EXPLORATION FOCUS

GEOLOGICAL SURVEY OF IRELAND MINERAL RESOURCES DIVISION EXPLORATION SECTION

Compiled by J.R. Creighton

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This is one in a series of pamphlets which summarize exploration work carried out on selected prospecting licence areas (PLs). It may be referred to as follows:

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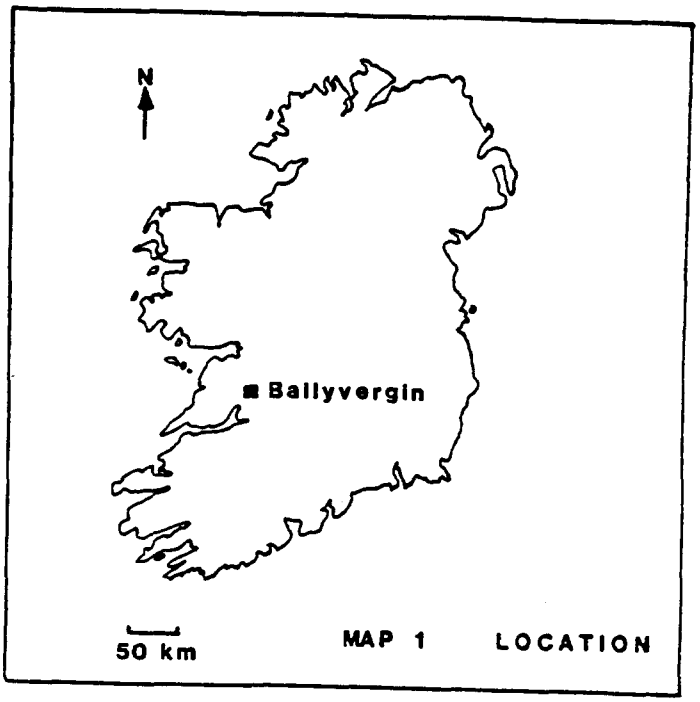
BALLYVERGIN

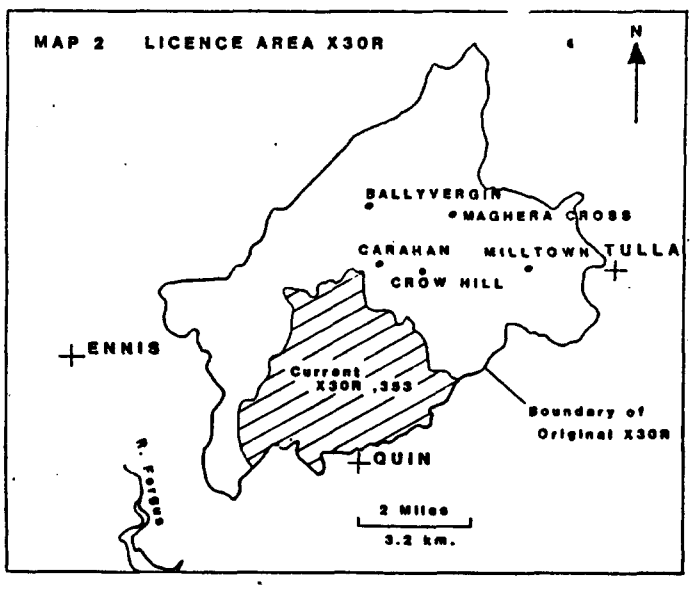
Ballyvergin - PL X30R



INTRODUCTION

The original PL X30 covered an area of some 80 km^2 to the east of Ennis, Co. Clare (Map 1). Within the area of X30 are located the sites of several nineteenth century mining operations for copper and lead, including Ballyvergin, Carahan, Crow Hill and Milltown. Mineralization at Ballyvergin occurred as a calcite/sulphide vein in crinoidal calcarenites and black shales in the Lower Carboniferous. Production records show 275 long tons of 8% Cu in 1856 (Hallof et. al 1962). In the early 1960s a disseminated sulphide deposit was identified at Ballyvergin from an IP anomaly and subsequent drilling. The Lower Carboniferous stratigraphy of Somerville and Jones (1985) has been adopted for the purposes of this pamphlet. This has been correlated with the stratigraphy used by Irish Base Metals (IBM) in their exploration programmes in the 1960s (Schultz 1963) (Table 1.) The thickness of the overburden - mainly glacial till deposited by an ice-sheet moving southwest across East Clare - is highly variable, the maximum known thickness from boreholes being 83 ft (25.3 m) while the average thickness is 15.7 ft. (4.8 m).

