

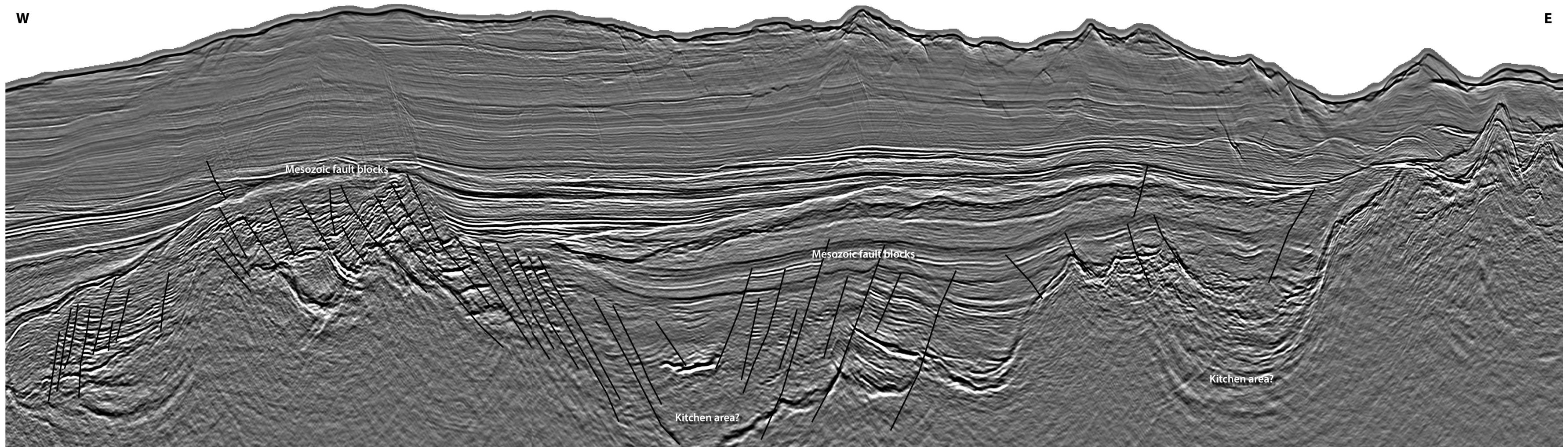
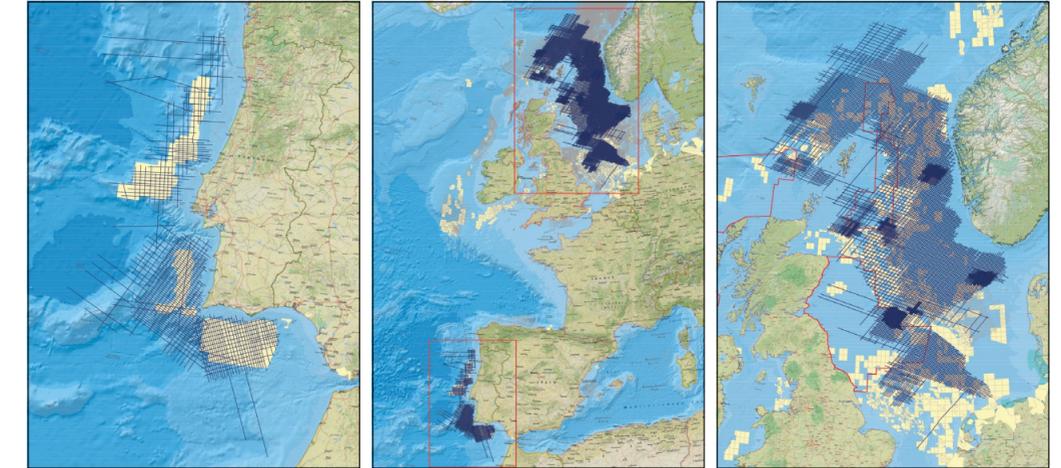
Clari-Fi™ Broadband Processed 2D Seismic in Portugal and the Mid-North Sea High

Clari-Fi™ is a broadband processing package which includes denoising, deghosting, designature and inverse-Q. A multi-domain denoising process attenuates various types of noise before the deghosting algorithm accounts for the local variations of source and receiver depths and the sea state. A global statistical approach is then used to address the source signature in different directions, before Q compensation with respect to the ray-paths. The resulting high quality broadband data improves visual and quantitative interpretation.

