

## ASX Announcement

30 April 2108

# March Quarterly Activities Review

## *Strong Progress on All Fronts*

Advanced materials company, First Graphite Limited (FGR) is pleased to provide a review of the Company's development for the quarter ended 31 March 2018.

### HIGHLIGHTS

1. Positive results from testing on concrete building material
2. Continued positive development of the FireStop™ fire retardant
3. Development of the BEST Battery™ has continued in line with the established milestones
4. The Company's Commercial Graphene Facility commenced production
5. A placement to strategic investors was completed, raising \$3.4m
6. The Company reported significant improvement with its mining operations in Sri Lanka

## 1. Graphene in Concrete

### Background

Experiments conducted in other jurisdictions have focussed on the use of graphene oxide (GO) being added to concrete to improve both compressive and tensile strength. GO is considerably more expensive than graphene and available only in limited quantities. Therefore, any experiments involving GO would be difficult to commercialise. The hydrophilic and high resistivity nature of GO also limits its applications in things such as 'smart' cement.

Due to the high aspect ratio of nano-reinforcements such as graphene and carbon nanotubes, they have the ability to arrest the crack propagation (by controlling the nano-sized cracks before they form micro-sized cracks) and hence greatly improve peak toughness, making them more effective than even conventional steel bar or fibre reinforcements.

### Premium Concrete Products – Smart Cement

Ultra-High Performance Concrete (UHPC) operates at such a high-performance level that it competes with steel rather than regular concrete grades. Advantages include lower lead times compared to steel. UHPC can cost in excess of \$500/tonne, with enhancements such as micro-reinforcements further increasing the price. Due to the immense importance of compression strength and other factors such as blast, ballistic and earthquake resistance, additive premiums can be significant. UHPC is over an order of magnitude more expensive than regular concrete, but in an environment where material usage and weight are such essential considerations, it can actually be cheaper to use the more expensive grades in the long run, especially factoring in the reduced maintenance costs incurred by UHPC.

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### ASX Code

FGR

FGROC

The UoA testing of FGR's graphene, with the aim of making "smart cement" with conductive graphene flakes which may;

- i. address the concerns of cracking and corrosion, and
- ii. provide conductivity for better monitoring the health of concrete structures.

The first test results indicated the addition of 0.03% standard graphene is the optimal quantity of graphene from the test conducted to date, showing a 22 - 23 % increase in compressive and tensile strength, respectively.

### **Conclusions – Promising Results with Favourable Economics**

The initial work has yielded very promising results with very small amounts of FGR graphene required to greatly increase the strength of the materials. Determining the optimum mixing methods and concentration to develop a consistent material will be the key to further developing this project.

## **2. FireStop™**

### **Background**

Development of the FireStop™ product is being conducted in collaboration with the University of Adelaide as part of the Company's participation as a Tier-1 member of the ARC Research Hub for Graphene Enabled Industry Transformation.

The Flame Retardancy market was worth \$8 billion in 2016. The most valuable segment is in plastics at \$5.7 billion, followed by textiles at \$1.1 billion, wood/paper at \$0.33 billion and coatings/paints at \$0.31 billion.

### **Test Work Conducted**

Following the successful development of a fire-retardant coating formulation the product was tested according to the UL94<sup>1</sup> standard test method with simultaneous testing of a commercially available competitor product.

Performance in the UL94 test was evaluated in relation to the thickness of coating required for effective fire protection.

### **Sample Preparation for UL94 Testing**

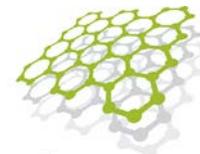
Coating formulations were applied to untreated balsa wood test pieces with a paint brush. The coating thicknesses were controlled by using a fixed number of coats. The coating thicknesses were then measured after deposition. Balsa wood is used in the test specimens because of its high flammability.

Test specimens were prepared with the following dry thicknesses:

1. Untreated balsa wood.
2. First Graphene FireStop™ at 450 microns.
3. Competitor coating at 700 microns.
4. First Graphene FireStop™ at 700 microns
5. Competitor coating at 1020 microns.

