



Mining and Metallurgical Society of America

P.O. Box 810, Boulder, CO 80306-0810

Phone: (303) 444-6032

Web site: www.mmsa.net

OFFICERS:

President, Michael Blois
Vice President, Amy Jacobsen
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Colorado: Robert Cameron
Nevada: Jack McPartland
Utah: Tony Troutman

EXECUTIVE DIRECTOR:

Betty L. Gibbs
contactmmsa@mmsa.net

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President's Message
Mining the Lightest Elements??

By Michael D.S. Blois

ROADKILL – This is the heading on the cover page of The Economist's August 12th edition. The sketch is meant to resemble a dead head of cattle but is actually drawn as a dead version of the Internal Combustion Engine. The sketch shows the engine with four pipes representing the legs and the exhaust pipe / catalytic converter as the cattle's tail.

The Economist believes that the days of Internal Combustion Engines are numbered. "Rapid gains in battery technology favor electric motors instead. The bank UBS optimistically predicts that Electric Vehicles (EVs) will make up 14% of global car sales by 2025, up from 1% today. Last month Britain and France joined a lengthening list of electric-only countries, saying that all new cars must be zero-emission by 2040 – 2050. These forecasts are being revised upwards as the lithium-ion batteries get cheaper and better. The cost per kWh has fallen from \$1,000 in 2010 to \$130-200 today.

"That this is even conceivable is a tribute to the remarkable expansion of the lithium-ion battery business – and to the belief that it is set to get much bigger.



Michael D.S. Blois
 MMSA President, 2017-2018

The first such batteries went on sale just 26 years ago, in Sony's CCD-TR1 camcorder".

For the most part, those of us in the hardrock side tend to associate mining industry innovations with the heavier ferro – base precious metals, i.e. Elements No. 26 onwards. Clearly there is a large part of our industry associated with Element No. 6 – Carbon, e.g. the coal, diamond and graphite sectors. The graphite sector has also been positively impacted by the growth in lithium-ion batteries.

We also tend to overlook our brethren in the fertilizer industry with the mining of the alkali metal potassium. Indeed the lighter metal sodium formed one of the earliest sectors of the global mining industry. In 2200 BC, the Chinese emperor Hsia Yu levied one

of the first known taxes, which was a tax on sodium chloride salt.

In Tibet, Marco Polo noted that tiny cakes of salt were pressed with images of the Grand Khan and used as coins. Salt is still used as money among the nomads of Ethiopia's Danakil Plains. Salt was of crucial importance economically. The expression "not worth his salt" stems from the practice of trading slaves for salt in ancient Greece. Special salt rations given to early Roman soldiers were known as "salarium argentum," the forerunner of the English word "salary."

The focus today is on the lightest of the alkali metals – lithium.

According to Deutsche Bank AG, the demand for Lithium Carbonate Equivalent (LCE), a normalized re-

porting standard for the lithium industry, was about 200,000 tonnes in 2016 and is forecast to rise to about 530,000 tonnes in 2025.

The EV battery industry seems to prefer the lithium hydroxide monohydrate (LiOH·H₂O) form to lithium carbonate. Based on the announced plans of automakers and battery manufacturers to date, several market experts believe that the dominant cathode formulations for EV batteries will be nickel-cobalt-aluminum ("NCA") and nickel-manganese-cobalt ("NMC").

According to Benchmark Mineral Intelligence, the adoption of battery technologies using NCA cathodes will be the primary factor in LiOH·H₂O demand growth. Benchmark forecasts the demand to grow from about 40,000 tonnes in 2016 to

150,000 tonnes in 2025.

On the supply side, Benchmark estimates that LiOH·H₂O production accounted for approximately 20 percent of global lithium chemical production in 2016, or around 39,000 tonnes. Benchmark estimates that the world supply of LiOH·H₂O will grow from 39,000 tonnes in 2016 to almost 135,000 tonnes.

The major lithium compounds like lithium carbonate and LiOH·H₂O are generally sold under private term contracts and do not have quoted prices on any recognized metals or minerals exchange.

The market pricing of these materials is somewhat opaque, but it has been widely reported that prices for lithium compounds have doubled in the past 12-18 months. Recent reports of LiOH·H₂O prices have been in the range of \$16,000-\$20,000 per tonne up from about \$7,000 in 2015. Mid-range price forecasts for 2015 are about \$16,000 per tonne.

