The Lonmin-Inco Sudbury PGM joint venture: An integrated geophysical and geological search for low-sulphide high-PGE-Au mineralization in the Sudbury Basin

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SUMMARY

A new style of PGE-Au mineralization has recently been identified in Sudbury Ontario where high grades of PGE-Au are associated with low levels of copper-nickel sulphides (low-sulphide high-PGE-Au mineralization). Low-sulphide high-PGE-Au mineralization has become an increasingly higher profile exploration target in the footwall of the Sudbury Basin and is being explored, evaluated and in some instances mined by a number of companies. The Lonmin-Inco Sudbury PGM Joint Venture was established in January 2005 to explore for low-sulphide high-PGE-Au mineralization on six Inco properties.

Geophysical exploration for these targets has focused primarily on using induced polarization methods and, to a lesser degree, electromagnetic methods.

Fully integrating all available geologic and geophysical information is essential for directing drilling of target areas. Results from three properties are presented (Denison, Levack North and Wisner) where massive and disseminated sulphide, and low sulphide high PGE-Au mineralization have been intersected during the 2005 exploration program. These properties continue to have significant exploration opportunities for the discovery of low-sulphide high-PGE-Au mineralization and resources.

Key words: Induced Polarization, PGE-Au, Sulphide, Sudbury.

INTRODUCTION

The Sudbury Igneous Complex (SIC), which has been dated at approximately 1850 Ma, consists of norite, quartz gabbro and granophyre. Underlying footwall rocks in the North Range are dominantly Archean migmatic gneisses and granitoids of the Northern Province, while footwall rocks in the South Range are dominantly metavolcanics and metasediments of the Southern Province (Naldrett and Hewins, 1984). Sudbury Breccia crosscuts all of the footwall rocks, ranging from small veins to regionally extensive features.

Contact style mineralization occurs at the base of the SIC, and ranges from massive to disseminated sulphides that are high in nickel (Ni) and copper (Cu), but low in platinum group elements (PGE). Footwall style mineralization ranges from veins of Cu-PGE-Au-rich massive sulphide and stockwork systems to weakly disseminated PGE-Au-rich low sulphide mineralization.

The low-sulphide high-PGE-Au mineralization represents a new style of PGE-Au mineralization recently identified in Sudbury Ontario. It has become a high profile exploration target in the Sudbury Basin and is being explored, evaluated and in some instances mined by a number of companies. It has been identified in a number of geological settings to date including as fine-grained disseminations and fracture fills in footwall Sudbury Breccia, metavolcanic, granitic and gneissic rocks.

The Lonmin-Inco Sudbury PGM Joint Venture was established in January 2005 to explore for low-sulphide high-PGE-Au mineralization on six Inco properties; Levack North, Trillabelle, Denison, McKim, Capre and Wisner. These properties host significant exploration opportunities for the discovery of low-sulphide high-PGE-Au style mineralization and resources.

Exploration results from three of the properties are presented here: Denison, Levack North and Wisner. The integration of geological prospecting and geophysical surveys (induced polarization (IP) and electromagnetic surveys) has been used to assist the exploration in these areas.

METHOD AND RESULTS

Exploration Methods

Exploration for low-sulphide high-PGE-Au mineralization has demonstrated the need for a full integration of geological data and geophysical methods. The exploration program has included a review of previously mined areas for unrecognized PGE-Au potential, a search for a new PGE-Au mineralization in areas currently being mined for PGE-Au, and the generation of PGE-Au targets in new areas. This work included a review and compilation of all historical geological, geophysical and mining information.

Electromagnetic geophysical methods have been the standard for mineral exploration around the Sudbury Basin as highly
conductive massive Ni-Cu sulphide deposits have been the traditional exploration target. The low-sulphide style of mineralization may have occasional veinlets of massive to semi-massive sulphide that are connected enough to generate a detectable EM response, but with a much weaker response than massive sulphide targets. There are also large weakly disseminated portions that are not well enough connected to allow the generation of eddy currents in an EM survey. In order to target the weakly disseminated mineralization, surface and borehole induced polarization methods have been utilized, with borehole electromagnetic methods used to detect more massive portions of mineralization. 2D inversions of the surface induced polarization data have been used to obtain positioning of the sources of the anomalies. Where there are enough boreholes with down-hole IP surveys, 3D block models have been inverted to aid in geometric interpretations.

Around the Sudbury Basin there are large amounts of uneconomic disseminated Ni-Cu sulphide mineralization. This makes the exploration for low-sulphide high-PGE-Au mineralization challenging from a geophysical standpoint. As a result it is necessary to use the geophysical information to help extend geological concepts, and to use geological constraints to guide exploration towards better geophysical targets in a fully integrated exploration model.

**Denison**

The Denison property is located on the South Range of the Sudbury Basin. Exploration on this property has been targeted on examining the PGE-Au potential of locations that had previously been exploited for massive sulphide deposits, as well as attempting to locate new low sulphide PGE-Au targets.

The 9400 Zone is hosted in a large terraced trough structure, which acted as a trap for the accumulation of sulphides. This deposit is also influenced by a shear zone, resulting in remobilized Ni-Cu-PGE-Au sulphide mineralization. The 9400 Zone deposit was previously mined as a massive Ni-Cu sulphide deposit. Subsequent work identified the strike and plunge extensions as having the potential for low sulphide high PGE-Au mineralization. The 2005 exploration successfully intersected massive to semi-massive Ni-Cu-PGE-Au sulphide and low sulphide high PGE-Au mineralization both down plunge and along strike. Extensions of the massive sulphide portion of the deposit have been modelled and drilled using the results obtained from borehole electromagnetic surveys.

Detection of the low sulphide mineralization has proven more challenging, as the ground based IP surveys in the vicinity of the 9400 Zone were overwhelmed with the response of old mine workings. However, borehole IP surveys have been able to give an estimate of the distance and direction off-hole to the best chargeable anomalies. It has been essential to integrate the down-hole IP information with the geological information to assist with interpreting the distribution of the mineralization.

**Levack North**

The Levack North area is host to several current mining operations, which are extracting massive Ni-Cu sulphides. Recent in-mine and near-mine discoveries have revealed the presence of low-sulphide high-PGE-Au mineralization associated with footwall style veinlets and weakly disseminated sulphide mineralization. A combination of field mapping and surface IP work has identified chargeable anomalies in the footwall, hosted within or proximal to a horizon of Sudbury Breccia.

Recent drilling of targets generated from 2D inversions of the IP data has intersected veinlets of chalcopyrite and disseminated pyrite. Additional work will determine the extent of this mineralization.

**Wisner**

The Wisner property has only recently been explored for low sulphide high PGE-Au mineralization. A review of historic drill data and completion of detailed surface mapping, sampling and trenching identified zones of interest. 2D inversions of the surface IP data have located chargeable anomalies within favourable geology that are proximal to high-PGE-Au grab samples collected on surface. Subsequent drilling of these targets has intersected disseminated chalcopyrite and pyrite mineralization.

Down-hole IP surveys have been completed in a number of the historic drill holes, where a sufficient density of holes is present to allow an inversion the data into a 3D block model. The results indicate that one of the new zones of low sulphide mineralization may extend and improve beyond the current drilling.

**CONCLUSIONS**

Exploration for low-sulphide high-PGE-Au mineralization in the Sudbury Basin presents a challenging target. The presence of both economic and non-economic disseminated sulphides makes the direct targeting of induced polarization anomalies difficult. However, when fully integrating geological information with geophysical targeting, better targets can be chosen, and prospective areas can be defined and extended.

**REFERENCES**