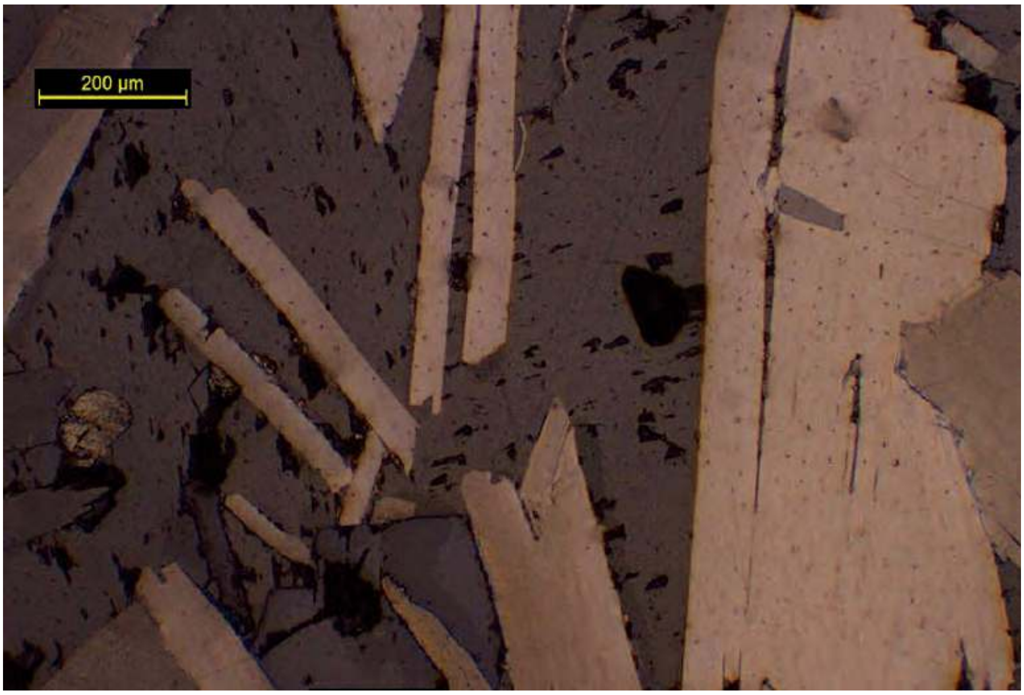
Graphite: Where size matters

Over the last few years graphite has become the focus of attention for many listed exploration companies, particularly due to developments in battery technologies related to the emerging electric vehicle and green energy market.

Consequently, the race has been on to report larger tonnage exploration targets and resources, with certain projects being described as world-class, the biggest or highest grade, with perhaps hundreds of millions of tonnes containing a certain percentage of graphite.

However, being the biggest doesn't necessarily mean being the best and there is a need to report resources by market-related specifications, according to JORC 2012 (Clause 49), which requires that 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."



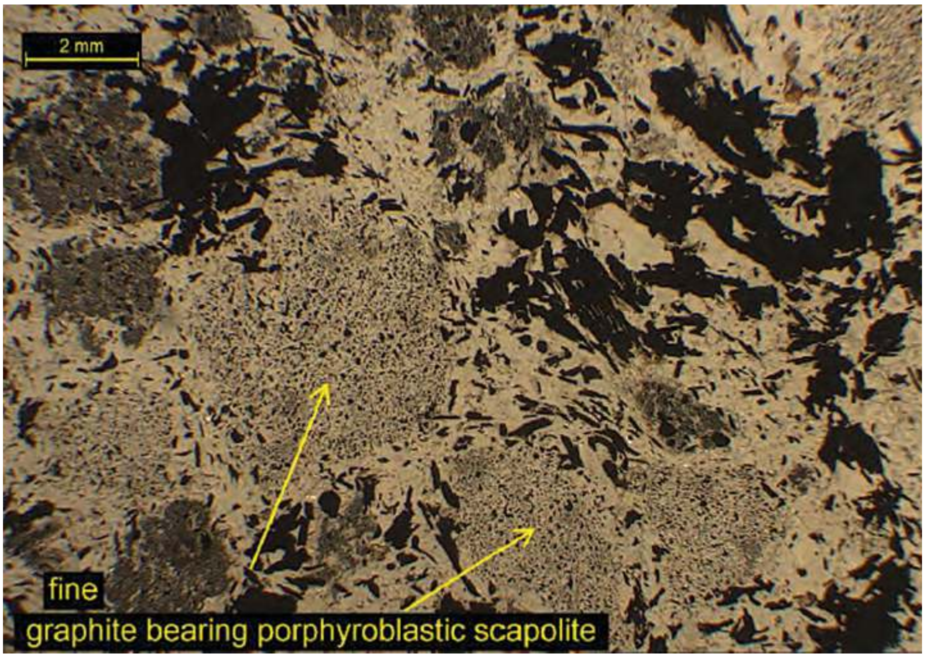
Photomicrograph of large 'clean' graphite flakes

Although resource tonnes and graphitic carbon content (grade) are key metrics in assessing projects, the evaluation of graphite projects is more complex. Out of the numerous considerations, key attributes (in addition to size of deposit and grade) are product flake size distribution and purity.

