A Study of the Distribution of Zinc in the South Crosscut of the C.S.M. Mine

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Abstract

THE general geology of the crosscut is described and the order of formation of the geologic components therein is established. The distribution of zinc is noted : the analytical method employed is outlined, and the significance of the results is discussed.

This paper contains the results of work undertaken primarily in order to obtain experience in the application of geochemical methods to the search for ore-bodies underground. It was also hoped that useful information might be obtained concerning the nature of geochemical anomalies in lode-bearing granite.

For a number of reasons (some of which were non-geological), it was decided to carry out the work at the School Mine which is situated near Beacon on the N.W. flank of the Permo-Carboniferous Carn Menellis granite mass ; and the south crosscut, which is about 90 ft. below the surface, was selected as the most promising part to study. It was, however, realised at the outset that the limited length of the crosscut would probably preclude the collection of sufficient data to establish a *comprehensive* picture of the distribution of any given metal in the lode-bearing granite.

As the Main Lode, which occupies one end of the crosscut, contains appreciable quantities of sphalerite it seemed likely that the adjacent country-rock might contain significantly higher-than-background amounts of zinc which would indicate the presence of the lode at points where direct mineralogical evidence was lacking. Consequently it was decided to study the distribution of this metal.

The course of the study was as follows :

1. Mapping the geologic components of the crosscut and determining their mineralogical characteristics, etc.
2. Determining sampling points : sample collection and preparation of samples for analysis.
3. Selecting a suitable analytical method.
4. Analysing the crosscut samples.
5. Determining the zinc background values of the local granite.
6. Evaluating the combined geologic and analytical results.

1. General Geology (see Plate 1.)

The crosscut is in granite which is intersected by porphyry and aplite dykes, joints, and hypothermal veins which vary considerably in size and mineralogical characteristics.

Granite

The unaltered granite of the crosscut is a gray porphyritic variety containing much biotite mica. The felspar phenocrysts, which are about one inch in length, are for the most part orientated with their long axes dipping at approximately 47° N.

Porphyry Dykes

The most prominent feature in the east wall is a dark gray, quartz-porphyry dyke which occurs at about 30 ft. from the cross-cut entrance and branches at about 2 ft. from the floor. It splits into three branches in the roof and these persist in the west wall. The largest is 2 ft. wide, whilst the other two vary in width from a fraction of an inch to 2 in. and from 4 to 6 in., respectively. Within these bodies the felspars are unorientated and the larger ones tend to occur in aggregates. Small granite xenoliths are in evidence. The porphyry is locally intersected by stringers containing tourmaline and/or chlorite, and in some places the rock is tourmalinised in the vicinity of the stringers. A small pocket of fluorite occurs in the porphyry on the west wall.

Another dyke, which is mineralogically similar to the one already described, is exposed at a few feet from the present working face. It dips 50° S. and varies in thickness from about a $\frac{1}{4}$ to $1\frac{1}{2}$ inches.

The dykes cut sharply across the felspars of the granite and are doubtless true intrusives.

Aplites

Two tourmaline-aplite dykes, each about an inch wide, occur near the entrance of the crosscut. The more regular one dips 78° S.E. and has a strike of 025°. In this dyke the tourmaline consists of fine, needle-like crystals disseminated throughout the body, but there is an increased concentration on the hanging-wall side. In the other dyke there is a much greater tendency for tourmaline aggregates to occur which are composed of crystals up to a quarter of an inch in length.

Jointing

The strikes and dips of the predominant joints in the granite are as follows :—300°, dipping 84° N.E. ; 345°, dipping 85° N. ; and 075°, dipping 60° S.

The strikes of the two major joint systems of the porphyry dykes are 300° and 025° and their dips are, respectively, 80° N.E. and 73° N.W.

Veins and Lodes

Throughout the granite and porphyry numerous extremely narrow stringers occur which display considerable variation both in dip and strike. (The dips vary from 70° S. to 70° N.) These stringers consist of quartz, together with tourmaline and/or chlorite, and when the latter is present traces of sphalerite may also occasionally be seen. Moreover, the crosscut also intersects the following comparatively large veins :—

i. The Main Lode, which is situated at the entrance of the crosscut, varies in width from an inch to 7 feet within the mine and has an average dip of 85°-90° S. and a mean strike of 070°. (This strike coincides with that of the major tin/copper lodes of the district.)

The lode consists essentially of chloritised granite and contains pyrite, chalcopyrite, arsenopyrite, fine-grained cassiterite, and large, irregularly distributed aggregates of small dark sphalerite crystals.

