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PROJECT 720063 BEAR-SLAVE OPERATION ALLAN, CAMERON AND DURHAM 1972.

PROJECT TITLE: RECONNAISSANCE GEOCHEMISTRY USING
LAKE SEDIMENTS AND WATERS OF A 36,000-SQUARE MILE
AREA OF THE CANADIAN SHIELD.

The principal investigators were R.J.Allan, E.M. Cameron, and C.C. Durham.

Pilot study field work was done in 1971. The main field operation was done in 1972. Twenty-four raw data maps and a summary report were published (Allan et al. 1973).

The objectives were to test the feasibility of low sample density lake sediments-lake waters surveys as a method for systematic evaluation of the mineral potential of the northern Canadian Shield and to provide reference geochemical data on the various geologic and tectonic domains of the shield. Parts of Bear-Slave Structural Provinces were chosen because of varied geologic and tectonic terrains, undeveloped mineral potential, relative accessibility for mineral development, and the availibility of background element concentration data in an uncontaminated environment.

The project area covers about 36,000 sq. mi. (93,000km2) bounded by N 64-30 to N 66 degrees and W 106 to W 118 degrees. The area is divided into three sectors, as follows

SHEET NO.	NTS SHEETS	N. LAT.	W. LONG.
1	86F, 86G, 86B(N1/2), 86C(N1/2)	64-30 TO 66-00	118-00 TO 114-00
2	76E, 86H, 76D(N1/2), 86A(N1/2)	64-30 TO 66-00	114-00 TO 110-00
3	76G, 76F, 76B(N1/2), 76C(N1/2)	64-30 TO 66-00	110-00 TO 106-00

Note that in addition to the regional sampling a small area (750 sq.mi.-2000 km2) between Regan and Muskox Lakes (N 65-00, W 108-00) was sampled in more detail (one sample site per 2.5 sq.mi.).

Descriptions of the map sheets follow:

Sheet 1 This lies within Wopmay subprovince of Bear Structural Province. Aphebian miogeosynclinal sediments (quartzite, shale, conglomerate, siltstone,dolomite, minor andesitic flows) of the Snare and Epworth Groups underlie the eastern part and also form a north-south belt along Wopmay River. The central and western parts contain granitized Snare-Epworth eugeosynclinal rocks (1700-1900 m.y.), granodiorite, migmatite and gneiss. West of Wopmay fault (river) high-level granites and volcanic rocks, arkose, shale and conglomerate of the Cameron Bay and Echo Bay Groups are present.

Most known mineralization is west of Wopmay fault. Included are U deposits at Port Radium, some quartz stockworks containing U, Ag at Port Radium (Eldorado) and similar Ag occurrences at Echo Bay, Camsell River (Terra mine), and Contact Lake (El Bonanza, Norex and Silver Bay). Cu is mined with Ag at Echo Bay. Chalcopyrite float has been found east of the Wopmay fault.

Sheet 1 is 90 per cent underlain by discontinuous permafrost and 10 per cent by continuous permafrost. Drainage in the west and northwest is mainly into Great Bear Lake. In the south drainage is into Great Slave Lake.

Direction of glacial advance (Wisconsin-Laurentide sheet) was mainly east to west.

Rocks of the Wopmay Subprovince are relatively enriched in U. In Hardisty Lake map sheet in the S.W. part of the project area U averages 8.1 ppm in rocks (Eade and Fahrig, 1971) whereas in the Fort Enterprise sheet in Slave Province to the east the average is 1.7 ppm .

Sheets 2 and 3. These are within Slave Structural Province. They are underlain by Archean granitic and gneissic rocks containing belts of metamorphosed (greenschist and amphibolite facies) volcanics and sediments of the Yellowknife Supergroup. The latter includes basal mafic lavas, acidic to intermediate flows and pyroclastics, and conformably-overlying flysch sediments (greywacke, shale) with subordinate quartzite, limestone and iron formation. In N.E. sheet 3 Archean rocks are unconformably overlain by little-deformed Aphebian argillite, quartzite, siltstone and conglomerate of Goulburn Gp.

Granitic rocks of Slave Province mainly postdate Yellowknife Group but some bodies may be older.

