# A CATCHER UNDER THE SEA: A research group is developing ways of monitoring carbon dioxide deposition under the sea to assess the safety of carbon capture and storage

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**Alongside the political tussles** surrounding the reduction of $CO_2$ emissions by preventing them in the first place, there is also considerable debate in scientific and engineering circles about reducing levels once it is already released into the atmosphere. The question of whether the oceans can absorb sufficient carbon to mitigate the problem has often been raised.

## Buffer zone

Clearly the oceans are already functioning as a buffer and are estimated to have absorbed 48% of emissions between 1800 and 1994 (see *The Marine Professional* October 2015). Indeed, some are advocating 'geoengineering' to alter the way in which the ocean sequesters carbon, although this approach is highly controversial.

But what about the deliberate deposition of the gas in seafloor sediments in the deep sea? The offshore storage of $CO_2$ in depleted oil and gas reservoirs and saline aquifers, potentially locking the carbon on the seafloor for thousands of years, is a possible solution. The technology to do this already exists in the form of 'carbon capture and storage' (CCS).

However, the impacts of such deposition is an ongoing worry. In particular, environmental scientists cannot make up their minds whether or not $CO_2$ leaks from the deposition would significantly lower the pH of (and acidify) the surrounding water. To date, research on monitoring depositions has been scant. Now a team of scientists and technologists, supported by significant funding from the European Union, is hoping to change that.

## Project participants:

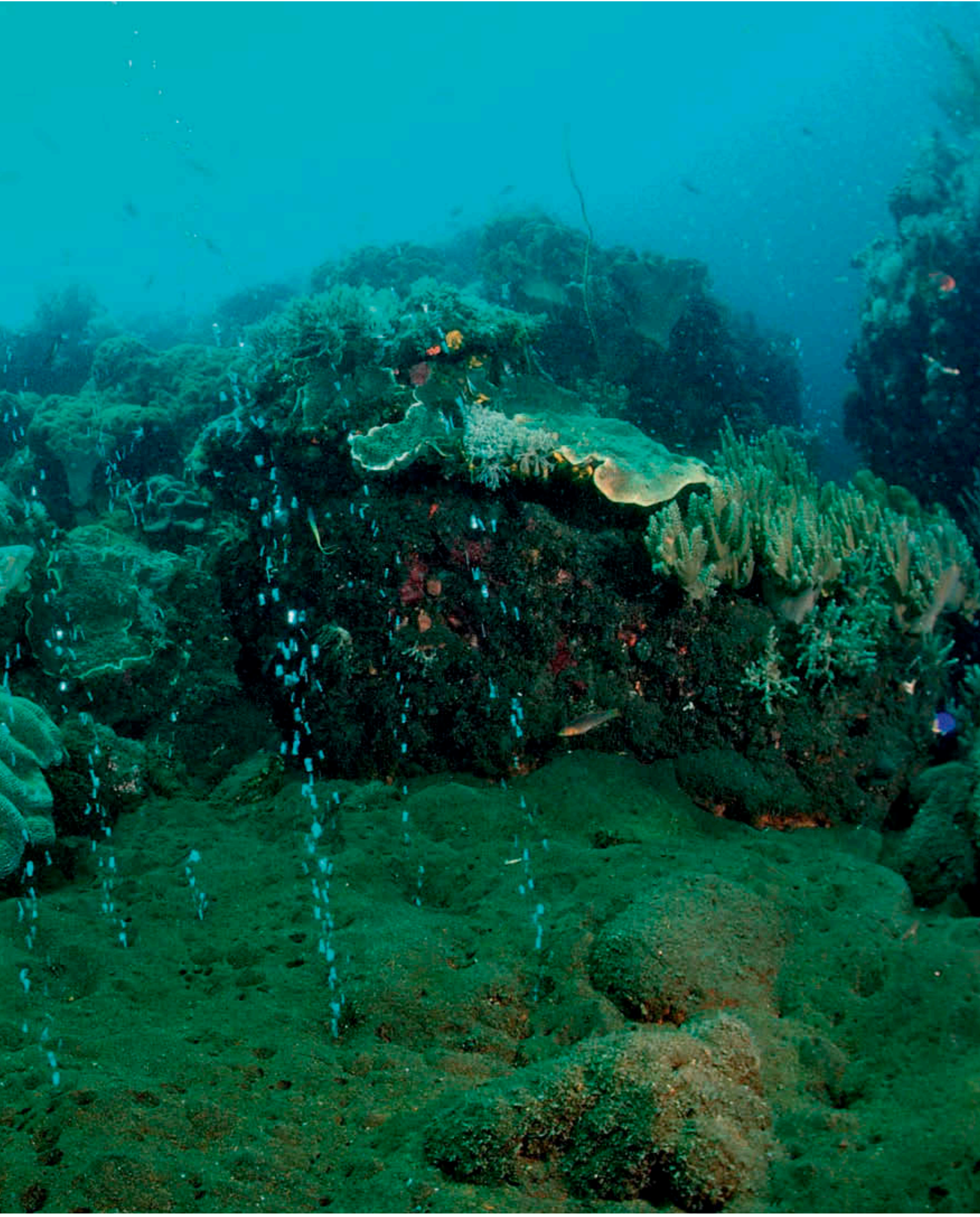
**STEMM-CCS brings together an array of European research and industrial organisations: the oil, gas and energy corporation Shell; from the UK, the National Oceanography Centre (NOC) at the University of Southampton, Heriot Watt University, Plymouth Marine Laboratory, and Seascape Consultants; from Germany, the GEOMAR Helmholtz Centre for Ocean Research Kiel and the Max Planck Institute; from Norway, The Norwegian Institute for Water Research (NIVA), Uni Research, and the Universities of Bergen and Tromso; and the Technical University of Graz from Austria.**

