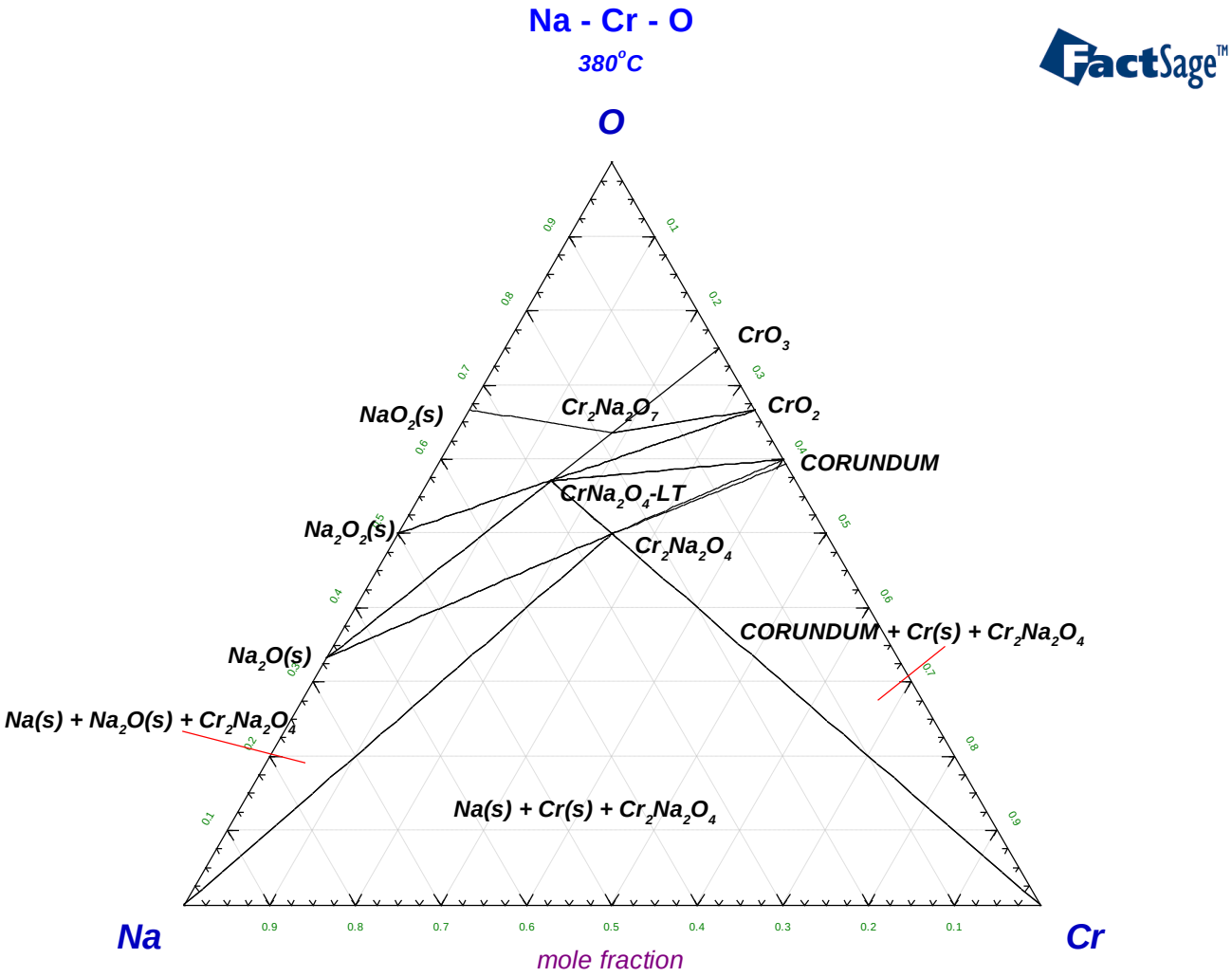



K - Cr - O
380°C
O
gas_ideal + CORUNDUM + K2Cr2O7
K2Cr2O7
CORUNDUM
K2CrO4(s)
KCrO2
K2CrO4
K4CrO4
CORUNDUM + Cr(s) + CrKO2(s)
K(s) + Cr(s) + CrKO2(s)
Cr
K
mole fraction

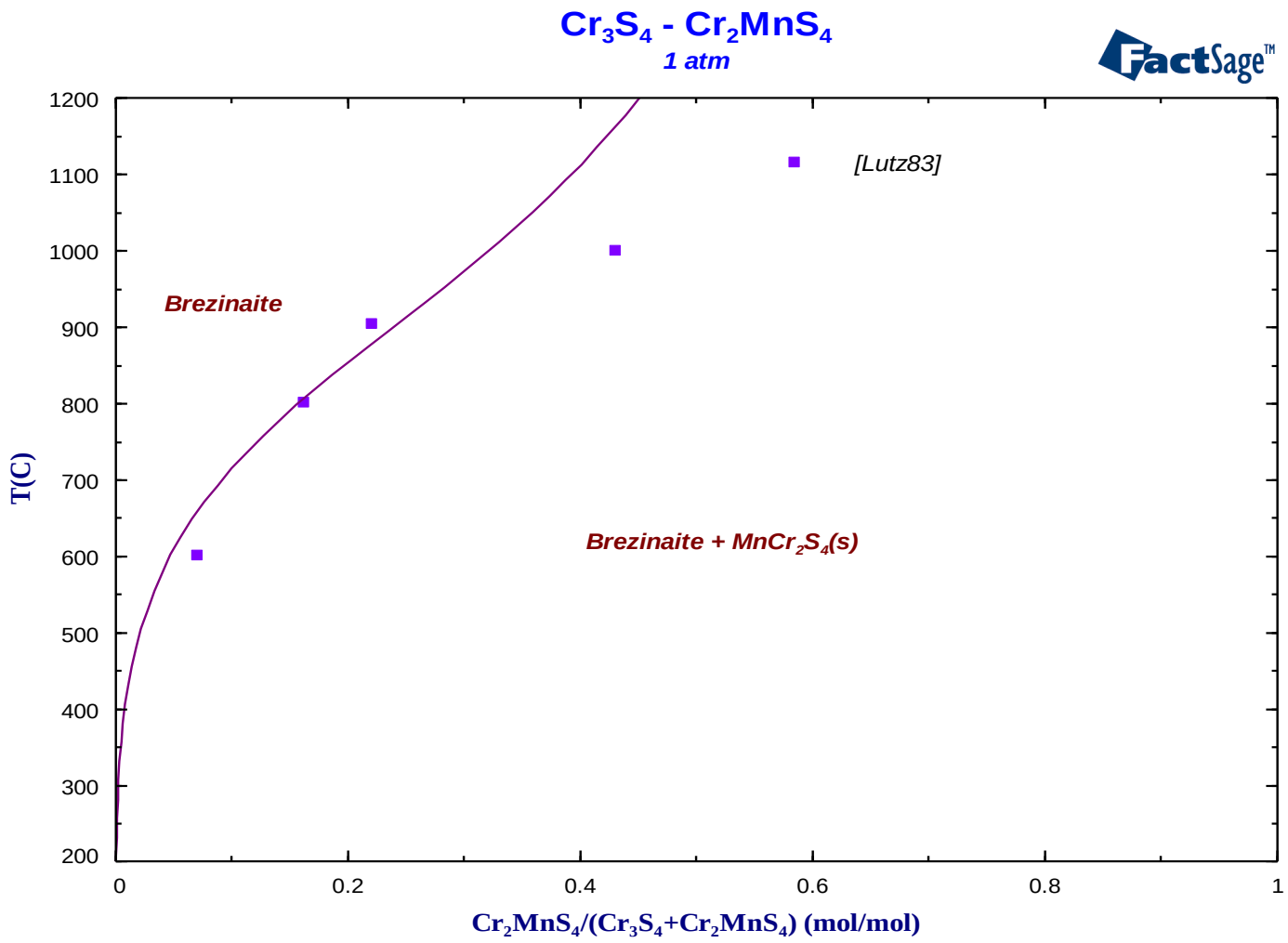
Cr-K-O, Mole fraction, Isopleth K2Cr2O7-K2CrO4



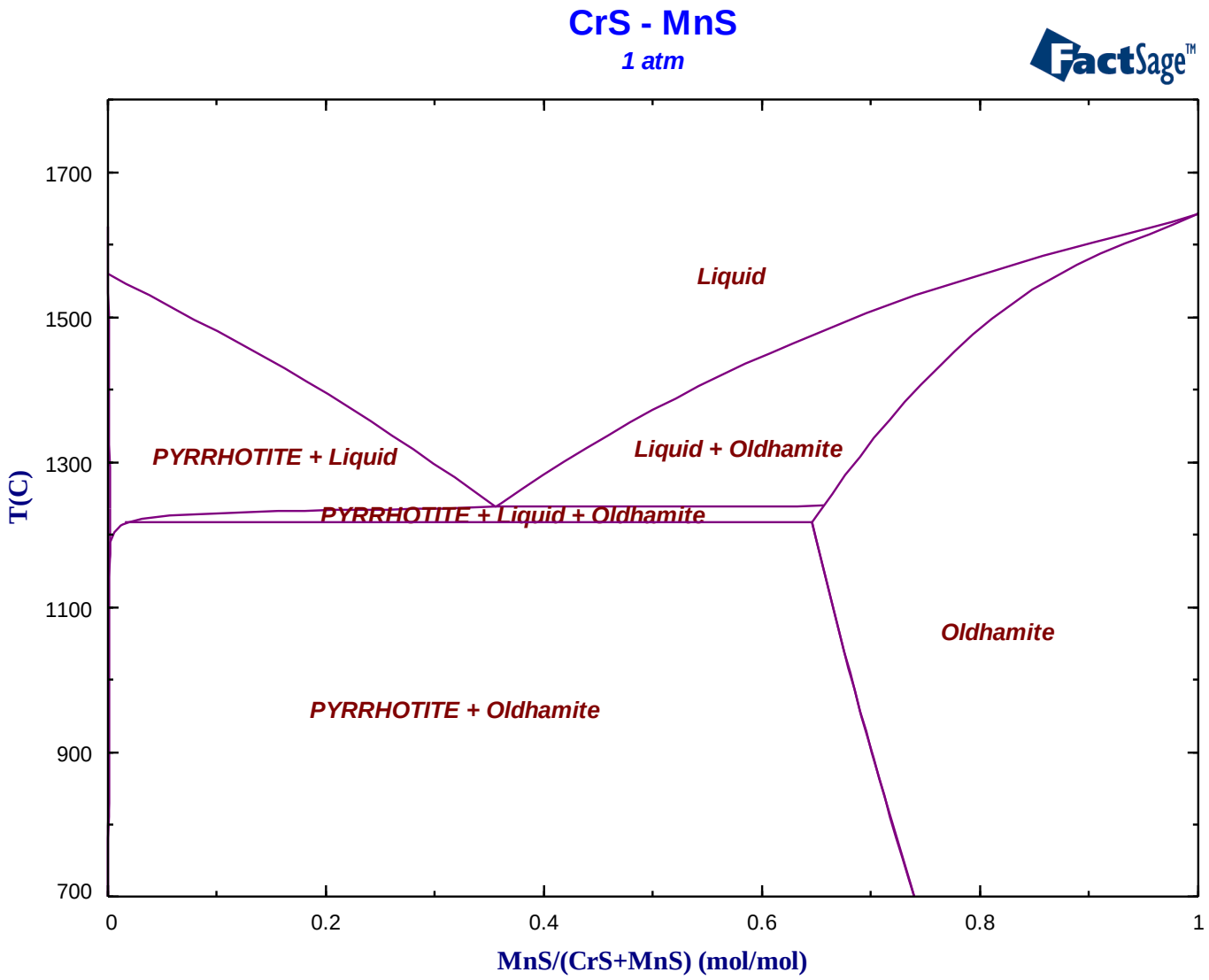
Cr-Na-O, Mole fraction 380°C

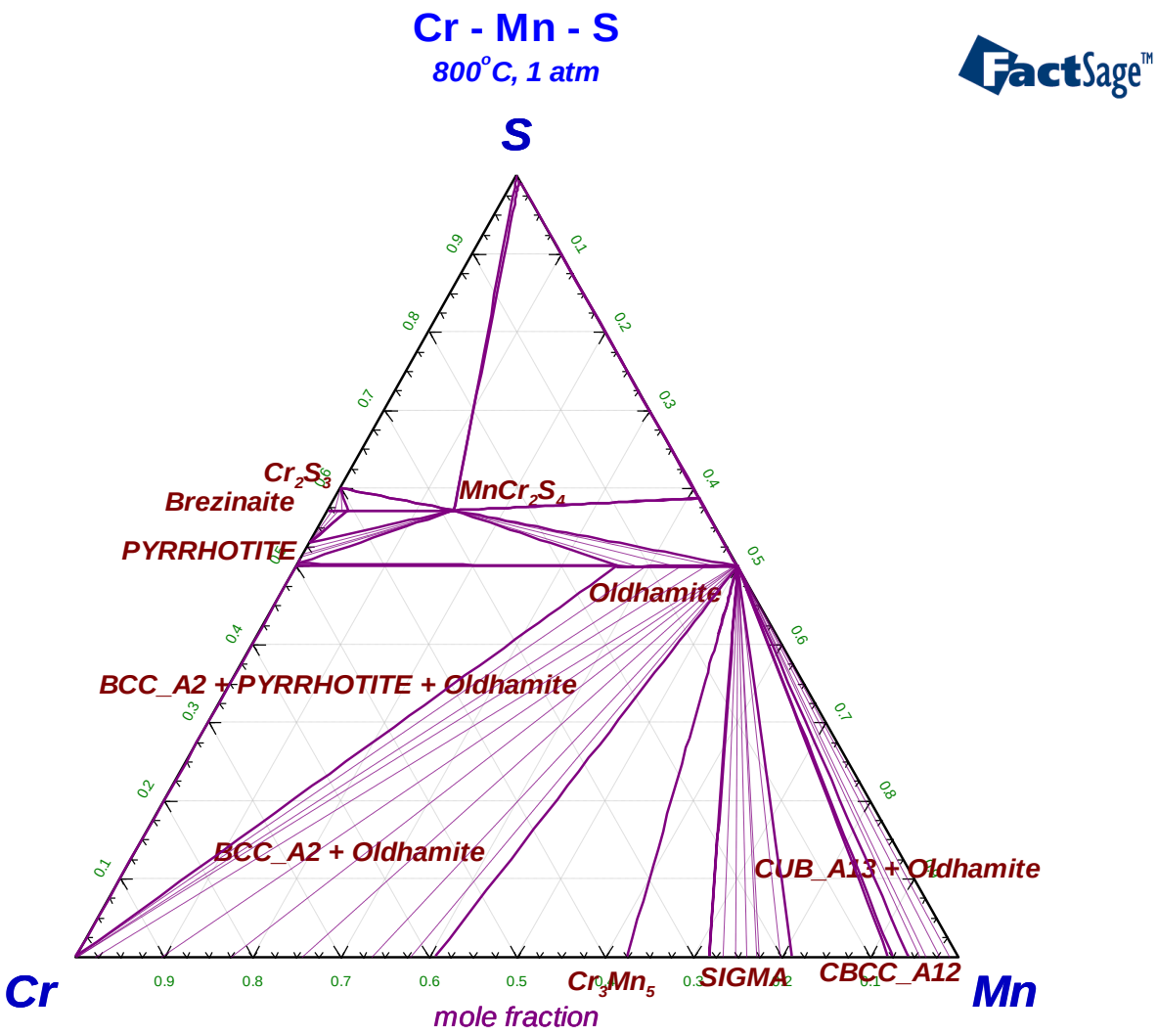


Cr-Mn-S,
Mole fraction Cr2MnS4-Cr3S4

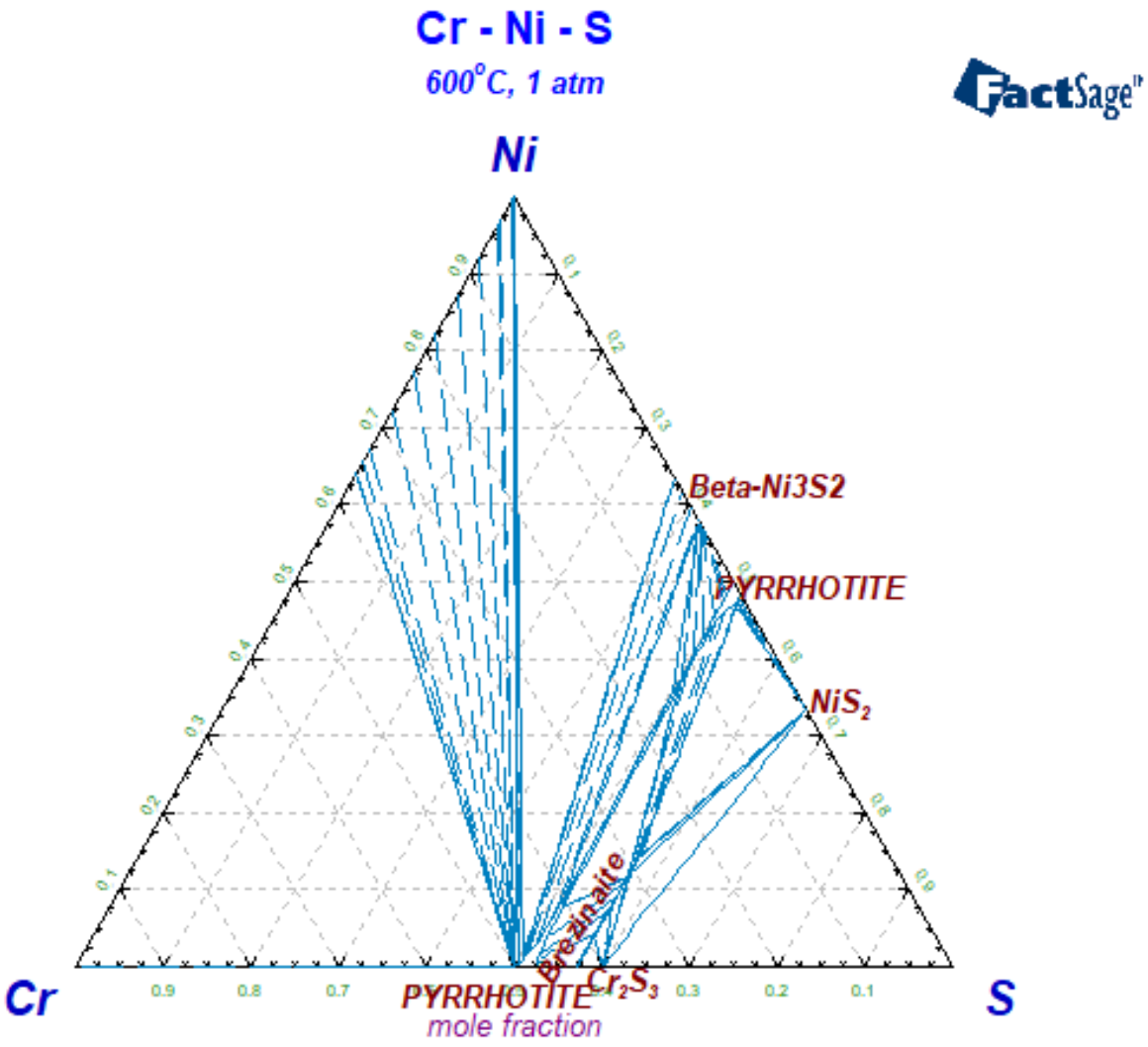


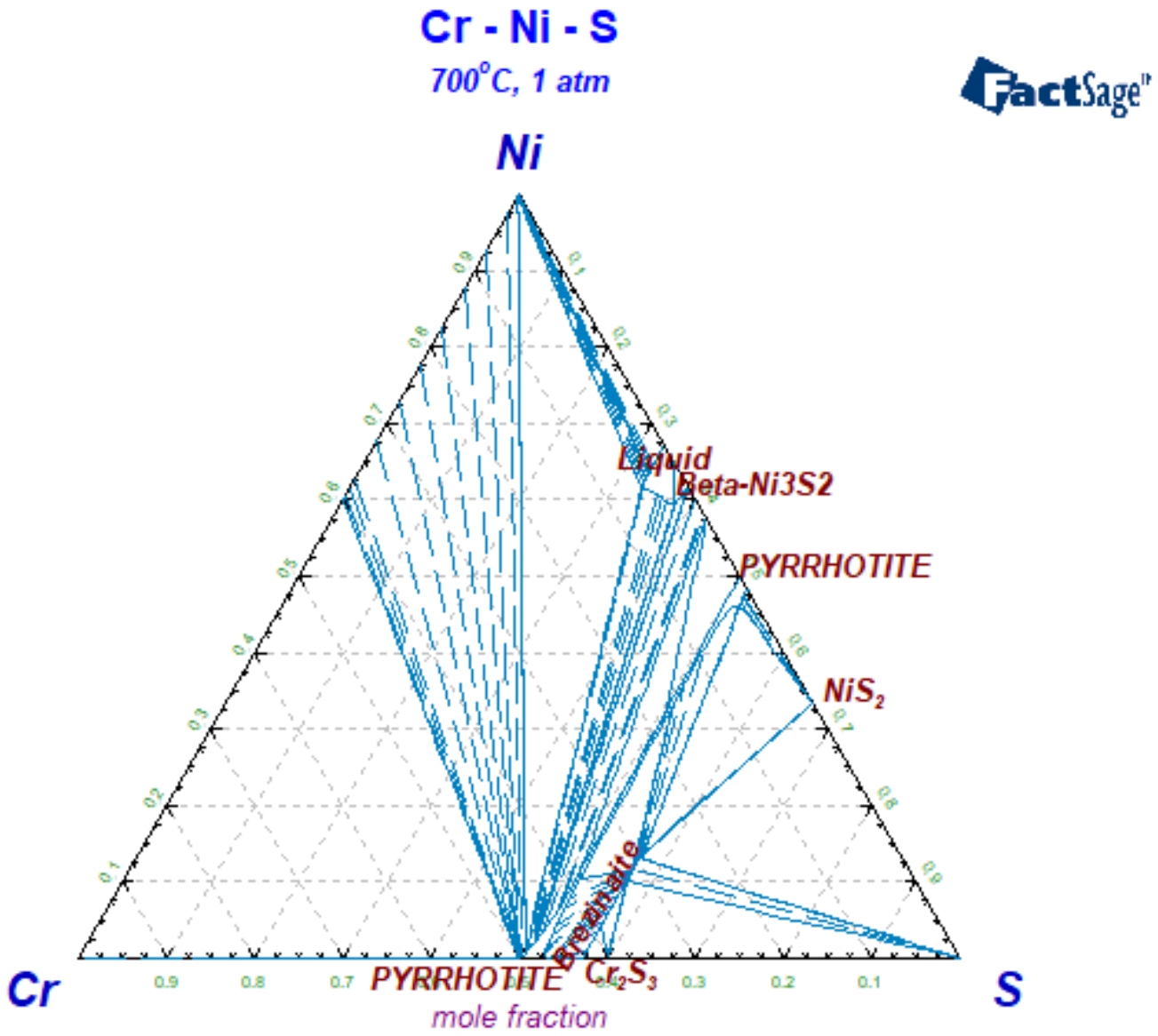
Mole fraction CrS-MnS

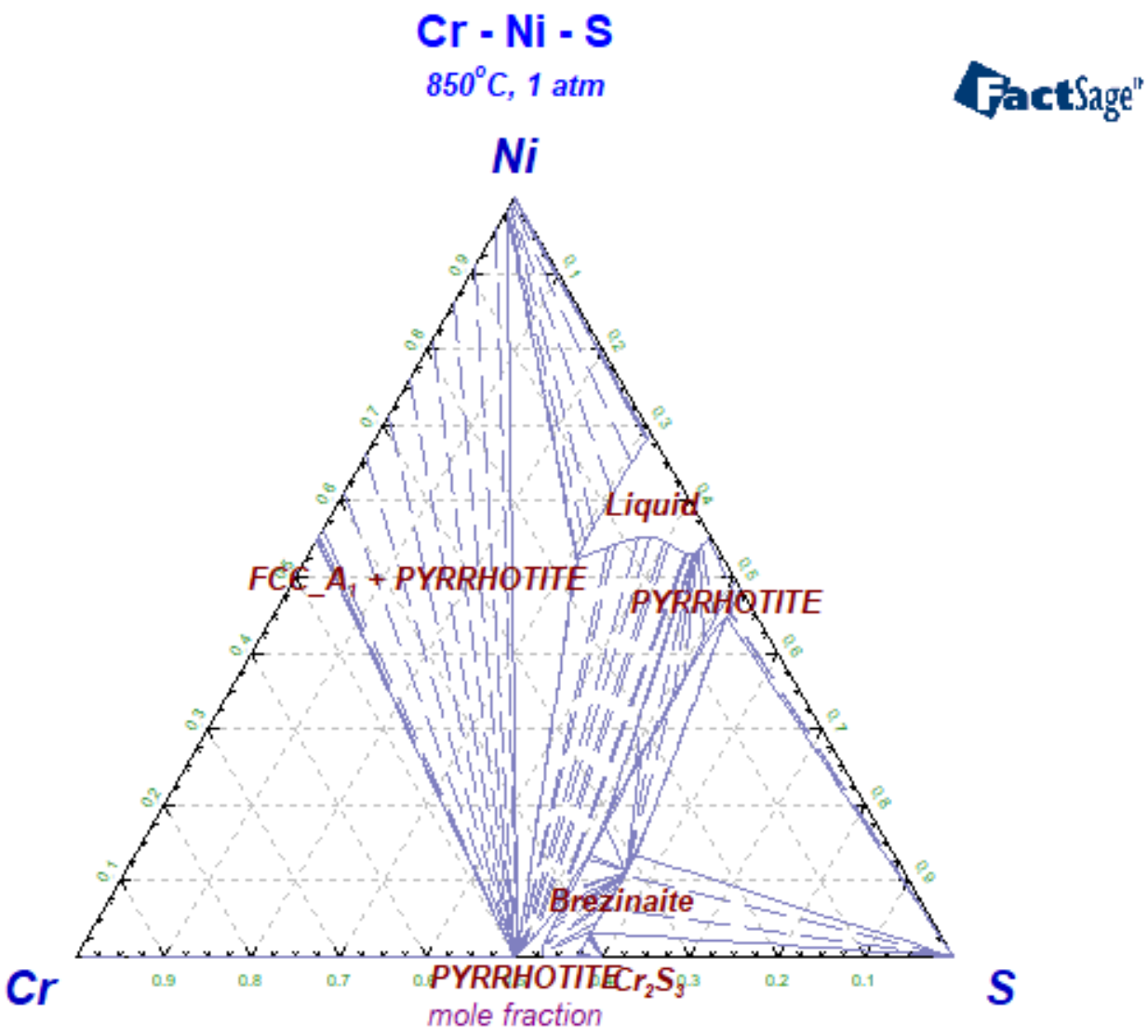



Cr - Mn - S
800°C, 1 atm
S
Cr
Mn
Cr2S3
Brezinaite
MnCr2S4
PYRRHOTITE
Oldhamite
BCC_A2 + PYRRHOTITE + Oldhamite
BCC_A2 + Oldhamite
CUB_A13 + Oldhamite
Cr3Mn5
SIGMA
CBCC_A12
mole fraction

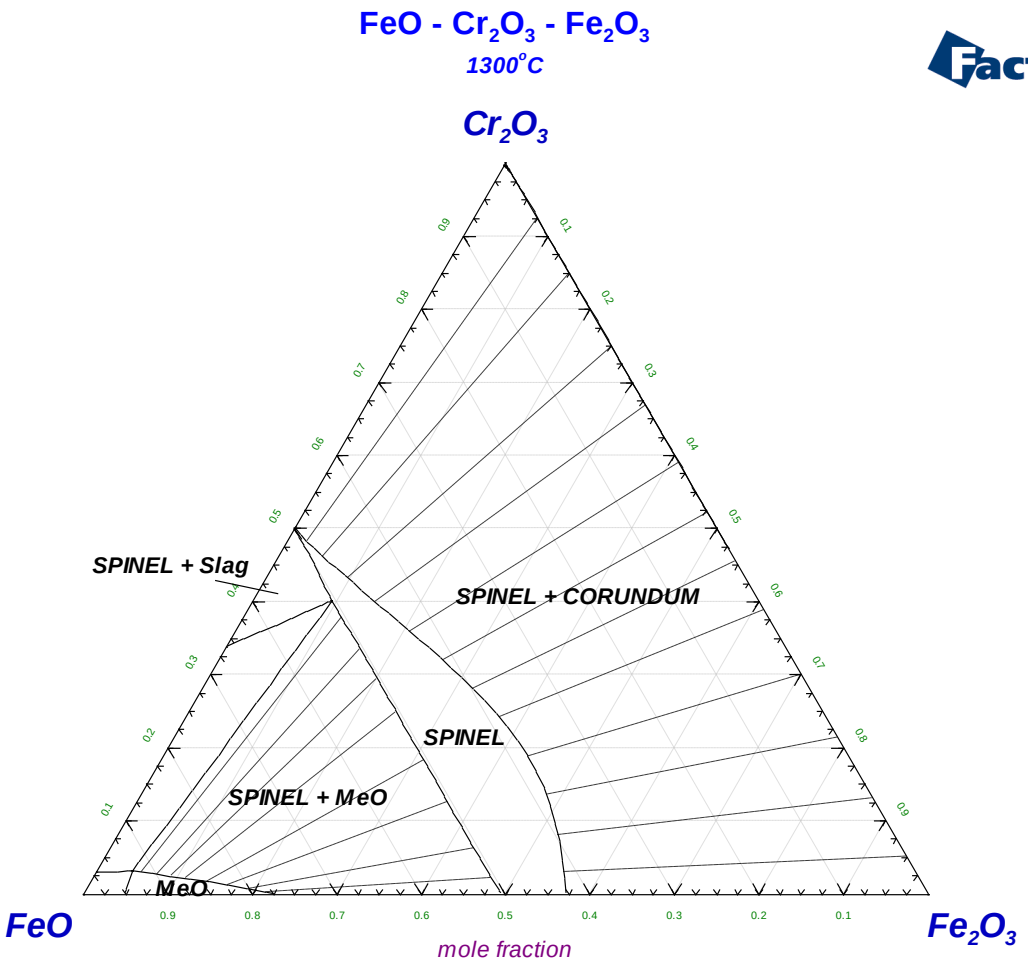
Cr-Ni-S,
Mole fraction 600°C



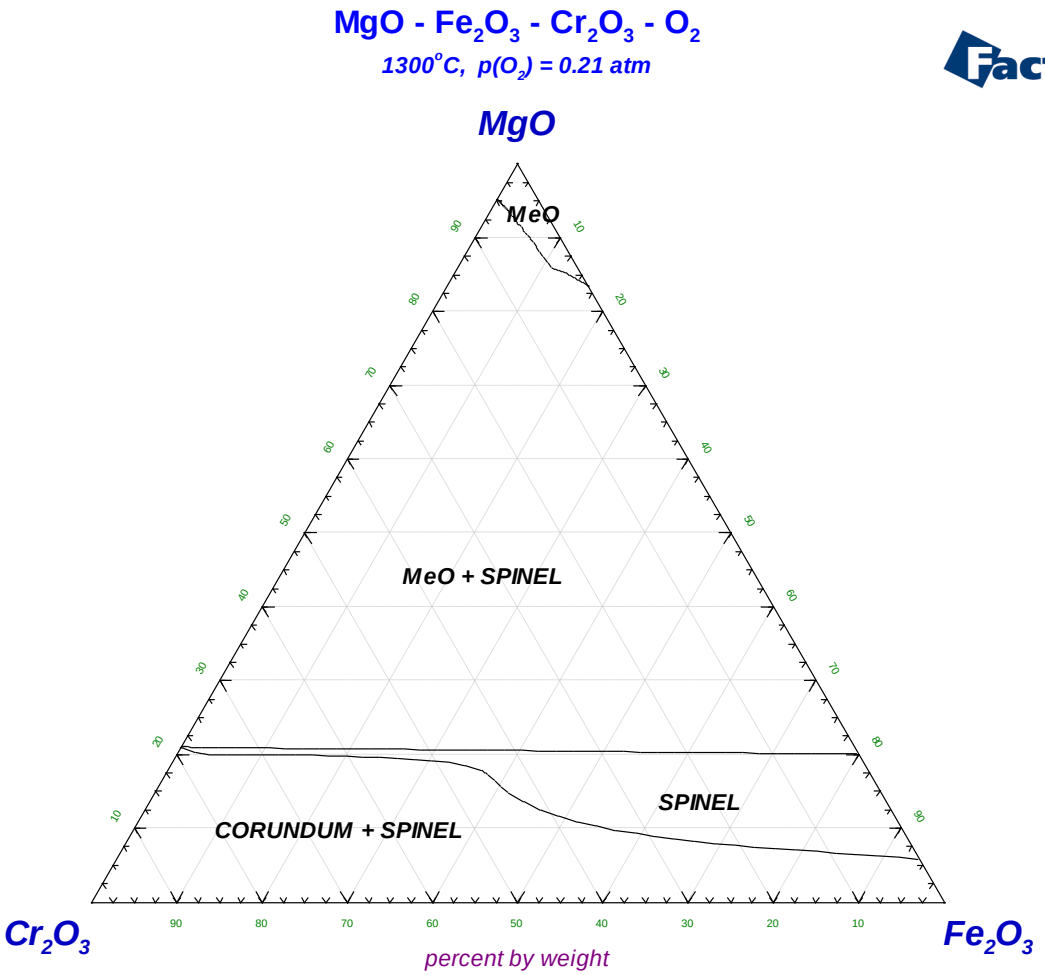

Cr - Ni - S
700°C, 1 atm
FactSage
Ni
Liquid
Beta-Ni3S2
PYRRHOTITE
NiS2
Brezinaite
PYRRHOTITE
Cr2S3
Cr
S
mole fraction


Cr - Ni - S
850°C, 1 atm
FactSage
Ni
Liquid
FCC_A1 + PYRRHOTITE
PYRRHOTITE
Brezinaite
PYRRHOTITE
Cr2S3
Cr
S
mole fraction

Cr2O3-Fe2O3-FeO,
Mole fraction 1300°C

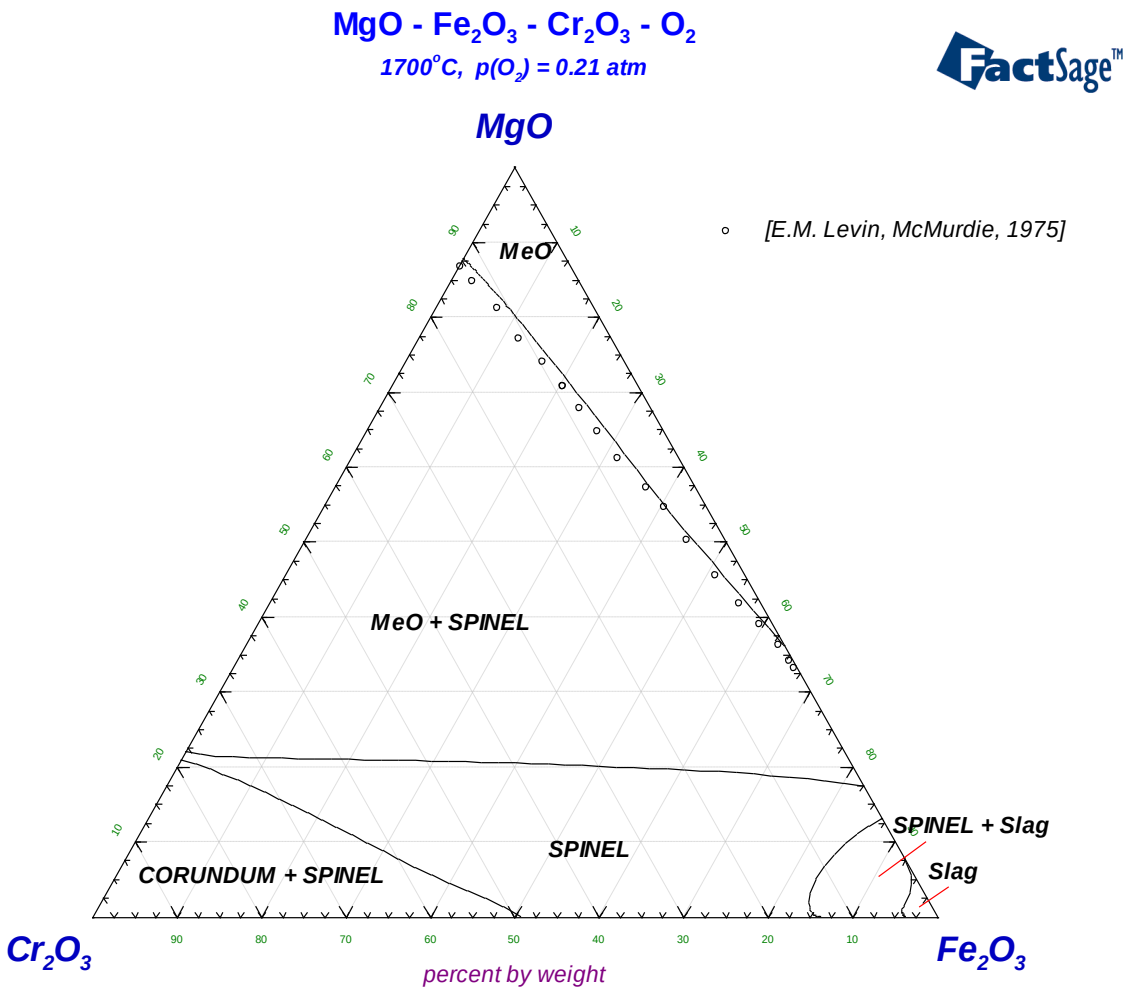


Cr2O3-Fe2O3-MgO,
Weight percent 1300°C

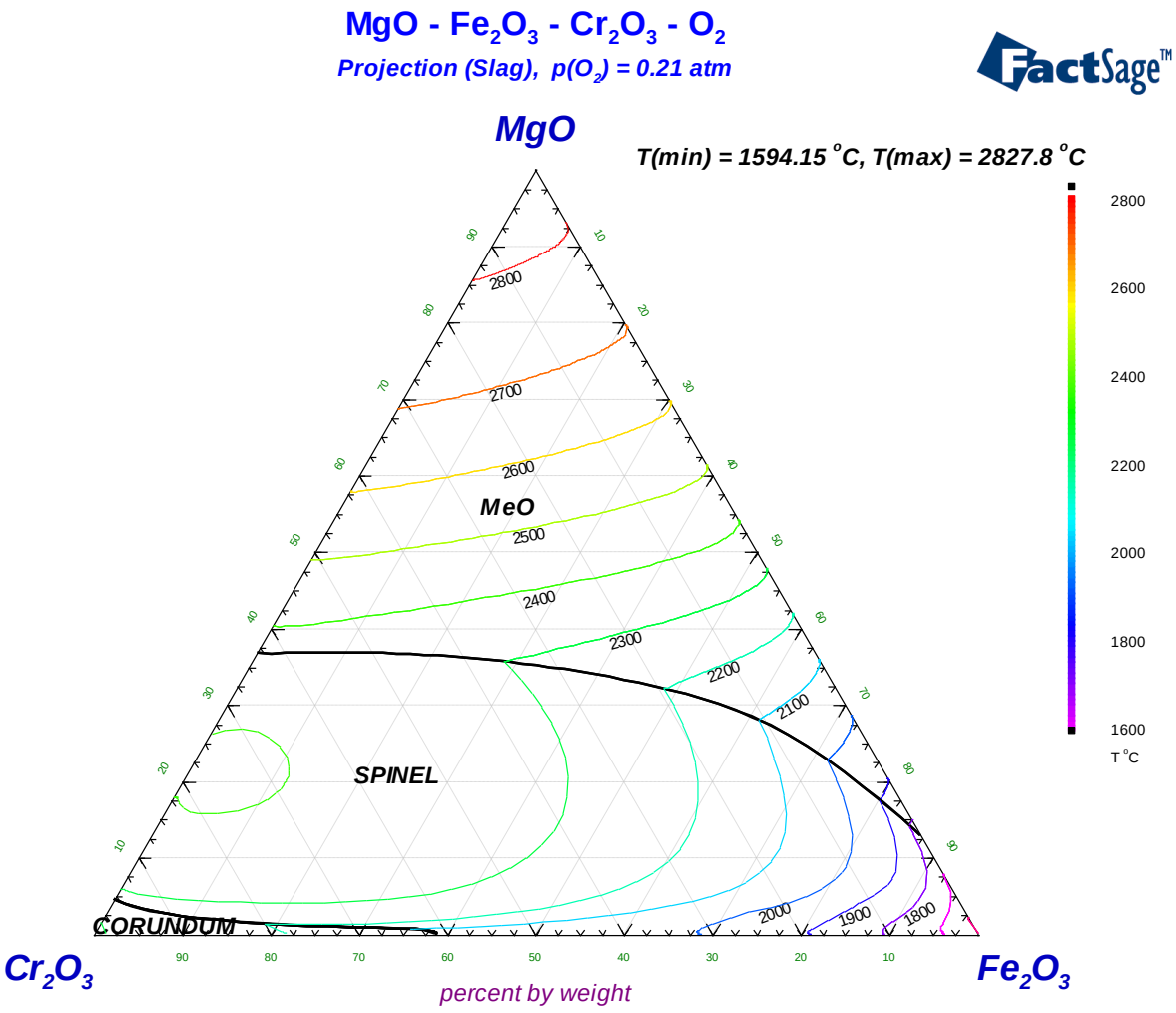


Cr2O3-Fe2O3-MgO,

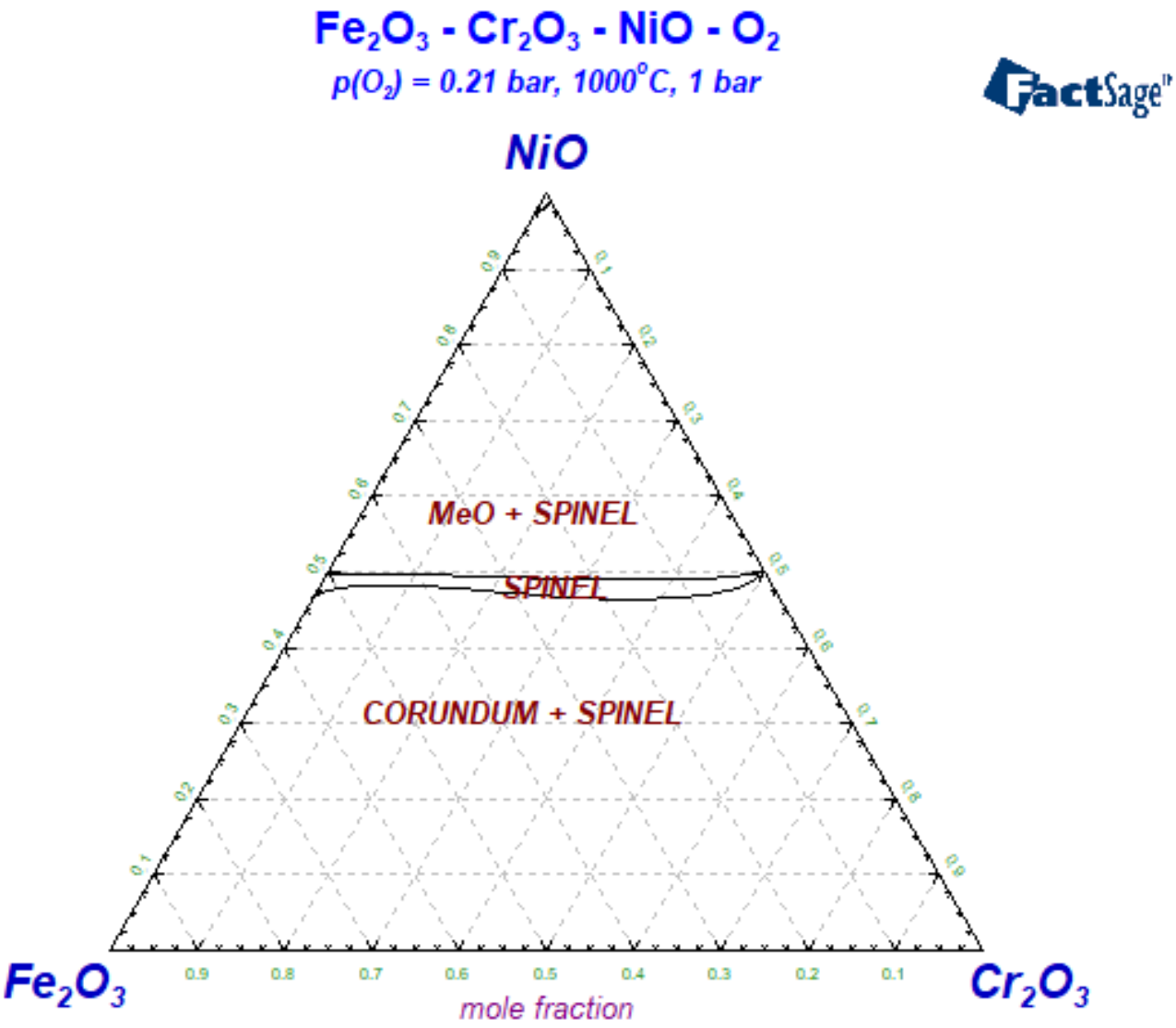
Weight percent 1700°C

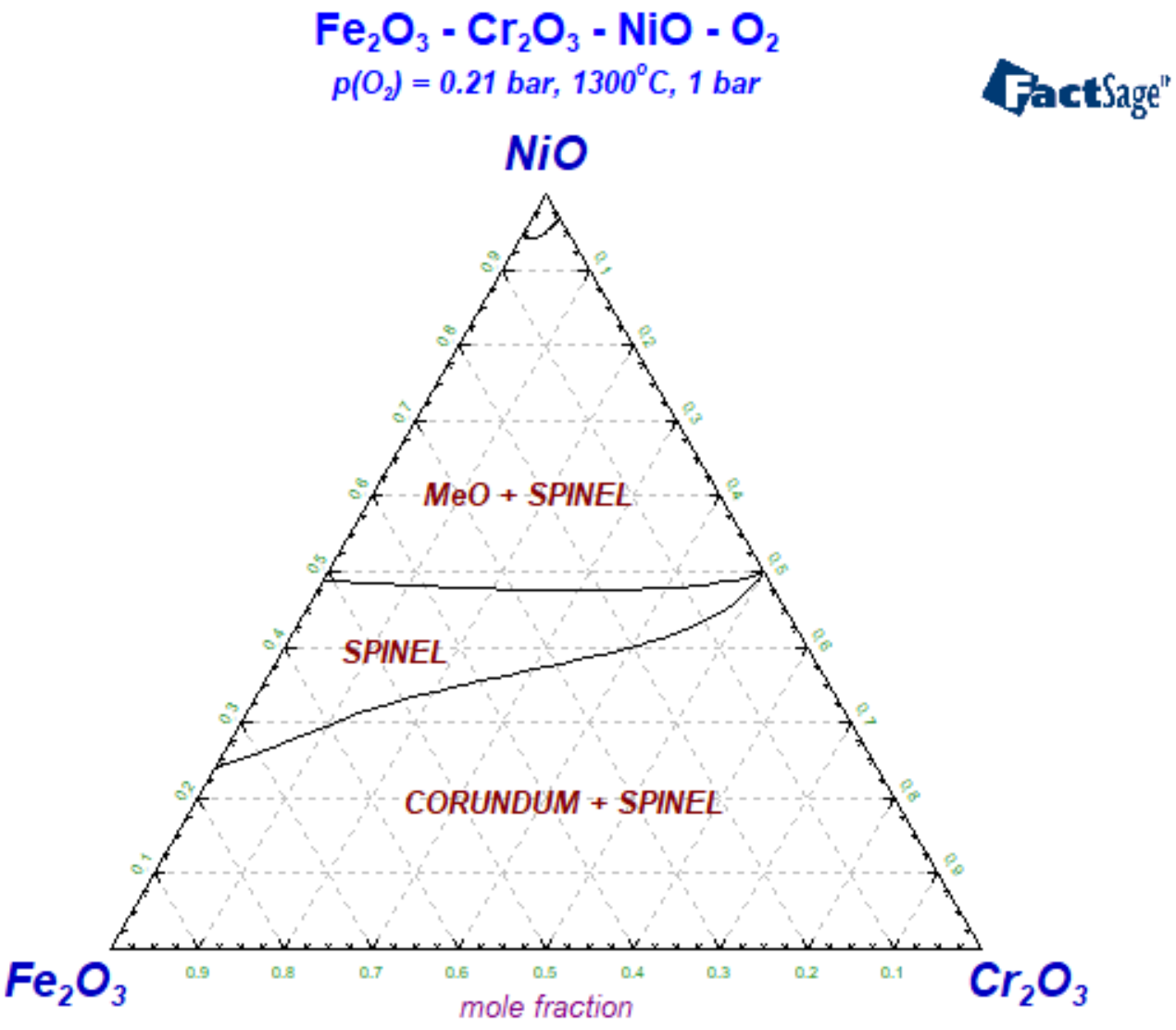


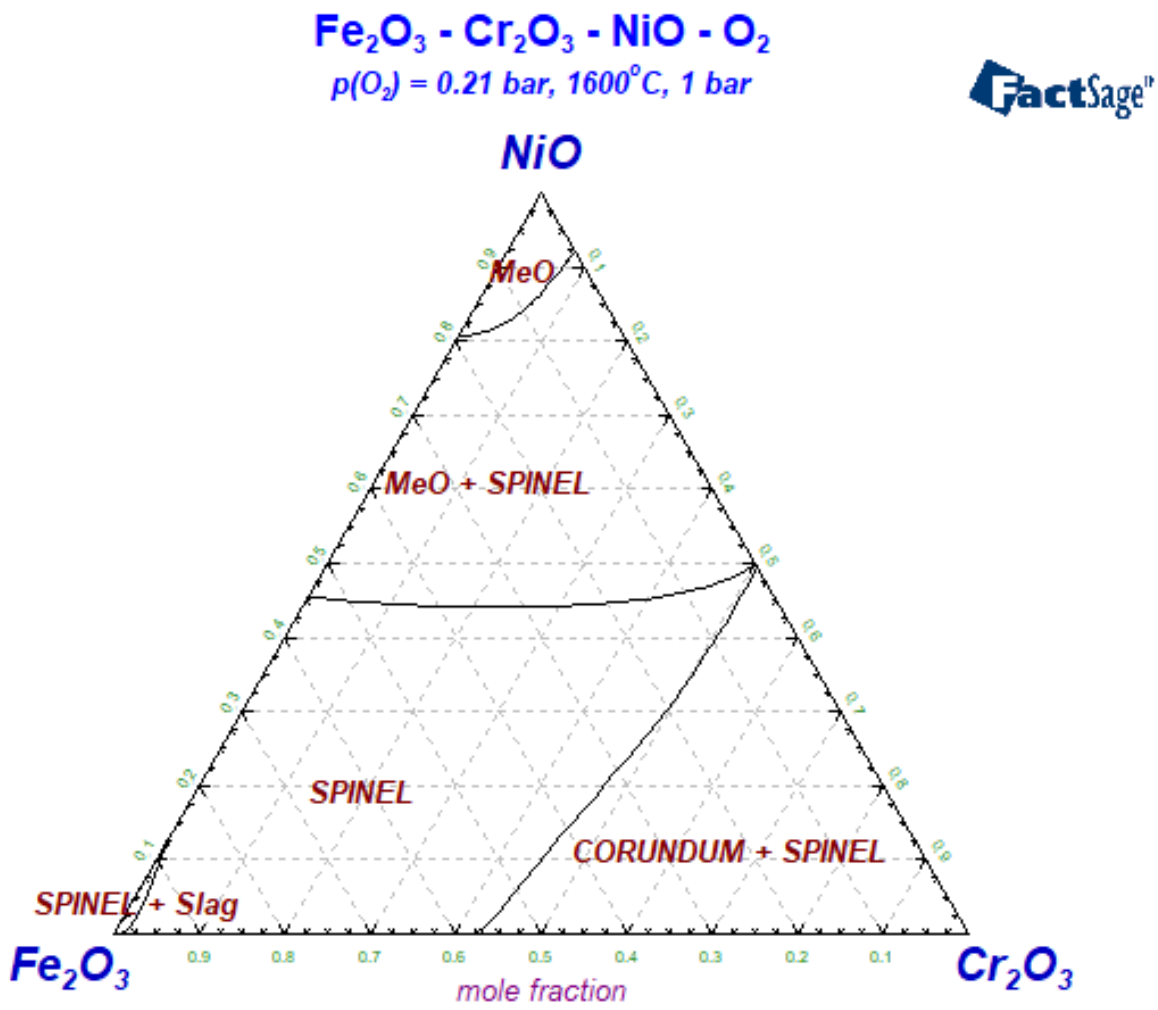
Weight percent
Liquidussurface

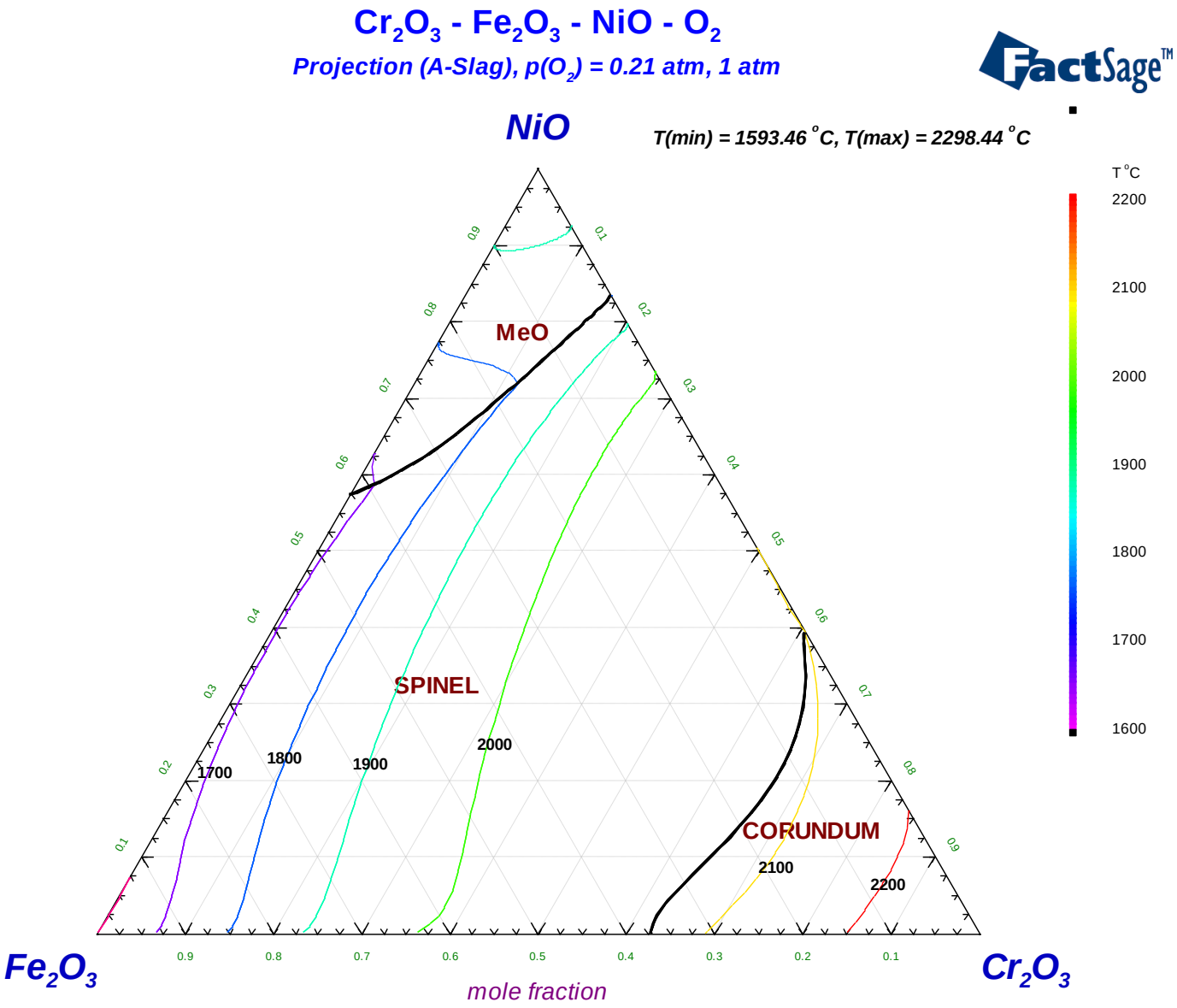


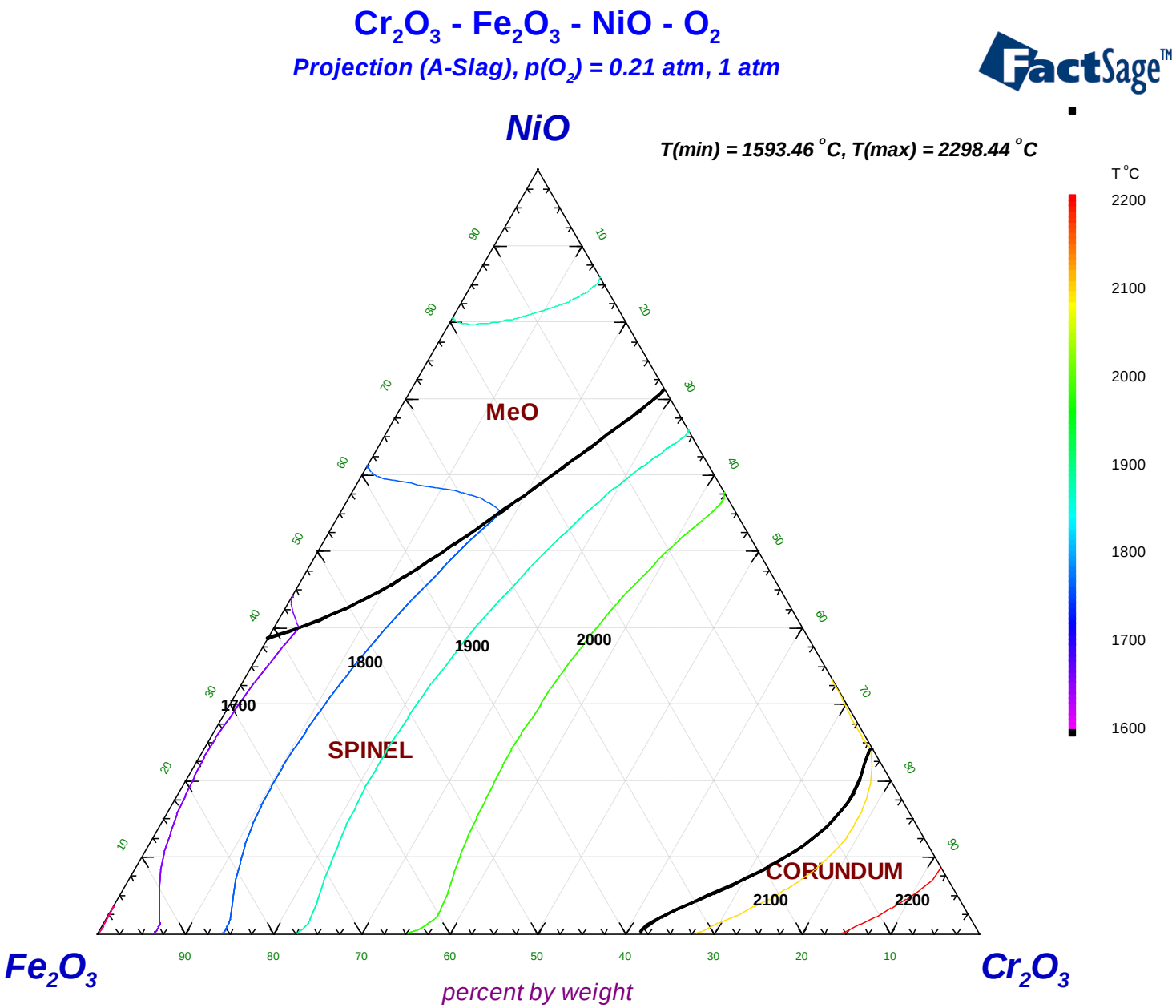
Cr2O3-Fe2O3-NiO, Mole fraction, 1000°C



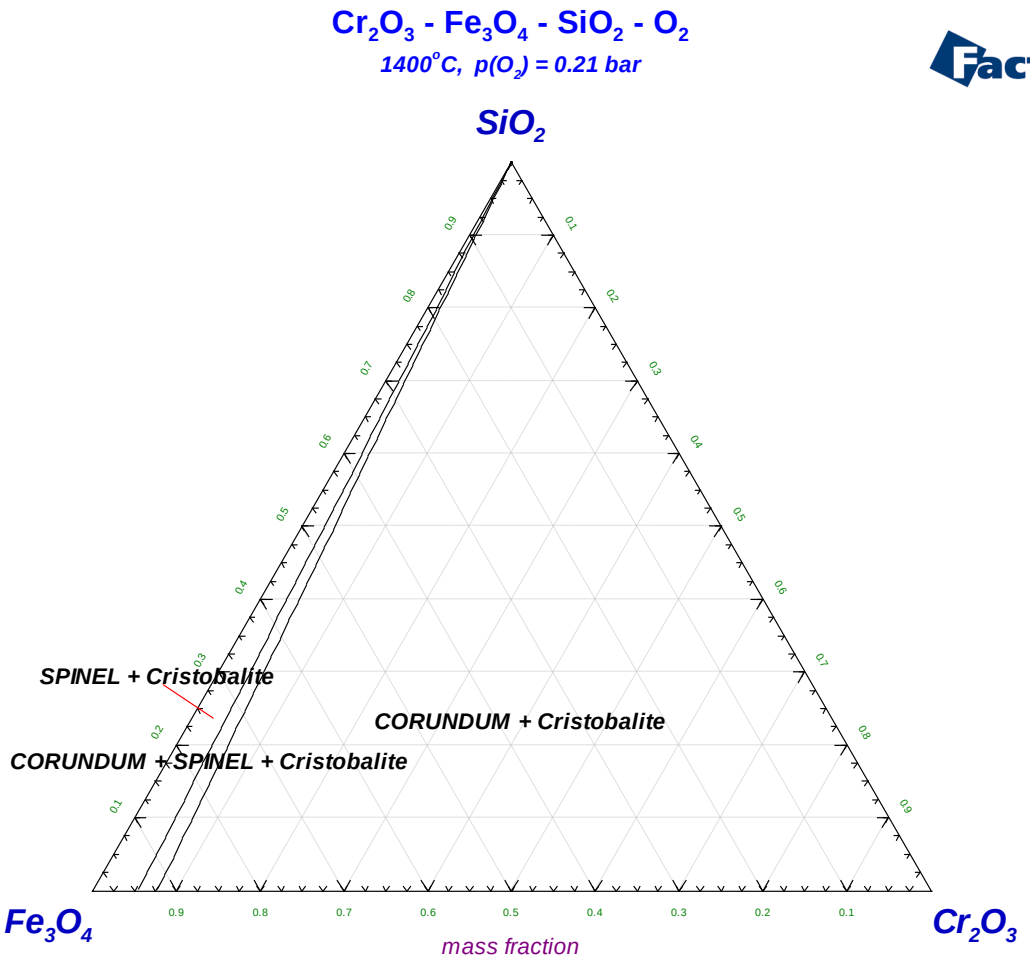

Fe2O3 - Cr2O3 - NiO - O2
p(O2) = 0.21 bar, 1300°C, 1 bar
FactSage
NiO
MeO + SPINEL
SPINEL
CORUNDUM + SPINEL
Fe2O3
Cr2O3
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
mole fraction


Fe2O3 - Cr2O3 - NiO - O2
p(O2) = 0.21 bar, 1600°C, 1 bar
FactSage
NiO
MeO
MeO + SPINEL
SPINEL
CORUNDUM + SPINEL
SPINEL + Slag
Fe2O3
Cr2O3
mole fraction


Cr_2O_3 - Fe_2O_3 - NiO - O_2
Projection (A-Slag), $p(O_2)$ = 0.21 atm, 1 atm
FactSage™
NiO
T(min) = 1593.46 °C, T(max) = 2298.44 °C
T °C
2200
2100
2000
1900
1800
1700
1600
MeO
SPINEL
CORUNDUM
1700
1800
1900
2000
2100
2200
Fe_2O_3
Cr_2O_3
mole fraction

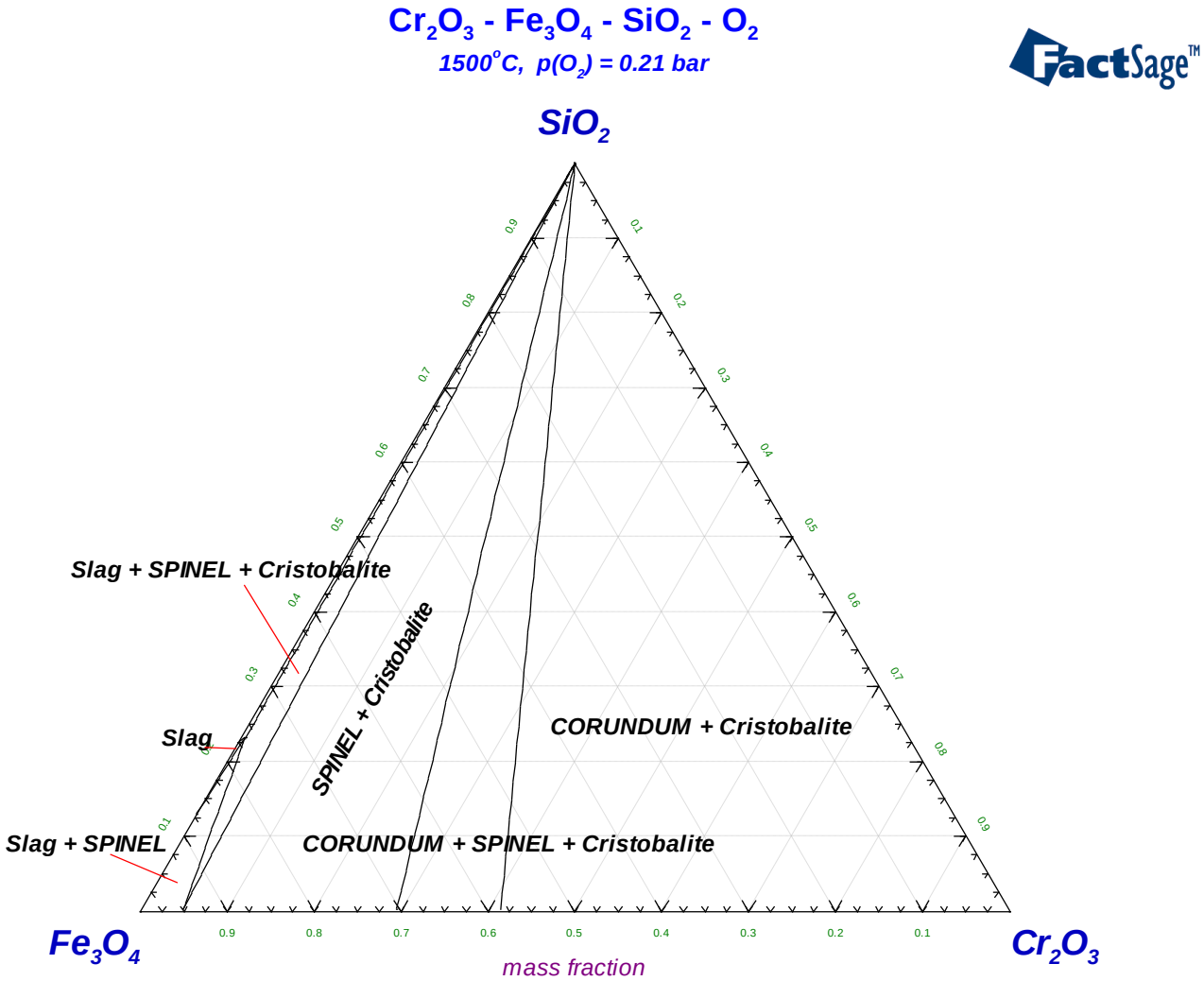

Cr_2O_3 - Fe_2O_3 - NiO - O_2
Projection (A-Slag), $p(O_2)$ = 0.21 atm, 1 atm
FactSage™
NiO
T(min) = 1593.46 °C, T(max) = 2298.44 °C
T °C
2200
2100
2000
1900
1800
1700
1600
MeO
SPINEL
CORUNDUM
1600
1800
1900
2000
2100
2200
Fe_2O_3
Cr_2O_3
percent by weight

Cr2O3-Fe3O4-SiO2,
Weight percent 1400°C



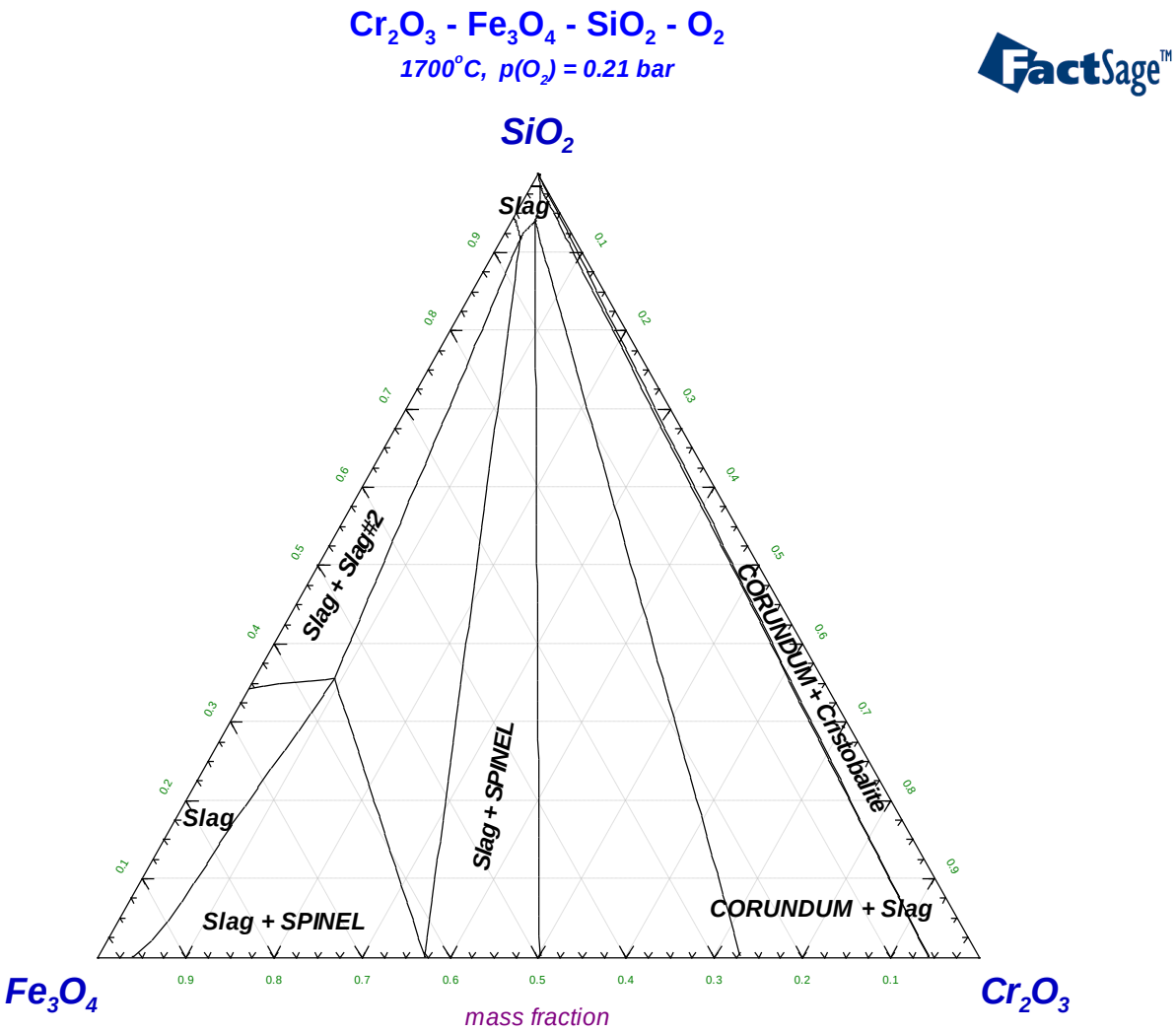
Cr2O3-Fe3O4-SiO2,

Weight percent 1500°C



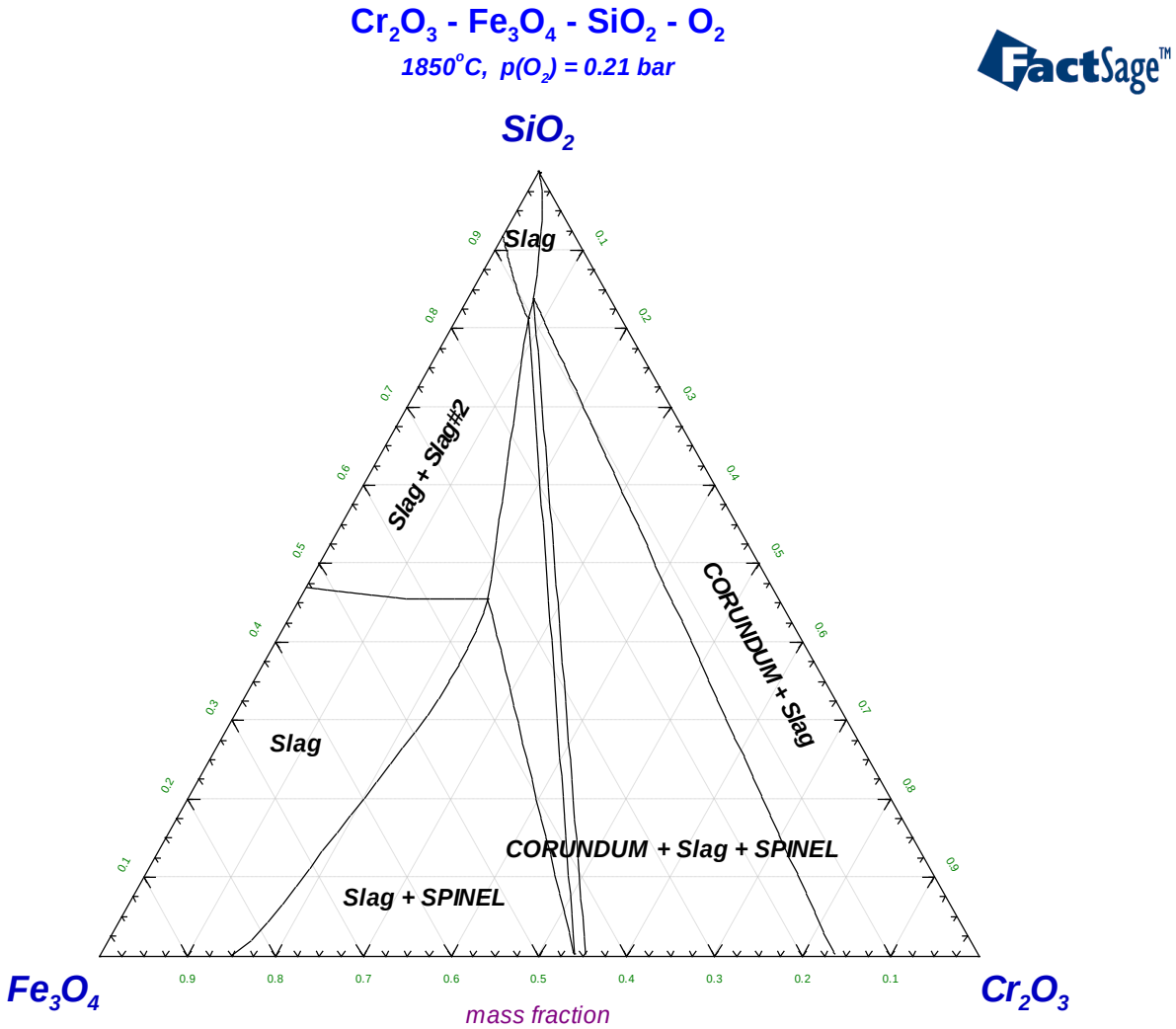
Cr2O3-Fe3O4-SiO2,

Weight percent 1700°C

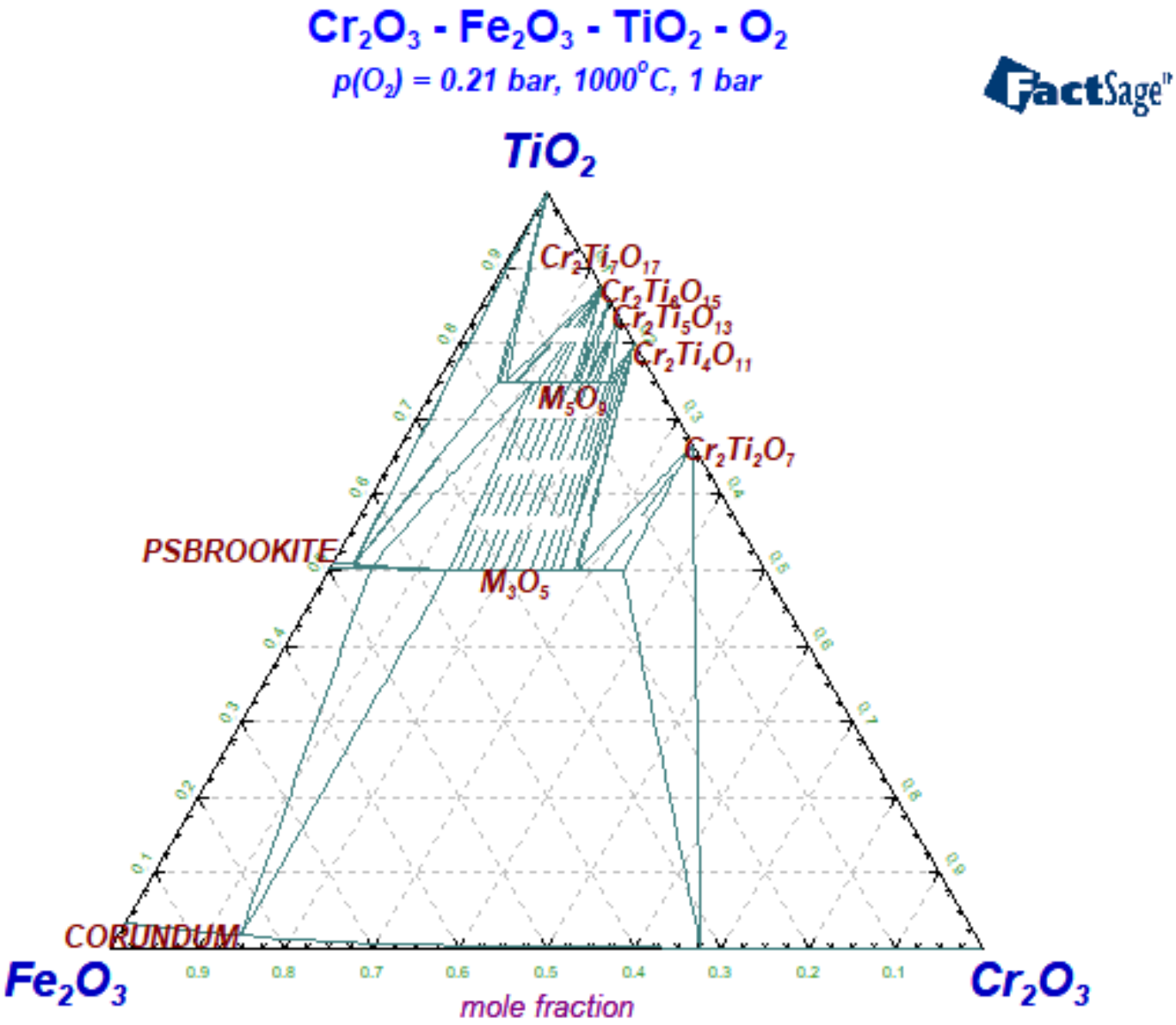


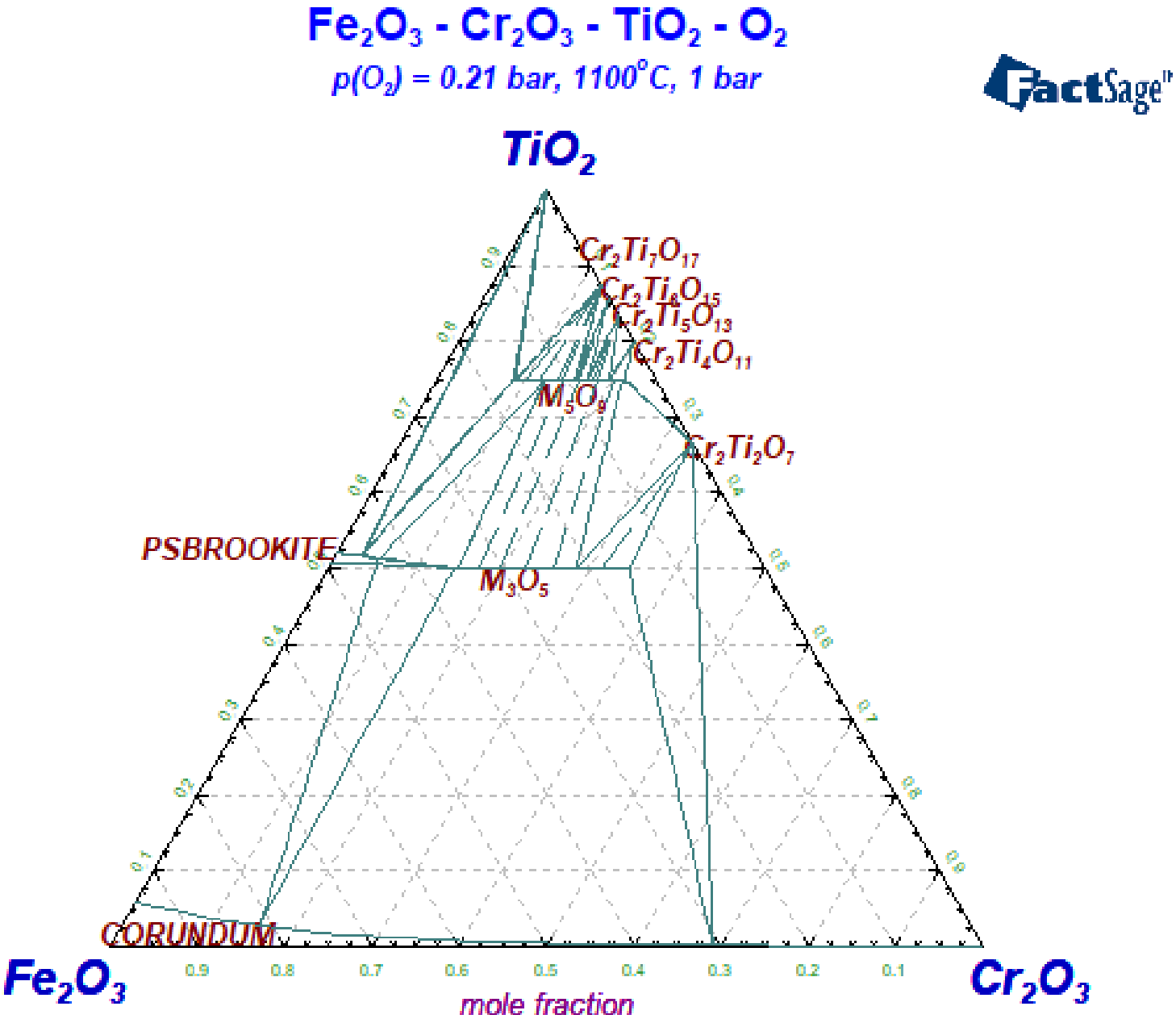
Cr2O3-Fe3O4-SiO2,

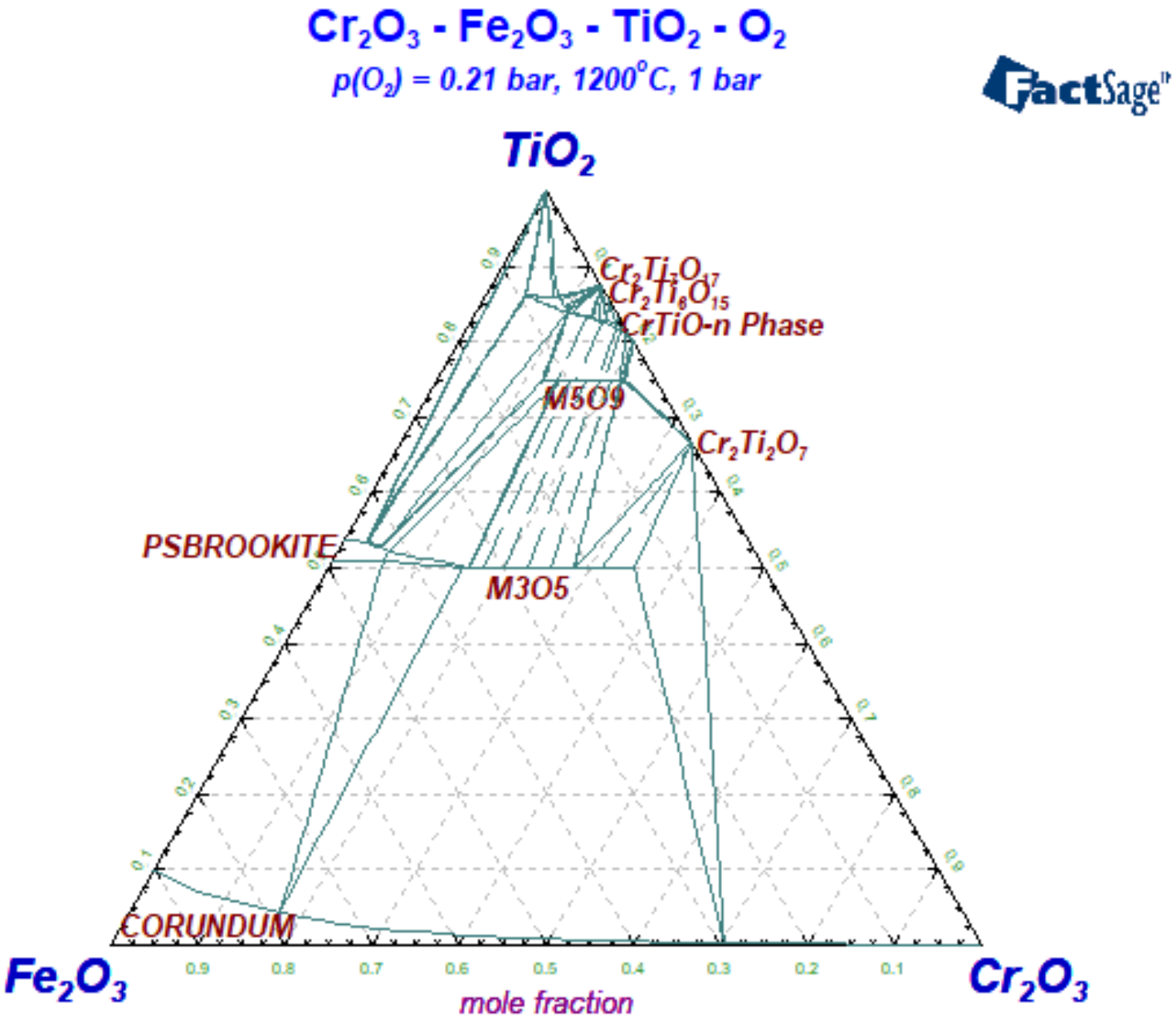
Weight percent 1850°C

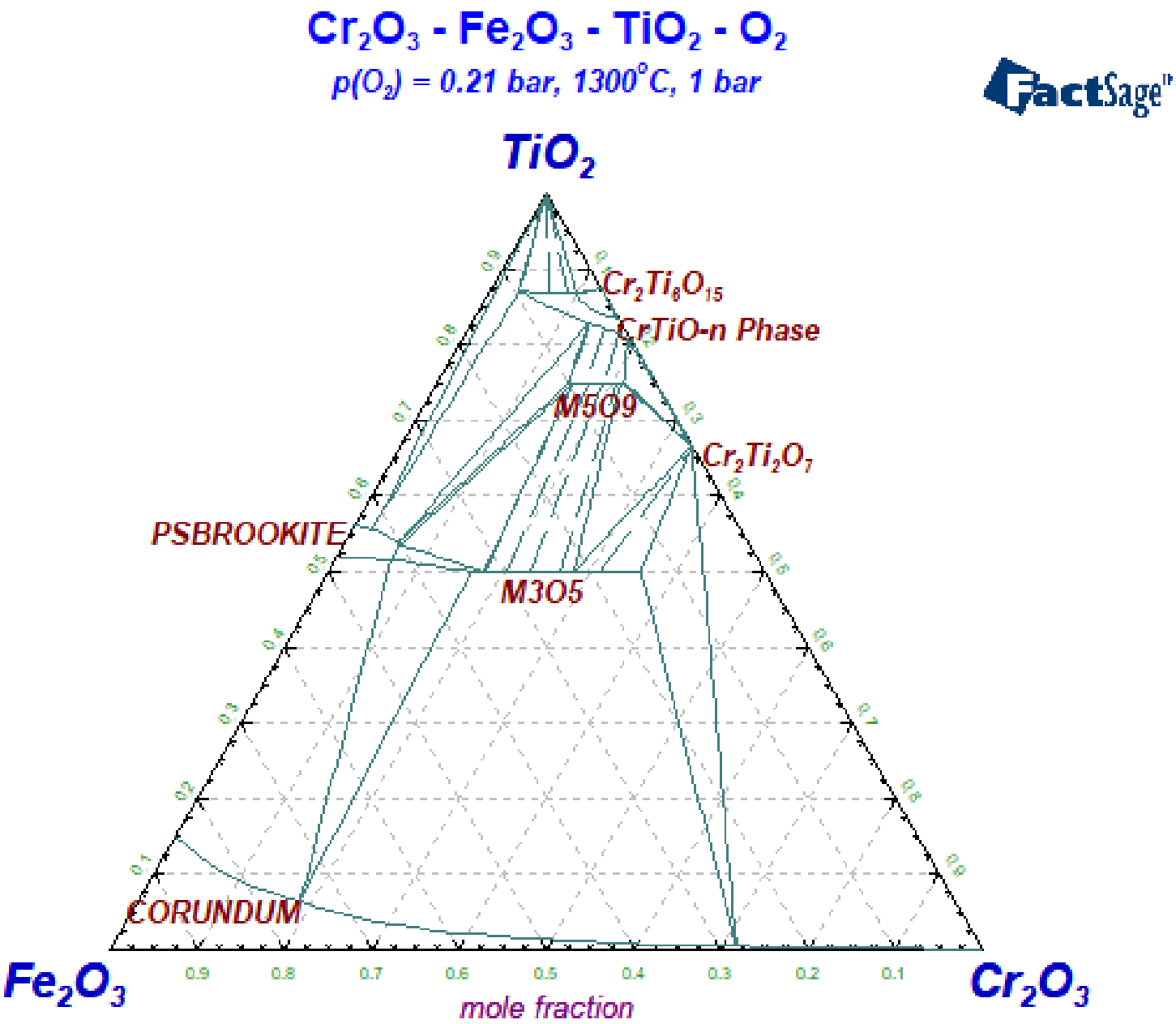


Cr2O3-Fe2O3-TiO2, Mole fraction, 1000°C



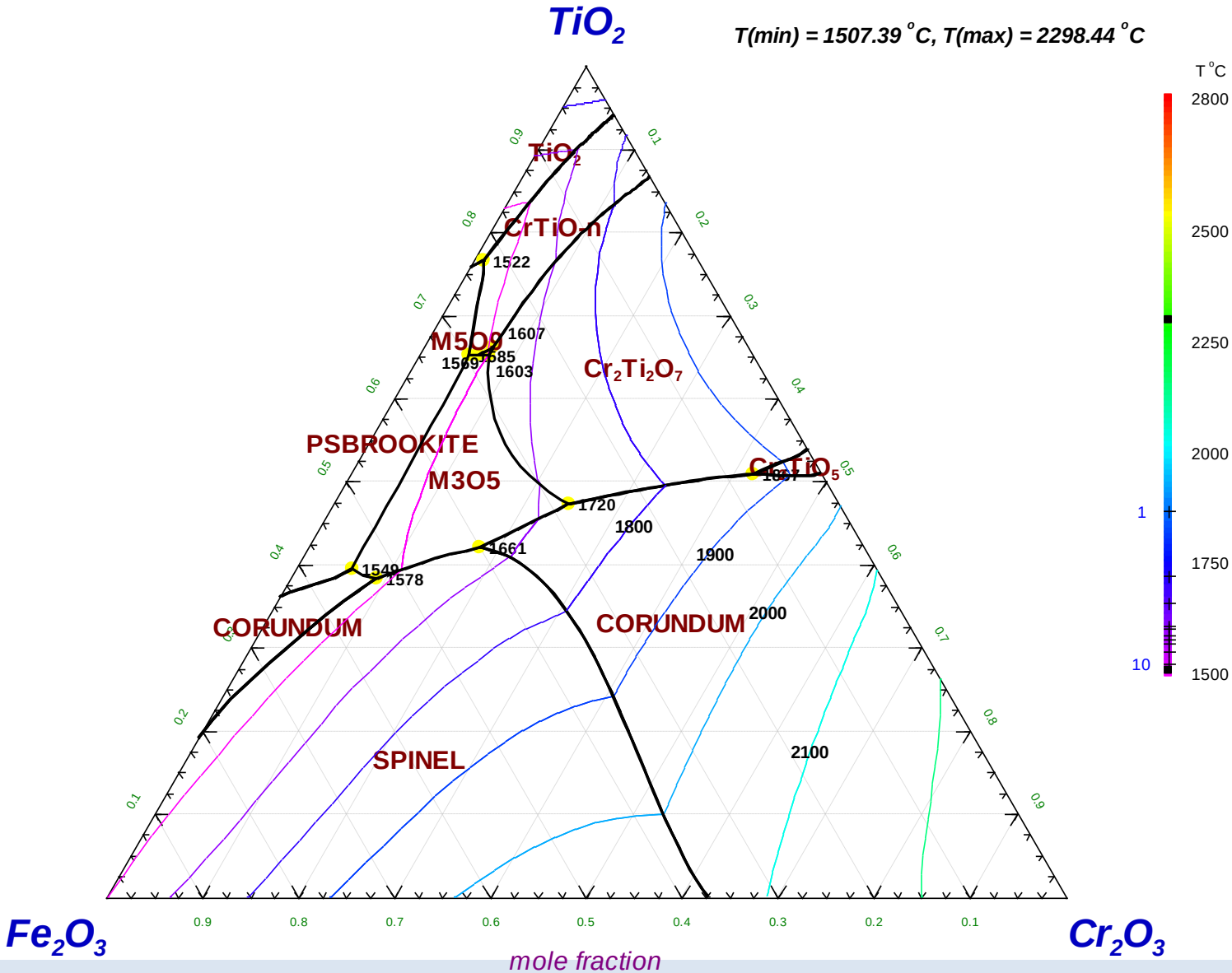

Fe2O3 - Cr2O3 - TiO2 - O2
p(O2) = 0.21 bar, 1100°C, 1 bar
FactSage
TiO2
Cr2Ti7O17
Cr2Ti6O15
Cr2Ti5O13
Cr2Ti4O11
M5O9
Cr2Ti2O7
PSBROOKITE
M3O5
CORUNDUM
Fe2O3
Cr2O3
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
mole fraction


Cr_2O_3 - Fe_2O_3 - TiO_2 - O_2
$p(O_2)$ = 0.21 bar, 1200°C, 1 bar
FactSage
TiO_2
$Cr_2Ti_7O_{17}$
$Cr_2Ti_6O_{15}$
CrTiO-n Phase
M5O9
$Cr_2Ti_2O_7$
PSBROOKITE
M3O5
CORUNDUM
Fe_2O_3
Cr_2O_3
mole fraction


Cr_2O_3 - Fe_2O_3 - TiO_2 - O_2
$p(O_2)$ = 0.21 bar, 1300°C, 1 bar
FactSage
TiO_2
$Cr_2Ti_6O_{15}$
CrTiO-n Phase
M5O9
$Cr_2Ti_2O_7$
PSBROOKITE
M3O5
CORUNDUM
Fe_2O_3
Cr_2O_3
mole fraction

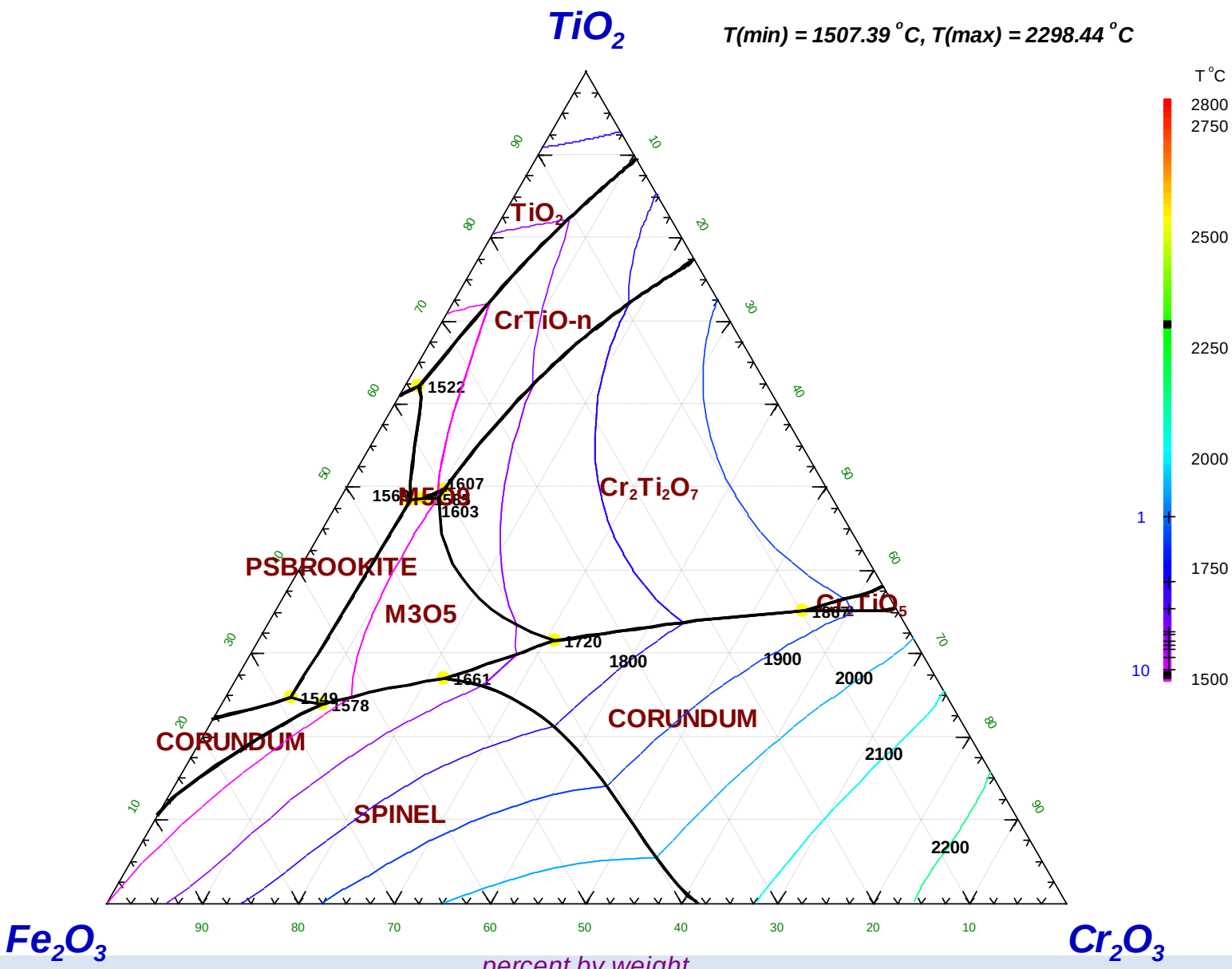
Cr_2O_3 - Fe_2O_3 - TiO_2 - O_2

Projection (A-Slag), p(O_2) = 0.21 atm, 1 atm



Cr_2O_3 - Fe_2O_3 - TiO_2 - O_2

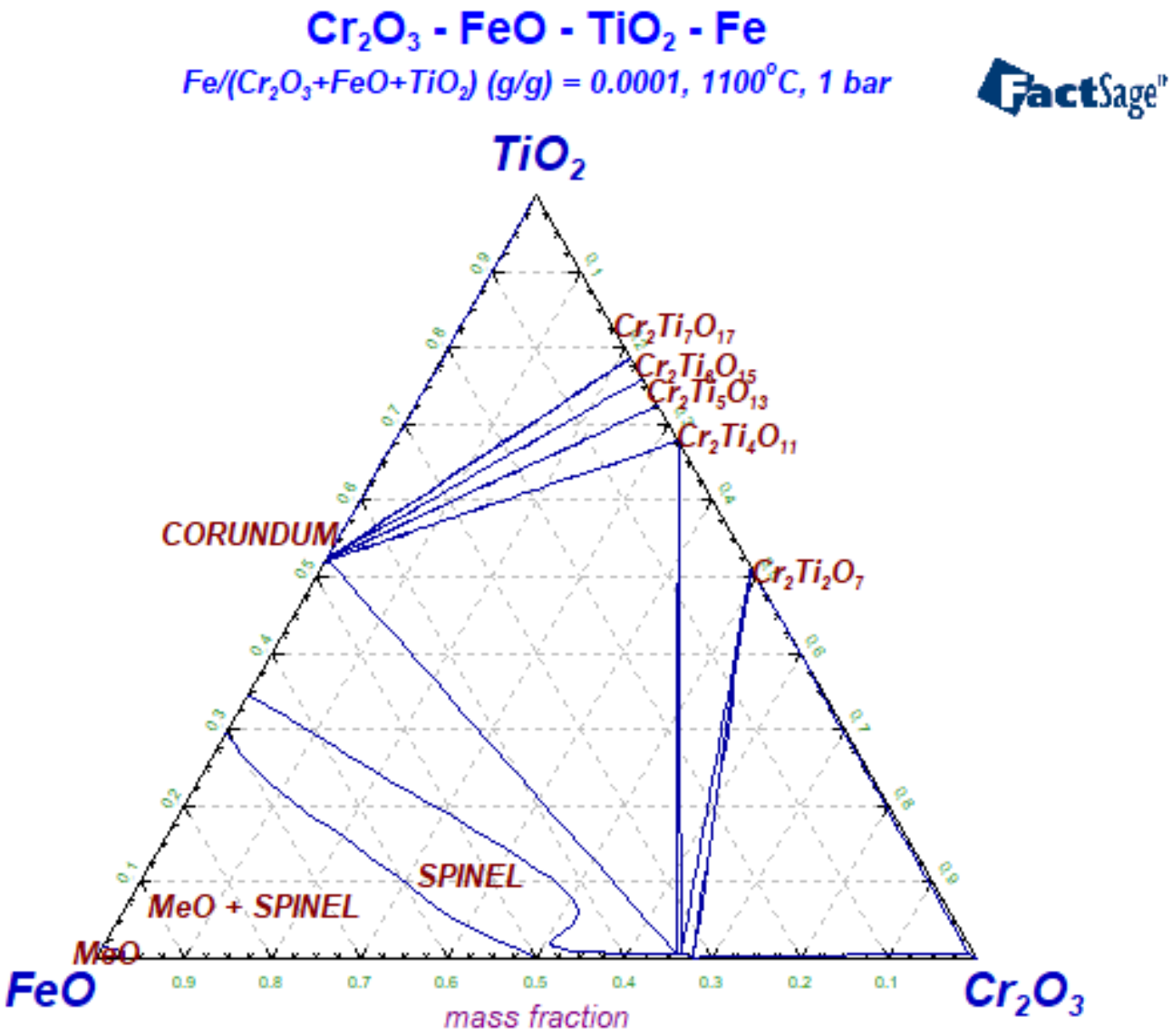
Projection (A-Slag), $p(O_2)$ = 0.21 atm, 1 atm

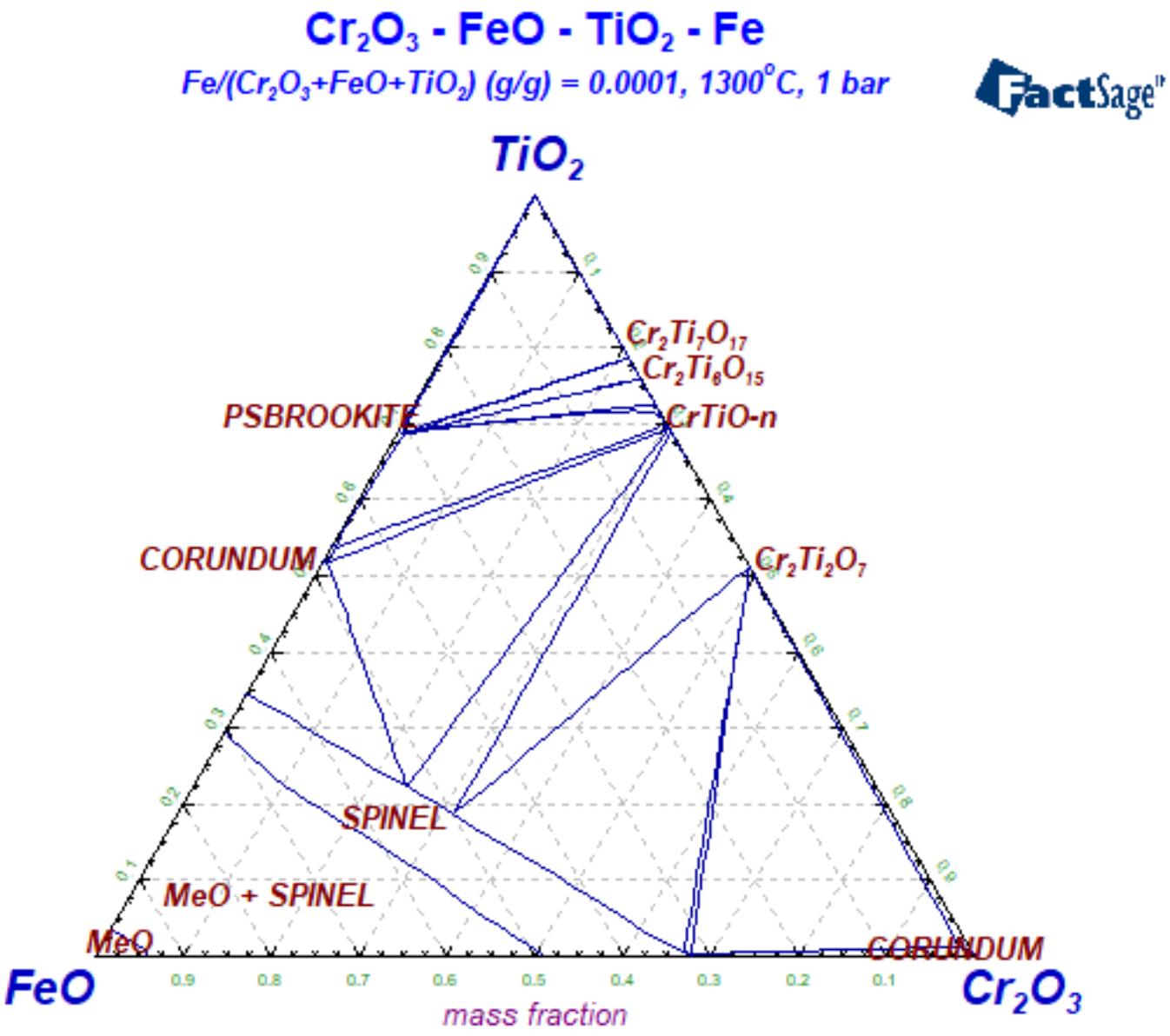


Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction				Weight percent			
	A = TiO2, B = Fe2O3, C = Cr2O3				A = TiO2, B = Fe2O3, C = Cr2O3			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1. CORUNDUM / Cr2Ti2O7(s) / Cr2TiO5	0.50914	0.07060	0.42026	1866.59	35.111	9.735	55.154	1866.60
2. CORUNDUM / Cr2Ti2O7(s) / M3O5	0.47338	0.28135	0.24527	1720.18	31.502	37.436	31.062	1720.19
3. CORUNDUM / M3O5 / SPINEL	0.42064	0.40020	0.17916	1661.05	26.933	51.236	21.831	1661.04
4. Cr2Ti2O7(s) / CrTiO-n / M5O9	0.66126	0.26609	0.07266	1607.01	49.660	39.955	10.385	1607.01
5. Cr2Ti2O7(s) / M3O5 / M5O9	0.65213	0.27489	0.07298	1603.16	48.642	40.997	10.360	1603.14
6. CrTiO-n / M3O5 / M5O9	0.65269	0.28562	0.06169	1585.43	48.666	42.581	8.753	1585.42
7. CORUNDUM#1 / M3O5 / SPINEL	0.38412	0.52619	0.08969	1578.42	23.904	65.473	10.622	1578.42
8. CrTiO-n / M3O5 / PSBROOKITE	0.65167	0.29584	0.05249	1569.39	48.520	44.042	7.437	1569.39
9. CORUNDUM#1 / M3O5 / PSBROOKITE	0.39494	0.54652	0.05854	1548.97	24.698	68.335	6.967	1548.97
10.CrTiO-n / PSBROOKITE / TiO2	0.76563	0.22437	0.01000	1521.58	62.081	36.376	1.543	1521.58

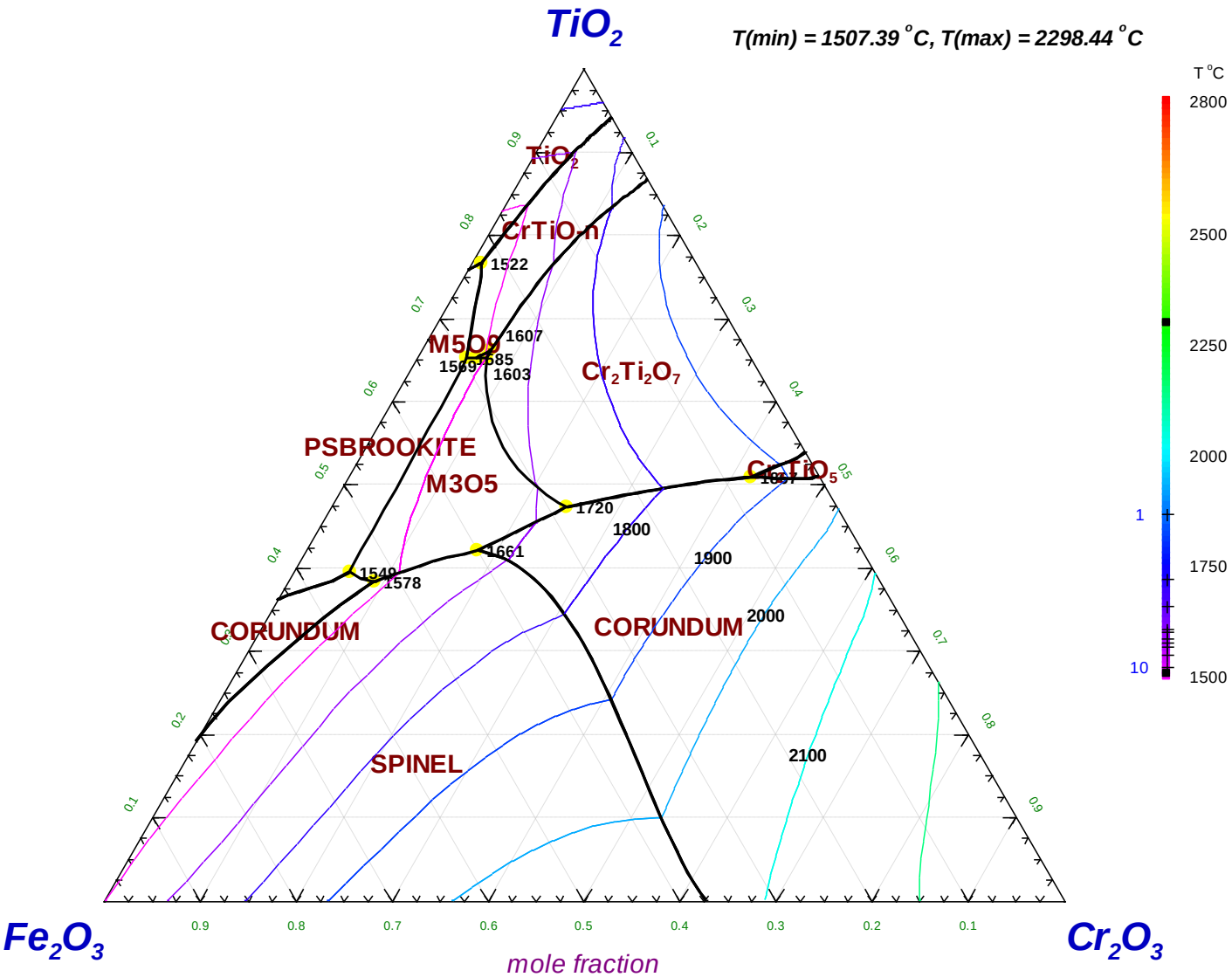
Cr2O3-FeO-TiO2, Mole fraction, 1100°C

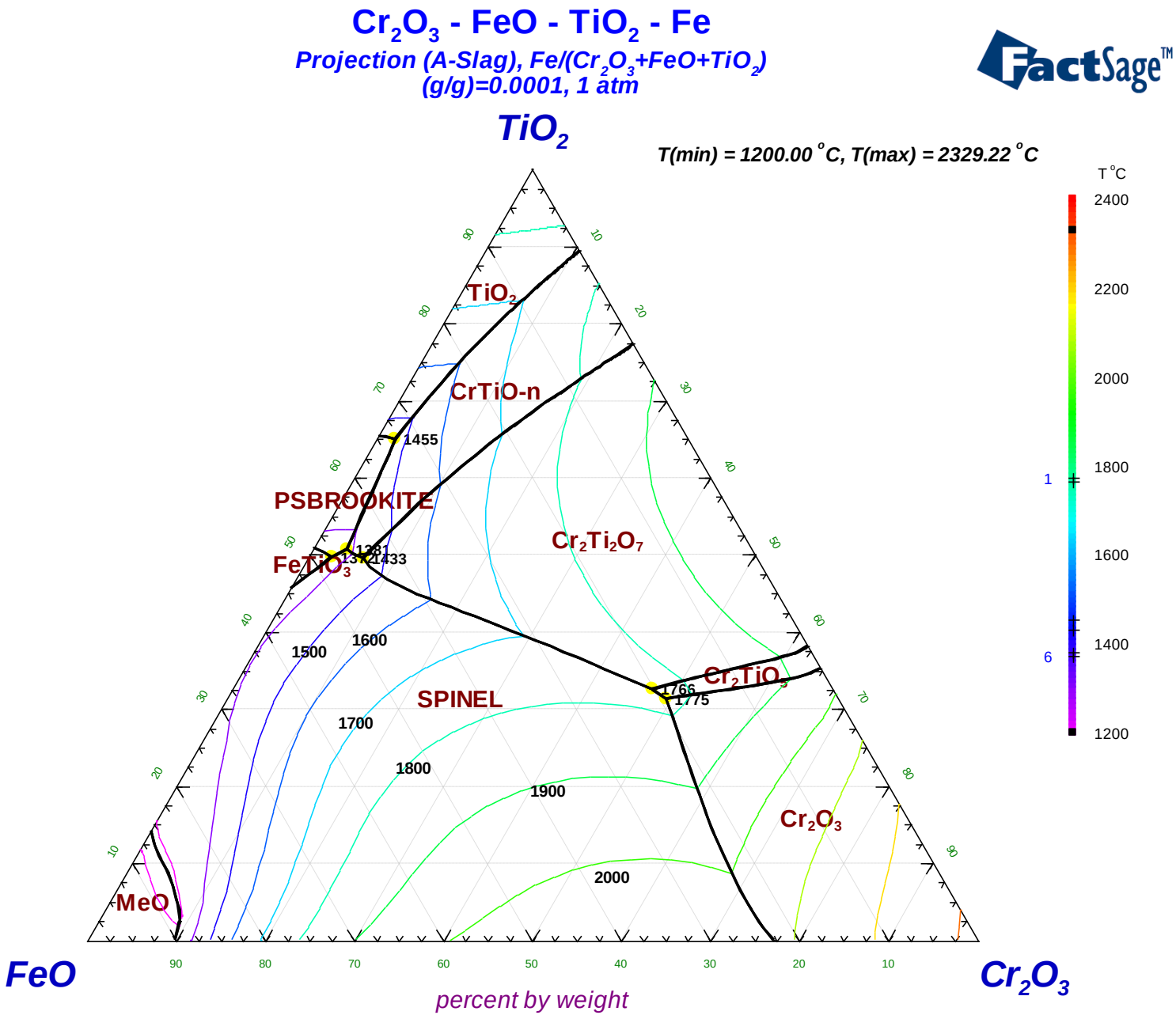



Cr2O3 - FeO - TiO2 - Fe
Fe/(Cr2O3+FeO+TiO2) (g/g) = 0.0001, 1300°C, 1 bar
FactSage
TiO2
Cr2Ti7O17
Cr2Ti6O15
PSBROOKITE
CrTiO-n
CORUNDUM
Cr2Ti2O7
SPINEL
MeO + SPINEL
MeO
CORUNDUM
FeO
Cr2O3
mass fraction

Cr_2O_3 - Fe_2O_3 - TiO_2 - O_2

Projection (A-Slag), $p(O_2)$ = 0.21 atm, 1 atm

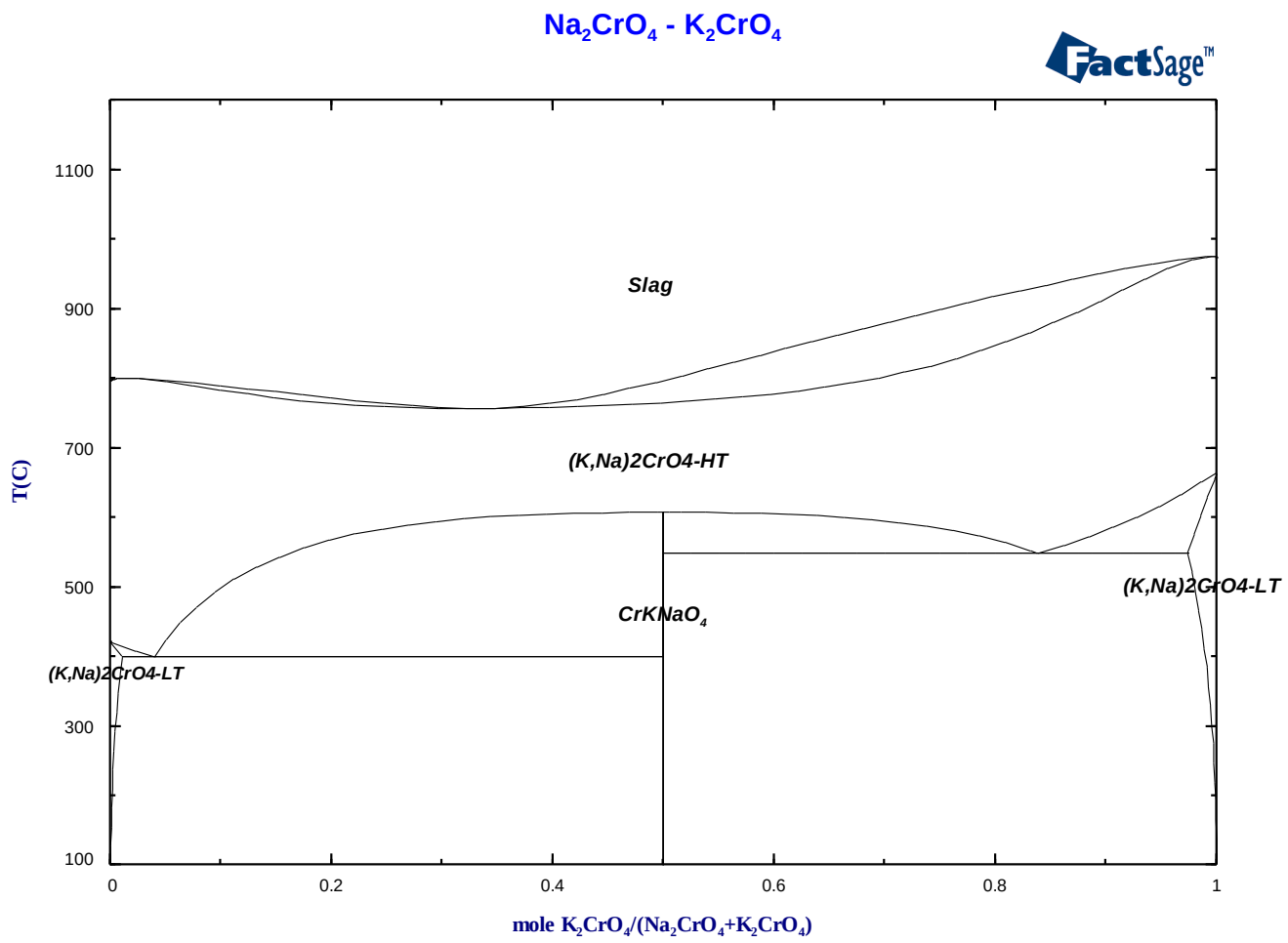



Cr_2O_3 - FeO - TiO_2 - Fe
Projection (A-Slag), Fe/(Cr_2O_3+FeO+TiO_2) (g/g)=0.0001, 1 atm
FactSage™
TiO_2
T(min) = 1200.00 °C, T(max) = 2329.22 °C
T °C
2400
2200
2000
1800
1600
1400
1200
1
6
TiO_2
CrTiO-n
1455
PSBROOKITE
$FeTiO_3$
1381
1433
$Cr_2Ti_2O_7$
1500
1600
1700
1800
1900
2000
SPINEL
Cr_2TiO_5
1766
1775
Cr_2O_3
MeO
FeO
Cr_2O_3
percent by weight

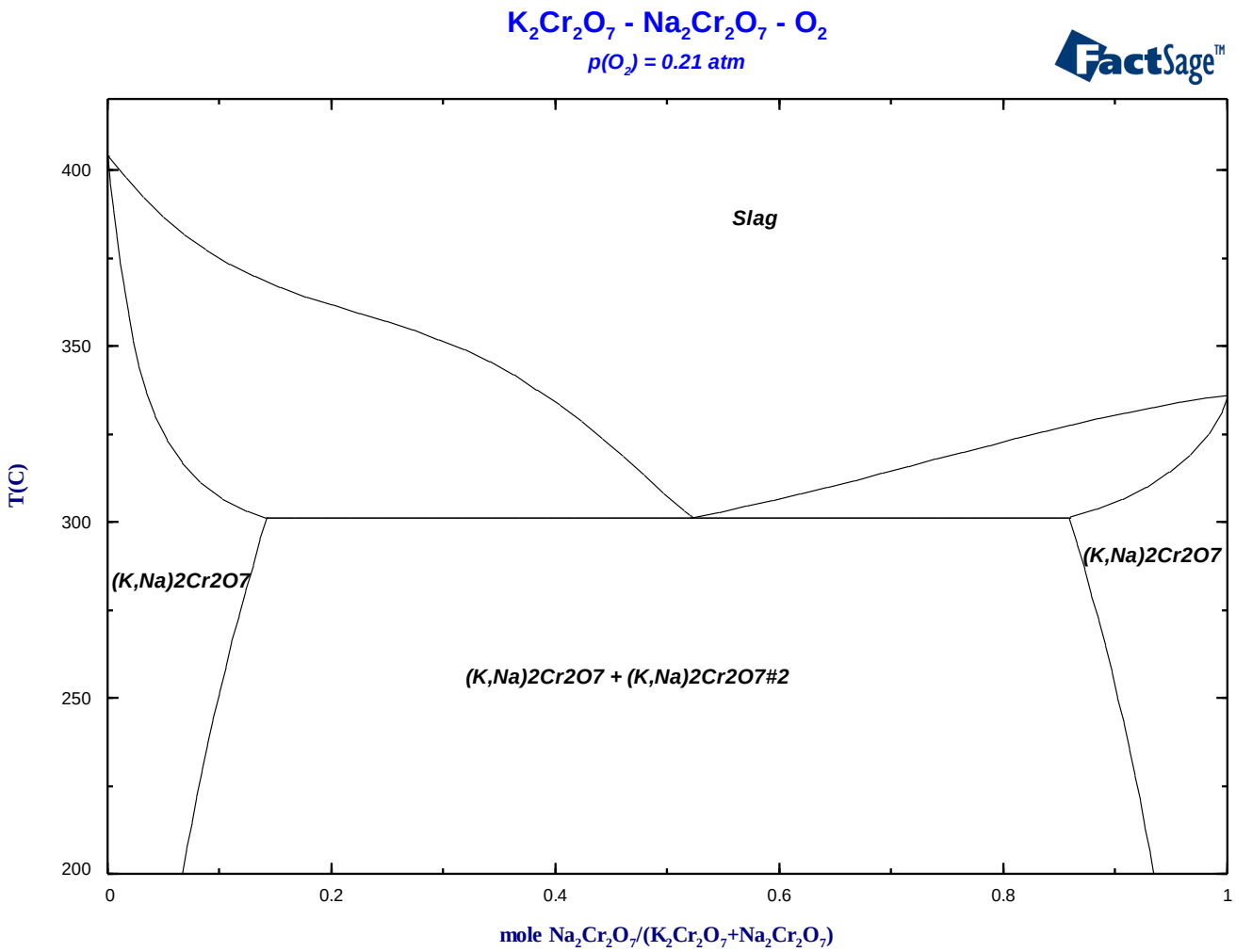
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction				Weight percent			
	A = TiO2, B = FeO, C = Cr2O3				A = TiO2, B = FeO, C = Cr2O3			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1. Cr2O3 / Cr2TiO5 / SPINEL	0.39850	0.27191	0.32959	1774.77	31.371	19.243	49.385	1774.78
2. Cr2Ti2O7 / Cr2TiO5 / SPINEL	0.40810	0.28227	0.30963	1765.55	32.617	20.282	47.100	1765.56
3. CrTiO-n / PSBROOKITE / TiO2	0.63352	0.35586	0.01061	1455.11	65.060	32.867	2.074	1455.10
4. Cr2Ti2O7 / CrTiO-n / SPINEL	0.48636	0.48171	0.03192	1432.60	49.610	44.196	6.194	1432.54
5. CrTiO-n / PSBROOKITE / SPINEL	0.49191	0.48890	0.01920	1380.69	50.806	45.421	3.773	1380.65
6. FeTiO3 / PSBROOKITE / SPINEL	0.47814	0.50879	0.01307	1371.54	49.773	47.634	2.593	1371.53

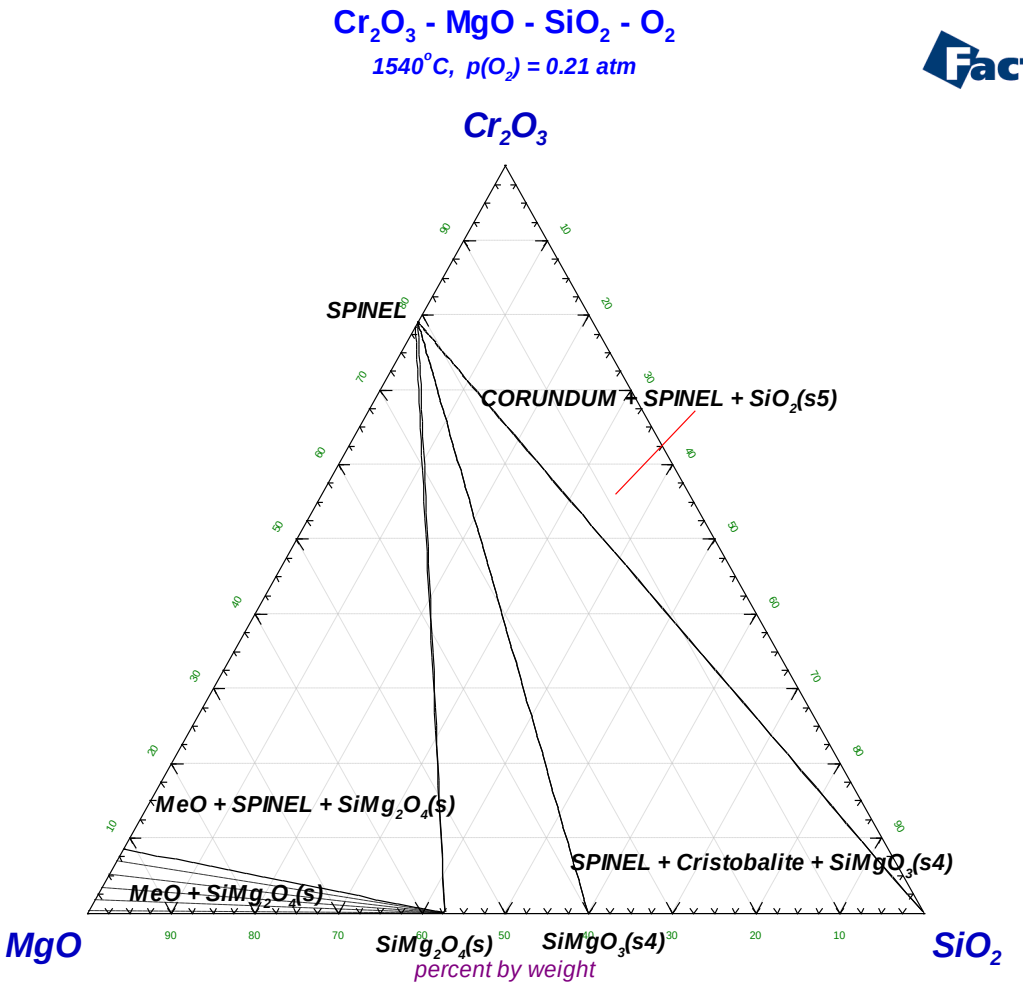
Mole fraction
Isopleth K2CrO4-Na2CrO4



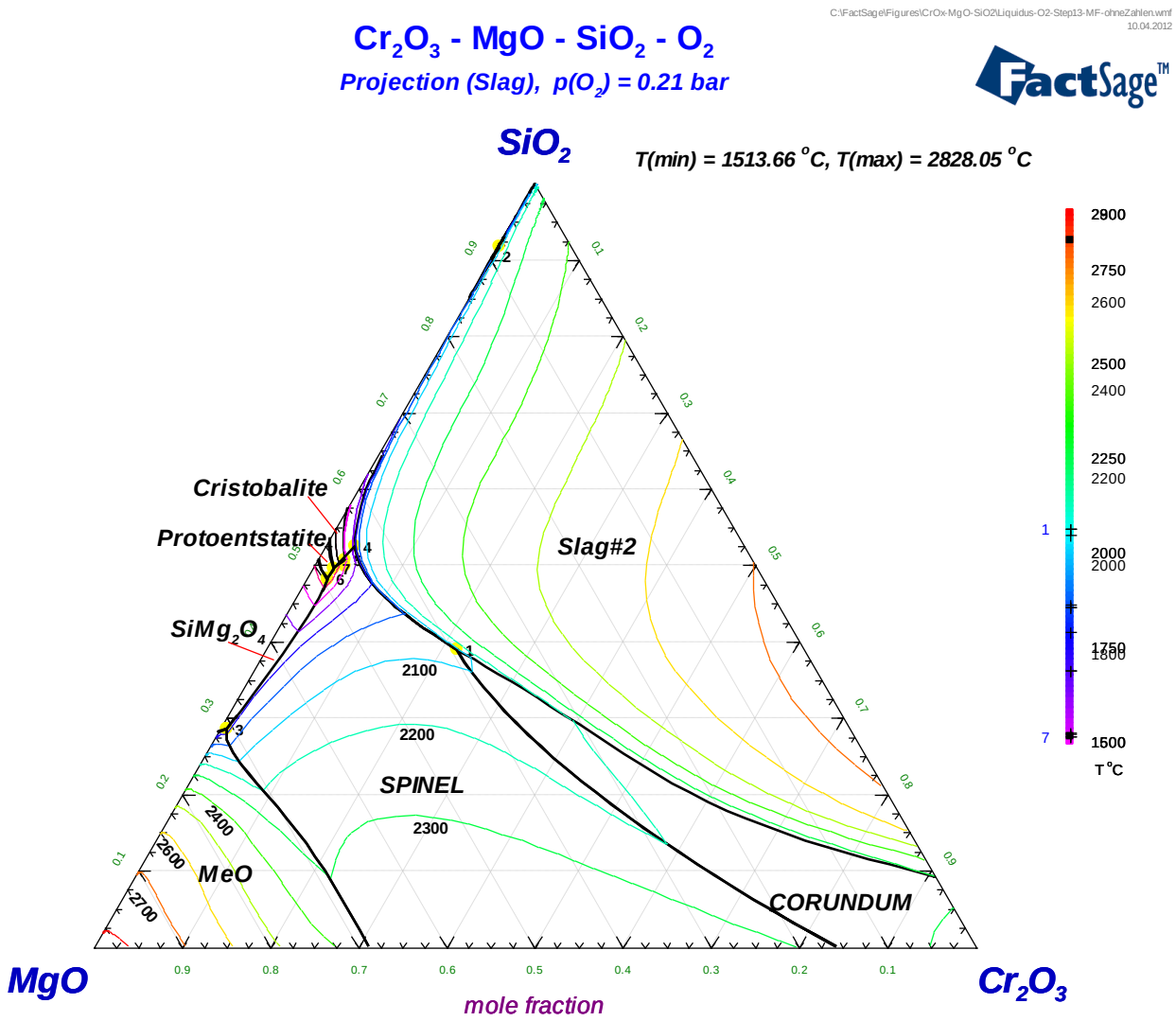
Mole fraction
Isopleth K2Cr2O7-Na2Cr2O7



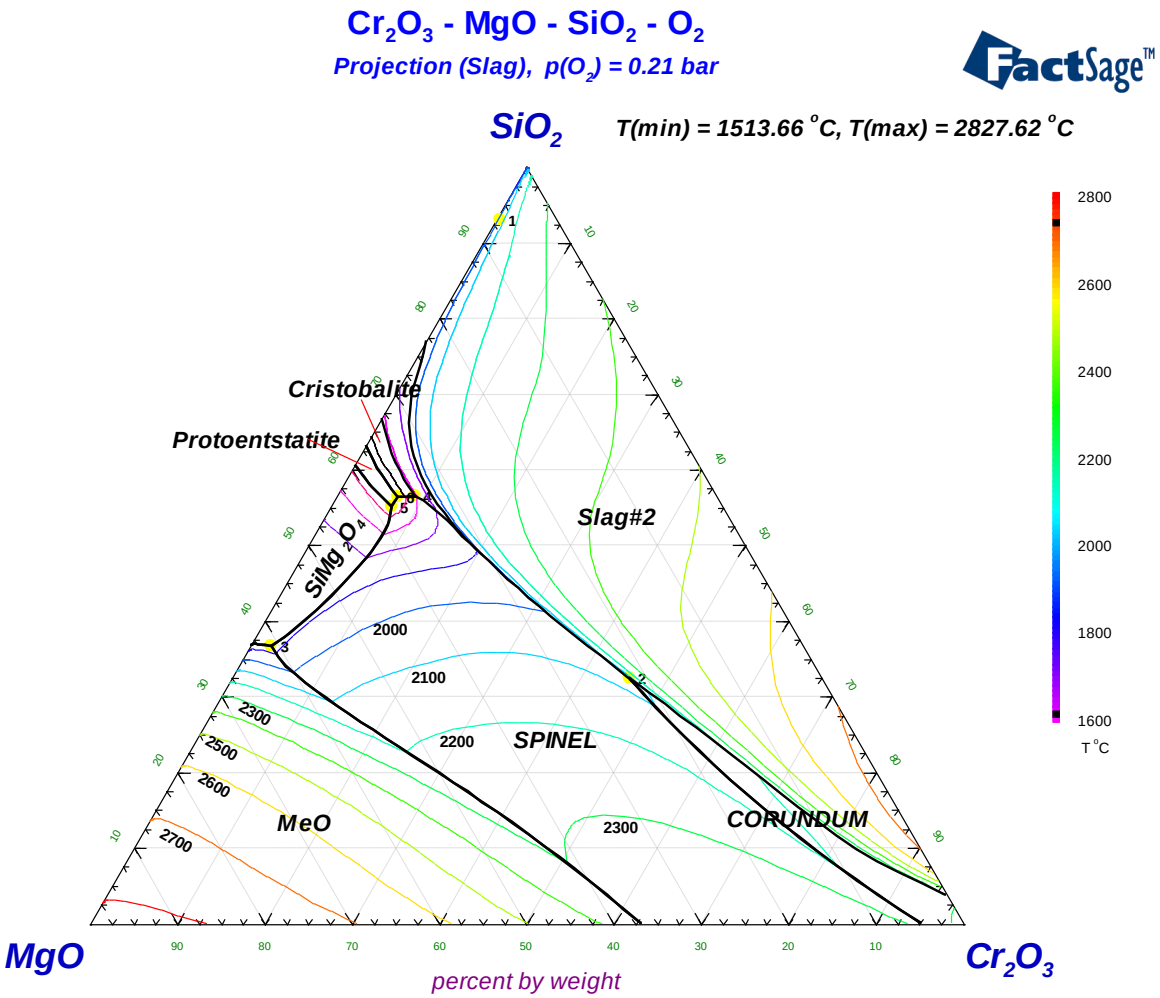
Cr2O3-MgO-SiO2,
Weight percent 1540°C



Mole fraction
Liquidussurface



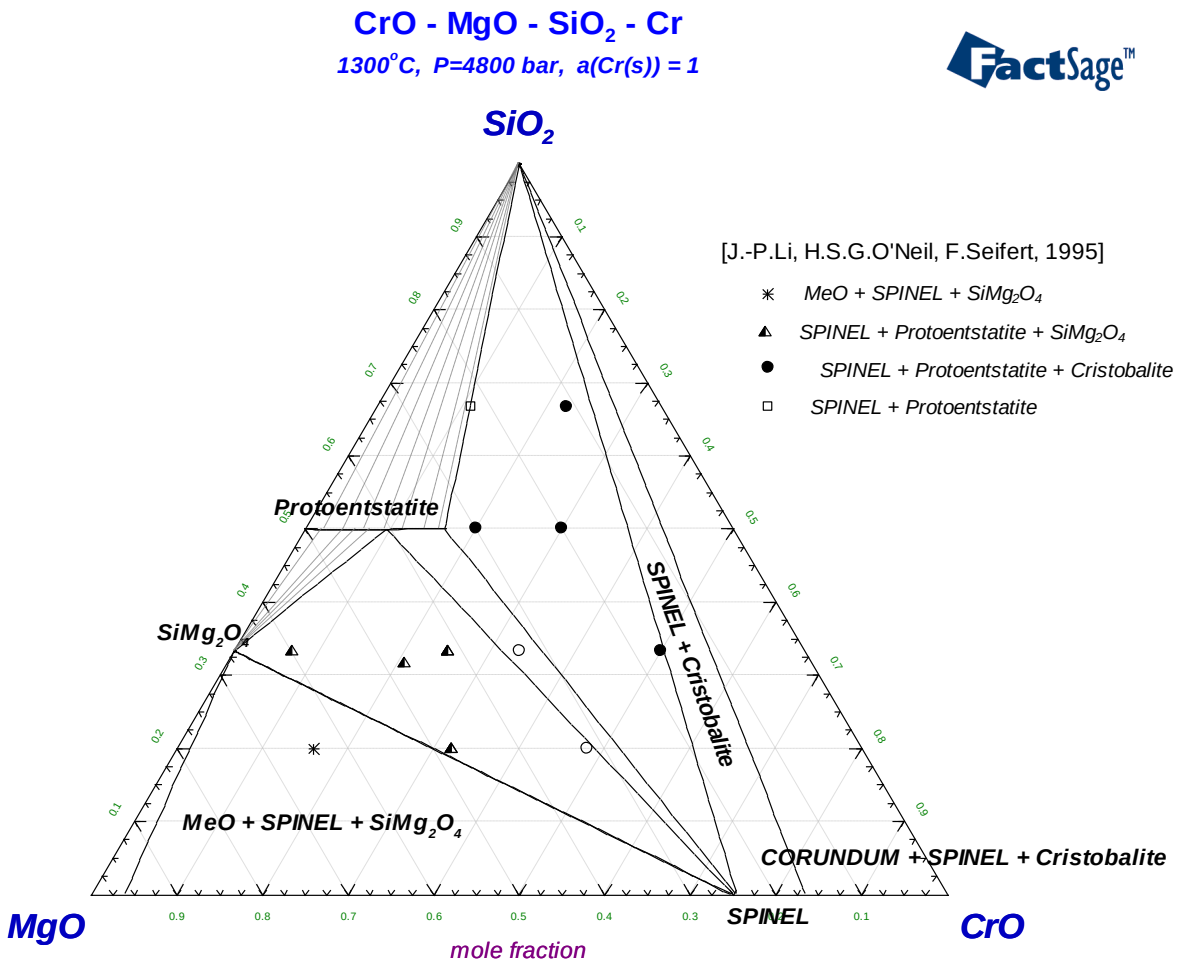
Weight percent
Liquidussurface



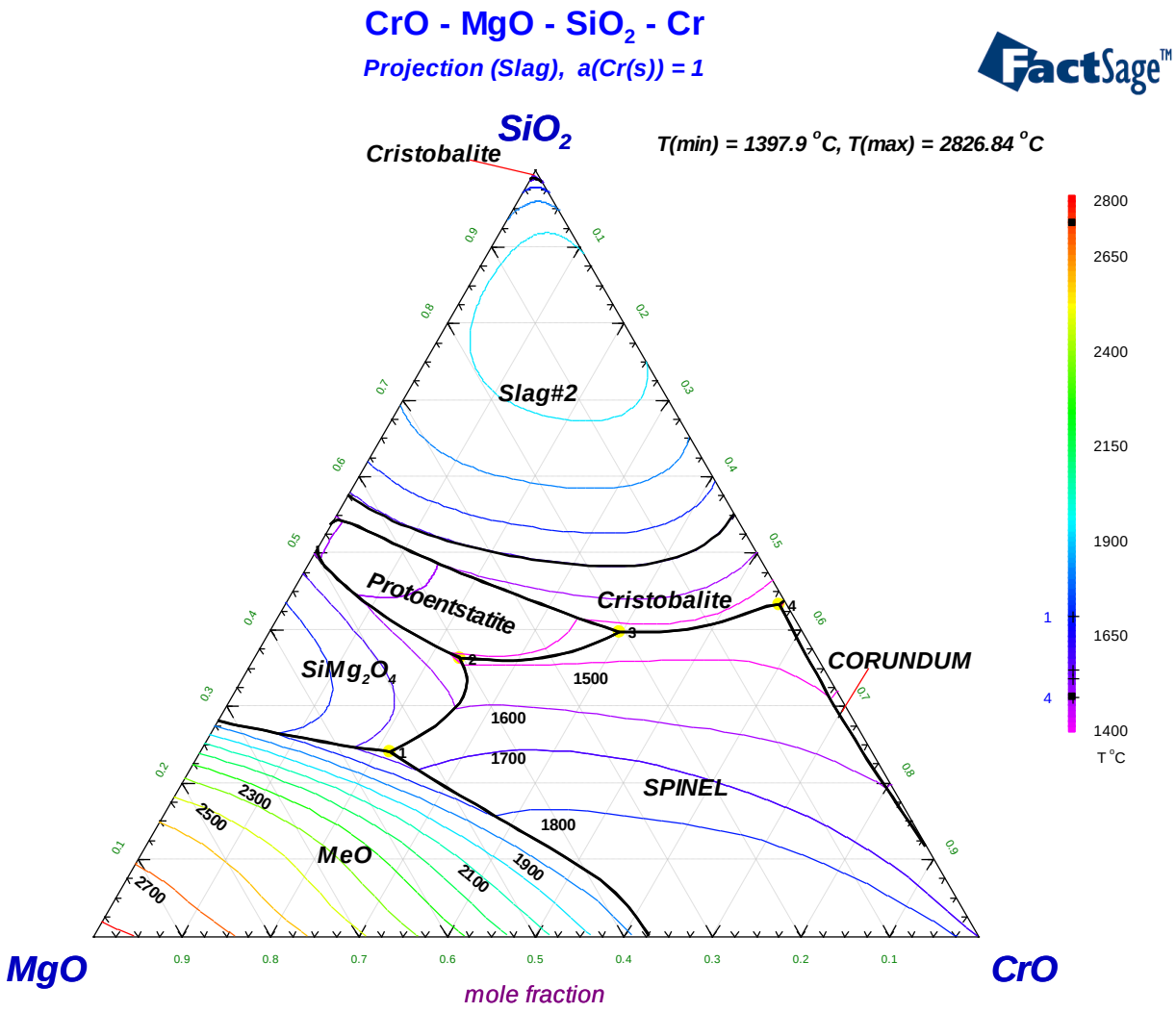
Invariant equilibria on the liquidus surface

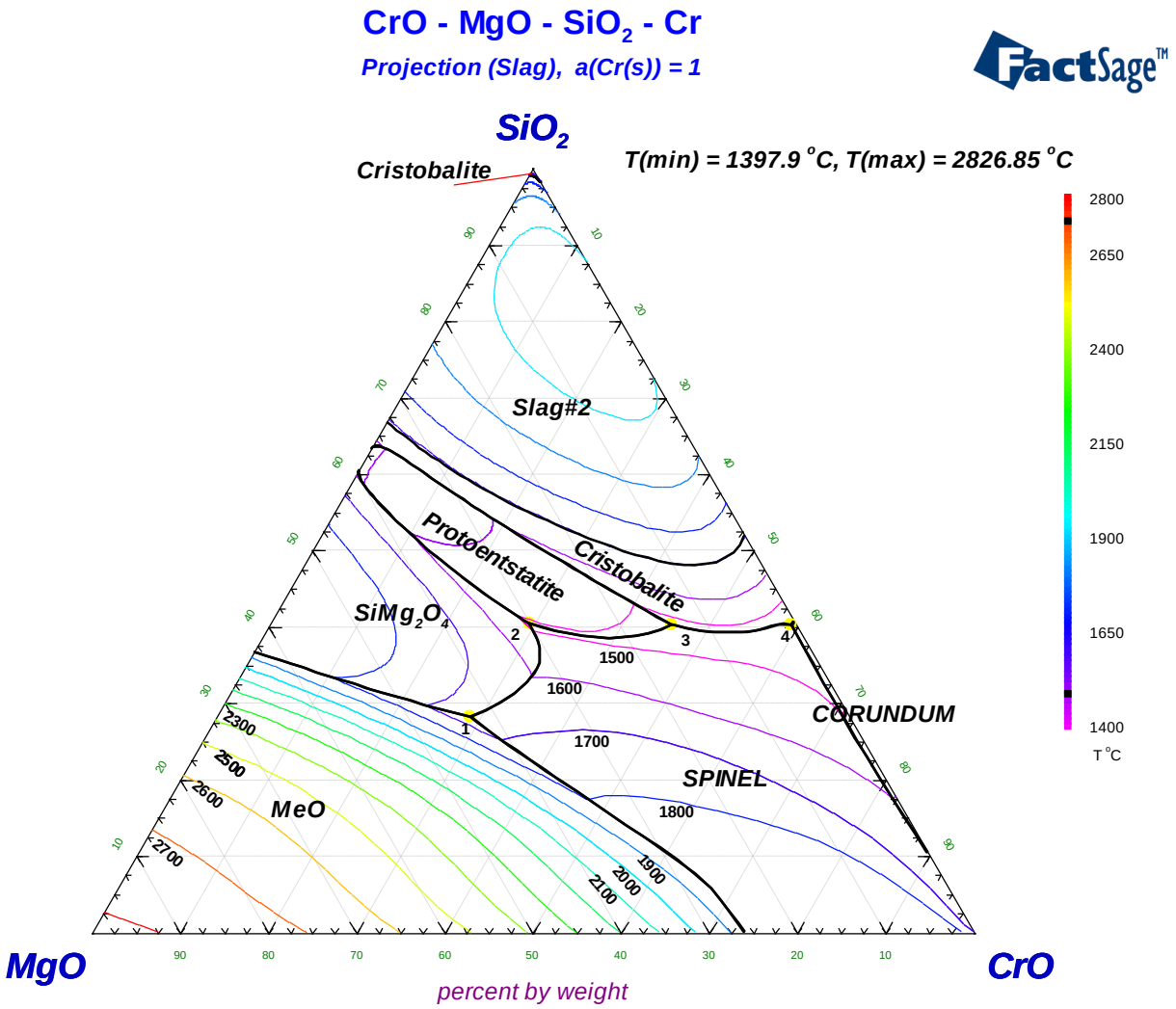
Intersections with slag	Mole fraction				Weight percent			
	A = SiO2, B = MgO, C = Cr2O3				A = SiO2, B = MgO, C = Cr2O3			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: CORANDUM / SPINEL / Slag#2	1: 0.38985	0.39395	0.21620	2064.98	1: 32.460	22.003	45.537	2064.98
2: CORANDUM / SPINEL / Slag#2	2: 0.90456	0.09361	0.00183	2064.98	2: 93.064	6.460	0.476	2064.98
3: MeO / SPINEL / SiMg2O4	3: 0.28568	0.70682	0.00750	1856.91	3: 36.682	60.880	2.437	1856.91
4: SPINEL / Cristobalite / Slag#2	4: 0.52473	0.44157	0.03370	1789.90	4: 57.906	32.687	9.407	1789.90
5: SPINEL / Cristobalite / Slag#2	5: 0.50671	0.46158	0.03170	1688.77	5: 56.519	34.536	8.945	1688.74
6: Protoentstatite / SPINEL / SiMg2O4	6: 0.48225	0.49383	0.02392	1522.04	6: 55.177	37.901	6.922	1522.03
7: Protoentstatite / SPINEL / Cristobalite	7: 0.49669	0.47912	0.02419	1513.66	7: 56.488	36.552	6.960	1513.66

CrO-MgO-SiO2,
Mole fraction 1300°C



Mole fraction
Liquidussurface

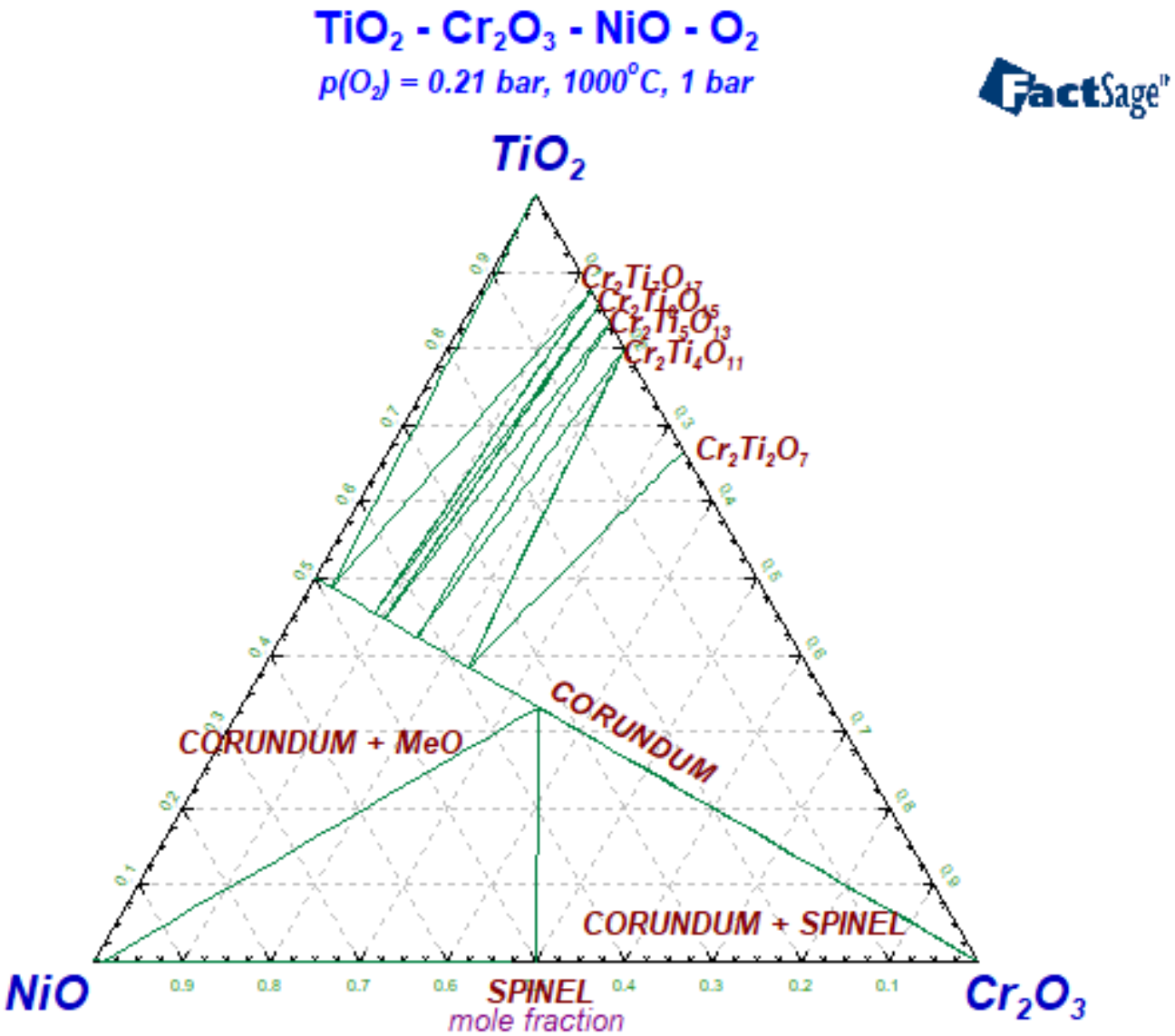


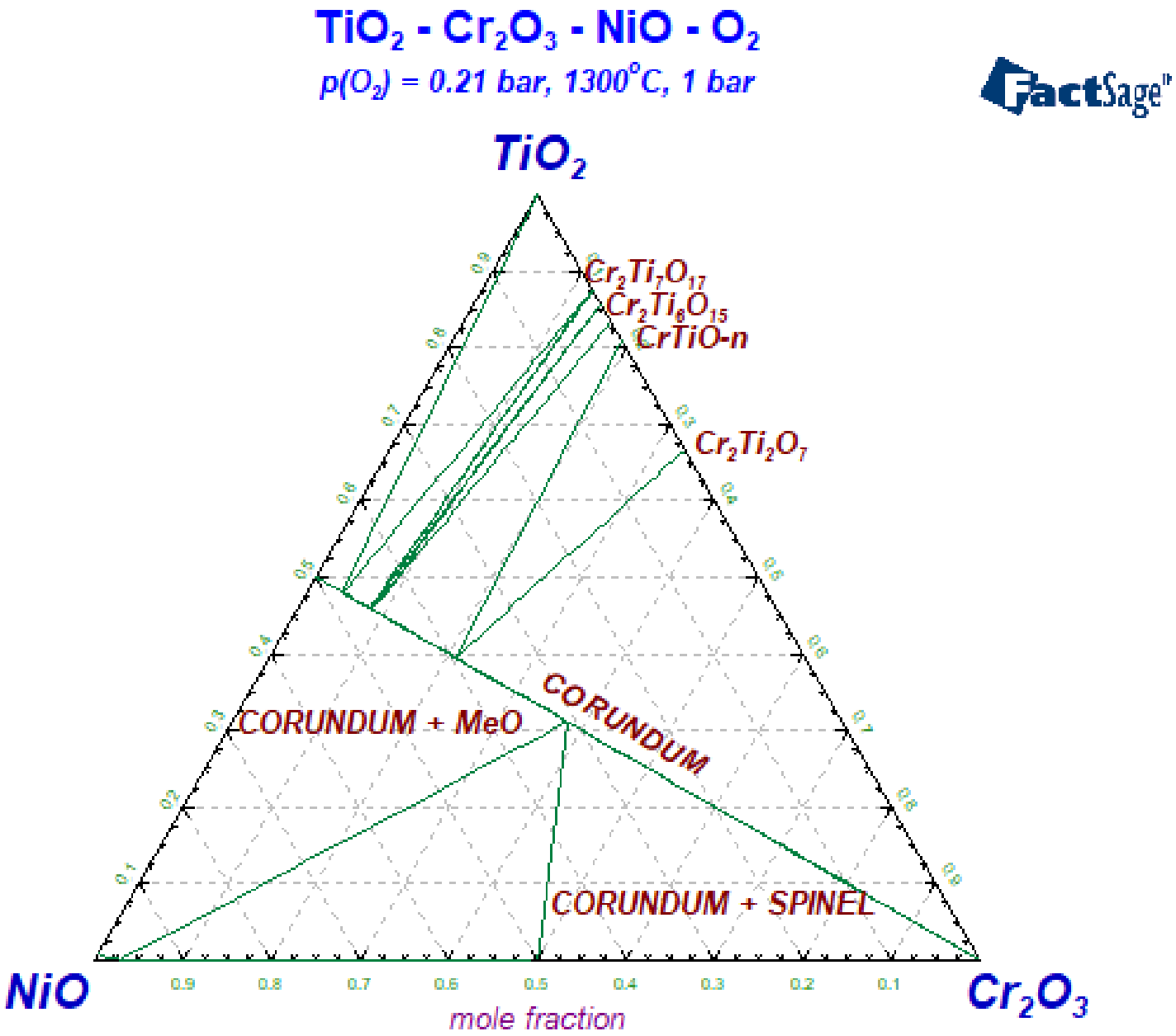

CrO - MgO - SiO2 - Cr
Projection (Slag), a(Cr(s)) = 1
FactSage™
SiO2
Cristobalite
T(min) = 1397.9 °C, T(max) = 2826.85 °C
2800
2650
2400
2150
1900
1650
1400
T °C
Slag#2
Protoentstatite
Cristobalite
SiMg2O4
CORUNDUM
SPINEL
MeO
1500
1600
1700
1800
1900
2000
2100
2300
2500
2600
2700
1
2
3
4
MgO
CrO
percent by weight

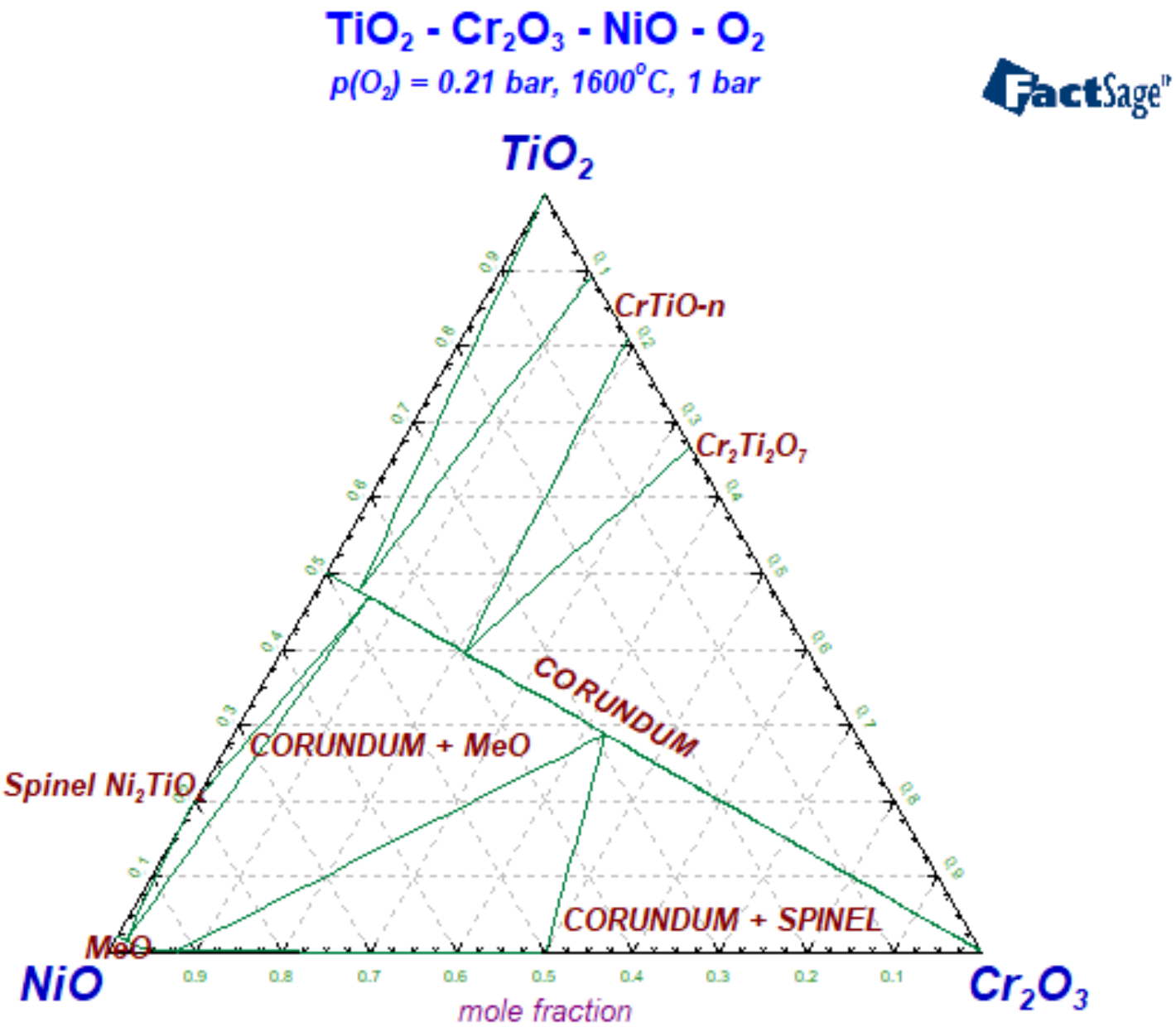
Invariant equilibria on the liquidus surface

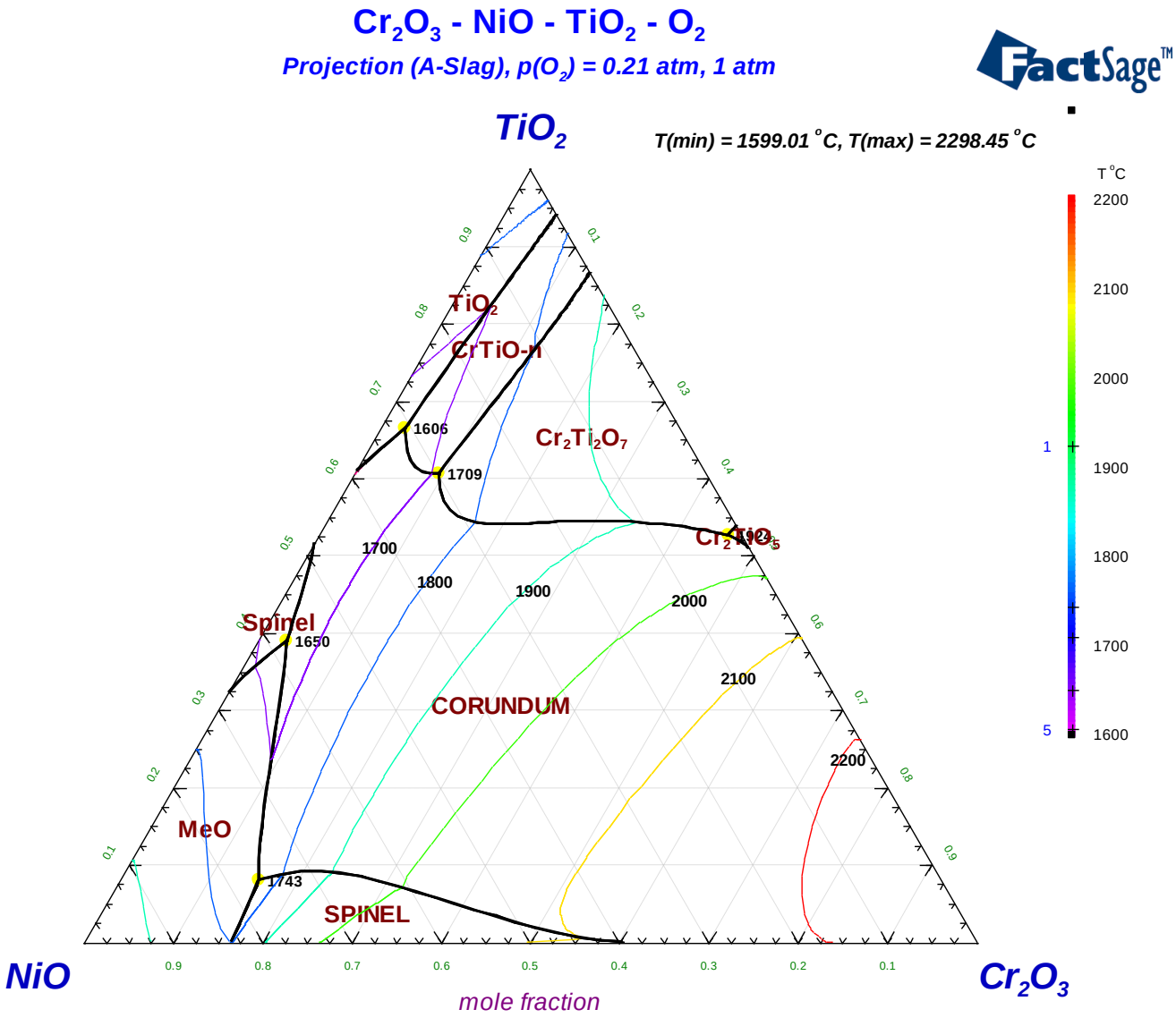
Intersections with slag	Mole fraction					Weight percent				
	A = SiO2, B = MgO, C = CrO					A = SiO2, B = MgO, C = CrO				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: MeO / SPINEL / SiMg2O4	1:	0.24040	0.54388	0.21571	1644.09	1:	28.304	42.954	28.741	1644.10
2: Protoentstatite / SPINEL / SiMg2O4	2:	0.36318	0.40371	0.23311	1482.82	2:	40.453	30.163	29.384	1482.81
3: Protoentstatite / SPINEL / Cristobalite	3:	0.39691	0.20635	0.39674	1456.63	3:	40.324	14.063	45.614	1456.63
4: CORANDUM / SPINEL / Cristobalite	4:	0.43165	0.00796	0.56039	1397.90	4:	40.297	0.499	59.204	1397.90

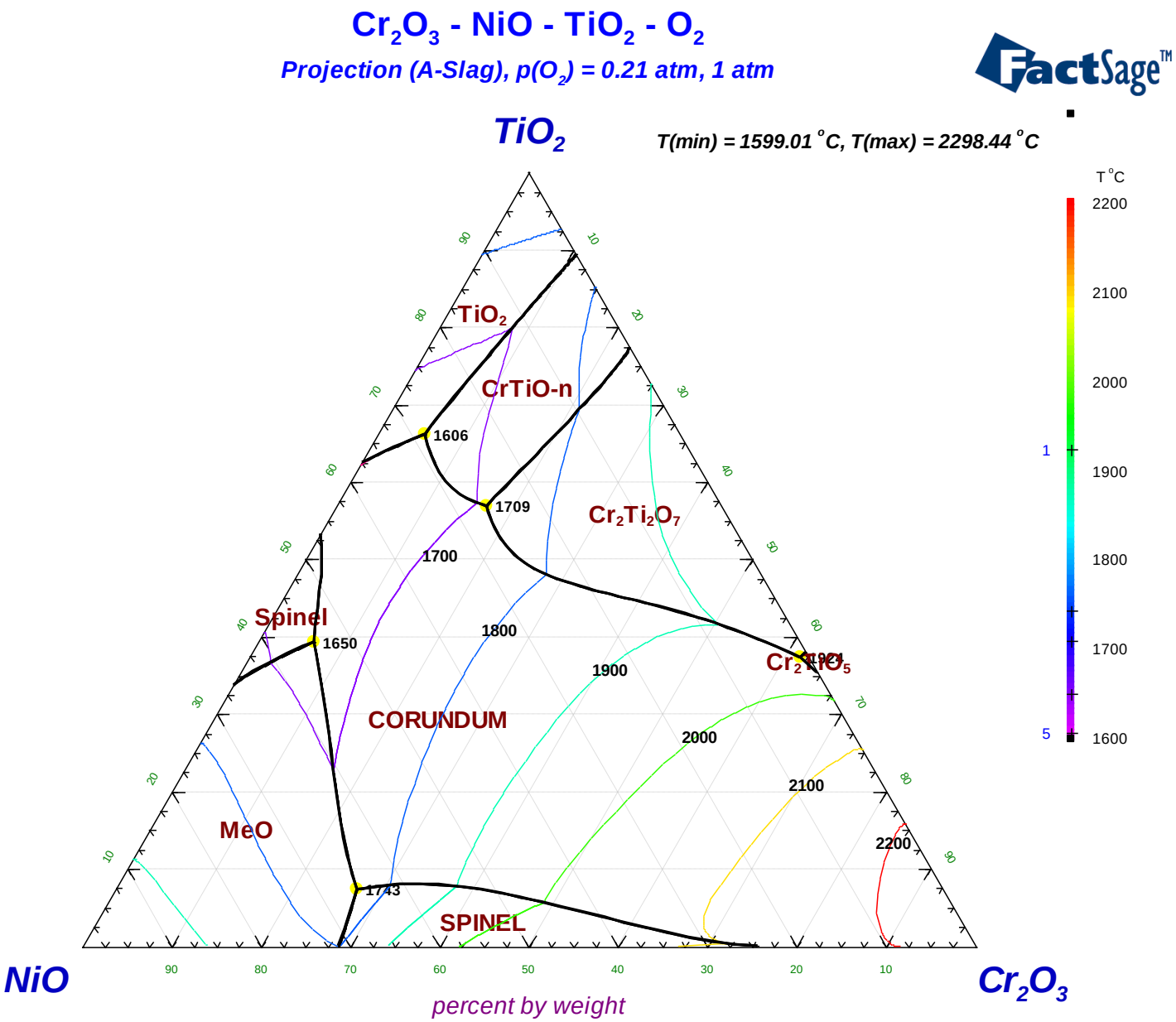
Cr2O3-NiO-TiO2,
Mole fraction 1000°C




TiO2 - Cr2O3 - NiO - O2
p(O2) = 0.21 bar, 1300°C, 1 bar
FactSage
TiO2
Cr2Ti7O17
Cr2Ti6O15
CrTiO-n
Cr2Ti2O7
CORUNDUM + MeO
CORUNDUM
CORUNDUM + SPINEL
NiO
Cr2O3
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
mole fraction


TiO2 - Cr2O3 - NiO - O2
p(O2) = 0.21 bar, 1600°C, 1 bar
FactSage
TiO2
CrTiO-n
Cr2Ti2O7
CORUNDUM
CORUNDUM + MeO
Spinel Ni2TiO4
CORUNDUM + SPINEL
MeO
NiO
Cr2O3
mole fraction

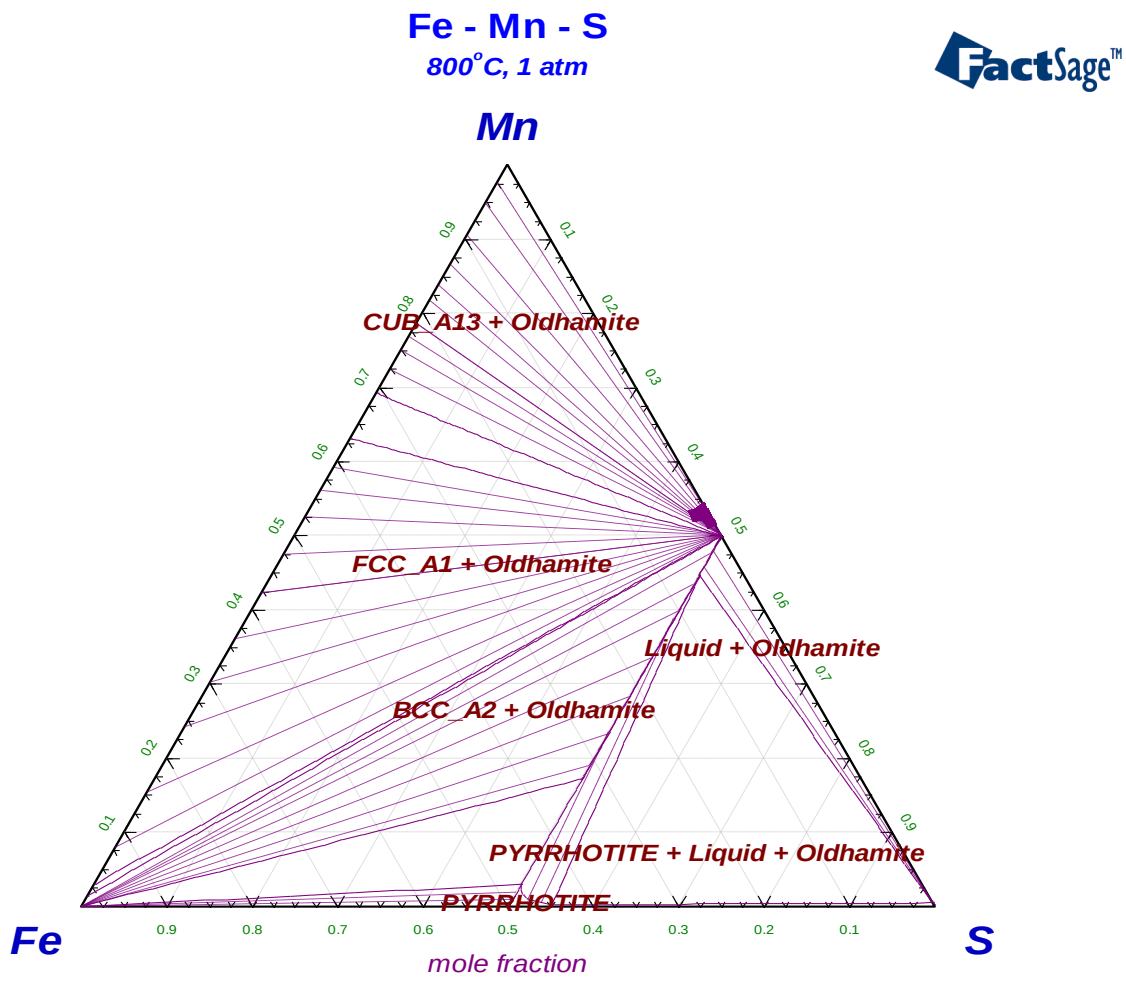

Cr_2O_3 - NiO - TiO_2 - O_2
Projection (A-Slag), $p(O_2)$ = 0.21 atm, 1 atm
FactSage™
TiO_2
T(min) = 1599.01 °C, T(max) = 2298.45 °C
T °C
2200
2100
2000
1900
1800
1700
1600
TiO_2
CrTiO-II
$Cr_2Ti_2O_7$
Cr_2TiO_5
Spinel
CORUNDUM
MeO
SPINEL
1606
1709
1700
1800
1900
2000
2100
2200
1650
1743
NiO
Cr_2O_3
mole fraction

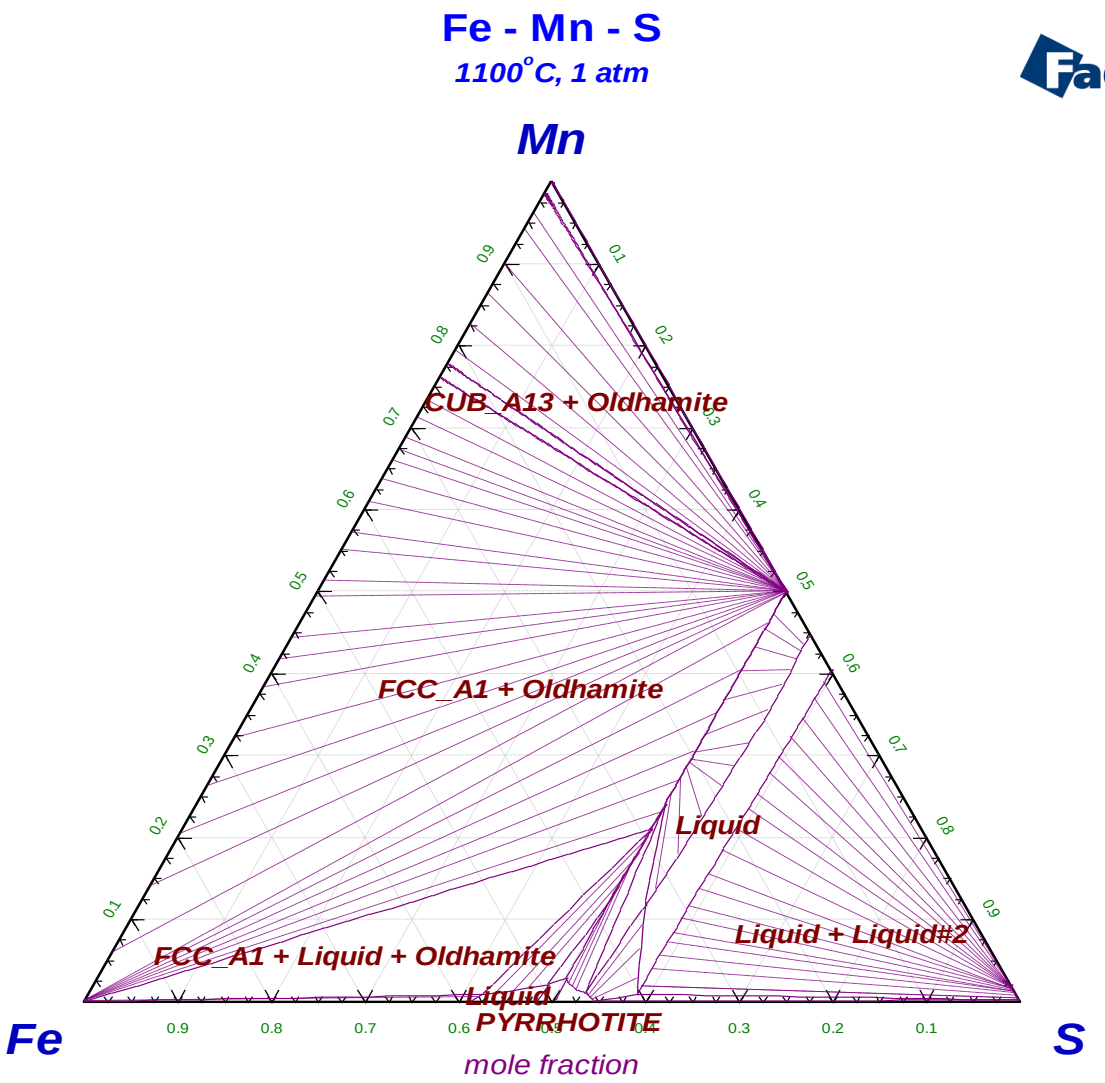

Cr_2O_3 - NiO - TiO_2 - O_2
Projection (A-Slag), $p(O_2)$ = 0.21 atm, 1 atm
FactSage™
TiO_2
T(min) = 1599.01 °C, T(max) = 2298.44 °C
T °C
2200
2100
2000
1900
1800
1700
1600
1
5
TiO_2
CrTiO-n
1606
1709
$Cr_2Ti_2O_7$
1700
Spinel
1650
1800
1900
Cr_2TiO_5
1924
CORUNDUM
2000
2100
2200
MeO
1743
SPINEL
NiO
Cr_2O_3
percent by weight

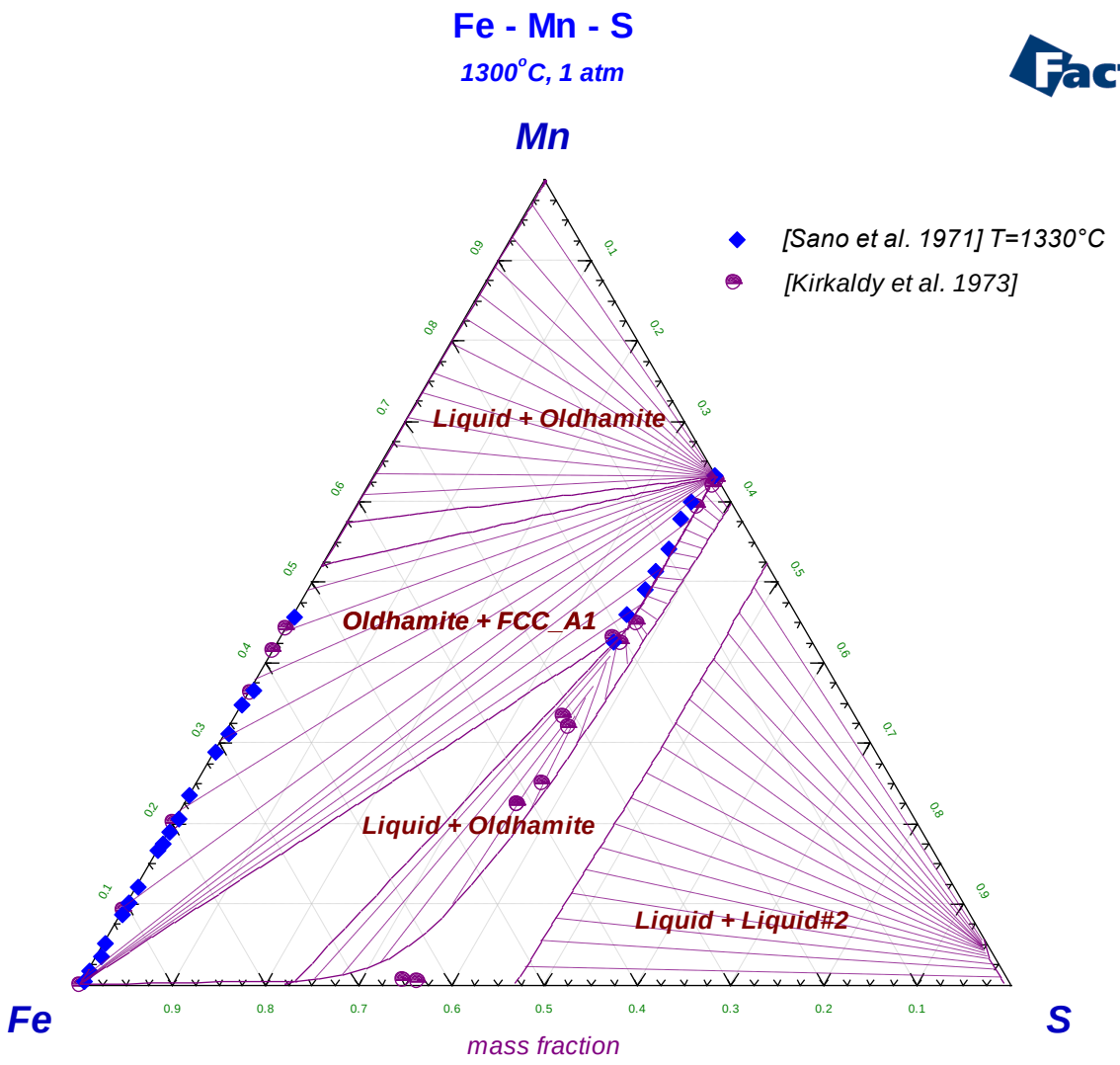
Invariant equilibria on the liquidus surface

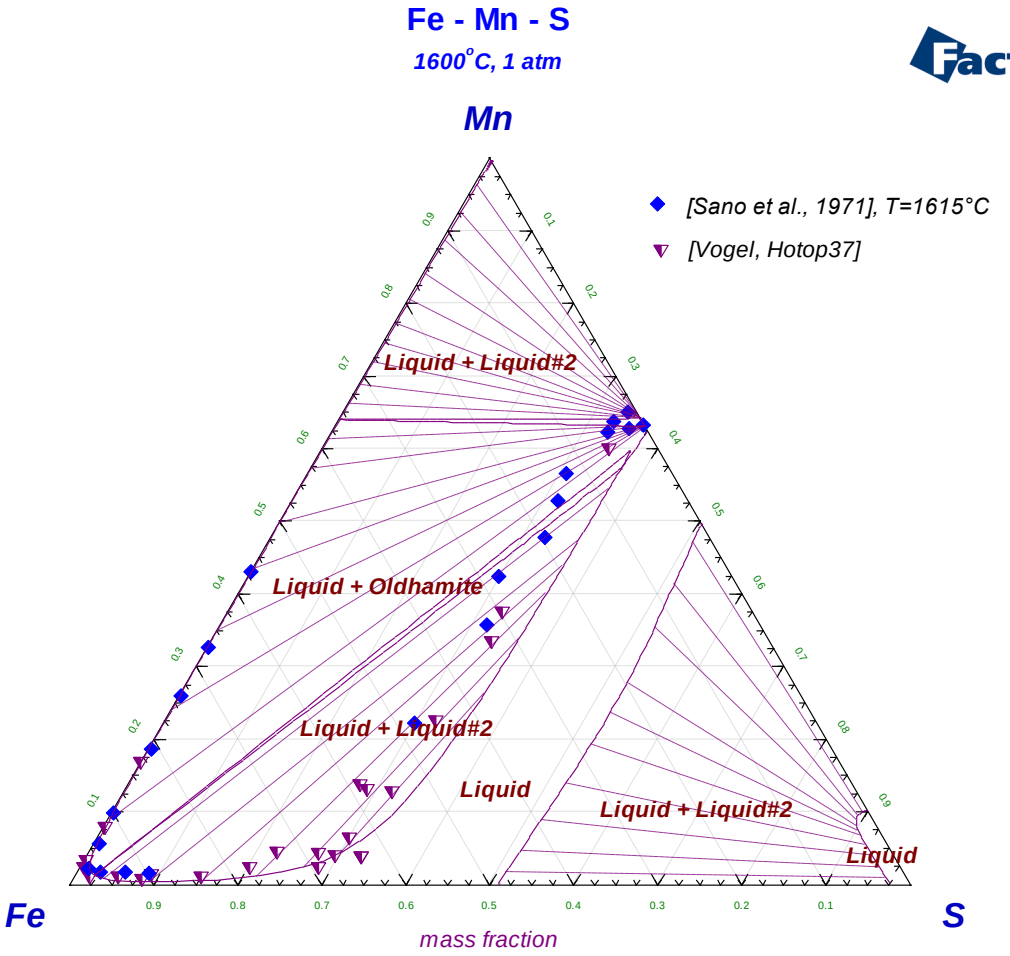
Intersections with slag	Mole fraction				Weight percent			
	A = TiO2, B = NiO, C = Cr2O3				A = TiO2, B = NiO, C = Cr2O3			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1. CORUNDUM / Cr2Ti2O7 / Cr2TiO5	0.52745	0.01419	0.45836	1923.80	37.328	0.939	61.733	1923.80
2. CORUNDUM / MeO / SPINEL	0.08008	0.76465	0.15528	1742.83	7.342	65.565	27.093	1742.83
3. CORUNDUM / Cr2Ti2O7 / CrTiO-n	0.60670	0.29944	0.09386	1709.26	56.948	26.286	16.766	1709.24
4. CORUNDUM / MeO / Spinel	0.39040	0.57734	0.03226	1649.64	39.365	54.444	6.191	1649.64
5. CORUNDUM / CrTiO-n / TiO2	0.66533	0.30729	0.02738	1605.64	66.213	28.601	5.186	1605.64

Fe-Mn-S,
Mole fraction 800°C

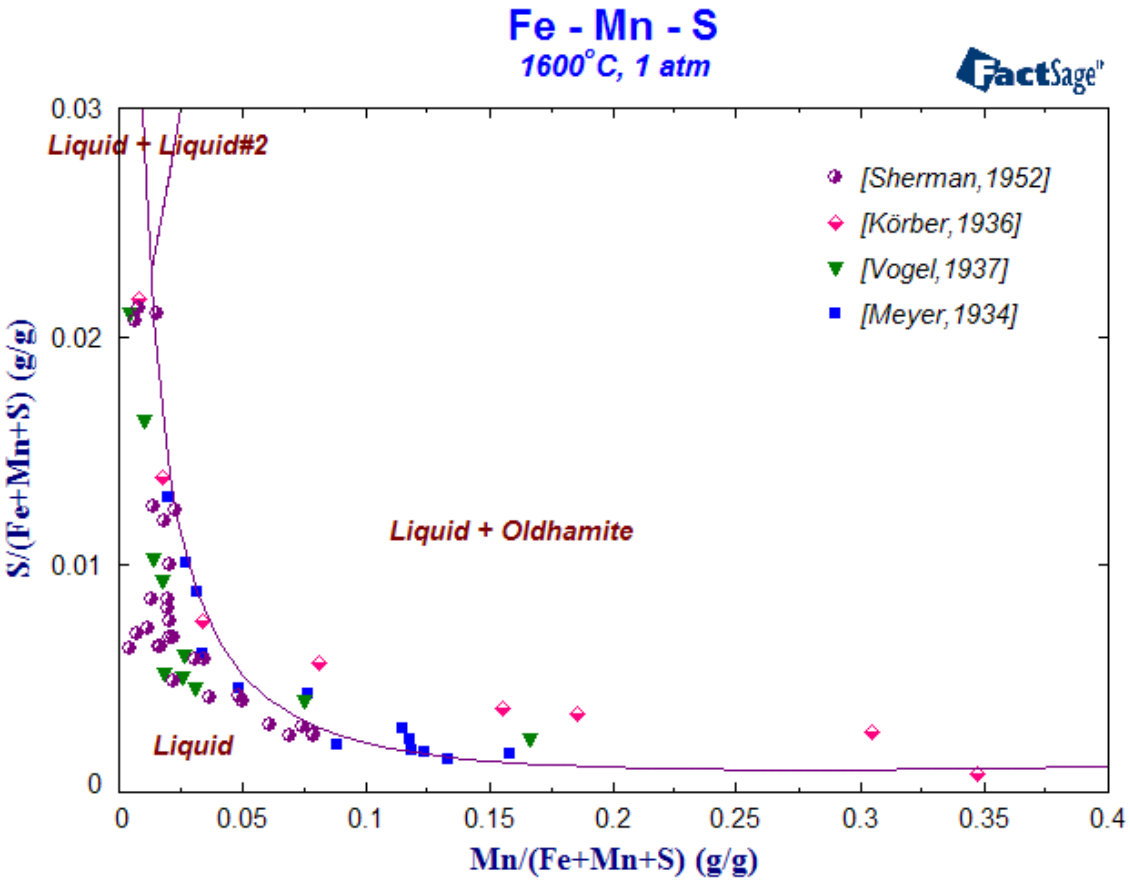



Fe - Mn - S
1100°C, 1 atm
Mn
CUB_A13 + Oldhamite
FCC_A1 + Oldhamite
Liquid
Liquid + Liquid#2
FCC_A1 + Liquid + Oldhamite
Liquid
PYRRHOTITE
Fe
S
mole fraction

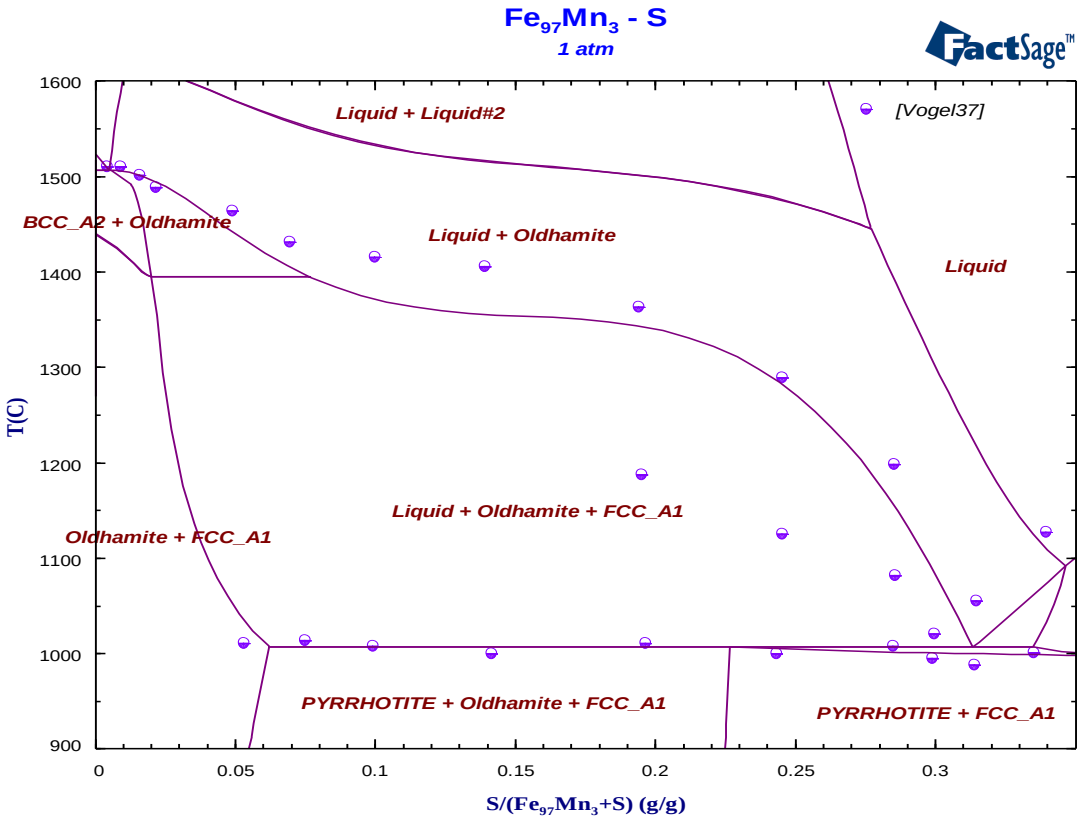

Fe - Mn - S
1300°C, 1 atm
Mn
[Sano et al. 1971] T=1330°C
[Kirkaldy et al. 1973]
Liquid + Oldhamite
Oldhamite + FCC_A1
Liquid + Oldhamite
Liquid + Liquid#2
Fe
S
mass fraction


Fe - Mn - S
1600°C, 1 atm
Mn
[Sano et al., 1971], T=1615°C
[Vogel, Hotop37]
Liquid + Liquid#2
Liquid + Oldhamite
Liquid + Liquid#2
Liquid
Liquid + Liquid#2
Liquid
Fe
S
mass fraction

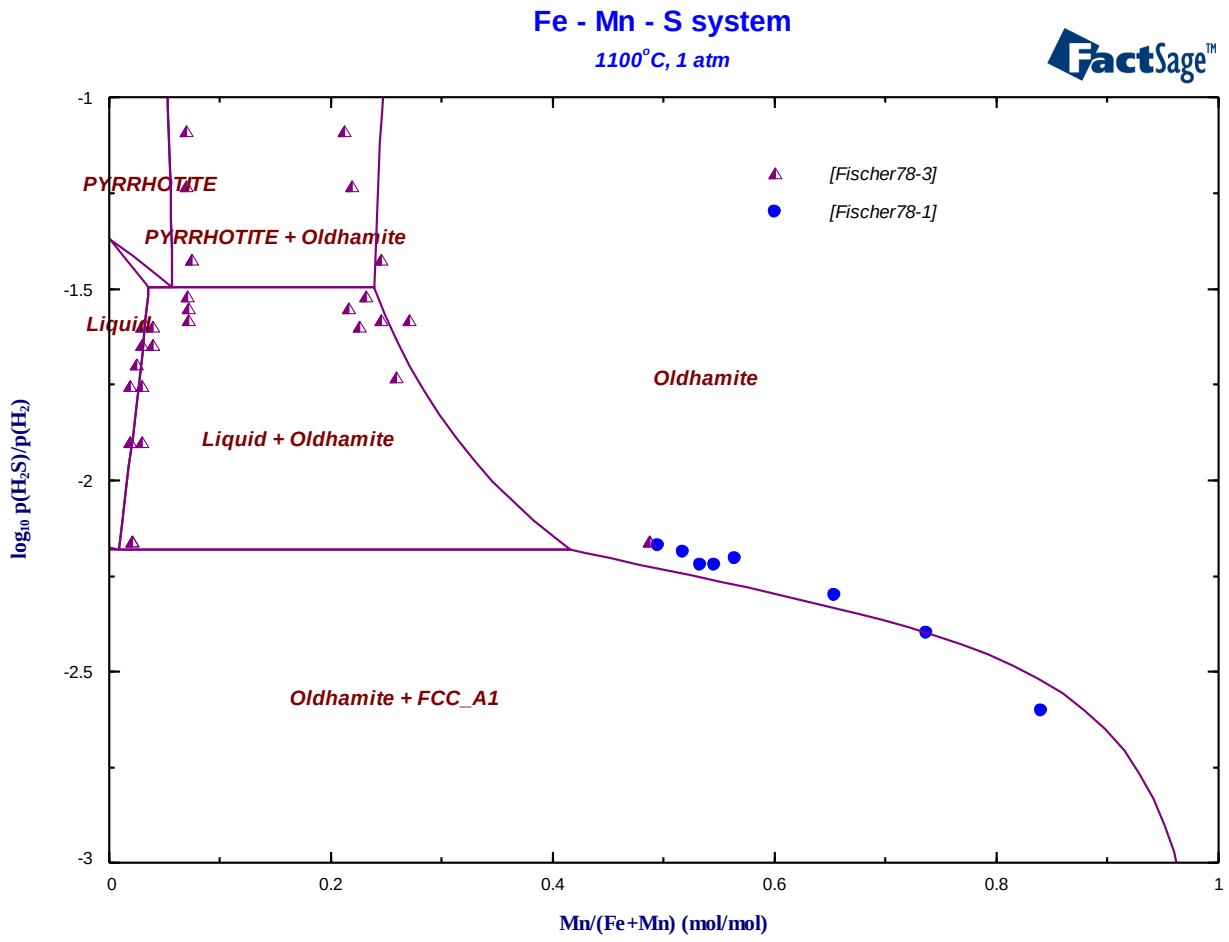
Weight fraction 1600°C, solubility of Mn and S in Fe-rich liquid



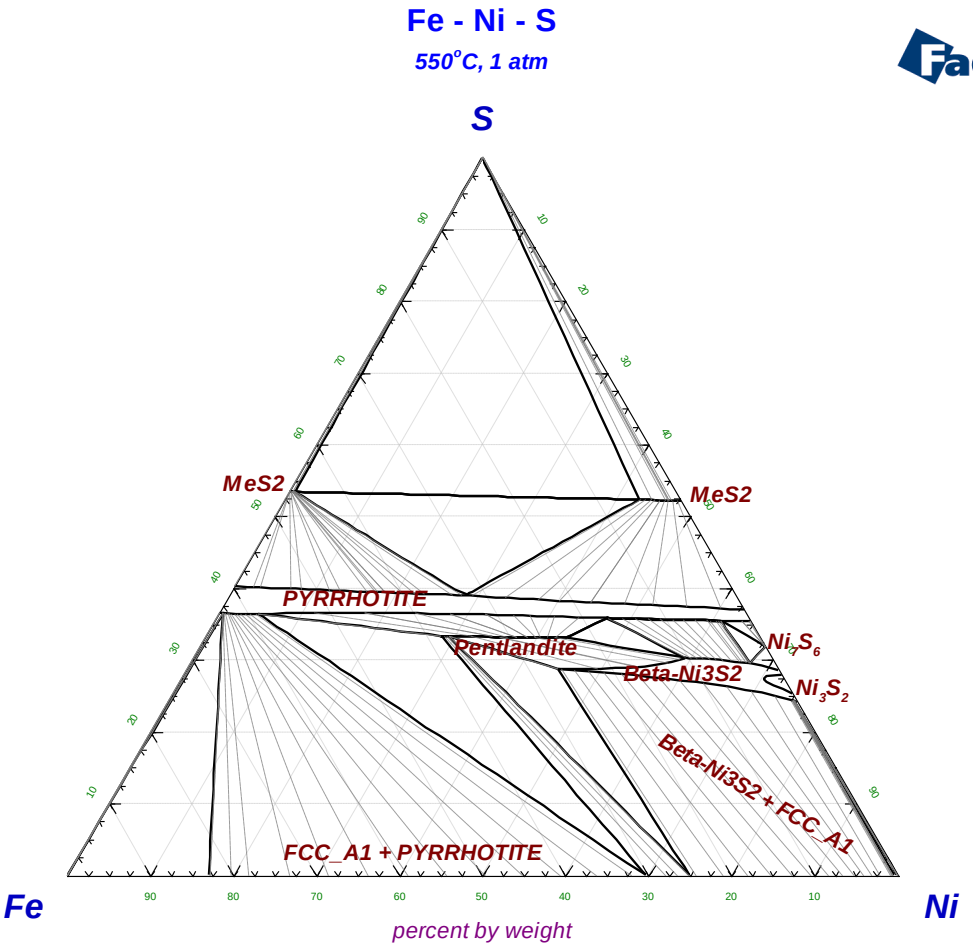
Weight fraction, isopleth section Fe/Mn=97/3



