

A GEOCHEMICAL RECONNAISSANCE SURVEY AT MINAS DA ARGEMELA, PORTUGAL

K. F. G. HOSKING,
B.Sc., M.Sc., Ph.D., A.M.I.M.M.

Abstract

The determination of tin, by Wood's gallein method, in B-horizon samples from a shallow residual soil overlying hilly slate country containing numerous, often closely-spaced, narrow, near-vertical cassiterite/quartz veins, has demonstrated that applied geochemistry can locate those ore-bodies which are economically most important. Hence it can greatly facilitate and expedite prospection and general evaluation.

The work has also indicated a hitherto unknown tin-high zone.

Minas da Argemela is a tin mine situated in Central Portugal at about 13 km. to the east of the famous wolfram producer Minas da Panasqueira. (Fig. 1.)

Although it is possible that the area may have been known for centuries to be tin-bearing, serious interest in its mineral potential was first taken in the period 1947-50 when three cross-cuts were driven which intersected many cassiterite veins and some of the richest of these were locally worked to c. 150 ft. below the surface. Comparatively recently the area was acquired by Beralit Tin and Wolfram, Ltd., and this company has, to date, largely confined its attention to determining the potential of the area by means of exploratory cross-cuts, diamond drilling and by driving along certain economically interesting veins. However, in addition, some cut and fill stoping has been done and also some opencast work.

Geology (Figs. 1 and 2.)

The area in which the tin veins occur consists of a pale-grey Cambrian phyllite (charged locally in the vicinity of the ore-bodies with crystals of arsenopyrite) which forms the north-western flank of a hill containing a core of quartz porphyry outcropping at the summit. The present mine workings are largely confined to the sides of a valley excavated in the slate and striking c. N.N.W.

Two dykes — the "White" and the "Black" — both near-vertical and several metres wide — have been encountered during mining operations. The White Dyke is very fine-grained and is composed almost entirely of soda-rich plagioclase crystals in a matrix in which minute plates of mica are prominent: it may well

