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Mineral investigations at Tredaule, near Launceston, Cornwall

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BRITISH GEOLOGICAL SURVEY

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Mineral investigations at Tredaule, near Launceston, Cornwall

Geochemistry

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Cover illustration

A banded carbonate/sphalerite/marcasite/galena vein from the Gwynfynydd Gold Mine, near Dolgellau in North Wales

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SUMMARY

This report describes geochemical investigations commenced in the vicinity of Tredaule, about 1km to the east of Altarnun and north of the A30 road, but not comprehensively completed owing to logistical problems.

Five sediment samples from the two small streams east of Tredaule yielded panned concentrates with anomalous contents of both tin and tungsten, suggestive of local mineralisation. A single soil sampling traverse was sited parallel to the main stream and in the analyses of 34 soils from this line a small group of coincident tin and tungsten anomalies were reported, as well as a marked pair of silver anomalies farther to the south.

In an endeavour to determine the source of these anomalies a gridded pattern of soil samples was collected over ground near Newhay farm. A total of 379 samples were analysed for a range of ore metals and associated elements. For some elements the results were combined with those from the adjacent traverse line prior to statistical treatment. From these combined results it is possible to recognise several soils anomalous in tin, usually with associated elevated levels of tungsten, and a different set anomalous in silver. The latter are sometimes associated with anomalous levels of copper, but there is a separate grouping of copper anomalies which may have closer relationships either to the tin anomalies or to the volcanic rocks over which they are located.

There remains an open question of whether the anomalies have been fully defined in this restricted geochemical programme or whether they continue to the east of the Tredaule stream through the fields where sampling was not carried out. Because of this uncertainty it is unwise to speculate too deeply upon the form of mineralisation giving rise to the observed anomaly pattern, although the correlation between tungsten and tin, and the location of their anomalies relative to those of copper and to the mapped geology, is suggestive of an east-west hypothermal vein. A source for the silver anomalies is not obvious.

INTRODUCTION

The area under investigation derives its title from the hamlet of Tredaule [SX 234.811]* which lies just 1km east of Altarnun [224.812] and about 0.6km north of the A30 Launceston-Bodmin road (Figure 1). It also includes the farms of Trecorner [244.808] to the east, Newhay [243.816] to the north-east, and Trebant [237.805] to the south-east. Two small streams, one rising at Tredaule and the other at Trebant, join north-west of Trecorner and drain in a north-easterly direction into the Penpont Water, a tributary of the River Inny which is itself a tributary of the River Tamar. The larger water courses are cut into a generally rounded topography of moderate relief. A short distance to the south-west lies the higher ground of Bodmin Moor.

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* All localities quoted in this report lie within the Ordnance Survey National Grid square designated by the letters SX.

Launceston [332.845] is the nearest main supply centre and is some 14km to the north-east along the A30, now a much improved major road. The closest railhead is at Liskeard [252.646], about 22km distant and reached by narrower and twistier roads.

Off the moor much of the mineral ownership remains attached to the land holdings and, therefore, is held in rather small parcels by several landlords. Mineral interest during the present century has largely by-passed Tredaule and its immediate vicinity, though some attention has been paid to cassiterite and wolframite potentialities in alluvial deposits and as veins, both on and off the granite. Such attempts at mining are not wholly forgotten in the Altarnun district, but the land has been devoted exclusively to agriculture for at least thirty years, the last small mine working having closed in 1957.

GEOLOGICAL SETTING

The area around Tredaule is included within the Geological Survey One-inch Sheet 337 (Tavistock and Launceston) first mapped at the six-inch scale and described by Reid et al (1911). Recently this sheet has been remapped by a team from Exeter University but neither the map nor the descriptive memoir has been published to date. Figure 2 is based upon six-inch field slips from the earlier survey.

The Tredaule area is underlain entirely by Lower Carboniferous and Upper Devonian slates, together with interbedded volcanic rocks. Although generally thermally metamorphosed, the sedimentary rocks are rather poorly exposed; on the other hand, because of their frequent usage for building purposes and as roadstone, the volcanic and igneous rocks are well displayed in scattered quarries.

The Memoir (Reid et al, 1911) notes that the succession could not be determined with any certainty due in part to the lack of palaeontological evidence and in part to complexity of structure brought about by frequent inversion and overthrusting. Further, the rocks were later shouldered aside by intrusion of the Bodmin Moor Granite. In recent years it has become apparent that the Survey account needs major modification in the light of modern studies elsewhere in Cornwall, but there are no published descriptions which refer to the Tredaule area.

Reid et al (1911) show the unfossiliferous Woolgarden Phyllites (shown as Woolgarden-type slates in Figure 2) as the lowest horizon represented in the study area, occupying a NW-SE band stretching from the granite contact to Tredaule hamlet. They are essentially silver grey in colour due to abundant sericitic mica, well banded and with minute green chloritoid spots and crystals developed all over the cleavage planes. They usually have a distinctive saccharoidal texture, and fairly massive appearance with only a poor cleavage parting. Tourmaline is commonly present and is presumably a metasomatic introduction originating from the nearby granite; within the thermal aureole of the Bodmin Moor Granite cordierite is widely developed.

These phyllites are considered to underlie a Volcanic Series comprising mainly grey, green or blue rocks which locally are intensely sheared into a schistose condition. Where they are unaffected by movement these rocks commonly display pillow structures and bands of vesicles, supporting a belief that most of the volcanic rocks were submarine spilitic lavas. There are also some associated layers of ash in the sequence. In a gorge of the Penpont Water, to the west of Oldhay [238.821], both the Woolgarden Phyllites and the lavas are overlain by Carboniferous grits and shales. The old surveyors remark that the lavas are "associated at top and bottom with black slate". Although they refer these slates to the Devonian they describe them as difficult to distinguish from Carboniferous rocks. It is probable that correctly they should be ascribed to the Barras Nose Formation, recognised near the base of the Lower Carboniferous in North Cornwall (Selwood, 1961). Such an attribution casts serious doubt on the stratigraphical placement of the Volcanic Series made by Reid et al. (1911), this perhaps requiring to be correlated now with the Tintagel Volcanic Formation, and mainly in the Lower Carboniferous.

The early stratigraphers placed the soft, smooth, fine-grained, greyish green slates, now called the Tredorn Slates but shown as grey-green slates in Figure 2, above the lavas and as part of the Upper Devonian succession. Edmonds et al (1975), following the work of House and Selwood (1966), favour these slates as directly overlying the Woolgarden Phyllites and so, whilst still of Upper Devonian age, probably wholly underlying the lavas. Most of the Tredorn Slates are reasonably well cleaved; they are sporadically fossiliferous with Cyrtospirifer verneuili, bryozoans and crinoids the commonest forms.

Current bedded grits and carbonaceous shales which form the ground east of Tredaule (Figure 2) were attributed to the Upper Carboniferous by the early workers on the basis of their similarity to plant-bearing sediments of that age farther north. This narrow trough is now considered as predominantly, if not wholly, Lower Carboniferous in age (Edmonds et al, 1975).

The epidiorites are mostly sill-like in form and are confined mainly to the Upper Devonian succession into which they were forcibly intruded. At the sill contacts the host rocks are commonly altered to spilosites. Nearly all these hard, greenish grey and fine-grained igneous rocks have been affected by granitic thermal metamorphism and their original composition remains in some doubt.

In small streams such as those at Tredaule, and in the Penpont Water at elevations of less than 165m, there is no evidence of older alluvium such as is seen on the higher moorland. The modern stream sediments of the larger waterways which drain the granite obviously carry some detrital cassiterite, and most have been turned over at various times in the past. Only minor residual disturbance is now apparent.

METALLIFEROUS MINING

Although there are no metal mines in close proximity to Tredaule, the study area, being but a short distance from the granite contact, is geologically well placed for possible mineralisation, especially of tin, tungsten, arsenic or copper. Indeed, it seems somewhat strange that this area has not been actively prospected in the past.

The closest cluster of former mines lies to the south-west of Tredaule and is entirely contained within the granite. Lodes on either side of the valley upstream from Trewint village [220.805] were formerly worked as part of Wheal Vincent, a mine alternatively known as Altarnun Consols, Trewint Down or Trewint Consols. Five veins are reported (Dines, 1956) but only two are known to have been followed to any depth, these to a maximum of 55 fms (100m) below surface. Only small and probably incomplete productions of tin, tungsten and arsenic have been recorded and the workings were finally abandoned in 1920.

A short distance to the south, now largely concealed by Forestry Commission plantation [c. 212.787], lie the remains of Halvana and Foxtor mines which at one time worked separately but later combined. The lodes are very similar to those at Wheal Vincent and consist of bunches of thin quartz veins with sporadic cassiterite and wolframite in a generally greisenised granite. The plans show development only to a 20 fm (36.5m) Level below Adit (itself at 16 fms, ie 29m, below surface). Halvana Mine was started about 1843, Foxtor possibly about the same time, and the combined mines last worked in 1918. Only small amounts of tin and wolfram seem to have been sold.

Between Tregune farm [228.792] and the River Lynher an adit and four shafts mark the site of Great Tregune Consols, tried for tin and copper between the 1840s (when it was known as East Alvenny) and 1865. It was developed to a final depth of 92 fms. but the only recorded production was a mere 53 tonnes of copper ore. At the bottom of the mine the main lode was said to be 1m wide and of quartz and chlorite with pyrite, copper ores and a little tin. The mine is wholly within the Bodmin Moor Granite but is very close to the contact.

In an identical geological position a little farther east, at Treburland farm [235.794], tin and tungsten (and probably also some arsenic) were produced from the Treburland Mine, known at other times as Wheal Annie or Wheal Flop. Of the worked lodes, two consisted of bunches of quartz veins in granite carrying granular arsenopyrite, scattered coarse crystals of cassiterite and blades of wolframite; the other comprised 1.5m of chloritised hornfelsed slate with a sprinkling of sulphides and a little cassiterite. Early workings were opencast from the surface, with later exploitation all above Adit Level until exploration was resumed in the last war. At that time Flop Lode was explored to 50ft (15m) below Adit Level but without promising results. Production of tin and tungsten has been reported intermittently from 1881 until 1945, but the figures are almost certainly incomplete.

Immediately east of this mine, on the southern bank of the River Lynher, manganese was formerly worked by adits driven into lenticular masses of oxide, carbonate and silicate ore enclosed in slates, calc-silicate rocks and cherts associated with greenstones, in the thermal aureole and very close to the granite contact. This working was known as Treburland Manganese Mine and seems to have had only a brief productive life, between 1887 and 1890 (Dines, 1956; Russell, 1946). There is now little evidence of the adits but a small dump with some manganese ores still remains.

About 2.5km to the south-east and straddling the contact lie the workings of Trebartha Lemarne Mine [256.777] in which three lodes have been tried at various times. The mine is recorded as producing tin, copper and gold in the 16th century; tin, arsenic and tungsten between 1884 and 1888; and some wolfram (with tin?) from 1951 to 1954 (Dines, 1956). Mining has not proceeded below a Deep Adit Level but in some parts much of the mineralisation has been removed above this horizon. Fluorite is reported from the dumps, but this mineral seems not to have been separated as a by-product.

Similar Sn-W-As-F veins have been intermittently tried from other locations on the granite contact even farther south-east, around Beriowbridge [273.756], Middlewood [267.752] and Kingbear [272.748]. One of these properties, Hawkswood Mine, was worked for wolframite in 1944-6 and 1952-7 but no sales are recorded.

Some 3.7km west-north-west of Tredaule, in the valley between Bray Down and Carne Down, are the remains of Wheal Bray [198.823] which worked a wide east-west quartz vein carrying scattered pyrite, chalcopyrite, and native copper. Two narrow crosscourses carry nickel and uranium minerals. A very small production of low-grade copper is recorded during the mid-19th century (Dines, 1956).

At various times, including the 1914-18 war, the streams near the granite margin have been worked for alluvial cassiterite; some were also tried during the last war for both cassiterite and wolframite. The most extensive operations were those south of Bowithick [182.828], on the headwaters of the River Lynher above Trewint and upstream of Tregirls [221.800], and lower on the River Lynher around Trebartha Hall [263.776]. Although some good values remain (especially for wolframite) the valleys commonly contain too many big boulders to be readily worked by modern machinery.

DRAINAGE GEOCHEMISTRY

During a regional geochemical survey carried out in 1971 as part of an investigation of uranium mineralisation in south-west England, panned concentrates from the Tredaule catchment were noted to contain anomalous concentrations of tin. It was this result which directed further attention to the area. The locations of these samples are shown in Figure 2; sample numbers are prefaced by BTC for stream sediments and BTP for the panned concentrates derived from them.

A more comprehensive collection of stream sediments carried out and described by Jones (1981) included, from the close vicinity of Tredaule, five which report anomalous levels of both tungsten and tin. Locations for these samples are shown in Figure 2, full analyses for the sediments (-100 BSS mesh fraction) and their panned concentrates are given in Appendices 1 and 2. In the statistical summaries which form Table 1 the elemental contents in sediments are compared against those in their panned concentrates. Although the two sets of samples were analysed by different methods, with differing sensitivities for some of the elements, comparison is nonetheless believed to be valid but numerically inexact. Appendix 3 provides partial analyses for screened fractions from these sediments; unfortunately, they were not determined for tungsten.

The stream sediment was wet sieved to pass a 0.1 inch (2.5mm) mesh screen and was then homogenised. A portion was retained for analysis and a sub-sample of about 2kg was hand-panned down to 50g and then dried. A 5g sub-sample of this concentrate, together with 3g of Elvasite, was ground by agate Tema mill ready for X-ray fluorescence analysis. The sediment sample was also oven dried and then screened into four size fractions:- +30 mesh, 30-60 mesh, 60-100 mesh and -100 mesh BSS. From each size fraction sub-samples of about 10g were taken and ground to -200 mesh in an agate mortar.

Table 1. Comparison of analyses of stream sediments and panned concentrates (n = 5)

Element	Sediment			Panned concentrate		
	Range	Mean	Median	Range	Mean	Median
Ag	0-3	1	1	3-12	8.2	8
As	40-50	45	45	50-240	100	80
B	130-180	140	130	-	-	-
Ba	100-420	224	180	60-240	158	190
Be	3-4	3.6	4	-	-	-
Ca	-	-	-	2500-8300	5700	5900
Ce	-	-	-	250-530	360	320
Co	24-42	29.2	24	-	-	-
Cr	180-420	296	320	-	-	-
Cu	15-30	21	20	5-10	6	5
Fe*	-	-	-	4.51-24.96	15.46	14.25
FeOx	56000-100000	68600	56000	-	-	-
Mn	1800-4200	3320	3200	1200-5700	3880	4100
Mo	0	0	0	-	-	-
Nb	0-100	37.4	56	-	-	-
Ni	56-75	71.2	75	60-95	85	90
Pb	40-90	58	50	90-140	108	100
Sb	-	-	-	0	0	0
Sn	56-4200	1275	560	2600-29400	10780	8000
Sr	-	-	-	6-56	32.4	34
Ti*	-	-	-	1.03-12.79	7.5	7.06
U	2.2-2.7	2.5	2.6	-	-	-
V	56-75	71.2	75	-	-	-
W	35-300	177	150	400-7000	1910	750
Y	13-24	18.4	18	-	-	-
Zn	200-310	264	270	190-360	304	320
Zr	320-560	408	420	151-247	182	177

* quoted in per cent

From this tabulation it can be seen that even in the case of tin and tungsten, metals expected to be mainly contained in refractory mineral species, concentration in the panned concentrates falls short of the 40 times attained on the sample bulk. The up-graded elements can be separated into two groups; W, Sn and Ag are significantly concentrated whilst As, Pb and Fe are only slightly so. Mn, usually a scavenger metal, and its associates Ni and Zn, along with Ba appear to be scarcely concentrated at all. Contents of the other two elements, Cu and Zr, are both reduced in the panned fractions, the former is probably held mainly on clay minerals and the latter in zircon which has been panned out with other light coloured species.

There can be little doubt, therefore, that detrital cassiterite and wolframite have been concentrated in the two streams, but from what source is not evident. Silver minerals are not normally found with these two species and the presence of this element in anomalous amounts is entirely enigmatic. Because there is no likelihood of Ag being present in the cassiterite or wolframite lattices, the silver is presumed to exist in discrete mineral form, one which is not readily dissolved by humic acids but has not been recognised in a cursory examination of the panned concentrate mineralogy.

The size distribution of minerals carrying these metals would be of special interest but, unfortuntely, data for Ag and W is not available. From Appendix 3, however, it is clear that the cassiterite is present as grains of varying size and not concentrated in only the finer grain sizes. There is no strong correlation between Sn and any other element determined.

SOIL GEOCHEMISTRY

Newhay traverse. For logistical reasons the drainage anomalies were followed up only on the Newhay side of the streams. A soil sampling traverse 660m long and approximately parallel to the stream course was established from a point near its junction with the Penpont Water to one just below the meeting of its headwaters (Figure 3). Samples were collected at 20m intervals from depths of about 1m. Most of this traverse is situated immediately above the alluvium feather edge, though the upstream leg ends within the alluvium. The majority of samples, therefore, were taken from the 'C' soil horizon.

The collection yielded 34 samples each of about 100g weight which were first oven dried, then screened at 100 mesh BSS. Sub-samples were submitted to BGS Analytical Chemistry Unit for analysis by AAS, OES, colorimetric and gravimetric methods and to AERE, Aldermaston, for determination of U by delayed neutron activation. The results are listed in Appendix 4 and a statistical summary is given in Table 2. Because of the high Ag levels recorded, repeat determinations of this metal were carried out for samples BTS 133-143 inclusive and all these results are incorporated in the summary. With such a small set of samples the preparation of log-probability distribution plots was considered to be inappropriate.

