Section 6: Geochemistry

TR14-158-183

41. Geochemical investigations in the vicinity of Oliver Hill, north-west Tasmania

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ABSTRACT

Anomalous lead values have been detected in the vicinity of Oliver Hill, 12 miles SW of Sheffield, NW Tasmania. This area stands over 2,000 feet above sea level and lies amongst the western foothills of Mt Claude. The predominant outcrop is of Ordovician Moina Sandstone with sporadic occurrence of ironstone for about a mile along the northern flank of Oliver Hill. The ironstone has been found to carry up to 6.84% lead with a median value of 200 scatter samples of 0.67%. Zinc and copper are far less abundant with median values of only 0.11% and 0.01% respectively.

Soils of the area are dominated by podzolic humus-rich sands although in the proximity of the ironstone these are modified by the presence of a considerable amount of iron oxide. A soil survey on a 100 ft interval grid over the northern flank of the hill yielded 540 samples which defined a substantial lead anomaly with a range of values from 5 to 14,000 ppm and a median value of 140 ppm which is high compared with a world average figure of 12 ppm. Median values for zinc and copper are below average although within the range obtained from the samples statistical analysis yields anomalies similar to that obtained for lead.

For ground and creek waters, only lead with ranges of 10-115 ppb and 5-25 ppb respectively has values above the average range for fresh waters. Preliminary study of vegetation indicates that the metal present in eucalypt leaves does not reflect the soil content of the metal. For lead, the ash of leaves generally contains less than 100 ppm whereas the supporting soils range from 50-5,000 ppm.

INTRODUCTION

Oliver Hill is situated about 12 miles SW of Sheffield in NW Tasmania. It stands at about 2,500 ft above sea level and lies amongst the western foothills of a range of mountains which include Mts Claude, Vandyke and Roland. These are part of the divide between the Mersey and Forth Rivers and they form the eastern extremity of an arc of mountain ranges underlain by Precambrian and Palaeozoic rocks which sweep around from the west coast of the State. Drainage from Oliver Hill is carried by NW trending creeks into the Forth River.

The vegetation is variable with the poorer soils (podsols) carrying fairly open eucalypt forest dominated by white top stringybark (*Eucalyptus delegatensis* R. T. Baker). Where there has been repeated burning, thick stands of ti-tree (*Melaleuca ericifolia* Sm.) laced with vines (*Bauera rubioides* Andr.) have developed. More fertile soils overlying basalt (stony kraznozems) are restricted to the NW slopes of Oliver Hill and in places these support a more dense forest in which the eucalypts are subordinate to musk (*Olearia argophylla* F. Muell.) and dogwood (*Bedfordia salicina* D.C.).

GEOLOGICAL SETTING

The regional geology of the area is shown in Figure 47. The predominant formation cropping out on Oliver Hill is the Moina Sandstone of Ordovician age. The basal formation of the Ordovician, the Roland Conglomerate, is less than 100 ft thick in the vicinity of Oliver Hill although it thickens rapidly to 800 ft on Mt Roland to the NE. The Ordovician rocks unconformably overlie Cambrian volcanics and both are intruded by the Dolcoath Granite of Devonian age, which occurs as a small stock about 1 mile NW of Oliver Hill. A partial cover of Tertiary basalt and sediments, Pleistocene fluvioglacials, Recent alluvium and talus occurs in the area. Detail of rock outcrop along the NE slope of Oliver Hill is given in Figuιe 48. The major structure is unknown but minor folding in the Moina Sandstone is assymetric with steep SW-facing limbs and shallow plunges to the SE. At the southern end of the NE slope of Oliver Hill a narrow strip of quartz porphyry with abundant bi-pyramidal quartz phenocrysts crops out within the Moina Sandstone. The contacts between these rock types are obscured by thick soil but as the porphyry is similar to rocks assigned to the Cambrian in other studies which have been summarised by Carey (1947) it is likely that it occurs in faulted relationship with the Moina Sandstone. Along this zone there is also sporadic development of black ironstone. This crops out everywhere at a lower level than the basalt and at one point, near the Tin Spur, it can be traced to the lower edge of a thin basalt flow. It is thus likely that the ironstone is of pre-basalt age. Much of the ironstone, particularly in the Tin Spur area, occurs as dispersed float with few outcrops. In marginal areas some Tertiary gravels have been cemented by iron derived from the earlier ironstone.

PREVIOUS INVESTIGATIONS

Although there is no record of production a small amount of alluvial gold was won around 1895 from the Devonian Mine, high on the NE slope of Oliver Hill. There has also been prospecting for tin on the N slopes of Oliver Hill where it falls away along Tin Spur into the Forth Valley. There is no record of base metal prospecting on Oliver Hill although 2 miles to the N, at Round Hill there was spasmodic mining activity (from 1880 to 1927) on several small orebodies which yielded about 4,700 tons of lead. The more important of these were developed into softer beds of the Moina Sandstone where these were involved in a sheared anticlinal crest (Jennings, 1958). During 1958 the southern part of Oliver Hill was mapped by R. G. Robinson of the Department of Mines and some of the ironstone (then referred to as ferromanganese) was sampled. The assay results were extremely variable and whilst values of up to 8.8% lead were obtained, the majority of samples gave only trace or nil returns for the metal. Zinc, copper, silver and gold were also detected in some samples. The interpre-

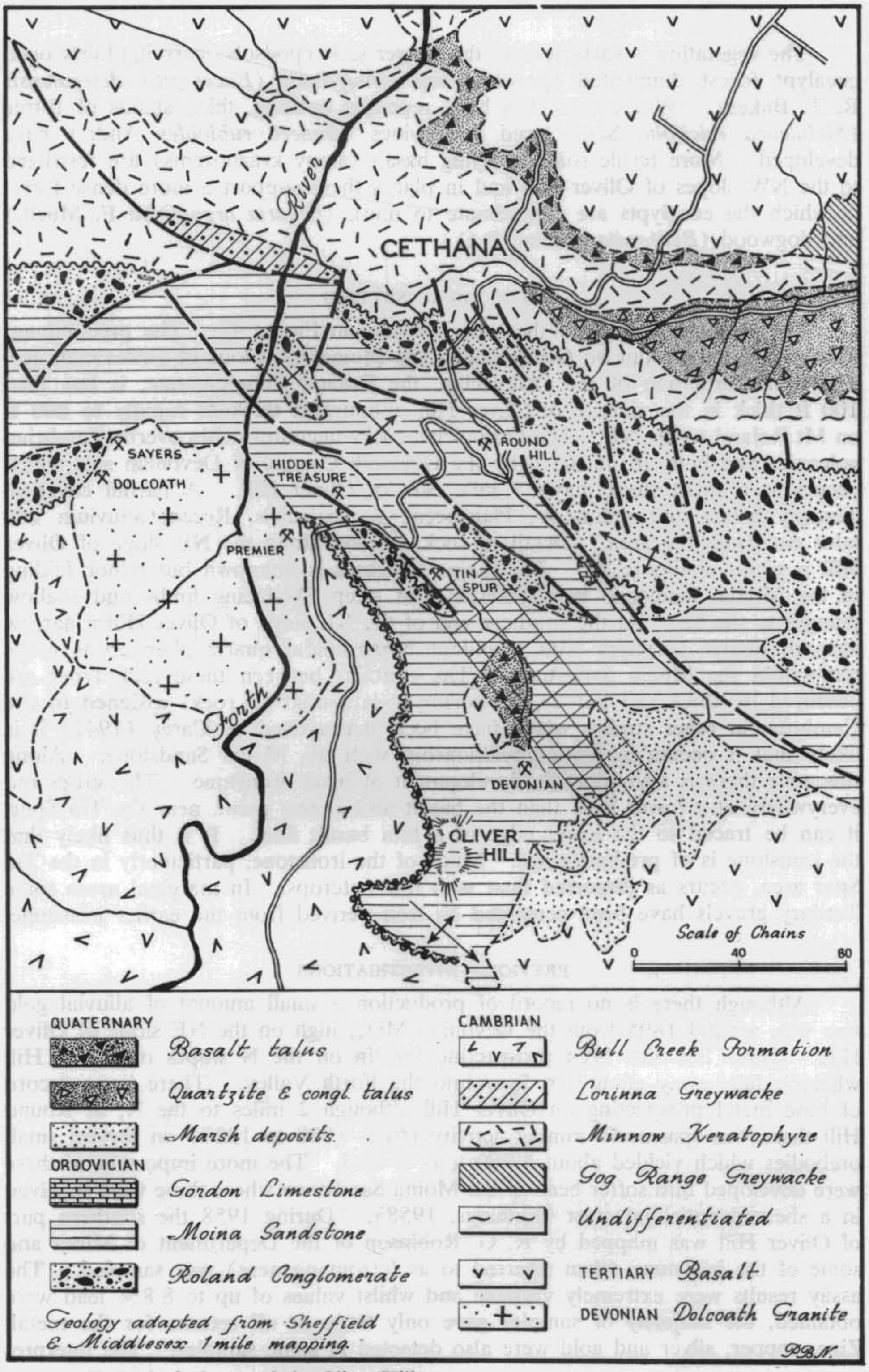

FIGURE 47. Geological map of the Oliver Hill area.

