MINERAL RESOURCES OF THE IRISH REPUBLIC

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Abstract: Ireland's mineral resources are divided into three main categories: non-metals, metals and carbonaceous deposits. The principal component of the non-metals category is construction materials, including building stone, aggregates, cement, clay and gypsum. Other important minerals in this category are magnesite and barytes. Metals are considered in the context of three different formative geological environments: Carboniferous Limestone, Devonian and Lower Palaeozoic rocks. The first of these is by far the most important, involving the major deposits at Navan, Tynagh and Silvermines, the exhausted deposit at Gortdrum and a number of other minor deposits. The only working deposit remaining from either of the other two types of environment is Avoca. Carbonaceous deposits are subdivided into: peat, of which Ireland is the world's second producer; coal, which is of little economic significance; and oil and gas, some of which have already been discovered. Further oil/gas discoveries are anticipated from a major exploration programme beginning in 1976.

Developments over the last decade have caused a major reappraisal of the common view of Ireland as a mineral-poor country. This is not to suggest that Ireland has not had a long tradition of widespread mining activity. On the contrary, in a celebrated compilation published in 1922, the geologist Grenville Cole listed 120 viable metalliferous mines in the twenty-six counties which had been in operation in the late nineteenth century,[2] and some old Irish mines, particularly Avoca, enjoyed international repute in their time.[3] Nevertheless, most of these operations represented superficial and low-grade deposits which were put out of business by the discovery of massive, high-grade, deposits in Africa, South America and elsewhere in the late nineteenth and early twentieth centuries. By the 1950s, with one or two exceptions, mining in Ireland had been reduced to small-scale, sporadic activities.

The purpose of this paper is to indicate the degree to which this picture has been reversed, by outlining the extent of the present mineral resource base in the Irish Republic, including the locations, nature of occurrence and economic significance of the various mineral deposits, together with the possibilities of future expansion of this resource base. The term mineral has a number of usages; here it will be taken to mean 'materials of economic value to be found in the rocks of Ireland'[4]. It is apparent from this definition that a material may gain or lose mineral status over time, with changing technology and market characteristics.

At the outset, Ireland's mineral resources may be usefully divided into a threefold categorisation: non-metals, metals and carbonaceous deposits.

NON-METALS

Construction materials

The great bulk of output in this category is used directly or indirectly in the construction industry. It comes from hundreds of quarries of varying size scattered throughout the country; although most of these are quite humble operations, when added together they achieve major significance. The construction industry is of fundamental importance to any economy; in Ireland, its output represents 15% of gross national product and it provides direct employment for about 85,000 people, representing 7.5% of total employment in the economy, while a further 20,000 are employed in directly related activities and services such as the supply of building materials. A further indication of the importance of the industry is that the largest construction materials company, Cement-Roadstone Holdings Limited, is also the country's largest industrial company, with a 1975 turnover of £91.5m and a workforce of about 7,000. A further significant and advantageous feature of the construction industry is that it has a very low import content, since most of the basic raw materials occur in Ireland. Ireland's construction minerals may be discussed under the headings: building stone, aggregates, cement, clay and gypsum.

The use of building stone in construction diminished greatly since the advent of concrete. Where it is used, the local stone is normally resorted to, and this gives a leading position to carboniferous limestone, the most widespread rock type, particularly in the central lowlands (Fig. 2). This rock is comprised mostly of calcium carbonate, derived from the remains of marine organisms which lived in the warm shallow seas which covered Ireland over 300 million years ago. There is also a substantial and growing internal traffic in building stone such as granite, quartzite and limestone/marble, particularly for use in the construction of large buildings in Dublin and other cities.

Aggregates are used for concrete production, trunking and other purposes. About half of Ireland's aggregate supply is provided through crushing rock, the rock type used normally reflecting local availability. The other half is derived from materials which have already been crushed naturally, particularly by the glaciations of the last two million years, which ground up enormous quantities of bedrock. Nature has often been generous in sorting out this material, in the form of eskers, kames, glacial lake deposits, and outwash sands and gravels. The sand and gravel quarries at Blessington, County Wicklow (Fig. 1), represent a particularly spectacular source of this material.

The role of cement in the construction industry requires no elaboration. The basic ingredients in cement production are limestone, shale or clay, and gypsum, roughly in the ratio 80:17:3. The significance of Ireland's massive limestone deposits becomes even more apparent here. Cement production in Ireland is by Cement Limited, of the Cement-Roadstone group, at three plants (Fig.1): Limerick (capacity 760,000 tonnes); Drogheda (570,000 tonnes); and Platin, near Drogheda (420,000 tonnes). The Platin plant, which is being expanded, will eventually replace that at Drogheda. Total cement production in 1974 was 1,630,000 tonnes, of which 130,000 tonnes were exported. The limestone requirement of two million tonnes comes from quarries adjacent to each of the

