

EXPLORATION AND MINING DIVISION IRELAND

ZINC • LEAD • COPPER • GOLD • SILVER • BARYTES • GYPSUM • COAL • DOLOMITE • TALC



THE "TOP 55" DEPOSITS



Department of Communications, Marine and Natural Resources

The Mining Heritage

Ireland is richly endowed with a diversity of mineral deposits, with a mining heritage extending for over 4,000 years. Although much of the information is shrouded in time, enough remains to show that the country was firmly established as a significant metal producer at several distinct stages in history. During the Final Neolithic/Early Bronze Age (c.2400-1500 B.C.) Irish mines were an important source of copper, while alluvial gold may have been used for some of the abundant gold ornaments of this period. The 16th and 17th centuries were a time of extensive iron production, while the 19th century saw continuous copper, lead and silver output for over 70 years, as well as a “gold rush” around the start of the century. And finally, the period since the 1960s have seen Ireland enjoy the status of a world-ranked producer of zinc, lead and barite, and become one of the most promising exploration territories in Europe.

Historical Record

The first evidence of mineral deposits as an important resource in Ireland after the Stone Age is to be found in Bronze Age times (c.2300-500 B.C.) or a little earlier. Recent research has established that primitive copper mines were worked in SW Ireland in the period c.2400-1500 B.C., with the bulk of those dated during the period c.1700-1500 B.C. These mines were located both in mineralized quartz veins and sedimentary copper beds, as workings which rarely exceeded 10m in depth. Near-site smelting is likely, and the copper production made Ireland an important European producer of bronze axes and other utilitarian products during this time. The subsequent decline was probably due to the exhaustion of accessible mineralization. It is also likely that gold was first discovered during the Bronze Age, since there is reference to gold being found in c.1600 B.C. and worked at a site to the south of Dublin.

Few records remain of mining activity prior to the major period of mining in the 19th century. Sparse texts attest to iron working at **Avoca** in the 2nd century, to iron and copper mines in the 9th century, alum mining in the 12th century and lead-silver workings and copper mining around 1500. Better information exists for the 16th and 17th centuries however, which were marked by widespread iron production. Although iron ores were probably mined and smelted from shortly after the Bronze Age (500 B.C.), Irish production did not rise to prominence until this time, when iron became an important export to England. The ores worked were gossans from **Avoca**, carbonate ore (‘ironstones’) from the coalfields, haematite, and the widespread ‘bog iron’ ore. As charcoal sources were exhausted the industry declined. The last charcoal furnace closed in 1765. Lead and silver were also mined in the 17th century at several locations (e.g. **Silvermines**).

The flowering of the metal mining industry in the late 18th and 19th centuries was triggered by the needs of the Industrial Revolution in Britain. Copper mining boomed in SW Ireland, especially at **Allihies**, but there was considerable lead, copper (e.g. **Avoca**) and silver mining elsewhere, with almost every coastal county having at least one mine, based on high-grade low-tonnage vein deposits (e.g. **Bunmahon**). This period also saw the main phase of coal mining (**Rossmore** and **Ballinagarry** areas) and slate quarrying as well as pyrite from **Avoca** and manganese and barite production from southern Ireland, with mining employment at peaks never to be reached again. Fortunes were made and lost, not least during the “gold rush” between 1795 and 1830 at the **Gold Mines River**, where an estimated 7-9,000 oz of gold was extracted from alluvial gravels.



Bronze Age copper mine at Muckross, Killarney, Co. Kerry.

By the end of the 1880s however, a bleak period of some 70 years was to ensue. The exhaustion of deposits, falling metal prices and the lack of new discoveries saw the virtual cessation of metal mining. Up to the 1950s the only mining of note was a period of bauxite production in Northern Ireland, pyrite for sulphur from **Avoca**, and phosphate from the west of Ireland, reflecting economic demand during the war years, barite from **Benbulbin** (1942-1960) and gypsum mining from the **Kingscourt** area from 1936 onwards. Coal mining continued from the **Arigna**, **Rossmore** and **Ballinagarry** areas from thin seams, but output otherwise largely consisted of limestone for agricultural use and materials for the Irish construction industry.

The stage however had been set for the finest period in Irish mining history. A comprehensive Minerals Development Act (1940), followed by significant tax measures in the 1956 Finance Act, had a catalytic effect on mineral exploration by attracting a number of Canadian exploration companies to the country. Encouraged by the State discovery of economic reserves at the lead-zinc deposit in Lower Carboniferous rocks at **Abbeytown** (in production from 1950-1962), a surge of exploration focused in this stratigraphical level. Early confirmation of the existence of significant mineralization came with the discovery of the **Ballyvergin** copper deposit in 1957, followed by the **Tynagh** zinc-lead-silver orebody in 1961. It was the discovery of this latter deposit, in a geological setting which had not previously produced any significant mineralization, that set off a chain of discoveries (see Table). In 1962 the **Silvermines** zinc-lead orebody was discovered; this was followed by the world-class **Ballynoe** barite deposit, in its time the fifth largest barite producer in the world, and in 1964 the **Gortdrum** copper-silver-mercury deposit was found. All of these became profitable mines.

