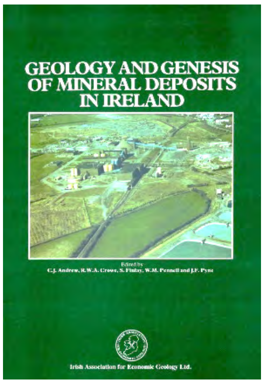

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Geology and genesis of the Courtbrown Pb-Zn-Ag deposit.

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Abstract

Courtbrown is situated 25km west of Limerick city in southwestern Ireland. Following reconnaissance soil geochemical and IP surveys in 1962, drilling intersected ore-grade lead-zinc mineralization. Further drilling was conducted between 1968 and 1974, after which the prospect was abandoned until 1980 when more drilling was undertaken.

The 1962 drilling programme indicated reserves of 250 000t at a grade of 6.5% Pb+Zn. Following the 1980 drilling the probable reserves were estimated as 1Mt grading 2.0% Pb, 3.5% Zn and 14g/t Ag.

The mineralization is hosted within pale grey micrite near the base of the Waulsortian Mudbank Reef Limestone. At the base of the Reef there is a thin green shale unit which underlies most of the mineralization. The mineralized zone lies on the flank of a monocline which is cut by several NNW — trending faults. Six textural styles of mineralization have been recognized, the most widespread being "semi-massive sulphides". Sulphides also occur along stylolites, in veins, as disseminations within the Reef and as veins within the underlying Ballysteen Limestone. The principal minerals are galena, sphalerite and pyrite, with minor amounts of tennantite and arsenopyrite. The main zone of mineralization is from 1 to 8m thick and extends 425m along strike and 100m down dip.

Introduction

The Courtbrown deposit is situated in NW County Limerick where the River Deel enters the Shannon Estuary (Fig. 1). The area around the deposit is flat-lying and the northern edge of the deposit is at the high water mark of the Shannon Estuary. Glacial overburden is very thin, (usually <1m thick), although exposures are mainly confined to the coastal section.

The area was originally explored by Consolidated Mogul in 1961 and 1962 when they carried out routine reconnaissance soil geochemistry (150m x 60m grid), detailed soil geochemistry (60m x 30m) and Induced Polarization (dipole — dipole) surveys. The main geochemical anomaly, which was in excess of 400ppm Zn, was drilled (11 holes) in 1962 (Fig. 2). Drilling was then abandoned due to the discovery of the major deposits at Silvermines by the company. Between 1962 and 1981 the deposit received scant attention in the literature, Schultz (1970), who briefly mentioned the prospect, being the exception. During this period further work (mainly the drilling of 60 holes) was carried out by Irish Base Metals and Dresser Minerals.

Stratigraphy

The stratigraphy of the area (Table 1), based on Shephard-Thorne (1964), is known in considerable detail from diamond-drilling. In ascending order the succession is as follows:

Old Red Sandstone (ORS): The uppermost beds of the ORS consist of fine-grained sandstones and laminated mudstones. These are generally more akin to the Kiltorcan Beds of Co. Kilkenny than to the typical ORS of N Munster. The typical ORS sequence, estimated to be approximately 1500m thick, is not seen in drilling.

Mellon House Beds: These conformably overlie the ORS and consist of flaser-bedded sandstones which are often bioturbated and exhibit loadcasts and sole structures. Towards the top, the unit becomes very variable with calcareous sandstones, shales, siltstones and thin argillaceous limestone beds.

Ringmoylan Shales: These can be subdivided into three sub-units; the lowermost sub-unit consists of carbonaceous shales with thin limestones and minor siltstones towards the base; the middle sub-unit consists of thicker-bedded (15-30cm) limestones separated by shale bands and partings which become more shaly towards the top. The uppermost sub-unit consists of thin-bedded limestones and shales, the general limestone texture being nodular with wispy shale bands and partings.

Ballyvergin Shale: This is a distinctive grey-green, non calcareous shale with thin silty bands.

