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Gold-Telluride Ore Deposits: Tellurium Mineral Economics, Resource Assessment, and Potential Value Add

Brian A. McNulty, Simon M. Jowitt
University of Nevada Las Vegas, Las Vegas, NV, USA

Tellurium is a key raw material required for manufacturing thin-film cadmium-telluride photovoltaic (CdTe PV) modules that will have a vital role in the transition to a carbon-neutral future. This reflects the fact that solar photovoltaics are currently one of the most rapidly deployed renewable energy technologies with global grid-connected capacity achieving some 707.5 gigawatts by the end of 2020. Of this, CdTe PVs contributed ~31 gigawatts, although annual installation predictions suggest this will increase to >250 gigawatts per year by the year 2050, indicating a likely rapid increase in demand for tellurium. However, global tellurium resources and production chains remain unclear, indicating that significant uncertainties exist over whether current supplies are sufficient to meet this forecasted increase in demand.

With the exception of the Kankberg gold-silver-tellurium mine in Sweden and unconfirmed production from tellurium-bismuth mines in China, over 90% (~400 tonnes) of annual tellurium production is sourced as a by-product of copper mining, typically from porphyry copper and volcanic-hosted massive sulfide deposits. However, the latter represents by-product tellurium that is only recoverable from copper anode slimes associated with pyrometallurgical metal production rather than hydrometallurgical approaches. In addition, of the 124 copper refineries worldwide, less than 10 recover tellurium. This reliance on copper production increases uncertainty around whether increased demand for tellurium can be met by current mining and refining practices.

One possible solution to a potential tellurium shortage is by-product tellurium derived from active gold mines. Accessory, precious metal-bearing tellurides are common in many gold deposits although tellurium concentrations are not routinely measured, making tellurium deportment difficult to quantify. Here we present the results of an analysis of 518 mineral deposits that are known to contain tellurium, of which 64 are active gold mines (Fig. 1). The tellurium potential of these active gold mines was assessed using three proxies based on publicly available tellurium assay data, telluride mineralogy, and tellurium concentrations in sulfide. These data suggest an unrealized by-product tellurium potential of 167,273 tonnes or ~300 years worth of current global tellurium production. These initial estimates require further research to verify their accuracy as well as to assess mine-specific recovery potential. Assuming a tellurium price of $70,000 per tonne, annual recoveries of 1.4 or 14.3 tonnes could yield 1% of an operation's cost of $10 or $100 million. This indicates that the potential recovery of this critical element may be economically beneficial. A recent example of this value add is the Kennecott mine where Rio Tinto is investing $2.9 million to construct a 20 tonne/year plant that will extract ~$1.4 million worth of tellurium that would otherwise report to waste. Tellurium exemplifies the opportunity to add value to active mines by considering the recovery of by-product critical elements. For some active gold mines, recovering tellurium that would otherwise report to waste could provide increased economic value, global resource stability, and the necessary raw materials for the technologies needed to achieve carbon neutrality.

Fig. 1. Key geological and geographical results of the identified 518 tellurium-bearing mineral deposits.