Graphite purity is particularly important for the higher value end uses like lithium-ion batteries and is a key determinant in saleability of the product. It is also a key factor in the cost of production because if further processing is required to make the product saleable this could dramatically increase the operating cost.

Graphite flake size distribution is one of the more debated project factors; however a number of facts about flake size are true; firstly, the larger the flake (in a given deposit) the higher the purity of the graphite product is likely to be and secondly, the larger the flake size the higher the price (see Table 1).

This point was illustrated recently by the chief executive of a graphite mill, when asked about the ideal project to source graphite from. His reply was: "A graphite mine that would produce at a 94-96% purity level. It would have as much medium (plus-80 mesh) and large flake (plus-50 mesh) as possible. The lower the percentage of fine flake (minus-80 mesh), the better, since it is the most abundant material in the market and thus has the lowest selling price…."



Photomicrograph illustrating two graphite populations within one sample: large flakes in the general rock matrix, compared with fine flakes within a mineral known as scapolite

The responsibility falls on the competent person (as defined by JORC) to ensure that exploration samples are tested for appropriate parameters in addition to basic assay tests for graphitic carbon content.

Individual or appropriate composite samples should be evaluated according to flake size and purity in relation to market performance specifications.

The question is often raised about how to test graphite flake size across a deposit, given that relatively expensive and time-consuming lab flotation procedures are usually required to separate graphite from gangue minerals.

It is suggested that petrographic examination of polished thin sections be done in the early stages and during the subsequent resource drilling phase.

Thin sections are relatively inexpensive and can be used to determine the size and shape of in-situ graphite flake populations, relationships with other minerals including contaminants such as sulphide minerals, and for estimating likely liberation size.

It must be borne in mind that in-situ flake size estimations don't necessarily translate directly to flake sizes produced by metallurgical processes such as gravity separation or froth flotation.

Core drilling is the preferred technique for

Investors and analysts are still coming to terms with what constitutes an economic graphite orebody

graphite exploration, as this provides undisturbed samples for thin sections and for metallurgical tests.

RC drilling chips may also be used to make thin sections, but RC chips are not suitable for metallurgical tests.

Graphite explorers should "get back to basics" and use thin section petrography as a tool to evaluate and compare prospective targets, and to assess graphite characteristics across a resource. Thin sections have value in explaining metallurgical test results and for geometallurgical domaining of deposits.

A suite of samples can be prepared representing the main lithologies from which two thin sections can be made for each sample, one perpendicular to the graphite flakes and a second approximately parallel to the flakes.

An example of how thin sections can help understand metallurgical results is where a certain head grade of contained graphitic carbon is measured, the flakes are generally large but graphite recoveries were lower than anticipated. Thin section examination highlighted that there were two graphite populations, with the majority as coarse flakes but with a second population of very small flakes within large crystals (porphyroblasts) of a mineral known as scapolite (Figure 1). The small flakes were not being liberated at the coarse crushing size used to liberate large flakes.

A second example may be where flake size varies across an individual prospect, or between prospects within a region and the explorer wishes to select an appropriate target.

Microns	Mesh Size	Purity	Market Terminology	Price / tonne (US$)
>300	+48	90 to 97%	Extra large or 'Jumbo' Flake	~2,000
180 to 300	-48 to +80	90 to 97%	Large Flake	~1,300
150 to 180	-80 to +100	90 to 97%	Medium Flake	~1,100
75 to 150	-100 to +200	90 to 97%	Small Flake	~750
<75	-200	80 to 85%	Fine Flake / Amorphous	~450

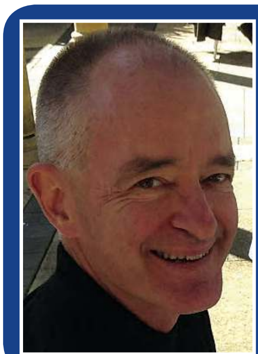
Examples of approximate prices relative to graphite product flake size and purity

In this particular case, the explorer identified one target as having very small flakes and a second target to contain coarse flakes and not surprisingly elected to follow up on the second target.

Sulphide minerals such as pyrite and pyrrhotite are common (possibly deleterious) accessories in graphite deposits and thin section petrography can help define areas or specific lithologies where sulphides may be absent (Figure 2), present as discrete grains or interleaved within graphite flakes and hence more difficult to liberate. Such petrographic data is a first step to defining (domaining) the geometallurgical characteristics of a deposit.

Knowing this type of information means being smarter early on in the project and can guide to more intelligent and informed selection of composite drill samples for metallurgical testing, in addition to benefitting mine planning and metallurgical processing further down the line.

Graphite explorers and mine developers are urged to 'get back to basics' and use thin section petrography as a tool to help classify Mineral Resources according to JORC 2012 (Clause 49) requirements, to assist with geometallurgical domaining and to drive sample selection for metallurgical testing.



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