AAS results for Cu, Pb and Zn are rounded to the nearest 10 ppm, the colorimetric values for W and As to the nearest 5ppm and 10 ppm respectively, and the OES plate measurements are rounded to a pre-set series of values on a logarithmic scale.

Table 2 clearly shows that the range of elemental contents is so great in many instances that the standard deviation either equals or exceeds the mean value. Under such circumstances the recognition of truly anomalous samples is no longer a simple matter. In order to achieve a meaningful separation, recourse has been made to the log-probability plots derived for the grid soils or from the combined grid and traverse results (Figures 5 - 11). Using this basis it has been possible to plot in Figure 4 the distribution of samples reporting anomalous values of base metals and some of their commonly associated elements. Usually in Cornwall W values in excess of about 50 ppm would be considered anomalous and this level is employed in preference to the 213 ppm derived from Figure 11. Pb and Mo show a near-gaussian distribution (Figures 10 and 11) and, therefore, do not appear in Figure 4. Because there is no extended data for As, this element is arbitrarily plotted at values above 50ppm.

Table 2. Statistical summary for analyses Newhay traverse soils (in ppm except for FeOx and LOI which are quoted in per cent)

Element	Range	Mean	S.D.	Median
Ag*	0-17	2.222	3.565	1
As	10-120	44.85	29.37	30
B	0-240	86.54	57.06	75
Ba	0-2400	556.7	537.7	320
Be	0-4	0.718	1.131	0
Co	0-56	18.82	17.80	18
Cr	0-560	161.6	149.2	130
Cu	10-90	23.82	14.30	20
FeOx	0.0-24.0	7.059	5.768	5.6
Mn	18-2400	661.0	524.1	420
Mo	0-2	0.308	0.562	0
Nb	0-180	47.85	47.76	56
Ni	0-240	66.13	67.79	42
Pb	20-80	55.29	13.77	60
Sn	0-750	63.00	153.0	10
V	42-320	164.6	73.94	130
W	0-200	16.83	40.81	5
Y	0-56	18.97	17.40	13
Zn	20-490	91.18	78.09	80
Zr	0-2400	633.8	557.4	420
LOI£	4.6-29.4	10.6	4.5	10.2

* n = 45 for Ag; 34 for As, Cu, Pb, Zn and LOI; 30 for W and 39 for all other elements.
£ only meaningful to one decimal place

Anomalous tin, directly associated with anomalous tungsten, is reported from a restricted group of samples around the mid-point of the traverse. Notably, arsenic levels are not elevated in these samples but are anomalous at many of the sampling points to the north. Although not plotted in Figure 4, boron also does not correlate with the tin. Farther south on the traverse are scattered groupings of samples anomalous in silver. Only one of these was collected within the alluvium, though even that was derived from a depth below the stream sediment. One of these samples is also anomalous in copper.

Only two samples were anomalous for zinc, a surprising result inan area containing basic intrusive rocks. The plots for barium and vanadium show neither element to correlate systematically with any of the other metals.

<u>Newhay grid</u>. In an attempt to define more closely the sources of these anomalies a grid laid out to the west of the Tredaule stream was

sampled at 10m intervals along north-south lines spaced 30m apart. Once again the samples were collected from the 'C' soil horizon by hand augering to a depth of about 1m. Including duplicates, a total of 379 samples were taken.

After oven drying and disaggregation the soils were screened at 80 mesh BSS. Undersize fractions were submitted to the BGS Analytical Chemistry Unit for analysis by the same techniques as for the traverse soils; B, Be, Cr, Y and LOI were not determined on the grid soils and U was reported for only some. AAS figures were rounded as previously but the OES measurements were made on a fully linear scale. The full results are listed in Appendix 5 and a statistical summary is given in Table 3. Log-probability plots, shown in Figures 5 to 9, have been prepared for those elements where the differing methods of analytical measurement give rise to significantly divergent values.

Table 3. Statistical summary for analyses of Newhay grid soils (in ppm)

Element	Range	Mean	S.D.	Median	Main inflexion pts£
Ag*	0-7	0.693	1.089	0	see Table 4
Ba	47-1632	369.5	191.0	316	220 (15.5%); 295 (46%); 660 (91.5%)
Co	2-376	23.20	33.44	13	9.3 (33%); 36.5 (75%); 59 (98%)
Cu	10-1500	31.88	77.07	25	see Table 4
FeOx	8380-136346	45855	24043	37850	22000 (8.5%); 120000 (98.7%)
Mn	0-5110	912.3	771.1	586	195 (2%); 1700 (85%); 3400 (98.4%)
Mo	0-39	1.896	2.322	2	see Table 4
Ni	14-1799	99.28	130.3	45	35 (41%); 180 (75%); 385 (98.7%)
Pb	10-110	35.87	13.89	30	see Table 4
Sn	1-1853	26.92	120.3	7	see Table 4
U	0.1-6.6	3.026	0.749	3.1	2.7 (21%); 3.6 (92.5%); 5.6 (98.2%)
V	52-356	158.4	44.38	150	215 (92%); 320 (98.3%)
W	0-700	8.161	42.53	5	see Table 4
Zn	20-34000	225.4	1972	70	see Table 4
Zr	108-692	352.6	106.8	349	380 (30%); 650 (99.2%)

* n = 378 for Ag, Cu, Pb, W and Zn; 285 for U; and 376 for the rest
£ derived from log-probability plots (Figures 5 - 9); figures in parentheses indicate percentages of the total samples
LOI was not determined for the grid soils

Because the traverse and grid soils were collected from adjacent areas and were analysed by the same methods in the same laboratories, it was thought acceptable to combine those traverse and grid sample results reported by similar methods of measurement. Although this criterion is not strictly true for Sn, log-probability plots for both the grid soils and the combined soils showed so little difference of detail as to permit the combination of results for this metal. The AAS results for Ag, Cu, Pb and Zn, the OES analysis for Mo, and the colorimetric results for W, however, fully meet these restrictions. Table 4 provides a summary of the statistical data for these elements and Figures 8 to 11 display their log-probability plots.

Table 4. Statistical summary for analyses of combined traverse and grid soils (in ppm)

Element	Range	Mean	S.D.	Median	Inflexion points£
Ag*	0-17	0.856	1.623	1	3 (95%); 5.8 (98.2%)
Cu	10-1500	31.21	73.97	20	55 (94%)
Mo	0-39	1.747	2.265	2	near-gaussian?
Pb	10-110	37.48	14.88	30	gaussian?
Sn	0-1853	30.31	124.1	8	5.6 (45%); 34 (85%); 57 (94%); 560 (99%)
W	0-700	8.799	42.47	5	213 (99.3%)
Zn	20-34000	214.4	1889	70	45 (36%); 145 (93.3%); 315 (97.8%)

* n = 423 for Ag; 412 for Cu, Pb and Zn; 408 for W; and 415 for Mo and Sn.
£ Derived from log-probability plots (Figures 8 - 11); figures in parentheses indicate percentages of the total samples.

The log-probability plots for Co and Ni (Figure 5) can be interpreted as showing two populations for each of these metals. In each case a lower set, representing some 60% of the total, is assumed to reflect these metals in the local sediments with a higher set being derived from the volcanic series. A mere one or two per cent of the total are highly anomalous. In Figure 6 similar interpretations can be placed upon the Fe and Mn plots with the lower sets containing 58% and 44% of the total samples respectively. Again, the anomalous populations are very small. By comparison the plots for V and Zr are rather simple (Figure 7) with only few anomalous samples. A break at 60% in the Zr plot may separate populations from the two different rock-types. The Ba plot (Figure 8) also seems to show two separate sets but for this element significantly more samples are anomalous. A similar size of anomalous group is found for U (Figure 9) but it is less easy to discern populations which can be readily ascribed to the two lithologies.

A complex plot is derived from the Sn results (Figure 8), with at least 6% (perhaps even 15%) of the total being distinctly anomalous. Two populations may be recognised below this, the lowest set being 45% of the total samples and presumably representing the tin-poor volcanic rocks. Cu offers a very simple plot (Figure 9) with some 6% of the soils being anomalous. Zn also displays a similar proportion of anomalous samples (Figure 10), but it appears that Pb shows a gaussian distribution.

In Figure 11 it can be seen that the plot for W is remarkably simple with a single inflexion point suggesting anomalous contents at levels in excess of 213 ppm. By Cornish standards this cut-off is ridiculously high; it would normally be expected that anomalous values begin at 20-40 ppm, but there is no sign of an inflexion point at this value. Mo would seem to have a near-gaussian distribution. In the case of Ag it seems appropriate to accept the lower inflexion point (at 3 ppm) as defining an upper anomalous set, this comprising 5% of the total samples.

CONCLUSIONS

Distribution plots for major metals reported in Tredaule soils constitute Figures 12 to 16. With the exception of tungsten, the cut-off values used are those derived from respective log-probability plots. As previously indicated, the tungsten value is ridiculously high and in consequence the distribution of this metal is shown at values of 10 ppm or above (Figure 12). In reality, it appears more meaningful to consider only those samples of 20 ppm and above.

Such a revised distribution, when compared against that for tin (Figure 13), shows a very clear sympathetic relationship with a Sn:W ratio which is crudely constant at about 3. As might be expected, the highest metal values are found in samples taken from within the alluvium - though some of these (particularly those near the feather edge) reputedly derive from subsoil below the drift cover. It is distinctly feasible, however, that particulate cassiterite and wolframite from the base of the alluvium has been carried downwards during augering.

The main group of anomalies lies well down the Tredaule stream, to the south-east of Newhay farm and close to the site from which an anomalous stream sediment (BTC 105) was reported (Jones, 1981). Somewhat weakly anomalous values of both metals continue up-slope sufficiently far away from the stream to appear meaningful. The placement of this zone at the mapped contact of (Tintagel Volcanic Formation?) lavas and Carboniferous sediments seems strange; the presence of even low-grade tin-tungsten mineralisation within lavas would be unexpected. It is acceptable, however, to interpret the anomaly distribution as lying on an east-west strike which would here accord with the mapped contact, and thus to suggest that the mineralisation may be contained in a vein structure of normal regional strike within that (faulted?) contact. If this is indeed a reasonable premise then there follows a clear possibility that the mineralisation may continue farther eastwards under the fields of Trecorner farm.

Five more samples carrying anomalous tin values, four of them in a linear cluster, were collected from the alluvial flat higher up the stream. These do not report associated anomalous tungsten, but two are accompanied by anomalous silver, three by anomalous zinc and two by anomalous copper (Figures 12 to 16). There is no obvious source for these weak anomalies; they may represent merely localised concentrations of heavy minerals or, perhaps, indicate the possibility of some mineralisation to the east of the stream.

Samples containing anomalous silver (Figure 14) are clustered about mid-way down the Tredaule stream and mainly in the soils just above the mapped alluvium line. Their distribution, approximately parallel to the stream, is not immediately suggestive of vein-type mineralisation, nor is their northerly spread indicative of strata-controlled disseminations. Dines (1956) does not record any silver mineralisation from surrounding mine workings, though persistent local rumours talk of silver minerals in veinlets within the quarry at Two Bridges [272.817]. If the rumour is based on fact, such veinlets would be hosted in volcanic rocks, not in Carboniferous sediments. It is also necessary to consider whether these anomalies might be due to contamination, but no immediate explanation on these lines would seem to satisfy the observed distribution. There is, then, no nearby model upon which to base an interpretation of the silver anomalies and further investigation of these anomalies, with included coverage of the area to the east of the stream, is obviously desirable.

Anomalous copper values appear to cluster into three groups. Of these the most easterly, a cluster of only four samples of 60-75 ppm, shows no meaningful correlation with any other metal and can probably be dismissed as representing a localised weak dissemination of chalcopyrite in the volcanic rocks. The larger grouping to the west shows a closely similar low tenor of copper content, but it clearly lies on strike with the main group of tin anomalies and also close to the mapped contact of the Volcanic Formation and the Carboniferous rocks. It is not clear which of these factors, if either, is the more significant. The former gives additional weight to the belief that the anomalies reflect the presence of an east-west vein structure which carries tin-tungsten mineralisation with a halo of copper minerals. This structure may occupy a zone of weakness at the lava-sediment contact. Alternatively, the anomaly grouping just within the lava outcrop may merely reflect localised disseminated sulphides within those rocks.

The third group of anomalies is stretched out along the middle reaches of the Tredaule stream. Among this group is the only highly anomalous sample which, notably, is not located within the alluvium. In many of these samples there is close correlation with anomalous silver contents and some show a correlation with zinc. It would be simple to suggest that these anomalies indicate, involving as they do an association of highly mobile elements, local hydromorphic enrichments but the distribution appears too erratic to fit this theory. Their source remains a mystery, calling for further study. As with the silver anomalies, it is desirable that geochemical cover should be extended east of the stream.

Zinc anomalies (Figure 16) can be regarded as two groupings, one immediately south-east of Newhay farm, correlating closely with copper anomalies and lying to the west of the main cluster of tin anomalies. It is again tempting to suggest that this distribution strengthens the interpretation of vein-type mineralisation here. Alternatively, it would not be unexpected to find minor concentrations of sphalerite developed within the volcanic rocks close to their margin. The other grouping is very scattered and extends along much of the length of the Tredaule stream. There is correlation with copper and silver in a few some samples. It is probable that many of the anomalies reflect hydromorphic concentrations of zinc, but two very high values (one in alluvium) almost certainly represent particulate sphalerite.

RECOMMENDATIONS

A lack of coverage to the east of the Tredaule stream creates a major gap in the geochemical picture. Interpretation of the limited information available suggests that there may be a tungsten-tin vein, with its copper and zinc halo, marking the junction between volcanic lavas and Carboniferous sediments. If so, it may be presumed to have an easterly extension which needs to be defined by further geochemical soil sampling.

Scattered Ag anomalies in the middle reaches of the stream, with their associated copper or zinc, currently defy interpretation, partly due to the shortage of data and to the intervention of the alluviual strip. It is highly desirable that the geochemistry be continued to the east of the stream in this area also.

It is recommended, therefore, that efforts be made to complete the geochemical soil sampling programme through the ground belonging to Trecorner farm. Thereafter it may be appropriate to attempt to confirm the source of the anomalies by diamond drilling.

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APPENDIX 1. Analyses of stream sediments (in ppm except for FeOx, which is in per cent)

Sample No.	OES B	Ba	Be	Co	Cr	FeOx	Mn	Mo	Nb	Ni	Sn
BTC 102	130	240	4	24	320	5.6	3200	0	75	75	560
103	180	420	4	24	180	5.6	1800	0	0	56	56
104	130	100	3	24	240	5.6	3200	0	100	75	560
105	130	180	3	42	420	10.0	4200	0	56	75	4200
106	130	180	4	32	320	7.5	4200	0	56	75	1000

Sample No.	OES V	OES Y	OES Zr	AAS Ag	AAS Cu	AAS Pb	AAS Zn	COL As	COL W	DNA U
BTC 102	75	13	320	0	30	90	260	45	250	2.7
103	75	24	320	3	15	50	200	45	35	2.3
104	75	13	420	1	25	60	310	45	150	2.6
105	56	18	420	0	15	40	280	50	300	2.2
106	75	24	560	1	20	50	270	40	150	2.7

APPENDIX 2. Analyses of panned concentrates (most in ppm; but Fe, Sn and Ti are in per cent)

Sample No.	XRF Ag	As	Ba	Ca	Ce	Cu	Fe	Mn	Ni
BTP 102	7	80	190	5900	320	10	22.13	4700	95
103	8	80	240	2500	250	5	4.51	1200	60
104	11	50	60	6100	380	5	24.96	5700	95
105	12	50	240	5700	530	5	14.25	4100	85
106	3	240	60	8300	320	5	11.47	3700	90

Sample No.	XRF Pb	Sb	Sn	Sr	Ti	Zn	Zr	COL W
BTP 102	140	0	0.49	6	11.29	340	152	800
103	90	0	0.90	56	1.03	190	181	600
104	100	0	0.26	31	12.79	360	151	400
105	100	0	0.80	34	7.06	320	177	750
106	110	0	2.94	35	5.33	310	247	7000

APPENDIX 3. Analyses of stream sediment fractions (in ppm except for FeOx, which is in per cent)

Sample &	OES							AAS			COL
Mesh size	Ba	Co	FeOx	Mn	Ni	Sn	Zr	Cu	Pb	Zn	As
BTC 102											
+30	560	24	7.5	1800	75	130	75	30	70	250	40
+60	320	24	7.5	2400	75	420	420	25	70	230	40
+100	320	32	10.0	2400	100	1300	420	25	70	220	30
-100	240	24	5.6	3200	75	560	320	30	90	260	45
BTC 103											
+30	420	24	5.6	1800	56	130	180	20	50	180	25
+60	320	32	5.6	2400	56	1300	560	15	40	150	30
+100	420	32	7.5	1800	56	750	750	15	40	160	30
-100	420	24	5.6	1800	56	56	320	15	50	200	45
BTC 104											
+30	560	24	5.6	1800	42	13	75	35	80	340	60
+60	560	18	5.6	1800	75	100	100	25	60	330	50
+100	180	42	10.0	4200	75	1300	420	20	60	290	40
-100	100	24	5.6	3200	75	560	420	25	60	310	45
BTC 105											
+30	320	42	7.5	2200	100	180	180	25	60	280	70
+60	420	24	5.6	1000	56	1800	56	15	30	250	50
+100	180	56	7.5	2400	100	3200	240	15	40	250	45
-100	180	42	10.0	4200	75	4200	420	15	40	280	50
BTC 106											
+30	420	24	4.2	750	75	1800	130	15	30	240	50
+60	560	56	10.0	3200	100	240	130	20	50	290	40
+100	560	32	10.0	2400	75	2400	180	20	60	250	25
-100	180	32	7.5	4200	75	1000	560	20	50	270	40

