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No. 12

Mineral investigations in the Teign Valley, Devon
Part 1 - Barytes

Natural Environment Research Council

Institute of Geological Sciences

Mineral Reconnaissance Programme Report No. 12

Mineral investigations in the Teign Valley, Devon

Part 1 - Barytes

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with a geophysical contribution by J.M.C. Tombs, BSc

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Mineral investigations in the Teign Valley, Devon

Part 1 - Barytes

K.E. Beer and T.K. Ball

Summary

Geochemical studies in the Teign Valley, employing stream sediment and soil samples, have indicated extensions of barytes mineralisation some 2.5 km north and 1.2 km south of the formerly mined strike length. Ba-Pb-Zn mineralisation is now known to extend over a total length of 12.3 km and over a width rarely less than 0.5 km, though ore bodies large enough to be worked occur only intermittently within this belt.

The part of the southern extension lying outside the Dartmoor National Park was investigated by a programme of deeper sampling using a Voltrac percussive drill to obtain powdered rock samples for assay. To the south of Hennock village a barytes-rich zone has been defined, some 1.2 km long and 260 m wide, within which narrower high-grade deposits are indicated. Base metal analyses suggest that this barytes is relatively free from serious sulphide contaminants but, in some cases, the iron oxide content is appreciable and the ore is highly discoloured.

GENERAL GEOLOGY

Between Dunsford [SX 813 892]* and Chudleigh [868 796] the River Teign cuts across a succession of Upper Palaeozoic sediments and volcanic rocks which form one structural element in a broad thrust belt which flanks the south-eastern margin of the Dartmoor Granite (Fig. 1). The lowest beds exposed are the Hyner Shales, a sequence of well-cleaved dark blue or blue-grey shales and mudstones with a few calcareous horizons and siliceous nodules, mainly of Upper Devonian age, the uppermost strata being Lower Carboniferous. This formation is conformably succeeded by the Trusham Shale and Combe Shale which have a combined thickness of some 210 m at maximum development. The Trusham Shale is usually olive green or locally grey micaceous shale and the Combe Shale is commonly bluish black in colour. Both are of Lower Carboniferous age. Above these shales lie some 225 m of well bedded cherts and shales - the Teign Chert Formation. Some pyroclastic keratophyric horizons in the cherts are widely developed throughout the valley and with these are associated manganiferous horizons, the richest of which were mined in the early 19th century. In the uppermost part of the cherty beds there are thin layers of grey limestone. The top of this formation marks the upper limit of the Lower Carboniferous. Conformably overlying the cherts are black shales with subordinate thin sandstones and siltstones, the Ashton Shale Member of the Upper Carboniferous Crackington Formation. The major part of this formation consists of grey shales with many turbiditic sandstones.

Within the thermal aureole of the Dartmoor Granite the shales are spotted or hornfelsed and may bear andalusite or cordierite. The limy horizons and some of the cherts have been altered to calc-silicate rocks.

Intrusive sills of albite-dolerite, varying in thickness from a few metres to more than 60 m, occur mainly in the shale formations and rarely in the cherts. Though widely developed in the valley the individual sills usually have only limited lateral extent. They were formerly worked as sources of building stone and aggregate but the only remnant of this industry is now seen at the roadstone and concrete pipe operation at Trusham [849 810].

The Palaeozoic sediments are disposed in a series of broad, but fairly tight, anticlines and synclines with axes trending between north-east/south-west in the north and east/west in the south. The southern folds are sensibly vertical but to the north they are overturned northwards with axial planes dipping at 60° or more. All show an easterly plunge of 40-55°, possibly indicating a tilting effected during the emplacement of the Dartmoor Granite.

Two major north-north-east trending dislocations, the Scanniclift and Lower Ashton stretch thrusts, transect these folds and attenuate the limbs which they displace. Chesher (in Selwood and others, in preparation) regards them as contemporary with the folding and as having originated from the stretching of the overturned steep limbs of the major folds. Also of pre-granite age is the low-angle Bridford Thrust, which marks the northern limit of the Teign Valley succession where it overrides Upper Carboniferous (Crackington Formation) of the Central Devon Synclinorium (Selwood and McCourt, 1973). Normal faulting is widely developed throughout the area. North-west of Doddiscombsleigh [855 866] and Christow [835 850] normal faulting with a north/south strike can be traced; the former cuts and shifts the Bridford Thrust. Normal faults with an east/west strike are more common and several of this trend intersect and heave the granite margin.

Neither the stretch thrusts nor the normal faults appear to carry any mineralisation but Great Rock Mine [around 825 815] and Shuttamoor Mine [around 824 829] worked micaceous hematite filling joints (and small faults?) with an east/west trend. These lodes are displaced slightly by small north/south faults and are probably cut off by a north-west/south-east fault or master joint which defines the valley of the Kennick Tottiford reservoirs [800 850 to 813 827]. Well-developed north-west drainage lines in this part of the granite outcrop are strongly reminiscent of the la-- tear faults recorded in the northern margin of

*All locations mentioned in this report lie within the National Grid 100 km square SX

Dartmoor (Edmonds and others, 1968), though no stratal or contact displacement has been recorded by Chesher to substantiate such an interpretation. A little farther west however, major faults of this trend form the western margin of the Bovey Basin, a deep trough filled with Oligocene sediments, and a fault of similar trend passes through the town of Bovey Tracey [816 786]. The reality of other, iferred, north-west tear faults is more than an academic issue, for such structures may explain the abrupt southern cut-off of the Teign Valley lode zone.

This zone, up to 200 m wide and some 9 km in length trends approximately north/south almost parallel to the granite contact and about 1 km from it. The zone cuts across all the Palaeozoic strata and folding, through the stretch thrusts and the Bridford Thrust and, apparently, is unaffected by (and presumably postdates) the north/south fault near Christow. Locally along its strike minor displacement by east/west faulting has been recorded. The zone comprises several discontinuous en-echelon veins of varying width and mineral tenor, commonly connected by narrower branch veins. Rarely, as described from Bridford Mine [830 865] (Vipan, 1959), stockwork deposits are developed in the walls of the main lodes. All the major veins have steep dips though connecting branch veins may be more gently inclined.

The lodes wherever worked display a similar mineral content though the proportions of those minerals vary considerably. Barytes and quartz, commonly chalcedonic, form the essential gangue, with lesser amounts of calcite, fluorite and, especially in the south, siderite. The major metalliferous minerals are galena and sphalerite with a little chalcopyrite, tetrahedrite and pyrite and traces of argentite. Stibnite has been recorded from Frankmills Mine [836 820] and cobalt and nickel (species unspecified) were reported from Wheal Adams [836 837] in 1853 (Schmitz, 1973). There is a suggestion of some lithological control upon mineral distribution, economically viable tenors of galena being preferentially developed within slaty host rocks (particularly the Hyner Shales) while barytes, essentially free of sulphides and chalcedonic quartz, is best developed within the Teign Chert. Between Aller Mine [835 839] and Bridford Mine, however, galena and barytes are poorly represented, the vein material seen at surface being mainly chalcedonic quartz with some sphalerite.

Surface exposures of the veins are seen only at Bridford Quarry [829 865] and in a trackside [836 833] north of Canonteign House. Both lodes are essentially composed of barytes, dip steeply east and have been worked below the outcrops. At the former locality the main vein (No. 1 of the Bridford Mine) is some 2.5 m wide and consists of sugary and platy barytes with a little quartz but no sulphides. At the latter site the vein (probably East Lode of Wheal Exmouth) is up to 7 m wide and consists of discoloured and white barytes, much of which is brecciated and recemented by brown earthy iron oxides. Within the purer white mineral there are frequent spots of tetrahedrite some of which are altered to green secondary copper carbonates.

MINING HISTORY

Although barytes is a common gangue mineral in the Teign Valley lodes and can be found, in some cases abundantly, on most of the mine waste dumps, sales are recorded from only two mines - Frankmills and Bridford. A comprehensive account of the history of lead mining in the Teign Valley has been published by Schmitz (1973) and the same author has prepared an unpublished sequel upon the barytes industry.

Wide, barytes-rich veins were recorded in several of the mines from the earliest stages in their development but this mineral seems to have commanded no market until 1855 when 35 tonnes were sold by Bridford Mine immediately prior to its temporary closure. At about the same date a substantial barytes ore-body was encountered in the southernmost developments of Birch Ellers Mine [826 870], immediately north of the Bridford property. This was not worked then, nor has it been exploited subsequently.

Bridford Mine reopened for three years between 1870 and 1872 but no production is known to have resulted. In 1875 it was again restarted, the market for pure barytes having noticeably improved by this time, and it remained in continuous production under various ownerships until 1958. During that period it is estimated (Schmitz, 1973) to have produced a total of some 430,000 tonnes of high-grade barytes, mainly for the chemical and paper industries. The only other known production of barytes was 887 tonnes from Frankmills Mine in 1880 (Dines, 1956).

Bridford Mine was developed to a depth of 500 feet (152 m) but most of the production came from workings down to 115 m, below which the lodes were found to carry increasing amounts of deleterious metallic sulphides. Eight significant veins were recognised in the mine, together with several subsidiary branch veins, but only five were worked. The lodes vary in width from 0.6 m to 15 m (Dines, 1956) with the best developements of pure white barytes occurring in the thicker parts. In the wider parts of the lodes it was customary to work only the central purer portion, leaving the less desirable discoloured or sulphidic vein walls to act as additional support for the otherwise structurally weak host rock. Undefined, though perhaps significant, reserves of impure barytes remain, therefore, within the developed sections of this and other Teign Valley mines.

GEOCHEMICAL SURVEYS

During a UKAEA-sponsored uranium reconnaissance project, predating the present programme, a number of stream sediment samples collected in the area were found to contain substantial quantities of barium. Although most of the anomalies could be explained as derived from contamination by mine waste or from known mineralised structures, there were three localities in the north which indicated the possibility of hitherto unsuspected mineralisation. A panning concentrate anomaly of 4.79% Ba was found at [807 896] to the north of Dunsford and others of 430 ppm at [815 909] and 310 ppm at [835 883] to the east of the River Teign, suggesting that barytes mineralisation occurred to the north and east of the known lode outcrops. Mineralogical examination identified barytes in these panning concentrates. The results of these and more extensive investigations carried out on drainage samples from the area are summarised in Fig. 2.

South and south-east of Hennock anomalous concentrations of barium are found in both stream sediments and panning concentrates in an area not known to have supported barytes mining, although a trial at [839 803] might have been for barytes (see page 5). These samples also contained identifiable barytes in the panning concentrates.

Merefield (1973, 1974) considered certain aspects of the drainage geochemistry of the Teign Valley and carried out detailed soil traverses over a number of known veins paying special attention to the non-metallic elements. His maps of the distribution of barium in 22 stream sediments reflect closely the position of known mineralisation with the significant exception of an anomaly of 2040 ppm Ba at [841 793] about 2 km south-east of Hennock, in the same area as high stream sediment and panning concentrate anomalies found by the IGS survey.

Stream sediments collected by Camborne School of Mines from the River Teign and its western tributaries between Swanaford [821 884] and Hennock also reflect barium contamination from former mining operations (R. P. Edwards, personal communication).

Barytes ($BaSO_4$) is the least soluble and most abundant barium mineral in the earth's crust. Its resistance to corrosive attack indicates that it is introduced to the secondary environment mainly by mechanical processes and it may be transported some distance from source while still retaining its integrity as a mineral. The analysis of residual soils therefore provides a means of locating buried barytes deposits and, although the possibility of lateral movement by downhill creep and solifluction should be borne in mind, interpretational problems introduced by the presence of hydromorphic anomalies are minimal.

