Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.12437

Quantitative assessment of CO_2 uptake by silicate weathering during continental erosion. Application to the Himalayan erosion

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Tracing continental weathering and more particularly silicate weathering remains challenging even when observing present-day river systems. The application to the geological record relies on geochemical proxies of chemical weathering (that are more or less reliable) often based on ratios of mobile to immobile elements and recorded in detrital sediments. Alternatively global evolution of weathering can be traced using fingerprints of chemical riverine input to the oceans and recorded in oceanic sediments. While very useful for qualitative approach of continental weathering trends, these are not fitted to quantify the effective carbon uptake.

With the aim to constrain an approach which can be applied to detrital sediment records, we use major element composition of river sediment to quantitatively determine the release of critical cations to the river system and ocean. This is mainly based on the chemical difference between bedrock and eroded sediment in a catchment. Difficulties include assessment of the protolith composition, nature of the weathering reactions, nature of ions involved, and exchange effects associated to the particulate flux in the ocean. Sediments are submitted to acid leaching in order to separate Ca and Mg of silicate and carbonate. Himalayan and Transhimalayan sources are traced using Sr and Nd isotopic compositions. The relationships between grain size sorting and cation depletion are characterized in order to establish normalization rules allowing to compare sediments ranging from sand to fine silt.

Applied to late Pleistocene Bengal fan turbiditic levee sediments, the mean release of Ca and Mg from silicate weathering is estimated to 0.04 to 0.16 and 0.05 to 0.13 mol/kg of eroded rock respectively. Assuming these cations will ultimately precipitate carbonate, this compares with the mean burial rate of contemporaneous organic carbon of 0.2 to 0.3 mol/kg.