PL	County	6" Sheets
X30R	Clare	26, 27, 34, 35, 42.



PREVIOUS LICENCEES/OPERATORS

PL X30 was originally issued to IBM in August, 1960. The small licence area 353 within X30 was also issued to IBM in 1964. X30 was subsequently revised as X30R. In 1985 the licence was assigned from IBM to Westland, and in 1986 Westland entered into a joint venture agreement with Buckley Mining who became the operators of X30R and 353. A further substantial revision of X30R occurred in 1987 reducing the area to approximately 20 km^2 as compared with the original 80 km^2 (Map 2). The exploration data summarized here is for the surrendered part of the original X30 only, and does not include data within the current X30R (and 353).

GEOLOGICAL SETTING

The geological map (Map 3) has been prepared from exploration data submitted by IBM and from the work of the Geological Survey. X30R is underlain mainly by rocks of Lower Carboniferous age. These lie conformably on the 'Old Red Sandstone' facies which outcrops in the north of the licence area. The four formations above the Old Red Sandstone and below the Ballysteen Limestone Formation have been grouped as the Lower Limestone Shale (LLS) for the purposes of Map 3.

The Old Red Sandstone is directly overlain by some 30 m of the Mellon House Formation, composed of dark grey and green calcareous shales and siltstones, with minor sandstones and limestones. (The lithologies of the Mellon House Formation were referred to as the 'Mixed Rock' unit in borehole sections.) The Formation becomes more shaly towards the top, and there is a marked laminated shale facies at the junction with the overlying Ringmoylan Shale Formation. The Ringmoylan Shale Formation is some 20-30 m thick and comprises dark grey to black calcareous shales with thin beds of limestone. The third formation above the Old Red Sandstone is the Ballyvergin Shale Formation (or M1 shale in borehole logs), an important regional marker throughout the Limerick Province (Philcox, 1984). It is a grey-green non-calcareous shale, and in borehole logs ranges in thickness from 1.5 to 8.1 m, being 5.2m thick on average. Overlying this is the Ballymartin Limestone Formation (Somerville and Jones

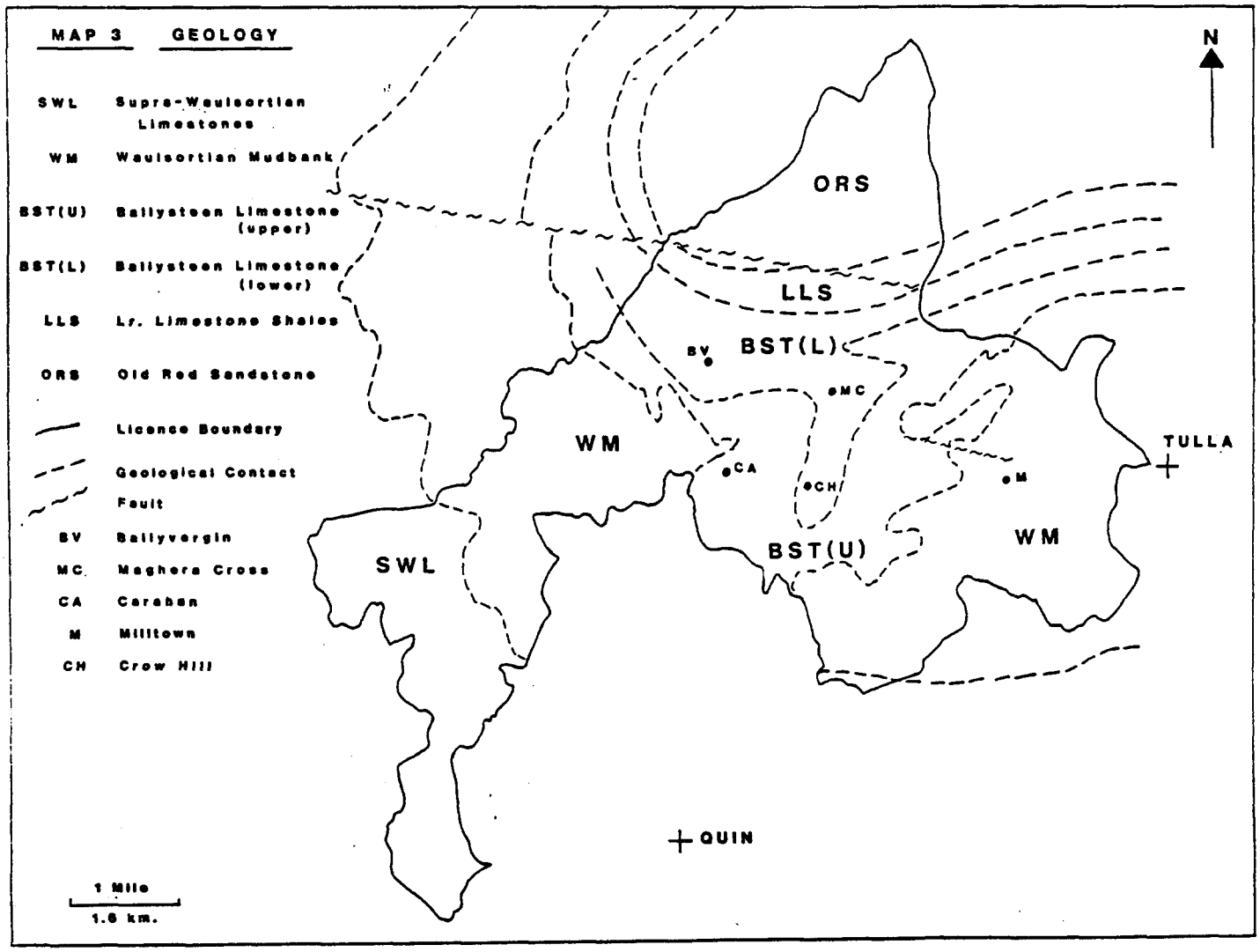
1985), which can be correlated with the upper L1 Limestone and Shale unit in the IBM stratigraphy (Table 1). The Ballymartin Limestone Formation consists of 30 m of dark calcareous shales interbedded with thin argillaceous bioclastic limestones.