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<sup>1</sup> UL94 refers to Underwriters Laboratories a USA Test House which develops and performs internationally respected test methods for product safety and quality. UL94 is the recognised test method for flammability and evaluates both the burning and afterglow times and dripping of the burning test specimen.



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The appearance of coated products is shown in Fig. 1 and the test specimens after exposure to UL94 test conditions are shown in Fig. 2.



Untreated balsa wood	First Graphene FireStop™ 450 μm	Competitor Product 700 μm	First Graphene FireStop™ 700 μm	Competitor Product 1020 μm
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Figure 1 Appearance of coated test specimens



First Graphene FireStop™ 450 μm	Competitor Product 700 μm	First Graphene FireStop™ 700 μm	Competitor Product 1020 μm
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Figure 2 Appearance of coated test specimens after exposure to UL94 test conditions

### **Results of UL94 testing:**

First Graphene FireStop™ performs well at both 450 microns and 700 microns; meeting the UL94-V0 requirements at both thicknesses.

The competitor product does not meet the UL-94-V0 standard at a coating thickness of 700 microns and requires a much thicker coating, in this case, measured at just over 1000 micron (or 1mm) to reach the UL94-V0 standard.

### **Summary**

The graphene based Firestop™ product offers a new approach to fire retardant coatings which facilitates fire protection using thinner coatings – reducing both coating material consumption and labour costs during application. This performance is enabled by the excellent gas barrier and thermal conductivity properties of First Graphene's graphene additives.

### **Future work**

These initial test results are very encouraging, The University of Adelaide continues to carry out performance testing using recognised test procedures, including LOI (Limiting Oxygen Index) to confirm these findings. Prior to submitting samples to testing at CSIRO the Company is evaluating the requirements of the European Union's (EU) Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) standards to ensure compliance with their regulations. As the EU is a large potential market for the fire retardant it is critical the FireStop™ product's components comply with the relevant regulation.

## **3. BEST Battery™**

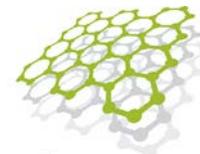
### **Background**

While it is generally accepted that lithium-ion batteries are the state-of-the-art energy storage device available for consumer products today, they are not without their issues. In particular, we have seen examples of where they can cause fires in some instances due to thermal runaway. There is a vast number of companies and research institutions working to provide safer, more reliable and longer life batteries which utilise materials other than lithium-ion. Some of these involve the use of graphene.

First Graphene, through its research and licencing agreements with Swinburne University of Technology, is pursuing a significantly different path to the development of the next generation of energy storage devices. Rather than trying to improve existing chemical battery technology, it is pioneering the field of advanced supercapacitors which have the potential to change the future for energy storage forever, particularly in handheld and consumer products.

Using the advanced qualities of graphene, First Graphene is developing the BEST Battery™. This energy storage device promises to be chargeable in a fraction of the time and it will be fit for purpose for at least 10 times the life of existing batteries. It will be significantly safer and more environmentally friendly. All these improvements are made possible because the science relies on physics rather than chemical reactions, and on the remarkable properties of graphene materials.

The table below provides an interesting comparison of key operating parameters of the BEST Battery™ alongside existing lithium-ion batteries and existing supercapacitors available in the market. What is particularly noteworthy is the 10x increase in the energy density expected for the BEST Battery™, when compared with supercapacitors currently on sale in the market place, and the much lower cost per Wh. These features will provide great commercial advantages.



Parameters	Supercapacitor (BEST Battery™)	AA Rechargeable battery	Existing Commercial Supercapacitor (including Skeleton Supercapacitors)
Storage mechanism	Physical	Chemical	Physical
Charge time	1-10 seconds	1 – 4 hours	1-10 seconds
Cycle life	Minimum 10,000 cycles	300 – 1,000 cycles	Minimum 10,000 cycles
Cell voltage	3.5 V (target for this project)	1.25 – 1.5 V	2.70 V (Average supercapacitor in the market) 2.85 V (Best of Skeleton)
Energy density (Wh/L)	50- 60 (target for this project)	100 to 200	5.9 (Average supercapacitor in the market) 6.8 (Best of Skeleton)
Power density (W/L)	10,000 (target for this project)	35 to 300	9,500 (Average supercapacitor) 42,000 (Best of Skeleton)
Cost per Wh	\$0.30 (target for this project)	\$0.50 - \$1.00 (large system)	\$20 (Average supercapacitor) N/A (Skeleton)
Service life	10 to 15 years	1 to 2 years	10 to 15 years
Disposal	No special requirement, environmentally friendly	Land fill, harmful to environment	No special requirement, environmentally friendly

