Solubility of simple pelitic and granitic mineral assemblages in chloride rich aqueous solutions at 2 kbar, and 400°–650°C

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Alkali chlorides complexes are the principal solutes of most hydrothermal fluids. An understanding of the solubility of alkali metal silicates will thus provide insight into the origins of hydrothermal fluids, and physical and chemical condi-tions of fluid-rock interaction during alkali metasomatism and ore formation. Several studies have shown the mobility of alkali metals during regional metamorphic proces-ses (e.g. Dipple *et al*, 1990; Ague, 1991). Similarly, potassic alteration in porphyry copper deposits is abundant (e.g. Hemley, 1959). In order to obtain a better under-standing of fluid-rock interaction during such metamophic events, we have mea-sured the solubility of the assemblages albite(ab)+K-feld-spar(kfs)+andalusite (and) +quartz (qtz) at 600° and 650°C and ab+muscovite(mu)+and+qtz at 550°C at 2kbar over a total chloride range of 0.01 to 4 m Cl^{tot}. These assemblages were selected to approximate high grade pelitic assemb-lages in contact aureoles. Additional studies with the simplified granitic mineral assemblage ab+mu+kfs+qtz were obtained over a temperature range of 400° to 600°C at 2kbar total pressure and 1 m total chloride.

The rapid-quench technique was used. Na, K, Al, Si, and pH were measured on quench. Starting solutions contained variable amounts of NaCl, KCl, and HCl, so that Na and K concentrations were app-roached from under- and supersaturation. Si and Al concentrations were always approached from under-saturation. The results are summarized in Table 1.

TABLE 1.

Assemblage	T, °C	K/Na**
ab+kfs+and +qtz	650	0.33 (±0.02)
	600	0.3 (±0.02)
ab+mu+and +qtz	550	0.2 (±0.01)
ab+kfs+mu +qtz	600	0.3 (±0.01)
	550	0.25 (±0.02)
	500	0.23 (±0.03)
	450	0.16 (±0.06)
	400	0.15 (±0.06)

all data at 2kbar and 1mCl^{tot};
**molar ratio

K/Na ratio in equilibrium with 2 alkali feldspars and muscovite decreases by 50% as temperature decreases from 600° to 400°C. K/Na ratio is generally chloride independent, but it decreases at 600° and 650°C at chloride concentrations above 1 molal Cl, probably due to increased for-mation of higher order alkali Cl comp-lexes. The temperature gradient of the K/Na ratio in pelitic assemblages is larger below 600°, within the muscovite stability field, indicating that chloride rich fluids are more efficient in producing alkali metasomatism at temperature below 600°C, 2kbar.

Comparison of our experimental results with various thermodynamic models for aqueous solutions (Pokrovskii and Helgeson, 1995; Oelkers *et al*, 1995) show considerable improvement in prediction of total metal concentrations over the last years, resulting in good agreement with the experimental data. These models never-theless do not accurately describe the chloride dependance of Na and K especially at chloride concentrations in excess of 1 mCl^{tot}. Such concentrations are typical for most metamorphic and ore-forming solutions. This is due to either a failure of activity - composition relation-ship at these relatively high ionic strength solutions, problems in the speciation scheme, or a combination of both. Hence, accurate predictions of important variables, such as pH, still limit the applicability of quantitative mass transport calculations for metamorphic conditions.

References

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