Oil and gas in Ireland—exploration, production and research

P.M. Shannon

Introduction

Ireland produces an average of 239 mmcf (6.76 million m³) of gas per day from two offshore gasfields. This represents about 18% of the country's primary energy requirements. A pipeline network relays gas to most of the major centres of population and industry and the construction of a gas import/export interconnector with the UK started early in 1993. The country has one refinery, situated on the south coast.

Despite offshore exploration since 1970, most of the prospective offshore sedimentary basins are underexplored. The onshore petroleum potential is very limited. Exploration, legislative and research aspects of the petroleum industry in the Republic of Ireland are described in this article.

Basins and petroleum plays

Offshore basins

Ireland is almost surrounded by Upper Palaeozoic to Cenozoic prospective sedimentary basins (Fig. 1) with lightly explored exploration potential (Shannon 1991). Some of these extend onshore in the north-east of the country (Naylor and Shannon 1982). Upper Palaeozoic basins occur onshore and have local gas potential in the north-west of the country. Basins lying east of Ireland are typically Upper Palaeozoic to lower Mesozoic half-grabens containing up to 3 km of pre-Middle Jurassic

---

1Department of Geology, University College Dublin, Belfield, Dublin 4, Ireland.
sediments. Source rocks lie in Upper Carboniferous coals and shales and, where encountered in the Kish Bank Basin, are at the peak stage of gas generation (Jenner 1981). Reservoir rocks are 'Permo-Triassic fluvial, alluvial and locally aeolian sandstones. Cap rocks are Permo-Triassic evaporites and marls. Structures are four-way dip-closed folds, tilted fault blocks and stratigraphic pinchouts against basement horsts. Seven exploration wells have been drilled in these basins, two of which had shows reported. Water depths in the region are generally less than 100 m. Basins to the south of Ireland typically have a thick (up to 9 km) Triassic to Cretaceous succession. Source rocks lie in the Lower Jurassic (oil and gas), Middle and Upper Jurassic (oil) and locally in the lowermost Lower Cretaceous (oil) shales. Gas if produced commercially from shallow marine Greensand (Albian) and shoreface to fluvial Wealden (Barremian-Aptian) sandstones. Oil flows have been recorded from these and from Lower Wealden (Valanginian-Hauterivian) and Oxfordian fluvial sandstones, Middle Jurassic shelf limestones and deltaic Lower Jurassic sandstones. Reservoir-quality sandstones have also been encountered in Triassic fluvial-aeolian sandstones. Cap rocks occur at Upper Triassic, Lower, Middle and Upper Jurassic and Lower Cretaceous levels. Traps comprise Early Tertiary inversion structures, generally with four-way dip closure; Triassic, Jurassic and Lower Cretaceous tilted fault blocks and Lower Cretaceous stratigraphic traps. Water depths are typically in the range 100-200 m. Seventy-six exploration and appraisal wells have been drilled to date (Fig. 2) in the Irish sector of the Celtic Sea basins (Fastnet,
North Celtic Sea, South Celtic Sea basins), with 15 flowing oil or gas on test and the majority of the others recording shows. The Kinsale Head field (over 1.6 TCF of gas initially in place) and the Ballycotton field (70 BCF of gas initially in place) are in production, while the Helvick and Seven Heads fields represent the most significant of the sub-commercial oil discoveries in the region (Fig. 1).

