

MINNESOTA GEOLOGICAL SURVEY

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Information Circular 25

ISSN 0544-3105

**ANALYTICAL RESULTS OF THE
PUBLIC GEOLOGIC SAMPLE PROGRAM,
1985-1987 BIENNIUM**

OCT 22 1996

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PUBLIC GEOLOGIC SAMPLE PROGRAM,
1985-1987 BIENNIUM**

By

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INTRODUCTION

In 1983 the Minnesota Geological Survey, in conjunction with the Minnesota Department of Natural Resources, Division of Minerals, began a geologic sample program involving the chemical analysis of geological materials, in part submitted by the general public. This Information Circular summarizes the results of that program during the 1985-1987 biennium. In all, 163 samples were analyzed for a variety of minor and trace elements (Tables 1-6); 111 samples were analyzed for major elements as well as minor and trace elements (Tables 7-12). The tables within those categories are organized by the geological age of the materials analyzed.

ANALYTICAL PROCEDURES

A variety of analytical services, and consequently methods, were used during the 1985-1987 biennium. The various analytical facilities, their methods and reported detection limits are summarized below:

I. MINOR-ELEMENT EXPLORATION PACKAGE--TABLES 1-6

Table 1 through Table 4, analysis 1; Geochemical Services Inc.

Element	Value	Detection Limit	Analytical Method
Ag	ppm	0.025	Inductively Coupled Plasma
As	ppm	1.0	"
Au	ppm	0.001 or .0005	Fire Assay-Atomic Absorption
Bi	ppm	0.50	Inductively Coupled Plasma
Cd	ppm	0.25	"
Cu	ppm	0.025	"
Ga	ppm	0.50	"
Hg	ppm	0.10	"
Mo	ppm	0.10	"
Pb	ppm	0.25	"
Pd	ppm	0.10	"
Pt	ppm	0.25	"
Sb	ppm	1.0	"
Se	ppm	0.5	"
Sn	ppm	0.5	"
Te	ppm	0.5	"
Tl	ppm	0.5	"
Zn	ppm	1.0	"

Table 4, analyses 2-13; Bondar-Clegg & Company Ltd.

Element	Value	Detection Limit	Analytical Method
Cu	ppm	1.0	Atomic Absorption
Ni	ppm	2.0	"
Pt	ppm	15.0	Fire Assay - Atomic Absorption
Pd	ppm	2.0	"

Table 5; Chemex Labs Ltd.

Element	Value	Detection Limit	Analytical Method
As	ppm	1.0	Inductively Coupled Plasma
Mo	ppm	1.0	"
W	ppm	2.0	"
Zn	ppm	1.0	"
P	ppm	5.0	"
Pb	ppm	1.0	"
Bi	ppm	0.1	"
Cd	ppm	0.1	"
Co	ppm	1.0	"
Ni	ppm	1.0	"
Ba	ppm	10.0	"
Mn	ppm	5.0	"
Cr	ppm	5.0	"
V	ppm	5.0	"
Be	ppm	0.1	"
Cu	ppm	1.0	"
Ag	ppm	0.1	Atomic Absorption
Sr	ppm	1.0	Inductively Coupled Plasma

Table 6; X-Ray Assay Laboratories, Limited

Element	Value	Detection Limit	Analytical Method
Au	ppb/ppm	2.000/0.001	Neutron Activation/Fire Assay
Ba	ppm	15.000	"
Be	ppm	0.100	Direct Current Plasma
B	ppm	10.000	"
Sc	ppm	0.010	Neutron Activation
V	ppm	2.000	Direct Current Plasma
Mn	ppm	2.000	"
Co	ppm	0.100	Neutron Activation
Ni	ppm	1.000	Direct Current Plasma
Cu	ppm	0.500	"
Zn	ppm	0.500	"
Ge	ppm	10.000	"
As	ppm	1.000	Neutron Activation
Se	ppm	0.500	"
Br	ppm	0.500	"
Mo	ppm	2.000	"
Ag	ppm	0.500	Direct Current Plasma
Cd	ppm	1.000	"
Sb	ppm	0.100	Neutron Activation
Cs	ppm	0.200	"
La	ppm	0.00	"
Ce	ppm	1.000	"
Nd	ppm	3.000	"
Sm	ppm	0.010	"
Eu	ppm	0.050	"
Tb	ppm	0.100	"

Yb	ppm	0.050	"
Lu	ppm	0.010	"
Hf	ppm	0.200	"
Ta	ppm	0.500	"
W	ppm	1.000	"
Ir	ppm	5.000	"
Pb	ppm	2.00	Direct Current Plasma
Th	ppm	0.200	Neutron Activation
U	ppm	0.100	"
Rb	ppm	10.000	"

II. WHOLE-ROCK ANALYSIS--TABLES 7-12

Table 7 through Table 11, analyses 1-27 and Table 12; X-Ray Assay Laboratories, Limited

Constituent	Value	Reproducibility Detection Limit	Analytical Method
SiO ₂	%	+ 1%	X-ray fluorescence
Al ₂ O ₃	%	"	"
CaO	%	"	"
MgO	%	"	"
Na ₂ O	%	"	"
K ₂ O	%	"	"
Total Fe as Fe ₂ O ₃	%	"	"
MnO	%	"	"
TiO ₂	%	"	"
P ₂ O ₅	%	"	"
LOI	%	"	"
Cl	ppm	50.000	"
H ₂ O+	%	0.100	Wet Chemical
CO ₂	%	0.010	"
S	%	0.010	X-ray-fluorescence
FeO	%	0.100	Wet Chemical
Rb	ppm	10.000	X-ray-fluorescence
Sr	ppm	10.000	"
Y	ppm	10.000	"
Zr	ppm	10.000	"
Nb	ppm	10.000	"
Ba	ppm	10.000	"
Cr	ppm	10.000	"
La	ppm	0.100	Neutron Activation
Ce	ppm	1.000	"
Nd	ppm	3.000	"
Sm	ppm	0.010	"
Eu	ppm	0.050	"
Tb	ppm	0.100	"
Yb	ppm	0.050	"
Lu	ppm	0.010	"

Table 11, analyses 28-37; Chemex Labs Ltd.

Constituent	Value	Reproducibility Detection Limit	Analytical Method
SiO ₂	%	0.01%	Inductively coupled
Al ₂ O ₃	%	"	plasma/atomic
CaO	%	"	emission spectrometry
MgO	%	"	"
Na ₂ O	%	"	"
K ₂ O	%	"	"
Total Fe as Fe ₂ O ₃	%	"	"
MnO	%	"	"
TiO ₂	%	"	"
H ₂ O+	%	"	"
CO ₂	%	"	"
S	%	"	"
FeO	%	"	"

EXPLANATION OF THE ABBREVIATED T-R-S SYSTEM

A great majority of townships in Minnesota are north of a zero standard parallel and west of a zero principal meridian. Therefore in Minnesota T.130N., R.33W., sec. 29 is the description of a legal section of land--in this case, Hartford Township in Todd County. More precise locations within a legal section can be specified by the ABCD system, which is a simplification of the "NW¹/₄SE¹/₄..." system that traditionally has been used in legal land descriptions. In the ABCD system (Fig. 1), A is the northeast quadrant, B is the northwest quadrant, C is the southwest quadrant, and D is the southeast quadrant, and the largest quadrant pertaining to a location is given first. In our example, the location of a drill hole or sample in the NE¹/₄ of the SE¹/₄ of the SW¹/₄ of the SW¹/₄ of the NW¹/₄ of section 29 in Hartford Township of Todd County, would be described as BCCDA.

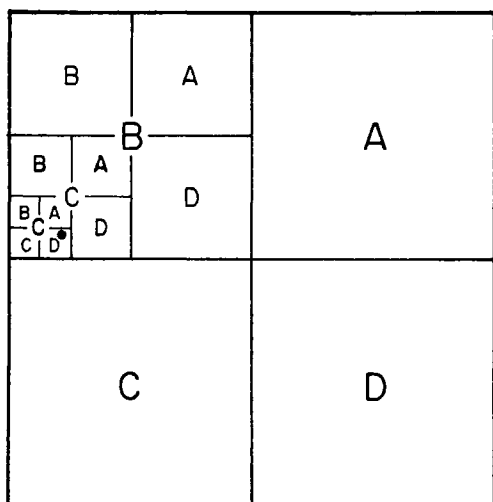


Figure 1. Location of the drill hole or sample in the example given.

Table 1. Publicly Submitted Samples--Minor-Element Exploration Package

	1	2	3
Ag	.133	<.025	1.
As	<1.0	<1.0	181.
Au	.001	.001	.015
Bi	.693	<.5	97.
Cd	1.85	<1.0	10.
Cu	33.9	3.29	8.
Ga	<.5	<.5	<2.
Hg	<.5	<.5	2.5
Mo	1.97	1.83	44.
Pb	121.0	3.62	28.
Pd	<.25	<.25	15.
Pt	<.5	<.5	63.
Sb	.472	<.25	215.
Se	<1.0	<1.0	7.
Sn	<0.5	<0.5	<0.5
Te	.679	<.5	>10000.
Tl	<.5	<.5	21.4
Zn	416.0	14.9	3.0

1. GSP-38--Ankerite-quartz vein, unknown location.
2. GSP-39--Quartz vein; Thomson Formation, Early Proterozoic; outcrop sample, T. 62 N., R. 19 W., sec. 14; St. Louis County.
3. GSP-43--Quartz vein, chalcopyrite, pyrite, pyrrhotite, and molybdenite-bearing; unnamed formation, Precambrian; test pit, T. 62 N., R. 22 W., sec. 2, center B; Itasca County.

