My head in the Cloud

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Over the past 3 years, there has been a significant change in storage possibilities for data: it goes by the name the ‘Cloud’.

Really up until a few months ago, Cloud technologies were not part of my vocabulary in terms of viable technology for exploration data storage, and this was typically due to the sheer size of the data with which we deal. How on earth would we get them into and out of the Cloud?

Recently, I attended a training course and have since been investigating the possibilities that the Cloud now offers. I can confidently say I am a serious convert. The offerings of companies like Amazon for instance that offer infinite storage and massive computing power at a fraction of the cost of owning the equipment and doing it yourself are simply too hard to pass up. Furthermore, since completing my training, I cannot stop thinking about the Cloud and its endless possibilities, especially where exploration data is concerned.

The most common rejection I get from users to using the Cloud is ‘the Cloud is simply not fast enough for me to get access to the data, especially given the size of the files I use’. So let me address the issues of speed and size.

When a user talks about speed, they are usually doing comparative analysis: ‘I can get access to data this fast right now, so how fast will it be if I move to the Cloud?’. Well, fair question, but let’s not give too much credit to the user for asking, as typically the users forget a few important elements at play in this analysis. Using oil and gas data as an example:

- Newly collected data is usually accessed heavily within the first 3–6 months of acquisition and then 95% of the data is normally not accessed for many years at a time – or ever again. Therefore, you almost only ever need rapid access to data you are working on right now, not everything you have ever acquired. Additionally, the data you are working on right now probably won’t have originated in the Cloud.
- Let’s say you actually do need rapid access to that 95% of data you acquired 3 years ago, but usually don’t need. How fast is it really going to be to get that data in the conventional way as compared to Cloud access? Well, in most cases the data from 3 years ago is on a tape in storage somewhere. You are looking at 36 hours minimum in the best circumstances to get this data by conventional means – probably more like 72 hours. I can assure you the Cloud can manage to beat that timing on a routine basis without the need for intermediate tapes to be created, avoiding duplication costs and the need to interact with one of Australia’s friendly courier drivers.
- Okay, so the Cloud is pretty fast, but the size of the files I need are massive and the Cloud can’t handle moving that huge 3D we acquired back onto my network – sorry user, wrong again. Not only do Cloud providers offer direct connect access or import/export facilities to speed that process up, but more importantly I would question why you would download it at all when you can process the data in the Cloud without moving it using the almost infinite compute power available in the Cloud.

So, when will people start to migrate to the Cloud in the exploration industry? I believe the move in earnest has begun. People are asking questions and testing the capability much more routinely and it is only a matter of time (months not years) before someone integrates it into its forward planning.

I know what you are saying as you approach the end of this article… ‘Guy finally wrote something that is serious relating to a “Data Trend”’, and for this I must apologise.

Seismic window: where is the seismic line?

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Recently our data manager spent several months cleaning up a large seismic database that had numerous misties at line intersections. The misties were the result of incorrect positional data associated with the seismic lines and some protracted detective work was needed by him to correct the errors. This article describes some causes of the errors and is illustrated with sketches from his notes. The project database covers an area of the offshore Browse Basin and was populated with data from several sources: processing contractors, joint venture operators, study groups, acreage gazettal data packs, purchases, 'the Internet' and government agencies. It was found that where multiple versions of a seismic line were present they rarely plotted in the same place on a map (Figure 1).

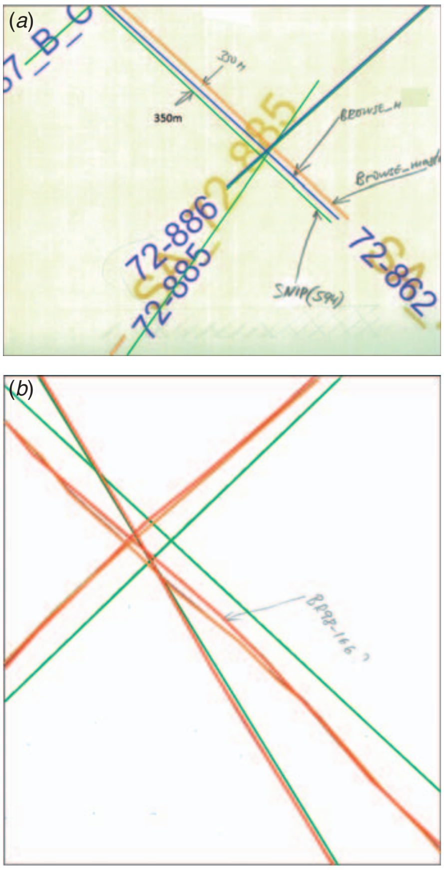

Fig. 1. *(a,b) Typical examples showing a seismic line plotting in three different locations depending on the source of the coordinate information.*

The seismic trace data (or wiggles) are fine and the issue is locating the trace data in the correct position on the ground? Often the navigation data is poorly documented and it is still common for data from different sources to have different coordinates. Why is there a variety of locations for the same trace and how can the real location be determined?

