By John Myers

# Digging Into the Promise of Copper

*Some of the world's most* **important metals** *lie below the forests of northeastern Minnesota. Mining could start within two or three years. But some say risks to the state's waters and wild places are too high.*

More than 1 billion years ago, as the Earth was spewing forth molten lava and pushing up mountain ranges, copper and nickel and platinum settled under what is now northeastern Minnesota. There's gold down there too—and silver and palladium and titanium.

Geologists call this underground rock formation the Duluth Complex. And they say if you dig deep enough, you'll find a fortune of metals—an estimated 4 billion tons worth far more than $1 trillion. No one really knows how much is there. The more geologists look, the more they find.

"We do know that this is the third-largest copper and nickel resource on the planet, mined or unmined. It's fourth for contained precious metals," said Jim Miller, geology professor at the University of Minnesota Duluth and director

DRILL RIG TAKING CORE SAMPLES ON BIRCH LAKE BY DAVE WITT

PHOTO COURTESY OF IDEA DRILLING, LLC

*This drill rig is mounted on rubber tracks to minimize ground pressure and soil compaction.*

## Demand Going Up

Nonferrous metals are key elements in just about everything we own, from copper wiring in homes to palladium in catalytic converters in cars. Inside every smartphone is a potpourri of copper, gold, palladium, and platinum. More than 8,000 pounds of copper go into a single large wind turbine. If you own a hybrid car, you're driving around with about 9 pounds of nickel and 75 pounds of copper.

"The ironic thing is that none of this push to high-tech, green technology would be possible without one of the oldest industries known to man: mining. There's no other way to do it," said Bob McFarlin, Twin Metals vice president of public and government affairs. "Our vision is that Minnesota can become a principal producer of raw materials for the global green economy."

Many of these metals are also considered strategically important for national defense. The United States is currently importing most of them, often from nations with poor records of environmental protection.

"If we have this vast resource here, if we know we can do it the right way, aren't we somewhat obliged to mine it here?" said Larry Kramka, DNR Lands and Minerals director.

