MINERAL MAPPING FROM BEDROCK TO PLAYA SEDIMENTS: EXAMPLES FROM ST IVES

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Introduction

Visible and shortwave-infrared spectroscopy is a reliable and fast technique for mineralogical analysis of fresh and weathered rocks. The technique is sensitive to clays, hydrous silicates, other hydrous minerals and carbonates, although it does not recognize feldspars, quartz, sulfides and other non-hydrous minerals. The data may be used to identify regolith type, primary lithology and gold associated alteration, and thus provide valuable support to visual logging of drill cuttings and core. The study had the objectives of using IR spectroscopy to map fresh rock alteration, to test the capacity to log regolith stratigraphy "objectively", and to investigate spectral parameters for the determination of lithological features from highly weathered samples. Spectra were taken from down-hole samples from two traverses over Au deposits in the St Ives Mining Camp, Lake Lefroy, Western Australia (Figure 1), courtesy of St Ives Gold Mining Company Pty Ltd. The equipment used was the ASD[1], which has a wavelength range from 350 to 2500 nm, followed by input into "The Spectral Geologist"[2]. The "Spectral Assistant" module was used to derive mineral compositions.

Figure 1: Location of the St Ives Mining Camp

Intrepide Traverse

The east-west Intrepide traverse extends for 730 m, with approximately 200 m of ultramafic and flanking by intermediate rocks (Figure 2). The regolith consists of 10-12 m of sediments over saprolite and saprock weathered to 50 m. Gold distribution is erratic (Figure 3), but appears to be locally higher along lithological contacts.

[1] Analytical Spectral Device – Fieldspec Pro ©
[2] © Ausspec International Pty Ltd

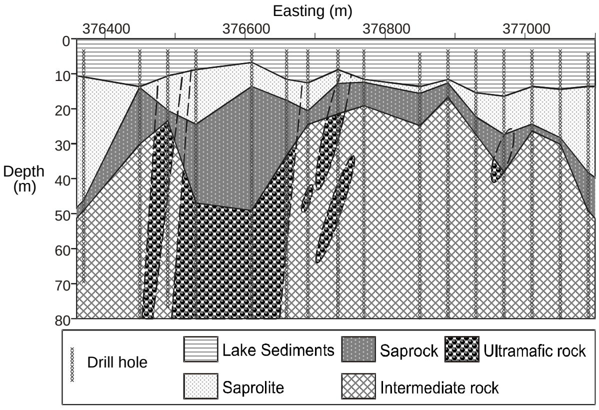

Figure 2: Geology and regolith stratigraphy of the Intrepide traverse

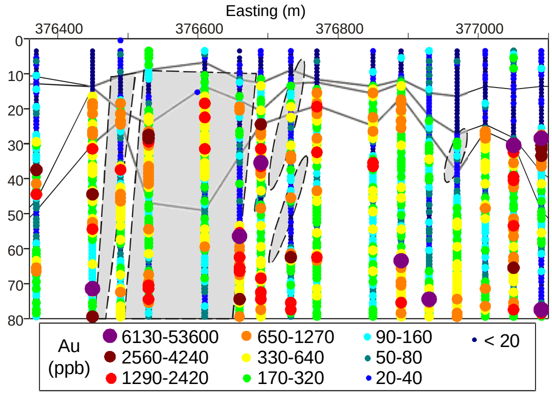

Figure 3: Gold distribution for the Intrepide traverse

Mineral maps and mineral assemblages obtained from the ASD are consistent with, and enhance visually logged geology. Intermediate rocks are distinguished by common muscovite (Figure 4) and the Si- and Mg-rich muscovite, phengite (Figure 5). The phengitic zones, not observed by visual logging, may be a useful alteration indicator. Ultramafic rocks are characterized by chlorite as a major mineral (Figure 6), they have an outer chlorite/talc zone, with carbonates (Figure 7) along the contact with intermediate rocks. On this basis, the rocks in some drill holes appear to have been incorrectly logged as intermediate, with their chlorite-rich and mica-poor mineralogy indicating ultramafic rocks. In addition, the apparent deeper weathering on the western and eastern parts of the traverse may represent lithological contacts and fault, with weathering along faults.

