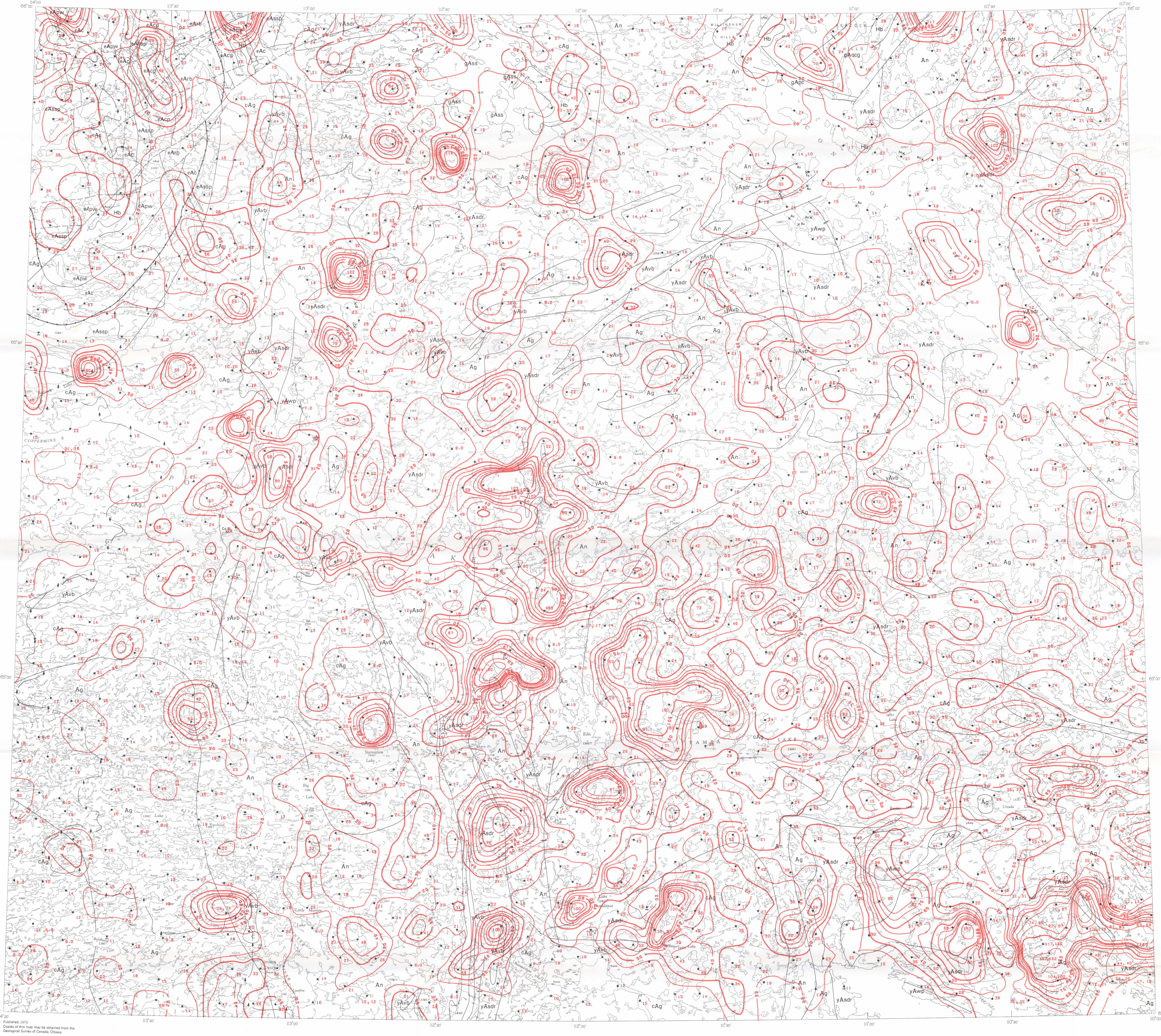
PRELIMINARY SERIES

GEOLOGICAL SURVEY OF CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES



LEGEND

PROTEROZOIC	
HADRYNIAN	
Hb	Gabbro sheets, sills
APHEBIAN	
	GOULBURN GROUP
gAss	BROWN SOUND FORMATION: red siltstone, shale, sandstone
gApc	PEACOCK HILLS FORMATION: shale, dolomite, sandstone
gAqcg	BURNSIDE RIVER FORMATION: quartzite, conglomerate
	EPWORTH GROUP
eArb	TAKIYUAK FORMATION: red sandstone, shale
eAcp	COWLES LAKE FORMATION: limestone, shale
eApw	RECLUSE FORMATION: argillite, shale, greywacke
eAc	ROCKNEST FORMATION: dolomite
eAssp	ODJICK FORMATION: sandstone, shale, argillite, andesite
ARCHEAN	
Ag	Quartz diorite, quartz monzonite, granodiorite, granite. In part porphyritic
An	Granitic gneiss, migmatite, mixed gneisses involving Yellowknife rocks
cAg	Complex of plutonic granitic rocks that may be, in part, older than Yellowknife Supergroup
	YELLOWKNIFE SUPERGROUP
yAwp	Greywacke, shale
yAsdr	Cordierite-andalusite bearing knotted schist and other metamorphic equivalents of yAwp
yAvb	Intermediate to basic lava, tuff, agglomerate, and undifferentiated acidic volcanic rocks

Boundary between Bear and Slave geological provinces ......
Fault, observed or assumed ....
Approximate position of treeline ....
Syncline ....
Mineral prospect showing principal element(s) .... Au ×
Lake sample site and metal concentration (sediment sieved to minus 250 mesh) .... • 15
