Industrial Minerals Resources
Public Reporting According to Clause 49 of JORC 2012
Presentation overview

• What is JORC 2012?
• JORC 2012 Clause 49
• Mineral specifications – prices & markets
• JORC Table 1 ‘if not, why not’ requirement
• Exploration Quality Control (QC)
• Conclusions
What value does this ‘resource’ have?

• **XX is the world’s biggest graphite deposit**

• The total Mineral Resource comprises x,xxx Million Tonnes at 10% Graphite

• This impressive result confirms the true world class potential of the XX project. The company is now one step closer to becoming a market-leading low-cost graphite producer.

• But - what is the quality of the graphite?
What is JORC 2012?

• The JORC Code was first published in 1989, with the most recent revision in late 2012
• The JORC Code sets minimum standards for Public Reporting of Mineral Resources and Ore Reserves
• The JORC Code is mandatory for listed public companies in Australia and New Zealand
• JORC 2012 - mandatory from Dec. 1, 2013
• Significant change between JORC 2004 (Clause 44) and JORC 2012 (Clause 49)
• Industrial mineral resources or reserves must be reported in terms of mineral specifications
• “For minerals that are defined by a specification, the Mineral Resource or Ore Reserve estimation must be reported in terms of the mineral or minerals on which the project is to be based and must include the specification of those minerals.”
Why do we need Specifications?

- Without a market, an industrial mineral deposit is merely a geological curiosity
- Without meeting defined specifications, an industrial mineral deposit doesn’t have a market
- Market-related specifications are critical to economics of a project
### Relationship between specification and price

<table>
<thead>
<tr>
<th>Material</th>
<th>Specification</th>
<th>Price Range (US$) (Oct 2014)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Barite</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OCMA/API</td>
<td>bulk lump, SG 4.1, FOB Chennai</td>
<td>110-125</td>
</tr>
<tr>
<td>OCMA/API</td>
<td>bulk lump, SG 4.2, FOB Chennai</td>
<td>138-145</td>
</tr>
<tr>
<td>Paint grade</td>
<td>Chinese lump, CIF Gulf Coast</td>
<td>235-275</td>
</tr>
<tr>
<td><strong>Chromite</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical</td>
<td>grade, 46% Cr$_2$O$_3$ wet bulk, FOB South Africa</td>
<td>220-250</td>
</tr>
<tr>
<td>Refractory</td>
<td>grade, 46% Cr$_2$O$_3$ wet bulk, FOB South Africa</td>
<td>300-330</td>
</tr>
<tr>
<td>Foundry</td>
<td>45.8% min Cr$_2$O$_3$ wet bulk, FOB South Africa</td>
<td>280-360</td>
</tr>
<tr>
<td>Foundry</td>
<td>+47% Cr$_2$O$_3$ dried 1 tonne big bags FOB South Africa</td>
<td>340-420</td>
</tr>
<tr>
<td><strong>Graphite</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fine flake</td>
<td>94-97% C, -100 mesh CIF European port</td>
<td>1000-1050</td>
</tr>
<tr>
<td>Medium flake</td>
<td>94-97% C, +100-80 mesh CIF European port</td>
<td>1100-1200</td>
</tr>
<tr>
<td>Large flake</td>
<td>94-97% C, +80 mesh CIF European port</td>
<td>1350-1400</td>
</tr>
</tbody>
</table>
Specifications
Bentonite example

• Basic characteristics
  • Do not define markets
  • CEC, XRF chemistry, XRD mineralogy, Na / Ca exchangeable cations

• Performance specifications
  • Necessary to define markets
  • Free swell, viscosity, fluid loss, bond strength, thermal durability
Bentonite Performance affected by oxidation

Blue
- CEC ~80 meq
- Low Viscosity
- Low Free Swell

Yellow
- CEC ~80 meq
- High Viscosity
- High Free Swell
Bentonite
Performance affected by oxidation
Bentonite Thermal Durability
JORC Table 1

• Table 1 is a checklist for resource reporting
• Comments must be on an ‘if not, why not’ basis
• Example: did not measure flake size – why not?
### JORC Code, 2012 Edition – Table 1 report template

#### Section 1 Sampling Techniques and Data

(Criteria in this section apply to all succeeding sections.)

<table>
<thead>
<tr>
<th>Criteria</th>
<th>JORC Code explanation</th>
<th>Commentary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality of assay data and laboratory tests</td>
<td>• Nature of quality control procedures adopted (e.g. standards, blanks, duplicates, external laboratory checks) and whether acceptable levels of accuracy (i.e. lack of bias) and precision have been established.</td>
<td></td>
</tr>
<tr>
<td>Verification of sampling and assaying</td>
<td>• The use of twinned holes.</td>
<td></td>
</tr>
<tr>
<td>Metallurgical factors or assumptions</td>
<td>• The basis for assumptions or predictions regarding metallurgical amenability. It is always necessary as part of the process of determining reasonable prospects for eventual economic extraction to consider potential metallurgical methods.</td>
<td></td>
</tr>
</tbody>
</table>
Why QC?

• Nowhere is the old adage of garbage in, garbage out more appropriate than in the mining industry.

• We rely on a miniscule sample size to make enormous decisions regarding the set up of a mining project

• The lab results must be accurate and precise to reflect the truth
What are Precision, Accuracy and Bias?

- **Precision**: repeatability of repeated assays
- **Accuracy**: how close assays are to true value
- **Bias**: systematic difference between repeat samples and true value
QC procedures:
• Monitor contamination
• Evaluate precision, accuracy, contamination and bias
• Use specially prepared standards of known grade and sample duplicates to achieve this (standards, duplicates, blanks, umpire lab)
What are standards, duplicates and external laboratory checks?

• **Standard**: sample of known or accepted value, also known as ‘CRM’

• **Duplicate**: sample collected in an identical manner to an original sample, to provide a measure of the total error of sampling

• **Blanks** are barren samples with an expected low value (e.g. Fe$_2$O$_3$) relative to the mineralisation being evaluated. To check for contamination during sample preparation. Effectively a CRM

• **External laboratory check**: pairs of pulverised exploration samples to define inter-laboratory precision and bias (also known as *umpire*)
Precision & Bias

Precision – Standard

Bias – Umpire Lab

Control Chart: Standard GGC06

Histogram: +0.71mm_O vs +0.71mm_U
Exploration drilling methods

• Graphite or Vermiculite flakes
  • RC (percussion)drilling reduces average size
  • RC drilling changes population distribution

• Bentonite Clay
  • Auger Drilling shears the clay, improves Viscosity and Fluid Loss
Exploration drilling methods

Histograms of DD +710 micron vs RC +180 micron

- Mean = 24.5%
- Mean = 23%
What are twinned holes?

- Twinned holes are for the verification of sampling and assaying
- Traditionally drilled to verify historic data or comparison of different drilling methods
- Twinned holes are typically drilled less than 5m apart
How to verify twins?

Twinned RC & DD holes
Original intervals (noisy)

Twinned RC & DD holes
Composited intervals (less noisy)
How to verify twins?

**QQ Plot of twinned RC & DD graphite populations (no bias)**

**QQ Plot illustrating bias**
Conclusions

• It is not sufficient to simply report a resource of contained industrial mineral
• The resource estimation must include the specification of those minerals
• The drilling method used should be appropriate for the mineralization style (e.g. RC, DD or RAB)
• QC must be used to confirm accuracy and precision of lab results