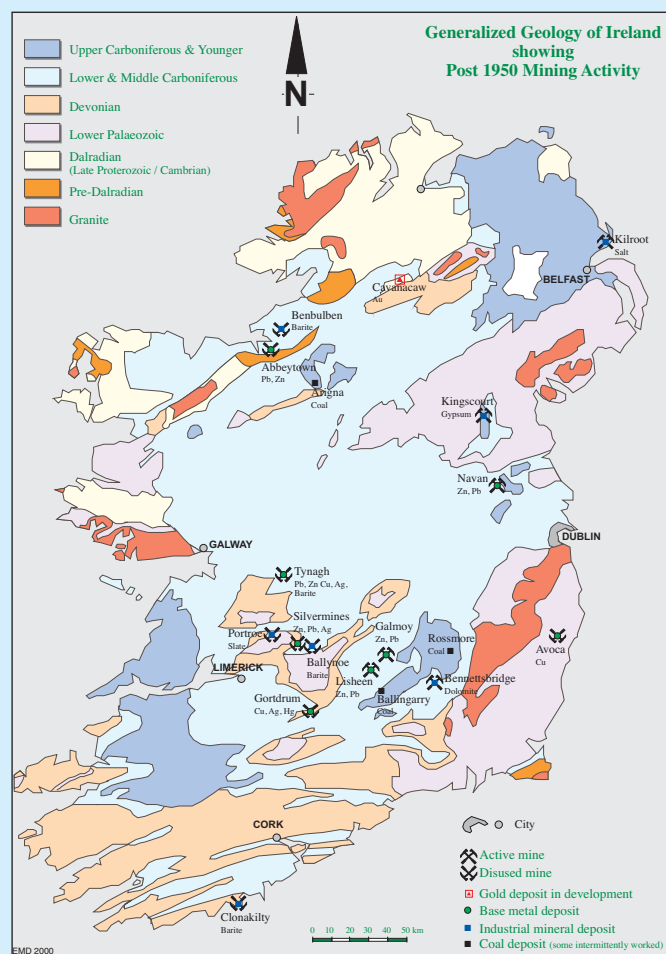
Then in late 1970, the **Navan** deposit was discovered. Initial reserves for the deposit were almost 70 million tonnes grading 10% zinc and 2.5% lead, and production started in 1977. The discovery of the large tonnage **Navan** deposit put Ireland firmly on the international map and resulted in a large demand for prospecting licences. By the end of 1974, a total of 924 licences covering 32,000km² were current, accounting for almost 50% of the total land area of the Republic of Ireland. However, during the next twelve years, the efforts of the exploration companies resulted in what can only be described as technical successes. While a number of minor deposits (e.g. **Tatestown**, **Courtbrown**, **Charlestown**) were found, none were economic. This lack of success in the late 1970s led to many of the multinational exploration companies leaving Ireland. The resulting vacuum was filled by the formation of a number of junior Irish exploration companies, which kept alive the flame of exploration in Ireland, at a time of depressed base metal prices and relatively little funding available for base metal exploration. Fortunately, the discovery of the **Curraghinalt** gold prospect in Northern Ireland in 1983 proved that Ireland had real potential for bedrock gold. This and the high price of gold at the time enabled funding to be raised and led to a surge in gold exploration in Ireland between 1982 and 1988, with some success, notably the discovery of the **Lecanvey** and **Cregganbaun** deposits. However, in 1986, a more significant discovery was made, that of the **Galmoy** base

metal deposit (6.18Mt, 11.31% Zn, 1.12%Pb). This sparked a revival in Ireland's base metal industry, resulting in the return to Ireland of a number of multinational companies. Further success followed in 1990 with the discovery of the **Lisheen** deposit (18.9Mt, 12.75% Zn, 2.2%Pb). Additional significant mineralization has been outlined at both Navan and Galmoy. In 1999, a resource of 13.5Mt at 8.9% Zn and 1.8% Pb was outlined at Navan (the SWEX, or South West Extension), while mineralization discovered in 2002 (the R Zone) adjacent to the CW orebody is expected to result in a longer mine life at Galmoy.

With all three mines (Navan, Galmoy, Lisheen) in full production, Ireland is firmly positioned as a major international producer of both zinc and lead, being the largest producer in Europe and among the ten largest in the world. The succession of discoveries since the late 1950s have demonstrated that Ireland hosts a zinc-lead province of considerable magnitude, ranked first in the world in terms of zinc metal discovered per sq. km, and second for lead.

DEPOSIT	YEAR OF DISCOVERY	TONNAGE (Mt)	GRADE		
			Zn+Pb %	Cu %	Ag g/t
<i>*Economic</i>					
* Avoca	18th c	16		0.6	
* Abbeytown	18th c	1.1	5.3		45
Allihies	1961	1.3		1.65	
* Tynagh	1961	11.8	11.5	0.6	70
Courtbrown	1962	1.0	5.5		14
Keel	1962	1.9	8.75		40
* Silvermines	1963	17.7	8.96		23
* Gortdrum	1965	3.8		1.2	25
Aherlow	1965	6.0		0.89	34
Ballinalack	1969	7.8	7.4		27
* Navan	1970	69.9	12.5		11
Mallow	1973	3.6		0.7	28
<i>including</i>		0.6		0.6	150
Tatestown	1975	3.6	6.9		37
Harberton Bridge	1975	3.7	9.9		10
Garrycam	1976	1.4	2.9		(plus 36% BaSO ₄)
Oldcastle	1977	1.4	5.2		
Charlestown	1979	3.0		0.6	
* Galmoy	1986	6.2	12.43		
* Lisheen	1990	18.9	14.95		32
* Navan SWEX	1999	13.5	9.8		
* Galmoy R Zone	2002	2.3	25.8		

Significant zinc-lead and copper deposits (resource > 1Mt) in Ireland. Zinc-lead deposits are mostly zinc dominant.



There is, however, more to Ireland than just zinc and lead. Gold exploration continues, with one mine in production since late 2000 at **Cavanacaw** in Northern Ireland. Current mining also includes gypsum at **Kingscourt** and salt at **Kilroot**, while deposits of talc, calcite, dolomite, fireclay, perlite, lignite, ballclay and roofing slate have all been located. This wide-ranging mineral heritage is reflected in the "Top 55" mineral deposits on the following pages, in which the absence of coal deposits is merely a reflection of the decline of a once important local industry due to the exhaustion of economic reserves.

The “Top 55” Deposits

- **Abbeytown (Zn, Pb)**

Stratabound sphalerite and galena occur in a Viséan carbonate sequence. Textural evidence suggests that Abbeytown is a replacement-style MVT deposit. Mined intermittently since 1785, most production took place between 1950 and 1962. Total production is estimated at 1.1Mt grading 3.8% Zn, 1.5% Pb and 45g/t Ag. Potential reserves of 1Mt of ore-grade Zn, Pb and Ag have been outlined.

- **Aclare (Li)**

Pegmatites along the eastern margin of the Leinster Granite locally contain spodumene. The pegmatites are up to 20m thick and 400m in length. Tin and niobium-tantalum minerals are common accessories. The pegmatites have a grade of 1.6% Li.

- **Aherlow (Cu, Ag)**

The discordant Cu-Ag deposit at Aherlow is hosted in basal Carboniferous limestones and shales as well as in the underlying Devonian clastics. Mineralization occurs as a steeply-dipping shear zone on the northern limb of the Aherlow Syncline. A series of lenses containing chalcopryrite, bornite and chalcocite, each up to 30m wide, can be traced for 600m and to a depth of more than 250m. Diamond drilling has outlined a “geological tonnage of more than 6Mt grading 0.89% Cu and 33.8g/t Ag”.



Copper oxides in historic workings at Allihies, Co. Cork.

