LOCATING ORE UNDERCOVER USING LOCATORE® AND OTHER GEOCHEMICAL TECHNIQUES. EXAMPLES FROM STAWELL, VICTORIA AND HONEYMOON WELL, WA

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As mining industries move into the 21st century new economic mineral deposits are becoming more difficult to locate. Exploration for major ore bodies is progressing under various depths and types of regolith cover. As this trend in exploration continues, geochemical investigation will play an important role in the success of exploration, particularly in regions of transported overburden and poor geophysical response.

Partial chemical extraction techniques have been widely employed as a geochemical exploration tool. Partial extractions seek to remove part of a mineral phase or phases into solution rather than a specific chemical species that is targeted by selective extraction techniques. Similar techniques used in other studies have had some ability to locate buried ore bodies in specific environments and can provide a rapid and cost effective method for geochemical exploration under regolith cover (Bajc, 1998; Williams and Gunn, 2002). Although previous studies have found the information gained from partial chemical extractions beneficial, they have also concluded that such extractions are of limited use as 'stand alone' procedures (Bajc, 1998).

The use of bacteria in partial extractions of regolith samples has the potential to greatly magnify the geochemical signature imparted on the sample by the underlying mineralisation. The bacteria cause dissolution of only ultra-thin surface layers of mineral particles, so the geochemical signature is not diluted in the sample matrix. The objective of this investigation is to understand the efficacy of a new bacterial leach LocatOre® and other more common geochemical techniques to identify mineralisation undercover. Two very different prospects are investigated; Wildwood, gold mineralisation in north western Victoria and Honeymoon Well, nickel mineralisation in central Western Australia.

The Wildwood Au prospect is located 250 km northwest of Melbourne and is situated on the boundary of the Ballarat Trough and Murray Basin, comprising predominantly sandstones, mudstones, shales and slates, with some regions of basalt, overlain by Quaternary alluvial sands, silts, and clays (Douglas and Ferguson, 1976). Recent efforts have been made to explore the region where potentially repeating gold bearing units occur under a varied thickness of regolith. The regolith cover overlying the mineralised zone is 25-75 m thick. Murray basin alluvial sediments at this location overlie basalt, volcanogenic sediments and psammopelitic rocks. The regolith can be categorised as a thin, weathered soil underlain by Loxton/Parilla sands, above Geera clays and a thin layer of saprolite. The regolith thickness generally increases to the north.

The Honeymoon Well Ni prospect is located 45 km south of Wiluna in the Agnew-Wiluna greenstone belt. Disseminated and massive sulphide deposits are hosted in the ultramafic sequence of diverse metamorphosed komatiite lithologies (Gole and Woodhouse, 2000). The regolith in the study site is 15-40m depth of mixed transported material.

Soil sampling was undertaken along traverses across areas overlying known mineralisation. Samples at Honeymoon Well were taken at the surface and at 30-40 cm below the surface, while samples from Wildwood were taken at the argillic horizon 30-85 cm below the surface. Samples were subjected to LocatOre® analysis and the results combined in geochemical element suites to predict the underlying mineralisation. The combining of potentially anomalous elements suppresses the background and increases expression, thus enabling recognition of an anomaly where it may have been overlooked in investigations using single elements only. The element combinations are typically necessary given the bacterial mechanisms for non-preferential, incomplete, partial digestion. The element suites in this study used combinations of the following: As, Bi, Cu, Ga, Ge, Ni, Sb, Se, Te, Ti, V and W.

