Battery-grade lithium hydroxide successfully produced from Rhyolite Ridge lithium-boron ore

Highlights

- ioneer engaged world-leading lithium processing technology group, Veolia, to produce battery-grade lithium hydroxide from Rhyolite Ridge lithium-boron ore using standard commercial processes
- Testwork undertaken by Veolia successfully validated the ioneer process and confirmed key flowsheet parameters for the Rhyolite Ridge Lithium-Boron Project
- Represents the successful completion of key steps in the Definitive Feasibility Study (**DFS**), which remains on track for completion in Q3 2019
- ioneer's pilot plant is now utilising the same flowsheet to further simulate commercial processes in a continuous cycle

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Tuesday, 11 June 2019 – Emerging lithium-boron supplier, ioneer Ltd (**ioneer** or the **Company**) (ASX: INR) today announced that battery-grade lithium hydroxide has been successfully produced from Rhyolite Ridge ore using standard commercial processes.

ioneer engaged Veolia Water Technologies Inc. (**Veolia**) to complete extensive testwork as part of the Rhyolite Ridge DFS. Veolia is the world's largest supplier of evaporator and crystalliser systems and is globally regarded for its processing expertise. Veolia's bench-scale testwork simulated major unit operations within the DFS process flowsheet and produced:

- Boric acid and lithium carbonate; and
- High-purity (battery grade) lithium hydroxide.

Director of Process at Veolia, Mr Jim Rieke, commented:

> "We are pleased that our bench-scale testwork completed over the past five months on the Rhyolite Ridge flowsheet has achieved ioneer's objectives for boric acid, lithium carbonate, and lithium hydroxide using Veolia's proven purification, evaporation and crystallisation technologies. We look forward to continuing to support ioneer in achieving commercialisation of their Rhyolite Ridge operations."

Managing Director of ioneer, Mr Bernard Rowe, commented:

> "Veolia has a strong track record in designing and supplying production processes for the lithium industry. By simulating major unit operations of the Rhyolite Ridge process flowsheet, Veolia has successfully validated the commercial process and confirmed key flowsheet parameters being finalised in the Rhyolite Ridge DFS. This gives us confidence that our commercial process is both straightforward and scalable.
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> "Using the technical-grade lithium carbonate produced from Rhyolite Ridge DFS flowsheet, Veolia has successfully completed bench-scale testing to support the commercial application for crystallising battery-grade lithium hydroxide.
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> "The testwork confirms that Rhyolite Ridge will be able to produce a range of products at the mine site including boric acid, lithium carbonate and lithium hydroxide."
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> "ioneer is well placed to meet the expected strong North American demand for lithium as the United States looks to develop a domestic battery supply chain."

The table below details the high purity of the lithium hydroxide monohydrate produced by Veolia's testwork.

Chemical Analysis of Rhyolite Ridge Lithium Hydroxide Monohydrate

		Rhyolite Ridge Analysis	Typical Industry Specifications
Lithium Hydroxide	wt%	**56.5**	56.5
Sodium	ppm	**28**	≤ 30
Potassium	ppm	**12**	≤ 200
Iron	ppm	**<1**	≤ 7
Boron	ppm	**<1**	≤ 3
Calcium	ppm	**<10**	≤ 250
Sulphate	ppm	**<30**	≤ 300
Chlorine	ppm	**<100**	≤ 100
Magnesium	ppm	**<5**	≤ 5
Silica	ppm	**14**	≤ 20
Carbon Dioxide	wt%	**0.10**	≤ 0.35

Note: Chromium, nickel, copper, lead, aluminium and zinc all analysed <1ppm with typical industry specifications ranging from ≤5ppm to ≤10ppm.

Veolia is also undertaking process testwork on several different pathways to produce battery-grade lithium carbonate from the Rhyolite Ridge technical-grade lithium carbonate. ioneer will update the market on the results as they become available.

Testwork conducted by Veolia complements earlier work conducted by Kemetco Research Inc (**Kemetco**) of Vancouver, an independent commercial laboratory.

The flowsheet has been scaled up at the Company's pilot plant located at Kemetco's state of art facilities in Vancouver, Canada (see Company announcement dated 13 March 2019). The pilot plant will run in a continuous cycle over the coming three months and will allow the Company to further optimise the commercial process for the DFS and detailed engineering design. Output from the plant will provide sufficient products with defined specifications for ioneer's potential off-take partners.

The DFS is evaluating the range of potential Rhyolite Ridge lithium products (carbonate, hydroxide and sulphate) to determine which products provide the most commercial benefits to the Company and its future customers.

