**ASX ANNOUNCEMENT**
By e-lodgement
**8 November 2021**

# HIGH PERFORMANCE RESULTS FROM BUNYU BATTERY CELL TESTWORK

## Highlights

- **Coin cell cycle testing demonstrates LIB grade material**
- **Extremely low capacity loss after 100 charge/discharge cycles – testing is now past 170 cycles with continuing low capacity loss**
- **Proprietary process flow sheet enables significantly higher yields of purified spheroidal graphite**
- **Non-spherical fraction retains high level of purity and is currently undergoing performance testing in traditional battery systems with direct oversight by Volt's potential offtake partner, which operates in the lead-acid battery market**
- **Results facilitate current discussions with battery manufacturers and technology groups as the Company progresses with battery-ready coated spherical anode-grade graphite production plans in the USA and Europe**
- **Feasibility studies to commence for battery anode production facilities in Europe and USA**
- **Testwork program undertaken by U.S. company AETC as part of a technology integration program including long-term cycle testing of Bunyu graphite for lithium ion batteries (LIB)**

Graphite producer and battery anode material developer **Volt Resources Limited** (**ASX: VRC**) ("**Volt"** or "**the Company"**) is pleased to report the successful LIB cell cycle testing results using coated spheronised purified graphite ("**CSPG**") produced from natural graphite originated at Bunyu Resource in Tanzania. The results are reported below and show very low irreversible capacity loss after 100 cycles and the continuation of low capacity loss after 170 cycles. Low capacity losses relate to battery life and this measure is a key performance indicator for battery anode material to be used in the production of lithium-ion battery technologies. The testwork program was undertaken by an established commercial graphite producer and processor, American Energy Technologies Co. (**"AETC"**) which is headquartered in Illinois, USA.

**Volt's Managing Director, Trevor Matthews, commented** "*We continue to be delighted with the battery cycle testwork results reported by AETC. This has confirmed Bunyu's flake graphite is suitable for use in the production of battery-ready anode material for energy storage solutions.*

*"Now that we have completed 170 cycles of the battery cell testwork program with Bunyu flake, we will shortly commence feasibility studies for the development of battery anode production facilities in Europe and the USA. Additionally, we will undertake an evaluation and sampling program with a number of technology and battery end-user groups which we have engaged with in the past months, to further our commercialization objectives in the electric vehicle, consumer and energy storage battery platforms in Europe, the United States and Asia.*

*Volt will be adopting the inverted flow sheet for its downstream operations following the successful spheronisation and purification results achieved during the testwork program. The use of this flowsheet will allow us to not only convert a significant portion of our graphite into battery-ready anode material for lithium-ion batteries, but will also generate a range of ultra-high purity by-products for use as electrically conductive diluents in battery cathodes and in a variety of valuable non-battery applications."*

**Battery Cell Cycling Testwork**

The testwork program's goal is to develop a technical support data package for market introduction of the Bunyu natural graphite product and the provision of battery-ready CSPG material for samples to be provided to potential LIB manufacturing customers.