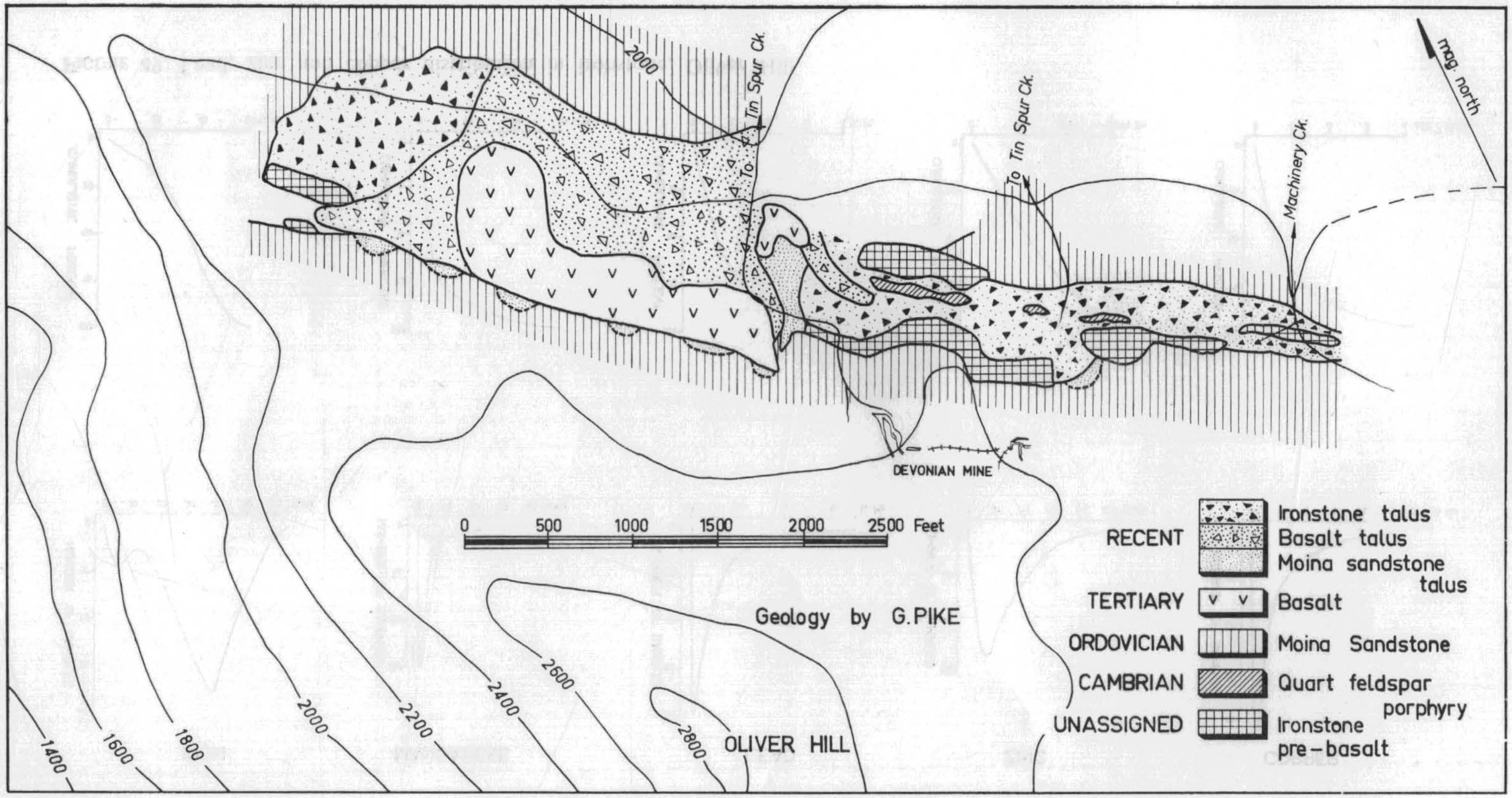

FIGURE 48. Rock type distribution, Oliver Hill.

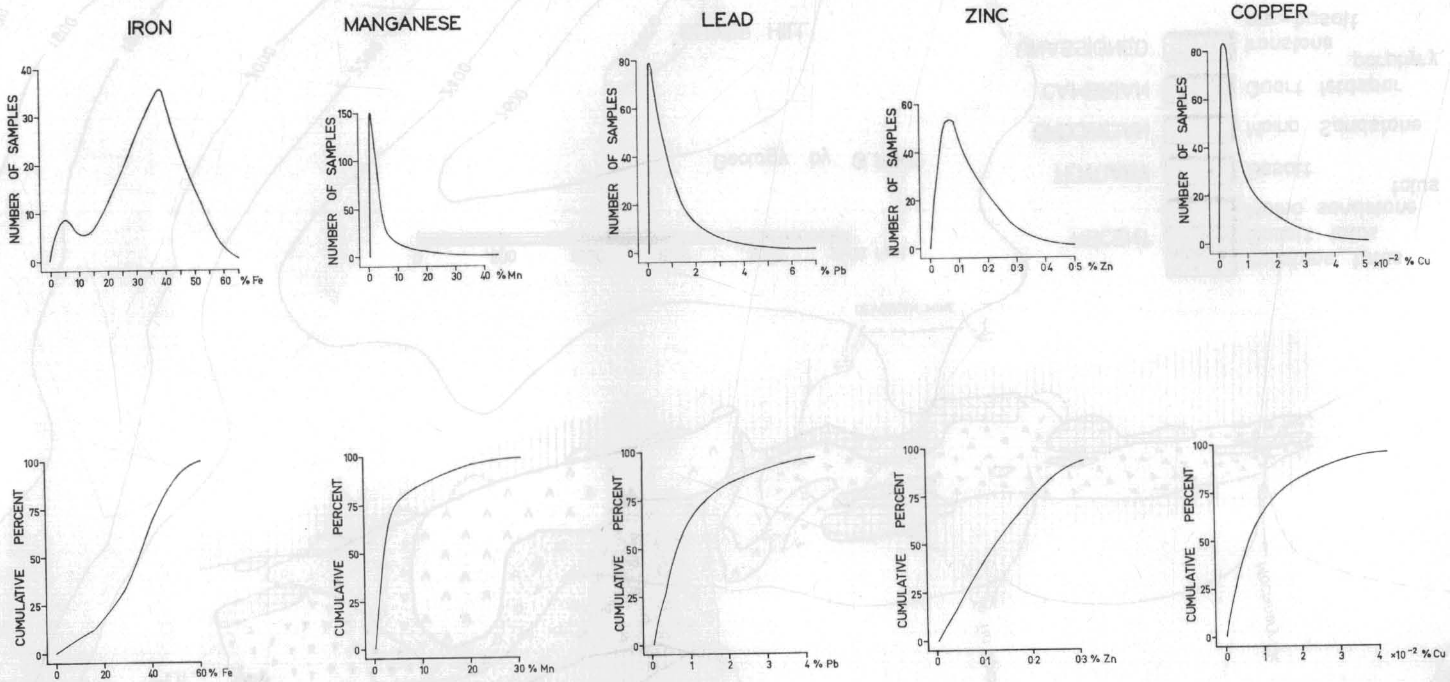

FIGURE 49. Lead, zinc and copper distribution in ironstone, Oliver Hill.

tation then favoured for these ironstones was that they were iron-rich sediments and no further work was undertaken. The results of Robinson's survey were compiled by Jennings (1963). In 1966 stream sediment analysis was applied to exploration throughout the region by a private company and as this revealed nothing of interest in creeks draining Oliver Hill the area was not investigated further.

GEOCHEMICAL INVESTIGATIONS

Study of the ironstone

The current project was commenced by the Department of Mines in March 1969 with a re-assessment of the ironstone. As no survey grid existed at this time an uncontrolled scatter sampling of the ironstone was carried out along the NE slope of Oliver Hill for a distance of about a mile. This yielded 200 samples which were analysed for iron, manganese, lead, zinc and copper. The metals were extracted with hot concentrated hydrochloric acid and the analyses were carried out by atomic absorption spectrophotometry of solutions which were 10% v/v hydrochloric acid and 5% w/v ammonium acetate. The results are given in Table 1. The statistical consideration of geochemical results at present used in the Department of Mines follows the procedures outlined by Yufa and Gurvich (1964) which make use of the median and quartile values to establish averages and deviations for populations of unknown distribution type. The range of lead values is from 0.01% to 6.84%, with a median value of 0.67% and with a quarter of the values exceeding 1.5%. The lead distribution in the ironstone is thus more regular than was suggested by the earlier analyses. Zinc and copper values are far less significant with median values of only 0.11% and 0.01% respectively. Even allowing for differences in mobilities of the three metals during development of the ironstone these results suggest that the parent mineralisation was dominated by galena as was the case at Round Hill. Manganese ranges from 0.01% to 40.43% with a median of 0.54% whilst iron ranges from 0.86% to 62.24% with a median of 35.16%. Most of the material carries little manganese and the term ironstone is preferable to ferromanganese.

In Figure 49 the analytical data are presented as frequency and cumulative per cent curves. The frequency curve for iron is bimodal although one maximum is weak and the majority of the population of values gives rise to a slightly negatively skewed distribution curve. The bimodal character is also apparent in the break in slope in the cumulative per cent curve. The two populations represented in these curves probably reflect the fact that whilst the bulk of the samples were taken from the pre-basalt(?) ironstone sufficient iron-cemented Tertiary gravels were inadvertently included and these produce the weaker maximum. The curves for manganese, lead, zinc and copper differ from those of iron, and all have a strongly positively skewed form. This suggests that manganese is associated with the base metal sulphides whereas the iron may be derived from pyrite which does not necessarily have any quantitative relationship to the former sulphides. Hematite and pyrite spherulites also occur in bands in the Moina Sandstone and these could also be a source of iron. Where manganese is of high value in the ironstone the lead content is also generally high although high lead is not always accompanied by high manganese. Tests of correlation can only be used as guides with data that departs widely from normality as in this study. The data were transformed to logarithms to remove some of the skewness and