- **Allihies (Cu)**

Mining has occurred in the Allihies Region since 1810 with ten separate mines worked in the area during the 1800s. Copper mineralization occurs in steeply-dipping quartz veins in Devonian slates and sandstones. During 1957-61 an exploration programme included dewatering of the underground workings at the Mountain Mine. Subsequent drilling (underground) outlined a subeconomic deposit of 1.3Mt grading 1.65% Cu. Gold has also been reported from the area, with vein material from the Mountain Mine assaying .035 oz/ton Au.

- **Avoca (Cu)**

A major Caledonian volcanogenic massive sulphide orebody, mining records for Avoca go back to the 16th century when iron was mined from the gossans in the sulphide lodes. Copper mining started around 1750. Chalcopryrite is the principal economic sulphide but sphalerite and galena are also found. Total production to

1982 was approx. 16Mt grading 0.6% Cu. The copper concentrates contained payable levels of gold and silver.

- **Ballinalack (Zn, Pb)**

The Ballinalack Zn-Pb deposit is hosted in basal Waulsortian (Lower Carboniferous) mudbank limestones similar to the Tynagh, Silvermines, Galmoy and Lisheen deposits. Weaker mineralization is found in the underlying Mixed Beds, the stratigraphic equivalent of which hosts the Navan deposit. At Ballinalack the Main Zone contains measured and indicated resources of 7.83Mt grading 6.4% Zn and 1.0% Pb, the central core of which contains a measured resource of 3.2Mt at 8.1% Zn and 1.4% Pb.

- **Ballymoney, Northern Ireland (Lignite)**

Drilling in the late 1980s confirmed the existence of a very significant near-surface deposit of Tertiary lignite at Ballymoney, Co. Antrim, in Northern Ireland. Six seam groups combine over a thickness of 70-180m to give a total of 620Mt of lignite.

BALLYNOE

At peak production of 300,000 tpa during the early 1980s, Ballynoe was the largest barite mine in Europe and provided 5% of world demand. Barite was mined continuously at Ballynoe for 30 years.

- **Ballynoe (Barite)**

The stratiform barite deposit at Ballynoe occurs at the base of Waulsortian (Lower Carboniferous) mudbank limestones. The barite is genetically related to the adjacent Silvermines sedex Zn-Pb deposits. Open pit mining began in 1963 and continued to the late 1980s; this was followed by underground mining to 1993 when the mine closed due to exhaustion of reserves. During its continuous 30 year operation the mine produced 5.13Mt of ore at 90% BaSO₄.

- **Ballyvergin (Cu)**

The small Ballyvergin copper deposit occurs in basal carbonates and shales of the Lower Carboniferous. Disseminated, cross-cutting and replacive chalcopryrite, pyrite, arsenopyrite and galena are concentrated at the crest of a pericline. The mineralogy and the stratigraphic and structural setting are all similar to the other copper deposits in southern Ireland viz. Gortdrum, Mallow and Aherlow. The deposit is estimated to contain 233,000t grading 0.97% Cu and 15g/t Ag.



Western end of Ballynoe barite open-pit.

- **Benbulbin (Barite)**

Discovered in the latter part of the 19th century, a vertical vein of barite cuts the massive Lower Carboniferous limestones of Benbulbin Mountain, Co. Sligo. Averaging 1.2m in thickness, the vein has been worked intermittently since 1875. Approximately 100,000t of barite was produced between 1942 and 1960. More recently, approximately 10,000tpa was produced between 1975 and 1979.



Partially worked out barite vein at Benbulbin, Co. Sligo.

- **Bennettsbridge (Dolomite)**

A large resource of dolomite and dolomitic limestone occurs in Lower Carboniferous rocks near Bennettsbridge, Co. Kilkenny. Roadstone Provinces Ltd. operate the quarry and produce between 250,000 and 500,000t of dolomite annually. The dolomite is used for concrete aggregate, aggregate for tarmacadam and for fertilizer.

- **Bohaun (Au)**

An epithermal gold-bearing structure up to 160m wide and 1600m long cuts a Silurian metasedimentary sequence. Trenching has yielded consistent values of 40 to 190g/t Au across vein widths of 1 metre.

- **Bunmahon (Cu)**

The Bunmahon area contains a number of historic copper mines. All are based on vein-type or shear-hosted deposits of chalcopyrite in Ordovician volcanics and sediments. Although records are incomplete, they show that during 1800 to 1878 approximately 250,000 tons of dressed ore grading 10% Cu were produced. The average grade of mined ore was 3% Cu.

- **Carnew (Au)**

Drilling by Irish Marine Oil on a gold-bearing structure in altered Ordovician metasediments and metavolcanics near Carnew intersected significant gold values. Best intersection was 18.40g/t Au (with visible gold) over 0.5m at a depth of 71m; a previous hole nearby had intersected 11.6g/t Au over 0.38m at a depth of 108m. Both intersections are believed to be from the same mineralized zone, the limits of which have yet to be defined.

- **Carrickittle (Zn, Pb)**

Epigenetic Pb-Zn mineralization occurs in basal Waulsortian (Lower Carboniferous) mudbank limestones. Massive and disseminated/stringer mineralization are found, and the host rocks can be dolomitized or undolomitized. Although the discontinuous nature of the mineralization does not allow for the calculation of a tonnage, 17 out of 33 drillholes averaged 3m grading 6% Zn and 1.5% Pb.

- **Cavanacaw, Northern Ireland (Au)**

The gold deposit at Cavanacaw, in Northern Ireland, is hosted in steeply-dipping quartz veins and shear zones in Dalradian metasediments. The gold infills microfractures or forms discrete grains within lead, copper and iron sulphides. A proven and probable reserve of 367,000 tonnes grading 7.52 g/t Au over a width of 4.43m was estimated for the main Kearney deposit from surface to a depth of 37m. A further indicated reserve of 1.18 Mt at a grade of 7.02 g/t Au over a width of 4.43m was estimated from 37m to a depth of 137m. A small-scale opencast operation is in progress by the operator and owner, Galántas Gold Corporation, who sell the gold as jewellery through their wholly owned subsidiary Galántas Irish Gold Limited.

- **Charlestown (Cu)**

The Charlestown Cu deposit is centred on a shallow Ordovician dacite complex. Significant sulphide mineralization is confined to a central silicic zone where chalcopyrite, sphalerite and galena occur in hydraulic fractures. The deposit contains approx. 3Mt of 0.6% Cu with subsidiary Zn-Pb-Ag mineralization.