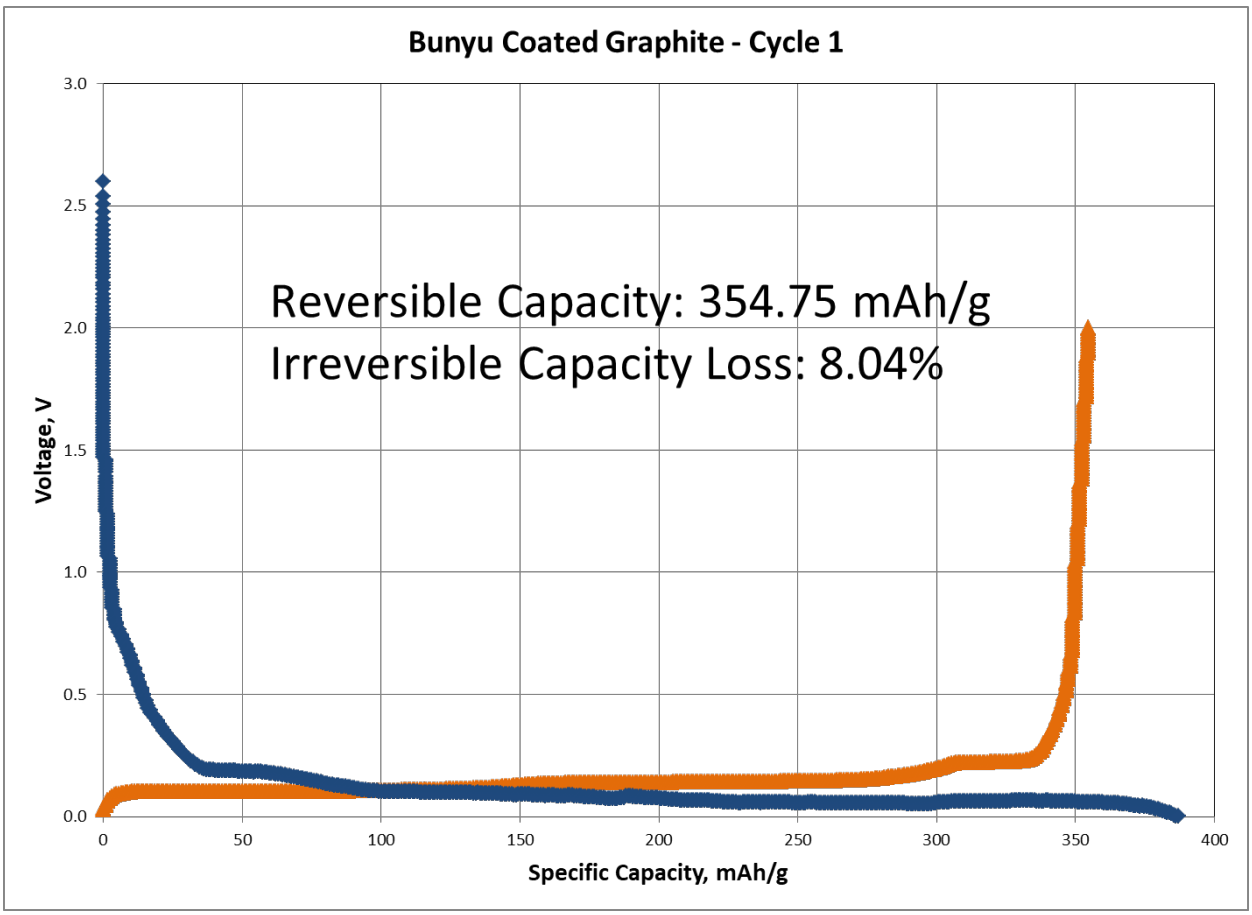
The program involved the production of SPG, followed by its surface coating prior to commencing extended cycling in batteries. Cycling tests assess the initial electrochemical performance of carbon coated spherodised graphite in the industry standard CR2016 coin cells (i.e. reversible, irreversible capacity and irreversible capacity loss). The program is designed to perform long-term cycling (100 cycles initially), which is used to assess the viability of the Bunyu CSPG for energy storage applications.


**CR2016 coin cells**

Initial electrochemical performance of Bunyu Graphite is presented in the chart 1 below. This graph represents a galvanostatic charge-discharge curve commonly used in the industry to derive values of reversible and irreversible capacity, as well as first cycle efficiency. It is evident that Bunyu graphite has a reversible capacity on the order of 355 mAh[1]/g, with irreversible capacity loss amounting to less than ten percent (i.e. 8.04%).