Recently, TGS delivered more than 120,000 km regional broadband data offshore Portugal and in the North Sea.



Clari-Fi broadband reprocessed east-west seismic section through expected bidding areas west of the Porto Basin offshore Portugal. Clari-Fi reprocessing reveals rotated Mesozoic fault blocks creating huge closures with sharp imaging of faults.



Clari-Fi™ Reveals Portuguese and North Sea Secrets

SINDRE JANSEN,
WILL BRADBURY and
BENT ERLAND KJØLHAMAR, TGS

North Sea Renaissance: Exploring the Mid-North Sea High

Offshore exploration in the North Sea dates back to 1964 when the UK Continental Shelf Act came into force. Several gas discoveries were made, but exploration interest quickly declined towards 1968 due to low gas prices and therefore little commercial value. In 1969, Phillips Petroleum discovered Ekofisk with 6.4 Bbo in place. This triggered a surge of discoveries which up until now has made the North Sea one of the most prolific oil provinces in the world.

Clari-Fi Broadband Reprocessing

During the exploration history of the North Sea, a huge variety of seismic surveys has been acquired. However, by early 2000 few datasets existed which had been shot using long-offset streamers for deeper imaging, and no regionally consistent dataset had been acquired. In 2003 TGS therefore decided to start acquiring a multi-year super-regional south-west to north-east/north-west to south-east grid using long-offset streamers. The project was named North Sea Renaissance (NSR). By end of 2013, this huge NSR multi-year project had resulted in a super-regional grid with ~100,000 km of long-offset 2D seismic covering the entire North Sea.

One of the main objectives while acquiring the NSR grid was to ensure a regionally consistent long-offset 2D dataset. This was partially ensured by maintaining