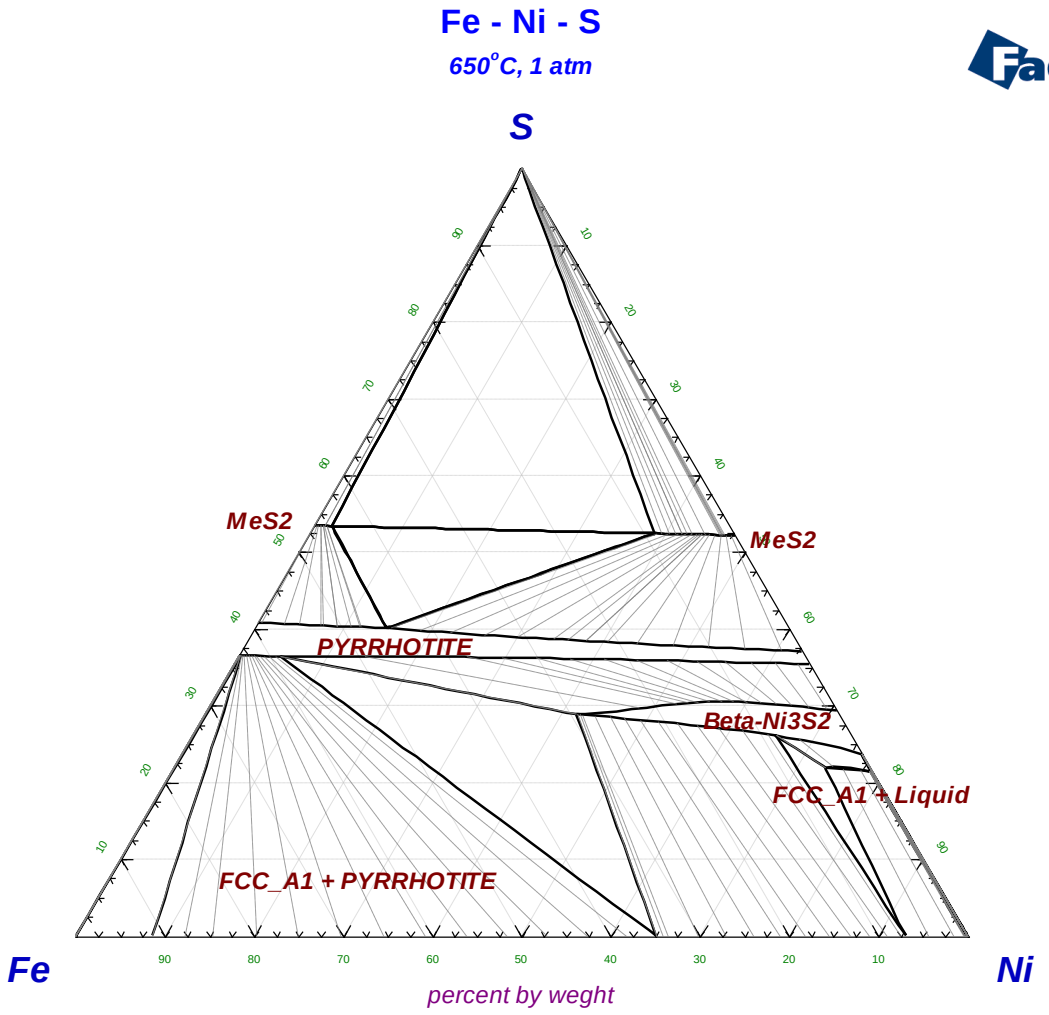
Mole fraction 1100°C, relationship between S potential and Mn fraction

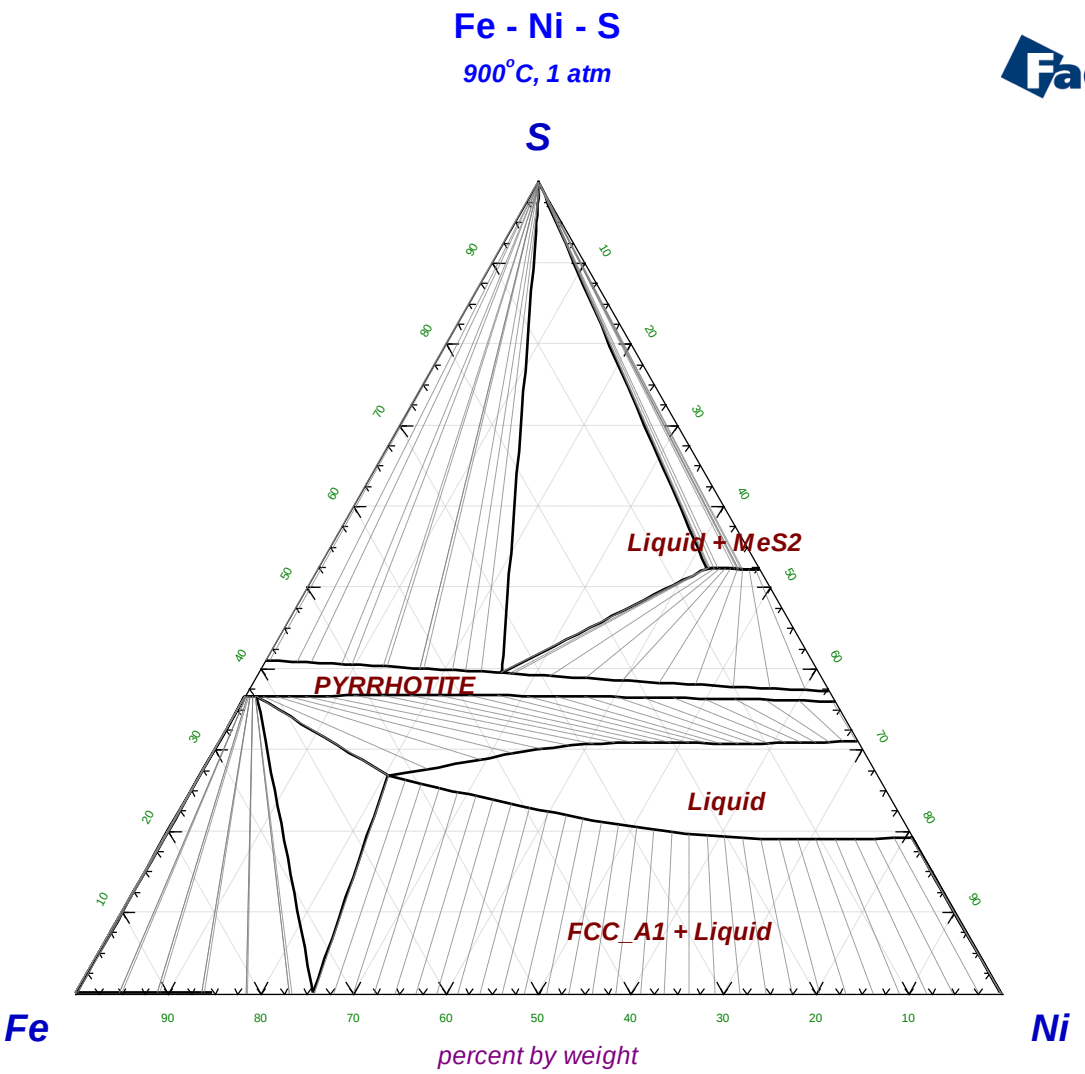


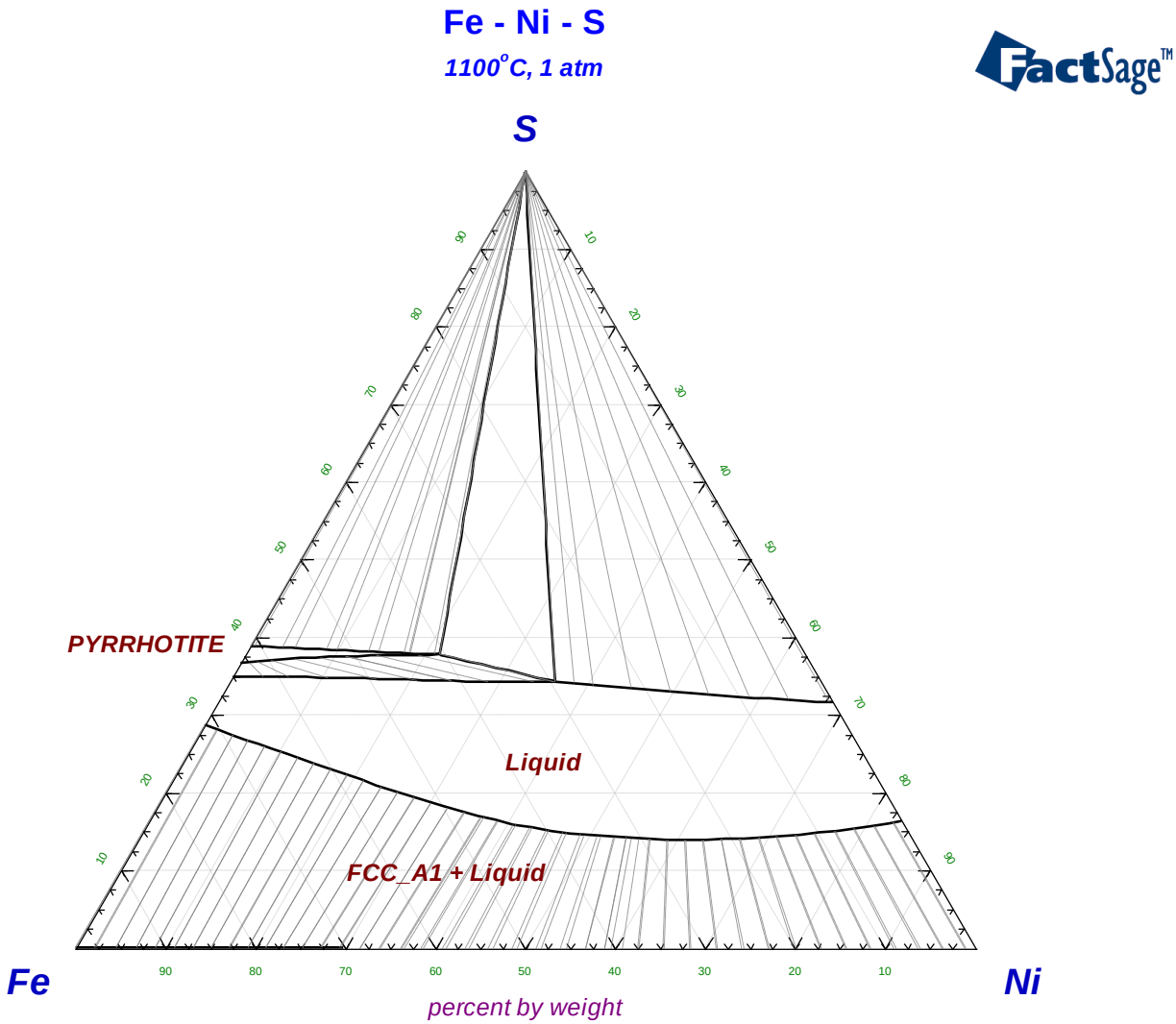
Fe-Ni-S,
Weight percent 550°C

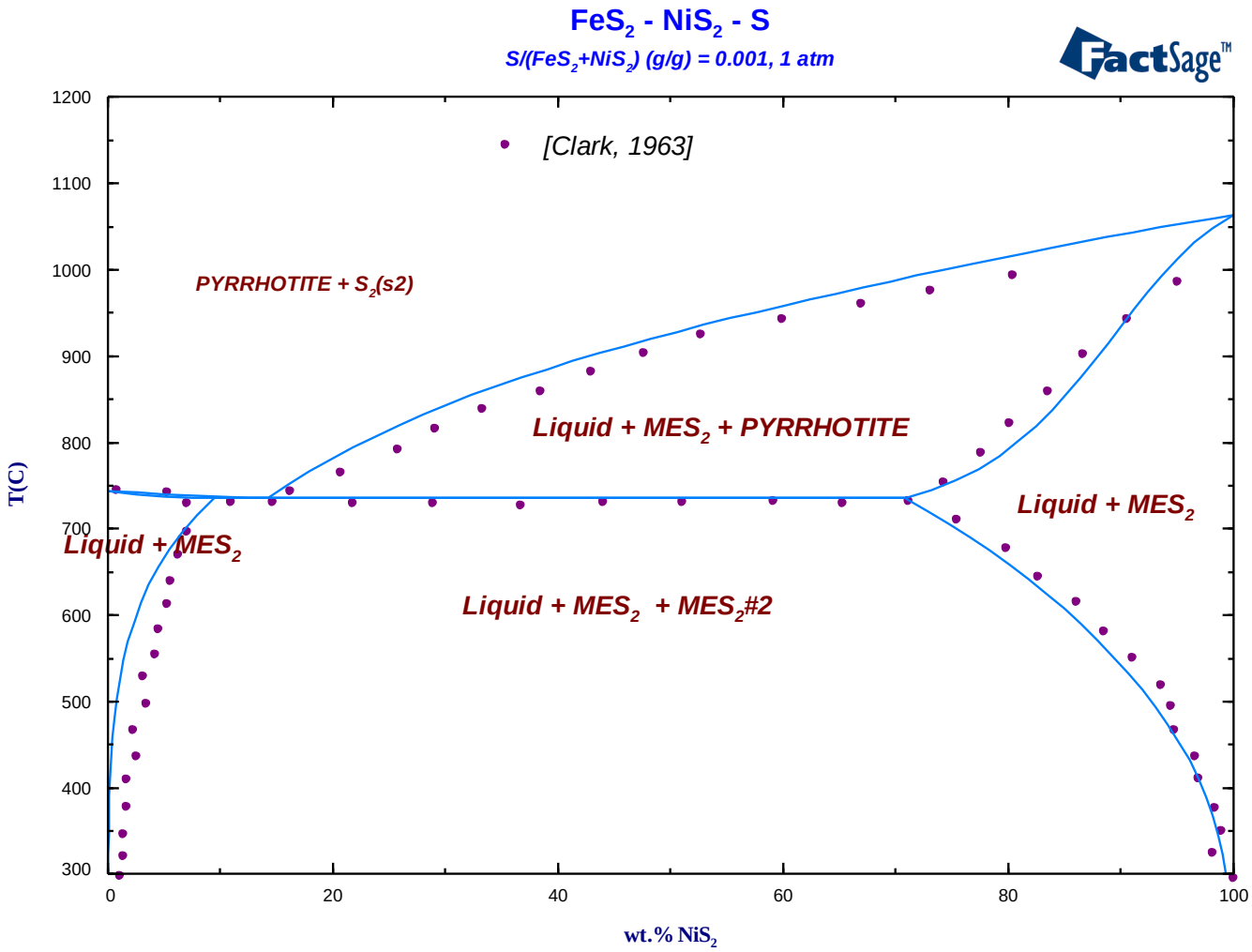


Fe-Ni-S,
Weight percent 650°C

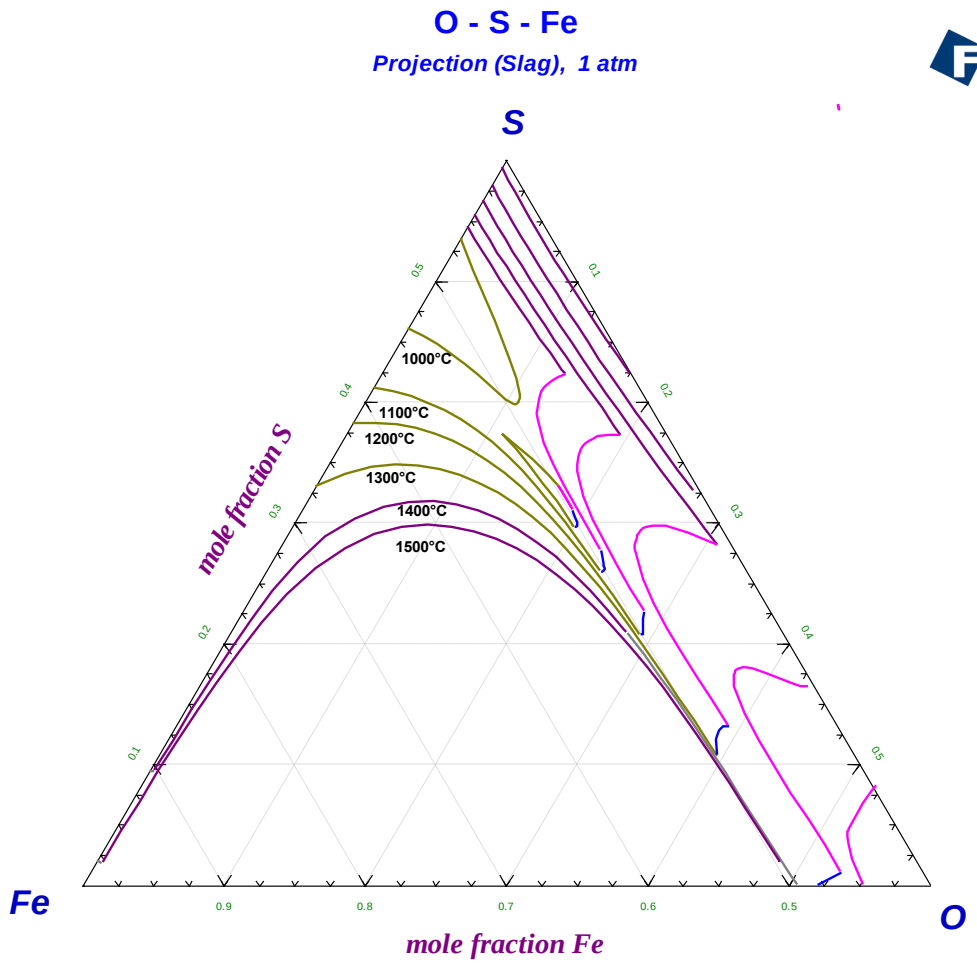


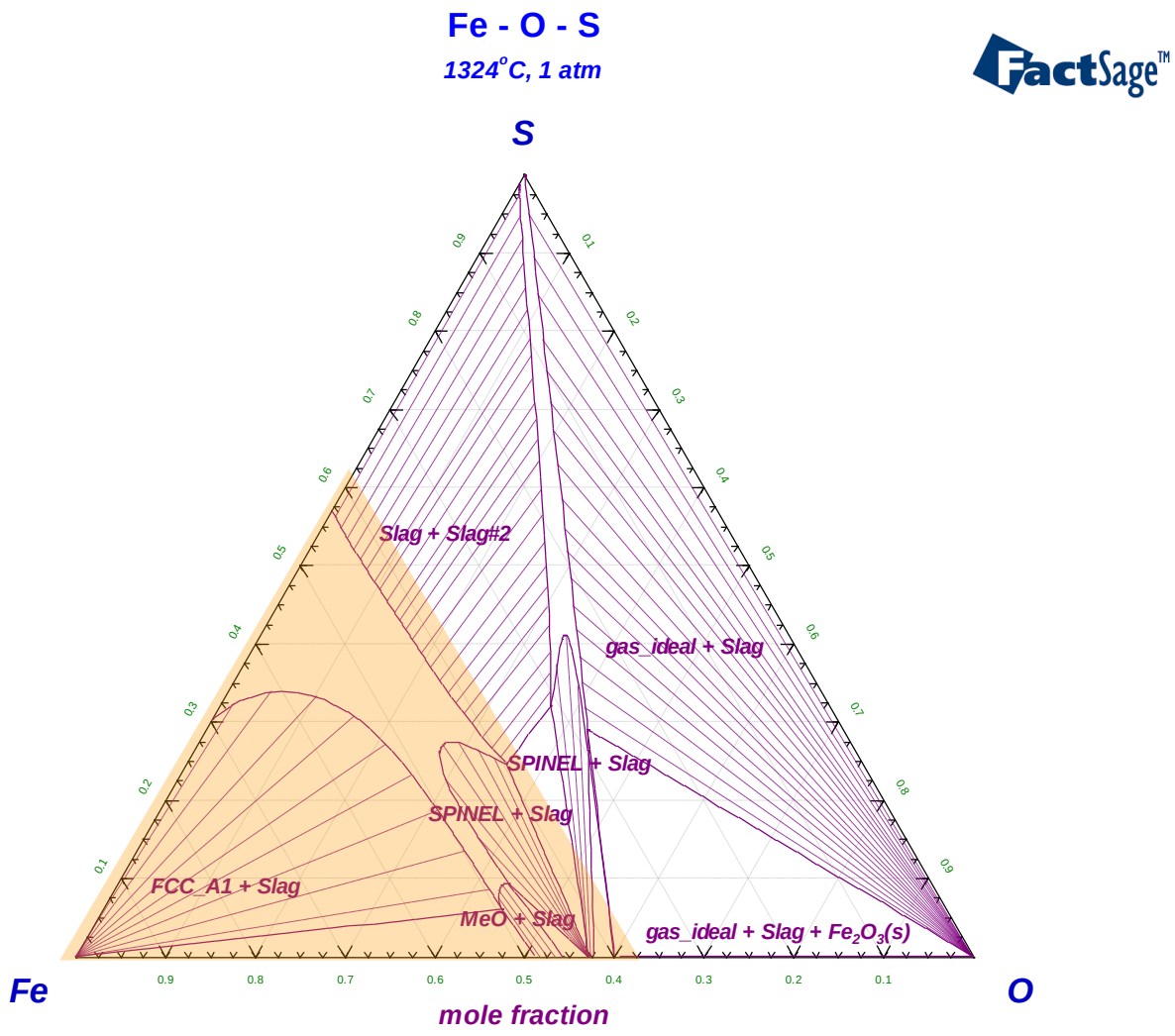

Fe - Ni - S
900°C, 1 atm
S
Liquid + MeS2
PYRRHOTITE
Liquid
FCC_A1 + Liquid
Fe
Ni
90
80
70
60
50
40
30
20
10
percent by weight

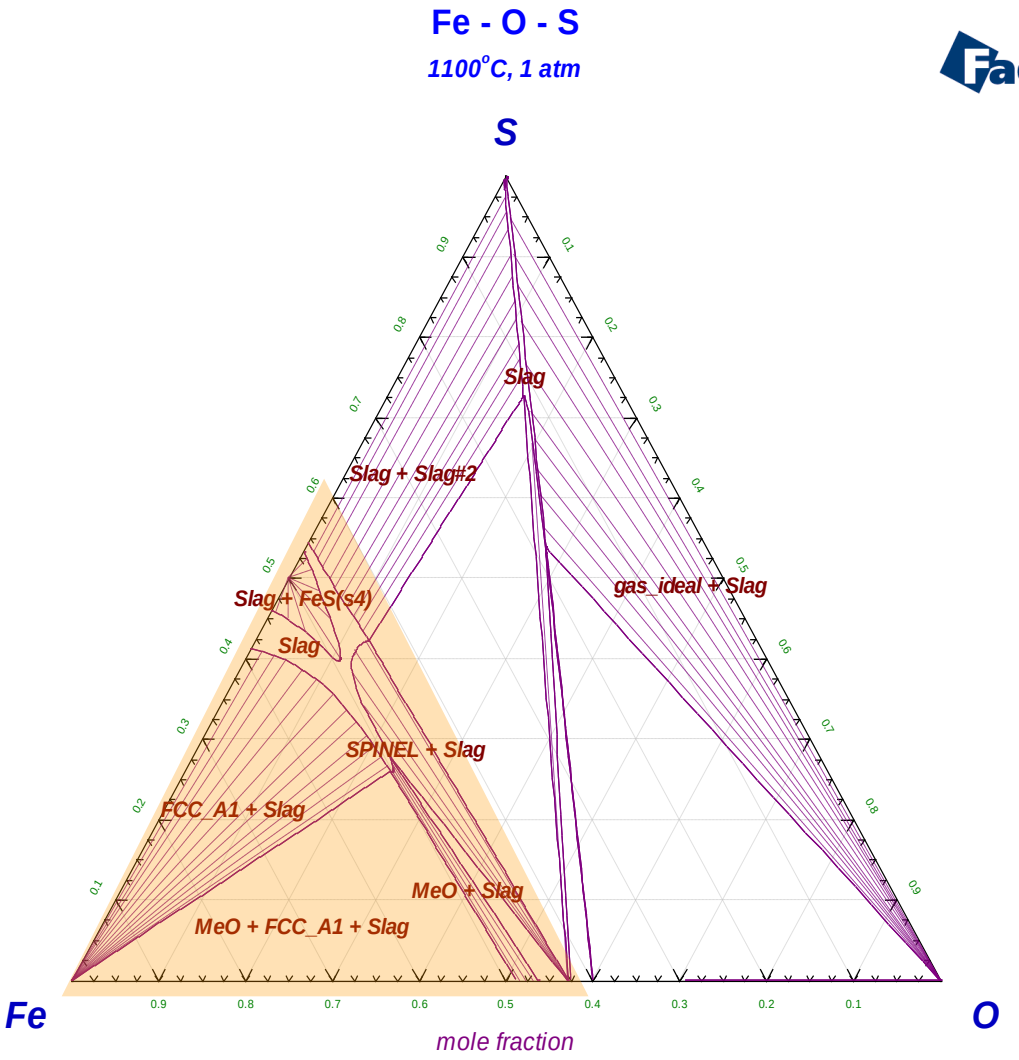

Fe - Ni - S
1100°C, 1 atm
S
PYRRHOTITE
Liquid
FCC_A1 + Liquid
Fe
Ni
percent by weight

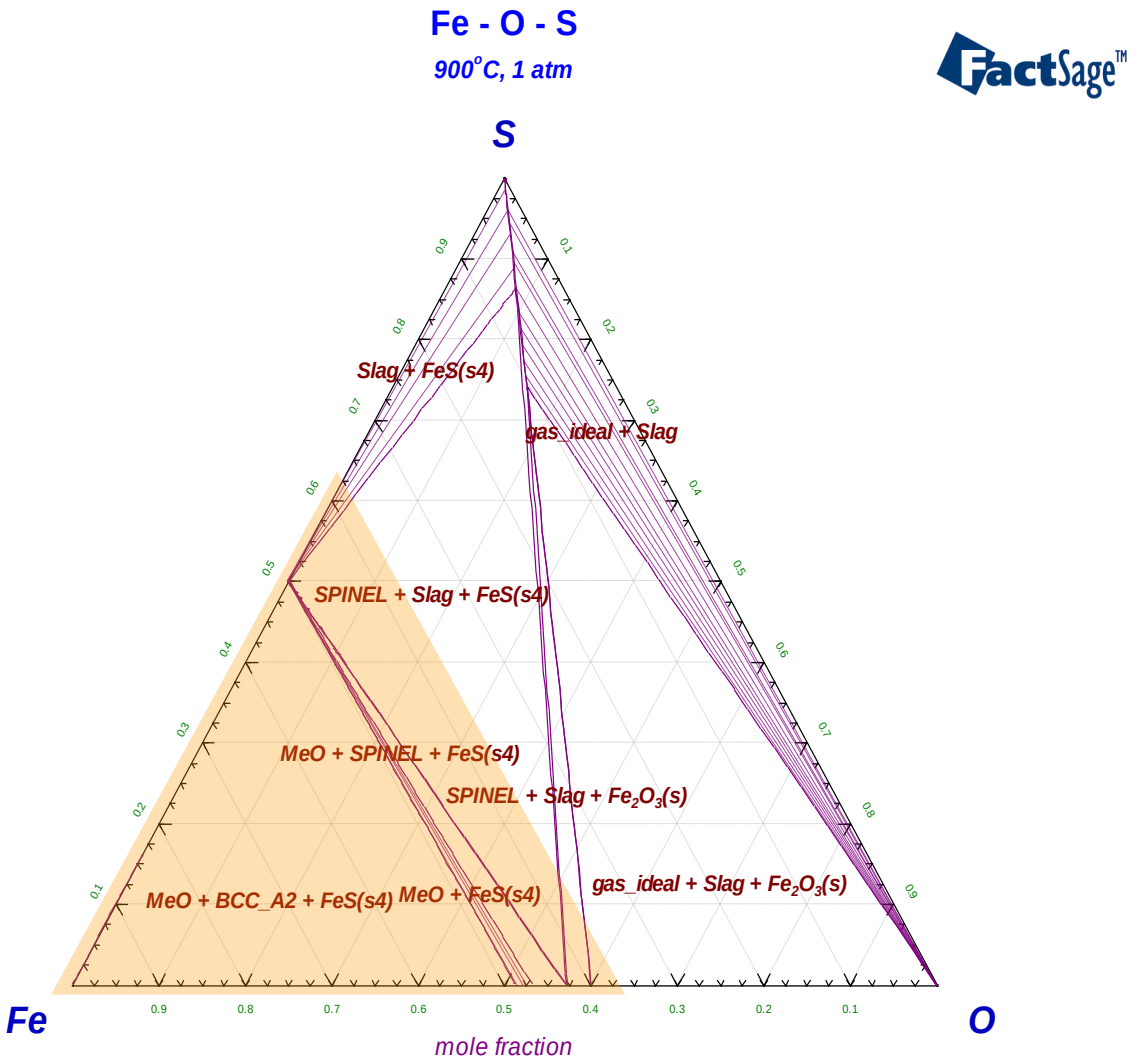

FeS2 - NiS2 - S
S/(FeS2+NiS2) (g/g) = 0.001, 1 atm
FactSage™
[Clark, 1963]
PYRRHOTITE + S2(s2)
Liquid + MES2 + PYRRHOTITE
Liquid + MES2
Liquid + MES2
Liquid + MES2 + MES2#2
T(C)
wt.% NiS2
1200
1100
1000
900
800
700
600
500
400
300
0
20
40
60
80
100

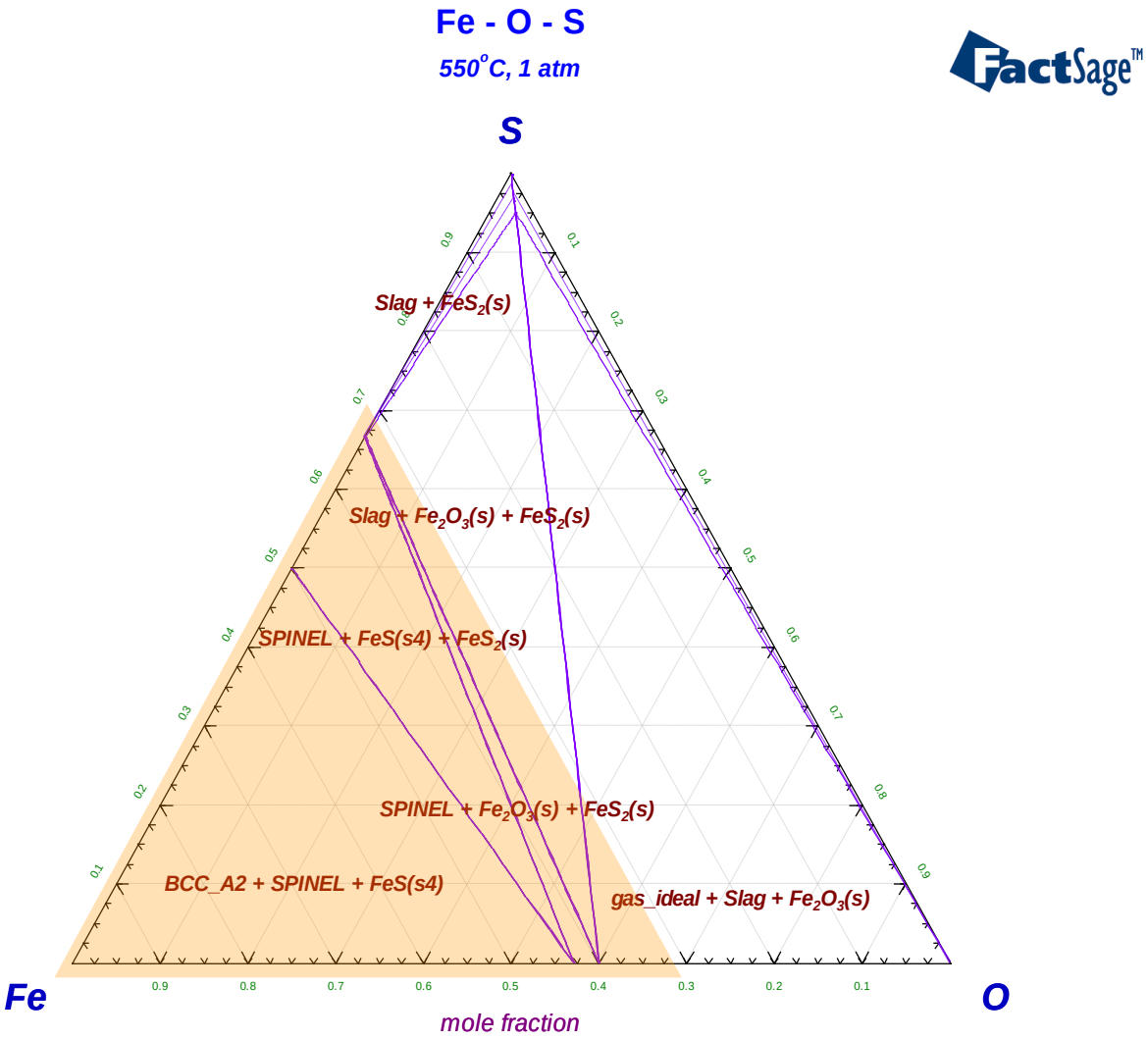
Fe-O-S,
Mole fraction, Liquidus lines at 1000°-1500°C



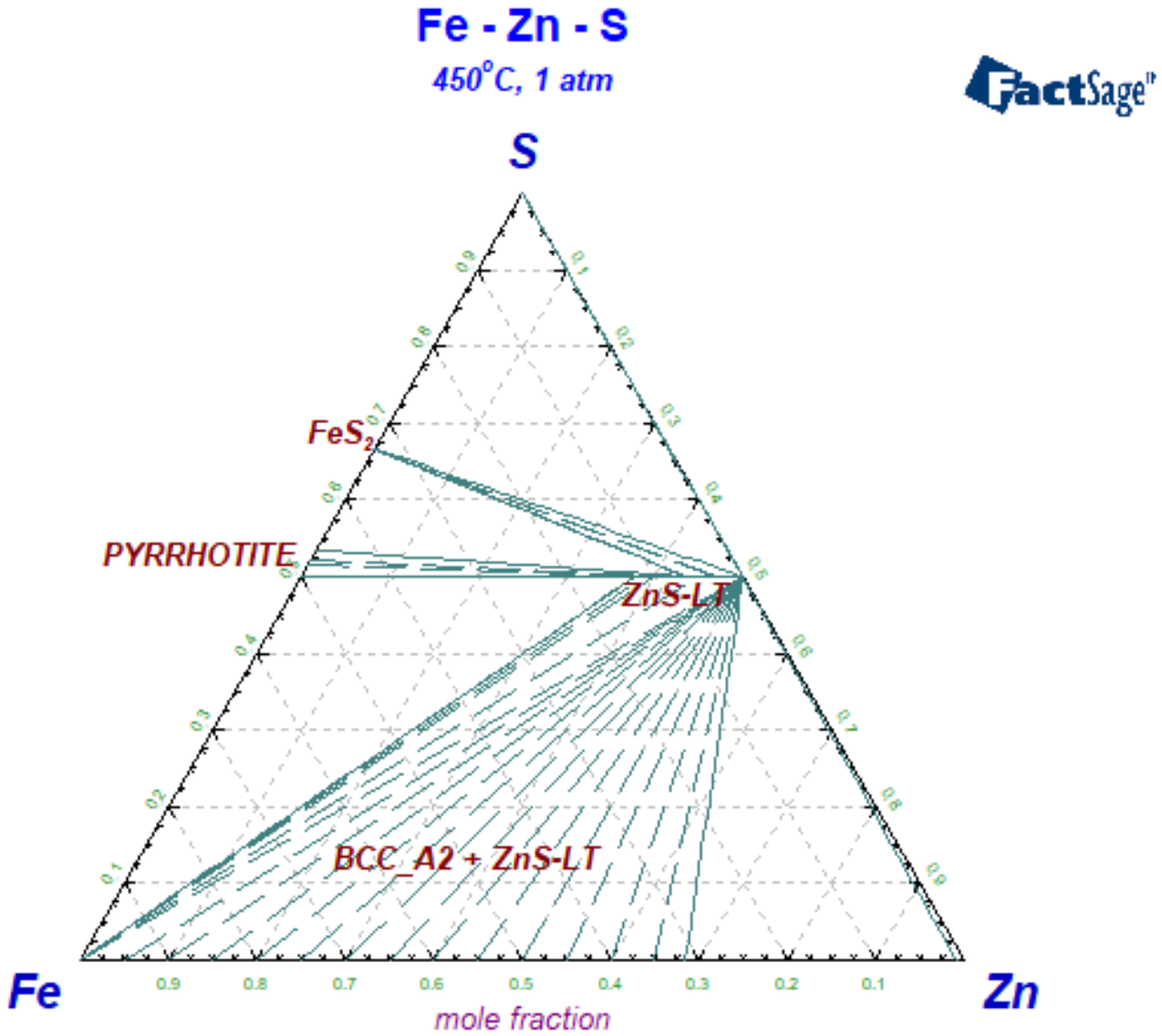

Fe - O - S
1324°C, 1 atm
S
Slag + Slag#2
gas_ideal + Slag
SPINEL + Slag
SPINEL + Slag
FCC_A1 + Slag
MeO + Slag
gas_ideal + Slag + Fe2O3(s)
Fe
O
mole fraction

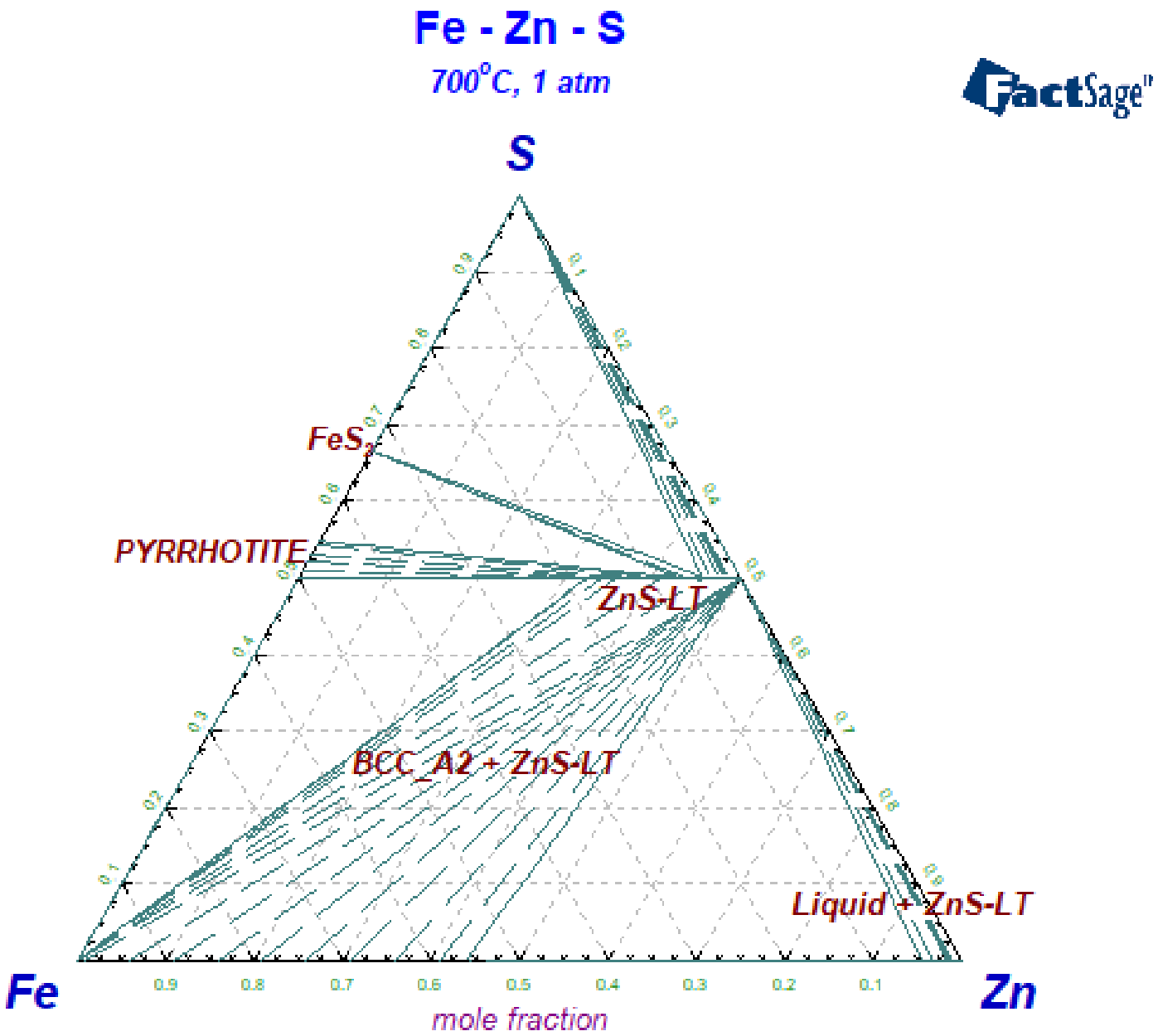

Fe - O - S
1100°C, 1 atm
S
Slag
Slag + Slag#2
Slag + FeS(s4)
Slag
gas_ideal + Slag
SPINEL + Slag
FCC_A1 + Slag
MeO + Slag
MeO + FCC_A1 + Slag
Fe
O
mole fraction

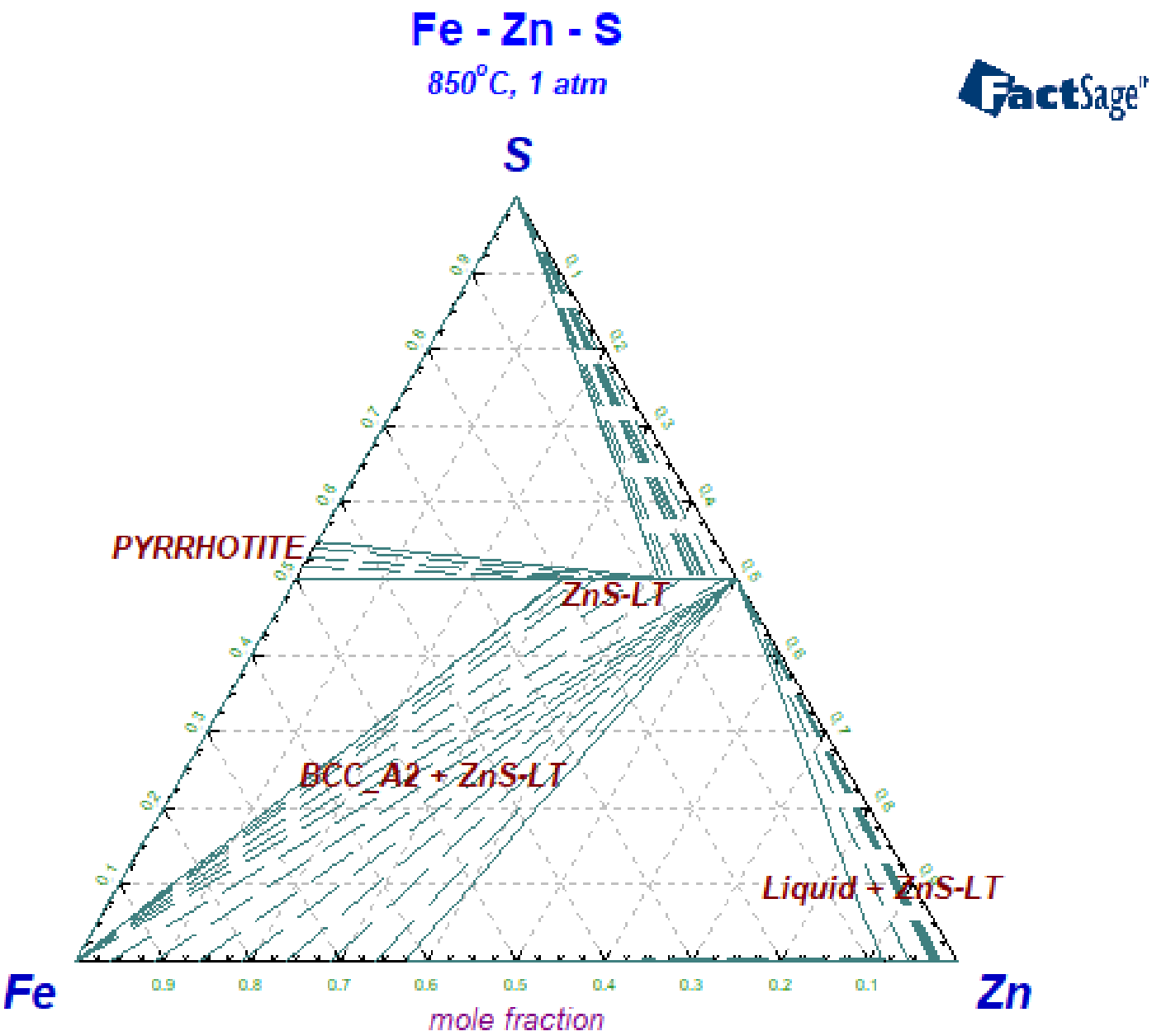

Fe - O - S
900°C, 1 atm
S
Slag + FeS(s4)
gas_ideal + Slag
SPINEL + Slag + FeS(s4)
MeO + SPINEL + FeS(s4)
SPINEL + Slag + Fe2O3(s)
MeO + BCC_A2 + FeS(s4)
MeO + FeS(s4)
gas_ideal + Slag + Fe2O3(s)
Fe
O
mole fraction

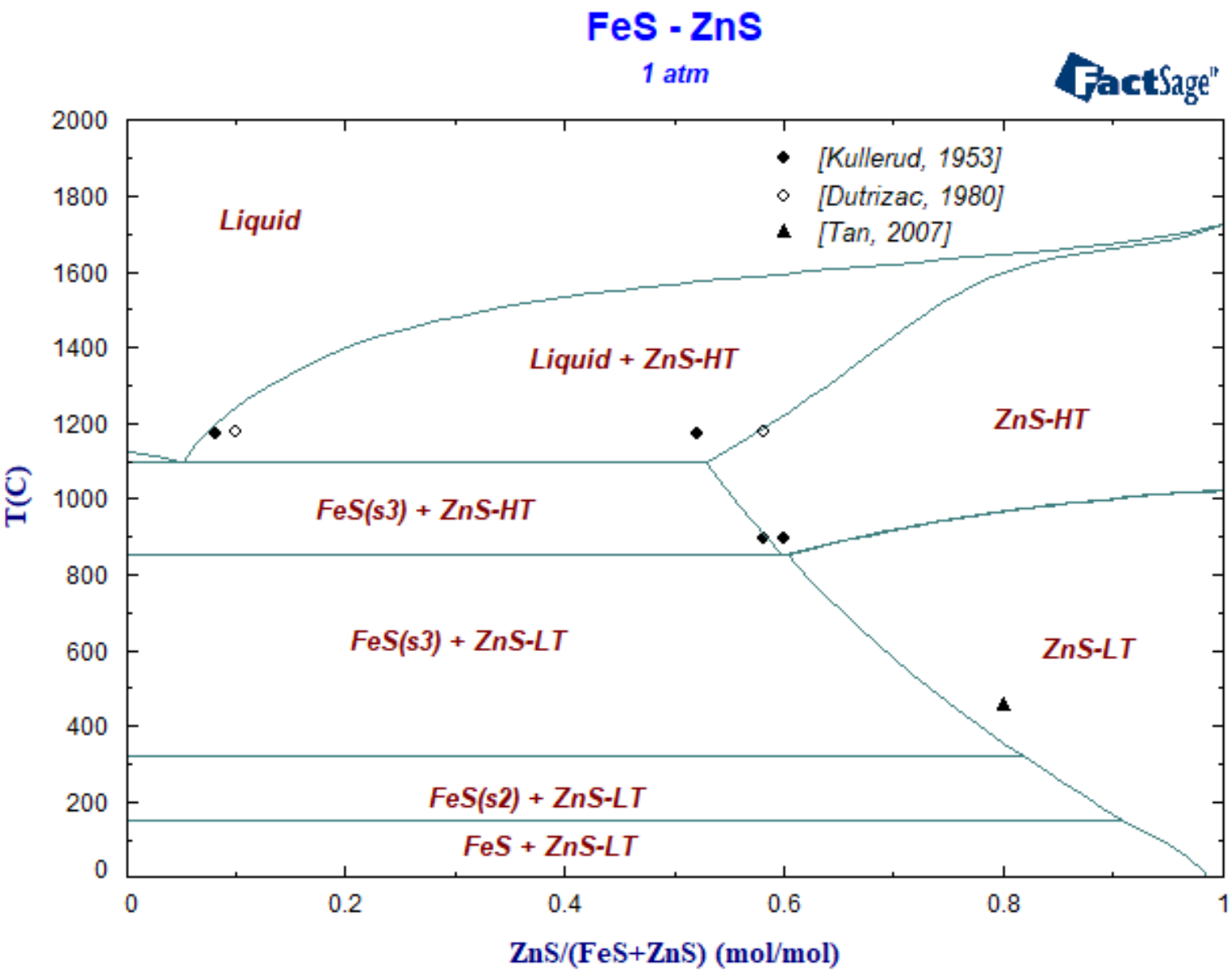

Fe - O - S
550°C, 1 atm
S
Slag + FeS2(s)
Slag + Fe2O3(s) + FeS2(s)
SPINEL + FeS(s4) + FeS2(s)
SPINEL + Fe2O3(s) + FeS2(s)
BCC_A2 + SPINEL + FeS(s4)
gas_ideal + Slag + Fe2O3(s)
Fe
O
mole fraction

Fe-S-Zn,
Mole fraction, 450°C

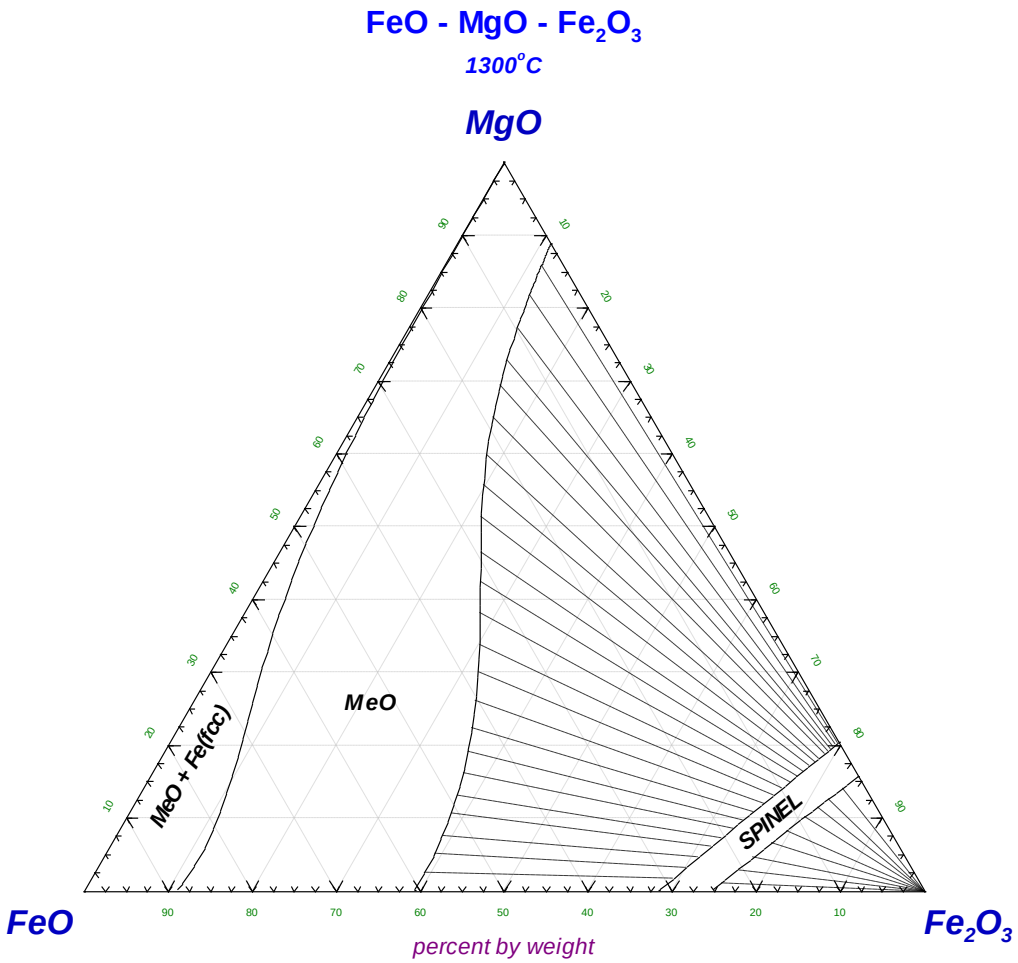


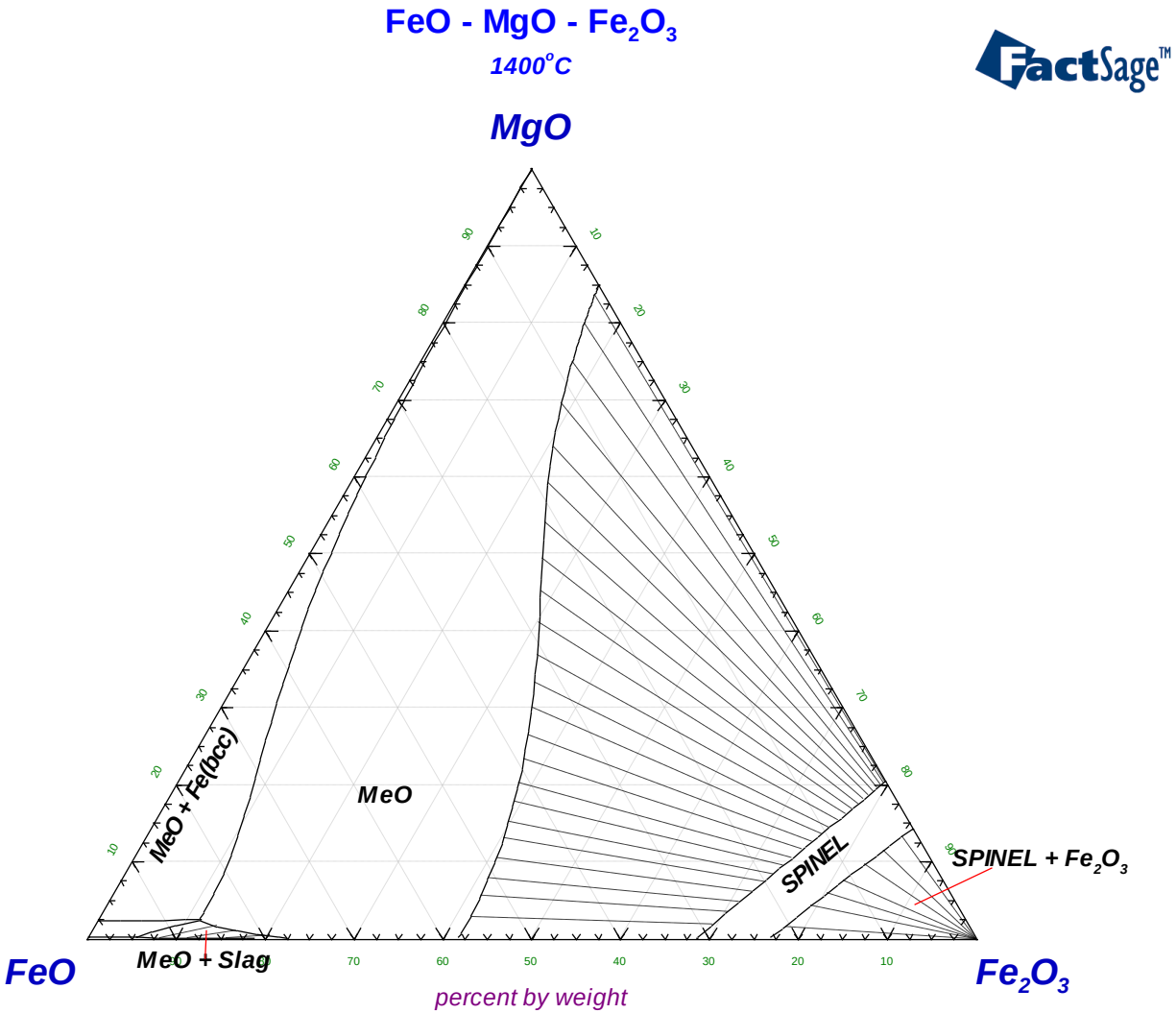

Fe - Zn - S
700°C, 1 atm
FactSage
S
FeS2
PYRRHOTITE
ZnS-LT
BCC_A2 + ZnS-LT
Liquid + ZnS-LT
Fe
Zn
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
mole fraction

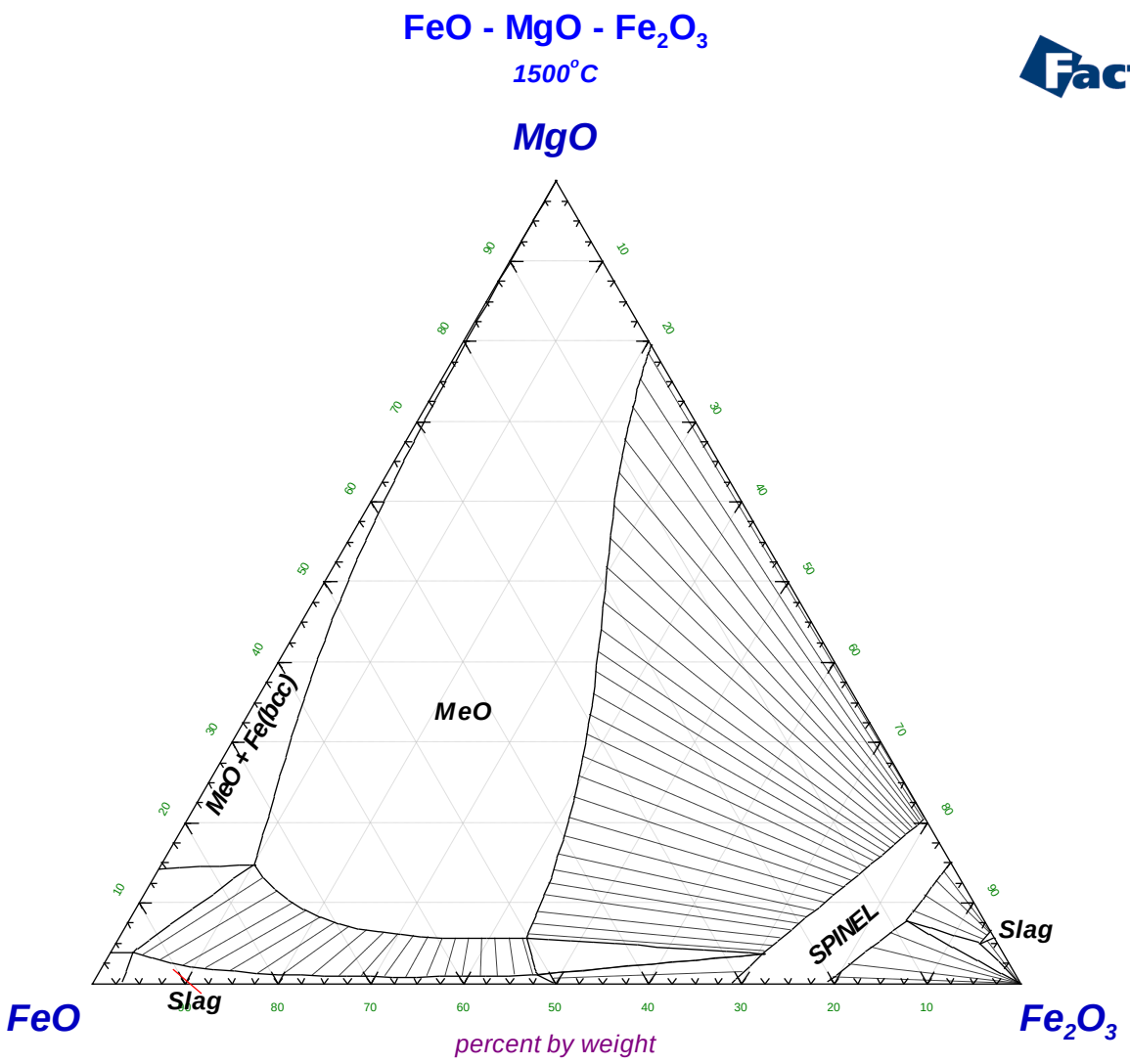

Fe - Zn - S
850°C, 1 atm
S
PYRRHOTITE
ZnS-LT
BCC_A2 + ZnS-LT
Liquid + ZnS-LT
Fe
Zn
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
mole fraction

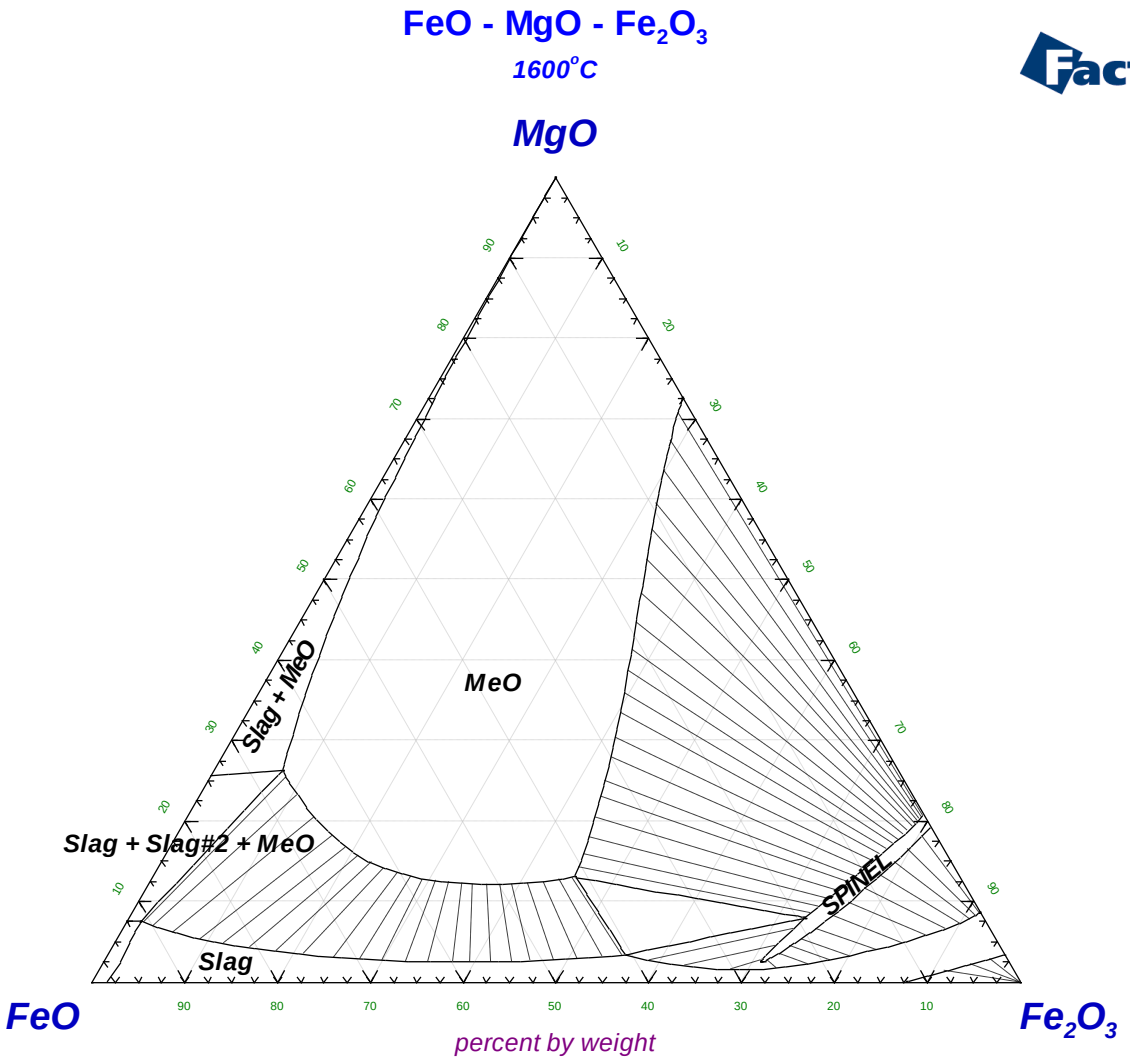

FeS - ZnS
1 atm
FactSage
[Kullerud, 1953]
[Dutrizac, 1980]
[Tan, 2007]
Liquid
Liquid + ZnS-HT
ZnS-HT
FeS(s3) + ZnS-HT
FeS(s3) + ZnS-LT
ZnS-LT
FeS(s2) + ZnS-LT
FeS + ZnS-LT
T(C)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
0.2
0.4
0.6
0.8
1
ZnS/(FeS+ZnS) (mol/mol)

Fe2O3-FeO-MgO,
Weight percent 1300°C

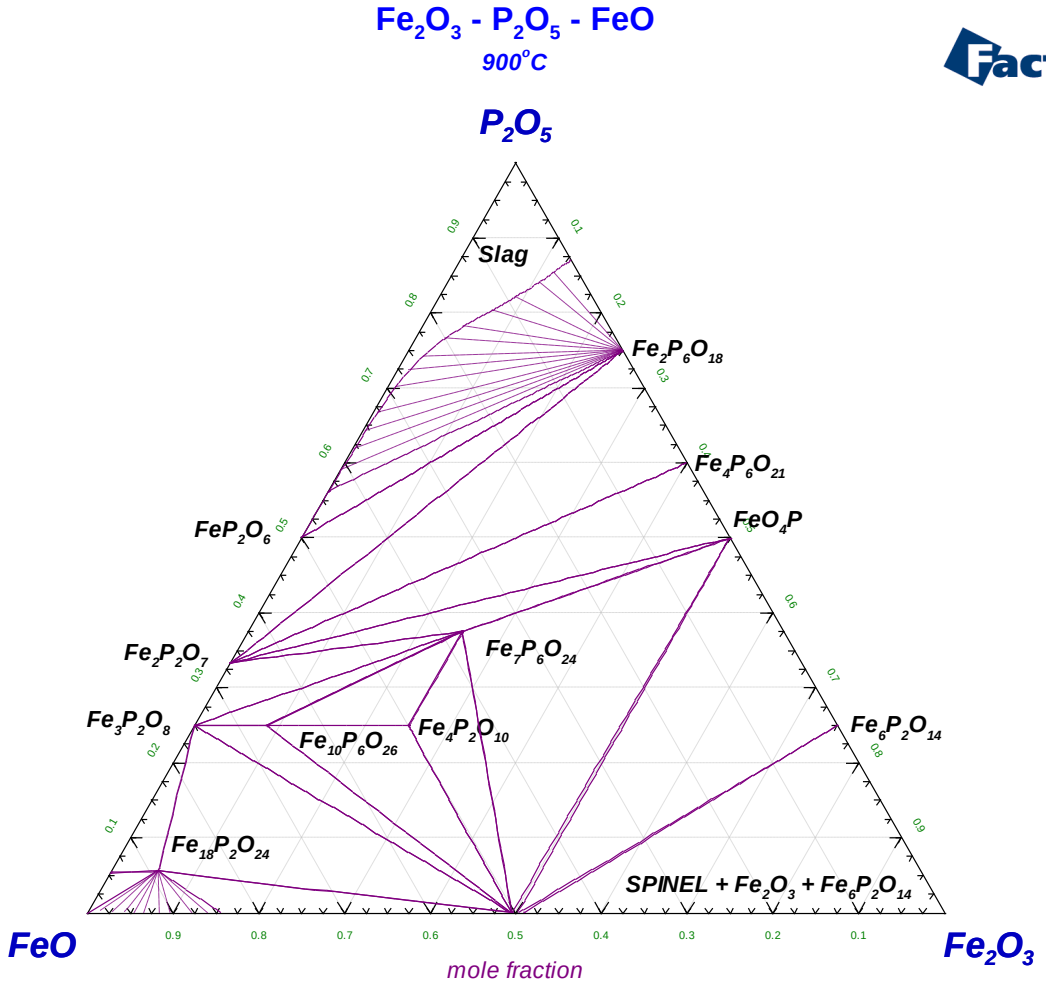



FeO - MgO - Fe2O3
1400°C
MgO
MeO + Fe(bcc)
MeO
SPINEL
SPINEL + Fe2O3
FeO
MeO + Slag
Fe2O3
percent by weight

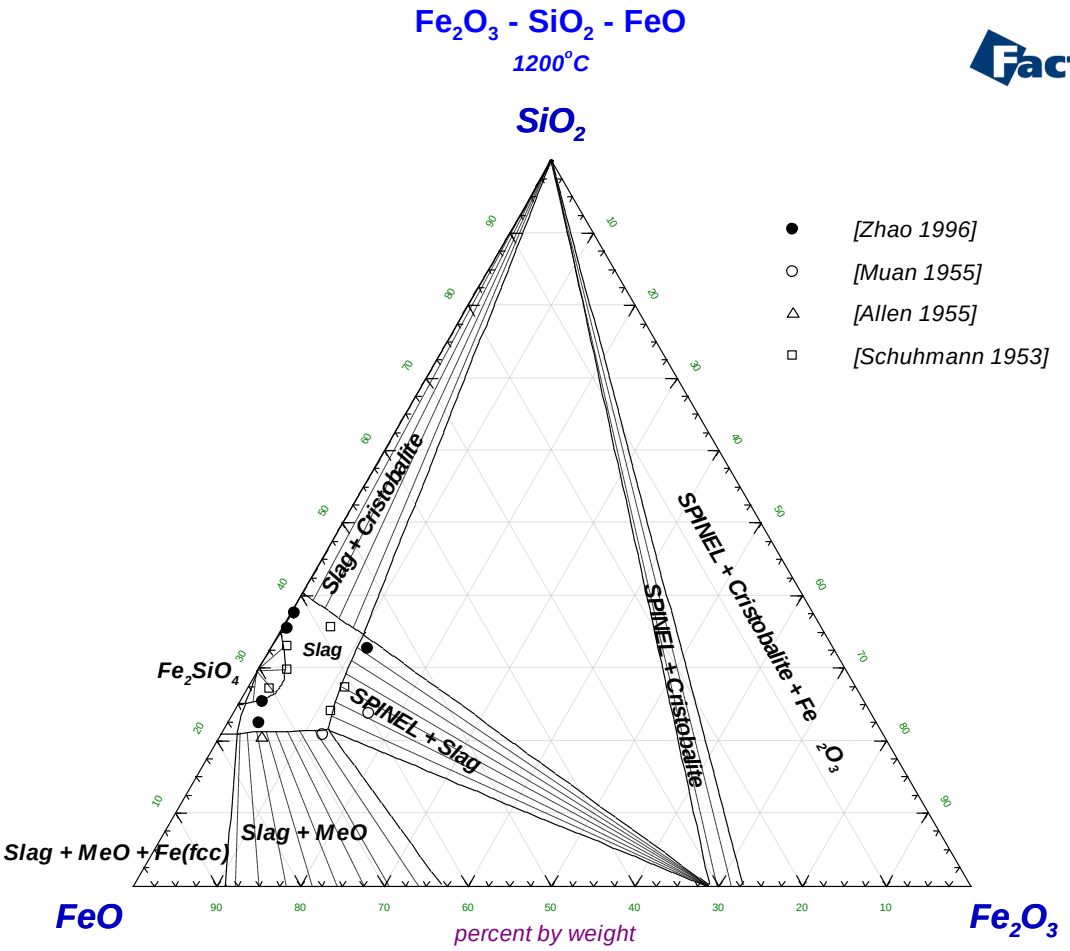

FeO - MgO - Fe2O3
1500°C
MgO
MeO
MeO + Fe(bcc)
SPINEL
Slag
Slag
FeO
Fe2O3
percent by weight

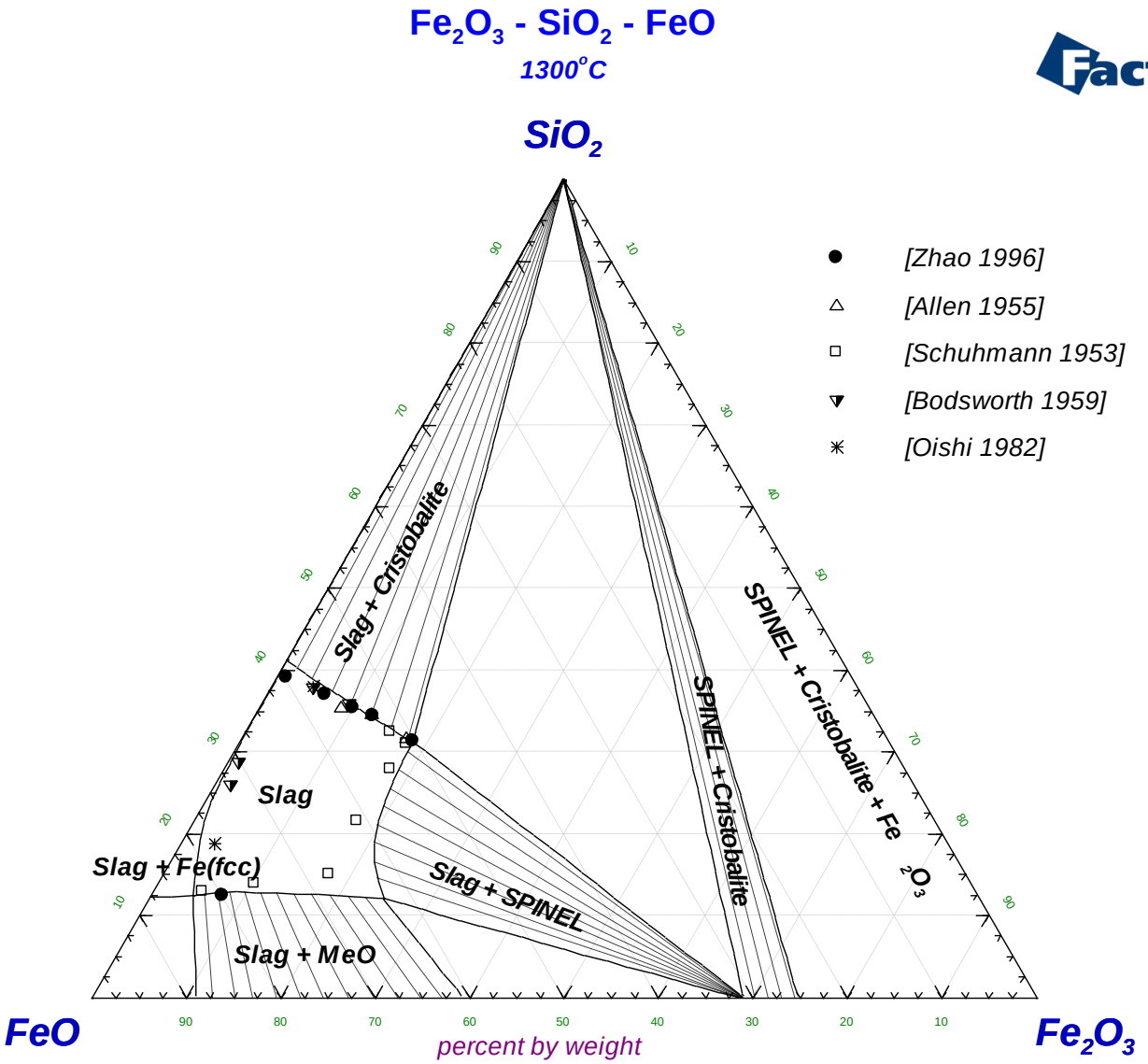

FeO - MgO - Fe2O3
1600°C
MgO
MeO
Slag + MeO
Slag + Slag#2 + MeO
Slag
SPINEL
FeO
Fe2O3
percent by weight

Fe2O3-FeO-P2O5,
Mole fraction 900°C

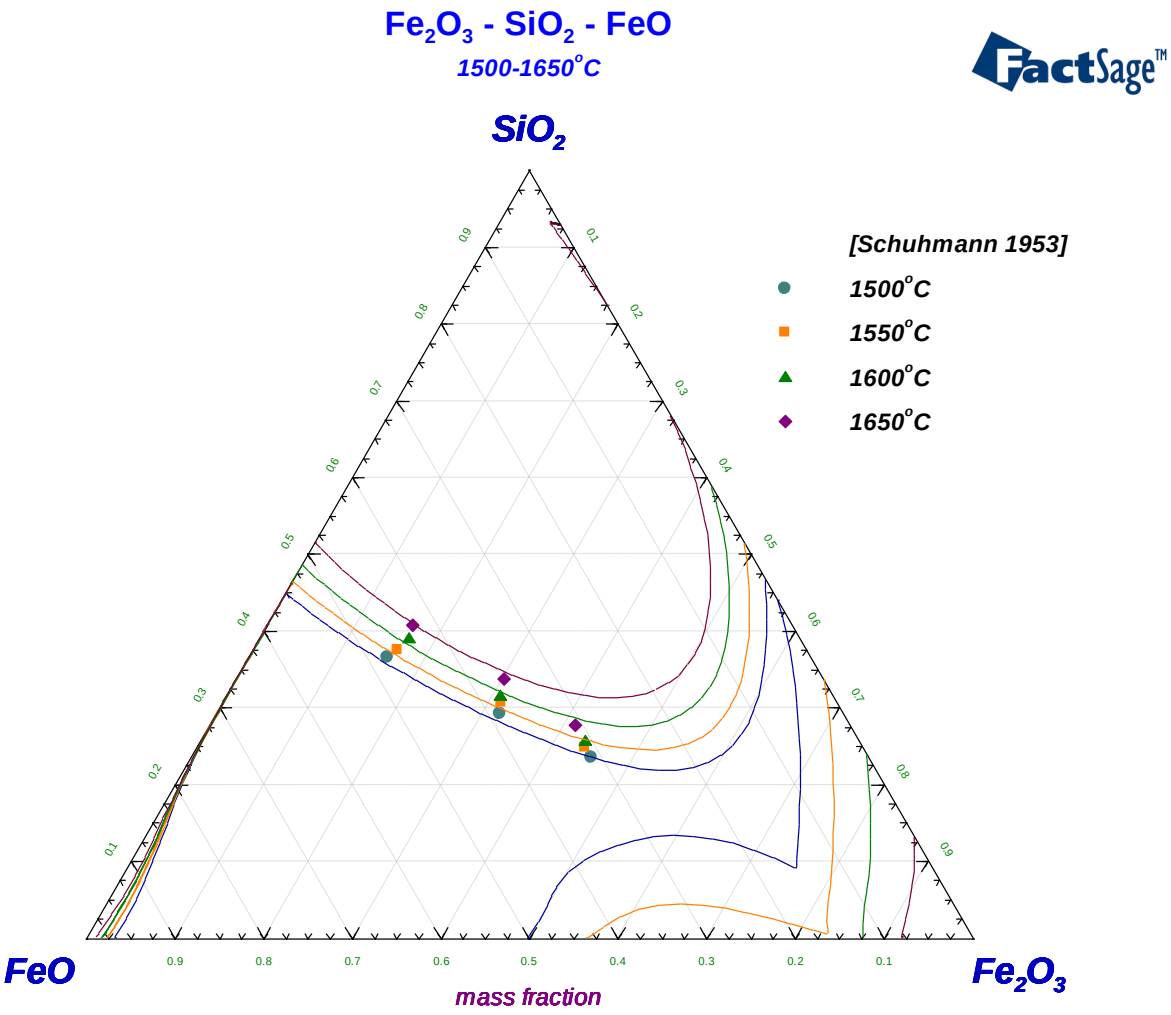


Fe2O3-FeO-SiO2,
Weight percent 1200°C

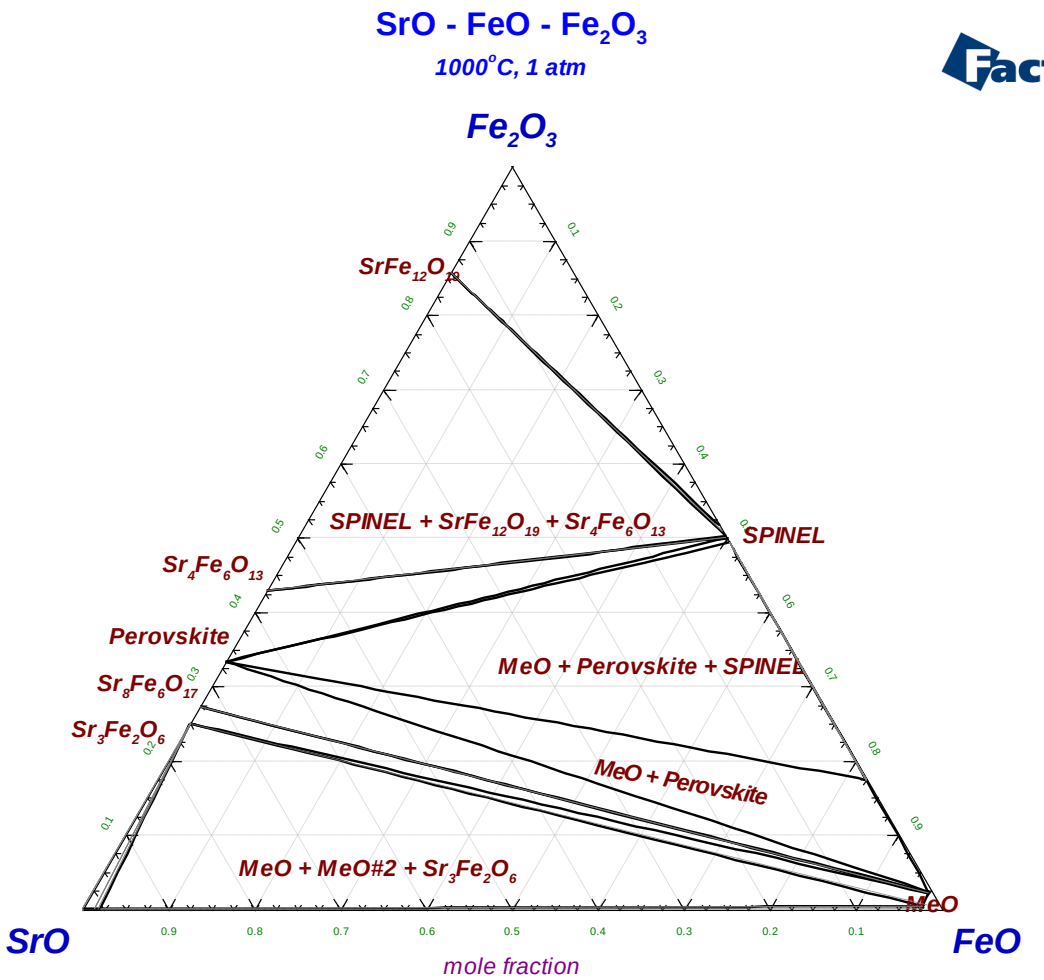


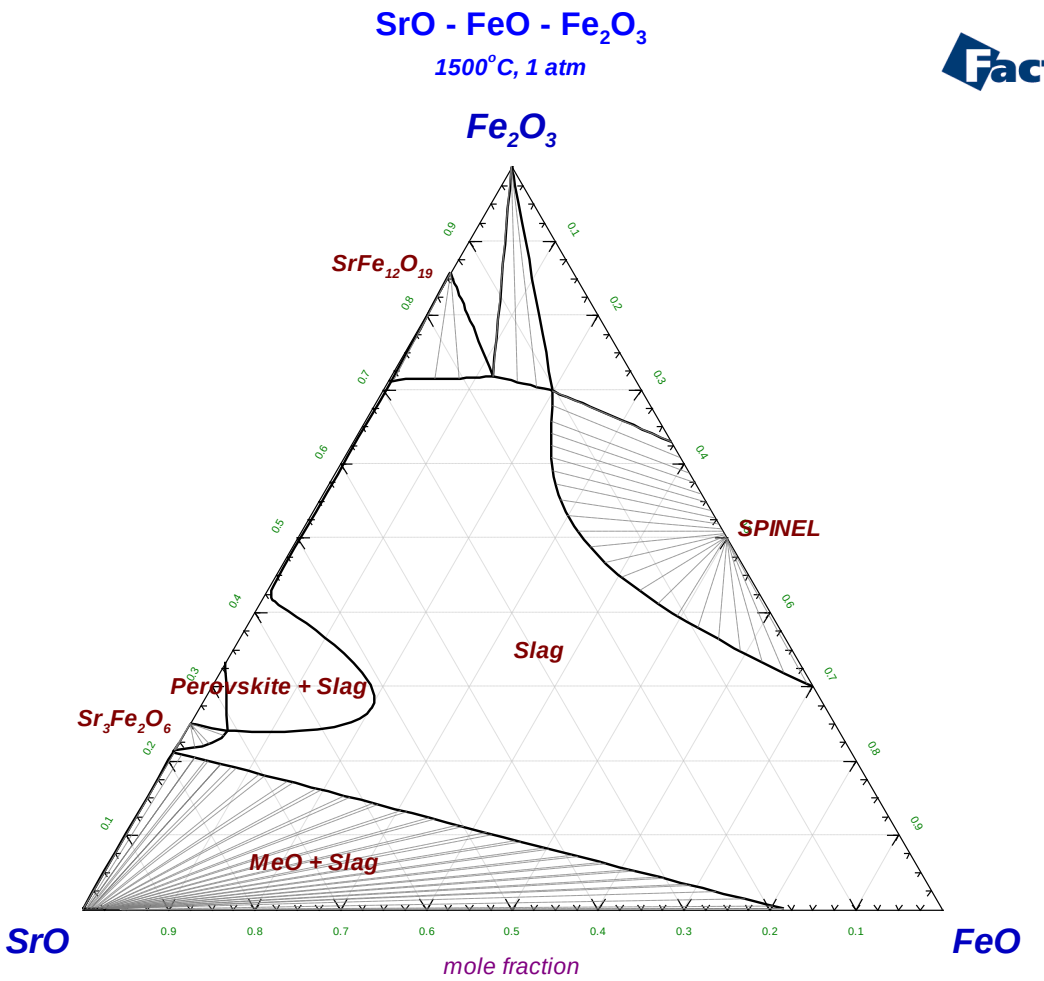

Fe2O3 - SiO2 - FeO
1300°C
SiO2
FeO
Fe2O3
percent by weight
[Zhao 1996]
[Allen 1955]
[Schuhmann 1953]
[Bodsworth 1959]
[Oishi 1982]
Slag + Cristobalite
SPINEL + Cristobalite + Fe2O3
SPINEL + Cristobalite
Slag
Slag + Fe(fcc)
Slag + SPINEL
Slag + MeO

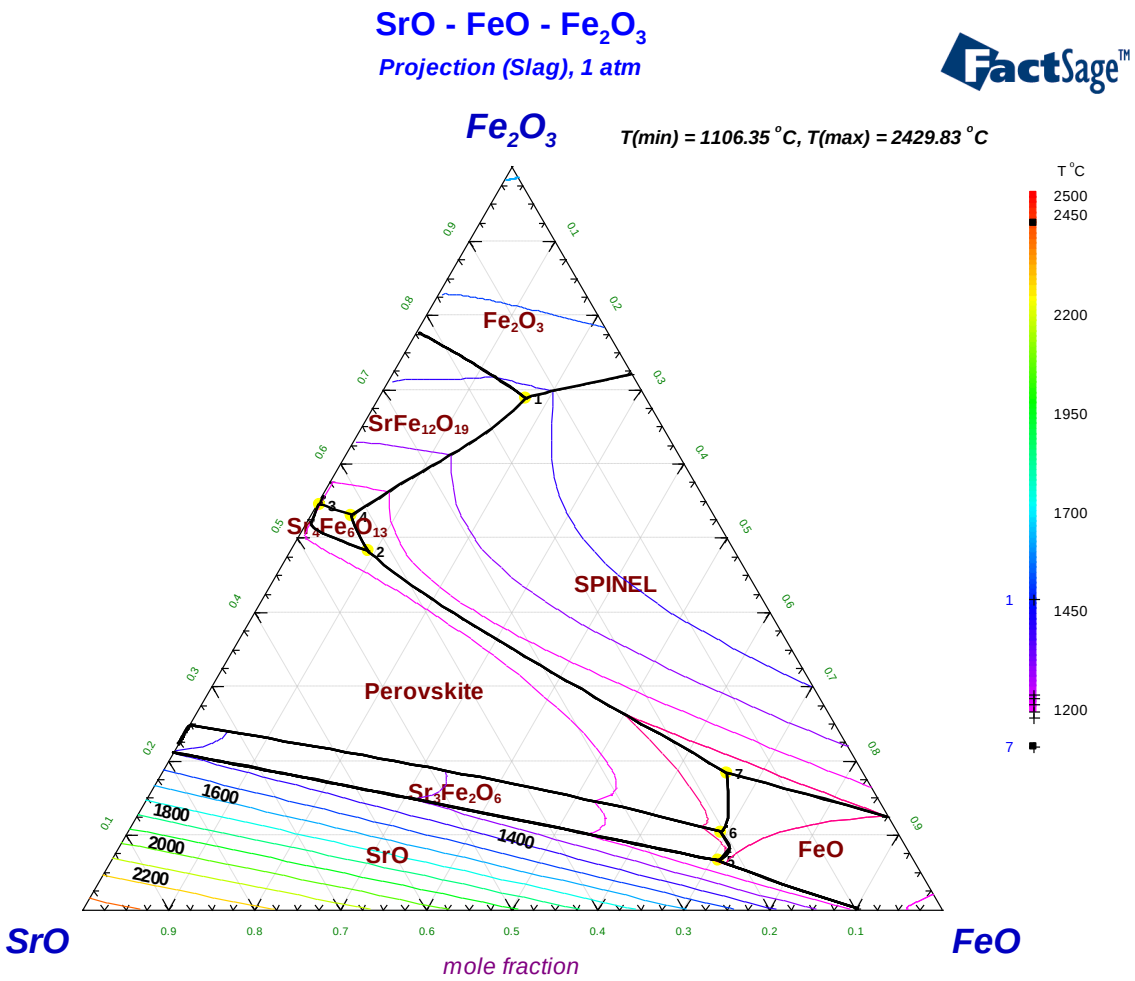
Fe2O3-FeO-SiO2,
Weight percent, Liquidus lines at 1500-1650°C

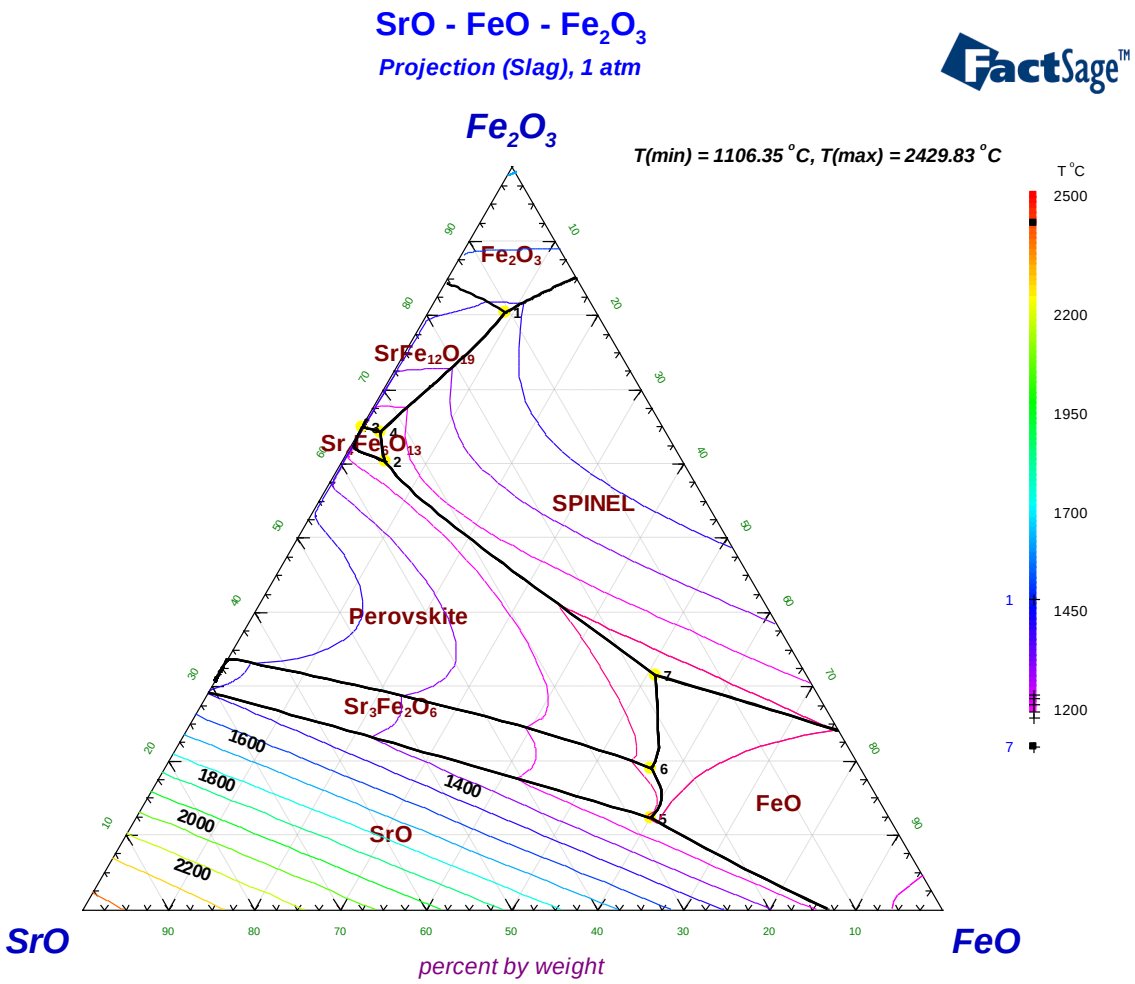


Fe2O3-FeO-SrO,
Mole fraction 1000°C




SrO - FeO - Fe2O3
1500°C, 1 atm
Fe2O3
SrFe12O19
SPINEL
Slag
Perovskite + Slag
Sr3Fe2O6
MeO + Slag
SrO
FeO
mole fraction

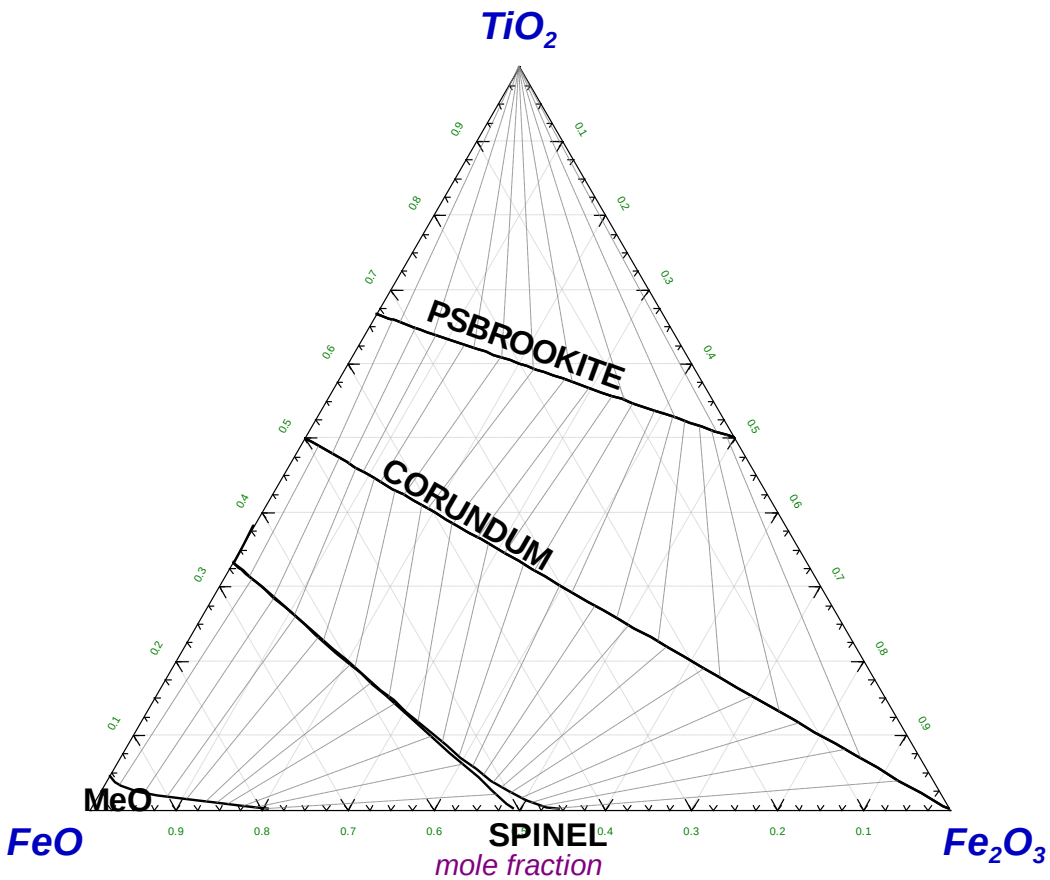

SrO - FeO - Fe2O3
Projection (Slag), 1 atm
FactSage™
Fe2O3
T(min) = 1106.35 °C, T(max) = 2429.83 °C
T °C
2500
2450
2200
1950
1700
1450
1200
Fe2O3
SrFe12O19
Sr14Fe6O13
SPINEL
Perovskite
Sr3Fe2O6
SrO
FeO
1600
1800
2000
2200
1400
SrO
FeO
mole fraction


SrO - FeO - Fe2O3
Projection (Slag), 1 atm
FactSage™
Fe2O3
T(min) = 1106.35 °C, T(max) = 2429.83 °C
T °C
2500
2200
1950
1700
1450
1200
Fe2O3
SrFe12O19
Sr4Fe6O13
SPINEL
Perovskite
Sr3Fe2O6
FeO
SrO
1600
1800
2000
2200
1400
SrO
FeO
percent by weight

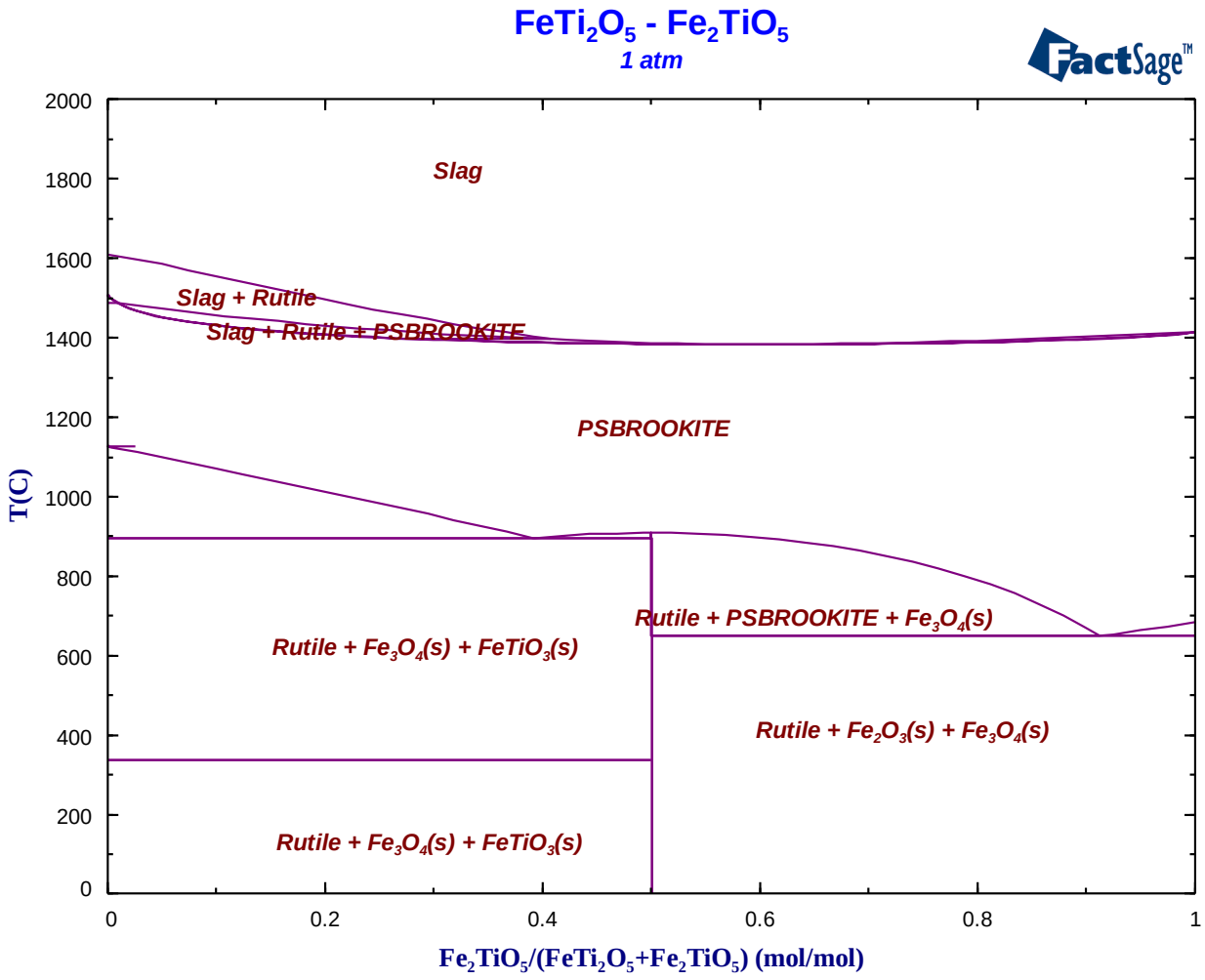
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction					Weight percent				
	A = Fe2O3, B = SrO, C = FeO					A = Fe2O3, B = SrO, C = FeO				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: Fe2O3 / SPINEL / SrFe12O19	1:	0.68863	0.13915	0.17222	1477.77	1:	80..409	10.543	9.047	1477.78
2: Perovskite / SPINEL / Sr4Fe6O13	2:	0.48223	0.42640	0.09137	1238.90	2:	60.277	34.585	5.138	1238.90
3: Perovskite / Sr4Fe6O13 / SrFe12O19	3:	0.54511	0.45160	0.00329	1227.22	3:	64.923	34.901	0.176	1227.24
4: SPINEL / Sr4Fe6O13 / SrFe12O19	4:	0.53080	0.42134	0.04786	1213.08	4:	64.282	33.110	2.608	1213.12
5: FeO / Sr3Fe2O6 / SrO	5:	0.06522	0.22670	0.70808	1195.63	5:	12.284	27.709	60.007	1195.65
6: FeO / Perovskite / Sr3Fe2O6	6:	0.10421	0.20499	0.69080	1178.71	6:	19.016	24.272	56.712	1178.71
7: FeO / Perovskite / SPINEL	7:	0.18373	0.15715	0.65912	1106.35	7:	31.556	17.514	50.930	1106.35

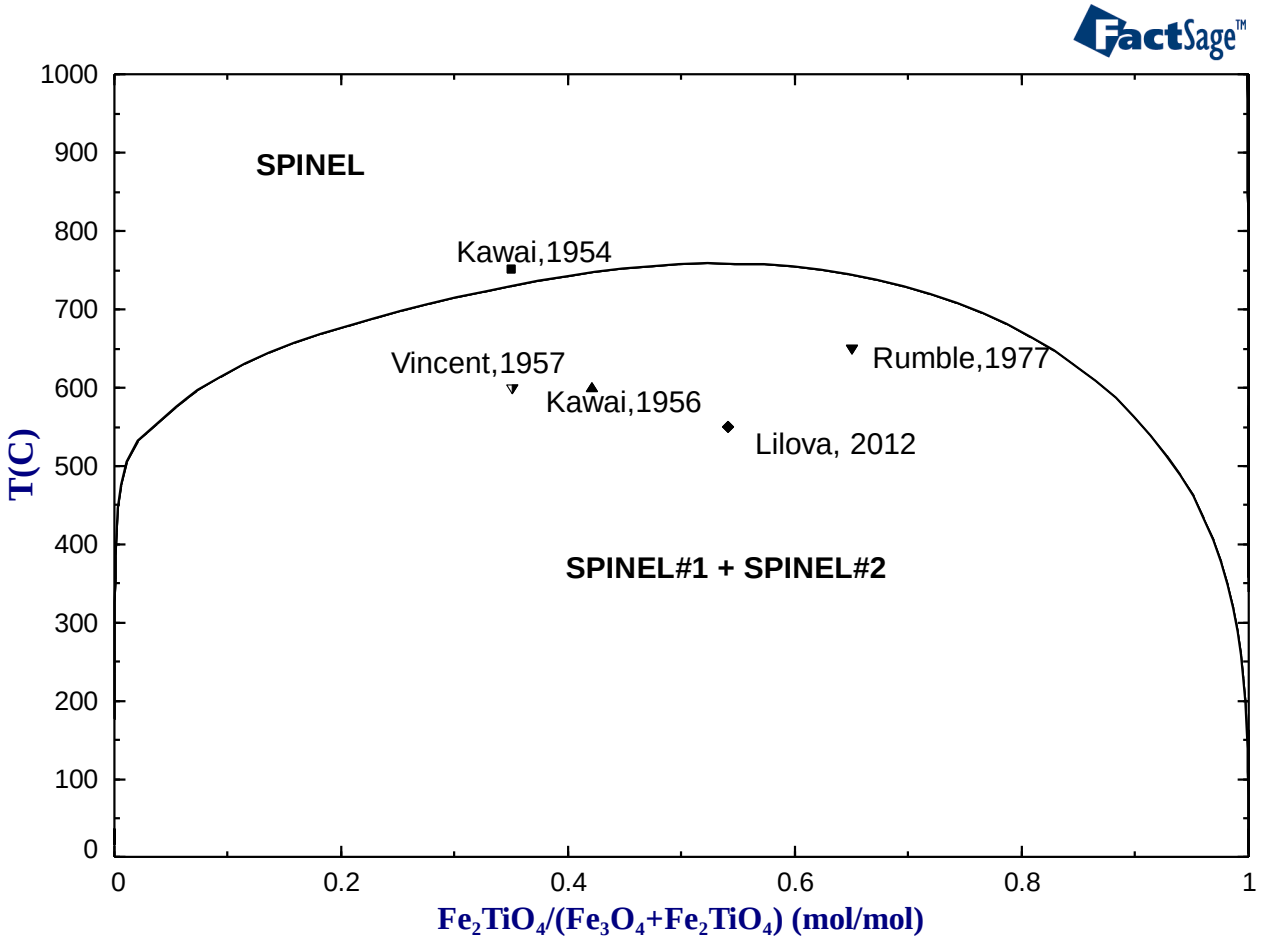
Fe2O3-FeO-TiO2,
Mole fraction 1300°C



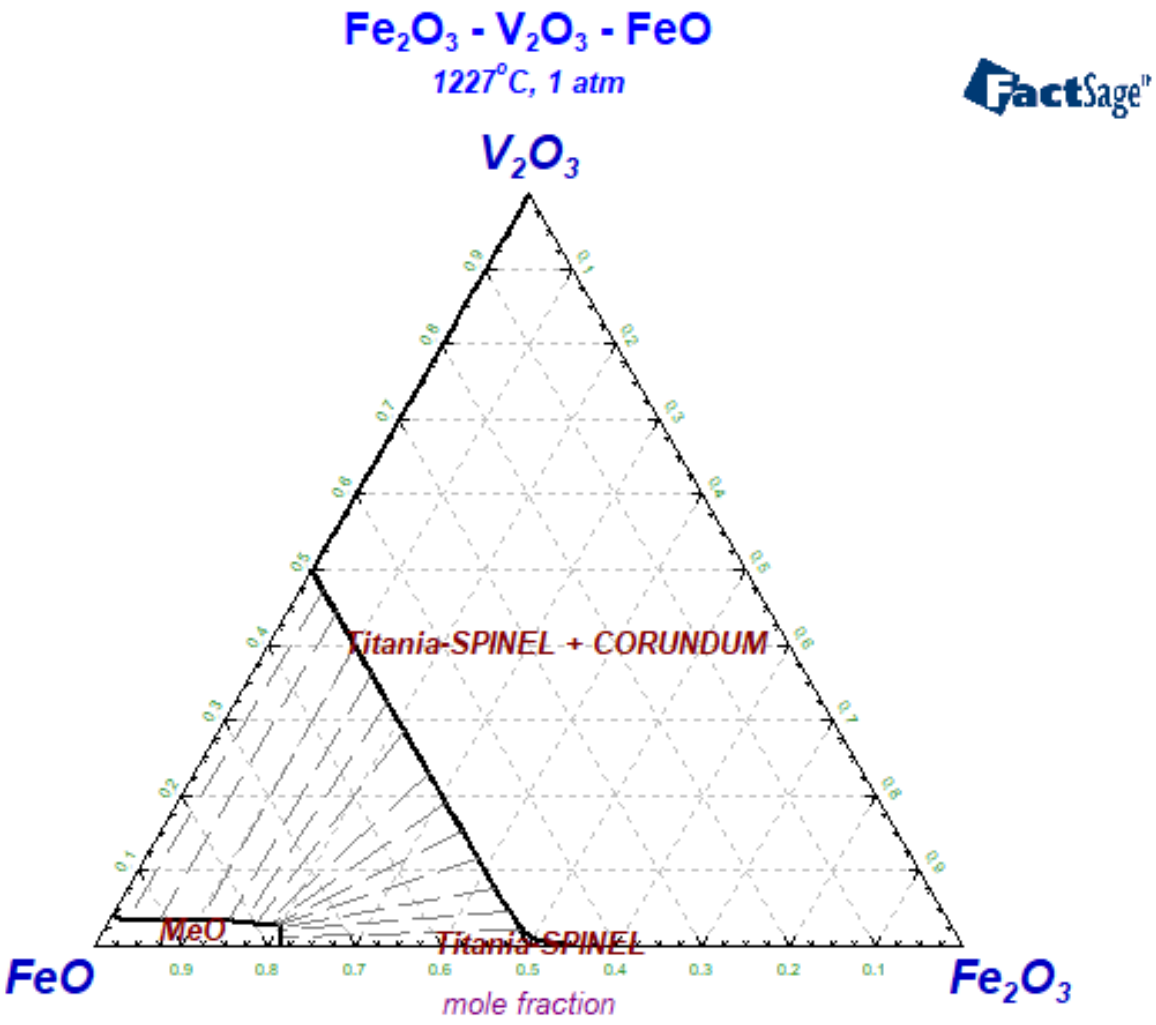
Isopleth section FeTi2O5-Fe2TiO5, mole fraction

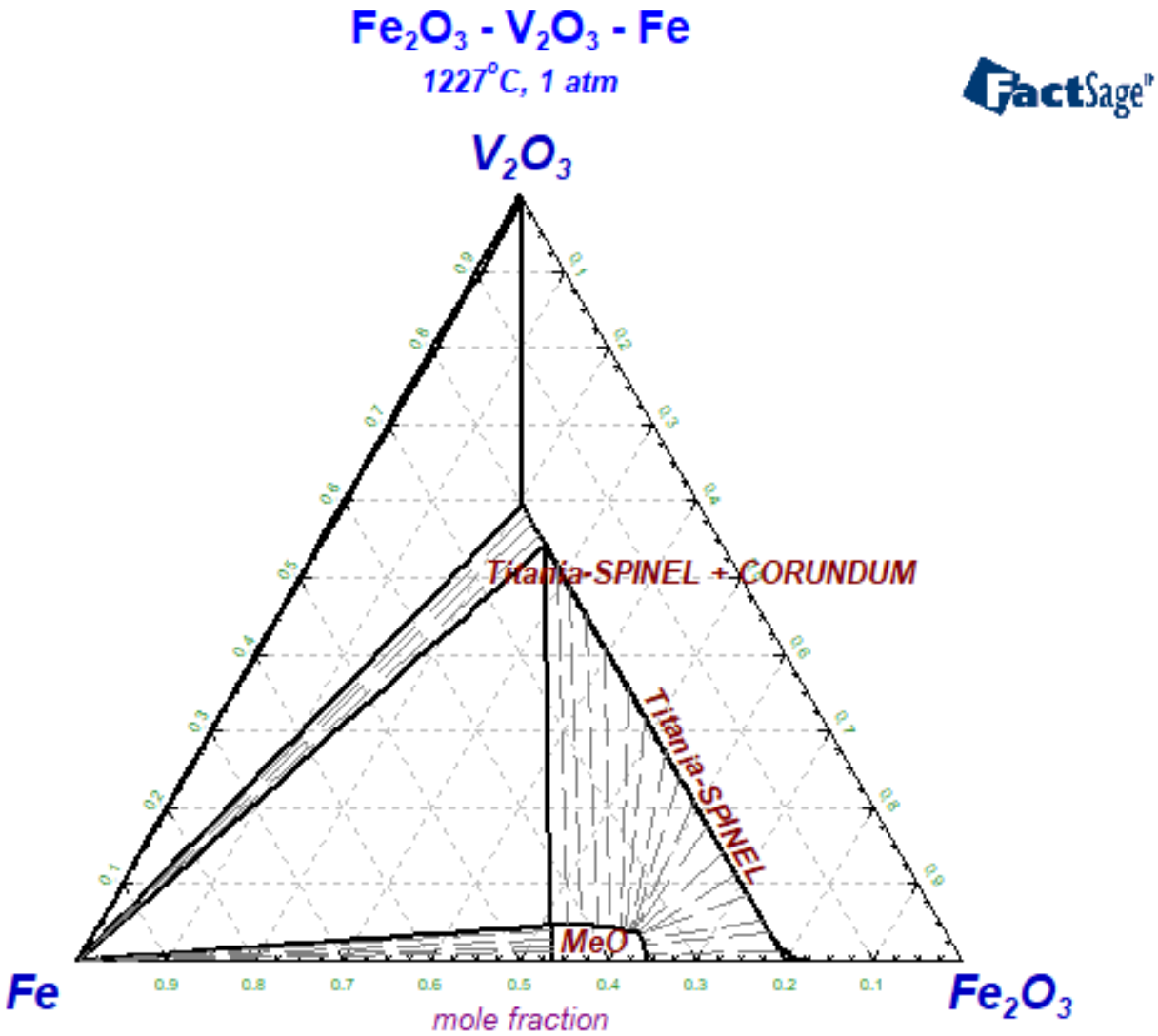


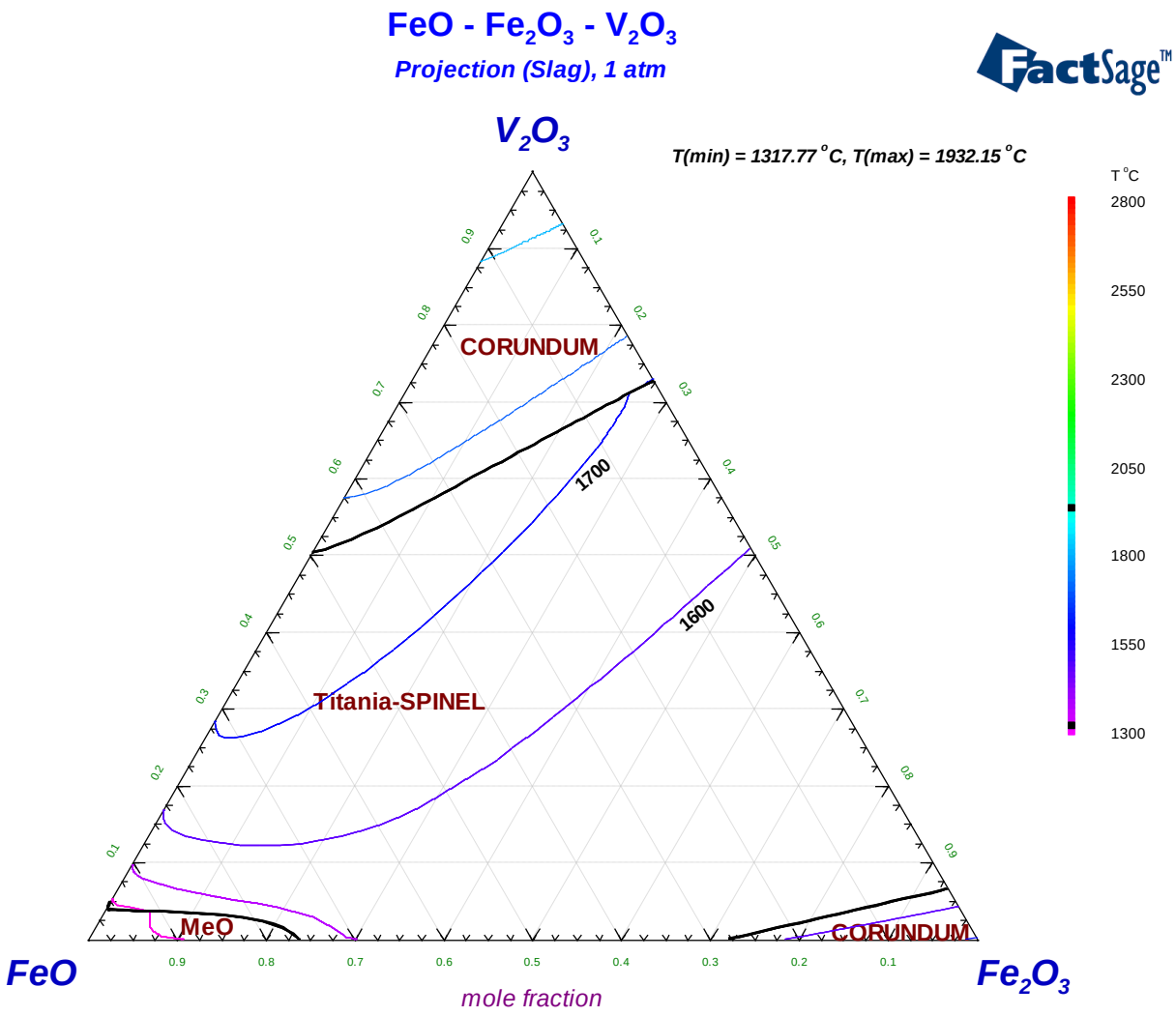
Isopleth section Fe3O4-Fe2TiO4, mole fraction

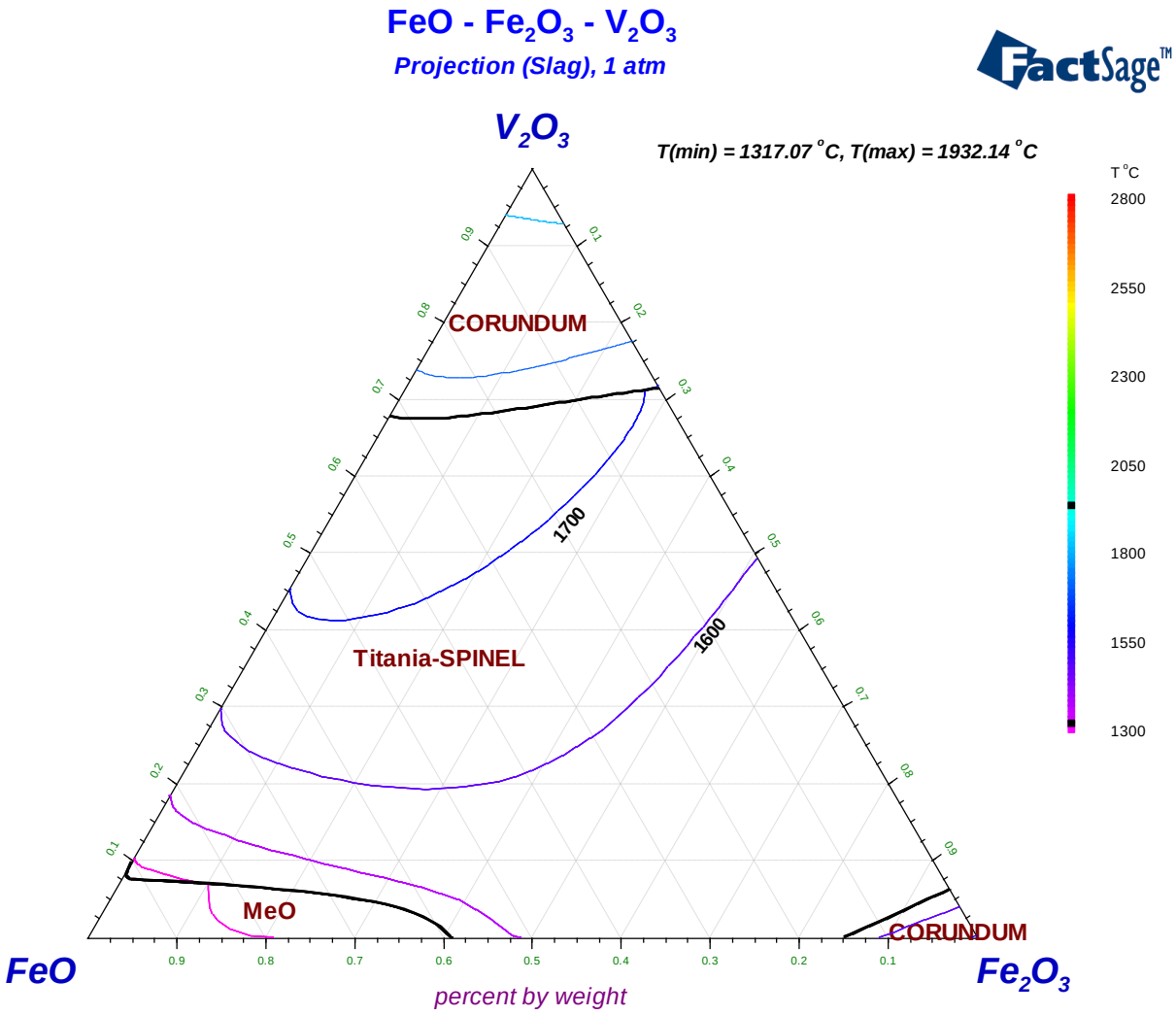


Fe2O3-FeO-V2O3,
Mole fraction 1227°C

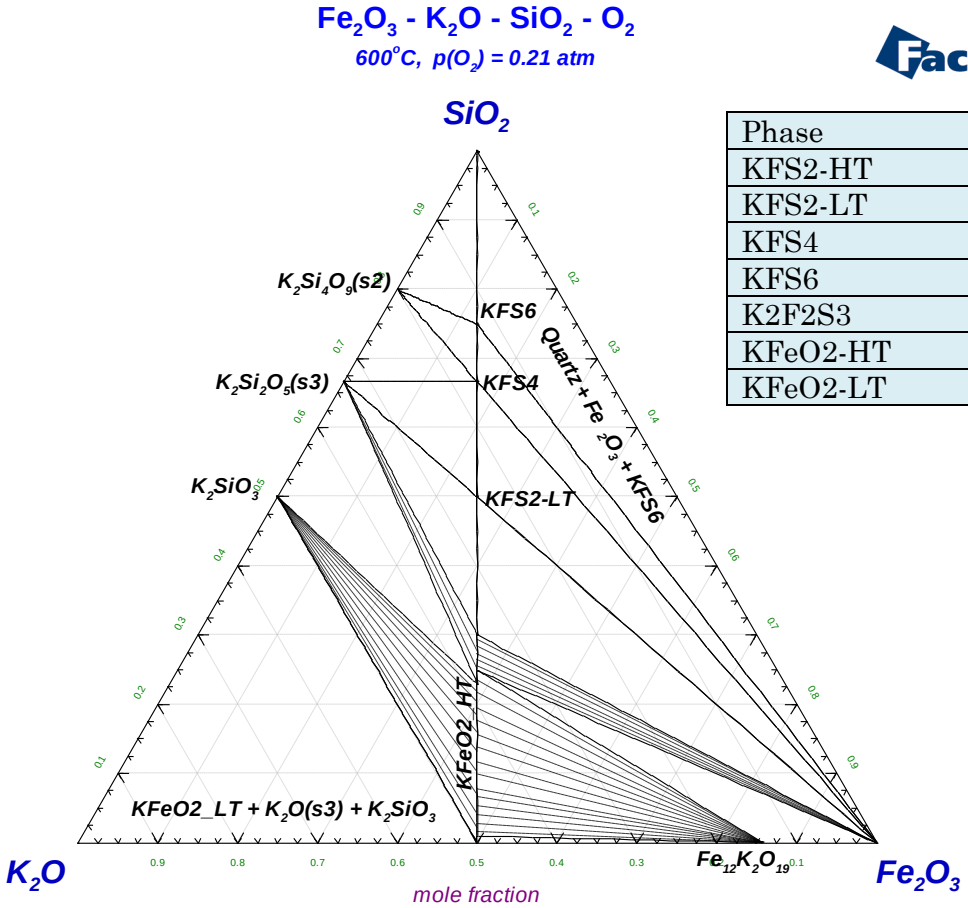



Fe2O3 - V2O3 - Fe
1227°C, 1 atm
FactSage
V2O3
Titania-SPINEL + CORUNDUM
Titania-SPINEL
MeO
Fe
Fe2O3
mole fraction

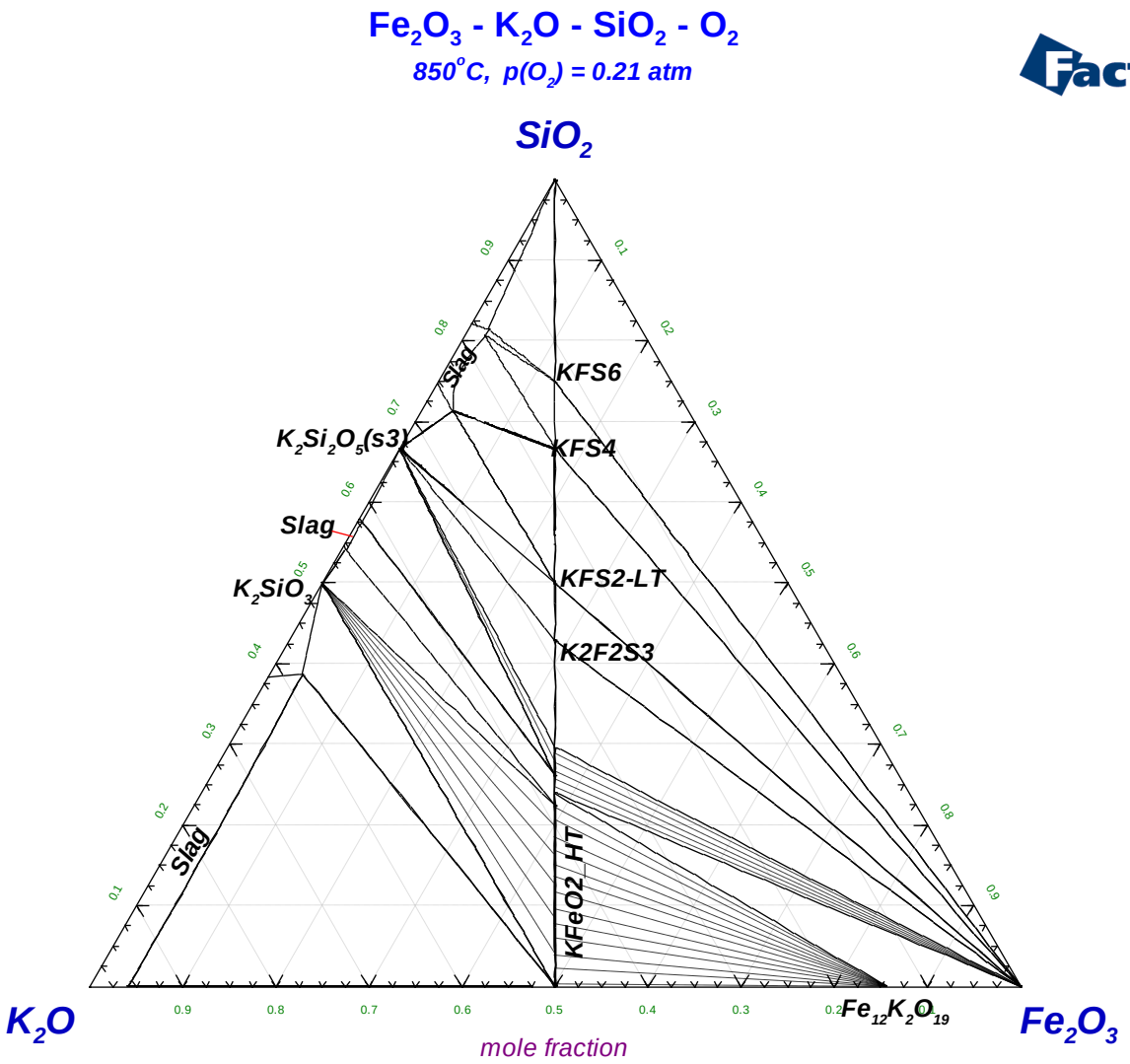

FeO - Fe2O3 - V2O3
Projection (Slag), 1 atm
FactSage™
V2O3
T(min) = 1317.77 °C, T(max) = 1932.15 °C
T °C
2800
2550
2300
2050
1800
1550
1300
CORUNDUM
1700
1600
Titania-SPINEL
MeO
CORUNDUM
FeO
Fe2O3
mole fraction


FeO - Fe2O3 - V2O3
Projection (Slag), 1 atm
FactSage™
V2O3
T(min) = 1317.07 °C, T(max) = 1932.14 °C
T °C
2800
2550
2300
2050
1800
1550
1300
CORUNDUM
1700
1600
Titania-SPINEL
MeO
CORUNDUM
FeO
Fe2O3
percent by weight

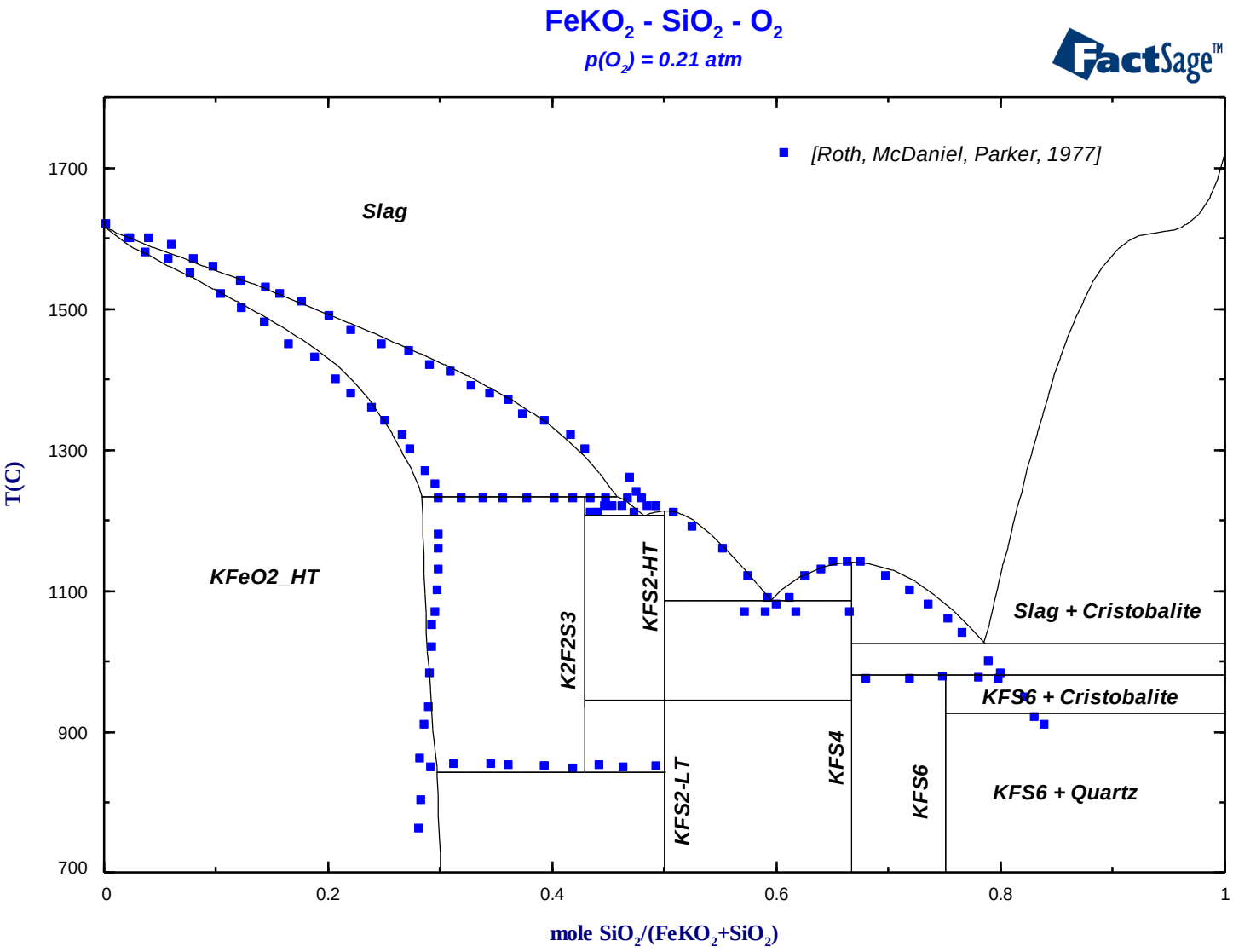
Ternary phases in Fe_2O_3-K_2O-SiO_2

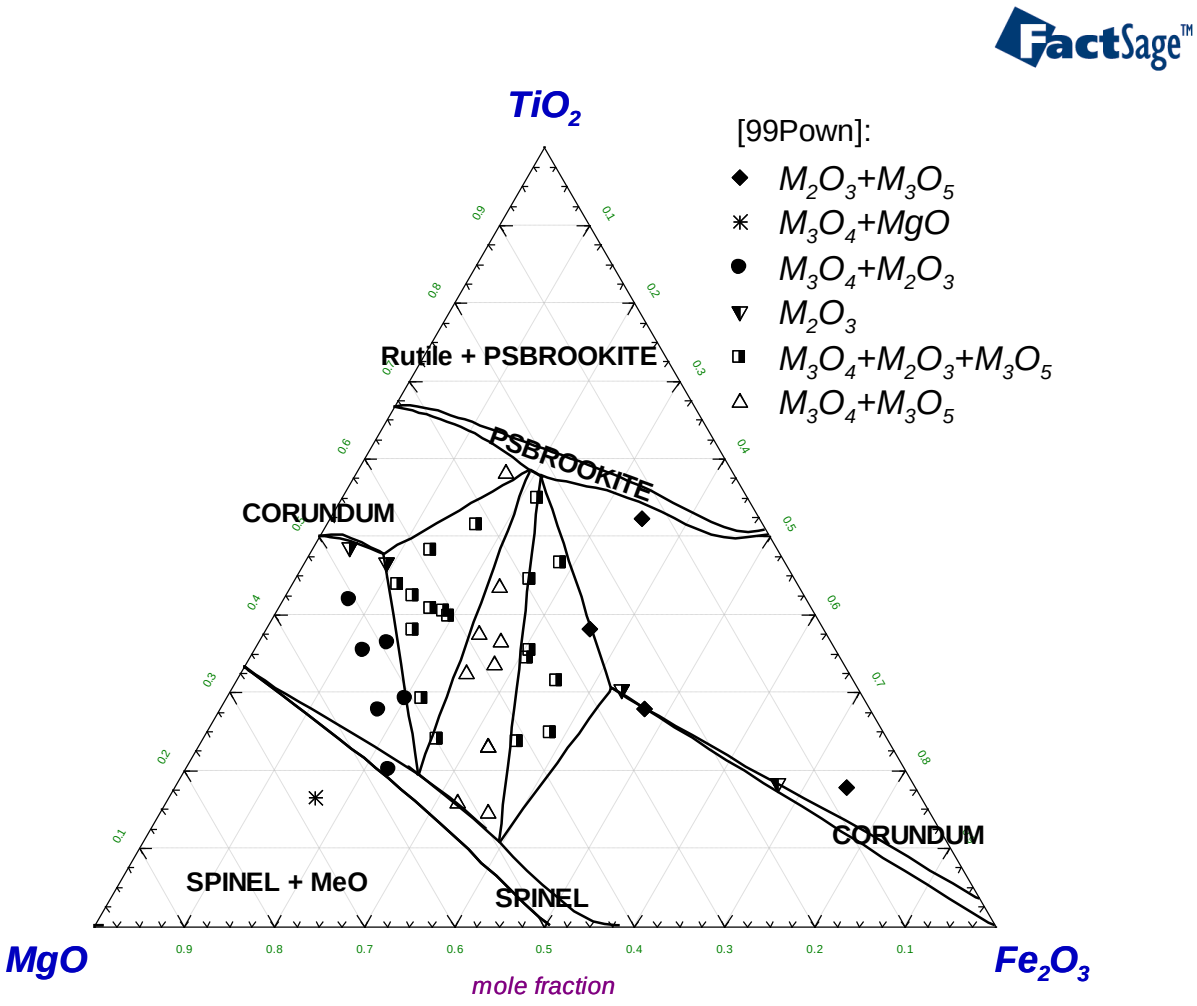


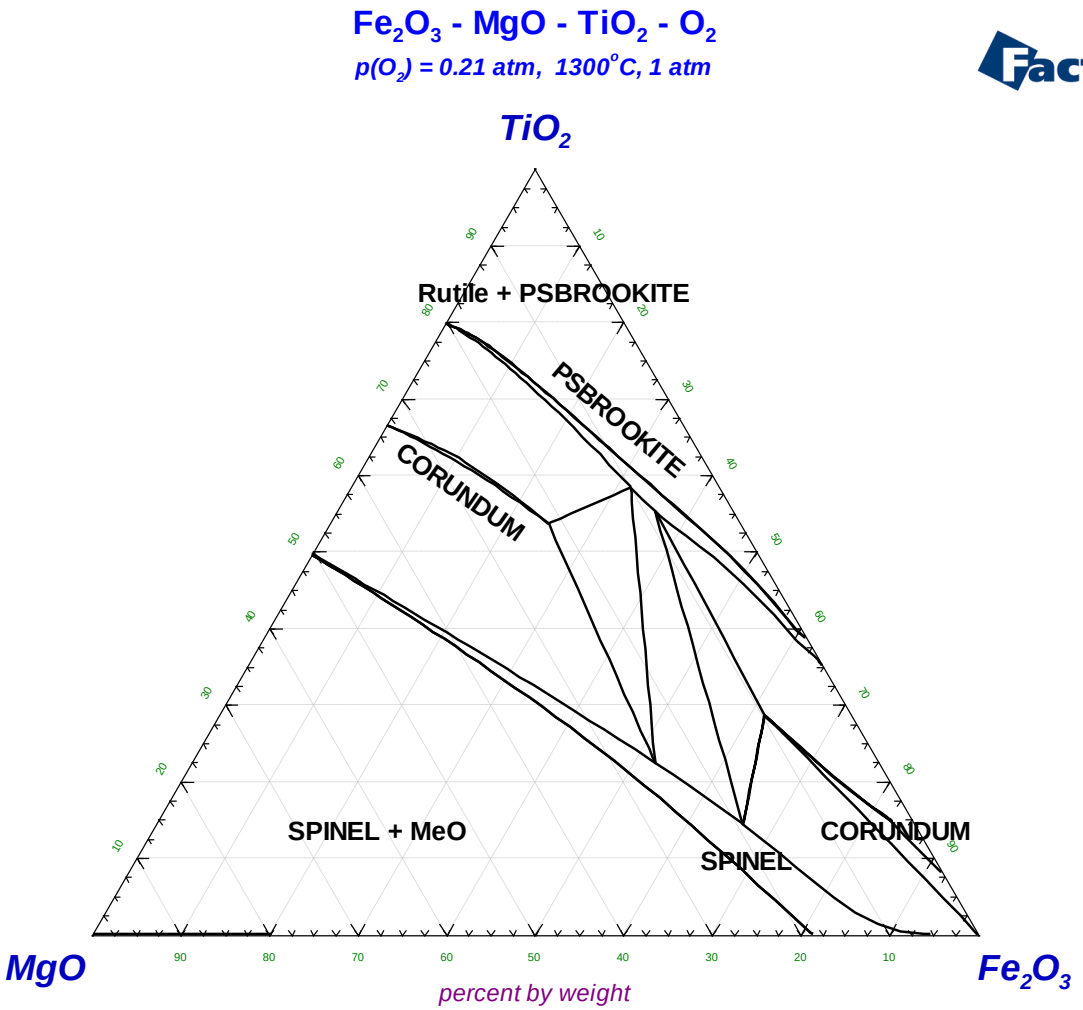
Phase	Description	Formel
KFS2-HT	Stoichiometric	$Fe_2K_2Si_2O_8$
KFS2-LT	Stoichiometric	$Fe_2K_2Si_2O_8$
KFS4	Stoichiometric	$Fe_2K_2Si_4O_{12}$
KFS6	Stoichiometric	$Fe_2K_2Si_6O_{16}$
K2F2S3	Stoichiometric	$Fe_4K_4Si_3O_{14}$
KFeO2-HT	Solid solution phase	$(K^{1+},Va)(Fe^{3+},Si^{4+})(O^{2-})_2$
KFeO2-LT	Solid solution phase	$(K^{1+},Va)(Fe^{3+},Si^{4+})(O^{2-})_2$


Fe2O3 - K2O - SiO2 - O2
850°C, p(O2) = 0.21 atm
SiO2
K2O
Fe2O3
mole fraction
Slag
KFS6
K2Si2O5(s3)
KFS4
Slag
K2SiO3
KFS2-LT
K2F2S3
Slag
KFeO2_HT
Fe12K2O19
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1

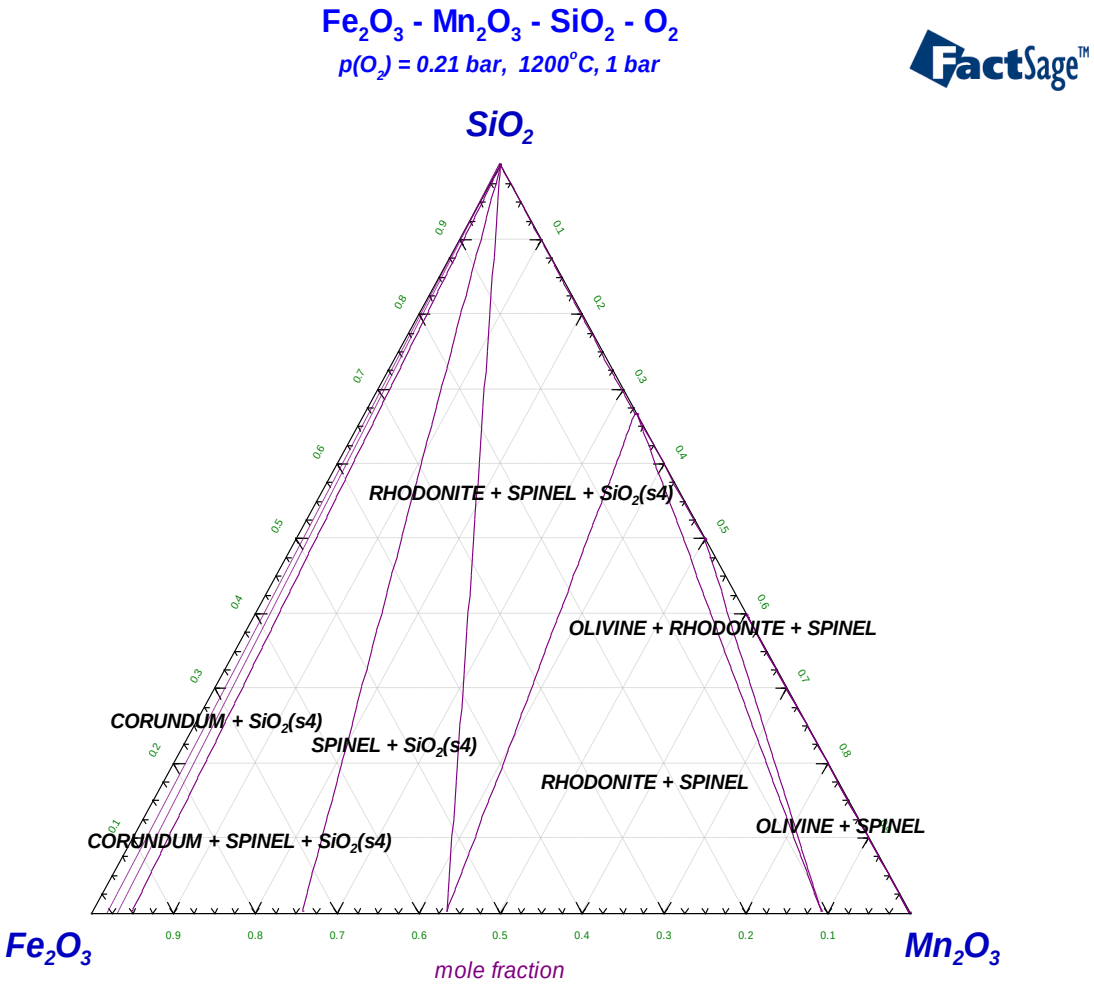
Mole fraction,
FeKO2-SiO2 compared with experimental data

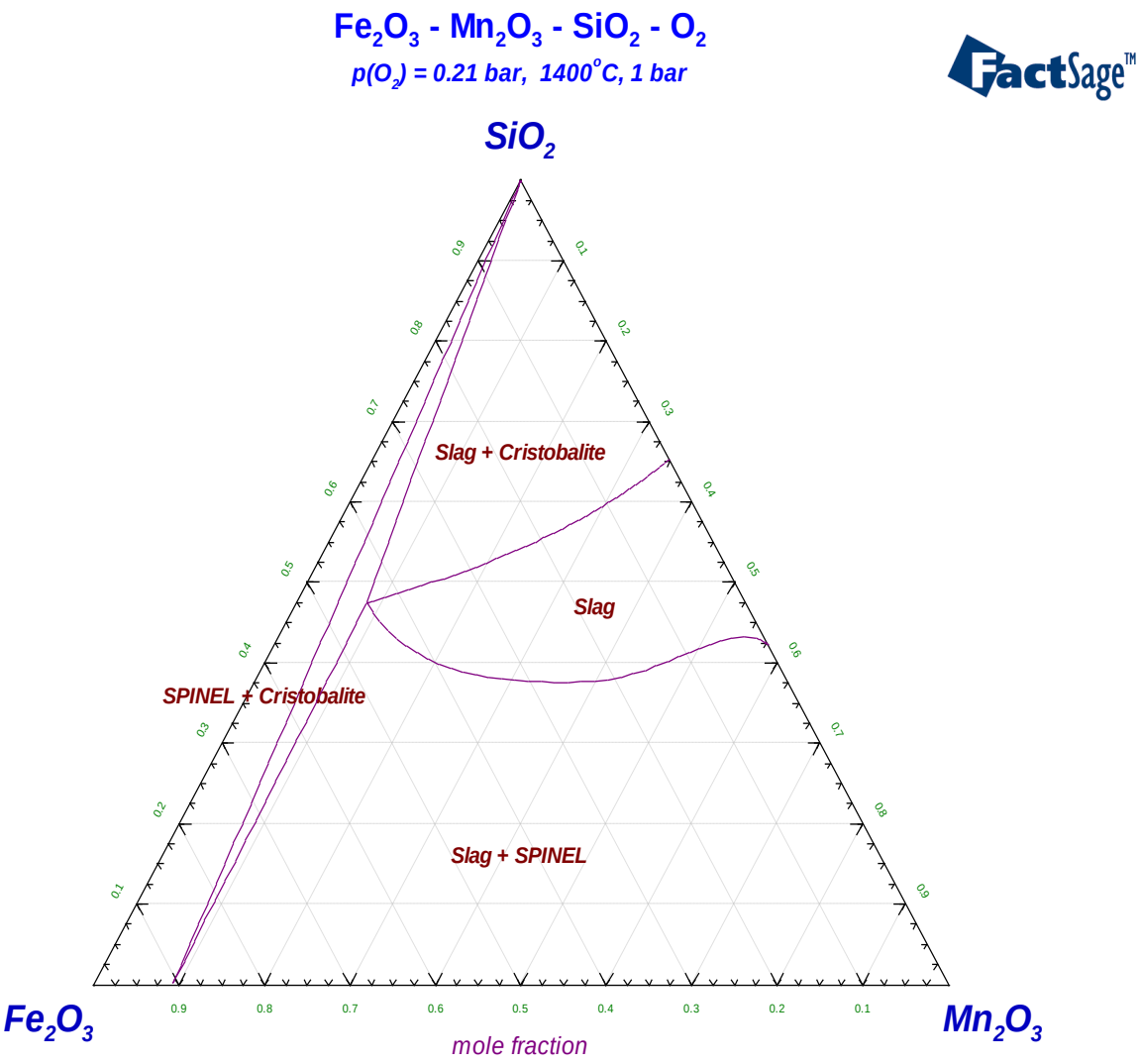


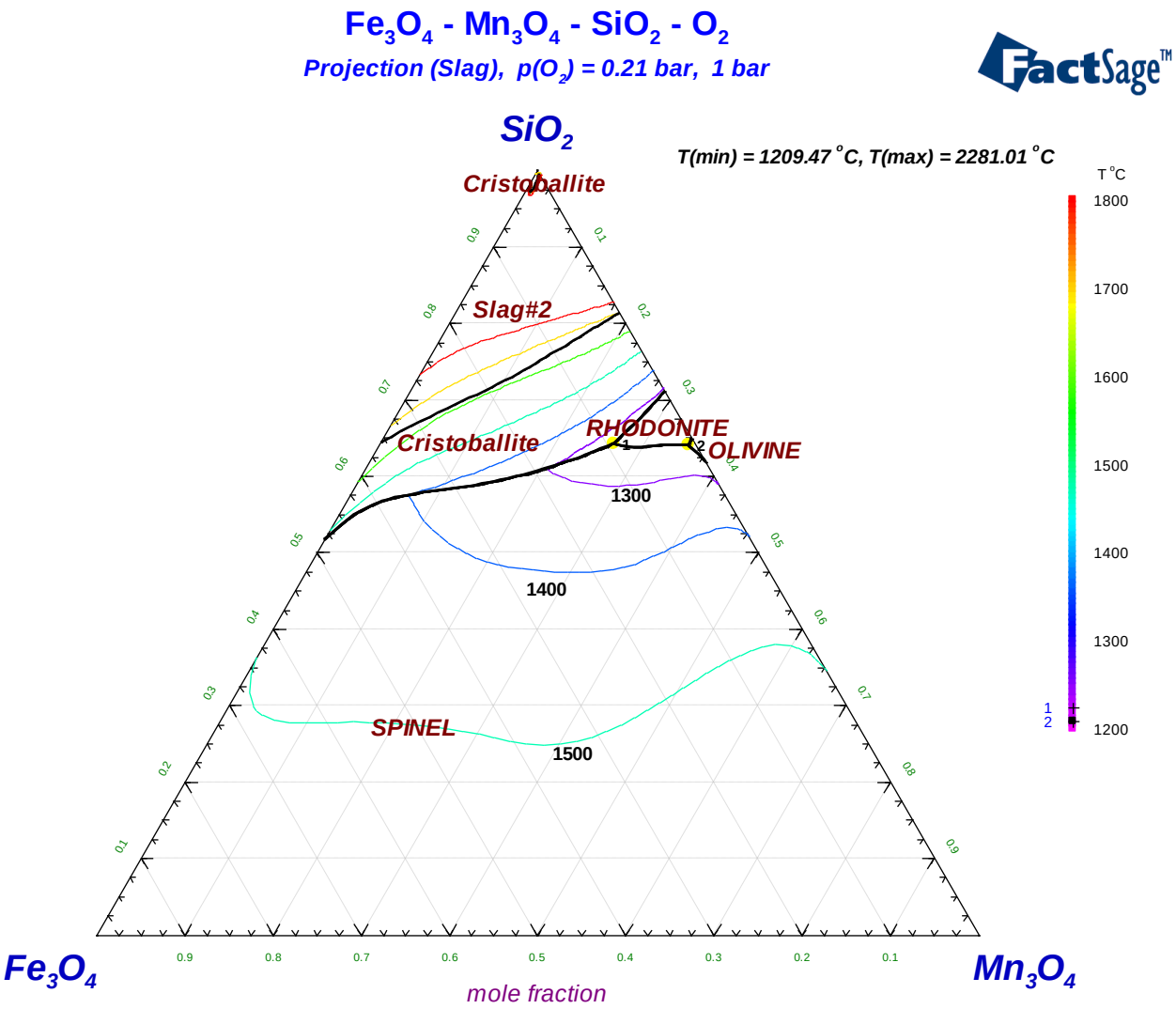

TiO2
[99Pown]:
M2O3+M3O5
M3O4+MgO
M3O4+M2O3
M2O3
M3O4+M2O3+M3O5
M3O4+M3O5
Rutile + PSBROOKITE
PSBROOKITE
CORUNDUM
CORUNDUM
SPINEL + MeO
SPINEL
MgO
Fe2O3
mole fraction

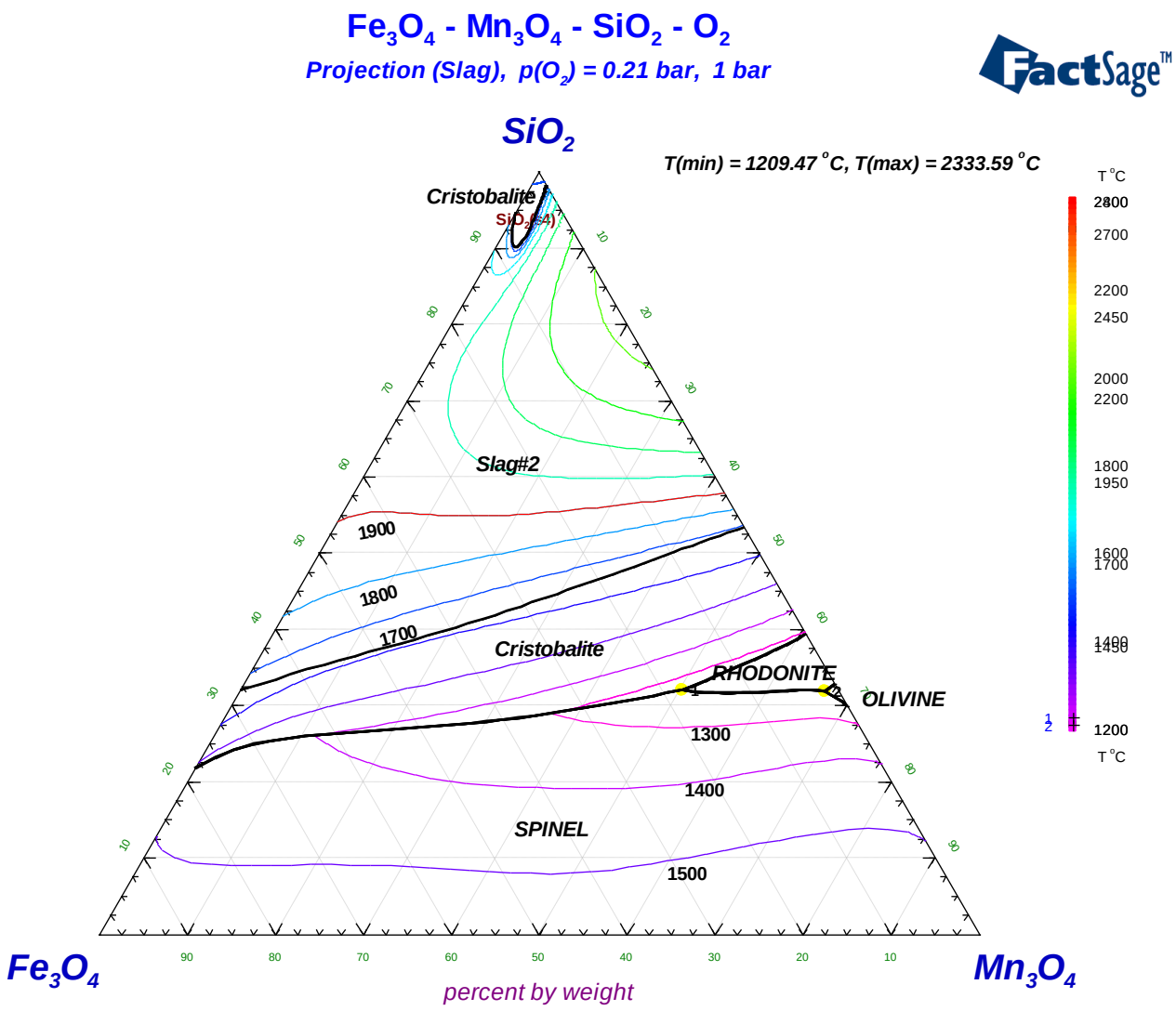

Fe2O3 - MgO - TiO2 - O2
p(O2) = 0.21 atm, 1300°C, 1 atm
TiO2
Rutile + PSBROOKITE
PSBROOKITE
CORUNDUM
SPINEL + MeO
SPINEL
CORUNDUM
MgO
Fe2O3
percent by weight

Fe2O3-Mn2O3-SiO2, Mole fraction 1200°C




Fe_2O_3 - Mn_2O_3 - SiO_2 - O_2
$p(O_2)$ = 0.21 bar, 1400°C, 1 bar
FactSage™
SiO_2
Slag + Cristobalite
Slag
SPINEL + Cristobalite
Slag + SPINEL
Fe_2O_3
Mn_2O_3
mole fraction

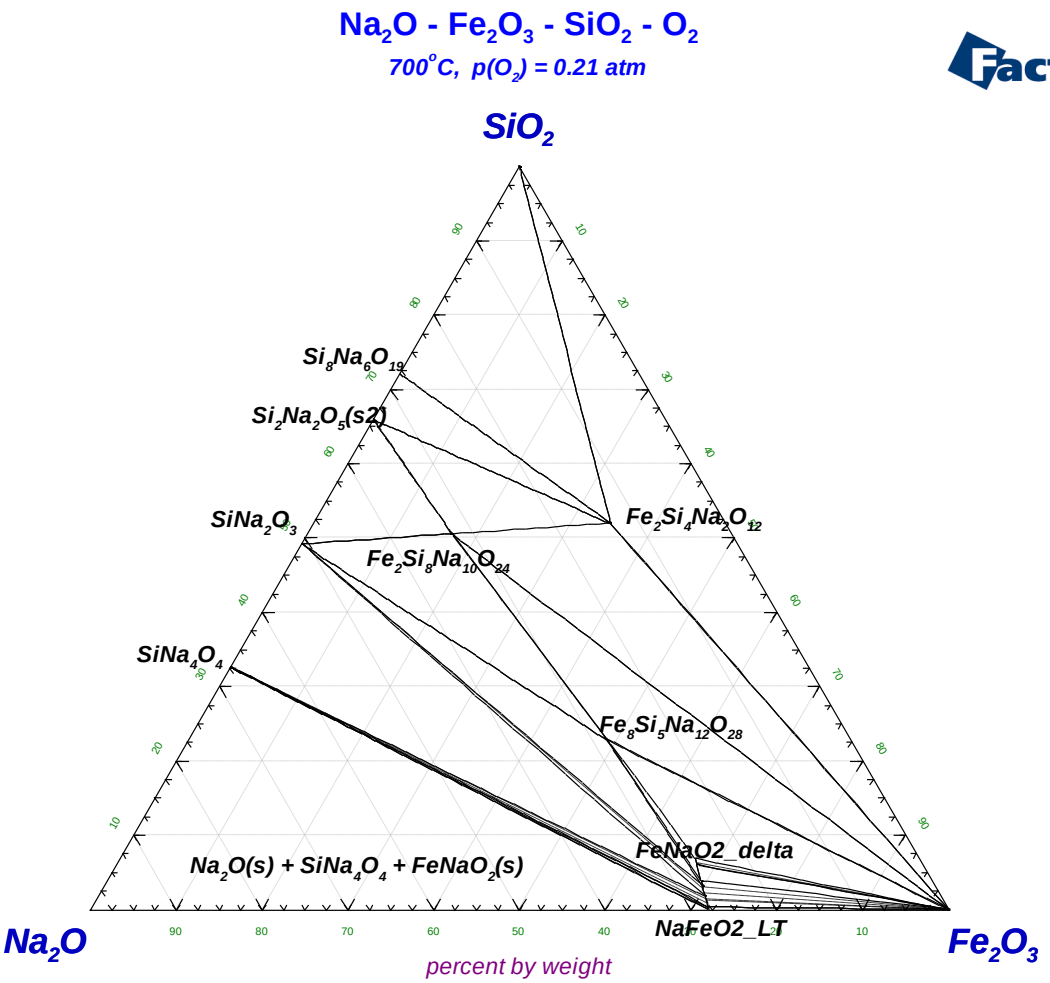

Fe3O4 - Mn3O4 - SiO2 - O2
Projection (Slag), p(O2) = 0.21 bar, 1 bar
FactSage™
SiO2
T(min) = 1209.47 °C, T(max) = 2281.01 °C
T °C
1800
1700
1600
1500
1400
1300
1200
Cristoballite
Slag#2
Cristoballite
RHODONITE
OLIVINE
1
2
1300
1400
SPINEL
1500
Fe3O4
Mn3O4
mole fraction

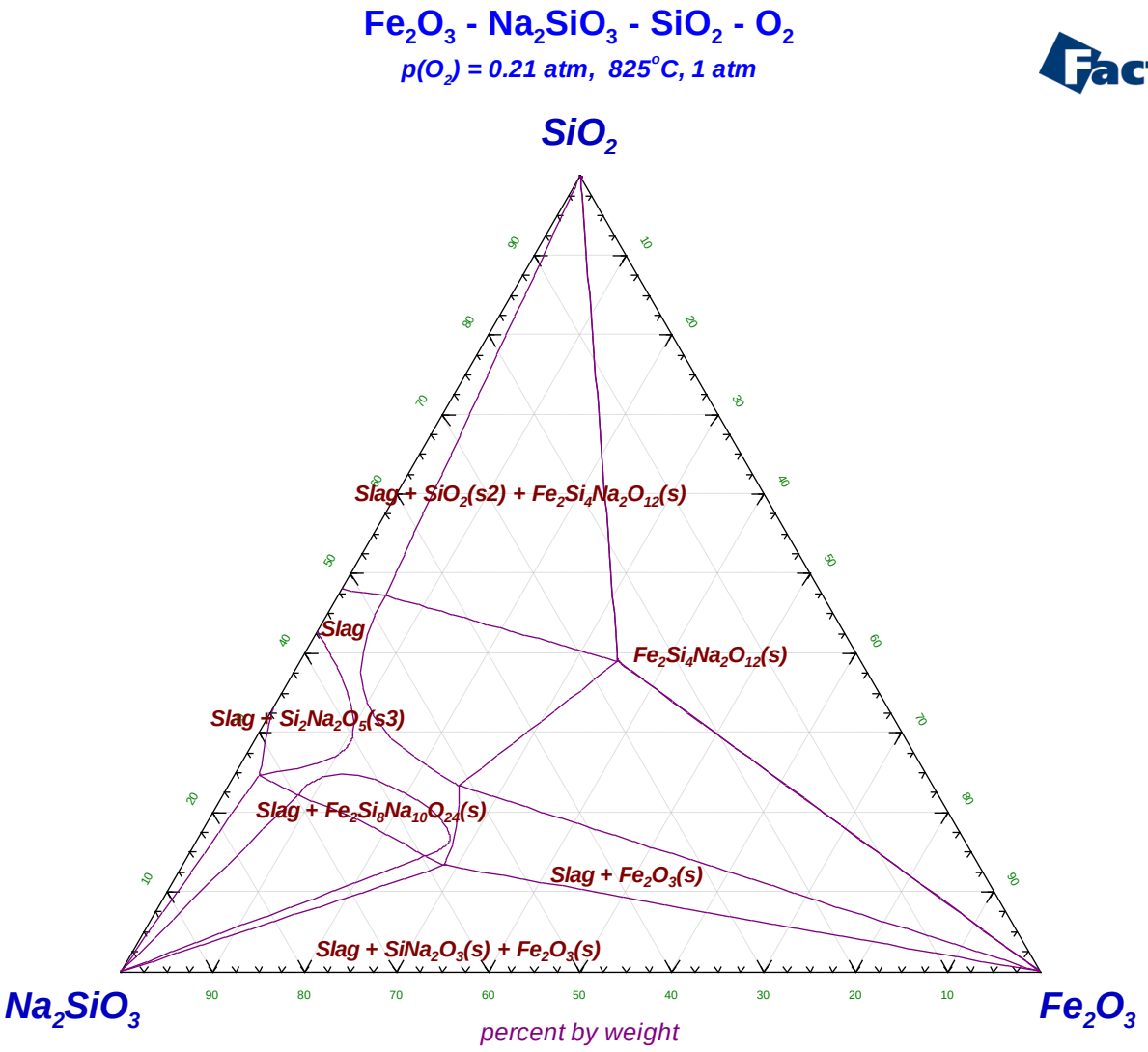

Fe3O4 - Mn3O4 - SiO2 - O2
Projection (Slag), p(O2) = 0.21 bar, 1 bar
FactSage™
SiO2
T(min) = 1209.47 °C, T(max) = 2333.59 °C
T °C
2800
2700
2200
2450
2000
2200
1800
1950
1600
1700
1400
1450
1200
T °C
Cristobalite
SiO2(L4)
Slag#2
1900
1800
1700
Cristobalite
RHODONITE
OLIVINE
1300
1400
SPINEL
1500
Fe3O4
Mn3O4
percent by weight

Invariant equilibria on the liquidus surface

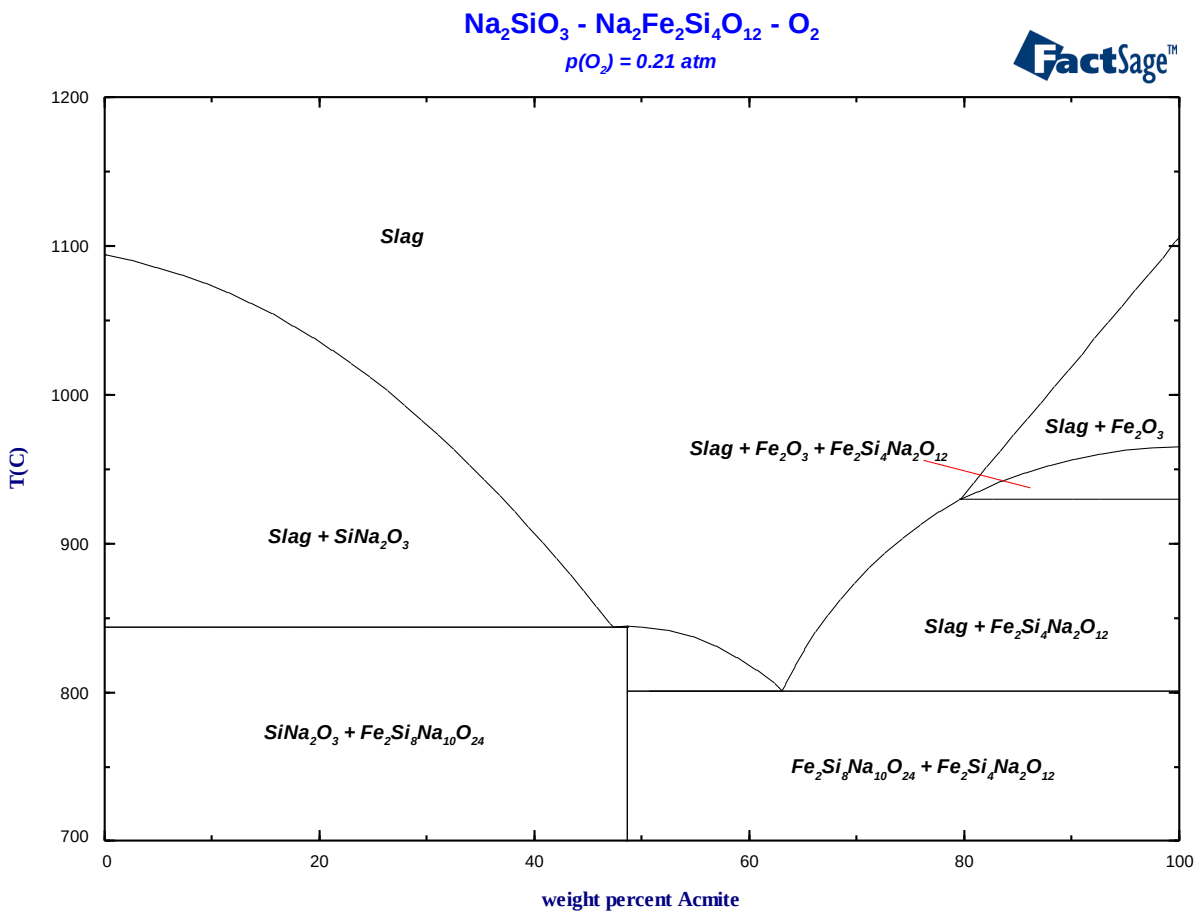
Intersections with slag	Mole fraction					Weight percent				
	A = SiO2, B = Fe3O4, C = Mn3O4					A = SiO2, B = Fe3O4, C = Mn3O4				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: RHODONITE / SPINEL / Cristobalite	1:	0.64241	0.09257	0.26502	1225.01	1:	31.987	17.762	50.252	1225.01
2: OLIVINE / RHODONITE / SPINEL	2:	0.64043	0.00830	0.35127	1209.47	2:	31.861	1.590	66.549	1209.47

Fe2O3-Na2O-SiO2, Weight percent 700°C

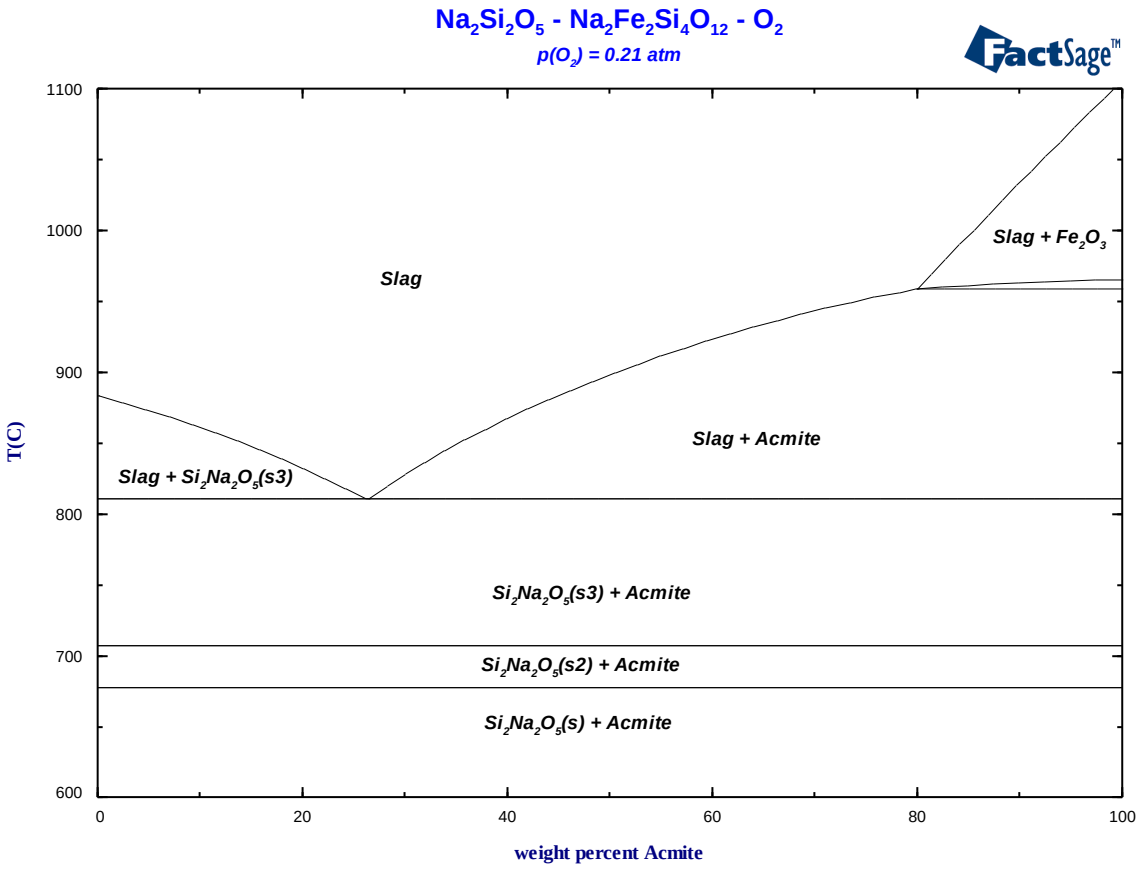



Fe2O3 - Na2SiO3 - SiO2 - O2
p(O2) = 0.21 atm, 825°C, 1 atm
SiO2
Slag + SiO2(s2) + Fe2Si4Na2O12(s)
Slag
Fe2Si4Na2O12(s)
Slag + Si2Na2O5(s3)
Slag + Fe2Si8Na10O24(s)
Slag + Fe2O3(s)
Slag + SiNa2O3(s) + Fe2O3(s)
Na2SiO3
Fe2O3
percent by weight

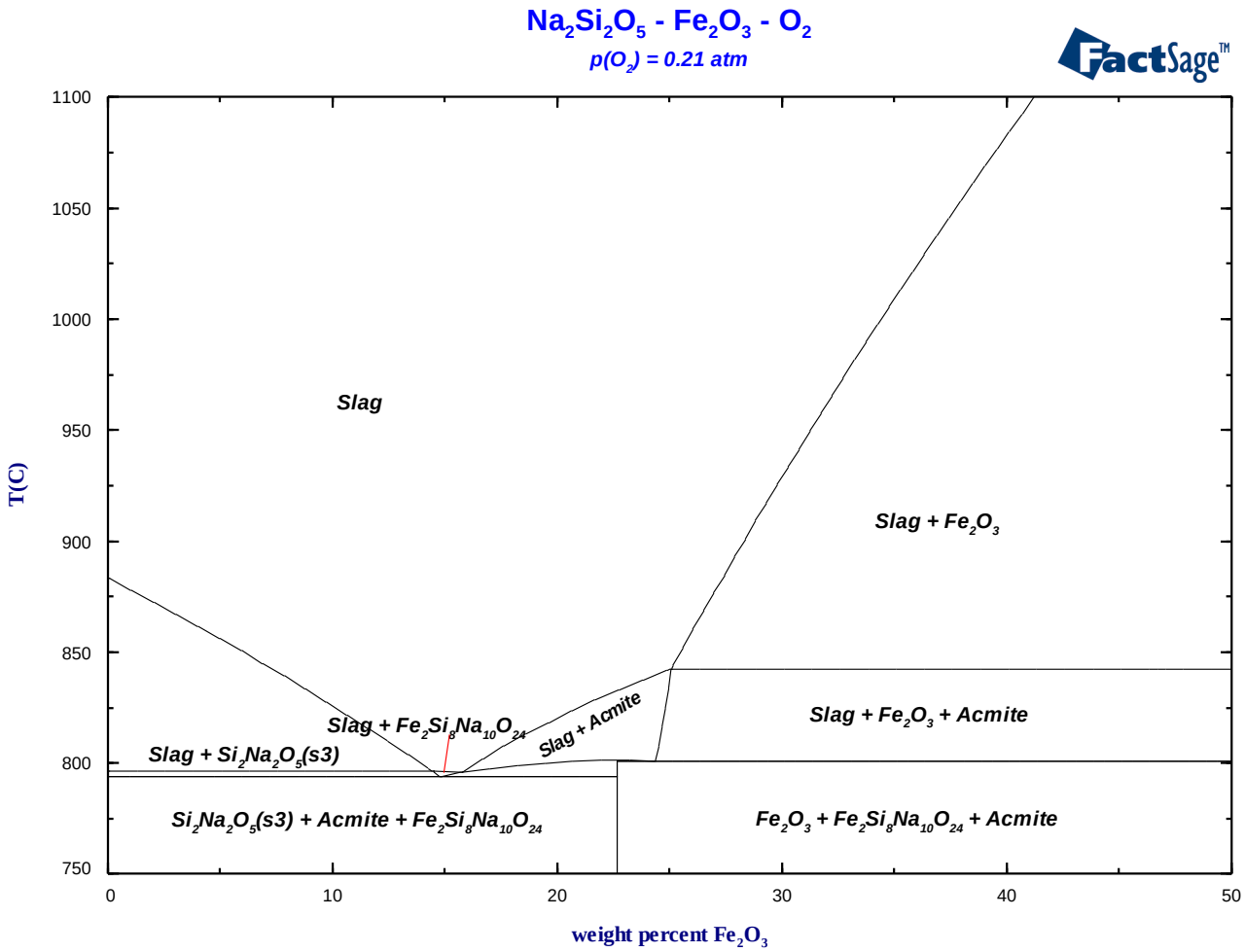
Weight percent,
Isopleth Acmite-Na2SiO3



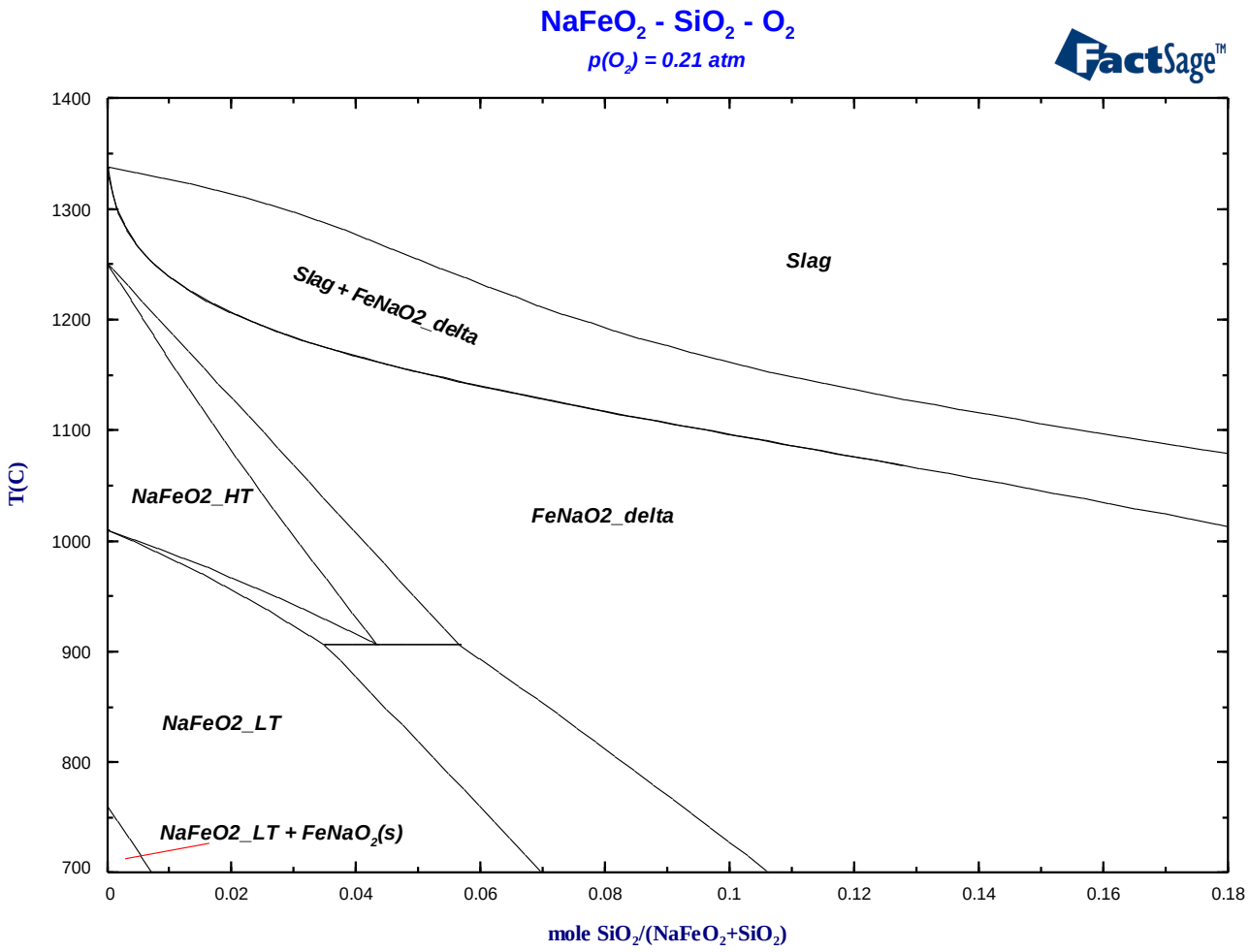
Weight percent,
Isopleth Acmite-Na2Si2O5



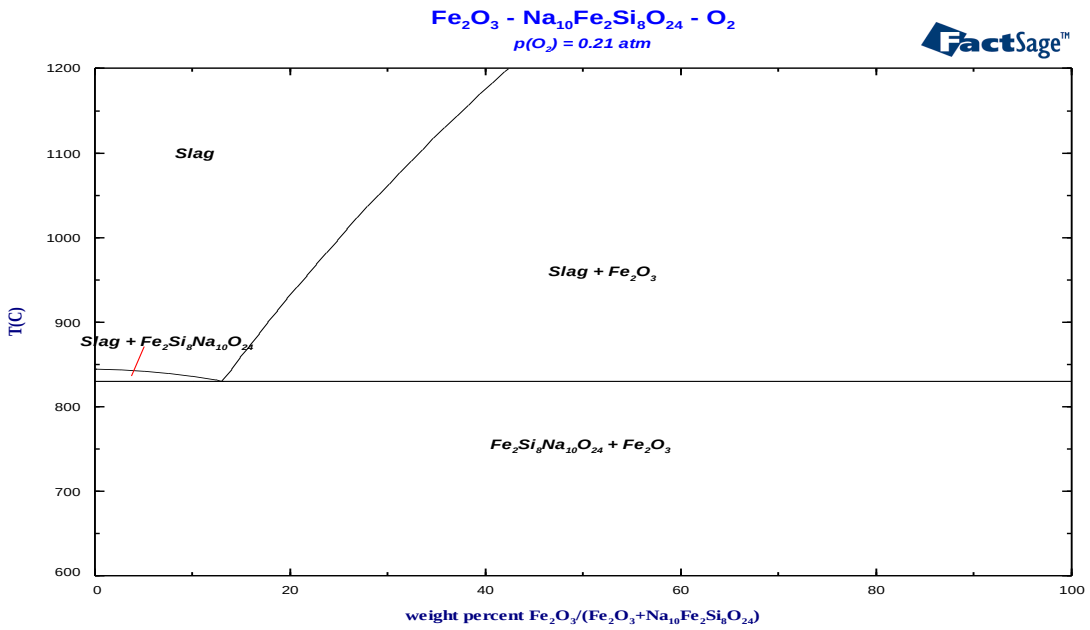
Weight percent,
Isopleth Fe2O3-Na2Si2O5

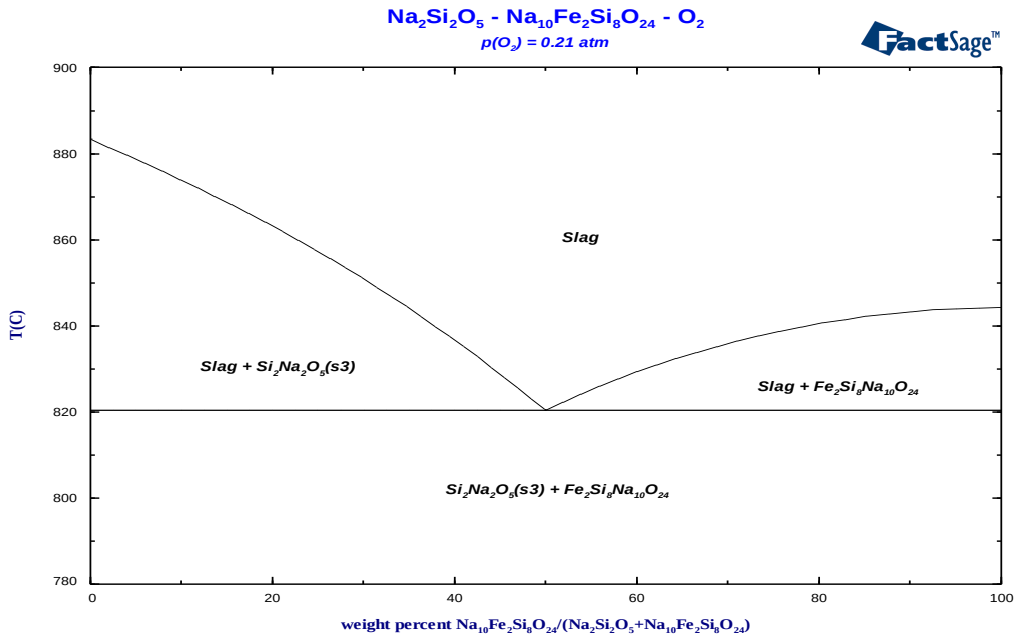


Mole fraction,
Isopleth FeNaO2-SiO2



Weight percent,
Isopletale Schnitte mit 5Na2O Fe2O3 8SiO2

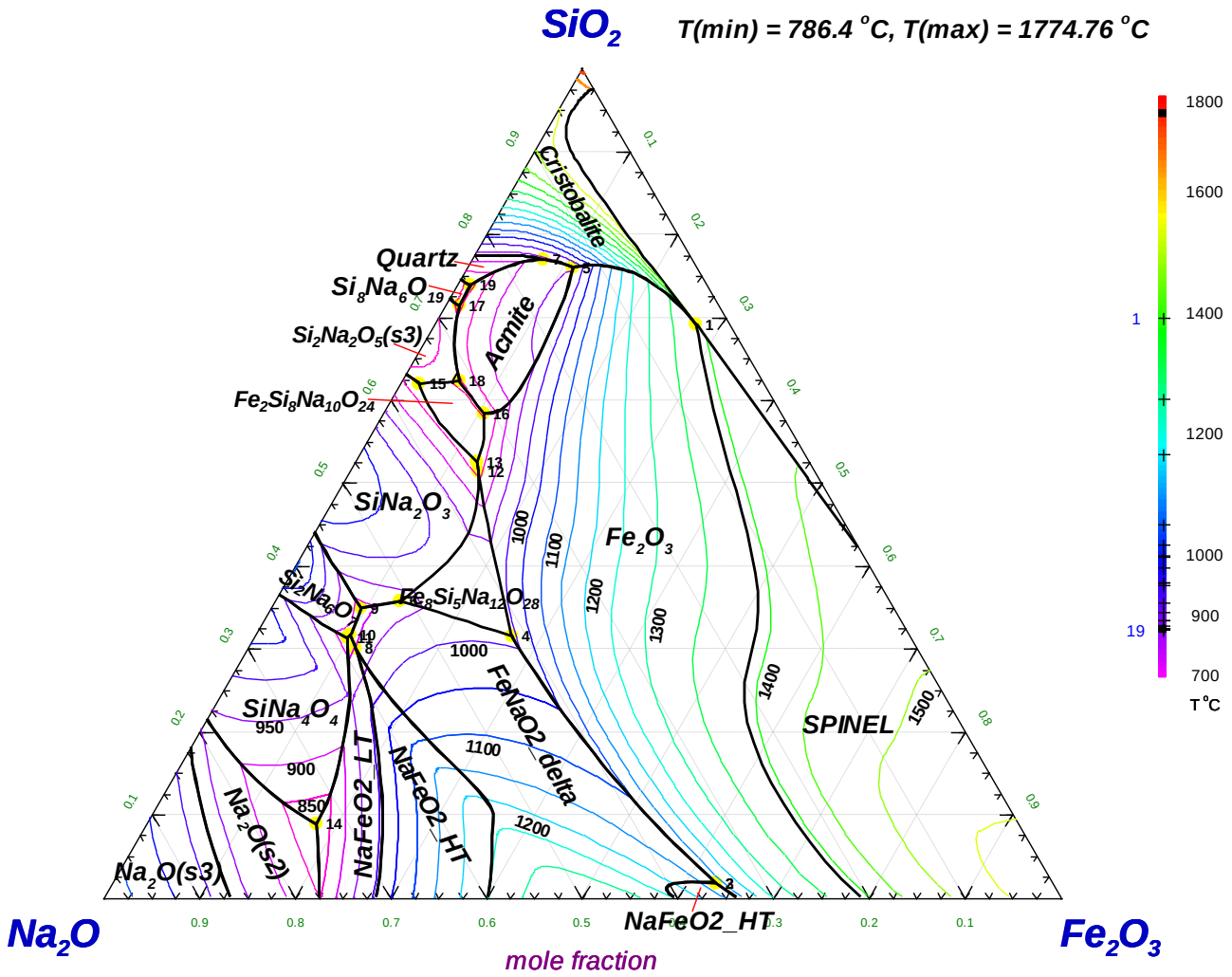




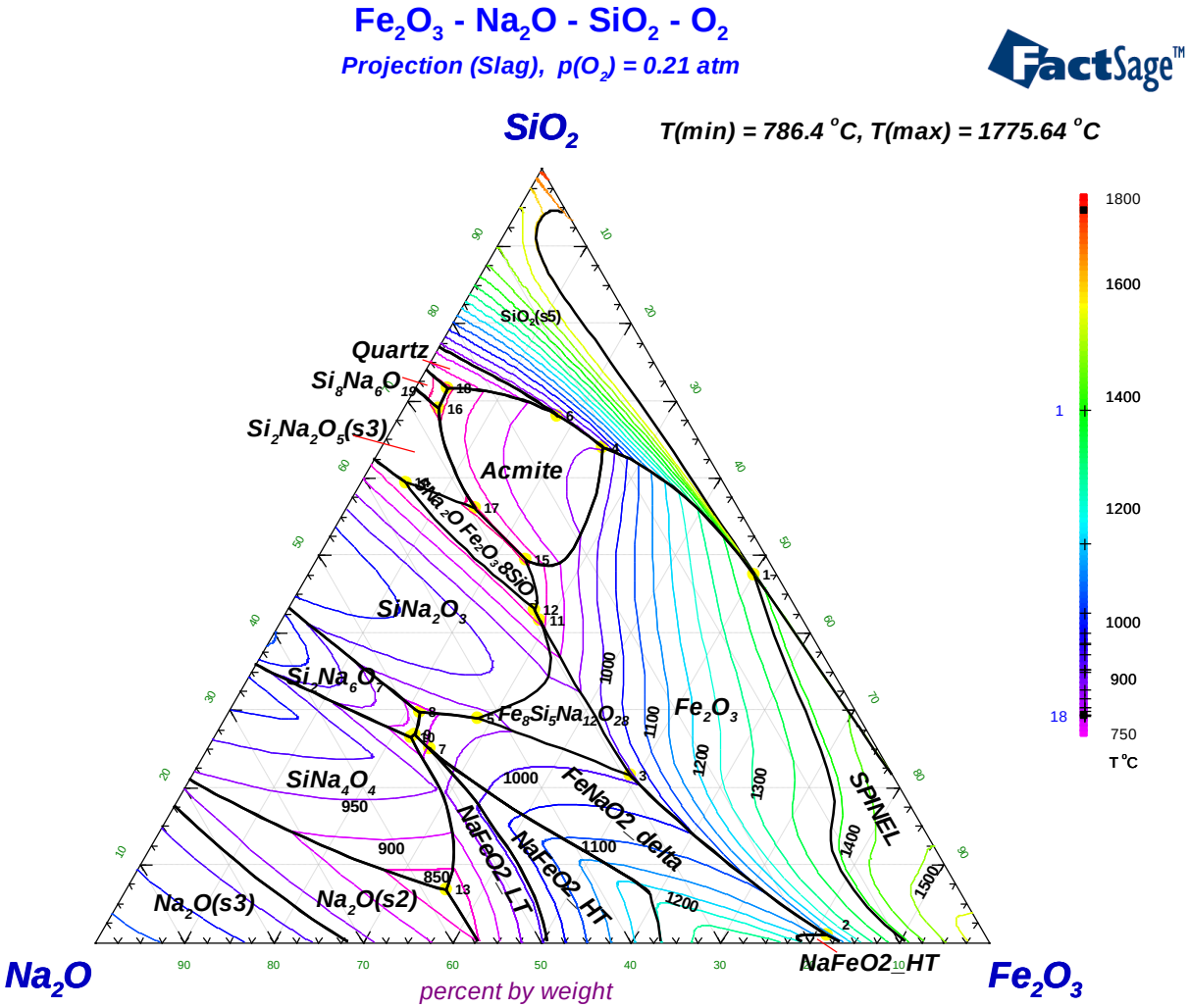
Mole fraction, Liquidussurface

Fe_2O_3 - Na_2O - SiO_2 - O_2

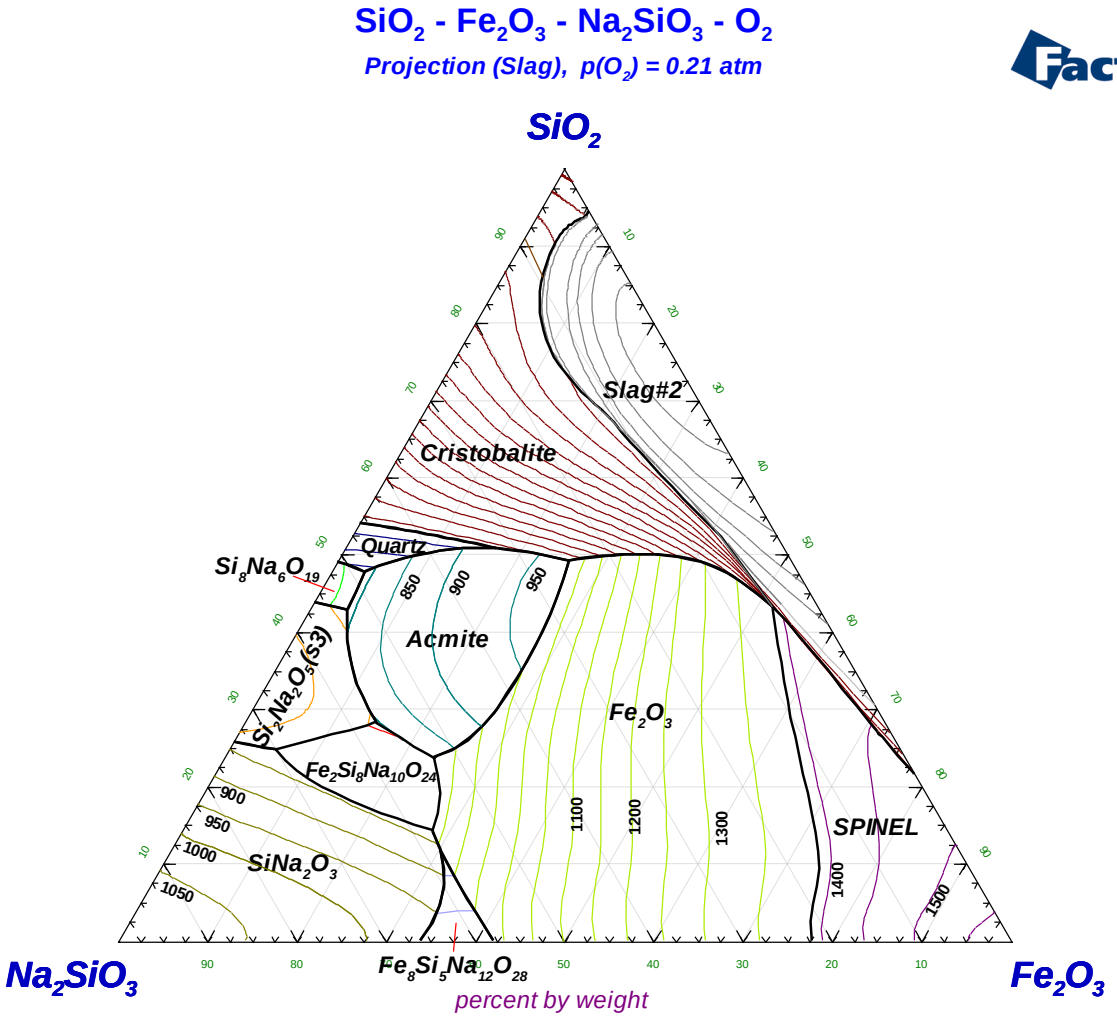
Projection (Slag), $p(O_2)$ = 0.21 atm



Weight percent, Liquidussurface



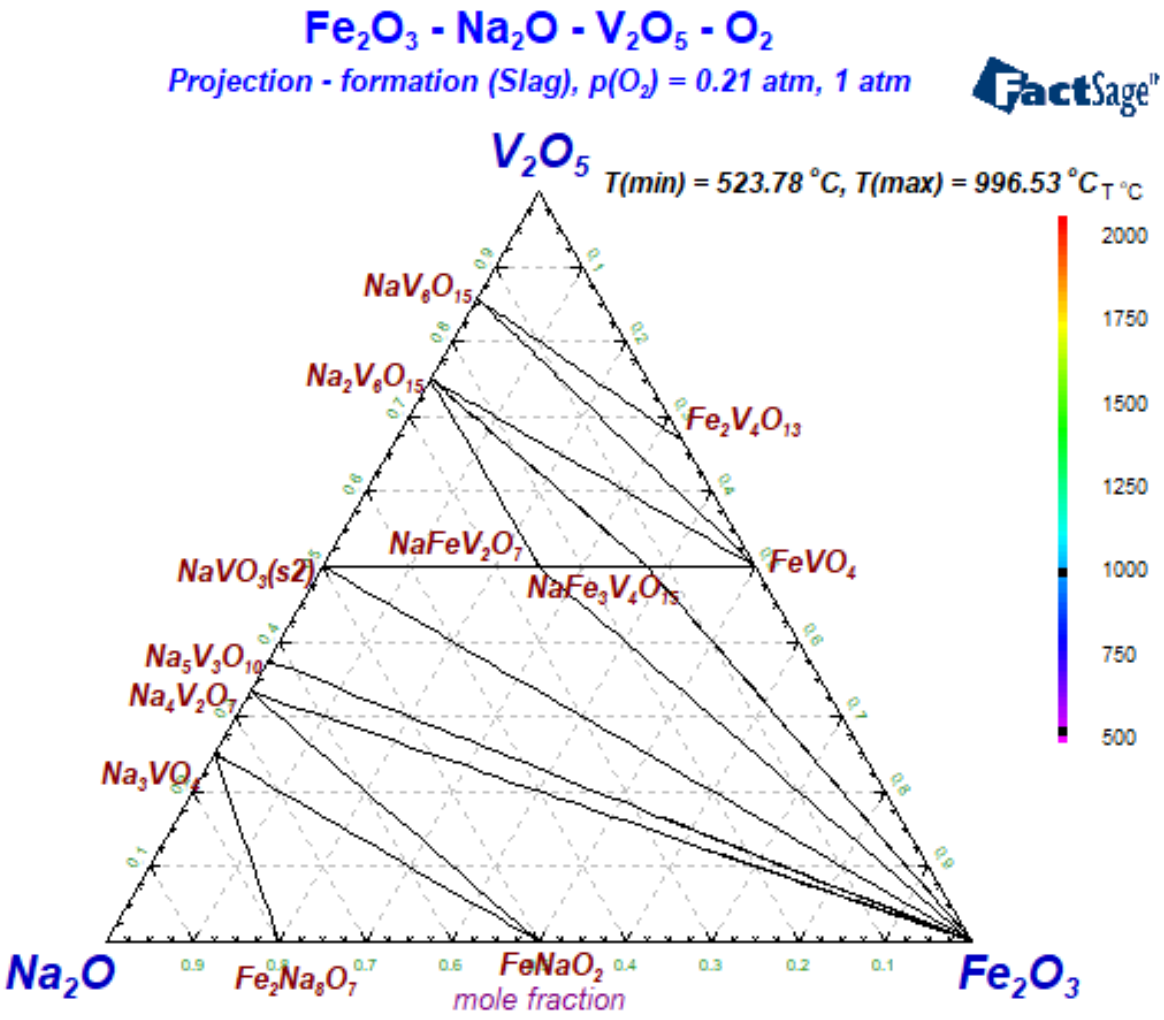
Weight percent,
Liquidussurface Fe2O3-Na2SiO3-SiO2

