ASX: EV1 | 12 July 2022

ASX ANNOUNCEMENT

Thermal purification achieves exceptional, industry-leading purity level of 99.9995% C as battery precursor

HIGHLIGHTS

- **Evolution is undertaking a commercial verification program with an established US manufacturer of battery graphite products to evaluate the amenability of Chilalo graphite fines to producing coated battery anode materials using thermal purification and proprietary coating technologies.[1]**
- **The battery anode process flow sheet adopted by Evolution's US-based technology partner involves thermal purification as the first step (see Figure 1 for how Evolution's flow sheet differs to a conventional flow sheet).**
- **Thermal purification has achieved an exceptional, industry-leading purity level of 99.9995% C as a battery precursor. This level of purity easily exceeds the required purity level as a precursor to battery-grade spherical graphite.**
- **Thermally purified Chilalo graphite also exceeds the specifications required for nuclear-grade graphite, which sells for approximately US$30,000 per tonne.**
- **Adopting thermal purification is a more sustainable technique than existing commercial supply chains which utilise toxic hydrofluoric (HF) acid or other methods of purification, such as "low acid" and "caustic bake" techniques.**
- **Continuous thermal purification, which was adopted by Evolution for processing of Chilalo flake graphite concentrate, is typically lower cost than HF/HCl acid leach treatment in traditional purification circuits.**
- **Thermal purification, particularly if powered by renewable energy sources, would substantially minimise the environmental footprint of the battery anode supply chain.**
- **Battery anode testwork is ongoing with further results expected in the coming weeks.**

Evolution Energy Minerals ("Evolution" or the "Company") (ASX: EV1, FSE: P77) is pleased to report exceptional thermal purification testwork results achieved using the fines fraction of graphite from the Company's Chilalo Graphite Project in Tanzania. The results confirm that purified Chilalo graphite is a premium precursor material to producing spherical graphite for battery anode applications. The testwork was performed in partnership with Evolution's US-based technology partner, an established manufacturer of advanced battery materials. The testwork involves several stages with an earlier stage confirming that Chilalo's graphite contains very low concentrations of the impurities, Molybdenum and Boron. Further results are expected over the coming weeks as the testwork continues.

Phil Hoskins, Managing Director of Evolution Energy Minerals, commented, "*The successful purification results indicate that Chilalo graphite is highly amenable to a range of value-added applications in advanced battery systems, including lithium-ion battery anodes. Our graphite was shown to be easily refined due to the impurities being situated predominantly on the flake surface, hence the ease with which they can be removed.*

"*We are excited to have achieved industry-leading purity levels of 99.9995 wt.% C using thermal purification, as opposed to most conventional graphite purification technologies that use toxic leaching agents, such as HF acid. Evolution is committed to producing sustainable battery anode materials and adopting a thermal purification process using renewable electric power, which creates a greener and more sustainable product for battery supply chains of the future.*"

[1] For further information on Evolution's sustainable battery anode materials strategy, see ASX announcement 14 February 2022

