

EXPLORE & DISCOVER

A CORPORATE NEWSLETTER

Published by Big Rock Exploration, LLC



2018 Summer Quarterly ©Big Rock Exploration, LLC, 2018

Contents

Note From The Corner Office	3
Strategic Minerals	4
Geologic Mapping	5
Big Rock: In The Field	6
Team Big Rock	7
Rocks In The News	8
Bridging The Gap	9

Who is Big Rock Exploration?

Big Rock is an international technical consulting company based out of Minneapolis, Minnesota. We specialize in natural resources including metals, minerals and energy.



What does Big Rock do?

Big Rock is focused on identifying, exploring and evaluating mineral and other natural resources. Our vast network of geoscientists, project managers, GIS professionals and field technicians provides clients with reliable expertise for all kinds of natural resource projects.

We focus on tailored project solutions for our clients by offering diverse and professional technical services.

EXPLORE OUR SERVICES

Let's get in touch!



www.bigrockexploration.com

info@bigrockexploration.com

612.236.4562



1620 Central Ave NE #104 Minneapolis, MN 55413

Note From The Corner Office



Metals & Minerals Can Help Cut Pollution & Promote Environmental Sustainability

Yes, it's true, metals and minerals offer a solution to curb many of the pollutants across our global ecosystems. The world is feeling many drastic and negative impacts from pollution, from which a variety of opportunities are being born. Metals and minerals provide many new opportunities to cut emissions, purify water, and provide resources that pose a much smaller threat to the environment than many of the current sources.

In this issue we cover the following primary topics:

- Copper, its significance and implications for providing real solutions to cutting carbon emissions through electric vehicle expansion
- Innovative new technology for geologic mapping using electronic tablet devices with streamlined, real-time, data management
- Sand and gravel modern exploration and targeting methods; materials crucial in repairing our transportation and infrastructure.



DIG DEEPER:

How Plastic Became A Global Environmental Crisis

READ MORE

The National Geographic published an article in their June 2018 issue, which explores the effects of plastic pollution. Until recently, many of us never thought of plastic as a major toxic pollutant. While I read the article, I kept thinking...what did we make things from *before* plastic? The answer is simple and profound...before plastics, things were made from minerals, metals and agricultural products.

Plastics have polluted our oceans and landfills with such staggering volumes compared to other known substances. Why is this? Multiple reasons, but the economics of recycling minerals and metals continues to evolve, while the economics of recycling plastic continues to be a struggle.

Big Rock firmly believes that many of the world's waste problems can be solved with new and innovative ways of thinking. A key component is bridging-the-gap in understanding the true value of the mining industry and its critical connections to sustainability and environmental stewardship. If we stand a chance of eliminating the numerous challenges of pollution, in its many forms, we must acknowledge the fact that minerals and metals offer a real solution to that. Solar panels, wind turbines, electric cars, battery powered technology, water purification, and many other technologies rely heavily on the production of metals and minerals. An important point to consider is the fact that responsible mining companies have proven again and again that they can extract resources safely. Do the environmental and social risks of mining outweigh the numerous benefits to the environment and modern society? I would argue not.

Mining is a critical necessity in modern society.

Cheers

Brian Lentz Vice President Big Rock Exploration, LLC



The real risks lie in where and how the mining occurs. Do we believe that the US, Canada, Australia and other countries can mine more responsibly than unregulated countries with little regard for human rights? Big Rock believes that we can help provide sustainable solutions for the future through responsible mining initiatives.

EXPLORE & DISCOVER: 2018 Summer Quarterly

Strategic Minerals

THE CRITICAL STATE OF COPPER

By Gabriel Sweet, Senior Geologist, Big Rock Exploration - Based on concepts by Dr. Phil Larson, Vesterheim Geoscience, PLC

The green energy industry has been steadily increasing its share of the global energy market over the last decade. As a result, the immediate demand for technology-critical metals like copper, cobalt and lithium have spiked, and global markets and the mining industry have responded by investing heavily in exploration and development of responsibly-sourced resources. Copper has been a key metal in the development of the industrial revolution and it is currently a critical metal for advancing many of today's societal and green energy needs.

Copper in an Energy Revolution

Since the birth of commercial electricity, copper continues to play a critical role in energy generation and movement.

No other element combines key properties of abundance, affordability, ductility, malleability, and electrical conductivity. Copper is also easily recycled making it a highly sustainable metal.