Table 2. Samples of Archean Age--Minor-Element Exploration Package

	1	2	3	4	5	6	7	8
Ag	.068	.115	.075	.612	<.025	.032	.095	<.025
As	<1.0	<1.0	<1.0	3.02	1.42	<1.0	4.26	<1.0
Au	.002	.002	.248	.157	.001	.001	.002	.006
Cu	4.65	300.	43.6	365.	22.0	24.8	170.	122.0
Hg	<.1	<.1	<.1	.331	<.1	<.1	<.1	<.5
Mo	2.06	.875	.462	2.56	.317	.972	.731	.609
Pb	2.27	1.14	9.00	19.5	.647	3.92	1.91	1.15
Sb	.257	.328	.303	8.51	.429	.328	.479	<.25
Tl	<.5	<.5	<.5	<.5	<.5	<.536	<.5	<.5
Zn	31.7	48.7	82.7	101.	65.5	94.1	82.0	37.2
Bi	<.25	<.25	<.25	.268	<.25	<.25	<.25	<.5
Cd	<.25	<.25	<.25	<.25	<.25	<.25	<.25	<.5
Ga	22.0	4.27	8.28	8.52	10.1	9.88	10.2	3.49
Pd	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.25
Pt	<.25	<.25	<.25	<.25	<.25	<.25	<.25	<.5
Se	<1.0	1.74	<1.0	1.17	<1.0	<1.18	1.84	<1.0
Sn	.662	<.5	.526	10.3	<.5	<.5	<.5	<.5
Te	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
	9	10	11	12	13	14	15	16
Ag	<.025	<.025	1.23	<.025	<.025	<.025	<.025	.032
As	<1.0	<1.0	10.8	<1.0	<1.0	<1.0	<1.0	2.4
Au	<.0005	.001	.002	<.0005	.002	<.0005	.001	.001
Cu	21.5	11.9	90.1	149.0	55.5	31.4	.802	96.0
Hg	.998	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Mo	.616	1.06	<.5	<.5	.531	<.5	<.5	<.5
Pb	2.58	.718	29.0	2.44	1.25	.834	.6	1.0
Sb	<.25	<.25	.548	<.25	<.25	<.25	<.25	<.25
Tl	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Zn	93.6	34.5	188.0	33.4	33.2	53.5	45.0	75.6
Bi	<.5	<.5	.71	<.5	<.5	<.5	<.5	<.5
Cd	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Ga	8.11	4.29	11.0	1.69	1.81	6.4	4.31	5.97
Pd	<.25	<.25	<.25	<.25	<.25	<.25	<.25	<.25
Pt	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Se	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sn	.714	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Te	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5

Table 2 continued

	17	18	19	20	21	22	23	24
Ag	<.025	.528	.08	<.025	.079	.099	<.025	<.025
As	<1.0	8.27	2.55	<1.0	1.21	<1.0	<1.0	<1.0
Au	<.0005	.001	.001	<.0005	.001	.001	<.0005	<.0005
Cu	110.0	30.4	13.2	1.1	57.6	380.0	12.1	68.15
Hg	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Mo	.6	1.15	1.24	<.5	<.5	<.5	.556	<.5
Pb	<.5	19.7	3.4	<.5	2.41	1.11	.515	1.74
Sb	<.25	.375	<.25	<.25	<.25	<.25	<.25	<.25
Tl	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Zn	68.0	179.0	74.3	109.0	204.0	93.9	51.7	54.9
Bi	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Cd	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Ga	4.19	6.25	3.71	8.96	10.3	.62	2.29	1.46
Pd	<.25	<.25	<.25	<.25	<.25	<.25	<.25	<.25
Pt	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Se	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sn	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Te	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
	25	26	27	28	29	30	31	32
Ag	<.025	<.025	<.025	<.025	<.025	<.025	<.025	<.025
As	<1.0	2.25	<1.0	<1.0	1.3	<1.0	2.07	<1.0
Au	.001	<.0005	.001	<.0005	<.0005	<.0005	<.0005	.001
Cu	13.6	99.0	48.0	.623	39.4	86.8	86.7	19.6
Hg	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Mo	<.5	.601	<.5	.784	<.5	.741	<.5	<.5
Pb	.966	1.72	.885	<.5	.764	<.5	1.19	.982
Sb	<.25	<.25	<.25	<.25	<.25	<.25	<.25	<.25
Tl	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Zn	153.0	63.8	43.3	56.0	73.9	48.5	48.8	58.6
Bi	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Cd	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Ga	10.4	3.19	2.41	6.94	6.65	2.61	2.04	4.69
Pd	<.25	<.25	<.25	<.25	<.25	<.25	<.25	<.25
Pt	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Se	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.05	<1.0
Sn	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Te	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5

Table 2 continued

	33	34	35	36	37	38	39	40
Ag	<.025	<.025	<.025	<.025	<.025	.151	.175	.086
As	<1.0	<1.0	<1.0	<1.0	1.29	87.3	58.6	40.3
Au	<.0005	.002	.001	<.0005	.002	.422	.336	.206
Cu	1.35	.945	42.3	111.0	51.1	49.1	144.0	64.8
Hg	<.5	<.5	<.5	<.5	<.5	1.19	1.29	<.5
Mo	<.5	<.5	<.5	<.5	<.5	6.69	9.07	4.82
Pb	.868	<.5	2.25	1.84	1.14	5.26	13.5	4.46
Sb	<.25	<.25	<.25	<.25	<.25	3.96	3.95	1.59
Tl	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Zn	71.2	76.7	85.5	69.4	65.9	23.0	40.7	42.2
Bi	<.5	<.5	<.5	<.5	<.5	.536	.539	<.5
Cd	<.5	<.5	<.5	<.5	<.5	1.87	1.76	1.66
Ga	5.71	5.5	5.74	5.22	4.78	<.5	<.5	.687
Pd	<.25	<.25	<.25	<.25	<.25	<.25	<.25	<.25
Pt	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Se	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sn	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Te	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
	41	42	43	44	45	46	47	48
Ag	<.025	.029	<.025	<.025	.072	.064	.507	.082
As	19.7	8.47	5.39	2.81	5.5	2.58	10.0	<1.0
Au	.124	.064	.062	.026	.045	.025	.083	.029
Bi	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Cd	1.01	1.16	1.1	<1.0	1.89	1.94	3.84	<1.0
Cu	15.5	15.3	115.0	7.02	62.2	45.5	389.0	94.0
Ga	3.04	<.5	2.83	<.5	<.5	<.5	<.5	1.8
Hg	<.5	<.5	<.5	<.5	.78	.86	1.85	<.5
Mo	2.41	2.81	.619	4.26	2.44	1.71	5.69	1.78
Pb	2.5	3.69	1.08	1.1	3.59	3.25	7.32	1.79
Pd	<.25	<.25	<.25	<.25	<.25	<.25	.373	<.25
Pt	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Sb	1.13	.676	.52	.276	.584	.425	.614	.31
Se	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sn	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Te	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Tl	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Zn	60.5	36.0	91.1	4.4	39.4	40.1	20.3	43.8

Table 2 continued

	49	50	51	52	53	54	55	56
Ag	.283	.148	.197	.052	<.025	<.025	.059	.039
As	2.79	1.26	3.26	<1.0	3.47	1.53	<1.0	<1.0
Au	.036	.017	.021	.006	.02	.013	.003	<.000
Bi	<.5	.857	<.5	<.5	<.5	<.5	<.5	<.5
Cd	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cu	79.5	515.0	332.0	83.0	10.2	5.9	38.9	72.6
Ga	<.5	3.5	.645	<.5	<.5	4.54	1.37	.788
Hg	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Mo	2.35	1.22	7.84	1.88	1.04	.904	.75	1.02
Pb	2.48	5.72	24.4	3.78	2.06	1.54	2.87	2.79
Pd	<.25	<.25	<.25	<.25	<.25	<.25	<.25	<.25
Pt	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Sb	.385	.272	17.4	1.09	.57	<.25	.498	.762
Se	1.09	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.01
Sn	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Te	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Tl	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Zn	10.7	51.4	59.8	37.5	12.6	99.4	42.5	28.4

6

1. CUS-3A--Fine-grained metagraywacke and felsic tuff, interbedded, mylonitic zone; Archean; core sample, T. 158 N., R. 28 W., sec. 35, ADDDDD; Koochiching County.
2. CUS-10--Laminated hornblende schist; unnamed formation, Archean; core sample, T. 160 N., R. 31 W., sec. 20, AABBBC; Lake of the Woods County.
3. CUS-17--Clinopyroxenite, extensively altered to chlorite, serpentine; unnamed formation, Archean; core sample, T. 159 N., R. 33 W., sec. 18, CABBCDA; Lake of the Woods County.
4. CUS-19--Epidote-chlorite-actinolite schist; network of carbonate veins; unnamed formation, Archean; core sample, T. 159 N., R. 35 W., sec. 3, BCCBCA; Lake of the Woods County.

Table 2 continued

5. CUS-21B--Crinkled chlorite phyllite; partly recrystallized mylonite; unnamed formation, Archean; core sample, T. 158 N., R. 36 W., sec. 30, AACDDA; Beltrami County.
6. CUS-24--Mafic hornblende quartz diorite; unnamed formation, Archean; core sample, T. 160 N., R. 36 W., sec. 18, BCCBCC; Lake of the Woods County.
7. CUS-27A--Retrograded chlorite-bearing amphibolite, strongly foliated; unnamed formation, Archean; core sample, T. 157 N., R. 34 W., sec. 13, AAABBC; Lake of the Woods County.
8. 14512--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 25 ft.; H = 236 ft., relative to 225 ft. reference mark; East Wall, St. Louis County.
9. 14966--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 24 ft.; H = 120 ft., relative to 225 ft. reference mark; West Wall, St. Louis County.
10. 14994--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 23.5 ft.; H = 95 ft., relative to 225 ft. reference mark; East Wall, St. Louis County.
11. 15601--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 20 ft.; H = 148 ft., relative to 225 ft. reference mark; West Wall, St. Louis County.
12. 15614--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 5 ft.; H = 0 ft., relative to 225 ft. reference mark; West Wall, St. Louis County.
13. 14514--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 25 ft.; H = 225 ft., relative to 225 ft. reference mark; East Wall, St. Louis County.
14. 14516--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 26 ft.; H = 215 ft., relative to 225 ft. reference mark; East Wall, St. Louis County.

Table 2 continued

15. 14518--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 25 ft.; H = 205 ft., relative to 225 ft. reference mark; East Wall, St. Louis County.
16. 14520--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 27 ft.; H = 195 ft., relative to 225 ft. reference mark; East Wall, St. Louis County.
17. 14522--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 29 ft.; H = 185 ft., relative to 225 ft. reference mark; East Wall, St. Louis County.
18. 14524--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 26 ft.; H = 175 ft., relative to 225 ft. reference mark; East Wall, St. Louis County.
19. 14526--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 25 ft.; H = 165 ft., relative to 225 ft. reference mark; East Wall, St. Louis County.
20. 14979--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 25 ft.; H = 60 ft., relative to 225 ft. reference mark; West Wall, St. Louis County.
21. 14981--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 27 ft.; H = 150 ft., relative to 225 ft. reference mark; East Wall, St. Louis County.
22. 14982--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 27 ft.; H = 153 ft., relative to 225 ft. reference mark; East Wall, St. Louis County.
23. 14983--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 27 ft.; H = 154 ft., relative to 225 ft. reference mark; East Wall, St. Louis County.

Table 2 continued

24. 14984--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 26 ft.; H = 145 ft., relative to 225 ft. reference mark; East Wall, St. Louis County.
25. 14986--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 25 ft.; H = 135 ft., relative to 225 ft. reference mark; East Wall, St. Louis County.
26. 14989--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 24 ft.; H = 115 ft., relative to 225 ft. reference mark; East Wall, St. Louis County.
27. 14991--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 25 ft.; H = 105 ft., relative to 225 ft. reference mark; East Wall, St. Louis County.
28. 14996--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 24 ft.; H = 90 ft., relative to 225 ft. reference mark; East Wall, St. Louis County.
29. 14998--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 22 ft.; H = 80 ft., relative to 225 ft. reference mark; East Wall, St. Louis County.
30. 15000--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 20 ft.; H = 70 ft., relative to 225 ft. reference mark; East Wall, St. Louis County.
31. 15013--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 25 ft.; H = 125 ft., relative to 225 ft. reference mark; East Wall, St. Louis County.
32. 15604--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 9 ft.; H = 50 ft., relative to 225 ft. reference mark; West Wall, St. Louis County.