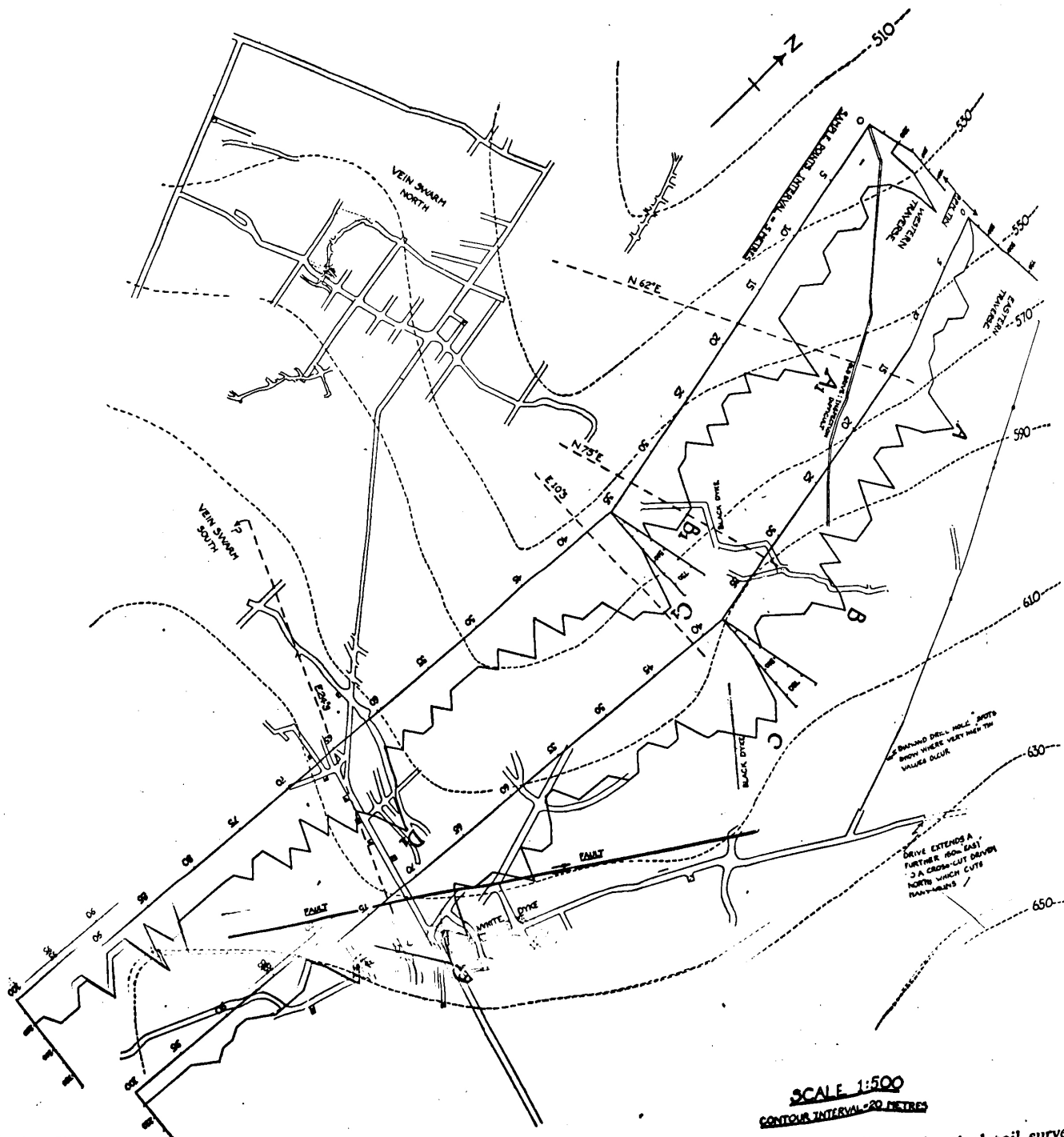


Fig. 2. Simplified plan of drives, etc., on Level 1, Minas da Argemela, together with the results of the geochemical soil survey.
(This plan is published by permission of Beralt Tin & Wolfram, Ltd.)

be that the matrix has been greisenised during the period of tin-vein formation. Blebs of greisen are also occasionally seen in thin section, as are stringers of white mica bordered by scattered crystals of arsenopyrite.

The Black Dyke was originally composed essentially of tiny crystals of plagioclase, but it has since been so greisenised that only traces of the original feldspars are now visible. The rock is charged with minute black crystals, occurring singly or in aggregates, which are almost certainly magnetite. Pyrrhotite, often surrounded by quartz, is common, and was possibly introduced during the phase of vein development. Exploratory work suggests that mineralisation tends to be poorer to the east than to the west of the dyke. In view of the distribution pattern of the lodes (noted below) it is likely that the mineralising agents entered the area from a point considerably to the west of the dyke, and so it may well be that the latter tended to restrict their migration eastwards.

The considerable mineralogic differences between these two — as yet petrologically unclassified — dykes may be due, at least in part, to the fact that whereas the Black Dyke is roughly normal to many of the important veins, the White Dyke tends to strike parallel to those adjacent to it.

The countless "mineralised" veins encountered in the mine are frequently closely spaced, generally near-vertical, and vary in thickness from a fraction of an inch to c. 8 in. Cassiterite is the only mineral of economic importance, and the larger veins often consist of two bands of this mineral separated by a central quartz leader which itself may be bordered by slight selvages, or marginally disposed pockets of sericite. In addition, certain veins contain some pyrite and/or arsenopyrite.

Underground exploration has indicated that swarms of tin-rich veins are separated by zones which are comparatively poorly mineralised. Recent work has been largely concerned with two swarms, the "North" and the "South". Underground work has also shown that the richest veins are arranged, in plan, in the form of a fan — a fact which has been emphasised by the geochemical study — and they probably diverge from a point at no great distance to the west of the workings on the North vein swarm.

Several post-vein faults have been discovered in the area and their existence must be constantly borne in mind when interpreting geochemical analytical results. However, so far as the present study is concerned, only one, which strikes approximately N. 32° E., and which occupies the ground between anomalies D and D1 (Fig. 2), may be of importance. Possibly the lateral displacement due to this fault may have caused the line joining the "centres" of the anomalies D and D1 to be so orientated that the strike of the vein (or veins) to

which these high values are due, appears to depart from north by a greater amount than may, in fact, be the case. Against this possibility the highest values in these anomalous areas are on the *same* side of the fault as it is represented on the plan. Faults, however, are rarely as simple as they appear to be on plans and obviously more information relating to this fault is desirable. Finally, it is important to note that the whole of the area is covered by a thin residual soil which supports pines, ericas and other calciphobic plants. It follows, also, that the collection of soil samples in this area is very easy.