- **Clonakilty (Barite)**

A vein deposit of barite cuts Devonian and Carboniferous slates and sandstones on the southern coast of Ireland at Clonakilty, Co. Cork. The deposit comprises an almost vertical E-W vein averaging 2m in thickness, but locally up to 5m thick. The barite is generally high grade (locally of chemical grade) and has been in production sporadically since 1855. Records show that approximately 5,000tpa had been produced from 1876 to 1901. More recently 20,000 tpa had been produced between 1979 and 1982, at which time it was estimated that 230,000t of recoverable reserves were present, two thirds of which was of direct shipping grade.

- **Clontibret (Au)**

The gold prospect at Clontibret, Co. Monaghan occurs in a sequence of Ordovician greywackes. The prospect comprises a number of lodes which were worked historically for antimony, and the gold occurs in late-stage arsenopyrite-stibnite veins. The gold is found in solid solution in arsenopyrite and pyrite as well as local inclusions of native gold within these sulphides. Drilling by Conroy Diamonds and Gold PLC has yielded best values of 16.24g/t Au over 2.42m (from 37m depth) and, in the same hole, 10.48g/t Au over 2.78m (from 56m). A second hole gave 2.91g/t Au over 4.79m (from 21m) and 5.2g/t Au over 1.30m (from 77m). More recent drilling intersected 6.23g/t Au over 1.50m (from 22.70m), including 0.3m of 21.75g/t Au, and 6.75m of 3.15g/t Au (from 78.50m).

The “Top 55” Deposits

- **Courtbrown (Zn, Pb)**

Situated on the southern shore of the Shannon estuary, the Courtbrown Zn-Pb-Ag deposit is hosted in basal Waulsortian (Lower Carboniferous) mudbank micrite. Although the overall habit of the deposit is stratiform, mineralization is both cross-cutting and semi-massive. Reserves of 1Mt at 5.5% Zn + Pb (2:1) include possible and inferred categories. There are probable reserves of 300,000t grading 8.2% Zn + Pb and 14g/t Ag.

- **Cregganbaun (Au)**

The Cregganbaun gold deposit is hosted in an E-W shear zone which strikes through the central part of the Ordovician sequence of the South Mayo Trough. Gold mineralization is found along the shear zone over a distance of 33km. The lithological assemblage in the vicinity of the shear zone includes feldspathic tuffs, turbidites (containing chromite and fuchsite), ultramafic rocks of listvenitic character, and lamprophyre and porphyry dykes. Native gold is commonly visible in quartz veins. It is estimated, based on drilling, that the Cregganbaun East Zone contains 530,000t at 6g/t Au over a depth of 80 metres. At Cregganbaun West, bedrock sampling has yielded values of up to 280g/t Au in one metre channel samples.

- **Crumlin, Northern Ireland (Lignite)**

Three separate lignite seam groups occur at Crumlin, Co. Antrim, in Northern Ireland. An extensive drilling programme has been carried out on the deposit by Antrim Coal Company Ltd. The seam groups vary in thickness up to a maximum of 63 metres and the deposit is reported to contain several hundred million tonnes of lignite.

A MAJOR BASE METAL PROVINCE

Ireland is the largest producer of zinc concentrates in Europe and the second largest producer of lead concentrates.

Ireland now ranks as the 8th largest producer of zinc concentrates in the world and as the 12th largest producer of lead concentrates.

The Lisheen mine having come on stream in 1999, Ireland now has three underground Zn-Pb mines viz. Navan, Galmoy and Lisheen. Annual total production from the three mines will be in the order of 700,000 tonnes of zinc concentrate and 110,000 tonnes of lead concentrate.

Known carbonate-hosted deposits contain some 11Mt of zinc metal, approximately 1.5% of world zinc found to date. Ireland is ranked 1st in the world in terms of zinc discovered per sq km and 2nd in the world for lead discovered per sq km.

- **Curraghinalt, Northern Ireland (Au)**

At Curraghinalt, in Northern Ireland, gold is associated with pyrite in steeply-dipping quartz veins in Dalradian metasediments. Drilling and underground development has outlined a measured and indicated resource of 460,000t grading 16.94g/t Au. The deposit is undergoing further evaluation.

- **Derrykearn (Zn, Pb)**

Diamond drilling at Derrykearn in 1987 intersected 19.5 feet grading 13.8% Zn and 3.21%. The prospect lies on the NE-SW ‘Rathdowney trend’ which contains the Lisheen and Galmoy orebodies. Lower Carboniferous carbonate-hosted sulphide mineralization is described as being in a similar geological setting to that of the Galmoy deposit.

- **Duncormick (Zn, Pb)**

Epigenetic Zn and Pb sulphides occur within two dolomite horizons near the base of the Lower Carboniferous carbonate sequence. Grades are up to 12% Zn over 1 metre, but are more commonly 5-6% Zn over 3 to 10 metres.

- **Galmoy (Zn, Pb)**

The Galmoy Zn-Pb deposit is hosted in a rock matrix breccia at the base of dolomitized Waulsortian (Lower Carboniferous) mudbank limestone. There are two orebodies approx. 1km apart and at 70m depth. The CW orebody is 700m by 450m and has an average thickness of 6m. The G orebody is 450m x 300m and has an average thickness of 8m. Underground mining commenced in March 1997. The known mineable reserves of 6.2Mt at 11.31% Zn and 1.12% Pb were subsequently increased, while drilling in 2002 outlined another zone of very significant mineralization 200m southeast of the CW orebody. Arcon International Resources believe that the mine life will be extended to 2012.

- **Glangevlin (Gypsum)**

The Glangevlin gypsum deposit occurs in near-shore sediments of the upper part of the Lower Carboniferous. There is an estimated *in situ* resource of 14.8Mt of which 8Mt at 78% gypsum is thought to be recoverable.

- **Gold Mines River (Au)**

The Gold Mines River in Co. Wicklow was the site of intensive alluvial gold mining in the late 18th and early 19th centuries. Total production has been estimated at 300kg of gold, although the true figure is likely to be higher, as much of the mining was unauthorised.

- **Gortdrum (Cu, Ag, Hg)**

The Gortdrum Cu-Ag-Hg orebody is a hydrothermal deposit emplaced during the late Carboniferous (at least) in basal Carboniferous limestones. The deposit is spatially related to both an ENE normal fault system and to high-level basic intrusions. Ore reserves were initially calculated at 3.8Mt containing 1.19% Cu and 25.1g/t Ag. Subsequently the ore was found to contain recoverable quantities of mercury. Due to problems of stability in the open pit, it was not possible to mine the deepest parts of the orebody. Subeconomic mineralization, identical to that of the ore, continues for several thousand feet beneath the deposit.