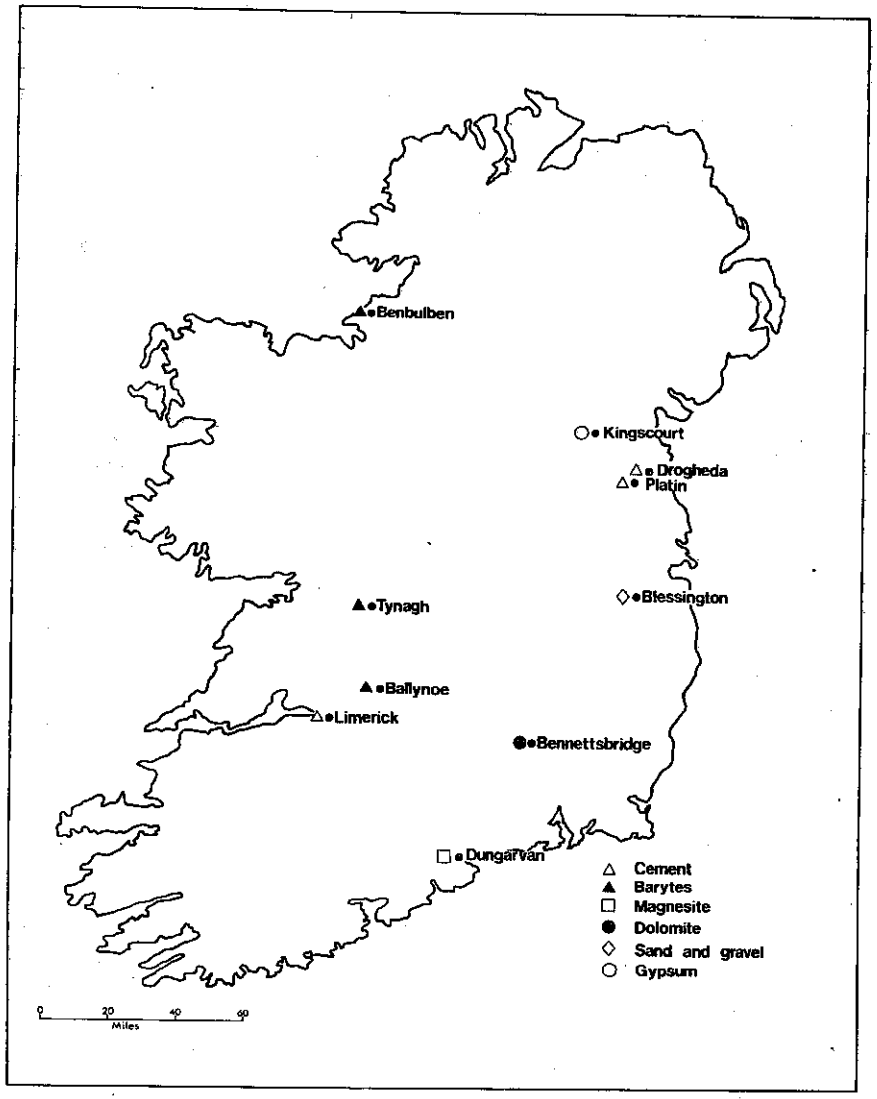

Fig. 1 Non-metallic operations

plants; clay for the Limerick plant (200,000 tonnes) is dredged from the Shannon estuary; clay for the Drogheda works (150,000 tonnes) is excavated at Simonstown, eleven miles north of Drogheda; shale for the Platin operation (110,000 tonnes) is quarried at Denhamstown, eight miles south-west of the works. The combined gypsum requirement (80,000 tonnes) is met from the mine at Kingscourt, County Cavan.

Clay, in addition to its use in cement manufacture, is also used in the production of bricks, tiles and pipes. Clay forms from the gentle accumulation of fine-grained sediment under quiet water conditions. Although clay from recent alluvial deposits is used, as with the Limerick cement works, the most important source is the shales and mudstones overlying the carboniferous limestone throughout Ireland, with particular importance attaching to the claybands associated with the various coal measures.

Gypsum forms from residual salts deposited during intense evaporation of shallow seawater in hot, arid, conditions, such as existed in north-east Ireland some 250m. years ago (Permian-Triassic). With change of climate, such deposits are highly susceptible to erosion, but downfaulting has preserved a major deposit at Kingscourt, County Cavan (Fig. 1). This deposit is mined by Gypsum Industries Limited, a subsidiary of B.P.B. Industries of the United Kingdom. With the exception of that for cement production, the gypsum is used in the production of plaster and plasterboard. In 1973 about 250,000 tonnes were used for this purpose locally, at a plant near Kingscourt, with another 100,000 tonnes exported to Great Britain (70%) and Northern Ireland (30%). In 1973 a capital investment plan to double plasterboard capacity at Kingscourt was announced, but output has been affected by the current recession, with its consequential impact on the construction industry.

Other non-metallic minerals

Magnesite is, in fact, a very specialised type of construction material, produced entirely for export. A highly heat-resistant (refractory) material, it is used for lining the walls of basic oxygen steel furnaces. The raw materials are seawater and dolomite, a combination of calcium carbonate and magnesium carbonate which is found extensively in the limestone areas, particularly in the south of Ireland. One such deposit is being mined near Bennettsbridge, County Kilkenny, at a rate of 250,000 tonnes per annum, from which 75,000 tonnes per annum of magnesite are produced at Ballinacourty, near Dungarvan (Fig. 1), by Quigley Magnesite Limited, a subsidiary of the Charles Pfizer Chemical Corporation of New York. The capacity of this plant is currently being expanded.

Barytes or barite is Ireland's most internationally-renowned non-metallic mineral. It is used principally in drilling for oil and gas, as its high density makes it a suitable ingredient for the drilling mud which lubricates the drill-bit, prevents oil/gas seepage and carries drilled rock to the surface. Ireland's 1974 production of 315,000 tonnes made it the third producer in the non-communist world, after the United States (1.1m. tonnes) and West Germany (400,000 tonnes). Deposits are found in association with base metal sulphides, suggesting a similar origin. The major source is Ballynoe, County Tipperary (Fig. 1), leased by the Silvermines Company to Magcobar of Houston, Texas, the world's leading supplier. Production is of the order of 250,000 tonnes per annum. A further 50,000 tonnes is produced yearly at Tynagh, County Galway, by Milchem, another USA-based leading world supplier, working on lease from Irish Base Metals Limited. Milchem is also investigating disused bartes mines in west Cork. Another old mine near Benbulben, County Sligo is currently being prepared for reopening by yet another leading supplier from the United States, Imco Drilling Services, reflecting the rapid growth

in demand for the material as oil/gas exploration outside the OPEC countries is increased.