Geochemical work

The geochemical work described in this paper was carried out primarily in order to discover if the analysis of soil samples from Minas da Argemela would yield data which would facilitate the tracing and discovery of the most important tin-bearing veins despite the fact that incipient mineralisation was widespread. With this aim in view c. 200 soil samples were taken from near the base of the B-horizon at intervals of 5 metres along two parallel traverse lines which were c. 60 metres apart. (See footnote.) These lines were so sited that they passed over the South vein swarm where it had been examined underground, and over an area to the N.E. of the North swarm workings but into which the swarm was likely to extend. They also passed over an isolated drive on a promising vein and across a central zone which had not been explored.

The soil samples were taken by means of an auger, then stored in resin-impregnated envelopes and shipped to England where they were analysed by third year students of the Camborne School of Metalliferous Mining.

Analytical method

Tin was determined in the minus 80-mesh fraction of the dried soil by Wood's gallein method (1956) and the original paper should be consulted for details. However, in essence, the method first involves fusing 0.2 g. of the soil with ammonium iodide in an 18×180 -m.m. Pyrex tube. The cooled product is next leached with 5.0 ml. of N-HCl, and after allowing the insolubles to settle, an aliquot of the clear solution (0.1 or 0.2 ml.) is transferred to a 15×150 -m.m. tube. A volume of chloroacetic acid/sodium chloroacetate/hydroxylamine hydrochloride buffer solution, equivalent to four times the volume of the test solution is warmed gently until it becomes colourless. The volume of the solution is then increased to 10 ml. by the addition of metal-free water and 1.0 ml. of 0.005 per

The choice of sampling horizon was determined partly by the shallow nature of the soil and partly by experience gained in similar areas.

cent. aqueous solution of gallein is added. (This reagent forms a pink complex with tin.) After 10 minutes the colour of the unknown is compared with the colours of a series of standards freshly prepared daily.

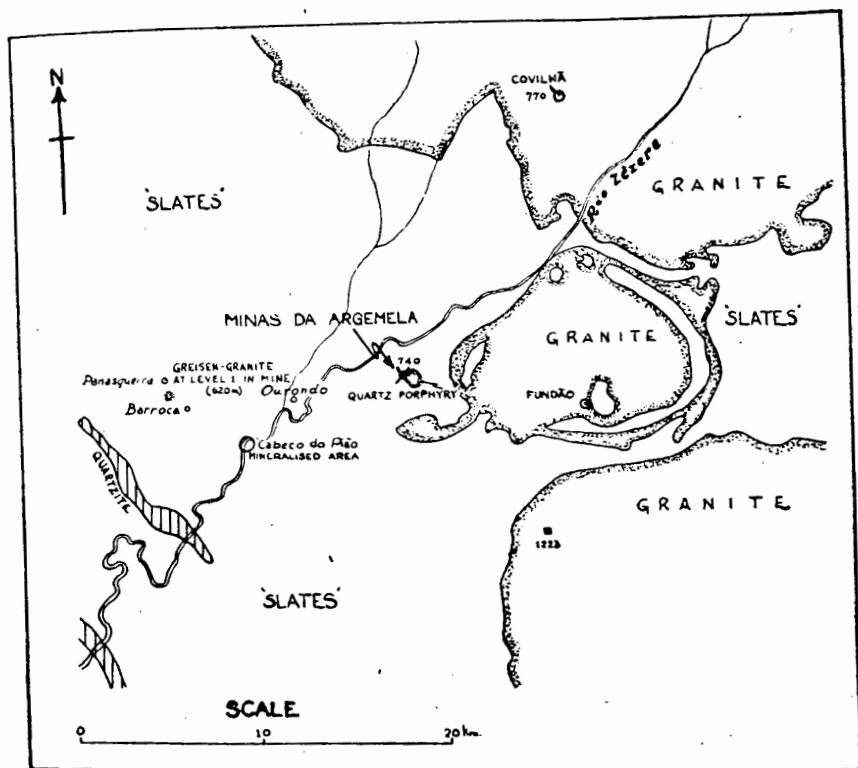


Fig. 1. Map showing the location of Minas da Argemela, and the general geology of the area.