The overlying Ballysteen Limestone Formation is informally divided into two units by Somerville and Jones (1985). The lower unit (L2 equivalent), some 70 m thick in East Clare, is a relatively clean bioclastic limestone with a rich fauna including crinoids, brachiopods and gastropods. The upper unit is 40-50 m thick and has a much higher shale content. Much of the upper unit can be correlated with the L3 or Muddy Limestone, as described in IBM boreholes logs. The uppermost part of the Ballysteen Limestone is rich in chert and forms the transition (L4 equivalent) to the Waulsortian Mudbank Limestone. This cherty limestone is some 20 m thick and is seen only in boreholes at Carahan (Map 3). The Waulsortian Mudbank Limestone ('Reef') is typically a pale grey to grey stromatactid, massive micrite with a thickness in East Clare of 300-450 m (Andrew 1986) in East Clare. The top of the 'Reef' may be dolomitized. The supra-Waulsortian limestones conformably overlie the 'Reef' and outcrop in the southwest of the licence area only.

The major structural feature in the region is the south-westerly - plunging East Clare Syncline between the Lower Palaeozoic inliers of the Slieve Aughty hills to the north and Slieve Bernagh hills to the southeast. The Syncline, the axis of which lies just to the south of X30R, is broadly asymmetrical, with shallower dips on the northern limb. The beds have been substantially affected by faulting and folding both on a regional and local scale. The mapped Ballysteen/Waulsortian Limestone contact bulges southwards contrary to the regional east-west trend; this may reflect a tectonic warp, resulting in a NNW-SSE elongated dome to the south of Crow Hill. Later minor folding, particularly in the less competent shaly limestones, has resulted in a number of small domes and anticlines (Schultz 1963). A major fault, the Derrynalane Fault, trending WNW-ESE, is inferred near the contact with the Old Red Sandstone. Other faults, trending approximately north-south, cut the minor folds and domal structures.

Somerville and Jones 1985	Schultz 1963
Waulsortian Limestone Formation	Reef Limestones (Waulsortian)
Ballysteen Limestone Fm.	L4 Cherty Limestone
	L3 Limestone and shale "Muddy Limestone"
	L2 Limestone, mostly crinoidal with minor shale "Bioclastic Limestone"
Ballymartin Limestone Formation	L1 Limestone and Shale (upper)
Ballyvergin Mudstone Formation	Ballyvergin Shale
Ringmoylan Shale Formation	L1 Limestone and Shale (lower)
Mellon House Formation	Lower Shales and Sandstones
Old Red Sandstone Facies	Old Red Sandstone

Table 1. Stratigraphy of East Clare. A Correlation of the stratigraphy of Somerville and Jones (1985) with the IBM stratigraphy (Schultz 1963).