[1] Unit measure of electric energy over time

**Chart 1: Cycle characteristics.**

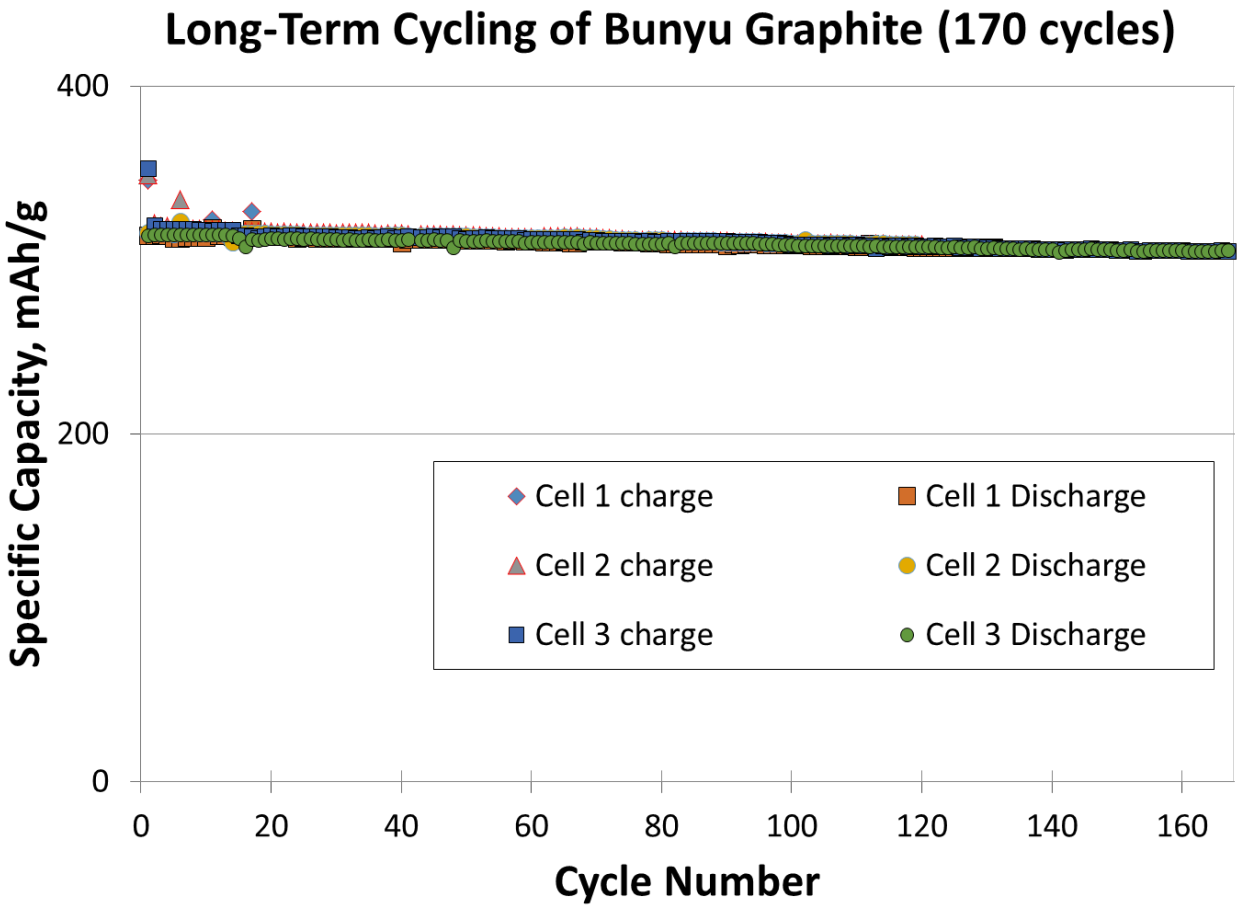



**Long-term Cycling Results**

Chart 2 below illustrates the current status of 170 cycles of long-term cycling results. Three cells containing Bunyu CSPG are being used for the long-term cycling testwork. The results from the three cells cycling performance are shown below and are consistent with LIB battery-grade material's specifications. It is worth noting that cells designed for long term cycling are intentionally built for slightly lower capacity ratings, therefore the reversible capacity values for the three cells in the test series range between 315 and 320 mAh/g. **These cells demonstrate highly consistent performance with virtually negligible degradation from cycle to cycle. The flat curve signals that Bunyu graphite could compete not only with other natural graphite battery anode material ("BAM"), but also a great number of costlier synthetic graphite BAM offerings, in its long-term cycling performance.**

The Cell Comparison Maximums reported in Chart 2 below show **excellent cell-to-cell stability and extremely low 1.79% reversible capacity decay (or 98.21% capacity retention) after 100 cycles. Further results were a low 2.69% reversible capacity decay (or 97.31% capacity retention) after 150 cycles and 2.83% reversible capacity decay (or 97.17% capacity retention) after 170 cycles.**

**Chart 2: Long Term Cycling Results**




**Application of High Purity, Non-Spherical Portion of Bunyu Graphite in Battery Cathodes**

Spheronization process with thermally purified Bunyu flake, with purity measured by the platinum crucible LOI 950 test as 99.987% TGC grade, resulted in the separation of approximately 70 wt.% of spheres with the balance being spheroidization process rejects. The aforementioned spheroidization yield is considered high-performance in the industry sector, since traditional spheroidization cascading circuits commonly generate between 35 to 50 wt.% of useable SPG.