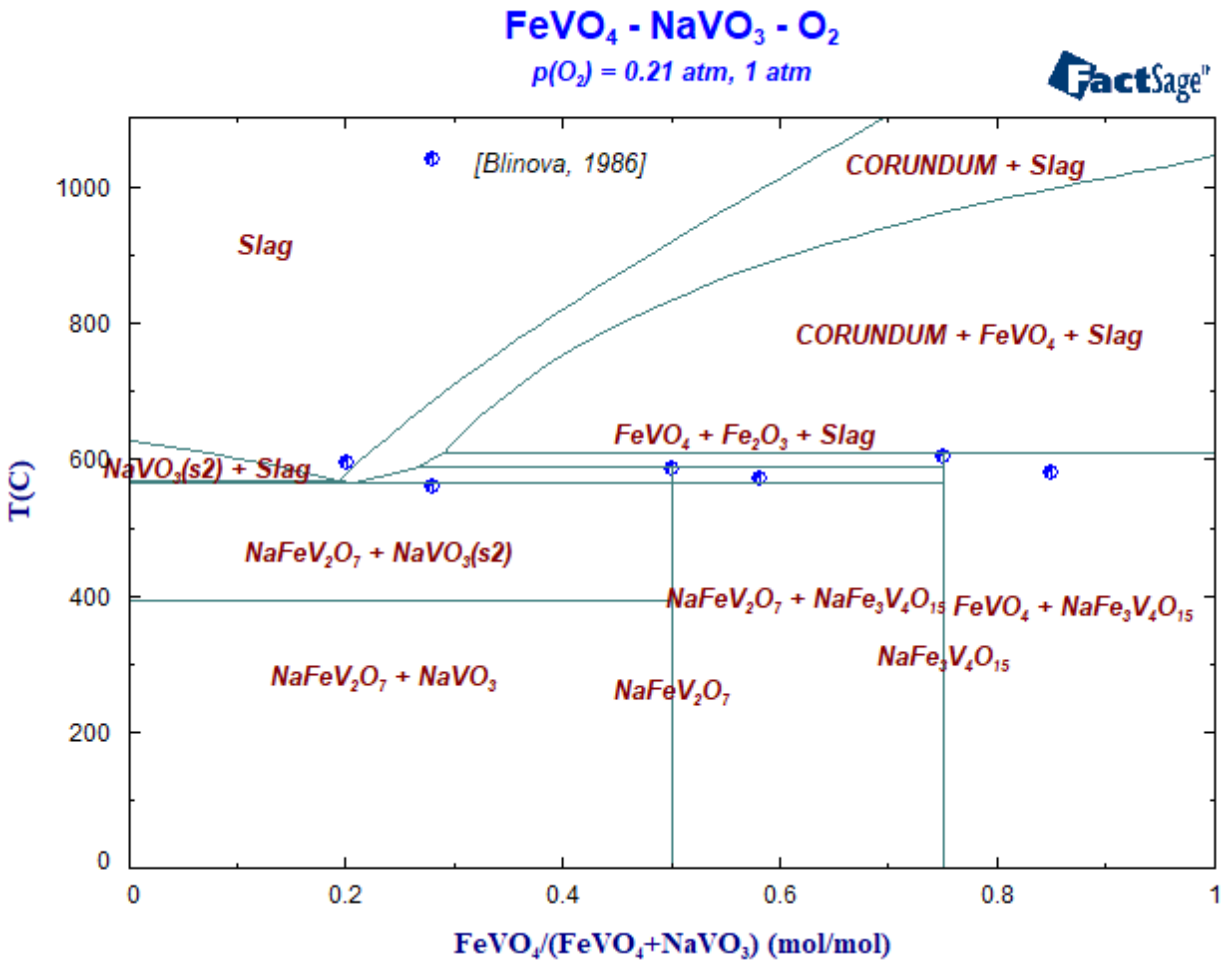


Invariant equilibria on the liquidus surface

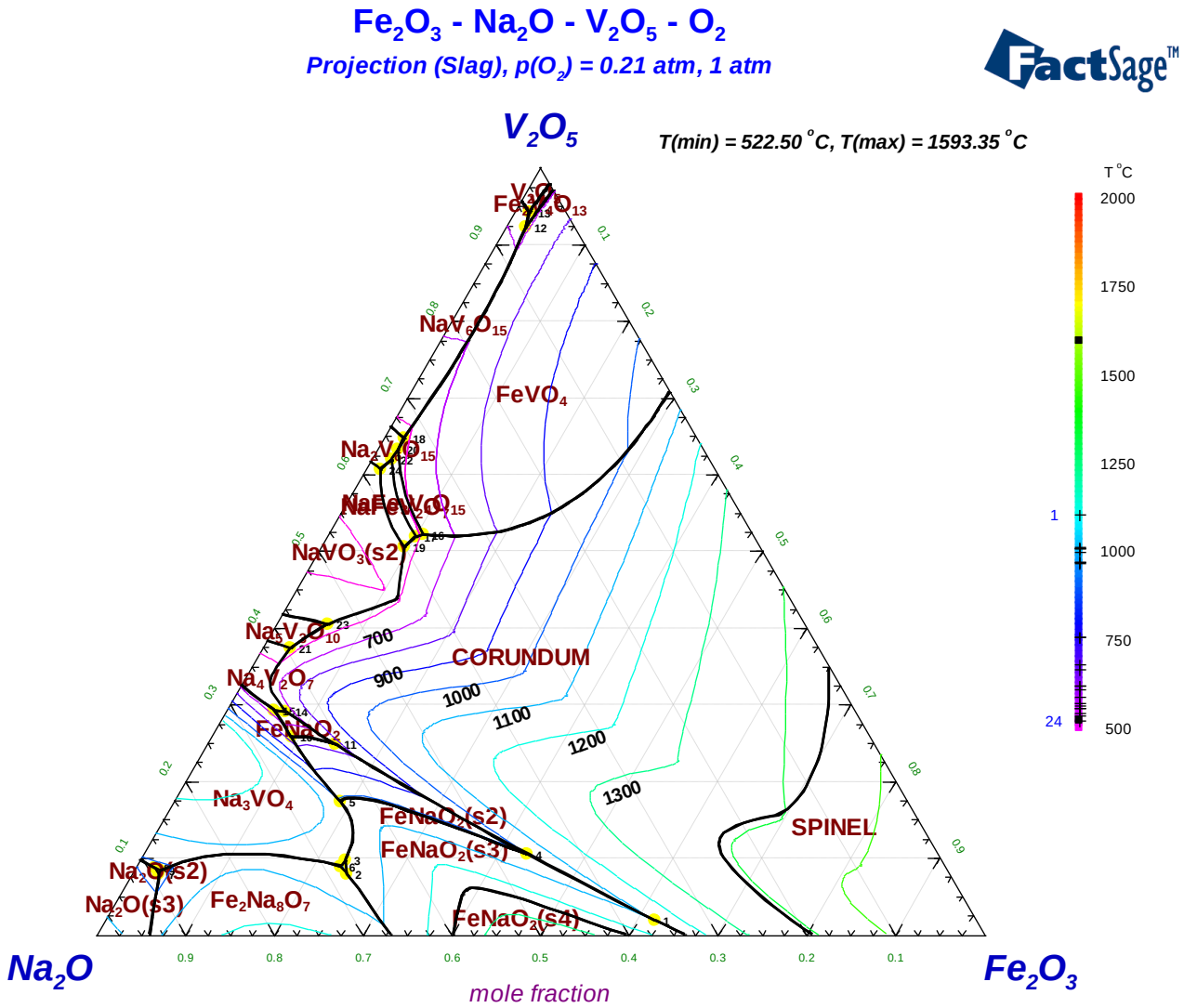
Intersections with slag	Mole fraction A = SiO2, B = Na2O, C = Fe2O3				Weight percent A = SiO2, B = Na2O, C = Fe2O3			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: Fe2O3 / SPINEL / Cristobalite	0.69142	0.03469	0.27389	1384.37	47.516	2.459	50.025	1384.36
2: NaFeO2_HT / Fe2O3 / FeNaO2_delta	0.01782	0.35086	0.63132	1122.80	0.866	17.589	81.544	1122.80
3: Fe2O3 / Fe8Si5Na12O28 / FeNaO2_delta	0.31457	0.41541	0.27002	988.58	21.535	29.335	49.130	988.58
4: Fe2O3 / Acmite / Cristobalite	0.76006	0.12891	0.11103	948.33	63.972	11.192	24.836	948.33
5: Fe8Si5Na12O28 / FeNaO2_delta / SiNa2O3	0.35732	0.51076	0.13192	927.31	28.937	42.668	28.394	927.31
6: Acmite / Cristobalite / Quartz	0.76945	0.15492	0.07563	926.28	68.077	14.139	17.784	926.28
7: NaFeO2_HT / NaFeO2_LT / FeNaO2_delta	0.30108	0.58556	0.11336	906.23	24.957	50.069	24.973	906.23
8: FeNaO2_delta / Si2Na6O7 / SiNa2O3	0.34889	0.55599	0.09512	877.14	29.687	48.802	21.511	877.14
9: NaFeO2_LT / FeNaO2_delta / Si2Na6O7	0.31733	0.58293	0.09974	876.88	26.807	50.798	22.395	876.87
10: NaFeO2_LT / Si2Na6O7 / SiNa4O4	0.31300	0.58875	0.09825	872.51	26.493	51.405	22.102	872.48
11: Fe2O3 / Fe8Si5Na12O28 / SiNa2O3	0.51333	0.35156	0.13511	838.20	41.563	29.362	29.075	838.18
12: Fe2O3 / Fe2Si8Na10O24 / SiNa2O3	0.52549	0.34680	0.12771	819.51	42.980	29.259	27.760	819.52
13: NaFeO2_LT / Na2O(s2) / SiNa4O4	0.08821	0.73342	0.17838	803.70	6.688	57.365	35.947	803.68
14: Fe2Si8Na10O24 / Si2Na2O5(s3) / SiNa2O3	0.62011	0.35935	0.02054	803.36	59.319	35.460	5.221	803.36
15: Fe2O3 / Acmite / Fe2Si8Na10O24	0.58430	0.31063	0.10507	794.51	49.350	27.063	23.586	794.51
16: Acmite / Si2Na2O5(s3) / Si8Na6O19	0.71357	0.27086	0.01557	788.35	68.987	27.012	4.000	788.35
17: Acmite / Fe2Si8Na10O24 / Si2Na2O5(s3)	0.62245	0.31666	0.06089	788.17	56.030	29.403	14.566	788.17
18: Acmite / Si8Na6O19 / Quartz	0.73837	0.24738	0.01425	786.43	71.588	24.741	3.671	786.40

FeO-Na2O-V2O5,
Mole fraction, Subsolidus surface

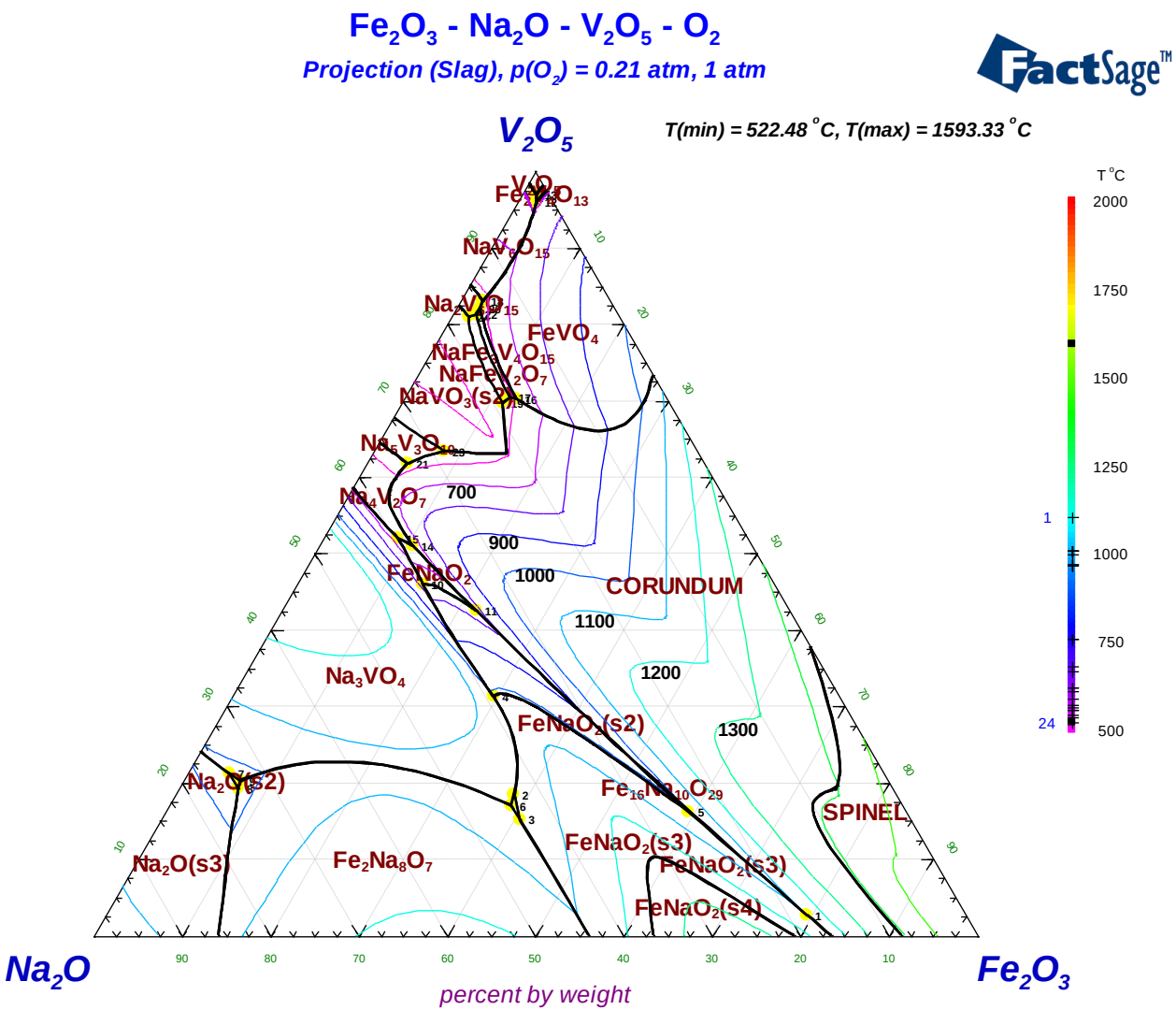



FeVO4 - NaVO3 - O2
p(O2) = 0.21 atm, 1 atm
FactSage
[Blinova, 1986]
CORUNDUM + Slag
Slag
CORUNDUM + FeVO4 + Slag
FeVO4 + Fe2O3 + Slag
NaVO3(s2) + Slag
NaFeV2O7 + NaVO3(s2)
NaFeV2O7 + NaFe3V4O15
FeVO4 + NaFe3V4O15
NaFe3V4O15
NaFeV2O7 + NaVO3
NaFeV2O7
T(C)
1000
800
600
400
200
0
0
0.2
0.4
0.6
0.8
1
FeVO4/(FeVO4+NaVO3) (mol/mol)

FeO-Na2O-V2O5,
Mole fraction, Liquidus surface



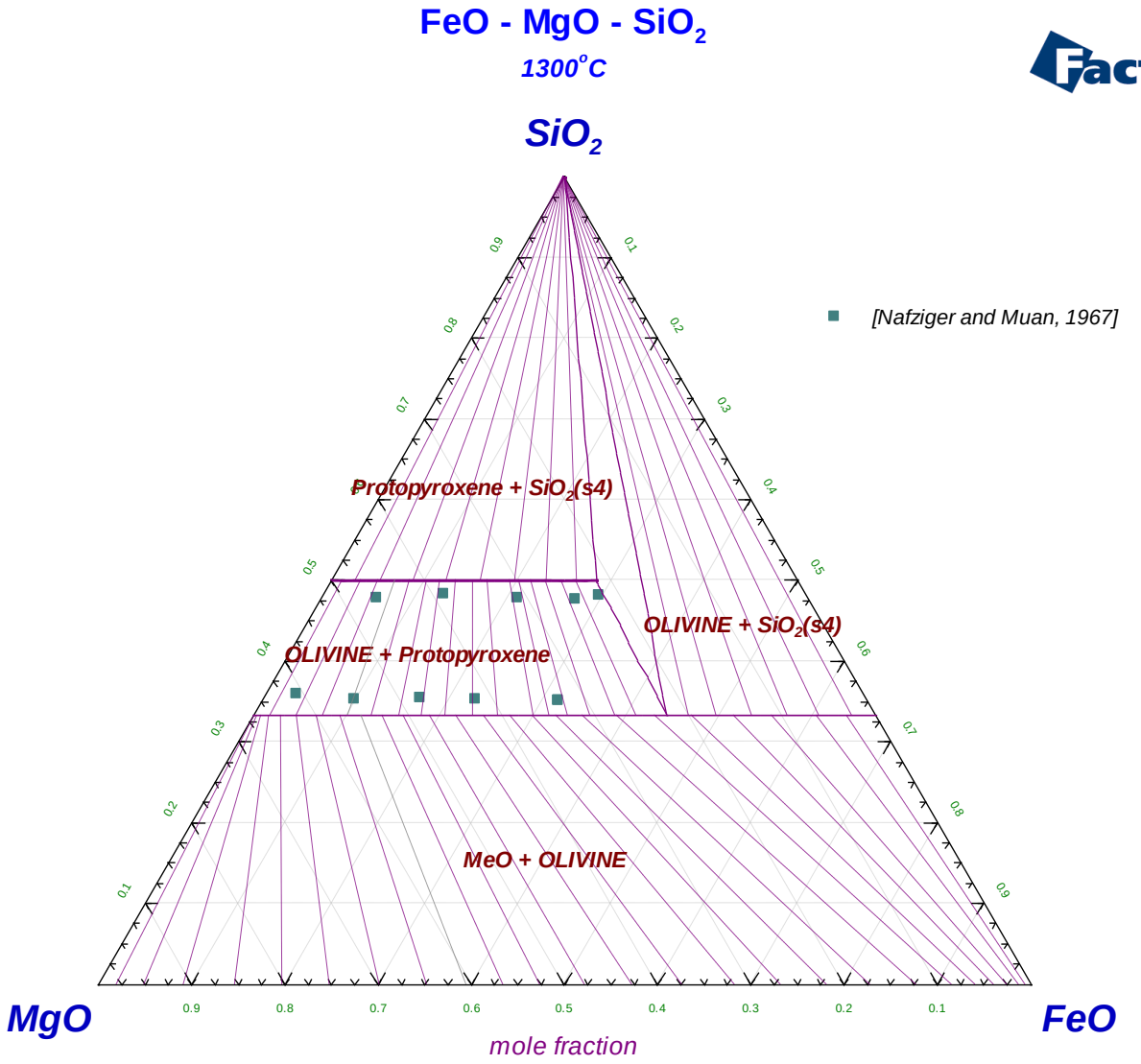
FeO-Na2O-V2O5,
Weight percent, Liquidus surface

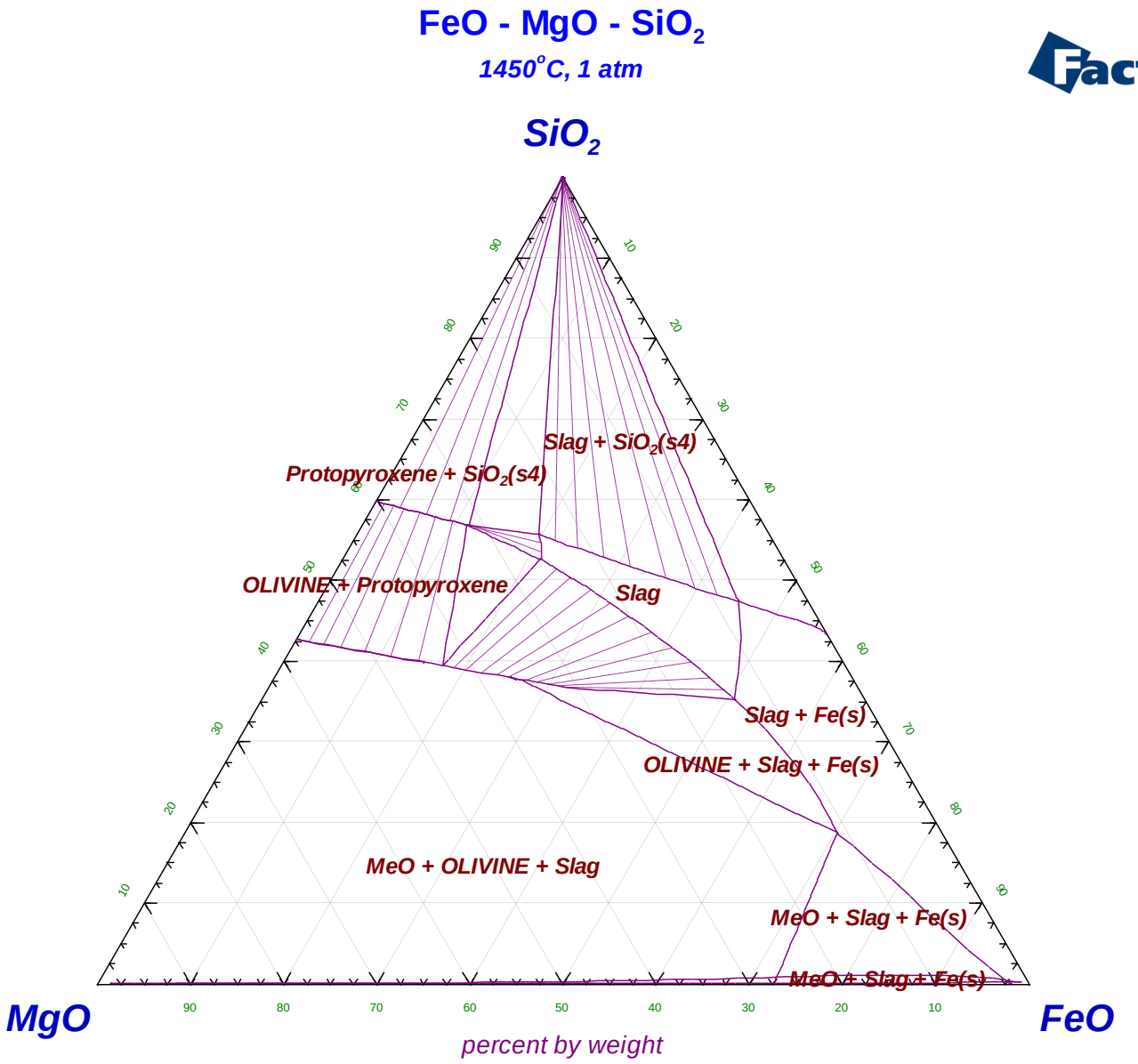


Invariant equilibria on the liquidus surface

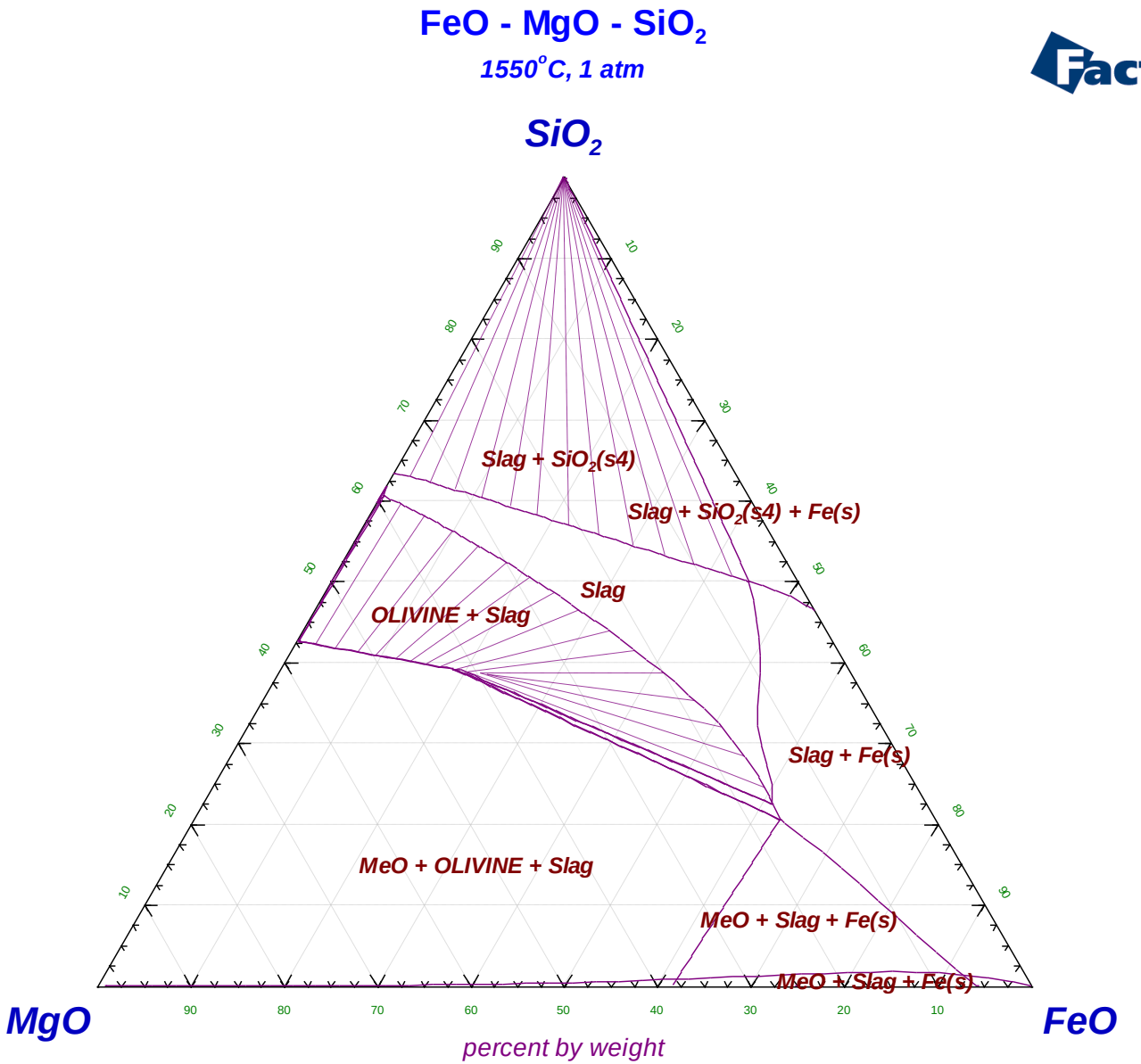
Intersections with slag	Mole fraction					Weight percent				
	A = V2O5, B = Na2O, C = Fe2O3					A = V2O5, B = Na2O, C = Fe2O3				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: CORUNDUM / Fe16Na10O29 / FeNaO2(s3)	1:	0.01896	0.36092	0.62012	1105.21	1:	2.763	17.919	79.318	1105.22
2: Fe2Na8O7 / FeNaO2(s3) / FeNaO2(s2)	2:	0.07967	0.67805	0.24228	1012.77	2:	18.408	43.210	38.382	1009.87
3: FeNaO2(s3) / FeNaO2(s2) / Na3VO4	3:	0.09743	0.67118	0.23139	1009.87	3:	15.220	44.141	40.639	1009.86
4: Fe16Na10O29 / FeNaO2(s3) / FeNaO2(s2)	4:	0.10426	0.46243	0.43331	1009.85	4:	31.306	39.130	29.564	1009.85
5: FeNaO2(s3) / FeNaO2(s2) / Na3VO4	5:	0.17411	0.63862	0.18727	1009.85	5:	16.233	24.535	59.233	1009.85
6: Fe2Na8O7 / FeNaO2(s2) / Na3VO4	6:	0.08952	0.67984	0.23064	996.53	6:	17.094	44.237	38.668	996.53
7: Fe2Na8O7 / Na2O(s2) / Na2O(s3)	7:	0.07904	0.88959	0.03137	971.74	7:	21.270	74.067	4.663	970.05
8: Na2O(s2) / Na2O(s3) / Na3VO4	8:	0.08720	0.89103	0.02177	970.05	8:	19.291	73.987	6.722	970.05
9: Fe2Na8O7 / Na2O(s2) / Na3VO4	9:	0.08384	0.88607	0.03008	964.82	9:	20.341	73.252	6.408	964.83
10: FeNaO2(s2) / FeNaO2(s) / Na3VO4	10:	0.25754	0.65190	0.09056	759.85	10:	46.056	39.726	14.218	759.85
11: CORUNDUM / Fe16Na10O29 / FeNaO2(s)	11:	0.24800	0.60629	0.14571	759.76	11:	42.572	35.467	21.961	759.76
12: Fe2V4O13 / FeVO4 / NaV6O15	12:	0.92322	0.05469	0.02209	681.08	12:	96.043	1.939	2.018	681.08
13: Fe2V4O13 / NaV6O15 / V2O5	13:	0.94192	0.04163	0.01645	666.14	13:	97.051	1.461	1.488	666.13
14: Fe2O3 / FeNaO2(s) / Na4V2O7	14:	0.29082	0.64121	0.06797	621.24	14:	51.110	38.402	10.488	621.24
15: FeNaO2(s) / Na3VO4 / Na4V2O7	15:	0.29306	0.65322	0.05372	620.35	15:	52.070	39.550	8.380	620.36
16: CORUNDUM / FeVO4 / NaFe3V4O15	16:	0.52230	0.37059	0.10711	609.32	16:	70.332	17.005	12.663	609.32
17: CORUNDUM / NaFe3V4O15 / NaFeV2O7	17:	0.51926	0.38116	0.09958	587.91	17:	70.496	17.634	11.870	587.90
18: FeVO4 / Na2V6O15 / NaV6O15	18:	0.64813	0.32963	0.02223	573.09	18:	83.096	14.401	2.502	573.07
19: CORUNDUM / NaFeV2O7 / NaVO3(s2)	19:	0.50531	0.40098	0.09372	564.49	19:	69.772	18.867	11.361	564.48
20: FeVO4 / Na2V6O15 / NaFe3V4O15	20:	0.63254	0.34377	0.02370	558.98	20:	82.096	15.204	2.700	559.00
21: CORUNDUM / Na4V2O7 / Na5V3O10	21:	0.37354	0.59494	0.03151	558.95	21:	61.850	33.569	4.581	558.95
22: Na2V6O15 / NaFe3V4O15 / NaFeV2O7	22:	0.62004	0.35712	0.02283	544.46	22:	81.393	15.975	2.632	544.44
23: CORUNDUM / Na5V3O10 / NaVO3(s2)	23:	0.40534	0.53722	0.05744	536.58	23:	63.449	28.657	7.894	536.58
24: Na2V6O15 / NaFeV2O7 / NaVO3(s2)	24:	0.60712	0.37650	0.01637	522.50	24:	80.971	17.111	1.917	522.48

Mole fraction 1300°C

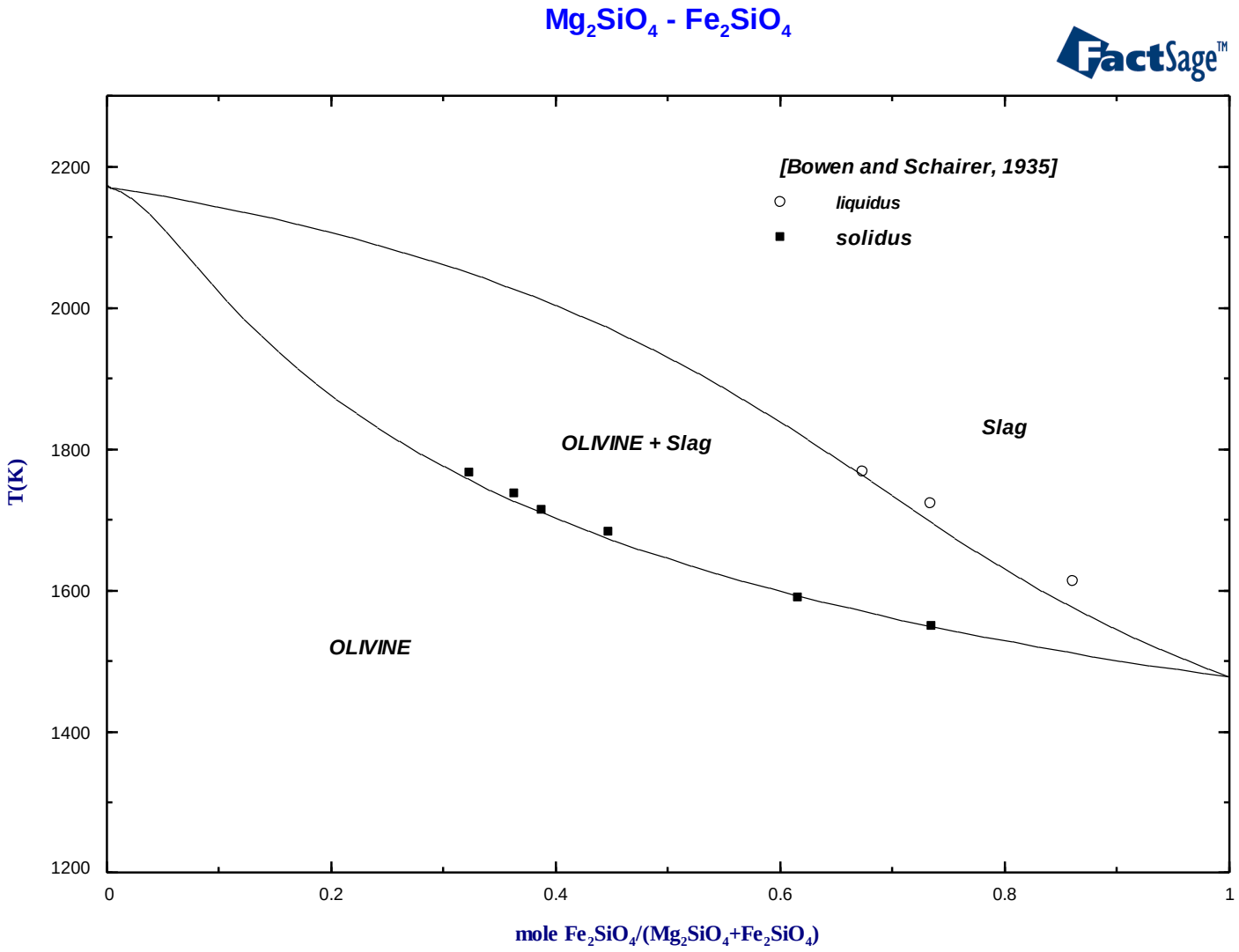



FeO - MgO - SiO2
1450°C, 1 atm
SiO2
Slag + SiO2(s4)
Protopyroxene + SiO2(s4)
OLIVINE + Protopyroxene
Slag
Slag + Fe(s)
OLIVINE + Slag + Fe(s)
MeO + OLIVINE + Slag
MeO + Slag + Fe(s)
MeO + Slag + Fe(s)
MgO
FeO
90
80
70
60
50
40
30
20
10
percent by weight

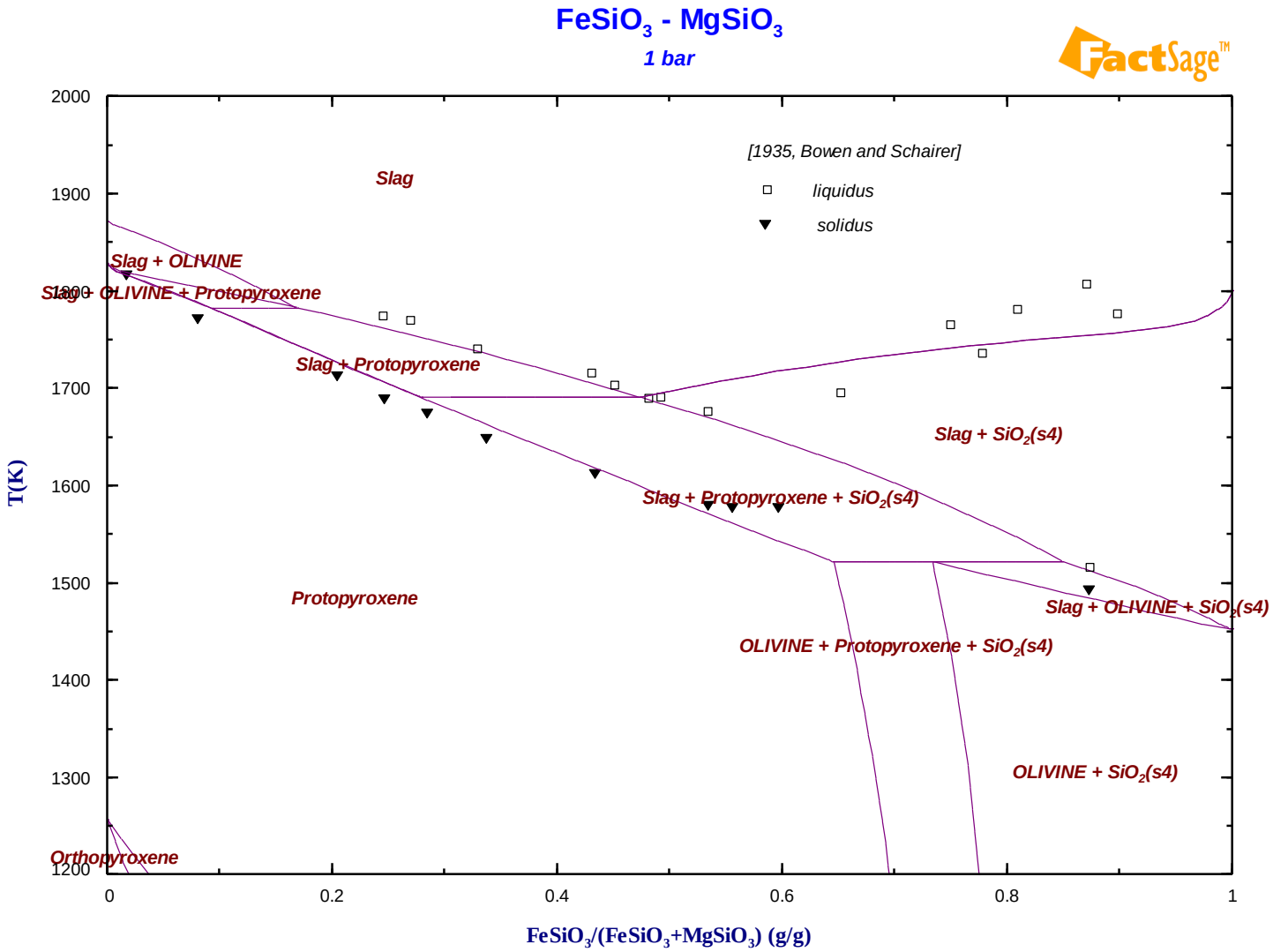
Weight percent 1550°C



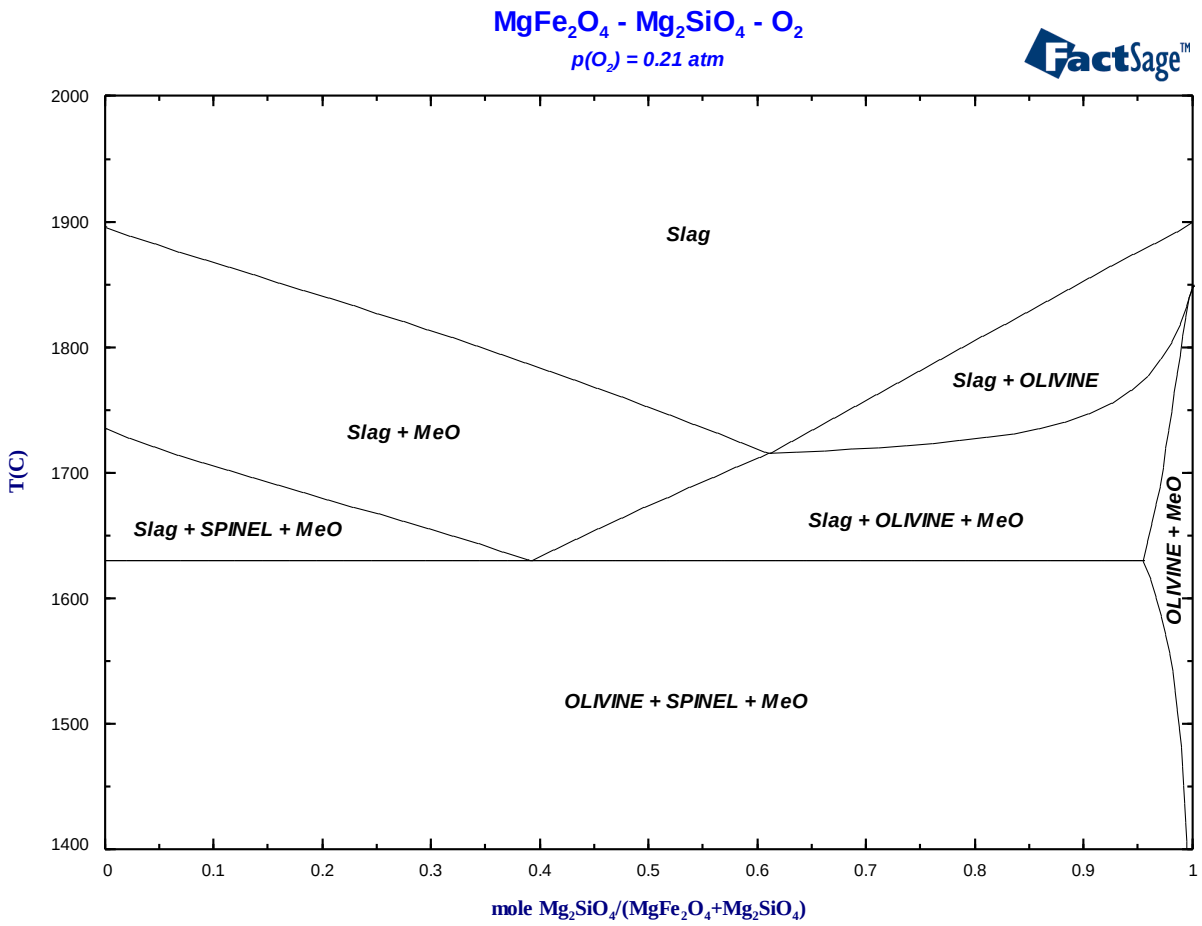
Mole fraction in Kelvin compared with experimental data



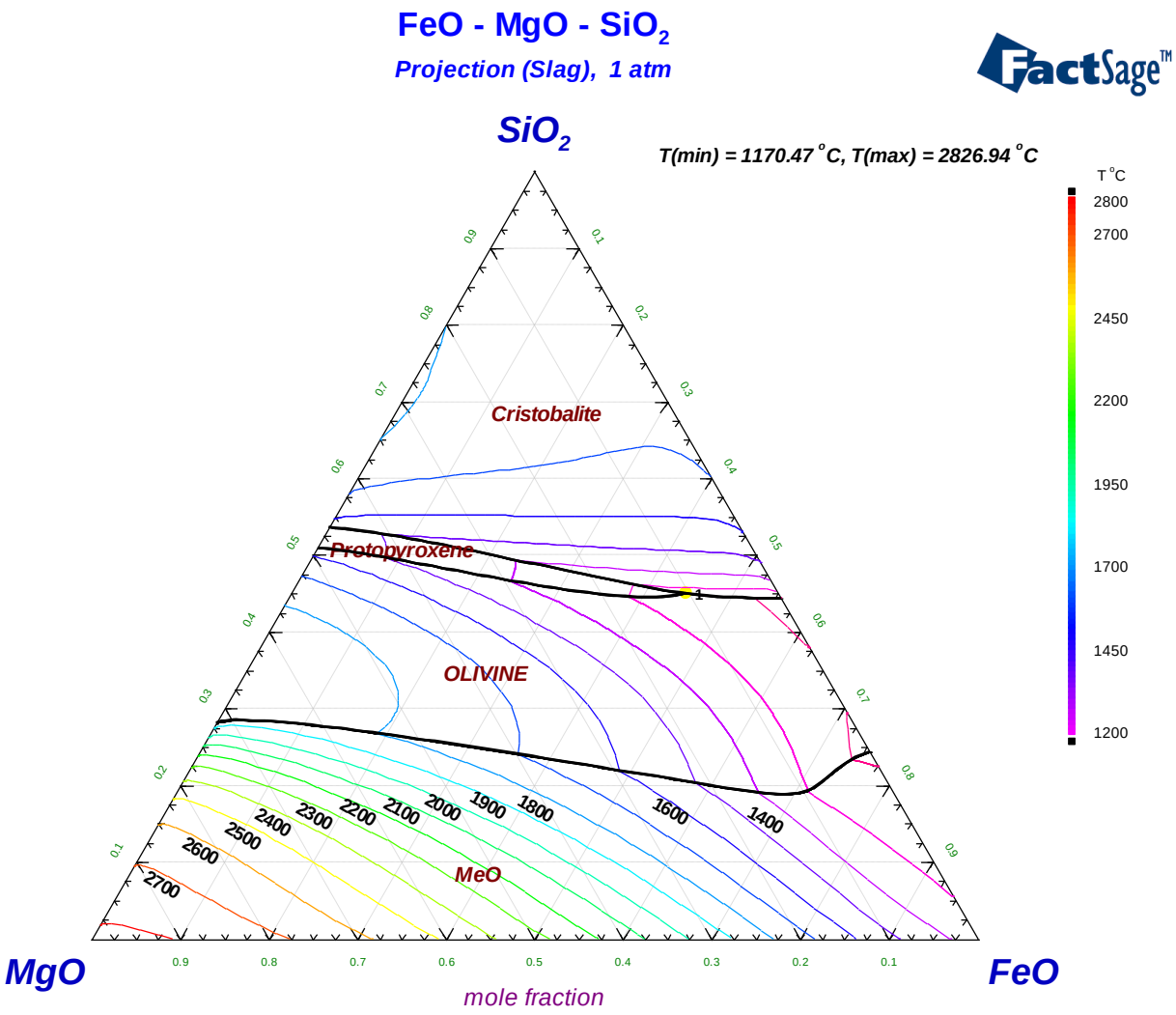
Mole fraction in Kelvin MgSiO3-FeSiO3 compared with experimental data



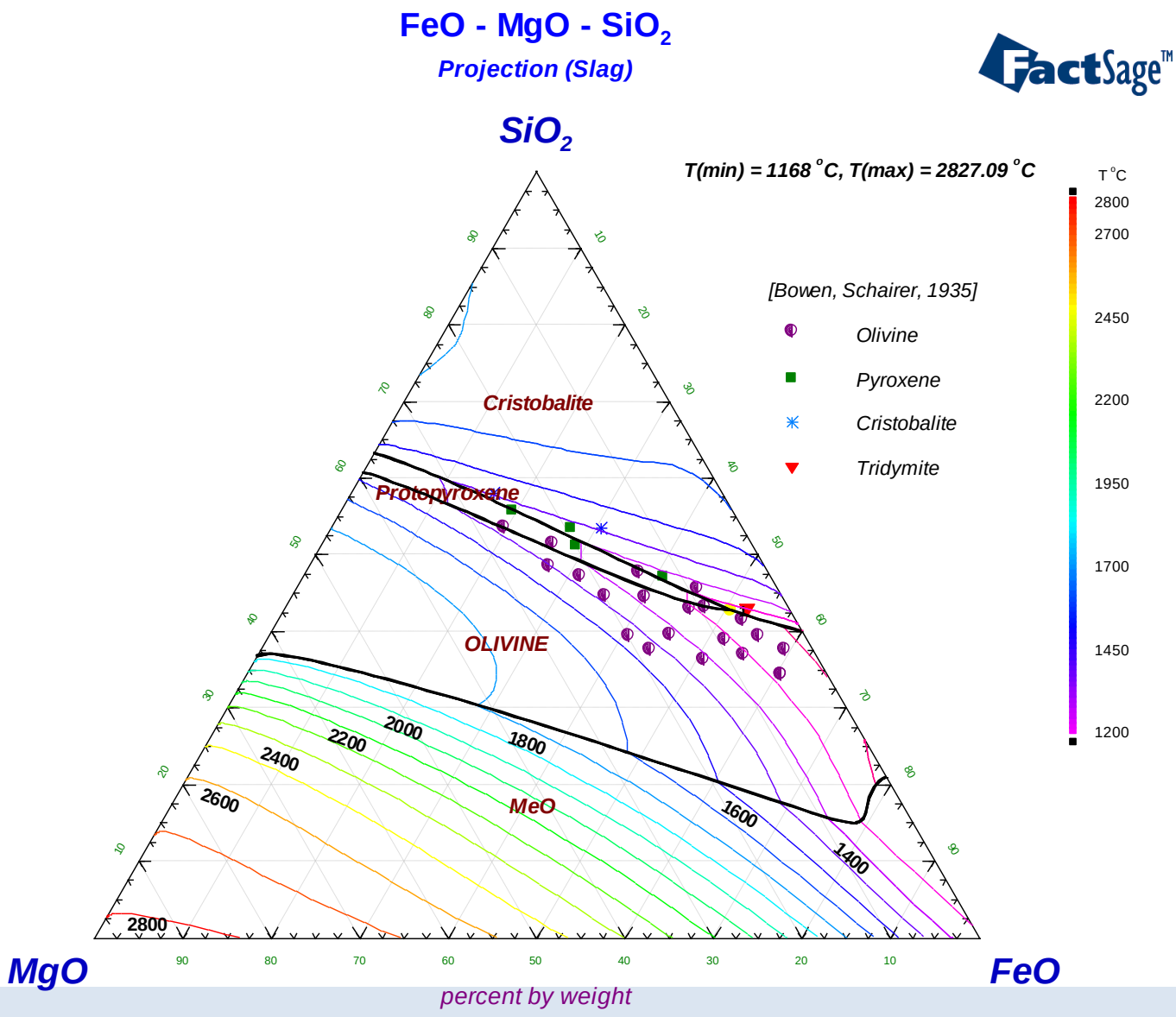
Mole fraction MgFe2O4-Mg2SiO4-O2



Mole fraction, Liquidussurface



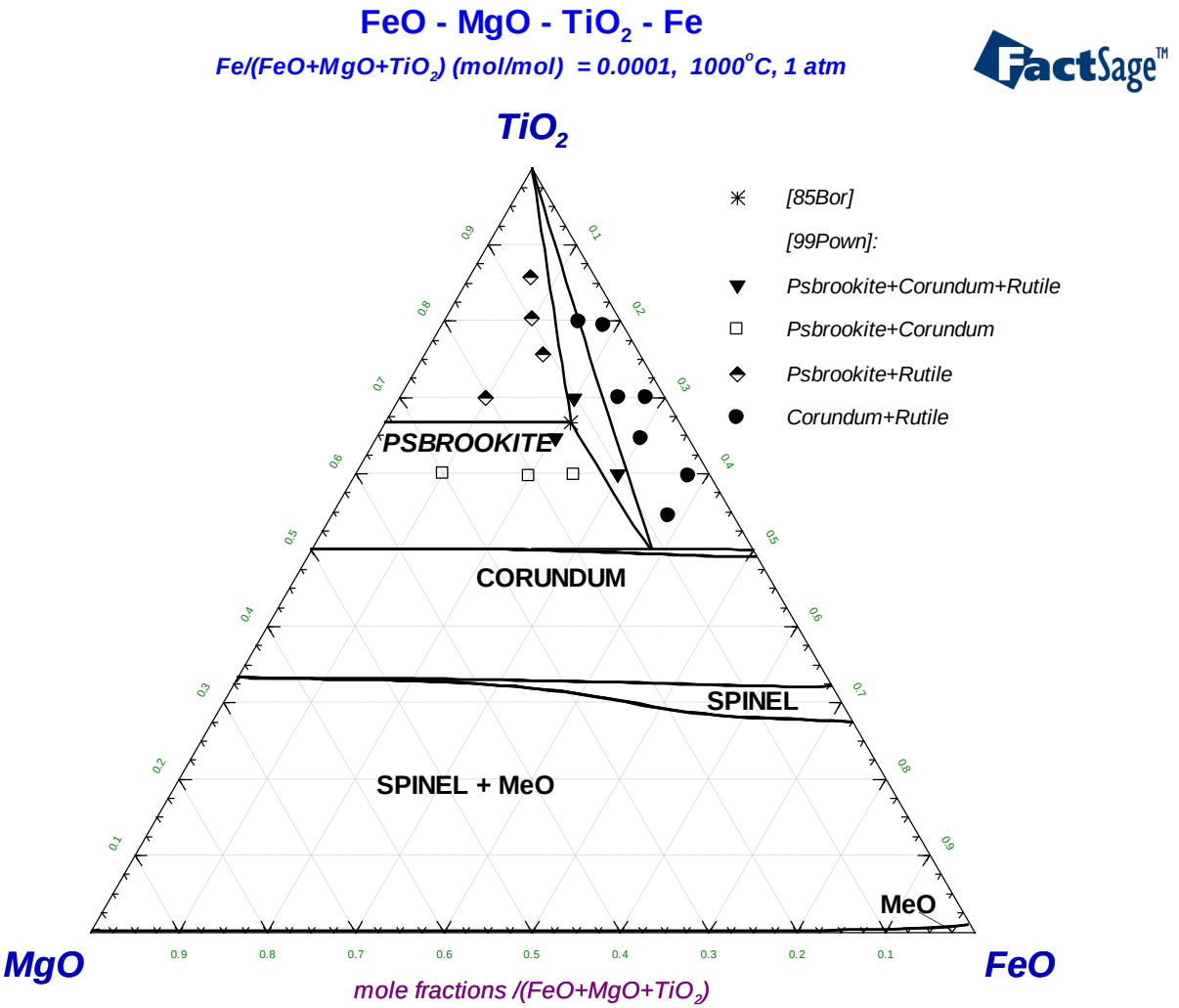
Weight percent,
Liquidussurface compared with experimental data



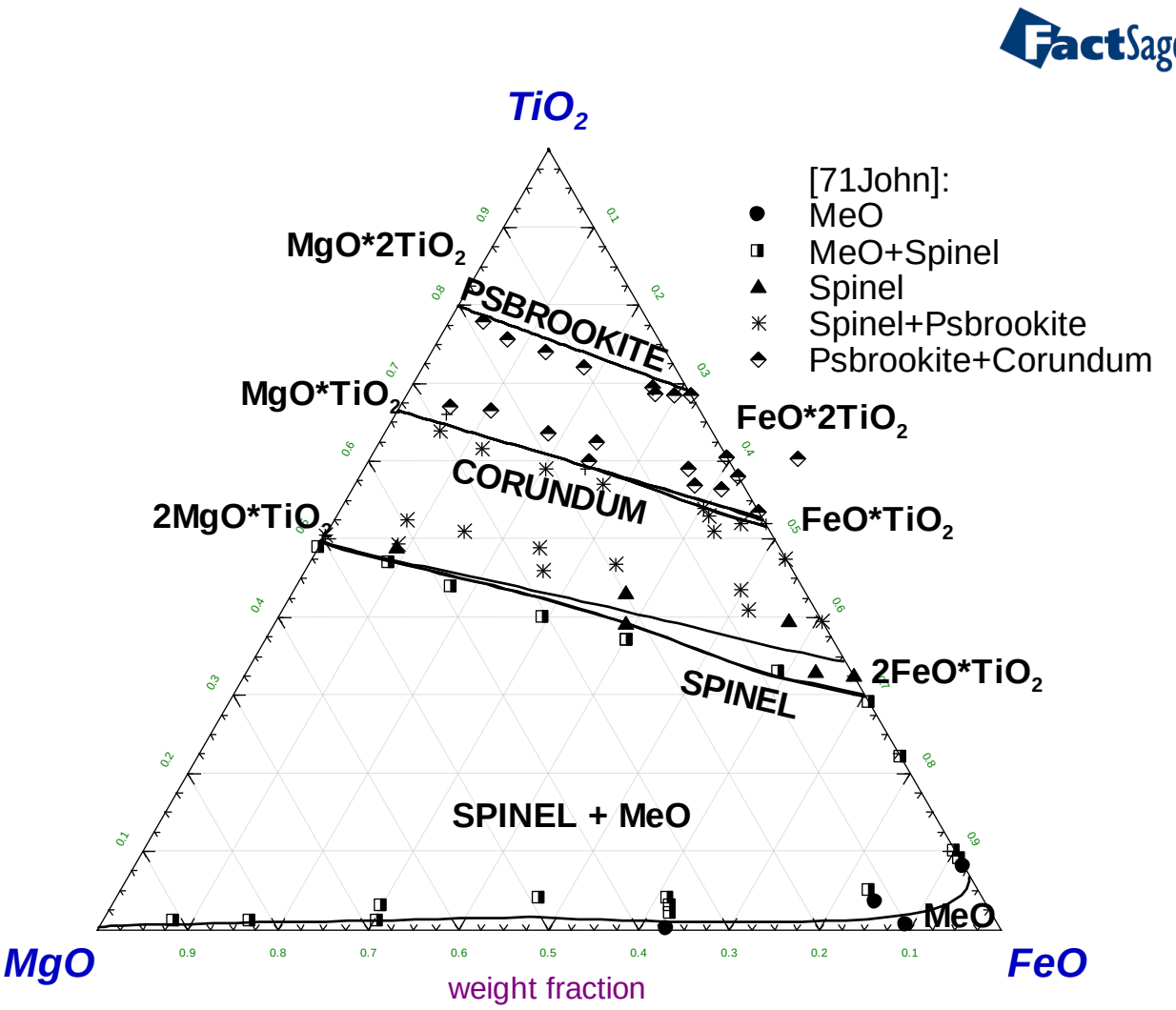
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction				Weight percent			
	A = SiO2, B = MgO, C = FeO				A = SiO2, B = MgO, C = FeO			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: PROTOPYROXENE / OLIVINE / Cristobalite	1: 0.44990	0.10418	0.44591	1248.50	1: 42.745	6.623	..50.632	1248.63

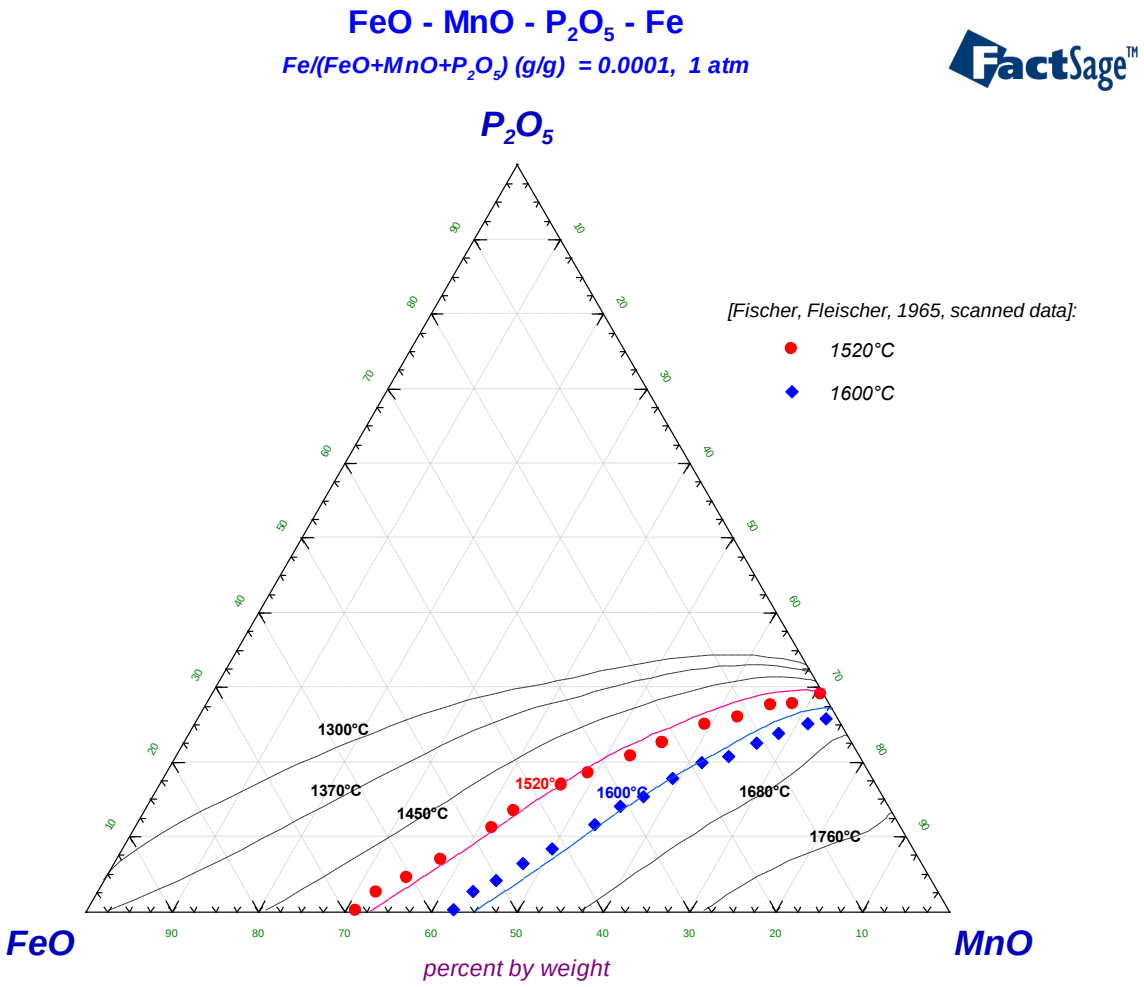
FeO-MgO-TiO2,
Mole fraction, 1000°C



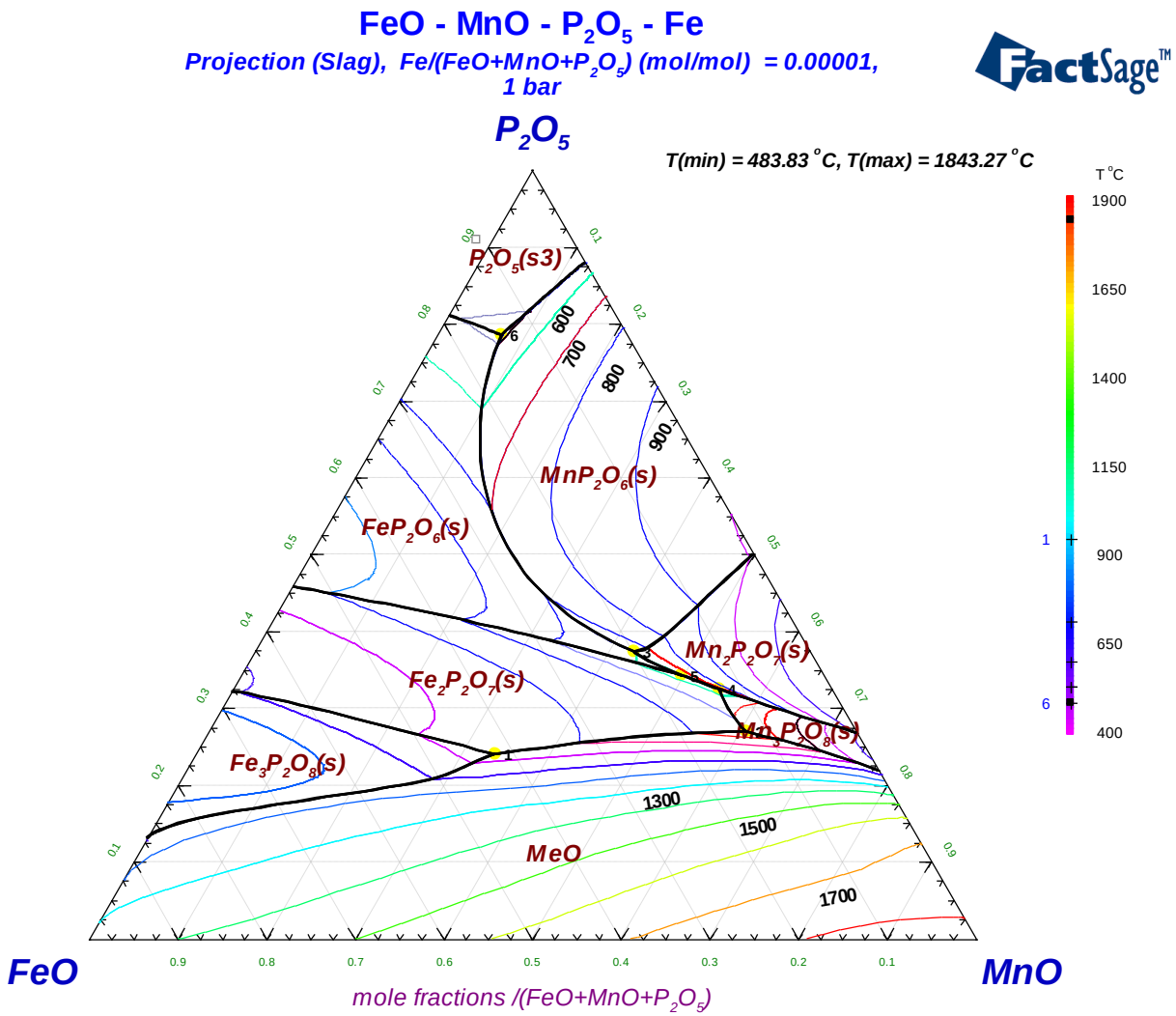
FeO-MgO-TiO2,
Weight percent 1300°C compared with experimental data

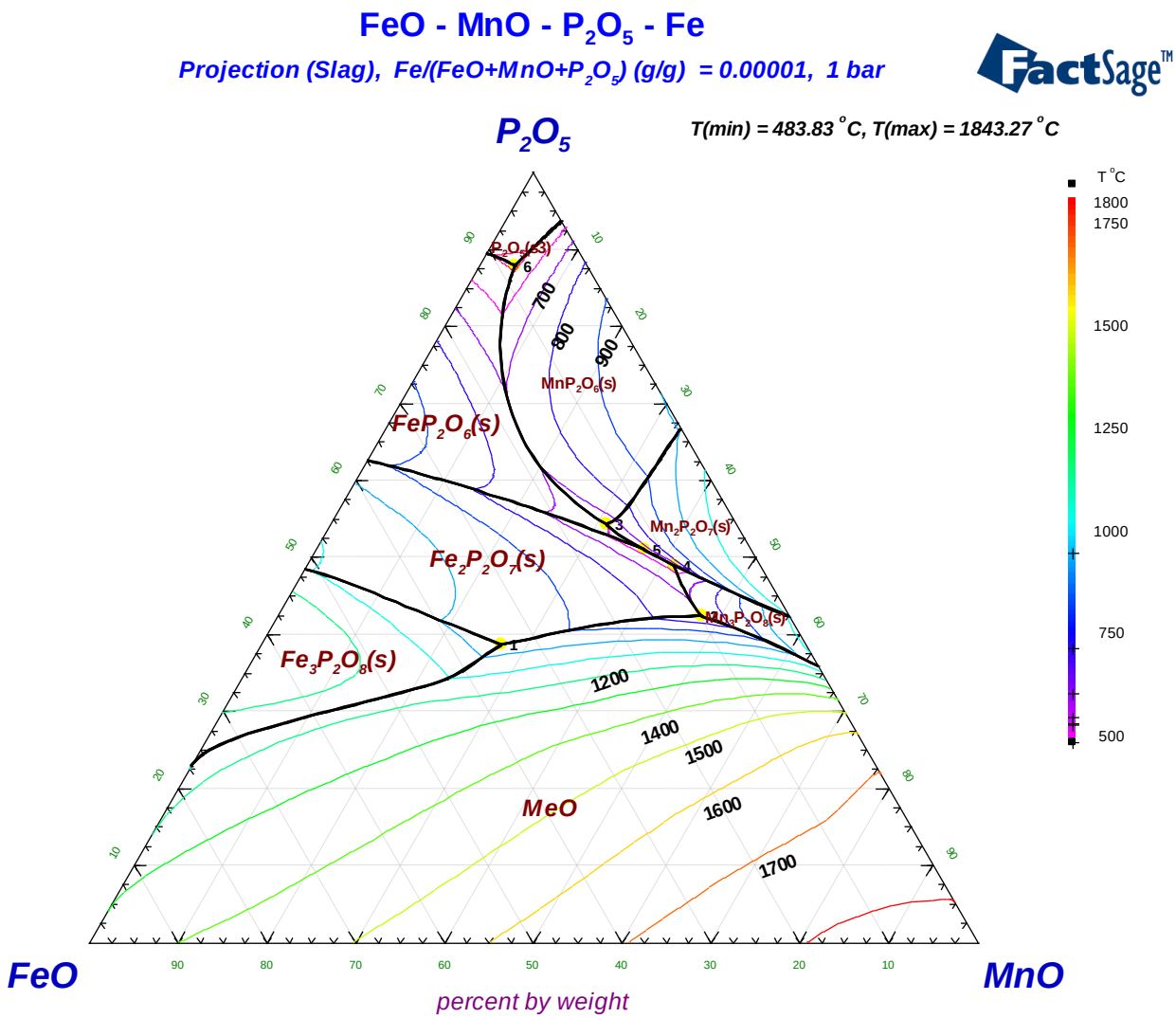


FeO-MnO-P2O5,
Weight percent, Part of liquidus surface



Mole fraction, Liquidus surface

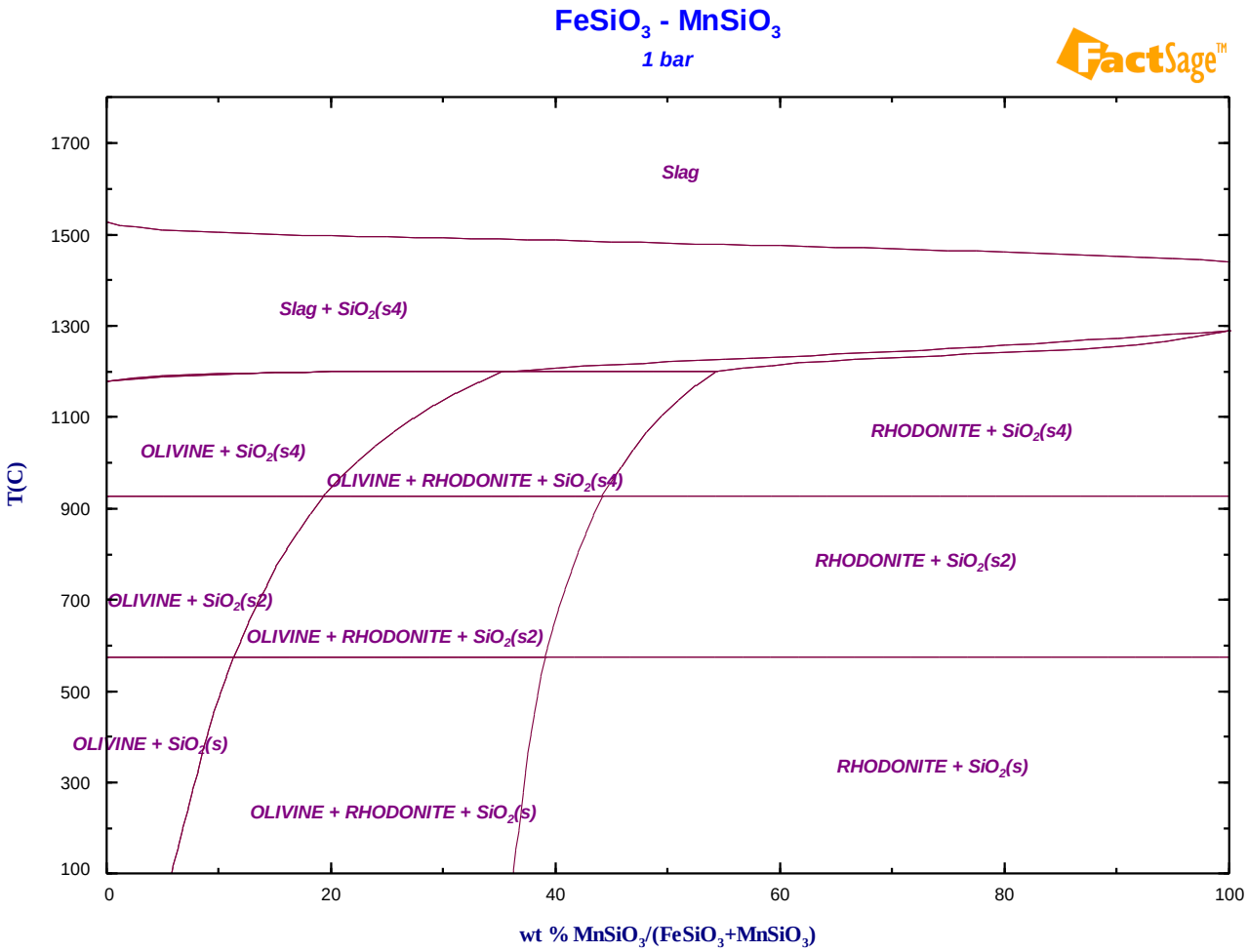



FeO - MnO - P2O5 - Fe
Projection (Slag), Fe/(FeO+MnO+P2O5) (g/g) = 0.00001, 1 bar
FactSage™
P2O5
T(min) = 483.83 °C, T(max) = 1843.27 °C
T °C
1800
1750
1500
1250
1000
750
500
P2O5(s)
MnP2O6(s)
FeP2O6(s)
Mn2P2O7(s)
Fe2P2O7(s)
Mn3P2O8(s)
Fe3P2O8(s)
MeO
700
800
900
1200
1400
1500
1600
1700
FeO
MnO
percent by weight

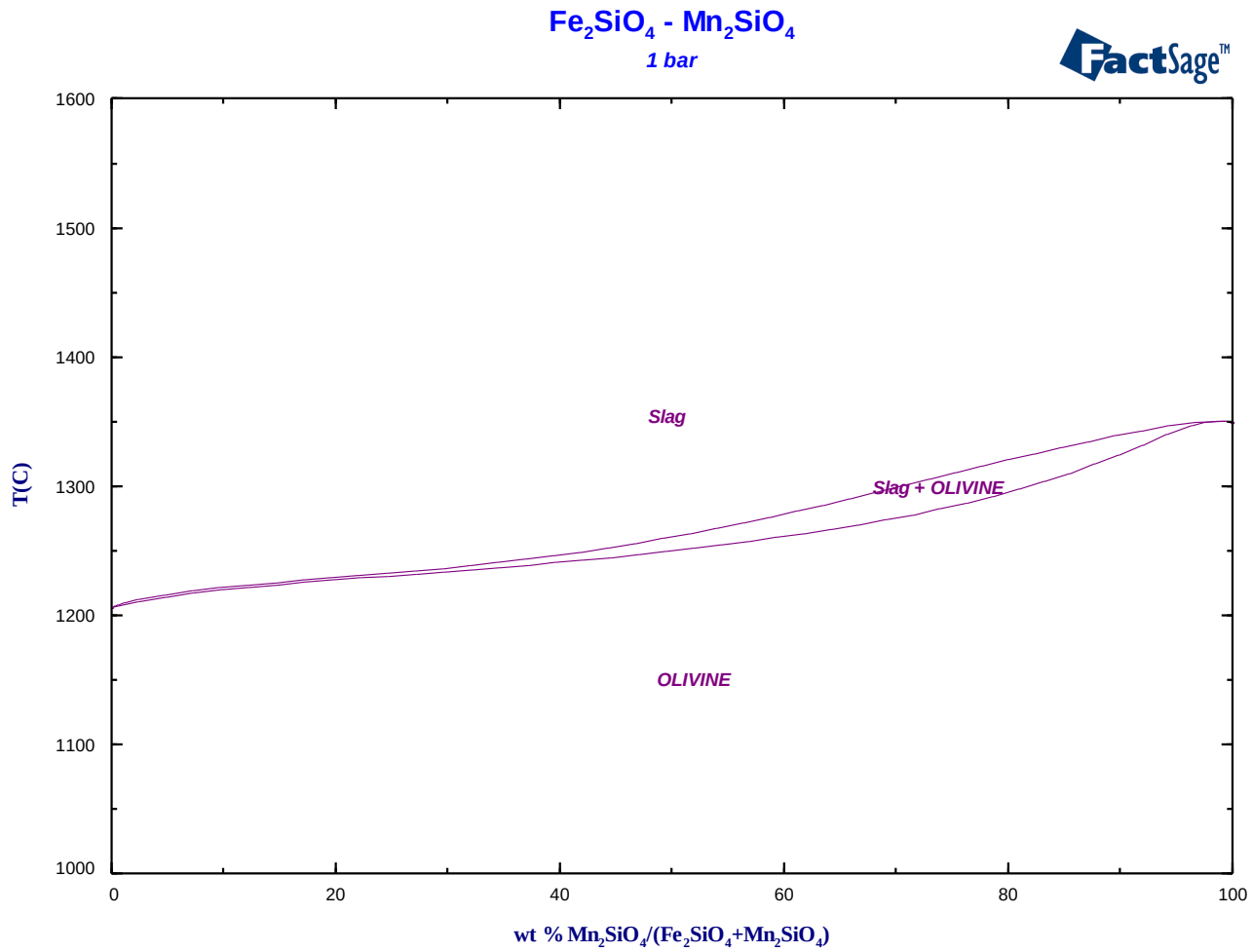
Invariant equilibria on the liquidus surface

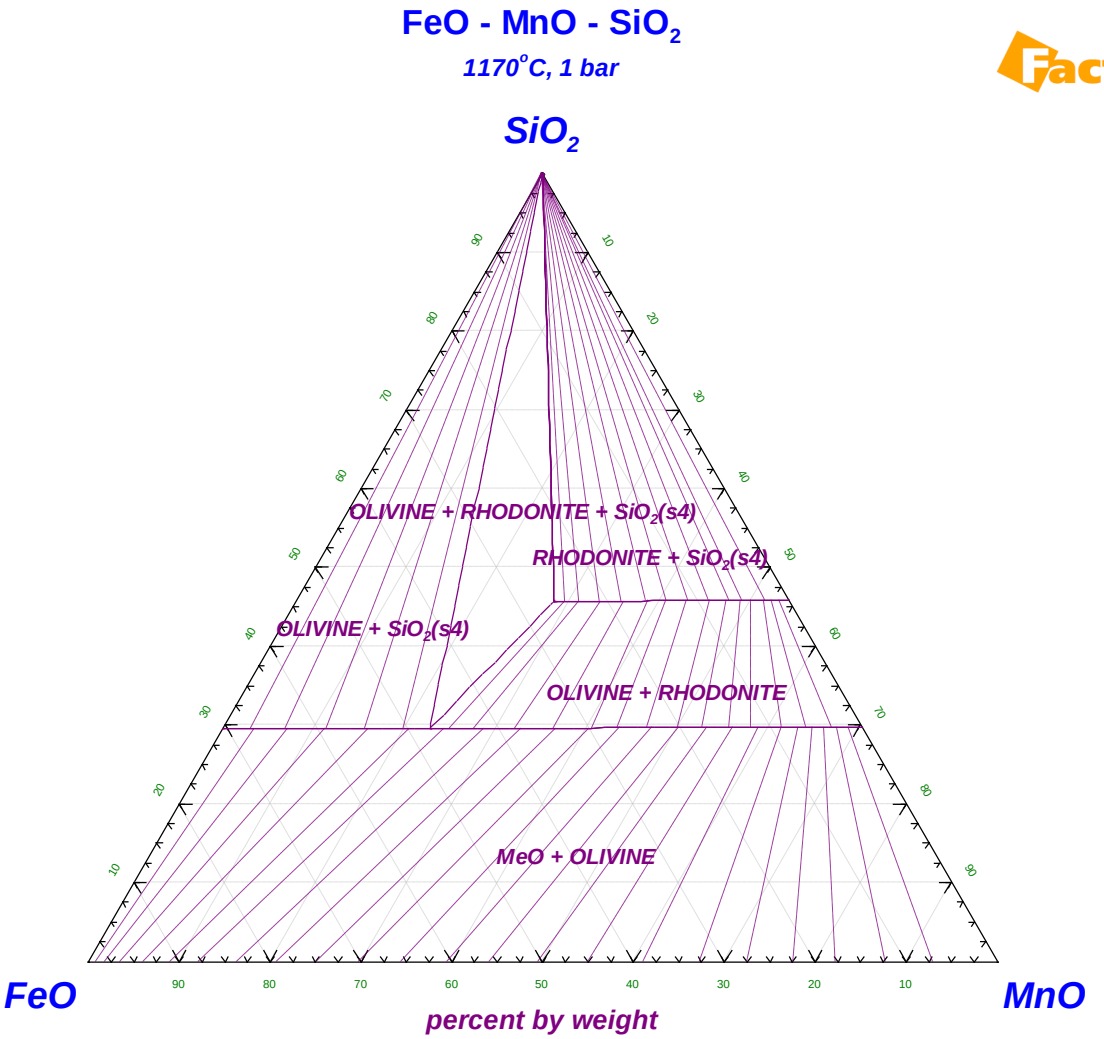
Intersections with slag	Mole fraction					Weight percent				
	A = P2O5, B = FeO, C = MnO					A = P2O5, B = FeO, C = MnO				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: Fe2P2O7(s) / Fe3P2O8(s) / MeO	1:	0.24052	0.42177	0.33771	944.32	1:	0.38621	0.34278	0.27101	944.32
2: Fe2P2O7(s) / MeO / Mn3P2O8(s)	2:	0.26907	0.12379	0.60714	712.28	2:	0.42363	0.09864	0.47773	712.28
3: FeP2O6(s) / Mn2P2O7(s) / MnP2O6(s)	3:	0.37300	0.19842	0.42859	600.24	3:	0.54244	0.14604	0.31152	600.25
4: Fe2P2O7(s) / Mn2P2O7(s) / Mn3P2O8(s)	4:	0.32476	0.12658	0.54866	527.15	4:	0.48981	0.09662	0.41357	527.15
5: Fe2P2O7(s) / FeP2O6(s) / Mn2P2O7(s)	5:	0.34292	0.16009	0.49699	526.84	5:	0.51005	0.12050	0.36945	526.84
6: FeP2O6(s) / MnP2O6(s) / P2O5(s3)	6:	0.78540	0.14225	0.07235	483.83	6:	0.87896	0.08057	0.04047	483.83

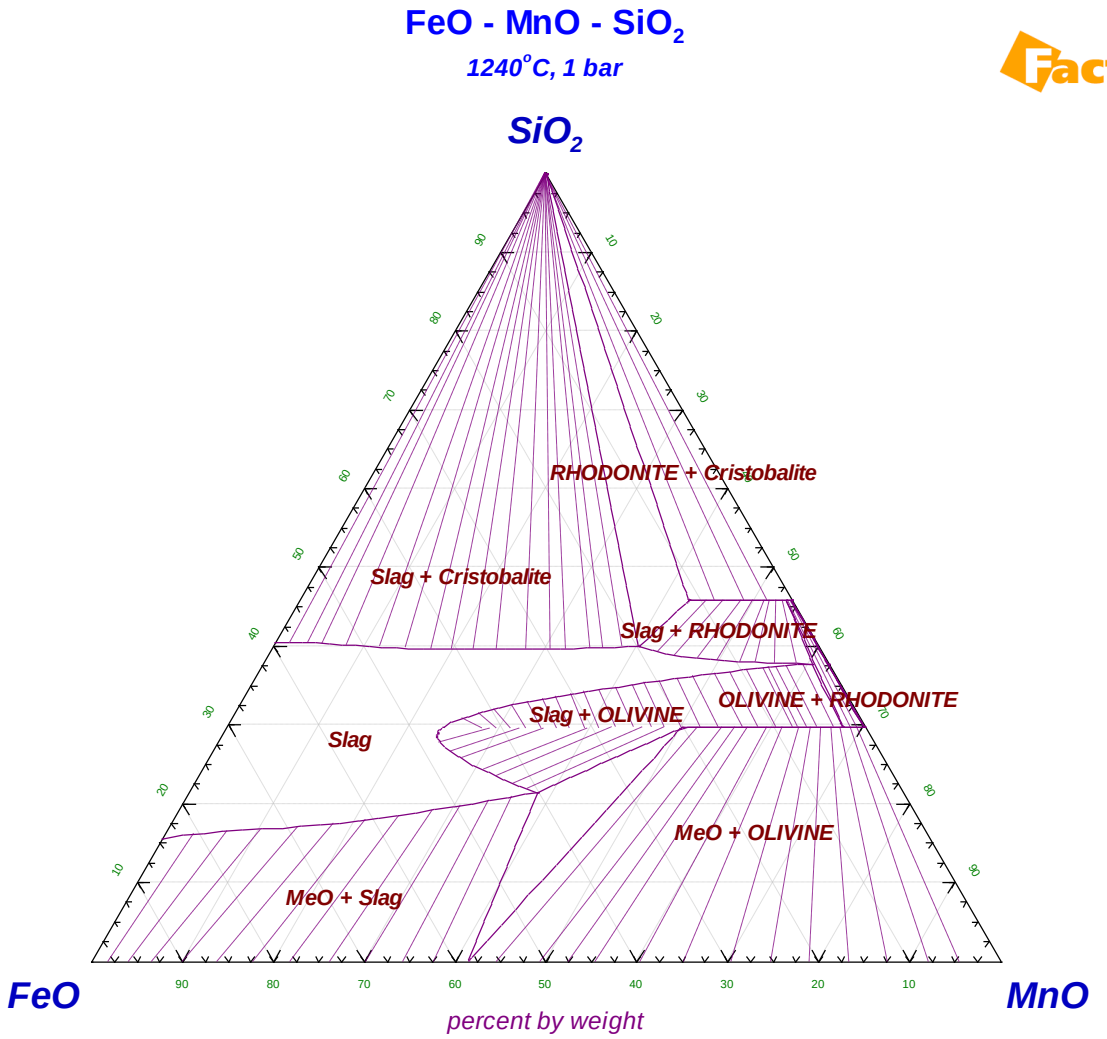
Weight percent, Isopleth metasilicate section FeSiO3-MnSiO3

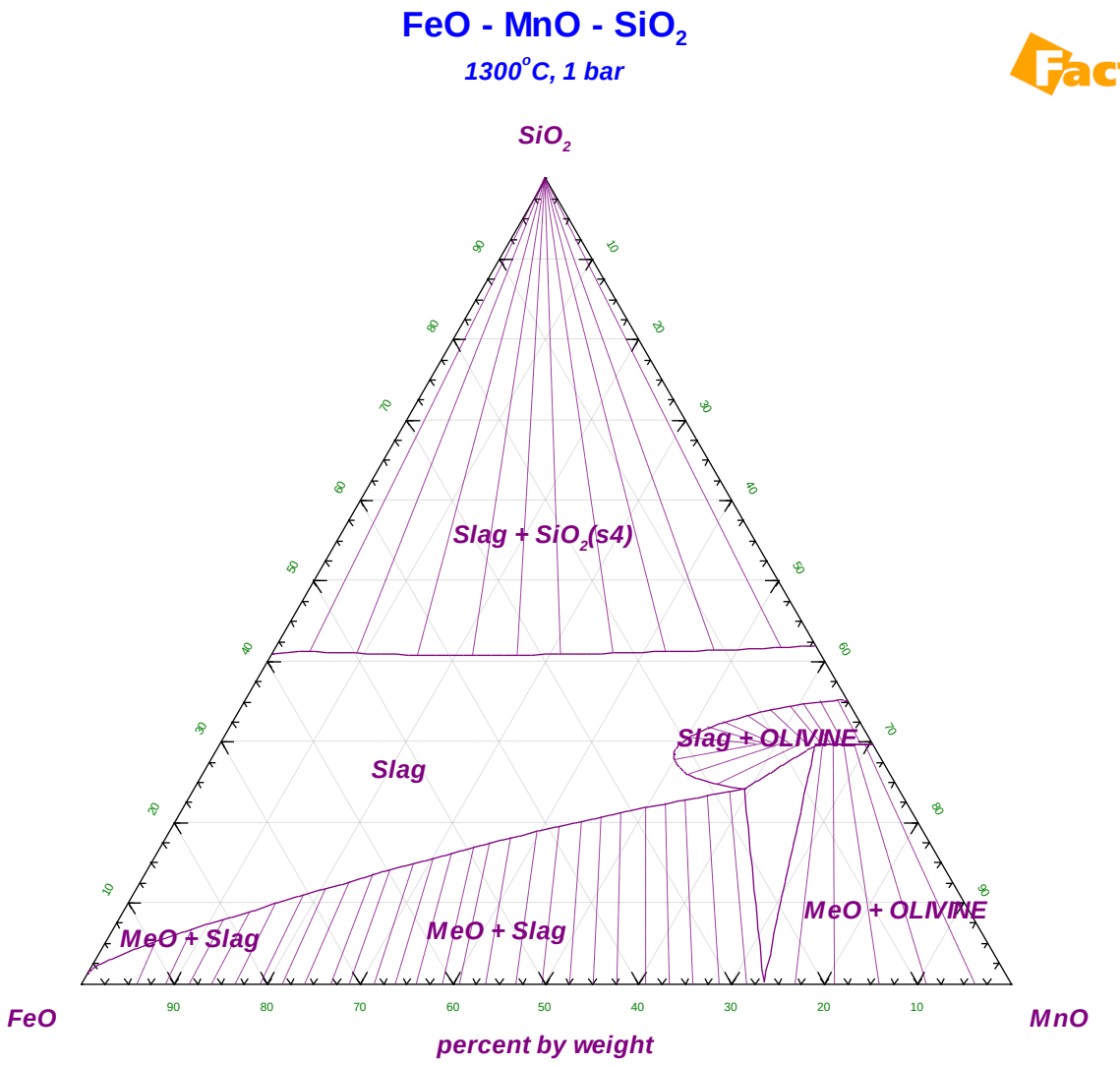


Weight percent, Isopleth orthosilicate section Fe2SiO4-Mn2SiO4

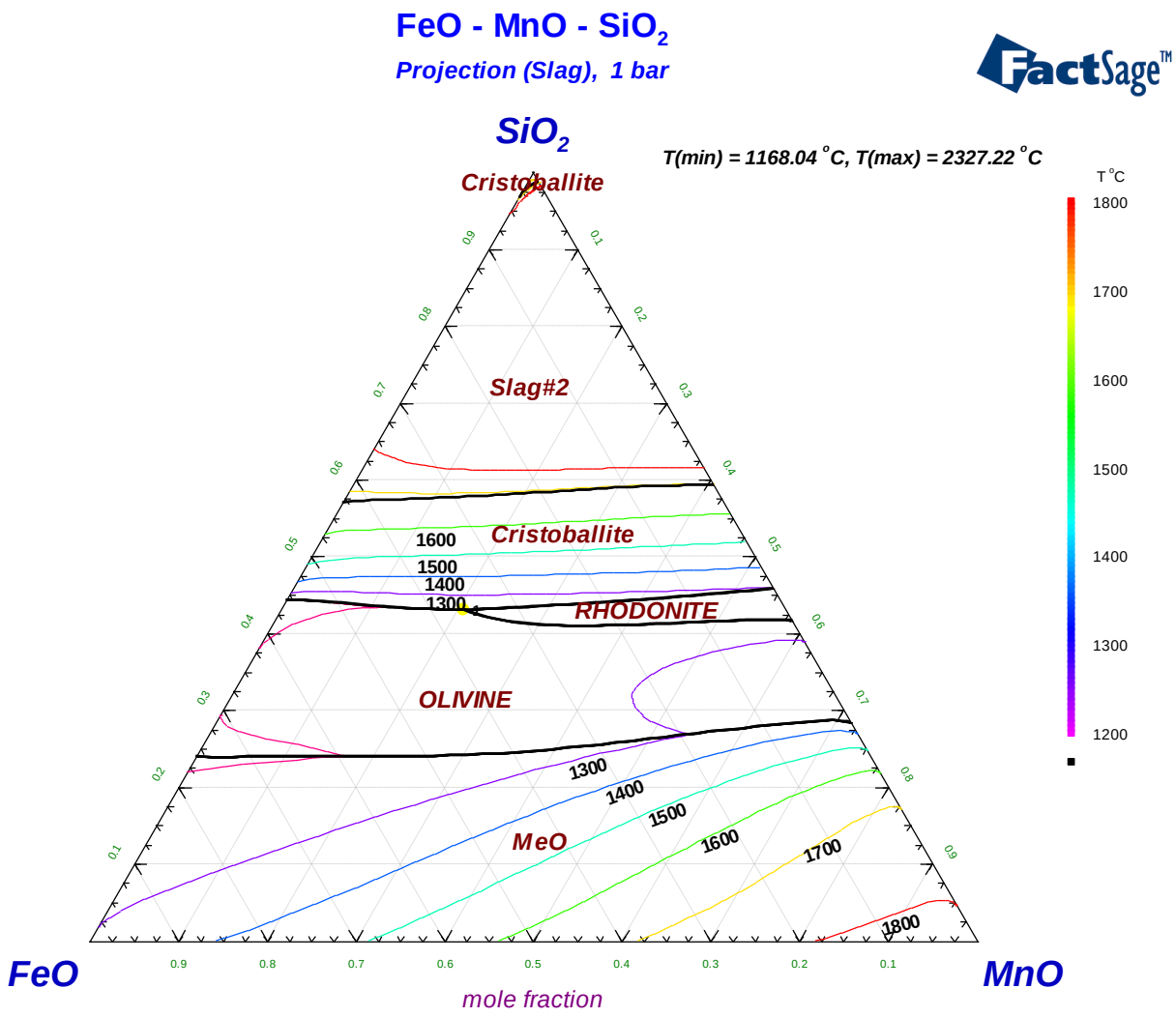



FeO - MnO - SiO2
1170°C, 1 bar
SiO2
OLIVINE + RHODONITE + SiO2(s4)
RHODONITE + SiO2(s4)
OLIVINE + SiO2(s4)
OLIVINE + RHODONITE
MeO + OLIVINE
FeO
MnO
percent by weight

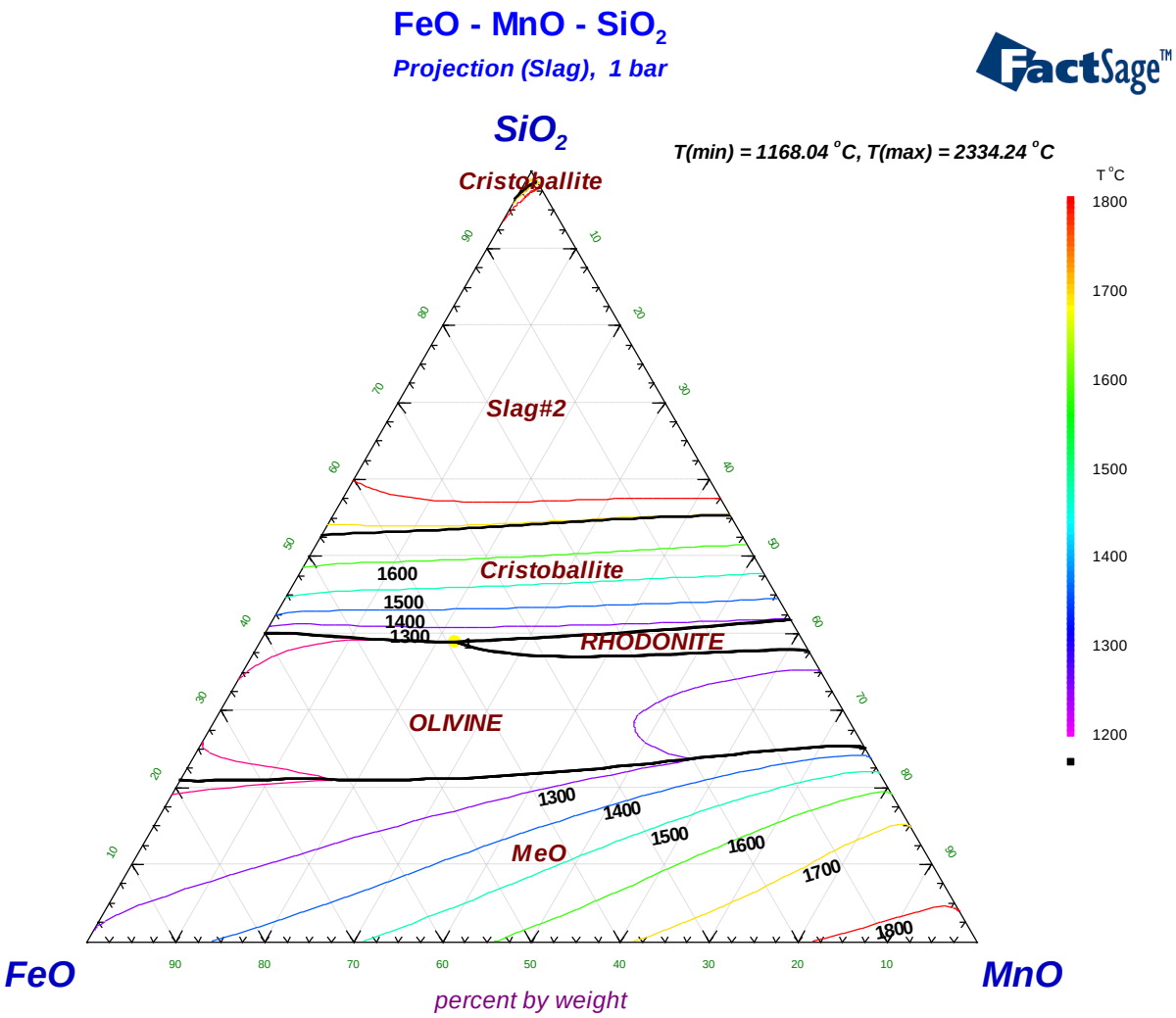

FeO - MnO - SiO2
1240°C, 1 bar
SiO2
RHODONITE + Cristobalite
Slag + Cristobalite
Slag + RHODONITE
OLIVINE + RHODONITE
Slag + OLIVINE
Slag
MeO + OLIVINE
MeO + Slag
FeO
MnO
90
80
70
60
50
40
30
20
10
percent by weight


FeO - MnO - SiO2
1300°C, 1 bar
SiO2
Slag + SiO2(s4)
Slag
Slag + OLIVINE
MeO + Slag
MeO + Slag
MeO + OLIVINE
FeO
MnO
percent by weight

Mole fraction, Liquidus surface



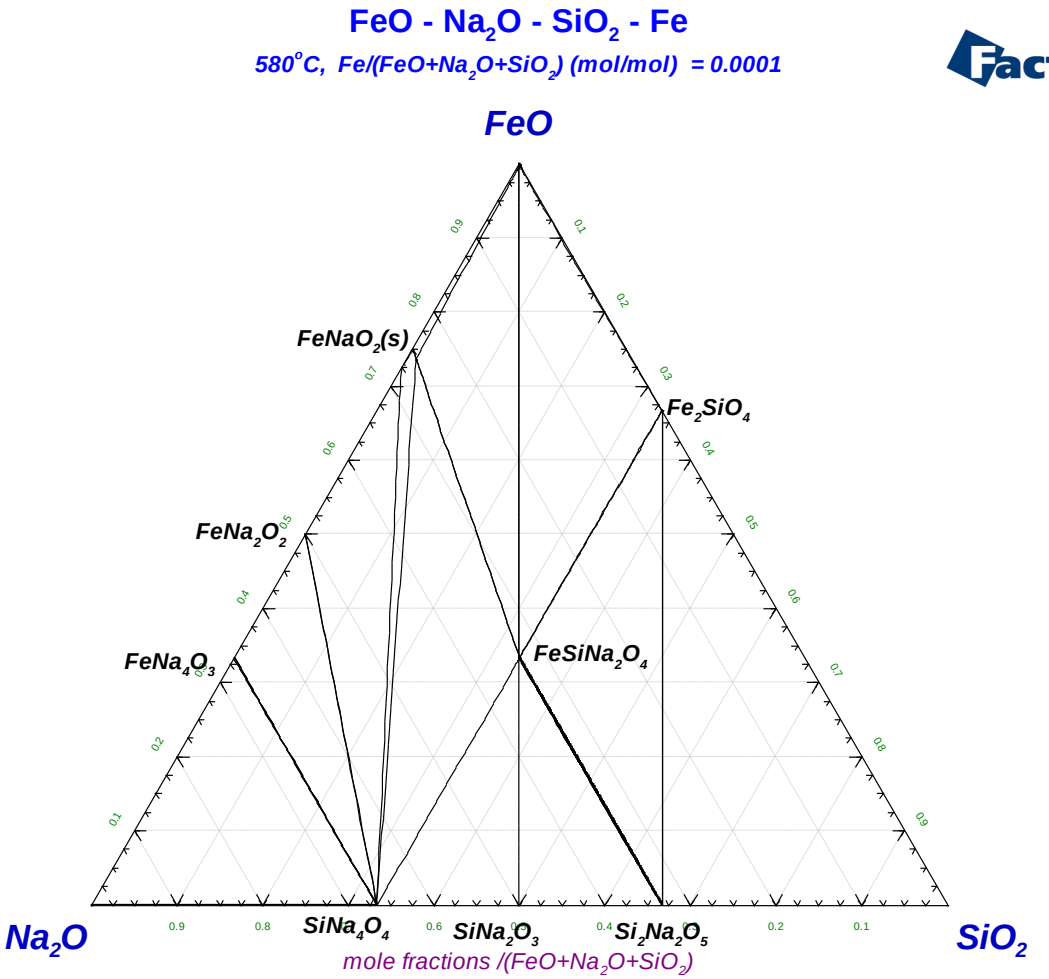
Weight percent, Liquidus surface



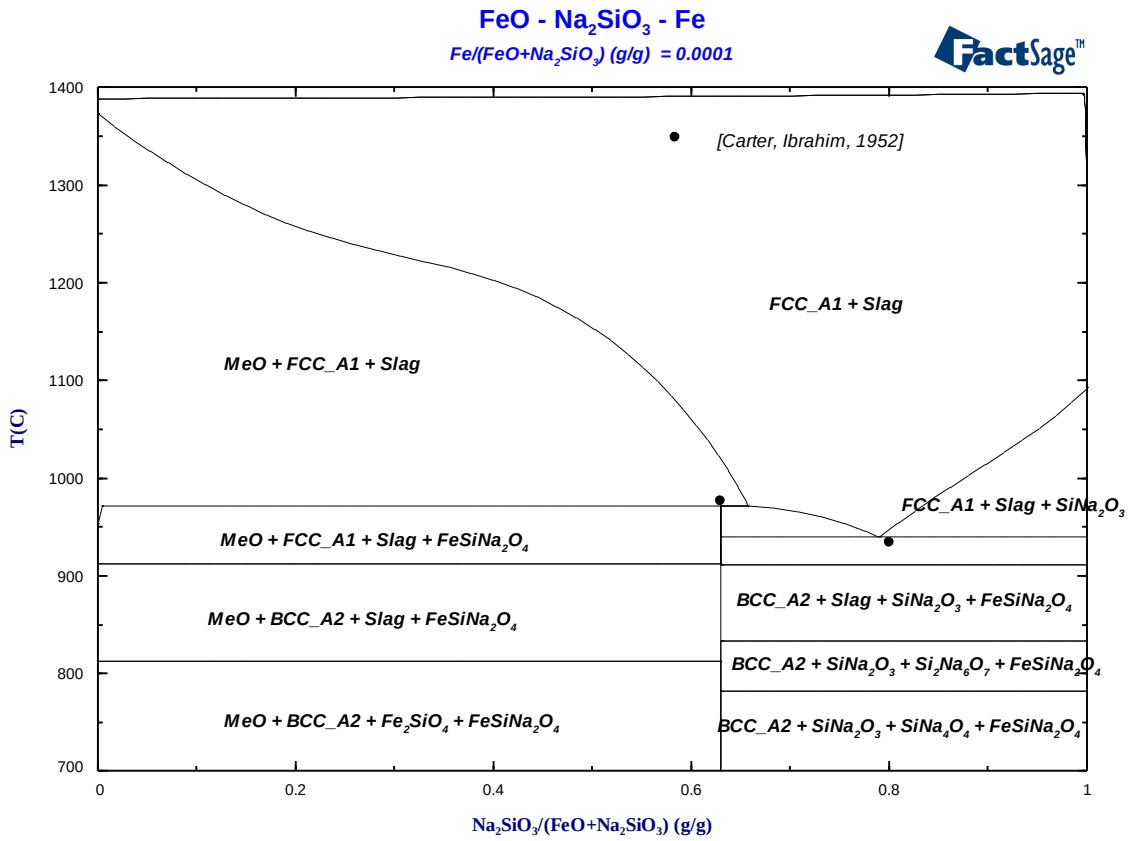
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction				Weight percent			
	A = SiO2, B = FeO, C = MnO				A = SiO2, B = FeO, C = MnO			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: OLIVINE / RHODONITE / Cristobalite	1: 0.43066	0.36269	0.20665	1200.63	1: 38.857	39.130	22.013	1200.63

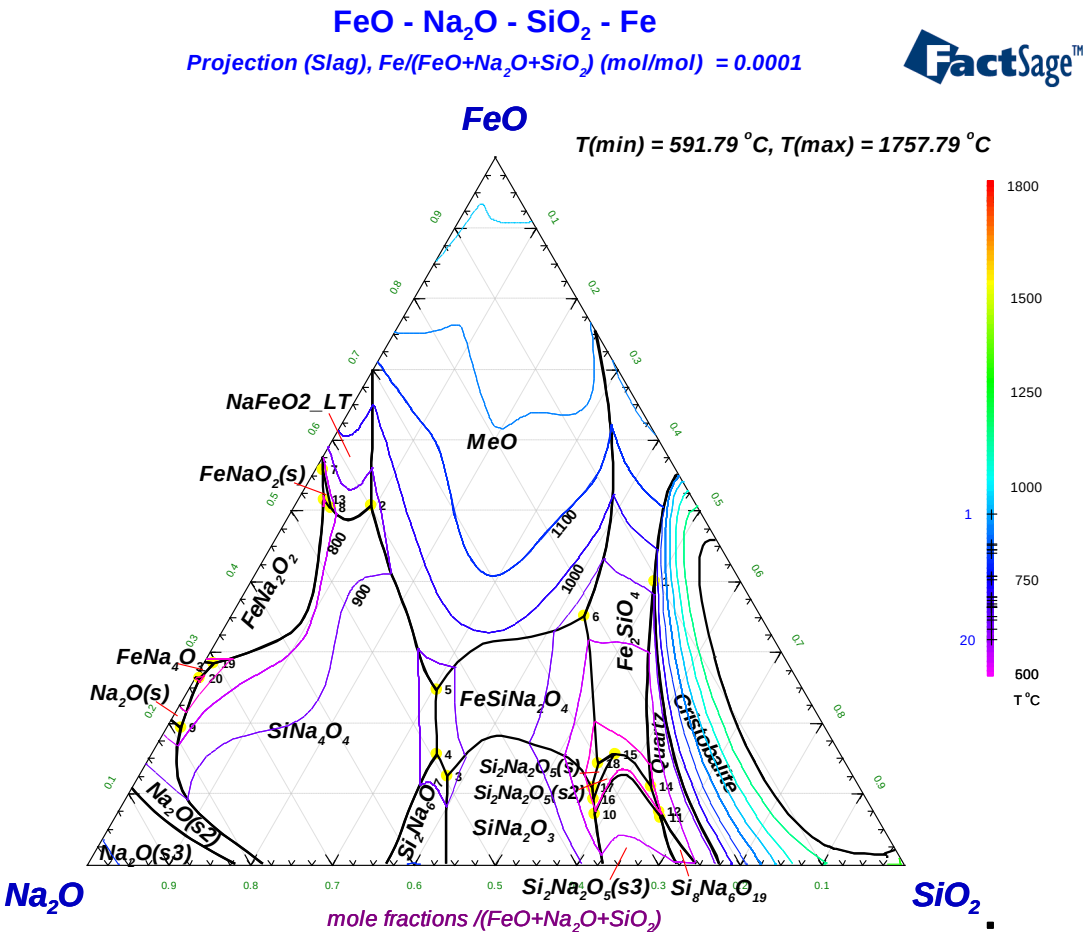
FeO-Na2O-SiO2,
Mole fraction 580°C

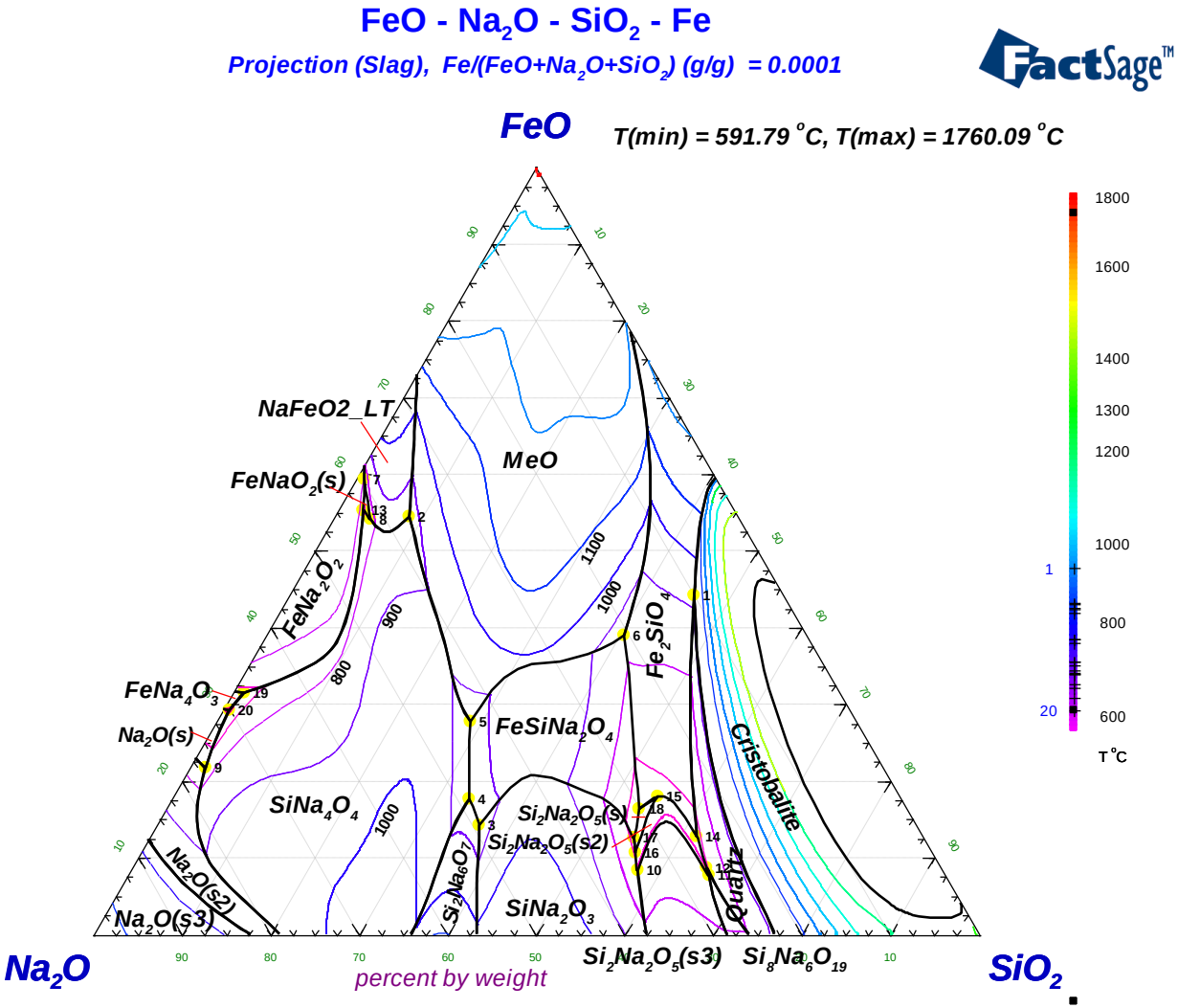


Mole fraction, Isopleth FeO-Na2SiO3



Mole fraction, Liquidussurface

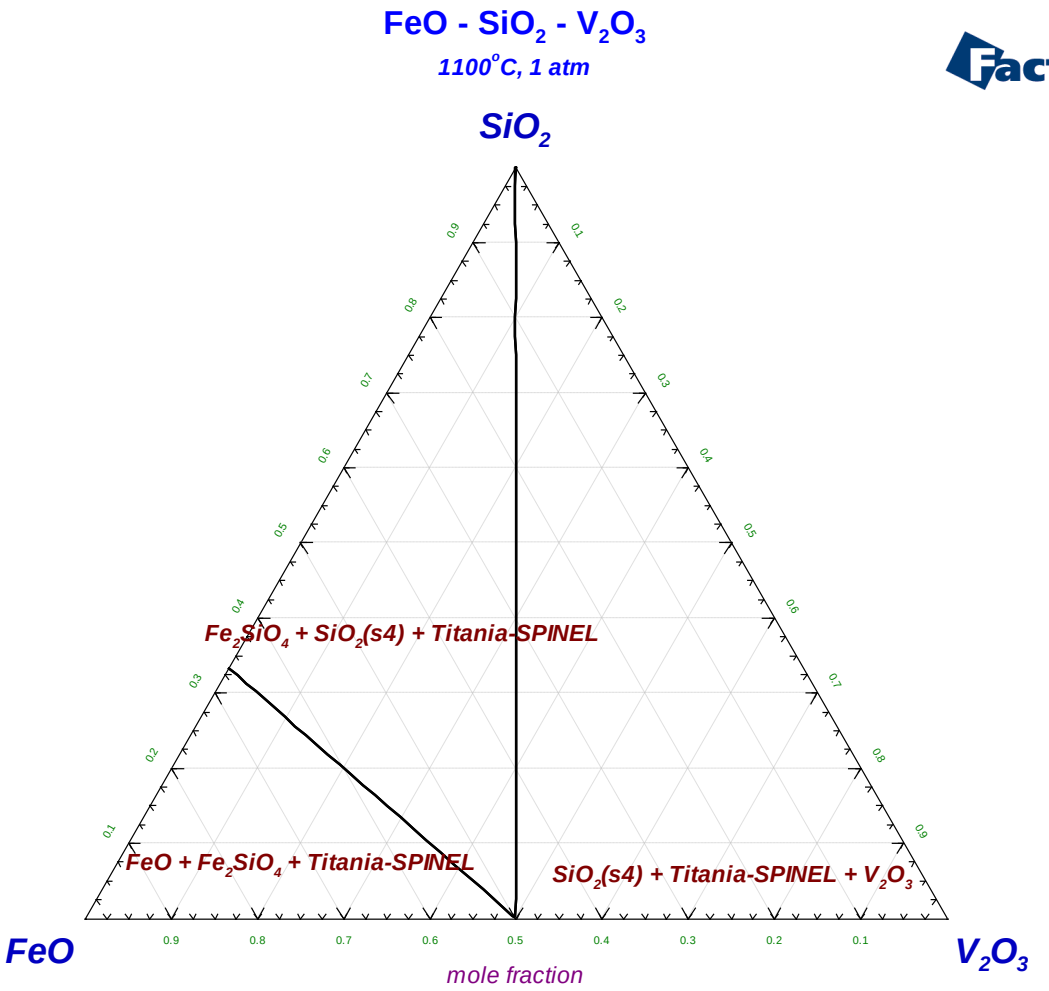



FeO - Na2O - SiO2 - Fe
Projection (Slag), Fe/(FeO+Na2O+SiO2) (g/g) = 0.0001
FactSage
FeO
T(min) = 591.79 °C, T(max) = 1760.09 °C
NaFeO2_LT
FeNaO2(s)
MeO
FeNa2O2
FeNa4O3
Na2O(s)
FeSiNa2O4
Fe2SiO4
Cristobalite
SiNa4O4
Si2Na2O5(s)
Si2Na2O5(s2)
Na2O(s2)
Na2O(s3)
Si2Na6O7
SiNa2O3
Na2Si2O5
Si2Na2O5(s3)
Si8Na6O19
Na2O
SiO2
percent by weight
T °C

Invariant equilibria on the liquidus surface

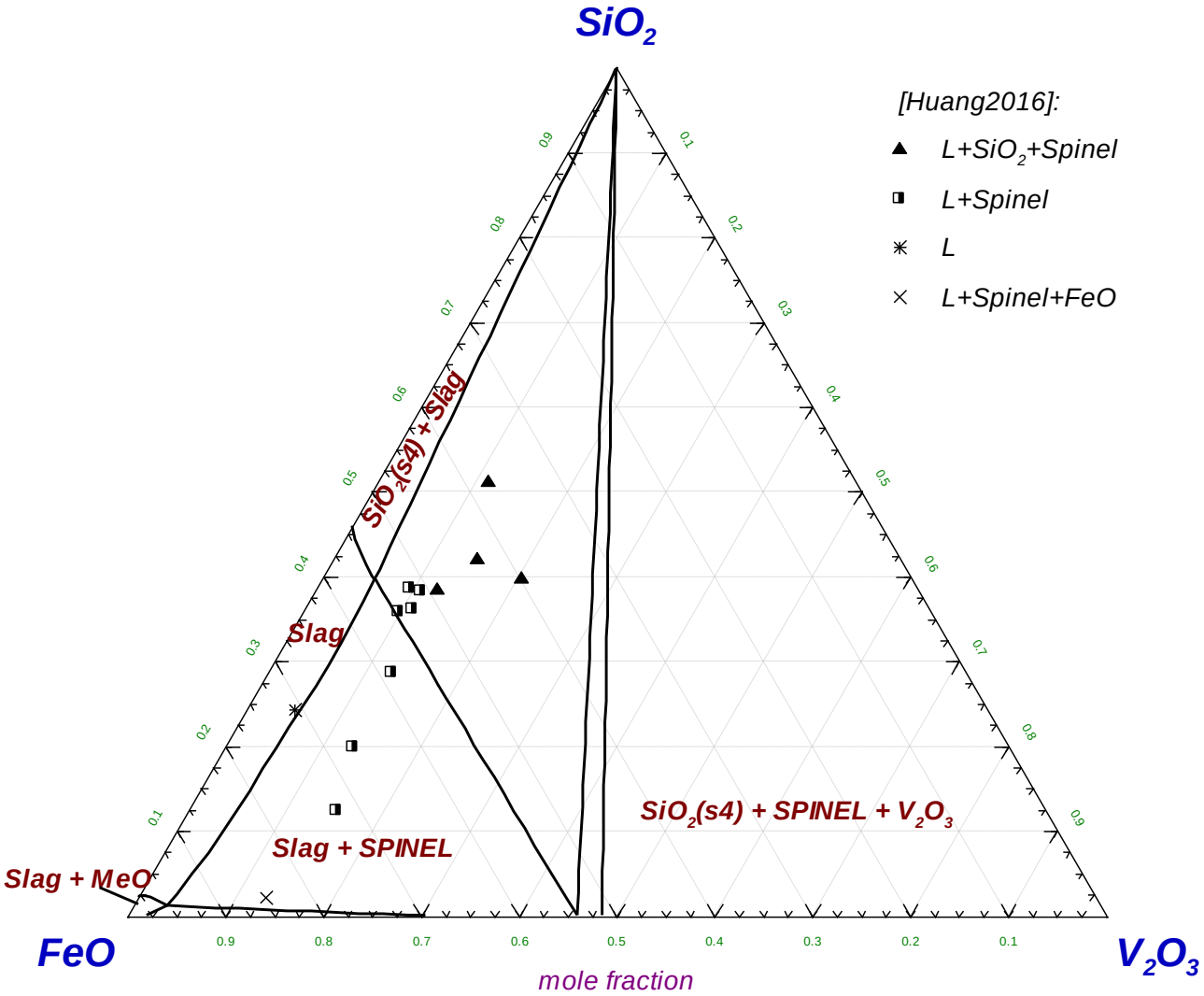
Intersections with slag	Mole fraction A = FeO, B = Na2O, C = SiO2				Weight percent A = FeO, B = Na2O, C = SiO2			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: Fe2SiO4 / Cristobalite / Quartz	1: 0.40027	0.10467	0.49506	926.28	1: 44.248	9.982	45.770	926.30
2: NaFeO2_LT / MeO / SiNa4O4	2: 0.50669	0.39901	0.09430	844.75	2: 54.497	37.021	8.482	844.76
3: FeSiNa2O4 / Si2Na6O7 / SiNa2O3	3: 0.12450	0.49622	0.37929	842.30	3: 14.314	49.217	36.469	842.30
4: FeSiNa2O4 / Si2Na6O7 / SiNa4O4	4: 0.15519	0.49339	0.35142	832.17	4: 17.742	48.659	33.599	832.17
5: FeSiNa2O4 / MeO / SiNa4O4	5: 0.24602	0.44876	0.30522	830.40	5: 27.693	43.576	28.732	830.40
6: Fe2O4Si / FeSiNa2O4 / MeO	6: 0.35046	0.21495	0.43459	821.84	6: 38.973	20.618	40.409	821.89
7: NaFeO2_LT / FeNa2O2 / FeNaO2(s)	7: 0.55758	0.43226	0.01015	759.85	7: 59.381	39.715	0.905	759.87
8: NaFeO2_LT / FeNaO2(s) / SiNa4O4	8: 0.50439	0.44956	0.04605	759.84	8: 54.193	41.670	4.138	759.84
9: Na2O(s) / Na2O(s2) / SiNa4O4	9: 0.19297	0.78835	0.01869	750.05	9: 21.714	76.528	1.759	750.05
10: Si2Na2O5(s2) / Si2Na2O5(s3) / SiNa2O3	10: 0.07122	0.34176	0.58701	706.87	10: 8.311	34.404	57.285	706.87
11: Si2Na2O5(s2) / Si2Na2O5(s3) / Si8Na6O19	11: 0.06595	0.26389	0.67016	706.86	11: 7.721	26.656	65.624	706.86
12: Si2Na2O5(s2) / Si8Na6O19 / Quartz	12: 0.07469	0.26098	0.66433	697.86	12: 8.730	26.320	64.950	697.88
13: FeNa2O2 / FeNaO2(s) / SiNa4O4	13: 0.51606	0.45220	0.03174	687.12	13: 55.329	41.825	2.846	687.13
14: Fe2SiO4 / Si2Na2O5(s2) / Quartz	14: 0.11007	0.25374	0.63619	679.71	14: 12.783	25.423	61.794	679.70
15: Fe2SiO4 / Si2Na2O5(s2) / Si2Na2O5(s)	15: 0.15586	0.27511	0.56902	677.83	15: 17.934	27.308	54.757	677.84
16: Si2Na2O5(s2) / Si2Na2O5(s) / SiNa2O3	16: 0.09169	0.33365	0.57466	677.83	16: 10.660	33.465	55.875	677.83
17: FeSiNa2O4 / Si2Na2O5(s) / SiNa2O3	17: 0.10870	0.32681	0.56450	654.40	17: 12.600	32.679	54.721	654.39
18: Fe2SiO4 / FeSiNa2O4 / Si2Na2O5(s)	18: 0.14234	0.30257	0.55509	643.77	18: 16.406	30.086	53.508	643.77
19: FeNa2O2 / FeNa4O3 / SiNa4O4	19: 0.28422	0.70269	0.01310	620.74	19: 31.532	67.253	1.215	620.63
20: FeNa4O3 / Na2O(s) / SiNa4O4	20: 0.26237	0.73024	0.00739	591.79	20: 29.201	70.112	0.688	591.79

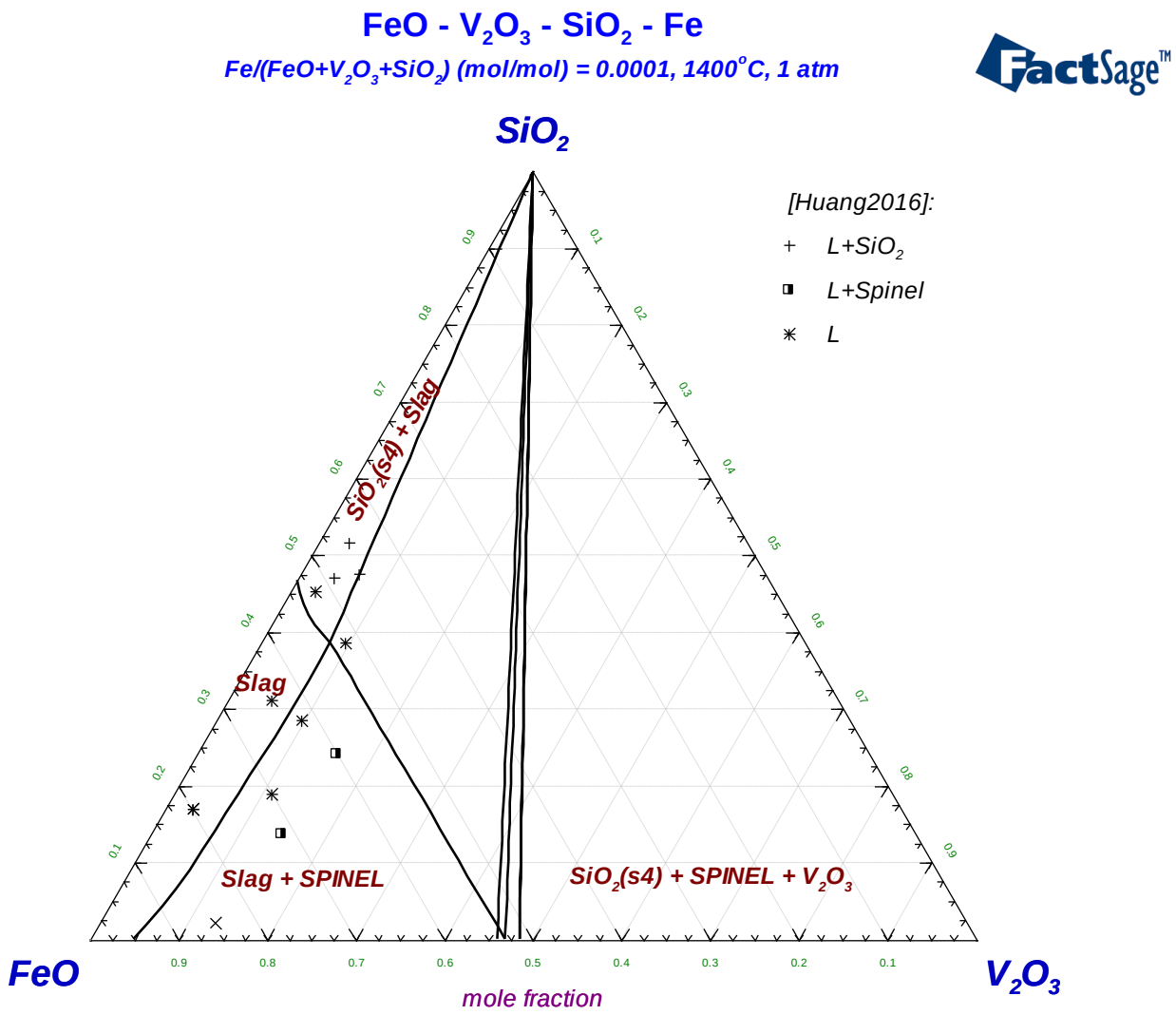
FeO-SiO2-V2O3,
Mole fraction 1100°C



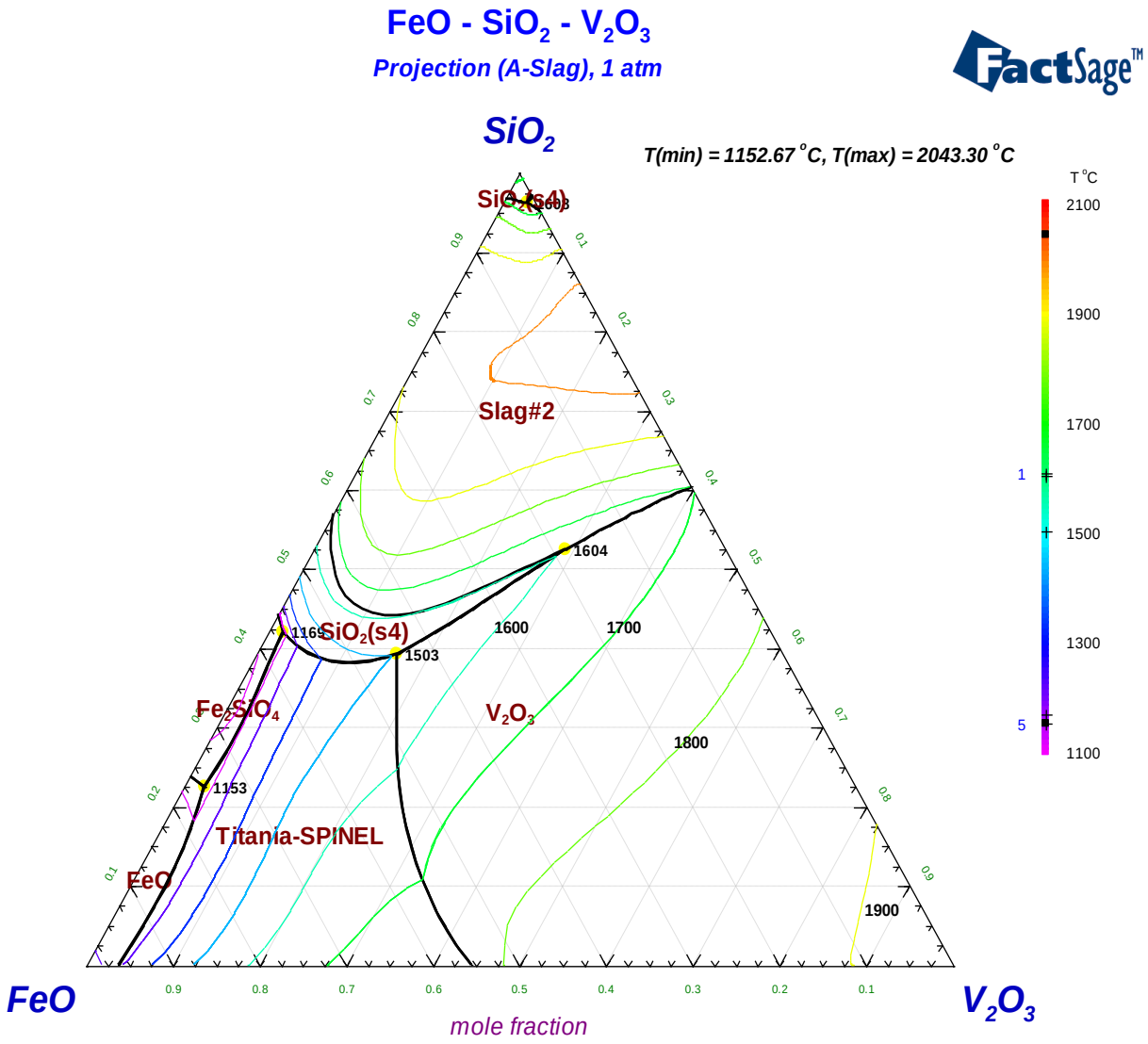
$FeO - V_2O_3 - SiO_2 - Fe$

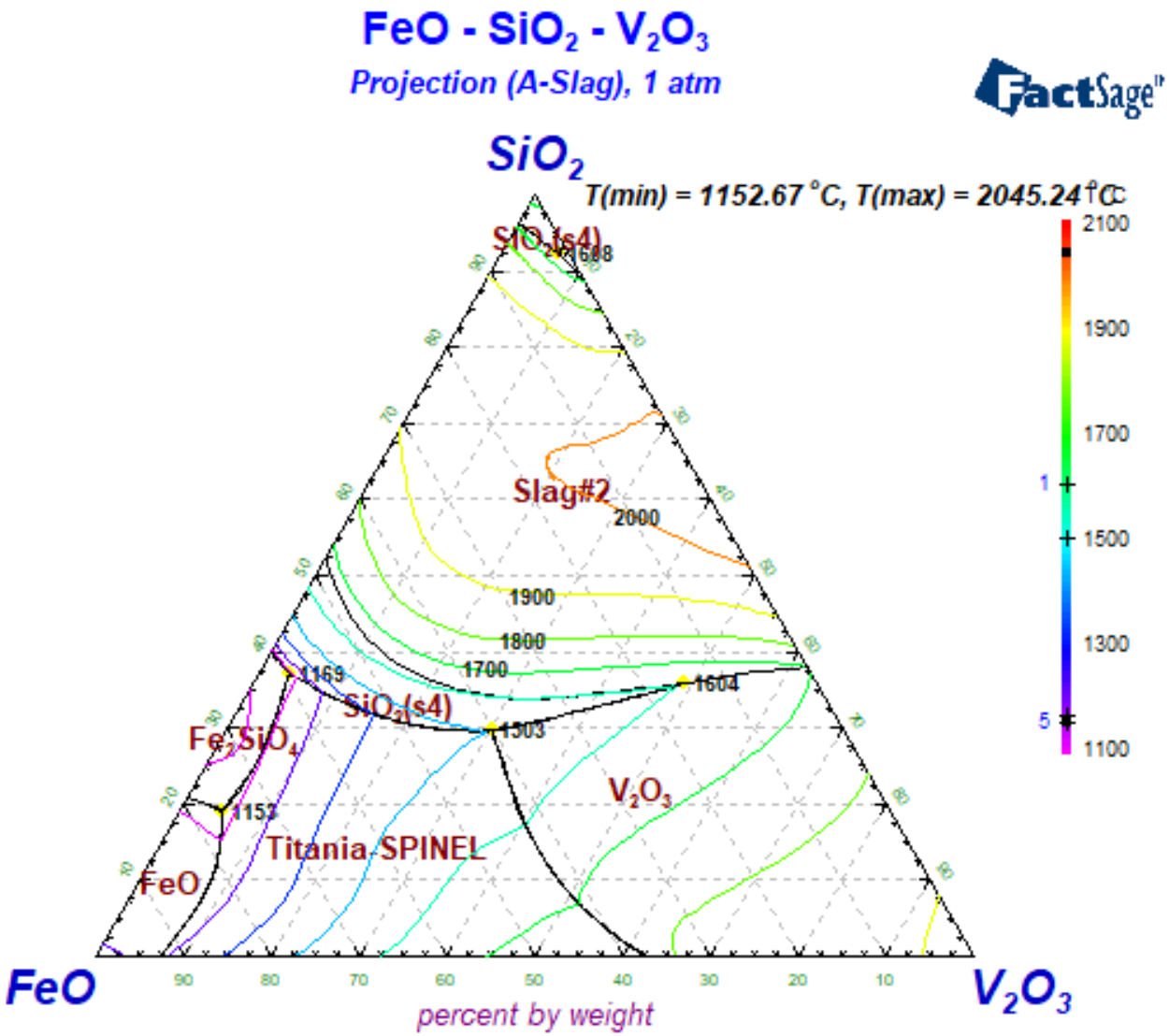
$Fe/(FeO+V_2O_3+SiO_2)$ (mol/mol) = 0.0001, 1350°C, 1 atm




FeO - V2O3 - SiO2 - Fe
Fe/(FeO+V2O3+SiO2) (mol/mol) = 0.0001, 1400°C, 1 atm
FactSage™
SiO2
[Huang2016]:
+ L+SiO2
L+Spinel
L
SiO2(s4) + Slag
Slag
Slag + SPINEL
SiO2(s4) + SPINEL + V2O3
FeO
V2O3
mole fraction

FeO-SiO2-V2O3,
Mole fraction, Liquidussurface

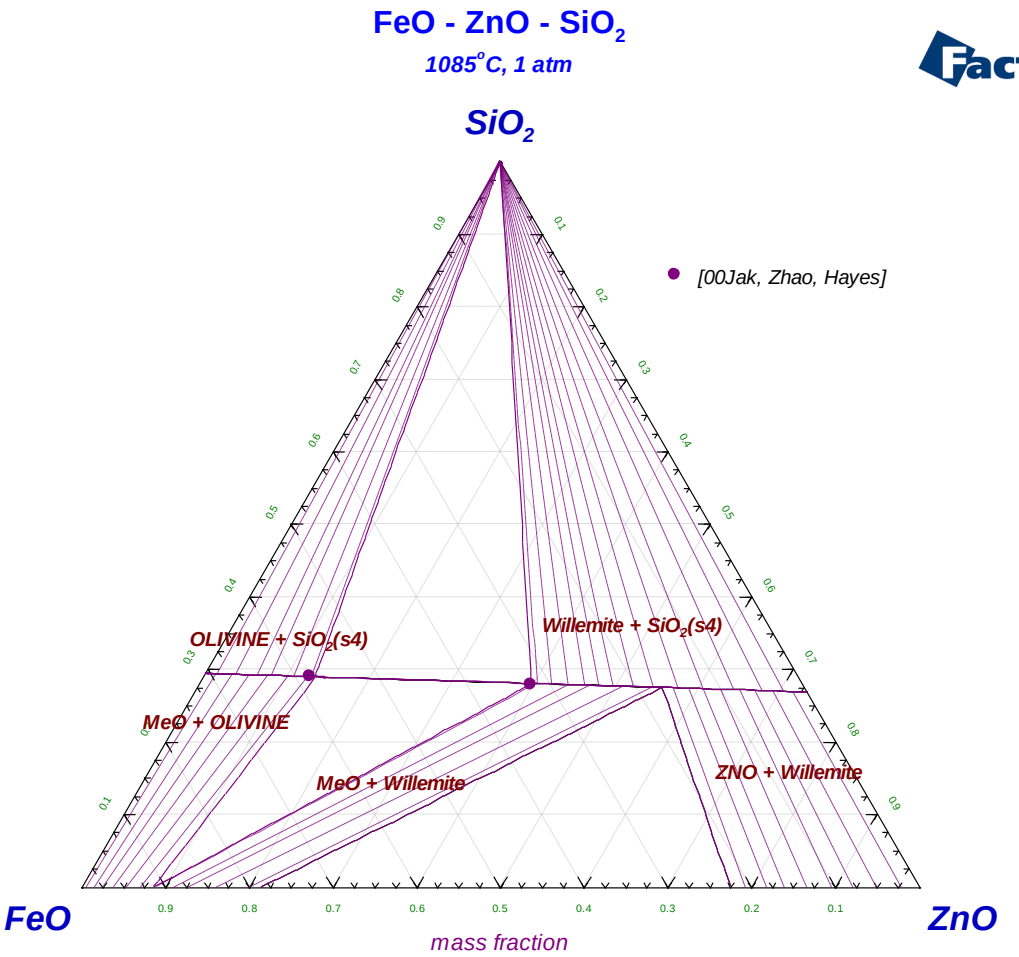



FeO - SiO2 - V2O3
Projection (A-Slag), 1 atm
FactSage
SiO2
T(min) = 1152.67 °C, T(max) = 2045.24 °C
SiO2(s4)
1688
Slag#2
2000
1900
1800
1700
1169
1604
1303
Fe2SiO4
1153
Titania SPINEL
FeO
V2O3
2100
1900
1700
1500
1300
1100
1
5
FeO
V2O3
percent by weight

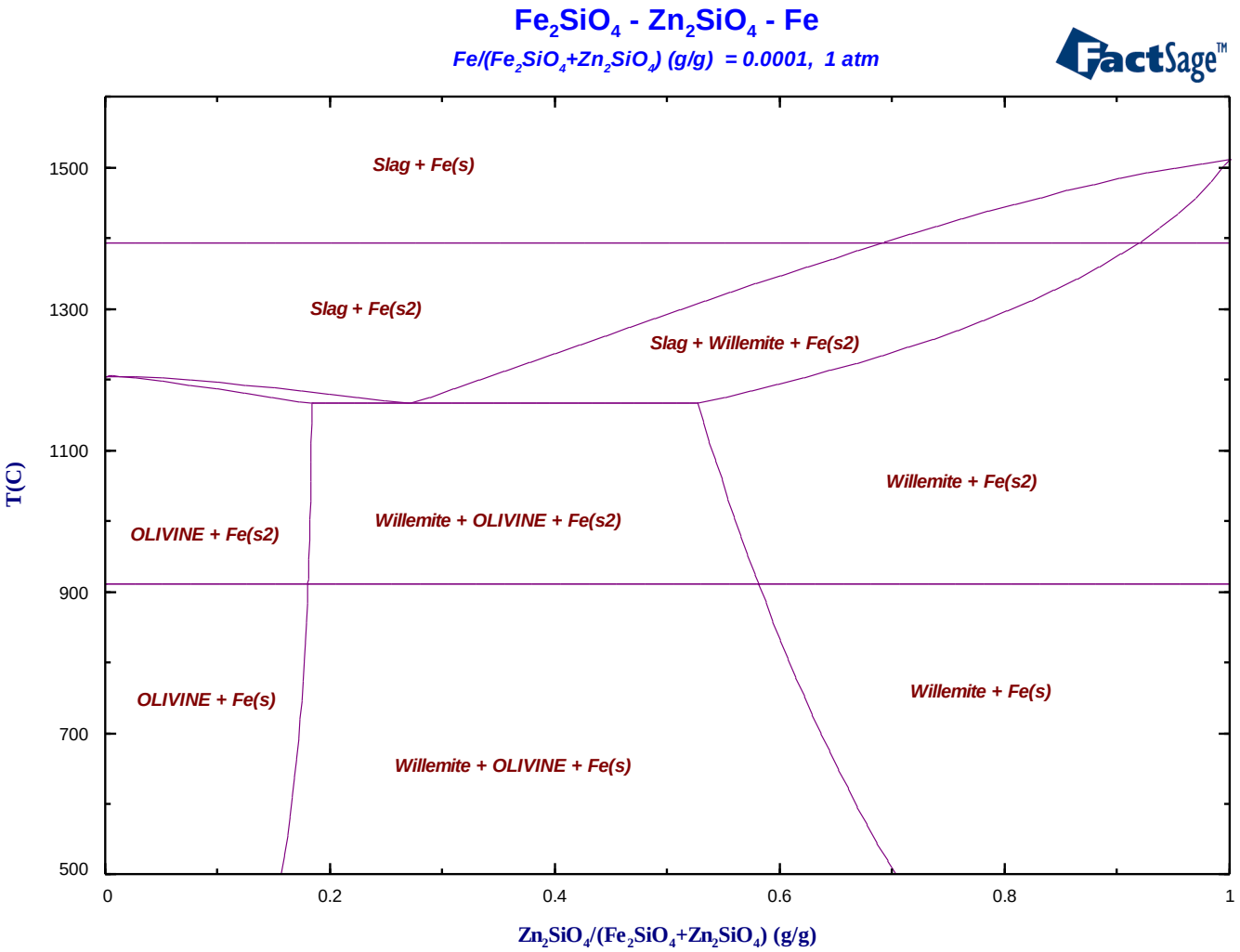
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction				Weight percent			
	A = SiO2, B = FeO, C = V2O3				A = SiO2, B = FeO, C = V2O3			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1. SiO2(s4) / Slag#2 / V2O3	0.96367	0.00903	0.02731	1607.59	92.431	1.035	6.533	1607.59
2. SiO2(s4) / Slag#2 / V2O3	0.52522	0.18481	0.28997	1604.28	35.741	15.038	49.221	1604.28
3. SiO2(s4) / Titania-SPINEL / V2O3	0.39309	0.44545	0.16146	1503.16	29.589	40.093	30.318	1503.16
4. Fe2SiO4 / SiO2(s4) / Titania-SPINEL	0.42076	0.56306	0.01618	1168.91	37.091	59.351	3.558	1168.91
5. Fe2SiO4 / FeO / Titania-SPINEL	0.22592	0.75093	0.02315	1152.67	19.120	75.993	4.887	1152.70

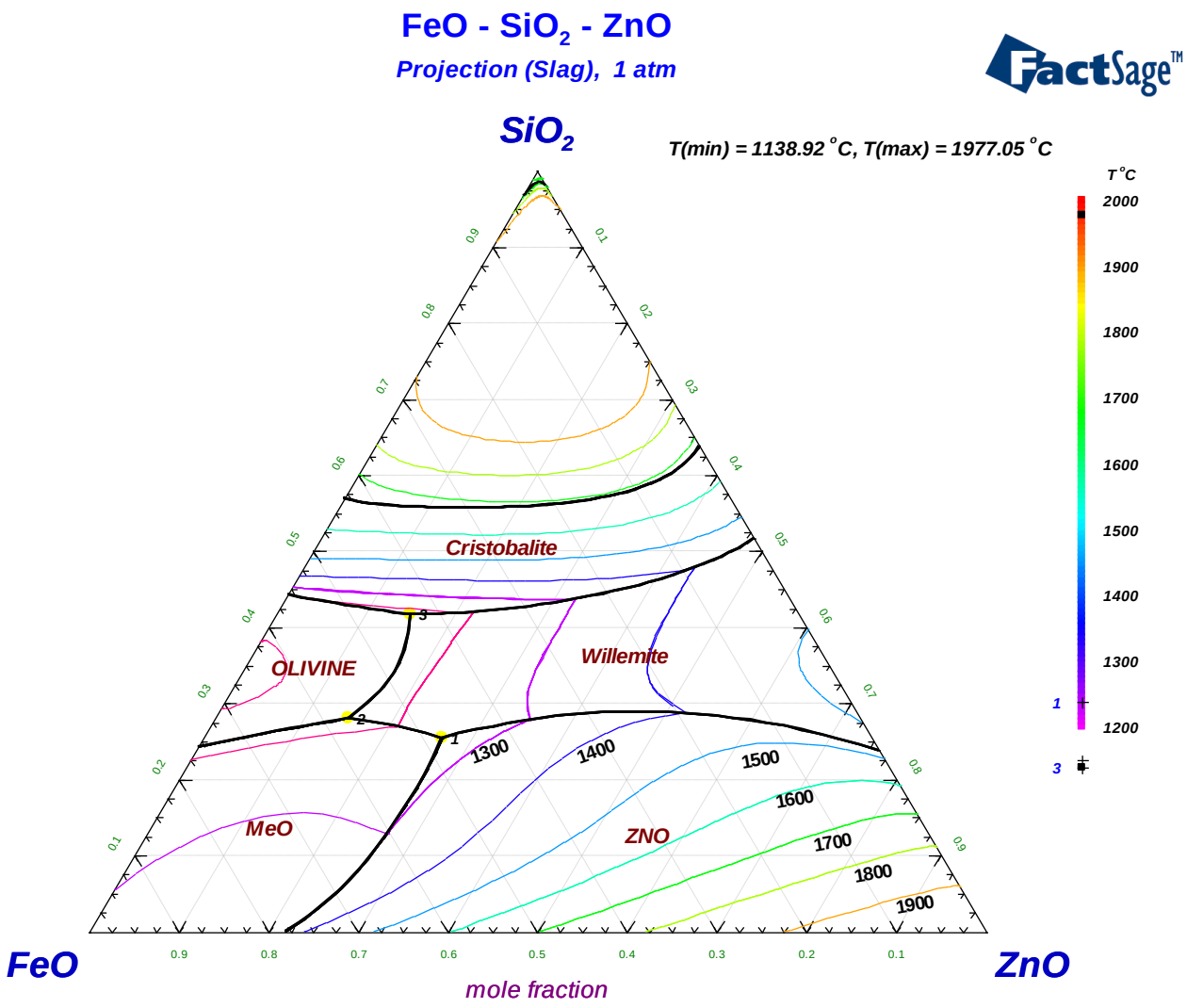
Mole fraction 1085°C



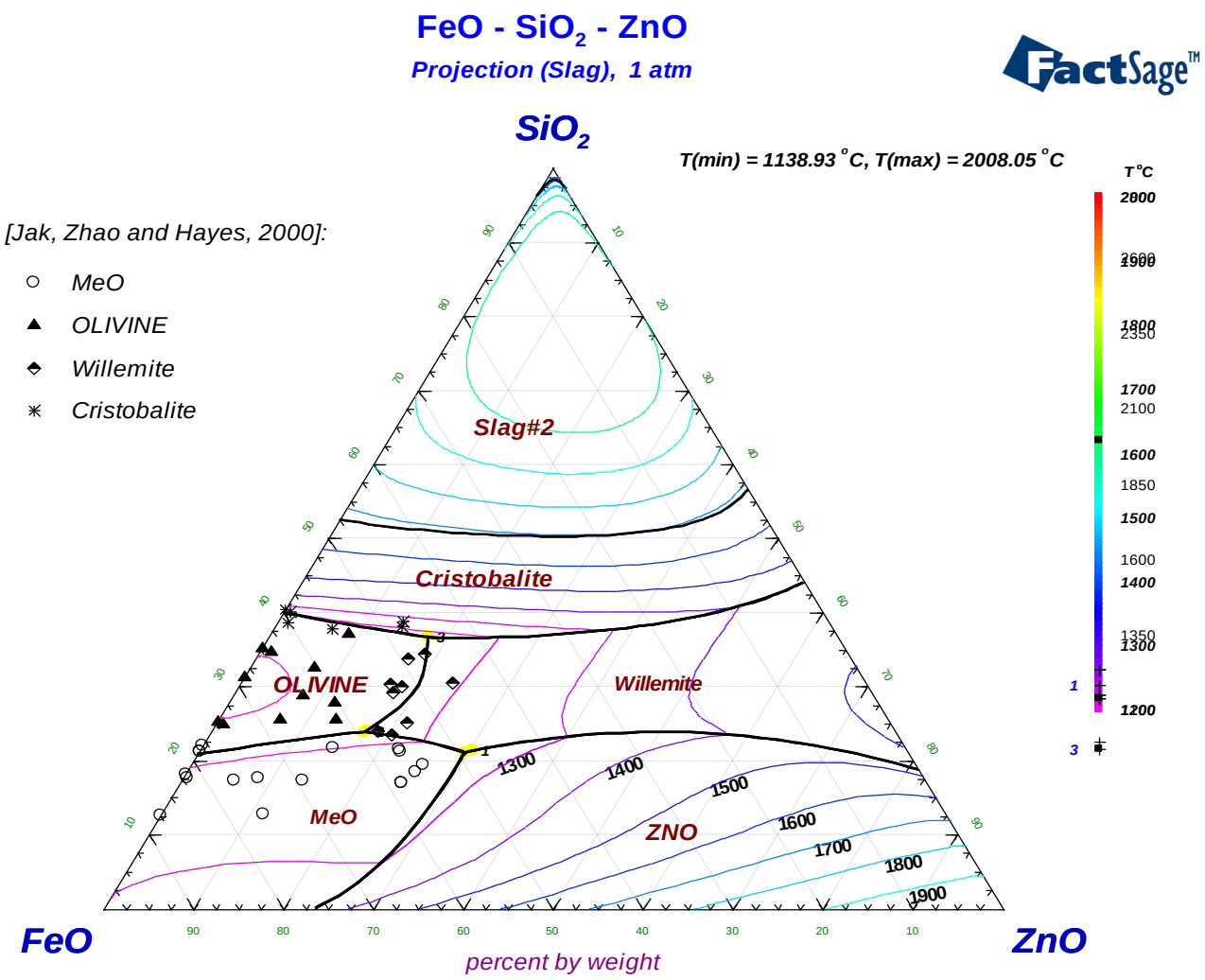
Mole fraction, Isopleth Fe2SiO4-Zn2SiO4-Fe



Mole fraction, Liquidussurface



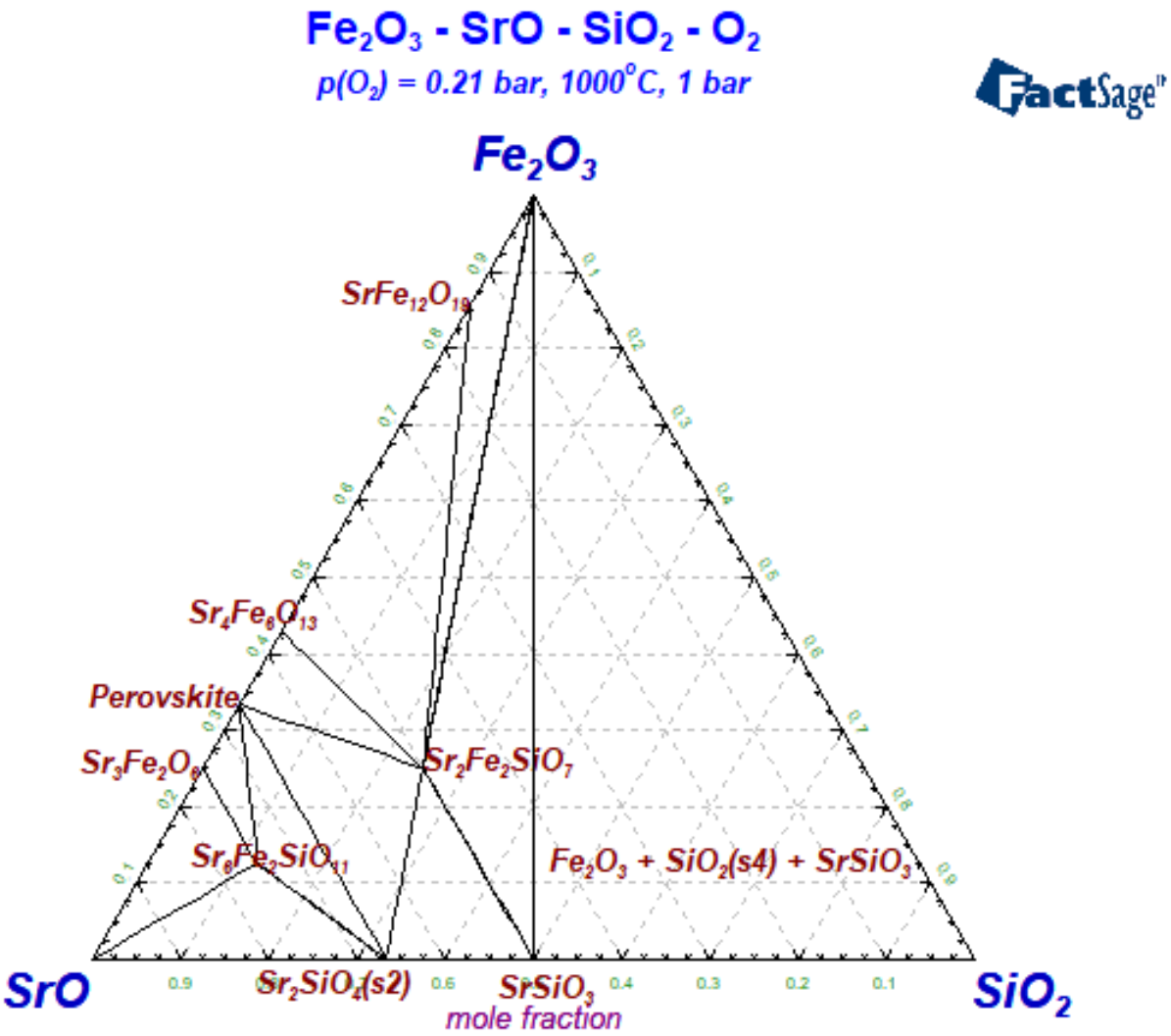
Weight percent, Liquidussurface compared with experimental data



Invariant equilibria on the liquidus surface

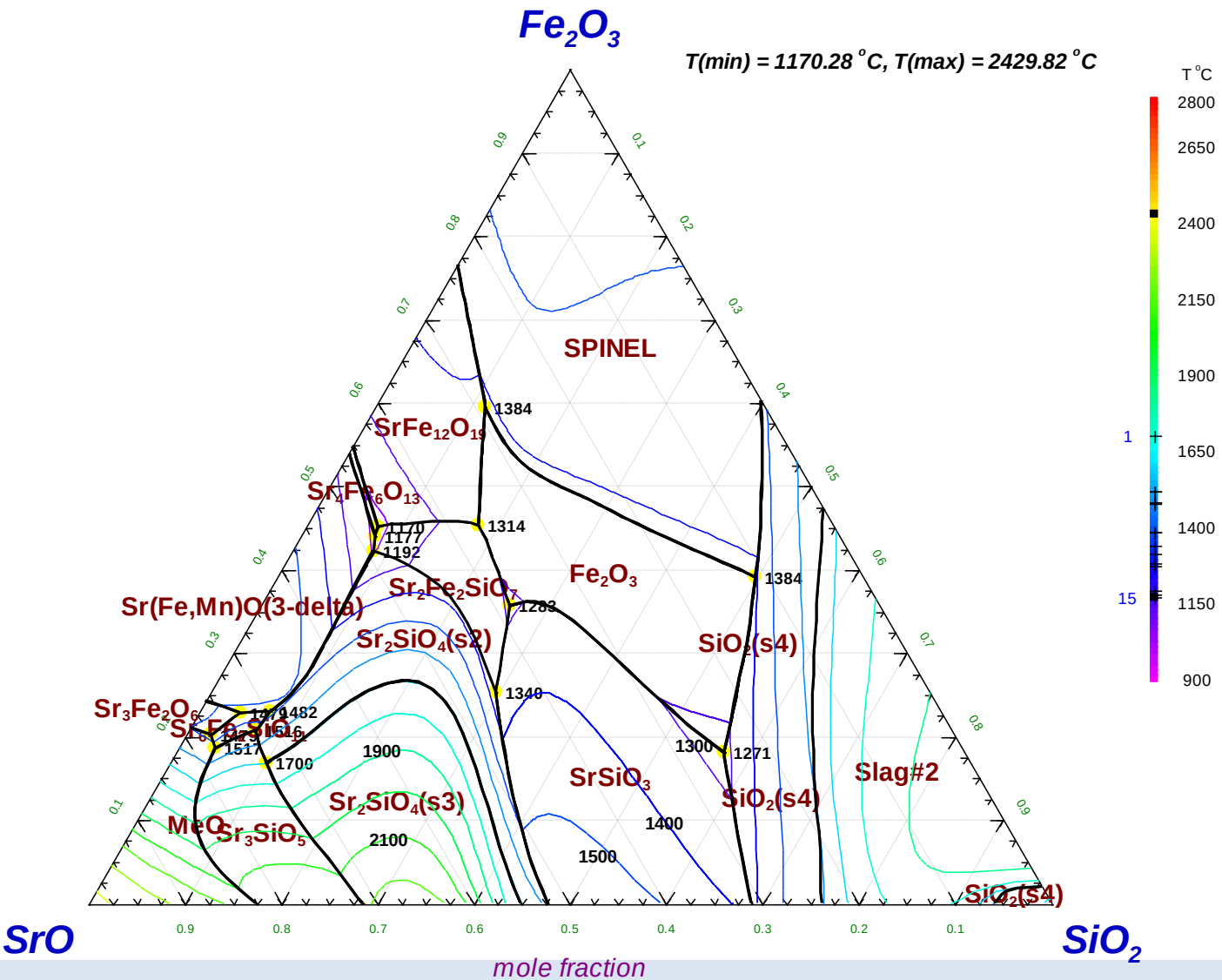
Intersections with slag	Mole fraction				Weight percent			
	A = SiO2, B = FeO, C = ZnO				A = SiO2, B = FeO, C = ZnO			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: MeO / Willemite / ZNO	1: 0.25479	0.47973	0.26548	1238.15	1: 21.447	48..286	30.267	1238.17
2: MeO / OLIVINE / Willemite	2: 0.28066	0.57088	0.14846	1149.20	2: 24.104	58.626	17.269	1149.20
3: OLIVINE / Cristobalite / Willemite	3: 0.41705	0.43358	0.14937	1139.00	3: 36.654	45.566	17.780	1138.92

Fe2O3-SrO-SiO2,
Mole fraction 1000°C



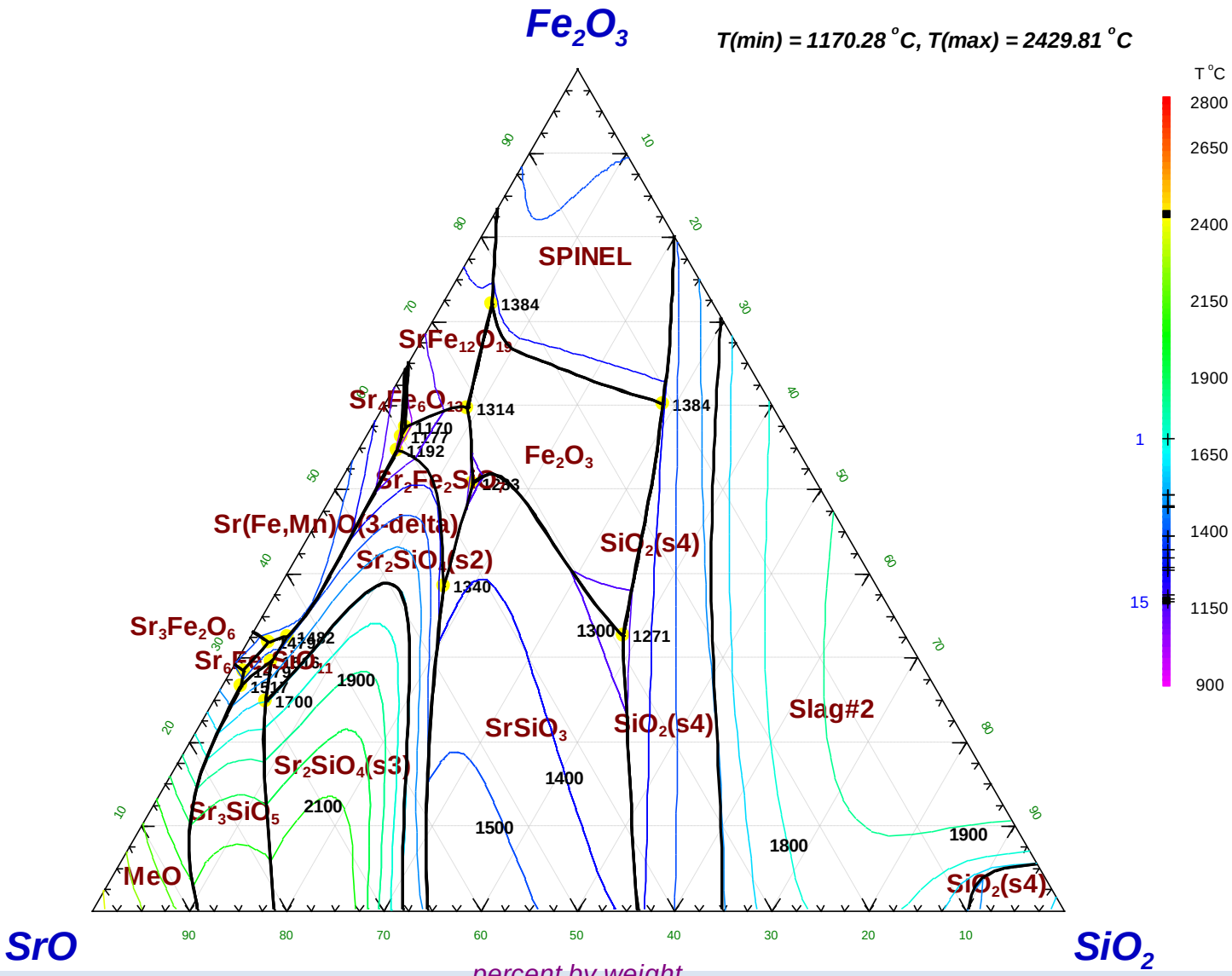
Fe_2O_3 - SrO - SiO_2 - O_2

Projection (A-Slag), p(O_2) = 0.21 atm, 1 atm



Fe_2O_3 - SrO - SiO_2 - O_2

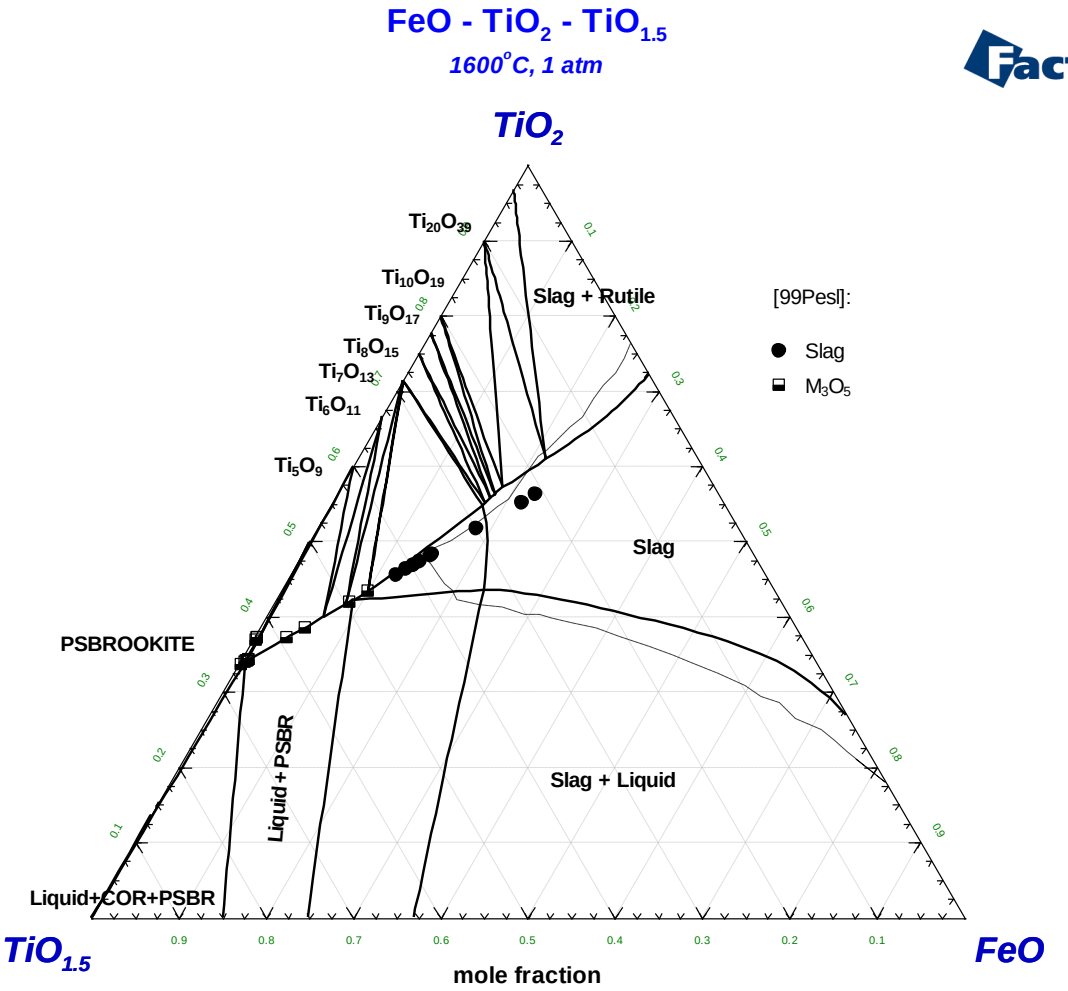
Projection (A-Slag), p(O_2) = 0.21 atm, 1 atm

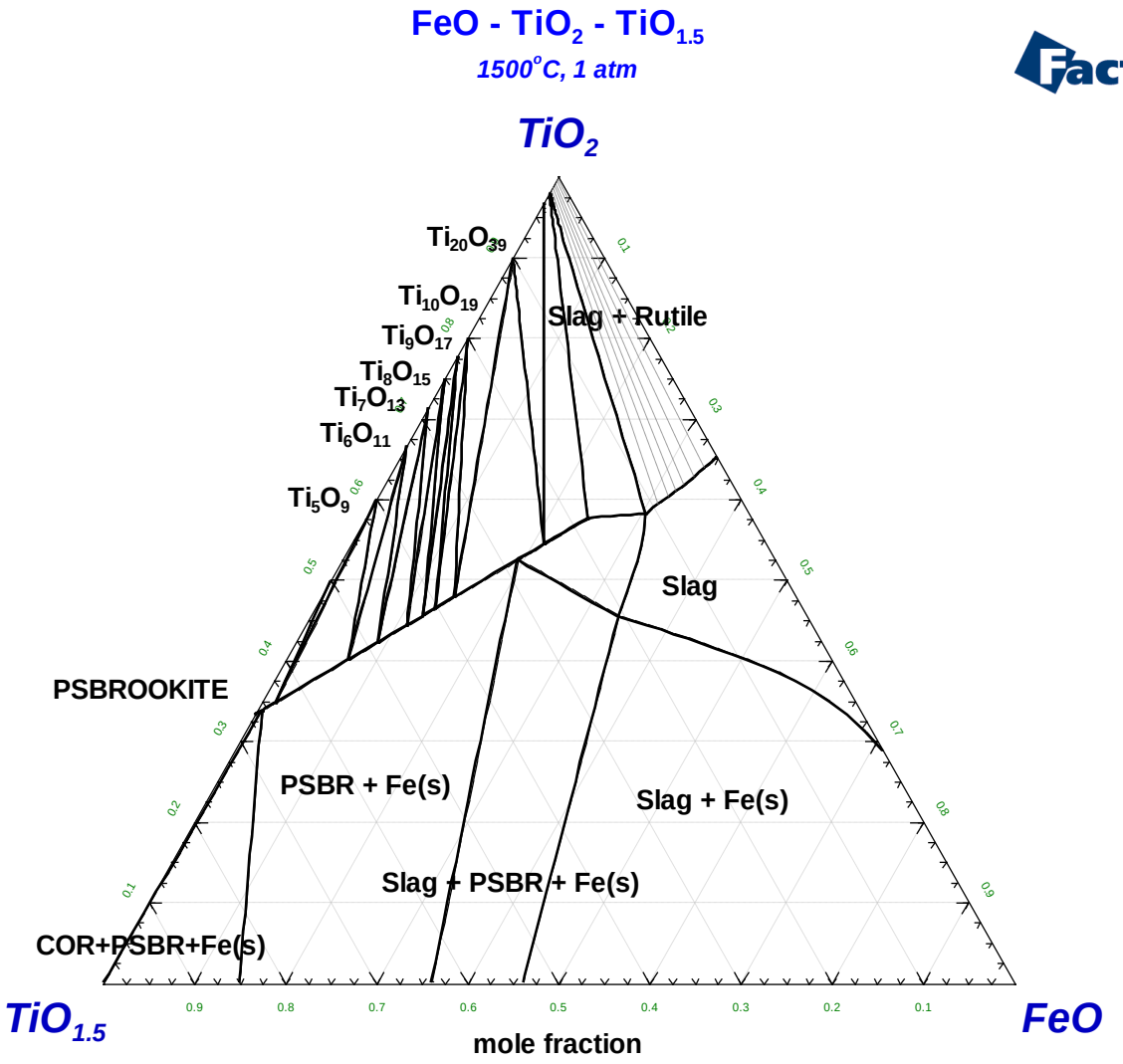


Invariant equilibria on the liquidus surface

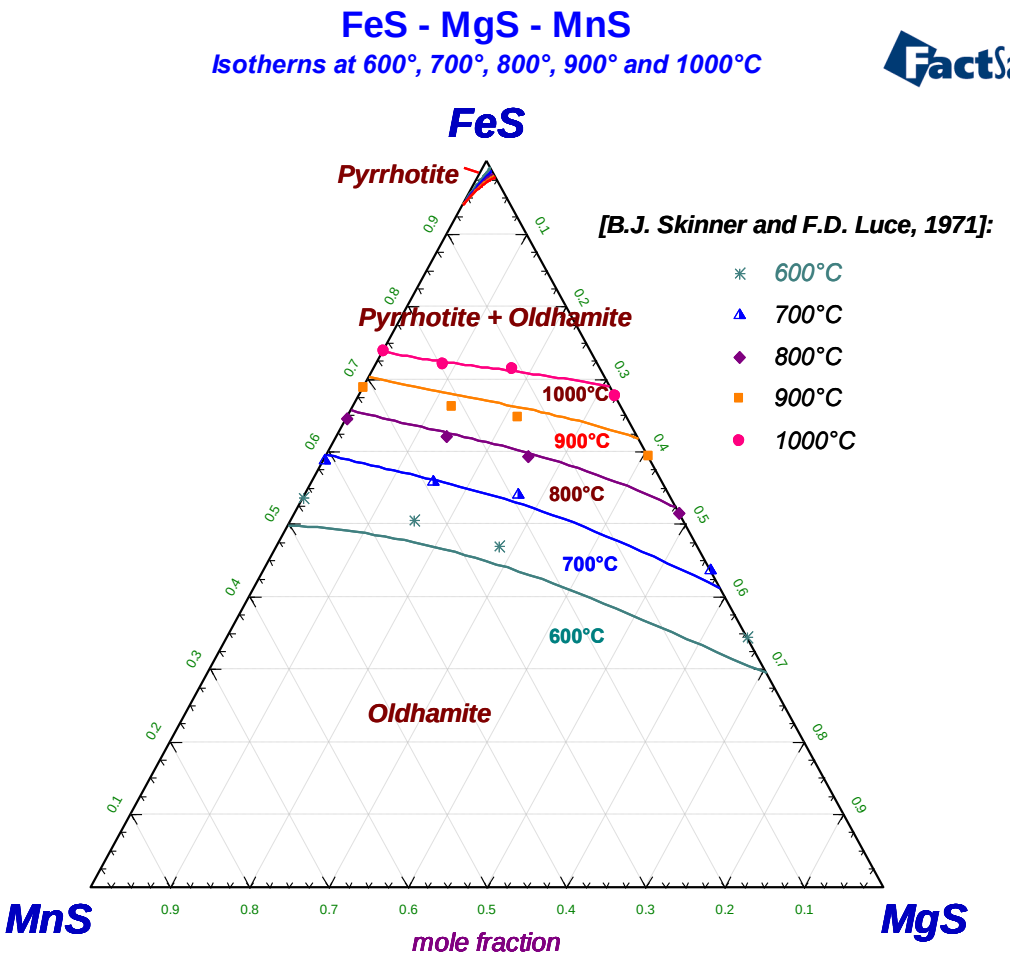
Intersections with slag	Mole fraction				Weight percent			
	A = Fe2O3, B = SrO, C = SiO2				A = Fe2O3, B = SrO, C = SiO2			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1. Sr2SiO4(s2) / Sr2SiO4(s3) / Sr3SiO5	0.16913	0.73103	0.09984	1699.85	0.24833	0.69651	0.05516	1699.85
2. MeO / Sr3SiO5 / Sr6Fe2SiO11	0.18709	0.77504	0.03786	1516.96	0.26566	0.71411	0.02023	1516.96
3. Sr2SiO4(s2) / Sr3SiO5 / Sr6Fe2SiO11	0.20824	0.72246	0.06930	1516.21	0.29617	0.66674	0.03709	1516.21
4. SrFeO(3-delta)/Sr2SiO4(s2)/Sr6Fe2SiO11	0.23039	0.69622	0.07339	1481.79	0.32460	0.63650	0.03890	1481.64
5. SrFeO(3-delta)/ Sr3Fe2O6 / Sr6Fe2SiO11	0.22835	0.72772	0.04392	1478.69	0.31844	0.65851	0.02305	1478.69
6. MeO / Sr3Fe2O6 / Sr6Fe2SiO11	0.20262	0.77160	0.02578	1478.60	0.28418	0.70221	0.01361	1478.60
7. Fe2O3 / SPINEL / SiO2(s4)	0.39133	0.11178	0.49689	1384.46	0.60128	0.11145	0.28727	1384.37
8. Fe2O3 / SPINEL / SrFe12O19	0.59607	0.28976	0.11417	1384.36	0.72072	0.22734	0.05194	1384.36
9. Sr2Fe2SiO7 / Sr2SiO4(s2) / SrSiO3	0.25265	0.45082	0.29653	1340.24	0.38469	0.44542	0.16988	1340.23
10.Fe2O3 / Sr2Fe2SiO7 / SrFe12O19	0.45362	0.36815	0.17823	1313.73	0.59721	0.31450	0.08829	1313.73
11.Fe2O3 / Sr2Fe2SiO7 / SrSiO3	0.35686	0.38428	0.25886	1283.11	0.50718	0.35439	0.13843	1283.11
12.Fe2O3 / SiO2(s4) / SrSiO3	0.18169	0.24938	0.56893	1270.98	0.32586	0.29022	0.38393	1270.98
13.SrFeO(3-delta)/Sr2Fe2SiO7/ Sr2SiO4(s2)	0.42338	0.49283	0.08379	1191.60	0.54651	0.41279	0.04070	1191.82
14.SrFeO(3-delta)/Sr2Fe2SiO7/ Sr4Fe6O13	0.44104	0.48225	0.07671	1176.88	0.56339	0.39974	0.03687	1176.88
15.Sr2Fe2SiO7 / Sr4Fe6O13/ SrFe12O19	0.45268	0.47387	0.07346	1170.28	0.57461	0.39031	0.03508	1170.28

FeO-TiO2-Ti2O3,
Mole fraction 1600°C

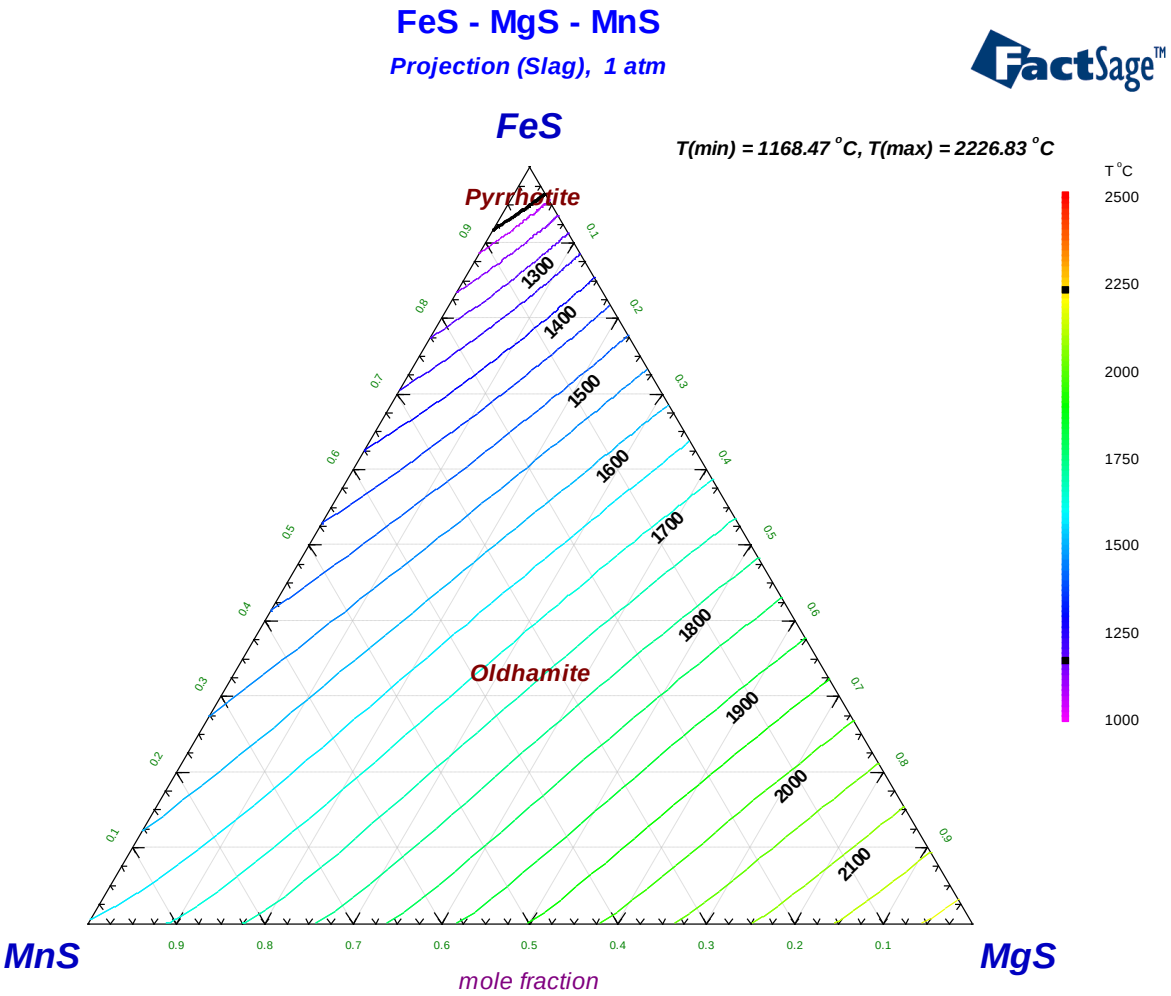



FeO - TiO2 - TiO1.5
1500°C, 1 atm
TiO2
Ti20O39
Ti10O19
Ti9O17
Ti8O15
Ti7O13
Ti6O11
Ti5O9
Slag + Rutile
Slag
PSBROOKITE
PSBR + Fe(s)
Slag + Fe(s)
Slag + PSBR + Fe(s)
COR+PSBR+Fe(s)
TiO1.5
FeO
mole fraction

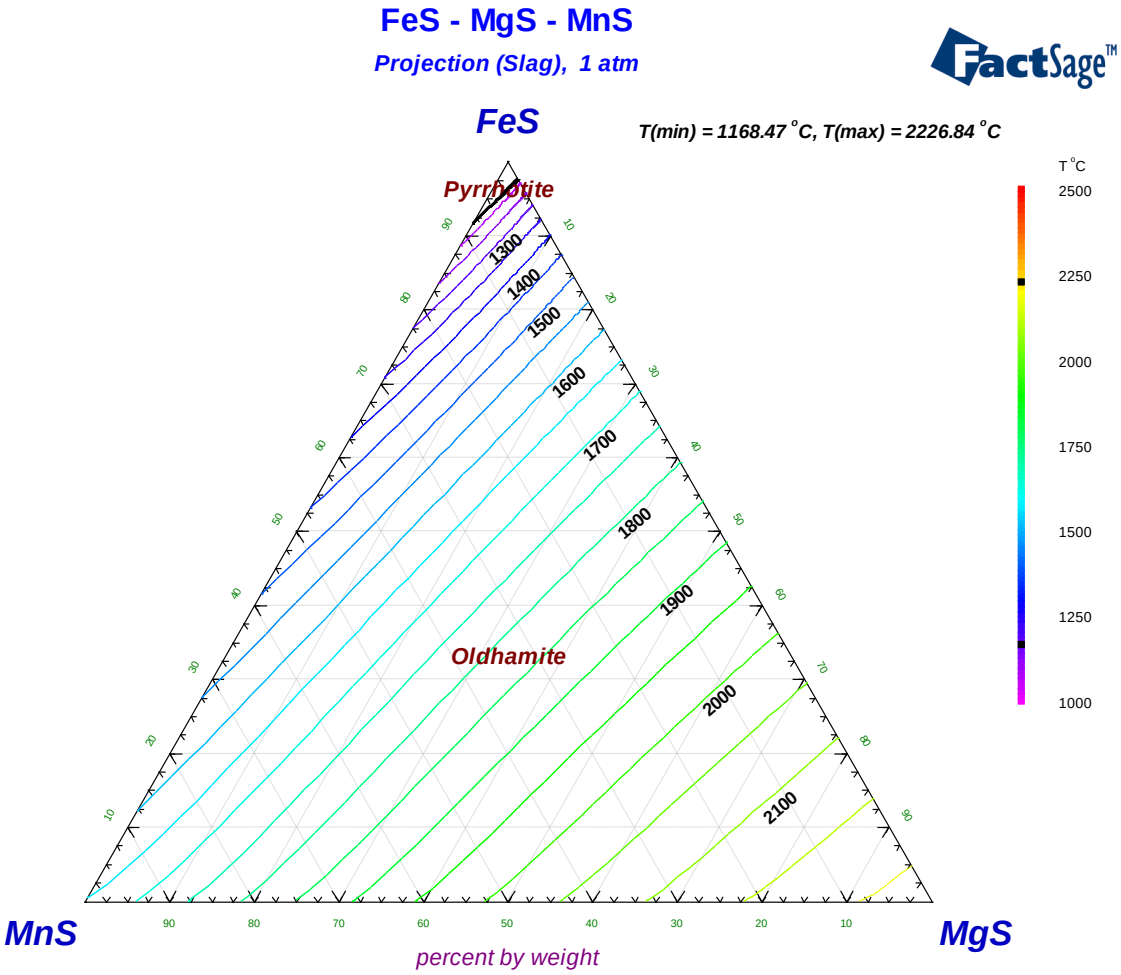
Mole fraction, Isotherms at 600°, 700°, 800°, 900° and 1000°C



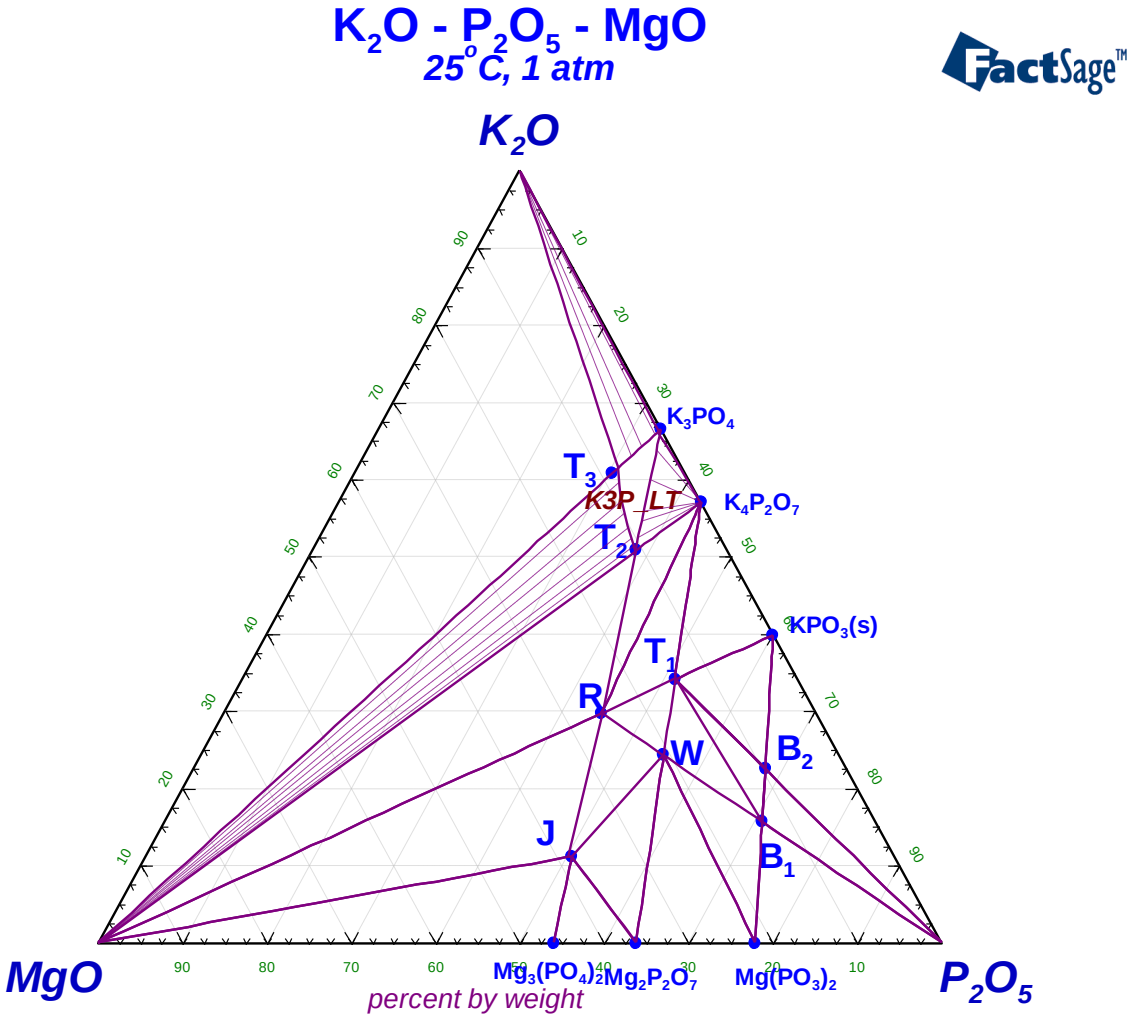
Mole fraction, Liquidussurface



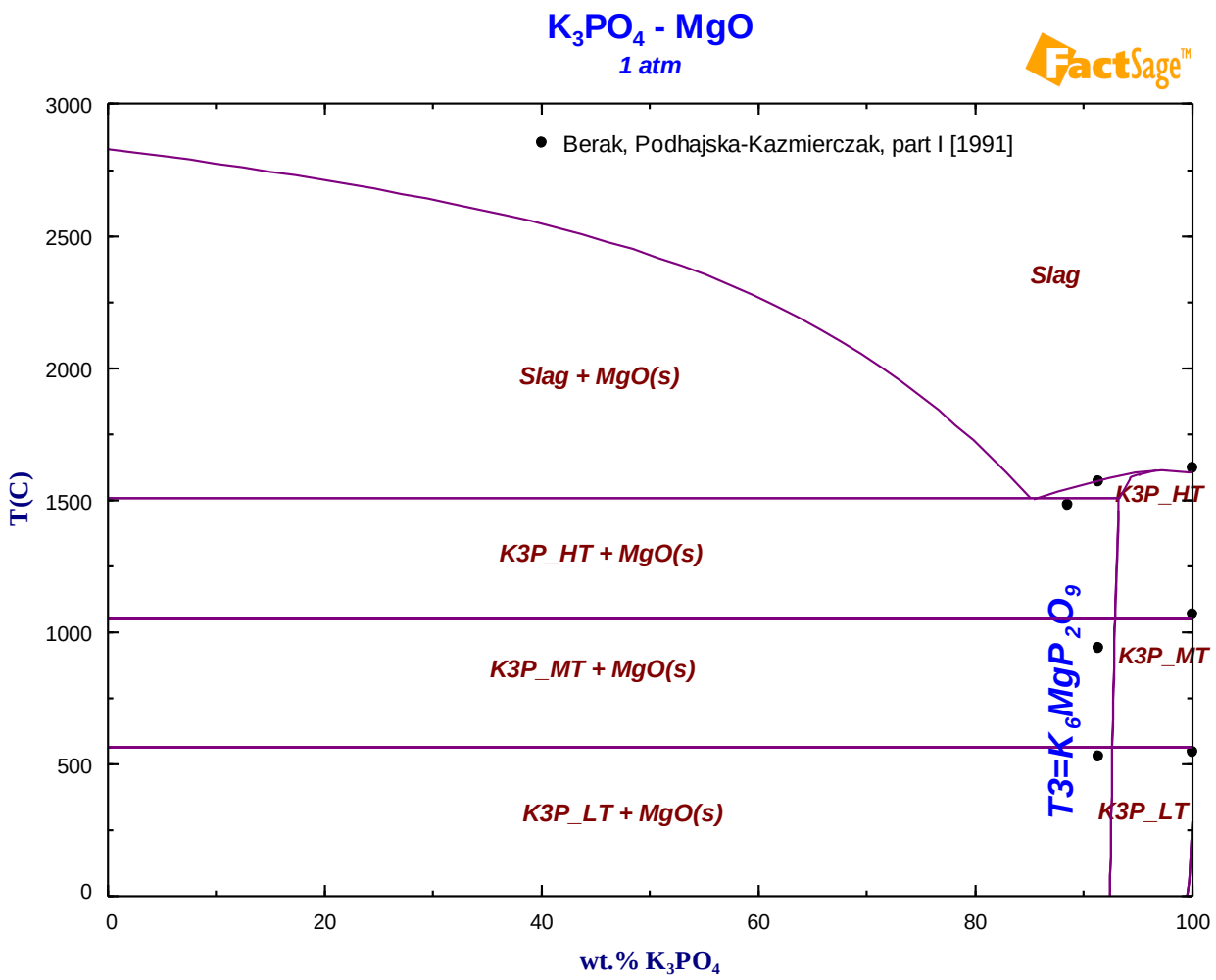
Weight percent, Liquidussurface



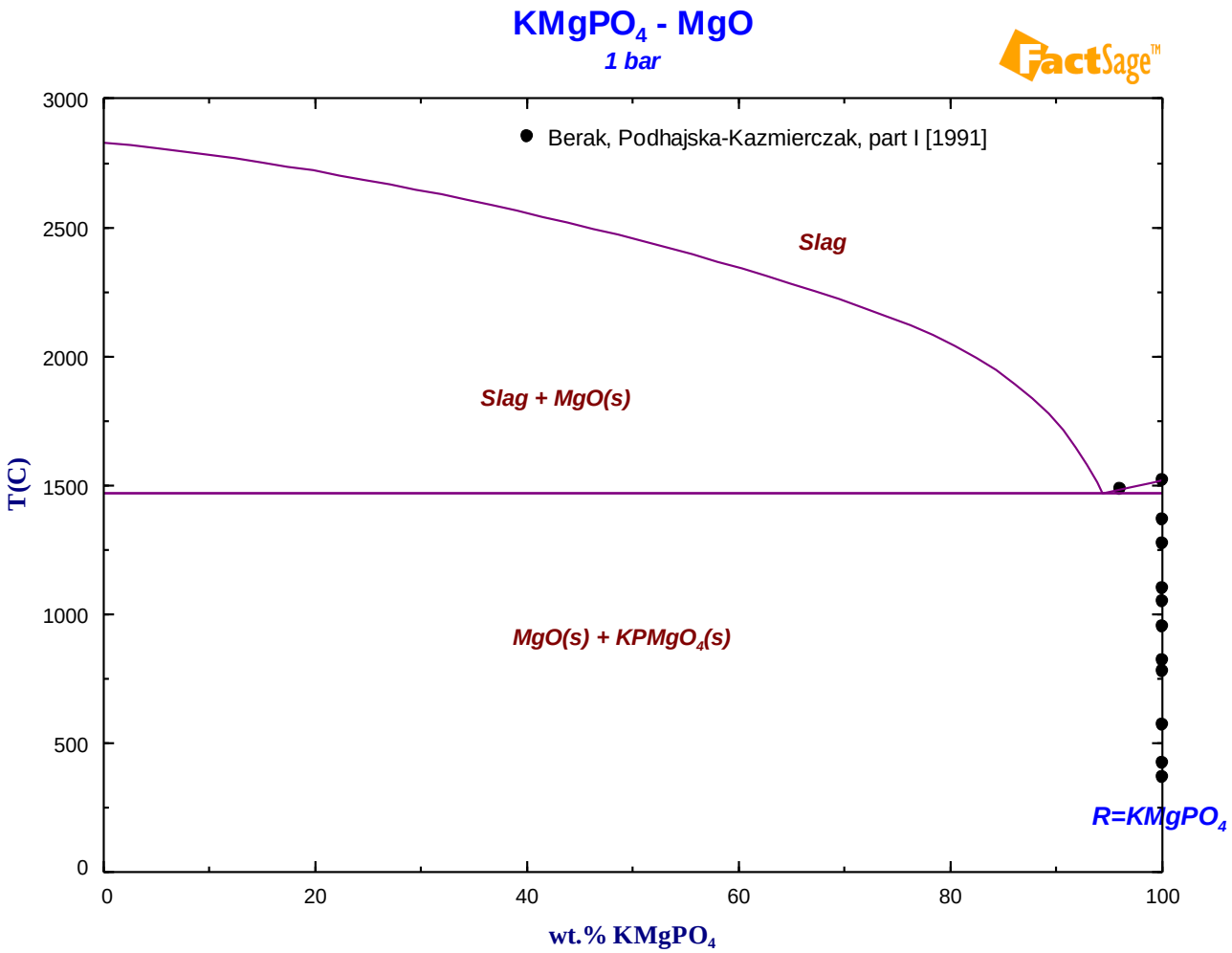
Name	*Composition*	*Melting, °C*	*Liquid species*	*Description*
R	$KMgPO_4$	1519, congruent	$KMgPO_4$(liq)	stoichiometric
J	$KMg_4(PO_4)_3$	1148, incongruent	$KMg(PO_3)_3$ (liq)	stoichiometric
W	$K_4Mg_4P_6O_{21}$	790, incongruent		stoichiometric
T1	$K_2MgP_2O_7$	736, incongruent		stoichiometric
T2	$K_4Mg(PO_4)_2$	1377, congruent		K3P-T2-T3 solution
T3	$K_6MgP_2O_9$	1570, incongruent		K3P-T2-T3 solution
B1	$KMg(PO_3)_3$	904, congruent		stoichiometric
B2	$K_2Mg(PO_3)_4$	735, incongruent		stoichiometric


K2O - P2O5 - MgO
25°C, 1 atm
K2O
MgO
P2O5
K3PO4
T3
K3P_LT
K4P2O7
T2
KPO3(s)
T1
R
W
B2
J
B1
Mg3(PO4)2
Mg2P2O7
Mg(PO3)2
percent by weight

