

12.480 Handout #4 and #5

Models of ternary feldspars

Seck (1971a) Neues Jahrb Mineral Abh 115:315-345.

Seck (1971b) Contrib Mineral Petrol 31:67-86

Johannes (1979) Contrib Mineral Petrol 68:221-230.

Brown and Parsons (1981) Contrib Mineral Petrol 76:369-377.

Green and Udansky (1986) Amer Mineral 71:1100-1108.

Stormer and Whitney (1985) Amer Mineral 70:52-64.

Ghiorso (1984) Contrib Mineral Petrol 87:282-296.

Fuhrman and Lindsley (1988) Amer Mineral 73:201-215.

Elkins and Grove (1990) Amer Mineral 75: 544-559.

Kroll et al. (1993) Contrib Mineral Petrol 114: 510-519.

Wen and Nekvasil (1994) Comp Geosci 20: 1025-1040.

Holland and Powell (2003) Contrib Mineral Petrol 145: 492 – 501

Benisek et al. (2004) Amer Mineral 89: 1496-1504

Ghiorso (1984)

In this paper Ghiorso expanded the Al-avoidance configurational entropy model of Kerrick and Darken (1975) and Newton et al. (1980) to ternary feldspars. The Kerrick and Darken approach is intended to provide an approximation of the ideal part of the activity when mixing takes place with charge balance constraints. We know this as coupled substitution. These models for the ideal part of the activity give larger negative values to the entropy of mixing term ($-T\Delta S_{\text{mix}}$).

Ghiorso used the constraints from all three equilibria to estimate equilibration temperature.

Ghiorso's analysis of Seck's (1971) experimental data resulted in a negative W_s term for the W_{oran} excess parameter.

Green and Udansky (1986)

In this paper Seck's 1, 5 and 10 kbar data were used to derive a W_v term for the An-Or excess free energy term. The magnitude of this term was large and led Green and

Udansky and others to suggest a pressure sensitivity to feldspar equilibria. Therefore, coexisting feldspars might serve as a barometer and a thermometer.

Stormer and Whitney (1985)

In this paper Stormer and Whitney estimated a pressure for the Fish Canyon tuff of 8 to 9 kbar (24-27 km depth). They cite a pressure dependence of 18 °C/kbar on feldspar equilibria. This pressure dependency comes from Brown and Parsons (1981) CMP 76:369-377. B&P fit a pressure dependency to the Ab-Or solvus using a variety of experimental data, and derive this pressure dependency.

Fuhrman and Lindsley (1988)

In response to the G&U and S&W papers, F&L remodeled the Seck 1 kbar experimental data. Their contribution to evolution of these models was to fit x-ray data for ternary feldspars to derive an expression for W_v . They also evaluate critically the utility of two feldspar thermometry and provide a calculation procedure for estimating two-feldspar temperatures.

Elkins and Grove (1990)

New experimental data on coexisting ternary feldspars and a model for excess free energy that uses the simpler $X \ln X$ formulation for $-T\Delta S_{\text{mix}}$.

Kroll et al. (1993)

Critical analysis of everybody's experiments!

Wen and Nekvasil (1994)

Nice program (MOTHERM3) for recovering temperatures of coexisting ternary feldspars.

Holland and Powell (2003)

Some alternative formulations for asymmetric solutions. Includes van Laar reformulation of a variety of mineral systems including ternary feldspars, carbonates, silicate melts and solids and H₂O - CO₂.

Benisek et al. (2004)

This is Kroll's (1993) next missive on the topic of ternary feldspar equilibria. The critics use experimental data to improve feldspar thermometry.