METALS

Carboniferous limestone environments

The current interest in Ireland's mineral resources was initially generated by a series of major discoveries over the last decade. The first of these was at Tynagh, County Galway (Fig. 2) in 1961, and the consequent upsurge in exploration activity has unearthed a number of metal deposits of widely varying size. The most striking feature of these deposits is their similarity of occurrence. Invariably they have been found along east-west faults in the carboniferous limestone, and consist for the most part of sphalerite (zinc sulphide), galena (lead sulphide) and chalcopyrite (iron-copper sulphide). The most popular explanation of their occurrence is that the faults in question act as avenues of escape for mineral-bearing hot aqueous solutions deriving from volcanic eruptions deep in the earth's crust. As these solutions approach the surface they cool rapidly, precipitating the contained minerals; these are then found as replacement features in the limestone, some of which is dissolved and removed by the passing hot solution.

Only two of these deposits, at Tynagh and Silvermines, are being worked at present. Production at Tynagh started in 1965 and at its peak was western Europe's leading producer of lead and silver. In 1974, a changeover from open-cast to underground mining meant a substantial reduction in annual output to 26,000 tonnes of lead, 21,000 tonnes of zinc, 2,300 tonnes of copper and 36 tonnes of silver. The mine is operated by Irish Base Metals, a subsidiary of Northgate Exploration of Canada.

At Silvermines, County Tipperary, an underground mine produced 45,000 tonnes of zinc, 11,000 tonnes of lead and 18 tonnes of silver in 1974. This makes it western Europe's leading zinc/lead/silver producer. The mine is operated by Mogul of Ireland, which is 25% owned by Silvermines Limited, an Irish-registered company with substantial British shareholdings, and 75% by the Canadian Kerr-Addison company, which in early 1976 bought out the interests of International Mogul Mines of Canada. The major shareholder in Kerr-Addison is Noranda Mines, which is in turn the leading shareholder in Tara Exploration and Development.

Tynagh and Silvermines have together accounted for about two-thirds, by value, of the country's mineral exports in the period 1965-74, approximately £190m out of £300m at end-1975 prices. The zinc and lead concentrates have been exported for smelting and further processing to a variety of countries, as indicated in Table 1. The importance of the other EEC countries, even before Irish membership, is striking. The proportion going to any one country annually can vary quite markedly.[5]

At Gortdrum, near Tipperary Town, Northgate, through a subsidiary, opened mining operations in 1967, but closed them down again in 1975, due to ore exhaustion. Apart from producing 5,000 tonnes of copper and some silver annually, this mine was also an internationally-significant source of mercury, producing on average over 1,000 seventy-six-pound flasks per annum.

Production is due to begin in 1977 at Navan, County Meath, where one of

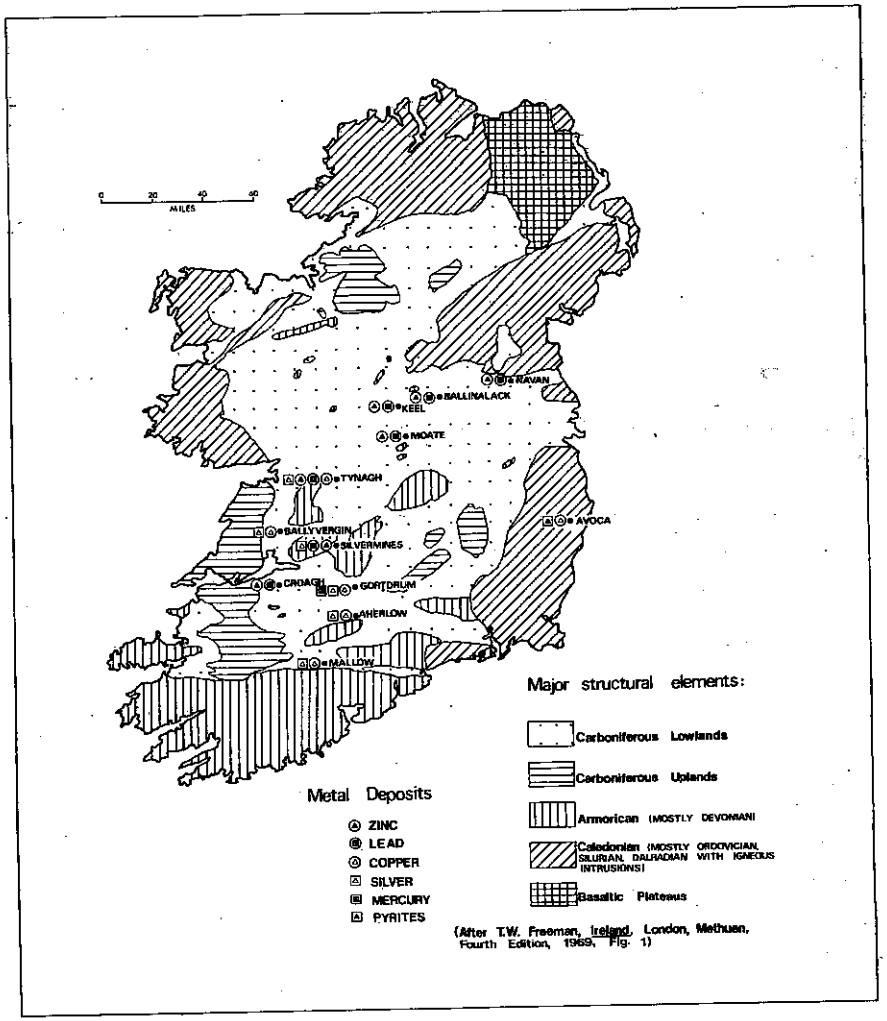

Fig. 2 Metal deposits

the largest zinc/lead deposits in the world has been discovered. This deposit is divided between two independent operators, Bula Limited and Tara Mines Limited, and its exact size is a matter of some doubt. Bula has reported reserves of 19.64m. tonnes of ore, grading 6.77% zinc and 1.23% lead. Tara has issued no detailed report since 1972, when it claimed reserves of 61.11m. tonnes, grading 11.10% zinc and 2.72% lead. As indicated in Tara's 1975 annual report, potential reserves may add further to these figures. In this report, the expected grade from the Tara section of the deposit is put at 11.00% zinc and 2.40% lead.

