NICKEL LITHO AND SULPHIDE GEOCHEMICAL MODELLING. PREDICTING NICKEL RECOVERY FROM REAL WORLD EXAMPLES

N.W.Brand[1]

[1]Geochemical Services Pty Ltd, Suite 10, 5 Colin Street, West Perth, Western Australia, 6005 nwbrand@gspty.com.au

Introduction

Multi-element assaying of samples is an established routine for exploration and resource work. Sample scale (1-2m) assay data can be used to derive estimates of key metallurgical performance parameters including recoverable nickel sulphides, nickel tenor, nickel-in-silicates and the effects of potential deleterious components and their distribution leading to predictions on sulphide liberation, rock grindability, consumption of consumables. Estimates derived at the sample scale along with predicted mineralogy can be modelled spatially, and therefore used to classify materials in an ore resource.

Methodology

Routine laboratory analysed exploration assay samples are used to calculate a summary lithological association and sulphide association for a deposit. These associations are unique and specific to individual deposit and provide critical information on the deposit. From these associations a nickel in-silicate and nickel-in-sulphide models are calculated (Figure 1).

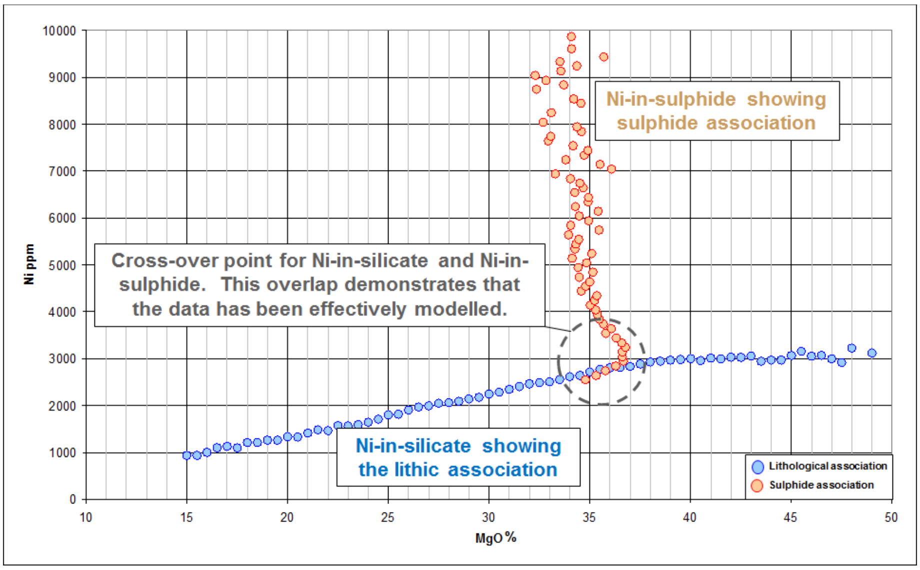

Figure 1. Modelled Ni-lithic and sulphide trends in a disseminated Ni deposit.

This model is then applied to each drill sample to derive a calculated nickel-in-silicate value and subtracted from the Ni assay value to derive a calculated nickel-in-sulphide value. These calculated nickel parameters are used to calculate the predicted nickel-sulphide recovery and sulphide mineralogy.

Nickel tenor (i.e. nickel concentration in 100% sulphides) is calculated using the formula from Barnes et al (2011). For disseminated nickel sulphides the nickel tenor can never be reliably estimated in rocks with sulphur contents much below 2%, and is subject to large uncertainties for sulphur contents up to 5%. Calculating the silicate Ni content for individual samples provides a more robust estimation of nickel-tenor for low grade nickel sulphide deposits along with a robust estimation of the sulphide mineralogy.

Results

Case Study 1: Nickel sulphide recoveries from disseminated sulphides

Using routine laboratory analysed exploration data from over 40,000 samples a calculated mineralogical model showed a simple sulphide assemblage for the deposit composed of 80% pentlandite and 20% Fe-sulphide irrespective of nickel grade. This exploration data was then used to calculate a Ni-lithological and Ni-sulphide association for the disseminated Ni deposit.

Combining the two calculated parameters a Ni-sulphide recovery model was derived and suggested a high variance of Ni-recovery ranging, typically 20% to 60% with only 2% of samples having a Ni-recovery greater than 70%.

When individually ore-domains within the disseminated Ni suphide deposit were modelled, a very close similarity was observed between actual metallurgical test samples and the Ni-recovery model (Figure 2).