Current lithium mining operations are either of the hardrock type or the brine type. The Greenbushes spodumene mine in Western Australia is the largest of the hardrock type.

The majority of brine deposits occur in the "Lithium Triangle" of South America; this is situated over a large area roughly at the northwest corner of Argentina, southern Bolivia and eastern Chile.

The traditional process route for the recovery of lithium carbonate from brines is with the use of large and expensive evaporation ponds. This process route adds 18 - 24 months to the production schedule while the water is evaporated away and results in a loss of water in already dry environments. Lithium carbonate is then precipitated from the concentrated brines by the addition of sodi-

Membership Applications

New Regular and QP Member Applications:

The following individual(s) have submitted membership applications and/or changes to their membership status. They have either received approval of the Membership Committee as candidates or are currently under review:

If any member of MMSA has good cause to believe that any of the applicant(s) should not be granted Regular membership or QP membership, as appropriate, you are requested to make known your objections, in writing, to **Betty Gibbs**, Executive Director, within 30 days from issue of this Newsletter. In the absence of any objections and after receiving approval of the various committees, the candidate members and those members requesting a change of status will be confirmed as Regular Members or QP Members, as provided by the ByLaws.

<u>Applicant</u>	<u>Endorsers</u>	<u>Applicant</u>	<u>Endorsers</u>
Josef CR Bilant	Courtney Young Corby Anderson Greg Robinson (Supervisor)	Gregory Gillian	Randy Pitts James Sorensen Robert Evans Diego Romero
Richard Waller	Mike Blois Matt Bender Mark Jorgensen		

QP Applications

Josef CR Bilant
Gregory Gillian

Area of Special Expertise

Metallurgy/Processing
Mining, Metallurgy/Processing

um carbonate; this then must undergo further processing to produce the $\text{LiOH}\cdot\text{H}_2\text{O}$ required by the battery manufacturers. Currently, the only US producer of lithium products from brines is Albemarle's Silver Peak operation in Clayton Valley, western Nevada.

With the increasing demand from the EV battery manufacturers, there is a "race to market" to bring new lithium production on-line. The "Big 4" current producers have all announced expansion plans at their existing operations: Albemarle at its Salar de Atacama in Chile, Albemarle and the Chinese company Tianqi at their jointly owned Greenbushes Mine, FMC at its Salar del Hombre Muerto in Argentina.

Given these market conditions, it is hardly surprising that companies in the supply side of lithium are developing innovative processes. To highlight the innovative nature of the

mining industry, a few of the novel approaches are mentioned below.

Nemaska Lithium's new Whabouchi mine has demonstrated that it is able to produce spodumene concentrates which are transformed into $\text{LiOH}\cdot\text{H}_2\text{O}$ at its commercial demonstration plant at Shawinigan, Quebec, Canada. This process involves the calcination of the spodumene concentrates and then sulfuric acid digestion. Neo Metals is developing a similar process but using chloride digestion for its Mt. Marion mine near Kalgoorlie in Western Australia.

Enirgi has produced lithium carbonate directly from brines at its commercial demonstration plant at the Salar de Rincon near Salta in Argentina.

Korean steel-maker POSCO has demonstrated that it is able to produce lithium phosphate as an intermediate product. Depending on the grade of the brines, evaporation ponds may or may not be needed.

Tenova Advanced Technologies is testing the use of solvent extraction for the direct recovery of lithium from brines in its LiSX^{TM} process. No evaporation ponds would be required. $\text{LiOH}\cdot\text{H}_2\text{O}$ is produced using an electrolysis step, LiEL^{TM} . Pure Energy Minerals intends to pilot plant test this innovative technology for its Clayton Valley Project in Nevada. In the interests of full disclosure, I am currently involved with the development of this technology.

Bacanora has been testing the recovery of lithium carbonate from its Sonora, Mexico hectorite deposit. This process involves reverse flotation of calcite to recover lithium bearing clays, gypsum leaching, solvent extraction and ion exchange for the removal of deleterious ions.

Clearly the global mining industry is continuing its proudly held tradition of being a great innovator to meet the demands of an ever changing society.

The lithium market is obviously of great interest to the mining industry and I will provide an update in future President's letters.

MMSA News

MMSA Council Retreat

October 21, 2017

The MMSA Council will continue the series of retreats started in 2014. The Fall 2015 retreat brought a focus on three areas for defining future directions for the Society.