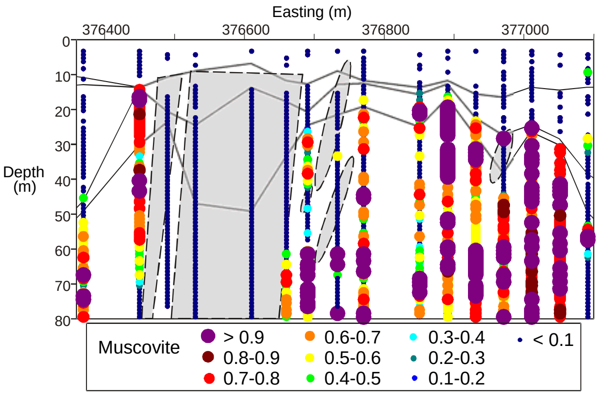

Figure 4: ASD-derived muscovite distribution for the Intrepide traverse

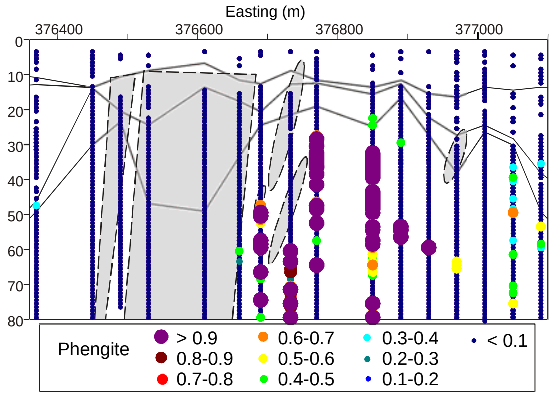

Figure 5: ASD-derived phengite distribution for the Intrepide traverse

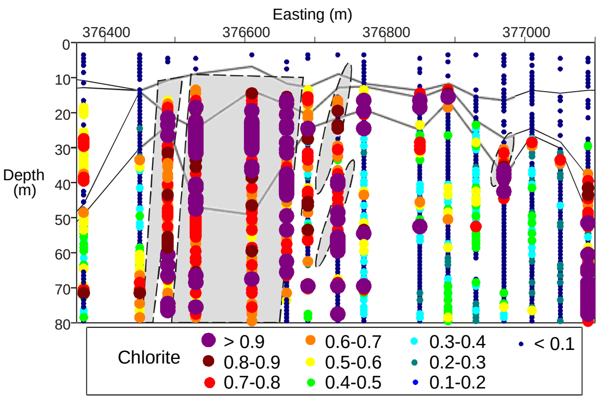

Figure 6: ASD-derived chlorite distribution for the Intrepide traverse

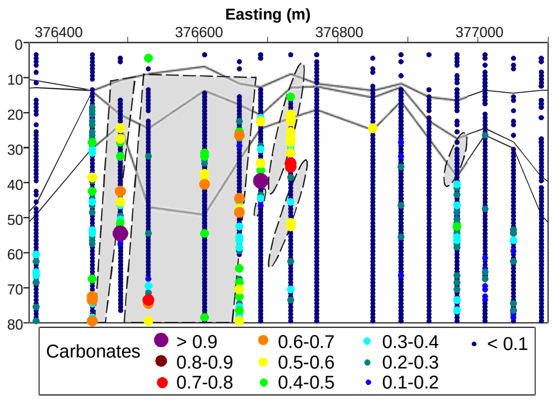

Figure 7: ASD-derived carbonate distribution for the Intrepide traverse

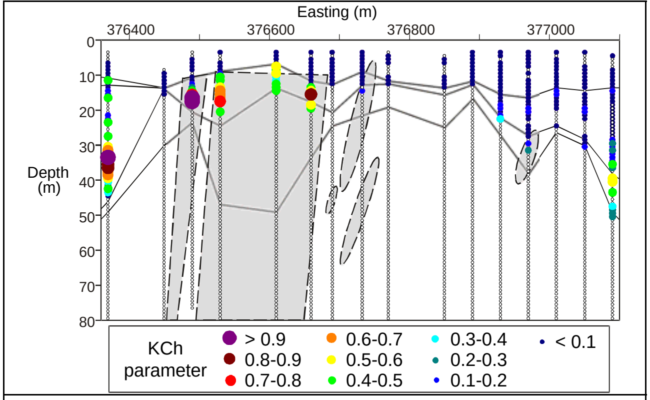

Figure 8: ASD-derived KCh parameter distribution for the Intrepide Traverse

Weathering of basic rocks commonly produces Fe-rich kaolinite, which is characterized by a minor, though readily observed peak at approximately 2240 nm. This is measured using the in-house derived KCh parameter. For the Intrepide traverse, this parameter (Figure 8) successfully recognizes ultramafic rocks from analysis of overlying saprolite. The high KCh parameter values on the eastern and western margins of the traverse indicate a contact with ultramafic rocks not identified in visual logging (as also indicated by chlorite analyses; Figure 6).

Using spectral data, areas of sediments (Figure 9), residual regolith (Figure 10), and fresh rock (Figure 11) are distinguished respectively using the 500, 1950 and 2200 nm spectral regions. An overlap between regolith and rock indicates saprock (Figure 12). The spectrally interpreted zones agree well with those determined by visual logging, as indicated by the lines on Figure 12.

Revenge Traverse

The Revenge traverse is composed dominantly of mafic rocks, weathered to 70 m below surface, and overlain by sediments up to 25 m thick. The presence of muscovite (Figure 13) is indicative of mineralization, with various alteration or weathering effects, such as Fe oxides at depth (Figure 14), also observed. Not surprisingly, high Fe oxide contents are also observed in the saprolite and clay.

