Revised Structural Evolution of the North Celtic Sea Basin Based on Modern 2D and 3D Seismic Data

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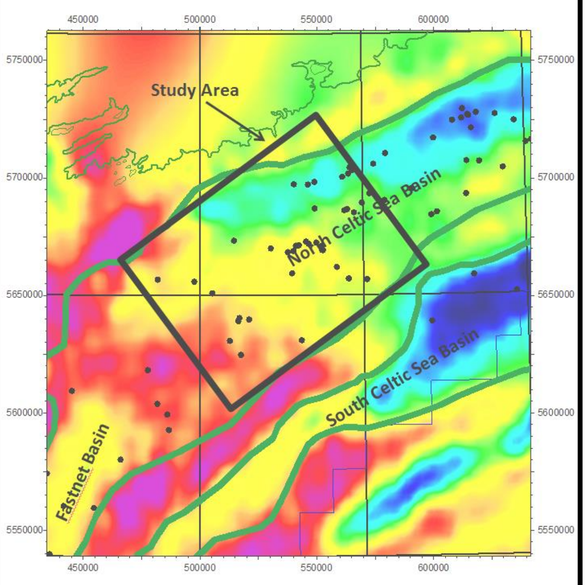
Smith & Sandwell Freeair Gravity Map Showing Study Area



The North Celtic Sea Basin (NCSB) is one of a number of basins related to Mesozoic extension across north-west Europe. Tucker & Arter (1987) describe the NCSB as having a conventional steers head geometry while other authors (Musgrove *et al*. 1995; Rowell 1995; Naylor & Shannon, 2011) describe how extension was accommodated on a large low angle normal fault that bounds the northern margin of the basin, leading to a half graben geometry. Deep reflection seismic data across the NCSB show a significant low angle detachment feature beneath the basin believed to be a Variscan thrust (BIRPS & ECORS, 1986; McGeary *et al*., 1987), which was later reactivated to form the north bounding fault of the NCSB.

Seismic acquisition and processing improvements in the last decade have assisted in providing new insights into the structural evolution of the NCSB. The 2011 Barryroe 3D seismic survey provided the first 3D view of the Triassic section showing significant fault surfaces that demonstrate the importance of intra-basinal faulting. Interpretation from the Barryroe 3D seismic dataset has been extended using a modern 2D long-offset regional seismic survey acquired by TGS/Fugro in 2006 and a Merlin Profilers 1984 2D regional seismic dataset reprocessed by WesternGeco in 2014. The improved seismic imaging allows for a more robust regional interpretation of the structural evolution of both the North Celtic Sea Basin and adjacent South Celtic Sea Basin.

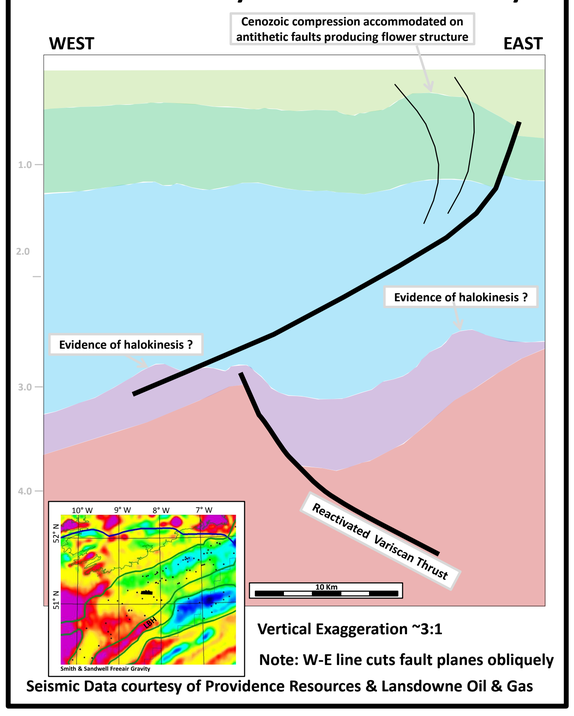
Seismic interpretation suggests significant rifting in the Triassic and earliest Jurassic as pre-existing Variscan thrust surfaces were reactivated to form a half graben geometry. Well 57/09-1 (1984) encountered over 1,000m of Triassic section and several units of massive halite, proving evaporite deposition in the NCSB. The seismic character of this interval on modern data is successfully utilised to identify the Triassic elsewhere in the basin. Minor localised halokinesis has also been identified which further supports the presence of halite within the Triassic section.