Gortdrum Cu-Ag-Hg open-pit, looking E. Devonian sandstones on right (brown) thrust over Lower Carboniferous limestones on left (grey).

- **Harberton Bridge (Zn, Pb)**

The Zn-Pb mineralization at Harberton Bridge is contained in a series of breccia pipes. These breccias occur through 500m of the Lower Carboniferous carbonate sequence, although they are best developed at the base of the Waulsortian mudbank micrite. The Harberton Bridge mineralization is distinctly different than that of the major deposits at Navan, Silvermines and Tynagh, and is comparable to classic MVT deposits. Four distinct zones of mineralization are found, with a total indicated resource of 3.7 Mt grading 8.8% Zn and 1.1%Pb.

- **Inishannon (Zn, Pb)**

Structurally-controlled Zn-Pb mineralization cross-cuts Carboniferous carbonates and clastic sediments of the South Munster basin. Narrow high-grade sphalerite-galena veins dip steeply to the north; massive pyrite, apparently stratiform, and cross-cut by fracture-fill sphalerite and galena, is found in the lower part of the succession. Best values are 12.4% Zn and 3.8% Pb over 3.4m, and 6.2% Zn and 1.6% Pb over 8m.

GORTDRUM

The Gortdrum mine in Co. Tipperary is the only recently-discovered copper-silver deposit in Ireland to have been mined. It is also unique as the only mine to have produced mercury. The mine gave its name to a newly-discovered copper-mercury sulphide, gortdrumite ($(\text{Cu,Fe})_6\text{Hg}_2\text{S}_5$).

- **Inishturk (Au)**

On the island of Inishturk gold occurs in quartz veins in Ordovician metasediments. The occurrence is at the western extension of the auriferous Cregganbaun Shear Zone. Channel samples have assayed from 4.3 to 31.6g/t Au over widths of 0.6 to 2.0 metres.

- **Kedrah (Dolomite)**

A deposit of pure dolomite has been identified at Kedrah in southeast Tipperary. Waulsortian limestone here has been heavily dolomitized and contains in excess of 20% MgO and less than 0.1% Fe_2O_3 . Drilling has outlined reserves of some 1.5Mt and an inferred resource of 4.5Mt.

- **Keel (Zn, Pb, Barite)**

The Keel Zn-Pb deposit occurs as disseminations and as stockwork sulphide mineralization in Upper Devonian and Lower Carboniferous clastics and carbonates faulted against Lower Palaeozoic metasediments. Diamond drilling and underground exploration have outlined indicated and inferred resources of 1.85Mt grading 7.71% Zn, 1.04% Pb, 0.12% Cd and 39.6g/t Ag. The Garrycam barite deposit is less than 1km distant and is genetically related to the Keel mineralization. The stratiform barite (with some sphalerite) is hosted in basal Waulsortian (Lower Carboniferous) micrite. The deposit contains 1.35Mt grading 2.67% Zn, 0.18% Pb and 36.14% BaSO_4 . The structural and stratigraphic settings of the Garrycam/Keel deposits are analogous to the Ballynoe/Silvermines deposits.

- **Kilbreckan (Calcite)**

A high-purity calcite deposit at Kilbreckan occurs in Lower Carboniferous limestones. The deposit contains a measured resource of 900,000t averaging in excess of 99.0% CaCO_3 .

- **Kildare (Au)**

The discovery in 1993 of visible gold in quartz float in Co. Kildare, southwest of Dublin, made this region of Lower Palaeozoic greywackes a new target area.



Native gold with vein quartz in float material from Co. Kildare.

- **Kilgeever (Au)**

At Kilgeever gold is found in quartz veins in Silurian quartzites. A 0.5t bulk sample assayed 6.7g/t Au and sub-economic grades have been encountered by drilling to the east and west. The prospect is along strike to the west from the Lecanvey deposit.

- **Kilmacoo (Au)**

At the northeastern end of the Ordovician volcanogenic massive sulphide deposit of Avoca, gold is found in a succession of tuffs, felsites and pelites. Although no resource estimate has been published, twenty drillholes indicated the presence of 300,000 - 500,000t at 1.5-2g/t Au over a strike length of 125m. The limits of the mineralized zone have not been defined along strike or at depth.

- **Kilroot, Northern Ireland (Salt)**

Bedded salt was been worked in the area of Kilroot, Northern Ireland, for more than a hundred years. Prior to 1958 the salt was worked by brine pumping. In 1965 Irish Salt Mining and Exploration Co. Ltd. commenced underground dry mining of the five distinct beds of Triassic salt. The beds vary in thickness from 6m to 20m with significant lateral variation in thickness of all beds. The rock salt is processed on site and is used for winter road maintenance in the UK, Ireland and the USA. Production depends upon demand but averages 400,000tpa. Considerable reserves are believed to exist.

- **Kingscourt (Gypsum)**

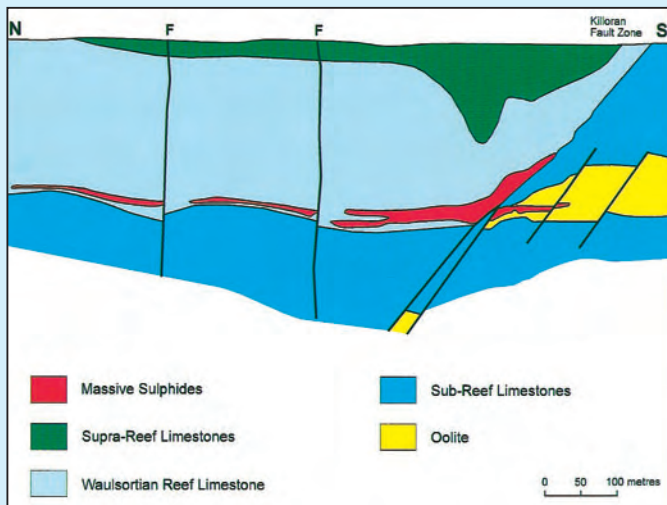
Mining of gypsum has been carried out continuously at Kingscourt since 1936. The gypsum occurs in a Permian mudstone sequence and has been mined both underground and in open-pits. Production to date exceeds 12Mt, with the

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greater part having been mined in the past 25 years. Current production is in the order of 500,000tpa. The gypsum is used locally to manufacture plasterboard. In 2004, Irish Gypsum received planning approval for the development of an underground mine at Drummond, adjacent to their current opencast operation.