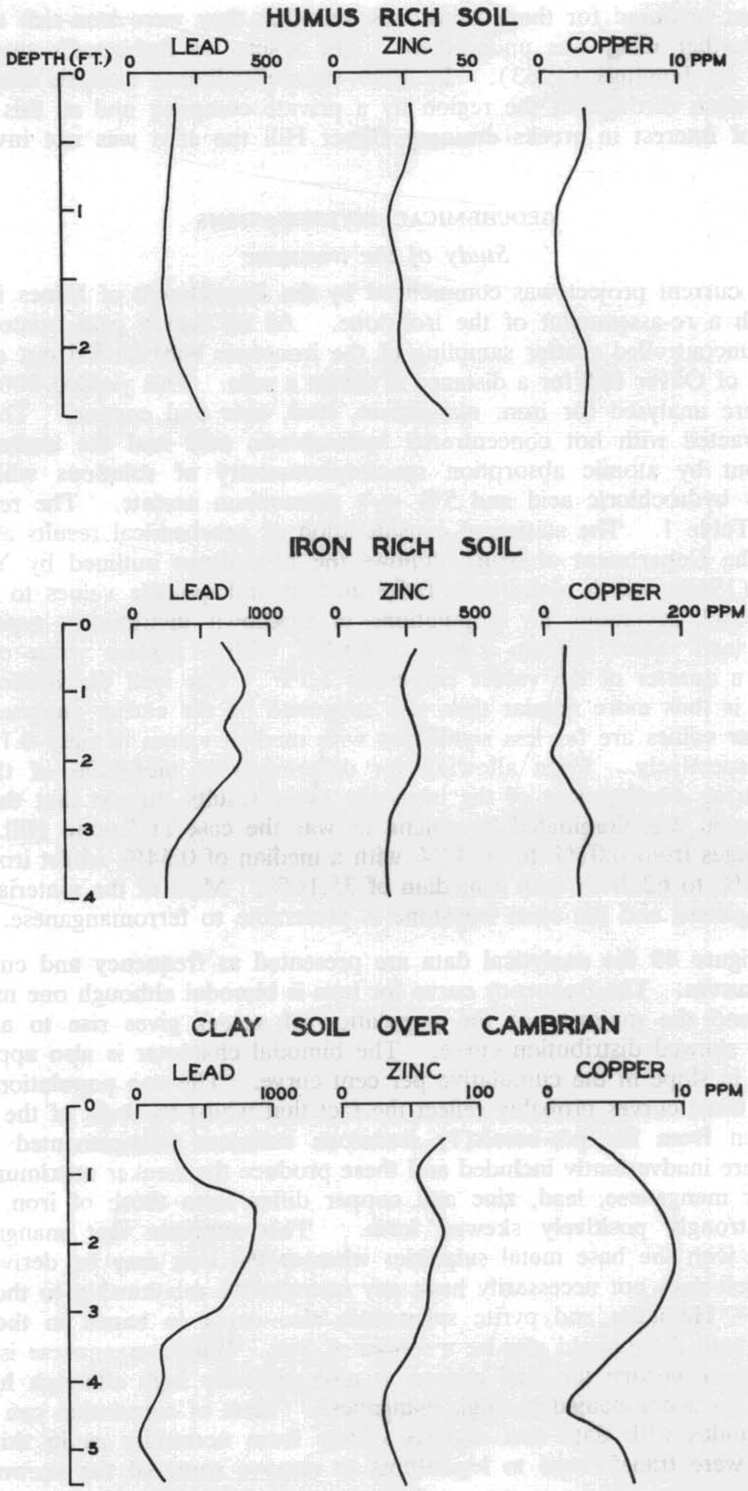

FIGURE 50. Metal distribution in soil profiles: lead, zinc and copper in soils from Oliver Hill.

correlation coefficients were calculated for these values. These are given in Table 2 where it can be seen that the tendency for high manganese and lead to go together is supported by a correlation coefficient of 0.666. Zinc and copper show a weaker correlation with lead whilst zinc shows no correlation with copper.

The results obtained from the study of the ironstone were sufficiently encouraging to warrant more detailed investigations. A rectangular grid of 100 ft interval aligned approximately SW (214° mag.) and NW (304° mag.) was surveyed over the NE slope of Oliver Hill and a soil sampling programme was undertaken.

Soil studies

The major soil type throughout the area of interest is a humus-rich sandy podsol, although close to ironstone outcrop this is modified by the presence of considerable amounts of iron oxides. Over the limited occurrence of Cambrian porphyry the soils are also podzolic, containing less humus but more clay than the soils over Moina Sandstone. These soil types were sampled through to bed-rock and the distribution of metals with depth examined. Soil samples were sieved to — 80 mesh and 0.25 g quantities were ashed prior to extraction with concentrated hydrochloric acid and determination of the metals by atomic absorption spectrophotometry. From the metal distribution through the soil profiles (fig. 50) it can be seen that there is little variation with depth in the humus podsols whilst in the iron-rich soils and soils over Cambrian porphyry the metal values tend to be more variable. A sampling depth of 12-18 in was selected as giving an average figure for metal content, regardless of soil type, and was considered to be deep enough to be reasonably free from surface burning.

Sampling over the grid yielded 540 samples which were analysed for lead, zinc and copper. The metal values are given in Table 3. Sample designation is by grid co-ordinates with distances in feet approximately NW and SW from the grid origin near Machinery Creek. Median (M_e) and quartile values were obtained from this data and the standard deviation above the median (S_u) calculated. The median value for lead of 140 ppm is well above the average figure of 12 ppm given by Vinogradov (1959) whereas the values for zinc and copper of 20 ppm and 4 ppm respectively are less than the average values of 50 ppm and 20 ppm given by the former author. If the data of Table 3 are considered in conjunction with the geological map (fig. 48) the relationship of metal variation and rock type becomes apparent. Over barren Moina Sandstone the contents of lead, zinc and copper are comparable although they vary in detail and generally copper is lower than lead and zinc. In the vicinity of ironstone there is a marked increase in metal values with lead showing a much larger increase than zinc or copper. Where basalt blankets the area the amount of lead in the soils decreases whilst zinc and copper increase, reflecting the relative abundance of these metals in the parent rock.

The ability of iron oxides and humus to concentrate metals has been well documented (Vinogradov, 1959; Hawkes and Webb, 1962). No formal correlation tests were undertaken during the course of the present study to examine this possibility, although the results of analysis of a limited number of samples (Tables 4 and 5) suggest that these factors have little bearing on the metal distribution in this case. The data in these tables which are arranged in order of increasing content of ferric oxide and organic matter show no evidence of an accompanying increase in trace elements.

Geochemical maps were prepared from the data of Table 3 and these are shown in Figures 52-54. Contours have been drawn at metal values approximating the median plus one and two deviations ($M_e + 1S_u$ and $M_e + 2S_u$). The lead anomaly is a tolerably striking feature which shows an approximately linear trend over a distance of about a mile. The zinc and copper anomalies are far less spectacular but they show the same general distribution pattern. It is obvious from the magnitude of lead values in the soil and the extent of their distribution that a considerable quantity of this metal has migrated through the environment. The hopeful viewpoint would be that the source of the lead may be a economic deposit of the metal. This has to be somewhat moderated by the fact that the evidence suggests that the ironstone is pre-basalt in age and if this is the case the parent mineralisation could have been subjected to an extensive period of erosion before being covered by basalt. Also any mineralisation may be in the form of relatively small pods as in the case of the Round Hill mines, although at Oliver Hill the ironstone is far more extensive than that recorded from the former mines.

Some preliminary studies of metal distribution in ironstone and adjacent soil have been undertaken. The results of these are given in Table 6. Whilst the data are too few in number to make a conclusive assessment of metal migration in the soils of the area, the relative mobilities of iron and manganese are of interest. Comparison of the Fe:Mn ratios between ironstone-soil pairs shows that iron is invariably enriched in the soil or alternatively manganese is relatively more mobile. This is shown very markedly by sample 00-750 in which a manganese content of 30.05% in the ironstone falls to 0.45% in the adjacent soil, whilst iron decreases from 9.96% to 5.86%. From a consideration of analyses from a number of countries Vinogradov (1959) has shown that in general the Fe:Mn ratio decreases from about 50 in rocks to 30 in soils. This suggests that iron is a little more mobile than manganese. The reason for the high mobility of manganese at Oliver Hill is not yet clear but it is possibly related to the activity of humic acids which are moderately abundant at this locality. Movement of manganese is often attributed to the mobility of the Mn^{2+} ion which is held to be relatively stable in acid solutions although Hemstock and Low (1953) present evidence that oxidation can occur in dilute manganese solutions over a wide range of pH values. It would appear that the existence of Mn^{2+} is an unlikely situation in the present study in view of the fact that the parent material is an oxidised body (ironstone). Heintze and Mann (1947) have shown that Mn^{3+} compounds are soluble in the sodium salts of several organic acids (citric, tartaric, malic and salicylic) and it is possible that humic acids may likewise take the manganic ion into solution. Whilst this could explain the mobility of manganese it does not account for the extreme leaching of manganese relative to iron. Fe^{3+} compounds react with organic acids in a manner similar to those of Mn^{3+} although Schnitzer and Skinner (1964) have shown that the solubility of iron-soil organic matter compounds in the organic acids noted above is dependent upon the amount of metal in the organic matter complex. Experimental studies are being undertaken to provide data which may allow more adequate discussion of this problem.

Ratios are also given in Table 6 for lead, zinc and copper. These are generally of erratic nature due to the extreme values of lead relative to zinc and copper. For sample 00-750 the lead content of the ironstone is fairly small and a normal decrease in the associated soil is evident. Thus the expected low mobility of lead and moderate mobility of zinc and copper in slightly acid groundwaters is evident in the ratios for this sample.

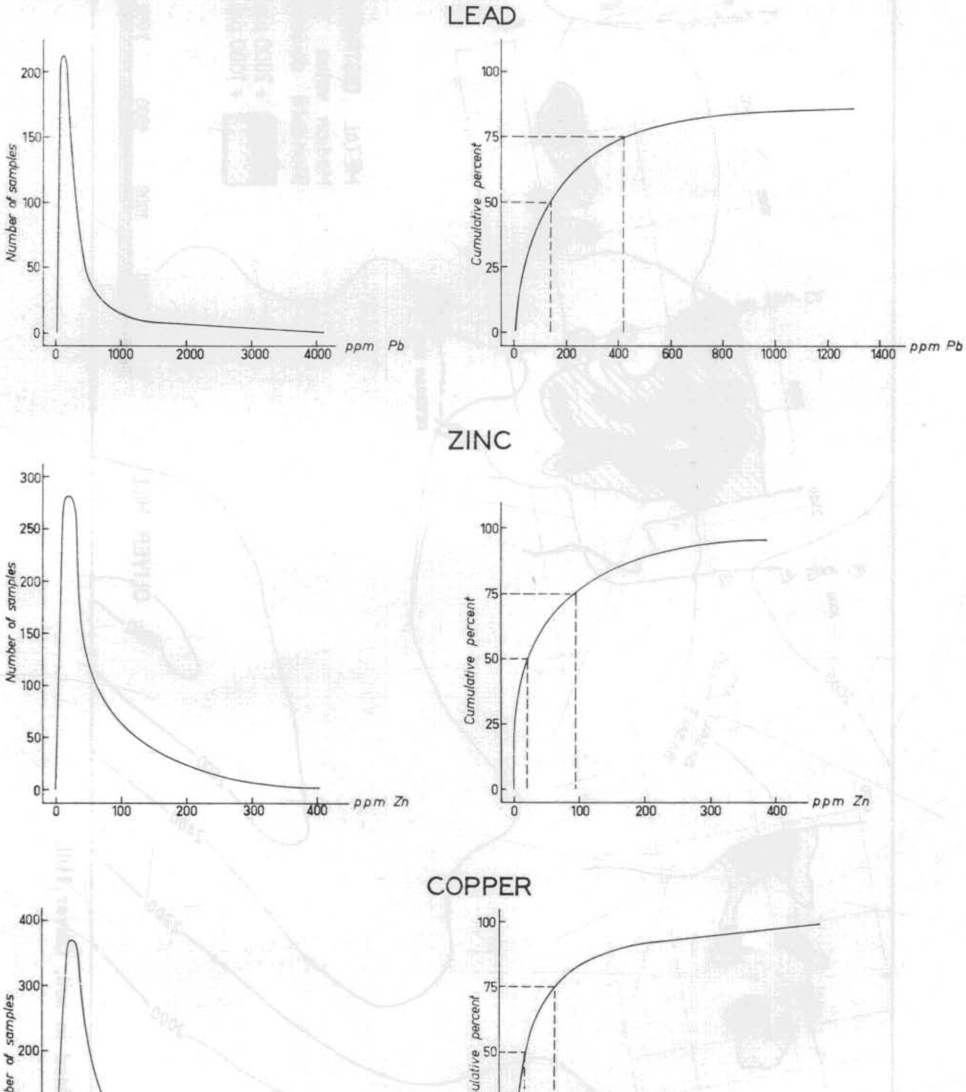

FIGURE 51. Frequency and cumulative frequency curves for lead, zinc and copper in soils from Oliver Hill.

