Addition of K_2O and Na_2O to the Al_2O_3-CaO-FeO_x-MgO-SiO_2 Oxide System

GTT-Technologies, Herzogenrath

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Elephant's wedding

Al_2O_3-K_2O-Na_2O-SiO_2

Al_2O_3-CaO-FeO-Fe_2O_3-MgO-SiO_2

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Introduction

The associate species containing K or Na were added in order to describe the liquid phase in the Al_2O_3-CaO-FeO_x-MgO-SiO_2 system containing K_2O or Na_2O.

The composition of the liquid oxide species are as introduced by Spear taking two moles of cations per associate.

System	Associate species
FeO_x – K_2O	$FeKO_2$
FeO_x – Na_2O	$FeNaO_2$, $(FeNa_2O_2)$:1.5
Al_2O_3– CaO – Na_2O	$(Al_{10}Ca_3Na_4O_{20})$:8.5
CaO – Na_2O – SiO_2	$(Na_2Ca_3Si_6O_{16})$:5.5
FeO_x – Na_2O – SiO_2	$(FeSiNa_2O_4)$:2

Modelling of new phases in binary sub-systems

System	Phase	Description	Work	Used data
FeO_x-K_2O	**$FeKO_2$-HT**	**$(Fe^{3+})(\underline{K}^{1+},Va)(O^{2-})_2$**	GTT	Cp data from SGPS are used
	$FeKO_2$-LT	**$(Fe^{3+})(\underline{K}^{1+},Va)(O^{2-})_2$**	GTT	
	$Fe_{12}K_2O_{19}$	**stoichiometric**	GTT	
	$Fe_{22}K_2O_{34}$	**stoichiometric**	GTT	
FeO_x-Na_2O	**$FeNaO_2$(s4)**	**stoichiometric**	GTT	$FeNaO_2$(s) from SGPS is used as basic
	$FeNaO_2$-HT	**$(Fe^{3+})(\underline{Na}^{1+},Va)(O^{2-})_2$**	GTT	
	$FeNaO_2$-LT	**$(Fe^{3+})(\underline{Na}^{1+},Va)(O^{2-})_2$**	GTT	
	$FeNaO_2$(s)	**stoichiometric**	GTT	
	$FeNa_2O_2$	**stoichiometric**	GTT	H_f [84Dai2]
	$FeNa_4O_3$	**stoichiometric**	GTT	
	$Fe_{16}Na_{10}O_{29}$	**stoichiometric**	GTT	

Modelling of new phases in ternary systems

System	*Phase*	*Description*	*Work*	*Used data*
Al_2O_3-CaO-K_2O	K2C3A5	$(K^{1+},Va)(Ca^{2+},K^{1+})(Al^{3+})_2(O^{2-})_4$	GTT	
Al_2O_3-CaO-Na_2O	N2C3A5 NC3A8 NC8A3	$(Na^{1+},Va)(Ca^{2+},Na^{1+})(Al^{3+})_2(O^{2-})_4$ $Na_2Ca_3Al_{16}O_{28}$ $Na_2Ca_8Al_6O_{18}$	GTT GTT GTT GTT	
Al_2O_3-Fe_2O_3-K_2O	(Fe,Al)KO2-HT (Fe,Al)KO2-LT	$(\underline{Fe}^{3+}, \underline{Al}^{3+})(\underline{K}^{1+}, Va)(O^{2-})_2$ $(\underline{Fe}^{3+}, \underline{Al}^{3+})(\underline{K}^{1+}, Va)(O^{2-})_2$	GTT	$AlKO_2$ (s2)FZJ $AlKO_2$ (s) FZJ
Al_2O_3-Fe_2O_3-Na_2O	(Fe,Al)NaO2-HT (Fe,Al)NaO2-LT	$(\underline{Fe}^{3+}, \underline{Al}^{3+})(\underline{Na}^{1+}, Va)(O^{2-})_2$ $(\underline{Fe}^{3+}, \underline{Al}^{3+})(\underline{Na}^{1+}, Va)(O^{2-})_2$	GTT	$AlNaO_2$(s2)FZJ $AlNaO_2$(s) FZJ

Modelling of new phases in ternary systems

System	*Phase*	*Description*	*Work*	*Used data*
Al_2O_3-K_2O-MgO	Beta-prime	$(K^{1+})_2(\underline{Al^{3+}},Va)_2(Mg^{2+},\underline{Va})_3(Al_{10}O_{19}^{8-})$	GTT	$K_2Al_{12}O_{19}$ (Jülich)
	Beta-tri	$(\underline{O^{2-}},Va)_3(\underline{Al^{3+}},K^{1+})_2(\underline{Al^{3+}},Mg^{2+})_2$ $(Al_{40}K_4Mg_5O_{70}^{6-})$	GTT	
Al_2O_3-MgO-Na_2O	Beta-prime	$(Na^{1+})_2(\underline{Al^{3+}},Va)_2(Mg^{2+},\underline{Va})_3(Al_{10}O_{19}^{8-})$	GTT	$Na_2Al_{12}O_{19}$ (Jülich)
	Beta-tri	$(O^{2-},Va)_3(Al^{3+},Na^{1+})_2(Al^{3+},Mg^{2+})_2$ $(Al_{40}Na_4Mg_5O_{70}^{6-})$	GTT	
CaO-Na_2O-SiO_2	NC2S3	$(Na^{1+},\underline{Va})_2(\underline{Ca^{2+}},Va)\ (Na_2CaSi_3O_9)^{2-}$	GTT	
	111	Na_2CaSiO_4	GTT	
	115	$Na_2CaSi_5O_{12}$	(GTT)	Spear data
	122	$Na_2Ca_2Si_2O_7$	GTT	
	136	$Na_2Ca_3Si_6O_{16}$	(GTT)	Spear data
	213	$Na_4CaSi_3O_9$	(GTT)	Spear data

Modelling of new phases in ternary systems

System	*Phase*	*Description*	*Work*	*Used data*
Fe_2O_3-K_2O-SiO_2	FeKO2-HT	$(\underline{Fe}^{3+}, Si^{4+})(\underline{K}^{1+}, Va)(O^{2-})_2$	GTT	
	FeKO2-LT	$(\underline{Fe}^{3+}, Si^{4+})(\underline{K}^{1+}, Va)(O^{2-})_2$	GTT	
	K2F2S3	$Fe_4K_4Si_3O_{14}$	GTT	
	Kaliophilite-HT	$Fe_2K_2Si_2O_8$	GTT	
	Kaliophilite-LT	$Fe_2K_2Si_2O_8$	GTT	
	Iron-Leucite	$Fe_2K_2Si_4O_{12}$	GTT	
	Iron-Orthoclase	$Fe_2K_2Si_6O_{16}$		
Fe_2O_3-Na_2O-SiO_2	FeNaO2-δ	$(\underline{Fe}^{3+}, Si^{4+})(\underline{Na}^{1+}, Va)(O^{2-})_2$	GTT	
	FeNaO2-HT	$(\underline{Fe}^{3+}, Si^{4+})(\underline{Na}^{1+}, Va)(O^{2-})_2$	GTT	
	FeNaO2-LT	$(\underline{Fe}^{3+}, Si^{4+})(\underline{Na}^{1+}, Va)(O^{2-})_2$	GTT	
	Acmite	$Fe_2Si_4Na_2O_{12}$	GTT	
	N5F1S8	$Fe_2Si_8Na_{10}O_{24}$	GTT	
	N6F4S5	$Fe_8Si_5Na_{12}O_{28}$	GTT	
FeO-Na_2O-SiO_2	NFS	$FeSiNa_2O_4$	GTT	
MgO-Na_2O-SiO_2	Roedderite	$Na_2Mg_5Si_{12}O_{30}$	GTT	
	NM2S6	$Na_2Mg_2Si_6O_{15}$	GTT	
	NMS4	$Na_2MgSi_4O_{10}$	GTT	
	NMS	Na_2MgSiO_4	GTT	
	N2M2S3	$Na_4Mg_2Si_3O_{10}$	GTT	

Modelling of new phases in quaternary systems

System	*Phase*	*Description*	*Used data*
Al_2O_3-K_2O-MgO-Na_2O	Beta-prime	$(K^{1+},Na^{1+})_2(\underline{Al^{3+}},Va)_2(Mg^{2+},\underline{Va})_3$ $(Al_{10}O_{19}^{8-})$	$Al_{12}K_2O_{19}$(s) $Al_{12}Na_2O_{19}$(s) from FZJ
	Beta-tri	$(\underline{O^{2-}},Va)_3(\underline{Al^{3+}},K^{1+}, Na^{1+})_2(\underline{Al^{3+}},Mg^{2+})_2$ $(Al_{40}K_4Mg_5O_{70}^{6-}, Al_{40}Na_4Mg_5O_{70}^{6-})$	
Al_2O_3-Fe_2O_3-K_2O-Na_2O-SiO_2	(Al,Fe)(K,Na)O_2-HT	$(\underline{Al}^{3+}, \underline{Fe}^{3+}, Si^{4+})(\underline{K}^{1+}, \underline{Na}^{1+},Va)(O^{2-})_2$	Al_2O_3-K_2O-Na_2O-SiO_2 data from FZJ
	(Al,Fe)(K,Na)O_2-LT	$(\underline{Al}^{3+}, \underline{Fe}^{3+}, Si^{4+})(\underline{K}^{1+}, \underline{Na}^{1+},Va)(O^{2-})_2$	
Al_2O3-Fe_2O_3-K_2O-SiO_2	KAF4S3	$(\underline{Al}^{3+},\underline{Fe}^{3+})_4(K^{1+})_4(Si^{4+})_3(O^{2-})_{14}$	$Al_4K_4Si_3O_{12}$(s)FZJ
	Kaliophilite-HT	$(\underline{Al}^{3+},\underline{Fe}^{3+})_2(K^{1+})_2(Si^{4+})_2(O^{2-})_8$	$Al_2K_2Si_2O_8$(s2)FZJ
	Kaliophilite-LT	$(\underline{Al}^{3+},\underline{Fe}^{3+})_2(K^{1+})_2(Si^{4+})_2(O^{2-})_8$	$Al_2K_2Si_2O_8$(s)FZJ
	Leucite	$(\underline{Al}^{3+},\underline{Fe}^{3+})_2(K^{1+})_2(Si^{4+})_4(O^{2-})_{12}$	$Al_2K_2Si_4O_{12}$(s)FZJ
	Feldspar	$(\underline{Al}^{3+},\underline{Fe}^{3+})(K^{1+},Na^{1+})(Si^{4+})_3(O^{2-})_8$	Al(K,Na)Si_3O_8FZJ
Al_2O_3-CaO-K_2O-Na_2O	(K,N)2C3A5	$(K^{1+}, Na^{1+},Va)(Ca^{2+},K^{1+}, Na^{1+})$ $(Al^{3+})_2(O^{2-})_4$	

Proposed CaO-K_2O and K_2O-MgO phase diagrams

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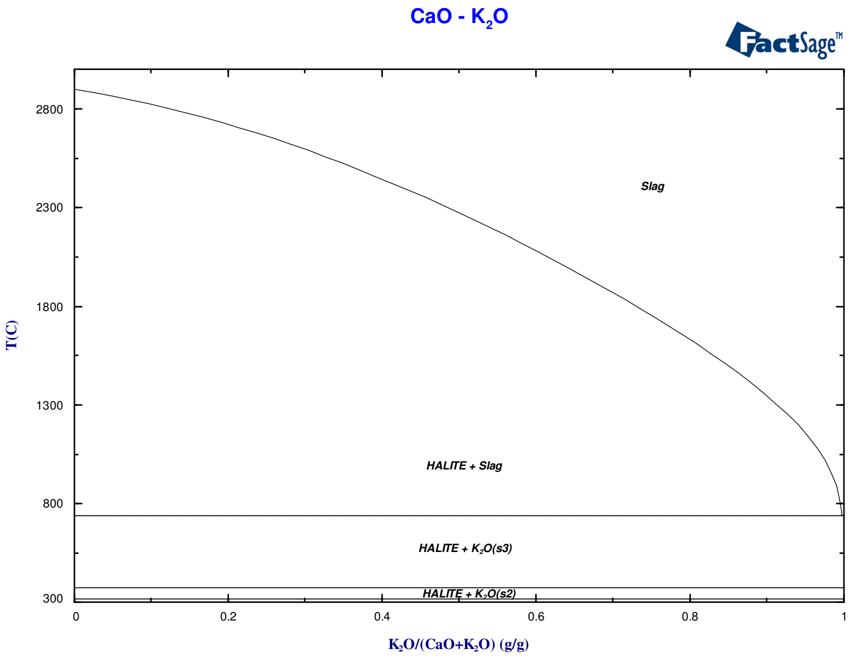

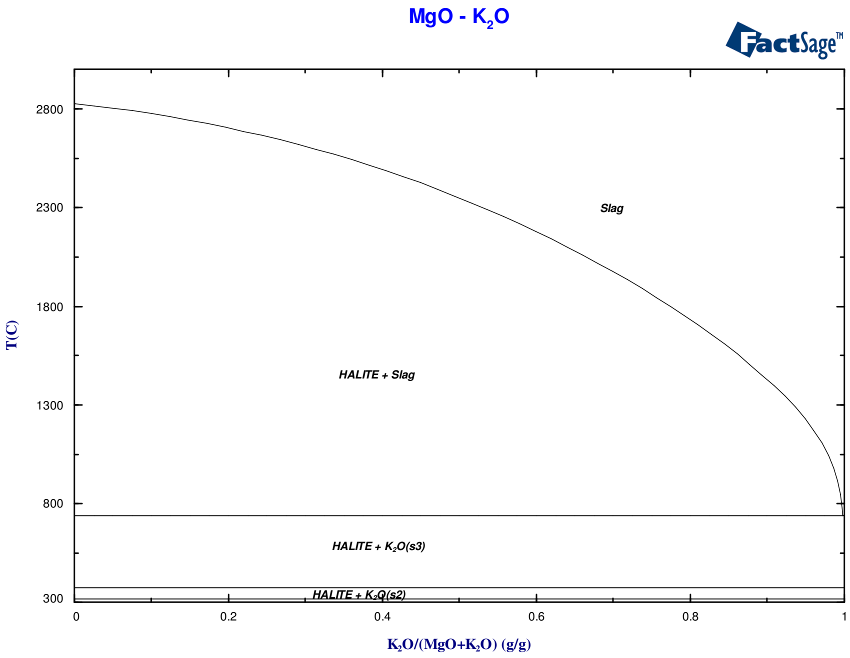

Proposed CaO-Na_2O and MgO-Na_2O phase diagrams

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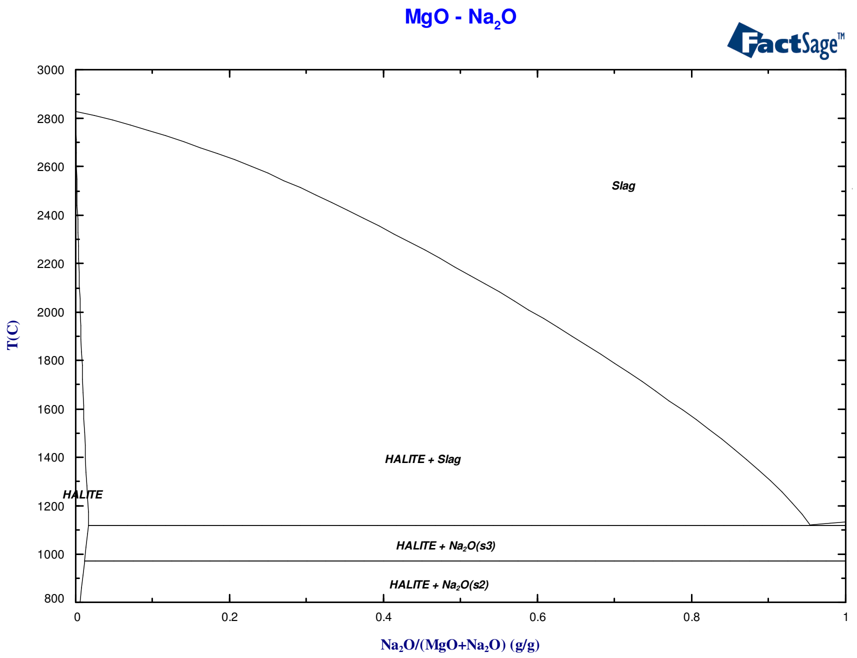
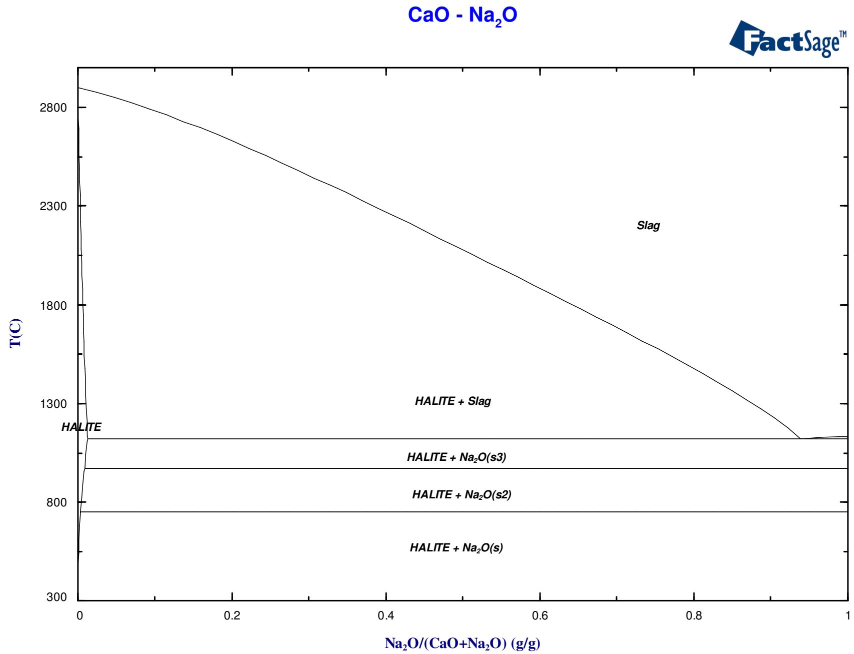
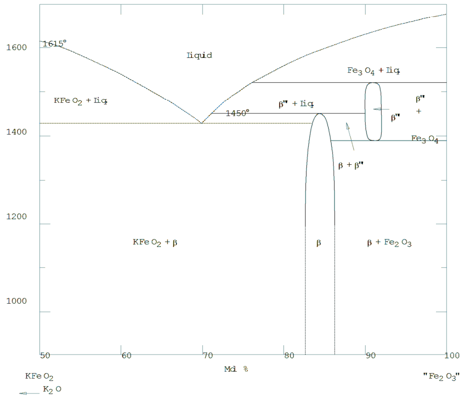


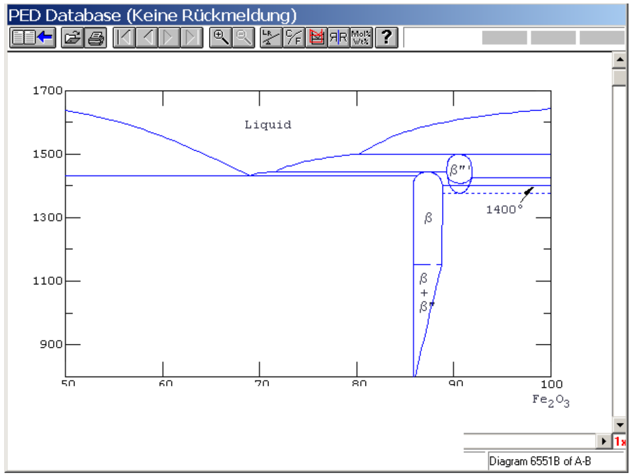


Binary Fe_2O_3 - K_2O phase diagram in air

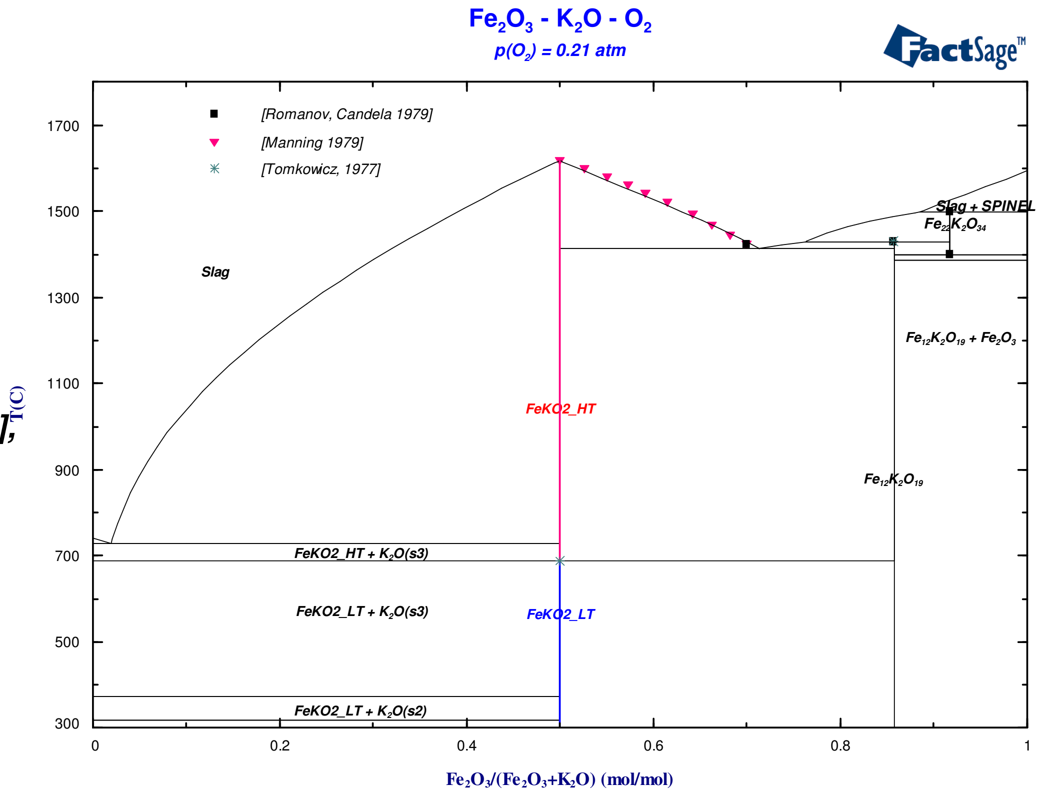
E.R. Plante, H.S. Parker, R.S. Roth, C.D. Olson, Natl. Bur. Stand. (US) Int. Rep., NBSIR 79-1767 (1979), pp.82-102.



V.P. Romanov, G.A. Candela, R.S. Roth, L.J. Schwartzengruber, J. Appl. Phys., 507 (1979), [10], pp. 6455-6458.



687°C
$FeKO_2$-LT→ $FeKO_2$-HT [77Tom]



FeO-K_2O phase diagram for equilibrium with Fe

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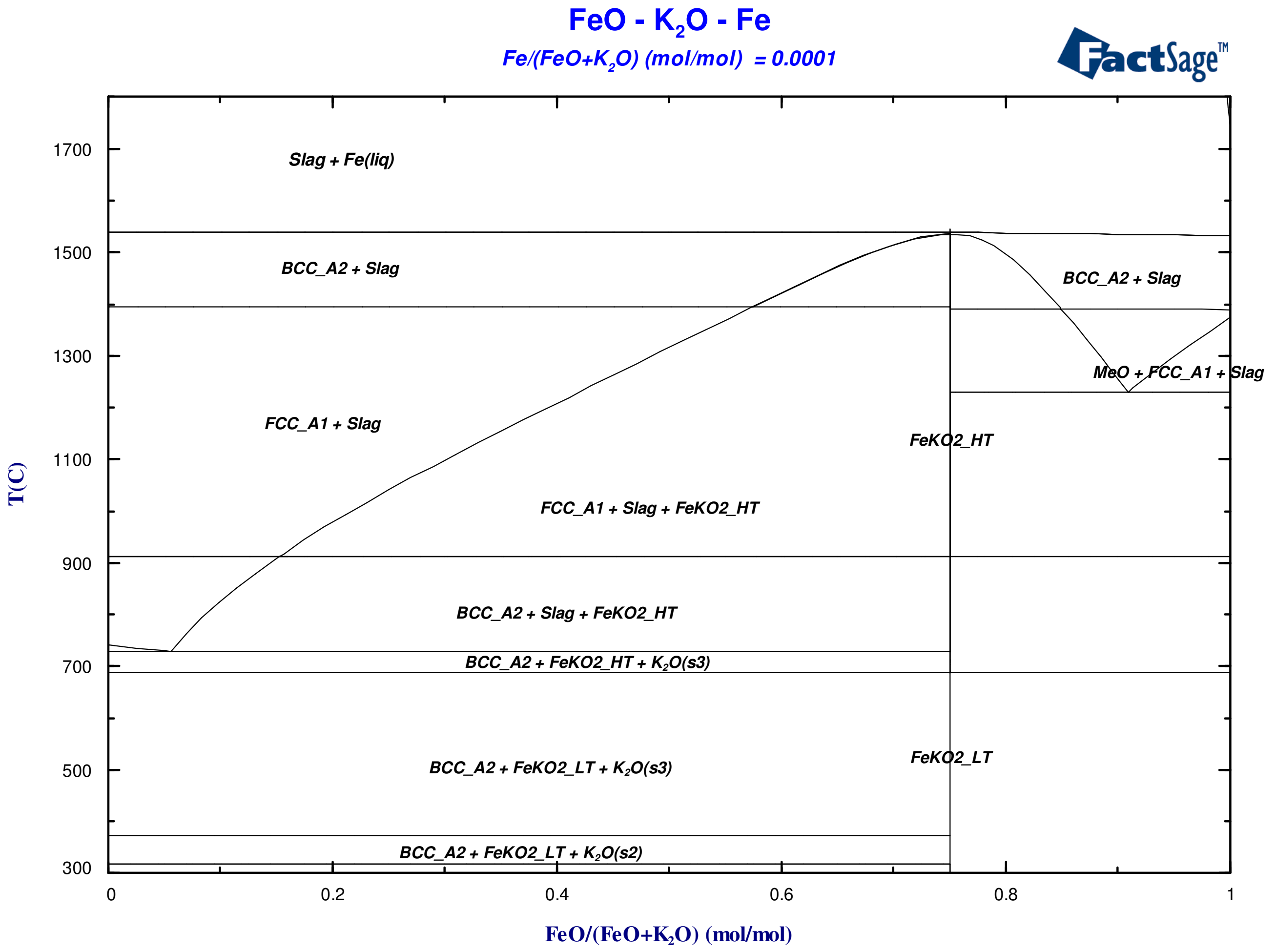
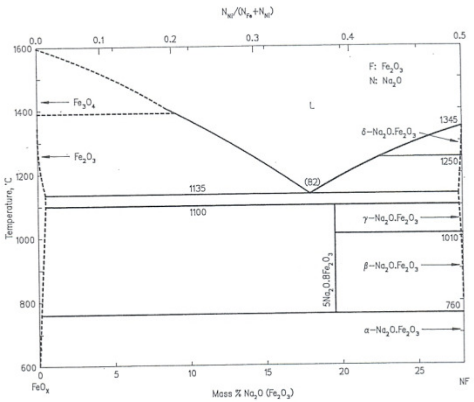


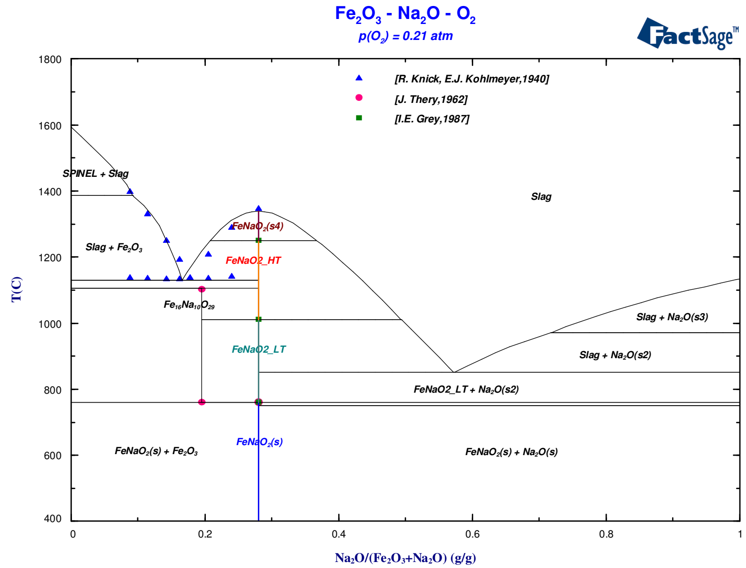
Binary Fe_2O_3 - Na_2O phase diagram in air

760°C 1010°C 1250°C

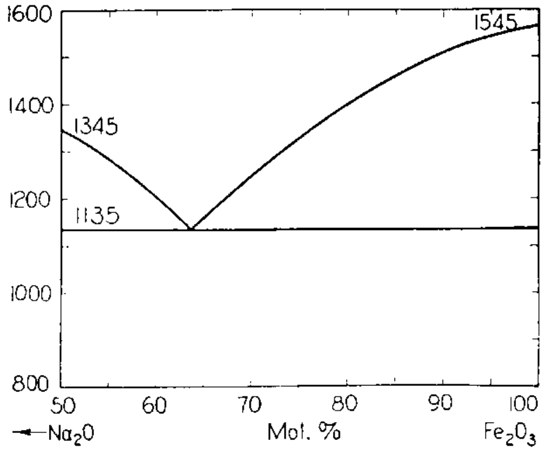
$FeNaO_2(s) \rightarrow FeNaO_2\text{-LT} \rightarrow FeNaO_2\text{-HT} \rightarrow FeNaO_2\text{-}\delta$ [87Grey]

***Slag Atlas* (1995), p.75.**

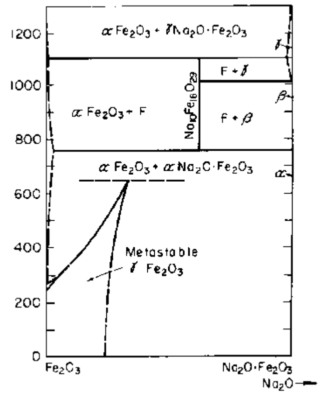




R. Knick, E.J. Kohlmeyer, *Z. Anorg. Allg. Chem.*, 244 [1], (1940), pp.67-84.



J. Thery, *Ann. Chim. (Paris)*, 7 [3-4], (1962), pp.207-238.



FeO-Na_2O phase diagram for equilibrium with Fe

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W. Dai, S. Seetharamab, L.-I. Staffansson, Metall. Trans. B, 15B, (1984), No.2, pp. 319-327.

