

UAV-Based Hyperspectral Outcrop Mapping at the Paleoproterozoic Kay Volcanogenic Massive Sulfide Deposit, Black Canyon City, Arizona

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The Kay volcanogenic massive sulfide (VMS) deposit is a brownfield exploration project located 70 km north of Phoenix, Arizona. Recent exploration has delineated an indicated resource of 9.28 million metric tonnes grading 0.97% Cu, 0.33% Pb, 2.39% Zn, 1.39 g/t Au, and 27.6 g/t Ag and an inferred resource of 0.86 million tonnes grading 0.87% Cu, 0.20% Pb, 1.68% Zn, 1.06 g/t Au, and 15.4 g/t Ag at a cut-off grade of 1.00% Cu equivalent. The Kay deposit is one of the most important VMS deposits in the 1.7-1.8 Ga Yavapai Supergroup in Arizona. Sulfide formation resulted in the development of a hydrothermal alteration halo, which includes the development of a pipe of intense chlorite alteration in the stratigraphic footwall that grades outward into white mica alteration. The hydrothermal alteration halo has been overprinted by regional metamorphism at greenschist-facies conditions. Due to high-strain structural overprint, geometric relationships have been modified, and original volcanic textures are difficult to discern.

Using a HySpex Mjolnir VS-620 hyperspectral camera mounted on a Harris Aerial heavy-lift H6HL unmanned aerial vehicle, mineral mapping was conducted at Kay at a spatial resolution of ~6 x 6 cm per pixel. This resolution revealed discrete hydrothermally altered zones that were previously not recognized within the metamorphosed host rock succession. The case study shows that UAV-based hyperspectral mineral mapping can be effectively conducted to map exposed surfaces at high spatial resolution at a rate of ~80 hectares per day. The mapping technique is ideal for high-grade low-tonnage deposits such as VMS, which are characterized by a comparably small alteration footprint that cannot be easily recognized on coarse-resolution satellite imagery (e.g., EnMap that has 30 x 30 m spatial pixels). The implementation of this method opens the avenue for rapid target generation on a project scale in highly deformed volcanic terranes.