(By courtesy of Beralt Tin & Wolfram, Ltd.)

Interpretation and discussion of results

The following facts emerge from an examination of Fig. 2 in which the geochemical results, underground workings, etc., are plotted:—

The tin content of the soil is rarely less than 250 p.p.m. This fact reflects the widespread mineralisation of the area, as the background value (obtained by the analysis of similar soil samples from unmineralised slate areas) is of the order of 40-50 p.p.m. In addition, however, several exceptionally tin-high zones were located and these are indicated by A, A1, . . . D1 on Fig. 2.

Anomalies A and A1 are probably due to the eastward extensions of one, or more, important veins which have been explored underground to the west. A line joining the "centres" of these anomalies has substantially the same strike as that of the relevant underground workings on the North lode swarm. That this swarm continues in strength to the east beyond the soil-traverse zone is suggested by the distribution of the high tin values in the diamond-drill hole there. (It is, however, realised that this last piece of evidence is far from conclusive as a solitary diamond-drill core can give little or no reliable data concerning the tin content of any given vein which the drill might have intersected.)

Anomalies B and B1 almost certainly reflect the tin-rich zone which has been explored partly by the most southerly of the North swarm drives and partly by an adit driven from east to west.

Anomalies C and C1, which are the largest recorded, occupy ground which has neither been explored by "normal" surface nor underground methods, and they may well be due to the hitherto unsuspected presence of one, or more, tin-rich veins. Further geochemical work should be carried out to the east of the Black Dyke to discover the effect of the latter on the distribution of tin in this zone.

Anomalies D and D1 certainly reflect the presence of a rich vein, or veins, in South lode swarm: indeed, D1 is almost exactly over a particularly rich vein which has recently been explored underground. That the apparent strike of the veins, obtained by joining the "centres" of the anomalies is possibly more easterly in trend than the true strike (because of the displacement effected by the development of a fault in the area between the two traverse lines) has already been noted.

Except when a vein strikes at right-angles to the contours of the surface, the resulting heavy-metal anomaly in the overlying soil is likely, because of "creep", to be displaced down-hill. The A/A1 and D/D1 anomalies are the most likely to be so displaced, but there is no evidence that this has been of any real magnitude in either case.

Finally, it is worth noting again that the geochemical work has emphasised the fan-shaped distribution pattern of the major veins which underground exploration had already suggested.

Conclusions

The present study has shown — with somewhat surprising clarity — that at Argemela applied geochemistry can facilitate and accelerate the discovery and the delineation of those veins which have the greatest economic potential. It also suggests that elsewhere in the world areas which are characterised by the presence of numerous closely-spaced mineralised veins — not necessarily tin-bearing — may well repay examination by geochemical methods.

Acknowledgements

The writer wishes to thank the Directors of Beralit Tin and Wolfram, Ltd., for permission to publish this paper. He is also grateful to Mr. G. A. Smith, General Manager of the Panasqueira and Argemela mines, for making maps, plans and much other data available to him. To Mr. S. Smith, a student of the Camborne School of Metalliferous Mining, he extends his thanks for collecting the necessary soil and rock samples and for carrying out the field and underground work relevant to this study. Finally, he wishes to acknowledge the assistance of those 3rd-year students who made the analyses.

REFERENCE

- WOOD, G. A. A rapid method for the determination of small amounts of tin in soils. Technical Communication of the Geochemical Prospecting Research Centre, Imperial College of Science and Technology, London. 1956.

What We Want To Know

Who embraced whom in South Crofty ?
 Why the mine water is acid ?
 Who entered his car for the Grand National ?
 Who has been "taped" ?
 Who sent for the Fire Engine ?
 Who joined the Chain Gang ?
 If "Tuyères" rhymes with "pliers".
 Why Classifiers have guards ?
 What is the attraction in London ?
 Does the Army really need you ?
 Does beating the Reds always mean free firkins ?
 Who wasn't 21 this year ?
 Who forgot the Bottle ?
 Where is the Station gate ?
 Who has all the cards ?
 Snap !
 Who wants Home Rule anyway ?
 Are there any questions ?
 Yes . . . Who won the Squash Cup ?