THE DISTRIBUTION AND GENESIS OF LEAD AND ASSOCIATED ORES IN WESTERN SHROPSHIRE

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INTRODUCTORY.—The recent appearance of the Geological Survey Memoir dealing with the mining district of Western Shropshire, and the extensive extracts from that Memoir given in the "Mining Digest" of the Magazine for April last, have directed attention to the ore occurrences of that region. Since, however, the official publication is concerned mainly with the actual occurrence and mining of the deposits, rather than with their origin, an account of the conditions governing the distribution of the ores in relation to the problems of their genesis may be considered a suitable continuation to the information already published.

The present writer was engaged by the Shropshire Mines, Ltd., whose operations extend over the greater part of the mining area, to make an examination of the geological features of the district in relation to the nature and distribution of the ores. The results of this work, which entailed the making of a six-inch geological map, were communicated to the company in a private report in March, 1919. That report was later passed to the Geological Survey, and considerable portions of it, together with reductions of a part of the map and the sections, have been incorporated in the official Memoir and need not be repeated here.

The following remarks present the writer’s conclusions concerning the genesis of the ores based upon a study of the conditions governing their occurrence and distribution.

The ores, comprising those of lead, zinc, copper, and barium, occur principally in or in close association with a series of fissures trending N.W.—S.E. and E.N.E.—W.S.W. These directions are subject to some variation, but they represent the main lines of fracturing which influenced the flow of the metal-bearing solutions and determined the positions of the resultant mineral veins. Subsidiary occurrences of ore occupy spaces between bedding planes, produced by differential movement of the strata during folding.

Since 1845, the first year for which official statistics are available, this district has produced approximately 250,000 tons of lead concentrate, 20,000 tons of zinc concentrate, and 300,000 tons of barytes, together with a small amount of copper ore. Previously, although no reliable statistics are procurable, there must have been a considerable production of lead ore, since its mining dates back to Roman times. Zinc ore was first recorded in 1858 and barytes in 1860.

GENERAL GEOLOGY.—The area is composed of a series of Cambro-Ordovician strata in conformable sequence, having a general north-easterly strike and north-westerly dip, faulted at their base against the Pre-Cambrian rocks of the Longmynd area, and overlain unconformably by Silurian strata of Upper Llandovery age.

The distribution of these strata in the main area of mineralization may be seen on the map published in the Survey Memoir. Attention may here be directed to an error in

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**Fig. 1.—Map of West Shropshire.**
the drawing of this map. The narrow strip left blank in the lower right-hand corner of the figure, between the Hope shales and the Stiperstones quartzite, is part of the Mytton beds and should, therefore, be stippled. This map is reproduced in Fig. 3, p. 203, with the alteration made.

The accompanying section (Fig. 2.) gives a diagrammatic representation of the geological sequence across the district, roughly from west to east. This brings out the folding of the Lower Ordovician rocks and the regular westerly dip of the Middle and Upper divisions, but faulting and local irregularities have been omitted in the generalization. The sub-divisions are those recognized and described by the late Professor Lapworth. (See "Proceedings Geological Association," Vol. XIII (1893-4), pp. 311-19, and "Summary of Progress of the Geological Survey" for 1915.)

A very marked physical feature is furnished by the Stiperstones quartzite which forms the base of the Ordovician sequence. Owing to its hard and resistant character this rock forms a high ridge and is readily distinguishable. Special allusion is made to this important feature since it so happens that it forms an easily recognized divisional line between two very distinct metalliferous areas, namely, that occupied by the lead and zinc bearing Ordovician strata on the west, and that of the copper bearing Pre-Cambrian (Longmyndian) strata on the east. The Ordovician rocks consist principally of an alternating series of grits and shales, with intercalated volcanic material and intrusive diabase, and the occurrence of ore has an intimate relationship to the lithological nature of the enclosing strata. Thus, the shales are everywhere quite barren, and mineralization is confined mainly to the grits and, to a less extent, the volcanic ashes.

The main ore-bearing horizon is furnished by the Mytton beds, which immediately overlie the Stiperstones quartzite and are succeeded by the Hope shales. These beds have yielded commercial deposits of lead and zinc ores, with accompanying barytes. Higher in the sequence no important lead-bearing deposits have been located, but barytes occurs at several horizons, and has been extensively worked in the Stapeley ashes at Clifdade and in the Hagley and Whitty ashes at the top of the sequence, adjacent to the Silurian cover. Here the largest deposit of high-grade barytes known in the district was for many years worked at Wotherton.