5 cm

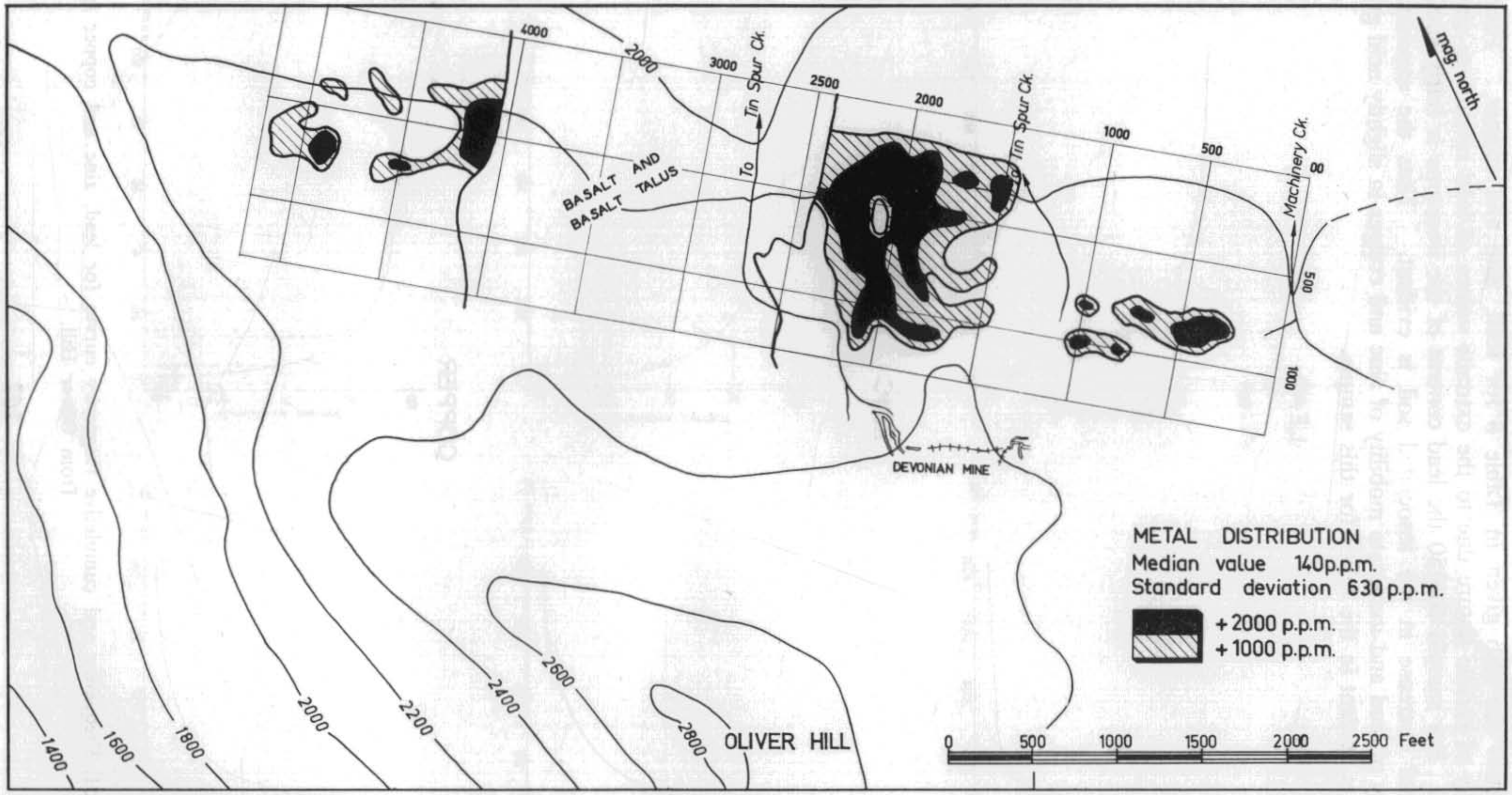

FIGURE 52. Anomalous lead in soil, Oliver Hill.

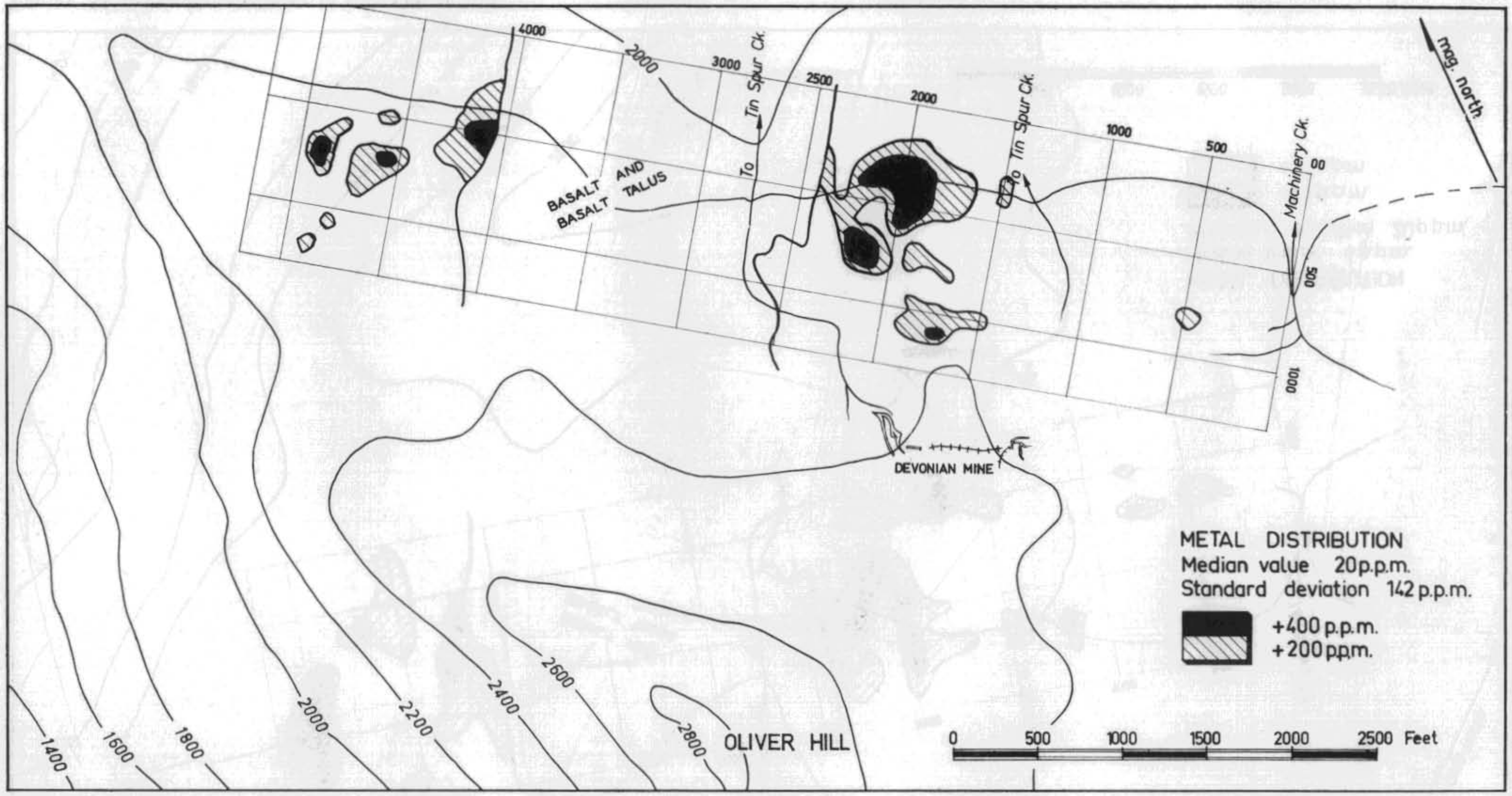

FIGURE 53. Anomalous zinc in soil, Oliver Hill.

