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Public Reporting of Industrial Minerals Resources according to Clause 49 of JORC 2012

Andrew Scogings, PhD Geology, MAIG, MAusIMM
Director, KlipStone Pty Ltd, Associate Consultant at CSA Global Pty Ltd

THE CURRENT EDITION OF The Australasian Joint Ore Reserves Committee (JORC) Code was published in 2012 and came into mandatory operation from 1 December 2013. There are some significant changes between JORC 2004 and 2012 for the reporting of industrial mineral resources which should be addressed by players in the industrial minerals space.

Recent interest in Industrial Minerals

Industrial minerals are essentially minerals and rocks mined and processed for the value of their non-metallurgical properties and for the benefits they impart to the products and processes in which they are used. Industrial minerals are commonly classified according to their end uses, where there are a diverse (and sometimes bewildering) number of specifications, for example, abrasiveness chemical purity, mineralogy, particle size distribution, whiteness, density, water absorption, thermal resistance, rheology and insulating properties.

Industrial minerals such as graphite and spodumene have recently become the focus of much attention for listed exploration and mining companies, partly due to developments in battery technologies related to the emerging electric vehicle market. Consequently the race has been on to report larger tonnage exploration targets and resources, with some projects being described as the *biggest* or *second biggest* in the world, or *world class* with perhaps hundreds of millions of tonnes containing a certain percentage of a particular mineral. However being the biggest doesn't necessarily mean being the best and the author's intention is to highlight the need to report resources by market-related specifications (Scogings, 2014).

"Without a market, an Industrial Mineral deposit is merely a geological curiosity."

As noted on the website of Industrial Minerals Magazine "Without a market, an Industrial Mineral deposit is merely a geological curiosity". Too many industrial minerals explorers forget the significance of this, which is a bit like the geochemical anomaly in metals exploration that remains a geochemical anomaly and never becomes a mineable resource. Similarly, as noted by Border and Butt (2014) concerning the modifying factors for industrial minerals "Without a potential market, there can be no resource; without a good knowledge of the planned market (volume, price and competition), there is no reserve".

JORC 2012 – Reporting Industrial Mineral Resources and Reserves according to Specifications

The fundamental difference between JORC 2004 (Clause 44) and JORC 2012 (Clause 49) is contained in an all-important new paragraph in Clause 49, which requires that Industrial Mineral Resources or Reserves must be reported in terms of mineral specifications, where:

"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."

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AIG Secretariat
Contact: Ron Adams
Ph: (08) 9427 0820
Fax: (08) 9427 0821
Email: aig@aig.org.au
c/- Centre for Association Management
36 Brisbane Street, Perth WA 6000
PO Box 8463, Perth Business Centre, Perth WA 6849

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Further references to specifications are found in the following excerpts from the JORC 2012 (Clause 49) guidelines which are listed below:

"It may be necessary, prior to the reporting of a Mineral Resource or Ore Reserve, to take particular account of certain key characteristics or qualities such as likely product specifications, proximity to markets and general product marketability."

"Some industrial mineral deposits may be capable of yielding products suitable for more than one application and/or specification. If considered material by the reporting company, such multiple products should be quantified either separately or as a percentage of the bulk deposit."

It is significant to note that the word "specification" is referred to no less than four times in Clause 49, demonstrating its significance in reporting according to JORC 2012.

Examples of Industrial Mineral Specifications

Industrial Minerals which are commonly defined according to size and/or purity specifications include andalusite, barytes, chromite, graphite, kaolin, limestone, magnesite, silica, vermiculite, wollastonite and zircon. Other minerals and clays such as attapulgite or bentonite may be specified according to final product sizing, but more importantly according to performance in particular markets and applications as diverse as civil engineering (Figure 1), oil well drilling, cat litter (Figure 2), metal casting (Figure 3) and iron ore pelletising.

Figure 1. Geosynthetic Clay Liner (GCL) being used to line a landfill site. The bentonite within the GCL has to meet various specifications such as particle size, swelling characteristics, fluid loss and permeability. Source: AMCOL Australia.

