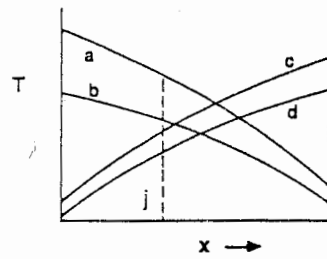
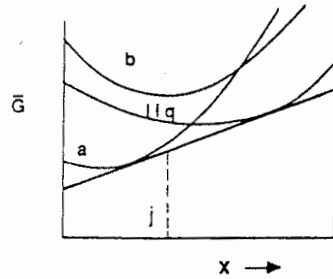


Walker et al. (1972);
this study

From
Longhi
(1991)

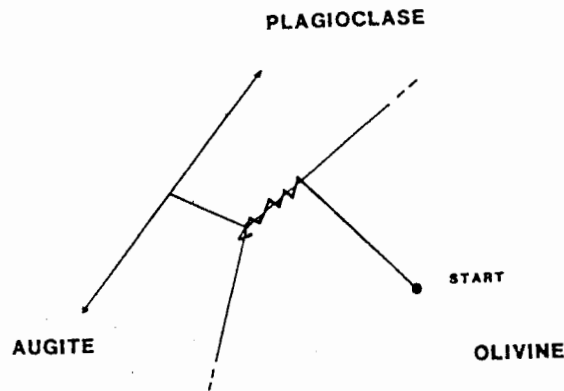


Roeder (1975);
Langmuir and Hanson (1981);
Nielsen (1988)



Ghiorso et al. (1983)

Fig. 1. Schematic representation of various methods of predicting liquidus phase equilibria.



From
Nielsen
(1988)

FIG. 6. Expanded section of a hypothetical augite-plagioclase-olivine phase diagram showing schematic liquid line of descent.

12.480**Silicate melt – mineral equilibria*****MELTS – latest update –***

Ghiorso and Sack (1995) Contrib. Mineral. Petrol. 119: 197-212.

Multiply-saturated liquids

Grove et al. (1992) Amer. Geophys U Mono. 71: 281-310.

Langmuir et al. (1992) Amer. Geophys U Mono. 71: 183-280.

Ariskin et al. (1993) Comp. Geosci 19: 1155 – 1170.

Yang et al. (1996) Contrib. Mineral. Petrol. 124: 1 – 18.

Plagioclase – liquid

Panjasawatwong et al. (1995) Contrib. Mineral. Petrol. 118: 420-432.

Housh and Luhr (1991) Amer. Mineral. 76: 477 – 492.

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Some thermodynamic models for silicate mineral/melt equilibria

Direct approach using solution calorimetry

Weill, Hon and Navrotsky in Hargraves, ed. "Physics of magmatic processes" p.49-89.

Other empirical models

Langmuir and Hanson (1981) In Newton et al., eds. "Thermo of minerals and melts

Glazner (1984) Contrib Mineral Petrol 88:260-268.

Burnham and Nekvasil (1986) Amer. Mineral. 71:239-263.

Nielsen and Dungan (1983) Contrib Mineral Petrol 84:310-326.

Russel and Nichols (1985) Canad. Mineral. 23:479-488.

Nielsen (1988) Geochim. Cosmochim. Acta 52:27-39.

Weaver and Langmuir (1990) Computers and Geosciences 16:1-19.

Overviews/Reviews

Reviews in Mineralogy, v. 17, Thermodynamic modeling of geological materials: Minerals, fluids and melts (1987)

Reviews in Mineralogy, v. 24, Modern methods of igneous petrology: Understanding magmatic processes (1990)

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**Silicate mineral - silicate melt
equilibria and models**

Olivine - Liquid

Roeder and Emslie (1970) Contrib Mineral. Petrol. 29, 275-289.

A highly successful empirical model that uses mineral/melt partition coefficients (K_D 's). R&E found a strong temperature dependence for the formation reactions of the forsterite and fayalite olivine components from liquid components (K_D^{Mg} and K_D^{Fe}), and a nearly temperature independent exchange K_D^{Fe-Mg} .

