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Sediment transfer and deposition throughout the Himalayan continental and oceanic basin : constraint from geochemical composition of river sediments

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The Himalayan erosion system presents a highly contrasted transport system with a very steep and relatively short mountainous part and a long and very flat floodplain and deltaic part. Indeed the modest slope and the subsidence in the floodplain tend to favour deposition and it's importance is difficult to assess. Because deposition preferentially involves coarse and quartz rich sediments it tends to fractionate the overall sediment load transported by the rivers [1]. This can be tracked using the evolution of major element concentrations in the sediment tacking into account the potential bias due to chemical erosion.

Overall, estimated in the Ganga-Brahmaputra delta, chemical denudation represents less than 10% of the total erosion flux and it is mainly generated from carbonate dissolution. On the silicate side, chemical erosion does not affect the most important major elements and even for a relatively soluble element like Si, it does not exceed 2%. Therefore concentrations of Si, Al, Fe in sediments can be considered as conservative.

We present a set of modern river sediment samples from the Himalayan front to the Bangladesh delta and from sediments from the modern and Neogene Bengal fan. Most river sampling were performed during monsoon when rivers are at their high stage. Sampling includes river depth sampling to document river variability due to settling processes in the water column, daily sampling on the Narayani-Gandak river to document seasonal variability. Data show that grain size/mineralogical segregation becomes more pronounced downstream and is clearly dependant on the hydrodynamical conditions [1]. At the Himalayan front, data show that Al/Si ratios vary from 0.29 to 0.20 with minor variation in the water column. Average pebble composition is highly enriched in quartz with a ratio of 0.11. Ganga and Brahmaputra rivers in Bangladesh typically vary from 0.32 at the surface to 0.13 in the bedload. In the Lower Meghna estuary, surface suspension is at 0.36, and gradually decreases to 0.15 in the bedload. This represents quartz proportion varying from less than 30% in the upper suspension to ca. 60% in the bedload. In the Bengal Fan, Al/Si ratio range from 0.17 to 0.48 with most data between 0.3 and 0.4. Unlike upper and mid Fan, the deepest part of the fan (ODP Leg 116) is not significantly depleted in Si compared to the river sediments except during Upper Miocene.

Himalayan rivers compositions allow to constrain the mean Himalayan Al/Si ratio close to 0.23 which is comparable to the integrated sediment composition estimated for the Ganga in Bangladesh [1]. The modest evolution of Al/Si ratios from Himalaya to the Delta implies that relatively minor deposition (< 10% of the total flux) occurs in the floodplain. In contrast Bengal Fan sediments have significantly Si depleted composition even on the middle shelf implying that up to 50% of the Himalayan erosion flux is deposited as sandy-silt in the estuarine zone and the upper part of the submarine delta.

[1] Lupker et al 2011: JGR doi:10.1029/2010JF001947