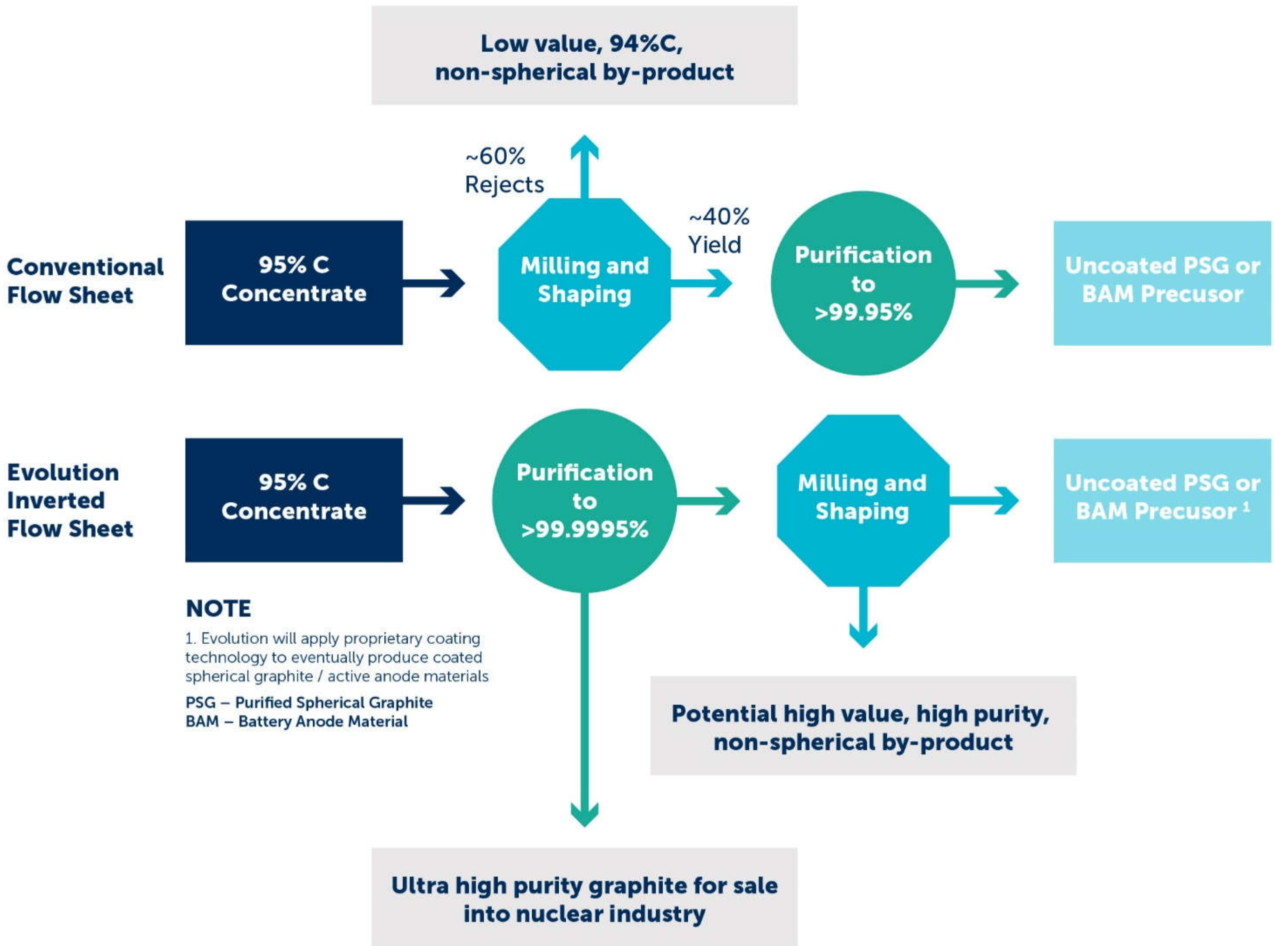
Inverted flow sheet

In conjunction with its US technology partner, Evolution has decided to adopt an inverted flow sheet for producing battery anode materials, which involves implementing the purification step prior to spheroidisation (see Figure 1 below).

This processing design allows for the production of both spherical and non-spherical graphite simultaneously. Any purified graphite not yielding the usable spheres required for lithium-ion battery anodes will be sold into a range of high-margin applications, including battery conductivity enhancement additives for lithium primary, alkaline, lead-acid, lithium-ion and metal-air batteries.

Conventional battery anode material flow sheets are limited to producing spherical graphite for lithium-ion battery anodes only, representing approximately 40% yields into high revenue-generating products. Evolution's chosen flow sheet positions the Company to produce a portfolio of high-value battery graphite materials from nearly 100% of the thermally purified output, which provides a substantial competitive advantage to the overall economics compared to existing or potential battery anode producers adopting a conventional flow sheet.

Figure 1: Conventional vs EV1 'inverted' flow sheet



Thermal purification – sustainability and cost advantage

Evolution believes that sustainability is critical to the development of a successful battery anode strategy. 100% of the world's battery (spherical) graphite is produced in China using highly toxic chemicals such as hydrofluoric (HF) acid (as a component of a process blend solution). The Company understands that existing anode manufacturers in China use between 400-600kg of HF acid for every 1 tonne of graphite feedstock. Thermal purification, particularly if powered by renewable energy sources, would substantially minimise the environmental footprint of the battery anode supply chain.

By combining environmentally-friendly thermal purification technology with Evolution's desire to develop Chilalo as the world's first net zero carbon graphite mine, the Company is positioning itself to produce the world's most green and sustainable battery anode materials. The use of thermal purification is expected to enable a lower carbon footprint for Chilalo's battery anode material supply chain.

Cost is also a very important factor in developing a competitive battery anode material supply chain. In 2021, the operating cost associated with traditional graphite refinement using HF/HCl in China was approximately US$700 per tonne and it produces a 99.9 to 99.95 wt.% C product. This product is then subjected to thermal treatment in bulk using energy-intensive Acheson furnaces that consume 9-12 kWh/kg of graphite in addition to the aforementioned cost.