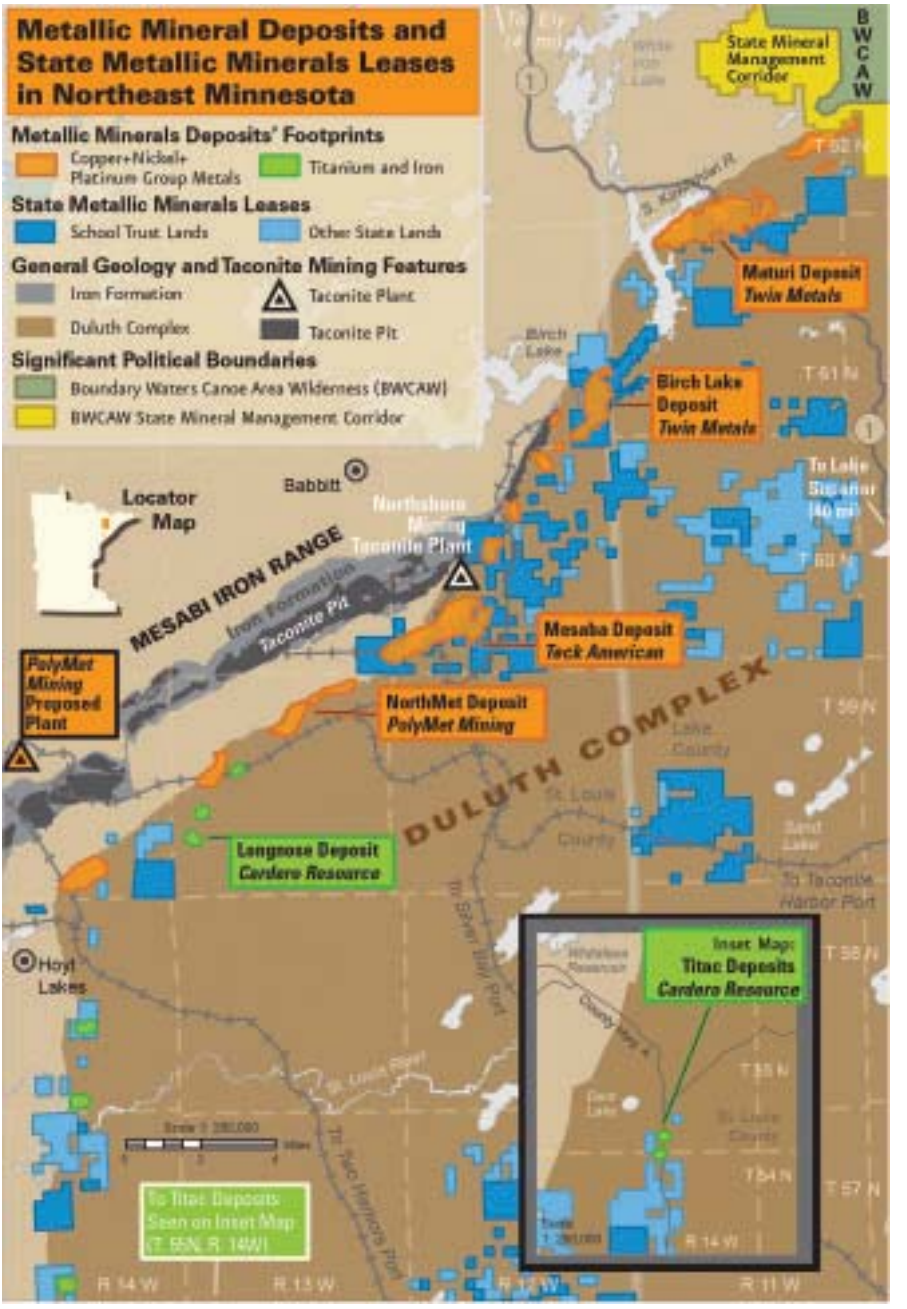
of its Precambrian Research Center. "This isn't some small sideshow. This is a world-class mineral deposit."

It's the sheer quantity of what's down there—coupled with skyrocketing demand for copper and other metals for new technology, green energy, electronics, and growing markets worldwide—that explains why Miller believes it's inevitable that copper will be mined in northern Minnesota, sooner rather than later.

"We're talking about a copper range here that will rival or perhaps surpass the Iron Range in economic impact. It's not a few hundred jobs for a decade or two. It's thousands of jobs for maybe a century," Miller said. "It's really not a question of whether it will be mined. The question should be: When will it be mined?"

The answer from at least some Minnesotans is a resounding "not now."

Some conservationists, local residents, tribal members, and even some government officials are skeptical, saying too many unanswered questions remain about what happens when you mine copper in a region rich with lakes and rivers. The loss of wetlands and forest habitat and industrial encroachment into quiet areas are concerns. Others question why the state wants to




DNR

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tie itself to another cyclical mining industry, which can, like iron ore has for more than a century, go from boom to bust in a matter of months and leave workers and entire communities in despair during the bad times.

But perhaps the biggest concern surrounding copper mining is the potential for polluted runoff into waterways. Unlike iron ore, which is mined from mostly benign less-reactive rock, copper is usually found in sulfide-ore bodies. When exposed to air and water, sulfide-bearing rock generates sulfuric acid, which must be managed, if it is in high enough concentrations, so that it does not lead to acidic runoff.