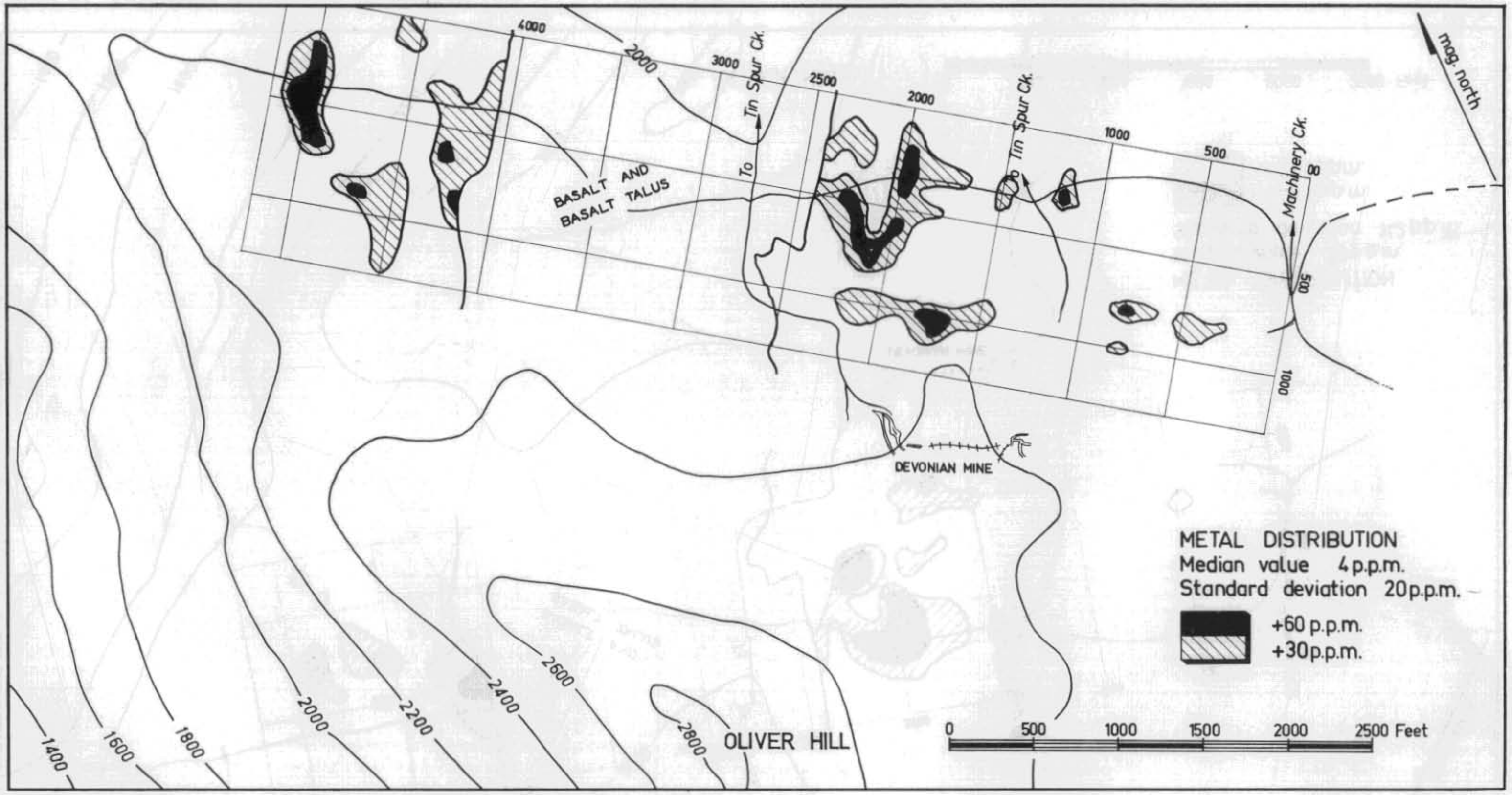

FIGURE 54. Anomalous copper in soil, Oliver Hill.

Water and vegetation studies

A number of groundwater and creek samples from the area were analysed for lead, zinc and copper. These waters are all acidic with the pH of the groundwaters ranging from 4.0-5.0 whilst that of the creeks is in the range 5.0-5.5. The results (Table 7) show a range of 5-115 ppb* lead, 25-150 ppb zinc and 2-10 ppb copper. In Tin Spur Creek which is the main drainage channel out of the area the values fall to 5, 25 and 2 ppb respectively. Ranges for river water given by Hawkes and Webb (1962) are 0.3-3 ppb lead, 1-200 ppb zinc and 0.2-30 ppb copper. Thus it is seen that whilst lead is above the range and may have aroused some interest had water analysis been undertaken during regional geochemical reconnaissance, the values for zinc and copper are very low in the respective ranges. Since the humic acid content of the waters is relatively high it is possible that the metals present are in the form of humic complexes and this would reduce the likelihood of their entering into exchange reactions with stream sediments. Under these conditions it is not surprising that a stream sediment survey in which samples were analysed for zinc, copper and tin revealed nothing of interest in Tin Spur Creek.

The leaves of eucalypts were also analysed and the values compared with those of the supporting soil. These results (Table 8) which are presented on an air-dry leaf and ash basis indicate that the metal values of eucalypt leaves do not reflect the metal distribution in the supporting soil. In all but one leaf sample (1800-950) lead is low regardless of the concentration in the soil whereas zinc and copper are high relative to their content in the soils. It would appear that the sampling of eucalypt leaves does not offer a means of biogeochemical prospecting.

CONCLUSIONS

The substantial geochemical anomaly detected in the vicinity of Oliver Hill gives this area some priority as an exploration target. Very little is known about the relationship between the various rock units of the area and it would be advantageous to have a cut across these at a point which would reveal the Moina Sandstone, Cambrian porphyry and the ironstone. This should yield evidence of the attitude of the strata and enable some prediction to be made as to the likely position of possible mineralisation related to the surface ironstone. Geophysical investigations of the area may also be of value in further delineating the source of the geochemical dispersion. Regardless of whether or not these measures clarify the interpretation of the geochemical data it will ultimately be necessary to design a drilling programme to thoroughly test the area keeping in mind the difficulties posed by the structural environment found at Round Hill.

ACKNOWLEDGMENTS

The writer wishes to express his thanks to I. B. Jennings, Chief Geologist, Department of Mines, Tasmania for introducing him to the Oliver Hill area and for much useful discussion. Thanks are also due to K. Williams, A. Jackson and S. Harris who assisted with the sampling of the area. P. Nankivell, H. Mackinnon and T. R. Bellis produced the illustrations for this report from the writer's rough originals.

* parts per billion, 10^{-9}.

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Table 1. METAL CONTENT OF IRONSTONE FROM OLIVER HILL

Sample No.	% Fe	% Mn	% Fe+Mn	% Pb	% Zn	% Cu
1	0.86	5.53	6.39	2.555	0.072	0.010
2	8.05	0.01	8.06	0.050	0.007	0.016
3	8.89	0.03	8.92	0.027	0.006	0.012
4	12.42	0.21	12.63	0.168	0.179	0.001
5	13.06	0.03	13.09	0.977	0.053	0.004
6	13.53	0.07	13.60	0.167	0.038	0.001
7	6.39	7.26	13.65	0.472	0.035	0.007
8	4.32	9.86	14.18	0.670	0.048	0.017
9	15.72	0.56	16.28	0.442	0.038	0.003
10	2.19	14.34	16.53	1.248	0.026	0.001
11	18.57	0.03	18.60	0.013	0.081	0.001
12	18.83	0.28	19.11	0.508	0.127	0.004
13	19.12	0.06	19.18	0.025	0.081	0.001
14	19.09	0.16	19.25	0.140	0.033	0.022
15	19.15	0.14	19.29	0.398	0.134	0.014
16	19.72	0.16	19.88	0.190	0.044	0.009
17	20.00	0.07	20.07	0.012	0.067	0.001
18	20.45	0.17	20.62	0.408	0.197	0.016
19	9.08	12.12	21.20	0.916	0.067	0.004
20	1.39	19.90	21.29	2.198	0.089	0.014
21	10.00	11.38	21.38	1.760	0.067	0.005
22	21.74	0.03	21.77	0.012	0.014	0.003
23	13.11	8.93	22.04	0.146	0.088	0.004
24	22.05	0.03	22.08	0.056	0.071	0.001
25	15.77	6.82	22.59	4.329	0.081	0.011
26	5.73	17.31	23.04	0.731	0.066	0.006
27	22.99	0.12	23.11	0.187	0.067	0.012
28	22.07	1.16	23.23	0.123	0.108	0.004
29	3.71	19.52	23.23	0.689	0.029	0.010
30	24.34	0.03	24.37	0.013	0.209	0.006
31	24.34	0.07	24.41	0.629	0.142	0.016

TABLE 1. METAL CONTENT OF IRONSTONE FROM OLIVER HILL—*continued*

Sample No.	% Fe	% Mn	% Fe+Mn	% Pb	% Zn	% Cu
32	17.24	7.29	24.53	1.900	0.247	0.022
33	24.91	0.32	25.23	3.029	0.470	0.005
34	23.34	1.93	25.27	0.836	0.098	0.001
35	25.61	0.28	25.89	0.094	0.234	0.005
36	25.94	0.06	26.00	0.025	0.016	0.002
37	25.94	0.18	26.12	1.099	0.039	0.031
38	4.02	22.21	26.23	0.708	0.030	0.009
39	26.39	0.16	26.55	0.743	0.261	0.024
40	26.34	0.24	26.58	0.357	0.055	0.018
41	3.86	23.21	27.07	0.917	0.031	0.016
42	27.07	0.04	27.11	0.983	0.032	0.031
43	26.05	1.27	27.32	0.201	0.087	0.019
44	27.41	0.21	27.62	0.888	0.232	0.006
45	28.05	0.45	28.50	0.285	0.051	0.015
46	28.65	0.12	28.77	0.441	0.072	0.006
47	21.77	7.27	29.04	0.503	0.034	0.005
48	28.60	0.45	29.05	0.199	0.024	0.002
49	27.04	2.16	29.20	0.813	0.088	0.017
50	25.00	4.23	29.23	1.017	0.067	0.002
51	28.05	1.21	29.26	0.956	0.108	0.006
52	29.35	0.06	29.41	0.025	0.174	0.001
53	29.44	0.07	29.51	0.214	0.089	0.009
54	29.72	0.11	29.83	0.211	0.048	0.001
55	24.61	5.24	29.85	1.885	0.266	0.005
56	24.57	5.77	30.34	2.702	0.304	0.036
57	30.24	0.12	30.36	0.575	0.120	0.008
58	10.61	20.11	30.72	6.842	0.067	0.006
59	18.83	11.92	30.75	2.040	0.125	0.001
60	31.00	0.06	31.06	0.044	0.124	0.004
61	30.94	0.16	31.10	0.571	0.057	0.028
62	31.12	0.04	31.16	0.022	0.104	0.005
63	31.04	0.12	31.16	0.444	0.110	0.009
64	31.50	0.07	31.57	0.074	0.053	0.002
65	15.83	15.76	31.59	1.738	0.273	0.004
66	31.00	0.74	31.74	0.242	0.096	0.001
67	31.85	0.06	31.91	0.012	0.136	0.004
68	31.96	0.43	32.09	0.341	0.379	0.008
69	31.46	0.92	32.38	0.386	0.213	0.002
70	32.32	0.27	32.59	0.170	0.019	0.002
71	31.04	2.02	33.06	0.983	0.138	0.004
72	17.05	16.21	33.26	5.847	0.255	0.049
73	32.45	0.81	33.26	0.621	0.129	0.004
74	33.28	0.07	33.35	0.649	0.257	0.025
75	23.01	10.82	33.83	3.806	0.494	0.004
76	33.75	0.16	33.91	0.321	0.204	0.006
77	27.52	6.63	34.15	0.977	0.078	0.001
78	34.21	0.29	34.50	0.784	0.095	0.035
79	2.72	31.80	34.52	3.010	0.074	0.013
80	34.11	0.62	34.73	0.749	0.094	0.005
81	34.68	0.16	34.84	0.816	0.129	0.018
82	34.65	0.21	34.86	0.708	0.127	0.017
83	35.19	0.20	35.39	0.649	0.106	0.050
84	35.55	0.21	35.76	0.241	0.024	0.002
85	35.68	0.12	35.80	0.408	0.098	0.009
86	35.68	0.12	35.80	0.134	0.159	0.001
87	34.69	0.15	35.84	1.813	0.063	0.033
88	36.01	0.03	36.04	0.313	0.073	0.005
89	32.28	4.39	36.67	1.248	0.216	0.003

