CREATING VALUE IN AN UNCERTAIN WORLD

How to proactively manage risks and pursue opportunity while addressing global challenges

EXPLORE & DISCOVER
QUARTERLY NEWSLETTER
Responsible exploration and development of Earth’s resources has never been more critical to human life and well-being. Mining of metals, minerals and energy enabled the industrial revolution and elevated much of the world’s population out of poverty into the prosperous, thriving economies we know today. However, the continuity and future success of global societies will depend on our ability to find and utilize these critical materials without compromising the sustainability of our planet’s natural systems.

Today’s risk environment is, in many ways ignorant of industry, sector, nationality or locale. The vulnerability and disruption of manmade systems like globalized supply chains, or natural systems like our Earth’s climate, pose risks for business and value creation that span the globe. Modern business and community leaders must chart a course amidst conditions that are increasingly interconnected, interdependent, and rapidly changing.

Major drivers of complex global changes like population growth, urbanization, and technological advancement can strain our societal institutions. These conditions are presenting novel challenges to the viability of historically sound business models and pushing proven strategic frameworks towards obsolescence. These new challenges to growth stimulate competition and present new frontiers for the best innovators and entrepreneurs.

In this issue we explore strategic minerals that are critical for renewable energy and modern tech. As highlighted in previous issues, strategic minerals are essential components of our daily life and an increasingly important building block of our modern society. We also take a look through the microscope at how valuable and important petrography and ore microscopy methods are for finding and classifying ore deposits. Furthermore, we discuss our continued focus on key fundamentals of Big Rock; our growth culture, specialized team and sustainability. Stay tuned throughout 2019 as we embark on an exciting path to explore and discover into the future.

Cheers!

BRIAN LENTZ
Vice President
Part of our business development strategy is taking a high-level view of industries and sectors that rely heavily on strategic minerals we’re exploring for. It’s no secret that technology companies make up a massive portion of the global economy, and their products such as the iPhone contain a tremendous number of specialized components.

By breaking down the iPhone into its constituent components we can identify where in the supply chain certain manufacturers are positioned, and then evaluate the nature of their sourcing and pricing. This level of analysis also helps us track the flow of capital investment to various projects and forecast the fluctuating demand for commodities based on regional scarcity or abundance.
ANY MINING GEOLOGIST WILL AGREE THAT THE MOST CHALLENGING MINERAL ASSEMBLAGES TO CLASSIFY ARE THOSE RELATED TO THE FORMATION, ALTERATION, AND WEATHERING OF AN ORE DEPOSIT. PETROGRAPHERS COLLECT A VARIETY OF DATA FROM THIN SECTIONS INCLUDING PRIMARY AND SECONDARY MINERALIZATION, ALTERATION, STRUCTURE, AND TEXTURES RELATED TO THESE EVENTS. THESE CRITERIA ARE ESSENTIAL TO CONSTRUCTING PARAGENESIS, MINERALIZATION TIMING, AND DEFORMATIONAL EVENTS. PETROGRAPHY CAN HELP TO BUILD A REGIONAL ALTERATION AND STRUCTURAL FRAMEWORK AND REVEAL MINERAL ZONATION PATHFINDERS TO TARGET A DEPOSIT. FINALLY, PETROGRAPHIC WORK IS A REQUISITE FIRST STEP TO SELECTING SAMPLES FOR MORE ADVANCED ANALYTICAL METHODS SUCH AS LASER ABLATION (LA-ICP-MS), SIMS, OR SYNCHROTRON-BASED STUDIES.

While the common rock-forming minerals – a small subset of the mineral kingdom – provide criteria for rock-classification, the accessory mineral species must be equally regarded. Since ore deposits are generated through various physiochemical reactions, identifying all products of these reactions is key to elucidating their conditions of formation. Hand sample and drill core analysis relies on the naked eye and is often supplemented with very expensive analytical techniques. At relatively low-cost, one can adhere a 30 micron-thick slice of rock to a microscope slide and reveal a wealth of information to boost exploration.