Also, traditional flowsheets have a number of well-known built-in disadvantages in that they process concentrate-purity grade flake (typically 94-95 %TGC) whose mineral impurities (mainly silica and alumina, both belonging to a group of classic abrasives) grind and wear processing machinery, leading to greatly increased repair and maintenance cost and high downtime during spheronization.

Moreover, the non-spherical portion of processed flake, which reaches approximately 94 % TGC by the end of spheroidization, is too costly to refine or purify as fines, and consequently is commonly sold into low technology markets at prices in the order of US$500/tonne. The above disadvantages of the traditional spheroidization process flowsheet constitute major factors that severely impact the profitability of a typical spheroidization operation.

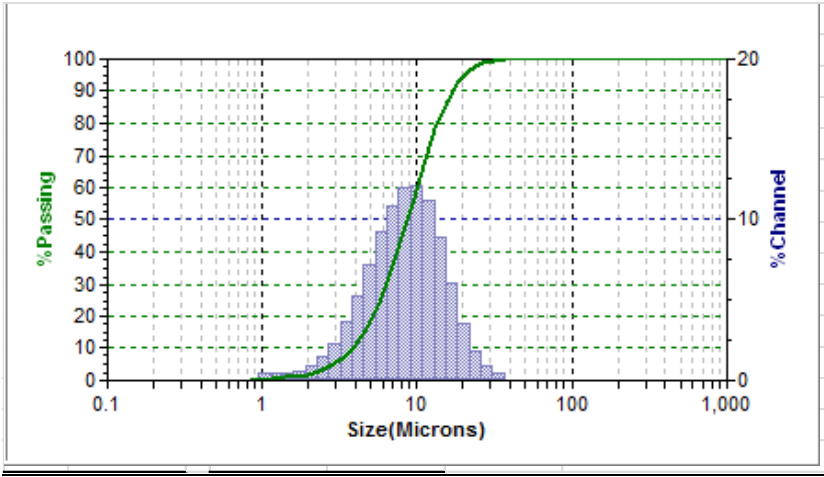
By contrast, Volt is seeing greatly increased spheronization yields (e.g. approximately 70 wt.% of Bunyu flake input into the spheronizer mills), reduced repairs and maintenance and equipment downtime, while collecting approximately 30 wt.% of spheroidization process rejects that retain the premium level of purity on the order of 99.95+ wt.%C, making them suitable for a host of

applications in electrical conductivity enhancement markets, such as in battery cathodes of LIBs and in a variety of other advanced battery and non-battery applications.

Volt is currently evaluating the electrochemical performance of its ultra-high purity spheroidization rejects for use in the expander of lead acid batteries. Test data from the aforementioned initiative will be published in the coming weeks. This work is being performed under the close oversight of Volt's potential off-take partner, a lead-acid battery company.

In this report, the electrical performance of Bunyu's thermally refined spheroidization rejects has been compared to the performance of the industry's premium grade of synthetic graphite, MX-15 (a product by Imerys Graphite & Carbon, Bodio, Switzerland). The selling price of this product is believed to be greater than US$10,000 per tonne and its main application is in the cathodes of alkaline primary Zinc (Zn) / Manganese Dioxide (EMD) batteries. For reference, the market of graphites for alkaline batteries exceeds 12,000 tonnes per year and grows at a CAGR of 4%.

