Si isotope and Ge/Si ratios record successive cycles of dissolution/precipitation of pedogenic clay minerals

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Pedogenic clay minerals provide the most significant and reactive surface area in soils and as such largely govern biogeochemical processes at the interface between lithosphere and biosphere. Deciphering the mechanisms governing clay formation is therefore of the utmost importance to understand how soils will evolve and how they control the Earth's biogeochemical cycles. Pedogenetic transformations governing the dynamic of clay minerals in soils are however still not fully understood.

Compared to the original geochemical signature of clay-size minerals in the deepsoil Bw horizon of a Podzol ($\delta^{30}Si$ = -0.49±0.01‰; Ge/Si = 3.8±0.17μmol/mol), we document increasing enrichment of ^{28}Si and Ge in clay-size minerals produced during podzolization by the mobilization, transport and precipitation of carbon, metals and silicon. Partial dissolution of clay minerals previously enriched in ^{28}Si isotope and Ge in the eluvial E horizon ($\delta^{30}Si$ = -0.57±0.05‰; Ge/Si = 8.59±0.22μmol/mol) is the only process that could account for the occurrence of even lighter Si and greater enrichment of Ge in aluminosilicates in the illuvial Bh/Bs horizon ($\delta^{30}Si$ = -1.14±0.15‰; Ge/Si = 10.1±0.32μmol/mol).

This study provides consistent evidence for previously unrecognized cycles of (partial) dissolution and precipitation of pedogenic clay minerals during podzolization, leading to tertiary and quaternary silicate neoformation. This challenges the concept that pedogenic clay minerals would be the stable end soil-product in equilibrium with soil-forming factors and suggests that they are reactive over time depending on soil physico-chemical conditions. Si isotope and Ge/Si ratios record a "mineral memory" of the soil-forming processes, and as such provide a powerful tool for the understanding of biogeochemical processes governing soil formation.

Geologic evolution of the Cerro Quema Au-Cu deposit, Azuero Peninsula (Panama)

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Central America hosts a variety of metallic mineral resources including Au, Cu, Ag, Pb, Zn, Ni, Co, Sb, W, and Al, spanning a broad range of deposit types. In Panama, Au and Cu are the most economically important metals, and they are mainly related to epithermal and porphyry copper systems.

Cerro Quema is a high sulfidation epithermal deposit located in the Azuero Peninsula (SW Panama), it is constituted by serveral mineralized bodies named from W to E: La Pava, Cerro Quemita and Cerro Quema. Estimated Au resources are 7.23 Mt with an average gold grade of 1.10 g/T. Cerro Quema is located in the fore-arc basin of the Panamanian Cretaceous volcanic arc. It is related to an E-W trending regional fault system, and is hosted by the dacite dome complex of the Río Quema Formation (Campanian to Maaastrichtian in age).

Hydrothermal alteration consits of an inner zone of nearly pure quartz (vuggy silica alteration), with local quartz-alunite and pyrophyllite alteration (advanced argillic alteration), enclosed by a kaolinite, illite and illite/smectite-bearing zone (argillic alteration), grading to an external halo of propylithic alteration.

Gold occurs as disseminated submicroscopic grains and "invisible gold" within the pyrite lattice. Copper is associated to Cu-bearing phases such as chalcopyrite, enargite, tennantite, covellite and chalcocite.

Cerro Quema was formed by fluids derived from the emplacement of an underlying porphyry copper intrusion emplaced along E-W trending regional faults located in the Cretaceous fore-arc basin, during Paleogene times. The proposed geologic model suggests that high sulfidation epithermal deposits are not exclusive of volcanic edifices or volcanic domes related to subduciton zones. This deposits can also occur in fore-arc basins, associated with acidic intrusions located between the volcanic arc front and the subduction trench. This should be taken into account for exploration in geologically similar terranes.

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