SOIL GEOCHEMISTRY OF THE AGRICOLA LAKE MASSIVE SULPHIDE PROSPECT

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The soil sample grid is centred over the "B" horizon massive sulphide prospect. Survey lines, normal to this horizon and to the strike of the volcanics, were established at 30-m intervals. Soil samples were collected at 15-m intervals along these lines. The main part of the soil grid extends from 640 E (metres) to 1240 E and from 790 N to 1165 N (Fig. 1). For the four lines 1060 N to 1150 E, the sampling was extended to 1390 N. This extension is over a stream draining the

prospect; these additional soils were sampled to study dispersion along this drainage channel.

The geology of the soil study area is shown elsewhere (Cameron, this section, Fig. 2). It is situated in the upper part of the near vertical-dipping volcanic sequence. The 1165 N boundary is roughly coincident with the lower contact of the quartz porphyry sill. The "B" (exhalative) horizon (Cameron and Durham, 1974a, 1974b) runs parallel and close to the 1000 N base
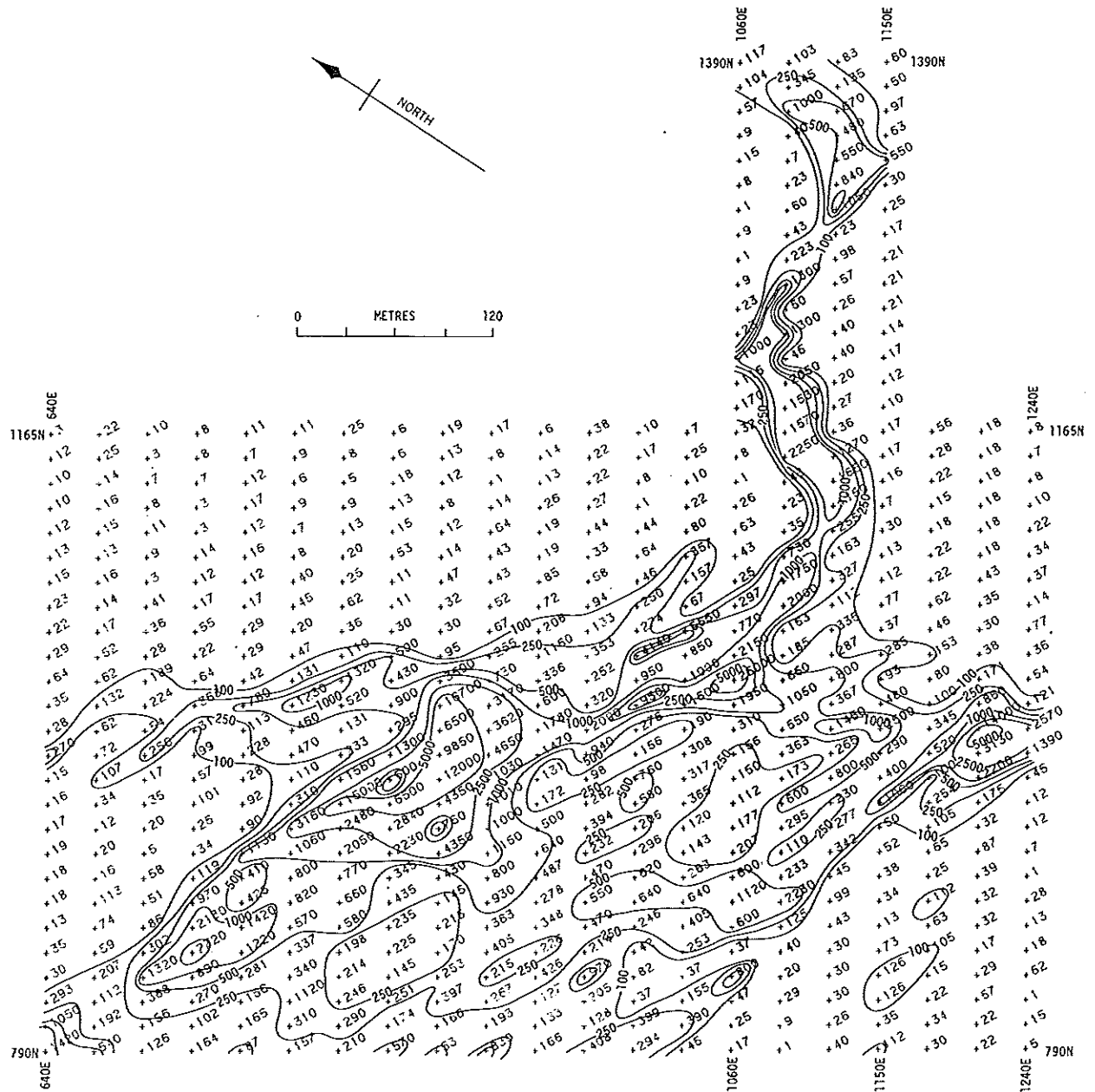

