

SEG 2023 Conference: Resourcing the Green Transition

The Spence Porphyry Copper System Revisited: An Integrated Mineral Systems Study

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The Spence porphyry copper system in northern Chile was discovered by Rio Algom in 1996 through drilling to bedrock in grids over areas concealed by relatively young geological cover sequences. Despite the serendipity of this discovery, subsequent studies have revealed geological factors that could have facilitated effective exploration targeting for this “blind” discovery.

Spence was emplaced along a major dextral strike-slip fault known as the Antofagasta-Calama Lineament (ACL). Whilst the surface expression of the ACL is poorly defined, evidence for the ACL has been documented both through geophysical methods and in the form of fractures exhibiting mineral concretions and geochemical anomalies expressed within the gravels overlying Spence. Using a mineral systems framework, the ACL has acted as a fundamental geological control on porphyry copper deposit formation in this area, providing both a pathway and a zone of deposition for magmas and fluids, with this relationship being observed from regional to deposit scale.

We utilize the latest in Earth observational and geophysical methods to examine the ACL as a geologic feature and highlight evidence for its relevance in ore-forming processes, using the Spence porphyry copper deposit as a case study. By applying geological constraints such as fault surfaces to our geophysical inversions, it is possible to better delineate geologically reasonable features within the geophysical data. These data are visualized in three-dimensional space to better constrain the geometry of geophysical anomalies and showcase areas of interest. We utilize a range of spectral data sets to examine the surface geology, identify features of interest, and enhance our understanding of the regional- to local-scale geology. By placing this relatively well-studied deposit in a multi-scale holistic framework, we highlight exploration opportunities and derive new insights for the regional controls on mineralization in this mature mineral district.