



GEOLOGICAL SURVEY OF CANADA

OPEN FILE 3345

Geochemistry of humus from the southern La Ronge Domain, Saskatchewan (NTS 73P/7)

C.E. Dunn

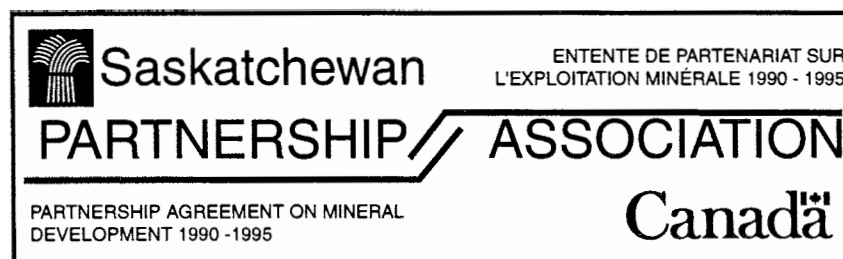
1998



Natural Resources
Canada

Ressources naturelles
Canada

Canada



GEOLOGICAL SURVEY OF CANADA

OPEN FILE 3345

Geochemistry of humus from the southern La Ronge Domain, Saskatchewan (NTS 73P/7)

C.E. Dunn
Geological Survey of Canada
601 Booth Street,
Ottawa, Ontario
K1A 0E8

1998



Emergency Preparedness Protection civile
Canada Canada

CONTENTS

ABSTRACT	1
INTRODUCTION	1
SURVEY DESCRIPTION AND METHODOLOGY	2
<i>Scope of Survey</i>	<i>2</i>
<i>Vegetation Cover and Sampling Considerations</i>	<i>8</i>
<i>Sample Collection, Preparation, and Analysis</i>	<i>9</i>
<i>Analytical Quality Control</i>	<i>10</i>
GEOLOGICAL SUMMARY	15
MAP PRODUCTION AND HANDLING	16
ELEMENT DISTRIBUTION MAPS	16
SURFACE CONTAMINATION	25
NOTES ON DATA LISTINGS AND ELEMENT DISTRIBUTION MAPS ..	26
ACKNOWLEDGEMENTS	26
REFERENCES	27
APPENDICES	
<i>A. Data Listings</i>	
<i>B. Element Distribution Maps and Statistical Summaries</i>	

LIST OF FIGURES

Fig. 1	Survey area with respect to National Topographic System (NTS) map sheets	Facing p. 1
Fig. 2	Locations of samples selected for analysis (with sample numbers)	3
Fig. 3	Mineral deposits, showings and occurrences	4
Fig. 4	Geological synopsis	14
Fig. 5	Gold in humus samples: a) entire data set (n=316); b) data set with top 5% of values removed (n=301).	18

LIST OF TABLES

Table 1	Mineral deposits, showings and occurrences, and mines in and adjacent to the survey area (cross referenced to Figure 2)	5
Table 2	Instrumental neutron activation analysis (INAA) of 19 standard vegetation samples (V6)	11
Table 3	Analysis of duplicate field samples (19 pairs)	12
Table 4	Samples with gold enrichment greater than 5 ppb Au (i.e. 95 th percentile)	20

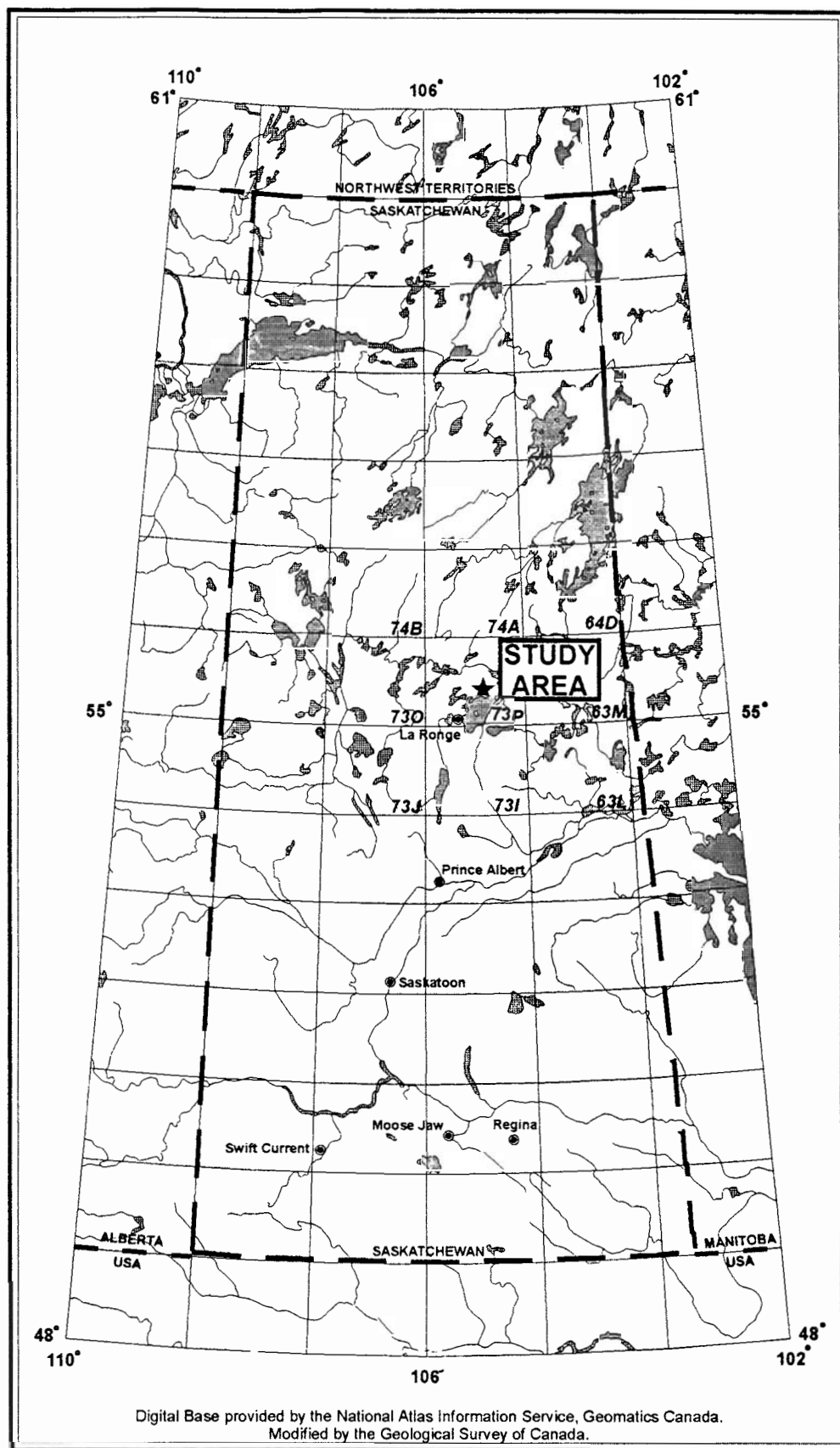


Fig. 1: Survey area with respect to National Topographic System (NTS) map sheets

GEOCHEMISTRY OF HUMUS FROM THE SOUTHERN LA RONGE DOMAIN, SASKATCHEWAN

Colin E. Dunn

ABSTRACT

Humus samples from 316 locations within a 300 km² area north of Lac la Ronge were analysed for 35 elements by instrumental neutron activation (INAA). Plots of element distribution patterns show sites and zones of relative enrichment. Anomalous concentrations of gold (up to 174 ppb Au) occur near several zones of known mineralization, commonly in association with several 'pathfinder' elements (e.g. As, Sb, Co, Ba), notably near Sulphide, Preview, PAP, Ramsland, Hebden, MacKay and Teneycke lakes. In addition, similar element associations occur in areas with no known mineralization, providing encouragement that other Au-rich zones may subcrop beneath the cover of forest, soil and glacial sediment. Of note are gold enrichments in humus that are coincident with previously reported anomalous concentrations of gold in common trees and shrubs of the northern forests. Sites that fall into this category occur between Lynx Lake and Wadin Bay, and south of Aikenhead Lakes.

Linear trends of several elements related to iron occur along highway 102 suggesting that there may be some contamination from road dust. Although samples were collected from a minimum of 50 m from the road, it appears that 200 m would be a more suitable distance in order to minimize the effects of dust contamination.

INTRODUCTION

In 1984 a reconnaissance geochemical sampling programme involving the collection of organic samples was undertaken in the southern part of the La Ronge Domain (Dunn, 1984, 1985, 1986a). Whereas the primary focus was vegetation, the opportunity was taken to collect humus samples in the event that at some later date funding may become available for their analysis. In 1995 sufficient funds were identified from the Canada-Saskatchewan Partnership Agreement on Mineral Development (1990-1995) to cover the cost of their multi-element analysis by instrumental neutron activation (INAA). Samples were recovered from archival storage at the Subsurface Geological Laboratory of Saskatchewan Energy and Mines in Regina, and prepared for analysis at GSC laboratories in Ottawa.

The data listed in Appendix A are available in digital form on a 3.5" 1.44 Mb diskette, which can be read by any D-Base-compatible software, and as a comma delimited ASCII file. It can be obtained from:

GSC Bookstore
Geological Survey of Canada
601 Booth St.
Ottawa
ON K1A 0E8
Tel: (613) 995-4342; Fax: (613)943-0646

SURVEY DESCRIPTION AND METHODOLOGY

SCOPE OF SURVEY

More than 800 humus samples were collected during traverses throughout an area of approximately 300 km² northward from Lac la Ronge (NTS 73P/7 [1:50,000], Fig. 1). Sufficient funding was available for analysis of less than half of these, and so a subset of 316 samples was selected for chemical analysis (Fig. 2). There are few roads and trails to facilitate sample collection in the survey area, and the abundance of lakes, bogs and streams further dictates the choice of practical traverses. Where possible, traverses were run normal to the north-easterly regional bedrock strike and samples were collected at 200 m intervals. At the time of the sample collection there had been no mining activity in the survey area, and the only nearby mining operation was the abandoned Anglo-Rouyn open pit copper mine, a few kilometres south of the survey area on the north shore of Lac la Ronge. Gold mineralization near Sulphide Lake was under investigation, but there was little disruption of the environment other than cut survey lines and minor trenching. Elsewhere there had been earlier exploration activity involving some cut lines and minor trenching, mostly in the search for gold (e.g. PAP Lake, Preview Lake, Teneycke Lake, MacKay Lake, Ramsland Lake, and west of Hebden Lake) and copper. Figure 3 (cross referenced with Table 1) shows the known mineral occurrences within and adjacent to the survey area, as reported in the Saskatchewan Mineral Deposits Index of Saskatchewan Energy and Mines. At the time of sample collection the Contact Lake Gold Mine (Fig. 3, #37) had not been discovered.