Few economic deposits are known in the Slave part of the project area but a potential may exist for quartz-gold deposits of the Yellowknife type and for massive sulphide (Zn, Pb, Cu, Ag) deposits in Yellowknife Supergroup acidic volcanics. Near-economic examples of the latter occur at Hackett River within the project area, at High Lake north of the area, and at Clinton-Colden Lake, a prospect south of the area.

Sheet 2 is underlain 90 per cent by continuous permafrost and 10 per cent by discontinuous permafrost. Sheet 3 is underlain entirely by continuous permafrost.

In southern sheet 2 drainage is into Great Slave Lake, whereas the northern part drains predominantly into the Arctic Ocean. In sheet 3 drainage is west and north into the Arctic Ocean. Ice direction movement was as sheet 1.

In 1971 eight pilot areas averaging 200 sq. mi. (520 km2) each were sampled. These were McGregor Lake, High Lake, Terra Mine, Hackett River, Muskox Lake, Bode Lake, Indin Lake and Harding Lake. Seven of the areas contain mineralization. Analysis of lake sediments, waters, and rock samples showed that....(1) Lake sediment geochemistry correlates with bedrock geochemistry.... (2) Areas containing significant mineralization are detectable by lake sediment geochemistry (Allan et al, 1972).

The main Bear-Slave sampling program was carried out June 25 to August 2, 1972 using 3 helicopters and an Otter f/w support a/c. A total of 4,102 sites was sampled, giving an average density of about 1 site per 10 sq. mi. (26 km2). A lake sediment sample and a water sample were taken at each site. average time per sample site was 9.9 mins. All-inclusive costs (incl. analytical work) were about $7.50 per square mile.

Inorganic lake sediment samples were collected from nearshore shallow-water sites using a six-foot extension soil auger. Water depths at sample sites were restricted to the range 3-8 feet.

Details of samples follow:

Sample site number sequences were 1-1393, 2001-3375, 4001-5335 and 6000-6013. This gives a total of 4117. However, within these sequences two numbers were not used, for unknown reasons, leaving 4115 sample sites.

Thirteen sites were not sampled. These were 261, 2078, 4053, 4336, 4388, 4389, 4448, 4561, 4562, 4563, 4564, 4914 and 5235. This gives a total of 4102 sites. Sample locations are listed on Geol. Surv. Can. Map 16-1972 (sheets 1, 2, 3).

Three sediment samples were lost in transit (5046, 5047, 5049) leaving 4099 for analysis. The samples were dried and halved. One-half the sample was sieved to minus 250 mesh and the minus 250 fraction used for analysis. Twenty-seven samples did not yield enough minus 250 material for analysis. These were 227, 253, 268, 314, 465, 2039, 2404, 2410, 2508, 2614, 4152, 4223, 4291, 4347, 4363, 4377, 4432, 4447, 4497, 4548, 4623, 4626, 4753, 4799, 5071, 5080, and 5081. These samples were sieved to minus 100 mesh and the minus 100 fraction was ball-milled before analysis. Note that of the 27 samples above, two samples (253 and 2410) have duplicate -250 mesh samples from the same sites (252, 2409).

Analytical methods follow:

All analytical work was done in the geochemical laboratories of the Geological Survey of Canada.

SEDIMENTS	
Atomic absorption spectrophotometry	ZN, AG, MN, LI, HG
Fluorimentry	U
Colorimetry	AS
Emission Spectrophotometry	PB, SN, V, MO, CR, CU, CO, NI, BE, LA, Y, ZR, SR, BA, TI, CA, MG, FE, K (See Timperley et al. 1973).

The optical density (OD) has been measured as an estimate of the organic matter content of sediment samples (Geol. Surv. Can. Map 12-1972) using a colorimetric method developed by J.J. Lynch, I.R. Jonasson and R.G. Garrett at the Geological Survey. To interpret the data, the paper Lynch et al. (1973) in the reference list should first be consulted.

