Orphan Basin, Offshore Newfoundland: New seismic data and hydrocarbon plays for a dormant Frontier Basin

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ABSTRACT

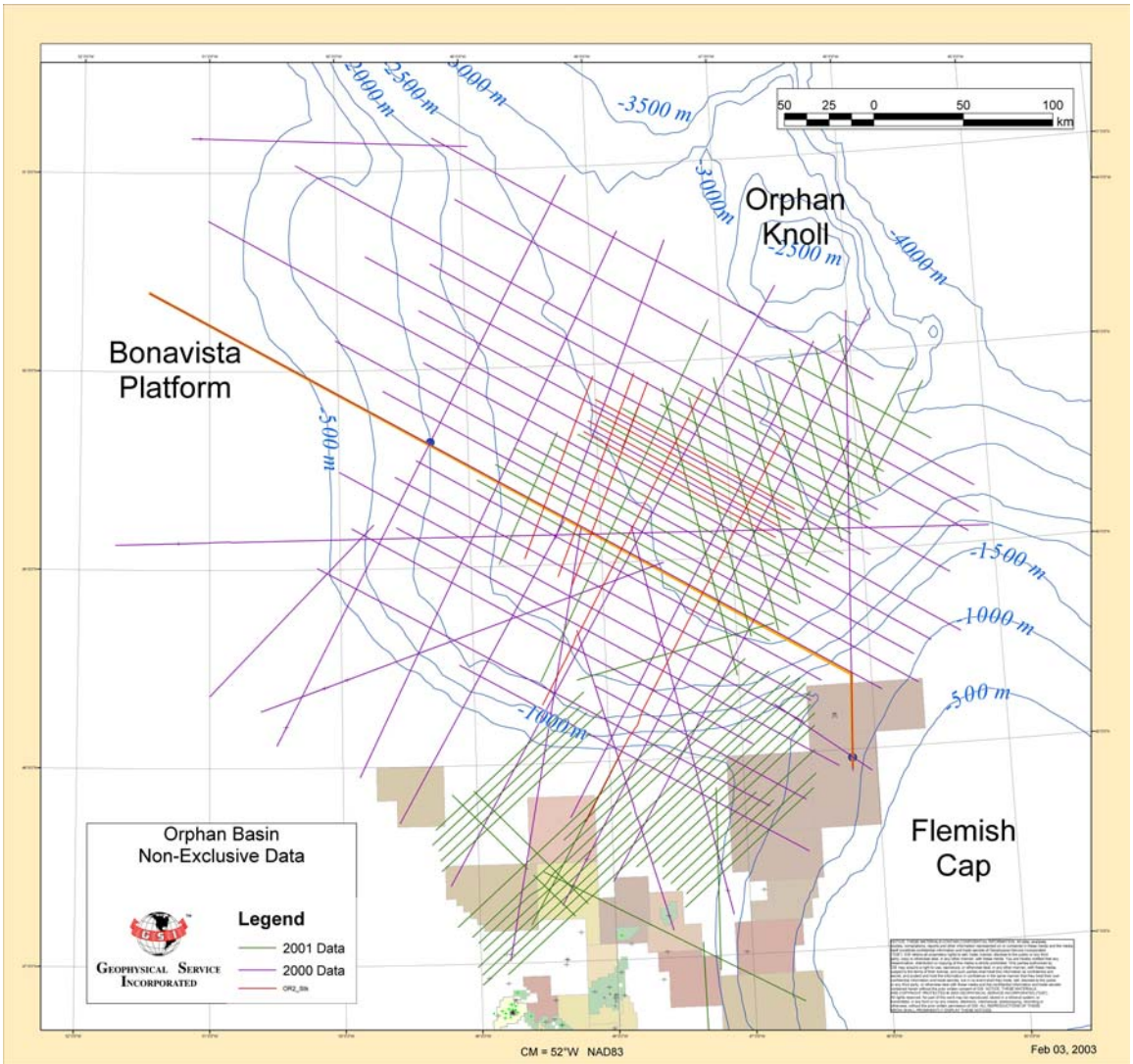
The Orphan Basin comprises an area of over 100,000 sq. km, located off of the coast of Newfoundland, some 370 km N.E. of St. John's. Water depths over the Basin range from 250 m in the west to over 2500 m in the central part of the basin.

