First data on *REE* distributions in the Changjiang water: Weathering processes and fluxes to the East China Sea

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The rare earth elements (*REES*) transported through rivers from the continents to the ocean play an important role in the geochemical cycle of *REE*s in the ocean, and help the interpretation of the *REE* pattern of seawaters. This work studies the *REE* concentrations of Changjiang water, to characterize the *REE* fractionations between suspended loads and dissolved phase, and to estimate the riverine input of the *REE*s to the East China Sea.

River water samples were collected across 2500 km along the river from Changjiang inlet to upper reaches during October 13-19, 1997. Sampling was made by using a 10 L clean polyethylene bucket while the ship was slowly steaming. Immediately after collection, all river water samples were filtered through 0.1 mm hollow fibres (Milli pore). The samples used for *REE* determination were acidified to pH < 1.6 and transferred to the laboratory on land for trace element analysis.

Major cations were determined with an inductively coupled plasma-association emission spectrometer, and anions with an ion chromatography. The method for *REE* (including yttrium) concentration determination in the river waters were the same as that reported recently (Zhang *et al.*, 1994) for the seawaters. Indium was added as a yield monitor for the chemical procedure which was quantitative (> 95 %), and Cd added to the final solution was used as a monitor in the efficiency of ionization and ICP-MS detection. The blanks for the entire procedure and reagents were measured in parallel with the samples and suitably corrected. They were the highest for the *LREE*s being ~10 % for Ce and ~5% for La, Pr and Nd, but relatively minor (< 3%) for Y, *MREE*s and *HREES*. The accuracy and precision of *REE* measurements were better than ± 3%.

Major element distributions in Changjiang water are mainly controlled by weathering and erosion of carbonates and silicates in the drainage basin. Among the elements measured, calcium, magnesium, sodium and potassium are the major cations, with a concentration variation order of $Ca^{2+} > Mg^{2+} > Na^{+} > K^{+}$. The cations in this calcic water show conservative abundances from the Changjiang inlet to the upper reaches like almost other world river, with one exception collected from Shanghai bay which probably influenced by urban draining water. Ca^{2+} and Mg^{2+} concentration are quite high as compared with other large rivers. The total cations (~50 mg/L) are about 1.7 times that of the global average (29 mg/L). It suggests that the high suspended sediment and major element loads of the Changjiang reveal intense chemical weatherings over the Chinese continent.

Although the *REE* concentrations are variable within different sample locations, all compositions of river water are very similar except for those from Shanghai Bay which shows larger variations of heavy *REE*s than those of light *REES*. The shale-normalized *REE* abundances pose slight enrichment of middle *REES*, insufficiency of heavy *REES*, and clear positive Ce anomalies. However, all of these samples with variable light *REE* abundances shows about 10 fold changes larger than the variation of heavy *REE*. concentration. The light *REE* concentration decrease from the inlet to upper reaches of the Changjiang. It is therefore likely that light *REE*s is distinctly fractionated during solution-particle interaction. Nozaki *et al.* (1997) have estimated global fluxes to the ocean of 27 × 10^6 mol/yr for Y and of 0.48 × 10^6 mol/yr for Ho, depending on the result from the Japanese river. Based on a yearly discharge amount of 9.28 × 10^{14} kg/yr of Changjiang, our calculation results in river fluxes to East China Sea of dissolved *REE*s vary from 0.6 to 550 × 10^6 mol/yr, with Y about 5 times and Ho about 4 times those of the corresponding average global values.

References

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