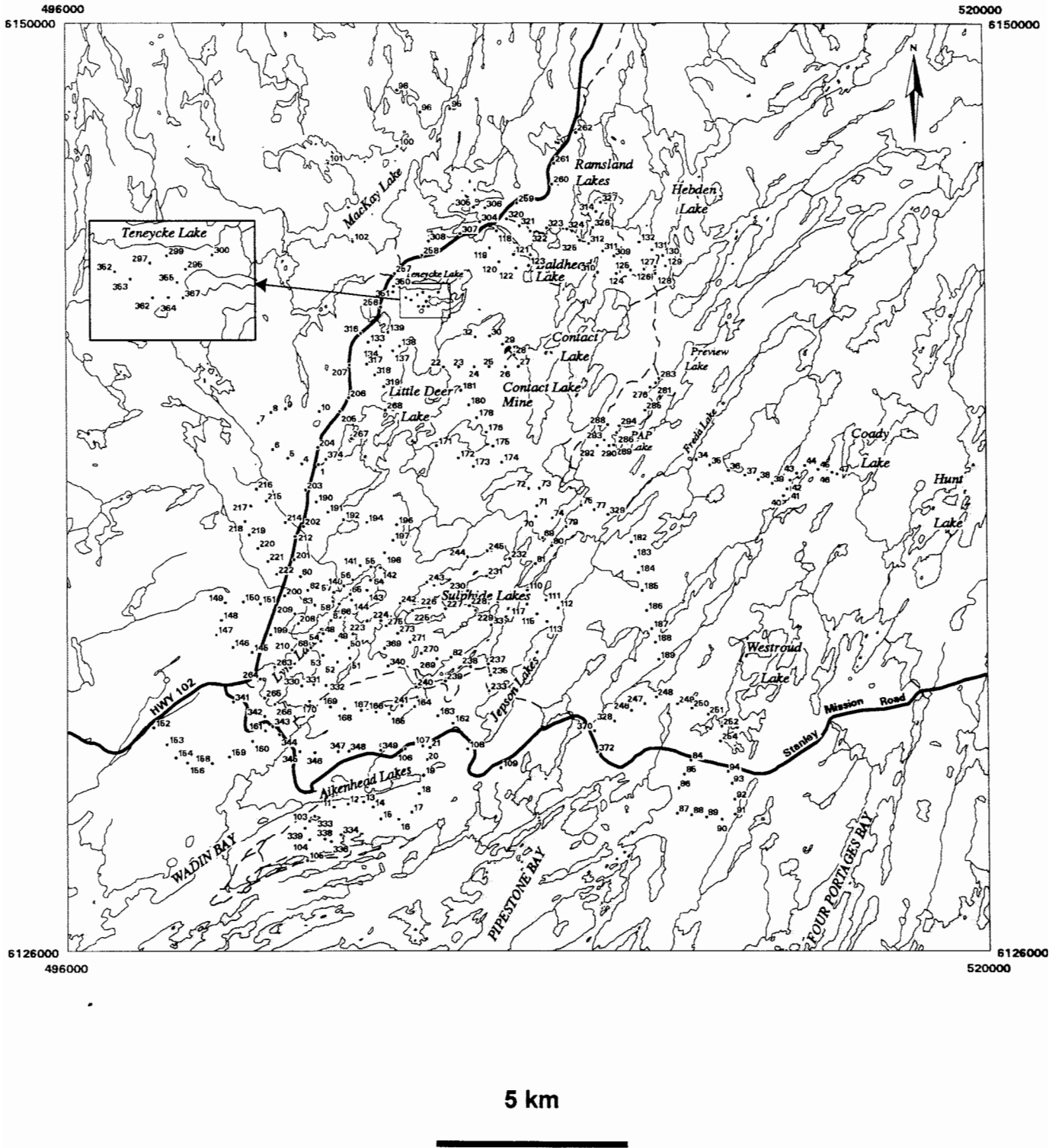


Fig. 2: Locations of samples selected for analysis (with sample numbers).
See large folded map for more details.

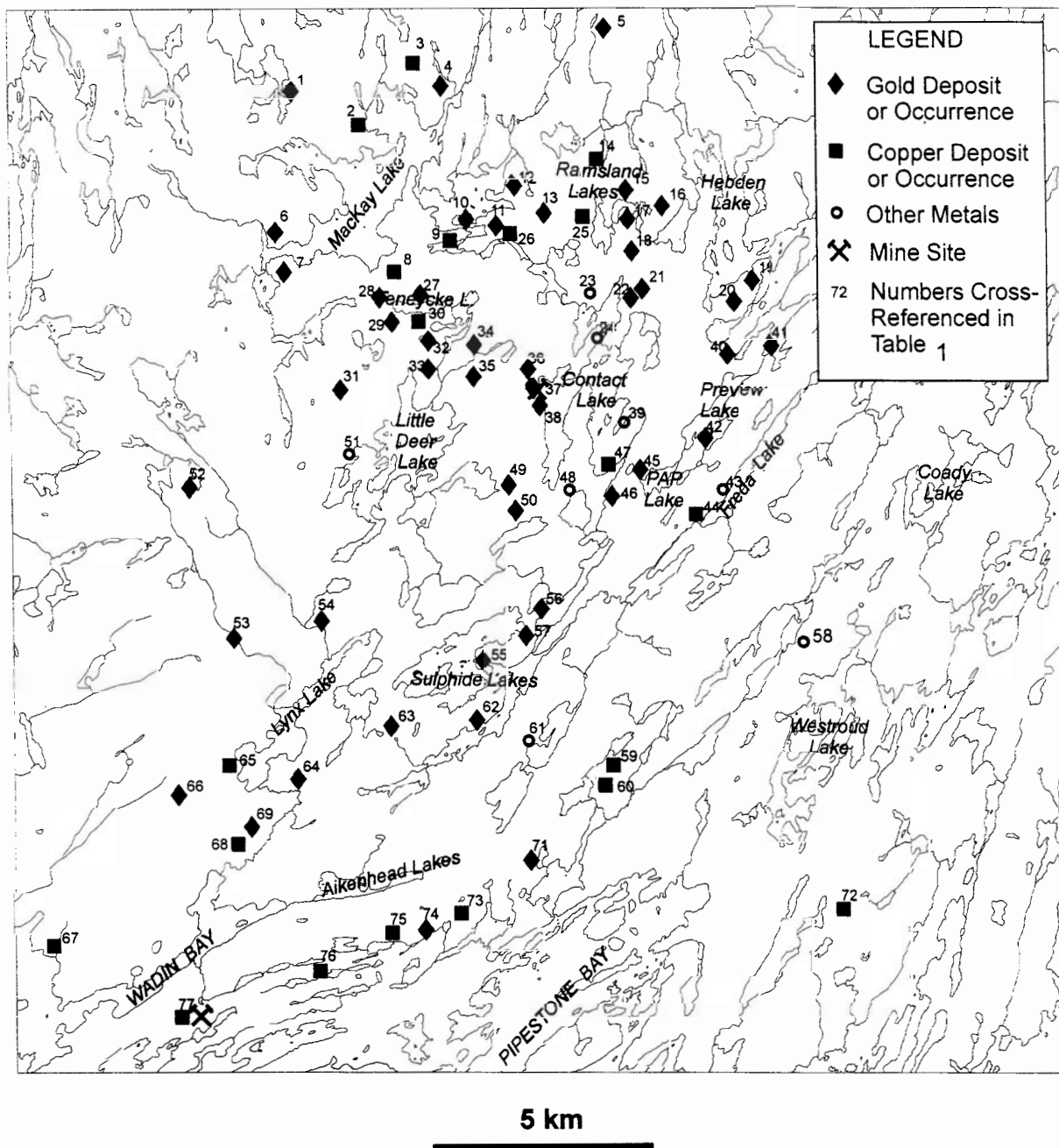


Fig. 3: Mineral deposits, showings, occurrences and mine sites

Ref. ¹	SMDI ²	Commodity	SMDI ² Description
1	2622	Au	'This' Au occurrence
2	782	Cu	Claude #72 showing
3	781	Cu	Pat gossan zone; GID Cu occurrence/Claude #71 showing
4	2363	Au	Duck Au showing
5	2081	Au	North Lake Au showing
6	2571	Au	MacKay Lake (west of) Au occurrence
7	2588	Au	MacKay Lake (southwest end) Au occurrence
8	780	Cu	Connie claims - Cu occurrence
9	775	Cu	BJJ Cu showing (A to C zones)
10	2508	Au	Grab samples 41212 and 41217
11	2445	Au	Walter Au showing
12	755	Au, Cu	East Eureka Au-Cu zone; Main Eureka zone; Hanson A showing; West Eureka Au-Cu zone; Hanson B showing; Hanson Cu showing
13	2513	Au	Randy Au showing
14	774	Cu	Mullock Lake trenches
15	768	Au	Ramsland North Au occurrence
16	770	Au	Ramsland East Au occurrence
17	769	Au	Ramsland Centre Au showing; Point area showings (84-1 to 84-7)
18	771	Au	Ramsland South Au showing; Point 84-7 showing; Hill 300 Au showing; Area A Au showing; Area B Au showing
19	766	Au	SOCKO-TYON Au showing
20	2496	Au	Lily Au showing
21	2277	Au	North Contact Au zone (part)
22	791	Au, Pb	Pb North Contact Lake Au zone; Showing No. 6 (Py-Pb-Zn); Showing 65-2D (Au-Pb)
23	751	Ag	LA GUERITA claim Ag occurrence
24	753	As	Home As showing (extension of North Contact Pb-Cu-Au showing)
25	776	Cu	Zitz Cu showing
26	779	Cu	PETE claim trench
27	767	Au	Teneycke Lake area trench No. 4; Teneycke north showing
28	2663	Au, Cu	New Pit Au-Cu occurrence; 14 north Cu-Au showing
29	765	Au	Upises Au showing; Upiesaw Au showing
30	778	Cu	Teneycke Lake A to E Cu zones; Teneycke showings

31	2666	Au	Drill holes LD94-1 and LD94-2
32	2662	Au	'This' Au occurrence; 733 Au-Cu zone
33	2521	Au	Curry Au showing; Curry II Au showing; Ericks Au showing; Rain Au showing; Hail Au showing
34	2554	Au	'That' Au showing; Hatt lineament Au showing
35	2434	Au	OWL I Au showing; OWL II Au showing; OWL III Au showing
36	2572	Au	Muskeg lineament Au showing (includes area B-3 Au showing, area 15-4 Au showing)
37	619	Au	Contact Lake Au mine; Bakos Au deposit; BK-1, BK-2, BK-3 zones
38	619b	Au	Keya Au zone
39	792	Pb	CONTACT claims showing trenches
40	760	Au	Joe Au showing
41	2284	Au	Quartz vein 87-1 showing; Quartz vein 87-2 showing
42	754	Au	Preview north Au zone/adit; Preview south Au zone/adit or PAP C zone
43	798	U	PIX U-Cu, Mo showing
44	773	Cu	Caribou Cu showing
45	1147	Au	PAP SW Au deposit; PAP K and L zones
46	764	Au	Clearwater A Au showing; AVAILL Au showing; Clearwater B Au showing; Vern Au showing
47	772	Cu	CUE claim No.14 Cu occurrence
48	752	Ag	OLGA claims Ag-Au showing; Curry structure and Curry Ag-Au zone
49	2279	Au	Shear #1 Au showing, Shear #2 Au showing
50	2278	Au	Turtle Lake Au showing; Quartz vein Au showing (Quartz vein #1, Quartz vein #2)
51	800	Zn	Little Deer Lake (southwest of) Drill Hole A-1
52	2530	Au	Studer B Au showing; Studer C Au showing
53	2276	Au	Boundary Au showing (Boundary north Au showing or E showing; Boundary south Au showing or D showing)
54	2495	Au	Grab sample MR-33b
55	756	Au	Lucky Strike Au showing
56	762	Au	Main Camp Au showing; DEE-2 north Au showing; North camp As-Au showing; Pyrrhotite showing
57	759	Au	South Camp Au showing; Discovery Au showing; Studer S+O Au showing; Studer Main Au showing; DEE-2 Au showing; Dee South Au showing
58	2135	As, Fe	Scramstead Lake As-Py occurrence
59	784	Cu	Rob Lake Cu-Au showing

60	2283	Cu	Drill holes BRA87-1 and -2
61	799	Zn	Drill hole No.16
62	757	Au, Pb	Galena Au-Pb showing; Bee zone Au showing; Island zones As-Au showing; BEE 9 As-Au showing
63	763	Au	Sulphide Lake or Studer zones A, B, C (zone blocks 1, 2, and 3), D, E, and F
64	761	Au	GEM Au showing
65	794	Cu	Lynx Lake (south of) pyrite-pyrrhotite occurrences
66	2364	Au	Lynx Lake (southwest of) Au geochemical anomaly
67	743	Cu	Knox syndicate drill holes Nos. 4 and 7
68	788	Cu	REVIEW claims showing trenches
69	1876	Au	Drill holes 75-LC-1 and -2, MEP-73-2 and -3, and SYD-84-1 (extension of the GEM Au showing)
70	2365	Au	Rio Tinto R-1, R-1A, R-1B, R-2, and R-2A trenches
71	777	Cu	PIPE claim trenches
72	793	Cu	Stroud Lake drill holes
73	786	Cu	Dam-Crescent lakes Cu showing (R-12 trench)
74	2366	Au	Trenches of Anglo-Rouyn mine horizon
75	785	Cu	Rio Tinto trench R-14 (Cu-Au)
76	787	Cu	Anglo-Rouyn mine, Anglo Rouyn B, C, D, and E Lake zones; Anglo-Rouyn Lake zone
77	732	Cu, Au	Anglo-Rouyn mine (Open pit orebodies A, B, and C): Moose Point Cu-Zn showing

¹ Numbers in first column refer to those indicated on Fig. 3 (and transparent overlay).

