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The Solubility of Corundum in H_2O at High Pressure and Temperature, and its Consequences for Al Mobility in Subduction Zone Environments

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Aluminium has long been regarded as one of the least soluble elements during metamorphic and metasomatic processes (e.g. Carmichael, 1969). However, widespread geological evidence such as aluminiumsilicate-bearing veins in regional metamorphic complexes (e.g. Kerrick, 1990, suggests at least local Al mobility. In the absence of unusually high fluid fluxes, such observations imply high Al solubility in metamorphic fluids, although the mechanism of Al solubility as well as the chemical properties of the appropriate carrier fluid have not been established. Most experimental investigations on corundum solubility in pure H_2O have so far only been performed at low pressures (<0.3 GPa) and yielded low Al solubility and little change with temperature. On the other hand, Becker et al. (1983) showed that corundum solubility increases with P up to 2 GPa, but their data are limited to 700˚C. We measured the solubility of corundum in H_2O at 800-1100˚C and 1-2 GPa by weight-loss experiments using a piston-cylinder apparatus with run times between 12 and 192 hours. The solubility of corundum strongly increases with temperature. At 1 GPa, molality increases from 0.003 (800˚C) to 0.020 m (1100˚C) and at 2 GPa, from 0.005 (800˚C) to 0.027 m (1100˚C). The results indicate an increase in solubility with increasing pressure. We conducted two experiments at 800˚C, 1 GPa, with run times of 12 and 192 hours. No change in solubility was observed. Extrapolation of our results to 700˚C at 1 and 2 GPa gives solubilities that agree well with the results of Becker et al. (1983) at 700˚C, 1 and 2 GPa, and 6 hours. The results indicate that the Al solubility may be quite high under mantle wedge conditions, but at low- and medium $P-T$ conditions, high Al solubility probably requires a strong degree of polymerization within the fluid phase involving other silicate components and that Al in pure H_2O is unlikely to be "immobile" during metamorphic and metasomatic processes which take place in the deep parts of subduction zones.

References:

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