Figure 1. Distribution of lead (as ppm) in soils, Agricola Lake massive sulphide prospect, N.W.T.

line. The sampled area is roughly basin-shaped. The "B" horizon, the underlying hydrothermally altered rocks, and the shales form low, partly swampy ground with poor rock exposure. This is surrounded on all sides by better drained ground of greater relief, within which the rocks are well exposed. As noted above the basin drains (grid) north.

The soils in the central area of low ground are extensively dissected by frost boils. These soils tend to be stony and many are of a buff, gossanous colour. The hanging-wall volcanics are more resistant than the footwall volcanics or "B" horizon exhalite. This has caused the latter to be covered in many places by boulder fields derived from the hanging-wall volcanics.

The soils were sampled at a depth of 6-8 inches. Where possible, organic-rich soils were avoided, but in some places there was no alternative sample type. After drying, the soils were sieved, the minus 80-

mesh fraction being used for analysis. Zn, Cu, Pb, and Ag were analyzed in the field by atomic absorption spectrometer. Extraction was with hot HNO_3-HCl. Samples below the detection limit of 2.5 ppm Pb were assigned a value of 1 ppm. Attempts were made in a number of places to sample the soil in profile. However, the highly thixotropic nature of the active layer, accentuated by a wet summer, rendered this impossible.

In Figures 1 and 2 we show the distribution of Pb and Cu in the soils. Figures 3 and 4 illustrate the frequency distribution of these elements in the sample population. We believe that there have been three important processes responsible for the transportation of Pb in the soil study area. This has been shown diagrammatically in Figure 5. Solifluction has dispersed the solid material relatively short distances downslope in the immediate vicinity of the sulphide body. Glaciation is believed to have produced a more extensive dis-
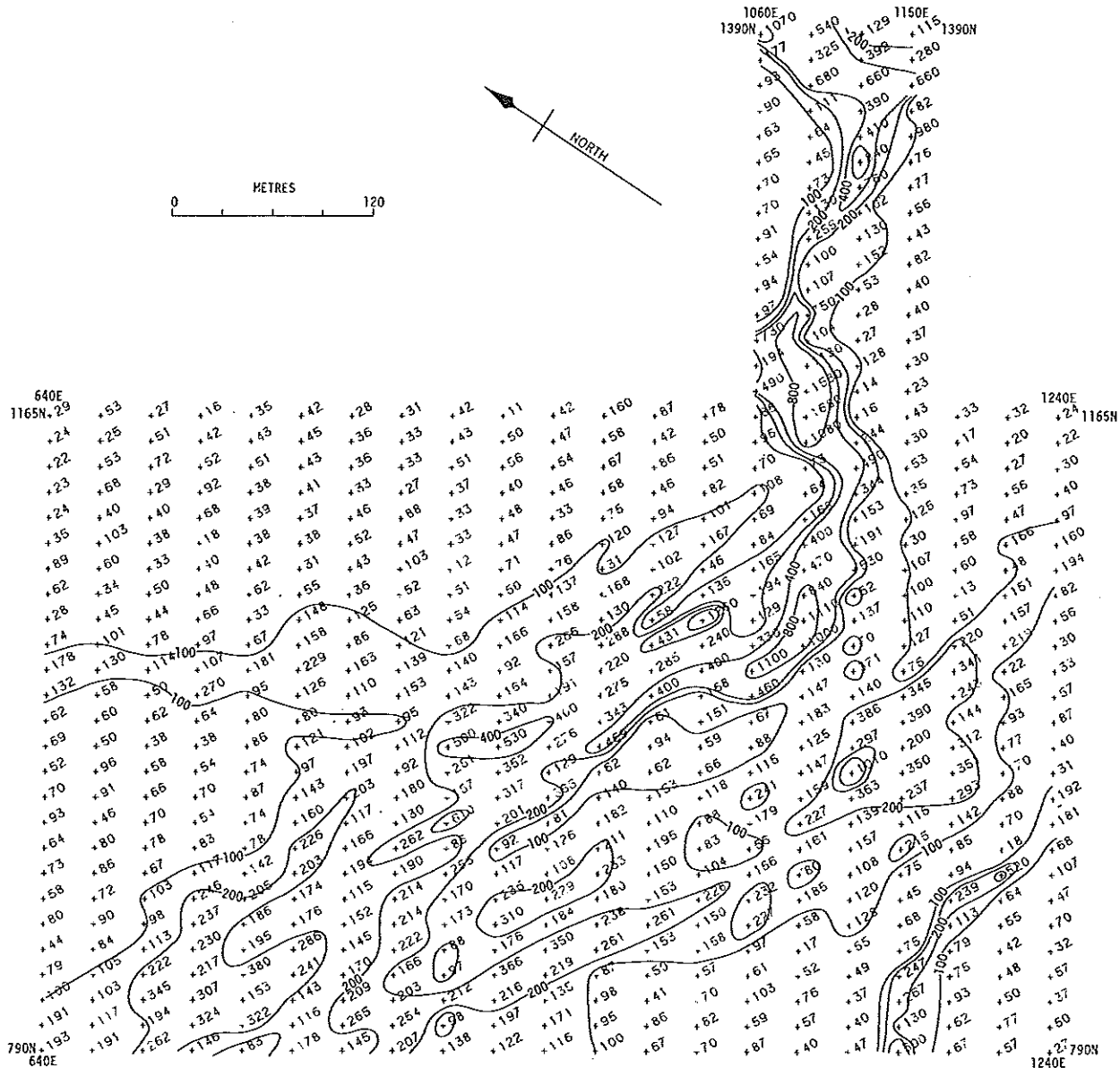

