X-ray Spectroscopy and Microscopy Studies on the Role of Natural Organic Matter in Elemental Cycles in Soils

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Rock weathering and soil formation releases several biologically important elements into natural waters, and play a central role in the cycling of elements in terrestrial systems, and water quality of rivers and groundwaters. Our recent studies point that the weathering plant biomass and soil humus contribute to the majority of bioelement pool in weathering environments, much more than what is currently considered.

Our studies conducted in the last few years on P, S, and selected halides, first and second row transition metals, and alkaline and alkaline earth elements suggest that the concentration-depth profiles of these elements in soils correlate well with the organic matter content and composition. The speciation of these elements, examined by X-ray spectroscopy, reveals that significant fractions of these elements are coordinated to organic molecule functional groups. The speciation of these elements change from metal-organic complex in the top soil O-horizin to inorganic species at lower levels. Plant biomass weathering studies also suggest the same as it is converted to soil humus. In addition, redox active elements, such as Mn, Fe, S, halides, show significant variations in their oxidation states with depth and weathering of plant biomass. These speciation trends for these elements are also similar for different soil types across differing weathering regimes.

A summary of these results suggest plant biomass plays a dominant role in the solubility and cycling of elements in soil systems than previously thought. Details of our X-ray spectrscopy and microscopy studies on bioelements will be presented.