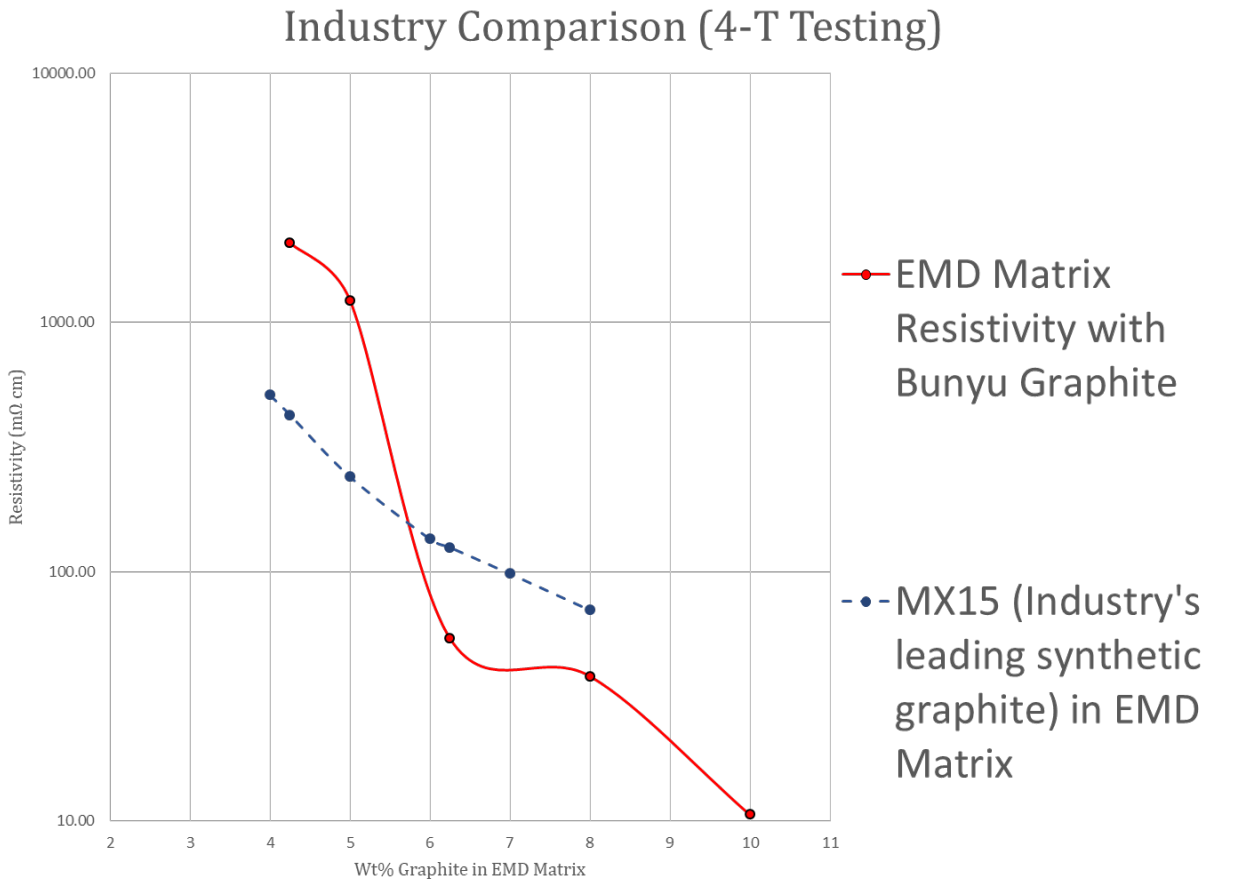
Presented below are the testwork results in an alkaline battery industry standard four-probe (4-T) resistivity test of compression moulded EMD pellets which contain various concentrations of Bunyu's thermally purified spheroidization rejects graphite, having a particle size of D90 of approximately 16.8 microns. The laser diffraction pattern of this graphite is presented in the Figure below. The 4-T data for Bunyu flake is plotted on the same graph with 4-T performance of MX-15 synthetic graphite, which was used in this study as control. MX-15 is a similarly sized graphite, which has a nominal D90 of approximately 15 microns.




| Data | Value |
|---|---|
| MV(um): | 9.67 |
| MN(um): | 2.493 |
| MA(um): | 6.77 |
| CS: | 8.86E-01 |
| SD: | 4.95 |
| | |
| Mz: | 9.3 |
| si: | 5.06 |
| Ski: | 0.2658 |
| Kg: | 1.046 |

| %Tile | Size(um) |
|---|---|
| 10 | 3.85 |
| 20 | 5.18 |
| 30 | 6.32 |
| 40 | 7.45 |
| 50 | 8.63 |
| 60 | 9.96 |
| 70 | 11.52 |
| 80 | 13.52 |
| 90 | 16.75 |
| 95 | 19.98 |

