AIG Journal

Published by the Australian Institute of Geoscientists
ISSN 1443-1017

Reporting industrial mineral exploration results according to the JORC Code

A. Scogings[1], I. Chen[2] & G. Jeffress[3]

[1] MAIG, MAusIMM, RP Geo (Industrial Minerals). CSA Global Pty Ltd
[2] MAusIMM, GAICD. Non-exec. Member of the VALMIN Committee. CSA Global Pty Ltd.
[3] FAIG, RPGeo, FAusIMM, FSEG. Member of the JORC Committee. CSA Global Pty Ltd.

Abstract

Industrial minerals such as graphite are minerals and rocks mined and processed mainly for the value of their physical properties. They are commonly classified according to a diverse range of specifications, including chemical purity, mineralogy, particle size distribution, and density.

The requirements for publicly reporting the outcomes of exploration activities remain underpinned by the requirements of the JORC Code and the listing rules of the Australian Securities Exchange (ASX).

This paper examines the reporting of industrial mineral exploration results in general, with an emphasis on considerations that should be applied to the reporting of flake graphite results.

Industrial minerals including graphite, and more recently lithium minerals, have become the focus of attention for listed exploration and mining companies. This is mainly due to developments in rechargeable battery technologies, driven by growing demand from the emerging electric vehicle market and solar storage sectors.

Consequently, the race has been on to acquire tenure, report larger exploration targets and resources, and to tell the market why one's project has merits above and beyond competitor projects. Additionally, the need to differentiate and stand out from the crowd, to attract investment is a strong driver for many projects reliant on equity funding.

In Australia, publicly listed companies are required to adhere to the Australian Corporations Act, the listing rules of the Australian Stock Exchange (or other relevant exchanges), and the JORC Code, when releasing public reports on matters relating to Mineral Resources and Ore Reserves. Additionally, members of the JORC parent professional organisations, the AIG and AusIMM, are bound by their respective Codes of Ethics to adhere to the requirements of the JORC Code, when preparing public reports.

As with all other commodities, public reports about industrial mineral ("IM") Exploration Results ("ER") require the input of suitably experienced Competent Persons ("CP") presenting material information in a transparent and material way.

The authors note that review is for information purposes only and does not specifically constitute the opinion of either CSA Global, nor the JORC[1] and VALMIN[2] committees.

[1] *While Graham Jeffress is a member of JORC, any comments and views presented are his own and should not be taken as necessarily representing those of the full JOR committee.*
[2] *While Ivy Chen is a non-executive of VALMIN, any comments and views presented are her own and should not be taken as necessarily representing those of the full VALMIN committee.*

Reporting of Exploration results (JORC Code Clauses 4, 5, 18, 19 and Table 1)

The **JORC Code Clause 18** states that *"Exploration Results include data and information generated by mineral exploration programmes that might be of use to investors but which do not form part of a declaration of Mineral Resources or Ore Reserves."* and that *"Examples of Exploration Results include results of outcrop sampling, assays of drill hole intersections, geochemical results and geophysical survey results."*

An exploration company may wish to publish exploration results and there are very clear guidelines in the **JORC Code Clause 19**, which highlight that *"Public Reports of Exploration Results must contain sufficient information to allow a considered and balanced judgement of their significance."* and *"Public Reports of Exploration Results must not be presented so as to unreasonably imply that potentially economic mineralisation has been discovered."* (JORC, 2012).

"Where assay and analytical results are reported, they must be reported using one of the following methods, selected as the most appropriate by the Competent Person:

- *Either by listing all results, along with sample intervals (or size, in the case of bulk samples), or;*
- *By reporting weighted average grades of mineralised zones, indicating clearly how the grades were calculated."*

Also, it is very important to support a clear understanding of the exploration results: *"Clear diagrams and maps designed to represent the geological context must be included in the report. These must include, but not be limited to a plan view of drill hole collar locations and appropriate sectional views".* Please note that the underlining was added by the authors to highlight a key aspect of Clause 19, and that the underlining is not part of the JORC Code.

The authors' opinion is that there will be very few cases where a collar plan and appropriately annotated cross sections are not required when presenting drilling results.