To the east of the Stiperstones considerable quantities of barytes and small amounts of copper ore have been mined in the Pre-Cambrian grits of the Longmynd district.

The existing geological structure of the area is the outcome of repeated folding, faulting, and denudation due to successive earth movements, and the history of the mineralization is intimately bound up with that of these changes.

One of the most pronounced geological features of the district is the large fault which separates the Pre-Cambrian strata of the Longmynd from the newer rocks to the west. This represents a considerable displacement of the strata, and has doubtless been a line of disturbance at successive periods. It now separates two very distinct ore-bearing horizons. The adjacent Cambrian shales are conformably succeeded by the Ordovician strata, and the whole form an uninterrupted sequence up to the unconformable base of the overlying Silurian.

**Fissuring.**—In late Ordovician or early Silurian (Lower Llandovery) times the Ordovician rocks were subjected to earth movement, accompanied by folding and
Fig. 3—Geological Map of Western Shropshire Mining District.
fracturing, and it was upon their upturned and denuded edges that the succeeding Silurian strata (Upper Llandovery) were laid down. To these post-Ordovician disturbances are due the north-north-easterly folds and strike faults and the majority of the igneous intrusions, all of which are anterior in formation to the period of mineralization. The north-westerly and east-north-easterly fractures, with their accompanying dykes, on the other hand, are quite independent of the pre-Silurian folding, which they intersect at a high angle, and are evidently younger, for though they do not, except in one demonstrable case, penetrate the Silurian strata, there is good reason to suppose that they are the result of the earth movements which at the close of Silurian and the beginning of Devonian times so profoundly affected large parts of the British Isles. The effect of these movements (Caledonian System) on the Silurian strata of this neighbourhood is seen in the pronounced north-easterly strike, so well displayed in the Long Mountain syncline to the north-west, and in the Ludlow-Wenlock area east of the Longmynd. It follows that these movements must have acted upon both the Silurian and the underlying Ordovician rocks, though it can be readily conceived that the effects produced may have been very different. Thus, while the former, being previously undisturbed, would readily lend themselves to simple folding, the latter, having already had one set of structures impressed upon them, would tend to resist any further adjustment, with the consequence that stresses would be set up resulting in fracturing across the earlier folds. A co-ordinated system of fissures oblique to the general strike of the rocks was thus produced, into which material derived from deep-seated igneous activity connected with the movements found its way and formed the mineral veins. This system of fracturing, regarded as due to compressive stresses, is a type well recognized in many mining districts. Both sets must have been formed concurrently, and they often intersect without any relative displacement, as at the Bog Mine and elsewhere. At Snailbeach Mine, however, the main vein, which occupies an east-north-easterly fissure, is deflected by a north-westerly fracture.

Both veins are mineralized, but more especially the east-north-easterly ones, which constitute most of the principal veins of the district, such as the Ryder vein of the Grit and Pennerley Mines, the Big Spur vein of Perkins Beach Mine, and the Main veins of the Bog and Snailbeach Mines. The north-west fissures are represented principally by the Roman vein of Roman Gravels Mine, and the Wood vein of the East Roman Gravels Mine.

The former show little relative displacement of the walls, and do not therefore materially affect the geological structure. In fact, were it not for their extensive mineralization they would doubtless in most cases escape attention during mapping. The north-westerly fractures, on the other hand, have frequently experienced considerable movement and are readily recognized by the abrupt termination of the strata against them. It appears, therefore, that adjustments along the fractures after their formation followed principally a north-westerly direction. The movements must have taken place previous to mineralization, as no case has been recorded where the vein filling of a displaced fracture is faulted out; so far as observation goes, it always continues along the plane of junction of the two fissures.

These fissures are best developed in the harder beds, such as the Mytton grits, Stapeley ashes, etc., and tend to die out or lose their individuality in the soft shales. Such beds under the stress of earth movement would experience an ill-defined fracturing, and any spaces formed would be liable to become filled or "pugged" by crushed material readily broken from the walls. To this absence of well-defined planes of fracture which could serve as suitable circulation channels for ore solutions may be attributed the non-productiveness of these rocks.