² Saskatchewan Mineral Deposit Index

Table 1: Mineral Deposits, Showings, Occurrences, and Mines in and Adjacent to the Survey Area.

VEGETATION COVER AND SAMPLING CONSIDERATIONS

The survey area is moderately to densely covered with vegetation typical of the boreal forest that extends across a broad swath of central and northern Canada. Conifers are the dominant trees: notably black spruce (*Picea mariana*), with lesser development of white spruce (*Picea glauca*) and jack pine (*Pinus banksiana*) in drier or rocky areas. Some balsam fir (*Abies balsamea*) occurs locally as stands in mature forest. Scattered amongst the conifers are stands and individuals of paper birch (*Betula papyrifera*) and trembling aspen (*Populus tremuloides*). Other tree species are mostly isolated and quite rare. The understorey of vegetation is dominated by two species of alder - river or speckled alder (*Alnus rugosa*) in the wet areas, and green or mountain alder (*Alnus crispa*) where the ground is relatively dry. Thick groves of Labrador tea (*Ledum groenlandicum*) occur, especially where drainage is poor. Leather leaf (*Chamaedaphne calyculata*) is commonly associated with Labrador tea in boggy areas. The lichen mounds commonly known as reindeer moss (*Cladonia* sp.) are present throughout the survey area. There are many other species covering the forest floor but they are quantitatively minor. A comprehensive description of plants that occur in the boreal forest is given in Johnson *et al.*, 1995.

Each of these plant species has a different chemical composition. Furthermore, each tissue type (i.e. leaf, stem, flower, bark, trunk wood, root) from a single tree or shrub is substantially different in composition. A detailed account of the nature and chemistry of humus and its contained compounds is given in Stevenson (1994). Given that the humic layer on the forest floor is made up of a variety of plant species and tissue types, it is to be expected that some inter-site variations in humus chemistry can be attributed to the various components of the forest from which the humus sample is derived. In order to minimise this variation, field crews were instructed to collect all humus samples, wherever possible, from beneath alder shrubs. Unfortunately, 'humus' is an inconsistent sample medium, and there is inevitably some variation in sampling procedures amongst field crews. Close examination of the 'humus' samples at the end of the field season revealed a variety of sample types. Many were true humus (decomposed black to dark-brown organic material), but others ranged from handfuls of rotted logs at one end of the spectrum to pebbly material with a high inorganic content at the other. Out of the original collection of samples approximately 20% were discarded because they were considered atypical of the main set of humus samples. Of the remainder, 50% were selected for analysis in order to remain within budgetary constraints. Generally, a sample was selected from each second sample station (200 m spacing), thereby providing a humus sample spacing of 400 m along each traverse. This report includes data obtained from the analysis of 316 samples.

SAMPLE COLLECTION, PREPARATION AND ANALYSIS

At each sample station the layer of forest litter beneath alder shrubs (mostly mountain alder) was scraped to one side, and a stainless steel trowel was used to dig out sufficient humic material to fill a standard 'kraft' soil sample bag. Sampling crews did not wear any gold or silver rings in order to preclude any precious metal contamination. Samples were air-dried at the Subsurface Geological Laboratory of Saskatchewan Energy and Mines in Regina. When dry, they were visually categorised according to their composition and relative content of organic material, then boxed and stored in their original sample bags for 10 years.

Upon retrieval of samples for analysis in 1995 it was found that there had been degradation of some sample bags, which was attributed to the acidic nature of the humus. Typically, the pH of humus developed on podzols is approximately 3, or even lower (Lentschig and Fiedler, 1967). Each of the 316 samples selected for analysis was placed in a plastic colander with apertures of approximately 2 mm and pressed gently through the apertures by hand swirling. The sieved material was collected in a large aluminum oven tray, and shaken by hand to allow simple gravitational separation of any inorganic particles. Approximately 15 g of each sieved organic material was then placed in a fresh 'kraft' soil bag, and submitted to Activation Laboratories Ltd. (ACTLABS, Ancaster, Ontario) for instrumental neutron activation analysis (INAA). At ACTLABS the entire sample was pressed into a briquette, weighed, and shrink-wrapped to ensure that there was both sample integrity and no inter-sample contamination. Samples were activated by irradiation with neutrons in a nuclear reactor to produce radioactive isotopes. Upon removal from the reactor the short-lived isotopes were allowed to decay for a few hours. Isotopes of specific elements were identified by their characteristic gamma-ray energies and quantified by measurement of the peak areas. Calibration was carried out by comparison with standard reference materials. Data were reported on the concentrations of 35 elements, of which 34 are presented in this report. The only missing element is iridium for which all values were below the detection level of 1 ppb Ir. Although from an exploration point of view it would be useful to have analytical data for Cu, Pb, and Cd, the multi-element INAA does not provide data for these elements.

ANALYTICAL QUALITY CONTROL

Included within each block of 20 samples was one standard sample (V6) for evaluating analytical accuracy and one duplicate sample (two splits of a field sample) for evaluating analytical precision. The V6 standard is a composite of dry vegetation tissues, developed by the GSC, composed mostly of jack pine twigs, bark and needles. The data obtained for each element in V6 are given in Table 2. Concentrations below the detection limits (d.l.) are expressed as half of the d.l. The d.l. is given in the first row of data beneath the element headings in Appendix A and in the statistical summaries for each element in Appendix B. For most elements the accuracy is good to excellent. For a few, notably Rb and some Sr analyses the reproducibility of the data is not as good. In the case of the Rb, concentrations in the survey samples are mostly higher than in V6 and the reproducibility is considerably improved (Table 3).

Analyses of duplicate pairs of samples are given in Table 3. With a few exceptions the precision is very good. The detection limits of each element are given in the data listings beneath each element heading (Appendix A) and in the statistical summaries in Appendix B.

Lab No	Au	Ag	As	Ba	Br	Ca	Ce	Co	Cr	Cs	Eu	Fe	Hf	Hg	K	La	Lu	Mo
	ppb	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm
<i>d.l.*</i>	1.0	0.3	0.01	5	0.1	0.20	0.3	0.1	0.3	0.05	0.05	0.005	0.05	0.5	0.05	0.01	0.001	0.5
AL95/H03	1.8	0.2	0.45	24	2.6	1.00	2.1	0.6	4.7	0.03	0.03	0.107	0.29	0.3	0.21	1.10	0.010	0.3
AL95/H33	0.9	0.2	0.53	26	2.6	1.00	2.5	0.6	5.3	0.03	0.03	0.109	0.32	0.3	0.19	1.10	0.014	0.5
AL95/H61	1.2	0.2	0.57	27	2.7	0.98	2.1	0.6	4.7	0.03	0.05	0.123	0.31	0.3	0.24	1.10	0.011	0.3
AL95/H78	0.5	0.2	0.64	27	2.6	0.88	2.2	0.6	4.6	0.07	0.03	0.108	0.32	0.3	0.23	1.10	0.013	0.7
AL95/H99	0.6	0.2	0.47	30	2.7	0.97	2.2	0.5	4.6	0.03	0.03	0.107	0.31	0.3	0.24	1.10	0.012	0.3
AL95/H116	1.1	0.2	0.56	18	2.6	0.91	2.3	0.6	4.3	0.03	0.03	0.115	0.28	0.3	0.19	1.10	0.013	0.3
AL95/H135	1.0	0.2	0.44	22	2.7	0.98	2.2	0.6	4.2	0.03	0.03	0.116	0.28	0.3	0.19	1.20	0.012	0.3
AL95/H157	0.8	0.2	0.43	22	2.5	0.83	2.5	0.5	4.3	0.03	0.03	0.113	0.31	0.3	0.22	1.20	0.015	0.5
AL95/H179	1.0	0.2	0.55	25	2.8	0.95	2.3	0.6	4.8	0.03	0.03	0.120	0.32	0.3	0.18	1.10	0.014	0.3
AL95/H195	0.8	0.4	0.50	17	2.5	0.73	2.0	0.6	3.7	0.03	0.03	0.103	0.31	0.3	0.25	1.10	0.013	0.3
AL95/H213	0.3	0.2	0.37	29	2.8	1.00	2.4	0.6	4.1	0.14	0.03	0.115	0.35	0.3	0.21	1.10	0.015	0.5
AL95/H236	0.3	0.2	0.64	35	2.6	0.98	2.1	0.6	5.1	0.19	0.03	0.120	0.35	0.3	0.24	1.20	0.012	0.3
AL95/H255	0.3	0.2	0.46	22	2.5	0.92	2.0	0.5	4.8	0.03	0.03	0.095	0.32	0.3	0.21	1.00	0.013	0.3
AL95/H274	1.3	0.4	0.64	23	2.8	0.97	2.3	0.6	5.2	0.03	0.03	0.110	0.36	0.3	0.20	1.20	0.016	0.3
AL95/H278	0.9	0.2	0.66	29	2.6	0.95	2.2	0.5	4.0	0.09	0.03	0.113	0.31	0.3	0.22	1.10	0.016	0.3
AL95/H302	1.0	0.2	0.52	19	2.7	1.00	2.4	0.5	4.9	0.03	0.03	0.110	0.29	0.3	0.22	1.10	0.011	0.3
AL95/H315	1.3	0.2	0.46	26	2.7	1.10	2.3	0.6	5.5	0.03	0.03	0.108	0.29	0.3	0.28	1.10	0.011	0.3
AL95/H337	0.6	0.2	0.40	24	2.4	0.85	2.0	0.5	4.1	0.03	0.03	0.095	0.26	0.3	0.26	1.10	0.012	0.3
AL95/H373	0.3	0.2	0.46	25	2.6	0.90	2.0	0.6	4.6	0.03	0.03	0.101	0.29	0.3	0.34	1.10	0.012	0.3
Mean	0.8	0.2	0.51	24.7	2.6	0.94	2.2	0.6	4.6	0.05	0.03	0.110	0.31	0.3	0.23	1.12	0.013	0.3
Std. Deviation	0.4	0.1	0.09	4.39	0.1	0.08	0.2	0.0	0.5	0.05	0.00	0.008	0.03	0.0	0.04	0.05	0.002	0.1