Most of the soils in the area are, or were, forest brown earths and since deforestation the structure of the soil has been maintained in large part by ploughing. A certain amount of gleying occurs near stream courses, however. Owing to the dissected nature of the terrain and since only reconnaissance work was proposed, most of the traverses were arranged along ridges, thus minimising problems arising from downhill creep, periglacial phenomena and hydromorphic effects. In an attempt to avoid contamination from industrial, domestic and agricultural sources, soil samples were taken with a 1" soil auger from a depth of 0.5 to 1 m, that is below plough level and the level reached by percolation from airborne industrial particulates.

The geochemical soil sampling took place in two stages. Initially samples were collected, subdivided and a fraction analysed for barium, cobalt, nickel, iron and manganese by optical emission spectrography. The same samples were also analysed for copper, lead and zinc by atomic absorption spectrophotometry. In common with other elements which are present in resistant minerals, and in which the final subsample for analysis is small (approximately 10 mg), the subsampling precision for barium is very poor - 30-60% relative standard deviation. The rather high detection limit of about 100 ppm Ba was perfectly adequate for the investigations however, since all the soils contained more than this amount. Subsequent follow-up and extension soil samples were analysed by X-ray fluorescence spectrometry. This procedure has the advantage of analysing several grammes of sample and also has an improved detection limit of about 10 ppm Ba. Threshold values are different for the two analytical procedures. In the earlier analyses the log-probability plot shows a point of reflection at about 1000 ppm Ba (Fig. 3A), whereas in the later analyses this occurs at 750 ppm Ba (Fig. 3B). Owing to the difference in analytical techniques, and the fact that different populations are considered, this 25% difference is not regarded as being important in terms of the identification of mineralised structures.

The first series of traverses was designed to (i) explain the drainage anomalies near Dunsford and east of the River Teign; (ii) investigate the possibility of continuous barytes mineralisation between the former mining sites and (iii) investigate the possibility of extension of the mineralised zone to the north and south of the limits of past mining activity. The results of this early phase of work are represented in Fig. 1, the traverses being identified by crosshatching and the values above threshold level by solid ornament. Further fill-in and extension traverses are identified by the absence of crosshatching with samples above the threshold level indicated by unfilled ornament.

In the north of the area, near Dunsford, the soil sampling traverses show low to moderate values of barium, irregularly arranged with no evidence of a continuous barytes structure. Farther south, in the central part of the area, the irregular appearance of barium anomalies is in accord with the known sporadic distribution of barytes gangue in the lodes.

The major new anomalies were located south of Teign Village [838 810] with substantial values of barium apparently defining a mineralised zone parallel to that known between Hennock and Teign Village but extending farther to the south. The two traverses immediately to the south of Teign Village indicate an apparent width of 400 m of barium values in excess of 1300 ppm, with maximum values of 10 500 ppm. The next traverse to the south indicates an apparent width of anomaly of 150 m greater than 1300 ppm, with two maxima of 6500 and 6700 ppm Ba. The most southerly traverse with an identifiable anomaly exhibits a length of about 300 m with values greater than 1000 ppm and reaching a maximum of 8000 ppm Ba. No barium anomalies were detected in traverses carried out farther west and to the north of Bovey Tracey, although the presence of base metals was indicated. Subsequent drilling confirmed the paucity of barium minerals.

The samples for which barium was determined were also analysed for other metals. The base metal distribution will be the subject of another report but it is appropriate to consider the spatial relationship between the concentration of barium and that of other metals in soils in the expectation that this will indicate the presence of sulphide or iron/manganese concentrations which might adversely affect the commercial value of the barytes.

Anomalous values of manganese and iron (> 3000 ppm Mn and > 14% Fe) are mostly found in the central part of the area between Christow and the vicinity of the Bridford Mine. Although high values occur in samples containing high barium the distribution generally indicates that manganese and iron are not confined to barium-bearing structures. In the southern part of the area, that is south of Hennock, very few anomalously high values of iron and manganese occur and these are not related to high barium concentrations in soils.

High lead, zinc, and to a lesser extent copper anomalies correspond to anomalous barium values in samples from the vicinity of the Bridford Mine, but to the north and west the interrelationship is not close. Between Bridford Mine and Christow, geochemical evidence for barium veins is not conclusive but substantial lead and zinc anomalies are found. There appear to be few lead and zinc anomalies south of Hennock and these are of low amplitude (< 135 ppm Pb and < 270 ppm Zn).

The spatial distribution is borne out by the product moment correlation coefficients calculated for barium with copper, lead, zinc, iron and manganese in drill pulps:

	Cu	Pb	Zn	Fe	Mn
Ba	0.339	0.292	-0.199	-0.243	-0.129

The table illustrates the low degree of correlation of barium with copper and lead and the inverse relationship with zinc, iron and manganese.

The purity of the barytes, as indicated by geochemical soil data, is in agreement with the available lode information, derived both from mine records and recent IGS drilling. Significant quantities of sulphides were discovered in the lower workings of Bridford Mine (Vipan, 1959), necessitating selective mining of quantities of sulphide-free barytes during the last years of operation.

South of Hennock little sulphide was encountered in the drill chippings and low values of base metals were detected when the drill pulps were analysed. Product moment correlation coefficients listed above show that barium and iron are inversely related in the drill pulps, supporting evidence from visual examination.

BARYTES DISTRIBUTION

Soil geochemistry suggests that barium and lead mineralisation persists to both north and south of the formerly mined sections of the Teign Valley lode zone and that there is, in general, an antipathetic relationship between barytes and galena. North of the Exeter to Moretonhampstead road (B3212), in the vicinity of Whidley House [806 891], the barium anomalies are markedly more scattered than those around Bridford Mine and only rarely do they exhibit any clustering (Fig. 1). It may be inferred, therefore, that they represent small and well-scattered veins of barytes which probably trend north-west/south-east and all of which lie within the Dartmoor National Park.

A thorough search for mineralised field float detected only occasional fragments of barytes, frequently with adhering quartz, many of the locations being at or close to the geochemical anomaly sites. Nowhere north of the River Teign (that is, north of Wheal Lawrence [808 885]) was there any clear evidence of former mineral exploration despite the suitability of such terrain for prospect adits.

The cluster of anomalous barium values around Bridford and Birch Ellers mines is an obvious reflection of the closely spaced barytes veins known in these properties. From the geochemical results it appears that barytes mineralisation does not persist north of the Birch Ellers workings, and that south of Bridford Mine the ore shoots pinch out rapidly, as suggested by Vipan (1959). There is an inevitable danger of a contamination halo around Bridford Mine but it seems that the isolated anomalies detected to the east and south-east of the mine are indeed genuine and may substantiate Col. Ramsden's belief (quoted by Schmitz, MS) that further barytes veining existed east of the worked lodes and should be sought by eastward cross-cutting. Ramsden also proposed surface exploration as far east as Venn [833 870] and Southwood [835 861], both in the vicinity of these geochemical anomalies. Barytes field brash has been found both north and south of Southwood.

Between Bridford Mine and Christow geochemical barium levels are uninteresting, though there are several anomalous lead values and particularly wide-spread high levels of zinc. There is only one historical record of barytes being found in this part of the valley, at the southern end of Christow near the village school (Ramsden MSS). Farther south, between Christow and Reed [836 837] each of two geochemical soil traverses produced one barium anomaly, both being located on line with the main mineralised trend. Close to each there is a former mining trial, Bennah Mine [833 846] to the north and Aller Mine to the south, in which barytes is recorded as a gangue constituent of the veins (Schmitz, 1973).

In the more heavily mined section of the lode zone, from Reed to South Wheal Exmouth [around 836 808] no geochemical traverses were attempted. Barytes is commonly found in all the waste heaps as large or small fragments, pure white or discoloured. The content of barytes in these dumps has been variously claimed at up to 30% but visual examination would tend to corroborate the figure of 8-10% for Frankmills quoted by Dines (1956). All the mines are recorded as working veins with a barytes-quartz gangue and numerous statements in the Mining Journal (quoted by Schmitz, 1973) suggest that significant bodies of barytes, certainly poor in sulphides, were encountered in Wheal Adams, Wheal Exmouth [around 837 830], Frankmills and South Wheal Exmouth. The outcrop of one of these lodes, trending north/south and dipping at 70°E, has recently been examined during track excavations some 400 m north of Canonteign House [835 829]. Over much of its exposed length the vein is highly ferruginous, most of the iron oxide occurring as a cement to brecciated barytes and quartz or as discontinuous bands between layers of spar minerals. Visual examination suggests a content of some 60% barytes by volume. Rare kernels and lenses of almost pure white colour contain 90% or more barytes with fine quartz and occasional calcite. Judged by material from the dumps of Wheal Exmouth, it would appear that in depth the vein filling is less commonly brecciated and pervaded by iron oxides. To the west of this outcrop shallow trenching has revealed narrower branch veins of discoloured barytes with considerable variation in attitude. These presumably have not been traced to their fullest westward extent as barytes fragments occur as field float uphill from the trenched area.

Geochemical sampling was resumed from South Wheal Exmouth southwards and westwards towards Bovey Tracey. Within this area the anomalous barium results are closely clustered to outline a zone some 1.2 km long and, at its widest, some 600 m broad, narrowing southwards. This zone is parallel to, but about 300 m east of, the lead lodes worked in South Wheal Exmouth. Most of this indicated strike length lies outside the National Park.

On the ground much of the geochemically anomalous zone can be defined by the presence of barytes fragments occurring as field float. They are particularly abundant east and south of Warmhill [835 804] and north of Frost [838 795] (Fig. 4) and around these fields larger boulders of impure barytes are incorporated in the hedges. Most of this material is discoloured, a little is purer white and some of the bigger fragments are spectacularly banded (Plate I). Followed southwards this train of debris narrows rapidly between Hele [835 796] and Frost and stops abruptly immediately north of the road corner [837 794] south-west of the latter farm. In the fields south of the road there is no evidence of barytes or chalcedonic quartz float but there is some massive white quartz debris. It seems probable that the barytiferous zone may be truncated by a north-north-west fault defining the valley between Hele and Frost, the existence of which may also be marked by the presence of vein quartz.

Northwards from Warmhill it is somewhat more difficult to follow the zone. Immediately south of the road from Trusham there is a poor scattering of stained barytes but in the fields north of the road recent hedge clearance and dumping of the resultant debris has largely concealed the original surface. Abundant barytes is scattered through the fields adjacent to South Wheal Exmouth but how much may be due to contamination from the mine is uncertain.

During this field examination a previously unrecorded adit entrance [8386 8028] was found in the valley bottom 400 m east-south-east of Warmhill. The entrance is partially blocked and the level now almost full of water, but it appears to be drived on an azimuth of 300° into the barytiferous zone. Some fragments of barytes were found in the debris from the cut and also lower downstream. Local informants claim that the level was driven for 100 fathoms in an unsuccessful search for lead. There is no knowledge, nor any evidence, of a connecting air shaft. This opening should not be confused with the adit and dump a little farther east [8400 8027] which is part of the Riley manganese mine.

GEOPHYSICAL INVESTIGATIONS

Theoretical calculations show that, in favourable circumstances, closely-spaced gravity measurements could be used to locate moderately large tabular bodies of high-grade barytes (density =4.5 gcm^{-3}) in a host rock of density 2.6-2.7 gm^{-3}. A pure barytes vein 2 m wide, of long strike and 100 m depth extent, for example, would yield a maximum anomaly of about 0.3 mgal. An appreciable content of galena (7.6 gm^{-3}) would slightly enhance the gravity anomaly. In contrast, a vein of similar proportions but composed of quartz and calcite gangue with the unlikely content of 20% galena would give an anomaly of less than 0.1 mgal.