Table 2 continued

33. 15605--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 8 ft.; H = 45 ft., relative to 225 ft. reference mark; West Wall, St. Louis County.
34. 15606--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 7 ft.; H = 40 ft., relative to 225 ft. reference mark; West Wall, St. Louis County.
35. 15608--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 6 ft.; H = 30 ft., relative to 225 ft. reference mark; West Wall, St. Louis County.
36. 15610--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 5 ft.; H = 20 ft., relative to 225 ft. reference mark; West Wall, St. Louis County.
37. 15612--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 5 ft.; H = 10 ft., relative to 225 ft. reference mark; West Wall, St. Louis County.
38. I10B--Chert with disseminated pyrite; unnamed formation, Archean; outcrop sample, T. 60 N., R. 24 W., sec. 3, ADD; Itasca County.
39. I16A--Black vein in metabasalt; unnamed formation, Archean; outcrop sample, T. 60 N., R. 22 W., sec. 7, ADD; Itasca County.
40. I16D--Silicified metabasalt with quartz-carbonate veins; unnamed formation, Archean; outcrop sample, T. 60 N., R. 22 W., sec. 7, ADD; Itasca County.
41. I18C--Breccia with felsic volcanic clasts in chloritic matrix; unnamed formation, Archean; outcrop sample, T. 60 N., R. 24 W., sec. 1, BDA; Itasca County.
42. I61A--Dacite porphyry; unnamed formation, Archean; outcrop sample, T. 60 N., R. 22 W., sec. 6, ADD; Itasca County.
43. I65A--Metabasalt with quartz-carbonate veins; unnamed formation, Archean; outcrop sample, T. 60 N., R. 23 W., sec. 14, BAA; Itasca County.

Table 2 continued

44. I75B--Cherty banded iron-formation; unnamed formation, Archean; outcrop sample, T. 60 N., R. 23 W., sec. 23, ACC; Itasca County.
45. I86B--Banded iron-formation, magnetite- and pyrite-bearing; unnamed formation, Archean; outcrop sample, T. 60 N., R. 23 W., sec. 23, BAD; Itasca County.
46. I87C--Conglomerate, felsic-intermediate, volcanic and sedimentary clasts; unnamed formation, Archean; outcrop sample, T. 60 N., R. 23 W., sec. 23, BAD; Itasca County.
47. I92B--Sulfide-rich vein in banded iron-formation; unnamed formation, Archean; outcrop sample, T. 60 N., R. 23 W., sec. 23, BCA; Itasca County.
48. I103C--Metabasalt with disseminated pyrite; unnamed formation, Archean; outcrop sample, T. 60 N., R. 23 W., sec. 24, ABB; Itasca County.
49. I154B--Banded iron-formation, sulfide-rich; unnamed formation, Archean; outcrop sample, T. 60 N., R. 23 W., sec. 36, DCA; Itasca County.
50. I167B--Intermediate agglomerate with clasts of pyrite-filled scoria; unnamed formation, Archean; outcrop sample, T. 60 N., R. 22 W., sec. 18, AAD; Itasca County.
51. I175B--Metagabbro, amphibolitic with relict ophitic texture; unnamed formation, Archean; outcrop sample, T. 60 N., R. 22 W., sec. 18, BBB; Itasca County.
52. I184C--Dacite porphyry; unnamed formation, Archean; outcrop sample, T. 60 N., R. 22 W., sec. 18, CDD; Itasca County.
53. 85-10-348.5--Gneissose rock, plagioclase-rich, wholly altered to sericite and zoisite; unnamed formation, Archean; sample depth 348.5 ft., Minnesota Geological Survey drill hole 1985-10, T. 130 N., R. 35 W., sec. 28, DDDDBA; Todd County.
54. 85-10-355.5--Schist, garnet-biotite-quartz-plagioclase, very coarse grained; unnamed formation, Archean; sample depth 355.5 ft., Minnesota Geological Survey drill hole 1985-10, T. 130 N., R. 35 W., sec. 28, DDDDBA; Todd County.
55. 85-2-284--Diorite, appinitic; unnamed formation, Archean(?); sample depth 284 ft., Minnesota Geological Survey drill hole 1985-2, T. 136 N., R. 31 W., sec. 19, DCDCDD; Cass County.
56. 85-5-257--Hornblende tonalite/diorite; unnamed formation, Archean(?); sample depth 257 ft., Minnesota Geological Survey drill hole 1985-5, T. 131 N., R. 35 W., sec. 10, ABAAAB; Todd County.

Table 3. Samples of Early Proterozoic Age--Minor-Element Exploration Package

	1	2	3	4	5	6
Ag	.046	<.025	.115	<.025	.16	.289
As	<1.0	1.22	1.06	29.6	<1.0	7.0
Au	.002	.012	.003	.004	.004	.004
Bi	<.5	<.5	<.5	<.5	.726	.701
Cd	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cu	100.0	340.0	56.8	9.93	20.7	135.0
Ga	1.12	7.51	1.14	1.66	<.5	1.77
Hg	<.5	<.5	<.5	<.5	<.5	<.5
Mo	1.58	<.5	1.41	1.22	2.24	3.07
Pb	1.92	3.46	4.59	3.23	6.67	16.6
Pd	<.25	<.25	<.25	<.25	<.25	<.25
Pt	<.5	<.5	<.5	<.5	<.5	<.5
Sb	.258	.372	.5	.271	1.22	1.91
Se	<1.0	<1.0	1.39	<1.0	1.42	1.06
Sn	<.5	<.5	<.5	<.5	<.5	<.5
Te	<.5	<.5	<.5	<.5	<.5	<.5
Tl	<.5	<.5	<.5	<.5	<.5	<.5
Zn	18.4	157.0	34.8	29.7	13.4	98.4

- 85-11-338.5--Mylonite derived from gabbroic protolith; unnamed formation, Early Proterozoic; sample depth 338.5 ft., Minnesota Geological Survey drill hole 85-11, T. 129 N., R. 35 W., sec. 24, ADADDA; Todd County.
- AB-22-212.5--Metabasalt, plagioclase-phyric; unnamed formation, Early Proterozoic; sample depth 212.5 ft., Minnesota Geological Survey drill hole AB-22, T. 46 N., R. 28 W., sec. 13, CCABDA; Crow Wing County.
- AB-24A-416--Slate/phyllite, graphitic, laminated; unnamed formation, Early Proterozoic; sample depth 416 ft., Minnesota Geological Survey drill hole AB-24A, T. 45 N., R. 28 W., sec. 2, CDBCCC; Crow Wing County.
- AB-24A-414--Slate/phyllite, graphitic, laminated; unnamed formation, Early Proterozoic; sample depth 414 ft., Minnesota Geological Survey drill hole AB-24A, T. 45 N., R. 28 W., sec. 2, CDBCCC; Crow Wing County.
- AB-24A-413--Slate/phyllite, graphitic, laminated; unnamed formation, Early Proterozoic; sample depth 413 ft., Minnesota Geological Survey drill hole AB-24A, T. 45 N., R. 28 W., sec. 2, CDBCCC; Crow Wing County.
- DH-8-815--Shale, carbonaceous, laminated; Virginia Formation, Early Proterozoic; sample depth 815 ft., drill hole IRRRB-8, T. 55 N., R. 24 W., sec. 36, AD; Itasca County.

Table 4. Samples of Middle Proterozoic Age--Minor-Element Exploration Package

	1	2	3	4	5	6	7	8
Ag	1.408							
As	40.4							
Au	.014							
Bi	1.31							
Cd	1.05							
Cu	108.0	3250.	2220.	1800.	2930.	1280.	1760.	8150.
Ga	<.5							
Hg	2.67							
Mo	2.16							
Pb	12.2							
Pd	<.25							
Pt	<.5							
Sb	11.9							
Se	1.06							
Sn	<.5							
Te	<.5							
Tl	<.5							
Zn	8.29							
Ni		324.	260.	400.	400.	88.	134.	970.
Pt		50.	<15.	<15.	50.	<15.	40.	50.
Pd		85.	<2.	2.	60.	10.	80.	20.

Table 4 Continued

	9	10	11	12	13
Ag					
As					
Au					
Bi					
Cd					
Cu	8810.	1770.	1365.	8200.	2005.
Ga					
Hg					
Mo					
Pb					
Pd					
Pt					
Sb					
Se					
Sn					
Te					
Tl					
Zn					
Ni	1140.	308.	112.	1020.	284.
Pt	100.	<15.	<15.	<15.	20.
Pd	340.	10.	15.	20.	50.

1. 48-16-1-1--Pyrite-cemented conglomerate; basal Fond du Lac Formation, Keweenawan Supergroup, Middle Proterozoic; outcrop sample, T. 48 N., R. 16 W., sec. 1, ACBC; Carlton County.
2. D-12-86--Anorthositic gabbro, medium-grained sulfides; Middle Proterozoic; second highest outcrop on hill under powerline, T. 49 N., R. 15 W., sec. 1, ADB; St. Louis County.
3. D-32-F-86--Anorthositic gabbro, granophyre-rich, medium- to coarse-grained, contains sulfides; Middle Proterozoic; outcrop 50 ft. south of 10th St. W. bridge over Miller Creek in Lincoln Park, Duluth, T. 50 N., R. 14 W., sec. 32, DBA; St. Louis County.
4. L-5-86--Anorthositic gabbro, sulfide bearing; Middle Proterozoic; outcrop north side of west end of Copper Lake, T. 64 N., R. 4 W., sec. 9, ACB; Cook County.

Table 4 continued

5. L-20A-86--Gabbro, fine-grained, sulfide-rich; Middle Proterozoic; outcrop south side of west end of Copper Lake, T. 64 N., R. 4 W., sec. 10, DBA; Cook County.
6. L-20B-86--Sulfide-bearing rock, fine- to medium-grained, greatly altered; Middle Proterozoic; outcrop south side of west end of Copper Lake, T. 64 N., R. 4 W., sec. 10, DBA; Cook County.
7. L-21B-86--Anorthositic gabbro, coarse-grained, biotite-bearing; Middle Proterozoic; outcrop south side stream from east side of Copper Lake, T. 64 N., R. 4 W., sec. 10, DBA; Cook County.
8. L-30-86--Sulfide-bearing gossan; Middle Proterozoic; outcrop west side of north tip of Jester Lake (immediately west of Fool Lake), T. 64 N., R. 4 W., sec. 11, BCB; Cook County.
9. BL-32-86--Gabbro, sulfide-olivine-oxide-bearing; Middle Proterozoic; outcrop south side of Spruce Road where it intersects a trail heading south, T. 62 N., R. 10 W., sec. 19, BDD; Lake County.
10. L-13A-86--Gabbro, coarse-grained, altered; Middle Proterozoic; outcrop extreme west end of Copper Lake, north side, directly on shore, T. 64 N., R. 4 W., sec. 9, ACC; Cook County.
11. L-13B-86--Gabbro, coarse-grained, biotite-bearing, altered; Middle Proterozoic; outcrop extreme west end of Copper Lake, north side, directly on shore, T. 64 N., R. 4 W., sec. 9, ACC; Cook County.
12. L-99-86--Sulfide-bearing, gossan; Middle Proterozoic; outcrop west side of north tip of Jester Lake (immediately west of Fool Lake), T. 64 N., R. 4 W., sec. 11, BCB; Cook County.
13. BL-27-B-86--Anorthositic gabbro; Middle Proterozoic; outcrop at or few feet to the east of sec. 7 - sec. 8 boundary line on north side of road, T. 61 N., R. 10 W., sec. 8, BBB; Cook County.