**Particle Size Distribution of Spheroidisation Process Rejects with Volt's Bunyu Natural Flake Graphite**

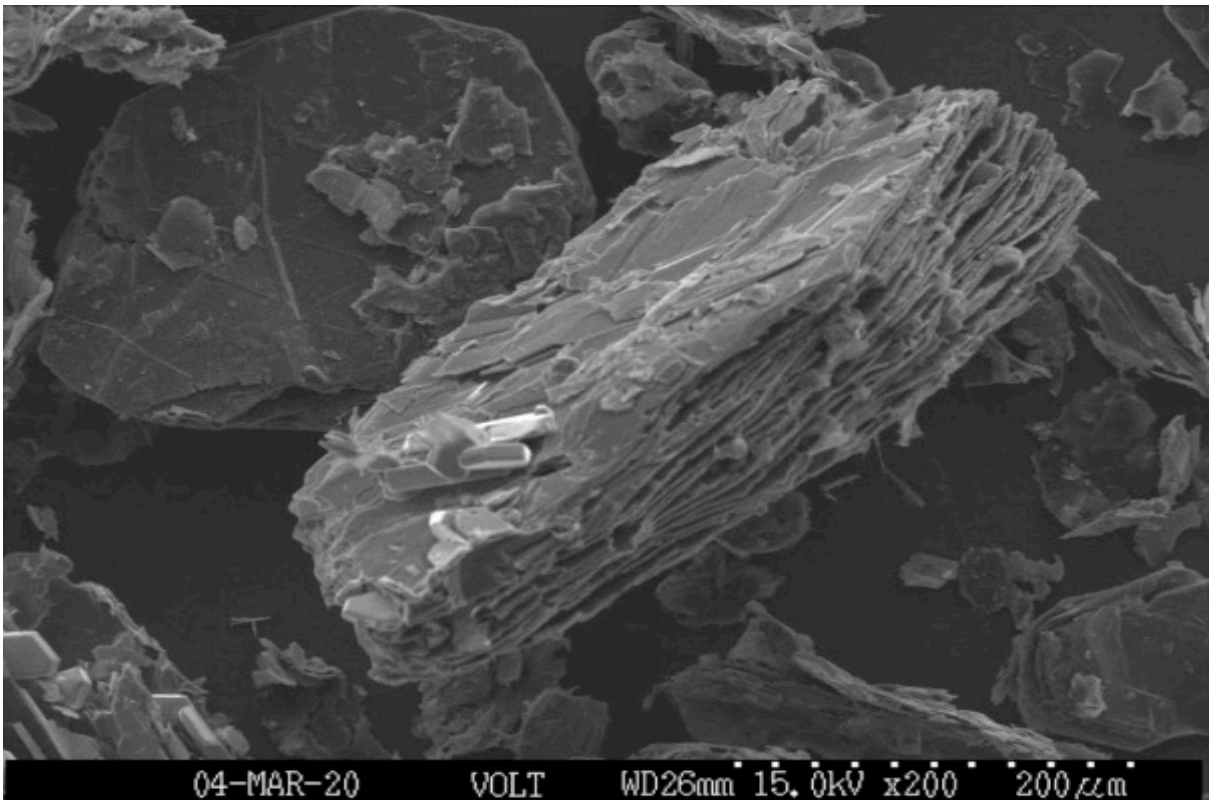



It is evident that starting from approximately 5.75 wt.% loading of graphite in the EMD both graphites display similar electrical performance. For reference, most alkaline Zn/EMD primary batteries employ 6.25 to 8 wt.% of graphite in their cathodes. This is the range where Bunyu natural flake graphite significantly exceeds in performance compared with the premium grade synthetic graphite, MX15.