Detection limits follow:

SEDIMENTS

ELEMENT	METHOD	DETECTION LIMIT PPM
ZN	ATOMIC ABSORPTION	2
AG		0.5
MN		10
LI		1
U	FLUORIMETRY	0.2
HG	FLAMELESS A.A.	5(PPB)
AS	COLOURIMETRY	0.5 TO 1.0
PB	DIRECT READING EMISSION SPEC.	2
SN		2
V		3
MO		2
CR		1
CU		1
CO		2
NI		2
BE		1
LA		12
Y		5
ZR		25
SR		2
BA		3

TI	7
CA	N/A
MG	N/A
FE	N/A
K	N/A

Precision information follows:

SEDIMENTS

ELEMENT	METHOD	MEAN(PPM)	STD.DEV.	COEF. VAR.
ZN	ATOMIC ABSORPTION	116	7.9	6.8
AG		.59	.08	13.6
MN		249	12	4.8
LI		26	1.4	5.4
U	FLUORIMETRY	1.5	.13	8.7
AS	COLORIMETRY			
PB	DIRECT READING EMISSION	37.6	4.7	13
SN		1.96	1.4	71
V		63.9	8.5	13
MO		1.48	.4	27
CR		52.9	7.5	14
CU		53.5	7.4	14
CO		14.8	3.3	22
NI		36.8	4.4	12
BE		1.88	0.8	43
LA		50.2	10.5	21
Y2		3.0	5.3	23
ZR		281	62	22
SR		261	29	11
BA		540	55	10
TI		3271	356	11
		MEAN %		
CA		1.1	0.1	9
MG		1.2	0.2	17
FE		3.1	0.2	6
K		1.9	0.2	11

Note that precision data above were obtained from a composite lake sediment sample from the 1971 Bear-Slave pilot study. The figures apply to 254 analyses of the same composite run over a period of one month.

Laboratory personnel follow:

Overall supervisor	J.J. Lynch
Emission Specrometry	R. Horton, W. Nelson, W. Alexander
Atomic Absorption- Waters	G. Gauthier
Sediments	A. McLaurin, A. Lemieux, R. Crook
Mercury	L. Tripp
Fluorimetry Uranium	J. Pelchat
Sample Preparation	P. Lavergne, A. Martineau

Results follow:

Three maps showing sample locations have been published - Geol. Surv. Can. Map 16-1972, Sheets 1,2 and 3.
Twenty-one maps showing the element content of lake sediments have been published. These are:

ELEMENT

URANIUM	MAP 9-1972 SHEETS 1, 2, 3
ZINC	MAP 10-1972 SHEETS 1, 2, 3
LEAD	MAP 11-1972 SHEETS 1, 2, 3
MANGANESE, IRON AND ORGANIC CONTENT	MAP 12-1972 SHEETS 1, 2, 3
COPPER	MAP 13-1972 SHEETS 1, 2, 3
NICKEL	MAP 14-1972 SHEETS 1, 2, 3
POTASSIUM	MAP 15-1972 SHEETS 1, 2, 3

The maps are computer contoured using the general purpose contouring program (GPCP) of California Products Inc.

There are two data files, FIELD.TXT (field observations) and CHEM.TXT (chemical data).

Description of field text by columns from the left:

SAMPLE NUMBER
NTS MAP SHEET NUMBER
PROVINCE ID. 1 = Bear; 2 = Slave.
UTM ZONE
EASTING
NORTHING
ROCK TYPE. CODES ARE AS FOLLOWS:

AVCC	ACIDIC VOLCANIC
ACSC	ANDALUSITE, CORDIERITE SCHIST
ARGL	ARGILLITE
BSLT	BASALT
CDSC	CORDIERITE SCHIST
CGLM	CONGLOMERATE
DLMT	DOLOMITE
FPPP	FELDSPAR PORPHYRY
GBBR	GABBRO
GRCK	GREYWACKE
GRDR	GRANODIORITE
GRGS	GRANITE GNEISS
GRNT	GRANITE
LMSN	LIMESTONE
MGMT	MIGMATITE
MSDM	METASEDIMENT
PLLT	PHYLLITE
QRTZ	QUARTZITE
SHLE	SHALE
SNDS	SANDSTONE
TUFF	TUFF

WEATHER DURING COLLECTION. 1 = clear; 2 = rain

LAKE SURFACE CONDITIONS. 1 = glassy; 2 = ripply; 3 = choppy

RELIEF OF AREA AROUND LAKE. 1 = high; 2 = medium; 3 = low

VEGETATION AROUND LAKE. 1 = coniferous; 2 = deciduous; 3 = grassy; 4 = moss; combinations of numbers are used to denote mixtures of vegetation types, e.g., 13 = coniferous + grass.

