First Graphite Ltd

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ASX Symbol
FGR, FGROA, FGROB

# Technology Update

## *Continued Excellent Results from Technology Developments*

First Graphite (ASX:FGR) is pleased to provide an update on its ongoing technology development work which demonstrate the superior quality of its graphite and graphene products.

## Highlights

- Tests confirm extremely low resistance i.e. extremely high conductivity when compared to other graphene and reduced graphene oxide (RGO) products.
- Tests conducted in the USA confirm the very high quality of FGR's Aluketiya graphite with a grade of 99.87% for the sample provided.
- Licence agreement signed for development of fire retardants and multipurpose graphene based composite.
- Further outstanding results at Flinders University using the Vortex Fluidic Device to work on FGR graphite.

### Electrical Resistivity Tests

Tests conducted recently at the University of Adelaide as a part of FGR's ongoing commitment with the University have demonstrated the extremely low resistivity of FGR's high quality graphene.

Conversely this means the electrical conductivity is extremely high and therefore suitable in a number of electrical based applications which require the transference of electrical energy.

The FGR graphene had a resistance of less than 100 Ohm, which was between 17 and 50 times better than pristine graphene and reduced graphene oxide (RGO). Other pristine graphene had resistance in the range of 1,700 – 1,900 Ohm and RGO had resistance of greater than 5,000 Ohm.

Furthermore, the spraying of FGR's graphene resulted in a homogenous distribution of overlapping graphene sheets on the interdigitated electrode while standard graphene made clusters (islands) and increased its resistivity (lowered conductivity).

While not yet measured optically, visually FGR graphene looks to have better transparency when compared with standard graphene.

Figure 1: FGR Large area graphene resistance <100 Ohm

Figure 1: Pristine Graphene resistance 1,700 – 1,900 Ohm

## SEM and STEM Microscopies Evaluation of First Graphite Vein Graphite

Following recent meeting in the United States of America FGR was asked to provide a sample of its Aluketiya graphite and its graphene to a large corporation focused in two major areas: leading-edge materials and process development, and development of next-generation vehicle-related information communication technology.

The initial test results received on the graphite sample provided from Aluketiya were exceptional and provided further evidence of the very high grade of the material.

A Scanning Electron Microscope (SEM) and Scanning Transmission Electron Microscope (STEM) were first used to evaluate the morphology and structural features of the graphite.