- **Lecanvey (Au)**

Since the discovery of gold in south Co. Mayo by Tara Prospecting Ltd. in 1984, the area has been intensively explored for gold. Surface exploration during 1987 to 1989 by Burmin Exploration/Tara Prospecting confirmed the presence of significant gold mineralization in quartz veins in Silurian quartzites at Lecanvey. A geological reserve of 498,000t grading at least 9.94g/t Au has been outlined by drilling. The Lecanvey deposit occurs on the flank of Croagh Patrick mountain. Given the religious and cultural significance of Croagh Patrick, in May 1990 the Minister for Energy decided not to renew the Prospecting Licence over the area of the Lecanvey deposit. Adjacent areas with gold mineralization similar to that at Lecanvey are available for application.



Diagrammatic cross section through the Lisheen Zn-Pb deposit (Main Zone).

- **Lisheen (Zn, Pb)**

The Lisheen Zn-Pb deposit occurs mainly in dolomitized Waulsortian (Lower Carboniferous) limestones, with subordinate mineralization found in an underlying oolite member. Although the deposit is stratiform, textural evidence shows the sulphides in the Waulsortian to be

replacive, the sulphides being hosted in a hydrothermal black matrix breccia. The primary controls on the distribution of the three zones of sulphide mineralization are two NE faults at the southern edge of the orebody. The initial mineable reserve was 18.94Mt at 12.75% Zn and 2.2% Pb. This is expected to support a mine life of 14 years. Mining commenced in late 1999 and, at full production, delivers 300,000tpa of zinc concentrates and 40,000tpa of lead concentrates. The mine is owned 100% by Anglo American PLC.

- **Mallow (Cu, Ag)**

The Mallow Cu-Ag deposit is hosted in a Devonian/Carboniferous sandstone-shale sequence. A cross-cutting, near-vertical, 40m wide, 120m deep zone of vein-hosted and disseminated bornite and chalcopyrite occupies the central portion of a local monocline and accounts for 80% of the deposit. A shallow-dipping stratabound zone, which also contains tennantite and is up to 10m thick, intersects the base of the vertical zone. The deposit is estimated to contain 3.6Mt grading 0.7% Cu and 27.5g/t Ag of which the silver-rich stratabound zone contains 0.6Mt grading 150g/t Ag and 0.6% Cu.

- **Moyvoughly (Zn, Pb)**

At Moyvoughly both stratiform and cross-cutting Zn-Pb mineralization are hosted in shallow-water carbonates, the stratigraphic equivalent of the host to the major Navan Zn-Pb deposit. A small deposit of 125,000t grading 8% Zn + Pb was outlined.

- **Murvey (Mo)**

At Murvey a small molybdenum deposit is contained within the Carna Dome granodiorite, the westernmost expression of the composite Galway Granite (c. 400 Ma). Molybdenite occurs in early quartz veins and appears to be concentrated in a 500m long zone adjacent and parallel to the granodiorite margin. Drilling has established the presence of a small, low-grade, near-surface deposit containing 240,000t at 0.13% Mo.

NAVAN AND THE ENVIRONMENT

The underground Zn-Pb mine at Navan is located adjacent to the historic rural town of Navan in Co. Meath. The mine is located in some of the highest quality agricultural land in the country and adjacent to an important salmon fishing river, the Blackwater. From the beginning Tara Mines paid great attention to the environment; indeed Tara carried out an Environmental Impact Assessment at Navan 15 years before such a study became mandatory. The mine has won a number of environmental awards, both nationally and internationally.

- **Navan (Zn, Pb)**

The Navan deposit is hosted in basal Carboniferous shallow-water carbonates. The deposit comprises a stacked series of stratiform and stratabound sulphide lenses aligned approx. NE and parallel with major faulting. This world-class orebody was discovered in 1970, and initial reserves were 69.9Mt at 10.01% Zn and 2.6% Pb. Underground mining commenced in 1977. In recent years near-mine exploration has defined further resources southwest and northeast of the main orebody, which will result in an extended mine life. A small Zn-Pb deposit at Clogherboy is



Open-pit at Kingscourt gypsum mine. Evidence of earlier underground workings can be seen in lower centre. (Courtesy: Gypsum Industries Plc).

a satellite to the Navan orebody. Stratiform sulphide mineralization occurs at the same level as at Navan. The deposit contains 0.3Mt at 7.0% Zn + Pb.



Rehabilitated area of the Tailings Management Facility at Navan, Co. Meath. (Courtesy : Tara Mines Ltd.).



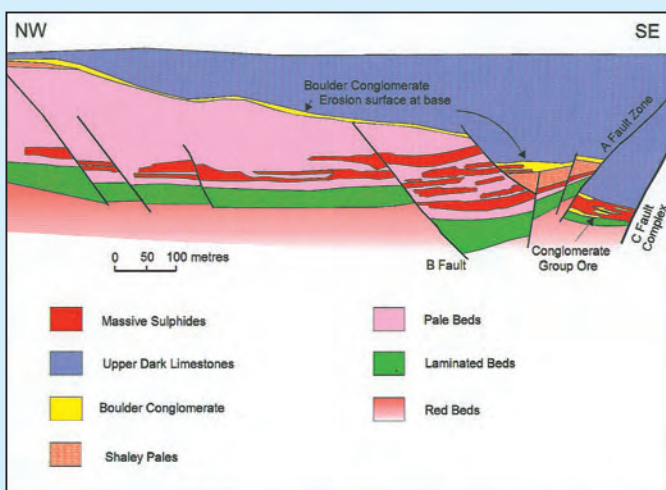
Preparing for a blast at the underground Navan Zn-Pb deposit. (Courtesy : Tara Mines Ltd.).

NAVAN

Discovered in 1970, the Navan deposit is the largest zinc mine in Europe and one of the largest in the world. Initial reserves were 69.9Mt at 10.1% Zn and 2.6% Pb. Mining commenced in 1977 and reserves are sufficient to sustain mining until at least 2010.

- **Newtown Cashel (Zn, Pb)**

The Newtown Cashel Zn-Pb prospect is hosted in basal Carboniferous shallow-water carbonates which have been correlated with part of the main mineralized unit at Navan. However, the sulphide mineralization is clearly related to faulting. Best intersections to date are in the order of one metre grading 6.3% Zn + Pb.



Diagrammatic NW-SE cross-section through the central part of the Navan Zn-Pb deposit.

- **Oldcastle (Zn, Pb)**

The Oldcastle Zn-Pb deposit is hosted in basal Carboniferous shallow-water carbonates. Although the mineralization is clearly related to a NE fault, the fracture-fill sulphides are mainly contained within a micrite unit. Limited drilling has indicated the possibility of a small deposit of between 1 and 3Mt grading 4.5% Zn and 0.7% Pb.