APPENDIX 4. Analyses for Newhay soil traverse (in ppm except for FeOx and LOI, which are in per cent)

Sample No.	OES B	Ba	Be	Co	Cr	Fe	Mn	Mo	Nb	Ni	Sn	V
BTS 110	100	240	2	32	320	13.0	2400	1	0	56	10	130
111	18	240	0	0	0	1.0	320	0	0	4	1	100
112	0	240	0	2	0	1.0	240	0	0	3	2	42
113	75	1000	0	24	130	4.2	1000	0	56	42	8	130
114	130	750	2	32	180	13.0	1800	0	0	75	10	130
115	100	750	2	32	180	18.0	1000	0	56	100	6	180
116	0	180	0	8	0	1.0	320	0	0	8	2	56
117	180	1000	2	24	180	10.0	750	1	75	42	13	180
118	130	750	2	32	100	13.0	750	0	0	56	13	320
119	100	320	0	42	240	7.5	1000	1	56	42	13	240
120	100	240	0	42	420	13.0	1000	1	75	130	56	320
121	0	0	0	18	32	1.8	560	0	0	32	42	100
122	56	320	0	32	320	7.5	1300	0	0	130	56	180
123	42	420	0	56	420	13.0	1000	0	75	240	6	180
124	42	320	0	56	420	13.0	1000	0	180	240	130	180
125	42	1000	0	56	320	13.0	560	0	75	240	750	240
126	42	0	0	56	560	13.0	1300	2	56	240	240	240
127	18	0	0	8	42	1.3	320	0	0	24	320	100
128	42	180	0	3	0	1.0	100	0	0	24	18	130
129	180	320	0	24	180	3.2	320	2	75	56	42	240
130	100	1300	0	24	130	7.5	750	1	56	75	1	240
131	100	240	0	24	420	13.0	1300	1	56	56	13	240
132	180	240	0	24	320	5.6	560	1	56	42	18	320
133	130	2400	2	2	56	5.6	240	0	0	42	0	130
134	180	750	2	2	130	5.6	420	0	100	42	8	180
135	32	0	0	0	0	0.0	18	0	130	0	1	75
136	56	0	0	0	0	1.0	100	0	0	4	8	75
137	75	0	0	0	0	1.3	100	0	0	10	3	75
138	240	320	2	6	240	3.2	320	0	56	42	8	240
139	130	1000	3	2	130	4.2	320	0	0	42	4	130
140	100	1000	0	0	42	2.4	130	0	0	32	1	180
141	100	0	0	3	100	1.3	560	0	130	24	18	100
142	75	1000	0	0	0	1.3	100	0	0	4	13	100
143	130	1000	2	4	130	13.0	240	1	130	56	4	180
111R	32	240	0	2	0	2.4	420	0	75	10	4	56
112R	100	1300	3	13	100	10.0	1300	0	56	42	13	130
116R	130	1800	4	18	180	24.0	1300	0	130	130	0	240
121R	13	100	0	13	42	2.4	320	0	56	42	42	130
127R	75	750	0	18	240	10.0	240	0	56	100	560	180

R = Duplicate sample for check analysis

APPENDIX 4 (cont.)

Sample No.	---OES--- Y	Zr	---------AAS--------- Ag	Cu	Pb	Zn	----COL--- As	W	GRAV LOI
BTS 110	42	130	1	30	60	150	20	5	11.2
111	3	130	1	15	40	80	30	0	6.0
112	0	100	0	15	50	70	90	0	17.6
113	10	180	1	15	60	490	30	0	4.6
114	13	180	1	20	70	130	30	0	10.2
115	18	240	1	20	40	100	15	0	10.8
116	0	100	0	20	50	130	80	0	9.4
117	18	1000	0	15	40	100	40	5	12.2
118	13	1300	0	15	50	110	85	5	7.6
119	24	1000	1	15	40	80	100	5	5.2
120	42	1300	1	15	60	130	120	10	8.2
121	0	240	1	25	60	120	100	15	8.6
122	0	420	1	25	60	110	75	15	11.8
123	18	1800	1	30	40	100	90	5	6.0
124	32	1300	1	30	40	100	70	35	15.2
125	10	560	0	30	30	120	45	200	11.4
126	32	420	1	25	20	130	25	100	11.8
127	0	0	1	20	50	80	30	80	6.8
128	10	750	1	10	70	50	45	10	10.2
129	42	560	1	10	70	40	45	5	7.8
130	6	1000	0	20	50	80	20	0	7.0
131	32	560	0	25	60	80	20	0	8.2
132	42	1300	1	15	70	50	40	0	7.8
133	10	420	5	30	60	60	30	ND	6.2
134	56	750	15	90	70	40	30	ND	13.8
135	0	130	1	15	50	30	40	0	12.4
136	2	180	1	30	70	30	20	0	9.4
137	2	0	4	30	80	80	30	0	10.0
138	56	1300	4	15	50	20	20	ND	11.6
139	32	130	5	45	80	60	20	0	16.4
140	24	1300	0	15	70	30	10	0	13.6
141	56	130	8	45	50	40	15	ND	29.4
142	13	1000	1	15	60	30	25	5	14.0
143	42	2400	1	20	60	50	40	5	8.2
111R	0	100	ND	ND	ND	ND	ND	ND	ND
112R	10	320	ND	ND	ND	ND	ND	ND	ND
116R	13	1000	ND	ND	ND	ND	ND	ND	ND
121R	4	240	ND	ND	ND	ND	ND	ND	ND
127R	13	750	ND	ND	ND	ND	ND	ND	ND

ND = Not determined

Repeated Ag determinations were as follows:- BTS 133 = 4ppm, 134 = 17, 135 and 136 = 0, 137 = 4, 138 = 8, 139 = 3, 140 = 0, 141 = 3, 142 and 143 = 0.

APPENDIX 5. Analyses for Newhay soil grid (all in ppm)

Sample	OES						
No.	Ba	Co	Fe	Mn	Mo	Ni	Sn
BTS 2001	276	14	24462	475	0	76	60
2002	248	13	30366	365	1	38	2
2003A	320	51	19231	532	1	101	4
2003B	600	51	23806	751	2	103	7
2004	244	39	24903	1536	1	38	17
2005	639	15	38085	1137	2	78	25
2006A	250	18	60345	406	2	41	5
2006B	292	15	60358	502	1	42	3
2007	288	19	17516	394	0	45	2
2008	243	33	32973	1291	2	44	12
2009	206	9	28622	428	1	27	7
2010	371	11	25063	667	1	66	31
2011A	492	10	50606	379	2	34	7
2011B	231	13	47757	360	2	31	4
2012	293	13	40523	947	1	53	3
2013	180	12	41987	454	2	60	4
2014	290	10	39558	416	2	49	3
2015	397	7	60425	826	2	32	32
2016	321	7	15029	322	2	15	4
2017	296	8	29641	431	1	54	2
2018	392	12	42572	503	2	56	9
2019	390	12	11304	336	2	19	7
2020	236	6	22246	405	0	15	6
2021A	408	11	43516	638	2	36	5
2021B	226	8	38467	351	2	37	2
2022	576	12	53089	1079	1	50	9
2023	-		-	-	-	-	-
2024	302	10	64856	538	2	54	5
2025	241	8	29544	404	1	28	3
2026	1094	11	8380	166	3	24	7
2027	374	470	98141	781	39	1799	9
2028	213	6	25756	430	2	20	13
2029	504	6	39215	682	2	40	8
2030	334	7	22722	491	1	30	14
2031	302	8	14675	248	2	21	10
2032	563	15	30674	348	3	108	40
2033	324	14	14214	293	5	133	73
2034A	244	7	28989	247	2	19	6
2034B	156	5	15403	311	2	16	3
2035	229	10	28674	365	2	23	5
2036	215	7	29841	329	2	20	11
2037	296	7	12709	238	1	37	2
2038	511	10	12319	494	4	89	77
2039	273	9	34802	443	2	27	4
2040	235	10	34778	341	1	20	5
2041	297	10	36063	298	2	34	18
2042	229	11	26524	311	2	32	8
2043	426	6	9734	112	1	21	37
2044	468	11	11157	420	2	120	60
2045	148	95	22353	210	4	302	11
2046	278	8	33088	358	2	23	7

APPENDIX 5 (cont.)

Sample No.	---OES---- V	Zr	------------AAS------------ Ag	Cu	Pb	Zn	DNA U	COL W
BTS 2001	115	303	1	30	50	140	2.9	15
2002	150	272	0	15	30	60	2.8	0
2003A	148	382	0	15	40	310	3.1	0
2003B	178	189	1	15	40	310	-	0
2004	107	293	0	15	40	90	2.9	5
2005	163	207	0	35	50	140	2.6	5
2006A	177	296	0	10	20	80	2.6	0
2006B	138	329	0	10	30	90	-	0
2007	136	303	0	10	20	50	2.7	5
2008	138	359	0	15	30	120	3.1	5
2009	155	269	0	10	50	60	2.9	5
2010	112	237	1	25	60	100	2.5	10
2011A	130	368	0	15	30	50	3.1	5
2011B	139	475	0	20	30	50	-	5
2012	167	301	0	20	40	90	3.1	0
2013	158	233	0	20	40	100	2.7	5
2014	165	334	0	20	30	80	3.1	5
2015	149	254	0	20	50	40	1.8	5
2016	112	390	0	10	30	30	2.9	5
2017	162	320	0	50	40	100	3.5	5
2018	133	268	0	30	30	100	2.8	5
2019	163	343	0	10	40	30	2.8	5
2020	130	381	0	10	40	20	2.3	5
2021A	173	255	0	15	40	70	2.7	0
2021B	202	314	0	10	30	70	-	0
2022	177	294	1	20	40	90	2.7	0
2023	-	-	0	30	40	90	3.1	5
2024	172	312	0	20	50	60	2.7	5
2025	146	247	0	10	40	60	-	5
2026	136	356	0	55	50	34000	2.9	5
2027	125	190	0	20	40	60	3.2	5
2028	132	320	0	30	30	80	3.2	5
2029	161	305	0	25	40	100	3.0	5
2030	144	299	0	20	50	20	2.5	5
2031	157	346	0	20	50	70	1.0	0
2032	102	251	1	25	50	230	1.4	5
2033	95	183	0	20	30	50	3.3	5
2034A	147	342	0	20	30	60	3.2	5
2034B	58	305	0	20	20	50	-	5
2035	112	311	0	20	40	50	3.1	5
2036	135	356	0	25	20	80	3.1	0
2037	105	429	1	30	90	120	1.8	5
2038	103	230	1	25	70	100	0.3	0
2039	140	486	0	15	30	40	3.3	5
2040	148	309	0	20	30	50	3.1	5
2041	137	543	0	20	30	70	3.5	0
2042	145	638	0	25	40	40	2.9	5
2043	131	506	2	35	40	220	2.3	0
2044	99	294	3	35	40	600	-	0
2045	52	145	0	20	30	50	3.6	0
2046	175	397	0	20	30	50	3.3	0

APPENDIX 5 (cont.)

Sample No.	OES Ba	Co	Fe	Mn	Mo	Ni	Sn
BTS 2047	236	9	34678	459	2	26	17
2048	751	14	29475	552	1	18	43
2049	381	8	24606	247	1	16	29
2050	408	5	17797	476	2	39	205
2051	270	11	10394	323	2	46	37
2052	251	9	33109	345	2	31	5
2053	213	8	31614	385	2	29	2
2055	356	8	36074	458	2	18	40
2056	275	6	9874	0	0	31	28
2057	140	7	13278	269	2	41	3
2058	225	304	63964	2070	6	440	12
2059	937	15	38270	1022	4	39	10
2060	472	7	31582	473	1	26	8
2061	246	8	29426	337	2	23	5
2062	245	8	26217	339	3	26	4
2063	428	8	18660	421	2	21	33
2064	380	5	13883	308	2	29	4
2065	354	210	79835	2891	9	501	37
2066	615	13	42018	838	3	31	9
2067	296	11	33327	519	2	36	7
2068	468	12	30663	392	1	31	5
2069	274	7	24174	293	1	25	3
2070	458	8	32791	259	2	27	5
2071	565	8	22113	564	1	28	15
2072	1632	43	64083	582	4	190	33
2073	711	9	37910	933	2	25	6
2074	381	9	26592	382	1	28	4
2075	316	8	31904	402	2	27	5
2076	603	11	36014	358	2	21	5
2077A	468	13	33747	521	1	23	7
2077B	588	2	28426	300	2	14	26
2078	411	9	12333	189	1	37	3
2079	748	73	23481	269	1	200	3
2080	709	8	40602	773	2	31	7
2081	619	10	39054	484	1	36	2
2082	767	11	39505	696	3	27	8
2083	302	9	26520	312	2	26	11
2084	360	7	33574	302	3	17	3
2085	568	14	37073	401	2	31	8
2086	386	7	9374	139	1	16	3
2087	611	10	18700	527	2	41	6
2088	282	9	32463	540	2	28	7
2089	294	7	31083	454	1	21	9
2090	363	8	27781	330	1	27	3
2091	256	9	26250	282	1	31	3
2092	224	8	21998	210	1	24	2
2093	385	6	31238	327	2	14	5
2094	431	7	34709	273	2	14	11
2095	364	11	22590	284	1	25	13
2096	604	7	40067	886	2	31	6
2097	184	7	25270	227	2	27	8

APPENDIX 5 (cont.)

Sample No.	---OES---- V	Zr	------------AAS------------ Ag	Cu	Pb	Zn	DNA U	COL W
BTS 2047	130	323	0	15	40	50	3.5	5
2048	130	444	0	15	20	40	3.4	0
2049	129	404	7	50	40	90	-	10
2050	137	259	6	55	50	70	4.1	5
2051	88	219	0	15	20	50	3.4	0
2052	129	354	0	15	20	50	3.5	0
2053	112	302	0	15	30	40	3.1	5
2055	161	354	7	90	30	40	5.7	5
2056	110	257	0	25	20	80	3.4	0
2057	123	461	1	30	50	1690	1.7	0
2058	123	257	0	30	20	60	4.0	0
2059	167	240	0	15	30	60	3.0	0
2060	134	420	0	20	30	50	3.0	0
2061	135	369	0	15	30	40	3.3	0
2062	178	490	4	30	110	40	3.6	0
2063	138	297	3	30	30	40	3.8	0
2064	131	575	0	10	20	80	0.9	0
2065	100	235	0	20	30	50	3.5	5
2066	172	367	0	15	30	50	2.8	5
2067	127	431	0	15	20	40	3.1	0
2068	124	542	0	15	30	50	3.1	0
2069	110	537	0	15	30	40	3.0	0
2070	146	491	7	55	40	60	4.0	5
2071	134	442	4	40	90	230	2.8	0
2072	140	283	0	15	30	60	3.2	5
2073	148	400	0	15	20	50	3.0	5
2074	112	349	0	15	30	50	3.2	5
2075	142	433	0	15	30	30	3.3	0
2076	147	388	0	15	40	30	3.4	5
2077A	180	412	0	10	40	30	2.8	5
2077B	159	412	-	-	-	-	-	-
2078	163	308	5	30	60	40	5.0	5
2079	171	228	4	60	70	790	2.5	0
2080	141	451	0	15	30	60	3.0	5
2081	143	364	0	15	20	50	2.8	0
2082	154	345	0	15	30	40	3.0	5
2083	137	692	0	15	30	40	3.3	5
2084	168	395	0	15	40	30	3.2	5
2085	160	516	0	15	30	40	3.0	0
2086	120	419	6	35	60	20	4.7	5
2087	160	369	6	60	60	70	6.0	0
2088	135	452	0	15	30	50	2.8	0
2089	125	389	0	15	40	50	3.1	5
2090	111	419	0	20	30	40	2.9	0
2091	116	498	0	25	40	50	3.3	5
2092	114	411	0	15	30	40	3.2	5
2093	136	401	0	10	40	30	2.8	0
2094	147	493	1	10	40	30	2.8	5
2095	164	400	6	60	80	50	6.6	5
2096	131	408	1	20	80	1150	0.1	5
2097	129	479	0	15	20	50	2.7	0

APPENDIX 5 (cont.)