Table 5. Samples of Cretaceous Age--Minor-Element Exploration Package

	1	2	3	4	5	6	7	8
As	21.6	5.	5.	3.	1.	3.	3.	1.
Mo	6.43	2.	3.	2.	<1.	<1.	3.	1.
W		<10.	<10.	<10.	<10.	<10.	<10.	<10.
Zn	4.19	60.	67.	52.	13.	71.	65.	28.
P		240.	80.	200.	235.	230.	445.	330.
Pb	13.5	20.	26.	16.	2.	20.	24.	10.
Bi	1.53	<2.	<2.	<2.	<2.	<2.	<2.	<2.
Cd	<.25	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Co	<.5	12.	14.	10.	1.	15.	12.	7.
Ni		30	33	24	6	34	29	14
Ba		320	330	305	100	315	300	170
Mn		135.	160.	178.	5550.	182.	320.	98.
Cr		108.	105.	108.	44.	95.	83.	72.
V		87.	102.	72.	8.	89.	77.	36.
Be	<.25	1.5	1.5	1.4	1.5	1.5	1.5	1.0
Cu	9.36	36.	37.	38.	21.	25.	26.	17.
Ag	<.025	<0.2	0.4	0.4	<0.2	0.4	0.6	<0.2
Sr		134.	155.	102.	64.	118.	114.	73.
	9	10	11	12	13	14	15	16
As	5.	3.	4.	3.	5.	4.	11.	7.
Mo	2.	5.	10.	10.	21.	15.	18.	19.
W	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.
Zn	58.	66.	77.	62.	100.	61.	78.	82.
P	265.	355.	515.	395.	475.	405.	495.	700.
Pb	20.	14.	16.	16.	16.	14.	8.	10.
Bi	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.
Cd	<0.5	0.5	2.0	0.5	3.0	1.5	1.0	<0.5
Co	13.	5.	5.	3.	4.	2.	4.	7.
Ni	26	25.	34.	31.	49.	26.	28.	47.
Ba	280	135.	169.	215.	170.	130.	160.	280.
Mn	127.	171.	168.	85.	117.	142.	114.	91.
Cr	84.	49.	36.	39.	46.	26.	33.	76.
V	83.	60.	88.	72.	200.	89.	65.	107.
Be	1.5	1.0	0.5	0.5	<0.5	<0.5	0.5	0.5
Cu	21.	40.	60.	50.	71.	56.	50.	45.
Ag	0.4	<0.2	0.4	<0.2	<0.2	<0.2	<0.2	<0.2
Sr	123.	295.	645.	720.	690.	660.	660.	795.

Table 5 Continued

	17	18	19	20	21	22	23	24
As	4.	10.	7.	6.	7.	10.	12.	4.
Mo	6.	3.	2.	2.	<1.	1.	2.	2.
W	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.
Zn	87.	60.	57.	52.	60.	59.	52.	91.
P	620.	385.	330.	445.	520.	520.	1670.	375.
Pb	10.	14.	14.	20.	24.	24.	24.	24.
Bi	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.
Cd	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Co	10.	8.	10.	10.	11.	12.	9.	18.
Ni	36.	26.	31.	29.	30.	31.	25.	42.
Ba	240.	230.	220.	240.	245.	250.	225.	350.
Mn	98.	117.	96.	190.	174.	157.	225.	255.
Cr	83.	87.	80.	90.	88.	94.	94.	100.
V	89.	84.	90.	94.	108.	110.	92.	118.
Be	1.0	1.0	1.5	1.5	1.5	1.5	1.5	2.0
Cu	26.	18.	18.	19.	22.	24.	22.	29.
Ag	0.4	<0.2	<0.2	<0.2	<0.2	<0.2	0.4	<0.2
Sr	166.	143.	129.	144.	155.	178.	194.	146.
	25	26	27	28	29	30	31	32
As	3.	4.	1.	20.	1.	1.	1.	2.
Mo	4.	<1.	2.	3.	4.	<1.	3.	<1.
W	<10.	15.	<10.	<10.	20.	<10.	<10.	<10.
Zn	86.	58.	67.	44.	70.	19.	92.	75.
P	570.	660.	425.	455.	400.	650.	25.	165.
Pb	30.	22.	20.	30.	28.	2.	26.	26.
Bi	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.
Cd	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Co	19.	12.	13.	7.	18.	<1.	22.	19.
Ni	41.	29.	30.	21.	38.	7.	42.	42.
Ba	365.	300.	325.	340.	740.	90.	370.	315.
Mn	360.	198.	194.	118.	265.	7490.	198.	440.
Cr	100.	94.	96.	80.	100.	41.	98.	98.
V	119.	100.	106.	85.	118.	18.	117.	118.
Be	2.0	2.0	2.0	1.5	2.0	2.0	2.0	2.0
Cu	30.	21.	22.	21.	25.	18.	36.	33.
Ag	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Sr	168.	140.	145.	159.	173.	70.	113.	108.

Table 5 Continued

	33	34	35	36	37	38	39	40
As	70.	7.	6.	3.	7.	2.	1.	1.
Mo	<1.	3.	2.	3.	<1.	2.	2.	<1.
W	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.
Zn	35.	43.	71.	74.	17.	82.	55.	37.
P	130.	10.	130.	370.	3630.	540.	485.	535.
Pb	14.	24.	20.	18.	2.	18.	12.	12.
Bi	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.
Cd	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Co	12.	15.	11.	13.	3.	16.	11.	7.
Ni	25.	29.	23.	31.	6.	37.	24.	15.
Ba	190.	270.	260.	285.	165.	350.	300.	235.
Mn	310.	172.	163.	455.	1450.	505.	177.	515.
Cr	74.	96.	91.	100.	45.	98.	76.	59.
V	68.	117.	141.	143.	196.	107.	77.	57.
Be	1.0	1.5	1.5	1.5	1.5	2.0	1.5	1.0
Cu	17.	23.	19.	26.	17.	30.	18.	16.
Ag	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Sr	57.	105.	94.	126.	168.	152.	122.	102.
	41	42	43	44	45	46	47	48
As	2.	5.	4.	5.	4.	4.	5.	6.
Mo	<1.	2.	2.	1.	3.	3.	6.	4.
W	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.
Zn	20.	64.	76.	64.	65.	71.	75.	73.
P	6180.	725.	420.	485.	335.	230.	245.	335.
Pb	2.	24.	26.	28.	24.	26.	18.	12.
Bi	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.
Cd	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Co	7.	13.	15.	13.	13.	14.	13.	13.
Ni	13.	33.	36.	33.	34.	39.	40.	39.
Ba	105.	310.	340.	305.	300.	250.	245.	290.
Mn	>10000.	285.	355.	265.	370.	160.	158.	161.
Cr	59.	96.	100.	94.	99.	96.	93.	93.
V	24.	105.	116.	104.	120.	109.	125.	119.
Be	2.0	2.0	2.0	1.5	2.0	1.5	1.5	1.5
Cu	17.	23.	27.	23.	24.	26.	28.	27.
Ag	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Sr	210.	175.	181.	155.	168.	197.	199.	198.

Table 5 continued

	49	50	51	52	53	54	55	56
As	4.	4.	9.	5.	3.	4.	4.	1.
Mo	4.	4.	15.	4.	2.	2.	2.	<1.
W	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.
Zn	85.	87.	106.	78.	66.	84.	76.	25.
P	195.	325.	355.	345.	395.	335.	505.	380.
Pb	16.	24.	26.	24.	24.	20.	26.	2.
Bi	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.
Cd	<0.5	<0.5	1.0	<0.5	<0.5	0.5	<0.5	<0.5
Co	14.	15.	14.	15.	13.	18.	18.	4.
Ni	42.	42.	54.	40.	28.	38.	39.	12.
Ba	340.	295.	235.	280.	355.	345.	325.	170.
Mn	179.	179.	157.	173.	465.	265.	1160.	2900.
Cr	100.	105.	100.	100.	84.	100.	105.	82.
V	132.	111.	155.	111.	80.	111.	98.	22.
Be	2.0	1.5	1.0	1.5	1.5	2.0	2.0	1.5
Cu	31.	30.	33.	28.	28.	32.	29.	21.
Ag	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Sr	215.	190.	205.	181.	135.	195.	186.	84.
	57	58	59	60	61	62	63	64
As	1.	1.	1.	7.	3.	9.	3.	4.
Mo	3.	2.	2.	2.	2.	6.	7.	24.
W	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.
Zn	87.	75.	79.	75.	81.	93.	98.	100.
P	355.	195.	545.	535.	380.	750.	665.	1350.
Pb	22.	16.	14.	16.	14.	16.	20.	12.
Bi	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.
Cd	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	2.0
Co	20.	16.	16.	15.	16.	16.	16.	5.
Ni	44.	36.	32.	37.	39.	44.	45.	53.
Ba	395.	415.	315.	290.	305.	465.	625.	125.
Mn	565.	625.	205.	255.	250.	225.	205.	595.
Cr	110.	88.	95.	110.	110.	110.	110.	52.
V	108.	89.	96.	110.	113.	118.	118.	157.
Be	2.0	1.5	2.0	2.0	1.5	1.5	1.5	<0.5
Cu	34.	34.	22.	24.	25.	32.	40.	52.
Ag	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Sr	154.	95.	176.	176.	180.	210.	215.	645.

Table 5 continued

	65	66	67	68	69	70	71	72
As	5.	7.	22.	3.	4.	11.	14.	12.
Mo	30.	17.	35.	15.	21.	29.	27.	21.
W	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.
Zn	117.	82.	133.	52.	63.	109.	111.	106.
P	265.	675.	455.	445.	595.	575.	1070.	640.
Pb	10.	14.	10.	4.	6.	16.	12.	18.
Bi	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.
Cd	2.0	1.5	0.5	1.0	1.0	1.0	1.0	1.0
Co	9.	7.	14.	3.	5.	12.	11.	14.
Ni	73.	52.	82.	34.	41.	64.	59.	58.
Ba	170.	130.	70.	135.	60.	195.	185.	195.
Mn	375.	605.	88.	56.	83.	134.	171.	162.
Cr	80.	59.	59.	13.	22.	70.	67.	86.
V	290.	158.	210.	67.	155.	178.	154.	160.
Be	<0.5	1.0	<0.5	0.5	<0.5	<0.5	<0.5	0.5
Cu	58.	47.	44.	30.	40.	41.	39.	41.
Ag	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Sr	400.	530.	275.	595.	495.	290.	240.	210.
	73	74	75	76	77	78	79	80
As	4.	14.	7.	3.	3.	6.	7.	6.
Mo	10.	8.	5.	<1.	2.	6.	5.	5.
W	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.
Zn	71.	92.	85.	58.	57.	59.	82.	111.
P	630.	325.	260.	490.	530.	480.	300.	305.
Pb	18.	16.	10.	16.	8.	16.	16.	26.
Bi	<2.	<2.	<2.	<2.	<2.	<2.	<2.	<2.
Cd	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Co	12.	15.	15.	10.	10.	10.	14.	15.
Ni	37.	46.	44.	32.	33.	32.	45.	41.
Ba	285.	225.	295.	255.	220.	225.	215.	205.
Mn	154.	171.	174.	138.	161.	136.	575.	200.
Cr	87.	94.	100.	90.	85.	89.	91.	105.
V	108.	104.	102.	87.	79.	93.	99.	106.
Be	1.0	1.5	2.0	1.5	1.5	1.5	2.0	2.0
Cu	31.	31.	32.	28.	26.	30.	32.	54.
Ag	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Sr	135.	141.	174.	195.	162.	193.	154.	149.