Compared with open pit mines, under-

*Open pit copper mining follows steps similar to that of iron ore mining, shown here. An electric shovel* (below) *scoops up raw taconite blasted into chunks no larger than 48 inches.*

REPRESENTATIONAL PHOTOS FROM MINNESOTA TACONITE MINE BY JENNIFER ENGSTROM, DNR

*A mammoth truck hauls 240 tons of ore to the crusher* (above left and right), *which breaks it into 8-inch and smaller chunks. A fine crusher further reduces chunks to half an inch and smaller.*

# Copper Mining **Process**

The process of excavating copper from open pit mines isn't much different from the iron ore mining ongoing in Minnesota for more than 120 years. Geologists find the richest deposits they can, and then miners break the rock away from the earth, smash it up, and separate the valuable stuff from the rest.

Rock that holds the valuable metals is crushed and concentrated, and the target metals are pulled out. The concentration of copper in the raw rock may be only 0.30 percent, but a concentrator can bring that up to 30 percent before it's processed into actual copper metal.

The process of concentrating metals depends on the geologic conditions at the mine site. Copper mining

ground mines offer substantially less opportunity for air, water, and sulfur-bearing rock to mix, lessening the potential for acidic runoff from the mine itself. Still, all copper mines will need settling ponds, called tailings basins, which remove nonmetallic minerals. Water from these basins will need to be treated before being released into local streams, to make sure levels of pH, sulfate, metals, and other characteristics comply with federal Clean Water Act regulations and any standards the state sets in discharge permits.

At many copper mines in other parts of the world, acidic runoff—from mine pits, stockpiles, processing plants, and waste areas—has polluted waterways and killed

*Rod and ball mills* (top) *reduce taconite to face-powder consistency. In flotation cells* (above), *the ore is separated into high-grade concentrate and waste tailings.*

*The thickener* (above) *separates the process water from the concentrate, allowing the water to be reused.*

companies may use a hydrometallurgical process to separate out valuable metals in a contained pressure cooker of sorts, with little air or water emissions. The main byproduct is gypsum. Smelting is an older method of processing copper and nickel ore that is still in use. Unlike past smelters, current smelters have air-emission scrubbers that remove sulfur dioxide.

Because the waste rock can be acidic when exposed to air and water, how it is handled is a big issue. The water from rain and snow running off nearly all areas of the mine, including stockpiles and waste tailings basins, will be collected and treated before it's allowed to flow into nearby streams.

DNR PHOTO

*The DNR Drill Core Library in Hibbing stores drill-core samples from mineral exploration dating back to the early 1900s.*

## Mineral Rights

Not only the mining company makes money when copper and other ores are mined. The person, trust, corporation, or government that owns the ore in the ground also comes away with cash.

Mineral rights may be owned separately from the surface of the land. In general, the mineral owner has the right of entry to explore for and mine minerals, with the surface owner compensated for any resulting damages to the surface.

In Minnesota, owners of mineral rights that are severed from surface ownership must register their interests in the county recorder's office and pay an annual severed-minerals interest tax. Failure to comply with this law results in forfeiture of the mineral rights to the state to hold in trust for the local taxing districts.

Although federal, state, and local governments own or control some of the mineral interests in Minnesota, most mineral interests remain privately held.

You can find out if you own your mineral rights by checking your property's abstract. Any severance of the mineral rights should be recorded in the deeds transferring ownership.

fish and other aquatic animals and plants. That is a particular concern in Minnesota because the proposed mines are so close to the Boundary Waters Canoe Area Wilderness and the St. Louis River, which flows into Lake Superior.

"That's why we need a prove-it-first law in Minnesota, like Wisconsin has. Until someone shows us you can mine for years, close a sulfide mine, and still have pristine water, we shouldn't even start here," says Frank Moe, a former state lawmaker who now runs a dog sledding business on the North Shore. This past March, Moe mushed his dog team from Grand Marais to St. Paul to deliver petitions to lawmakers and the governor asking for a copper mining moratorium or a prove-it-first law. So far, no such legislation has advanced. But mining plans have.

### Big Plans Closer to Reality

Minnesota's first-ever copper mine proposal is for an open pit operation north of Hoyt Lakes proposed by Vancouver-based PolyMet Minerals Corp. PolyMet is planning a $600 million mine and concentrating plant, employing about 350 people and processing about 32,000 tons of ore containing copper and other metals every day for 20 years or more.

