USGS

WATER RESOURCES RESEARCH GRANT PROPOSAL

Project ID: 2002MO1B

Title: Fate and Transport of Metal Contaminants in the Big and Black River Systems of Missouri

Project Type: Research

Focus Categories: Surface Water, Toxic Substances, Models

Keywords: Transport of Metal Contaminants, contaminant migration, transport, modeling

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Matching Funds: $73060.00

Congressional District: Missouri 9th

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Abstract: The Old and New Lead Belt regions of Missouri have been major producers of lead and zinc mineralization since the 1860's. These regions have historically received only scant attention with respect to contaminant migration despite their prominence as a world class lead-zinc producing regions. With respect to potential effects on contaminant migration, the lead-zinc ores of the Old and New Lead Belts differ from the typical acid mine drainage settings in the western US. These differences lie principally in the immense size of the MVT deposits (e.g., 285 million tons of ore were processed in the Old Lead Belt with the generation of 250 million tons of waste tailings), the carbonate gangue host rock, and their lower proportion of associated iron sulfide gangue minerals. Because of these differences, weathering processes in MVT waste materials generally do not result in significant sulfuric acid generation, while any acids that are generated are quickly neutralized through reactions with associated carbonate host rock. Solubilities of metals and dissolution rates of metal sulfides are expected to be relatively low under such conditions. The transport systematics of the metals under such conditions is expected to be extremely complex, being influenced in part by the effects of hydrologic sorting of mineral grains, phase solubility, abrasion, bioorganic processes, and river dynamics. The working hypotheses of this proposed research is that the transport and bioavailability of heavy metals in streams impacted by mining activity are a function of particle size distribution, mineralogy, density, acid

leachability, specific surface area, and other key parameters. We anticipate that the distribution and speciation of metal contaminants in the Big and Black River Systems will be dominated by particulate material transport due to the slightly alkaline chemistry of the Missouri water systems and resultant low solubility of many metal species. The heavy metals to be the focus of this work include lead, zinc, copper, cadmium, cobalt, and nickel. Funds requested in this proposal will be used to characterize study reaches of the Big and Black Rivers (MO) and to develop and establish sampling, processing and analytical methods. These funds will also be used to characterize the bed-load and water-column metals and organics materials on a quarterly basis and also during two distinct hydraulic events: a rapid rise and fall ("summer storm event"), and a slow rise and fall ("spring melt"). One of the major goals of this study is to develop an understanding of the physical and chemical forms of transportable heavy metals within the study system and the influence that various forms may have on the transport properties of metals. Sediment samples will be sieved in the field to collect 2000 – 177 ìm (coarse to medium sand), 177 – 63 ìm (medium to very fine sand), and less than 63 ìm fraction (silt and clay). Each fraction will be analyzed independently to determine metal contents as a function of particle size. Transport can be further influenced by the types and sizes of the various particles suspended in the water column. Water samples will be sequentially filtered to collect an unfiltered water sample, 5.0 ìm filtered sample, 0.45 ìm filtered sample, and a 0.02 ìm filtered sample. Hydraulic monitoring will also be performed on stretches of the rivers that are being sampled for metal content. The hydraulic characterization will include USGS gauging station data where available and direct measurement of the stream hydrodynamics where USGS coverage is lacking. To this end, three gauging stations will be established on the Black River. They will be installed at stable cross sections of the river and will include upstream and downstream ends of the river reach under study. Rating of each gauging station will accomplished by measuring discharge (velocity area method) and stage (elevation of the surface with respect to fixed datum) at various times so as to develop an appropriate rating curve (curve of discharge versus elevation). The modeling component of this project is intended to provide an example of how a simplified model can be used to evaluate the interaction of the hydraulics, the sediment transport and the transport of metals in the rivers. Once calibrated and validated, the river model will be used to plan future data collection campaigns. The model of the Big and Black Rivers will consist of a one-dimensional application of the Environmental Fluid Dynamic Code (EFDC) (Ji et al., 2002).