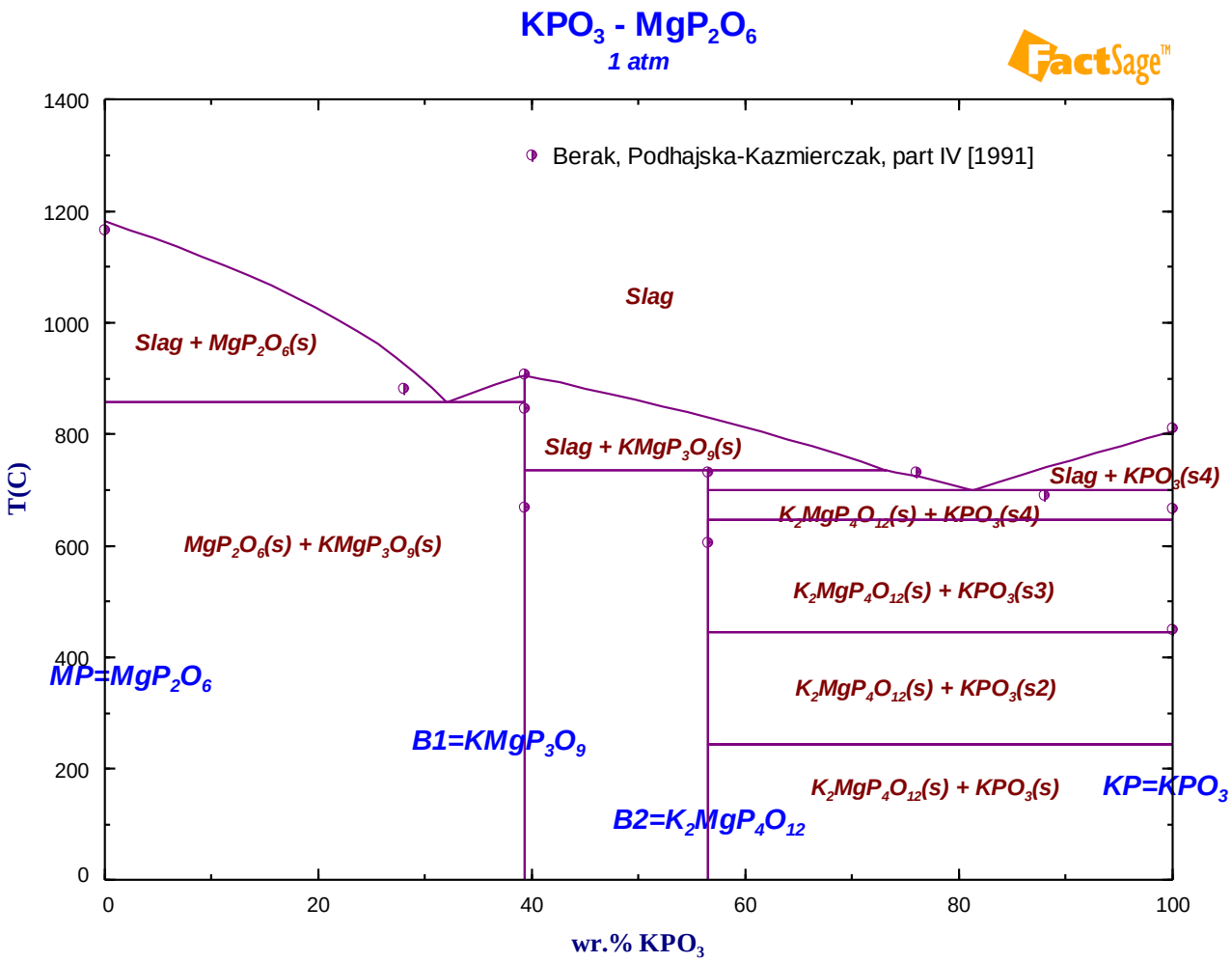
Weight percent, Isopleth K3PO4-MgO



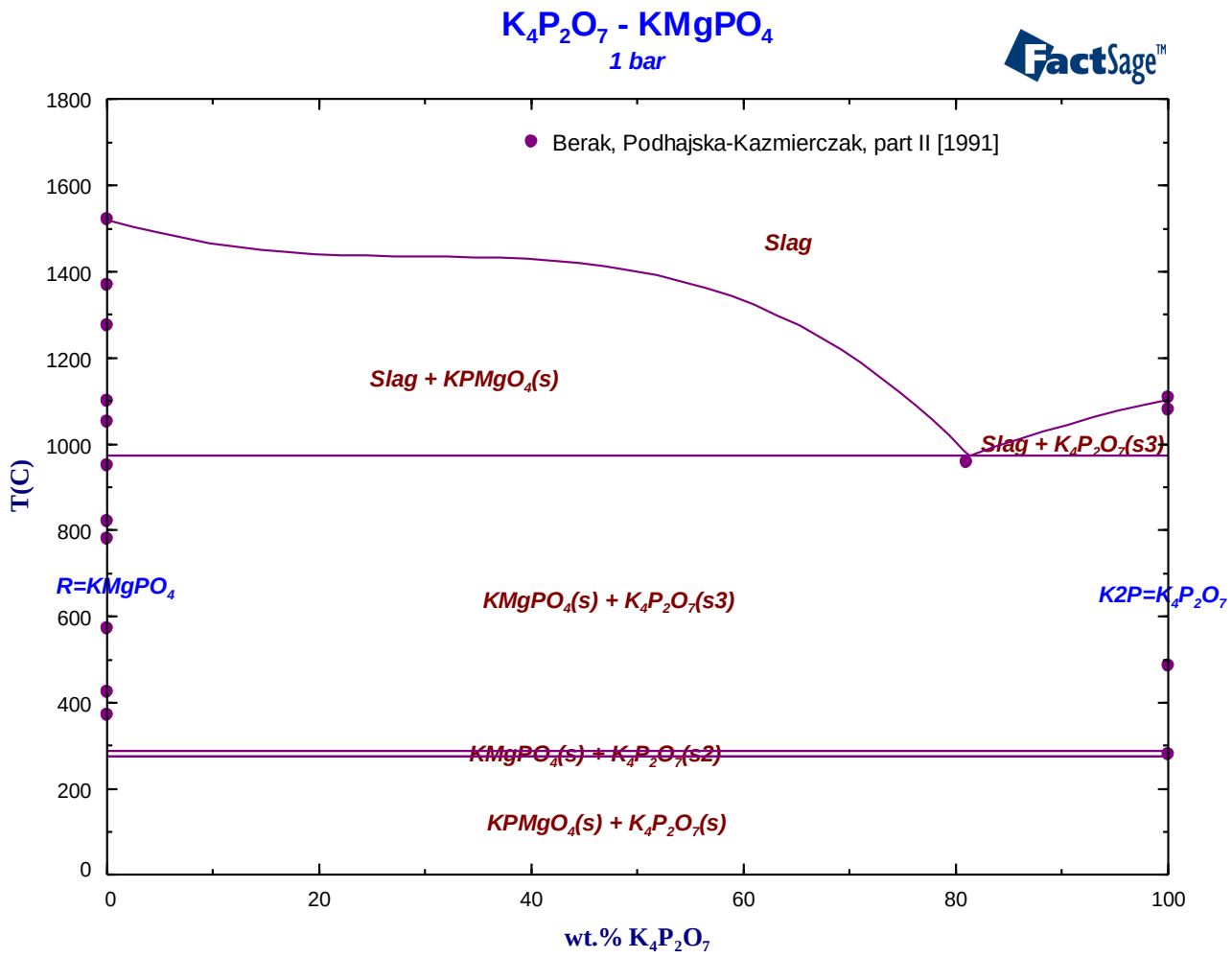
Weight percent, Isopleth KMgPO4-MgO



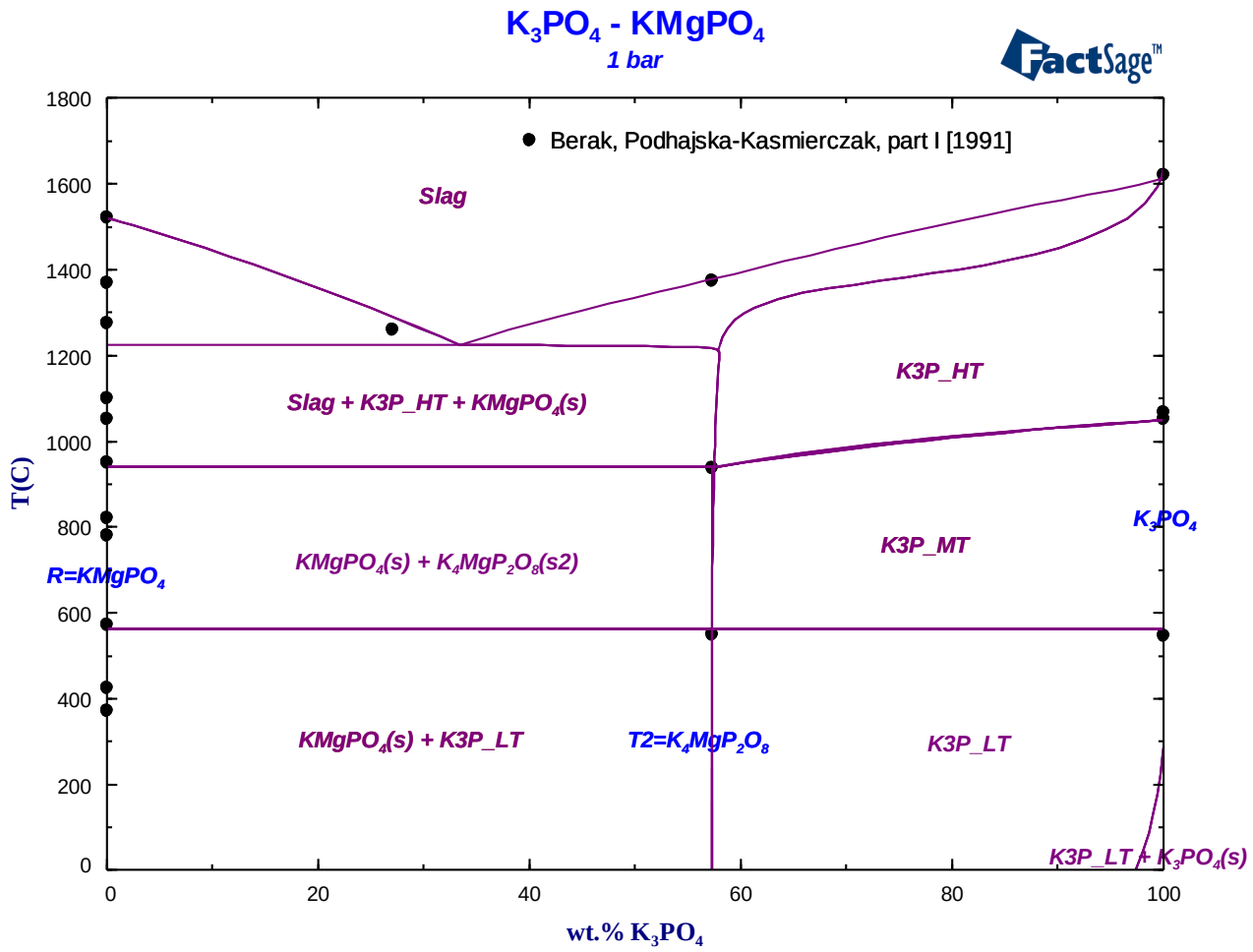
Weight percent, Isopleth KPO3-MgP2O6



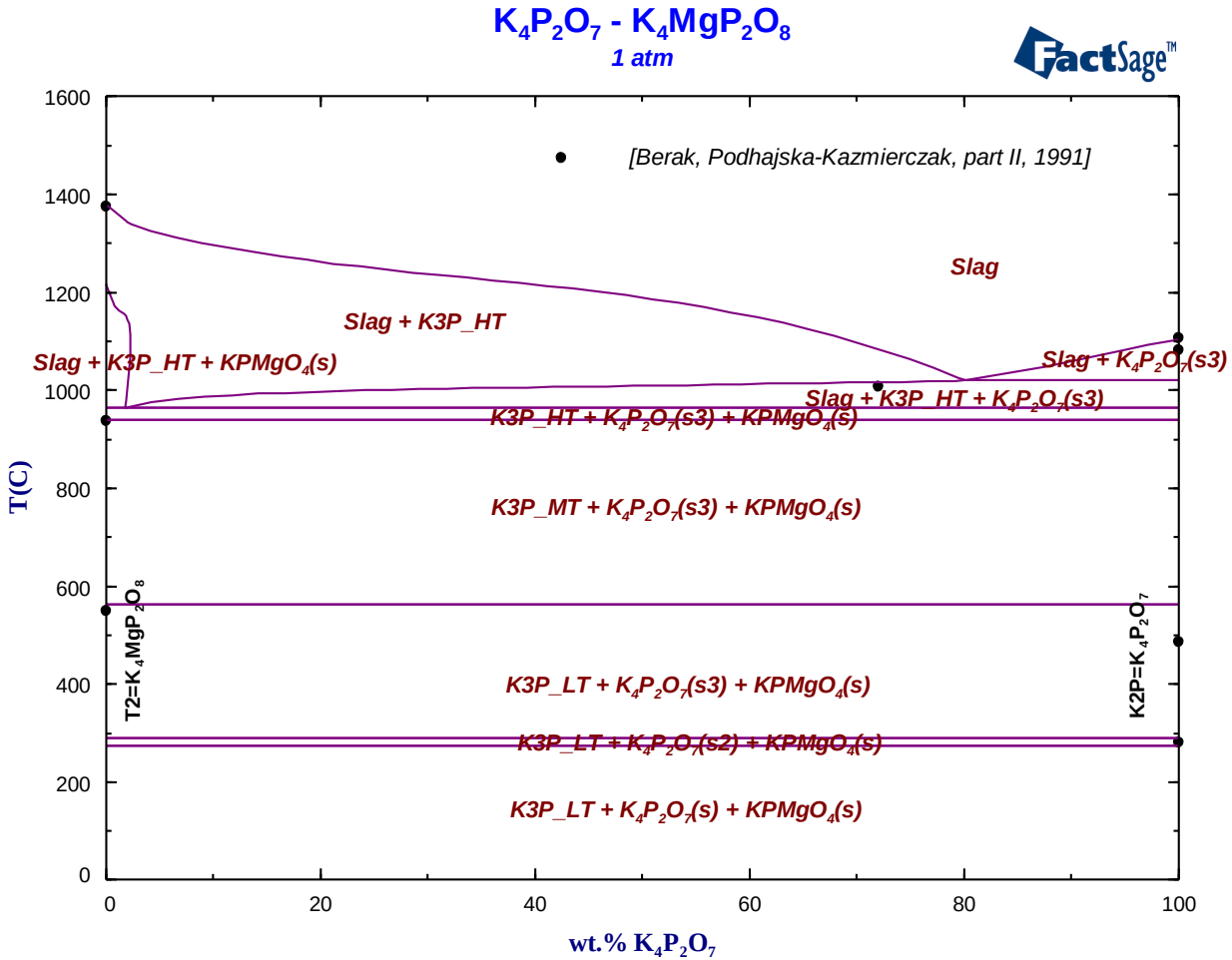
Weight percent, Isopleth K4P2O7-KMgPO4



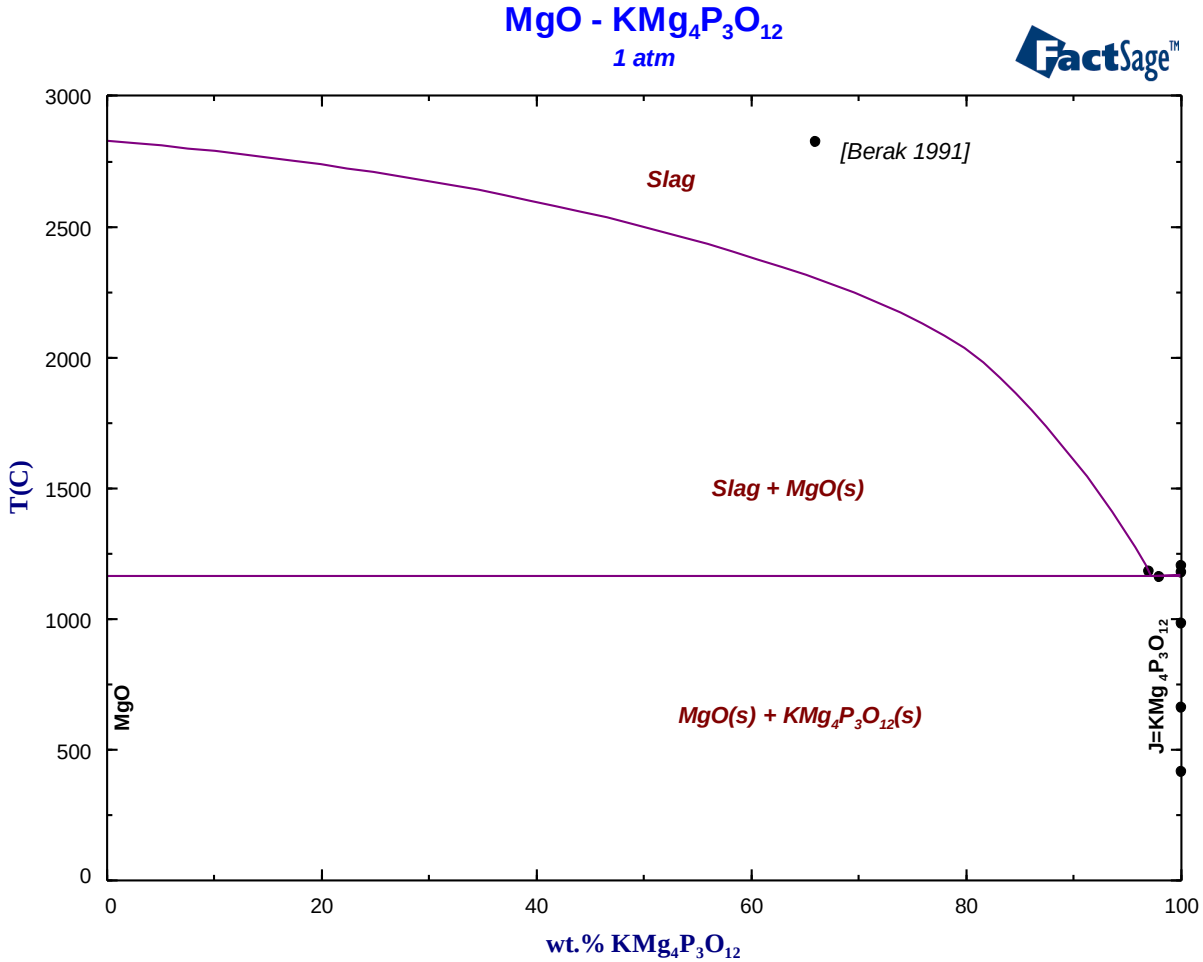
Weight percent, Isopleth K3PO4-KMgPO4

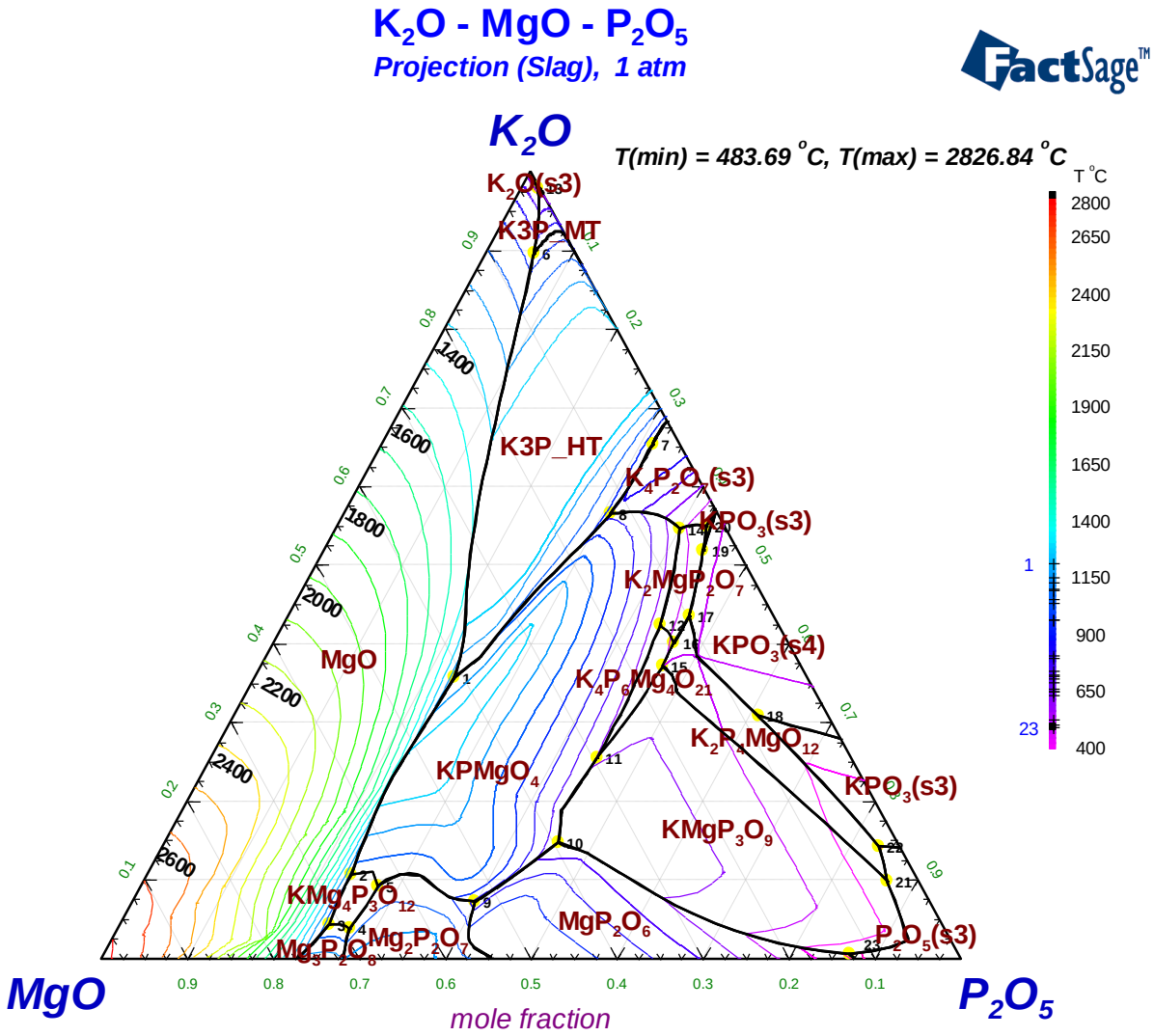


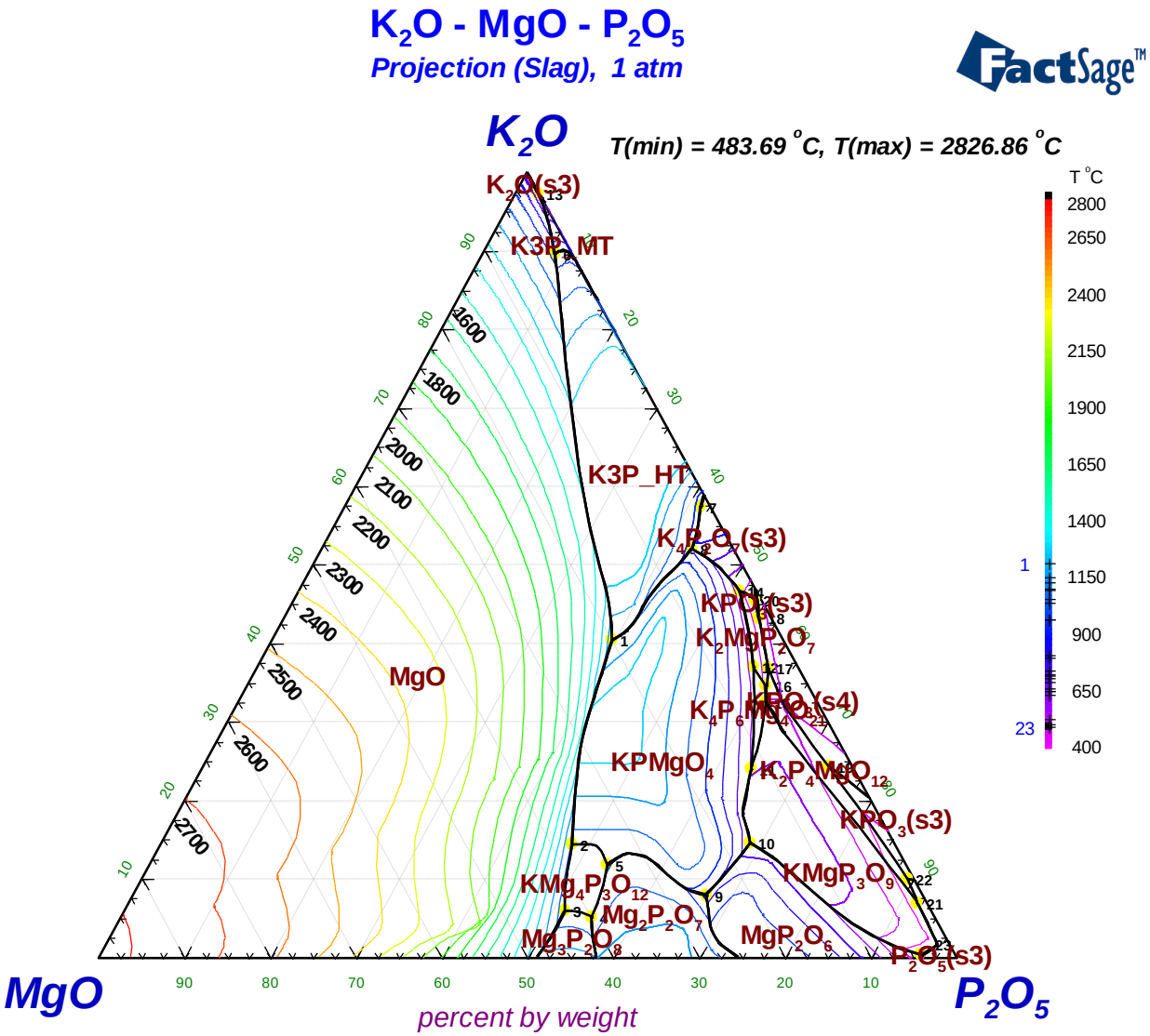
Weight percent, Isopleth K4P2O7-K4MgP2O8



Weight percent, Isopleth KMg4P3O12-MgO




K2O - MgO - P2O5
Projection (Slag), 1 atm
FactSage™
K2O
T(min) = 483.69 °C, T(max) = 2826.84 °C
T °C
2800
2650
2400
2150
1900
1650
1400
1150
900
650
400
K2O(s3)
K3P_MT
K3P_HT
K4P2O7(s3)
KPO3(s3)
K2MgP2O7
KPO3(s4)
K4P6Mg4O21
K2P4MgO12
KPO3(s3)
KPMgO4
KMgP3O9
KMg4P3O12
Mg3P2O8
Mg2P2O7
MgP2O6
P2O5(s3)
MgO
1400
1600
1800
2000
2200
2400
2600
MgO
P2O5
mole fraction


K2O - MgO - P2O5
Projection (Slag), 1 atm
FactSage™
K2O
T(min) = 483.69 °C, T(max) = 2826.86 °C
T °C
2800
2650
2400
2150
1900
1650
1400
1150
900
650
400
K2O(s3)
K3P_MT
K3P_HT
K4P2O7(s3)
KPO3(s3)
K2MgP2O7
K4P6MgO24
KPO3(s4)
KPMgO4
K2P4MgO12
KPO3(s3)
KMgP3O9
KMg4P3O12
Mg2P2O7
Mg3P2O8
MgP2O6
P2O5(s3)
MgO
1600
1800
2000
2100
2200
2300
2400
2500
2600
2700
MgO
P2O5
percent by weight

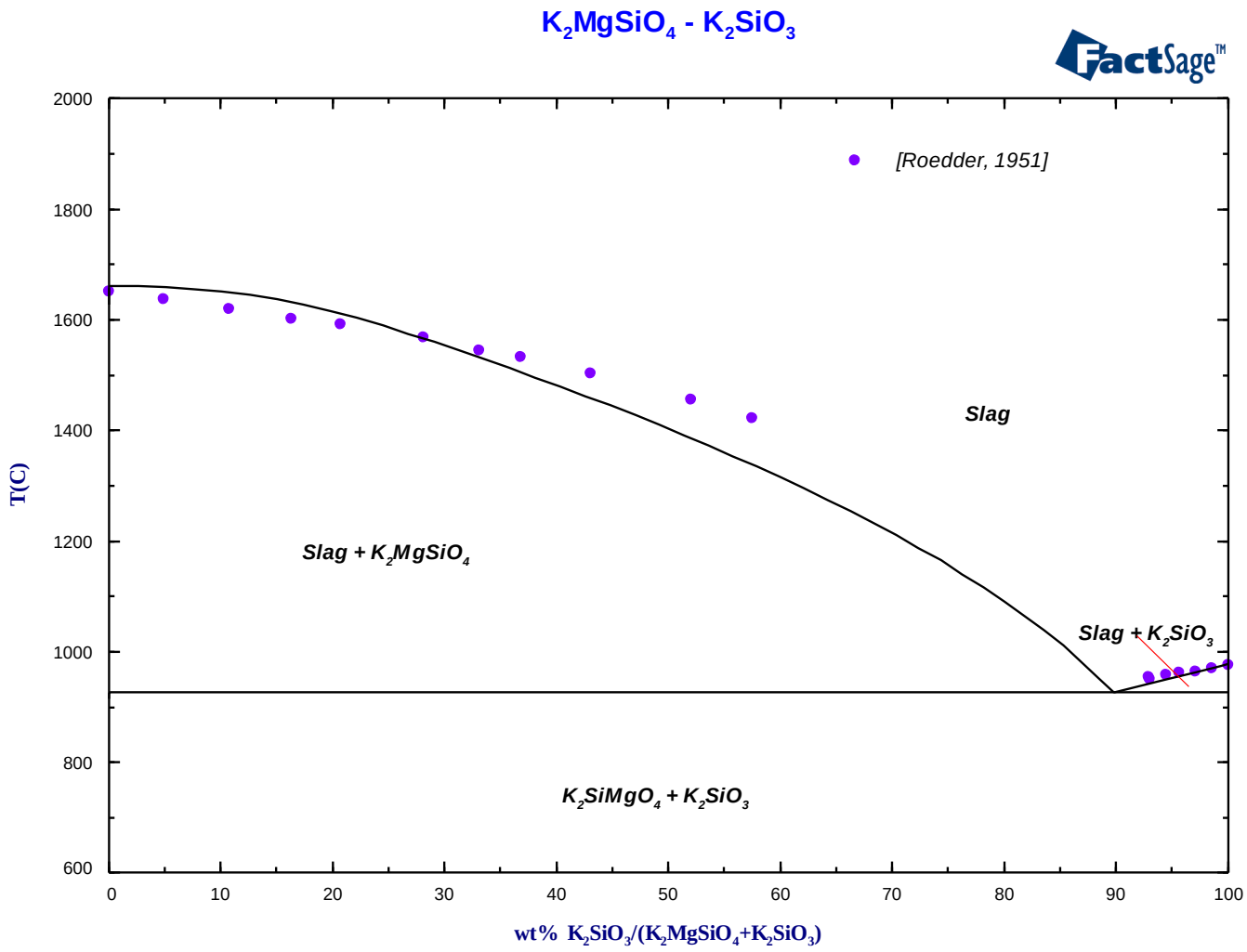
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction				Weight percent			
	A = K2O, B = MgO, C = P2O5				A = K2O, B = MgO, C = P2O5			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: K3P_HT / KPMgO4 / MgO	1: 0.35679	0.41127	0.23194	1210.78	1: 40.440	19.945	0.39.614	1210.78
2: KMg4P3O12 / KPMgO4 / MgO	2: 0.10685	0.65568	0.23746	1148.68	2: 14.338	37.646	0.48.016	1148.68
3: KMg4P3O12 / Mg3P2O8 / MgO	3: 0.04241	0.71445	0.24314	1124.97	3: 5.935	42.785	0.51.280	1124.69
4: KMg4P3O12 / Mg2P2O7(s) / Mg3P2O8(s)	4: 0.03834	0.69251	0.26915	1096.11	4: 5.180	40.029	0.54.791	1096.06
5: KMg4P3O12 / KPMgO4 / Mg2P2O7(s)	5: 0.09140	0.63299	0.27562	1090.83	5: 11.754	34.832	0.53.414	1090.73
6: K3P_HT / K3P_MT / MgO	6: 0.89683	0.04818	0.05500	1047.98	6: 89.654	2.061	0.08.285	1047.98
7: K3P_HT / K3P_MT / K4P2O7(s3)	7: 0.65463	0.03125	0.31411	1031.12	7: 57.356	1.172	41.472	1031.12
8: K3P_HT / K4P2O7(s3) / KPMgO4	8: 0.56531	0.12461	0.31008	962.66	8: 52.059	4.910	43.030	962.66
9: KPMgO4 / Mg2P2O7(s) / MgP2O6(s)	9: 0.07172	0.52955	0.39873	961.28	9: 7.977	25.199	66.824	961.26
10: KMgP3O9 / KPMgO4 / MgP2O6(s)	10: 0.14741	0.39433	0.45826	799.95	10: 14.643	16.760	68.596	800.66
11: K4P6Mg4O21 / KMgP3O9 / KPMgO4	11: 0.25437	0.29631	0.44932	790.43	11: 24.038	11.981	63.982	790.42
12: K2MgP2O7 / K4P6Mg4O21 / KPMgO4	12: 0.42353	0.13822	0.43824	733.15	12: 37.052	5.174	57.773	733.15
13: K2O(s3) / K3P_MT / MgO	13: 0.97976	0.00290	0.01734	717.12	13: 97.282	0.123	2.595	717.12
14: K2MgP2O7 / K4P2O7(s3) / KPMgO4	14: 0.54650	0.05448	0.39902	713.57	14: 46.665	1.990	51.344	713.59
15: K2P4MgO12 / K4P6Mg4O21 / KMgP3O9	15: 0.37164	0.16108	0.46728	700.02	15: 32.466	6.021	61.513	700.02
16: K2MgP2O7 / K2P4MgO12 / K4P6Mg4O21	16: 0.40145	0.13285	0.46570	681.43	16: 34.606	4.900	60.494	681.43
17: K2MgP2O7 / K2P4MgO12 / KPO3(s4)	17: 0.43583	0.09782	0.46635	656.32	17: 36.921	3.546	59.533	656.32
18: K2P4MgO12 / KPO3(s3) / KPO3(s4)	18: 0.30835	0.08189	0.60976	645.90	18: 43.241	1.429	55.330	645.92
19: K2MgP2O7 / KPO3(s3) / KPO3(s4)	19: 0.51915	0.04007	0.44078	645.90	19: 24.427	2.776	72.797	645.89
20: K2MgP2O7 / K4P2O7(s3) / KPO3(s3)	20: 0.54892	0.02169	0.42939	625.28	20: 45.544	0.770	53.686	625.24
21: K2P4MgO12 / KMgP3O9 / P2O5(s3)	21: 0.09804	0.03644	0.86553	517.75	21: 6.914	1.100	91.986	517.75
22: K2P4MgO12 / KPO3(s3) / P2O5(s3)	22: 0.14221	0.02405	0.83373	499.22	22: 10.094	0.731	89.175	499.22
23: KMgP3O9 / MgP2O6(s) / P2O5(s3)	23: 0.00531	0.12704	0.86766	483.69	23: 0.388	3.976	95.636	483.73

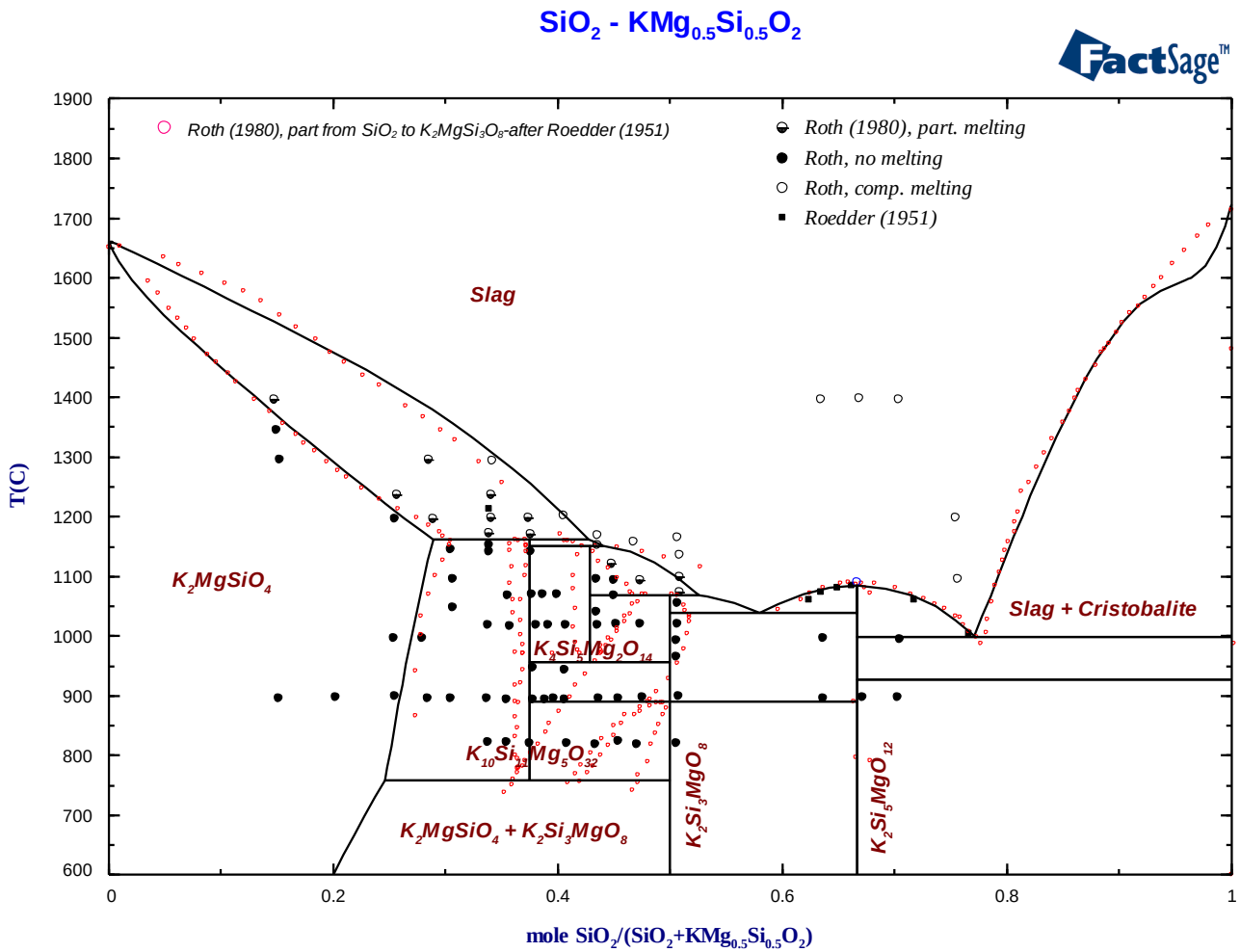
Ternary Phases in K_2O-MgO-SiO_2 System

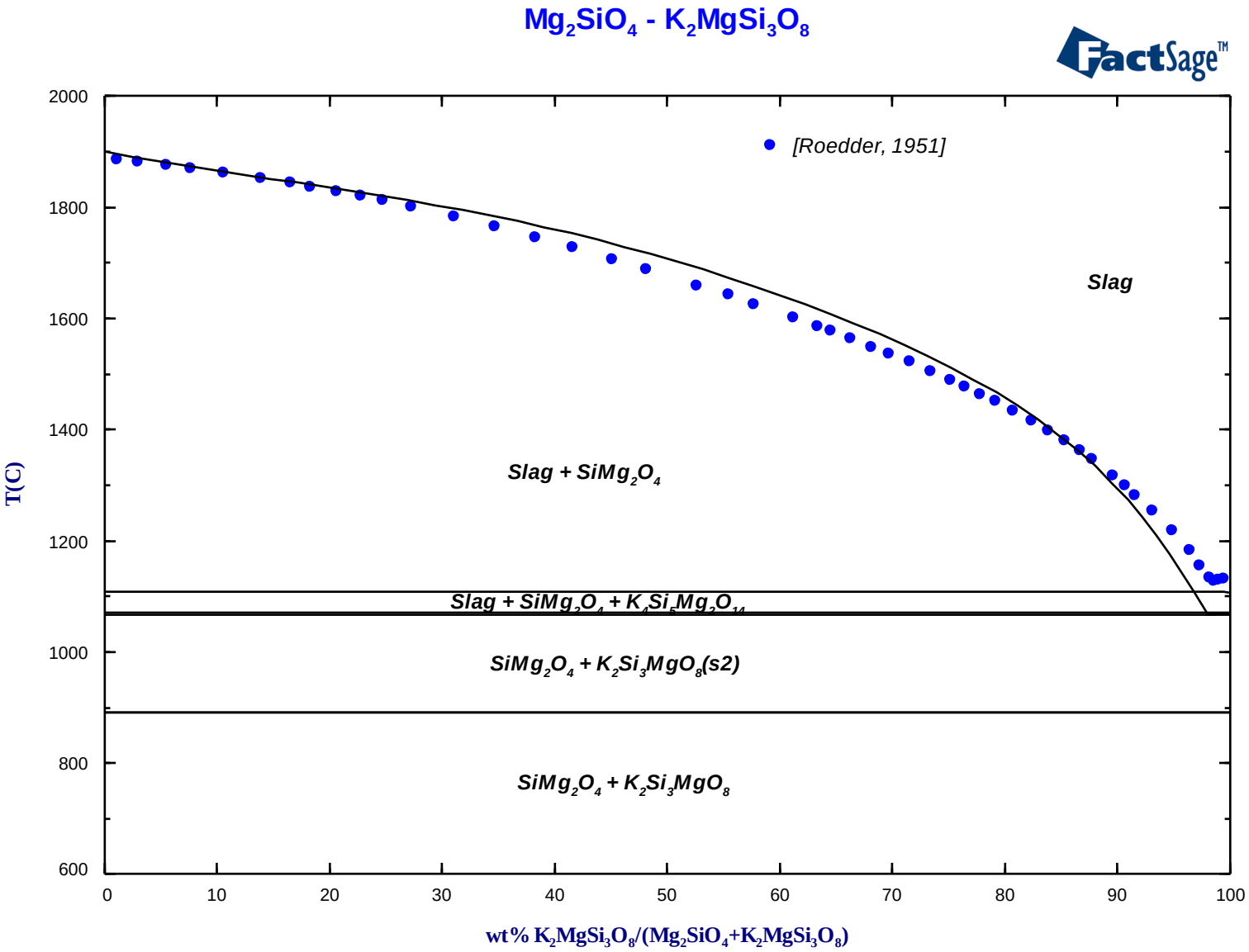
Phase	Description	Formel
KMS (111)	Solid solution	$(Mg^{2+},Si^{4+})_1(Si^{4+})_1\ (K^{1+},Va)_2(O^{2-})_4$
KMS_3 (113-LT)	Stoichiometric	$K_2MgSi_3O_8$ (s1)
KMS_3 (113-HT)	Stoichiometric	$K_2MgSi_3O_8$ (s2)
KMS_5	Stoichiometric	$K_2MgSi_5O_{12}$
KM_5S_{12} (Roedderite)	Stoichiometric	$K_2Mg_5Si_{12}O_{30}$
$K_2M_2S_5$ (Ortho)	Stoichiometric	$K_4Mg_2Si_5O_{14}$
$K_5M_5S_{11}$ (Tetra)	Stoichiometric	$K_{10}Mg_5Si_{11}O_{32}$

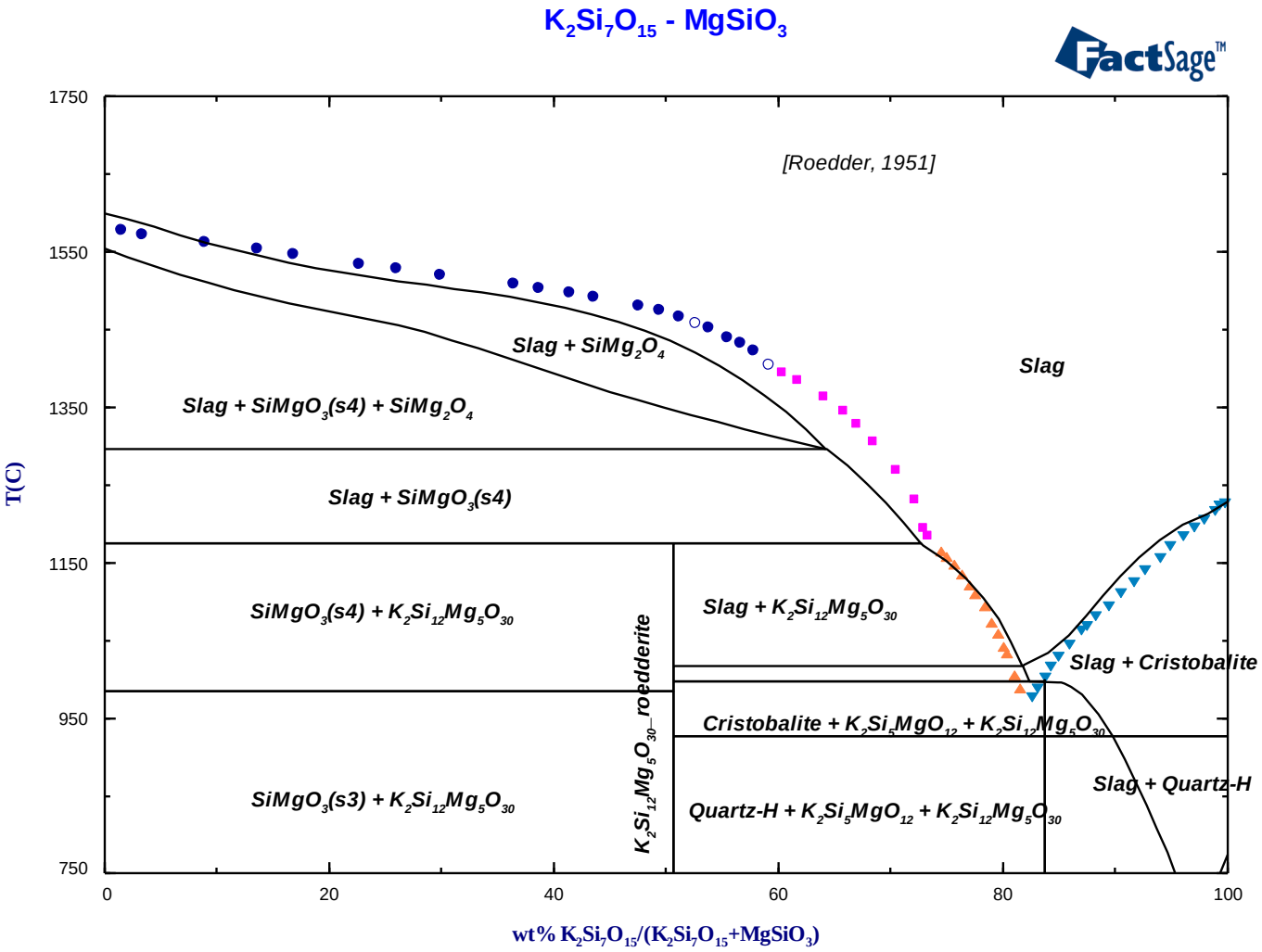
Weight percent , Isopleth K2SiO3-K2MgSiO4 compared with experimental data



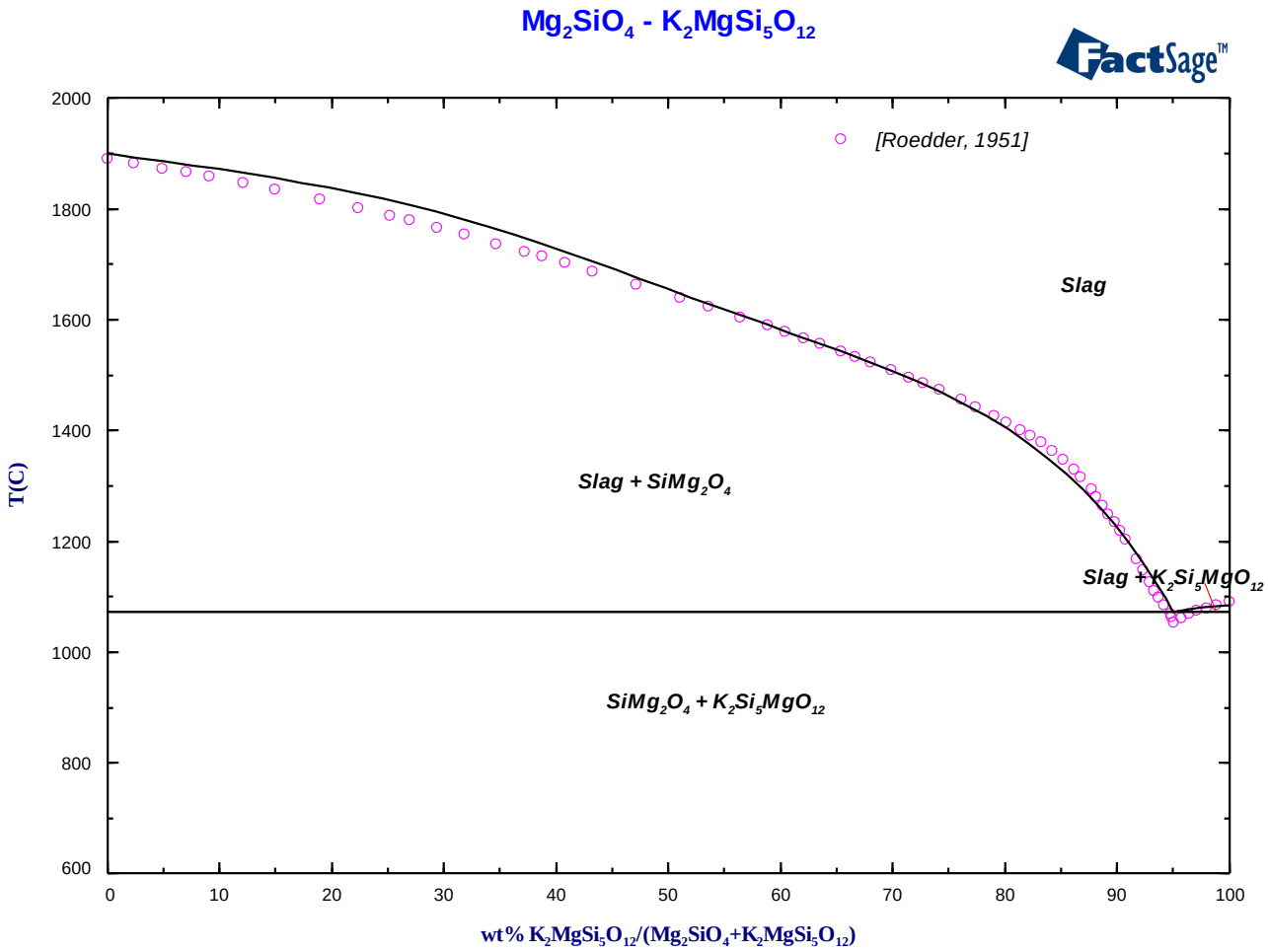
K2O-MgO-SiO2,
Mole fraction, Isopleth 0.5(K2MgSiO4)-SiO2°



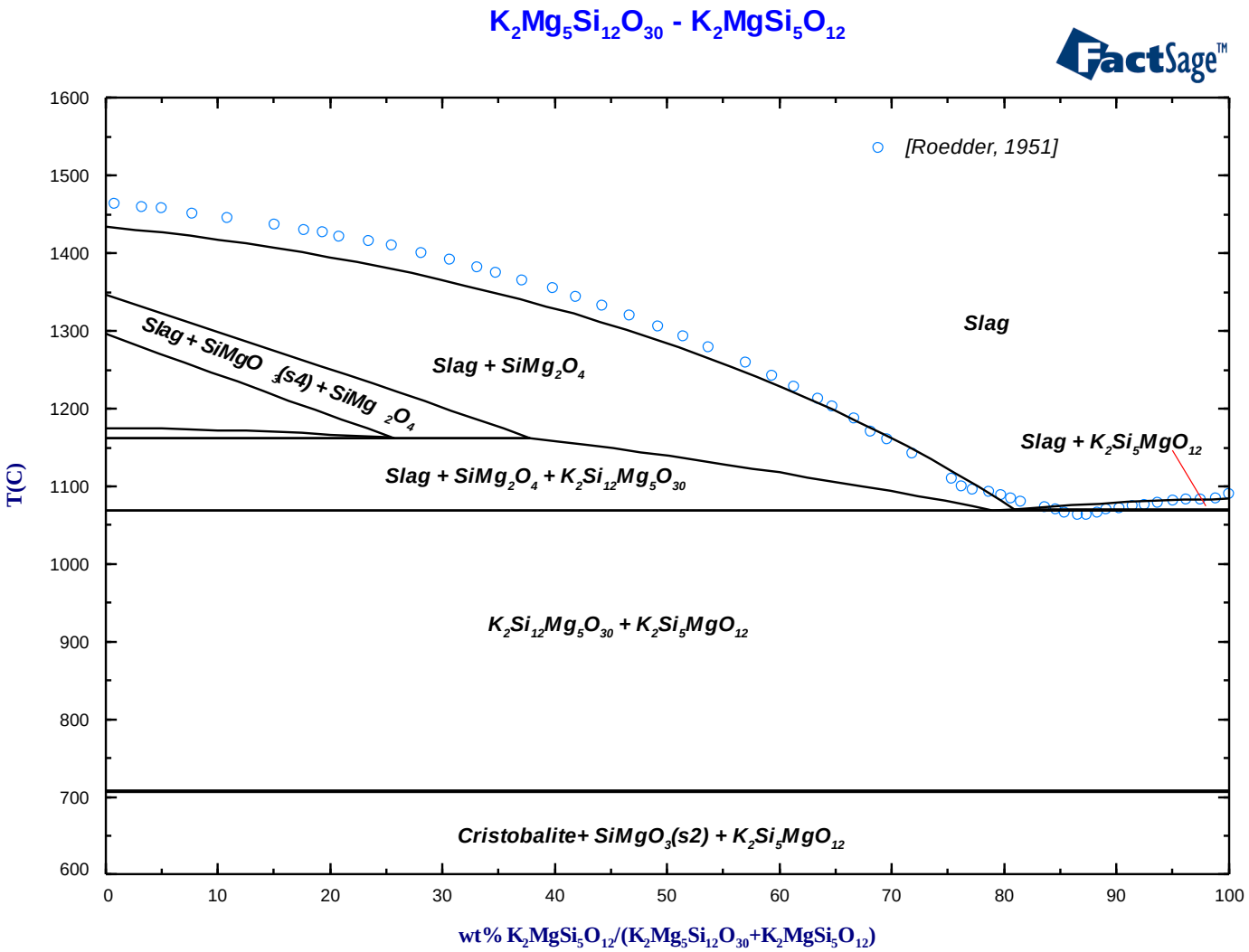

Mg2SiO4 - K2MgSi3O8
FactSage™
[Roedder, 1951]
Slag
Slag + SiMg2O4
Slag + SiMg2O4 + K4Si5Mg2O14
SiMg2O4 + K2Si3MgO8(s2)
SiMg2O4 + K2Si3MgO8
T(C)
2000
1800
1600
1400
1200
1000
800
600
0
10
20
30
40
50
60
70
80
90
100
wt% K2MgSi3O8/(Mg2SiO4+K2MgSi3O8)


K2Si7O15 - MgSiO3
FactSage™
[Roedder, 1951]
Slag + SiMg2O4
Slag
Slag + SiMgO3(s4) + SiMg2O4
Slag + SiMgO3(s4)
SiMgO3(s4) + K2Si12Mg5O30
Slag + K2Si12Mg5O30
Slag + Cristobalite
K2Si12Mg5O30_roeddderite
Cristobalite + K2Si5MgO12 + K2Si12Mg5O30
Slag + Quartz-H
SiMgO3(s3) + K2Si12Mg5O30
Quartz-H + K2Si5MgO12 + K2Si12Mg5O30
T(C)
1750
1550
1350
1150
950
750
0
20
40
60
80
100
wt% K2Si7O15/(K2Si7O15+MgSiO3)

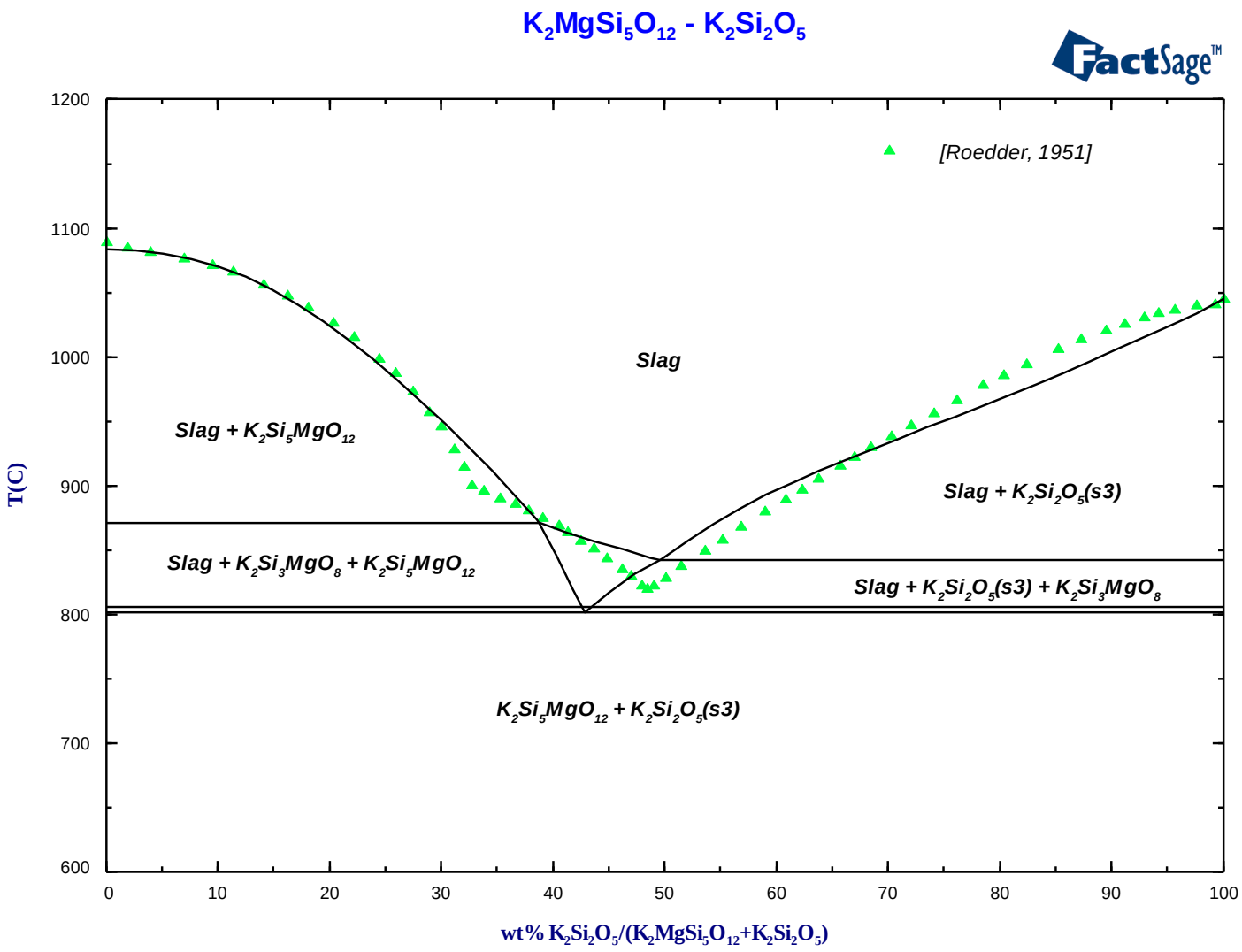
Weight percent , Isopleth Mg2SiO4-K2MgSi5O12 compared with experimental data°



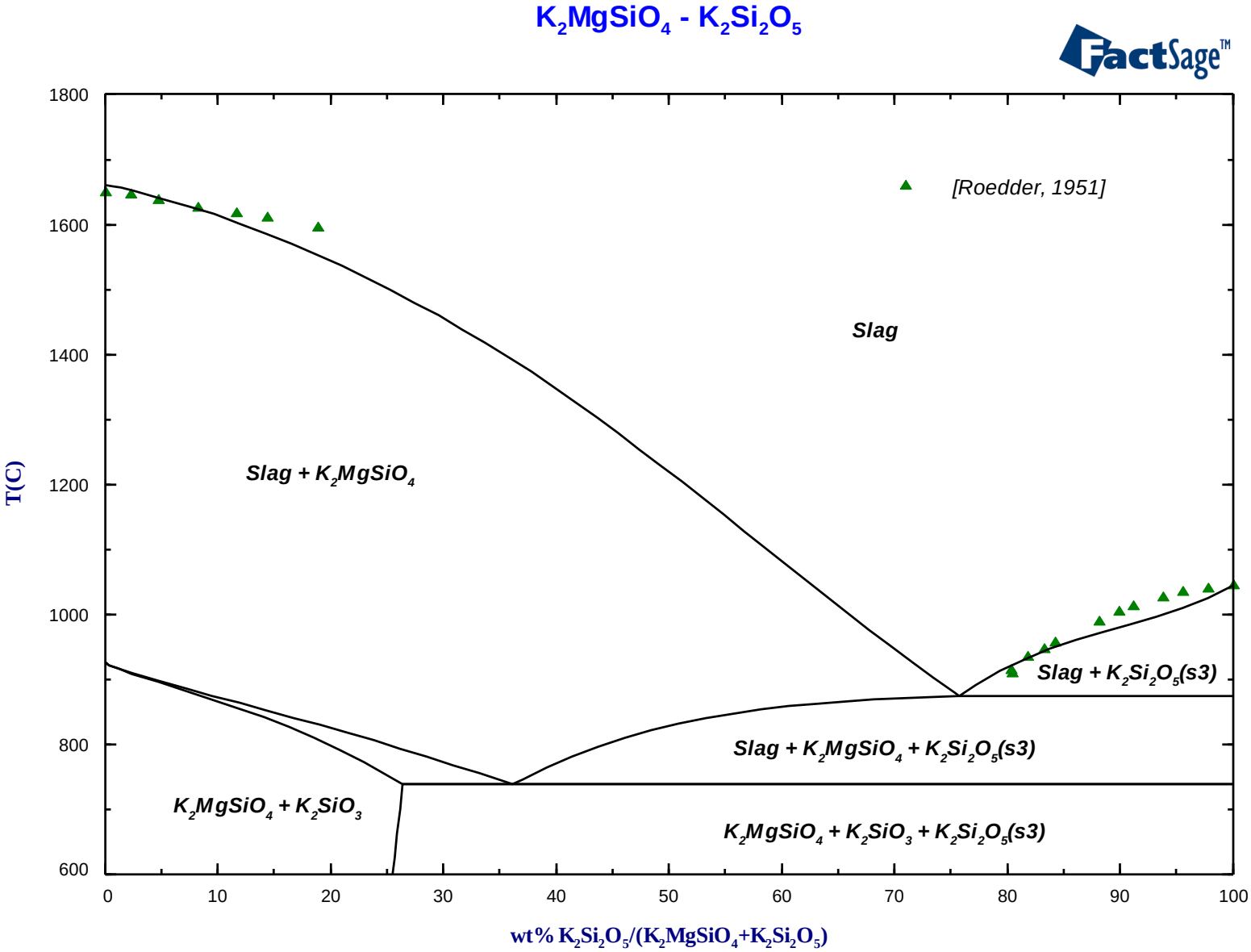
Weight percent
compared with experimental data°



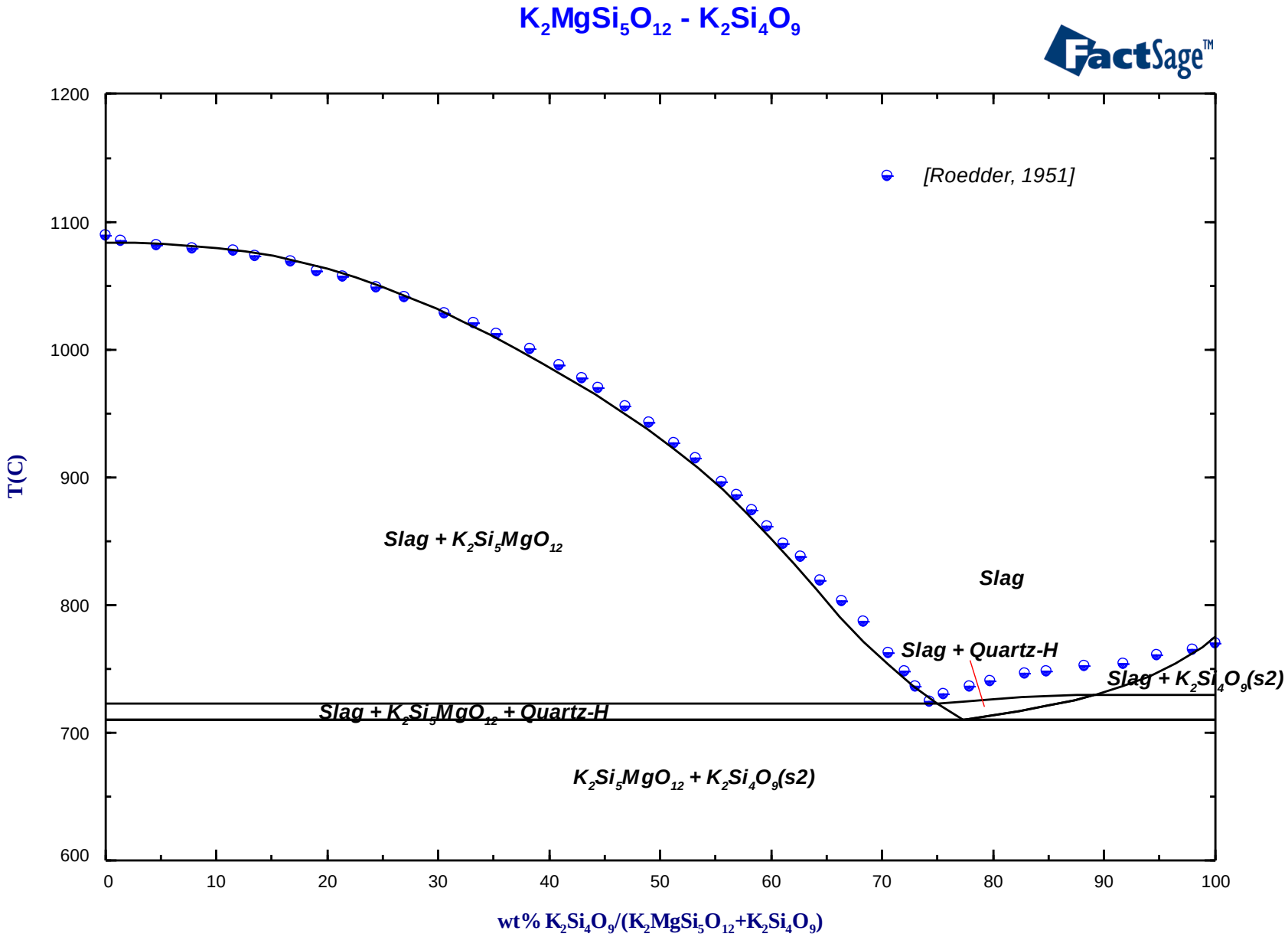
Weight percent
compared with experimental data°

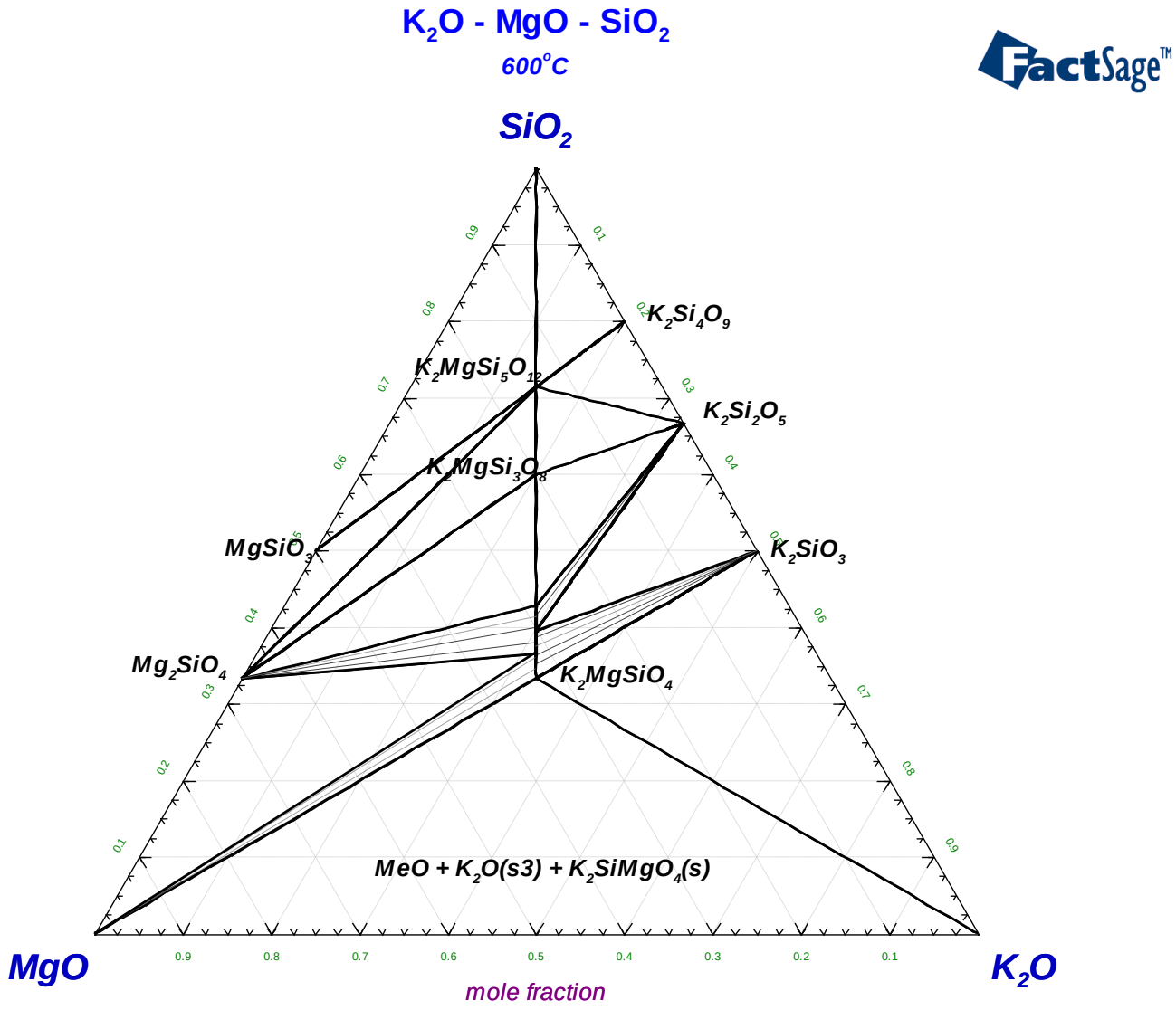


Weight percent , compared with experimental data



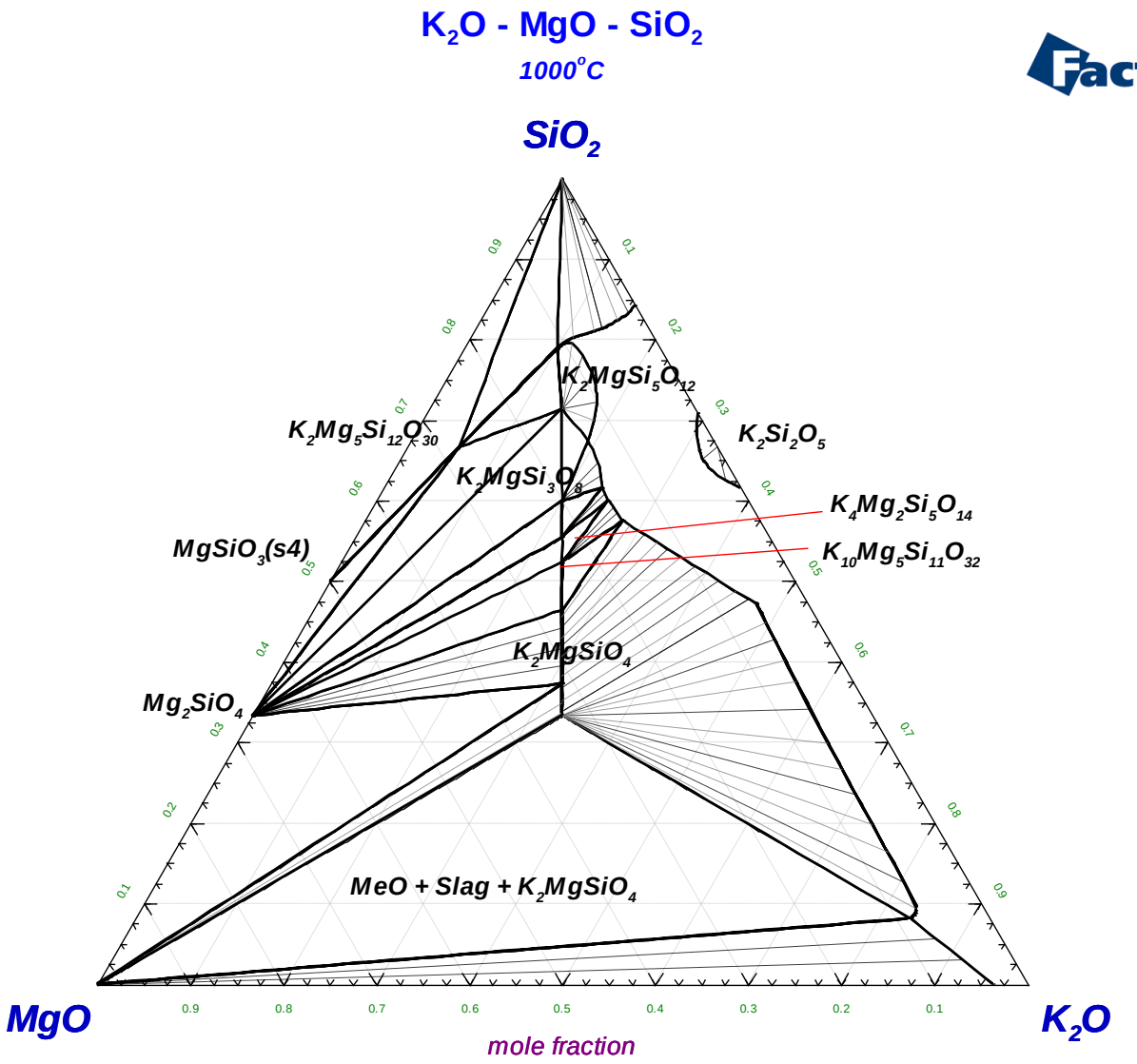
Weight percent, compared with experimental data



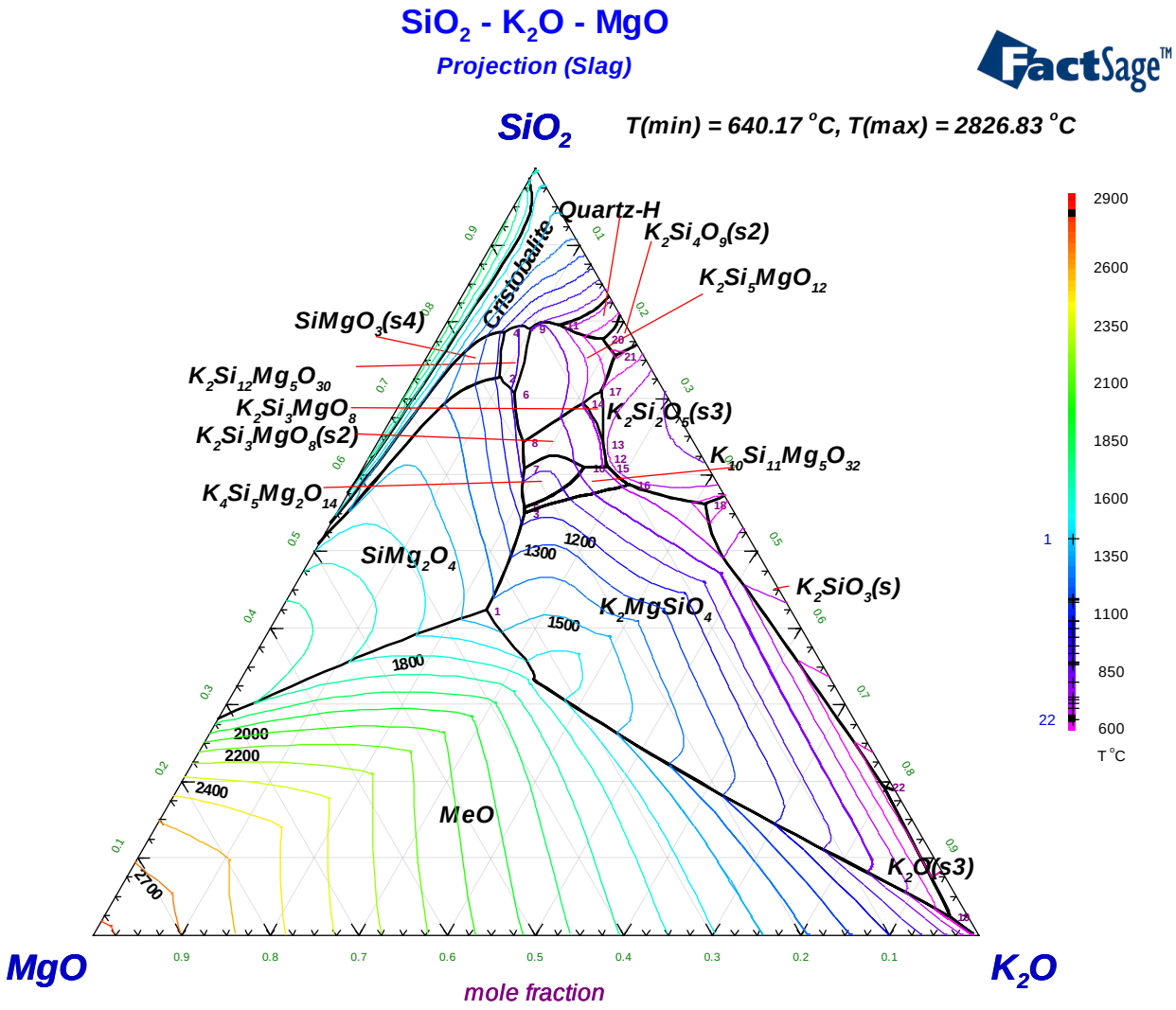

K2O - MgO - SiO2
600°C
SiO2
K2Si4O9
K2MgSi5O12
K2Si2O5
K2MgSi3O8
MgSiO3
K2SiO3
Mg2SiO4
K2MgSiO4
MeO + K2O(s3) + K2SiMgO4(s)
MgO
K2O
mole fraction

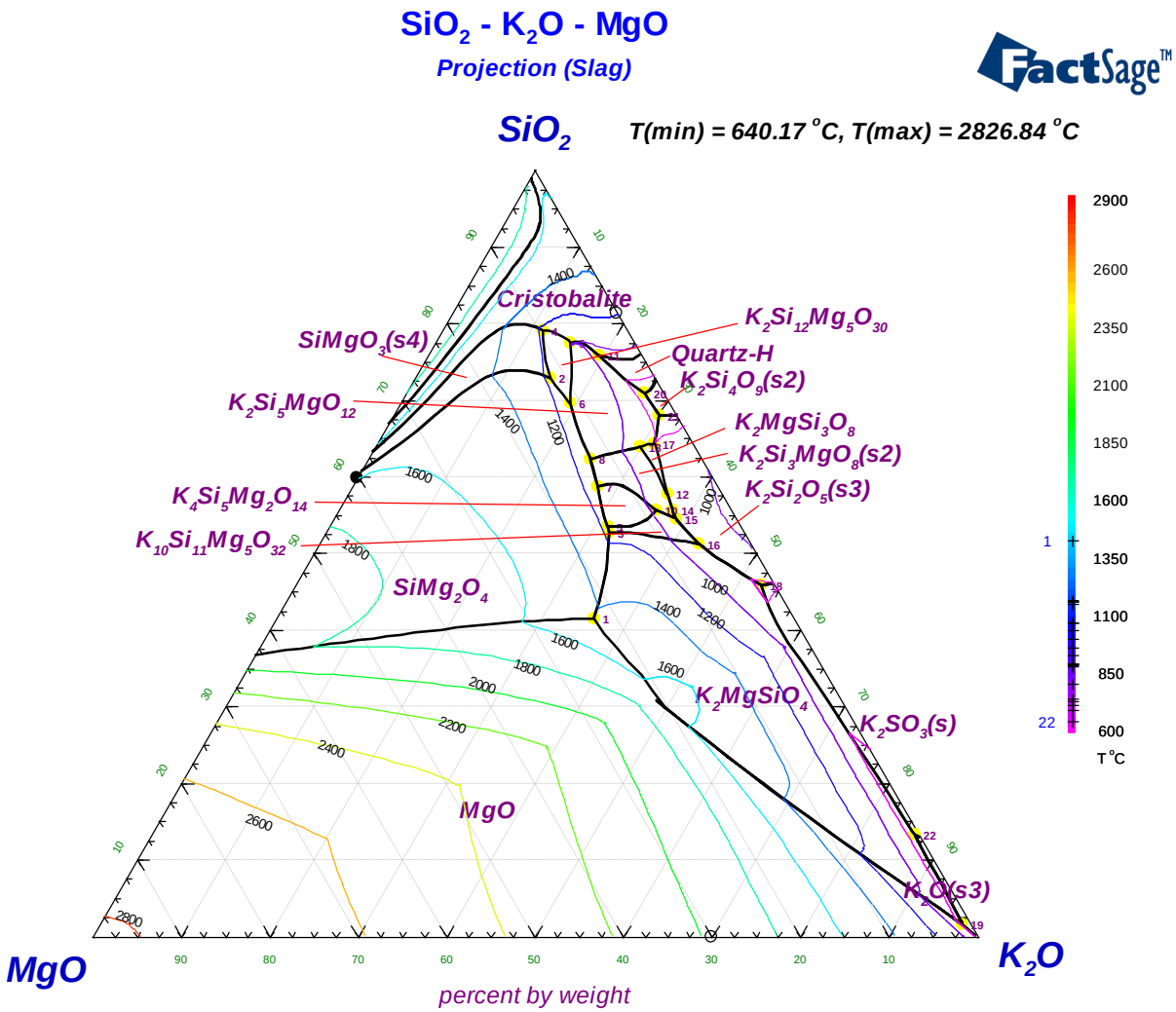
K2O-MgO-SiO2,

Mole fraction 1000°C



K2O-MgO-SiO2, Mole fraction , Liquidussurface

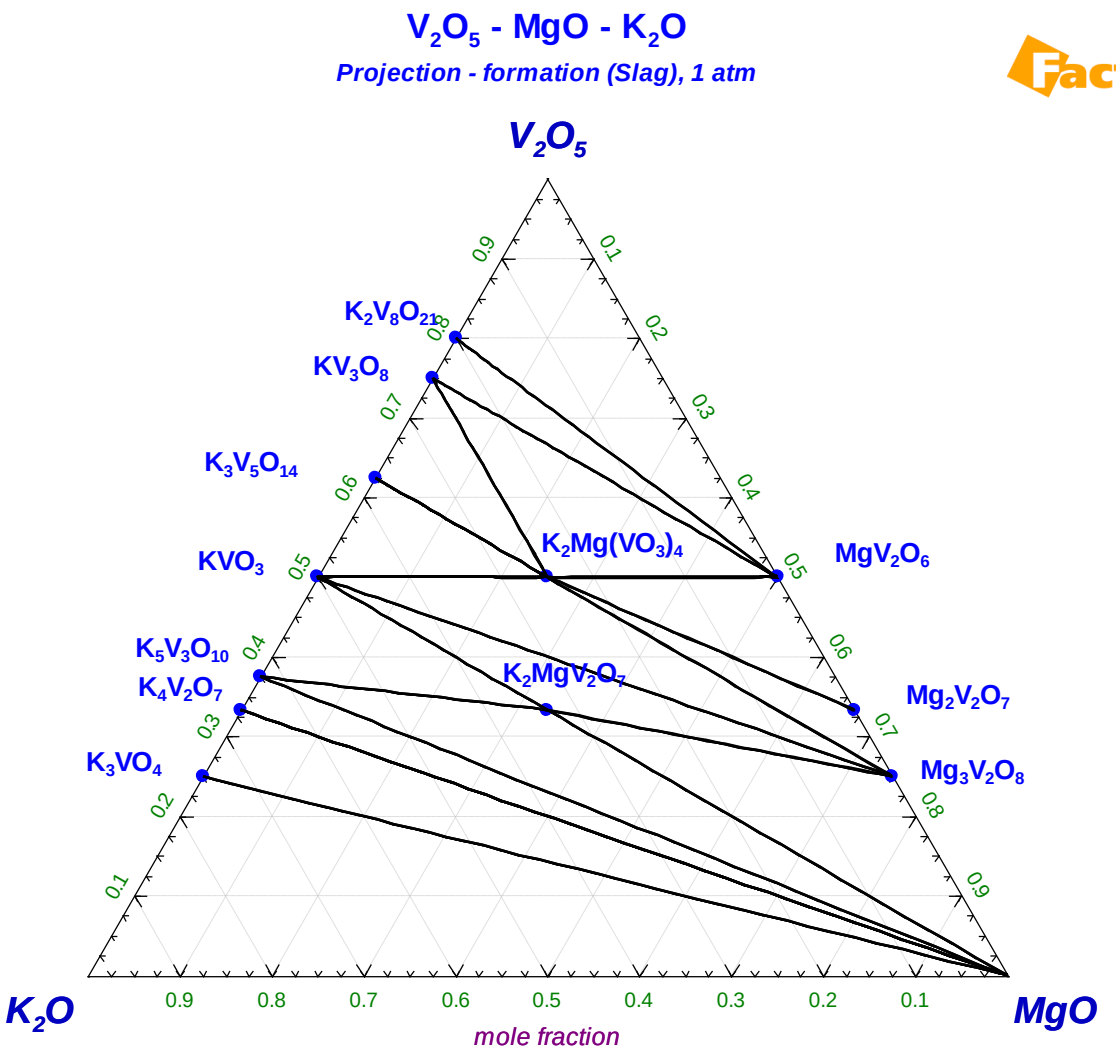


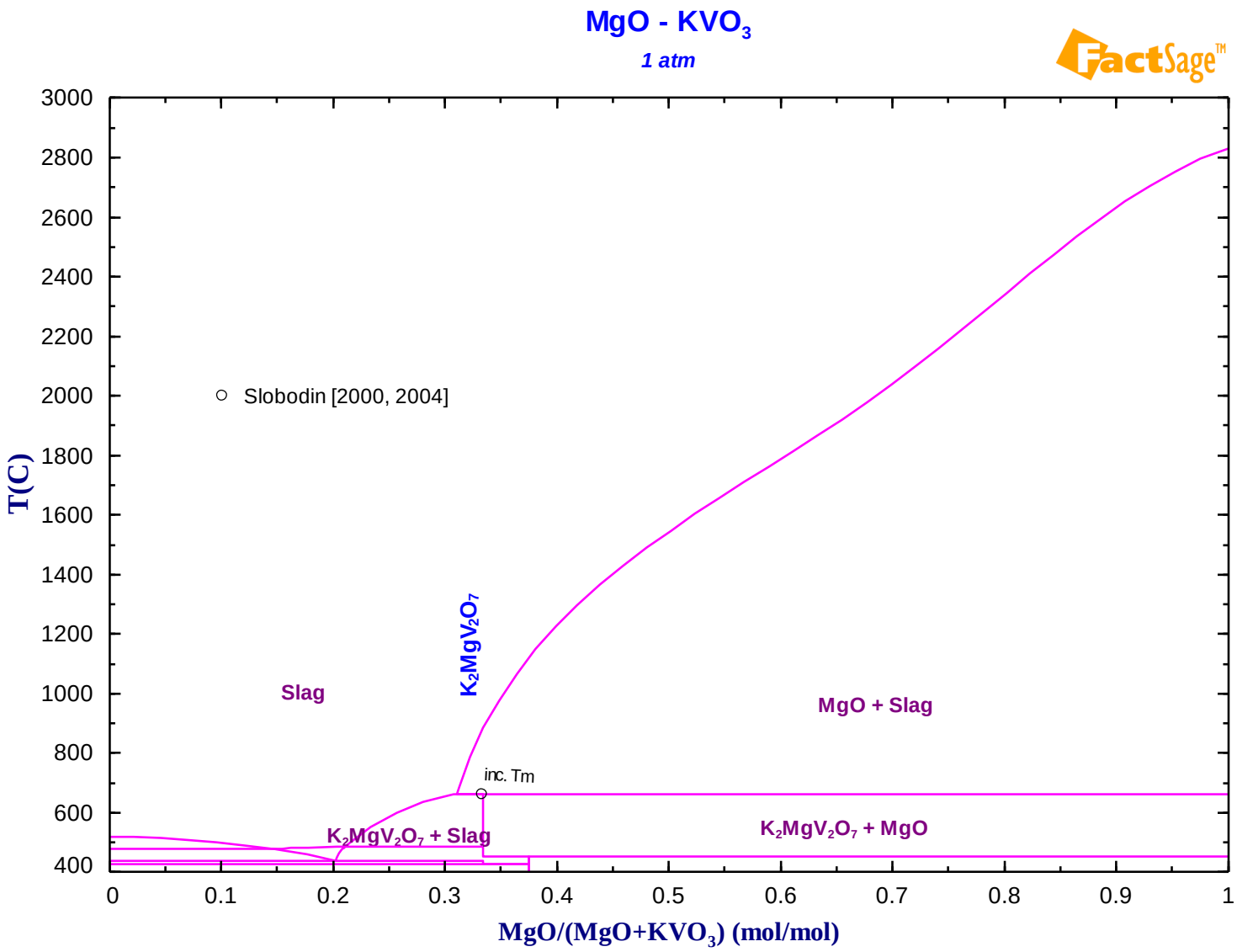

SiO2 - K2O - MgO
Projection (Slag)
FactSage™
SiO2
T(min) = 640.17 °C, T(max) = 2826.84 °C
Cristobalite
SiMgO3(s4)
K2Si12Mg5O30
Quartz-H
K2Si4O9(s2)
K2Si5MgO12
K2MgSi3O8
K2Si3MgO8(s2)
K4Si5Mg2O14
K2Si2O5(s3)
K10Si11Mg5O32
SiMg2O4
K2MgSiO4
K2SO3(s)
MgO
K2O(s3)
MgO
K2O
percent by weight
T °C
2900
2600
2350
2100
1850
1600
1350
1100
850
600

Invariant equilibria on the liquidus surface

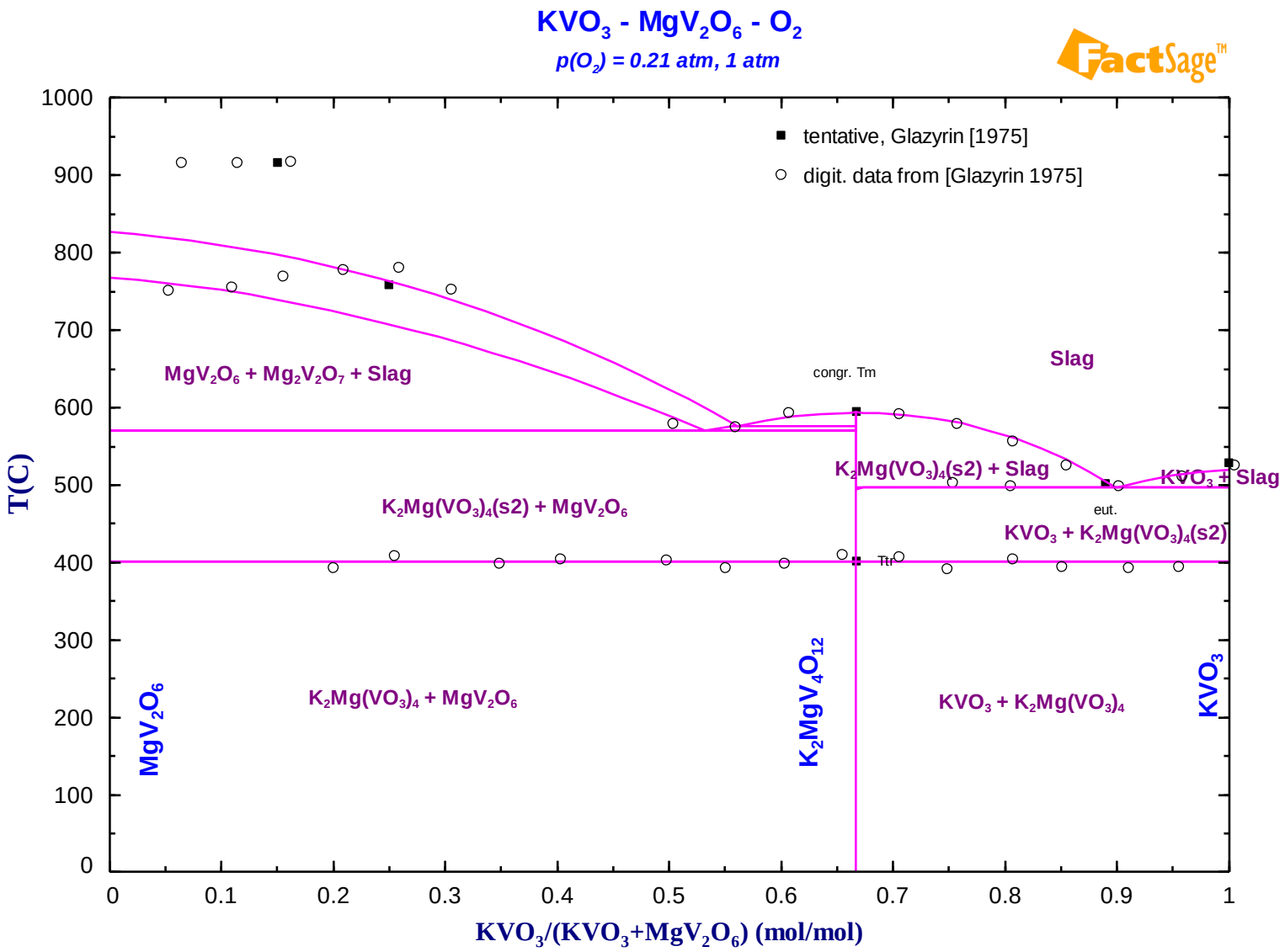
Intersections with slag	Mole fraction A = SiO2, B = MgO, C = K2O				Weight percent A = SiO2, B = MgO, C = K2O			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: KMS / MeeO / SiMg2O4	1: 0.42272	0.34388	0.23341	1423.16	1: 41.471	22.630	35.899	1423.17
2: K2Si12Mg5O30 / SiMg2O4 / SiMgO3(s4)	2: 0.72661	0.17618	0.09721	1161.71	2: 72.865	11.851	15.283	1161.71
3: K10Si11Mg5O32 / KMS / SiMg2O4	3: 0.54970	0.23743	0.21287	1158.14	3: 52.719	15.275	32.006	1158.14
4: K2Si12Mg5O30 / SiMgO3(s4) / Cristobalite	4: 0.78610	0.14118	0.07272	1157.64	4: 79.020	9.520	11.460	1157.77
5: K10Si11Mg5O32 / K4Si5Mg2O14 / SiMg2O4	5: 0.55738	0.23370	0.20892	1146.57	5: 53.508	15.049	31.443	1146.57
6: K2Si12Mg5O30 / K2Si5MgO12 / SiMg2O4	6: 0.70614	0.16991	0.12395	1068.88	6: 69.609	11.235	19.156	1068.88
7: K2Si3MgO8(s2) / K4Si5Mg2O14 / SiMg2O4	7: 0.60784	0.20855	0.18361	1065.31	7: 58.695	13.509	27.797	1065.31
8: K2Si3MgO8(s2) / K2Si5MgO12 / SiMg2O4	8: 0.64209	0.19251	0.16540	1034.32	8: 62.306	12.531	25.163	1034.32
9: K2Si12Mg5O30 / K2Si5MgO12 / Cristobalite	9: 0.79010	0.10980	0.10010	996.38	9: 77.409	7.216	15.375	996.37
10: K10Si11Mg5O32/K2Si3MgO8(s2)/ K4Si5Mg2O14	10: 0.60956	0.13916	0.25129	956.34	10: 55.573	8.510	35.916	956.34
11: K2Si5MgO12 / Cristobalite / Quartz_H	11: 0.79498	0.07588	0.12914	926.28	11: 75.833	4.855	19.312	926.28
12: K2Si2O5(s3) / K2Si3MgO8(s2) / K2Si3MgO8	12: 0.62108	0.11006	0.26886	889.85	12: 57.710	6.176	36.113	889.85
13: K2Si2O5(s3) / K2Si3MgO8(s2) / K2Si3MgO8	13: 0.64156	0.10236	0.25608	889.85	13: 63.856	6.097	30.048	889.85
14: K2Si3MgO8(s2) / K2Si3MgO8 / K2Si5MgO12	14: 0.69325	0.09867	0.20808	889.85	14: 55.632	6.613	37.755	889.85
15: K10Si11Mg5O32 / K2Si2O5(s3) / K2Si3MgO8	15: 0.60979	0.11290	0.27731	884.35	15: 54.432	6.760	38.808	884.35
16: K10Si11Mg5O32 / K2Si2O5(s3) / KMS	16: 0.58662	0.10043	0.31296	879.40	16: 51.250	5.885	42.864	879.41
17: K2Si2O5(s3) / K2Si3MgO8 / K2Si5MgO12	17: 0.70855	0.07104	0.22040	801.34	17: 64.312	4.325	31.362	801.30
18: K2Si2O5(s3) / K2SiO3 / KMS	18: 0.56182	0.02621	0.41197	737.96	18: 45.854	1.435	52.712	737.96
19: K2O(s3) / KMS / MeO	19: 0.02360	0.02008	0.95631	724.99	19: 1.536	0.877	97.587	725.01
20: K2Si4O9(s2) / K2Si5MgO12 / Quartz_H	20: 0.77701	0.03460	0.18838	709.70	20: 70.924	2.119	26.958	709.71
21: K2Si2O5(s3) / K2Si4O9(s2) / K2Si5MgO12	21: 0.75555	0.03179	0.21266	687.13	21: 68.051	1.921	30.028	687.12
22: K2O(s3) / K2SiO3 / KMS	22: 0.19260	0.00962	0.79779	640.17	22: 13.285	0.445	86.270	640.17

K2O-MgO-V2O5,
Mole fraction, Subsolidus

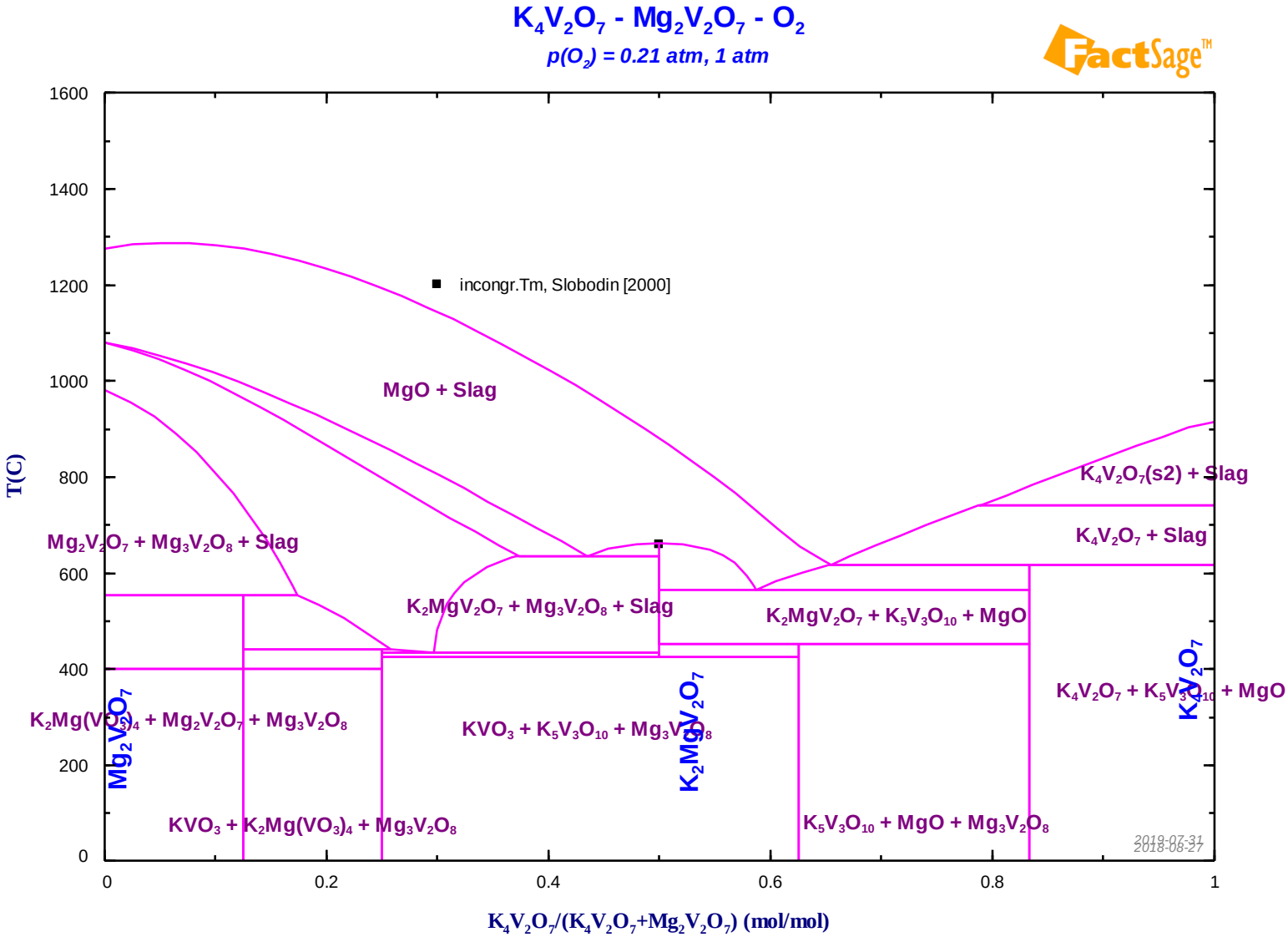


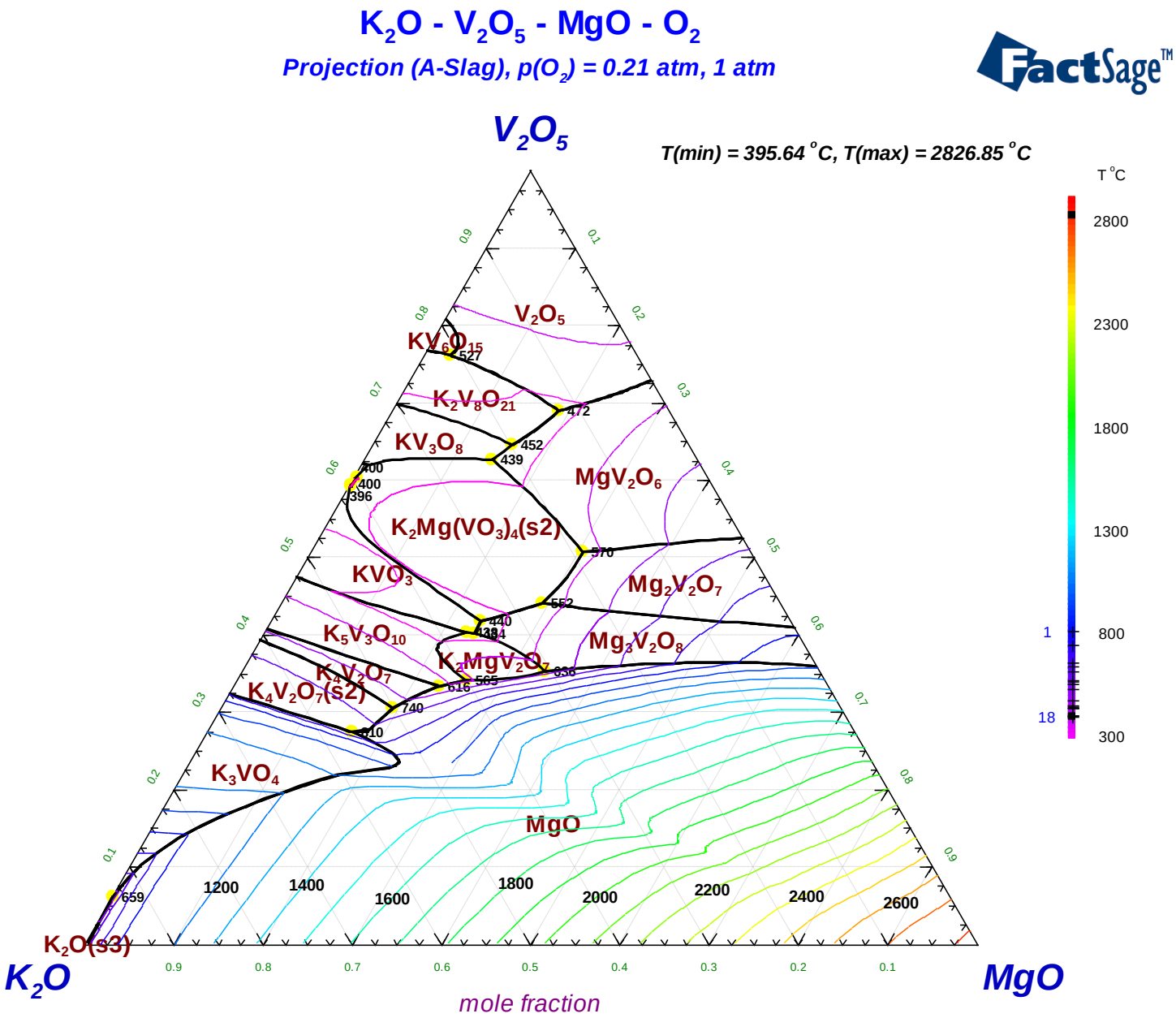

MgO - KVO3
1 atm
FactSage™
T(C)
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
Slobodin [2000, 2004]
Slag
K2MgV2O7
MgO + Slag
inc. Tm
K2MgV2O7 + Slag
K2MgV2O7 + MgO
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
MgO/(MgO+KVO3) (mol/mol)

K2O-MgO-V2O5,
Mole fraction, Isopleth KVO3-MgV2O6



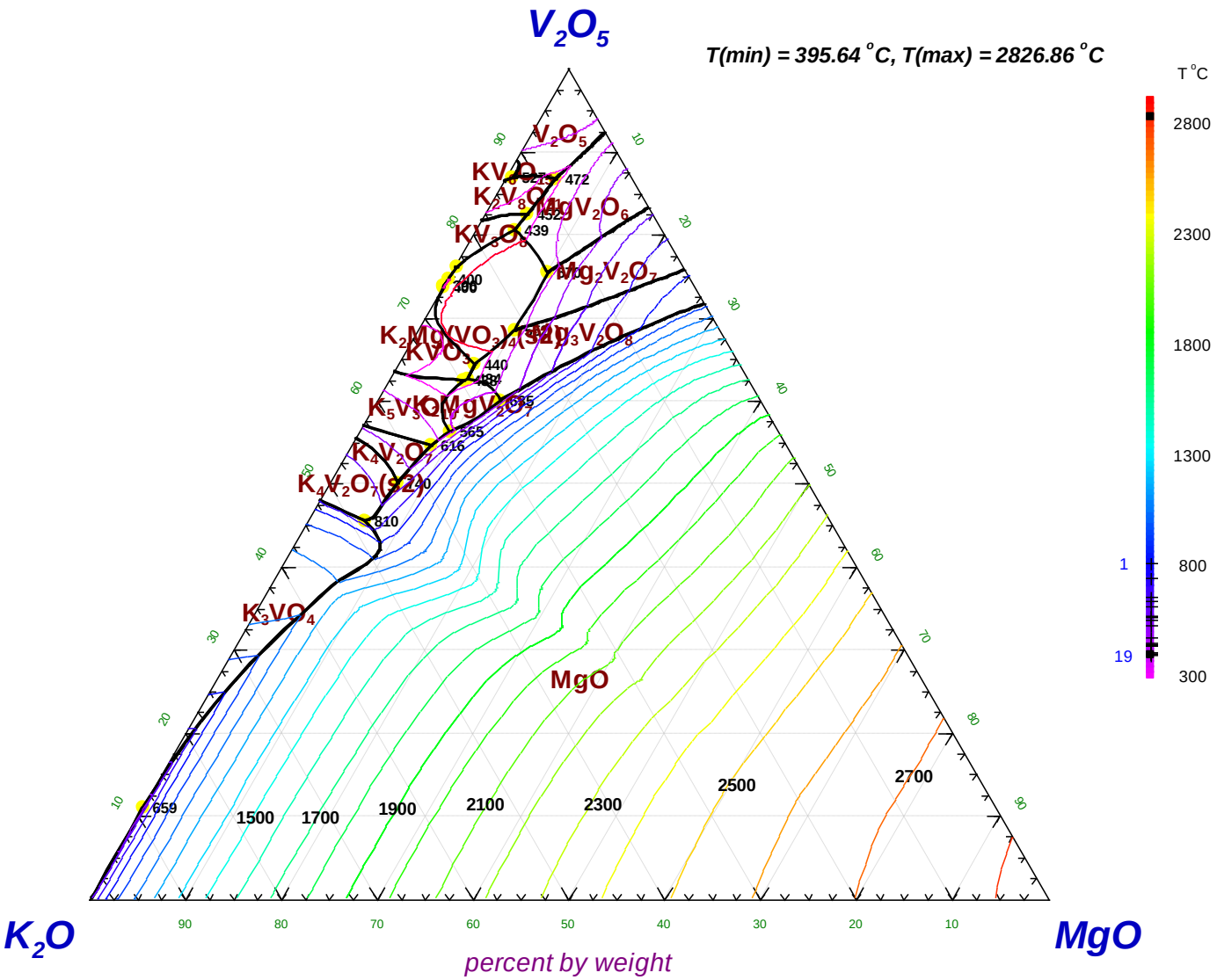
K2O-MgO-V2O5,
Mole fraction, Isopleth K4V2O7-Mg2V2O7




K2O - V2O5 - MgO - O2
Projection (A-Slag), p(O2) = 0.21 atm, 1 atm
FactSage™
V2O5
T(min) = 395.64 °C, T(max) = 2826.85 °C
T °C
2800
2300
1800
1300
800
300
1
18
V2O5
KV6O15
K2V8O21
KV3O8
MgV2O6
K2Mg(VO3)4(s2)
KVO3
Mg2V2O7
K5V3O10
Mg3V2O8
K2MgV2O7
K4V2O7
K4V2O7(s2)
K3VO4
MgO
K2O(s3)
1200
1400
1600
1800
2000
2200
2400
2600
K2O
MgO
mole fraction

K_2O - V_2O_5 - MgO - O_2

Projection (A-Slag), p(O_2) = 0.21 atm, 1 atm

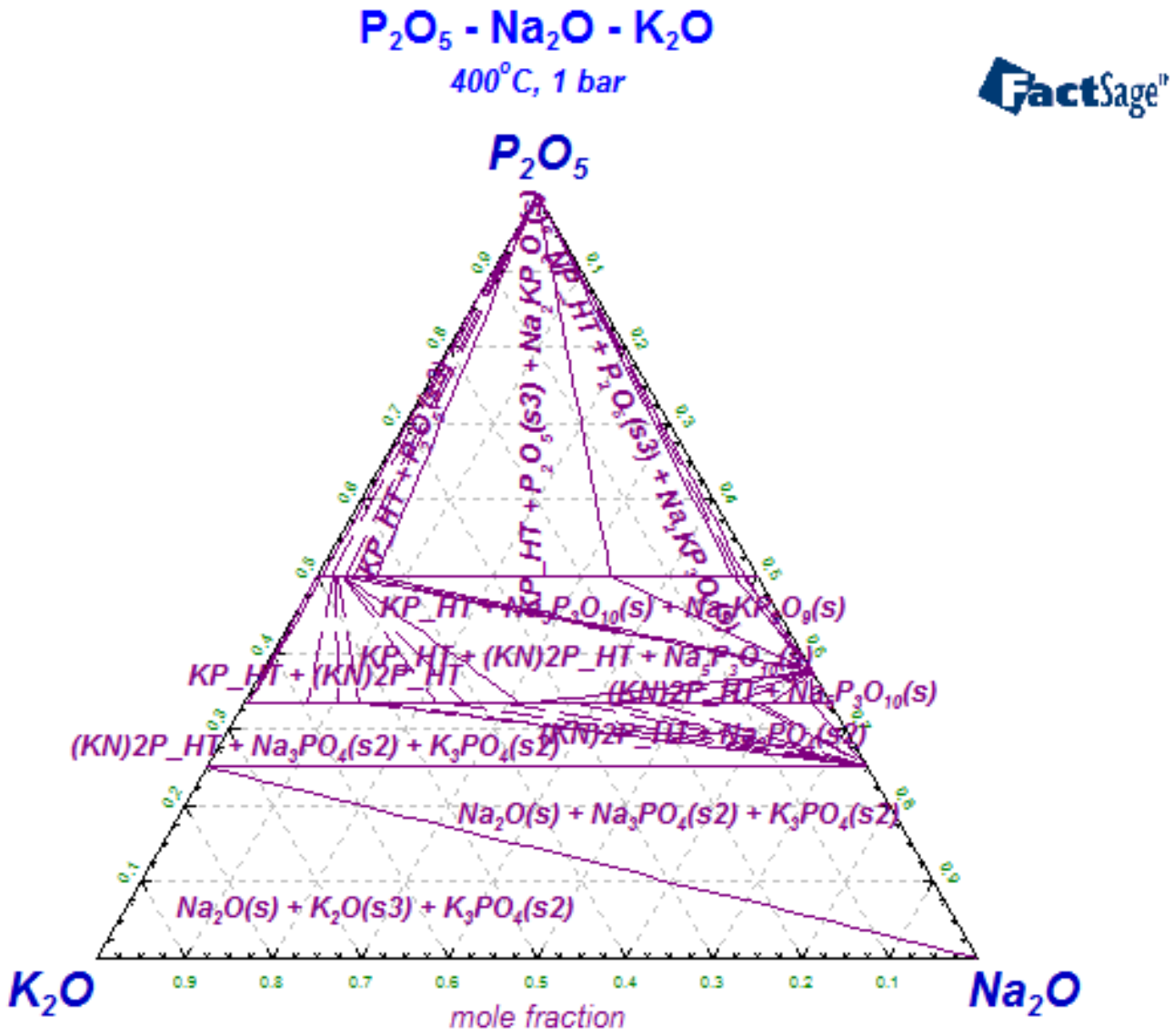


Invariant equilibria on the liquidus surface

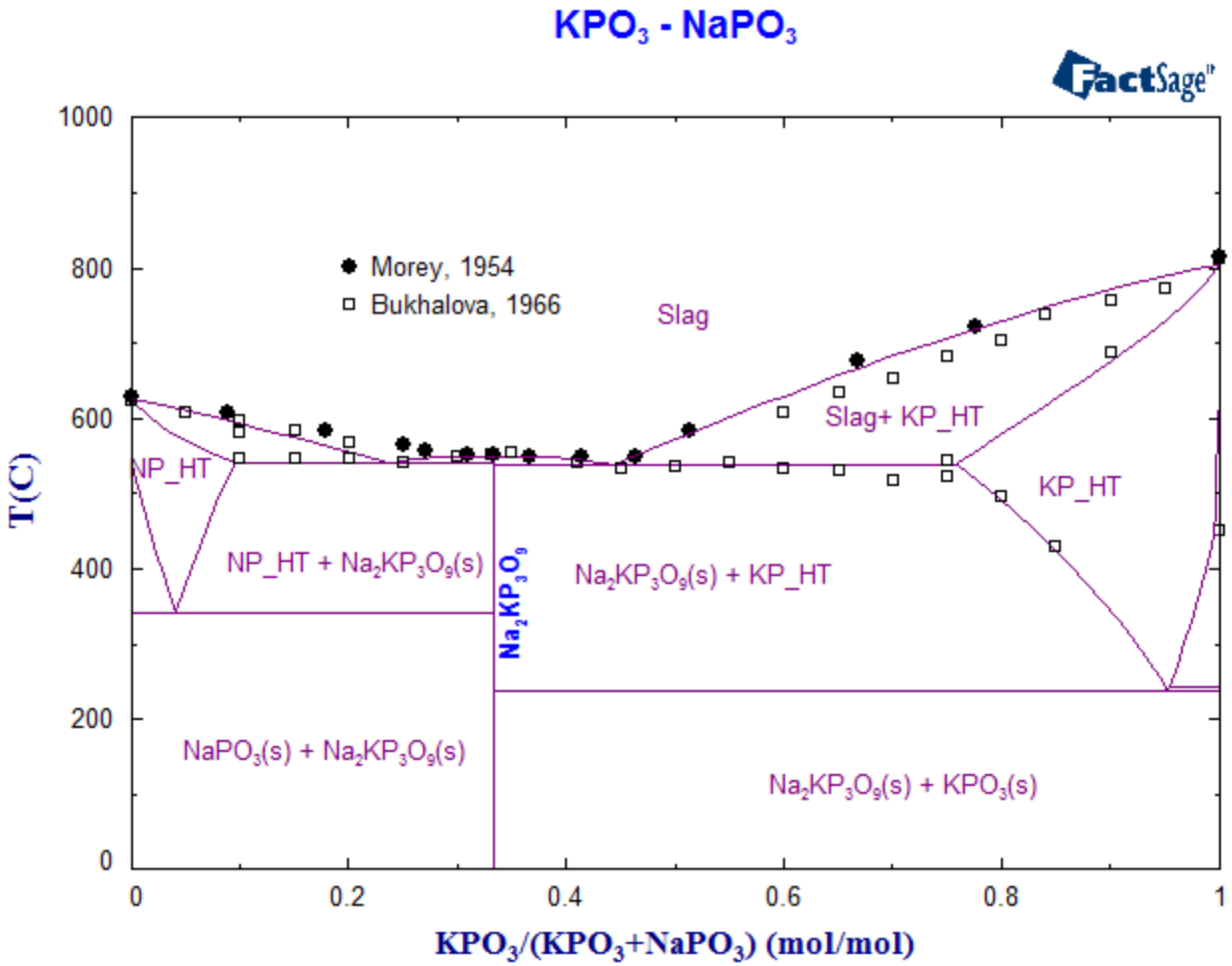
Intersections with slag	Mole fraction				Weight percent			
	A = V2O5, B = K2O, C = MgO				A = V2O5, B = K2O, C = MgO			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1. K3VO4 / K4V2O7(s2) / MgO	0.27421	0.56316	0.16263	810.00	45.557	48.456	5.987	810.00
2. K4V2O7 / K4V2O7(s2) / MgO	0.30465	0.50167	0.19368	740.01	50.158	42.776	7.066	740.00
3. K2O(s3) / K3VO4 / MgO	0.06032	0.93807	0.00161	659.18	11.037	88.897	0.065	659.18
4. K2MgV2O7 / Mg3V2O8 / MgO	0.35274	0.30704	0.34022	635.53	60.077	27.083	12.840	635.15
5. K4V2O7 / K5V3O10 / MgO	0.33341	0.43600	0.23059	615.82	54.629	36.998	8.373	615.82
6. K2Mg(VO3)4(s2) / Mg2V2O7 / MgV2O6	0.50664	0.18813	0.30523	569.82	75.426	14.505	10.069	569.83
7. K2MgV2O7 / K5V3O10 / MgO	0.34148	0.40094	0.25759	564.84	56.330	34.254	9.416	564.84
8. K2Mg(VO3)4(s2) / Mg2V2O7 / Mg3V2O8	0.44127	0.26539	0.29334	552.36	68.550	21.352	10.098	552.36
9. K2V8O21 / KV6O15 / V2O5	0.76132	0.20943	0.02924	527.30	86.882	12.378	0.740	527.30
10.K2V8O21 / MgV2O6 / V2O5	0.68971	0.12304	0.18725	471.52	86.764	8.016	5.220	471.52
11.K2V8O21 / KV3O8 / MgV2O6	0.64588	0.19716	0.15696	451.52	82.512	13.045	4.443	451.54
12.K2Mg(VO3)4(s2) / KVO3 / Mg3V2O8	0.41811	0.34655	0.23534	439.96	64.350	27.623	8.027	439.96
13.K2Mg(VO3)4(s2) / KV3O8 / MgV2O6	0.62615	0.22953	0.14433	439.20	80.585	15.299	4.116	439.20
14.K2MgV2O7 / K5V3O10 / KVO3	0.40231	0.37065	0.22704	438.12	62.414	29.781	7.806	438.12
15.K2MgV2O7 / KVO3 / Mg3V2O8	0.40226	0.36122	0.23652	433.82	62.682	29.151	8.167	433.82
16.K2Mg(VO3)4 / K2Mg(VO3)4(s2) / K3V5O14	0.60286	0.39311	0.00403	400.01	74.674	25.216	0.111	400.01
17.K2Mg(VO3)4 / K2Mg(VO3)4(s2) / KVO3	0.59126	0.40601	0.00273	400.01	73.711	26.214	0.075	400.00
18.K2Mg(VO3)4 / K3V5O14 / KVO3	0.59313	0.40444	0.00243	395.64	73.853	26.080	0.067	395.64

K2O-Na2O-P2O5,

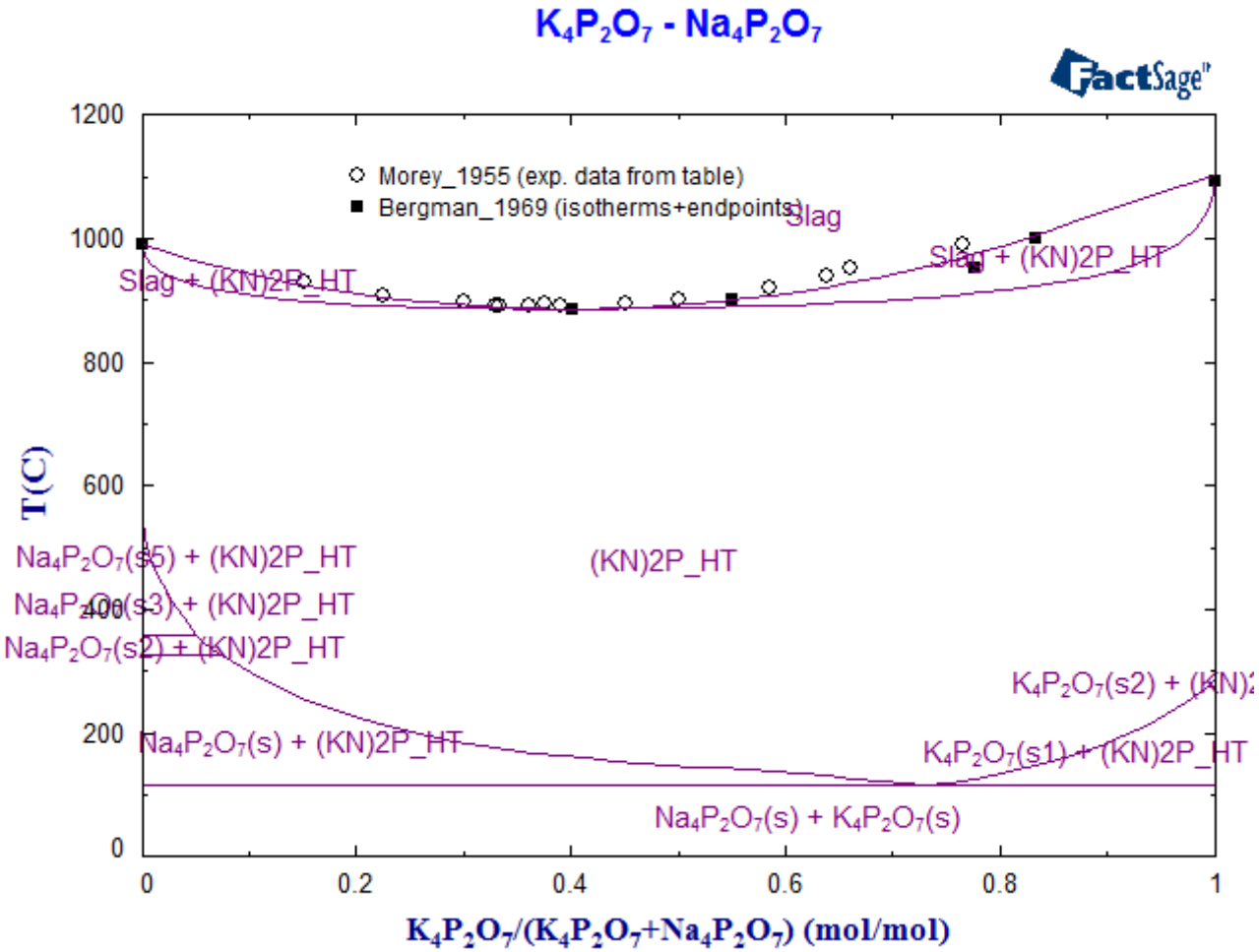
Mole fraction 400C°



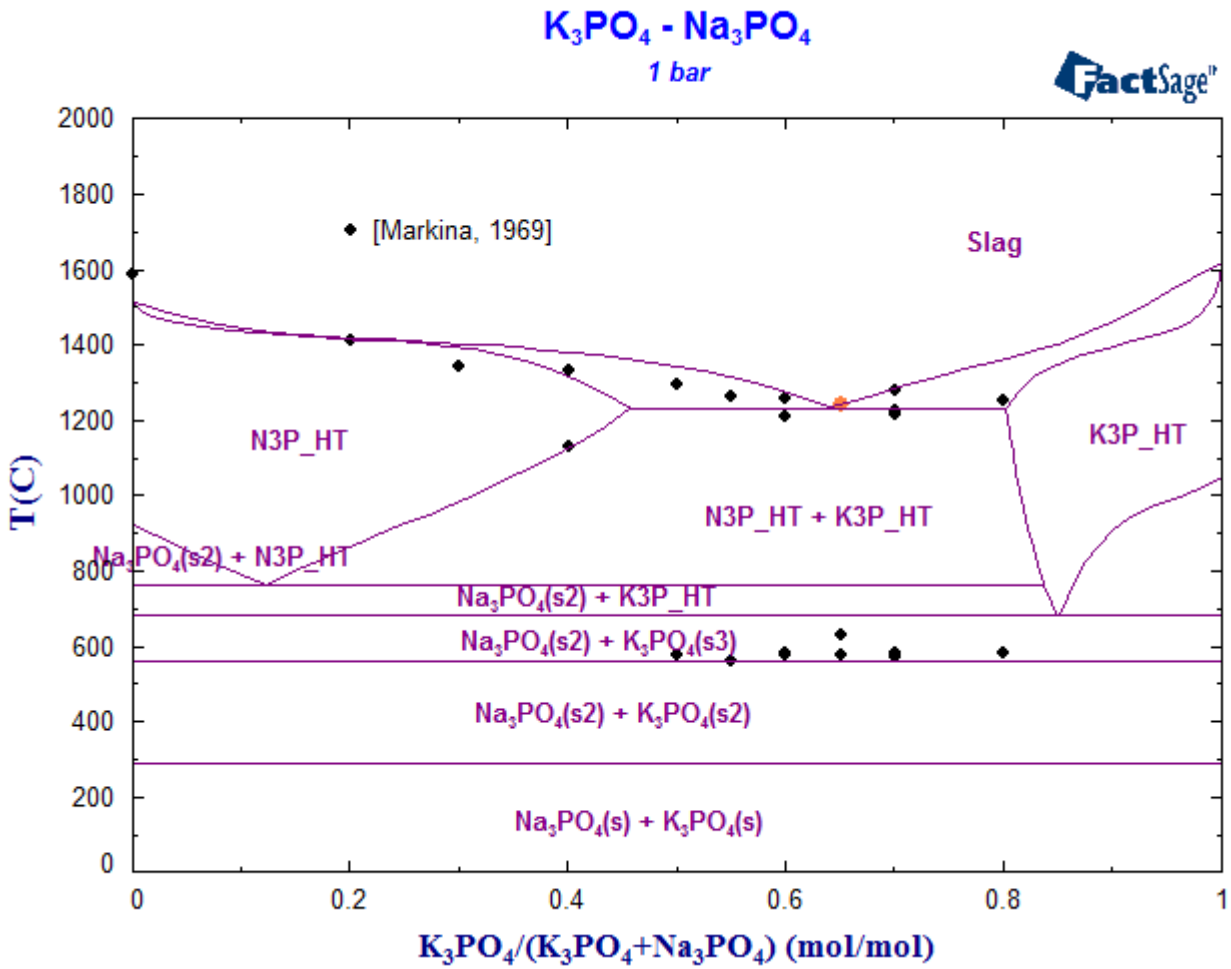
Mole fraction, Isopleth KPO3-NaPO3 compared with experimental data



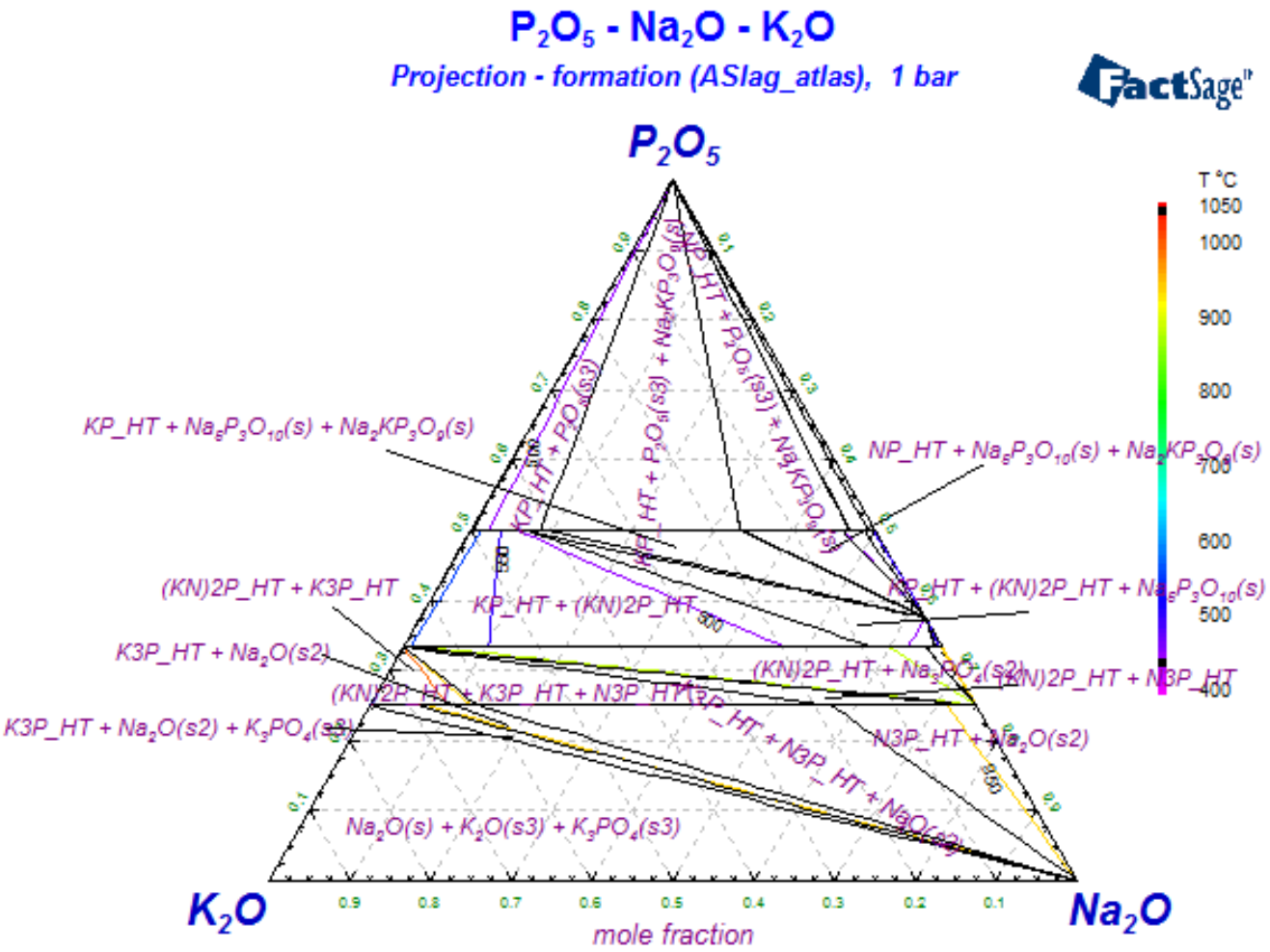
Mole fraction Isopleth K2P2O7-Na2P2O7 compared with experimental data



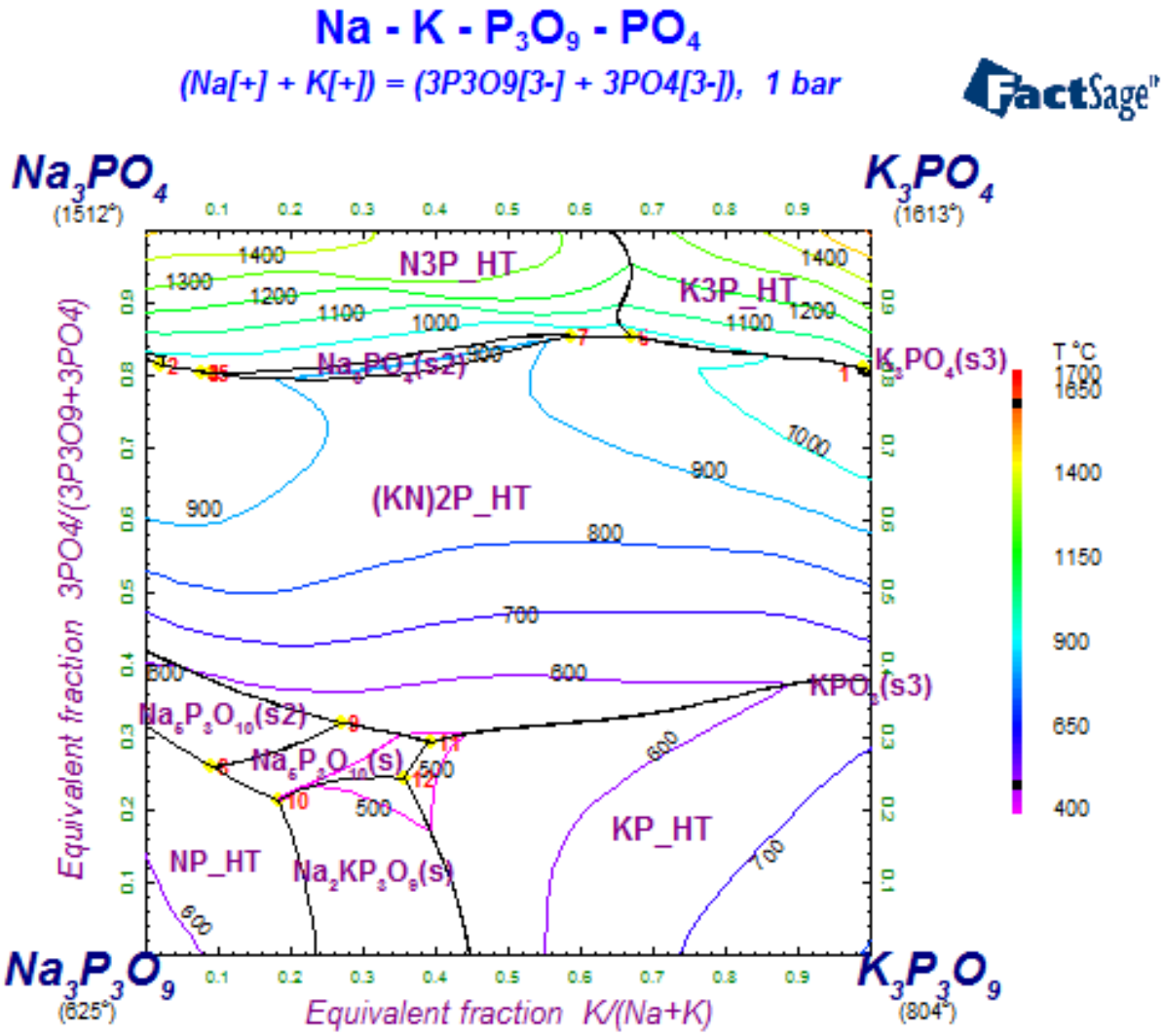
Mole fraction Isopleth K3PO4-Na3PO4 compared with experimental data



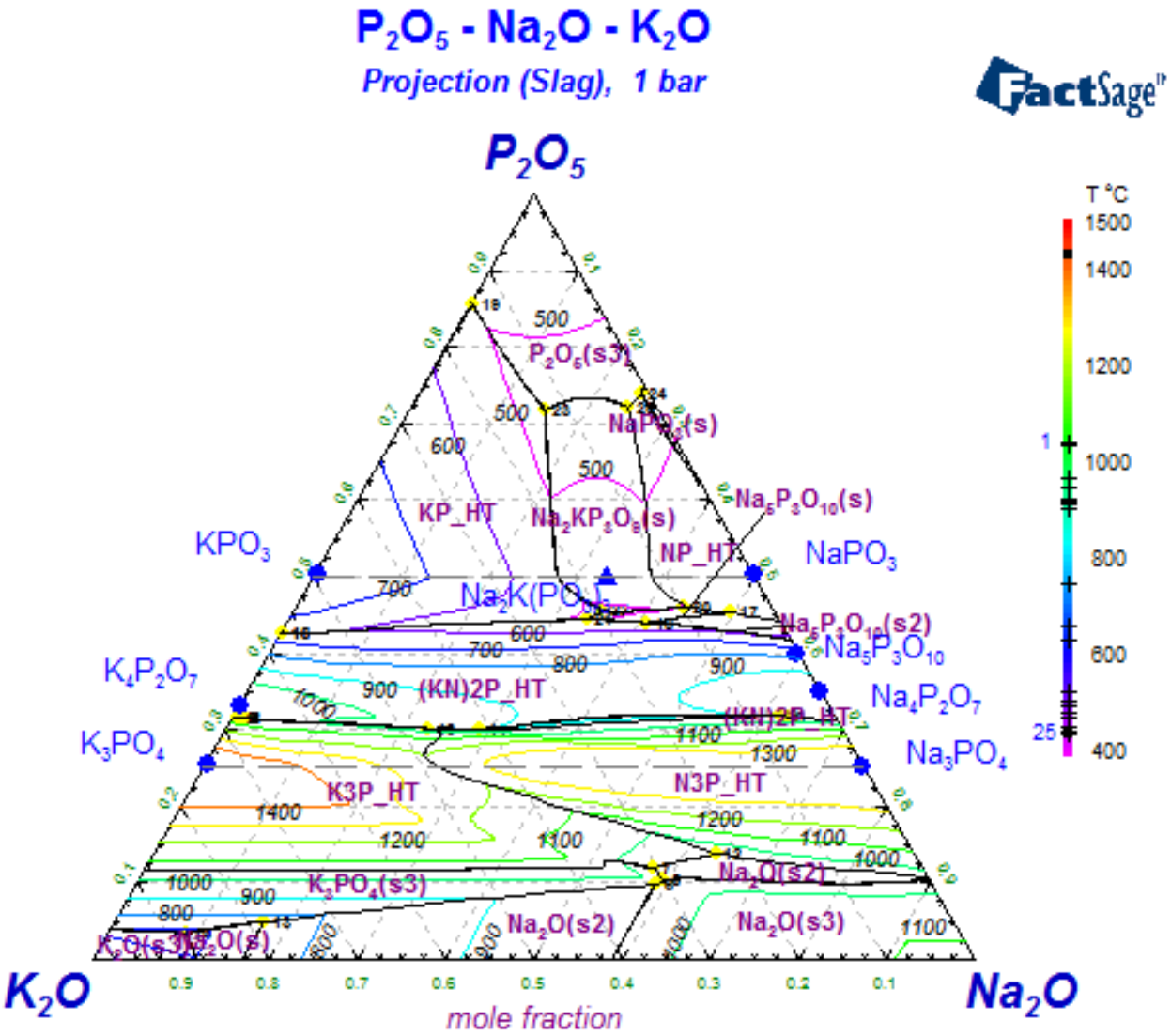
Mole fraction, Subsolidus surface

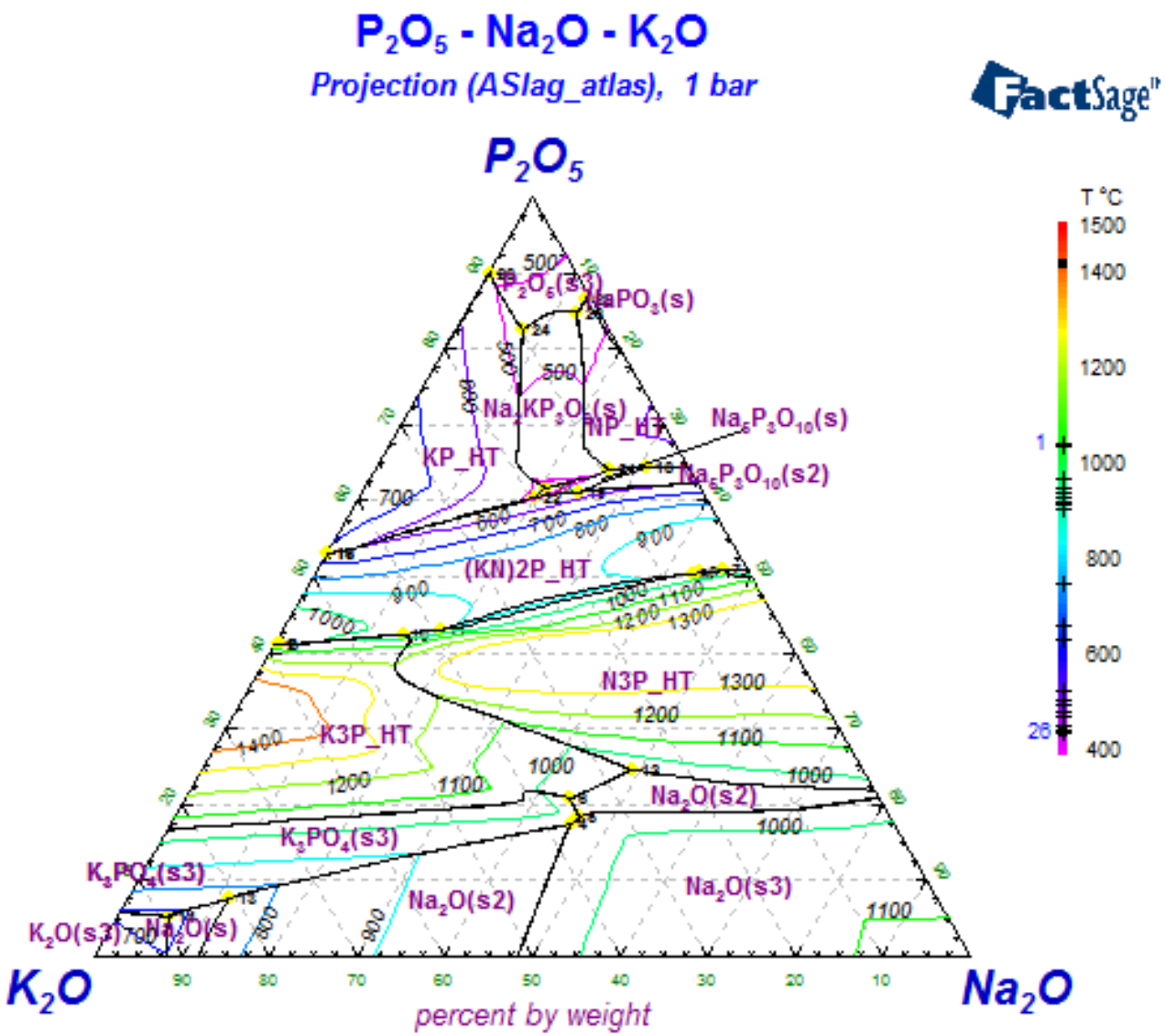


Mole fraction, Reciprocal liquidus surface Na-K-P3O9-PO4



Mole fraction, Liquidus surface



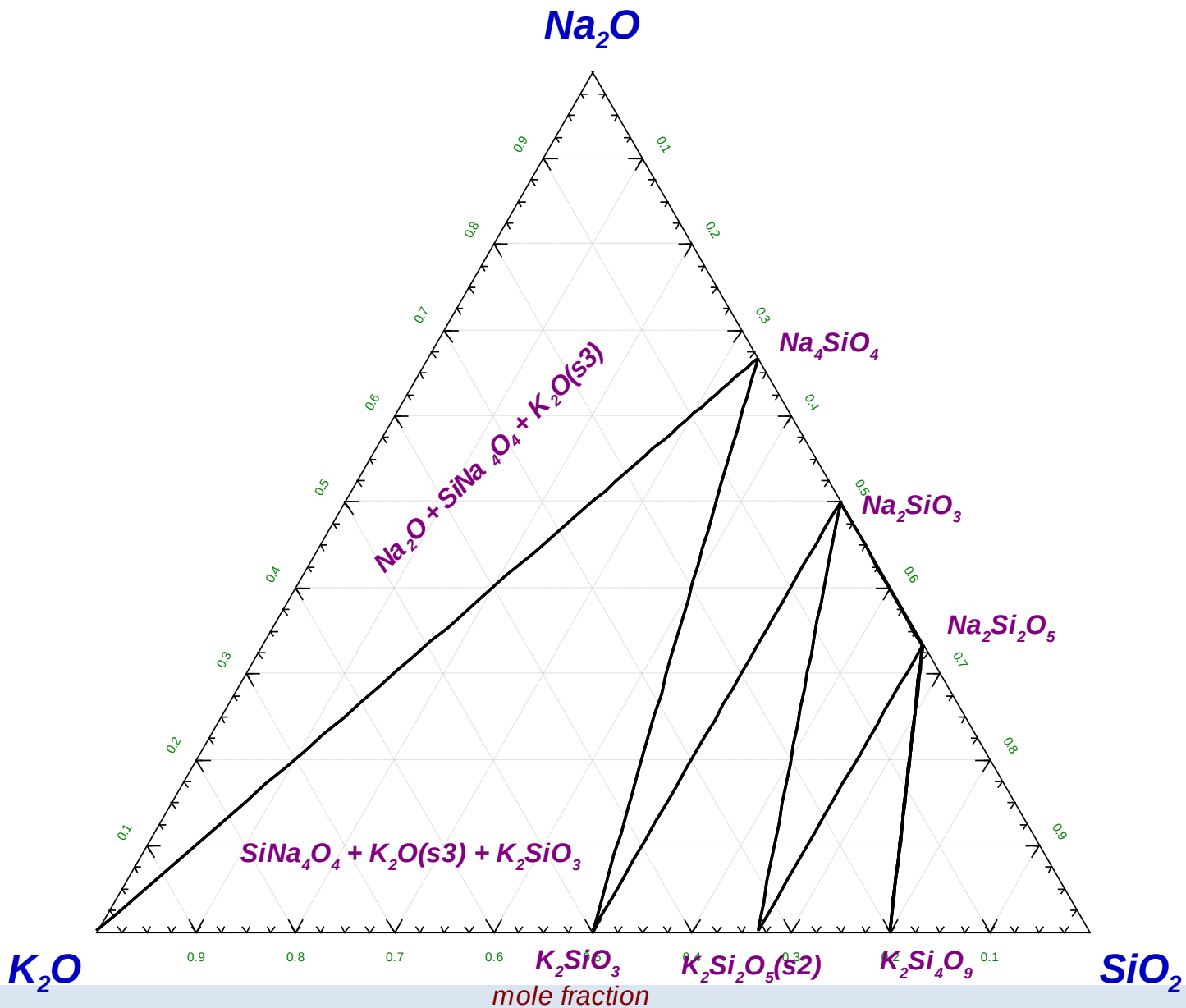

P2O5 - Na2O - K2O
Projection (ASlag_atlas), 1 bar
FactSage
P2O5
K2O
Na2O
percent by weight
T °C
1500
1400
1200
1000
800
600
400
P2O5(s3)
NaPO3(s)
Na2KP3O9(s)
NP_HT
Na5P3O10(s)
Na5P3O10(s2)
KP_HT
(KN)2P_HT
N3P_HT
K3P_HT
Na2O(s2)
K3PO4(s3)
K2PO4(s3)
Na2O(s3)
K2O(s3)
H2O(s)

Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction					Weight percent				
	A = P2O5 B = K2O C = Na2O					A = P2O5, B = K2O, C = Na2O				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: (KN)2P_HT / K3P_HT / K4P2O7(s3)	1:	0.31582	0.67679	0.00739	1043.88	1:	41.117	58.551	0.332	1044.72
2: (KN)2P_HT / K3P_HT / K4P2O7(s3)	2:	0.31578	0.67655	0.00767	1043.74	2:	41.113	58.466	0.420	1043.88
3: (KN)2P_HT / K3P_HT / K4P2O7(s3)	3:	0.31509	0.67166	0.01325	1040.77	3:	41.101	58.095	0.804	1040.32
4: (KN)2P_HT / K3P_HT / K4P2O7(s3)	4:	0.31491	0.67033	0.01476	1039.97	4:	17.497	36.858	45.645	970.07
5: K3PO4(s3) / Na2O(s2) / Na2O(s3)	5:	0.10411	0.30109	0.59480	970.05	5:	18.471	35.450	46.079	969.99
6: K3PO4(s3) / Na2O(s2) / Na2O(s3)	6:	0.09853	0.31278	0.58869	970.05	6:	20.768	35.274	43.958	951.29
7: K3PO4(s3) / K3P_HT / Na2O(s2)	7:	0.11895	0.30445	0.57660	951.29	7:	50.804	2.661	46.534	941.66
8: (KN)2P_HT / N3P_HT / Na3PO4(s3)	8:	0.31692	0.05334	0.62974	926.44	8:	50.523	5.634	43.843	930.73
9: (KN)2P_HT / Na3PO4(s3) / Na3PO4(s2)	9:	0.31739	0.06176	0.62085	922.40	9:	50.422	6.511	43.067	922.40
10: (KN)2P_HT / K3P_HT / N3P_HT	10:	0.30165	0.46801	0.23034	919.21	10:	42.318	43.571	14.110	919.21
11: (KN)2P_HT / N3P_HT / Na3PO4(s2)	11:	0.30128	0.41069	0.28802	909.97	11:	43.066	38.957	17.977	909.97
12: K3P_HT / N3P_HT / Na2O(s2)	12:	0.13826	0.22419	0.63755	909.72	12:	24.452	26.313	49.235	909.72
13: K3PO4(s3) / Na2O(s) / Na2O(s2)	13:	0.04923	0.78081	0.16997	750.09	13:	7.672	80.760	11.567	750.05
14: K2O(s3) / K3PO4(s3) / Na2O(s)	14:	0.03469	0.87723	0.08807	664.63	14:	5.294	88.837	5.869	664.60
15: (KN)2P_HT / KPO3(s3) / KP_HT	15:	0.42767	0.57134	0.00098	635.88	15:	52.979	46.968	0.053	636.52
16: (KN)2P_HT / K4P2O7(s3) / KP_HT	16:	0.42767	0.57123	0.00110	635.83	16:	52.980	46.959	0.061	635.82
17: NP_HT / Na5P3O10(s) / Na5P3O10(s2)	17:	0.45260	0.05036	0.49705	528.85	17:	64.377	4.753	30.870	528.85
18: (KN)2P_HT / Na5P3O10(s) / Na5P3O10(s2)	18:	0.43996	0.15194	0.40810	528.85	18:	61.192	14.024	24.784	528.85
19: KPO3(s3) / KP_HT / P2O5(s3)	19:	0.85620	0.14143	0.00237	509.78	19:	90.023	9.868	0.109	509.78
20: NP_HT / Na2KP3O9(s) / Na5P3O10(s)	20:	0.46137	0.09848	0.44015	498.97	20:	64.176	9.090	26.733	498.97
21: (KN)2P_HT / KP_HT / Na5P3O10(s)	21:	0.44542	0.21739	0.33719	483.57	21:	60.443	19.577	19.980	483.57
22: KP_HT / Na2KP3O9(s) / Na5P3O10(s)	22:	0.45552	0.19431	0.35017	473.00	22:	61.777	17.487	20.736	473.00
23: KP_HT / Na2KP3O9(s) / P2O5(s3)	23:	0.71866	0.12863	0.15270	454.07	23:	82.538	9.804	7.658	454.07
24: NP_HT / NaPO3(s) / P2O5(s3)	24:	0.74009	0.00840	0.25151	443.68	24:	86.511	0.651	12.837	443.68
25: NP_HT / Na2KP3O9(s) / P2O5(s3)	25:	0.72082	0.03271	0.24647	439.16	25:	84.788	2.554	12.659	439.16

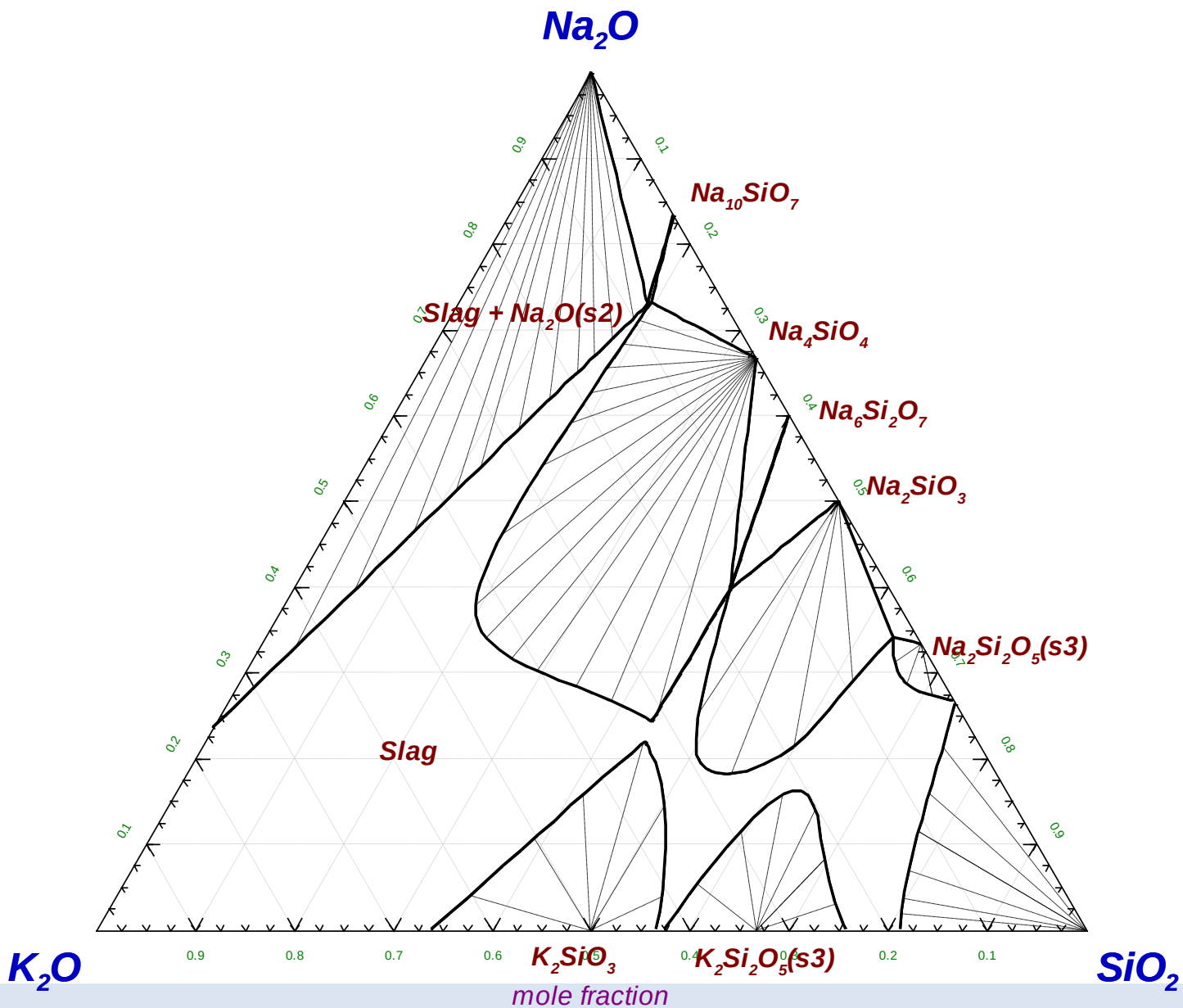
Na_2O - SiO_2 - K_2O

600°C



K_2O - Na_2O - SiO_2

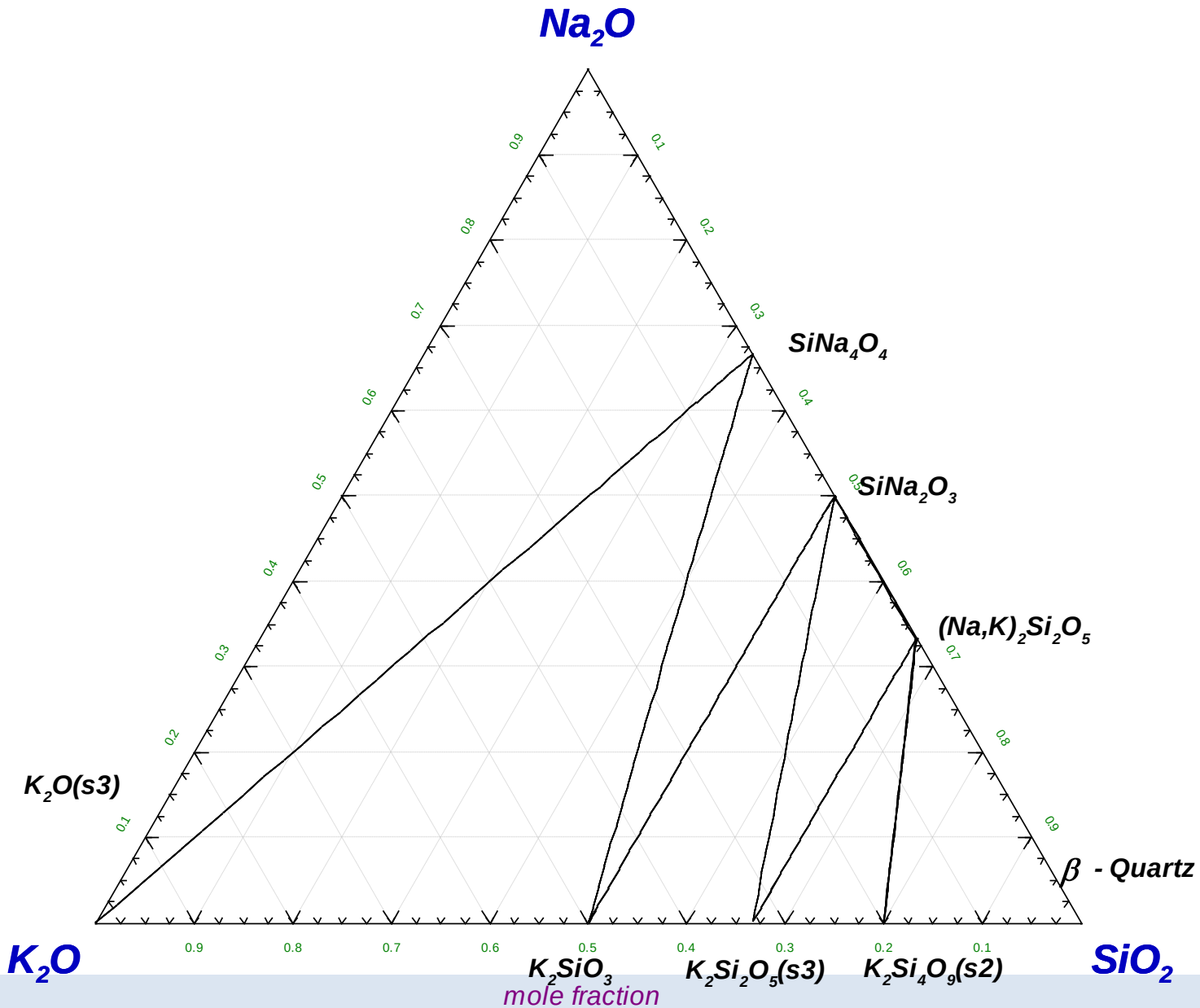
800°C



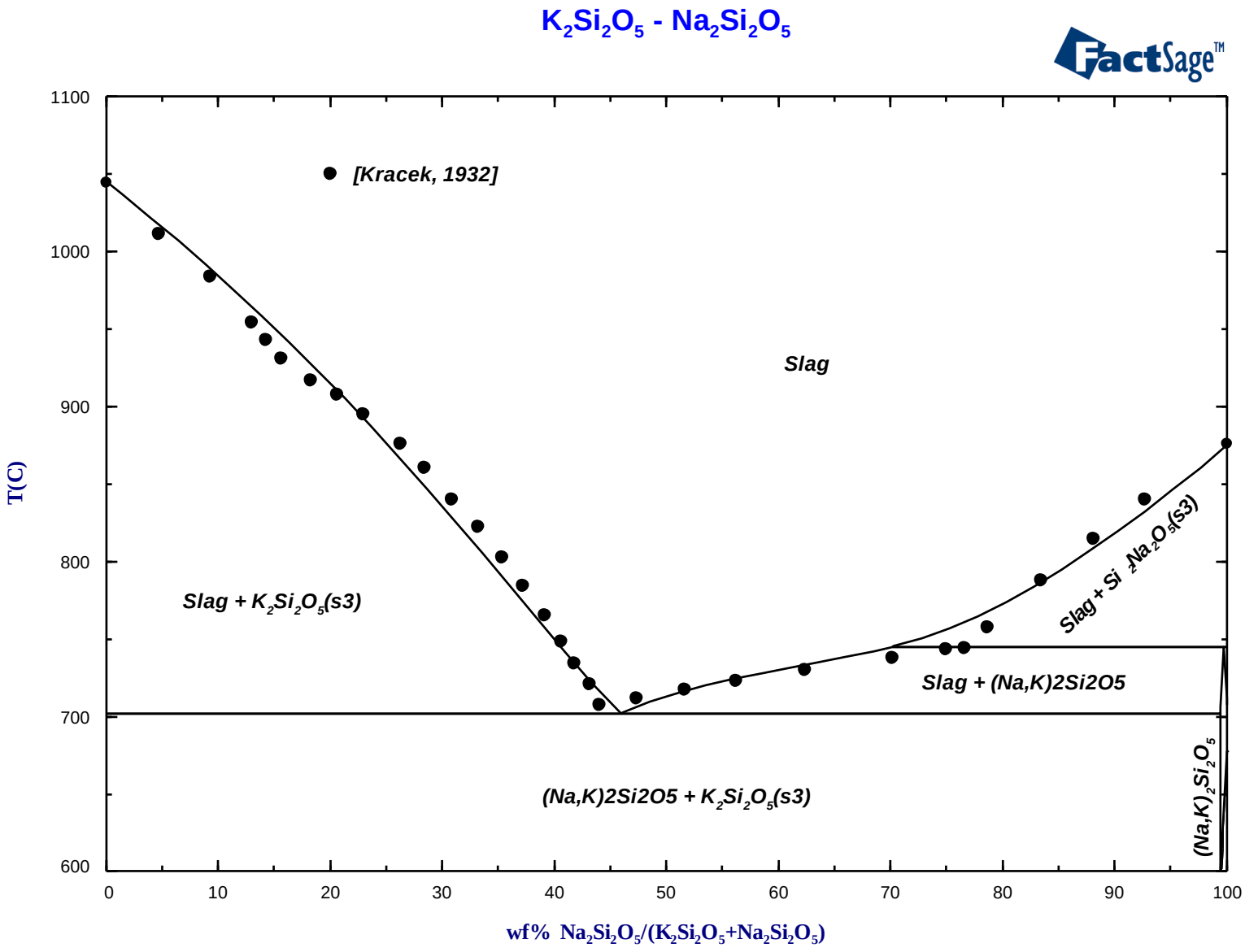
Mole fraction
kurz unterhalb Liquidussurface

K_2O - Na_2O - SiO_2

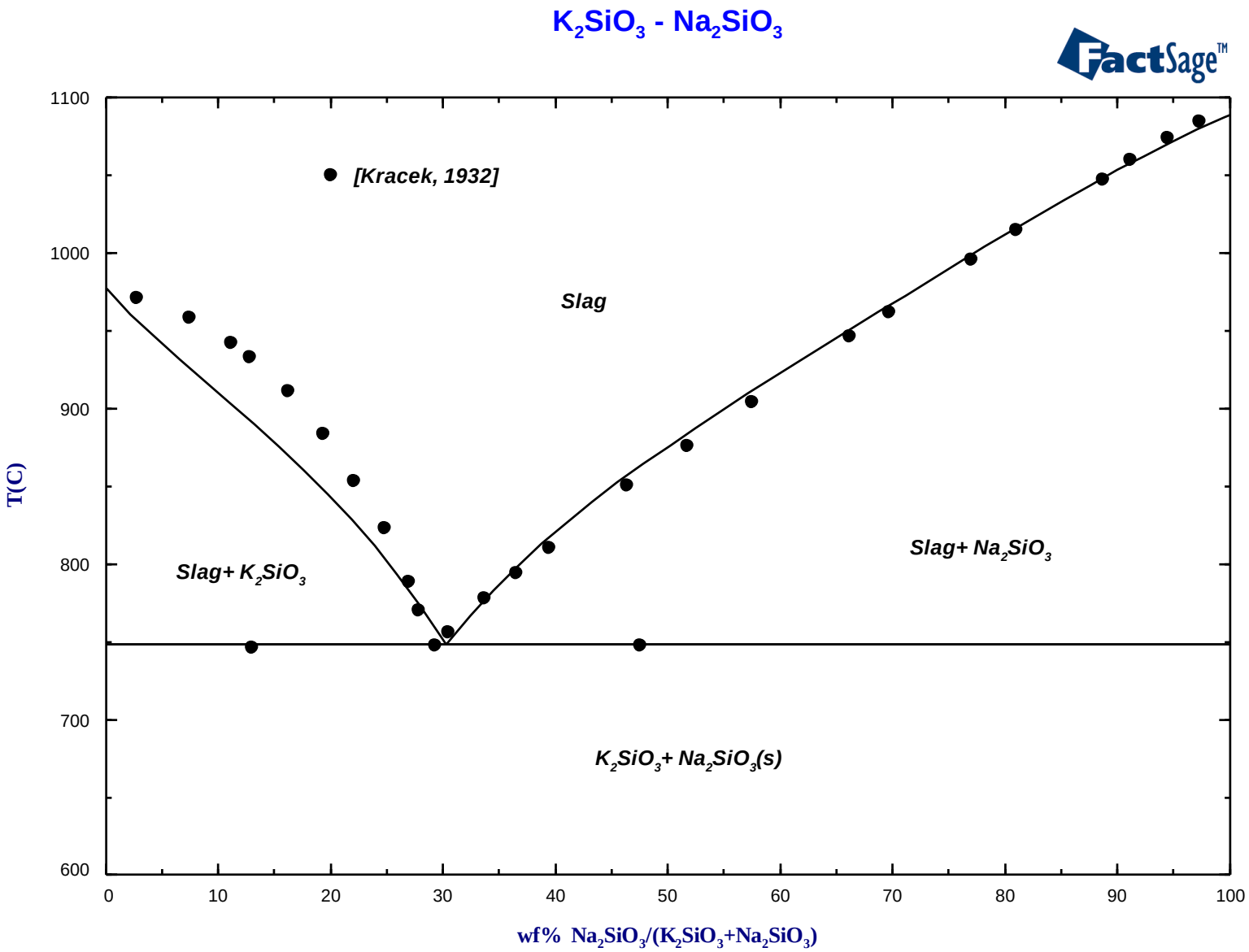
595°C



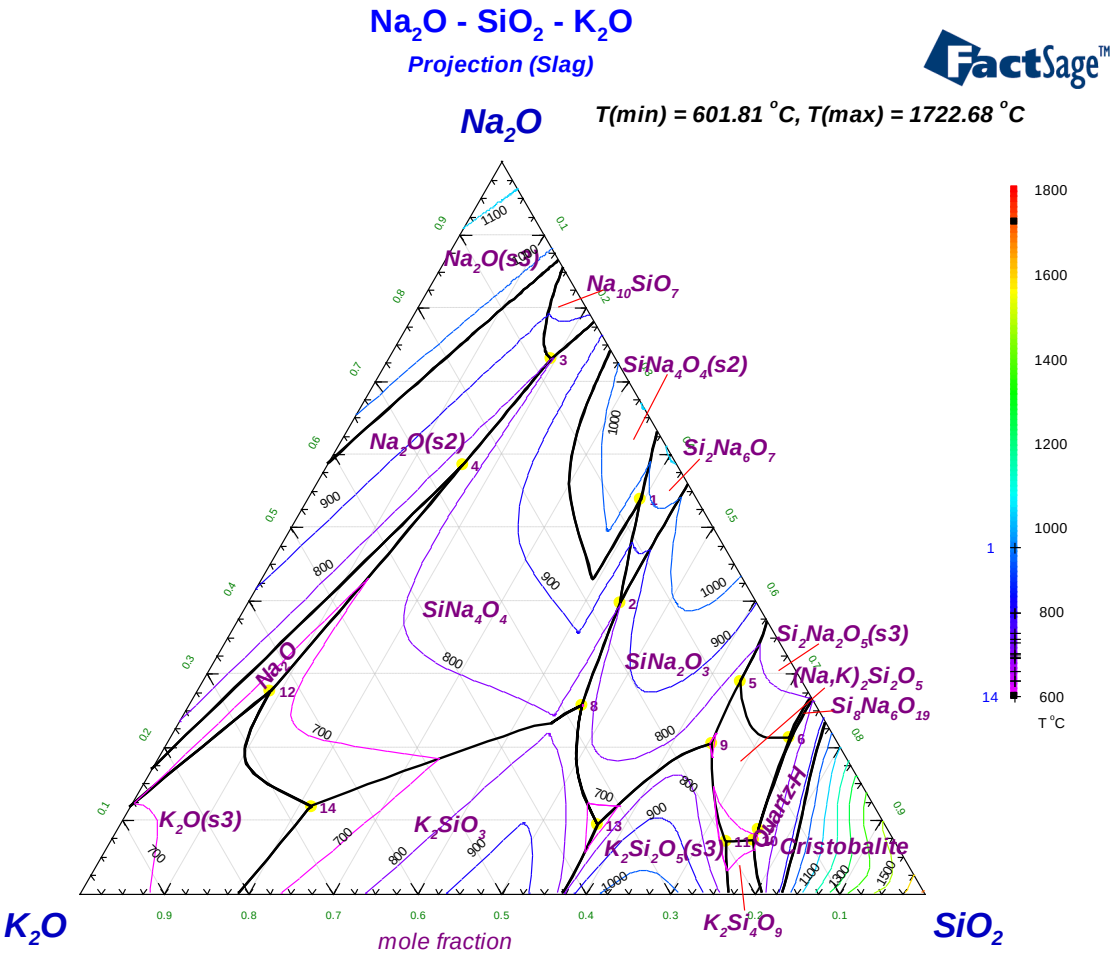
Weight percent
compared with experimental data



Weight percent
compared with experimental data

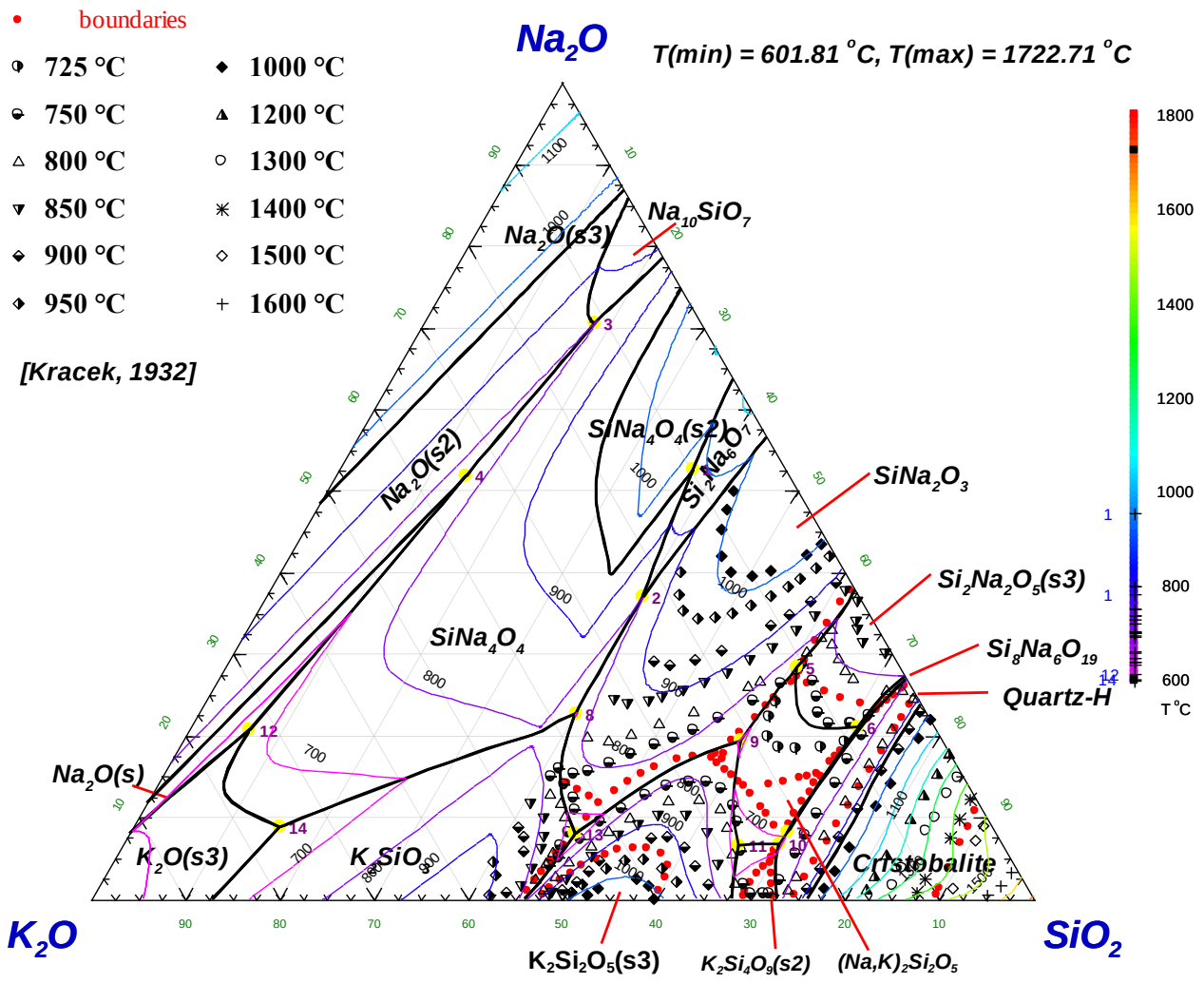


Mole fraction
Liquidussurface



Weight percent
Liquidussurface compared with experimental data

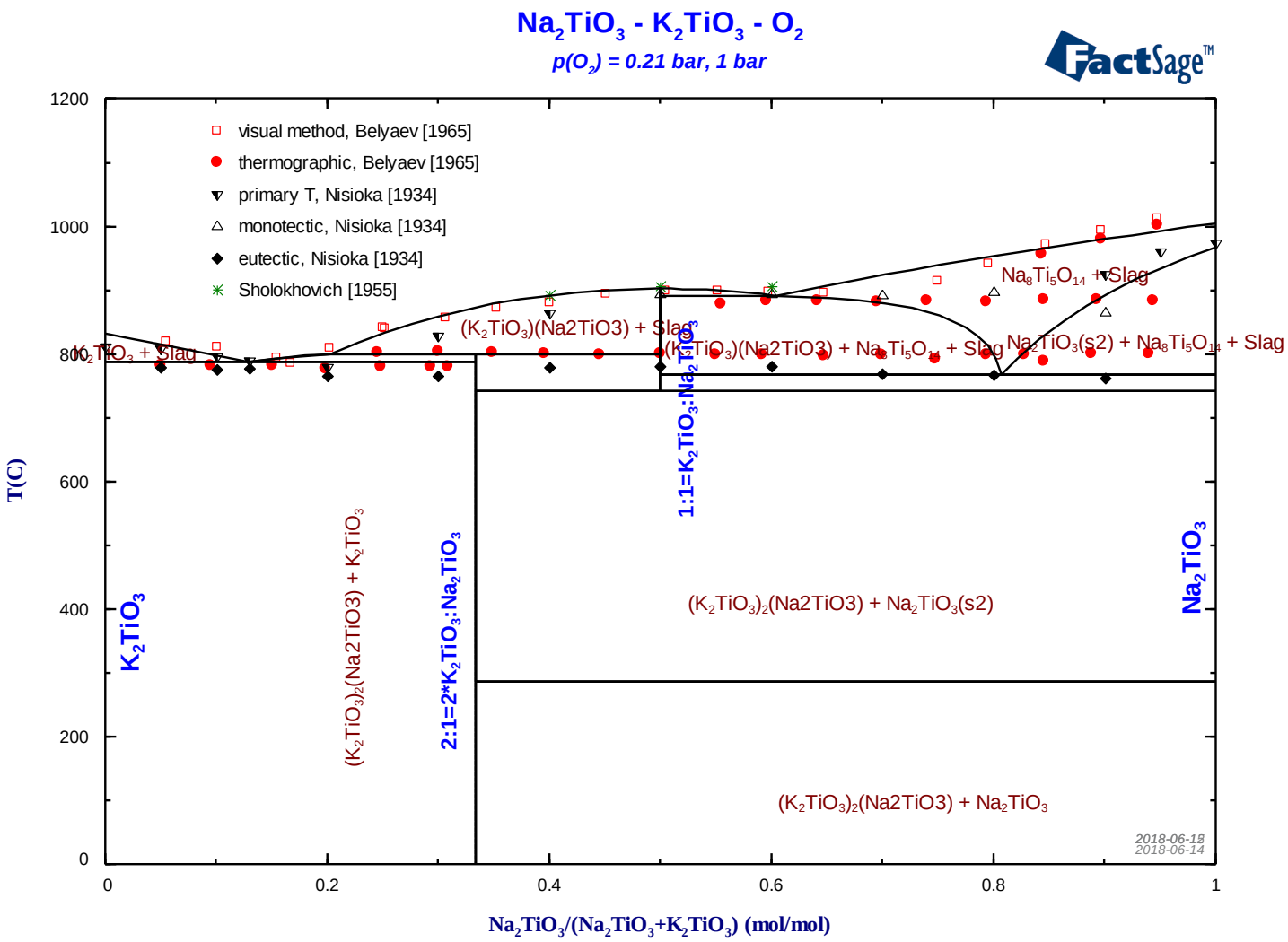
K_2O - Na_2O - SiO_2



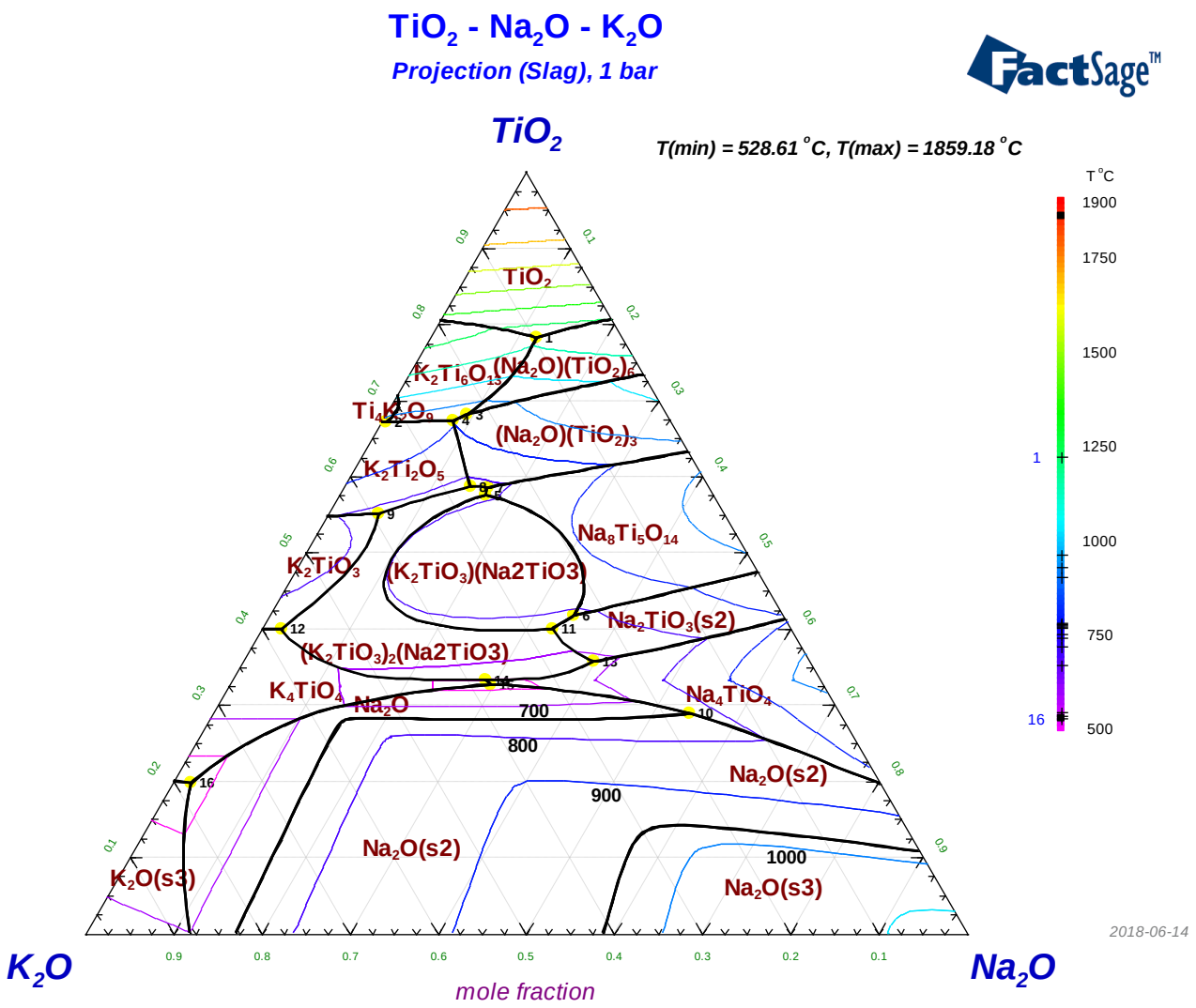
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction				Weight percent			
	A = Na2O, B = K2O, C = SiO2				A = Na2O, B = K2O, C = SiO2			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: Si2Na6O7 / SiNa4O4(s2) / SiNa4O4	1: 0.53787	0.06599	0.39614	954.75	1: 52.619	9.811	37.569	954.76
2: Si2Na6O7 / SiNa2O3 / SiNa4O4	2: 0.39662	0.16124	0.44215	799.04	2: 37.057	22.895	40.048	799.01
3: Na10SiO7 / Na2O(s2) / SiNa4O4_lt(s)	3: 0.72971	0.07683	0.19346	797.16	3: 70.570	11.292	18.138	797.16
4: Na2O(s) / Na2O(s2) / SiNa4O4	4: 0.58476	0.25397	0.16127	750.05	4: 51.883	34.246	13.871	750.05
5: (Na,K)2Si2O5 / Si2Na2O5(s3) / SiNa2O3	5: 0.28987	0.07234	0.63779	736.68	5: 28.472	10.798	60.730	736.68
6: (Na,K)2Si2O5 / Si2Na2O5(s3) / Si8Na6O19	6: 0.21178	0.05353	0.73469	726.40	6: 21.065	8.092	70.843	726.40
7: (Na,K)2Si2O / Si8Na6O19 / Quartz_H	7: 0.08681	0.15260	0.76059	703.18	7: 8.220	21.961	69.819	703.18
8: K2SiO3 / SiNa2O3 / SiNa4O4	8: 0.25714	0.27650	0.46636	698.69	8: 22.766	37.205	40.028	698.72
9: (Na,K)2Si2O5 / K2Si2O5(s3) / SiNa2O3	9: 0.20501	0.14865	0.64634	694.32	9: 19.386	21.363	59.251	694.32
10: (Na,K)2Si2O5 / K2Si4O9(s2) / Quartz_H	10: 0.07172	0.16511	0.76317	691.83	10: 6.750	23.618	69.632	691.83
11: (Na,K)2Si2O5 / K2Si2O5(s3) / K2Si4O9(s2)	11: 0.07125	0.19872	0.73003	659.22	11: 6.591	27.939	65.470	659.24
12: K2O(s3) / Na2O(s) / SiNa4O4	12: 0.27599	0.63587	0.08814	638.55	12: 20.785	72.780	6.435	638.56
13: K2Si2O5(s3) / K2SiO3 / SiNa2O3	13: 0.09330	0.33999	0.56671	637.13	13: 8.047	44.567	47.386	637.17
14: K2O(s3) / K2SiO3 / SiNa4O4	14: 0.11882	0.66617	0.21501	601.81	14: 8.869	75.573	15.558	601.82

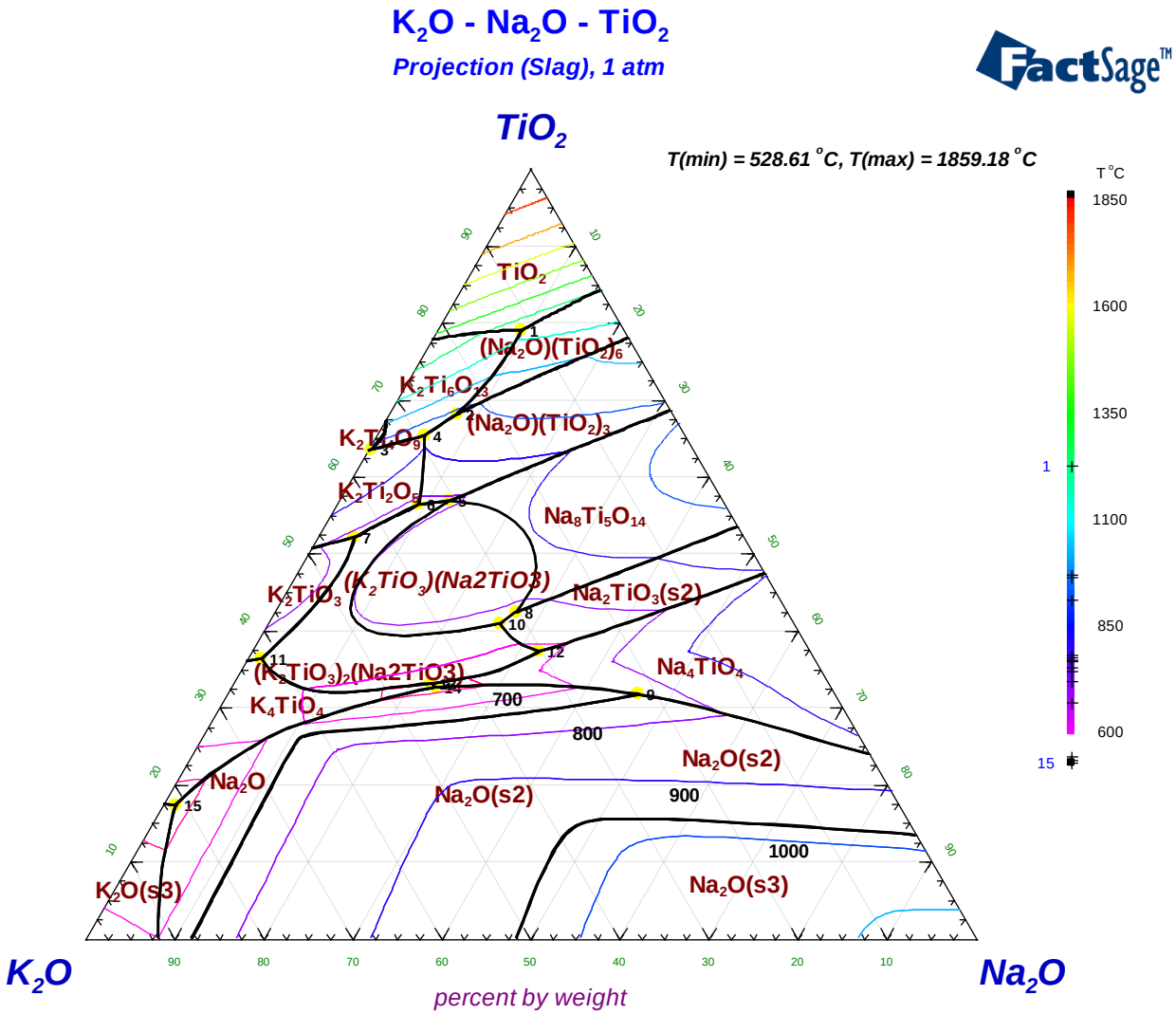
Mole fraction, Isopleth K2TiO3-Na2TiO3 compared with experiments



Mole fraction
Liquidussurface



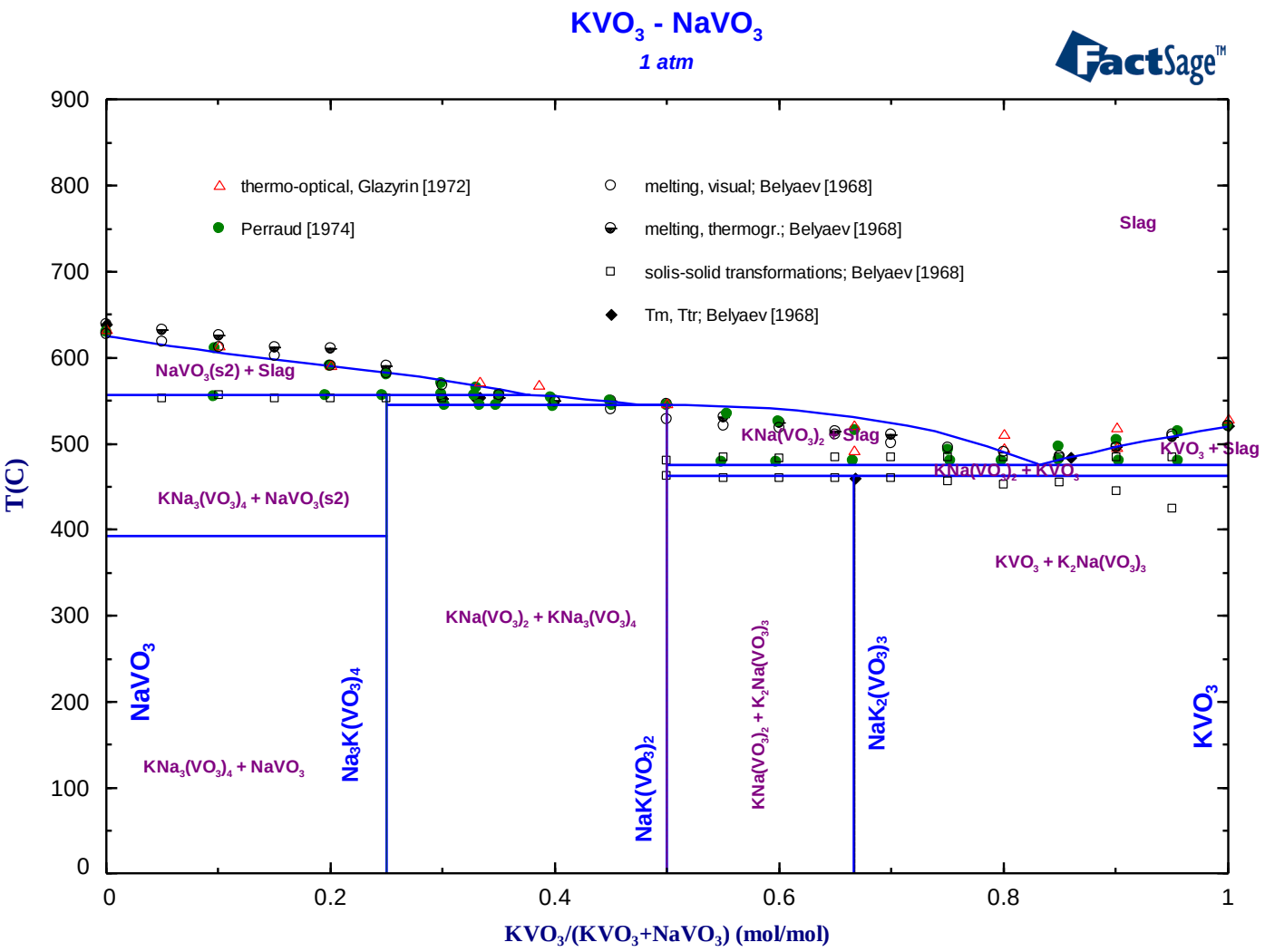
Weight percent
Liquidussurface

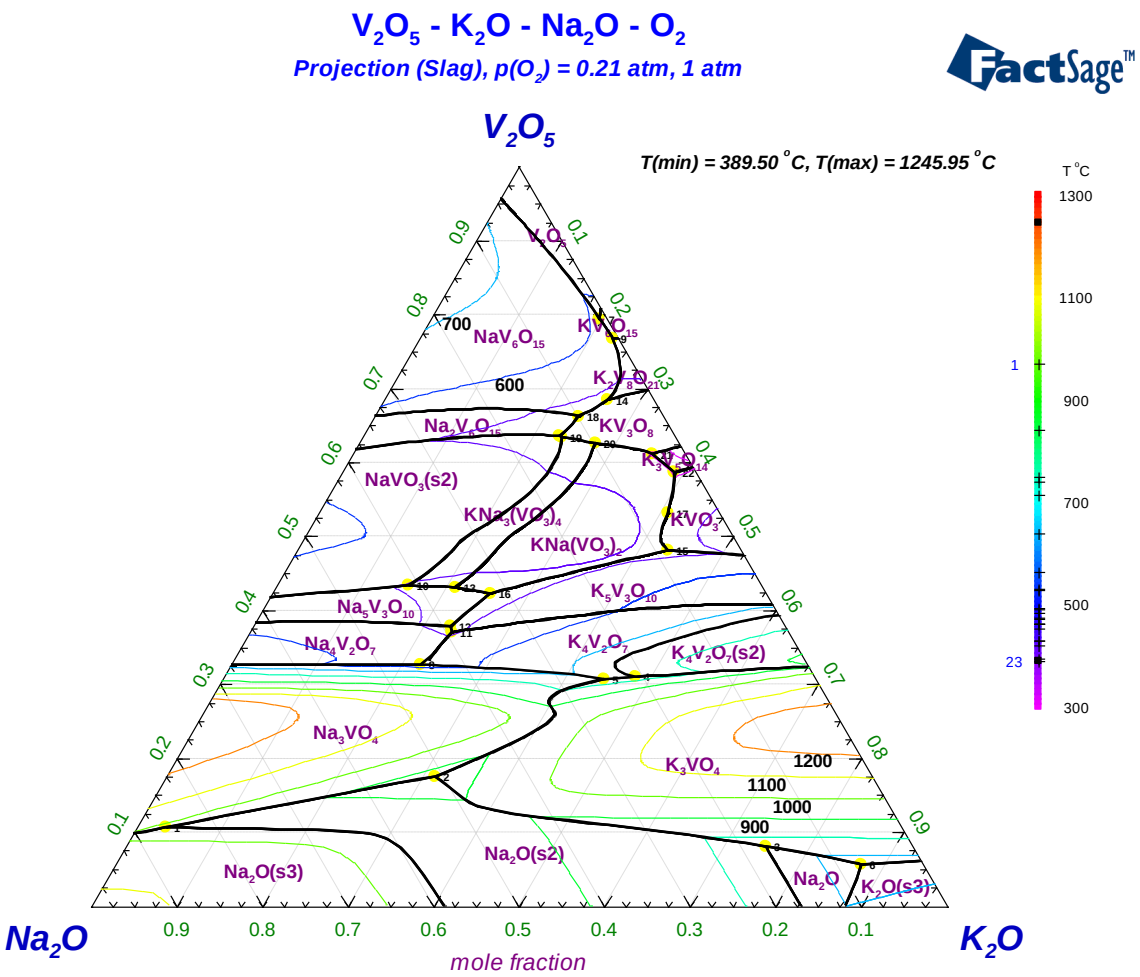


Invariant equilibria on the liquidus surface

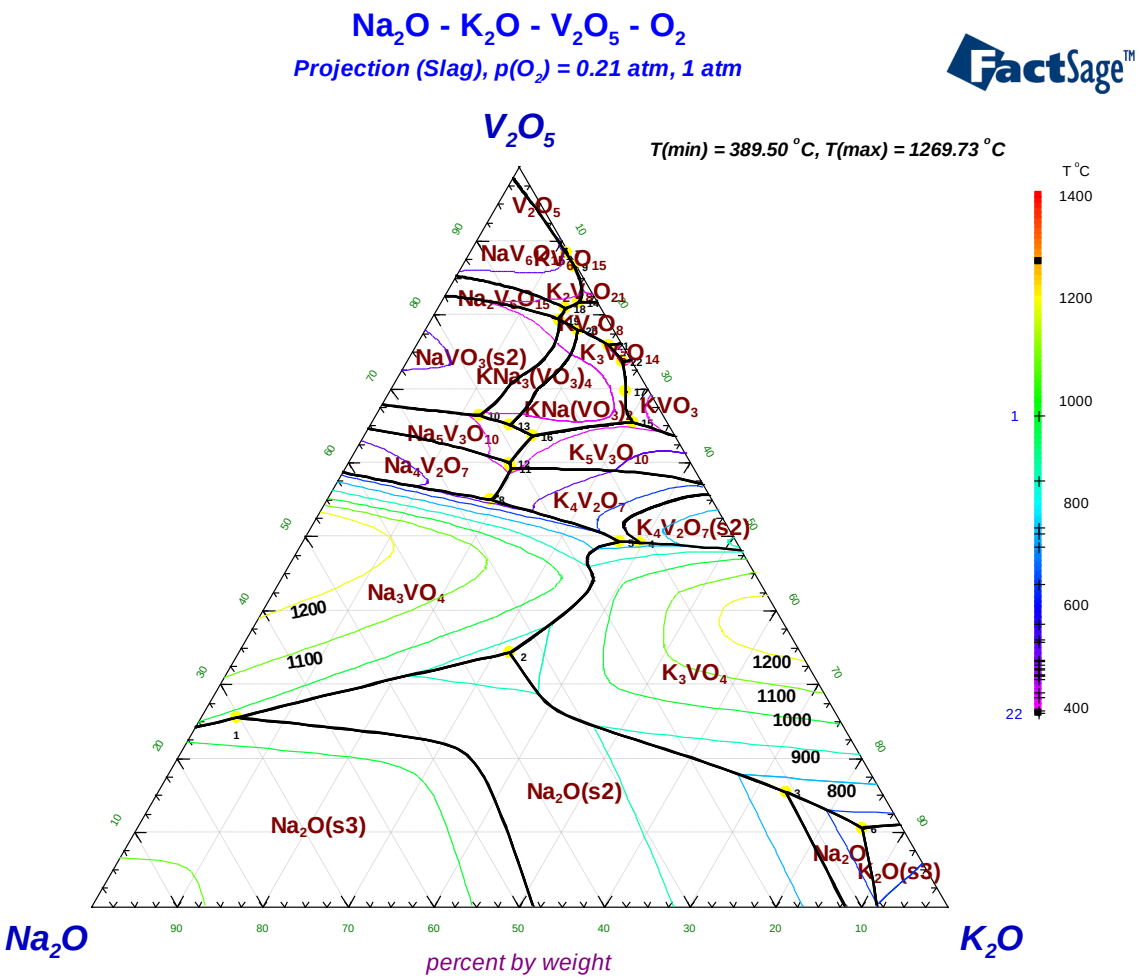
Intersections with slag	Mole fraction				Weight percent			
	A = TiO2, B = K2O, C = Na2O				A = TiO2, B = K2O, C = Na2O			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: (Na2O)(TiO2)6 / K2Ti6O13/ TiO2_Rutile	1: 0.78332	0.09651	0.12017	1222.48	1: 79.091	11.493	9.416	1222.48
2: (Na2O)(TiO2)3/ (Na2O)(TiO2)6 / K2Ti6O13	2: 0.69239	0.20791	0.09969	969.20	2: 68.218	24.160	7.623	969.21
3: K2Ti2O5 / K2Ti4O9 / K2Ti6O13	3: 0.67188	0.32323	0.00489	961.97	3: 63.570	36.071	0.359	961.99
4: (Na2O)(TiO2)3 / K2Ti2O5 / K2Ti6O13	4: 0.67304	0.25576	0.07119	909.37	4: 65.347	29.288	5.364	909.37
5:(K2TiO3)2(Na2TiO3) / (Na2O)(TiO2)3 / Na8Ti5O14	5: 0.57479	0.26273	0.16247	780.61	5: 56.868	30.658	12.474	780.61
6:(K2TiO3)2(Na2TiO3) / (Na2O)(TiO2)3 / K2Ti2O5	6: 0.57945	0.29894	0.12161	773.77	6: 56.454	34.351	9.195	773.77
7:(K2TiO3)2(Na2TiO3) / K2Ti2O5 / K2TiO3	7: 0.55170	0.39185	0.05645	769.09	7: 52.162	43.696	4.142	769.07
8:(K2TiO3)(Na2TiO3) / Na2TiO3(s2) / Na8Ti5O14	8: 0.41146	0.25008	0.33846	765.89	8: 42.459	30.437	27.104	765.89
9: Na2O(s) / Na2O(s2) / Na4TiO4	9: 0.28877	0.16965	0.54158	750.07	9: 31.763	22.008	46.229	750.06
10:K2Na2Ti2O6 / (K2TiO3)2(Na2TiO3) /Na2TiO3(s2)	10: 0.40027	0.27277	0.32696	740.50	10: 41.023	32.972	26.005	740.50
11:(K2TiO3)2(Na2TiO3) / K2TiO3 / K4TiO4	11: 0.39921	0.57801	0.02278	718.12	11: 36.338	62.053	1.609	718.12
12:(K2TiO3)2(Na2TiO3) / Na2TiO3(s2) / Na4TiO4	12: 0.35639	0.24628	0.39734	669.47	12: 37.310	30.409	32.281	669.47
13:(K2TiO3)2(Na2TiO3) / K4TiO4 / Na4TiO4	13: 0.33334	0.37923	0.28743	542.45	13: 33.214	44.561	22.225	542.44
14: K4TiO4 / Na2O(s) / Na4TiO4	14: 0.32717	0.37645	0.29638	534.65	14: 32.679	44.348	22.973	534.65
15: K2O(s3) / K4TiO4 / Na2O(s)	15: 0.19726	0.78184	0.02090	528.61	15: 17.370	81.202	1.428	528.61

K2O-Na2O-V2O5
Mole fraction, Isopleth KVO3-NaVO3 compared with experiments




V2O5 - K2O - Na2O - O2
Projection (Slag), p(O2) = 0.21 atm, 1 atm
FactSage™
V2O5
T(min) = 389.50 °C, T(max) = 1245.95 °C
T °C
1300
1100
900
700
500
300
1
23
NaV6O15
KV6O15
K2V8O21
Na2V6O15
KV3O8
K3V5O14
NaVO3(s2)
KNa3(VO3)4
KNa(VO3)2
KVO3
Na5V3O10
K5V3O10
Na4V2O7
K4V2O7
K4V2O7(s2)
Na3VO4
K3VO4
Na2O(s3)
Na2O(s2)
Na2O
K2O(s3)
700
600
1200
1100
1000
900
Na2O
K2O
mole fraction

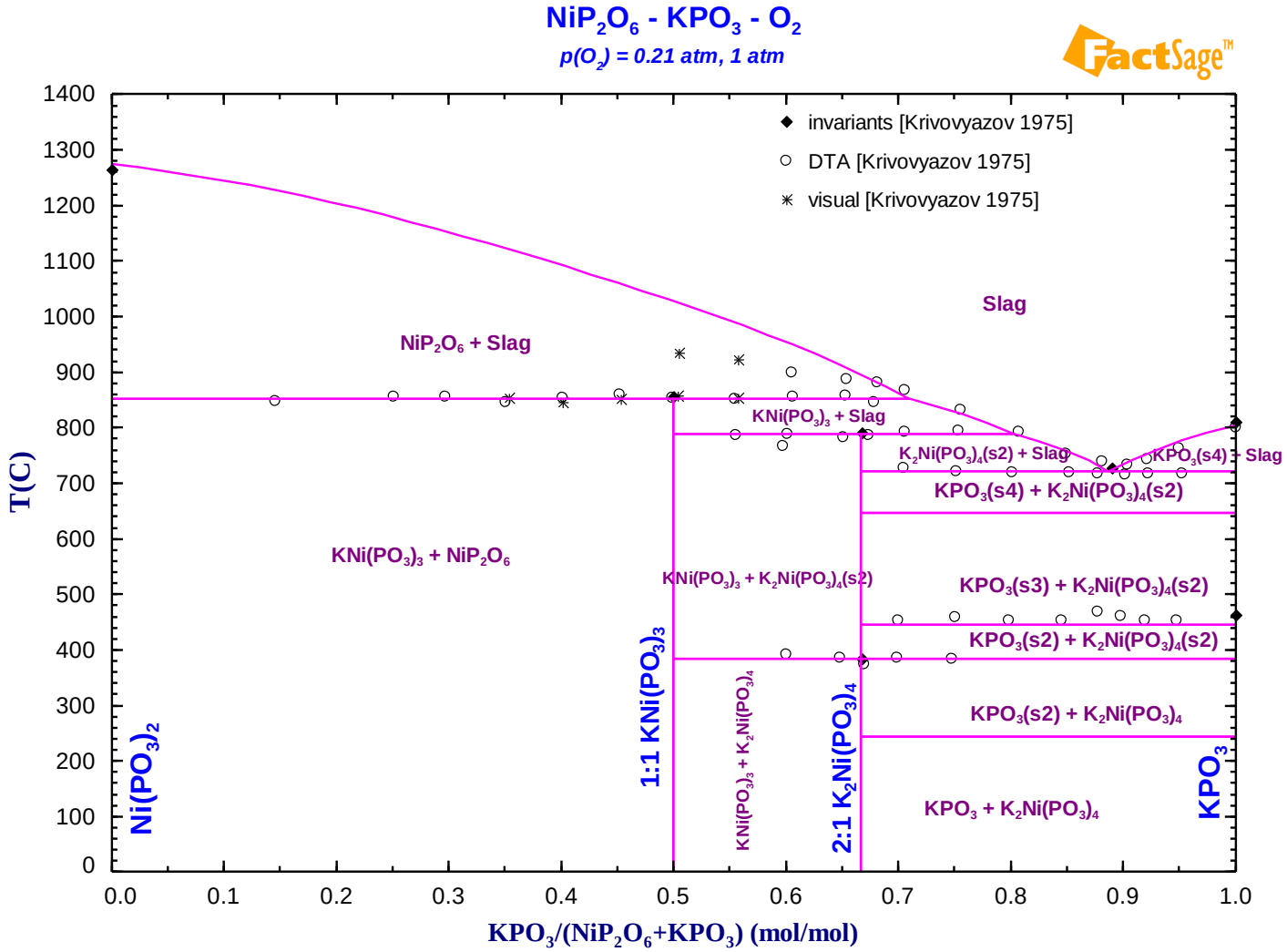
K2O-Na2O-V2O5
Weight percent, Liquidussurface

