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U Fluxes of the Himalayan Rivers: Implications for the U Oceanic Budget

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Rivers draining the Himalayas are recognized to be major contributors to the increase of Sr and Os in the world ocean during the past 40 million years, and to influence the marine budget of other elements such as U (Sarin et al., 1990; Palmer and Edmond, 1993). Quantification of these Himalayan fluxes and evaluation of their responses to climate or tectonic changes are needed for a correct estimate of their impact on the chemical mass budget of seawater over the last million years.

The aim of this study is to use TIMS analysis of ($^{234}U/^{238}U$) activity ratio in the dissolved load of Himalayan and Bangladeshi rivers to address these questions for U. The water samples from the Nepalese Himalayan rivers were collected in the Narayani and Karnali watersheds, which drain two third of the Nepal Himalaya. They include a detailed sampling of the Kali-Gandaki river, and a sampling of rivers draining specifically each of the main structural units of the Himalaya, i.e. the Tethyan Sedimentary Series (TSS), the High Himalaya Crystalline (HHC), the Lesser Himalaya (LH) and the Siwaliks, from north to south. The Bangladesh water samples were collected in the Ganges and the Brahmaputra main streams, and in two of their tributaries: the Tista and the Meghna rivers.

Data on Himalayan rivers revealed that ($^{234}U/^{238}U$) activity ratio have specific values within each structural himalayan unit, with values slightly lower than unity for rivers draining the TSS area, and ratios slightly higher than unity for waters from the LH and HHC regions. Only rivers draining the Siwaliks part have systematically high ($^{234}U/^{238}U$) activity ratios with values ranging from 1.20 to 1.37. Water samples of the Himalayan rivers generally define quite good correlations in the ⁸⁷Sr/^{86}Sr - ($^{234}U/^{238}U$) diagram. Mass balance calculation using these data outline that more than 70% of the U dissolved load of the Himalayan rivers originate from the TSS area, i.e. from the northern formations of the Tibetan plateau. Compared to the Himalayan rivers, water samples collected in the Bangladesh define, in the ⁸⁷Sr/^{86}Sr - ($^{234}U/^{238}U$) diagram, a correlation different from that of the Himalayan rivers, between an end-member represented by the Tista samples in the LH-HHC domain and an end-member outside the Himalayan domain, which is represented by the Meghna samples and characterized by low $^{87}Sr/^{86}Sr$ and high ($^{234}U/^{238}U$) ratios. This correlation outlines the contribution of the Indian plain on the chemical fluxes carried by the Ganges in its discharge area, with certainly a significant flux coming from the Deccan Plateau. This plain contribution remains however quite limited for U, whereas for Sr it could reach 35 to 55%. These results reveal, therefore, the partly uncoupled origin of the dissolved Sr and U fluxes of the Ganges in its discharge area, with an immediate consequence when is considered the response of these fluxes to climatic variations: the weight of the Ganges Brahmaputra river system on the Sr increase of the world ocean is more or less unchanged during the glacial period, whereas for U it would significantly decrease. Such climatic, and hence cyclic, variations of U fluxes of the Ganges - Brahmaputra river system are certainly a key point to understand the present U activity ratio of sea-water.

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