Dissolved and colloidal trace elements in rivers

A.M. SHILLER*

Dept. Of Marine Science, Univ. Southern Mississippi, Stennis Space Center, MS 39529, USA
(*correspondence: alan.shiller@usm.edu)

Understanding of trace elements in rivers has somewhat lagged our understanding of their behavior in the oceans, in part because of the wide spatial and temporal variability of fluvial concentrations. As the Greek philosopher Heraclitus stated: "You could not step twice into the same river; for other waters are ever flowing on to you." However, with the application of ultra-clean techniques and the subsequent accumulation of high quality fluvial trace element data, great progress has been made in this important aspect of water quality. Application of new techniques ranging from field flow fractionation to x-ray spectroscopy have also yielded insight into fluvial trace element behavior.

Fe and Mn are key metals in natural waters because their redox cycling tends to involve the cycling of organic matter and because the oxides of these elements are important carriers of other trace elements. For Fe, the colloidal suspended phase largely results from precipitation of ferric hydroxide except in glacial regimes where colloidal Fe is associated with alumino-silicates. Dissolved (or small colloidal) Fe behavior can generally be reproduced by a simple model balancing organic complexation versus FeOOH solubility control, both of which are pH-dependent. For Mn, reducing sources are particularly important as can be microbial oxidation in floodplain waters.

For many other trace elements, their particle-reactivity or organic complexation affects their behavior in a manner similar to that of Fe. Redox cycling, either of the specific trace element or of Fe, Mn, and organic carbon can also be a dominant variable. Indeed, "redox pumping" from seasonal effects such as the spring soil flush, overturning lakes, and temperature effects on redox processes can be an important factor in temporal concentration variability. Among the various groups of trace elements, the rare earth elements (REEs) hold great promise as indicators of the importance of sorption versus complexation versus redox processes, even in the face of anthropogenic perturbation of some REEs in the series.