The UK West Central Graben: A Broadband Seismic Perspective

As part of the ongoing effort to discover the remaining oil reserves in the North Sea, a broadband seismic dataset was recently acquired by CGG in the West Central Graben Margin area. The survey covers approximately 2,100 km² within UK Quadrants 21 and 22. By using the latest advances in broadband seismic technology it has brought a new level of understanding of the various stratigraphic levels to unveil the remaining hydrocarbon potential. The area is already populated with a number of producing fields and discoveries such as the Gannet and Guillemot fields in the Tertiary Tay Formation, the Orchid discovery in the Upper Cretaceous Chalk and the Teal and Christian fields in the Jurassic Fulmar sands.
Recent advances in seismic acquisition and processing technology such as broadband seismic help the geologist to understand the subsurface structures and properties in greater detail. Using its curved variable-depth streamer solution, BroadSeis™, CGG recently acquired a new broadband survey in the UK North Sea West Central Graben (WCG) area with several objectives in mind:

- Improve high-resolution imaging of the near-surface to tackle this problem in the West Central Graben. There are also benefits for drilling hazards identification, reducing the uncertainty on the location of potential shallow gas caps.

- Mapping the Tay Sands. A number of producing fields are found within the Tay sands in the WCG area where these reservoir sands can show porosities of up to 35%, high net-to-gross and high permeabilities. The Guilloiret and Carrot fields have been producing from this reservoir for about two decades. The Guilloiret field is characterised by a high-amplitude seismic anomaly highlighting the presence of hydrocarbons within the Tay reservoir sands, which is more evident in the low-frequency component of the broadband bandwidth of the seismic data. The top of the Tay Formation is defined by a bright continuous reflector on seismic data, marking a drastic transition from clino-deduced Eocene sediments to clean shallow turbidites. Looking at seismic data from an interpreter's point of view, the benefits brought by broadband seismic are twofold. First, the introduction of lower frequencies into the signal reduces the side-lobes of the zero-phase wavelet which interferes with the picking of a specific reflector. This is illustrated in the figure below, where we can see that conventional seismic data struggles to define dissolution features within the upper Chalk interval, whereas they are very well delineated with broadband data. In the Eocene, also, the lower frequencies highlighted a regional facies trend: marl, sand in darker grey shades, while the white and lighter grey shades indicate the presence of carbonate-rich chalk.

- Seismic data showing high-resolution imaging of shallow channels in the West Central Graben area.

A local seismic section comparison focusing on the Tay Formation and demonstrating the imaging improvements brought by the use of broadband seismic data on the north part of the field is shown below. The top Tay reflector is prominent side-lobe (i.e. the white halo appearing above and below the Top Tay reflector) around the actual Top Tay reflector. Second, the introduction of higher frequencies sharpens the central peak of the wavelet, pushing the tuning limits further and increasing the resolution of top and base of these beds and subtle structure. This image also shows the presence of a thin zone on the conventional data through the central part of the section which affects the Top Tay reflector, which is not the case on the BroadSeis data. This demonstrates that broadband seismic brings additional, useful information from outside the conventional seismic bandwidth to better image the Tay sands, hence supporting the identification of potential new leads in the West Central Graben.

Deep Jurassic Interpretation: A number of fields have been discovered in the Jurassic formation in the WCG area. Christian, Cook, Teal, Bligh, and Gannet fields are within the Jurassic formations. The Guilloiret and Carrot fields are part of the Guilloiret field, which is located to the west of the Cook field. These fields are considered high pressure/high temperature, and high permeabilities. The Guillemot and Gannet fields are within the Jurassic formations, and these reservoirs are considered high pressure/high temperature, which makes them suitable for drilling. These low frequencies also give more character to the seismic data, which provide useful information to correlate deep Jurassic sands across adjacent fault blocks (see figure above). In addition, knowing that a number of these deep-fields in the WCG area are considered high pressure/high temperature, the extra low-frequency content of broadband seismic data can potentially be used to determine pressure gradients more accurately from seismic velocities.

A Powerful Technology: Located in an established producing area of the Central North Sea, this BroadSeis survey recently acquired in the UK West Central Graben demonstrates the huge value of the broadband curved variable-depth streamer solution. The exploration industry is now using these enhanced seismic data to unveil the remaining potential of the area. Further broadband seismic datasets are being acquired across the Central North Sea, which will no doubt shed new light on our geological understanding of an already very mature basin.

Image courtesy of CGG Data Library.

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