**Table 1: Comparison between BEST Battery™ Target development and existing Li Ion AA Batteries and an existing commercial Supercapacitor.**

While the exact details of the design and construction of the BEST Battery™ must remain confidential for reasons of commercial security, we can disclose the process of manufacturing the battery involves the use of lasers to create nanopores in graphene-based materials which achieve energy densities more than 10x as great as the pre-existing technology. Practical matters being addressed include the scaling up to the size of the battery from simple laboratory demonstrations of the effectiveness of the science, to devices which will be effective substitutes for batteries used in a wide range of hand held consumer products.

### Recent Progress

The initial months of the BEST™ Battery development project entailed the recruitment of additional, highly qualified research scientists and the acquisition of specialised equipment needed to prepare and manufacture the components of the BEST™ Battery. Work has commenced on the improvement of many design aspects in order to optimise the configuration of the battery, with the ultimate objective being to develop a product suitable for mass scale production. At the same time, the methodology of making the battery is being subjected to continuous experimentation to improve the effectiveness and efficiency of the materials and processes used in the device. In addition, the pilot production line for building the BEST Battery™ prototype has been set up, which enables the manufacturing of the BEST Battery™ to meet industrial standards.

Swinburne recently reported that a single layer of the BEST Battery™ prototype made by the pilot production line was able to sustain an LED globe for a period of 15-20 minutes with only a few seconds of initial charge. This is a very significant outcome, auguring well for the ultimate product which is intended to comprise many more stacked layers of graphene sheets.

### Graphene-Based Flexible Smart Watch

The research being undertaken also involves the development of flexible batteries for smart watches which can be incorporated into the watchband itself. These will be light-weight and flexible, they will be able to be recharged in 1-2 minutes, and they will be fit for purpose for many tens of thousands of cycles. Information will be displayed not only on the watch face, but also on the band itself.

