The Role of Mixing on Nutrient and Metal Interactions at the Sediment-Water Interface[1]

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Abstract: A greenhouse microcosm study simulated nutrient/metal interactions at the sediment layer-water column interface in a large Oklahoma reservoir. Grand Lake O' the Cherokees (GLOC), downstream of the Tri-State Lead-Zinc Mining District, demonstrates elevated sediment metals concentrations and is eutrophic due to nutrient-rich agricultural and urban run-off. Three different mixing treatments were established in nine 20-L vessels containing lake sediments: control (no mixing), low mixing (200 rpm, Reynold's number (Re) ≈13,500) and high mixing (500 rpm, Re≈33,700), using overhead blade-stirrers. An initial 2-hour mixing period produced significant increases in total suspended solids (TSS), peaking at 204 mg L^{-1} and 19,200 mg L^{-1}, respectively. Over the 7-day settling period, mixing treatment TSS decreased to 10-20 mg L^{-1}, similar to the control. Mixing treatments produced significant initial increases in total phosphorus (P), iron (Fe), manganese (Mn), and zinc (Zn) in the water column, indicating nutrient and trace metal release from sediment due to mixing disturbance. During the settling period, concentrations decreased, indicating metal precipitation and nutrient sorption. Lead (Pb) and nickel (Ni) shared trends for the high mixing treatment. The low mixing treatment demonstrated a continuously decreasing trend for Pb but Ni stayed relatively constant. Cadmium (Cd) concentrations were consistently below the practical quantitation limit (PQL). Sediment Zn and Cd concentrations increased with greater mixing as follows: control (34,800 and 307 mg kg^{-1}) < low mixing (36,400 and 324 mg kg^{-1}) < high mixing (40,300 and 352 mg kg^{-1}), respectively. All treatments had greater concentration then the initial sediment (29,200 and 239 mg kg^{-1}). Sediment Pb concentrations were also greater than the initial concentrations (3,602 mg kg^{-1}) as follows: control (4,923 mg kg^{-1}) > low mixing (4,883 mg kg^{-1}) < high mixing (5,070 mg kg^{-1}), respectively. Resuspension caused by mixing and subsequent settling helps precipitate aqueous trace metals to the sediment layer.[3]

Additional Key Words: phosphorus, trace metals, total suspended solids

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3. Work reported here was conducted near 35°11'0.52" N, 97°26'52.27"W.