Table 5 continued

1. KRPC-1--Pisolitic clay; unknown formation, Late Cretaceous, Cenomanian; outcrop sample, T. 122 N., R. 29 W., sec. 20, D; Stearns County.
2. KC2-1--Shale; Graneros Shale, Late Cretaceous; sample depth 865.7 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
3. KC2-2--Shale; Graneros Shale, Late Cretaceous; sample depth 867 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
4. KC2-3--Shale; Graneros Shale, Late Cretaceous; sample depth 845 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
5. KC2-4--Siltstone; Graneros Shale, Late Cretaceous; sample depth 841 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
6. KC2-5--Shale; Graneros Shale, Late Cretaceous; sample depth 827 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
7. KC2-6--Shale; Graneros Shale, Late Cretaceous; sample depth 820 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
8. KC2-7--Silty shale; Graneros Shale, Late Cretaceous; sample depth 812 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
9. KC2-8--Shale; Graneros Shale, Late Cretaceous; sample depth 799 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
10. KC2-9--Limey shale; Greenhorn Limestone, Late Cretaceous; sample depth 793 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
11. KC2-10--Limey shale; Greenhorn Limestone, Late Cretaceous; sample depth 787 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
12. KC2-11--Shaly limestone; Greenhorn Limestone, Late Cretaceous; sample depth 782 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.

Table 5 continued

13. KC2-12--Shaly limestone; Greenhorn Limestone, Late Cretaceous; sample depth 777 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
14. KC2-13--Shaly limestone; Greenhorn Limestone, Late Cretaceous; sample depth 772 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
15. KC2-14--Shaly limestone; Greenhorn Limestone, Late Cretaceous; sample depth 767 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
16. KC2-15--Shaly limestone; Greenhorn Limestone, Late Cretaceous; sample depth 762 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
17. KC2-16--Shaly limestone; Greenhorn Limestone, Late Cretaceous; sample depth 757 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
18. KC2-17--Limey shale; Greenhorn Limestone, Late Cretaceous; sample depth 753 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
19. KC2-18, Shale; Carlile Shale, Late Cretaceous; sample depth 745 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
20. KC2-19, Shale; Carlile Shale, Late Cretaceous; sample depth 735 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
21. KC2-20, Shale; Carlile Shale, Late Cretaceous; sample depth 725 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
22. KC2-21, Shale; Carlile Shale, Late Cretaceous; sample depth 715 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
23. KC2-22, Shale; Carlile Shale, Late Cretaceous; sample depth 705 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
24. KC2-23, Shale; Carlile Shale, Late Cretaceous; sample depth 691 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.

Table 5 continued

25. KC2-24, Shale; Carlile Shale, Late Cretaceous; sample depth 680 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
26. KC2-25, Shale; Carlile Shale, Late Cretaceous; sample depth 673 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
27. KC2-26, Shale; Carlile Shale, Late Cretaceous; sample depth 663.5 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
28. KC2-27--Shale; Niobrara Shale(?), Late Cretaceous; sample depth 641-660(?) ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
29. KC2-28--Shale; Niobrara Shale(?), Late Cretaceous; sample depth 602 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
30. KC2-29--Siltstone; Niobrara Shale(?), Late Cretaceous; sample depth 602 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
31. KC2-30--Shale; Niobrara Shale(?), Late Cretaceous; sample depth 585 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
32. KC2-31--Shale; Niobrara Shale(?), Late Cretaceous; sample depth 570(?) ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
33. KC2-32--Shale; Niobrara Shale(?), Late Cretaceous; sample depth 566 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
34. KC2-33--Shale; Niobrara Shale(?), Late Cretaceous; sample depth 557 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
35. KC2-35--Shale; Niobrara Shale(?), Late Cretaceous; sample depth 550 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
36. K186-1--Shale; Niobrara Shale(?), Late Cretaceous; sample depth 25-30 ft., drill hole KNF-186, T. 111 N., R. 41 W., sec. 36, DD; Lyon County.

Table 5 continued

37. K186-2--Calcareous stringer; Niobrara Shale(?), Late Cretaceous; sample depth 35-38 ft., drill hole KNF-186, T. 111 N., R. 41 W., sec. 36, DD; Lyon County.
38. K186-3--Shale; Niobrara Shale(?), Late Cretaceous; sample depth 43-50 ft., drill hole KNF-186, T. 111 N., R. 41 W., sec. 36, DD; Lyon County.
39. K186-4--Shale; Niobrara Shale(?), Late Cretaceous; sample depth 55-60 ft., drill hole KNF-186, T. 111 N., R. 41 W., sec. 36, DD; Lyon County.
40. K186-5--Shale with calcareous stringers; Niobrara Shale(?), Late Cretaceous; sample depth 64-70 ft., drill hole KNF-186, T. 111 N., R. 41 W., sec. 36, DD; Lyon County.
41. K186-6--Rock stringer; Niobrara Shale(?), Late Cretaceous; sample depth 74-80 ft., drill hole KNF-186, T. 111 N., R. 41 W., sec. 36, DD; Lyon County.
42. K186-7--Shale; Carlile Shale, Late Cretaceous; sample depth 92-100 ft., drill hole KNF-186, T. 111 N., R. 41 W., sec. 36, DD; Lyon County.
43. K186-8--Shale; Carlile Shale, Late Cretaceous; sample depth 105-110 ft., drill hole KNF-186, T. 111 N., R. 41 W., sec. 36, DD; Lyon County.
44. K186-9--Shale; Carlile Shale, Late Cretaceous; sample depth 120-125 ft., drill hole KNF-186, T. 111 N., R. 41 W., sec. 36, DD; Lyon County.
45. K186-10--Shale; Carlile Shale, Late Cretaceous; sample depth 135-140 ft., drill hole KNF-186, T. 111 N., R. 41 W., sec. 36, DD; Lyon County.
46. K186-11--Shale; Carlile Shale, Late Cretaceous; sample depth 150-156 ft., drill hole KNF-186, T. 111 N., R. 41 W., sec. 36, DD; Lyon County.
47. K186-12--Shale; Carlile Shale, Late Cretaceous; sample depth 160-170 ft., drill hole KNF-186, T. 111 N., R. 41 W., sec. 36, DD; Lyon County.
48. K186-13--Shale; Carlile Shale, Late Cretaceous; sample depth 180-185 ft., drill hole KNF-186, T. 111 N., R. 41 W., sec. 36, DD; Lyon County.

Table 5 continued

49. K186-14--Shale; Greenhorn Limestone(?), Late Cretaceous; sample depth 195-200 ft., drill hole KNF-186, T. 111 N., R. 41 W., sec. 36, DD; Lyon County.
50. K186-15--Shale; Greenhorn Limestone(?), Late Cretaceous; sample depth 210-215 ft., drill hole KNF-186, T. 111 N., R. 41 W., sec. 36, DD; Lyon County.
51. K186-16--Shale; Greenhorn Limestone(?), Late Cretaceous; sample depth 225-233 ft., drill hole KNF-186, T. 111 N., R. 41 W., sec. 36, DD; Lyon County.
52. K186-17--Shale; Greenhorn Limestone(?), Late Cretaceous; sample depth 203 ft., drill hole KNF-186, T. 111 N., R. 41 W., sec. 36, DD; Lyon County.
53. K186-18--Shale; Graneros Shale/Dakota Sandstone, Late Cretaceous; sample depth 290-298 ft., drill hole KNF-186, T. 111 N., R. 41 W., sec. 36, DD; Lyon County.
54. K186-19--Shale; Graneros Shale/Dakota Sandstone, Late Cretaceous; sample depth 302 ft., drill hole KNF-186, T. 111 N., R. 41 W., sec. 36, DD; Lyon County.
55. K186-20--Shale; Graneros Shale/Dakota Sandstone, Late Cretaceous; sample depth 307 ft., drill hole KNF-186, T. 111 N., R. 41 W., sec. 36, DD; Lyon County.
56. K186-21--Rock stringer; Graneros Shale/Dakota Sandstone, Late Cretaceous; sample depth 336-340 ft., drill hole KNF-186, T. 111 N., R. 41 W., sec. 36, DD; Lyon County.
57. K186-22--Shale; Graneros Shale/Dakota Sandstone, Late Cretaceous; sample depth 380-385 ft., drill hole KNF-186, T. 111 N., R. 41 W., sec. 36, DD; Lyon County.
58. K286A-1--Shale; Carlile Shale, Late Cretaceous; sample interval 40-45 ft., drill hole KNF-286A, T. 114 N., R. 44 W., sec. 24, AA; Yellow Medicine County.
59. K286A-2--Shale; Carlile Shale, Late Cretaceous; sample interval 70-75 ft., drill hole KNF-286A, T. 114 N., R. 44 W., sec. 24, AA; Yellow Medicine County.
60. K286A-3--Shale; Carlile Shale, Late Cretaceous; sample interval 100-105 ft., drill hole KNF-286A, T. 114 N., R. 44 W., sec. 24, AA; Yellow Medicine County.

Table 5 continued

61. K286A-4--Shale; Carlile Shale, Late Cretaceous; sample interval 130-135 ft., drill hole KNF-286A, T. 114 N., R. 44 W., sec. 24, AA; Yellow Medicine County.
62. K286A-5--Shale; Carlile Shale, Late Cretaceous; sample interval 160-165 ft., drill hole KNF-286A, T. 114 N., R. 44 W., sec. 24, AA; Yellow Medicine County.
63. K286A-6--Shale; Carlile Shale, Late Cretaceous; sample interval 175-180 ft., drill hole KNF-286A, T. 114 N., R. 44 W., sec. 24, AA; Yellow Medicine County.
64. K286A-7--Shaly limestone; Carlile Shale-Greenhorn Limestone, Late Cretaceous; sample interval 184.5 ft., drill hole KNF-286A, T. 114 N., R. 44 W., sec. 24, AA; Yellow Medicine County.
65. K286A-8--Shaly limestone; Carlile Shale-Greenhorn Limestone, Late Cretaceous; sample interval 185.5 ft., drill hole KNF-286A, T. 114 N., R. 44 W., sec. 24, AA; Yellow Medicine County.
66. K286A-9--Shaly limestone; Carlile Shale-Greenhorn Limestone, Late Cretaceous; sample interval 187 ft., drill hole KNF-286A, T. 114 N., R. 44 W., sec. 24, AA; Yellow Medicine County.
67. KLT-1--Shale; unknown formation, Late Cretaceous; sample interval 10-12 ft., drill hole Lake Traverse Test, T. 125 N., R. 49 W., sec. 2, DA; Traverse County.
68. KLT-2--Shale; unknown formation, Late Cretaceous; sample interval 24-26 ft., drill hole Lake Traverse Test, T. 125 N., R. 49 W., sec. 2, DA; Traverse County.
69. KLT-3--Shale; unknown formation, Late Cretaceous; sample interval 42-44 ft., drill hole Lake Traverse Test, T. 125 N., R. 49 W., sec. 2, DA; Traverse County.
70. KLT-4--Shale; unknown formation, Late Cretaceous; sample interval 54-56 ft., drill hole Lake Traverse Test, T. 125 N., R. 49 W., sec. 2, DA; Traverse County.
71. KLT-5--Shale; unknown formation, Late Cretaceous; sample interval 66-68 ft., drill hole Lake Traverse Test, T. 125 N., R. 49 W., sec. 2, DA; Traverse County.