Oxidation of the sulphide components is slight and *may* have occurred largely during the phase of mining operations.

ii. In the west wall, at about the middle of the crosscut and just to the north of the major porphyry dyke, a near-vertical vein occurs which varies in width from a small fraction of an inch to 1½ inches. This vein splits into two branches in the roof and these persist to near the base of the east wall where they again unite. The vein is composed of quartz and a few small scattered crystals of fluorite. No heavy-metal minerals are visible. The granite along both sides of the vein is heavily chloritised for about 3 inches and some of the adjacent felspars are pink.

iii. A quartz vein which is a quarter of an inch wide and bordered by chloritised granite intersects the porphyry dyke in the extreme end of the crosscut. On entering the dyke the vein is deflected so that its dip approximates to that of the host.

Late Hematite-stained Fissures

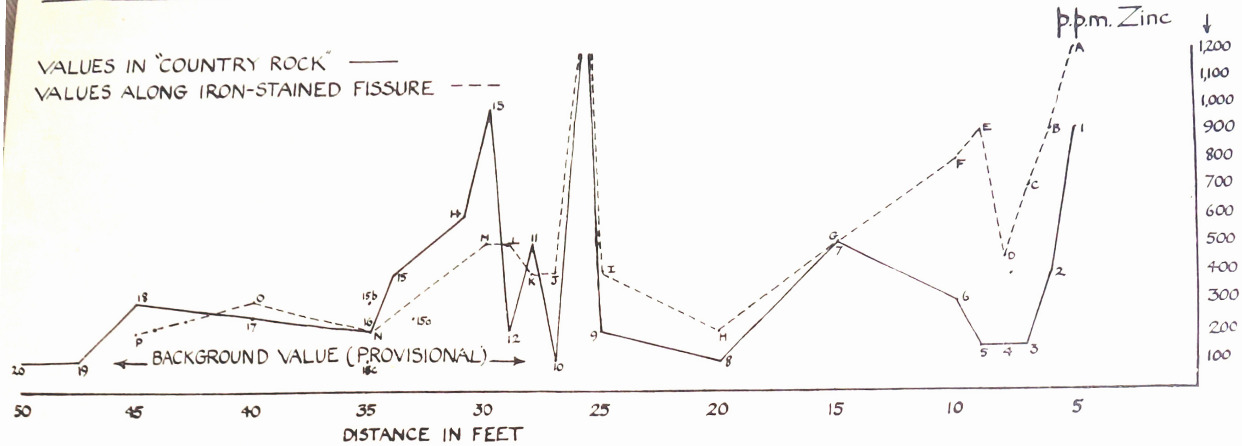
A fairly flat hematite-stained fissure extends along most of the crosscut at 3 to 5 ft. above the floor. This fissure appears to die out within a few feet of the present working face but another commences there at a slightly higher horizon and persists to the limit of working.

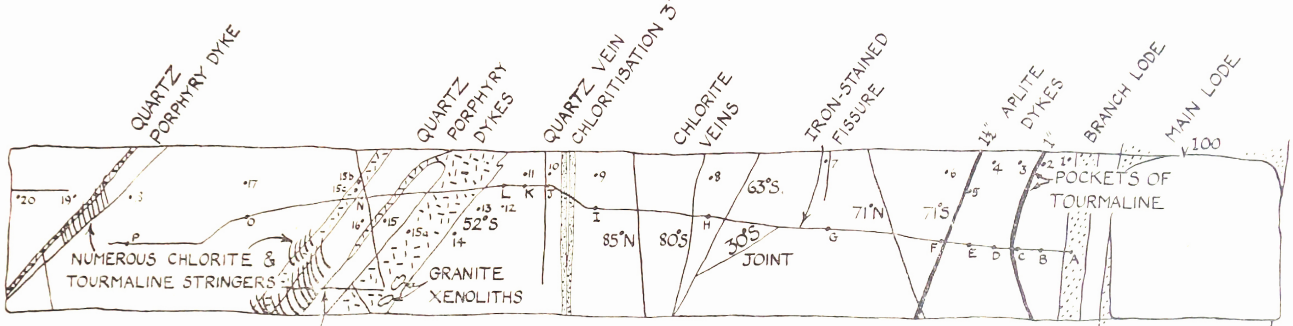
It is probable that these fissures are floor joints which have served as passage-ways for supergene, iron-charged water.