JORC Table 1 is a checklist or reference for use by those preparing Public Reports on Exploration Results, Mineral Resources and Ore Reserves, and Sections 1 and 2 must be included with public announcements of Exploration Results.

JORC Table 1 includes Criteria (e.g. sampling techniques) and the CP is required to comment on the criteria on a 'if not why not' basis. In this regard, the JORC Code states that "It is the responsibility of the Competent Person to consider all the criteria listed below and any additional criteria that should apply to the study of a particular project or operation. The relative importance of the criteria will vary with the particular project and the legal and economic conditions pertaining at the time of determination".

JORC Table 1 is not a definitive checklist, it provides minimum standards: the CP can, and should, do better whenever it is possible, keeping in mind always the JORC pillars of transparency, competence and materiality. All criteria in Table 1 must be addressed; criteria cannot be deleted, but criteria may be added and the CP should provide opinions that answer the questions in Table 1, not merely provide descriptions of the work done.

The value-add provided by the Competent Person derives from the quality of the opinion provided: an adequately completed JORC Table 1 presents sufficient material information to allow the reader to form their opinion; a good JORC Table 1 presents information as well as an opinion, bearing in mind Clauses 4 and 5 of the JORC Code, which provide the scope for why the Code exists at all, which is to inform investors. Please note that the underlining is added by the authors to highlight the key aspects of Clauses 4 and 5, and is not part of the JORC Code.

JORC Code Clause 4 *"In particular, the Competent Person must consider that the benchmark of Materiality is that which includes all aspects relating to the Exploration Results, Mineral Resources or Ore Reserves that an investor or their advisers would reasonably expect to see explicit comment on from the Competent Person. The Competent Person must not remain silent on any material aspect for*

which the presence or absence of comment could affect the public perception or value of the mineral occurrence."

JORC Code Clause 5 *"Table 1 provides a checklist or reference of criteria to be considered by the Competent Person in developing their documentation and in preparing the Public Report. In the context of complying with the principles of the Code, comments relating to the items in the relevant sections of Table 1 should be provided on an 'if not, why not' basis within the Competent Person's documentation. Additionally, comments related to the relevant sections of Table 1 must be complied with on an 'if not, why not' basis within Public Reporting for significant projects (see Appendix 1 Generic Terms and Equivalents) when reporting Exploration Results, Mineral Resources or Ore Reserves for the first time. Table 1 also applies in instances where these items have materially changed from when they were last Publicly Reported. Reporting on an 'if not, why not' basis is to ensure that it is clear to an investor whether items have been considered and deemed of low consequence or are not yet addressed or resolved. "*

What constitutes industrial mineral Exploration Results?

We may ask what constitutes Exploration Results for industrial minerals? In the authors' opinion, industrial mineral Exploration Results may be grouped into three main categories (Scogings, 2017):

- **Analytical ("assay")** results including geochemistry, outcrop, drill sample, trench or bulk samples; visual estimates of drill hole intersections; or petrographic examination.
- **Geophysical** surveys and **geology observations/mapping**, often reported early on in a project.
- **Metallurgical** or **beneficiation** testing, including **product performance** tests on concentrates (e.g. graphite), or rocks and minerals (e.g. bentonite, vermiculite, kaolin, etc.).

We note that metallurgical testing associated with process design testing or process optimisation, may not necessarily be considered material to Exploration Results, and naturally there will be commercially confidential information that cannot be disclosed to the market. The key considerations under these circumstances should be:

- whether the results of the metallurgical or beneficiation analysis are material to providing context for Exploration Results; and
- if these results impact the project's prospects for eventual economic extraction.

If the results are material but commercially confidential, then the market needs to be informed accordingly, in consultation with the company's legal advisers.

Are Exploration Result announcements meeting JORC Clause 18 and 19 requirements?

Public Reports of Exploration Results must contain sufficient information to allow a considered and balanced judgement of their significance. Reports must include relevant information such as exploration context, type and method of sampling, relevant sample intervals and locations, distribution, dimensions and relative location of all relevant assay data, methods of analysis, data aggregation methods, land tenure status plus information on any of the other criteria listed in Table 1 that are material to an assessment.