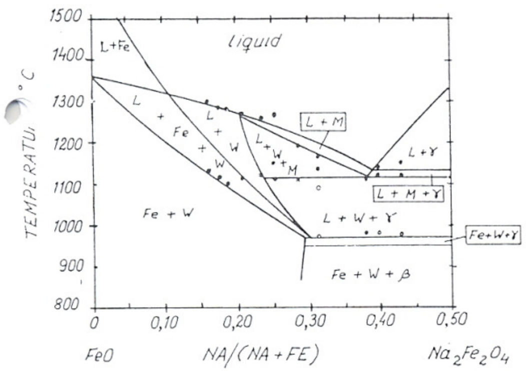


Fig. 7—Phase relations in the FeO-$Na_2Fe_2O_4$ section. *W*: wustite. *M*: magnetite. *β*: β-$Na_2Fe_2O_4$. *γ*: γ-$Na_2Fe_2O_4$.

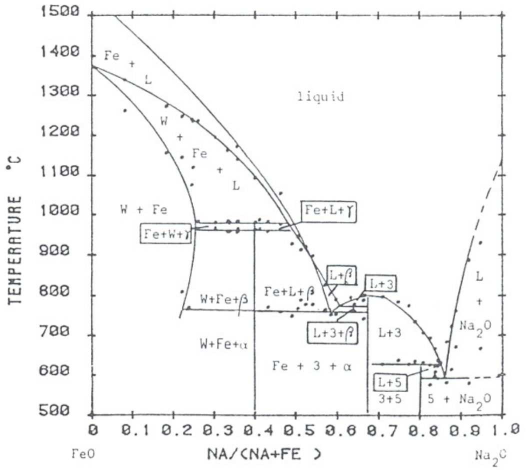
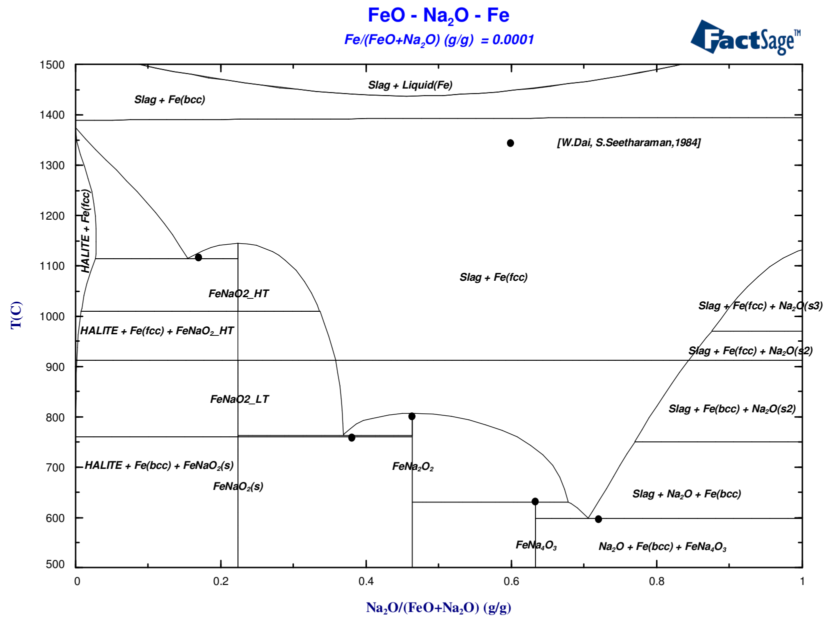
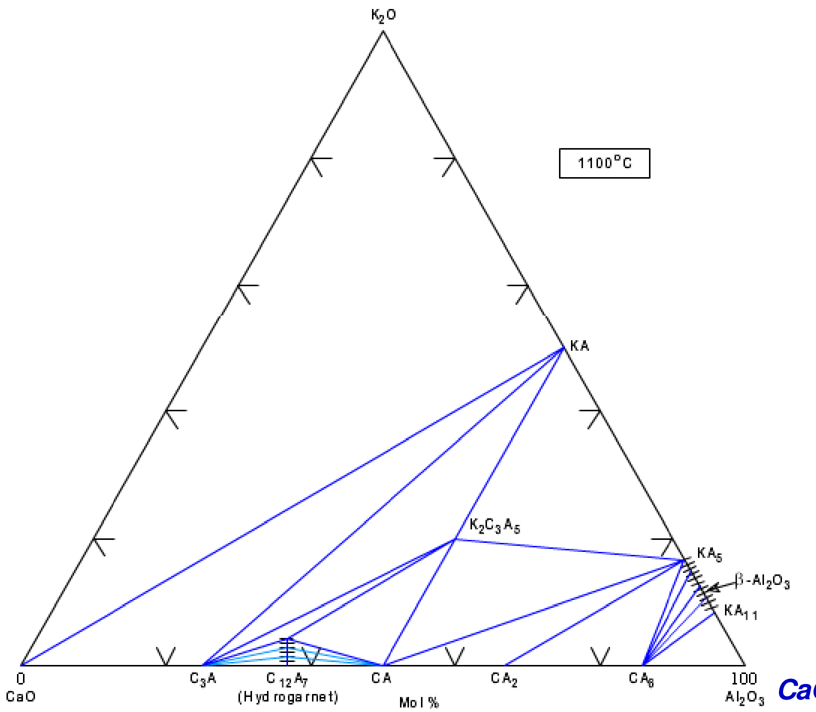


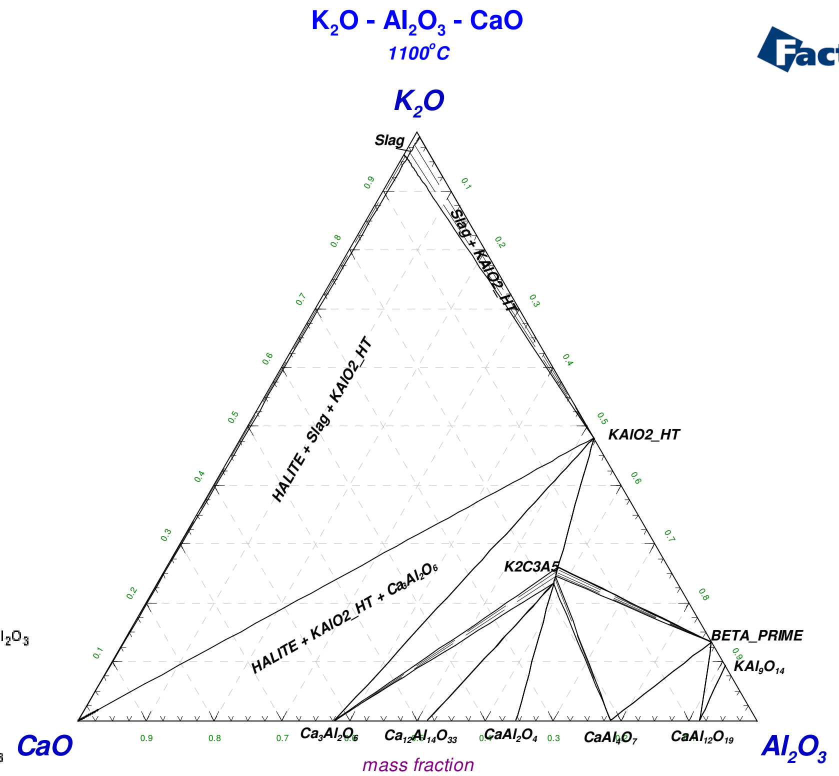
Fig. 4—The FeO-Na_2O section of the Fe-Na-O system. *W*: wustite. α: α-$Na_2Fe_2O_4$, β: β-$Na_2Fe_2O_4$, γ: γ-$Na_2Fe_2O_4$, 3: Na_3FeO_2, 5: Na_4FeO_3.



Isothermal section at 1100°C in Al_2O_3-CaO-K_2O

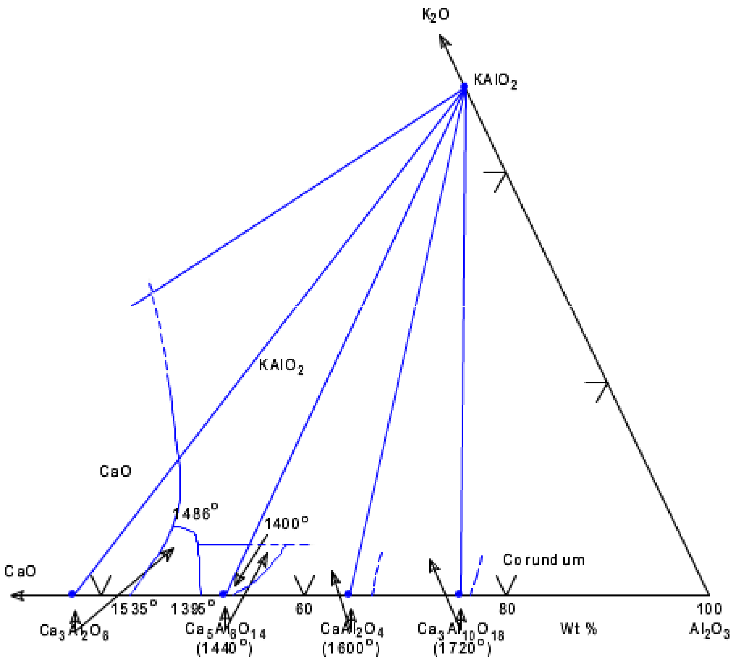
J. A. M. Van Hoek, F. J. J. Van Loo, and R. Metselaar,
Mater. Sci. Monogr., 66B (1991), pp. 581-590.

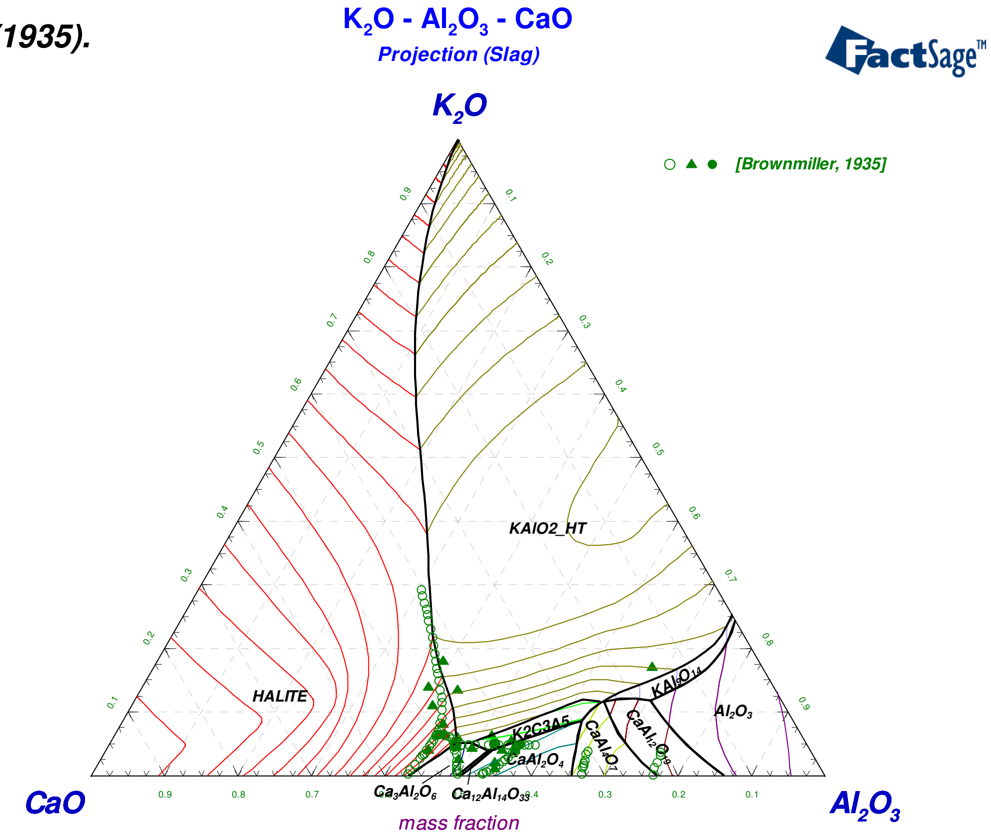




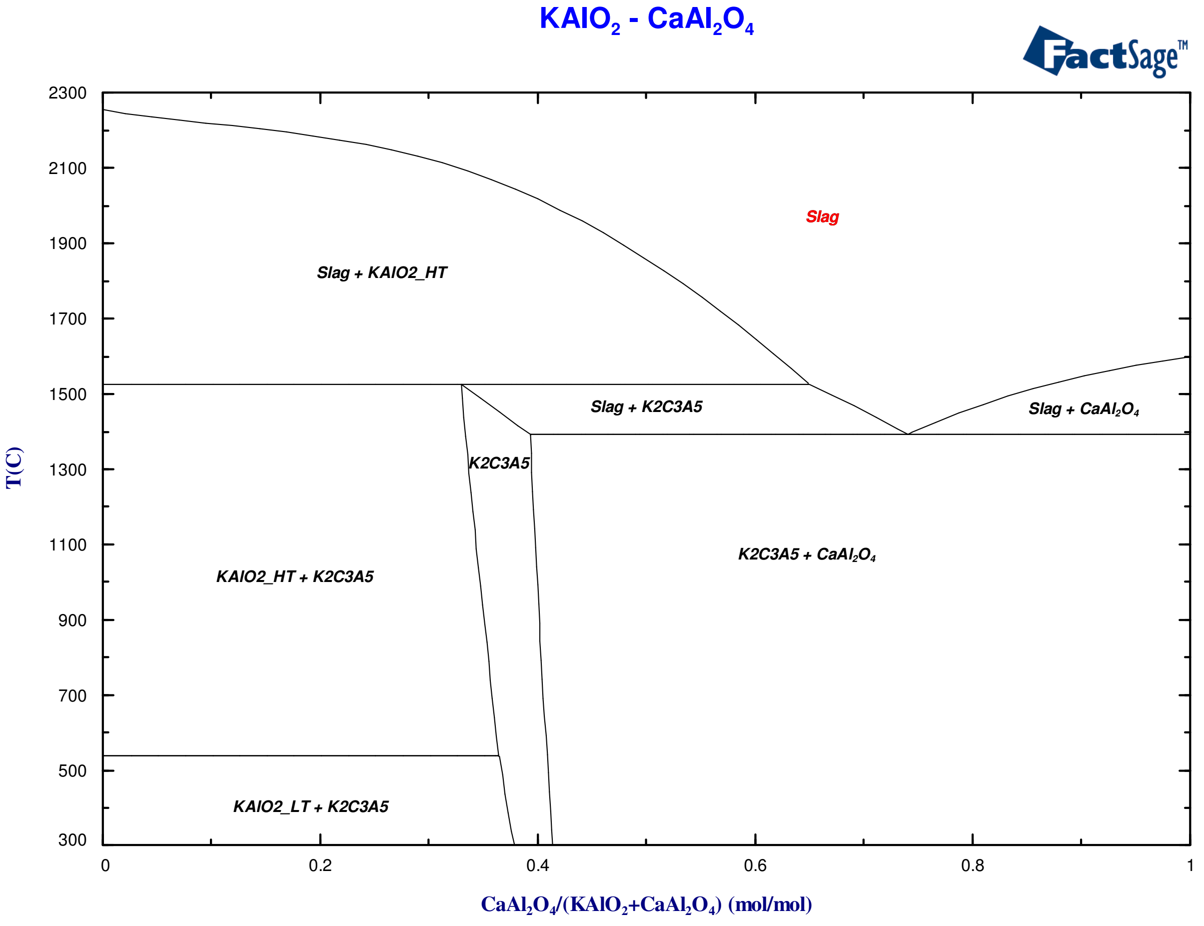
Liquidus surface in Al_2O_3-CaO-K_2O

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



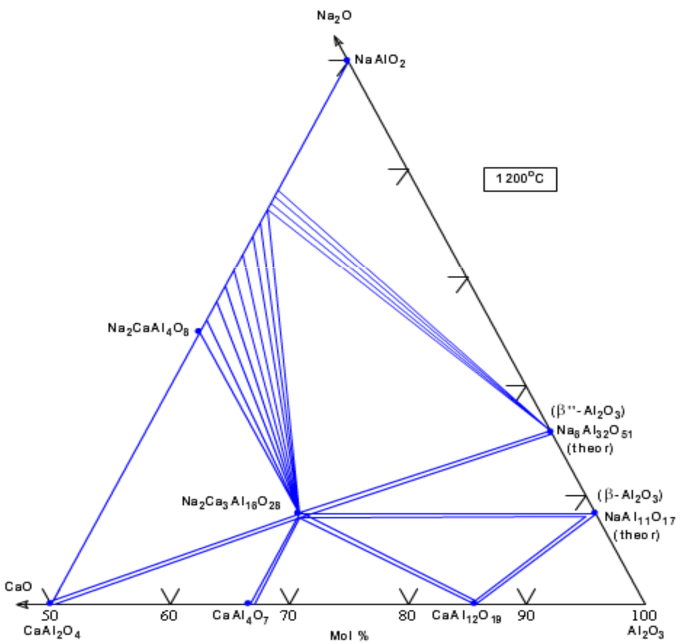


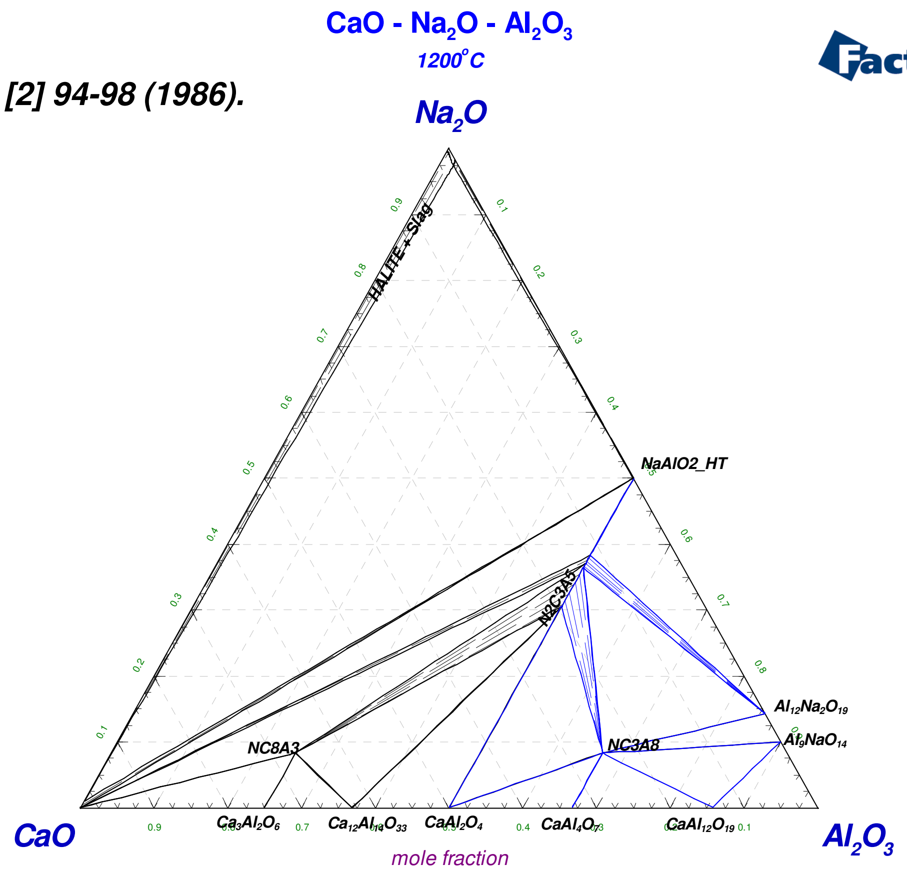
Proposed isopleth section $K_2Al_2O_4$ - $CaAl_2O_4$



Isothermal section at 1200°C in Al_2O_3-CaO-Na_2O

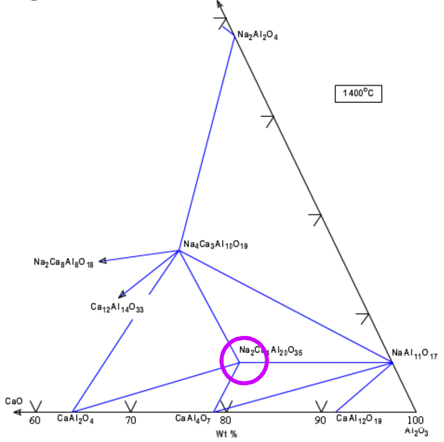
H. Verweij and C. M. P. M. Saris, J. Am. Ceram. Soc., 69 [2] 94-98 (1986).



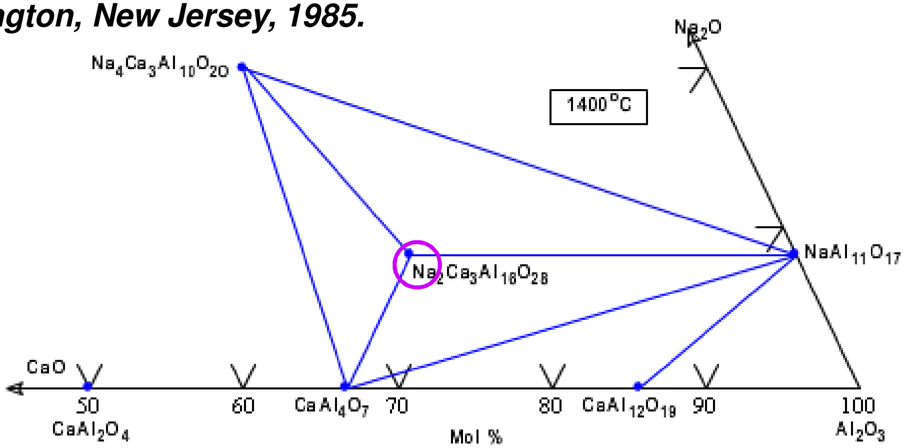


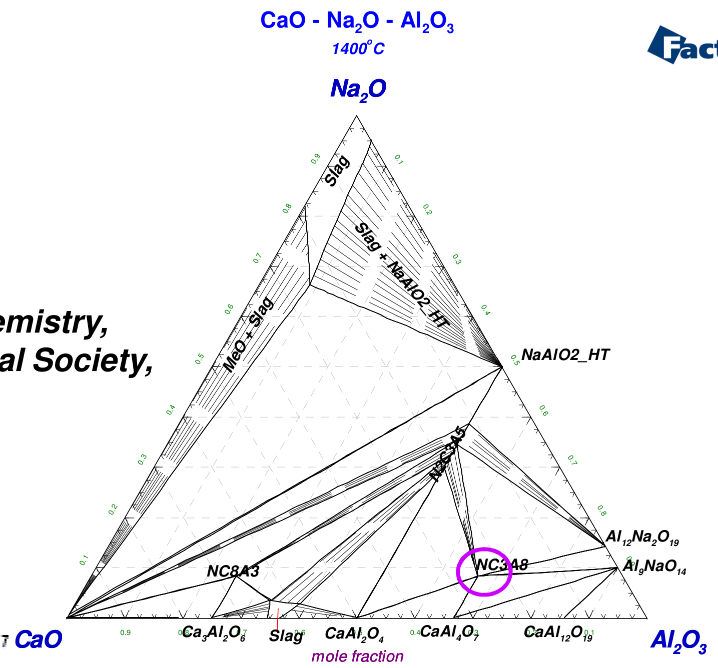
Isothermal section at 1400°C in Al_2O_3-CaO-Na_2O

G. I. Zaldat, M. S. Kupriyanova, and A. L. Tubolev, Izv. Akad. Nauk SSSR, Neorg. Mater., 21 [1] 51-53 (1985).



J. D. Hodge, in Proc. - Electrochem. Soc., High Temperature Lamp Chemistry, 1985, Vol. 85-2, pp. 261-270, Edited by E. G. Zubler, The Electrochemical Society, Inc., Pennington, New Jersey, 1985.