Evolution's chosen technology of continuous thermal purification is significantly more energy efficient than the Acheson process, requiring a very low energy input in the order of 1.9 kWh/kg of graphite. At a power cost of US$0.05/kWh, the cost of thermal purification to a super-premium product using Evolution's process is approximately US$500 per tonne – notably lower than the cost of refining graphite using the traditional Asian flowsheets.

Successful removal of impurities harmful to battery applications

Prior to purification, the Chilalo graphite concentrate contained 4.3% ash – a collection of mineral impurities, typically in the form of iron, aluminium, and silicon oxides. After thermal purification, the total quantity of mineral impurities was measured to be 5ppm. Among those, Iron was measured as 0.97ppm, Nickel 0.64ppm, Aluminium 0.73ppm, Chromium 0.71ppm, Molybdenum 0.1ppm, and Silicon 0.66ppm. All of the above are recognized deleterious elements, which are particularly harmful for application in advanced battery systems, such as premium-performance lithium-ion and alkaline batteries.

Super-premium grades of graphite for lithium-ion batteries must maintain iron levels below 10 ppm (note Chilalo graphite reached an iron concentration over two orders of magnitude lower). The same trend was observed for all other mineral impurities. Thermally purified Chilalo graphite therefore holds great potential as a precursor for advanced battery applications.

Not only does Chilalo flake graphite contain very low levels of impurities, those impurities that are present reside primarily on the surface and are therefore easily removed. Figure 2 illustrates a scanning electron microscopy ("**SEM**") image of a typical Chilalo flake at the concentrate purity (~95% C). It is evident that mineral impurities in Chilalo material sit predominantly on the graphite surface. Impurities on the surface are much easier to remove than those intercalated in between graphite layers as gangue. In contrast, Figure 3's SEM image highlights purified Chilalo graphite, which exhibits a very clean (essentially impurity-free) flake.

For more information on the purification process adopted by Evolution through its US technology partner, see Appendix 1.

Figure 2. Scanning Electron Microscopy image of Chilalo flake of concentrate purity