Ballysteen Limestone: At Courtbrown the Ballysteen Limestone comprises a sequence of argillaceous bioclastic limestones with variable amounts of argillaceous and bioclastic material, and is sub-divided into the Lower, Middle and Upper members (see Table 1) as follows: The Muddy Bioclastic Limestone (37m) consists of medium-grey bioclastic limestone with a high shale content (50% at the base, decreasing to 20% near to the top).

The Bioclastic Limestone Unit is 25m thick; it consists of medium-grey bioclastic limestones within which crinoidal debris is ubiquitous and abraded brachiopod shells are also common; there is little shale. The overlying Shaly Bioclastic Limestone Unit averages 97m in thickness and consists of medium-grey bioclastic limestones interbedded with shale beds up to 30cm thick; the overall shale content is 15-20%.

The Muddy Limestone Unit is 55-73m thick and consists of bands of dark-grey argillaceous limestones (5-15cm) which are relatively free of fossil debris in the top 20m.

Table 1.
Stratigraphy of the Courtbrown area.

Stratigraphic Units and Thicknesses

Shephard-Thorne (1963)	Courtbrown (this paper): Major units	Courtbrown (this paper): Sub-units			Lithological description
Reef Limestone (>1000m)	Reef Limestone (>1000m)	Mudbank Reef			Pale grey stromatactid micrite, bioclastic.
		Transition Reef (0-10m)			Pale greenish-grey crinoidal micrite, thin green shale bands and partings.
Ballysteen Limestone (200m)	Ballysteen Limestone (250m)	Upper	Low Shale Muddy Lst. Nodular Muddy Lst. Muddy Lst.	(4-9m) (9-23m) (55-73m)	Med.-dark grey lst., nodular chert and black shale. Dark grey lst., nodular, black mudstones. Dark grey argillaceous lst., shale interbeds.
		Middle	Shaly Bioclastic Lst. Bioclastic Lst.	(97m) (25m)	Med. grey lst., crinoidal, thin shales. Med. grey lst., abundant crinoids, minor shale.
		Lower	Muddy Bioclastic Lst.	(37m)	Med. grey lst., shale interbeds, 50% at base, 20% at top.
Ballyvergin Shale (?)	Ballyvergin Shale (6m)	Ballyvergin Shale (6m)			Grey-green shale, silty bands.
Ringmoylan Shales (60m)	Ringmoylan Shales (32m)	Upper Ringmoylan			Nodular medium grey lst., wispy shale partings.
		Middle Ringmoylan			Dark grey limestones and shales.
		Lower Ringmoylan			Black thin-bedded carbonaceous lst. and shales.
Mellon House Beds (10m)	Mellon House Beds (10m)				Flaser-bedded bioturbated sandstones. Load casts common, calcareous upwards.
Old Red Sandstone (>100m)	Old Red Sandstone (>100m)				Fine-grained white and red to green sandstones and laminated mudstones at top. Reddish sandstones and conglomerates below. Base not seen.

These beds alternate with calcareous shales. Overall the shale content is between 30 and 60%. The Nodular Muddy Limestone Unit is 9 to 23m thick and gradationally overlies the Muddy Limestone. It consists of dark grey argillaceous limestone bands (2-7cm) generally displaying a nodular appearance, interbedded with calcareous mudstones (7-30cm). The argillaceous content varies from 40-70%. Occasional specks of pyrite occur in the mudstones. The Low Shale Muddy Limestone Unit is 4-9m thick and comprises medium to dark grey argillaceous limestone with dark grey to black chert nodules and thin black shale wisps (5-15%), and abundant crinoidal debris.

