

Re-assessing the Carbonate Contribution to High Himalayan Dissolved Load

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A number of recent studies on rock weathering in the Himalayas have focused on interpreting the sources of dissolved cations to major rivers, using river water and sediment chemistries to deduce weathering processes (Harris et al., 1998; Krishnaswami et al, 1992; Galy and France-Lanord, 1999). Significant progress has been made in understanding patterns of weathering across the Himalayas, but important questions about weathering processes still remain since existing studies have relied on stream water chemistries, which may give ambiguous signals about weathering sources. One particular ambiguity is whether carbonate or silicate weathering dominates the dissolved load, especially in catchments draining the predominantly silicate lithology of the High Himalayan Crystalline Series. One study of major cation chemistry in surface waters has suggested that the vast majority of dissolved calcium (70-85%) must come from carbonate weathering (Blum et al., 1998). This is surprising given that carbonate is only a trace mineral (abundance <1%) in the meta-silicate bedrock. Based on flux estimates, our calculations suggest that supplying this much calcite for weathering would require denudation rates significantly higher, by almost an order of magnitude, than the most extreme estimates of Himalayan erosion. To understand this discrepancy, we have examined more closely the weathering processes in High Himalayan catchments in India and Nepal. Our work suggests that studies of Himalayan weathering based principally on major cation chemistry of stream water may be misleading. Simple cation mass balance calculations in the several small catchments we have sampled do indeed indicate high (50-90%) contributions from the weathering of calcite. However, a more complete calculation of individual phase mole balances, using the USGS aqueous modelling software PHREECQ, points to significantly lower (15-35%) contribu-

tions from calcite to the dissolved load. This is more consistent with estimated fluxes based on realistic denudation rates in the Himalayas. These calculations remain an ambiguous estimate of weathering sources since they are still based on the assumption that calcium and magnesium concentrations in surface waters represent a direct signal of weathering. Across the Himalayas we have found a direct correlation between Ca and Mg concentrations that suggests that these may well be controlled by processes other than weathering, such as exchange or re-precipitation, perhaps because most waters are saturated with respect to carbonate. While the cations almost certainly have an initial weathering source, their close relationship across dramatically varying lithologies suggests that their relative concentrations in stream and river waters may not directly reflect the composition of the source rock. The discrepancy suggests that analysis of major cations alone may be a poor indication of weathering sources in the Himalayas. This conclusion has important implications for studies seeking to identify weathering sources in larger rivers. Further work on weathering processes, including soil profile analysis, will be necessary to fully understand Himalayan weathering processes.

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