Isopleth section $Na_2Al_2O_4$ - $CaAl_2O_4$

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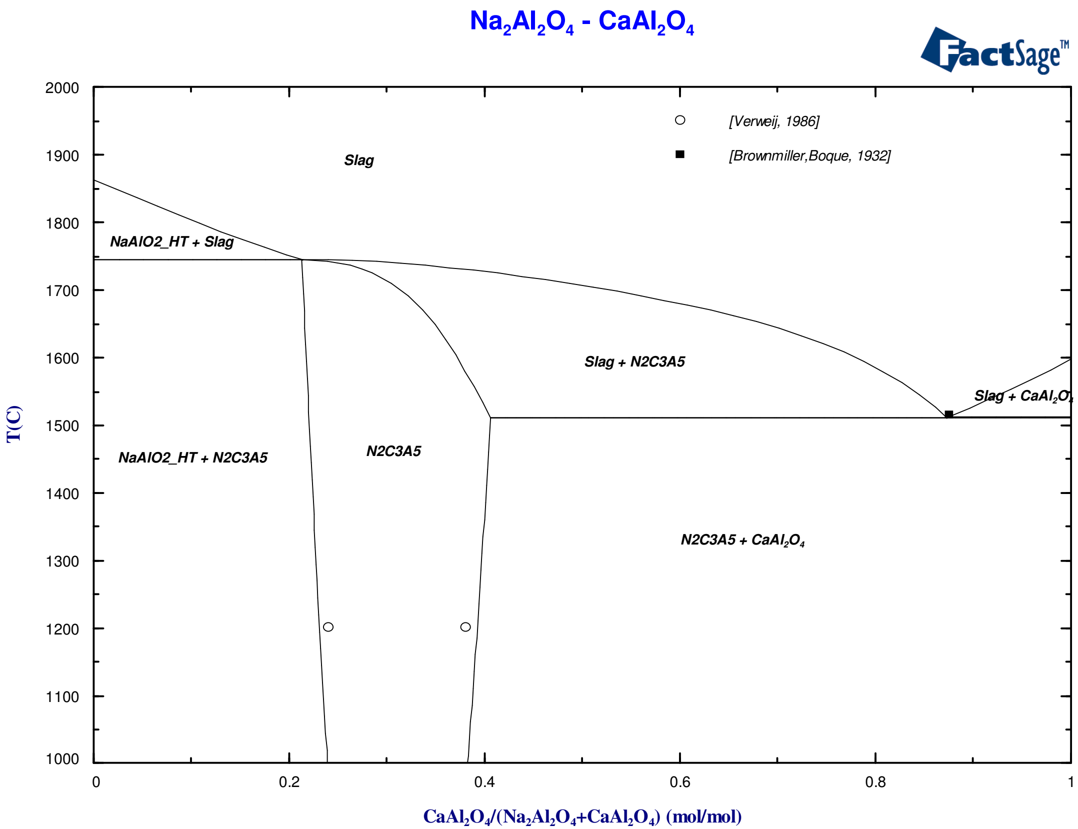

Liquidusoberfläche in Al_2O_3-CaO-Na_2O

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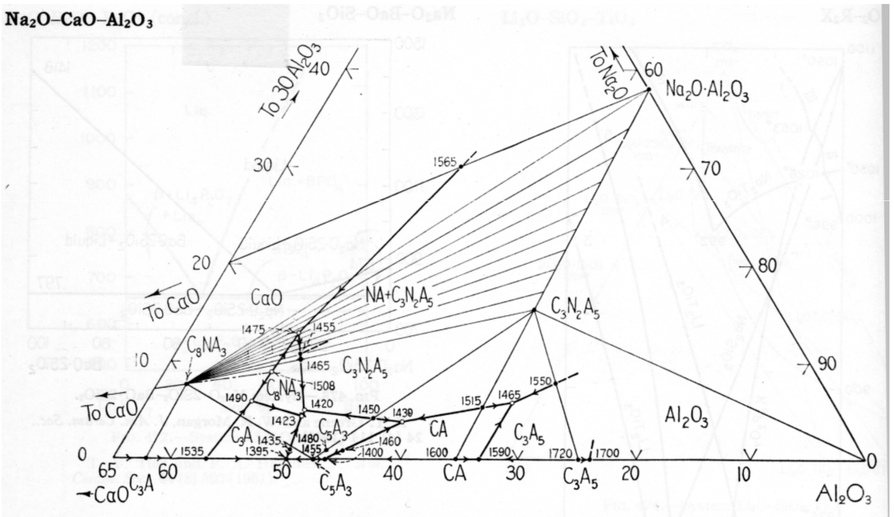
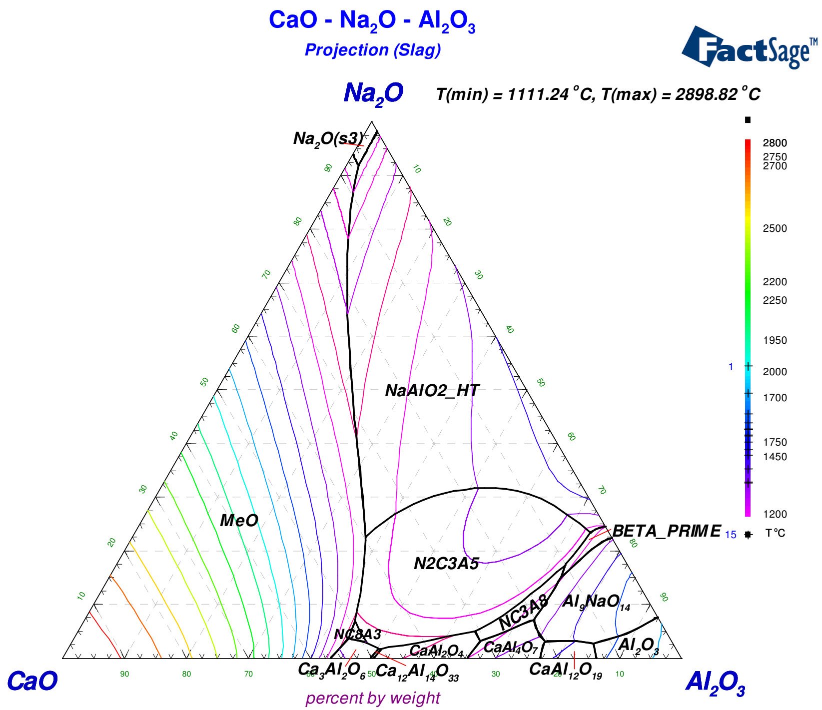
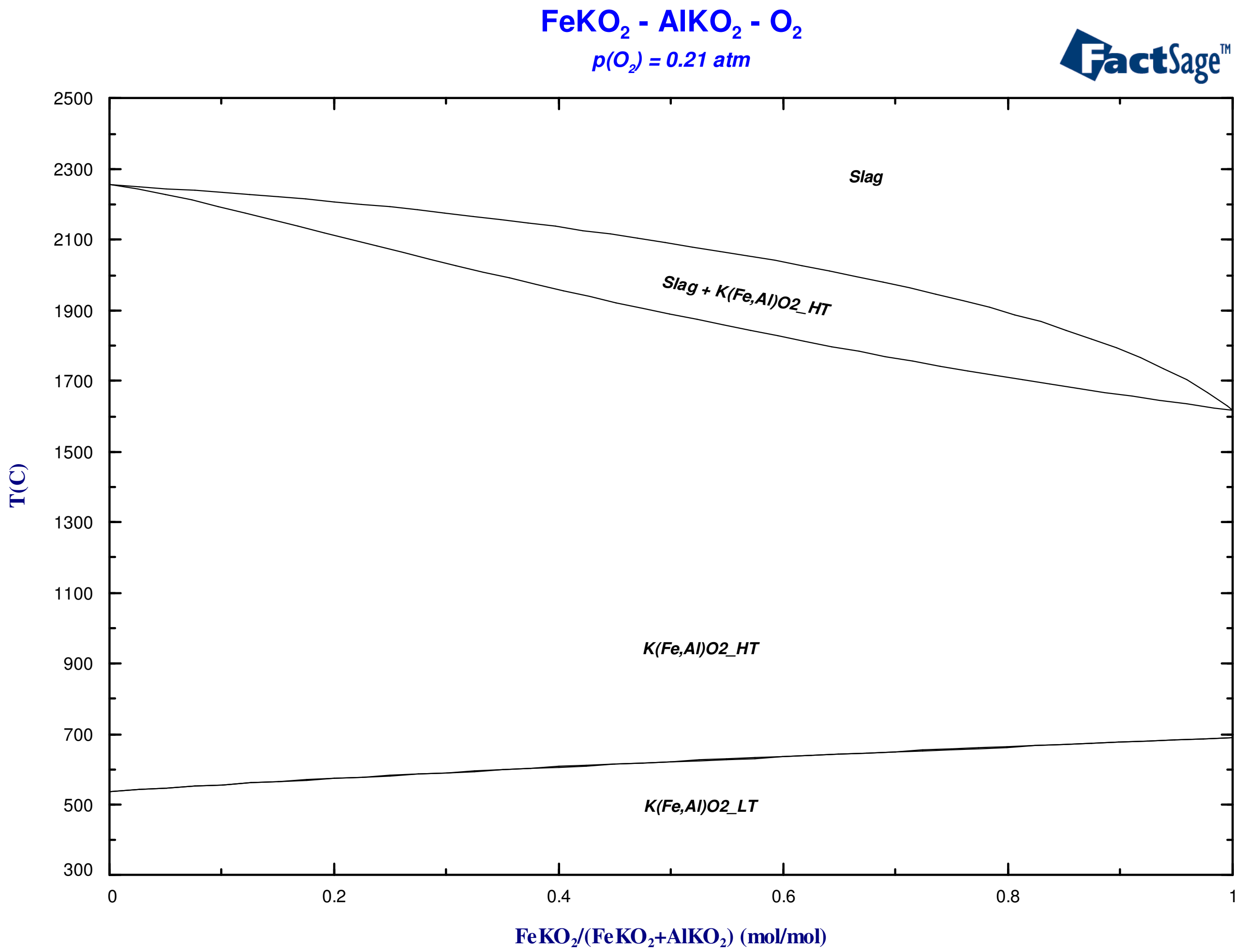


FIG. 480.—High Al_2O_3 corner of system Na_2O–CaO–Al_2O_3.
L. T. Brownmiller and R. H. Bogue, *Bur. Standards J. Research*, 8 [2] 293 (1932); R. P. 414.

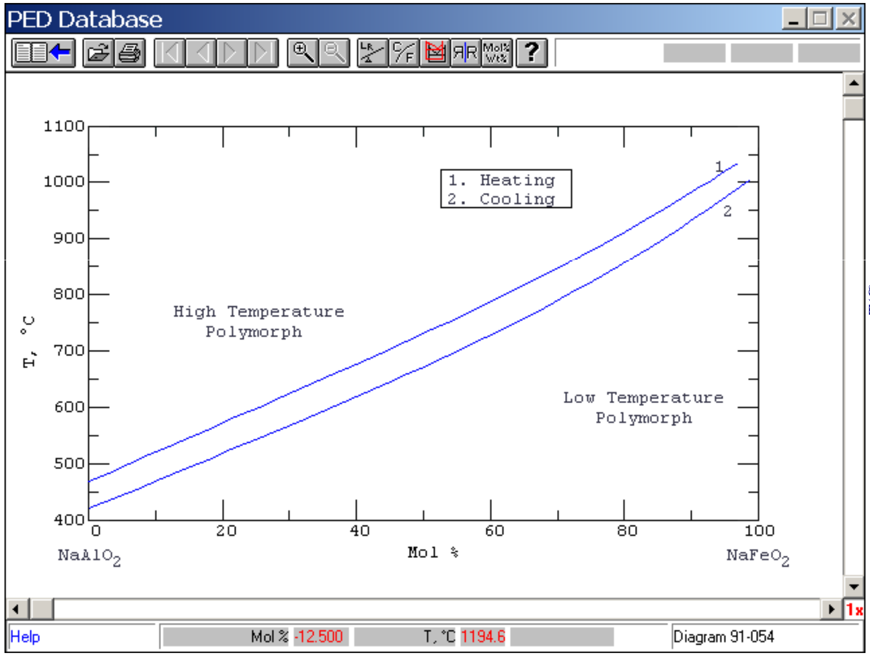


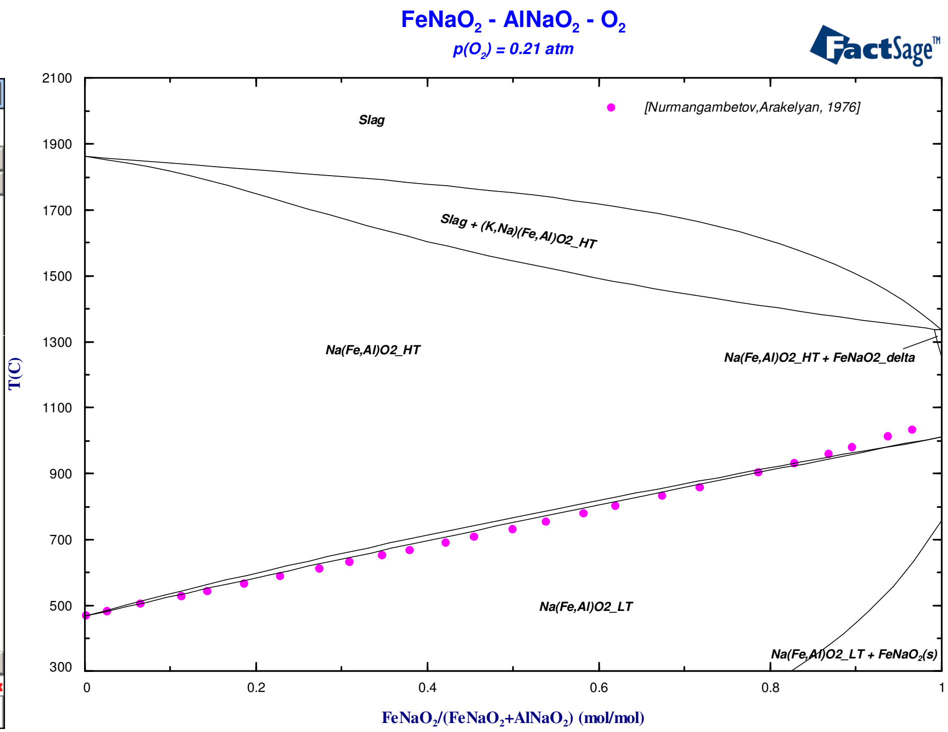
Proposed isopletal section $FeKO_2$-$AlKO_2$ in air



Isopletal section $FeNaO_2$-$AlNaO_2$ in air

Kh.N. Nurmangambetov, O.I.Arakelyan, S.A.Shcherban, Z.S.Karpenko, M.V.Tsvetkova, Izv. Vyssh.Uchebn,Zaved., Tsvetn. Metall., No.3, (1976), pp.61-65.





Isothermal section at 1100°C in Al_2O_3-K_2O-MgO

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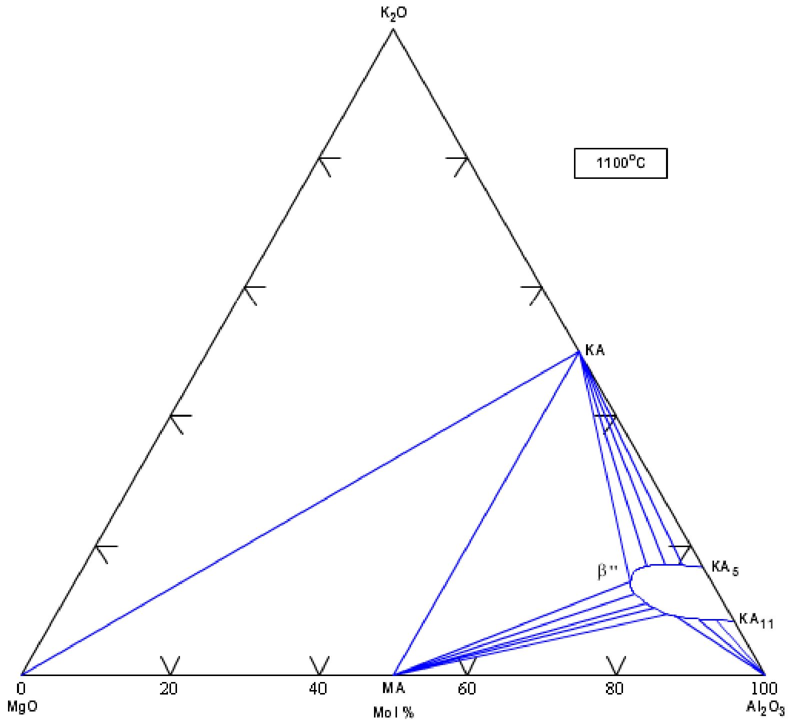
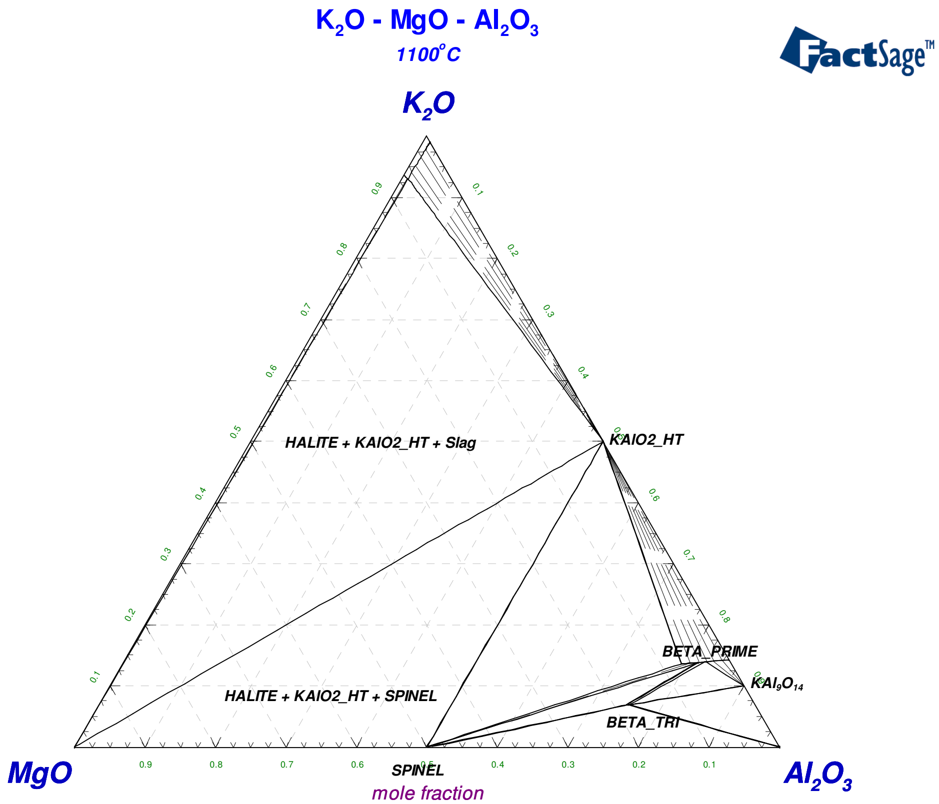
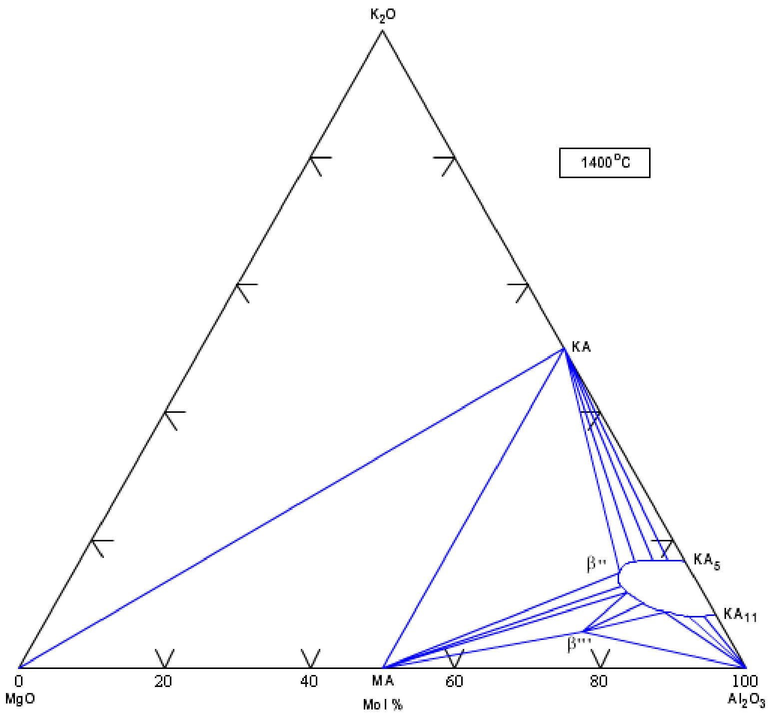
J. A. M. Van Hoek, F. J. J. Van Loo, and R. Metselaar, Key Eng. Mater., 53-55 [Austceram '90] 111-119 (1991).

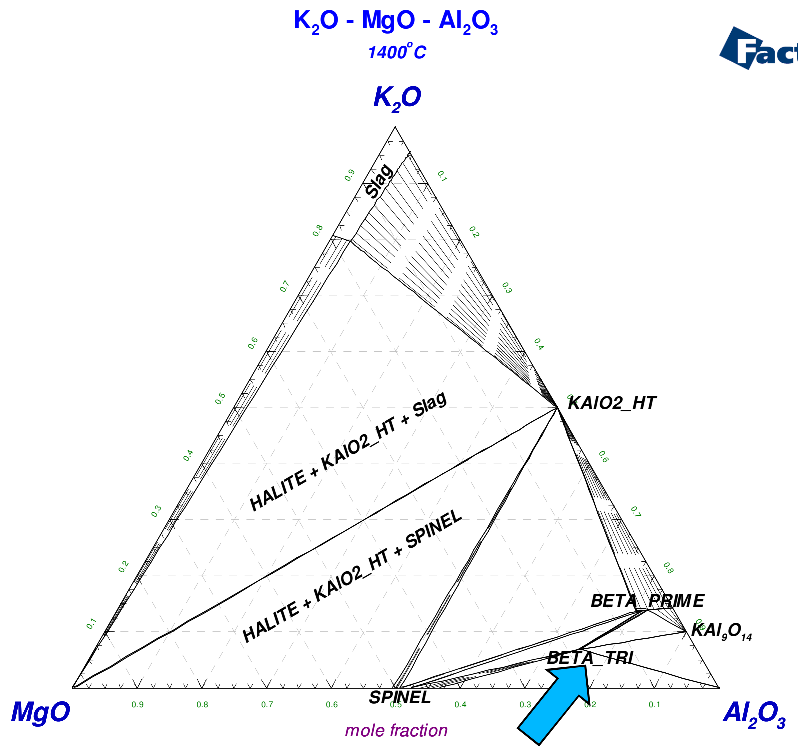




Isothermal section at 1400°C in Al_2O_3-K_2O-MgO

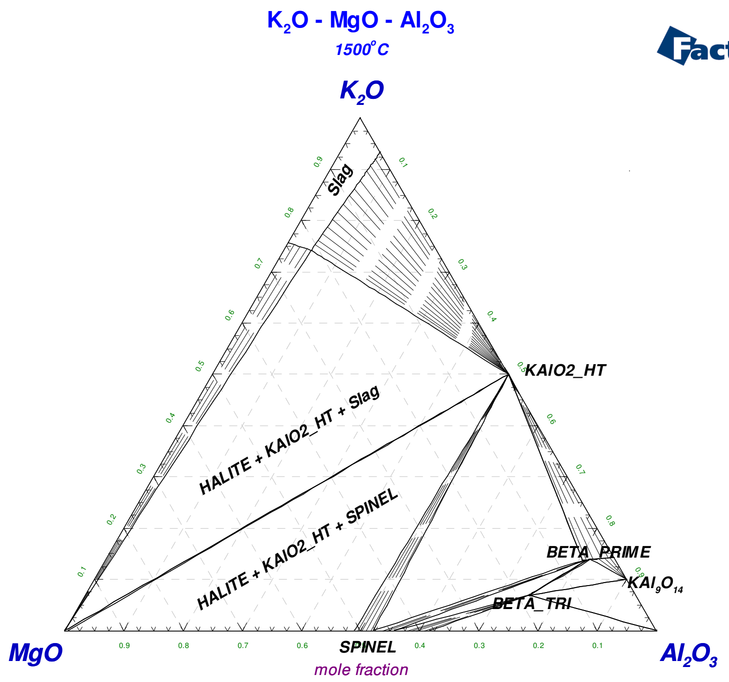
J. A. M. Van Hoek, F. J. J. Van Loo, and R. Metselaar, Key Eng. Mater., 53-55 [Austceram '90] 111-119 (1991).