A review of the *Price Listing* pages in Industrial Minerals Magazine (April 2014) highlights that different specifications and markets command a range of prices (Table 1). For example, barytes for use as a weighting agent in drill muds varies, according to SG, between US$110 and US$150 per tonne FOB Chennai. High brightness, high purity barytes for paint applications commands an even higher price of up to US$400 per short ton.

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From Your President — Wayne Spilsbury

G'DAY AIG MATES. This being my first activity report to members, I thought I would first share with you a little secret — "How does one become the President of AIG?" It begins with unofficial Rule 1 — A Councillor cannot resign until they have found a replacement.

Thus it was with great pride that I accepted Rick Rogerson's nomination for the position of Vice-President when Rick stepped down from Council, at the time not being aware that the Vice-President would then be nominated for the President's role after a two year apprenticeship. So here I am, somewhat wiser but still proud to be able to return as much as I can to a profession that gave me a long, challenging and sometimes exciting career. Still, it would be much better if more members put up their hands for election to Council, so at next year's AGM why not put your name forward for a Council position rather than waiting for that sly tap on the shoulder?

Over the past two years I have mainly watched as Past-President, Kaylene Camuti with ceaseless assistance from more experienced Councillors, has transformed AIG into a modern, efficient organisation solely dedicated to serving its members. A great foundation for the new Council to build upon.

Elsewhere in this issue you will see short biographies for each Councillor and Committee Chairs. We come from all corners of Australia and I encourage you to communicate with those Councillors you know or are from you area and voice your concerns and suggestions for further improving our organisation. Your new Council will hold a Strategic Planning Meeting on 20 – 22 June in Bendigo, a town literally built on mining. So if you have issues you would like to see discussed please contact me or another Councillor.

"One of the big tasks recently completed was the revamp of the AIG website. Have you logged on recently?" www.aig.org.au

While in Bendigo we will have the inaugural meeting of the National Graduate Committee, a new committee formed to address the concerns and needs of AIG Graduate Members as they gain work experience.

One of the big tasks recently completed was the revamp of the AIG website (http://www.aig.org.au). Have you logged on recently? As well as a fresh new look, we've created an Events Calendar that monthly lists all AIG professional development opportunities as well as those of other geoscientific organisations. Plans are underway for a Consultants List that will function as a consultants 'finder' for prospective 'clients'. It will be a business card type directory that will allow you to advertise your services. Also in the construction stage is a reinvigoration of the AIG Journal that needs a new name which we ask members to submit, and which will provide a means for members to rapidly publish short, topical articles dealing with any aspects of professional and technical practice. It is intended to fill a gap in the current geoscience publication landscape and provide credible exposure of our members' skills and experience.

Under implementation is an on-line, secure, Australian developed and supported membership data management system that is outlined elsewhere in this issue. **It is highly recommended that you provide a unique personal email address (not your business address) when filling in your contact details.**

AIG membership continued to grow and in March this year was approaching 3000 out of an estimated 9,000 geoscientists (estimated from Census data). I think we can rightfully say we are the **PEAK** body representing geoscientists in Australia. But like all Not for Profit organisations we are only as strong as our engagement with members. I thus encourage you to attend the social and technical events of your local branch, write an article for Field Notes or AIG News, mentor that Graduate Member working for you, join your State Committee, present a paper at an AIG seminar or conference — help us all to continue our professional development.

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Similarly chromite sand varies significantly in price according to specification and markets, from US$230 per tonne for chemical grade to US$500 per tonne for refractory grade FOB South Africa. The chromite price is generally directly related to specifications such as particle size, SiO_2 and Cr_2O_3 content and Cr/Fe ratio and is driven by overall market conditions.

Of particular importance in today's industrial minerals arena, crystalline graphite may range from US$700 per tonne to as much as US$1300 per tonne. It is clear that such price variations could have a significant impact on the economics of a graphite project, especially considering the wide range of possible markets e.g. friction linings, lubricants, electrical, refractories and foundries.

