Jackson Oil Field: a test of modern interpretation tools

Michael Micenko
micenko@bigpond.com

The Jackson Oil Field, located in southwest Queensland, was discovered in 1981 and all the seismic interpretation leading up to the discovery was carried out on paper sections – 2D, of course, because the first and only 3D survey in the basin at the time (Cuttapirie) had just been acquired earlier in the same year. In 1981 I spent several weeks working on the paper sections – picking horizons with coloured pencils and carefully folding each paper display at every line intersection to tie round loops. Then the picked sections were placed on a digitising table and each horizon was painstakingly digitised by hand. The digitised values were then posted on a map, contoured by hand and maybe coloured with pencils.

Today there is good 3D seismic coverage over the field and the data can be readily obtained so I thought I'd try out some of the latest tools in my interpretation kit bag to see how well they work.

First off is an automatic fault picker which I mentioned briefly last year. The fault tracker requires a discontinuity, coherence or similarity attribute volume as input. Recently some new attributes of this type have been developed based on the Grey Level Co-location Matrix (GLCM) and this was a good opportunity to test them against the older, more familiar attributes. The fault picker I tried is still in development and like most automated processes it requires a good input dataset and a good deal of experimentation to select the best parameters to use. I spent a large amount of time applying filters to optimise the data for the fault tracker and the results are quite good (Figure 1). Figure 2 compares the fault sticks picked using a similarity volume with those picked with a GLCM dissimilarity volume as input.

The results are similar. Because the GLCM attributes are derived from a large cube of data around the sample point they appear smoother than the standard similarity, but this does not appear to affect the identification of fault sticks. It is now a simple task to create fault surfaces from the fault sticks. Interestingly, the shallow and deep faults in this dataset are related but rarely does the tracker find a fault propagating through the entire section. I attribute this to the geology rather than the software.

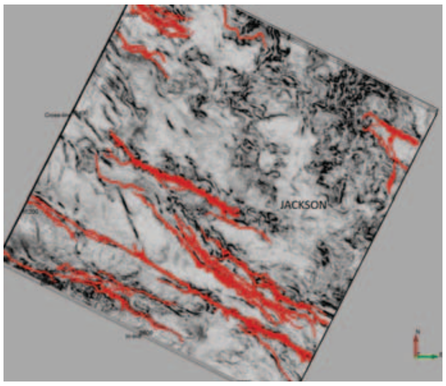

Figure 1. *Automatically picked fault sticks on and above the time slice of similarity attribute at 1719 ms (each side of the volume is about 12 km).*

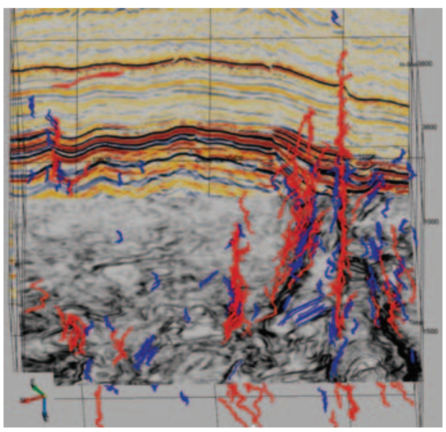

Figure 2. *3D view of auto-tracked faults using similarity (red) and GLCM dissimilarity (blue). The vertical seismic is PSTM line 4100, the horizontal slice is the GLCM dissimilarity at 1719 ms.*

Next, I was able to try a horizon auto-tracker using the faults to constrain the picking (Figure 3). These are common now and horizons at the top and base of the zone of interest took much less than an hour to propagate across the whole survey area from as little as a single seed point for each horizon. Two horizons were picked – the 'C' horizon at the top and a marker 'P' at the base. It is interesting to compare the 'C' horizon time map from the auto-tracked 3D with the 1984 time structure map (Figure 4). The broad structural configuration is similar but the 3D version has much more detail. In the mid-80s the two-way time structure map was the main product of an interpretation project although sometimes a depth map was considered necessary. But things have progressed and this is really just the starting point today.

