GSWA Lower Lesueur 2D Seismic Survey

A summary on the impact of the new seismic survey on the Collie Hub Carbon Capture and Storage Project
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1 Introduction

1.1 Seismic Survey

The earth is composed of multiple layers of rock deposited over millions of years. Some of these layers trap resources (water, minerals, oil, and gas) and also hold potential for storing large volumes of CO₂ for thousands of years. Geoscientists use a number of techniques to map these layers and subsequently develop models for what the earth at that location may look like in cross-section. A seismic survey is one such technique and is used widely in the mineral and oil and gas industry.

A seismic survey records sound waves reflected by rock layers (geological formations). These sound waves are used to image the different layers of rock below the surface. It can be compared to an ultrasound test that doctors perform in a human body but at different scale and frequency.

The survey is conducted by installing receivers or sensors called geophones at the surface to record the echoes that were reflected by the rock layers below the surface. To create the echoes or waves, sound sources such as special vibration trucks are used. These trucks are equipped with large pads that send vibrations through the earth.

In conducting a seismic survey, the crew will place a series of cables equipped with geophones along a grid over the area to be mapped. Once geophones are placed, vibration trucks will move in tandem down pre-defined paths lowering a vibration pad onto the earth’s surface every few meters. The waves created by the pad will travel deep underground and be reflected back as echoes from different rock layers. These reflections are picked up by the geophones and sent to a recording system, which captures the data for computer processing and analysis.

From the timing of the reflection data, the depths of the layers can be determined, and an image of the subsurface can be formed.

![Image: Sound waves transmitted by vibration trucks bounce off rock layers and are collected by geophones.](image)

*Figure 1-1: Images above show how the sound waves transmitted by the vibration trucks bounce off each layer of rock and are collected by the geophones and transmitted to the recording truck. As sound waves travel deeper they continue to bounce each rock layer.*

1.2 The South-West Collie Project Exploration Program

Under this program the suitability of Lower Lesueur area as a site for storing CO₂ underground for the Collie Hub Carbon Capture and Storage Project is being assessed. This exploration program will help improve the understanding of the Lower Lesueur area with regards to its potential for storing large volumes of industrial CO₂ underground safely.

Seismic data of various vintages from the 60’s to 2008 was available for the initial studies conducted in the Collie region, however majority of the data was old and of poor quality. As the South-West Collie Project developed
there was need for more data to help better define the geology. As part of the exploration program, new seismic data was acquired in March 2011 by Geological Survey WA (GSWA); hereafter referred to as Lower Lesueur seismic. In addition, a new stratigraphic well; the proposed Harvey-1 well is scheduled to be drilled in January 2012.

The Lower Lesueur seismic was interpreted and incorporated into the existing geological interpretation and used to assist in the design of Harvey-1 well. Figure 1-2 shows the location of the study area and the well and seismic that was used to assist the interpretation.

This initial stage of the exploration program will guide a subsequent stage wherein more seismic data will be acquired over a broader region and more wells drilled. This process will allow a staged development building technical confidence in the storage site.

Figure 1-2: Location map showing offset wells and existing seismic in white, proposed GSWA Harvey-1 in blue and Lower Lesueur seismic in red. The study area is within the yellow box.
2 Lower Lesueur Seismic

2.1 Horizon and Fault Interpretations

In order to evaluate the geological formations (reservoirs) that have the potential for storing CO$_2$, existing seismic together with the new Lower Lesueur seismic needed to be interpreted. Horizon (layer tops) interpretation of seismic reflectors identifies the different reservoirs while fault interpretation defines the storage container boundaries. Three main seismic reflectors were selected for interpretation due to their continuity through most of the study area. They are the unconformity, top Wonnerup and base Lesueur reflectors and can be correlated to geological formations by stratigraphic table (see Figure 2-1). In the study area, the Lesueur Sandstone which can be divided to two members; Myalup and Wonnerup, has been identified as having potential for storing CO$_2$.

![Stratigraphic Table](Figure 2-1: Stratigraphic column of the southern Perth Basin showing the interpreted horizons and proposed reservoir intervals (the Myalup and Wonnerup Members of the Lesueur Sandstone).)

In the older seismic surveys the data quality is poor without good continuous reflectors (see Figure 2-2). In the newer Lower Lesueur seismic, it is easy to identify the top and bottom layers straddling the distinctive transparent zone (see Figure 2-3).
Figure 2-2: The seismic panel above from the Preston Detail seismic (acquired in 1970) has an east-west orientation. There is no clear seismic character (reflectors) and the image is chaotic. Reservoirs of interest, thus the location for injecting CO₂ is hard to identify.

Figure 2-3: The panel above is from the new Lower Lesueur seismic and has similar east-west orientation as the one in Figure 2-2. There is a major improvement in the seismic character and the new data allows the reservoirs to be imaged clearly.
The study area is confined to the east by the Darling Fault and dominated by three fault trends (N, NW and NE striking faults) which are related to the orientation of geological rifting events after these formations were deposited millions of years ago. Many more faults can now be interpreted towards the eastern side of the area of interest due to the new Lesueur Seismic (see Figure 2-4). As can be seen from the new data the area is more compartmentalised than previously assumed. This is very important information and has an impact on determining the container size and the volume of CO₂ that can be safely stored.

Figure 2-4: Both seismic panels have similar east-west orientation. The seismic panel at the top has limited faults interpreted due to lack of clear reflectors (poor data quality) and the interpretation could not be extended to the east due to lack of seismic coverage. However, the seismic panel at the bottom has more faults interpreted and the interpretation extends further east due to the extension the seismic coverage from the new Lower Lesueur seismic.
2.2 Conclusion

The new Lower Lesueur seismic is of better quality data than older seismic surveys. This allows

1) Better delineation of the target reservoirs and improved definition storage capacity.
2) Appropriate selection of the Harvey-1 well location. The proposed well location avoids any interpreted faults, and the definition of the structure around the well is clearer. This can be seen when comparing the old and new maps (Figure 2-5). Compared to earlier interpretations, the area of interest is more faulted and therefore compartmentalised. This may have an impact on the amount of CO₂ that can be injected (Figure 2-5).

![Updated Depth Structure Map Top of Wonnerup](image1)

**Figure 2-5:** On the left is the updated map for top Wonnerup based on new data from Lower Lesueur seismic. On the right was the older interpretation form phase 1(b) work. Note how the area of interest is now more compartmentalised.

3 Next Steps

Results from the drilling of proposed Harvey-1 well combined with the current reservoir and containment definition from Lower Lesueur seismic will assist in defining the next data acquisition stage of the exploration program wherein more focused seismic and wells can be planned. The integration of all this data will allow taking informed steps towards building technical confidence in the Collie Hub Carbon Capture and Storage Project.
4 References