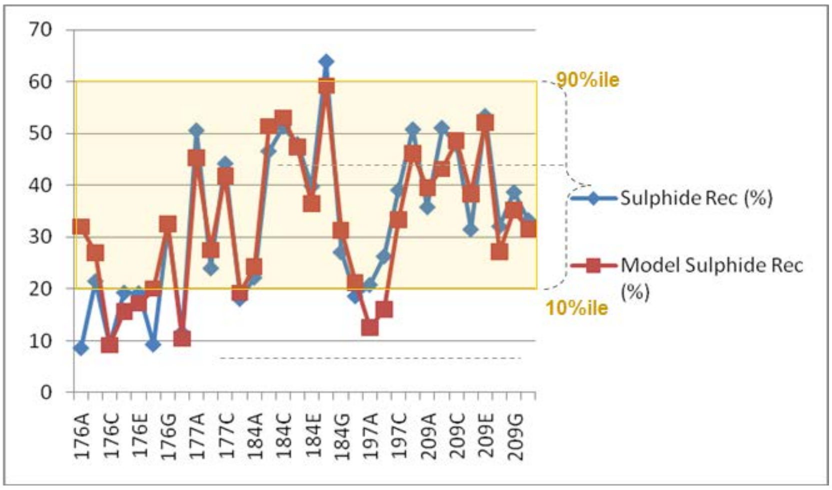

Figure 2. Modelled vs actual sulphide recovery from three domains within a disseminated nickel deposit.

Case History 2: Nickel sulphide recoveries from oxidised massive sulphides

This study was instigated to investigate the exceptionally very poor Ni-sulphide recovery from a newly commissioned processing plant and to establish whether the plant was at under-performing or the nature of the run-of-mine material was the cause.

A Ni-sulphide recovery model was constructed from the exploration data for the deposit and integrating the mill data. The results showed the mill Ni -recovery data for oxidised and upper transitional mill feed plotted outside the minimum recovery boundary for Ni-sulphides despite having average Ni-grades in the order of 3-5%.

The main transitional nickel-recovery plotted along the lower margin of the nickel recovery model irrespective of geology. A batch of third party massive Ni-sulphide ore used to test the performance of the new plant plotted on the boundary of the maximum Ni-recovery model and confirmed that the plant was performing to specifications and that the quality of Ni-ore feed was the cause of the very poor Ni-sulphide recoveries.

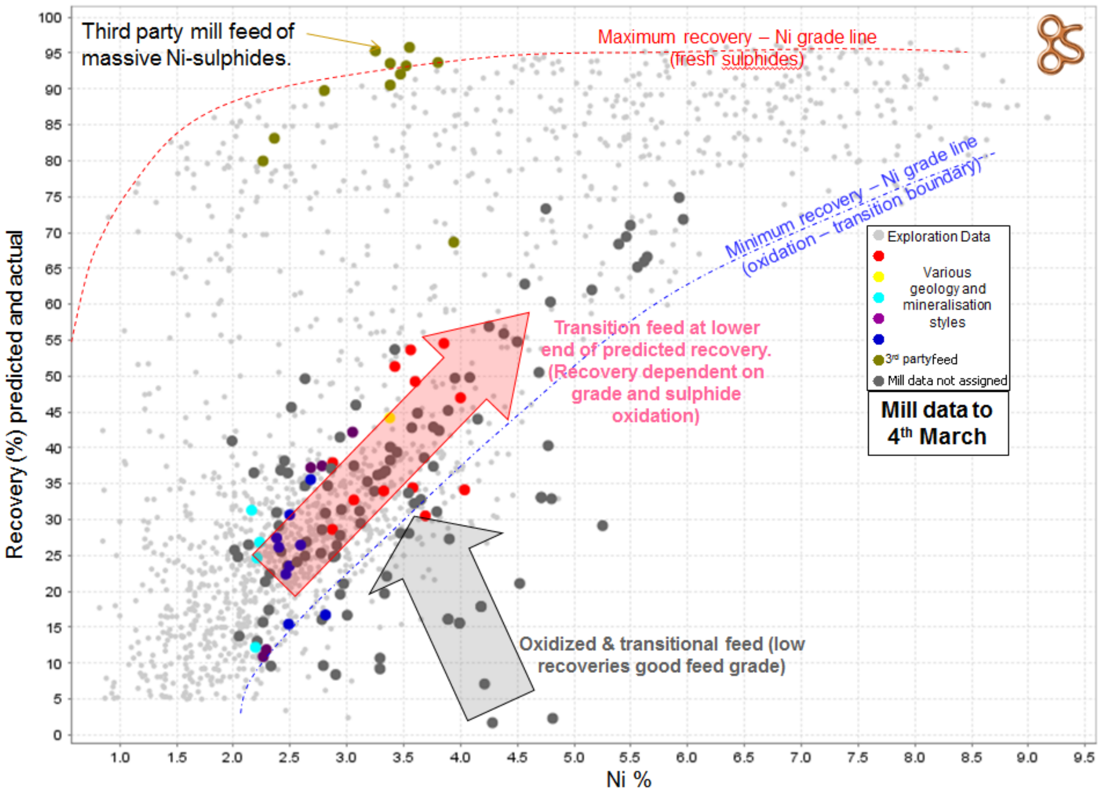

Figure 3. Nickel concentration vs Ni-recovery showing that the mill was preforming to expectations with the quality of Ni-ore feed causing very poor Ni-sulphide recovery.

