SEG 100 Conference: Celebrating a Century of Discovery

L2
Large-Scale Multidimensional Mineralization Processes: A Bottom-Up Approach to Predictive Exploration for Tier 1 Deposits

Andrew Wurst
Barrick Gold Corporation, Montreal, QC, Canada

Not all places on the planet are created equal when it comes to metal endowment and the processes of ore deposit formation.

A large portion of metal endowment is often contained in a few key districts or subprovinces, including one or more so-called Tier 1 deposits. These are "company-making" mines that are very large, long lived, and low cost. Discovery of new Tier 1 deposits is exceedingly rare, and only a handful of concealed discoveries have been made in the last 20 years. To meet global metal needs for the future, additional Tier 1 discoveries will need to be made in the coming decades, and a scaled predictive approach is required to increase our chances of discovery under covered terranes.

Local- to district-scale mineralizing processes leading to these well-endowed areas are generally well studied at the shallow crustal scale but are poorly understood at the continental and deeper crustal scale. Mineralization is often studied after discovery and development, generating a new deposit model, which in turn drives further exploration. The model-driven approach can be successful but leads to search spaces being exhausted relatively quickly in districts and the discovery of a swarm of smaller, less economic deposits or "bycatch."

Notably, this model and paradigm driven-approach is unsuccessful at predicting the size and/or grade of a deposit. Significantly, models do not predict the occurrence in time and space of Tier 1 deposits.

The key features contributing to Tier 1 deposits include enhanced components of plumbing (long-lived translithospheric structures), fertility (source of fluids and metals), and long-lived and wide-reaching geodynamic activity (global plate reorganization events). These features are interdependent and corelated in both time and space. While the understanding of the importance of plumbing, fertility and geodynamics, as well as preservation and exposure for the older deposits, is not new, we have been limited by the inherent challenges of studying the architecture and processes of the mantle and subcontinental lithospheric mantle.

Recent insights have changed our understanding of larger-scale temporal and spatial geologic processes. This includes improved dating to constrain epochs of ore deposit formation and various geophysical and geochemical techniques and proxies to understand deep architecture. These insights invariably raise further questions, and new tectonic thinking may be required to reconcile features such as the long-lived continental lineaments that locate the position of Tier 1 deposits.

Understanding the earth's deep architecture and its impact on locating Tier 1 deposits requires a "bottom-up approach" focused on the interplay between deep crustal architecture and shallower crustal mineralization processes in four dimensions. This fundamental shift in exploration strategy is crucial to predicting the occurrence of Tier 1 deposits undercover and will boost exploration success across a range of commodities far into the future.