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Chemical Weathering Rates and Solute Fluxes from Catchments of the Greenland Ice Sheet

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Measurements of water chemistry were made from two adjacent glaciated catchments at the margin of the Greenland Ice Sheet, West Greenland during the summer meltseason of 1999. Both catchments are underlain by 2.8 Ga gneiss, likely have similar specific runoff values and similar glacial thermal regime. In the smaller catchment, a continuous record of discharge was generated for the entire meltseason, where instantaneous discharges were up to 34 m^3 sec^{-1}. The adjacent catchment was considerably larger (4-5 times) and the runoff was estimated to be 4-5 times higher than in the smaller measured catchment. The chemical composition of the runoff in both catchments showed similar concentrations of dissolved species and similar seasonal trends. This suggests that in catchments where the bedrock lithology, specific runoff and glacier thermal regime are similar the chemical denudation rate is independent of catchment size.

The water chemistry indicates that the hydrolysis of carbonates and silicates and the oxidation of sulfide minerals are the dominant weathering reactions in this glaciated environment. The continual supply of freshly ground bedrock through the processes of glacial crushing and abrasion, liberate sufficient quantities of trace bedrock minerals e.g. carbonates to dominate the runoff chemistry. This compares favourably with other studies on chemical weathering in non-carbonate glacierised catchments (Sharp et al., 1995) and experimental weathering studies on granitic rocks (White et al., 1999), where trace quantities of reactive minerals dominate the aqueous geochemistry.

Anderson et al., (1997) indicate that cation denudation rates scale with specific discharge in both glaciated and non-glaciated catchments. Estimates of the specific discharge for the Greenland catchment place it as the third highest when compared to all the catchments in the Anderson et al. database, both glacial and non-glacial. However, the cationic denudation rate is significantly lower than would be expected, when compared to the majority of the other glaciated catchments. The only other glaciated catchment with such a low denudation rate relative to specific discharge is located on Baffin Island and is underlain by Precambrian gneiss/granite bedrock. This suggests that the low chemical denudation rates in Greenland and Baffin Island are likely due to the generally unreactive nature of the Precambrian gneissic bedrock. This highlights the importance of lithology in controlling chemical weathering rates, despite the fact that it is the weathering of trace phases such as carbonates and sulfides which contribute the bulk of the solute.

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