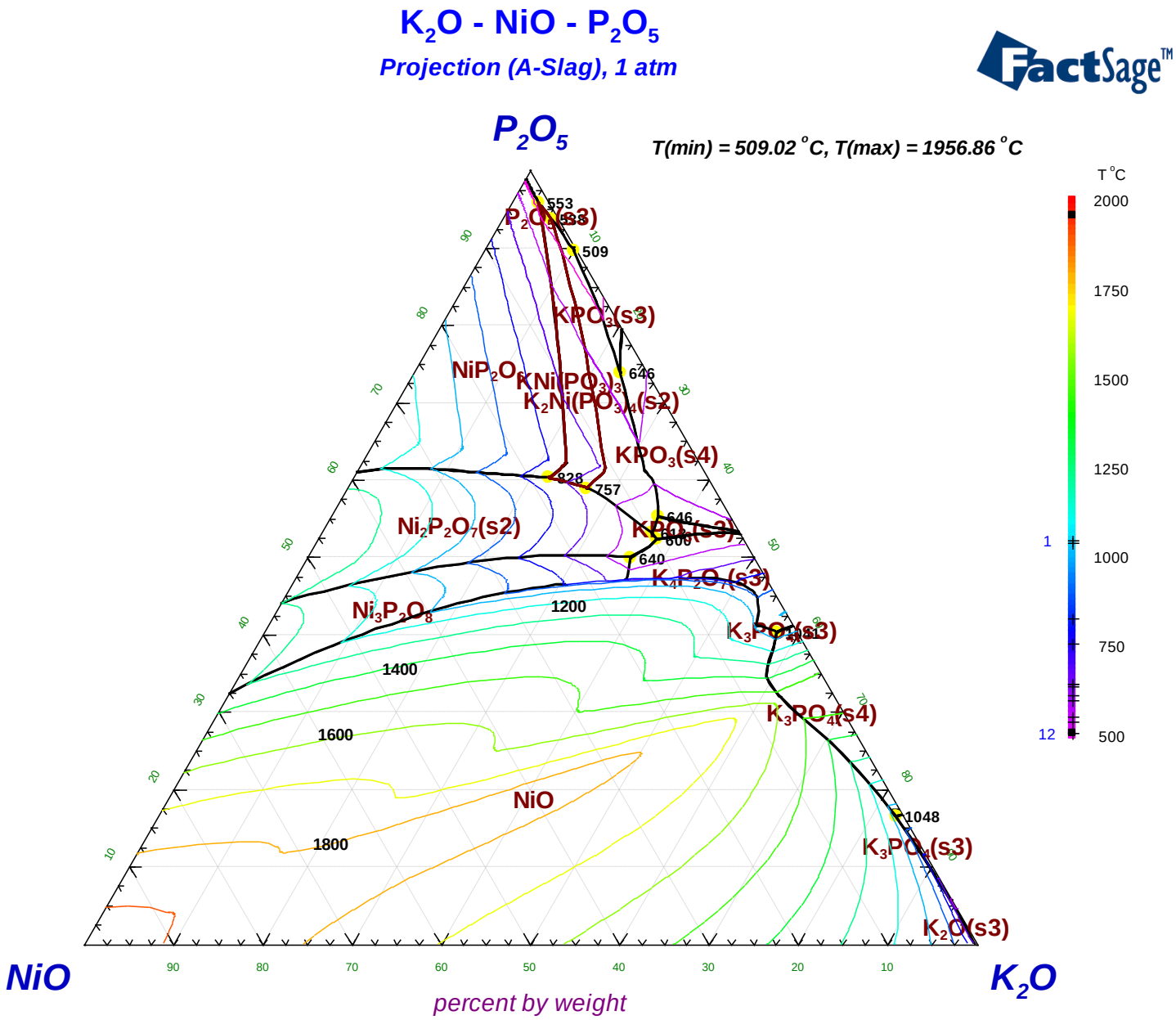


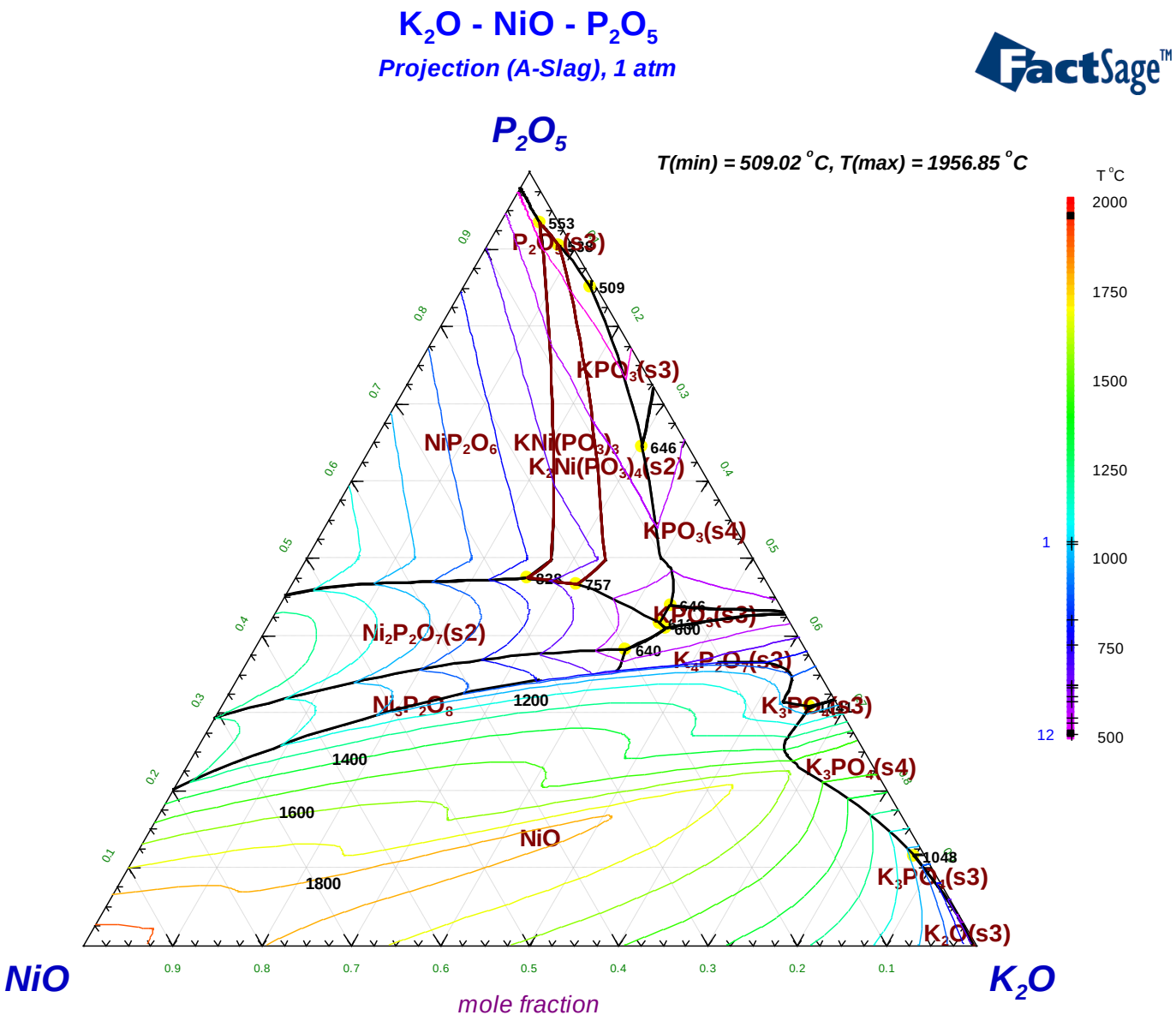
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction					Weight percent				
	A = V2O5, B = Na2O, C = K2O					A = V2O5, B = Na2O, C = K2O				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: Na2O(s2) / Na2O(s3) / Na3VO4(s)	1:	0.10628	0.85964	0.03408	970.05	1:	25.495	70.271	0.04234	970.05
2. K3VO4(s) / Na2O(s2) / Na3VO4(s)	2:	0.17539	0.51051	0.31410	841.81	2:	34.254	33.975	0.31770	841.76
3. K3VO4(s) / Na2O(s) / Na2O(s2)	3:	0.08094	0.17078	0.74828	750.05	3:	15.369	11.050	0.73581	750.05
4. K3VO4(s) / K4V2O7(s) / K4V2O7(s2)	4:	0.30981	0.20874	0.48144	740.00	4:	49.154	11.286	0.39560	740.02
5. K3VO4(s) / K4V2O7(s) / Na3VO4(s)	5:	0.30654	0.24721	0.44626	714.14	5:	49.291	13.546	0.37163	714.14
6. K2O(s3) / K3VO4(s) / Na2O(s)	6:	0.05634	0.07121	0.87244	639.72	6:	10.582	4.558	0.84860	639.73
7. KV6O15(s) / NaV6O15(s) / V2O5(s)	7:	0.79423	0.00840	0.19737	563.41	7:	88.315	0.318	0.11366	563.41
8. K4V2O7(s) / Na3VO4(s) / Na4V2O7(s)	8:	0.32712	0.45114	0.22174	532.17	8:	54.915	25.807	0.19278	532.17
9. K2V8O21(s) / KV6O15(s) / NaV6O15(s)	9:	0.76814	0.00646	0.22540	528.02	9:	86.592	0.248	0.13159	528.02
10.KNa3(VO3)4(s) / Na5V3O10(s) / NaVO3(s2)	10:	0.43371	0.41196	0.15433	492.48	10:	66.314	21.465	0.12221	492.49
11.K4V2O7(s) / K5V3O10(s) / Na4V2O7(s)	11:	0.37116	0.39221	0.23663	490.60	11:	59.162	21.304	0.19534	490.60
12.K5V3O10(s) / Na4V2O7(s) / Na5V3O10(s)	12:	0.37813	0.39097	0.23090	484.14	12:	59.930	21.116	0.18954	484.14
13.KNa(VO3)2(s) / KNa3(VO3)4(s) / Na5V3O10(s)	13:	0.43118	0.35859	0.21023	475.32	13:	65.108	18.452	0.16441	475.32
14.K2V8O21(s) / KV3O8(s) / NaV6O15(s)	14:	0.68494	0.05397	0.26109	473.23	14:	81.682	2.193	0.16125	473.23
15.K5V3O10(s) / KNa(VO3)2(s) / KVO3(s)	15:	0.48076	0.08531	0.43393	463.37	15:	65.448	3.958	0.30594	463.37
16.K5V3O10(s) / KNa(VO3)2(s) / Na5V3O10(s)	16:	0.42289	0.32219	0.25492	462.33	16:	63.621	16.517	0.19862	462.33
17.K2Na(VO3)3(s) / KNa(VO3)2(s) / KVO3(s)	17:	0.53205	0.06010	0.40784	461.86	17:	69.663	2.681	0.27655	461.86
18.KV3O8(s) / Na2V6O15(s) / NaV6O15(s)	18:	0.66282	0.09933	0.23785	454.55	18:	80.846	4.129	0.15025	454.56
19.KNa3(VO3)4(s) / KV3O8(s) / NaVO3(s2)	19:	0.63473	0.13226	0.23301	429.04	19:	79.294	5.630	0.15076	429.03
20.KNa(VO3)2(s) / KNa3(VO3)4(s) / KV3O8(s)	20:	0.62554	0.09824	0.27622	419.80	20:	77.990	4.174	0.17836	419.80
21.K3V5O14(s) / KNa(VO3)2(s) / KV3O8(s)	21:	0.61176	0.03805	0.35019	394.45	21:	75.893	1.608	0.22499	394.45
22.K2Na(VO3)3(s) / K3V5O14(s) / KNa(VO3)2(s)	22:	0.58709	0.02489	0.38802	389.75	22:	73.706	1.065	0.25229	389.75

Mole fraction, Isopleth KVO3-NiP2O6 compared with experiments



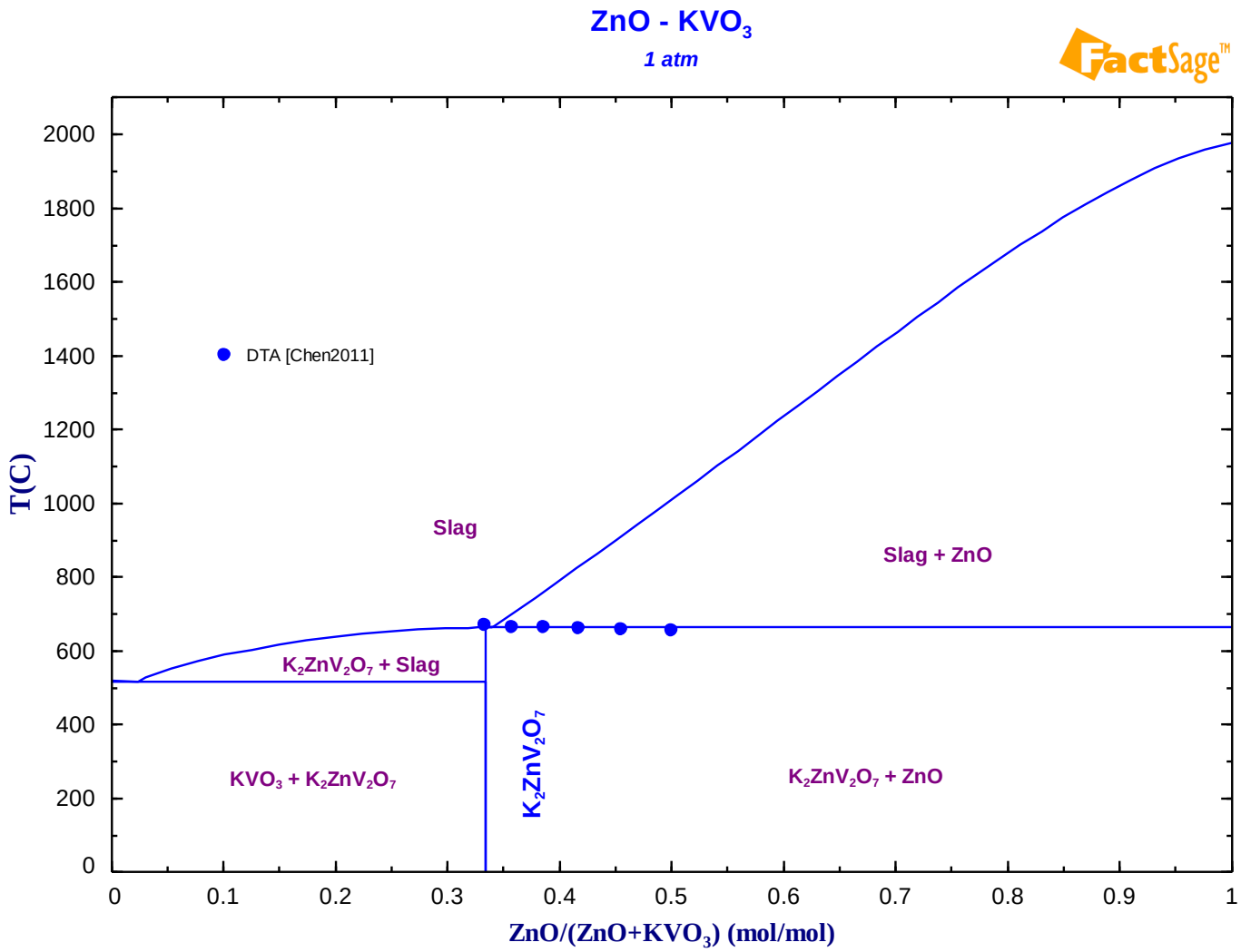

K2O - NiO - P2O5
Projection (A-Slag), 1 atm
FactSage™
P2O5
T(min) = 509.02 °C, T(max) = 1956.86 °C
T °C
2000
1750
1500
1250
1000
750
500
1
12
P2O5(s3)
KPO3(s3)
NiP2O6
KNi(PO3)3
K2Ni(PO3)4(s2)
KPO3(s4)
Ni2P2O7(s2)
K4P2O7(s3)
Ni3P2O8
K3PO4(s3)
K3PO4(s4)
NiO
K2O(s3)
553
509
646
828
757
646
600
640
1200
1400
1600
1800
1048
NiO
K2O
percent by weight

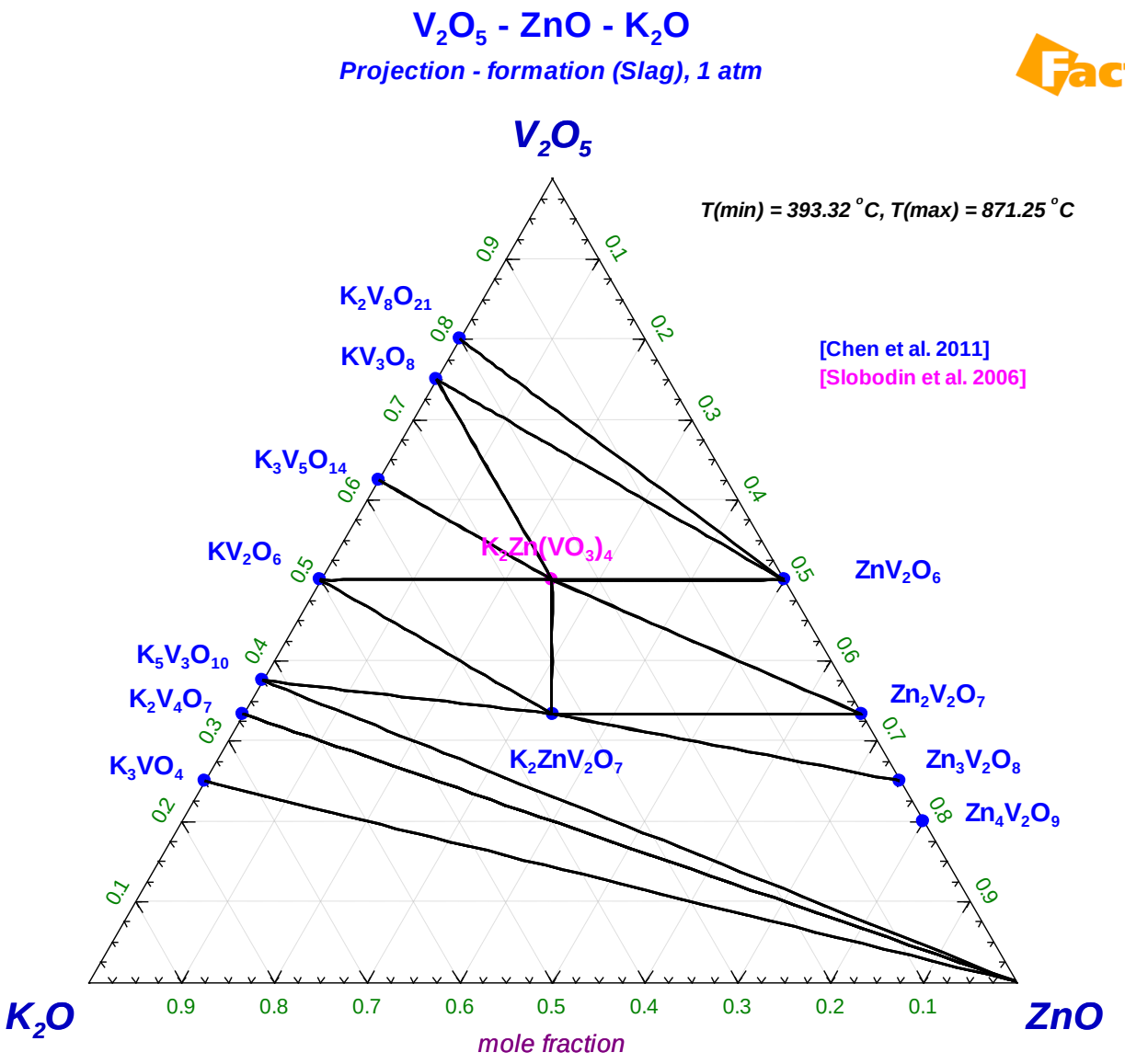

K2O - NiO - P2O5
Projection (A-Slag), 1 atm
FactSage™
P2O5
T(min) = 509.02 °C, T(max) = 1956.85 °C
T °C
2000
1750
1500
1250
1000
750
500
1
12
553
538
509
P2O5(s3)
KPO3(s3)
NiP2O6
KNi(PO3)3
K2Ni(PO3)4(s2)
646
KPO3(s4)
838
757
646
KPO3(s3)
600
Ni2P2O7(s2)
640
K4P2O7(s3)
Ni3P2O8
1200
K3PO4(s3)
1400
K3PO4(s4)
1600
NiO
1048
K3PO4(s3)
1800
K2O(s3)
NiO
K2O
mole fraction

Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction				Weight percent			
	A = P2O5, B = NiO, C = K2O				A = P2O5, B = NiO, C = K2O			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1. K3PO4(s3) / K3PO4(s4) / NiO	0.11555	0.01076	0.87370	1048.25	16.483	0.807	82.709	1048.10
2. K3PO4(s3) / K4P2O7(s3) / NiO	0.30787	0.03269	0.65944	1041.37	40.367	2.255	57.378	1041.40
3. KNi(PO3)3 / Ni2P2O7(s2) / NiP2O6	0.47404	0.26566	0.26030	827.87	60.266	17.773	21.961	827.87
4. K2Ni(PO3)4(s2)/KNi(PO3)3 / Ni2P2O7(s2)	0.46641	0.21347	0.32012	756.84	58.952	14.198	26.851	756.84
5. K2Ni(PO3)4(s2) / KPO3(s3) / KPO3(s4)	0.64463	0.05092	0.30445	645.91	73.800	3.068	23.131	645.92
6. K2Ni(PO3)4(s2) / KPO3(s3) / KPO3(s4)	0.43933	0.12205	0.43862	645.90	55.287	8.082	36.630	645.90
7. K4P2O7(s3) / Ni2P2O7(s2) / Ni3P2O8	0.38230	0.20020	0.41750	639.74	49.993	13.777	36.231	639.74
8. K2Ni(PO3)4(s2)/ KPO3(s3) / Ni2P2O7(s2)	0.41664	0.14572	0.43764	613.38	53.160	9.784	37.056	613.38
9. K4P2O7(s3) / KPO3(s3) / Ni2P2O7(s2)	0.40918	0.14274	0.44807	599.92	52.349	9.610	38.041	599.92
10.KNi(PO3)3/ NiP2O6 / P2O5(s3)	0.93337	0.02170	0.04494	552.56	95.769	1.171	3.060	552.56
11.K2Ni(PO3)4(s2) / KNi(PO3)3 / P2O5(s3)	0.90531	0.01472	0.07997	538.45	93.705	0.802	5.493	538.45
12.K2Ni(PO3)4(s2) / KPO3(s3) / P2O5(s3)	0.85133	0.00587	0.14279	509.02	89.691	0.326	9.983	509.02

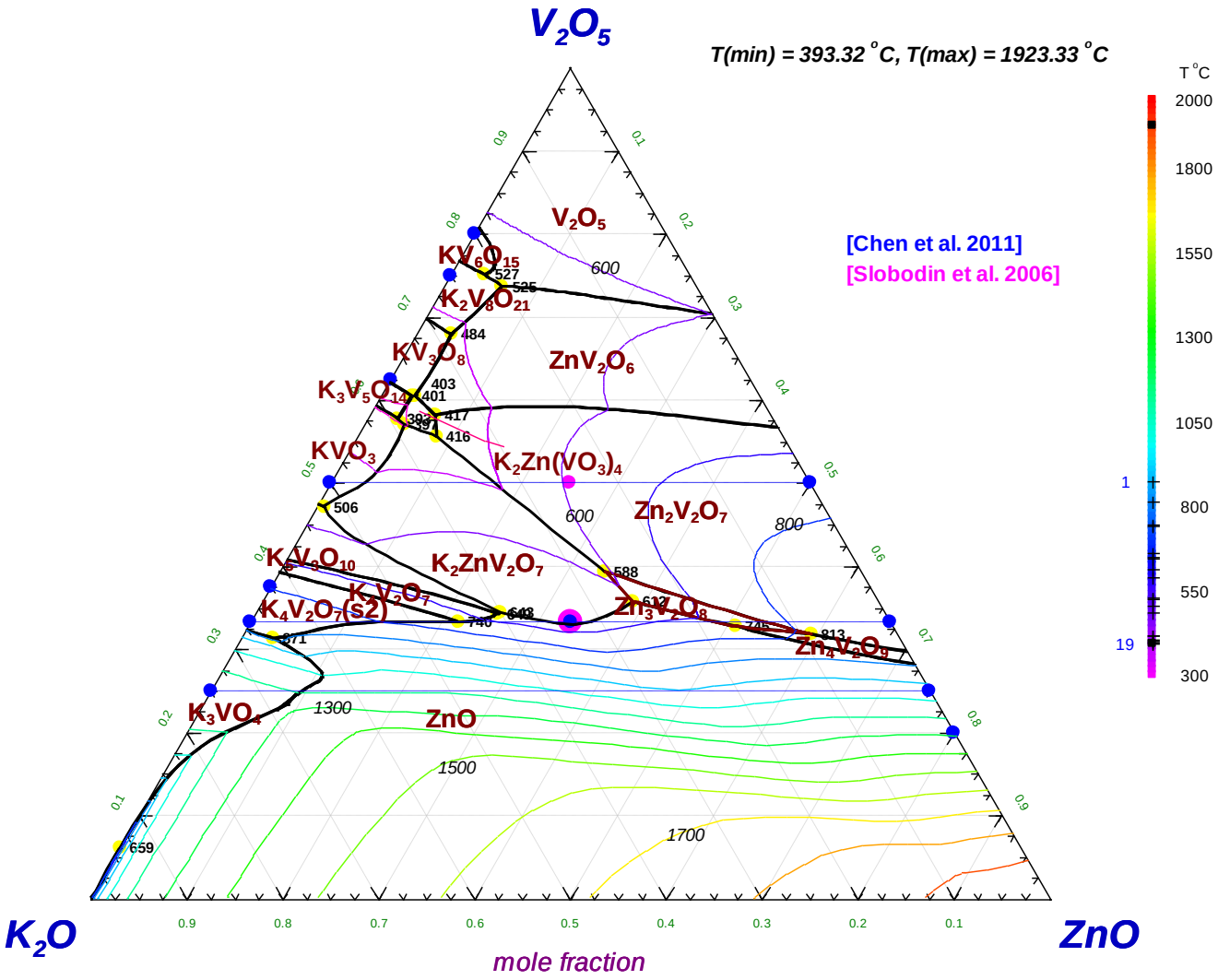
K2O-V2O5-ZnO,
Mole fraction, Isopleth KVO3-ZnO



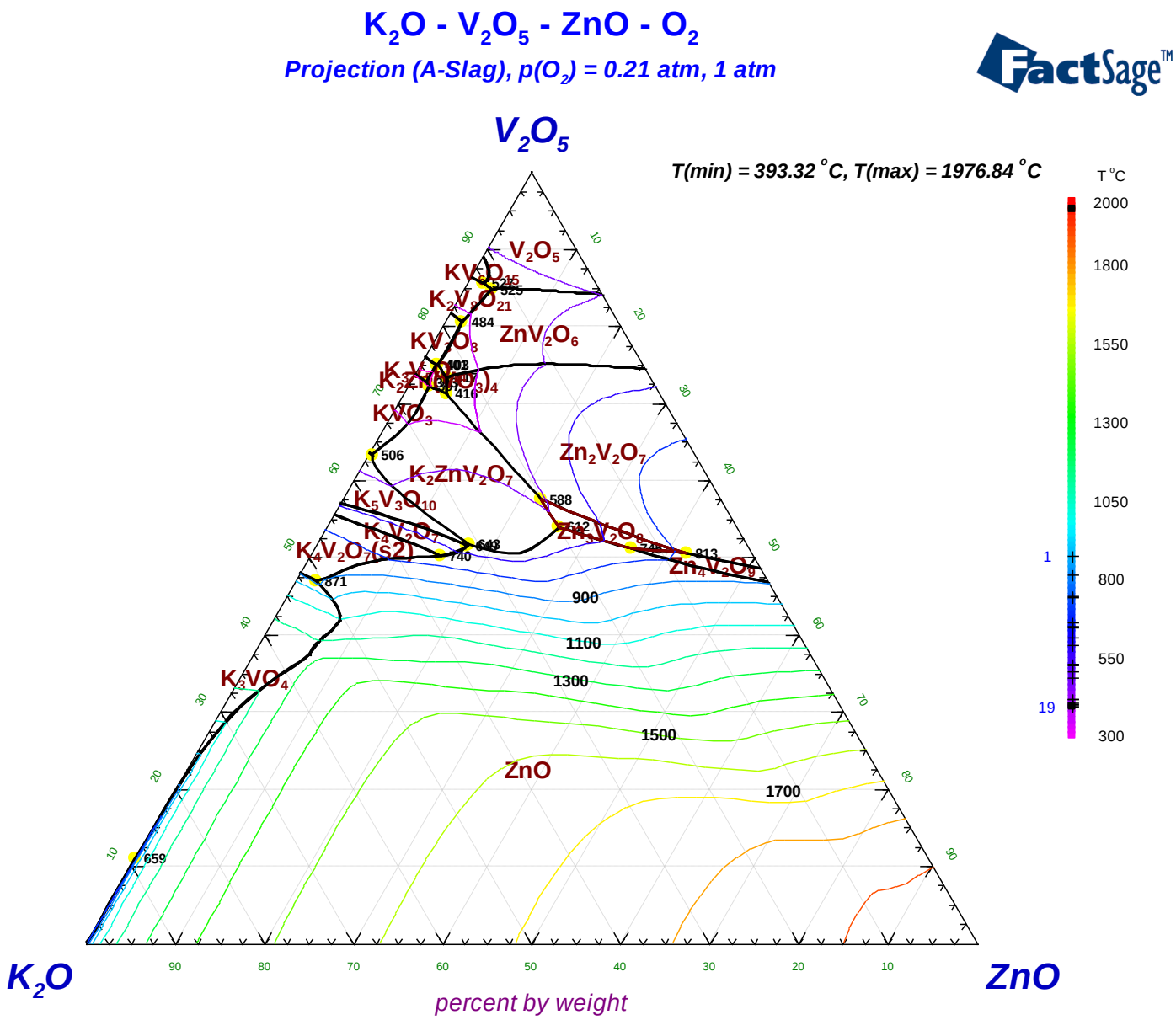

V2O5 - ZnO - K2O
Projection - formation (Slag), 1 atm
FactSage™
V2O5
T(min) = 393.32 °C, T(max) = 871.25 °C
[Chen et al. 2011]
[Slobodin et al. 2006]
K2V8O21
KV3O8
K3V5O14
KV2O6
K2Zn(VO3)4
ZnV2O6
K5V3O10
K2V4O7
Zn2V2O7
K3VO4
K2ZnV2O7
Zn3V2O8
Zn4V2O9
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
K2O
ZnO
mole fraction

K_2O - V_2O_5 - ZnO - O_2

Projection (A-Slag), p(O_2) = 0.21 atm, 1 atm



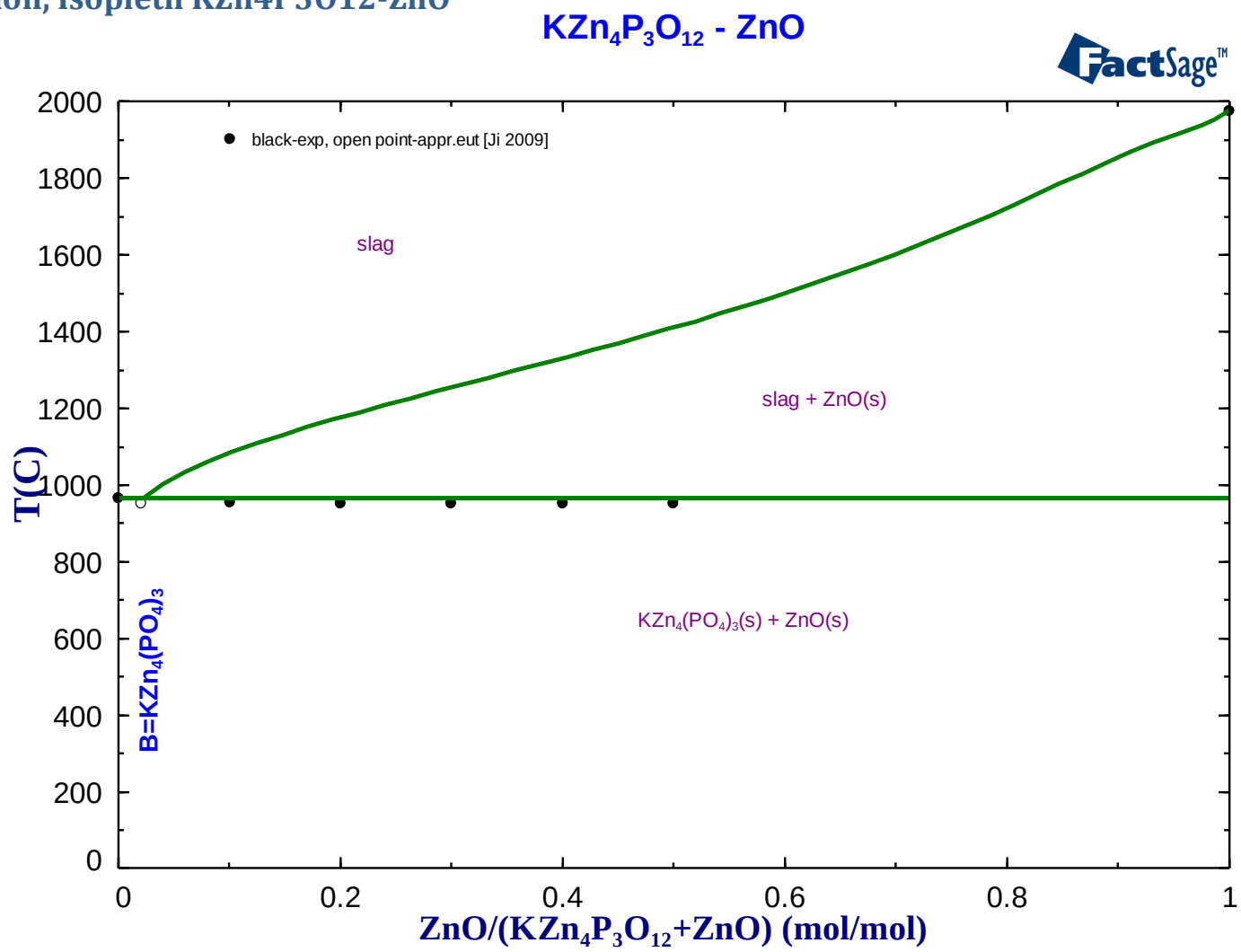
K2O-V2O5-ZnO,
Weight percent, Liquidus surface

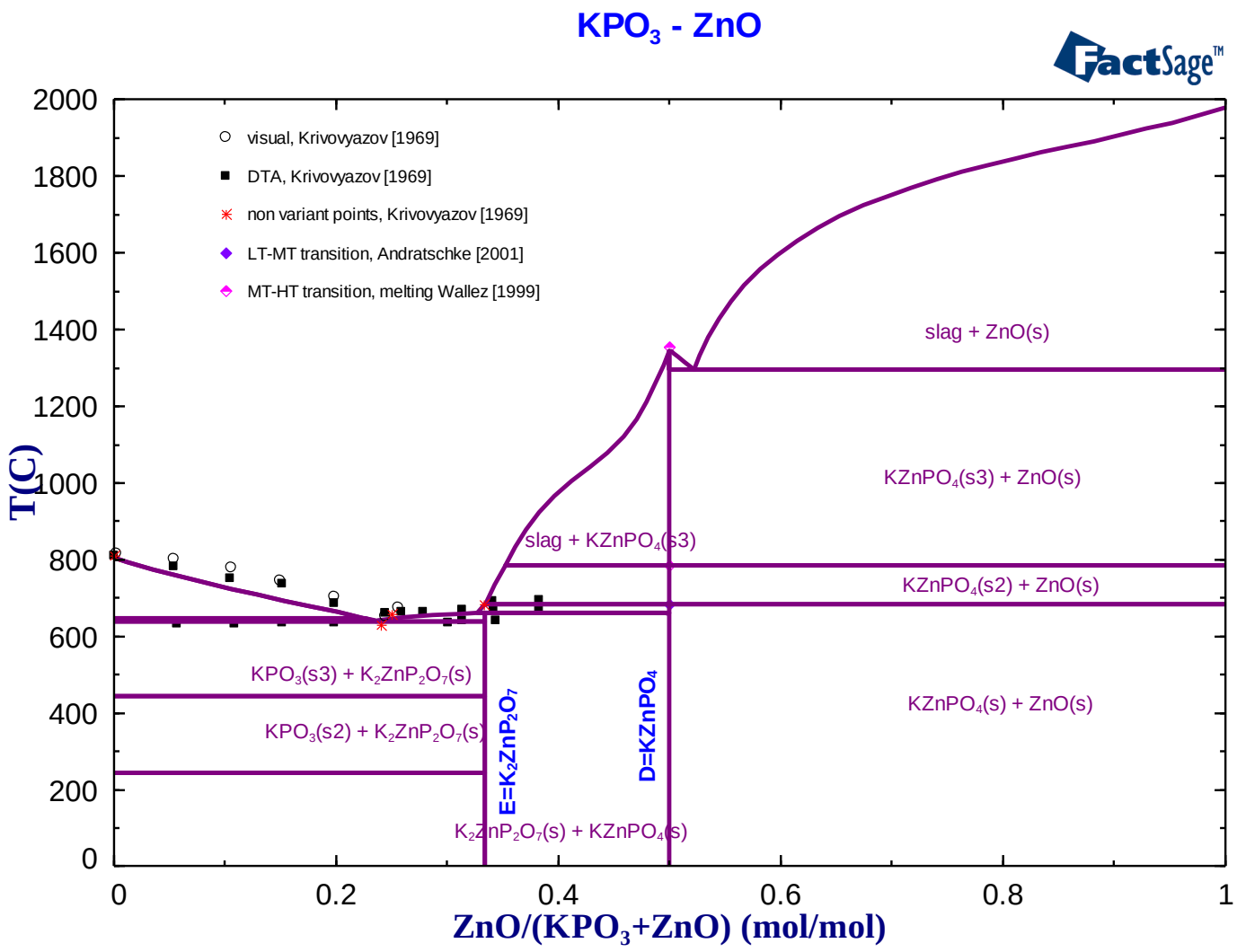


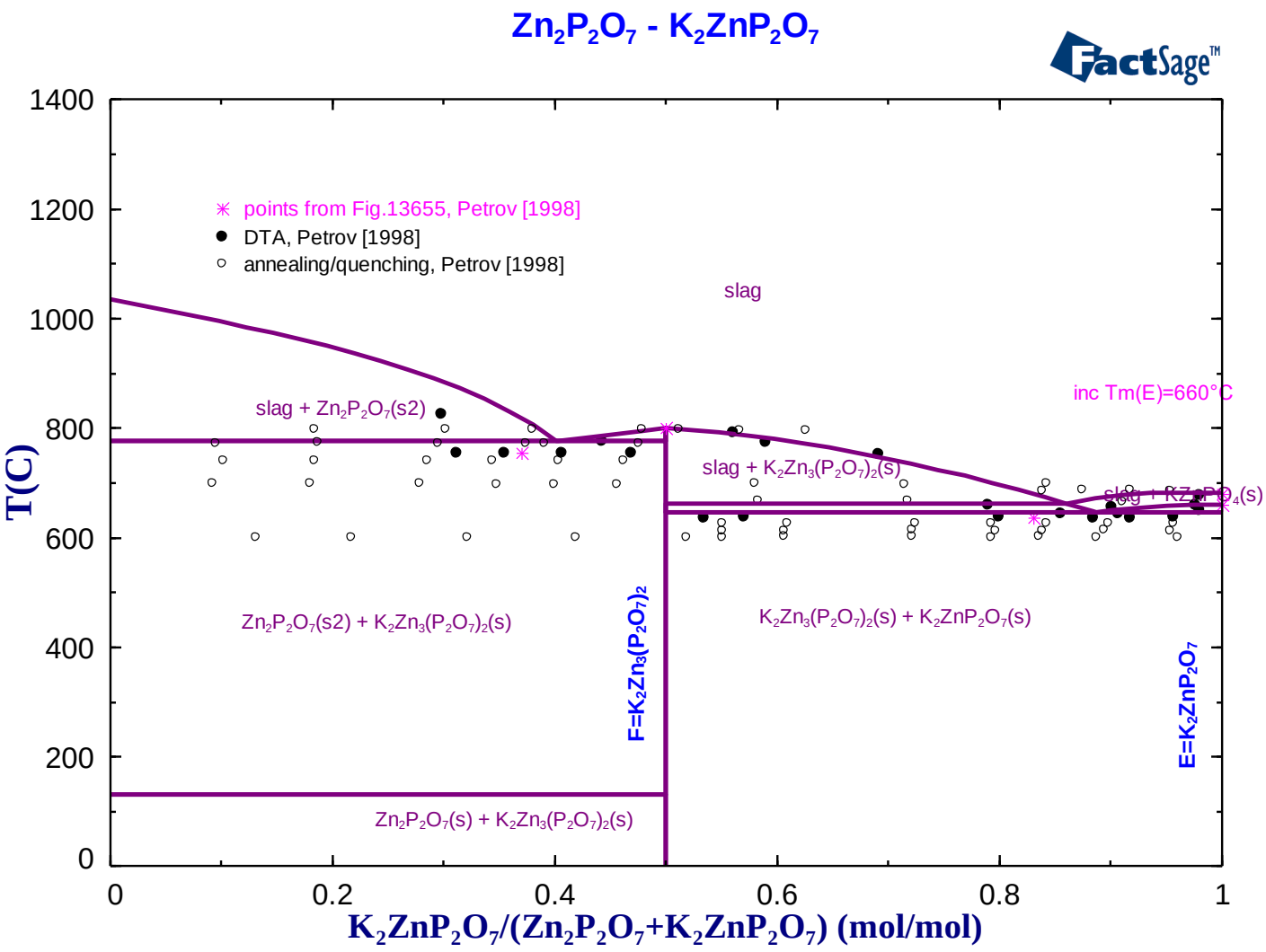
Invariant equilibria on the liquidus surface

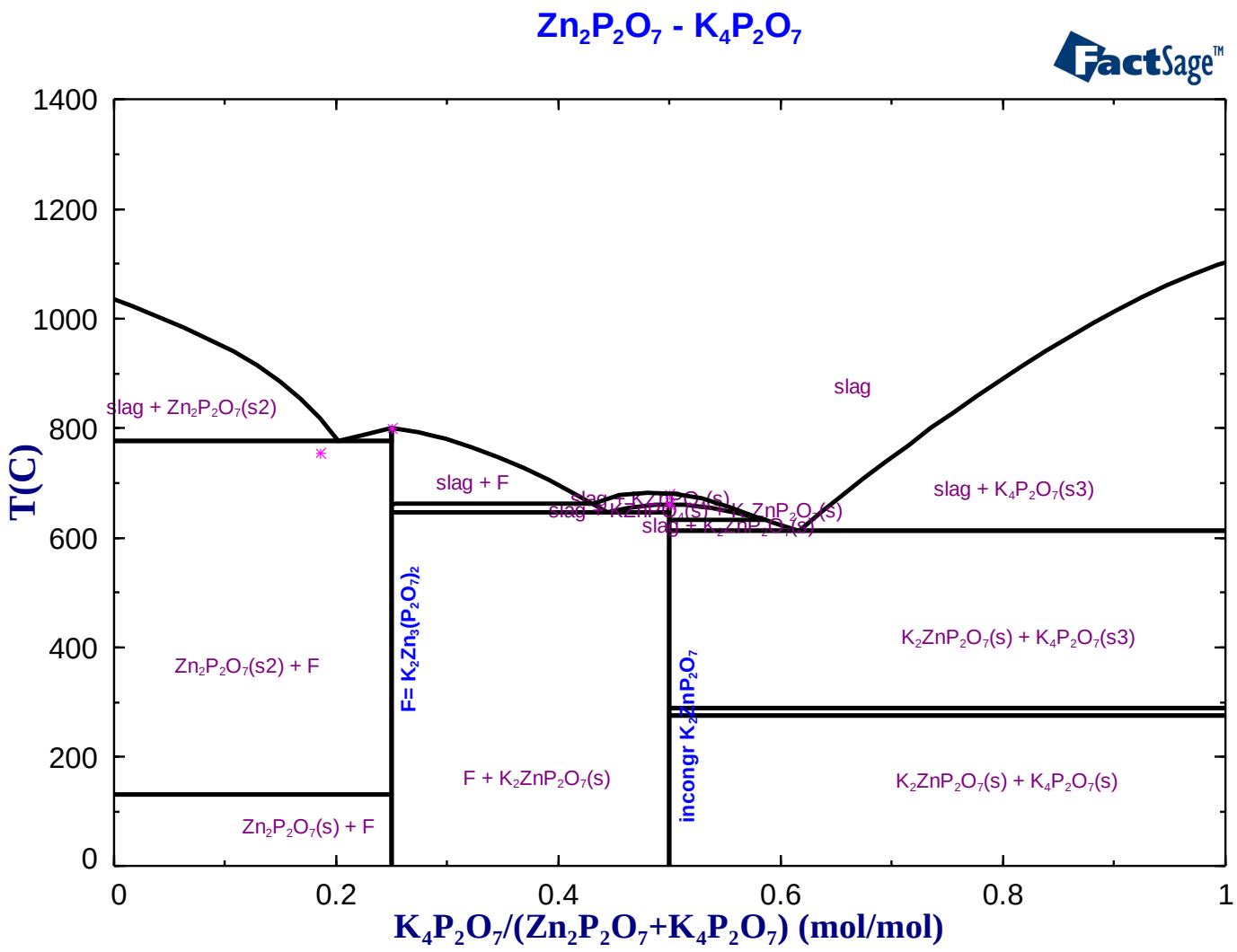
Intersections with slag	Mole fraction				Weight percent			
	A = V2O5, B = K2O, C = ZnO				A = V2O5, B = K2O, C = ZnO			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1. K3VO4 / K4V2O7(s2) / ZnO	0.31365	0.65277	0.03358	871.25	47.042	50.705	2.253	871.25
2. Zn2V2O7 / Zn3V2O8 / Zn4V2O9	0.31820	0.08873	0.59307	812.55	50.547	7.300	42.153	812.53
3. Zn3V2O8 / Zn4V2O9 / ZnO	0.32767	0.16301	0.50933	745.12	51.200	13.191	35.609	745.12
4. K4V2O7 / K4V2O7(s2) / ZnO	0.33334	0.44957	0.21709	740.00	50.255	35.102	14.644	740.00
5. K2O(s3) / K3VO4 / ZnO	0.06040	0.93955	0.00005	659.39	11.041	88.955	0.004	659.39
6. K4V2O7 / K5V3O10 / ZnO	0.34349	0.40439	0.25212	649.19	51.596	31.459	16.945	649.19
7. K2ZnV2O7 / K5V3O10 / ZnO	0.34397	0.40050	0.25553	643.10	51.669	31.157	17.175	643.10
8. K2ZnV2O7 / Zn3V2O8 / ZnO	0.35743	0.25550	0.38707	612.30	53.916	19.960	26.124	612.30
9. K2ZnV2O7 / Zn2V2O7 / Zn3V2O8	0.39388	0.26650	0.33962	587.54	57.597	20.182	22.221	587.54
10.K2V8O21 / KV6O15 / V2O5	0.75108	0.21349	0.03543	527.30	85.593	12.600	1.806	527.30
11.K2V8O21 / V2O5 / ZnV2O6	0.73715	0.20207	0.06078	525.02	84.828	12.043	3.130	525.02
12.K2ZnV2O7 / K5V3O10 / KVO3	0.47192	0.52054	0.00754	505.56	63.355	36.192	0.453	505.53
13.K2V8O21 / KV3O8 / ZnV2O6	0.67922	0.28436	0.03642	483.75	80.592	17.474	1.933	483.79
14.K2Zn(VO3)4 / Zn2V2O7 / ZnV2O6	0.58208	0.34988	0.06804	416.54	73.335	22.830	3.835	416.54
15.K2Zn(VO3)4 / K2ZnV2O7 / Zn2V2O7	0.55600	0.36068	0.08332	416.30	71.275	23.946	4.779	416.30
16.K2Zn(VO3)4 / KV3O8 / ZnV2O6	0.60525	0.35891	0.03584	403.33	74.984	23.029	1.987	403.33
17.K2Zn(VO3)4 / K3V5O14 / KV3O8	0.60562	0.36191	0.03247	401.39	74.992	23.209	1.799	401.39
18.K2Zn(VO3)4 / K2ZnV2O7 / KVO3	0.57100	0.38794	0.04106	397.43	72.253	25.423	2.325	397.43
19.K2Zn(VO3)4 / K3V5O14 / KVO3	0.57796	0.39062	0.03142	393.32	72.762	25.468	1.770	393.32

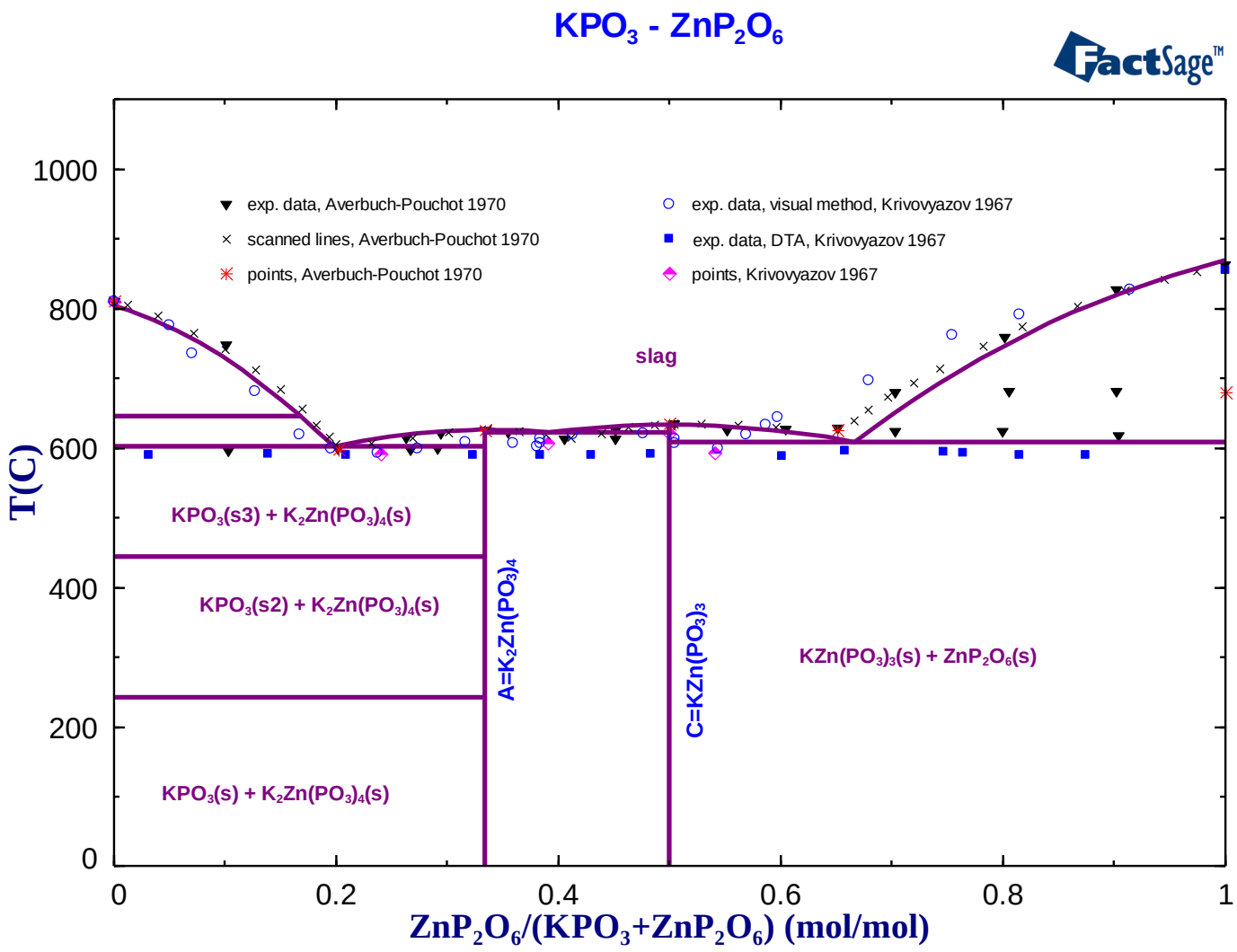
K2O-P2O5-ZnO,
Mole fraction, Isopleth KZn4P3O12-ZnO

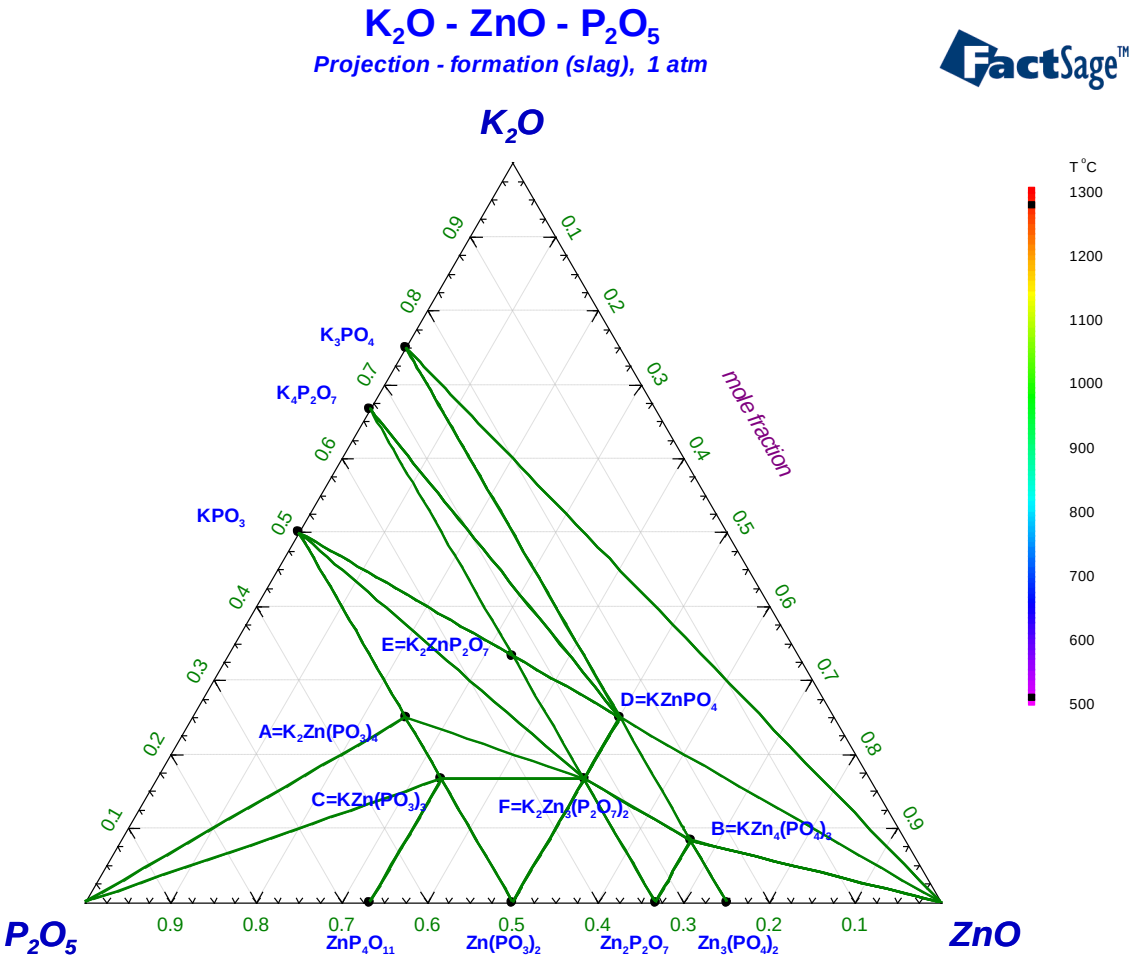


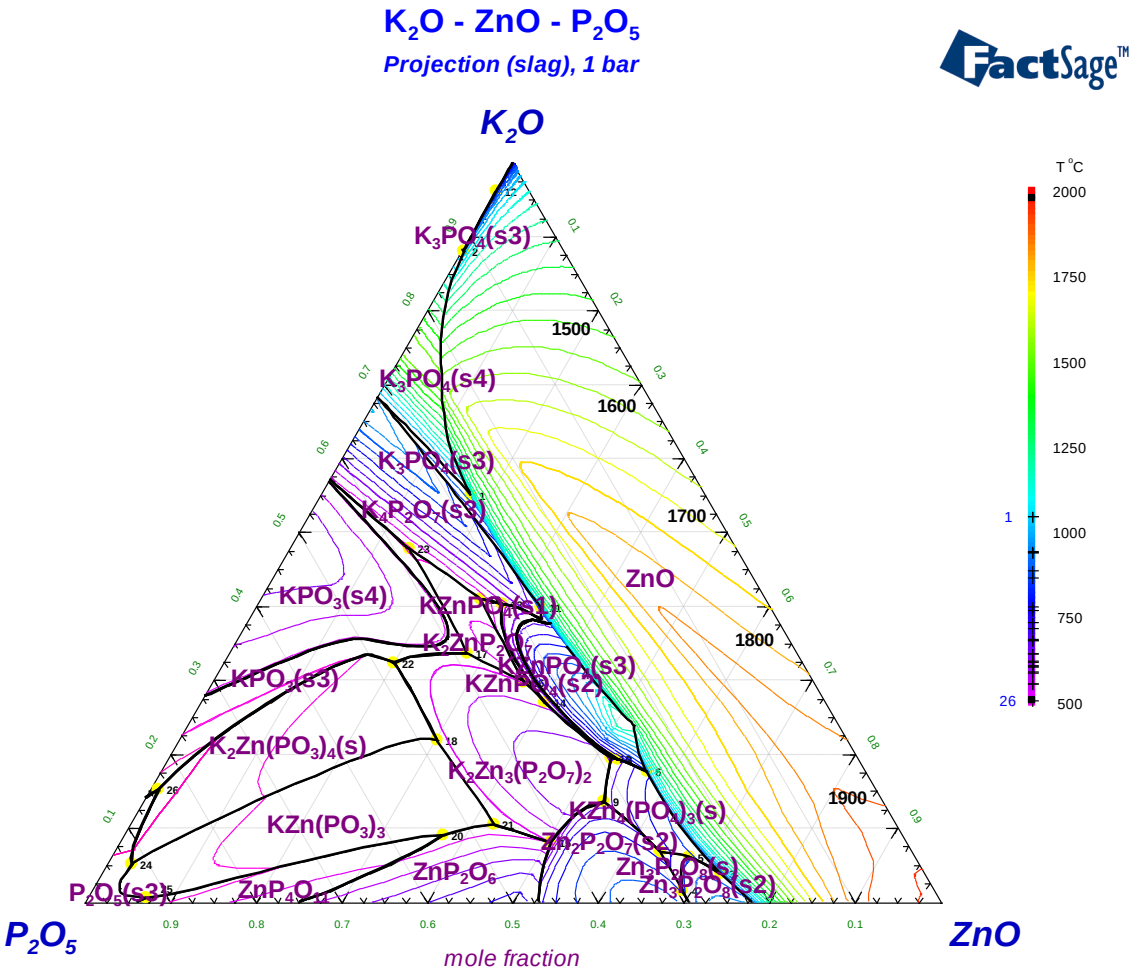

KPO3 - ZnO
FactSage™
visual, Krivovyazov [1969]
DTA, Krivovyazov [1969]
non variant points, Krivovyazov [1969]
LT-MT transition, Andratschke [2001]
MT-HT transition, melting Wallez [1999]
slag + ZnO(s)
KZnPO4(s3) + ZnO(s)
slag + KZnPO4(s3)
KZnPO4(s2) + ZnO(s)
KPO3(s3) + K2ZnP2O7(s)
KPO3(s2) + K2ZnP2O7(s)
E=K2ZnP2O7
D=KZnPO4
KZnPO4(s) + ZnO(s)
K2ZnP2O7(s) + KZnPO4(s)
T(C)
ZnO/(KPO3+ZnO) (mol/mol)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
0.2
0.4
0.6
0.8
1

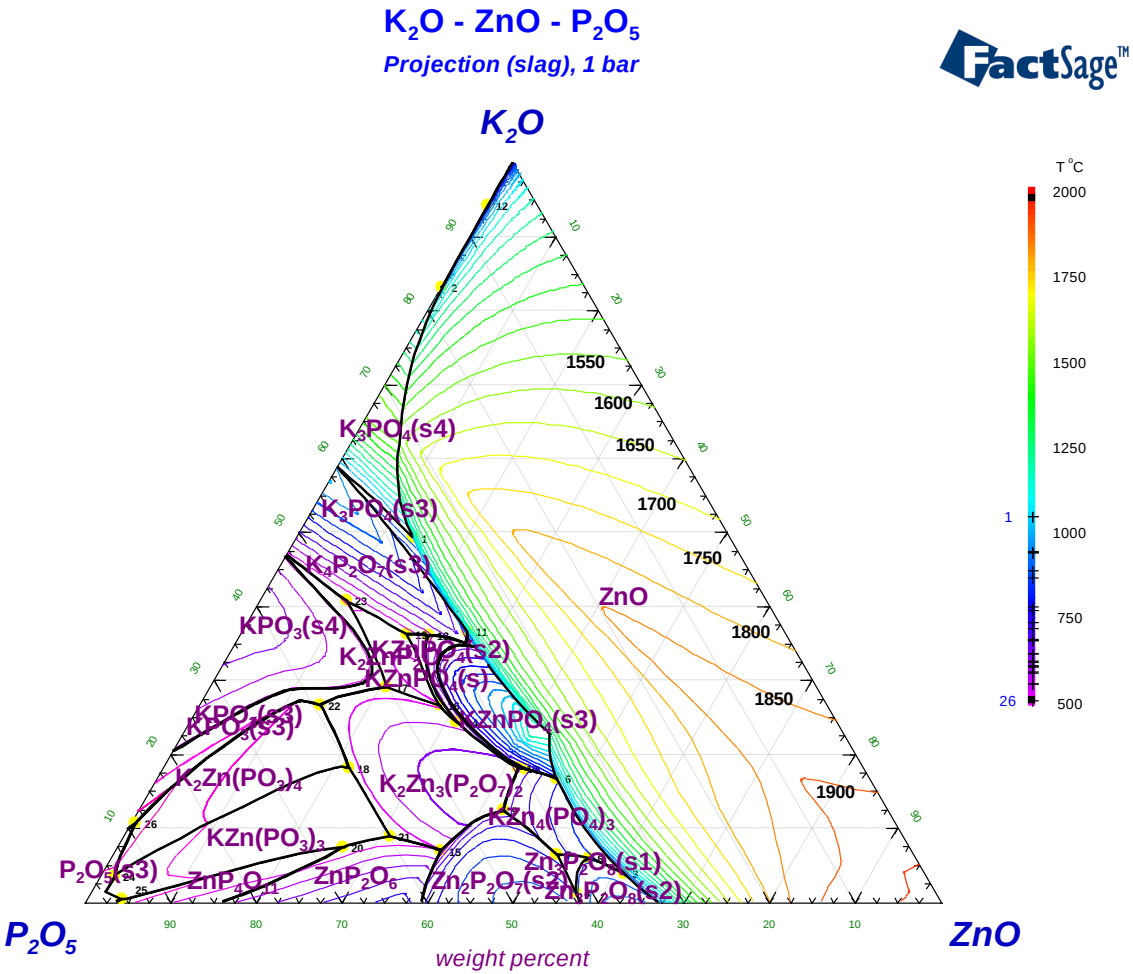

Zn2P2O7 - K2ZnP2O7
FactSage™
points from Fig.13655, Petrov [1998]
DTA, Petrov [1998]
annealing/quenching, Petrov [1998]
slag
inc Tm(E)=660°C
slag + Zn2P2O7(s2)
slag + K2Zn3(P2O7)2(s)
slag + K2ZnP2O7(s)
Zn2P2O7(s2) + K2Zn3(P2O7)2(s)
K2Zn3(P2O7)2(s) + K2ZnP2O7(s)
Zn2P2O7(s) + K2Zn3(P2O7)2(s)
F=K2Zn3(P2O7)2
E=K2ZnP2O7
T(C)
1400
1200
1000
800
600
400
200
0
0
0.2
0.4
0.6
0.8
1
K2ZnP2O7/(Zn2P2O7+K2ZnP2O7) (mol/mol)


Zn2P2O7 - K4P2O7
FactSage™
T(C)
1400
1200
1000
800
600
400
200
0
0
0.2
0.4
0.6
0.8
1
K4P2O7/(Zn2P2O7+K4P2O7) (mol/mol)
slag + Zn2P2O7(s2)
slag
slag + F
slag + K4P2O7(s3)
Zn2P2O7(s2) + F
F= K2Zn3(P2O7)2
K2ZnP2O7(s) + K4P2O7(s3)
incongr K2ZnP2O7
F + K2ZnP2O7(s)
K2ZnP2O7(s) + K4P2O7(s)
Zn2P2O7(s) + F


KPO3 - ZnP2O6
FactSage™
exp. data, Averbuch-Pouchot 1970
scanned lines, Averbuch-Pouchot 1970
points, Averbuch-Pouchot 1970
exp. data, visual method, Krivovyazov 1967
exp. data, DTA, Krivovyazov 1967
points, Krivovyazov 1967
slag
KPO3(s3) + K2Zn(PO3)4(s)
KPO3(s2) + K2Zn(PO3)4(s)
KPO3(s) + K2Zn(PO3)4(s)
A=K2Zn(PO3)4
C=KZn(PO3)3
KZn(PO3)3(s) + ZnP2O6(s)
T(C)
1000
800
600
400
200
0
0
0.2
0.4
0.6
0.8
1
ZnP2O6/(KPO3+ZnP2O6) (mol/mol)


K2O - ZnO - P2O5
Projection - formation (slag), 1 atm
FactSage™
K2O
P2O5
ZnO
mole fraction
T °C
1300
1200
1100
1000
900
800
700
600
500
K3PO4
K4P2O7
KPO3
E=K2ZnP2O7
D=KZnPO4
A=K2Zn(PO3)4
C=KZn(PO3)3
F=K2Zn3(P2O7)2
B=KZn4(PO4)3
ZnP4O11
Zn(PO3)2
Zn2P2O7
Zn3(PO4)2

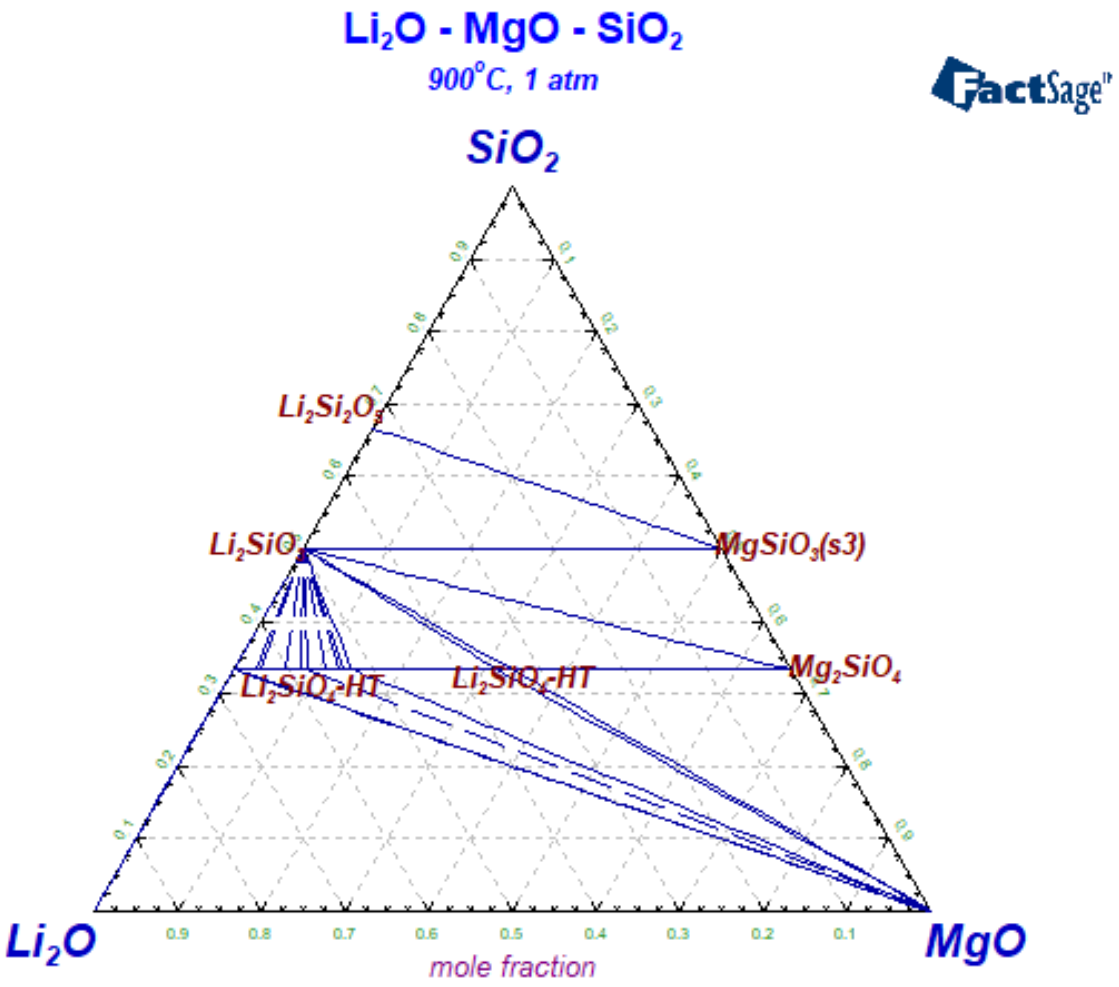

K2O - ZnO - P2O5
Projection (slag), 1 bar
FactSage™
K2O
P2O5
ZnO
mole fraction
T °C
2000
1750
1500
1250
1000
750
500
1
26
K3PO4(s3)
K3PO4(s4)
K3PO4(s3)
K4P2O7(s3)
KPO3(s4)
KZnPO4(s1)
K2ZnP2O7
KZnPO4(s3)
KZnPO4(s2)
KPO3(s3)
K2Zn(PO3)4(s)
K2Zn3(P2O7)2
KZn4(PO4)3(s)
KZn(PO3)3
Zn2P2O7(s2)
Zn3P2O8(s)
Zn3P2O8(s2)
ZnP2O6
ZnP4O11
P2O5(s3)
ZnO
1500
1600
1700
1800
1900


K2O - ZnO - P2O5
Projection (slag), 1 bar
FactSage™
K2O
P2O5
ZnO
weight percent
T °C
2000
1750
1500
1250
1000
750
500
1550
1600
1650
1700
1750
1800
1850
1900
ZnO
K4P2O7(s4)
K3PO4(s3)
K4P2O7(s3)
KPO3(s4)
KZnPO4(s2)
KZnPO4(s)
KZnPO4(s3)
KPO3(s3)
K2Zn(PO3)4
K2Zn3(P2O7)2
KZn4(PO4)3
KZn(PO3)3
P2O5(s3)
ZnP4O11
ZnP2O6
Zn2P2O7(s2)
Zn3P2O8(s1)
Zn3P2O8(s2)

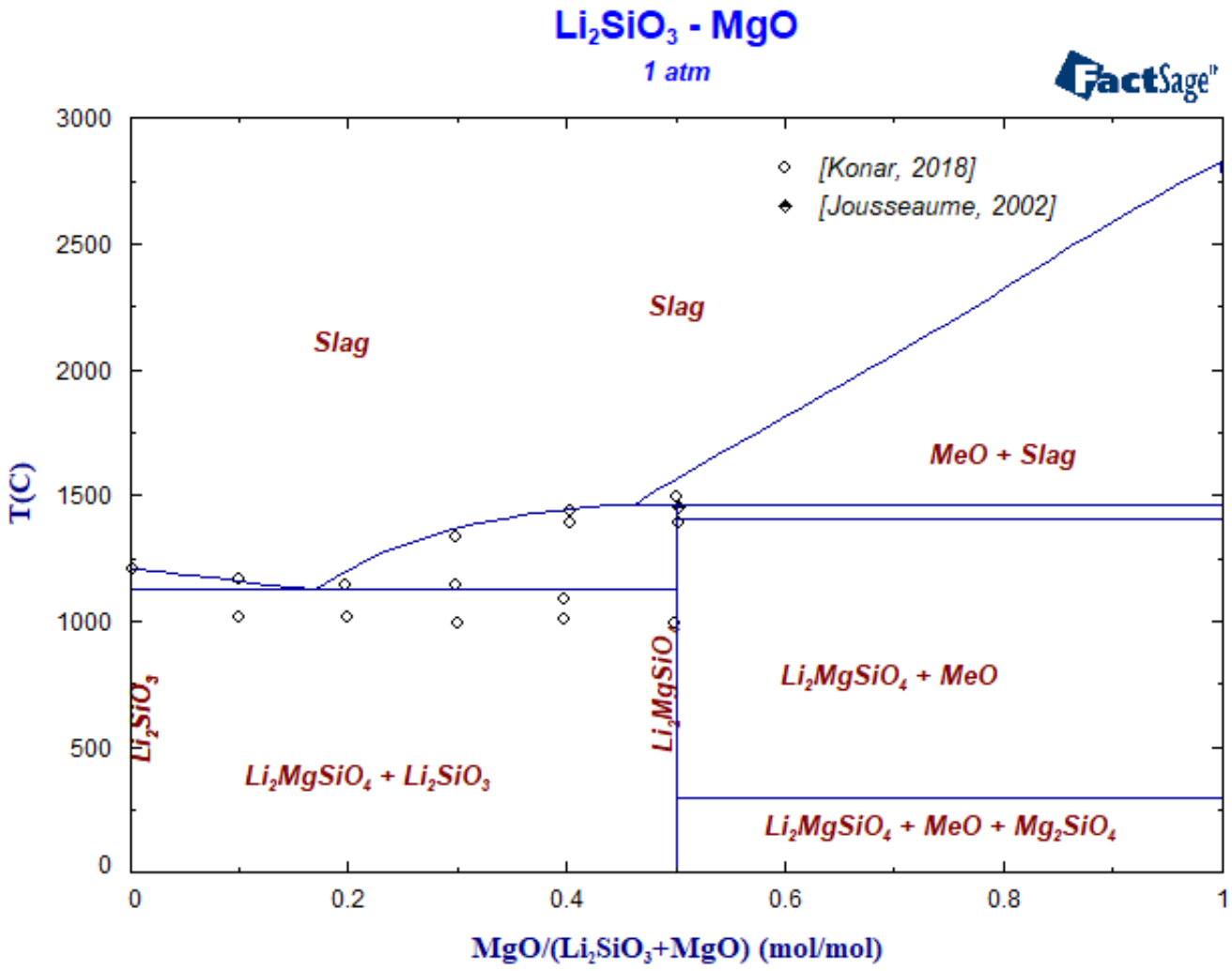
Invariant equilibria on the liquidus surface

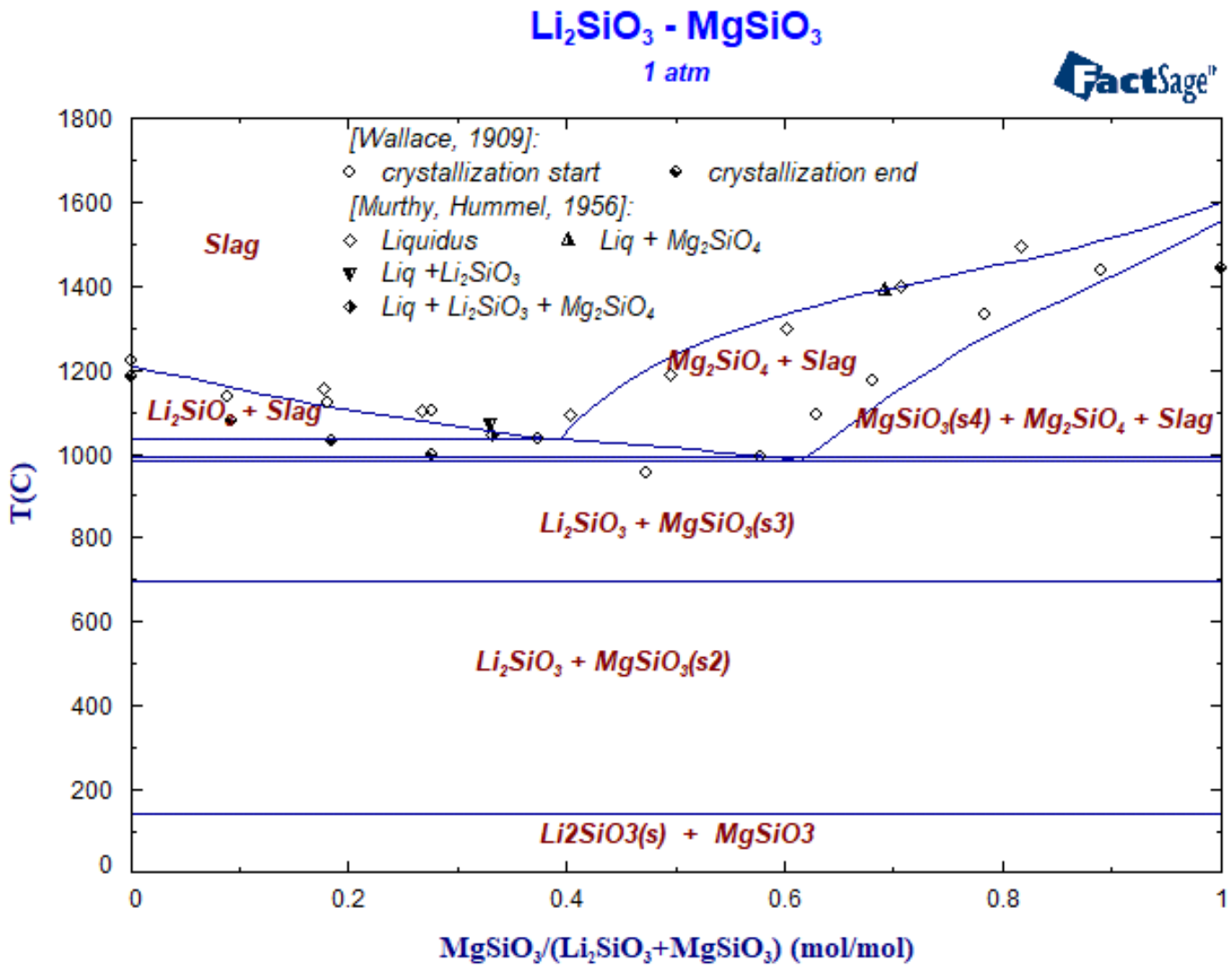
Intersections with slag	Mole fraction					Weight percent				
	A = K2O, B = P2O5, C = ZnO					A = K2O, B = P2O5, C = ZnO				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: K3PO4(s3) / K3PO4(s4) / ZnO	1:	0.54921	0.27353	0.17726	1048.10	1:	49.277	36.982	13.740	1048.10
2: K3PO4(s3) / K3PO4(s4) / ZnO	2:	0.88024	0.11683	0.00294	1048.10	2:	83.134	16.627	0.240	1048.10
3: KZn4(PO4)3 / Zn3P2O8(s2) / ZnO	3:	0.03835	0.23754	0.72411	946.26	3:	3.753	35.028	61.219	946.26
4: Zn2P2O7(s2) / Zn3P2O8(s) / Zn3P2O8(s2)	4:	0.01541	0.29338	0.69121	941.85	4:	1.462	41.917	56.621	941.85
5: KZn4(PO4)3 / Zn3P2O8(s) / Zn3P2O8(s2)	5:	0.06154	0.26283	0.67563	941.85	5:	5.910	38.035	56.055	941.85
6: KZn4(PO4)3 / KZnPO4_HT(s3) / ZnO	6:	0.17625	0.25494	0.56881	888.98	6:	16.756	36.524	46.720	888.99
7: KZn4(PO4)3 / Zn2P2O7(s2) / Zn3P2O8(s)	7:	0.06794	0.29328	0.63878	867.87	7:	6.399	41.625	51.977	867.87
8: KZn4(PO4)3 / KZnPO4_HT(s3) / KZnPO4_MT(s2)	8:	0.19299	0.28015	0.52686	783.00	8:	18.031	39.442	42.527	783.04
9: K2Zn3(P2O7)2 / KZn4(PO4)3 / Zn2P2O7(s2)	9:	0.13521	0.32513	0.53965	774.25	9:	12.389	44.892	42.719	774.25
10: K2Zn3(P2O7)2 / KZn4(PO4)3 / KZnPO4_MT(s2)	10:	0.19504	0.28742	0.51754	738.95	10:	18.139	40.279	41.582	738.81
11: K3PO4(s3) / K4P2O7_HT(s3) / KZnPO4_MT(s2)	11:	0.39841	0.26823	0.33335	720.10	11:	36.531	37.062	26.407	720.11
12: K2O(s3) / K3PO4(s3) / ZnO	12:	0.96131	0.03864	0.00005	689.43	12:	94.284	5.711	0.004	689.43
13: K4P2O7(s3) / KZnPO4_LT(s) /KZnPO4_MT(s2)	13:	0.40354	0.31039	0.28607	683.50	13:	36.081	41.821	22.098	683.08
14: K2Zn3(P2O7)2 / KZnPO4_LT(s)/KZnPO4_MT(s2)	14:	0.27026	0.32679	0.40294	683.00	14:	24.330	44.331	31.338	683.00
15: K2Zn3(P2O7)2 / Zn2P2O7(s2) / ZnP2O6	15:	0.07985	0.41577	0.50438	646.81	15:	6.992	54.856	38.153	646.81
16: K2Zn3(P2O7)2 / K2ZnP2O7 / KZnPO4_LT(s)	16:	0.29784	0.33731	0.36486	645.69	16:	26.561	45.329	28.110	645.69
17: K2Zn3(P2O7)2 / K2ZnP2O7 / KPO3(s3)	17:	0.33653	0.38509	0.27838	623.47	17:	29.078	50.141	20.781	623.47
18: K2Zn(PO3)4 / K2Zn3(P2O7)2 / KZn(PO3)3	18:	0.21872	0.47918	0.30210	619.36	18:	18.199	60.084	21.717	619.36
19: K2ZnP2O7 / K4P2O7_HT(s3) / KZnPO4_LT(s)	19:	0.41002	0.33280	0.25718	611.64	19:	36.166	44.235	19.598	611.67
20: KZn(PO3)3 / ZnP2O6(s) / ZnP4O11	20:	0.09093	0.53539	0.37367	609.87	20:	7.450	66.100	26.450	609.87
21: K2Zn3(P2O7)2 / KZn(PO3)3 / ZnP2O6(s)	21:	0.10450	0.46919	0.42631	607.68	21:	8.857	59.926	31.217	607.70
22: K2Zn(PO3)4 / K2Zn3(P2O7)2 / KPO3(s3)	22:	0.32398	0.47652	0.19950	593.22	22:	26.678	59.129	14.192	593.21
23: K2ZnP2O7 / K4P2O7_HT(s3) / KPO3(s3)	23:	0.47833	0.38219	0.13947	587.84	23:	40.718	49.025	10.257	587.84
24: K2Zn(PO3)4 / KZn(PO3)3 / P2O5(s3)	24:	0.05167	0.91967	0.02866	557.83	24:	3.533	94.773	1.694	557.83
25: KZn(PO3)3 / P2O5_O'-Phase(s3) / ZnP4O11_S1(s)	25:	0.00513	0.92555	0.06932	555.85	25:	0.352	95.546	4.103	555.85
26: K2Zn(PO3)4_S1(s) / KPO3(s3) / P2O5(s3)	26:	0.15250	0.83760	0.00990	508.00	26:	10.715	88.684	0.601	508.00

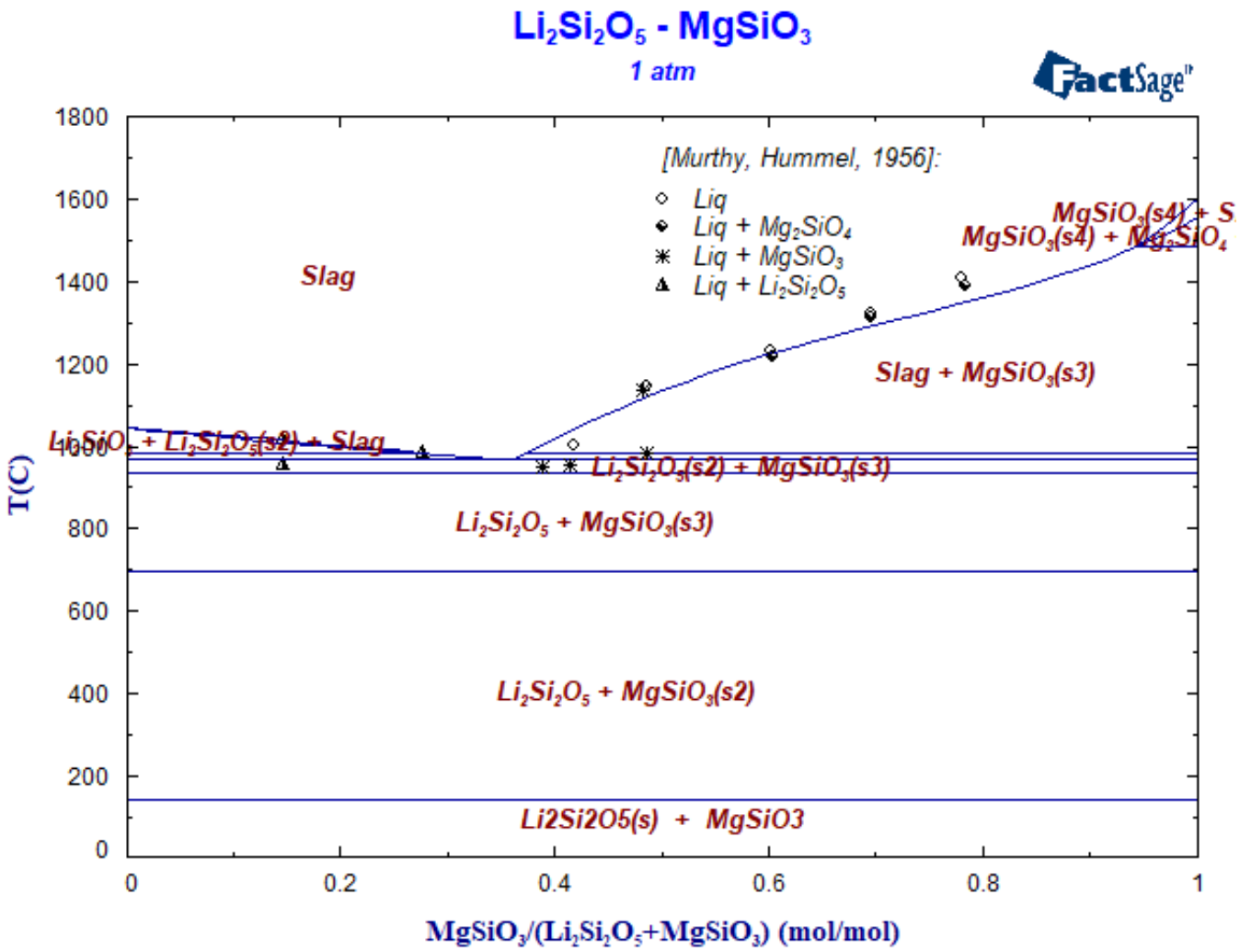
Li2O-MgO-SiO2, Mole fraction, 900°C

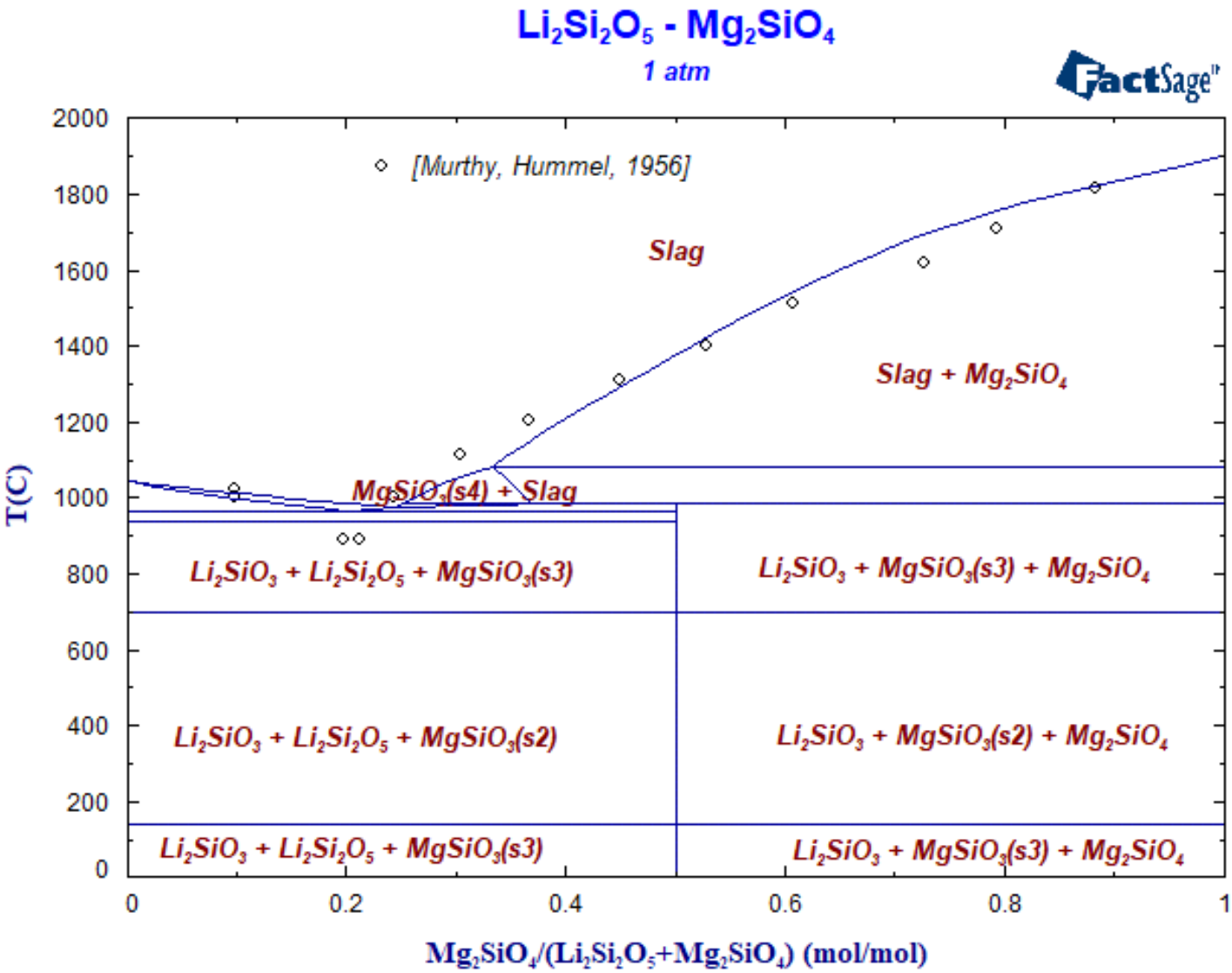


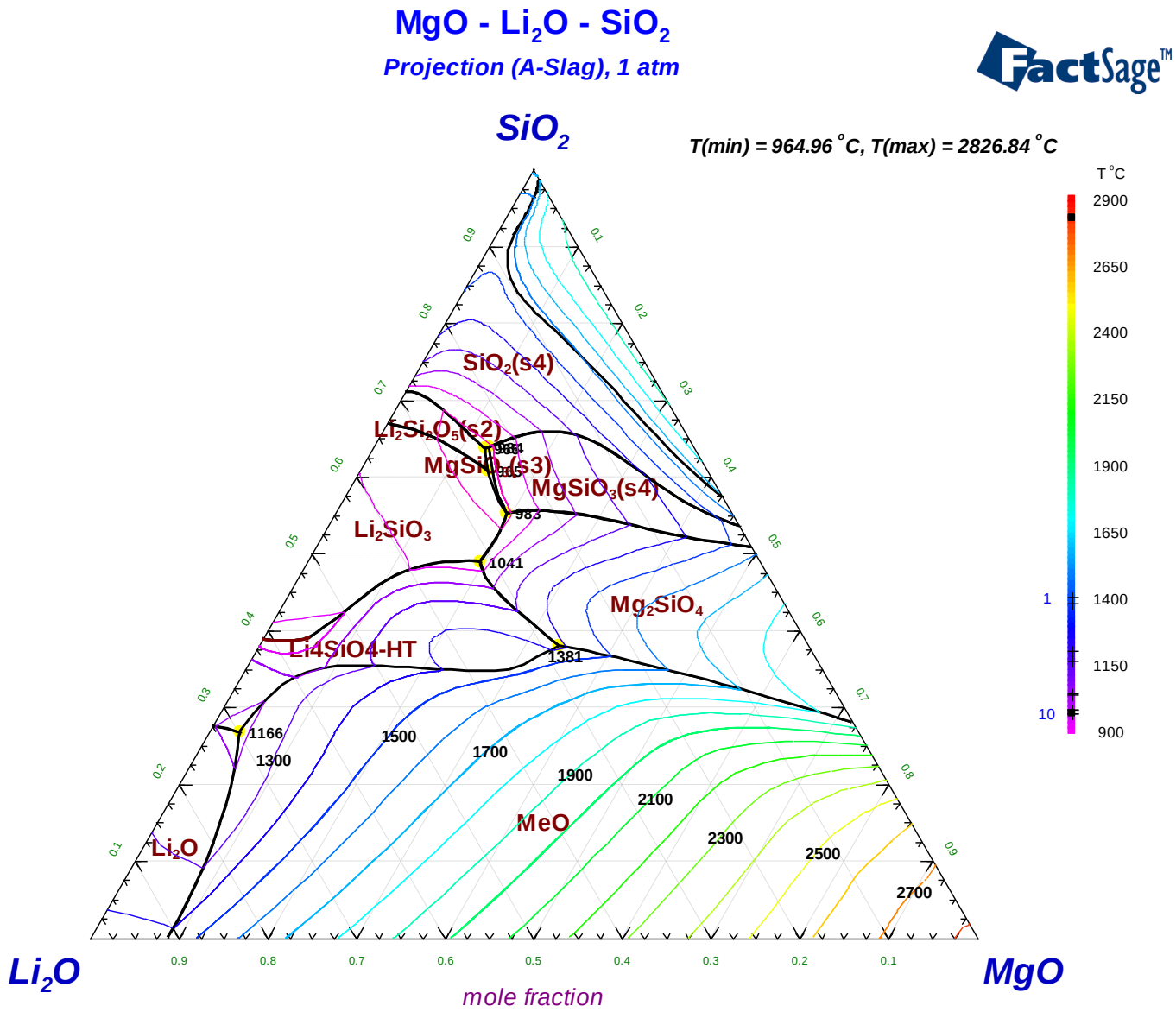
Slag	(MgO, Li_2O, SiO_2, Li_2SiO_3, Li_2SiO_3, $Li_2Si_2O_5$, $MgSiO_3$, Mg_2SiO_4, Li_2MgSiO_4)	This work
Li_4SiO_4-HT	$(Li_2^{+2})(Li_2^{+2}, Mg^{+2})(SiO_4^{-2})$	[Konar2018]
Li_2MgSiO_4	stoichiometric	[Konar2018]

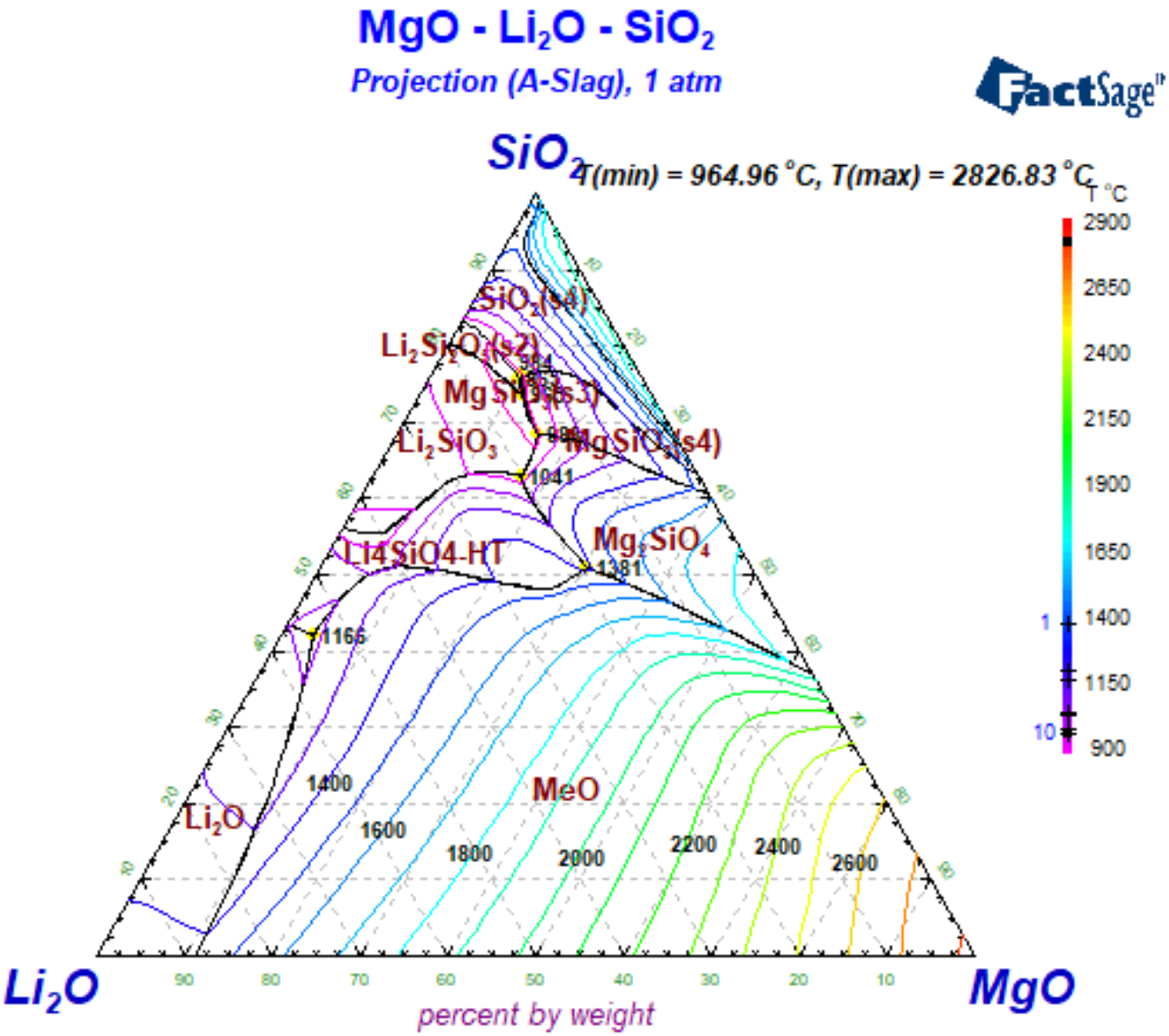

Li2SiO3 - MgO
1 atm
FactSage
[Konar, 2018]
[Jousseaume, 2002]
Slag
Slag
MeO + Slag
Li2MgSiO4 + MeO
Li2MgSiO4 + Li2SiO3
Li2MgSiO4 + MeO + Mg2SiO4
Li2SiO3
Li2MgSiO4
T(C)
3000
2500
2000
1500
1000
500
0
0
0.2
0.4
0.6
0.8
1
MgO/(Li2SiO3+MgO) (mol/mol)


Li2SiO3 - MgSiO3
1 atm
FactSage
[Wallace, 1909]:
crystallization start
crystallization end
[Murthy, Hummel, 1956]:
Liquidus
Liq + Mg2SiO4
Liq +Li2SiO3
Liq + Li2SiO3 + Mg2SiO4
Slag
Mg2SiO4 + Slag
Li2SiO3 + Slag
MgSiO3(s4) + Mg2SiO4 + Slag
Li2SiO3 + MgSiO3(s3)
Li2SiO3 + MgSiO3(s2)
Li2SiO3(s) + MgSiO3
T(C)
1800
1600
1400
1200
1000
800
600
400
200
0
0
0.2
0.4
0.6
0.8
1
MgSiO3/(Li2SiO3+MgSiO3) (mol/mol)


Li2Si2O5 - MgSiO3
1 atm
FactSage
[Murthy, Hummel, 1956]:
Liq
Liq + Mg2SiO4
Liq + MgSiO3
Liq + Li2Si2O5
Slag
MgSiO3(s4) + S
MgSiO3(s4) + Mg2SiO4
Slag + MgSiO3(s3)
Li2SiO3 + Li2Si2O5(s2) + Slag
Li2Si2O5(s2) + MgSiO3(s3)
Li2Si2O5 + MgSiO3(s3)
Li2Si2O5 + MgSiO3(s2)
Li2Si2O5(s) + MgSiO3
T(C)
1800
1600
1400
1200
1000
800
600
400
200
0
0
0.2
0.4
0.6
0.8
1
MgSiO3/(Li2Si2O5+MgSiO3) (mol/mol)


Li2Si2O5 - Mg2SiO4
1 atm
FactSage
[Murthy, Hummel, 1956]
Slag
Slag + Mg2SiO4
MgSiO3(s4) + Slag
Li2SiO3 + Li2Si2O5 + MgSiO3(s3)
Li2SiO3 + MgSiO3(s3) + Mg2SiO4
Li2SiO3 + Li2Si2O5 + MgSiO3(s2)
Li2SiO3 + MgSiO3(s2) + Mg2SiO4
Li2SiO3 + Li2Si2O5 + MgSiO3(s3)
Li2SiO3 + MgSiO3(s3) + Mg2SiO4
T(C)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
0.2
0.4
0.6
0.8
1
Mg2SiO4/(Li2Si2O5+Mg2SiO4) (mol/mol)

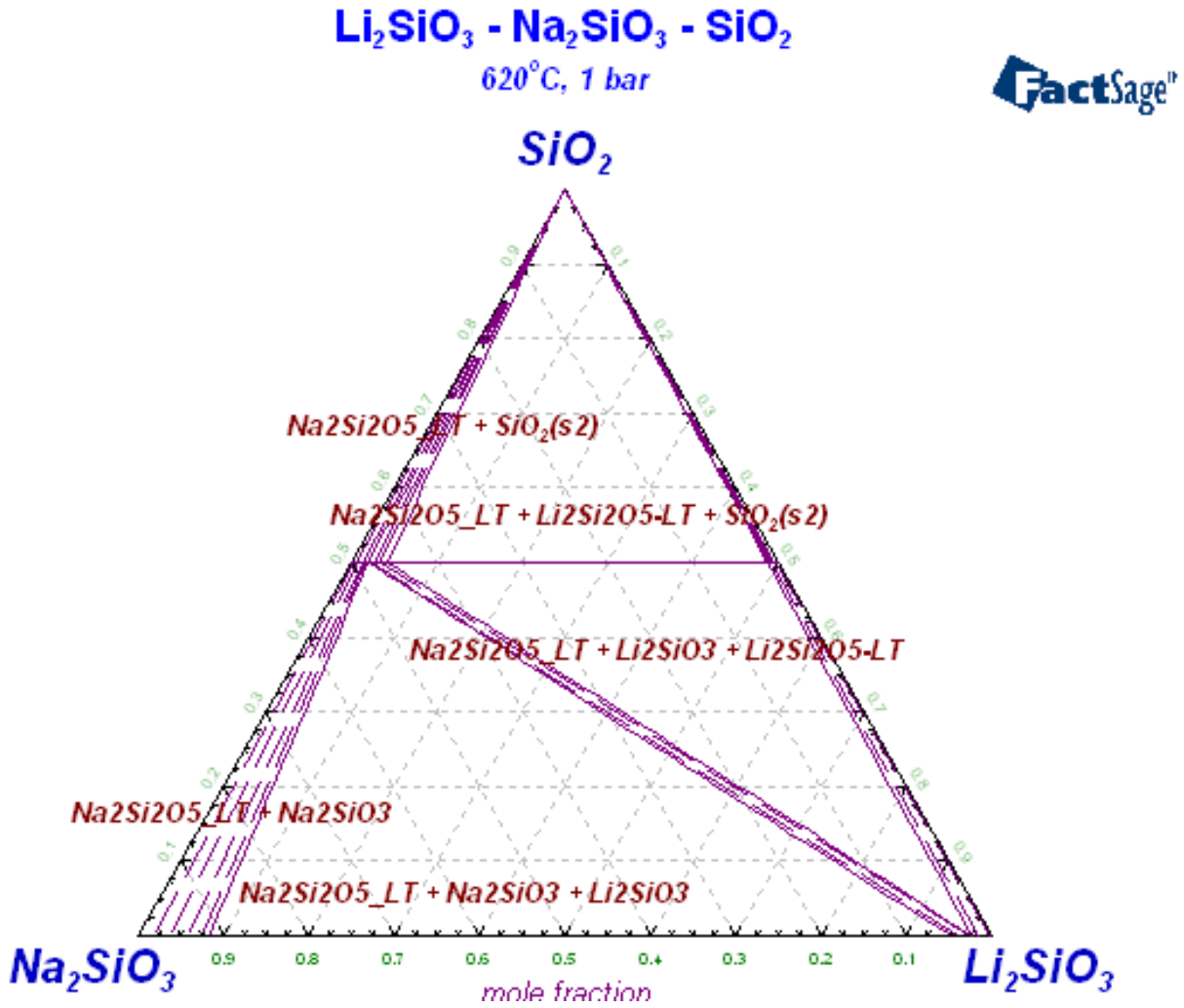

MgO - Li2O - SiO2
Projection (A-Slag), 1 atm
FactSage™
SiO2
T(min) = 964.96 °C, T(max) = 2826.84 °C
T °C
2900
2650
2400
2150
1900
1650
1400
1150
900
1
10
SiO2(s4)
Li2Si2O5(s2)
MgSiO3(s3)
MgSiO3(s4)
Li2SiO3
Mg2SiO4
Li4SiO4-HT
MeO
Li2O
1041
983
1381
1166
1300
1500
1700
1900
2100
2300
2500
2700
Li2O
MgO
mole fraction

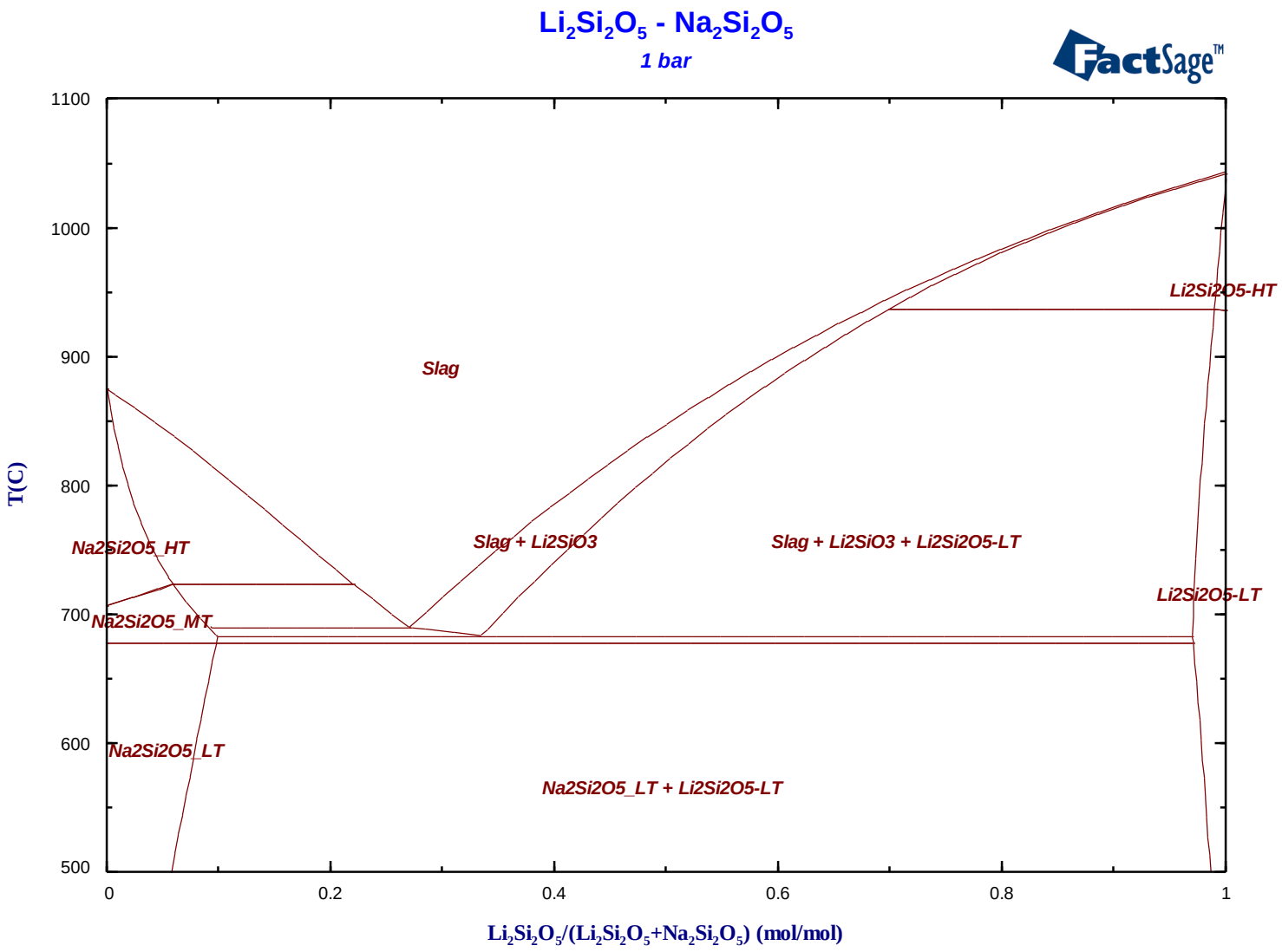

MgO - Li2O - SiO2
Projection (A-Slag), 1 atm
FactSage
SiO2
T(min) = 964.96 °C, T(max) = 2826.83 °C
T °C
2900
2850
2400
2150
1900
1650
1400
1150
900
SiO2(s4)
Li2Si2O5(s2)
Mg2SiO4(s3)
Li2SiO3
Mg2SiO4(s4)
1041
Li4SiO4-HT
Mg2SiO4
1381
1166
1400
1600
1800
2000
2200
2400
2600
MeO
Li2O
Li2O
MgO
percent by weight

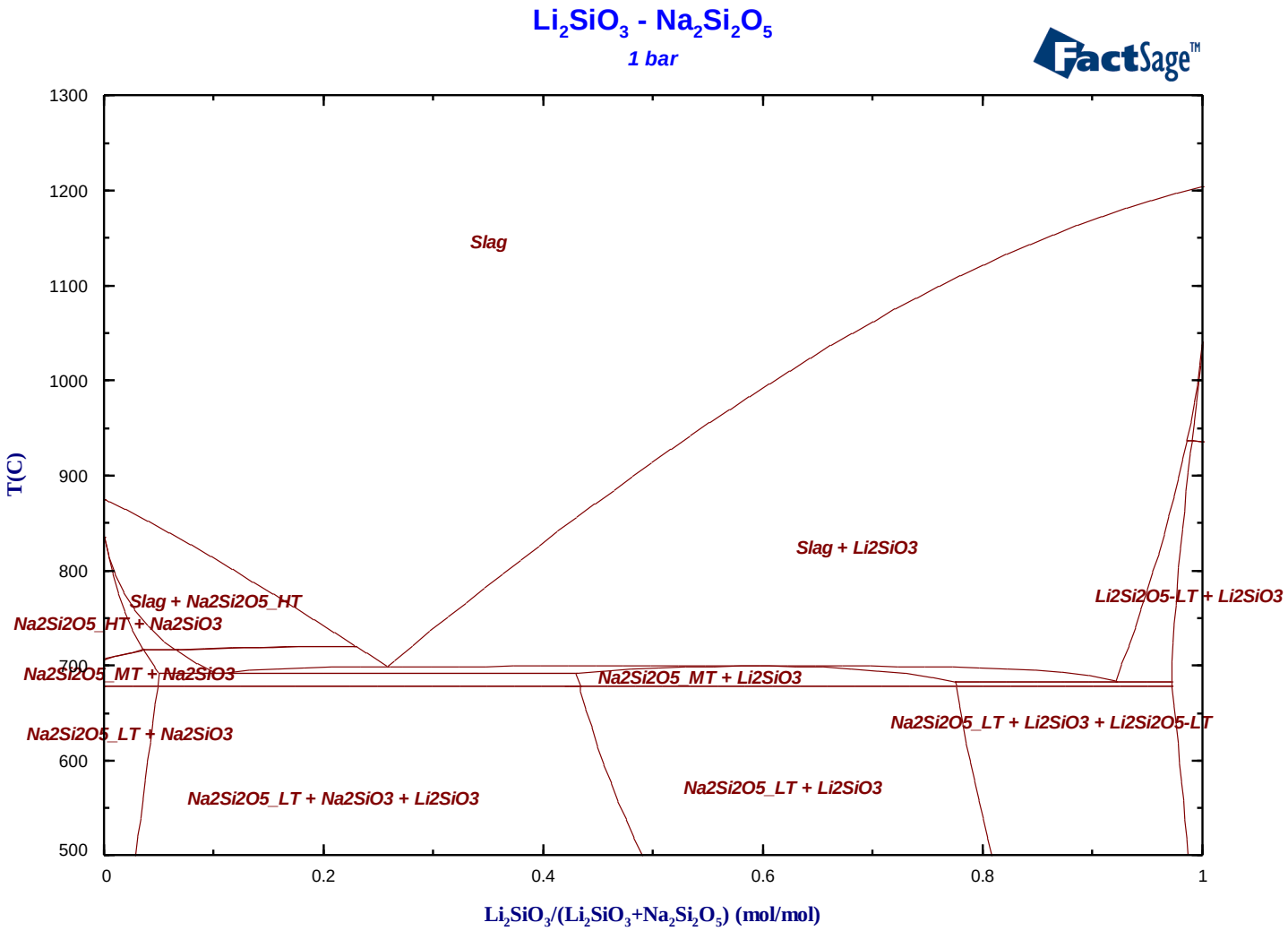
Invariant equilibria on the liquidus surface

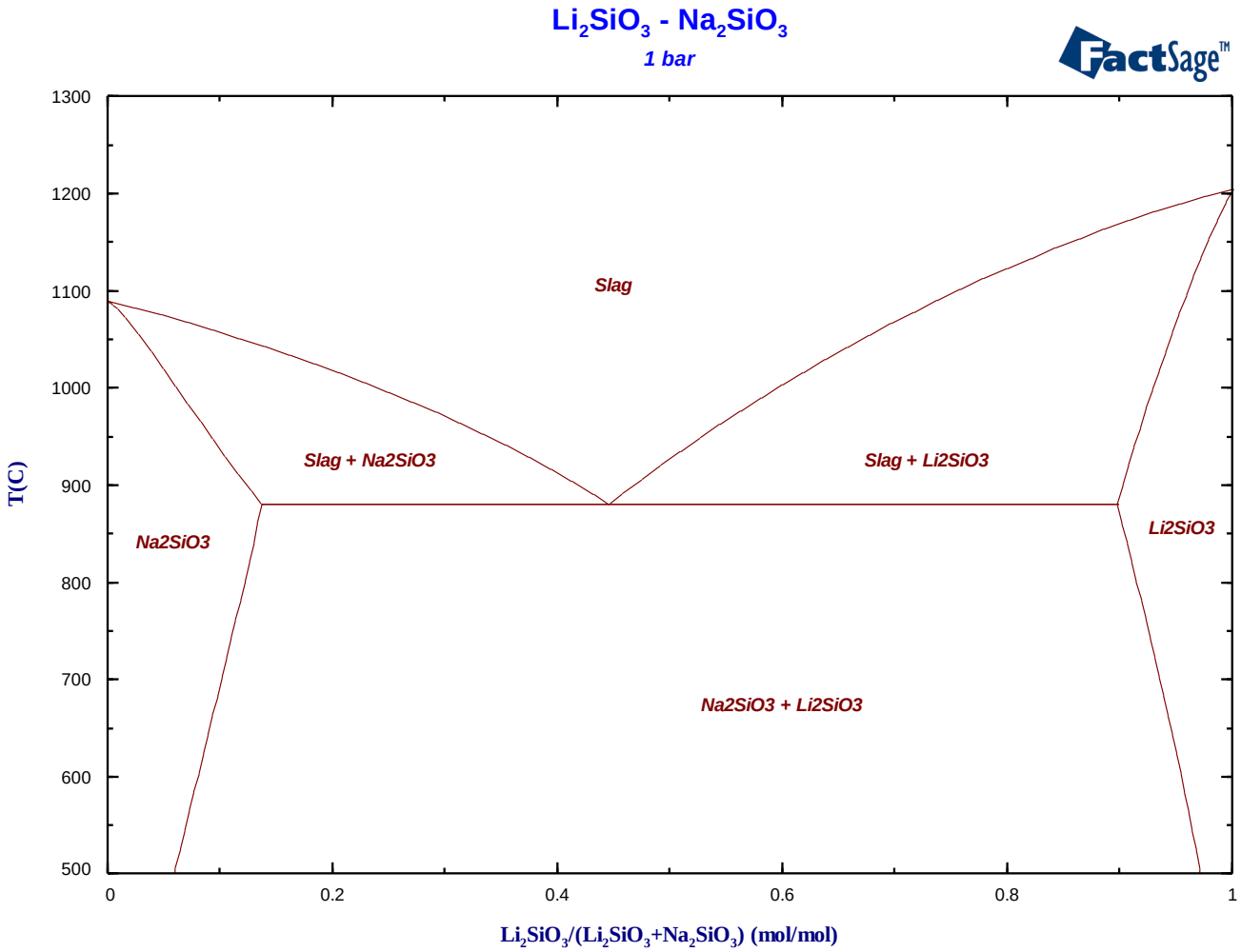
Intersections with slag	Mole fraction				Weight percent			
	A = SiO2, B = Li2O, C = MgO				A = SiO2, B = Li2O, C = MgO			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1. Li4SiO4-HT / Mg2SiO4 / MeO	0.37969	0.28068	0.33963	1380.97	50.821	18.684	30.495	1380.97
2. Li2O / Li4SiO4-HT / MeO	0.26778	0.69755	0.03467	1165.60	41.975	54.379	3.646	1165.60
3. Li2SiO3/ Li4SiO4-HT / Mg2SiO4	0.49012	0.31498	0.19491	1041.33	63.037	20.147	16.816	1041.33
4. MgSiO3(s3) / MgSiO3(s4) / SiO2(s4)	0.63904	0.23052	0.13044	983.56	75.969	13.629	10.402	983.59
5. Li2SiO3 / Mg2SiO4 / MgSiO3(s3)	0.55275	0.25376	0.19349	982.70	68.347	15.604	16.049	982.70
6. Li2Si2O5(s2) / Li2SiO3 / MgSiO3(s3)	0.60895	0.24736	0.14369	965.08	73.513	14.851	11.636	965.08
7. Li2Si2O5(s2) / MgSiO3(s3) / SiO2(s4)	0.63711	0.23632	0.12657	964.96	75.888	13.999	10.113	964.96

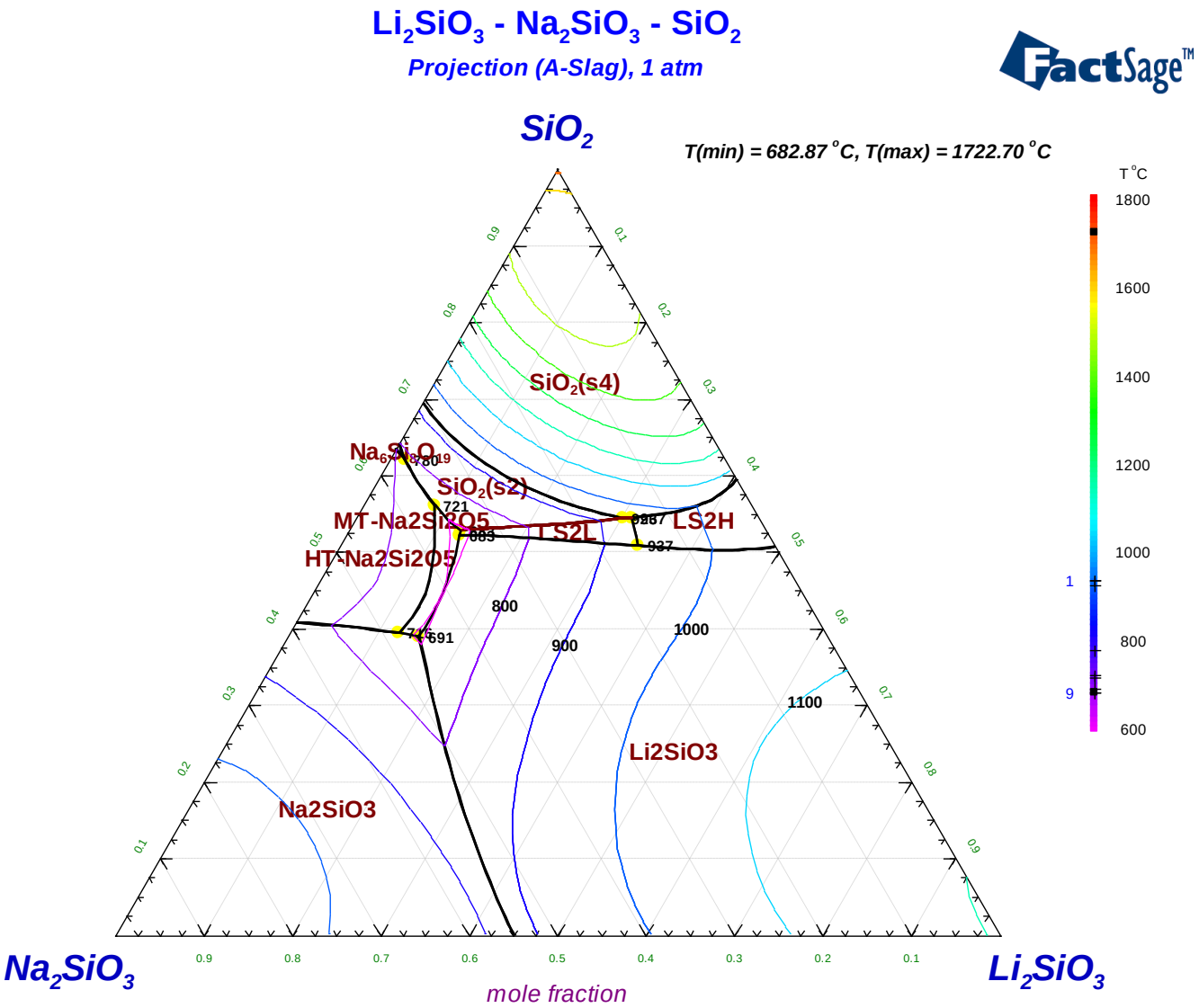
Li2O-Na2O-SiO2, Mole fraction, 620°C

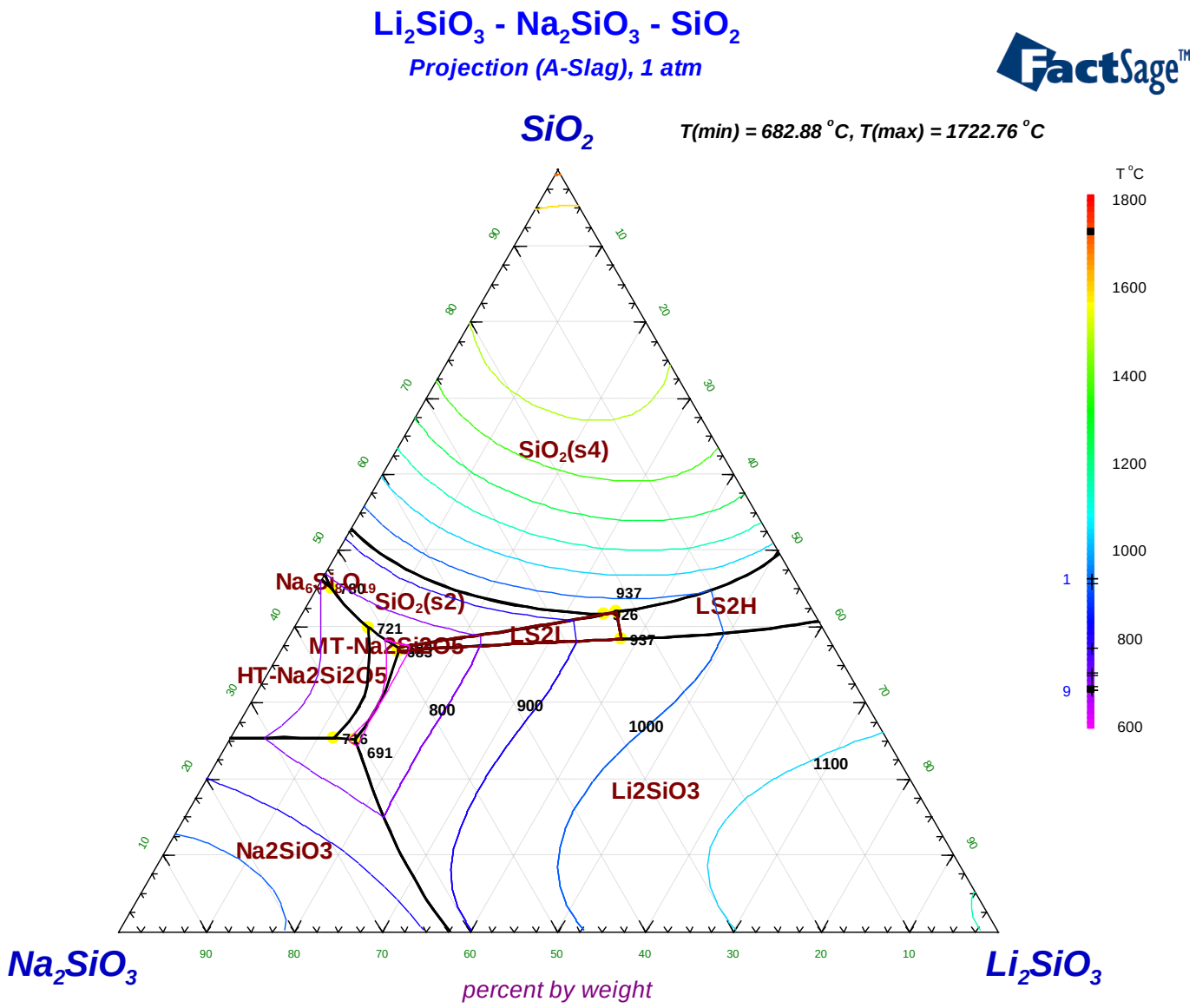



$Li_2Si_2O_5$ - $Na_2Si_2O_5$
1 bar
FactSage™
1100
1000
900
800
700
600
500
T(C)
Slag
Li2Si2O5-HT
Na2Si2O5_HT
Slag + Li2SiO3
Slag + Li2SiO3 + Li2Si2O5-LT
Li2Si2O5-LT
Na2Si2O5_MT
Na2Si2O5_LT
Na2Si2O5_LT + Li2Si2O5-LT
0
0.2
0.4
0.6
0.8
1
$Li_2Si_2O_5/(Li_2Si_2O_5+Na_2Si_2O_5)$ (mol/mol)


Li2SiO3 - Na2Si2O5
1 bar
FactSage™
T(C)
1300
1200
1100
1000
900
800
700
600
500
0
0.2
0.4
0.6
0.8
1
Li2SiO3/(Li2SiO3+Na2Si2O5) (mol/mol)
Slag
Slag + Li2SiO3
Slag + Na2Si2O5_HT
Na2Si2O5_HT + Na2SiO3
Li2Si2O5-LT + Li2SiO3
Na2Si2O5_MT + Na2SiO3
Na2Si2O5_MT + Li2SiO3
Na2Si2O5_LT + Na2SiO3
Na2Si2O5_LT + Li2SiO3 + Li2Si2O5-LT
Na2Si2O5_LT + Na2SiO3 + Li2SiO3
Na2Si2O5_LT + Li2SiO3


Li2SiO3 - Na2SiO3
1 bar
FactSage™
Slag
Slag + Na2SiO3
Slag + Li2SiO3
Na2SiO3
Li2SiO3
Na2SiO3 + Li2SiO3
T(C)
1300
1200
1100
1000
900
800
700
600
500
0
0.2
0.4
0.6
0.8
1
Li2SiO3/(Li2SiO3+Na2SiO3) (mol/mol)


Li2SiO3 - Na2SiO3 - SiO2
Projection (A-Slag), 1 atm
FactSage™
SiO2
T(min) = 682.87 °C, T(max) = 1722.70 °C
T °C
1800
1600
1400
1200
1000
800
600
SiO2(s4)
Na6Si8O19
SiO2(s2)
MT-Na2Si2O5
HT-Na2Si2O5
LS2L
LS2H
721
683
937
691
800
900
1000
1100
Li2SiO3
Na2SiO3
Na2SiO3
Li2SiO3
mole fraction

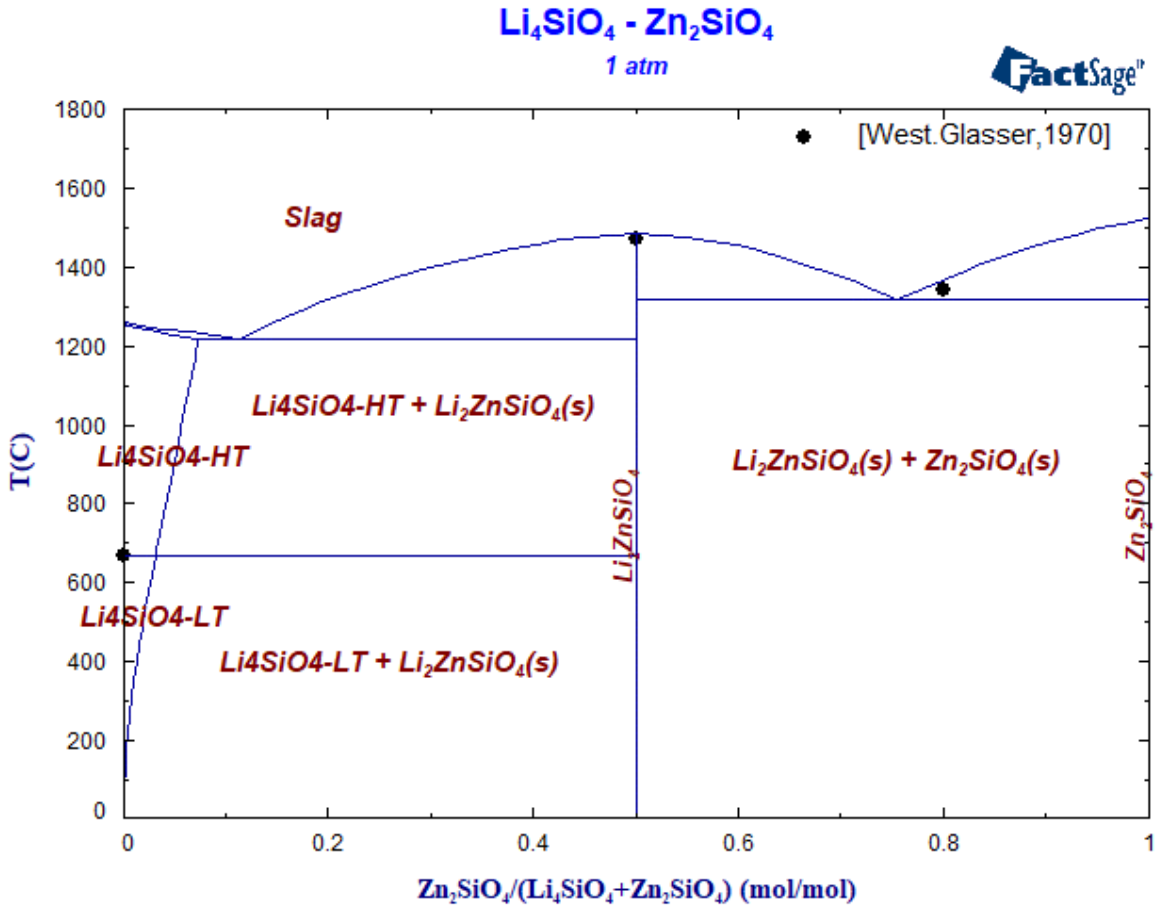

Li2SiO3 - Na2SiO3 - SiO2
Projection (A-Slag), 1 atm
FactSage™
SiO2
T(min) = 682.88 °C, T(max) = 1722.76 °C
T °C
1800
1600
1400
1200
1000
800
600
SiO2(s4)
SiO2(s2)
LS2H
LS2L
MT-Na2Si2O5
HT-Na2Si2O5
Li2SiO3
Na2SiO3
937
926
721
716
691
800
900
1000
1100
Na2SiO3
Li2SiO3
percent by weight

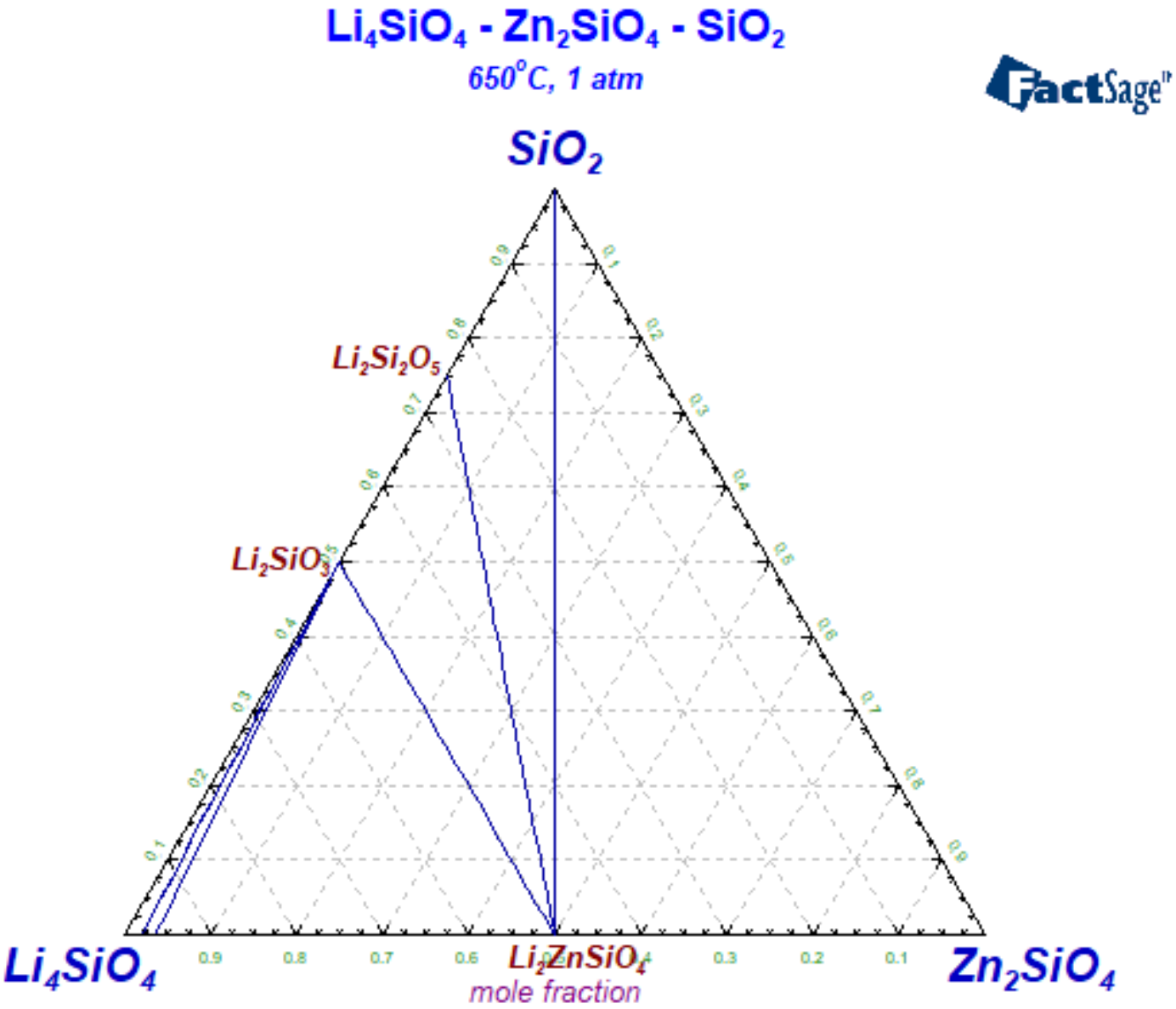
Invariant equilibria on the liquidus surface

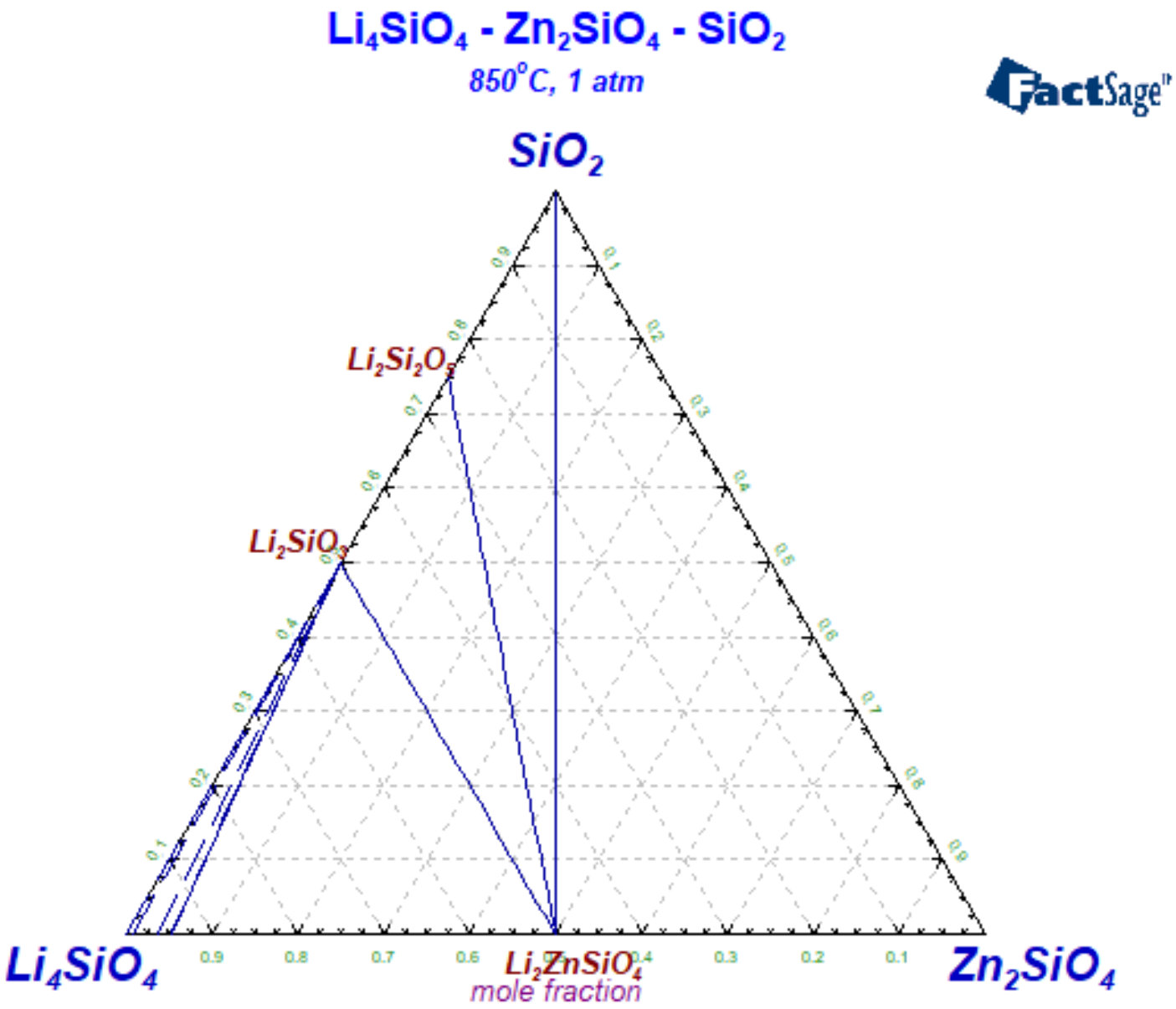
Intersections with slag	Mole fraction				Weight percent			
	A = SiO2, B = Na2SiO3, C = Li2SiO3				A = SiO2, B = Na2SiO3, C = Li2SiO3			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1. LS2H / LS2L / Li2SiO3	0.50832	0.15421	0.33747	936.52	38.309	23.611	38.081	936.51
2. LS2H / LS2L / SiO2_cristobalite_be(s4)	0.54523	0.14305	0.31172	936.51	41.857	22.311	35.832	936.51
3. LS2L / SiO2(s4) / SiO2_quartz_beta(s2)	0.54437	0.15402	0.30161	926.30	41.591	23.905	34.504	926.29
4. HT-Na2Si2O5 / Na6Si8O19 / SiO2(s2)	0.62200	0.36188	0.01612	779.90	45.030	53.223	1.747	779.92
5. HT-Na2Si2O5 / MT-Na2Si2O5 / SiO2(s2)	0.56128	0.35782	0.08090	721.47	39.825	51.579	8.596	721.46
6. HT-Na2Si2O5 / MT-Na2Si2O5 / Na2SiO3	0.39438	0.48254	0.12308	716.19	25.298	62.882	11.821	716.18
7. Li2SiO3 / MT-Na2Si2O5 / Na2SiO3	0.38928	0.46207	0.14864	690.90	25.106	60.540	14.354	690.91
8. LS2L / Li2SiO3 / MT-Na2Si2O5	0.52258	0.34890	0.12852	683.41	36.703	49.782	13.515	683.41
9. LS2L / MT-Na2Si2O5 / SiO2(s2)	0.52859	0.34572	0.12569	682.87	37.248	49.491	13.261	682.88

Li2O-SiO2-ZnO, Mole fraction, Isopleth Li4SiO4-Zn2SiO4

Note the strong simplification, that was necessary for the center composition range because of missing thermochemical information.

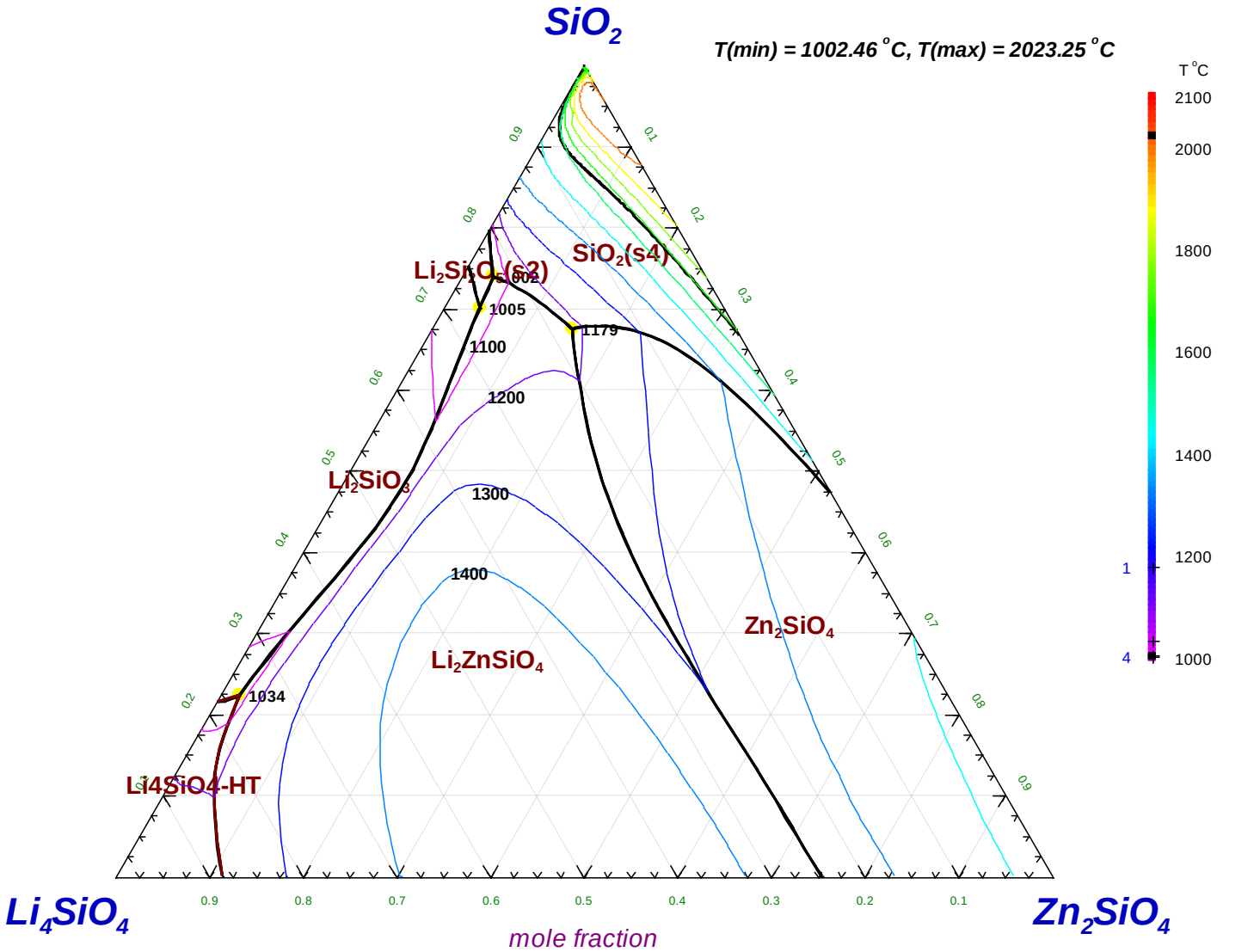



Li_4SiO_4 - Zn_2SiO_4 - SiO_2
650°C, 1 atm
FactSage
SiO_2
$Li_2Si_2O_5$
Li_2SiO_3
Li_4SiO_4
Li_2ZnSiO_4
Zn_2SiO_4
mole fraction


Li4SiO4 - Zn2SiO4 - SiO2
850°C, 1 atm
FactSage
SiO2
Li2Si2O5
Li2SiO3
Li4SiO4
Li2ZnSiO4
Zn2SiO4
mole fraction

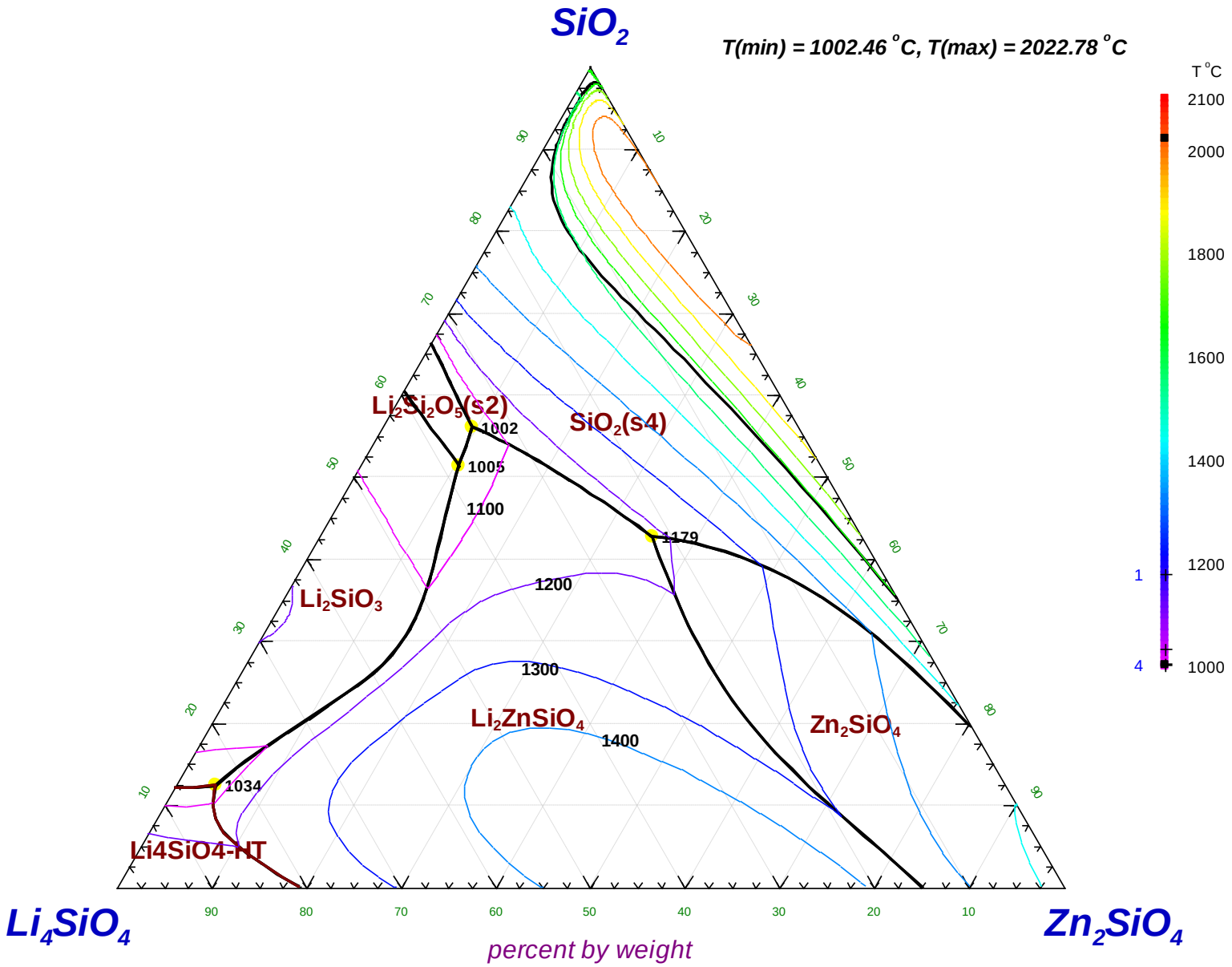
Li_4SiO_4 - Zn_2SiO_4 - SiO_2

Projection (A-Slag), 1 atm



Li_4SiO_4 - Zn_2SiO_4 - SiO_2

Projection (A-Slag), 1 atm

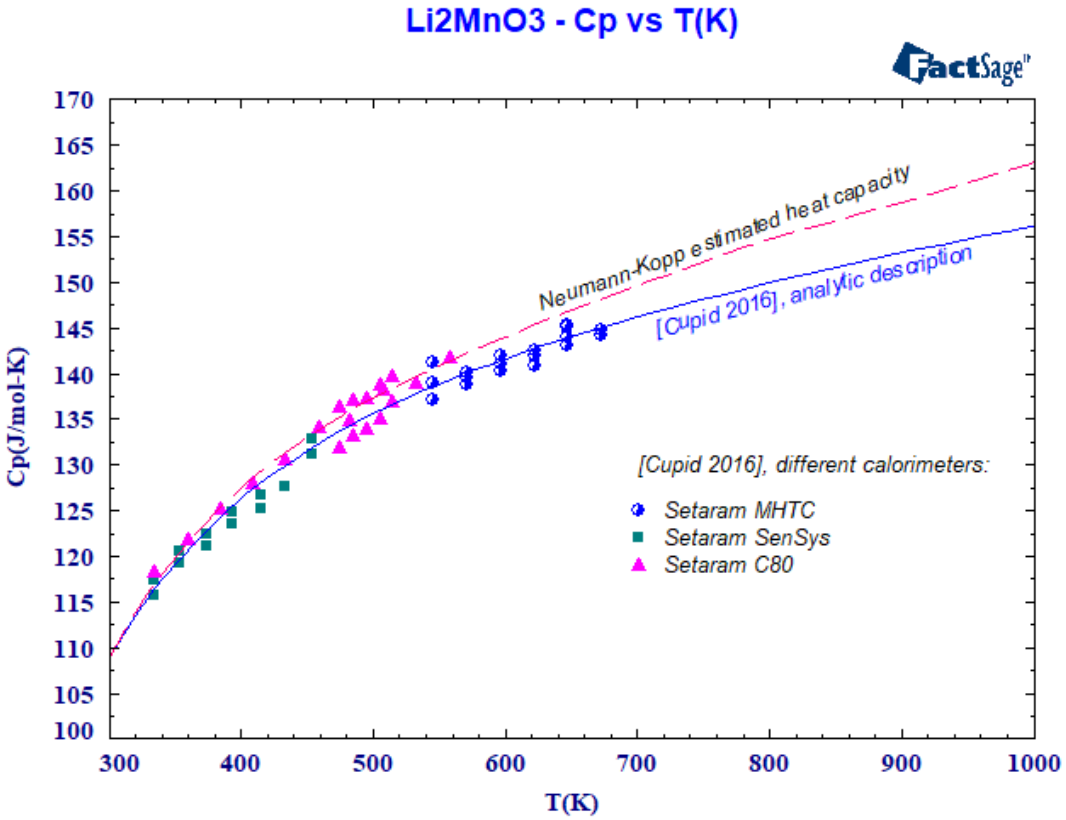


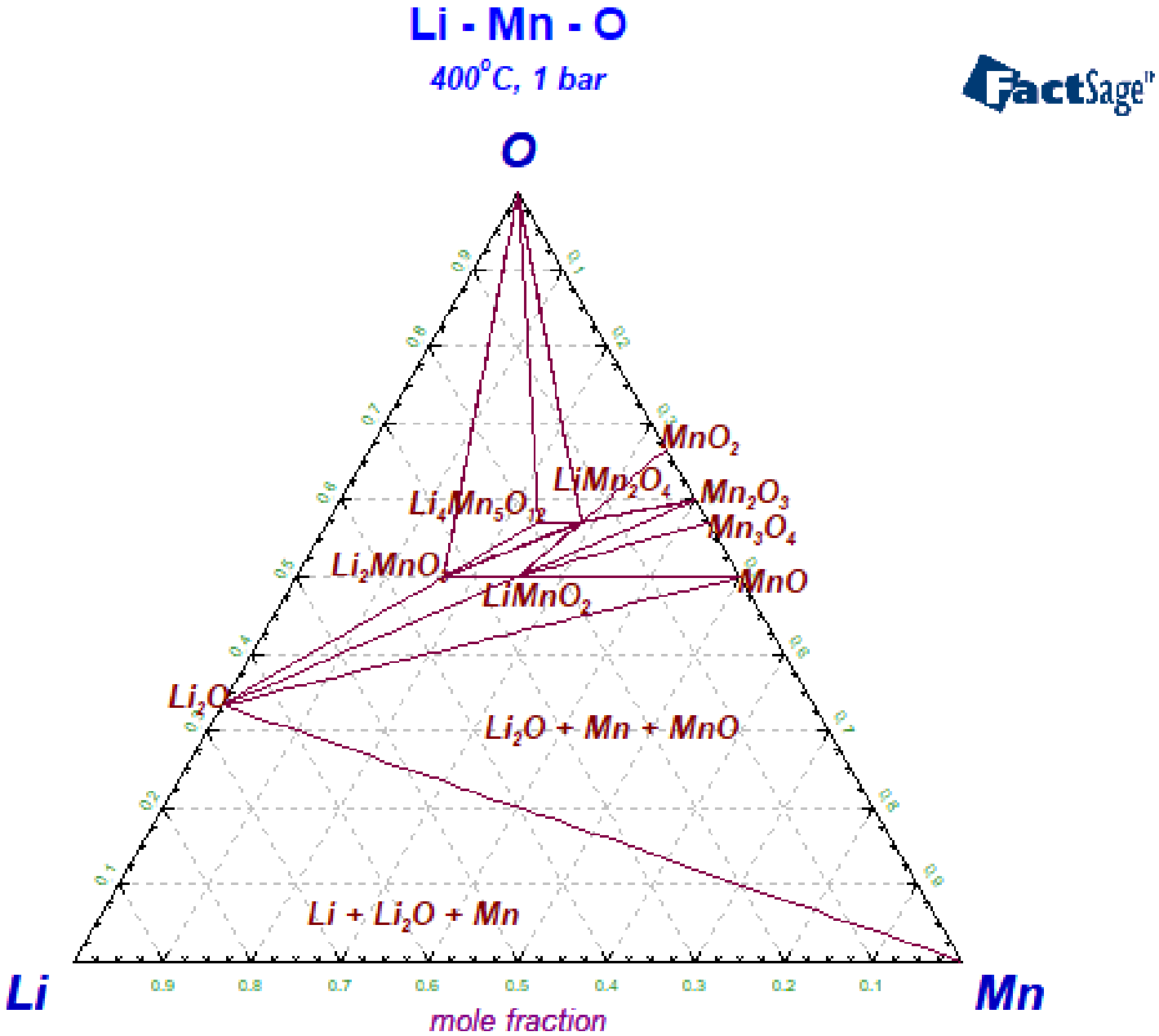
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction				Weight percent			
	A = SiO2, B = Li4SiO4, C = Zn2SiO4				A = SiO2, B = Li4SiO4, C = Zn2SiO4			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1. Li2ZnSiO4 / SiO2(s4) / Zn2SiO4	0.67558	0.17490	0.14952	1178.53	42.785	22.094	35.121	1178.54
2. Li2SiO3 / Li2ZnSiO4 / Li4SiO4-HT	0.22445	0.75511	0.02044	1034.23	12.425	83.379	4.196	1034.25
3. Li2Si2O5(s2) / Li2SiO3 / Li2ZnSiO4	0.70127	0.26052	0.03820	1005.04	51.465	38.136	10.398	1005.04
4. Li2Si2O5(s2) / Li2ZnSiO4 / SiO2(s4)	0.73942	0.22709	0.03349	1002.46	56.162	34.405	9.433	1002.46

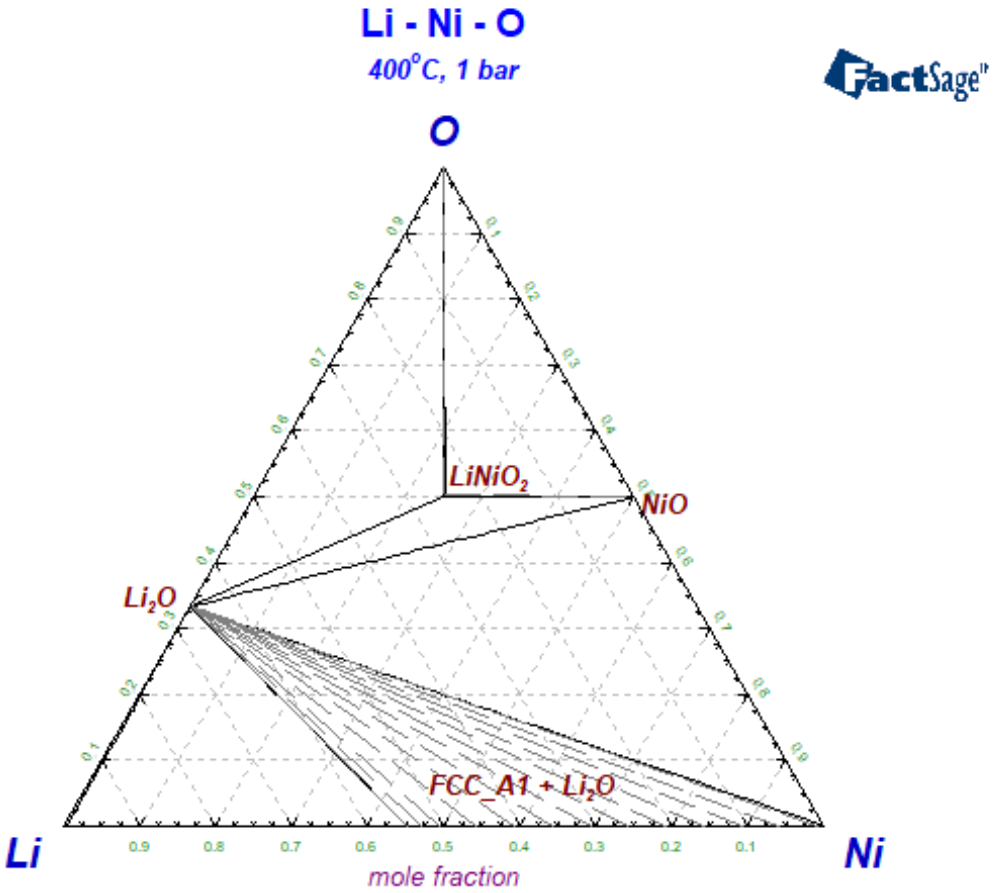
Li-Mn-O, Ternary compounds

Heat of formation, kJ/mol				
	Hoang2015	Wang2005	Wang2005-2	This work
$LiMnO_2$	-813.672	-829.115		-813.672
Li_2MnO_3	-1187.208			-1184.05
$LiMn_2O_4$	-1340.678		-1381.216	-1342.678
$Li_4Mn_5O_{12}$	-3892.692			-3907.692



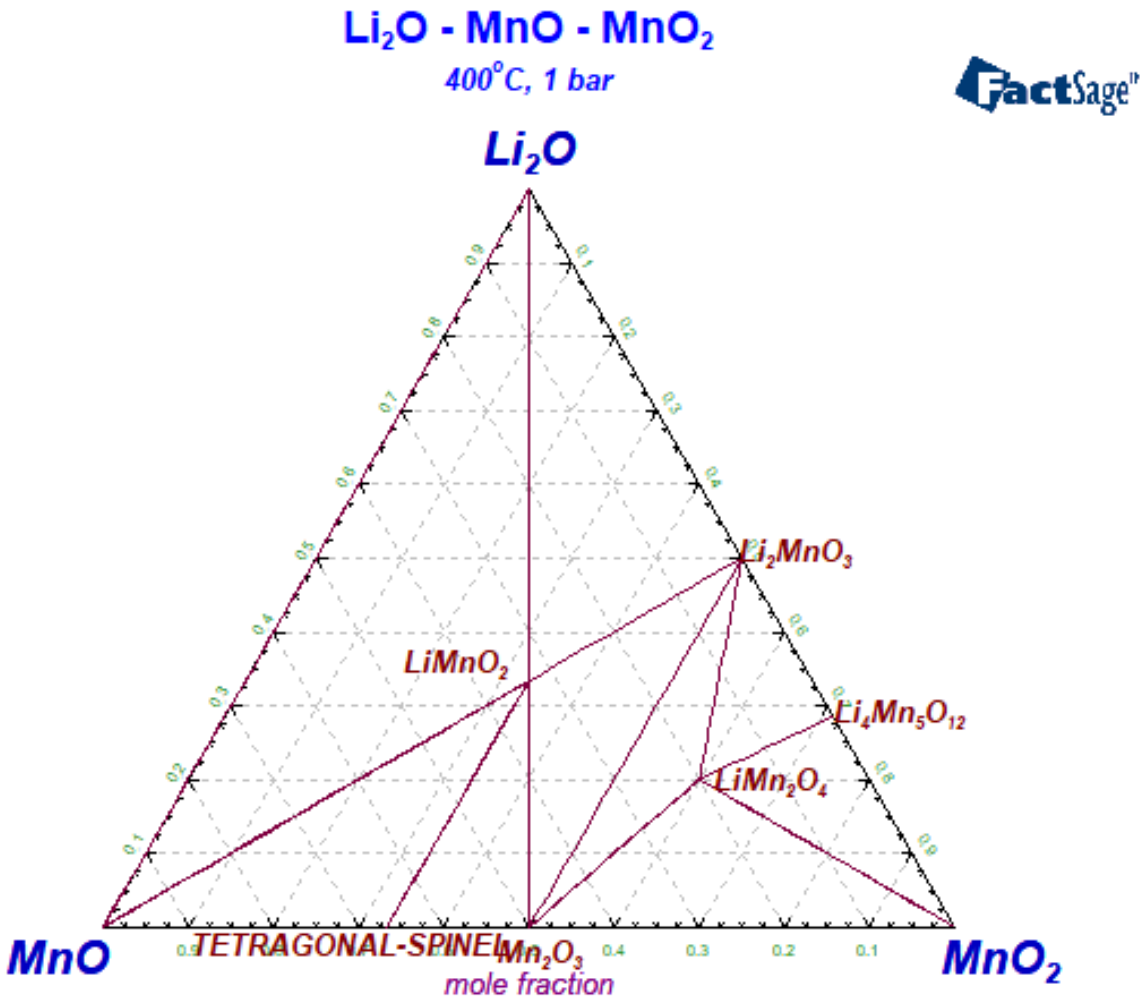

Li - Mn - O
400°C, 1 bar
FactSage
O
MnO2
LiMn2O4
Mn2O3
Mn3O4
Li4Mn5O12
Li2MnO3
LiMnO2
MnO
Li2O
Li2O + Mn + MnO
Li + Li2O + Mn
Li
Mn
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
mole fraction

Li-Ni-O,Mole fraction, 400°C

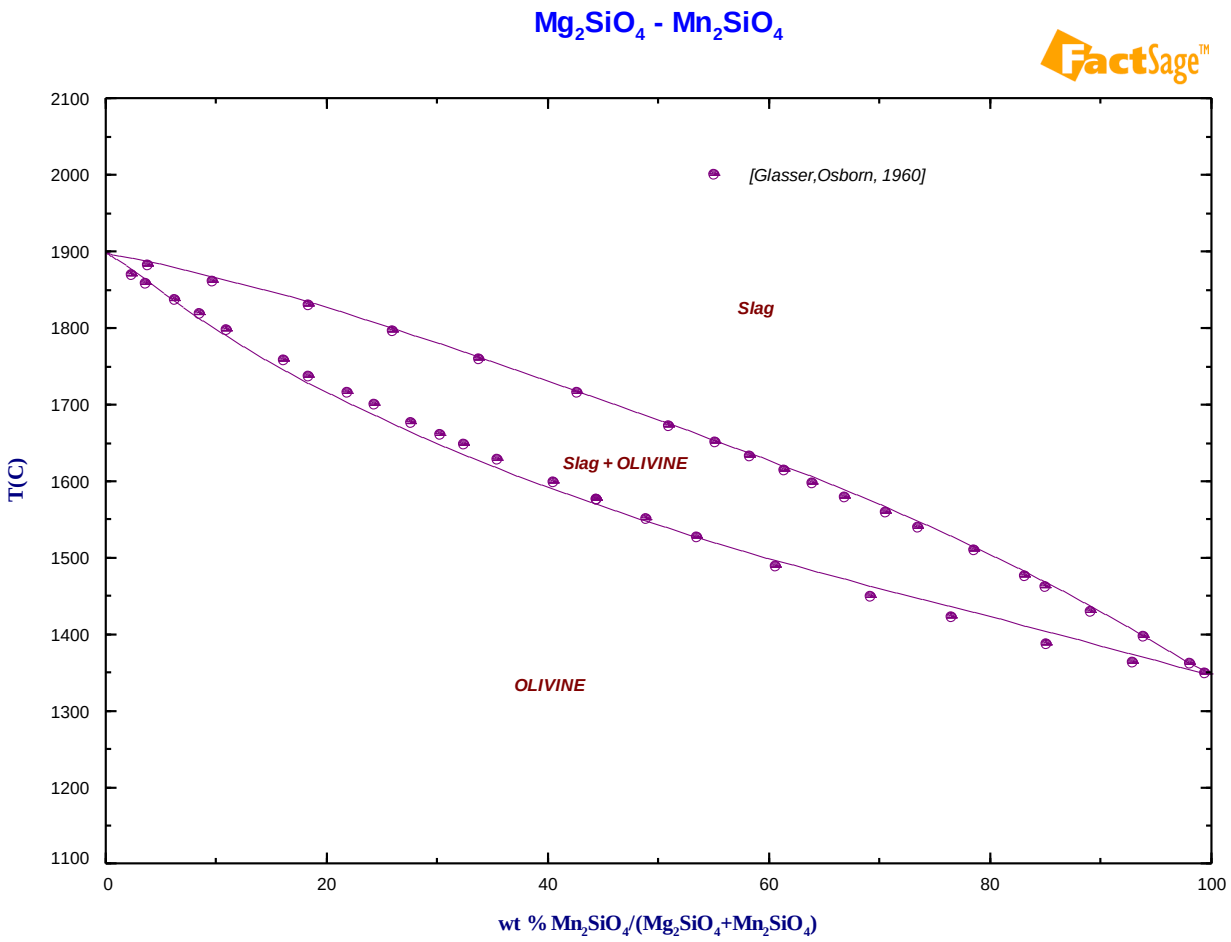


Slag	***(Co_2O_2, Li_2O, $LiNiO_2$)***	This work
$LiNiO_2$	***stoichiometric***	This work Hf [Wang, Navrotsky 2004]
MeO	***(Ni^{+2}, Li_2^{+2}, Va)(O^{-2})***	This work

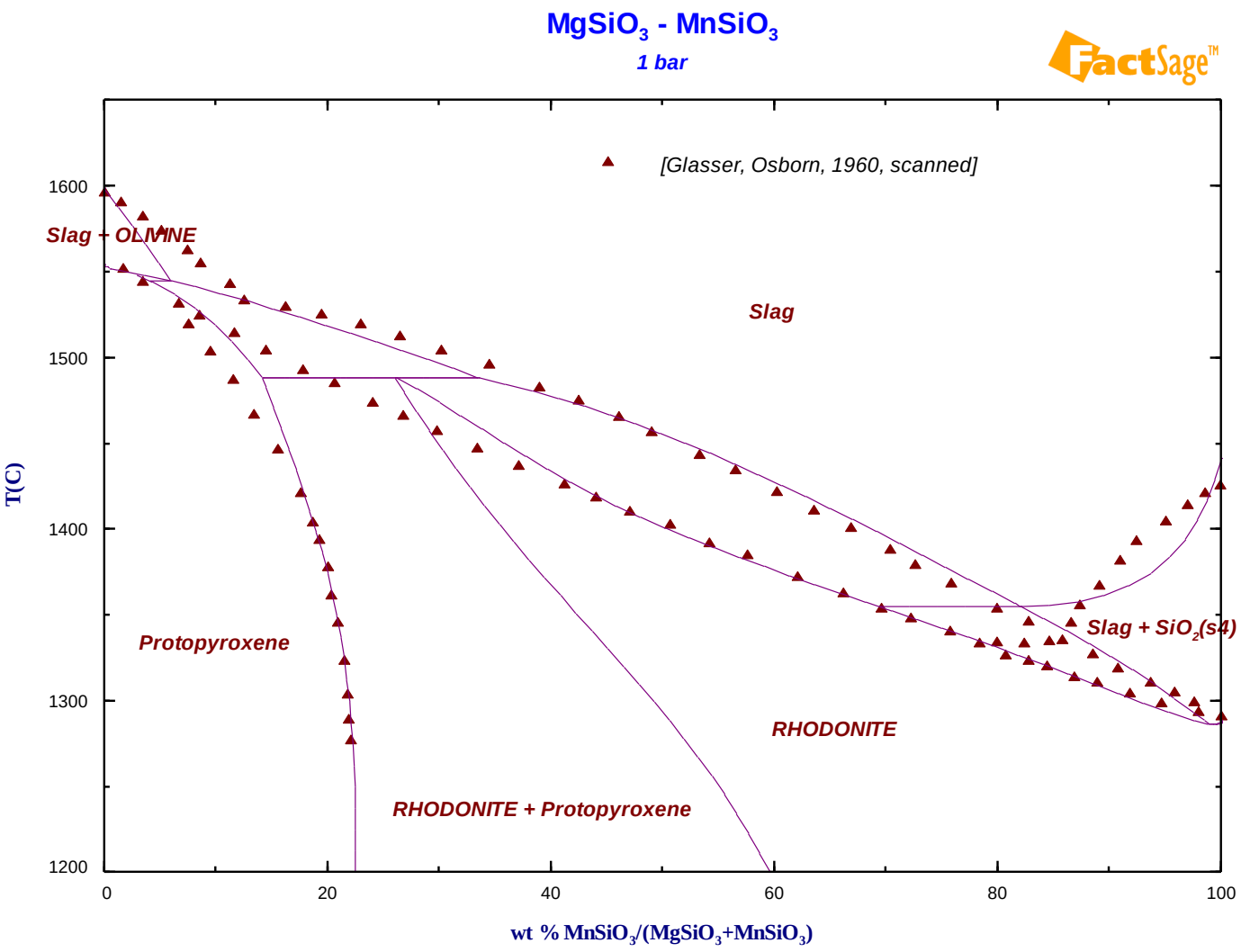
Li2O-MnO-MnO2, Mole fraction, 400°C

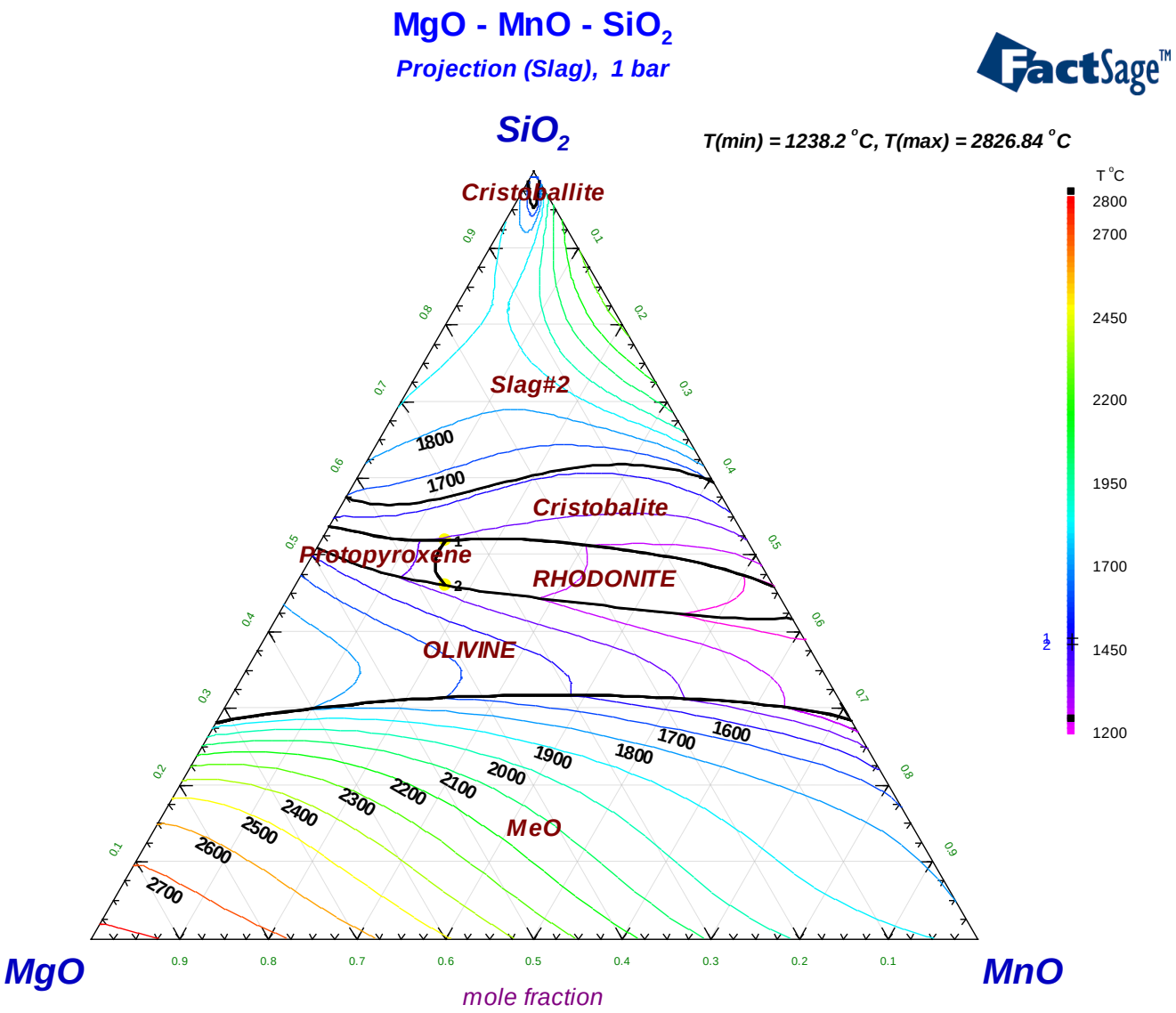


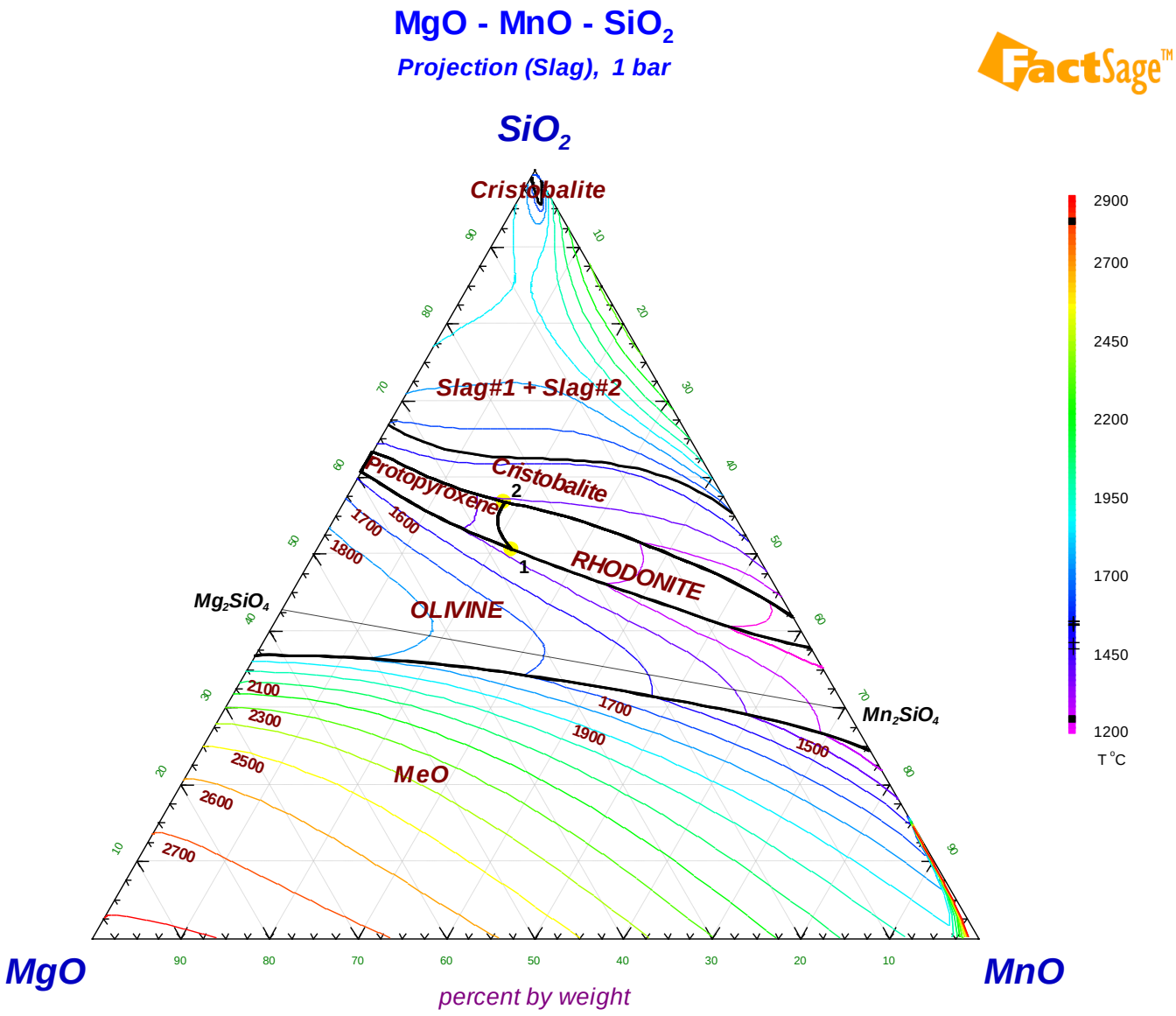
Weight percent, Orthisilicate section Mg2SiO4-Mn2SiO4 compared with experimental data



Weight percent, Metasilicate section MgSiO3-MnSiO3 compared with experimental data




MgO - MnO - SiO2
Projection (Slag), 1 bar
SiO2
T(min) = 1238.2 °C, T(max) = 2826.84 °C
T °C
2800
2700
2450
2200
1950
1700
1450
1200
Cristobalite
Slag#2
1800
1700
Cristobalite
Protopyroxene
RHODONITE
OLIVINE
1600
1700
1800
1900
2000
2100
2200
2300
2400
2500
2600
2700
MeO
MgO
MnO
mole fraction

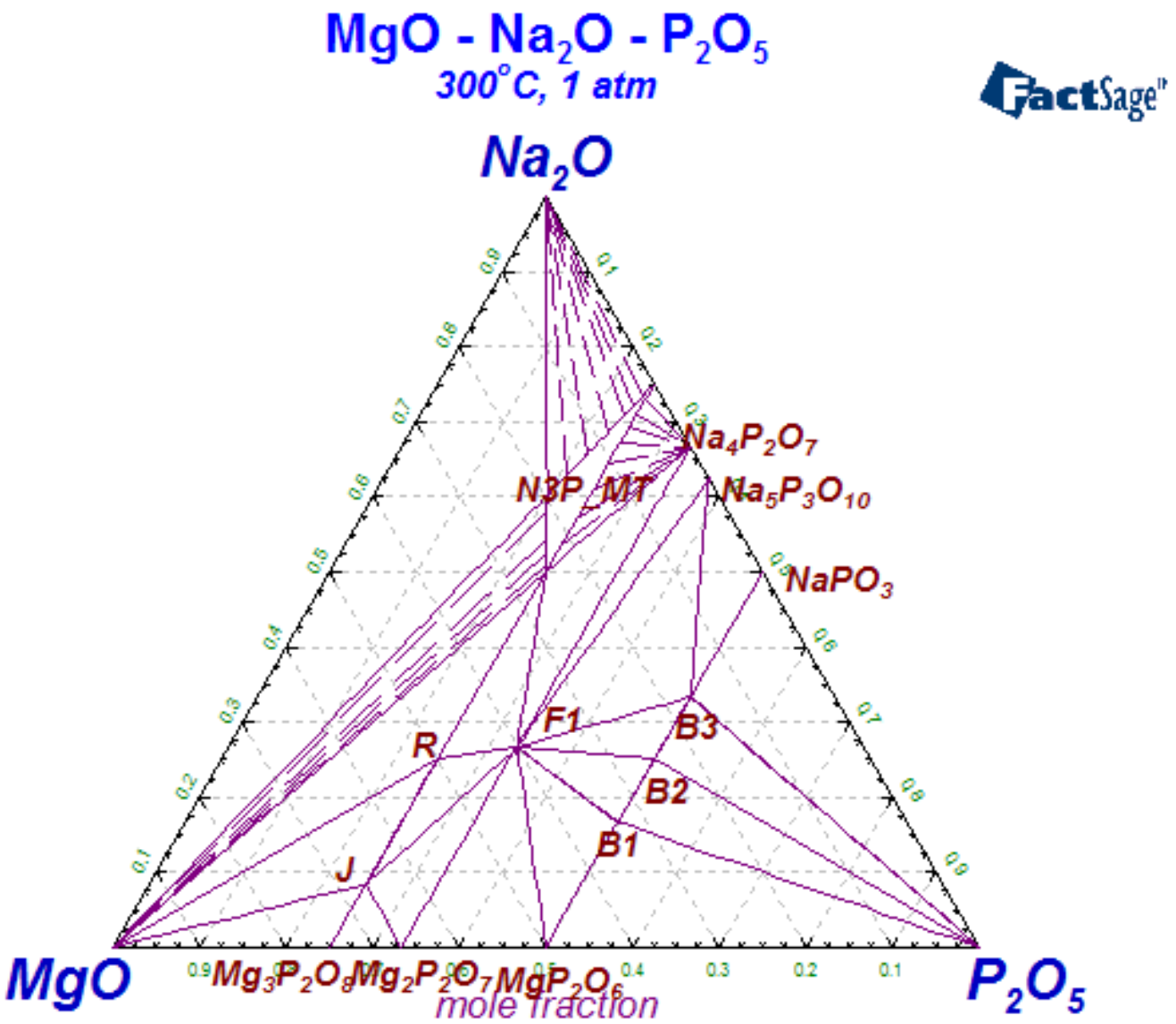

MgO - MnO - SiO2
Projection (Slag), 1 bar
SiO2
Cristobalite
Slag#1 + Slag#2
Protopyroxene
Cristobalite
RHODONITE
OLIVINE
MeO
Mg2SiO4
Mn2SiO4
1700
1600
1800
2100
2300
2500
2600
2700
1900
1500
1
2
MgO
MnO
percent by weight
2900
2700
2450
2200
1950
1700
1450
1200
T °C

Invariant equilibria on the liquidus surface

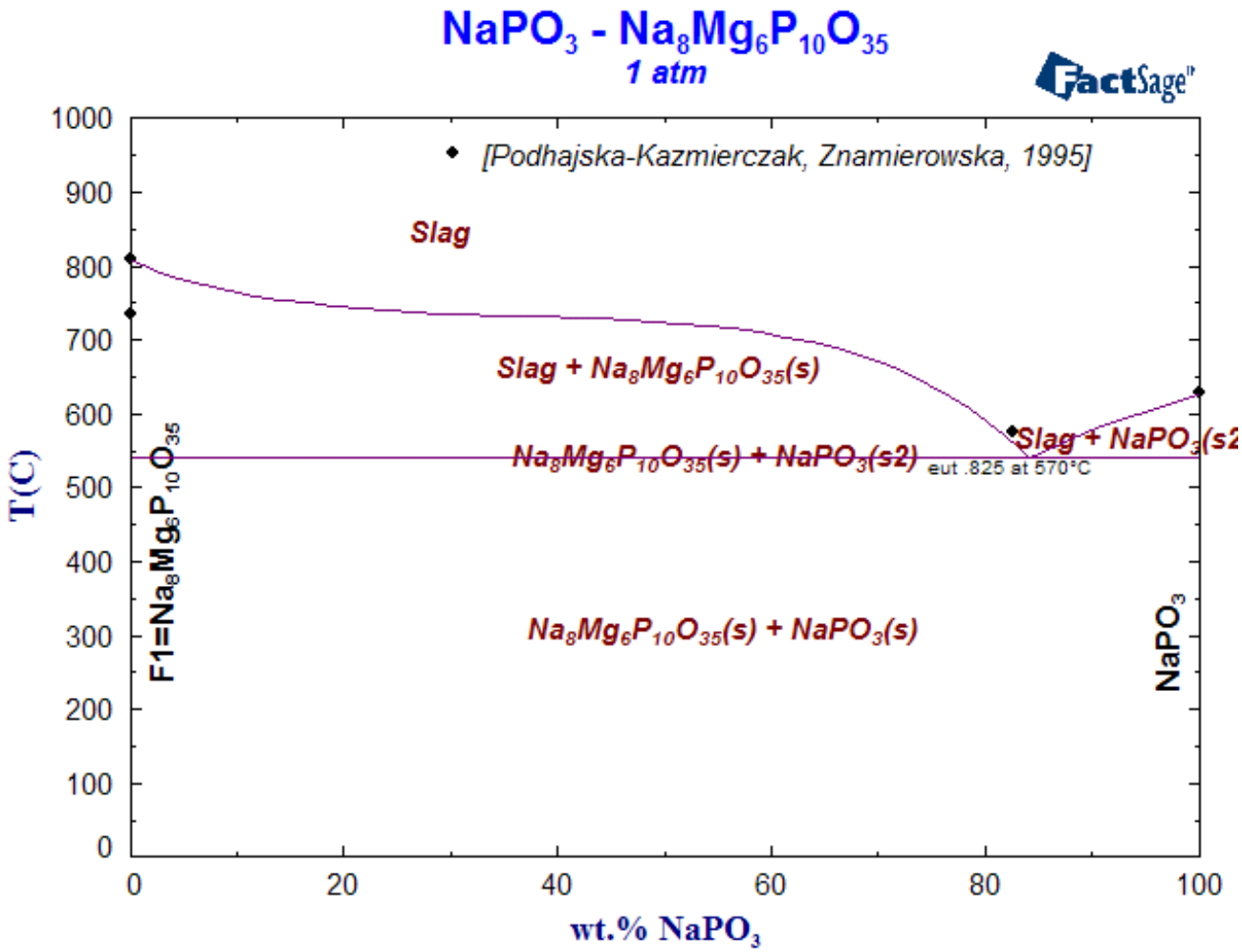
Intersections with slag	Mole fraction					Weight percent				
	A = SiO2, B = MgO, C = MnO					A = SiO2, B = MgO, C = MnO				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: Protopyroxene / RHODONITE / Cristobalite	1:	0.51821	0.34089	0.14090	1485.00	1:	56.744	25.040	18.216	1485.00
2: OLIVINE / Protopyroxene / RHODONITE	2:	0.46025	0.36927	0.17048	1464.79	2:	50.620	27.243	22.137	1464.81

Name	Formel	T_m, °C	Liquid species	Description
R	$NaMgPO_4$	968, incongr.		stoichiometric
J	$NaMg_4P_2O_{12}$	1155, incongr.		stoichiometric
T2	$Na_4Mg(PO_4)_2$	1655, congr.	$Na_4Mg(PO_4)_2 \cdot 2/7$	N3P-T2-T3 solution
T3	$Na_6MgP_2O_9$	1665, congr.		N3P-T2-T3 solution
B1	$NaMg(PO_3)_3$	941, incongr.		stoichiometric
B2	$Na_2Mg(PO_3)_4$	916, congr.		stoichiometric
B3	$Na_4Mg(PO_3)_6$	784, incongr.		stoichiometric
F1	$Na_8Mg_6(P_2O_7)_5$	811, congr.	$Na_8Mg_6(P_2O_7)_5 \cdot 1/12$	stoichiometric

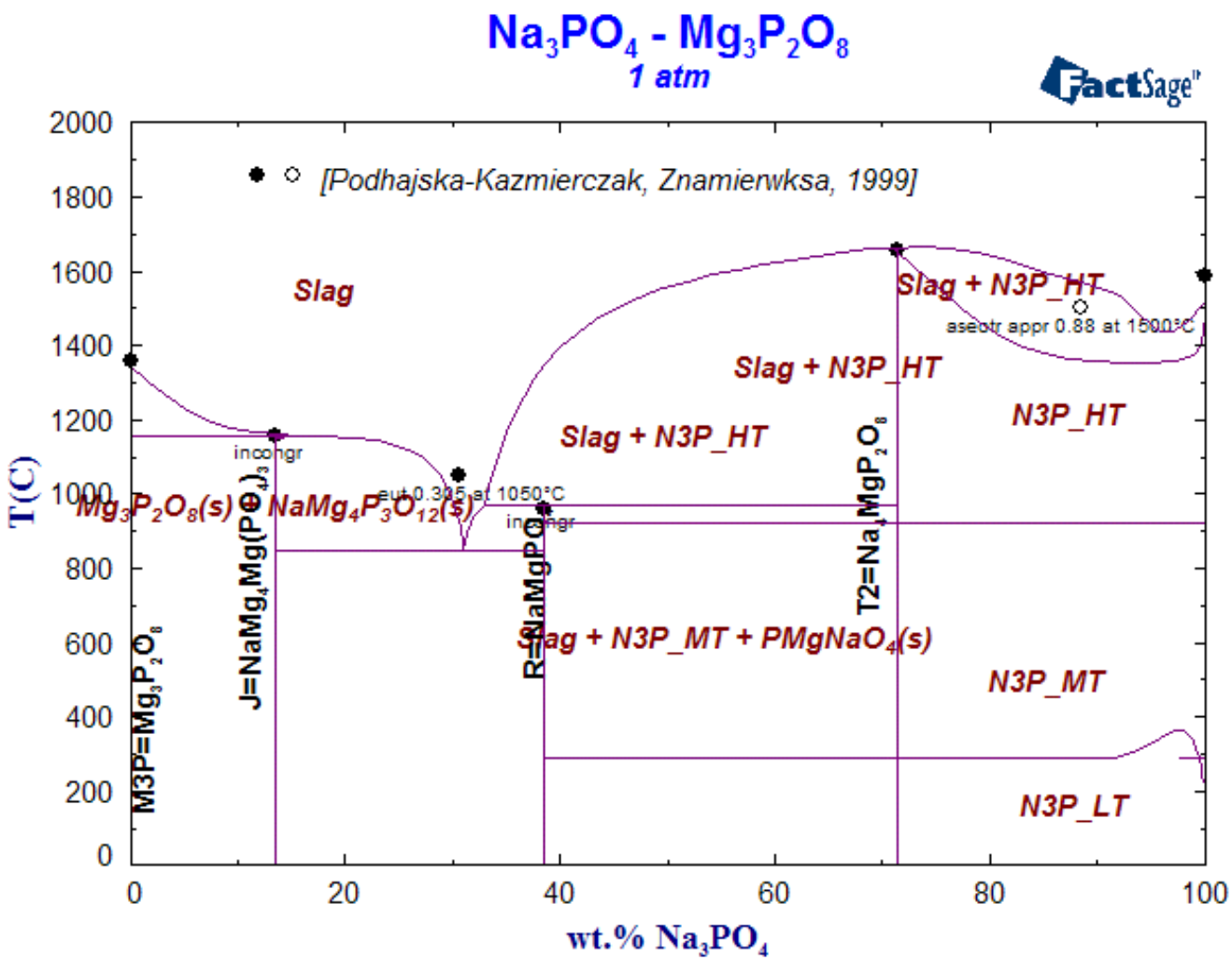
Mole fraction, 300°C



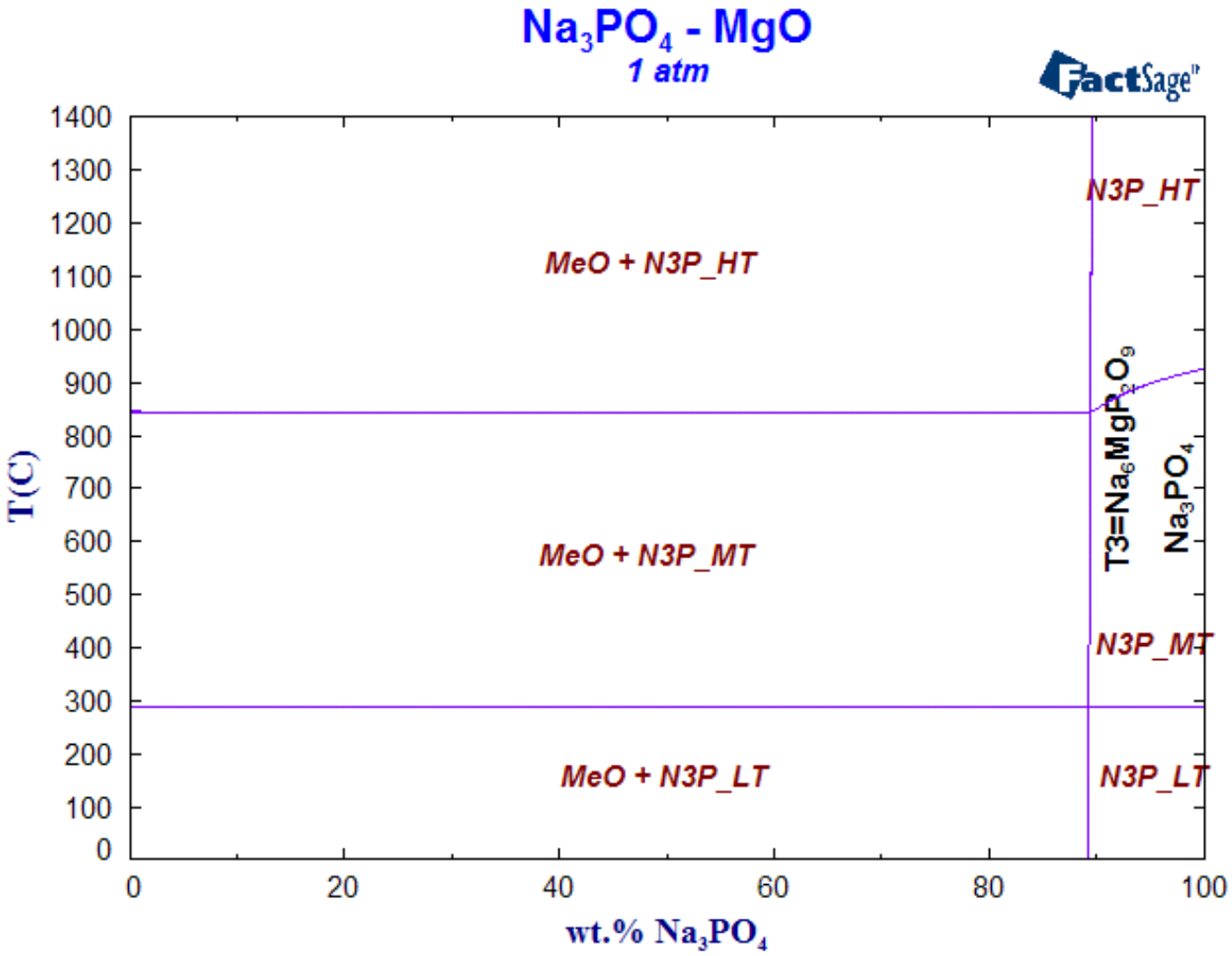
Weight percent, Isopleth NaPO3-Na8Mg6P10O35 compared with experimental data



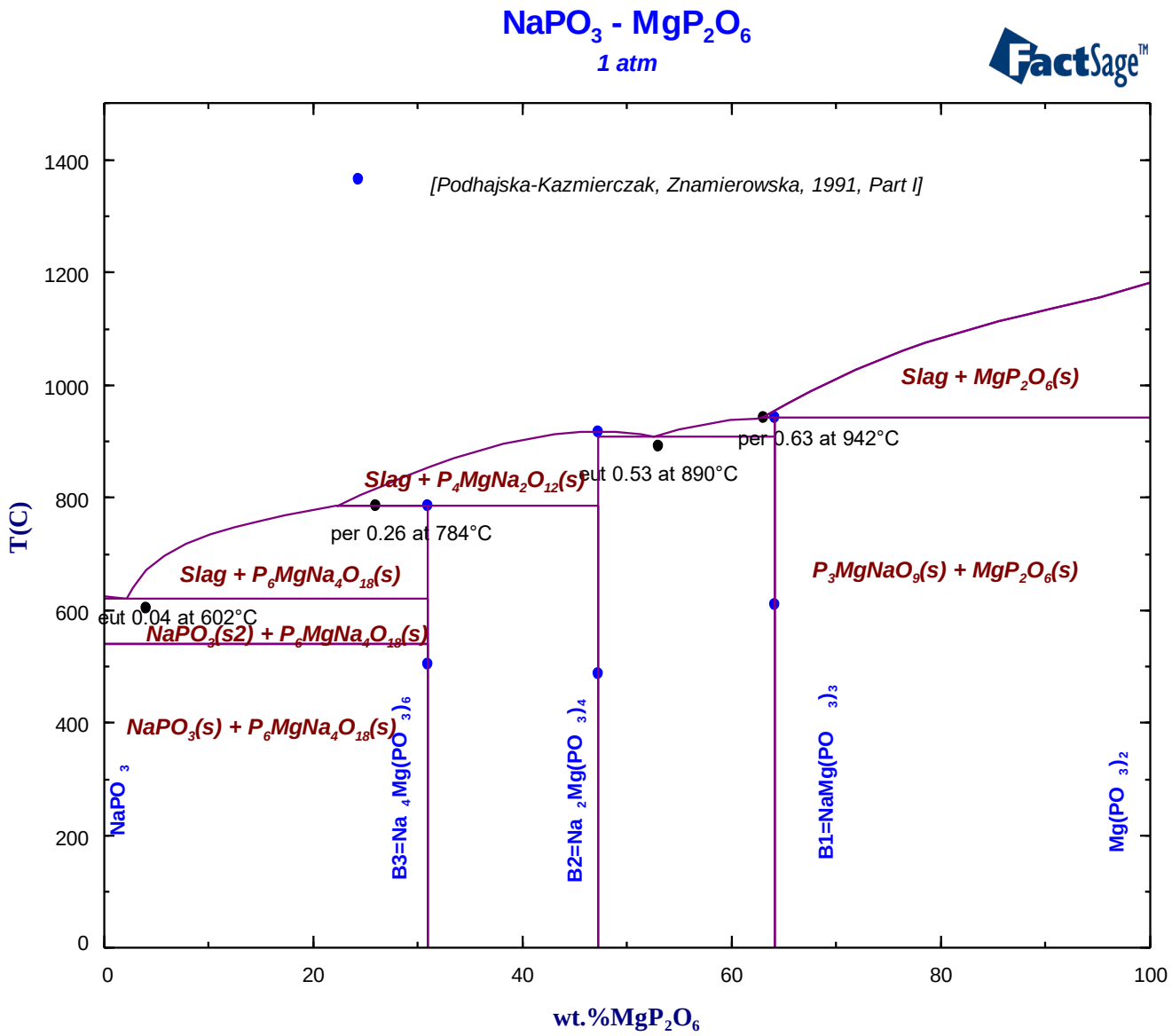
Weight percent, Isopleth Na3PO4-Mg3P2O8 compared with experimental data

