The riddle of **the black shales**

Alberta is basking in its oilsands boom, but it is about to wake up to an equivalent minerals bonanza as Toronto-based DNI Metals unveils its massive minerals and rare earths deposits

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Shahe Sabag has been exploring and developing projects in the mining industry for 35 years, and is perfectly prepared to admit that it's rare for anyone to come up with anything really new in the way of scientific or technological breakthroughs. But occasionally, he says, someone finds a different way of doing things, or applies an existing technology in a novel situation. That is when the game changes—and people like him get excited.

Back in the 1990s he became aware of the black shale deposits of northern Alberta, at about the same time that large scale but low grade deposits of nickel accompanied by other metals were being discovered thousands of miles away in eastern Finland—also hosted in black shales. At the time, both discoveries were shelved because there was no viable way to recover commercial quantities of the metals from the shale deposits.

All that changed from around 2005, when the European Union-funded Bioshale Project demonstrated that there was indeed a way to release significant amounts of metals from black shale even if they were highly diffused. The process, known as bioheapleaching, has the potential to thoroughly disrupt the way base metal extraction is done.

There's a close analogy in the gold mining industry—in the old days the goal was to discover high grade seams of gold that you could pick out of the rock. Gold is rarely found in nuggets though, so it had to be smelted out of the rock, an expensive and polluting process; then in the 1960s heap leaching was developed. You could grind up the ore, dissolve the gold by passing cyanide through the heap and recover it from the solution that drained out at the bottom.

Bioleaching was first used in the 1970s as a way to release gold trapped in sulphides. In place of cyanide, bioleaching uses bacteria to free the minerals from the rock. The black shales of Alberta are rich in microbes that feed on iron oxides and sulphides. Introduced to a heap of ground rock and fed with sulphur and water they reproduce as micro-organisms do, creating heat in the process and producing acidic secretions that compost the rock. It's a slow process compared to smelting, taking a couple of years before continuous production is achieved, but it is a lot better for the environment than any other method, using no polluting chemicals, no energy to speak of and generating no harmful effluents. The business model requires that you shift a lot of rock. "If you don't bulk-mine you don't make money."

By 2008, Talvivaara Mining had put this technology into practice in Finland and was starting to produce nickel, cobalt, copper, manganese and zinc from its mineralized black shales discovered in the 1990s. Sabag, now president and CEO of Toronto-based DNI Metals Inc (formerly Dumont Nickel Inc.), saw that this could be the answer to unlocking the potential value contained in the 2,720 square kilometre deposit DNI had secured in the Birch Mountains, north of Fort McMurray and close to the oilsands of northern Alberta.

Heap bioleaching will be every bit as disruptive to the metals mining industry as the Alberta oilsands were to the oil industry, where the reserves now equal those of Saudi Arabia, says Sabag. "If in the 1980s someone had said you can get oil by boiling up rock they would have laughed at you—and they did! But here we have up to three trillion barrels of oil sitting in this rock that is full of bitumen, and basically all you have to do is to steam it and let the oil flow out."

The magnitude of the potential polymetallic mineralization over which DNI holds mineral rights is almost unimaginable. DNI has identified the potential for 1.4-1.5 billion short tons of mineralized shale extending over 26 square kilometres hosted in its Buckton Mineralized Zone, which is only one of six similar zones at the property, with world class amounts of eight metals that are in short supply globally, as follows:

Molybdenum*	225,000,000 – 338,000,000 lbs*
Nickel	293,000,000 – 419,000,000 lbs
Uranium*	72,000,000 – 113,000,000 lbs*
Vanadium*	2,719,000,000 – 3,649,000,000 lbs*
Zinc	683,000,000 – 940,000,000 lbs
Copper	169,000,000 – 217,000,000 lbs
Cobalt	46,000,000 – 63,000,000 lbs
Silver	12,000,000 – 34,000,000 oz

