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Silicon biogeochemical processes in a large river (Cauvery, India)

Mangalaa Kameswari Rajasekaran (1), Dapoigny Arnaud (2), Riotte Jean (3,4), Sarma Vedula V.S.S (5), Sarma Nittala.S (6), Subramanian Sankaran (7), Gurumurthy Gundiga Puttojirao (8), Balakrishna Keshava (9), and Damien Cardinal (1)

(1) Sorbonne Universités (UPMC, Pierre and Marie Curie University)-CNRS-IRD-MNHN, LOCEAN Laboratory, 75252 Paris, France. (krmlod@locean-ipsl.upmc.fr, damien.cardinal@upmc.fr), (2) LSCE/IPSL - Laboratoire des Sciences du Climat et de l'Environnement Laboratoire CEA-CNRS-UVSQ, Gif sur Yvette Cedex – France-91198.(arnaud.dapoigny@lsce.ipsl.fr), (3) Geosciences Environnement Toulouse (Universite de Toulouse, CNRS, IRD), Toulouse, France-31400. (riotte@get.obs-mip.fr), (4) Indo-French Cell for Water Sciences, Indian Institute of Science, Bangalore 560012, India.(riotte@get.obs-mip.fr), (5) National Institute of Oceanography, Council of Scientific and Industrial Research, Visakhapatnam, India.(sarmav@nio.org), (6) School of Chemistry, Andhra University, Visakhapatnam-530 003, India. (ssarma@rediffmail.com), (7) Materials Engineering Dept, Indian Institute of Science, Bengaluru 560012 India, (ssmani@materials.iisc.ernet.in), (8) Manipal Centre for Natural Sciences, Manipal University, Manipal 576104, India (gurumurthy.gp@manipal.edu), (9) Manipal Institute of Technology, Manipal University, Manipal 576104, India (k.balakrishna@manipal.ed)

Silicon (Si), one of the key nutrients for diatom growth in ocean, is principally released during silicate weathering on continents and then exported by rivers. Phytoplankton composition is determined by the availability of Si relative to other nutrients, mainly N and P, which fluxes in estuarine and coastal systems are affected by eutrophication due to land use and industrialization. In order to understand the biogeochemical cycle of Si and its supply to the coastal ocean, we studied a tropical monsoonal river from Southern India (Cauvery) and compare it with other large and small rivers. Cauvery is the 7^{th} largest river in India with a basin covering 85626 sq.km. The major part of the basin (∼66%) is covered by agriculture and inhabited by more than 30 million inhabitants. There are 96 dams built across the basin. As a consequence, 80% of the historical discharge is diverted, mainly for irrigation (Meunier et al. 2015). This makes the Cauvery River a good example of current anthropogenic pressure on silicon biogeochemical cycle.

We measured amorphous silica contents (ASi) and isotopic composition of dissolved silicon (δ^{30}Si-DSi) in the Cauvery estuary, including freshwater end-member and groundwater as well as along a 670 km transect along the river course. Other Indian rivers and estuaries have also been measured, including some less impacted by anthropogenic pressure.

The average Cauvery δ^{30}Si signature just upstream the estuary is 2.21±0.15 ‰ (n=3) which is almost 1‰ heavier than the groundwater isotopic composition (1.38±0.03 ‰). The δ^{30}Si-DSi of Cauvery water is also almost 1‰ heavier than the world river supply to the ocean estimated so far and 0.4‰ heavier than other large Indian rivers like Ganges (Frings et al 2015) and Krishna. On the other hand, the smaller watersheds (Ponnaiyar, Vellar, and Penna) adjacent to Cauvery also display heavy δ^{30}Si-DSi. Unlike the effect of silicate weathering, the heavy isotopic compositions in the river Cauvery may result from the successive dams along the main course which are expected to favor the retention of isotopically light Si isotopes in sediments via diatom uptake in reservoirs and/or, Si uptake by vegetation. Both processes likely result in heavier δ^{30}Si-DSi downstream.

In the estuary, the average δ^{30}Si-DSi is 2.20±0.17 ‰ (n=11). There is a significant positive relationship between ASi contents and fucoxanthin (diatom marker pigment) ($r=0.61$, $p<0.05$, $n=11$) suggesting a significant control of diatoms on ASi. However a dominant mixing effect is observed in dissolved silicon with a strong positive relationship between 1/DSi and δ^{30}Si-DSi ($r=0.71$, $p<0.01$, $n=11$).

A comparative study with a west-flowing river, the Netravathi (southwest India) will be performed and presented during the session. We will also compare the Si isotopic signatures in Cauvery along the transect with focus on seasonal variability and on upstream vs. downstream large dams to strengthen interpretations.