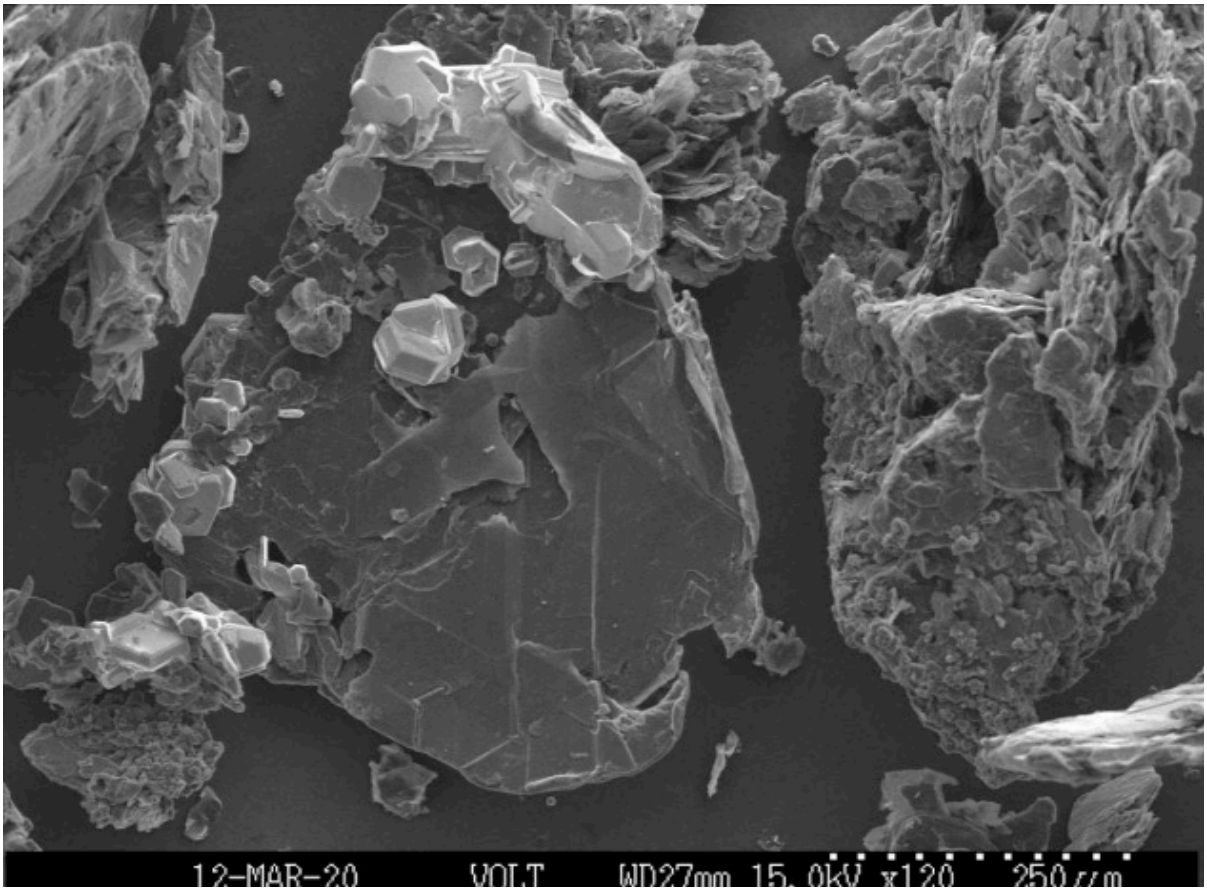
Primary alkaline batteries whose EMD matrixes contain Bunyu's spheroidization process rejects of 99.95+ wt.%C purity level are positioned to last longer, work at higher operating current densities, demonstrate reduced tool wear in cathode manufacturing processes (i.e. natural graphite is far more lubricious than its synthetic counterpart) and enable cost reductions to the alkaline battery industry since the superior purity of Bunyu graphite will likely allow reduced loadings of gas suppressant on the anode (the latter is one of the most expensive ingredients in the materials of a typical commercial alkaline battery). Cost reductions to the alkaline cell producers will also be enabled by the fact that spheroidization rejects is a by-product stream of Volt's main process i.e. the production of spherical graphite for LIBs.

**Other Testwork Results – Previously Reported**

The Bunyu graphite is composed of extremely thick particles which act as a natural lubricant. The thinner stacks of graphene layers are partially primed open, as seen in the scanning electron microscopy image below. That is a unique feature that will facilitate easier intercalation and de-intercalation of lithium ions that could lead to longer LIB cycle life.




**Bunyu flake graphite showing thickness**




**Impurities on the surface of Bunyu flake graphite**

***Purification***

The Scanning Electron Microscopy image above is of the concentrate-purity Bunyu graphite. It shows pale inclusions attributed to gangue, clearly located either on the surface of larger flakes or on edge planes. Typically, impurities are embedded as gangue in between flake layers of classic graphite. However, Bunyu flakes are unique in their impurity topography, allowing for easier

removal of impurities and therefore lowered processing costs.

AETC was able to consistently produce a 99.987% TGC grade graphite. The purified Bunyu flake graphite had extremely low concentrations of deleterious elements such as iron (Fe) at 7.4 ppm, nickel (Ni) at 4.8 ppm and cobalt (Co) at 3.7 ppm.

Low sulphur levels at 62.7 ppm were also achieved using thermal purification. Such low levels are linked to the extended calendar life of LIBs.

***Spheronisation***

Using the Bunyu purified flake graphite as feed material, a milling stage was used to appropriately size or micronise the purified flake graphite prior to its spherodisation. The purified and micronised material may then be used for applications in lead acid batteries and in alkaline batteries. Alternatively, they are further processed into SPG for LIBs.

