

Trace-metal nanoparticles in pyrite

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Pyrite in ore deposits contains significant amounts of minor and trace elements in the form of nanoparticles (NPs). NPs in pyrite from Carlin-type (Deep Star, Lone Tree, Screamer) and epithermal (Pueblo Viejo, Porgera) gold deposits were characterized using electron microprobe analysis (EMPA) and high-resolution transmission electron microscopy (HRTEM). All pyrite contain NPs that are 5 to 100nm in diameter; galena NPs are up to 500nm. Maximum concentrations of trace elements (wt %) in the analyzed pyrite are As (11.2), Ni (3.04), Cu (2.99), Sb (2.24), Pb (0.99), Co (0.58), Se (0.2), Au (0.19), Hg (0.19), Ag (0.16), Zn (0.04), and Te (0.04). Pyrite from Carlin-type deposits and Porgera show a negative correlation between As and S. In contrast, pyrite from Pueblo Viejo, shows a negative correlations between As+Cu and Fe. HRTEM studies revealed that NPs in these pyrites are crystalline (with the exception of As-S-Fe NPs in Pueblo Viejo pyrite) and that they are commonly hosted by distorted polycrystalline pyrite. Based on chemical composition, NPs can be classified into three groups: (i) native metals; Au, Ag and electrum (ii) sulfides and sulfosalts; PbS (galena), HgS (cinnabar), Pb-Sb-S, Pb-Ag-Sb-S, Ag-Pb-S, Pb-Sb-Bi-Ag-Te-S, Pb-Te-Sb-Au-Ag-Bi-S and Cu-Fe-S; and (iii) unclassified NPs: Au-Ag-Ni-As-S, Fe-As-Ag-Ni-S Fe-As-Sb-Pb-Ni-Au-S; The NPs in group-iii are significantly depleted in S as compared with pyrite matrix.

Three major processes are proposed for the formation of NPs: (i) Direct precipitation of the crystalline NPs at the mineral surface from hydrothermal fluid and subsequent incorporation into the pyrite; (ii) Thermal and/or chemical alteration of trace-element rich pyrite, and possible exsolution from the pyrite matrix and (iii) Entrapment of liquid/melt NPs during pyrite growth (especially for As-S-Fe NPs. Formation of NPs via supersaturation may be expected in highly contaminated reducing sediments, thus, controlling elemental transport and potential bioavailability of toxic metals in the environment.

Sr and Nd isotopic studies on various size fractions from weathering profiles developed in Western Ghats, India – An insight into mineral weathering

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Sr and Nd isotope variations in marine and stream sediments are used as tracers of provenance and paleo-environmental indicators [1, 2]. Hence, to understand variation of ⁸⁷Sr/⁸⁶Sr and ¹⁴³Nd/¹⁴⁴Nd ratios in different size fractions samples of *in situ* weathering profiles developed over Archean granitoid gneisses and granulites on either side of Western Ghats of south India were studied.

The size fractions of 63-20 μm , 20-6 μm , 2-0.6 μm , 0.6-0.2 μm and < 0.2 μm were separated. The results of Sr and Nd isotope analysis are given in the figure below.

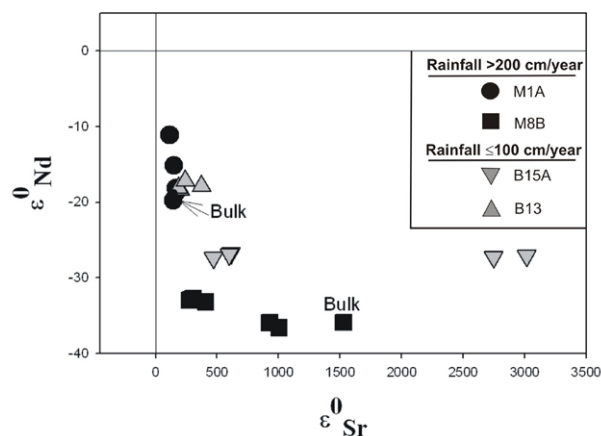


Figure 1: The Sr and Nd isotope data expressed in ϵ units for size fractions (SF) and bulk weathering profile samples.

Weathering profiles from zones receiving > 200 cm/y rainfall show a larger range in ϵ_{Nd} than ϵ_{Sr} while the one from semi-arid zone shows a larger spread in ϵ_{Sr} . Compared to the unweathered rocks the size fractions from weathering profile show significantly larger variation in the ϵ_{Nd} and ϵ_{Sr} values. Generally, the finer size fractions have higher ϵ_{Nd} and lower ϵ_{Sr} values than the coarser ones. Hence, it is inferred that the finer size fractions could have derived mostly by weathering of primary minerals having high Sm/Nd and low Rb/Sr ratios.

[1] Innocent *et al.* (2000) *Mar. Geol.* **168**, 79–87. [2] Walter *et al.* (2000) *GCA* **64**, 3813–3827.