Lake sample site and metal concentration (sediment sieved to minus 100 mesh) .... • 20
Geochemical concentration contours as ppm 10

MINERALS

Copper	Cu	Iron	Fe
Gold	Au	Nickel	Ni

Geology after unpublished map compiled by J. C. McGlynn, 1971

Field work by R. J. Allan, E. M. Cameron, C. C. Durham, R. Benson, R. Colley, B. Cumming, G. Lund, D. Mann, C. Pride, G. Thomas and B. Woronuk

Analyses by J. J. Lynch, Alice I. MacLaurin, A. P. Lemieux and R. T. Crook

Marginal notes by R. J. Allan and E. M. Cameron

Geochemical contours and metal concentration numbers drawn by computer drum plotter

Geological cartography by the Geological Survey of Canada

Any revisions or additional geological information known to the user would be welcomed by the Geological Survey of Canada

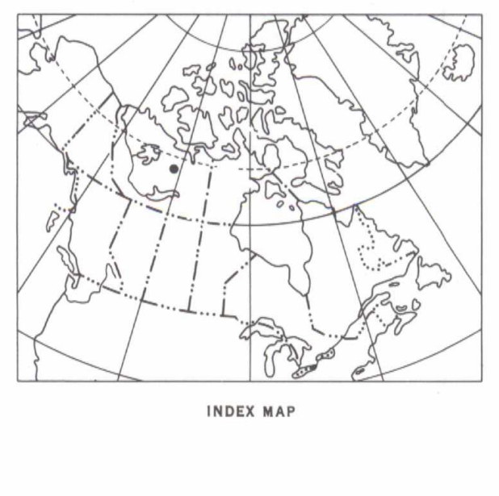
Base-map assembled by the Geological Survey of Canada from maps published at the same scale by the Army Survey Establishment R. C. E. in 1962, 1964

Copies of the topographical maps covering this map-area may be obtained from the Canada Map Office, 615 Booth Street, Ottawa, Ontario K1A 0E9

Mean magnetic declination 1972, 34°20' East, decreasing 8.2' annually. Readings vary from 31°54' in the SE corner to 37°11' in the NW corner of the map-area

Elevations in feet above mean sea-level

Published, 1973
Copies of this map may be obtained from the Geological Survey of Canada, Ottawa


