Trace Elements in Soils and Plants from the Active Hydrothermal Area of Nisyros (Greece)

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The trace element loading in soil is a function of the parent material plus subsequent atmospheric or water-borne deposition. The mobility, solubility, speciation and bioaccumulation of trace elements depend on various factors, as well as on theirgeochemical properties. Mobility can be favoured by a strongly acidic environment. In volcanic environments, significant amounts of trace elements discharged from gas emissions, contribute to produce air particulate. Nisyros Island, a stratovolcano located along the South Aegean active Volcanic Arc, is characterized by intense hydrothermal activity in the Lakki caldera. In particular, the fumaroles located in the craters of Stefanos, Kaminakia, Lofos Dome and the area comprising Phlegeton, Polyvotes Micros and Polyvotes Megalos discharge hydrothermal fluids rich in H_2O (91– 99%), CO_2 and H_2S. Their temperatures are almost 100° C and H_2S accounts for up to 26 % of the released dry gasphase.

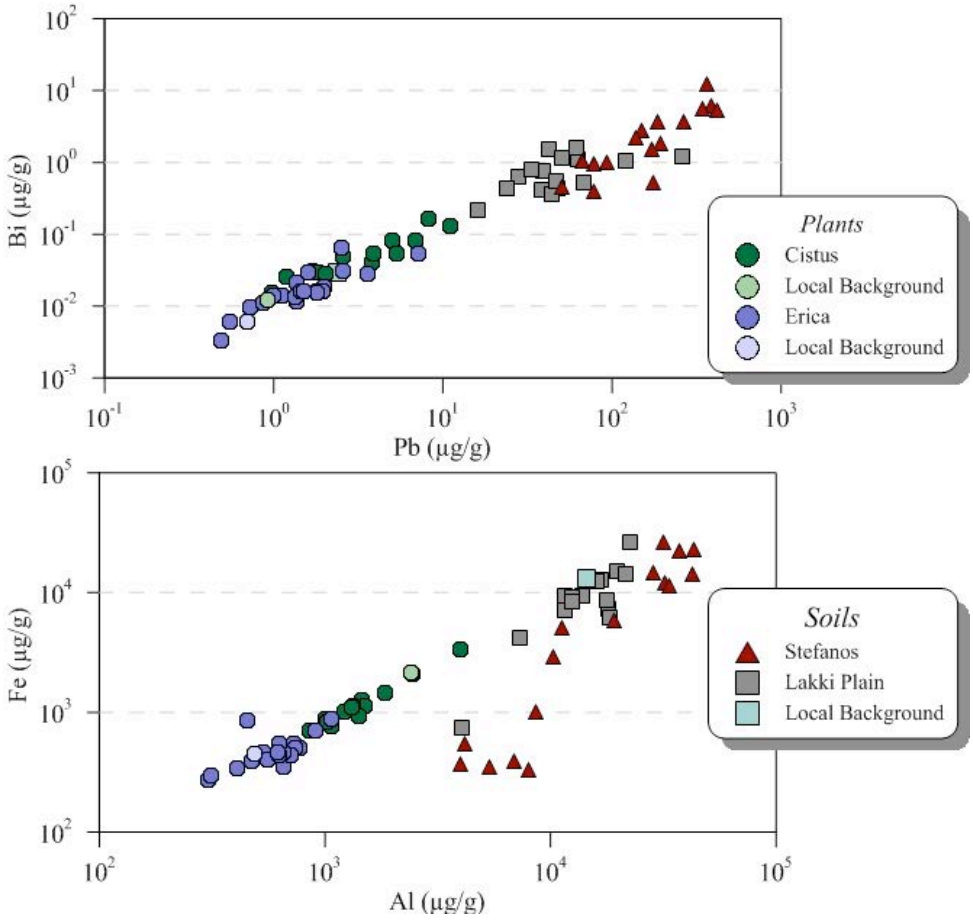

Figure 1. Binary plots showing the concentrations of Bi and Pb (a) and Fe and Al (b) in soil and plant samples. Note that plants were not present in the Stefanos crater.

On June 2013, during a multidisciplinary field trip on Nisyros island, 33 samples of top soils and 31 of endemicplants (Cistus creticus and salvifolius and Erica arborea and manipuliflora) were collected in the caldera area, to determinate the main mineralogical composition and to investigate the distribution of trace elements concentrations and the possible relationship to the contribution of deep originated fluids. Moreover, one sample of plant and soil was collected outside the caldera as local background, for comparison. All the soil samples were powdered avoiding metal contamination and the mineralogical composition was determinated via XRD analysis. Chemical composition of the soils was analyzed with two different extraction methods: microwave digestion (HNO_3 + HCl) and leaching with de-ionized water. The leaves of plants were gently isolated, dried and powdered for microwave extraction (HNO_3 + H_2O_2). All the solutions were analyzed for major and trace elements contentsby using ionic chromatography (IC) and inductively plasma spectrometry (ICP-MS and ICP-OES).

The results showed a good negative correlation between S concentration and pH, testify for the effect of H_2S degassing at the crater areas. H_2S, which is one of the main components of the fumarolic gases at Nisyros, in the shallow oxidizing environment produces great amounts of H_2SO_4 in the soils. The active fumarolic area (Stefanos) shows the lowest pH values (1.9 - 3.8), the samples collected in the remaining area within the Lakki Plain shows somewhat higher values (4.2 - 5.8) while the background soil has a neutral pH. In the majority of the Lakki Plain soils the main mineralogical composition is Quartz, Feldspar and Gismondine whereas in the Stefanossoils, because of the lower pH and the higher temperatures, the main composition comprises mostly hydrothermal alteration minerals. Moreover,high enrichments of many trace elements were noticed both in plants and soils respect tothe local background, in particular for Tl, Rb, Zn, Mn, As, Pb, Se, Te, Rb, Bi, Al. The highest concentrations were found both in soils and plants close to the most active fumarolic areas and also close to the Geothermal exploration well. Moreover, both soils and plants showed a good correlation between Cu-Zn, Cu-Pb, Bi-Pb, Ba-Sr, Bi-Tl, Ti-Al, Ni-Al, Tl-As, Te-Tl, Te-Se as well as REE's. From the comparison between Cistus sp. and Erica sp. we found a significant enrichment in the former respect to the latter, making Cistus sp. the most suitable plant for biomonitoring studies at Nisyros.