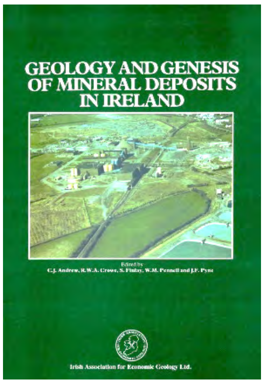

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To cite this article: Brand, S.F. & Emo, G. (1986) A note on Zn-Pb-Ba mineralization near Oldcastle, County Meath. *In:* Andrew, C.J., Crowe, R.W.A., Finlay, S., Pennell, W.M., and Pyne, J.F. '*Geology and Genesis of Mineral Deposits in Ireland*', Irish Association for Economic Geology, Dublin. 297- 304
DOI:

To link to this article: https://

A note on Zn-Pb-Ba mineralization near Oldcastle, County Meath.

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Abstract

Sub-economic Zn-Pb-Ba mineralization is present near Oldcastle, County Meath in beds stratigraphically equivalent to those hosting the lower part of the Navan deposit, 30km to the SE.

Minor amounts of Zn, Pb and Ba are regionally present in these beds, but east of Oldcastle a metal-enriched, SW-trending zone, over 2km wide, has been recognized. Within this zone the best developed mineralization occurs in bird's eye micrites on either side of the SW-trending Drumlerry Fault, where 3Mt at 4.9% Zn+Pb may be present.

The mineralization is mainly epigenetic in style, occurring in steeply dipping veins. However, there is evidence for an earlier phase of mineralization, leaving open the possibility for a more substantial, laterally equivalent, syndiagenetic deposit in the area.

Introduction

Significant, though sub-economic, Zn-Pb-Ba mineralization has been discovered in the Oldcastle area and in particular at Drumlerry (Fig. 1). Until recently it was believed that this mineralization was entirely epigenetic, being formed significantly later than the more attractive syndiagenetic Irish deposits. However, recent petrographic studies have provided evidence that, in addition to the epigenetic phase, some sulphides were introduced early in diagenesis.

The town of Oldcastle is situated to the north of a conspicuous range of hills called Slieve na Calliagh, which form part of the southern margin of the Lower Palaeozoic Longford-Down Inlier (Figs. 1 and 2). Zn-Pb-Ba mineralization occurs principally in micrites east of Oldcastle in beds stratigraphically equivalent to those hosting the lower part of the Navan orebody, 30km to the SE (Fig. 1).

Reconnaissance exploration in the area commenced in the early 1960s and intensified following the discovery, by Rio Tinto Finance and Exploration Limited, of Zn-Pb-Ba mineralization in micrites in an overgrown limestone quarry at Ballaghdorragh, County Cavan (Fig. 2). Narrow fractures filled with sphalerite, galena and barite occur in the quarry faces, while micrite boulders grading over 20% Zn+Pb have been found in the waste tips. Early exploration, including stream-sediment sampling, soil geochemistry and IP surveys outlined a soil geochemistry and IP anomaly near the quarry at Ballaghdorragh, and subsequent core drilling indicated the presence of a small Lower Carboniferous outlier with minor sulphide mineralization. Following the discovery of the Navan deposit in 1970 (O Brien and Romer, 1971), exploration activity over the Carboniferous rocks flanking the Lower Palaeozoic inlier increased, and a short-hole diamond-drilling programme was undertaken to help define the structure and stratigraphy in an area of very few exposures. In addition, prospecting located a number of mineralized areas, notably Ballinvalley, with sphalarite and galena in micrite float, and the southern margins of Slieve na Calliagh, where barite is present in Lower Palaeozoic greywacke (Fig. 2). Subsequent drilling over soil and IP anomalies to the west of Ballaghdorragh resulted in several mineralized intersections adjacent to the SW-trending Drumlerry Fault (Fig. 2).

The area is currently being explored by Billiton Exploration Ireland Limited under separate joint-venture agreements with Rio Tinto Finance and Exploration Limited and Shallee Exploration Ireland Limited/Betheire Mines Limited.

Geological setting

The Slieve na Calliagh range of hills form a prominent structural feature of resistant Lower Palaeozoic rocks which plunge under the overlying Carboniferous sediments (Fig. 1). Similarly plunging features are found at Navan, Crossakeel and Granard along the margins of the Longford-Down Inlier, and the presence of mineralization in each of these areas suggests a possible association with this type of structure. The Lower Palaeozoic rocks were folded and faulted during the Caledonian orogeny, with a subsequent period of non-deposition and erosion followed by the unconformable deposition of Lower Carboniferous sediments.