**ASSOCIATED IGNEOUS ROCKS.** — The abundant intrusive rocks which are found throughout the district are of basic composition and belong, with few exceptions, to the group of diabases or dolerites. They occur in the form of laccoliths, sills, or dykes. Although they show no close genetic relationship with the mineral veins and, as already stated, were chiefly formed long anterior to the period of mineralization, there are certain long, narrow dykes, having an east-north-easterly trend and obviously younger than the main intrusions, which show a close similarity in occurrence to the mineral veins. They are often found in contact with the veins for long distances, seemingly occupying the same fissures. This association occurs
in the case of the Ryder vein at Pennerley and the Grit Mines; the Whitestone or North vein at the Bog Mine; at Cliffe Dale Mine; at Resting Hill, south of Snailbeach; and at Callow Hill. Most of these examples are now covered up and cannot be examined. But at Callow Hill the relations can be well observed in the underground workings which are still open. Here the dyke is in contact with the vein only in part of its course, and is otherwise quite normal and unaltered. In the neighbourhood of the junction, however, it undergoes a change, and at the place of contact is in a state of profound alteration, which causes the rock to assume a whitish or pale grey colour and to lose much of its hardness and coherency. A microscopic examination of the altered rock shows the chief modification to consist in the breakdown of the original felspar to a white powdery substance of a micaceous nature, and the change that is known as sericitization.

Specimens of a similar nature may be gathered from the dumps at the Bog Mine, and Morton in his paper on "The Mineral Veins of Shelve" (see Proc. of Liverpool Geol. Soc., 1869), speaks of a white "comb" projecting above the surface at the Grit and Bog Mines. It seems, therefore, that in all cases where dykes and veins are in contact we should find, could we examine them, that this alteration is a constant feature, and it furnishes an explanation of the terms "whiterock vein" or "whitestone-vein" so often used in the district by the old miners. Moreover, a knowledge of this fact possesses considerable significance as bearing upon the possible location of otherwise hidden ore-bodies.

The chemical nature of this alteration may be seen from the analyses in the table in the preceding column which show the compositions of a typical unaltered diabase of the district, and of the altered rock in contact with the vein at Callow Hill. This evidence conclusively proves that the dykes are of earlier formation than the mineral veins, and occupied the fissures prior to their invasion by the metal-bearing solutions which so markedly affected them. It appears, however, that they may be referred to the same causes and are the result of igneous activity accompanying the Caledonian disturbances, which are regarded as responsible for the formation of the fissures. Into these fissures igneous material, now represented by the dykes, first found its way. But this phase of intrusion does not seem to have been of any great extent, and the chief period of fissure-filling appears to have been reserved until later, when the material from which the mineral veins were formed was being expelled from the underground reservoirs.

**The Mineral Veins.**—The mineralization of the post-Silurian fractures, to which the formation of the veins is due, was evidently connected with the ascent of magmatic solutions emanating from deep-seated igneous intrusions during a period of crustal disturbance. Although, as previously stated, the veins show no close genetic relationship with any of the exposed igneous intrusions, it is highly probable that they are connected with a concealed granite mass. In many areas affected by the Caledonian movements the accompanying igneous activity is represented by intrusions of granite, and similar rocks doubtless exist in this district, though concealed under the overlying strata. In Wicklow, the Isle of Man, the Lake District, and Scotland lead-bearing veins are found in close association with these granite masses, suggesting a genetic relationship, and we may reasonably suppose a similar association here though denudation has not proceeded sufficiently far to reveal it. In this district we have only an earlier, basic, phase of intrusion visibly present. These dykes may be regarded as representing an early expulsion from the parent magma, which later consolidated as granite; the formation of the mineral veins was connected with the last phase of consolidation.

As already stated, it is considered that the

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**Table of Analyses of Diabases.**

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<th>Unaltered Diabase</th>
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<tr>
<td>CO₂</td>
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(Analyses by E. G. Radley.)

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formation of the fissures took place during the Caledonian disturbances which affected the district in post-Silurian times. Not only may the fissuring of the district be attributed to these movements, but it is also reasonable to suppose that the deposition of the ores may be traced to the same causes and that it was a result of igneous activity accompanying the disturbances. Metal-bearing solutions emanating from deep-seated intrusions during cooling would find a ready exit along the fractures then formed, and during their upward passage the mineral contents would be thrown out of solution with fall of temperature.

