BIOGEOCHEMICAL IMPLICATIONS OF CHANGING GROUNDWATER AND SURFACE WATER HYDROLOGY AT LAKE POWELL, UTAH AND ARIZONA, AND THE MERCED RIVER, CALIFORNIA, USA

Thesis by

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Abstract

This thesis examines some effects of surface water and groundwater hydrology on the mobility of trace elements and phosphorus in natural environments. Three separate field sites are studied: 1) the shoreline of Lake Powell, a large reservoir on the Colorado River in Utah and Arizona where the surface elevation fluctuates on yearly and multi-yearly timescales, 2) the Colorado River inflow region to Lake Powell, where the sediment delta has been exposed due to low water levels, and 3) the lower Merced River, which is located in the San Joaquin Valley, California, amidst extensive agricultural development.

On the shoreline of Lake Powell, depth profiles of manganese and uranium were used to estimate the redox state of sediment porewater. Samples were collected before and after a fluctuation in reservoir level exposed two sampling locations to air and then resubmerged them. Results indicate that reducing conditions are re-established at different rates in two nearby shoreline locations, and that manganese reduction occurs more rapidly than uranium reduction upon resubmergence.

In the Colorado River inflow region of Lake Powell, sediment samples were collected from the lakebed and shoreline. Measurements indicate that particle size anticorrelates with the concentrations of most elements and clay minerals and explains much, but not all, of the variation in trace elements. Spatial trends of particle size imply that low reservoir levels may induce resuspension of fine sediment, a process that may lead to increased primary productivity observed in monitoring data. Sequential extractions performed on these sediment samples suggest that phosphorus, the limiting nutrient in Lake Powell, is primarily associated with calcite and biogenic apatite.

Sorption experiments indicate that fine particles sorb much more phosphorus than coarse particles, and that only a small amount of the sediment-associated phosphorus is desorbed during sediment resuspension. When reservoir levels are low, measurements of dissolved phosphorus suggest that sediment resuspended by the Colorado River may supply phosphorus to the photic zone under specific hydrologic conditions.

Samples of groundwater collected from beneath the Merced River were analyzed for a suite of trace elements. Statistical analyses suggest that hydrologic processes generally influence the transport of trace solutes more than redox chemistry, and results vary between strontium, barium, uranium, and phosphorus.

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