At Big Rock, we use our petrographic microscope to study rocks from a variety of ore deposit types. A typical petrographic microscope passes transmitted light through a slice of rock to highlight the transparent silicate minerals while an ore microscope reflects light off the thin section to illuminate the opaque metallic minerals. Big Rock’s scope has both capabilities. This allows us to study whole-rock crystallography and textures as well as metallic ore and accessory minerals.

In conjunction with other exploration tools, we’ve found that petrography can add great value to an exploration program and is crucial to understanding the formation of an ore deposit. Petrographic study of minerals in thin section is also employed in other industries including manufactured materials like cement and ceramics, and in medicine to image kidney stones and bones. Using microscope technology to analyze rocks and minerals is a proven method to explore and discover future resources.

Fig. 1: Trans_photomicrograph: Photomicrograph image of quartz-rich rock showing quartz deformation textures, muscovite alteration, and arsenopyrite mineralization. 4x magnification. Cross-polarized transmitted light. Qtz = quartz. Bt-Musc = biotite and muscovite. Apy = arsenopyrite.

Fig. 2: Refl_photomicrograph: Photomicrograph image of gold-bearing rock showing multiple metallic minerals in a carbonate matrix with trace gold mineralization. 40x magnification. Plane-polarized reflected light. Ank = ankerite. Py = pyrite. Sph = sphalerite. Au = gold.
Big Rock believes a strong growth culture is one that is dedicated to honest and thorough self-assessment with a continuous effort to refine, develop and improve. This isn't just an organizational quality, it is an essential characteristic we look for when recruiting the next generation of explorers. While seeking out talented scientists has been a core objective to building an effective staff, we've been hyper-focused and deliberate about finding the right people that embody our values and help to elevate the team. Valuing our people as unique assets in our company is a core value we are proud to promote at Big Rock.

Once we've identified the right people for opportunity with Big Rock, it's important that we get to work building the long-term relationship. Part of this process is finding a mutually-beneficial fit within the company to help maximize an individual's strengths while balancing perspectives and personalities across the team. From a leadership standpoint, the relationship with our staff is built on trust, respect, and commitment from each side to the mission and vision of Big Rock. When new staff join our team, they know they're in a culture that values family, environmental and social responsibility, scientific quality and hard work.

One of the strongest ways we can express our commitment to staff growth is by investing in their well-being and professional development. Whether it's actively placing them on projects that ignite their passions, or opening doors for continuing education opportunities like conferences, trainings and short courses, we believe that if we create value for our team, they will in turn help create exceptional value for our clients.

Big Rock is continually looking for talented, driven professionals that want to be part of a young, energetic, and growth-minded team. Each person is vital to the our collective success and responsible for delivering exceptional results for our clients.
My family goes camping a lot so I was outdoors a lot as a kid. In the summer during high school, I went on canoe trips with YMCA Camp Widjiwagan (based in Ely, MN) culminating with a 6-week whitewater canoeing trip through the Northwest Territories and Nunavut. When I started college that fall, I took my first Geology class and I think I liked it so much because it helped explain why the different landscapes I had seen look the way they do... How rivers and glaciers change a landscape, how it's influenced by the bedrock underneath... 

After that one class, I was hooked and haven't looked back since.

A college class in "Mineral Resources and the Environment" sparked my interest in economic geology, and I've always loved working in MN because it has everything from Archaean to Quaternary geology.

My research in grad school focused on removing metals from effluent at the Soudan Underground Iron Mine site using native fungi and bacteria. I enjoy thinking about the interactions between biology and geology, especially at small scales.

My dream project:
My grandfather worked for the Bureau of Mines trying to figure out how to drill on the Moon. It would be really cool to follow up on that and work on a project that studied mining in space. Another (more plausible) dream project would be biomining, using microbes to sequester metals from low-grade ore and waste rock.

Why Big Rock?
I'm excited to learn and grow with Big Rock on a hard-working team that values creativity, collaboration, and care for each other and the environments in which we work.