Rifting in the Upper Jurassic and Lower Cretaceous created localised back rotation of fault blocks and subsequent erosion at the basin flanks, however the centre of the NCSB was largely unaffected and a complete Cretaceous and Jurassic interval is preserved. Seismic evidence shows this phase of extension was accommodated predominantly by large mid-basinal faults, antithetic to the main half-graben fault. It is possible that halites within the Triassic section, which had been highly rotated in the previous rifting event, became a detachment zone for mid basinal normal faulting in the Upper Jurassic. A regional uplift at this time in north-west Europe, postulated to be a hot-spot related dome (Underhill & Partington 1993), may be represented in the NCSB by a shift from Middle Jurassic marine facies to non-marine and lacustrine shales of the Purbeckian (Tithonian to Berriasian).

Murdoch *et al*. (1995) described up to 1,100m of basin centred uplift and erosion in the Cenozoic while Tucker & Arter (1987) noted uplift was commonly associated with reverse faults. In this study the mid-basinal antithetic faults are preferentially reactivated during compression due to the presence of a detachment within Triassic halites. The seismic data shows significant reversal on these faults creating either broad mid-basinal anticlines, such as the Kinsale Head and Seven Heads structures, or smaller inversion flower structures.

The importance of these mid basinal antithetic faults and the evolution of the basin from a half graben to a full graben had not been recognised before. This study places greater focus on the role of mid basinal faulting on sedimentation in the Upper Jurassic and Lower Cretaceous and indeed structural evolution within the NCSB.