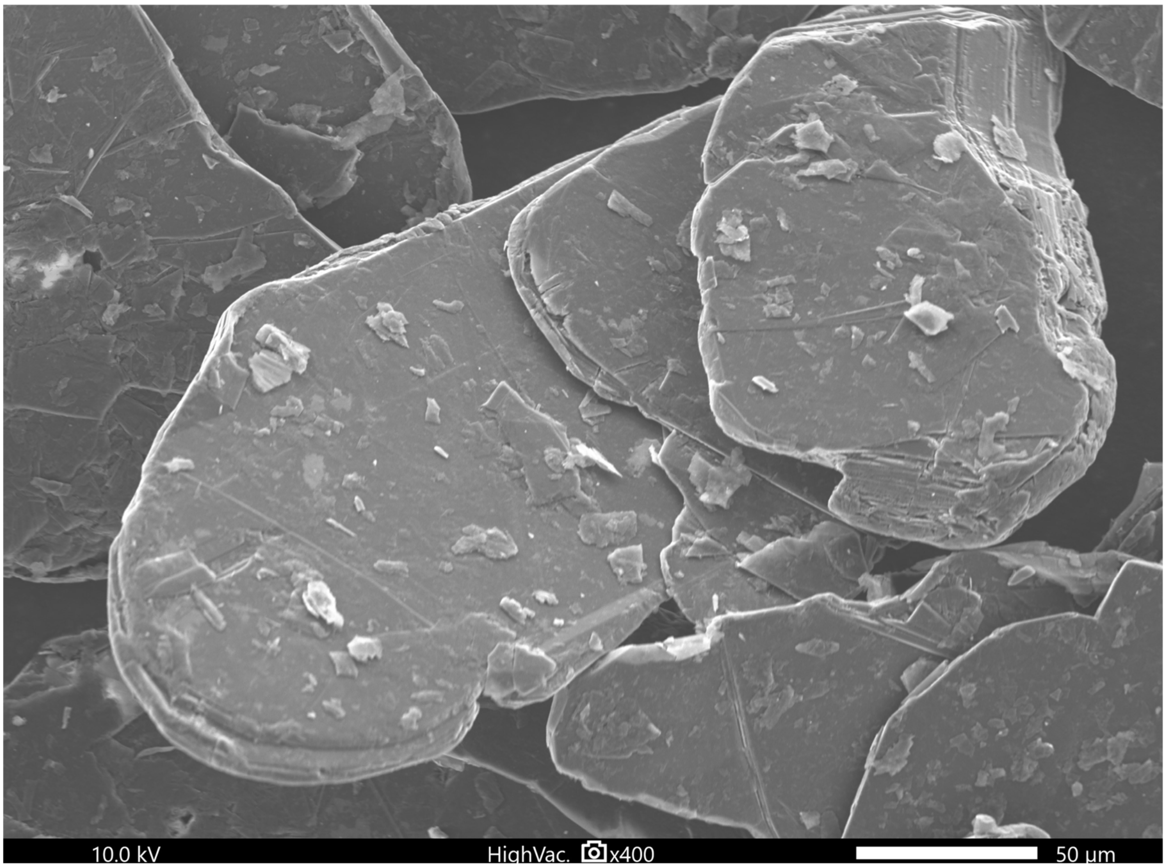
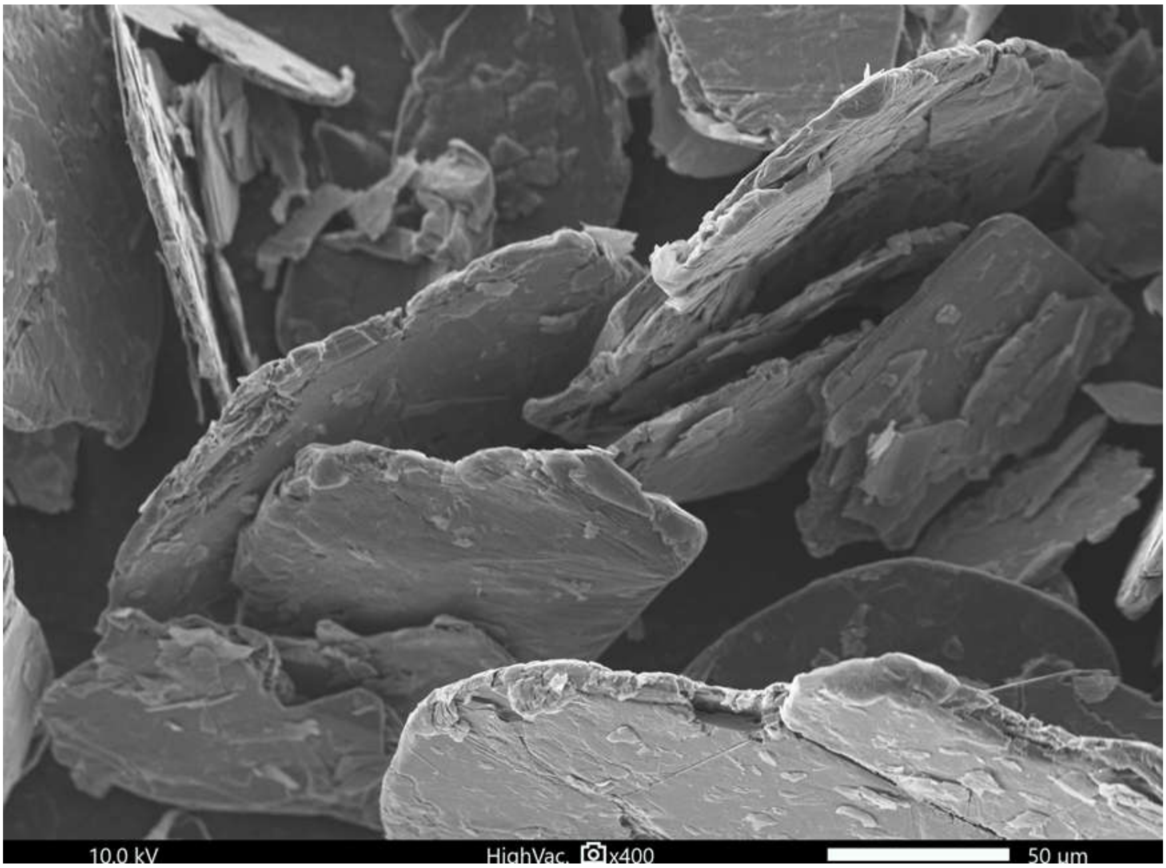


Figure 3. Scanning Electron Microscopy image of thermally purified Chilalo flake



The flakes occasionally contain imprints (miniature craters), which formerly held smaller mineral impurities. As a result, calculations conducted by Evolution's US technology partner prior to purification predicted 99.95% C ('three nines' or 3N) purity was likely to be achievable, however 99.9995% C ('five nines' or 5N) was actually achieved.