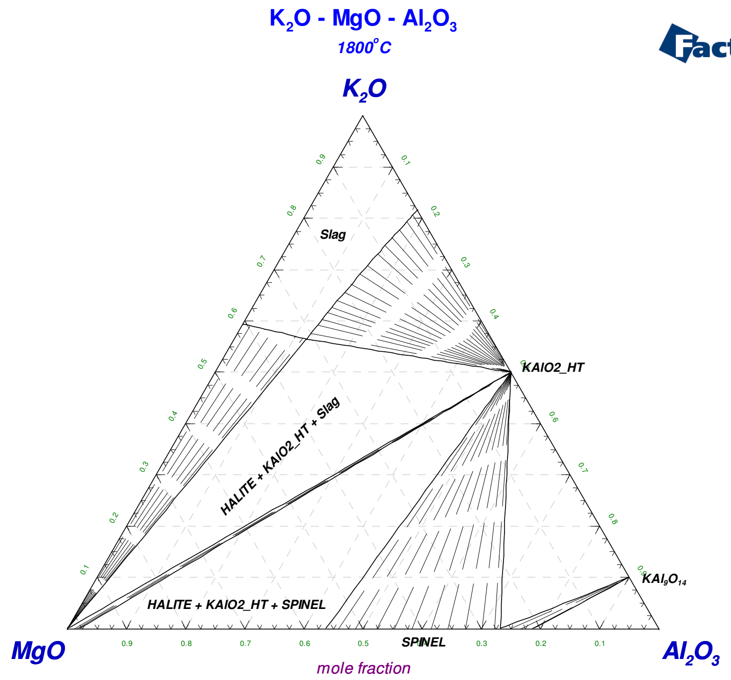




$(Al_{40}K_4Mg_5O_{70})^{-6}(\underline{O^{-2}},Va)_3(\underline{Al^{+3}},K^{+1})_2(\underline{Al^{+3}},Mg^{+2})_2 = 22Al_2O_3 \cdot 2K_2O \cdot 5MgO$

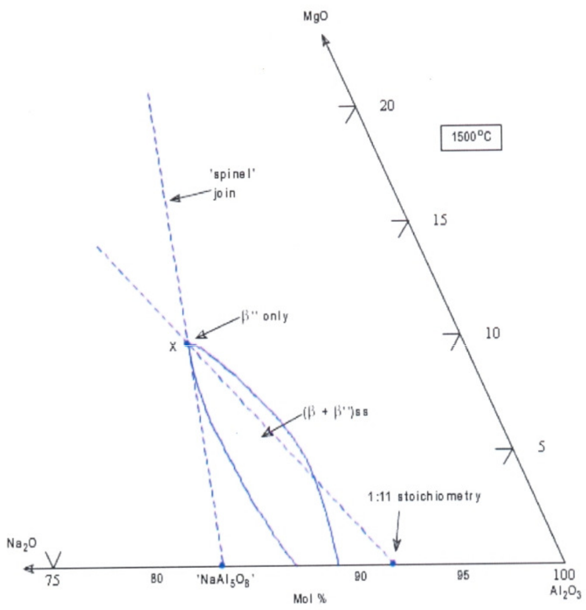
Proposed isothermal sections in Al_2O_3-K_2O-MgO

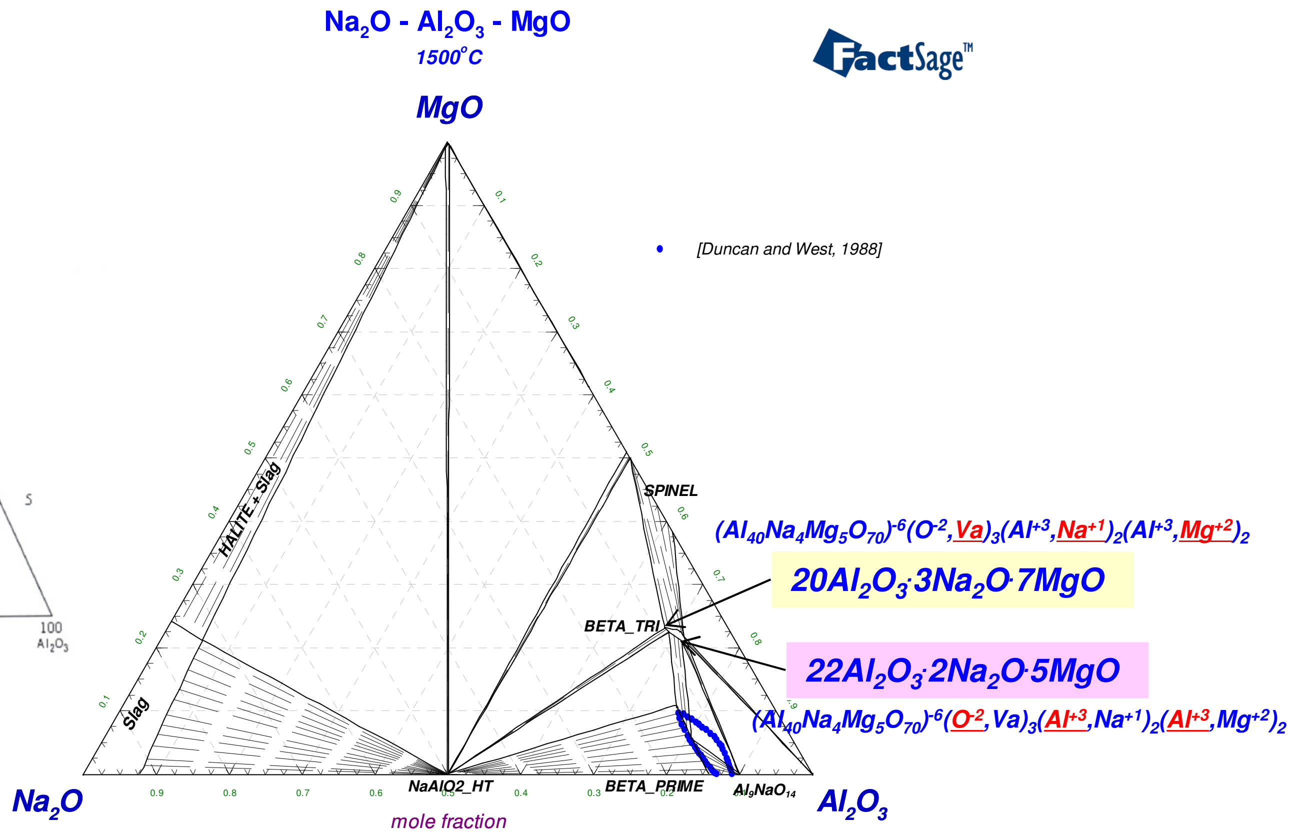




Isothermal section at 1500°C in Al_2O_3-MgO-Na_2O

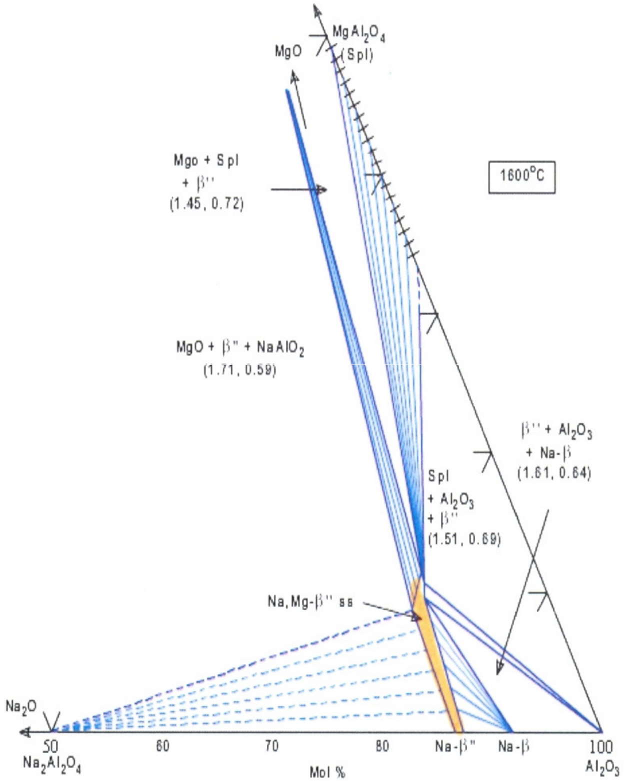
G. K. Duncan and A. R. West, Solid State Ionics, 28-30 [Pt. 1] 338-343 (1988).

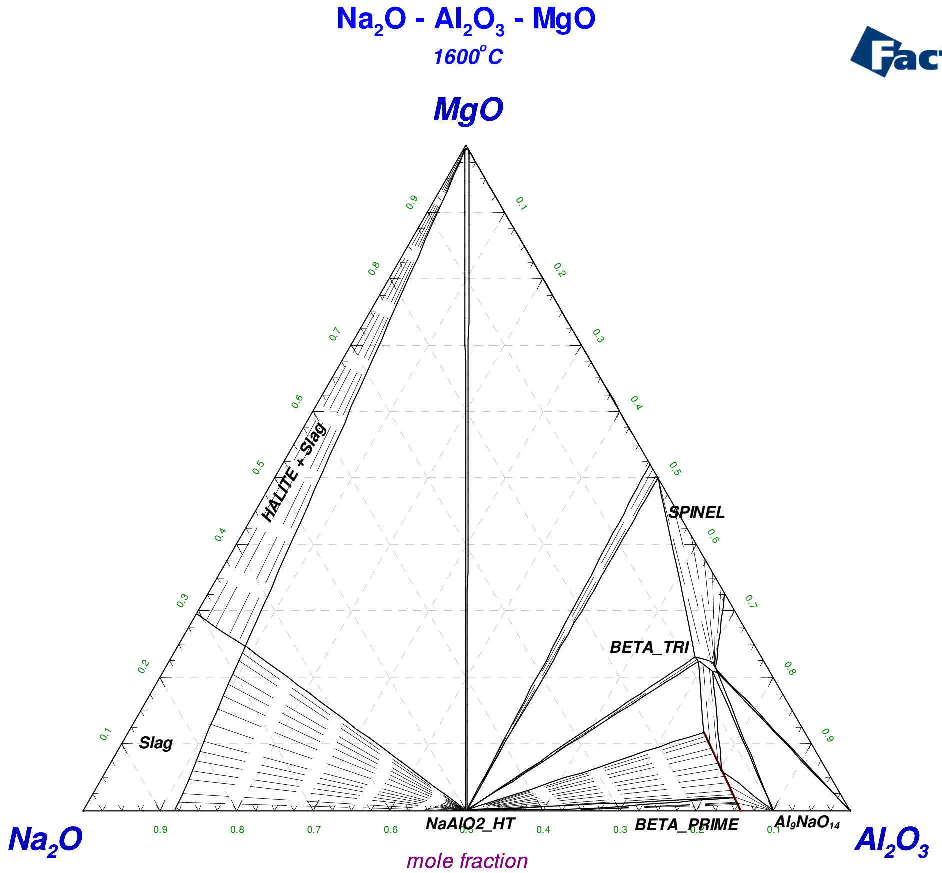




Isothermal section at 1600°C in Al_2O_3-MgO-Na_2O

M. Alden, Solid State Ionics, 20 [1] 17-23 (1986).





Isothermal section at 1680°C in Al_2O_3-MgO-Na_2O

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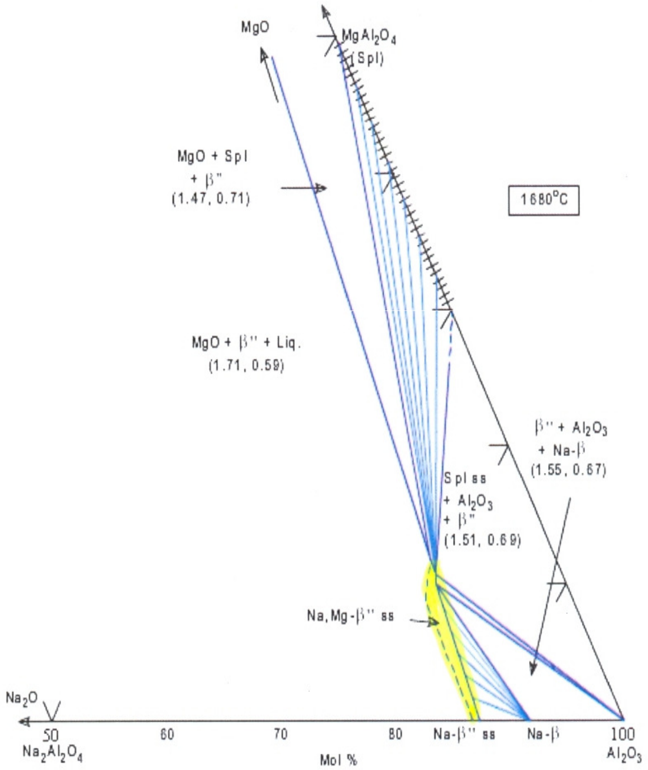
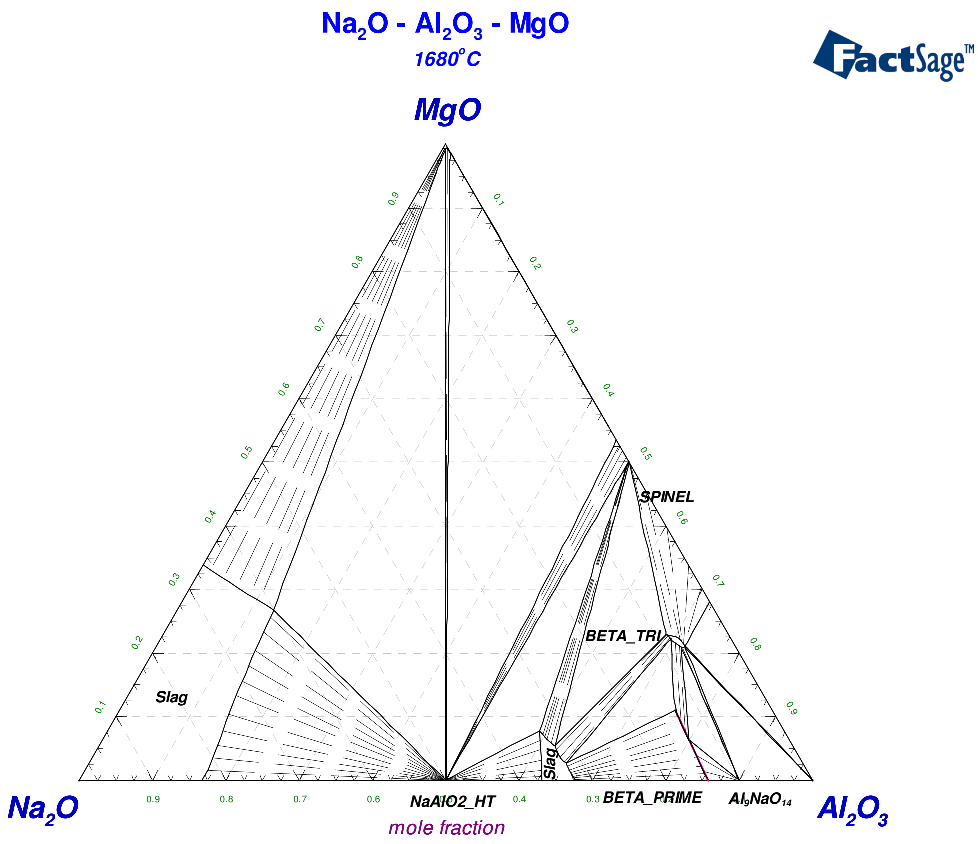
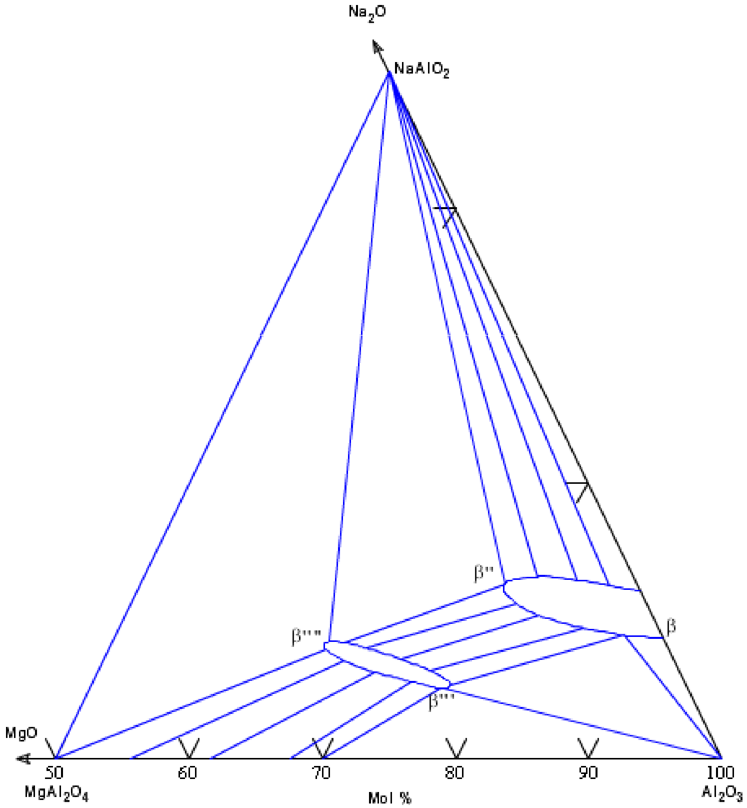
M. Alden, Solid State Ionics, 20 [1] 17-23 (1986).

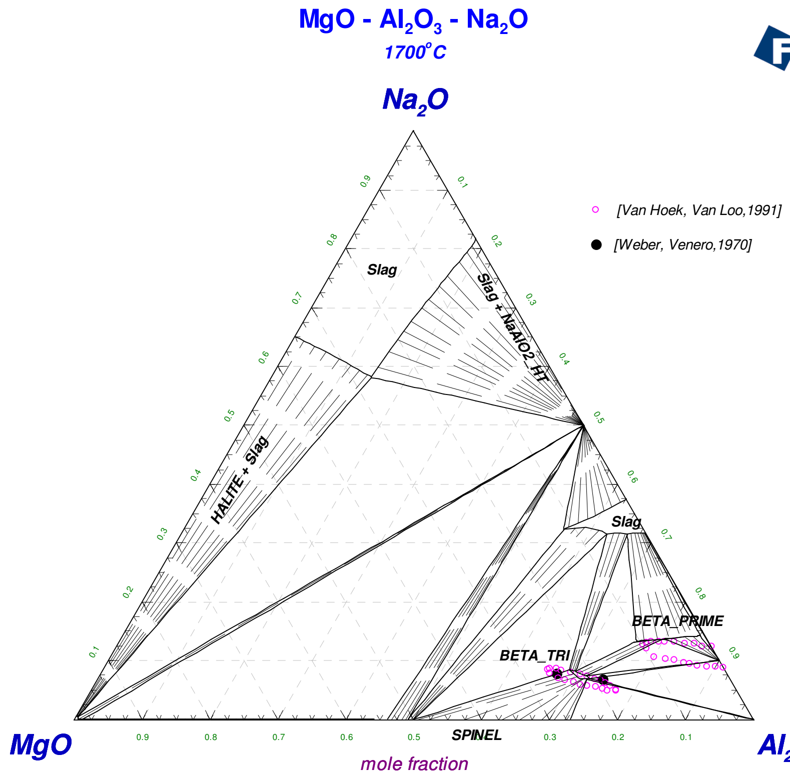




Isothermal section at 1700°C in Al_2O_3-MgO-Na_2O

J. A. M. Van Hoek, F. J. J. Van Loo, and R. Metselaar, Key Eng. Mater.,53-55 [Austceram '90] 111-119 (1991).





Isothermal section at 1700°C in Al_2O_3-MgO-Na_2O

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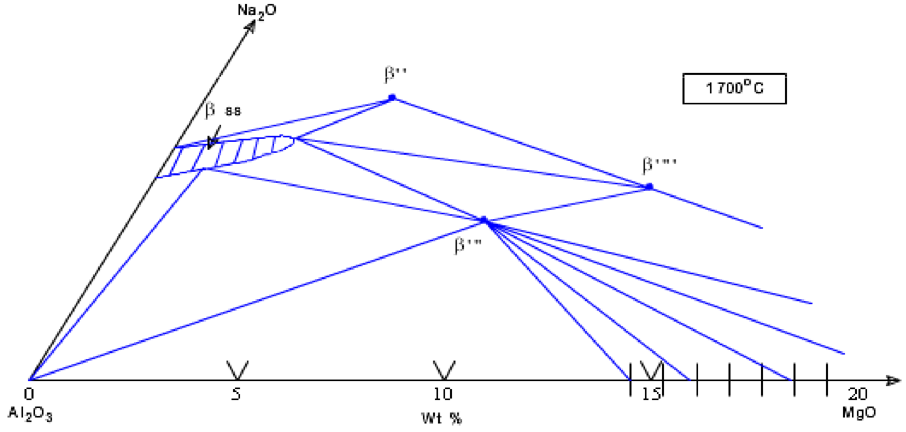
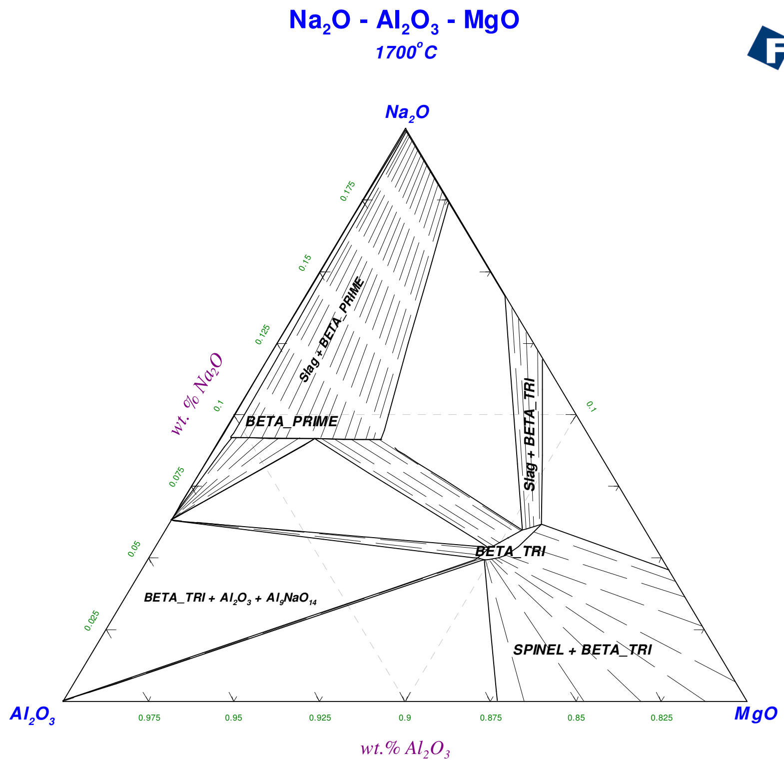
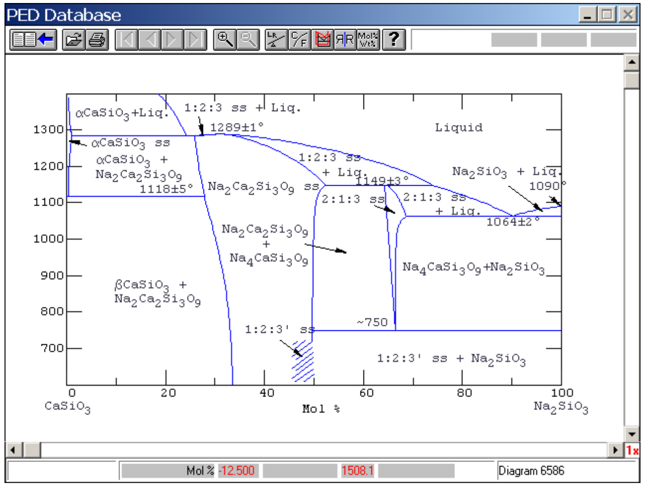
J. T. Kummer, "β-Alumina Electrolytes"; Chp. 5; pp. 141-175, in Progress in Solid State Chemistry, Vol. 7. Edited by H. Reiss and J. O. McCaldin. Pergamon Press (Elsevier Science Inc.), New York, New York, 1972.



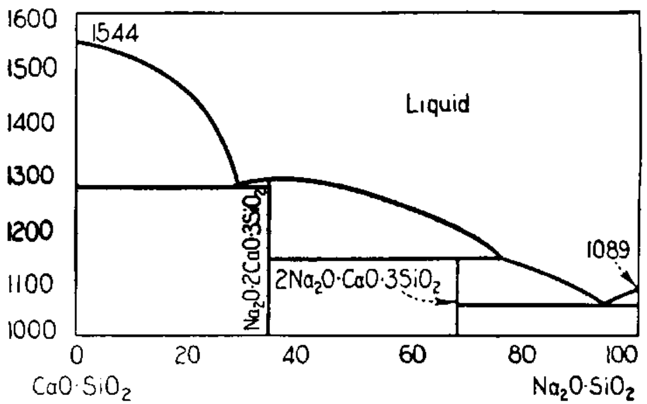


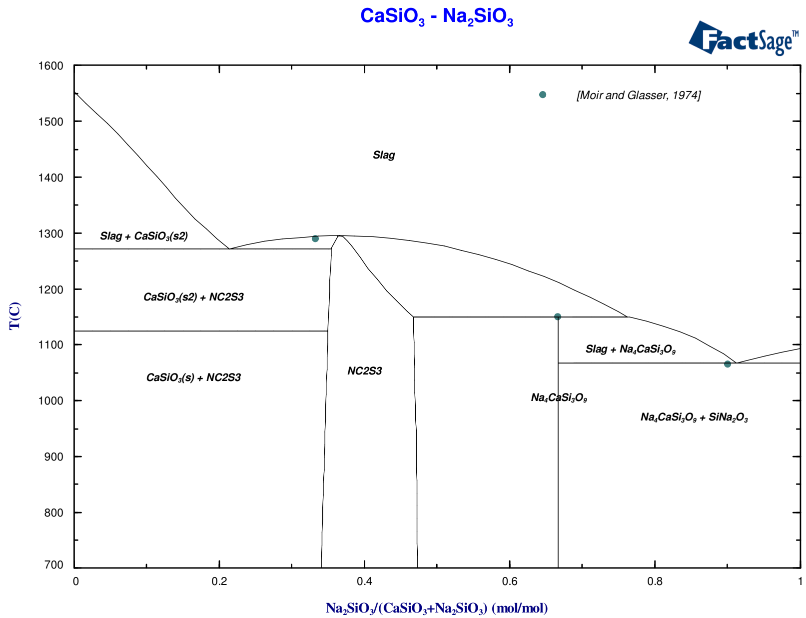
Orthosilicate isopletal section in CaO-Na_2O-SiO_2

G. K. Moir and F. P. Glasser, Trans. J. Br. Ceram. Soc., 73 [6], (1974), pp. 199-206



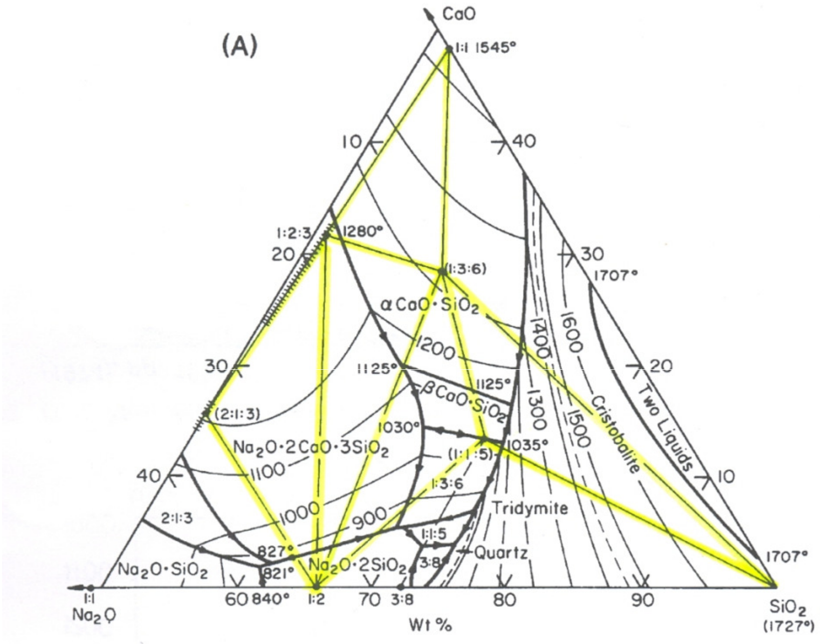
G. W. Morey and N. L. Bowen, J. Soc. Glass Technol., 9, 226-264 (1925).

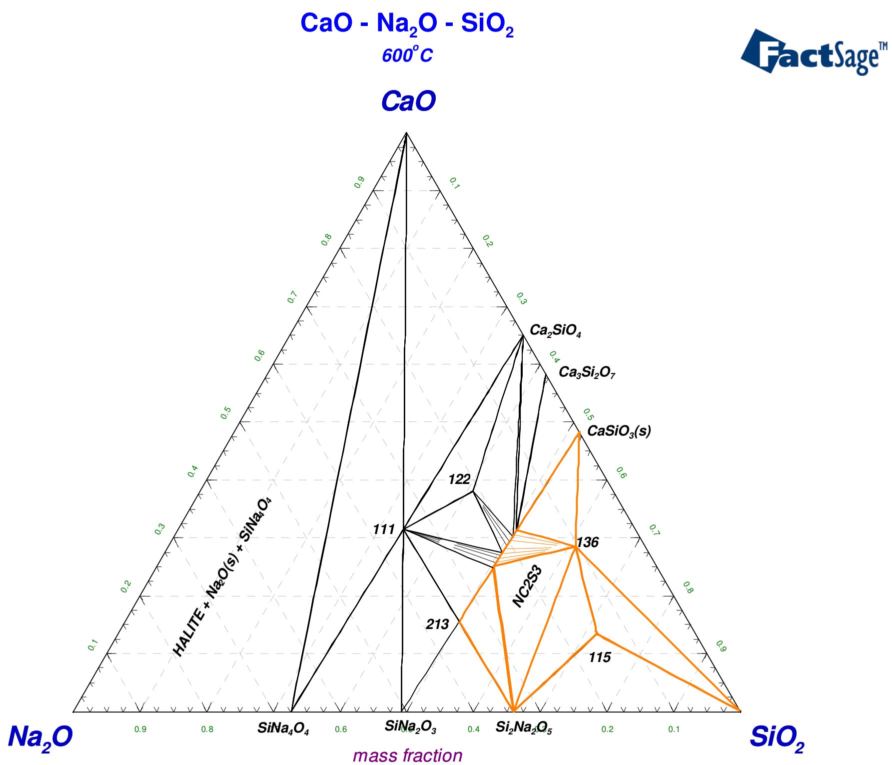




Isothermal section at 600°C in $CaO-Na_2O-SiO_2$

K.A. Shahid, F.P. Glasser, Phys. Chem. Glasses, 12 [2], (1971), pp.50-57.