TABLE 1
Principal destinations of zinc and lead exports, 1966-74

Country	Zinc (%)	Lead (%)
France	25	26
West Germany	16	24
Belgium	14	29
United Kingdom	15	6
Netherlands	12	9
Italy	9	4
Total value of exports (end - 1975 prices)	£102.4m	£86.8m

At the projected rate of extraction, and allowing for metal losses at the concentration stage, the combined Tara/Bula annual output should amount to 285,000 tonnes of zinc and 55,000 tonnes of lead for at least twenty years, and possibly somewhat longer. The Tara section, representing about 80% of the total orebody, should last at least thirty years. This projected rate of output is, by itself, equivalent to 6.3% and 2.2%, respectively, of the 1974 non-communist world output of zinc and lead. The entire deposit, going on available company statistics, represents an increment of about 9% and 2.5%, respectively, to 1971 non-communist world reserves of zinc and lead. At June, 1976 prices, the annual concentrate output of the joint operations at Navan will be worth £65m., equal to 2% of Ireland's gross national product and 4.5% of 1975 exports. Complete smelting in Ireland would double these values and further processing would add considerably more.It is apparent that, both in world terms and in the context of the Irish economy, the Navan orebody represents a discovery of major proportions.[6]

The Bula company is Irish-based and the Irish government will have a 49% shareholding in its Navan operations. No plans have yet been published about the disposal of its annual output. The government will also have a 25% shareholding in Tara Mines, whose Canadian-based parent company, Tara Exploration and Development, is jointly owned by four other mining companies: Northgate, which also controls the Tynagh mine; Cominco, which operates the world's largest zinc/lead smelting works at Trail, British Columbia; Charter Consolidated, a British-based subsidiary of the South African mining giant, Anglo American; and Noranda, which is the company's major policy controller; together with some private shareholdings. The company has already announced plans to export the mine's output to seven smelters in Belgium, West Germany, France, Spain and the United Kingdom. At the same time, the Irish Government is currently investigating the possibilities of establishing an Irish-based zinc

smelter, which is expected to utilise about one-third of the Navan annual output.

Meanwhile, several other zones of mineralisation have been identified in carboniferous limestone environments throughout Ireland and are currently undergoing appraisal as regards economic viability. The most significant of these are listed in Table 2 (see also Figure 2). The Syngenore company, which is 72% owned by Noranda, has applied for special tax concessions to open up the Ballinalack deposit. Anglo United, an associate of Northgate, is also investigating mineralised zones in Kerry and Wexford. In addition, much publicity has been occasioned by the interest shown by the major USA mining and processing concern, American Mining and Smelting, in a prospect near Croagh, in west County Limerick.

The prospects for further mineral finds in carboniferous environments are bright. About 40% of the land area of the country is underlain by carboniferous limestone, and most of this has been licensed out for prospecting purposes. A major hindrance to the on-going exploration effort is the fact that large tracts of the carboniferous area are covered by lakes and peat bogs. While significant natural resources in themselves, these lakes and bogs inhibit the standard surveying methods employing geophysics and geochemistry. It is noteworthy that the major finds thus far are on the periphery of the principal carboniferous limestone area (Fig. 2).

Other environments

Metal ore concentrations in Ireland are not confined to carboniferous limestone environments. Significant mineralisation zones have also been encountered elsewhere, particularly in the Lower Palaeozoic rocks of Counties Wicklow, Wexford and Waterford, and in the Upper Palaeozoic (Devonian) rocks of south Counties Kerry and Cork (Fig. 2). In both instances, mineral deposits take the form of narrow veins, rather than the massive deposits characteristic of the limestone environment; this feature is linked to the resistance of the host rocks to chemical weathering compared with limestone. The most commonly occurring minerals are chalcopyrites (copper-iron sulphide) and pyrites (iron sulphide), although commercial quantities of zinc and lead have in the past been worked in these environments. In the south-west, the origin of mineralisation is similar to that described for carboniferous limestone, but in the south-east, mineralisation is associated with local volcanic intrusions; mineralised solutions and gases derived from the intruding magma entered fissures in the country or host rock and in the cooling magma itself to form ore veins.

Although both of the areas under discussion have long mining histories, the only mine of this type working is at Avoca in County Wicklow. The present operation began in 1971, under the control of a Canadian consortium in which Discovery Mines has the major shareholding, and has been plagued with financial difficulties, arising mainly from the notoriously unstable international copper price. In 1975, 3,500 tonnes of copper were produced, although production had previously reached 7,000 tonnes. The mine's principal product is pyrites, of which 70,000 tonnes were produced in 1975. Sulphur from the pyrites is used for the production of fertiliser at the nearby Nitrigin Eireann Teoranta plant.