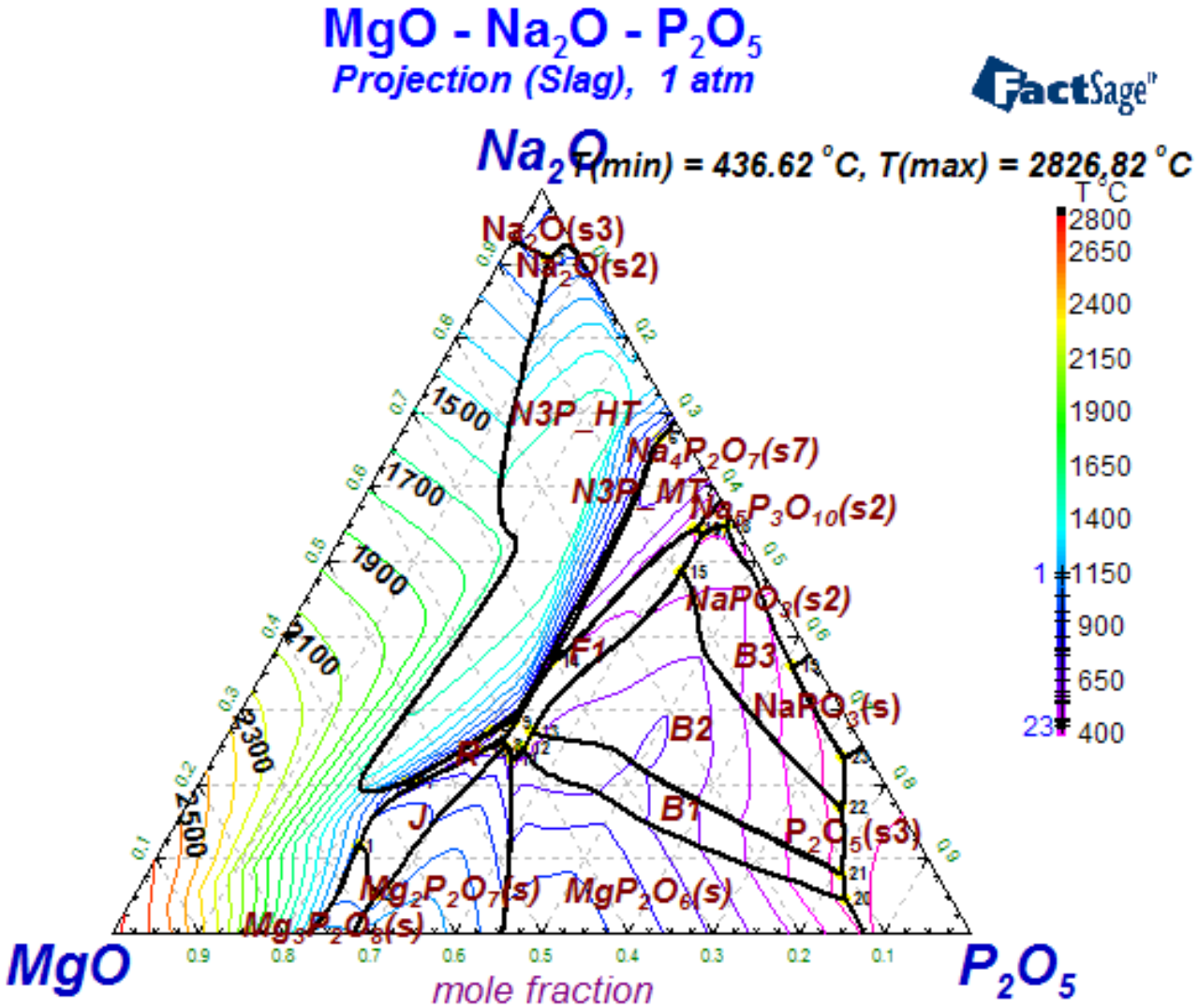


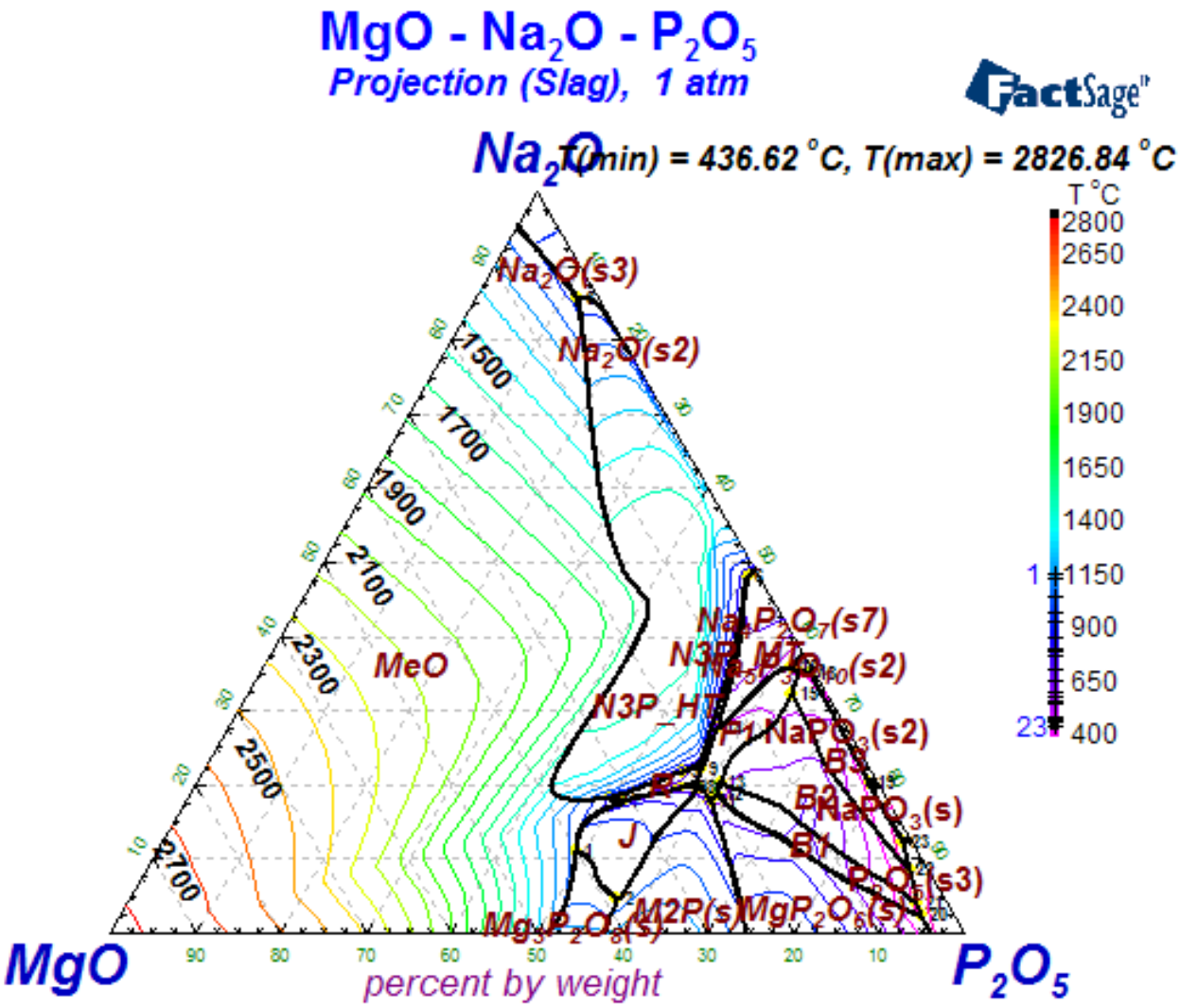
Weight percent, Isopleth MgO-Na3PO4



Weight percent, Isopleth MgP2O6-NaPO3 compared with experimental data



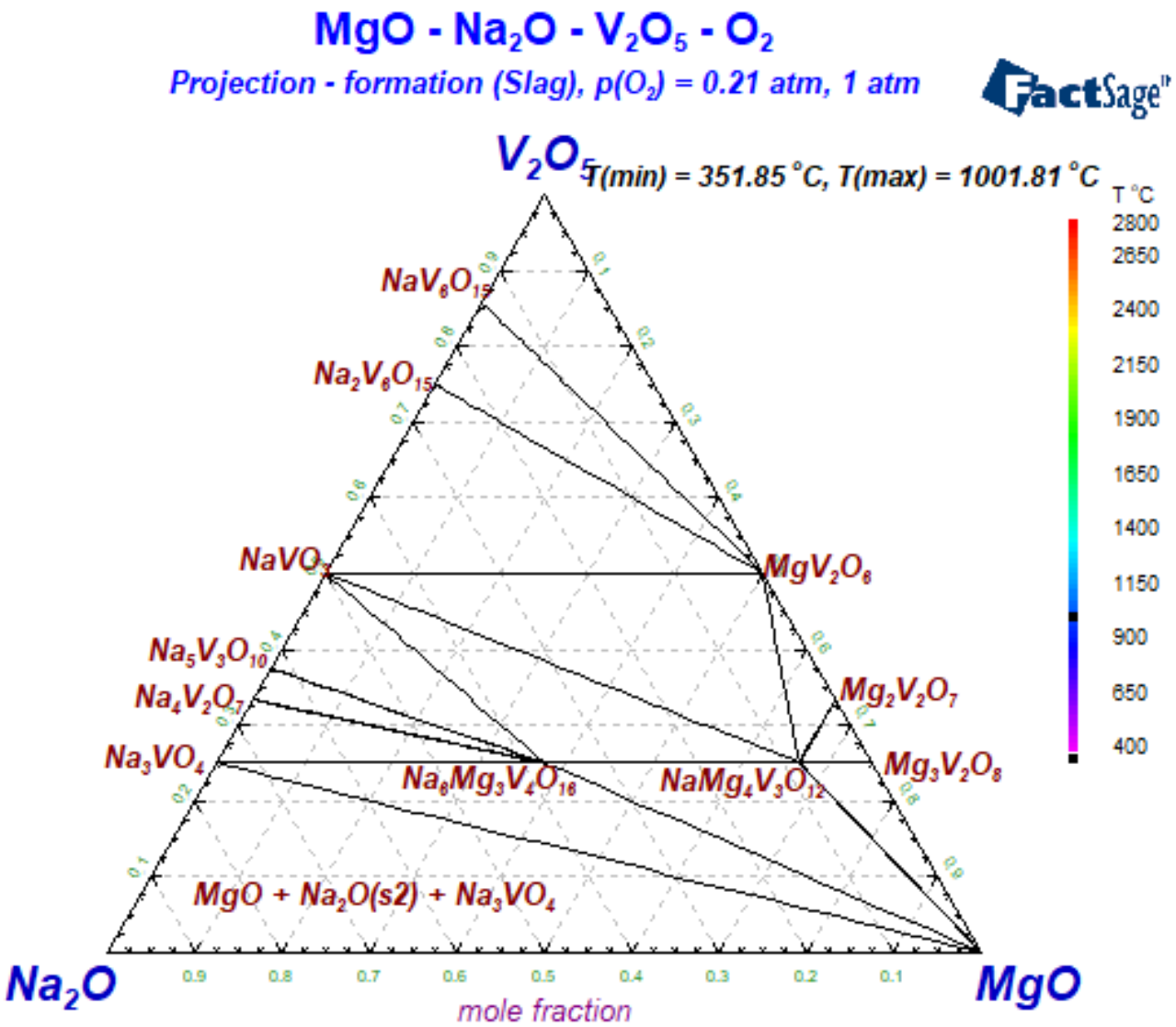

MgO - Na2O - P2O5
Projection (Slag), 1 atm
FactSage
Na2O
T(min) = 436.62 °C, T(max) = 2826.82 °C
T °C
2800
2650
2400
2150
1900
1650
1400
1150
900
650
400
Na2O(s3)
Na2O(s2)
1500
N3P_HT
Na4P2O7(s7)
1700
N3P_MT
Na5P3O10(s2)
1900
NaPO3(s2)
2100
F1
B3
NaPO3(s)
B2
2300
B1
P2O5(s3)
2500
J
Mg2P2O7(s)
MgP2O6(s)
Mg3P2O8(s)
MgO
P2O5
mole fraction


MgO - Na2O - P2O5
Projection (Slag), 1 atm
FactSage
Na2O
T(min) = 436.62 °C, T(max) = 2826.84 °C
T °C
2800
2650
2400
2150
1900
1650
1400
1150
900
650
400
1
23
Na2O(s3)
Na2O(s2)
1500
1700
1900
2100
2300
2500
2700
MeO
Na4P2O7(s7)
N3P_MT
(s2)
N3P_HT
P1
NaPO3(s2)
B3
B2
NaPO3(s)
B1
P2O5(s3)
J
M2P(s)
MgP2O6(s)
Mg3P2O8(s)
MgO
P2O5
percent by weight

Invariant equilibria on the liquidus surface

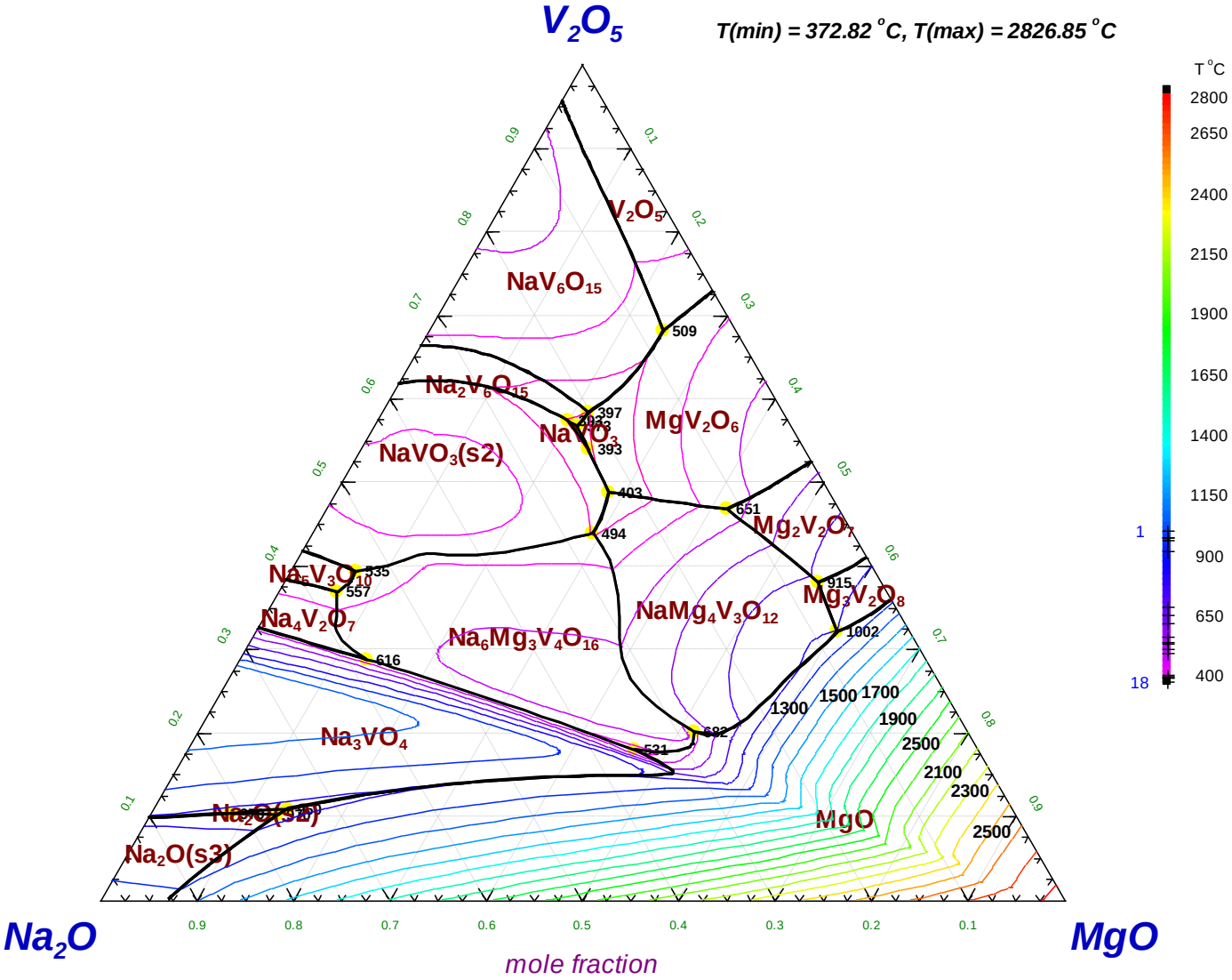
Intersections with slag	Mole fraction					Weight percent				
	A = Na2O, B = MgO, C = P2O5					A = Na2O, B = MgO, C = P2O5				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: MeO / Mg3P2O8(s) / NaMg4P3O12_J	1:	0.11576	0.65616	0.22808	1148.36	1:	10.872	40.072	49.056	1148.36
2: Mg2P2O7(s) / Mg3P2O8(s) / NaMg4P3O12_J	2:	0.05033	0.66713	0.28254	1126.74	2:	4.449	38.350	57.201	1126.74
3: MeO / N3P_HT / Na2O(s3)	3:	0.90573	0.03895	0.05531	1040.27	3:	85.629	2.395	11.976	1040.27
4: MeO / N3P_HT / PMgNaO4_R	4:	0.20469	0.55214	0.24317	967.80	4:	18.265	32.040	49.695	967.80
5: N3P_HT / N3P_MT / PMgNaO4_R	5:	0.27098	0.42308	0.30594	922.40	5:	21.734	22.067	56.199	922.40
6: N3P_HT / N3P_MT / Na4P2O7_S7(s7)	6:	0.66477	0.02929	0.30594	922.38	6:	48.016	1.376	50.609	922.38
7: MeO / NaMg4P3O12_J / PMgNaO4_R	7:	0.20228	0.54231	0.25541	843.66	7:	17.746	30.938	51.316	843.66
8: Mg2P2O7(s) / Na8Mg6P10O35 / NaMg4P3O12_J	8:	0.25182	0.41709	0.33109	793.41	8:	19.654	21.168	59.178	793.37
9: N3P_MT / Na8Mg6P10O35 / PMgNaO4_R	9:	0.28288	0.39004	0.32709	781.71	9:	22.003	19.729	58.268	781.61
10: Na8Mg6P10O35 / NaMg4P3O12_J / PMgNaO4_R	10:	0.24441	0.44744	0.30815	780.81	10:	19.693	23.444	56.863	780.81
11: Mg2P2O7(s) / MgP2O6(s) / Na8Mg6P10O35	11:	0.23325	0.41674	0.35002	768.45	11:	17.861	20.753	61.386	767.97
12: MgP2O6(s) / Na8Mg6P10O35 / P3MgNaO9_B1	12:	0.24684	0.39690	0.35627	761.43	12:	18.688	19.540	61.772	761.36
13:Na8Mg6P10O35/P3MgNaO9_B1/P4MgNa2O12_B2	13:	0.26884	0.37614	0.35502	758.92	13:	20.267	18.439	61.294	758.92
14: N3P_MT / Na4P2O7(s7) / Na8Mg6P10O35	14:	0.36583	0.30422	0.32995	696.79	14:	27.729	14.995	57.276	696.79
15: Na8Mg6P10O35/P4MgNa2O12/P6MgNa4O18_B3	15:	0.48407	0.09554	0.42039	643.32	15:	32.079	4.118	63.8.03	643.36
16: Na4P2O7(s7) / Na5P3O10(s2) / Na8Mg6P10O35	16:	0.54275	0.05054	0.40671	594.82	16:	36.014	2.181	61.805	594.82
17: Na5P3O10(s2)/Na8Mg6P10O35/P6MgNa4O18_B3	17:	0.53638	0.04358	0.42004	573.48	17:	35.133	1.856	63.011	573.48
18: Na5P3O10(s2) / NaPO3(s2) / P6MgNa4O18_B3	18:	0.54629	0.01265	0.44106	549.50	18:	34.915	0.526	64.559	549.53
19: NaPO3(s2) / NaPO3(s) / P6MgNa4O18_B3	19:	0.35779	0.02895	0.61327	539.35	19:	20.087	1.057	78.856	539.40
20: MgP2O6(s) / P2O5(s3) / P3MgNaO9_B1	20:	0.04628	0.12354	0.83018	471.28	20:	2.282	3.962	93.756	471.28
21: P2O5(s3) / P3MgNaO9_B1 / P4MgNa2O12_B2	21:	0.08023	0.11019	0.80958	470.38	21:	4.000	3.572	92.428	470.38
22: P2O5(s3) / P4MgNa2O12_B2 / P6MgNa4O18_B3	22:	0.16699	0.06749	0.76552	457.71	22:	8.502	2.235	89.263	457.71
23: NaPO3(s) / P2O5(s3) / P6MgNa4O18_B3	23:	0.23579	0.03011	0.73409	436.62	23:	12.176	1.011	86.813	436.62

MgO-Na2O-V2O5, Mole fraction, Subsolidus



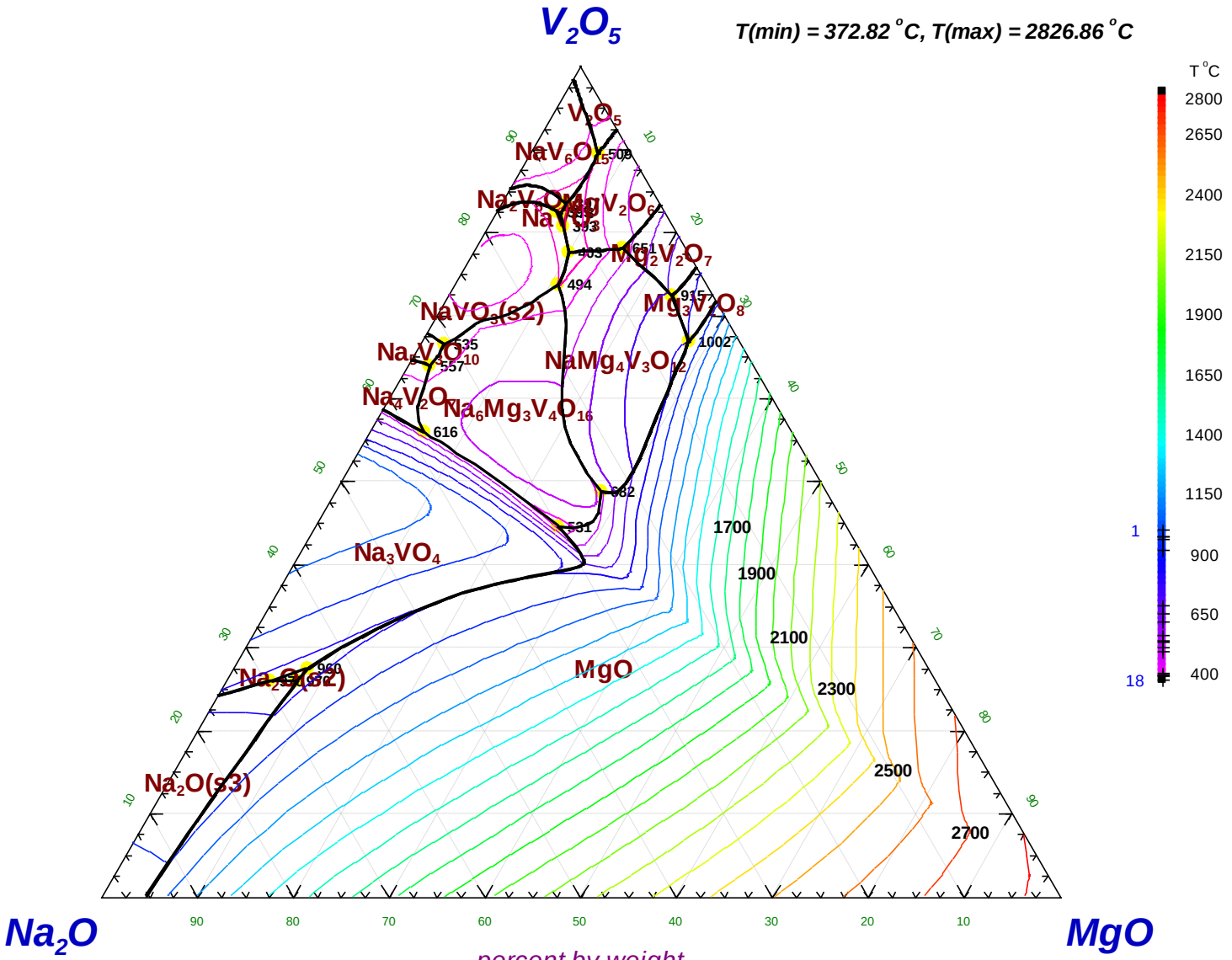
$MgO - Na_2O - V_2O_5 - O_2$

Projection (A-Slag), $p(O_2)$ = 0.21 atm, 1 atm



$MgO - Na_2O - V_2O_5 - O_2$

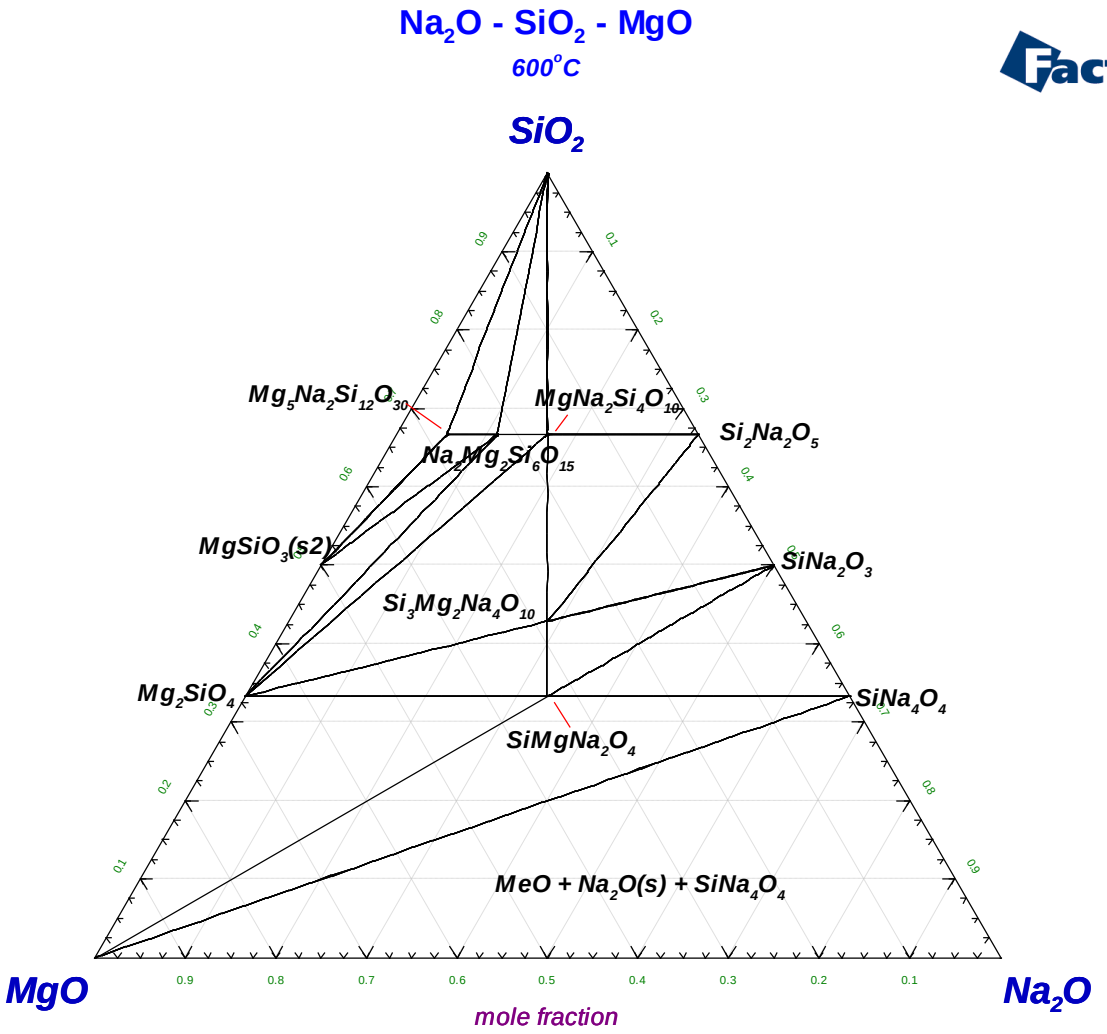
Projection (A-Slag), $p(O_2)$ = 0.21 atm, 1 atm

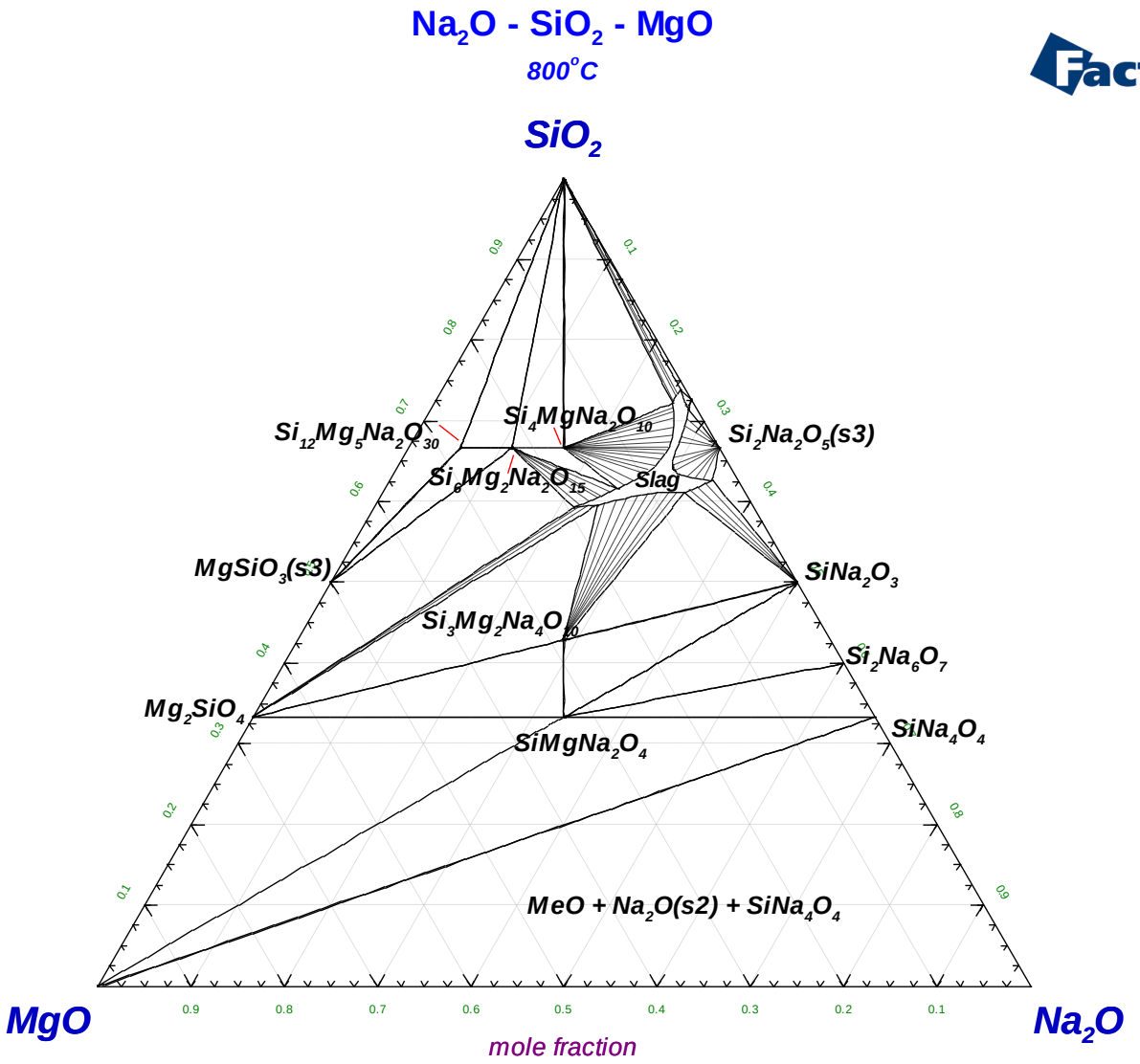


Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction				Weight percent			
	A = V2O5, B = Na2O, C = MgO				A = V2O5, B = Na2O, C = MgO			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1. Mg3V2O8 / MgO / NaMg4V3O12	0.32130	0.07424	0.60446	1001.90	66.862	5.264	27.874	1001.84
2. Na2O(s2) / Na2O(s3) / Na3VO4	0.10387	0.81282	0.08332	970.05	25.970	66.530	7.499	970.07
3. MgO / Na2O(s2) / Na2O(s3)	0.10182	0.76549	0.13269	970.05	26.011	69.365	4.624	970.05
4. MgO / Na2O(s2) / Na3VO4	0.10897	0.75153	0.13950	959.94	27.520	64.673	7.807	959.94
5. Mg2V2O7 / Mg3V2O8 / NaMg4V3O12	0.38071	0.06507	0.55422	914.76	72.420	4.218	23.362	914.76
6. MgO / Na6Mg3V4O16 / NaMg4V3O12	0.20089	0.28278	0.51633	681.58	48.799	23.408	27.793	681.60
7. Mg2V2O7 / MgV2O6 / NaMg4V3O12	0.46830	0.11596	0.41575	651.03	78.057	6.586	15.356	651.03
8. Na3VO4 / Na4V2O7 / Na6Mg3V4O16	0.28821	0.57978	0.13200	616.11	55.960	38.61	5.680	616.11
9. Na4V2O7 / Na5V3O10 / Na6Mg3V4O16	0.36913	0.57007	0.06080	556.89	63.989	33.675	2.336	556.88
10.Na5V3O10 / Na6Mg3V4O16 / NaVO3(s2)	0.39373	0.53819	0.06808	534.70	66.484	30.968	2.547	534.71
11.MgO / Na3VO4 / Na6Mg3V4O16	0.18031	0.35568	0.46401	531.48	44.593	29.977	25.430	531.48
12.MgV2O6 / NaV6O15 / V2O5	0.68155	0.07556	0.24288	508.97	89.546	3.383	7.071	508.97
13.Na6Mg3V4O16 / NaMg4V3O12 / NaVO3(s2)	0.43959	0.26922	0.29119	493.68	73.774	15.396	10.829	493.69
14.MgV2O6 / NaMg4V3O12 / NaVO3(s2)	0.48812	0.22789	0.28398	402.96	77.639	12.352	10.009	402.96
15.MgV2O6 / Na2V6O15 / NaV6O15	0.58422	0.20117	0.21461	396.89	83.421	9.788	6.791	396.88
16.Na2V6O15 / NaVO3 / NaVO3(s2)	0.57355	0.22741	0.19904	392.86	82.507	11.148	6.345	392.85
17.MgV2O6 / NaVO3 / NaVO3(s2)	0.53932	0.22394	0.23675	392.85	80.725	11.422	7.853	392.85
18.MgV2O6 / Na2V6O15 / NaVO3	0.56745	0.22110	0.21146	372.83	82.281	10.925	6.795	372.82

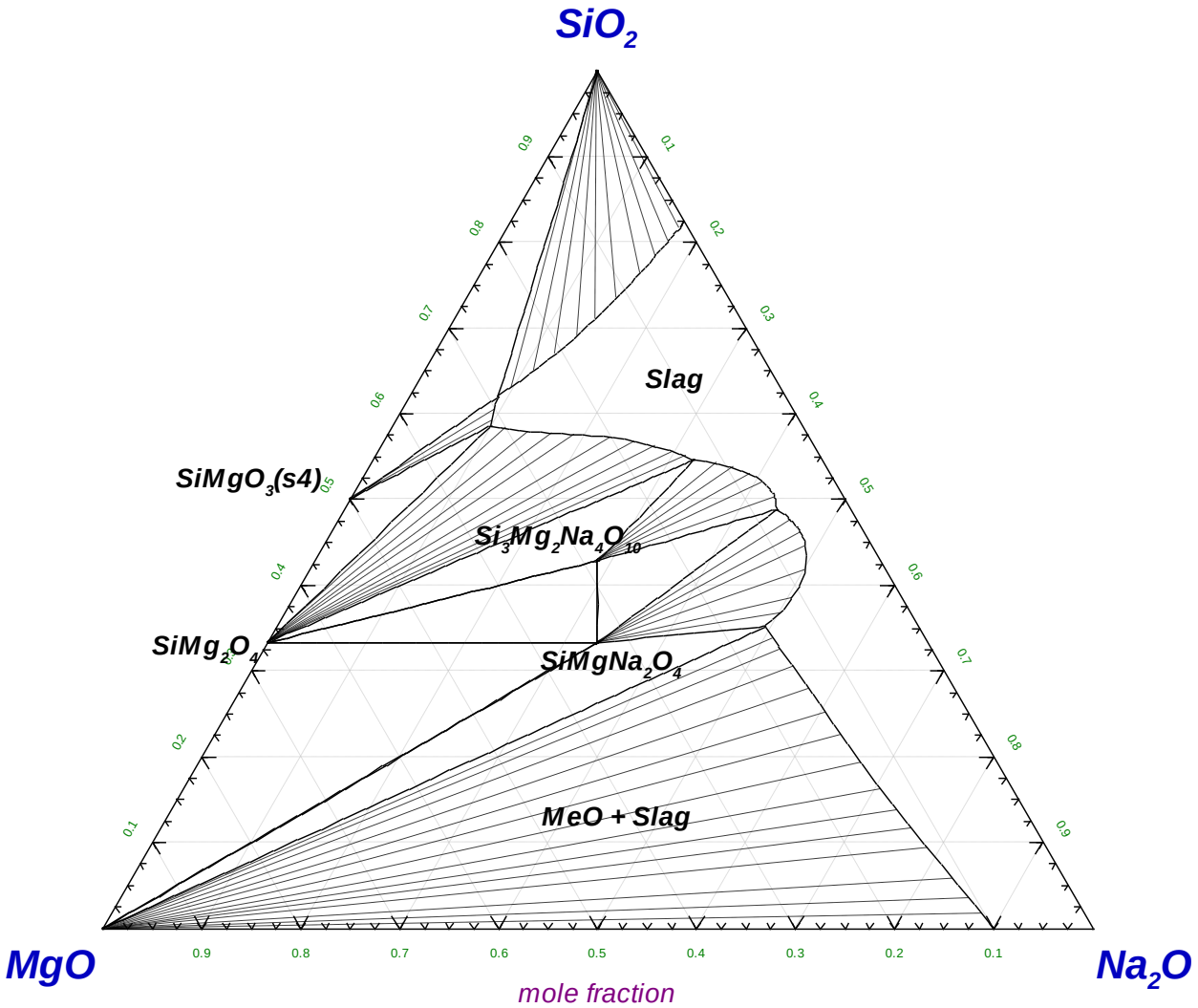
MgO-Na2O-SiO2,
Mole fraction 600°C

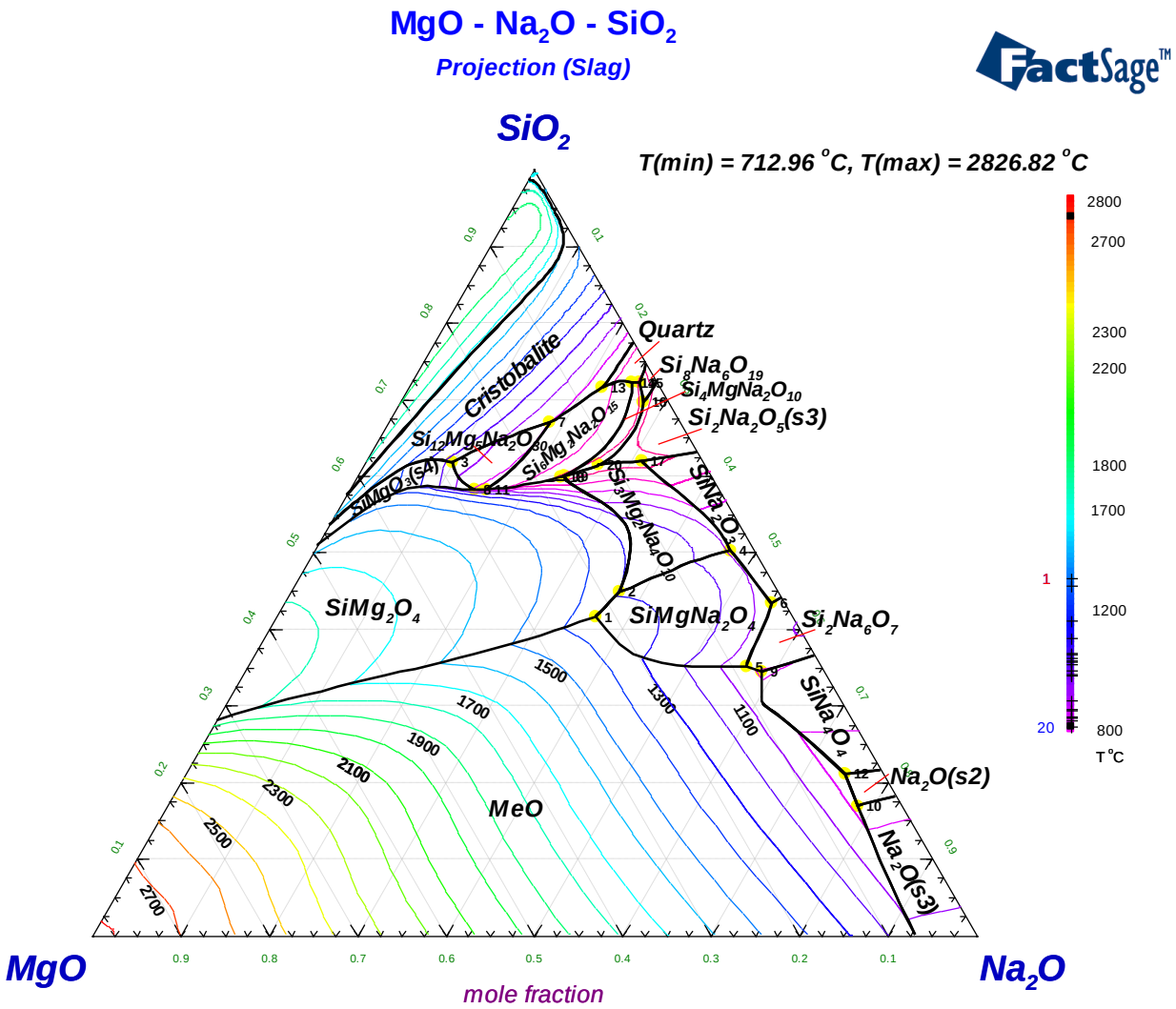



Na2O - SiO2 - MgO
800°C
SiO2
Si12Mg5Na2O30
Si4MgNa2O10
Si2Na2O5(s3)
Si6Mg2Na2O15
Slag
MgSiO3(s3)
SiNa2O3
Si3Mg2Na4O10
Si2Na6O7
Mg2SiO4
SiNa4O4
SiMgNa2O4
MeO + Na2O(s2) + SiNa4O4
MgO
Na2O
mole fraction

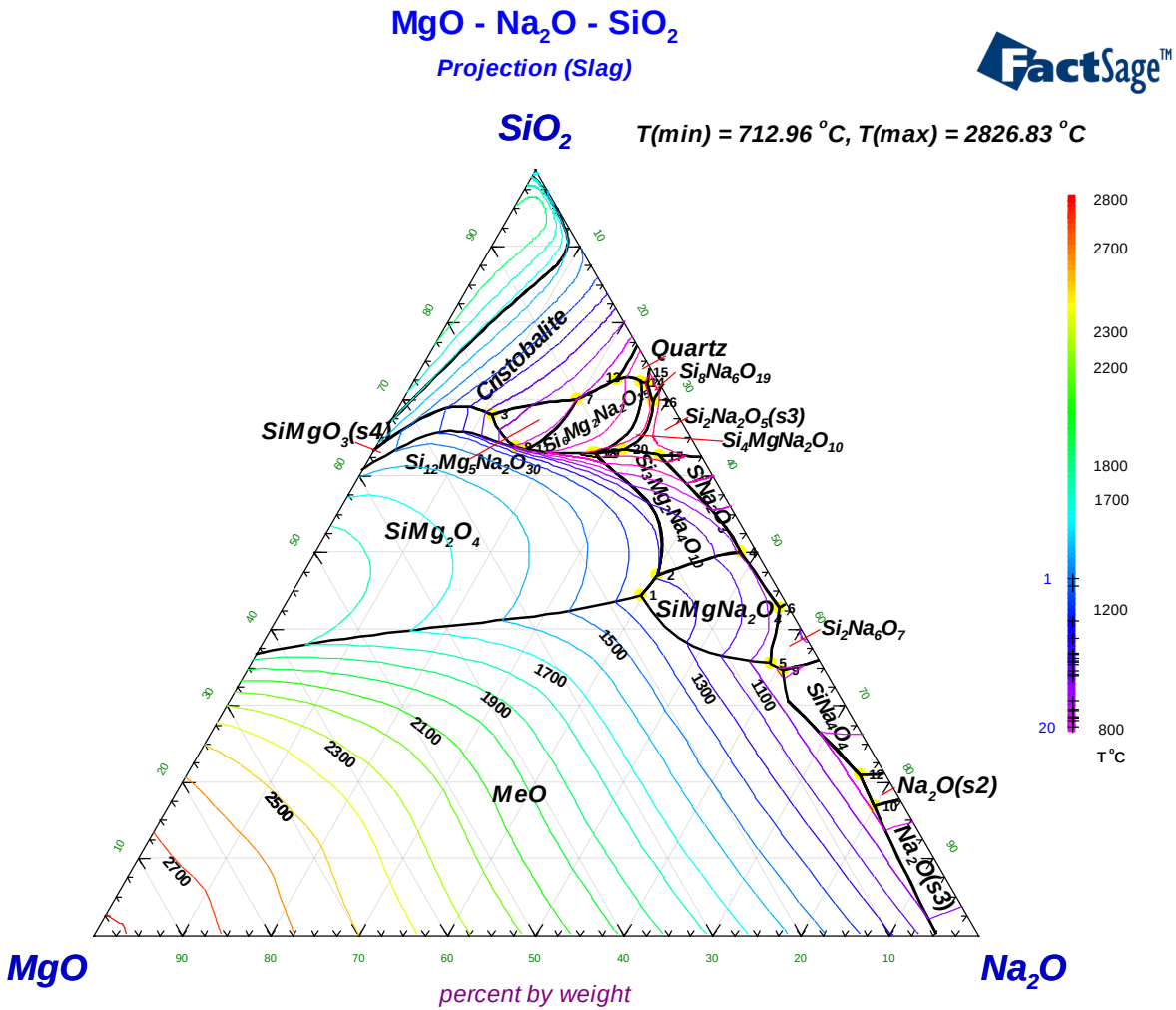
Na_2O - SiO_2 - MgO

1200°C




MgO - Na2O - SiO2
Projection (Slag)
FactSage™
SiO2
T(min) = 712.96 °C, T(max) = 2826.82 °C
Quartz
Cristobalite
Si8Na6O19
Si4MgNa2O10
Si2Na2O5(s3)
Si12Mg5Na2O
Si6Mg3Na2O15
SiMgO3(s4)
Si3Mg2Na4O10
SiNa2O3
SiMg2O4
SiMgNa2O4
Si2Na6O7
SiNa4O4
Na2O(s2)
Na2O(s3)
MeO
2700
2500
2300
2100
1900
1700
1500
1300
1100
2800
2700
2300
2200
1800
1700
1200
800
T °C
MgO
Na2O
mole fraction

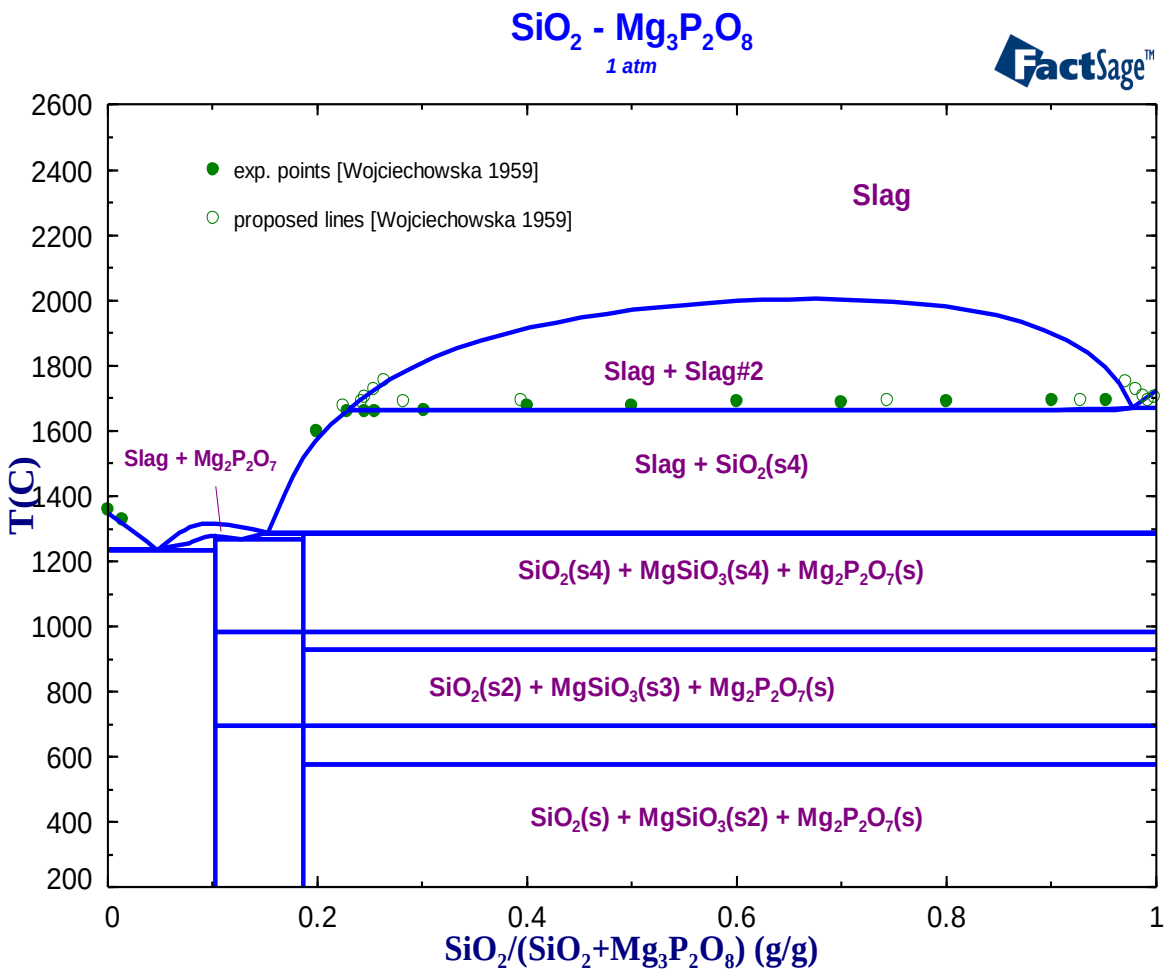
Weight percent
Liquidussurface



Invariant equilibria on the liquidus surface

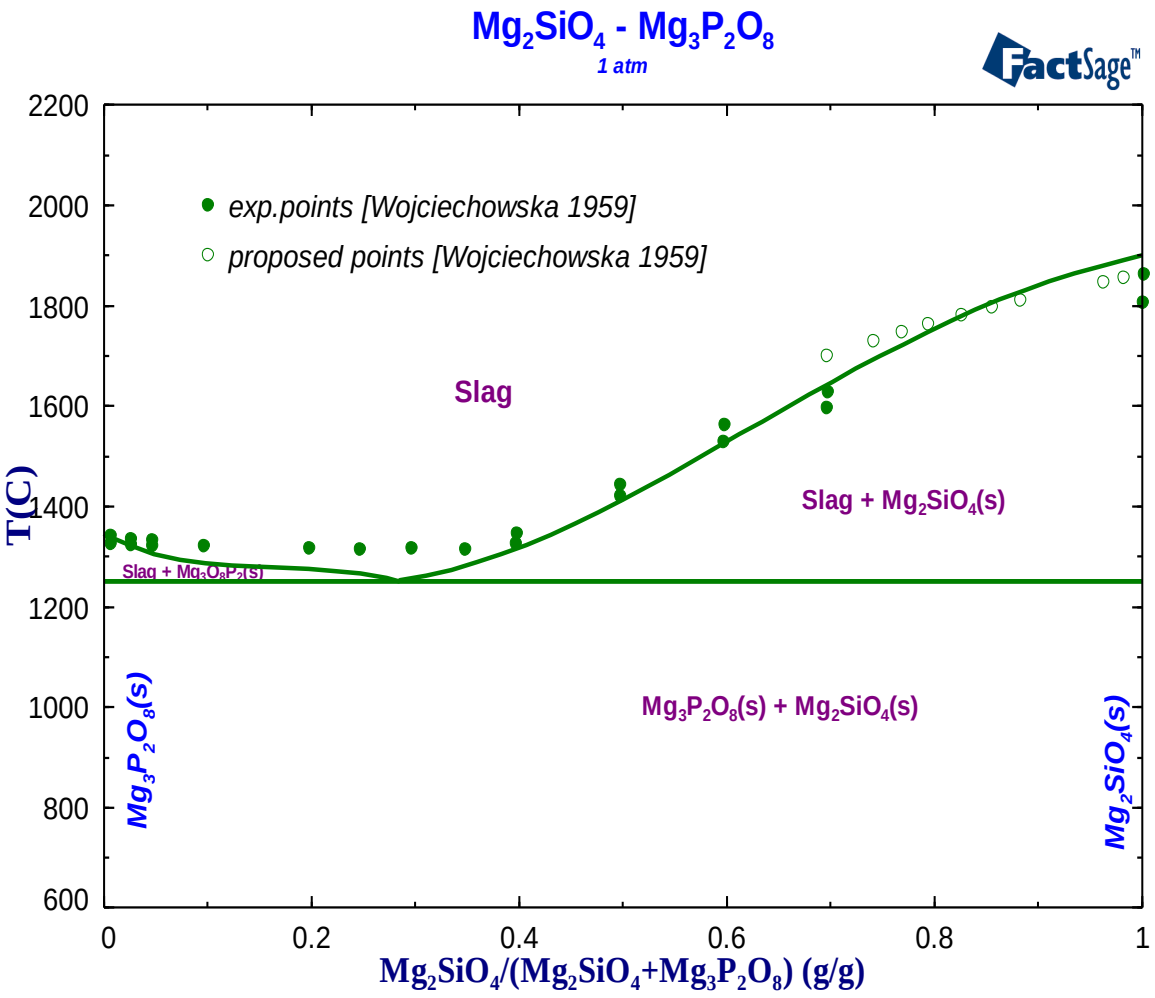
Intersections with slag	Mole fraction				Weight percent			
	A = SiO2, B = MgO, C = Na2O				A = SiO2, B = MgO, C = Na2O			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: MeO / SiMg2O4 / SiMgNa2O4	1: 0.41659	0.22201	0.36140	1326.64	1: 44.398	15.872	39.730	1326.64
2: Si3Mg2Na4O10 / SiMg2O4 / SiMgNa2O4	2: 0.44814	0.17965	0.37222	1294.45	2: 47.044	12.650	40.306	1294.45
3: Si12Mg5Na2O30 / SiMgO3(s4) / Cristobalite	3: 0.61809	0.28377	0.09815	1153.71	3: 67.946	20.925	11.129	1153.71
4: Si3Mg2Na4O10 / SiMgNa2O4 / SiNa2O3	4: 0.50311	0.02680	0.47010	1078.19	4: 50.010	1.787	48.203	1078.17
5: MeO / Si2Na6O7 / SiMgNa2O4	5: 0.35161	0.08395	0.56445	1017.93	5: 35.510	5.687	58.803	1017.97
6: Si2Na6O7 / SiMgNa2O4 / SiNa2O3	6: 0.43344	0.01490	0.55165	1012.77	6: 42.810	0.987	56.203	1012.77
7: Si12Mg5Na2O30 / Si6Mg2Na2O15 / Cristobalite	7: 0.66963	0.14727	0.18310	995.54	7: 69.951	10.319	19.730	995.54
8: Si12Mg5Na2O30 / SiMg2O4 / SiMgO3(s4)	8: 0.58222	0.27644	0.14134	985.10	8: 63.738	20.301	15.961	985.12
9: MeO / Si2Na6O7 / SiNa4O4	9: 0.34424	0.07041	0.58536	981.48	9: 34.587	4.745	60.668	981.48
10: MeO / Na2O(s2) / Na2O(s3)	10: 0.16922	0.04891	0.78187	970.05	10: 16.779	3.253	79.968	970.05
11: Si12Mg5Na2O30 / Si6Mg2Na2O15 / SiMg2O4	11: 0.58257	0.26292	0.15451	943.31	11: 63.439	19.205	17.355	943.31
12: MeO / Na2O(s2) / SiNa4O4	12: 0.21086	0.04254	0.74659	930.49	12: 20.887	2.827	76.286	930.49
13: Si6Mg2Na2O15 / Cristobalite / Quartz	13: 0.71560	0.06512	0.21927	926.28	13: 72.615	4.433	22.952	926.28
14: Si4MgNa2O10 / Si6Mg2Na2O15 / Quartz	14: 0.72215	0.02781	0.25003	819.99	14: 72.307	1.868	25.825	819.98
15: Si4MgNa2O10 / Si8Na6O19 / Quartz	15: 0.72191	0.01947	0.25862	785.60	15: 72.065	1.304	26.631	785.61
16: Si2Na2O5(s3) / Si4MgNa2O10 / Si8Na6O19	16: 0.69581	0.02838	0.27581	780.07	16: 69.626	1.905	28.470	780.07
17: Si2Na2O5(s3) / Si3Mg2Na4O10 / SiNa2O3	17: 0.61893	0.06874	0.31233	755.11	17: 62.695	4.671	32.635	755.11
18: Si4MgNa2O10 / Si6Mg2Na2O15 / SiMg2O4	18: 0.59848	0.17034	0.23118	748.11	18: 62.918	12.012	25.070	748.11
19: Si3Mg2Na4O10 / Si4MgNa2O10 / SiMg2O4	19: 0.59945	0.16602	0.23453	740.29	19: 62.918	11.689	25.393	740.29
20: Si2Na2O5(s3) / Si3Mg2Na4O10 / Si4MgNa2O10	20: 0.61403	0.11990	0.26607	712.96	20: 63.372	8.301	28.326	712.96

MgO-P2O5-SiO2,
Weight fraction, Isopleth Mg3P2O8-SiO2



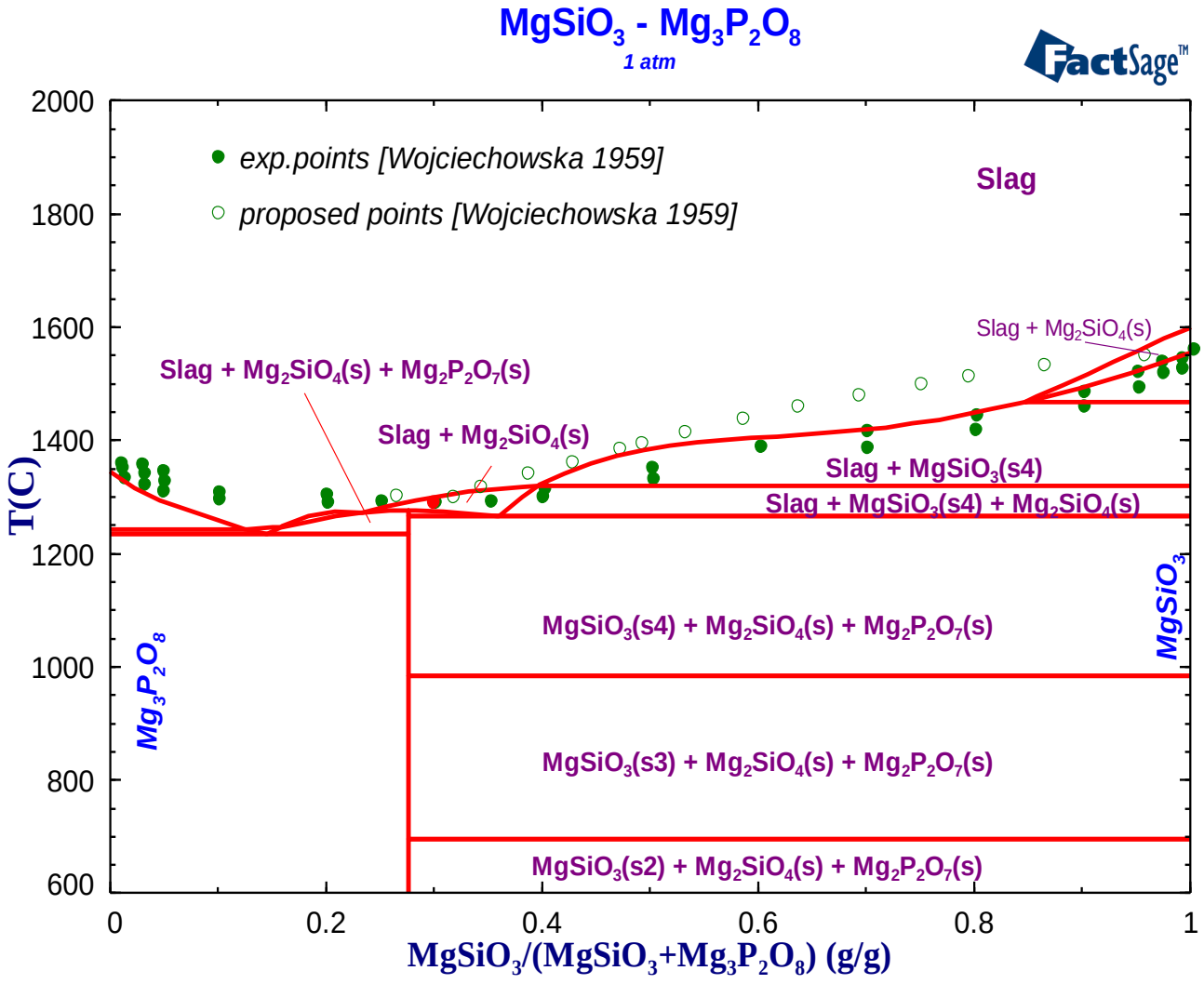
MgO-P2O5-SiO2,

Gewichtsanteil, Isopleth Mg3P2O8-Mg2SiO4

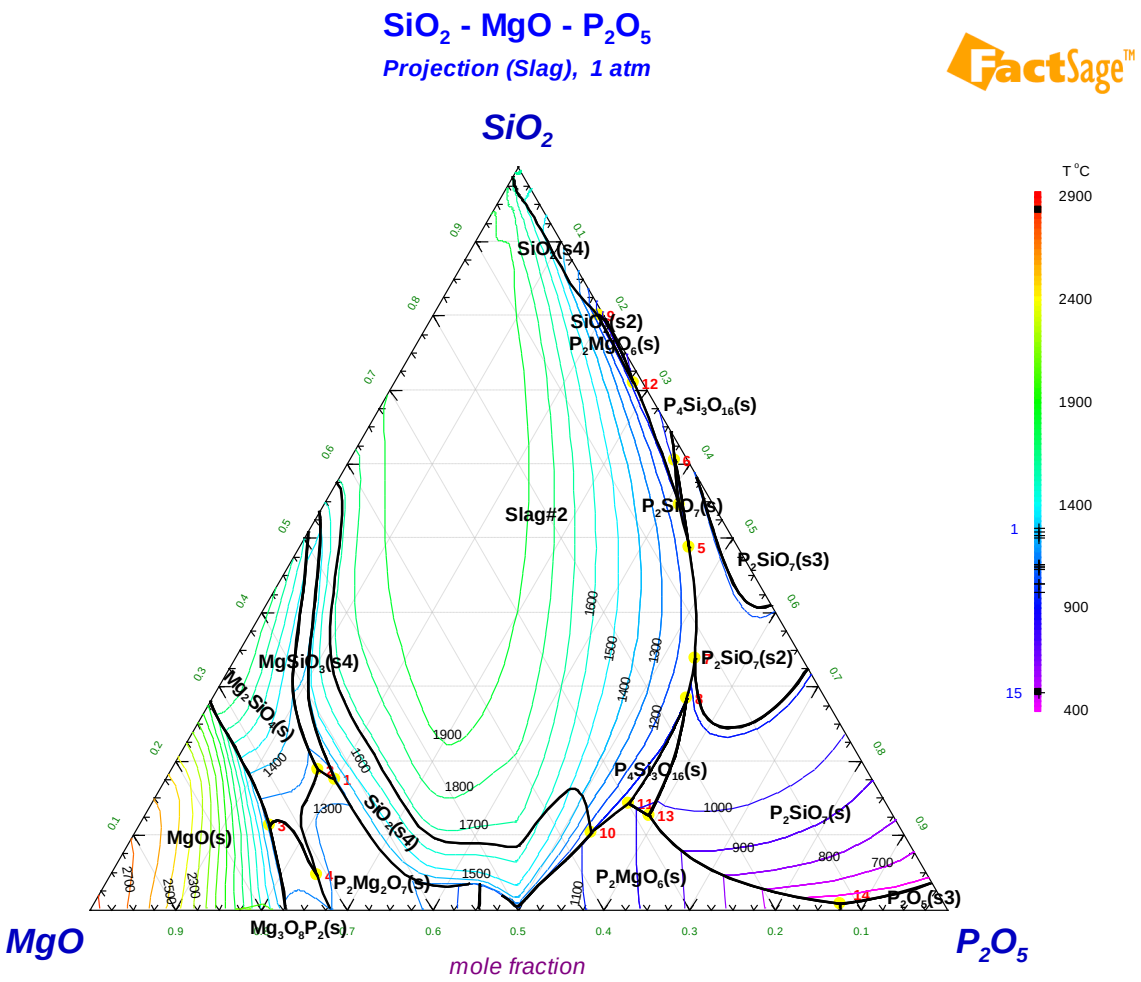


MgO-P2O5-SiO2,

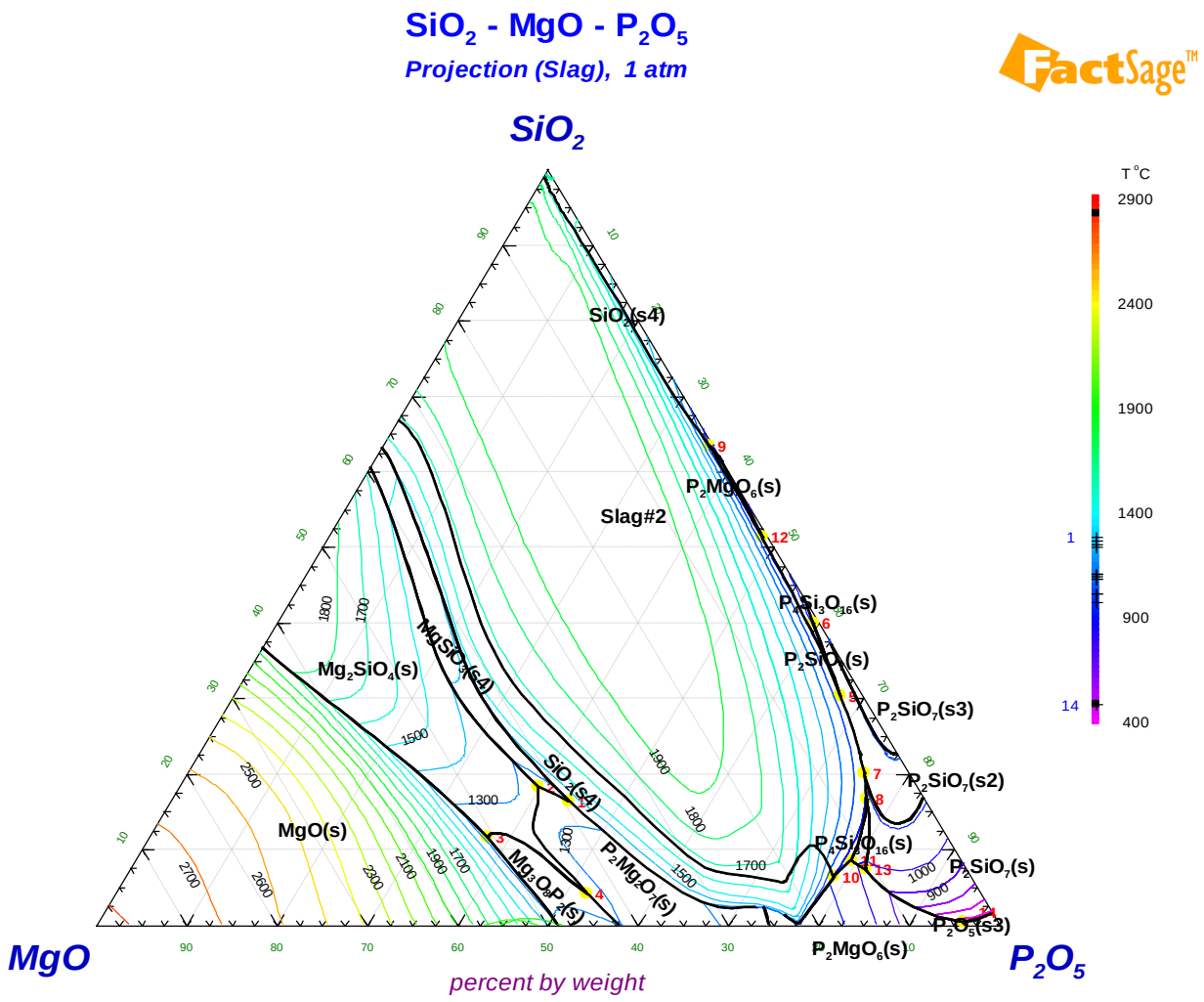
Gewichtsanteil, Isopleth Mg3P2O8-MgSiO3



Mole fraction, Liquidussurface



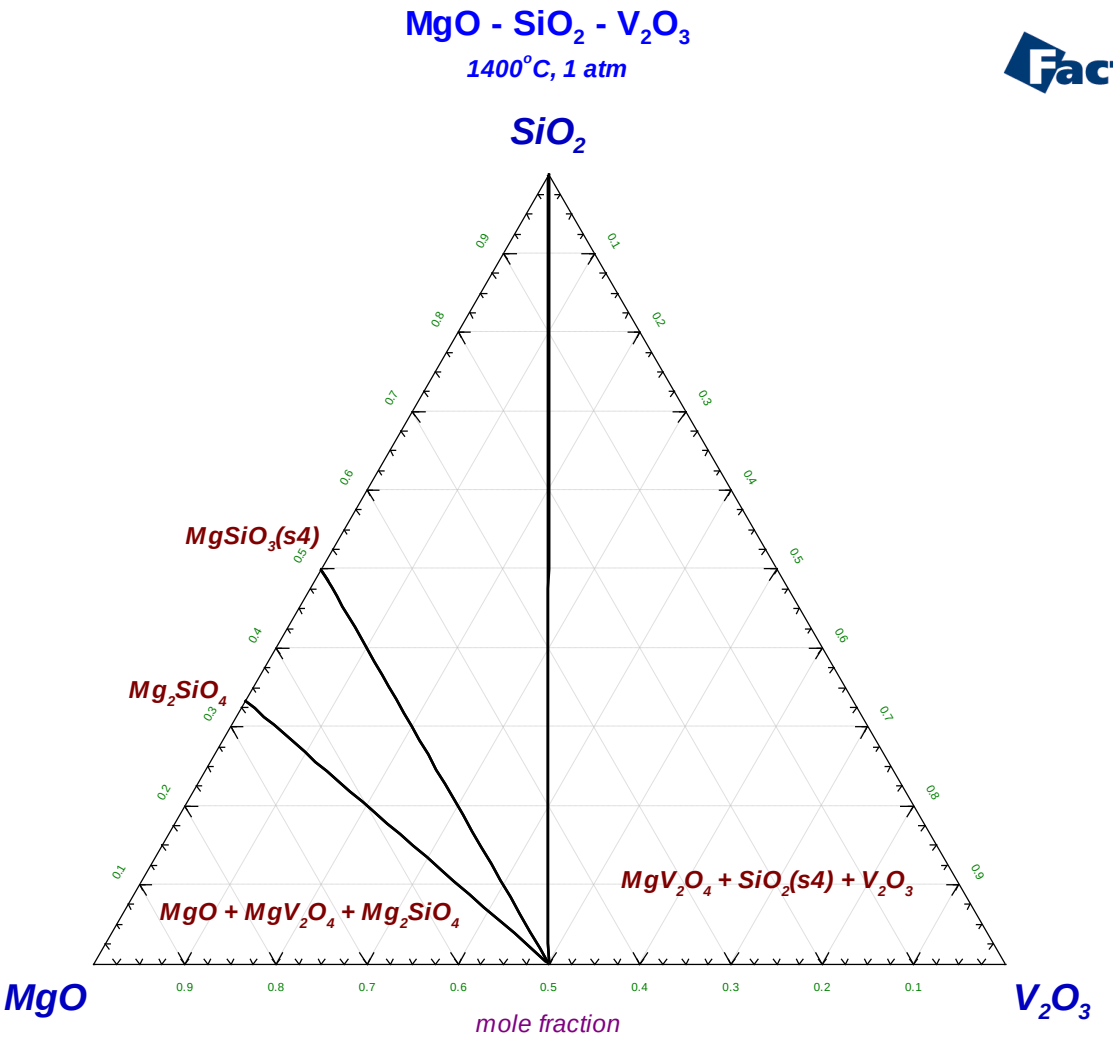
Weight percent, Liquidussurface

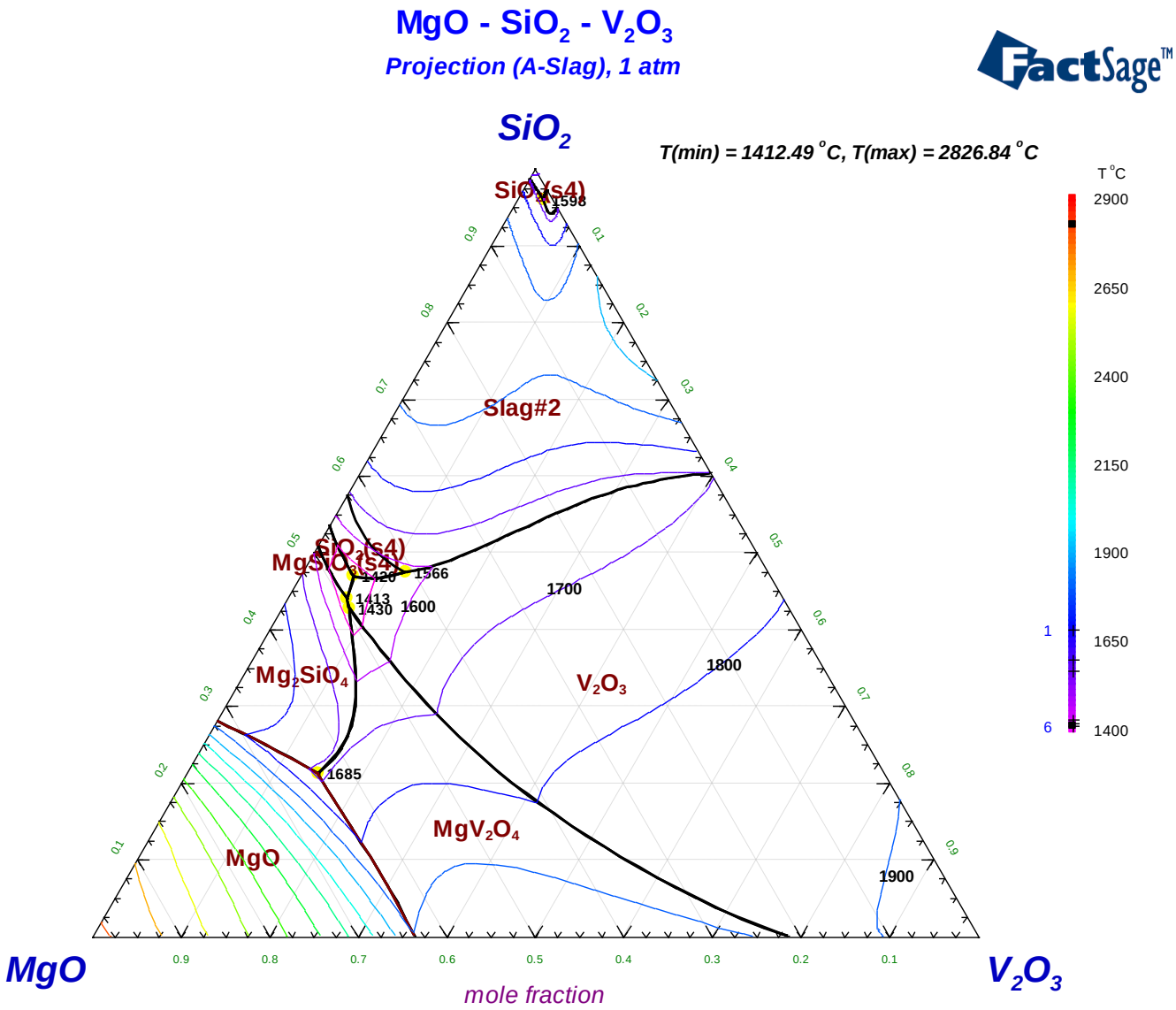


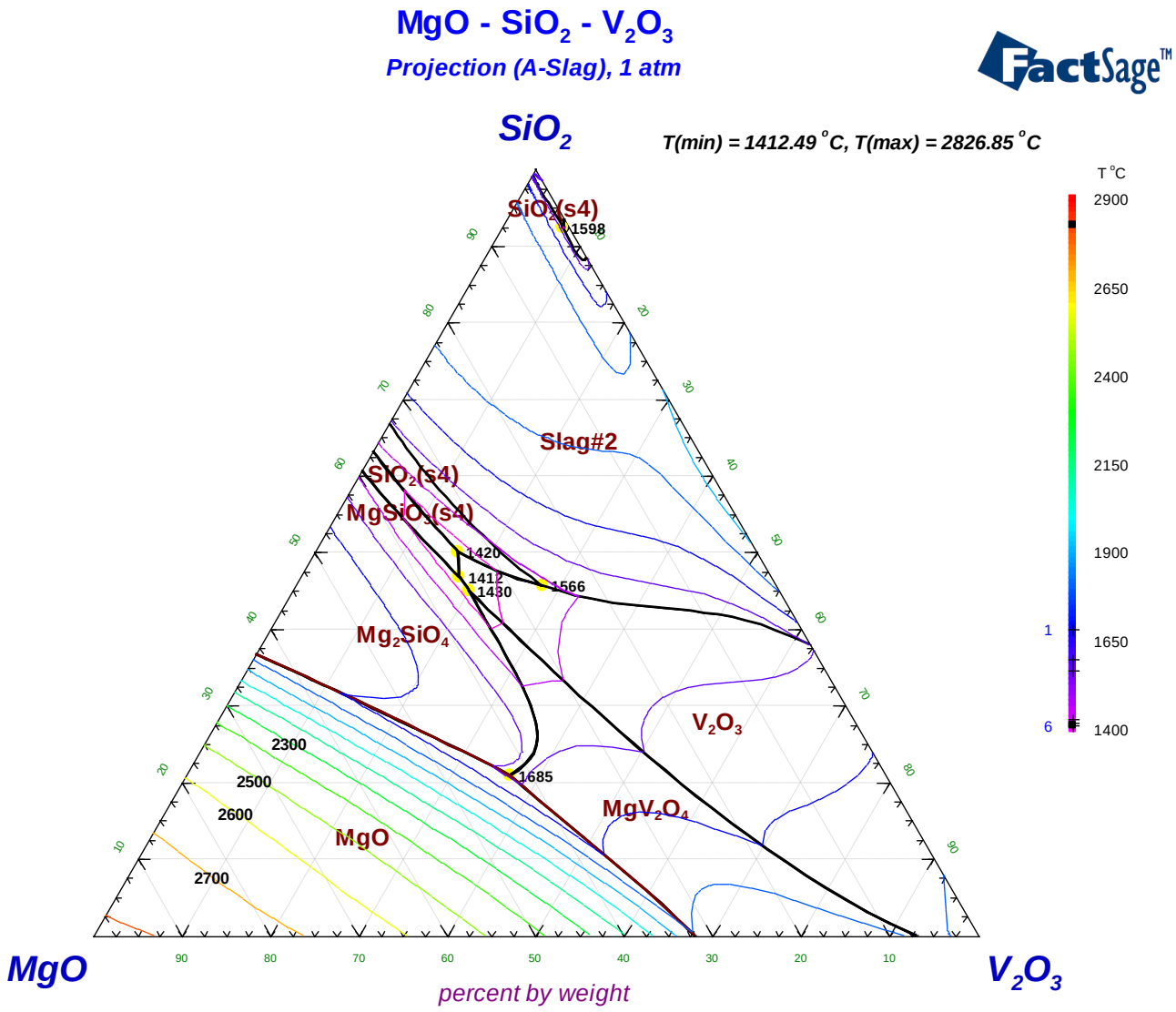
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction					Weight percent				
	A = SiO2, B = MgO, C = P2O5					A = SiO2, B = MgO, C = P2O5				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: MgSiO3(s4) / P2Mg2O7 / Cristobalite	1:	0.17445	0.62655	0.19900	1281.75	1:	16.382	39.469	44.149	1281.75
2: Mg2SiO4 / MgSiO3(s4) / P2Mg2O7	2:	0.18815	0.63988	0.17196	1264.97	2:	18.381	41.932	39.687	1264.98
3: Mg2SiO4 / Mg3O8P2 / MgO	3:	0.11252	0.73384	0.15364	1245.53	3:	11.627	50.867	37.507	1245.53
4: Mg2SiO4 / Mg3O8P2 / P2Mg2O7	4:	0.04586	0.71185	0.24229	1233.71	4:	4.185	43.578	52.237	1233.71
5: P2SiO7(s1) / P2SiO7(s2) / Slag#2	5:	0.48737	0.05663	0.45600	1106.85	5:	30.411	2.370	67.219	1106.85
6: P2SiO7(s1) / P2SiO7(s2) / P4Si3O16	6:	0.60507	0.01413	0.38080	1106.85	6:	39.961	0.626	59.413	1106.85
7: P2SiO7(s1) / P2SiO7(s2) / Slag#2	7:	0.33869	0.12436	0.53695	1106.85	7:	20.034	4.934	75.032	1106.85
8: P2SiO7(s1) / Slag#2 / P4Si3O16	8:	0.28385	0.16137	0.55478	1092.72	8:	16.670	6.357	76.972	1092.72
9: P2MgO6 / Cristobalite / Slag#2	9:	0.80058	0.00655	0.19287	1083.00	9:	63.507	0.348	36.144	1083.00
10: P2MgO6 / Cristobalite / Slag#2	10:	0.10297	0.36282	0.53421	1082.99	10:	6.402	15.132	78.466	1082.99
11: P2MgO6 / P4Si3O16 / Slag#2	11:	0.14231	0.29917	0.55852	1013.45	11:	8.560	12.072	79.368	1013.45
12: P2MgO6 / P4Si3O16 / Slag#2	12:	0.70891	0.01020	0.28090	1013.47	12:	51.395	0.496	48.109	1013.45
13: P2MgO6 / P2SiO7(s1) / P4Si3O16	13:	0.12646	0.28388	0.58967	970.70	13:	7.395	11.136	81.468	970.70
14: P2MgO6 / P2O5(s3) / P2SiO7(s1)	14:	0.00736	0.12080	0.87184	486.27	14:	0.343	3.772	95.885	486.28

MgO-SiO2-V2O3, Mole fraction, 1400°C



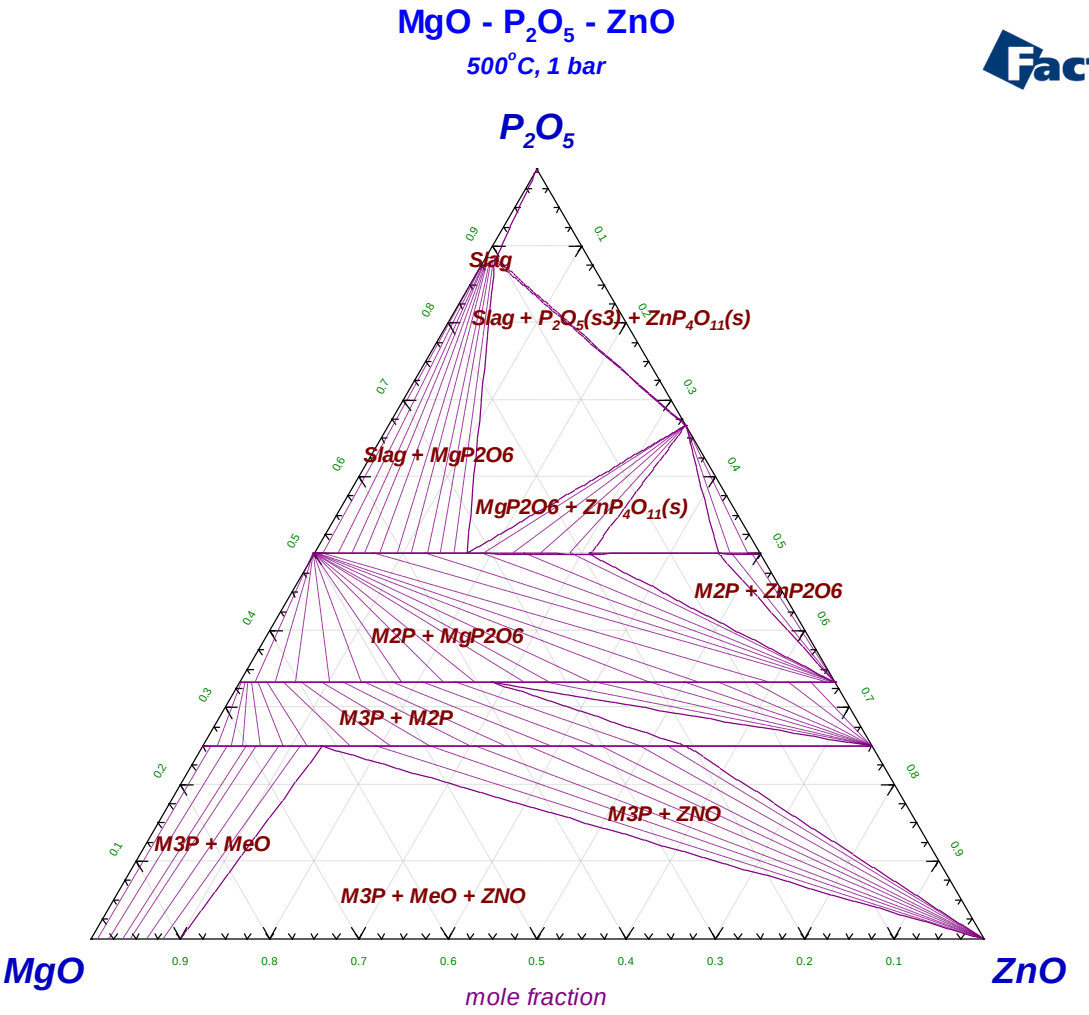

MgO - SiO2 - V2O3
Projection (A-Slag), 1 atm
FactSage™
SiO2
T(min) = 1412.49 °C, T(max) = 2826.84 °C
T °C
2900
2650
2400
2150
1900
1650
1400
SiO2(s4)
1598
Slag#2
SiO2(s4)
MgSiO3(s4)
1420
1566
1413
1430
1600
1700
1800
1900
Mg2SiO4
V2O3
1685
MgV2O4
MgO
MgO
V2O3
mole fraction


MgO - SiO2 - V2O3
Projection (A-Slag), 1 atm
SiO2
T(min) = 1412.49 °C, T(max) = 2826.85 °C
T °C
2900
2650
2400
2150
1900
1650
1400
SiO2(s4)
1598
Slag#2
SiO2(s4)
MgSiO3(s4)
1420
1412
1430
1566
Mg2SiO4
V2O3
1685
MgV2O4
MgO
2300
2500
2600
2700
MgO
V2O3
percent by weight

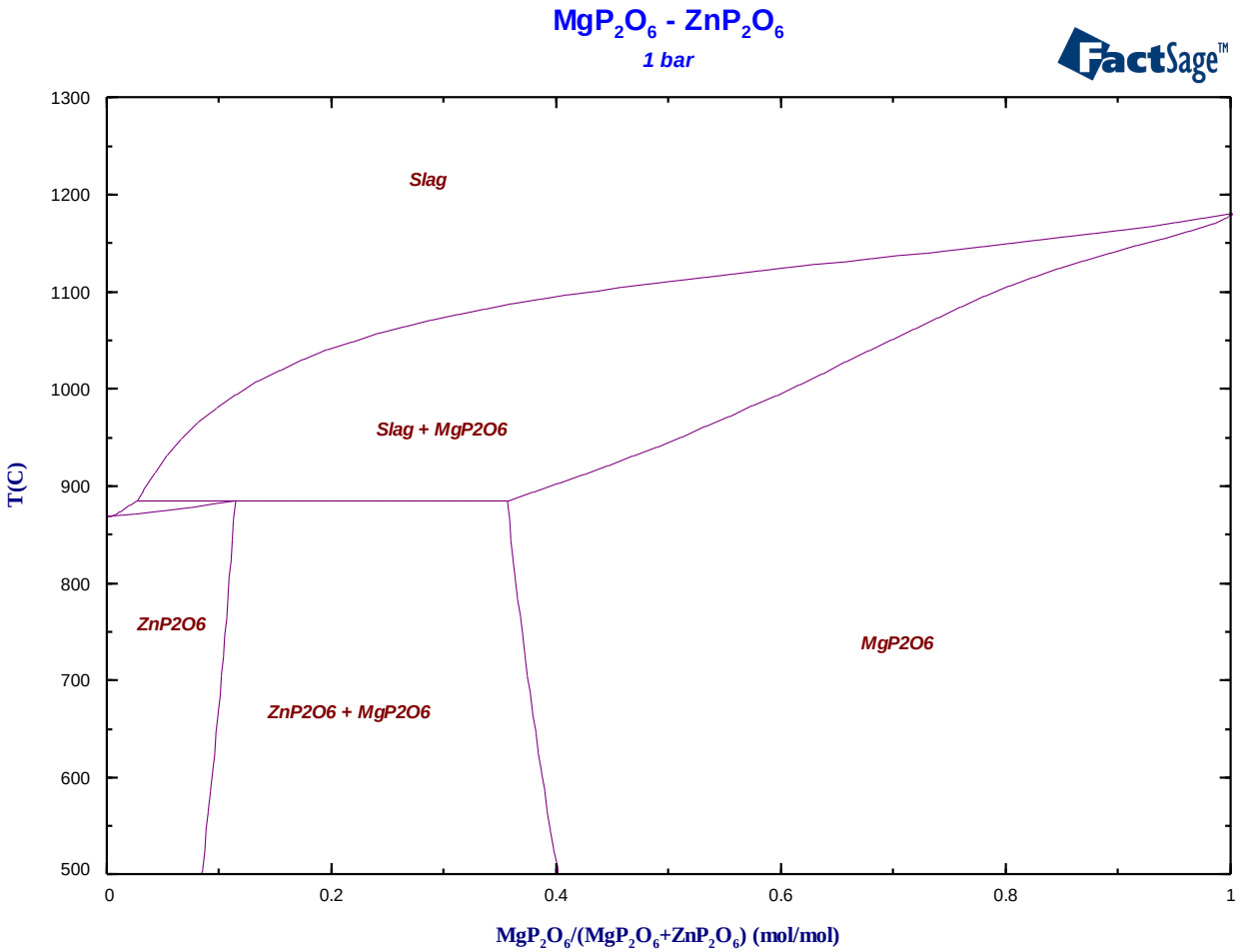
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction				Weight percent			
	A = SiO2, B = MgO, C = V2O3				A = SiO2, B = MgO, C = V2O3			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1. Mg2SiO4 / MgO / MgV2O4	0.21204	0.63953	0.14843	1684.60	0.20967	42.421	36.612	1684.56
2. SiO2(s4) / Slag#2 / V2O3	0.96054	0.01081	0.02864	1598.28	92.427	0.698	6.875	1598.28
3. SiO2(s4) / Slag#2 / V2O3	0.47457	0.40941	0.11602	1565.71	45.693	26.442	27.865	1565.70
4. Mg2SiO4 / MgV2O4 / V2O3	0.42816	0.49617	0.07568	1429.66	45.080	35.043	19.876	1429.66
5. MgSiO3(s4) / SiO2(s4) / V2O3	0.46906	0.47025	0.06069	1419.93	50.119	33.705	16.177	1419.93
6. Mg2SiO4 / MgSiO3(s4) / V2O3	0.43985	0.49255	0.06760	1412.51	46.849	35.191	17.961	1412.49

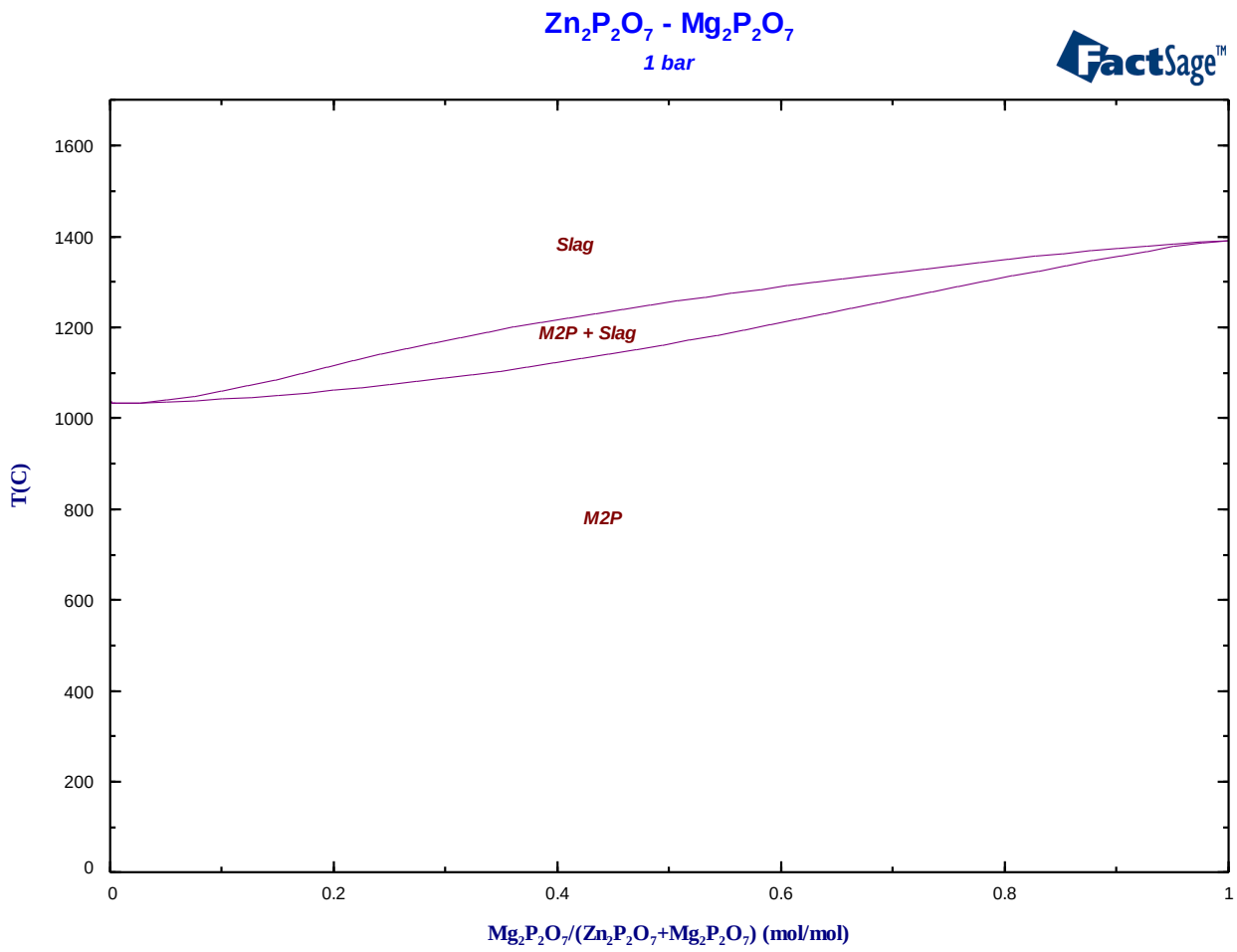
Mole fraction, 500°C



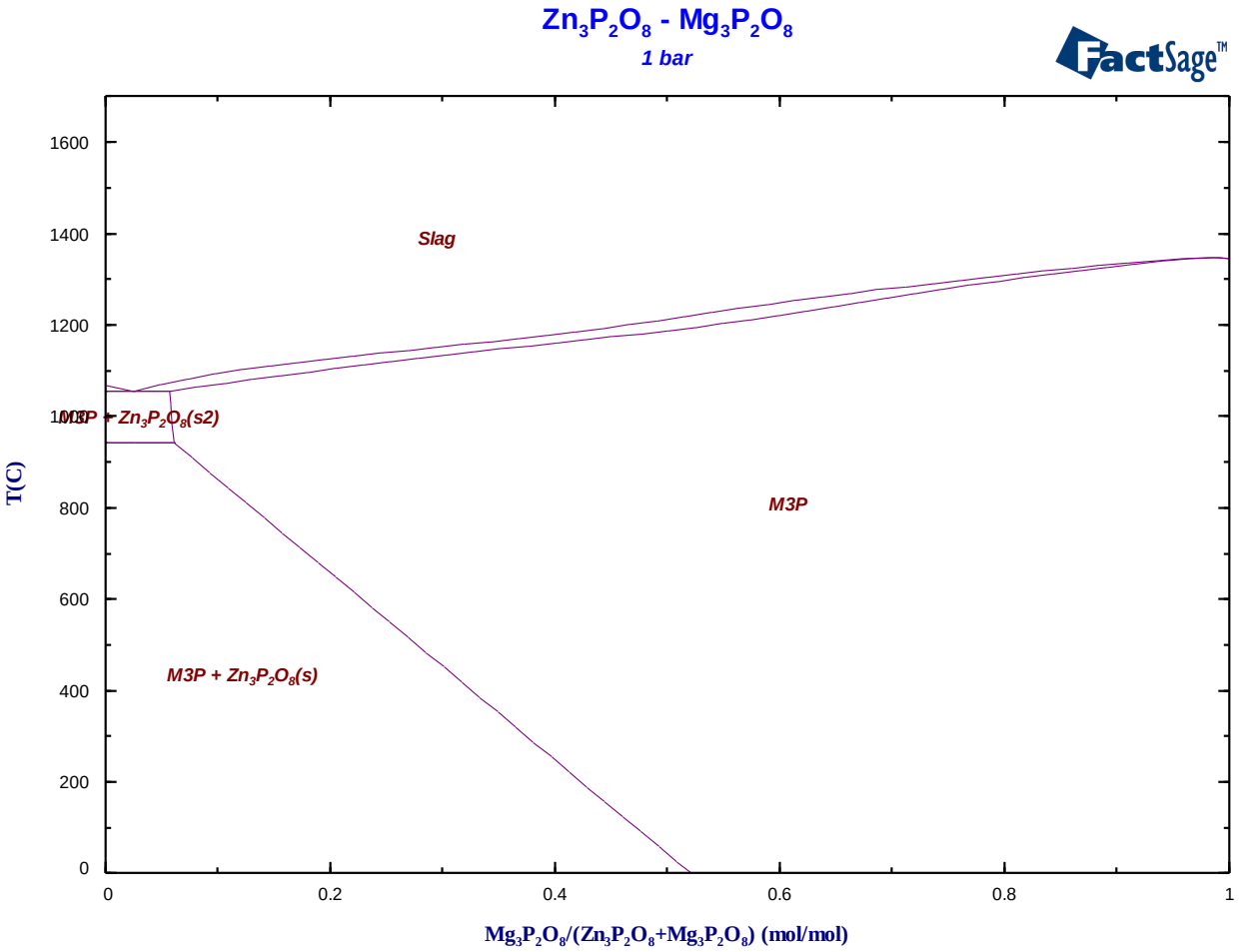
Mole fraction, Isopleth MgP2O6-ZnP2O6

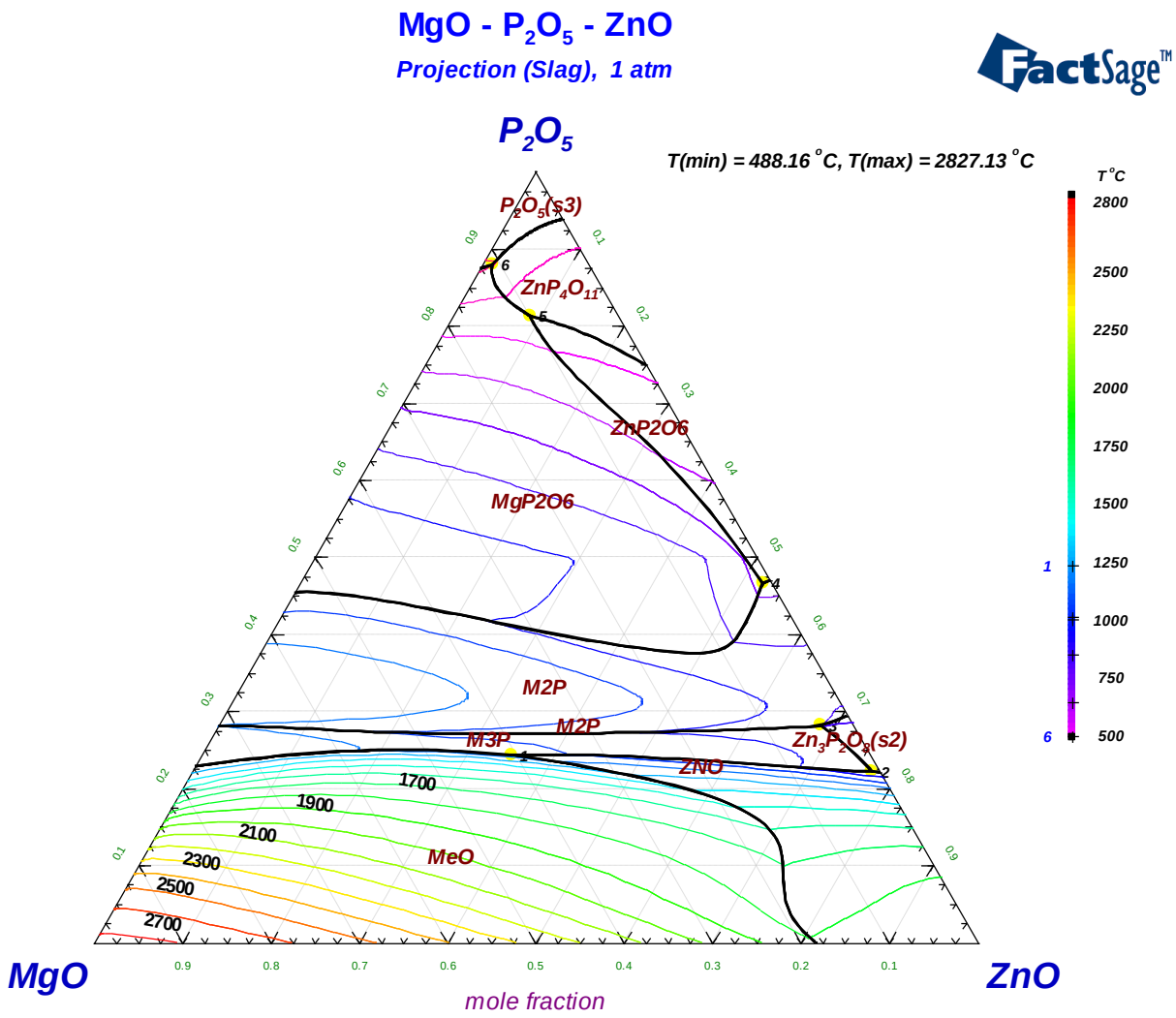


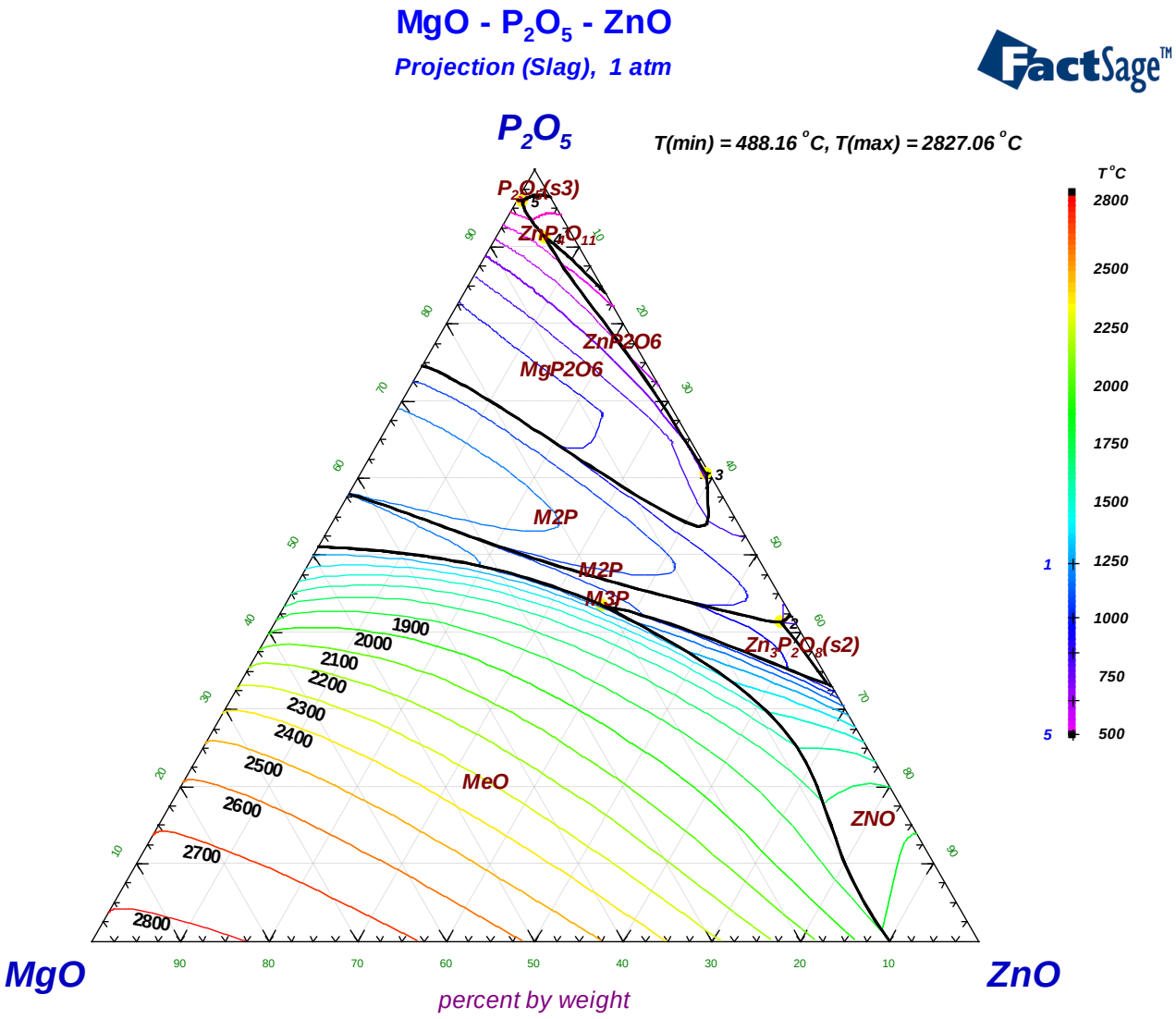
Mole fraction, Isopleth Mg2P2O7-Zn2P2O7



Mole fraction, Isopleth Mg3P2O8-Zn3P2O8



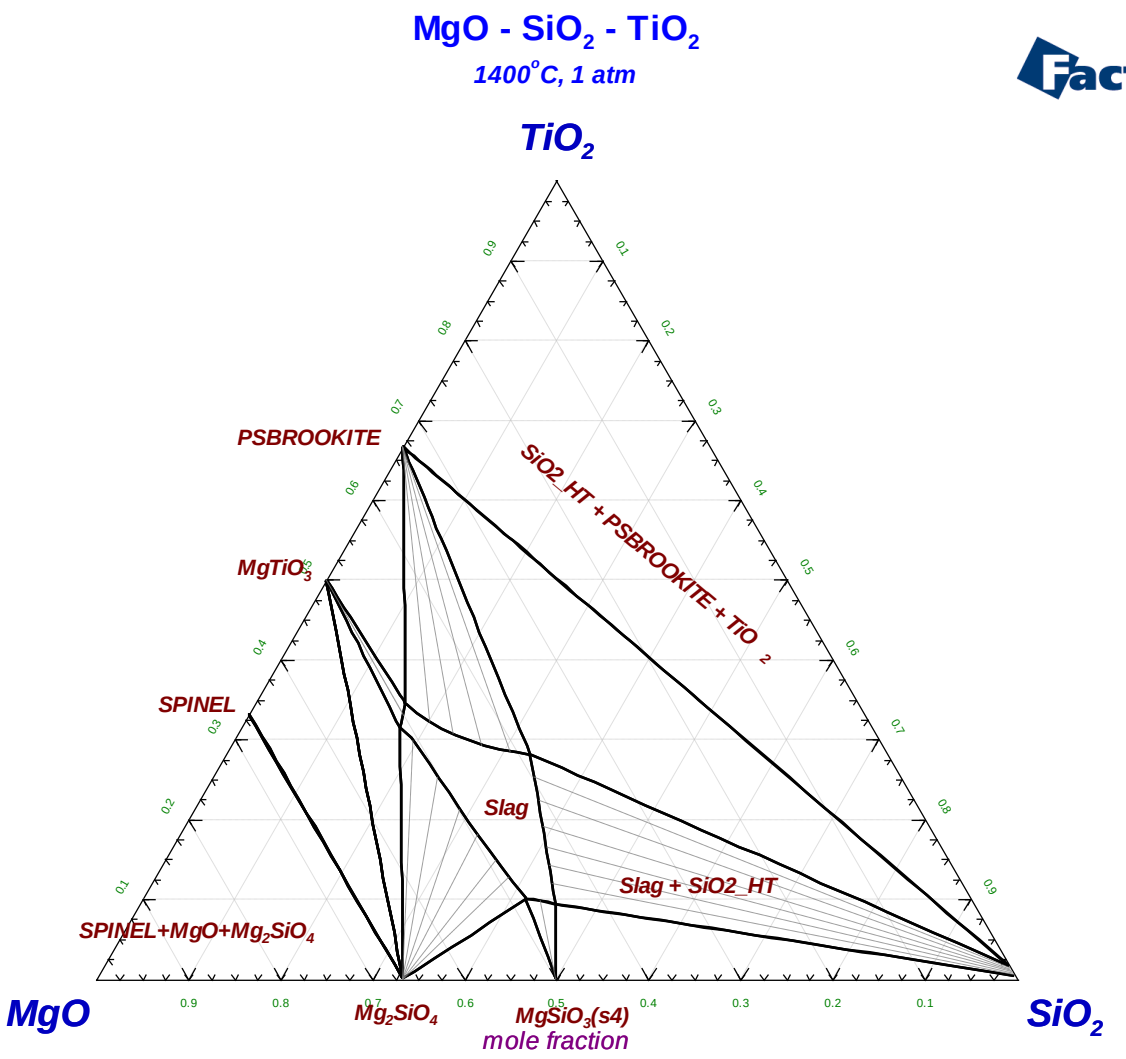

MgO - P2O5 - ZnO
Projection (Slag), 1 atm
FactSage™
P2O5
T(min) = 488.16 °C, T(max) = 2827.13 °C
T °C
2800
2500
2250
2000
1750
1500
1250
1000
750
500
P2O5(s3)
ZnP4O11
ZnP2O6
MgP2O6
M2P
M2P
M3P
Zn3P2O8(s2)
ZnO
MeO
1700
1900
2100
2300
2500
2700
MgO
ZnO
mole fraction


MgO - P2O5 - ZnO
Projection (Slag), 1 atm
FactSage™
P2O5
T(min) = 488.16 °C, T(max) = 2827.06 °C
T°C
2800
2500
2250
2000
1750
1500
1250
1000
750
500
P2O5(s3)
ZnP4O11
ZnP2O6
MgP2O6
M2P
M2P
M3P
Zn3P2O8(s2)
MeO
ZNO
1900
2000
2100
2200
2300
2400
2500
2600
2700
2800
MgO
ZnO
percent by weight

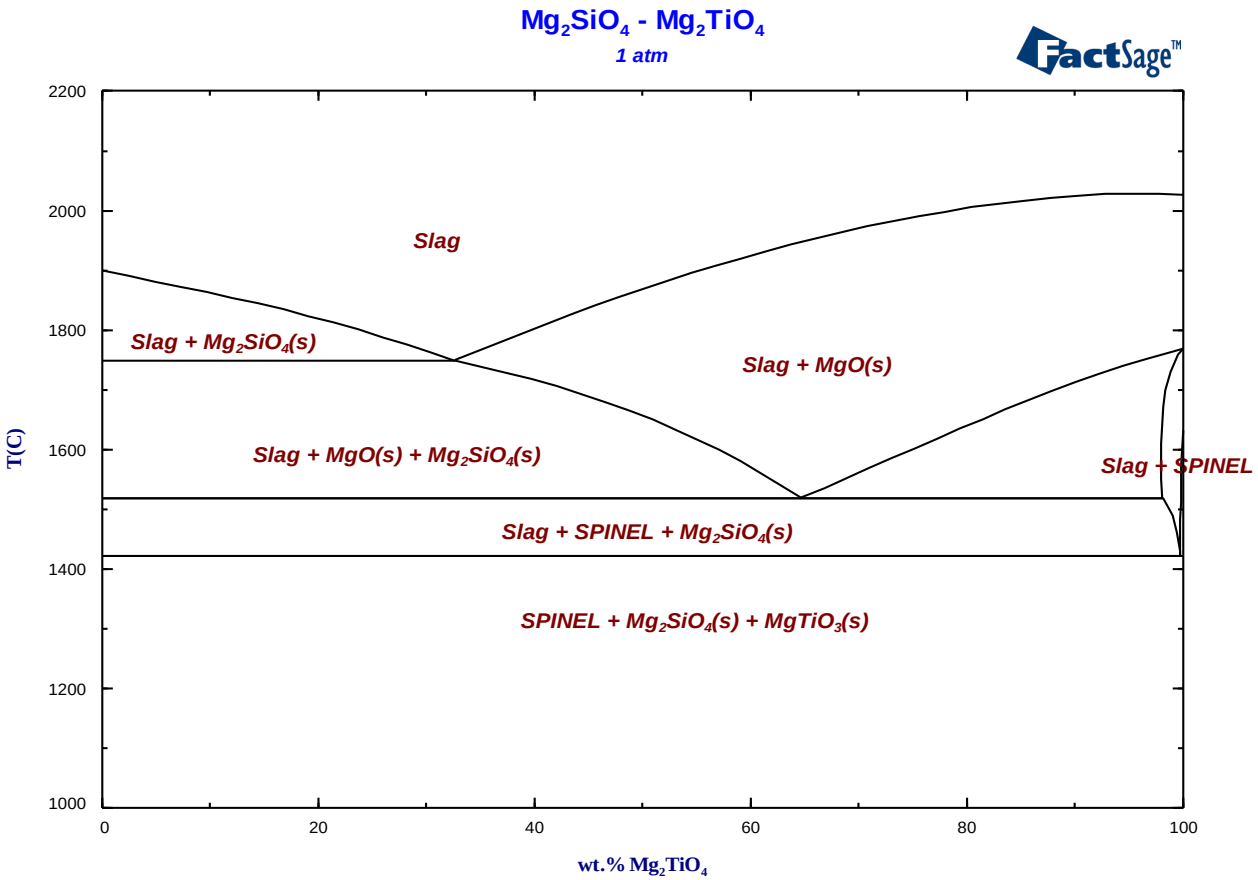
Invariant equilibria on the liquidus surface

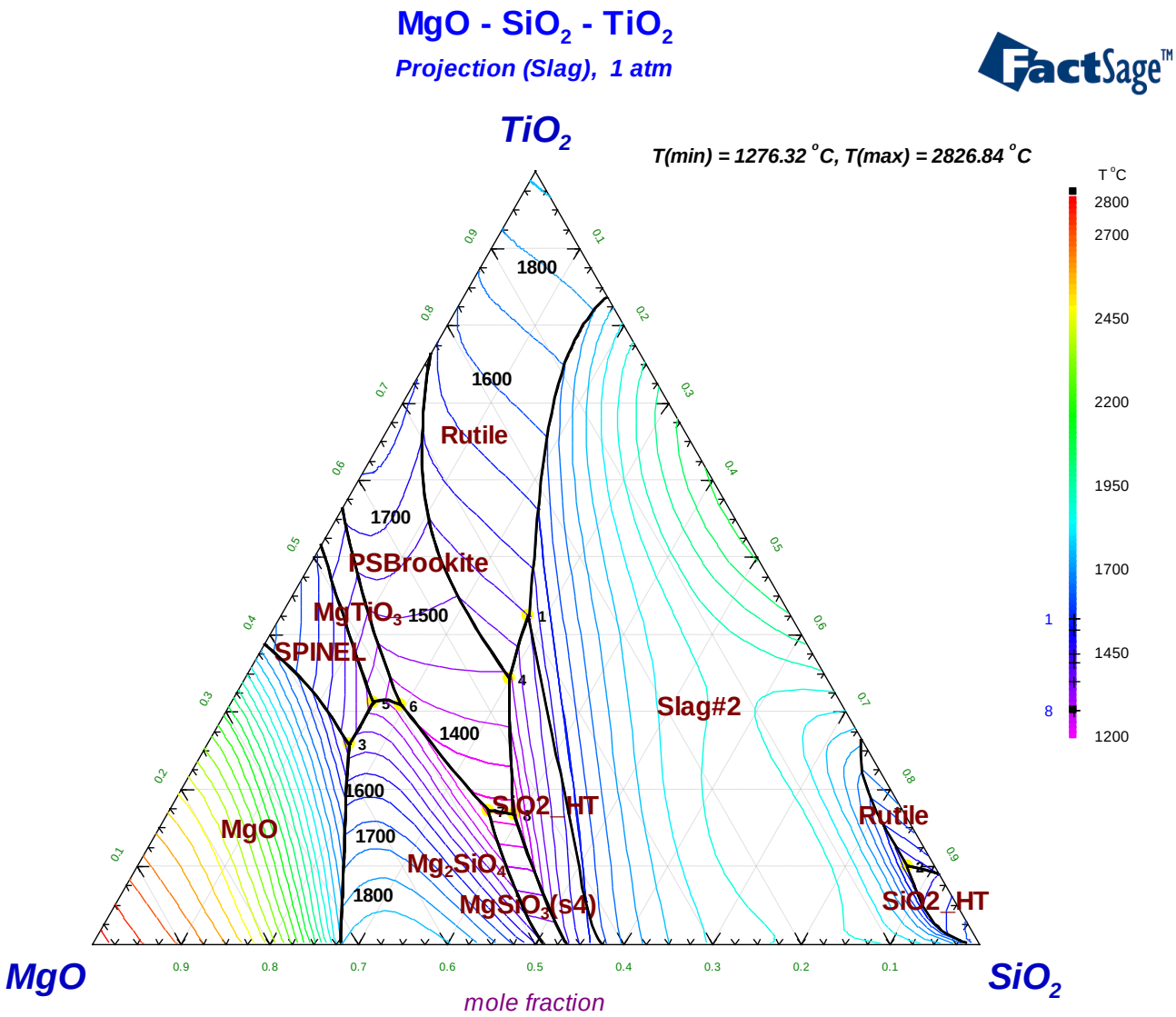
Intersections with slag	Mole fraction					Weight percent				
	A = P2O5, B = MgO, C = ZnO					A = P2O5, B = MgO, C = ZnO				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: M3P / MeO / ZNO	1:	0.24332	0.40617	0.35051	1229.58	1:	43.481	20.609	35.910	1229.58
2: M2P / M3P / Zn3P2O8_S2(s2)	2:	0.28185	0.03634	0.68181	998.36	2:	41.263	1.510	57.227	998.36
3: M2P / MgP2O6 / ZnP2O6	3:	0.46601	0.01003	0.52396	845.29	3:	60.579	0.370	39.050	845.35
4: MgP2O6 / ZnP2O6 / ZnP4O11_S1(s)	4:	0.81278	0.10001	0.08721	639.68	4:	91.203	3.187	5.611	639.68
5: MgP2O6 / P2O5_O'-Phase(s3) / ZnP4O11_S1(s)	5:	0.87948	0.10960	0.01092	495.12	5:	95.923	3.394	0.683	495.12

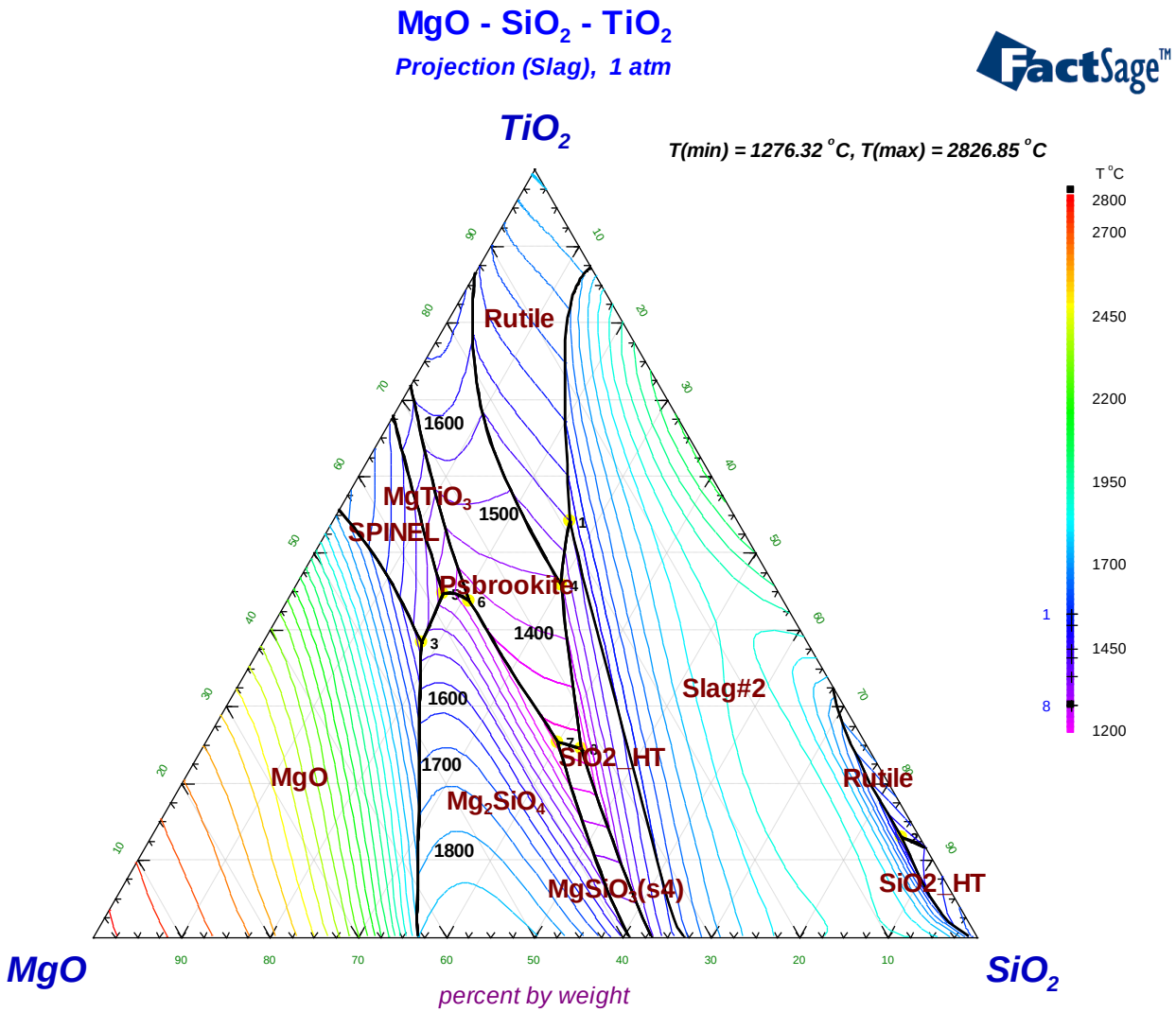
MgO-SiO2-TiO2,
Mole fraction, 1400°C



MgO-SiO2-TiO2,
Weight percent, Isopleth section Mg2SiO4-Mg2TiO4




MgO - SiO2 - TiO2
Projection (Slag), 1 atm
FactSage™
TiO2
T(min) = 1276.32 °C, T(max) = 2826.84 °C
T °C
2800
2700
2450
2200
1950
1700
1450
1200
1800
1600
1700
1500
1400
1600
1700
1800
Rutile
PSBrookite
MgTiO3
SPINEL
Slag#2
MgO
SiO2_HT
Mg2SiO4
MgSiO3(s4)
Rutile
SiO2_HT
MgO
SiO2
mole fraction

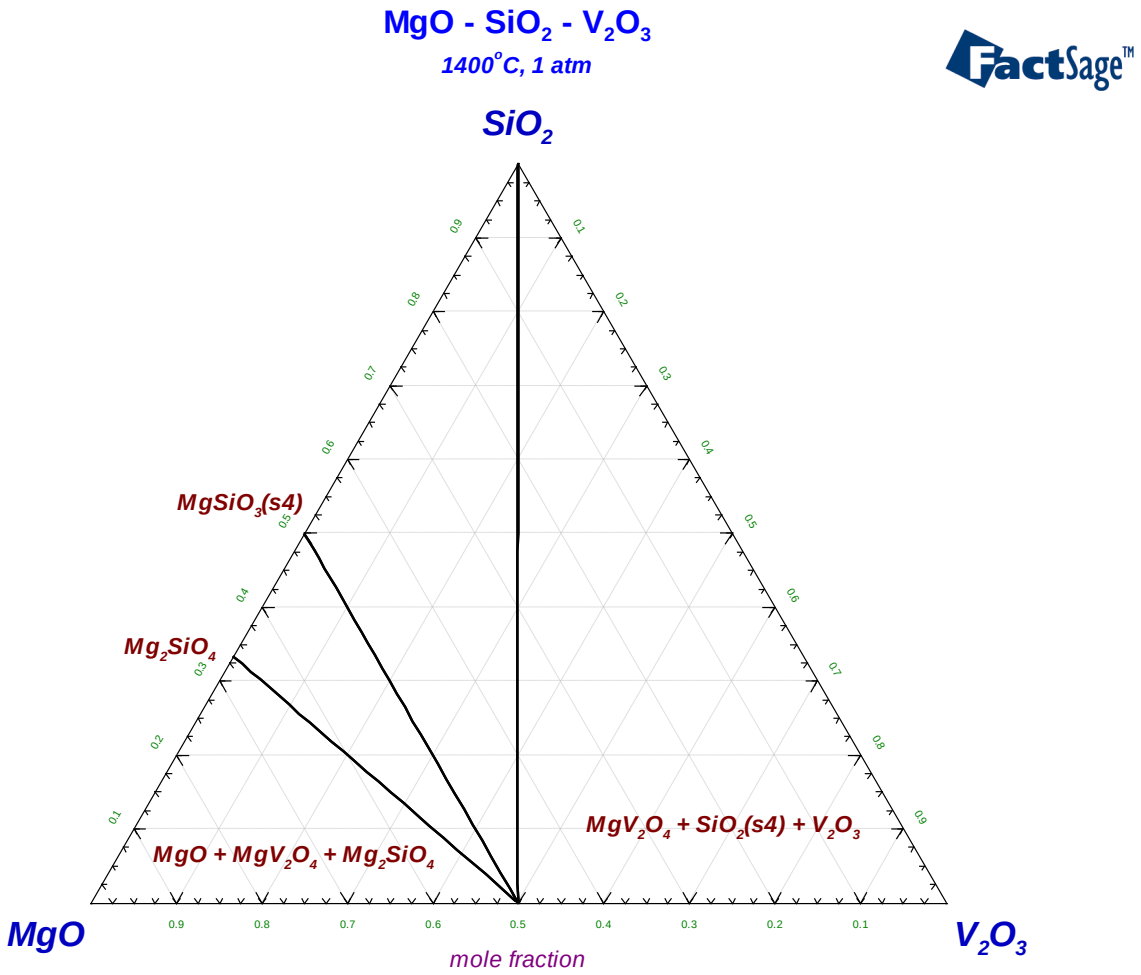

MgO - SiO2 - TiO2
Projection (Slag), 1 atm
FactSage™
TiO2
T(min) = 1276.32 °C, T(max) = 2826.85 °C
T °C
2800
2700
2450
2200
1950
1700
1450
1200
Rutile
1600
MgTiO3
SPINEL
1500
Psbrookite
1400
Slag#2
1600
1700
MgO
Mg2SiO4
1800
SiO2_HT
MgSiO3(s4)
Rutile
SiO2_HT
MgO
SiO2
percent by weight

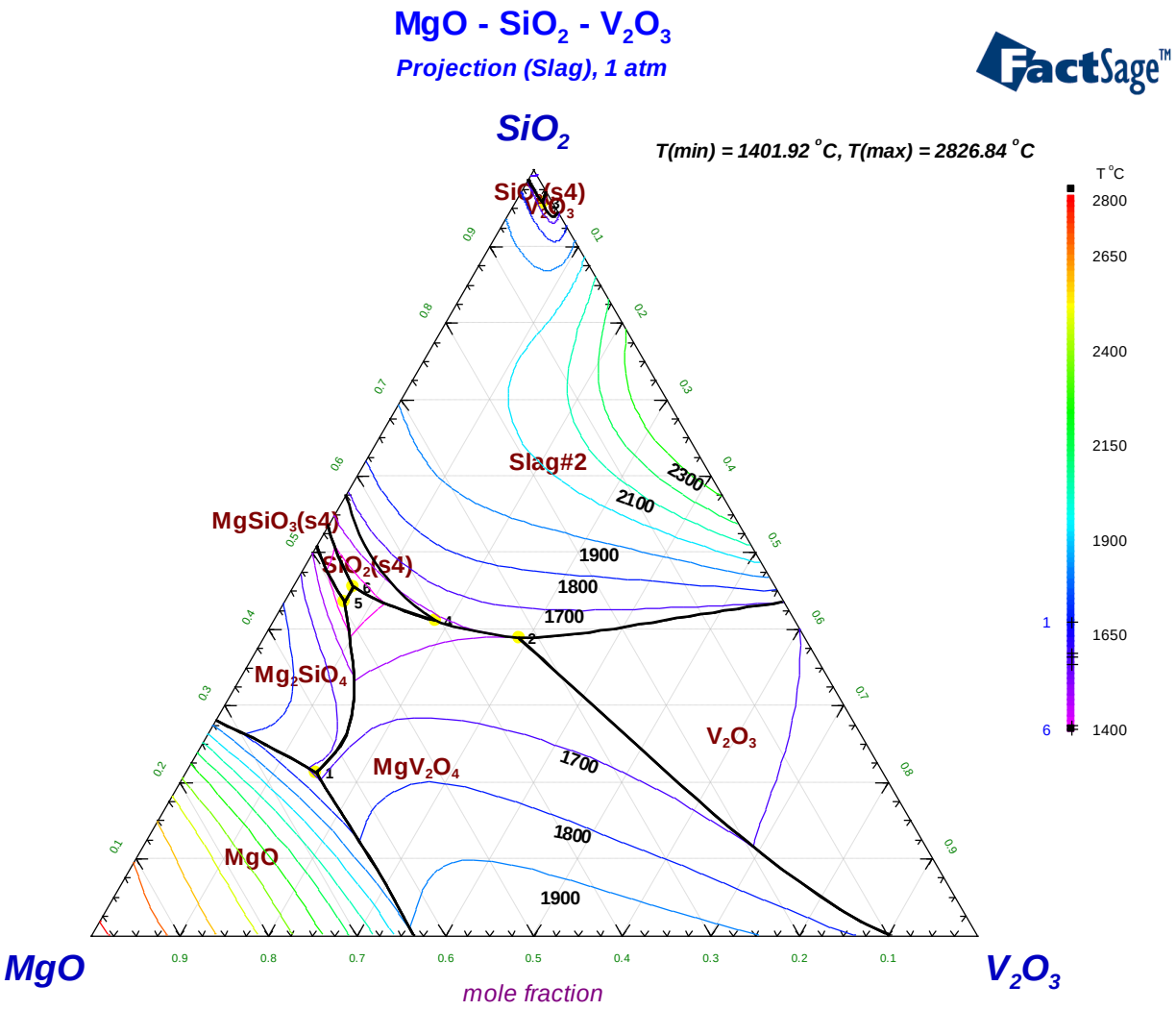
Invariant equilibria on the liquidus surface

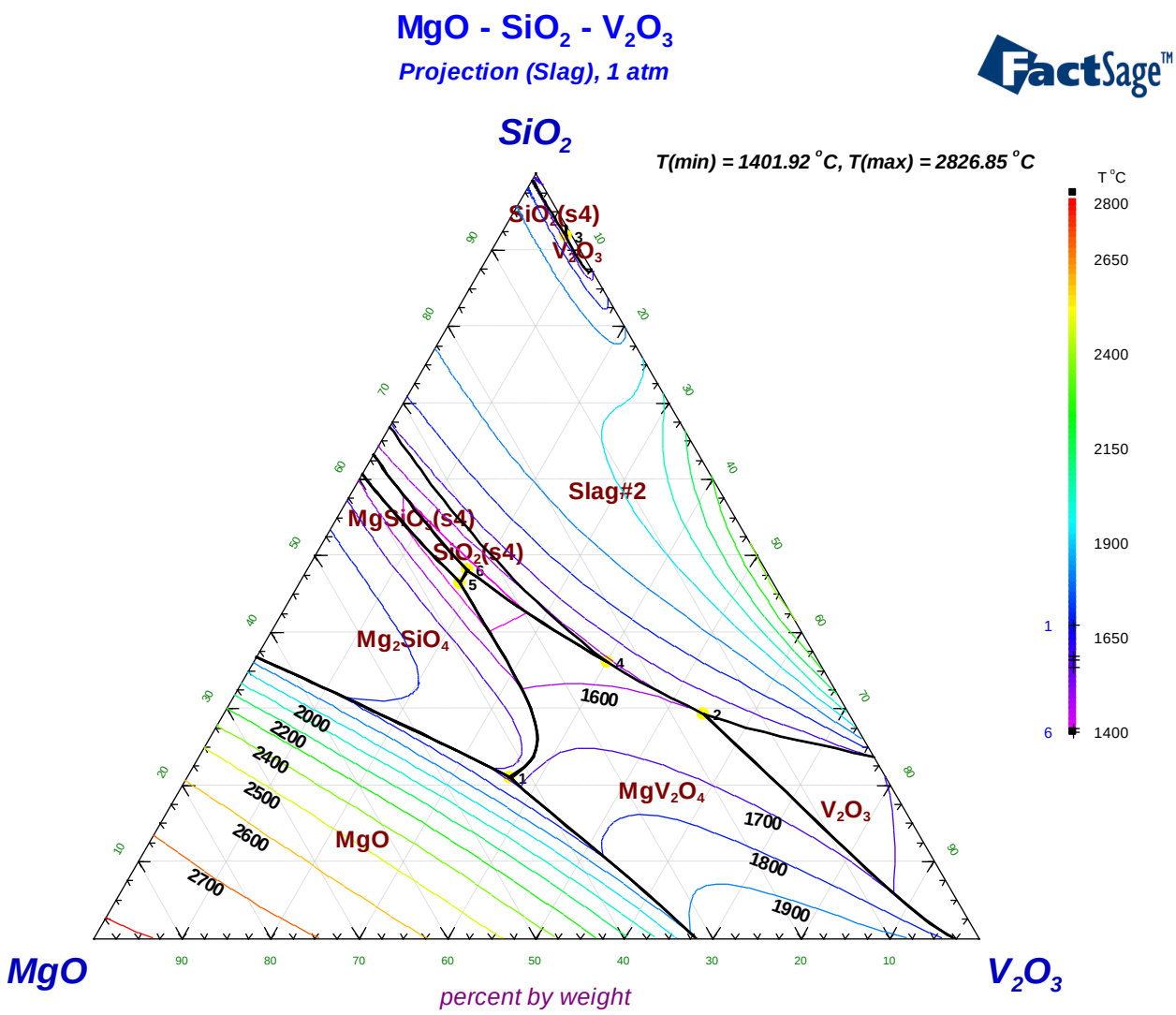
Intersections with slag	Mole fraction					Weight percent				
	A = TiO2, B = MgO, C = SiO2					A = TiO2, B = MgO, C = SiO2				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: Rutile / SiO2_HT / Slag#2	1:	0.42437	0.29491	0.28072	1549.63	1:	54.102	18.974	26.924	1549.61
2: Rutile / SiO2_HT / Slag#2	2:	0.10020	0.03004	0.86975	1549.59	2:	13.019	1.970	85.011	1549.59
3: Mg2SiO4 / MgO / SPINEL	3:	0.25773	0.58126	0.16101	1518.44	3:	38.342	43.638	18.020	1518.44
4: Pseudobrookite / Rutile / SiO2_HT	4:	0.34269	0.35739	0.29992	1443.96	4:	45.773	24.090	30.137	1443.96
5: Mg2SiO4 / MgTiO3 / SPINEL	5:	0.31259	0.52671	0.16070	1420.65	5:	44.701	38.011	17.288	1420.65
6: Mg2SiO4 / Pseudobrookite / MgTiO3_S1(s)	6:	0.30886	0.49682	0.19432	1362.12	6:	43.763	35.524	20.713	1362.12
7: Mg2SiO4 / MgSiO3(s4) / Pseudobrookite	7:	0.17210	0.46698	0.36092	1277.86	7:	25.336	34.692	39.972	1277.86
8: MgSiO3(s4) / Pseudobrookite / SiO2_HT	8:	0.16741	0.44024	0.39235	1276.32	8:	24.448	32.445	43.107	1276.32

MgO-SiO2-V2O3,

MgO-SiO2-V2O3,
Mole fraction, 1400°C



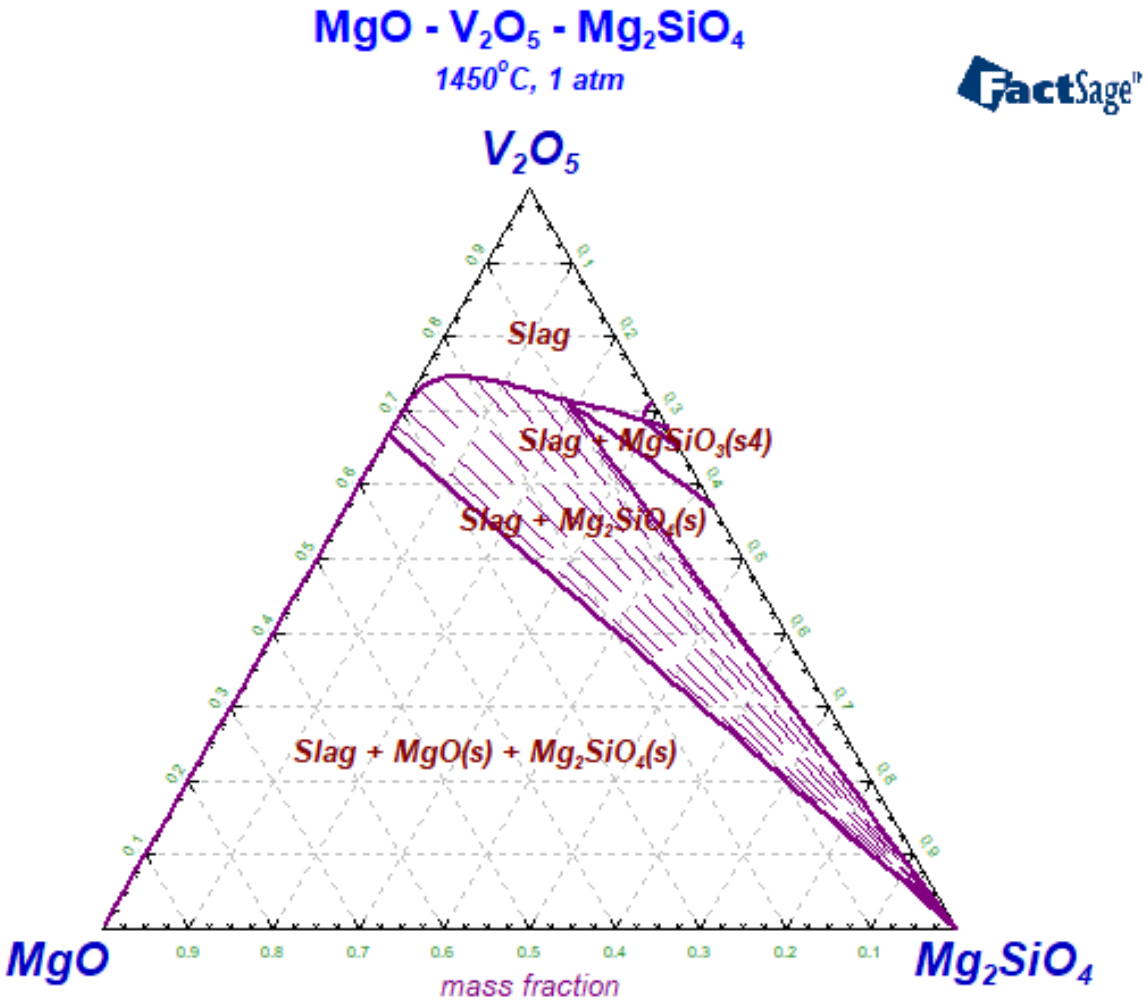

MgO - SiO2 - V2O3
Projection (Slag), 1 atm
FactSage™
SiO2
T(min) = 1401.92 °C, T(max) = 2826.84 °C
T °C
2800
2650
2400
2150
1900
1650
1400
SiO2(s4)
V2O3
Slag#2
MgSiO3(s4)
SiO2(s4)
Mg2SiO4
MgV2O4
V2O3
MgO
2300
2100
1900
1800
1700
1700
1800
1900
MgO
V2O3
mole fraction

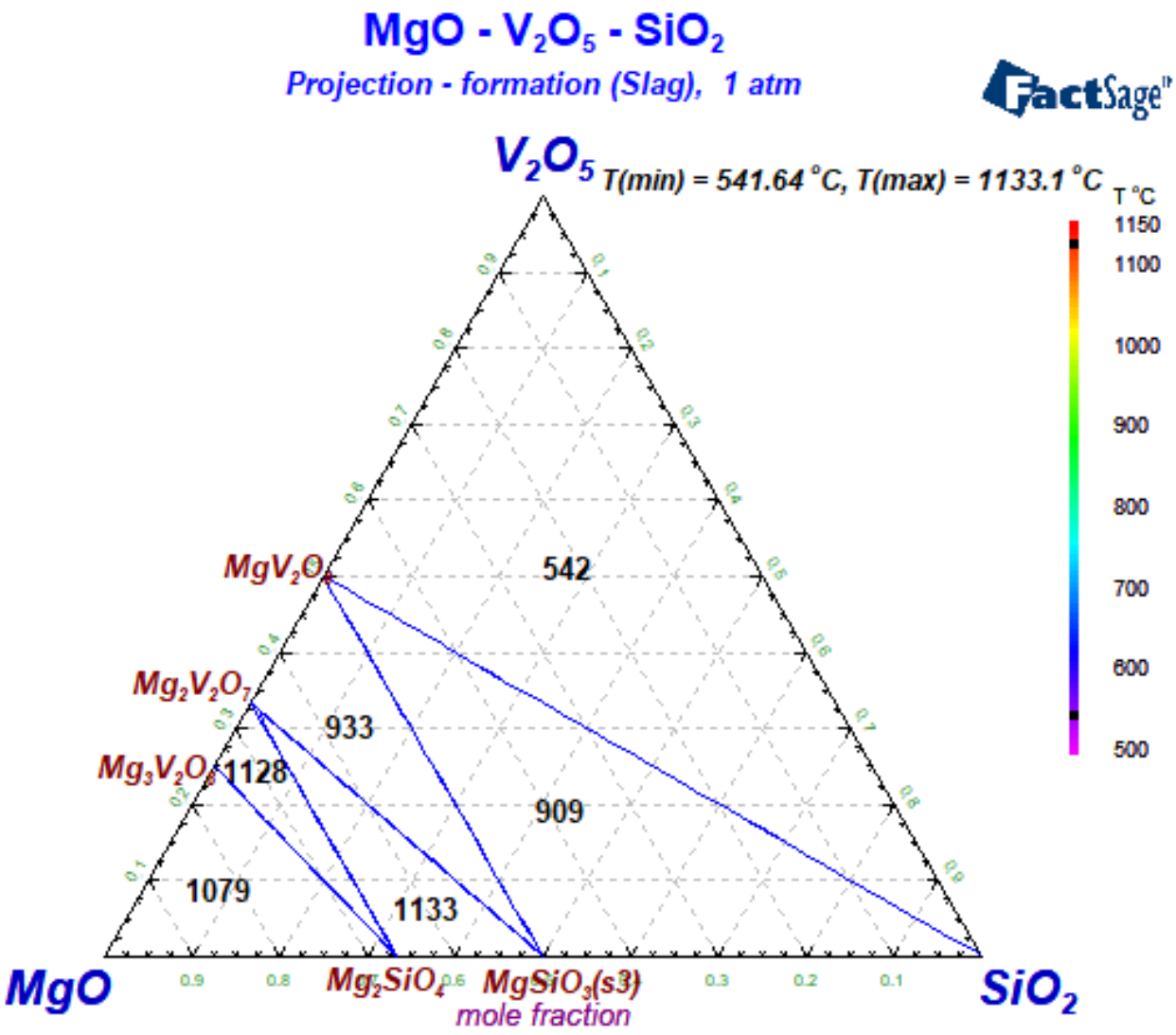

MgO - SiO2 - V2O3
Projection (Slag), 1 atm
FactSage™
SiO2
T(min) = 1401.92 °C, T(max) = 2826.85 °C
T °C
2800
2650
2400
2150
1900
1650
1400
SiO2(s4)
V2O3
Slag#2
MgSiO3(s4)
SiO2(s4)
Mg2SiO4
MgV2O4
V2O3
MgO
1600
1700
1800
1900
2000
2200
2400
2500
2600
2700
MgO
V2O3
percent by weight

Invariant equilibria on the liquidus surface

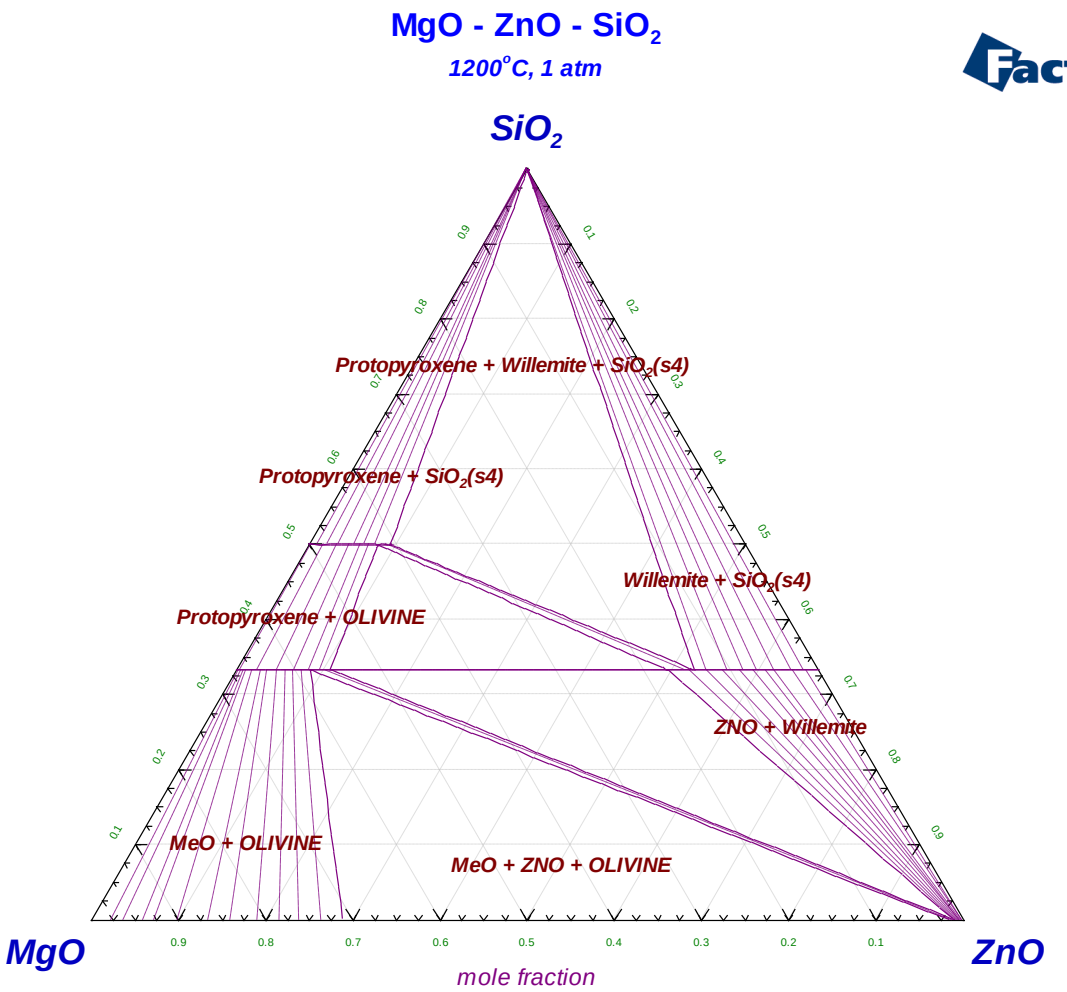
Intersections with slag	Mole fraction					Weight percent				
	A = SiO2, B = MgO, C = V2O3					A = TiO2, B = MgO, C = V2O3				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1 Mg2SiO4 / MgO / MgV2O4_Spinel	1:	0.21220	0.63959	0.14821	1684.78	1:	20.990	42.438	36.571	1684.78
2. MgV2O4_Spinel / Slag#2 / V2O3	2:	0.38811	0.32267	0.28922	1601.31	2:	29.268	16.323	54.409	1601.31
3. SiO2(s4) / Slag#2 / V2O3	3:	0.95711	0.01125	0.03164	1590.42	3:	91.713	0.723	7.564	1590.43
4. MgV2O4_Spinel / SiO2(s4) / Slag#2	4:	0.41103	0.40533	0.18363	1571.07	4:	36.024	23.829	40.147	1571.07
5. Mg2SiO4 / MgSiO3(s4) / MgV2O4_Spinel	5:	0.43600	0.49521	0.06879	1409.80	5:	46.394	35.348	18.258	1409.80
6. MgSiO3(s4) / MgV2O4_Spinel / SiO2(s4)	6:	0.45511	0.47576	0.06913	1401.92	6:	48.074	33.711	18.215	1401.92

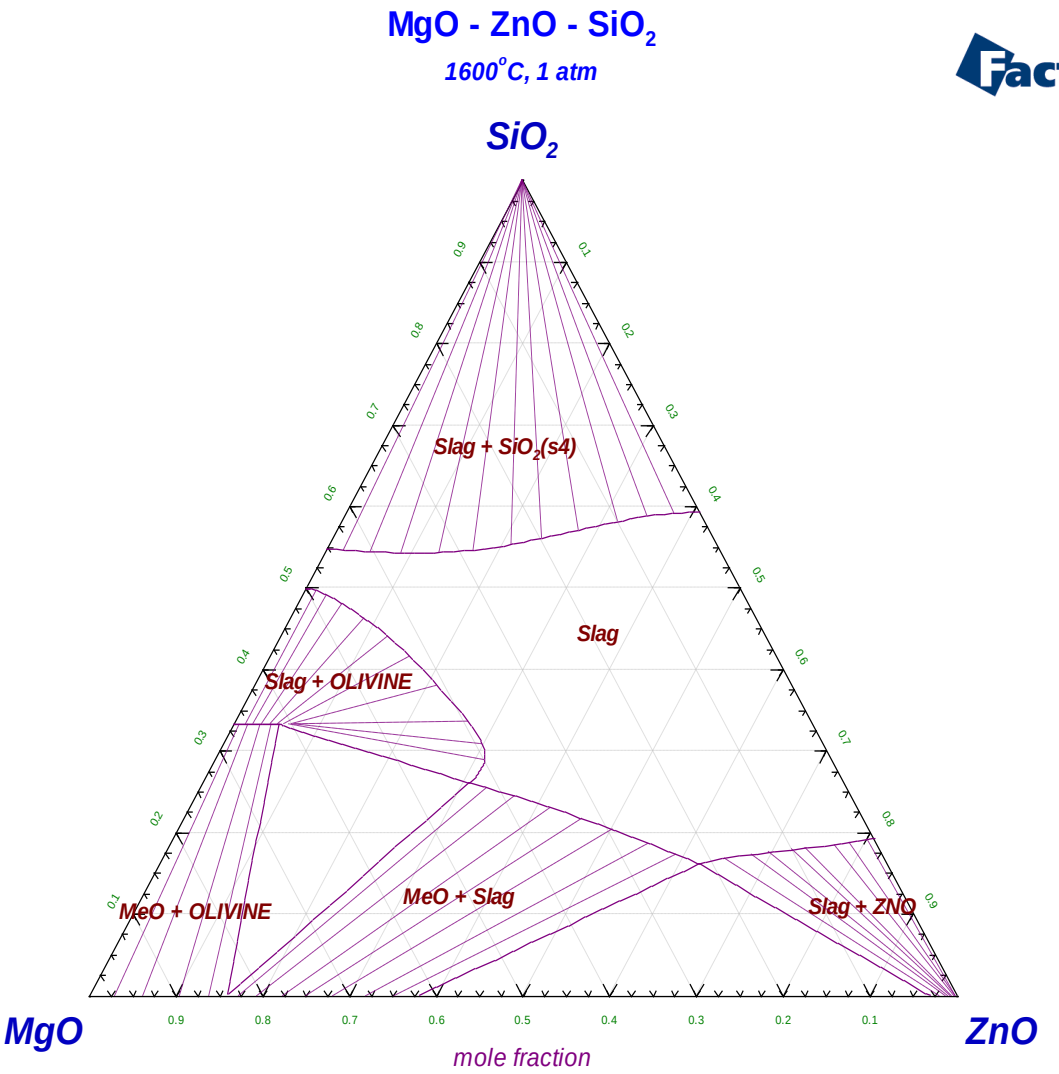
MgO-SiO2-V2O5,
Mole fraction, 1450°C



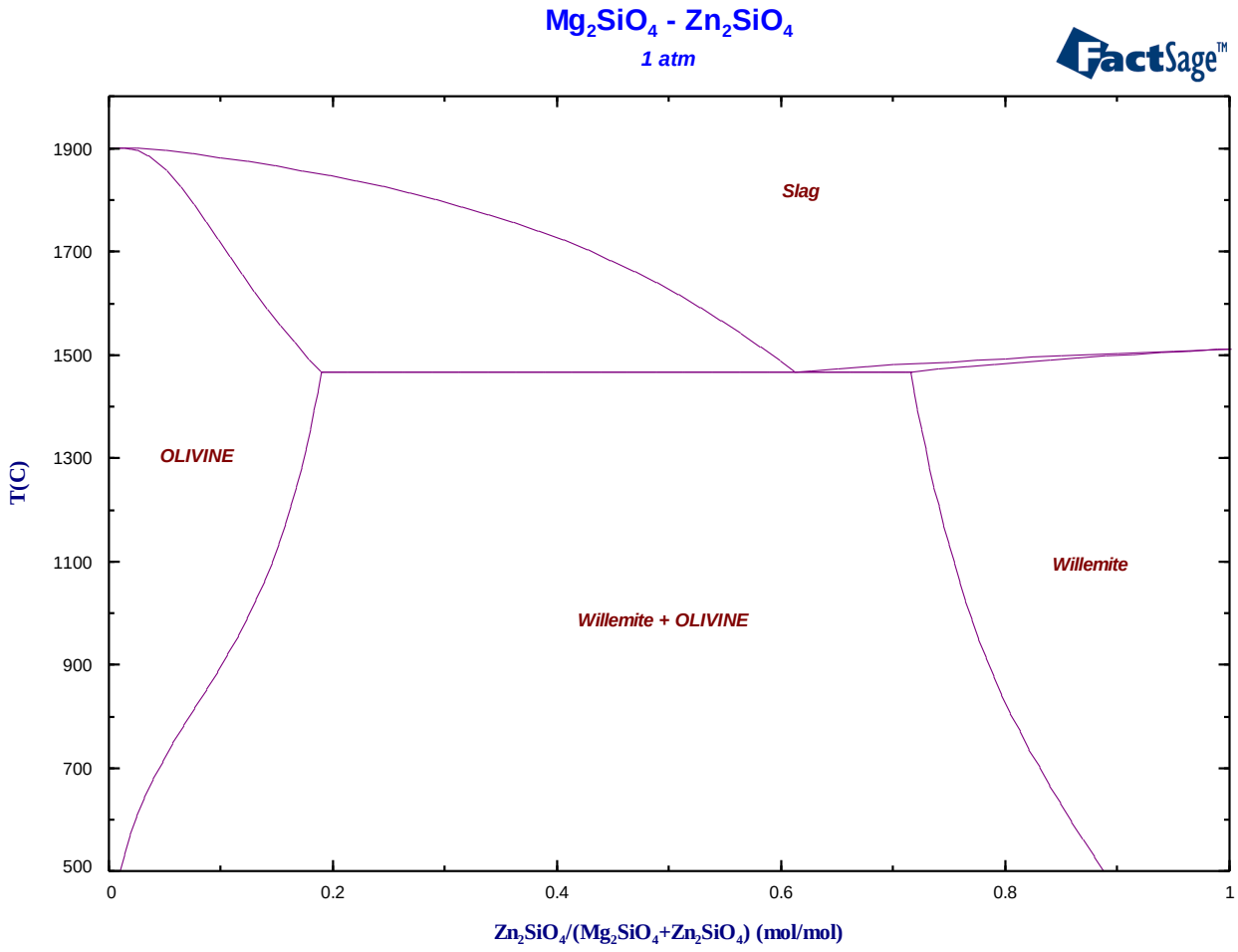

MgO - V2O5 - SiO2
Projection - formation (Slag), 1 atm
FactSage
V2O5
T(min) = 541.64 °C, T(max) = 1133.1 °C
T °C
1150
1100
1000
900
800
700
600
500
MgV2O6
Mg2V2O7
Mg3V2O8
542
933
1128
909
1079
1133
MgO
Mg2SiO4
MgSiO3(s3)
SiO2
mole fraction

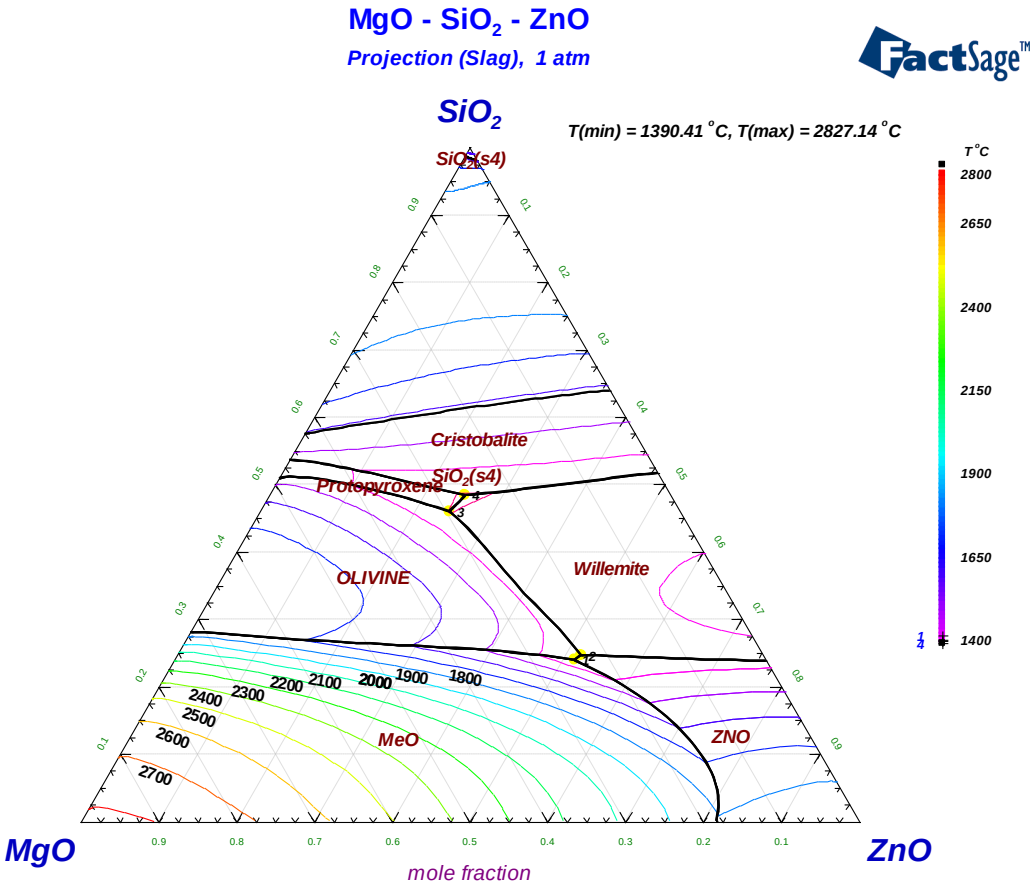
Mole fraction, 1200°C



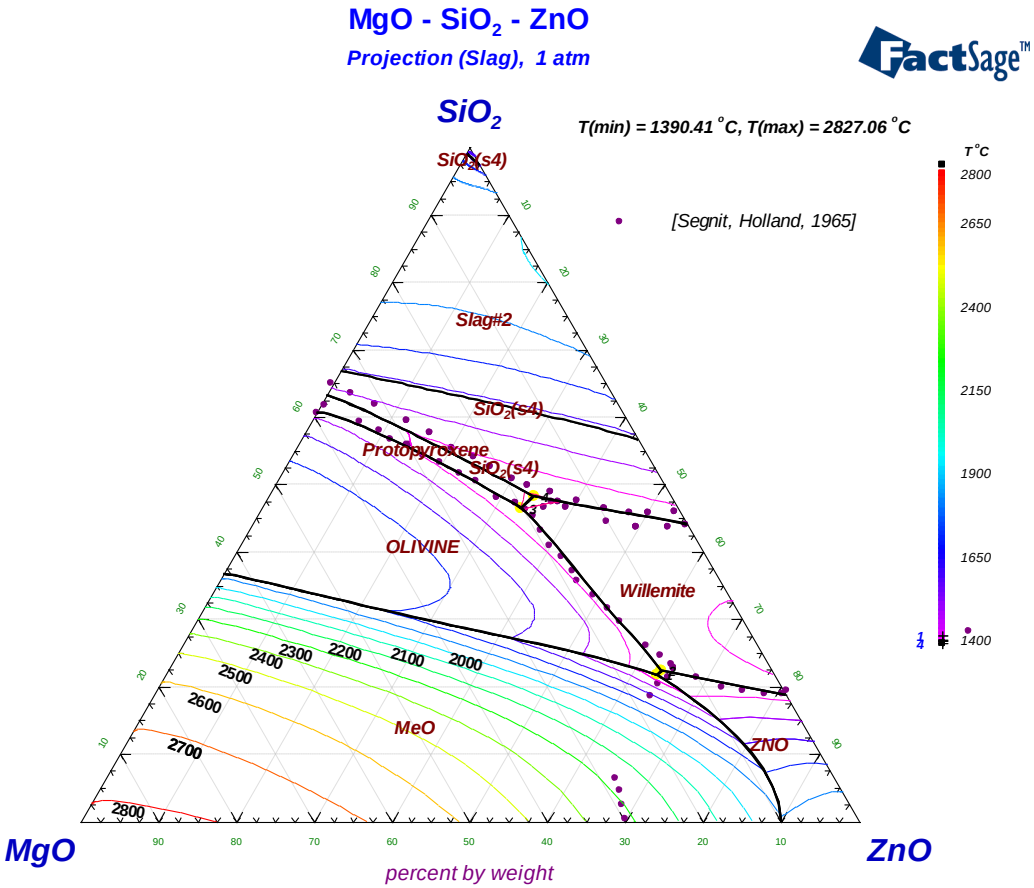

MgO - ZnO - SiO2
1600°C, 1 atm
SiO2
Slag + SiO2(s4)
Slag
Slag + OLIVINE
MeO + OLIVINE
MeO + Slag
Slag + ZNO
MgO
ZnO
mole fraction

Mole fraction, Isopleth Mg2SiO4-Zn2SiO4




MgO - SiO2 - ZnO
Projection (Slag), 1 atm
FactSage™
SiO2
T(min) = 1390.41 °C, T(max) = 2827.14 °C
T°C
2800
2650
2400
2150
1900
1650
1400
SiO2(s4)
Cristobalite
SiO2(s4)
Protopyroxene
OLIVINE
Willemite
MeO
ZNO
2700
2600
2500
2400
2300
2200
2100
2000
1900
1800
MgO
ZnO
mole fraction

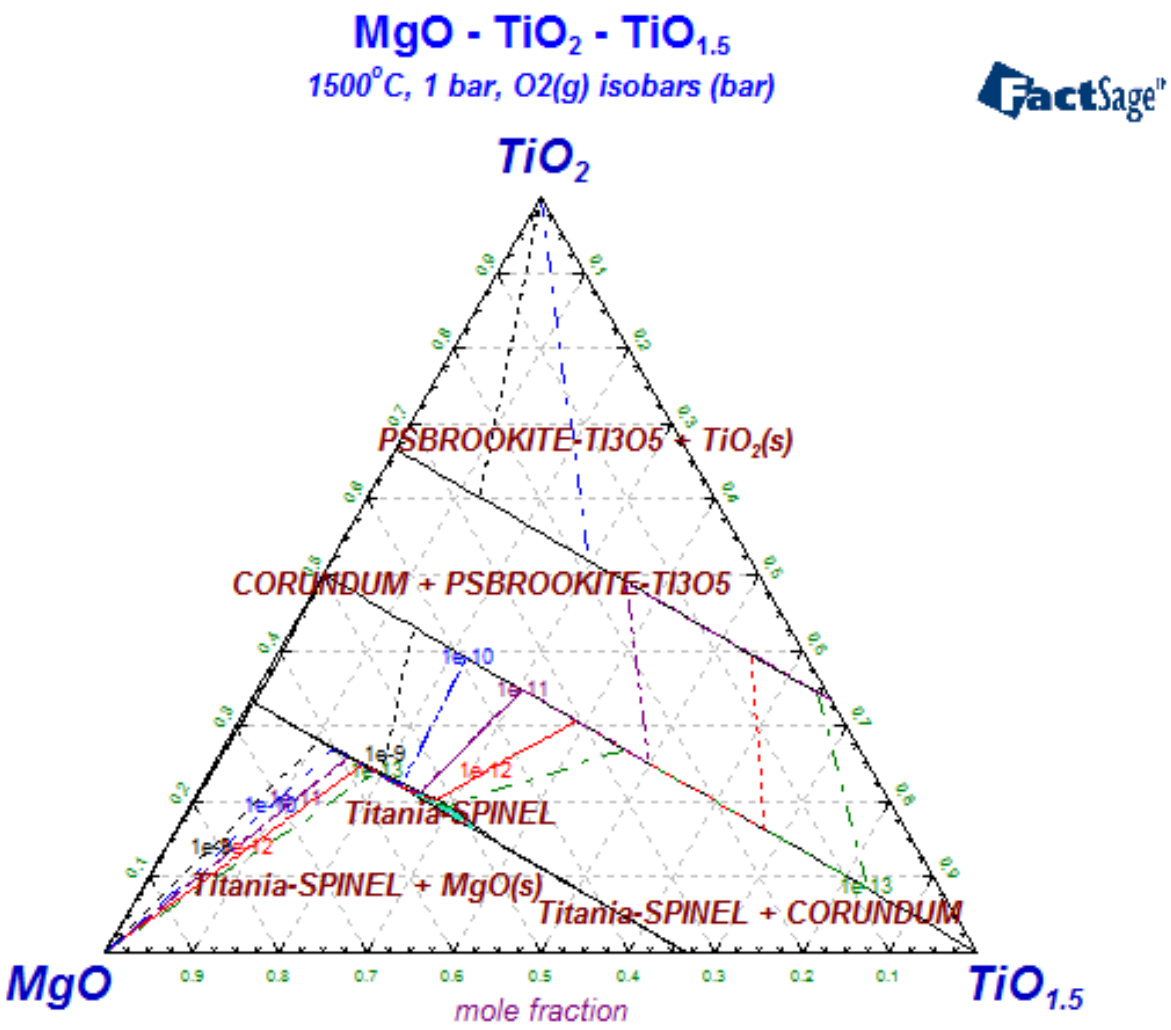
Weight percent, Liquidussurface compared with experimental data



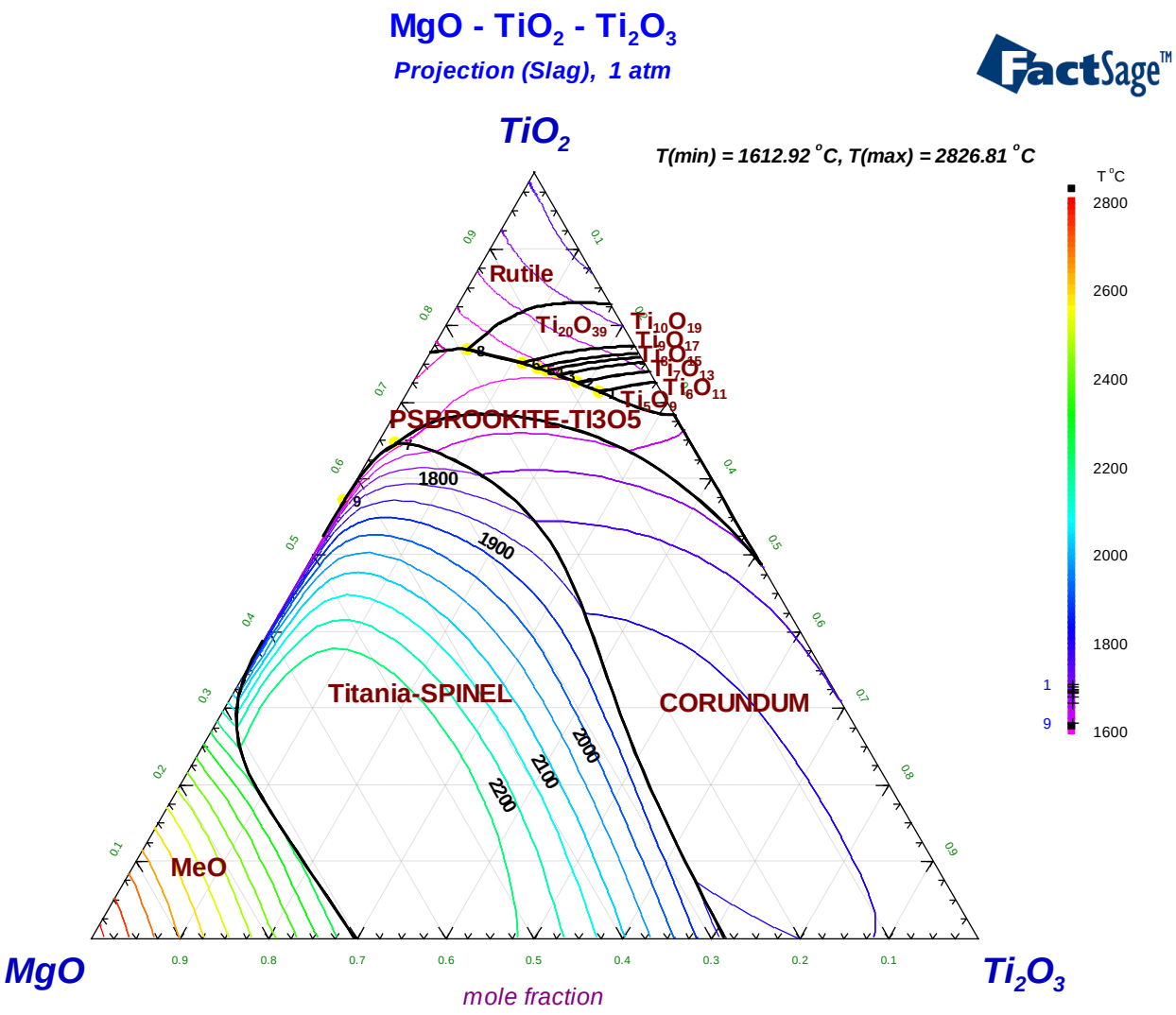
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction					Weight percent				
	A = SiO2, B = MgO, C = ZnO					A = SiO2, B = MgO, C = ZnO				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: MeO / OLIVINE / ZNO	1:	0.23981	0.24600	0.51419	1415.70	1:	21.776	14.984	63.240	1415.70
2: OLIVINE / Willemite / ZNO	2:	0.24736	0.23351	0.51913	1401.07	2:	22.343	14.148	63.509	1401.07
3: OLIVINE / Protopyroxene / Willemite	3:	0.46043	0.29617	0.24340	1398.54	3:	46.566	20.093	33.341	1398.59
4: Protopyroxene / Cristobalite / Willemite	4:	0.48397	0.26394	0.25209	1390.42	4:	48.278	17.662	34.060	1390.41

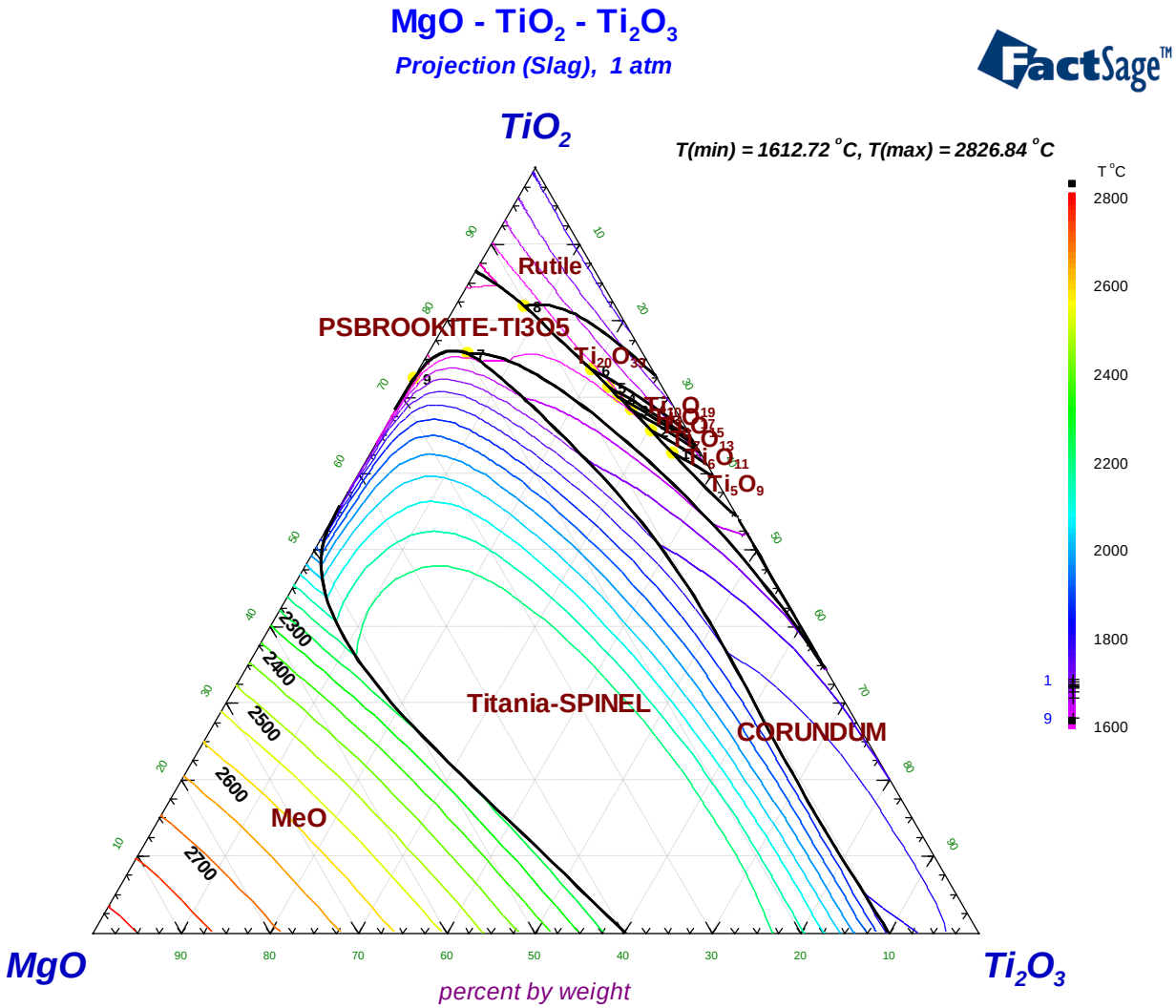
MgO-TiO2-Ti2O3,
Mole fraction, 1500°C



MgO-TiO2-Ti2O3,
Mole fraction, Liquidus surface



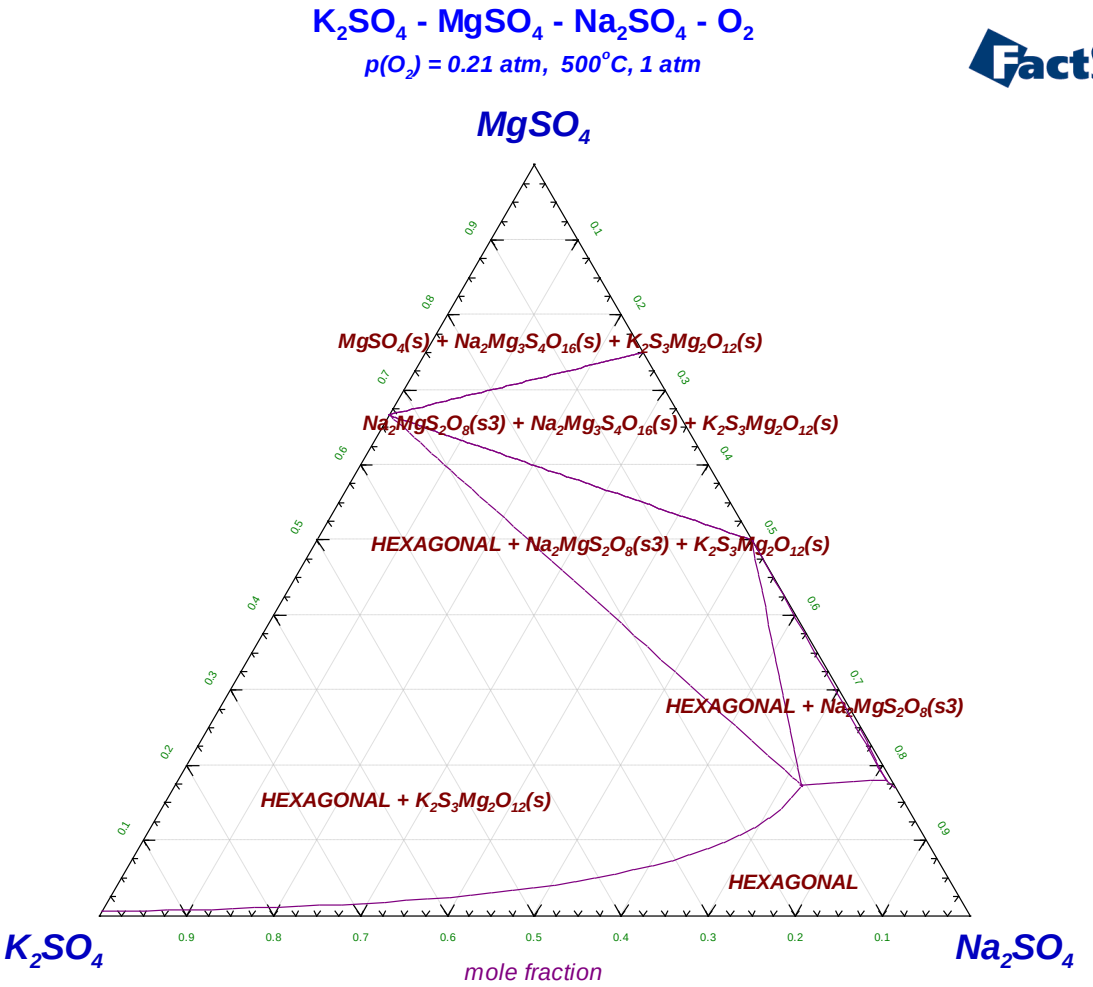
MgO-TiO2-Ti2O3,
Weight percent, Liquidus surface

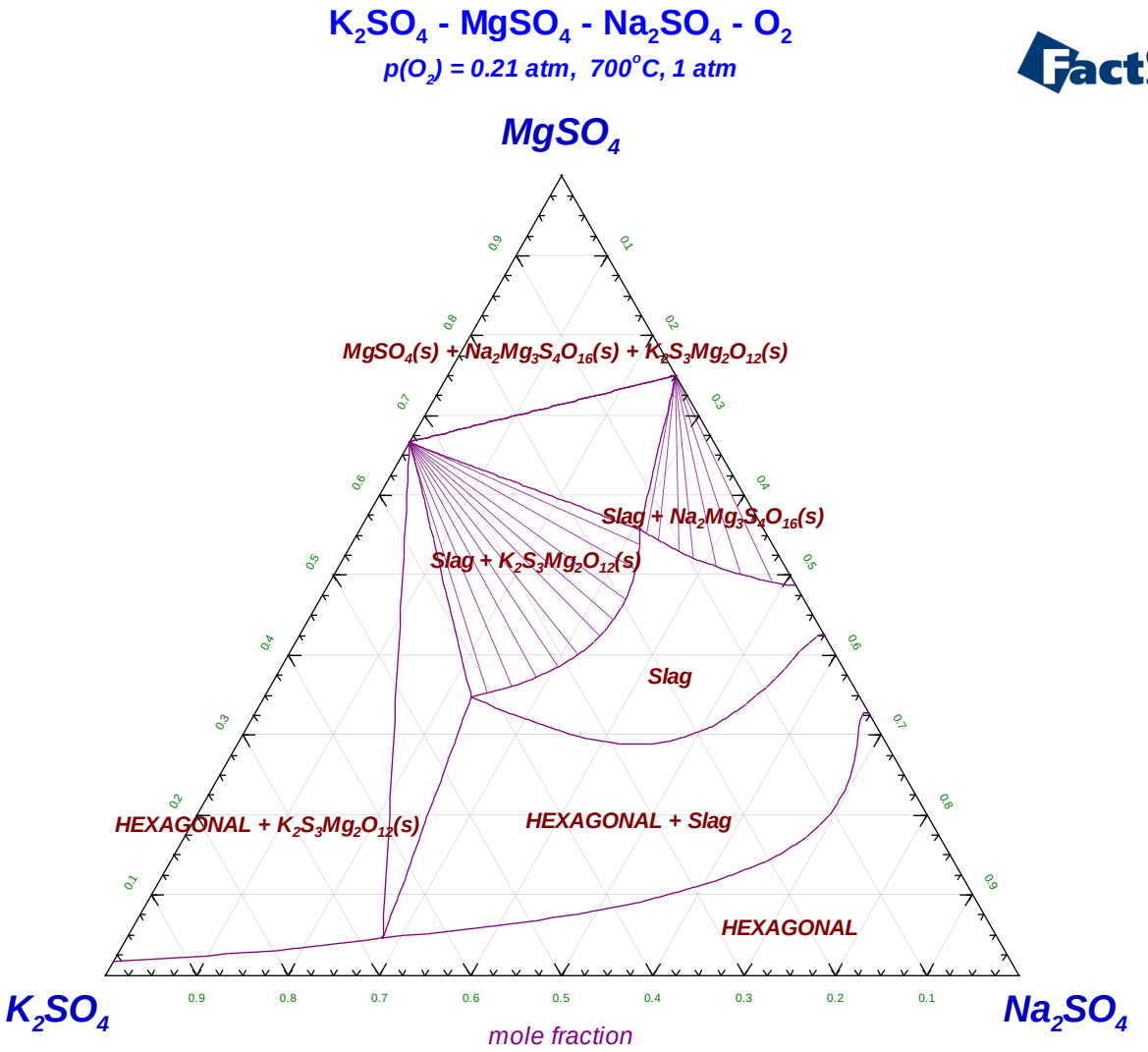


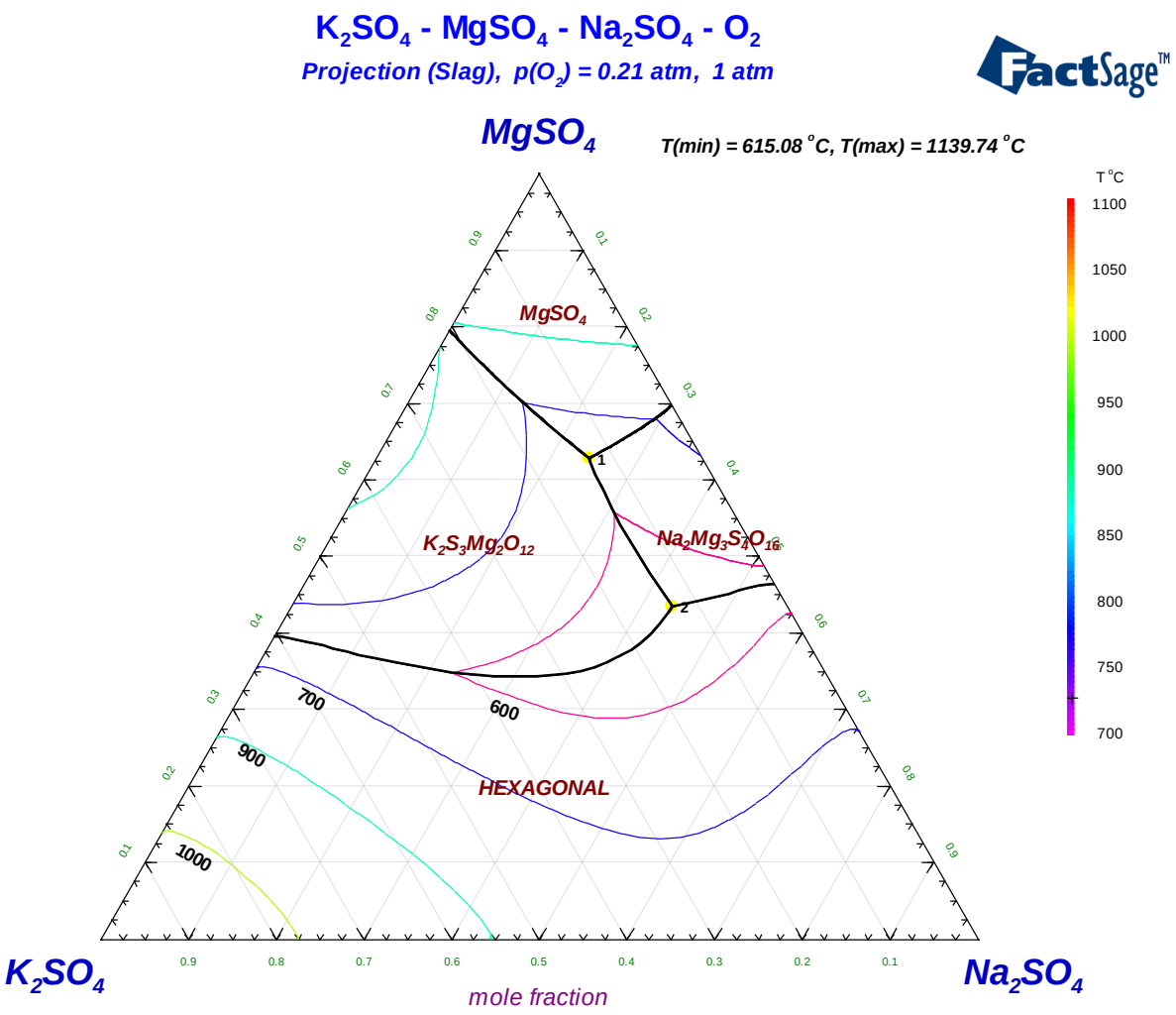
Invariant equilibria on the liquidus surface

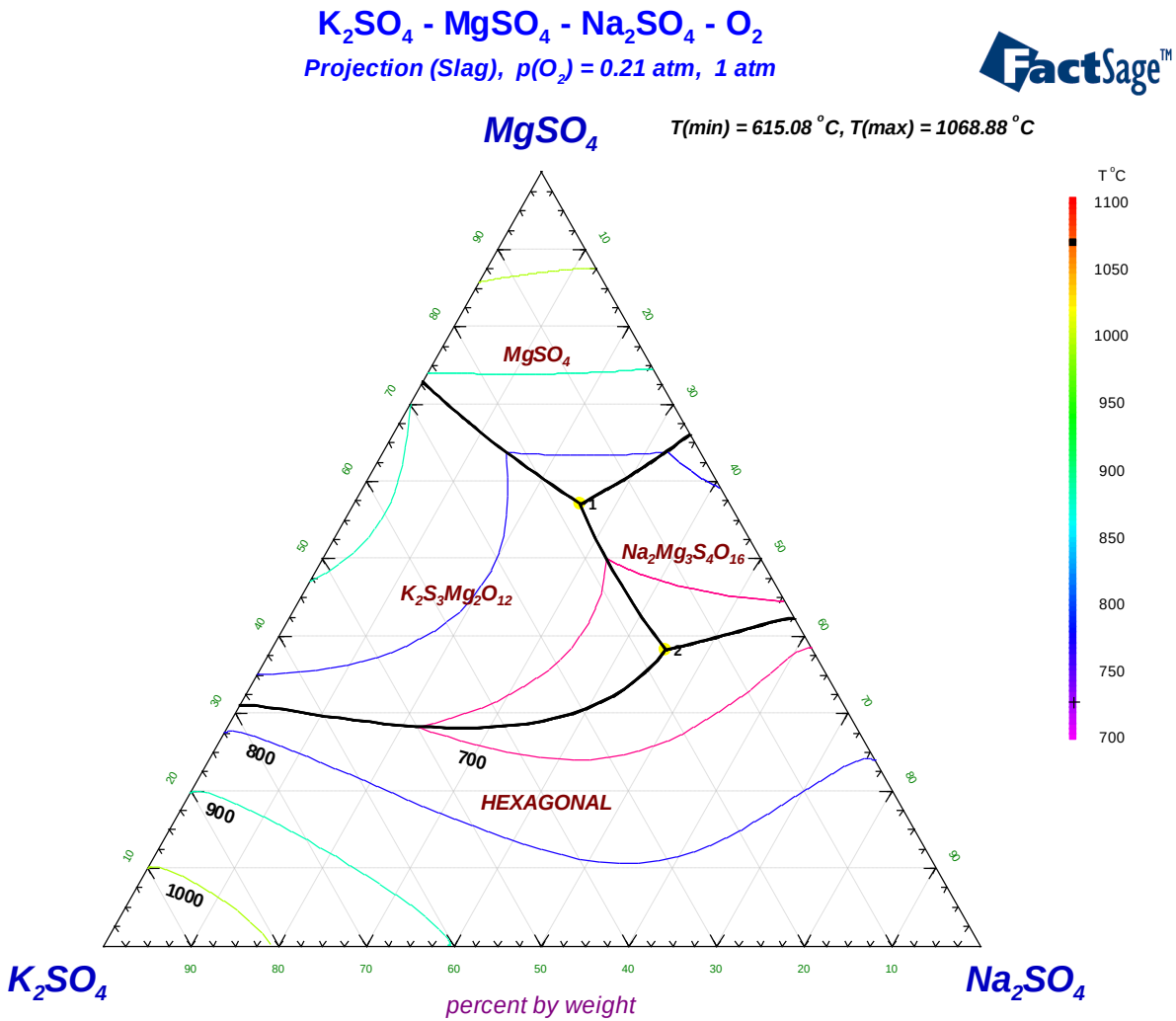
Intersections with slag	Mole fraction					Weight percent				
	A = TiO2, B = MgO, C = Ti2O3					A = TiO2, B = MgO, C = Ti2O3				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: PSBROOKITE-TI3O5 / Ti5O9 / Ti6O11	1:	0.71330	0.06905	0.21765	1708.81	1:	62.579	3.057	34.364	1708.81
2: PSBROOKITE-TI3O5 / Ti6O11 / Ti7O13	2:	0.72497	0.08855	0.18648	1702.35	2:	65.593	4.043	30.364	1702.35
3: PSBROOKITE-TI3O5 / Ti7O13 / Ti8O15	3:	0.73456	0.10562	0.15982	1697.03	3:	68.301	4.956	26.743	1697.03
4: PSBROOKITE-TI3O5 / Ti8O15 / Ti9O17	4:	0.74004	0.11585	0.14411	1693.86	4:	69.956	5.527	24.518	1693.86
5: PSBROOKITE-TI3O5 / Ti10O19 / Ti9O17	5:	0.74403	0.12373	0.13224	1691.44	5:	71.236	5.978	22.786	1691.44
6: PSBROOKITE-TI3O5 / Ti10O19 / Ti20O39	6:	0.75074	0.13720	0.11206	1686.97	6:	73.483	6.777	19.740	1686.97
7: CORUNDUM / PSBROOKITE / Titania-SPINEL	7:	0.64511	0.33343	0.02146	1680.83	7:	75.717	19.749	4.533	1680.83
8: PSBROOKITE-TI3O5 / Rutile / Ti20O39	8:	0.76845	0.19027	0.04128	1664.49	8:	81.858	10.229	7.913	1664.49
9: CORUNDUM / PSBROOKITE / Titania-SPINEL	9:	0.57125	0.42823	0.00052	1620.25	9:	72.466	27.414	0.119	1620.22

Mole fraction, 500°C




K2SO4 - MgSO4 - Na2SO4 - O2
p(O2) = 0.21 atm, 700°C, 1 atm
MgSO4
MgSO4(s) + Na2Mg3S4O16(s) + K2S3Mg2O12(s)
Slag + Na2Mg3S4O16(s)
Slag + K2S3Mg2O12(s)
Slag
HEXAGONAL + K2S3Mg2O12(s)
HEXAGONAL + Slag
HEXAGONAL
K2SO4
Na2SO4
mole fraction

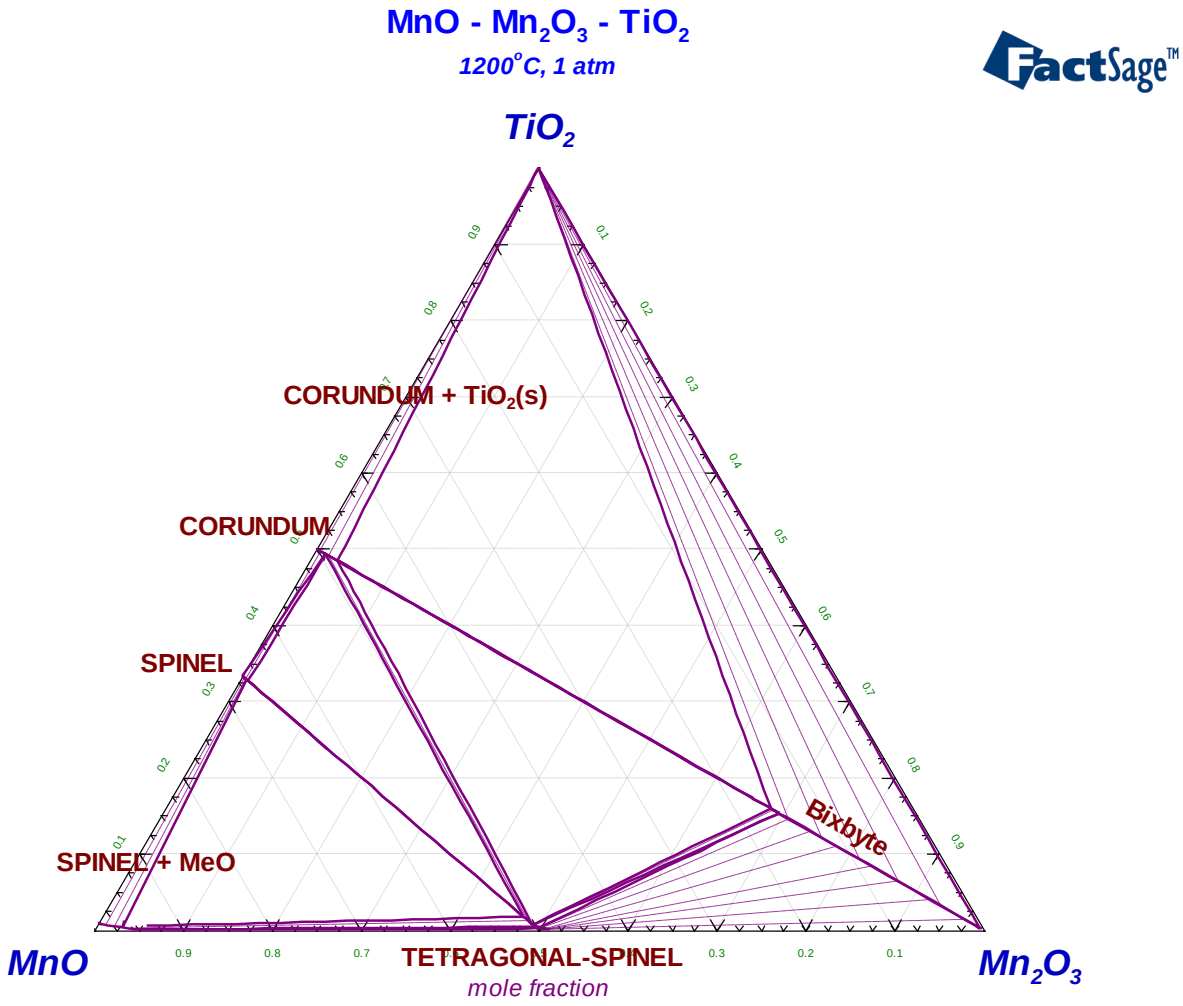

K2SO4 - MgSO4 - Na2SO4 - O2
Projection (Slag), p(O2) = 0.21 atm, 1 atm
FactSage™
MgSO4
T(min) = 615.08 °C, T(max) = 1139.74 °C
T °C
1100
1050
1000
950
900
850
800
750
700
MgSO4
K2S3Mg2O12
Na2Mg3S4O16
1
2
700
600
900
1000
HEXAGONAL
K2SO4
Na2SO4
mole fraction


K2SO4 - MgSO4 - Na2SO4 - O2
Projection (Slag), p(O2) = 0.21 atm, 1 atm
FactSage™
MgSO4
T(min) = 615.08 °C, T(max) = 1068.88 °C
T °C
1100
1050
1000
950
900
850
800
750
700
MgSO4
Na2Mg3S4O16
K2S3Mg2O12
HEXAGONAL
1
2
800
700
900
1000
K2SO4
Na2SO4
percent by weight