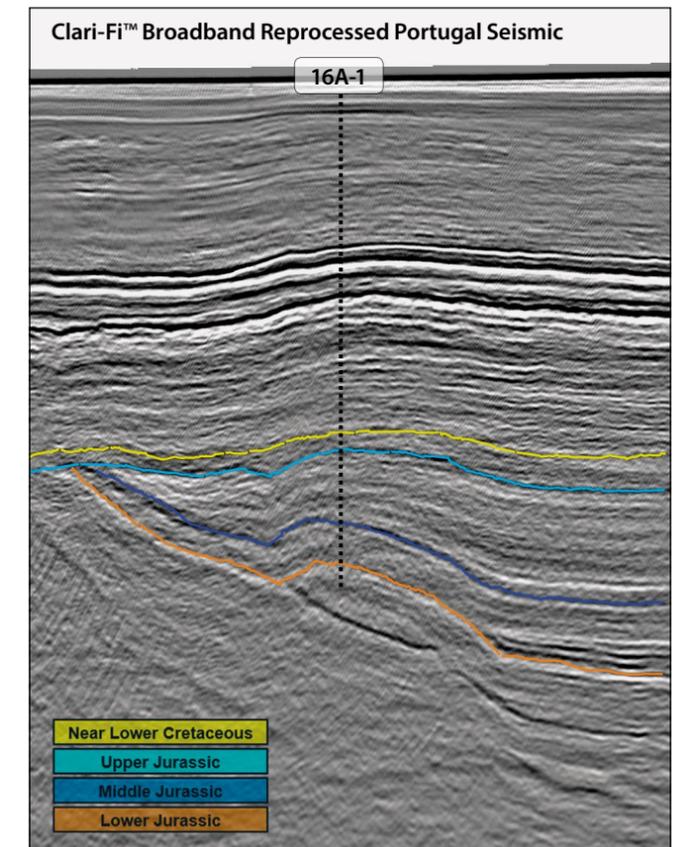
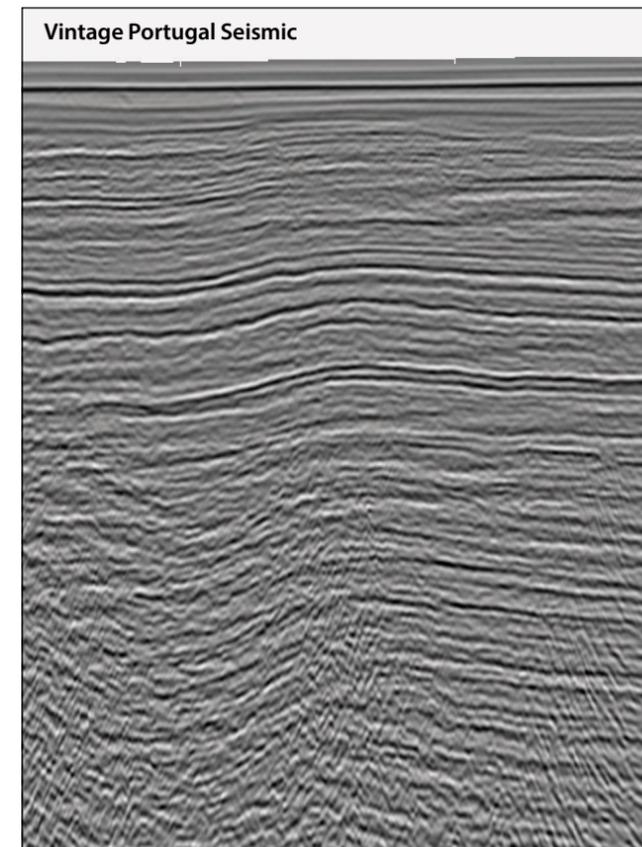
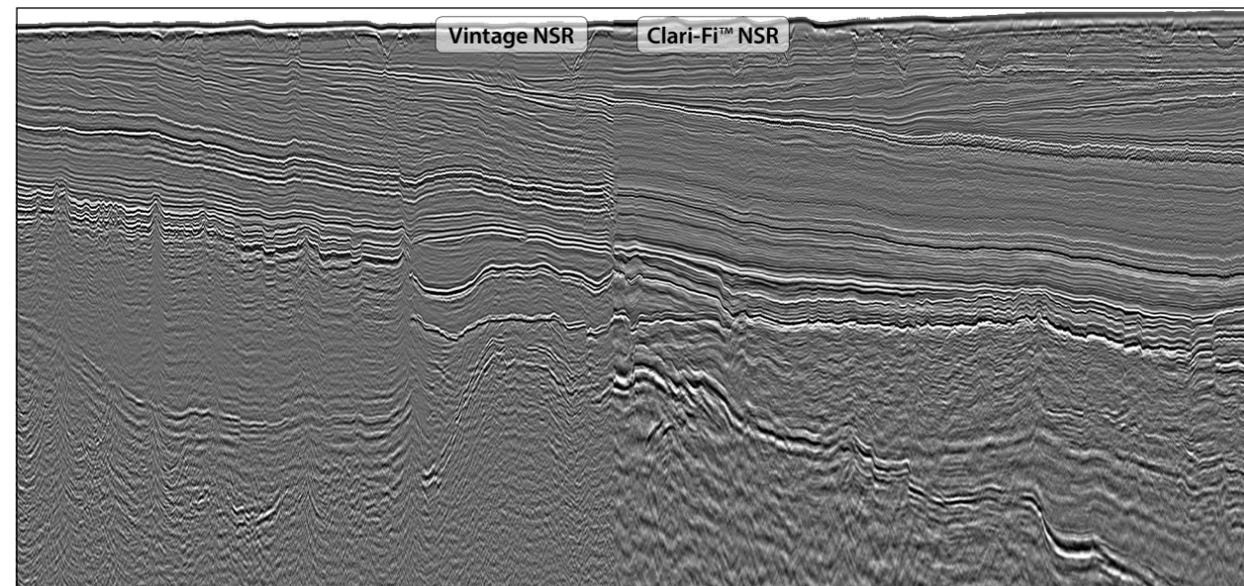
consistency in the acquisition parameters for the different vintages. However, some variations between them occurred due to each vintage being separately processed as they were acquired, as well as variations in processing sequences as TGS processing technology advanced.