**quoted as oxide*

Sufficient drilling has been completed over a 5.7 square kilometre portion of the Buckton Mineralized Zone to estimate an initial inferred resource of approximately 250 million short tons, which are open in three directions, containing the following amounts of metals, in addition to recoverable rare earth elements whose quantities have not yet been announced by DNI:

Molybdenum*	28,656,000 lbs*
Nickel	66,454,000 lbs
Uranium*	16,513,000 lbs*
Vanadium*	257,604,000 lbs*
Zinc	136,065,000 lbs
Copper	22,832,000 lbs
Cobalt	10,412,000 lbs
Lithium**	75,507,000 lbs**

**quoted as oxide*

***quoted as carbonate*

All this is found in just one of six mineral systems on the property, known as the Buckton Zone. To reflect the diversity of the resource, Dumont changed its name to DNI Metals Inc in 2010 and refocused its entire effort on black shale deposits. "You have to start somewhere," says Sabag. "We may acquire other projects elsewhere in the world, but for the moment all our attention is concentrated in Alberta."

DNI Metals has no ambition to move into production. Its commercial objective is to prove the resource through a programme of drilling and testing. "The discovery phase of the project is long past. We know that the black shales extend under the entire extent of our property, and we know that grades are exceptionally uniform across these zones," he says.

Working strictly within the limits set by Canada's National Instrument 43-101 the company's goal has been to establish an officially compliant resource and to demonstrate that the metals are indeed recoverable from the shale. DNI has achieved these goals by recently announcing an initial 250 million short ton resource from a small portion of one of its six zones. The plan is

to push that forward in 2012 into a preliminary economic analysis—a scoping study—following which the market will have confirmation of the enormous dollar values attached to each mineral alongside its actual production potential.

Eventually someone will have to put up the money to build a mining operation. The production phase was financed by offtake agreements in the case of Talvivaara and the same model will work for DNI's deposits, though the economics are different—in the case of the Finnish mine, nickel accounts for the bulk of its output, with uranium a significant by-product and it has signed long term agreements with Norilsk Nickel of Russia and Cameco of Canada to purchase its entire production. DNI's Buckton Zone, on the other hand, is not dominated by a single metal but a cocktail of minerals that are very highly sought after by China in particular, and that is where the next tier of partnership will come from rather than from North America, Sabag believes.

Heap leaching is a catch-all process, he explains. Anything that is soluble will drip out of the bottom of the heap and you end up with a 'pregnant solution' from which you can separate the target metals. In the case of Talvivaara, uranium was a by-product which at 15 parts per million would have been considered insignificant by Canadian standards—yet because the volume of rock processed is so large, the Finnish mine can produce a million pounds of uranium annually, enough to make the country self-sufficient.

The mineral resource is massive. "We believe these deposits are as large as the oil sands, and could have as big an impact on the economy of Alberta," Sabag believes. However, before bioleaching came along, the black shales would have been regarded as hardly worth exploiting. Even less interesting would have been the stuff that lies on top of the mineral-bearing shale and which has to be stripped away before that stratum can be reached. Even Sabag and his fellow geologists had disregarded it. That was until the tests started to show the presence of rare earth elements alongside other specialty metals such as lithium.

Rare earth elements like cerium, lanthanum, neodymium, samarium, yttrium, and scandium are in demand for a host of applications in batteries, medical appliances, lasers and the like. They turned up in DNI's Buckton resource itself but are also plentiful in the overburden, which then started to look like yet another resource, three times larger than the resource below it. "We are excited because these elements are recoverable as incidental co-products," says Sabag. "We don't have to design a whole new recovery circuit just for the rare earths."

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During the course of 2012 an addendum to the existing Buckton mineral study will be issued, showing the amount of rare earths in the mineralised resource, but that will be followed by yet another separate resource study, this time covering the rare earths in the overburden. It could dramatically increase the market value of DNI Metals. **www.dnimetals.com** ■