Sample No.	OES Ba	Co	Fe	Mn	Mo	Ni	Sn
BTS 2098	438	9	33832	329	2	22	5
2099	370	6	27433	443	2	24	6
2100	389	9	35998	407	2	18	11
2101	182	112	127896	722	7	524	48
2102	361	6	38338	426	2	24	7
2103	270	9	30177	325	2	27	4
2104	262	11	27416	328	1	23	9
2106	404	20	23865	463	2	74	5
2109A	868	10	31849	444	2	25	10
2109B	391	8	23836	328	2	27	3
2110	326	7	27620	373	2	19	4
2111	268	7	27188	339	2	26	4
2112	280	6	24924	324	1	25	2
2113	562	13	35314	516	2	33	6
2115	234	76	15689	239	9	215	2
2116A	299	13	18753	286	1	42	1
2116B	425	14	22054	474	1	38	8
2117	417	8	33268	421	2	34	1
2118	308	8	22934	334	2	28	1
2118B	566	8	29941	481	2	31	4
2119	313	5	26839	345	2	25	3
2120A	466	7	32476	420	2	30	2
2120B	255	9	27403	469	2	26	4
2121	469	10	32185	374	2	22	5
2122	599	8	35863	450	1	35	3
2123A	331	10	32406	393	2	30	3
2123B	515	13	36891	662	2	29	6
2124	544	12	22866	148	2	22	2
2125	555	39	29049	284	2	82	4
2126	477	10	23440	199	0	43	3
2127	670	14	38800	687	3	30	6
2128	255	5	24600	248	2	16	5
2129	252	7	25006	426	1	23	2
2130	432	8	28426	287	2	25	3
2131	317	4	31752	477	2	19	8
2132	233	5	27643	347	1	24	3
2133	312	7	35055	752	1	30	4
2134A	272	7	28421	389	1	28	3
2134B	236	8	28163	361	1	27	2
2135	312	12	37851	778	2	45	15
2136	626	13	34626	438	2	53	5
2137	543	10	21801	510	5	38	3
2138	512	10	26564	450	3	53	17
2139	470	8	40060	505	2	31	3
2140	778	6	31581	585	2	18	7
2141	689	8	36345	848	1	30	8
2142	493	8	31264	730	2	24	3
2143	292	6	29187	323	2	14	2
2144A	252	6	26106	281	1	24	2
2144B	280	8	24531	230	1	22	3
2145	330	3	34394	456	2	34	4

APPENDIX 5 (cont.)

Sample No.	---OES---- V	Zr	------------AAS------------ Ag	Cu	Pb	Zn	DNA U	COL W
BTS 2098	176	447	0	15	30	40	3.0	5
2099	130	475	0	15	30	40	3.1	0
2100	156	454	0	15	30	30	3.4	5
2101	85	178	0	15	30	40	3.3	5
2102	172	343	0	15	30	40	2.9	0
2103	143	521	0	15	30	40	2.6	5
2104	138	333	3	35	50	40	4.3	0
2106	161	328	1	40	30	720	3.9	0
2109A	185	369	0	20	30	30	3.2	0
2109B	127	436	0	20	30	50	-	0
2110	114	456	0	15	40	40	3.2	0
2111	130	484	0	15	40	40	2.9	5
2112	94	403	0	15	30	40	3.1	0
2113	151	674	0	15	30	150	2.8	0
2115	109	518	1	1500	40	18000	3.6	5
2116A	119	401	1	35	30	70	4.2	0
2116B	130	461	1	35	30	70	-	5
2117	131	373	0	15	30	40	2.9	5
2118A	95	439	0	20	30	40	3.0	5
2118B	132	540	0	20	30	50	-	0
2119	129	500	0	15	30	30	3.1	5
2120A	128	342	0	15	30	40	3.0	5
2120B	139	479	0	20	30	40	-	0
2121	156	414	0	20	40	40	3.1	5
2122	142	400	0	20	40	50	3.1	5
2123A	148	372	0	15	30	40	3.1	0
2123B	153	350	0	15	30	50	-	0
2124	169	429	3	50	20	40	5.5	0
2125	150	416	4	60	40	110	5.8	5
2126	177	349	0	20	30	50	3.4	0
2127	173	296	0	10	20	40	2.9	0
2128	106	366	0	15	30	20	3.2	5
2129	119	390	0	20	40	40	3.3	0
2130	158	425	0	20	30	40	3.1	0
2131	138	385	0	15	40	40	3.1	5
2132	123	445	0	15	30	40	3.4	5
2133	146	326	0	20	30	50	3.4	5
2134A	111	407	0	20	20	40	3.5	5
2134B	107	332	0	20	20	40	-	0
2135	130	411	0	20	40	70	3.0	5
2136	219	336	2	35	20	90	3.8	5
2137	185	363	0	40	30	50	3.7	0
2138	140	412	0	30	30	70	2.9	5
2139	167	288	0	10	20	40	2.8	5
2140	169	468	0	10	20	20	3.1	0
2141	179	420	1	15	20	30	3.3	0
2142	167	380	1	20	30	40	3.2	0
2143	132	340	0	15	30	30	3.1	5
2144A	116	479	0	15	20	40	2.9	0
2144B	85	338	0	15	20	40	-	0
2145	135	272	0	15	20	40	3.2	5

APPENDIX 5 (cont.)

Sample No.	Ba	Co	Fe	Mn	Mo	Ni	Sn
	OES						
BTS 2146	406	12	31264	404	1	35	4
2147	405	11	48461	392	1	45	6
2148	659	14	28255	609	2	54	11
2149	414	29	22090	364	1	69	2
2150	620	10	23746	401	2	43	3
2151	805	15	35146	644	5	53	13
2152	419	10	30130	422	1	31	3
2153	525	15	28715	417	2	31	7
2154	565	9	34336	470	3	22	5
2155	354	8	29803	450	1	28	3
2156	559	8	37844	1012	2	38	15
2157	334	9	32388	558	1	43	4
2158	694	16	40542	851	2	55	8
2159	592	11	38368	809	2	46	5
2160	242	20	42494	792	2	68	24
2161	410	11	28336	499	2	52	30
2162A	799	8	16629	509	1	38	11
2162B	480	7	17468	337	2	39	6
2163	316	28	28754	424	6	96	34
2164	288	4	33586	387	2	23	3
2165	175	6	24862	247	2	20	4
2166	387	8	31775	334	2	27	3
2167	697	10	40481	619	3	29	5
2168	280	9	36398	530	2	35	3
2169	251	13	32190	586	1	40	4
2170	248	14	36399	695	2	42	11
2171	388	16	42983	759	2	49	20
2172	246	13	30138	482	1	45	3
2173	298	13	45901	1141	2	45	5
2174	280	15	42373	996	2	58	14
2175	273	6	19649	343	3	25	36
2176	341	15	40675	457	3	62	145
2177	312	5	25038	238	2	21	3
2178	305	8	32311	249	2	19	6
2180	450	8	31609	475	2	26	3
2181	377	8	32818	375	1	22	5
2182	253	7	34297	473	2	29	3
2183A	347	11	50391	756	1	43	6
2183B	379	11	51619	870	2	40	7
2184	265	9	35541	722	1	39	4
2185	304	13	38454	723	2	50	5
2186	221	17	50874	1161	1	51	7
2187	520	14	63529	833	9	72	5
2188	310	13	47004	726	3	50	20
2189	186	11	42097	745	2	34	66
2190	104	30	67154	1948	1	148	783
2191	223	41	59003	1401	1	187	1853
2192	264	6	25685	153	2	22	6
2193	305	9	32690	298	2	22	4
2194	216	7	27051	305	2	30	2
2195	390	12	33322	388	2	32	3

APPENDIX 5 (cont.)

Sample No.	---OES---- V	Zr	------------AAS------------ Ag	Cu	Pb	Zn	DNA U	COL W
BTS 2146	113	441	0	15	20	50	3.1	5
2147	192	341	0	15	30	60	3.1	5
2148	153	394	1	20	30	50	3.3	0
2149	121	658	0	25	20	140	4.0	5
2150	124	330	0	30	30	50	4.2	5
2151	120	335	1	25	40	90	2.8	5
2152	135	347	1	10	30	40	2.5	0
2153	136	399	1	15	30	30	3.0	0
2154	149	445	0	15	30	30	2.8	5
2155	112	366	0	20	30	40	3.2	0
2156	147	495	0	15	30	50	2.9	5
2157	111	458	0	15	20	50	3.1	5
2158	115	484	0	20	30	60	3.0	5
2159	132	440	1	20	30	60	3.2	5
2160	169	539	1	25	40	80	3.0	5
2161	137	386	2	25	50	130	3.1	5
2162A	198	382	2	25	40	40	4.0	5
2162B	200	335	2	20	40	40	-	5
2163	111	290	0	30	40	270	3.2	10
2164	135	330	0	25	30	40	3.3	5
2165	130	381	0	15	40	30	2.9	5
2166	143	316	0	15	20	30	3.1	0
2167	169	404	0	15	30	30	3.1	0
2168	159	364	0	20	40	40	3.1	0
2169	105	453	1	15	30	50	3.0	5
2170	121	466	1	15	30	50	3.1	0
2171	162	401	1	20	30	60	3.0	0
2172	120	497	1	25	30	60	3.3	0
2173	146	363	1	15	40	60	3.2	0
2174	137	360	0	20	50	80	3.3	0
2175	117	329	0	30	40	50	3.2	10
2176	147	249	0	50	50	130	3.2	50
2177	130	282	0	25	40	30	3.6	5
2178	156	322	0	10	20	20	2.9	5
2180	150	333	0	20	20	40	3.5	0
2181	150	307	0	20	40	40	3.1	5
2182	152	314	0	15	30	50	3.4	0
2183A	182	293	0	15	40	60	3.4	5
2183B	176	263	1	25	50	80	-	5
2184	108	333	0	20	30	70	2.9	5
2185	132	252	0	25	50	70	3.2	5
2186	162	293	1	20	40	70	3.3	5
2187	185	243	1	70	60	90	6.3	0
2188	160	200	1	20	70	70	3.5	0
2189	164	304	1	20	70	60	2.9	15
2190	200	227	1	25	60	90	2.4	200
2191	181	351	1	35	40	110	2.3	700
2192	118	524	0	15	30	30	3.0	5
2193	136	439	0	15	40	30	3.0	0
2194	120	431	0	20	30	30	2.9	0
2195	135	445	1	20	40	40	3.0	5

APPENDIX 5 (cont.)

Sample No.	OES Ba	Co	Fe	Mn	Mo	Ni	Sn
BTS 2196	221	9	30350	511	1	32	7
2197	238	12	32875	435	1	46	3
2198	377	14	40355	726	2	42	4
2199	247	15	40536	818	2	62	6
2200	302	14	30026	524	1	50	4
2201	280	20	43115	997	2	73	7
2202	424	22	55229	1123	3	89	12
2203	276	18	40532	758	3	59	16
2205	159	42	60283	1289	1	183	1001
2206	299	8	29810	440	1	22	6
2207	488	9	30204	300	2	22	4
2208	392	11	27903	241	2	25	1
2209	251	9	25357	267	1	33	1
2210	258	10	27710	368	1	33	5
2211	567	16	40173	685	2	42	4
2212	378	13	41973	762	2	48	4
2213	396	20	47015	1046	1	69	10
2214	338	22	44601	1163	2	86	9
2215	330	18	41845	948	2	64	5
2218	284	49	64700	1899	1	194	210
2219	208	44	60312	1327	1	222	546
2220	584	9	30646	418	3	21	6
2221	687	10	27758	516	1	32	4
2222	739	11	31212	510	2	29	8
2223	604	14	39950	754	2	45	7
2224	277	14	34632	580	2	51	6
2225	239	14	35122	650	2	51	6
2226A	440	20	41358	771	2	78	4
2226B	409	18	37311	603	2	76	1
2227	452	17	38395	899	1	65	7
2228	433	21	45612	901	2	91	3
2229	707	22	51165	1240	1	86	7
2230	741	40	73889	3131	2	149	31
2231	295	51	65301	3323	2	187	41
2232	378	48	69922	2983	1	207	217
2233	251	39	62641	2134	1	168	204
2234	204	49	63373	1771	0	207	93
2235	249	9	23548	251	1	25	4
2236	515	14	27660	400	2	24	4
2237	267	9	26785	585	1	24	6
2238	-	-	-	-	-	-	-
2239	586	19	49315	739	4	61	5
2240	323	14	52458	597	1	61	6
2241	677	27	83935	1153	4	102	18
2242	298	17	54245	942	2	89	15
2244	829	33	76130	2283	5	116	15
2245	415	44	94009	3584	5	231	33
2246	501	54	107534	5110	3	211	91
2247	255	50	101392	2788	0	245	125
2248	276	52	114941	3008	0	238	87
2249	243	49	91664	1820	0	209	57

APPENDIX 5 (cont.)

Sample No.	---OES---- V	Zr	------------AAS------------ Ag	Cu	Pb	Zn	DNA U	COL W
BTS 2196	120	506	1	20	50	40	3.2	0
2197	123	536	0	20	40	60	3.0	5
2198	120	559	0	15	40	60	2.8	5
2199	124	406	0	20	40	70	3.0	0
2200	87	624	0	15	30	60	3.0	5
2201	131	439	1	25	40	90	3.0	5
2202	157	429	1	35	60	100	3.8	5
2203	166	493	1	25	60	80	3.2	5
2205	173	305	1	30	30	80	2.1	320
2206	130	342	1	10	40	30	2.8	0
2207	135	567	0	10	40	20	3.0	0
2208	157	439	1	15	30	30	3.0	5
2209	110	462	1	15	40	40	2.8	5
2210	128	445	1	15	50	50	2.9	5
2211	166	369	0	25	40	70	3.4	0
2212	144	444	0	20	50	70	3.2	5
2213	139	429	0	20	40	80	3.2	0
2214	130	528	0	25	40	90	3.5	0
2215	152	305	0	25	30	90	3.0	0
2218	217	360	1	35	30	90	2.0	50
2219	161	284	0	40	50	120	1.8	240
2220	160	407	0	15	40	30	3.1	5
2221	137	489	0	20	30	30	3.4	0
2222	163	498	0	20	20	30	3.6	5
2223	146	618	0	20	40	40	3.4	5
2224	151	421	0	20	40	50	3.0	5
2225	135	449	0	20	40	60	3.0	5
2226A	125	639	0	30	40	90	3.5	5
2226B	160	507	1	30	50	90	-	5
2227	124	443	0	25	50	100	3.1	5
2228	150	369	0	30	30	90	3.4	5
2229	184	296	0	35	40	110	3.4	10
2230	204	406	1	35	60	120	3.6	5
2231	216	336	1	50	70	150	3.5	20
2232	187	327	1	30	30	100	2.5	50
2233	167	324	1	30	30	80	2.2	25
2234	172	280	1	35	40	90	2.3	25
2235	138	458	0	10	40	30	3.1	5
2236	143	374	0	15	30	30	3.4	0
2237	123	369	0	15	30	30	3.2	0
2238	-	-	0	20	40	50	3.1	5
2239	243	530	0	20	30	50	3.2	5
2240	197	495	0	20	30	50	3.0	5
2241	266	376	1	30	40	100	3.6	0
2242	167	318	1	35	50	110	3.4	5
2244	313	436	1	45	60	120	3.8	5
2245	336	342	1	45	50	160	3.2	10
2246	356	419	1	45	40	130	2.8	10
2247	298	381	1	35	30	90	2.1	25
2248	330	331	1	35	30	80	1.9	20
2249	309	396	1	35	30	80	1.8	10

APPENDIX 5 (cont.)

Sample No.	OES Ba	Co	Fe	Mn	Mo	Ni	Sn
BTS 2250	944	11	43196	563	3	33	7
2251	587	11	41758	390	2	34	8
2252	712	14	59459	958	5	36	10
2253	352	13	60827	1108	3	63	14
2254	761	12	67164	1081	4	74	11
2255	640	16	53905	1088	2	68	8
2256	267	21	68928	1205	2	108	23
2257	467	18	64856	993	3	81	7
2258	287	38	88798	2061	3	187	16
2259	715	33	73640	2063	3	133	11
2260	138	40	66821	1380	1	201	12
2261	205	41	63205	1977	1	174	58
2262	214	40	58695	1042	1	204	74
2263	102	37	54104	1141	0	161	15
2264	143	40	64452	1246	1	214	38
2265	682	11	30638	413	2	28	6
2266	550	15	43219	1121	2	44	14
2267A	398	15	34651	715	3	59	31
2267B	256	10	28333	487	2	46	8
2268	405	16	39843	633	2	59	4
2269	127	19	40072	645	2	92	4
2270	442	20	48468	1623	2	99	6
2271	47	44	85426	4121	0	249	5
2273	201	35	63377	2051	1	146	11
2274	66	34	50770	1688	1	155	22
2275	156	44	76370	1495	0	238	11
2276	324	44	73442	1623	2	168	11
2277	147	42	63909	1879	1	187	46
2278	321	12	34756	632	1	42	8
2279	374	9	39071	631	2	43	6
2280	229	12	35181	473	3	43	4
2281	332	16	46218	801	1	83	14
2282A	154	45	136346	3577	2	297	16
2282B	230	40	130597	2131	2	312	9
2283	196	37	90816	1081	1	350	7
2284	79	35	88614	1990	2	237	17
2285	231	40	77392	2300	1	170	39
2286	299	41	80668	1994	0	201	39
2287	286	40	70183	1909	4	184	38
2288A	258	38	73383	1289	0	190	15
2288B	164	36	74522	1267	0	176	15
2289	240	36	70958	1467	1	186	13
2290	-	-	-	-	-	-	-
2291	225	13	44979	674	2	52	8
2292	320	16	49663	855	4	63	12
2293	129	9	46227	947	5	74	12
2294	106	40	87386	2074	2	251	9
2295	273	47	130741	3558	1	234	42
2296	226	43	72514	2084	3	194	15
2297	452	39	84425	1795	1	201	46
2298	253	44	80354	1549	1	213	35

APPENDIX 5 (cont.)