Inline From Barryroe 3D Seismic Survey

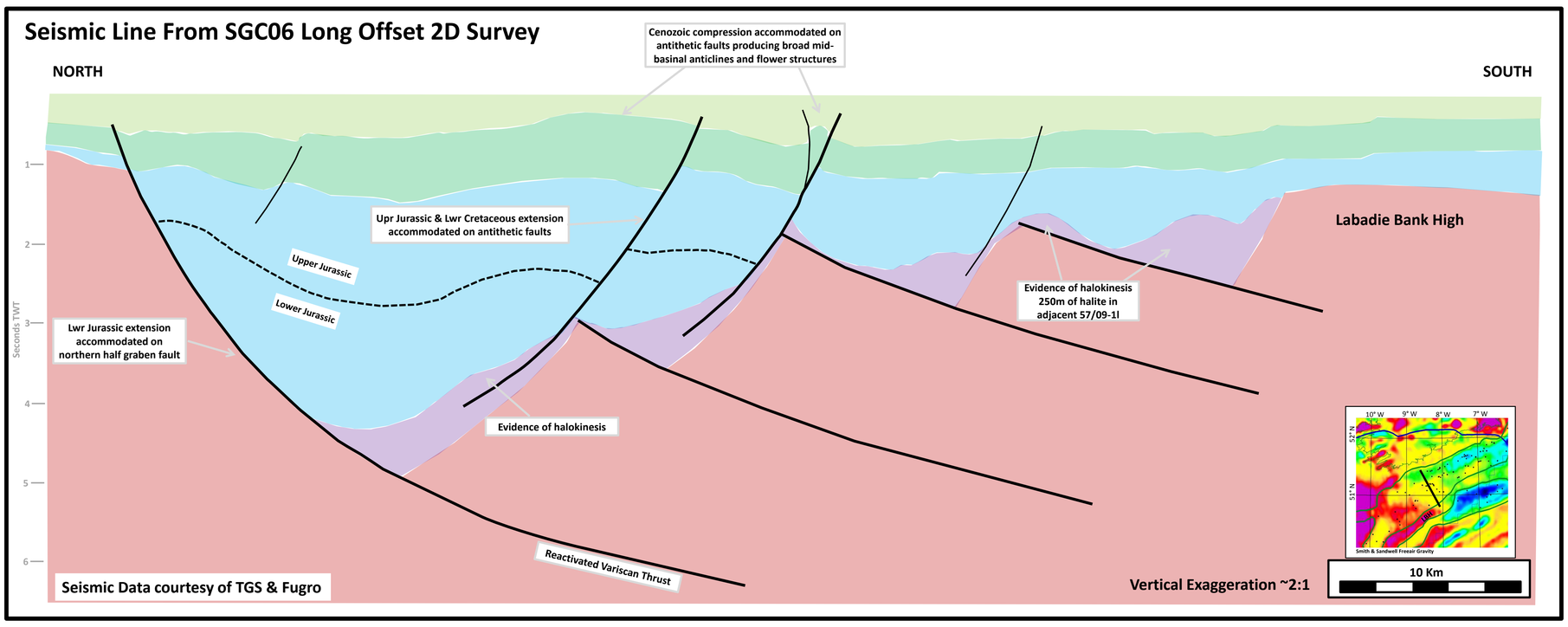


Vertical Exaggeration ~3:1

Note: W-E line cuts fault planes obliquely

Seismic Data courtesy of Providence Resources & Lansdowne Oil & Gas

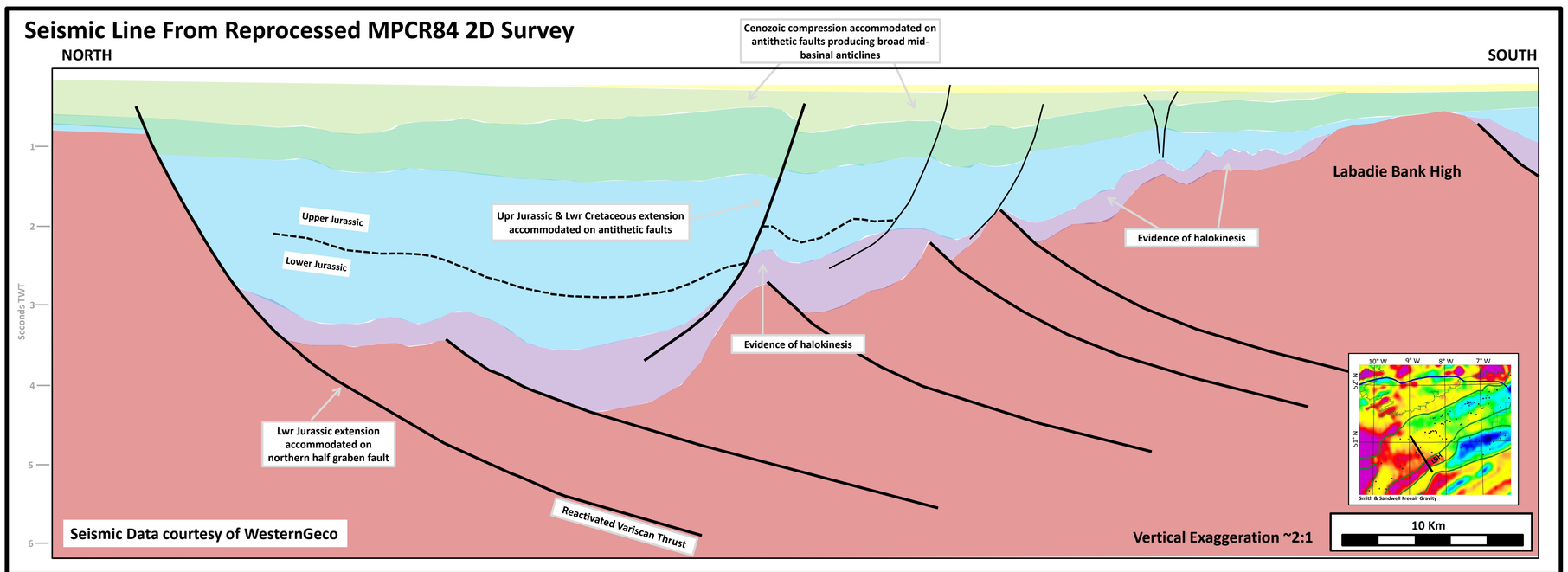
Seismic Line From SGC06 Long Offset 2D Survey



