Mineralogy, Geochemistry and Metals content in tailings, sediments and soils next to some metallic ore deposits in east central Mexico

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Several metal sulfides ore deposits (epithermal veins and skarn type deposits) occur in the central east portion of Mexico (Sierra Madre). Historically, some of these deposits have been exploited since the 1500´s and 1600´s. Currently, there are millions of tons of mine waste material with high content of potentially toxic metals. The ore material contains stibinite, cinebar, realgar, chalcopyrite, galena, sphalerite, and minerals with Ag, Au and As. The mine waste material contains considerable amounts of Cd, Cr, Co, Cu, Ni, Pb, Hg, As, and Sb, posing a treat to the local population.

Some of the mine tailings consist of abundant metal oxides and metal sulfides. Redox reactions locally produce pH around 2 in leachates, and high metal content. Secondary mineralogy includes malachite, goethite, ferrihydrite, jarosite group minerals and gypsum, among others. The geochemical activity is controlled by the seasonal rains (from June to September), along with high evaporation rates. These factors produce acid mine drainage, metal leaching, redox and dissolution-precipitation reactions. Most important, high amounts of heavy metals and As are incorporated and transported in sediments, soil and surface water. As and metal content in tailings is up to 7 gr/Kg of As, 1 gr/Kg of Cu, 5 gr/Kg of Zn and 3 gr/Kg of Pb. River sediments concentrations are: As = 2.5 gr/kg, Cu = 0.146 g/Kg, Zn = 1 g/Kg, and Pb = 0.117 g/Kg. For agricultural soils (small patches of land along river terraces) As and metals concentrations are: As = 0.117 g/kg, Cu = 0.022 g/kg, Zn = 0.087 g/kg, and Pb = 0.037 g/kg. For surface water (seasonal mountain creeks) the As and metals concentrations are: As = 0.05 mg/l; Cu = 0.01 mg/l; Pb <0.017 mg/l, and Zn = 0.01 mg/l. The ultimate goal is to understand the geochemical controls of As and heavy metals in this environment. This work is financed by UNAM-PAPIIT Grant IN 112311.

Crystallization kinetics in hydrous magmas subject to decompression

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Recent experimental work on crystallization kinetics in water-saturated magmas from Stromboli (Shoshonitic basalt) and Campi Flegrei (Trachyt-Phonolitic) provide insights into how magma decompression can significantly affect crystal abundances and thus melt physical properties during magma movement within the crust of the Earth.

Water-saturated samles of a primitive Stromboli basalt were subjected to isothermal (1075°C) decompression from 100 MPa to final pressures of 75 to 5 MP and samples were allowed to crystallize at the final pressure for times of 0.5 to 16 hr. Measured crystal growth rates show a strong dependence on time, varying from $\sim 10^{-6}$ cm/s in the shortest experiments to $\sim 10^{-8}$ cm/s in the longest experiments. The experimental results, combined with observations on natural samples, suggest timescales of hrs to several weeks for crystallization of small Plag crystals (<~200 microns, not showing resorption textures) in Stromboli scoria. Observed variation of Plag composition with P(H2O) suggest depths less than ~400 m for the upper part of the Stromboli feeding system.

Experiments on a trachytic composition from the Campi Flegrei (Naples) area studied the effects of decompression and cooling on alkali feldspar (Afsp) crystallization. Afsp is the main phase present in this trachyte and its abundance can strongly vary with small changes in pressure, temperature and water content in the melt, implying appreciable variations in magma physical properties and eruptive behavior. Results obtained show large variations with ΔT, time, and melt water content. In general, at small ΔT growth dominates crystallization, whereas at large ΔT nucleation dominates. Time also is important variable during crystallization, because long experiment durations involve more nucleation events. This is an important aspect to better understand magma evolution in the magma chamber and in the conduit, and consequent effects on magma rheology.

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