Clear diagrams and maps designed to represent the geological context must be included in the report. These must include, but not be limited to a plan view of drill hole collar locations and appropriate sectional views (Figures 1 and 2).

It is apparent that industrial mineral Exploration Result announcements have not all been treated equally and, in the authors' opinion:

- Analytical result announcements are generally the best reported and usually have appropriate maps, cross sections and Table 1 in addition to a CP statement.

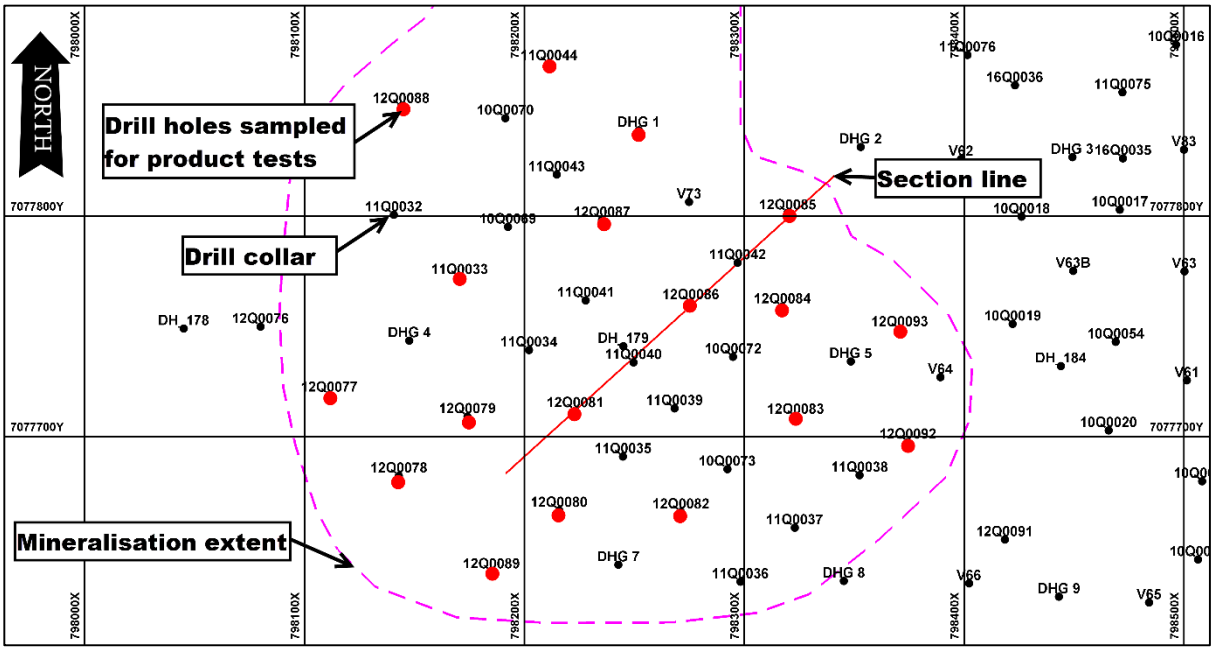

Figure 1. Map showing drill collars, locations of drill samples used to make a bentonite composite for product tests, and approximate mineralisation extent. Map grid 100 x 100 m