EXPLORATION HISTORY

Beginning in 1960 IBM carried out extensive exploration work on PL X30, one of a group of licences which that company held in the East Clare region. The licence area has been the subject of extensive reconnaissance and detailed soil and stream sediment sampling. Over sixty boreholes have been drilled in that part of the original X30 under review here.

The initial work was focused on the old mines and the areas between them. IP anomalies were identified at the Ballyvergin mine, which indicated an extension to known mineralization in the area east of the mine, and at Maghera Cross. In 1960-62 these anomalies were drilled. At Ballyvergin twenty-three boreholes were drilled (BV1-23) with a further hole, BV24 drilled in 1980 (Clayton et. al 1980). A mineralized zone was identified in the central part of a periclinal fold which has been subjected to extensive north-south faulting. The mineralization occurs as disseminated and fracture-filled sulphides (mainly chalcopyrite) in thickened beds of the Ringmoylan Shale Formation directly below the Ballyvergin Shale. The deposit at Ballyvergin has been variously estimated at 150,000 tonnes at 1.2% Cu and 15 g/t up to 233,000 tonnes at 0.97% Cu and 15g/t Ag (Andrew 1986). (A summary of assay results is given in Table 3.) A detailed account of the mineralization at Ballyvergin is given in Andrew (1986).

In the eight holes drilled at Maghera Cross (M1-8) chalcopyrite and pyrite were encountered. Five holes (CA1-5) were drilled at the Carahan mine which is located on the southern limb of a SW-NE syncline near the Ballysteen/Waulsortian 'Reef' Limestone contact. Only minor mineralization (mainly galena) was intersected. From this first phase of exploration activity it was concluded that, although mineralization was widespread in the licence, in the absence of well-developed fracture zones, the

TABLE 2 SUMMARY OF DIAMOND DRILLING IN X30R
The depth to the base of each unit is given in feet

Hole No.	OB	SWL	WM	Trans	BST(U)	BST(L)	BM	BV	RS	MH	ORS	EOH	Comments
BV1	10.0					172.0	271.6	289.4	348.0	395.0	B	440.0	MZ 297.3-328.5
BV2	8.6					124.0	216.1	235.3	299.5	348.4	B	370.8	MZ 235.3-293.0/329.0-342.5
BV3	5.0					B						58.5	
BV4	26.9						119.2	142.5	213.8	255.8	B	268.6	MZ 142.5-205.8/237.3-244.7
BV5	25.0						101.2	121.6	220.5	B		257.0	MZ 121.6-201.0
BV6	5.8					B						41.5	
BV7	7.2					147.0	238.5	254.5	307.5	339.5	B	366.5	MZ 120.7-128.7 (No MZ below BV)
BV8	18.8					B						138.5	MZ 26.8-48.5 (No MZ below BV)
BV9	13.9					B						122.2	
BV10	7.6						105.0	255.4	275.0	300.9	B	329.6	MZ 255.4-275.0
