Carbonate and plagioclase weathering rates in Pleistocene glacial drift deposits: Solute fluxes from soils to shallow groundwater systems

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Thick Pleistocene glacial drift deposits mantle large portions of the upper Midwestern U.S.A.. In lower Michigan, high permeability of soils and underlying glacial drift produce unusually close chemical linkages among soil, ground and surface waters. This region also provides an ideal natural laboratory with abundant organic matter and freshly eroded, reactive minerals in which to determine sequence and mass balances of carbonate and silicate mineral weathering and the evolution of soil waters into shallow groundwaters.

Sites were instrumented for soil water chemistry in vertical profile to 4 meters depth (UM George Reserve). Water and solute budgets were determined by Br tracer intoduction to instrumented soil monoliths at the LTER site at the MSU Kellogg Biological Station.

Soil water Na concentrations derived from plagioclase dissolution (corrected for atmospheric inputs) typically attain concentrations between 30-120 uM within the upper 25-50 cm and show little increase thereafter, implying that the reaction is largely completed within the rooting zone

Carbonate dissolution (DIC, divalent cations) is localized in deeper soil horizons where carbonate minerals are still abundant. Dolomite and calcite appear to dissolve at similar rates (Mg/Ca ratio of 0.4) and soil waters are near equilibrium with respect to dolomite which is more soluble than calcite at these relatively low temperatueres (<15C).

Taken together, these data demonstrate the rapid and early nature of solute acquisition and the importance of root respiration and dissolved organic matter flux.

Origin of radiogenic Sr in surface waters of central Texas, USA

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Stream waters from the four tributaries in the Lake Waco drainage basin in central Texas were analyzed for their Sr isotopic composition in order to investigate the origin of the solutes in the lake and the extent of weathering of limestones in the basin. All of the stream waters have Sr isotope ratios that are more radiogenic than the Cretaceous limestones (maximum of 0.7076) that underlie the watershed (Table 1).

Table 1. Sr isotopic composition of Lake Waco drainage basin surface waters

Sample	$^{87}Sr/^{86}Sr$
Up-basin North Bosque River	0.70885
Mid-basin North Bosque River	0.70853
Lower-basin North Bosque River	0.70837
Hogg Creek	0.70910
Middle Bosque River	0.70894
South Bosque River	0.70852
Lake Waco	0.70846

The North Bosque is the largest of the four streams and becomes less radiogenic downstream. The smallest of the subbasins, Hogg Creek, has the most radiogenic Sr of any of the surface waters. The most likely source of the radiogenic Sr in the stream waters is dust that contains high Sr ratios which has accumulated in the soils of the drainage basin. This idea is consistent with the higher Sr ratios observed in streams that receive abundant soil water or shallow groundwater such as the shallowly incised upstream North Bosque and Hogg Creek.

If Sr can be used as a proxy for the origin of Ca, then the amounts of externally derived Ca in the stream waters can be estimated. Using a typical Sr ratio for Saharan or Gobi desert dust of 0.715, it appears that between 10 to 20% of the calcium in the streams may be derived from weathered dust that has been deposited in the soils.