Sample No.	---OES---- V	Zr	------------AAS------------ Ag	Cu	Pb	Zn	DNA U	COL W
BTS 2250	243	527	0	20	30	30	2.0	5
2251	198	480	0	30	20	30	3.5	0
2252	217	491	0	20	40	40	3.4	5
2253	224	559	0	20	50	40	3.0	5
2254	250	408	0	30	40	70	3.2	5
2255	192	479	0	25	40	70	3.3	5
2256	218	354	1	30	50	100	3.1	5
2257	245	300	1	40	30	80	3.6	5
2258	243	389	1	40	50	140	3.3	5
2259	236	433	1	55	60	140	3.6	5
2260	144	228	1	50	40	160	2.6	5
2261	156	356	1	35	30	110	1.4	10
2262	177	264	1	40	30	80	-	20
2263	163	291	1	40	30	80	2.2	5
2264	165	258	1	45	40	80	2.0	5
2265	134	416	0	20	40	40	3.3	5
2266	150	521	0	20	50	50	3.1	5
2267A	127	335	1	25	30	60	3.1	0
2267B	100	361	1	25	30	60	-	0
2268	140	294	1	20	40	70	3.3	0
2269	144	255	1	35	50	120	3.0	5
2270	149	322	1	35	40	130	3.2	5
2271	170	166	1	60	30	320	2.3	5
2273	155	243	1	40	40	130	2.8	5
2274	169	213	1	35	30	110	2.5	5
2275	210	161	1	60	20	60	1.3	5
2276	234	229	1	60	20	90	1.8	5
2277	195	226	1	40	50	100	2.0	15
2278	130	460	0	20	40	50	2.9	0
2279	154	371	1	25	40	60	3.2	0
2280	163	284	1	25	50	70	3.1	5
2281	135	226	1	40	50	110	3.2	5
2282A	209	160	1	60	40	250	2.7	10
2282B	263	112	2	60	30	680	-	5
2283	180	152	1	60	20	210	2.0	5
2284	182	174	1	55	30	160	2.2	0
2285	169	108	1	35	30	130	2.2	5
2286	209	222	1	30	30	90	1.9	5
2287	198	242	1	30	20	80	1.9	0
2288A	196	215	2	50	30	80	1.7	0
2288B	202	215	2	45	30	90	-	0
2289	204	205	1	40	40	100	1.6	5
2290	172	418	1	30	110	70	3.1	5
2291	202	329	1	30	50	70	3.1	5
2292	202	329	1	35	90	80	3.5	5
2293	186	233	2	80	30	210	1.9	5
2294	193	158	2	65	40	200	1.3	5
2295	327	232	2	40	30	180	2.4	5
2296	264	248	1	40	30	120	2.1	5
2297	244	278	1	30	20	90	2.1	5
2298	297	237	1	40	30	100	2.0	10

APPENDIX 5 (cont.)

Sample No.	OES Ba	Co	Fe	Mn	Mo	Ni	Sn
BTS 2299A	198	41	78335	1415	0	202	3
2299B	161	44	108557	1239	0	223	16
2300	281	11	24089	387	5	61	20
2301	666	16	40334	695	3	59	7
2302	735	12	43925	645	6	56	13
2303	227	40	86340	1299	1	280	13
2304	220	44	85041	1885	1	240	7
2305	434	44	71128	2485	3	249	7
2307	732	37	62308	1212	5	156	24
2308	88	47	85739	1848	1	241	40
2309	194	35	68553	1523	1	177	18
2310	154	32	56914	1118	1	166	17
2311	366	47	85562	1850	1	305	39
2312	1165	13	44097	1127	4	42	13
2313	304	25	106708	669	0	232	12
2314	680	47	76569	2776	5	217	13
2316	382	32	73314	2004	4	146	10
2317	583	39	71514	2631	2	195	24
2318	389	41	81549	2821	0	198	13
2319	634	41	87585	1666	0	221	45
2320	711	38	79273	1216	0	207	45
2321A	217	43	70374	1425	2	283	4
2321B	237	49	100750	2119	0	394	5
2322	355	24	40330	759	1	112	30
2323	350	29	124730	2212	0	262	14
2324	125	51	81912	1626	0	338	3
2325	283	39	59996	1831	1	164	6
2326	112	39	70975	1816	2	198	26
2327	323	52	69866	2148	1	257	18
2328	558	45	75144	1095	3	202	24
2329	251	47	72732	1456	1	239	42
2330	227	50	56836	1073	1	242	21
2331	528	31	67945	1311	1	147	42
2332	101	38	79988	1006	0	240	4
2333	47	41	90072	1411	1	279	8
2334	324	39	78335	3181	0	184	13
2335	149	39	57539	1631	0	190	11
2336	228	49	86538	2252	0	272	26
2337	120	36	75093	1355	4	208	14
2338	248	55	74679	1731	1	301	58
2339	425	56	86531	1581	0	279	28
2341	188	32	83422	833	2	232	5
2342	170	45	87932	1759	0	307	4
2344	152	41	71868	760	1	271	6
2345	326	42	85163	2546	1	226	20
2346	76	50	75830	1155	0	329	5
2347	334	54	78866	1379	0	372	19
2348	159	44	64030	1841	2	223	48
2349A	252	38	56270	1826	1	145	5
2349B	224	33	52650	1630	1	121	5
2350	181	43	67040	1310	1	243	8

APPENDIX 5 (cont.)

Sample No.	---OES---- V	Zr	------------AAS------------ Ag	Cu	Pb	Zn	DNA U	COL W
BTS 2299A	203	189	2	70	20	80	2.2	5
2299B	336	162	2	70	20	80	-	5
2300	59	303	1	35	40	110	1.9	20
2301	165	383	1	30	50	80	-	0
2302	157	273	1	40	100	90	-	0
2303	222	219	1	70	30	130	-	5
2304	203	274	2	60	30	170	-	5
2305	176	175	1	55	40	150	-	5
2307	163	168	1	50	20	90	-	0
2308	232	246	1	40	30	90	-	10
2309	223	224	1	50	20	70	-	5
2310	149	245	1	50	30	90	-	5
2311	250	256	1	40	40	110	-	10
2312	182	403	1	30	60	70	-	5
2313	149	211	1	50	40	180	-	5
2314	173	132	1	70	40	150	-	5
2316	168	254	1	40	30	160	-	5
2317	228	307	1	35	30	120	-	5
2318	217	321	1	35	30	110	-	5
2319	231	205	2	50	20	90	-	5
2320	248	235	1	40	20	90	-	5
2321A	201	178	1	75	30	90	-	0
2321B	315	159	1	75	40	100	-	5
2322	135	392	1	25	30	100	-	0
2323	194	212	1	50	20	120	-	5
2324	190	260	1	60	20	100	-	5
2325	144	428	1	30	30	80	-	5
2326	201	233	1	40	30	100	-	5
2327	192	321	1	30	20	80	-	5
2328	191	252	1	35	20	60	-	5
2329	139	249	1	35	20	80	-	10
2330	149	321	1	35	40	100	-	5
2331	204	207	1	30	50	100	-	10
2332	117	178	1	60	20	90	-	5
2333	152	343	1	55	30	100	-	5
2334	181	481	1	30	30	90	-	5
2335	154	254	1	40	30	100	-	5
2336	199	256	1	35	20	80	-	5
2337	196	217	1	40	10	60	-	5
2338	170	212	1	40	30	90	-	10
2339	227	231	1	50	40	110	-	5
2341	149	265	1	55	30	100	-	5
2342	167	245	1	55	20	100	-	5
2444	178	167	1	40	20	70	-	5
2345	193	244	1	35	20	70	-	5
2346	164	252	1	40	10	50	-	0
2347	176	183	1	45	20	80	-	5
2348	154	312	1	40	40	100	-	10
2349A	161	440	1	30	30	90	-	5
2349B	168	356	1	30	30	90	-	5
2350	135	240	1	45	20	70	-	0

APPENDIX 5 (cont.)

Sample No.	OES						
	Ba	Co	Fe	Mn	Mo	Ni	Sn
BTS 2351	145	51	68071	1452	2	276	26
2352	180	67	61334	1588	1	471	18
2353	393	34	61988	3184	1	130	12
2354	243	46	78328	1455	2	208	15
2355	186	58	84059	2744	2	306	58
2356	267	8	35658	396	2	35	3
2357	396	12	40193	491	2	44	3
2358	231	9	27715	267	1	26	3
2359	462	8	30918	398	2	22	4
2360	467	14	31090	317	1	24	5
2361A	655	35	84687	2779	0	168	9
2361B	270	8	29780	331	1	24	3
2362	116	53	82409	1499	0	262	7
2363	227	46	75166	2697	1	272	51
2364	228	55	81071	2524	3	286	38
2367	140	45	57784	1723	1	229	23
2368A	269	11	31583	647	1	31	11
2368B	502	14	36338	475	2	21	6
2369	411	8	30784	355	1	25	3
2370	453	3	27540	298	1	21	4
2371	463	13	32056	394	1	35	3
2372	386	12	34214	443	1	24	4

APPENDIX 5 (cont.)

Sample No.	---OES---- V	Zr	------------AAS------------ Ag	Cu	Pb	Zn	DNA U	COL W
BTS 2351	160	283	1	40	30	90	-	10
2352	150	181	1	40	60	100	-	0
2353	172	386	1	30	20	90	-	0
2354	155	238	1	40	20	80	-	0
2355	183	236	1	35	40	110	-	5
2356	129	341	0	15	20	50	-	0
2357	144	362	0	15	20	50	-	5
2358	125	365	0	15	30	30	-	5
2359	136	402	0	15	30	30	-	5
2360	149	354	0	15	30	30	-	5
2361A	173	372	1	30	20	70	-	5
2361B	125	396	0	15	30	40	-	5
2362	169	276	1	50	40	110	-	0
2363	171	209	1	40	60	130	-	5
2364	191	233	1	35	40	120	-	5
2367	122	225	1	40	50	130	-	5
2368A	137	311	1	15	20	50	-	0
2368B	163	465	1	15	30	30	-	0
2369	141	475	0	15	30	30	-	0
2370	116	466	0	10	30	30	-	0
2371	119	417	0	15	30	70	-	5
2372	115	422	0	15	40	40	-	5