BV11	52.2						117.0	138.1	B			299.0	MZ 138.1-273.0
BV12	31.3						100.2	114.4	220.0	B		246.9	MZ 114.4-200.0
BV13	50.0						143.3	166.1	256.2	B		287.6	MZ 166.1-215.0
BV14	20.0					27.0	197.3	217.6	302.5	350.0	B	456.6	See Clayton et al (1980)
BV15	15.0					87.0	209.8	228.6	315.2	377.0	B	430.3	MZ 228.6-301.8 No ore grades
BV16	18.0								B			320.3	
BV17	25.0					35.0	B					212.0	
BV18	10.0						153.5	171.5	274.0	B		327.0	
BV19	46.6						195.2	213.9	290.4	B		297.5	
BV20	60.0						176.6	198.6	301.0	B		321.1	
BV21	26.0						150.5	172.7	272.7	B		307.6	
BV22	9.2						215.7	235.7	B			296.5	
BV23	12.0						226.4	255.5	387.6	B		396.5	
BV24	7.0					199.0	303.0	319.0	355.5	B		385.0	(1980)
CA1	11.7	argillaceous cherty limestones and shales to 156ft. Argillaceous limestones and shale to 246.2											Stratigraphy not identified
CA2	10.3	argillaceous cherty limestones and shales to 171ft. Argillaceous limestones and shale to 301.0											Stratigraphy not identified
CA3	8.0			34.0	135.0							202.0	
CA4	-			63	B							101.0	
CA5	11.0			53.5	202.0	B						417.0	
CA6	4.0		71.0	91.0	B							110.0	(1981)
CA7	8.0		72.0	136.0	B							173.0	(1981)
M1	5.0					79.0	187.0	200.0	279.5	B		390.0	
M2	10.0						123.0	141.0	227.5	B		289.0	
M3	8.0						106.0	126.0	205.0	B		269.0	
M4	4.0					27.0	134.0	148.5	227.0	B		243.0	
M5	-					73.0	197.5	211.0	287.5	B		306.0	
M6	1.0					28.0	141.3	161.0	245.0	B		254.0	
M7	8.0					60.0	185.6	205.2	286.6	B		306.0	
M8	6.0					108.0	218.0	233.2	327.5	B		366.0	
014-1	5.0		231.0	245.0	B							407.0	
014-2	1.0		93.0	NI	315.0	B						533.0	
014-3	2.0					130.0	245.5	254.0	340.0	B		379.0	
014-4	1.0					76.0	174.0	182.0	250.0	270.0	B	294.0	
014-5	4.0				69.0	284.0	334.0	351.0	B			367.0	
014-9	24.0				215.0	455.0	555.0	573.5	B			586.0	
014-10	2.0		254.0	NI	B							373.0	
014-11	9.6						88.0	108.0	B			182.0	
014-12	11.0						57.0	B				66.8	
014-13	-				53.0	235.0	345.0	366.5	B			420.0	
014-17	0.5		312.0		B							392.0	
014-18	2.0				46.0	197.0	278.5	305.0	B			330.0	
014-19	16.0		70.0		B							201.0	
014-20	48.0	174.0	256.0	276.0	380.0	B						510.0	
014-21	23.0					32.0	149.0	170.0	222.0	277.0	B	283.0	
014-22	45.0					50.5	162.5	172.0	B			205.0	
014-23	40.0					129.0	224.0	236.0	B			256.0	
014-24	20.0					126.5	163.0	179.5	B			215.0	
014-26	83.0				144.0	332.5	B					378.0	
014-27	5.0					305.0	401.0	416.7	B			447.0	
014-29	3.0					63.5	167.2	187.5				356.0	
014-30	22.0					25.0	54.0	65.0	148.0	B		183.0	
014-31	4.0					79.0	147.0	B				164.0	
NG1	20.0				60.0	B						202.0	
NG2	8.0					360.0			B			390.5	

