

Northern Ontario Circular Economy Symposium

Mining Innovation



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SUDBURY
INTEGRATED NICKEL
OPERATIONS
A GLENORE COMPANY

Executive Summary

On January 19, 2021 speakers from Canada and abroad came together to speak about current and future opportunities of a circular economy in Northern Ontario. A circular economy refers to a system that reduces waste by reusing material in the creation of new products.

Peter Xavier is the Vice-President of the Glencore Greater Sudbury Operations as well as the Chair of the Ontario Mining Association. His presentation focused on the experience of Glencore in relation to circular economy and green practices. Below are some of the practices undertaken that can be used as examples of how mining can interact in the circular economy and green practices.

- Contextual factors of where Glencore operations are important when making decisions. The Raglan operation is very remote and runs off diesel generators. Windmills were installed to displace some of that. In Sudbury, that makes less sense, as Glencore would be displacing clean hydro energy.
- Extracting metals from secondaries (waste from other industries) and putting the metals back into the marketplace.
- Alongside slag being used in the construction industry, another way Glencore participates in circular economy practices is by providing the sulphuric acid by-product to the agriculture industry and for water treatment systems.
- Transitioning to the use of battery electric vehicles in Glencore's underground mines. Such a decision is important because BEVs reduce GHGs as they don't burn diesel, and they also improve the hygiene underground and with less air they need smaller fans and heating systems.

Glencore and the mining industry in general have the potential to be important players in moving towards a circular economy. Glencore itself is at what Xavier says is the front end of the circular economy for it produces raw and finite materials for the market. They have operations across Canada, but this report focuses on Sudbury's operations and the steps they have taken to reduce waste and GHG emissions. For instance, the Sudbury operations are transitioning to clean hydro energy. Xavier's work, and the link between Glencore and circular economy, directly impacts Sudburians, Northerners and their workers.



Vice-President of Glencore
and Chair of Ontario Mining
Association

Peter Xavier is Vice President of Glencore's Sudbury Integrated Nickel Operations consisting of an exploration group, two underground mines, concentrator, smelter and Port facilities. Peter is also responsible for project investment developing the Onaping Depth Mine. Peter is currently Chair of the Board of the Ontario Mining Association (OMA). He is also on the Board of Governors at Laurentian University. Peter is also a Warden of Camp 22 which oversees the engineering oath and iron ring ceremony and on the Kivi Park Board.

Purpose

This commentary was transcribed from a presentation Peter Xavier gave on January 19, 2021, at the online Northern Ontario Circular Economy Symposium event. The editor has adapted some of the text for the sake of structure and narrative. The presentation is viewable on ParlAmerica's Youtube channel.

The event aimed to explore current and future opportunities of a circular economy in Northern Ontario, which refers to a system that “aims to gradually decouple growth from the consumption of finite resources” (Ellen MacArthur Foundation n.d.) — in other words, reducing waste by reusing material in the creation of new products. By doing so, we can create more self-sustaining communities, produce more jobs, become our own supply chain, and reap benefits across Ontario's northern regions.

“ In the end, the term ‘circularity’ may just be one way to make us aware that we need a more encompassing, integrated and restorative sustainability path that includes people as much as technology and nature. ”

- Michiel Schwarz, A Sustainist Lexicon



Mining Innovation

To start off just from a Glencore perspective, we're proud and it gives real purpose to our organization and our employees to provide a lot of the key products that the world needs for modern life. From a Sudbury context, we produce mainly nickel and copper. We also produce cobalt, platinum, palladium, gold, and silver as well. They're really the front end of the circular economy which is producing the raw materials for the marketplace.

Among the challenges we face is that we're dealing with finite resources, so we're always having to look for new investment opportunities, and those are getting into more remote areas — in Sudbury's case, getting deeper and deeper. We don't set the price for a lot of our products, so we're not able to pass on costs to the consumer, which is a particular challenge especially as we go to depth in Sudbury. But there's a lot of talk around new uses of metals as modern life continues to evolve and talk about batteries or your cell phone, mobile devices et cetera. Even just the basics of life, whether getting electricity and clean water to your house — some of the things we rely on that maybe we don't even think about. So, there are really a lot of uses for our products and, as the old adage goes, if in terms of the source for raw materials, if you can't grow it, you have to mine it. It wouldn't be much of an agriculture industry without some of the contributions from mining.

From an economic perspective, we have Glencore operations throughout a large part of Canada. A lot of the base metal operations are really focused around Ontario and Quebec. I'll focus just on the Sudbury contribution. There is a long history of mining in Sudbury. Our economic contributions support our employees and contractors, communities, First Nation communities, who are key stakeholders. We have a very good relationship with all communities and collaborate constantly. Downstream users benefit from the products we produce, small and medium-sized enterprises, academic research, and so on, and most of the benefit from our spending is really right in the community, and what's not in the community is mostly in the province.