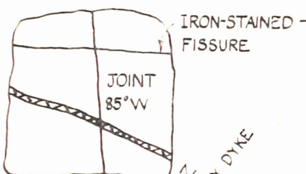
Developmental History

Following the emplacement of the granite a number of porphyry and aplite dykes were intruded. Subsequently quartz/tourmaline stringers were formed and locally the rock adjacent to these was somewhat tourmalinised. In due course fissuring became more intense and the character of the ascending mineralising agents changed so that stringers of quartz/chlorite were formed, together with larger veins composed essentially of quartz and bordered by chloritised granite, and lodes consisting essentially of highly chloritised granite in which cassiterite, chalcopyrite, sphalerite, etc., were

DISTRIBUTION OF ZINC IN THE WEST WALL

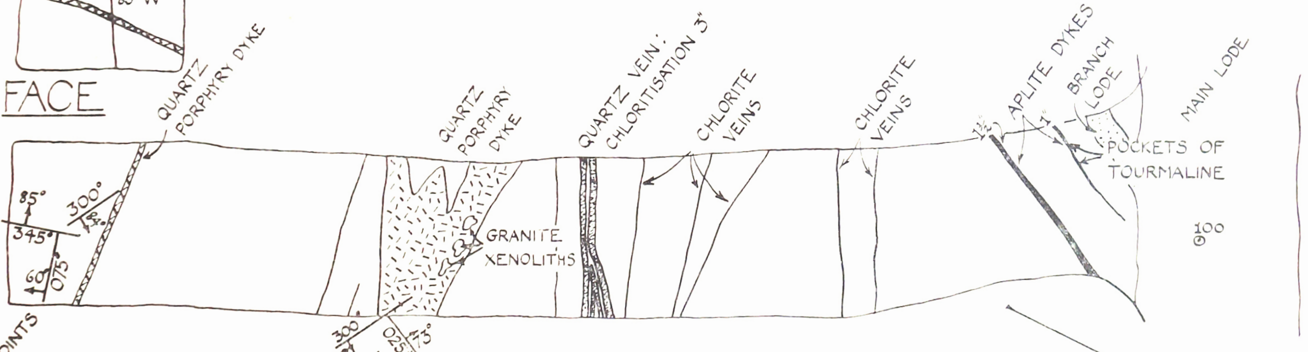




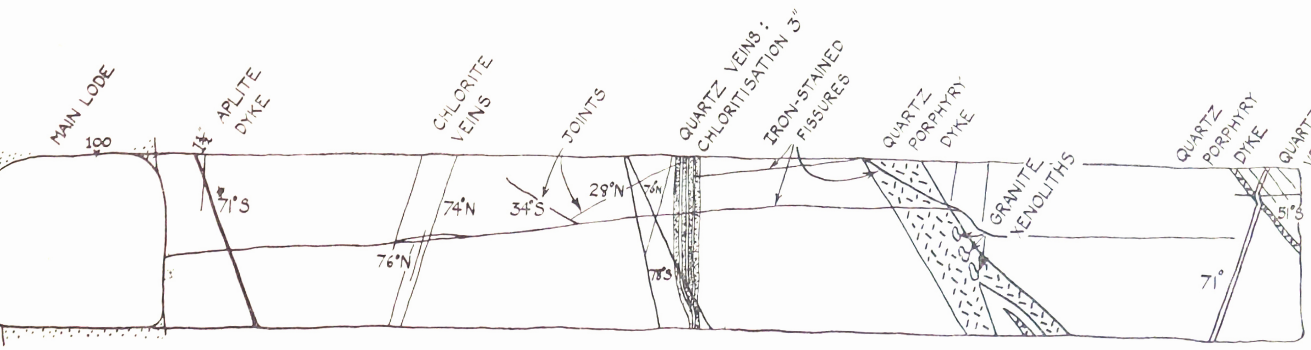


FACE

WEST WALL (WITH SAMPLE POINTS INDICATED)



PLAN



EAST WALL

SCALE 1:30

PLATE 1

volumes of the supernatant solution are shaken with 5 ml. of a 0.0025 per cent. solution of dithizone in carbon tetrachloride until a colour is obtained which matches that of the standard.

About 60 determinations can be made on powdered samples per man-day, but great care must be taken to prevent contamination. Furthermore, a fresh standard must be prepared at intervals of 30 minutes and a number of check analyses must be carried out.

The results obtained were plotted immediately above a geological section of the west wall for ease of reference (see Plate 1.).

4. The Zinc Background Value

In order to make the maximum use of the results obtained by analysing the samples from the crosscut it was necessary to obtain the zinc background value of the granite of the area. This presented some difficulty as a true background value could not be obtained by analysing weathered outcropping granite, and therefore the only granite which could be employed was that from quarries or mine dumps. The danger attending the use of material from mines is obvious ; and quarries in the area are not numerous and, in any case, the rock in them is often somewhat mineralised. Furthermore, only a few of the available quarries are situated on the same type of granite as that of the School Mine. However, apparently fresh granite was analysed from five sources and the results obtained were as follows :—

	p.p.m. Zinc
Bosleake Qy. (Carn Brea)	140
Martin's Qy. (Carn Marth)	140
Carnsew Qy. (Carn Menellis)	140
Trumpet Consols Dump (Carn Menellis) ...	110
Holman's Qy. (Carn Menellis)	80

(Holman's Quarry is comparatively near the School Mine and situated on the same type of granite.)