These Lower Carboniferous sediments, while broadly similar over much of the southern margins of the Longford-Down Inlier (Philcox, 1984) show remarkable local variations in thickness and in detailed lithology north and south of Slieve na Calliagh (Fig. 3). For example, a thin Red Bed sequence unconformably overlies the Lower Palaeozoic rocks on the northern side, but a pale grey, non calcareous sandstone is present on the southern side. More striking differences, however, occur within the Pale Beds (Philcox, 1984). On the northern side, the Pale Beds compare well with the thick development of this unit at Navan, in contrast to the relatively thin Pale Beds sequence to the south of Slieve na Calliagh. The Micrite Unit, at the base of the Pale Beds, contains an evaporitic unit on the northern side not seen on the southern side or at Navan. In contrast with the thick development of Pale Beds on the northern side, the overlying Shaly Pales and Argillaceous Bioclastic Limestone are both notably thinner on the north than on the south.

Another feature representing the differences in deposi-

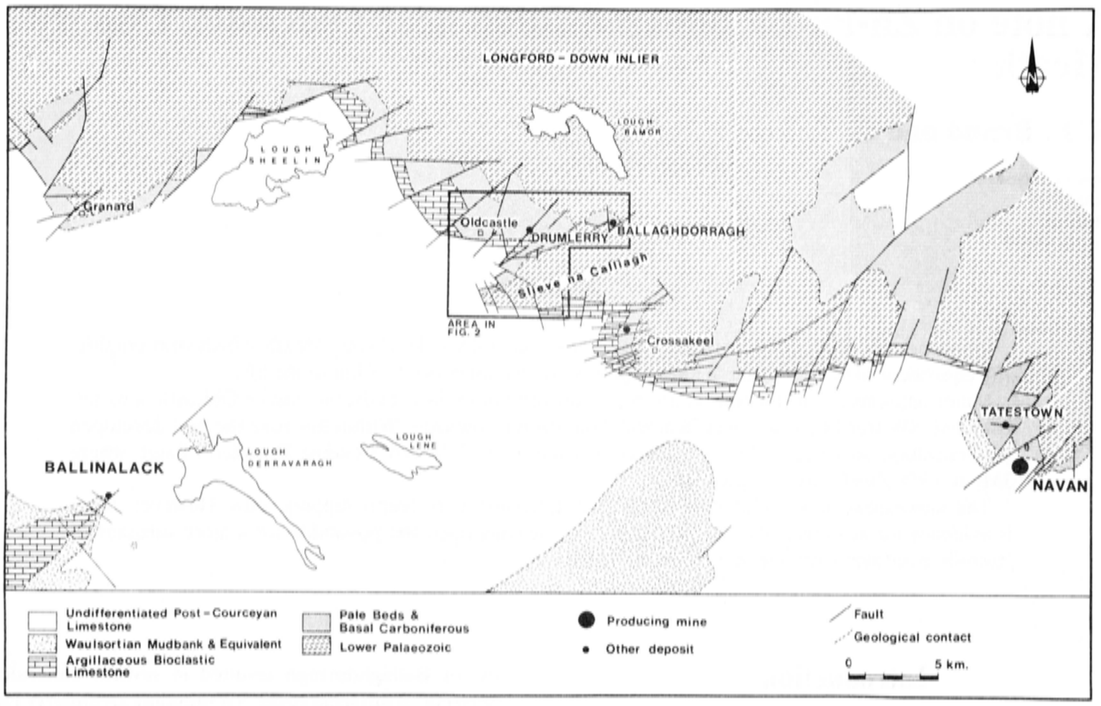

Figure 1. Location and regional geology.