In the Teign Valley, barytes bodies approaching this size have been worked at Bridford Mine and are suspected from the records of Wheal Exmouth, and the impure or discoloured portions of such veins have been left below surface, either intact or as backfill. Thus, the conditions for gravimetric exploration, though not ideal, offer some encouragement. Geophysical orientation studies, therefore, were initiated in the two areas where barytes mineralisation of appropriate width was known to occur at surface.

Four traverses, one north of Bridford Quarry and three around Canonteign outcrop (Fig. 5), were run with Worden gravimeters and the Bouguer anomalies (Fig. 6) were derived by standard methods. In traverse 9, over the outcropping barytes vein at Canonteign, the anomaly due to barytes is only just recognisable above the general 'noise' level. The latter is attributable not only to variations of detailed lithology, superficial and hydrothermal alteration but also to the steep irregular topography and reading inaccuracies of up to $\pm$ 0.02 mgal inherent in the gravimeter. Terrain corrections would reduce the noise somewhat, but to do so involves inner-zone corrections derived from field estimates - themselves subject to considerable uncertainty. Traverses 1, 5 and 8 were run over smoother terrain but, despite a lower noise background, they yielded results of doubtful significance.

It was clear from these disappointing orientation studies that gravimetric surveys could not be applied with any confidence as a primary tool in determining the location and distribution of vein-style barytes ore-bodies within the Teign Valley lode zone.

DEEP SAMPLING

Neither soil geochemistry nor field examination could define the distribution of barytes within the anomalous zones and to this end a programme of shallow drilling, deep enough to penetrate bedrock, was undertaken as the next stage of investigation. Conservation considerations recommend the sparing use of drilling equipment within the Dartmoor National Park and, in consequence, it was decided to examine first the line of the geochemical anomaly south-east of Hennock [830 809]. It was hoped that from these results some analogies could be drawn for the assessment of the anomalies inside the Park boundary.

The equipment used was a Voltrac pneumatic percussive drill (vole drill) mounted on caterpillar tracks and towing its own air compressor. Using a $3\frac{1}{2}$-inch bit with tungsten carbide inserts, this machine was capable of drilling to depths far greater than needed through the toughest rocks likely to be encountered. It combined the assets of versatility, flexibility, speed and low cost with minimum disturbance and surface damage.

Three traverses were arranged to cross the indicated strike of the barytes zone. The northern traverse, designated

Plate I. Banded barytes from Frost Farm, Hennock

This block, approximately 16 cm cube, was collected from field float close to drill line HF. Composed entirely of barytes, it shows fine banding of pure white and pink, slightly ferruginous ore. The specimen is typical of Teign Valley barytes veins, with a banded marginal zone and a massive or brecciated central portion

line HW, crossed two fields east of Warmhill (Fig. 7) in an east-north-east direction; the middle traverse, line HF (Fig. 8), ran west-north-west parallel to the road about mid-way between Warmhill and Frost; and the southern traverse, line HFC (Fig. 9), followed a field boundary south-west of Frost and south of the apparently faulted cut-off. Each traverse was adequately long to cover the full width of significant geochemical anomaly and the full extent of barytic surface float. All holes were drilled at an inclination of 45° to lengths of 53 ft (16.2 m) or less where the water table was penetrated. Hole spacing was arranged to ensure that each hole overlapped the adjacent one, thus providing a complete cross-section along each traverse. Rock dust and chippings recovered from the holes were sampled over 5 ft (1.5 m) lengths and roughly assayed on-site for barium.

These field assays were performed on an Ekco Mineral Analyser using an Americium-241 source and iodine and technetium filters specially prepared for Ba analysis. Crushed high-grade white barytes from the Wheal Exmouth dumps was diluted with pure quartz to provide a range of comparative standards. The original sample was assumed to be pure and to contain 58.5% Ba, though this was later proved to be a slightly exaggerated figure. In the presence of appreciable iron the apparent barium count is drastically reduced and to obviate the risk of rejecting iron-rich barytiferous samples comparisons were made against a set of prepared standards with varying contents of barytes and hematite. A rough estimate of the iron oxide content of each pulp was made from its colour.

On the basis of field assaying, all samples containing more than an indicated 0.1% Ba were submitted for laboratory analysis by X-ray fluorescence spectrometry. Barium, lead, zinc, cobalt, nickel, iron and manganese were determined on each sample and antimony, calcium and titanium on the first four. Owing to problems of analysing for lead in the presence of barium, little reliance can be placed on the values for lead; fortunately these are all of low tenor, only four reporting more than 0.1%. The full analytical results are listed in Appendix 1.

Comparison of the field assays with laboratory determinations suggests that the former were generally low. This was especially true of the more ferruginous samples, and presumably reflects errors in the visual assessment of iron oxide content. With the exception of five samples from traverse HFC, all analysed samples contained more than 0.1% Ba but it is almost certain that other samples of this low tenor were missed during selection.

INTERPRETATION OF RESULTS

The distribution of significant barium values in traverses HW and HF is shown in Fig. 10. It can be seen that the barytiferous zones are narrow and scattered in traverse HW, though they are usually rich and separated by distinctly low-grade material. In contrast, traverse HF shows higher barium values to be restricted to a zone some 60 m wide, outside which the barytes content is uniformly low. The width and tenor of these zones are presented in greater detail in Table 1. Between hole 9 at surface

Table 1. Particulars of barytiferous zones, Hennock

Drillhole	Inclined Depth (ft)*	True width (ft)	(m)	Ba %	Barytes %	Fe_2O_3 %	Comments
HW 2	29-49	14.1	4.3	6.12	10.4	3.5	Pb at top, little Mn
HW 17	28-53	17.7	5.5	15.62	26.6	5.6	Cu at top
HW 18	0-18	12.7	3.9	5.41	9.2	7.3	
HW 20	18-28	7.1	2.2	5.02	8.5	10.0	
HW 22	8-13	3.5	1.1	2.11	3.6	12.7	
HW 23	28-43	10.6	3.2	21.28	36.2	7.7	High Cu throughout
HW 24	0-13	9.2	2.8	9.70	16.5	9.2	Moderate Cu, lower half Fe-rich
HF 7	33-53	14.1	4.3	2.57	4.4	8.3	High Pb near top, high Fe at base
HF 8	0-28	19.8	6.0	5.48	9.3	7.4	Moderate Pb
	43-53	7.1	2.2	3.91	6.6	5.4	Moderate Pb
	[0-53]	[37.5]	[11.4]	[3.97]	[6.7]	[6.9]	[Moderate Pb throughout]
HF 9	0-43	30.4	9.3	9.52	16.2	6.8	Moderate Cu at top and base
	[0-53]	[37.5]	[11.4]	[7.99]	[13.6]	[6.6]	[Variable Fe]
HF 10	0-53	37.5	11.4	9.36	15.9	5.8	High Fe 38-43 ft
HF 11	0-53	37.5	11.4	7.35	12.5	6.9	Moderate Pb top and base
HF 12	0-48	33.9	10.3	15.82	26.9	3.5	Moderate Pb throughout
	[0-53]	[37.5]	[11.4]	[14.50]	[24.6]	[3.7]	Low Fe in Ba-rich zones
HF 13	0- 8	5.7	1.7	4.56	7.8	4.3	Soil only

*Contractor's equipment in Imperial sizes and hole 12 at 48 ft (14.6 m) inclined depth there is a zone of 131 ft (40 m) true width averaging almost 17% $BaSO_4$ and 6% Fe_2O_3, which includes a 1.1 m section containing 45% calculated barytes and another 3.2 m wide containing 51% barytes.

In the absence of tested down-hole geophysical methods for determining barium the detailed distribution of barytes within each hole could not be ascertained. In some cases, however, changes of dust colour and texture provided a crude visual discrimination between barytes vein and host rock. From such observation and the evidence of field brash it is apparent that some of the veins are but a few centimetres in width and composed wholly of near-white barytes. Others are variably ferruginous, the barytes being stained pink or brown, commonly banded (Plate I) with some purer barytes and hematite layers in the sequence, and sometimes highly brecciated with iron oxides cementing barytes fragments. The ferruginous veins appear to range from very narrow to more than a metre in width, the wider structures seemingly being combinations of banded, massive and brecciated forms.

No wholly satisfactory correlation can be drawn between drillholes and it must be assumed from known exposures and former mining that the individual veins are steeply dipping, probably to the east. The distance between traverses HW and HF precludes confident vein correlation; indeed, the differences in barytes distribution along each line suggests that individual rich zones may not persist over long strike lengths. According to Schmitz (MS notes) such impersistence along strike was a feature of some of the Bridford veins and both Dines (1956) and Vipan (1959) record large variations in vein width and pinching-out of barytes bodies.

The distribution of barium shown by drilling can be roughly correlated with the surface scatter of barytes debris observed around the traverse lines and more closely equated with the soil geochemical results. From a wider application of these correlations it is possible to derive a useful, if imprecise, interpretation of the untested geochemical anomalies. In combination with surface and mining data, such interpretations provide a more meaningful assessment of the undeveloped barytes potentialities than has hitherto been possible.

Within the newly identified southern baytiferous zone the abundant spread of white, grey and brown barytes fragments in the field north of traverse HF and in the upper parts of two fields south of this traverse suggests mineralisation of similar tenor to that in the HF drillholes confined to a zone some 50-100 m wide. The strike length of this zone is about 250 m. Southwards the mineralisation continues for a futher 350 m ending immediately north of the lane between Frost Farm and Frost Cross. Over this strike length the width of the zone, judged from the distribution of surface float, narrows considerably and due west of Frost may be as small as 10 m. The zone is difficult to trace northwards into Warmhill Farm. Scrubby woodland in a wet valley soth-east of the farm buildings conceals the scatter of barytes debris and immediately to the north of this the barytes mineralisation appears to be restricted, or even absent, where the zone passes through a dolerite body. East of the farm barytes float is irregularly scattered through four adjacent fields, the distribution of richer patches of debris vaguely reflecting the pattern of barium values revealed by drilling. Here, soil sampling indicated barium levels greater than 700 ppm extending to about 260 m west of the drill traverse, presumably reflecting further low-grade mineralisation in this direction. Although farming disturbance and mining contamination confuses the surface evidence north of the Warmhill-Trusham lane, soil geochemistry indicates a continuation of the zone in this direction but with an apparent narrowing and possible decrease in average tenor. Surprisingly the soil anomalies do not correlate with the lodes worked in South Wheal Exmouth but suggest the presence of previously unrecorded barytes veining some 50-250 m east of the workings. A single barium anomaly in excess of 1000 ppm south-east of the Hennock Mine site [8360 8144] probably represents the same vein zone, here even narrower, about 100 m east of the worked lead lode. No attempt has been made to trace this mineralisation farther north in the vicinity of Frankmills Mine, Wheal Exmouth and Wheal Adams.

From the woodland south-east of Warmhill to the lane which marks the Dartmoor National Park boundary a strike length of 600 m is indicated. Barytes is probably distributed in narrow and well-separated veins as seen from the drillholes and it appears that this traverse intersects the zone at its widest development. North of the lane there is an indicated strike length of at least 700 m.

Analysis of the drill rock pulps provides a clear indication of the relative purity of the barytes intersected. Copper sulphides (probably both chalcopyrite and tetrahedrite) and galena are estimated to be present at maximum concentrations of about 0.1%. Sphalerite occurs only in trace amounts. The main contaminant is iron oxide, which ranges from 0.8 to 17.2 per cent in a general inverse relationship to the barium content. Experience at Bridford Mine suggests that the degree of ferruginous staining may decrease with depth but the sulphide content will probably vary locally with perhaps a tendency to increase downwards. The Warmhill adit is apparently driven towards the most westerly of the barytes zones recognised in the drillholes (that of HW 2). This zone yielded the highest values for lead, a feature which goes some way to confirming the local belief that this adit was a lead trial.

