Visualisation and delineation techniques adopted from other industries to increase productivity of the G&G work in the Oil and Gas industry.

Bisset A. Han C.

Given the recent increase of seismic data quality owing to improvements in seismic acquisition and processing, it is surprising that the oil and gas industry is still using standard desktop screens with 256 colour resolution software displays, and for most of the seismic representations, using only three types of colour bars (peak-trough, grey scale or rainbow) for human interpretation, comprehension and decision making processes.

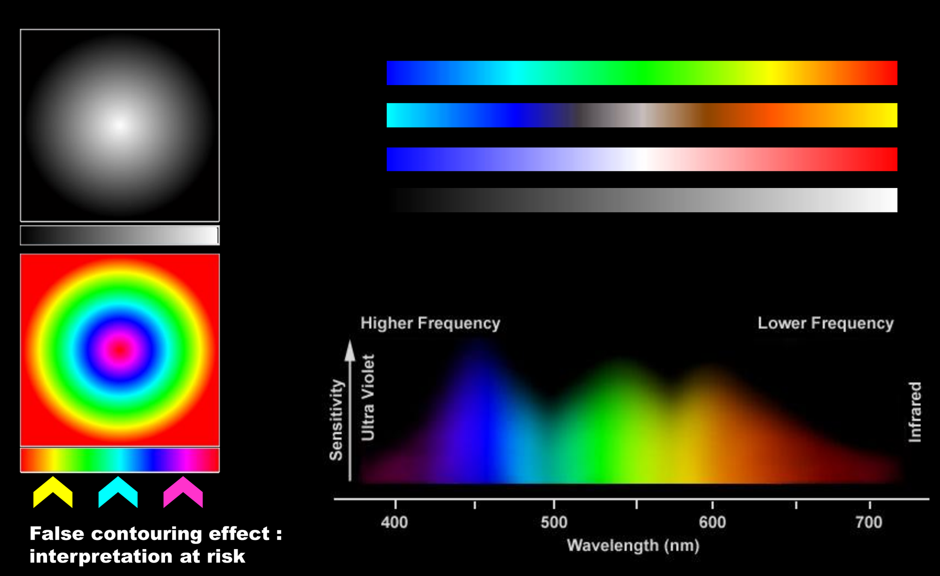
Knowing that these displays show 0.000006% of the details captured in 32 bit resolution data. Not only the data display itself but also the steps to get to alternative representations have been longer and more complex than necessary.
So one can wonder: is the oil and gas industry using the available data to its maximum potential to decrease the risk of drilling dry wells?

This poster present some of the solutions to these issues that have been faced for years in our industry and that are now available to the everyday user as well as tools to gain quantitative information from the improved representation of the data.

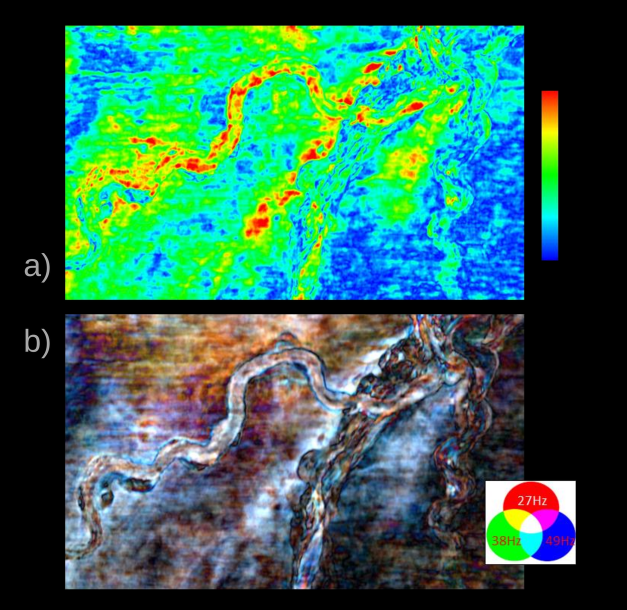
Colour Perception

The pitfalls of human colour perception is one field where recent improvements have become more widespread in the geoscience interpretation workflow. Visualisation issues are numerous and examples among them include; luminance sensitivity, nonlinearity, apparent depth, simultaneous contrast; to name only some of the most important ones (Froner et al.2013).