Figure 2. Distribution of copper (as ppm) in soils, Agricola Lake massive sulphide prospect, N.W.T.
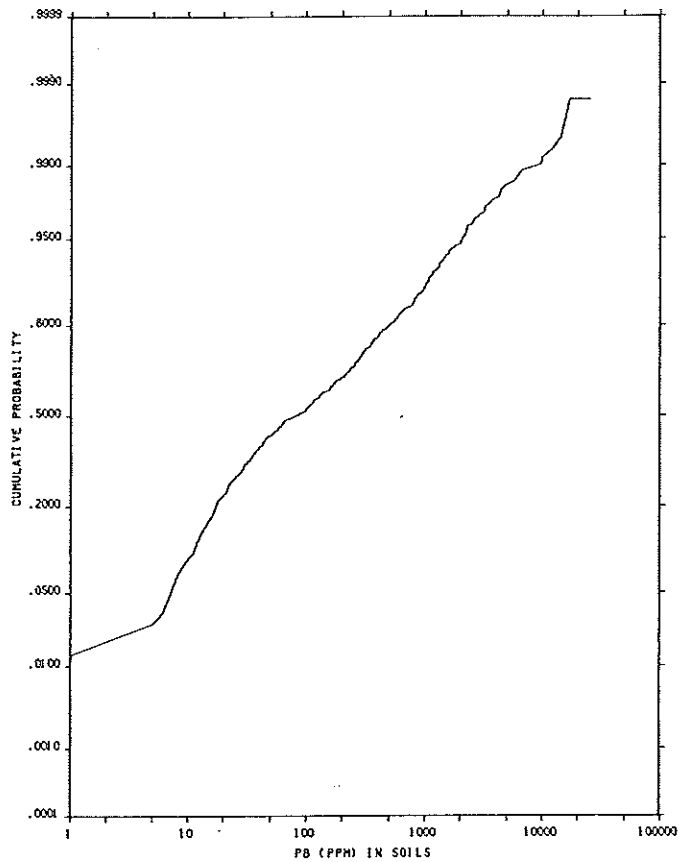
Figure 3. Frequency distribution of lead in soils, Agricola Lake massive sulphide prospect, N.W.T. (606 samples)
