Anorthite/fluid partitioning of europium
at 650°C and 1.3 kbar

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Abstract: The partitioning of Eu between synthetic anorthite and Cl-bearing fluids is studied at 650°C and 1.3 kbar, as a function of the chloride concentration of the fluids. The partition coefficient strongly depends on the composition of the solution. The incorporation of Eu into anorthite is enhanced as the chlorinity decreases. At a given chlorinity, the partition coefficient depends on the Eu concentration in anorthite, for example, it decreases from 9-10 to 4 and from 2-3 to 0.1 as the concentration of Eu in anorthite increases from 0.1 to about 15000 ppm, for 0.5 and 3.0 mole Cl per liter solutions, respectively. It can be shown independently that europium occurs exclusively in the trivalent state in these experiments and that its incorporation into anorthite is not a single cation exchange reaction, but also involves trapping in extended defects. The relative importance of these processes cannot be assessed from the results given here, but the partition coefficients obtained are in agreement with previously published data. They should thus be useful in modelling the hydrothermal geochemistry of REE.

Key-words: REE, europium, anorthite, fluid, partition coefficient.

Introduction

Geochemists attach great importance to the rare-earth elements (REE) which are considered to be good tracers of geochemical processes, especially magmatic phenomena. Hydrothermal applications are, however, more problematic. Depending on the nature of the mineral phases, the temperature, the pressure and also the nature of the fluids involved during the hydrothermal or weathering events, the REE may be either mobilized (Hellman & Henderson, 1977) or even unaffected (Herrman et al., 1974). In granites, REE are trapped in accessory phases (sphene, apatite, allanite, zircon . . .), all of which, except allanite, are considered as stable during alteration processes. Even these types of rock display variable REE behaviours (Exley, 1980; Alderton et al., 1980). Humphris (1984) and Fleet (1984) have presented excellent reviews of these different behaviours. Nevertheless, the transportation of REE during fenitization of quartzites has been demonstrated by Martin et al. (1978) and the light REE are known to be more strongly affected than the heavy REE. The REE would be mobilized by hot fluids. However, such mobilization is in conflict with the scarce data on experimental partition coefficients of REE between minerals and fluids (Cullers et al., 1973; Zielinksy & Frey, 1974) which show a strong incorporation of the REE into minerals. However, one must bear in mind that these scarce experiments are subject to controversy. Although experiments by Cullers et al. (1973) seem more conclusive (apparent reproducibility of results), Zielinsky & Frey (1974) state that, concerning the partition of Gd between diopside and Cl-bearing fluids; “We have not been able to achieve equilibrium in experiments . . . We caution that data from experiments of this type will not provide useful applications in natural systems until the experimental system is well understood”. Their experiments show a strong relationship between the partition coefficients and the experimental parameters; fluid/solid ratio and nature of the initial material.

In this paper, we present partitioning experiments of Eu between anorthite and Cl-bearing fluids at 650°C and 1.3 kbar. Usually, natural