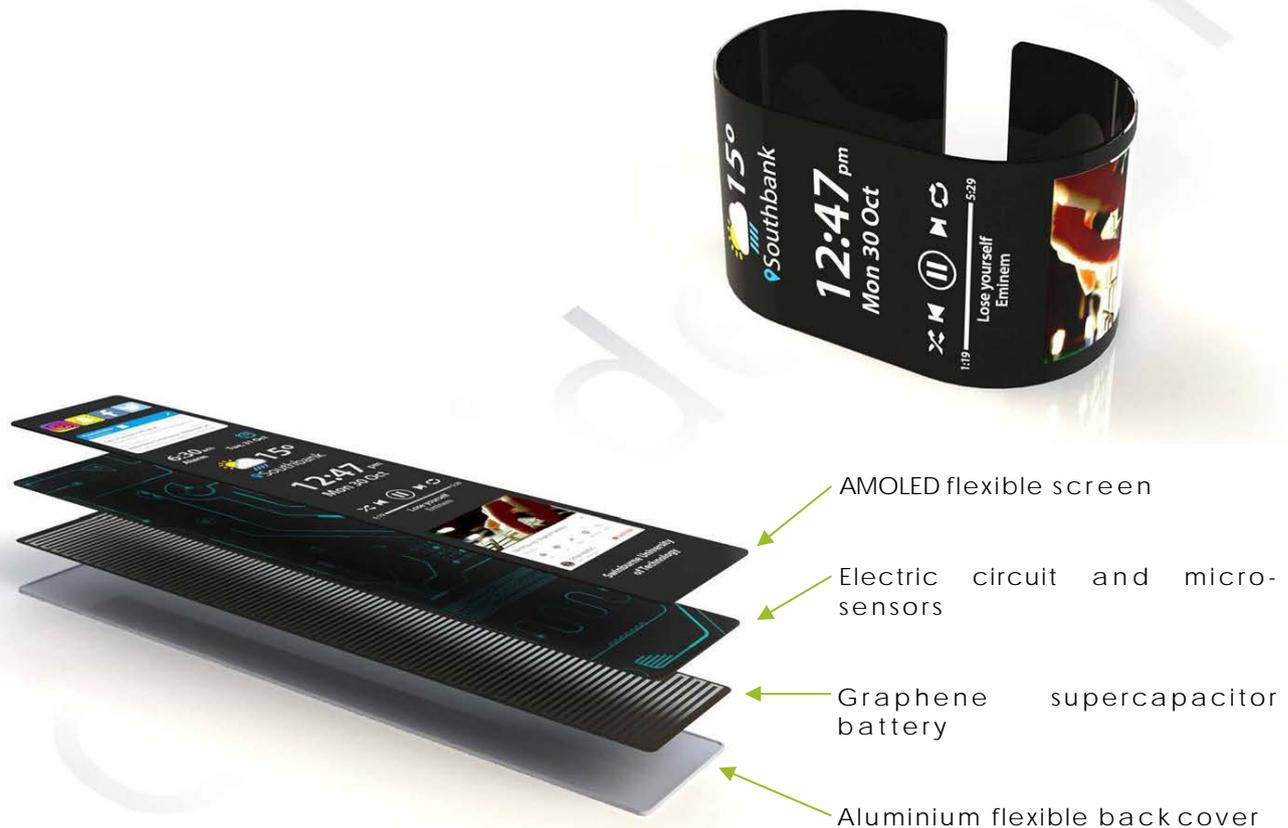


Figure 3: Graphene Watch – Flexible Smart Watch concept

### Target Markets

While it is intended that the BEST Battery™ development program will eventually provide suitable substitutes for many devices which currently used flat pack and cylindrical batteries, it will also provide batteries for new, innovative purposes. The thin profile of the device, and its flexibility, will make it suitable for use in clothing. It could also be integrated into smart watch bands, as an example, rather than having a solid block configuration. It is already showing excellent ability to convert kinetic energy into stored energy due to the speed at which it can charge i.e. simple movement of shaking can recharge the device.

#### 4. Commercial Graphene Facility (CGF)

##### Background

As advised last year the Company leased 960m<sup>2</sup> premises in the Australian Marine Complex in Henderson, south of Fremantle in Western Australia. The new 960m<sup>2</sup> premises provide the Company with a dedicated facility in which to expand its graphene production and packaging, which will provide industry the ability to source graphene in bulk.

In August last year the Company was granted a Works Approval by the Department of Environment Regulation (DER) for its facility and was able to commence work on the construction of the facility. The Company received its Registration of Premises under the Environmental Protection Regulations 1987, on 31 January 2018.

The facility was officially opened by Mr Josh Wilson MP, Federal Member for Fremantle, on 23 November 2017.

Shortly after the opening FGR despatched its first material from the facility to a USA-based construction materials company for testing in cement products. This sale had resulted from enquiries at the IDTechEx Conference in Santa Clara earlier in November 2017. This shipment demonstrated FGR's ability to meet customer orders from the facility and supply commercial quantities at short notice.



Figure 4: Product Palletised and Ready for Shipment in late November

### Factory Development and Commissioning

After November work continued apace to complete the facility. This has resulted in graphene production commencing on Monday, 26 February 2018.

This was a significant milestone for the Company and toward world graphene developments. The Graphene Council has previously identified the three largest impediments to graphene as a lack of production capacity, a need for consistent quality and pricing which makes graphene attractive for industry to adopt the advanced material. In commissioning the facility FGR can now address all these issues.

Furthermore, this facility has been constructed for well less than the A\$1m budget previously advised to the market. As Chairman, Warwick Grigor, stated in his address at the Company's Annual General Meeting, *"Through careful management and sourcing of equipment for this production facility, management has been able to achieve excellent costs reductions."*



Figure 5: Prototype cell and Production Cell #1

The Company has also installed a laboratory to perform constant quality assurance and control procedures. Having purchased its own Raman spectrograph FGR is probably the only commercial entity in Australia able to complete these procedures on its own premises.

