3D Seismic Interpretation And Visualization

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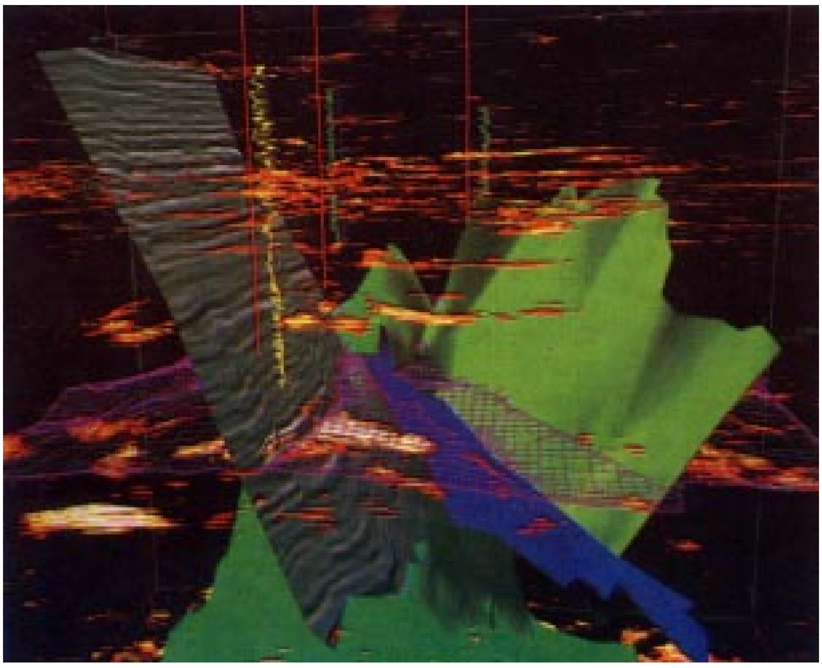
Exploration in recent years has become increasingly dependent on integration of technical disciplines. An integrated team approach tends to reduce the uncertainty otherwise inherent in quantitative prospect appraisal. Consequently, oil companies worldwide are reorganizing into crossfunctional asset teams. Geophysicists, geologists, log analysts and reservoir engineers work together with far greater synergy to evaluate the options for exploration/production drilling so as to improve the success ratio and also to accurately assess reserve volumes.

The role of 3D seismics in the sedimentary description of reservoirs has gained recognition in production circles over the years and it has become a common occurrence to see 3D seismic surveys carried out over fields, which have been producing for over two decades or more. The use of this technique and its eventual acceptance as a routine mainstream exploration tool is also growingly becoming common. In fact the ever-widening use of 3D seismic asserts itself at the forefront of advances made in hydrocarbon exploration.



The interactive interpretation seismic workstations are valuable tools for efficiently performing interpretation of large volumes of 3D seismic data. Their ability to organise and manipulate large quantities of data in a convenient and efficient manner permits faster and more meaningful interpretations. Till recently, 3D interpretation was done by displaying a series of individual 2D ‘slices’ or inlines of the survey from the 3D’cube’ stored in the system on the monitor, track horizons of interest, mark the faults and utilize this information for preparing contour maps. Conceptualization of geological structures in three dimensions was done by the geoscientists in their minds. However, lately the situation has become quite different. Visualization technology has emerged as an important entity. In effect it has become a tool for characterising and understanding surface as well as subsurface phenomena. But what is visualization? Visualization is simply the construction of visual images out of numerical data. It is now possible to produce a three dimensional image on the screen that a geoscientist views, analyses and interprets. He can visually move through a cube of raw data even before picking faults and horizons to get a feel for the geological relationships involved before focusing his attention on specific structures. He can manipulate, rotate and interpret in a form which can be easily understood by other members of his team. Besides, volume visualization allows the geoscientists to freely rotate the data cube so that it can be examined from any orientation for a better understanding of the attributes and relationships in the seismic data.