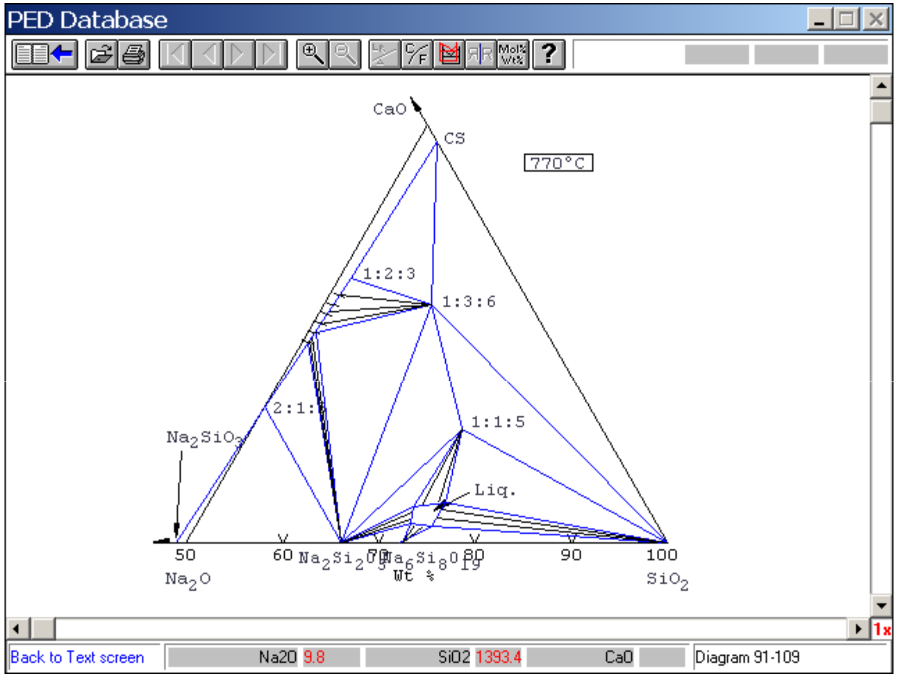


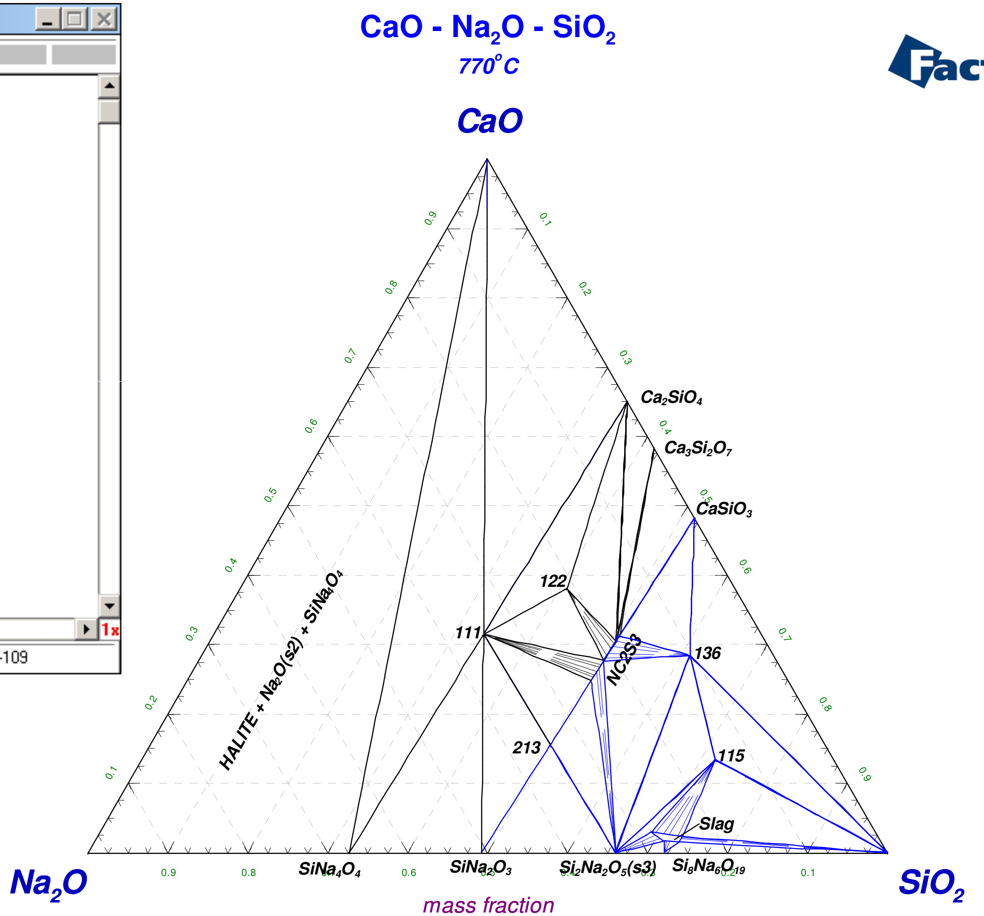


Phase	Description	Formula
111	Stoichiometric	Na_2CaSiO_4
115	Stoichiometric	$Na_2CaSi_5O_{12}$
122	Stoichiometric	$Na_2Ca_2Si_2O_7$
136	Stoichiometric	$Na_2Ca_3Si_6O_{16}$
213	Stoichiometric	$Na_4CaSi_3O_9$
NC2S3	Solid solution	$(Na^{1+},Va)_2(Ca^{2+},Va)(CaNa_2Si_3O_9{}^{2-})$

Isothermal section at 770°C in $CaO-Na_2O-SiO_2$

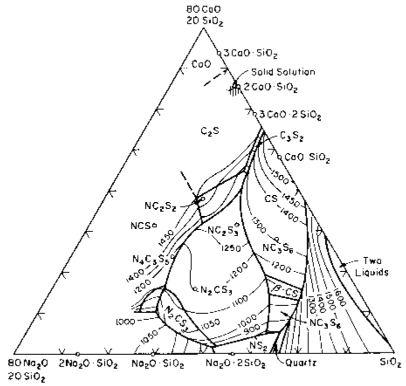
G. K. Moir and F. P. Glasser, Phys. Chem. Glasses, 17 [3] 45-53 (1976).



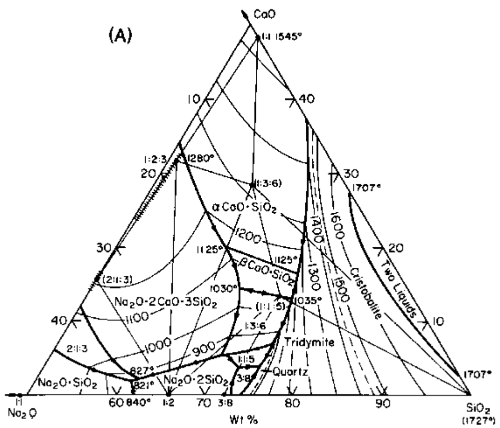


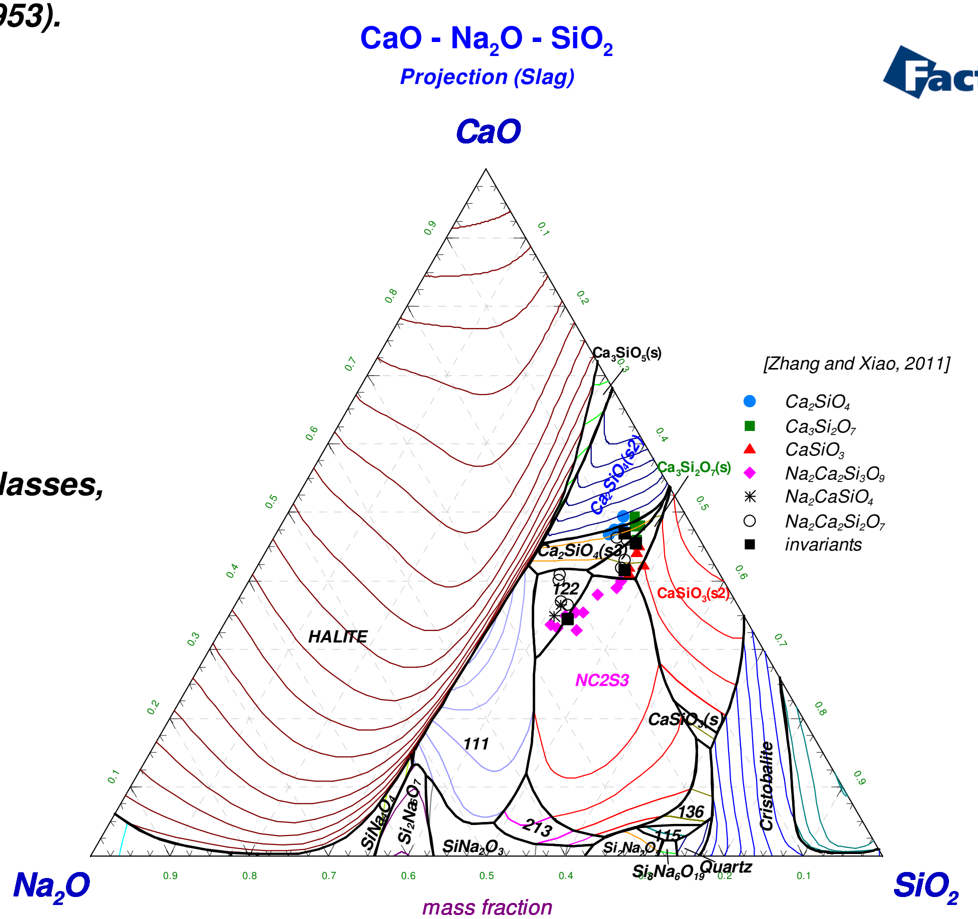
Liquidus surface in CaO-Na_2O-SiO_2

E. R. Segnit, Am. J. Sci., 251 [8] 586-601 (1953).



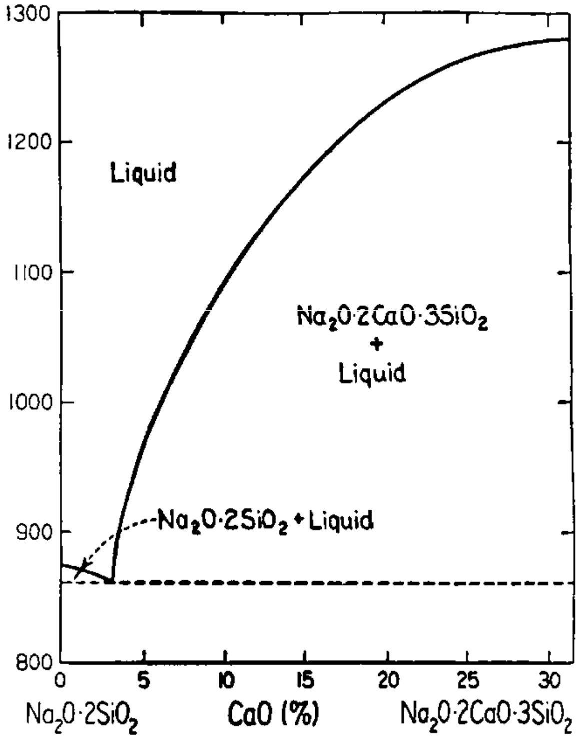
K.A. Shahid, F.P. Glasser, Phys. Chem. Glasses, 12 [2], (1971), pp.50-57

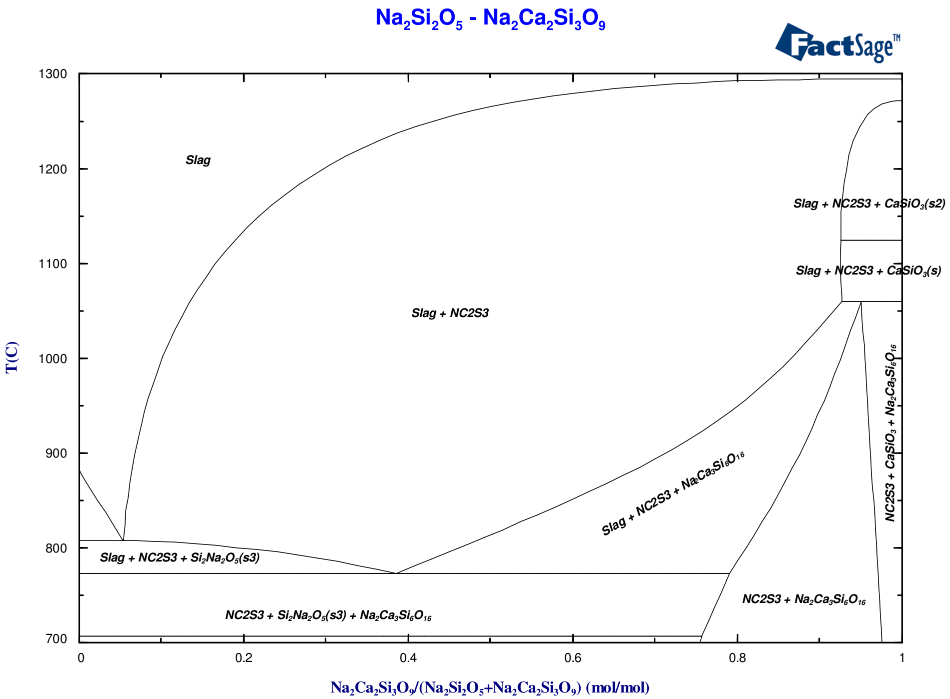




Isopletal section in $CaO-Na_2O-SiO_2$

G. K. Moir and F. P. Glasser, Trans. J. Br. Ceram. Soc., 73 [6], (1974), pp. 199-206





Isopletal section $FeKO_2$-SiO_2 in air

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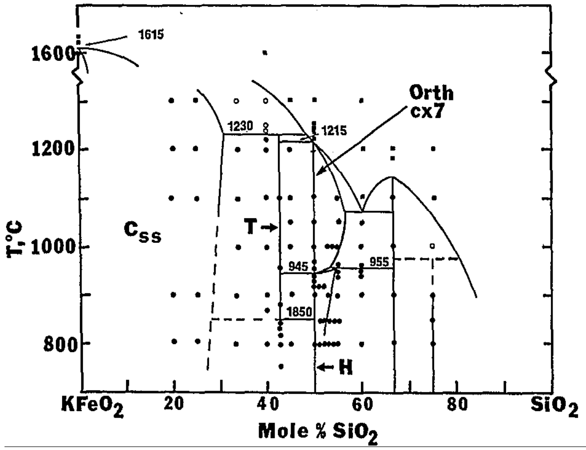
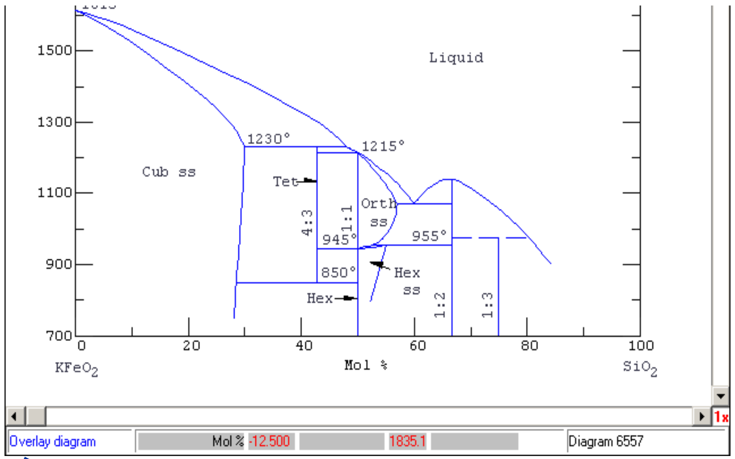
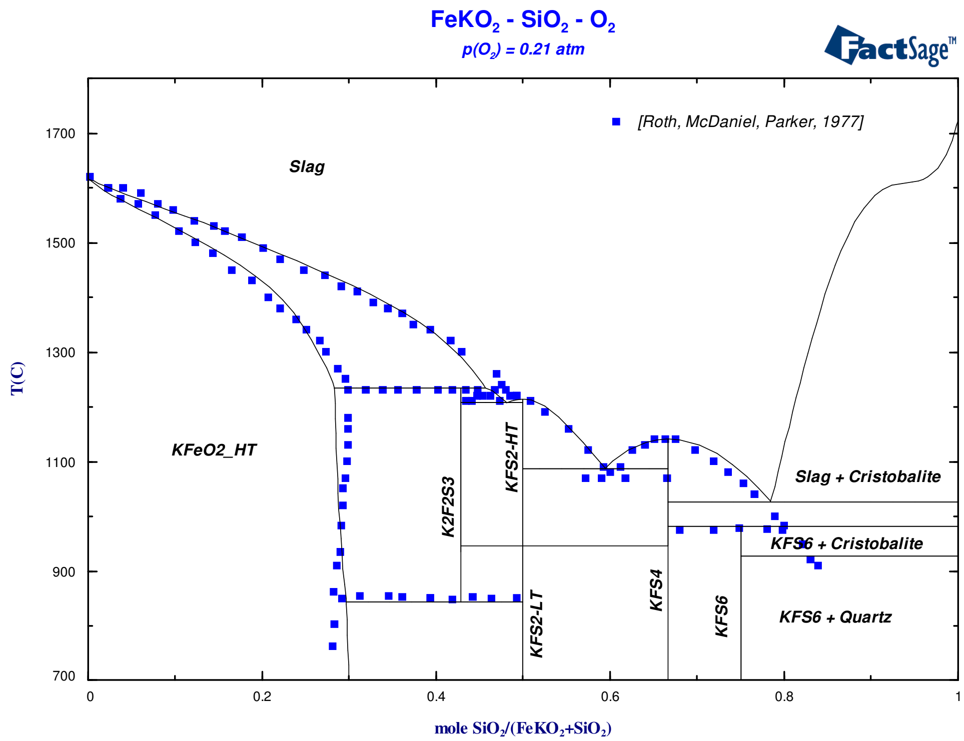
R.S. Roth, Adv. Chem. Ser., No. 186,, (1980), pp. 391-408.



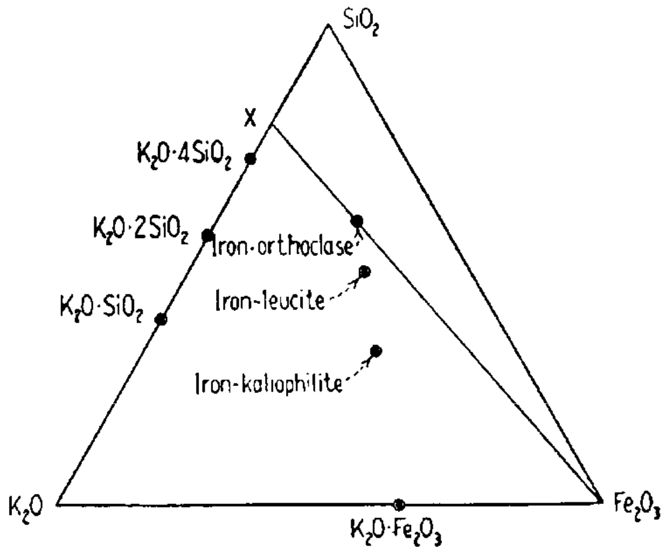
R.S. Roth, C.L. McDaniel, H.S. Parker., Geol. Soc. Am. Abstr., 9 [7], (1977), p. 1149.

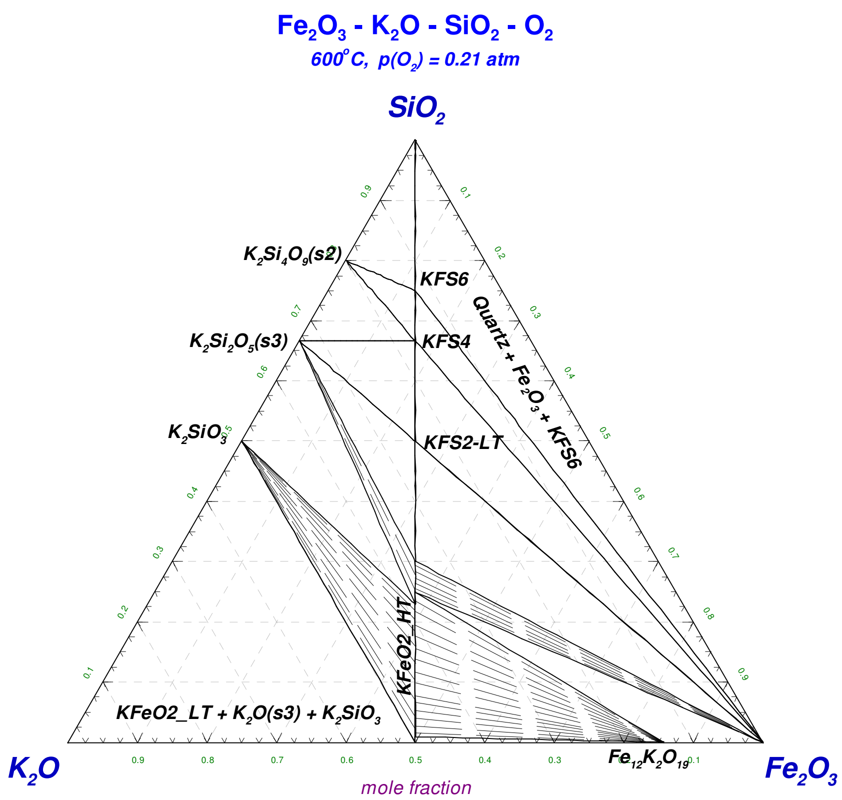




Isothermal section at 600°C in Fe_2O_3-K_2O-SiO_2 in air

G.T. Faust, Am. Mineral, 21 [12], (1936), pp. 735-763.

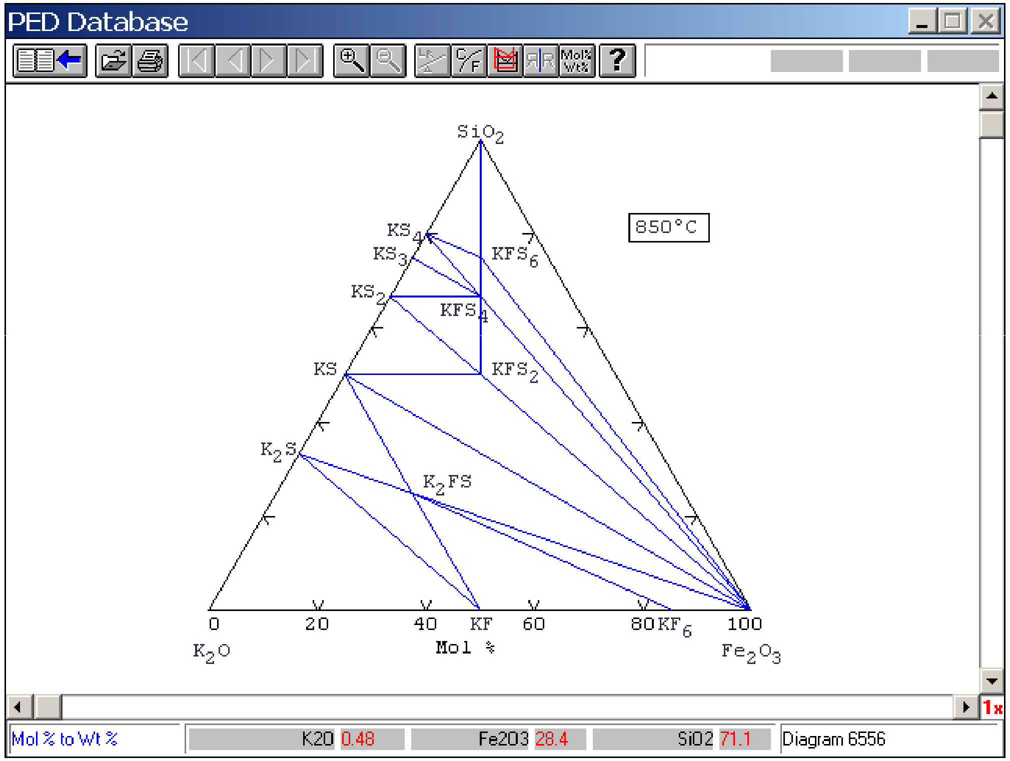


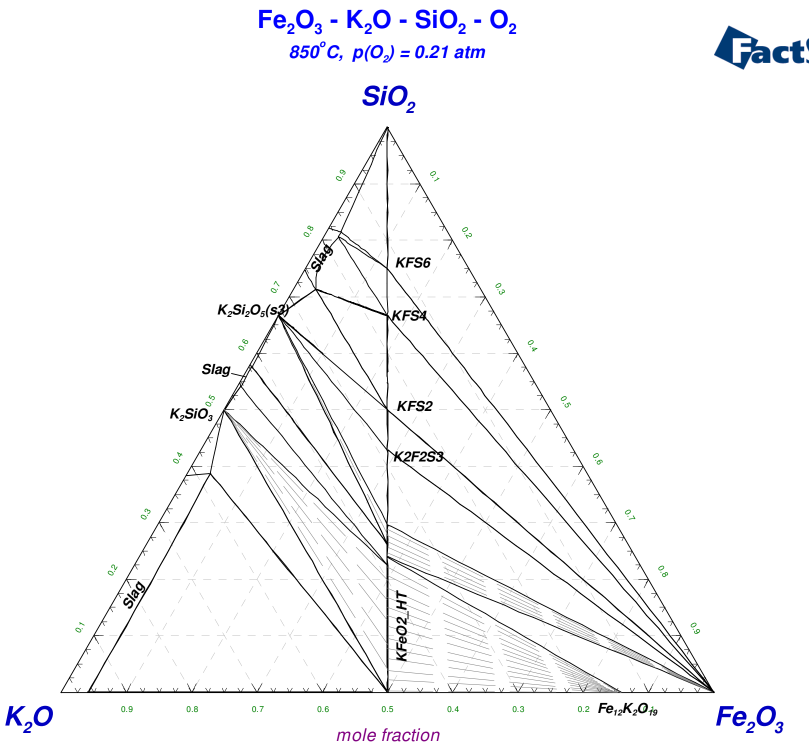


Phase	Description	Formel
KFS2-HT	Stoichiometric	$Fe_2K_2Si_2O_8$
KFS2-LT	Stoichiometric	$Fe_2K_2Si_2O_8$
KFS4	Stoichiometric	$Fe_2K_2Si_4O_{12}$
KFS6	Stoichiometric	$Fe_2K_2Si_6O_{16}$
K2F2S3	Stoichiometric	$Fe_4K_4Si_3O_{14}$
KFeO2-HT	Solid solution	$(K^{1+},Va)(Fe^{3+},Si^{4+})(O^{2-})_2$
KFeO2-LT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

Isothermal section at 850°C in Fe_2O_3-K_2O-SiO_2 in air

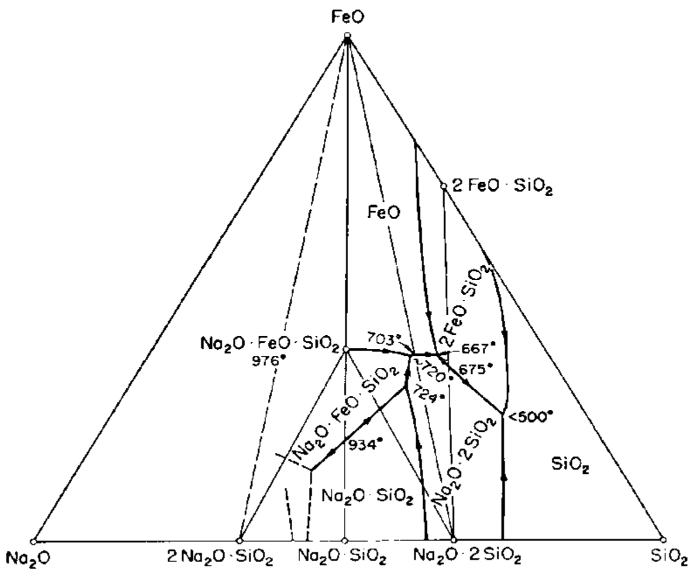
A.P. Protsyuk, G.A. Konechnyi, L.G. Latysheva, Izv. Akad. Nauk SSSR, Neorg. Mater., 15 [1], (1979), pp. 173-174.

