Sensitivity of mineral weathering rates to variations in climate

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Climate variables, such as precipitation amount and temperature, may exert a strong influence on mineral weathering rates. The relation between weathering rates and annual precipitation amount was examined for eight catchments in the western U.S ranging in size from 0.04 to 469 km^2 [1]. Weathering rates were calculated using the solute mass-balance technique [2]. Although runoff increased in nearly direct proportion to annual precipitation, annual volume-weighted mean (AVWM) concentrations of weathering products exhibited much less variation. As a result, net fluxes of weathering products increased, and calculated weathering rates exhibited a strong, positive relation to annual precipitation amount [1].

The increased net flux of weathering products in response to increased precipitation indicates that stream-water chemistry does not result from simple mixing of groundwater and precipitation. During years of high precipitation, flow rates through soil increase and water tables rise. This may cause increased flushing of solutes from micropores, providing a transient source of weathering products and an apparent increase in weathering rates. Flushing of micropores with dilute precipitation may cause a real increase in weathering rates as solutions become increasingly undersaturated with respect to primary and secondary minerals [3].

Annual variations in temperature also may cause variations in weathering rates [4]. However, the coefficient of variation in annual temperature often is smaller than the coefficient of variation in annual precipitation; in that situation, temperature's influence on weathering rates would tend to be smaller than that of precipitation.

At the global scale, spatial variations in precipitation and temperature exert strong controls on weathering rates [4]. And at geologic time scales, variations in atmospheric- and soil-CO_2 concentrations are important as well [5].

[1] Clow & Drever (1996) *Chem. Geol.* **132**, 131-141. [2] Garrels, in *Res. in Geochem.* 2; P. H. Abelson, ed. 405-420. [3] Drever *et al.* (1994) *Mineral. Mag.* **58A**, 239-240. [4] White *et al.* (1999) *GCA* **63**, 3277-3291. [5] Berner (1992) *GCA* **56**, 3225-3231.

Fossil coral constraints on tropical Pacific temperature and hydrology during the last millennium: Lessons and updates

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Fossil corals from the central tropical Pacific provide accurate, well-dated records of the El Nino-Southern Oscillation (ENSO) and tropical Pacific climate through most centuries of the last millennium. Indeed, by splicing together multi-century oxygen isotopic ($\delta^{18}O$) records from fossil corals located on Palmyra Island (6°N, 162°W), Cobb *et al.* (2003) demonstrated a high level of coral-to-coral reproducibility on interannual timescales. However, poor coral-to-coral reproducibility of absolute $\delta^{18}O$ values, in addition to uncertainties associated with the temperature versus hydrological contributions to low frequency coral $\delta^{18}O$ anomalies ultimately limit the utility of the reconstruction. Most importantly, these shortcomings prevent a thorough assessment of the relationship between climatic forcing, background tropical Pacific climate, and ENSO characteristics. Here we present an updated reconstruction that includes the following improvements: i) inclusion of a fossil coral $\delta^{18}O$ reconstruction from Christmas Island (2°N, 157°W), ii) addition of five new fossil coral $\delta^{18}O$ reconstructions from Palmyra Island, and iii) new fossil coral Sr/Ca data that are used to constrain sea-surface temperatures during the Medieval Climate Anomaly (MCA) and the Little Ice Age (LIA). Thin sections reveal some evidence for secondary aragonite crystals (<10% by mass) in one of the Palmyra fossil corals, which could explain anomalously enriched $\delta^{18}O$ and Sr/Ca values in that coral. In general, the new fossil coral $\delta^{18}O$ data are consistent with trends observed in the Cobb *et al*. (2003) reconstruction, with enriched values during the MCA consistent with cool/dry conditions during this time, and relatively strong ENSO activity during the LIA. The new fossil coral Sr/Ca values are consistent with significant cooling (2-3°C) during the MCA, and moderate cooling (1-2°C) during the LIA, although these paleo-temperature estimates are associated with significant uncertainties.