TABLE 2
Minor metal deposits found in carboniferous limestone

Deposit	Company	Ore Grade* Zn	Pb	Cu	Ag	Known reserves (000 tonnes)
Aherlow (Co. Tipperary)	Denison Mines (Canada)	-	-	0.86	1.23	5,130
Ballinalack (Co. Westmeath)	Syngenore (Canada)	4.35	0.66	-	-	1,820
Ballyvergin (Co. Clare)	Northgate (Canada)	-	-	1.20	0.50	140
Keel (Co. Longford)	Rio Tinto Zinc (UK)	3.00	4.00	-	-	1,640
Mallow (Co. Cork)	Anglo United (Canada)	-	-	0.69	0.86	3,640
Moate (Co. Westmeath)	Rio Tinto Zinc (UK)	6.4	1.0	-	-	110
Navan (Co. Meath) -1	Northgate (Canada)	6.72(Zn/Pb)		-	-	1,450
Navan (Co. Meath) - 2	Rennicks/Bennett (Ireland/Canada/S.Africa)	7.60 (Zn/Pb)		-	-	1,180

*Grade: Zn (Zinc), Pb (Lead), Cu (Copper) per cent; Ag (Silver) ounces per tonne.

Exploration is being carried out elsewhere in the Devonian and Lower Palaeozoic areas, and a watchful eye is being kept in particular on the deposit at Allihies in County Cork, the site of extensive mining operations in the nineteenth century, which is marginally subeconomic at present.

Ireland's copper exports, derived principally from Avoca and Gortdrum, have represented nearly 15 per cent by value (£38m out of £266m. at end- 1975 prices) of total mineral exports in the period 1968-74. Spain has been the steady recipient of about 80 per cent of the total, with the remainder going irregularly to a variety of other countries, mostly European.[7]

CARBONACEOUS DEPOSITS

This category derives its name from the fact that all the minerals concerned were formed from sediments containing dead organic matter. While normally used as fuels, these minerals can also be very important industrial raw materials. In the Irish context, carbonaceous deposits may be subdivided into peat, coal, and oil and gas.

Peat

Ireland is second only to the Soviet Union as a peat producer. Peat results from an inability of dead vegetation to decay due to water saturation. In Ireland, two types of peat bog are important: raised bogs, resulting from retarded drainage and found mainly in the central lowland, and blanket bogs, resulting from an abundance of rainfall and found mostly in upland and western areas (Fig. 3). Since blanket bogs are normally associated with difficult terrain, they are not amenable to mechanical harvesting. However, hand-won turf is an important source of domestic fuel in western areas, and also supplies some small power stations.

The extensive expanses of raised bog on the central lowland are quite amenable to mechanical harvesting and are the major focus of interest for Born na Mona, the state-owned Peat Development Authority which was established in 1946. In 1975, Bord na Mona produced milled and sod peat thermally equivalent to 1.2 million tonnes of oil which, if imported, would have cost £40m. The company also produced 300,000 tonnes of peat briquettes and nearly one million cubic metres of moss peat, primarily for export. Fulltime employment is 4,500, with another 1,000 added during the peak harvesting season. Most of the peat output goes to ESB generating stations (Fig. 3), which account for about 25 per cent of the country's total electricity supply.

In 1974, Bord na Mona announced a £20m. expansion programme, which will add over 16,000 hectares of bogland to the 52,600 hectares already under the company's control. The additional milled and sod peat production will have an annual oil equivalent of 350,000 tonnes, worth £21m. in obviated imports. The expansion programme will provide an extra 1,500 fulltime and 300 part-time jobs. Intensive research is being carried out into possible agricultural uses for exhausted bogs, the first of which will appear within the next few years. Total exhaustion of the presently-worked bogs is expected around the year 2020.

