

Apatite Reactivity in the Presence of Rare Earth Elements (REE) and Uranium

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Previous studies have demonstrated that apatite can be particularly reactive in the presence of aqueous metals. This reactivity has been interpreted as the result of the interaction between the phosphate released from apatite, and the aqueous metal, which then combine to precipitate, due to the significantly lower solubility of the metal phosphate compared to apatite. This reaction will drive further dissolution of the apatite, until all apatite (or metal) is consumed (Valsami-Jones et al., 1998).

The formation of metal phosphates in natural environments is not well documented, perhaps partly due to their presence as minute crystals, often associated with apatite and therefore mistakenly taken to be trace components of the apatite. However metal phosphates are highly insoluble (e.g. Nriagu, 1984) and therefore, their formation may represent a significant sink for the metal and/or phosphorus. More specifically to the system under study, it has been suggested that the formation of early diagenetic REE phosphates and alumino-phosphates may represent a major sink for oceanic phosphorus (Rasmussen, 1996). The purpose of the present paper is to elucidate the potential of formation of such phosphates. It is also the intention to probe into the mechanism itself, by studying the REE, a group of elements which show well defined, regular variation of physico-chemical properties as a function of their atomic number. Applications of the results of this work to nuclear waste disposal are also noted.

Here, we are presenting preliminary results from a series of laboratory experiments, involving monitoring the reaction between individual aqueous REE (La, Ce, Sm, Gd, Tb, Er, Tm,

Lu) or U and a well-characterised synthetic apatite. The experiments show loss of REE/U from solution at a fast rate, and concomitant release of calcium, consistent with a dissolution/precipitation mechanism described previously for other metals such as Pb (Valsami-Jones et al., 1998). The release of calcium into solution correlates on a mole-for-mole basis with the removal of REE from solution, and may thus be used to compare behaviour within the REE group (Figure 1). Our results show that the highest aqueous concentrations of Ca are released in the presence of La, Ce and Lu and the lowest in the presence of Gd. The overall pattern shows an irregular variation as a function of atomic number, resembling perhaps the pattern of REE phosphate stability. The presence of REE and U phosphates in the solid fraction, following these experiments, was confirmed with X-ray diffraction and Scanning Electron Microscopy.

These results suggest that formation of REE and U phosphates will play an important role in their distribution in environments where phosphate is present or may be released during secondary processes. Further experimental work, including reaction between solutions containing a mixture of REE and apatite, is currently under progress.

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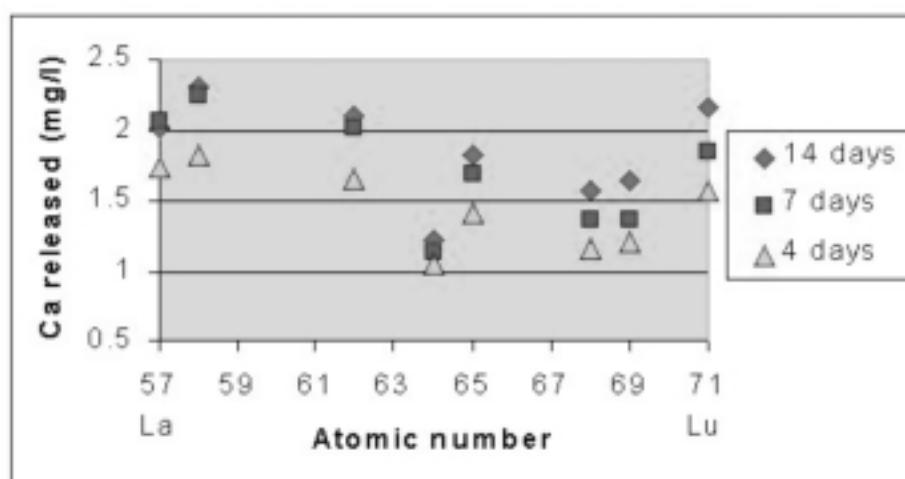


Figure 1: Calcium loss from solution in the presence of a single Rare Earth, as a function of its atomic number.