Visualization thus allows the geoscientist to think about large quantities of data, provides for speedy analysis, and importantly pro-

motes integration amongst relevant disciplines (geophysical, geological, petrophysical and engineering).

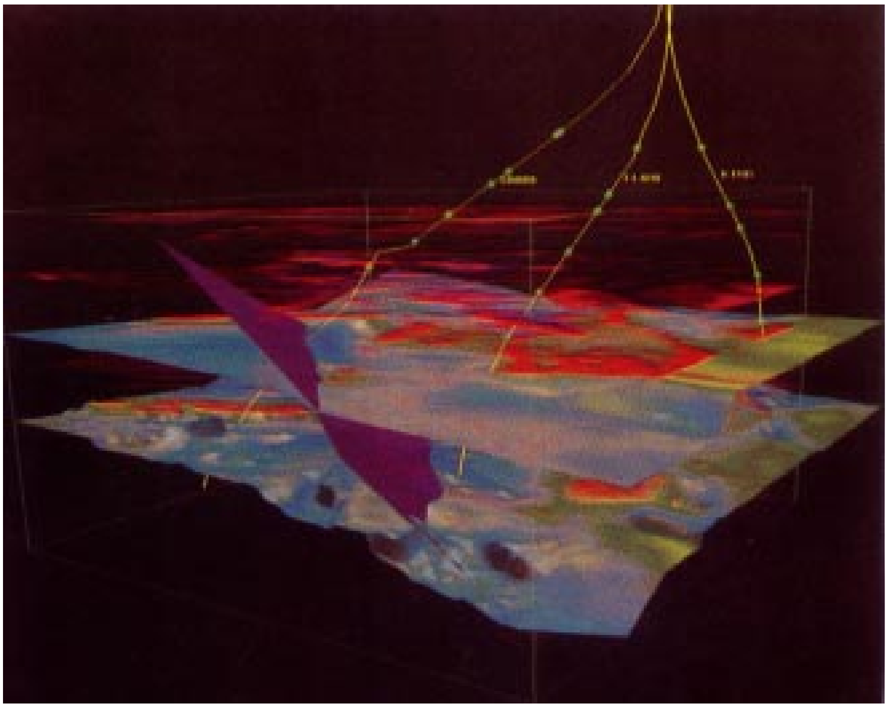
In addition to interpretation and visualisation of 3D seismic data volumes, interactive 3D animation is also possible. This option enables scanning through the entire 3D cube onscreen, to get a quick feel for the geology. It is possible to cut away the data volume along fault planes or any arbitrary surface. Fast and highly accurate autotracking is also possible in addition to display of interpreted horizons and faults, well, paths in 3D perspective.

The latest idea to hit the industry is the development of voxel based 3D imaging software. The power of this type of 3D visualisation comes from volume rendering, which uses colour and opacity to filter seismic data attributes for selective display in three dimensions. In volume rendering each sample in the seismic trace is rendered as a three-dimensional pixel known as a voxel. The colour and opacity of voxels depends on the values of the attribute being analysed. The user can adjust the opacity and colour of the 3D seismic volume to isolate only the pertinent data attributes like phase, porosity or velocity which may predict the presence of hydrocarbons. The surrounding data is rendered transparent so that the isolated attributes appear in 3D space as attribute clouds. Such attribute clouds can then be examined closely by rotating the cube and their surface and volumetrics calculated automatically.

By rendering data transparent, it is possible to 'see through' the seismic data volume to quickly isolate the significant seismic attributes. The VoxCube display accurately defines the geographic distribution of such plays and provides a higher confidence level about their predictability.

Earthcube is the 'next generation' fully functional interpretation system offered by Landmark Graphics Corporation. It leverages the high end, state-of-the-art desktop graphics power of Silicon Graphics Workstations, Besides 3D volume rendering and 3D surface visualization, Earth cube also affords flexible seismic plane animation, a feature unique to Earthcube. It is possible to create as many seismic planes as are required, - vertical, horizontal, arbitrary or at oblique angles, which is much like building a dynamic fence diagram with seismic. Rotation & reorientation of seismic planes helps in understanding the relationships and geometry of important events, boundaries and intervals in a better way.

