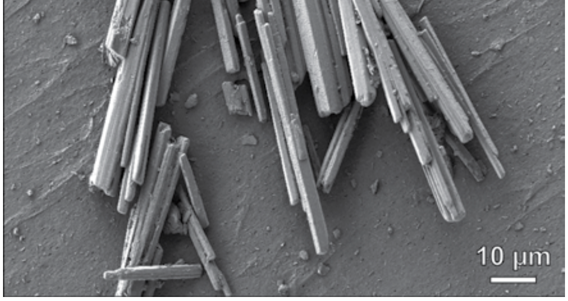
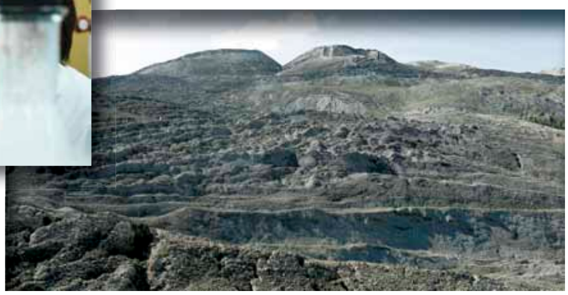
MINE TAILINGS CAPTURE CARBON DIOXIDE



A scanning-electron microscope image of the carbonate nesquehonite formed in the experiments.

About 5 percent of all U.S. industrial emissions come from mines. Capturing and storing carbon dioxide from these mines is one potential way of cutting down on the release of greenhouse gases. Current methods for stashing carbon, which involve storing carbon dioxide under high temperature and pressure, are too expensive and risky to be useful. Now, scientists have lab-tested a way to lock carbon in a solid form by accelerating carbonation, a natural chemical reaction, using only materials found in mine waste.

Researchers working on an experiment on brucite (from left: Ian Power, Greg Dipple, Anna Harrison).



Ultramafic mine tailings at the Clinton Creek mine in the Yukon Territories, Canada.

"We found it's possible to accelerate carbonation and offset a significant portion of mine emissions by reacting a relatively minor mineral," says Anna Harrison, a graduate student at the University of British Columbia in Canada.

Carbonation occurs when carbonic acid (carbon dioxide in water) reacts with and dissolves certain minerals. A form of geological weathering, carbonation of these minerals, along with the subsequent formation of other carbonate-containing minerals, is one of Earth's natural processes for scrubbing carbon dioxide from the atmosphere. But it occurs too slowly in nature to make a dent in rates of human-induced greenhouse gas emissions.

Accelerating the rate of carbonate formation in waste rock at large mines could more than offset greenhouse gas emissions of those mining operations, according to Harrison and her colleagues.

Harrison and her team found that brucite, a common but minor component of ultramafic mine tailings, reacts readily with carbon dioxide to lock carbon into mineral form, with the resulting minerals being hydrated magnesium carbonate minerals such as nesquehonite. Ultramafic rocks typically contain high levels of minerals containing magnesium and iron and occur in mines where nickel, chromium, diamonds and asbestos, among other materials, are extracted.

In a laboratory simulation of conditions at the Mount Keith Nickel Mine in Western Australia, researchers bubbled gases with various concentrations of carbon dioxide through water containing brucite, a process the researchers called brucite carbonation. They found that gas containing a 10 to 20 percent mixture of carbon dioxide — roughly the same concentration emitted by mine site power plants — would be sufficient to react all the brucite produced annually by the Mount Keith Nickel Mine into nesquehonite. That could potentially offset mine emissions by 22 to 57 percent annually, at up to four times faster than natural carbonation rates of bulk tailings at the mine.

"This is a very stable way to store carbon and much more easily monitored than carbon storage techniques that rely on injecting carbon dioxide deep into the ground," says Gregory Dipple, a geologist at the University of British Columbia and Harrison's advisor. Dipple estimates that carbonate minerals, when sealed in abandoned mine sites, may lock carbon into solid form for 10,000 years or more.

Complete carbonation of brucite in waste stockpiled at the Mount Keith Nickel Mine could sequester a total of one to three megatons of carbon dioxide annually. Under a carbon tax scheme, such as the one implemented last July in Australia, that can spell big savings — an estimated $4.8 million annually for the mine. And brucite carbonation comprises only a small portion of the total sequestration potential of mine tailings, the researchers reported in Environmental Science & Technology.

While the results seem promising, it is unclear whether the technology will ultimately prove effective at industrial scales.

"This experiment establishes proof of concept, but not how one might execute it at scale," says David Keith, a geoengineer at Harvard University and president of Carbon Engineering, a Canadian start-up developing carbon capture technologies.

Dipple says that their research team, funded by Carbon Management Canada, hopes to begin testing the system in field experiments at working mine sites within the next three years. Dipple also aims to test the carbon-sequestering abilities of other magnesium-rich minerals, such as serpentine and forsterite, found in mine tailings. If other minerals can be reacted at rates similar to brucite, the total sequestration potential of mine waste may be vastly underestimated, according to the researchers.

And if the technology can be made economically feasible on an industrial scale — turning mines into net greenhouse gas sinks — the long-term potential of accelerating chemical weathering to store carbon could be great, Keith says. "It would be huge. We could potentially bury all the carbon we ever emitted."

Lindsey Konkel

Left: Carbon Management Canada; middle and top: courtesy of Anna Harrison