Finding the Goldilocks sites to store carbon dioxide underground

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Carbon capture and storage has been heralded as a new technology for reducing greenhouse gas emissions. In an effort to help slow climate change, human-produced carbon dioxide (CO2) is captured at point-source emitters like power stations and sequestered in underground rocks. In porous rocks like sandstone, the CO2 is trapped in tiny spaces or pores, which act like a sponge and soak up the injected fluid.

In 2000, one of the first commercial examples of this technology was conducted in Weyburn, Saskatchewan Province, Canada where approximately 3 megatonnes of CO2 (the equivalent of emissions from 500,000 cars) are successfully sequestered every year. Scientists at Bristol have played a key research role in developing methods for monitoring the CO2 migration and storage in this vast oil and gas reservoir.

In a paper published today in the *Proceedings of the National Academy of Sciences*, Dr James Verdon and colleagues from Bristol, the Geological Survey of Canada, the British Geological Survey and BP Alternative Energy compare results from the world's three largest CCS projects.

Their study finds that not all sites are equal and successful implementation of CCS requires careful appraisal. For the approach to work the gas must remain trapped for thousands of years, but some geoscientists have argued that the injection process could increase the pressure enough to open fractures that will allow the CO2 to escape.

To address this concern, Dr Verdon and colleagues examined the 'geomechanical deformation' at three commercial-scale CCS sites that inject more than a megatonne of CO2 underground per year: Sleipner Field in the Norwegian North Sea; Weyburn Field in Central Canada; and the In Salah Field in Algeria. The authors found that these three sites have each exhibited very different responses, highlighting the need for systematic geomechanical appraisals prior to gas injection.

Whilst showing no signs of leakage, the Weyburn site has shown a complicated response, due to a history of 50 years of oil production prior to CO2 injection. At the In Salah site, slower fluid flow means that pressures can build up, and there is evidence for fracturing in and around the reservoir, and uplift of several centimetres at the surface has been seen from satellite monitoring. The size of the Sleipner site, and the excellent flow properties means that approximately 1 megatonne of CO2 can be stored every year with little response from the subsurface.

This variability of response means that future large-scale CCS operations will need to conduct comprehensive and on-going monitoring to ensure continued integrity of underground storage sites, according to the authors.

Dr Verdon said: "Existing commercial CCS sites have shown that, from a technical perspective, it is possible to sequester CO2 in underground rocks. However, to make a dent in mankind's total emissions, billions of tons of CO2 must be stored every year. The challenge is therefore to find 3,000 more sites just like Sleipner.

"Every future CCS site will have a different geological setting, and our study has shown that this can lead to very different responses to CO2 injection. There is not likely to be a 'one-size-fits-all' approach to CCS. Instead, each future site must be judged on its merits: some may be very effective for storing large volumes of CO2, but some may be more limited in the amount of CO_2 they can take."

Co-author Dr Mike Kendall added: "This study underscores the importance of long-term monitoring at any CCS storage site. Regulators have yet to impose long-term seismic monitoring guidelines that are necessary to ensure secure storage."

More information: 'Comparison of geomechanical deformation induced by megatonne-scale CO_2 storage at Sleipner, Weyburn, and In Salah' by James P. Verdona, J.-Michael Kendall, Anna L. Stork, R. Andy Chadwick, Don J. White, and Rob C. Bissell in *PNAS*. www.pnas.org/cgi/doi/10.1073/pnas.1302156110

Provided by University of Bristol

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