Table 5 continued

72. KLT-6--Shale; unknown formation, Late Cretaceous; sample interval 74-76 ft., drill hole Lake Traverse Test, T. 125 N., R. 49 W., sec. 2, DA; Traverse County.
73. KLT-7--Shale; unknown formation, Late Cretaceous; sample interval 92-94 ft., drill hole Lake Traverse Test, T. 125 N., R. 49 W., sec. 2, DA; Traverse County.
74. KLT-8--Shale; unknown formation, Late Cretaceous; sample interval 120-122 ft., drill hole Lake Traverse Test, T. 125 N., R. 49 W., sec. 2, DA; Traverse County.
75. KLT-9--Shale; unknown formation, Late Cretaceous; sample interval 164-166 ft., drill hole Lake Traverse Test, T. 125 N., R. 49 W., sec. 2, DA; Traverse County.
76. KLT-10--Shale; unknown formation, Late Cretaceous; sample interval 216-218 ft., drill hole Lake Traverse Test, T. 125 N., R. 49 W., sec. 2, DA; Traverse County.
77. KLT-11--Shale; unknown formation, Late Cretaceous; sample interval 232-234 ft., drill hole Lake Traverse Test, T. 125 N., R. 49 W., sec. 2, DA; Traverse County.
78. KLT-12--Shale; unknown formation, Late Cretaceous; sample interval 262-264 ft., drill hole Lake Traverse Test, T. 125 N., R. 49 W., sec. 2, DA; Traverse County.
79. KLT-13--Shale; unknown formation, Late Cretaceous; sample interval 290-292 ft., drill hole Lake Traverse Test, T. 125 N., R. 49 W., sec. 2, DA; Traverse County.
80. KLT-14--Shale; unknown formation, Late Cretaceous; sample interval 324-326 ft., drill hole Lake Traverse Test, T. 125 N., R. 49 W., sec. 2, DA; Traverse County.

Table 6. Miscellaneous Samples--Thirty-Six Element Exploration Package

	1	2	3	4	5
Au ppb	<2.	<5.	<5.	<5.	<5.
Ba		250.	160.	<15.	440.
Be	3.				
B	30.				
Sc	22.6	4.37	49.3	54.5	12.9
V	10.				
Mn	84.				
Co	1.2	1.6	67.0	56.0	17.0
Ni	4.				
Cu	6.5				
Zn	7.0				
Ge	<10.				
As	3.	5.	8.	<2.	2.
Se	<2.0	3.	<3.	<3.	<3.
Br	2.4	2.6	2.1	2.1	6.9
Mo	<2.	<5.	<5.	<5.	<5.
Ag	<0.5				
Cd	<1.		<0.2	<.02	<.02
Sb	1.3	0.7			
Cs	0.4	<0.5	0.9	1.5	0.7
La	26.6	32.9	11.5	11.3	50.5
Ce	52.	65.	25.	25.	96.
Nd	20.	27.	13.	13.	43.
Sm	4.02	5.1	2.9	3.0	8.0
Eu	0.90	1.0	1.0	1.2	2.7
Tb	1.1	1.1	0.5	0.5	0.8
Yb	8.38	5.0	2.3	2.9	1.9
Lu	1.29	0.7	0.34	0.40	0.28
Hf	10.0	4.1	1.5	2.1	5.1
Ta	1.5	0.5	<0.5	0.7	<0.5
W	1.	<3.	<3.	<3.	<3.
Ir	<5.				
Pb	6.				
Th	23.0	10.0	0.9	1.2	7.5
U	2.5	1.6	<0.2	0.4	1.9
Rb		<20.	20.	20.	80.

Table 6 continued

1. SX-60-PEB-1--Rhyolite pebbles; basal conglomerate, Sioux Quartzite, Early Proterozoic; outcrop sample acquired by blasting, T. 106 N., R. 47 W., sec. 36, CCCDA; Pipestone County.
2. SX-60-MTX-1--Matrix material; basal conglomerate, Sioux Quartzite, Early Proterozoic; outcrop sample acquired by blasting, T. 106 N., R. 47 W., sec. 36, CCCDA; Pipestone County.
3. HB-1-671.3--Augite gabbro; unnamed formation, Precambrian; sample depth 671.3 ft., Minnesota Geological Survey drill hole HB-87-1, T. 142 N., R. 35 W., sec. 6, DDCDCA; Hubbard County.
4. HB-1-678.3--Augite gabbro; unnamed formation, Precambrian; sample depth 678.3 ft., Minnesota Geological Survey drill hole HB-87-1, T. 142 N., R. 35 W., sec. 6, DDCDCA; Hubbard County.
5. HB-4-724--Syenite; unnamed formation, Precambrian; sample depth 724.0 ft., Minnesota Geological Survey drill hole HB-87-4, T. 142 N., R. 37 W., sec. 22, DBCCBC; Becker County.

Table 7. Publicly Submitted Samples--Whole-Rock Analyses

	1
SiO ₂	13.2
Al ₂ O ₃	44.0
CaO	0.27
MgO	0.21
Na ₂ O	0.03
K ₂ O	0.09
Total Fe as Fe ₂ O ₃	22.7
MnO	0.15
TiO ₂	1.32
P ₂ O ₅	0.15
LOI	17.8
Cl	
H ₂ O+	15.0
CO ₂	0.33
S	
FeO	
Rb	30
Sr	40
Y	10
Zr	760
Nb	40
Ba	210
Cr	210

1. KRPC-1--Claystone, pisolitic; unnamed formation, Late Cretaceous; outcrop sample, T. 22 N., R. 29 W., sec. 20, DD; Stearns County.

Table 8. Samples of Archean Age--Whole-Rock Analyses

	1	2	3	4	5	6	7	8
SiO ₂	49.8	48.3	55.2	68.5	50.8	61.2	65.5	9.47
Al ₂ O ₃	15.1	14.6	14.6	15.2	16.8	12.2	18.4	7.96
CaO	12.8	11.6	7.38	2.47	5.37	1.60	1.79	0.06
MgO	4.10	7.37	6.89	1.24	7.08	2.52	1.72	2.35
Na ₂ O	3.00	1.86	3.42	5.33	5.01	0.05	0.87	0.04
K ₂ O	0.27	0.11	2.95	2.97	0.08	1.15	2.46	0.04
Total Fe as Fe ₂ O ₃	11.8	14.2	7.93	2.58	8.44	16.0	4.47	56.8
MnO	0.23	0.24	0.14	0.05	0.15	0.14	0.06	0.08
TiO ₂	1.24	0.92	0.77	0.34	0.85	0.62	0.16	0.25
P ₂ O ₅	0.11	0.09	0.39	0.13	0.18	1.07	1.20	0.04
LOI	1.85	0.77			0.03	0.03	0.02	0.01
Cl			0.23	1.23	3.77	3.47	3.54	23.5
H ₂ O+	0.8	0.6	0.3	0.7	3.0	3.7	2.7	4.6
CO ₂	0.08	0.13	0.03	<0.01	1.23	0.03	0.02	0.02
S	0.48				0.05	0.04	0.03	26.5
FeO					6.6	13.2	3.1	12.3
Rb	10	20	60	110	10	60	100	<10
Sr	130	90	1030	720	170	<10	250	<10
Y	30	20	20	20	20	10	20	20
Zr	50	50	30	90	80	70	<10	120
Nb	10	10	10	10	30	20	10	40
Ba	80	60	1220	920	130	200	400	180
Cr	100	160	250	30				

1. D-962--Volcanic rock(?) dark greenish gray, aphanitic; unnamed formation, Archean(?); sample depth 962.7 ft., drill hole D-4, T. 129 N., R. 47 W., sec. 12, BC; Traverse County.
2. NEI-54--Basalt, dark greenish gray; unnamed formation, Archean; outcrop sample, T. 61 N., R. 22 W., sec. 34, CA; Itasca County.

Table 8 continued

3. NEI-242--Inokersantite [lamprophyre clan(?)], dark gray, medium-grained; Archean; outcrop sample, T. 60 N., R. 22 W., sec. 10, AA; Itasca County.
4. NEI-283--Granite, medium- to coarse-grained, typical quartz eyes; unnamed formation, Archean(?); T. 60 N., R. 23 W., sec. 28, center B; Itasca County.
5. 14512--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 25 ft.; H = 236 ft., relative to 225 ft. reference mark; East Wall, St. Louis County.
6. 14966--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 24 ft.; H = 120 ft., relative to 225 ft. reference mark; West Wall, St. Louis County.
7. 14994--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 23.5 ft.; H = 95 ft., relative to 225 ft. reference mark; East Wall, St. Louis County.
8. 15601--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 20 ft.; H = 148 ft., relative to 225 ft. reference mark; West Wall, St. Louis County.

Table 8 continued

9	
SiO ₂	59.3
Al ₂ O ₃	23.6
CaO	0.34
MgO	1.04
Na ₂ O	1.57
K ₂ O	3.34
Total Fe	
as Fe ₂ O ₃	4.40
MnO	0.04
TiO ₂	1.36
P ₂ O ₅	0.21
LOI	4.08
Cl	100
H ₂ O+	2.7
CO ₂	<0.01
S	0.12
FeO	3.2
Rb	120
Sr	190
Y	<10
Zr	70
Nb	10
Ba	280
Cr	

9. 15614--Department of Natural Resources; Soudan Iron Formation, Archean; Tower-Soudan mine, T. 62 N., R. 15 W., sec. 27, BB; No. 8 Shaft, 2700 foot level--V = 5 ft.; H = 0 ft., relative to 225 ft. reference mark; West Wall, St. Louis County.