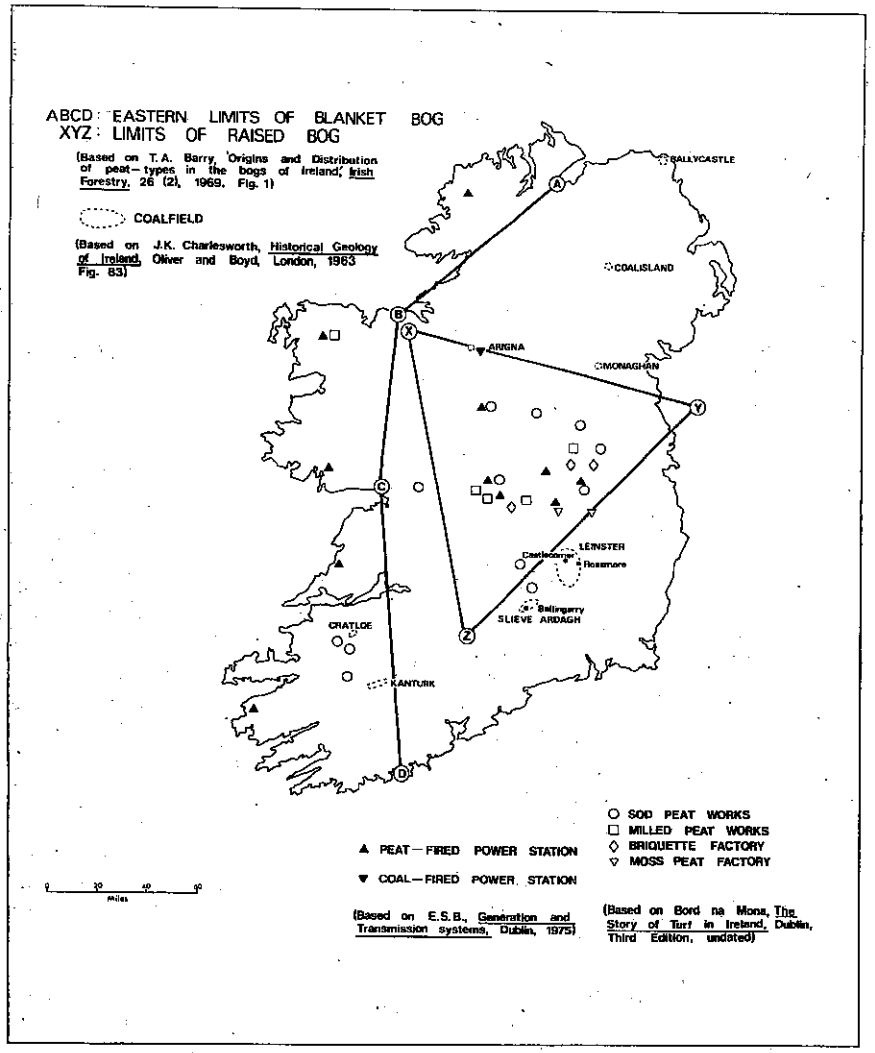

Fig. 3 Peat and coal operations

Coal

Whereas most of Ireland's peat is post-glacial in origin (less than 15,000 years old), Ireland's coal deposits date back 300 million years, when most of Ireland was a swamp, with a moist equatorial climate. Whereas the warm environment facilitated a rapid turnover of vegetation, the swamps inhibited decay, as a result of which large masses of dead vegetable matter were able to develop. Subsequent burial under sediment and deformation of the strata in which the matter occurred led

to a general reduction in the moisture and volatile content and a corresponding increase in the carbon content. This process is referred to as coalification.

Subsequent erosion has left Ireland with only eight identified coalfields, and there are now only two working mines worth mentioning (Fig. 3). One of these, at Arigna, County Roscommon, provides 50,000 tonnes of semi-bituminous coal annually for a nearby generating station which accounts for 1 per cent of total electricity supply. Within the Leinster (Castlecomer) Coalfield, at Rossmore, County Carlow, 15,000 tonnes of anthracite are produced annually for domestic use. The present high price of energy has suggested a reappraisal of some other closed coalmines, and the Slieve Ardagh (Ballingarry) deposits have been particularly mentioned in this context. An interesting possibility which has been raised recently is that of using low-grade Irish coal as a fuel in zinc-smelting operations.

Oil and Gas

Oil and gas are derived from dead marine organisms which become trapped in great profusion, suggesting a warm climate, in sediments accumulating on continental shelves. Between two and three hundred million years ago, what is now Ireland and the surrounding area comprised a shallow sea on the margin of a great landmass to the north-east, of which the Donegal and Scottish mountains represent the last remnants. With a tropical climate prevailing, conditions were quite suitable for oil and gas formation.

Interest in the possibility that Ireland and the surrounding area might constitute a source area for oil/gas was first expressed in 1959, when Ambassador Irish Oil, representing a United States consortium, obtained an exploration licence from the Irish Government applying to the whole area of Ireland plus the adjacent territorial sea within the three-mile limit. In 1966 Marathon Oil of Ohio, a member of the original consortium, took over the licence through its subsidiary, Marathon Petroleum Ireland Limited. Six wells were drilled unsuccessfully on the mainland before gas discoveries in the North Sea shifted attention to the offshore area. In 1968 the Irish Government claimed jurisdiction over some 45,000 square kilometres of continental shelf off the west and south coasts, and this area became subject to the Marathon lease in 1969.

In 1970 and twice in 1974, the Irish Government extended further the offshore area over which it claims jurisdiction, to the limits indicated in Figure 4. The area now claimed is roughly equivalent to the 200mile (322 km) economic zone which is expected to be ratified as a general principle by the current law of the Sea Conference, due to finish in 1977. However, in March 1976 the Irish Government declared its intention of claiming a further 200 miles of adjacent seas. In addition, dividing lines have yet to be agreed with the United Kingdom and France with respect to the areas lying between the three countries, and with the United Kingdom with respect to the controversial Rockall area.

The Irish Designated Area has been divided into a number of 'Sectors' (Fig.4), each coinciding with one degree of latitude and longitude. These are further subdivided into thirty 'Blocks', each measuring 10' in latitude and 12' in longitude, and covering about 250 sq.km. in area. The Block is the basis of the licensing system, under which three principal types of licence may be issued:

1. A Petroleum Prospecting Licence, which gives the holder non-exclusive permission to search for oil/gas in a specified area.

2. A Petroleum Exploration Licence, which gives the holder exclusive rights to search for oil/gas in a specified area.

3. A Petroleum Lease, which gives the holder exclusive access to any oil/gas in a specified area.

Under the Marathon agreement, the company is guaranteed a petroleum lease for any block in its licensed area in which it has drilled an exploration well, regardless of whether or not oil/gas has been found. At March, 1975, ten such leases were held. Each lease lasts initially for twenty-one years, but where oil/gas is found the lease becomes effective as long as production continues. Under the agreement, Marathon has to relinquish, at regular five-yearly intervals, portion of its remaining licensed area for which leases have not been granted. The outstanding area at February 1976 for which Marathon has licences/leases is depicted in Figure 4. In order to speed up exploration, Marathon entered into a farm-out agreement with Esso Exploration in 1972, whereby the latter is to explore part of the Marathon licensed area (Fig.4), with the proceeds of any oil/gas finds in that part being divided equally between the two companies.

The licensing terms available to other companies provide for an initial exploration licence of six years and, where oil/gas has been found, a guaranteed twenty-eight year petroleum lease, with provision for further extensions. Whereas under the Marathon agreement, the Irish Government cannot take more than 40 per cent of the company's net income from its Irish operations, it has reserved the right to take up to 16 per cent in royalties, a 50 per cent shareholding and 50 per cent in company tax in the licences issued to other companies. Up to June 1976, eleven companies or consortia had received licences, as indicated in Table 3 and Figure 4.

