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Test for carbon capture leaks developed

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Carbon dioxide.

Scientists have developed the first ever fail-safe test to check for carbon dioxide (CO2) leaks from carbon capture and storage sites deep underground.

The test may help reassure both the public and industry regulators that in the unlikely event of a CO2 leak from one of these sites, geologists could detect it quickly and cheaply.

Carbon capture and storage is a technique which captures CO2 emissions from power stations and buries them underground.

Crucially, the pioneering technique lets researchers work out if CO2 comes from a harmless, natural source near the Earth's surface or from a deep storage site. It relies on a quirk of the noble gases, a group of colourless and odourless elements which includes helium, neon and xenon.

The exact proportion of noble gases in a sample depends on the source of the CO_2. If it comes from deep underground, nearer to the mantle, you mostly get a type of helium called helium-3. Helium-3 was trapped within the mantle when the Earth formed 4.6 billion years ago.

But the natural radioactive decay of elements in the Earth's crust like uranium and thorium gives a different form of the chemical called helium-4. This is easy to detect at the surface, as there's very little helium in the atmosphere. This is because helium atoms are too light to be retained by the Earth's gravity and are lost to space.

"We've shown that the noble gases come out of the ground with the CO_2; they travel together," says Dr. Stuart Gilfillan from the University of Edinburgh, lead author of the study.

The breakthrough gives researchers have a powerful tool that will tell them the source of the CO_2.

"This is a major step forward in the possibility of identifying possible leaks," adds Gilfillan.

The technique has already been used at a carbon capture and storage site in Saskatchewan in Canada, after residents reported fears of a CO_2 leak at nearby farm. Test results revealed that high levels of CO_2 must have come from wetlands close to the farm, and not from the Weyburn Oil Field carbon capture and storage site.

Carbon capture and storage has been touted as one way to reduce CO_2 emissions, especially from power stations. The idea is to capture the gas as it's produced and inject it deep underground to be stored in old oil and gas fields. But many have questioned the safety of this approach. Exactly how secure is the stored CO2, and how would we know if it escaped through cracks to the Earth's surface?

Gilfillan and colleagues realised that because the type of helium in a sample depends on where it comes from, noble gases could be used to answer some of these questions.

"We had a fair idea it would work. Helium that comes from deep underground has a very distinctive signature compared to helium from closer to the surface," Gilfillan adds. "That means it's easy to distinguish."

Together with colleagues from the universities of Edinburgh adn Strathclyde, and from the US, Gilfillan decided to use a natural CO2 reservoir in the US to investigate their ideas.

St. John's Dome is a naturally-occurring CO2 reservoir on the border of Arizona and New Mexico in the US. It also features surface springs and groundwater wells that contain large amounts of dissolved CO2.

Naturally-occurring carbon dioxide can be trapped in two ways. The gas can dissolve in underground water – like bottled sparkling water. Or it can react with minerals in rock to form new carbonate minerals, locking it away underground.

The various sites at St John's gave the researchers the perfect opportunity to test the ratio of noble gases in samples from different sources. Their results showed a distinct ratio of helium-3 to helium-4 in the samples they tested, compared with the ratio in the air around us.

There was also much more helium-4 in the samples from the springs and groundwater wells than you'd expect.

"There's a geological faultline in the region, so it looks like the natural CO2 and helium-4 escaped to the shallower waters through that," explains Gilfillan.

To apply the technique, some sites might need researchers to add extra noble gases to CO2. "That's if there's not enough there naturally to provide a strong fingerprint," says Gilfillan. "At some sites, you might get a very high concentration of noble gases, so you wouldn't need to add more."

The study is published in *International Journal of Greenhouse Gas Control*.

More information: Stuart M.V. Gilfillan, Mark Wilkinson, R. Stuart Haszeldine, Zoe K. Shipton, Steven T. Nelson, Robert J. Poreda, He and Ne as tracers of natural CO2 migration up a fault from a deep reservoir, *International Journal of Greenhouse Gas Control*, Volume 5, Issue 6, November 2011, Pages 1507-1516, Available online 14 September 2011, doi:10.1016/j.ijggc.2011.08.008

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