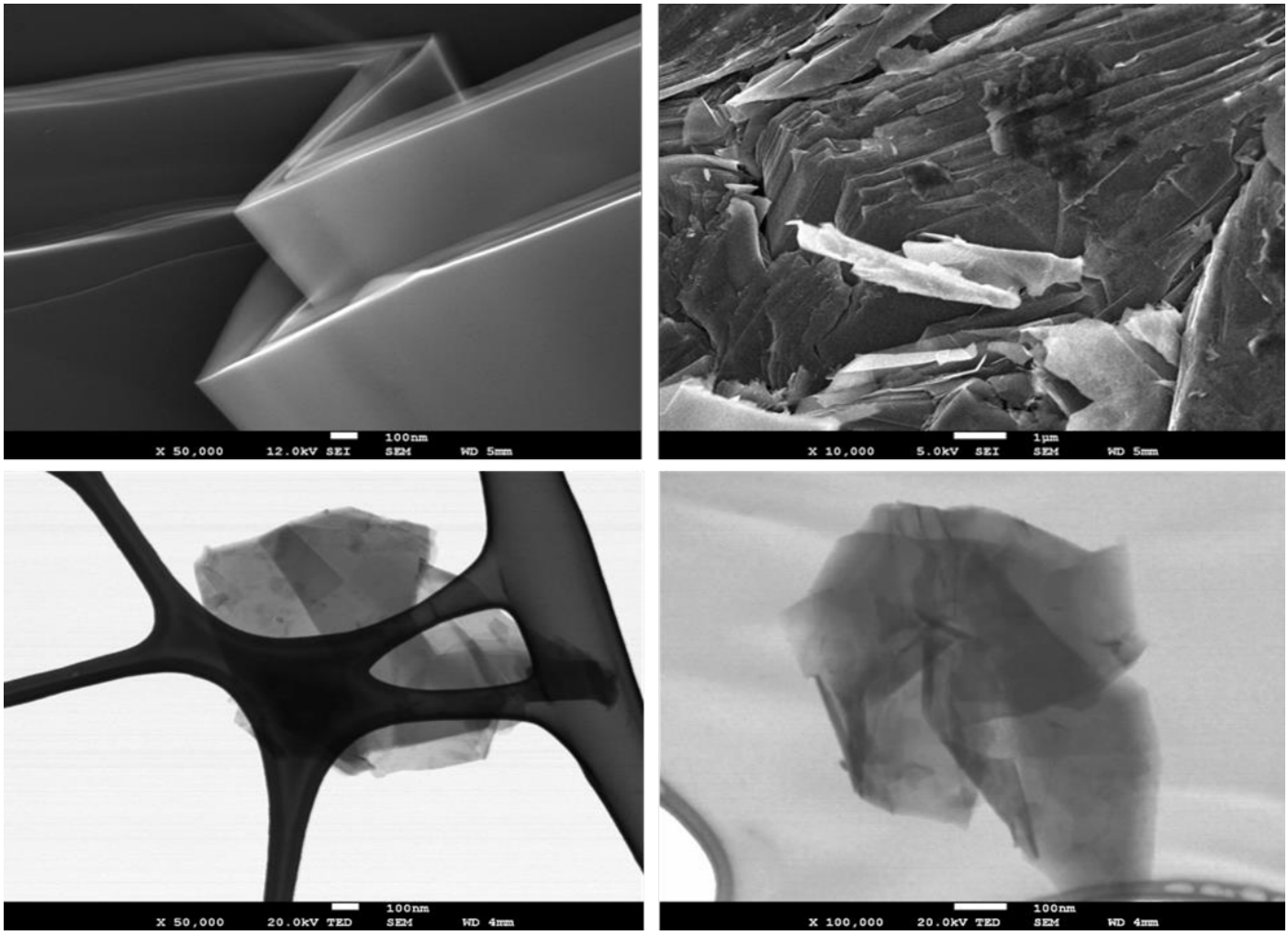


Figure 2: High magnification SEM (top) and STEM (bottom) images demonstrate the surface morphology and the structural features of graphite

Further work was then undertaken with Energy Dispersion X-Ray Spectroscopy (EDS SEM) and the data showed 100% Carbon (C). X-Ray Fluorescence Wavelength Dispersive Spectrometry (XRF WDS) confirmed the material is a high grade with about 99.87 % C, no impurity elements were detected in the amounts > 50 ppm.

| | Compound Name | Concentration (%) | Absolute Error (%) |
|---|---|---|---|
| 1 | C | 99.87 | |
| 2 | Mg | 0.01 | 0.003 |
| 3 | Al | 0.01 | 0.003 |
| 4 | Si | 0.04 | 0.006 |
| 5 | Cl | 0.02 | 0.004 |
| 6 | Ca | 0.00 | 0.002 |
| 7 | Fe | 0.04 | 0.006 |

Table 1: Results of XRF WDS Analysis

Raman Spectroscopy exhibited C sp2 graphitic G-band and an overtone 2D band; no C sp3 defect D-band is detected. The Raman data proves the high quality of this material.