In 2014, TGS therefore decided to fully reprocess the entire long-offset NSR grid into one seamless matched and merged Clari-Fi broadband dataset, using the latest TGS processing technologies.

Preparing for the Next UK Licensing Rounds

Exploration through the last decade in the expected 29th round area has focussed on pre-Zechstein targets. Leads and prospects have suffered significant uncertainties due to the poor imaging of the vintage data available. The Clari-Fi broadband dataset allows better definition both regionally and at prospect level, significantly reducing key uncertainties within a wider regional structural and stratigraphic framework. Utilization of gravity and magnetic data during processing highlighted the areas in the 29th Round that required more focussed processing effort in order to provide better imaging of deeper basins and sub-basins. Further integration of seismic, gravity and magnetics will allow both previously identified and new leads in the older sections to be more confidently evaluated. ■

The figure shows an east-west Clari-Fi broadband reprocessed seismic section (right) versus NSR vintage (left) through the Mid-North Sea High. This area is included in the UK 29th licensing round.



An east-west Clari-Fi reprocessed seismic section (right) through well 16A-1 in the Lusitanian Basin highlights great differences in imaging compared to the vintage data (left). While the vintage data is ringing with multiples and few seismic horizons can be interpreted with confidence, the Clari-Fi reprocessed seismic clearly outlines the drilled 4-way dip closure, and enables detailed seismic interpretation of the structural and stratigraphic framework.

Portugal: New Clari-Fi Broadband Reprocessed Data Available

Initial offshore exploration in Portugal was restricted to shallow waters close to shore. In total 27 offshore wells were drilled from the mid-seventies up to up the early nineties with water depths ranging from <200m up to 540m. Most of the well locations were based on old vintage 2D data compromised by shallow high velocity carbonates causing strong multiples. Despite the uncertainties regarding the structural interpretation, six of the wells in the Lusitanian and Porto Basin yielded hydrocarbon shows, with two recovering oil on DST.

The northernmost well in the Porto Basin, Lula-1, is positioned at the break from a shallow carbonate platform into the deep waters in the west. Based on considerations that the oil shows in Lula-1 did not have the same footprint as the known source in the Porto Basin, indicating that this oil probably migrated from the west, TGS acquired a small seismic program into deep waters early in 2000. The results were encouraging and confirmed the presence of basins with thick sedimentary sequences and interesting structural features. In 2000–2002 TGS therefore acquired in total over 22,000 km of multiclient conventional 2D seismic offshore Portugal.

Conjugate Margin

Continental plate reconstruction at the Early Mesozoic era indicates that the north-western margin of Portugal was situated as a conjugate to the Jean D'Arc and Grand Banks Basins offshore Eastern Canada. These basins have

experienced great success in recent years with several high impact oil discoveries. Most of these discoveries occur in huge rotated Triassic and Jurassic fault blocks associated with the opening of the Atlantic Ocean from the Late Triassic to the Early Cretaceous. As expected, great similarities can be observed on seismic lines along the north-west margin of Portugal, and similar play types are expected within the same interval.

Unlocking the Subsurface Potential

Huge variations in water depth (150–4,300m), extremely rough seabed, shallow carbonates, salt, and highly complex structures in the subsurface offered great challenges with respect to processing the TGS Portugal vintage data in 2000–2002. Recent TGS processing technology advances now significantly reduce the uncertainties in the structural and stratigraphic interpretation. Steeply dipping events have been preserved in the data through pre-stack time migration and very little post-stack scaling. This is especially important in order to get the necessary structural control of the prospective pre/syn rift Mesozoic basins with huge rotated fault blocks as shown in the foldout seismic line.

Observations on the new Clari-Fi reprocessed dataset show that this dataset will be key in the process of tying-in existing well information with seismic interpretation to unlock the great future hydrocarbon potential offshore Portugal. ■