

Geochemical composition of Ganga basin rivers: assessing the spatial and temporal variability in chemical weathering

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Trace elements play a crucial role in riverine systems as they influence water quality and terrestrial biogeochemistry. Further, their riverine supply to ocean is crucial in regulating ocean productivity, influencing the oceanic biological pump, which modulates the atmospheric CO₂ levels and global climatic variability. This study presents a detailed investigation of the major and trace element chemistry in seasonally and spatially resolved samples from the rivers in the Ganga basin. Based on analyses of 210 water (river water, groundwater and hot springs) and sediment samples (SPM and channel sediments), this study aims to (a) assess the spatial and seasonal distribution of trace elements and selected isotopes, (b) identify the sources contributing to the riverine trace metal chemistry, (c) assess the downstream evolution of source rock contributions, (d) examine the impact of discharge on river water chemistry and (e) quantify the dissolved trace element fluxes to the ocean.

Preliminary observations indicate that the dissolved concentrations are primarily controlled by the weathering of silicate and carbonate rocks. In the highland regions, river chemistry is predominantly influenced by carbonate and/or (Ca²⁺+Mg²⁺) rich silicates weathering, as (Ca²⁺+Mg²⁺) and (HCO₃⁻) account for ~85% of total cations and anions. However, a noticeable decline in the contribution of (Ca²⁺+Mg²⁺) and ~50% (Na⁺+K⁺) proportion in the lower reaches suggests that river chemistry in downstream regions is influenced by weathering of silicates, alkaline soils, or both. Interestingly, the contributing sources of trace metals (Li, Mo, U, Ba, V, etc.) vary among the river catchments, with silicates being the dominant source in the lean flow period. However, negative intercept obtained in the sodium normalized metal concentrations vs. [Ca/Na*] ratios indicates that a significant fraction of the trace metals is contributed by either carbonates or (Ca²⁺+Mg²⁺) silicates.

Measurements of δ⁷Li in river water and sediments (bulk, exchangeable and acid-leachable phases) are currently underway to assess the variability in weathering and solid-solution interactions within the catchment. Further, to better understand the nature and intensity of weathering, the chemical composition in different phases will be analyzed to assess their respective contributions to dissolved compositions and to determine order of relative effective mobility of elements.