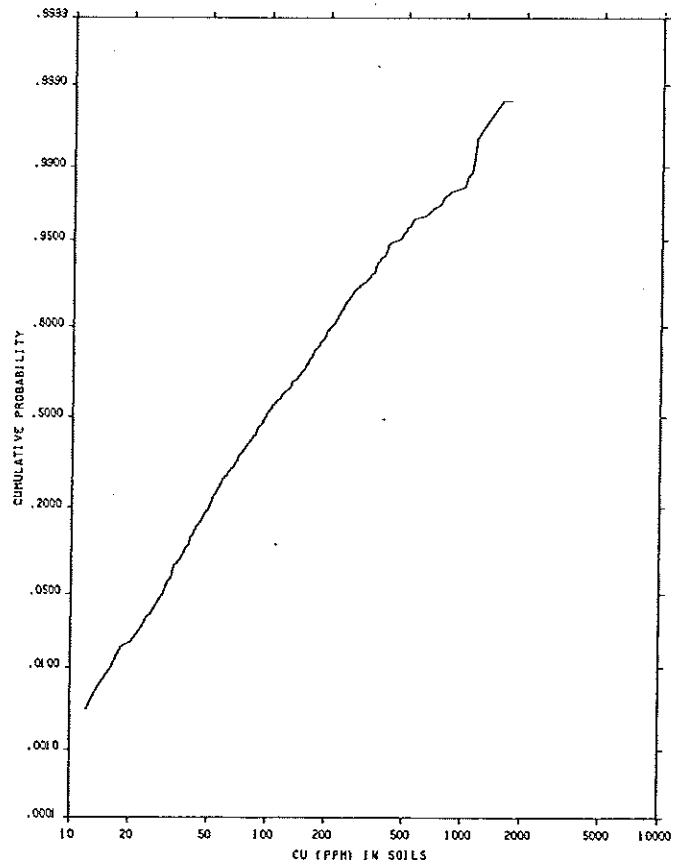
Figure 4. Frequency distribution of copper in soils, Agricola Lake massive sulphide prospect, N.W.T. (606 samples)
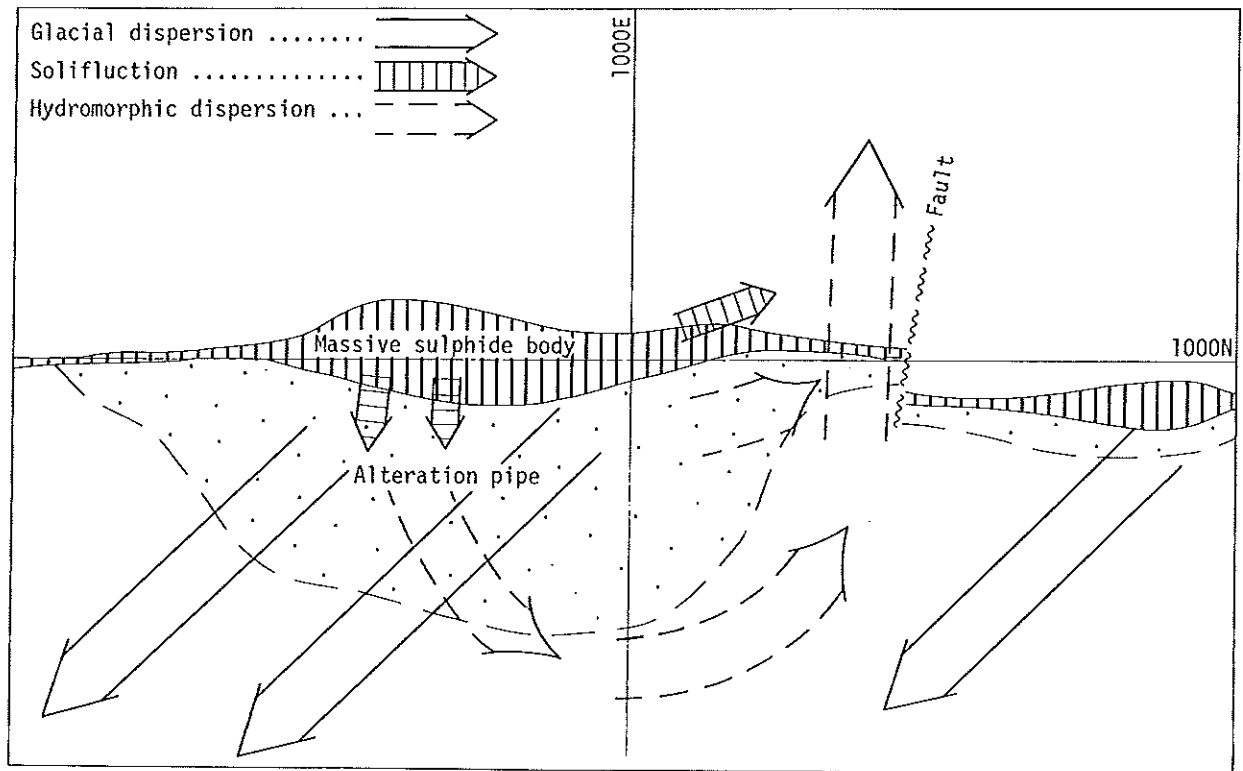