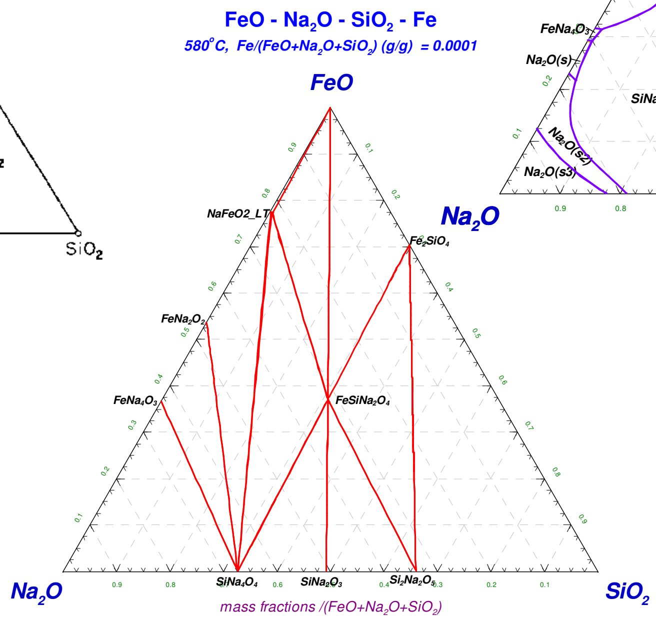


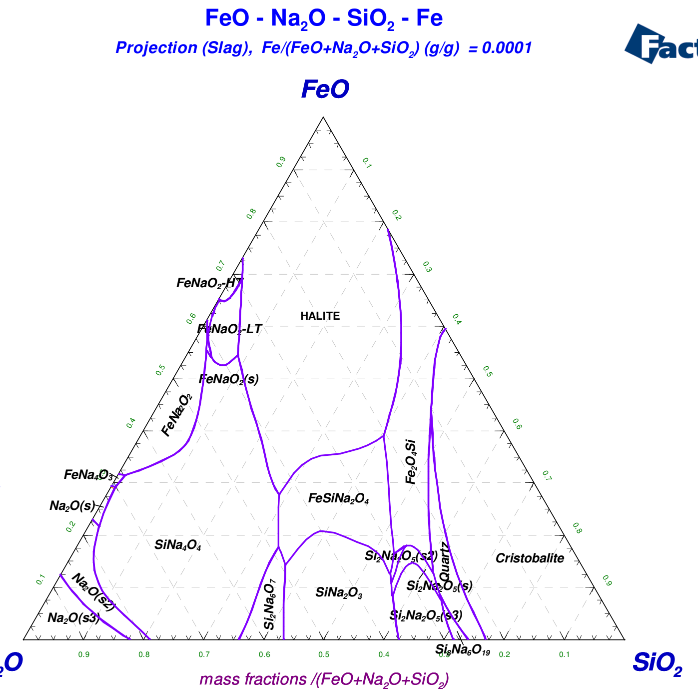


Liquidus surface in $FeO-Na_2O-SiO_2$ in equilibrium with Fe

P. T. Carter and M. Ibrahim, J. Soc. Glass Technol., 36 [170] 142-163 (1952).

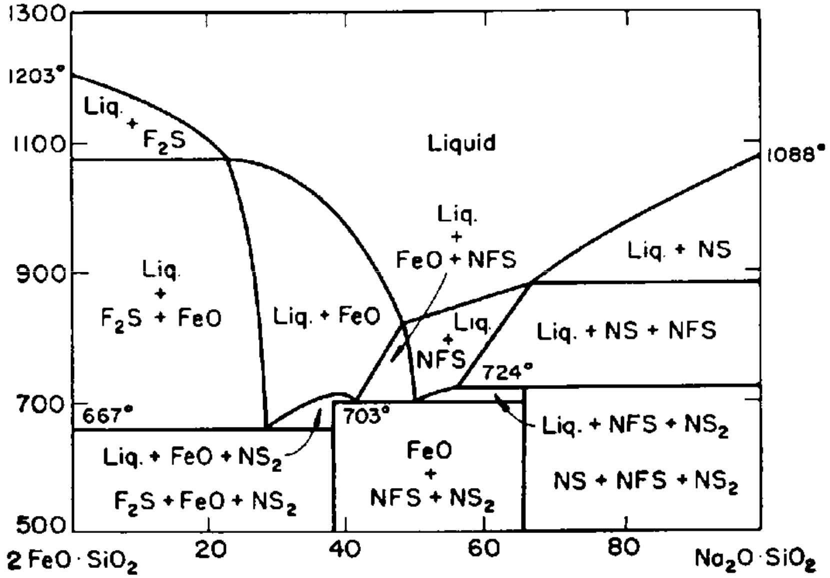


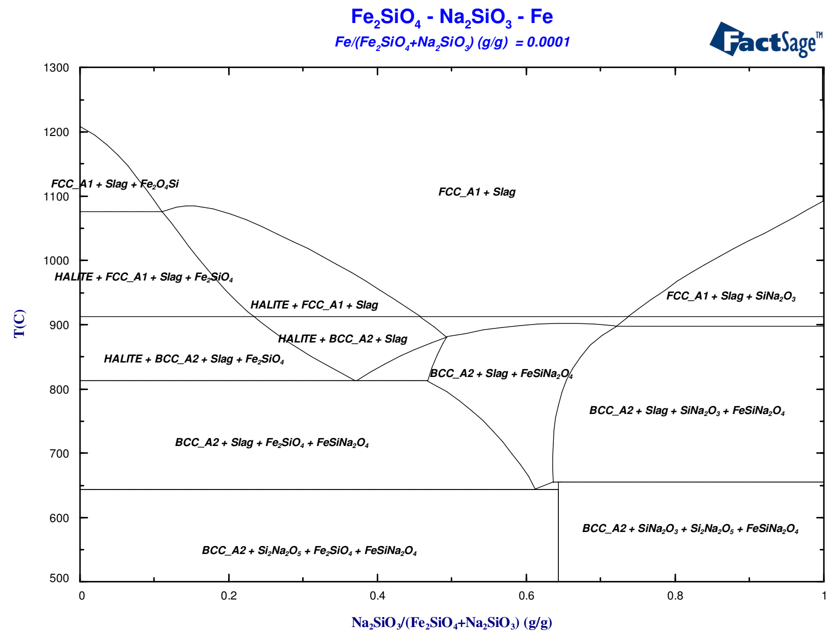




Isopletal section in Fe_2SiO_4-Na_2SiO_3 in equilibrium with Fe

P. T. Carter and M. Ibrahim, J. Soc. Glass Technol., 36 [170] 142-163 (1952).





Isopletal section in Fe_2SiO_4-Na_4SiO_4 in equilibrium with Fe

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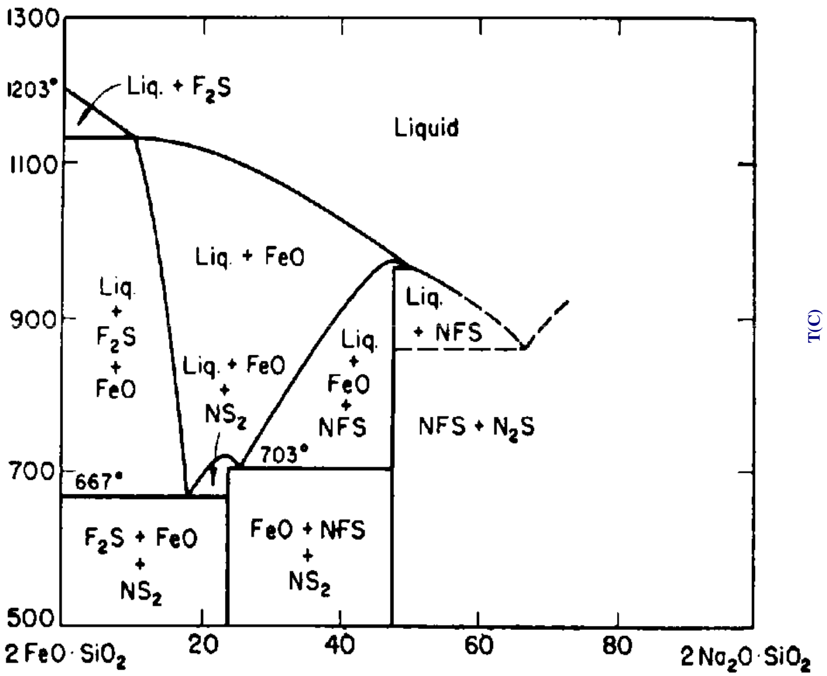
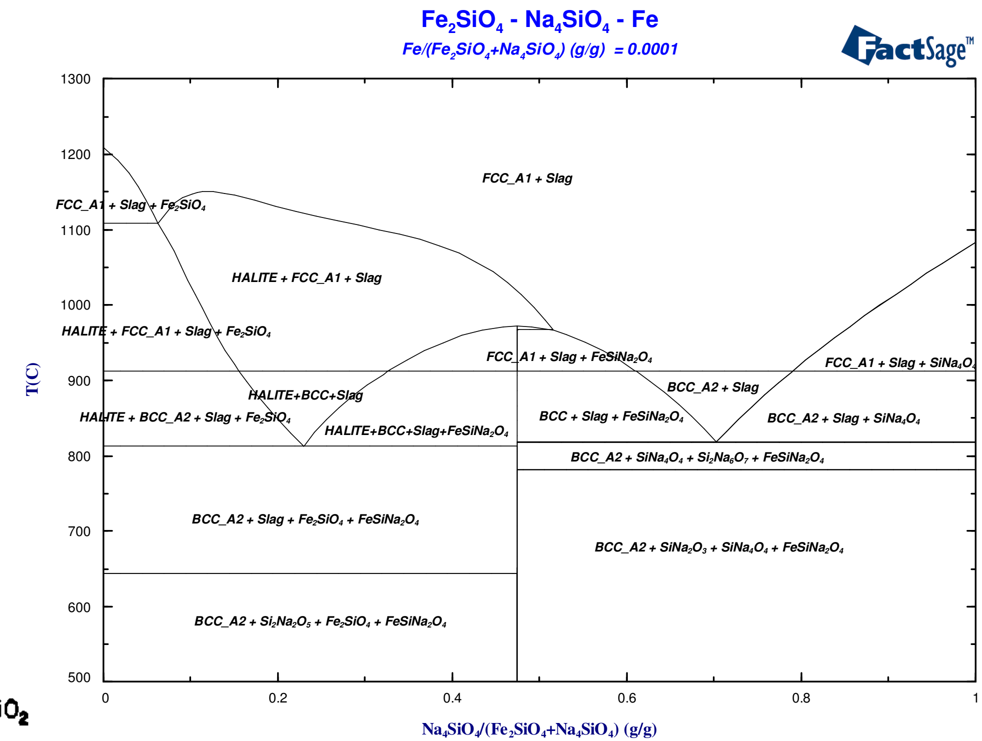
P. T. Carter and M. Ibrahim, J. Soc. Glass Technol., 36 [170] 142-163 (1952).

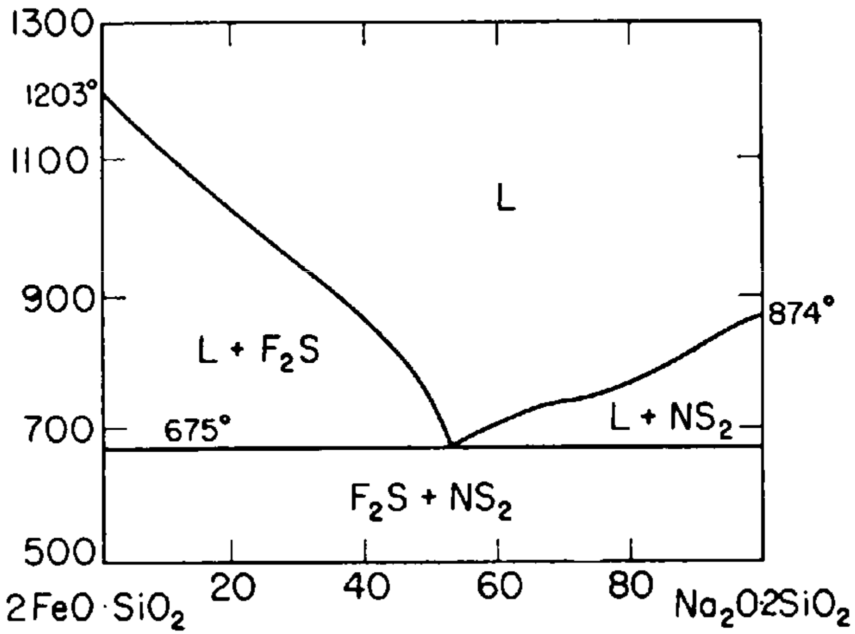


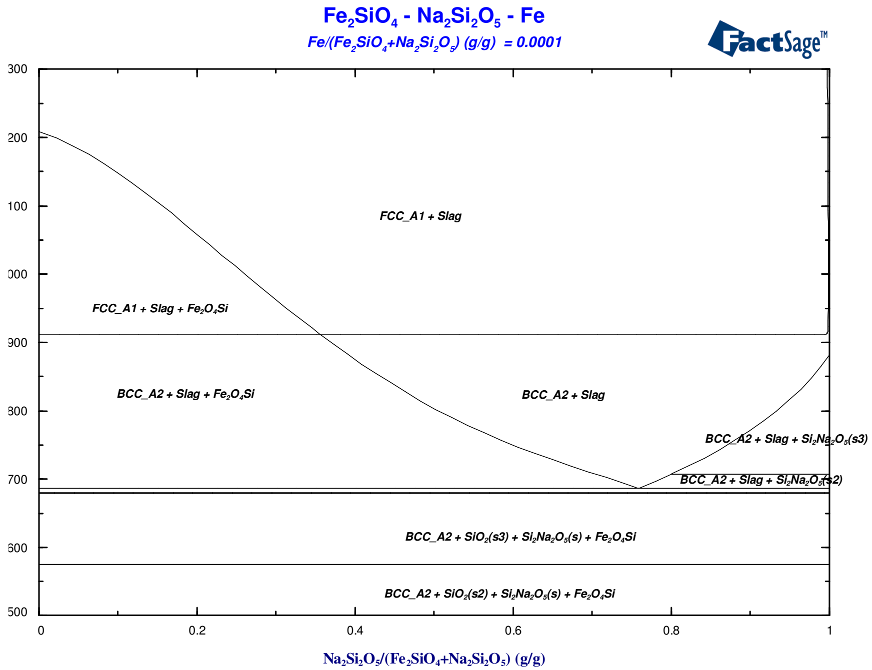


Isopletal section in Fe_2SiO_4-$Na_2Si_2O_5$ in equilibrium with Fe

GTT-Technologies

P. T. Carter and M. Ibrahim, J. Soc. Glass Technol., 36 [170] 142-163 (1952).

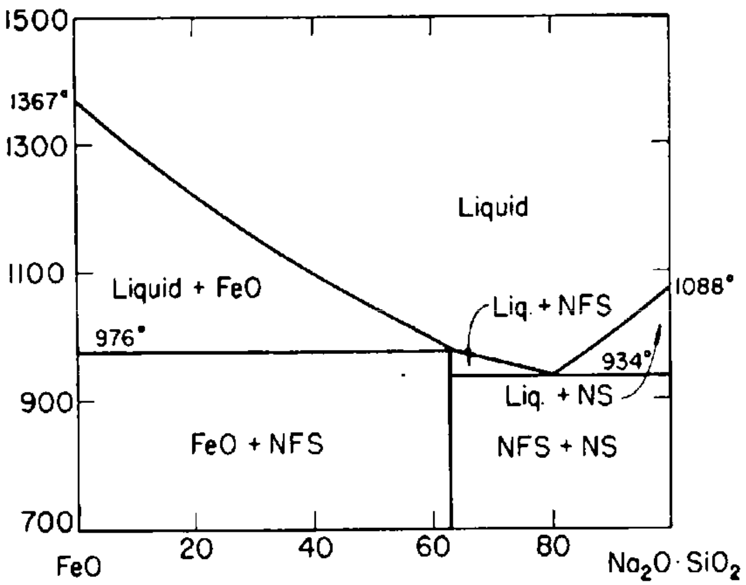


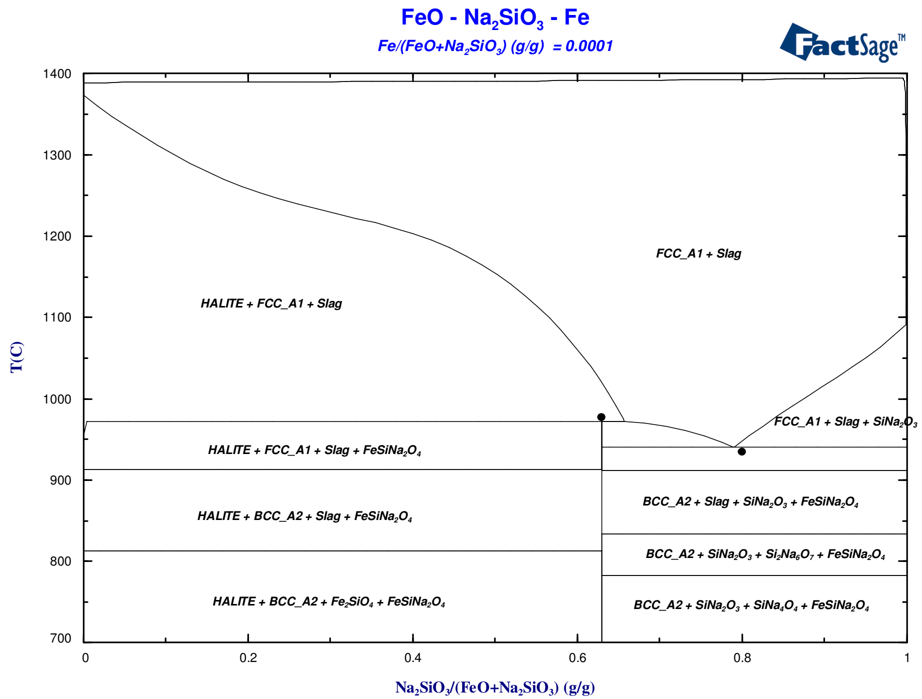


Isopletal section in Halite-Na_2SiO_3 in equilibrium with Fe

GTT-Technologies

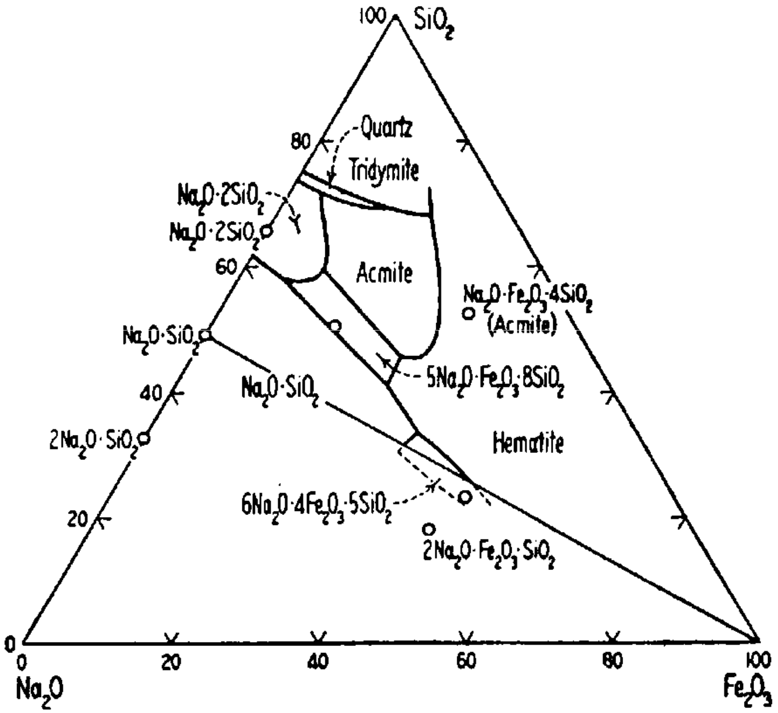
P. T. Carter and M. Ibrahim, J. Soc. Glass Technol., 36 [170] 142-163 (1952).

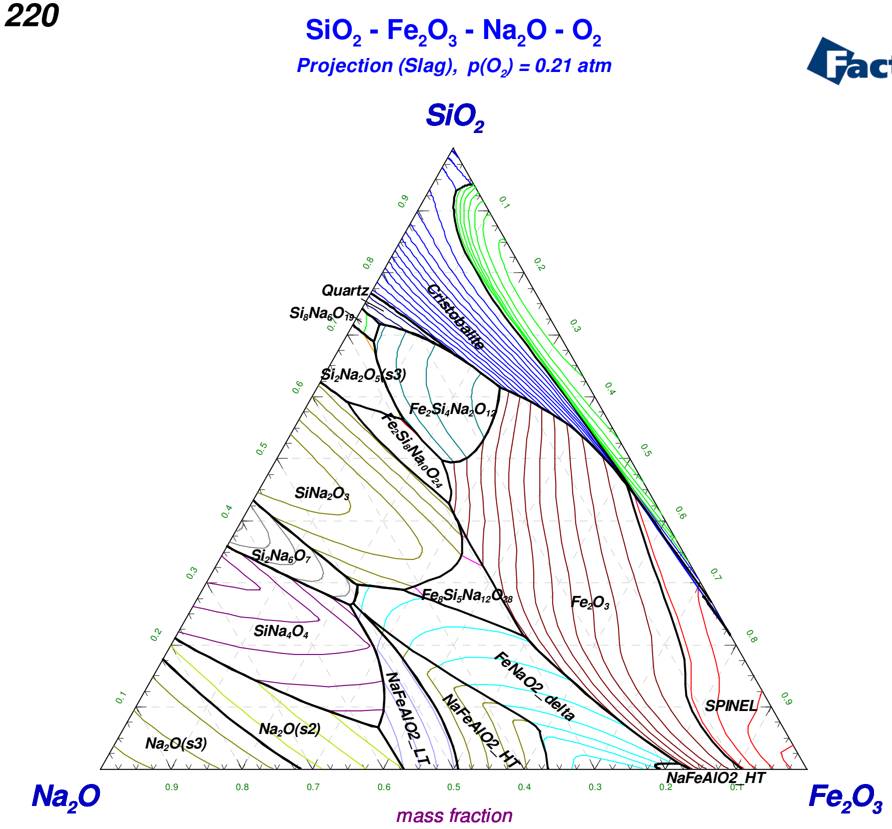




Liquidus surface in Fe_2O_3-Na_2O-SiO_2 in air

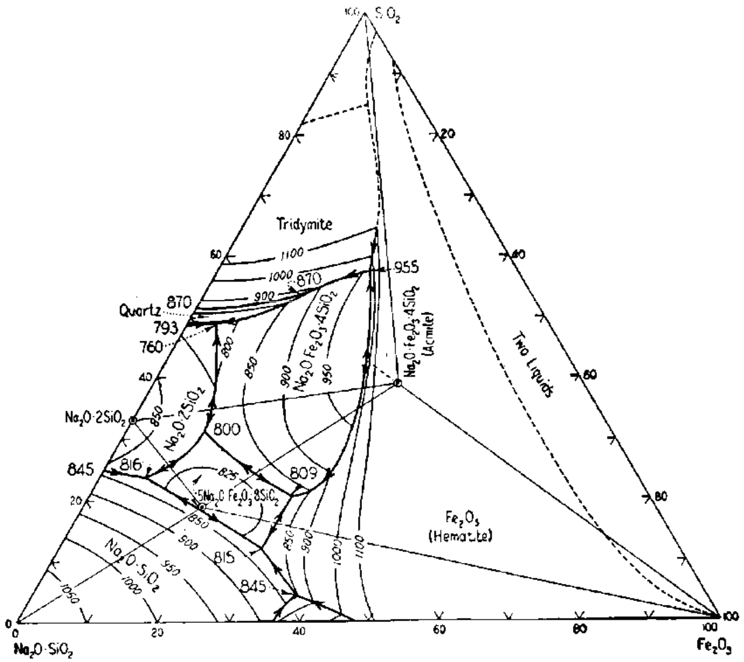
N.L. Bowen, J.F. Schairer, H.W.V. Willems, Am. J. Sci., 220 (20), [20], (1930), pp. 405-455

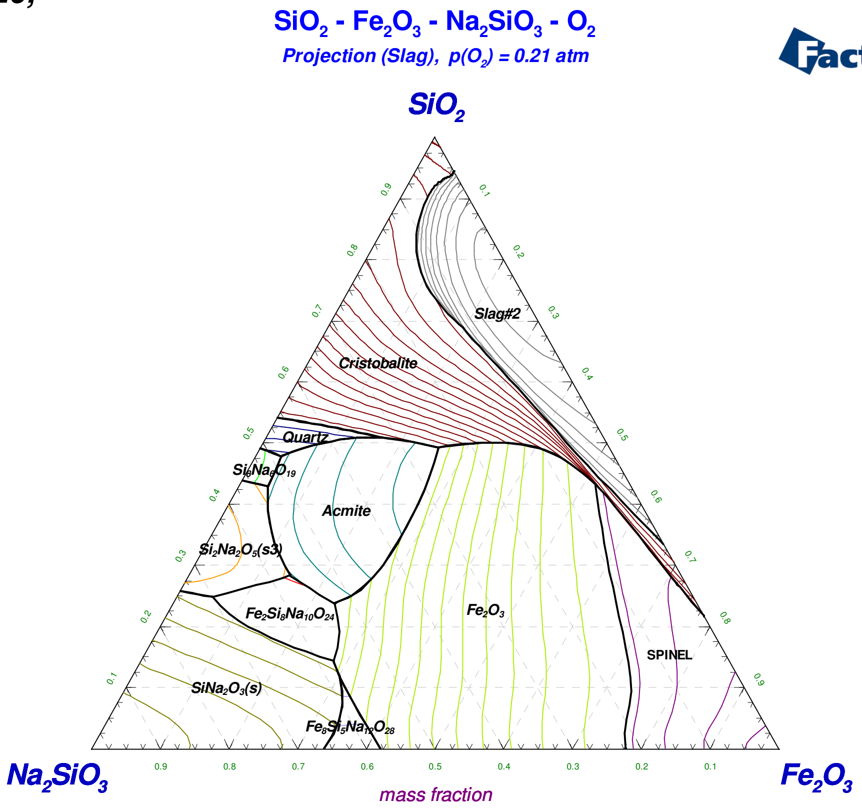




Liquidus surface in Fe_2O_3-Na_2SiO_3-SiO_2 in air

N.L. Bowen, J.F. Schairer, H.W.V. Willems, Am. J. Sci., 220, [20], (1930), pp. 405-455.