LAKE BOTTOM. 1 = rocky; 2 = sandy; 3 = clayey; 4 = organic; combinations of numbers are used to denote mixed bottoms, e.g., 34 = clay + organics.

WATER COLOUR. 1 = clear; 2 = yellow; 3 = brown.

SUSPENDED MATERIAL. 1 = light amount; 2 = large amount.

SEDIMENT COLOUR (wet sample). 1 = yellow; 2 = grey; 3 = brown; 4 = black; 5 = white; combinations of numbers are used to denote mixed colours, e.g., 23 = grey-brown.

SEDIMENT COMPOSITION. This is shown as four columns for sand, silt, clay, and organics. The proportions are shown, adding up to 10 for all four columns.

WATER DEPTH. Water depth at sample site in feet.

LAKE AREA. Area of lake or estimated sample domain, such as a bay, in square kilometers.

SOURCE OF CONTAMINATION IN IMMEDIATE SAMPLE AREA. 1 = mine workings or trenches; 2 = camp; 3 = fuel cache; 4 = gossan; combinations of numbers are used to denote multiple causes for contamination, e.g., 23 = camp + fuel.

DUPLICATE. This means that this sample is a duplicate taken close to the previous sample.

DESCRIPTION OF CHEMICAL DATA BY COLUMN
SAMPLE NUMBER
FE %
MG %
CA %
K %
SR PPM
BA PPM
TI PPM
MN PPM
OD (OPTICAL DENSITY)
ZN PPM
CU PPM
PB PPM
AG PPM
HG PPB
AS PPM
CO PPM
NI PPM
CR PPM
V PPM
U PPM
LI PPM
MO PPM
BE PPM
LA PPM
Y PPM
ZR PPM

Since this was one of the first major lake sediment surveys carried out by the Geological Survey of Canada, a program of follow-up investigations was carried out from 1973 on. The following reference list contains the reports of these surveys, together with the paper describing the BEAR-SLAVE SURVEY (GSC Paper 72-50) and papers describing the orientation surveys

preliminary to the BEAR-SLAVE SURVEY.

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1971: Lake sediment: a medium for regional geochemical exploration of the Canadian Shield; Can. Min. Metall. Bull., v. 64, p. 45-99.

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Allan, R.J. and Cameron, E.M.
1972: Bear-Slave Operation proves worthy prototype for geochemical reconnaissance of the Shield; Northern Miner, November 30, 1972, p. 54.

1973: U, Zn, Pb, Mn, Fe, Cu, Ni and K content in sediments: Bear-Slave Operation; Geological Survey of Canada, Maps 9-1972 to 15-1972.

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1973: Bear-Slave Operation; Geological Survey of Canada, Paper 73-1, Part A, p. 50-52.

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1972: Geochemical methods of exploration in permafrost areas; Geological Survey of Canada, Paper 72-1, Part A, p. 61-68.

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Cameron, E.M.

1974: Geochemical methods of exploration for massive sulphide mineralization in the Canadian Shield; in Proceeding of the Fifth International Geochemical Exploration Symposium, Vancouver, 1974, Elsevier.

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Cameron, E.M. and Allan, R.J.
1973: Distribution of uranium in the crust of the northwestern Canadian Shield as shown by lake sediment analysis; Journal of Geochemical Exploration, v. 2, p. 237-250.

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1974: Follow-up investigations on the Bear-Slave geochemical operation; Geological Survey of Canada, Paper 74-1, Part A, p. 53-60.

1974: Geochemical studies in the eastern part of the Slave Structural Province, 1973. With a contribution on the petrology of the volcanic rocks by Mariette Turay; Geological Survey of Canada, Paper 74-27, 22 p.

1975: Soil geochemistry of the Agricola Lake massive sulphide prospect; Geological Survey of Canada, Paper 75-1, Part A, p. 199-202.

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1975: Colour photography in the Beechey Lake belt, District of Mackenzie; Geological Survey of Canada, Paper 75-1, Part A, p. 226.

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