Goldschmidt 2000
September 3rd–8th, 2000
Oxford, UK.

Journal of Conference Abstracts
Volume 5(2), 329
© 2000 Cambridge Publications

Re Geochemistry of the Yamuna River in the Himalaya

Tarun K. Dalai (tarunk@prl.ernet.in), **J. R. Trivedi** (jtrivedi@prl.ernet.in) & **S. Krishnaswami** (swami@prl.ernet.in)

Earth Science and Solar System Division, Physical Research Laboratory, Navrangpura, Ahmedabad; Gujarat, 380 009, India

The river Yamuna, a major tributary to the Ganga, originates in the Higher Himalaya from the Yamunotri Glacier (altitude 3186m), about 70 kilometers west of the Gangotri Glacier, the source of the Ganga. The annual water flow (Rao, 1975) of the Yamuna is ~11x10^{12} liters at the foothills of the Himalaya (near Dehradun), about half the discharge from the Ganga at Hardwar (about 60km southeast of Dehradun). The headwaters of Yamuna in the Himalaya drain a variety of lithologies ranging from crystallines in the Higher Himalaya consisting predominantly of granites and granodiorites, to sedimentaries in the Lesser Himalaya comprising of quartz-arenites, slates, limestones, dolomites, shales and siltstones. The concentrations of Re in the Yamuna and its tributaries were measured to assess its behaviour and mobility during weathering and transportation and constrain its sources to the river waters. Towards this, water and sediment samples of the Yamuna and its tributaries were collected along its entire stretch in the Himalaya (Figure 1) from Hanuman Chatti to the foothills of the Himalaya near Saharanpur during three seasons, October 1998, June 1999 and September 1999. The water samples were filtered at site (0.45μ Nucleopore), acidified to pH 2 with ultrapure HNO_3 and brought to laboratory for analysis. Re and a suite of other properties (major ions, stable isotopes, Sr, Ba, $^{86}Sr/^{86}Sr$ etc.) were measured in the water. For Re, ~100ml water samples were spiked with ^{185}Re, evaporated to dryness, Re separated by ion exchange and measured by NTIMS (Singh et al.,1999). The procedural blank centered around 1-3pg and precision better than 4%. The range in Re concentrations (uncorrected for blank) during peak discharge is ~0.35 to 4.7ng l^{-1} (mean 1.8ng l^{-1}), marginally lower than that measured during October 1998 ~1 to 6.2ng l^{-1} (mean 2.1ng l^{-1}) mimicking the TDS variations. The dissolved Re concentrations of 1-2ng l^{-1}, typical of these rivers, is difficult to be accounted for from the weathering of the crystallines and common sedimentary rocks from the Himalaya, as they generally have low Re, 0.02 to 2ng g^{-1} (Pierson-Wickman et al., 2000). Weathering of black shales is likely to be the dominant source of dissolved Re in the waters. Indeed, Re in black shales from underground mines in the Lesser Himalaya, average ~60ng g^{-1} (Singh et al., 1999). This is much higher than the average Re in black shale outcrops of Lesser Himalaya, ~5ng g^{-1}, supporting to the idea of Re mobilization during their weathering. The impact of black shale weathering on dissolved Re, however, is not clearly evident from Re-SO_4 plot which seem to be dominated by mixing of various end members with Re/SO_4 molar ratio ranging between ~10^{-9} to ~10^{-7}. The dissolved Re flux at the foothills of the Himalaya from the Yamuna and the Ganga are 120 and 200 moles y^{-1} respectively. It can be estimated that Re from ~30mg of black shales will have to be supplied per liter of river water to yield ~2ng l^{-1} dissolved Re. The contribution of (Na+K+Mg+Ca) from these black shales, if they are also released congruently will be ~2mg, ~ 4% of their abundances in the river water. The weathering of black shales, though can account for the entire dissolved Re in rivers, its contribution to dissolved major ions would at best be a few percent. Analogous to Re, weathering/alteration of black shales can also influence the budget of several other elements in rivers, which are enriched in them, these include PGE (Peucker-Ehrenbrink and Hannigan, 2000), uranium, phosphorous and vanadium. Similarly, if oxidation of organic matter is the dominant process during the weathering/alteration of the black shales, it could also contribute to CO_2 budget. Rough estimates indicate that for dissolved Re flux of 120 moles y^{-1} (Ganga at Rishikesh), the weathering/alteration rate of black-shales has to be 20x10^3 kg km^{-2} y^{-1}. Oxidation of carbon of these black shales (~3% wt) would yield a CO_2 flux of ~5x10^4 moles $km^{-2}y^{-1}$. This compares with ~3-4x10^5 moles km^{-2} $y^{-1}$of CO_2 consumption rate for silicate weathering in the Bhagirathi and Alaknanda basins (Krishnaswami et al., 1999).

Rao KL, *India's water wealth, Orient Longman,* (1975).

Singh SK, Trivedi JR & Krishnaswami S, *Geochem. Cosmochim. Acta*, **63**, 2381-2392, (1999).

Pierson-wickmann A-C, Reisberg L & France-Lanord C, *Earth Planet. Sci. Let*, **176**, 203-218, (2000).

Peucker-Ehrenbrink B & Hannigan RE, *Geology*, **28**, 475-478, (2000).

Krishnaswami S, Singh SK & Dalai TK, *Ocean Science,Trends and Future Directions, Academia International*, 23-52, (1999).