Lab No	Na	Nd	Ni	Rb	Sr	Ta	Tb	Th	U	W	Yb	Zn
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
<i>d.l.</i>	0.5	0.5	**	1	50	0.1	0.1	0.1	0.1	0.2	0.005	10
AL95/H03	524	0.8	1	3	25	0.1	0.1	0.2	0.1	0.1	0.100	37
AL95/H33	570	0.9	1	0.5	25	0.1	0.1	0.2	0.1	0.1	0.090	37
AL95/H61	540	0.3	1.5	3	62	0.1	0.1	0.3	0.1	0.1	0.109	32
AL95/H78	526	0.6	1	0.5	25	0.1	0.1	0.2	0.1	0.1	0.086	38
AL95/H99	544	0.7	1.5	0.5	53	0.1	0.1	0.2	0.1	0.1	0.096	42
AL95/H116	560	1.0	1.5	0.5	25	0.1	0.1	0.2	0.1	0.1	0.103	35
AL95/H135	555	0.7	1.5	0.5	25	0.1	0.1	0.2	0.1	0.1	0.093	37
AL95/H157	543	0.6	1	3	25	0.1	0.1	0.3	0.1	0.1	0.079	32
AL95/H179	572	1.2	1.5	0.5	25	0.1	0.1	0.2	0.1	0.1	0.086	37
AL95/H195	520	0.6	1	4	25	0.1	0.1	0.2	0.1	0.1	0.098	31
AL95/H213	560	1.0	1.5	3	25	0.1	0.1	0.3	0.1	0.1	0.098	38
AL95/H236	528	1.0	1.5	0.5	25	0.1	0.1	0.3	0.1	0.1	0.101	39
AL95/H255	521	0.6	1.5	0.5	25	0.1	0.1	0.2	0.1	0.1	0.085	40
AL95/H274	565	1.4	1.5	6	25	0.1	0.1	0.2	0.1	0.1	0.095	44
AL95/H278	544	1.4	1.5	5	25	0.1	0.1	0.3	0.1	0.1	0.123	42
AL95/H302	541	0.3	1.5	0.5	25	0.1	0.1	0.2	0.1	0.1	0.078	33
AL95/H315	546	0.3	1.5	3	66	0.1	0.1	0.2	0.1	0.1	0.119	33
AL95/H337	499	1.1	1	0.5	25	0.1	0.1	0.2	0.1	0.1	0.095	33
AL95/H373	542	0.8	1	2	25	0.1	0.1	0.2	0.1	0.1	0.091	36
Mean	542	0.8	1.32	1.95	30.6	0.1	0.1	0.2	0.1	0.1	0.096	36.63
Std. Deviation	19.2	0.35	0.25	1.77	13.4	0	0	0.045	0	0	0.012	3.73

*d.l. = Detection limit; **variable detection limit, depending upon matrix - 2 or 3 ppm for V6
Values below d.l. taken at 0.5 d.l. for computational purposes

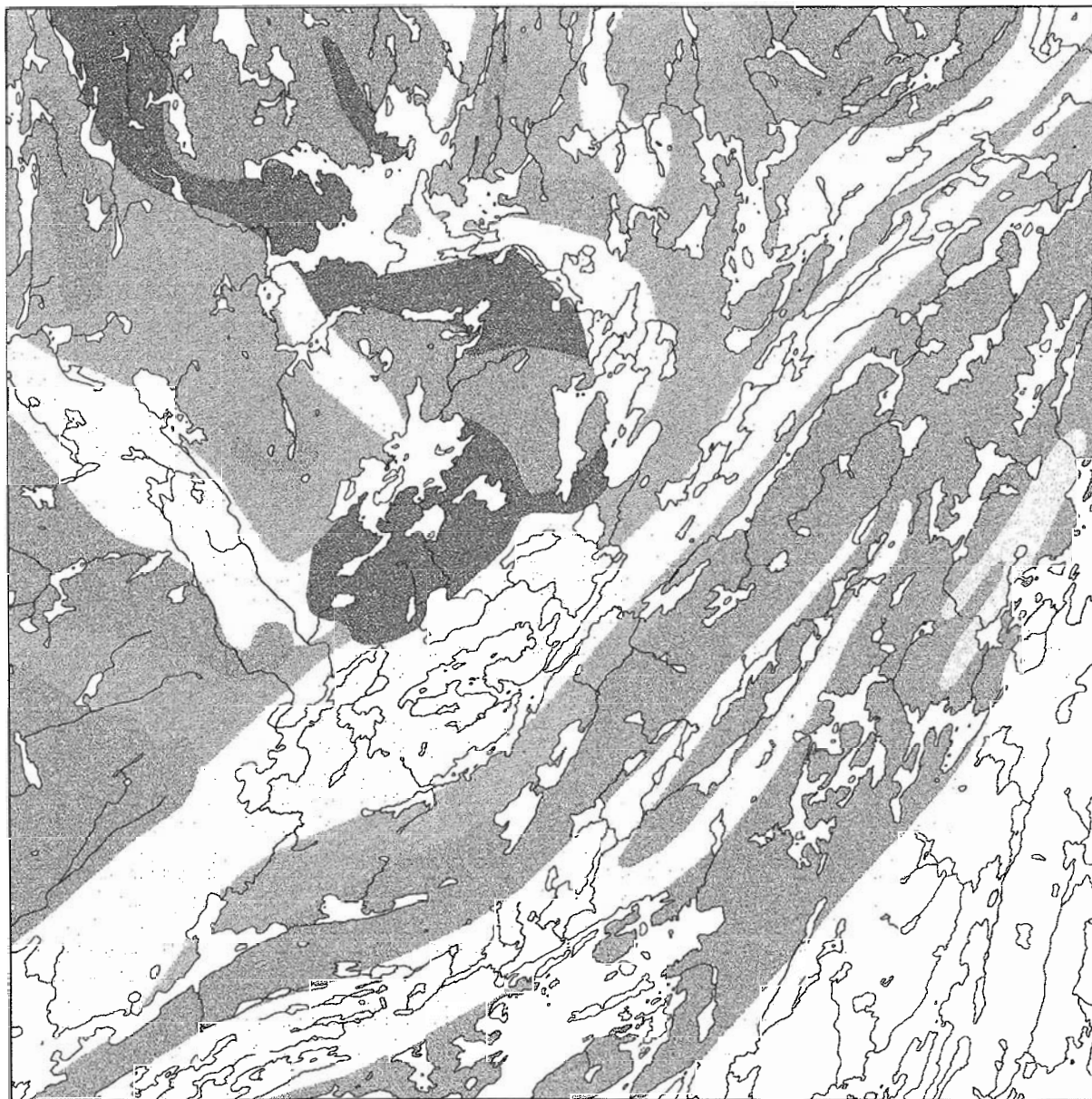
Table 2: Instrumental neutron activation analysis (INAA) of 19 standard vegetation samples (V6).

Site ID	Type	Au ppb	Ag ppm	As ppm	Ba ppm	Br ppm	Ca %	Ce ppm	Co ppm	Cr ppm	Cs ppm	Eu ppm	Fe %	Hf ppm	Hg ppm	K %	La ppm	Lu ppm
3178	D1	1.2	0.2	0.91	280	5.1	2.50	10.0	4.5	14.0	0.74	0.16	0.599	0.85	0.3	0.77	5.70	0.050
3178	D2	1.3	0.2	0.93	220	5.1	2.10	9.5	4.4	12.0	0.78	0.13	0.563	0.78	0.3	0.64	5.40	0.055
3237	D1	0.8	0.2	2.80	92	7.7	0.10	11.0	2.8	4.4	0.98	0.18	0.256	0.46	0.3	0.39	6.00	0.041
3237	D2	1.1	0.2	2.60	94	7.5	0.32	11.0	2.8	4.3	0.80	0.17	0.251	0.42	0.3	0.36	5.70	0.037
3291	D1	0.3	0.2	4.80	62	15.0	1.00	2.2	1.4	2.9	0.20	0.03	0.547	0.28	0.3	0.28	1.40	0.016
3291	D2	0.3	0.2	5.10	51	15.0	1.10	2.5	1.4	2.7	0.18	0.06	0.555	0.31	0.3	0.20	1.30	0.018
3325	D1	0.3	0.2	1.50	360	5.7	2.40	4.4	7.3	3.6	0.46	0.08	0.164	0.33	0.3	0.32	2.30	0.016
3325	D2	0.9	0.2	1.60	360	5.5	2.00	4.7	7.2	4.7	0.54	0.09	0.184	0.35	0.3	0.31	2.50	0.018
3389	D1	0.3	0.2	2.40	100	6.4	0.46	3.2	2.3	9.6	0.74	0.06	0.252	0.50	0.3	0.24	2.00	0.026
3389	D2	0.3	0.2	2.50	92	6.0	0.44	3.5	2.4	11.0	0.60	0.03	0.263	0.43	0.3	0.26	2.10	0.029
3030	D1	0.7	0.2	1.50	96	6.4	0.52	3.7	1.0	4.5	0.43	0.07	0.228	0.59	0.3	0.36	2.20	0.023
3030	D2	1.8	0.2	1.80	140	5.7	0.36	4.7	1.3	6.1	0.52	0.09	0.280	0.62	0.3	0.58	2.60	0.032
3065	D1	1.7	0.2	1.10	310	6.7	1.60	4.9	4.9	7.1	1.00	0.10	0.398	0.59	0.3	0.33	2.80	0.032
3065	D2	0.3	0.2	1.40	280	6.2	1.70	4.7	6.2	8.5	0.89	0.09	0.612	0.60	0.3	0.35	2.80	0.040
3115	D1	2.3	0.2	1.20	81	5.6	0.57	3.1	1.5	4.0	0.45	0.03	0.168	0.39	0.3	0.54	1.50	0.020
3115	D2	2.3	0.2	1.60	90	5.5	0.51	3.3	1.7	5.6	0.48	0.03	0.184	0.42	0.3	0.53	1.80	0.023
3167	D1	0.9	0.2	3.20	130	5.8	0.65	6.7	1.4	5.1	0.36	0.09	0.243	0.42	0.3	0.30	3.70	0.026
3167	D2	0.3	0.2	3.50	130	5.6	0.45	6.6	1.3	5.1	0.37	0.09	0.239	0.50	0.3	0.24	3.80	0.028
3198	D1	0.3	0.2	1.70	170	5.4	0.52	3.7	2.8	17.0	0.47	0.07	0.267	0.31	0.3	0.29	2.10	0.023
3198	D2	0.7	0.2	1.70	150	4.9	0.65	4.2	3.3	28.0	0.48	0.07	0.376	0.52	0.3	0.35	2.60	0.027
3238	D1	0.7	0.2	0.73	130	2.8	1.10	11.0	6.0	20.0	1.10	0.17	1.160	0.94	0.3	1.10	8.60	0.075
3238	D2	0.9	0.2	0.78	160	2.9	0.95	13.0	6.2	22.0	0.97	0.20	1.150	1.20	0.3	1.20	9.00	0.080
3284	D1	1.1	0.2	1.90	29	7.5	0.10	1.7	1.0	4.4	0.42	0.03	0.112	0.31	0.3	0.20	1.10	0.018
3284	D2	1.2	0.2	1.60	25	7.0	0.20	2.1	0.8	3.1	0.21	0.03	0.110	0.23	0.3	0.19	1.10	0.015
3329	D1	0.3	0.2	1.50	86	5.6	0.60	5.3	1.4	2.7	0.57	0.07	0.113	0.11	0.3	0.23	3.00	0.015
3329	D2	0.5	0.5	1.40	95	5.7	0.46	5.8	1.5	2.9	0.58	0.07	0.109	0.21	0.3	0.15	3.00	0.012
3396	D1	0.3	0.2	3.90	140	8.8	1.10	4.4	1.0	4.9	0.41	0.06	0.302	0.44	0.3	0.25	2.40	0.022
3396	D2	1.6	0.9	3.80	140	8.6	0.85	4.2	1.1	4.7	0.51	0.07	0.279	0.37	0.3	0.25	2.30	0.017
3003	D1	30.0	0.2	87.00	230	4.7	2.40	5.6	13.0	42.0	0.58	0.15	1.460	0.33	0.3	0.67	4.00	0.041
3003	D2	21.9	0.2	64.00	200	3.5	2.00	4.4	13.0	44.0	0.55	0.15	1.620	0.51	0.3	0.68	3.60	0.059
3058	D1	0.3	0.2	2.80	240	6.3	0.94	9.2	6.1	13.0	0.85	0.17	0.910	1.20	0.3	0.85	5.70	0.077
3058	D2	1.4	0.2	1.70	180	4.4	0.81	6.7	5.6	12.0	0.63	0.12	0.997	0.88	0.3	0.83	5.10	0.066
3198	D1	0.3	0.2	2.30	310	8.0	1.70	6.4	3.8	14.0	0.75	0.11	0.436	0.80	0.3	0.37	3.40	0.043
3198	D2	1.1	0.2	2.30	310	8.6	1.90	7.3	3.8	16.0	0.95	0.12	0.492	0.78	0.3	0.51	3.70	0.042
3067	D1	0.3	0.2	0.99	140	4.0	0.88	3.8	1.3	4.5	0.31	0.10	0.358	0.84	0.3	0.95	3.40	0.031
3067	D2	1.0	0.2	1.30	200	4.7	0.69	4.7	1.5	5.2	0.42	0.11	0.397	1.00	0.3	1.20	3.90	0.042
3157	D1	0.3	0.2	3.30	130	5.8	0.10	7.9	2.9	13.0	0.46	0.13	0.437	0.99	0.3	0.43	4.50	0.045
3157	D2	0.3	0.2	3.10	100	6.1	0.10	7.9	3.0	12.0	0.51	0.12	0.430	0.94	0.3	0.45	4.40	0.047