From the above examples it is obvious that when publicly reporting an industrial mineral resource it is insufficient to simply report a tonnage and the contained percentage of the mineral. Not only is this contrary to JORC 2012 requirements but it could be misleading to investors. Let us take the case of a hypothetical flake graphite resource reported as 200 million tonnes at 10% graphitic carbon. Essentially all this tells us that the resource contains 20 million tonnes of in-situ flake graphite, but it tells us nothing specific about i) the size range of graphite flakes, ii) the likely purity of extracted graphite flakes, iii) impurities such as sulphides that may impact on mineral extraction, nor iv) possible markets which may be relatively limited compared with the reported resource.

Table 1. Selected barytes, chromite and graphite prices. (Industrial Minerals Magazine, April 2014.)

Barytes	**US$**
OCMA/API bulk lump, SG 4.2, FOB Chennai	135-150
OCMA/API bulk lump, SG 4.1, FOB Chennai	110-130
Paint Grade Chinese lump, CIF Gulf Coast	235-275
Paint Grade ground, 96-98% $BaSO_4$, ex-works USA ($/s. ton)	315-400
Chromite	
Chemical Grade, 46% Cr_2O_3 wet bulk, FOB South Africa	230-280
Refractory Grade, 46% Cr_2O_3 wet bulk, FOB South Africa	425-500
Foundry, +47% Cr_2O_3 dried 1 tonne big bags FOB South Africa	330-360
Foundry, 45.8% min Cr_2O_3 wet bulk, FOB South Africa	260-290
Graphite – Crystalline	
Fine, 90% C, -100 mesh	750-850
Medium, 94-97% C, +100-80 mesh	1050-1150
Large flake, 94-97% C, +80 mesh CIF	1250-1300

The same would apply to a vermiculite deposit, where flake size and exfoliation or expansion characteristics are required in order to grade the deposit. In the case of clay such as bentonite, simply reporting a

tonnage based on a purity measurement (e.g. Cation Exchange Capacity or XRD mineralogy indicative of montmorillonite content) conveys little or no meaningful information as to possible market applications — if any. Individual bentonite deposits may have similar montmorillonite content, but perform entirely differently in markets as diverse as paper manufacture, metal casting or oil well drilling. Bentonite quality may also be affected by depth of weathering, whereby "blue" bentonite is oxidised to "yellow" bentonite at shallow depths and may display enhanced performance in drilling products, despite having identical CEC and montmorillonite content.

Appropriate Quality Tests (Assays)

The responsibility falls on the Competent Person to ensure that exploration samples are tested for appropriate parameters in addition to basic tests for mineral content. As per JORC 2012 Clause 49 guidelines:

"Assays may not always be relevant, and other quality criteria may be more applicable. If criteria such as deleterious minerals or physical properties are of more relevance than the composition of the bulk mineral itself, then they should be reported accordingly."

- Individual or appropriate composite samples should be evaluated according to size, purity of extracted minerals and / or market performance specifications.
- It may be difficult to find a commercial laboratory that can run such tests, as most industrial minerals testing is done in-house by producers. Either a current producer may be approached to test the samples, or test methods will have to be developed internally.
- Some test methods are industry standards e.g. bentonite slurry viscosity and barite density for drilling mud applications, and are available from institutions such as the American Petroleum Institute.
- Other test methods may be obtained from institutions such as the British Geological Survey (eg Mitchell, 1993).

For example, bentonite may be characterised by a number of metrics such as purity, chemistry and exchangeable cations:

- Moisture %
- pH
- Grit %
- Swelling volume in water
- Purity – montmorillonite vs inert minerals
- Ca, Mg and Na exchangeable cations
- XRF (chemistry)
- XRD (mineralogy)

Figure 2. Clumping cat litter. Colour and clump strength are specifications which may be measured to ascertain market suitability for a specific bentonite resource.

Figure 3. Moulding sand used for metal-casting applications. Known as "greensand" this incorporates silica sand, bentonite and carbonaceous additives. Bentonite is the bonding agent and is typically qualified according to mechanical properties such as green, dry and wet tensile strengths, in addition to thermal durability. Source: AMCOL Metalcasting.