Basins west of Ireland contain up to 10 km of Upper Carboniferous to Tertiary sediments. They are very lightly explored, with no wells in the Irish sector of the Rockall Trough, the largest of the Irish offshore basins, or in the Hatton–Rockall Basin, 25 wells in the Porcupine Basin (Fig. 2) and 4 wells in the NW Offshore basins (Slyne Trough, Erris Trough and Donegal Basin). Source rocks in the Porcupine Basin lie at Upper Carboniferous (gas), locally Liassic (oil), Middle and Upper Jurassic (oil) and Lower Cretaceous (oil) levels. Producing sandstone reservoirs have been encountered in the Middle and Upper Jurassic (fluvial), and Upper Jurassic and Lower Cretaceous (sediment gravity flows). Other reservoir quality sandstones lie in Triassic (non-marine), Lower Cretaceous (deltaic), Lower Tertiary (deltaic) and locally Upper Carboniferous (deltaic) sandstones. Cap rocks lie at Carboniferous, Permo-Triassic, Jurassic, Cretaceous and Tertiary levels. A range of traps, including tilted fault blocks at Carboniferous and Jurassic level, and stratigraphic traps (e.g. deltaic, submarine fans, pinchout and onlap) occur in the Jurassic and Cretaceous (Croker and Shannon 1987). Four wells flowed good quality oil (35–45° API) or gas, with many others recording shows. The sub-commercial Connemara field (Fig. 1) contains 120 million barrels of oil-in-place (MacDonald et al. 1987). Water depths in the Porcupine Basin range from approximately 300 m in the north to in excess of 1700 m in the south of the basin, while water depths in the other basins further west vary from less than 200 m to more than 2000 m (Fig. 1).

Onshore basins

The Variscan Front passes across the southern part of the country (Fig. 1) and Upper Palaeozoic basins are typically tectonized in all but the northern and northwestern parts of the country. Here gas-prone source rocks have been recorded in Carboniferous shales, with Visean (Lower Carboniferous) deltaic sandstones having some reservoir potential. Carboniferous shales and evaporites have capping potential. Structural traps contain gas in tight reservoir sandstones and primary flow rates of up to 30,000 cubic feet per day were recorded during an early phase of exploration of Visean sandstones in the northwestern part of Ireland.

Exploration and production

History

Exploration drilling began in 1962 when the Ambassador Irish Oil Company drilled a series of wells testing
Carboniferous targets in a number of onshore basins (Fig. 2). Small gas flows were recorded in Carboniferous sandstones in the north-west of Ireland. Following acquisition of seismic data, drilling started in the offshore in 1970 when Marathon commenced sandstones in the north-west of Ireland. Following the First Licensing Round, and drilling reached a peak in 1978, with 15 wells drilled. The Second Licensing Round in 1981 marked a return to exploration in the Celtic Sea. Typically 2-7 wells have been drilled each year (Fig. 3). The Ballycotton field was discovered in 1989 and came on stream in 1991. A return to exploration onshore in the early 1980s confirmed the high risk nature of the tight Carboniferous reservoirs, with two wells yielding disappointing results.

_Licensing_

The legal instruments governing oil and gas exploration in Ireland are the Petroleum and Other Minerals Development Act (1960) and the Continental Shelf Act (1968). The extent of the Irish designated area is shown in Figure 4. A number of 21-year leases granted in the Celtic Sea region in the early 1970s pre-dated the more modern legislation of the 1975 Licensing Terms brought in before the First Licensing Round of 1976. Rounds in 1982 and 1985 were interspersed with periods when licences were granted under an 'open door' policy whereby companies and consortia negotiated licences over unlicensed blocks of interest to them. New licensing terms and petroleum taxation legislation were introduced in 1992. The range of licences comprises non-exclusive Petroleum Prospecting Licences (required to shoot seismic data), exclusive Exploration Licences (required to carry out drilling programmes) and Petroleum Leases (required for production). Licensing Options, typically of 1-2 years' duration, allow for the working-up of leads and seismic acquisition prior to a decision on commitment to the drilling obligations of an exploration licence, while Lease Undertakings are available when marginal oil or gas discoveries have been made and it is expected that commerciality could become possible within a few years. Standard Exploration Licences are of 6 years' duration and deepwater licences are 12 years where water depths exceed 200 m. A frontier licensing round, involving 128 blocks or part blocks in the Slyne and Erris troughs and the eastern margin of the Rockall Trough (Fig. 2) will close for bidding on 15 December 1993. Frontier licences will be for 16 years, with a well obligation not required until the second phase after 4 years.