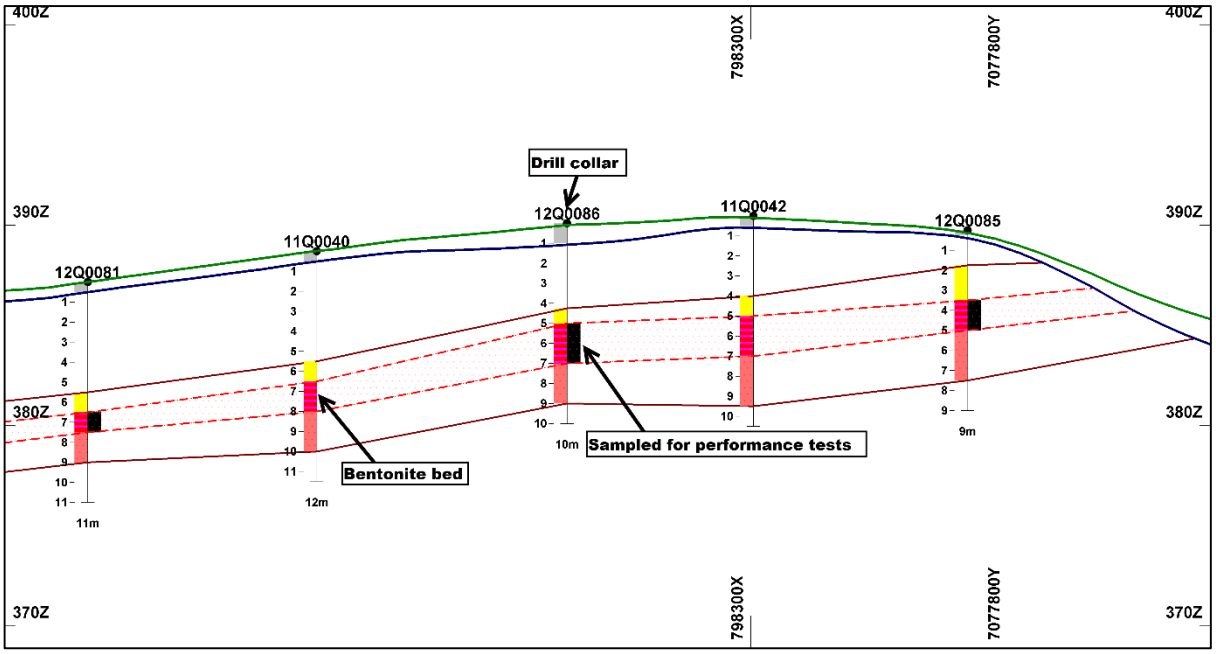

Figure 2. Cross section showing visually-logged bentonite mineralisation and examples of product performance sample locations. Section looking NW. Vertical exaggeration = 3x.

- Geophysical survey announcements generally have maps (and cross sections when applicable but sometimes fail to include units and legends), in addition to JORC Code Table 1. However, the Table 1 is often 'borrowed' from previous assay results announcements and may not always be appropriate for geophysical surveys. In addition, a CP statement is not always included and if there is a CP statement, this may not be from a geophysicist.
- Metallurgical, beneficiation or product performance results are often not considered to be true Exploration Results. They frequently don't have maps or sections, Table 1 or a CP statement

and are weakly presented, without sufficient context to demonstrate the material impact of these metallurgical results on the project.

Reporting of analyses (assays)

Taking graphite as an example, graphite or carbon content may be reported in several ways and it must be made clear which is being used. For example, analytical laboratories may report Total Carbon ("TC"), Total Graphitic Carbon ("TGC") or Loss on Ignition ("LOI") for graphite concentrates, whereas Exploration Results Mineral Resources are usually reported as TGC. The CP should comment on the analytical method being used and its suitability for the commodity being reported.

The nature and concentration of potentially deleterious components such as sulphide minerals also need to be discussed.

Reporting of visual estimates

In those instances where a company determines that continuous disclosure obligations require the public release of drilling results prior to receipt of the laboratory analytical results, it is essential that the CP disclose information on the identity and quantity of the minerals of interest (graphite flakes, or spodumene, petalite, feldspar, vermiculite, etc.), in addition to the gangue minerals present (Scogings, et al., 2016). It is not sufficient to simply quote intervals of interest, metres of pegmatite or graphitic schist, without providing an estimate of what is in those intervals – is it a speck, half the rock, or 5-10%? Such information should be provided as ranges of percentage estimates, and include cautionary language about the uncertainty of visual estimates and the importance of laboratory confirmation (Waltho, 2015).

Reporting of geophysical results

Geophysical techniques are an indirect way of tracing geological and/or mineralisation trends across an exploration project. Using graphite as an example, various electromagnetic (EM) methods can be highly effective exploration tools for graphite mineralisation and provide supporting evidence for mineralisation continuity along strike and down dip. As such, geophysical survey results are generally material to graphite projects and should be considered as Exploration Results.

