EDUCATIONAL POSTER

Information from Images

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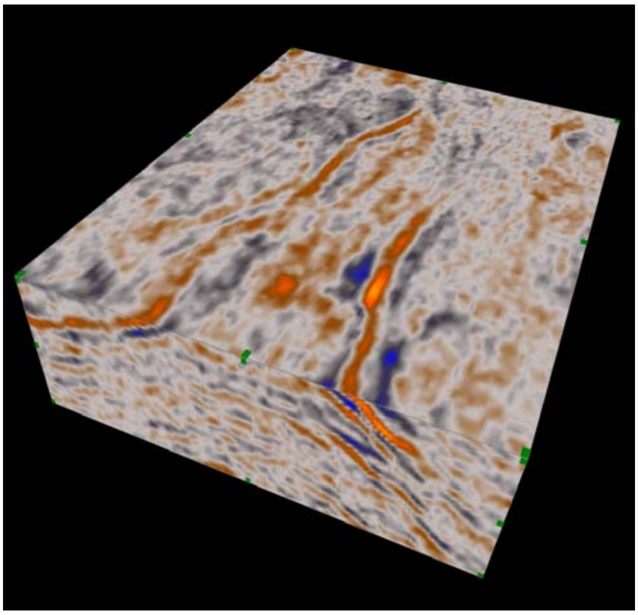
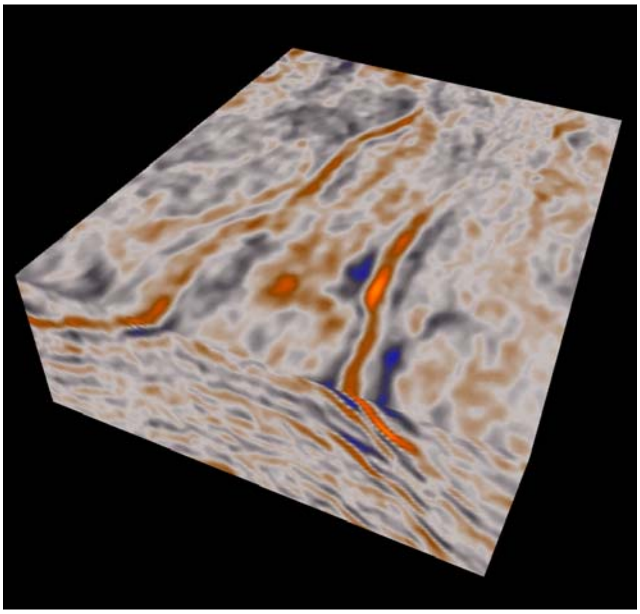
The benefits of having high-resolution subsurface information mean that 3D seismic is employed at all stages in the E & P cycle from frontier exploration to field development. 3D seismic surveys produce a huge amount of data and effectively extracting information and value from this data represents a formidable challenge. To meet this challenge, new techniques must be deployed to enable the information content of a 3D seismic data set to be more thoroughly investigated than is possible with more conventional seismic analysis and interpretation techniques. One set of techniques that is rapidly gaining importance in seismic interpretation is 3D Image Processing and Analysis (IPA). The reason for this is that 3D IPA techniques can extract detailed information from 3D seismic data in a manner that is objective, fast and reliable. Access to information of the quality provided by IPA techniques can contribute to a more in-depth understanding of the subsurface, potentially leading to higher confidence and better decision making.

Although IPA techniques can be mathematically sophisticated, they are often based on concepts that are quite intuitive. Well designed IPA workflows combine sophisticated processing functionality with high quality 3D visualisation to provide fast and easy to use tools, which can be used on a day-to-day basis, to support the interpretation workflow. Many 3D IPA workflows follow a standard format: remove the noise, highlight features of interest, delineate the highlighted features as 3D objects and finally analyse the delineated objects. An example of a workflow that follows this format is described below.

Noise and resolution are the two fundamental issues that limit the amount of information that can be extracted from any data. Removing noise will have a positive impact both on the ability of IPA techniques to detect subtle but potentially very important features and on manual interpretation. Noise takes many forms and distinguishing between variations in the data that represent noise and those that convey information is a complex IPA task requiring the use of sophisticated processing algorithms but the results can make a spectacular difference to the data quality. As IPA based noise cancellation techniques work on the final stacked and migrated data they are also much cheaper to employ than having the data reprocessed.



