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Nanoscale mineralogy of arsenic in a region of New Hampshire with elevated As-concentrations in the groundwater

SATOSHI UTSUNOMIYA, STEPHEN C. PETERS,* JOEL D. BLUM, AND RODNEY C. EWING†

Department of Geological Sciences, University of Michigan, Ann Arbor, Michigan 48109-2104, U.S.A.

ABSTRACT

Bedrock samples were examined from a region in south-central New Hampshire in order to understand the factors responsible for elevated As-concentrations (up to 180 ppb) in the groundwater. Although the As is predominantly from natural sources, the precise mineralogy of the As-bearing phases was unknown. As-bearing samples were examined in detail using advanced electron microscopy techniques, including high-angle annular dark field scanning electron microscopy (HAADF-STEM), STEM elemental mapping, and high resolution TEM. Numerous As-bearing minerals were observed, predominantly arsenopyrite (FeAsS) with some westerveldite (FeAs). The arsenopyrite was partially altered to nanocrystalline (~20 nm) magnetite and westerveldite, most likely during hydrothermal circulation of fluids following the emplacement of a nearby granitoid pluton. A reaction rim surrounds the pristine cores of arsenopyrite, with compositionally variable amorphous zones (containing Fe, As, K, and O), a Cu-sulfide, and a uranium-bearing phase, suggesting at least three distinct fluid compositions during alteration. Because the K-Fe-As-oxide is amorphous and the nanocrystalline FeAs has a high surface area per unit mass, the dissolution rate of As-bearing phases during recent low-temperature weathering is increased. The rapid dissolution of the reduced As phase (FeAs), which is unstable under oxidizing conditions, may be an important factor in the elevated As-concentrations in the groundwaters of this region.