Fissuring and mineralization must have been closely connected, since free channels of circulation could only be furnished by recently formed fractures. Fractures of earlier date would most likely be sealed up, and would offer, therefore, no ready passage to the solutions. For this reason it is not anticipated that a search for ore in the pre-Silurian fractures is likely to meet with any success. On the other hand, spaces formed between bedding planes by the differential movement of the strata during folding were sometimes the receptacles of ore, and this mode of occurrence is well seen along the bedding planes at the junction of the Stiperstones quartzite and Mytton beds, south of the Bog Mine. The so-called parallel veins which, according to old plans, run diagonally across the Ryder vein in the Pennerley Mine would also appear to be of this nature, and there is little doubt that throughout the district this infiltration of material into suitable spaces bordering the main lines of mineralization has led to a false conception of the number of true veins.

**Genesis and Distribution of the Ores.**

From the foregoing it will be gathered that the genesis of the ores is attributed to magmatic solutions emanating from deep-seated intrusions during a period of crustal disturbance connected with the Caledonian movements, which affected the district in post-Silurian times. The occurrence, in other parts of the British Isles, of granite masses of Caledonian age suggests a similar presence in this district, the rocks being still concealed at some depth below the surface.

With the exception of the barytes deposits in the Pre-Cambrian strata, which have been formed by a rearrangement of previously deposited material, there is no evidence that the ores are of superficial origin. Their manner of occurrence, vertical distribution, and physical characters all favour the assumption of a deep-seated formation. On the other hand, this conclusion must not be taken as implying a more or less indefinite continuation in depth, for there must have been particular conditions of temperature and pressure controlling ore-formation, and deposition was closely dependent upon the characters of the country rocks adjacent to the fissures. The distribution of the ores, therefore, must be considered in relation to these various factors, and by so doing a fairly definite range can be established.

The relative distribution of the several ores is a result of their different solubilities at successive temperatures during the cooling of the solutions accompanying their upward passage. The limitation of different metals, in deposits carrying a number of ores, to more or less well-defined zones has been established in many mining districts, and the conditions attending deposition at different horizons have been investigated in considerable detail, especially by American geologists. It has been shown, for example, that the sequence of deposition from solutions containing tin, copper, zinc, and lead takes place in the following order, with the formation of a series of easily recognizable zones, though their definition is necessarily subject to a certain degree of overlapping:

1. A deep zone carrying tin and some copper.
2. An intermediate zone of chiefly copper.
3. An upper zone containing chiefly zinc and lead, the deposition of the former metal being in advance of the latter. Barytes, also, is formed in this zone.

In this district, the first-named zone is not represented at the surface, though it may possibly exist at considerable depth. Of the latter, the copper zone is found in the Pre-Cambrian rocks on the east of the Stiperstones, while the lead-zinc-barytes zone is confined to the Ordovician rocks on the west of that feature. Only insignificant amounts of lead ore have been encountered in the Pre-Cambrian area, while the occurrences of copper in the lead-bearing veins of the Ordovician rocks are likewise unimportant, being of the nature of small and impermanent stringers. It is evident, therefore, that we are dealing with deposits which represent different zones of mineralization, formed at different horizons. A study of the geological
relationship of the two areas shows that they are separated by a pronounced fault which represents a considerable displacement of the strata, and as already suggested, has doubtless experienced repeated disturbance. It may be safely assumed, therefore, that the relative positions of the zones have undergone considerable modification since the period of mineralization.

The accompanying diagram (Fig. 4) is intended to illustrate the conditions supposedly existing at the time of mineralization. It is considered that at that time the Cambro-Ordovician strata occupied a higher position relatively to the Pre-Cambrian rocks than they do now, and that these latter were then concealed at such a depth that they were largely within the zone of copper deposition. The Ordovician rocks, on the other hand, received the mineralizing solutions at a temperature at which most of the copper had been extracted and the deposition of zinc, lead, and barytes was taking place. Subsequent faulting has brought the two zones into horizontal position, and the accompanying denudation has removed the lead-bearing rocks which formerly overlay the Pre-Cambrian strata to the east.

So far as the available evidence goes, therefore, we may conclude that the ore-bearing solutions deposited their copper content during their passage through the deep-seated Pre-Cambrian rocks, and that it was not until they entered the upper portion of those strata, or even the overlying Ordovician rocks that the temperature had fallen sufficiently to allow of the deposition of zinc, followed by lead. The barytes was one of the last minerals formed, so that its position in the veins is of the nature of a capping.