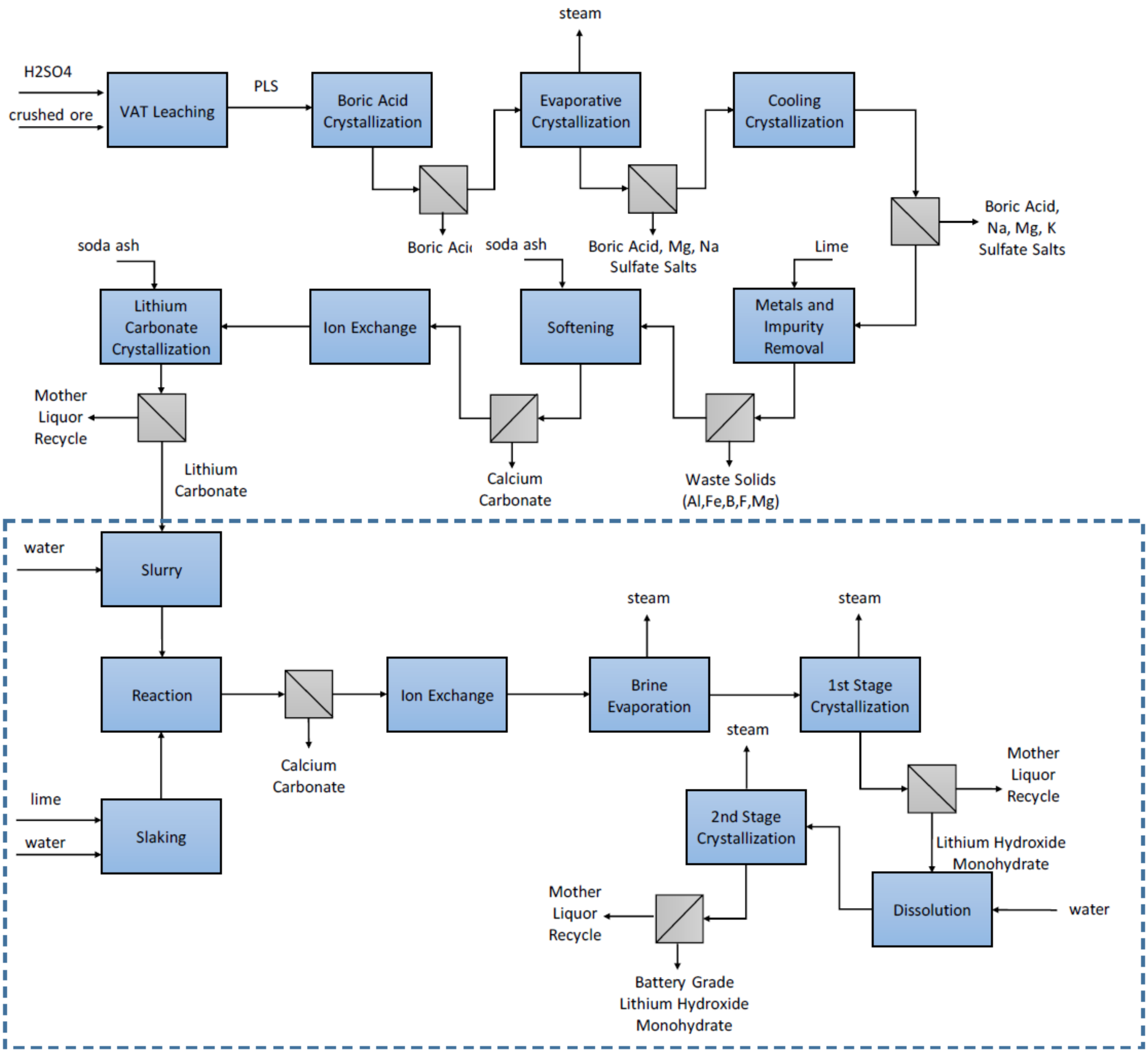
Background to Veolia Testwork

The bench-scale testwork was completed by Veolia using HPD® evaporation and crystallisation technology. Just as with the current ioneer project, Veolia has confirmed the designs of many commercial processes with testing at the bench and pilot scales at the Phillip J. Stewart Technology Center in Plainfield, Illinois.

The testwork used approximately 150 gallons (567 litres) of pregnant leach solution (**PLS**) produced by Kappes Cassiday in Reno, Nevada using the planned vat leach process. Using the process flowsheet shown below, Veolia produced boric acid and technical grade lithium carbonate. To confirm that the technical grade lithium carbonate produced through the ioneer process could be readily further processed into battery grade material using standard processes, the technical grade lithium carbonate was then processed to produce high purity (battery grade) lithium hydroxide.

The diagram below shows the DFS process flowsheet. The portion within the dotted line in the diagram below shows the processes used to convert technical-grade lithium carbonate to battery-grade lithium hydroxide monohydrate.