Longhi et al. (1978) Geochim Cosmochim Acta 42, 1545-1558.

Longhi uses a Temkin-like model for silicate melts, and adds an empirical correction factor. Si/O, Si/(Si+Al) and several other mixing models are assumed. This data set spans a wide range in composition space, and shows that there are activity effects in both the network modifier and network former "sites" in silicate melt.

Herzberg (1979) Geochim. Cosmochim. Acta, 43, 1241-1251.

Herzberg attempts to evaluate the activity coefficient for Mg^{2+} and SiO_4^{4-} in silicate by looking at the formation reaction of forsterite from these two melt components. Herzberg assumes ideal mixing in the Mg-Fe system, and then adds CaAl and alkalis as components. He formulates activity coefficients for these alkali components which account for the effects of the alkalis on the Mg^{2+} species. SiO_4^{4-} activity is not specifically dealt with in the model.

Ford et al. (1983) J. Petrol. 24, 256-265.

A completely empirical model which "fits" olivine/liquid partition coefficients in terms of compositional parameters. Silica activity is not considered in the model, except as a fit coefficient. The other fit coefficients are the sum of network formers (Mg, Fe, Ca, Mn, Cr, and Ni), Al, Na+K, etc., T and P.

Nielsen and Dungan (1983) Contrib Mineral. Petrol. 84, 310-326.

The mixing properties of silicate melts are modeled assuming that the melt components mix on two sites. One is composed of network former components (Si, KAl, NaAl, CaAl, MgAl, FeAl) and the other of network modifiers (the oxides of Mg, Fe, Ca, Na, K). Melt component activities are calculated by assuming ideal mixing on each of these two melt sites. Therefore, melt activities are simply the normalized mole fraction of the species on the site. There is no free energy of mixing assumed between the network former and network modifier site.

Glazner et al. (1984) Contrib Mineral. Petrol. 88, 260-268.

This paper calculates standard state free energy values for melt and olivine and plagioclase. Component choice in the silicate melt are the mineral components forsterite and fayalite. Activity of Fo and Fa in the melt are calculated as second

order expansions of composition in terms of oxide components (SiO_2 , FeO , MgO , K_2O , Na_2O , CaO , Al_2O_3). Of all the models we've looked at, this one is most similar to the Ghiorso et al. approach. The authors attempt to calculate an equilibrium from a standard state basis and to estimate activity for the equilibria using a Margules-like binary excess function.

Pyroxene - Liquid

Nielsen and Drake (1979) Geochim. Cosmochim. Acta, 43, 1259-1272.

Nielsen et al. (1988) Contrib. Mineral. Petrol. 100, 790-811.

Both papers use a similar approach to modelling silicate melt, but write reactions between pyroxene and liquid. In the 1988 version, the pyroxene model is updated and the experimental data base is expanded.

Plagioclase - Liquid

Kudo and Weill (1970) Contrib. Mineral. Petrol. 25, 52-65.

Present an empirical thermometer for plagioclase - melt. This paper represents an important first step, but recovery of temperature and melt composition is not great +/- 55 °C and +/- 12 An units.

Drake (1976) Geochim. Cosmochim. Acta, 40, 457-460.

Drake uses Bottinga-Weill components to model liquid components. Discusses how melt may deviate from ideal behavior.

Others

Hanson and Langmuir (1980) Geochim. Cosmochim. Acta, 42, 725-741.

Nielsen (1988) Geochim. Cosmochim. Acta 52, 27-38.

Weaver and Langmuir (1990) Computers and Geosciences, 16, 1-19.

These papers use mineral/melt K_d 's to predict mineral saturation in a melt vs temperature and composition. Melt evolution is modeled using an iterative computational method.

Longhi (1991) Amer. Mineral. 76, 785-800.

Grove et al. (1992) Ridge Summer Institute 1990 Volume (in press).

These papers use constraints from phase diagrams to calculate mineral/melt crystallization processes in natural systems.