Nodal Acquisition Seismic Experiment in the highlands of Victoria/NSW, Australia, and challenges in processing of the data

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The Southeast Lachlan reflection seismic survey was carried out on a 629 km transect across the Lachlan Orogen in Victoria and New South Wales in 2018. The aim of the Southeast Lachlan survey was to improve our understanding of the geological architecture of the region and to increase knowledge of potential mineral resources and natural hazards of the eastern domain of the Lachlan Fold Belt in southeast Australia.

A total of 629 kilometres of deep crustal data were collected along three lines. A cable-less nodal acquisition system rather than conventional cable system was employed due to very complex rugged terrain, high elevation region and narrow, windy access tracks. Geoscience Australia has traditionally collected regional two-dimensional (2D) vibroseis seismic reflection data using strings of 6-geophones over 20 m as a receiver array. However for the Southeast Lachlan survey we used SmartSolo IGU 16, 10Hz nodes (Dynamic Technologies (DTCC)) with a spacing of 10 m.

An advantage of using a nodal system is continuous collection of data. During the Southeast Lachlan survey the data were recorded continuously in internal DLD format and also output in SEGD format and then, after harvesting and cross-correlation of the data, standard SEGY shot gathers were produced. Some of the most challenging aspects of acquisition and, in particular in the deployment of instrumentation, were the crookedness of lines, and the significant elevation range (up to 1.2 km) along the transect. The crookedness of the line, in addition to extreme elevation variation and hard rock environment, introduces a number of data processing challenges.

The significant bends in the lines resulted in obtaining a wide midpoint distribution around those bends. This created a considerable challenge in producing adequate geometry for CMP binning. To address this issue, two alternative approaches were employed to image the data - a 2D crooked line binning, and a pseudo-three-dimensional (3D) binning approach. Both approaches were based on a smooth 2D CMP line picked through the scatter of midpoint locations. The data were processed through a post stack 2D Time Migration path, as well as 2D Pre-Stack Time Migration path, and a Pseudo-3D Pre-Stack Time Migration path. Although the pseudo-3D approach did not result in a true 3D image of the subsurface, we were able to compare the 2D migrations with the pseudo-3D to isolate some reflections out of plane of the 2D CMP line.

Despite the various data acquisition and processing challenges, the project was successful in imaging the whole crust in this area of the Lachlan Orogen and provided fundamental structural information on the crustal architecture in southeast Australia.