The Basin represents an area of thinned and foundered continental crust with stretch factors greater then .5 over most of the area (Keen and Dehler, 1993; Chian et al., 2001). Orphan Basin formed during the period from late Triassic to late Cretaceous, as a result of the opening of the North Atlantic Ocean. It is bounded to the West by the Bonavista platform, to the South by a high block separating it from the Jeanne d'Arc and Flemish Pass basins (Cumberland Belt of Enachescu,1987), to the North by onlap of sediments onto a series of basement ridges and Charlie Gibbs Fracture Zone, and to the east by a high basement ridge that runs between the Orphan Knoll and the Flemish Cap.

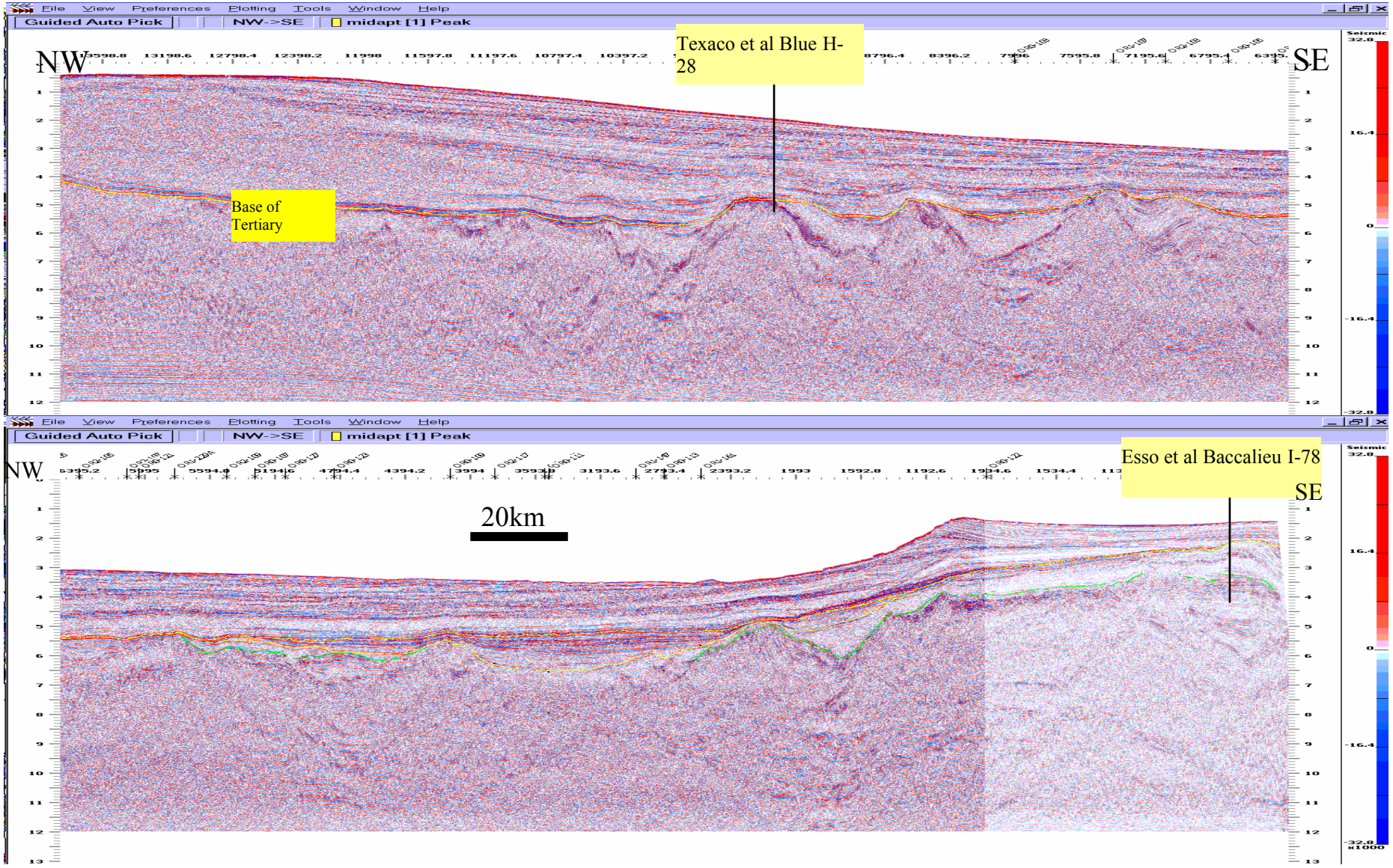
Well control in the Basin is extremely sparse, with only one exploration well, the Texaco Shell et al Blue H-28 well drilled in the Basin. This well was drilled on a basement high and encountered only thin Mesozoic sediments before entering the Paleozoic. The DSDP (Joides) 111 well drilled on the Orphan Knoll also provides some geologic data. Similarity of geologic histories and correlation of major tectonic events in adjacent basins, (i.e. the Jeanne d'Arc Basin, the Flemish Pass Basin and the Porcupine Basin off the west coast of Ireland) have been used to identify major Mesozoic sequence boundaries within the Orphan Basin. Tops from wells in these Basins, notably the Baccalieu well in the Flemish Pass, have also been carried into the Orphan Basin where possible.