In this project, incorrect coordinate data fell into two categories: an incorrect coordinate reference system (CRS); and deficiencies in the data. Most errors fall into the first category and to explain why, a brief history and explanation follows.

Up until the 1980s Australia used the Australian Geodetic Datum (AGD) and Australian Map Grid (AMG). AGD was based on a spheroid that gave a good match to the shape of the earth's surface in Australia, but was a poor match away from Australia. Unfortunately, the AGD spheroid was not geocentric (the centre of the spheroid was not the centre of the earth) and with the widespread use of satellite-based positioning there was a requirement for a geocentric spheroid.

During the 1990s Geocentric Datum of Australia (GDA) was introduced to replace AGD and was adopted by most companies from around 2000 onwards. GDA uses a geocentric spheroid and is very close to the World Geodetic System (WGS), which was commonly used by marine seismic contractors from the mid-1980s. So in the latter part of the past century seismic data was recorded using WGS while the official system for government reporting was AGD. The difference between AGD and GDA (or WGS) is ~200 m. Unfortunately, the difference was not fully appreciated and data was stored in whatever form was available (GDA, AGD, WGS) without full documentation. Sounds confusing – well many data-loading technicians also thought so and some (actually most) coordinate databases turned into a 'dog's breakfast'. About this time the Shared Navigation Integration Project (SNIP) consortium began to sort things out and provided vetted sets of coordinates to subscribers. SNIP is being replaced with the Geoscience Australia Marine Surveys (GAMS) Project and data can be obtained from Geoscience Australia. GAMS has a disclaimer and is not guaranteed to be correct.

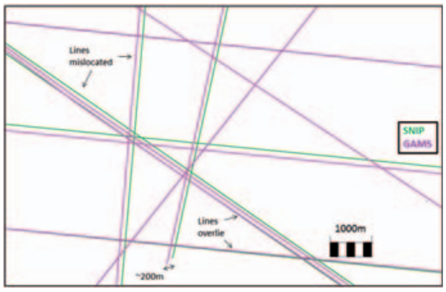

Fig. 2. *Example showing a difference between SNIP (green) and GAMS (purple) line locations downloaded from the Geoscience Australia website in August 2013. Some lines match and others don't!*

(The SNIP data was purchased by Geoscience Australia from Fugro Multi Client Services in 2007. The dataset includes 3156 onshore and offshore seismic navigation data from Australia and New Zealand for surveys acquired prior to 2003.)

So how do we find out which version of the navigation data is correct? My first step would be to check the locations against the SNIP or GAMS database. This works most of the time but sometimes there is an error in SNIP or GAMS (Figure 2). Next step is to try and get the original navigation information from the contractor or acquisition or processing reports. If these efforts still leave some doubt then the line locations from a number of sources can be compared and the most common positioning is selected.

Here are the top five reasons we found (Figure 3) for the wrong coordinate information being used, followed by examples:

1. Coordinates are believed to be GDA, but are actually AGD. Line is ~200 m SW of true position. The difference between GDA and AGD grid coordinates on a map is ~200 m so it is common for lines to be 200 m (or multiples of this) away from their true location. Even though GDA has

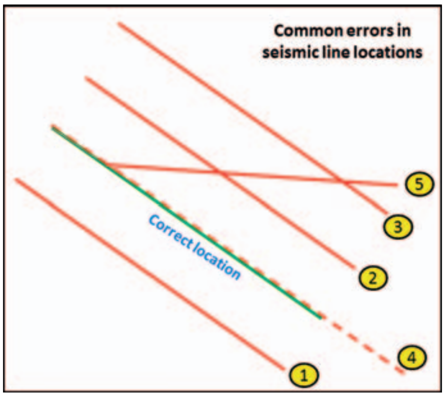

Fig. 3. *Common types of seismic line location errors. Types 1, 2 and 3 are caused by errors in the CRS while Types 4 and 5 are because of lack of coordinate information or reading errors.*

been in place for several years this error is still seen and the example in Figure 2 is a concern because not even the two common databases (SNIP and GAMS) have resolved this issue.