- represents element not determined

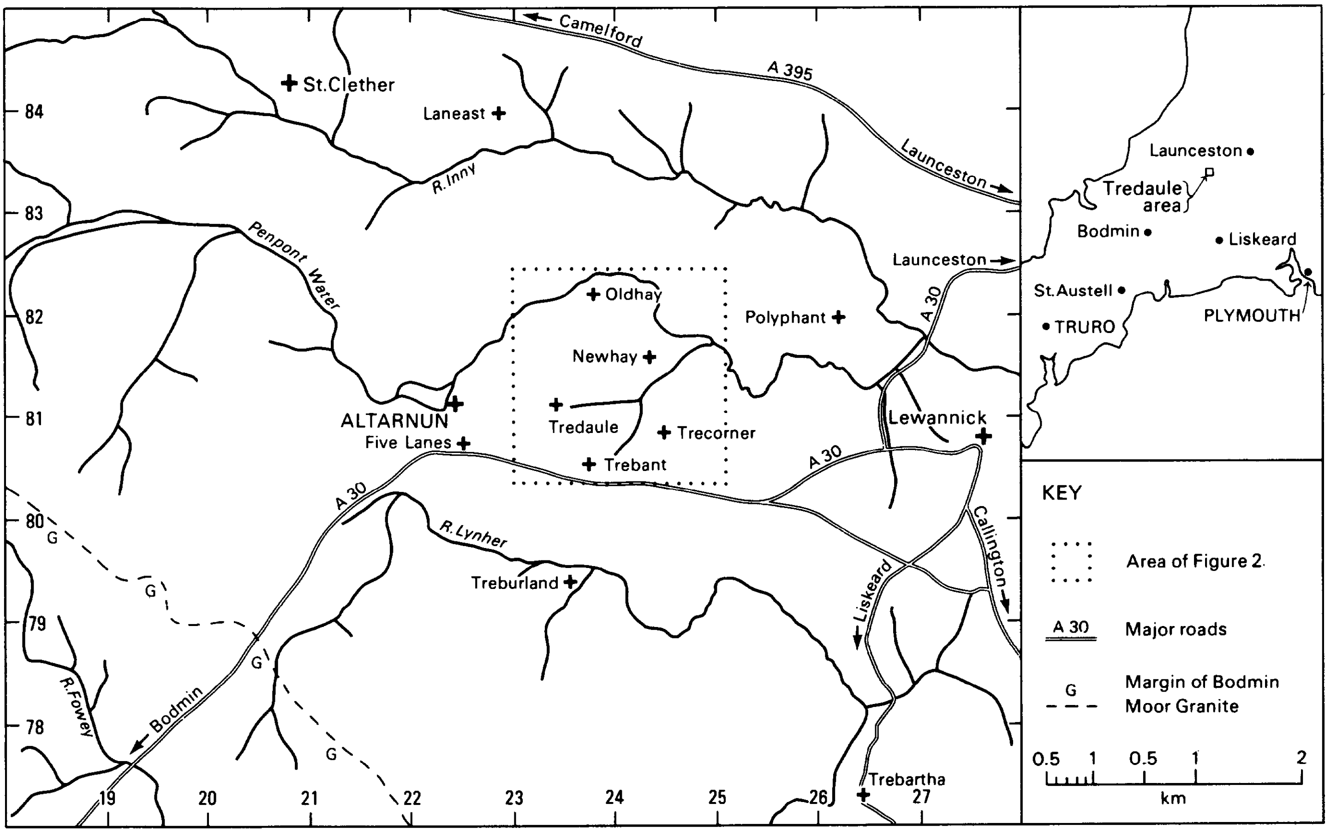

Figure 1 Location map

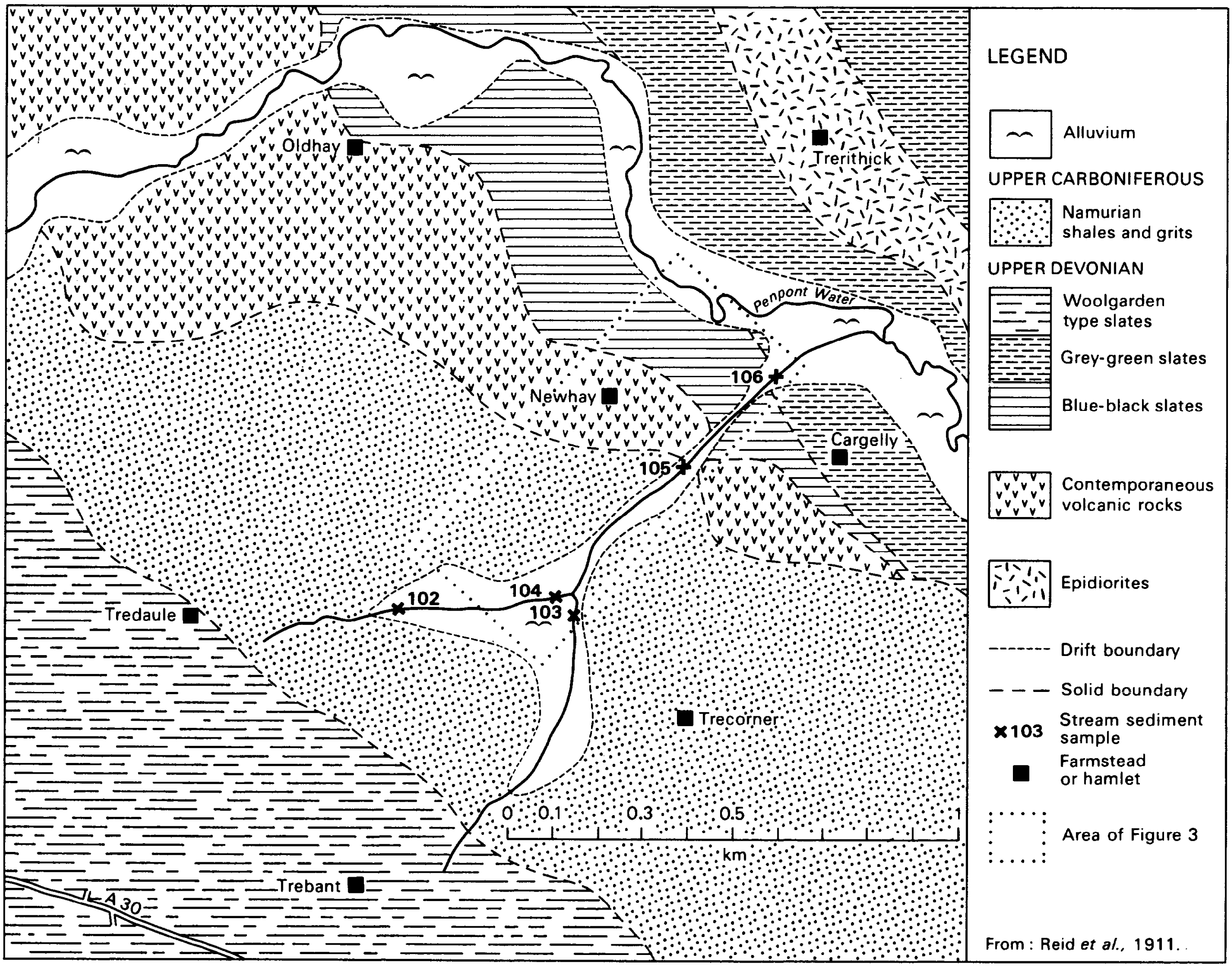

Figure 2 Geology of the Tredaule area

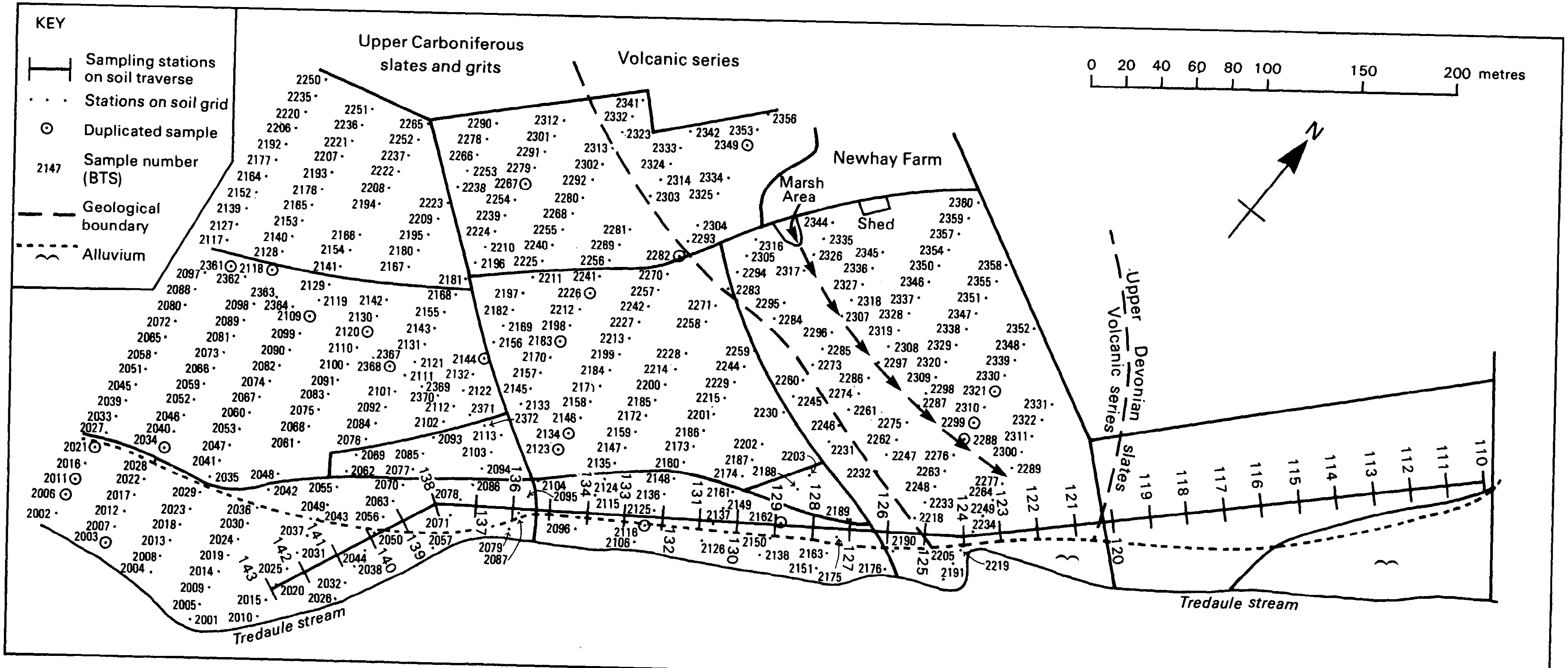

Figure 3 Soil sample locations

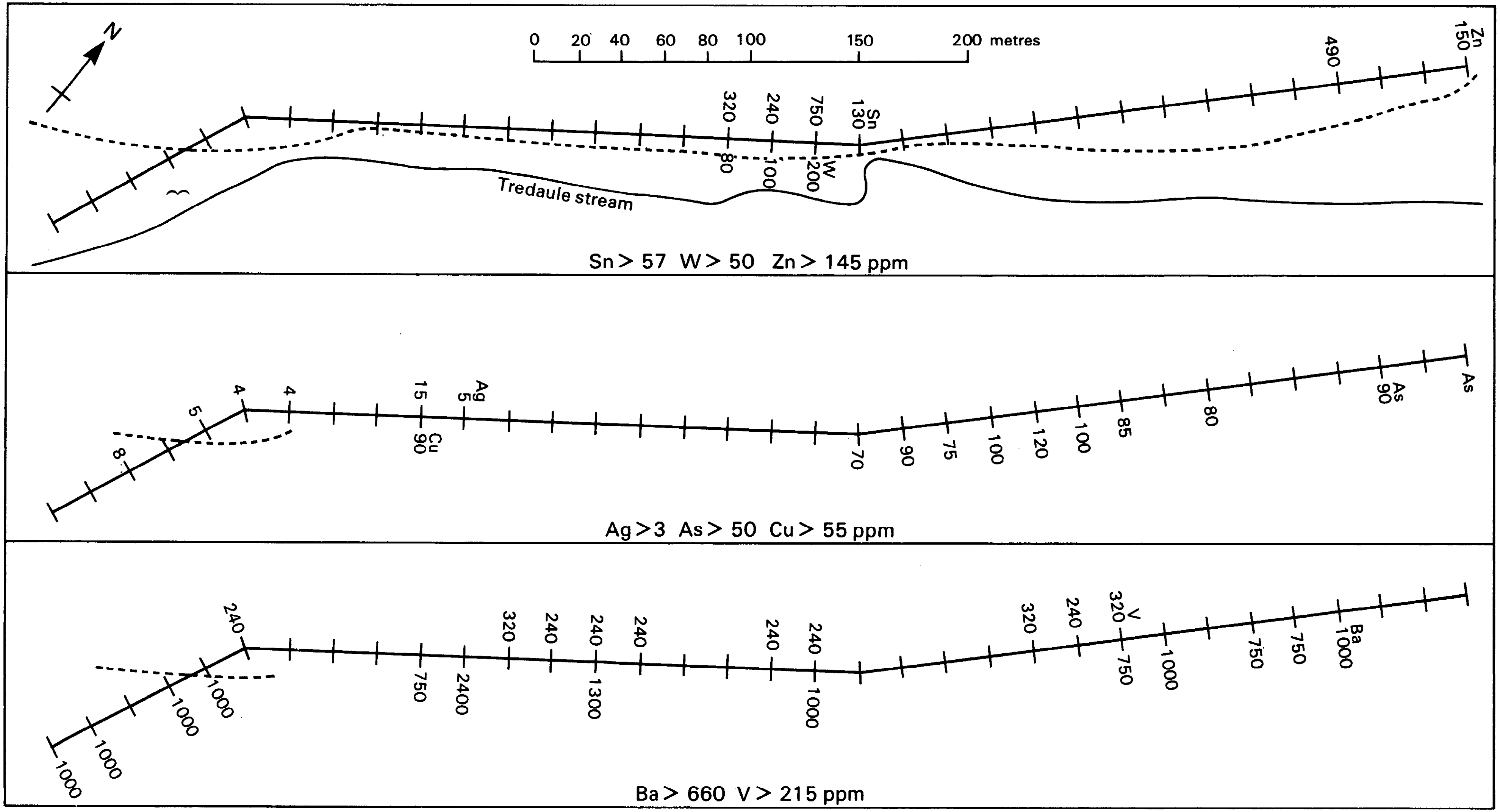

Figure 4 Distribution of base metals in Newhay traverse

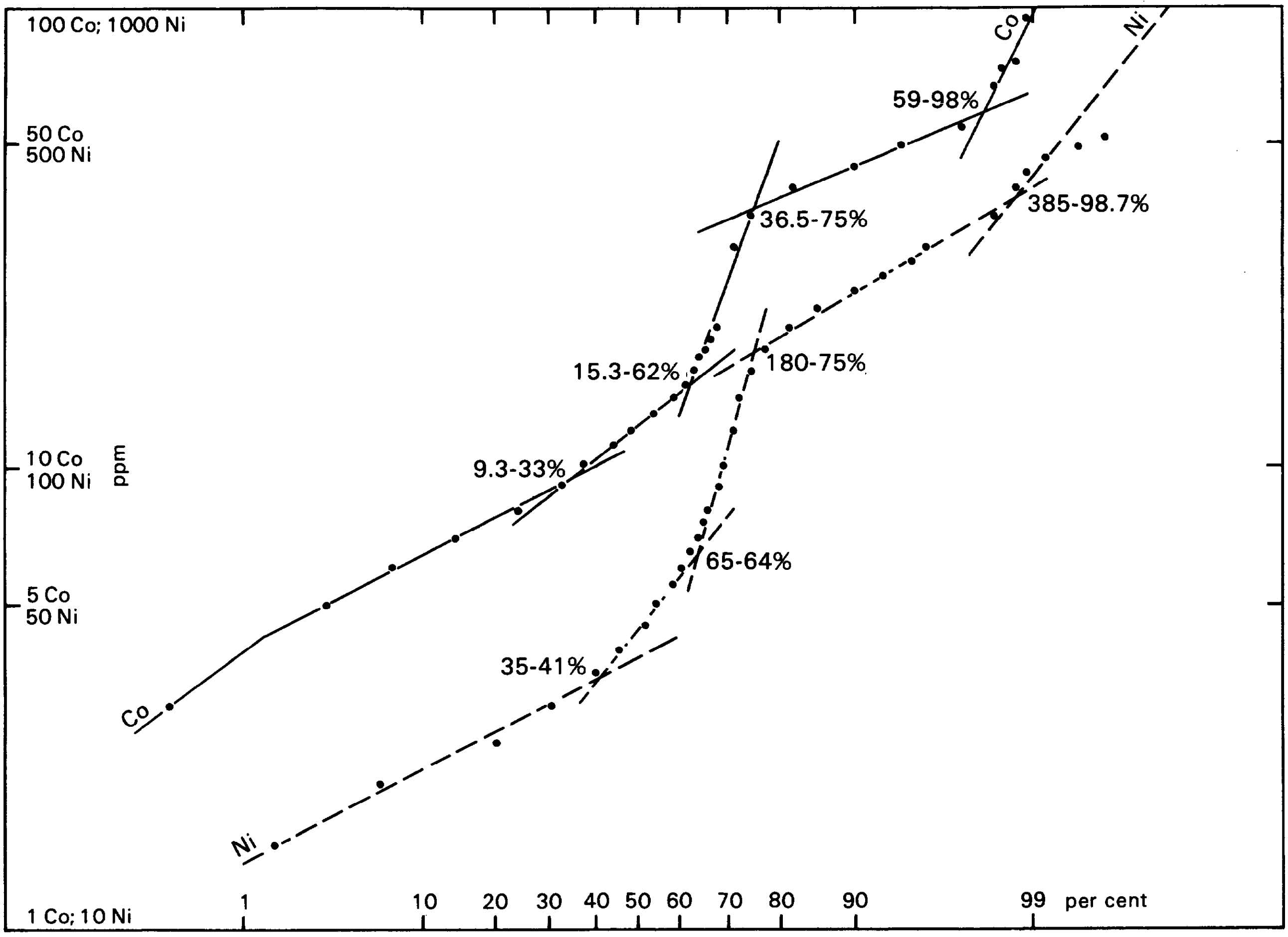

Figure 5 Log-probability plots for cobalt and nickel in grid soils

