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Interactions between vegetation and rock chemical weathering: A study with a coupled hydrological and biogeochemical model

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The ASPECTS (*Atmosphere-Soil-Plant Exchanges of Carbon in Temperate Sylvae*, [1]) model has been developed to calculate tree productivities and carbon sequestration in temperate ecosystems. The soil hydrological module describes the transfer of water between soil layers and evaluates surface runoff, root uptake and transpiration, as well as drainage to the deep soil or groundwater reservoirs. The model also calculates soil CO₂ production through root respiration, litter and soil organic carbon decomposition. This soil CO₂ production flux is used to calculate soil pCO₂ and its variation over the year. ASPECTS is used in conjunction with a recently developed model of chemical weathering describing the dissolution of rock minerals and the budget of major ions in soil water. The model is calibrated and validated on some stream catchments of the Moselle basin in the Vosges mountains, France, with granite and sandstone lithologies. It evaluates the chemical composition of stream water and its seasonality, considering the interactions between water and primary minerals in both surface and deep flows.

Model sensitivity tests are run to: (1) estimate the impact of vegetation on weathering fluxes through the increase of soil pCO₂ and the presence of organic acids, (2) analyse the importance of vegetation uptake for the seasonality of ion concentrations in soil and stream waters, (3) assess the possible role of vegetation heterogeneity in the spatial variation of weathering rates and stream water chemistry.

Reference

- [1] Rasse D.P., François L., Aubinet M., Kowalski A.S., Vande Walle I., Laitat E., and Gérard J.-C. (2001) *Ecol. Model.* **141**, 35-52.

4.5.P06

Mobilisation of metals and metalloids from historical smelting slag dumps, Rio Tinto, Spain

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While the chemistry and mineralogy of sulfidic, AMD producing wastes have been studied in great detail, few studies have focused on smelting residues commonly present at historic mine sites. This is despite the fact that historical base metal smelting slags contain elevated levels of heavy metals and metalloids and are subject to contemporaneous weathering processes thereby releasing elements to ground and surface waters. This work reports the chemistry and mineralogy of slag deposits (3 Mt) at the historic Rio Tinto smelter site, southwest Spain.

The microcrystalline slags contain primary slag phases, relict flux, ore and furnace materials and secondary weathering related minerals. Common primary slag phases are glass, Zn-rich fayalite and Zn-rich hedenbergite/augite. The slag materials contain wt% concentrations of Zn, major (ie. 1000 – 10000 ppm) Cu and Pb, minor (ie. 100 – 1000 ppm) Co, Sb and Sn, and traces (ie. <100 ppm) of Ag, As, Bi, Cd, Mo, Ni, Tl and W. The slags have been subject to weathering since dumping in the 19th and 20th century, and a series of mineral efflorescences has been observed. They most commonly occur as powdery or cemented salt precipitates at seepage points and as solid aggregates in protected overhangs facing the Rio Tinto river. Mineral salts include gypsum, epsomite and copiapite as well as a series of minor phases such as roemerite, bloedite and hexahydrate. The mineral mixtures contain variable metal concentrations, including major Cu and Zn, minor As and Co, and traces of Cd, Ni and Pb.

Rio Tinto slags have high concentrations of metals and metalloids in the order of Zn>Cu>Pb>Sb>Co>As>Ni. In contrast, the mineral salt mixtures have metal concentrations in the order of Zn>Cu>As>Co>Ni>Sb. Such distinctly different relative concentrations of elements in the two sample media collected from the weathered slag dumps can be related to the different mobility of elements in surface environments. For example, Sb displays a reduced mobility possibly due to the formation of insoluble precipitates, coprecipitation and adsorption in the slag dump. Thus, weathering of siliceous smelting slags is accompanied by the preferential mobilisation of some trace elements (ie. As, Co) into pore and seepage waters. Evaporation of the saline, metalliferous seepage waters emanating from the siliceous slag dumps causes the precipitation of secondary minerals. These minerals temporarily store metals, metalloids and sulfate until redissolution during the next rainfall. The Rio Tinto slag dumps represent long-term sources of metals and metalloid pollutants to local ground and surface waters.