Nuclear analytical techniques for the determination of elemental distributions in geo- and hydrothermal substrates – the case of the Los Azufres (Mexico) volcanic complex.

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ABSTRACT

Niche volcanic ecologies such as those around fumaroles and hydrothermal vents, possess extreme microclimates, unusual substrate and ground-water geochemistry and primitive extremophilic biota such as algae, mosses and ferns that display a unique biogeochemistry. This work concerns the detailed elemental mapping of the 4 microecological niches of Nopalitos, Cumbres-1, Cumbres-2 and Maritaro, of the Los Azufres (Michoacán, Mexico) volcanic caldera, investigated through the nuclear and atomic spectrometric techniques of Polarized Energy Dispersive X-ray Fluorescence, Inductively Coupled Plasma Optical Emission and Instrumental Neutron Activation Analysis. A comprehensive analysis of elements from B to U in the native volcanic substrate (VS), the hydrothermal water (HW) and sediment (HS), the tissue (P/T) and rhizospheric soil (RS) of the extremophilic plants and algae, was carried out, as well as the *in situ* and laboratory physico-chemical characterization of the samples. The latter indicated a probable similitude between the fumarolic environment and the bio-geosphere of the mid-late Ordovician Period that is notable for the first marine mass extinction (LOME). The results showed that the VS elemental concentrations were the highest, the RS showed relatively the greatest capacity of labile element retention, the HW concentrations were substantially higher than those in non-volcanic streams and the extremophiles captured high concentrations of many elements including the transition metals, Lanthanides and post-Lanthanides. The discussion centres on the implications of the findings for deep-Earth geochemistry and the extraction of rare elements, the biota´s potential for bioremediation and the support to the hypothesis of LOME being caused by heavy element toxification of the Ordovician seas through large-scale volcanism.

Key words: fumaroles, Los Azufres, nuclear analytical techniques, extremophiles