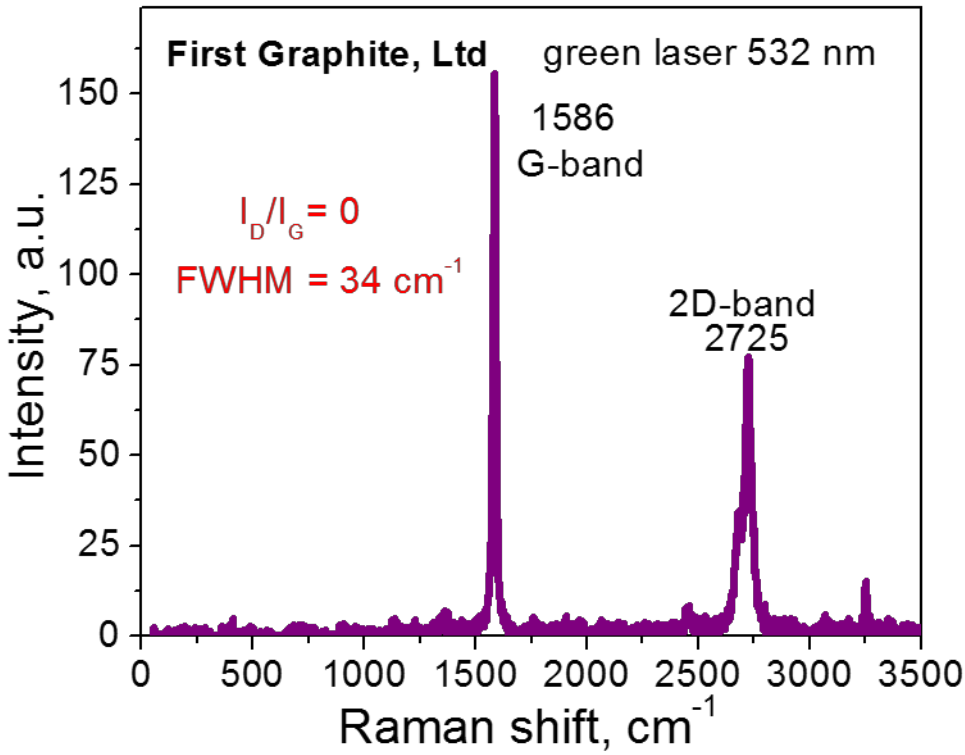


Figure 3: Raman Spectroscopy of FGR Vein Graphite

A summary of these results is;

- A combination of microscopic and spectroscopic techniques was used to evaluate the structural, morphological, and chemical quality of the material.
- 99.87 % grade of carbon detected with no impurities >50 ppm level.
- Raman shows no D-peak evidencing high quality of material
- Quality evaluation test of graphene from FGR is in progress.

## Fire Retardant Licence

FGR has executed an Interim Licence agreement on the fire retardant technology being developed by the University of Adelaide. This technology is the subject of two patent applications relating to fire retardant and multipurpose graphene based composite technologies.

Expandable flake graphite has been used for some time in flame retardant resins. Their successful use is dependent on the purity of the graphite flake, particle size of flake and also on the expansion properties of expandable graphite.

The use of graphene in these retardants will significantly improve their effectiveness.

## Flinders University - Vortex Fluidic Device (VFD)

Flinders University used Sri Lankan graphite which was processed within dynamic thin films in the vortex fluidic device (VFD) at an inclination angle of $45^0$ and rotational speed of 7,500 rpm. Two different solvent systems were employed namely (1) water and (2) a mixture of toluene and water at a 1:1 ratio. The resulting material was primarily characterised using atomic force microscopy (AFM) and Raman spectroscopy to confirm the thickness of the graphene sheets and to confirm integrity of the material.