The display of data is can have a great impact on the detection and interpretation of the geological information. To try to decrease the risk associated with these issues, the use of numerous colour bars, illumination options and other visualisation techniques have been used, but still, the uncertainty associated with interpreting different colour displays can be more than 200% (Henderson et al, 2012). This leads to the question of interpreting data or 3 colour bars. The use of colour blending of seismic attributes can reduce subjectivity by using a more natural colour display which is more attune to human visual capabilities.



Colour blending technology is now used in objects as common as digital screens of laptops, TV sets, smartphones, and also digital prints and home printers. Such technologies were pioneered at the beginning of the spatial or medical imaging, to produce more natural looking images that would appeal to a wider number of people and be more intuitive to interpret.
Different types of colour blending are now available for geoscientists, with the first mention to be made in the industry dating back to last century (Partyka et al,1999). Then software ergonomy and hardware capability made it cumbersome to spread across the community of users.



Figures above :
Channels imaged within Parihaka dataset (NZ)
a) Standard amplitude spectrum colour display
b) RGB frequency decomposition colour blend display

Fifteen years later many geoscience software packages have colour blending features and it is rapidly becoming a standardised technology to count on during interpretation workflows. By far the most commonly used colour system is the red green and blue (RGB). As an additive colour scheme the most beneficial way to use it is with attributes containing positive values showing some continuous character, such as amplitudes or magnitudes.

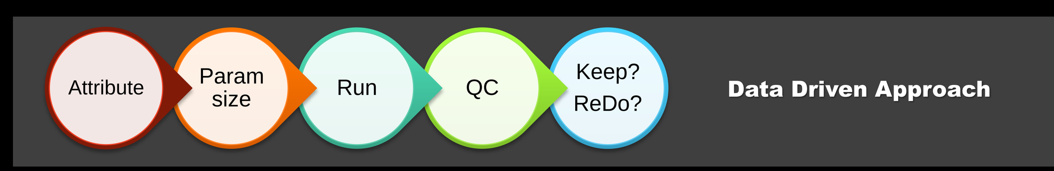
Attributes that are very similar but show subtle differences such as spectral decomposition products or angle stacks, or even azimuthal seismic, can benefit from being displayed with RGB. The similarity increases the colour interference so that subtle differences between the input attributes are represented as colour changes, that can markedly increase the detection of geological detail.

Other colour blending schemes are used in a lesser extent. To be noted though, the CMY (cyan, magenta, yellow) blending system, being subtractive, works extremely well with attributes to show discontinuities, such as edge detection type attributes. Faults commonly show different seismic expression depending on their nature, this can be phase breaks, amplitude breaks and orientation or gradient changes. Therefore, when carrying out interpretation of fault networks, a combination of attributes sensitive to each of these different types of seismic fault expression in a colour blended display, can give a more comprehensive picture of the fault network as opposed to any of the input attributes individually.

Cognitive cybernetics

Cybernetics describes the feedback loop process where an action generates a change that then acts to guide further adaption based on the results of the initial change.

In working with seismic attributes, a cybernetics approach is mostly needed when changing a filter or a parameter size to see the effect on the result, which can then allow further adjustments to be made in response to the outcome.
Deciding which filter and filter size gives the best result has generally been a trial and error process. This results in significant time in processing and in comparing results as well as unnecessary data being processed. Considering that the size of the data sets used has increased in recent times filtering a volume, or any other calculation, can take hours or days. Repeating this process several times with a different filter for an optimised result is a task that companies find costly. A workaround that has been in the past is to cut a subset of the full seismic volume for trial purposes. It is not easy, however, to compare these versions. Display refresh times and other common display issues could prevent the user investigating all the possibilities before choosing the best attribute with which to proceed.
When generating seismic attributes, to save on time, the user may just select the default parameter settings, which usually will produce a suboptimal result. This is can be the case where the user does not have a great deal of experience with filter settings. To simplify and make the process more efficient a different approach to optimisation is presented. This uses techniques that allow quick and effective data comparisons before to processing the full volume.