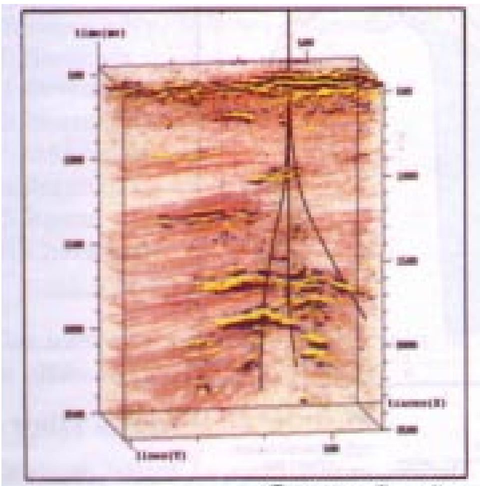
Within Earthcube, 3D surface visualization with zooming and free rotation facility allows a better understanding of the geometric relationship among interpreted surfaces, well curves and the seismic volume. In essence Earthcube lets interpreters interact with the entire 3D data set and visualize the data for preview and accurate interpretation. Seismic projects with horizon and fault interpretations are immediately available and continuously updated while working in Earthcube. Fig I depicts the seismic interpretation analysis, volume rendering and 3D surface visualisation in an integrated environment.



Texture mapping is also being used to supplement the interpreted display with more information. A stippling of dots or some sign corresponding to any attribute such as amplitude information or phase or velocity can be draped over to the structure of a surface to understand how the attributes relate to the horizon.

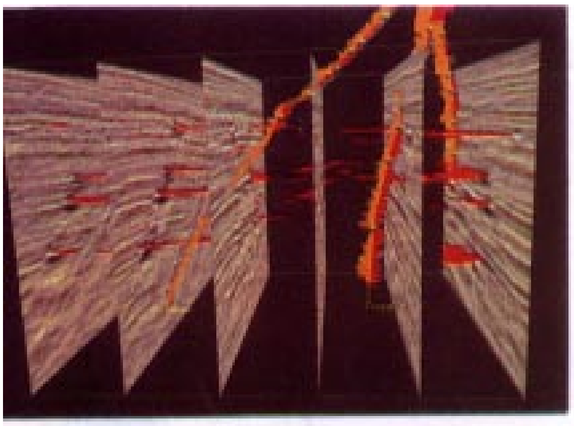
Voxel Geo 2.0 is an advanced volume interpretation system from Cogniseis. Fig 2 shows a 3D Gulf of Mexico survey showing a salt dome with associated faulting and bright spots viewed in their true 3D positions. The opacity is adjusted so that the low amplitudes are transparent and high amplitudes caused by bright spots associated with gas accumulations are opaque. In addition, the volume has been sculpted to reveal a lower rock unit and an upper horizon allowing the seismic amplitudes to be viewed on their surfaces.

Fig 3 depicts the relationship between bright spot and wells. Geoviz is the interactive three-dimensional interpretation software from Schlumberger GeoQuest. Fig. 4 depicts the Voxels 3D volume rendering wherein red voxels represent trough ampitudes. Also shown are two horizon surfaces overlaid with colour seismic amplitudes, a fault plane surface and three deviated well bores.



Courtesy CognSeis

Fig 5 displays red voxels as representing the highest trough amplitude anomalies. The seismic inlines, used for reference, help to show where the anomalies diminish. Gamma ray (Orange) and porosity (red) curves are also displayed. Such examples, exhibiting voxel visualization being used in an effective manner offer great hope and promise for its successful future. Visualization technology is accurate, more insightful and useful for solving real problems in a timely fashion allowing quick assessment of prospects for their economic viability. However, it needs to be cost effective and user accessible



Courtesy Schlumberger-GeoQuest