High-resolution far-offset VSP survey with Carina® Sensing System for permanent CO_2 storage monitoring in Otway, Australia

Client: CO2CRC

Project

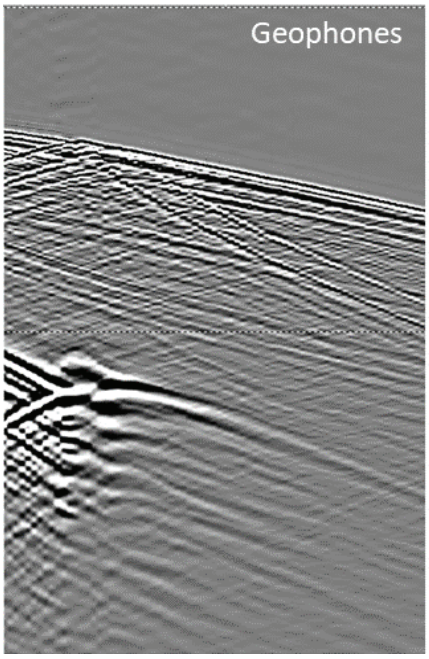
CO2CRC's Otway research facility is Australia's first demonstration of the deep geological storage of carbon dioxide (CO_2), the most common greenhouse gas. CO2CRC's Otway Stage 3 Project aims to develop and deploy a sophisticated monitoring system in the subsurface through up to five new wells. The monitoring system should deliver a permanently deployed solution that is reliable, cost-effective and with high-resolution. It should provide on-demand seismic data for high quality 4D imaging of the CO_2 plume migration.

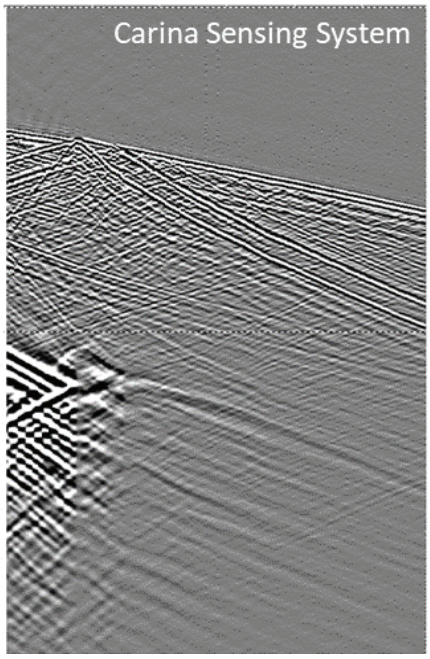
Challenge

The benefits of DAS as a seismic acquisition tool are proven and well-suited to this application. High-resolution measurements with full wellbore coverage for every shot provide unique levels of detail. However, with most VSP type measurements, the imaging aperture is limited, meaning only a small area of the reservoir around the wellbore is imaged. Using far-offset source locations can widen this aperture but often the signal-to-noise ratio is not sufficiently high to extend the seismic image, even when using conventional wireline geophone sensors.

Solution

The advanced Carina Sensing System, developed by Silixa, provides a further 20dB (100 times) improvement in the signal-to-noise performance of DAS measurements, and offers capabilities beyond conventional geophones in many seismic applications. This step-change improvement in performance was confirmed during a baseline VSP acquisition at the Otway research site.





Results

The figures below show a comparison between shot gather data for both a conventional wireline geophone tool and the Carina Sensing System at two different shot locations. Figure 1 shows data from a 700m offset, Figure 2 shows data from a 1800m offset. The source was a single 26,000lbs vibroseis truck using a 6-150Hz, 24sec sweep.

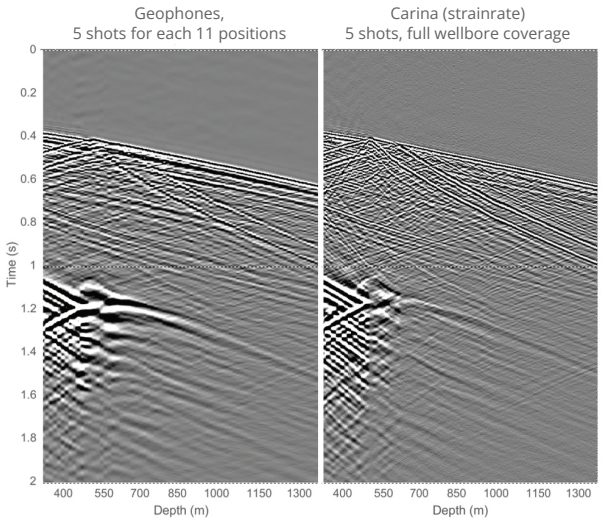


Figure 1 a) 700m offset, Geophone Z component;
b) 700m offset, Carina Sensing System

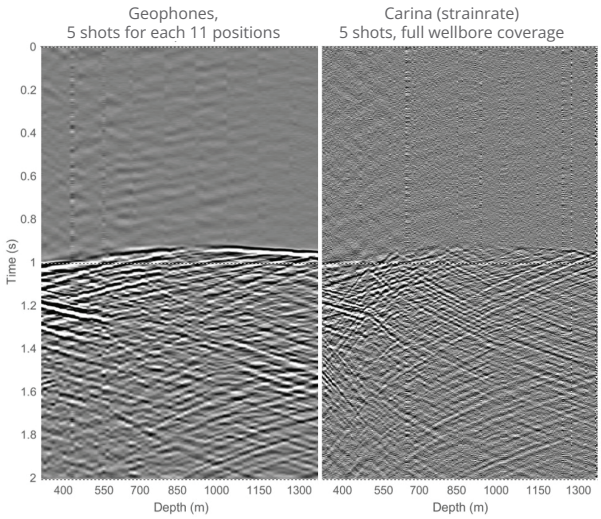


Figure 2. a) 1800m offset, Geophone Z component;
b) 1800m offset, Carina Sensing System

It can clearly be seen in both figures that the Carina data shows more detail and stronger upgoing reflection energy than the geophone data with the same number of stacked shots. The Carina Sensing System provides high-resolution data with high signal-to-noise ratio.

Figure 2, at the farthest offset source location of 1800m from the wellhead, shows clear coherent reflected energy even at receiver positions towards the bottom of the well. This level of source offset is not typically included in the post-processing imaging for VSP measurements as the signal-to-noise ratio is not sufficiently high with conventional geophones. The Carina Sensing System provides a new level of performance to change this methodology and could therefore provide wider aperture, finer resolution subsurface images with one-shot™.

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