Seisware Interpretation of Eromanga and Cooper Basin in Southern Australia

GOPH 559

Lawrence Lines

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Abstract

Seismic surveys are one of the most popular geophysical techniques in order to extract data about the local subsurface. Using Seisware, a 3D volume plus two 2D seismic lines from the Eromanga and Cooper Basin in southern Australia is interpreted. 3D to 2D seismic data was first tied and seismic-to-well ties were then performed using synthetic seismograms. On the seismic shot records, two horizons were then picked at a certain interval between lines (100) over the entire 3D volume, in line and crossline. This resulted in generating time structure, amplitude and isochron maps which pointed to a fluvial-deltaic depositional setting, with one one of the horizons acting as a seal for trapped gas.

Introduction

The following figure 1 shows a brief overview of the local area in study. The black diamond area (or technically 3D volume) measures 45km x 45km to provide the reader with a sense of scale. It is referred to as the Moomba Big Lake volume. The two green lines are referred to as the 8ti-tpz crossline and 8ti-tqj inline perpendicular to each other and they provide the 2D seismic data. These two datasets were first tied together by looking at the seismic data side by side and matching it.

Two wells are also given marked by the black spiked dots and they are referred to as the Moomba 138 on top and Moomba 132 on the bottom. These wells provided their respective sonic, density and gamma ray logs to assist in the interpretation. Notice that these black dots are overlain on red lined irregularly shaped polygons. These polygons outside and inside of the black diamond represent a 'culture layer' which outlines the known gas fields.

After tying 3D seismic data to 2D, two geological horizons known as the Cadna-Owie and Toolachee were picked across the entire 3D volume in both inline and crossline directions, Cadna-Owie being at higher elevation. Time structure, amplitude and isochron maps were finally generated as results to attempt to interpret the data in terms of inferring trapping mechanisms, relative timing of uplift and general depositional settings visible.

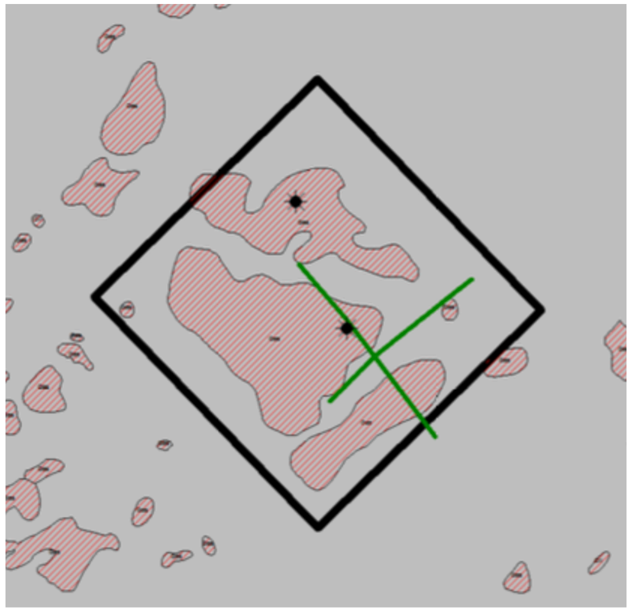

Figure 1: basemap of project study data, southern Australia

Interpretation and Results

After tying 3D seismic data to 2D and generating well synthetic seismograms which are then tied to the shot record, it is quite discernible that uplifting has occurred after deposition of the Cadna-Owie and Toolachee formations. It can be inferred as such due to the fact that both horizons Cadna-Owie and Toolachee were shifted an equal amount. The Cadna-Owie formation is obviously younger as it lies on top of the Toolachee horizons.

Lateral changes that are very abrupt may be indicative of faulting. This pattern can be seen when looking at the Toolachee formation's time structure map, indicative of faulting in the area. The thought on faulting can further supported with the amplitude map of the Toolachee horizon. Higher amplitude values along with the linear geometry when compared to the surroundings is also indicative of a fault especially when combined with the time structure map. The isochron map of the Toolachee formation also features narrow channels due to greater vertical time 'thickness'. Amplitude maps for both Cadna-Owie and Toolachee horizons showed large acoustic amplitude areas surrounded by lower amplitude, possibly inferring towards a fluvial-deltaic depositional setting.

The Toolachee horizon was formed in the late Permian Age and the high organic content in the Permian sediment led to the formation of coals and carbonaceous shale, both of which being hydrocarbon source rock. These were deposited on the eroded surface which became part of the Cooper Basin. Following the deposition of the Toolachee formation and a few other formations in the Jurassic, the Cadna-Owie formation was deposited in the early Cretaceous. The Cadna-Owie formation is part of the Eromanga Basin. The initial deposition in the Jurassic was primarily controlled by the topography on the unconformity surface. Uplift happened after the deposition of the Toolachee and Cadna-Owie formation.

