

# Arsenic and Rare Earth Elements Trapping by Carbonates and Hydrous Iron Oxides Precipitates Generated by Degassing and Oxidation of Mineralised Waters

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In the Massif Central (France), actively precipitating hydrous iron oxides and carbonates are commonly associated with cool CO<sub>2</sub>-rich spring waters. Water-normalised diagrams for oxides and carbonates show high elemental enrichment in oxides and carbonates (Casanova et al., 1999), especially for trace elements, which are more concentrated in oxides than in carbonates. As part of a study on the mobility of chemical elements in natural mineralised waters subjected to changes in oxidation states and to degassing of carbon dioxide (Criaud and Fouillac, 1989; Cornu et al., 1998, Casanova et al., 1999, Négrel et al., 2000), a dynamic *in-situ* experimental system has been implemented. It consists in a network of reactors fed both with natural water and a solution spiked in various selected elements, including Rare Earth Elements (REE) and arsenic (As). The concentrations of total dissolved As and REEs in the mineral waters vary over several orders of magnitude and fall in the range 2.25 to 1850 ppm for As and 60 to 1700 ppb for REE (Négrel et al., 2000). The reactors were designed based on carbonates and ferrihydrite precipitation kinetics, as determined by laboratory experiments. The successive reactors have increasing sizes, corresponding to increasing solution residence time capacities, in order to allow a regular distribution of precipitates in the reactors. Two networks of reactors were set up *in-situ*: a so-called "fast" one, with a cumulated residence time of 2 hours, and a so-called "slow" one, with a cumulated residence time of 24 hours. The 24-hour residence time corresponds to the time at which carbonate and iron hydroxide precipitation kinetic curves reach steady state during laboratory experiments. The REE content entering the

system was equivalent to 0.1 µmol/l. Arsenic was added with a concentration of 0.5 µmol/l. Non conservative parameters of the solution (Eh, pH, temperature and conductivity) were analysed over the entire experiments. After 7 h for the fast network and 27 hours for the slow network, the solution in each reactor was filtered through 0.22 µm membranes for chemical analysis. Alkalinity was titrated immediately after filtering. REE analysis was performed by ICP/MS, major anions by ion chromatography, major cations by capillary ion analysis, iron and silica by colorimetry. The analyses show a decreasing content of REE in the solution in the successive reactors of both networks, which corresponds to the trapping of the elements by the hydrous iron oxide and carbonate precipitates. The lower the REE molar mass, the higher the amount of element trapped in the precipitates. The data show evidence of REE partitioning during trapping by hydrous ferric oxides and carbonates. Arsenic is trapped in a similar proportion to REE. The experimental results are discussed in terms of co-precipitation and sorption as potential trapping mechanisms.

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