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ADVANCES IN TELLURIUM FOR GOLD PROCESSING AND EXPLORATION

By

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ABSTRACT

Introduction: Worldwide demand for gold (Au) is increasing, driven both by uses in jewellery and electronics and by its proven safety in times of crisis. Australia is among the world's four biggest gold-producing nations and features highly prospective terrains that are extensively regolith-covered, highlighting the need for innovative geochemical proxies. Tellurium (Te) is an element intimately associated with gold. Tellurium is one of the rarest elements in the Earth's crust, with an abundance comparable to that of platinum (~1 µg/kg). However, tellurium accumulates (to weight % levels) together with precious metals including gold and silver in some ore deposits, including the giant Golden Mile deposit, Western Australia. In geochemical exploration, tellurium is a useful 'pathfinder' element for gold and silver. Tellurium is a more environmentally mobile element than silver and gold and low natural backgrounds contribute to small anomalies being significant, meaning it may have a greater role to play in far-reaching exploration. Several recent papers have added to the scientific understanding of tellurium biogeochemistry, with flow-on improvements for tracing elevated signatures of environmental Te back to precious metal deposits.

To make the Australian industry more productive, improvements in the processing of complex refractory gold ores are required. Occurrence of Au-Te minerals is a major cause of low gold recovery, so new technologies inspired from natural geo(bio)chemical processes that result in the breakdown of Au-Te minerals and the dispersion of Te in the environment are desirable. Finally, tellurium is also an emerging 'critical metal' in the pursuit of cleaner energy sources, an application which is only likely to become more prevalent as world energy supplies shift away from fossil fuels. Cadmium telluride (CdTe) solar panels are some of the most efficient solar cells available, and are produced at an industrial scale (thousands of MW production, making up some 10% of solar panels worldwide). Co-recovery of gold and tellurium can change the economics of gold mining.

The project: Over the past decade, our research group has contributed major advances to tellurium geochemistry and mineralogy, and to the role of biogeochemistry in promoting the mobility of precious metals, especially gold, in the regolith. One major research focus has been the breakdown of gold tellurides to yield microporous gold, free from the more mobile tellurium. Upon this framework of excellence in Au and more recently Te research, we are performing the first systematic study of the controls of tellurium dispersion around Au-Te ores, in particular around one of the world's richest Te-deposits, the former Au mines of Moctezuma, Mexico. Our work in Mexico included a soil survey of both the elemental composition and microbial population of the soil, showing a robust and diverse community of microorganisms living in the soil in areas with high levels of Te and Au, driven by the toxicity of both metals to most microbes. The study of Moctezuma is complemented by similar analysis of Au- and Te- deposits in other western North American mines.

Expected outcomes: This study is leading to the discovery of new biogeochemical pathways for Au and Te migration, and will further our understanding of microbial action on minerals with the potential for applications in mineral exploration; in mining waste piles; in remediation; and/or in recycling. These applications include the more efficient processing of refractory gold concentrates based on our understanding of tellurium in gold(-silver) tellurides. In this presentation I will discuss two examples of such potential applications: (1) using microbes to process refractory gold tellurides such as the mineral calaverite at low temperatures with mild conditions; reaction times could be greatly reduced from months to days by the increased uptake of microbially-mediated processes; and (2) opportunities for hydrometallurgical processing of Au-Te ores under mild hydrothermal conditions.

We are continuing to work towards understanding the links between Te and Au and fully anticipate that the remainder of this project will provide potential benefits well beyond the academic sphere.

Keywords: tellurium, gold, process efficiency, refractory tellurides, geochemical signalling.