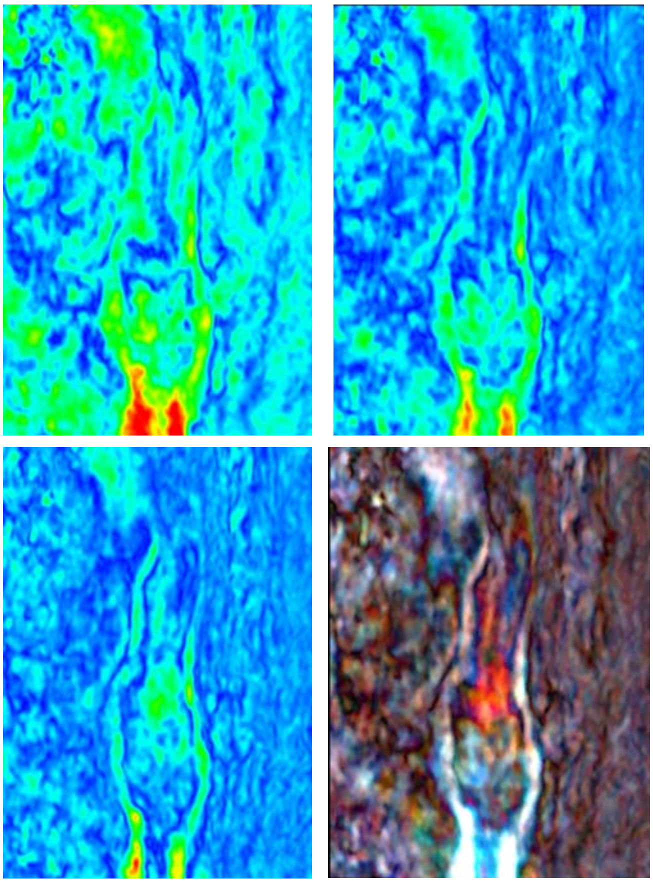


Original seismic data (top). Noise cancelled seismic data (bottom) (Data courtesy of Marathon North Sea Ltd)

Once an appropriately "cleaned" data set has been generated the next stage in the workflow is to highlight or reveal the geological features of interest. Spectral decomposition is an elegant way of doing this as it can highlight areas that are characterised by subtly changes in seismic response. Spectral decomposition is particularly powerful when combined with tools that allow the spatial variation of the frequency response in several different frequency bands to be compared simultaneously. This sounds like a very complex process. However, if the primary objective is to obtain qualitative information, a very simple workflow can be defined by integrating the processing functionality with appropriate visualisation techniques. This is illustrated below using the example of the multi-band volumetric spectral decomposition techniques for geobody delineation that are available in ffA's SVI Pro software.

Spectral decomposition based geobody delineation involves computing the frequency response at a number of user selected frequency bands. The frequency bands of interest are determined by examining the response at a broad range of frequencies at a representative horizon or time slice. Having selected the appropriate frequencies, individual volumes showing the response at the frequency over the whole data set or region of interest are calculated. To address the challenge of comparing the response at different frequencies simultaneously, ffA has built into SVI Pro, a proprietary method for creating an RGB blended volume from three individual frequency volumes. In a RGB blended volume, the amount of Red at each point in the final image is determined by the data values in the first frequency volume, the amount of Green from the values in the second volume and the amount of Blue from the values in the third volume to produce a full colour display. Changes in colour in the RGB blended volume are indicative of changes in seismic response. The acuity of the human eye for differentiating between colours allows relatively subtle changes in seismic response to be seen quite clearly. RGB blended volumes can show geological features with dramatic levels of detail.

Having been able to highlight interesting geological features, the next stage in the IPA workflow is to delineate



Frequency response at 19 Hz (top left), 25 Hz (top right) and 47 Hz and an RGB blend of the 3 frequency volumes (data courtesy of Marathon North Sea Ltd)

those features as 3D geobodies. A common technique for geobody delineation is to use opacity rendering to select voxels that have values within a given range and then applying a connectivity analysis on the selected voxels. Although this approach is attractive, as it is intuitive and allows for direct visual feedback, adapting it for RGB geobody delineation is non-trivial. This is because with the RGB volume SVI Pro is using a 3D colour map. Drawing an opacity curve in 3D is very difficult particularly as the colours that define the geobodies may not be contiguous in the RGB colour space even though they are contiguous within the RGB volume. ffA has addressed this issue in SVI Pro by providing a tool that enables the opacity to be set through directly interacting with the RGB display. A small region of interest is drawn on the RGB display so that it encompasses the colours that the user feels represent the geological elements of interest. This is used to define the opacity setting that is applied to the whole volume and produce a 3D display in which only the selected colours are rendered. Once an opacity rendered RGB display that defines the geological elements appropriately is obtained, a set of geobodies is created by applying a connectivity analysis to the rendered volume. This provides a very fast and simple to apply solution to a complex problem and allows the geologist / geophysicist to generate a sophisticated multi-attribute analysis through an interactive and intuitive visual feedback mechanism.