The barytiferous sections of the Teign Valley lode zone which lie inside the National Park can be subdivided conveniently into three groups; those between Christow and Canonteign; those around Bridford Mine, and those west of Dunsford. Abundant barytes debris in the dumps of Frankmills Mine, Wheal Exmouth and Wheal Adams suggests that this mineral features prominently in the gangue of the two lead lodes worked in these properties. Mining records (Schmitz MS) confirm that barytes was locally the major component of the veins and, indeed, a third lode was recognised in Wheal Exmouth and called Barytes (or Middle) Lode. The distribution of barytes in these mines is not defined in the plans and is only vaguely indicated by written accounts, but it seems that the richer pockets of this mineral were found at some depth below surface. In what is believed to be the outcrop of East Lode, however, ferruginous barytes is exposed over widths up to 3 m, in a traceable strike length of some 150 m, and smaller veins have been located farther west. However, there is no geochemical evidence of this mineralisation persisting immediately north of Wheal Adams. Only two small anomalies were located on this soil traverse, one lying well west of the Wheal Exmouth workings, the other a little west of the projected outcrop of the worked lead vein. The only significant clusters of barium anomalies are restricted to the south and south-east of Christow, the former around the site of Bennah Mine and the latter in untried ground close to the village. Adjacent traverses offer no suggestion of strike continuity and it is thought, therefore, that the anomalies may represent small discontinuous developments of barytes, probably of only moderate tenor.

The large anomalies recorded immediately north of the Bridford Mine site must undoubtedly relate to the several barytes lodes known in that mine and their high barium values reflect the richness of those veins. A traverse some 350 m to the south failed to recognise any surface continuity in this direction but Dines (1956) states that the ore bodies pitch southwards and, despite negative surface indications, it may be suggested that barytes in significant quantities could exist at depth. To the north near Birch Ellers Mine, a more restricted surface anomaly is recorded, again showing high values. This almost certainly confirms several statements made by Schmitz (MS) of significant barytes veins in the southern portions of this mine. There seems little doubt from all the evidence available that the mineralisation in these two mines is continuous, thought the individual lodes may not be so persistent. The remaining potential of this block of ground can only be assessed by a programme of deep drilling.

North-west of Birch Ellers mine barytes mineralisation can be traced for at least 4 km but most of the surface anomalies are widely scattered along the traverses, suggesting narrow and discontinuous veins. Two closer groupings of high barium values to the west and north-west of Dunsford village may reflect local concentrations of barytes worthy of more detailed investigation, though it is doubtful whether they would possess a potential equal to that of the Warmhill-Frost area. In the vicinity of Whidley House, however, the barium anomaly is closely associated with an open-ended geochemical lead anomaly, steep and wooded slopes having prevented further sampling. The possible occurrence of galena in association with barytes in an unmined area enhances, in some measure, its otherwise limited potential.

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PPENDIX I

XRF Analyses of vole drill rock pulps

ole	Sample depth ft	Ba %	Pb ppm	Zn ppm	Cu ppm	Fe %	Mn %	Ni ppm
W1	39-44*	0.2071	890	107	8	3.689	0.038	21
W2	24-29*	0.4835	1335	209	36	7.413	0.062	32
	29-34	9.9672	1321	88	35	1.762	0.011	13
	34-39	7.0614	371	124	52	1.774	0.121	23
	39-44	4.3845	199	139	37	1.954	0.113	15
	44-49	3.0780	135	216	98	4.296	0.033	25
W3	44-49*	0.0913	9	122	86	7.032	0.284	40
W4	13-18	1.7936	15	125	19	11.135	0.398	11
W5	28-33*	0.5093	50	40	95	7.518	0.241	11
	33-38	0.4818	37	153	92	10.721	0.227	15
W16	38-43	0.6505	14	24	19	7.260	0.104	5
	43-48	0.1281	48	28	36	7.707	0.120	3
	48-53	0.3258	10	39	76	12.186	0.551	11
W17	28-33	10.2050	29	21	346	4.646	0.107	14
	33-38	27.9396	26	50	105	1.868	0.039	28
	38-43	3.9166	34	43	167	4.175	0.008	21
	43-48	24.4490	28	36	53	3.120	0.003	25
	48-53	11.6055	25	27	198	5.631	0.005	24
W18	0-8	5.5068	14	30	169	5.538	0.009	13
	8-13	3.7811	4	20	104	5.575	0.002	13
	13-18	6.8830	18	26	64	3.949	0.003	11
	18-23	0.7037	23	25	103	3.620	0.003	6
	23-28	0.1381	16	25	79	3.447	0.003	5
	28-33	0.9041	13	21	135	3.784	0.003	4
	33-38	1.7375	39	10	104	3.794	0.008	4
	38-43	1.6438	24	6	85	4.561	0.009	4
	43-48	0.3595	21	5	157	5.757	0.008	3
	48-53	0.4328	13	40	311	9.056	0.028	4

*For additional analytical data see p. 5.

ole	Sample depth ft	Ba %	Pb ppm	Zn ppm	Cu ppm	Fe %	Mn %	Ni ppm
W19	8-13	0.3304	19	12	105	6.795	0.013	2
	13-18	2.5452	18	17	253	6.842	0.019	4
	18-23	0.3816	8	38	201	8.394	0.031	3
	23-28	1.5855	19	62	226	10.608	0.035	4
	28-33	0.3192	15	37	139	9.729	0.037	4
	33-38	0.1773	16	39	130	8.587	0.032	3
	38-43	0.1877	19	39	123	9.436	0.023	3
	43-48	0.3996	18	30	104	9.056	0.021	3
	48-53	0.1960	24	19	82	5.914	0.015	1
W20	0-8	0.3010	14	53	119	8.853	0.044	5
	8-13	0.9225	47	51	134	9.707	0.028	5
	13-18	0.3401	19	30	50	8.397	0.026	2
	18-23	4.9984	8	56	26	7.127	0.033	6
	23-28	5.0355	13	51	42	6.883	0.038	5
	28-33	0.5029	12	40	52	8.572	0.029	3
	33-38	0.6928	25	43	72	9.507	0.032	3
	38-43	0.2986	10	33	45	7.674	0.030	3
	43-48	0.2027	14	17	29	6.712	0.019	1
	48-53	0.6253	21	27	61	7.799	0.019	2
W21	0-8	0.3288	16	37	23	8.502	0.031	3
	8-13	0.4159	17	49	26	8.438	0.020	3
	13-18	0.3289	10	36	20	7.337	0.026	3
	18-23	0.6987	19	21	24	6.414	0.018	3
	23-28	0.2009	22	23	24	7.311	0.017	3
	28-33	0.4555	19	33	73	6.203	0.031	4
	33-38	0.3405	23	61	142	7.764	0.053	7
	38-43	0.2041	16	24	71	5.845	0.020	2
W22	8-13	2.1094	44	30	12	8.902	0.022	6
	13-18	0.2269	13	33	18	8.481	0.030	4
	18-23	0.1970	14	35	47	8.005	0.025	3
	23-28	0.2595	35	33	114	13.235	0.079	9

Hole	Sample depth ft	Ba %	Pb ppm	Zn ppm	Cu ppm	Fe %	Mn %	Ni ppm
HW23	8-13	0.2639	60	13	143	8.464	0.014	2
	13-18	0.2376	20	12	561	8.374	0.018	3
	23-28	0.2794	21	15	1120	7.144	0.057	7
	28-33	28.1799	19	27	843	5.244	0.036	20
	33-38	25.3200	16	36	319	4.488	0.014	16
	38-43	10.3360	23	47	206	6.329	0.008	10
	43-48	0.8915	19	40	273	17.258	0.090	8
	48-53	0.7323	19	45	509	11.931	0.024	6
HW24	0-8	14.4499	17	47	169	4.951	0.076	12
	8-13	2.1037	15	54	152	8.845	0.044	8
	13-18	0.9647	24	83	147	11.343	0.012	10
	18-23	0.2433	13	32	256	9.016	0.030	5
	23-28	0.4070	17	37	471	8.891	0.200	5
	28-33	0.3070	6	35	170	7.047	0.025	4
	33-38	0.7910	10	18	354	4.464	0.046	6
	38-43	0.5648	22	29	322	10.440	0.067	12
	43-48	0.3277	20	36	276	8.225	0.055	13
	48-53	0.2702	11	31	269	7.018	0.086	10
HW25	0-8	0.8899	25	51	265	13.865	0.174	12
	8-13	0.5657	27	59	237	12.357	0.042	11
	13-18	0.2968	14	46	280	12.155	0.068	16
	18-23	0.3329	4	80	261	11.406	0.073	18
	23-28	0.2373	2	127	66	10.090	0.064	13
	28-33	0.2256	5	120	63	9.952	0.066	7
	33-38	0.2252	6	103	7	9.555	0.065	3
HW26	0-8	0.7286	26	76	70	11.685	0.467	12
	8-13	0.2721	5	43	44	11.878	0.937	9
HW27	0-8	0.3060	16	87	44	13.849	0.217	10
	8-13	0.2391	15	97	6	11.901	0.142	7
	13-18	0.2551	14	144	9	14.386	0.161	10
	18-23	0.1362	16	43	4	10.019	0.283	8
HW28	8-13	0.2608	2	125	14	12.181	0.208	7
	13-18	0.2245	5	142	16	12.532	0.202	8
	18-23	0.2001	8	133	11	12.101	0.173	10

Hole	Sample depth ft	Ba %	Pb ppm	Zn ppm	Cu ppm	Fe %	Mn %	Ni ppm
HW29	0-8	0.3278	17	174	35	12.341	0.214	9
	8-13	0.2688	4	164	12	12.347	0.157	8
HW30	8-13	0.1581	62	96	16	8.249	0.083	40
HF7	23-28	0.1185	234	36	8	3.280	0.007	12
	28-33	0.1003	1747	63	51	6.468	0.094	13
	33-38	3.4624	552	63	51	5.053	0.063	14
	38-43	1.9832	1006	93	186	5.119	0.083	23
	43-48	2.4153	719	87	28	4.689	0.021	12
	48-53	2.4153	229	116	8	8.467	0.009	11
HF8	0-8	5.5651	368	85	38	4.448	0.011	12
	8-13	7.0694	348	105	12	4.559	0.004	10
	13-18	4.5681	750	93	7	5.430	0.004	9
	18-23	3.4131	167	82	5	5.365	0.006	11
	23-28	6.7306	192	85	0	6.463	0.006	13
	28-33	0.6322	307	73	6	6.179	0.003	7
	33-38	2.3886	472	43	4	4.151	0.002	6
	38-43	0.5130	363	57	10	4.292	0.002	5
	43-48	3.9586	185	139	7	4.192	0.003	11
	48-53	3.8563	146	59	8	3.340	0.003	9
HF9	0-8	11.1101	381	49	1	2.214	0.002	13
	8-13	4.7862	459	75	7	4.507	0.002	11
	13-18	18.1523	269	103	4	4.321	0.004	16
	18-23	12.0272	121	71	6	3.666	0.003	14
	23-28	5.1393	109	49	10	4.424	0.004	9
	28-33	5.5853	217	103	4	7.496	0.008	12
	33-38	6.8277	261	117	2	7.970	0.006	10
	38-43	11.5468	182	135	2	5.178	0.003	12
	43-48	0.7002	83	72	11	3.977	0.002	5
	48-53	2.1109	172	86	7	3.904	0.002	6
HF10	0-8	3.6937	103	48	6	2.847	0.003	10
	8-13	6.9329	80	36	5	2.048	0.002	14
	13-18	7.9043	78	29	4	2.445	0.002	10