Figure 5. Patterns of secondary base metal dispersion, Agricola Lake massive sulphide prospect, N.W.T.

201

persion along a bearing of 290° true N from the body. Soils from the (grid) southeast corner of the area shown in Figure 1 contain fragments of shale and hydrothermally altered volcanics. Since no similar lithologies were detected in the bedrock in this area, it is believed that these fragments were transported from the central portion of the soil study area. The topographic gradient is upwards in this direction, so that glacial transport is the only feasible explanation. The indicated direction of transport is similar to the bearing of other glacial features in the region. An esker 5 miles to the west of the study area has a bearing of 320° true N. The third, important mechanism for transport of Pb is by solution. This is believed to have caused some movement of Pb across the central swampy portion of the site, and then out along the stream valley draining the area. The dispersion of Pb along the latter may be readily discerned in Figure 1. The concept of hydromorphic dispersion of Pb is substantiated by the data showing that this element is held in solution in the springs and streams around the prospect (see Cameron and Lynch, this section, following report). Lead is a relatively immobile element (Table 1) but it is dissolved in the highly acidic groundwaters in contact with the massive sulphide body. It is then precipitated in the upper reaches of the drainage system. Surface waters in the area are not conducive to the solution of Pb, as is evidenced by the high values for this element obtained by soil analysis. Many soil values close to 1% were obtained over the sulphide body. This is approximately the same abundance as was found in the drill core cutting the sulphide body (0.71% Pb for 134 feet, of which the upper 72 feet averaged 1.18% Pb; Northern Miner, August 15, 1974). Lead is present in the soils as the sulphates, anglesite and plumbojarosite (Cameron and Durham, 1974a).

In the case of Cu the same general pattern of dispersion resembles that for Pb (Fig. 2). There is, however, one striking difference from the Pb data. The soils from the central portion of the study area, above the sulphide body, are only weakly enhanced in Cu compared to background values (although the 134 feet of core noted above averages 1.09% Cu). The highest Cu values were obtained from the stream bed draining the area.

This distribution reflects the greater mobility of Cu. In the central, less well drained portion, underlain by sulphides and hydrothermally altered rock, soils and surface waters are rather acidic. Values for pH in the range 3 to 4 are most common. In the surrounding, better drained terrain the pH is greater, in the range 5 to 6. Cu has been largely removed from the central, more acidic, area to be dispersed in drainage waters. Outside this central area a greater proportion of the Cu derived from the rocks or transported overburden has been retained in the soils.

Table 1.

Solubilities of heavy metal sulphates

Sulphate	Solubility in g/100 ml		
$ZnSO_4$	86.5	at	80°C
$ZnSO_4 \cdot 7H_2O$	96.5	at	20°C
$ZnSO_4 \cdot 6H_2O$	117.5	at	40°C
$CuSO_4$	14.3	at	0°C
$CuSO_4$	75.4	at	100°C
$CuSO_4 \cdot 5H_2O$	31.6	at	0°C
Ag_2SO_4	0.57	at	0°C
$AgSO_4$	1.41	at	100°C
$PbSO_4$	0.004	at	25°C

Since all three processes of surficial transport for Cu and Pb tend to disperse these elements across the hydrothermally altered zone, it is difficult to tell whether this zone is also enriched in base metals. In the opposite direction Pb and Cu values in soils overlying the hanging-wall are quite low.

For the other two elements determined, Ag mimics the distribution of Pb. Both are relatively immobile. Zn, on the other hand, shows the same trends as Cu, but more pronounced. As the most mobile element of the four, Zn shows an even greater depletion over the central area.

The soil anomaly in the area of the prospect is very extensive, as a result of glacial transport and hydromorphic dispersion. In a similar environment soils collected at a wider interval would give almost as much information as was obtained from this 30 m x 15 m grid. The distribution of base metals in the soils is largely determined by the individual chemical properties of these elements.

References

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1974a: Follow-up investigations on the Bear-Slave Geochemical Operation; in Report of Activities, April to October 1973, Geol. Surv. Can., Paper 74-1, Pt. A, p. 53-60.

1974b: Geochemical studies on the eastern part of the Slave Province, 1973; Geol. Surv. Can., Paper 74-27, 20 p.