2. Coordinates were believed to be AGD and were converted to GDA. Actually they were correct and no conversion was necessary. Line is 200 m NE of true position. This is common for old navigation WGS-based data stored in an AGD database. WGS is very close to GDA.

Fig. 4. *Example of Type 1. Line locations from different sources. Coordinates for one dataset are in AGD while the other is in GDA. The difference between the two systems is ~200 m in this area. But the southernmost line has 1900 m between the two versions. This is an example of a Type 4 error. One version did not have the complete set of coordinate information so the line is plotted by extrapolation from the last two known points.*

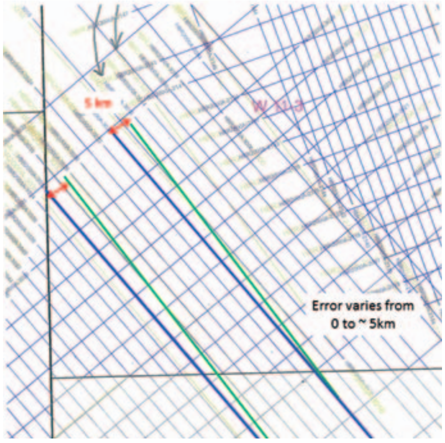

Fig. 5. *Another example of Type 4 with several lines located up to 5 km from their correct position. Two examples are highlighted but there are several more in this small area.*

3. As above but corrected twice or coordinates in WGS were saved in an AGD database, which was then converted to GDA. Line is ~400 m NE of true position
4. Extrapolation to areas of missing data. Common for lines recorded in parts where only coordinates for part A of the line were used and the extra shotpoints on Part B, C etc. were obtained by extrapolating from the last two shotpoints of part A. This is a very common error that can result in several kilometres of mislocation if the last two points deviate from the line (Figures 4 and 5). It is common because there are numerous lines recorded in parts for reasons such as whale activity or source malfunction. Each piece of the line is stored separately and often the ancillary data such as navigation files are lost or maybe no one remembers there is more than one part. This common error is usually easy to detect but correcting it requires the missing coordinate data.
5. SEG-Y header read incorrectly. Even today there are many versions of SEG-Y and the seismic trace number is stored in many places in the trace headers. If the wrong byte position is read the trace numbering can be incorrect. This produces interesting results with lines being extended far beyond their actual location. The example in Figure 6 shows offshore line locations plotting onshore, which is obviously wrong.

Fig. 6. *Example of Type 5 where lines plot several kilometres onshore because the SEG-Y trace header was not read correctly.*

These examples are all from offshore Western Australia, but don't think you are safe onshore. The problem exists everywhere and is not limited to 2-D seismic.

Why does an interpreter need to know about surveying issues?

Today our targets are much more subtle than in the past. Big undrilled anticlines are rare and our targets now are narrow horsts or stratigraphic features such as channel belts. In these cases an error of 2000 m to 5000 m, would result in a well missing the target completely. Even 200 m is important because a mislocated 3-D survey could have an interpreter trying to calibrate well results with the wrong seismic amplitudes. The answer is to make sure you really know the whereabouts of your seismic data.

Seismic window: unconformities are for superheroes

Looking back over the past year's articles it could be said that there is only one article on seismic interpretation, yet this column is nominally meant to address interpretation issues. There were articles on processing, acquisition, 'funny methods' and navigation. I suggest this is a good representation of what interpreters (or *interpretators* as the Chief Geophysicist in my first industry job would say) actually do with their time. A good interpreter should know everything about the data or at least as much as possible. This article will address the imbalance as it looks into the power of modern methods and the most difficult surface of all – the unconformity. In 1978 Nigel Anstey wrote, 'Strong continuous