Gleicher et al (2011) identified three main mental representation techniques used commonly to compare data. These were adapted for innate ability and limitations of humans to make objective data comparisons and can also help decrease the time involved in the process of making informed decisions.

Incorporating these techniques not only helps at making a choice between different options, from picking the most promising one amongst an initial pool of candidates to final QC against the original, but also the objectivity increases from the first to the third.
By applying this knowledge to geoscience workflows and technology, the process of seismic attribute optimisation and analysis can be streamlined to become quicker, simpler and less subjective. These techniques are being increasingly used in the oil and gas industry.

Comparison Methods (Gleicher et al. 2011)

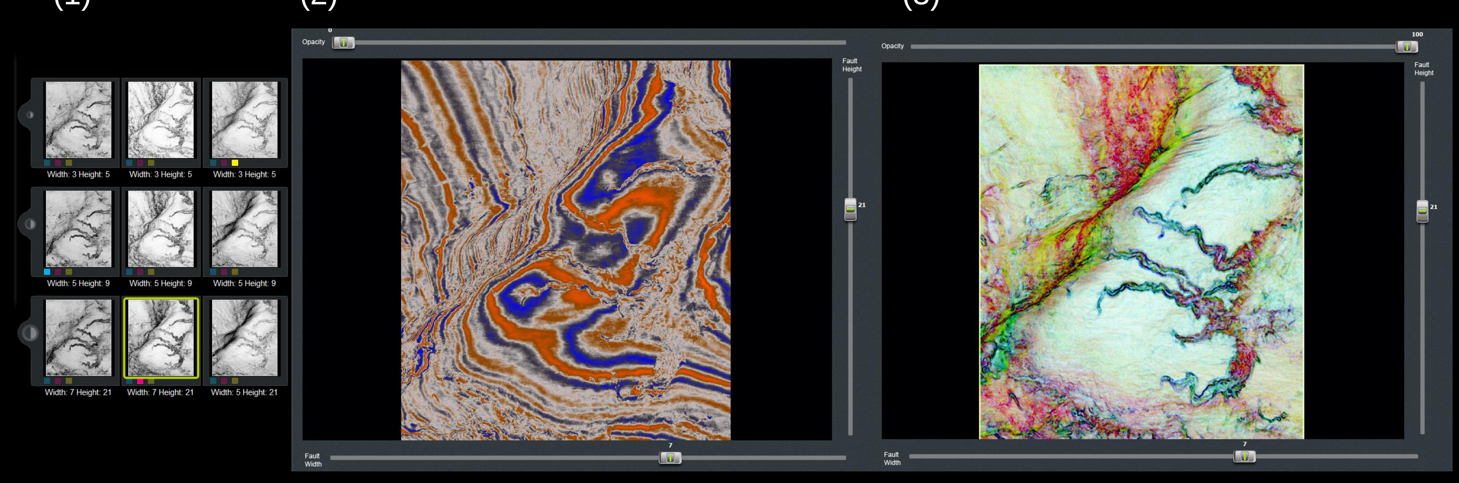
Juxtaposition :
Best for screening lots of options and making a quick and efficient choice

Superposition:
Best for spotting differences between 2 options

Explicit encoding:
visual differences between 3 options by colour coding
best for relative comparison and quantitative appraisal

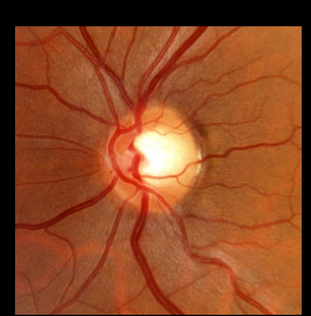
Figure below :
Comparison methods
Applied to rea life data set
(1) shows juxtaposition method to evaluate the best options for Edge detections
(2) & (3) show superposition method using controlled opacity from the result (3) over the original (2)

(1) (2) (3)

