White mica as a hyperspectral tool in exploration for Sunrise Dam and Kanowna Belle gold deposits, Western Australia

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Two greenschist facies Archean gold deposits in the Eastern Goldfields of Western Australia with contrasting variations in white mica Al-Si chemistry (Tschermak substitution) were selected for study using short-wave infrared (SWIR) spectrometry, focusing on the wavelength of the absorption positioned between 2190 and 2220 nm. These >10M ounce gold systems, namely Kanowna Belle and Sunrise Dam, represent structurally-controlled, hydrothermal deposits with broadly similar host rocks and alteration halos that extend for 0.5 to 1.5 km from the economic zone. Gold mineralization at Kanowna Belle is associated with white mica with higher levels of silica (~phengite) as well as quartz, chalcopyrite and pyrite with negative $\delta^{34}S$, and a relative lack of carbonate, chlorite and paragonite. In contrast, gold mineralization at Sunrise Dam is associated with white mica with low levels of silica as well as carbonate, Fe-rich chlorite and pyrite with positive $\delta^{34}S$, and relative lack of quartz and chalcopyrite. Laboratory geochemical analyses show that the change in 2200 nm absorption wavelength is proportional to the amount of tetrahedral Si and inversely with the tetrahedral and octahedral Al contents. Thermodynamic numerical modelling indicates that these changes in white mica Tschermak substitution can be explained by two different types of ore fluids. Importantly, this study shows that spectral detection of a gradient of 2190-2220nm in white mica Tschermak substitution composition, coupled with identification of other key alteration minerals (quartz, chlorite, carbonate, sulfide), can be used to measure and map alteration zonations as a vector towards hydrothermal gold deposits.