The Rockall Trough has been the center of political and geological controversy for the last two hundred years. It was first claimed by the British in 1955 during the cold war to extend the area of the continental shelf. Since then, numerous applications for blocks have been filed by several countries in the North Atlantic, particularly Britain and the United States. The area is named after the remote rocky island of Rockall and has been variously claimed by the British, Irish, and French. The ownership remains in dispute and is providing yet another headache for the United Nations Commission on the Law of the Sea.

The geological controversy stems from the area having been interpreted as both a continental and oceanic thinned crust. In addition, the age of the rifted shelf remains unknown. Seismic imaging traditionally has been poor because of the presence of extrusive and intrusive sills and shallow extrusive basalts that mask the underlying strata. In the summer of 2007, as part of the regional NEAtlanticSPANTM program, ION GX Technology (GXT) shot more than 2,000 km of seismic data across the Rockall Trough and adjacent areas in an attempt to evaluate the area's hydrocarbon potential.

The British government has recently initiated a transatlantic research program, using state-of-the-art technology, building on previous work that accurately depicts the geometry of the basin at the time of "break-up." Studying palaeographic reconstructions will help to better understand the Atlantic shelf sedimentary sequences and possible derivation of clastics from the North American Plate.

The IHOP-2002 regional reconnaissance seismic data was acquired using a 253 barrel peak output air gun on line 1060 (foldout line pages 36 - 38). All the seismic data was migrated using velocities derived from iterative tomographic velocity modeling. The velocity-modeled depths are within 5% of the depths from several calibration wells in the Faroes-Shetland Basin located offshore north of Scotland.

Seismic depth section imaging above thick (>1 km) Paleogene basalts, as can be achieved from iterative tomographic modeling, is essential for the future petroleum exploration in this area. Imaging below the basalts which usually have a high seismic attenuation factor is also important. The air gun and streamer deep-tow provided as much energy input at 20-30 Hz frequency. This low frequency energy penetrates through the basalts more effectively. Another significant data quality improvement was the reduced noise caused by improved streamer hydrophone technology.

The airgun and streamer deep-tow provided a minimum energy input. Maximum energy input at 20-30 Hz frequency. This acquisition produced more coherent reflections below the basalts which usually have a high seismic attenuation factor. Data was acquired to 18 seconds TWT, to image the complete crustal structure as seen below the basalts which usually have a high seismic attenuation factor. The airgun used was towed at depth (17.5m), as was the geophone streamer (18m) and bubble interference was kept to a minimum. Data was recorded to 18 seconds TWT, to image the complete crustal structure as seen below the basalts which usually have a high seismic attenuation factor.

Imaging below Basalts

The new seismic data shown here was shot and processed by GXT in 2007 and 2008. The same low frequency and high energy air gun Deep Shelf Deep-Acoustic (PSDM) processing was all designed to produce comprise imaging below 640 ft (194 Paleogene basalts, which cover most of the Northeast Atlantic region. This was achieved through using a long increase offset (110 -2 sec) and large source volume (PSDM). These new seismic results are improved imaging of the end and deep sea crustal levels in both the Porcupine Basin and PSDM volumes.

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UNEXPLORED ROCKALL BASIN

The area remains largely unexplored with its remote location, harsh weather and wave conditions. No wells have been drilled in the main deep central part of the Rockall Basin, and the few wells drilled thus far are located on the perched eastern margin rift shoulders or in the northern sub-basin. Most recently, Shell drilled the Dooish well 12/2-1 and sidetrack -1z in 2003, proving a gas condensate sandstone reservoir of probable early Permian age. A second deep-water well, 12/2-2, was drilled on the West Dooish Prospect in 2008, but the results remain confidential.

The presence of Jurassic rocks is perceived to be crucial to successful oil exploration in this basin. They occur in surrounding basins in the Slyne-Erris Trough to the east, and the Goban Spur and Fasnet Basin to the south. There is no direct evidence to confirm or disprove their presence in the central Rockall Basin. The sediment fill averages 4-6 km throughout the main basin which is thick enough to ensure hydrocarbon maturation from any Early or Late Jurassic source rocks (refer to seismic foldout line 1060).

A large part of the basin was affected by volcanism during the Paleogene period (54-59 million years ago) and several major seamounts are present in northern Rockall, as are extensive lava flows and intrusive sills. These volcanics have caused major problems.