Seismic Data courtesy of TGS & Fugro

Vertical Exaggeration ~2:1

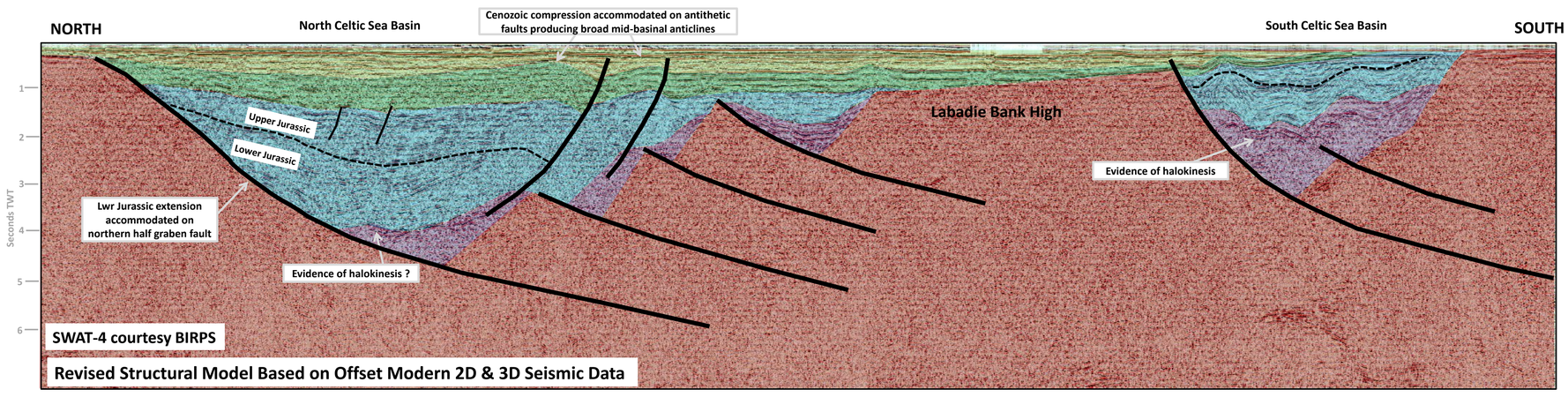
Seismic Line From Reprocessed MPCR84 2D Survey



