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Exploration-Stage Geometallurgy: A Value-Added Study of the Gold Hill Trend, Black Hills, South Dakota, USA

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The Gold Hill Trend is a newly (re)discovered gold district in the southwestern portion of the Precambrian core of the Black Hills, South Dakota. The 20-km^2 district is characterized by pervasive tourmaline(schorl-dravite)-graphite alteration and a distinctive Au-Bi+/-Te signature to mineralization hosted in sulfide-poor, shear-parallel veins crosscutting Paleoproterozoic metalamprophyre/alkalic metatuffs and pelitic schists, with gold grades up to 42.6 g/t in grab samples. To better understand the mode of occurrence of the precious metals, their variability and implications for ore processing routes, exploration-level metal deportment studies were completed. For this purpose, composites (>5 kg per composite) representing three different areas within the district were prepared from multiple individual samples and submitted for exploration-level gold deportment studies. The applied methodology includes crushing and milling to approximately 250 µm followed by sizing and gravity upgrading of three size fractions. Representative portions of the fraction heads and all processing products were assayed to obtain a mass-balanced distribution of the gold. In addition, polished block sections were prepared from all products and submitted for systematic scanning electron microscopy scans targeting the overall mineral content including gold-bearing particles. Statistically significant data (based on up to 1,100 gold grain observations per composite) was collected on the gold grain composition, gold grain size distribution, gold association with other minerals, and their liberation characteristics at the applied grind size. The results indicate that the gold mineralization in the southern portion of the district is evenly distributed within the size fractions and occurs predominantly as free native gold (>80% Au). Major gold associations include Bi- and Te-bearing mineral species as well as quartz. In the northern and central areas, the native gold shows a bimodal distribution across the size fractions with the gold reporting dominantly to the coarsest and finest fractions indicating a difference in liberation characteristics, which can be attributed to an overall finer gold grain size and a stronger association with hard silicates such as quartz (in addition to the primary association with Bi-Te-bearing minerals). These results indicate that ore of this composition is amenable to gravity concentration (albeit at a finer grind) followed by CIL (carbon-in-leach) extraction. Therefore, delineating zones with a high proportion of gravity recoverable gold will constitute a priority for further development work as it will improve the overall project economics, especially at the beginning of an operation. Studies of gold-bismuth mineralization from similar deposits attributes the close spatial and mineralogical associations of bismuth and gold observed in this study to reworking or remobilization of preexisting gold-sulfide-rich deposits during shallow intrusion of granitoids. The nearby Harney Peak Granite and related satellite intrusions are identified as a possible source for mineralizing fluids, further supported by granite related metasomatic tourmalinites similar to the host rocks described in this study. The presented gold deportment data represents a value-added study that provides detailed and statistically relevant information about the mineralized system and considers potential processing routes, which initiates a decision-making process for future development work informed by project economics, which go beyond simple grade and tonnage.