A Simple Test Case

Recent announcements by multiple developed nations and major automobile manufacturers to move away from combustion engine-based vehicles implies a serious copper supply chain crunch. To examine the impact of such a transition on copper consumption and new production, consider this simple case study:

0

What effect would we see on copper consumption and production if the US replaced its existing consumer vehicle fleet (approximately 250 million "light duty" vehicles) with available alternative energy vehicle (AEV) technology over the average expected lifetime of a vehicle (approximately 13 years)?

1,015,000,000 lbs

Total pounds of <u>annual</u> new copper production needed to convert existing fleet to fully-electric in 13 years.

The Future Of Copper: Numbers In Context

What do these numbers mean within the context of new copper production? Consider Polymet's Cu-Ni-PGE Project in Minnesota. The total production over the 20 year Life of Mine (LOM) is anticipated to be ~1.1 billion pounds of copper². To meet this level of copper production for fleet conversion, it would require mining the equivalent of a Polymet sized deposit each year for 13 years!





As surprising as this simple case study may be, it is vital to note that these numbers do not account for additional increases in copper consumption required for changes to the nation's energy infrastructure (e.g., charging stations) or power generation capabilities (e.g., solar, wind, hydro power) that are necessary to support the AEV fleet energy demands, resulting in an even higher demand for new copper production.

Also, this example is reflective of the United States only. Pending national and global-scale green energy initiatives, society will need to account for a substantial increase in new production of copper. The reality of changing the way we generate and consume energy may require a substantial increase in global production of copper and other associated strategic and critical minerals. Big Rock recognizes the connection between minerals, mining, energy and environmental initiatives and is leading the way in exploration and development of these critical resources.



Copper is a **CRITICAL** and **proven solution** to cut carbon emissions *AND* move towards more green energy products!

 Annual Minerals Commodity Summary - Copper: (USGS), 2018
Polymet Northmet NI-43-101 F1 Technical Report, (Polymet Mining LLC), March 26, 2018
Electric Vehicle Market and Copper Demand, (International Copper Association - Copper Alliance), June 2017

Geologic Mapping

MODERN FIELD MAPPING with ArcGIS Online©

By Roger Schulz, Geologist & Senior Data Manager, Big Rock Exploration

OVERVIEW

All field geologists have a very specific set of standard tools that have not changed for over a century. These tools always include a notebook, map, rock hammer, and compass. Big Rock Exploration has added to these time-honored tools and techniques with the help of modern technology. Though the standard field gear will never change, technology can be used to enhance the quality, efficacy, and quantity of data that is captured in the field. Big Rock utilizes a customizable digital mapping platform on numerous projects. Big Rock geologists are now able to digitally record their observations while sitting on an outcrop. These techniques, combined with traditional mapping, have benefitted clients with better quality data and more efficient map creation resulting in quicker identification of high quality resource targets.





Figure A shows a diagram representing the fluid data flow from the field to the office using ArcGIS Online as the Hub which allows for real-time data interaction Figure credits: Big Rock Exploration © 2018



Figure B represents how ArcGIS Online can be used as the central data platform for data collection, analytics, mapping and more. Figure credits: Big Rock Exploration © 2018



Figure C shows the user and user interface for the map interface and data collection features used in the field Figure credits: Big Rock Exploration © 2018

TRADITIONAL METHODS

A traditional approach requires the field geologist to record everything at the outcrop in a notebook, then sit at a computer and type up their notes in spreadsheets, introducing potential for simple data entry errors. This lack of standard structure can make data entry and cleanup a cumbersome task that slows down the project, potentially resulting in the development of bad or unusable data. Big Rock's innovative digital data collection approach adds a simple and cost effective step for field geologists.

MODERN METHODS

Big Rock is currently utilizing a number of apps and a fleet of smart devices to digitally record data and supplement the field notes. Geologists can quickly fill out all the standardized data, in a matter of minutes using easy and intuitive forms. The smart device can link field photos with data entry, log location information using the internal GPS, and even "scan" field notes. The app will cash all data on the device when there is not an internet connection and will sync it when a connection is available.

VALUE ADDED RESULTS

The implementation of a mobile field collection application has cut down on data compilation time, has reduced errors, and has delivered a more consistent, reliable product to our clients. The use of classic tools of notebook, map, rock hammer, and compass will not change, but the modern geologist will also add a smart device to their arsenal to enhance traditional scientific methodologies and will, in turn, create a better product. Big Rock continues to innovate and provide our clients with the best value while enhancing the scientific integrity and transparency to Explore & Discover new resources!

