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Seismic window

Michael Micenko
Associate Editor for Petroleum
micenko@bigpond.com

Waveform classification outshines amplitude

I can't remember if I was at the first ASEG Conference in Adelaide, I was definitely at the second, and last month I was lucky enough to attend the 25th and quite possibly last ASEG conference. The Australian geoscience community apparently can't support a variety of conferences so in future an amalgam of societies will present a joint conference that has been rebranded to AEGC (Australian Exploration Geoscience Conference).

There were a number of good petroleum papers presented at this year's conference, and two case studies that used waveform classification to map and determine thickness of reservoir sands caught my attention. I was interested in these papers because they are extensions of an idea I presented in 1988 and further discussed in a Seismic Window in 2013.

Briefly, waveform classification subdivides a seismic wavelet within a user specified window into a user specified number of clusters based on the waveform shape. An unconstrained classification maps how a waveform is changing across a survey without using *a priori* information. The technique uses a neural network to quantify changes in the waveform and assigns each location a discrete class which may be representative of a particular geology or facies. It is important to note that the software orders and numbers each class – there is no interpreter input to this process.

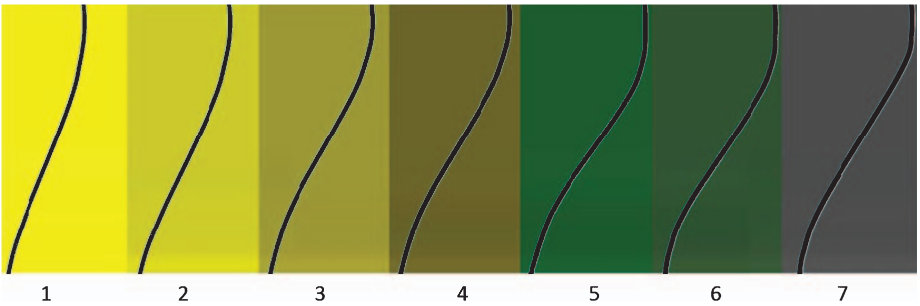

Figure 1. *Waveform classes from Cremasco et al. (2016). The use of a small window of half a wavelength results in amplitude being the only difference between classes.*

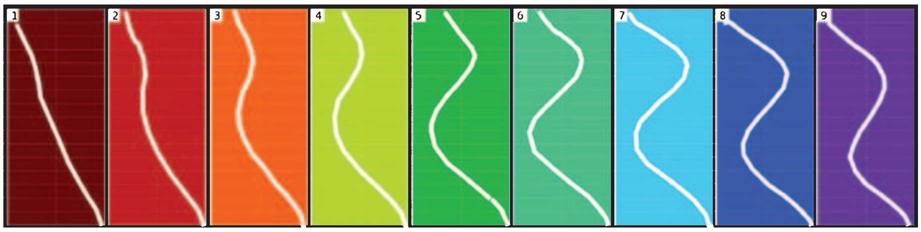

Figure 2. *Waveform classification from Lodwick and Grant-Wooley (2016). The main difference between classes is the peak-trough amplitude in the upper part of the analysis window.*

Paper 1 (Cremasco et al., 2016) identified a relationship between waveform class and the net reservoir thickness and used this to map sand filled channels across an area of interest. But why would a vaguely random number like waveform class be related to reservoir thickness? The answer lies in the number of samples used to classify the waveform. The window used in this case was only half a wavelength (Figure 1). And the sands were below tuning thickness. Wedge models show that below tuning thickness the wavelet shape does not change – the peak-trough separation remains constant – while destructive interference results in the amplitude decreasing almost linearly as the wedge thickness decreases. The waveform of each successive class is therefore only a slightly higher amplitude version of the previous class. The use of waveform classification in this case is possibly over kill and perhaps a simple peak-trough amplitude map would yield the same result and save some time.

Paper 2 (Lodwick and Grant-Wooley, 2016) also uses waveform classification, this time to produce a 'probability map', and states 'the map of waveform classification can be used in the surface calculator to generate a probability map of the lower non-reservoir thickness'. This is possibly an example of a Nintendo Geo pushing a button but not knowing exactly what happens. First, what is 'the surface calculator'? I think I know but I'm not sure.

Second, how does the waveform classification relate to probability? I don't believe it does. The lower non-reservoir is almost always present so it should have a probability close to 100% everywhere. Perhaps what the authors meant was the lower non-reservoir has a 50% chance of being at least a certain thickness. On further reading I found that 'the resulting probability map can be used to multiply the top porosity to MFS isochore and generate a lower non-reservoir thickness'. So now the map has morphed from probability to a measure of net-gross thickness. Once again the use of a small calculation window (up to one and a half wavelengths in this case) results in wave class being dominated by amplitude changes (Figure 2). When the waveforms of each class are overlain (Figure 3) the main difference is an increasing amplitude in the top part of the window. Once again it appears that a peak – trough amplitude map may yield a similar result.

These two papers have provided useful results for the development teams involved but I wonder if there is a proper understanding of the geophysics involved. I emailed the authors and judging by the responses I received I'm sure they are quite knowledgeable. Perhaps amplitude

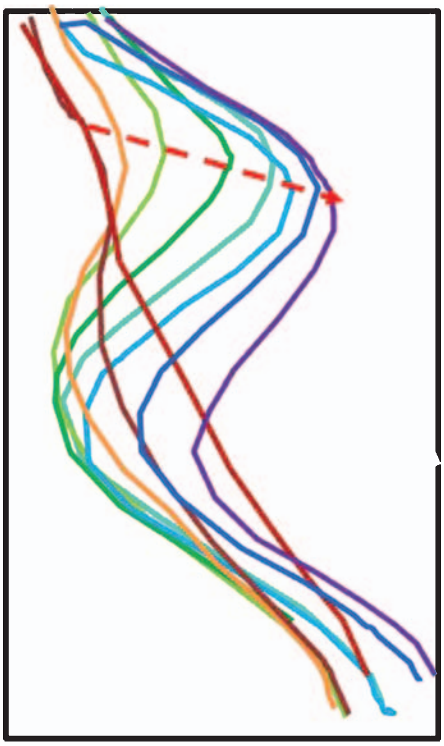

Figure 3. *Waveforms of Figure 2 overlain to highlight the main change between classes is amplitude. The amplitude increases from Class 1 (brown) to Class 9 (purple) with the peak shifting to later time.*

maps have become *passe* and conference attendees want to hear about more modern but complicated seismic attributes.

References

Cremasco, D., Basman II, Y.V. and Travers, J., 2016, Spatial mapping of seismic facies variations to mitigate reservoir risk in coal prone fluvial-deltaic settings: ASEG-PESA-AIG Extended Abstracts *Preview* (August).

Lodwick, B., and Grant-Wooley, L., 2016, Waveform classification as a pseudo for reservoir thickness: ASEG-PESA-AIG Extended Abstracts *Preview* (August).

Micenko, M., 2013, Talgeberry stratigraphic maps revisited: *ASEG-PESA 2013 Conference Handbook*.