However apart from confirming basic characteristics, these measures don't necessarily indicate how the clay might perform in various applications and therefore a range of performance tests may be required to determine market opportunities including:

- Water Absorption (iron ore or chromite pelletising)
- Green, Dry and Wet Tensile Strength (metal casting)
- Thermo Gravimetric Analysis (metal casting) — refer to Figure 4
- Viscosity and Fluid Loss (drilling mud)
- Fluid Loss, Free Swell and Permeability (geosynthetic clay liners)

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- Clump Strength (cat litter)
- Acid Activation (edible oil purification)
- Toxin Adsorption (animal feed)
- Lees Formation (fining of wine)

Conclusions

Clause 49 of JORC 2012 is a welcome and timely improvement to Clause 44 of JORC 2004.

When publicly reporting industrial mineral resource or reserve estimations according to JORC 2012 (which took effect from December 2013):

- It is no longer sufficient to simply report a resource of contained industrial mineral.
- The estimation must include the specification of those minerals, if those minerals are defined by a specification.
- If multiple products are possible from a deposit, such multiple products should be quantified either separately or as a percentage of the bulk deposit. A typical example is a bentonite deposit that yields metal casting and drilling products from different parts of the deposit, based on weathering domains.
- Specific market-related testing and / or metallurgical testwork are very likely to be required for industrial minerals deposits. It is not sufficient to rely solely on traditional mineralogical or chemical purity (assay grade) tests as commonly used in metals exploration.
- Commercial laboratories may not be equipped to test minerals to industry specifications. In this case test procedures could be developed either in-house or in conjunction with a commercial laboratory. Samples may alternatively be submitted to an existing industrial minerals producer or potential customer, for example a greensand foundry in the case of bentonite.
- Proximity to markets and general product marketability should be taken into account.

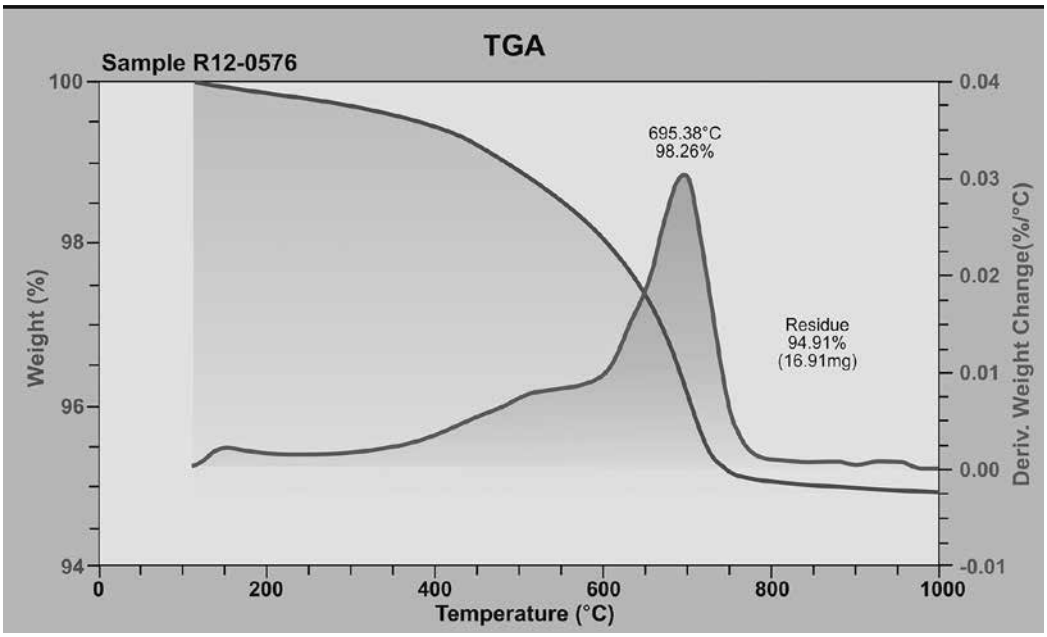

Figure 4. TGA analysis of '5D' bentonite from Queensland, Australia. Dehydroxylation peak at 695°C suggests high thermal durability suitable for metal-casting applications. Source: AMCOL Australia.

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