Big Rock: In The Field

SAND & GRAVEL EXPLORATION

By Leif Johnson, P.G. & Senior Geologist, Big Rock Exploration

UNDERSTANDING THE PROBLEM

Sand and gravel producers are constantly evaluating ways to improve production and reduce costs. Because sand and gravel are a low-priced, bulk commodity, small changes in the operational workflow can lead to larger profit margins.

Depending on market demand and the size of an operation, adding new properties to a company's resource base is also an ongoing necessity. These new properties need to be evaluated with a systematic approach to justify acquisition costs and to provide a reliable prediction of future product quality and availability.

IDENTIFYING AND CHOOSING THE RIGHT SOLUTION

In most cases, new properties will need to be drilled and the selected drilling and sampling method can have a significant impact on the future production costs for a property. The main revenue stream is typically found in coarser sized gravel.

So, the drilling and sampling method must be able to accurately capture this size fraction. Sonic drilling, while more expensive, can accurately collect coarser material and provides a continuous sample of the drill hole in difficult ground conditions.

DATA ENABLES SMART PLANNING & STRATEGIC DECISION MAKING

The cost of exploration drilling needs to be weighed against the desired and necessary data required to create a reliable mine plan.

In some cases, the operators can choose to spend more money on the front end of a project to have potential lower operating costs in the future.



Figure A . A gravel mine operation will eventually run low on reserves. It becomes necessary to evaluate new properties. Ideally, an adjacent property will be available to development. This usually means the geology is somewhat known and potential site conditions are predictable. If the site is a greenfield location, then a desktop geological review is required.



Figure B. Different drilling methods have pros and cons. Auger drilling is commonly used in sand and gravel exploration, but the data obtained can sometimes be incomplete. Sonic drilling, while more expensive, is an ideal method for unconsolidated deposits. With nearly 100% recovery, ability to capture coarser gravel, and low drill refusal potential on cobbles or even boulders, obtaining sound geological data is assured.



Figure C . Once an exploration program is complete, it's necessary to analyze the data competently and to complete a reliable resource estimate. Providing the drilling and sampling has been done with a systematic methodology, then the resource estimate can provide an accurate prediction of potential reserves and future cost projections.

Team Big Rock

MEET LINDSAY SMITH



Lindsay Smith

Project Manager

PERSONAL HIGHLIGHTS

EDUCATION

BSc Geosciences University of Victoria, Victoria, BC - 2013

EXPERIENCE

Magmatic Deposits (Ni-Cu) Mesothermal Veins (Au) Unconformity Associated Uranium (U) Kimberlite Pipes (Diamonds) Banded Iron Formations (Fe) Porphyry Deposits (Au-Ag, Mo-Cu) Epithermal Veins (Au-Ag) Magnetite Skarns (Fe-V) Shear Hosted Lode Gold (Au+/-Ag)

CERTIFICATIONS

Geologist in Training NWT WSCC Level II Supervisor

YEARS OF EXPERIENCE

7 years

 \square

lindsay@bigrockexploration.com

in Lindsay Smith

"I find Big Rock's commitment to transparent, ethical and environmentally sound resource extraction inspirational."

- Lindsay Smith

Lindsay grew up on Quadra Island in the Discovery Islands, B.C., Canada. She attended the University of Victoria, earning a double degree in geography and earth and ocean sciences. She currently enjoys life and the local geology on Vancouver Island, B.C., Canada.



Lindsay started working as a field hand for junior exploration companies in the summer of 2007 while attending university. She fell in love with economic geology and has been practicing with her pencil crayons, arguing with software, and obsessing over drill hole deviations ever since.

In an effort to broaden her skill set Lindsay has worked on a spectrum of deposits and projects over the years. Her clients have ranged from junior exploration companies, to service providers, to major mining companies. Her current skill base includes mapping, geophysics, geochemistry, remote sensing, drilling, targeting, and project management.

Since joining the Big Rock team in November 2013, Lindsay has worked on advanced exploration and mine site drilling programs with greenfields exploration and staking thrown in for currency. She usually acts as a supervisor or field manager these days, focusing on drill operations and geophysics.

"Lindsay is the type of person who can bring the brains and positivity to every single project. We are so excited to have Lindsay with her depth of knowledge and leadership" explains Brian Lentz, Principal and Vice President at Big Rock. "If there is anyone who we can rely on to get the job done right and fit seamlessly within any project, it's Lindsay."