The company is in the process of trading private forest land it purchased nearby for 6,700 acres of national forest land where the mine is proposed. PolyMet is proposing to pay for new wetlands to be created elsewhere because hundreds of acres of wetlands at the mine site will be destroyed.

A supplemental draft environmental impact statement (EIS) is being developed under a contract managed by the Department of Natural Resources and federal agencies. The EIS process, which began in 2005, has taken longer than expected as mining plans have changed and as state and federal regulators have continued to work on air- and water-quality modeling used to identify impacts and the needed mitigation measures. The first EIS drew 3,800 comments from agencies, groups, and the public.

The supplemental EIS will spell out how the company expects to mine, process metals, and eventually close the mine and reclaim the land. If state and federal regulators agree with its plan, PolyMet will receive permits to begin operations. Those state permits are issued under the federal Clean Air Act and Clean Water Act as well as state mining laws.

Twin Metals isn't far behind. It is considering a massive underground mine southeast of Ely along Minnesota Highway 1 and the Kawishiwi River. Prospectors for Twin Metals have drilled hundreds of test holes to pinpoint large deposits, including one under Birch Lake near the BWCAW. This past March, Twin Metals—a joint venture of Canada-based Duluth Metals and Chilean-based Antofagasta—asked its engineering contractor to draw up plans for a copper mine that will reach 4,500 feet underground and produce 80,000 tons of ore every day for a half-century or more. The company is gathering base-line environmental data this summer and hopes to start the first stage of the environmental review process, called scoping, after the information is collected.

Another half-dozen companies are looking at Minnesota metals as well. Global giant Rio Tinto is exploring in Aitkin and Carlton counties. Canadian firms Teck and Cardero Resource Corp. are test drilling south of Ely and just north of Duluth.

Mining supporters say society's demand for copper is so great, and the potential economic benefit for Minnesota so vast, that the state can't afford not to dig into this opportunity. A 2009 University of Minnesota Duluth study predicts the coming copper boom could eventually result in three, four, or more mines, which could create 12,000 construction jobs, 5,000 permanent mining and processing jobs, and 10,000 spinoff service, supply, and related jobs.

Because the state government owns the mineral rights where much of the mining would take place, taxpayers stand to see billions of dollars in royalties as the copper is mined for decades to come. On lands where the state holds the mineral rights, much of those royalties would go to the state's Permanent School Trust Fund (see page 64). The state would tax each ton of copper ore produced, as it now taxes taconite iron ore. That could pump millions more dollars into state, school district, and local government coffers each year.

Bill Skradski, an Ely school board member, urged St. Louis County commissioners this past winter to pass a resolution in support of copper mining that would breathe new economic life into a community that

continues to lack living-wage jobs. "This is about the survival of the school district, the survival of a community," Skradski said. The county board backed the pro-mining resolution by a 4-to-3 vote.

### Ownership and Options

Before mining begins, before copper is even confirmed, prospectors do exploratory drilling. Companies pinpoint deposits by drilling test holes and extracting samples. Hundreds of those drill sites are scattered across northeastern Minnesota. This drilling is drawing criticism because of noise, logging at drill sites, and a patchwork of new roads into wild areas.

Mining companies gain access to drill sites by acquiring mineral rights and access to the surface. The state and federal governments own mineral rights under vast areas

## Six Decades of Prospecting

The first big copper discovery in northeastern Minnesota came in 1948. By the 1960s, companies such as INCO and U.S. Steel were leasing land and mineral rights and looking hard at where copper was and how to get it out of the ground. But the deposits found at the time were considered lower grade and harder to get to than copper in mines already operating worldwide. Moreover, the environmental movement of the early 1970s swept over Minnesota, spurring a moratorium on new copper exploration in the state from 1974 to 1980.