Chilalo flake graphite is easier to purify than other sources of natural graphite, likely because of the naturally occurring lack of gangue or intercalated impurities translating to lower purification costs.

Concentration of Boron in purified Chilalo graphite

As previously announced, elemental analysis of impurities in Chilalo's 95% C flake graphite fines concentrate identified extremely low levels of naturally occurring Molybdenum and Boron, opening the pathway to premium performance batteries (where extremely low concentrations of Molybdenum are a pre-requisite), and nuclear-grade graphite (which depends on naturally low levels of Boron).[2]

Set out below are the specification requirements for nuclear-grade graphite demonstrating that Chilalo's thermally purified graphite exceeds the required specifications.

	Required specification[3]	Chilalo purified graphite	
Purity (% C)	99.995% C	99.9995% C	✓
Boron content	<2 ppm	0.34 ppm	✓

The primary demand driver for ultra-high-purity graphite is nuclear applications, specifically Pebble Bed Modular Reactors, which consume approximately 60,000 tonnes of purified graphite per annum and sells for approximately US$30,000 per tonne.

Whilst this was not the target market when this commercial verification program commenced, this value-added application cannot be ignored and the Company now plans to engage in qualifications of ultra-high purity Chilalo graphite with various customers in the nuclear industry, including government agencies.

Evolution's technology partnership

Evolution has now been working with its US partner for over five months, the key focus of which relates to a commercial verification program to evaluate the production of coated battery anode materials using commercially proven thermal purification and a proprietary coating technology to deliver the finished product. The work is also assessing the suitability of Chilalo graphite for a range of other downstream applications.

The Company is well progressed on an agreement to formalize a technology partnership that will allow Evolution to utilize advanced technologies and facilities to, among other things, toll treat its Chilalo graphite for product qualification initiatives.

Next steps

Downstream processing and battery anode testwork is continuing. The Company expects to shortly release the results of testwork on the production of coated spherical graphite using thermally purified Chilalo graphite. Subject to the results of that testwork, the Company expects to undertake a feasibility study on the production of coated battery anode materials and other advanced battery products.

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[2] See ASX announcement 6 July 2022.
[3] ASTM standard *D7219-08 – Standard Specification for Isotropic and Near-isotropic Nuclear Graphites.*

This announcement has been approved for release by the Evolution board of directors.

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ABOUT EVOLUTION (ASX:EV1)

Development ready
Chilalo Graphite Project in Tanzania

58% > 80 Mesh
World leading flake size = highest margins

Extensive product qualifications
Will result in quality offtakes and technology partnerships

Framework agreement
To provide Tanzanian government certainty

FID by H2 2022
Strategic ESG fund cornerstone support

Sustainable battery anodes
Non-HF, thermal puification program completed Q3

Carbon neutrality
Pursuing net zero carbon from day one

Evolution's vision is to become a vertically integrated company that will only supply sustainably sourced graphite products and battery materials.

This will be achieved by combining our unique graphite source with industry-leading technology partners, working closely with customers and producing diversified downstream products in both Tanzania and strategically located manufacturing hubs around the world. Evolution is committed to being global leaders in ESG and ensuring its operations support the push for decarbonisation and the global green economy.

Appendix 1. Purification process utilized by Evolution's US technology partner

For the purposes of the purification testwork, high-temperature processing was augmented by mild addition of chlorine gas. Purification occurs by exposing graphite to temperatures exceeding the sublimation points of deleterious elements contained in the graphite concentrate. In the case of Chilalo flake graphite concentrate, these elements are Aluminium (0.7%), Silicon (2%), Iron (0.83%), and a number of other, lower-presence elements.

Upon exposure of graphite to temperatures exceeding 2,700°C under the blanket of nitrogen gas, impurities are vaporized, picked up by the system's nitrogen gas, and carried to the furnace flu, where they are further combusted in an afterburner and captured as part of the gypsum by-product in a dual alkali scrubber. The addition of chlorine gas results in the formation of gaseous metal chlorides, which form at temperatures significantly lower than those of the process using only nitrogen gas as a carrier. Typically, for processes using chlorine gas, temperatures range from 900 to 2,200°C, depending on the furnace.

In the case of Chilalo flake graphite testing, a temperature of 2,100°C was applied for purification. In production, similar purification results are anticipated in a continuous process that uses only nitrogen gas at temperatures exceeding 2,700°C in an ultra-high temperature fluidized bed reactor.