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Benefits of Soil Clay Fraction Geochemistry for Surficial Exploration: A Case Study from the Tethyan Belt

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Analysis of clay soil and sediment fractions (<2 µm) compared to larger fractions (i.e., <180 µm) is generally considered to provide better contrast to background ratios for pathfinder elements, including Au. This enhanced contrast is assumed to be due to the reduction of dilution effects from other mineral components in the matrix. The clay fraction also provides greater analytical matrix homogeneity, which results in the reduction of nugget effects combined with lower detection limits. In order to determine if the clay fraction would provide the best anomaly response, a soil sampling orientation survey was undertaken by Dundee Precious Metals near the Ada Tepe Au project, near Krumovgrad, Bulgaria. The survey involved the collection of one transect of soil samples over both zones of mineralization (hosted by Miocene sedimentary rocks) and barren zones (sediments and basement metamorphic rocks, including amphibolite). Soil analysis was conducted at Bureau Veritas Minerals, Vancouver, and included clay separation to <2 µm (method CLYSP) followed by 0.5 g ultra-trace aqua regia/ICP-MS analysis (AQ250). A sample split was analyzed by sieving to <180 µm (method SS80), followed by a 30-g ultra-trace aqua regia/ICP-MS analysis (AQ252). Based on soil Au and Ag concentrations, both methods were successful at defining the mineralized zone. However, the results show that the <2-µm fraction has significantly better anomaly to background contrasts for Au and Ag (37% and 16%, respectively). This better signal is likely due to Au and Ag being in phases that remain as physical grains. In the <180-µm fraction, the signal appears to be diluted, likely due to higher silicate minerals content. Another benefit to the analysis of the clay fraction is the improved analytical reproducibility, especially for Au and Ag. The relative standard deviation (RSD) for these elements is up to 12% lower and is due to the removal of larger grains that produce nugget effects in the larger <180-µm fraction. Chalcophile pathfinder elements (i.e., Cu, Pb, Zn, As, Sb) demonstrate elevated concentrations in the <2-µm fraction. However, the background is also higher, so the contrast ratio is not enhanced significantly. The concentrations of the chalcophile elements correlate very well with Fe in both fractions, suggesting that adsorption to FeOx coatings on grains is likely the primary mechanism by which these ions are concentrating in the soils. There is also a strong association between Zn, Cu, and Al, likely due to the high cation exchange capacities for some clays. In addition to better identification of precious metal anomalies, the <2-µm fraction provides better determination of clay mineralogy, which might be related to hydrothermal alteration events.