Table 9. Samples of Early Proterozoic Age--Whole-Rock Analyses

	1	2	3	4	5	6	7	8
SiO ₂	55.8	64.3	48.3	64.0	58.5	66.0	42.8	69.5
Al ₂ O ₃	15.1	15.4	11.0	15.5	18.0	15.0	8.52	12.8
CaO	0.22	0.56	4.06	0.49	0.58	0.30	1.71	0.58
MgO	4.27	2.87	3.14	2.92	3.97	2.32	2.56	2.02
Na ₂ O	0.84	1.45	0.03	1.38	1.98	0.03	0.06	3.59
K ₂ O	2.35	4.35	4.22	4.34	3.63	7.16	3.21	1.90
Total Fe as Fe ₂ O ₃	15.4	6.27	13.5	6.44	8.29	4.43	25.9	6.22
MnO	0.87	0.09	3.00	0.10	0.05	0.04	0.25	0.04
TiO ₂	0.60	0.73	0.60	0.73	0.87	0.65	0.40	0.55
P ₂ O ₅	0.12	0.16	0.20	0.16	0.17	0.15	0.54	0.14
Cr ₂ O ₃	0.01	0.01	<0.01	0.01	0.03	0.01	0.01	0.02
LOI	4.70	3.85	10.8	4.08	4.23	3.85	14.1	2.85
Cl								
H ₂ O+	4.1	2.5	2.0	2.5	3.4	1.8	2.2	1.9
CO ₂	<0.01	0.15	8.07	0.17	<0.01	0.04	1.37	0.22
S	0.01	0.07	1.94	0.05	0.19	0.23	16.2	0.12
FeO	11.8	4.4	9.1	4.6	5.9	2.8	4.2	4.7
Rb	100	150	110	160	160	250	120	60
Sr	30	90	120	80	70	20	30	120
Y	10	40	20	40	30	20	50	10
Zr	100	180	80	170	140	160	80	180
Nb	20	30	10	30	30	10	30	20
Ba	420	650	460	690	660	970	470	580
Cr								

Table 9 continued

	9	10	11	12	13	14	15	16
SiO ₂	65.4	51.1	49.0	61.1	64.0	50.9	46.5	49.3
Al ₂ O ₃	13.5	27.4	22.7	20.0	15.6	13.7	14.5	14.6
CaO	1.02	0.10	2.06	0.27	0.42	10.6	10.0	10.3
MgO	2.35	3.01	3.59	2.90	2.97	5.68	5.00	5.61
Na ₂ O	0.03	0.06	0.06	0.05	1.49	1.24	2.67	1.43
K ₂ O	6.18	9.37	7.52	6.82	4.27	0.34	0.70	0.71
Total Fe as Fe ₂ O ₃	5.98	2.33	5.21	3.54	6.65	14.1	15.4	14.0
MnO	0.09	0.02	0.29	0.05	0.09	0.20	0.19	0.19
TiO ₂	0.66	0.62	1.52	0.71	0.76	1.51	2.03	1.56
P ₂ O ₅	0.15	0.05	1.45	0.19	0.16	0.16	0.26	0.18
Cr ₂ O ₃	0.01	<0.01	0.04	0.01	0.01			
LOI	4.85	5.93	6.16	4.16	3.62	1.70	1.77	2.08
Cl						<50	100	<50
H ₂ O+	2.1	2.9	3.3	2.4	2.6	1.4	1.8	2.4
CO ₂	0.66	<0.01	0.44	<0.01	0.09	0.68	0.49	0.14
S	0.80	0.08	0.23	0.10	0.01	0.07	0.15	0.04
FeO	3.3	0.3	2.8	1.7	4.5	10.3	11.0	9.9
Rb	190	340	280	260	150	<10	30	30
Sr	20	20	170	<10	80	140	770	230
Y	40	140	230	90	20	20	30	20
Zr	130	960	310	460	170	100	50	90
Nb	20	40	20	30	20	10	20	20
Ba	850	1410	1090	990	670	90	300	290
Cr						130	10	100

Table 9 continued

	17	18	19	20	21	22	23	24
SiO ₂	47.4	45.2	48.9	48.4	48.4	50.0	49.1	50.2
Al ₂ O ₃	15.0	15.1	13.1	13.6	16.3	13.3	13.6	13.4
CaO	8.81	12.3	9.95	11.7	9.53	8.02	9.20	6.96
MgO	6.63	3.99	4.71	6.49	4.42	4.75	5.08	4.20
Na ₂ O	2.11	1.34	2.49	1.28	3.09	1.90	3.05	2.89
K ₂ O	1.18	0.81	0.64	0.35	0.77	1.63	0.35	0.61
Total Fe as Fe ₂ O ₃	13.7	12.3	14.3	13.9	13.0	16.4	16.1	15.8
MnO	0.16	0.18	0.23	0.20	0.17	0.20	0.23	0.23
TiO ₂	1.61	1.58	1.95	1.52	1.69	2.03	1.97	1.97
P ₂ O ₅	0.18	0.17	0.25	0.17	0.20	0.25	0.24	0.30
LOI	2.70	6.62	2.77	1.39	1.62	1.08	0.31	3.16
Cl	<50	100	<50	100	<50	<50	<50	<50
H ₂ O+	2.3	1.8	1.1	0.9	0.9	1.4	0.5	2.0
CO ₂	0.55	4.86	2.39	0.36	0.56	0.09	<0.01	1.37
S	0.03	0.04	0.01	0.01	0.02		0.01	
FeO	10.3	9.5	10.8	10.3	10.0	12.5	12.1	12.6
Rb	40	20	10	10	50	80	<10	40
Sr	180	300	160	200	230	130	240	210
Y	20	20	20	20	10	30	20	30
Zr	90	100	160	110	130	190	180	210
Nb	20	40	10	40	20	30	30	50
Ba	210	270	290	100	340	880	150	290
Cr	160	100	50	110	180	50	60	30

Table 9 continued

	25	26	27	28	29	30	31	32
SiO ₂	48.3	47.9	59.5	52.8	51.1	48.1	44.0	83.6
Al ₂ O ₃	16.0	13.7	19.7	16.8	8.37	15.2	14.7	11.5
CaO	10.8	8.35	0.12	9.70	0.35	7.63	8.85	0.17
MgO	6.48	5.46	2.42	2.85	3.75	3.48	5.17	0.05
Na ₂ O	2.99	3.20	0.63	5.20	0.07	3.57	2.92	0.23
K ₂ O	0.29	0.71	3.00	0.32	0.26	1.44	0.84	0.20
Total Fe as Fe ₂ O ₃	10.9	14.5	9.94	7.85	27.3	16.3	13.1	1.23
MnO	0.15	0.21	0.04	0.13	0.55	0.23	0.19	
TiO ₂	1.14	1.93	0.68	1.69	0.33	1.87	1.57	0.22
P ₂ O ₅	0.16	0.33	0.05	0.22	0.09	0.44	0.26	0.09
LOI	2.54	2.62	4.31	1.62	8.23	1.08	8.31	
Cl	50	<50	<50	<50	100	150	<50	2.54
H ₂ O+	1.6	1.1	2.0	0.5	3.7	0.7	1.9	
CO ₂	0.29	0.51	<0.01	1.52	6.12	0.24	5.37	
S	TR			0.03	0.04	0.13	0.01	
FeO	7.0	11.3	7.7	5.9	22.1	12.5	10.7	
Rb	10	20	170	30	60	70	40	10
Sr	520	490	100	210	<10	580	740	260
Y	10	10	10	20	<10	30	10	100
Zr	40	150	100	110	50	160	50	320
Nb	20	40	30	20	20	30	20	20
Ba	140	900	440	110	150	950	520	240
Cr	90	30	160	180	80	10	10	20
La		33.1	36.9					
Ce		77.	68.					
Nd		41.	26.					
Sm		6.25	4.61					
Eu		1.98	1.03					
Tb		1.0	0.5					
Yb		2.34	1.18					
Lu		0.45	0.18					

Table 9 continued

	33	34
SiO ₂		
Al ₂ O ₃		
CaO		
MgO		
Na ₂ O		
K ₂ O		
Total Fe as Fe ₂ O ₃		
MnO		
TiO ₂		
P ₂ O ₅		
Cr ₂ O ₃		
LOI		
H ₂ O+		
CO ₂		
S		
FeO		
La	9.6	4.0
Ce	27.	10.
Nd	18.	8.
Sm	5.36	2.31
Eu	1.73	0.79
Tb	1.1	0.5
Yb	4.30	2.17
Lu	0.66	0.33

Table 9 continued

1. 2-660--Argillite, black, carbonaceous; Virginia Formation, Early Proterozoic; sample depth 660 ft., drill hole IRRRB-2, T. 58 N., R. 16 W., sec. 22, DB; St. Louis County.
2. 2-695--Argillite, black, carbonaceous; Virginia Formation, Early Proterozoic; sample depth 695 ft., drill hole IRRRB-2, T. 58 N., R. 16 W., sec. 22, DB; St. Louis County.
3. 2-781--Argillite, black, carbonaceous; Virginia Formation, Early Proterozoic; sample depth 781 ft., drill hole IRRRB-2, T. 58 N., R. 16 W., sec. 22, DB; St. Louis County.
4. 2-826--Argillite, black, carbonaceous; Virginia Formation, Early Proterozoic; sample depth 826 ft., drill hole IRRRB-2, T. 58 N., R. 16 W., sec. 22, DB; St. Louis County.
5. 2-1576--Argillite, black, carbonaceous; Virginia Formation, Early Proterozoic; sample depth 1576 ft., drill hole IRRRB-2, T. 58 N., R. 16 W., sec. 22, DB; St. Louis County.
6. 5-502--Tuff, green, very fine-grained; Virginia Formation, Early Proterozoic; sample depth 502 ft., drill hole IRRRB-5, T. 58 N., R. 20 W., sec. 36, BD; St. Louis County.
7. 5-520--Argillite, black, carbonaceous; Virginia Formation, Early Proterozoic; sample depth 520 ft., drill hole IRRRB-5, T. 58 N., R. 20 W., sec. 22, DB; St. Louis County.
8. 7-567--Argillite, black, carbonaceous; Virginia Formation, Early Proterozoic; sample depth 567 ft., drill hole IRRRB-7, T. 57 N., R. 22 W., sec. 36, CA; Itasca County.
9. 7-580--Argillite, black, carbonaceous; Virginia Formation, Early Proterozoic; sample depth 580 ft., drill hole IRRRB-7, T. 57 N., R. 22 W., sec. 36, CA; Itasca County.
10. 8-1040--Tuff, green, very fine-grained; Virginia Formation, Early Proterozoic; sample depth 1040 ft., drill hole IRRRB-8, T. 55 N., R. 24 W., sec. 36, AD; Itasca County.
11. 8-1063--Tuff, green, very fine-grained; Virginia Formation, Early Proterozoic; sample depth 1063 ft., drill hole IRRRB-8, T. 55 N., R. 24 W., sec. 36, AD; Itasca County.
12. 8-1080--Argillite, black, fine-grained; Virginia Formation, Early Proterozoic; sample depth 1080 ft., drill hole IRRRB-8, T. 55 N., R. 24 W., sec. 36, AD; Itasca County.