Provisionally 100 p.p.m. of zinc has been accepted as the upper background limit.

5. Discussion of Results

Four high-zinc zones have been established independently by analysis of each of the two groups of samples. These are spatially related to the Main Lode and its branch ; a chloritic stringer near sample point 7 ; the chloritised granite-bordered quartz vein in the middle of the crosscut ; and postulated micro-fissures situated between this vein and the *hanging* wall of the major porphyry dyke.

i. *Results obtained by analysing the "normal" wall-rock.*

The marked manner in which the concentration of zinc in the wall-rock decreases as the distance from the Main Lode and its branch increases is probably due largely to the paucity of micro-fissures in the rock adjacent to the ore-body, and to the highly effective zinc precipitation process which prevailed.

The comparatively low zinc values encountered between the aplite dykes is, of course, due largely to the fact that fissures were lacking which were more or less in *direct* contact with the source of the mineralising agents, but the dykes may also have assisted in keeping the values low by acting as barriers to zinc ions attempting to migrate laterally from the high-zinc zones immediately to the north and south.

The concentration pattern of zinc in the band of appreciably higher-than-background values in the vicinity of sample point 7 can be satisfactorily explained by assuming that the zinc there migrated laterally from a pronounced fissure which is now represented by the marked chloritic stringer noted on the accompanying section (see Plate 1). An alternative explanation may be offered by assuming that the zone was intersected by a series of steeply-dipping micro-fissures — all of which were in more-or-less direct contact with the source of the ore-forming "solutions" — and which were initiated contemporaneously with the marked chloritic stringer noted above, but which were progressively less well-developed to the north and south of this stringer and consequently permitted the passage of progressively smaller amounts of zinc. (It is to be noted that vein systems showing the fundamental characteristics postulated here are not uncommon in Cornwall.)

The extremely high zinc values associated with the chloritic granite-bordered quartz vein occurring in the middle of the crosscut is interesting in that no sphalerite is visible either in the quartz or in the adjacent altered granite (although it doubtless occurs in the latter in a finely disseminated state and might be recognised in a thin section).

It is likely that the reasons proposed to explain the marked decrease in zinc in the vicinity of the Main Lode apply equally well to the similar phenomenon encountered here.

It is worth noting that had the crosscut been driven from S. to N., the establishment of high zinc values in this vein, as soon as it was intersected, would strongly suggest that a belt of ground had been entered which might well contain economically important deposits and would constitute strong justification for extending the crosscut northwards.

The anomalous zinc values occurring between the vein noted immediately above and the major porphyry dyke must be due to the migration and subsequent precipitation of zinc along a series of micro-fissures during the phase of hypogene mineralisation. Whether the zinc-bearing "solution" ascended directly into these fissures, or whether it ascended a fissure now represented by the marked quartz vein immediately to the north and having been partially impounded by the porphyry dyke descended into the micro-fissures, is uncertain.

ii. *Results obtained by analysing the hematite-stained fissure material.*

The zinc distribution pattern established by analysing material intersected by the hematite-stained fissure approximates to that already described. This indicates that very little zinc has been added or abstracted by any supergene solutions which migrated along the fissure. However, the slight displacement of the "fissure anomaly" with respect to that established in the "normal" wall-rock near sample point 7 may be due to late and local migration of zinc along the fissure, which in this part of the crosscut dips northwards. Similarly, the much smaller variation in zinc values recorded along the fissure between points H and M than that between points 8 and 13 in the "normal" rock, may be due to slight, essentially northwards, movement along the fissure during the stage of supergene activity.

General Conclusion

On account of the somewhat limited nature of the investigations it is unwise to make more than a general and somewhat tentative conclusion. It would appear, however, that although zinc may not migrate far from a lode into the granite wall-rock, yet on account of the fact that frequently a given lode is closely associated with numbers of subsidiary stringers — some of which were developed contemporaneously with the lode — anomalous zinc values may be encountered at very considerable distances from the main seat of mineralisation, and the establishment of these would, therefore, facilitate the search for ore.

REFERENCES

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Field method for the determination of zinc in soils. 1949, **44**, 296-306.

MINING WITHOUT TEARS

Leading atomic scientist, Dr. Vannevar Bush, said science would discover ways of using atomic and solar energy to draw vast mineral wealth from deep inside the earth "without the need for any men working underground".

And he went on, scientists would be able to train living organisms — tiny plants and sea animals — "to recover metals from the sea".

***Daily Mail*, Dec. 10th, 1955.**

A.C.S.M.s for globigerina ?