Hole	Sample depth ft	Ba %	Pb ppm	Zn ppm	Cu ppm	Fe %	Mn %	Ni ppm
HF10	18-23	7.2153	63	41	1	2.280	0.003	10
	23-28	4.1459	83	43	5	2.835	0.004	10
	28-33	26.5996	41	44	0	1.543	0.000	18
	33-38	15.9161	105	49	0	5.246	0.002	12
	38-43	9.9475	111	48	2	11.115	0.003	11
	43-48	5.2359	90	44	5	5.759	0.003	11
	48-53	9.3786	178	57	9	4.812	0.003	14
HF11	0-8	8.4208	130	109	2	4.043	0.002	8
	8-13	7.9875	120	94	1	4.694	0.003	11
	13-18	5.6768	211	93	1	6.845	0.004	8
	18-23	6.5338	192	78	1	6.589	0.004	10
	23-28	4.4080	70	47	2	4.486	0.002	8
	28-33	3.7572	95	103	2	4.696	0.002	11
	33-38	2.1935	64	65	2	3.459	0.002	10
	38-43	10.0658	112	90	2	4.788	0.002	14
	43-48	10.9437	172	120	1	5.094	0.003	13
	48-53	12.8880	205	77	3	4.154	0.002	12
HF12	0-8	9.6139	487	157	6	2.857	0.003	13
	8-13	18.7860	221	46	10	1.640	0.002	16
	13-18	25.1711	377	45	8	0.848	0.000	20
	18-23	35.2506		35	0	0.544	0.002	22
	23-28	29.8815		45	3	1.331	0.000	19
	28-33	12.4626	144	66	72	4.319	0.004	15
	33-38	4.2595	126	80	31	3.864	0.005	12
	38-43	6.9691	168	48	25	2.996	0.004	12
	43-48	3.6693	199	62	25	3.709	0.004	11
	48-53	1.8642	161	50	21	3.733	0.005	16
HF13	0-8	4.5591	112	43	12	3.024	0.005	9
	8-13	0.4670	119	39	18	3.182	0.004	7
	13-18	0.4376	73	31	13	2.463	0.003	7
	18-23	0.3181	107	38	17	2.876	0.004	9
	23-28	0.2714	215	47	19	4.745	0.004	8
	28-33	0.1720	147	39	24	3.971	0.003	8

Hole	Sample depth ft	Ba %	Pb ppm	Zn ppm	Cu ppm	Fe %	Mn %	Ni ppm
HF13	33-38	0.1063	152	33	41	4.535	0.003	6
	38-43	0.4789	210	46	42	5.593	0.004	8
	43-48	1.7591	313	73	79	11.114	0.005	10
	48-53	3.8357	354	74	57	12.001	0.006	11
HF14	13-18	0.3449	276	75	23	6.099	0.003	9
	18-23	0.4602	289	78	90	7.290	0.003	9
	23-28	0.3309	268	54	80	7.264	0.004	7
	28-33	0.3025	278	49	126	10.695	0.004	7
HF14A	0-8	0.3073	171	37	117	5.325	0.004	5
	8-13	0.5587	208	23	98	5.508	0.002	4
	13-18	0.2815	128	18	34	2.312	0.002	2
	18-23	0.3046	105	17	58	2.960	0.002	3
	23-28	0.1886	103	16	58	3.834	0.002	4
HF15	0-8	0.2857	88	12	66	3.396	0.002	1
	8-13	0.2589	81	7	45	2.512	0.002	2
	13-18	0.2434	76	6	52	2.792	0.002	2
	18-23	0.2313	125	19	59	3.868	0.002	3
	23-28	0.4866	88	15	64	3.379	0.002	3
	28-33	0.4026	73	14	54	2.734	0.002	4
	33-38	0.3989	143	19	39	2.495	0.002	4
	38-43	0.5730	147	33	106	8.673	0.003	6
	43-48	0.2526	79	28	103	8.104	0.006	5
	48-53	0.3200	115	30	93	7.329	0.005	4
HFC15	28-33	0.0331	41	146	46	5.680	0.023	47
	33-38	0.0337	123	327	94	7.762	0.075	102
	38-43	0.0358	61	212	48	6.650	0.050	78
	43-48	0.0349	47	137	42	6.552	0.036	75
	48-53	0.0356	64	170	47	6.431	0.040	79

HW1	39-44	16 ppm Sb ,	21 ppm Ti ,	0.130% Ca
HW2	24-29	22	32	0.119
HW3	44-49	14	40	0.121
HW5	28-33	37	11	0.604

