Spatial variation of weathering in the Ganga Basin

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Links between physical erosion, climate, transport and Weathering responds to a large number of parameters including topography, climate and lithology. In this study we compare weathering in different Himalayan watersheds of Nepal and in the Gangetic floodplain.

We use major elements data of sediments transported by Himalayan Rivers from their source in Nepal downstream to the Bangladesh delta. An extensive dataset of suspended sediments along depth profiles at various places covering the Ganges' basin and systematic analysis of major elements allows us to capture sediment variability and compare weathering processes to physical characteristics amongst different Himalayan sub-basins. Depth sampling of suspended load allow to take into account the effect of mineral sorting that occur in the water column and which exert a first order control on the chemical composition of the sediments.

We observe that river sediments loose mobile elements throughout their transfer to the Indian Ocean. While Ca chemistry is dominated by carbonate, Na and K are strongly depleted in the sediments arriving in the bay of Bengal compared to Himalayan source rocks. This signal integrates weathering of the Himalayan source rocks within the mountainous catchments areas and during transfer in the flood plain highlighting differential behaviour of Na and K.

Inter-comparison of the major drainage systems of the Nepalese Himalaya: Karnali, Narayani and Kosi basins (from W to E) suggests that Narayani's and Kosi's suspended load, showing similar depletion patterns, experiences most of their weathering during flood plain transfer further down -stream. On the contrary Karnali river sediments in western Nepal, are already significantly depleted in Na on entering the flood plain compared to Kosi and Narayani sediments. These observations appear to be linked to morphological and climatic characteristics of the basins with the Western basin being less exposed to physical erosion than the two others. Downstream in the floodplain further weathering occurs. The intensity of weathering however appears more intense in the western part of the floodplain likely as a response to soil erosion.

Helium isotopes: From mantle degassing to ocean circulation

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Since the discovery in the 1970s of elevated $^3He/^4He$ ratios in deep Pacific ocean waters and in mid-ocean ridge basalts, the distinct isotopic signature of mantle helium has served as a useful tool for studying a variety of terrestrial processes. Detailed studies of heium isotopes in oceanic volcanic rocks have revealed that the mantle is heterogeneous with respect to He, Sr, Nd, and Pb isotopic signatures, with so-called "hot spots" such as Hawaii and Samoa having signatures distinct from mid-ocean ridge systems. Subduction zones seem to fall into yet a third category, having $^3He/^4He$ typically lower than the MORBs, presumably due to mixing of mantle material with melting of the degassed downgoing slab. In the oceans, the second piece of the puzzle was provided by the discovery of submarine hydrothermal systems, making it clear that the excess ^3He found in the deep ocean waters has been extracted from oceanic basalts by circulating hydrothermal fluids. Because it is a totally conservative ocean tracer, ^3He has been an extremely useful tool for locating seafloor hydrothermal activity and for studying deep ocean circulation and mixing. In some cases it has been possible to trace deep helium plumes for thousands of kilometers from the source regions on the mid-ocean ridge axis, thereby delineating the far-field pattern of deep ocean currents. Recently, helium isotopes have been used to study submarine volcanic and hydrothermal activity along volcanic arcs, where the activity is typically much shallower than along mid-ocean ridges. In particular, $CO_2/^3He$ ratios and $\delta^{13}C(CO2)$ values can be used to distinguish subduction zone volatiles from those found on mid-ocean ridges. Some submarine arc volcanoes are emitting pure CO_2 as a separate phase, resulting in a very high carbon flux. Since this CO_2 is laced with trace amounts of mantle heliuim, ^3He may once again be useful for tracing the fate of this carbon after it has been injected into the ocean.