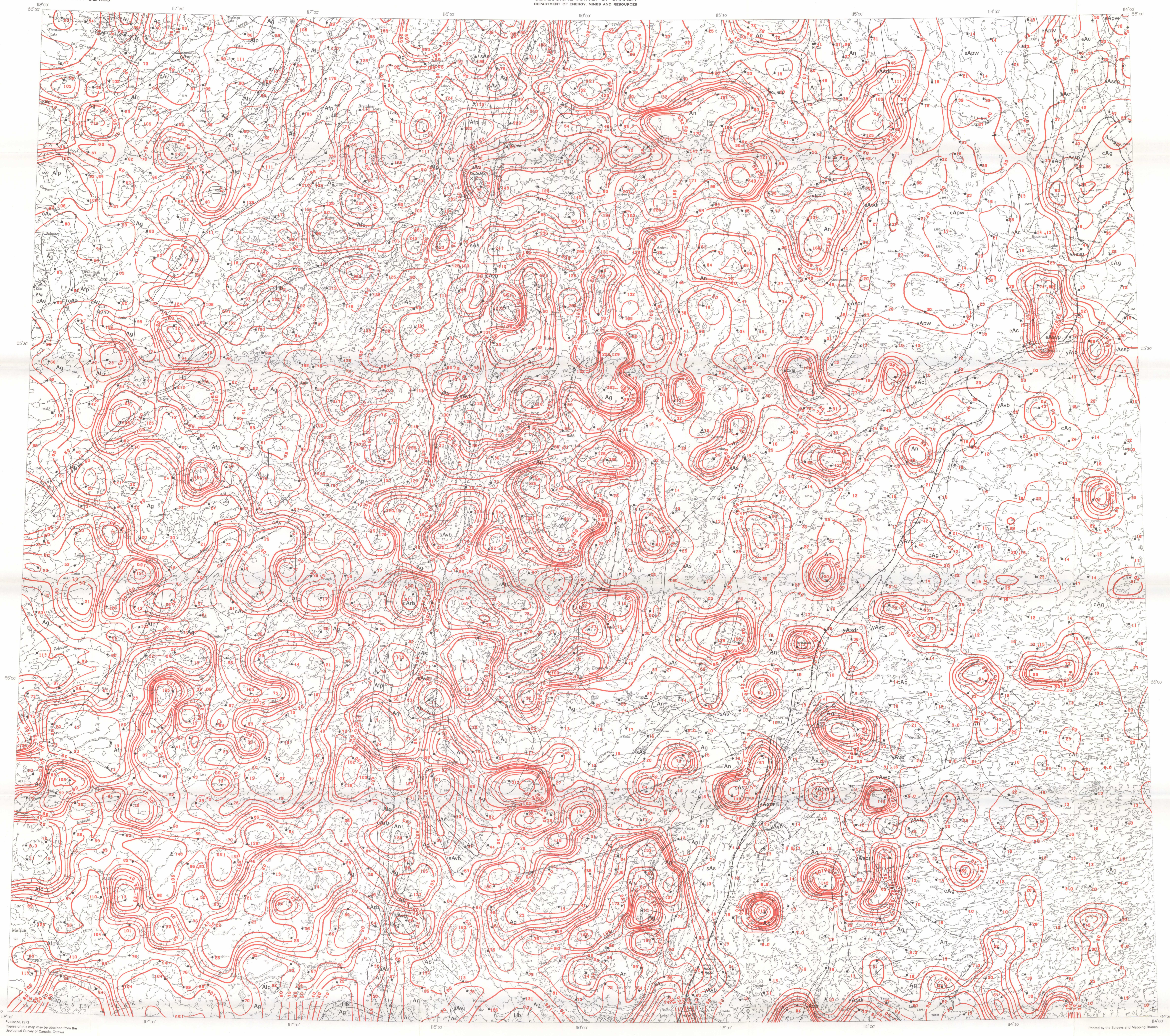
PRELIMINARY SERIES

GEOLOGICAL SURVEY OF CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES



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

Printed by the Surveys and Mapping Branch

LEGEND

PROTEROZOIC

HADRYNIAN

Hb	Gabbro sheets, sills

APHEBIAN

Afp	Felsite porphyry
Ag	Granodiorite, diorite, quartz diorite
An	Migmatite, granitic gneiss

CAMERON BAY GROUP

cAv	Intermediate porphyritic flow, tuff, agglomerate
cArb	Red arkose, conglomerate, shale
Ab	Gabbro, diorite

SNARE GROUP

sAvb	Basalt, tuff, minor chert
sAs	Quartzite, dolomite, siltstone, shale

EPWORTH GROUP

eApw	RECLUSE FORMATION: argillite, shale, greywacke
eAc	ROCKNEST FORMATION: dolomite
eAssp	ODJICK FORMATION: sandstone, shale, argillite, andesite
eAsdr	Metamorphosed Epworth Group

ARCHEAN

Ag	Quartz diorite, quartz monzonite, granodiorite, granite. In part porphyritic
An	Granite 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 ....

