White Mica as a Hyperspectral Tool in Exploration for Sunrise Dam and Kanowna Belle Gold Deposits, Western Australia

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Visible to near-infrared (VNIR) and short-wave infrared (SWIR) hyperspectral signatures of "alteration" minerals (such as white mica, chlorite, epidote, and carbonate) measured using drill core logging, field, airborne and spaceborne systems, are increasingly being used to map alteration zonation as a vector toward economic mineral systems. In particular, white mica is a common alteration mineral type (includes for example paragonite, margarite, muscovite, phengite, fuchsite, and roscoelite) found in sub-amphibolite facies, orogenic gold systems. The diagnostic absorption features of white micas include those at 2200, 2350, and 2450 nm that are related to the vibration of hydroxyl groups attached to specific cations (Al^{3+}, Fe^{2+}, Fe^{3+}, Mg^{2+}, Cr^{3+}, V^{3+}, site vacancies) in octahedral coordination that are effectively charge-balanced with the proportion of Si^{4+} to Al^{3+} in neighboring tetrahedral layers (this coupled substitution is called "Tschermak substitution"). However, even though pressure appears to be a (the) key driver for Tschermak substitution at higher metamorphic grades, it is less clear what the key driver(s) is at lower grades where mineralizing hydrothermal fluid processes are more common. Possible drivers for white mica Tschermak substitution at lower grades include the activities of water, Si and Al, pH and redox, P and T. It is also not clear what roles fluid-rock versus fluid-fluid interactions play in these systems.

Two contrasting orogenic gold deposits in the Eastern Goldfields of Western Australia were selected for detailed study to better understand what drives white mica Tschermak substitution at greenschist facies, These comprise (1) Sunrise Dam, which is located 55 km south of Laverton, comprises a resource of 11.1 Moz of gold, is hosted within volcanic and sedimentary rocks and is associated with decreasing white mica 2200 nm wavelengths with increasing alteration intensity, and (2) Kanowna Belle, which is located 18 km NE of Kalgoorlie, comprises approximately 10 Moz of gold, is mainly hosted within felsic volcaniclastic rocks and porphyries, and is associated with increasing white mica wavelength with increasing alteration intensity. Both gold systems are structurally controlled (~ fluid pathways) and generated similar alteration mineral suites (largely white mica, chlorite, carbonate, quartz, pyrite ± epidote).

Previous workers have generated 3D white mica composition (and other alteration minerals) maps of both Sunrise Dam and Kanowna Belle using VNIR-SWIR drill core spectra. The current study has accessed these historic data including spectra, geological logs and Au assays from 24 diamond drill holes from the Kanowna Belle and 42 drill holes from Sunrise Dam. This study is also building on this drill core data base by conducting the following: (1) thermodynamic modeling of mineralogy and system physicochemistry using Thermocalc software; (2) thin section microscopy for understanding mineral paragenesis; and (3) micron-scale Bruker-Hyperion spectral measurements and electron-microprobe chemical analyses of selected samples to understand partitioning and zoning/timing of chemical indicators.

This paper will present the preliminary results for this 2-3 year postdoctoral research project which is expected to ultimately deliver to explorers with new knowledge that will allow them to interpret

the significance of white mica Tschermak substitution for targeting economic deposits in su-amphibolite facies environments.