- **Portroe (Slate)**

At Portroe, Co. Tipperary, a deposit of grey-green slate occurs in a Silurian inlier. Reserves are estimated to be at least a half a million tonnes. Recent test production yielded heavy grade slates up to 20" (50cm) in length, of random widths. The slate is suitable for roofing, flooring, walling and paving.

- **Sandy Braes, Northern Ireland (Perlite)**

Perlite, a porphyritic obsidian, occurs in a Tertiary volcanic vent at Sandy Braes, Co. Antrim. Expanded perlite is used in lightweight construction materials (e.g. insulation), in filtration systems and in agriculture. Reserves are estimated at 1 - 1.5Mt. Antrim Perlite Ltd. have sought planning permission to develop the deposit.

SILVERMINES

Discovered in 1963, the Silvermines Zn-Pb deposit (17.7 Mt) in its time supported the largest underground zinc mine in Europe.

- **Silvermines (Zn, Pb)**

Two distinct but related zones of Zn-Pb mineralization are found at Silvermines. The upper sedex stratiform orebody occurs at the base of a Waulsortian (Lower Carboniferous) micrite mudbank. The underlying lower orebody is epigenetic and is hosted in basal Carboniferous dolomites, Devonian clastics and Lower Palaeozoic slates. The deposit is spatially and genetically related to the major E-W Silvermines Fault Zone, but more particularly to a system of WNW faulting within the Fault Zone. The Silvermines orebodies together contained 17.7Mt grading 6.43% Zn, 2.53% Pb and 23g/t Ag. Production between 1968 and 1982, when the mine closed, amounted to 10.7Mt at 7.36% Zn, 2.70% Pb. There remains an open-pittable resource of 1Mt grading 8.93% Zn, 1.86% Pb and an additional underground resource of 0.5Mt at 6.17% Zn and 1.60% Pb.

The "Top 55" Deposits

- **Tatestown (Zn, Pb)**

The Tatestown Zn-Pb deposit is hosted within Lower Carboniferous shallow-water carbonates. Sulphides are generally stratiform and thicken in the immediate hangingwall of a northerly dipping E-W normal fault which transects the orebody. The mineralization is diagenetic and the deposit is regarded as a satellite to the major Navan orebody which is 3km to the southeast. The deposit contains 3.6Mt grading 6.9% Zn + Pb.

- **Tomduff (Andalusite)**

Navan Resources discovered a significant andalusite prospect at Tomduff, Co. Carlow. Andalusite schists occur in a zone 200 - 300m in width and up to 5km long. Mineral processing studies demonstrated that 98% of the recoverable andalusite is within market specifications in terms of crystal size and alumina content.

TYNAGH

The Tynagh polymetallic deposit holds a special position in Ireland's recent mining history. Discovered in 1961 by a group of Irishmen who had cut their teeth in the Canadian mining industry, the Tynagh deposit was the first major stratabound carbonate-hosted deposit discovered in Ireland. The deposit is also remarkable in an Irish context in that it yielded significant economic amounts of lead, zinc, copper, silver and barite.

- **Tynagh (Pb, Zn, Cu, Ag, Barite)**

The Tynagh Pb-Zn-Cu-Ag-barite deposit, the first-discovered of Ireland's major carbonate-hosted base metal deposits (1961), comprises three separate zones. All of the mineralization is hosted within Waulsortian (Lower Carboniferous) micrite mudbank facies in the hangingwall of an E-W normal fault. There were two primary (sulphide) zones and a residual (oxide) zone. Total reserves were in the order of 11.8Mt grading 4.76% Pb, 4.27% Zn, 0.6% Cu and 70g/t Ag. The mine was in operation from 1965 to 1980, initially open-pit and then underground. Approximately 400,000t of sand-grade barite was recovered from the tailings in a secondary operation.



Mining the last of the secondary (oxide) ore at the Tynagh Pb-Zn-Cu-Ag open-pit.

- **Westport (Talc)**

The Westport talc-magnesite deposit occurs within a Pre-Cambrian serpentinite belt and has resulted from metasomatic alteration of the host lithology. Drilling and trenching has outlined an estimated 2Mt of 50% talc and 33% magnesite.



Exposure of talc-magnesite at Westport, Co. Mayo.

“Top 55” Commodity List

Base Metal Deposits

Abbeytown	(Zn, Pb)
Aclare	(Li)
Aherlow	(Cu, Ag)
Allihies	(Cu)
Avoca	(Cu)
Ballinalack	(Zn, Pb)
Ballyvergin	(Cu)
Bunmahon	(Cu)
Carrickittle	(Zn, Pb)
Charlestown	(Cu)
Courtbrown	(Zn, Pb)
Derrykearn	(Zn, Pb)
Duncormick	(Zn, Pb)
Galmoy	(Zn, Pb)
Gortdrum	(Cu, Ag, Hg)
Harberton Bridge	(Zn, Pb)
Inishannon	(Zn, Pb)
Keel	(Zn, Pb, Barite)
Lisheen	(Zn, Pb)
Mallow	(Cu, Ag)
Moyvoughly	(Zn, Pb)
Murvey	(Mo)
Navan	(Zn, Pb)
Newtown Cashel	(Zn, Pb)
Oldcastle	(Zn, Pb)
Silvermines	(Zn, Pb)
Tatestown	(Zn, Pb)
Tynagh	(Pb, Zn, Cu, Ag, Barite)