Reef Limestone: The Waulsortian Mudbank 'Reef' Limestone conformably overlies the Low Shale Muddy Limestone, although the contact is often gradational over a metre or so. The basal portion of the Reef sequence is colloquially termed Transition Reef which comprises pale grey micrite with thin grey-green shale partings which also impart a greenish tinge to the micrite. The thickness of this sub-unit varies from 0-10m. The Reef Limestone is typically a pale grey stromatactid micrite with a sparse but diverse fauna. Dolomitization is minor and usually occurs in the vicinity of the eastern edge of the deposit. Haematite staining is irregular and patchily developed.

Structure

Regionally the Courtbrown deposit lies on the southern flank of an ENE-trending anticline, cored by the Pallaskenry ORS inlier 8km to the east (Fig. 1). The western extension of the Silvermines-Gallows Hill Fault has been placed by some workers (e.g. Phillips et al., 1976) along the course of the Shannon Estuary to the north of Courtbrown. The area of the deposit is at the termination of a major NW aeromagnetic linear, attributed to Chadian and/or Asbian volcanism, running from the Pallas Grean volcanic centre and terminating SE of Courtbrown.

At Courtbrown there are a number of ENE-trending minor shallow amplitude folds, the most northerly of which

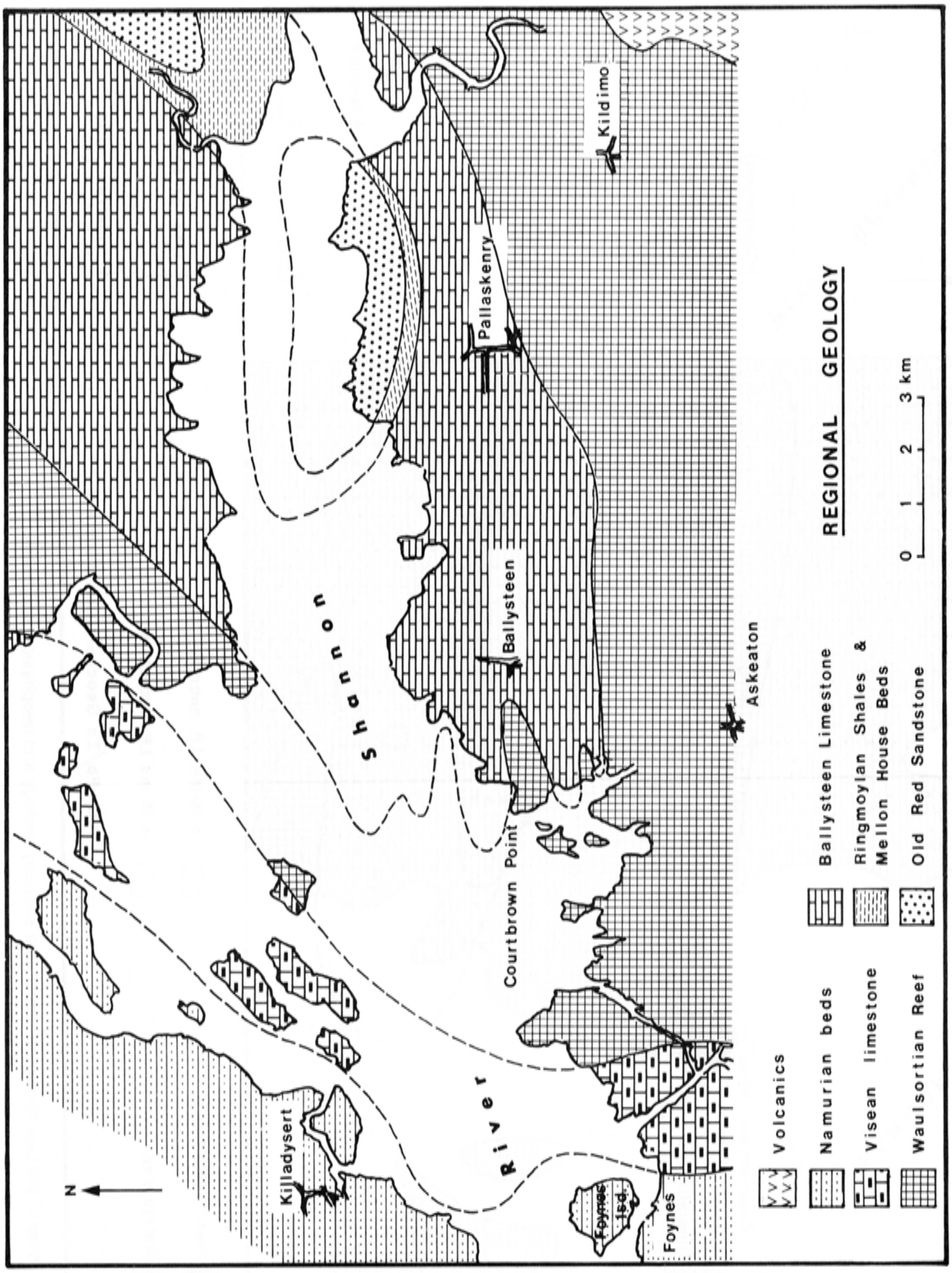

Figure 1. Regional geological map of NW County Limerick and the Shannon Estuary.