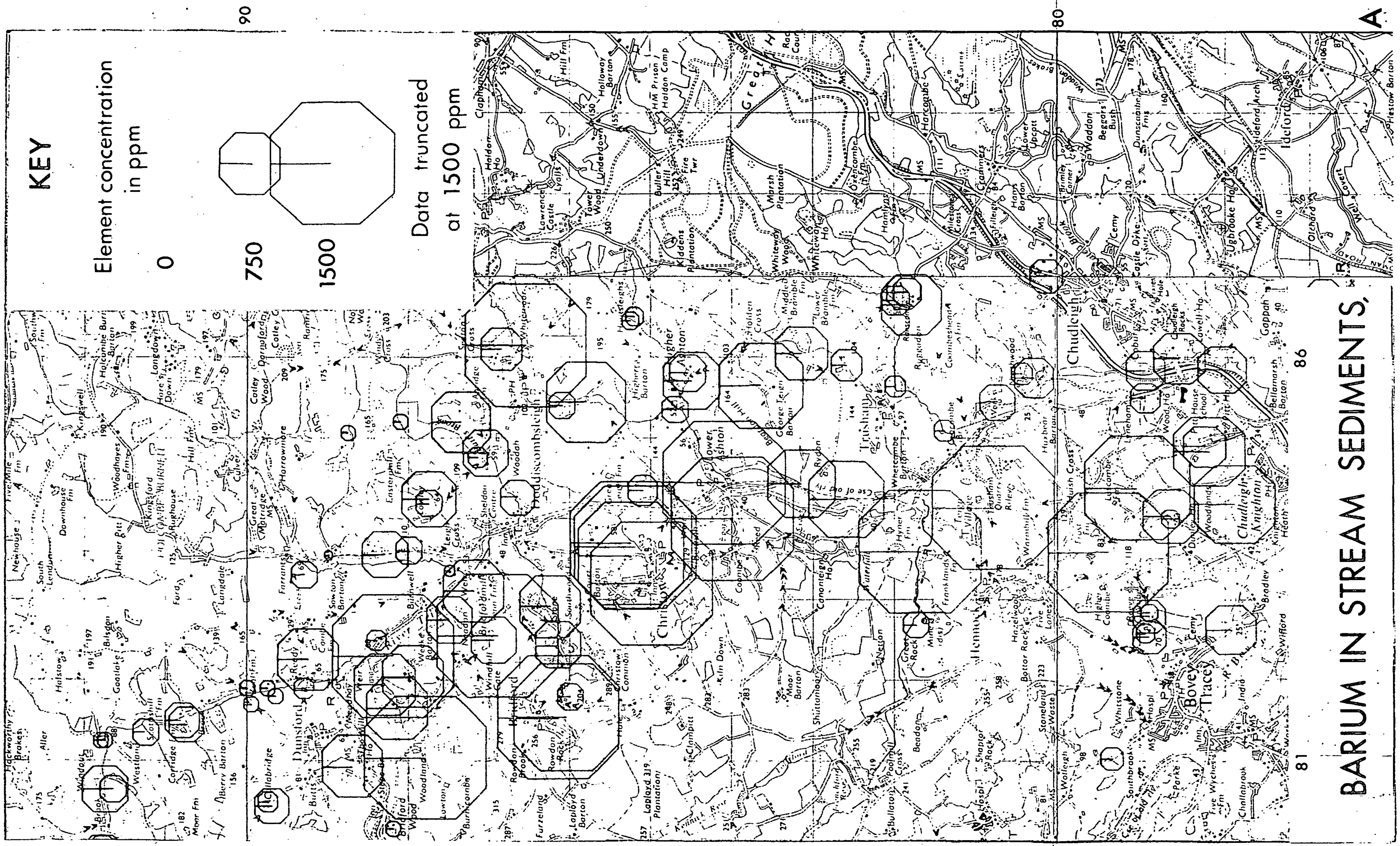

Fig. 2a. Drainage survey geochemical results

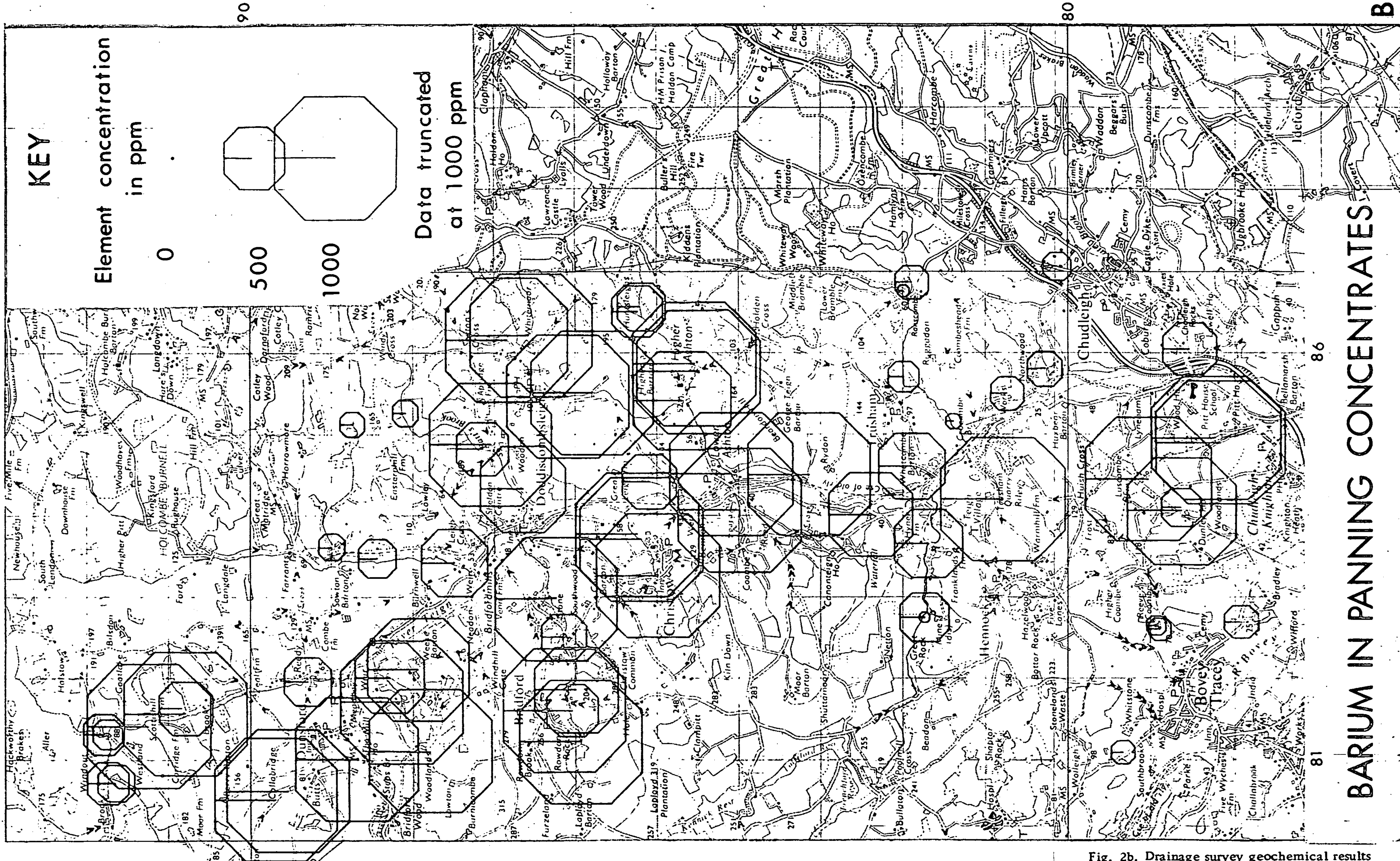

Fig. 2b. Drainage survey geochemical results

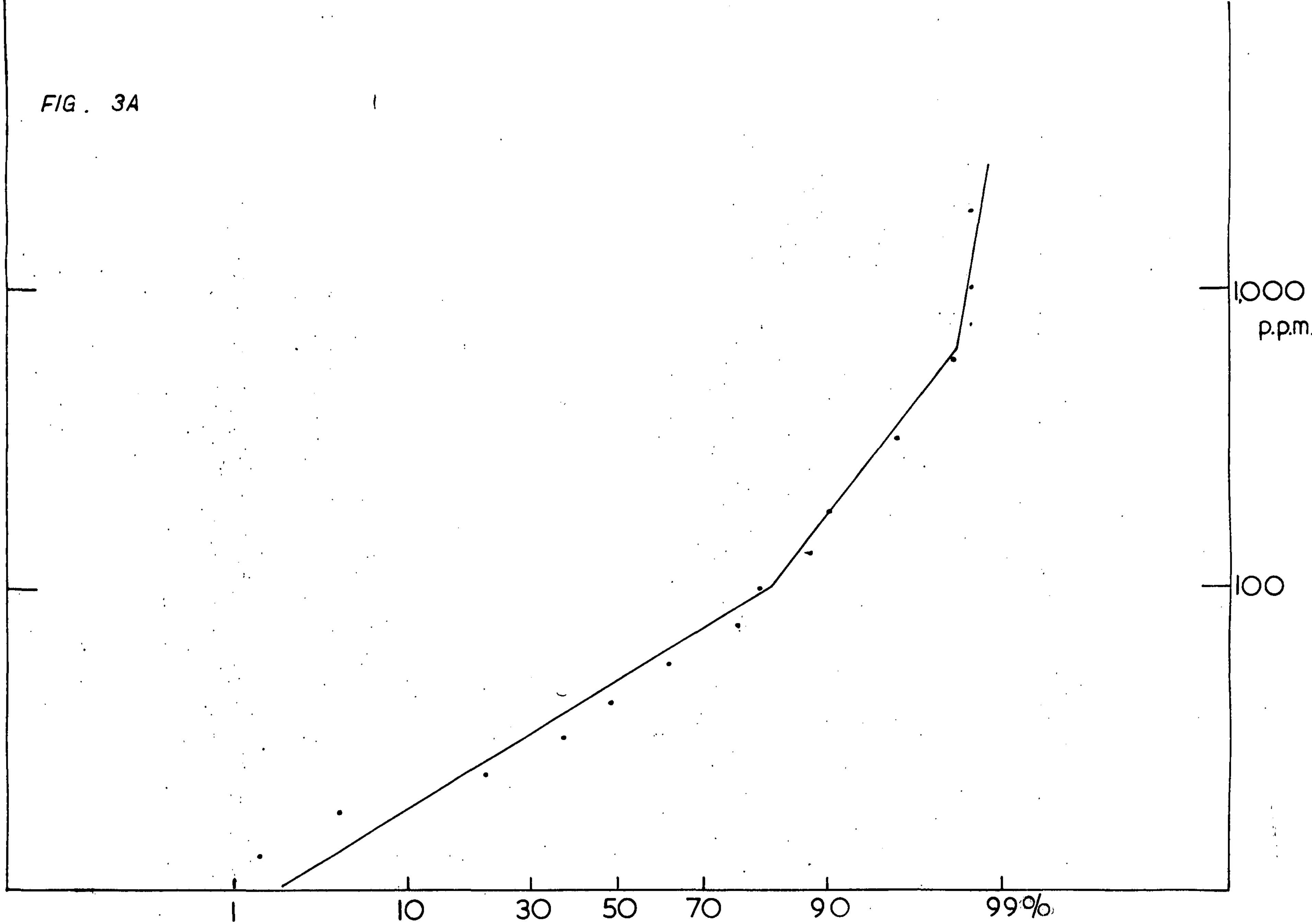

Fig. 3A. Log probability plots of barium in soils

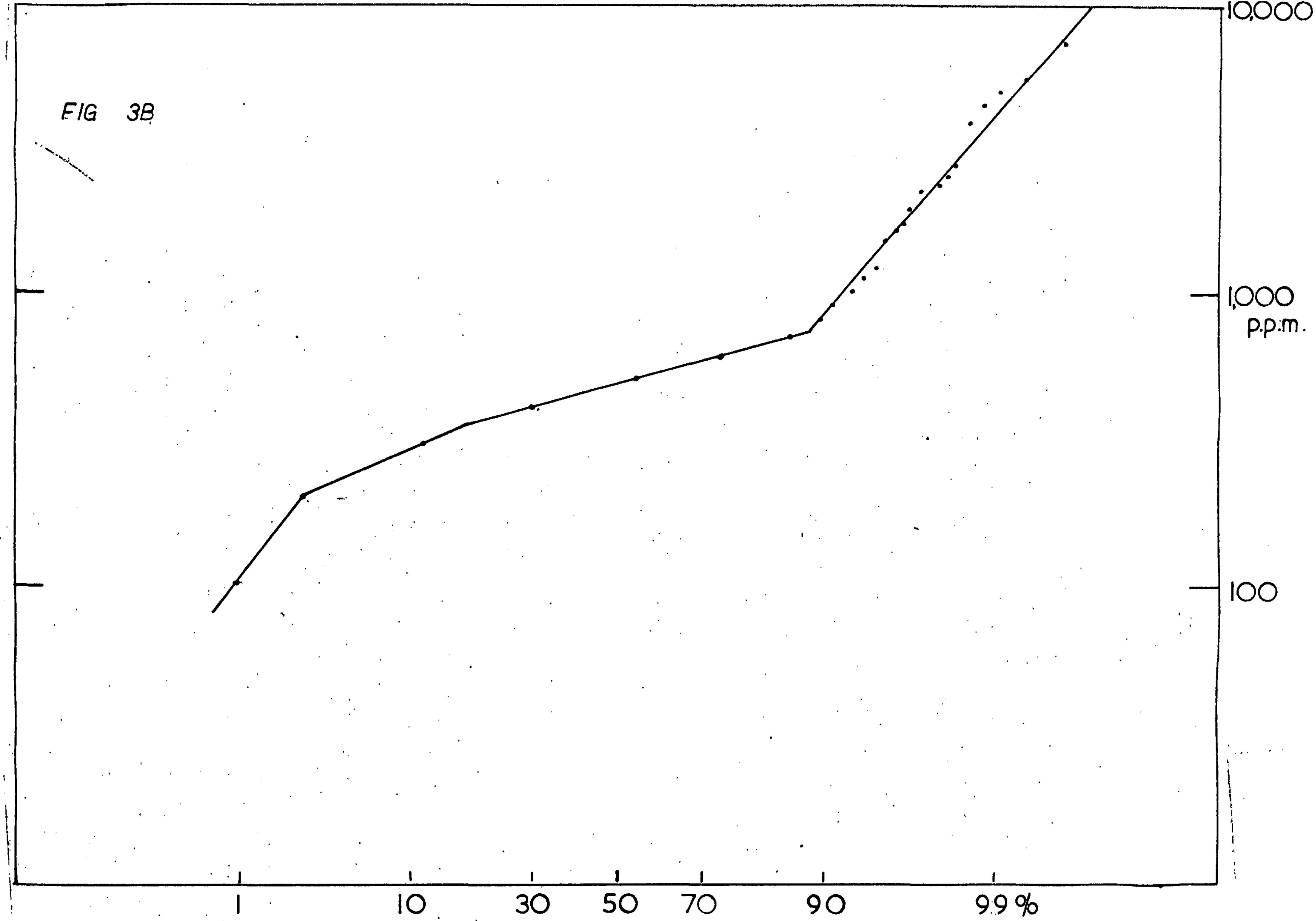

Fig. 3B. Log probability plots of barium in soils

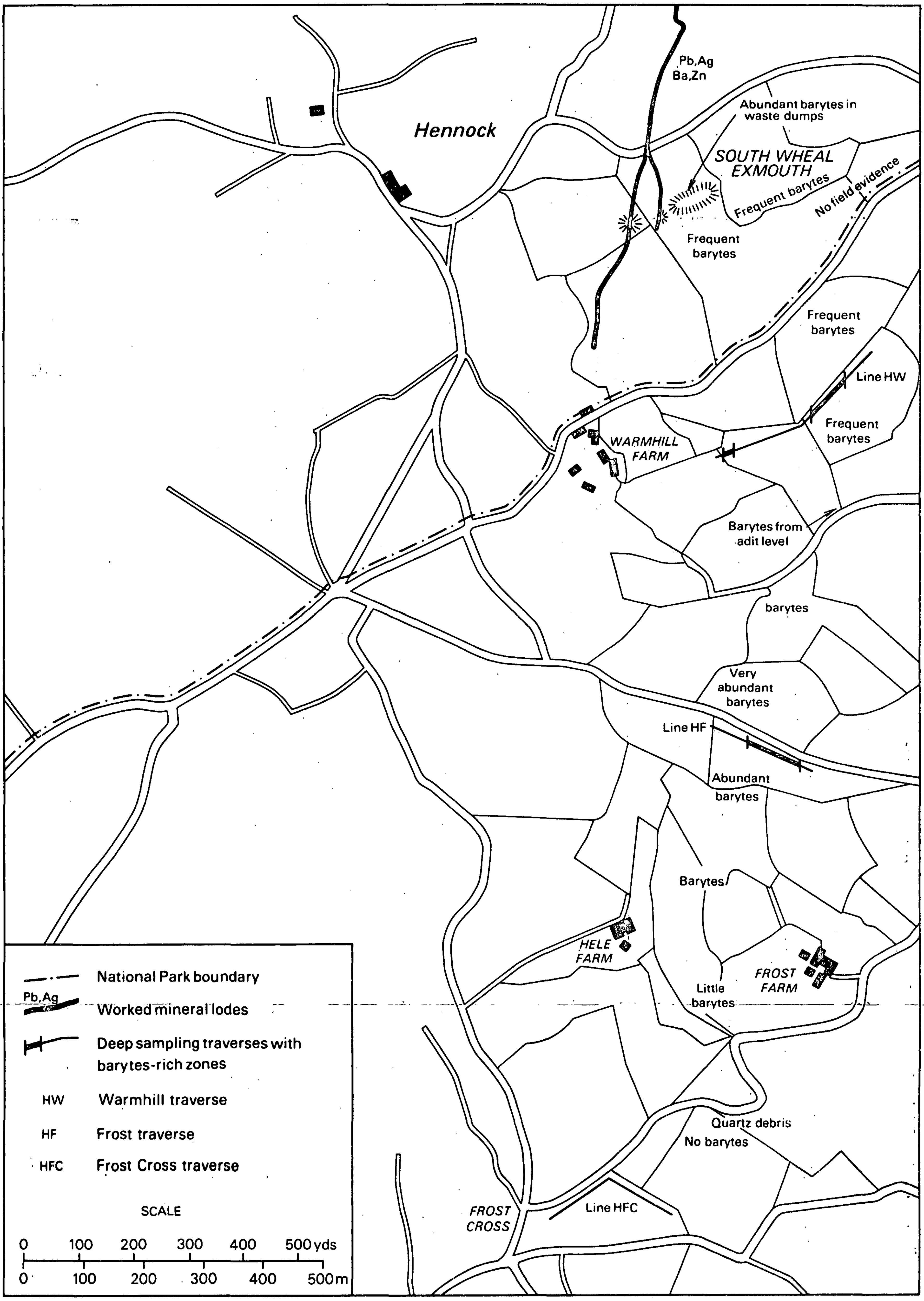

Fig. 4 Distribution of barytes debris south of Hennock, and locations of vole drilling traverses