## STEMM-CCS

STEMM-CCS – which stands for STrategies for the Environmental Monitoring of Marine CCS – is a coming together of several organisations – governmental and non-governmental, scientific and commercial (see box) – to test CCS and assess its effectiveness and its safety. The monitoring of deep-water experiments to store carbon in submerged reservoirs presents many technical and scientific challenges.

"CCS is seen as a key contributor to reducing anthropogenic greenhouse gas emissions by 80-95% by 2050," stated a recent announcement by the UK's National Oceanography Centre, which is leading the project. It is regarded as an important way of reducing the mitigation costs connected to the continued use of fossil fuels. The STEMM-CCS project will conduct the world's first 'real-world' deep water controlled experiment simulating emissions from a submerged $CO_2$ storage reservoir, with the aim of further verifying the safety of offshore capture and storage. The team says the work will help provide reassurance about the safety of CCS operations.

Funding was recently secured from the EU's Horizon 2020 scheme to help in these challenges. The sequestration experiment itself will take place in 2018. But, before that, monitoring techniques have to be developed. Next year the team will test them off Scottish waters, 100km northeast of Aberdeen. Acoustic and chemical sensors will be fitted to remote submarines, along with automated photographic software to check for any visual changes to the seafloor. These, together with measurements of temperature,



salinity, currents and other changes in the chemistry of the seabed, will enable the consortium to measure the impacts of CCS and make recommendations as to its use.

NOC's Doug Connelly, the project leader, said: "Currently, it is difficult to detect and quantify $CO_2$ emissions in the marine environment because of dispersion and attenuation effects, the small volumes involved and considering large existing natural variability. This project is a really exciting opportunity to develop innovative, safe and cost-effective technology to address these problems."

PHOTOS: NATIONAL OCEANOGRAPHY CENTRE

## Uncertain future

Despite strong interest in carbon storage, just a few days before the UN COP21 climate change summit got underway in Paris last December, the UK government cancelled a £1 billion competition that was to be awarded for innovation in the technology.

While the Paris meeting discussed various ways of reducing our reliance on fossil fuels, the enormous political capital being expended in this process – as well as wrangling about the relative importance of solar, wind and nuclear power – continues to overshadow research into mechanisms of capturing and storing $CO_2$.

Although it is unclear whether CCS and related methods will have a sufficient impact at the global level to slow down global warming – it at least has the potential to reduce the amount of $CO_2$ in the atmosphere. And some would say quite significantly.

Moreover, although CSS is not without cost, its political capital might be less costly than that of arguing for increased investment in nuclear power – witness the huge political storm about investment in the United Kingdom's nuclear power capability at Hinkley Point C in Somerset, with the plant now threatening to cost more than £18 billion – possibly up to £24.5 billion. ■

## Measuring $CO_2$ absorption

**The mechanism whereby the $CO_2$ released into the atmosphere ends in the sea is not fully understood. The Sentinel-3A satellite could play an important role in elucidating this.**

**$CO_2$ absorbed by the oceans changes the pH of seawater, challenging the survival of many organisms in the sea. Knowledge of the oceanic 'carbon cycle' is therefore vital if we are to understand how organisms cope with the increased acidity.**

**Satellites in orbit, together with measurements from ships and the study of cloud formations are helping to understand this process. Work led by teams from Heriot-Watt and Exeter universities in the UK shows that the seas around Europe annually absorb 24 million tonnes of carbon. They are making their data and cloud computing tools available so that the international scientific community can analyse this data for themselves.**

**Along with data from Europe's Copernicus Sentinel satellites – especially Sentinel-3A, which was launched in February and is soon to be commissioned – they can measure the temperature of the sea surface, currents, winds, waves and other biochemical factors. They will be able to calculate the flux of gases between the ocean and the atmosphere, and thus know more about the solubility of carbon dioxide in the seawater and the speed of gas transfer, taking into account sea-surface temperature and salinity, and the ocean surface wind and wave environment, which governs the speed at which carbon dioxide is transferred.**

**Andy Watson, from the University of Exeter's geography department, said: "Good knowledge of the ocean uptake and release of carbon dioxide is essential for predicting climate change. Eventually, most of the carbon dioxide we release will find its way into the oceans. This project will provide the most accurate estimates that we have and is accessible to anyone."**