Licences are granted by the Minister for Transport, Energy and Communications. The Petroleum Affairs Division of the Department of Transport, Energy and Communications administers and monitors exploration and production operations in Ireland. The recently enacted taxation legislation provides for a 25% rate of Corporation Tax on profits, with full allowances for exploration, development and abandonment costs. There are no special petroleum taxes and no royalties.

_Facilities and infrastructure_

Gas from the Kinsale Head and Ballycotton fields, produced from two fixed platforms and one subsea system, respectively, is landed on the south coast. An onshore pipeline network takes gas to most of the major centres of industry and population (Fig. 2). Additional spurs are planned. Work has commenced on the construction of a 292 km-long gas interconnector from Ireland to Scotland, funded jointly by Ireland and the EC. When completed in late 1993, at an expected cost of IE£280 million, this will allow for gas import or export. It will be operated by Bord Gáis Eireann (the Irish Gas Board).

The Whitegate oil refinery, situated on the south coast of Ireland (Fig. 2) is operated by the Irish National Petroleum Corporation (INPC). This hydroskimming refinery has a primary distillation capacity of 56000 barrels per day, naphtha reforming capacity of 14500 barrels per day and hydrodesulphurization capacity of 6000 barrels per day. Plans are in hand for upgrading the refinery, preferably in conjunction with an investing partner. A large oil storage terminal (storage capacity of over 7 million barrels) at Whiddy Island near Bantry (Fig. 2) is also owned by the INPC, and is currently used for strategic storage of crude.

_Companies_

The early offshore exploration was carried out largely by multinational companies such as Marathon, BP, Shell, Esso, Elf and Deminex. During the past 15 years all of these with the exception of Marathon have relinquished...
their exploration licences. Marathon, the operator of the Kinsale Head and Ballycotton gasfields, remains the major exploration company typically drilling 1 or 2 wells per year in the North Celtic Sea Basin. The past year has seen the entry of Mobil and Amoco into blocks in the North Celtic Sea Basin. Indigenous Irish oil companies such as Aran Energy, Arcon (formerly Atlantic Resources and Conroy Petroleum), Bula Resources, Oliver and Petroceltic (formerly Ardmore) have played an increasingly active rôle in maintaining exploration in the Irish offshore during the past 5 years. Active exploration interests (Exploration Licences or Licensing Options) in the Irish offshore are also held by Frontier Resources International Inc., Hamilton Brothers Oil and Gas Ltd. and Enterprise Oil plc. A total of 29 blocks or part blocks are currently held under old style Petroleum Lease by Marathon, 22 under Exploration Licence and 38 under Licensing Options.

Research and development in hydrocarbons
A small number of institutions are engaged in hydrocarbon R&D work in Ireland. Because the petroleum industry is small by international standards and is largely at the exploration phase, most of the research work is focused on upstream aspects. Theoretical and applied petroleum-related work is carried out by research teams at the universities (Petroleum Geology Unit at University College Dublin, Applied Geophysics Unit at University College Galway, and in the Geology departments at University College Cork and Trinity College Dublin), research institutes (Geophysics Section at the Dublin Institute for Advanced Studies), state agencies (EOLAS) and some consultancy organizations. Some of the significant research topics and projects being carried out by Irish institutions are:

- Definition, analysis and interactive modelling of hangingwall trap geometries and stratigraphies (University College Dublin)
- Deep geology and basin development of the Rockall region (Dublin Institute for Advanced Studies and University College Dublin)
- Sequence stratigraphy, sedimentology and diagenesis of Irish offshore basins (University College Dublin)
- Gravity and magnetics of Irish offshore basins (University College Galway)
- Palynology and micropalaeontology of Irish offshore basins (Trinity College Dublin)
- Diagenesis of Upper Cretaceous Chalk in the Celtic Sea (University College Cork)
- Monitoring and prediction of weather patterns in the Irish offshore (EOLAS)
- Downtime simulation and analysis of floating production facilities (EOLAS)

Petroleum research in Ireland is funded by the oil industry, the universities, state agencies and by the Commission of the European Communities.

Received 24 February 1993; accepted 18 May 1993.

References