A gallery of photographs of the facility can be seen by following the link below.

<https://firstgraphene.com.au/graphene/graphene-facility>

## 5. Corporate

### Placement Raised \$3.4m

In March 2018 the Company was pleased to advise it had received firm commitments for a placement of shares at \$0.18 raising \$3.4 million. The issue of the 28m shares and option securities was within the Company's capacity under Listing Rule 7.1 and did not require prior shareholder approval.

This was a limited private placement with most of it going to a European-based industrialist who approached FGR following a detailed study of the graphene sector and the companies with graphene credentials. The Company was pleased he selected FGR as a company with merit, in which he can take an equity investment and work beside, with a view to the possibility of introducing graphene to enhance his industrial product range.

This investment validated the Company's strategy of increasing the international awareness of its leading position in the graphene sector, as a supplier of high quality bulk volume graphene and a developer of valuable IP, is gaining traction.

## 6. Sri Lankan Mining Update

### Background

While the primary focus in 2017/18, has been the construction and commissioning of the Commercial Graphene Production Facility at Henderson, as the Company graduated into a technology focused enterprise. The development of the graphite mines in Sri Lanka has been continuing simultaneously, at a steady pace.

The board previously took the strategic decision it was not necessary to accelerate mine production ahead of the completion of the graphene processing facility, preferring a more prudent and lower cost approach that involved concentrating management resources on the more exciting growth opportunity which graphene presents. Now, the improvement in the mining performance corresponds with the commissioning of the graphene facility, positioning the Company as one of the world largest supplier of high quality bulk graphene.

The Company has found the development of its 100%-owned mines to be a challenging exercise, as it has progressively advised shareholders. It is a credit to the management team in Sri Lanka they have been able to progressively address and overcome the issues as they have arisen, to reach the point where we are now hoisting good volumes of vein graphite.

### Current Position – Phase 1 Completed at Aluketiya

After an extended time frame for the development of the Aluketiya mine, the vein graphite production rates have increased to up to 500 kg per day, though the mine continues to experience better and worse rates depending up daily conditions.

The Phase 1 mining has been completed and with this there are a multiple number of seam working faces which have been developed, ready for production. While these faces have been in the process of being established the graphite production has been ongoing. The underground geological interpretation continues to reinforce the current mine plan and rationalisation programmes have reduced the operating costs. The Company has ongoing training programmes to continue to improve efficiencies and production rates and mining option rates of return will bring Aluketiya productivity to best practice levels.

The table below demonstrates the tonnes per meter of advance achieved depending on drive height and vein thickness in meters. The circled area is the production range per meter based on geological drilling. When developed in the future the ALK 18 intersection of 1.14m may provide up to 5 tonnes per meter advance.

Production capacities based on a standard drive dimensions

	Tunnel Height	<i>Kilograms per meter advance</i>										
		0.050	0.075	0.100	0.125	0.150	0.175	0.200	0.225	0.250	0.275	0.300
<b>Vein thickness</b>		0.050	0.075	0.100	0.125	0.150	0.175	0.200	0.225	0.250	0.275	0.300
<b>Graphite Specific Gravity</b>	2.2											
<b>Production v tunnel height</b>	1.50	165	248	330	413	495	578	660	743	825	908	990
	1.80	198	297	396	495	594	693	792	891	990	1089	1188
	1.90	209	314	418	523	627	732	836	941	1045	1150	1254
	2.00	220	330	440	550	660	770	880	990	1100	1210	1320

**Description of the Production Plan - Aluketiya**

Crosscuts from development drives are being designed and excavated to follow the graphite veins to their extent and recover graphite material, with secondary production coming from winzing activities.

**J Shaft:** The EMS interpretation, in-situ mapping, diamond core drilling and the examination of old workings all continue to reaffirm the validity of the current mine plan. However, one important observation is that caution needs to be exhibited in the shaft, as we continue to uncover previous workings which had not be identified in drilling or the EMS survey. When the miners come across these voids they need to carefully determine the extent of the old working and how safe it is to enter the area. This necessary safety procedure will slow ore extraction rates from time to time.