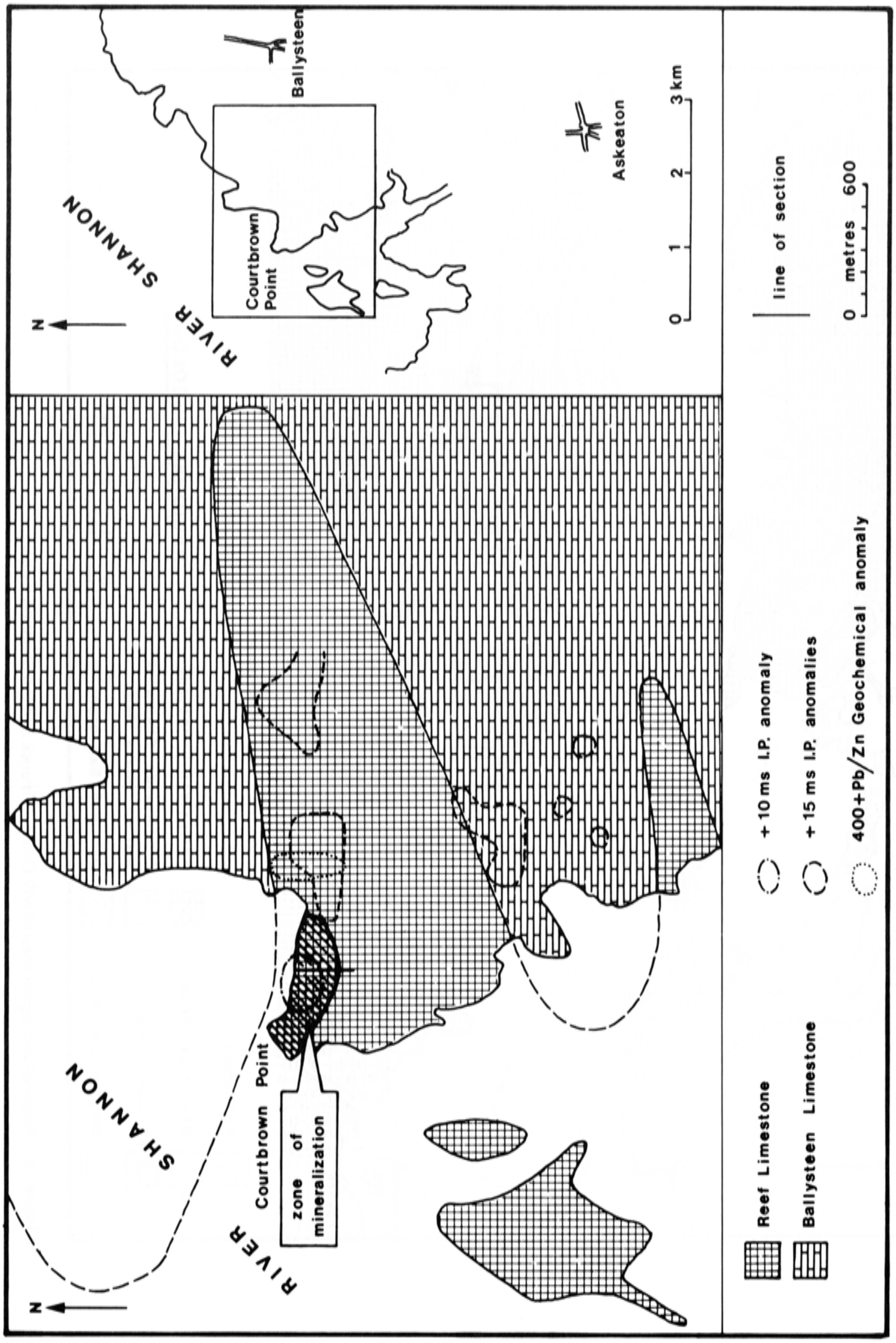

Figure 2. Map of the Courtbrown prospect area showing geology and geophysical anomalies.

runs from Courtbrown Point to Ballysteen House (Fig. 2). Most of the mineralization is concentrated along the northern margin of this asymmetric syncline. These subsidiary folds are not continuous along strike, which may be due to sedimentary interdigitation along the flanks of the Reef or due to displacement by small NNW-trending faults. Small scale structures such as folds, domes, undulations and minor faults on a scale of 1-16m are also common.

Mineralization

Most of the sulphide mineralization at Courtbrown is coarse-grained except for pyrite which is invariably fine-grained and, commonly, massive. Sphalerite and galena are the most common economic sulphides, but chalcopyrite and tennantite are also present in small quantities, particularly at the base of mineralization in the Transition Reef. The sphalerite is often spherulitic and may be either zoned or colour-banded. Arsenopyrite occurs at the base of the Reef and in the Transition Reef. Occasional lenses of massive pyrite, barren of economic sulphides, up to 1.5m thick may occur 1 to 5m above the main sulphide zone. Within this zone high grade mineralization in lenses 0.6 to 2.5m thick are separated by unmineralized barren limestone.

The style of mineralization falls into six categories, as follows:

1. *Stylolitic:* Large crystals of colour-zoned honey-yellow to brown sphalerite are developed along stylolites.