Just as a rough order of magnitude, our combined operating and capital spending last year was nearly a billion dollars, so that goes a long way toward benefiting the community. What's really nice to see is that, over the years, a lot of the smaller companies that grew up in Sudbury started out supplying local mining operations, have diversified and grown, and now serve the global marketplace, so there's a real sort of sustainability aspect of the economy here in Sudbury.

With regard to the Sudbury operations, we have two underground mines, a project and construction-in-depth project, and a mill concentrator smelter. Those operations are all underground hard rock now, so they have a pretty limited surface footprint. There are still several old mines around in the Sudbury Basin, but Nickel Rim is an example of a newer one built in 2010 — a lot of modern design features from an environmental sustainability perspective, and a very small footprint. One aspect of mining that many people don't realize is that, before we even do anything, we have to think about closure and decades beyond closure. For a normal construction or, say, a high rise in downtown Toronto, closure is not the sort of thing you have to think about, but it's part and parcel with the thinking that has to be applied to bring mining investment online.

On big depth, which I'll talk about a little later, but our current mines are over two and a half kilometres underground. Just for illustrative purposes, that's like going almost five CN towers underground — so we're having to go quite deep now to extract the metals. When Sudbury first started, you could see a lot of the outcrops right on the surface. Of course, a lot of the near-surface deposits are mined out.

In our Strathcona mill, we process the feeds from our local mines along with custom ore, as some smaller companies don't have their own processing facilities, so we take that niche contribution within the marketplace and from that we make several products — a nickel concentrate that goes on to our nickel smelter and copper concentrate that goes to our copper smelter in Quebec, and we make a classified tailings product. Tailings, in layman's terms, is really ground-up rock with all the metals removed as much as we can get out, and we use about 75 per cent of it back to fill the voids underground as backfill, so that's a real good development that we've taken advantage of for many years. There is a smaller portion with a high impurity that oxidizes and has a high sulfur content that we have to place in deep water deposition to ensure there are no minor acid drainage problems. Our water treatment system run by the mill is excellent. It's orders of magnitude below the emission standards from the regulatory authorities.



“ One aspect of mining that many people don't realize is that, before we even do anything, we have to think about closure and decades beyond closure. ”

A lot of research is currently underway to look at different uses for tailings or how to extract the metals that remain there. We've taken as much as we could, so that should tell you that what's left is quite hard to get out — pretty energy intensive — but there are efforts in academia and different research organizations, and some private enterprises are also looking at it.

The Sudbury smelter is really the hub of our sulphide nickel business. We process Sudbury feeds as well as our feed from Raglan, a mine we have in northern Quebec. There is a lot of talk about battery electric equipment in the marketplace, but it's good to point out here that we have an electric furnace at our smelter, and we benefit from a clean grid here in Sudbury, so electricity is pretty much carbon free, as most of it's sourced from nuclear and hydro facilities. Our focus historically has really been on emissions, but we are always looking at the context of where we operate. So, Raglan, given it's very remote and run off diesel generators, has installed windmills to displace some of that. In Sudbury, that makes less sense, as we'd be essentially displacing clean hydro energy. We always have to look at what's appropriate, depending on where we're operating. You can see all the effort of putting our feet through a mill and smelter — it's still just under half waste, so it just gives you a sense of how much effort it is to isolate the metals.

We do compete globally for custom feed into our smelter, and that's something in which we have to stay cost competitive and provide good recoveries and terms to continue to ensure that our smelter is full. And that's important because our local feed sources are declining. Secondaries are really a lot of waste products from other industries — a good example there of the circular economy, and it's a win-win situation. It's really what you call recycling win-win, because its materials that are very difficult to dispose of because they have metals in them for the facilities or industries that produce them, and good for us because we're able to extract the metals from that and put them back into the marketplace. Another product that we produce is sulphuric acid, so we're able to convert the sulphur in our ores into sulphuric acid. That's important for agriculture, for water treatment systems, a lot of important uses in the marketplace.

Finally, the slag product is our waste product which historically had been used in various construction activities.