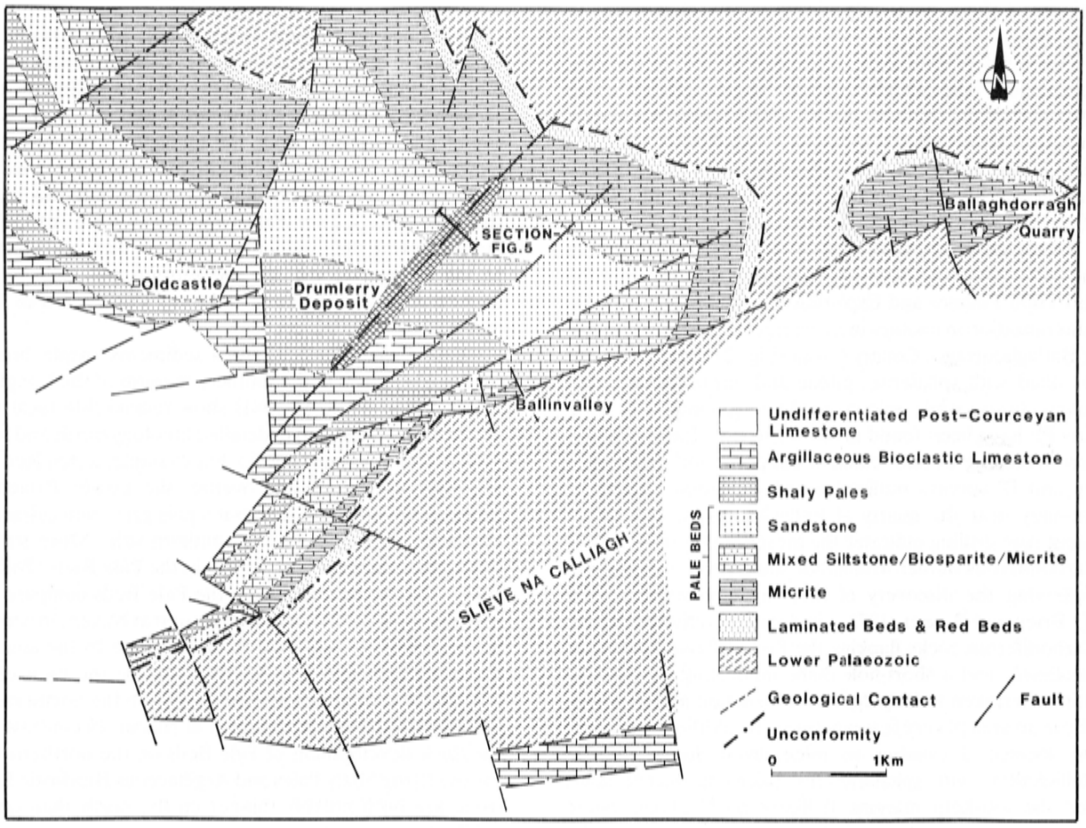

Figure 2. Detailed geology of the Oldcastle area.

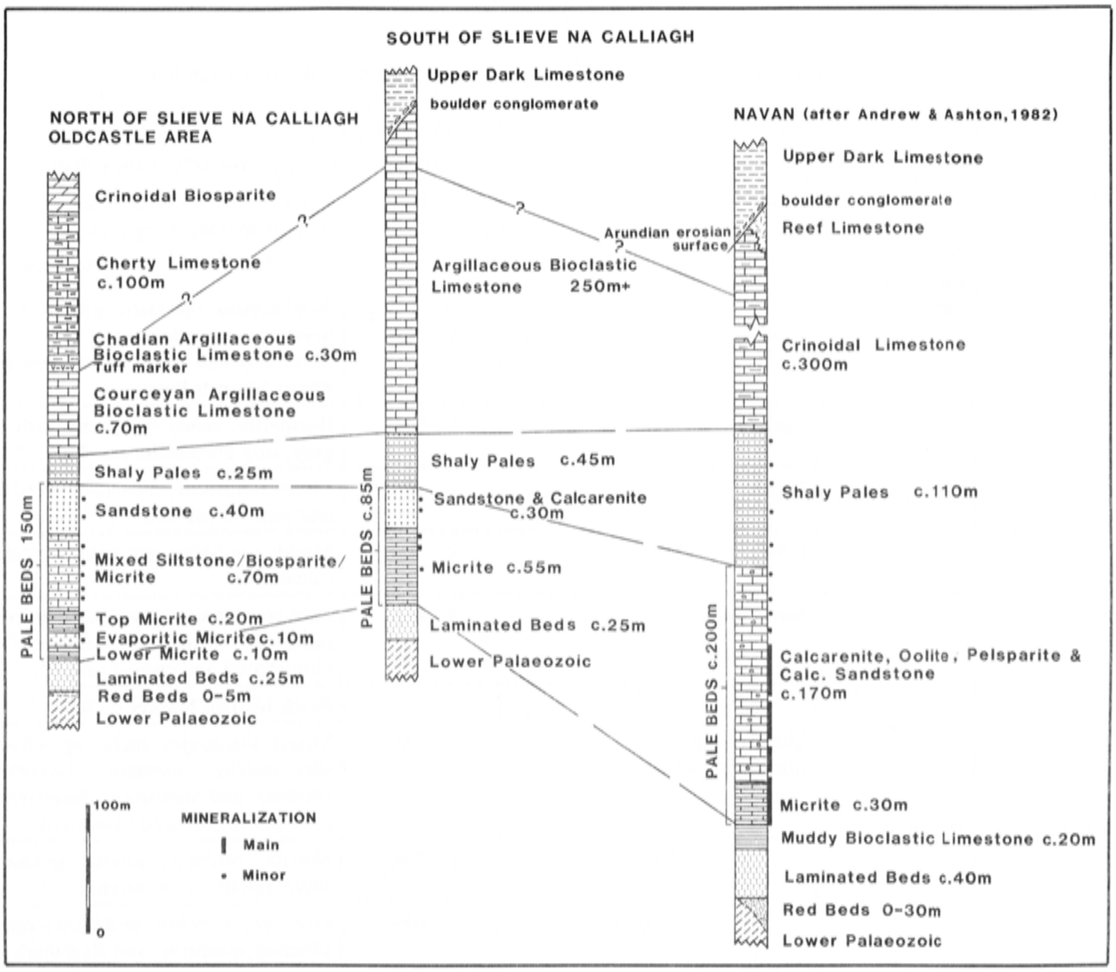

Figure 3. Comparative stratigraphy, Oldcastle-Navan areas.

tional environment across the area is shown by the presence of a shaly limestone boulder conglomerate, which sharply overlies the Argillaceous Bioclastic Limestone on the south side but which has not been recognised to the north. This conglomerate is similar to the Boulder Conglomerate at Navan (Andrew and Ashton, 1982). Also, above the Argillaceous Bioclastic Limestone a cherty limestone sequence is developed on the northern side in contrast with deeper water shales and limestone to the south.