2. *Modified Stylolites:* As a stylolite is traced vertically it may grade into a narrow (<5mm) irregular veinlet filled with sphalerite, calcite, pyrite or galena.

3. *Disseminated type:* Small crystals of sphalerite 1mm in diameter have been noted in the Reef Limestone which give the rock a spotted appearance.

4. *Semi-massive Sulphides:* Bands of massive pyrite or mixtures of galena and sphalerite occur over narrow widths (<30cm). The galena and sphalerite is usually coarse-grained and crystalline, whereas the pyrite is fine-grained. Some of the bands appear to parallel bedding planes.

5. *Vein type:* Apparently near-vertical veins occur near the base of the Reef and within the Transition Reef. These veins typically consist of finer grained pyrite, galena and sphalerite, as brecciated fragments within coarser crystalline white calcite

6. *Mineralization within the Ballysteen Limestone:* This mineralization occurs as irregular veins and veinlets up to 30cm in width. In addition to medium-grained crystalline galena, sphalerite and pyrite, arsenopyrite, tennantite and chalcopyrite are often present and the silver content is usually high.

The grade of mineralization varies according to type; the disseminated and stylolitic types grade only 1-4% Pb+Zn over <1m, whereas the larger vein/semi-massive sulphide types grade >20% over 2m. The Pb:Zn ratio averages approximately 1:2.

A number of reserve calculations have been made. There is at least 300 000t of probable reserves grading 8.2% Pb+Zn with >14g/t Ag. Other estimates have put reserves (including possible and inferred) closer to 1Mt at 5.5% Pb+Zn (Dresser Minerals company reports).