The extent of mineralization was controlled by the nature of the fissures to be traversed, the varying country rocks affording very different conditions in this respect. This influence was apparently entirely a physical one, and there seem to be no good grounds for supposing that chemical action played any important part. Thus, deposition must have been at a maximum in those rocks, which favoured the formation of clean, well-defined fractures, affording a free and easy circulation to the solutions, while retarded or opposed where the fracturing was ill-defined, as in shales. The latter, therefore, have a limiting effect upon the extent of mineralization, for the lack of suitable circulation channels would tend either to hold back the solutions or, in places where the hydrostatic pressure was sufficient to force a passage, the increased pressure would have the effect of raising their solvent power, thus delaying deposition until a more suitable environment was encountered.

These variations are well seen in the Cambro-Ordovician rocks. The Cambrian shales at the base of the sequence are quite unproductive, and the passage of the solutions through these rocks from the underlying Pre-Cambrian was evidently unaccompanied by ore-deposition. With the reduction of pressure accompanying the entry of the solutions into the freer channels of the overlying Mytton beds deposition became active, though here there are rich and poor zones of ore corresponding to the alternations of grit and shale bands. The succeeding Hope shales furnish another unproductive zone, and it is evident that ore deposition again failed here. Moreover, the nature of the ore occurrences at higher horizons suggests that these beds acted as a severe check to the further progress of the ore-bearing solutions so that the Mytton beds became the loci of maximum deposition in the lead-bearing zone. In certain favourable situations, however, the solutions worked their way to higher levels, but having already parted with the bulk of their lead, and almost certainly the whole of their zinc contents, contained principally barium. The practically pure barytes deposits of Weston and Wotherton Mines, and the sporadic occurrences of lead ore found in the Stapleley ashes at Rotton Castle and elsewhere, may
be thus accounted for, but the evidence shows that commercial deposits of lead and zinc are not to be generally anticipated above the horizon of the Mytton beds. These constitute, therefore, the chief ore-bearing zone of the district. The upper part of this zone is richest in lead, and this metal tends to be displaced by zinc at lower levels, while it is likely that there will be a general impoverishment in depth. The lower limit of the lead-zinc zone is furnished by the Stiperstones quartzite, and the underlying Cambrian shales are, as above stated, quite unproductive.

In the Pre-Cambrian rocks the exposed copper content is very disseminated in its occurrence, and gives evidence of having experienced considerable migration and dissipation in the porous country rocks. Secondary enrichment and concentration of the material have locally taken place, as at Westcott, where it was formerly mined, but on the whole it is widely diffused and holds out little encouragement for being worked. As we are dealing with a leached zone there is, of course, every possibility of meeting with richer and more defined deposits in depth, below the zone of oxidation, but so far as the nature of the exposed occurrences goes there is no evidence of the existence of any extensive bodies of ore.

The presence of barytes in association with the copper would appear to present an anomaly, since the formation of this material belongs to the last stage of mineralization and its primary deposition cannot have taken place, therefore, in the copper zone. An examination of the material, however, shows it to be markedly different from that occurring in the lead veins, and the distinction is so pronounced as to at once suggest a difference in origin. It is characterized by a pink colour, due to the presence of finely divided iron oxide, and is frequently intimately associated with quartz and mixed with brecciated fragments of the country rock; its habit and appearance are totally distinct from that of the white crystalline barytes which occurs in the veins of the Ordovician rocks. The latter material is usually very pure and forms considerable masses with well-defined walls and no admixture of country rock. All the evidence favours the idea of a secondary origin for the barytes of the Pre-Cambrian rocks, and it is to be regarded as a re-deposition of material removed from the upper portions of the veins during the denudation of the overlying rocks.

Its occurrence, therefore, is superficial in extent, and no great persistence in depth is to be expected.

Many of the lead veins of the district carry no barytes capping, and it seems likely that these belong to a slightly earlier period of mineralization than the others. As a general rule it may be taken that the veins having an easterly and westerly trend have a barytes capping, while those bearing north-west carry lead ore up to the surface and have little or no barytes content. The distribution of this mineral, however, is subject to much local variation, and veins carrying little or none may be found adjacent to others which have yielded it to a considerable depth with only a sprinkling of lead ore.

In many of the veins the barytes is stained black with bituminous matter and occurrences of a pitch-like substance in the veins have often been reported. This phenomenon is met with both in the veins of the Pre-Cambrian and of the Ordovician strata, but the fact that it is found principally in the northern portion of the area suggests that it may be attributed to the former presence of overlying Coal Measures, from which carbonaceous matter was derived by some process of distillation.

