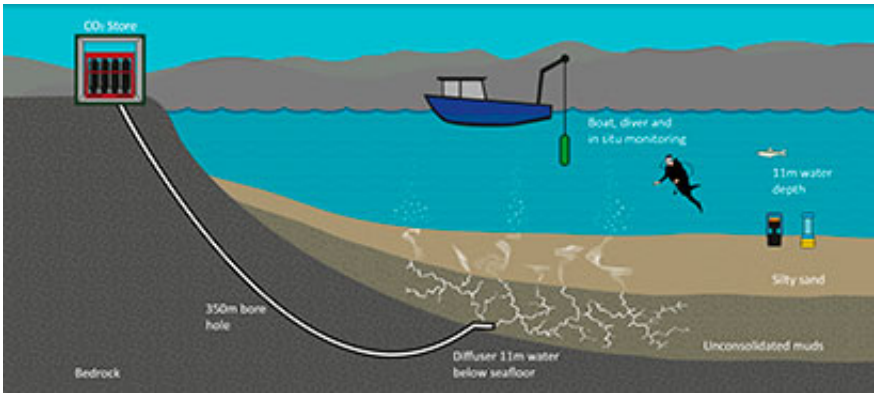
Scientists probe leak risk from seabed CO2 stores

October 2 2014, by Tom Marshall



How the experiment worked

A UK-led international research team has carried out the first experiment to recreate what would happen if CO_2 started leaking after being stored deep under the sea floor. Their findings add weight to the idea that this could be a viable way to cut our impact on the climate.

They piped 4.2 tonnes of the gas 11 metres below the seabed in Ardmucknish Bay, near Oban in Scotland, releasing it into the sediments there over 37 days. They then used chemical sensors and acoustic monitoring equipment to track how it emerged, while also measuring the effects on the ecosystem. Monitoring carried on for a year, to give a sense of how well the environment recovered from any changes the CO_2 had caused.

The aim of the project, known as Quantifying and Monitoring Potential Ecosystem Impacts of Geological Carbon Storage (QICS), was to see how the CO_2 made its way to the surface and so get an idea of what might happen if the gas started leaking out of a storage reservoir deep beneath the seabed.

The scientists found that small CO_2 leaks do little damage to the ecosystems around them, and that the effects fade quickly once the CO_2 stops flowing. And a lot of the gas didn't emerge at all - some 85 per cent seems to have been trapped in the sediments. It's an encouraging message for supporters of carbon capture and storage (CCS) - the idea of taking CO_2 emissions from power stations and other sources and storing them underground before they can affect the climate, in depleted oil or gas reservoirs or saline aquifers a kilometre or more under the seabed.

'Our results suggest that if you had a small leak - the kind you'd expect from something like an abandoned oil well bore going into the reservoir - the effects would be pretty limited in space and time,' says Dr Jerry Blackford of Plymouth Marine Laboratory (PML), who led the study, published in *Nature Climate Change*. 'There are some changes to sediment and water chemistry and nearby ecosystems, but they are confined to the immediate area of the leak and don't last for long once it stops.'

CCS is considered one of the most concrete, realistic proposals for fighting climate change and allow continued use of fossil fuels whilst other low carbon technologies are developed.

But there are concerns the gas could leak, perhaps damaging seabed ecosystems nearby.

This the first study to pipe CO_2 directly into the seabed; previous studies have relied on releasing the gas into the water just above it, meaning they

haven't shed light on the complex processes by which gas bubbles through sediment and escapes into the water.

These findings don't just establish that small leaks do little to harm local ecosystems, in the short term at least; they also show it's feasible to set up a monitoring system that would let us be sure they weren't taking place.

Both chemical changes to the water and effects on nearby living things were limited, and soon reversed once the CO_2 stopped. Environmental chemistry was back to normal within 17 days, for example. There were differences in the genes that were active in the site's microbial community while the gas was flowing, but Blackford says that there's little evidence of long-term harm.

'There's a huge variety of microbes in these sediments, but at any particular time not all of them are active,' he explains. 'The changes we detected probably came from a new set of bacteria becoming active because the CO_2 created conditions that suited them; the original bacteria hadn't gone away and reappeared once conditions returned to normal.'

Bigger organisms were also relatively unscathed. Some even seemed to enjoy the new conditions, and those that didn't could move away - the effects were confined to such a small area that animals didn't have to go far to be back in normal conditions again.

Of course it could be that longer-term exposure to leaking CO_2 would prove more harmful. Blackford is now planning a follow-up experiment that will last for longer, giving scientists a better idea of the effects of a more persistent leak. This should clarify questions like how long the sediments can keep absorbing so much of the CO_2, and how the seafloor community responds to a more permanent change in CO_2 levels.

Blackford is confident it will be possible to set up monitoring systems that can detect leaks using a combination of chemical sensors to detect CO_2 that's dissolved in the water and acoustic monitors to detect streams of bubbles housed in autonomous underwater vehicles (AUVs) moving about the site. He's part of a project aimed at developing AUVs with the right sensors for the job.

The QICS team included scientists from PML, the British Geological Survey, the National Oceanography Centre, the Scottish Association for Marine Science and Edinburgh, Heriot-Watt and Southampton Universities, alongside Japanese colleagues. The diving work to monitor CO_2 release from the seabed was done by the NERC Facility for Scientific Diving. Financial support came from the Scottish and Japanese governments as well as from NERC and Research Councils UK.

Scientists from other countries where such an experiment has not been possiblewere keen to collaborate with the British researchers. Alongside the existing Japanese partners, the follow-up project has also attracted Australian, German, Korean, Norwegian and US interest. 'Projects like this have created a real sense of UK leadership in this area; other nations want to do this kind of work but have found it difficult to get permission, Blackford says. 'This is a potentially controversial experiment, but with careful planning, risk management and communications we have showed that this kind of work can be carried out successfully.'

He adds that part of what enabled this was good relations with stakeholders and local people; it would be possible to portray the project as deliberately polluting a pristine environment, so it was vital to explain its significance and benefits as widely as possible. The team made it a priority to engage in depth with local people and stakeholder groups, from the formal regulators Marine Scotland and the Crown Estate, via

interested parties like Scottish National Heritage, the local planning authorities and fishermen's groups, as well as members of the public.

The experiment's results are now helping plan and design large-scale CCS pilot projects in the UK, enabling the companies involved to devise environmental surveys and future monitoring strategies.

More information: "Detection and impacts of leakage from sub-seafloor deep geological carbon dioxide storage." Jerry Blackford, Henrik Stahl, Jonathan M. Bull, Benoît J. P. Bergès, Melis Cevatoglu, Anna Lichtschlag, Douglas Connelly, Rachael H. James, Jun Kita, Dave Long, Mark Naylor, Kiminori Shitashima, Dave Smith, Peter Taylor, Ian Wright, Maxine Akhurst, Baixin Chen, Tom M. Gernon, Chris Hauton, Masatoshi Hayashi, Hideshi Kaieda, Timothy G. Leighton, Toru Sato, Martin D. J. Sayer, Masahiro Suzumura et al. *Nature Climate Change* (2014) DOI: 10.1038/nclimate2381.

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