Table 3: Analysis of duplicate field samples (19 pairs) - continued on next page

Site ID	Type	Mo ppm	Na ppm	Nd ppm	Ni ppm	Se ppm	Sm ppm	Sr ppm	Ta ppm	Tb ppm	Th ppm	U ppm	Yb ppm	W ppm	Zn ppm
3178	D1	0.3	2450	3.7	2.5	0.2	0.67	200	0.1	0.1	1.4	0.4	0.410	0.1	56
3178	D2	0.3	2370	3.6	2	0.2	0.63	170	0.1	0.1	1.4	0.4	0.386	0.1	50
3237	D1	0.7	616	3.9	2	0.3	0.70	25	0.1	0.1	0.5	0.3	0.317	0.1	34
3237	D2	0.3	604	3.7	1.5	0.3	0.66	25	0.1	0.1	0.4	0.3	0.281	0.1	27
3291	D1	0.6	533	0.3	2	0.9	0.17	25	0.1	0.1	0.4	0.1	0.103	0.2	11
3291	D2	0.3	544	0.3	1.5	0.8	0.17	25	0.1	0.1	0.4	0.2	0.137	0.1	14
3325	D1	0.3	398	1.3	1.5	0.2	0.28	25	0.1	0.1	0.4	0.1	0.138	0.1	24
3325	D2	0.3	533	1.5	1.5	0.2	0.31	81	0.1	0.1	0.4	0.1	0.145	0.1	19
3389	D1	0.3	832	0.3	1.5	0.2	0.24	25	0.1	0.1	0.5	0.1	0.167	0.1	12
3389	D2	0.3	924	0.9	1.5	0.2	0.24	25	0.1	0.1	0.5	0.1	0.190	0.1	8
3030	D1	0.3	1540	0.3	2	0.3	0.26	25	0.1	0.1	0.5	0.2	0.201	0.1	52
3030	D2	0.3	2760	1.5	2.5	0.2	0.31	110	0.1	0.1	0.6	0.1	0.230	0.1	42
3065	D1	0.3	1070	1.7	2.5	0.2	0.32	71	0.1	0.1	0.6	0.2	0.223	0.1	45
3065	D2	0.3	1580	0.3	2.5	0.2	0.35	25	0.1	0.1	0.6	0.2	0.264	0.1	38
3115	D1	0.3	583	0.3	1.5	0.8	0.18	25	0.1	0.1	0.4	0.2	0.149	0.1	42
3115	D2	0.3	733	1.2	1.5	0.4	0.21	25	0.1	0.1	0.5	0.2	0.170	0.1	48
3167	D1	0.6	654	2.5	2	0.2	0.39	78	0.1	0.1	0.6	0.3	0.195	0.1	28
3167	D2	0.3	664	2.7	1.5	0.2	0.38	25	0.1	0.1	0.6	0.4	0.225	0.1	24
3198	D1	0.3	1070	1.6	2	0.2	0.25	25	0.1	0.1	0.5	0.1	0.167	0.1	28
3198	D2	0.3	1820	2.0	2	0.2	0.31	110	0.1	0.1	0.5	0.1	0.229	0.1	45
3238	D1	0.3	6570	4.0	4	0.2	0.79	25	0.1	0.1	1.9	0.4	0.668	0.1	43
3238	D2	0.3	6640	4.1	4	0.5	0.84	25	0.4	0.1	2.2	0.6	0.628	0.1	62
3284	D1	0.3	323	0.3	1.5	0.2	0.13	25	0.1	0.1	0.3	0.1	0.109	0.1	16
3284	D2	0.3	287	0.3	1.5	0.2	0.13	25	0.1	0.1	0.3	0.1	0.101	0.1	15
3329	D1	0.3	308	2.0	1.5	0.2	0.32	25	0.1	0.1	0.2	0.3	0.125	0.1	24
3329	D2	0.3	297	1.9	1	0.2	0.31	25	0.1	0.1	0.2	0.3	0.116	0.1	27
3396	D1	1.0	557	1.8	2	0.2	0.28	25	0.1	0.1	0.6	0.1	0.152	0.1	27
3396	D2	0.9	530	1.2	2	0.2	0.27	25	0.1	0.1	0.6	0.2	0.157	0.7	31
3003	D1	0.3	3350	1.7	3.5	0.2	0.52	25	0.1	0.1	0.5	0.1	0.378	2.1	54
3003	D2	0.3	3860	2.1	4	0.2	0.44	25	0.1	0.1	0.4	0.2	0.377	0.1	2.5
3058	D1	0.3	4680	3.1	3.5	0.2	0.72	25	0.3	0.1	1.3	0.1	0.575	0.1	37
3058	D2	0.3	5870	2.5	3.5	0.2	0.50	25	0.1	0.1	1.0	0.2	0.493	0.1	33
3198	D1	0.3	1210	2.4	2.5	0.2	0.45	130	0.2	0.1	0.8	0.1	0.318	0.1	63
3198	D2	0.3	1290	2.9	2.5	0.2	0.48	75	0.1	0.1	0.9	0.2	0.343	0.1	85
3067	D1	0.3	5380	1.5	2.5	0.2	0.34	25	0.1	0.1	0.9	0.3	0.229	0.1	23
3067	D2	0.3	660	2.1	3	0.2	0.39	25	0.1	0.1	1.0	0.4	0.254	0.1	18
3157	D1	0.3	1730	3.8	2.5	0.2	0.52	25	0.1	0.1	1.2	0.4	0.355	0.1	40
3157	D2	0.3	1700	3.2	2.5	0.2	0.53	25	0.1	0.1	1.2	0.3	0.325	0.1	46

Table 3 (cont.): Analysis of duplicate field samples (19 pairs)



5 km

Geology

Plutons

- Mostly granitic to granodioritic
- Diorite

Volcanic Rocks

- Felsic to mafic

Metasediments

- Mostly wackes and arkoses

GEOLOGICAL SUMMARY

The Geological Survey of Canada carried out reconnaissance-level geological mapping in the survey area in the 1930s and early 1940s (McLarty, 1935; Keith, 1941). Subsequent mapping by the Saskatchewan Geological Survey was by Forsythe (1968), Lewry (1984), Lewry and Slimmon (1985), and Maxeiner and Sibbald (1995). More detailed local work is reported in Forsythe (1971), Coombe (1984), Sibbald (1986, 1987), Lewry (1986), Slimmon (1986), Thomas (1986), Thomas (1990) and Maxeiner, (1994). Studies of the Anglo-Rouyn Cu-Au deposit and the surrounding area are given in Forsythe (1971, 1972), and by Roberts and Krey (1992, 1993). Studies related to the Contact Lake Gold Mine are given in Chapman *et al.* (1990), Fayek *et al.* (1993) and Fayek and Kyser (1995).

The following summary of the survey area is a synopsis based upon the report and detailed map of Maxeiner and Sibbald (1995). The survey area is underlain entirely by a complex assemblage of metamorphosed Precambrian-Paleoproterozoic rocks of the La Ronge Domain. North-easterly striking metasedimentary and metavolcanic rocks have been intruded by plutons that range in composition from gabbroic to granitic (Fig. 4). Most of the intrusive rocks are felsic to intermediate in composition. The composition of the metavolcanic rocks encompasses a broad spectrum from basalt, through andesite to dacite, rhyodacite and rhyolite. Layered and lapilli tuff, tuff breccia, crystal tuff, pillowed flows and homogeneous to weakly layered flow rocks are all present. Similarly there is a wide range in composition of the metasediments derived from conglomerate, greywacke, arkose, pelite, sandstone and mixed calcareous sediments. The metasediments and metavolcanics are commonly interlayered and in many places the rocks are mixtures of particulates derived from both sources. The area has an extensive cover of Quaternary deposits dominated by glacial tills of variable thickness.

Figure 4 broadly categorises the bedrock into four units: plutons dominated by granite and granodiorite; plutons dominated by diorite and monzonite; rocks of volcanic origin; rocks of sedimentary origin. For geological features mapped at the 1:250,000 scale the reader is referred to Lewry and Slimmon (1985), and for 1:50,000 details to the compilation by Maxeiner and Sibbald (1995). Most of the geological contacts shown in Fig. 4 are taken from the latter publication. Many mineral occurrences have been reported of which most are gold and copper. Table 1 lists all mineral occurrences, within and marginal to the survey area, that are listed in the Saskatchewan Mineral Deposit Index. Locations of these occurrences, plotted on Fig. 3, have been copied directly from the digital map available from Saskatchewan Energy and Mines, and no attempt has been made to edit any of the locations. Figure 3 is supplied also as a transparent overlay at the same scale as the plots of element distributions in order to view relationships of humus anomalies to known mineral occurrences.

MAP PRODUCTION AND DATA HANDLING

The element distribution maps were drawn using a Transverse Mercator (TM) projection, based on the North American Datum 1927 (NAD27). The drainage and roads for the page size maps were obtained in AutoCad DXF digital format from the Geomatics Canada Sector of the Department of Natural Resources Canada. The proportional dot maps were generated using AML (ARC/INFO Macro Language). The macro, with its corresponding input menu, prompts the user to input percentile break points and an appropriate scaling exponent for each element to be mapped. Proportional dots are then generated, using the ARC/INFO SPOTSIZE, POINTSPOT and SPOT commands, with the user specifying an appropriate minimum and maximum dot size. For the purposes of this Open File, analytical values for a particular element that were greater than or equal to the 98th percentile were plotted at the maximum dot size; values less than the 98th percentile were scaled according to the user defined exponent. Exponents for individual elements were carefully chosen to provide the best view of the analytical data. Accordingly, care should be exercised when attempting to compare different elements plotted with different exponents. Element concentrations below analytical detection limits were reduced to half of the detection limit for data plotting and statistical calculations. For samples with duplicate analyses, data from the first of each duplicate pair were plotted.

ELEMENT DISTRIBUTION MAPS

Transparent Overlays

A coloured transparent overlay of Fig. 4 is provided at the same scale as the element distribution maps to assist in examining the relationships of element concentrations to the main geological units. Similarly, a second overlay, repeating the information given in Fig. 3, is provided to view the relationships of element concentrations to known mineral occurrences. Each element distribution map presented in Appendix B shows the relative concentrations of that element with respect to its data population, and summary statistics on the facing page. Elements are arranged in the order of gold first, followed by the elements in alphabetical order according to their chemical symbols.

