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THE USE OF SELECTIVE EXTRACTION GEOCHEMISTRY IN DEEP COVER PROSPECTING IN SOUTH AMERICA

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INTRODUCTION

Most geochemical methods currently available are often unable to detect an anomaly in areas of thick cover – be it barren bedrock, younger volcanic rocks or recent unconsolidated sediments from lake beds clays to sands or gravels. At the present time it is a widely held belief the next series of discoveries of new ore bodies will likely be found under some sort of cover as most areas with bedrock exposure and/or thin cover have been prospected. Additionally the application of the traditional geochemical, geophysical, and remote sensing methods is very limited and often completely negated in this exploration scenario. Therefore, in order to explore for and locate blind deposits in covered situations a nontraditional method is required. Over the last 5 years significant effort has been directed towards the application of Selective or Partial Geochemical Extractions (SPGE) to soil sampling. In South America SPGE geochemistry has been applied in the search for buried deposits in a wide variety of climatic and geologic regimes from the extreme arid and high altitude deserts of Chile and Peru to the humid tropical jungles of the Amazon of Brazil, Bolivia, Peru and Ecuador. This paper will present results from several studies of the 2 principal methods applied to date which are Enzime Leach (EL) and Mobile Metal Ion (MMI).

SPGE used in deep-cover prospecting for buried mineralization identifies geochemical anomalies that are not possible to detect using the normal geochemical techniques. Effective geochemical exploration for buried ore deposits is hampered by the fact that the often exotic overburden or non-mineralized bedrock cover masks or diminishes the surface response of the underlying target ore. In this scenario conventional geochemical methods generally reveal only the geochemical composition of the overburden or bedrock mask. The only present alternative to using surface geochemical techniques is blind drilling either on a grid pattern or wildcatting. This is both expensive and is also limited by considerations of target size to the search for large Porphyry or Epithermal systems. In Chile present drill costs are at historic low and yet the cost of a surface selective leach survey for Porphyry Coppers is about 5% of the cost of drilling. Additionally apart from cost concerns it is also considerably slower in the assessment of ground for follow up study. Depending on the density employed the risk is high that the target could be missed. SPGE presents a cost effective solution to screening areas with varied cover types some of which are presented in this paper.

EXAMPLES

In Southern Peru the Huyrondo Quartz Porphyry has Cu and Au mineralization associated with Monzonite-Tonalite stocks under a cover of around 150 m of Tertiary Moquegua Formation volcanics. The main discovery parameters here are the presence of leached cap and a magnetic low with the target covered by Jurassic Guaneros Formation sediments. An orientation study and comparative test of MMI and EL methods was conducted here on a grided sampling grid at 200 m and 400 m spacing respectively. The results indicate that the MMI geochemistry is strongly influenced by the leached cap and faults which produces diffuse patterns while EL has a typical circular low pattern in Cl, I, Br, Mo and Cu amongs others. The EL circular low anomaly pattern has an area of around 2 km^2 which is typical of Porphyry Copper systems in Chile and Peru.

The San Jorge Copper-Gold project in the Mendoza Province of Western Argentina presents an example of an application of SPGE to a gravel covered area. The mineralized area is found at outcrop but most of the system is quickly lost under the surrounding Pampa which has deep gravel in fill of more than 100 m. Ore estimates are for a body of 146,000,000 tonnes at an average of 0.5% Cu, 2 g per tonne of Au and 3.5 g per tonne of Ag. A total of approximately 90 samples were collected at 400 m intervals for a total of 5 lines. MMI has a typical Apical response in Cu, Au and Ag while EL has a zoned low pattern in Br, Cl, Mo, Re, U, Rb, Ti, Zr, Th, Mn, Cs and Ce as the outer zone about 1.5 km wide with a middle zone of V, W, Ba, I, Li, Zr, Y, Ce,La and Ga. The EL inner zone consists of small and well defined lows in As, Te, Sb, Cu, Zn, Co, Bi, Ag and Au which would be used as guide to drilling.

The Ximena Gold Mine, La Mana, is located SW of Quito in the coastal tropical rain forest of Ecuador and here the EL method was used to prospect for the source of placer Gold in the surrounding hills. The exploration targets are bodies of skarn approximately 30 m wide by 400 m long that occur in covered bedrock situation. The cover consists of 10-15 m of volcanic ash about 10,000-15,000 years old with the surface layers from a historically recorded eruption. The upper 10-30 m of the bedrock are also wheathered, but not strongly oxidized. The skarns are also enriched in Bi and Te in addition to Au. Most of the bedrock is mineralized, but Au values are the highest in the skarns. A total of approximately 450 soil samples were collected at 20 m stations and 200 m grid. The small sampling interval was required because of relatively small target size. Here the dominant feature of survey is a series of parallel anomalous zones to the strike which are continuous over 2 or 3 lines. Anomalous elements include: Ga, Mo, Nb, Pb and Zr.

The Au deposit at the Pucio Este Mine in the Pre Cambrian of Eastern Bolivia represents a possible extension to the working mine nearby and serves as an example of structural control of gold mineralization. A total of 70 soil samples at 10 and 25 m stations over 3 soil lines 100 m apart were collected. The quartz vein type mineralization is buried beneath a fairly shallow soil cover and was trenched and previously mapped. The bodies are strongly controlled by the vein pattern and to map the bodies over the 3 lines a 2.5 spacing was used over the sub cropping quartz bodies. The study outlined the presence of the buried reduced bodies at various places in all of the 3 lines of the study area. A series of sinuous lows in Cl, Mn, Ba, Th, Te, Ag and Rb define the quartz bodies while Sb, Zn and Pb were the main guides for drilling targeting.

The Fazenda Nova Au deposit near Goainia, Goas, Brazil serves as an example of a lode Au deposit in a lateritic terrain. The deposit consists of a series of lode Au veins associated with a series of Pre Cambrian sediments, volcanics, intrusives and gneisses. A total of 4 lines at various spacing were taken with a 50 m sample interval and soil samples taken just below the root zone in mostly latosols forming typical plateaus. The area is incised by several streams which provided the sediments upon which the first discovery was made. The general response is very muted with at least half of EL elements having no response. Over the main mineralization is covered by about 50 m of saprolite and shows a N Apical Anomaly for Au, Ba and As which define the ore zone. There also is a diffuse low in Br, Sr, Cl and V. The 50 m sample spacing was unable to differentiate the various vein bodies. The remainder of the survey was conducted over possible extensions of the deposit but the results were indeterminate.

CONCLUSIONS

The application of SPGE to exploration under cover of varying type from unconsolidated sediments to volcanic rocks and are consistent with other studies performed in South America. Consistent sampling strategies are just as or probably more important in the application of this type of geochemistry . Most present studies agree that the process of anomaly formation is strongly influenced by gas geochemistry which produces subtle, often high variation anomalies unrecognizable by traditional analytical methods such as ICP AES or AAS which are not all useful in this application. Most SPGE anomalies have a variety of form dictated by the size and type of buried orebody. As in conventional geochemistry a large alteration system such as a Porphyry produces the largest surface effect while a structurally controlled deposit the smallest. Applying an appropriate sampling density is crucial to accurately defining these anomaly patterns. The presence of faults also produces streaming and localization of the vapour phases towards the surface and is often an important control in anomaly patterns. The SPGE methods represent a cross over technique as thay have many of the features normally associated with geophysical techniques.

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