DNI Metals' breakthrough technology pioneers mining industry's green revolution

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CALGARY, AB, May. 25, 2010/ Troy Media/ — It sounds like something out of a science fiction movie: Bacteria exist in an alien environment and multiply by eating rock and living off their own heat and acid waste, leaving only valuable metals in their wake.

Well, it's not science fiction, but science fact that may soon be unfolding in the vast black shale mountains of northern Alberta. Called bio-heapleaching, this emerging technology is being pioneered in Canada by DNI Metals Inc., a small Toronto company that just might revolutionize the mining industry.

Bio-heapleaching — the future of mining

With industrial leaders and innovators looking for better, greener ways of keeping the world's economy churning, DNI believes bio-heapleaching is the future of mining, a sustainable technology that is easier on the environment, cheaper to operate, and will yield metals the future will desperately demand.

DNI is conducting tests to see how bio-heapleaching can be used in Alberta black shales. It sees the technology as the foundation for an industrial super-mine north of Fort McMurray, AB, where it has rights to a vast polymetallic store of minerals on 2,500 square-kilometres of land in the heart of Alberta's oilsands country.

If you break the name apart, you get to the astounding science behind it. A solution made up of naturally occurring bacteria captured from the black shale is dripped through heaps of low-grade ore that leach out usable minerals.

The process works in several stages that bridge the gap between biology and chemistry. According to Karen Budwill, a microbiologist at Alberta Innovates – Technology Futures (an arm of the Alberta government previously known as the Alberta Research Council), "It's a biological system that's creating a chemical reaction."

A simple beginning

"Bioleaching has its roots in the 1970s," says Shahe Sabag, DNI's president and chief executive officer. "It was primarily used for copper and hard to recover gold-bearing ores."

One of the environmental benefits of a bio-heapleach metals mine is that it consumes massive amounts of sulphur during normal operations. The bright yellow sulphur pyramids stockpiled in this aerial photo near Fort McMurray, Alberta, are part of the waste byproducts created when heavy oil is upgraded. Photo courtesy: DNI Metals Inc.

It then took more than a decade to invade the world inhabited by the bacteria living in ore rock to discover what their private lives were all about. It is a complicated society.

"There are about a dozen different species of bacteria," says Sabag, "all with different needs – temperature and moisture levels, for example. To find just the right ones to cultivate took time. It's like making yogurt; it's bacteria. And it took years to perfect yogurt," he says with a smile. "Empirical science can only take you so far. Sometimes you need a lot of trial and error in the lab to get answers."

This spring DNI got some of those answers. Results of leaching tests conducted at independent laboratories in Canada and France showed significant recovery of metals from the black shale. Actlabs, of Ancaster, Ont., pulled a cocktail of metals from the rock including nickel, copper, cobalt, cadmium, uranium, lithium, vanadium, molybdenum and zinc in 24-hour and 36-hour leaching tests.

The Bureau de Recherches Géologiques et Minières is France's leading Earth sciences institution. Its labs also demonstrated that metals can be readily extracted from the black shales via bioleaching, showing recoveries high enough to compel expansion of the test program.

Sabag says the test results are a milestone step toward development of what he calls the Alberta Black Shale Metals project.

Finnish firm Talvivaara pioneered the first bio-heapleaching polymetallic mine in 2008. Today, the company is recovering commercial quantities of nickel, cobalt, copper, zinc and manganese, building its stable of recoverable metals one by one from what were once useless deposits. Talvivaara recently added uranium to its stable of recoverables and forecasts enough supply to satisfy almost all of Finland's nuclear industry needs. Talvivaara is projecting a profitable future that will generate tens of billions of dollars over the next 75 to 100 years and with minimal operating costs or damage to the environment. Talvivaara spent about $750 million to get its mine up and running. Operating expenses are low compared to traditional mining methods because bio-heapleaching uses steady state production – the process never ends and there are no energy bills to pay.

Energy of creation

Down at the microbial level, the process vibrates with the energy of creation. A dilute solution containing bacteria native to the rock is sprayed over the heap, percolating through its core.

Here's where it gets interesting. With their living and reproductive conditions set to paradise, the bugs go busily about living the good life, dining on the iron and sulfur they relish, excreting powerful chemicals that liberate the metal compounds DNI is after. Sabag says DNI hopes to extract copper, silver, nickel, zinc, and uranium. DNI's property also holds lithium, molybdenum and vanadium, minerals that are expected to be in great demand for electric cars that can be recovered through this process. Leaching solutions are washed to the bottom of the leach pile to be collected and circulated back to the top of the heap. This is done a dozen times over until the solution is so pregnant with metals that it can be siphoned off and sent to a metal-separations plant. The spent liquid is recycled to the top of the pile, to which fresh rock is added, and the process continues without stop for decades.

Sustainable solution

It's all part of what Sabag calls the sustainable advantages bio-heapleaching has over traditional mining methods that use toxic chemicals and energy intensive smelting and refining processes. The chemical and biological reactions in bio-heapleaching are self-sustaining, operating in what is effectively a closed system that uses only air, water, sulphur and the native rock and bacteria. Spent byproducts are recycled back into the system so there are no wet tailings. There's no power needed to fuel the system.

The heat the pile generates keeps it operating in virtually any ambient air temperature. The pile requires industrial amounts of sulphur that is tilled and dripped into the heap to fuel the chemical reactions within and keep its pH levels in balance. DNI's property is adjacent to Alberta's oilsands mining operations that produce thousands of tonnes of sulphur as a waste byproduct of refining the heavy oil. A bio-heapleaching operation could be used to eat up those massive stores of waste sulphur.

"You have to have the proper acidity and temperature conditions to make the culture conducive for the bugs to be happy and grow," says Dr. Budwill.

The composting nature of the bio-heap is even being tested for its properties as a carbon sink, ultimately consuming greenhouse gas emissions created elsewhere. Dr. James Brydie is a research scientist at Alberta Innovates. He is working on the question of carbon sequestration, which is a fancy term for locking CO2 away permanently so it doesn't get into the atmosphere. "We are studying the effect of using CO2 both in the mining process and as a permanent sink in the crushed 'spent' shale. This can be potentially used as backfill," he says.

In today's world, satisfying regulations means the ecological impact of such a project must be parsed to the nth degree.

Jeremy Moorhouse, an eco-efficiency analyst for the Pembina Institute in Calgary, Alta., an environmental think tank, says a detailed lifecycle analysis must be performed covering the environmental impact of the facility. "The study runs the full gamut — including greenhouse-gas emissions and water use — from construction of the facility to its deconstruction," he says. "You have to determine what the strata produces and the scale of its impact per kilogram. You then have to look at how to reduce that impact, as well as how it can be incorporated into other projects."

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