Gold Deposits

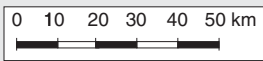
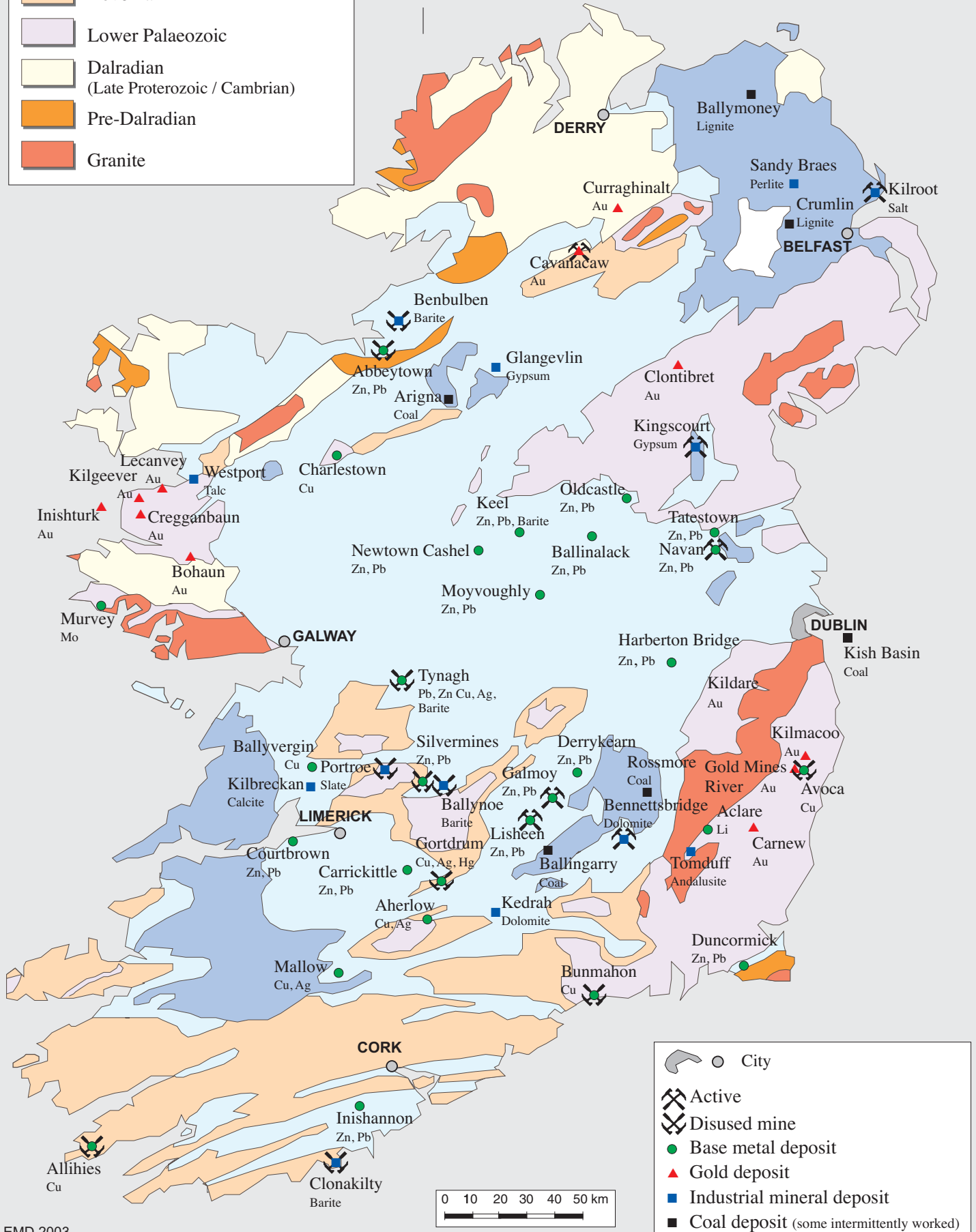
Bohaun
Carnew
Cavanacaw, N. Ireland
Clontibret
Cregganbaun
Curraghinalt, N. Ireland
Gold Mines River
Inishturk
Kildare
Kilgeever
Kilmacoo
Lecanvey

Industrial Minerals (Incl. Lignite)

Ballymoney, N. Ireland	(Lignite)
Ballynoe	(Barite)
Benbulbin	(Barite)
Bennettsbridge	(Dolomite)
Clonakilty	(Barite)
Crumlin, N. Ireland	(Lignite)
Glangevlin	(Gypsum)
Kedrah	(Dolomite)
Kilbreckan	(Calcite)
Kilroot, N. Ireland	(Salt)
Kingscourt	(Gypsum)
Portroe	(Slate)
Sandy Braes, N. Ireland	(Perlite)
Tomduff	(Andalusite)
Westport	(Talc)

Generalized Geology of Ireland showing "Top 55" Mineral Deposits

- Upper Carboniferous & Younger
- Lower & Middle Carboniferous
- Devonian
- Lower Palaeozoic
- Dalradian (Late Proterozoic / Cambrian)
- Pre-Dalradian
- Granite



- City
- Active
- Disused mine
- Base metal deposit
- Gold deposit
- Industrial mineral deposit
- Coal deposit (some intermittently worked)

Data Availability

A substantial amount of information is available from two Divisions, both within the Department of Communications, Marine and Natural Resources.

- **Exploration and Mining Division**

The Exploration and Mining Division (EMD) deals with minerals policy, the administration of the State mining and prospecting system and minerals promotion. The Division comprises both administrative and technical staff, and is a key reference point with a full support service on all regulatory matters, including:

- Legislative provisions
- Reference information on the geographical areas of all prospecting licences
- A quarterly publication on current ground holdings, or directly on an informal basis
- A contact for companies new to Ireland, or those interested in joint venture arrangements
- General reviews on various aspects of exploration and mining in Ireland
- Information on consultants and contractors based in Ireland
- Information on environmentally sensitive areas
- Exploration company reports released since 1 January 2000, in digital format
- Release of airborne geophysical surveys submitted by exploration companies

- **Geological Survey of Ireland**

The Geological Survey of Ireland (GSI) is a line Division of the Department of Communications, Marine and Natural Resources, whose mandate is the provision of

earth science information and advice. Relevant data sources include:

- Paper geological maps at various scales. 1:100,000 scale maps with selected mineral localities described in associated reports. 1:25,000 and 1:10,560 scale *ms* maps with outcrop data. Smaller-scale mineral deposit and metallogenic maps of Ireland.
- Digital maps. Seamless geological map, based on 1:100,000 scale paper maps. All outcrops on 1:10,560 scale *ms* maps have been digitised.
- Mineral Exploration Open File. Assessment reports submitted by exploration companies under the terms of their Prospecting Licences and released upon surrender of the licence or six years after lodgement, whichever is the sooner.
- Mine Records. Drawings, plans and documents on historic and recent mines.
- Mineral Localities Database. Summary information for over 5,500 known mineral localities.
- Regional Geochemical Database. Multielement data in both map and digital formats for selected areas.
- Publications on selected mineral commodities in Ireland, and mineral locality data compilations.
- Drillcore. 180,000m of drill core is available for inspection in a modern core storage facility.
- Aeromagnetic data. 49,000 line km at a 1-2 km line spacing of regional aeromagnetic data (1979-1981), covering the central two-thirds of the country. Data is also available from two localised heliborne surveys (magnetic, frequency EM, radiometric).

Further Information

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