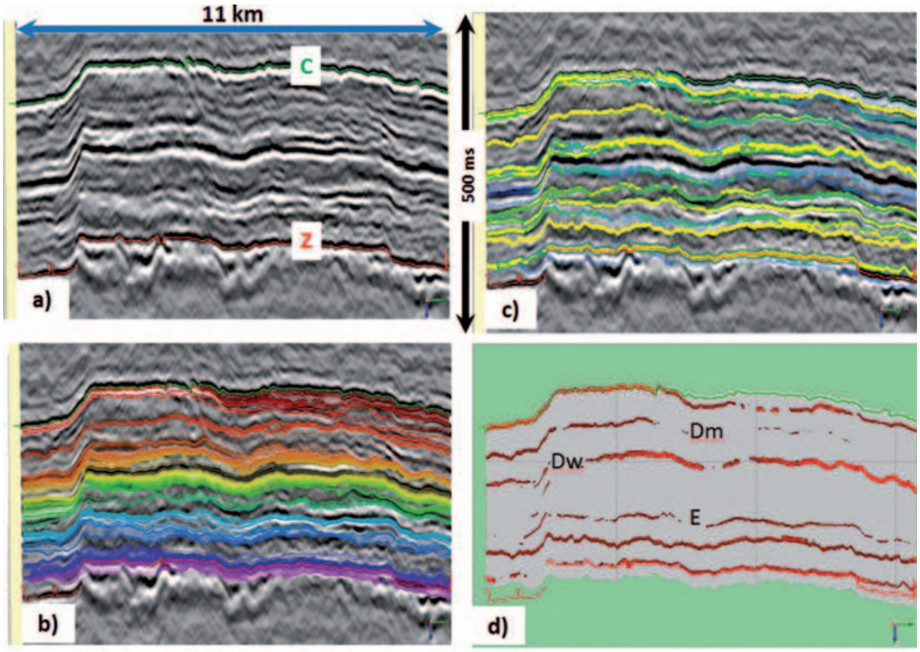

Fig. 1. *Talgeberry example: (a) N–S seismic line across Talgeberry with bounding horizons 'C' horizon – green, and 'Z' horizon – red; (b) automatically tracked horizons – density of auto-picked horizons varies; (c) shows high (yellow) and moderate (blue) horizon density; and, (d) colour bar adjusted to highlight strongest unconformities in red (Dm, Murta; Dw, Westbourne; E, Birkhead).*

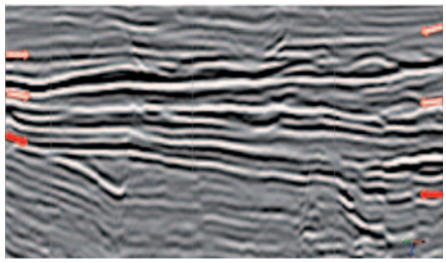

Fig. 2. *Example of seismic from the offshore Exmouth sub-basin. This line has several unconformities with some indicated by arrows. The unconformity at the top of the Barrow Group is indicated with solid red arrows*

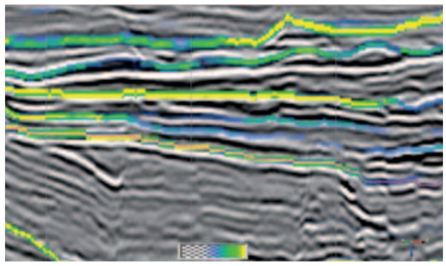

Fig. 3. *At vertical changes in dip the auto-tracked horizons tend to bunch up. Here high values of horizon density, shown in yellow and green, indicate potential unconformities. Previous hand-picked unconformity surface is shown in purple.*

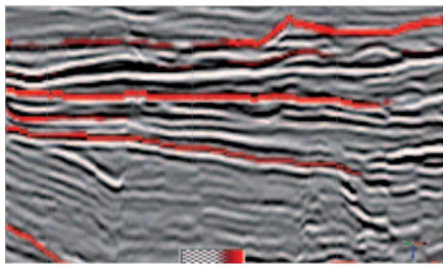

Fig. 4. *Again, the colour bar can be adjusted to highlight the key unconformities in the area.*

reflectors are for kids. Unconformities are for men'. Today it may be more appropriate to replace the last word with 'superheroes'; alternatives like adults, mankind, people or that ugly word 'persons' just don't work so superheroes it is. Unconformities are difficult because they are usually not a single continuous reflector, but an event with varying strength and polarity – basic auto trackers hate them.

But, workstations can now automatically pick every reflection in a 3-D volume as demonstrated at the recent ASEG Conference in Melbourne in a talk by Jim Dirstein of Total Depth and Paul de Groot in his keynote address. Once a volume of surfaces is picked it can be used in many ways and one application is finding and mapping unconformities – I will present two examples to demonstrate: first, an example from the Talgeberry Field in SW Queensland and second, from the Exmouth sub-basin of Western Australia.

The Talgeberry example (Figure 1) summarises the technique that is based on the OpendTect horizon cube. In this case, horizons were tracked across the entire dataset from seed points spaced at 1 ms intervals on a selected trace (Figure 1b). The horizons converge or diverge based on the calculated dip of the seismic data.