Seismic Data courtesy of WesternGeco

Vertical Exaggeration ~2:1

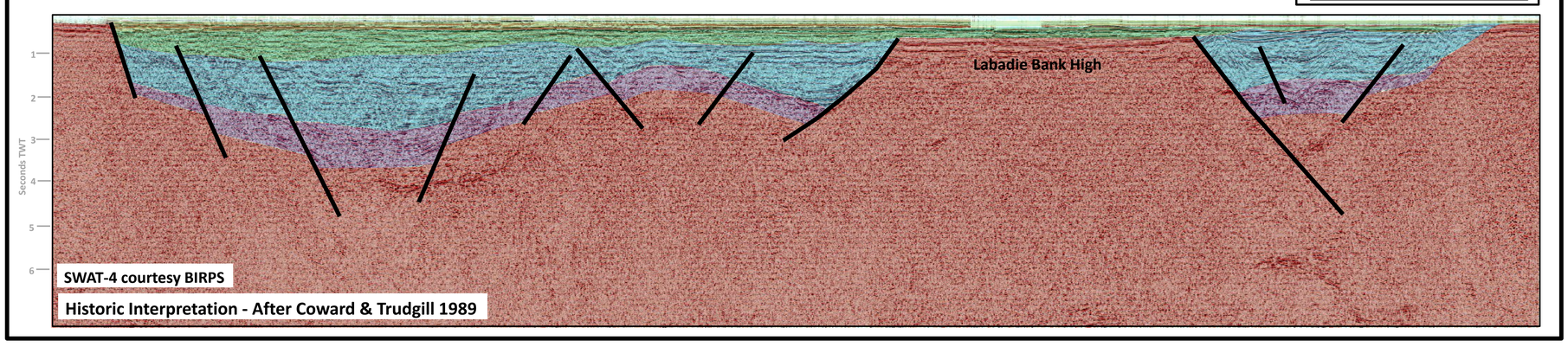
BIRPS 2D Line - SWAT 5



SWAT-4 courtesy BIRPS

Revised Structural Model Based on Offset Modern 2D & 3D Seismic Data

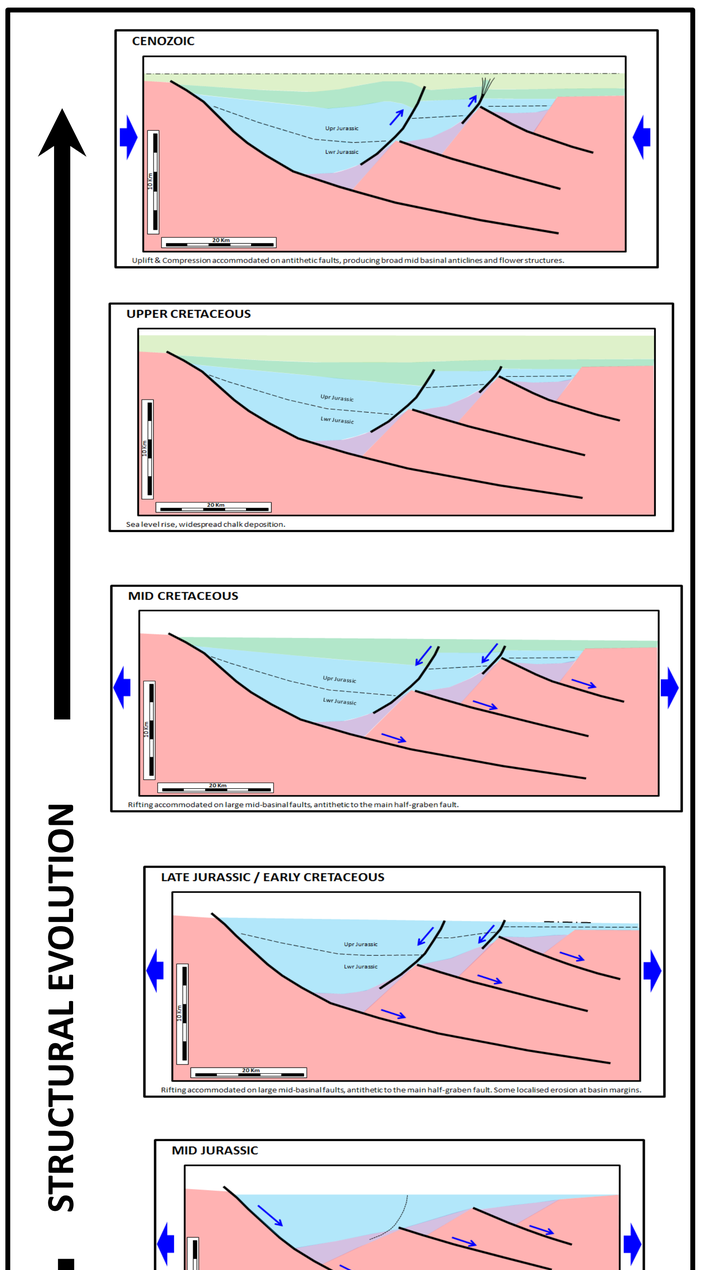
Vertical Exaggeration ~2:1



SWAT-4 courtesy BIRPS

Historic Interpretation - After Coward & Trudgill 1989

STRUCTURAL EVOLUTION



KEY

- CENOZOIC
- UPR & LWR JURASSIC
- UPR CRETACEOUS
- TRIASSIC
- LWR CRETACEOUS
- PALEOZOIC

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