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Evaluating the potential for Bismuth and Tellurium recovery from an existing Au mine

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Energy decarbonization efforts will rely on unprecedented supplies of critical minerals in the coming decades, which has spurred the evaluation of potential alternative sources of critical minerals. Bismuth and tellurium are critical minerals commonly enriched in, but not recovered from, granitoid-related gold deposits. Here we present the results of a detailed study on the mineralogy and mass flow of bismuth and tellurium throughout the gold extraction process at the Pogo Mine Mill (Interior Alaska, USA). Elemental composition, mineralogical, and microchemical analyses were conducted on samples collected from the crushing and grinding, gravity, flotation, and cyanide circuits. Electron microscopy shows that bismuth and tellurium are mostly hosted in minerals in the Bi-Te-(S) ternary system. Minerals with low S contents (joséite-B (Bi_4Te_2S), sulphotsumoite (Bi_3Te_2S), and tetradymite (Bi_2Te_2S) are the most abundant. Additionally, bismuth occurs as native Bi, and associated with Au either in Au + Bi symplectic intergrowths, or in the Au-Bi minerals jonassonite ($AuBi_5S_4$) and maldonite (Au_2Bi). Trace amounts of bismuth and tellurium occur—probably as solid solution in the crystal structure—in pyrite and arsenopyrite. Bulk chemical analyses indicate significant bismuth and tellurium enrichment in the gravity table concentrate (20,000 mg kg^{-1} bismuth and 5,400 mg kg^{-1} tellurium) relative to the ore (34 mg kg^{-1} bismuth and 30 mg kg^{-1} tellurium) but, due to the low volume generated, recovery from this concentrate alone would result in the production of only a few kg of bismuth and tellurium each year. In contrast, samples throughout the cyanide circuit, including the carbon-in-pulp tails, contain 200 mg kg^{-1} bismuth and 100 mg kg^{-1} tellurium, providing an opportunity for bismuth and tellurium recovery after the gold is extracted. At 50 percent recovery, (the typical tellurium recovery at Kankberg, a similar type of Au deposit) the cyanide circuit could yield about 13.5 and 7.5 metric tons of bismuth and tellurium per year, respectively. This and similar geometallurgical studies, are essential first steps in evaluating if granitoid related gold deposits could represent a future source of byproduct bismuth and tellurium.