Five of the principal companies involved in these consortia, B.P., Chevron, Gulf, Shell and Texaco, are among the seven major international oil companies. A sixth, Mobil, has a 21 per cent share in the Deminex consortium, while the seventh and largest, Esso (Exxon) has a major share in the Marathon licence. In addition, several west European governments have shares in some of the consortia. In all, thirty-one companies from eleven countries are involved in the consortia, apart from ten Irish companies. In addition to these, over sixty companies have been awarded non-exclusive prospecting licences.

It is evident that there is much international interest in the oil/gas possibilities of areas under Irish jurisdiction. From information received from licensees, the Geological Survey of Ireland has identified areas around Ireland which seem to hold the best potential for oil/gas discovery (Fig.5). These represent extensive sedimentary basins or troughs. The two most extensive, the Rockall and Porcupine Troughs, lie in water depths beyond the range of current exploitation capabilities, but it is expected that the required technology will be developed within the next few years. It is noteworthy that some of the blocks for which exploration licences have been issued do not coincide with the areas identified by the Geological Survey of Ireland (compare Figs 4 and 5).

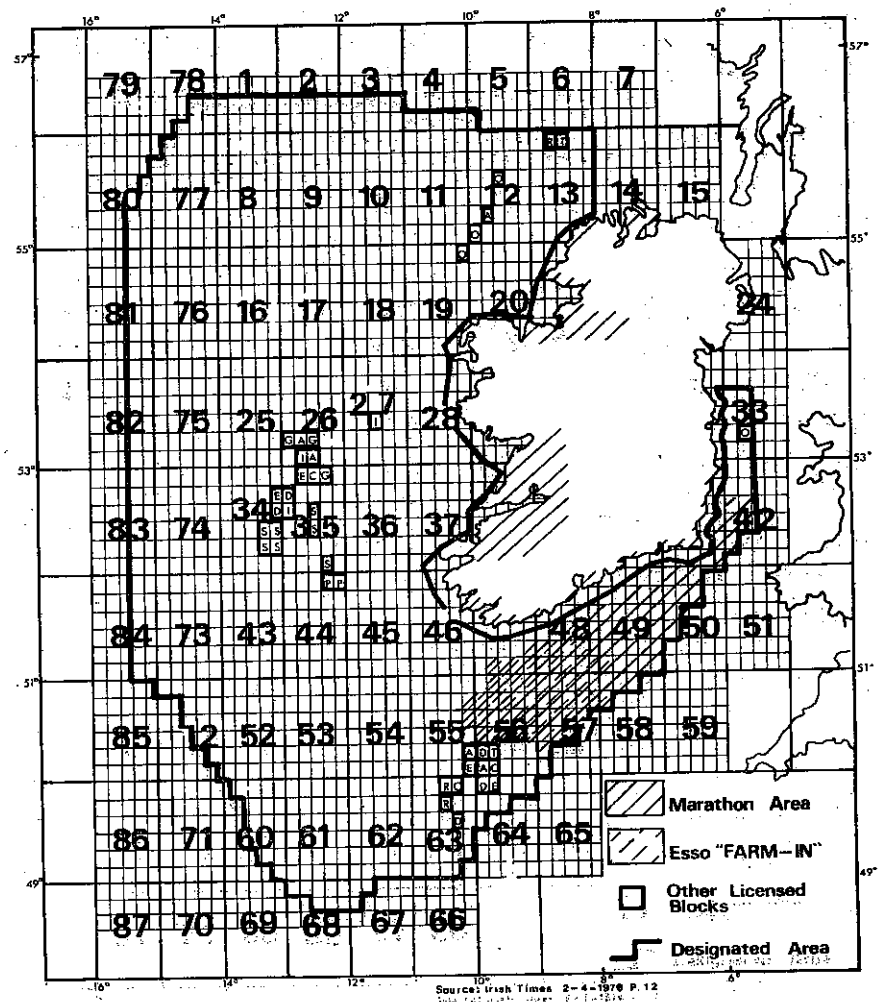

Fig. 4 Petroleum licensing

TABLE 3
Exclusive offshore exploration licences (June 1976), percentage participation given where known.

Principal company	Other foreign	Irish interest
Amoco (USA) 35%	58.75%	6.25%
B.P. (UK) 60%	15%	25%
Chevron (USA)	Yes	4%
Cities Services (USA)	Yes	20%
*Deminex (West Germany) 31.6%	65.3%	8.2%
Elf (France) 75%	10%	15%
Gulf (USA)	Yes	-
Marathon (USA)	Yes	-
Phillips (USA) 47.5%	52.5%	-
Ranger (Canada) 28.3%	54.7%	17%
Shell (Netherlands/UK)	Yes	-
Texaco (USA)	-	-

*Percentages do not total to 100 due to conflicting reports

Thus far, one commercial gas-field has been located by Marathon fifty kilometres off the Old Head of Kinsale. The initial strike was made in 1971 and the economic viability of the field was confirmed in 1973. In energy terms, this field represents about 12 per cent of Ireland's current annual energy requirement for a period of at least twenty-two years. However, about 40 per cent of the high quality methane gas will be used to produce fertiliser in a specially-built Nitrigin Eireann Teoranta plant in Cork harbour. Apart from a small quantity which is to be pumped into the Cork City domestic system, the remainder will be used by the ESB to generate electricity, and another special plant is being built in Cork harbour for this purpose. A state company, Bord Gais Eireann, has been set up to buy the gas as it comes ashore for resale to the subsequent users.