The question may be asked "where does the CP comment on geophysical results in Table 1?" It is recommended that these results be commented on under Section 2 *"Other substantive exploration data"* which includes *"Other exploration data, if meaningful and material, should be reported including (but not limited to): geological observations;* ***geophysical survey results****; geochemical survey results; bulk samples – size and method of treatment; metallurgical test results; bulk density, groundwater, geotechnical and rock characteristics; potential deleterious or contaminating substances."*

A geophysicist is the appropriate Competent Person to be responsible for the public release of geophysical results. Adherence to the JORC Code would require that the CP statement includes the geophysicist.

Reporting of metallurgical, beneficiation and product performance results

Metallurgical, beneficiation or product performance results are classified as Exploration Results if these are material to the project and include data that may be useful to investors (which is almost always the case with industrial minerals such as graphite) – as is clearly shown by their inclusion in Section 2 of Table 1. Metallurgical results should be reported with supporting maps and sections in the same way that analytical Exploration Results are announced.

Clause 49 of the JORC Code (2012), which requires that: "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."

In other words, to comply with the JORC Code, any announcement of industrial mineral metallurgical, beneficiation and / or product performance testing results should refer to common market requirements for the product in question.

Examples of test results include liberated flake size distribution, purity, density and peak oxidation temperature (graphite); flake size distribution and expansion rate (vermiculite); concentrate grade and iron content (spodumene), and viscosity, mechanical strength, and dehydroxylation temperature (bentonite clay). These test results would only have meaning if there is suitable context provided by providing quantitative information. For example, the dehydroxylation (loss of structural water) temperature of a highly durable bentonite for foundry markets could be expected to be in the range of approximately 670°C to 700°C, whereas many bentonites may be well below 600°C; hence this type of aspect needs to be discussed quantitatively. Another example might the expandability of graphite; which needs both the laboratory test to be provided as well as the numerical results and is not simply a qualitative comment such as "we have highly expandable graphite".

The reason that performance test results are material in public announcements is because they define likely markets for industrial mineral products. For example, a high peak oxidation temperature for graphite indicates suitability for use in high-temperature refractory products. Expanded vermiculite contains trapped air and is used in lightweight building products and for thermal and acoustic insulation; therefore, higher expansion = better performance. Low iron content in spodumene and other lithium minerals renders them suitable for use as fluxes in specialist ceramics and clear glass.

The viscosity of bentonite slurry is important when used as drilling mud, swelling index is important for some civil engineering applications, while mechanical strength and high thermal durability are important parameters when bentonite is used as a binder in sand moulds for metal casting. It may well be the case that bentonite from one part of a deposit may be suitable for drilling mud, but not be of any use for metal casting; this highlights the materiality of performance tests in public reporting of industrial minerals (see Table 1 for general examples of bentonite specifications and Figure 3 for examples of different swelling performance). It is noted that the Ca, Mg or Na cations in bentonite are reported collectively as the Cation Exchange Capacity ("CEC") and that the ratio of exchangeable cations impacts performance (e.g. swelling, viscosity, fluid loss and water absorption). The purity of bentonite does not necessarily indicate potential markets: note that the examples in Table 1 have similar CEC values.

Table 1. Some generalised bentonite market specifications and quality guidelines

Market	CEC (purity) (meq / 100g)	Free Swell (mL / 2g)	Fluid Loss (mL of filtrate)	Viscosity V600 (6.25% slurry)	Plate Water absorption (%)
Foundry	> 80	> 20			
Drilling mud	> 80		< 15	30	
Geosynthetic clay liner	> 80	> 24	< 18		
Iron ore / chromite pelletising	> 80				> 600

The question may be asked "where does the CP comment on metallurgical results in Table 1?" It is recommended that metallurgical results be commented on under Section 2 *"Other substantive exploration data" which includes "Other exploration data, if meaningful and material, should be reported including (but not limited to): geological observations; geophysical survey results; geochemical survey results; bulk samples – size and method of treatment;* ***metallurgical test results****; bulk density, groundwater, geotechnical and rock characteristics; potential deleterious or contaminating substances."*

Metallurgical, beneficiation or product performance tests results can be affected by the type of drilling and / or sampling method used. It is therefore required to comment in Table 1 on the drilling method used which may have a material impact on the industrial mineral being reported.