Isothermal section at 825º C in Fe_2O_3-Na_2SiO_3-SiO_2 in air

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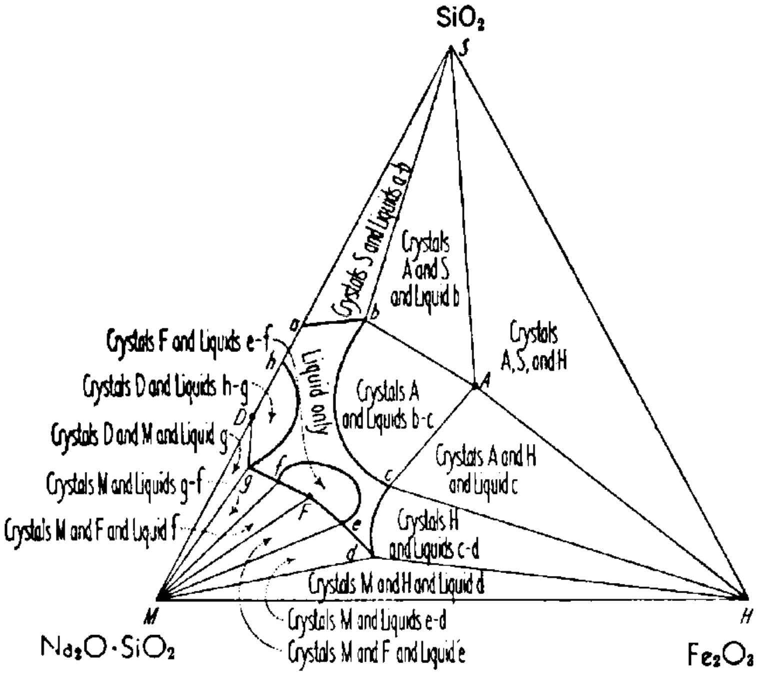
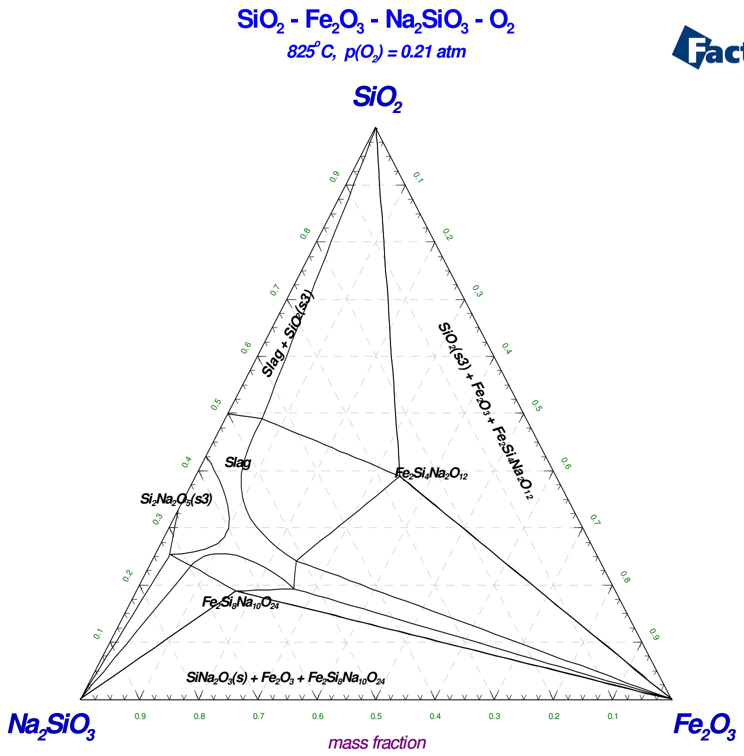
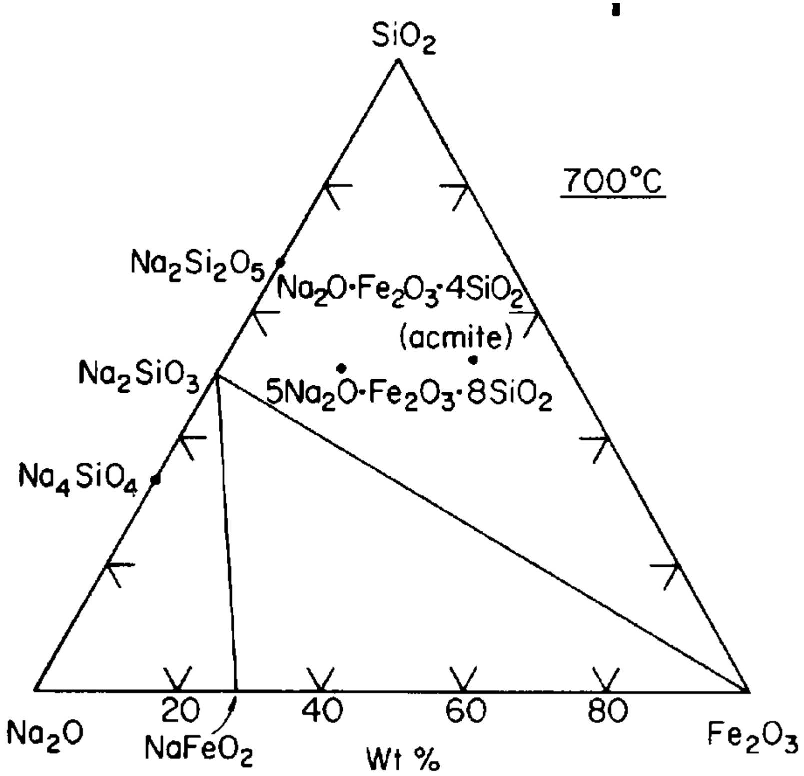
N.L. Bowen, J.F. Schairer, H.W.V. Willems, Am. J. Sci., 220, [20], (1930), pp. 405-455.

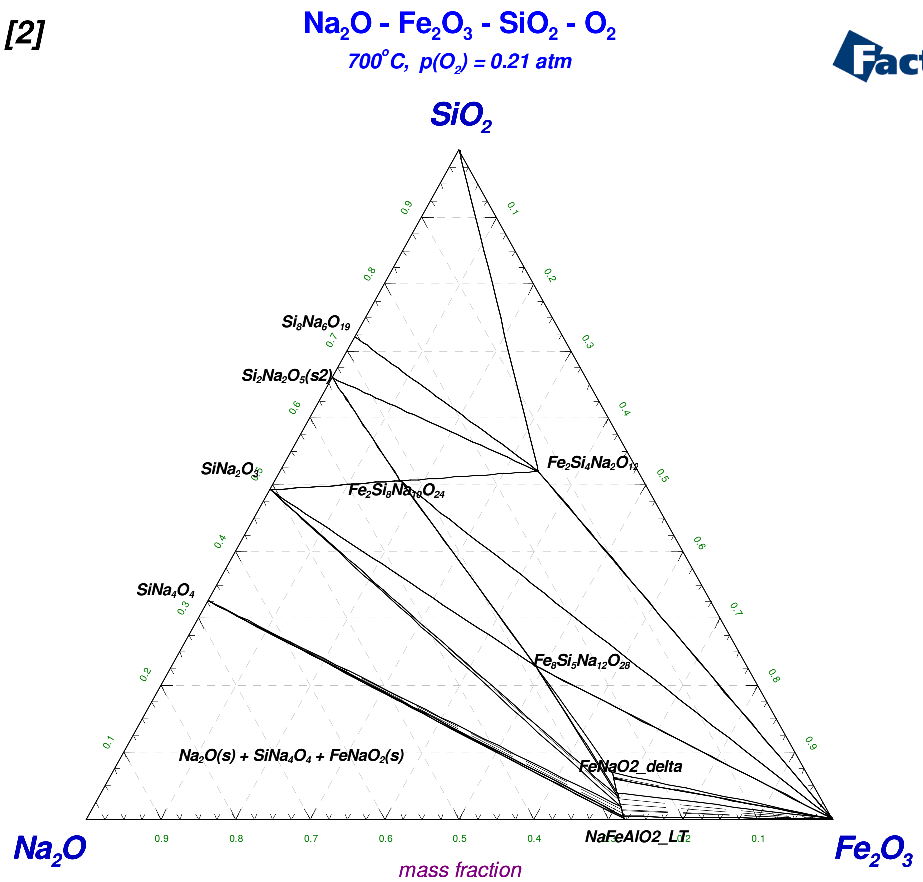




Isothermal section at 700º C in Fe_2O_3-Na_2O-SiO_2 in air

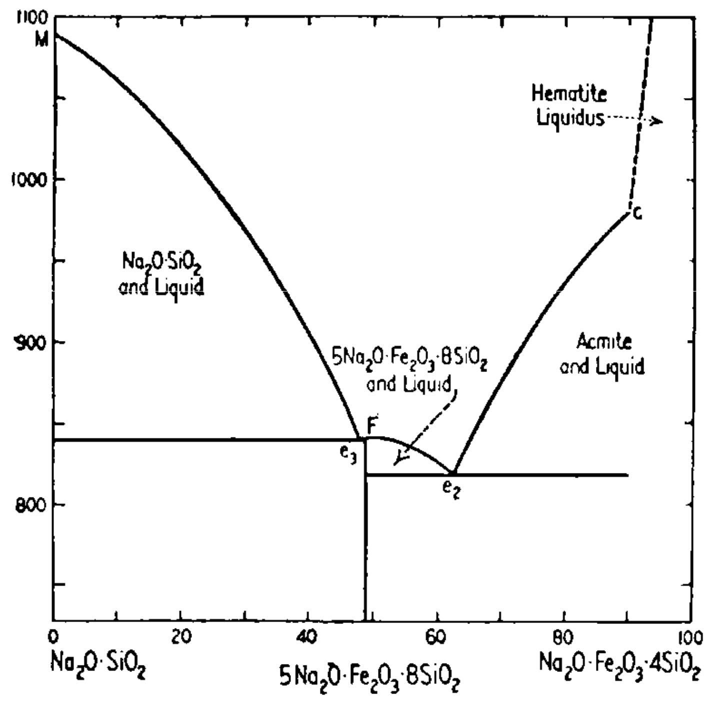
D. W. Collins and L. N. Mulay, J. Am. Ceram. Soc., 53 [2] 74-76 (1970).

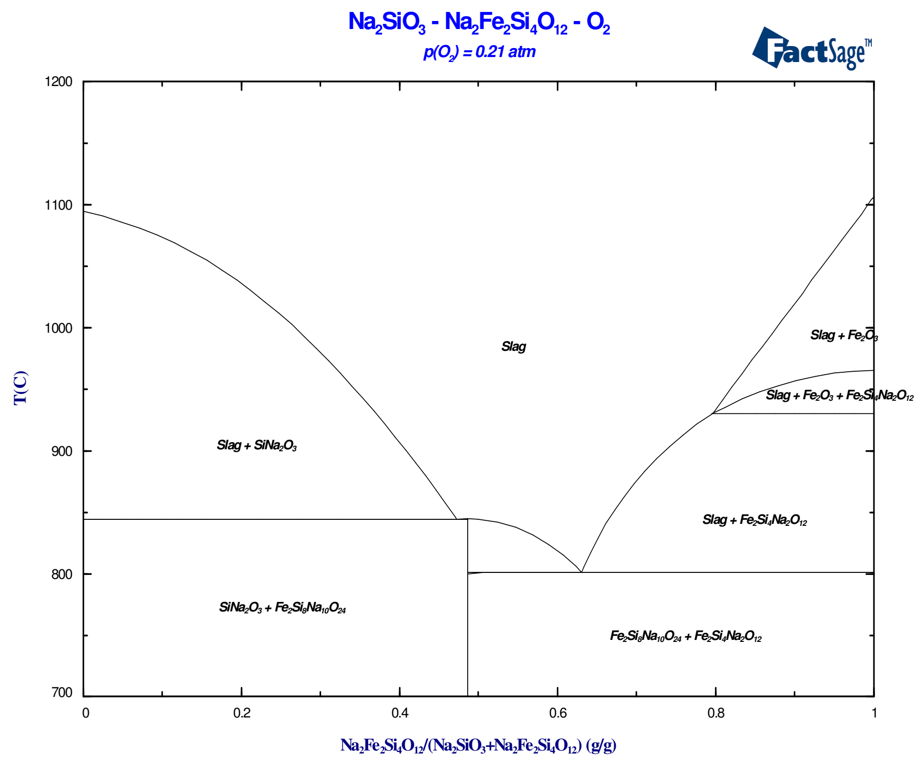




Isopletal section Acmite-Na_2SiO_3 in air

N.L. Bowen, J.F. Schairer, H.W.V. Willems, Am. J. Sci., 220, [20], (1930), pp. 405-455.

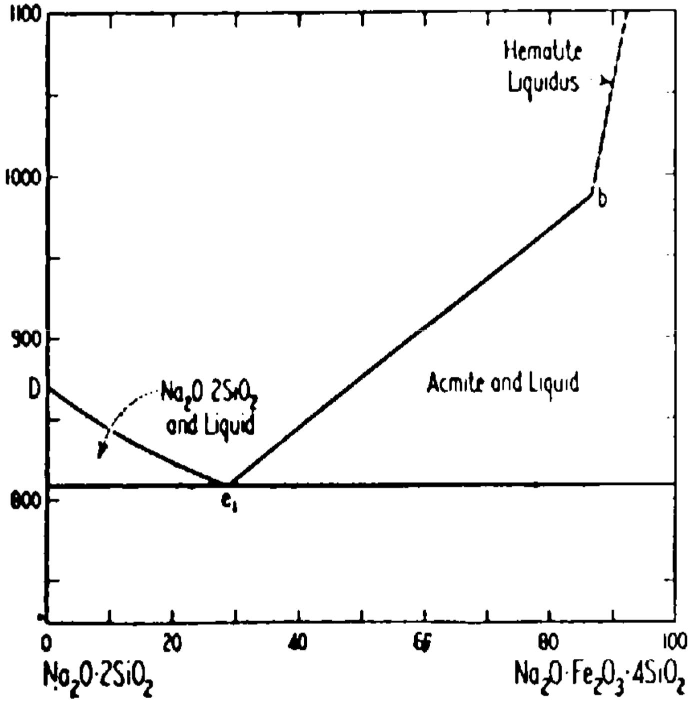


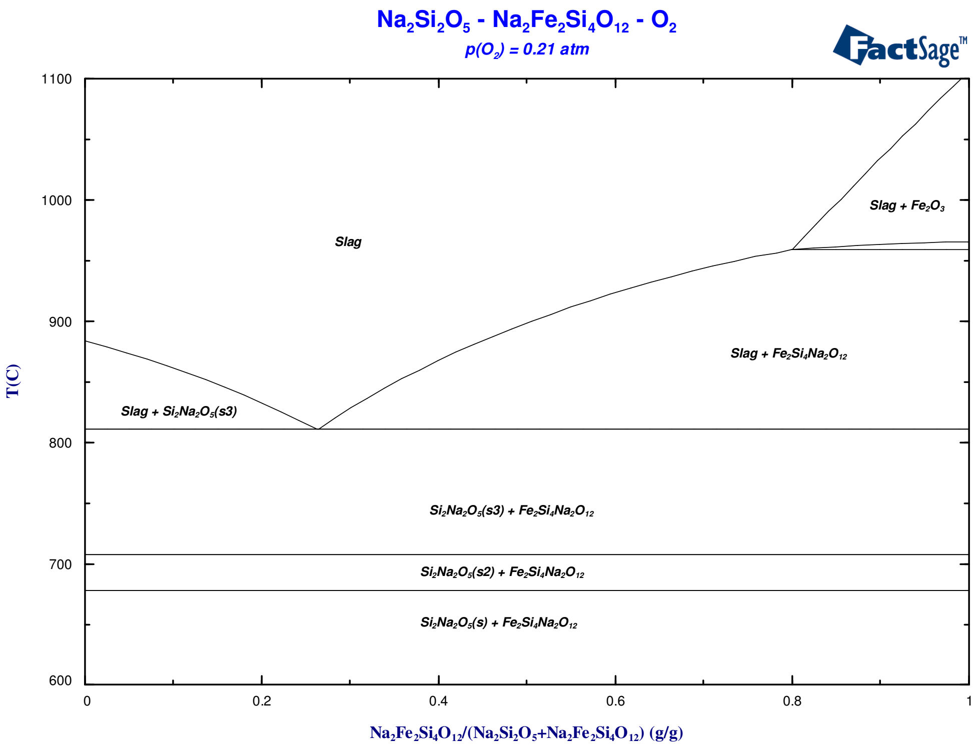


Isopletal section Acmite-$Na_2Si_2O_5$ in air

GTT-Technologies

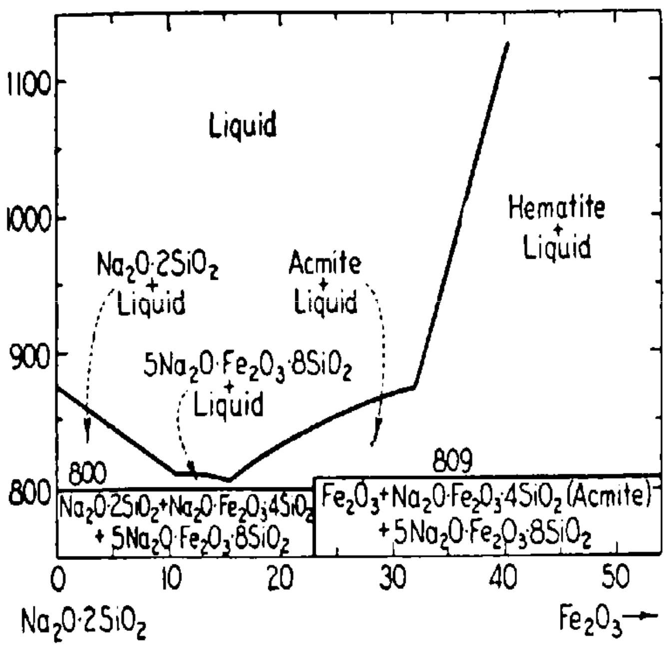
N.L. Bowen, J.F. Schairer, H.W.V. Willems, Am. J. Sci., 220, [20], (1930), pp. 405-455.

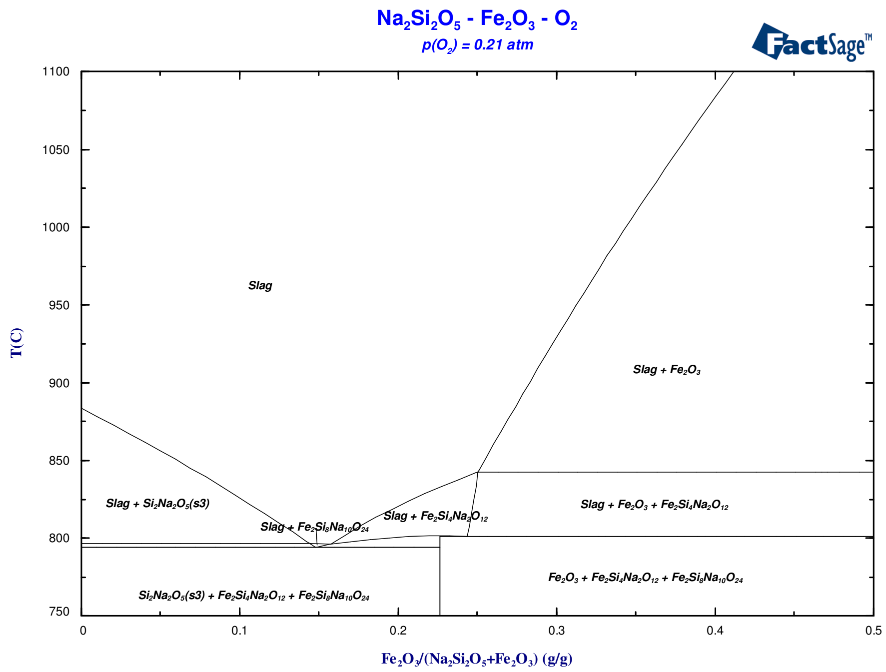




Isopletal section Fe_2O_3-$Na_2Si_2O_5$ in air

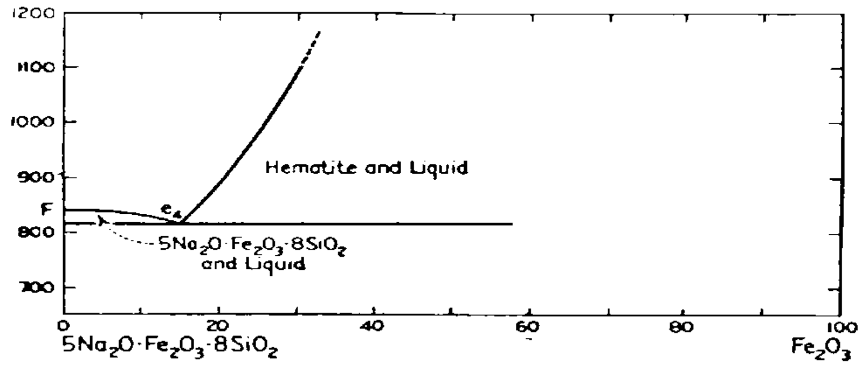
N.L. Bowen, J.F. Schairer, H.W.V. Willems, Am. J. Sci., 220, [20], (1930), pp. 405-455.

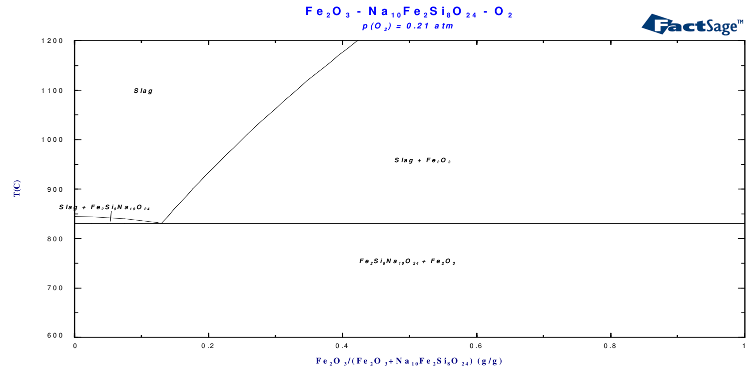




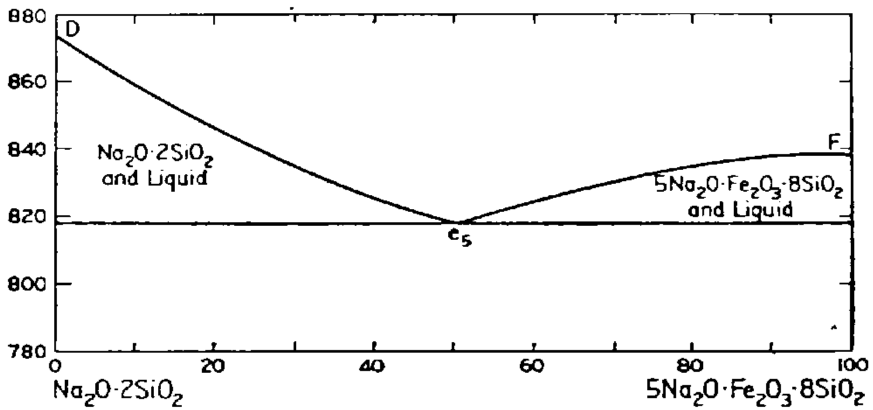
Isopletal sections with $5Na_2O \cdot Fe_2O_3 \cdot 8SiO_2$

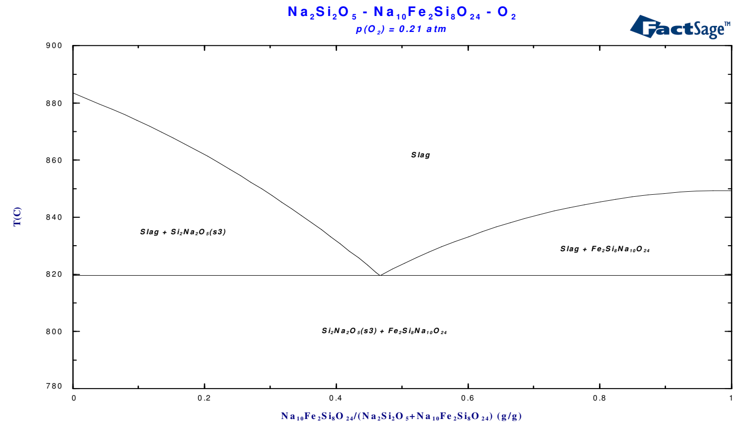
N.L. Bowen, J.F. Schairer, H.W.V. Willems, Am. J. Sci., 220, [20], (1930), pp. 405-455.





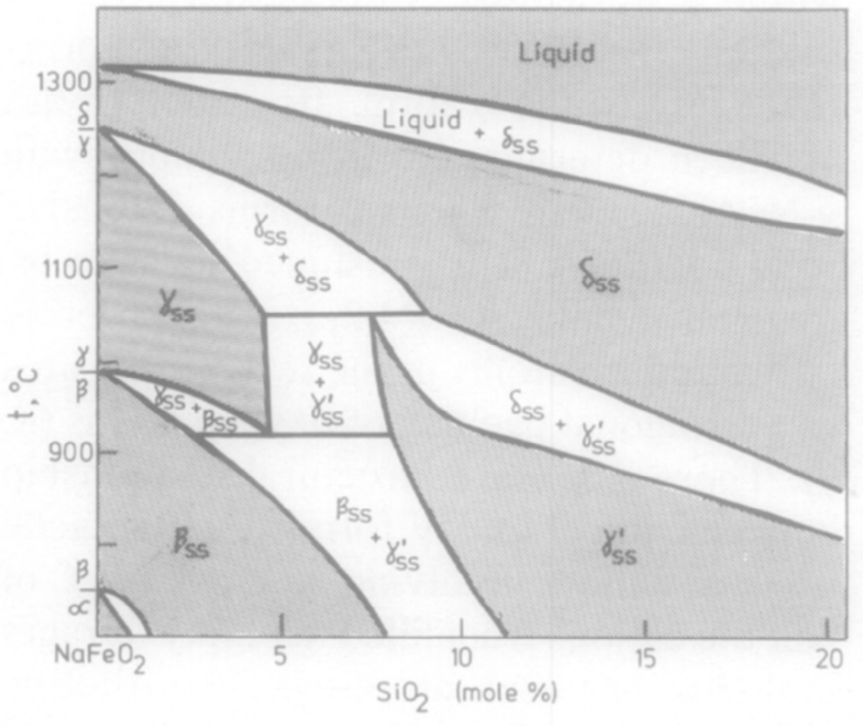
N.L. Bowen, J.F. Schairer, H.W.V. Willems, Am. J. Sci., 220, [20], (1930), pp. 405-455.