INDEX MAP

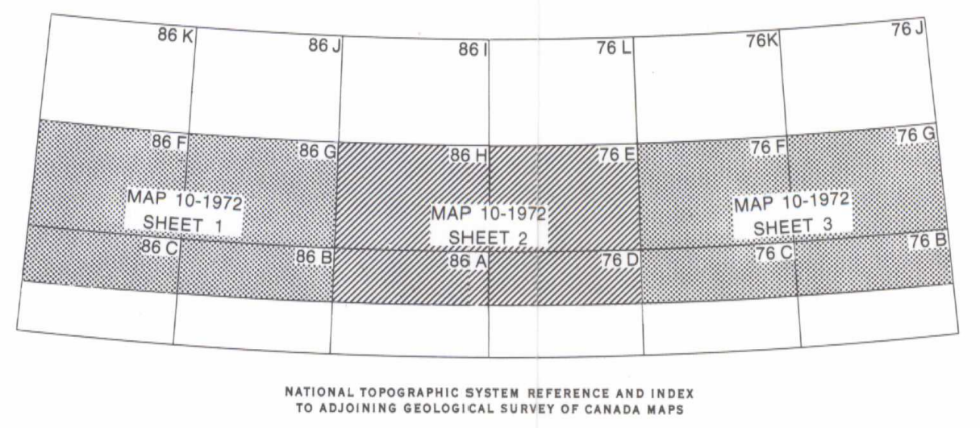
MAP 10-1972

SHEET 2

ZINC CONTENT OF LAKE SEDIMENTS
BEAR-SLAVE OPERATION
DISTRICT OF MACKENZIE

Scale 1:250,000

Miles 4 0 4 8 12 Miles
Kilometres 6 0 6 12 18 Kilometres



NATIONAL TOPOGRAPHIC SYSTEM REFERENCE AND INDEX TO ADJOINING GEOLOGICAL SURVEY OF CANADA MAPS

MARGINAL NOTES*

Lake Sediment Sampling The lake sediment samples were collected by post-hole auger from a helicopter. They were taken near the edge of the lake in water 3 to 8 feet deep. They comprise approximately the top 8 inches of sediment, less the surface layer. Of the variety of sediment types that may occur in lakes, the type of sample sought was of clay to silt grade and low in organic material.

Environmental Effects. Certain heavy metals, such as uranium, zinc, and copper, may be enriched in sediment samples containing organic matter or iron and manganese oxides. The content of Fe and Mn has been determined for all samples, together with an index of the organic content (optical density). These data will be released separately in the form of a composite map. These data may be examined when assessing anomalous areas on this map. It should be recognised, however, that metal enrichment on these materials is a highly variable phenomenon that depends on a variety of factors, principally the availability of metals in the environment. Also the Fe and Mn content of a sediment is not a direct measure of the amount of free oxides present. For these reasons the maps for the heavy metals are not presented on a statistically "corrected" basis. Further, since manganese and iron may be associated with these metals in the original rocks or primary mineralization, "correcting" the data may remove evidence of mineralization from the resulting map. If it is suspected that free oxides or organic material have created a false anomaly, then for those who do not have access to the original samples, the most satisfactory method of checking is to resample the area of the anomaly.

Sample Preparation and Analysis. Sediments were dried, then sieved to minus 250 mesh to give a powder suitable for analysis. A few coarse samples were sieved to minus 100 mesh, then ball-milled before analysis.

For the zinc determination, 400 mg of the sample was digested on a water bath at 90° C. for 1.5 hours with 6 ml of 4N HNO_3 plus two drops of concentrated HCl. The sample was diluted to 20 ml with metal-free water, well shaken, and allowed to settle. This sample solution was aspirated through a 5 cm. single slot burner of a Perkin-Elmer 303 atomic absorption spectrophotometer using an air-acetylene flame. Measurements were made at 2138Å with a slit width equivalent to 20Å. The detection limit of the method is 2 ppm Zn, but all samples analyzed contain greater than this amount.

Unlike uranium, which is analyzed using the same acid leaching procedure, all of the zinc is not extracted from the sample. The percentage that is dissolved depends on the mineralogical form of zinc in each sample; in general it may vary between 50%-95% of the total amount present. This method has the advantage that anomalies due to the dispersion of zinc from more easily leachable Zn minerals, perhaps zinc sulphide mineralization, are accentuated, relative to background.