Graphite veins in the crown (L) and face (R) in J Shaft

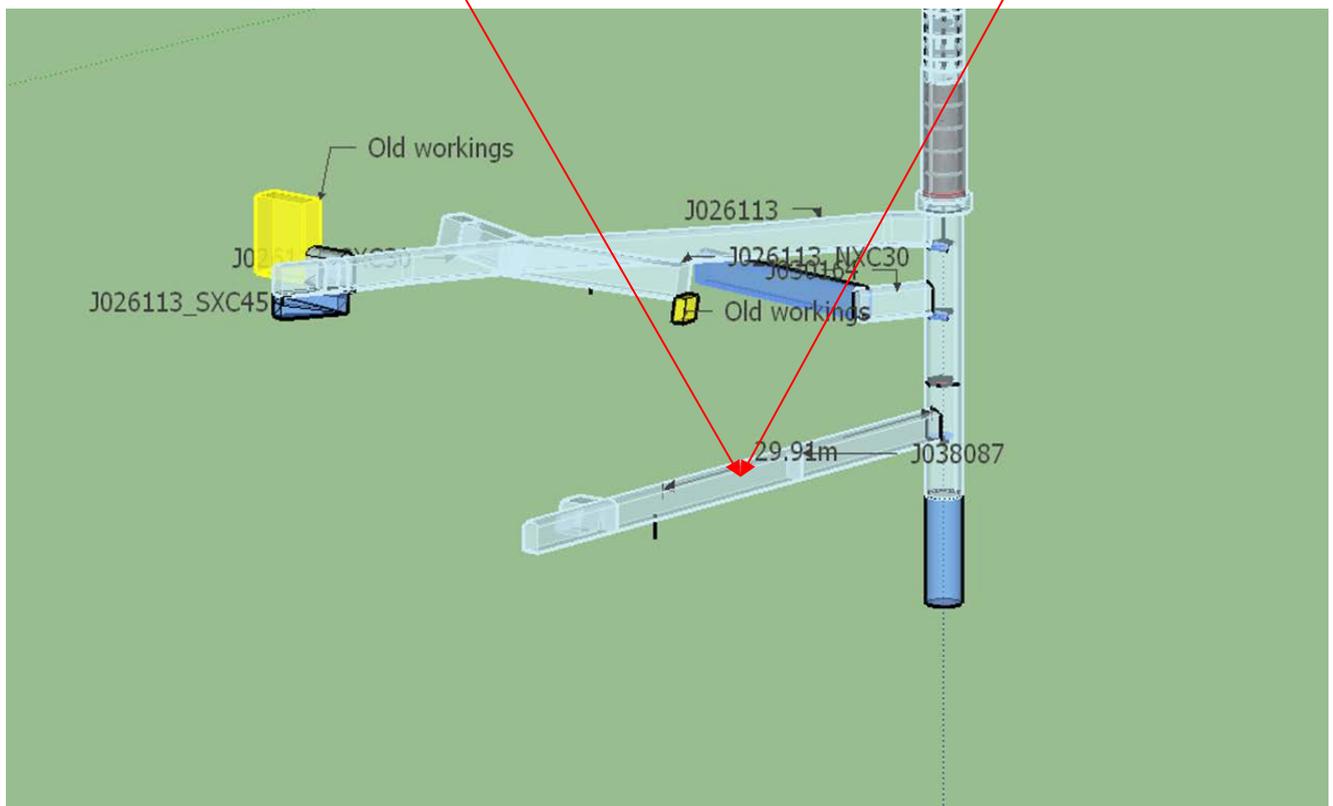
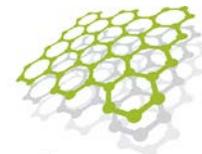


Figure 6: J Shaft Current Workings

**H Shaft:** As with Shaft J the EMS interpretation, in-situ mapping, diamond core drilling, along with the examination of old workings continue to reaffirm the suitability of the current mine plan. While old workings have been intersected in Shaft H they have not been as frequent as in Shaft J to date.