Case Study 3: The effect of arsenic on Ni tenor

A common problem in nickel-sulphide deposits is the presence of arsenic, a deleterious element that at high concentrations triggers financial penalties. Gersdorffite (NiAsS) is the common nickel-arsenide and at elevated concentrations (>1% As) modelling and mine-data shows it will significantly increasing the Ni-tenor of an ore-body (Figure 4). The distribution of arsenic along with Ni tenor enables mine-site blending to occur to minimise financial penalties.

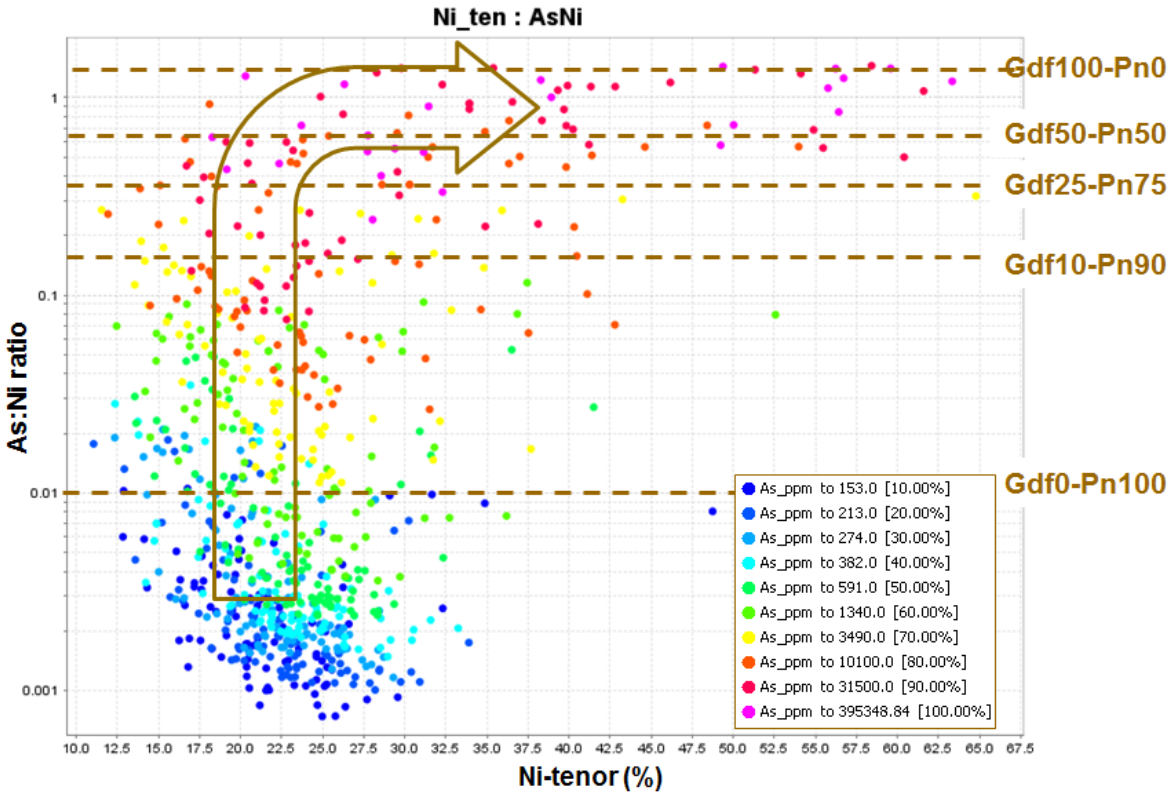

Figure 4. Ni tenor vs As:Ni ratio showing the effects of arsenic on Ni-tenor.

Discussion & Conclusions

Modelling of nickel-in-silicate to derive a nickel-in-sulphide has enabled nickel-recovery to be predicted from exploration data at a 1-2m scale. When integrated with metallurgical data from a disseminated nickel-sulphide deposit, the two data sets (predicted vs actual) show very close similarities.

The nickel-recovery model was able to demonstrate run-of-mine ore-quality rather than mill performance was the key factor in exceptionally poor nickel recoveries from a newly commissioned Ni-plant.

Predicting increased Ni-tenor as a function of increasing arsenic concentration, a deleterious element, has enabled mine-site blending to occur to minimise financial penalties.

The nickel-in-silicate and recovery models are specific to each deposit reflecting variations in local geology, drilling strategies (direction, spacing, sampling etc) and assaying (laboratory, sample prep, assaying etc).

The approach undertaken in these studies identifies nickel-sulphide and non-sulphide mineralogical controls related to key parameters that can be determined from 1-2m sample scale assay data. These modelled parameters provide a quantitative measure to characterise the quality of the resources.

References

BARNES, S.J., OSBORNE, G.A., COOK, D., BARMES, L., MAIER, W. D., & GODEL, B. (2011). The Santa Rita Nickel Sulfide Deposit in the Fazenda Mirabela Intrusion, Bahia, Brazil: Geology, Sulfide Geochemistry, and Genesis. *Economic Geology*, **106**, 1083-1110.