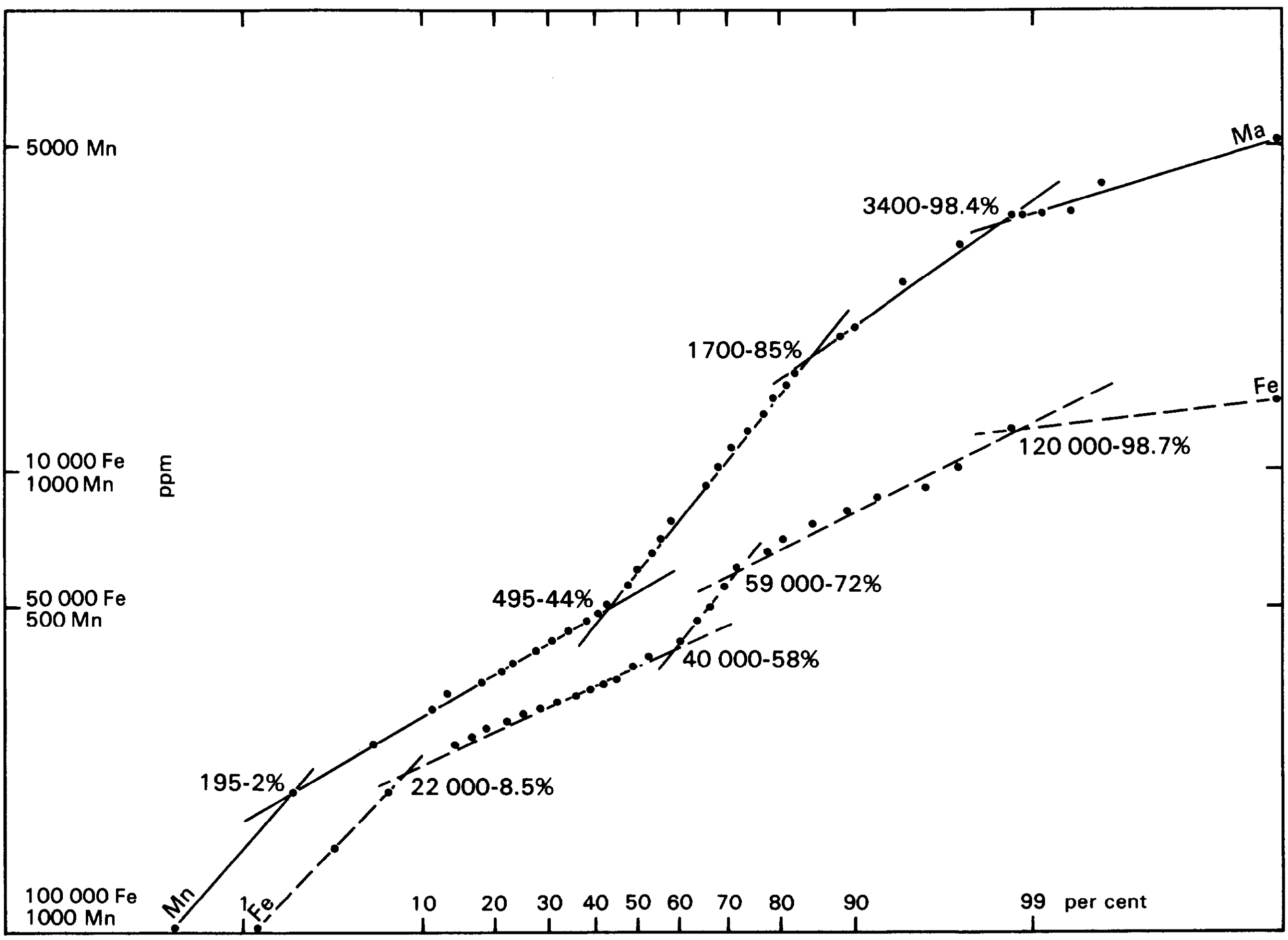

Figure 6 Log-probability plots for iron and manganese in grid soils

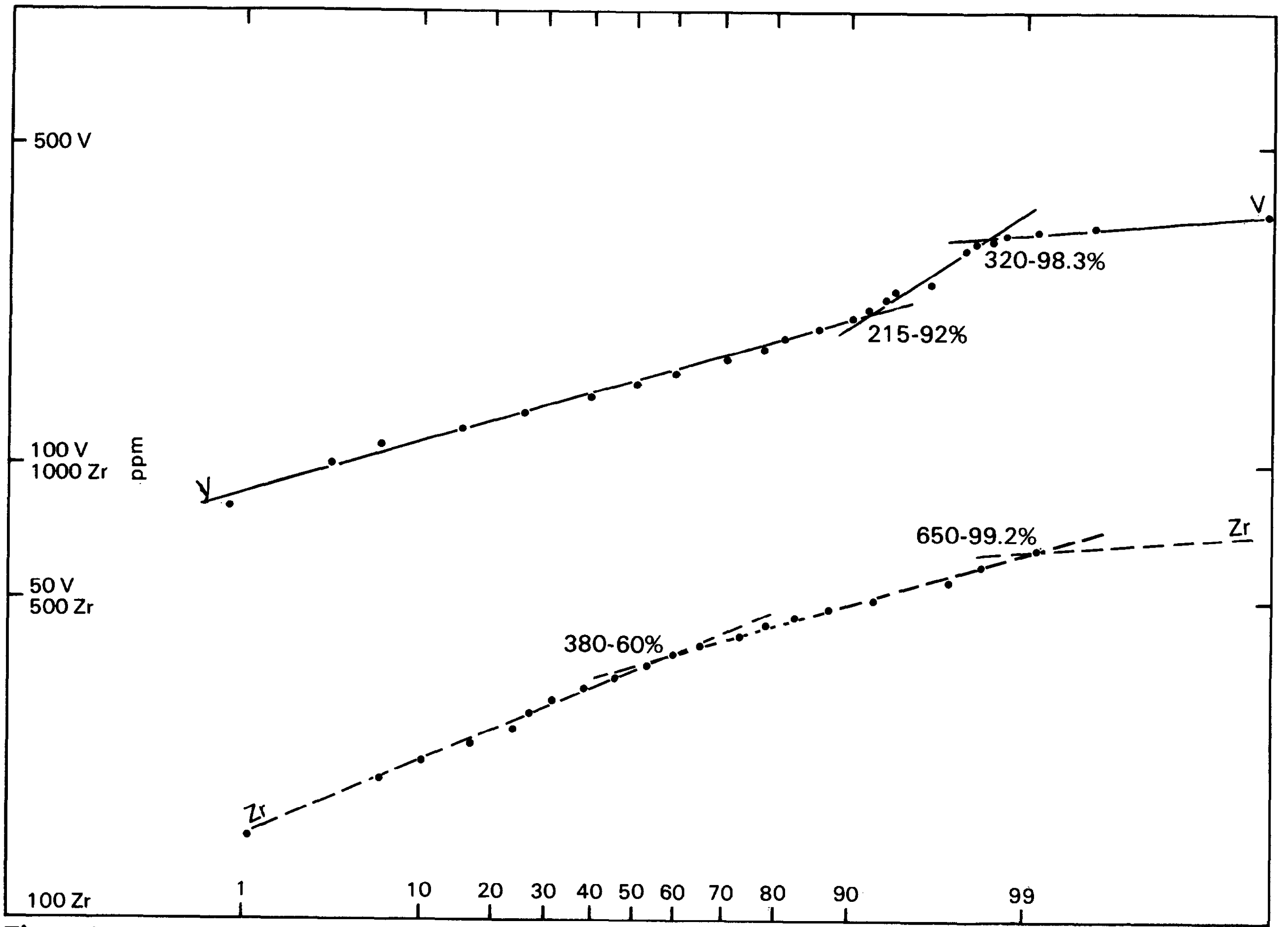

Figure 7 Log-probability plots for vanadium and zirconium in grid soils

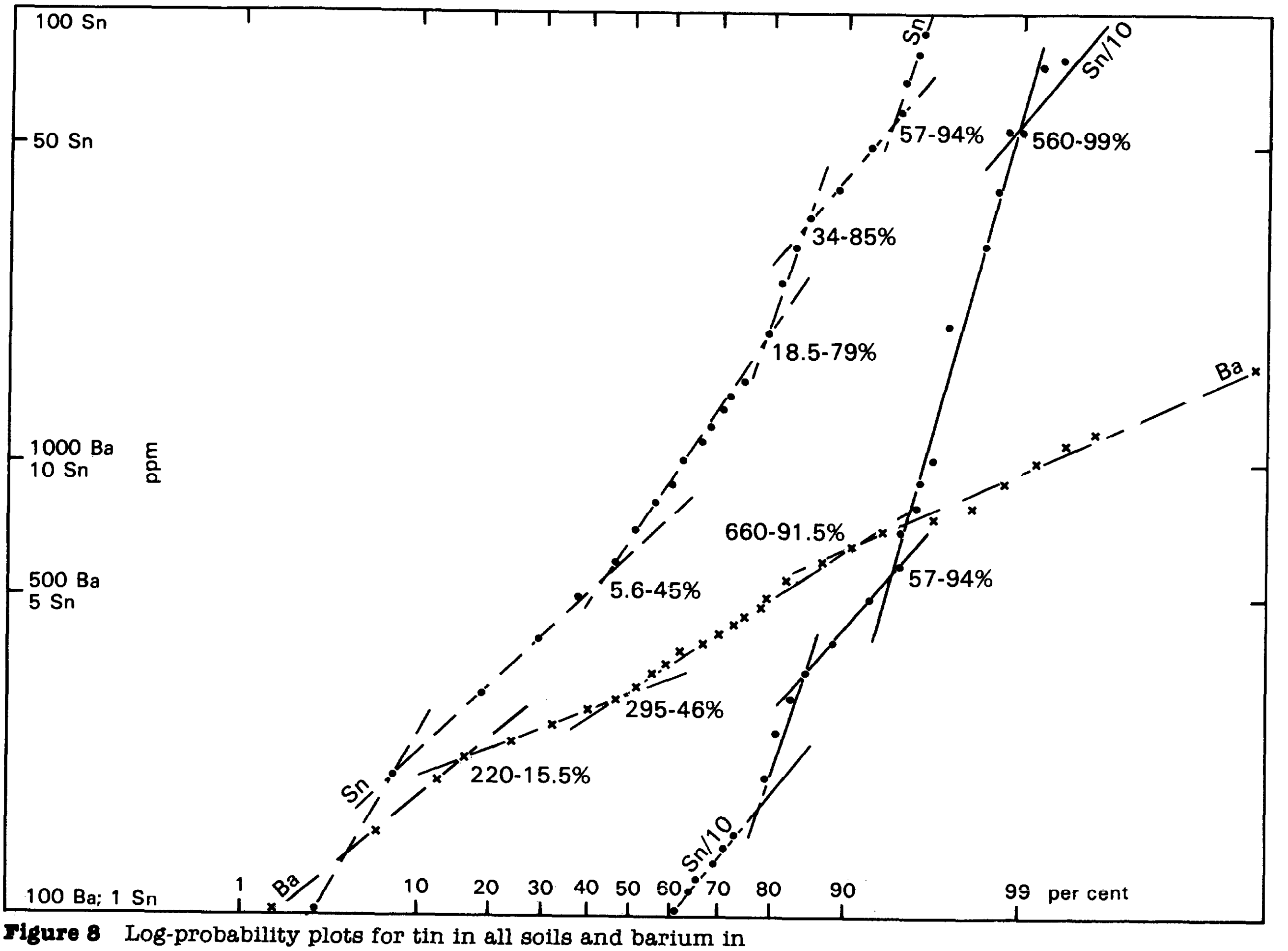

Figure 8 Log-probability plots for tin in all soils and barium in grid soils

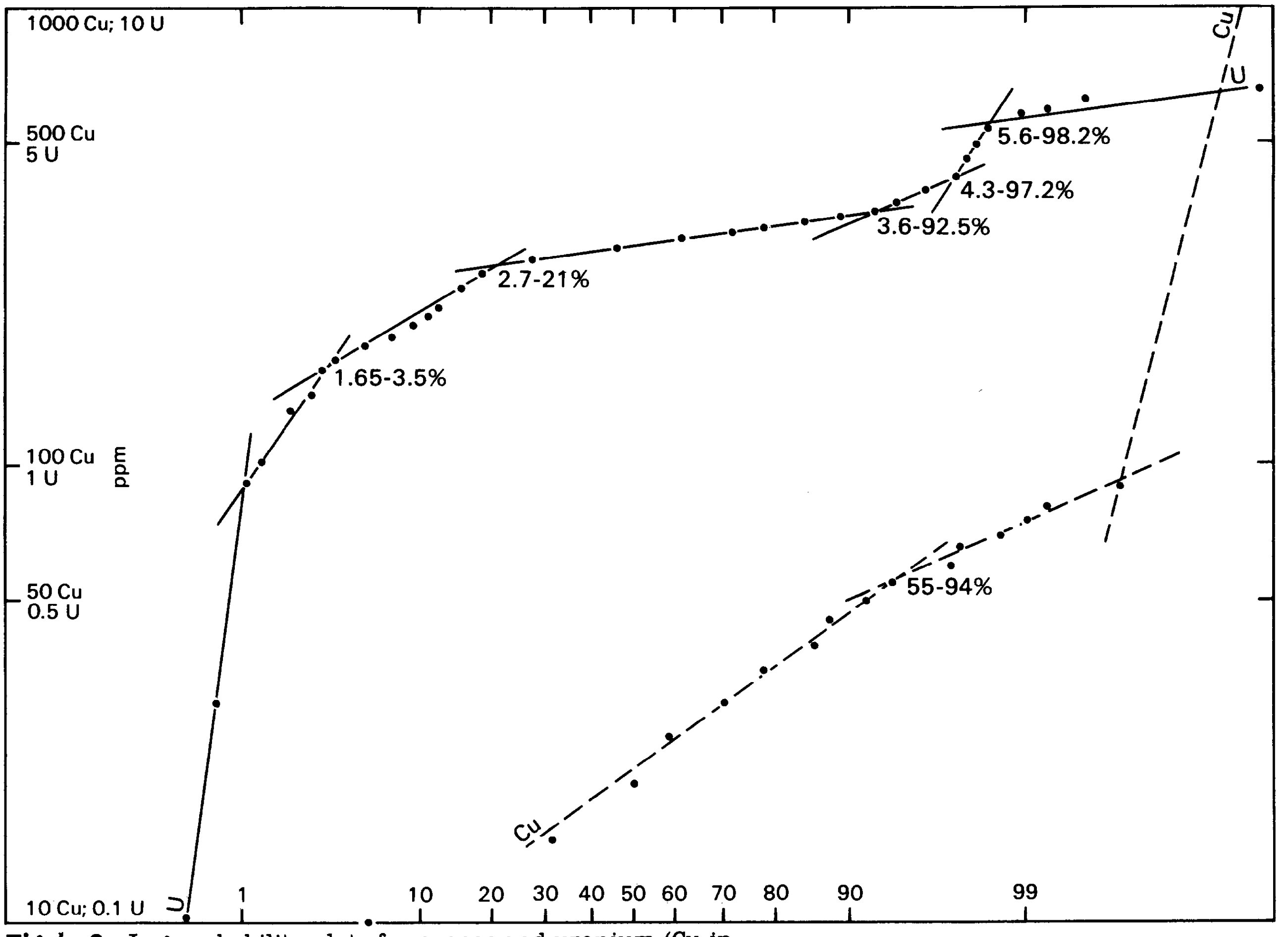

Figure 9 Log-probability plots for copper and uranium (Cu in all soils, U in some grid samples)