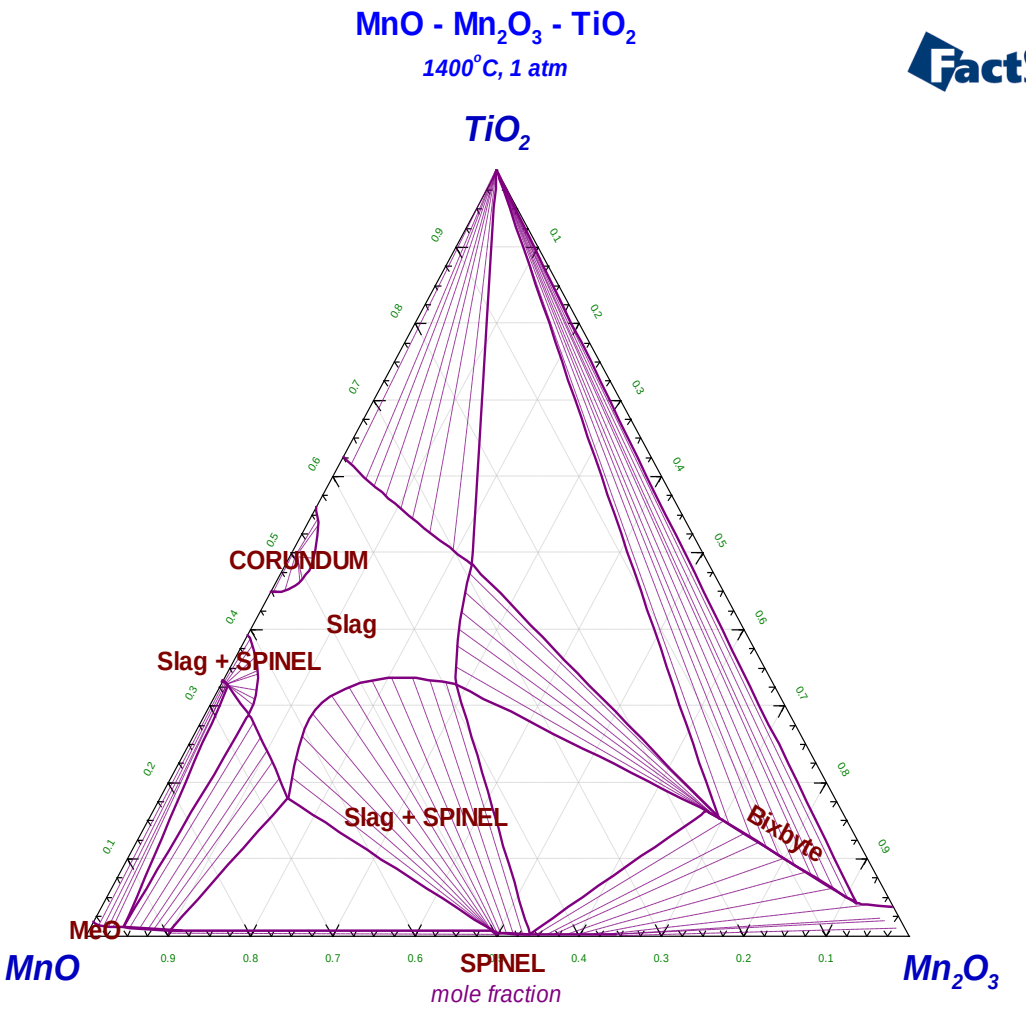
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction				Weight percent			
	A = MgSO4, B = K2SO4, C = Na2SO4				A = MgSO4, B = K2SO4, C = Na2SO4			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: K2S3Mg2O12 / MgSO4 / Na2Mg3S4O16	1: 0.62829	0.12938	0.24233	726.30	1: 57.037	17.003	25.960	726.30
2: HEXAGONAL / K2S3Mg2O12 / Na2Mg3S4O16	2: 0.43474	0.13083	0.43443	615.08	2: 38.242	16.661	45.096	615.08

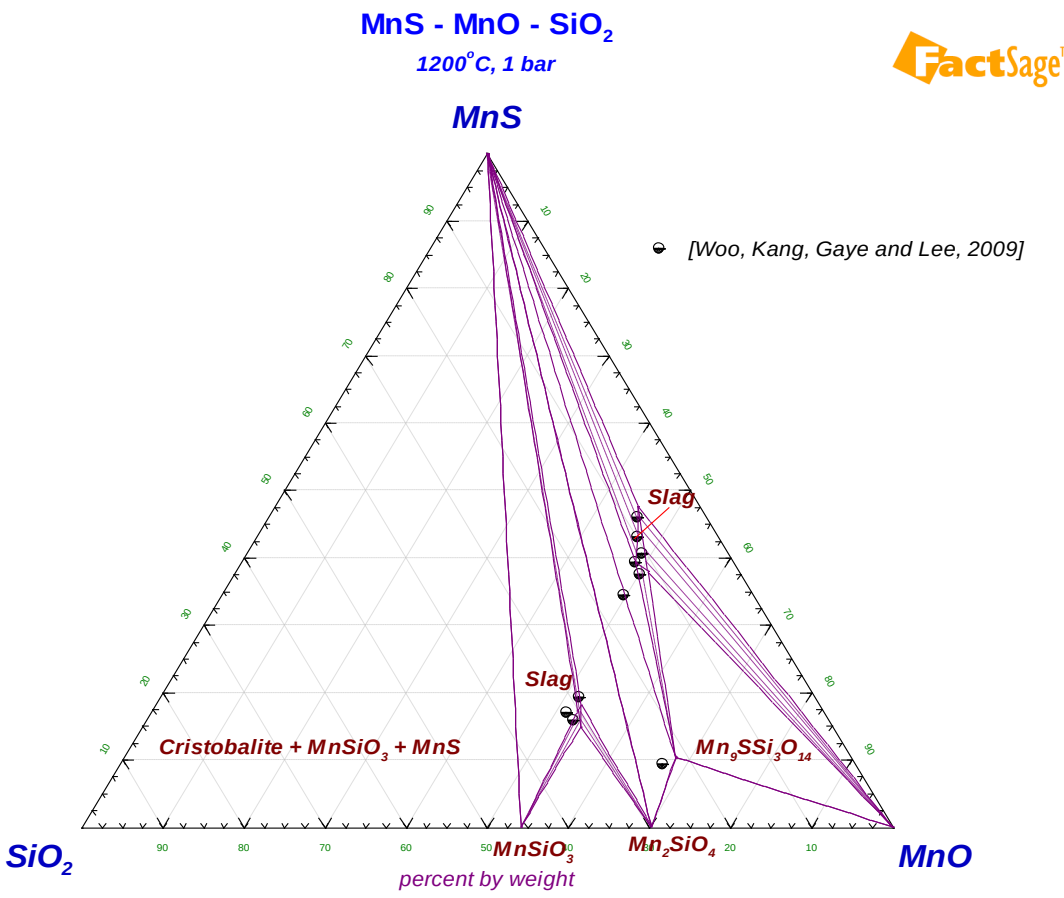
MnO-Mn2O3-TiO2,
Mole fraction, 1200°C



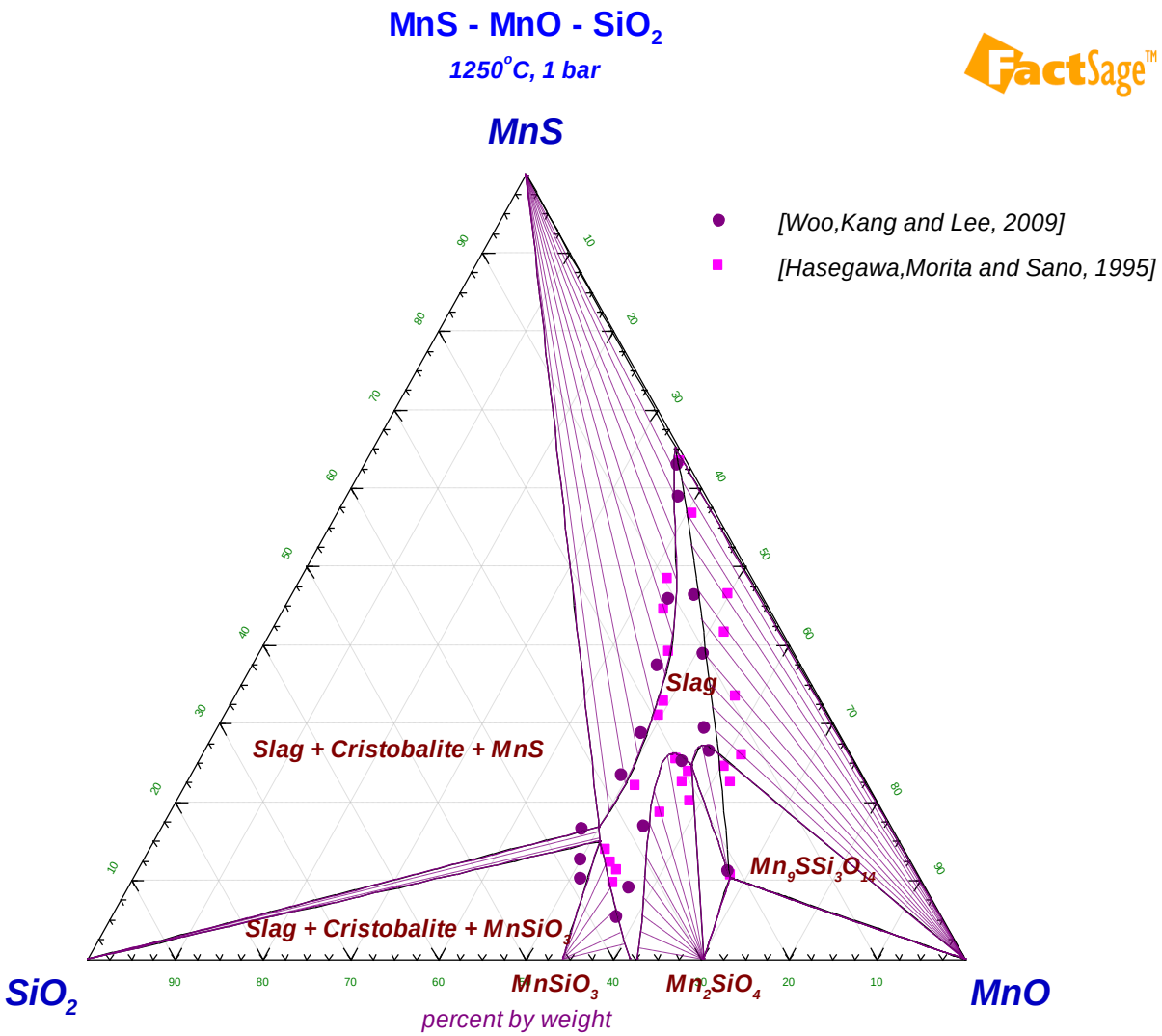
MnO-Mn2O3-TiO2,
Mole fraction, 1400°C

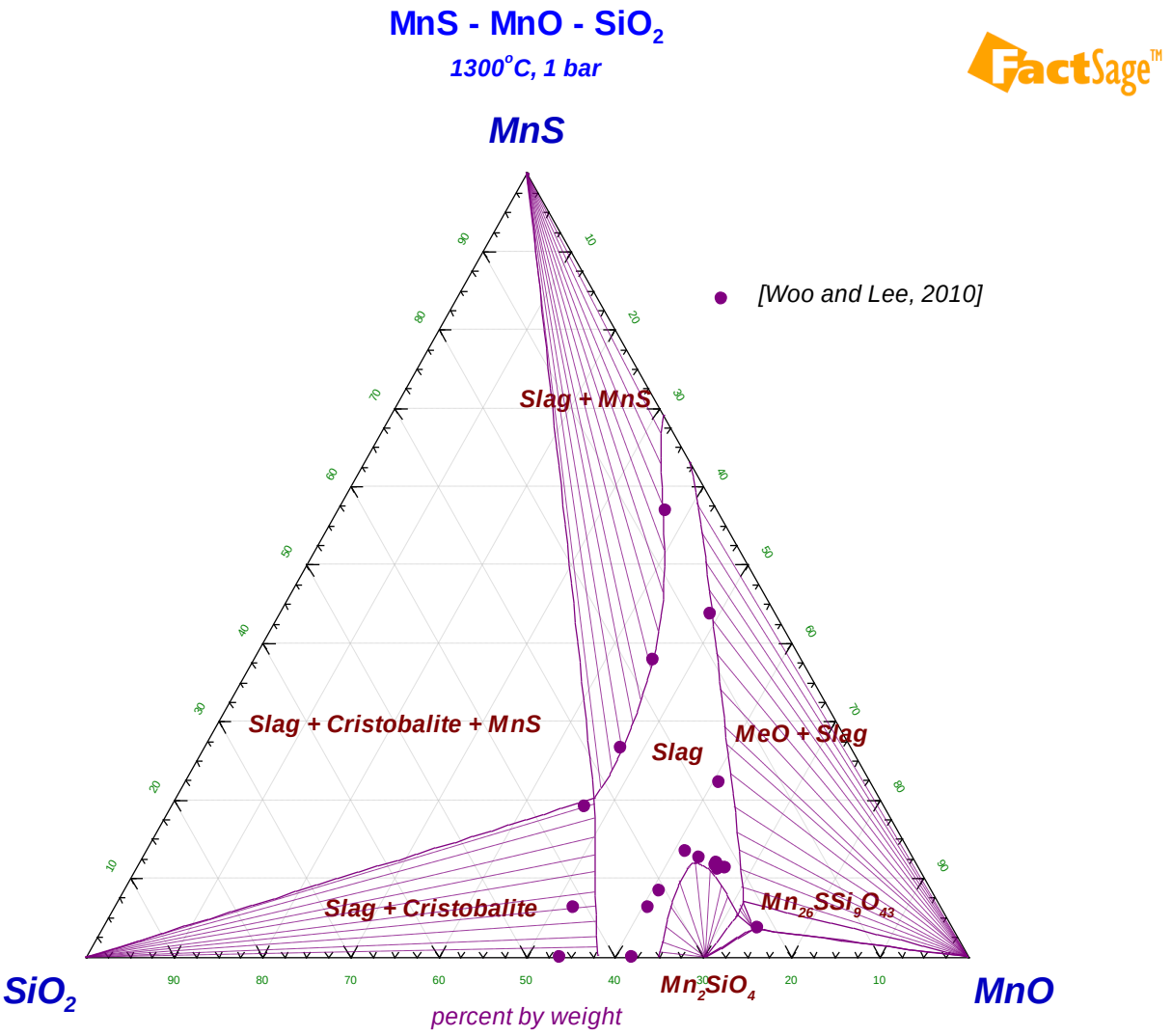


MnO-MnS-SiO2,
Weight percent, 1200°C

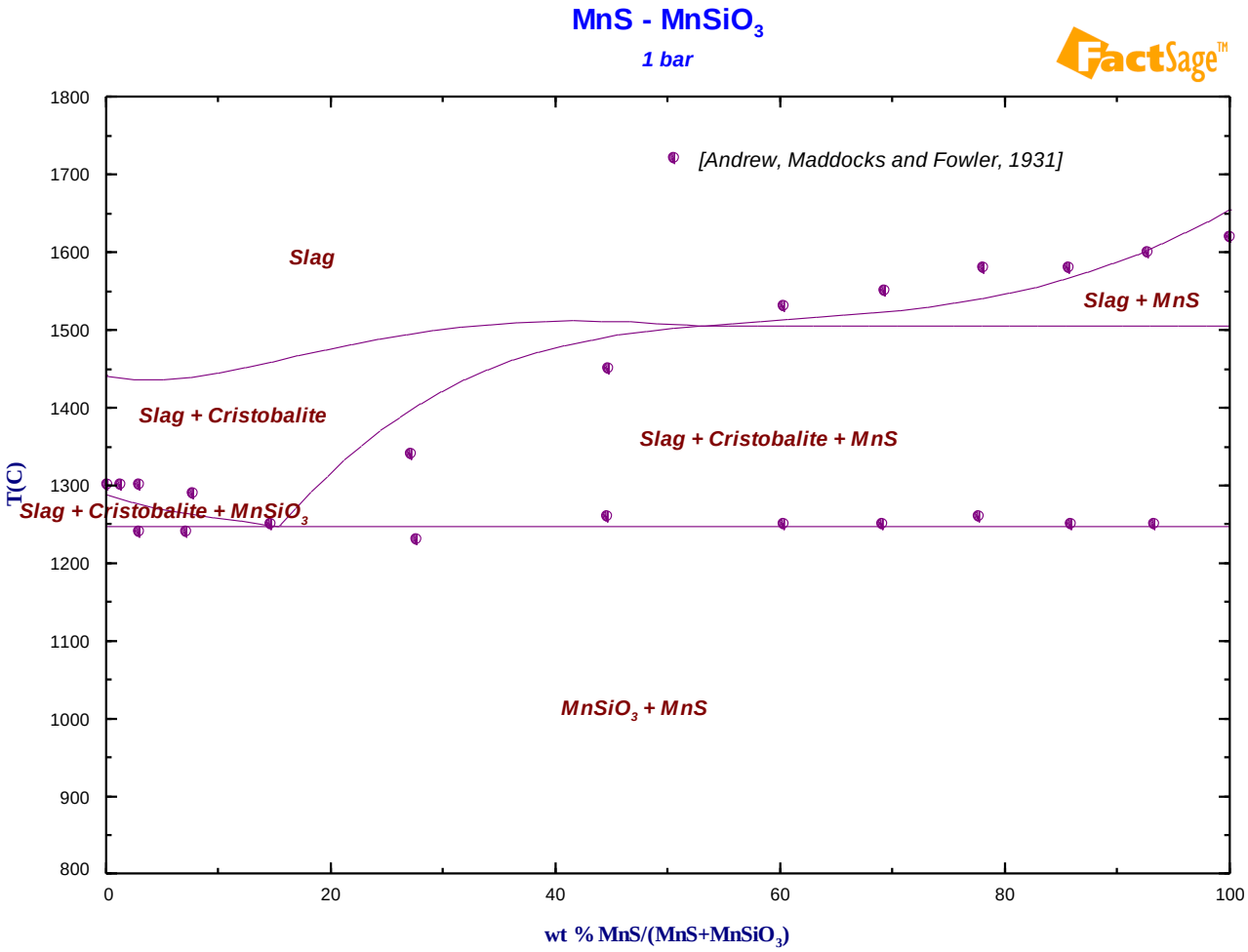


MnO-MnS-SiO2,
Weight percent, 1250°C

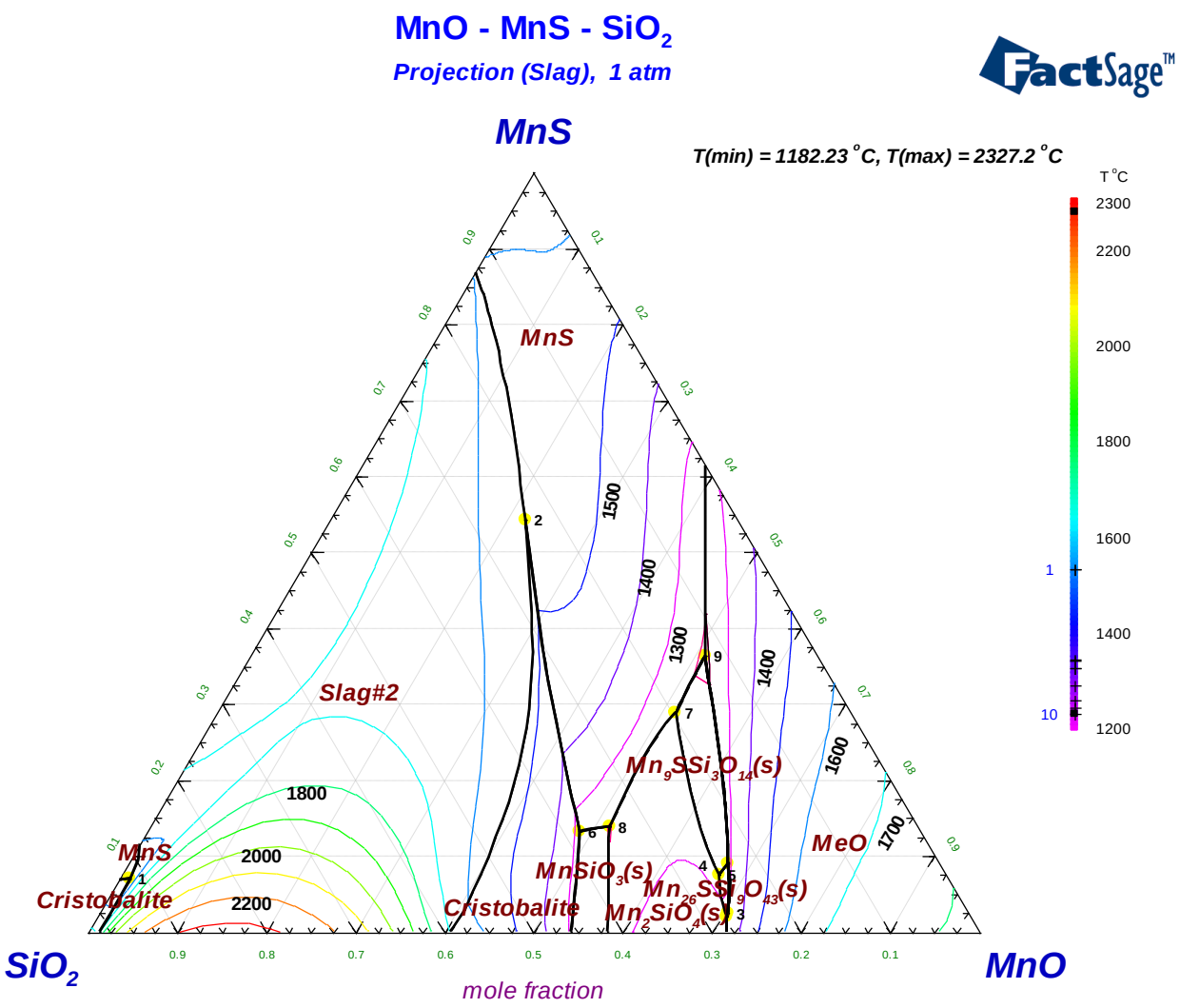



MnS - MnO - SiO2
1300°C, 1 bar
MnS
[Woo and Lee, 2010]
Slag + MnS
Slag + Cristobalite + MnS
Slag
MeO + Slag
Slag + Cristobalite
Mn26SSi9O43
Mn2SiO4
SiO2
MnO
percent by weight

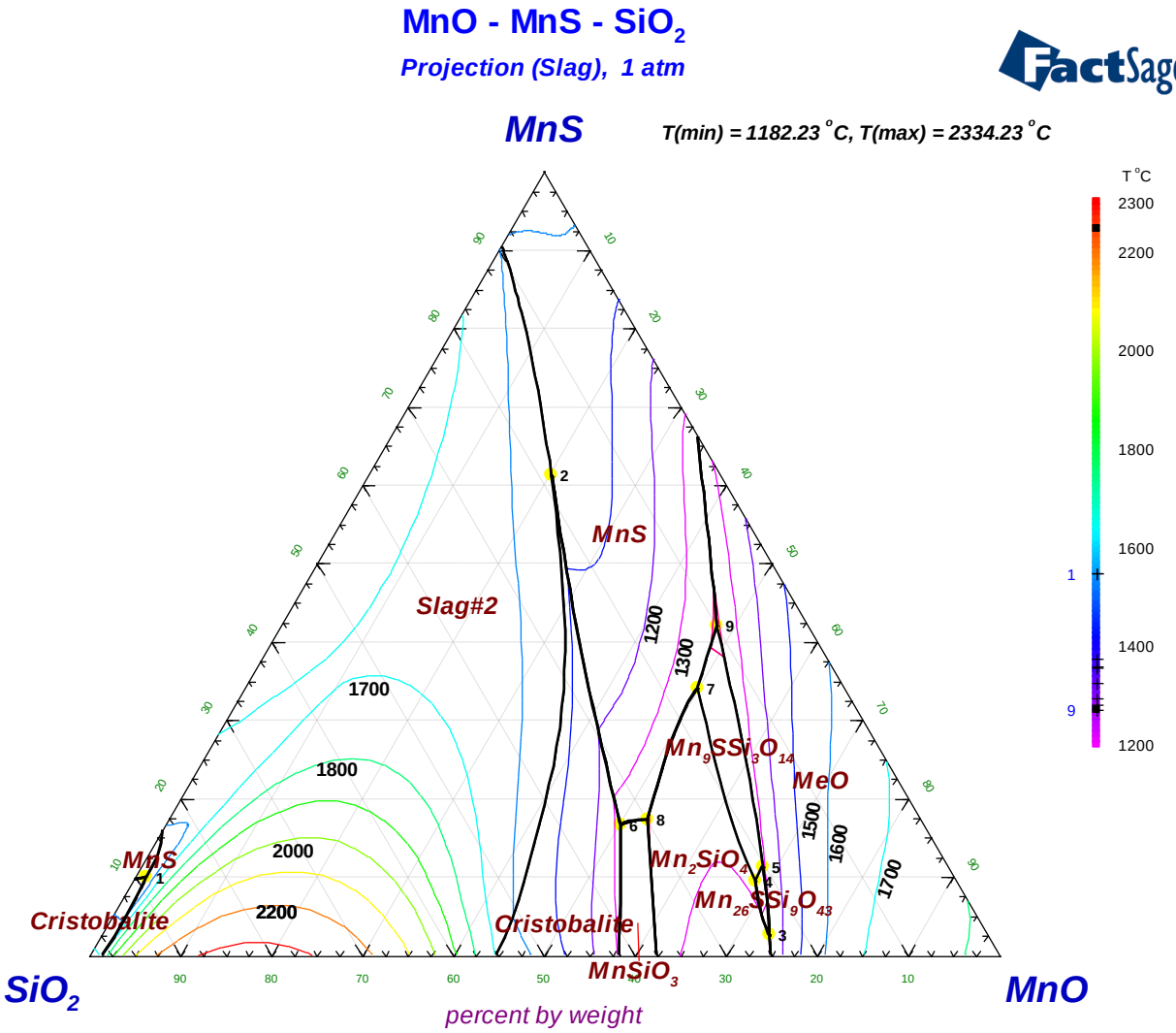
Weight percent, Isopleth MnS-MnSiO3 compared with experimental data



Mole fraction, Liquidussurface



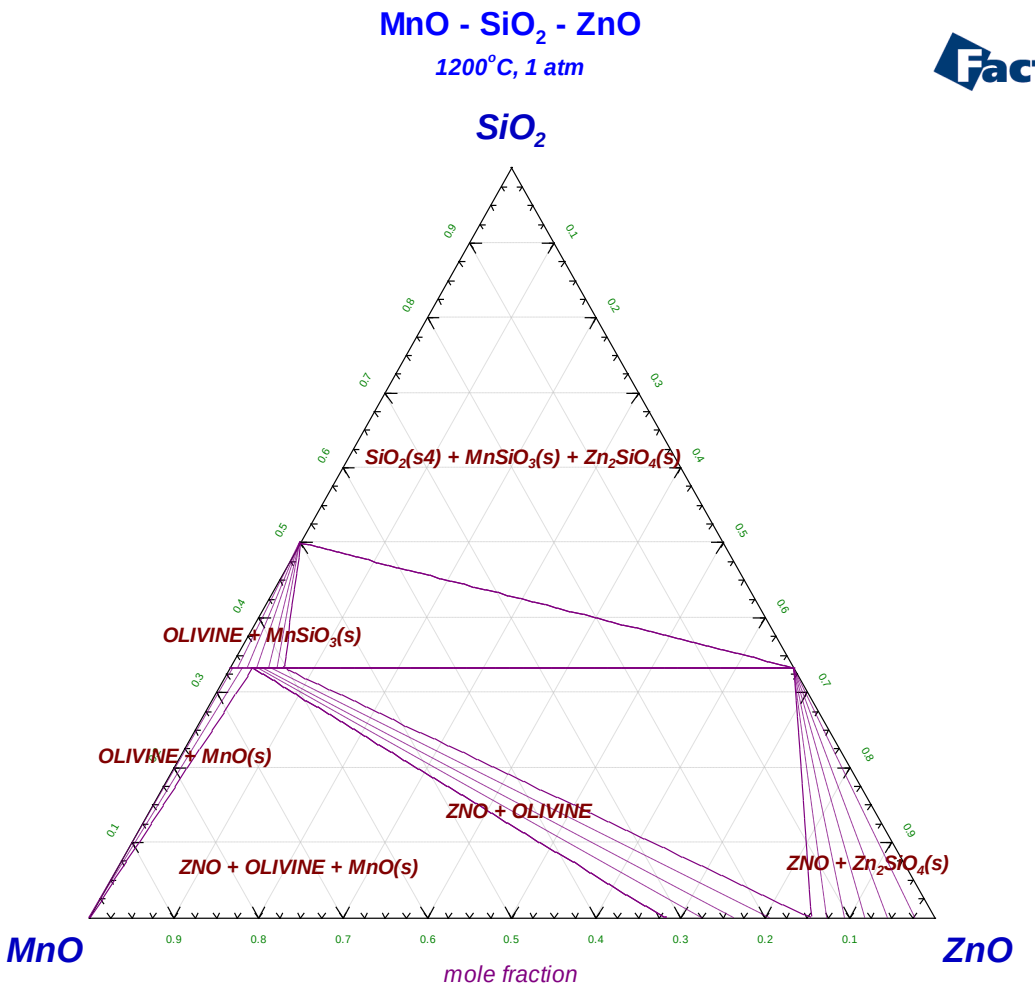
Weight percent, Liquidussurface



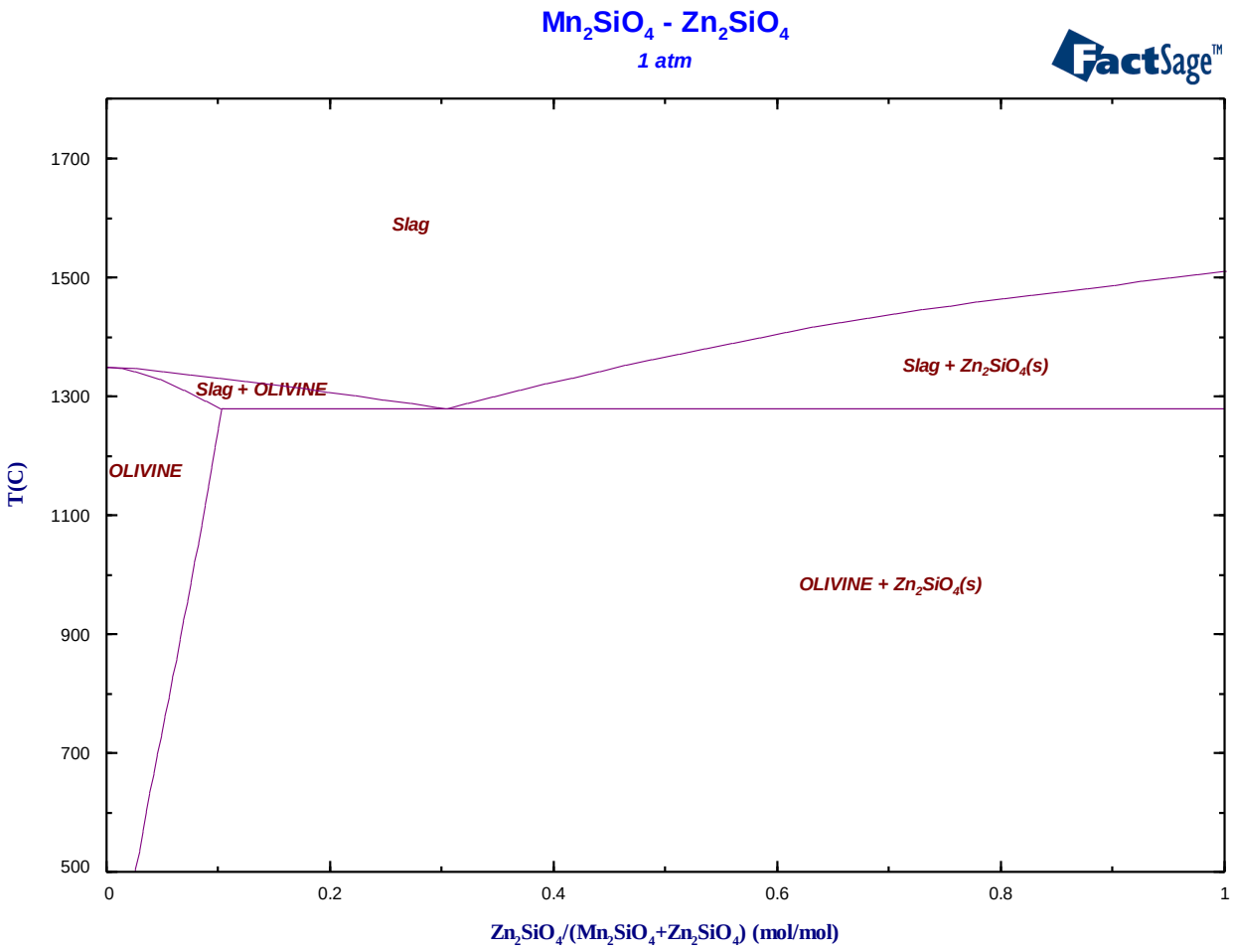
Invariant equilibria on the liquidus surface

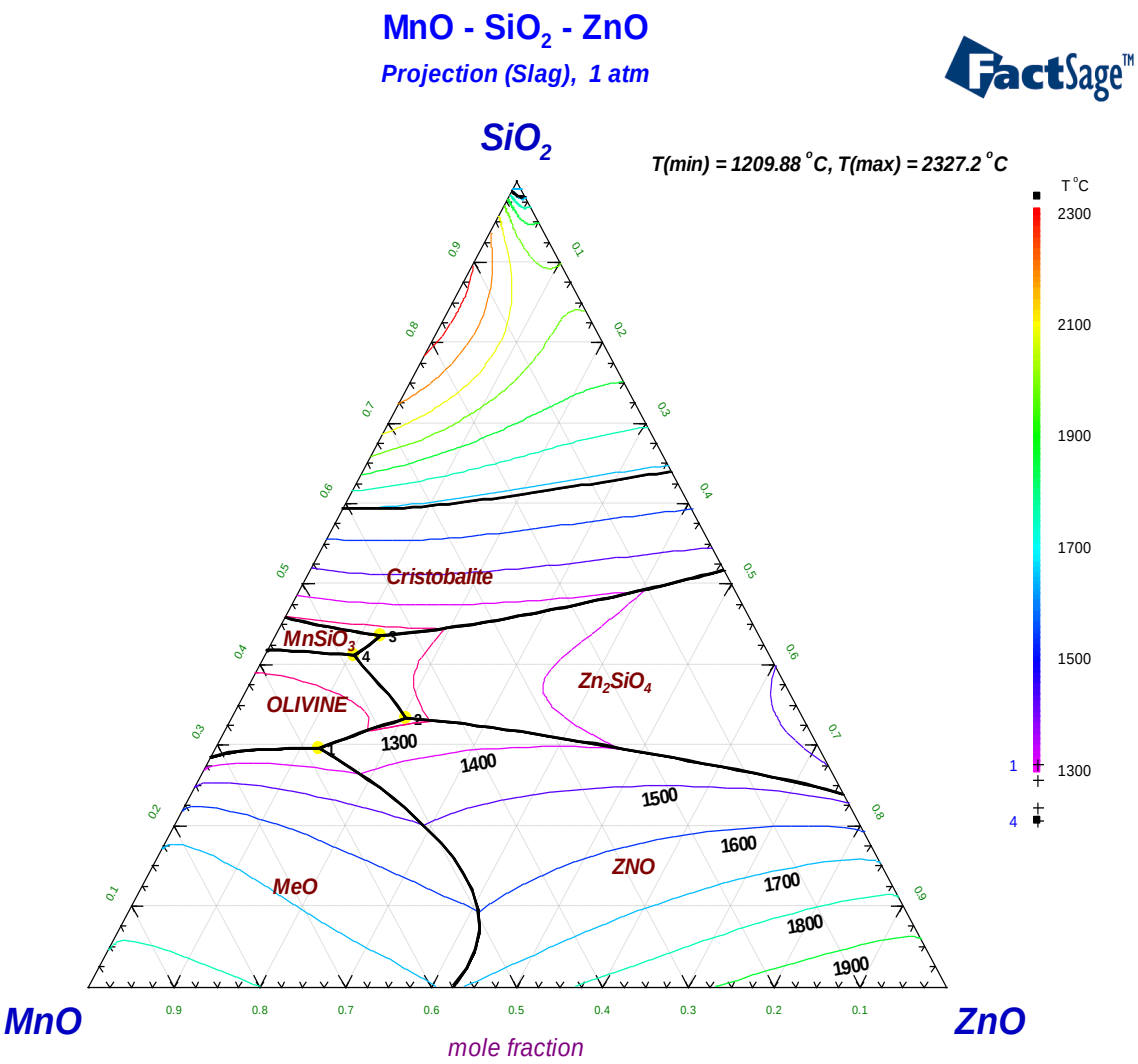
Intersections with slag	Mole fraction					Weight percent				
	A = MnS, B = SiO2, C = MnO					A = MnS, B = SiO2, C = MnO				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: MnS(s) / Cristobalite / Slag#2	1:	0.07162	0.91766	0.01072	1511.32	1:	10.029	88.747	1.224	1511.32
2: MnS(s) / Cristobalite / Slag#2	2:	0.54388	0.23741	0.21871	1511.31	2:	61.375	18.502	20.123	1511.31
3: MeO / Mn26SSi9O43 / Mn2SiO4(s)	3:	0.02058	0.27249	0.70692	1304.53	3:	2.622	23.968	73.411	1304.53
4: Mn26SSi9O43 / Mn2SiO4(s) / Mn9SSi3O14	4:	0.07577	0.25448	0.66975	1286.38	4:	9.499	22.035	68.466	1286.38
5: MeO / Mn26SSi9O43 / Mn9SSi3O14	5:	0.09100	0.23635	0.67265	1284.92	5:	11.337	20.335	68.327	1284.92
6: MnS(s) / MnSiO3(s) / Cristobalite	6:	0.13244	0.38184	0.48573	1247.34	6:	16.718	33.288	49.994	1247.34
7: Mn2SiO4(s) / Mn9SSi3O14 / MnS(s)	7:	0.28853	0.19627	0.51520	1211.65	7:	34.180	16.057	49.763	1211.65
8: Mn2SiO4(s) / MnS(s) / MnSiO3(s)	8:	0.13882	0.34590	0.51529	1195.30	8:	17.399	29.941	52.660	1195.30
9: MeO / Mn9SSi3O14 / MnS(s)	9:	0.36430	0.12559	0.51010	1182.24	9:	42.021	10.004	47.974	1182.23

MnO-SiO2-ZnO,
Mole fraction, 1200°C

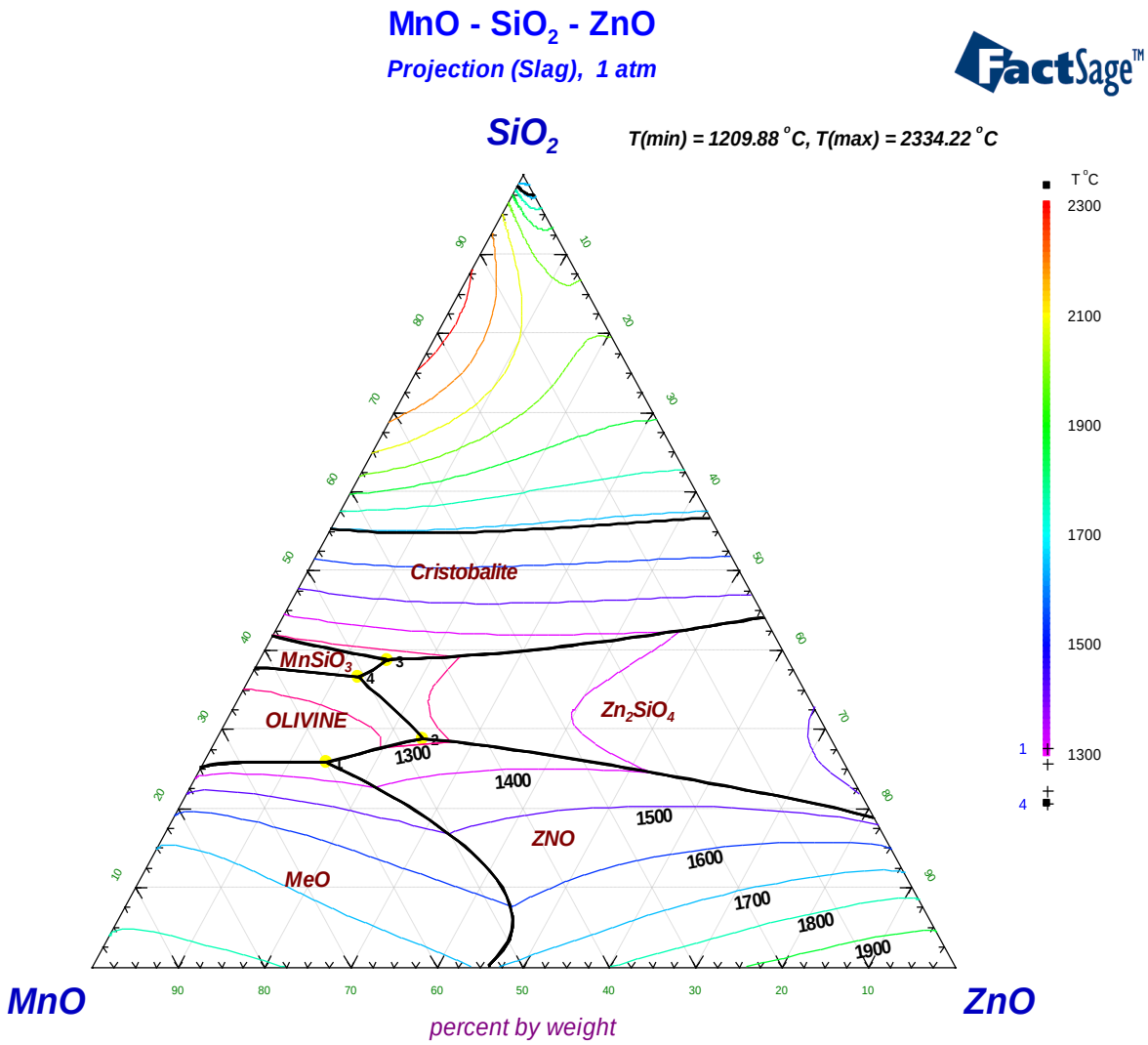


Mole fraction, Isopleth Mn2SiO4-Zn2SiO4




MnO - SiO2 - ZnO
Projection (Slag), 1 atm
FactSage™
SiO2
T(min) = 1209.88 °C, T(max) = 2327.2 °C
T °C
2300
2100
1900
1700
1500
1300
Cristobalite
MnSiO3
OLIVINE
Zn2SiO4
MeO
ZNO
1300
1400
1500
1600
1700
1800
1900
MnO
ZnO
mole fraction

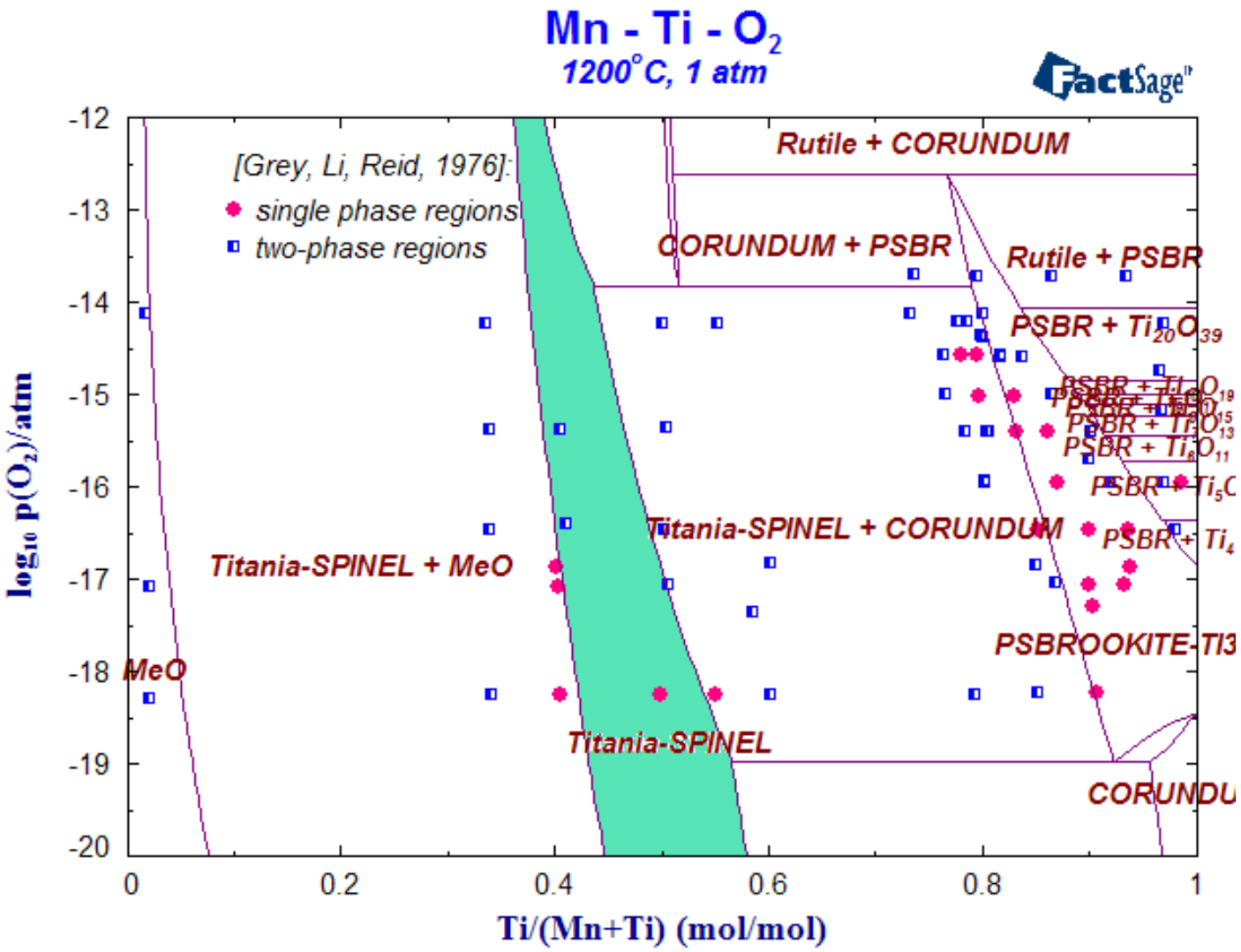
Weight percent, Liquidussurface



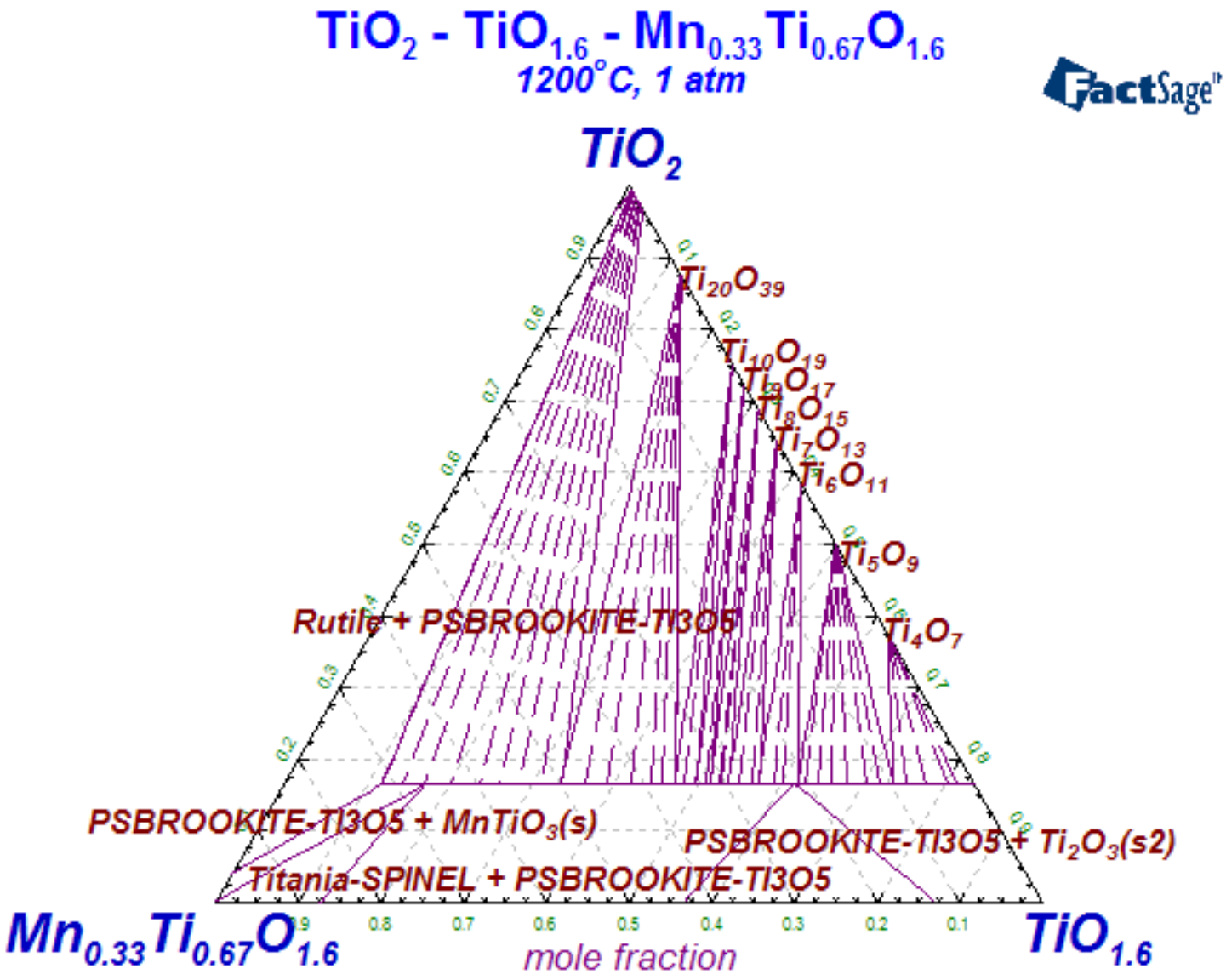
Invariant equilibria on the liquidus surface

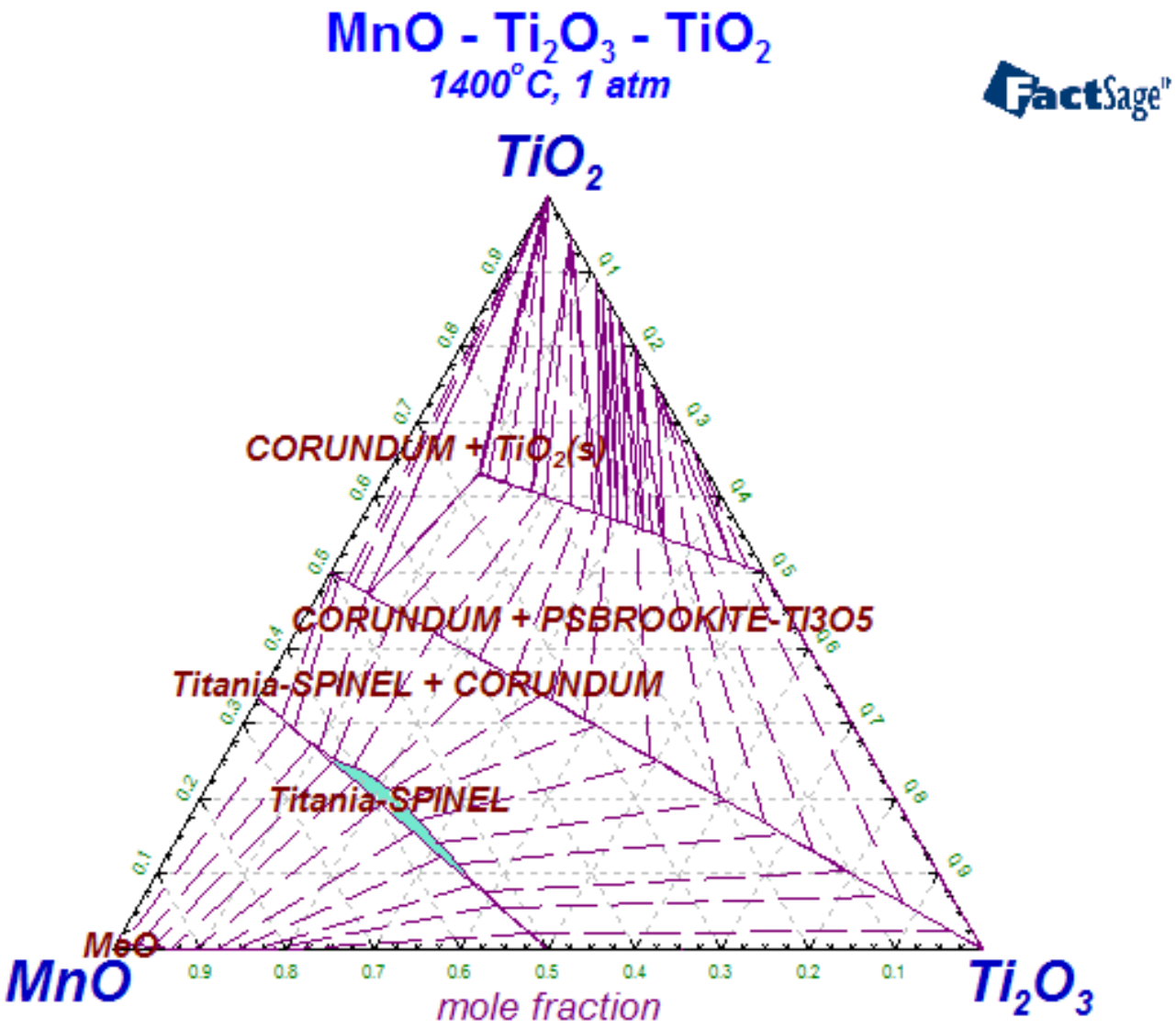
Intersections with slag	Mole fraction					Weight percent				
	A = SiO2, B = MnO, C = ZnO					A = SiO2, B = MnO, C = ZnO				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: MeO / OLIVINE / ZNO	1:	0.29561	0.58254	0.12185	1309.25	1:	25.741	59.889	14.370	1309.22
2: OLIVINE / ZNO / Zn2SiO4	2:	0.33302	0.46205	0.20493	1281.21	2:	28.806	47.186	24.009	1281.21
3: MnSiO3 / Cristobalite / Zn2SiO4	3:	0.43533	0.44135	0.12333	1232.57	3:	38.750	46.382	14.868	1232.69
4: MnSiO3 / OLIVINE / Zn2SiO4	4:	0.41100	0.48390	0.10511	1209.88	4:	36.544	50.798	12.658	1209.88

MnO-TiO2-Ti2O3,
Mole fraction, 1200°C

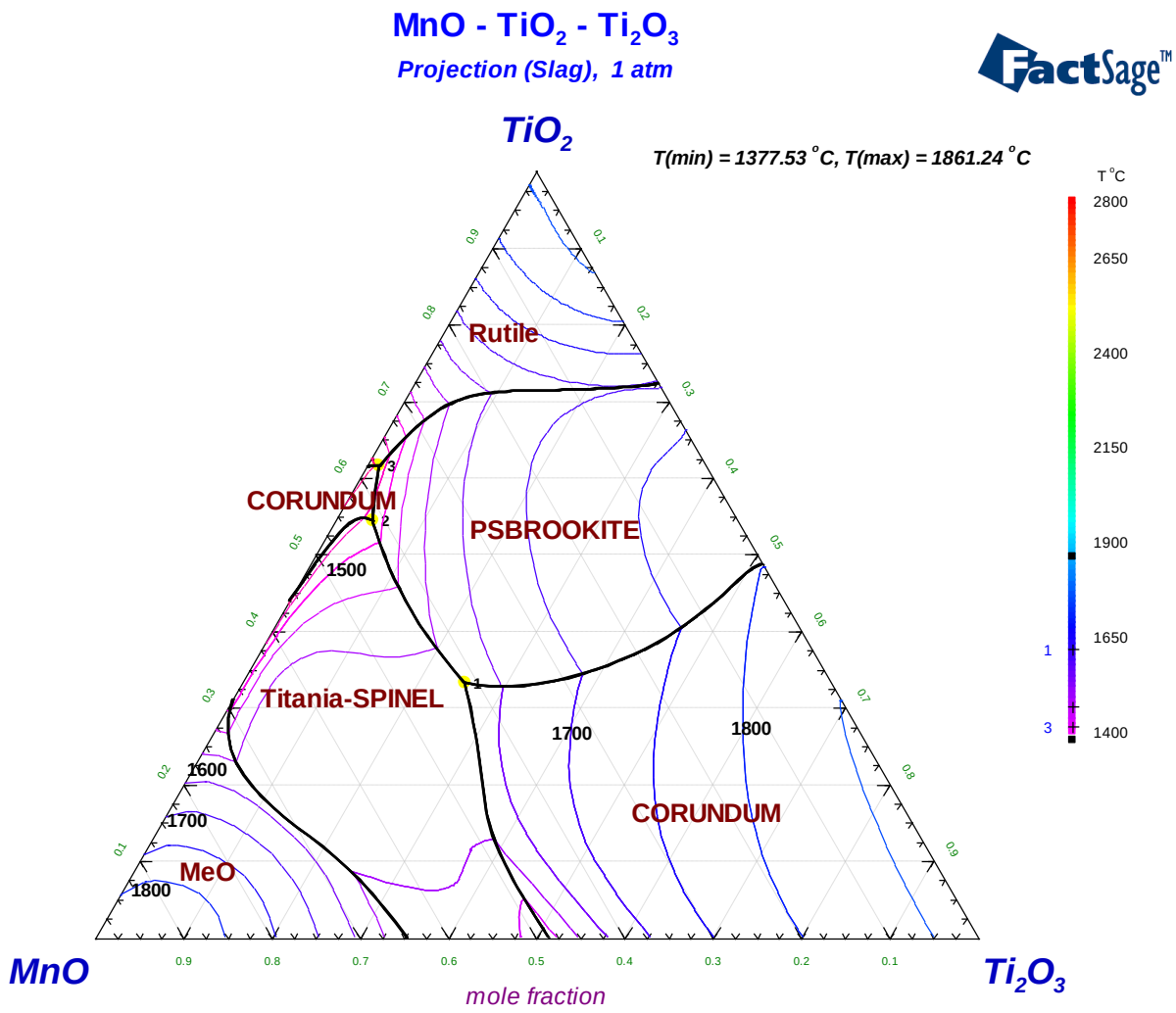


MnO-TiO2-Ti2O3,
Mole fraction, TiO2-TiO1.6-Mn.33Ti.67O1.6, 1200°C

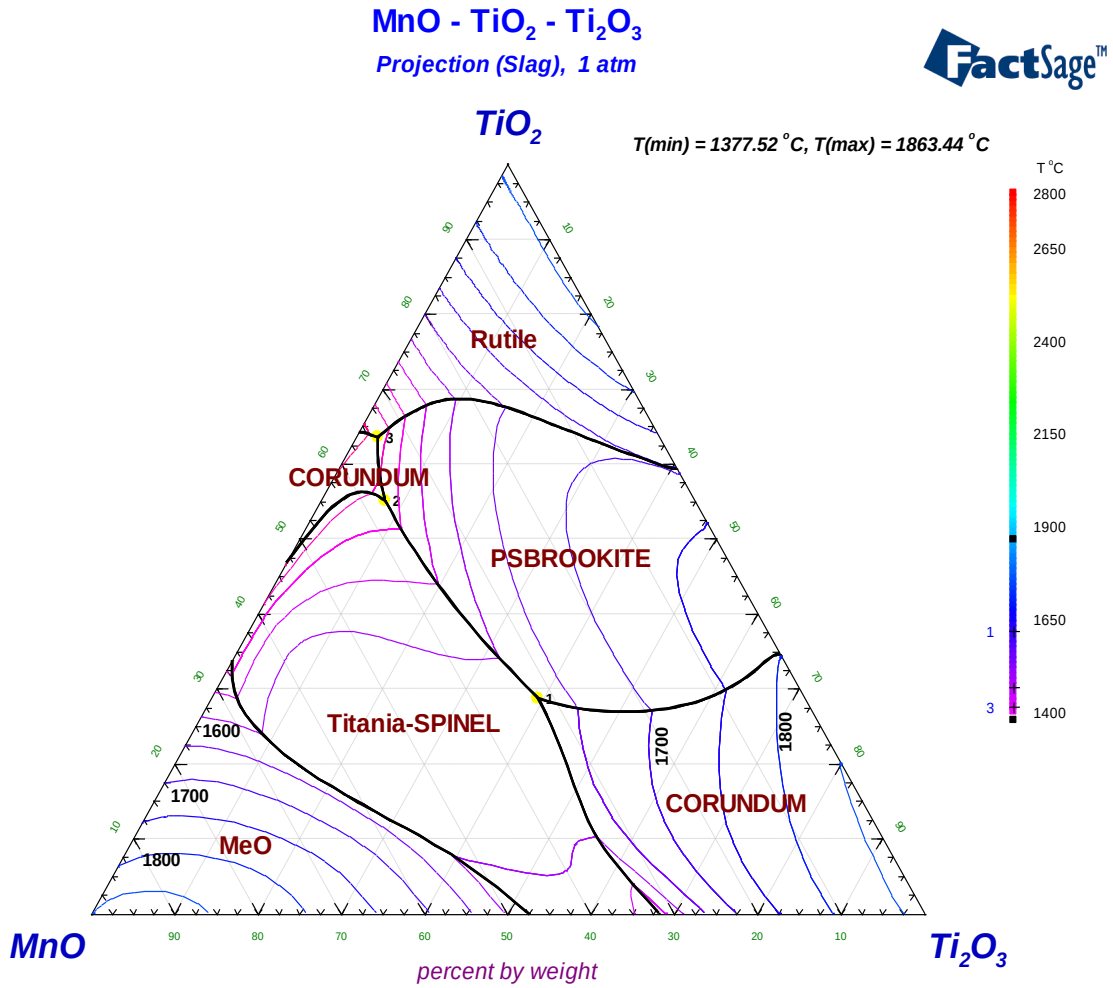



MnO - Ti2O3 - TiO2
1400°C, 1 atm
FactSage
TiO2
CORUNDUM + TiO2(s)
CORUNDUM + PSBROOKITE-Ti3O5
Titania-SPINEL + CORUNDUM
Titania-SPINEL
MnO
MnO
Ti2O3
mole fraction

MnO-TiO2-Ti2O3,
Mole fraction, Liquidussurface



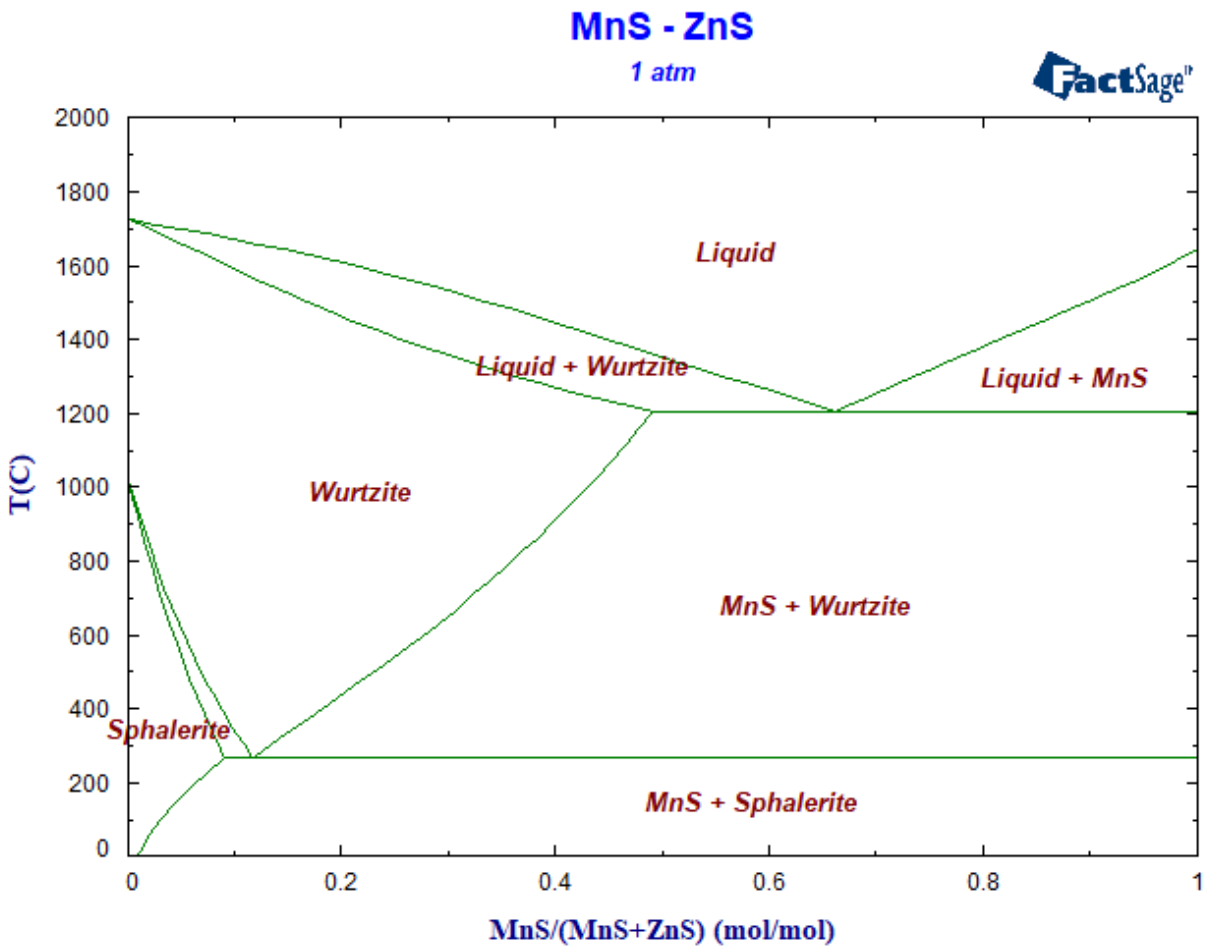
MnO-TiO2-Ti2O3,
Weight percent, Liquidussurface



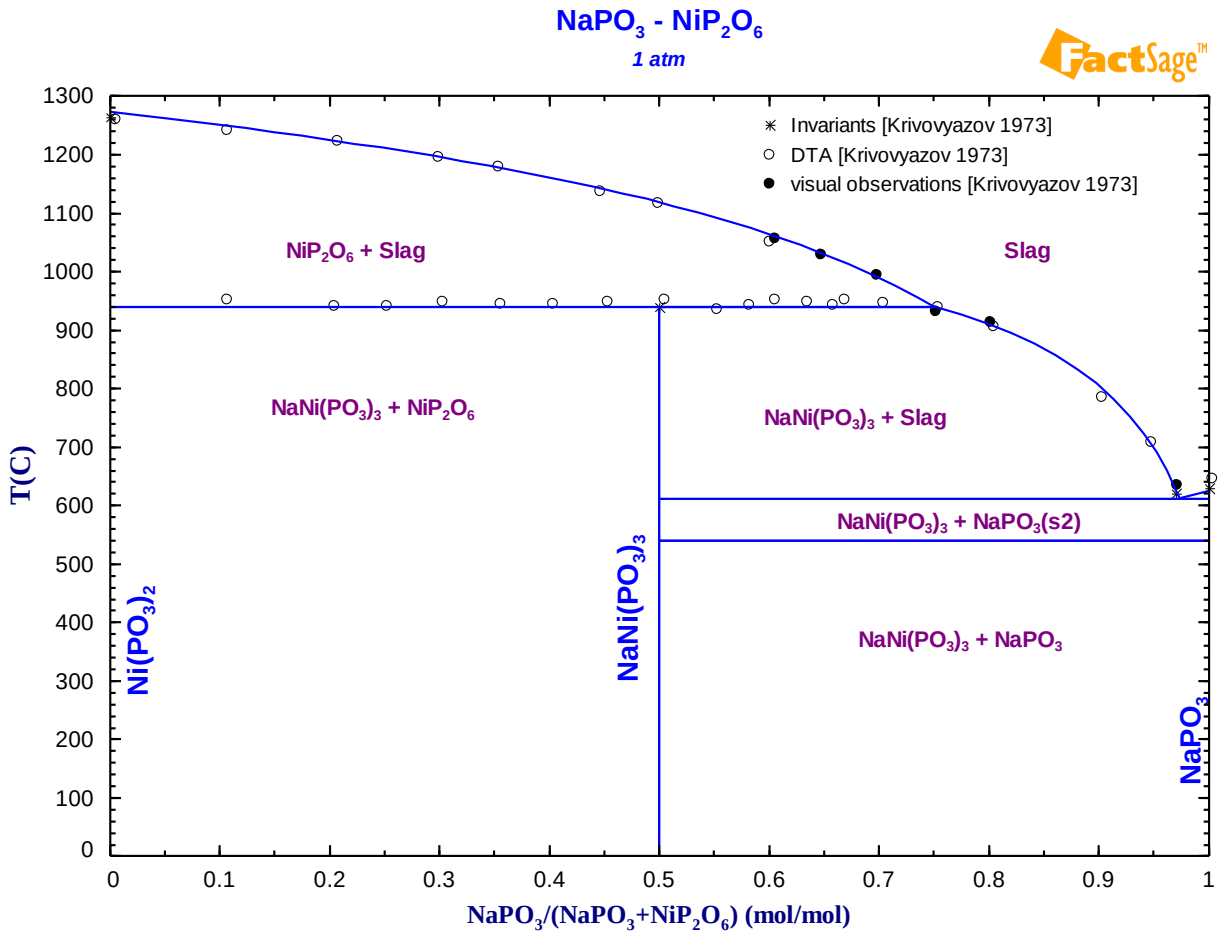
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction					Weight percent				
	A = TiO2, B = MnO, C = Ti2O3					A = SiO2, B = MnO, C = ZnO				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: CORUNDUM / PSBROOKITE / Titania-SPINEL	1:	0.33261	0.41551	0.25188	1618.96	1:	28.798	31.954	39.248	1618.96
2: CORUNDUM / PSBROOKITE / Titania-SPINEL	2:	0.54404	0.41335	0.04261	1466.40	2:	55.072	37.165	7.763	1466.40
3: CORUNDUM / PSBROOKITE-TI3O5 / Rutile	3:	0.61621	0.36991	0.01388	1415.70	3:	63.544	33.881	2.575	1415.70

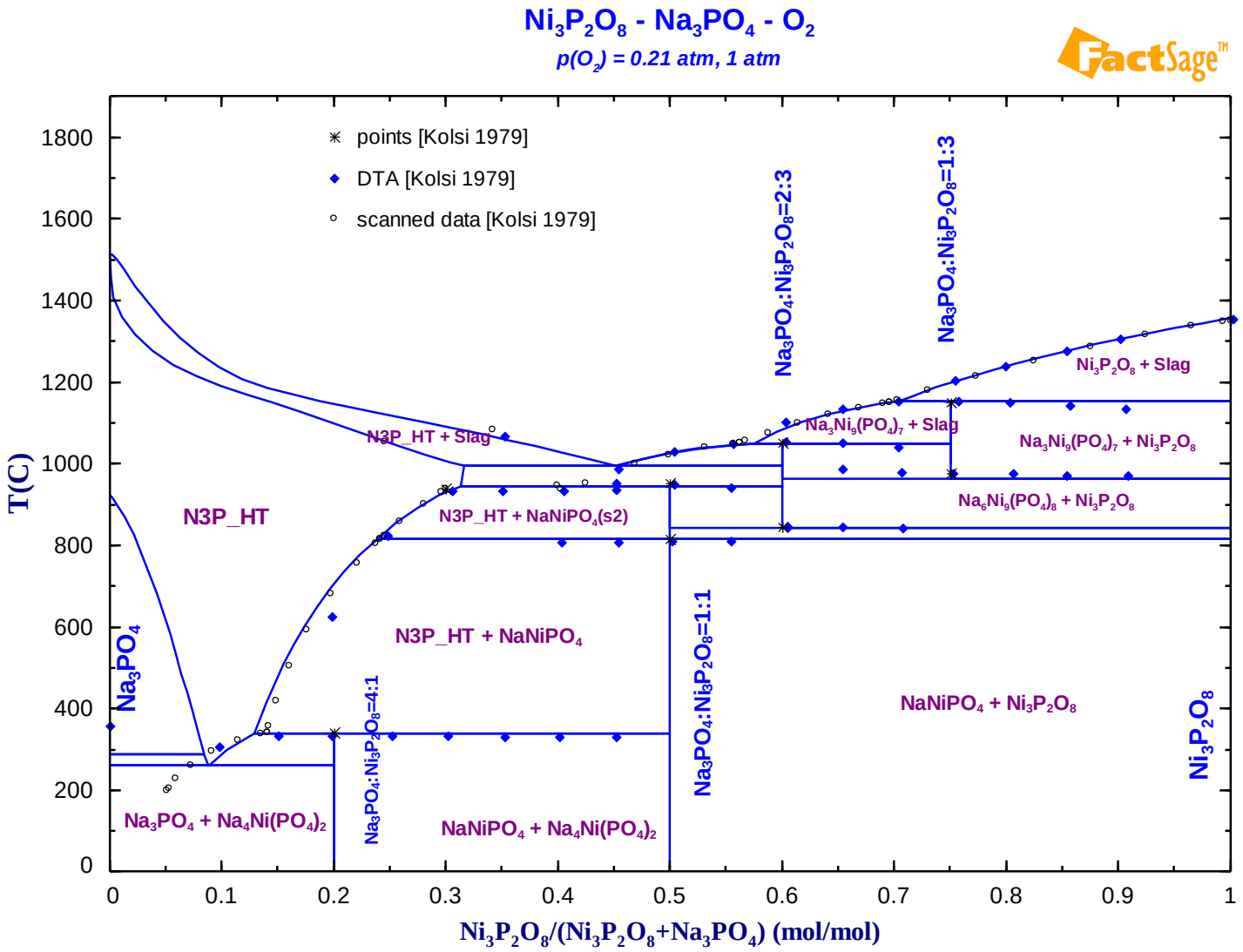
Mn-S-Zn, Mole fraction, Isopleth MnS-ZnS

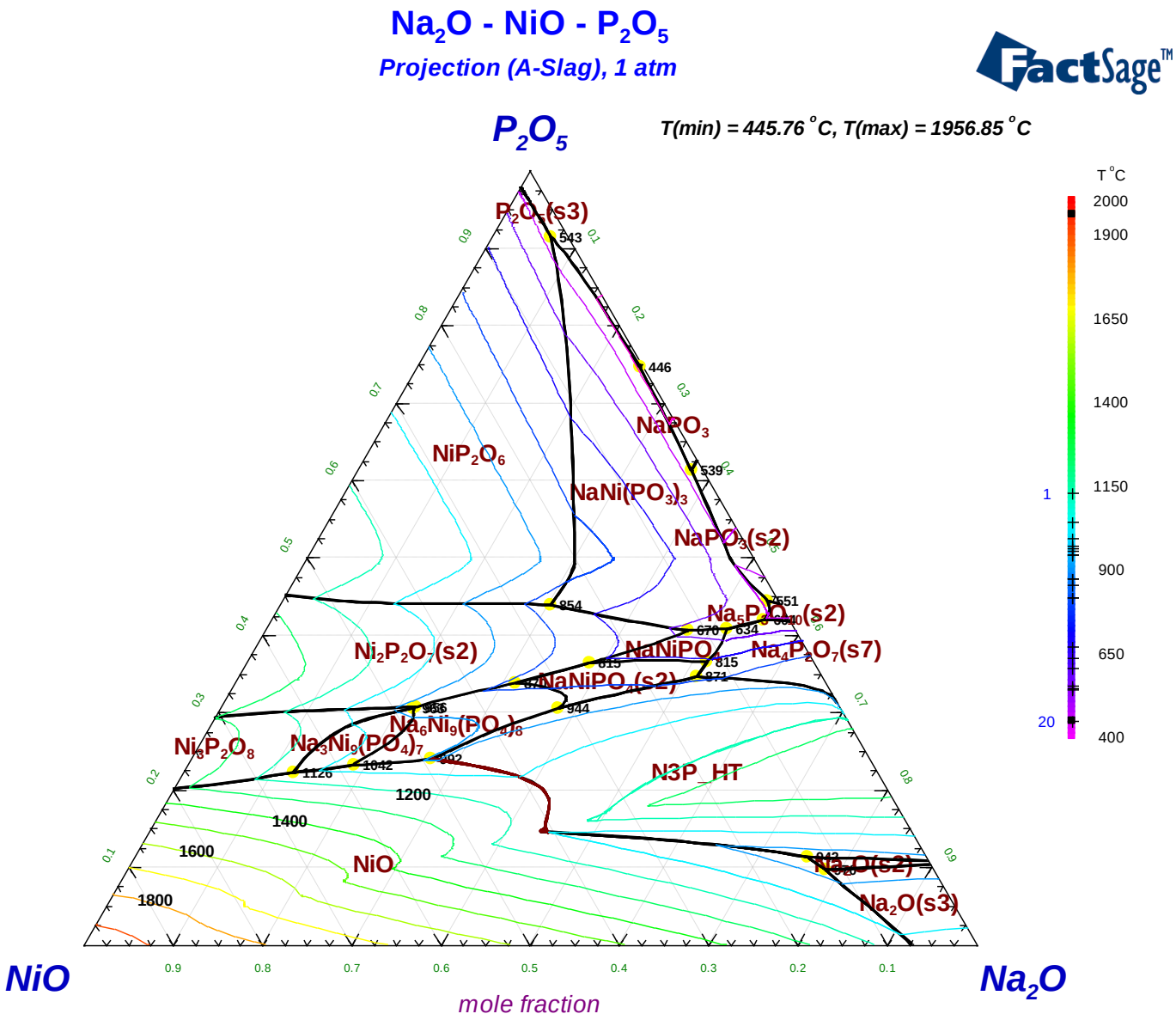


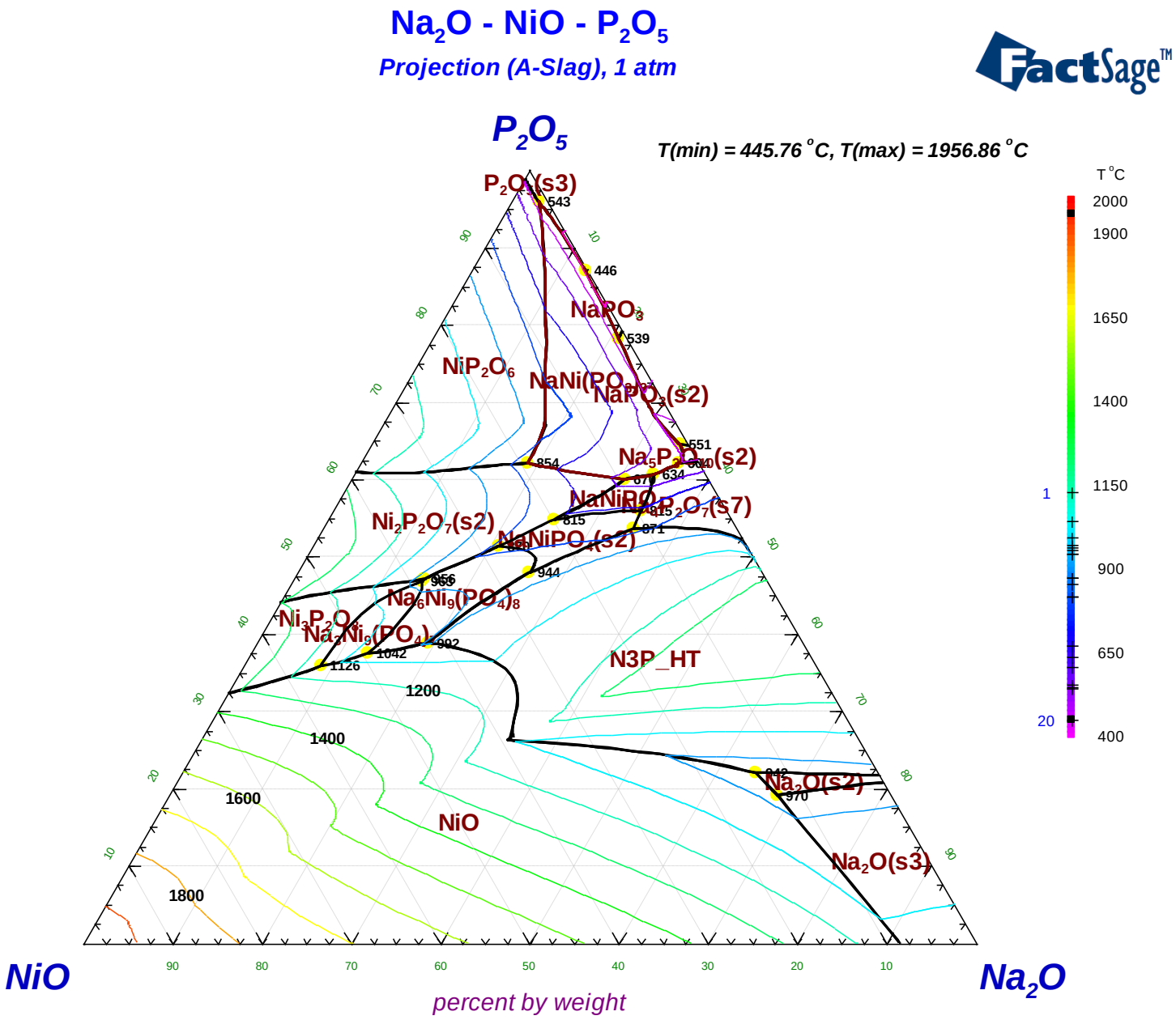
Na2O-NiO-P2O5, Mole fraction, Isopleth NaPO3-NiP2O6 compared with experimental data



Na2O-NiO-P2O5, Mole fraction, Isopleth Na3PO4-Ni3P2O8 compared with experimental data



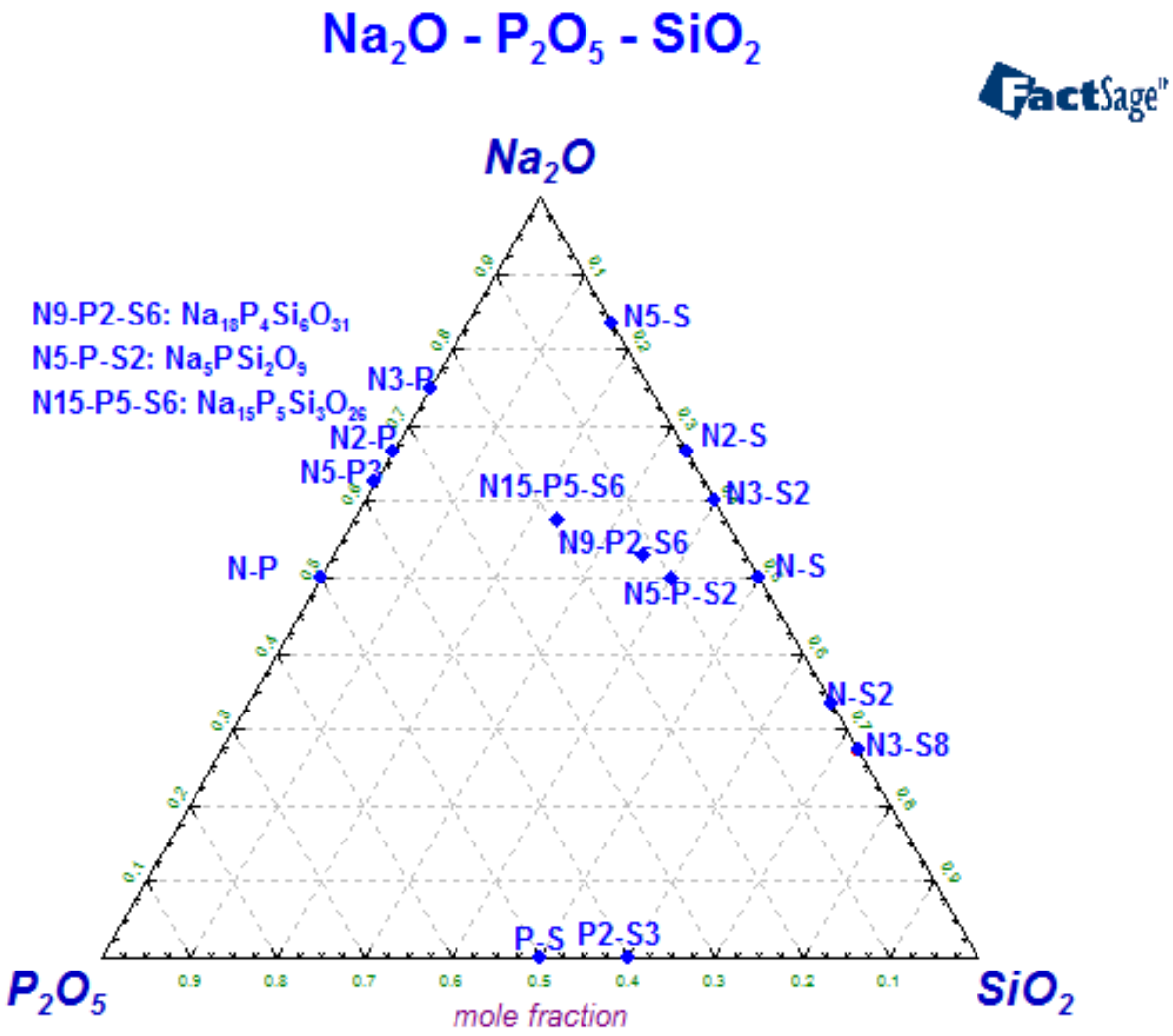

Na2O - NiO - P2O5
Projection (A-Slag), 1 atm
FactSage™
P2O5
T(min) = 445.76 °C, T(max) = 1956.85 °C
T °C
2000
1900
1650
1400
1150
900
650
400
P2O5(s3)
543
446
NaPO3
539
NiP2O6
NaNi(PO3)3
NaPO3(s2)
954
Na5P3O10(s2)
670
634
Ni2P2O7(s2)
NaNiPO4
Na4P2O7(s7)
815
871
NaNiPO4(s2)
944
Na6Ni9(PO4)8
Ni6P2O8
Na3Ni9(PO4)7
1126
1042
N3P_HT
1200
1400
1600
1800
NiO
Na2O(s2)
Na2O(s3)
NiO
Na2O
mole fraction


Na2O - NiO - P2O5
Projection (A-Slag), 1 atm
FactSage™
P2O5
T(min) = 445.76 °C, T(max) = 1956.86 °C
T °C
2000
1900
1650
1400
1150
900
650
400
P2O5(s3)
NaPO3
NiP2O6
NaNi(PO3)3
NaPO3(s2)
Na5P3O10(s2)
NaNiPO4
P2O7(s7)
Ni2P2O7(s2)
NaNiPO4(s2)
Na6Ni9(PO4)8
Ni3P2O8
Na7Ni9(PO4)8
N3P_HT
Na2O(s2)
NiO
Na2O(s3)
1200
1400
1600
1800
NiO
Na2O
percent by weight

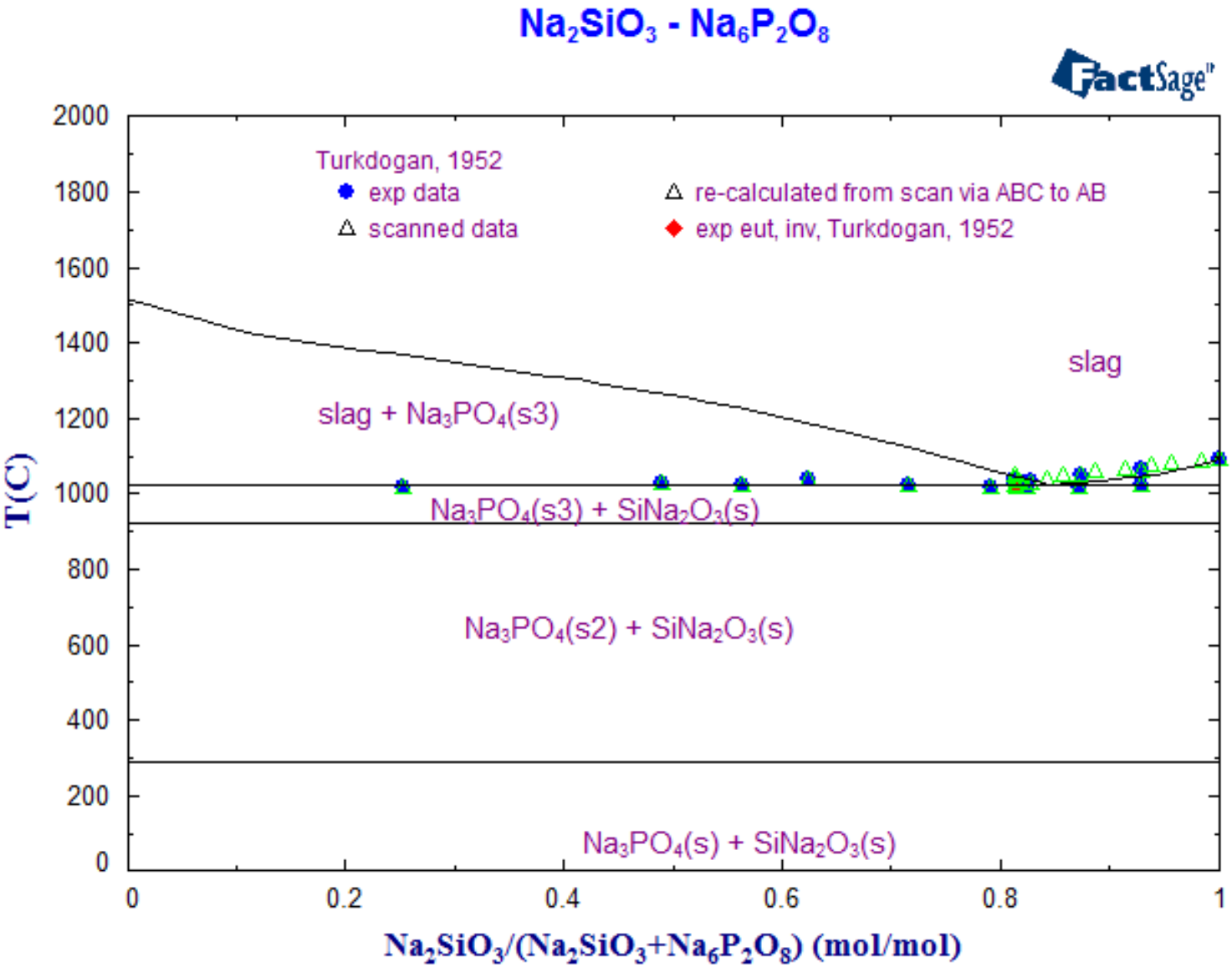
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction				Weight percent			
	A = P2O5, B = NiO, C = Na2O				A = P2O5, B = NiO, C = Na2O			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1. Na3Ni9(PO4)7 / Ni3P2O8 / NiO	0.22297	0.65338	0.12365	1125.63	35.917	55.385	8.698	1125.62
2. Na3Ni9(PO4)7 / Na6Ni9(PO4)8 / NiO	0.23251	0.58102	0.18647	1041.73	37.522	49.339	13.139	1041.74
3. N3P_HT / Na6Ni9(PO4)8 / NiO	0.23956	0.49076	0.26967	991.60	38.918	41.953	19.129	991.60
4. Na2O(s2) / Na2O(s3) / NiO	0.09612	0.12061	0.78327	970.09	19.164	12.653	68.184	970.05
5. Na3Ni9(PO4)7 / Na6Ni9(PO4)8 / Ni3P2O8	0.30502	0.47874	0.21624	962.94	46.828	38.676	14.496	963.21
6. Na6Ni9(PO4)8 / Ni2P2O7(s2) / Ni3P2O8	0.30730	0.47384	0.21886	955.88	47.117	38.230	14.653	955.88
7. N3P_HT / Na6Ni9(PO4)8 / NaNiPO4(s2)	0.30571	0.31522	0.37908	943.92	47.984	26.035	25.981	943.92
8. N3P_HT / Na2O(s2) / NiO	0.11297	0.13209	0.75493	942.41	22.060	13.573	64.367	942.41
9. N3P_HT / Na4P2O7(s7) / NaNiPO4(s2)	0.34553	0.14086	0.51361	871.45	53.661	11.511	34.828	871.45
10.Na6Ni9(PO4)8 /NaNiPO4(s2)/ Ni2P2O7(s2)	0.33793	0.34785	0.31422	870.50	51.344	27.810	20.846	870.50
11.NaNi(PO3)3 / Ni2P2O7(s2) / NiP2O6	0.43888	0.25748	0.30365	854.18	62.080	19.165	18.755	854.19
12.Na4P2O7(s7) / NaNiPO4 / NaNiPO4(s2)	0.36522	0.11865	0.51613	815.00	55.928	9.561	34.511	815.01
13.NaNiPO4 / NaNiPO4(s2) / Ni2P2O7(s2)	0.36403	0.25129	0.38468	814.99	54.805	19.908	25.287	815.00
14.NaNi(PO3)3 / NaNiPO4 / Ni2P2O7(s2)	0.40594	0.11983	0.47423	670.02	60.045	9.327	30.628	670.01
15.Na4P2O7(s7) / NaNi(PO3)3 / NaNiPO4	0.40833	0.07483	0.51684	634.36	60.639	5.847	33.514	634.36
16.Na4P2O7(s7) /Na5P3O10(s2) / NaNi(PO3)3	0.41965	0.02774	0.55261	603.87	62.120	2.161	35.719	603.87
17.Na5P3O10(s2) / NaNi(PO3)3 / NaPO3(s2)	0.44433	0.01124	0.54442	550.89	64.586	0.860	34.554	550.89
18.NaNi(PO3)3 / NiP2O6 / P2O5(s3)	0.91505	0.01886	0.06609	542.56	95.934	1.040	3.026	542.56
19.NaNi(PO3)3 / NaPO3(s2) / NaPO3	0.61285	0.01278	0.37437	539.40	78.265	0.859	20.876	539.41
20.NaNi(PO3)3 / NaPO3 / P2O5(s3)	0.74638	0.00365	0.24997	445.76	87.047	0.224	12.729	445.76

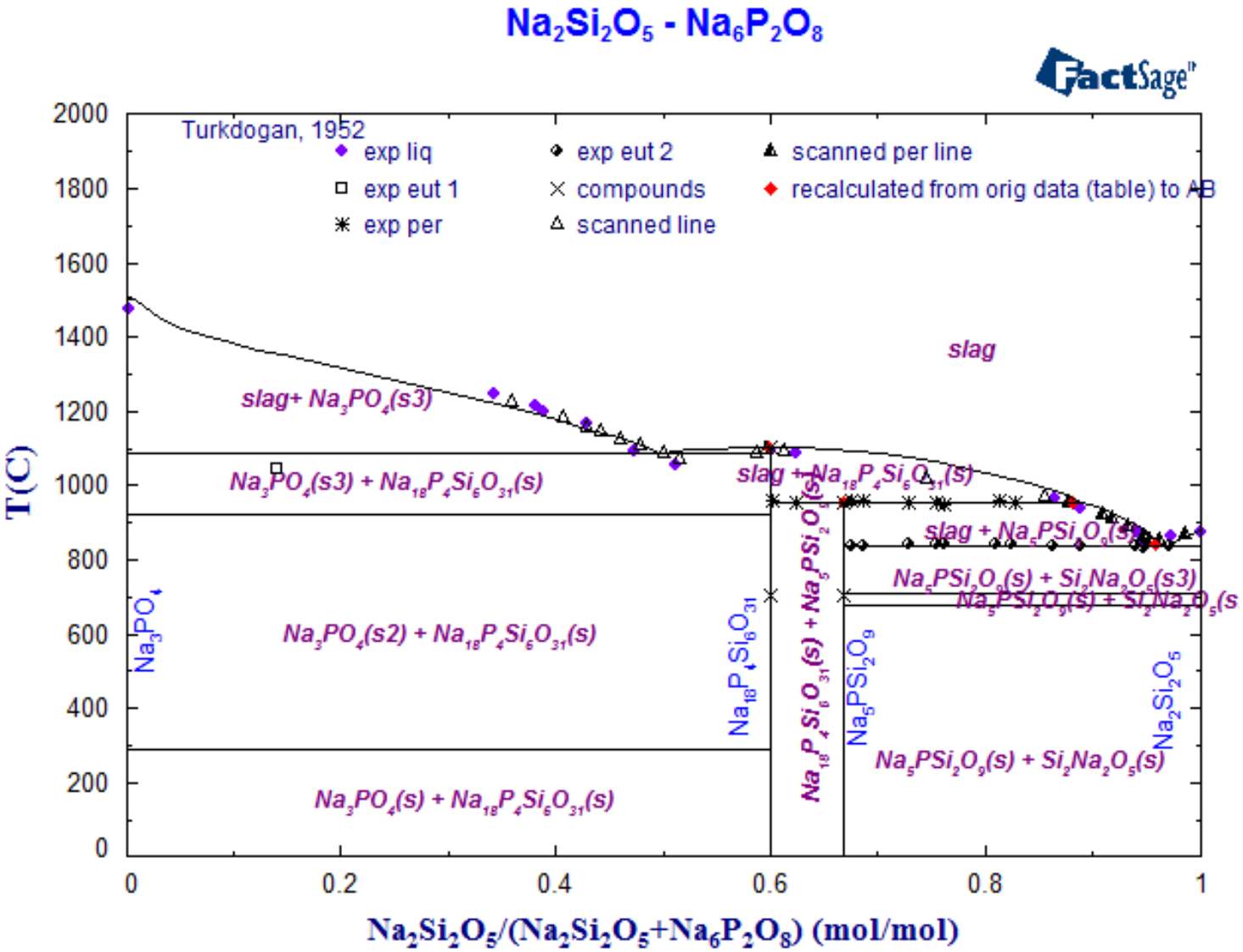
Na2O-P2O5-SiO2,
Mole fraction, ternary phases



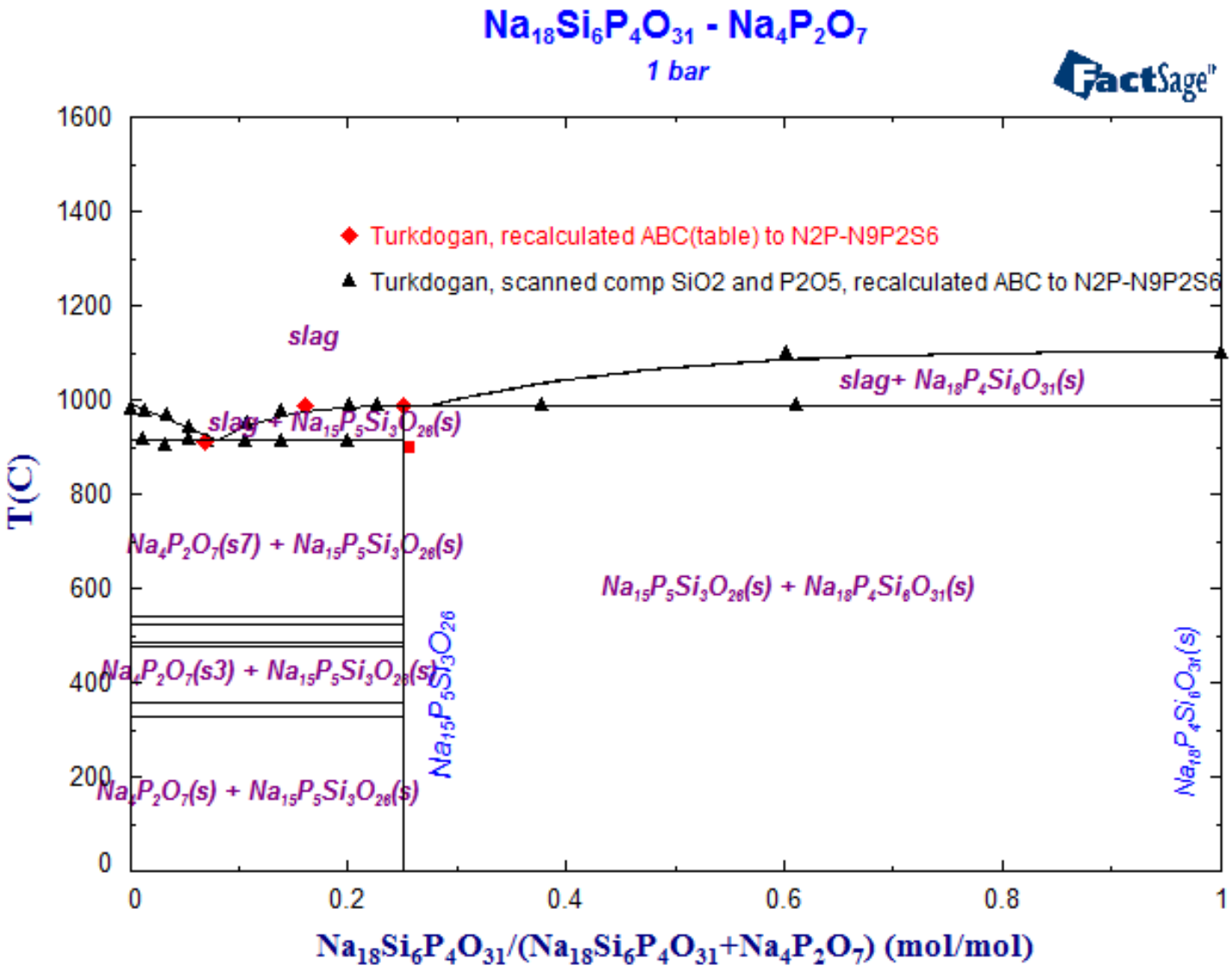
Mole fraction Isopleth $2Na_3PO_4$-Na_2SiO_3 compared with experimental data



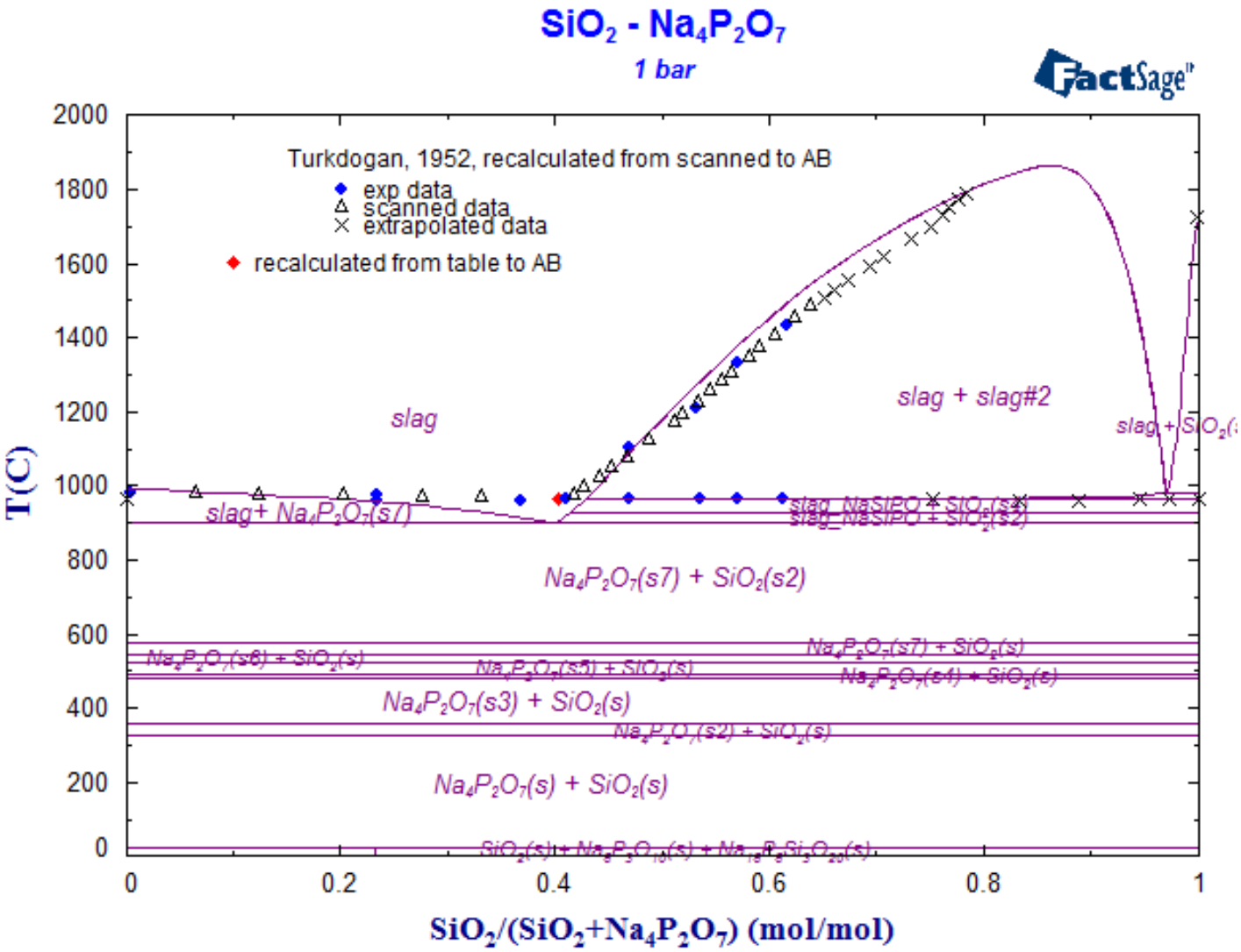
Mole fraction Isopleth $2Na_3PO_4$-$Na_2Si_2O_5$ compared with experimental data



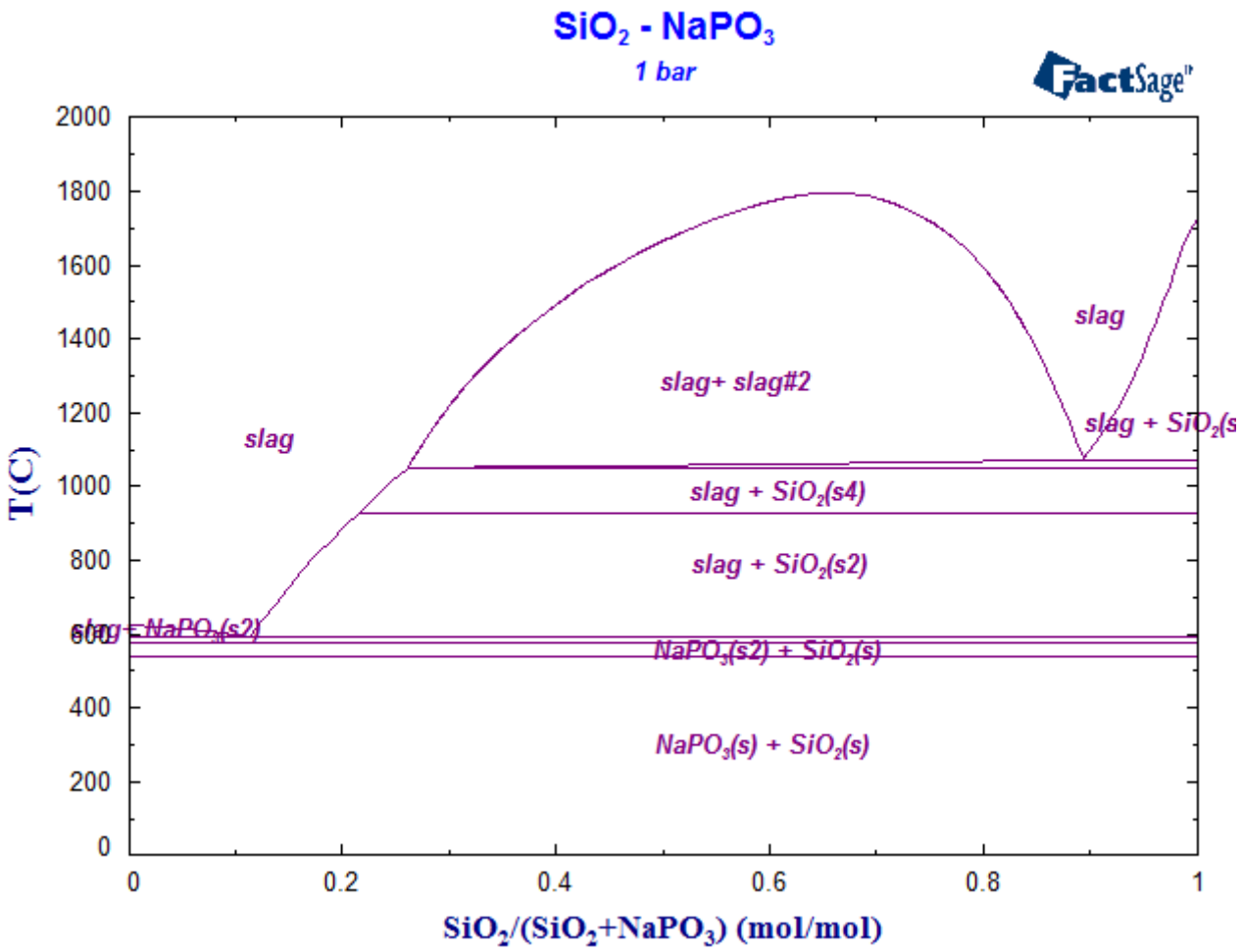
Mole fraction Isopleth $Na_{18}P_4Si_6O_{31}$-$Na_4P_2O_7$ compared with experimental data



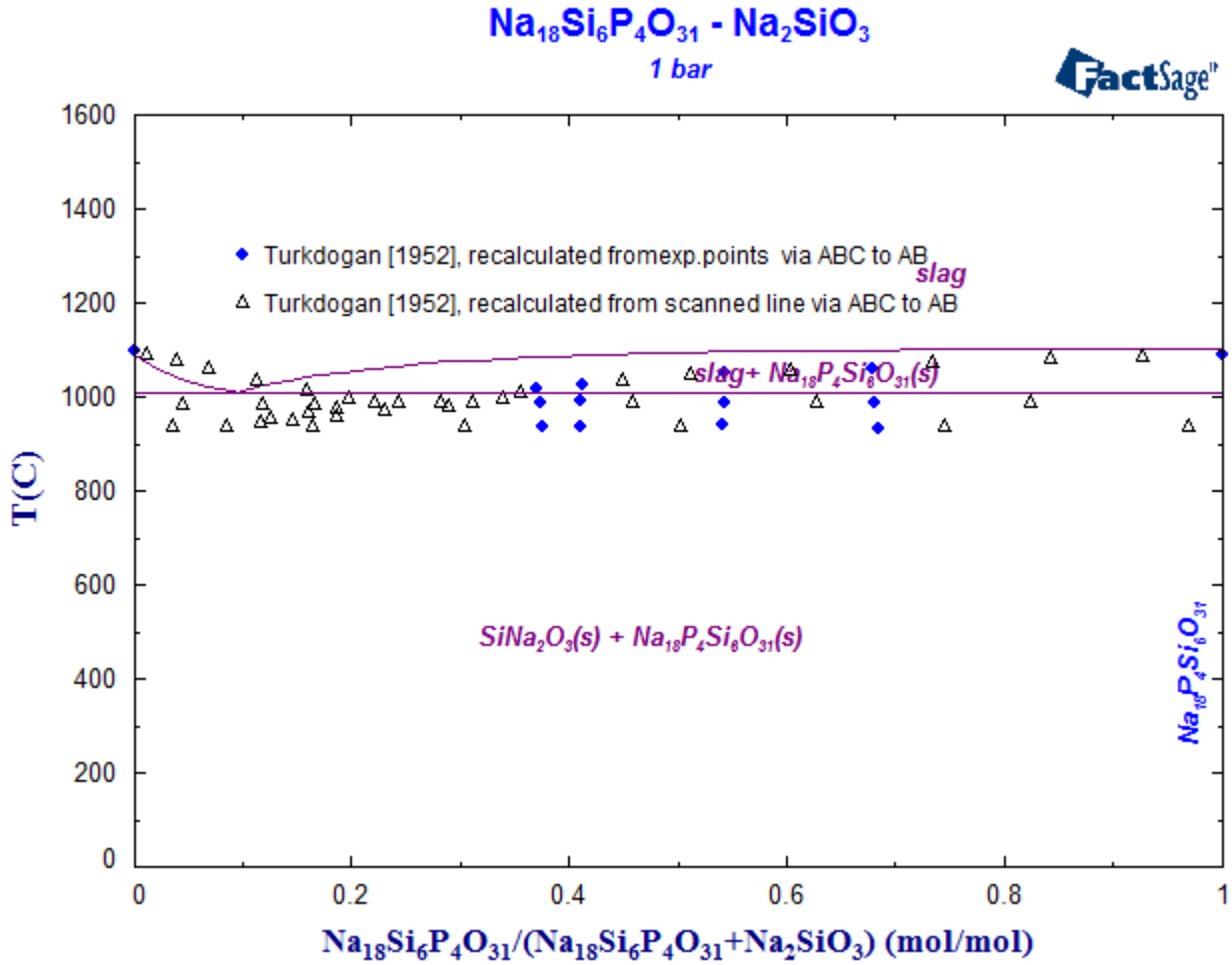
Mole fraction Isopleth $Na_4P_2O_7$-SiO_2 compared with experimental data

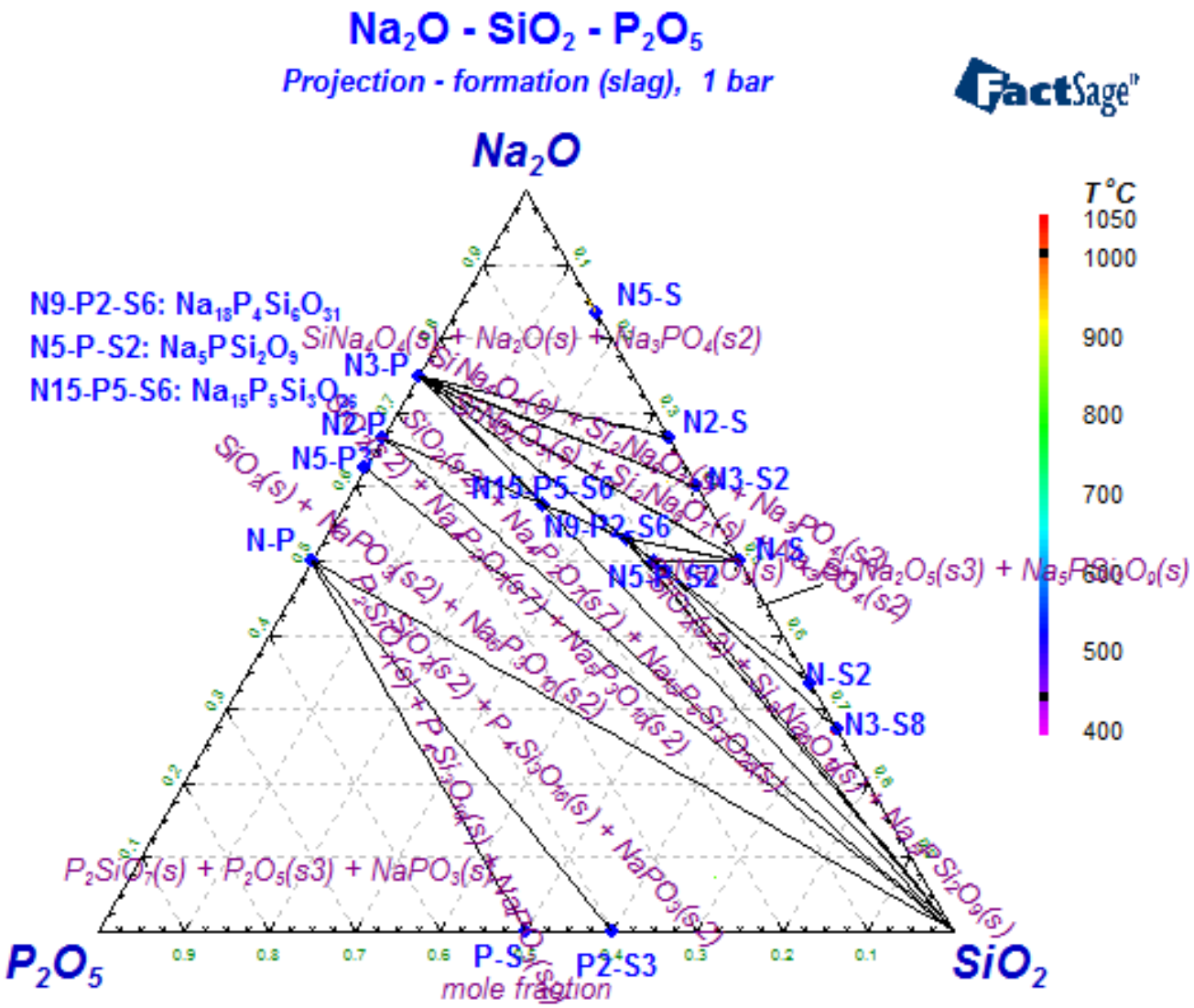


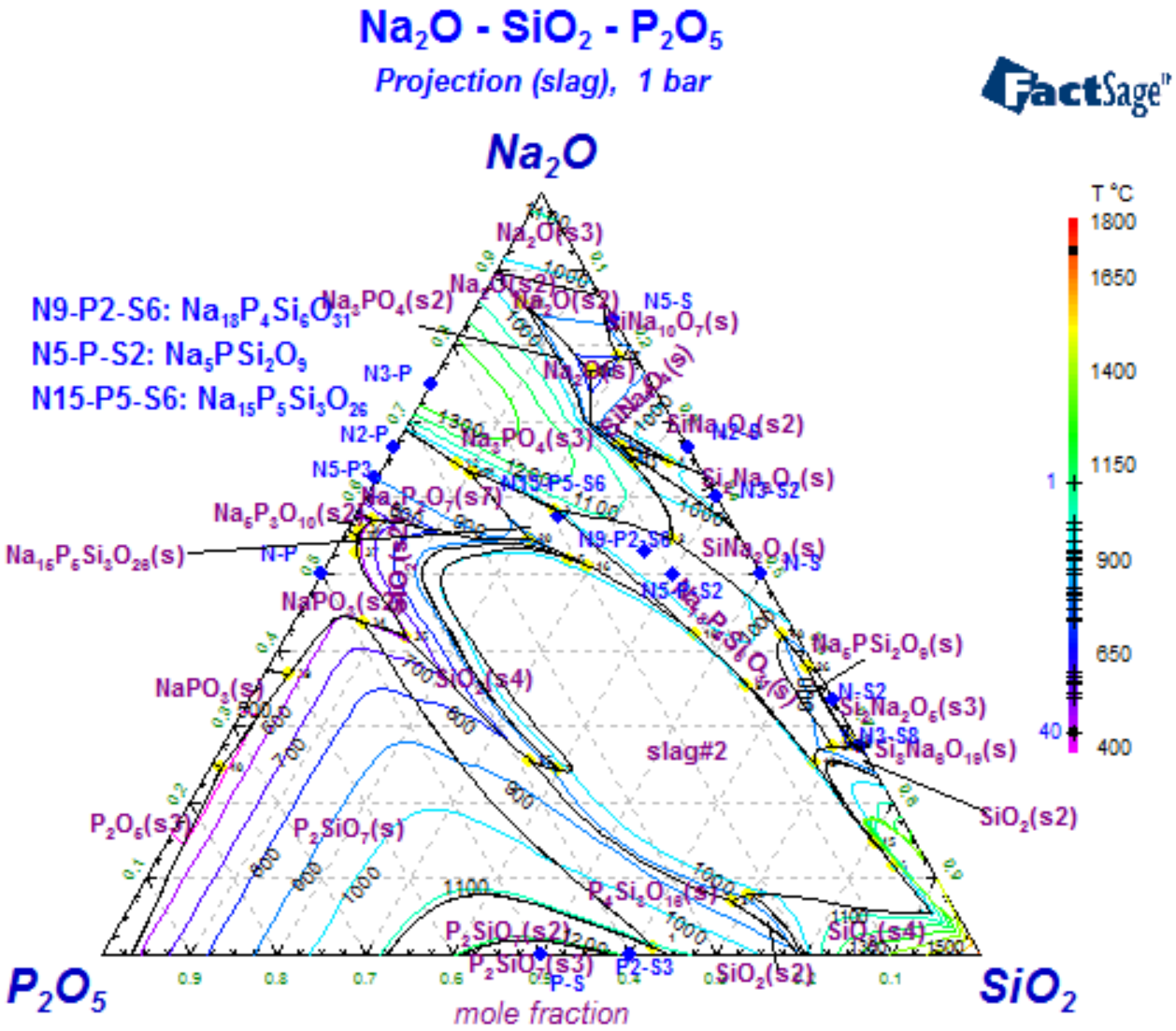
Mole fraction Isopleth $NaPO_3$-SiO_2 compared with experimental data

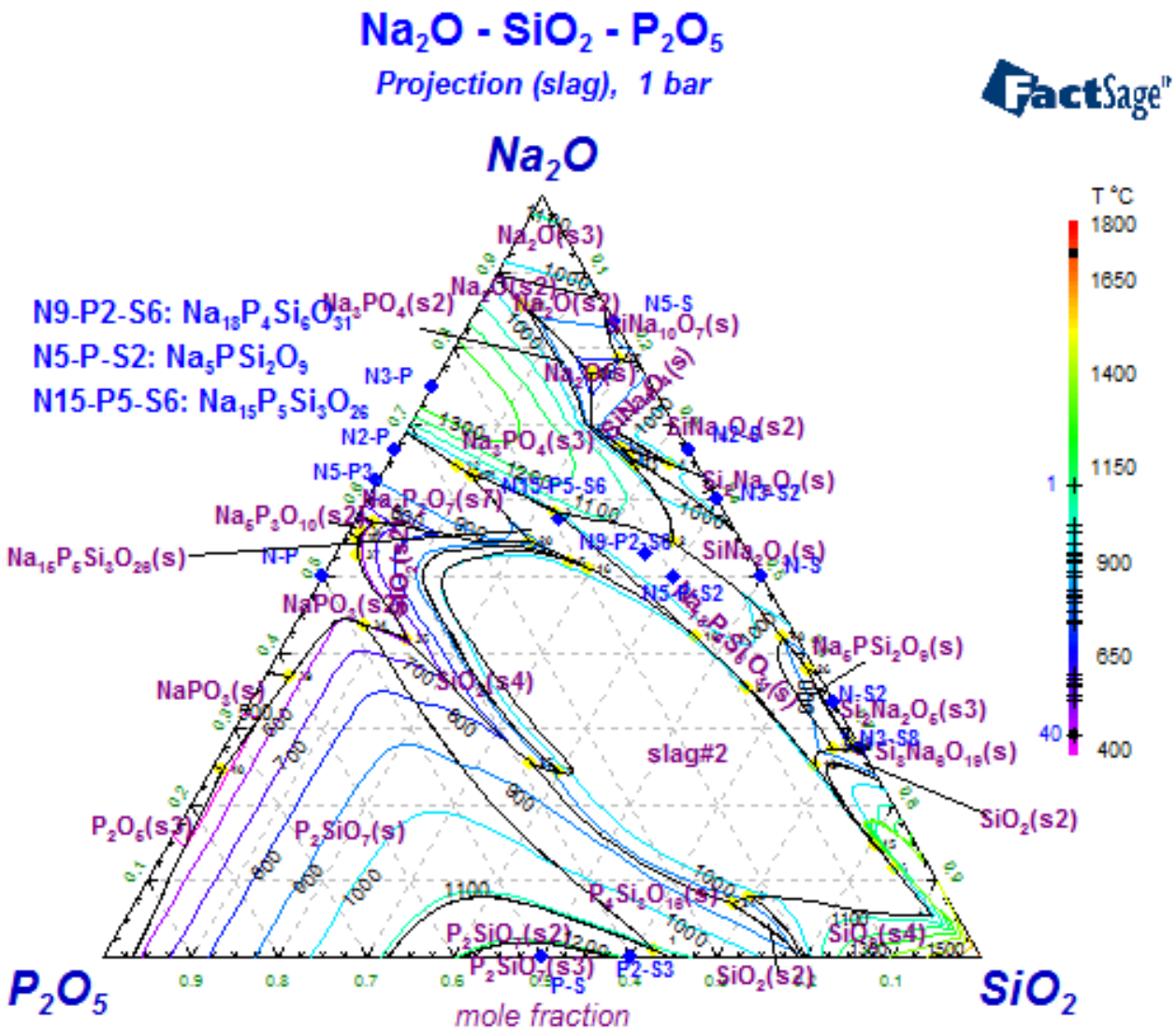


Mole fraction Isopleth $Na_{18}P_4Si_6O_{31}$-Na_2SiO_3 compared with experimental data




Na2O - SiO2 - P2O5
Projection - formation (slag), 1 bar
FactSage
Na2O
P2O5
SiO2
T °C
1050
1000
900
800
700
600
500
400
N9-P2-S6: Na18P4Si6O31
N5-P-S2: Na5PSi2O9
N15-P5-S6: Na15P5Si3O26
N5-S
N3-P
N2-S
N2-P
N5-P2
N3-S2
N15-P5-S6
N9-P2-S6
N-P
N4-S
N5-P-S2
N-S2
N3-S8
P-S
P2-S3
mole fraction
SiNa4O4(s) + Na2O(s) + Na3PO4(s2)
SiO2(s) + NaPO3(s2) + Na4P2O7(s7) + Na3P3O10(s2)
P2SiO7(s) + P2O5(s3) + NaPO3(s)
P2SiO7(s) + P4Si3O16(s) + NaPO3(s2)
Na2O(s) + Na2SiO3(s) + Na3PO4(s2)
Na2O(s) + Na2O5(s3) + Na5PSi2O9(s)

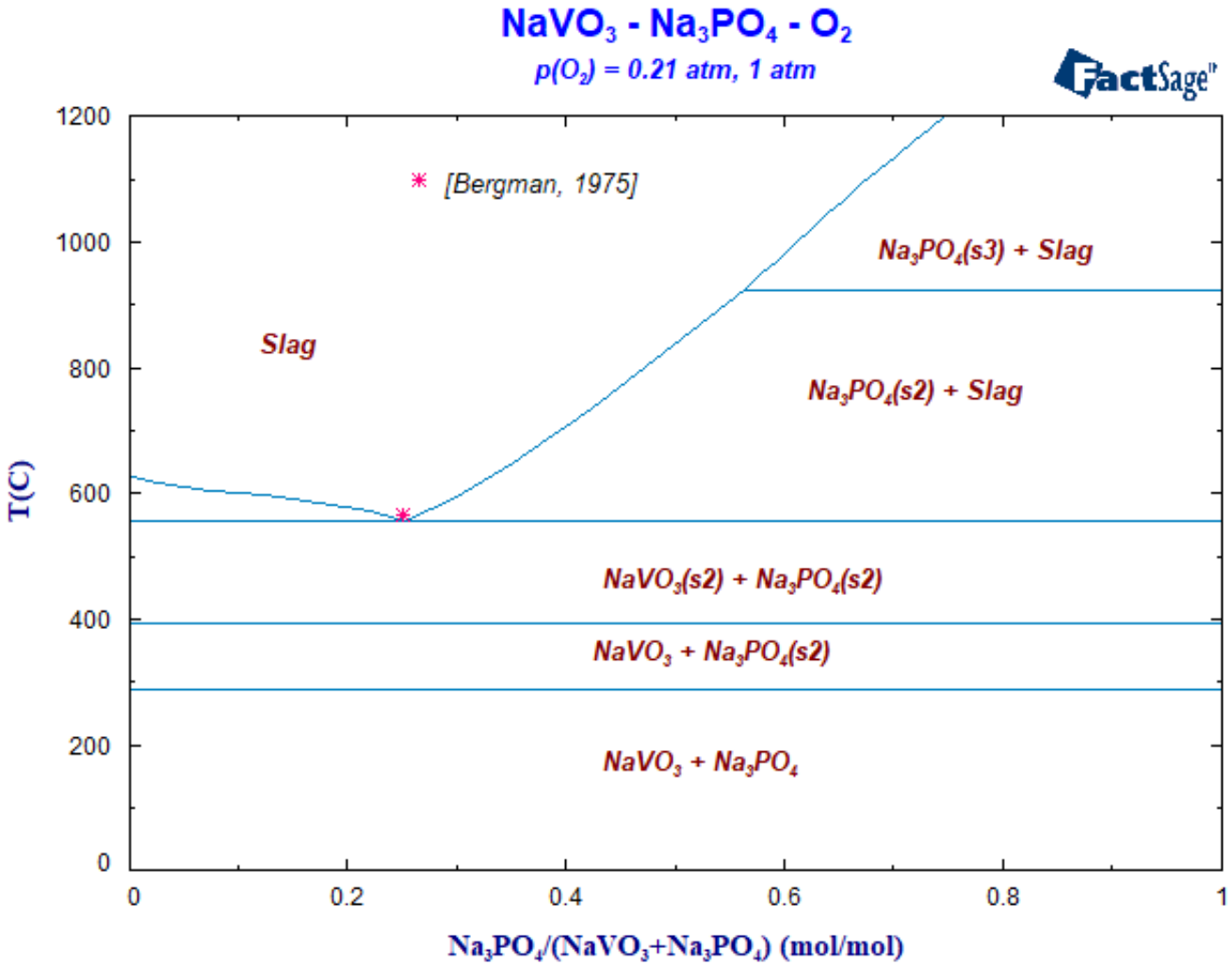

Na2O - SiO2 - P2O5
Projection (slag), 1 bar
FactSage
Na2O
N9-P2-S6: Na18P4Si6O31
N5-P-S2: Na5PSi2O9
N15-P5-S6: Na15P5Si3O26
Na3PO4(s2)
Na2O(s3)
Na2O(s2)
N5-S
SiNa10O7(s)
N3-P
Na2O(s)
SiNa2O3(s)
N2-P
Na3PO4(s3)
SiNa2O3(s2)
N2-S
N5-P3
N15-P5-S6
Si2Na2O5(s)
N3-S2
Na4P2O7(s7)
Na6P3O10(s2)
Na16P6Si3O28(s)
N-P
N9-P2-S6
SiNa2O3(s)
N-S
NaPO3(s2)
N5-P-S2
Na5PSi2O9(s)
NaPO3(s)
SiO2(s4)
N-S2
Si2Na2O5(s3)
N3-S8
Si8Na8O19(s)
slag#2
SiO2(s2)
P2O5(s2)
P2SiO7(s)
P4Si3O18(s)
P2SiO4(s2)
P2SiO4(s3)
P2-S3
P-S
SiO2(s4)
SiO2(s2)
T °C
1800
1650
1400
1150
900
650
400
1
40
P2O5
SiO2
mole fraction

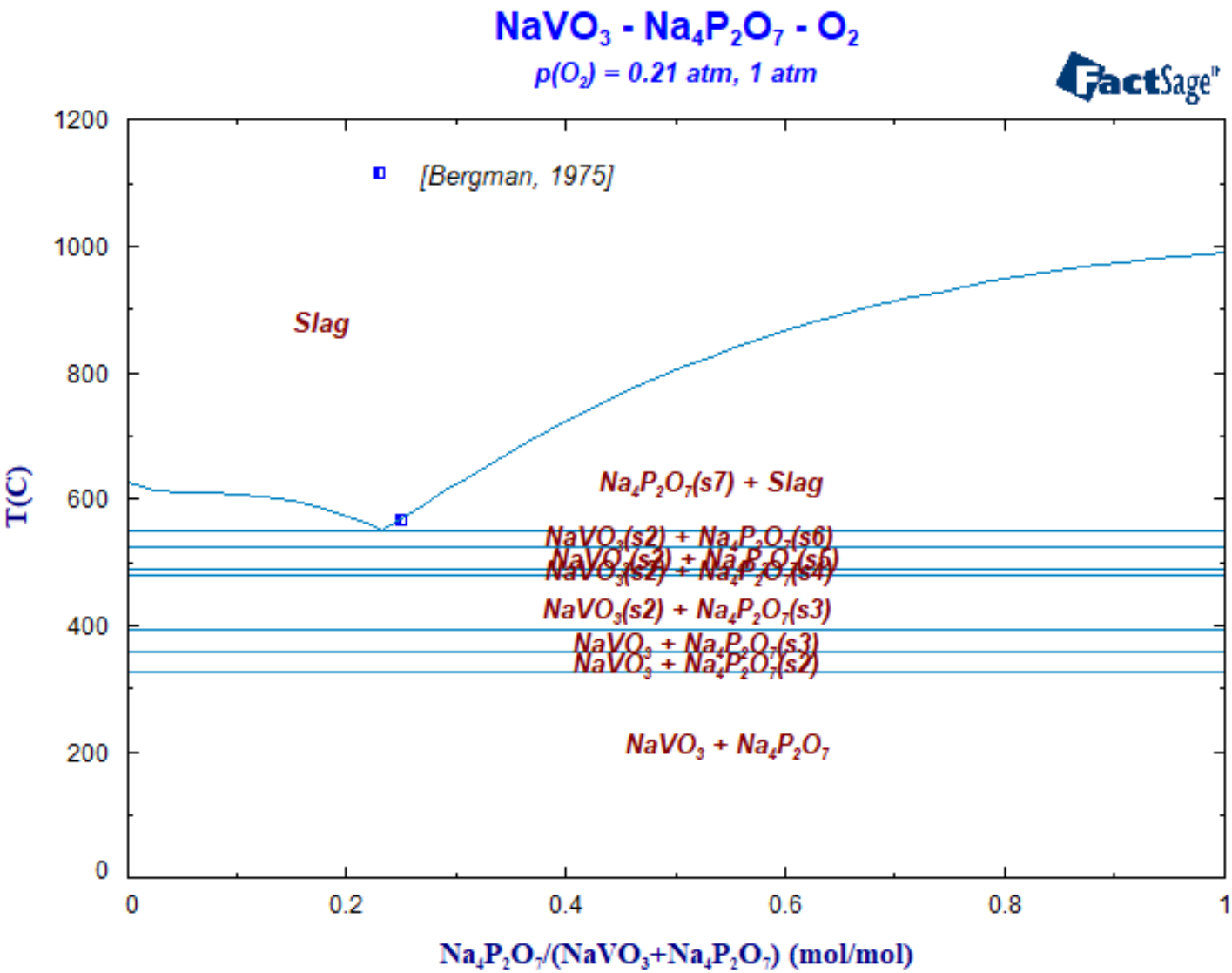

Na2O - SiO2 - P2O5
Projection (slag), 1 bar
FactSage
Na2O
N9-P2-S6: Na18P4Si6O31
N5-P-S2: Na5PSi2O9
N15-P5-S6: Na15P5Si3O26
Na3PO4(s2)
Na2O(s3)
Na2O(s2)
N5-S
SiNa10O7(s)
N3-P
N2-P
N5-P3
Na3PO4(s3)
N15-P5-S6
Na6P3O10(s2)
Na16P6Si3O28(s)
N-P
NaPO3(s2)
NaPO3(s)
SiO2(s4)
N9-P2-S6
SiNa2O3(s)
N-S
N5-P-S2
Na6PSi2O9(s)
N-S2
Si2Na2O5(s3)
N3-S8
Si3Na8O19(s)
slag#2
SiO2(s2)
P2O5(s2)
P2SiO7(s)
P4Si3O18(s)
P2SiO4(s2)
P2SiO4(s3)
P-S
P2-S3
SiO2(s2)
SiO2(s4)
P2O5
SiO2
mole fraction
T °C
1800
1650
1400
1150
900
650
400
1
40

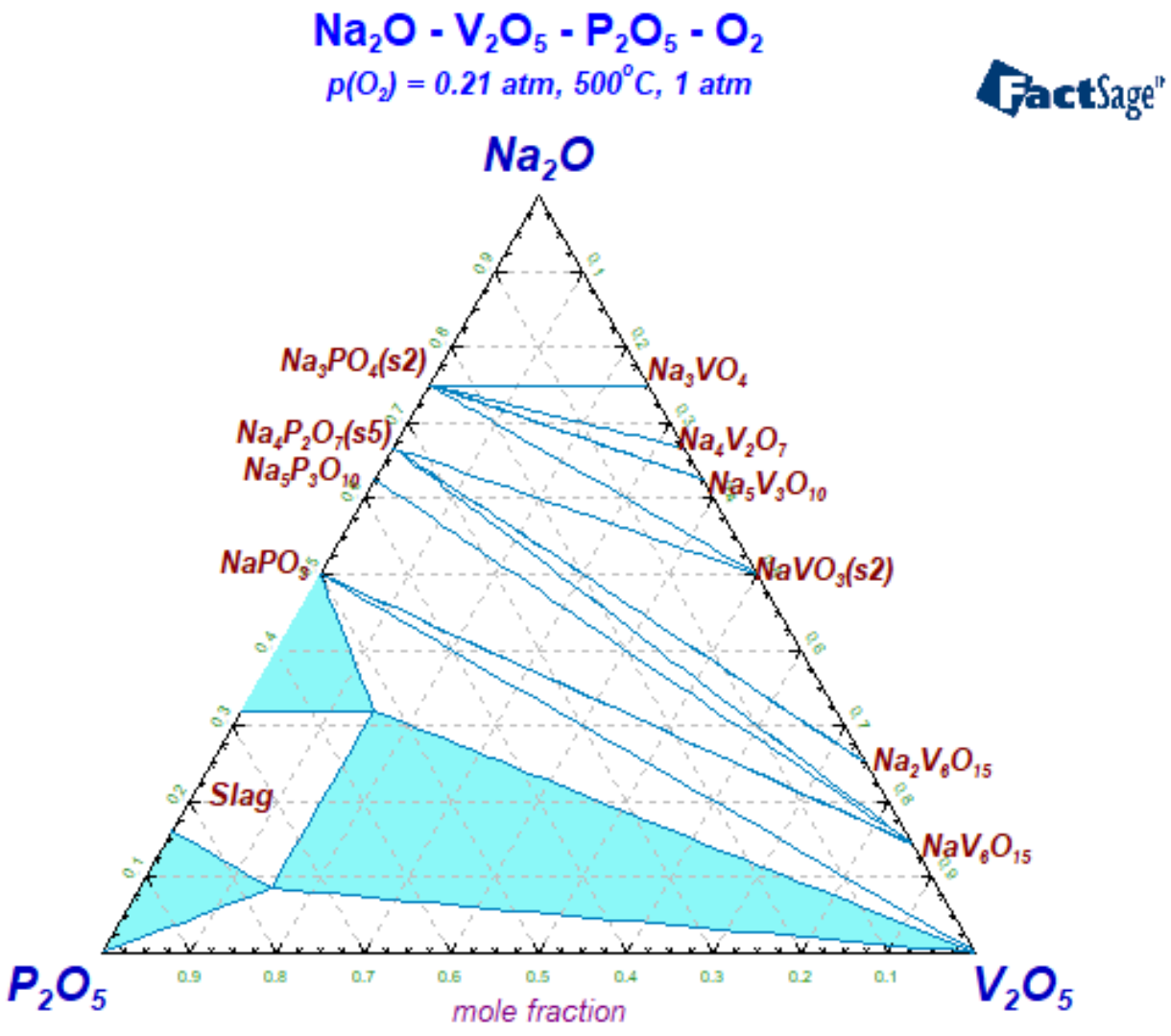
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction A = Na2O, B = P2O5, C = SiO2				Weight percent A = Na2O, B = P2O5, C = SiO2			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1: P2SiO7(s) / P2SiO7(s2) / P4Si3O16(s)	1: 0.00927	0.36673	0.62399	1106.85	1: 0.638	57.761	41.601	1106.85
2: Na18P4Si6O31 / Na3PO4(s3) / SiNa2O3(s)	2: 0.54560	0.07950	0.37490	1005.32	2: 50.004	16.687	33.309	1005.32
3: Na15P5Si3O26 / Na18P4Si6O31 / Na3PO4(s3)	3: 0.58443	0.19216	0.22340	985.19	3: 47.090	35.460	17.450	985.19
4: Si2Na6O7(s) / SiNa4O4(s2) / SiNa4O4(s)	4: 0.64715	0.03037	0.32247	954.76	4: 62.871	6.758	30.371	954.75
5: SiO2(s4) / SiO2(s2) / slag#2	5: 0.51964	0.20743	0.27293	926.29	5: 6.217	40.392	53.391	926.29
6: SiO2(s4) / SiO2(s2) / slag#2	6: 0.11679	0.04097	0.84224	926.28	6: 41.265	37.725	21.011	926.28
7: SiO2(s4) / SiO2(s2) / slag#2	7: 0.24329	0.36023	0.39648	926.28	7: 16.748	56.792	26.459	926.28
8: SiO2(s4) / SiO2(s4) / SiO2(s2)	8: 0.07877	0.22345	0.69778	926.26	8: 11.371	9.136	79.494	926.28
9: Na15P5Si3O26 / Na18P4Si6O31 / slag#2	9: 0.35407	0.08879	0.55715	922.72	9: 32.261	18.527	49.213	922.69
10: Na15P5Si3O26 / Na15P5Si3O26 /Na18P4Si6O31	10: 0.41958	0.11376	0.46666	922.69	10: 37.049	23.005	39.947	922.69
11: Na15P5Si3O26 / Na3PO4(s3) / Na3PO4(s2)	11: 0.63150	0.26034	0.10816	922.41	11: 59.348	15.203	25.449	922.40
12: Na3PO4(s3) / Na3PO4(s2) / Na4P2O7(s7)	12: 0.64477	0.27388	0.08135	922.40	12: 76.561	19.079	4.361	922.40
13: Na3PO4(s3) / Na3PO4(s2) / SiNa2O3(s)	13: 0.64343	0.07197	0.28460	922.40	13: 47.389	44.742	7.869	922.40
14: Na2O(s2) / Na3PO4(s3) / Na3PO4(s2)	14: 0.85648	0.09319	0.05032	922.40	14: 47.730	46.432	5.838	922.40
15: Na15P5Si3O26 / SiO2(s2) / slag#2	15: 0.14639	0.04764	0.80597	919.71	15: 14.119	10.524	75.358	919.71
16: Na15P5Si3O26 / SiO2(s2) / slag#2	16: 0.50946	0.19111	0.29943	919.71	16: 41.171	35.371	23.458	919.71
17: Na15P5Si3O26 / Na3PO4(s2) / Na4P2O7(s7)	17: 0.63250	0.26464	0.10286	912.82	17: 47.262	45.287	7.451	912.82
18: Na18P4Si6O31 / Na5PSi2O9 / SiNa2O3(s)	18: 0.41969	0.01679	0.56352	906.37	18: 41.783	3.829	54.388	906.39
19: Na15P5Si3O26 / Na18P4Si6O31 / SiO2(s2)	19: 0.25126	0.06383	0.68490	902.14	19: 23.672	13.773	62.555	902.14
20: Na15P5Si3O26 / Na4P2O7(s7) / SiO2(s2)	20: 0.54526	0.24024	0.21450	879.85	20: 41.834	42.212	15.954	879.88
21: Na18P4Si6O31 / Na5PSi2O9 / SiO2(s2)	21: 0.27201	0.03195	0.69604	869.77	21: 26.669	7.173	66.157	869.81
22: Na3PO4(s2) / Si2Na6O7(s) / SiNa2O3(s)	22: 0.65671	0.07193	0.27136	864.10	22: 60.554	15.189	24.257	864.08
23: Na3PO4(s2) / Si2Na6O7(s) / SiNa4O4(s)	23: 0.66936	0.07576	0.25488	832.21	23: 61.412	15.919	0.22.669	832.22
24: P4Si3O16(s) / SiO2(s2) / slag#2	24: 0.06915	0.24759	0.68326	815.91	24: 5.325	43.666	0.51.009	815.93
25: P4Si3O16(s) / P4Si3O16 / SiO2(s2)	25: 0.25543	0.38536	0.35921	815.91	25: 17.187	59.383	0.23.431	815.91
26: Na5PSi2O9 / Si2Na2O5(s3) / SiNa2O3(s)	26: 0.37674	0.00839	0.61487	812.87	26: 37.977	1.936	0.60.087	812.88
27: Na2O(s2) / SiNa10O7(s) / SiNa4O4(s)	27: 0.78515	0.01859	0.19626	797.16	27: 77.127	4.183	0.18.690	797.16
28: Na5PSi2O9 / Si2Na2O5(s3) / Si8Na6O19(s)	28: 0.28146	0.00844	0.71010	775.00	28: 28.454	1.955	0.69.592	775.00
29: Na5PSi2O9 / Si8Na6O19(s) / SiO2(s2)	29: 0.27726	0.00860	0.71415	774.04	29: 28.027	1.990	0.69.983	774.06
30: Na2O(s) / Na2O(s2) / Na3PO4(s2)	30: 0.76801	0.06324	0.16875	750.05	30: 72.025	11.907	0.16.068	750.06
31: Na2O(s) / Na2O(s2) / SiNa4O4(s)	31: 0.76787	0.05543	0.17671	750.05	31: 71.348	13.455	0.15.198	750.05
32: Na2O(s) / Na3PO4(s2) / SiNa4O4(s)	32: 0.76427	0.06268	0.17305	739.79	32: 71.056	13.347	0.15.597	739.78
33: Na4P2O7(s7) / Na5P3O10(s2) / SiO2(s2)	33: 0.56940	0.40742	0.02318	607.46	33: 37.339	61.187	0.01.473	607.47
34: NaPO3(s2) / P2SiO7(s) / P4Si3O16(s)	34: 0.43675	0.48372	0.07954	593.84	34: 26.932	68.313	0.04.755	593.81
35: NaPO3(s2) / P4Si3O16(s) / SiO2(s2)	35: 0.41646	0.44558	0.13796	581.23	35: 26.515	64.970	0.08.515	581.23
36: Na5P3O10(s2) / SiO2(s) / SiO2(s2)	36: 0.55936	0.42413	0.01651	574.85	36: 33.564	64.778	0.01.658	574.85
37: NaPO3(s2) / SiO2(s) / SiO2(s2)	37: 0.52807	0.44502	0.02691	574.85	37: 36.164	62.801	0.01.035	574.85
38: Na5P3O10(s2) / NaPO3(s2) / SiO2(s)	38: 0.54983	0.43502	0.01515	552.91	38: 35.227	63.832	0.00.941	552.94
39: NaPO3(s2) / NaPO3(s) / P2SiO7(s)	39: 0.36893	0.60190	0.02917	539.40	39: 20.777	77.631	0.01.593	539.41
40: NaPO3(s) / P2O5(s3) / P2SiO7(s)	40: 0.24444	0.74250	0.01306	443.18	40: 12.487	86.867	0.00.647	443.18

Na2O-P2O5-V2O5, Mole fraction, Isopleth NaVO3-Na3PO4-O2

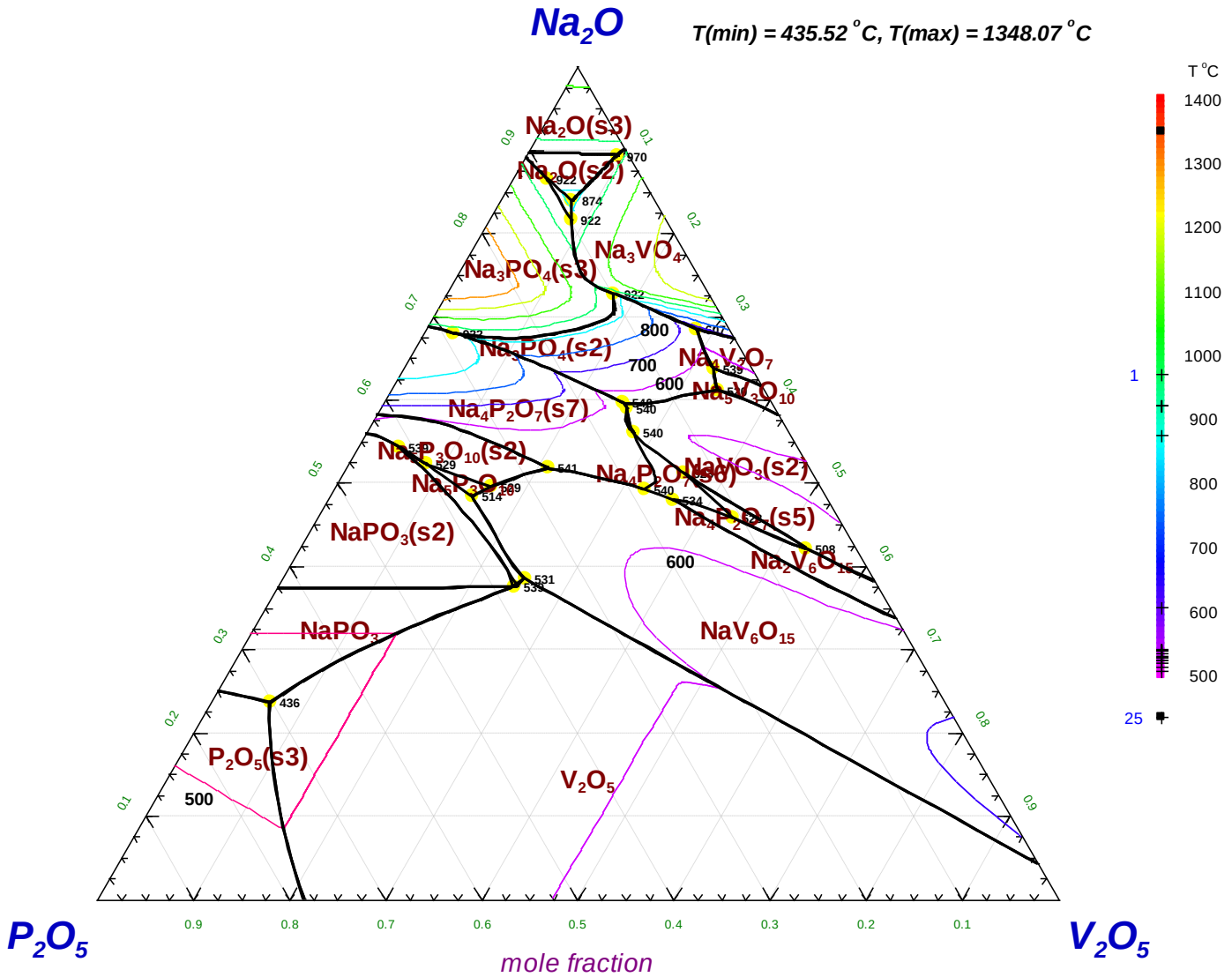


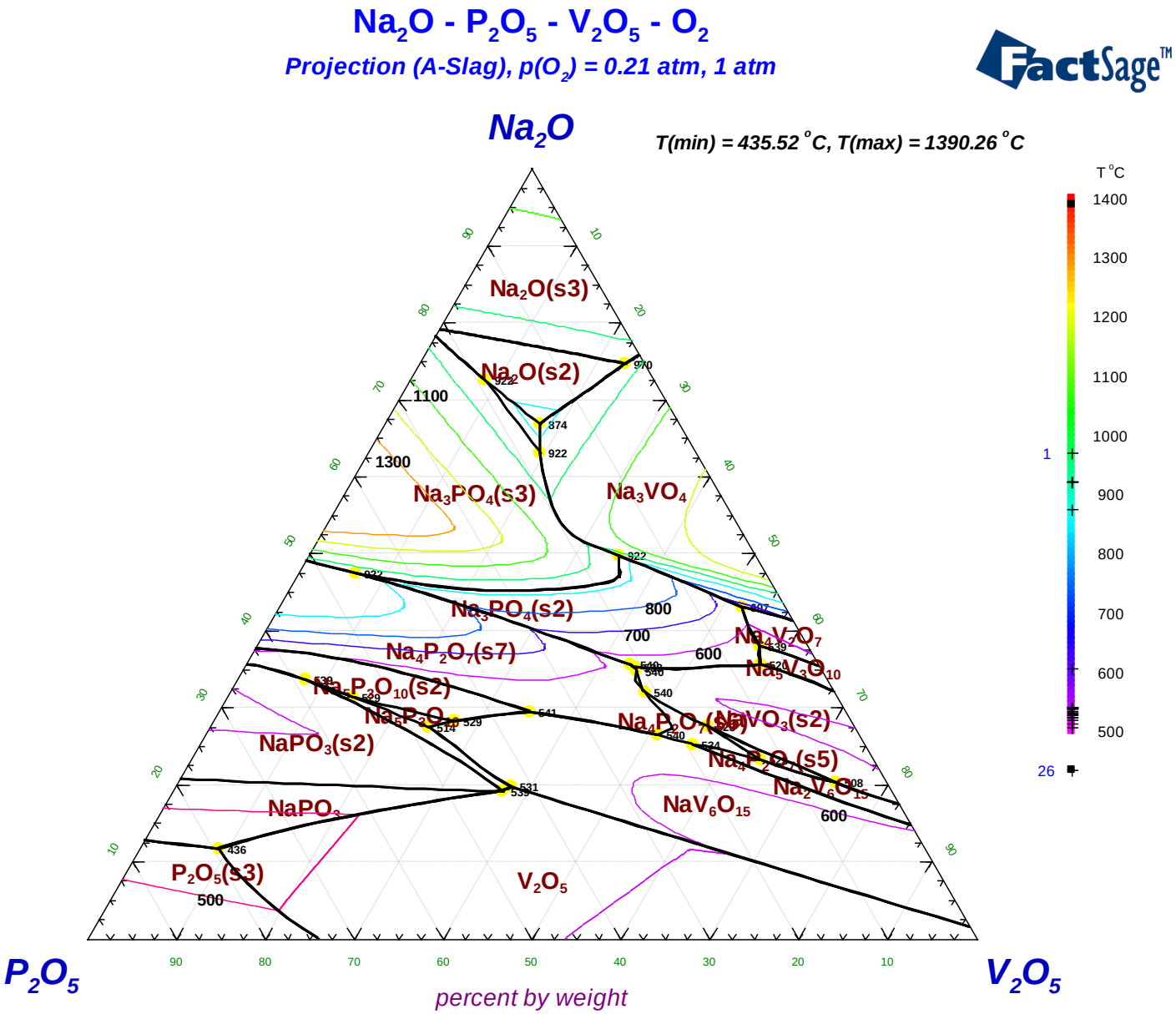

NaVO3 - Na4P2O7 - O2
p(O2) = 0.21 atm, 1 atm
FactSage
[Bergman, 1975]
Slag
Na4P2O7(s7) + Slag
NaVO3(s2) + Na4P2O7(s6)
NaVO3(s2) + Na4P2O7(s5)
NaVO3(s2) + Na4P2O7(s4)
NaVO3(s2) + Na4P2O7(s3)
NaVO3 + Na4P2O7(s3)
NaVO3 + Na4P2O7(s2)
NaVO3 + Na4P2O7
T(C)
1200
1000
800
600
400
200
0
0
0.2
0.4
0.6
0.8
1
Na4P2O7/(NaVO3+Na4P2O7) (mol/mol)


Na2O - V2O5 - P2O5 - O2
p(O2) = 0.21 atm, 500°C, 1 atm
FactSage
Na2O
Na3PO4(s2)
Na3VO4
Na4P2O7(s5)
Na4V2O7
Na5P3O10
Na5V3O10
NaPO3
NaVO3(s2)
Na2V6O15
Slag
NaV6O15
P2O5
V2O5
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
mole fraction

Na_2O - P_2O_5 - V_2O_5 - O_2

Projection (A-Slag), p(O_2) = 0.21 atm, 1 atm

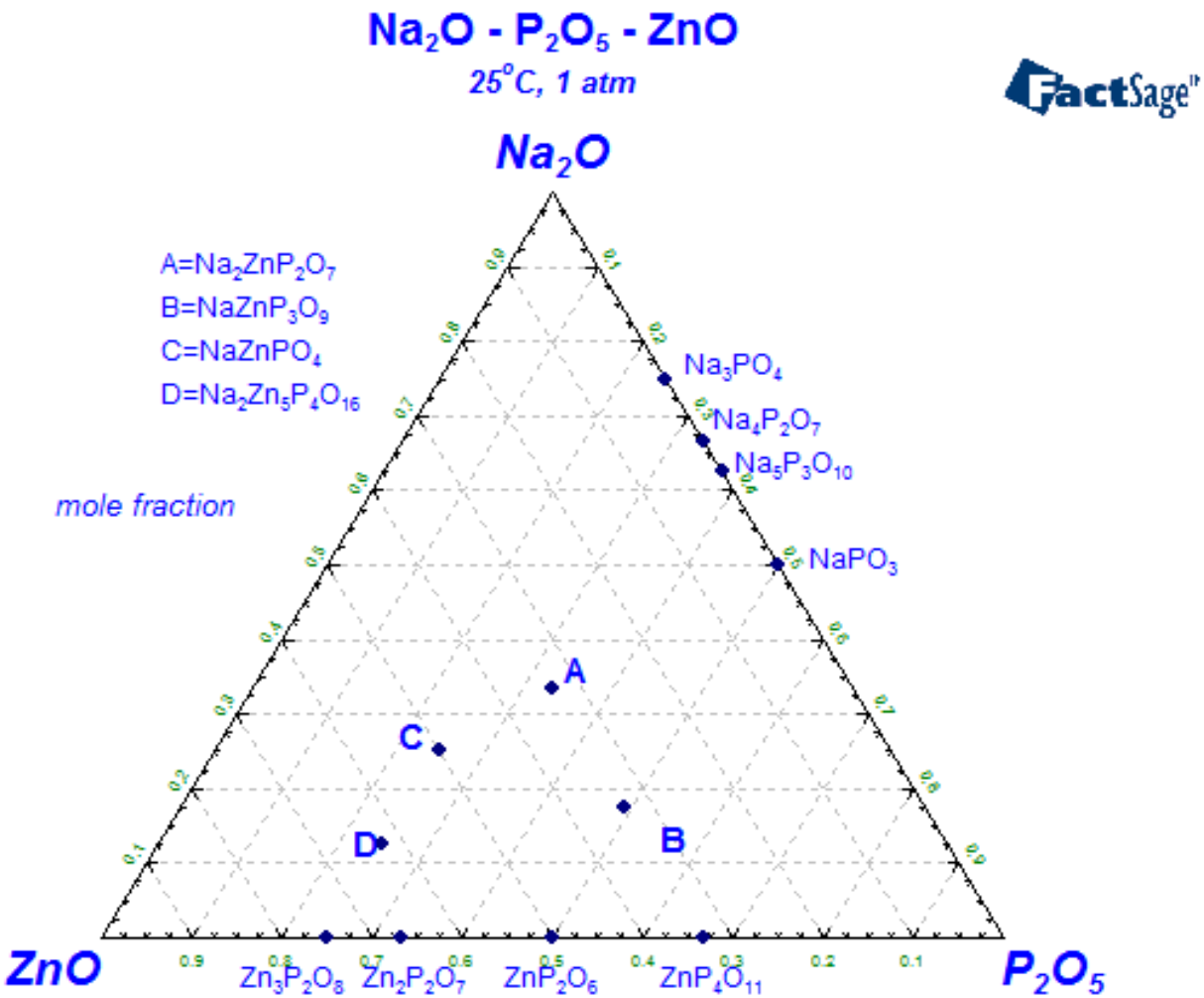



Na2O - P2O5 - V2O5 - O2
Projection (A-Slag), p(O2) = 0.21 atm, 1 atm
FactSage™
Na2O
T(min) = 435.52 °C, T(max) = 1390.26 °C
T °C
1400
1300
1200
1100
1000
900
800
700
600
500
Na2O(s3)
Na2O(s2)
Na3PO4(s3)
Na3VO4
Na3PO4(s2)
Na4P2O7(s7)
Na4P2O7(s5)
Na4V2O7
Na5V3O10
NaVO3(s2)
NaPO3(s2)
NaPO3
NaV6O15
P2O5(s3)
V2O5
1100
1300
800
700
600
500
P2O5
V2O5
percent by weight

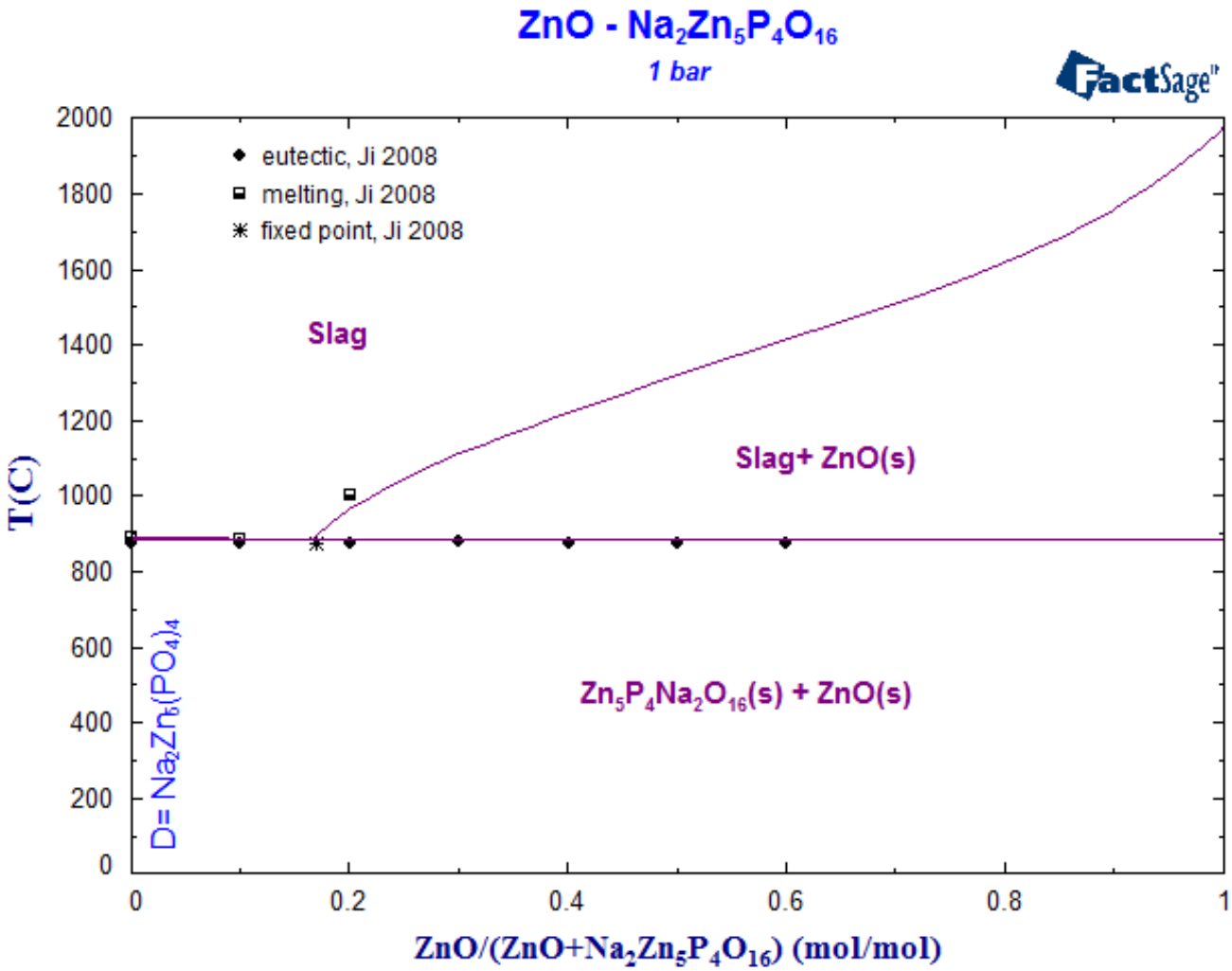
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction A = Na2O, B = P2O5, C = V2O5				Weight percent A = Na2O, B = P2O5, C = V2O5			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1. Na2O(s2) / Na2O(s3) / Na3VO4_solid(s)	0.89411	0.01160	0.09429	970.05	74.673	2.218	23.109	970.05
2. Na2O(s2)/Na3PO4_HT(s3) / Na3PO4_MT(s2)	0.86625	0.09901	0.03473	922.40	63.151	17.489	19.360	922.40
3. Na3PO4(s3) /Na3PO4_MT(s2)/ Na4P2O7(s7)	0.68026	0.28844	0.03130	922.40	72.493	18.977	8.530	922.40
4. Na3PO4_HT(s3) / Na3PO4_MT(s2) / Na3VO4	0.81607	0.09868	0.08525	922.40	49.717	15.360	34.923	922.40
5. Na3PO4_HT(s3) / Na3PO4_MT(s2) / Na3VO4	0.72766	0.09816	0.17418	922.40	47.481	46.108	6.411	922.40
6. Na2O(s2) / Na3PO4_MT(s2) / Na3VO4	0.83955	0.08593	0.07452	874.15	66.896	15.680	17.424	874.18
7. Na3PO4_MT(s2) / Na3VO4 / Na4V2O7	0.68488	0.03355	0.28158	607.36	43.128	4.838	52.034	607.37
8. Na4P2O7(s7) / Na5P3O10s2) / NaV6O15	0.51798	0.27185	0.21017	541.33	29.475	35.428	35.096	541.33
9. Na4P2O7(s6) / Na4P2O7(s7) / NaVO3(s2)	0.56030	0.16186	0.27785	540.11	35.528	21.089	43.382	540.11
10.Na3PO4_MT(s2)/Na4P2O7(s6)/ Na4P2O7(s7)	0.59691	0.15471	0.24838	540.10	32.085	21.227	46.689	540.11
11.Na4P2O7(s6) / Na4P2O7(s7) / NaVO3(s2)	0.58979	0.15386	0.25635	540.10	34.807	20.796	44.397	540.10
12.Na4P2O7(s6) / Na4P2O7(s7) / NaV6O15	0.49214	0.18443	0.32343	540.09	26.408	22.667	50.925	540.09
13.Na5P3O10(s2)/NaPO3_HT(s2)/ NaPO3_LT(s)	0.54374	0.41417	0.04210	539.40	33.651	58.703	7.645	539.40
14.NaPO3_HT(s2) / NaPO3_LT(s) / V2O5	0.37575	0.37722	0.24703	539.40	19.175	43.774	37.051	539.40
15.Na3PO4_MT(s2) / Na4V2O7 / Na5V3O10	0.63730	0.03939	0.32331	539.14	38.018	5.382	56.600	539.14
16.Na2V6O15 / Na4P2O7(s6) / NaV6O15	0.48008	0.16022	0.35970	534.27	25.233	19.286	55.481	534.27
17.NaPO3_LT(s) / NaV6O15 / V2O5	0.38543	0.36225	0.25232	531.07	35.297	20.651	44.052	533.30
18.Na5P3O10 / Na5P3O10(s2) / NaPO3_LT(s)	0.52287	0.39632	0.08082	528.99	19.710	42.425	37.865	531.07
19.Na5P3O10 / Na5P3O10(s2) / NaV6O15	0.49566	0.34191	0.16243	528.85	31.353	54.426	14.221	528.85
20.Na4P2O7(s5) / Na4P2O7(s6) / NaVO3(s2)	0.51170	0.13297	0.35533	522.90	27.526	16.381	56.093	522.90
21.Na2V6O15 / Na4P2O7s5) / Na4P2O7(s6)	0.45813	0.10981	0.43206	522.90	23.167	12.717	64.116	522.90
22.Na3PO4_MT(s2) / Na5V3O10 / NaVO3(s2)	0.61206	0.04820	0.33974	519.64	35.596	6.420	57.983	519.70
23.Na5P3O10 / NaPO3_LT(s) / NaV6O15	0.48404	0.36796	0.14801	513.83	27.485	47.851	24.663	513.83
24.Na2V6O15 / Na4P2O7(s5) / NaVO3(s2)	0.42145	0.05128	0.52727	508.04	20.202	5.629	74.169	508.03
25.NaPO3_LT(s) / P2O5s3) / V2O5	0.23681	0.70197	0.06123	435.52	11.699	79.424	8.876	435.52

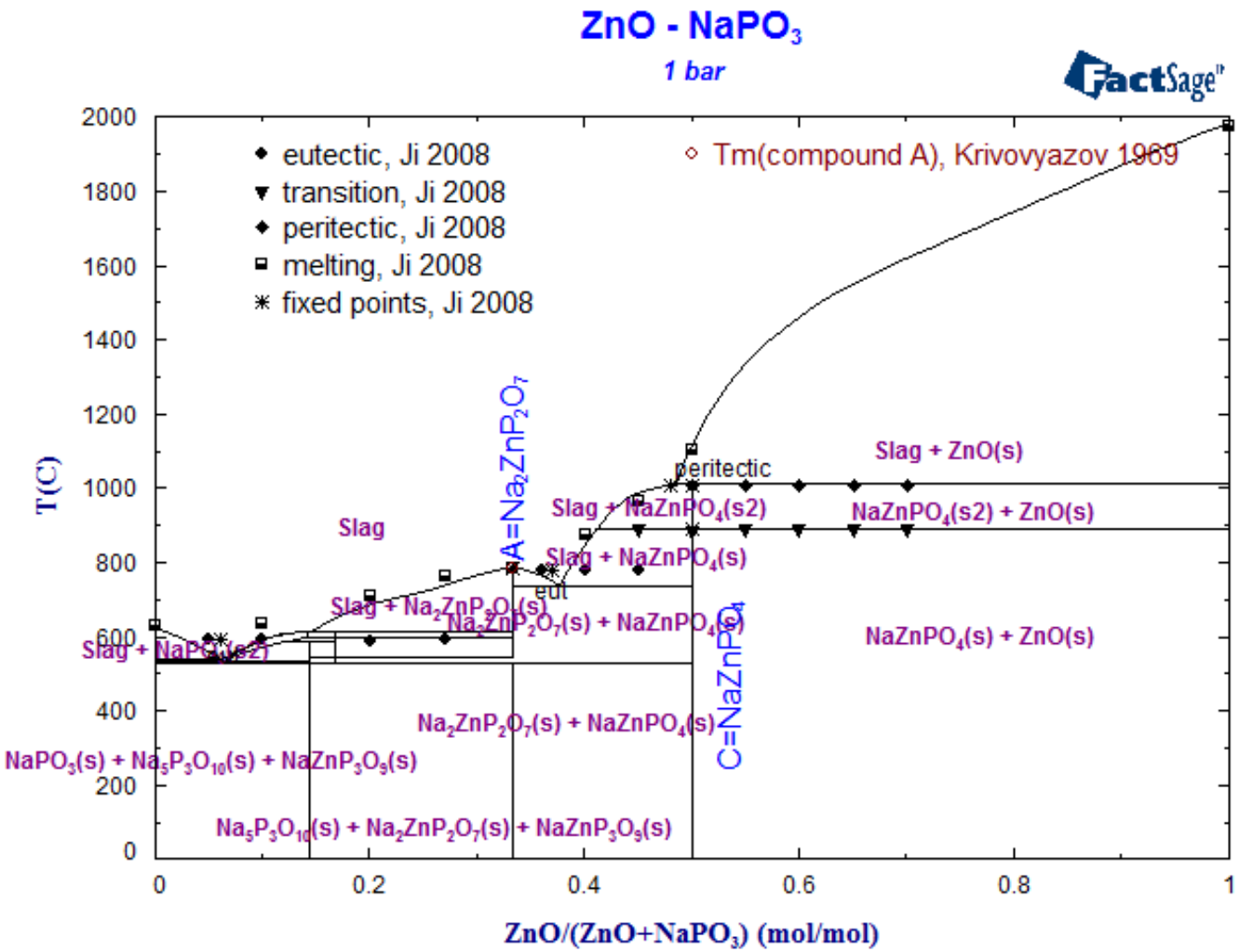
Mole fraction, Ternary phases



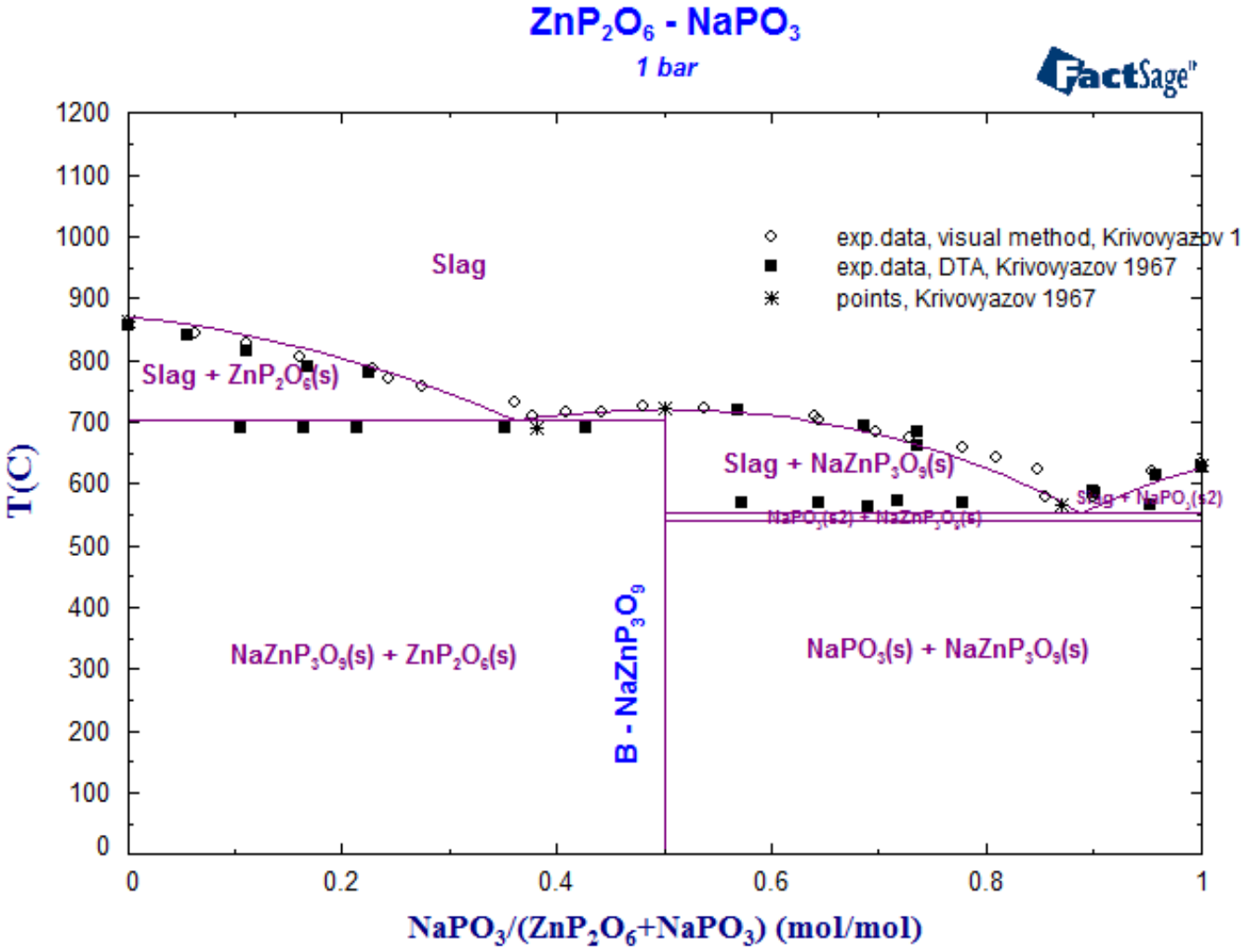
Mole fraction, Isopleth $ZnO\text{-}Na_2Zn_5P_4O_{16}$



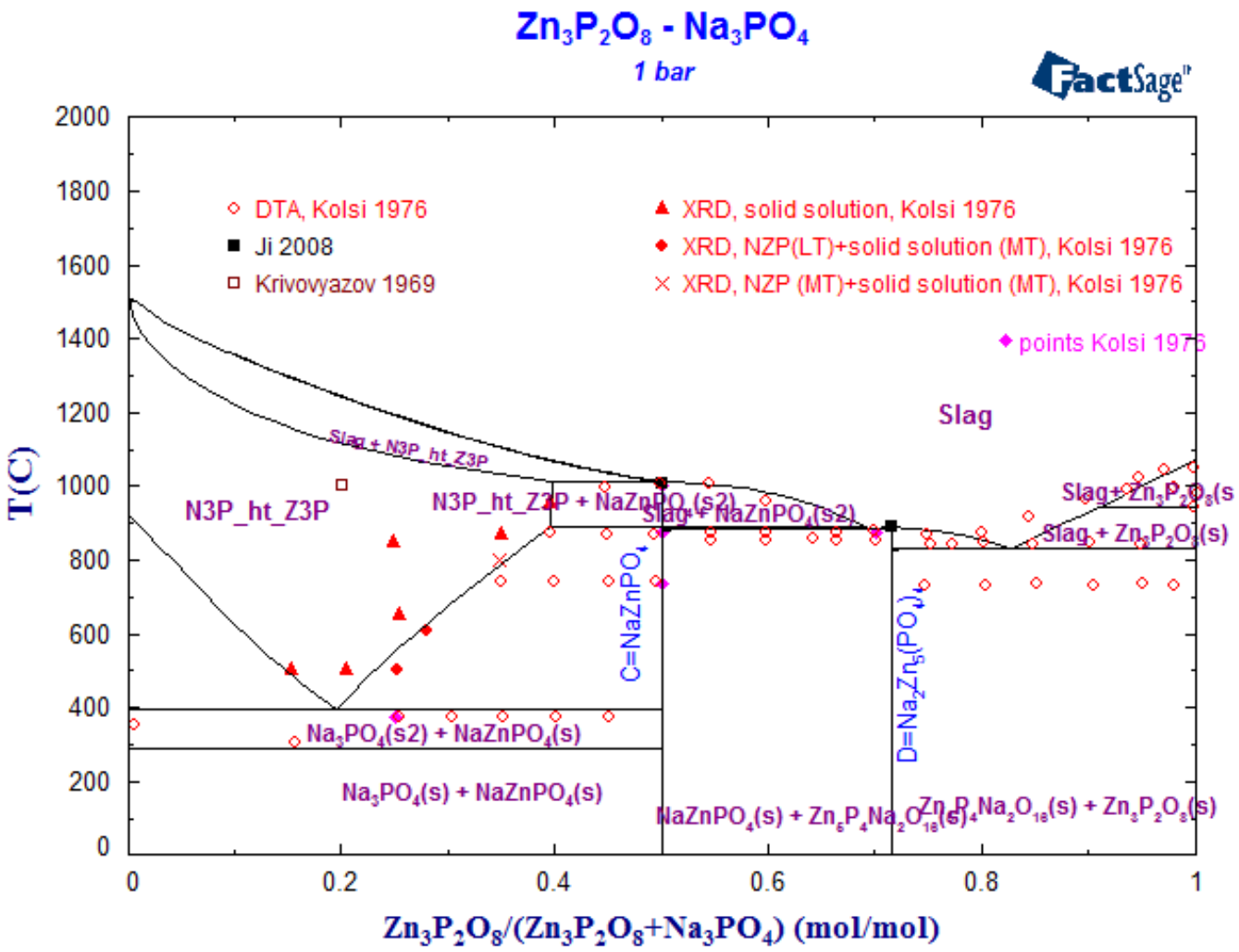
Mole fraction, Isopleth ZnO-$NaPO_3$



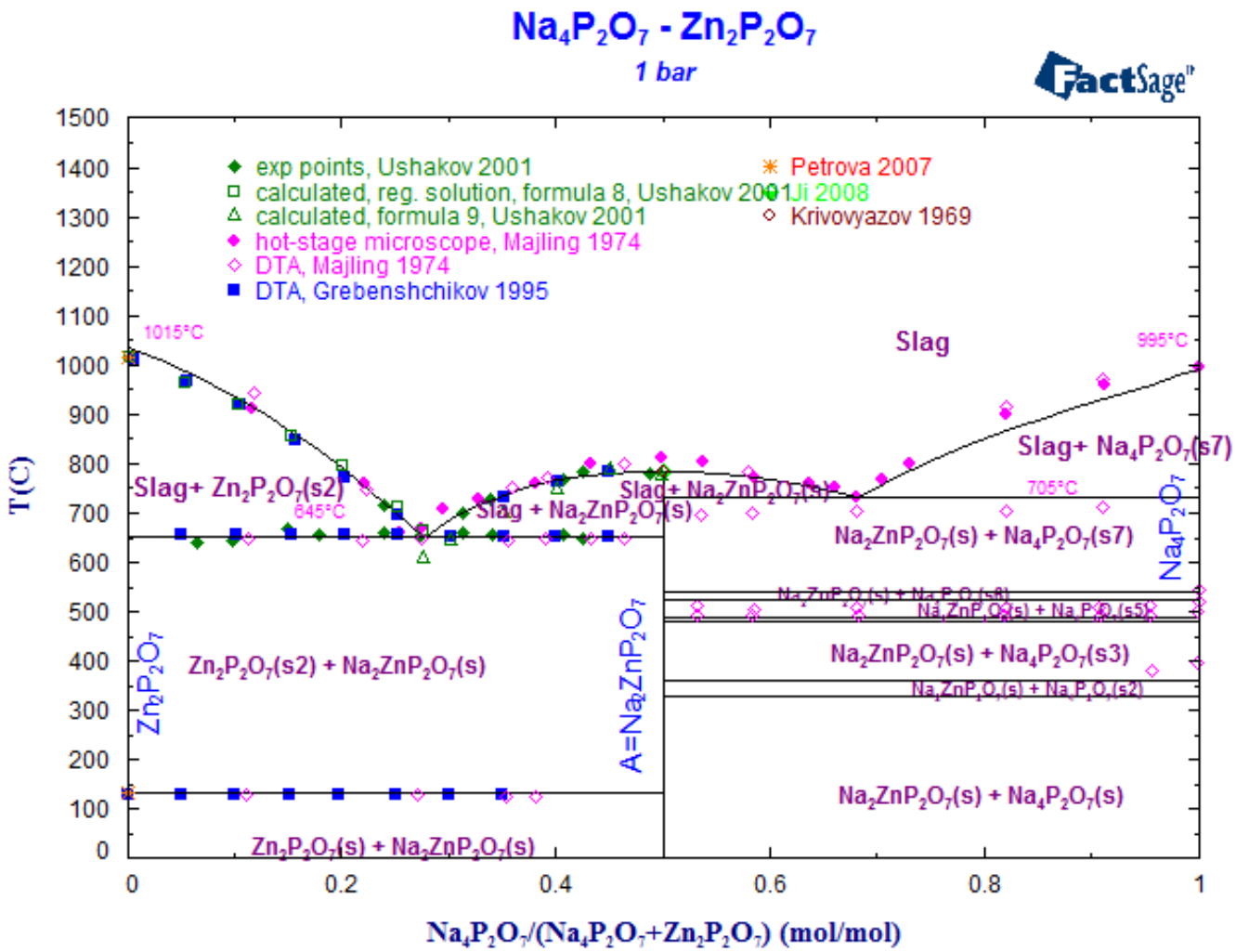
Mole fraction, Isopleth ZnP_2O_6-$NaPO_3$

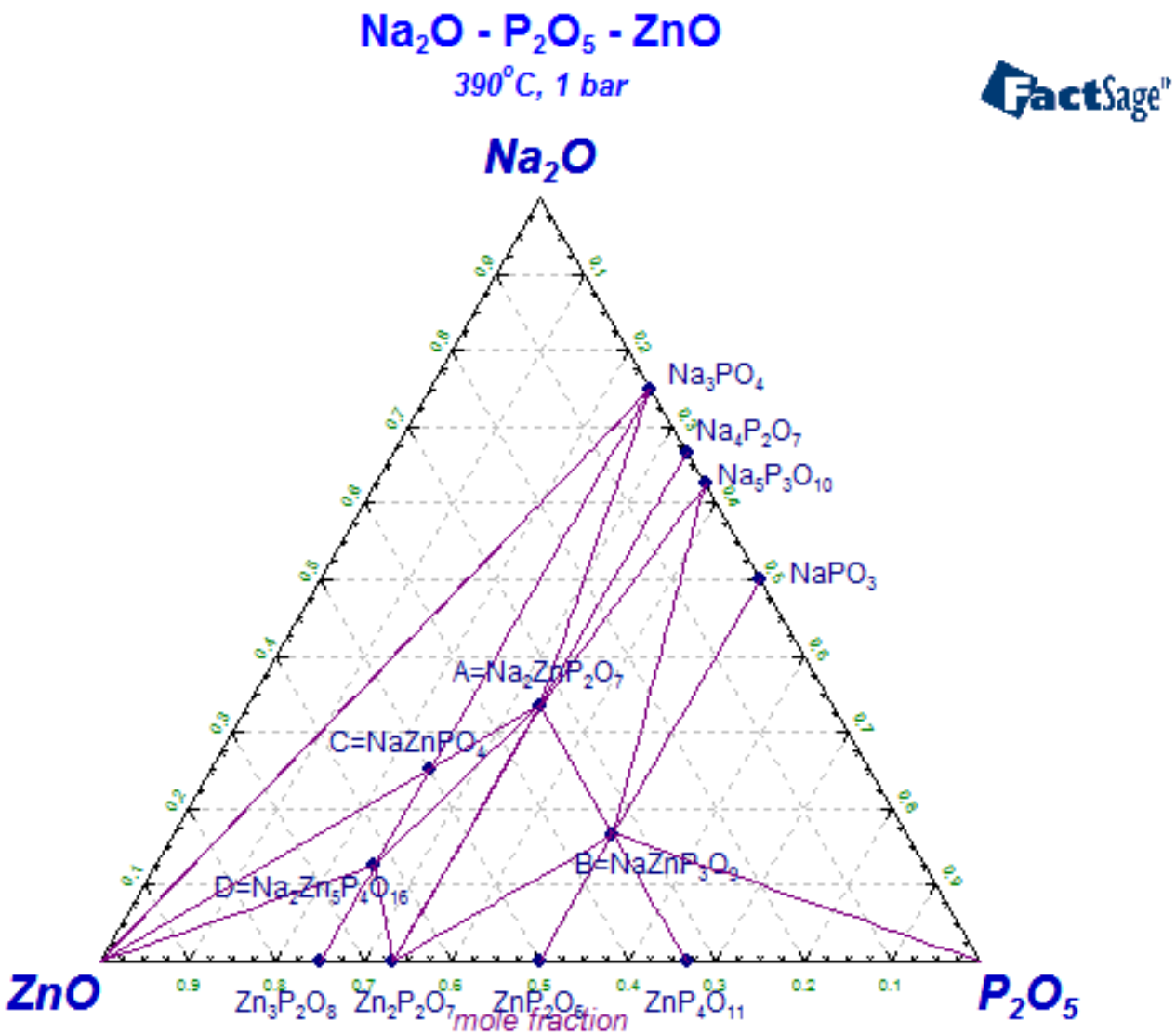


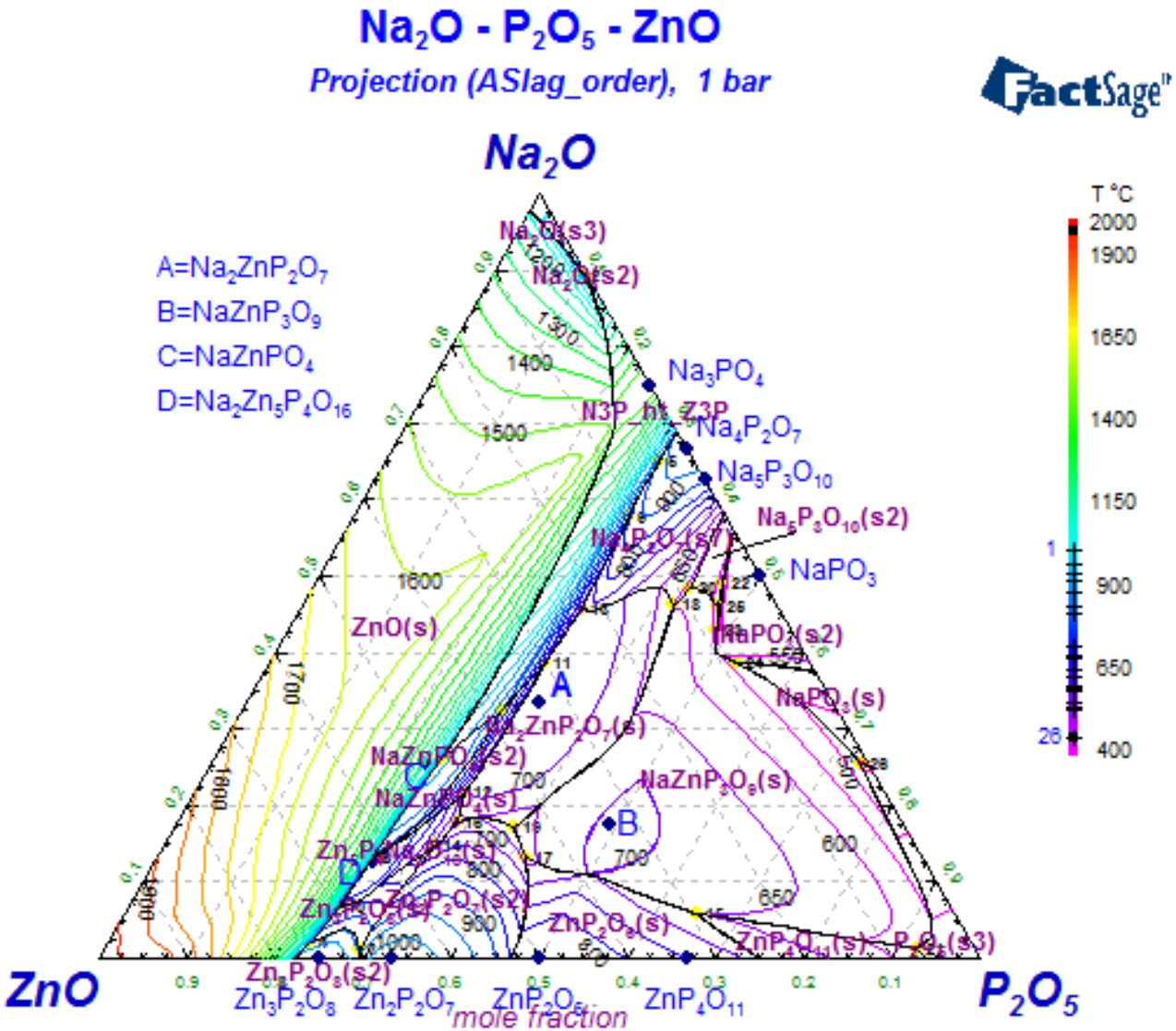
Mole fraction, Isopleth $Zn_3P_2O_8$-Na_3PO_4

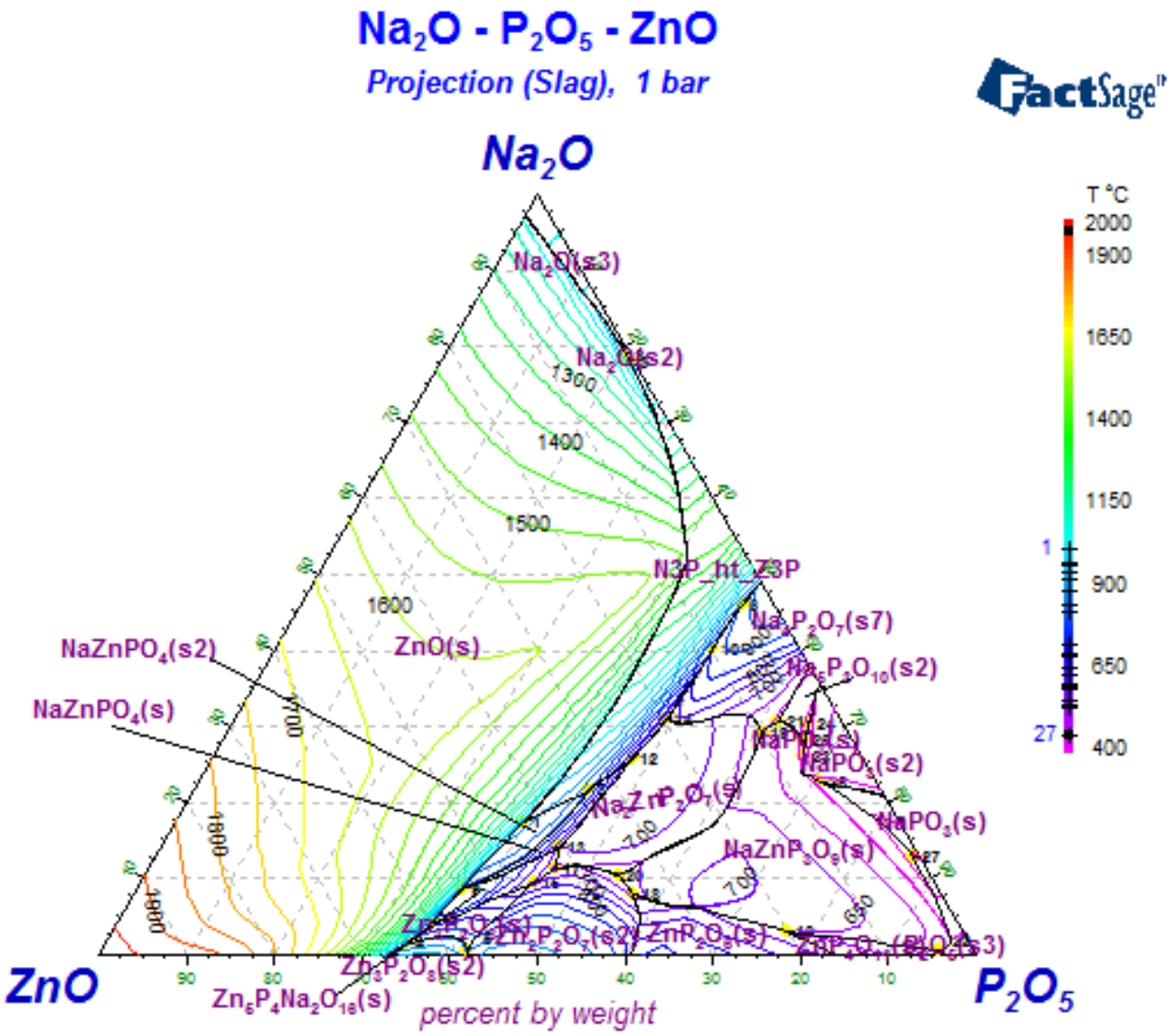


Mole fraction, Isopleth $Na_4P_2O_7$-$Zn_2P_2O_7$




Na2O - P2O5 - ZnO
390°C, 1 bar
FactSage
Na2O
Na3PO4
Na4P2O7
Na5P3O10
NaPO3
A=Na2ZnP2O7
C=NaZnPO4
B=NaZnP3O9
D=Na2Zn5P4O16
ZnO
P2O5
Zn3P2O8
Zn2P2O7
ZnP2O6
ZnP4O11
mole fraction

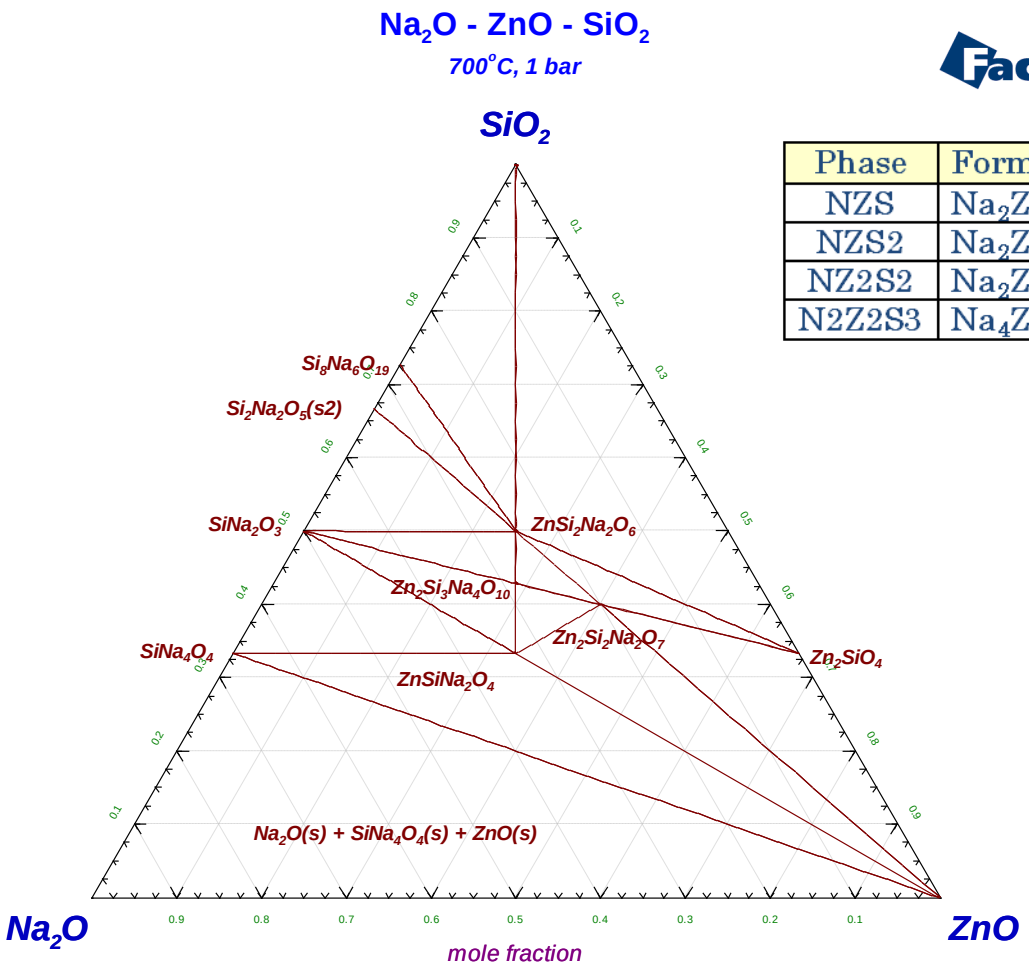

Na2O - P2O5 - ZnO
Projection (ASlag_order), 1 bar
FactSage
Na2O
ZnO
P2O5
mole fraction
A=Na2ZnP2O7
B=NaZnP3O9
C=NaZnPO4
D=Na2Zn5P4O16
T °C
2000
1900
1650
1400
1150
900
650
400
Na3PO4
Na4P2O7
Na5P3O10
Na5P3O10(s2)
NaPO3
NaPO3(s2)
NaPO3(s)
ZnO(s)
Na2ZnP2O7(s)
NaZnPO4(s2)
NaZnP3O9(s)
ZnP2O6(s)
ZnP4O11(s)
Zn3P2O8
Zn2P2O7
ZnP2O6
ZnP4O11


Na2O - P2O5 - ZnO
Projection (Slag), 1 bar
FactSage
Na2O
ZnO
P2O5
percent by weight
T °C
2000
1900
1650
1400
1150
900
650
400
Na2O(s3)
Na2O(s2)
N3P_ht_Z3P
Na4P2O7(s7)
Na6P4O10(s2)
NaPO3(s2)
NaPO3(s)
NaZnP3O9(s)
NaZnP2O7(s)
NaZnPO4(s2)
NaZnPO4(s)
ZnO(s)
Zn3P2O8(s2)
Zn6P4Na2O18(s)
1300
1400
1500
1600
1700
1800
1900
700
650

Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction					Weight percent				
	A = Na2O, B = ZnO, C = P2O5					A = Na2O, B = ZnO, C = P2O5				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: N3P_HT / NaZnPO4(s2) / ZnO(s)	1:	0.25914	0.48303	0.25783	1008.94	1:	17.464	42.742	39.794	1008.98
2: Na2O(s2) / Na2O(s3) / ZnO(s)	2:	0.89452	0.00307	0.10241	970.05	2:	78.945	0.355	20.699	970.05
3: Zn2P2O7(s2) / Zn3P2O8(s) / Zn3P2O8(s2)	3:	0.01067	0.69845	0.29089	941.86	3:	1.394	64.215	34.391	941.85
4: Zn3P2O8(s) / Zn3P2O8(s2) / ZnO(s)	4:	0.02134	0.74876	0.22990	941.86	4:	0.669	57.535	41.795	941.85
5: N3P_HT / Na3PO4(s2) / Na4P2O7(s7)	5:	0.64912	0.03994	0.31094	915.71	5:	45.918	3.710	50.373	915.71
6: NaZnPO4(s) / NaZnPO4(s2) / ZnO(s)	6:	0.13286	0.62198	0.24517	887.02	6:	8.793	54.048	37.160	887.01
7: N3P_HT / NaZnPO4(s) / NaZnPO4(s2)	7:	0.32489	0.37949	0.29562	887.00	7:	21.657	33.214	45.130	886.99
8: NaZnPO4(s) / Zn5P4Na2O16(s) / ZnO(s)	8:	0.13136	0.62362	0.24502	883.50	8:	8.691	54.179	37.130	883.50
9: N3P_HT / Na3PO4(s2) / Na4P2O7(s7)	9:	0.57738	0.10962	0.31300	839.50	9:	40.148	10.008	49.844	839.48
10: Zn3P2O8(s) / Zn5P4Na2O16(s) / ZnO(s)	10:	0.06546	0.69476	0.23978	822.21	10:	4.287	59.747	35.966	822.24
11: N3P_HT / Na2ZnP2O7(s) / NaZnPO4(s)	11:	0.38611	0.30045	0.31344	718.66	11:	25.767	26.327	47.906	718.66
12: Na2ZnP2O7(s) / NaZnPO4(s) / Zn5P4Na2O16	12:	0.21596	0.47710	0.30694	693.31	12:	13.975	40.537	45.489	693.31
13: N3P_HT / Na2ZnP2O7(s) / Na4P2O7(s7)	13:	0.45748	0.22372	0.31881	690.27	13:	30.882	19.829	49.288	690.27
14: Zn2P2O7(s2) / Zn3P2O8(s) / Zn5P4Na2O16	14:	0.14712	0.54506	0.30782	685.36	14:	9.384	45.649	44.966	685.33
15: NaZnP3O9(s) / ZnP2O6(s) / ZnP4O11(s)	15:	0.05875	0.29288	0.64836	651.91	15:	3.047	19.944	77.009	651.91
16: Na2ZnP2O7(s) / Zn2P2O7(s2) / Zn5P4Na2O16(s)	16:	0.17715	0.50558	0.31727	630.81	16:	11.301	42.347	46.352	630.76
17: NaZnP3O9(s) / Zn2P2O7(s2) / ZnP2O6(s)	17:	0.13156	0.44941	0.41903	628.87	17:	7.825	35.097	57.079	628.86
18: Na2ZnP2O7(s) / Na4P2O7(s7) / NaZnP3O9(s)	18:	0.46221	0.11659	0.42120	597.19	18:	29.255	9.689	61.056	597.21
19: Na2ZnP2O7(s) / NaZnP3O9(s) / Zn2P2O7(s2)	19:	0.17064	0.44341	0.38595	595.01	19:	10.425	35.571	54.004	595.01
20: Na4P2O7(s7) / Na5P3O10(s2) / NaZnP3O9_S1(s)	20:	0.48374	0.08697	0.42929	584.92	20:	30.596	7.222	62.182	584.93
21: NaZnP3O9(s) / P2O5(s3) / ZnP4O11(s)	21:	0.01293	0.06562	0.92145	552.55	21:	0.585	3.900	95.515	552.61
22: Na5P3O10(s2) / NaPO3(s2) / NaPO3(s)	22:	0.49070	0.04667	0.46263	539.40	22:	25.897	6.750	67.353	539.40
23: NaPO3(s2) / NaPO3(s) / NaZnP3O9(s)	23:	0.42842	0.08505	0.48653	539.40	23:	30.450	3.803	65.747	539.40
24: NaPO3(s2) / NaPO3(s) / NaZnP3O9(s)	24:	0.38644	0.08347	0.53008	539.40	24:	22.598	6.409	70.992	539.40
25: Na5P3O10(s2) / NaPO3(s) / NaZnP3O9(s)	25:	0.45855	0.06850	0.47295	532.32	25:	28.103	5.512	66.384	532.32
26: NaPO3(s) / NaZnP3O9(s) / P2O5(s3)	26:	0.25381	0.00940	0.73680	444.21	26:	12.992	0.631	86.377	444.21