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Graphite veins in the floor (L) and Face (R) of H Shaft

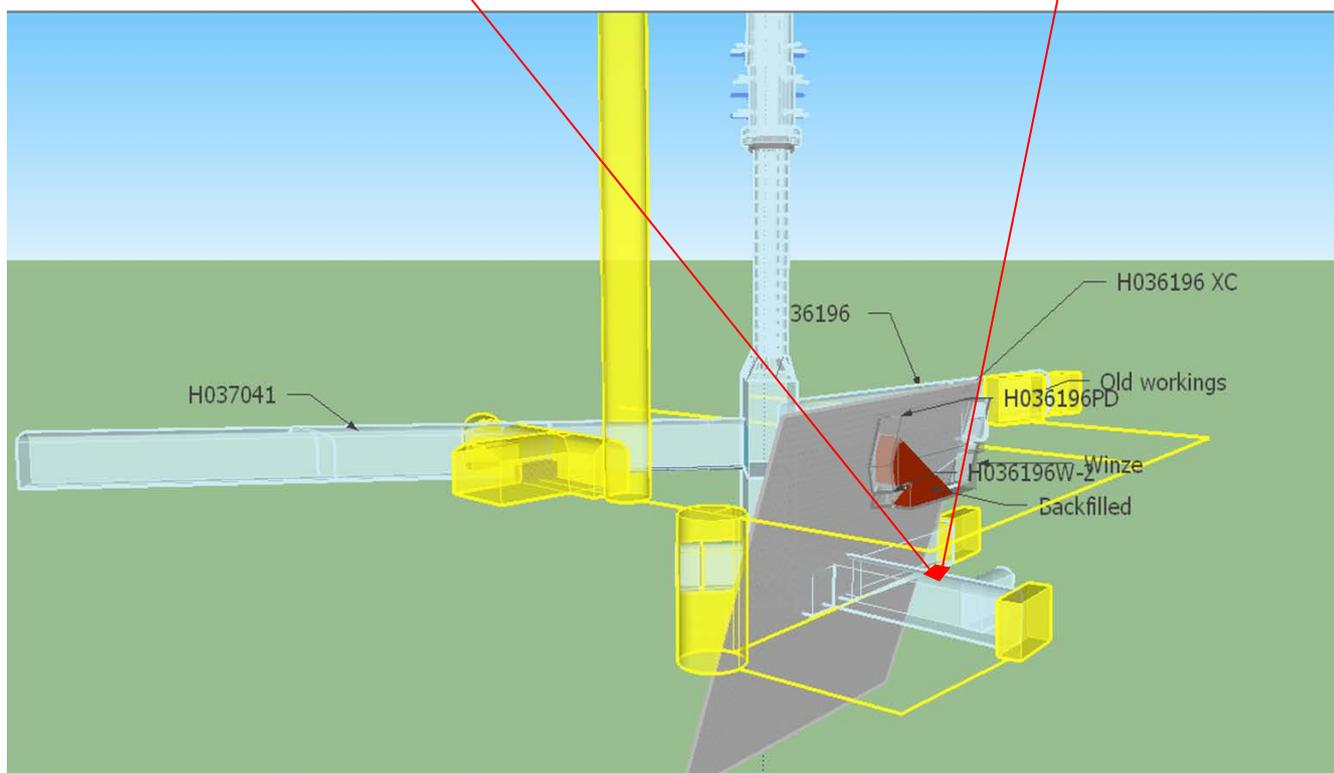


Figure 7: H Shaft Current Workings

## Phase Two - Expansion

In the future there will be a requirement to expand the mine shafts past the current mining horizons to maximise the production. Drilling records and limited available historical data indicate the consolidation of the graphite seams occurs at depth, thereby offering the opportunity of improved productivity. This was amply demonstrated from the results of drill hole ALK18. The long-term mining at Aluketiya will require only minimal capital expenditure to establish and continue as world best system standard mine.