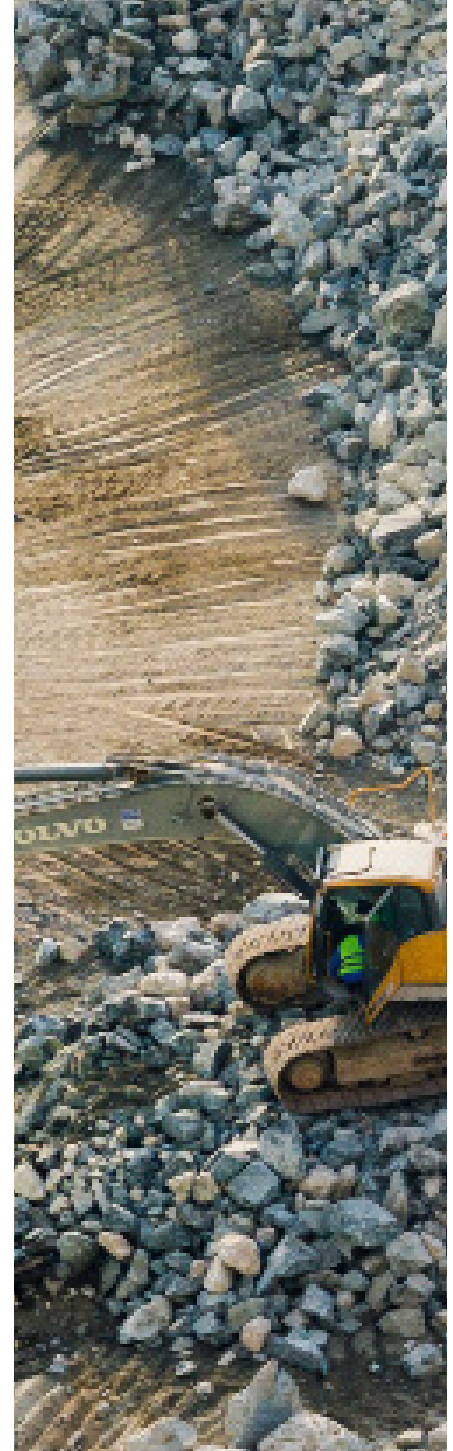


“ Another product that we produce is sulphuric acid, so we're able to convert the sulphur in our ores into sulphuric acid. That's important for agriculture, for water treatment systems, a lot of important uses in the marketplace. ”

If you live in Sudbury, you'll see that, in certain aspects, we've taken a more cradle-to-grave product stewardship perspective at present, but there perhaps could be an opportunity for alternate uses for this slag product. From a greenhouse gas perspective, it's one of our main sources, almost all of it, and we're pretty small — only just over a hundred thousand tonnes of greenhouse gases from our smelter. Comparatively, a steel plant might be several million tonnes, and most of that, 80 plus per cent, is from cold condition into our furnace. Coke is a by-product from another industrial process that we need as a reagent in our furnace to create the right conditions to smelt, but it does take care of a waste product from another industry. There's not currently an alternative for that, so that's a challenge for us. It would likely need another type of organic to create the right chemical conditions, and it's really classified as a fixed emission. We also built several years ago a calciner plant which expanded our ability to process various feeds from other industrial processes, dry the feeds to be safely put into the furnace. Also, for example, battery recycling has a lot of inorganics, plastics, et cetera, that have to be taken care of and cleaned before being put into the furnace.

From a policy perspective, one thing to keep in mind is that we are a small GHG producer. We are at the mercy of the carbon tax and pay into it, and that's set to increase. But unfortunately, there is a balance between reducing emissions and metals, and some of that comes at the expense of GHG production. For recycling, there's no way to take advantage of recycling efforts even though it's overall better for the environment. By recycling, we're increasing emissions and intensity, and the current policies are punitive towards that, so an opportunity to back up and consider some of these things in terms of what's overall best for the environment is what we'd recommend as a path forward.

Most of the focus of the smelter has been around metals emission reduction and SO_2 reduction. Since 1960, there's been a drastic change, where SO_2 emissions have been declining from around 300,000 tonnes emitted to around 25,000 tonnes in 2020; the highest point was in 1969, about 375,000 tonnes emitted. With regard to regulatory limits, those have also declined in tandem, which dispels some of the myth that regulation is the way to drive innovation at all times. We're really proud of the ingenuity and innovation in the team there that has found a way to reduce sulphur emissions quite drastically and at the same time increase nickel production. To do those things at the same time is quite the challenge. Currently, we have had roughly around \$300 million of smelter emission projects from about 2015 to present. It's had an indiscernible effect, however, which just illustrates that it's getting tougher and tougher to make that next little improvement. We're at the phase now where we have to start investing in our underground mines, as they're coming to end-of-life. I had to continue our operations in Sudbury, but these aren't off-the-shelf solutions you could pull off and just implement. A lot of the innovations were the result of the ingenuity of the team there, and various piloting and technology and process changes to scale it up,



put a business case together, implement it, and see the results. It's part of the challenge of why it takes time over the years. Of course, we believe government plays a role there in creating the conditions for innovation and investment, and understanding that these are complex and multivariant issues. Also, we're dealing with such long cycles — decades and decades from initial exploration to closure. We have to think about adaptation as climate changes. We're monitoring our operations decades after they've closed. Progressive rehabilitation is very important. In the past, we have been able to offset some of the carbon taxes through force management. We're no longer eligible, but we continue to do those things anyway to help where we can.

