RESEARCH IN FOCUS:

SUSTAINABLE PRACTICES IN MINING

CHALLENGE:

How do we balance growing demand, declining resources and more stringent environmental regulations?

SOLUTION:

Develop sustainable methods for mining, extraction and recycling.

UNIVERSITY OF TORONTO | Engineering

MINE OUR EXPERTISE

In an environment of constant change and challenges, the resource sector cannot afford to stand still. U of T Engineering, along with its industry partners, is developing techniques for mining, mineral processing and metallurgy that are lower-impact and more sustainable. Whether you are a sector-leading company, a nimble startup or a visionary entrepreneur, you can mine our expertise to achieve your goals. We have a strong track record of success in research, entrepreneurship, patents, inventions and industry solutions.

HERE'S WHAT PARTNERING WITH U OF T ENGINEERING DELIVERS:

- An inside track to breakthrough technologies
- Customized solutions to industrially relevant problems
- An extra spark of innovation to your company
- Collaboration with U of T Engineering's world-leading researchers, including top graduate students, undergraduate students and alumni

RESEARCH
IMPACT
EDUCATION
PARTNERSHIPS

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THE POWER OF PARTNERSHIP

You are surrounded by the products of mining — the steel in your car, the copper wires in your home electrical system, the rare earth elements in your smartphone. As the world's population grows so does the need for these resources, yet many of the 'easy' deposits have already been depleted. At the same time, citizens and governments are demanding that resource extraction be conducted with minimal environmental impact.

Engineers at the University of Toronto are developing innovative processes that will allow mining companies to find value in materials that have previously been considered uneconomical or waste. Whether it is using microbes to extract useful metals from discarded minerals and slag, or decreasing the amount of water and energy that must be expended per tonne of refined product, these projects will improve sustainability and safety for mining projects around the world. Leading companies like Vale, Agnico-Eagle, Barrick Gold and Anglo American have already formed partnerships with U of T Engineering researchers.

Our expertise also extends to mitigating the environmental impact of oil sands extraction. Working with researchers from organizations such as Syncrude and Suncor, we are using by-products like petroleum coke to capture air pollutants including sulphur oxides and mercury.

THE DETAILS

"Sustainable Materials Processing is about developing methods for producing engineering materials that enable our everyday technologies with the lowest impact on environment and in the most economic fashion."

Professor Mansoor Barati
Gerald R. Heffernan Chair in Materials Processing

Professor Mansoor Barati heads the Sustainable Materials Processing Research Lab, which looks for new ways to refine valuable elements. For example, silicon is currently refined to ultra-high purity using silicon-containing gases, which is an energy-intensive process. But silicon used in solar cells does not have to be quite as pure as that used for computer chips, so Barati and his team are working on lower-energy methods to remove impurities. These involve adding salts or metal oxides to molten silicon mixtures. The salts absorb the impurities and can be skimmed off, resulting in solar-grade silicon at a fraction of the cost.

Another project looks at recovering value-added products from the millions of tonnes of mine tailings produced by nickel refining projects. These tailings contain relatively high levels of iron sulphides and minor amounts of nickel. Burning the tailings can remove the sulphur (which can be recovered from flue gas) and leave behind iron and nickel oxides that can be more easily processed into pure metal. Given that virgin iron deposits are becoming more difficult to find, the ability to obtain the metal from what would otherwise be a waste product offers an excellent value proposition. In addition, the heat from the combustion can be used to generate electricity. The project builds on previous work with nickel giant Vale. Other companies that have partnered with Barati's team include engineering consultants Hatch, Process Research Ortech Inc. and the Saudi Arabian chemical manufacturer SABIC.

PROFESSOR MURRAY GRABINSKY
BUILDING BETTER BACKFILL

Cemented paste backfill (CPB) solves two mining problems: the need to safely dispose of mine tailings (contaminated water and crushed waste rock) and the need to prevent mine tunnels or stopes from collapsing. By mixing the tailings with cement and other binders, engineers create a tough, rigid structure that safely sequesters the waste product while keeping miners safe. This common-sense solution is widespread in the mining industry.

But there's a problem: the strength of various backfill formulations is usually measured under controlled conditions in a laboratory, while the real world is unpredictable and subject to seismic events like blasting and mining-induced earthquakes called rockbursts.

Professor Murray Grabinsky and his team have perfected a way of measuring CPB in the field. They use sophisticated non-destructive techniques and real-time monitoring of the CPB as it cures. Improved understanding of backfill behaviour helps mine planners optimize ore extraction strategies, leading to enhanced productivity and reduced cost. Grabinsky and his team have consulted for mines around the world, from Northern Ontario to Turkey.

Professor Murray Grabinsky's research is helping to improve mine safety.

PROFESSOR VLADIMIROS PAPANGELAKIS
RETHINKING RARE ELEMENTS

You may never have heard of neodymium, but you could well have some in your pocket right now. It is used to make the tiny-yet-powerful magnets inside ordinary ear-bud headphones. Neodymium is one of the so-called rare earth elements (REEs) that are increasingly needed for high-tech devices and efficient electric engines. Such elements can be obtained from clays, which have REEs adsorbed to their surface.

Professor Vladimiros Papangelakis and his team have perfected a process to extract REEs from these clays. It relies on a carefully calculated dosage of a salt solution. Through a natural chemical process, ions in the salt switch places with the REEs on the surface of the clays. The REEs can then be purified and recovered as oxides, by a more cost-efficient process than that offered by current technology. The team is working with a variety of clays from Asia, South America and Africa, and have partnerships with companies including Tantalus Rare Earths AG.

Papangelakis is also working on mine tailings from nickel extraction operations. Certain types of bacteria are known to catalyze reactions that can decompose sulphide minerals and turn contained metals into a form that is easier to recover. The process, known as bio-leaching, not only helps extract the last bits of nickel from the tailings, but also converts what is left into a less environmentally toxic form. Major nickel-mining companies like Vale and Glencore are working with the team in the hopes of one day applying such tactics to their operations.

PROFESSOR CHARLES JIA
CAPTURING AIRBORNE POLLUTION

Burning coal is still a major source of electricity production worldwide, especially in the United States and China. Depending on its source, coal could contain sulphur that upon burning becomes sulphur oxides, a major cause of acid rain. Coal burning is also a major source of airborne mercury, which eventually makes its way into the food chain, even in remote regions like the Arctic.

Professor Charles Jia and his team have discovered that petroleum coke — a carbon-based powder produced as a byproduct of the petroleum industry — is excellent at absorbing sulphur oxides and turning them back into elemental sulphur, thus keeping them out of the air. Moreover, once the coke is impregnated with sulphur, it begins to absorb airborne mercury as well. While other systems for capturing these pollutants exist, the chance to use one waste product to capture another is a very cost-effective engineering solution.

Jia is partnering with researchers at Syncrude and Suncor, among others, to optimize this process and prepare it for commercial production.

Pictured above: Chloe Feng, an MASc student in the Green Technologies Lab, analyzes a petroleum coke sample.