The gas fields are structurally trapped thereby confirming that there are seals present in each formation. The gas fields visible in the Cadna-Owie horizon are sourced from the Toolachee, meaning that the Triassic region seals were penetrated and led to the migration of the gas. The local seals in the major reservoir units are formed by shale. The depositional setting of the Cadna-Owie formation in the Eromanga basin represents the first encounter of marine depositions in the basin and is then dominated by fluvial deposition with high sediment volume. The depositional setting of the Toolachee formation in the Cooper Bin is non marine. There is also an anticline present from looking at the seismograms and shot records. Anticlines are a preferable geological structure for reservoirs and are easily traced due to arched shape.

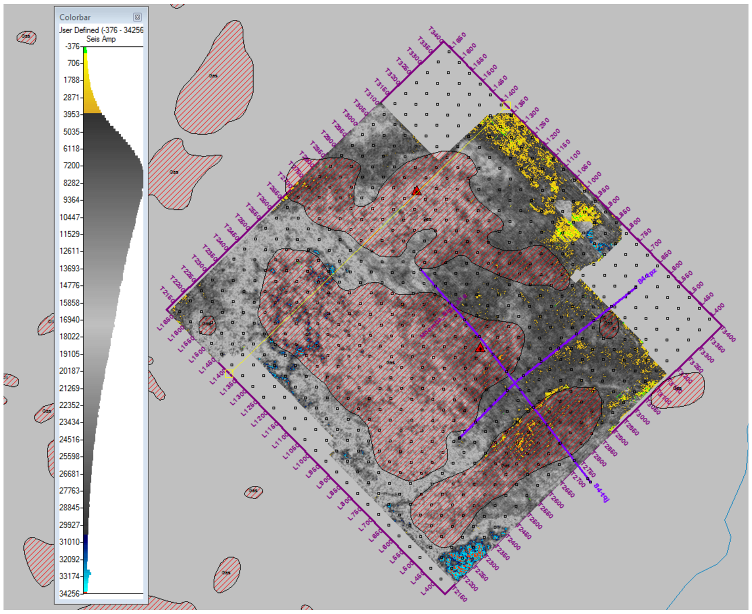

Figure 2: abrupt high amplitude values for the Toolachee formation

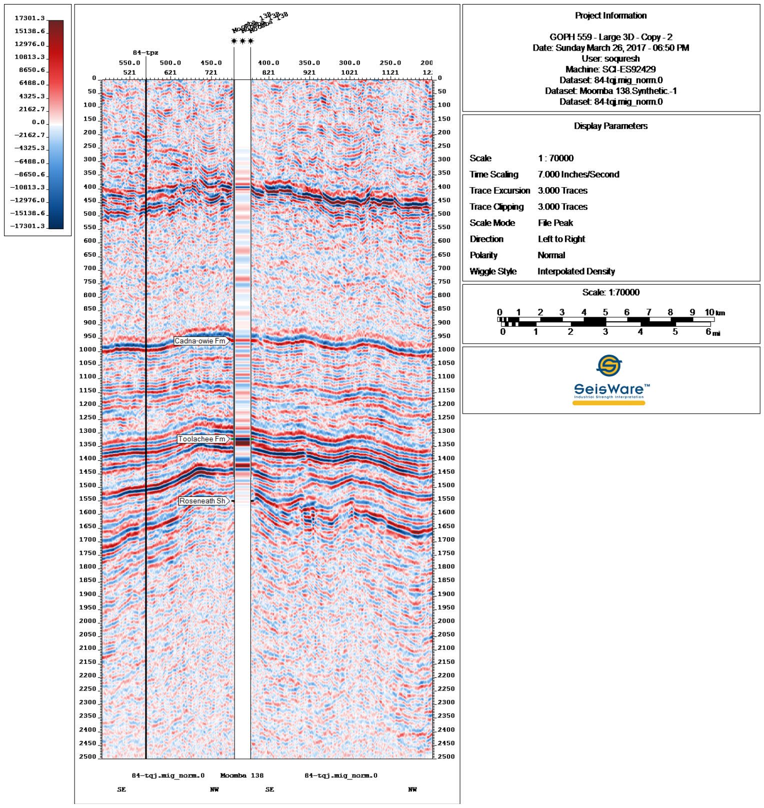

Figure 3: performing a well tie with 2D seismic line data

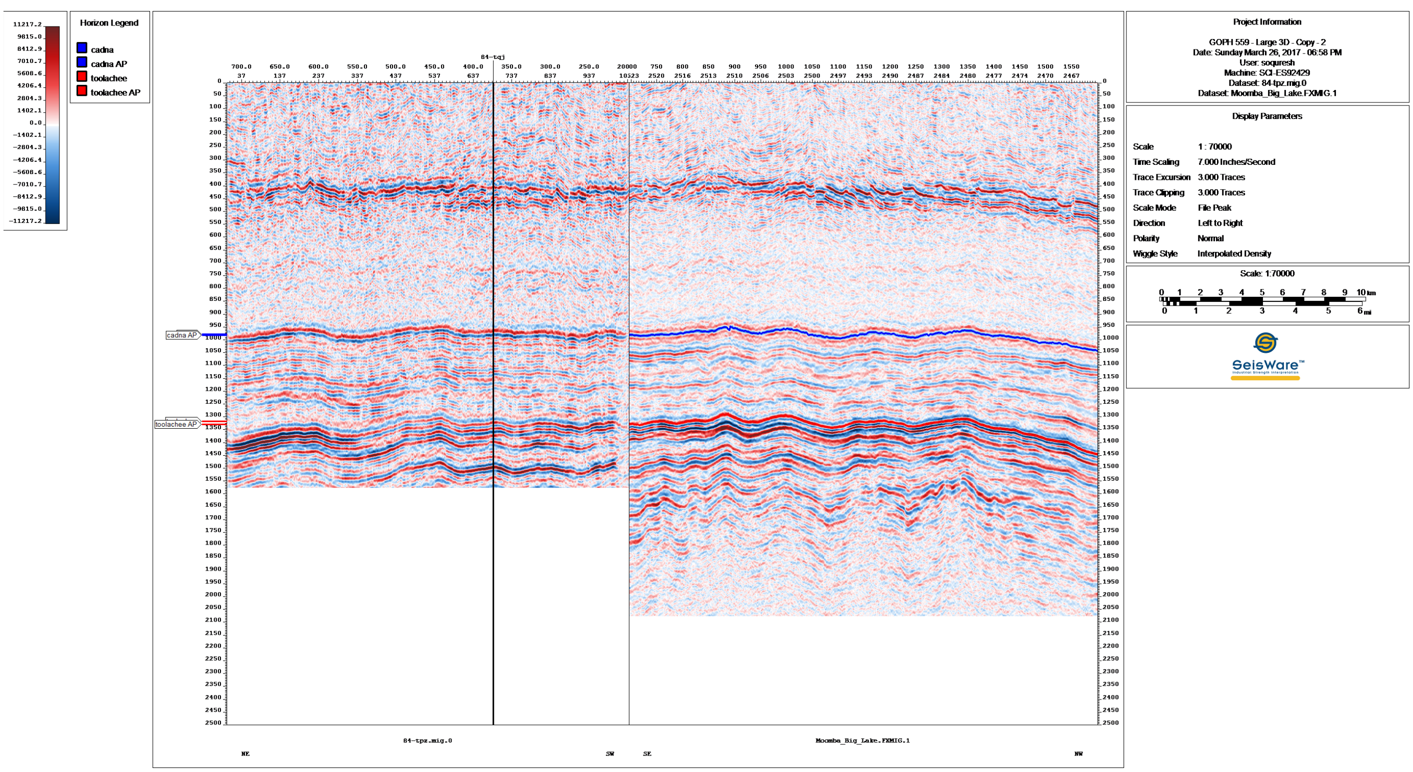

Figure 4: Tying 2D to 3D seismic data via correlating events and then tracing along a discernible pick for the appropriate geological ages (Cadna-Owie, Toolachee formations)

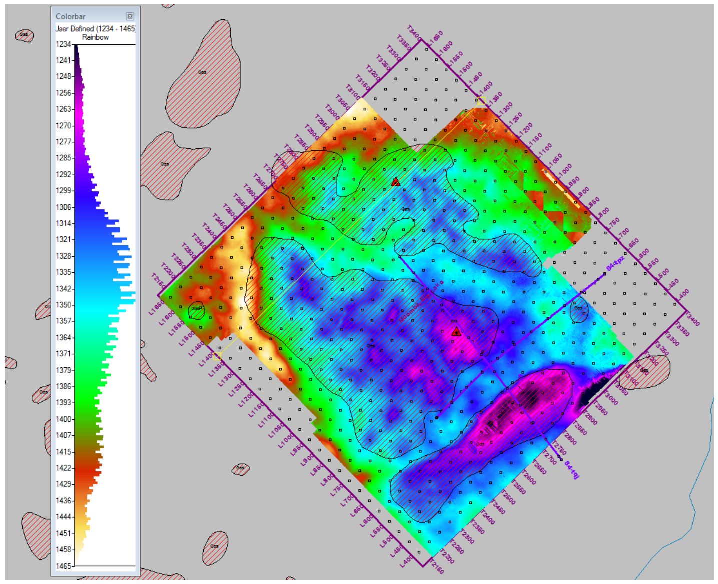

Figure 5: time structure map for the older, lower Toolachee formation, noting the three red triangles on the right most side due to a horizon auto picking error by the automated software