From these lithological and thickness variations it is evident that Slieve na Calliagh influenced Lower Carboniferous deposition for a considerable period of time.

Structure

The Lower Palaeozoic rocks are folded and cleaved along NE-trending axes with associated NE and later cross-cutting NW faults. In the Carboniferous, on the northern side of Slieve na Calliagh, the dominant fault set reflects the earlier Caledonian trend, but to date none of the Caledonian structures recognized in the Lower Palaeozoic rocks have been confidently traced into the Carboniferous. The faults are generally normal but some have a dextral slip component. The throws increase dramatically from a few metres in the NE to over 150m in the SW. The southern margin of Slieve na Calliagh is bounded by a major E-trending fault with an increasing throw to the west. Later northwesterly and northerly trending faults offset the earlier structures throughout the area.

The main mineralization discussed in this paper is associated with the SW-trending Drumlerry Fault (Fig. 2).

Stratigraphy of the Oldcastle area north of Slieve na Calliagh

A detailed chronostratigraphical succession has yet to be formalized for the area north of Slieve na Calliagh; however, a lithostratigraphy, following work by Smith (1975) and Ryder (1977), has been established and is summarized in Figure 3 and in Table 1.

The Lower Palaeozoic rocks consist of grey to green, thin to massive-bedded Silurian greywacke and shale. These are unconformably overlain by a variable thickness of Red Beds (0-5m), reflecting the unevenness of the depositional surface. The Red Beds consist of red siltstone and mudstone with conglomerates containing reddened clasts of Lower Palaeozoic lithologies and vein quartz. Where the Red Beds are absent, the Lower Palaeozoic lithologies are reddened, suggesting subaerial exposure.

Overlying the Red Beds are the Laminated Beds, which are equivalent to the Basal Transition Beds described by Philcox (1984). The lower part consists of sandstone with laminated and flaser-bedded sandstone and mudstone,

Table 1.

Stratigraphy and mineralization of the Oldcastle area north of Slieve na Calliagh

	Unit name			Thickness	Description
Chadian	Cherty Limestone			c.100m.	Cherty biosparite, minor shale.
Chadian	Argillaceous Bioclastic Limestone	Chadian		c. 30m.	Argillaceous bioclastic limestone — less shaly than underlying unit.
					— Thin green tuffaceous shale —
Courceyan	Argillaceous Bioclastic Limestone	Courceyan		c. 70m.	Argillaceous bioclastic limestone and fossiliferous black shale. Some silty and sandy bioturbated limestones towards base.
Courceyan	Shaly Pales	Upper		c. 12m.	Biosparite, sandy biosparite with dark grey, silty unfossiliferous shale.
		Middle		c. 8m.	Clean sandstone, bioclastic sandstone and sandy biosparite.
		Lower		c. 5m.	Muddy sandstone and muddy bioclastic calcarenite.
	Pale Beds	Sandstone		c. 40m.	Pale grey, massive, weakly calcareous, sandstone. Bioclastic horizons. Often bioturbated and cross-stratified.
		Mixed micrite siltstone/biosparite		c. 70m.	Black Micrite Marker c. 3m.
					Mixed lithologies including siltstone, silty micrite, pelmicrite, bioturbated siltstone and sandstone, biosparite, biopelsparite and sandy biosparite.
		Micrite Unit	Top	c. 20m.	Micrite, birdseye micrite, pelmicrite, shelly micrite, dolomicrite.
			Evaporitic	c. 10m.	Grey, green, yellow and brown micrite, siltstone, mudstone and algal mudstone. Gypsum nodules and pseudomorphs. Collapse breccias.
			Lower	c. 10m.	Micrite, birdseye micrite, dolomicrite and pelmicrite. Silty and muddy towards base.
	Laminated Beds			c. 25m.	Sandstone and muddy sandstone with calcareous beds towards top.
					Laminated and flaser bedded sandstone, siltstone and mudstone.
	Red Beds			0-5m.	Red siltstone, mudstone, conglomerate.
	— Unconformity —				— Unconformity —
	Lower Palaeozoic				Green greywacke and shale.

passing upwards into dominantly sandy beds, with thin calcareous beds towards the top.