Given its properties, Bunyu flake meets the established design criteria for negative electrode active materials of lithium ion batteries.

***Coating***

Testing of spherodised graphite products after surface coating was undertaken by analysing for: Loss on Ignition (LOI950), ash, sulphur, laser diffraction (particle size), BET surface area, Tap density, Scott Volume, and SEM.

AETC coated the Bunyu CSPG material and incorporated it into electrodes, which were then, in turn, integrated into LIB coin cells. These cells were used in the long term cycling testing.

**Battery Anode Material Flowsheet**

In a traditional flowsheet, graphite concentrates are milled, and then shaped into a sphere. The particles that have been spherodised are purified by an environmentally damaging acid leaching process. In addition, only 35%-40% of the graphite is spherodised and converted into battery-grade material. The non-spherical particles, amounting to 65%-70% of the feed in the traditional circuit, are collected and sold into lower-margin markets such as re-carburizers, pencils, aftermarket brake pads, and others.

With the flowsheet developed by AETC to produce spherical purified graphite (SPG), purification is completed first with all of the subsequent sizing and shaping undertaken with purified material. The purification process was undertaken exclusively using high temperature furnaces. No acid leaching or caustic bakes were employed.

The main benefits Volt enjoys from this inverted flowsheet are:

- Reduced wear and tear on shaping mill parts (due to processing being accomplished with high purity graphite, which is a natural lubricant), and,
- The ability to divert non-spherical portions of the purified graphite to higher-margin markets such as conductivity enhancement applications in LIB and other advanced battery cathodes.

With two world-class graphite resources incorporated in a strategically located operating mine and processing plant in Ukraine along with a development-ready project in Tanzania, Volt

Resources is well-positioned to become a globally significant graphite producer.

Volt plans to become a battery anode material producer in Europe and the United States based on an integrated supply chain using graphite manufactured from its own operations. This provides security and continuity of supply for the business, and the ability to manage product quality through the global graphite supply chain through to the LIB cell manufacturers and for other value-add graphite product end users.

**-ENDS-**

**This announcement was authorised for release by the Board of Volt Resources Ltd.**

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**About Volt Resources Limited**

Volt Resources Limited ("Volt") is a graphite producer/developer and gold exploration company listed on the Australian Stock Exchange under the ASX code VRC. Volt has a 70% controlling interest in the Zavalievsky Graphite business in Ukraine. Zavalievsky is in close proximity to key markets with significant developments in LIB facilities planned to service the European based car makers and renewable energy sector. Zavalievsky benefits from an existing customer base and graphite product supply chains based on excellent transport infrastructure covering road, rail, river and sea freight combined with reliable grid power, ample potable ground water supply and good communications. Zavalievsky has current plans to install a processing plant and equipment in order to commence production of spheronised purified graphite (SPG) for the European LIB market within the next 12 months[2].

Volt is also progressing the development of its large wholly-owned Bunyu Graphite Project in Tanzania, as well as gold exploration in Guinea leveraging the Company's existing extensive networks in Africa.

The Bunyu Graphite Project is ideally located near to critical infrastructure with sealed roads running through the project area and ready access to the deep-water port of Mtwara 140km from the Project. In 2018, Volt reported the completion of the Feasibility Study ("FS") into the Stage 1 development of the Bunyu Graphite Project. The Stage 1 development is based on a mining and processing plant annual throughput rate of 400,000 tonnes of ore to produce on average 23,700tpa of graphite products[3]. A key objective of the Stage 1 development is to establish infrastructure and market position in support of the development of the significantly larger Stage 2 expansion project at Bunyu.

The Guinea Gold Projects comprise 6 permits in Guinea, West Africa having a total area of 348km. The Projects are located in the prolific Siguiri Basin which forms part of the richly mineralised West African Birimian Gold Belt.

[2] Refer to Volt's ASX announcements titled "Volt to Acquire European Graphite Business following Completion of Due Diligence" dated 14 May 2021 and "Completion of the ZG Group Transaction Following Execution of New Convertible Securities Facility" dated 26 July 2021.

[3] Refer to Volt's ASX announcement titled "Positive Stage 1 Feasibility Study Bunyu Graphite Project" dated 31 July 2018. The Company confirms that it is not aware of any new information or data that materially affects the information included in this document and that all material assumptions and technical parameters underpinning the estimates continue to apply and have not materially changed.