The final stage of the IPA workflow is to analyse the objects which have been delineated. Although this stage of the workflow is not described here, measurements that provide useful information include descriptions of size, shape, orientation and the internal characteristics of the defined geobodies.

The workflow described above utilises only a small proportion of the tools within SVI Pro and provides just one example of how seismic analysis and 3D IPA can be combined to extract information from seismic data. However, it clearly illustrates how, using IPA techniques, it is possible to generate, in a very short time frame, the detailed information that is important to developing a complete understanding of the subsurface.

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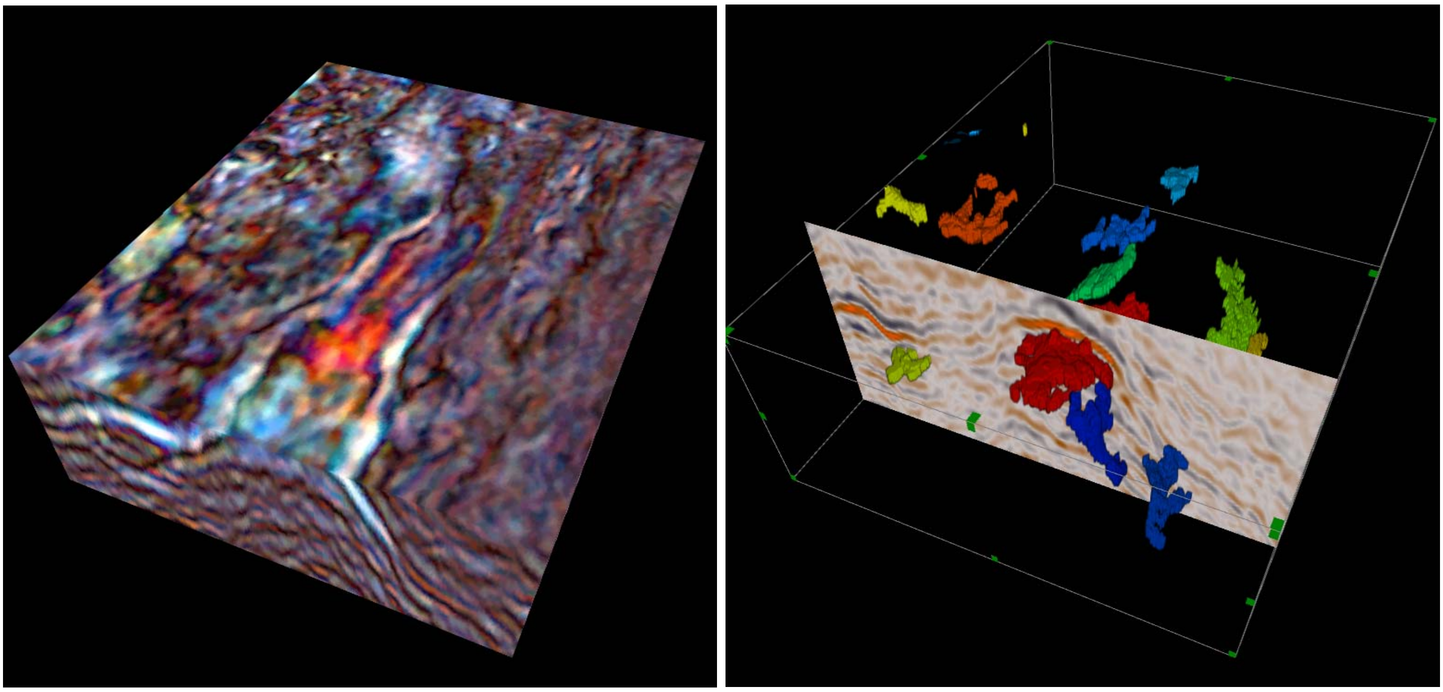

Volumetric RGB blend (left) and Geobodies defined by opacity rendering of the RGB blend (right).

(Data courtesy of Marathon North Sea Ltd)