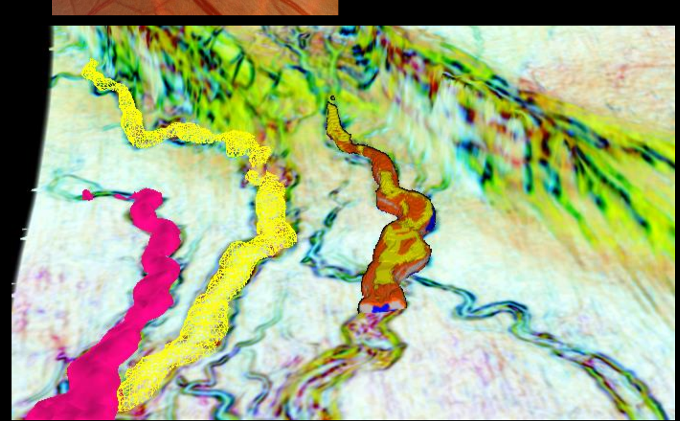


Data Isolation

Being able to image features in data is usually the first step in interpretation workflows, this is most often followed by delineation of these in a 3D sense, often crucial for calculating volumetrics and 3D modelling, for a multitude of purposes, such as reservoir and velocity model building.
Technologies derived from the medical imaging realm have been applied to seismic data. In Lowell et al (2004) there was a breakthrough in diabetic disease prevention. Knowing the location and size of the optic nerve head is a critical step in being able to automatically detect early signs of diabetic eye disease. Although optic nerve heads may look similar in appearance, the amount of variation in shape, size and contrast is large. To further complicate the problem image quality varies as well as distractors, such as haemorrhaging, that will obscure part of the nerve head.



Figures :
Left shows the optic nerve seen behind the retina and blood vessels
Below shows the Adaptive Geobodies ® delineating channelised features on a real life data set



For these reasons a model based approach was deemed to be the most appropriate method to accurately define the optic nerve head. Having identified the approximate location, the model mimics the optic nerve head by morphing its shape and size. The morphing or adaption occurs by generating forces derived from the desired boundary. This technology is now being applied in the same way to extract geological features from seismic datasets. Extraction of these features results in similar problems to extracting the optic nerve head-boundaries vary greatly in shape and size and the image quality may also vary. Generating geobodies using a data driven approach, similar to that used for imaging of the eye, can give greater accuracy in delineating boundaries of geological features and a less subjective result than a completely manual approach.

Conclusions

The improvement in data quality, algorithms and hardware to produce better attributes in a shorter time are still suffering from other issues which are still often being disregarded in G&G workflows. The issues faced include colour representation, optimisation of attributes, the ability to extract geomorphological features directly from the data and the overall timeframe to complete these workflows.
Yet, solutions have been found and have relatively recently been made available to the O&G industry, that address them.
Colour blending associated with frequency decomposition, angle stack, or edge attributes combinations addresses the false contouring effect.
Using a Cognitive Cybernetics approach to shorten the process of getting to the result with more confidence, helps shorten the process of getting geologically meaningful attributes.
Extraction of geological information can now be performed on co-rendered attributes.

References :
GLEICHER, M., ALBERS, D.,, WALKER, R., JUSUFI, I., HANSEN, C.D., AND ROBERTS, J.C., 2011—Visual Comparison for Information Visualization. SAGE Publications, 10 (4):289309.
PARTYKA, G., GRIDLEY, J. AND LOPEZ, J.,—1999. Interpretational applications of spectral decomposition in reservoir characterization. The Leading Edge, 18, 353–60
FRONER, B., PURVES, S.J., LOWELL, J., HENDERSON, J., 2012—Perception of Visual information – What are you interpreting from your seismic? Scandinavian Oil and Gas, 7
LOWELL, J., HENDERSON, J., PATON, G., VALENTI, J., 2014—Visualization, Interpretation and Cognitive Cybernetics. AAPG Interpretation visualization in the petroleum industry.
HUNT, R.W.G., 2004—The Reproduction of Colour (6th ed.). Chichester UK: Wiley–IS&T Series in Imaging Science and Technology