TABLE 1. METAL CONTENT OF IRONSTONE FROM OLIVER HILL—*continued*

Sample No.	% Fe	% Mn	% Fe+Mn	% Pb	% Zn	% Cu
90	36.67	0.07	36.74	0.167	0.184	0.005
91	36.67	0.07	36.74	0.181	0.184	0.005
92	36.71	0.08	36.79	0.959	0.125	0.009
93	32.28	4.52	36.80	1.713	0.167	0.002
94	36.01	0.85	36.86	0.369	0.225	0.005
95	36.71	0.19	36.90	0.696	0.093	0.043
96	8.34	28.77	37.11	1.614	0.219	0.012
97	37.26	0.08	37.34	0.339	0.147	0.012
98	37.26	0.14	37.40	0.187	0.041	0.009
99	37.26	0.14	37.40	0.632	0.272	0.010
100	37.54	0.05	37.59	0.313	0.079	0.005
101	37.54	0.09	37.63	1.387	0.050	0.033
102	36.66	1.15	37.81	0.199	0.106	0.048
103	29.39	8.50	37.89	2.491	0.193	0.007
104	37.73	0.23	37.96	0.522	0.078	0.006
105	38.31	0.21	38.52	0.242	0.118	0.001
106	38.90	0.69	38.59	2.456	0.244	0.012
107	32.76	6.01	38.77	1.589	0.081	0.013
108	38.85	0.11	38.96	0.633	0.046	0.027
109	38.85	0.29	39.14	0.850	0.288	0.009
110	38.35	0.92	39.27	0.567	0.175	0.022
111	26.72	12.70	39.42	2.696	0.415	0.008
112	9.44	30.03	39.47	4.693	0.265	0.010
113	38.90	0.57	39.47	0.199	0.043	0.005
114	39.51	0.15	39.66	0.614	0.115	0.009
115	18.09	22.27	40.36	3.043	0.089	0.015
116	40.17	0.21	40.38	0.341	0.186	0.013
117	36.85	3.76	40.61	1.141	0.285	0.006
118	39.39	1.32	40.71	0.702	0.041	0.011
119	39.92	0.92	40.84	0.562	0.147	0.002
120	40.68	0.18	40.86	0.571	0.102	0.010
121	41.29	11.67	40.96	1.862	0.038	0.007
122	40.52	0.47	40.99	0.288	0.268	0.001
123	41.11	0.12	41.23	0.261	0.195	0.005
124	31.10	10.15	41.25	0.836	0.179	0.002
125	41.37	0.03	41.40	0.488	0.039	0.064
126	31.89	9.64	41.53	3.573	0.207	0.006
127	40.73	0.84	41.57	0.211	0.142	0.065
128	1.18	40.43	41.61	2.864	0.269	0.007
129	37.76	4.52	42.28	1.099	0.354	0.004
130	39.51	3.08	42.59	2.427	0.227	0.048
131	34.16	8.44	42.60	5.289	0.083	0.030
132	26.42	16.22	42.64	2.360	0.164	0.017
133	40.58	2.06	42.64	0.916	0.187	0.001
134	35.14	7.57	42.71	3.904	0.090	0.029
135	42.31	0.62	42.93	0.308	0.089	0.030
136	42.57	0.52	43.09	0.571	0.305	0.005
137	43.29	0.07	43.36	0.649	0.036	0.027
138	41.90	1.61	43.51	1.043	0.493	0.003
139	39.08	4.53	43.61	3.177	0.197	0.013
140	41.80	2.12	43.92	1.219	0.189	0.013
141	42.97	1.23	44.20	0.722	0.291	0.001
142	40.07	4.52	44.59	3.116	0.087	0.035
143	30.64	14.15	44.79	2.194	0.187	0.004
144	44.69	0.19	44.88	0.064	0.190	0.002
145	39.92	5.00	44.92	3.358	0.219	0.017
146	38.35	6.99	45.34	2.491	0.234	0.034
147	40.29	5.07	45.36	0.990	0.069	0.026

TABLE 1. METAL CONTENT OF IRONSTONE FROM OLIVER HILL—*continued*

Sample No.	% Fe	% Mn	% Fe+Mn	% Pb	% Zn	% Cu
148	45.43	0.16	45.59	1.363	0.207	0.005
149	45.41	0.27	45.68	0.257	0.060	0.041
150	45.53	0.15	45.68	0.386	0.069	0.010
151	42.62	3.20	45.82	1.427	0.142	0.005
152	44.96	0.97	45.93	1.037	0.152	0.006
153	42.57	3.47	46.04	0.925	0.079	0.001
154	44.69	1.62	46.31	0.731	0.095	0.023
155	38.00	8.74	46.74	1.885	0.211	0.008
156	46.68	0.14	46.82	2.729	0.129	0.017
157	46.68	0.25	46.93	0.201	0.049	0.008
158	46.68	0.26	46.94	0.559	0.138	0.015
159	33.75	13.32	47.07	4.334	0.215	0.005
160	47.15	0.03	47.18	0.027	0.029	0.001
161	44.78	2.41	47.19	1.219	0.301	0.009
162	47.31	0.17	47.48	0.990	0.164	0.044
163	47.31	0.75	48.06	0.559	0.186	0.003
164	47.95	0.60	48.55	0.699	0.370	0.009
165	48.54	0.12	48.66	2.205	0.132	0.015
166	48.54	0.13	48.67	2.298	0.165	0.018
167	48.67	0.25	48.92	0.229	0.101	0.001
168	47.74	1.73	49.47	1.157	0.096	0.005
169	37.76	12.17	49.93	3.582	0.232	0.009
170	49.31	0.67	49.98	0.481	0.208	0.004
171	49.31	0.71	50.02	0.201	0.099	0.004
172	49.31	0.71	50.02	0.408	0.189	0.004
173	50.13	0.23	50.36	0.060	0.096	0.001
174	49.88	0.61	50.49	3.374	0.180	0.018
175	49.88	0.68	50.56	0.731	0.345	0.005
176	50.61	0.13	50.74	0.854	0.111	0.007
177	35.63	15.14	50.77	4.339	0.219	0.009
178	51.16	0.11	51.27	0.348	0.172	0.125
179	50.03	1.27	51.30	0.425	0.065	0.006
180	46.35	4.93	51.28	1.585	0.268	0.001
181	51.47	0.05	51.52	0.352	0.069	0.011
182	51.72	0.23	51.95	0.134	0.081	0.001
183	52.20	0.10	52.30	0.543	0.112	0.009
184	52.20	0.27	52.47	0.425	0.150	0.010
185	52.20	0.28	52.48	0.498	0.106	0.005
186	53.35	0.47	53.82	0.366	0.064	0.012
187	25.94	28.33	54.27	3.160	0.219	0.005
188	54.91	0.07	54.98	1.077	0.176	0.006
189	54.46	0.89	55.35	0.515	0.220	0.005
190	50.55	4.92	55.47	1.310	0.129	0.004
191	54.81	0.66	55.47	0.211	0.114	0.001
192	40.73	15.53	56.26	1.889	0.190	0.007
193	54.88	0.99	55.87	0.678	0.137	0.005
194	56.27	0.63	56.90	0.180	0.098	0.003
195	57.12	0.11	57.23	0.813	0.500	0.004
196	57.12	0.21	57.33	1.248	0.207	0.004
197	57.19	0.24	57.43	1.637	0.213	0.007
198	58.71	0.21	58.92	1.080	0.179	0.004
199	56.34	3.71	60.05	1.152	0.304	0.018
200	62.24	0.07	62.31	0.179	0.464	0.005

TABLE 2. CORRELATION COEFFICIENTS FOR METALS IN IRONSTONE FROM OLIVER HILL

	Fe	Mn	Fe+Mn	Pb	Zn	Cu
Fe	1.000	—0.381	0.713	—0.084	0.314	0.000
Mn	—0.381	1.000	0.101	0.666	0.222	0.041
Fe+Mn	0.713	0.101	1.000	0.285	0.471	0.073
Pb	—0.084	0.666	0.285	1.000	0.374	0.357
Zn	0.314	0.222	0.471	0.374	1.000	—0.008
Cu	0.000	0.041	0.073	0.357	—0.008	1.000