The June 2019 plan includes;

- there being zero HSE incidents;
- a rationalisation of the mine dewatering system and improved mine ventilation network; and
- a modification of the mine haulage system to facilitate the additional depths and mining rates.

## The March Quarter Program

FGR has another productive quarter planned for June 2018.

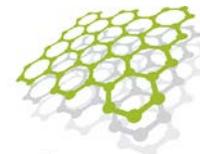
## 7. IDTechEx conference in Berlin 11-12 April.

Company representatives attended the above conference, from which over 60 leads were received. Work has now commenced on the follow up for potential sales, by providing samples and assisting with technical collaboration for the introduction and dispersion of graphene in potential customers products and manufacturing streams.

Further updates on the Company's IP activities will be provided to investors during the quarter.

Full details of this quarter's activities can be found in previous ASX releases as detailed below;

<b>Significant December Quarter Announcements</b>		
<b>Date</b>	<b>Subject Matter</b>	<b>URL Link</b>
08 Jan 2018	Interview with GOLDINVEST.DE	<a href="https://www.firstgraphite.com.au/investor-relations/asx-announcements?task=document.viewdoc&amp;id=330">https://www.firstgraphite.com.au/investor-relations/asx-announcements?task=document.viewdoc&amp;id=330</a>
08 Jan 2018	Project Development of Graphene-Based Industrial Products – Concrete	<a href="https://www.firstgraphite.com.au/investor-relations/asx-announcements?task=document.viewdoc&amp;id=315">https://www.firstgraphite.com.au/investor-relations/asx-announcements?task=document.viewdoc&amp;id=315</a>
22 Jan 2018	Project Development Update - FireStop™	<a href="https://www.firstgraphite.com.au/investor-relations/asx-announcements?task=document.viewdoc&amp;id=316">https://www.firstgraphite.com.au/investor-relations/asx-announcements?task=document.viewdoc&amp;id=316</a>
25 Jan 2018	Dr Andy Goodwin's Interview with Finance News Network	<a href="https://www.firstgraphite.com.au/investor-relations/asx-announcements?task=document.viewdoc&amp;id=320">https://www.firstgraphite.com.au/investor-relations/asx-announcements?task=document.viewdoc&amp;id=320</a>
21 Feb 2018	Strong Progress on BEST Battery™ Development	<a href="https://www.firstgraphite.com.au/investor-relations/asx-announcements?task=document.viewdoc&amp;id=324">https://www.firstgraphite.com.au/investor-relations/asx-announcements?task=document.viewdoc&amp;id=324</a>
26 Feb 2018	Commercial Graphene Facility Commences Production	<a href="https://www.firstgraphite.com.au/investor-relations/asx-announcements?task=document.viewdoc&amp;id=326">https://www.firstgraphite.com.au/investor-relations/asx-announcements?task=document.viewdoc&amp;id=326</a>
28 Feb 2018	Article in Australian Financial Review	<a href="https://www.firstgraphite.com.au/investor-relations/asx-announcements?task=document.viewdoc&amp;id=327">https://www.firstgraphite.com.au/investor-relations/asx-announcements?task=document.viewdoc&amp;id=327</a>
06 Mar 2018	Executive Director, Peter Youd's interview with Finance News Network	<a href="https://www.firstgraphite.com.au/investor-relations/asx-announcements?task=document.viewdoc&amp;id=328">https://www.firstgraphite.com.au/investor-relations/asx-announcements?task=document.viewdoc&amp;id=328</a>
13 Mar 2018	Completion of Strategic Capital Raising	<a href="https://www.firstgraphite.com.au/investor-relations/asx-announcements?task=document.viewdoc&amp;id=329">https://www.firstgraphite.com.au/investor-relations/asx-announcements?task=document.viewdoc&amp;id=329</a>
26 Mar 2018	Strong Improvement in Vein Graphite Mining Rates	<a href="https://www.firstgraphite.com.au/investor-relations/asx-announcements?task=document.viewdoc&amp;id=335">https://www.firstgraphite.com.au/investor-relations/asx-announcements?task=document.viewdoc&amp;id=335</a>



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

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

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

### *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, means 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 can be charged very quickly, yet also be able to store a large amount of electricity.*

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