Geophysics for Ni-Cu — Where are we at and where are we going?

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SUMMARY

Exploration for Ni-Cu sulphide deposits has been possibly the most significant factor in the development of modern minerals geophysical technology. The strong response of Ni-Cu sulphides to multiple geophysical methods has resulted in a heavy reliance on geophysics for exploration. This has, in turn, spurred researchers, instrument manufacturers and contractors to continually develop new and/or improved technology.

As discovery of outcropping and near-surface deposits is becoming rarer, the challenge is moving into covered areas and exploring deeper. Historical technology has proven effective in the 0-250m depths; current technology has extended this to more than 500m; new developments are pushing this towards 1000m.

Significant advances in acquisition have been facilitated by factors such as faster processors, large data storage, faster A-D convertors, miniaturisation of sensors, UAVs, integrated GPS and communications. Key developments, particularly in electrical and EM technology include high power transmitters, full waveform recording, and distributed arrays. Interpretation advances include small and large scale 3D inversion, integrated 3D visualisation, and advanced flexible modelling.

The physical properties of the target Ni-Cu sulphides as well as that of the host rocks, and complicating non-economic geological features, are key factors for the use of geophysics. The extreme conductivity of massive Ni-Cu sulphides and the chargeability of disseminated Ni-Cu sulphides are of fundamental importance.

For regional targeting, the task is to identify settings containing prospective mafic -ultramafic rocks. Current thinking involves the concepts of lithospheric structural control and intracrustal magma chambers as precursors. Regional magnetics and gravity are the traditional primary geophysical methods with large scale MT and seismic becoming more important.

The Fraser Range Belt is an example of regional targeting that has led to the identification of a new significant Ni-Cu province. Regional gravity and magnetic data, combined with advances in geological mapping and understanding indicated its prospectivity at the large scale. Subsequent project and prospect scale geochemistry and geophysics, using EM, magnetics and gravity, have led to the discovery of the Nova Ni-Cu deposit.

At the project scale, large scale geophysical data sets usually consist of airborne magnetic, electromagnetic, and gravity/ gravity gradiometer surveys. Targets generated become the focus of prospect scale, ground based, detailed surveys. The most successful direct sulphide detection methods are electromagnetics and induced polarisation, but gravity and magnetics can result in direct detection in some circumstances. The delineation and deep exploration stage following the discovery of mineralisation is usually primarily based on borehole EM, with the focus on the location and geometry of mineralisation, and the discovery of deeper repetitions.

The historical application of geophysics and its role in discovery and delineation of important global Ni-Cu deposits provides valuable insights into the successes and failures of various technologies. This has guided the continuous development of better instrumentation, survey design, processing and interpretation.

The new powerful geophysical tools and modelling options available to us allow exploration to considerable depths, and mean that large prospective areas previously considered fully explored in the past have completely new potential.