TABLE 3. METAL CONTENT OF SOIL SAMPLES FROM OLIVER HILL

Sample No.	Metal content ppm			Sample No.	Metal content ppm		
	Pb	Zn	Cu		Pb	Zn	Cu
00– 00	220	10	2	300– 00	120	10	2
– 100	190	15	5	– 100	170	10	5
– 200	170	5	2	– 200	240	20	2
– 300	210	15	5	– 300	250	10	5
– 400	40	15	5	– 400	40	10	2
– 500	140	15	5	– 500	70	10	5
– 600	260	25	15	– 600	20	10	2
– 700	890	50	40	– 700	140	25	10
– 800	90	20	10	– 800	2830	145	35
– 900	20	15	10	– 900	90	15	10
–1000	60	20	10	–1000	10	10	10
–1100	10	20	10	–1100	20	10	2
–1200	5	20	5	–1200	20	5	2
–1300	10	10	2	–1300	20	10	2
100– 00	110	15	2	400– 00	130	20	5
– 100	150	15	5	– 100	100	20	2
– 200	150	20	2	– 200	110	15	5
– 300	160	10	2	– 300	70	10	5
– 400	50	15	5	– 400	40	10	5
– 500	20	10	5	– 500	180	10	10
– 600	20	15	5	– 600	170	10	10
– 700	130	15	5	– 700	70	40	10
– 800	5	10	10	– 800	2420	110	30
– 900	10	15	10	– 900	3020	80	30
–1000	10	15	10	–1000	20	10	10
–1100	5	5	5	–1100	20	10	10
–1200	5	10	5	–1200	50	10	10
–1300	5	25	2	–1300	50	10	10
200– 00	240	20	5	500– 00	210	20	5
– 100	180	20	5	– 100	80	10	2
– 200	100	10	2	– 200	140	15	2
– 300	40	10	2	– 300	80	10	10
– 400	80	10	5	– 400	260	10	5
– 500	30	10	10	– 500	320	15	5
– 600	210	10	10	– 600	90	15	2
– 700	60	30	10	– 700	260	10	2
– 800	20	15	10	– 800	3020	270	40
– 900	5	15	10	– 900	2420	140	30
–1000	10	10	10	–1000	40	15	10
–1100	20	15	10	–1100	20	10	5
–1200	20	15	10	–1200	210	20	5
–1300	5	15	10	–1300	60	20	5

TABLE 3. METAL CONTENT OF SOIL SAMPLES FROM OLIVER HILL—*continued*

Sample No.	Metal content ppm Pb	Zn	Cu	Sample No.	Metal content ppm Pb	Zn	Cu
600– 00	110	10	2	1000– 00	160	15	5
– 100	170	10	5	– 100	260	20	2
– 200	230	20	5	– 200	120	10	2
– 300	50	15	2	– 300	140	15	2
– 400	100	10	2	– 400	40	15	2
– 500	380	10	10	– 500	50	25	5
– 600	130	10	10	– 600	240	25	5
– 700	280	10	10	– 700	100	30	5
– 800	1300	50	20	– 800	2430	35	5
– 900	1030	55	20	– 900	740	30	5
–1000	50	10	10	–1000	5460	50	10
–1100	60	10	10	–1100	50	25	5
–1200	70	10	10	–1200	20	25	5
–1300	160	10	10	–1300	40	25	5
700– 00	260	20	2	1100– 00	240	20	5
– 100	120	15	5	– 100	210	20	2
– 200	180	15	2	– 200	100	15	2
– 300	170	25	5	– 300	70	15	5
– 400	190	10	2	– 400	20	15	2
– 500	320	10	5	– 500	70	10	2
– 600	160	10	2	– 600	20	10	2
– 700	400	35	20	– 700	230	15	5
– 800	3560	145	45	– 800	25	25	5
– 900	240	20	10	– 900	730	35	5
–1000	80	10	10	–1000	400	30	5
–1100	110	15	2	–1100	20	5	10
–1200	70	10	2	–1200	5	5	10
–1300	110	15	2	–1300	20	5	2
800– 00	220	20	5	1200– 00	240	10	5
– 100	180	20	5	– 100	450	15	10
– 200	240	15	2	– 200	580	25	55
– 300	230	15	5	– 300	1200	25	225
– 400	260	10	2	– 400	330	10	5
– 500	150	20	5	– 500	210	15	10
– 600	290	30	5	– 600	200	25	5
– 700	690	25	5	– 700	360	30	5
– 800	1980	130	140	– 800	230	25	5
– 900	530	20	15	– 900	70	25	5
–1000	2860	85	30	–1000	90	35	5
–1100	390	10	10	–1100	80	35	5
–1200	90	10	10	–1200	20	25	5
–1300	280	10	10	–1300	80	25	5
900– 00	280	50	25	1300– 00	280	25	2
– 100	240	25	5	– 100	280	25	10
– 200	220	25	5	– 200	490	20	10
– 300	390	25	5	– 300	730	25	15
– 400	210	20	5	– 400	280	10	10
– 500	60	25	5	– 500	170	10	20
– 600	150	25	5	– 600	50	15	10
– 700	400	25	5	– 700	580	10	10
– 800	240	30	5	– 800	230	30	5
– 900	590	70	10	– 900	150	25	5
–1000	1090	175	25	–1000	240	60	5
–1100	150	20	5	–1100	210	15	10
–1200	330	20	5	–1200	30	5	5
–1300	50	20	5	–1300	70	5	10

TABLE 3. METAL CONTENT OF SOIL SAMPLES FROM OLIVER HILL—*continued*

Sample No.	Metal content ppm		
	Pb	Zn	Cu
1400– 00	310	10	5
– 100	400	15	5
– 200	460	25	10
– 300	590	45	25
– 400	220	5	10
– 500	60	15	10
– 600	30	15	10
– 700	130	15	10
– 800	780	65	25
– 900	890	30	15
–1000	360	15	10
–1100	60	20	10
–1200	30	20	10
–1300	20	35	10
1500– 00	380	30	10
– 100	600	80	25
– 200	1280	110	25
– 300	2340	245	45
– 400	2170	230	45
– 500	590	110	15
– 600	540	30	10
– 700	1130	120	25
– 800	600	105	20
– 900	1320	175	55
–1000	1420	200	45
–1100	260	10	5
–1200	40	5	2
–1300	40	5	2
1600– 00	320	25	10
– 100	390	45	15
– 200	1070	90	20
– 300	1880	150	15
– 400	1460	80	10
– 500	1160	60	15
– 600	370	100	15
– 700	360	65	15
– 800	1100	155	40
– 900	900	75	15
–1000	1820	220	40
–1100	280	50	15
–1200	20	20	10
–1300	280	15	10
1700– 00	400	20	5
– 100	400	20	10
– 200	1050	120	25
– 300	2240	225	45
– 400	1940	230	20
– 500	2600	225	25
– 600	390	60	15
– 700	490	80	10
– 800	1600	260	65
– 900	130	25	10
–1000	1700	300	65
–1100	5310	420	70
–1200	80	5	2
–1300	100	5	20
1800– 00	360	35	20
– 100	600	50	25
– 200	1290	130	25
– 300	1870	245	40
– 400	1820	155	20
– 500	2120	275	35
– 600	1900	115	25
– 700	1140	165	20
– 800	500	115	15
– 900	3340	80	15
–1000	1650	325	70
–1100	3030	210	55
–1200	60	25	10
–1300	150	25	10
1900– 00	240	20	10
– 100	380	50	15
– 200	2410	280	30
– 300	4180	450	35
– 400	2810	465	25
– 500	2670	550	45
– 600	2030	165	20
– 700	2050	250	10
– 800	2390	325	20
– 900	1280	190	25
–1000	1160	140	30
–1100	2650	200	25
–1200	90	10	2
–1300	140	10	10
2000– 00	330	25	10
– 100	560	150	35
– 200	1180	320	60
– 300	4450	580	80
– 400	2710	410	85
– 500	2140	565	45
– 600	4700	610	90
– 700	1380	180	55
– 800	1650	215	30
– 900	2390	95	25
–1000	2120	150	55
–1100	470	65	25
–1200	130	65	10
–1300	130	20	10
2100– 00	380	35	20
– 100	400	80	25
– 200	2740	380	25
– 300	6870	500	20
– 400	6240	510	20
– 500	220	10	2
– 600	90	10	5
– 700	5390	500	65
– 800	4140	470	115
– 900	1230	110	15
–1000	2290	145	50
–1100	6240	410	45
–1200	1840	110	20
–1300	590	30	15

TABLE 3. METAL CONTENT OF SOIL SAMPLES FROM OLIVER HILL—*continued*

Sample No.	Metal content ppm		
	Pb	Zn	Cu
2200– 00	960	155	30
– 100	380	105	25
– 200	1370	110	35
– 300	2300	365	35
– 400	2810	500	25
– 500	2800	265	130
– 600	2650	170	75
– 700	2510	495	80
– 800	5060	515	30
– 900	980	125	25
–1000	1720	150	45
–1100	210	30	15
–1200	70	15	2
–1300	5	5	2
2300– 00	300	15	5
– 100	580	90	35
– 200	1140	105	50
– 300	1380	95	25
– 400	2330	170	50
– 500	2360	140	65
– 600	3930	280	50
– 700	1530	155	25
– 800	1410	130	25
– 900	560	100	25
–1000	260	45	10
–1100	150	10	2
–1200	5	5	2
–1300	5	5	10
2400– 00	240	50	25
– 100	400	80	25
– 200	1050	160	30
– 300	1940	200	35
– 400	1700	230	25
– 500	2170	175	35
– 600	340	90	20
– 700	310	70	20
– 800	150	45	10
– 900	90	25	5
–1000	60	30	5
–1100	50	25	5
–1200	60	20	10
–1300	5	15	2
2500– 780	30	30	5
– 880	20	30	5
– 980	130	35	5
2600– 660	130	95	30
– 760	70	90	25
– 860	330	120	50
– 960	70	80	20
–1060	40	35	5
2700– 760	90	110	35
– 860	90	105	40
– 960	30	90	35
2800– 720	50	105	50
– 820	60	165	55
– 920	40	160	55
2900– 840	30	115	25
3000– 840	50	85	20
3100– 860	50	105	40
3200– 860	30	145	45
3300– 860	40	125	55
3400– 880	80	120	40
3500– 860	30	115	35
3600– 900	30	100	30
3700– 900	50	110	45
3800– 900	50	95	45
3900– 860	40	90	45
4000– 800	40	130	55
4100– 60	140	30	25
– 160	280	110	35
– 260	1050	250	50
– 360	4620	275	45
– 460	7470	610	60
– 560	5620	580	40
– 660	2960	325	35
– 760	130	85	55
– 860	80	75	45
– 960	120	35	20
–1060	260	50	20
–1160	60	50	15
–1260	80	55	10
4200– 00	100	65	5
– 100	280	130	10
– 200	240	105	15
– 300	1060	165	10
– 400	2940	380	45
– 500	3030	460	50
– 600	2720	290	50
– 700	800	225	55
– 800	110	90	60
– 900	600	95	70
–1000	400	80	30
–1100	260	85	25
–1200	120	60	40
–1300	110	40	10
4300– 00	190	135	2
– 140	220	80	2
– 240	200	75	2
– 340	1120	130	55
– 440	600	140	35
– 540	840	180	50
– 640	1330	305	65
– 740	300	130	40
– 840	340	160	20
– 940	350	100	20
–1040	210	60	25
–1140	180	80	10
–1240	120	130	15