Gold (Au)

The map of gold distribution in humus shows that there is a strong response to several zones of known gold mineralization - notably at Preview, PAP, Ramsland, MacKay and Sulphide Lakes. Concentrations attain a maximum of 174 ppb Au in a humus sample from close to the shore near the centre of the Sulphide Lake system. Table 4 gives details of the 15 sites (i.e. >95th percentile, 5 ppb Au) that yielded the highest concentrations of gold, and shows those elements that had coincident enrichments of greater than the 95th percentile of the data set for each element. Four humus samples were from sites more than 1 km from any reported gold occurrence.

In order to see the data distribution amongst samples with lesser concentrations of gold, the highest 5% of the gold values were removed from the data set and the data points replotted. The two maps, the first with all 316 samples and the second with 301 sites, are shown together as Fig. 5. Removal of these 15 sites shows (Fig. 5b) that highest relative concentrations in the remaining data set are 1) in the south, near Aikenhead Lakes, and at both the north and south ends of Lynx Lake; and 2) in the north near Baldhead, Hebden and Teneycke lakes. Data from biogeochemical samples at the same locations (Dunn, 1984, 1985, 1986a) also show gold enrichment in these areas, indicating that they are prospective for gold mineralization. Subsequently, an additional nine humus samples from sites near the western end of the Stanley Mission Road, between Highway 102 and Aikenhead Lakes, were retrieved from archive storage and analysed by INAA. Gold concentrations ranged from 3 - 10 ppb Au, and they were locally associated with anomalous concentrations of As, Ba, Co, Cr, Cs, Fe, Hg, Sb, Th and U. Additional vegetation sampling in the area in 1995 has confirmed enrichment of Au (up to 165 ppb in ash of Labrador tea) at a few sites between Lynx Lake and Wadin Bay. Locally, this enrichment is associated with Co, Cr, Cs, Mo, Th and U. South of Aikenhead Lakes, outer bark of jack pine has yielded high concentrations of Au and Sb at sites close to those with elevated levels of gold in humus (Dunn, 1985), and in birch bark and Labrador tea (Dunn and Schwann, 1990)

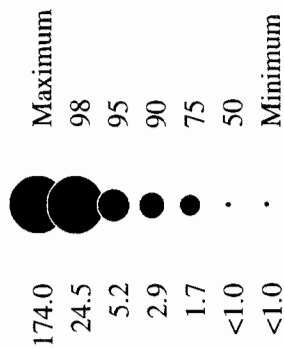
Near Teneycke Lake several species of tree and shrub have yielded unusually high concentrations of Au, As, Sb and Mo (Dunn, 1984, 1985, 1986a). In particular, pine bark yielded a maximum of 2400 ppb Au in ash close to a site where visible gold has been recorded.

Humus samples did not yield significant enrichment of Au from the vicinity of the Contact Lake Gold Mine. Antimony, Br and U, all pathfinder elements for gold, were the only elements to exhibit relative enrichment in the humus. The gold deposit which was later to become the Contact Lake Mine, was discovered after collection of the humus survey samples, and was found by till-sampling an area identified to have gold enrichment in lake sediments.

Fig. 5: Gold in humus samples - a) entire data set (n=316); b) data set with top 5% of values removed (n=301). See Table 4.

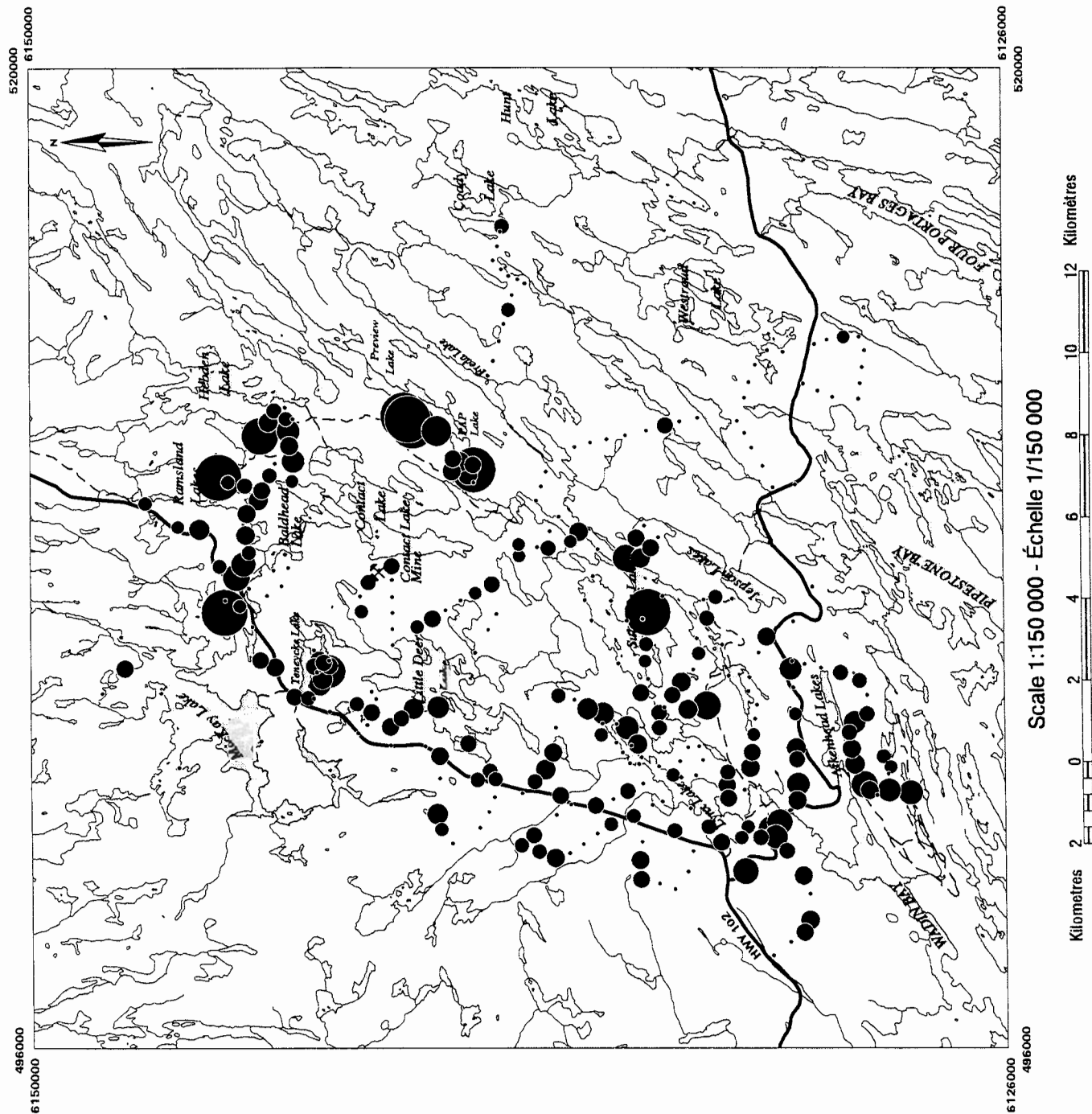
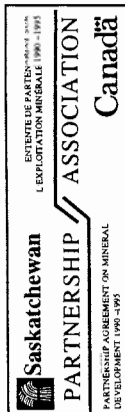
Au

GOLD in **HUMUS**

INAA**ppb Au Percentile**

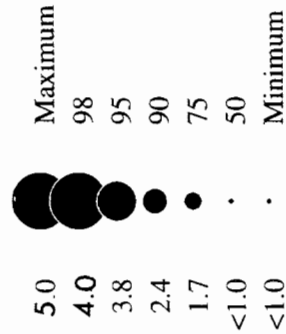
316 Samples
Exponent = 0.4

— Roads
- - - Trails

**5a**

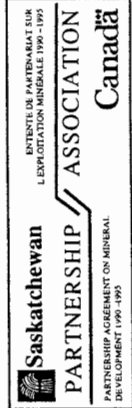
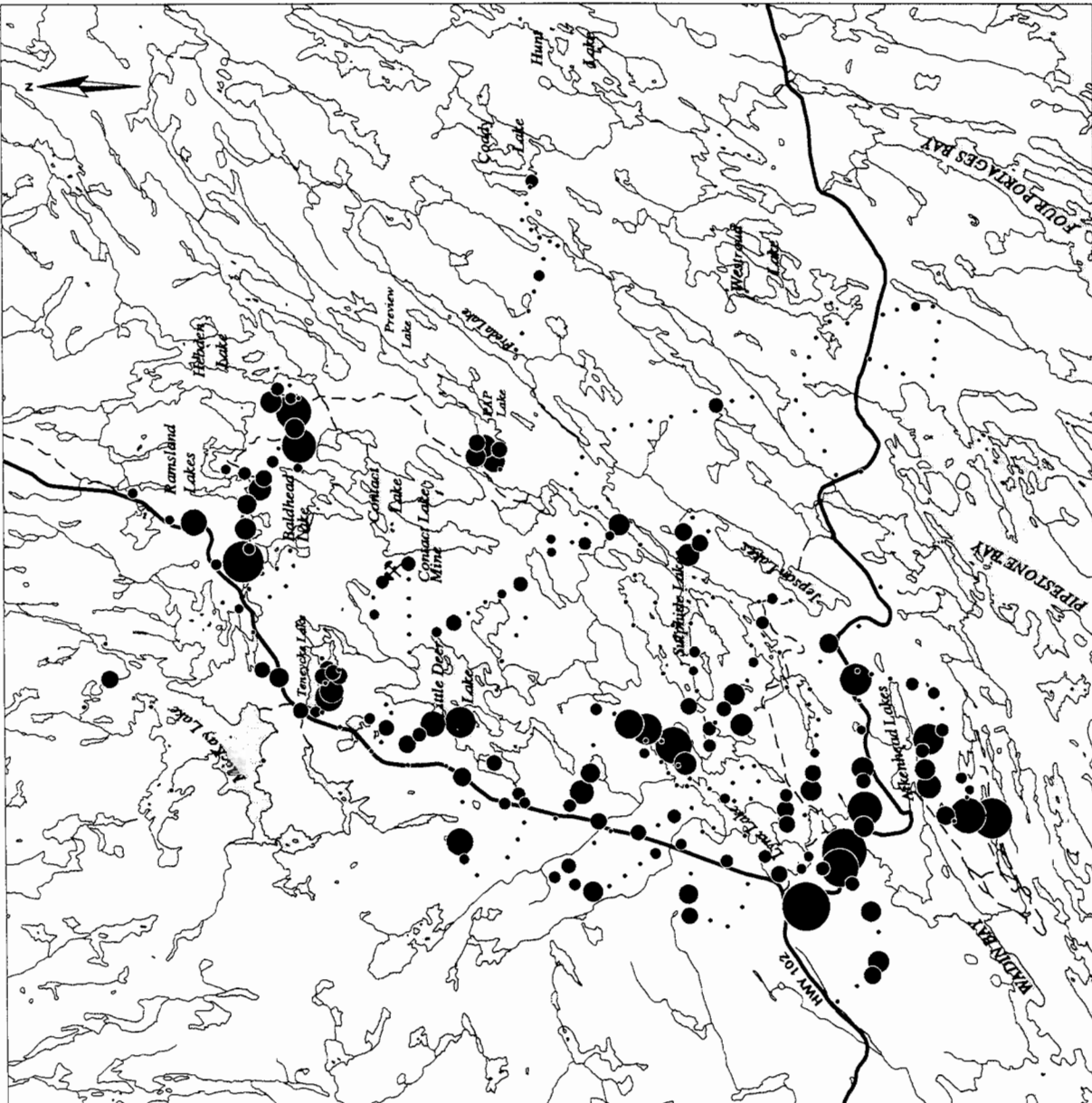
Au