South-west of the Kinsale gasfield, Esso found in 1974 an oil-field whose economic viability is still under appraisal, but which is regarded as being promising. In 1974, also, Marathon encountered oil and gas south of Ardmore, County Waterford, but this well has now apparently been abandoned. The other licensees received their licences in late 1975 or early 1976, and exploration is

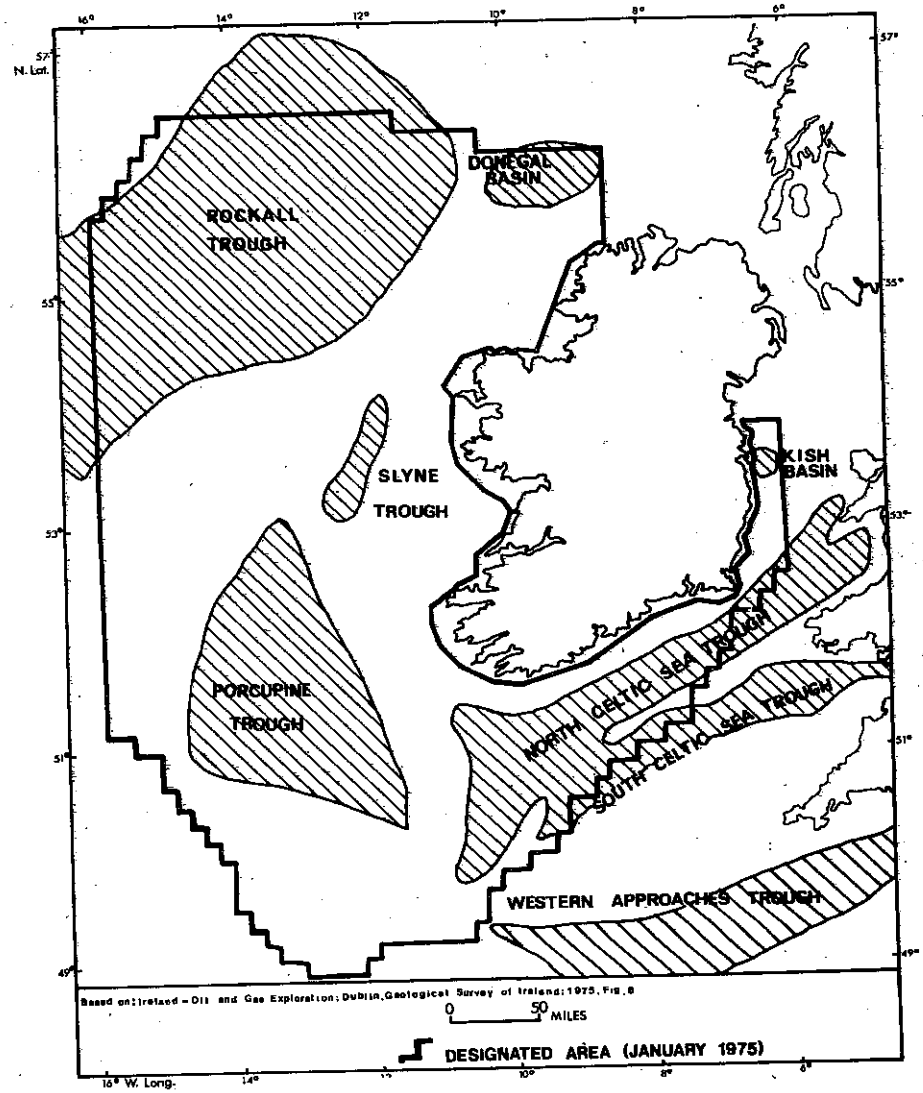

Fig. 5 Offshore potential hydrocarbon basins

due to begin in the summer of 1976. In all, an estimated £300m will be spent in surveying and drilling under these licences in the next five years. The size of this sum indicates both the level of optimism and the order of magnitude of the economic benefits which could accrue from a successful exploration effort. The Irish economy is small in relation to the oil/gas potential of the area under Irish jurisdiction. One oil well producing 100,000 barrels per day, modest by international standards, would meet Ireland's present annual requirements. A fraction of the North Sea success would make Ireland a substantial surplus producer. As the basic raw material for a number of products such as plastics, fertilisers and artificial fibres, oil and gas could offer great potential for industrial development in Ireland. The next few years, then, could offer both the greatest promise and the greatest challenge for the future of this country's economy and people.[8]

NOTES AND REFERENCES

1. Much of the factual material for this paper was taken from newspaper and company reports, and from various issues of *Mining Annual Review.* The author will provide further clarification or elaboration on request. Frequent use was made of P. Gardiner and R. Horne, 'Mining geology: what's where in Ireland', *Mining Ireland,* 1, 1973, 27-38. For a general discussion of mineral formation, readers are referred to R.F. Flint and B.J. Skinner, 'Sources of energy and minerals', Ch. 20 of *Physical geology,* Wiley, New York, 1974. Otherwise, where drawn upon, scholarly papers are acknowledged.
2. G.A.J. Cole, *Memoir and map of localities and minerals of economic importance and metalliferous mines in Ireland,* 1922, reprinted 1966, Stationery Office, Dublin; as referred to in M.H. Farmer, 'Making the most of metallurgy', *Irish Engineers* (Journal of the Institution of Engineers in Ireland), 28 (7), 1975, 22.
3. J.W. Platt, 'Avoca', *Mining Ireland,* 1,1973, 72.
4. Gardiner and Horne, *op.cit.*, 27.
5. See F. Walsh, 'Ireland's mineral export trade', paper read to University College, Galway Geographical Society, February 17, 1976. Copies available from the author.
6. See also F. Walsh, 'Some observations on the economic significance of the Navan zinc/lead orebody', paper read to the Annual Conference of Irish Geographers, University College, Cork, May 20, 1976. Copies available from the author.
7. F. Walsh, 'Ireland's mineral export trade', *op.cit.*
8. See also F. Walsh, 'Ireland and offshore oil and gas', *Irish Geography Teacher,* 2, 1976, 13-20.