Seismic control in the Orphan Basin has greatly improved over the last three years (2000 - 2002), with GSI's acquisition of over 16, 000 km of modern 2D seismic. A 10,449 km regional program was initially shot in 2000. This was followed by a 6,844 km program in 2001 and a 1,295 km program in 2002, which focused on areas of interest, identified the first program. Improvements in acquisition techniques, particularly the increased power and frequency content of the air gun arrays has

greatly enhanced the quality of the seismic data in the basin. While it was formerly only possible to identify the Base of Tertiary marker and the first major unconformity below it, (interpreted as the Avalon or Mid Aptian unconformity), the new data provides much greater penetration and imaging at depth. Several deeper seismic markers and major unconformities have been identified over much of the area, and it is now possible to develop a better understanding of the geologic history and hydrocarbon potential of the area.



Orphan Basin 2000, 2001 and 2002 Seismic programs



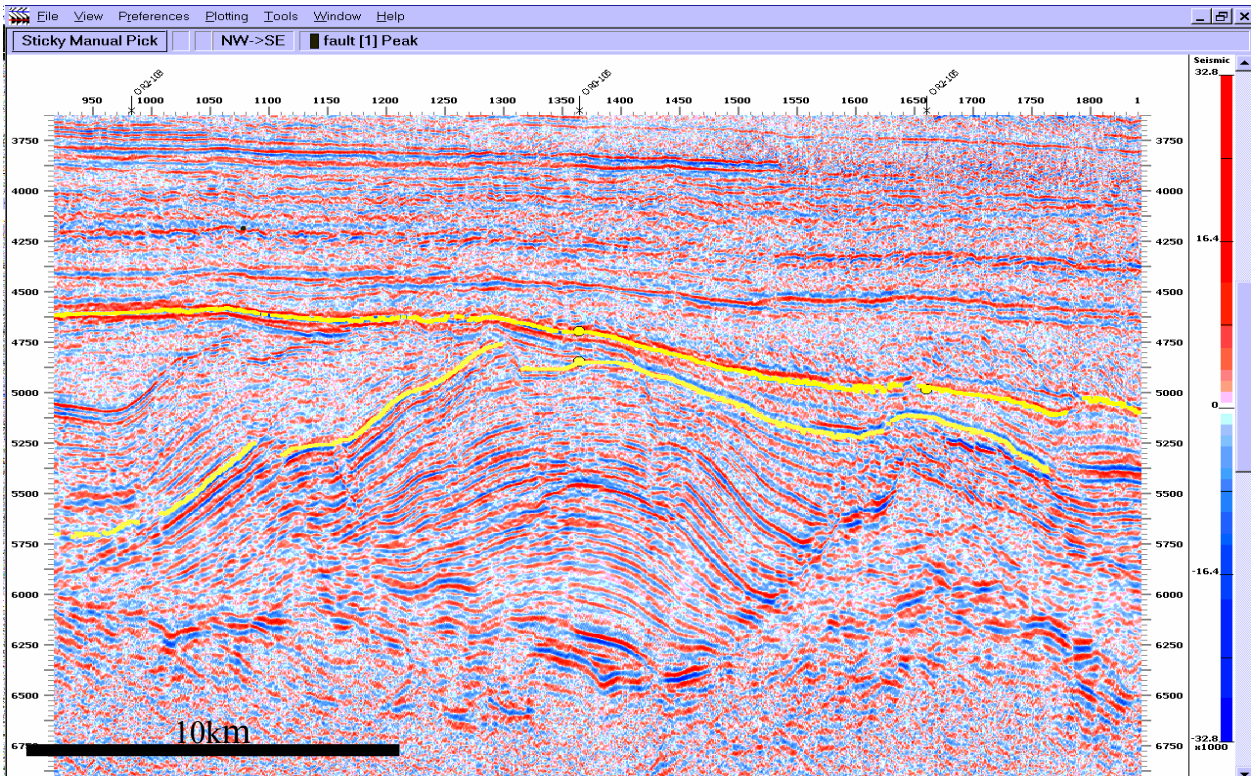
Regional Seismic Section Through Orphan Basin

The geologic evolution of the basin is similar to that of the adjacent Jeanne d'Arc, and Flemish Pass Basins, and is also similar to the history of the Porcupine Basin that lies off the West Coast of Ireland. Prior to the final rift episode leading to the opening of the North Atlantic, the Porcupine Basin was located immediately to the East of the Orphan Basin. All the basins began to form in the Late Triassic as rift basins that developed as a response to the rifting of Africa from North America. Deposition in the basins during these times consisted of continental clastics and evaporites. The rift basins trended in a NE – SW direction, parallel to the underlying crustal fabric established during the Hercynian Orogeny. This area was later affected by tectonic episodes related to the separation of Iberia and northern Europe from North America during two other rifting stages and several transfer faulting episodes in Late Jurassic - Early Cretaceous and Mid-Cretaceous.

