Transformation of bedrock to soil during granite and diabase weathering: The interplay of porosity and chemistry

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The chemical transformation of minerals and the formation of a pore network during bedrock weathering are interconnected: mineral weathering creates microporosity and causes microcracking that allows water to react more deeply in the rock [1]. We used small-angle and ultra-small angle neutron scattering (SANS/USANS) to study nanoporosity (1 nm to 20 μm) in two types of rocks that are chemically and texturally different but weathered under the same climatic conditions: diabase and granite [2]. We observed anisotropic scattering intensity maps for the weathered diabase samples, while isotropic ones for unweathered diabase. In contrast, both unweathered and weathered granite samples showed isotropic patterns similar to those we observed previously in other weathered granitic material (Fig. 1). Preliminary 3D micro-computed tomography did not reveal an increase in porosity (>3 μm) in weathered as compared to unweathered diabase. However, a chemical transformation such as the formation of nano-sized secondary Fe particles with anisotropic intergrain spaces may be responsible for the pattern. Such studies are needed to understand initiation of weathering of bedrock.

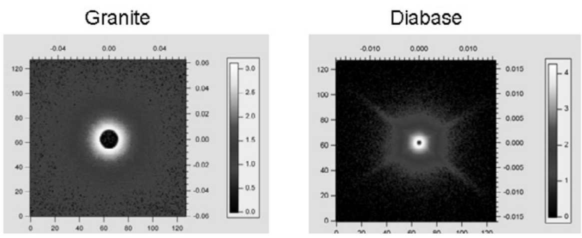

Figure 1. Isotropic scattering intensity of scattered neutrons in weathered granite (left), compared to the "asterisk" pattern for diabase (right). Scattering is consistent with isotropic or anisotropic distributions of fractures or pores respectively.

[1] Brantley & White (2009) *Reviews Mineral. Geochem.* **70**, 435–484. [2] Pavich *et al.* (1989) *U.S. Geol. Survey Prof. Paper* **1352**, 1–58.

Hydromechanical and geochemical coupling within an intercratonic sedimentary basin affected by glaciation/deglaciation events

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Sedimentary basins are complex systems affected by many interacting processes (i.e. groundwater flow, heat transfer, mass transport, water-mixing, rock-water interactions, and mechanical loading). Understanding the interactions between these processes is of importance for the optimal management of groundwater resources, crucial for the evaluation of the hydrodynamic and geochemical stability of geological CO_2 disposal sites, and critical for the safety evaluation of deep geologic repositories for radioactive waste. During a glaciation-deglaciation event, the migration and melting of ice sheets enhance this coupling and water fluxes in aquifers are significantly modified. Reactive transport modeling is used to understand the effect of long-term perturbations over geologic time scales (i.e. glaciation/deglaciation events) on the evolution of hydromechanical and geochemical coupling. Processes included in the model are density-driven flow and transport, as well as chemical reactions (aqueous complexation, mineral dissolution and precipitation including evaporites, sulfates and carbonates, as well as cation exchange). Transient boundary conditions are imposed in the upper part of the model to mimic ice sheet advance and retreat. The impact of Pleistocene glaciation on sedimentary basins is often identified based on geochemical data from groundwater and brines (Cl-Br-Na-Ca-Mg) accounting for the mixing between freshwater and resident brines, and rock-water interactions (i.e. dissolution of halite and dolomitization, etc.). Our modelling effort accounts for the impact of Pleistocene glaciation on groundwater flow in sedimentary basins, and attempts to integrate the simulated response with observed geochemical data.