Process Flowsheet to Produce Battery-Grade Lithium Hydroxide Monohydrate for Rhyolite Ridge Lithium-Boron Project



Summary of Steps to Produce Boric Acid and Technical-Grade Lithium Carbonate

Veolia simulated at bench-scale the following major steps in the Rhyolite Ridge process flowsheet to produce boric acid and technical-grade lithium carbonate:

Step 1 – Cooling crystallisation

The first step involved cooling the PLS which resulted in the crystallisation of boric acid. The crystals produced exhibit excellent dewatering ability.

Previous testwork (see Company announcement dated 28 August 2018) has shown the boric acid to be very high purity (>99.9%).

Step 2 – Evaporative crystallisation

Evaporation and concentration of the PLS resulted in the crystallisation of additional boric acid together with mixed (calcium, magnesium and sodium) sulphate salts. The boric acid is recovered from mixed sulphate salts by simple flotation as boric acid is hydrophobic.

Step 3 – Cooling crystallisation

Further cooling of the concentrated PLS resulted in the crystallisation of additional mixed sulphate salts. The solids were easy to separate and there was no indication of lithium precipitation during cooling step.

Step 4 – Precipitation of impurities

Lime was then added to the concentrated PLS and impurities including aluminium, iron, boron, fluorine and magnesium were precipitated and removed.

Step 5 – Softening to further reduce impurities

Soda ash and caustic soda were added to the PLS to precipitate calcium carbonate and magnesium hydroxide. This was followed by ion exchange to further soften the PLS.

Step 6 – Precipitation of lithium carbonate

Sodium carbonate (soda ash) was added to the remaining PLS to precipitate lithium carbonate. Technical-grade lithium carbonate was produced by a single stage of precipitation.

Summary of Steps to Produce Battery-Grade Lithium Hydroxide from Technical-Grade Lithium Carbonate

Step 1 - Feed for Lithium Hydroxide

A lithium carbonate slurry was prepared utilising the "re-pulped" technical-grade lithium carbonate generated from the bench-scale testwork outlined above.

In order to generate sufficient volumes for testing, the feed was supplemented with synthetic chemicals and impurities were added to match the concentrations of the "re-pulped" lithium carbonate sample.

Step 2 - Reaction with Lime

The lithium carbonate slurry was combined with slaked lime in order to solubilise lithium hydroxide and precipitate calcium carbonate. Approximately 75kg of lithium hydroxide brine was produced.

Step 3 - Ion Exchange

Ion exchange was used to reduce the hardness and boron concentration within the lithium hydroxide solution (brine) prior to evaporation and crystallisation of lithium hydroxide monohydrate.

Step 4 - Lithium Hydroxide Evaporation

The lithium hydroxide solution (brine) was then further concentrated using an evaporator.

Step 5 - Two-Stage Crystallisation to Produce Battery-Grade Lithium Hydroxide

The two-stage crystallisation of lithium hydroxide monohydrate was performed using an evaporative crystalliser. The testing was conducted for two weeks and utilised approximately 17 kilograms of the evaporator concentrate.

After the second stage of crystallisation and vacuum drying, the testwork generated approximately 200 grams of battery-grade lithium hydroxide monohydrate.

Elemental analysis showed that the lithium hydroxide product (>56.5% lithium hydroxide) met or exceeded the common specifications for battery-grade lithium hydroxide and had low levels of impurities.

The lithium hydroxide monohydrate crystals produced were large crystals that exhibited excellent dewatering ability.

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About ioneer

The Company's 100%-owned Rhyolite Ridge Lithium-Boron Project in Nevada, USA provides a substantial foundation for ioneer to become a responsible and profitable producer of the materials necessary for a sustainable future.

The Rhyolite Ridge Pre-Feasibility Study demonstrated the Project's scale, long life and potential to become the lowest cost lithium producer in the world as well as the largest lithium producer in the United States.

With forecast annual production of 20,200 tonnes lithium carbonate and 173,000 tonnes boric acid, Rhyolite Ridge will be a globally significant producer of both lithium and boron.

Lithium and boron are both used in a diverse range of everyday items and innovative technologies that are essential to modern life and emerging clean technologies such as electric vehicles.

Competent Persons Statement

The information in this report that relates to Exploration Results is based on information compiled by Bernard Rowe, a Competent Person who is a Member of the Australian Institute of Geoscientists. Bernard Rowe is a shareholder, employee and Managing Director of ioneer Ltd. Mr Rowe has sufficient experience that is relevant to the style of mineralisation and type of deposit under consideration and to the activity being undertaken to qualify as a Competent Person as defined in the 2012 Edition of the 'Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves' (JORC Code 2012). Bernard Rowe consents to the inclusion in the report of the matters based on his information in the form and context in which it appears.

In respect of production targets referred to in this report and previously disclosed, the Company confirms that it is not aware of any new information or data that materially affects the information included in the public report titled "Outstanding Results from Rhyolite Ridge Pre-Feasibility" dated 23 October 2018. Further information regarding the production estimates can be found in that report. All material assumptions and technical parameters underpinning the estimates in the report continue to apply and have not materially changed.