Mining companies backed off too, especially as the early 1980s recession sent copper prices plummeting. But by the 1990s, small mining companies and copper prospectors were looking again, poring over drill-core samples that DNR geologists and University of Minnesota Duluth researchers had cataloged from thousands of drill sites across the region. By the early 2000s, several companies had leased state and federal land mineral rights to explore. PolyMet and Duluth Metals, a parent company of Twin Metals, were already homing in on the richest deposits.

Then something happened on the other side of the planet that made Minnesota's copper deposits the focus of global interest. The price of copper, which sat around $1,000 per ton back in the '70s, topped $2,000 in 2004 as China began to use more and more metals to make more and more stuff. Demand and price continued to rise even through the recent global recession. In April 2012, copper stood at more than $8,300 per ton, and platinum, which had hovered around $400 per ounce in the 1990s, was at $1,600 per ounce.

While metals prices were skyrocketing, mining companies were developing new, cost-effective ways to extract small quantities of valuable metals out of huge amounts of rock.

"They've known the copper was there since the '50s, but it really wasn't economically viable to go get it," said Bob McFarlin of Twin Metals. "Now it is."

"It's probably a good thing that this didn't happen in the 1970s because Minnesota wasn't ready for it. The industry wasn't ready for it," said Jim Miller of the Precambrian Research Center. "But now the technology to find metals and process them is so much better. The environmental regulations are so much better. We can do this right."

in the northern half of the state, including below thousands of acres of private land.

Ron Brodigan owns more than 200 acres in the woods between Isabella and Ely. He built his Great Lakes School of Log Building there in 1975 because the area was wild and quiet. But the state owns the mineral rights under 120 acres of his land, and last year a mining company won the right to do exploratory drilling there. The company must negotiate with him for payment to gain access to the land, but Brodigan worries he may have little option to say no.

Brodigan said he knew he didn't own the mineral rights under his land. But he never thought Isabella would become a focal point for metals exploration. Now he's among the mining skeptics who say the copper rush will change the face of northern Minnesota forever.

"It's been very frustrating. They're saying we really don't have much control over what happens on our own land," he said. "I think we're going to see a huge social change up here as these mines develop. We'll have a mining boom like the oil boom in North Dakota. … But what about tourism? Will people want to vacation and canoe next to a mine? What about people who moved here to be around nature? I really don't know what I'm going to do."

PHOTO COURTESY OF TWIN METALS MINNESOTA

*A geologist with Twin Metals uses a compass to check the alignment of the drill rig to the exploration site.*

## New Technology, New Regs

The DNR Lands and Minerals Division oversees exploration and inventory of the state's minerals. The DNR and the Pollution Control Agency are charged with regulating mining projects and overseeing permit compliance. Both agencies will monitor development of the mines, processing plants, and tailings basins. The PCA permits, for example, will require the company to implement an extensive and detailed monitoring plan to ensure that all water-quality standards are met in waters downstream of the facility. The monitoring data will be watched closely for any sign that mine runoff may be negatively affecting water quality, such as any pH changes or increases in the levels of metals. Review of the monitoring data would also include watching the level of sulfate, a common by-product of mining, and industrial activities that are potentially harmful to wild rice at higher concentrations.

Lands and Minerals director Larry Kramka said he is convinced that Minnesota has the right environmental regulations in place and that the mining industry has the minerals-processing and pollution-control technology ready to protect the state's air and water.

RICHARD HAMILTON SMITH

# Wild Rice at Risk?

Some people worry that sulfate released from copper mines could affect wild rice in rivers. Sulfate, a natural chemical (a salt) in air, soil, and water, is often a by-product of manufacturing activities, including mining. Some tribal officials and biologists say a century of iron mining has increased sulfate levels in some rivers to the point where wild rice is harmed. It's believed elevated sulfate affects plant growth and the ability of rice seeds to germinate. The state adopted a sulfate standard for wild rice in 1973, and a Minnesota judge in May upheld that limit of 10 milligrams per liter of sulfate in waters used for production of wild rice. Meanwhile, state lawmakers have funded major new research to determine how much sulfate is too much for rice to thrive. Much of the proposed copper mining activity is planned for the St. Louis, Partridge, and other rivers that may already have high sulfate levels. Copper mining companies, including PolyMet, say they will meet the current standard by using wastewater treatment for water leaving the mine area.