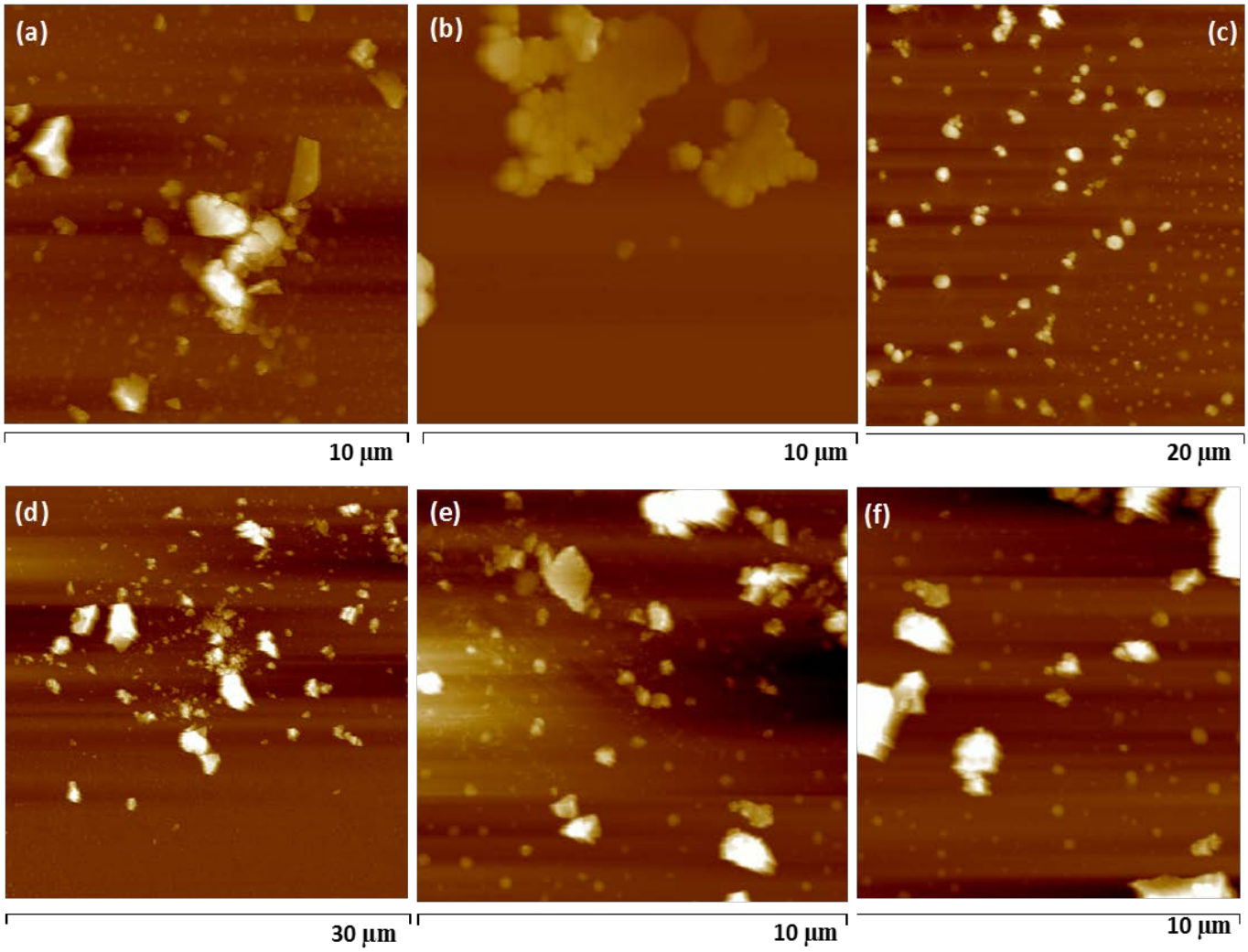


Figure 4: AFM height images of the processed graphite flakes in water in the VFD – real time images