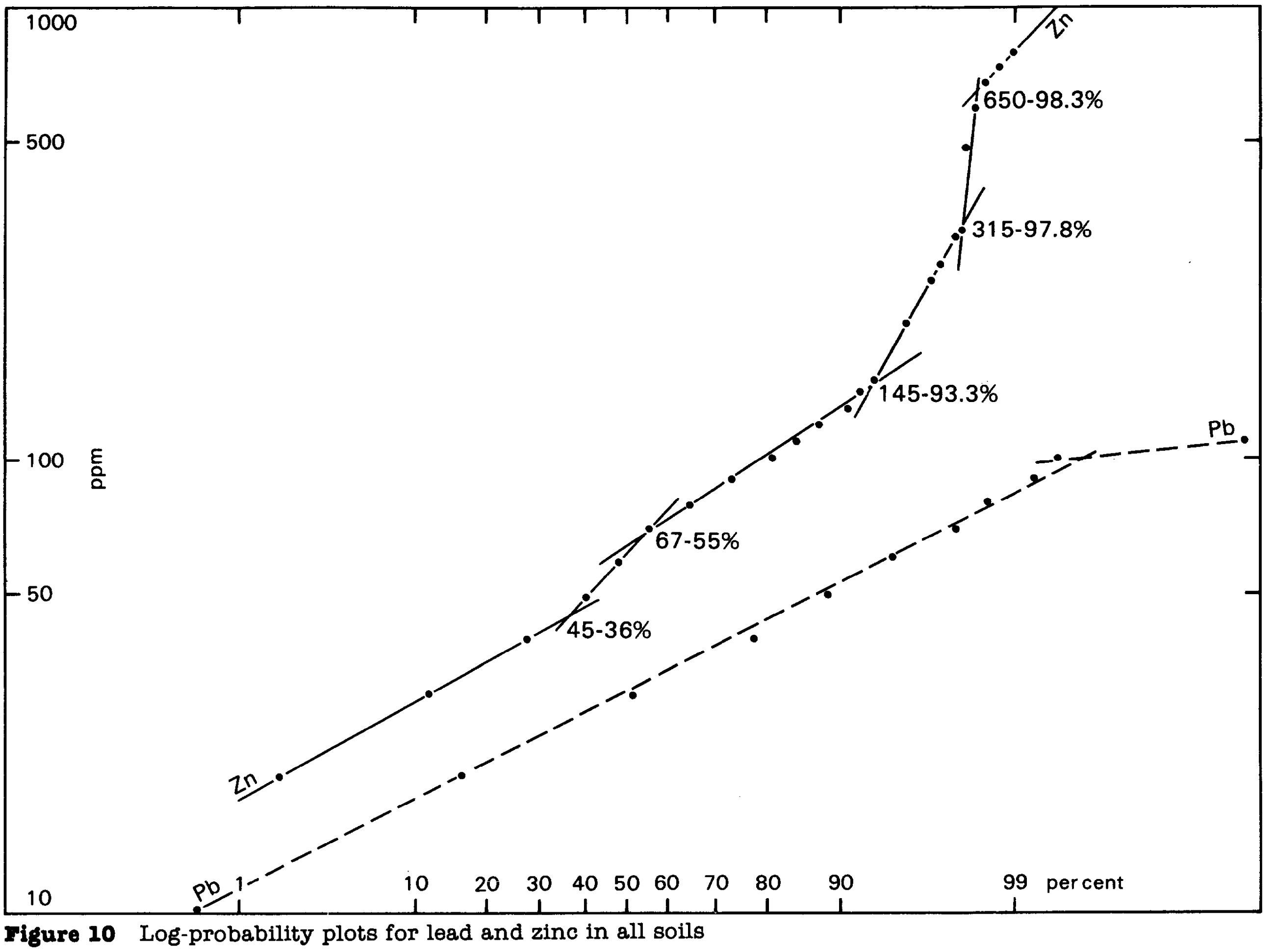

Figure 10 Log-probability plots for lead and zinc in all soils

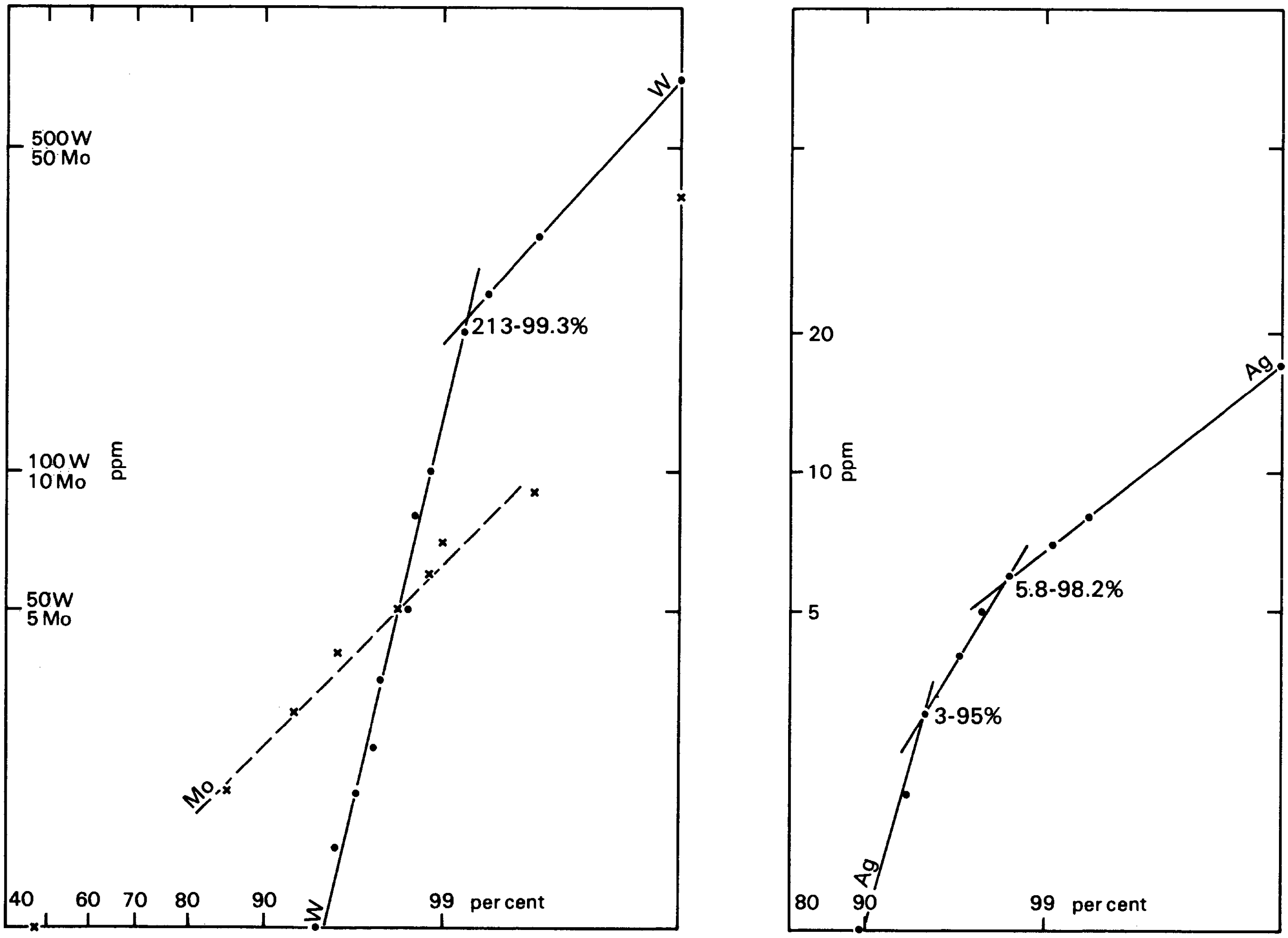

Figure 11 Log-probability plots for tungsten, silver and molybdenum in all soils

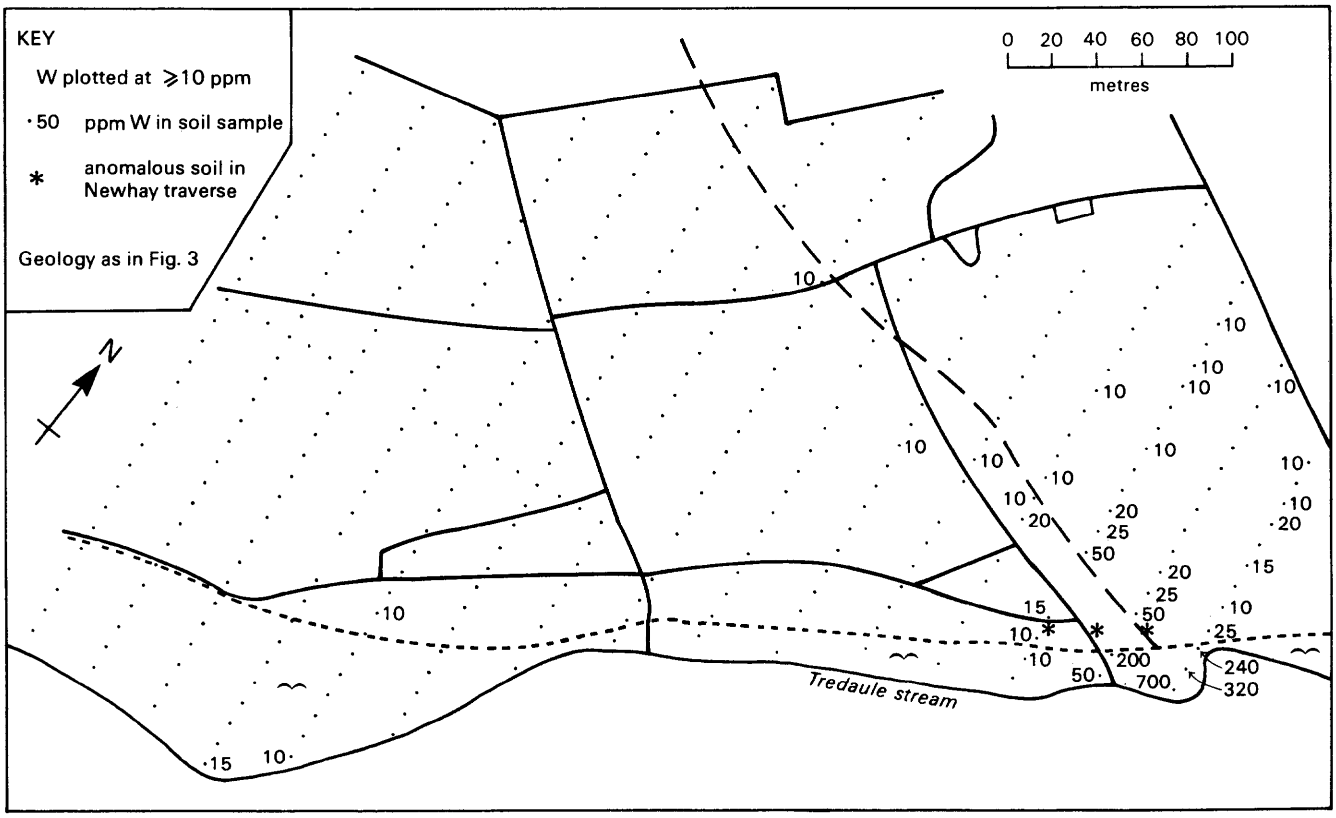

Figure 12 Distribution of anomalous tungsten in grid soils

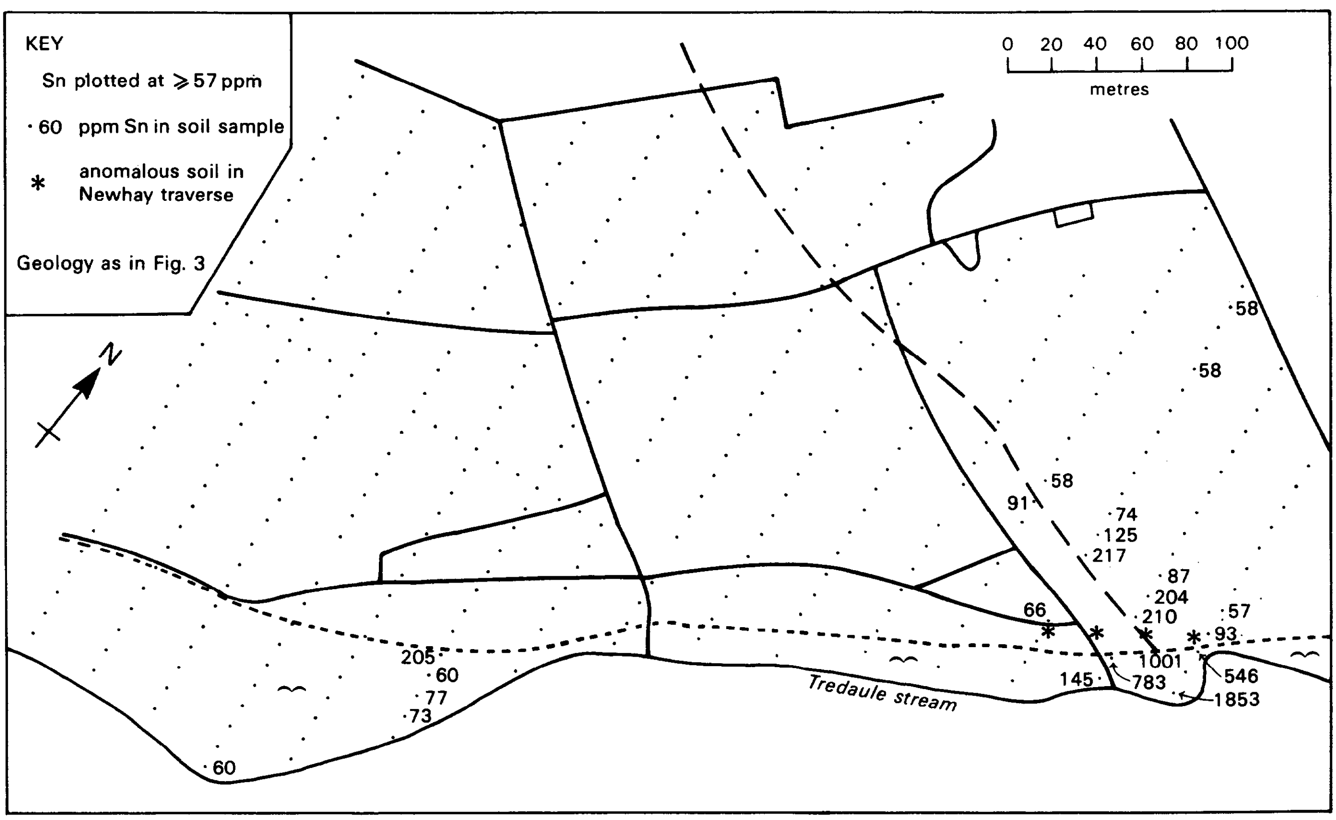

Figure 13 Distribution of anomalous tin in grid soils

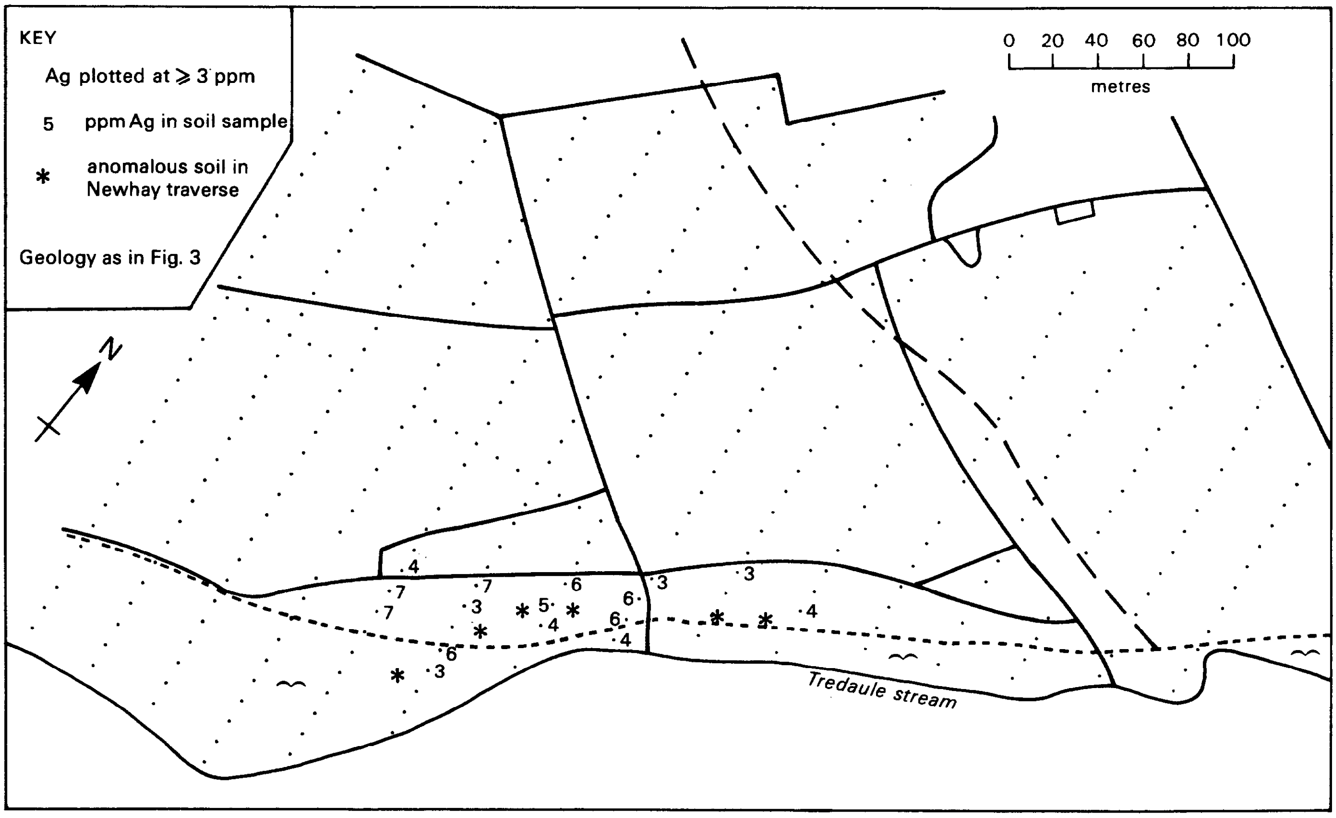

Figure 14 Distribution of anomalous silver in grid soils

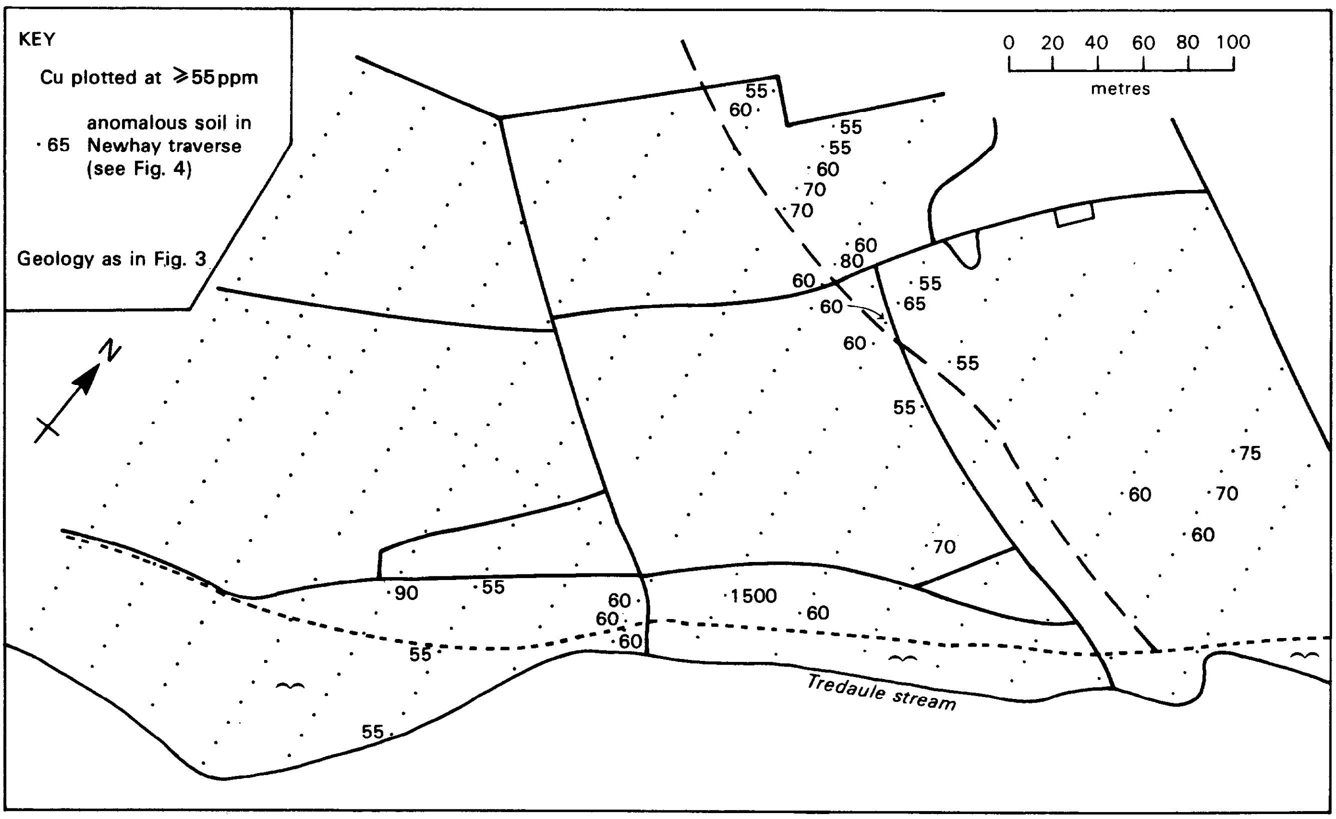

Figure 15 Distribution of anomalous copper in grid soils

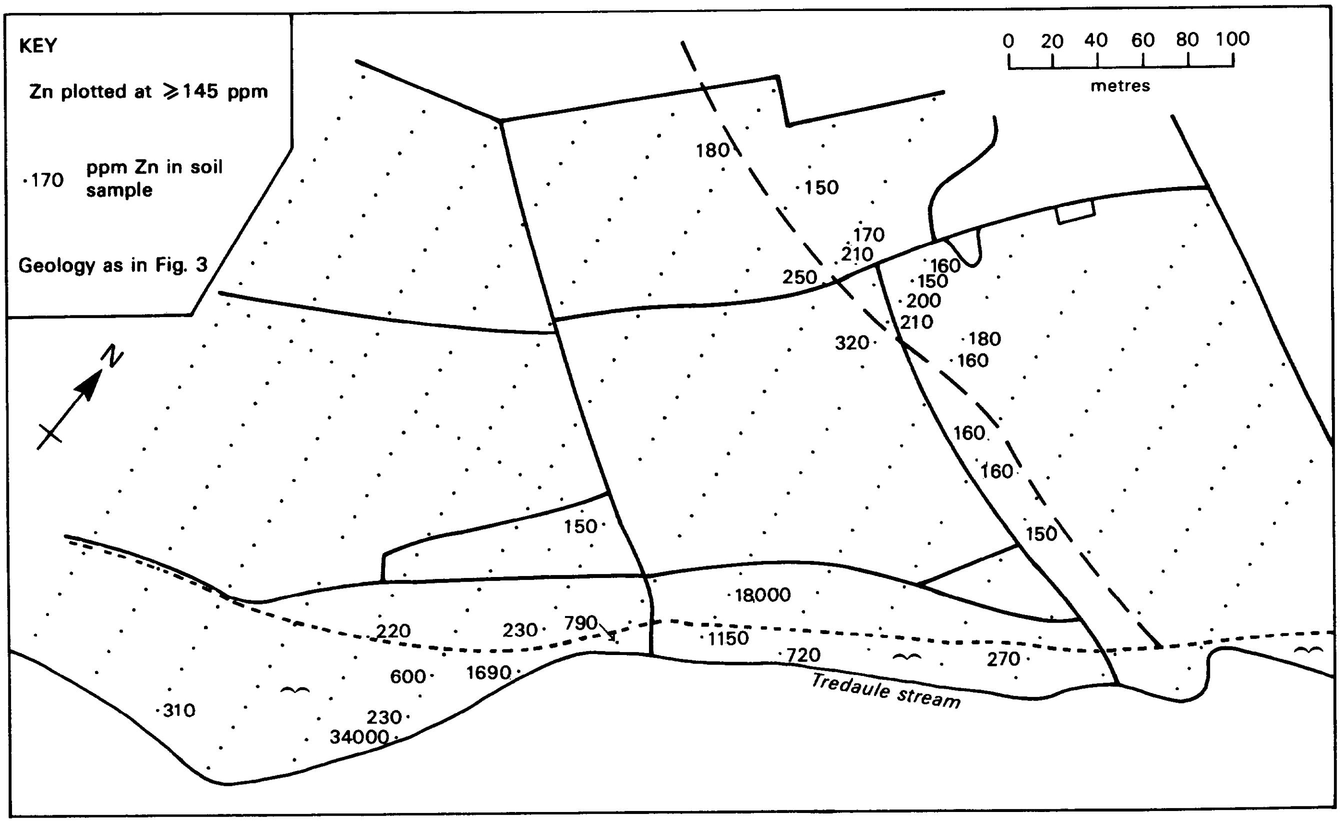

Figure 16 Distribution of anomalous zinc in grid soils