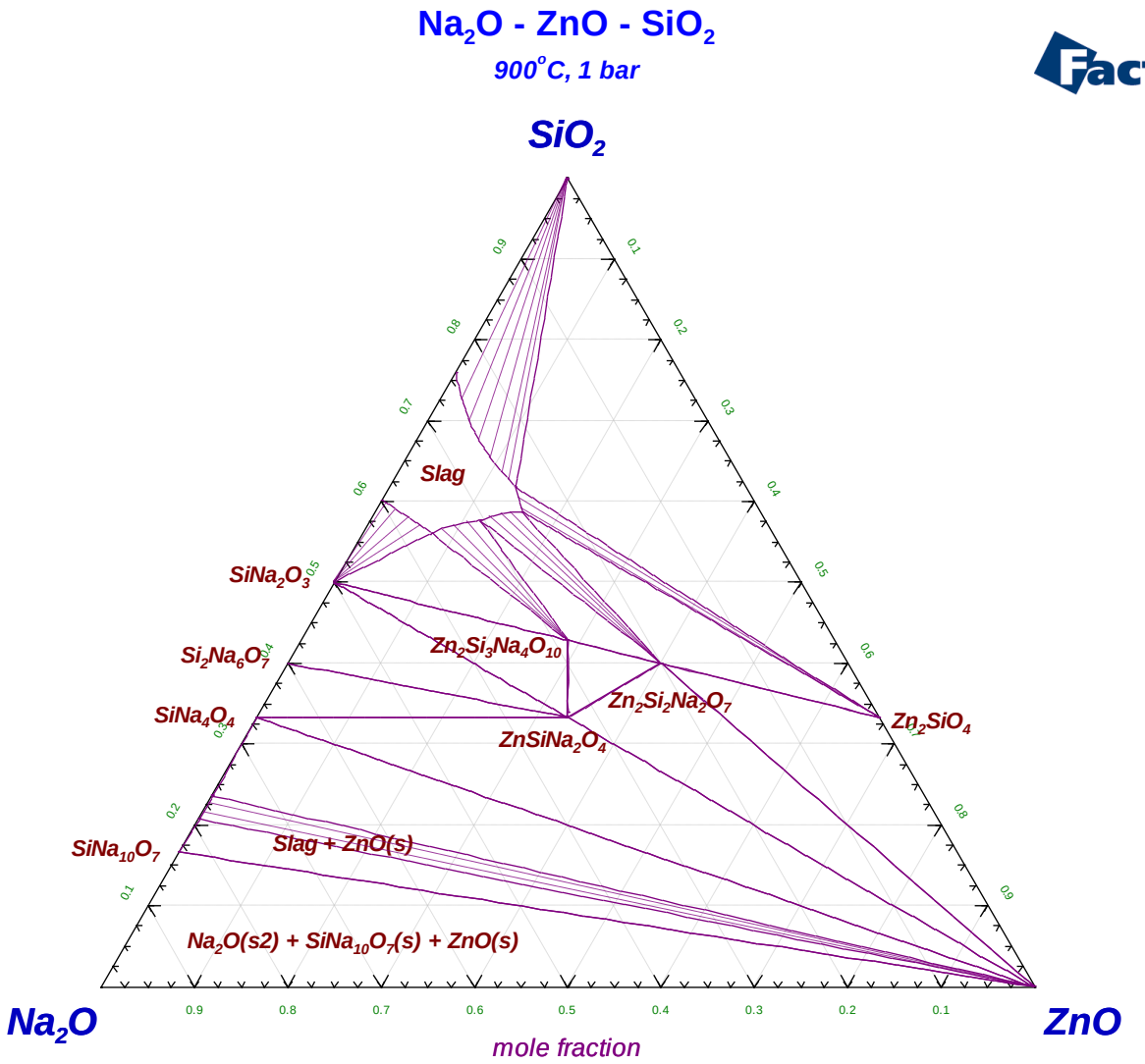
Na2O-SiO2-ZnO,
Mole fraction, 700°C
,

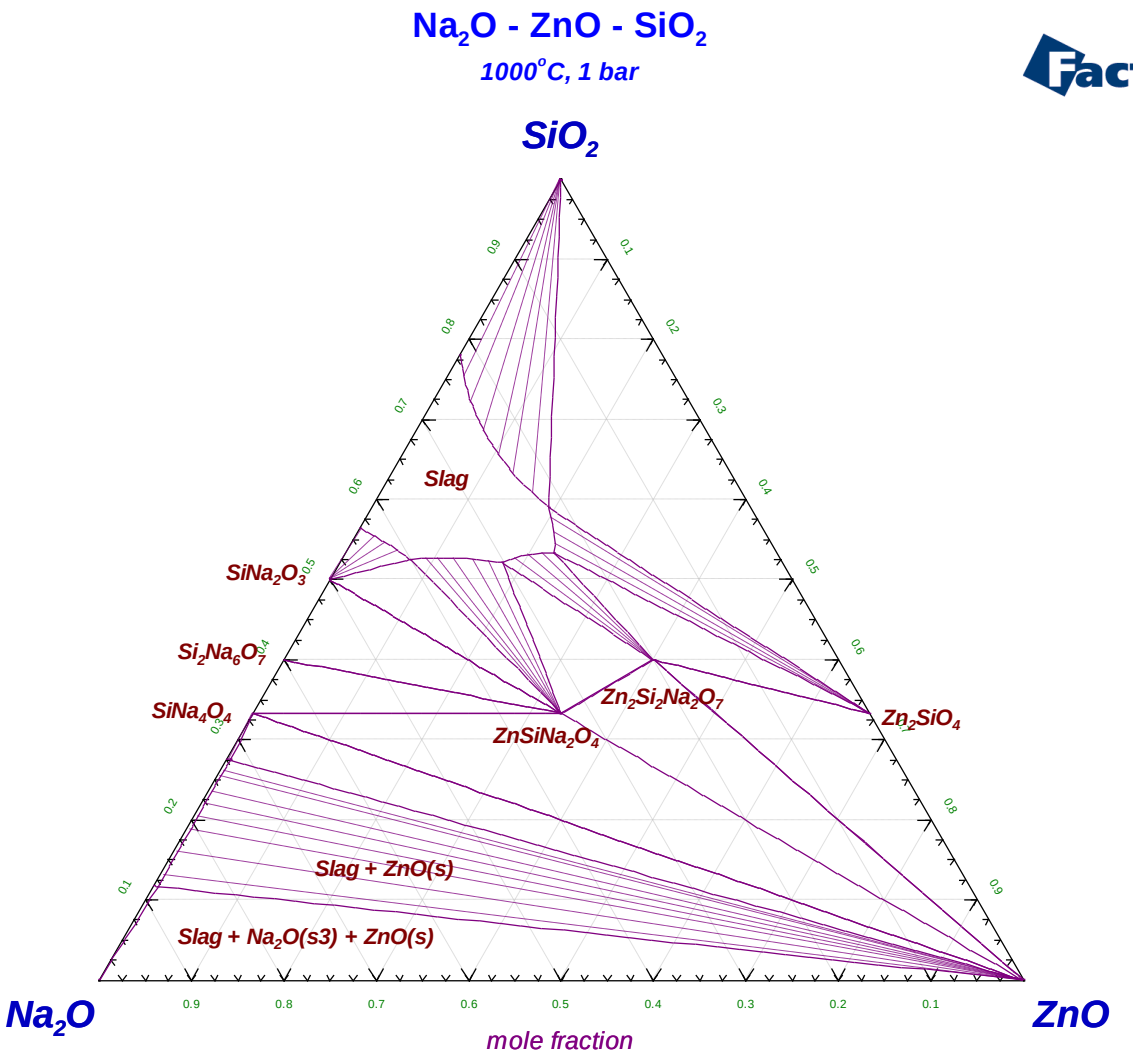


Phase	Formula	Tm,°C [1966Holland]	Tm,calc.
NZS	Na_2ZnSiO_4	1340	1339
NZS2	$Na_2ZnSi_2O_6$	860	859
NZ2S2	$Na_2Zn_2Si_2O_7$	1090	1088
N2Z2S3	$Na_4Zn_2Si_3O_{10}$	975	968

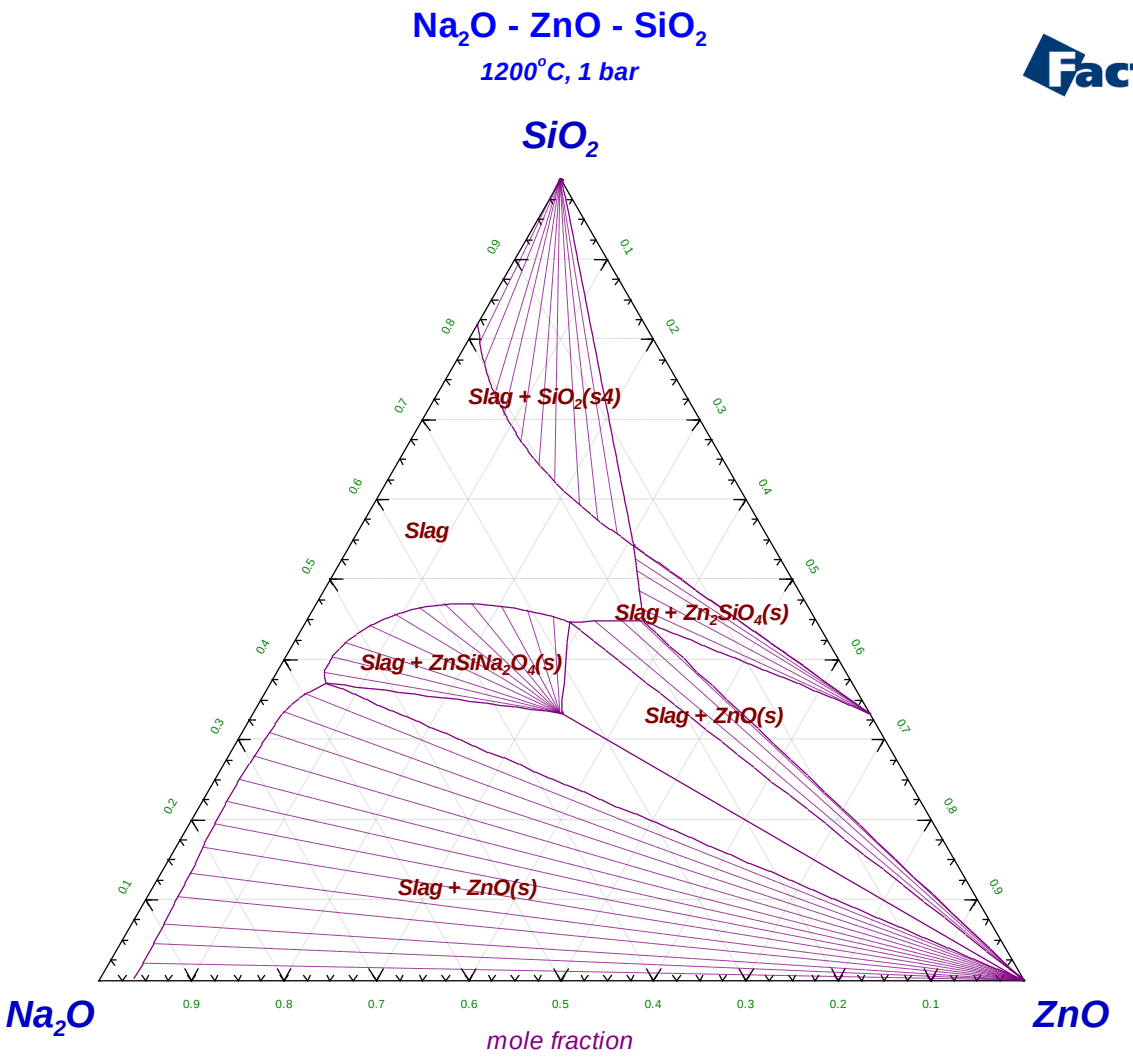
Na2O-SiO2-ZnO,
Mole fraction, 900°C

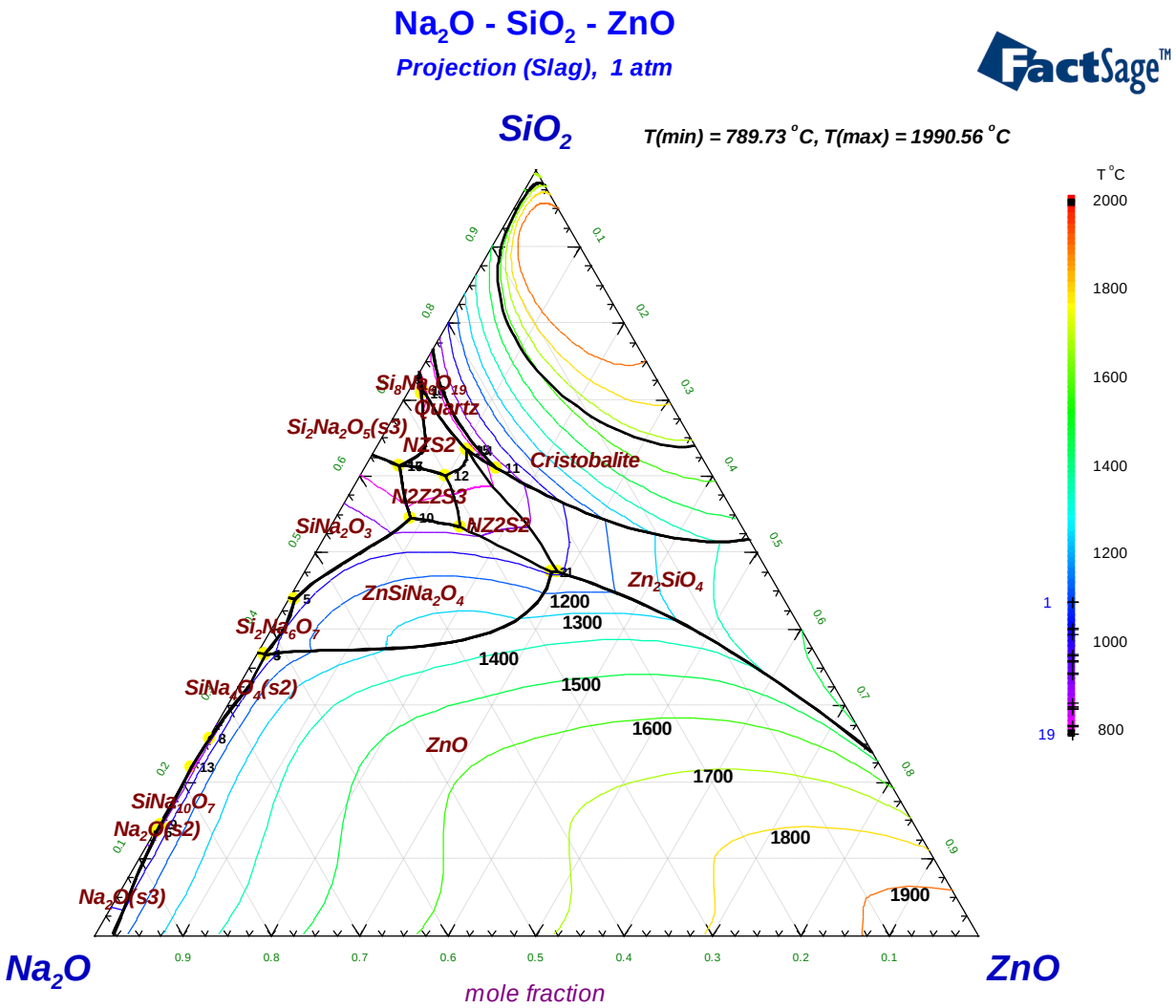
,

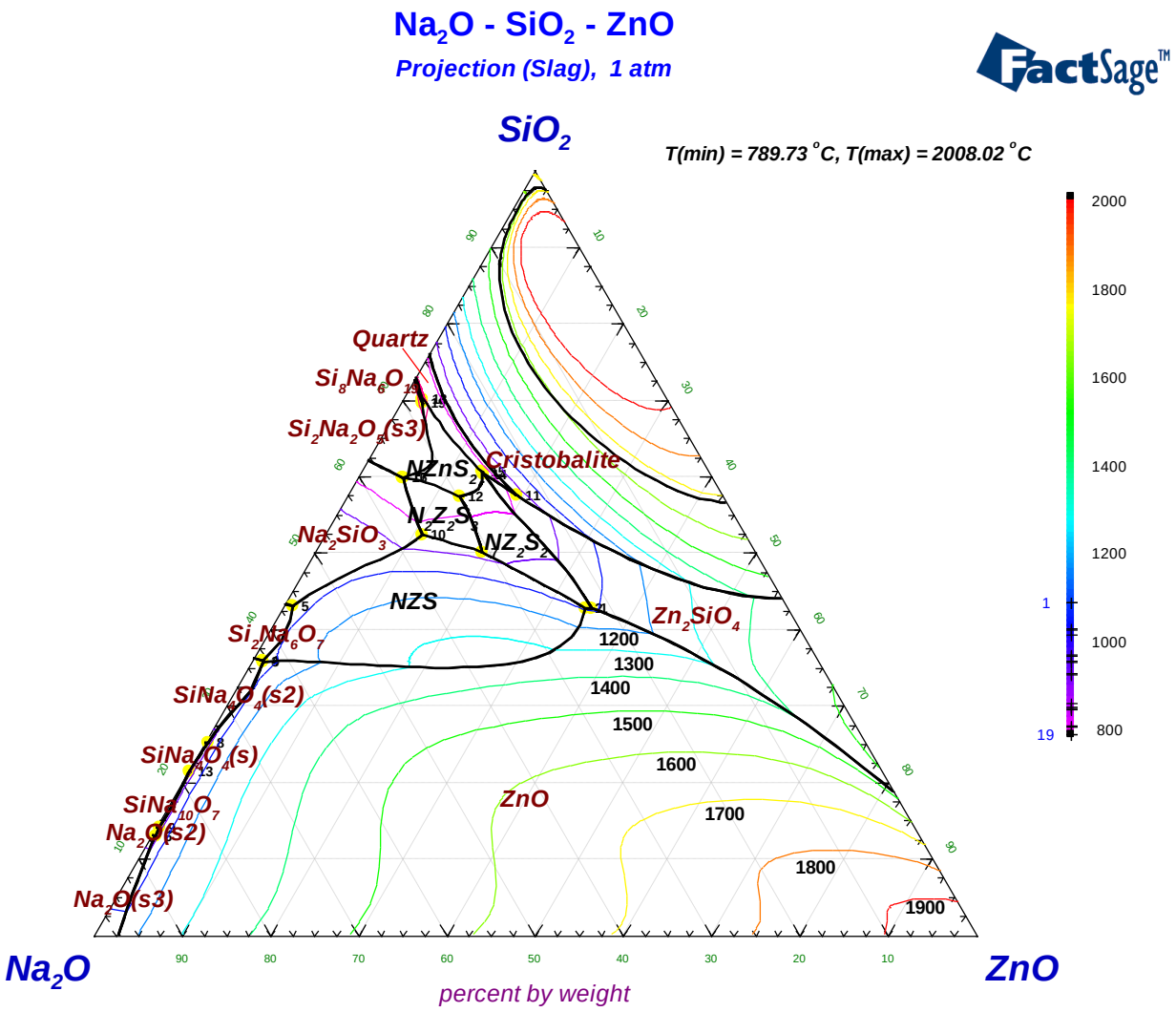



Na2O - ZnO - SiO2
1000°C, 1 bar
SiO2
Slag
SiNa2O3
Si2Na6O7
SiNa4O4
Zn2Si2Na2O7
ZnSiNa2O4
Zn2SiO4
Slag + ZnO(s)
Slag + Na2O(s3) + ZnO(s)
Na2O
ZnO
mole fraction

Na2O-SiO2-ZnO,
Mole fraction, 900°C
,



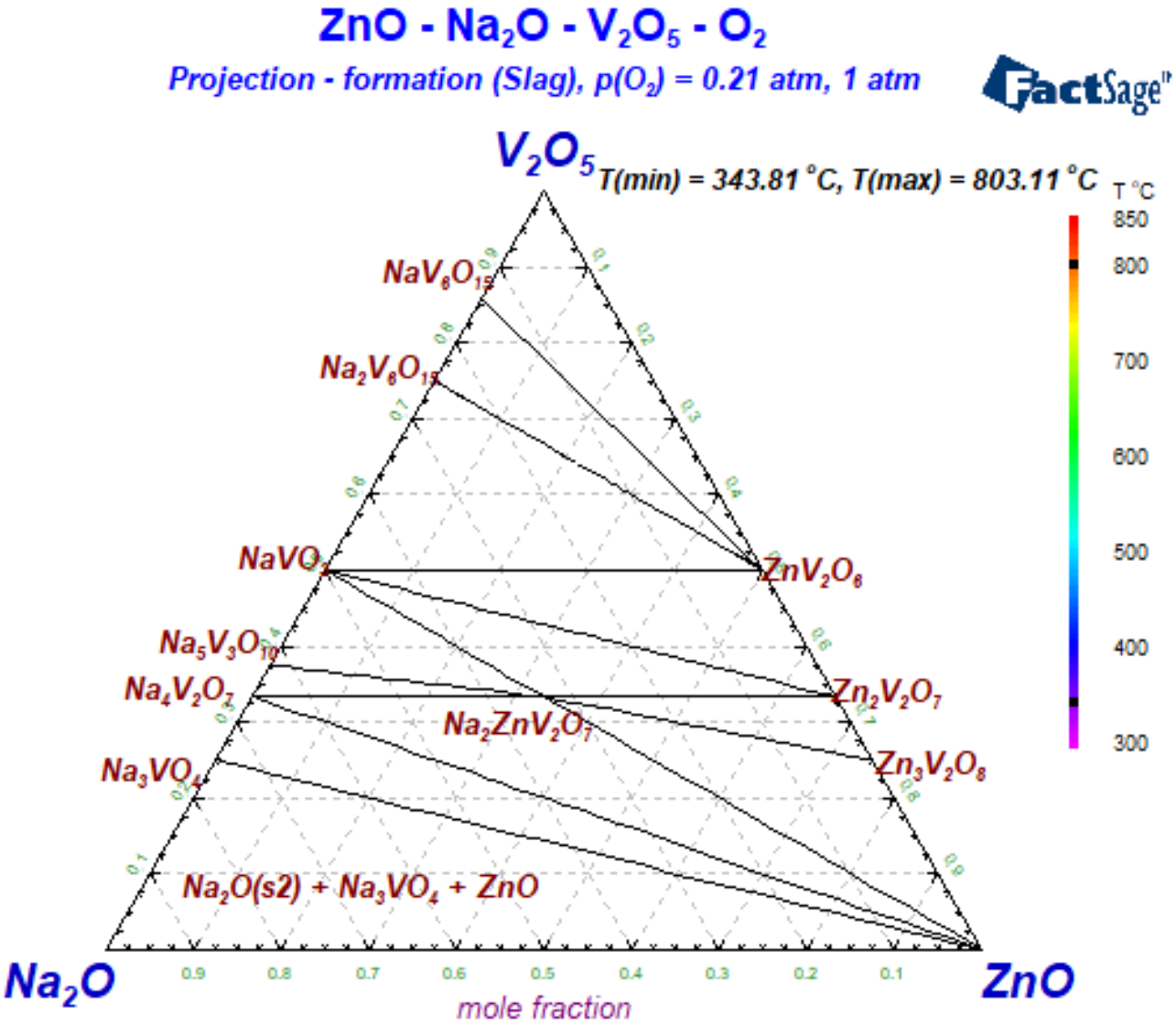

Na2O - SiO2 - ZnO
Projection (Slag), 1 atm
FactSage™
SiO2
T(min) = 789.73 °C, T(max) = 1990.56 °C
T °C
2000
1800
1600
1400
1200
1000
800
Si8Na2O19
Quartz
Si2Na2O5(s3)
NZS2
Cristobalite
N2Z2S3
SiNa2O3
NZ2S2
Zn2SiO4
ZnSiNa2O4
Si2Na6O7
SiNa4O4(s2)
ZnO
SiNa10O7
Na2O(s2)
Na2O(s3)
1200
1300
1400
1500
1600
1700
1800
1900
Na2O
ZnO
mole fraction


Na2O - SiO2 - ZnO
Projection (Slag), 1 atm
FactSage™
SiO2
T(min) = 789.73 °C, T(max) = 2008.02 °C
Quartz
Si8Na6O
Si2Na2O5(s3)
NZnS2
Cristobalite
N2Z2S3
Na2SiO3
NZ2S2
NZS
Zn2SiO4
Si2Na6O7
SiNa4O4(s2)
SiNa4O4(s)
SiNa10O7
Na2O(s2)
Na2O(s3)
ZnO
1200
1300
1400
1500
1600
1700
1800
1900
2000
1800
1600
1400
1200
1000
800
1
19
Na2O
ZnO
percent by weight

Invariant equilibria on the liquidus surface

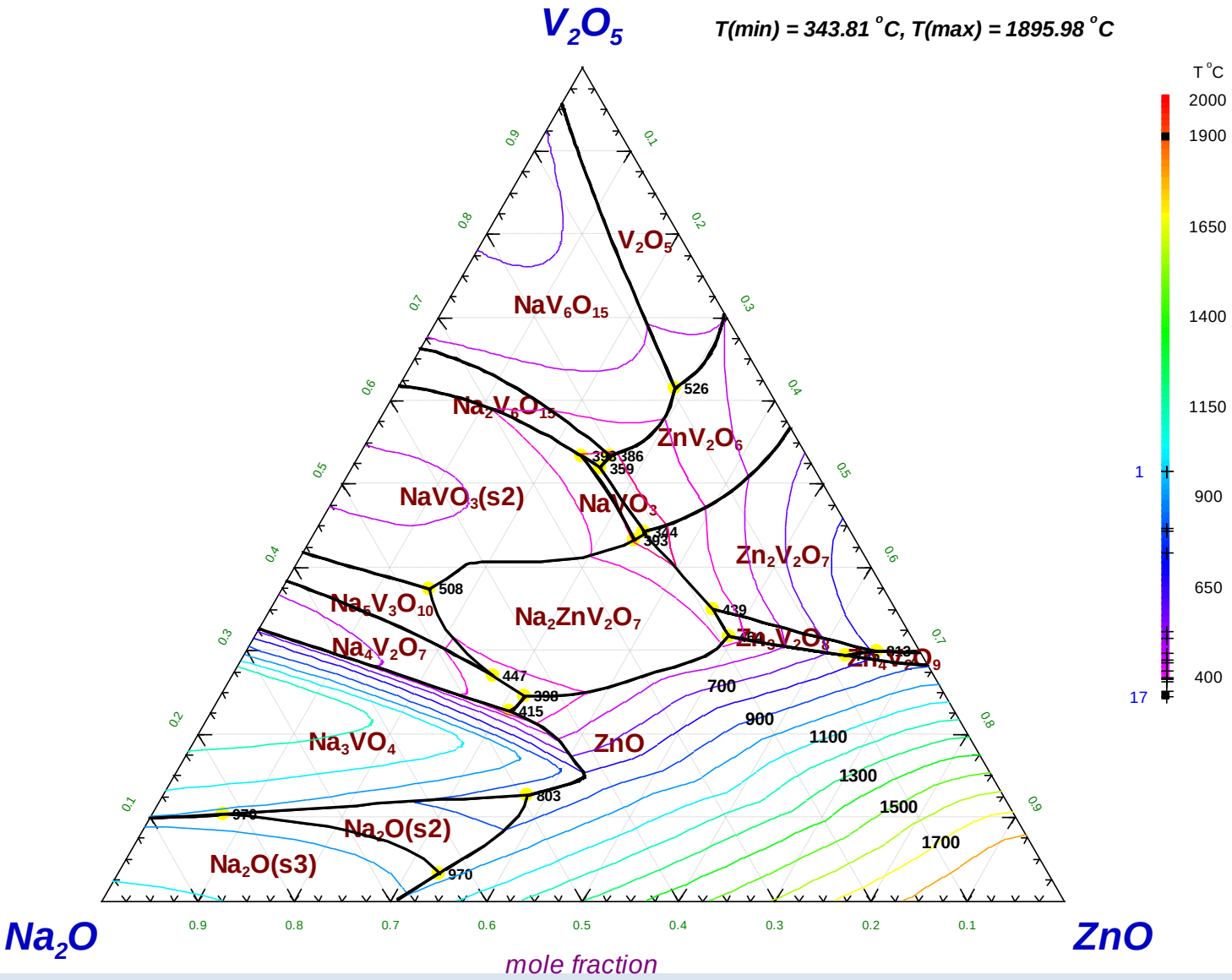
Intersections with slag	Mole fraction					Weight percent				
	A = SiO2, B = Na2O, C = ZnO					A = SiO2, B = Na2O, C = ZnO				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: Zn2Si2Na2O7 / Zn2SiO4 / ZnO	1:	0.47441	0.23848	0.28711	1088.31	1:	42.768	22.177	35.056	1088.31
2: Zn2Si2Na2O7 / ZnO / ZnSiNa2O4	2:	0.47414	0.24481	0.28104	1088.00	2:	42.819	22.806	34.376	1087.97
3: SiNa4O4_HT(s2) / ZnO / ZnSiNa2O4	3:	0.36503	0.62450	0.01046	1030.40	3:	35.669	62.946	1.385	1030.34
4: Si2Na6O7 / SiNa4O4_HT(s2) / ZnSiNa2O4	4:	0.36700	0.62388	0.00912	1026.71	4:	35.878	62.914	1.208	1026.71
5: Si2Na6O7 / SiNa2O3 / ZnSiNa2O4	5:	0.43896	0.55353	0.00751	1015.08	5:	43.031	55.972	0.997	1015.07
6: Na2O(s2) / Na2O(s3) / ZnO	6:	0.13390	0.86263	0.00347	970.05	6:	13.019	86.523	0.458	970.05
7: Zn2Si2Na2O7 / Zn2Si3Na4O10 / ZnSiNa2O4	7:	0.53298	0.31897	0.14805	968.12	7:	50.162	30.966	18.872	968.11
8: SiNa4O4(s2) / SiNa4O4(s) / ZnO	8:	0.25722	0.74021	0.00257	954.75	8:	25.114	74.546	0.340	954.80
9: Na2O(s2) / SiNa10O7 / ZnO	9:	0.14487	0.85235	0.00278	952.88	9:	14.095	85.540	0.366	952.88
10: SiNa2O3 / Zn2Si3Na4O10 / ZnSiNa2O4	10:	0.54528	0.36926	0.08546	927.97	10:	52.333	36.558	11.109	927.97
11: Cristobalite / Quartz_beta / Zn2SiO4	11:	0.61064	0.23965	0.14972	926.28	11:	57.574	23.307	19.119	926.28
12: Zn2Si2Na2O7 / Zn2Si3Na4O10 / ZnSi2Na2O6	12:	0.59985	0.30228	0.09787	858.86	12:	57.445	29.860	12.695	858.84
13: SiNa10O7 / SiNa4O4(s) / ZnO	13:	0.21894	0.78036	0.00070	853.02	13:	21.363	78.545	0.092	853.02
14: Quartz_beta / Zn2Si2Na2O7 / Zn2SiO4	14:	0.63205	0.25990	0.10805	847.39	14:	60.397	25.619	13.984	847.39
15: Quartz_beta / Zn2Si2Na2O7 / ZnSi2Na2O6	15:	0.63391	0.26082	0.10527	844.99	15:	60.630	25.733	13.637	844.99
16: SiNa2O3 / Zn2Si3Na4O10 / ZnSi2Na2O6	16:	0.61277	0.34806	0.03917	808.45	16:	59.790	35.033	5.177	808.46
17: Si2Na2O5(s3) / SiNa2O3 / ZnSi2Na2O6	17:	0.61350	0.34799	0.03851	807.49	17:	59.876	35.034	5.090	807.48
18: Si8Na6O19 / Quartz_beta / ZnSi2Na2O6	18:	0.71171	0.27171	0.01658	789.89	18:	70.158	27.629	2.213	789.89
19: Si2Na2O5(s3) / Si8Na6O19 / ZnSi2Na2O6	19:	0.70709	0.27516	0.01775	789.73	19:	69.666	27.965	2.369	789.73

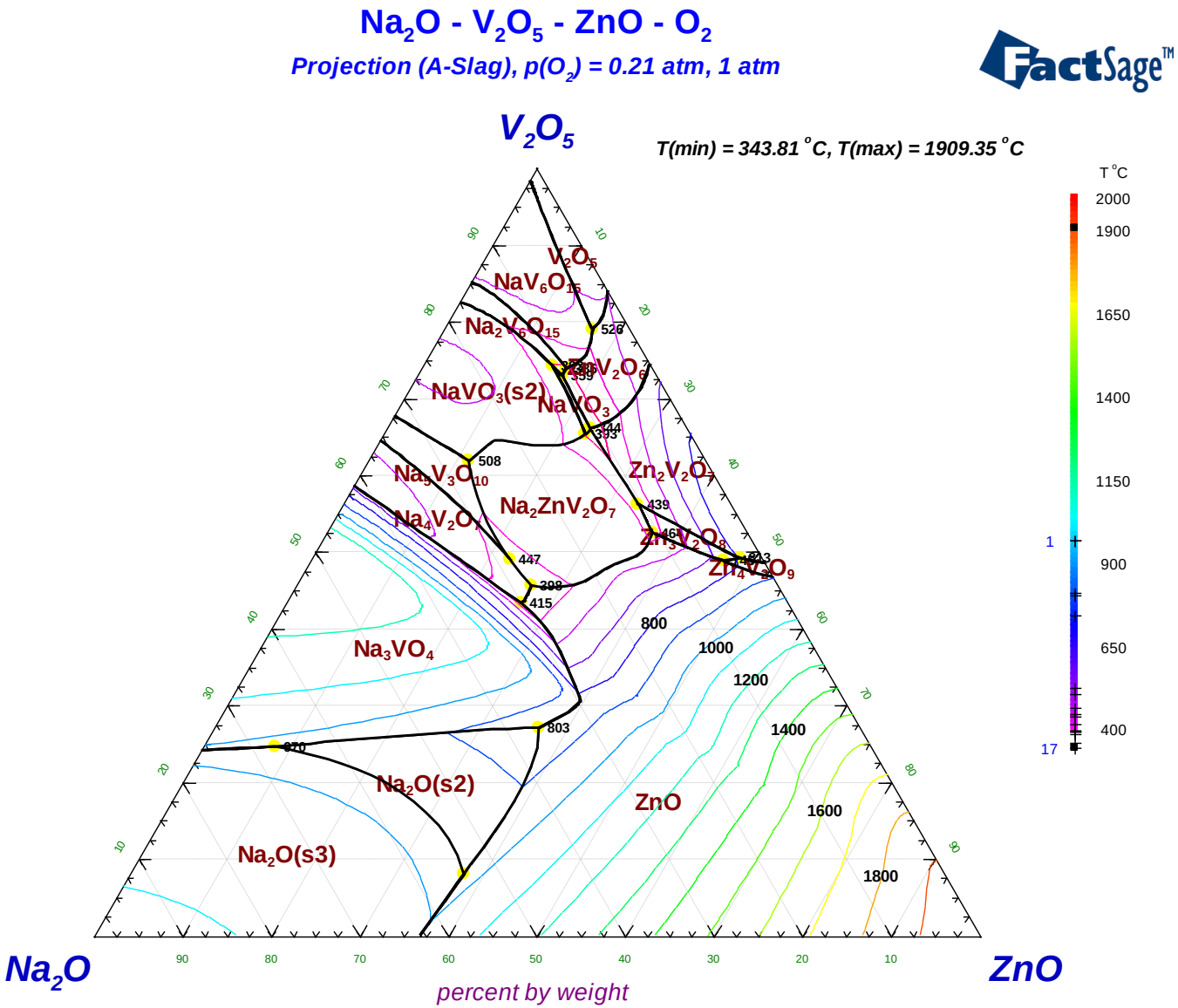
Na2O-V2O5-ZnO, Mole fraction, Subsolidus



Na_2O - V_2O_5 - ZnO - O_2

Projection (A-Slag), $p(O_2)$ = 0.21 atm, 1 atm



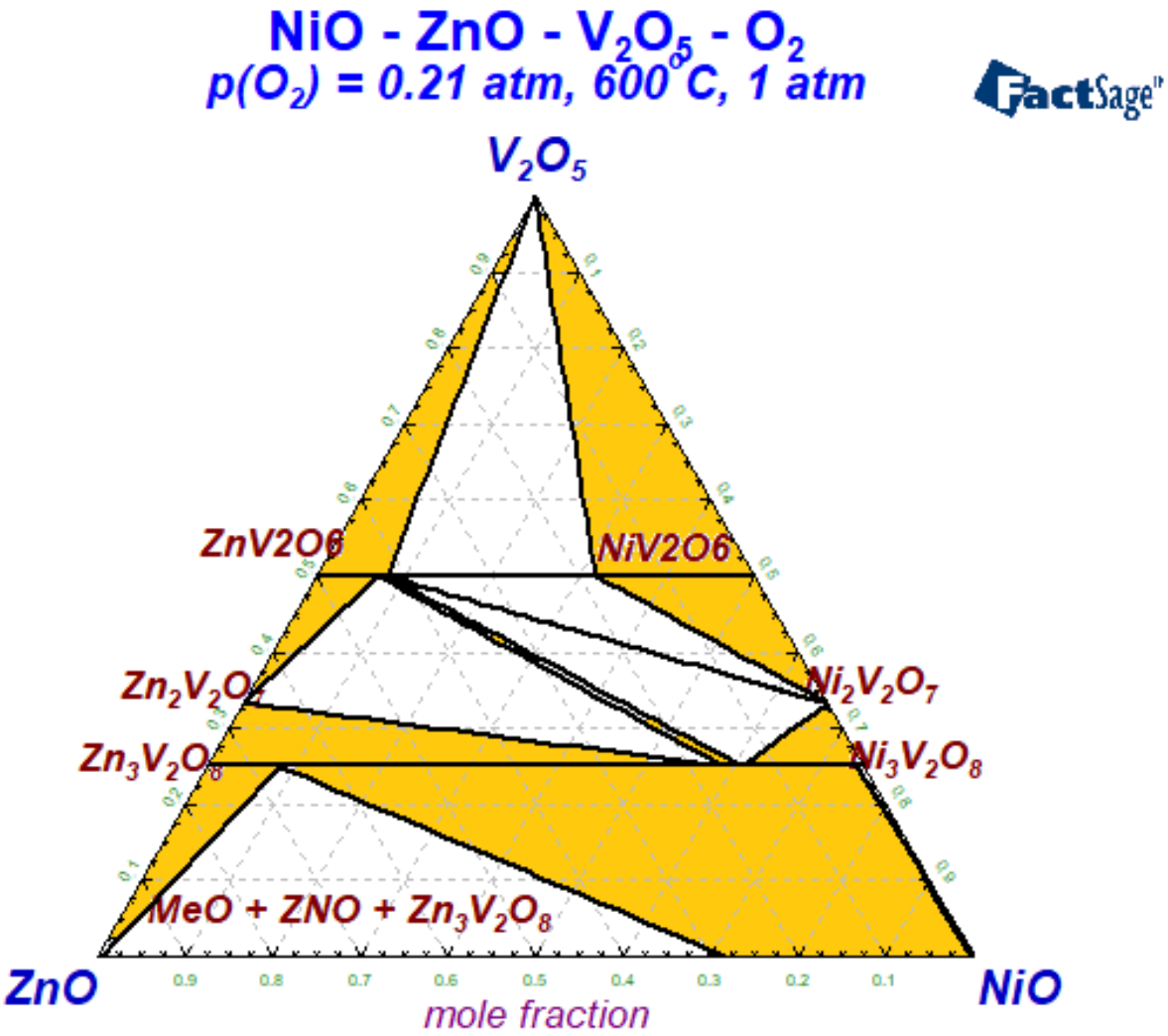

Na2O - V2O5 - ZnO - O2
Projection (A-Slag), p(O2) = 0.21 atm, 1 atm
FactSage™
V2O5
T(min) = 343.81 °C, T(max) = 1909.35 °C
T °C
2000
1900
1650
1400
1150
900
650
400
1
17
V2O5
NaV6O15
Na2V6O15
ZnV2O6
NaVO3(s2)
NaVO3
Na9V3O10
Na4V2O7
Na2ZnV2O7
Zn2V2O7
Zn3V2O8
Zn4V2O9
Na3VO4
Na2O(s2)
Na2O(s3)
ZnO
526
508
439
447
398
415
803
870
800
1000
1200
1400
1600
1800
Na2O
ZnO
percent by weight

Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction A = V2O5, B = Na2O, C = ZnO				Weight percent A = V2O5, B = Na2O, C = ZnO			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1. Na2O(s2) / Na2O_s3(s3) / Na3VO4	0.10297	0.82216	0.07486	970.05	8.044	54.250	37.706	970.05
2. Na2O(s2) / Na2O(s3) / ZnO	0.03198	0.63297	0.33505	970.05	24.715	67.245	8.040	970.05
3. Zn2V2O7 / Zn3V2O8 / Zn4V2O9	0.29943	0.04386	0.65671	812.53	49.231	2.457	48.312	812.54
4. Na2O(s2) / Na3VO4 / ZnO	0.12571	0.49405	0.38024	803.11	27.081	36.268	36.650	803.11
5. Zn3V2O8 / Zn4V2O9 / ZnO	0.29400	0.07875	0.62725	745.12	48.879	4.461	46.659	745.12
6. NaV6O15 / V2O5 / ZnV2O6	0.61450	0.09601	0.28949	526.38	79.112	4.212	16.676	526.38
7. Na2ZnV2O7 / Na5V3O10 / NaVO3(s2)	0.37407	0.47224	0.15370	508.11	61.956	26.653	11.390	508.12
8. Na2ZnV2O7 / Zn3V2O8 / ZnO	0.31676	0.18906	0.49419	463.64	52.592	10.696	36.712	463.73
9. Na2ZnV2O7 / Na4V2O7 / Na5V3O10	0.26912	0.45757	0.27331	446.63	49.170	28.488	22.342	446.63
10.Na2ZnV2O7 / Zn2V2O7 / Zn3V2O8	0.34952	0.18947	0.46101	439.07	56.341	10.408	33.251	439.07
11.Na3VO4 / Na4V2O7 / ZnO	0.22725	0.46222	0.31053	414.98	43.393	30.076	26.531	414.96
12.Na2ZnV2O7 / Na4V2O7 / ZnO	0.24459	0.43770	0.31772	398.42	45.641	27.832	26.527	398.42
13.Na2ZnV2O7 / NaVO3 / NaVO3(s2)	0.43288	0.22954	0.33759	392.85	74.344	11.097	14.559	392.85
14.Na2V6O15 / NaVO3 / NaVO3(s2)	0.53313	0.23352	0.23335	392.85	65.375	11.813	22.812	392.85
15.Na2V6O15 / NaV6O15 / ZnV2O6	0.53365	0.20378	0.26257	385.94	74.059	9.637	16.304	385.94
16.Na2V6O15 / NaVO3 / ZnV2O6	0.51931	0.22157	0.25912	358.60	73.065	10.623	16.312	358.60
17.NaVO3 / Zn2V2O7 / ZnV2O6	0.44247	0.21439	0.34314	343.81	66.133	10.919	22.948	343.81

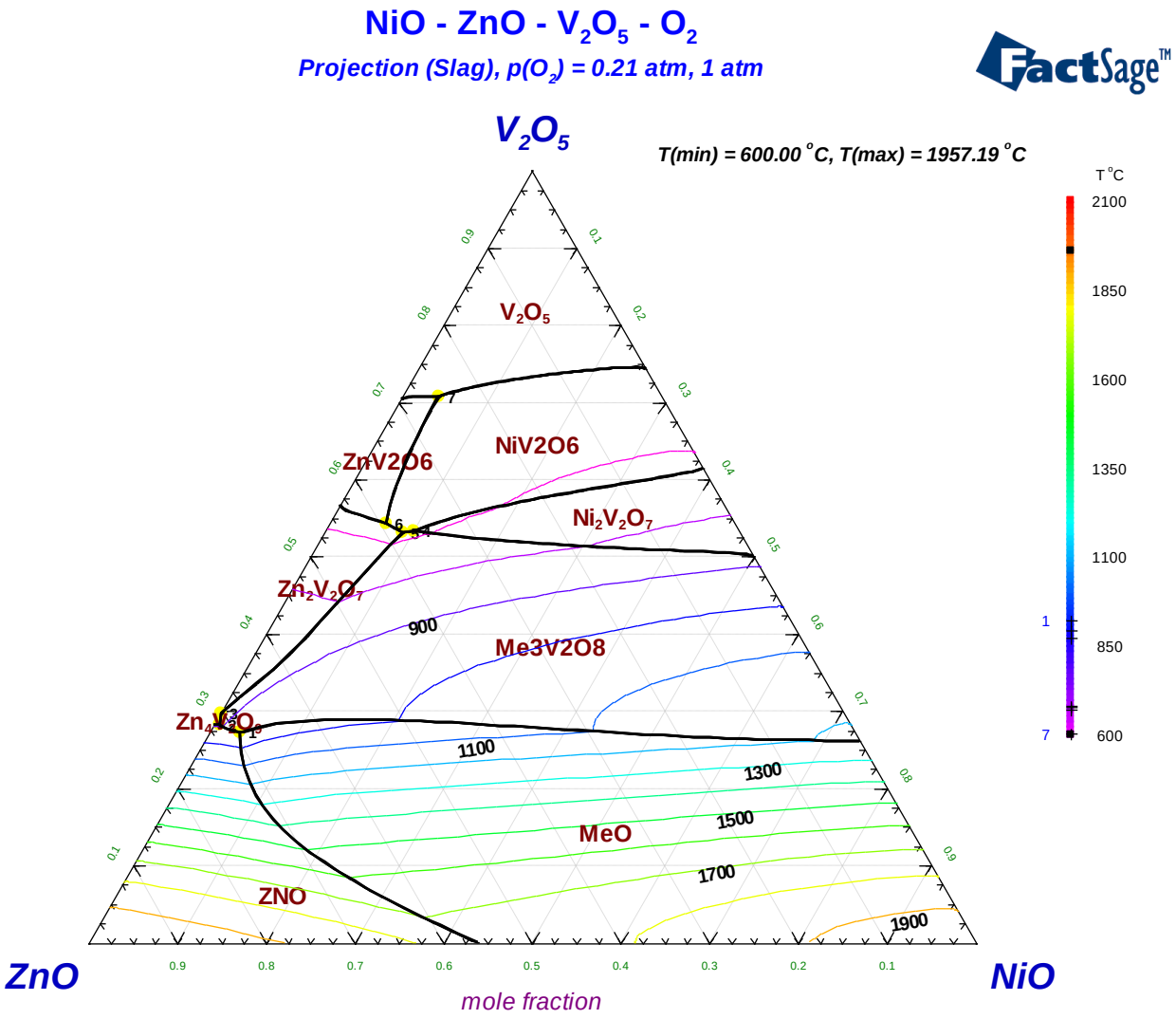
NiO-V2O5-ZnO,

NiO-V2O5-ZnO,
Mole fraction, 600°C
,

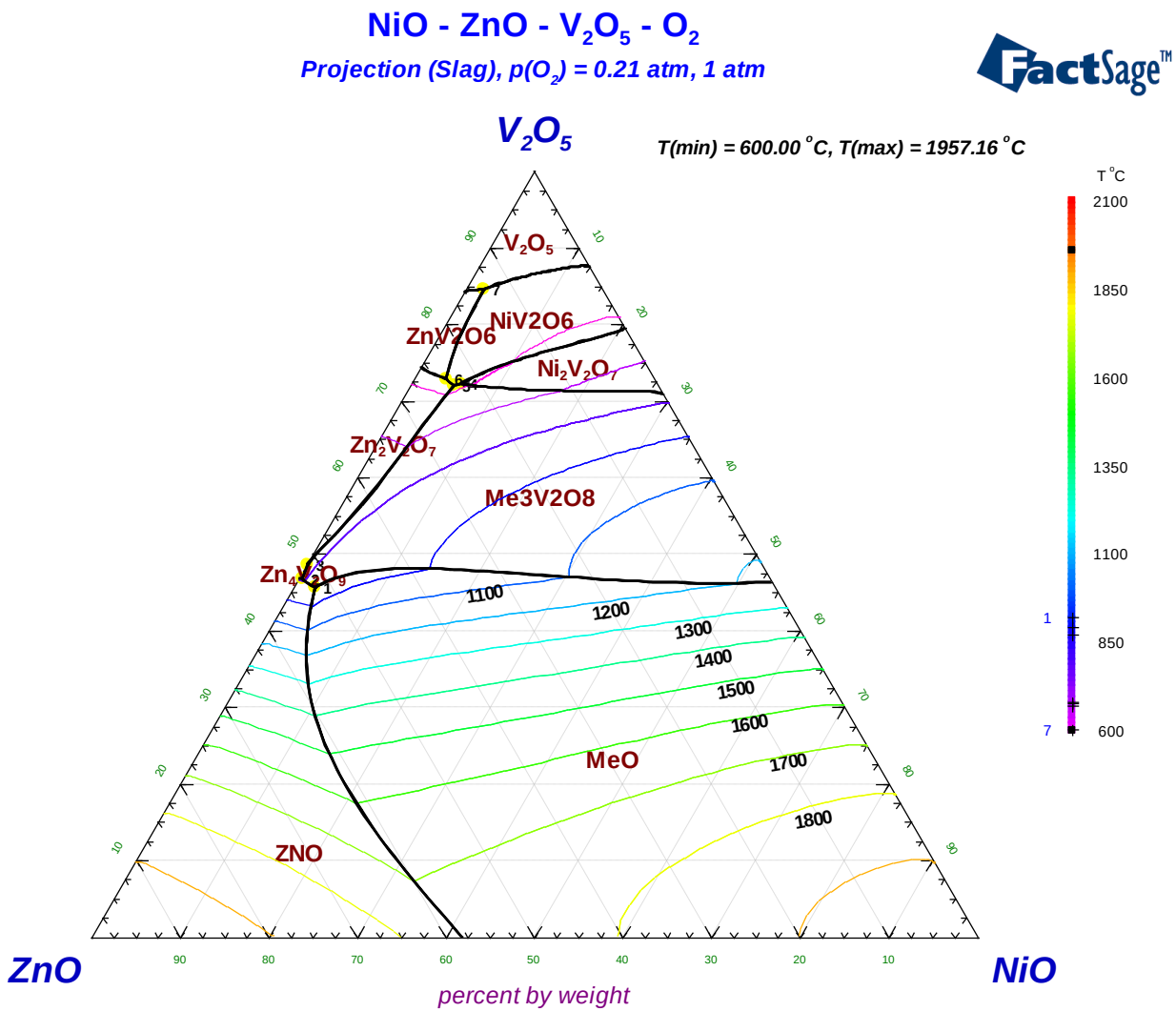


NiO-V2O5-ZnO,
Mole fraction, Liquidussurface

,



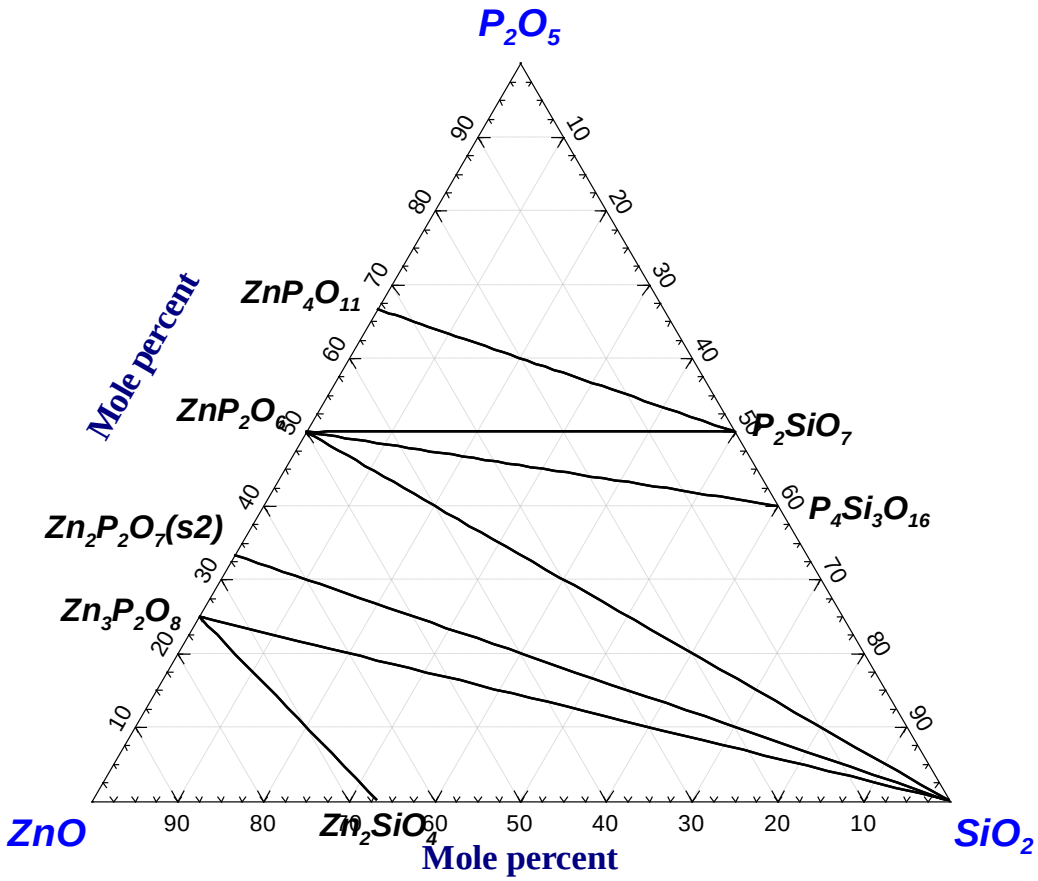
NiO-V2O5-ZnO,
Weight percent, Liquidussurface
,



Invariant equilibria on the liquidus surface

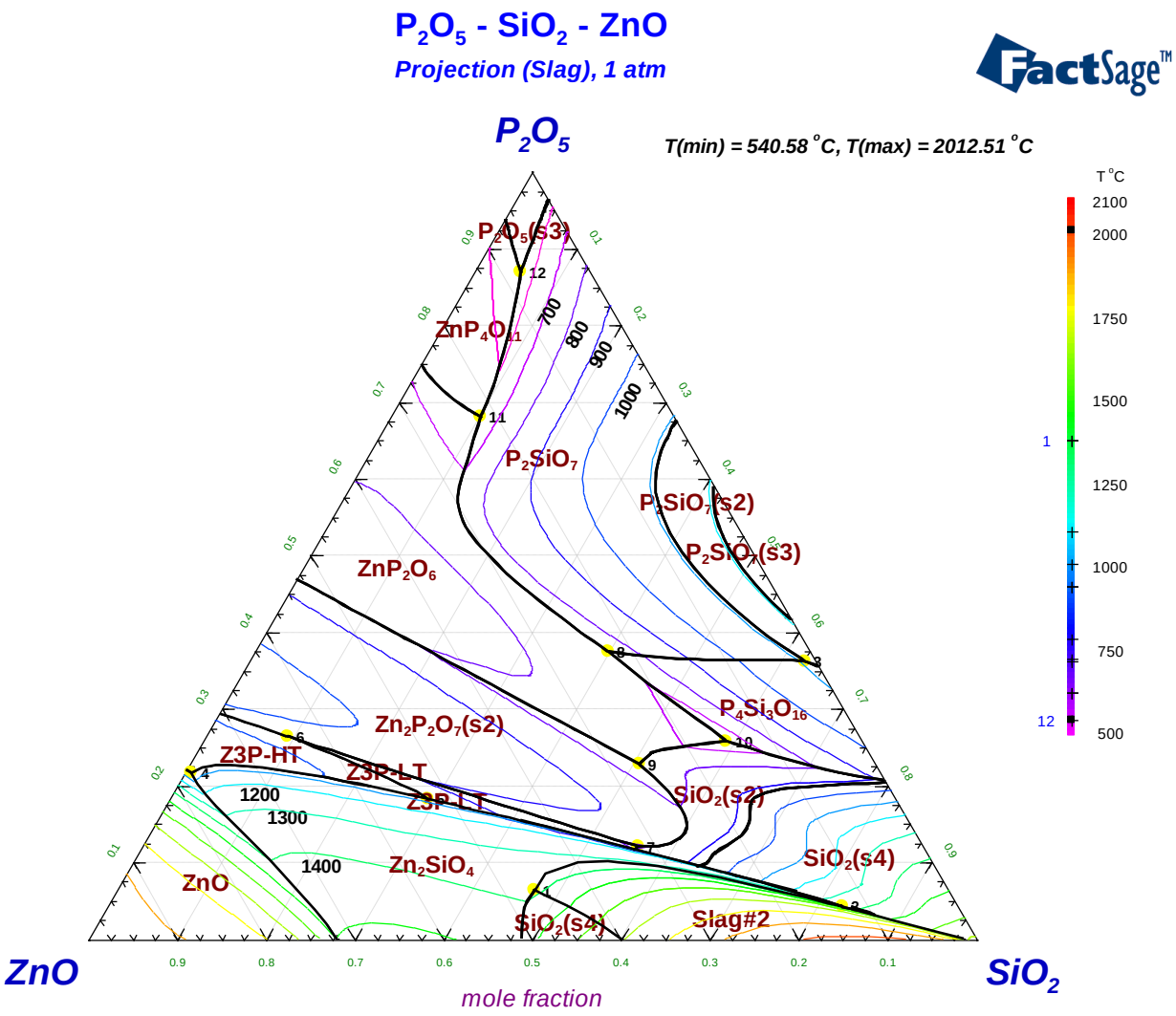
Intersections with slag	Mole fraction					Weight percent				
	A = V2O5, B = ZnO, C = NiO					A = V2O5, B = ZnO, C = NiO				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: MeO / Me3V2O8 / ZNO	1:	0.27212	0.69313	0.03475	920.32	1:	45.618	51.990	2.393	920.33
2: Me3V2O8 / ZNO / Zn4V2O9	2:	0.28206	0.71110	0.00683	894.80	2:	46.774	52.761	0.465	894.81
3: Me3V2O8 / Zn2V2O7 / Zn4V2O9	3:	0.29730	0.70191	0.00079	873.91	3:	48.603	51.344	0.053	873.90
4: Ni2V2O7 / Me3V2O8 / NiV2O6	4:	0.53390	0.36598	0.10011	682.75	4:	72.269	22.166	5.565	682.75
5: Me3V2O8 / NiV2O6 / Zn2V2O7	5:	0.53143	0.38047	0.08809	679.01	5:	72.025	23.072	4.903	679.01
6: NiV2O6 / Zn2V2O7 / ZnV2O6	6:	0.54352	0.39243	0.06405	670.51	6:	72.915	23.556	3.529	670.51
7: NiV2O6 / V2O5 / ZnV2O6	7:	0.70777	0.25183	0.04040	604.13	7:	84.556	13.461	1.982	604.12

P2O5-SiO2-ZnO,
Mole fraction, 500°C
,



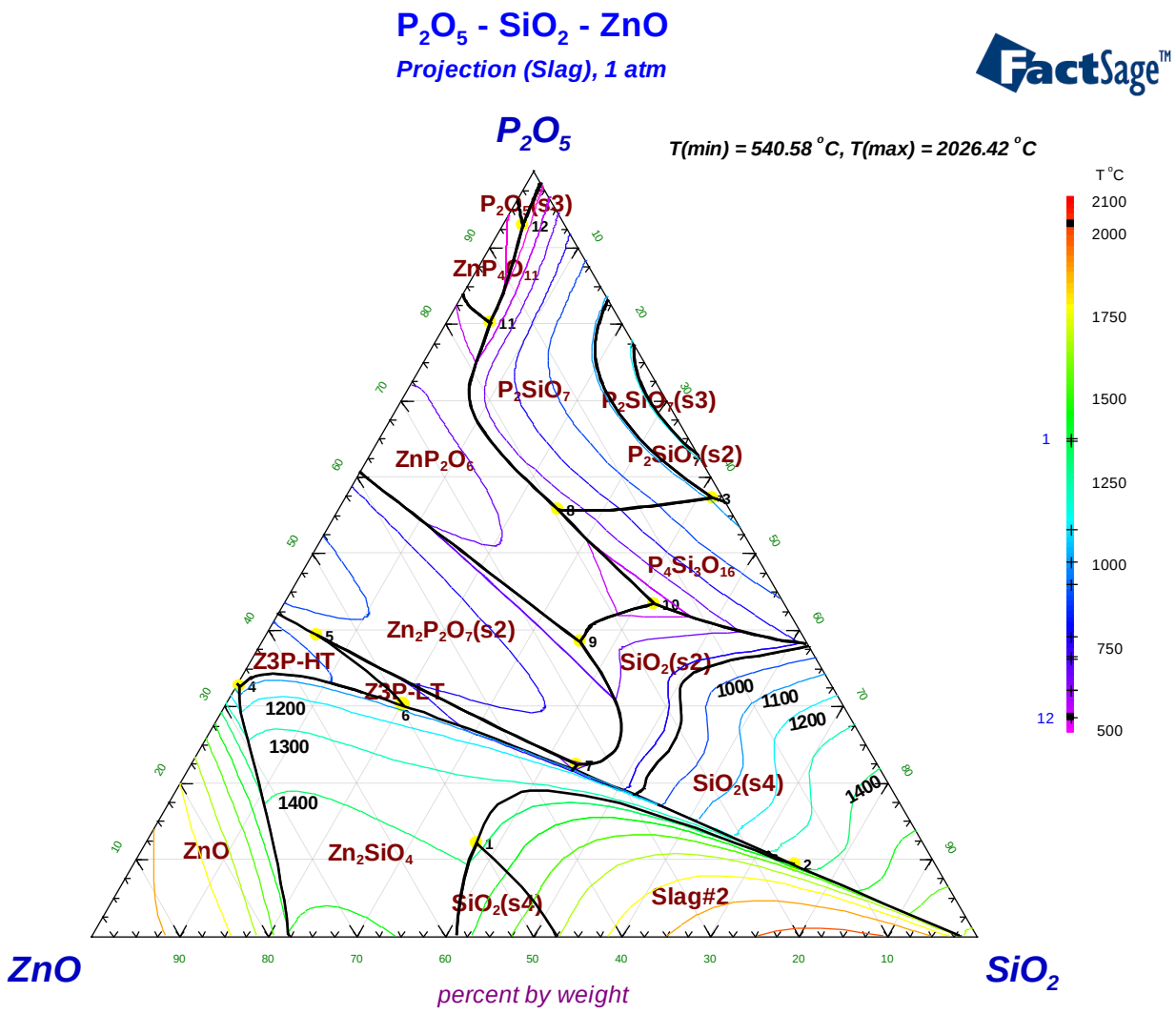
P2O5-SiO2-ZnO,
Mole fraction, Liquidus surface

,



P2O5-SiO2-ZnO,
Weight percent, Liquidus surface

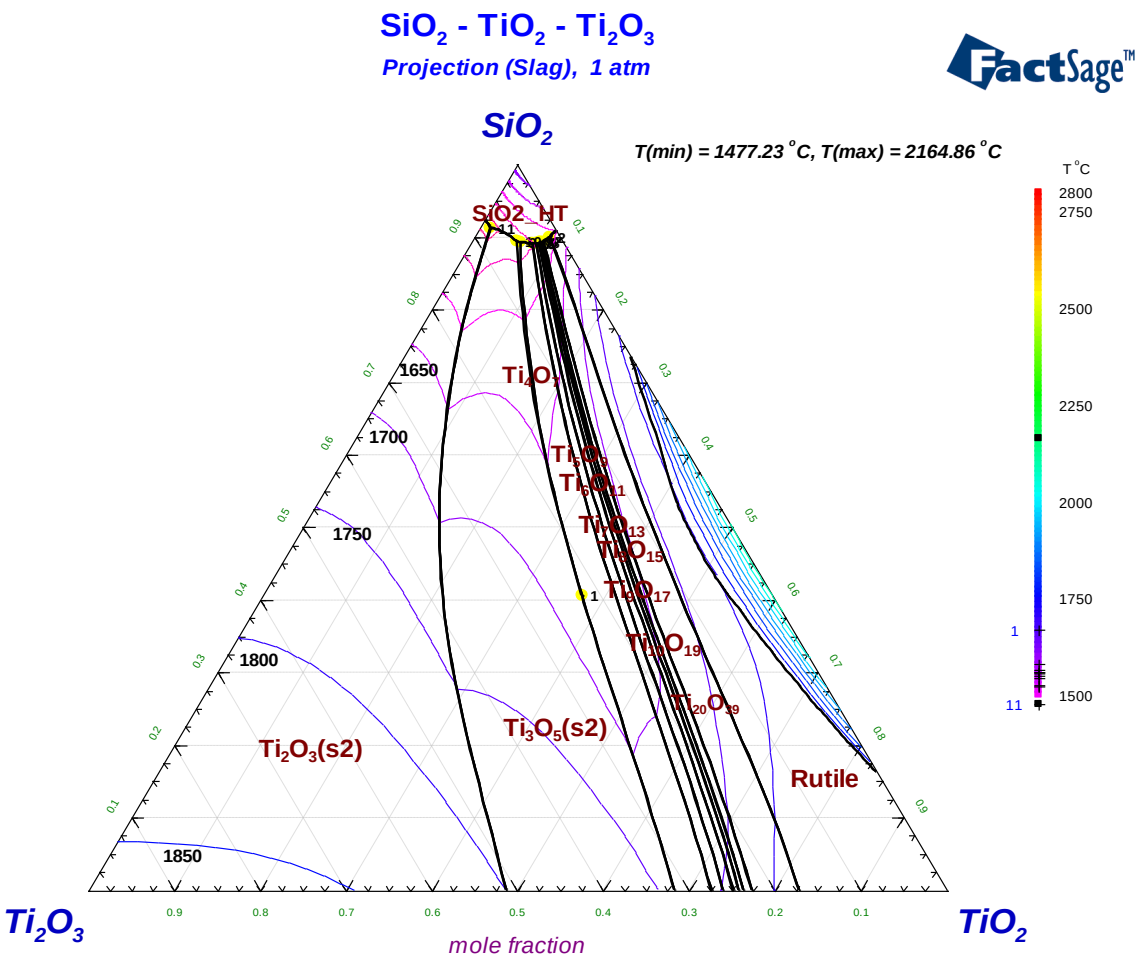
,

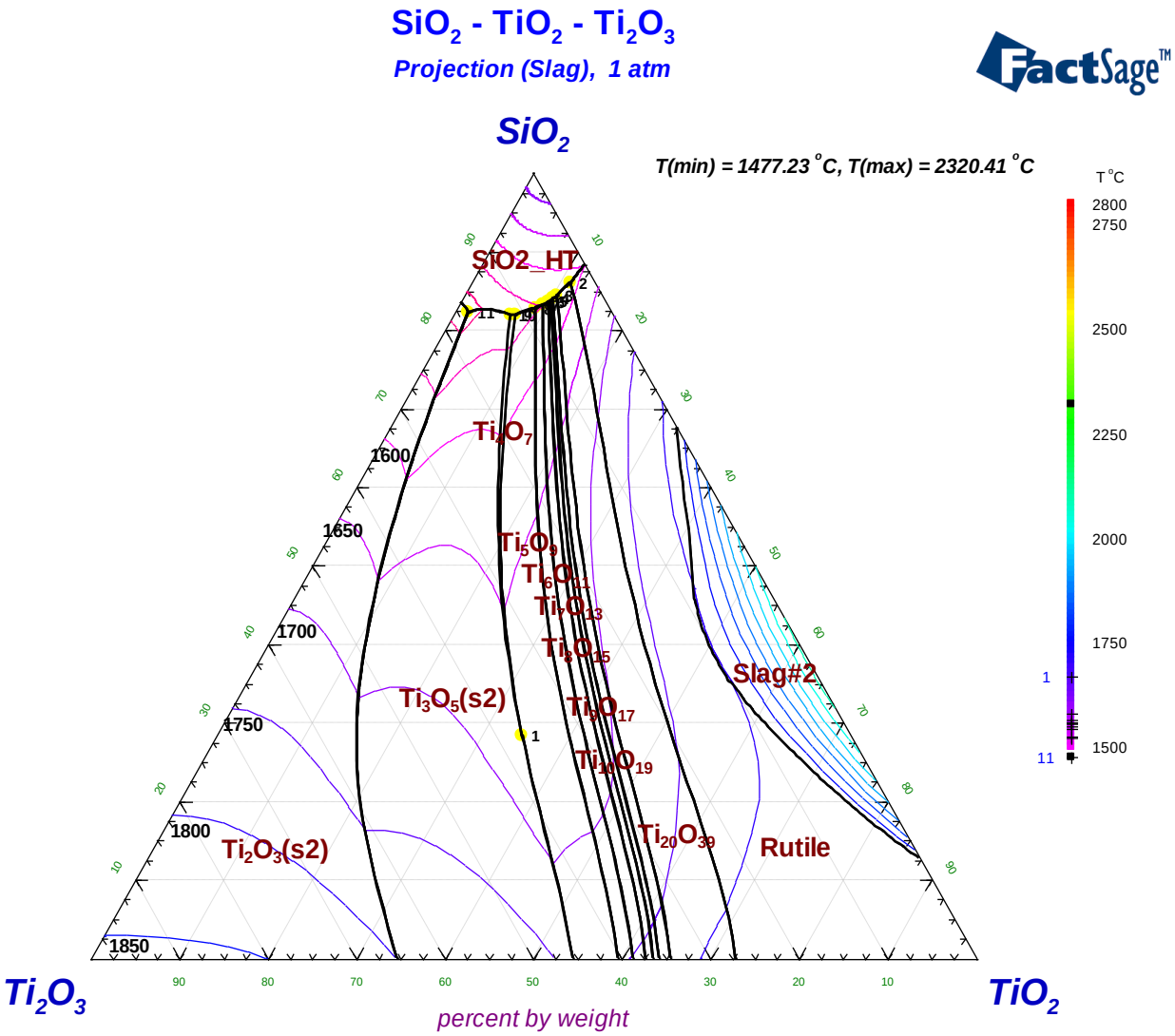


Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction				Weight percent			
	A = P2O5, B = ZnO, C = SiO2				A = P2O5, B = ZnO, C = SiO2			
	X(A)	X(B)	X(C)	T(C)	W(A)	W(B)	W(C)	T(C)
1. SiO2(s4) / Slag#2 / Zn2SiO4(s)	1: 0.06418	0.46534	0.47048	1380.56	1: 12.106	50.326	37.568	1380.54
2. SiO2(s4) / Slag#2 / Slag#2	2: 0.04255	0.12975	0.82770	1371.98	2: 9.331	15.794	74.875	1371.98
3. P2SiO7(s) / P2SiO7(s2) / P4Si3O16	3: 0.36317	0.01184	0.62499	1106.85	3: 57.237	1.070	41.694	1106.85
4. Z3P-HT / Zn2SiO4 / ZnO	4: 0.21697	0.77553	0.00750	1007.71	4: 32.638	66.884	0.478	1007.69
5. Z3P-HT / Z3P-LT / Zn2SiO4	5: 0.18249	0.52719	0.29031	941.85	5: 39.352	54.861	5.787	941.85
6. Z3P-HT / Z3P-LT / Zn2P2O7(s2)	6: 0.26462	0.64345	0.09193	941.85	6: 30.139	49.681	20.220	941.85
7. SiO2(s2) / Z3P-LT / Zn2P2O7(s2)	7: 0.12123	0.32081	0.55796	784.88	7: 22.395	33.976	43.629	784.88
8. P2SiO7(s) / P4Si3O16 / ZnP2O6(s)	8: 0.37538	0.22756	0.39706	721.76	8: 55.701	19.359	24.940	721.76
9. SiO2(s2) / Zn2P2O7(s2) / ZnP2O6(s)	9: 0.22868	0.26511	0.50620	715.25	9: 38.437	25.547	36.015	715.25
10. P4Si3O16 / SiO2(s2) / ZnP2O6(s)	10: 0.25884	0.15184	0.58932	623.25	10: 43.477	14.622	41.901	623.25
11. P2SiO7(s) / ZnP2O6(s) / ZnP4O11	11: 0.68083	0.21838	0.10079	622.32	11: 80.221	14.752	5.027	622.48
12. P2O5(s3) / P2SiO7(s) / ZnP4O11	12: 0.86984	0.07795	0.05221	540.58	12: 92.869	4.771	2.359	540.58

SiO2-TiO2-Ti2O3,
Mole fraction, Liquidus surface



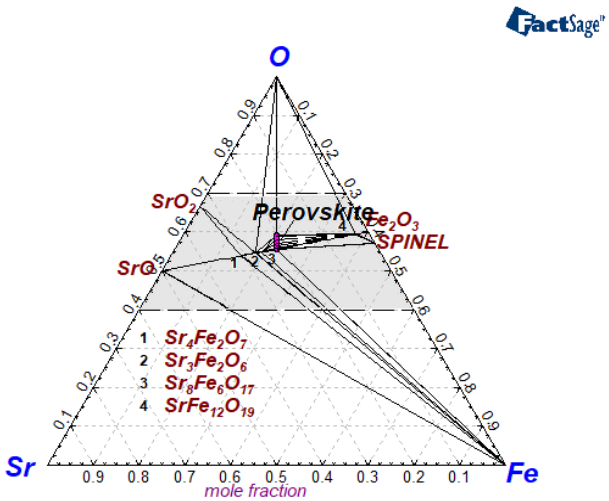

SiO2 - TiO2 - Ti2O3
Projection (Slag), 1 atm
FactSage™
SiO2
T(min) = 1477.23 °C, T(max) = 2320.41 °C
T °C
2800
2750
2500
2250
2000
1750
1500
SiO2_HT
Ti4O7
Ti5O9
Ti6O11
Ti7O13
Ti8O15
Ti9O17
Ti10O19
Ti20O39
Ti3O5(s2)
Ti2O3(s2)
Slag#2
Rutile
1600
1650
1700
1750
1800
1850
Ti2O3
TiO2
percent by weight

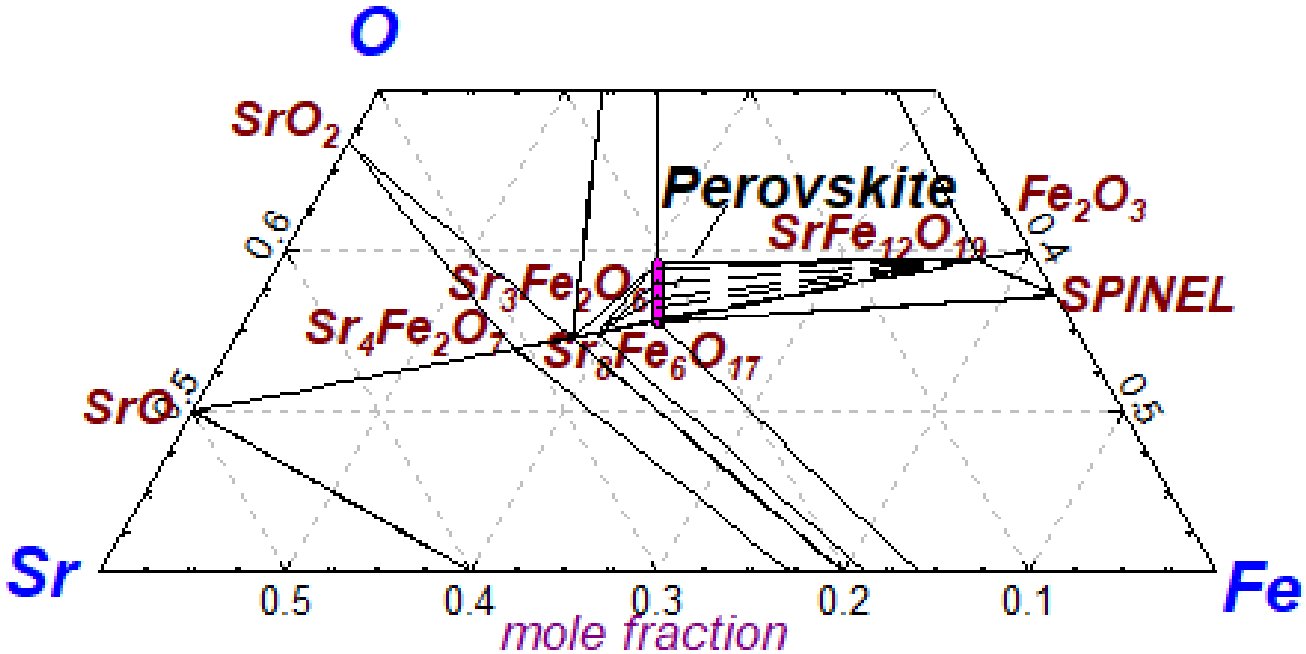
Invariant equilibria on the liquidus surface

Intersections with slag	Mole fraction					Weight percent				
	A = SiO2, B = Ti2O3, C = TiO2					A = SiO2, B = Ti2O3, C = TiO2				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: Ti3O5(s2) / Ti4O7 / Ti5O9	1:	0.40699	0.22158	0.37143	1669.74	1:	28.448	37.047	34.506	1669.75
2: Rutile / SiO2_HT / Ti20O39	2:	0.90043	0.01210	0.08747	1580.66	2:	86.113	2.768	11.119	1580.66
3: SiO2_HT / Ti10O19 / Ti20O39	3:	0.89390	0.02312	0.08298	1563.62	3:	84.370	5.219	10.411	1563.62
4: SiO2_HT / Ti10O19 / Ti9O17	4:	0.89299	0.02566	0.08134	1560.11	4:	84.045	5.778	10.176	1560.11
5: SiO2_HT / Ti8O15 / Ti9O17	5:	0.89252	0.02722	0.08027	1557.98	5:	83.858	6.118	10.024	1557.98
6: SiO2_HT / Ti7O13 / Ti8O15	6:	0.89203	0.02929	0.07868	1555.22	6:	83.626	6.569	9.805	1555.22
7: SiO2_HT / Ti6O11 / Ti7O13	7:	0.89150	0.03287	0.07563	1550.52	7:	83.267	7.344	9.390	1550.58
8: SiO2_HT / Ti5O9 / Ti6O11	8:	0.89140	0.03729	0.07131	1544.71	8:	82.890	8.296	8.814	1544.71
9: SiO2_HT / Ti4O7 / Ti5O9	9:	0.89318	0.05040	0.05642	1525.36	9:	82.037	11.074	6.889	1525.36
10: SiO2_HT / Ti3O5(s2) / Ti4O7	10:	0.89438	0.05298	0.05264	1521.40	10:	81.971	11.616	6.413	1521.41
11: SiO2_HT / Ti2O3(s2) / Ti3O5(s2)	11:	0.91289	0.07487	0.01224	1477.23	11:	82.372	16.160	1.468	1477.23

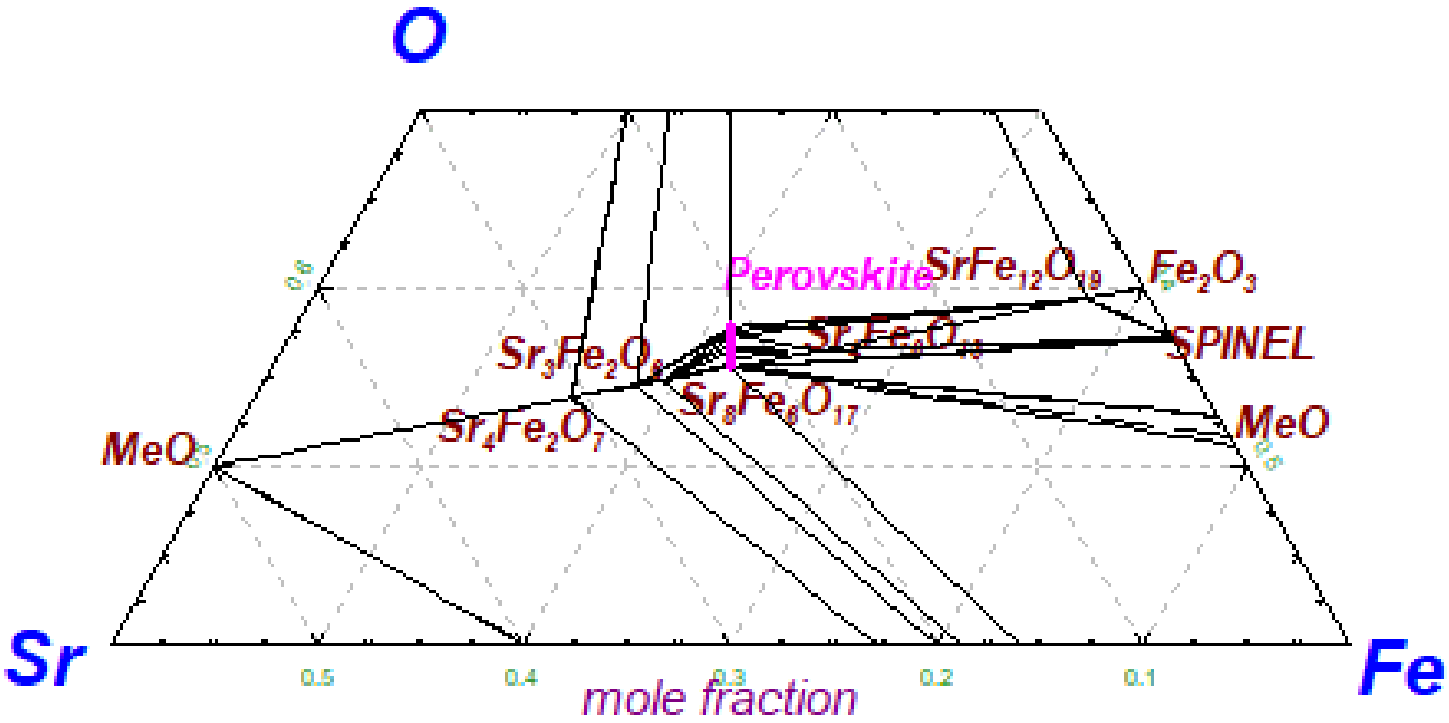
Sr-Fe-O,

Sr-Fe-O,
Mole fraction, 400°C

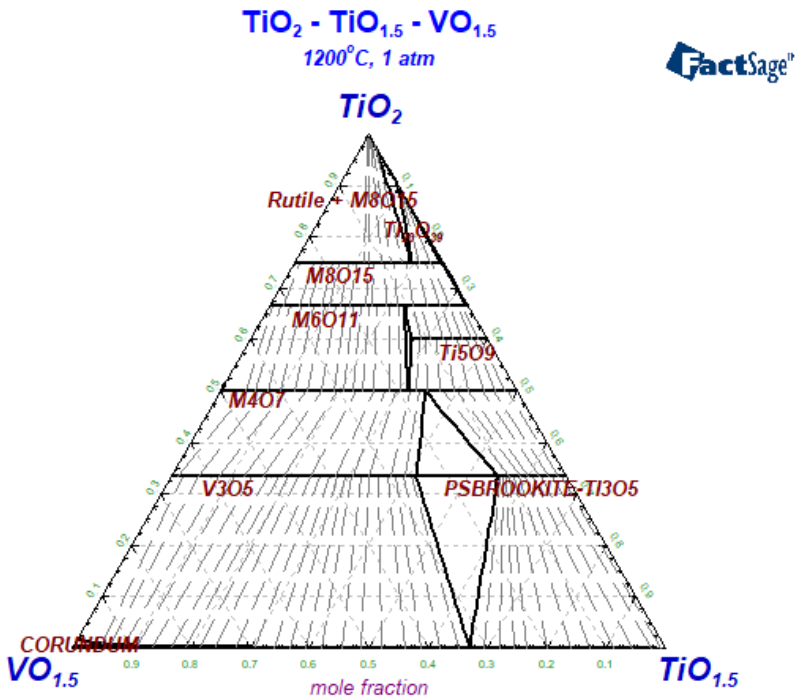




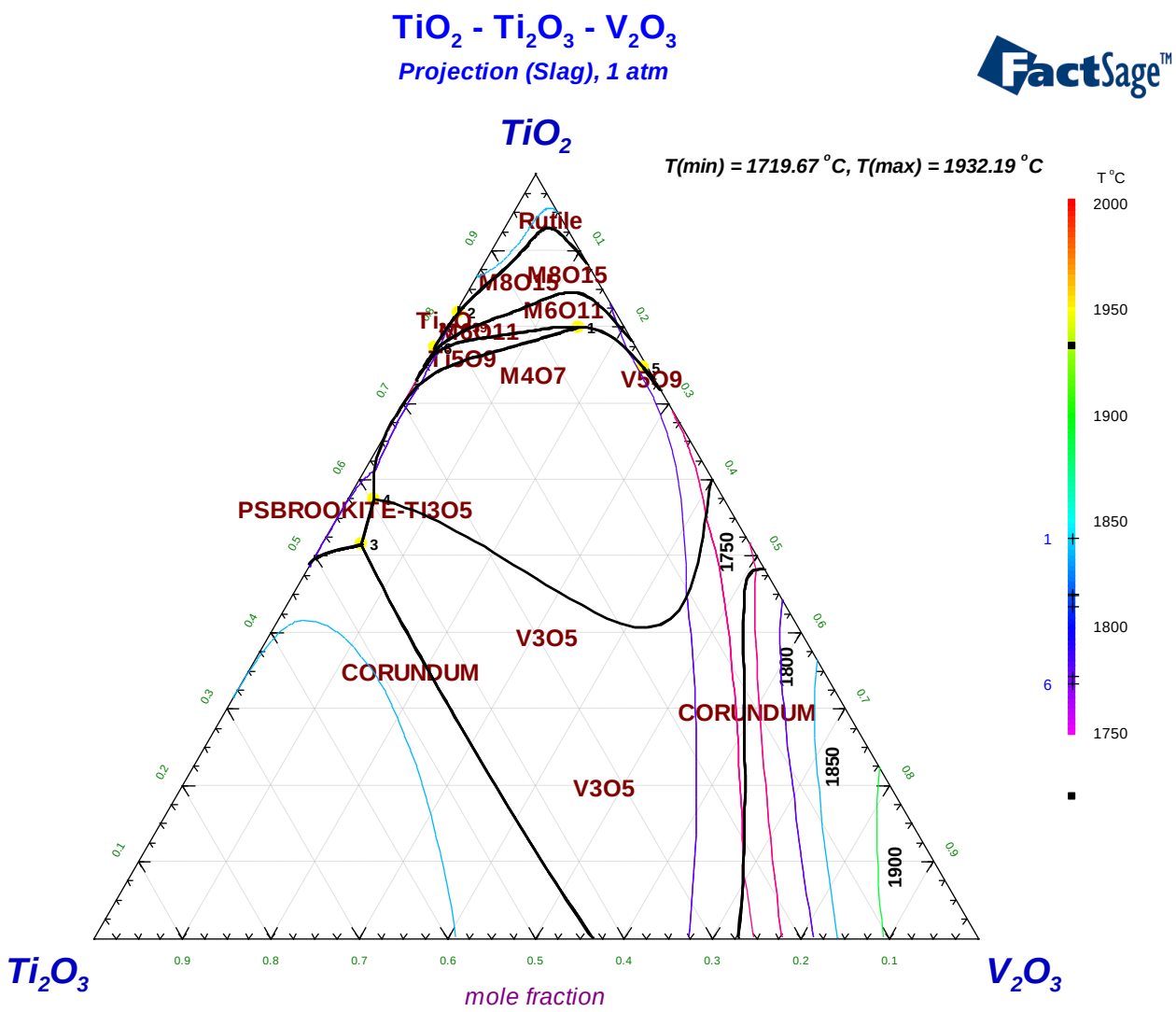
Sr-Fe-O,
Mole fraction, 800°C

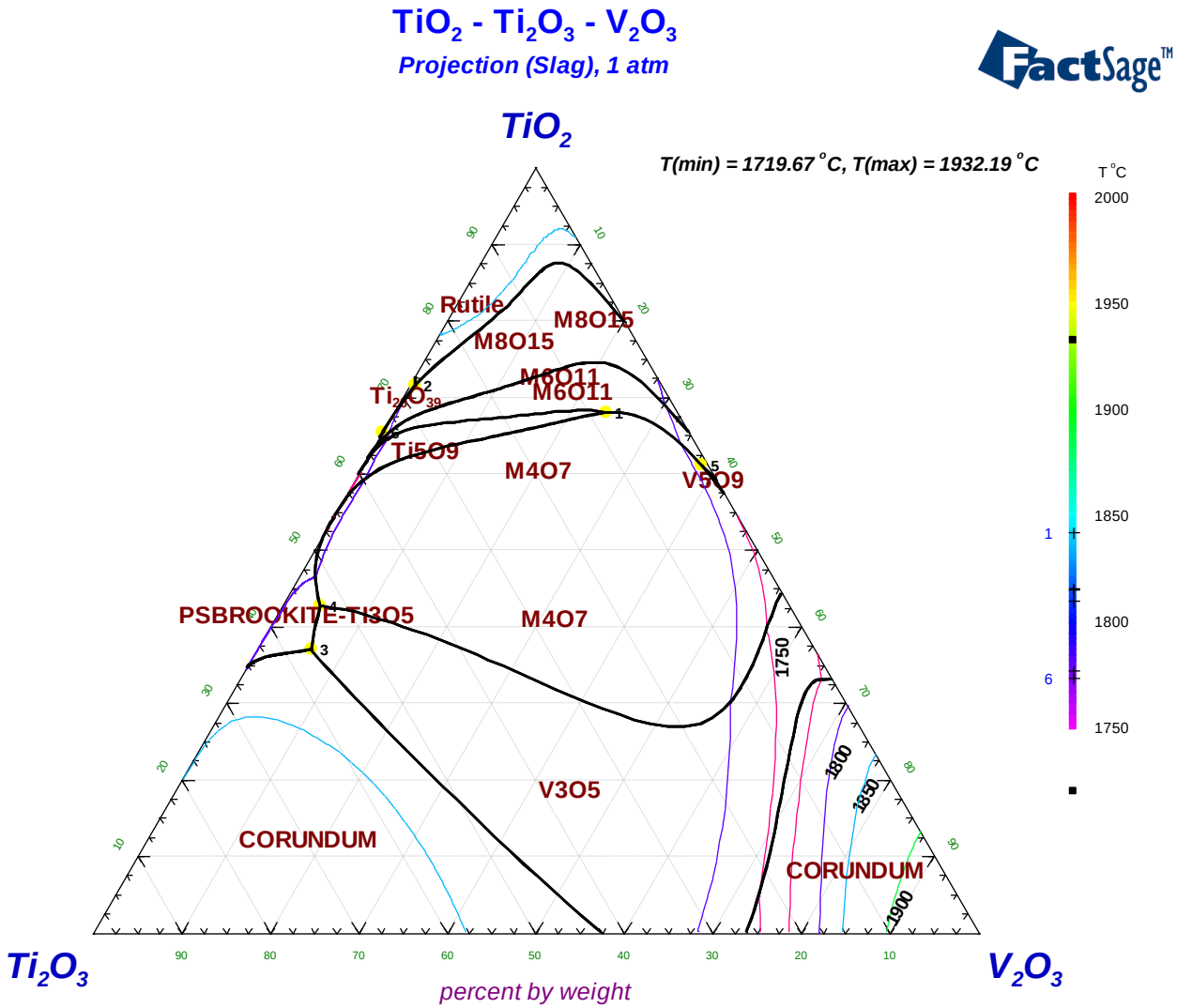


TiO2-Ti2O3-V2O3,
Mole fraction, 1200°C



Phase	Description	Used data
Corundum	$(Ti^{+3},V^{+3}, V^{+4})_2 (Va)_1(O^{-2})_3$	Present work
Pseudobrookite	$(Ti, V)_1(Ti)_1(Ti)_1(O)_5$	Present work
Rutile	$(Ti, V) (O, Va)_2$	[Yang17]
V_3O_5	$(Ti, \underline{V})_3(O)_5$	[Yang17]
M_4O_7	$(Ti, V)_4(O)_7$	[Yang17]
V_5O_9	$(Ti, \underline{V})_5(O)_9$	[Yang17]
M_6O_{11}	$(Ti, V)_6(O)_{11}$	[Yang17]
M_8O_{15}	$(Ti, V)_8(O)_{15}$	[Yang17]


TiO2 - Ti2O3 - V2O3
Projection (Slag), 1 atm
FactSage™
TiO2
T(min) = 1719.67 °C, T(max) = 1932.19 °C
T °C
2000
1950
1900
1850
1800
1750
Rutile
M8O15
M6O11
M4O7
V5O9
PSBROOKITE-TI3O5
V3O5
CORUNDUM
1750
1800
1850
1900
Ti2O3
V2O3
mole fraction

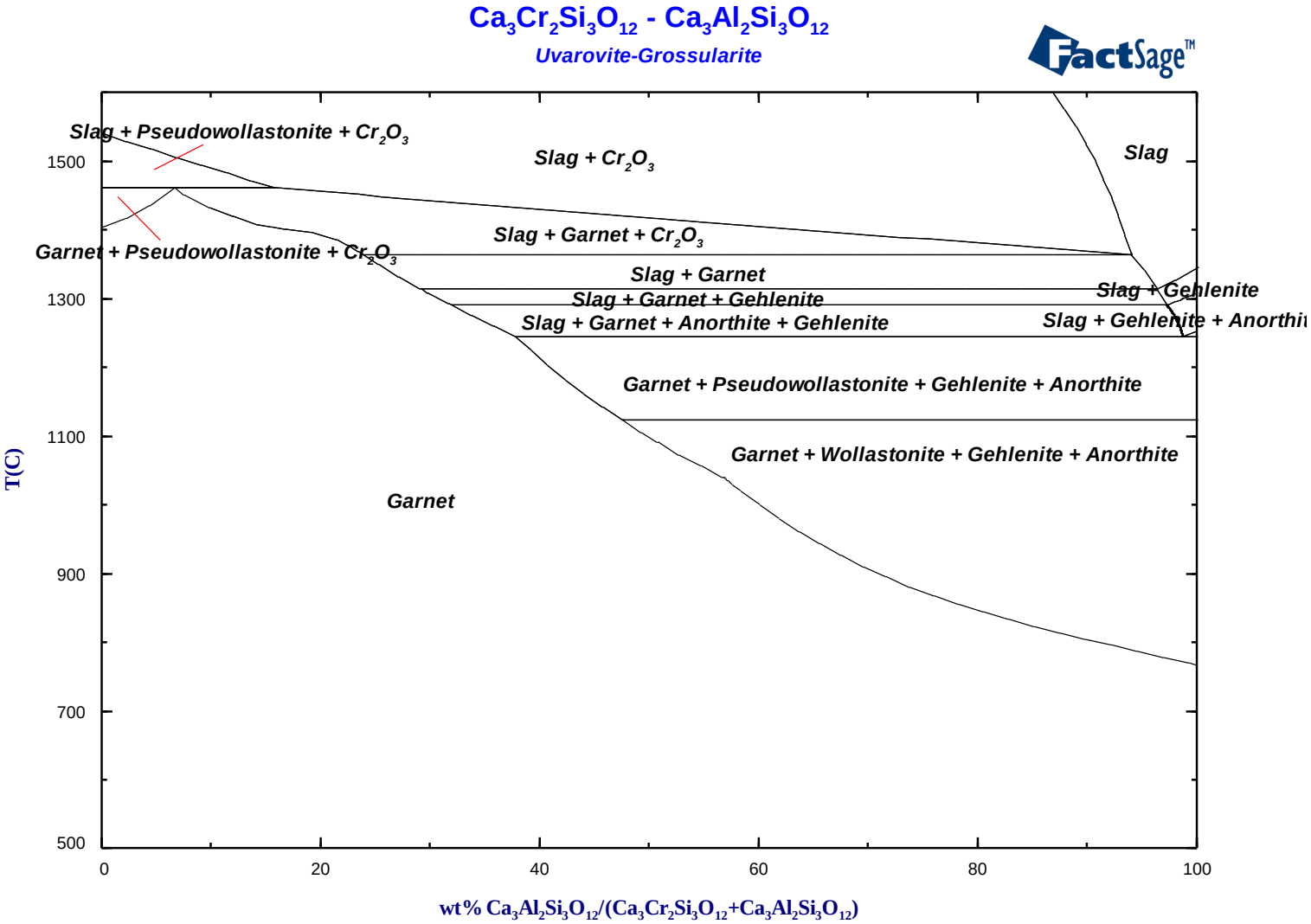

TiO2 - Ti2O3 - V2O3
Projection (Slag), 1 atm
FactSage™
TiO2
T(min) = 1719.67 °C, T(max) = 1932.19 °C
T °C
2000
1950
1900
1850
1800
1750
Rutile
M8O15
M8O15
M6O11
M6O11
Ti2O39
Ti5O9
M4O7
V5O9
PSBROOKITE-TI3O5
M4O7
V3O5
CORUNDUM
CORUNDUM
1750
1800
1850
1900
Ti2O3
V2O3
percent by weight

Invariant equilibria on the liquidus surface

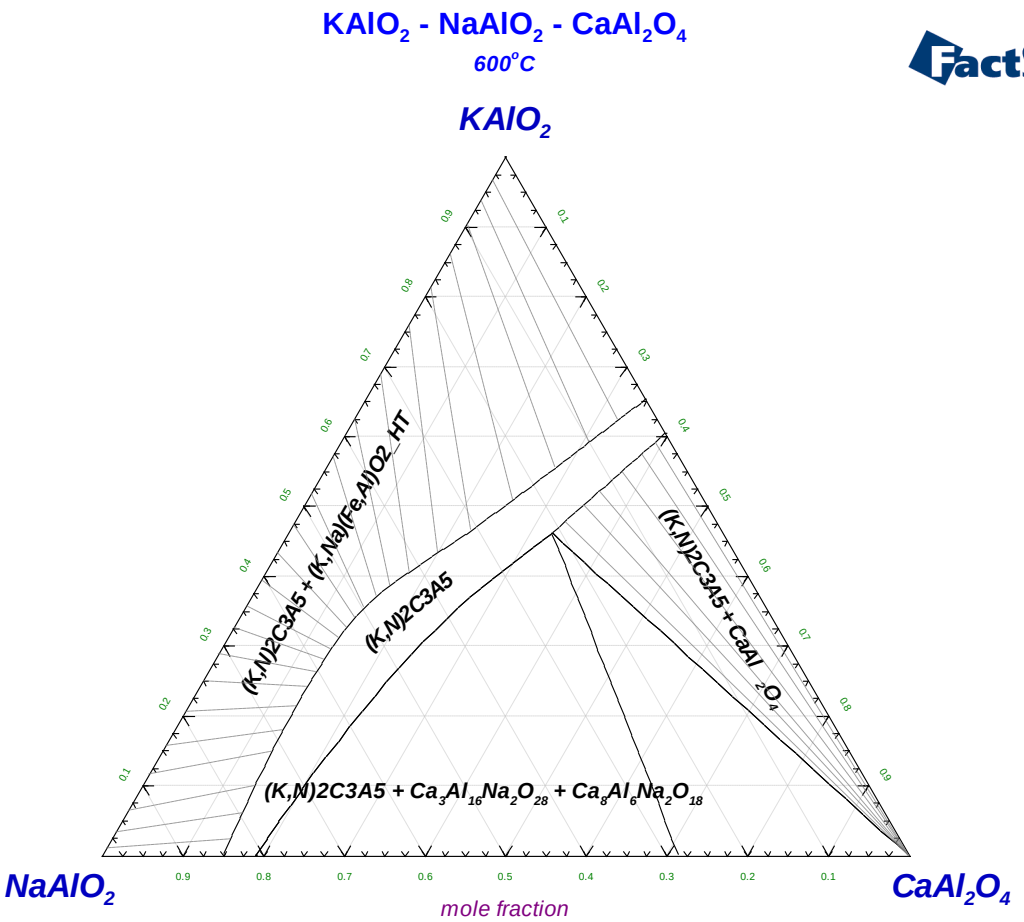
Intersections with slag	Mole fraction					Weight percent				
	A = TiO2, B = Ti2O3, C = V2O3					A = TiO2, B = Ti2O3, C = V2O3				
		X(A)	X(B)	X(C)	T(C)		W(A)	W(B)	W(C)	T(C)
1: M4O7 / M6O11 / Ti5O9	1:	0.79820	0.05251	0.14929	1841.83	1:	68.056	8.057	23.887	1841.83
2. M8O15 / Rutile / Ti20O39(s)	2:	0.81890	0.17751	0.00359	1815.21	2:	71.514	27.898	0.588	1815.21
3. CORUNDUM#1 / PSBROOKITE-TI3O5 / V3O5	3:	0.51476	0.43986	0.04538	1814.60	3:	36.992	56.888	6.120	1814.60
4. M4O7 / PSBROOKITE-TI3O5 / V3O5	4:	0.57383	0.39532	0.03085	1809.51	4:	42.722	52.968	4.310	1809.51
5. M4O7 / M6O11 / V5O9	5:	0.74656	0.00468	0.24876	1776.47	5:	61.102	0.689	38.209	1776.47
6. M8O15 / Ti10O19(s) / Ti20O39(s)	6:	0.77307	0.22690	0.00002	1772.92	6:	65.433	34.563	0.004	1773.02

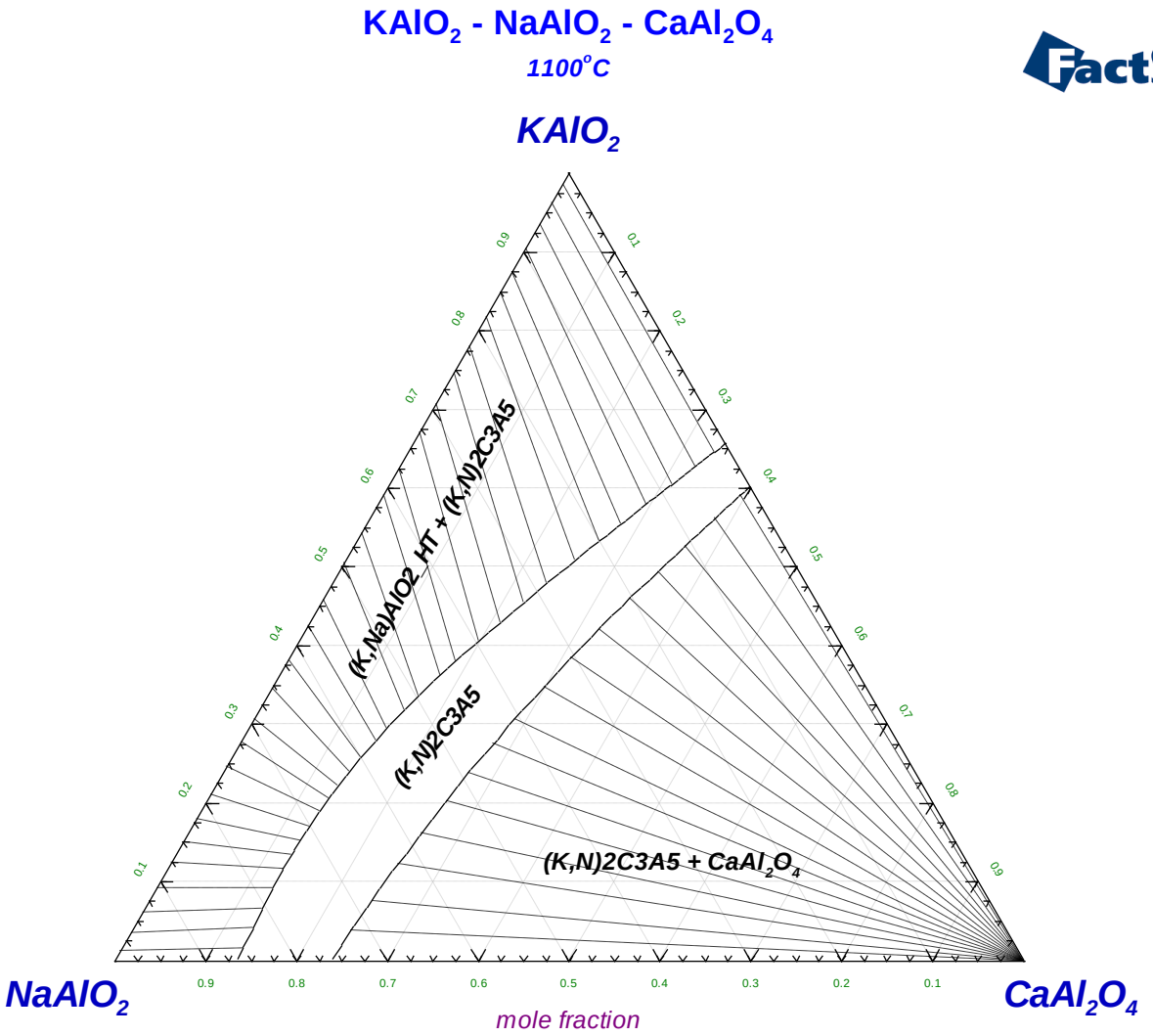
Quaternary systems:

Mole fraction,
Isopleth Uvarovite-Grossularite

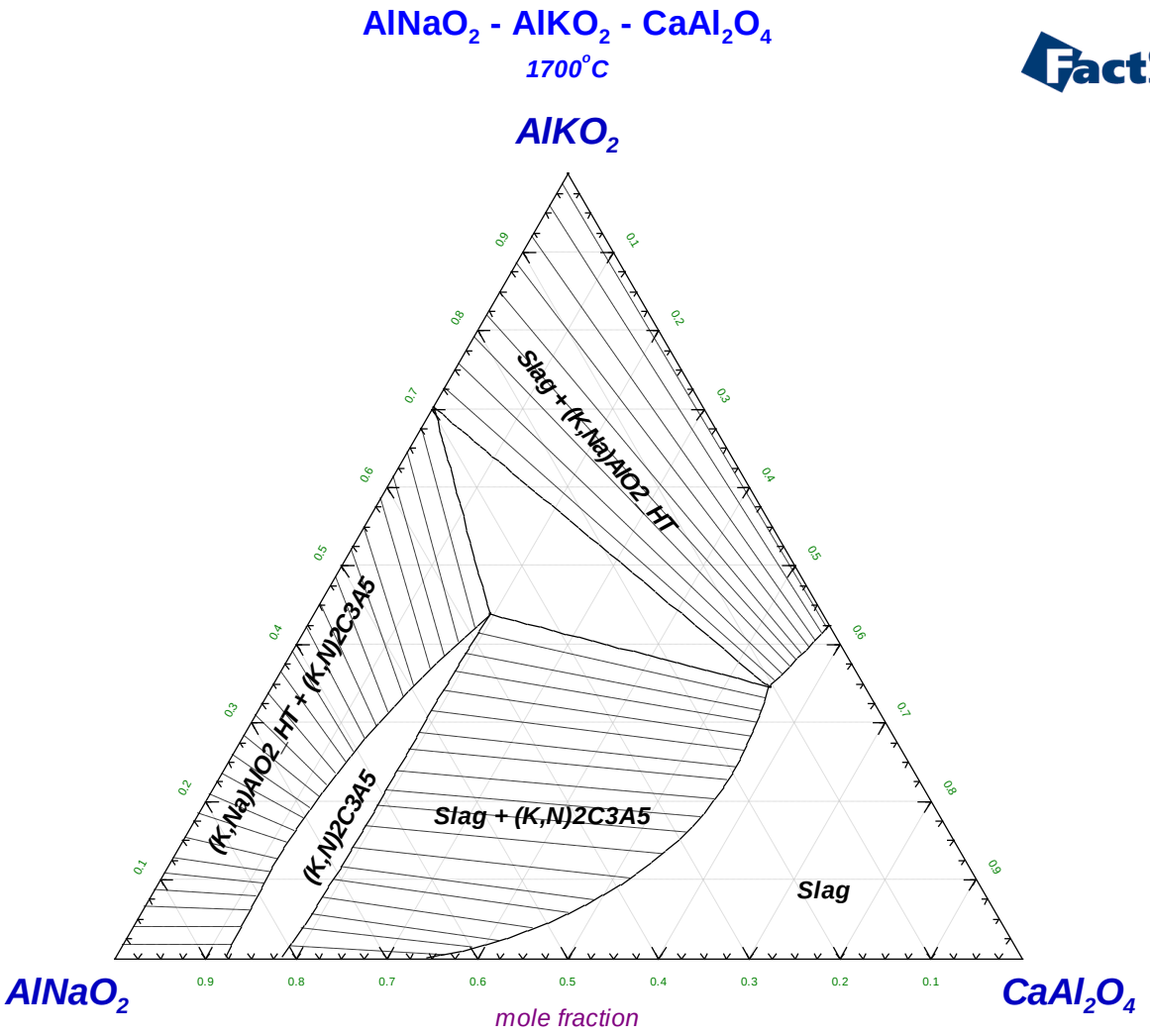


Mole fraction 600°C,
Isothermischer Schnitt im AlKO2-AlNaO2-CaAl2O4 System

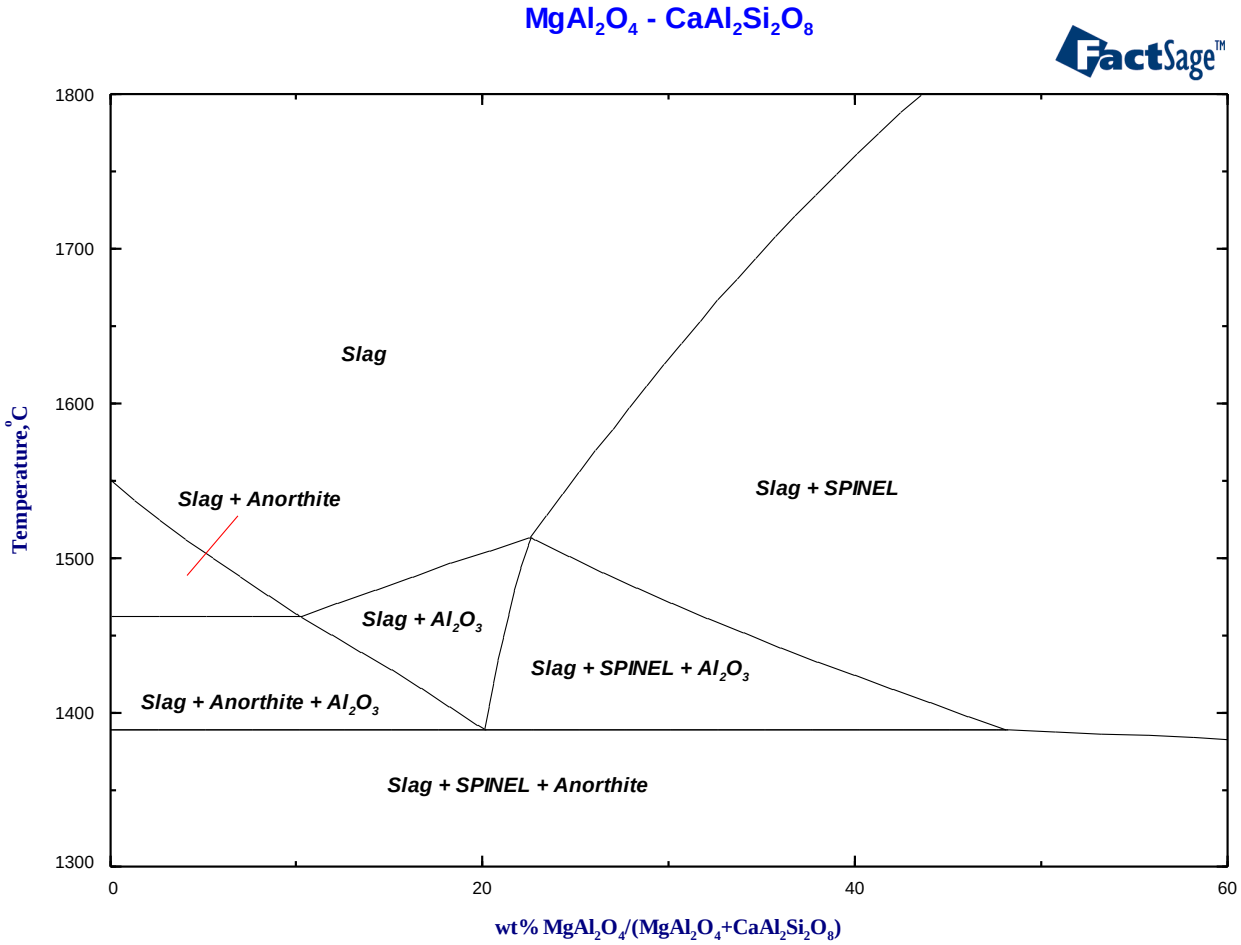



KAlO2 - NaAlO2 - CaAl2O4
1100°C
KAlO2
(K,Na)AlO2_HT + (K,N)2C3A5
(K,N)2C3A5
(K,N)2C3A5 + CaAl2O4
NaAlO2
CaAl2O4
mole fraction

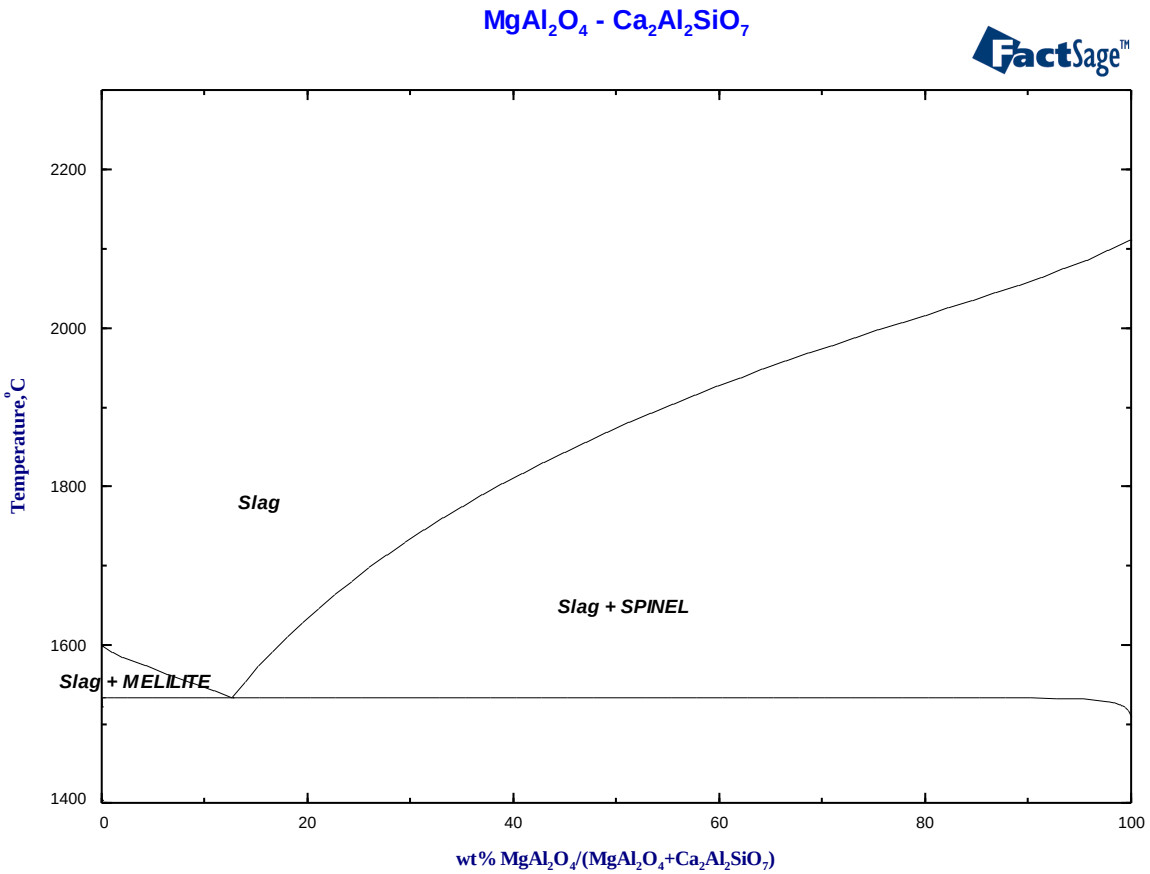
Mole fraction 1700°C,
Isothermischer Schnitt im AlKO2-AlNaO2-CaAl2O4 System



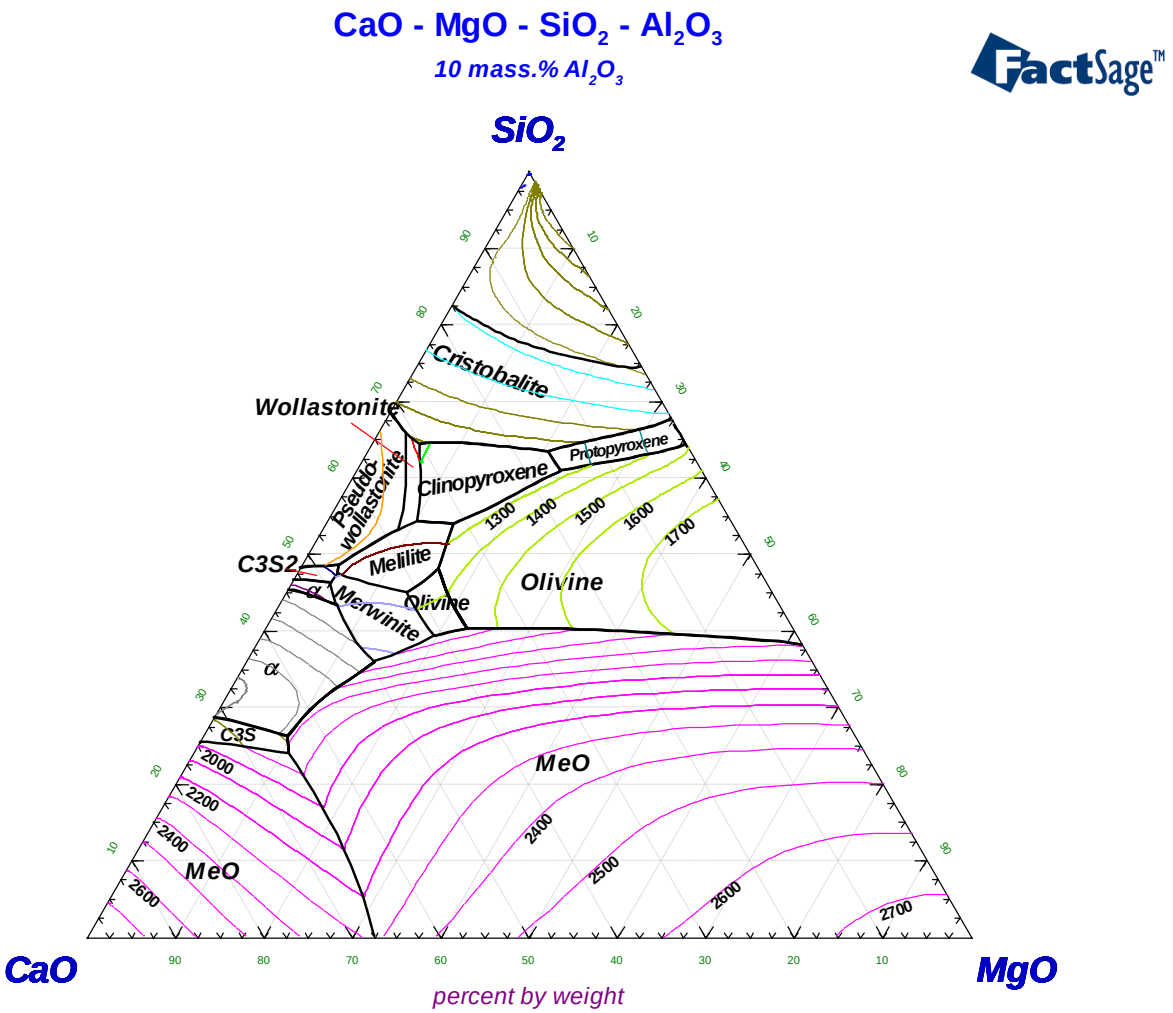
Weight percent,
Isopleth MgAl2O4-CaAl2Si2O7



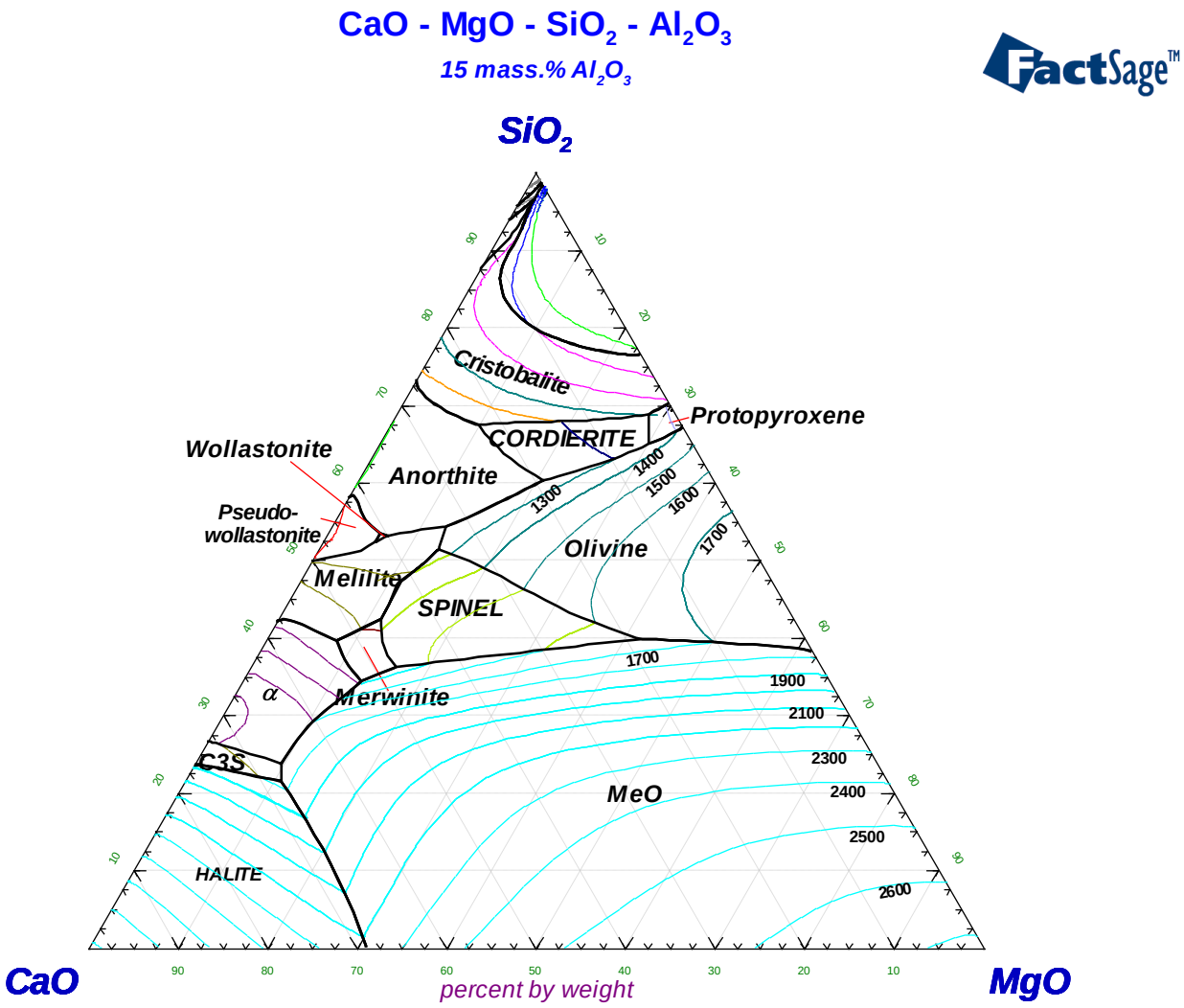
Weight percent,
Isopleth MgAl2O4-Ca2Al2SiO7



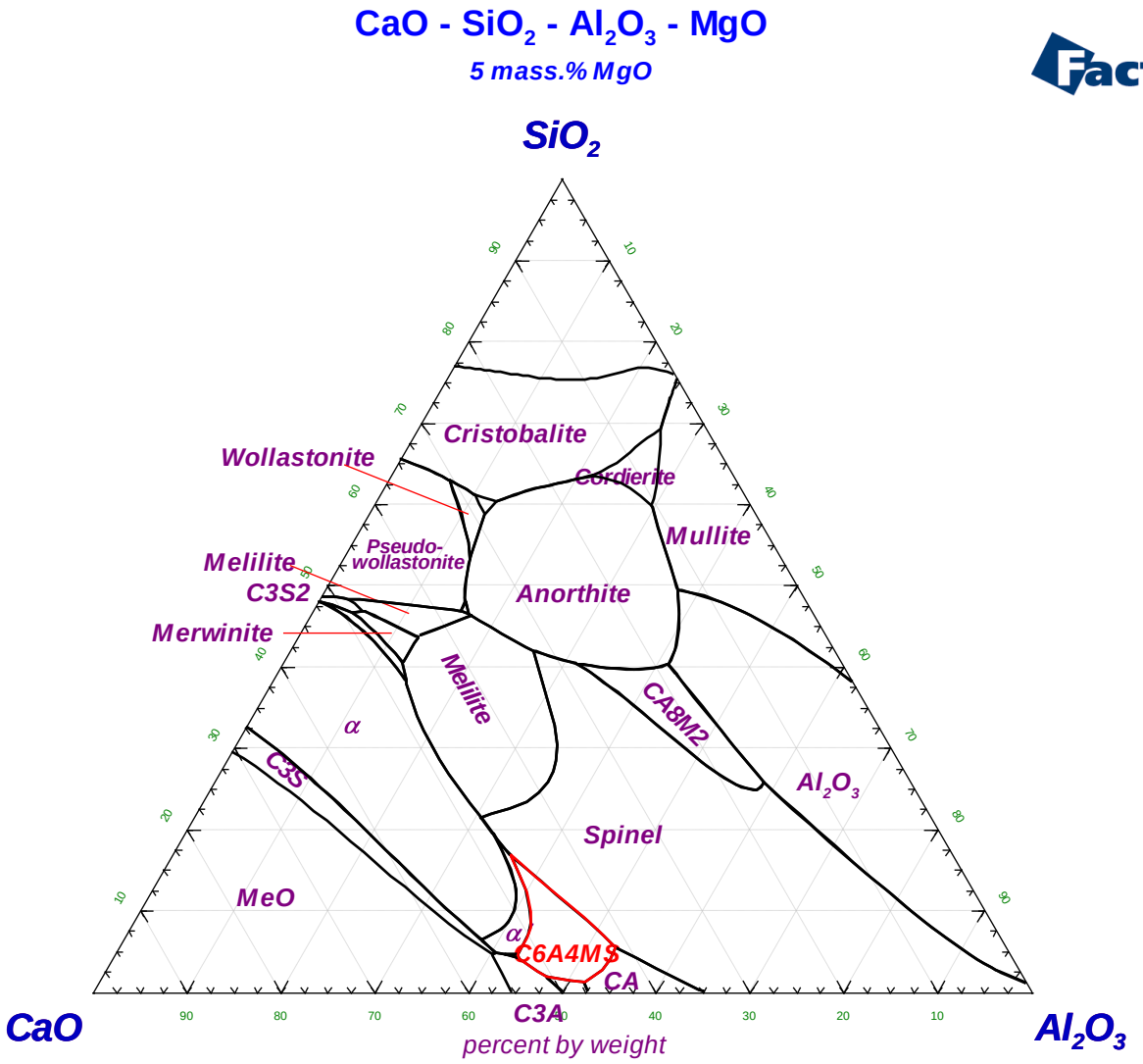
Weight percent,
Liquidusoberfläche bei 10 mass.% Al2O3



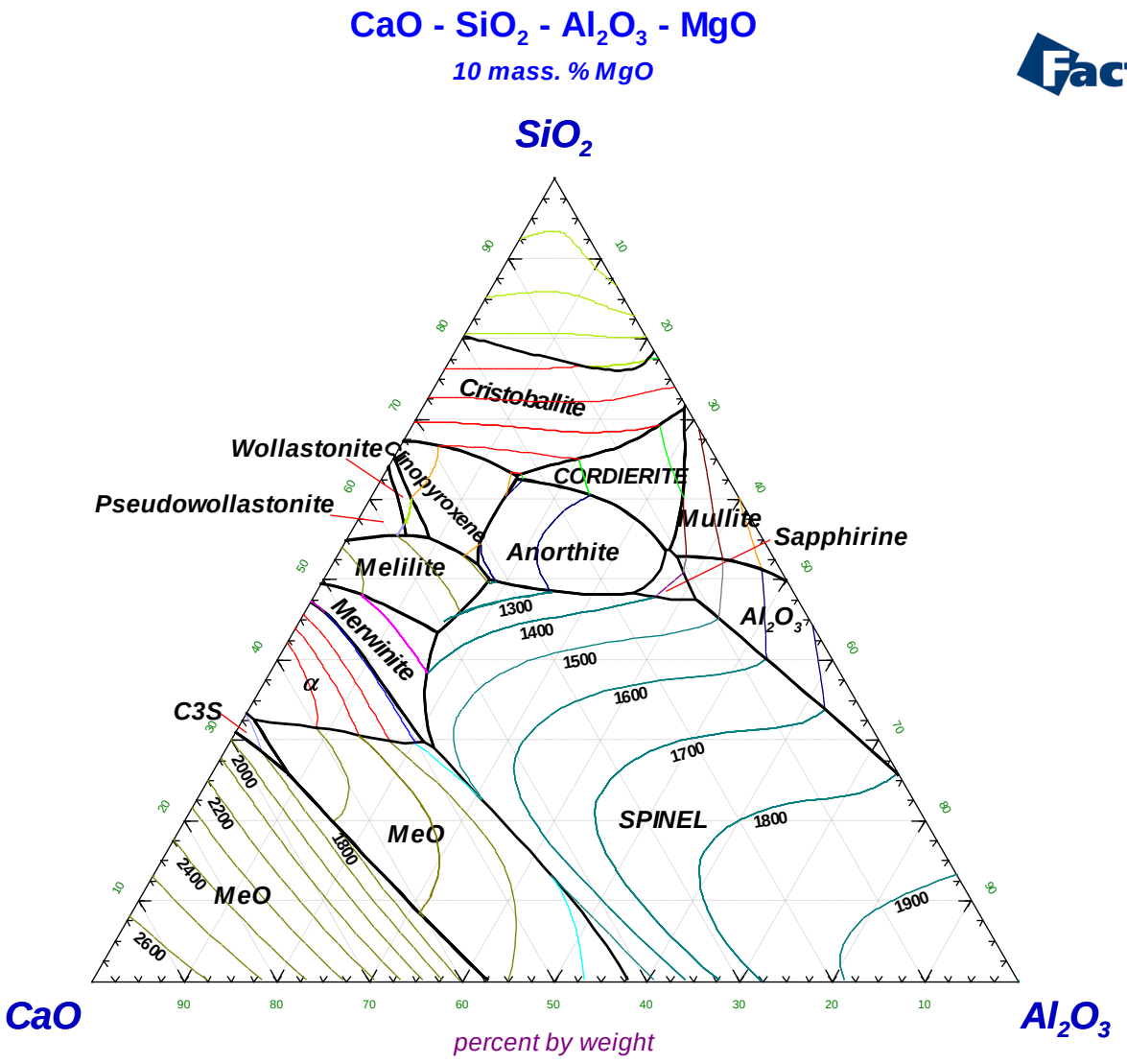
Weight percent,
Liquidusoberfläche bei 15 mass.% Al2O3



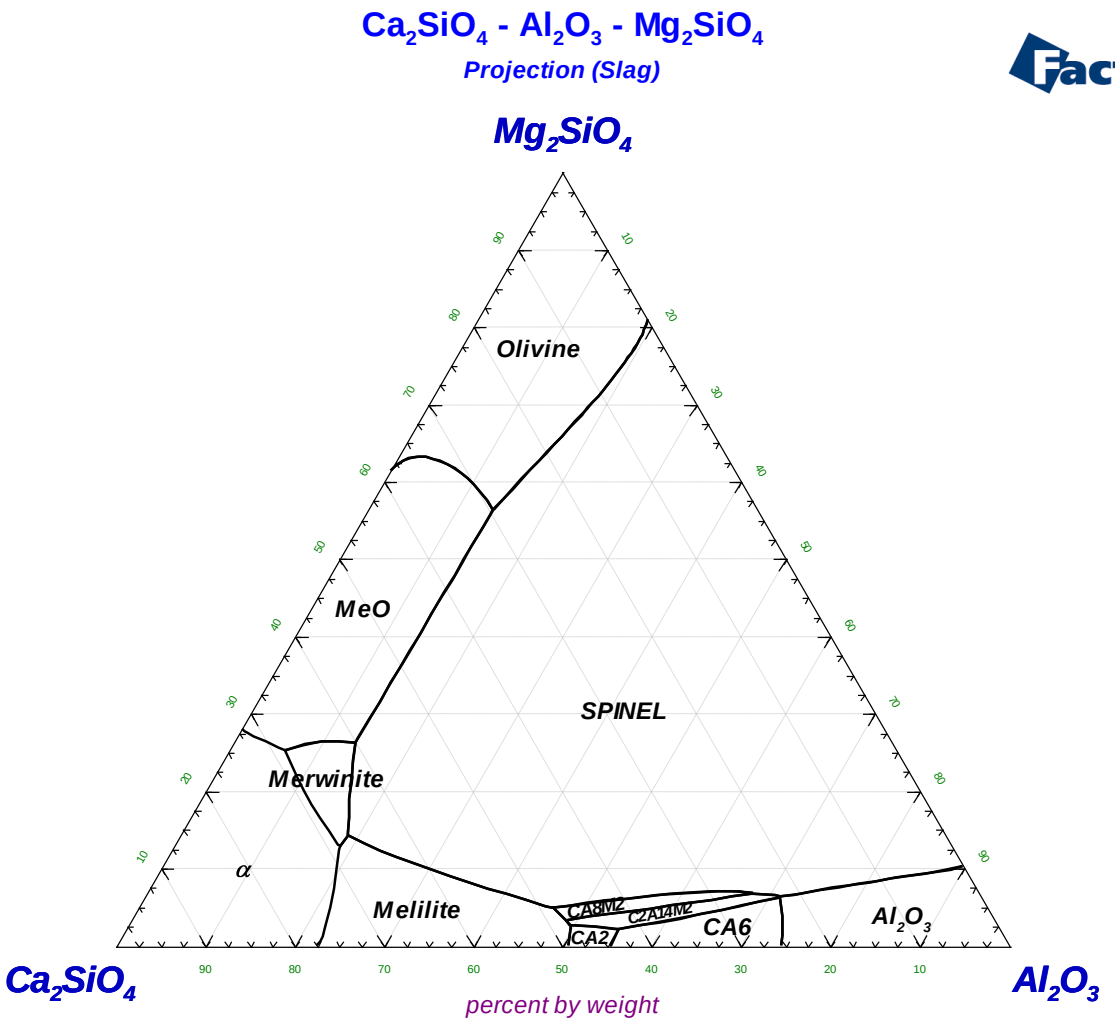
Weight percent,
Liquidusoberfläche bei 5 mass.% MgO



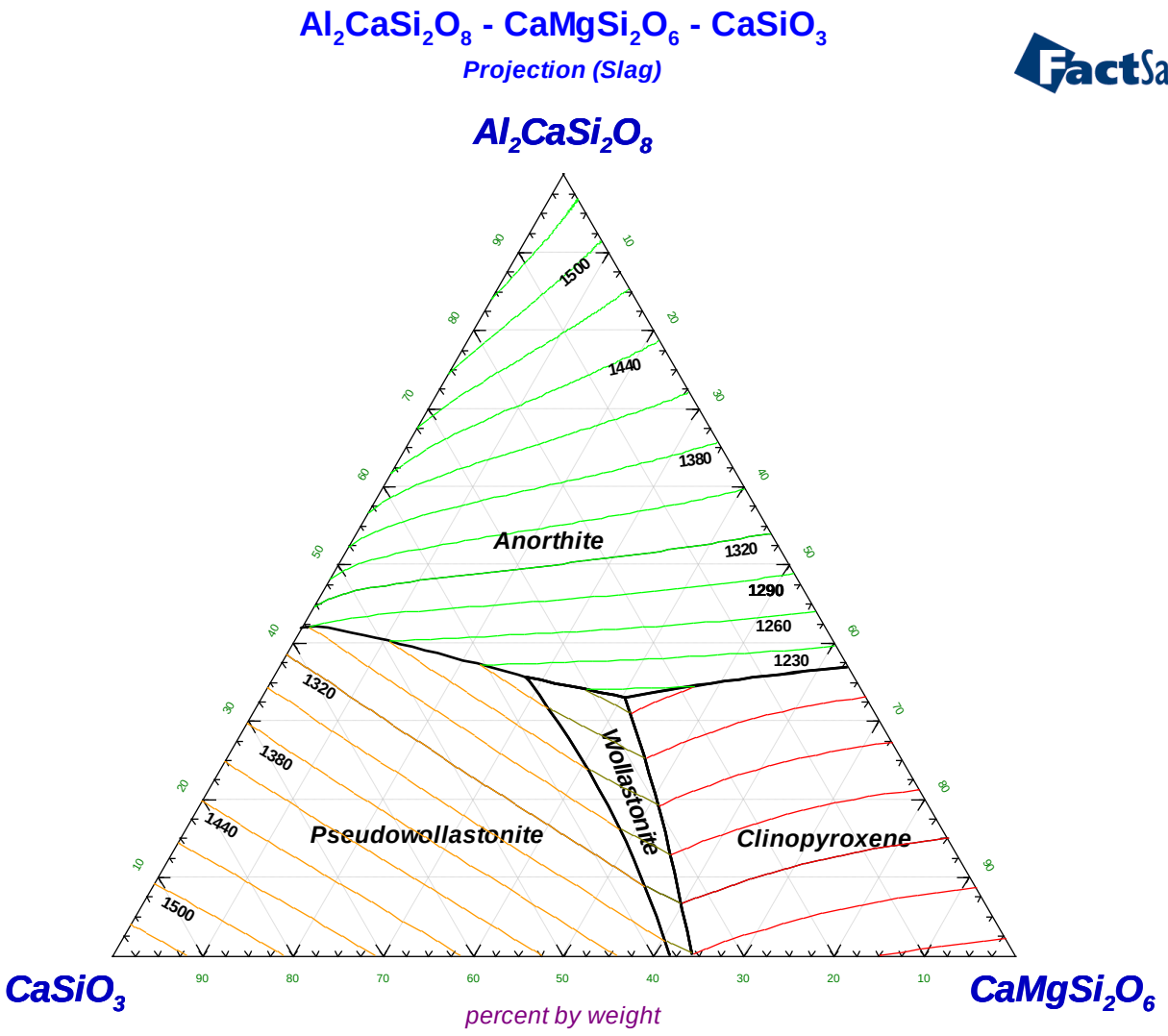
Weight percent,
Liquidusoberfläche bei 10 mass.% MgO



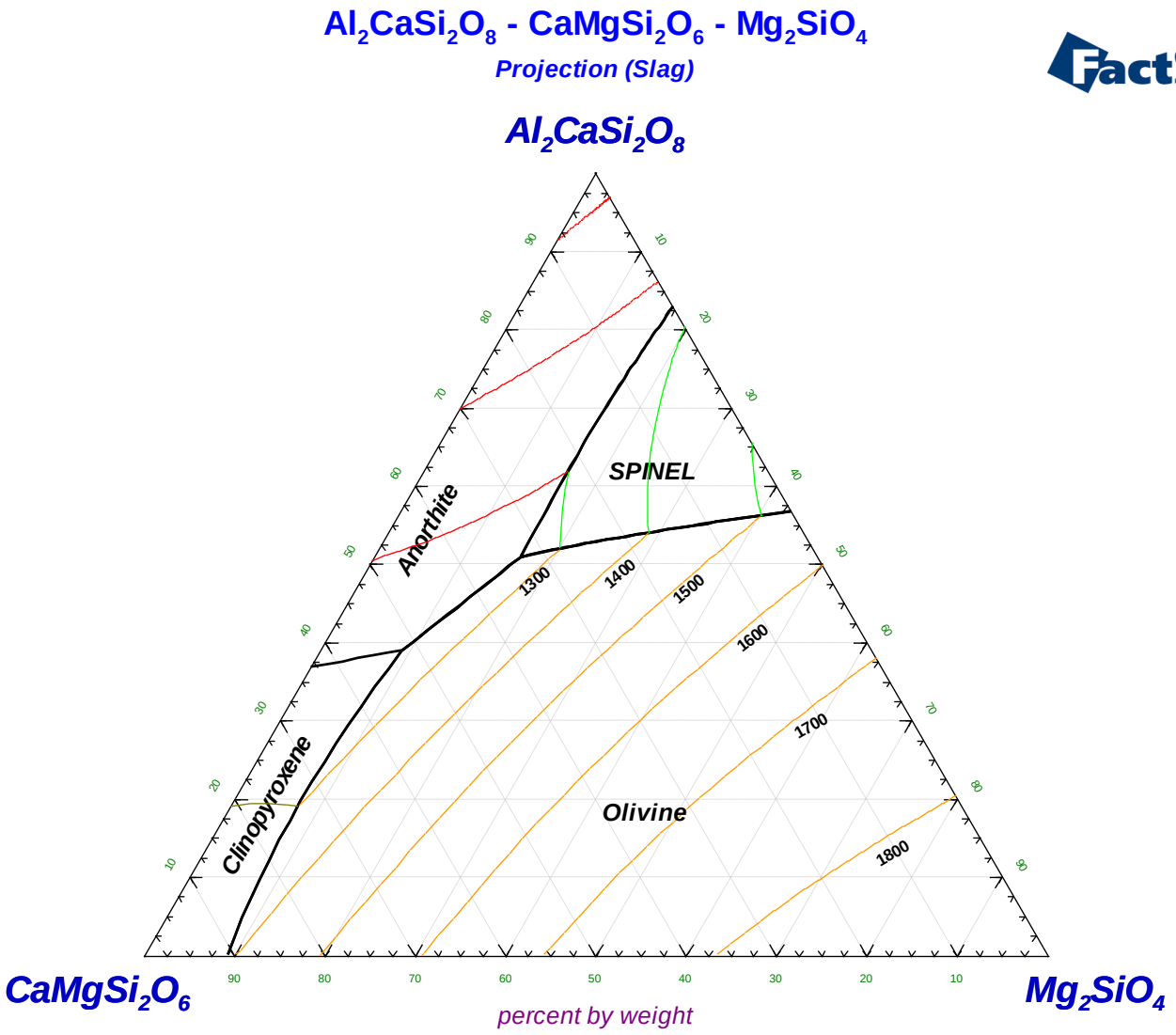
Weight percent,
Liquidusoberfläche im Ca2SiO4-Al2O3-Mg2SiO4 System



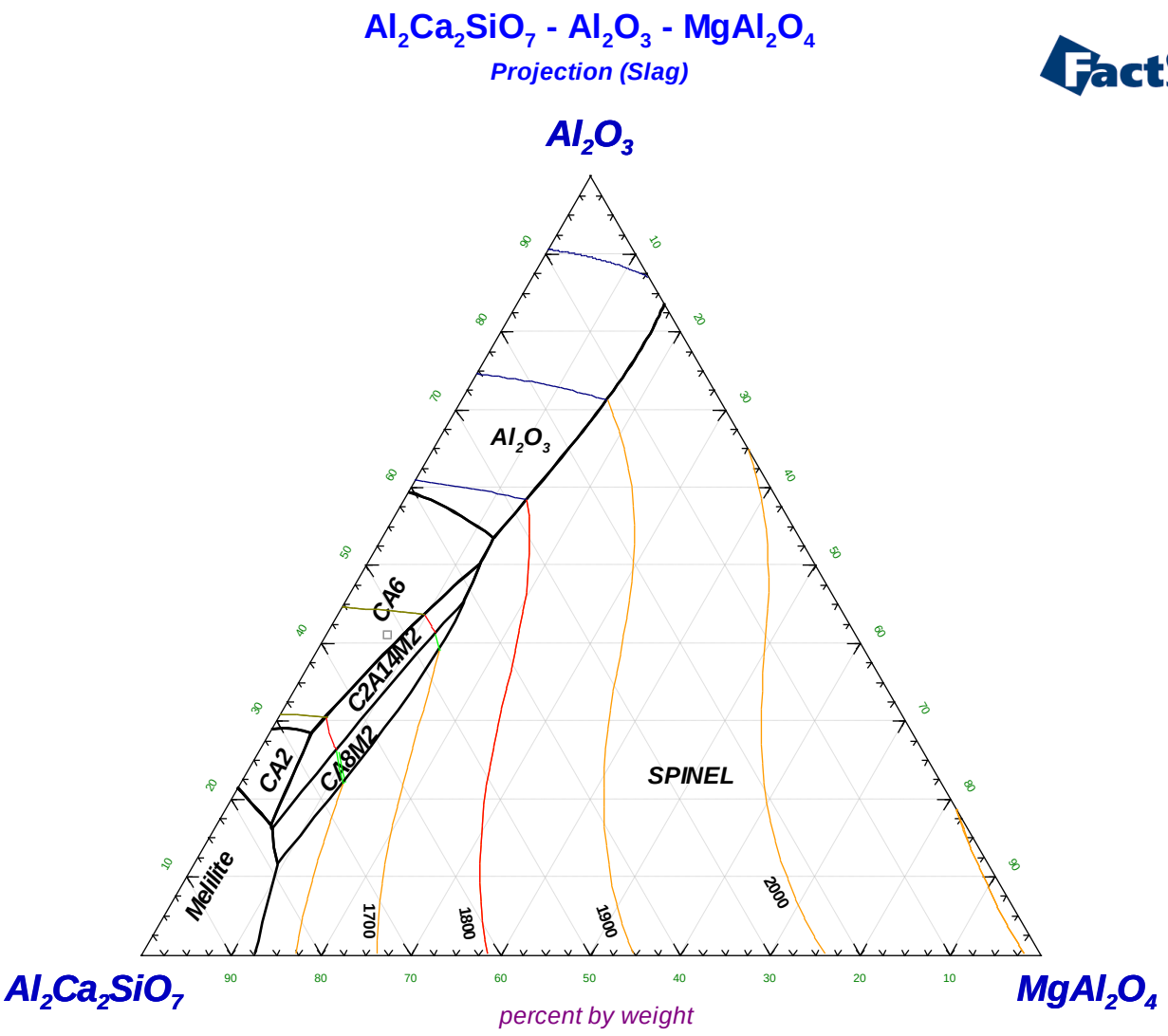
Weight percent,
Liquidusoberfläche im Al2CaSi2O8-CaMgSi2O6-CaSiO3 System



Weight percent,
Liquidusoberfläche im Al2CaSi2O8-CaMgSi2O6-Mg2SiO4 System

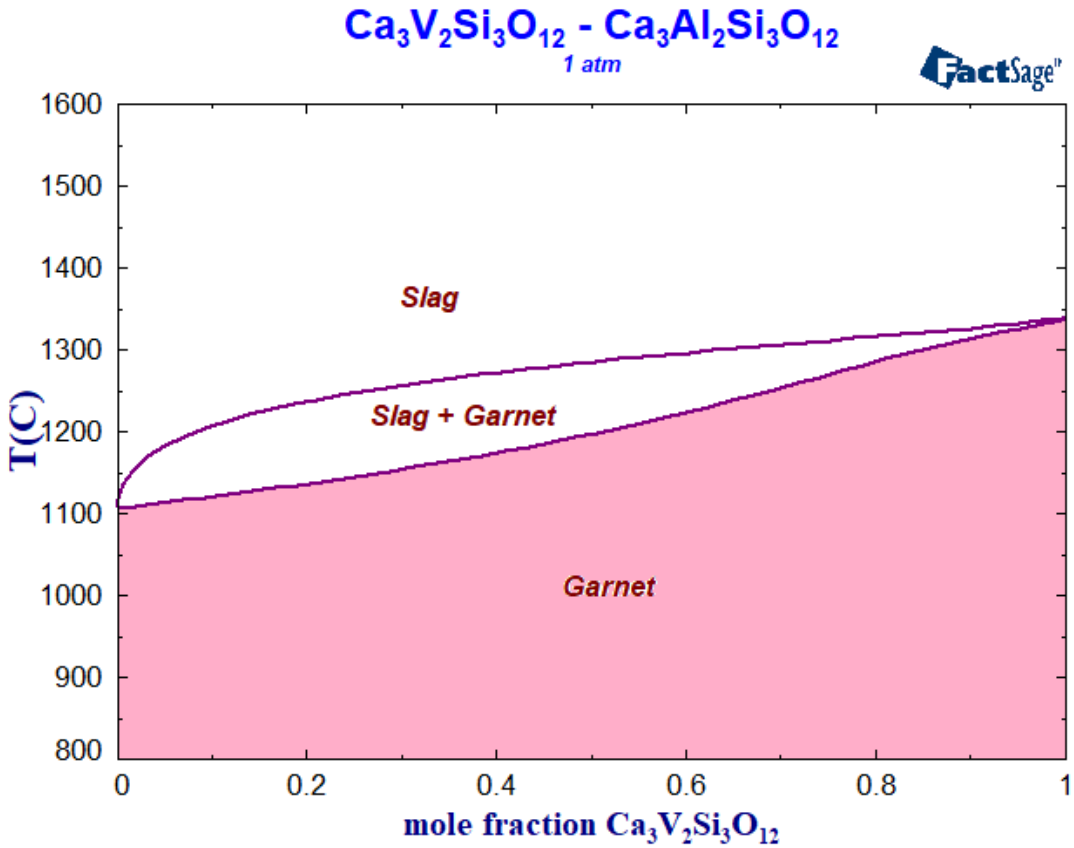


Weight percent,
Liquidusoberfläche im Al2O3-Al2Ca2SiO7-MgAl2O4 System



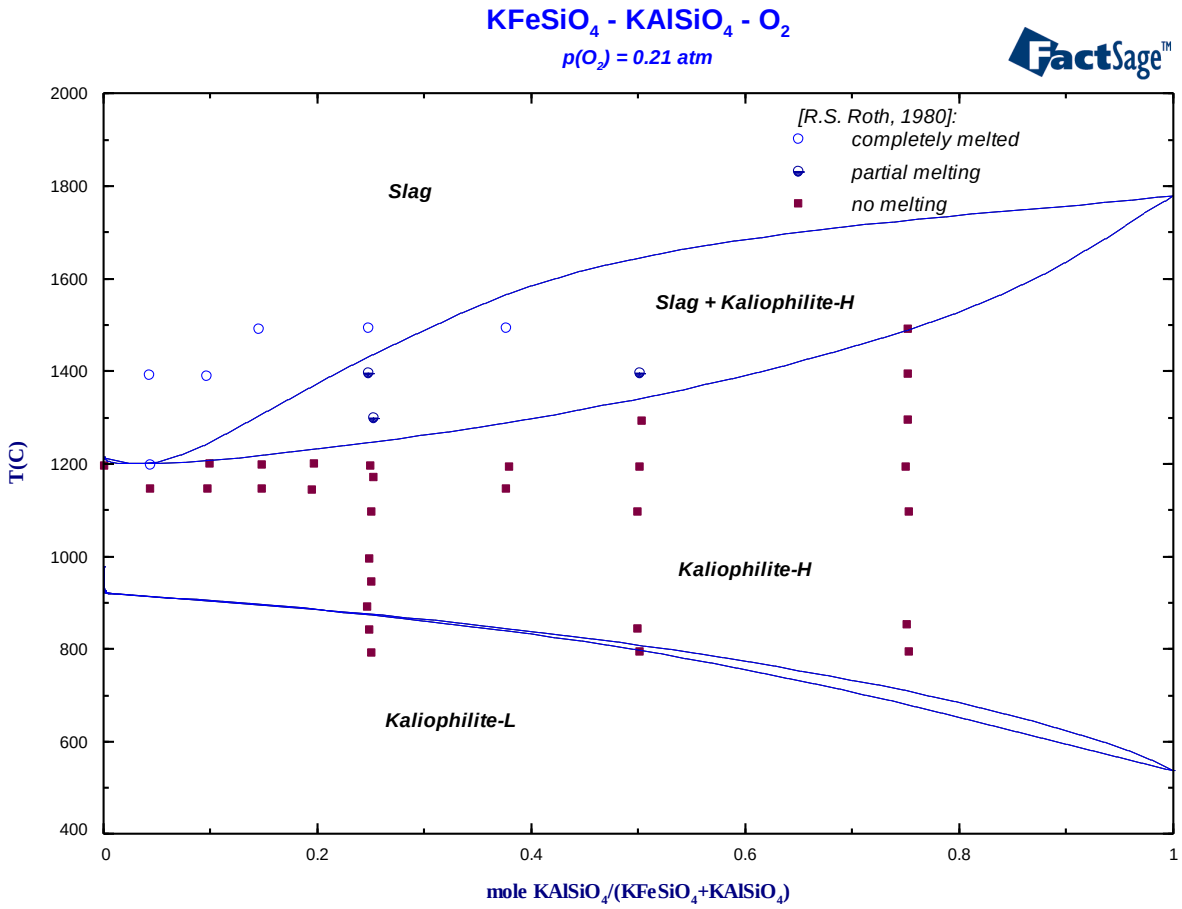
Al2O3-CaO-V2O3-SiO2,

Mole fraction, Isopleth Ca3V2Si3O12-Ca3Al2Si3O12

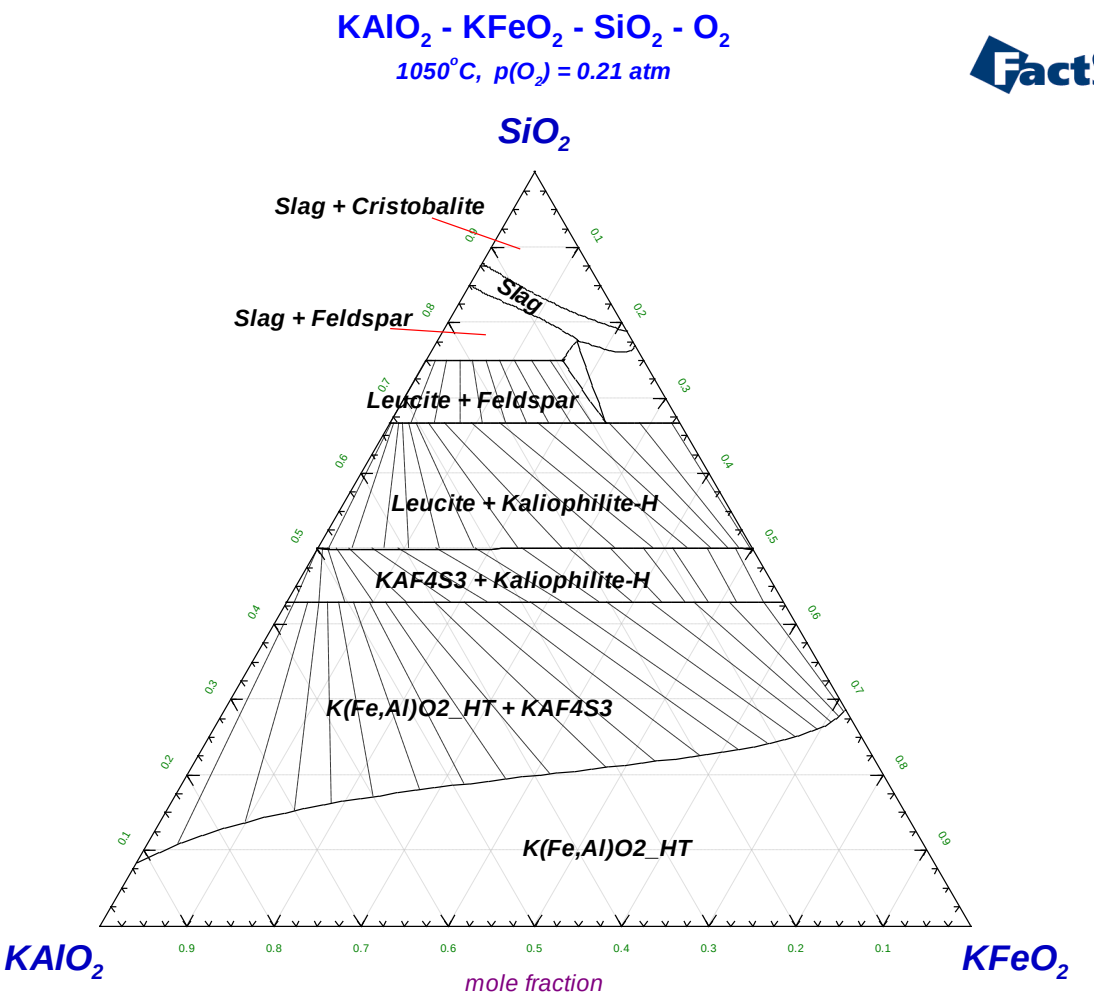


$Ca_3Al_2Si_3O_{12}$	Grossularite	**Garnet**
$Ca_3Cr_2Si_3O_{12}$	Uvarovite	
$Ca_3Fe_2Si_3O_{12}$	Andradite	
$Ca_3V_2Si_3O_{12}$	Goldmanite	

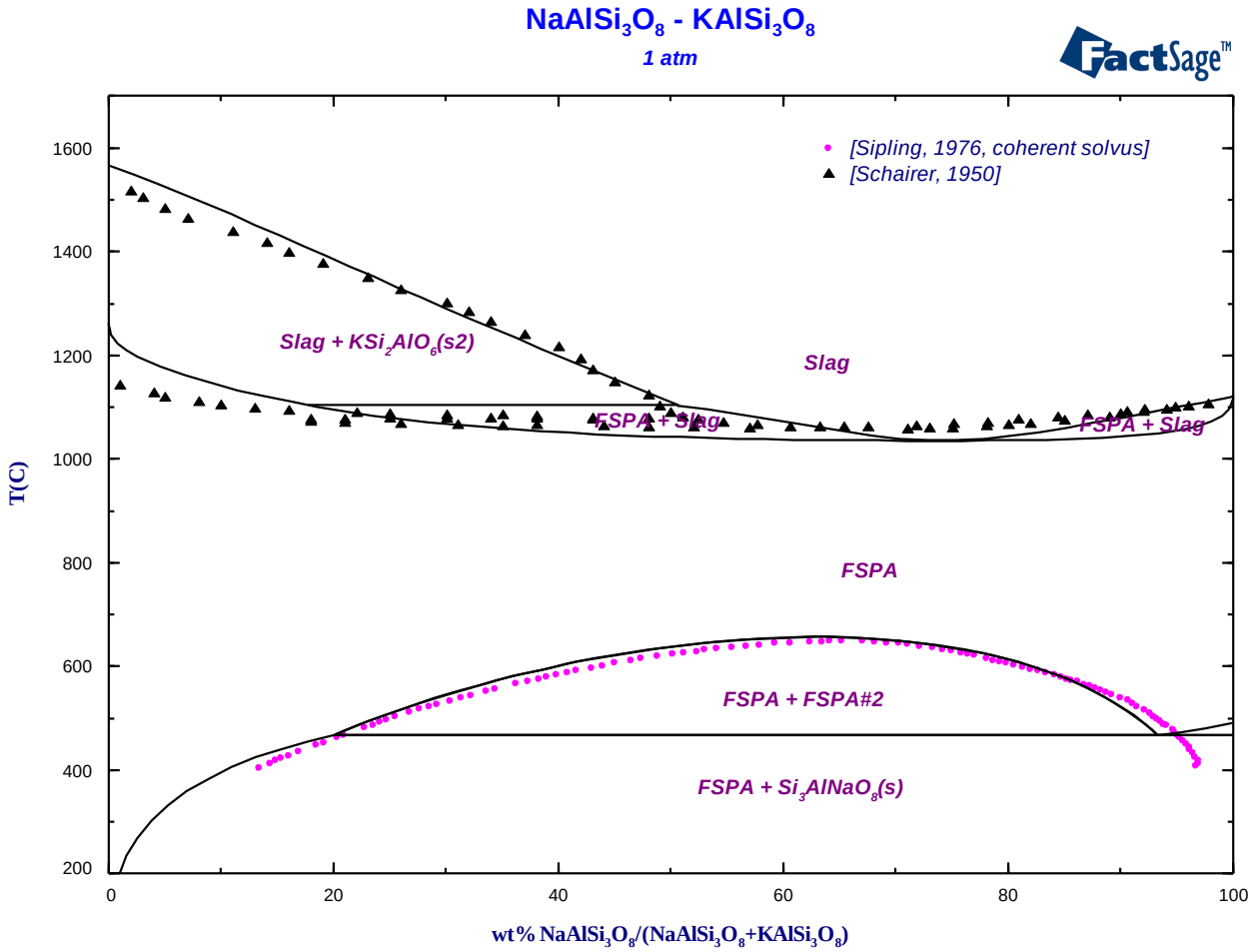
Mole fraction,
Isopleth KFeSiO4-KAlSiO4



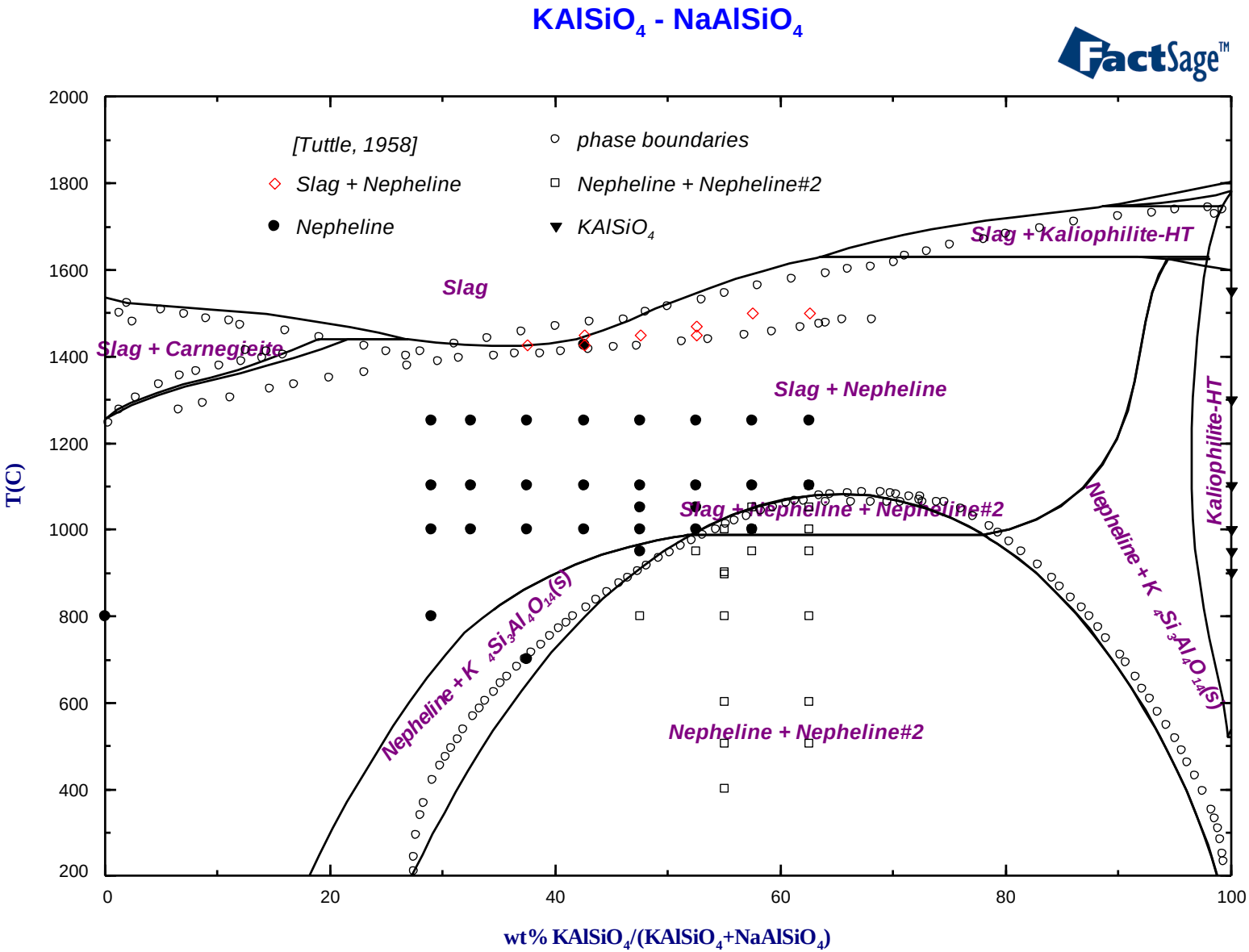
Mole fraction, 1050°C



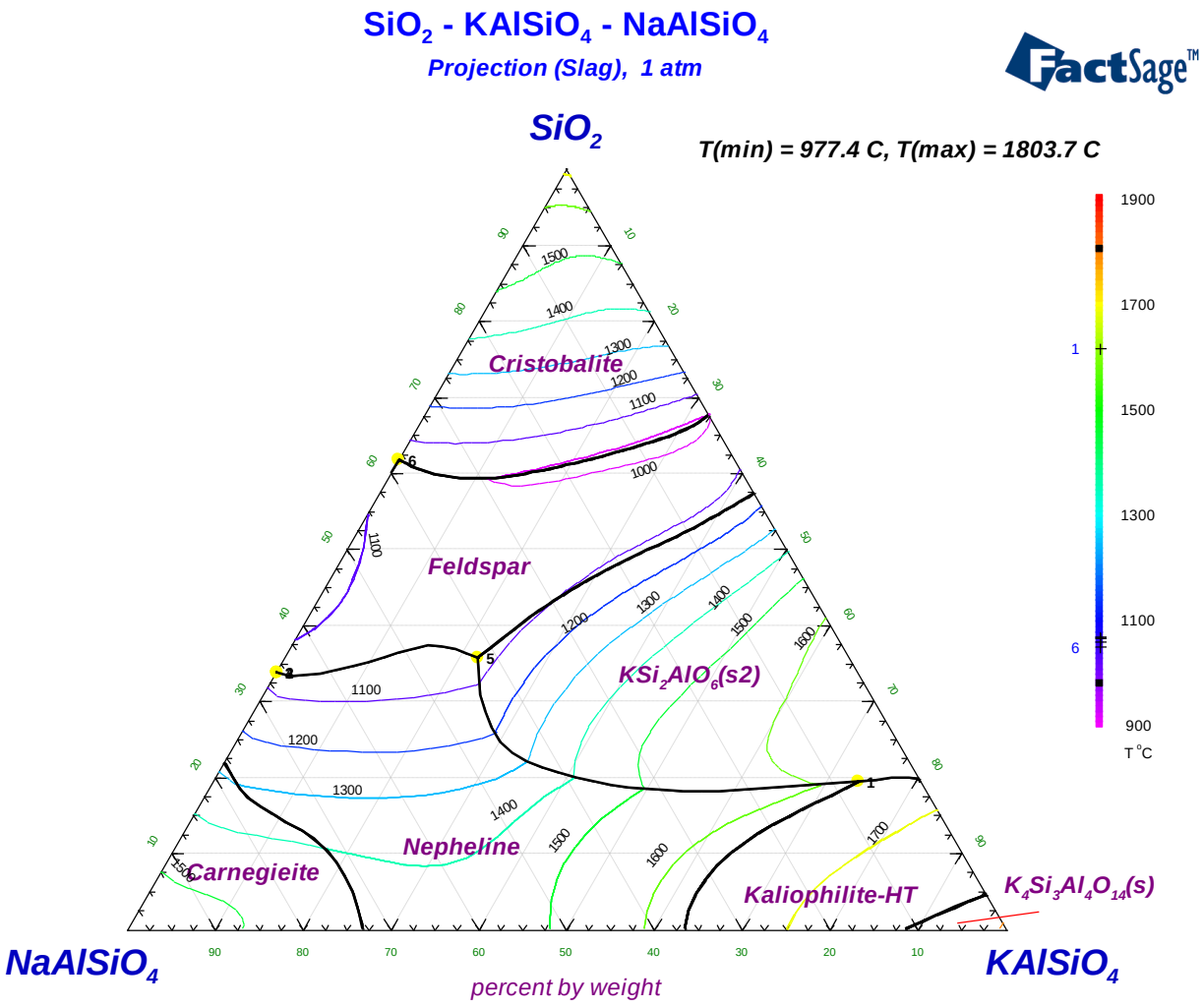
Weight percent,
Isopleth AlNaSi3O8-AlKSi3O8



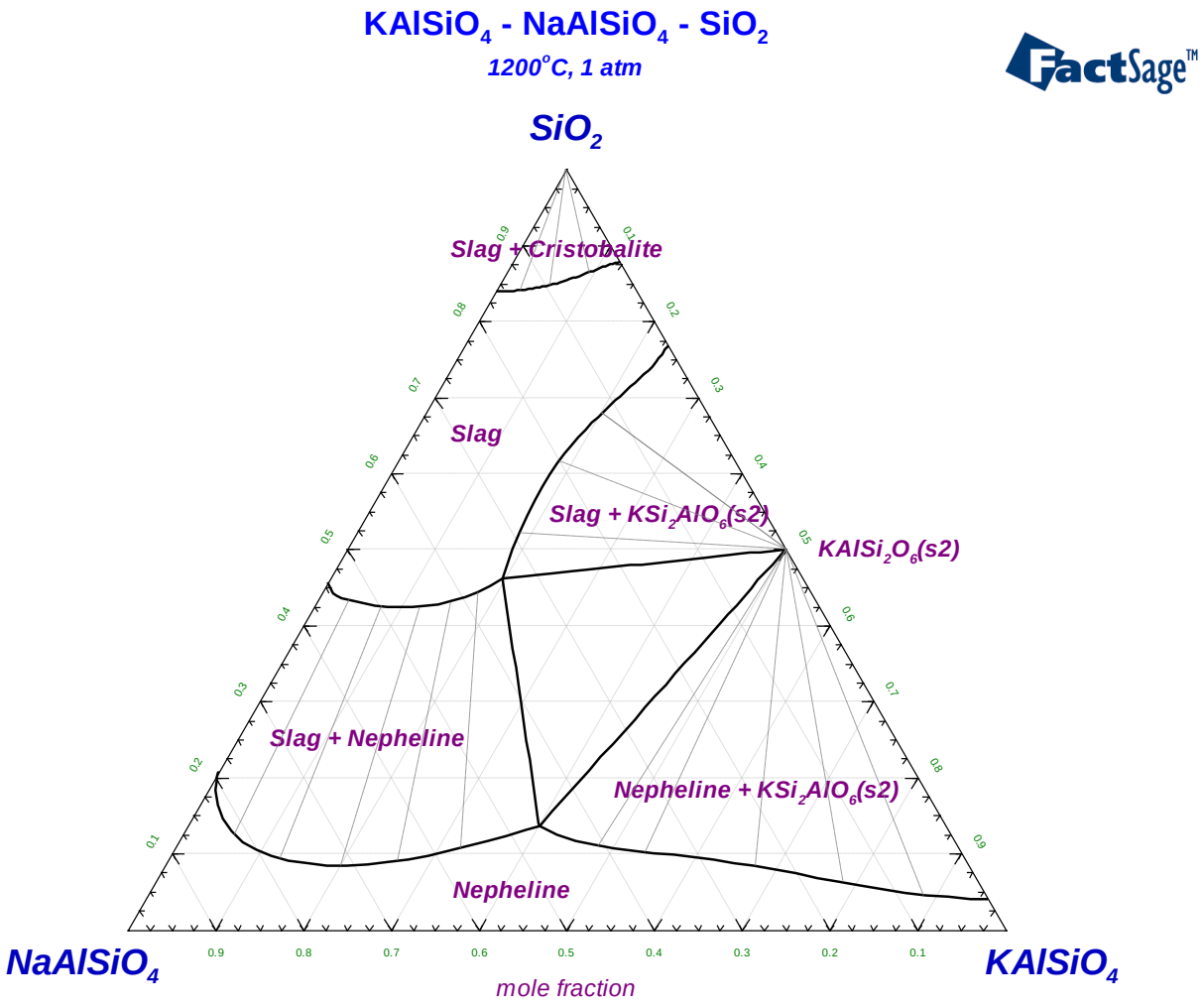
Weight percent,
Isopleth NaAlSiO4-KAlSiO4,
(proposed calculation)



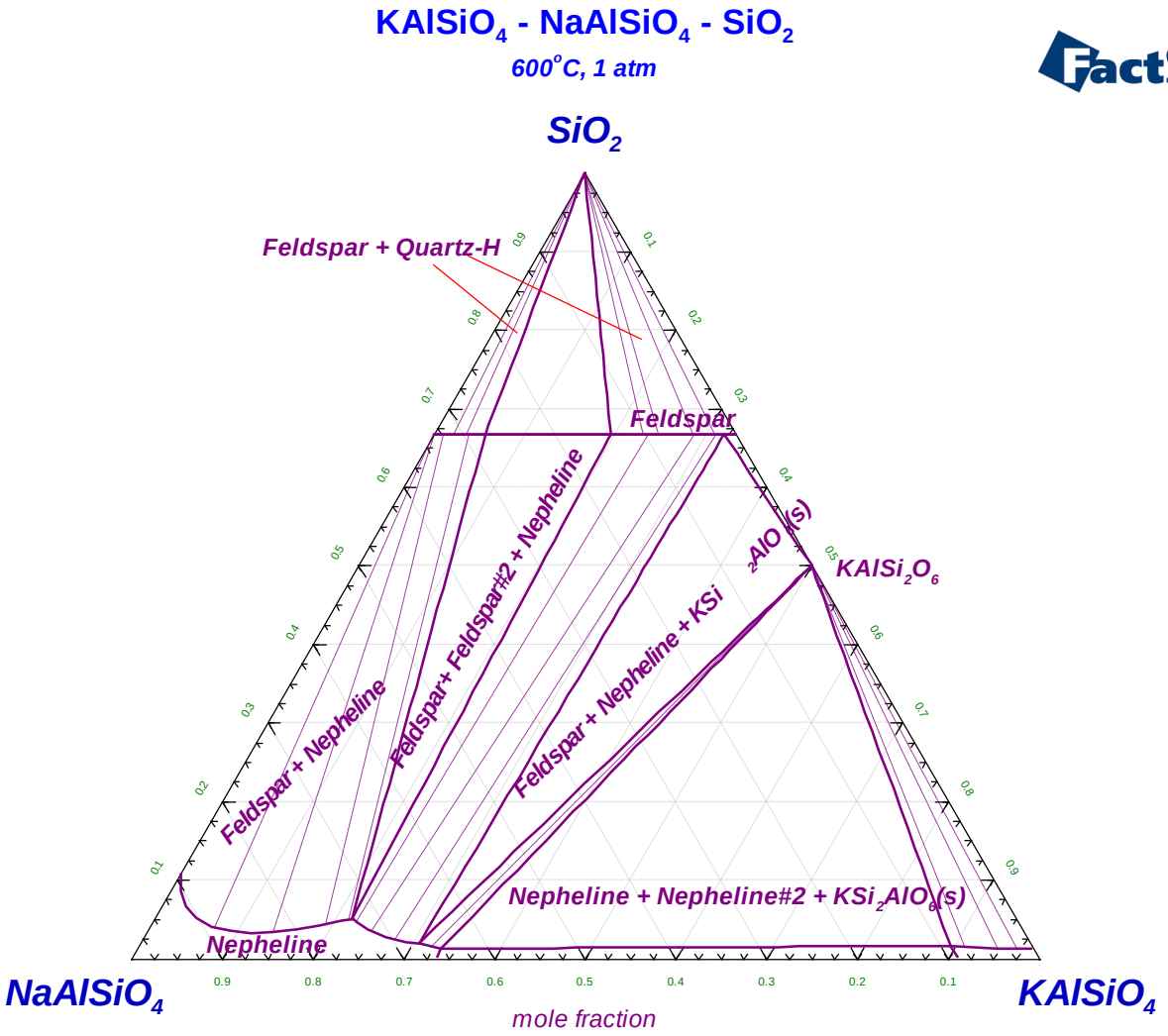
Weight percent,
Liquidussurface NaAlSiO4-KAlSiO4-SiO2



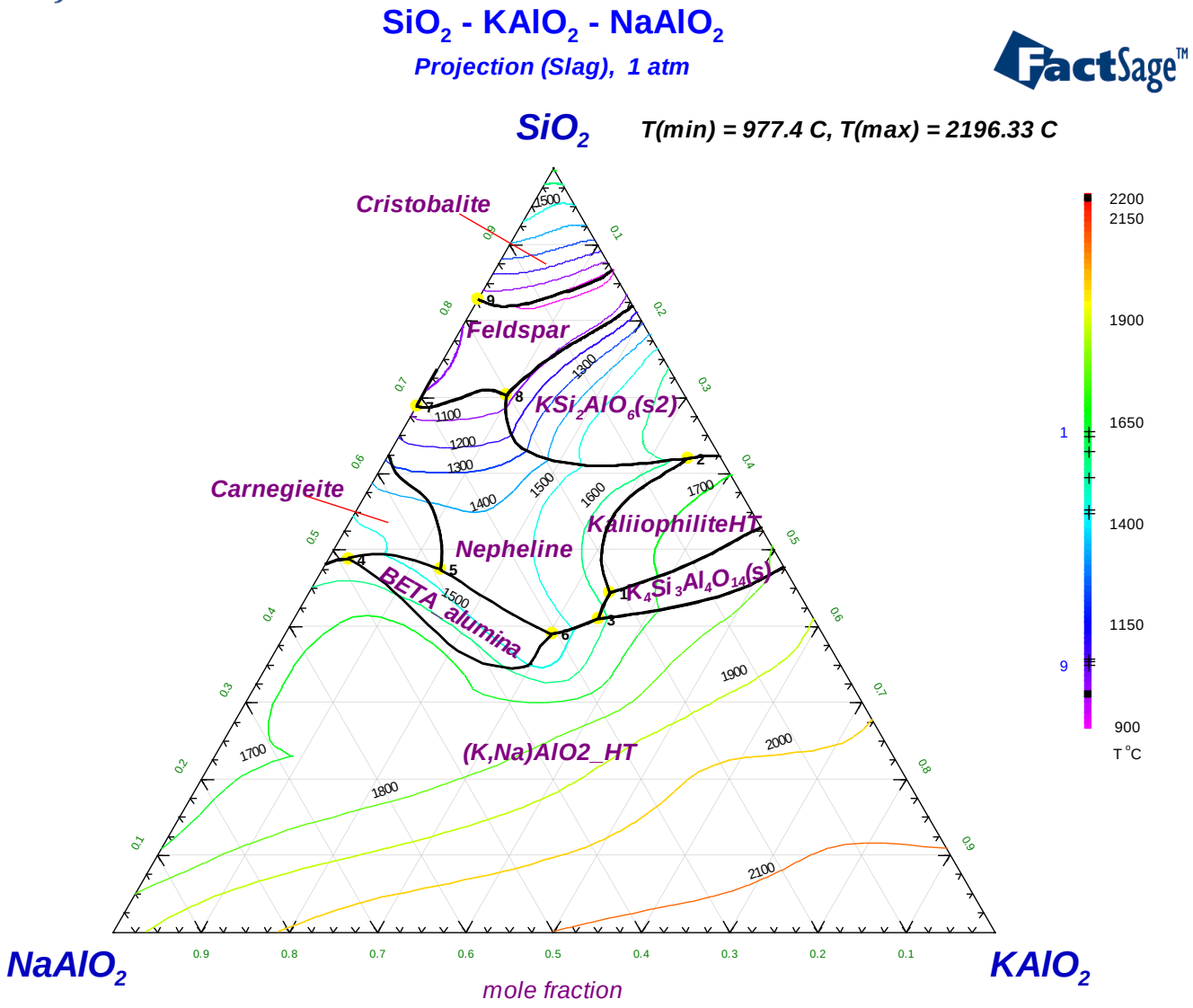
Mole fraction, 1200°C in NaAlSiO4-KAlSiO4-SiO2 (proposed calculation)



Mole fraction, 600°C in NaAlSiO4-KAlSiO4-SiO2 (proposed calculation)

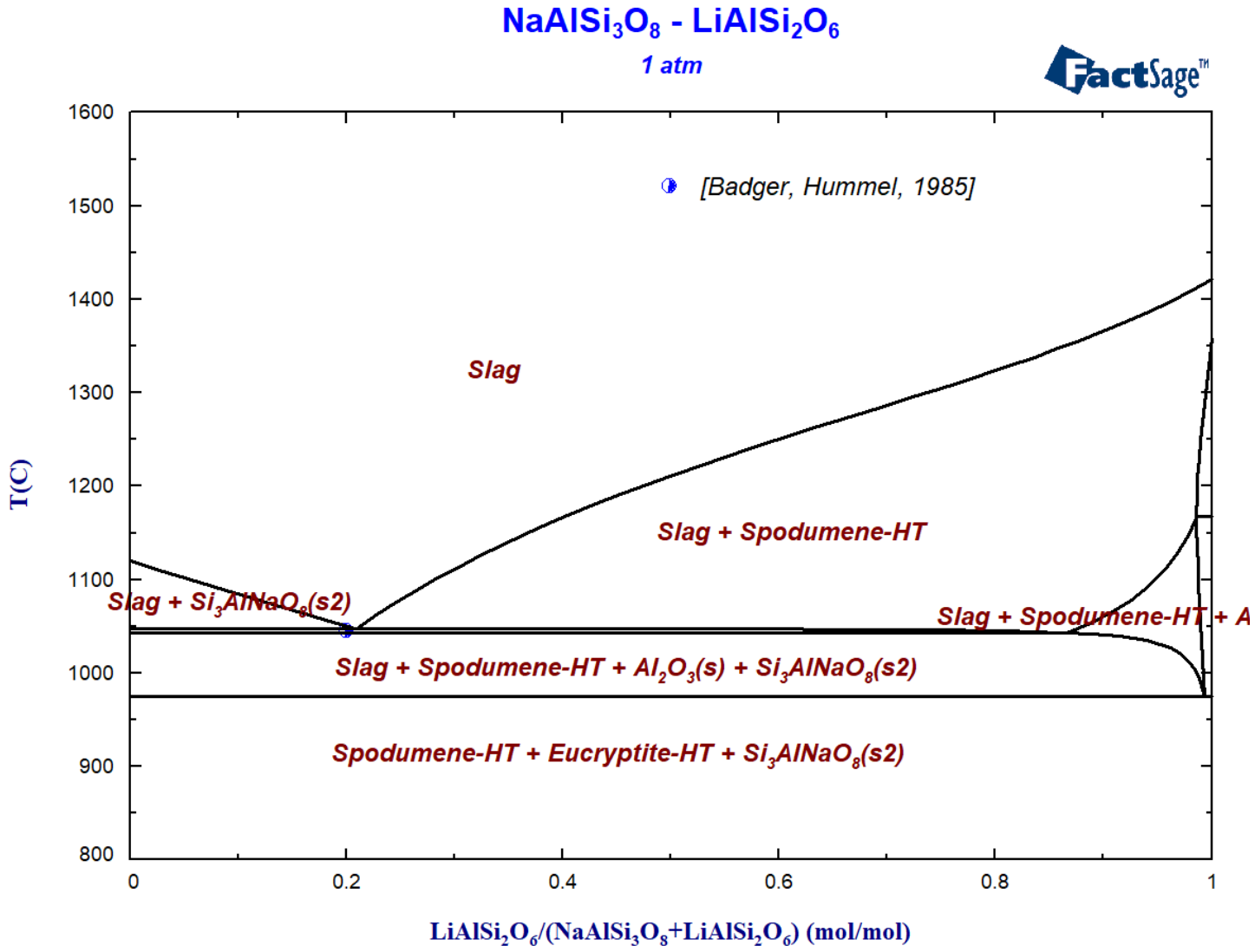


Mole fraction,
Liquidussurface NaAlSiO4-KAlSiO4-SiO2
(proposed calculation)

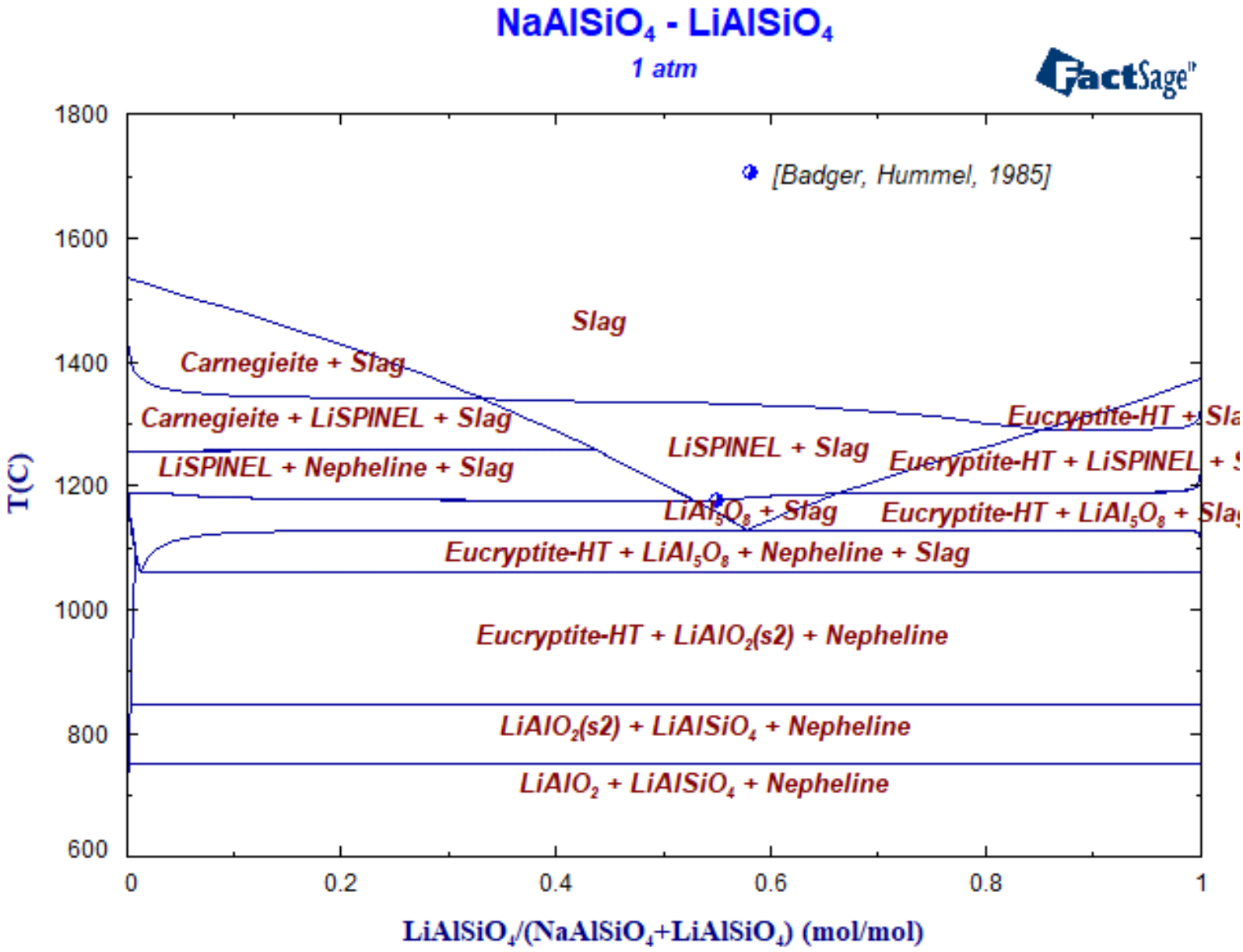


Al2O3-Li2O-Na2O-SiO2,

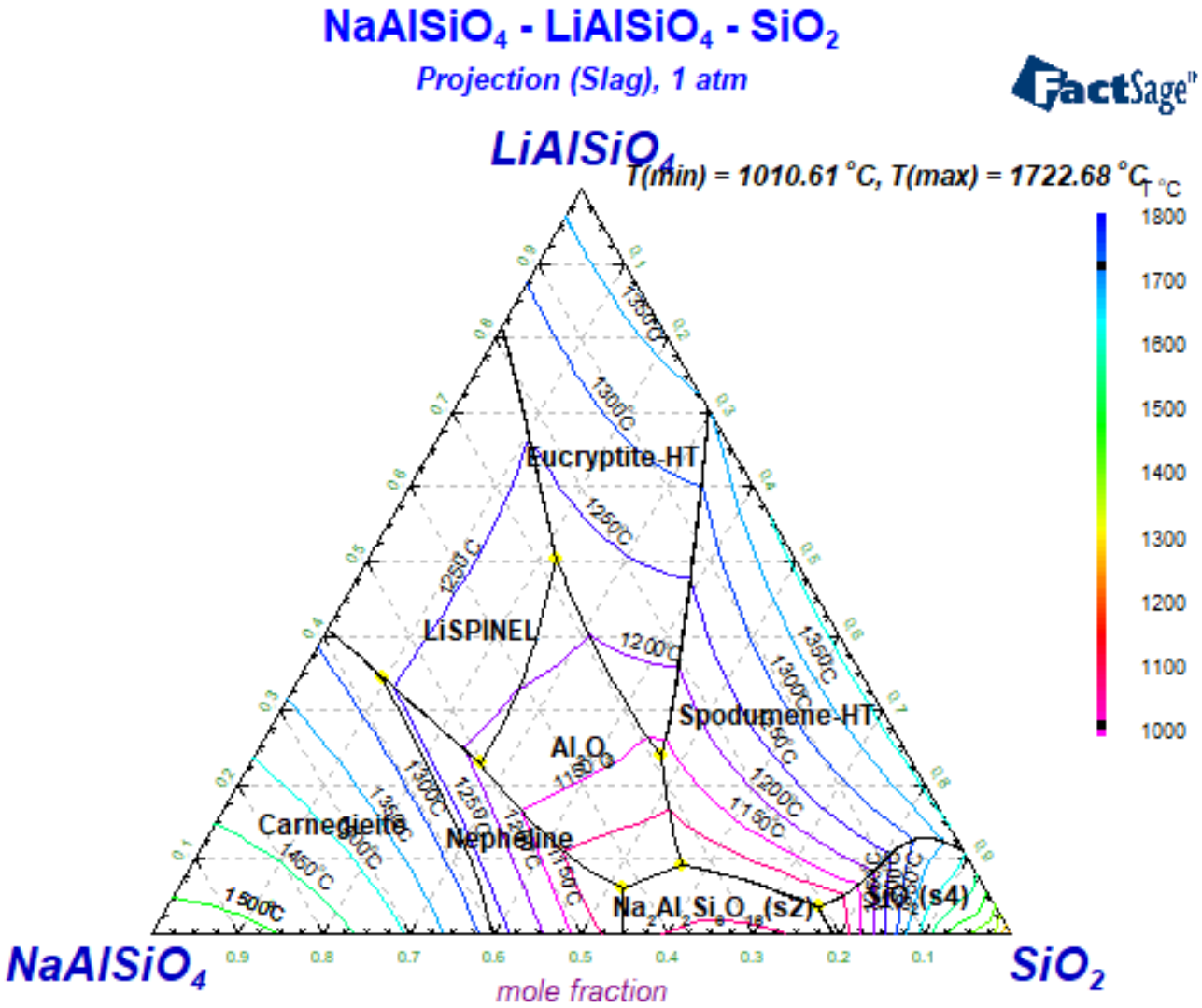
Mole fraction, Isopleth NaAlSi3O8-Spodumene



Mole fraction, Isopleth NaAlSiO4-LiAlSiO4

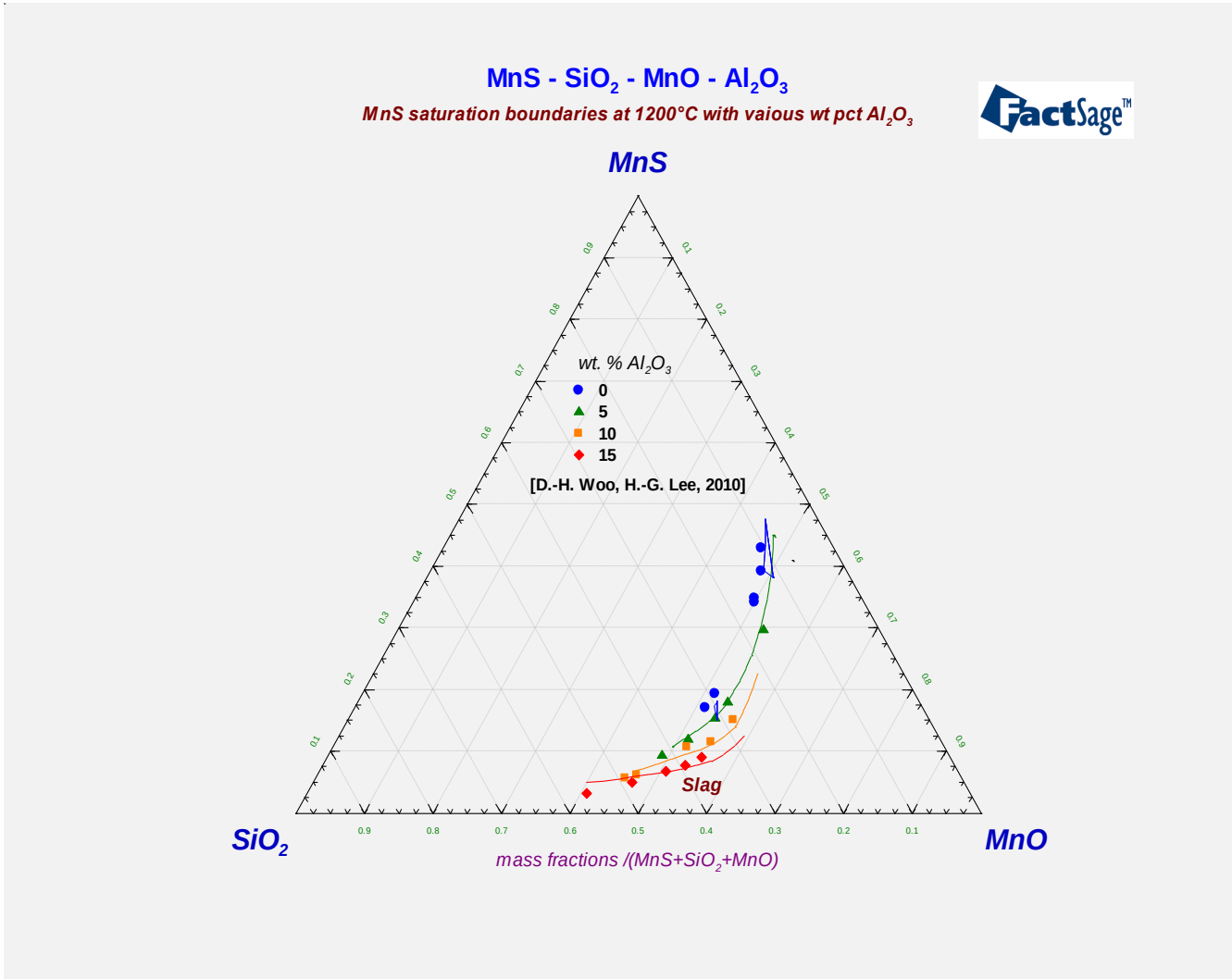


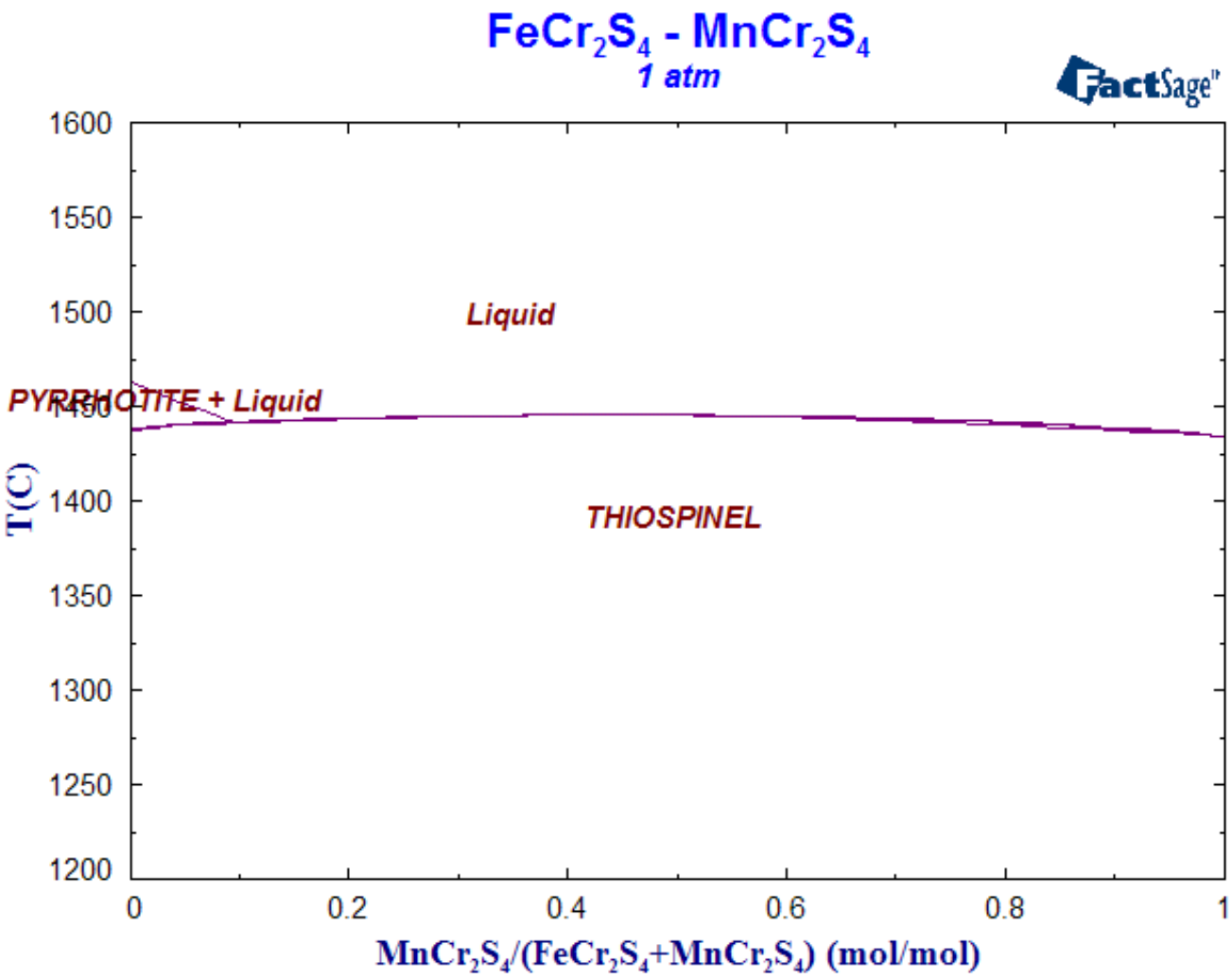
Mole fraction, Liquidus surface in NaAlSiO4-LiAlSiO4-SiO2



Al2O3-MnO-MnS-SiO2,

Weight percent,
MnS saturation boundaries at 1200°C with various wt pct Al2O3



Cr-Fe-Mn-S,

Mole fraction,
Isopleth section FrCr2S4-MnCr2S4