B analysis in natural waters by ion microprobe: A new technique for the study of B transfer from the continent to the ocean

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A recent emphasis has been put on boron isotopes studies because of their potential use as a proxy for palaeo-pH of the oceans (Vengosh *et al.*, 1991; Sanyal *et al.*, 1995). Boron is also a unique tracer among stable isotopes to solve provenance problems not adequately covered by other methods as demonstrated for groundwaters and sediments (Swihart and Moore, 1986). Despite their strong potential interest, B isotopes have never been extensively studied in river waters, their measurements being hampered by analytical difficulties.

In this study, a new technique has been developped for the measurement of boron isotopes in B-poor (ppb range) river and rain waters. ^{11}B/^{10}B ratios were measured with the CRPG-CNRS ims3f ion microprobe which offers a high sensitivity for B analysis. A precision of ± 1‰ on the ^{11}B/^{10}B ratio is demonstrated by repeated analyses of the boron NBS951 standard and of seawater.

Rivers are the major B input to the ocean (37×10^7 kg/yr as compared to B hydrothermal flux of 13×10^7 kg/yr at mid ocean ridges, Spivack and Edmond, 1987) which highlights the importance of the determination of B isotopic compositions of river waters in order to understand the present day and past B isotopic composition of the ocean.

The δ^{11}B values obtained for the main Himalayan rivers of central Nepal (Kali and Trisuli) and their tributaries draining the different formations of the Himalayan range (the Tibetan Sedimentary Series, the High Himalayan Cristalline and the Lesser Himalaya) range from -2.9‰ to +29.7‰ whereas the boron contents range from 0.65 to 5.92µmol/l. There is no obvious correlation between the δ^{11}B and B concentrations of river waters, but each lithology has a different B isotopic signature (Fig. 1).

Two rain waters collected above 3000 m high, have B concentrations of ~0.1 µmol/l and δ^{11}B values of +0.8 and +5.9‰. The geochemistry of these rivers (major and trace elements, H, C, O and Sr isotopes) has been studied in details (Galy and France-Lanord, submitted) and allows to discriminate between evaporite dissolution, silicate weathering and carbonate alteration (the dominant process) in the chemical erosion of the Himalayan range. The boron concentrations correlate with the chlorine concentrations of the rivers which are dominated upstream by an evaporite signature, their δ^{11}B values being high (+23.8‰ and +29.8‰). When corrected for the cyclic input and the evaporite contribution, the boron isotopic compositions of the rivers still show a ~30‰ range of variation. The corrected δ^{11}B values display several correlations with major and trace elements concentrations and reveals informations on the different silicate weathering processes.The corrected δ^{11}B values allow an estimation of the pH at the silicate weathering location: the soils, where the major B fractionation takes place with no later significant B fractionation occuring in the rivers themselves.

These results demonstrate that boron isotopic compositions of rivers are highly variable and can not be simply considered as similar to the average continental δ^{11}B value (i.e. -10‰). Therefore the variations of δ^{11}B values of river waters should be

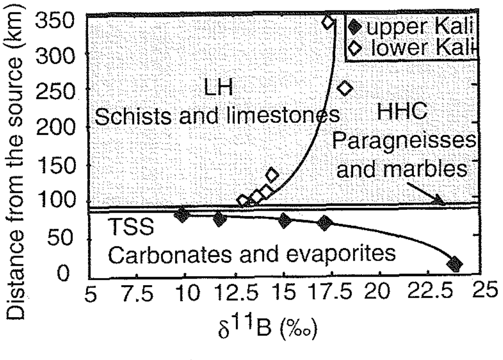

FIG.1. Variation of δ^{11}B from the Kali river as a function of the distance from the source of the river. The horizontal layers correspond to the different lithological units across which the river runs.

taken into account when trying to investigate the B isotopic evolution of the oceans through geological time. The explanation of the high +40‰ $\delta^{11}B$ value of the ocean resides probably in both adsorption processes on clay minerals during estuarine discharge (as already proposed by Palmer *et al.*, 1987) and variations of continental erosion processes.

References

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