Kramka is aware of concerns over acidic mine runoff, but he points out that Minnesota's copper is found in very low-sulfur rock compared with copper mines in other regions of the world such as Africa, South America, and Western states. Moreover, to prevent tainted runoff from entering local streams or ground water, the state will require state-of-the-art technology and practices—precision location and inspection of ore and waste rock to manage potentially acidic rock, use of membranes to prevent seepage, extensive water-treatment plants, and more.

Director of DNR Ecological and Water Resources Steve Hirsch said, "Copper mining can bring substantial economic benefits to the state, but it can also harm our state if we don't have good controls in place. It is critical for our environmental review to thoroughly analyze the potential for environmental impacts and identify alternatives or mitigation to address those impacts."

Mining companies won't receive permits to mine unless engineering and financial analyses show they have bankruptcy-proof financial assets, called financial assurance, and plans in place to cover the full cost of closure of the operations. Financial assurance

is reviewed annually by the DNR to ensure that assets remain adequate and to address the ongoing changes to the operation over the life of the mine.

"There won't be a mine functioning until they can prove it will meet state and federal environmental standards and until the financial assurance is there to back it up," Kramka said.

## Unanswered Questions

The Fond du Lac Reservation straddles the St. Louis River—the river into which discharge and runoff from many of the proposed mining projects will flow. Fond du Lac has federally granted oversight of the river's water quality within the reservation boundary. And nearly all of the new mining activity proposed would happen within the 1854 ceded territory across northeastern Minnesota, where Fond du Lac and other bands have federally guaranteed rights to hunt, fish, and gather wild rice.

"Anything that would affect the ecology of the ceded territory, that might diminish tribal members' ability to hunt, fish, or gather, that's a huge issue to our people," said Karen Diver, tribal chair of the Fond du Lac Band of Lake Superior Chippewa.

While state copper mining rules adopted in the 1990s require enough money be socked away for mine closure, cleanup, and reclamation no matter what happens to the mining company, Diver said those laws remain untested.

"It goes to the integrity of these global companies that want to do business in northern Minnesota," she said. "They have to put their money where their mouth is before they mine. Many of the mining companies are controlled by larger, multinational companies that seem to have a way to get out of their responsibilities when things go poorly."

Fond du Lac natural resources experts have been among the sharpest critics of the environmental review process for the proposed PolyMet copper mine.

"The band has not taken an anti-mining stand. We haven't passed any anti-mining resolutions. It's really about what can be done responsibly, sustainably," Diver said. "We're concerned about the cumulative impacts of so many new mining proposals. Each mine has releases into the waters allowed under their permits. Then you often get violations on top of what is allowed. It doesn't take long before a watershed is degraded. We're not going to let that happen."

Ultimately, copper mining skeptics say, the outcome may hinge on how state and federal governments hold mining companies to regulations laid out in state and federal permits.

"There's a sense of inevitability now that this new type of mining is coming," said Dave Zentner, a longtime Duluth conservation activist and former national president of the Izaak Walton League of America. "My hope is that we can at least put their feet to the fire and make these first copper permits in Minnesota the absolute gold standard of environmental protection, to set the example for the next mines coming down the road."

"The hope is that the mining engineers are right, that they know how to do this, for the sake of the St. Louis River and the Boundary Waters," Zentner said. "These resources are just too special to let them get it wrong."

*For more information, go to* www.mndnr.gov *and type* PolyMet *in the search box.*