Geophysical Exploration for Gold: A Major Company Perspective

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Barrick Gold is the world's leading gold producer, with (2008) reserves of 138.5 Moz. The company is operating in 10 countries on 5 continents, with a portfolio of 26 operating mines and over 20,000 employees. Barrick is expected to produce between 7.2 and 7.6 Moz of gold in 2009 and between 7.7 and 8.1 Moz in 2010. Our exploration goal is to find new ounces and grow production. Barrick focuses on supergiant / world-class deposits with long lives, high production rates and good economics.

Barrick has a proven track record in both brownfields and greenfields exploration. The geophysical group, an integral part of the exploration team, has an average age of 33, is strong in geology and mostly has honours degree or equivalent. The Barrick geophysical group has directly supported 8 honours projects and one PhD in the last 10 years. Four honours students are now employed as Barrick geophysicists. In addition, Barrick has employed 12 student interns over the past 10 years and is directly associated with KEGS, SEG, ASEG (Research Foundation), Curtin University of Technology (CUT), University of Western Australia (UWA), Centre for Exploration Technology (CET), University of British Columbia (UBC), University of Utah (UoU), Montana Tech (MT), CRC for Deep Exploration Targeting (CRC) and AMIRA International (AMIRA).

Barrick consider deposit types that give best chance of success at finding gold deposits. That is, types represented by largest number of deposits (greenstone, porphyry Cu-Au, epithermal); large percentage of population >10 Moz (greenstone, porphyry Cu-Au, epithermal); and, ones with good economics (Carlin, epithermal–alkalic, greenstone). Direct detection of these gold deposits using geophysics is possible (porphyry Cu-Au), but not common. Therefore, the focus is on petrophysics and understanding how it relates to geology, alteration and geochemistry for targeting. Barrick utilizes current best practices and supports research for development of new technologies and innovations. Recent geophysical applications on preferred deposit type follows.

A recent application of geophysics in the search for Carlin-style mineralization is (hardrock) seismic. Seismic suits the carbonate stratigraphy, having low-angle structural control on architecture and good acoustic impedance contrasts between lithologies and deposition facies. There are specific acquisition and processing considerations for hardrock seismic, requiring a lot higher resolution than softrock (oil and gas) seismic (10m receiver, 20m shot spacing) and higher fold (120+). These data are integrated with drilling data to construct comprehensive interpretation of structure on 2D sections. Hardrock seismic is an order of magnitude cheaper and can be more informative than a fence of drilling. Hardrock seismic data validate and update geologic models, leading to drill targets.

Airborne EM has been applied to exploration for greenstone gold mineralization. More typically, the sediment hosted sulphide-rich end member of greenstone deposits is better suited to electromagnetic (EM) techniques as apposed to lode gold style mineralization. Tight line spacing (50m) is better suited to map the sulphide variation in these systems. Where sulphide alteration is associated with mineralization, the most conductive near-surface response usually identifies the centre of these systems. Typically there are many other barren sulphide accumulations proximal to know mineralization. An example of helicopter time domain EM will be presented over a sediment hosted greenstone deposit.

Geophysical techniques can more easily detect alteration associated with Cu-Au rich porphyry style mineralization. Alteration mapping using magnetics/ radiometrics to map potassic alteration is well documented. The potassic core can be either conductive in sulphide-rich systems, or resistive in sulphide-poor systems, but ultimately it depends on the host rock (contrast and reactivity). The outer phyllic/ propylitic alteration is chargeable, magnetite destructive and is often resistive. Airborne magnetic/ radiometric/ electromagnetic and ground pole-dipole IP data are shown over a recent discovery.

Geophysical methods can also be applied to alteration mapping of near-surface high sulphidation (HS) epithermal deposits, where the upper part of a mineralized system is associated with vuggy silica alteration (high resistivity). Resistivity data can effectively map the typical alteration zonation (from centre outward) of advanced argillic with vuggy silica (resistive), to advanced argillic with quartz alunite (moderate resistor), to argillic with intense clay (conductive, chargeable). CSAMT data is shown mapping alteration zonation over a near-surface HS epithermal deposit.

Research is an integral part of the exploration effort. Barrick support research initiatives at UBC, ASEG, Curtin, MT, AMIRA and have more recently supported a collaborative project between Barrick and the Centre for Exploration Technology at UWA. This project developed an algorithm to recognize the footprint of near surface porphyry Cu-Au responses in magnetic data. The result was a fast, effective reconnaissance porphyry mapping tool for magnetic data. Examples show filter results versus mapped porphyry systems.

Geophysics will play an increasingly important role as near surface exploration opportunities decrease and focus is shifted deeper into bedrock and covered areas. Understanding petrophysics and how it relates to geology, alteration and geochemistry of giant gold deposits will help us decide on future exploration opportunities. To better understand these opportunities, Barrick geophysicists are embedded in regional exploration offices permitting maximum interaction and impact.