Zinc in Rocks and Ores of the Survey Area. During the 1971 orientation survey (Allan, Cameron and Durham, 1972) rock samples were collected from a number of areas within the Bear and Slave Provinces. A selection of the data for these rocks and lake sediments from the same areas are given below as an aid to the interpretation of the lake sediment data. The analyses were made after an HNO_3-HCl attack The High Lake and Hackett River areas contain zinc-bearing massive sulphide deposits; the Indin Lake area is not known to contain such deposits. The Terra Mine area contains native silver associated with nickel-cobalt-iron arsenides and minor stratiform copper mineralization.

The analyses for Indin Lake show that intermediate and basic volcanic rocks contain more zinc than unmineralized acid volcanics. However, in this area, the sedimentary and granitic rocks contain more zinc than any of the volcanic rocks. The volcanic rocks associated with the deposit at High Lake have a higher level of zinc than the volcanic rocks of the Indin Lake area. The high 90 percentile values from this area and that at Hackett River, show that the rocks contain scattered mineralization, particularly the acidic varieties. The silicious volcanics and sediments at Hackett River have a higher background level of zinc than the Indin Lake acid volcanics. The zinc values for the Bode Lake porphyries may represent the general level of abundance for the intrusive rocks of the Great Bear Batholith. The Terra Mine data show evidence of slight zinc mineralization.

	Number of Samples	Arithmetic Mean	Geometric Mean	Median	90 Percentile
			ppm Zn		
SLAVE PROVINCE					
High Lake:					
basic volcanics	22	86	80	80	182
intermediate volcanics	54	71	66	68	100
acid volcanics	16	1037	81	52	307
lake sediments	31	139	120	124	-
Hackett River:					
volcanics and sedimentary	37	68	42	43	146
lake sediments	28	71	51	44	-
Indin Lake:					
basic volcanics	55	48	40	42	98
intermediate volcanics	21	50	38	50	96
acid volcanics	31	32	21	32	89
sedimentary rocks	81	78	76	81	96
granites	5	67	66	77	85
lake sediments	35	76	66	70	-
BEAR PROVINCE					
Bode Lake:					
porphyries	57	83	80	79	105
lake sediments	12	59	51	61	-
Terra Mine:					
volcanic, sedimentary and intrusive rocks	65	118	74	72	273
lake sediments	39	96	90	95	-

In the Bear Province, zinc is sometimes present as a minor constituent of the uranium and silver vein deposits. There are a number of other rock types present in the province that may be associated with zinc mineralization. Some possible associations are: skarn mineralization with the high level granitic rocks to the west of the Wopmay Fault; volcanic-exhalative zinc mineralization within the migmatized eugeosynclinal sequence to the east of this fault; and lead-zinc mineralization with the Aphebian carbonate sediments.

Zinc-bearing massive sulphides of probable volcanic-exhalative origin are the most economically attractive exploration targets within the Slave Province. This mineralization is generally associated with the more acid volcanic rocks. In this province the volcanic rocks generally occur near the base of the rock sequence within the sedimentary volcanic belts—that is along the margins of these belts. Since there may be unrecognised volcanic rocks within the sedimentary sequence, the margins of these belts are prospective, even in the absence of mapped volcanic rocks. On the basis of orientation surveys around the High Lake and Hackett River deposits it was argued (Allan, Cameron and Durham, 1972) that this type of deposit was best outlined by a hierarchy of geochemical indicators in lake sediments:

(1) By indicators that suggest that the area is underlain by acidic volcanic rocks (e.g. high Si or K, low Mg).
(2) Within (1) zones underlain by exhalative facies rocks such as carbonates and iron-rich sediments (e.g. high Mn and Fe) or zones of rock alteration associated with mineralization (e.g. high Mg, high Ni).
(3) Anomalies due to massive sulphide mineralization (e.g. high Zn, Cu, Pb or Ag).

In general, areas of ore potential may be revealed in lake sediments by broad areas of high zinc concentration or less extensive areas with sharp anomalies. In areas where deposits are found there is a tendency for the geometric mean zinc concentration of lake sediments to be higher than the corresponding means for volcanic rocks. This is because the zinc in the lake sediments has in part been derived by preferential leaching of sulphides.