Abbreviations: OB = Overburden; SWL = Supra-Waulsortian Limestones; WM = Waulsortian Mudbank; Trans = Transition unit between Waulsortian Mudbank and Ballysteen Limestones; BST(U) = Ballysteen Limestone (upper shaly unit); BST(L) = Ballysteen Limestone (lower bioclastic unit); BM = Ballymartin Limestone; BV = Ballyvergin Shale; RS = Ringmoylan Shale; MH = Mellon House Beds; ORS = Old Red Sandstone; EOH = End of Hole; NI = Not intersected, B = Unit in which the hole has been terminated; MZ = Mineralized Zone.

likelihood of large sulphide deposits being located near surface was very small.

The next phase of activity, beginning around 1966, centred on a more detailed examination of the mineralized zone from west of Ballyvergin to east of Maghera Cross, with particular emphasis on the search for structural traps. This included more detailed IP and soil geochemistry surveys around Tyredagh, Newgrove and Kiltanon. Between 1966 and 1969 some twenty-three boreholes (in the DIA programme - see Table 2) were drilled. These were located mostly in the northern part of X30R in the Waulsortian

TABLE 3. SUMMARY OF DRILL HOLE ASSAYS

Hole No.	Depth (ft)	Interval (ft)	Cu(%)	Pb(%)	Zn(%)	Ag(oz/t)
BV1	310.0-313.8	3.8	0.46	0.11	-	-
	313.8-316.2	2.4	0.20	0.11	-	-
	316.2-319.7	3.5	0.33	0.16	-	-
	322.3-328.2	5.9	0.21	0.08	-	-
BV2	237.2-241.1	3.8	1.34	-	-	-
	241.1-247.9	6.8	1.98	-	-	1.08
	247.9-256.9	9.0	1.48	-	-	-
	314.3-315.0	0.7	-	5.00	-	0.44
	330.3-336.3	6.0	1.48	-	-	-
BV4	169.0-178.0	9.0	1.12	-	-	-
	178.0-184.0	6.0	1.02	-	-	-
	184.0-189.0	5.0	1.14	-	-	-
	189.0-195.9	6.9	1.29	-	-	-
	239.3-244.7	5.4	1.82	-	-	-
BV5	121.6-129.6	8.0	1.40	-	-	0.50
	129.6-138.6	9.0	1.18	-	-	-
	138.6-147.6	9.0	0.60	-	-	-
BV7	120.7-128.7	8.0	2.10	-	-	0.40
BV8	26.8- 30.3	3.5	0.23	15.25	-	3.90
	30.3- 33.1	2.8	0.53	3.50	-	-
	33.1- 40.8	7.7	0.15	0.57	-	-
	40.8- 45.8	5.0	0.38	-	-	-
	45.8- 48.8	3.0	4.65	2.45	-	2.95
BV10	255.4-265.4	10.0	0.75	0.10	-	-
	265.4-273.4	8.0	0.71	0.10	-	-
BV11	169.5-179.5	10.0	0.50	-	-	-
	179.5-189.5	10.0	1.20	-	-	-
	189.5-199.0	9.5	0.60	-	-	-
	199.0-204.0	5.0	0.70	-	-	-
	204.0-208.0	4.0	2.85	4.70	-	2.00
	208.0-219.0	11.0	0.60	-	-	-
	219.0-232.5	13.5	0.85	-	-	-
	232.5-239.5	7.0	1.05	-	-	-
	239.5-250.5	11.0	0.88	-	-	-
	250.5-261.5	11.0	1.58	-	-	-
	261.5-273.0	11.5	1.05	-	-	-
BV12	119.0-129.0	10.0	1.10	-	-	-
	129.0-139.0	10.0	0.70	-	-	-
CA3	43.4- 44.1	0.7	-	39.50	-	1.80
	61.0- 62.5	1.5	0.10	15.45	0.5	2.10
DIA-1	137.4-144.0	6.6	0.20	0.30	1.3	-
M2	133.0-138.0	5.0	0.2	All samples:		No Assays
	138.0-143.0	5.0	0.9	Traces only		
	143.0-148.0	5.0	0.8	found		
	148.0-153.0	5.0	1.4			
	153.0-158.0	5.0	1.5			
	158.0-163.0	5.0	1.2			
	163.0-168.0	5.0	1.3			
	168.0-173.0	5.0	1.3			
	173.0-178.0	5.0	1.0			
	178.0-183.0	5.0	1.3			
	183.0-188.0	5.0	0.9			
	188.0-193.0	5.0	0.9			
	193.0-198.0	5.0	1.1			
	198.0-203.0	5.0	0.3			
	203.0-208.0	5.0	1.1			
	208.0-213.0	5.0	0.7			
	213.0-218.0	5.0	1.0			
	218.0-221.0	3.0	1.4			
	224.5-228.0	3.5	1.1			
	228.0-233.0	5.0	0.7			
	233.0-238.0	5.0	0.1			

'Reef' and in the Ballysteen Limestones. In the mid-1970s further detailed soil sampling, IP work, deep augering and prospecting was done. This centred on the Newgrove (Crow Hill) area, where a Pb/Zn anomaly was found. This was subsequently drilled (Holes NG1; NG2), but no very significant mineralization was found. Further work in 1980-81 involved drilling at Carahan (CA6, CA7) to test the base of the 'Reef' Limestone. A small amount of pyrite was found in one of the holes (CA 7).

The activity on this licence over some 20 years provides a good example of the evolution of exploration techniques beginning with extensive soil and stream sediment sampling, of which much of the latter was found to be unsatisfactory on the terrain in question. With better data on the structural geology and improvements in instrumentation, more detailed surveys included, the use of deep overburden sampling, detailed geophysics and remote sensing from the mid-1970s onwards.

TARGETS

Although sulphide mineralization has been found at every level within the Lower Carboniferous stratigraphy, on the basis of significant intersections achieved to date the following lithostratigraphic levels appear to present favourable target horizons:

1. The shaly limestones (Ringmoylan Shale Formation) directly underlying the Ballyvergin Shale.
2. The cherty limestone (Reef Transition Beds) and the base of the Waulsortian Mudbank.
3. The top of the Waulsortian Mudbank, immediately below the cherty limestone which forms the basal facies of the "Calp" Limestone.

The mineralization is believed (Schultz 1963) to be due to the upward movement of hydrothermal fluids, and mineralized zones have developed where structural traps occurred e.g. the Ballyvergin Shale and the cherts associated with the Mudbank Limestones. Mineralization is also closely associated with fracture systems which facilitated the upward movement of fluids.

FURTHER INFORMATION

1. Open File Data on PL X30 at the Geological Survey of Ireland.
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