We participate as well through the nickel and cobalt institutes and life cycle analysis, so it's a transparent way for anyone to see our performance against other players in the nickel space, in the cobalt space. When we look at the magnitude of GHGs per nickel tonne across the globe, Canada is considerably lower than places such as China, the northern part of South America, Ukraine, and so on. This is why we don't want to see movement of investment from a Canadian jurisdiction to other parts of the world; we want to continue the investment here. I think obviously that's the best overall situation, but that's just a testament to the efforts that we've made here over the last couple of decades.

I'll finish off with a little bit on mining innovation. The mines are very small GHG producers — around 10,000 tons or so, mostly from natural gas that we need to heat the air in the wintertime, given the northern climate, to make it hospitable underground for our workers and also not to freeze our shafts. When you look at innovation, we made a choice. One example was to go 100 per cent battery electric



equipment in our underground mines. Northern Ontario is really at the forefront of pushing this, and we as an organization really pushed the marketplace for that. When we made this investment decision back in 2017, the marketplace was very young. Our challenges were not the ones to create or make the machines, so you had to convince the marketplace to do it. We collaborated with a lot of other organizations to help push that marketplace, and the original equipment manufacturers (OEMs) responded to create global standards so we don't have charging issues and other things that you might imagine. So, it's a lot of effort behind the scenes to push this marketplace ahead. We made the investment decision on the basis that it would be 100 per cent BEVs [battery electric vehicles] and it just goes to show you where you know you can't take an individual sort of narrow perspective on these things. BEVs are a good solution because they hit multiple fronts: they reduce GHGs because you're not burning diesel, and, more importantly, less air underground means less heating with natural gas. They also improve the hygiene underground and with less air they need smaller fans and heating systems. Unfortunately, at depth, we have to heat the air in the wintertime and then cool it back underground to deal with the rock temperatures and a lot smaller openings — so, a big scope reduction. That's really what made the investment decision about these BEVs compelling.

I encourage anyone to look at the Mining Association of Canada for sustainable mining initiatives. The Ontario Mining Association has strong zero-waste, zero-harm, and productivity increase initiatives, as does the Canadian Mining Innovation Council. All of these are strongly supported by the mining industry in order to achieve the ends we're talking about.



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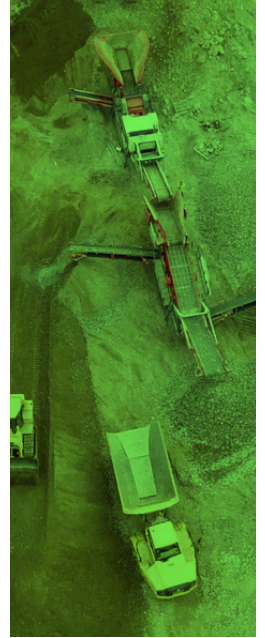
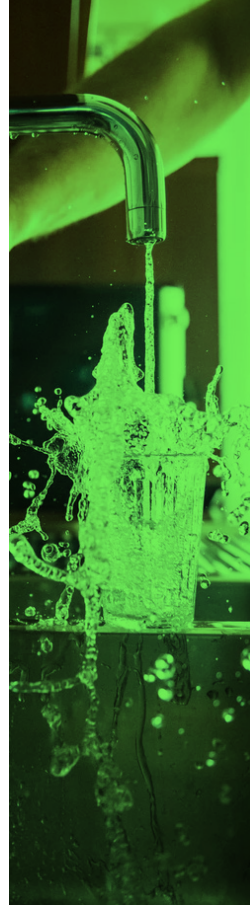
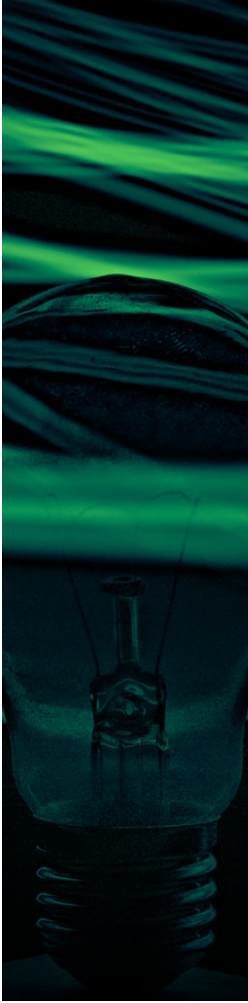
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