GOLD in **HUMUS**

INAA**ppb Au Percentile**

301 Samples
Exponent = 1.0

— Roads
- - - Trails

520000
61500006126000
520000

Scale 1:150 000 - Échelle 1/150 000

Kilomètres 2 0 2 4 6 8 10 12 Kilomètres

UTM Zone 13

496000
61500006126000
496000**5b**

Au (ppb)	Sample #	UTM ¹	Location	Nearby Mineralized Occurrence ²	Enrichment of other elements ³
174	229	506675 6134786	Sulphide L.	#55, S. of Lucky Strike	As, Cr, Mo, U, Na
110	327	509993 6145358	Ramsland L.	#15&17, Ramsland N & centre	Co, REE
98	281	511397 6140698	Preview L.	#42, Preview L.	As, Ba, Co, Cr, Cs, REE
90	305	506681 6145228	MacKay L. (E)	#10, Grab samples	W
30	276	511254 6140582	Preview L.	#42, Preview L.	As, Co, Cr, W, Fe
25	283	511486 6140807	Preview L.	#42, Preview L.	As, Ba, Co, Cr, Fe
23	290	510167 6139074	PAP L.	#45, PAP SW	
13	132	510997 6144333	Mahon L. (near Hebden L.)	None	Sr
9.5	362	505236 6142671	Teneycke L.	#29, Upises L.	
7.7	285	511116 6139988	Preview L.	#42 Preview L.	
6.5	340	504393 6133344	Sulphide L.	#63, Studer zones	As, Ba, Co, Sb, Sr
5.6	110	508000 6135315	Sulphide L.	None	Br
5.5	333	502457 6129467	Aikenhead L.	None	
5.3	343	501364 6131785	Lynx L.	#69, GEM	Sr
5.2	341	500338 6132424	Lynx L.	None	Co, Cr, Fe, Na

¹ Easting followed by northing (exact location of sample can be found by referring to map sheet NTS 73P/7)

² See Fig. 3 for location of mineralized site #, and cross-referenced description in Table 1

³ Elements listed are those that have enrichments in humus samples >95th percentile of the data set for that element

Table 4: Samples with gold enrichment greater than 5 ppb (i.e. 95th percentile)

Silver (Ag)

With rare exceptions, Ag values are uniformly low. The highest value of 1.3 ppm Ag occurs at site #74 near the northwest shore of Sulphide Lake. Only Mo (0.9 ppm) and Sb (0.47 ppm) also show subtle enrichment at this site.

Arsenic (As)

Moderate to high concentrations of As occur at Preview Lake (associated with known Au mineralization), south of Lynx Lake (where there are other indications of Au mineralization, but no significant discovery), and along Stanley Mission Road, north of Aikenhead Lakes. At the last of these locations, high concentrations of As (62 ppm and 31 ppm) are present at sites #106 and 107, where there is coincident enrichment of Fe, Co, and Sb, and up to 3.4 ppb Au.

Barium (Ba)

Several areas have relative enrichment of Ba, notably in the vicinities of Lynx, Sulphide, Preview and Teneycke Lakes. Barium enrichment is commonly associated with, but marginal to, zones of Au mineralization. High concentrations of Ba in vegetation occur near Teneycke Lake (15,000 ppm Ba in ash of spruce bark; Dunn, 1984).

Bromine (Br)

There is often an enrichment of Br in vegetation with some styles of Au mineralization (Dunn, 1985). Since humus comprises rotting vegetation it can be expected that this relationship will be retained in humus chemistry. Local enrichment of Br occurs in several areas: notably near Sulphide, Aikenhead and Lynx Lakes. Some enrichment is present, also, south of Teneycke Lake, at PAP Lake, and near the Contact Lake Gold Mine. Enrichment at sites east of Freda Lake, near the eastern side of the survey area, are a curiosity because a sample of jack pine bark yielded 1000 ppb Au in association with weak enrichment of As and Sb (Dunn, 1985). No mineralization has been reported from this area.

Calcium (Ca)

Areas with above background levels of Ca reflect mostly zones of till and/or bedrock with enrichment of carbonates.

Cerium (Ce) - see Lanthanum and Other Rare Earth Elements.

Cobalt (Co)

Cobalt anomalies are associated with mafic phases or with zones of Au mineralization. The latter association is apparent near Hebden, Preview, MacKay, and Teneycke Lakes. Of interest is a similar enrichment northeast of Aikenhead Lakes (sites #106 and 107) in association with As, Fe and weak Au enrichments, and south of Lynx Lake where other indications of Au mineralization occur.

Chromium (Cr)

Chromium enrichment may occur in association with Au deposits where it is commonly hosted by micas. In the survey area some of the highest levels of Cr occur near Preview and Teneycke Lakes. The highest value of 100 ppm Cr is from a sample on the west shore of Lynx Lake. At this site there are mafic volcanic rocks which may be contributing to the high value.

Cesium (Cs)

Cesium in organic-rich samples locally exhibits enrichment marginal to zones of Au mineralization (Dunn *et al.*, 1990). Levels in humus samples from the survey area are low, but with subtle enrichment near several zones of known Au mineralization (e.g. Ramsland, Hebden, Preview and Teneycke Lakes).

Europium (Eu) - see Lanthanum and Other Rare Earth Elements.

Iron (Fe)

Statistical analysis of multi-element data sets derived from organic media commonly shows Fe to be the dominant factor controlling data variability. This 'Fe-factor' usually has a closely associated suite of elements which include Hf, Na, Sc, Th and REE (Dunn, 1995). In the vicinity of Au or sulphide-rich mineralization additional elements may be associated (e.g. As, Au, Cr, U).

In the survey area the most striking feature of the Fe map is the linear arrangement of anomalies that follow Highway 102. Since there is no known Fe-rich feature that follows the highway, it is likely that the samples are reflecting some contamination from airborne dust generated by the passing traffic. It is also likely that the source of the highway surfacing materials has a mafic component in order to account for the relatively high levels of Fe in the humus samples. However, the presence of K and Rb anomalies at the same sites would suggest that there is also a micaceous component, since mica is the obvious host for these elements. 'Iron-factor' elements exhibit a very similar distribution of anomalies, except for sites where Fe appears to be related to mineralization (e.g. Preview Lake, and north of Aikenhead Lakes [sites #106 and 107]).

Hafnium (Hf) - see iron (Fe), which has a similar distribution pattern.

Mercury (Hg)

Few sites yielded concentrations above the detection level of 0.5 ppm Hg. A more sensitive analytical technique is required to determine the distribution pattern of Hg because background levels in humus are commonly less than 0.05 ppm Hg.

Potassium (K)

Potassium distribution patterns are very similar to those of Fe (see section on Fe). Most plants have a high K content and there is therefore a high background level of K in the humus. Anomalous concentrations are probably derived mostly from finely disseminated mica.

Lanthanum (La) and Other Rare Earth Elements (Ce, Eu, Lu, Nd, Sm, Tb, Yb)

The rare earth elements (REE or lanthanides) are a geochemically cohesive group of 15 elements with similar chemical properties. The INAA method readily determines eight of these elements as part of an economical multi-element package. Four of these (La, Ce, Nd and Sm) are considered 'light REE' (LREE), and three (Lu, Tb, and Yb) are 'heavy REE' (HREE). Europium has slightly different chemical properties (commonly occurring in both trivalent and divalent forms), and occupies a position in the middle of the lanthanide suite. Commonly the LREE are more concentrated than the HREE in nature, but the overall distribution patterns remain similar. Europium, because of its ability to reduce to the divalent state, sometimes gives a different distribution pattern that can be of value in petrologic studies when compared to the other REE.

Comparison of maps of REE in humus shows that distribution patterns are similar, with all showing enrichment in the Teneycke Lake area. The LREE and Eu are enriched at Ramsland, Preview and Lynx Lakes, whereas the HREE are not enriched at these sites. This implies an association of the LREE with mineralization. Some weak enrichment of the LREE (notably Nd) occurs near the site of the Contact Lake Gold Mine. Studies of vegetation chemistry near the Seabee gold mine (Laonil Lake) have found some Nd enrichment (Dunn, 1986b).

Lutetium (Lu) - see Lanthanum and Other Rare Earth Elements

Molybdenum (Mo)

Concentrations of Mo are low throughout the survey area, with only ten percent of sites yielding more than the detection limit of 0.5 ppm Mo.

Sodium (Na) - see Iron (Fe): similar distribution pattern.

Neodymium (Nd) - see Lanthanum and Other Rare Earth Elements.

Nickel (Ni)

Few sites have Ni concentrations above the detection limit of 10 ppm Ni. Detectable concentrations of Ni at sites around Lynx Lake are probably reflecting the mafic volcanic rocks of the area.

Rubidium (Rb) - see iron (Fe): similar distribution patterns to those of Fe and K.

Antimony (Sb)

Antimony levels are low throughout the survey area. The INAA method is very accurate and precise for Sb, so that subtle differences among samples may be significant. Of note is the relative enrichment of Sb near the Contact Lake Gold Mine, and at other sites with known Au mineralization. The source of the Sb in the east, near Hunt Lake, is unknown. There is not coincident Au enrichment in the humus .

Scandium (Sc) - see iron (Fe): similar distribution pattern.

Selenium (Se)

Selenium concentrations are low, but there is a northeasterly trend of weak enrichment from Lynx Lake through Sulphide and PAP lakes. These elevated Se values are probably associated with the sulphides which host much of the Au mineralization.

Samarium (Sm) - see Lanthanum and Other Rare Earth Elements.

Strontium (Sr)

Relative enrichment of Sr occurs in the Lynx-Sulphide-Little Deer lakes region. Some sites are coincident with Ca enrichment, suggesting a carbonate association, whereas others are more closely related to Ba.

Tantalum (Ta)

Concentrations of Ta are low. Most sites that yield above detection levels occur along highway 102, demonstrating an association with the Fe suite of elements.

Terbium (Tb) - see Lanthanum and Other Rare Earth Elements.

Thorium (Th) - see iron (Fe): similar distribution pattern.

Uranium (U)

Of note are the moderate enrichments of U around the Contact Lake Gold Mine, demonstrating the subtle but distinct enrichment that commonly occurs in association with many mineral deposits. Other zones of note are around Teneycke and Aikenhead lakes.

Tungsten (W)

There are few sites with more than the detection level of 0.1 ppm W. However, the cluster of sites with detectable W in the Teneycke-MacKay lakes area indicates that there is a zone of weak geochemical enrichment.

Ytterbium (Yb) - see Lanthanum and Other Rare Earth Elements.

Zinc (Zn)

Moderate concentrations of Zn occur between Lynx and Sulphide lakes, and in the Teneycke Lake area.

SURFACE CONTAMINATION

When interpreting geochemical data derived from the analysis of surface materials, due consideration must be given to the possibility of anthropogenic contamination. Humus is particularly sensitive to such effects, because it sits on the surface of soils and, unlike vegetation samples, it cannot be cleaned by washing. An extensive study of humus chemistry in the Flin Flon area has shown that the effects on humus chemistry extend for a radius of at least 50 km from the Pb/Zn smelter and for some elements the effects are discernible for over 100 km (Henderson, 1995; Henderson and McMartin, 1995; Henderson *et al.*, in press; McMartin and Henderson, in press). Studies of humus geochemistry from the Snow Lake area, Manitoba (beyond the maximum radius of the Flin Flon smelter contamination) where there is natural enrichment in Cu and Zn, confirm that humus can be a medium of use in defining the location of overburden-covered mineralization (Kaszycki *et al.*, 1996).