Where there is a vertical change in dip resulting in a truncation, such as at an unconformity, the auto-tracked horizons tend to bunch up. The number of horizons within a short time window can be calculated (Figure 1c) and high values indicating there are many horizons within the window can identify an unconformity. By adjusting the colour bar (Figure 1d) the main unconformities are highlighted. It is quickly apparent that there are a number of possible unconformities between the 'C' and 'Z' horizons; one of which is close to the top Birkhead Fm discussed in a previous article. Other unconformities are identified in the Westbourne and Murta Formations that are associated with oil pools.

The seismic line (Figure 2) from the Exmouth sub-basin in the second example has a number of unconformities. The major unconformity at the top of the Barrow Group (arrows in Figure 2) is associated with hydrocarbon accumulations, but it is often difficult to pick the reflection from the unconformity. The horizon density volume in Figure 3 has identified the Top Barrow unconformity and almost exactly follows the hand-picked horizon that took several days to interpret across the area. Again, adjusting the colour bar and making the low values transparent further highlights the unconformities (Figure 4).

Modern workstations and software can now pick unconformities across large datasets and perhaps Anstey's quote can be rewritten 'strong continuous reflectors are for common autotrackers, but unconformities are easy for complex algorithms and workflows'.

Merry Christmas.

References

Anstey, N. A. 1978. Seismic exploration for sandstone reservoirs.

De Groot, P. 2013, Global seismic interpretation techniques are coming of age. Keynote address, ASEG Conference and Exhibition.

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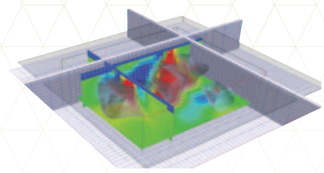

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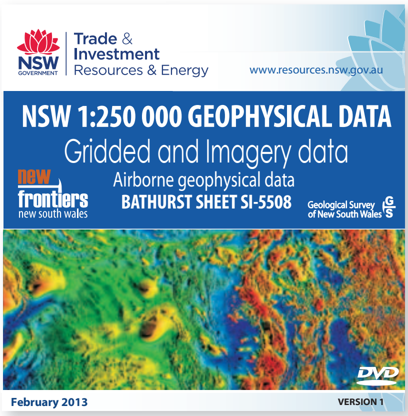

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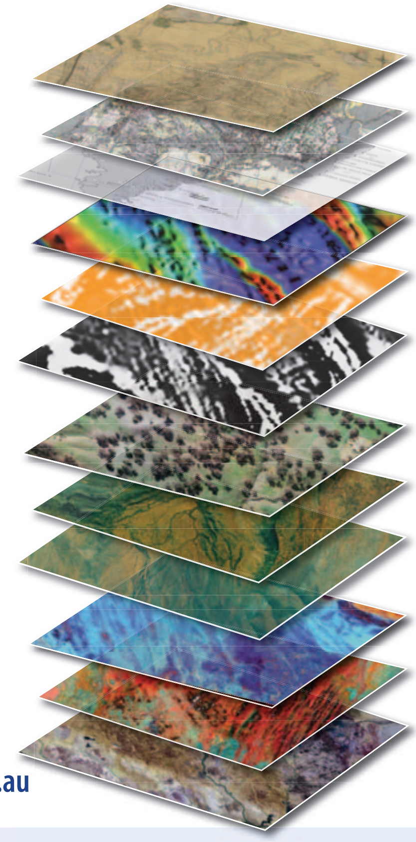

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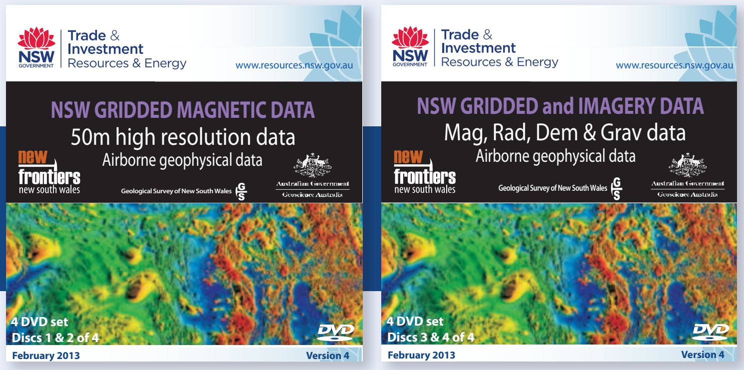

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