Mineral prospect showing principal element(s) .... Cu ×

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

Asbestos	asb	Molybdenum	Mo
Bismuth	Bi	Nickel	Ni
Cobalt	Co	Silver	Ag
Copper	Cu	Thorium	Th
Gold	Au	Uranium	U
Lead	Pb	Zinc	Zn

Geology after unpublished map compiled by J. C. McGlynn, 1971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

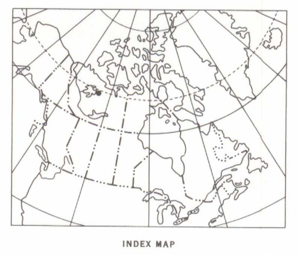
Any revisions or additional geological information known to the user would be welcomed by the Geological Survey of Canada

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 1961, 1962

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, 36°31' East, decreasing 8.7' annually. Readings vary from 34°52' in the SE corner to 38°42' in the NW corner of the map area

Elevations in feet above mean sea-level



INDEX MAP

MAP 10-1972
SHEET 1

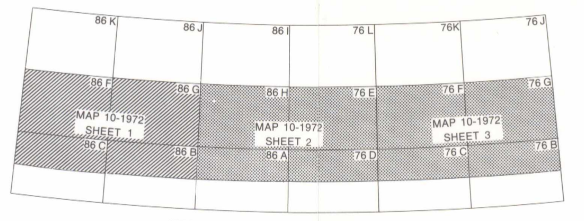
ZINC CONTENT OF LAKE SEDIMENTS
BEAR - SLAVE OPERATION
DISTRICT OF MACKENZIE

Scale 1:250,000

Miles 4 0 4 8 12 Miles

Kilometres 6 0 6 12 18 Kilometres

* 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.



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. Lake sediments from Sheet 1 have the highest concentration of zinc:

	Sheet 1	Sheet 2	Sheet 3
Number of Samples	1241	1293	1349
Arithmetic Mean	67	29.5	39
Geometric Mean	46	25	32
Standard Deviation	70	21	35

Also, by comparison with the data from the orientation survey that are summarized above, many of the lake sediment samples taken from the Bear Province are unexpectedly rich in zinc. The most distinctive feature in Sheet 1 is a regional anomaly of some 3000 square miles in the north-central part of the sheet with concentrations of 90 ppm Zn or greater. Other than for this large anomalous area, zinc is generally higher in the Bear Province than in the dominantly granitic part of the Slave Province sampled on this sheet. Farther east from Wopmay Fault, but still in the Bear Province, zinc concentrations decrease.

A crude comparison of levels of zinc in the lakes of the Bear Province, can be made with stream sediments from younger fold belts. At Keno Hill, in the Yukon Territory, an area of perhaps 800 square miles within this proven zinc province contains zinc values in stream sediments of similar magnitude to the 3,000-square-mile area discussed below (Gleeson, 1966). Many of the concentrations in stream sediments even within a twenty-square-mile area around Keno Hill itself are only 200 to 300 ppm Zn. It should also be noted that one would expect lake sediment values to be less than stream sediment values because of dilution effects. At Bathurst, a proven zinc province in the Appalachian belt, the geometric mean for stream sediments is 133 ppm Zn (Boyle et al, 1966).

Geochemical relief is high within the regional anomaly with close to one hundred samples (1,000 square miles) containing 150 ppm Zn or more. A surprising feature of this major zinc anomaly is that it straddles the quite dissimilar geological terranes on either side of the Wopmay Fault. To the west are high level granitic plutons and minor volcanic rocks; to the east, migmatites, gneisses and low level granitic rocks. In the north half of the map sheet, to the west of the Wopmay Fault there is an excellent spatial correlation between the anomalous contour patterns for uranium and zinc. To the east of the fault the uranium level drops off sharply. However, one can still discern a correlation between the anomalous contour patterns for zinc and the low level contours for uranium. In the southern half of the map sheet there is a spatial correlation between many of the zinc and the uranium anomalies on both sides of the Wopmay Fault, and even into the Slave Province. On this evidence it appears that many of the uranium and zinc anomalies could be genetically related. The orientation of most of the uranium anomalies is such that they appear to lie along either a set of northeast linaments or a set of northwest linaments. Most of the highest uranium concentrations may occur at the intersection of these suspected linaments. It is possible that at least some of the uranium and zinc anomalies are related to polymetallic epigenic veins that may lie along major fracture systems. The writers are not aware of any reported epigenic veins that might be zinc-bearing near to the major zinc anomalies. The uranium concentrations east of the Wopmay Fault are very low and this may imply that the zinc mineralization was not synchronous with the uranium mineralization.

In any of the anomalous areas there is the possibility that high zinc concentrations may be due to disseminated sulphides in the country rock or zinc contained in silicate minerals. In an area immediately to the north, Hoffman (1971) has reported disseminated chalcopyrite mineralization in granites. During follow-up work on anomalous areas the distribution of zinc in granites and other country rock should be examined.

MAP 10-1972
SHEET 1
ZINC
BEAR-SLAVE OPERATION
DISTRICT OF MACKENZIE