A varied sequence called the Pale Beds (Philcox, 1984), composed of a number of distinctive units, overlies the Laminated Beds. Variations in the thickness and composition of this unit across Slieve na Calliagh have been referred to earlier, but even on a local scale in the Oldcastle area, thickness variations are common and reflect a complex interplay of facies variations, synsedimentary and tectonic faulting and variable modes of diagenesis. The lowermost member of the Pale Beds, and the most strongly mineralized in the area, is the Micrite Unit which has been subdivided into three divisions viz. the Lower Micrite, the Evaporitic Micrite and the Top Micrite. The base of the Lower Micrite is gradational with the underlying unit and is composed of micrite, bird's eye micrite,dolomicrite and pelmicrite. The Evaporitic Micrite is composed of variably coloured grey, green to yellow and brown micrite with gypsum nodules and pseudomorphs after gypsum. A number of dessication features are also present together with evaporite collapse breccias. The beds are poorly fossiliferous and contain oncoliths suggestive of saline conditions of deposition. The Top Micrite consists of micrite, bird's eye micrite and dolomicrite with a notable shelly unit near the top. Variations in thickness of the entire Micrite Unit are common in the Oldcastle area, especially in the Evaporitic and Top Micrite Units.

A highly varied sequence of sediments, known as the

Mixed Siltstone/Biosparite/Micrite Unit overlies the Top Micrite, and consists of a variety of lithologies including pale to dark micrite, silty, pelletal micrite, dark to medium-grey bioturbated siltstone and sandstone, sandy biosparites and biopelsparites. A distinct marker, up to 3m thick, occurs at the top of this unit and is composed of black micrite, pelletal and silty micrite with thin silty laminae containing plant fossils. The Sandstone Unit overlies this marker and consists of pale-grey, massive, weakly calcareous to calcareous sandstone, often bioturbated and cross-stratified.

The overlying Shaly Pales (Philcox, 1984) have been subdivided into Lower, Middle and Upper parts.

The Lower Shaly Pales at Oldcastle are thin (c. 5m) and consist of muddy sandstone and muddy, sandy, bioclastic calcarenite. The Middle Shaly Pales are shale-free and are composed of pale-grey to yellow sandstone, bioclastic sandstone and sandy biosparites. Because of their overall sandy nature, Philcox (1984) has included these two divisions with the Sandstone Unit. The Upper Shaly Pales consist of pale to medium-grey, biosparite and sandy biosparite with interbeds of dark grey, unfossiliferous shale and silty laminated shale.

The base of the succeeding Argillaceous Bioclastic Limestone unit is gradational, and is taken after the last major silty unfossiliferous shale. This unit is sub-divided into a lower (Courceyan) and an upper (Chadian) division. The Courceyan division is composed of medium-grey bioclastic limestone with black fossiliferous shale, sometimes silty and with minor sandy bioturbated limestone. The succeeding Chadian is composed of muddy bioclastic limestone, less shaly but otherwise similar to the underlying beds from which it is separated by a thin green tuffaceous shale marker. The Waulsortian Mudbank facies is not developed in the area and the Argillaceous Bioclastic Limestone is overlain by cherty bioclastic limestones which are often dolomitized.

Basaltic sills and dykes are common in the Oldcastle area and these are thought to be similar to the Tertiary intrusives at Navan (Turner et al., 1972).

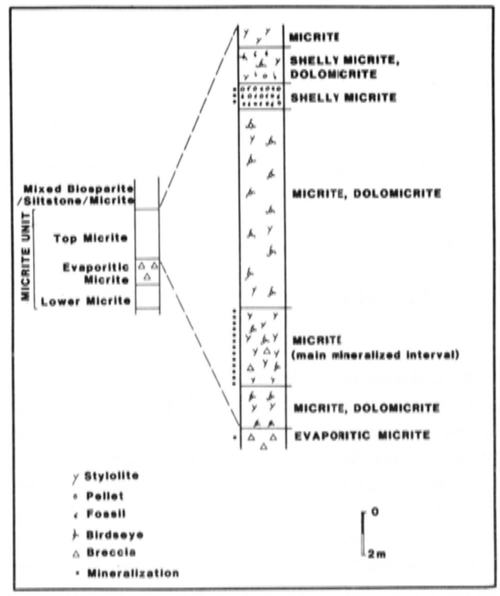

Figure 4. Sub-divisions of the Top Micrite Unit showing mineral distribution.