When drilling for minerals such as graphite or vermiculite, drilling methods could affect intrinsic properties such as flake size. For example, drilling methods such as RC or Air Core (“AC”) are likely to shred the mineral flakes and reduce their size relative to flakes in diamond drill (“DD”) core samples.

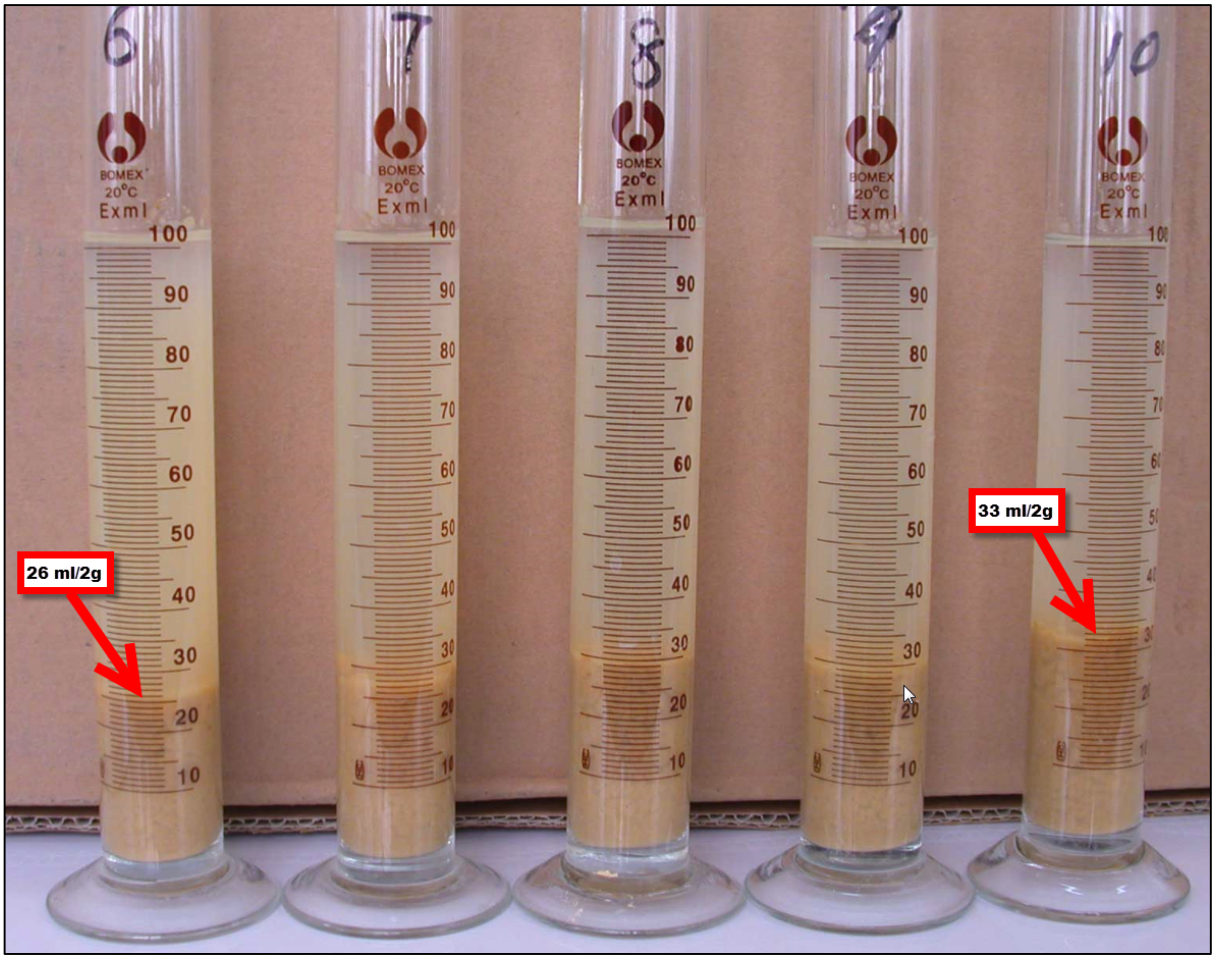

Figure 3. Examples of swelling index (Free Swell) being measured for different bentonite products immersed in water for 24 hours.