Zinc in the Surficial Environment. Zinc sulphides are relatively easily oxidized to soluble zinc salts such as $ZnSO_4$ and $ZnCO_3$. The element is amphoteric and forms the zinc ion $(Zn(H_2O_4)^{2+}$ in acid solutions and the zincate ion $(Zn(OH)_4{}^{2-})$ in basic solutions. In most of the survey area soils are poorly drained because of permafrost conditions; the pH of the interstitial waters is thereby normally acid to neutral. In these conditions the zinc ion is highly mobile because it is the least readily sorbed of the metal ions. Since zinc may travel considerable distances from ore deposits it is an excellent element for low sample density reconnaissance surveys. Zinc may be sorbed onto the clays and the iron and manganese hydroxides of lake sediments. It has also a strong affinity for organic radicles and may thus be enriched in the organic fraction of lake sediments. When considering zinc levels in sediments, it should be related to the organic content. An estimate of the organic content of each sample is being made.

Zinc may also be transported in the surficial environment as very small water-borne particles of zinc minerals such as zincblende (ZnS), smithsonite ($ZnCO_3$), willemite ($ZnSiO_4$), zincite (ZnO) and others; or as substituted ions, for Mg or Fe, in lattices of other minerals. Near mineralization, large quantities of zinc may be found in particulate form in lake sediments (Allan and Crook, 1972).

Zinc in Lake Sediments, This Sheet. There is a general correlation between the contour patterns for zinc and the geology of this sheet. This correlation is not in terms of rock units for there appears to be as much variation within areas mapped as one rock unit as between areas underlain by different rock units. The data given above for variation between different rock types occurring around Indin Lake may, therefore, be valid only for the rocks of this particular area.

The background level of abundance for zinc across this sheet (arithmetic mean, 29.5 ppm Zn; geometric mean, 25 ppm Zn) is less than the levels obtained during the 1971 orientation survey, noted in the above table. The total area enclosed by the 150 ppm contour is relatively small. At High Lake 11 of 32 samples over 320 square miles exceeded this value and 4 of 29 samples over 290 square miles at Hackett River. There are, however, a number of areas small and large that are anomalous relative to background. Many of these are in geologically favourable areas, such as over volcanic rocks and along the margins of metasedimentary-volcanic belts. As was suggested in the section above, proper interpretation of the zinc anomalies can only be done after considering the distribution patterns of a number of other critical elements.

Some of the most prominent anomalies are related to the margins of large northsouth trending sedimentary belt that occupies the Itchen Lake-Point Lake-Beauparlant Lake sectors of the sheet. Bostock (1967) and Fraser (1958) who have mapped much of this belt observed a large number of gossans. The geochemical data may hope to focus attention on selected areas within the belt containing these gossans. The other main metasedimentary belt on this sheet occurs in the northeast quadrant around Contwoyto Lake. The axial portion of this belt contains some of the lowest zinc levels of any part of the sheet. The areas adjacent to the margin of this belt contain some, but relatively few, anomalies.

The southeasterly quadrant is relatively enriched in zinc compared to other parts of the sheet. Much of this area is underlain by granitic rocks of various types. The area should be contrasted with the relatively low zinc content of lake sediments overlying granites along the western margin of the sheet. In part, the areas of higher zinc content correlate with anomalous areas for uranium, such as near to Yamba Lake. Large, relatively consistent anomalies like that at Yamba Lake are as likely to be caused by bedrock that has a higher dispersed metal content as by discrete mineralization. In follow-up work this question may be readily resolved by analysis of representative rock samples from the anomalous area. Some of the sharpest and highest anomalies on the sheet are in the southeast corner, south of Paul Lake to Lac de Gras and Lac du Sauvage. Seven samples have greater than 100 ppm Zn and three have more than 150 ppm. These anomalies are associated with above average contents of a number of elements, including Li, U, Mo, Cu, Co and Ni.

---

* Geological Survey Paper 72-50, contains a detailed description of the experimental basis for lake sediment sampling in the Shield; the geology and metallogeny of the region; the organization, methods, and costs of the sampling operation; the methods of sample analysis. If references quoted above are not given here, they can be found in Paper 72-50.

MAP 10-1972
SHEET 2
ZINC
BEAR-SLAVE OPERATION
DISTRICT OF MACKENZIE