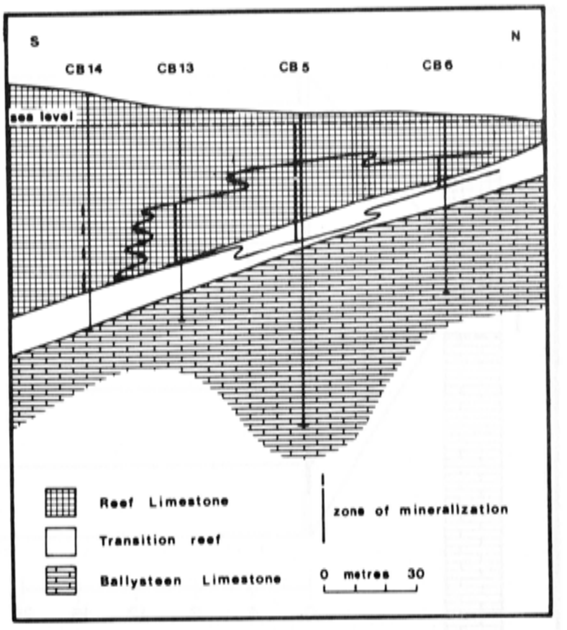

Figure 3. N-S section through the Courtbrown prospect.

Discussion

Very little has been published on the Courtbrown deposit, probably due to the fact that no academic studies have been conducted on the drill core derived from it. This paper attempts to draw together the data that has been generated by the three exploration companies who have worked on the deposit.

Regionally, Courtbrown is close to the Silvermines - Gallows Hill Fault; it is along strike of the Pallaskenry Inlier and it is at the termination of a series of volcanic cones, which extend northwestwards from Pallas Grean.

The style of mineralization at Courtbrown is quite different from that at Silvermines, Tynagh and Navan. It is, quite clearly, epigenetic and therefore is more comparable to that at Mallow, Gortdrum, Aherlow and Carrickittle. Indeed the content and style of the mineralization is very similar to that at Carrickittle as described by Brown and Romer (1982 and this vol.). However it should be noted that at Courtbrown there is very little dolomitization of the limestones within the mineralized zone, although there is dolomitization present to the east of the area of the deposit.

Following cementation and consolidation of the sediments there was extensive development of stylolites, particularly in the massive Waulsortian Reef. Significantly later (about 40Ma), solutions related to Asbian volcanism worked their way up through the ORS and into the basal Carboniferous carbonates, wherein they encountered a major physico-chemical boundary. The evidence from elsewhere (e.g., Mallow; Wilbur and Royall, 1975; Carter and Wilbur, this vol.) suggests that Cu, Ag and Hg tend to precipitate close to this boundary. Further up the stratigraphic column one finds small amounts of Cu, As,Ag, Pb