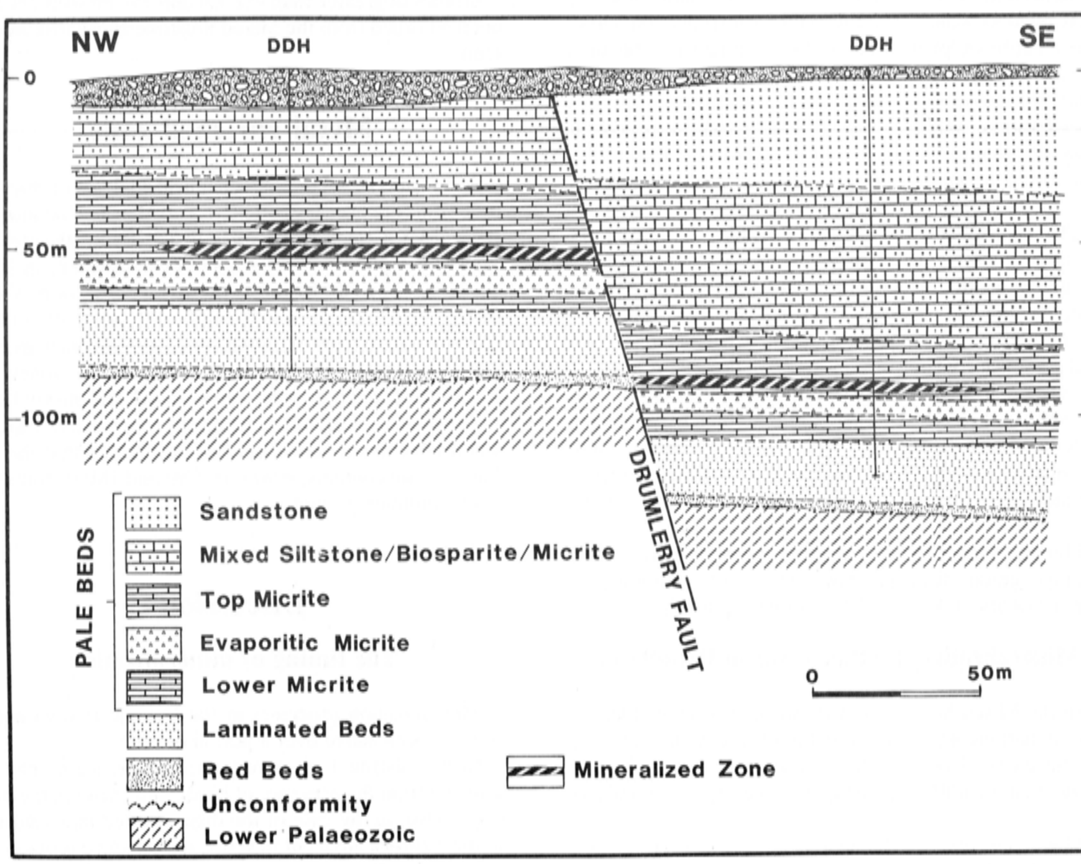

Figure 5. Cross-section through the Drumlerry deposit.

Mineralization

Mineralization in the Oldcastle area occurs principally in the Pale Beds, in a number of units, but is best developed in the Top Micrite. It is mineralization from this unit which makes up the Drumlerry deposit discussed below. Traces of sphalerite, galena and barite have also been noted in the Laminated Beds, Shaly Pales and Argillaceous Bioclastic Limestone. In addition, barite is present along faults and fractures in the Lower Palaeozoic rocks.

Mineralization in the Micrite Unit at Drumlerry

The divisions of the Micrite Unit are shown in Figure 3 with details of the Top Micrite in Figure 4. The Lower Micrite is essentially barren except for rare traces of sphalerite, with slightly more sphalerite together with barite occurring in the Evaporitic Unit. The best developed mineralization occurs in the lower part of the Top Micrite Unit at an almost constant 3m from its base (Figs. 4 and 5). The bulk of the mineralization consists of veins of sphalerite, galena, pyrite, barite and calcite generally cross-cutting the bedding, with dips averaging 70°. The veins appear to have resulted from dissolution and replacement along stylolitic partings and water escape structures. The margins of the veins commonly contain disseminations of sulphides, particularly sphalerite, which extend into the wall rock. Thin section examination has shown that these were produced by selective replacement of micrite pellets. A few millimetres away from the vein the number of replaced pellets decreases rapidly as does the degree of replacement of individual pellets (Finlow-Bates, pers. comm.). The Top Micrite Unit contains well-developed bird's eye features, most of which were filled with calcite prior to sulphide introduction. However, barite or pyrite does occur as bird's eye fill in a number of cases. In addition, towards the upper part of this Unit, sphalerite is present in the particularly fossiliferous Shelly Micrite, as a replacement of the sparry calcite cement (Fig. 4). No mineralization has been observed in the dolomicrites of the Micrite Unit or where the cement is dolomite.

The main micrite-hosted mineralization at Drumlerry is simplistically regarded as stratiform, with the footwall occurring about 3m above the base of the Top Micrite (Fig. 5). For the purpose of calculation, using minimum parameters of 1.5m at greater than 2% combined Zn+Pb and assuming continuity* between drill holes, it is possible to envisage a deposit with a strike length of almost 2km up to 100m either side of the fault. A total of nine drill holes adjacent to the fault have values exceeding these parameters, and the range of values is represented in Figure 6 which shows the average to be 2.8m at 4.3% Zn and 0.6% Pb.

Hence, by accepting all the above assumptions regarding average grade, thickness and, above all, continuity, a deposit of about 3Mt at 4.9% Zn+Pb is possible.

Mineralization in other Units at Drumlerry

In the Mixed Siltstone/Biosparite/Micrite Unit (Fig. 3), disseminations of pale brown sphalerite are present, usually in the coarse biosparite beds. Microscopic examination shows that, in addition to sphalerite occurring as a replacement of both cement and clasts, it also occurs as a filling to primary voids in crinoids and bryozoa (Sevastopulo, pers. comm.). In the Sandstone Unit, very fine-grained, pale-brown sphalerite occurs as disseminations replacing matrix calcite.