Do you think getting a bunch of engineers and geologists to agree on something is easy? Hah! At the first retreat, everyone had a say, but when it came time to put together the minutes, it was next to impossible to consolidate the ideas into categories. A lot of good points were made that were continued in discussions during the second retreat. By the third retreat in the Fall of 2015, we wised up and member John Wiebmer facilitated the session, whipped us into shape and we accomplished something!

That was the beginning of the three MMSA for the Future committees. Their activities have been reported in the newsletters.

The Committees have been working on compiling their strategies and recommendations. At the October 21 retreat, the Executive Committee and Councilors will gather and refine the proposals. Some of the proposals will require votes of the membership at the Annual Meeting.

If you have any other topics about MMSA and the future of the Society

Membership Update

The following changes in membership have taken place since the last newsletter, with the authority of the respective membership committees.

Regular Member Additions:

None

QP Members Confirmed:

None

Membership Deletions:

Bruce T Stanley

MMSA presently has a total of **340** members, **4 in process**. Currently, **196** members are QP members

Additions, deletions and routine changes to the Society's data base and member biographies are accessible through the Members Only page in our web site, at www.mmsa.net This data base is the best source for information on any particular member.

you would like the Council to address, please contact the MMSA office. It is important to keep the goals dynamic and make sure the needs of members are considered and implemented where possible.

Committee Reports -

QP Enhancement—The Committee has identified two additional QP categories that will be presented at the October retreat. The committee has worked on titles for the categories, the qualifications, and how to implement the new categories. If the Council approves the proposed categories, the details will be published to the membership and a vote will be taken at the 2018 Annual Meeting.

Quality Membership Committee—The committee has developed a list of criteria that would define the qualifications for Senior QP. The concept will be presented at the October Council Retreat for discussion and approvals. If the Council approves, the action will be presented to the

membership for a vote at the Annual Meeting in February. The committee has also discussed how MMSA can address the need to improve technical report writing and how to support educational opportunities for QP members.

Next Big Thing Committee—The committee is developing ideas about a workshop on abandoned mine lands. The idea developed as a result of the Mine Closure Summit the Colorado School of Mines organized in the Fall of 2016. CSM is planning another summit for November 14 with a theme of orphaned and abandoned mines (see announcement below). MMSA is collaborating with CSM on the November conference and will offer a speaker.

The committee has also developed a proposal for a workshop to be organized in the Spring of 2018. The MMSA Council has approved the concept and a program committee is being organized. The proposal will be discussed at the October retreat.

More information will be provided in coming newsletters.

Continuing Professional Development—The CPD Audit Committee has started auditing CPD logs from 15 QP members. The first group of logs submitted were requested from audit committee members. Eight logs have been approved so far. Several of the auditors have had questions and suggestions about the process, and the auditing methods will be refined during the coming months.

QP members are required to keep a log of their qualifying activities. Logs do not have to be submitted until requested. When a CPD log is requested, the QP must be prepared to submit logs for the most recent three years. QPs will be requested to submit a log at least once every seven years. More information about the CPD program and a sample log can be downloaded from the main page of the MMSA Web site.

A Framework to Manage the Environmental Reality of Orphaned and Abandoned Mine Lands

The Summit is being sponsored by the Colorado School of Mines and The Payne Institute for Earth Resources on **November 14, 2017**

This high-level summit will be convened to discuss best practices and potential opportunities to continue the discussion and navigate the complex

environmental, political and social aspects of managing orphaned and abandoned mine lands. The discussion topics will focus on Technical, Partnerships and Policy, and Administrative.

If you are interested in attending, **respond by October 1, 2017** to the online registration at <https://www.eventbrite.com/e/orphaned-and-abandoned-mine-lands-tickets-36462931610>.

MMSA will be participating in the conference.

QP seals are available from MMSA.

The seal comes as a self-inking rubber stamp and the stamp is about 1 high by 2.6 inches wide. The stamp has the MMSA logo, member name, and member number. The cost is \$35, including shipping. To order a QP seal, contact the MMSA office or order directly from the MMSA Web site (www.mmsa.net/payments). The QP seal is in the Products category.

2008 MMSA Centennial Medallions are available for the great price of \$40. The coin has 1 oz of silver and 24 carat gold plating.