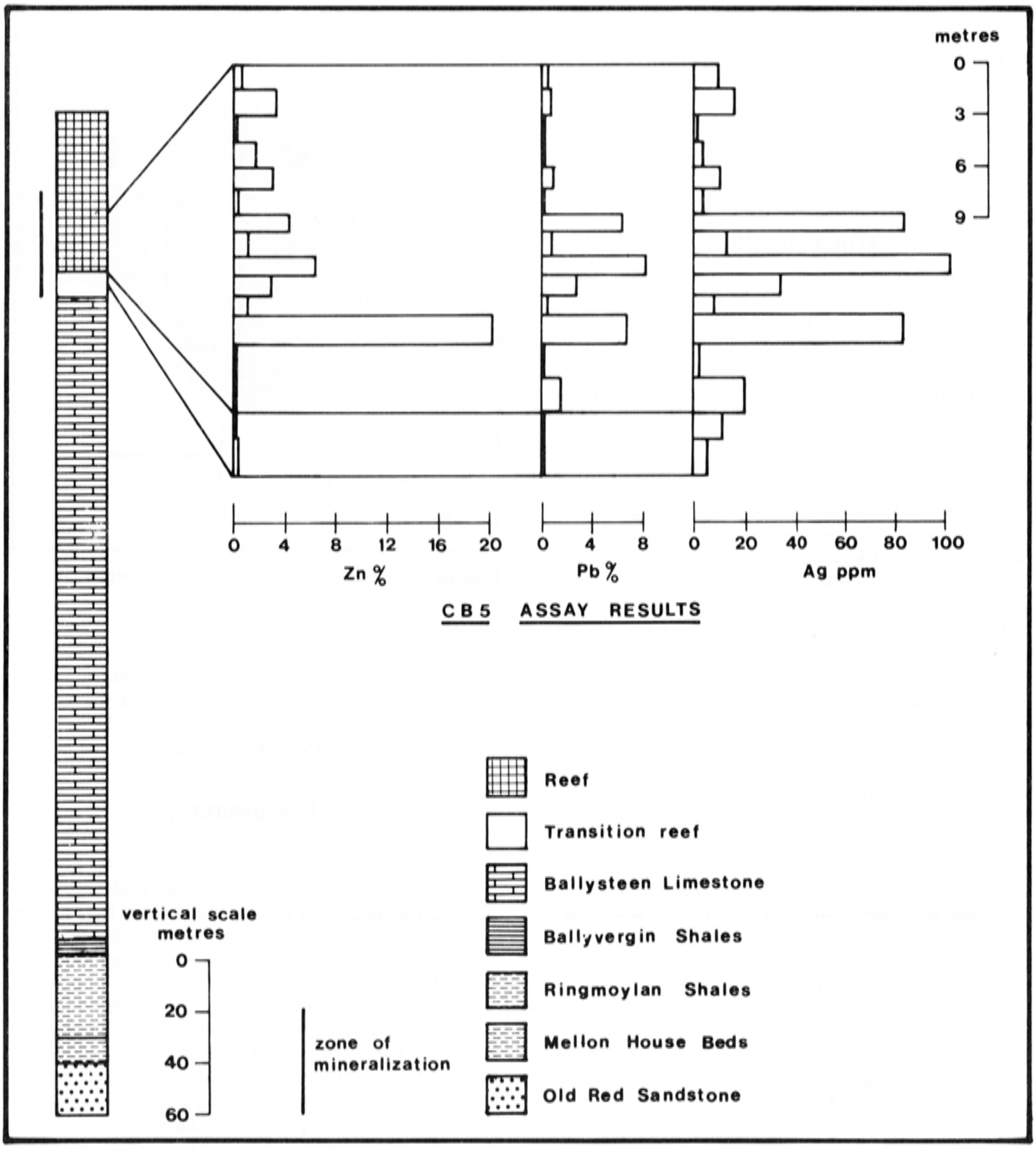

Figure 4. Analytical results from drillhole CB5 showing metal zoning in relation to stratigraphic position.

and Zn while higher still mainly Pb and Zn are encountered with some As and Ag and trace Cu (Steed and Tyler, 1979). Interestingly there is little Ba. Even though Steed and Tyler (1979) stated that there appeared to be no stratigraphic control, they later drew attention to "... favoured stratigraphic sites." The evidence from Courtbrown suggests that there is indeed stratigraphic control.

At Courtbrown the stylolites acted as pathways for the ore forming fluids. As the fluids persisted the stylolites were enlarged by dissolution and widened into veinlets. The presence of fine-grained sulphide breccia fragments in the larger of these veins suggests that there was also some fracturing and replacement of the host limestone. In the larger veins the paragenesis is very similar to that at Carrickittle, pyrite or dark sphalerite, followed by paler sphalerite, then minor but coarse-grained galena with central (final) infill of calcite.

Given this scenario, the deposit may be seen as a small compact stockwork vein-type deposit which may indicate a larger Cu-Ag deposit of Gortdrum-Mallow-Aherlow affinity at depth.

Acknowledgements

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