EFFECTS OF METAL RELEASE FROM BLACK SHALE WEATHERING ON THE DEVELOPMENT OF AT-RISK WATERSHEDS

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Anoxic marine sediments with high organic carbon contents efficiently scavenge trace metals, particularly oxyanions from seawater. These sediments, once lithified into black shales, are an important lithological unity in many watersheds. Black shales are enriched, compared to average crust, by orders of magnitude in many metals such as U (10-40 fold), Mo (10-100), Ni (10-20), Cr (2-5), Sc (2-5) and V (10-15). The high concentrations of organic matter and clay minerals make black shales susceptible to weathering, resulting in the mobilization of metals into the hydrosphere. We measured the trace element composition (groundwater, lake water, etc.) in two black shale dominated watersheds (Mohawk New York and Belt-Purcell Montana, USA). These high precision magnetic sector ICP-MS analyses indicate the relationship between the dissolved load and the black shales. We modeled the remobilization of these metals from the black shales using EQ 3/6+. We also performed fluidized bedrock reactor experiments on the shales. Our experimental data show that, using a reaction medium of pH5, up to 30% of the total metals from the shale after two weeks of weathering. This dramatic increase in the dissolved concentration suggests that the metals found in high concentration in black-shale dominated watersheds are from the black shales. Under conditions common to these watersheds these metals do not co-preprecipitate and fall out of solution but rather remain as free metal ions. Our modeling confirms that the trace metals, particularly Cu, Cr and As are free metal species and are not complexed and removed from solution within the groundwater.