Grades of greater than 4% Zn and 1% Pb over 1m have been recorded from the Mixed Siltstone/Biosparite/Micrite Unit.

*The assumption has been used only to put an upper limit on mineral potential of the area drilled.

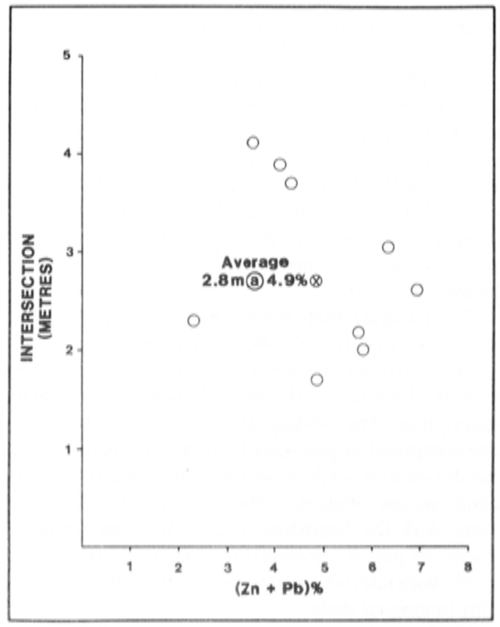

Figure 6. Plot showing range of grades and intersections at Drumlerry.

Metal-enriched zone

The results of average geochemical analyses of chip samples from core over the complete Top Micrite Unit intersections from a total of 42 holes in the Oldcastle area are shown in Figure 7. The samples were selected, as far as possible, to avoid obvious vein-fill mineralization. Values for Zn, Pb and Ba show that significantly anomalous values occur in a broad SW-trending zone, within which are individual narrower SW-trending, higher grade zones, the strongest of which is associated with the Drumlerry Fault.

The geochemical values represent a significant degree of metal enrichment and it has been estimated that the Top Micrite Unit contains between 0.5Mt and 1Mt of zinc metal in the anomalous zone.

Discussion

The timing of mineralization

Mineralization processes in the Drumlerry area appear to have been active over a period of time.

In the Micrite Unit a very early mineralizing phase is inferred from the presence of barite and pyrite in the bird's eyes. Also, in the case of the disseminated mineralization in the wallrock adjacent to veins, the selective replacement of micrite pellets suggests an origin before diagenesis was