SUMMARY OF THE HISTORY OF MINERALIZATION.—The main facts and deductions relating to the mineralization of the district may, for convenience of reference, be summarized as follows:—

The ores occur principally in, or in close association with, a series of fissures trending N.W.–S.E. and E.N.E.–W.S.W. These directions are subject to some variation, but they represent the main lines of fracturing which influenced the flow of the ore-bearing solutions and determined the positions of the resultant mineral veins. Subsidiary occurrences of ore occupy spaces between bedding planes, produced by differential movement of the strata during folding.

The formation and subsequent filling of the vein fissures were connected with the disturbances which affected the district in post-Silurian times. These disturbances, acting upon the resistant Ordovician and older rocks, found expression in the formation of two sets of fractures, approximately at right angles, and along these the ore-bearing solutions travelled from deep-seated sources.

The fracturing did not extend to the Silurian strata which, being previously undisturbed, underwent simple folding.
They subsequently offered, therefore, no suitable channels for the circulation of the solutions and did not become mineralized.

The fracturing of the older rocks was best developed in the harder beds, such as the Mytton grits, becoming ill-defined and dissipated in the soft shale bands. The former, therefore, by affording a free circulation to the ore solutions, favoured mineralisation, whereas the latter, by offering difficulties of negotiation, retarded or opposed deposition. Hence the mineral contents of the fissures do not extend for indefinite distances, but are intimately related to the country rocks and may be definitely allocated to particular horizons.

The source of the ores may be traced to deep-seated igneous activity connected with the earth movements, and they probably originated with the intrusion of subterranean granite masses, which subsequent denudation has not yet exposed. The solutions, emanating from these intrusions deposited, so far as the evidence goes, first ores of copper followed by those of zinc and lead, and finally barytes. The main zone of copper deposition was in the deep-seated Pre-Cambrian rocks, while the deposition of zinc and lead ores and barytes took place in the overlying Ordovician strata.

Faulting along the margin of the Pre-Cambrian mass, subsequently to vein formation, has brought the zinc-lead-barytes zone of the Ordovician alongside the copper zone of the Pre-Cambrian, much of which, together with the overlying rocks, has been removed by denudation.

The exposed occurrences of copper ore in the Pre-Cambrian rocks are the result of considerable alteration and rearrangement of material, and no primary deposit has yet been observed. This portion of the zone has evidently experienced considerable leaching, and enrichment may be expected in depth, but the observed data do not warrant the expectation of any large bodies of ore.

The barytes now occurring in the Pre-Cambrian rocks is a secondary deposition of material deriving from the upper portions of the veins during the denudation of the overlying strata. It is, therefore, superficial in extent, and unlikely to persist beyond moderate depths. It is widely distributed in veins of a somewhat impersistent character, varying from mere stringers up to deposits may feet in width. Considerable quantities of the material should be available.

No ore formation took place in the Cambrian shales. In the succeeding Ordovician rocks deposition took place chiefly in the Mytton beds, where the solutions were apparently dammed back by the overlying Hope shales. Such solutions as penetrated beyond that horizon appear to have carried principally barium and only small amounts of lead. Considerable bodies of the former material have been encountered at higher horizons, but no commercial deposits of lead are to be anticipated.

The vertical range of the productive lead and zinc ground is thus between the base of the Hope shales above and the Superstones quartzite below, with a maximum depth, where the beds dip most steeply, of about 2,000 ft. The upper portion of this zone, down to about 1,200 ft., is principally lead-bearing, below which there is a predominance of zinc. Horizontally the distribution of the ore is influenced by the alternations of grit and shale, the shoots, or rich portions, occurring in the former and dipping westward with the strata. The richest bunches of ore occur in pipes along the junctions of the two sets of fissures where these cross one another, as at Tankerville and the Beg Mines.

The barytes belongs to the last stage of mineralization; it therefore often forms a capping to the veins and gives place to lead in depth. The latter mineral, in its turn, becomes largely replaced by zinc, and it is likely that there will be a general impoverishment towards the bottom of the zone. The district undoubtedly still contains considerable reserves of zinc ore, but so far as lead ore is concerned several of the deposits appear to be worked out.

ACKNOWLEDGMENT.—Most of the information given in this article was obtained during an examination of the district made on behalf of the Shropshire Mines, Ltd., and the writer is indebted to the chairman and directors of that company for their courteous permission to make use of it.