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Using small, land-based seismic arrays to monitor microseismicity induced by CO_2 storage

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Carbon capture and storage involves removing CO_2 from industrial emissions or the atmosphere and sequestering it in a pressurised form. Onshore or offshore injection sites pump the liquefied CO_2 below ground, preventing its release into the atmosphere. Earthquakes can occur when fluid is injected into a formation, inducing stress changes that can act on nearby faults, resulting in a rupture. The physics of these ruptures and the effect that fault lubrication processes have in triggering them remain key topics of research. Real-time microseismic monitoring at injection sites is the most readily available tool for painting a better picture. Injection sites on land are easier to monitor, with instruments requiring relatively little maintenance. Offshore sites, however, are more costly and less convenient because local monitoring could require expensive ocean-bottom instruments and complex deployment procedures. Induced microseismicity at CO_2 injection sites is a critical measure of the reservoir and cap rock's response to injection. Thus, there is a need to locate events with low uncertainty, particularly in-depth.

There are plans for several megatonne-scale offshore CO_2 injection projects around the UK. Microseismicity at these sites must be well monitored over decades to ensure long term storage security, requiring novel, cost-effective monitoring strategies. We attempt to constrain the effectiveness of small, land-based arrays that could be used to deliver relatively low-cost monitoring and map out the areas of highest risk from induced seismicity. This study compares the data of such an array installed in northwest England with the national seismic network operated by the British Geological Survey (BGS). We analyse the capability of the array to detect and locate low magnitude (M<3) seismic events. Finally, we examine how to perfect array deployment for CO_2 storage monitoring by modelling the optimum size and spatial distribution of small seismic arrays.