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A New Geochemical Technique for Gold Exploration: Alkali Element Mobility Associated with Gold Mineralization in the West Australian Goldfields

Christopher J. Heath† and Ian H. Campbell

Research School of Earth Sciences, The Australian National University, Canberra, ACT 0200 Australia

Abstract

This study tests the hypothesis that alkali element mobility can be used as a tool to monitor fluid flow associated with gold-bearing hydrothermal systems and as a geochemical vector for locating new gold deposits. This was achieved by analyzing 114 samples of two mafic rock types from four localities in the Archean Yilgarn craton of Western Australia; the giant Golden Mile deposit at Kalgoorlie, the smaller Victory mine at Kambalda, two drill holes that intersected subeconomic mineralization 8 km south of Kalgoorlie, and two drill holes well away from gold mineralization. The results show that Cs, Rb, and Ba are enriched in areas that are prospective for gold-bearing mineralization and depleted in areas that are not. The primitive mantle normalized ratio $((Cs + Rb)/Th)_N$ is used as an alteration index to quantify and discriminate potentially mineralized, with $((Cs + Rb)/Th)_N > 5$, from unmineralized areas, with $((Cs + Rb)/Th)_N < 5$. The Golden Mile deposit is surrounded by a zone of $((Cs+Rb)/Th)_N > 5$ that is 10 to 100 times larger than the visible alteration halo. The alkali enrichment halos around the smaller Victory deposit and subeconomic mineralization south of Kalgoorlie are narrower, with lower $((Cs + Rb)/Th)_N$ but are still over 10 times larger than the visible alteration halos adjacent to veins. These zones of high $((Cs + Rb)/Th)_N$ around the mineralization show that the hydrothermal fluids penetrated tens of meters, and in the case of the Golden Mile, hundreds of meters into the wall rocks. Within this zone, $((Cs + Rb)/Th)_N$ increases toward ore and provides a vector to mineralization.

† Corresponding author: e-mail, Chris.Heath@ga.gov.au