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Potential for Tellurium Recovery from Legacy Mine Wastes

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Global shortfalls of tellurium (Te) supply are predicted because of increased demand from the solar industry for CdTe-based photovoltaics. Tellurium is enriched in some types of gold (Au) deposits but rarely recovered. Consequently, legacy mine wastes can be enriched in Te and could represent a future Te resource. Under surficial conditions, mine wastes undergo oxidative weathering and telluride ($Te^{<0}$) minerals oxidize to phases containing tellurite (Te^{4+}) and/or tellurate (Te^{6+}). The goal of this study is to document the oxidation state and host minerals of Te in weathered mine wastes and to evaluate if Te recovery from mine tailings is feasible. To that end, eight historical mine tailings samples were collected from a range of climates (arid to alpine) and deposit types (Comstock epithermal vein, quartz-alunite epithermal vein, and alkaline Au-Te). The tailings samples contained between 6 and 900 mg kg^{-1} Te. Simulated weathering experiments using the US EPA synthetic precipitation leach procedure (SPLP) on these tailings produced leachates with a wide range of pH (2.7-9.0) and conductivities (0.01-4.8 mS cm^{-1}). Grain-scale mineral identification using scanning electron microscopy and electron microprobe revealed a wide variety of minerals containing Te, only a few of which were residual primary telluride minerals. Some Te-essential minerals were detected, but in most Te-containing particles, the Te is a minor element substituting in phases such as iron (oxy)hydroxides. Consistent with this, linear combination fitting of Te K-edge X-ray absorption spectra indicate the presence of both Te^{4+} and Te^{6+} in most bulk samples, whereas significant fractions of telluride species were not detected. This ongoing work will lend insight into the behavior of Te under a broad range of environmental conditions and deposit types, which is important when assessing the potential for Te recovery from legacy mine wastes.