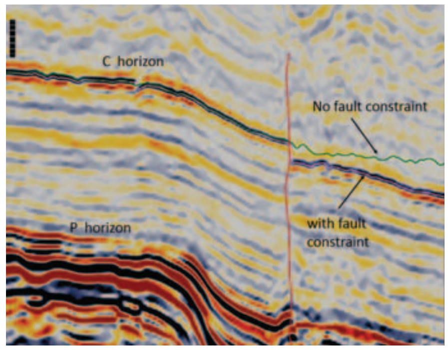

Figure 3. *What a difference the fault makes. Without fault constraints the auto-tracker horizons can easily go astray.*

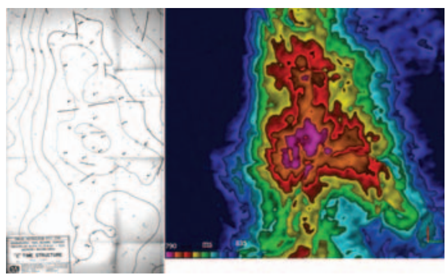

Figure 4. *Jackson Field C horizon TWT structure. Comparison of 1984 map (left, contour interval 10 ms) and 2014 auto-tracked C horizon map (right, colour interval 5 ms).*

With the top and bottom of the zone of interest defined it is easy to create a horizon cube, which is a volume of closely spaced horizons propagated from seeds on a selected trace. In this example (Figure 5) seed points were selected every 2 ms on a trace near Jackson-1. The horizon cube used only a single pass and it is quite apparent that there are some large gaps between horizons in places. For a full interpretation these gaps should be filled with further passes of the horizon cube tracker.

Once the horizon cube is generated there are a number of options available to the interpreters. They can extract key horizons with ease, identify unconformities across the whole volume and create Wheeler diagrams to unravel the depositional history. Scrolling through the over 130 automatically created horizons in the horizon cube it is easy to select and save key horizons. These usually extend across the area with a consistent seismic signature and could, perhaps, be interpreted as flooding surfaces. Five horizons in addition to the 'C' and 'P' were extracted from the horizon cube. These correspond closely to geological boundaries – near Top Murta Member, an Intra Murta, and near top Namur, Westbourne, Birkhead and Hutton Formations (Figure 5).

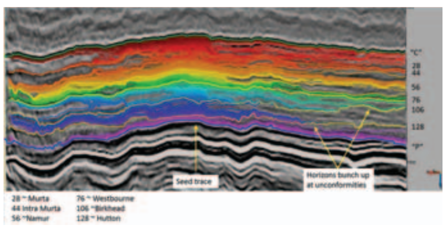

Figure 5. *Line 3975 showing horizon cube. Key horizons extracted from the cube are numbered and shown in yellow.*

Possible unconformities are also simple to identify by calculating the horizon density or number of horizons in a given time window. The more bunched the horizons the more likely it is an unconformity. The result of the Jackson trial is shown in Figure 6. Note, there appears to be some relationship between the unconformities (possible sequence boundaries) and the key horizons (possible flooding surfaces). Now we are well on the way to recreating the stratigraphic history of the area. Figure 7 is a 3D view illustrating the possible unconformities in an area around Jackson 1. Apart from anything else it demonstrates the difficulty of representing a 3D object on a static 2D surface.

Figure 8 shows a Wheeler diagram constructed along NE-SW trending line 3975. Basically, in this display each horizon is shown as a horizontal line so that the vertical axis is relative geological time (i.e. it is not calibrated to actual time). Blank areas represent either places of erosion or non deposition. On this example some erosion can be recognised at the top Hutton while the section above has had a series of prograding and flooding events as shown by the arrows. This is my quick interpretation and may be totally wrong. Including well information would provide more accurate reconstructions.