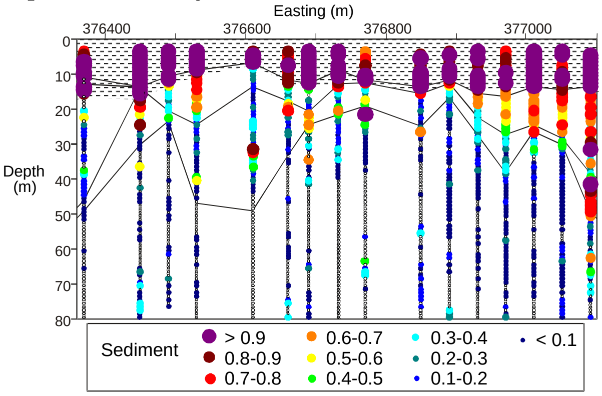

Figure 9: ASD-derived sediment distribution for the Intrepide Traverse

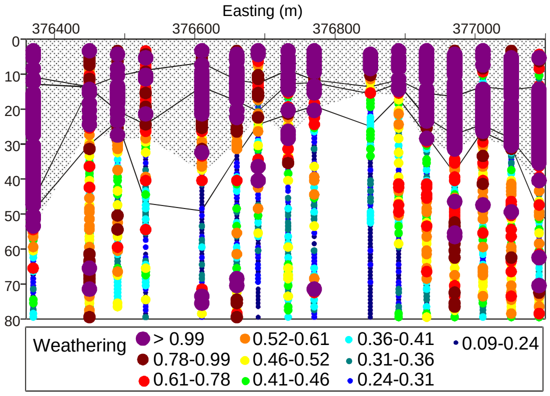

Figure 10: ASD-derived weathering distribution for the Intrepide Traverse

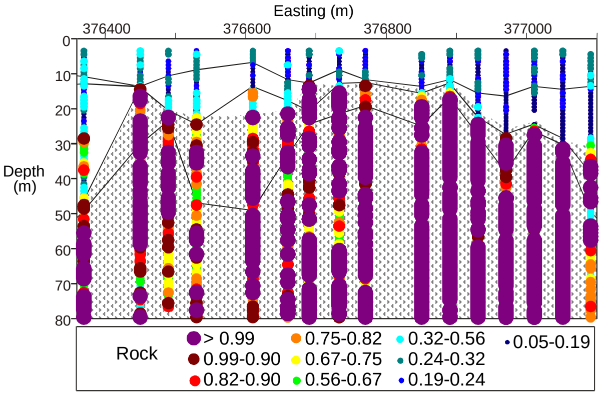

Figure 11: ASD-derived rock distribution for the Intrepide Traverse

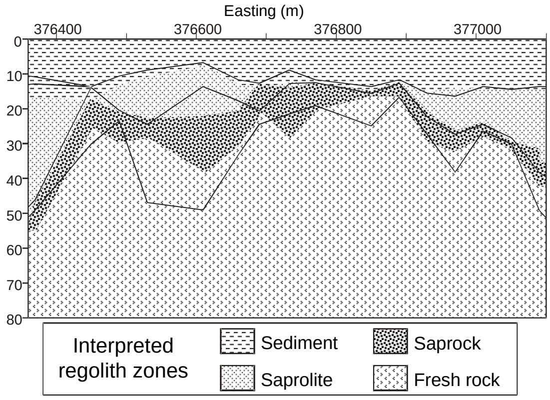

Figure 12: ASD-derived regolith zones for the Intrepide Traverse

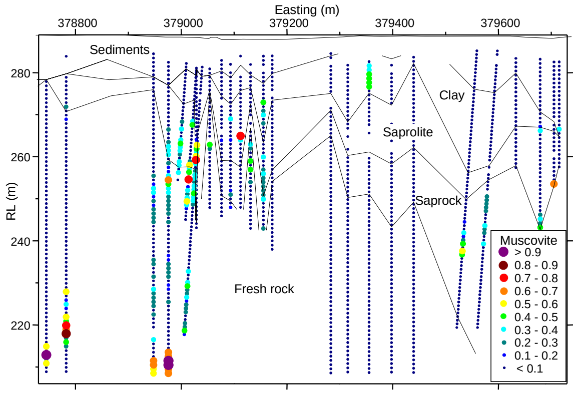

Figure 13: ASD-derived muscovite distribution for the Revenge traverse

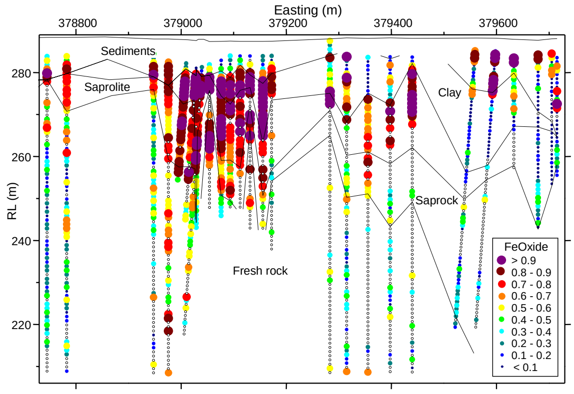

Figure 14: ASD-derived Fe oxide distribution for the Revenge traverse

Conclusions

Spectral analysis can recognize rock types, regolith units and differentiate sediments from in situ regolith. Alteration zones are clearly defined. The compositions of kaolinite in near surface zones, interpreted from the reflectance spectra, indicate underlying Fe-rich ultramafic parent rocks; crystallinity measures are indicative of transported materials. Reflectance spectral analysis can also be used to recognize zones of oxidation and reduction in fresh rock and regolith. This study demonstrates the potential usefulness of rapid spectroscopic techniques for mapping mineralogical parameters in rock and regolith.