Such size reduction would have a material impact on the economics of a vermiculite project, as coarse flakes typically attract a higher price than finer flakes.

Drilling with an auger may increase the viscosity of bentonite due to the shearing action of the auger flights, and the CP should be aware of such artefacts of drilling methods when reporting.

As with geophysical results, either the metallurgist and/or or the ‘product specialist’, is the appropriate Competent Person responsible for the public release of this type of information, and should be included in the CP statement as required by the JORC Code (and by their membership of a recognized professional institute such as the AusIMM or AIG, for example).

Concluding Remarks and Observations

In the authors’ experience, analyses are sometimes commissioned from highly specialised service providers, who may or may not be members of either the AIG, AusIMM or a ROPO. If the public announcement is by an entity listed on the ASX, a CP sign-off may still be required to demonstrate that the information has been reviewed and accepted as material and relevant to the project.

In these circumstances, either an internal CP (e.g. the Company's Technical Director), or an external CP (e.g. a consultant) may be an appropriate CP. What is critical is that the investing public has the confidence that a CP has reviewed the information being released and is prepared to stand by it.

When publicly reporting industrial mineral Exploration Results in compliance with the JORC Code (JORC, 2012), the authors recommend that the following points should be considered:

- Exploration Results for industrial mineral projects include: analyses (assays), geophysical surveys and the results of metallurgical / beneficiation and product performance tests that may be useful to investors.
- If you need to report visual estimates prior to receiving laboratory results, then you must identify the minerals of interest (e.g. graphite or spodumene) and include estimates of abundance (as ranges) – identity and quantity.
- There is rarely an excuse for not having a map of sample locations, drill holes, and geological sections of the drill holes when reporting Exploration Results.
- Don't 'cherry pick' results. Present all material results and use pictures (e.g. sections) to illustrate the context.
- Include units and legends in maps and sections, especially when reporting geophysical results.
- Include Table 1 and ensure that the commentary is applicable to the type of Exploration Results being reported. It's not just a case of 'copy and paste' commentary from previous announcements.
- CP statements must be included. This includes geophysicist and metallurgist CPs in addition to geologists, if those are the results being reported.
- Context is 'king'. It is essential that the reader appreciates the risk inherent in uncertainty that is invariably present in the early stages of any potential resource project development.
- Refresh your memory on clauses 4 (materiality), 5 (Table 1), 9–11 (CP), 18–19 (ER), Clause 49 (IM) and Table 1 of JORC (2012) before preparing a public report.

In conclusion:

- **Read (and understand) the JORC Code, especially Clauses 18-19, the preamble to Table 1, and Table 1.**

Bibliography

JORC (2012). "Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves (The JORC Code)". *The Joint Ore Reserves Committee of the Australasian Institute of Mining and Metallurgy, Australian Institute of Geoscientists and Minerals Council of Australia*.

Scogings, A. (2017). "Reporting graphite Exploration Results according to the JORC Code. Australian Graphite Conference. *Paydirt Media, Perth, 27 April 2017*.

Scogings, A., Porter, R. and Jeffress, G. (2016). 'Reporting exploration results and Mineral Resources for lithium mineralised pegmatites'. *AIG News Issue 125*, *September 2016*, pp 32-36.

Waltho, A. (2015). "Reporting Sulphide Mineral Observations in Drilling Intersections". *AIG News 122*, *November 2015,* pp 46-47

Acknowledgements

The permission of CSA Global to publish this paper is gratefully acknowledged.

AIG Journal Paper N2017-002
Received 6 Jul 2017
Reviewed 7 Aug 2017
Accepted 11 Aug 2017
Published 24 Sep 2017