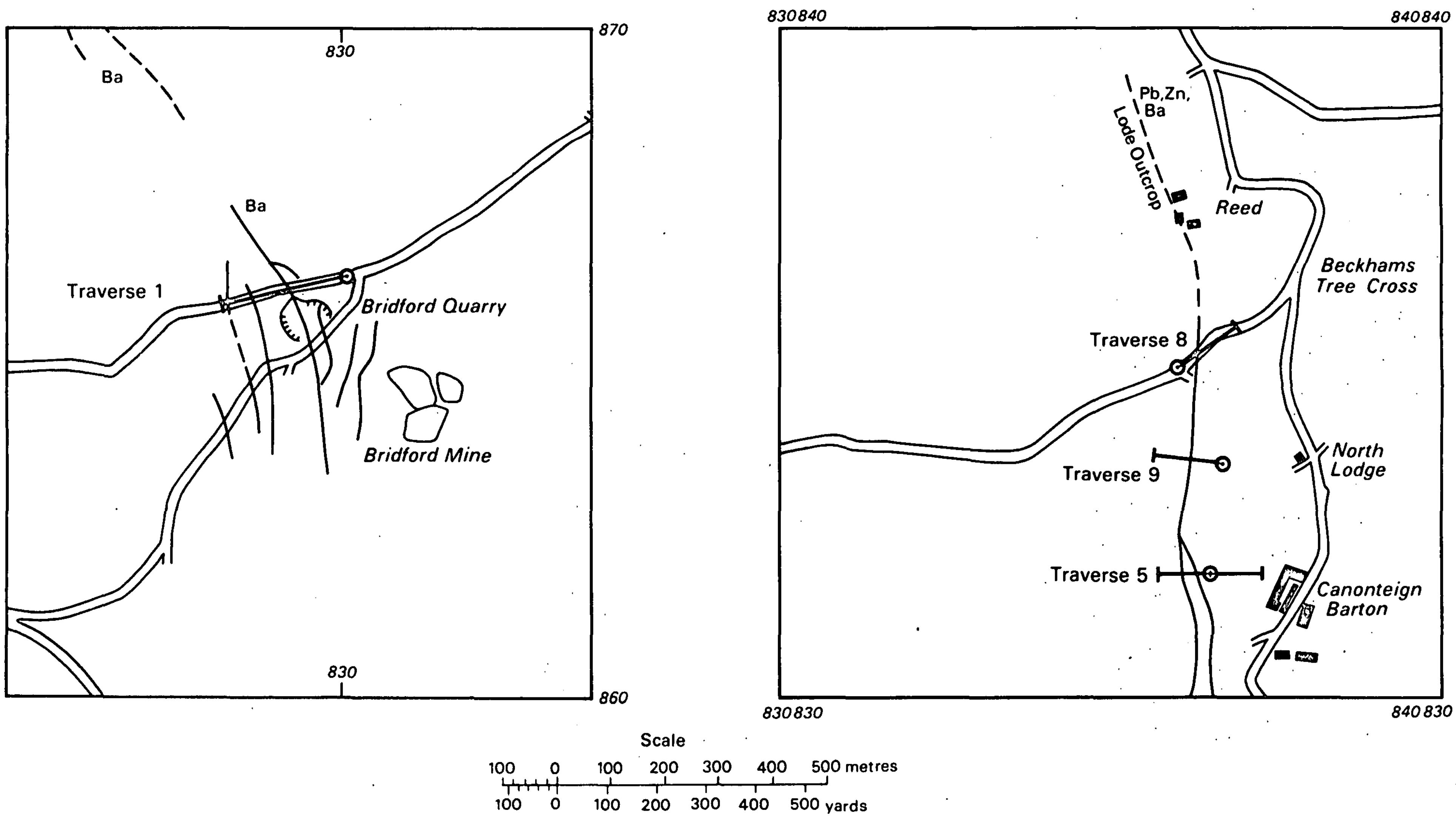

Fig. 5 Locations of gravimetric traverses over barytes zone

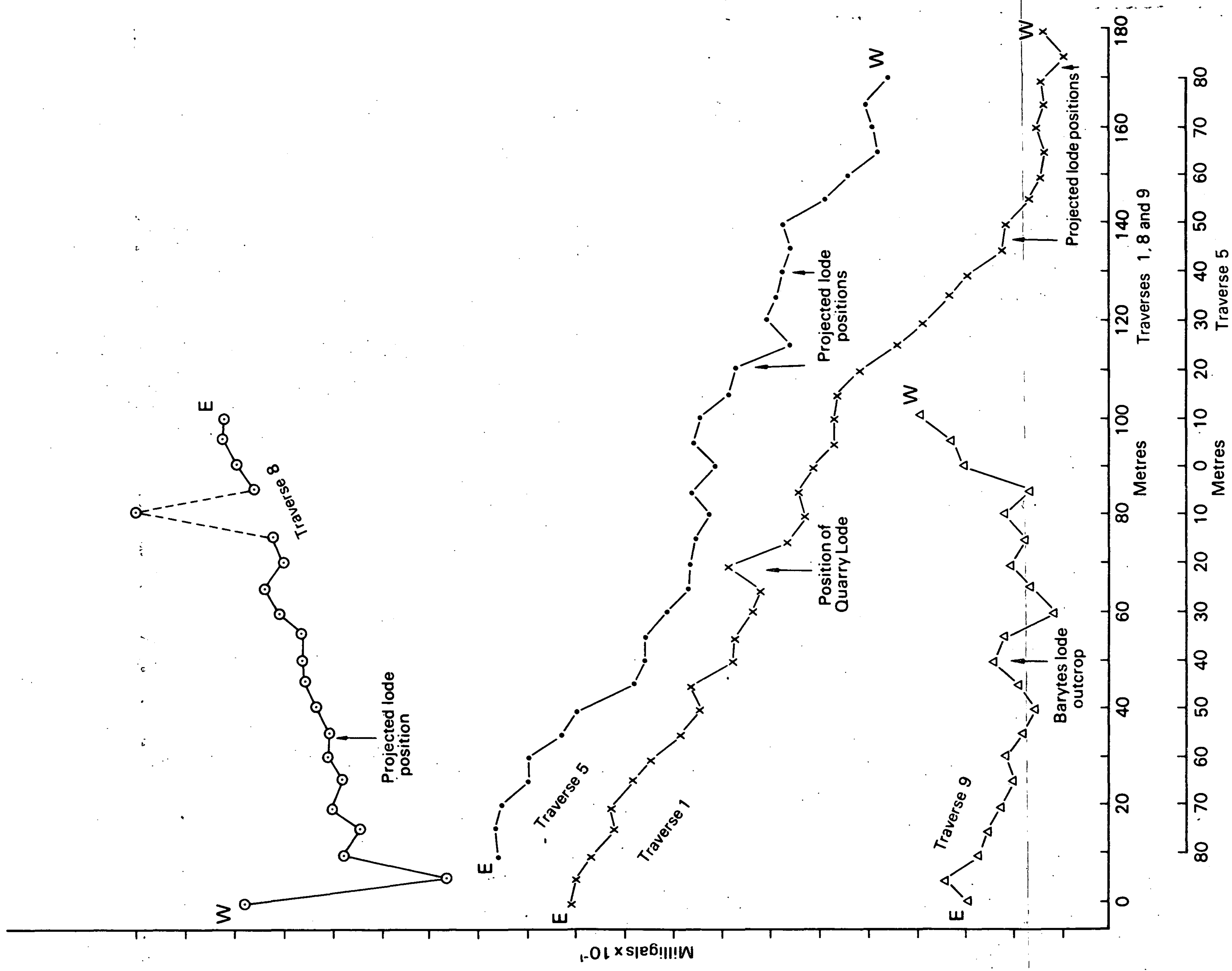

Fig. 6 Relative Bouguer anomalies along gravimetric traverse lines

Notes: 1. No terrain correction

2. Density 2.67 g cm^{-3}

3. All traverses referred to arbitrary and independent datum

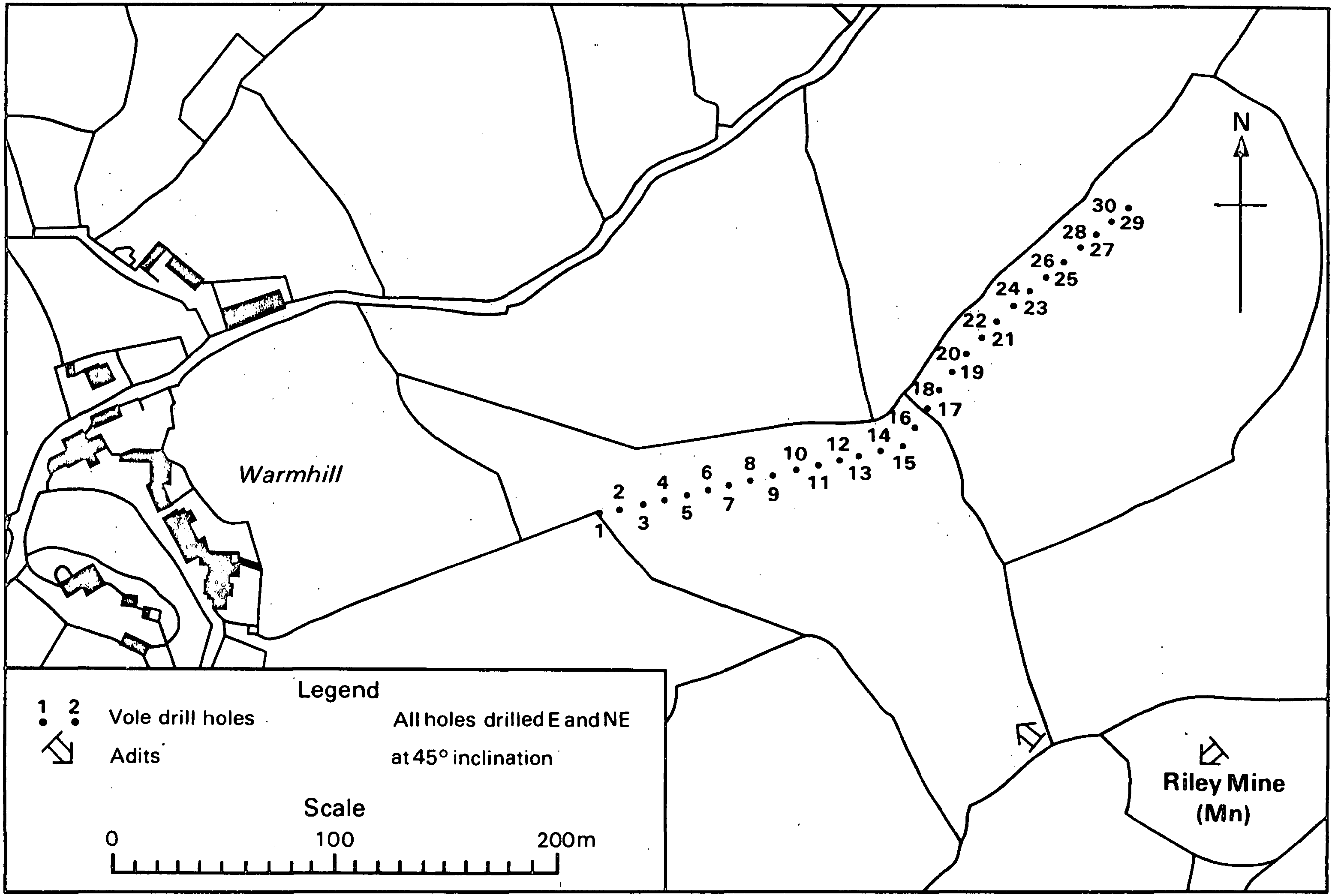

Fig. 7 Warmhill (HW) vole drill traverse

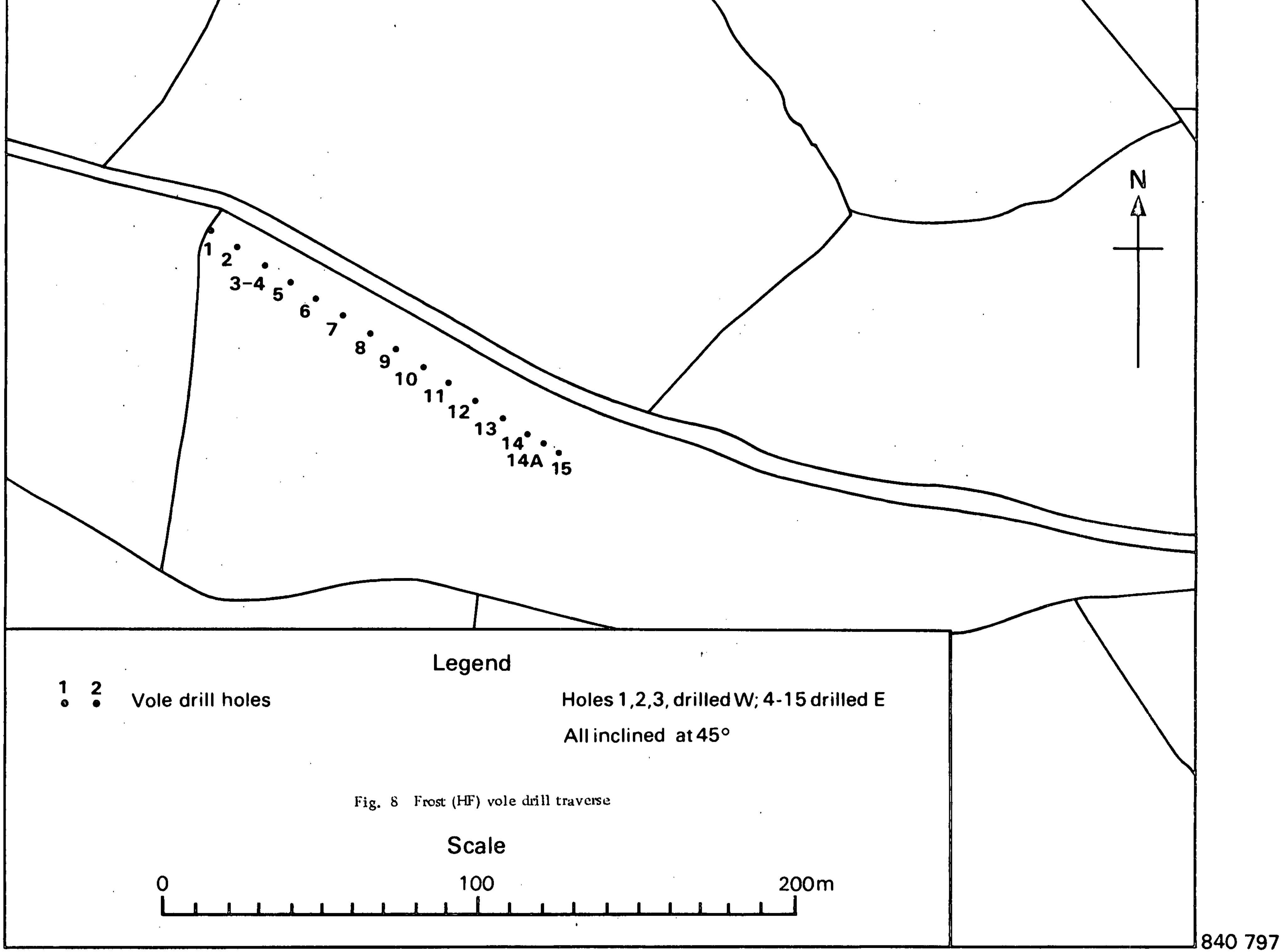

Fig. 8 Frost (HF) vole drill traverse

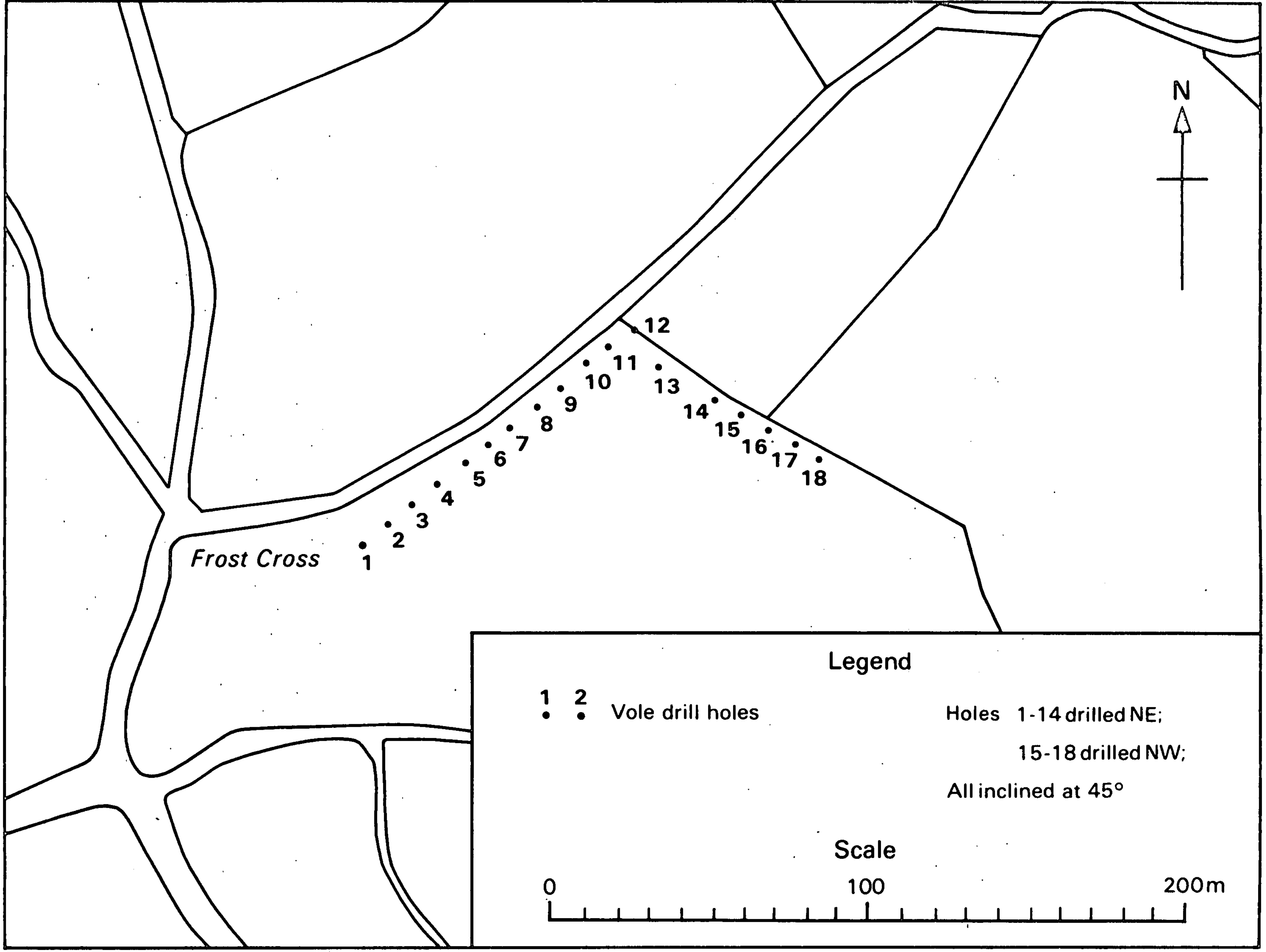

Fig. 9 Frost Cross (HFC) vole drill traverse

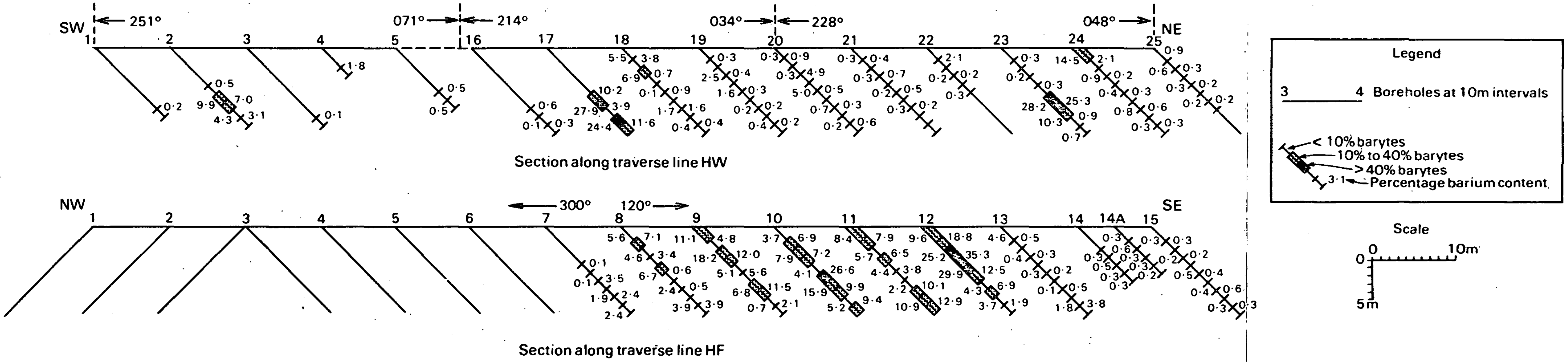

Fig. 10 Barium distribution in vole drill traverses HW and HF

TEIGN VALLEY
SOUTH DEVON
BARIUM IN SOIL
SCALE
0
1km
KEY
Sample Traverse 1972
Sample Traverse 1974
National Park Boundary
Fault
Thrust
Lode
Pb Ba Ag Mineralisation
Shaft
Alluvium
Terrace undifferentiated
BB Bovey Beds Oligocene
CKF Crackington Formation Upper Carboniferous
TC Teign Chert Formation
TCS Combe Shale Formation
Trusham Shale Formation
Lower Carboniferous
HS Hyner Shale Upper Devonian
G Granite
Z Tuff in Teign Cherts
D Dolerite
ELEMENT CONCENTRATION
1972 Data
1974 Data
N
80
90
85
River Teign
DUNSFORD
Wheal Anna Maria
Wheal Lawrence
National Park Boundary
Birch Ellers Mine
Bridford Mine
BRIDFORD
CHRISTOW
LOWER ASHTON
Kennick Reservoir
Tottiford Reservoir
Trenchford Reservoir
Aller Mine
Reed Mine (Wheal Adams)
Wheal Exmouth
Shuttamoor Mine
Frankmills Mine
Great Rock Mine
Hennock Mine
TEIGN VILLAGE
South Wheal Exmouth
Bowden Hill Mine
Plumley Mine
HENNOCK
BOVEY TRACEY
CHUDLEIGH KNIGHTON