Empirical assessments of anomaly expression of the geochemical techniques over the two sites were conducted using hypergeometric statistics (Stanley, 2003). This method requires an orientation survey using prior knowledge of the underlying geology to predicted sites of anomalous response. The following hypergeometric formula relates the probability of the anomalous points and false positives to the successful detection of mineralisation (Stanley, 2003).

$$P(x) = \frac{\binom{a}{x}\binom{t-a}{k-x}}{\binom{t}{k}} \times 100\%$$

a = number of predicted anomalous points
x = number of correct anomalous points
t = total sample points
k = number of anomalous points (true and false)

Hypergeometric statistics allow a rigorous comparison of conventional and new exploration techniques. LocatOre® significantly predicted mineralisation ($P(x)$<3%) on 2 of the 5 assessed traverses at Wildwood (Figure 1), but none of the 3 traverses at Honeymoon Well were successfully predicted. The lower the probability the more successfully the mineralisation is predicted (Stanley, 2003). The results indicate that LocatOre® is providing some beneficial results, but is not consistently identifying the mineralisation under cover. The LocatOre® geochemical suites respond similarly over all traverses. This trend is expected since certain elements are used in all derived groupings, however suite 1 provided the best results in the form of higher contrast anomalies and fewer false positives. Other geochemical techniques were not successful in detecting the mineralised zone undercover; however some techniques still need to be applied to the Honeymoon Well samples. No single element anomalies were evident at Wildwood, but some inconsistent single element anomalies were found at Honeymoon Well. These anomalous points at Honeymoon Well also require further investigation. Values of the surface materials were much lower than those collected at depth at Honeymoon Well location which could be of significant importance in future soil sampling exploration in the area. Future research on the influence of soil properties and anomaly expression will be required to better understand LocatOre® and other techniques in this region.

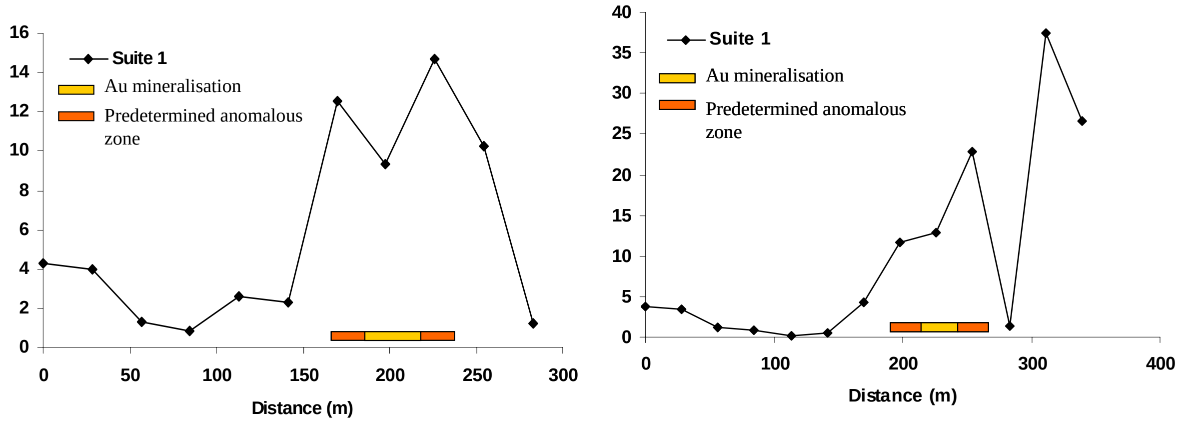

Figure 1. Two successfully predicted traverses from Wildwood using LocatOre®.

Further investigation of the soils was undertaken to compare the results of these chemical extractions with those of the LocatOre®. Comparing the responses for elements based on the various leach treatments by correlation and principle component statistical analysis indicated that LocatOre® was most similar to the weak hydroxylamine hydrochloride leach. The hydroxylamine hydrochloride specifically targets the amorphous Mn oxide phases and implies that LocatOre® may be slightly selective towards the same phase.

The results of this study have allowed for identification of possible areas of buried mineralisations using LocatOre® that were not apparent through other chemical extractions in Victoria. However, the success is inconsistent and was not successful in the different climate of Honeymoon Well. LocatOre® significantly provided different geochemical information than the other techniques, although hydroxylamine hydrochloride was similar. Whether LocatOre® has superior qualities as an individual 'stand alone' technique is yet to be determined. Regardless of this fact, LocatOre® and other partial or selective extractions are likely to be a beneficial tool in future geochemical exploration in areas of regolith cover.

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