Subglacial and Interglacial Chemical Weathering in the Transantarctic Mountains

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Active subglacial chemical weathering processes are indicated by mineral phases from rock and sediment samples collected at a blue ice moraine at the Mt. Achernar moraine complex. Widespread subglacial weathering would have implications for East Antarctica's impact on global climate and biogeochemical cycles. At the moraine, sediment progressively accumulates with distance from the active ice, with the oldest sediment exposed for >500 ka. Samples of freshly emerging fine sediment and cobbles, and fine sediment of progressively greater age, were collected. Sample aliquots were analyzed for clay and mineral content by X-ray diffraction and for salt, carbonate, oxyhydroxide, and oxide content by sequential extractions.

Salts and some carbonate species were largely absent from the rock and fresh sediment but developed in increasing abundance with age in the moraine sediment, due in part to atmospheric deposition. Oxides, oxyhydroxides, and clay minerals do not significantly increase in abundance with age in the moraine. Declining magnetic susceptibility suggests that magnetite may be oxidized with progressive surface exposure.

Substantial differences were observed between the rock and the freshly emerging sediment, suggesting that the latter cannot be merely a mixture of crushed rocks. In particular, smectite occurs in greater abundances in the emerging sediment than in any of the rock types represented in the moraine cobbles. Chlorite, kaolinite, and illite are comparably abundant in the moraine sediment and underlying sedimentary rocks. Oxides and oxyhydroxides are more abundant in the moraine sediments than in most (though not all) of the underlying rock.

We propose that subglacial formation of smectites and possibly some oxyhydroxide species best explains the observed data. Because clays, oxides, and oxyhydroxides do not appreciably accumulate under current interglacial conditions, either pre-glacial or subglacial formation is suggested. Pre-glacial soils are unlikely to be preserved in actively eroding subglacial environments and the represented rock types are not sufficiently rich in weathering products to produce the moraine sediment. Therefore, subglacial formation of weathering products is the preferred interpretation.