Experimental determination of Ca-Sr distribution between zoisite-fluid and lawsonite-fluid

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The distribution of Sr between a 1 molar $(Ca,Sr)Cl_2$ solution, (Ca,Sr)-zoisite and (Ca,Sr)-lawsonite was determined at 600°C, 2 and 4 GPa. The synthesized crystals of (Ca,Sr)-zoisite and (Ca,Sr)-lawsonite are homogeneous in electron microprobe analysis. The results indicate that Ca^{2+} can be replaced completely by Sr^{2+} at the M1 and M2-site in zoisite and at the M1-site in lawsonite. However, Rietveld refinement of the solid run products with site occupation refinement show that the larger M2 site in zoisite is preferred by Sr in the range X_{Sr}^{Zo} 0 – 0.40. Powder diffraction data show a phase transition in the lawsonite solid solution at $X_{Sr}^{Law} \approx 0.24$ with a change of the space group from *Cmcm* to $P2_1/m$.

The compositions of the product fluid were analyzed by inductively coupled plasma emission spectrometry. In both the (Ca,Sr)-zoisite-fluid and (Ca,Sr)-lawsonite-fluid systems, Sr fractionates preferentially into the fluid, similarly as at low pressure for Ca-Sr-margarite, anorthite and carbonate (1).

The mixing energies of the solids were calculated using a regular solution model. In the (Ca,Sr)-lawsonite-$(Ca,Sr)Cl_2$ system, $\Delta\mu^0$ is 4.1 kJ and WlawCaSr = 9.3 kJ. In the system (Ca,Sr)-zoisite-$(Ca,Sr)Cl_2$ the mixing energies for the M2 site were calculated and $\Delta\mu^0$ is 11.0 kJ and $W^{zo}{}_{CaSr}$ is –5.1 kJ.

The high $\Delta\mu^0$ values and, to a much lesser extent, the W_{CaSr} values cause the preferred fractionation of Sr into the fluid. The observed lawsonite and zoisite structures within the solid solution series as well as the moderate values for $W^{law}{}_{CaSr}$ and $W^{zo}{}_{CaSr}$ strongly suggest that complete solid solution series exists for (Ca,Sr)-lawsonite and (Ca,Sr)-zoisite.

References

[1] Thiele, M., Doersam, G., Franz, G., Liebscher, A., and Gottschalk, M. (2007) Ca-Sr fractionation between margarite, anorthite, calcite, and fluid at 400-500 °C and 3.5-5 kbar, this volume.

Petrology and geochemistry of Cemilköy Ignimbrite, Cappadocia, Turkey

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In this study, petrological and geochemical characteristics of the Cemilköy ignimbrite, in the Cappadocia region, located in the Central Anatolian Volcanic Province were identified by more detailed examination. The Cemilköy ignimbrite is composed of ash-size volcanic material, normally graded pumices and inversely graded lithic (volcanic and ophiolitic) clasts. Pumices are distinguished from other ignimbrites in the region by a slaty fabric. Mineralogical and petrographical studies show that pumices consist of plagioclases, biotite, quartz, amphiboles and oxide phenocrysts and microcrysts. Predominantly, vitrophyric-porphyritic fabric is observed in the pumices. Plagioclase phenocrysts are identified as bytownite- oligoclase (An_{47-19}) in composition and they are normally zoned. As a result of geochemical examinations, it has been determined that the Cemilköy ignimbrite is rhyolitic in composition and shows calcalkaline characteristics. The effect of fractional crystallisation process in the formation of the Cemilköy ignimbrite is observed from major and trace element versus SiO_2 diagrams. The Cemilköy ignimbrite is enriched with LILE and LREE contents, indicating that not only fractional crystallization process but also subduction and/or crustal contamination processes were effective. A negative anomaly trend of Nb and Ta elements in spider diagrams, the ratio of Ba/Nb>28 (56-77) and the location of all samples in subduction-related volcanic arc granites area in a Rb-Y+Nb discrimination diagram point to the effect of subduction process. As a consequence, Cemilköy ignimbrites appear to have been produced from the magma that derived by partial melting of OIB-like mantle which was enriched by subduction process and also assimilation–fractional crystallization (AFC) process was effected on evolution of these ignimbrites.