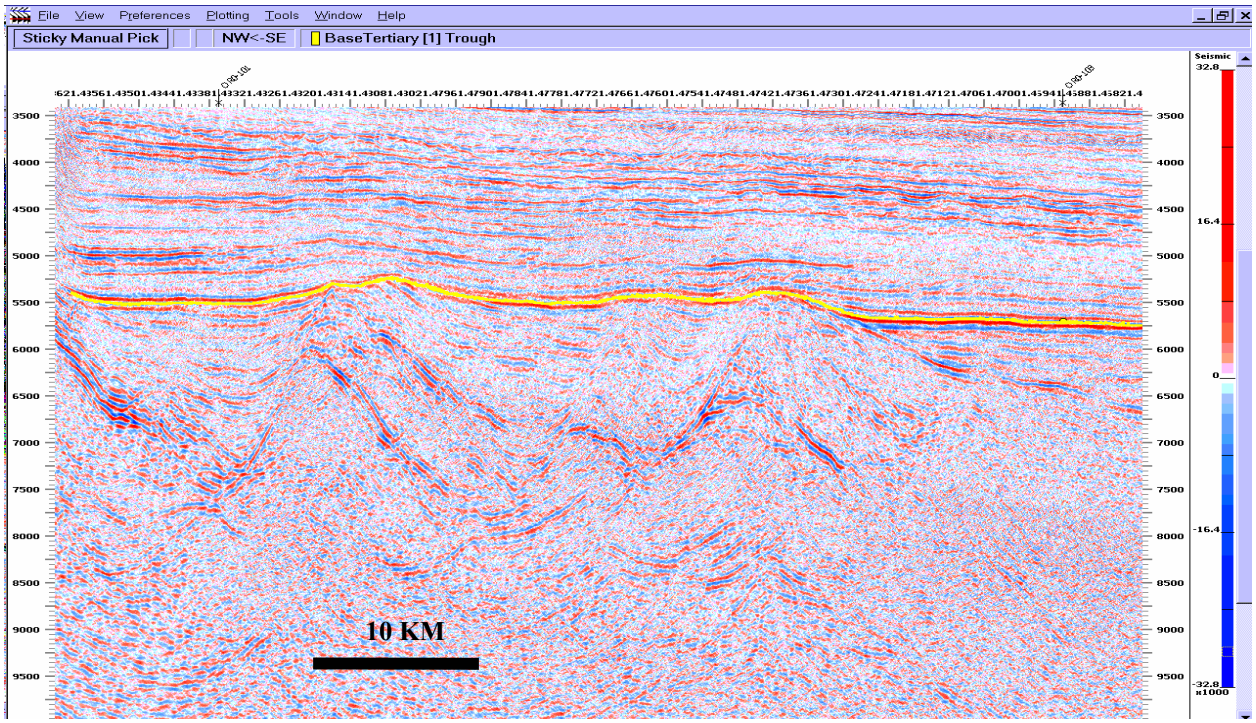
A critical time, from the perspective of petroleum system development in the Orphan basin area, was the Late Jurassic. After the termination of early intra-continental rifting that fragmented the area into connected sub-basins bounded by major faults, a period of regional thermal subsidence followed (Enachescu, 1987 and 1988). A broad epicontinental sea developed, extending beyond the boundaries of the initial rift basins (Sinclair, 1995). The organic rich sediments deposited in this sea during this period are the most significant oil source rocks in the basins, and are the source for the oil found in the Hibernia, Terra Nova and White Rose Fields in the Jeanne d'Arc Basin and the Connemara field in the Porcupine Basin. Given the presence of this organic rich facies in the Jeanne d'Arc and Porcupine Basins, it is very likely that this facies will be also present in the Orphan Basin. Numerous gas chimneys that can be seen on the 2000 -2002 seismic lines also indicate the presence of a hydrocarbon source in the basin, probably the equivalent of the Egret Member of the Rankin Formation in the Jeanne d'Arc Basin.

The Mesozoic section recognized in the Orphan Basin onlaps the basement highs that surround or lie within the basin, indicating that these blocks would have likely been subarially exposed throughout the Jurassic and Early Cretaceous. Based on sample descriptions from the Blue H-28 well (Koning et al., 1988) and the DSDP (Joides) 111 well that was drilled on the Orphan Knoll, these basement blocks are at least partly composed of Paleozoic sandstones, that may provide a provenance for reservoir quality sandstones deposited in the basinal areas during the Jurassic and early Cretaceous.

Intense tectonism during several extensional events coupled with possible halokinesis, has resulted in the Mesozoic section being structured into a number of potentially attractive hydrocarbon traps that can be documented and mapped on the modern seismic. These traps include anticlinal structures involving a thick Mesozoic section, tilted fault blocks, and onlap pinchout plays. Several of these features have associated amplitude anomalies.



Anticlinal Feature



Tilted Fault Blocks

Modern seismic data and correlation to the geologically adjacent petroleum basins, has given us a much better understanding of the geology and hydrocarbon potential of this vast, but less explored Canadian Frontier basin. Although the harsh climate and deep water will present challenges to the explorer and developer, the Orphan Basin, one of the few remaining true frontier areas, has the potential to become a significant petroleum province.

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