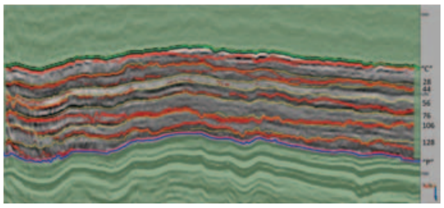

Figure 6. *Line 3975 showing key horizons extracted from horizon cube in yellow and possible unconformities in red.*

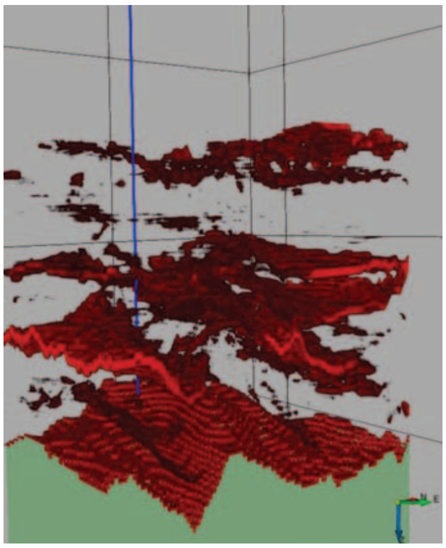

Figure 7. *3D view of unconformity surfaces around Jackson-1 well (blue) viewed from southeast.*

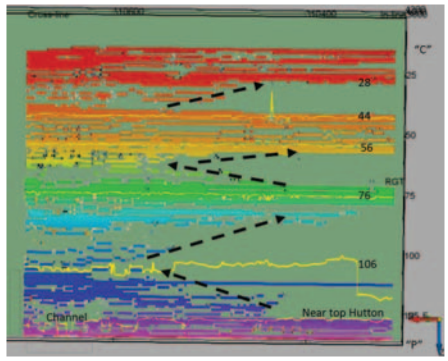

Figure 8. *Wheeler diagram of line 3975 showing erosion at the top Hutton and a series of prograding and flooding cycles. The vertical axis is relative geological time.*

Finally, there are numerous attributes to sift through. including several new ones based on the GLCM. I have not had much luck producing a good example here, although the two attributes shown in Figure 9 can be interpreted in completely different ways with a north-south aligned meander possible on the amplitude map while the GLCM energy shows a more east-west trend of more linear features.

To wrap up, seismic mapping has come a long way over the last 30 years with several new tools available to help make more geologically reasonable interpretations in less time. Because we have been so successful the focus has changed from mapping simple structures to recognising and defining stratigraphic plays and traps using a variety of new tools and techniques. If only we had time to use them all.

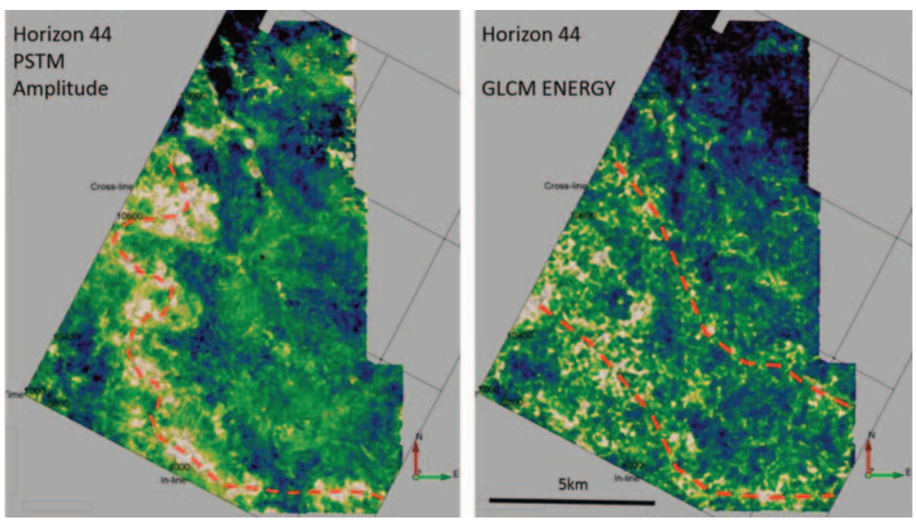

Figure 9. *Selected attribute displays at horizon 44 – Intra Murta. The PSTM amplitude (left) and GLCM energy (right) can be interpreted differently (red) without the benefit of well data.*