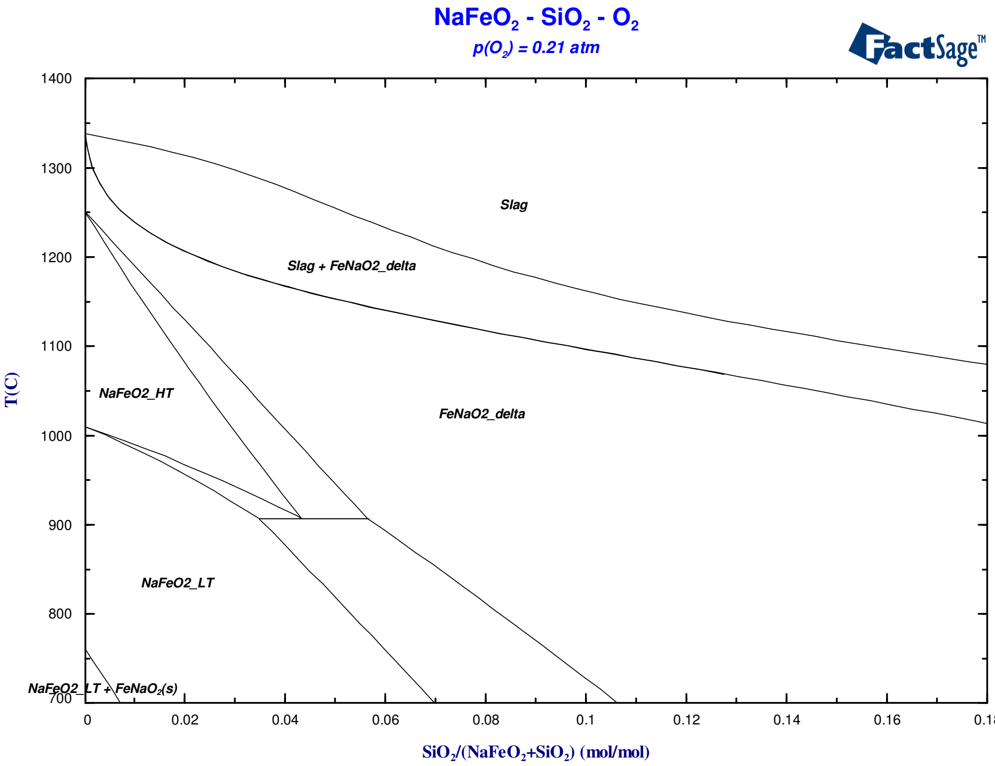




Isopletal section $FeNaO_2$-SiO_2 in air

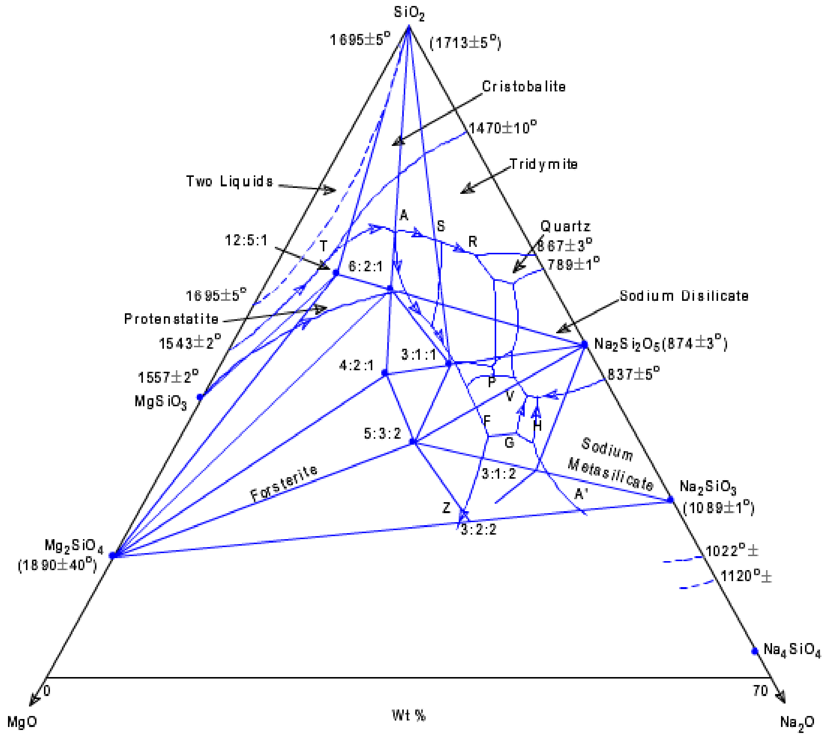
I. E. Grey and C. Li, J. Solid State Chem., 69 [1] 116-125 (1987).

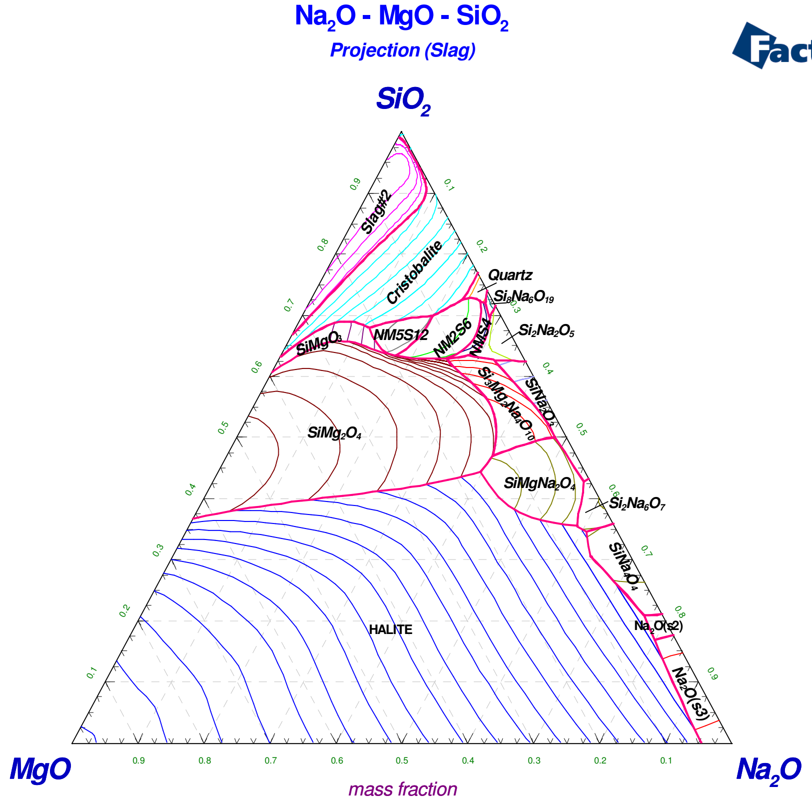




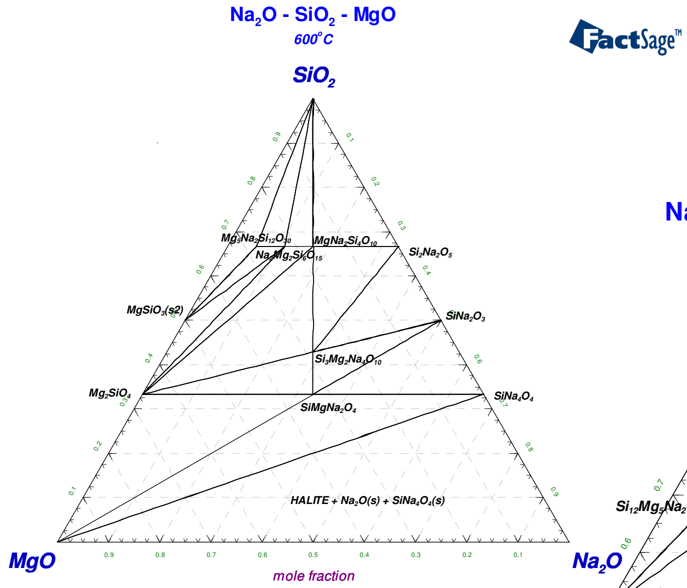
Liquidus surface in $MgO-Na_2O-SiO_2$

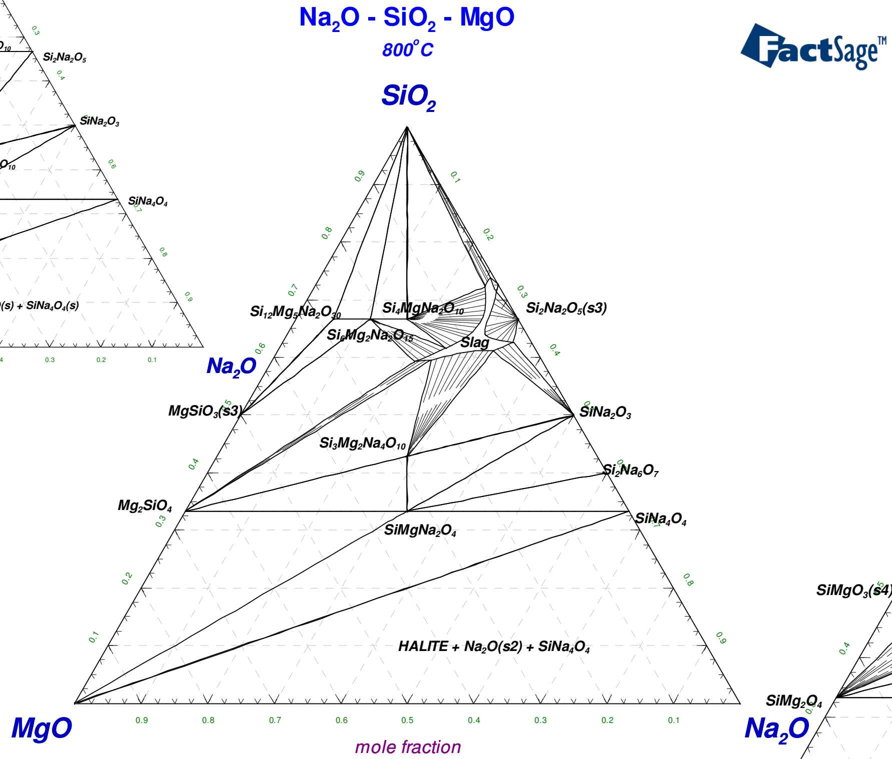
J. F. Schairer, J. Am. Ceram. Soc., 40 [7] 215-235 (1957).

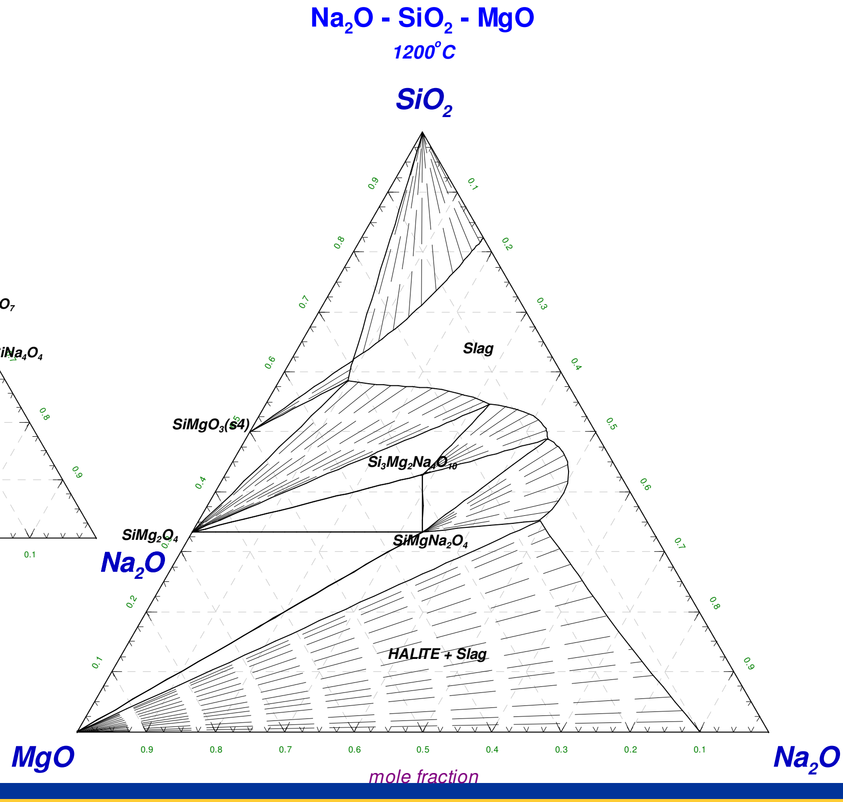




Predicted isothermal sections in MgO-Na_2O-SiO_2





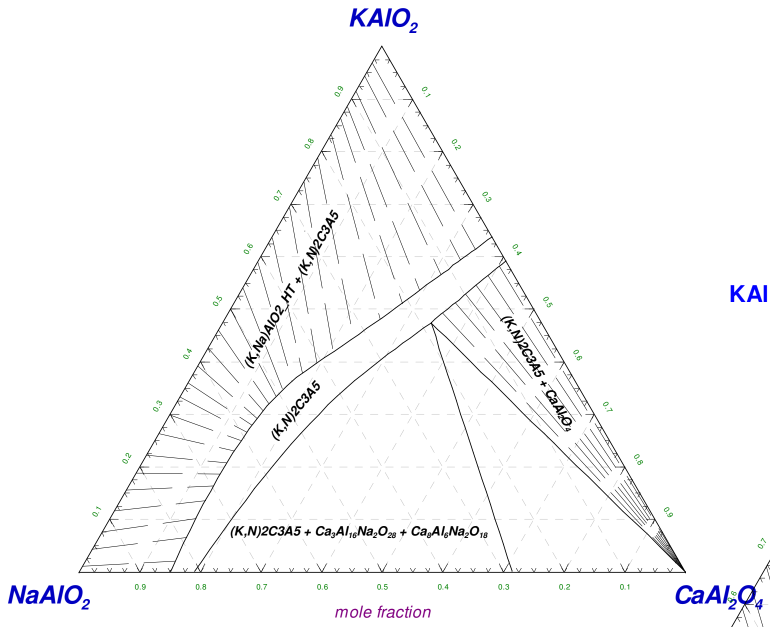


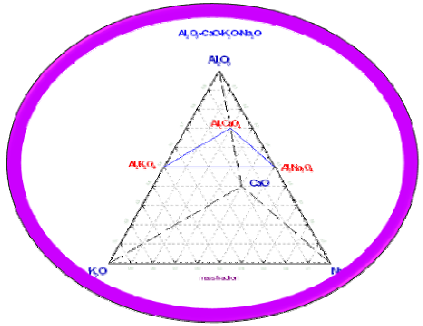
Proposed isothermal sections in Al_2O_3-CaO-K_2O-Na_2O

GTT-Technologies

$KAlO_2$ - $NaAlO_2$ - $CaAl_2O_4$

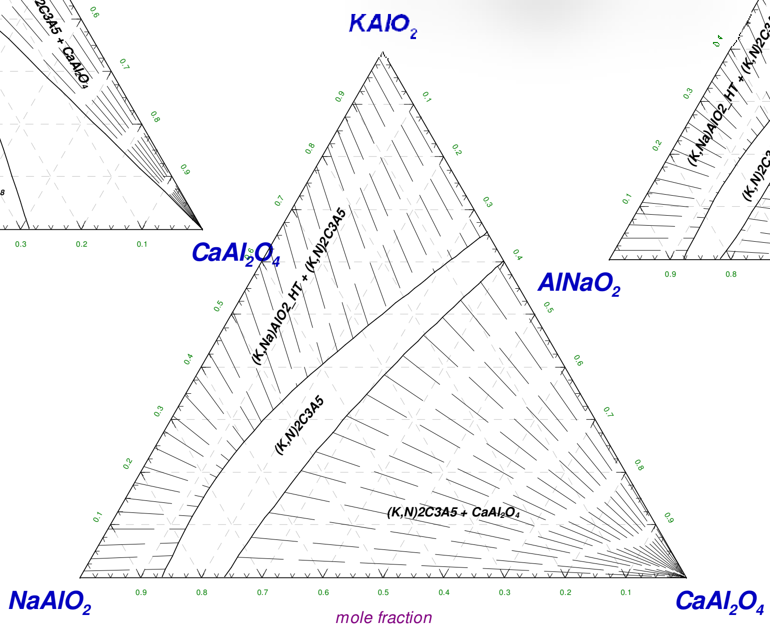
600°C





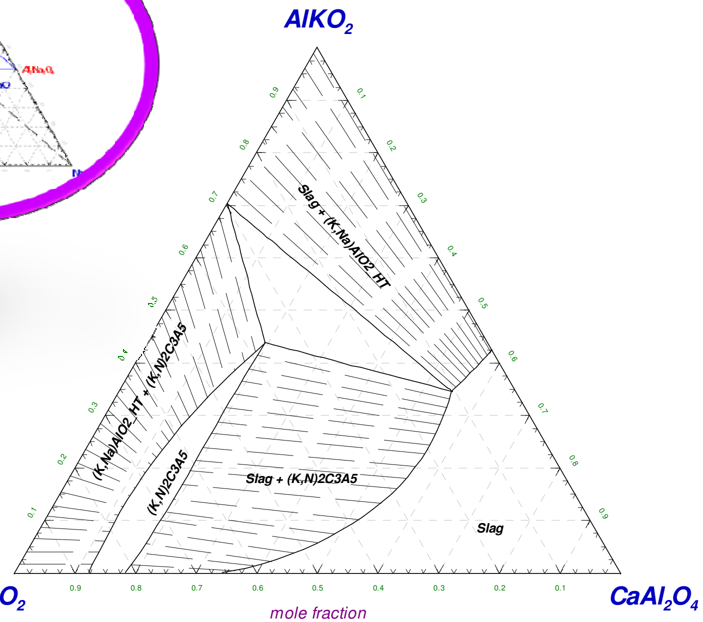
$KAlO_2$ - $NaAlO_2$ - $CaAl_2O_4$

1100°C



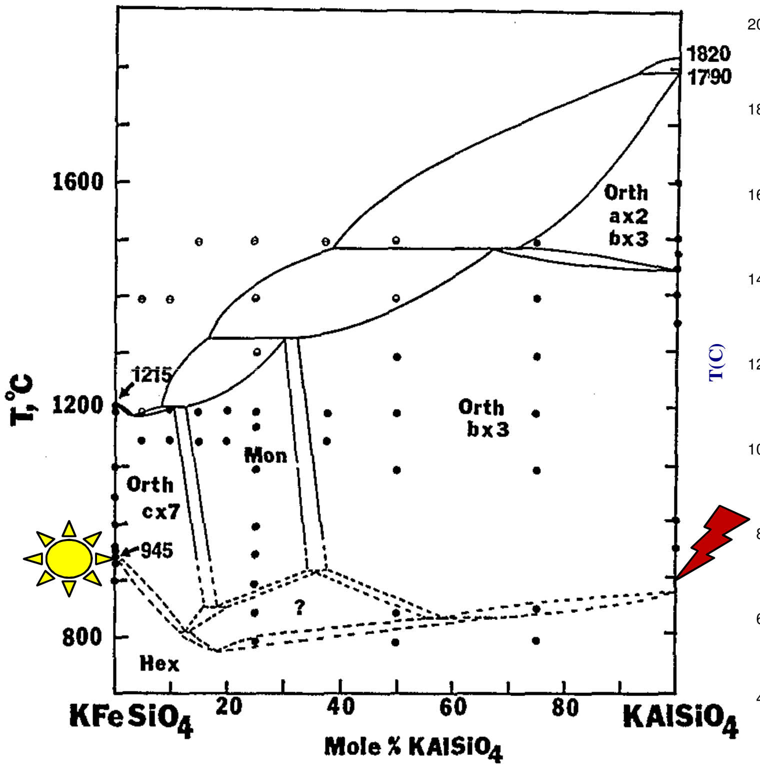
$AlNaO_2$ - $AlKO_2$ - $CaAl_2O_4$

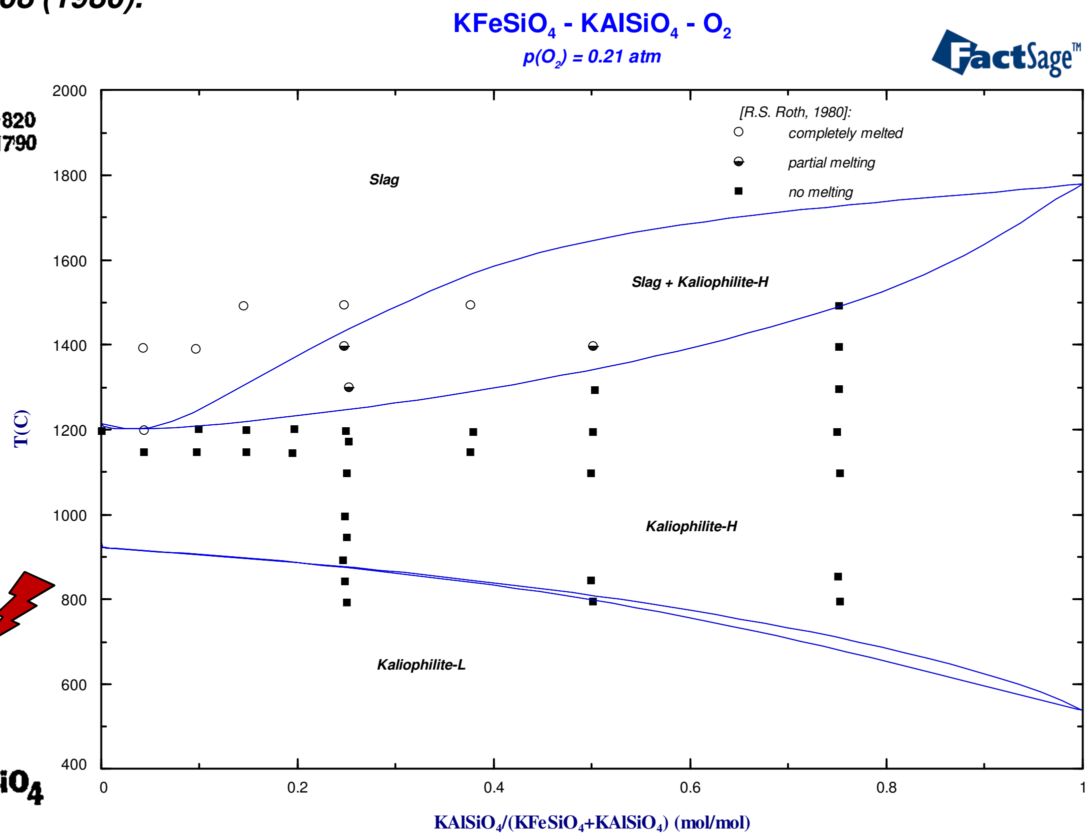
1700°C



Phase equilibria diagram of the system $KFeSiO_4$-$KAlSiO_4$

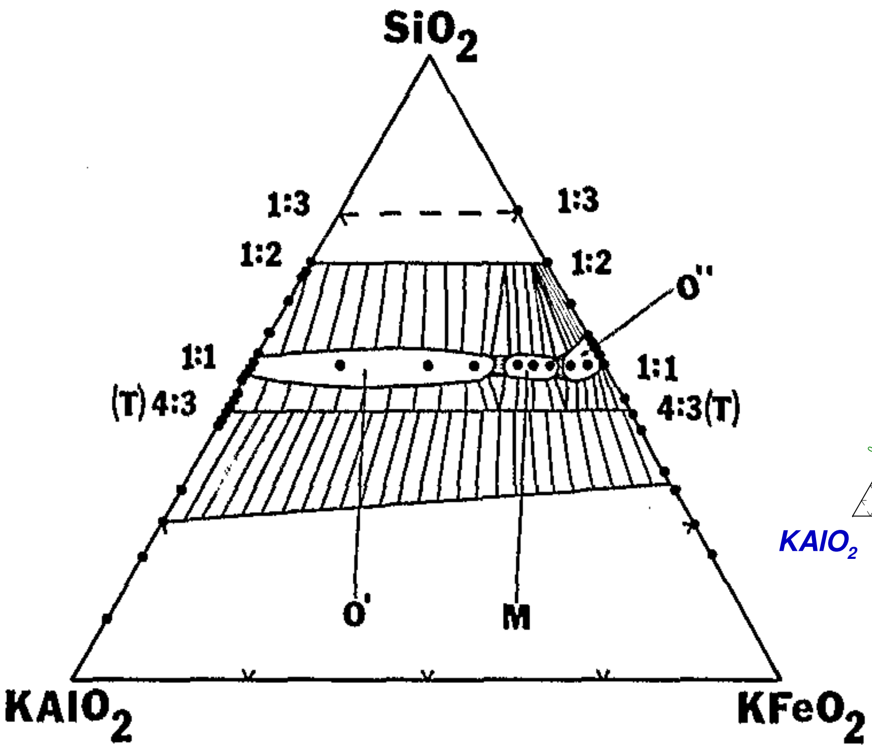
R.S. Roth, Amer. Chem. Soc., [20], pp. 391-408 (1980).

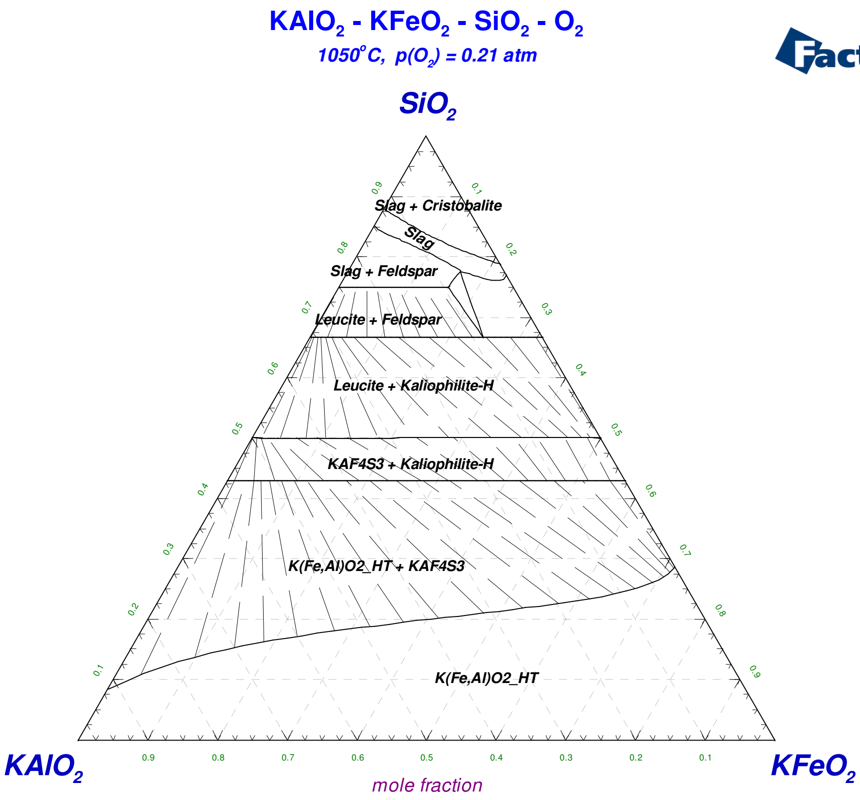




Phase equilibria diagram of the system $KFeSiO_4$-$KAlSiO_4$

R.S. Roth, Amer. Chem. Soc., [20], pp. 391-408 (1980).





Conclusions

- The database for the Al_2O_3-CaO-FeO-Fe_2O_3-K_2O-Na_2O-MgO-SiO_2 system was created combining the following databases: **Al_2O_3-CaO-FeO-Fe_2O_3-MgO-SiO_2** (GTT) and **Al_2O_3-Na_2O-K_2O-SiO_2** (FZ Jülich)
- The 3 binary systems, 11 ternary and 4 quaternary subsystems were assessed using available experimental information.
- The liquid phase in all subsystems was evaluated using associate species model (two cations per species).
- In order to get a compatibility the solubility ranges for iron were introduced into existing thermodynamic description for three solid solution phases.
- The solubility ranges of nine new solid solution phases were described using sublattice model. The missing Gibbs functions for these phases were estimated using appropriate reciprocal equations.
- The 29 stoichiometric phases were incorporated.

All phase diagrams incorporated in *New Slag Atlas*

Future developments

- Expansion of the entire database by addition of such oxides as MnO and NiO as well as CrO_x and P_2O_5.
- Addition of PbO, ZnO and V_xO_y in co-operative projects.
- Addition of non-oxidic components such as CaS, FeS and MnS is in planning.

Thanks for your attention!