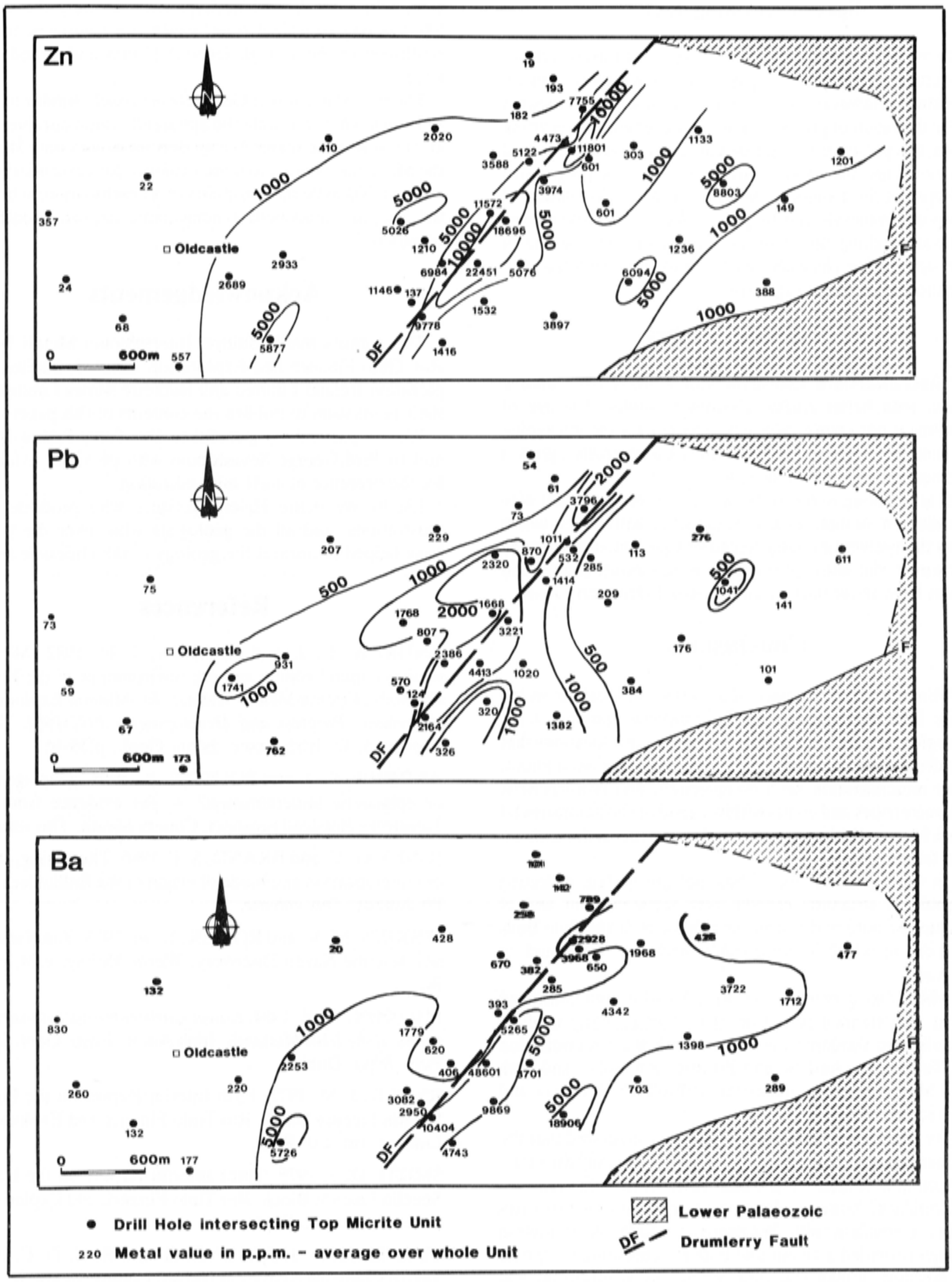

Figure 7. Metal values within the Top Micrite Unit.

complete and the rock became impermeable. The mineralization associated with stylolites occupies space which was generated by replacement at the pressure-solution interface, and it appears that this phase of mineralization occurred after the formation of these features. Additional phases of sulphides were deposited in the veins at progressively later stages to reinforce the dominant epigenetic style.

In the mineralized lithologies above the Micrite, very early mineralization is also suggested by the sulphide filling in primary voids in crinoids and bryozoa which are normally sealed off at an early stage in diagenesis (Sevastopulo, pers. comm.). In the coarse biosparite beds the replacement of clasts and cement by sulphides suggests that this mineralization also occurred before the rock became impermeable.

Space-generating factors

In the Top Micrite Unit, the presence of almost stratiform mineralization with many epigenetic characteristics is problematical. However, the best mineralized section is thought to be the result of preferential ground preparation resulting from the presence of a set of particularly well-developed water-escape features, at this level, and by progressive collapse in the Evaporitic Micrite below, by dissolution of evaporite minerals. It is suggested that the collapse caused relaxation along the stylolites and the further opening of the dewatering channels which allowed preferential permeation by mineralizing fluids.

Structural factors

Mineralization is associated with a broad SW-trending zone, with better grades adjacent to faults. The age of faulting is not known, although evidence for the thickening of some units across the Drumlerry Fault suggests a growth element or possible lateral slip.

It is tempting to regard the zone as a feeder system with localization of mineralization associated with faults, which may themselves be related to earlier Caledonian structures. However, the source of sulphides is not known and no drill holes have so far intersected the actual Drumlerry Fault.

Conclusions

Mineralization is present at a number of localities in the Pale Beds succession along the southern margins of the Longford-Down Inlier, but it is only in a few locations that grades such as those in the Oldcastle area have been found. This mineralization has both epigenetic and syndiagenetic characteristics and occurs within a zone of substantial metal enrichment which may be related to a structurally controlled feeder system.

In the Oldcastle area, lithologies are varied, reflecting significant structural control over sedimentation and of particular note is the thick development of the Pale Beds succession which is comparable with the succession at Navan.

Mineralizing processes in the Oldcastle area continued over an extended period of time, starting early in diagenesis, and similarities exist both with the mineralization at Tatestown (Andrew and Poustie, this vol.), and with the Mixed Beds mineralization at Ballinalack (Jones and Brand, this vol.).

By comparison with Ballinalack, it is suggested that the mineralizing fluids and processes were essentially the same, resulting in similar replacement textures in both areas. At Ballinalack, however, later stage mineralizing processes were coincident with Waulsortian Mudbank formation which provided a favourable host for substantial sulphide deposition, unlike Oldcastle where no Waulsortian was developed. It is also suggested that both deposits are associated with a similar, or perhaps even broadly the same, SW-trending structural zone, which can further be traced southwest to the Tynagh Deposit (Jones and Brand, this vol.).

The mineralization at Oldcastle is broadly similar to that at Tatestown, yet despite the apparently unfavourable style at Tatestown the major Navan deposit occurs only 3km to the SE. Thus, bearing in mind evidence for early mineralization at Oldcastle the possibility of a nearby, more substantial laterally equivalent syndiagenetic deposit should be considered.

Acknowledgements

The authors thank Billiton International Metals B.V., Rio Tinto Finance and Exploration Limited, Shallee Exploration Ireland Limited and Betheire Mines Limited for their permission to publish the contents of this paper.

We are particularly grateful to Dr. Terry Finlow-Bates and to Prof.George Sevastopulo who provided evidence for the presence of early mineralization.

Finally we thank Helen McGuire who produced the illustrations, and all the geologists who, over the years, have helped to unravel the geology of the Oldcastle area.

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