The La Ronge study area is remote from any smelter (Flin Flon being the nearest at more than 200 km to the southeast), and at the time of sample collection in 1984 there had been no mining activity within the area. The abandoned Anglo-Rouyn open-pit mine is located a few kilometres to the south. Only two roads, both unpaved, traverse the area. For the most part, therefore, the extent of possible anthropogenic contamination is minimal. It has been noted in the section on iron that several elements are concentrated in samples collected from sites along Highway 102. There is no known geological feature, such as a shear zone or a belt of relatively Fe-rich rocks, which might have given rise to this linear enrichment of elements. In a study of dust contamination of spruce twigs in northern Saskatchewan, it was found that much of the dust from an unpaved highway settles within 100 m from the road, but at 300 m there is still a measurable amount (Dunn, 1987). It is likely, therefore, that this trend of enrichment can be attributed to contamination from road dust and that the road metal has a moderate enrichment of fine-grained Fe-rich and micaceous particulates. Whereas the sampling procedure was to collect samples at a minimum distance of 50 m from roads, it appears that this was not far enough away to avoid the effects of the road dust. Even though the surface leaf litter at each sample station was removed before collection of the humus sample, this precaution proved inadequate to avoid some contamination. It seems probable that airborne particulates that landed on the surface were washed down in to the humus by rain and melting snow to give an enhanced signal to the chemistry of the humus. From these data it is recommended

that for future humus studies in similar environments, samples should be collected a minimum of 200 m from unpaved roads.

ACKNOWLEDGEMENTS

The field sampling programme was conducted in 1984 by the Saskatchewan Geological Survey under the first Canada-Saskatchewan Mineral Development Agreement (1984-1989). At that time Saskatchewan Energy and Mines employed the author, and Catherine Lawrence, Carmen Beloff, Liz Koopman, Janine Lorenz, Blaine Scott, Tom Yarrnton, Dave MacDougall and Guy Buller who provided field assistance. The analytical work and data compilation components of the study were funded under the Canada-Saskatchewan Partnership Agreement on Mineral Development (1990-1995). Sample preparation and data analysis were undertaken at the GSC. Tina Hearty and Robin Balma provided assistance for the data analysis and compilation. Additional cartographic help and advice was provided by Stephen Day and Susan Davis.

Tom Sibbald, Doug Paterson, Ralf Maxeiner, Bill Slimmon and Rick Bennett from Saskatchewan Energy and Mines are thanked for providing information and facilities to assist in production of this report. Steve Adcock's (GSC) comments on the final manuscript are gratefully acknowledged.

NOTES ON THE DATA LISTINGS AND ELEMENT DISTRIBUTION MAPS (Appendices A and B)

Appendix A contains lists of sample locations and all analytical data obtained for the humus samples. The first row of data shows the detection levels for each element. The analysis of each sample extends across two pages (Au-La on the first page, and Lu-Zn on the second). Appendix B provides for each element a simple statistical analysis of the data, and a proportional dot plot of element concentrations. The sequence of elements is the same as that in Appendix A, starting with Au and followed by elements arranged in alphabetic order by their chemical symbols,

REFERENCES

- Brooks, R.R., Dunn, C.E., and Hall, G.E.M., 1995. Biological Systems in Mineral Exploration and Processing. Ellis Horwood (Division of Simon and Schuster), Hemel Hempstead, UK, 538 pp.
- Chapman, R., Curry, G., and Sopuck, V., 1990. The Bakos deposit - A case history. *In: Modern Exploration Techniques* (Eds. L.S. Beck and C.T. Harper), Sask. Geol. Soc., Spec. Publ. #10, p.195-212.
- Coombe, W. , 1984. Gold in Saskatchewan. Sask. Energy and Mines, Open File Rep. 84-1, 134 pp.
- Coombe Geoconsultants Ltd. 1991. Base metals in Saskatchewan. Sask. Energy and Mines, Open File Rep. 91-1, 219 pp.
- Dunn, C.E., 1984. Biogeochemical method and surveys, southern La Ronge Belt. *In: Summary of Investigations 1984*, Saskatchewan Geological Survey, Sask. Energy and Mines, Misc. Rep. 84-4, p.95-103.
- Dunn, C.E., 1985. Biogeochemical exploration for gold in the La Ronge Belt, 1985. *In: Summary of Investigations, 1985*, Saskatchewan Geological Survey, Sask. Energy and Mines, Misc. Rep. 85-4, p.37-49.
- Dunn, C.E., 1986a. Gold exploration in northern Saskatchewan by biogeochemical methods. *Can. Inst. Min. and Metall., Sp. Vol. 38: p.418-434.*
- Dunn, C.E., 1986b. Biogeochemical studies in the Saskatchewan gold belt, 1986. *In: Summary of Investigations, 1986*, Saskatchewan Geological Survey, Sask. Energy and Mines, Misc. Rep. 86-4, p.129-135.
- Dunn, C.E., 1987. Biogeochemical exploration for minerals beneath the northern forests of Canada. *In: The Practical Applications of Trace Elements and Isotopes to Environmental Biogeochemistry and Mineral Resources Evaluation* (Eds. R.W. Hurst, T.E. Davis and S.S. Augustithis), Theophrastus Publications S.A., Athens, Greece, p.161-180.
- Dunn, C.E., 1995. Biogeochemical prospecting for metals. *In: Biological Systems in Mineral Exploration and Processing* (Eds. R.R. Brooks, C.E. Dunn and G.E.M. Hall), Ellis Horwood (Division of Simon and Schuster), Hemel Hempstead, UK, p.371-425.
- Dunn, C.E., and Schwann, P.L., 1990. Site investigation of a biogeochemical gold anomaly near Wadin Bay, Lac La Ronge. *In: Summary of Investigations, 1990*.

- Saskatchewan Geological Survey, Sask. Energy and Mines, Misc. Rep. 90-4, p.158-162.
- Dunn, C.E., George, H., and Spirito, W., 1990. Patterns of metal enrichment in vegetation in relation to geology and gold mineralization: Star Lake area, Saskatchewan. *In: Modern Exploration Techniques* (Eds. L.S. Beck and C.T. Harper), Sask. Geol. Soc., Special Publ. #10, p.12-27.
- Fayek, M., and Kyser, T.K., 1995. Characteristics of auriferous and barren fluids associated with the Proterozoic Contact Lake Gold Deposit, Saskatchewan, Canada. *Econ. Geol.*, v.90, p.385-406.
- Fayek, M., Kyser, T.K., Kusmirski, R.T., Sopuck, V., and Chan, D., 1993. Contrasting styles of alteration with barren and auriferous quartz veins from the Contact Lake lode gold deposit. *In: Summary of Investigations 1993*, Saskatchewan Geological Survey, Sask. Energy and Mines, Misc. Rep. 93-4, p.153-160.
- Forsythe, L.H., 1968. Geology of the Stanley area (west half), MacKay Lake area. Sask. Dept. Miner. Resour., Rep. 115 (part 1), 58 pp.
- Forsythe, L.H., 1971. The geology of the Nemeiben Lake area (east half) and the geology of mineral deposits in the Nemeiben-Stanley areas. Sask. Dept. Miner. Resour., Rep. 115 (part II), 178 pp.
- Henderson, P.J., 1995. Surficial geology and drift composition of the Annabel Lake-Amisk Lake area, Saskatchewan (NTS 63L/9, L/16, and part of 63K/12 and K/13). *Geol. Survey Canada, Open File 3026*, 202 pp.
- Henderson, P.J., and McMartin, I., 1995. Mercury distribution in humus and surficial sediments, Flin Flon, Manitoba, Canada. *Water, Air and Soil Pollution*, **80**, p.1043-1046.
- Henderson, P.J., McMartin, I., Hall, G.E.M., Percival, J.B., and Walker, D.A. (In press). The chemical and physical characteristics of heavy metals in humus and till in the vicinity of the base metal smelter at Flin Flon, Manitoba, Canada. *Environmental Geology*.
- Johnson, D., Kershaw, L., MacKinnon, A., and Pojar, J., 1995. *Plants of the Western Boreal Forest and Aspen Parkland*. Lone Pine Publ., Edmonton, 392 pp.
- Kaszycki, C.A., Nielsen, E., and Gobert, G., 1996. Surficial geochemistry and response to volcanic-hosted massive sulphide mineralization in the Snow Lake region. *In: EXTECH I: A multidisciplinary Approach to Massive Sulphide Research in the Rusty-Snow Lake Greenstone Belts, Manitoba* (Eds. G.F. Bonham-Carter, A.G. Galley, and G.E.M. Hall), *Geol. Survey Canada Bull.* 426, p.139-154.

- Keith, M.L., 1941. MacKay Lake, Saskatchewan. Geol. Surv. Can., Map 592A with descriptive notes.
- Kyser, T.K., Fayek, M., and Sibbald, T.I.I., 1992. Geochronological studies in the La Ronge and Glennie domains. *In: Summary of Investigations 1992, Saskatchewan Geological Survey, Sask. Energy and Mines, Misc. Rep. 92-4, p.130-134.*
- Lentschig, S., and Fiedler, H.J., 1967. Beitrag zur Kenntnis der Böden des Tharandt-Grillenburger Waldes. III. Chemische und mineralogische Untersuchungen usw. Abh. Staatl. Mus. Mineral. Geol., Dresden 12, p.229-258.
- Lewry, J.F., 1984. Bedrock compilation, Lac la Ronge and Wapawekka area (NTS 73P/73I). *In: Summary of Investigations 1984, Saskatchewan Geological Survey, Sask. Energy and Mines, Misc. Rep. 84-4, p.34-41.*
- Lewry, J.F., 1986. Bedrock geological mapping, MacKay Lake north (part of NTS 73P-7). *In: Summary of Investigations 1986, Saskatchewan Geological Survey, Sask. Energy and Mines, Misc. Rep. 86-4, p.48-53.*
- Lewry, J.F., and Slimmon, W.L., 1985. Compilation bedrock geology, Lac la Ronge, NTS area 73P/73I. Sask. Energy and Mines, Rep. 225 (1:250,000 scale map with original report).
- Maxeiner, R.O., 1994. Geology of the MacKay Lake and Anglo Rouyn Mine areas, southern La Ronge Domain. *In: Summary of Investigations 1995, Saskatchewan Geological Survey, Sask. Energy and Mines, Misc. Rep. 94-4, p.44-52*
- Maxeiner, R.O., and Sibbald, T.I.I., 1995. Controversial rocks in the Hebden-MacKay Lakes area, southern La Ronge Domain. *In: Summary of Investigations 1995, Saskatchewan Geological Survey, Sask. Energy and Mines, Misc. Rep. 95-4.*
- McLarty, D.M.E., 1935. Lac la Ronge sheet (east half). Geol. Survey Canada, Map 358A with descriptive notes.
- McMartin, I., and Henderson, P.J. (In press). Impact of a base metal smelter on the geochemistry of soils of the Flin Flon region, Manitoba and Saskatchewan. *Can. J. Earth Sciences.*
- Roberts, R.G., and Krey, K., 1992. The Anglo-Rouyn Mine, La Ronge area: A preliminary report. *In: Summary of Investigations 1992, Saskatchewan Geological Survey, Sask. Energy and Mines, Misc. Rep. 92-4, p.184-188.*

- Sibbald, T.I.I., 1986. Bedrock geological mapping, Sulphide Lake area (part of NTS 73P-7). *In*: Summary of Investigations 1986, Saskatchewan Geological Survey, Sask. Energy and Mines, Misc. Rep. 86-4, p.63-64.
- Sibbald, T.I.I., 1987. Bedrock geological mapping, Sulphide Lake area (part of NTS 73P-7). *In*: Summary of Investigations 1987, Saskatchewan Geological Survey, Sask. Energy and Mines, Misc. Rep. 87-4, map.
- Slimmon, W.L., 1986. Bedrock geological mapping, Hebden Lake area (part of NTS 73P-7). *In*: Summary of Investigations 1986, Saskatchewan Geological Survey, Sask. Energy and Mines, Misc. Rep. 86-4, p.42-47.
- Stevenson, F.J., 1994. Humus Geochemistry: Genesis, Composition, Reactions. John Wiley and Sons, Inc., Toronto, 496 pp.
- Thomas, D.J., 1990. North Lake Gold deposit: a model for arenite-hosted gold. *In*: Summary of Investigations 1990, Saskatchewan Geological Survey, Sask. Energy and Mines, Misc. Rep. 90-4, p.21-24.