BIOGEOCHEMISTRY OF THE GODAVARI RIVER BASIN (INDIA) – EVALUATION OF ORGANIC CARBON AND MINERAL TRANSPORT DYNAMICS

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Rivers are an important link in biogeochemical cycles globally by connecting soils (terrestrial sources) and marine sediments. Organic carbon (OC) is an important component which influences climate via feedback mechanisms. OC is continuously mobilized from soils that are a temporary storage of photosynthetically-fixed CO_2 and is either returned to the atmosphere, or – associated with a mineral matrix – transported downriver to the ocean, where OC can form a long-term sink. However, the fate of soil OC and mineral matter upon entering a river is often overlooked, and our understanding of spatial and temporal effects of river processes on OC cycling and mineral transport mechanisms is incomplete.

In this study, we investigate the biogeochemistry, OC and mineral transport in the Godavari River Basin in Central India, which is a very dynamic river with intense rainfall and high sediment transport driven by the Indian summer monsoon versus low flow, low transport conditions in the dry season. In order to evaluate the composition and sources of organic and mineral matter transported during high and low flow conditions, soils, river sediments (bulk and < 63 um) and suspended particulate matter (SPM) were sampled in high resolution during the monsoon and dry season in 2015.

Here, we use branched glycerol dialkyl glycerol tetraethers (brGDGTs) as soil-specific biomarkers, allowing us to follow soil-derived OC through the river basin, where variations in concentrations and composition of brGDGTs in soils, SPM, and river sediments provide insights in source-to-sink transport. BrGDGTs reveal marked spatial trends in contributions from the upstream tributaries to the Godavari delta, as well as pronounced differences in their relative distribution between the monsoon and dry season. The evolution of brGDGT signatures along the river course shows that the SPM in the delta carries primarily soil-derived OC that is contributed by the northern headwaters during the monsoon season [Figure 1]. Depth profiles at several river cross-sections reveal that brGDGTs are well-mixed in the water column and that no preferential transport occurs.

The SPM collected during monsoon and dry season is characterised by the dominance of respectively 5- or 6-methyl brGDGTs, which may be linked to the primarily soil or aquatic source of OC transported by the Godavari during the respective seasons. This pattern confirms the use of 6-methyl isomers as indicators for aquatic production as suggested by De Jonge et al. (2014a, 2014b). Hence, the dominance of the 6-methyl isomer in SPM from the arid upper part of the Godavari Basin thus indicates a year-round aquatic OC contribution in these western tributaries. The river water isotopic composition reflects year-round evaporating, low flow conditions promoting aquatic OC production in the upper tributaries where 6-me brGDGT is high, and more precipitation and higher runoff in the northern tributaries where brGDGT distributions of SPM resemble those in catchment soils. The specific source of brGDGTs discharged by the modern system indicates that a provenance change may a have large impact on the paleorecord in the Bay of Bengal.

Due to the geological differences in the upper and lower Godavari Basin, elemental analysis will enable us to also trace sediment provenance. Subsequent comparison with the brGDGT signatures should reveal the stability of organo-mineral bonds formed in soils upon entering a river, and thus whether land-sea sediment and OC transport is (de)coupled.

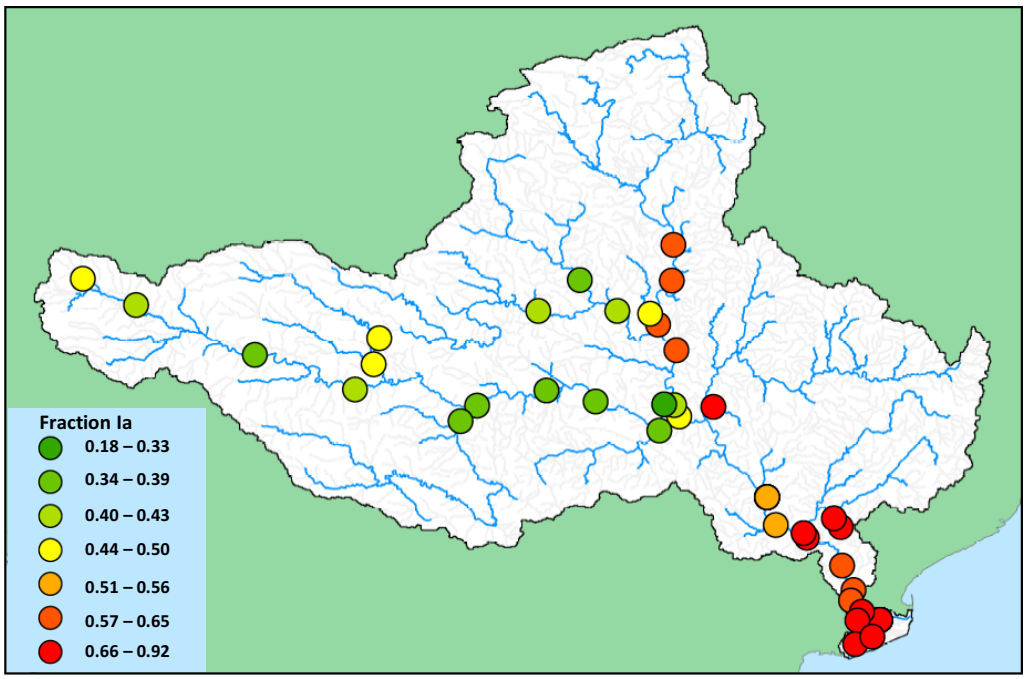

Figure 1 *Map of the Godavari River Basin with the Godavari River and its tributaries. Dots represent the sampling points in the monsoon season in 2015. The colouring indicates the relative abundance of brGDGT Ia in Suspended Particulate Matter (SPM) in the monsoon season.*

References

De Jonge, C., Hopmans, E., Zell, C., Kim, J-H., Schouten, S., Sinninghe Damsté, J.S. 2014a. Occurrence and abundance of 6-methyl branched glycerol dialkyl ethers in soils: implications for paleoclimate reconstruction. Geochimica et Cosmochimica Acta 141, 97-112.

De Jonge, C., Stadnitskaia, A., Hopmans, E., Cherkashov, G., Fedotov, A., Sinninghe Damsté, J.S. 2014b. In situ produced branched glycerol dialkyl glycerol tetraethers in suspended particulate matter from the Yenisei River, Eastern Siberia. Geochimica et Cosmochimica Acta 125, 476-491.