Effects of Uranium Mineralization and Historical Uranium Mining on Water Quality and Stream Sediment Chemistry: Results of a Regional Geochemical Survey West of Denver, Colorado.

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The Colorado Front Range west of Denver includes numerous historical mining districts of base and precious metals that date back to the late 19th century. Uranium (U) is a commonly associated element in the vein-type sulfide ores and, at some locations, concentrations were sufficient to support small amounts of historical U production, particularly in and around the Central City area. More substantial vein-type U deposits were discovered after 1950 in areas closer to the mountain front and outside the former metal-mining districts. One of these deposits, the Schwartzwalder, is the largest vein-type U deposit in the United States, having produced approximately 20 million pounds of U_3O_8.

Upon consideration of the number of U-enriched deposits, the identification of U-rich drainage from some metal mines, the proximity of some U deposits to streams, and the large downstream population in metropolitan Denver, the U.S. Geological Survey conducted sampling of U and other elements in 82 streams and 87 stream sediments in the Clear Creek drainage and surrounding areas in October, 1994. Interpretation of the spatial-chemical data for these waters and sediments indicate (1) aqueous processes that control the mobility of dissolved U and other elements, (2) the mode of occurrence of U in sediments, (3) lithologic and anthropogenic controls on the spatial distribution of U in the study area, and (4) effects of U on water quality and aquatic life. The results provide an important basis for comparison with more recent measurements of surface-water quality by other agencies and private groups. Such comparisons document the effects of ongoing cleanup of abandoned mines and mine wastes.

Dissolved U concentrations range from less than 1 to 65 μg/L and, at the circum-neutral pH of these streams, U occurs predominantly as U(VI) complexes with dissolved carbonate. Dissolved U concentrations are limited by sorption reactions and all sampled stream waters are greatly undersaturated with U minerals.

The fine-grained (<0.09 mm) fraction of stream sediments contains 5–50 μg/g U and hosts greater abundance of relatively insoluble U-bearing accessory minerals such as zircon and apatite. Secondary ferric oxides that coat grain surfaces are ubiquitous U hosts and can incorporate additional U by sorption. In areas underlain by Precambrian granitic and metamorphic rock, insoluble U-bearing minerals and strong sorptive uptake of U produces relatively U-rich sediment, but low U concentrations in stream water.

Streams that drain heavily mined areas with local U-rich acid mine drainage do not contain particularly high concentrations of dissolved U. This indicates dilution of acid drainage and (or) uptake of dissolved U by adsorption to stream sediments.

Fine-grained sediments collected from Ralston Creek at sites downstream from the Schwartzwalder U mine have locally anomalous concentrations of U and contain rare particles of uraninite and radium-bearing barite that are the products of mining-related activities. Slow dissolution of such particles contributes dissolved U and radium to Ralston Creek.

With three exceptions, concentrations of dissolved U in the sampled streams are below the USEPA drinking-water standard of 30 μg/L, and all dissolved U concentrations are well below locally applied aquatic-life toxicity standards. Concentrations of U in stream sediments are also below a proposed aquatic-life toxicity standard for sediment of 100 μg/g. Natural processes of dilution and sorption have apparently limited the environmental impact of U mobilized by metal mining.

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