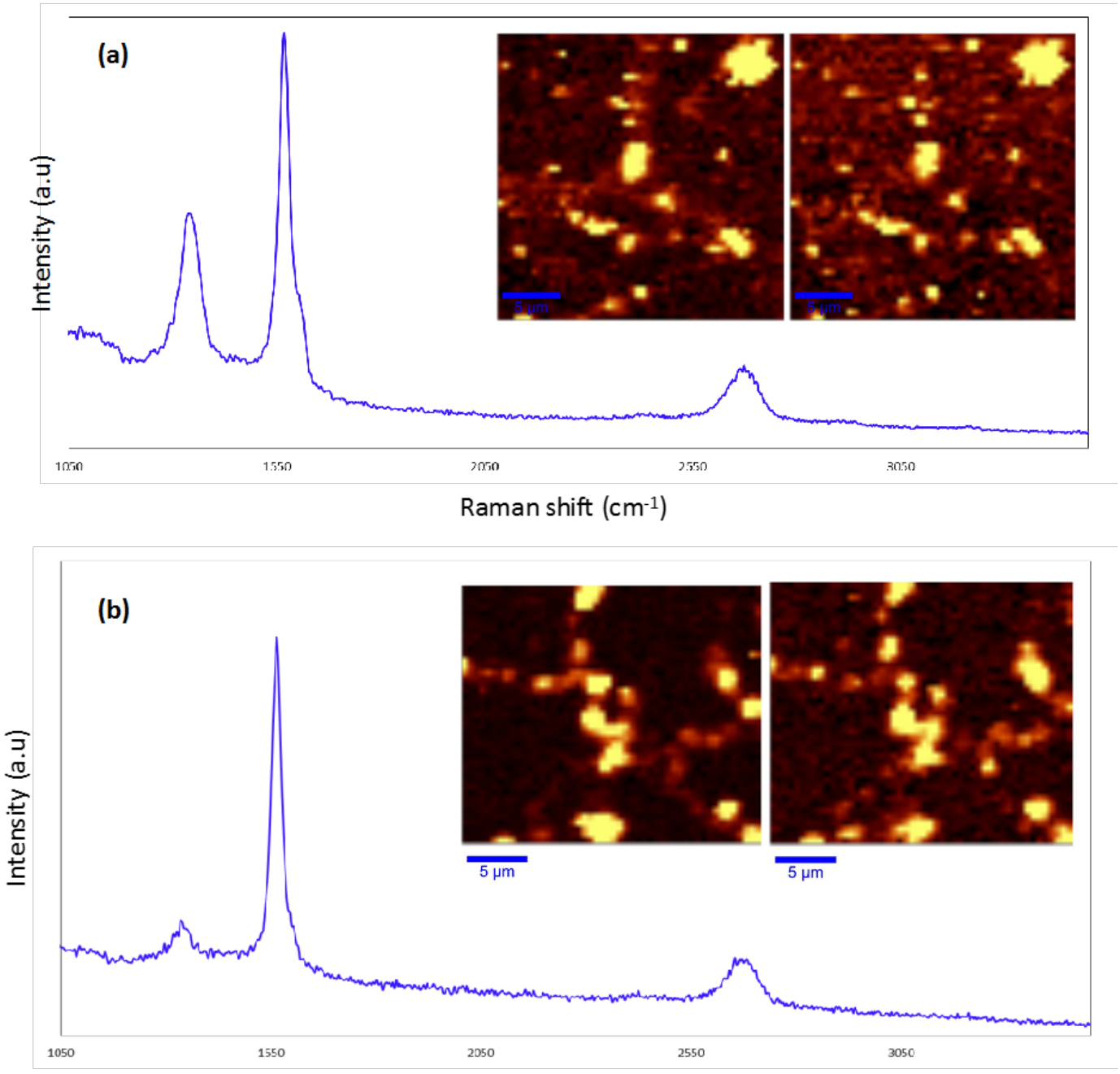


Figure 5: Confocal Raman mapping of the graphene sheets

The Raman spectra of the graphene sheets show a typical graphitic spectrum, D band (1338.2 cm-1), G band (1574.7 cm-1) and a 2D band (2700.0 cm-1). A significant increase in the averaged Raman ID/IG ratio (corresponding to the D-band and G-band intensities) of the sheets compared to the as received graphite flakes were observed, suggesting a significant increase in the density defects of the nanostructures which can well be attributed to the ripping of the graphene sheets due to intense shear in the VFD. The 2D band of the graphene sheets were narrower indicating the graphite flakes were indeed exfoliated to a certain extent.

The conclusions drawn by Flinders

- Water is the preferred solvent
- Conversion to multi-layer graphene sheets ~ 60% yield - AFM and Raman
- Requirement now for the use of peristaltic pumps
- System to be optimised

Managing Director, Mr Craig McGuckin said "*These results confirm the high quality and extraordinary properties of the graphene being produced with FGR's electrochemical exfoliation production cell. With the VFD as a supplement to our process we will be able to further characterise the graphene produced. The unique characteristics of the graphene produced will provide FGR with a competitive advantage in the growing market for the use of graphene. The work conducted in the USA further evidences the high grade and superior quality of the Sri Lankan graphite. While we continue to develop our own mine areas we have secured supply of graphite which will enable us to immediately meet demand for graphene production. We continue to work on a number of projects and developments in the technology area which will further add to our array of products and intellectual property.*"

## *About First Graphite Ltd (ASX: FGR)*

*First Graphite produces high quality graphene from high grade Sri Lankan vein graphite.*

*First Graphite seeks to develop graphene production methods and acquire graphene related intellectual property which can provide further revenue related opportunities.*

*The Company is developing its own mines and holds 39,500ha of prospective graphite exploration licences in Sri Lanka.*

## *About Graphene*

*Graphene, the well-publicised and now famous two-dimensional carbon allotrope, is as versatile a material as any discovered on Earth. Its amazing properties as the lightest and strongest material, compared with its ability to conduct heat and electricity better than anything else, mean it can be integrated into a huge number of applications. Initially this will mean graphene is used to help improve the performance and efficiency of current materials and substances, but in the future it will also be developed in conjunction with other two-dimensional (2D) crystals to create some even more amazing compounds to suit an even wider range of applications.*

*One area of research which is being very highly studied is energy storage. Currently, scientists are working on enhancing the capabilities of lithium ion batteries (by incorporating graphene as an anode) to offer much higher storage capacities with much better longevity and charge rate. Also, graphene is being studied and developed to be used in the manufacture of supercapacitors which are able to be charged very quickly, yet also be able to store a large amount of electricity.*

## *Nature of vein graphite*

*Sri Lankan graphite deposition model is best described from the 'bottom up': tension fractures formed in the metamorphic sediments, caused by the folding of the sediments, creating 'conduits' for the hydrothermal deposition of high quality vein graphite. Historically, mining of these veins has found the veins generally increase in thickness and grade quality with increasing depth. Graphite veins generally dip steeply at –70° to near vertical, enabling 'narrow vein' extraction mining techniques similar to those used on narrow vein, high grade gold deposits. The method commonly used is an overhead retreat stoping technique where the high grade vein graphite is mined and hauled to surface without contamination. The graphite selvages, in contact with the surrounding waste, is hauled to surface and stockpiled for upgrading. The balance of the waste is used to fill the floor of the stope.*

*Due to the nature of the vein graphite, it is anticipated vein widths of ~25cm, using narrow vein mining techniques can be economically extracted from underground operations.*

For further information:

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