West-East seismic depth section [30 km] across the northern Porcupine Basin, showing a mid-basin central ridge - the Dunquin prospect - that is interpreted to be a more than 1.5 km high volcanic buildup of early Cretaceous age which overlies rotated Jurassic fault blocks; the central volcanic high is thought to be topped by carbonate buildups. The volcanic ridge is probably comprised of mostly submarine basalt flows that erupted over a relatively short period of time around 120 Ma ago. The overlying late Aptian to Albian sequence consists of marine shelf claystones and sandstones which grade into deep marine shales in the southern part of the basin. The large angle of onlap of the Cretaceous strata onto the eastern and western basin margins suggests a deep basin hole was always present and which has never filled in. The red event at the deep crustal level is the Moho from gravity modeling.
for seismic imaging and have impeded exploration efforts for deeper targets so far. However, in the southern part of the basin the volcanics are absent. Large inversion fold traps have been imaged at Cretaceous levels in the southern part. These folds probably developed during Oligocene-Miocene times when regional basin inversion took place in the Faroes-Shetland Basin farther north.

Cretaceous and Early Palaeocene sandstones would be the most attractive reservoir targets. Sands may well have been derived from Greenland, similar to the inferred sediment provenance in other North Atlantic margin basins such as the outer Faroes-Shetland and Voring basins. The seismic data indicate these large fold closures are viable exploration targets, although a more detailed seismic grid will be required to confirm this.

PROVEN SOURCES IN PORCUPINE BASIN
To date, exploration in the Porcupine Basin has found several non-commercial fields. In the 1970s, BP discovered two oil accumulations at Connemara (200 MMbo in place) and in 1981, Phillips discovered the 100-200 MMbc Spanish Point gas and condensate field. GXT acquired more than 1,600 km of reconnaissance seismic across the Porcupine area in 2007.

This Basin is a sediment-starved Jurassic rift which opens southward into a bathymetric low reaching up to 4 km water depth at its southern end. There are good quality Jurassic source rocks of Kimmeridgian and Middle Jurassic age.

In the deep central part of the basin these rocks are buried to 8 km or more below sea bed where, at present, they are probably generating gas. Perched large rotated fault blocks occur along the margins of the basin and may contain mature sources in the oil window. Vertical gas chimneys and deep water carbonate mounds are present above seabed seeps indicating that the southern part of the basin is capable of generating hydrocarbons.

Providence Resources and Exxon currently hold license blocks over this ridge known as the Dunquin prospect. They were attracted by the large closure where carbonate reservoirs have been interpreted on the crest of the structure.

While the remote location and harsh conditions found in Ireland’s western offshore basins have limited exploration, this new data clearly show promising source rocks and large untested prospects like Dunquin. The new leasing round should spur companies to re-examine this area.

A FIRST STEP?
We consider the Irish offshore region to be a much neglected area of oil exploration. Good Jurassic source rocks are proven in the Porcupine Trough, and non-commercial hydrocarbons have been discovered. Unfortunately, the remote location and early lack of commercial success have limited the interest in this basin. The Rockall Trough is a huge basin with sufficient thickness of sediment to generate oil from source rocks in the bottom third of the rift. The presence of many large intrusive sills is a significant risk to exploration, due to possible overcooking of source rocks, but the southern part of the basin appears to have largely escaped volcanism and large Cenozoic folds have been imaged in this area that have never been tested. Realistically it may be some time before more seismic is shot in this remote basin and additional wells are drilled, but we hope the data shown here will spur companies on to re-examine this basin. The 2011 Irish Bid Round could be a first step in this direction.
Two Frontier Basins
Come to Light

Off the western Irish coast, new regional 2D seismic data is providing key information on the petroleum potential of a large and underexplored area.

The roughly southeast to northwest trending 420 km long seismic line 1060 shown here crosses the southern Rockall Basin. The 2D line depth section (PSDM) shows up to 6 km of sedimentary fill and large rotated fault blocks or half graben that contain potential Jurassic source rocks. The red line thought to be the top of crystalline basement or continental crust at depths of 23 – 27 km, rising to 16 – 17 km under the center of the Rockall Trough, is derived from gravity modeling and interpreted to be the Moho. The significant thinning and extension of the continental crust under the Rockall Trough to about a 6 km thickness is interpreted to reflect a combination of extension and gravity inversion that has occurred since the Late Jurassic. Results of gravity inversion studies (Welford, J.K., Shannon, P.M., O’Reilly, B, & Hall, J. 2010. Lithospheric density variations and Moho structure of the Irish Atlantic continental margin from unrestrained gravity inversion. Geophys. J. Int., 17 pp.) show similar thinning and major crustal stretching across the Rockall Trough.

See the complete story starting on page 39.