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## Broadband seismic instrumentation for monitoring CCS sites

Will Reis, **Marcella Cilia**, Neil Watkiss, Sally Mohr, Rui Barbara, and Phil Hill

Guralp Systems Ltd, Sales, Aldermaston, United Kingdom of Great Britain – England, Scotland, Wales (wreis@guralp.com)

Carbon Capture and Storage (CCS) sites require microseismic monitoring before, during and after operations to ensure safety of operational personnel and the wider public.

The high dynamic range and low self-noise of broadband seismometers allows for the detection of low magnitude microseismic events which fall below the threshold of less sensitive geophones. Higher long-period sensitivity also allows the full source spectra of earthquakes to be accurately measured, resulting in more accurate magnitude estimations which improve the integrity of any microseismic monitoring system.

Borehole instruments such as the Guralp Radian are a natural fit for detecting low magnitude microseismic events. Optional high gain at the higher frequencies makes the Radian extremely suitable for monitoring low-magnitude induced events while retaining long-period sensitivity for larger ruptures. The slim form factor and omni-angle operation allows the instrument to easily be lowered into decommissioned wells with little information about the orientation at depth.

The Radian is currently being utilised by the British Geological Survey as part of the UK GeoEnergy Test Bed (GTB) to monitor and improve understanding of fluid flow through natural subsurface pathways. A string of 6 interconnected Radians provides vertical profiling around the injection site with a maximum of 8 units able to join in a single string. The Radian will detect and monitor small changes in the subsurface at the GTB as part of the suite of monitoring technologies deployed onsite.

In addition to onshore networks, offshore depleted gas fields are becoming increasingly scrutinised for potential to store CO<sub>2</sub>. The advent of Guralp omnidirectional sensor technology combined with acoustic near-real-time data transmission means the Aquarius OBS provides a cost-effective solution for monitoring offshore CCS sites, with infrequent and rapid battery recharging and acoustic data extraction while the unit is still on the seafloor.