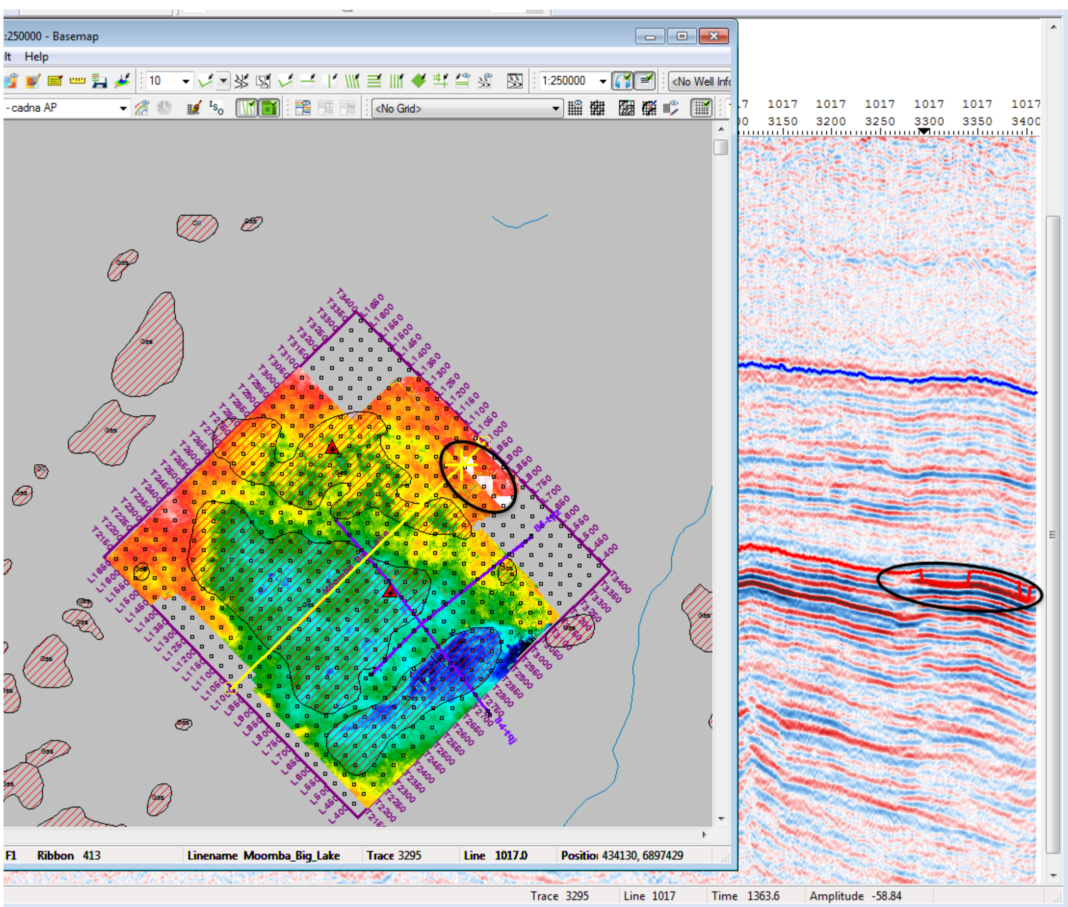

Figure 5: isochron map generated after all picks were done for the Toolachee-Cadna-Owie horizons. Here we can see the horizon auto pick error on the seismic , leading to those incorrect triangles on

Conclusions

Bringing it together, the software interpretation package Seisware allowed to look closely at a 3D volume in southern Australia. Resulting maps of time structure, amplitude and isochron, in conjunction with well ties to seismic data, can be used to infer the history of deposition in the subsurface. Trapping mechanisms can also be interpreted and in the case of this volume, clear faulting was seen. The faulting resulted in a partial break to the seals and the faulting led to migration from Toolachee to Cadna-Owie formation. The Cadna-Owie formation can most likely be assumed as a trap which encloses the gas field of interest, being of early Cretaceous in age and 20m to 60m thick from velocity analysis. Thus, the gas fields indicated by the red polygons on basemap where the wells are located are essentially trapped between the Toolachee and Cadna-Owie horizons. As such, emphasis in interpretation should be placed there which narrows down and focuses positions and locations within subsurface strata.

References

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