Team Big Rock

Specializations
- Field Mapping
- Sampling Programs
- Data Analysis
- Evaluations & Reporting
- Drilling Programs

Field Expertise
- Geomicrobiology
- Granite-Greenstone terranes
- Precambrian geology
- Orogenic gold
- Biogeochemistry
- Paleoenvironments
- Environmental geochemistry

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Scientists may have just found the oldest intact Earth rock—on the moon. A study published Thursday in Earth and Planetary Science Letters makes the case that one of the rocks collected by Apollo 14 astronauts in 1971 contains a fragment of Earth's ancient crust, dating back more than 4.011 billion years.

It's possible that the fragment formed in a weirdly water-rich pocket of magma deep within the ancient moon. But the study authors think it's likelier that the rock formed within our planet's crust and got jettisoned to the moon by one of the many meteor impacts that bombarded early Earth.

Ultima Thule, an icy world 4 billion miles from the sun, looks like a big snowman. Planetary scientists have never before seen a close-up of a body like Ultima Thule. It is likely a fragment that coalesced more than 4.5 billion years ago and which has remained in the deep freeze of the solar system's Kuiper belt ever since.

If it is indeed a pristine planetesimal, a building block of the planets, studying it will offer clues to how Earth and its neighbors formed.

On January 2nd, China National Space Administration (CNSA) was able to successfully land its Chang'e-4 spacecraft on the part of the moon that Earth cannot see and no other spacecraft has reached before. The ship was launched in early December and has been orbiting around the space mass for weeks in preparation for the "dark side" landing. According to the state news source Xinhua, the Chang'e-4 successfully landed on the Von Karman crater.

This mission is just one part of China's growing space exploration ambitions. This latest Chang'e-4 mission according to Xinhua intends to "provide firsthand data and clues for the evolution of the moon, earth and solar system."
In light of the theme that runs throughout this newsletter issue, Big Rock is excited to share that “Sustainability In Practice” is our key initiative for 2019. Thus far in our growth, as a company we’ve staked our reputation on a commitment to economic, environmental, and socially responsible business that “does no harm” and creates value for society. Just as we push ourselves to lead our scientific field, we’re seeking to lead by setting a new standard of stakeholder engagement and shared value. Later this year, Big Rock will be publishing its first ever sustainability report to further our transparency and communication with our stakeholders. Listed below are some of the steps we’ve taken to put our values into practice.

**ENVIRONMENTAL STEWARDSHIP**
We believe in the responsible use of our natural resources, protecting ecosystems, and minimizing our footprint.

**HIRE LOCAL, SOURCE LOCAL**
We recruit and employ talented and qualified professionals where we work and operate.

**WIN-WIN PARTNERSHIPS**
We compete to create value but collaborate and partner whenever and wherever possible to better serve clients.

**SUPPORT YOUTH & STUDENTS**
We create practical and relevant work-learning opportunities for students and young people.

**EMPLOYEE WELL-BEING**
We support healthy, active lifestyles, economic job security, and strong family support for our staff.

**COMMUNITY BUILDING**
We spend time in the communities where we work building stakeholder relationships and giving back.
EYES ON THE HORIZON

DO YOU HAVE AN AGGREGATES PROJECT?

HIRE A BIG ROCK GEO.
Big Rock has expertise in providing geologic services on a variety of sand and gravel projects. With our boots on the ground support you can:

SAVE TIME  SAVE MONEY  PRECISE DATA

CONTACT US FOR A FREE CONSULTATION

SME 2019 ANNUAL CONFERENCE

DENVER, COLORADO
FEBRUARY 24-27, 2019

COMING MEET WITH OUR TEAM

PDAC 2019
Our mission is to provide our clients tailored project solutions through quality scientific investigation. Big Rock’s project geologists all have extensive field experience and top-tier safety training. While much of our staff works remotely on active jobsites, we are always building capacity to deploy the necessary technical expertise whenever a client is in need. If your project needs boot-on-the-ground today, we’re ready to help.

30+ TECHNICAL STAFF
15 CORE SERVICES
11 ACTIVE PROJECTS
7 ACTIVE INDUSTRIES

GLOBAL HQ
Minneapolis, Minnesota, USA
44° 59' 12" N  93° 15' 29" W

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MINERALS ARE THE FUTURE

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