Lindsay enjoys gardening, quilting, gold panning, and sorting through her mineral collection in an endless attempt to "only keep what I absolutely need".

Rocks In The News

GEOLOGY MAKING HEADLINES

Meet The Covert Geologists That Helped The Allies Win The Second World War

July 31, 2018, Robin Andrews, Forbes

"Scientists are often recruited during times of conflict to serve the national cause. Generally, when we think of those stolen academics, we think of physicists, chemists, engineers and mathematicians - the type that can either build better weapons or crack the enemies' codes. That's fair enough: they certainly made up a disproportionate number of researchers recruited by the military in the 20th Century. What you may not know, however, is that geologists have played a role in warfare too..."



Photo Credit: Imperial War Museums

READ FULL STORY

There Are Over A Quadrillion Tons Of Diamonds Lurking 100 Miles Below The Earth's Surface

July 16, 2018 Jeremy Berke, Business Insider

Using sound waves, scientists uncovered a cache of diamonds distributed deep below the Earth's surface, and it amounts to over a quadrillion tons of the precious mineral.

That's according to a new study published by a team of researchers from MIT, Harvard, and the University of California at Berkeley, among other top-tier institutions.

"This shows that diamond is not perhaps this exotic mineral, but on the [geological] scale of things, it's relatively common," said Ulrich Faul , a research scientist in MIT's Department of Earth, Atmospheric, and Planetary Sciences who helped write the study. "We can't get at them, but still, there is much more diamond there than we have ever thought before."



Photo Credit: Wiki Commons

READ FULL STORY

Underground Lake Found on Mars? Get the Facts

July 25, 2018 Nadia Drake, National Geographic

Liquid water is refreshingly abundant on moons in the outer solar system, but it has proven surprisingly tough to find in reliable quantities on Mars–until now.

Radar scans of the red planet suggest that a stable reservoir of salty, liquid water measuring some 12 miles across lies nearly a mile beneath the planet's south pole. What's more, the underground lake is not likely to be alone.

"There are other areas that seem to be similar. There's no reason to say this is the only one," says Elena Pettinelli of Italy's Roma Tre University, a coauthor of the paper reporting the discovery today in the journal Science.



Photo credit: Science History Images Alamy Stock Photos

READ FULL STORY

EXPLORE & DISCOVER: 2018 Summer Quarterly

Bridging The Gap

EDUCATION AND OUTREACH

Libraries Rock With Big Rock

"I just wanted to say thank you for all that you and your geologists did to make yesterday's summer reading program activity day a success. Aubrey and Michael were great and the kids had an amazing time! The mineral samples were especially appreciated by all involved - especially by the kids. Again, thank you all for your service to this community"

- Library Director

Big Rock Continues To Support Local College Partners

Gabe Sweet, Senior Geologist at Big Rock Exploration, is a proud Alumnus of Macalaster College in St. Paul, MN. Big Rock has developed a strong partnership with Macalaster over the years, and is excited to have Gabe continue to participate and help lead field trips for their fall Mineralogy class.

Big Rock Talks Rocks With Local Preschool

Leif Johnson, Senior Geologist at Big Rock Exploration, talked rocks with Especially For Children Preschool. The kids were super excited to talk about rocks, minerals and dinosaurs! Leif made sure to dress the part and hand out plenty of mineral samples.

The Big Rock team is excited to help foster interest in the next generation of innovative geologists!



2017 Field Intensive <u>Fiel</u>d Team



Thank You card from the class



Excited kids picking out quartz crystals with Big Rock Geologist, Aubrey Lee

Big Rock Continues To Expand and Develop Strong Relationships At The YMCA

Y of the Twin Cities - MN

Big Rock is proud to continue as an inaugural sponsor of the Y's Prairie Burn Music Festival. Now in it's 5th season, PBMF continues to be a huge success in raising \$ to help send kids to Y camps throughout the Twin Cities. Get your tickets before they're gone!

Big Rock is proud to be Prairie Burn's title sponsor featured on this year's concert poster.



Y of Rapid City - SD

The Big Rock team is excited and proud to share the news of their new partnership with the Y of Rapid City, South Dakota and their Giraffic Park Day Camp. Big Rock was presented with an appreciation award for our financial support and our involvement in teaching kids about geology at the Day Camp.



Vice-President Brian Lentz is presented an award by the Y of Rapid City, South Dakota.