LATERITIC DEPOSITS

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This section discusses a group of residual deposits that typically develop as soils in areas with warm (typically tropical), wet climates. While many such deposits that have been mined, or are being mined, occur as surficial deposits, in some cases the deposits are buried and are mined by underground methods.

Nickel-Cobalt Laterites

Preamble

Nickel-cobalt lateritic deposits are residual concentrations formed by tropical-style weathering of ultramafic rocks. Lateritic deposits include a number of deposit sub-types that result from different geological, geomorphological and climatic conditions. Typically, a profile is developed with different zones. Each zone exhibits different compositions, mineralogies, chemistry, porosity and moisture content resulting in different bulk densities, swell factors, sedimentation/thickening characteristics and upgrading potentials. The metallurgical treatment of nickel-cobalt lateritic deposits is dependent on the part of the profile selected for mining. Plants may be deposit specific, though custom smelters operate in some parts of the world.

MRMR estimates for nickel-cobalt laterites consequently require some unique considerations and the following requires extra diligence when completing laterite MRMR estimates:

Categorization

Established metallurgical treatment processes tend to focus on one part of a lateritic profile and MRMR estimates should reflect this situation.

Metal values and mineralogical continuity diminish with depth in the laterite profile and consequently it may be necessary to vary sampling density requirements for MRMR estimates depending on which part of a profile is being evaluated. Close spaced drilling in representative areas is often required to statistically determine optimum drill hole spacing.

Drill Recoveries

Drill recoveries can be affected by variable lithologies, porosities and undecomposed rock content of the deposit profile due to incomplete weathering, voids (-100%) and swelling of cuttings (+100%). Over sampling of fines may result. Pitting was used extensively in the past but large diameter drilling (core and auger) are normal sampling methods now. Trenching may also be used where there is extreme inhomogeneity within a profile, to provide a bulk sample or to study mining characteristics. After the general geological structure and lithological character of the deposit is known, other forms of drilling (e.g. RC) can be used to determine chemical characterization of the deposit.

Sampling

The sampling interval should reflect the variability of the deposit in recovered metal grades, bulk chemistry and lithology. It is necessary to ensure sampling of each lithology and all facies types separately. Samples should be taken at regular vertical intervals down the profile. The lower part of the profile, being more heterogeneous, will often require a greater sample density.

Sample Preparation/Assaying

Special attention is required for sample handling and for QA/QC:

- Samples recovered in the field are often quite large, requiring special handling.
- Drying of samples must be carried out at low enough temperatures to avoid driving off the water of crystallization.

Although Ni and Co are the economic metals present, analyses for Fe and Mg are generally required to determine basic ore types and the boundaries of the zones in the profiles.

Bulk Density/Moisture Content

Due to the variability of mineralogy, porosity, compaction, rock content and internal drainage within the laterite profile, the moisture content and dry bulk density are highly variable. Wet weights should be determined before any moisture losses are determined.

Metallurgical Tests

Ore zone composites of duplicate drill or pit samples are often used for laboratory settling tests, bulk chemical analyses, and laboratory metallurgical tests. It is important to ensure that any such samples are representative of the part of the profile being considered for production.

Beneficiation

Simple beneficiation techniques may allow the raw lateritic material to be upgraded. The potential for beneficiation should be recognized at an early stage to allow the testing program to be designed correctly.

Categorization

It is unlikely that all facies can be placed in the same MRMR category due to differences in geological and grade continuity.

Varying controls on mineralization may require different drill spacing for any category of MRMR from one area to the next, or even along strike, in the same area. Close spaced drilling is often required to statistically determine the optimum spacing required.

Manganese

Preamble

Residual manganese deposits occur in a number of areas throughout the world. The deposits develop over a number of rock types and may be tabular or karstic. The mineralization may vary from lithified to powdery material. Mineralogy is typically variable.

Testing

Testing of residual manganese deposits may be difficult given the variable textures of the material in situ. The QP must consider the most appropriate methods for sampling.

Marketing

The marketing of manganese is an aspect that requires some special consideration. The discussion of marketing under the heading 'Industrial Minerals' should be examined.

The understanding of the marketing requirements entails an understanding of the impurities in the residual material. An understanding of the levels of various impurities and their relative effects on marketability are essential.

Beneficiation

As with other lateritic deposits, there is potential for beneficiation of the raw ore. Testing should examine this possibility.

Bauxite

Preamble

Bauxite is the most common source material for aluminum. In an industrial sense, bauxite is material that can be utilized economically in the Bayer Process. In this process, the economically important aluminum minerals are dissolved in hot caustic soda, the deleterious minerals are filtered off and the aluminum oxides recovered. The metallurgy of bauxite is affected by its mineralogy and the determination of the mineralogy of bauxite is an essential part of the testing of a deposit. Impurities may also be significant in the metallurgy of bauxite.

Deposits may develop in a number of different geological environments and on a number of different host rocks.

Bauxite has other uses separate to the production of metal. These other uses include refractory usage, in abrasives and in the chemical industries. These other uses have specific requirements for quality that would have to be addressed in the testing of any such deposit.

Testing

Testing may be carried out with augers in many cases. Pitting on a more widely spaced basis is useful to provide bulk samples and to confirm the auger results. In cases where the bauxite is lithified, other drilling techniques will be necessary.

Attention to the location of the contacts in the profiles is essential to avoid the inclusion of impurities during mining.

Sample Treatment

Drying of samples at temperatures low enough to avoid driving off the water of crystallization is essential.

Assay reproducibility may be a problem because of changes in the amount of water of crystallization.

Beneficiation

As with nickel laterites, bauxite may be amenable to upgrading prior to treatment. Attention to this matter during exploration and initial sampling is important.

Metallurgical Testing

It is unlikely that analytical results and mineralogical data alone will allow the prediction of the efficacy of metallurgical recovery. Metallurgical testing (typically 'bomb' testing) is required to allow a better appreciation of the response to treatment of different bauxite types.

Reporting Issues

Section 3.4(b) of NI 43-101 states that 'details of quantity and grade or quality' must be included in Technical Reports and other filings. Best practice reporting of MRMR for bauxite should include details of tonnage while the quality data should include details of recoverable alumina ($R.Al_2O_3$), reactive silica ($R.SiO_2$) and mineralogy.