TABLE 3. METAL CONTENT OF SOIL SAMPLES FROM OLIVER HILL—*continued*

Sample No.	Metal content ppm Pb	Zn	Cu
4400– 00	240	75	20
– 120	370	150	15
– 220	550	150	10
– 320	1030	135	40
– 420	590	85	5
– 520	430	100	5
– 620	210	170	2
– 720	1010	90	15
– 820	260	40	10
– 920	220	40	5
–1020	190	60	5
–1120	240	100	20
–1220	60	80	5
–1300	80	30	10
4500– 00	350	95	25
– 120	510	120	40
– 220	350	100	10
– 320	530	120	15
– 420	560	145	25
– 520	600	140	15
– 620	90	85	5
– 720	2360	330	30
– 820	270	115	30
– 920	140	95	55
–1020	180	90	45
–1120	260	140	50
–1220	230	120	50
–1300	50	80	30
4600– 00	180	100	45
– 100	600	90	55
– 200	290	90	5
– 300	380	35	5
– 400	1190	85	10
– 500	930	220	10
– 600	80	115	5
– 700	1260	490	15
– 800	1150	200	45
– 900	590	100	50
–1000	360	95	40
–1100	210	60	25
–1200	250	60	20
–1300	120	70	15
4700– 00	590	85	15
– 100	460	75	15
– 200	500	115	5
– 300	2360	145	20
– 400	650	85	5
– 500	280	130	2
– 600	400	130	2
– 700	870	210	5
– 800	480	225	10
– 900	910	335	80
–1000	320	95	10
–1100	480	120	15
–1200	180	85	10
–1300	210	45	5
4800– 00	5	20	2
– 60	40	40	5
– 160	50	35	5
– 260	210	35	5
– 360	510	45	5
– 460	790	140	10
– 560	580	275	5
– 660	900	180	25
– 760	720	180	15
– 860	230	140	35
– 960	210	160	10
–1060	570	210	20
–1160	400	130	120
–1260	80	115	2
4900– 00	5	20	2
– 80	5	45	2
– 180	50	35	5
– 280	200	40	5
– 380	1640	45	5
– 480	150	45	5
– 580	810	110	20
– 680	13970	435	125
– 780	2110	460	20
– 880	390	120	5
– 980	10	75	5
–1080	20	60	5
–1180	160	215	60
–1280	30	75	5
5000– 00	5	15	2
– 100	5	20	2
– 200	460	55	100
– 300	540	65	95
– 400	830	150	140
– 500	1030	185	140
– 600	580	75	70
– 700	1390	155	75
– 800	390	70	20
– 900	40	65	5
–1000	40	40	5
–1100	10	25	2
–1200	110	50	2
–1300	60	40	5
5100– 00	20	15	2
– 120	5	35	2
– 220	70	80	30
– 320	350	130	35
– 420	290	75	60
– 520	990	85	370
– 620	1080	55	10
– 720	1540	45	10
– 820	960	45	5
– 920	600	35	5
–1020	400	50	20
–1120	180	70	20
–1220	240	105	15
–1300	110	80	5

TABLE 3. METAL CONTENT OF SOIL SAMPLES FROM OLIVER HILL—*continued*

Sample No.	Metal content ppm Pb	Zn	Cu	Sample No.	Metal content ppm Pb	Zn	Cu
5200– 00	5	5	2	5200– 740	120	35	5
– 140	5	10	2	– 840	330	45	5
– 240	30	10	5	– 940	5	25	2
– 340	190	20	2	–1040	110	20	2
– 440	70	15	2	–1140	60	25	5
– 540	480	40	20	–1240	40	55	2
– 640	930	50	40				

TABLE 4. IRON OXIDE AND TRACE METAL CONTENT OF OLIVER HILL SOILS

Sample No.	Fe_2O_3 %	Trace metals (ppm) Pb	Zn	Cu
4900– 380	0.09	1640	45	5
1000–1000	0.29	5460	50	10
5100– 620	0.35	1080	55	10
5000– 500	0.53	1030	185	140
1400– 900	1.13	890	30	15
1800– 900	1.35	3340	80	15
1100– 900	1.88	730	35	5
1100– 800	2.88	2430	35	5
4700– 400	2.91	650	85	5
4400– 520	3.57	430	100	5
5200– 640	5.30	930	50	40
1600– 600	5.59	370	100	15
2000– 800	6.07	1650	215	30
4500– 520	7.07	600	140	15
4800– 760	7.56	720	180	15
1700– 800	8.78	1600	260	65
4800– 660	9.15	900	180	25
5000– 500	9.44	1030	185	140
4100– 660	10.20	2960	325	35
700– 800	11.30	3560	145	45
1500– 900	12.60	1320	175	55
800–1000	13.00	2860	85	30
1400– 800	14.00	780	65	25
5100– 520	14.20	1080	85	370
900–1000	21.00	1090	175	25

TABLE 5. ORGANIC MATTER AND TRACE METAL CONTENT OF OLIVER HILL SOILS

Sample No.	Organic matter %	Trace metals (ppm)		
		Pb	Zn	Cu
600– 900	4.0	90	15	10
00– 900	5.2	20	15	10
00– 800	5.2	90	20	10
100– 800	5.2	5	10	10
200– 600	5.6	210	10	10
200–1100	6.0	20	15	10
200– 800	6.0	20	15	10
200–1200	6.4	20	15	10
100– 900	6.8	10	15	10
600–1000	7.2	50	10	10
200–1300	8.0	5	15	10
200–1000	8.0	10	10	10
400– 600	8.8	170	10	10
100–1000	9.2	10	15	10
400–1000	9.6	20	10	10
600– 600	9.6	130	10	10
200– 700	10.8	60	30	10
00–1000	11.2	60	20	10
200– 500	11.6	30	10	10
600– 700	11.6	280	10	10
500–1100	12.4	20	10	5
200– 900	13.2	5	15	10
600– 500	20.0	380	10	10
400–1300	14.4	50	10	10
500–1000	18.0	40	15	10

TABLE 6. METAL CONTENT AND METAL RATIOS FOR IRONSTONE AND ASSOCIATED SOIL FROM OLIVER HILL

Sample No.	Fe (%)	Mn (%)	Pb (ppm)	Zn (ppm)	Cu (ppm)	Fe:Mn	Pb:Zn	Pb:Cu	Zn:Cu
00– 750	9.96	30.05	3625	1325	80	0.3	2.7	45.3	16.6
	5.86	0.45	725	70	<5	13.0	10.4	145.0	>14.0
600– 950	16.71	17.94	28400	700	40	0.9	40.6	710.0	17.5
	6.92	1.42	4350	250	<5	4.6	17.4	870.0	>50.0
800–1000	17.00	20.63	57100	850	120	0.8	67.2	475.8	7.1
	6.56	0.21	4950	175	20	31.2	28.3	247.5	8.8
1600–1000	40.80	6.73	20200	3575	130	6.1	5.7	155.4	27.5
	7.97	0.33	2000	250	40	24.2	8.0	50.0	6.3
1700– 800	38.69	3.47	9800	2500	60	11.2	3.9	163.3	41.7
	5.39	0.24	1500	200	30	22.5	7.5	50.0	6.7
1800– 900	29.01	12.56	43500	4225	90	2.3	10.3	483.3	46.9
	4.81	0.15	6950	250	30	32.1	27.8	231.7	8.3
1900– 900	19.64	21.08	64400	3500	40	0.9	18.4	1610.0	87.5
	4.16	0.21	1575	250	<5	19.8	6.3	315.0	>50.0
2000– 750	20.63	13.90	35000	1800	250	1.5	19.4	140.0	7.2
	2.93	0.13	1075	150	<5	22.5	7.2	215.0	>30.0
4900– 700	44.49	1.29	8150	3150	60	34.5	2.6	135.8	52.5
	12.07	0.13	7000	475	140	92.9	14.7	50.0	3.4
4950– 700	20.14	11.66	16600	2925	40	1.7	5.7	415.0	73.1
	15.24	0.21	10300	600	20	72.6	17.2	515.0	30.0

TABLE 7. METAL CONTENT OF GROUND AND CREEK WATERS IN THE VICINITY OF OLIVER HILL

Sample No.	Sample type	Metal content (ppb)		
		Pb	Zn	Cu
900– 900	Groundwater	115	40	4
900–1000	Groundwater	20	25	10
900–1100	Groundwater	110	135	8
900– 00	Creek	5	95	8
1000–1000	Groundwater	25	25	10
1000– 600	Creek	25	35	10
1400–1100	Groundwater	10	55	8
1400– 900	Groundwater	25	130	10
1400– 800	Groundwater	10	150	10
–	Tin Spur Creek	5	25	2

TABLE 8. METAL CONTENT OF EUCALYPT LEAVES AND SOIL FROM OLIVER HILL

Sample No.	Metal content of leaves (ppm)						Metal content of soils (ppm)		
	Air-dry leaves			Ash of leaves					
	Pb	Zn	Cu	Pb	Zn	Cu	Pb	Zn	Cu
400– 950	1.6	18.3	5.6	36	405	124	50	<1	2
400– 700	2.8	10.6	2.6	67	252	62	180	14	<1
450– 900	2.0	11.7	4.0	62	366	125	5475	355	88
600– 900	0.8	12.5	3.0	25	391	94	2850	148	14
620–1000	0.8	12.5	3.4	32	500	136	95	14	6
900– 850	0.4	12.4	3.8	10	302	93	500	24	6
1400– 850	0.8	14.1	3.6	31	542	138	790	138	10
1800– 950	14.0	16.4	2.8	530	630	108	3390	376	24
1800–1120	2.4	11.7	3.0	57	278	72	780	122	<1
1800– 850	0.4	11.0	3.0	12	334	91	1400	106	14