Table 9 continued

13. 8-1090--Argillite, black, fine-grained; Virginia Formation, Early Proterozoic; sample depth 1090 ft., drill hole IRRRB-8, T. 55 N., R. 24 W., sec. 36, AD; Itasca County.
14. 46-20-2-1A--Mafic metavolcanic; Thomson Formation, Early Proterozoic; outcrop sample; T. 46 N., R. 20 W., sec. 2; Carlton County.
15. 46-20-7-1B--Hornblende gabbro; Thomson Formation, Early Proterozoic; outcrop sample, T. 46 N., R. 20 W., sec. 7; Carlton County.
16. 46-20-22-1A--Mafic metavolcanic; Thomson Formation, Early Proterozoic; outcrop sample, T. 46 N., R. 20 W., sec. 22; Carlton County.
17. 46-20-22-2--Mafic metavolcanic; Thomson Formation, Early Proterozoic; outcrop sample, T. 46 N., R. 20 W., sec. 22; Carlton County.
18. 46-20-28-1--Mafic metavolcanic; Thomson Formation, Early Proterozoic; outcrop sample, T. 46 N., R. 20 W., sec. 28; Carlton County.
19. 46-20-29-2A--Mafic metavolcanic; Thomson Formation, Early Proterozoic; outcrop sample, T. 46 N., R. 20 W., sec. 29; Carlton County.
20. 46-20-29-3--Mafic metavolcanic; Thomson Formation, Early Proterozoic; outcrop sample, T. 46 N., R. 20 W., sec. 29; Carlton County.
21. 46-21-4-1A--Mafic metavolcanic, porphyritic; Thomson Formation, Early Proterozoic; outcrop sample, T. 46 N., R. 21 W., sec. 4; Carlton County.
22. 46-21-11-1C--Mafic metavolcanic; Thomson Formation, Early Proterozoic; outcrop sample, T. 46 N., R. 21 W., sec. 11; Carlton County.
23. 46-21-15-1A--Mafic metavolcanic; Thomson Formation, Early Proterozoic; outcrop sample, T. 46 N., R. 21 W., sec. 15; Carlton County.
24. 47-20-28-1A--Mafic metavolcanic; Thomson Formation, Early Proterozoic; outcrop sample, T. 47 N., R. 20 W., sec. 28; Carlton County.

Table 9 continued

25. 47-21-19-1--Hornblende gabbro; Thomson Formation, Early Proterozoic; outcrop sample, T. 47 N., R. 21 W., sec. 19; Carlton County.
26. AB-22--Metabasalt, plagioclase-phyric; unnamed formation, Early Proterozoic; sample depth 217 ft., Minnesota Geological Survey drill hole AB-22, T. 46 N., R. 28 W., sec. 13, CCABDA; Crow Wing County.
27. AB-28--Metaandesite; unnamed formation, Early Proterozoic; sample depth 150 ft., Minnesota Geological Survey drill hole AB-28, T. 46 N., R. 26 W., sec. 9, DDCAAB; Aitkin County.
28. KRCH-7-135--Mafic metavolcanic, porphyritic; Thomson Formation, Early Proterozoic; sample depth 135 ft., drill hole KRCH-7, T. 46 N., R. 21 W., sec. 4; Carlton County.
29. MG-5-410--Mafic metavolcanic, porphyritic; Thomson Formation, Early Proterozoic; sample depth 410 ft., Minnesota Geological Survey drill hole 5, T. 46 N., R. 20 W., sec. 7; Carlton County.
30. MG-7-238--Hornblende gabbro; Thomson Formation, Early Proterozoic; sample depth 238 ft., Minnesota Geological Survey drill hole 7, T. 46 N., R. 20 W., sec. 8; Carlton County.
31. MG-7-259--Andesite porphyry; Thomson Formation, Early Proterozoic; sample depth 259 ft., Minnesota Geological Survey drill hole 7, T. 46 N., R. 20 W., sec. 8; Carlton County.
32. SX-60-PEB-1--Rhyolite pebbles; basal conglomerate, Sioux Quartzite, Early Proterozoic; outcrop sample acquired by blasting, T. 106 N., R. 47 W., sec. 36, CCCDA; Pipestone County.
33. MD-6--Diabase dike, chilled margin 10 cm from wallrock contacts, dike 40 m wide; Kenora-Kabetogama dike swarm, Early Proterozoic; outcrop sample T. 71 N., R. 23 W., sec. 27, AAA (lat. 48.63°N, long. 93.25°W); Koochiching County.
34. MD-8--Diabase dike, chilled margin 3 cm from wallrock contact, dike 50 m wide; Kenora-Kabetogama dike swarm, Early Proterozoic; outcrop sample, T. 71 N., R. 24 W., sec. 35, BBD (lat. 48.62°N, long. 93.37°W); Koochiching County.

Table 10. Samples of Middle Proterozoic Age--Whole-Rock Analyses

	1	2	3	4	5	6	7	8
SiO ₂	47.7	46.3	46.2	46.2	43.2	47.5	51.4	67.4
Al ₂ O ₃	16.0	11.4	16.5	16.8	11.5	15.9	16.1	12.0
CaO	10.5	9.15	9.56	9.92	9.45	10.6	9.12	2.51
MgO	7.56	4.68	4.62	4.77	5.90	8.10	3.33	2.84
Na ₂ O	2.22	2.52	3.35	2.69	2.16	2.31	2.62	4.09
K ₂ O	0.29	0.55	0.68	0.53	0.71	0.33	1.03	2.96
Total Fe as Fe ₂ O ₃	11.7	17.7	13.5	14.6	20.8	12.5	12.8	5.19
MnO	0.18	0.24	0.18	0.19	0.24	0.17	0.18	0.07
TiO ₂	1.35	6.87	2.56	2.58	4.99	1.48	2.11	0.65
P ₂ O ₅	0.14	0.20	0.23	0.26	0.12	0.14	0.23	0.08
LOI	1.85	0.54	2.08	1.47	0.77	1.00	1.00	1.93
Cl								
H ₂ O+	1.8	1.1	2.3	1.5	1.5	1.3		
CO ₂	0.03	0.01	0.01	<0.01	<0.01	0.01		
S								
FeO								
Rb	20	30	40	20	<10	10	30	90
Sr	210	140	220	170	170	200	240	140
Y	30	10	30	40	<10	<10	30	90
Zr	90	180	140	150	70	60	170	450
Nb	20	40	30	30	30	30	30	40
Ba	140	190	210	160	150	140	280	720
Cr	140	10	210	150	110	160	60	70
Co							50	20
Ni							30	60

Table 10 continued

	9	10	11	12	13	14	15	16
SiO ₂	71.9	47.2	42.9	49.7	49.8	51.3	48.9	47.8
Al ₂ O ₃	12.4	13.2	11.0	12.4	16.1	12.1	15.4	15.7
CaO	0.45	7.14	9.60	8.63	9.48	7.35	10.4	10.2
MgO	0.23	3.73	3.84	4.42	5.45	3.97	5.03	7.99
Na ₂ O	4.05	2.97	2.40	2.55	2.57	2.60	2.62	2.09
K ₂ O	4.82	0.71	0.76	0.97	0.70	1.31	0.61	0.36
Total Fe as Fe ₂ O ₃	4.64	19.0	22.5	17.0	12.6	16.4	13.7	11.9
MnO	0.06	0.27	0.30	0.23	0.16	0.21	0.19	0.17
TiO ₂	0.46	3.14	4.00	2.76	1.65	2.83	2.01	1.32
P ₂ O ₅	0.06	0.41	1.75	0.30	0.25	0.28	0.18	0.14
LOI	0.62	2.08	1.23	0.62	0.77	1.39	0.47	1.85
Cl								
Rb	150	30	30	40	30	40	20	10
Sr	190	170	160	150	260	150	210	200
Y	60	50	60	50	20	50	30	30
Zr	660	220	180	260	160	330	120	80
Nb	40	30	60	30	20	40	30	20
Ba	1180	270	290	290	310	380	180	130
Cr	30	20	20	100	110	30	120	170
Co	10	70	60	60	60	60	60	70
Ni	<10	10	<10	50	40	90	50	170

Table 10 continued

	17	18
SiO ₂	47.1	60.6
Al ₂ O ₃	11.8	11.2
CaO	9.85	3.33
MgO	5.41	1.25
Na ₂ O	2.16	3.87
K ₂ O	0.76	2.77
Total Fe as Fe ₂ O ₃	18.5	13.7
MnO	0.22	0.16
TiO ₂	3.46	1.12
P ₂ O ₅	0.18	0.20
Cr ₂ O ₃	0.39	1.54
LOI		
H ₂ O+		
CO ₂		
S		
FeO		
Rb	20	<10
Sr	150	120
Y	20	110
Zr	150	690
Nb	30	60
Ba	240	790
Cr	40	30
Co	70	30
Ni	50	10

1. A279A--Inclusion-free phase of contaminated diabase; Beaver River Diabase, Middle Proterozoic; outcrop sample, T. 55 N., R. 8 W., sec. 2, BA; Lake County.
2. C-284--Ilmenite gabbro, coarse-grained; Lax Lake Gabbro, Middle Proterozoic; outcrop sample, T. 56 N., R. 8 W., sec. 2, BB; Lake County.

Table 10 continued

3. C-302--Olivine gabbro, ophitic, medium-grained; Beaver River Diabase or Lax Lake Gabbro, Middle Proterozoic; outcrop sample, T. 56 N., R. 8 W., sec. 9, DA; Lake County.
4. C-306--Oxide gabbro, subophitic, medium-grained; Lax Lake Gabbro, Middle Proterozoic; outcrop sample, T. 56 N., R. 8 W., sec. 4, DB; Lake County.
5. C-320--Oxide gabbro, coarse-grained; Lax Lake Gabbro, Middle Proterozoic; outcrop sample, T. 56 N., R. 8 W., sec. 9, BC; Lake County.
6. C-468--Diabase, contact phase, Beaver River Diabase, Middle Proterozoic; outcrop sample, T. 55 N., R. 8 W., sec. 2, BA; Lake County.
7. A275C--Diabase with felsic inclusions; Beaver River Diabase, Middle Proterozoic; outcrop sample, T. 55 N., R. 8 W., sec. 2, BA; Lake County.
8. A372B--Granite inclusion; Beaver River Diabase, Middle Proterozoic; outcrop sample, T. 56 N., R. 7 W., sec. 12, BB; Lake County.
9. B319--Diabase, oxide-rich; Beaver River Diabase, Middle Proterozoic; outcrop sample, T. 56 N., R. 7 W., sec. 9, BA; Lake County.
10. B326--Diabase; Middle Proterozoic; outcrop sample, T. 56 N., R. 7 W., sec. 4, DA; Lake County.
11. B307--Diabase, fine-grained, ophitic; unnamed formation, Middle Proterozoic; outcrop sample, T. 56 N., R. 7 W., sec. 4, center B; Lake County.
12. C458--Diabase, medium-grained, ophitic, oxidized; unnamed formation, Middle Proterozoic; outcrop sample, T. 56 N., R. 8 W., sec. 25, BD; Lake County.
13. B301A--Diabase, ferrodioritic, fine-grained; unnamed formation, Middle Proterozoic; outcrop sample, T. 56 N., R. 7 W., sec. 3, CC; Lake County.
14. C357--Gabbro, fine-grained, chilled margin; Lax Lake Gabbro, Middle Proterozoic; outcrop sample, T. 56 N., R. 8 W., sec. 10, DB; Lake County.

Table 10 continued

15. C341--Gabbro, fine-grained; Lax Lake Gabbro, Middle Proterozoic; outcrop sample, T. 56 N., R. 8 W., sec. 13, AB; Lake County.
16. A258C--Gabbro, medium-grained, intergranular ilmenite; Lax Lake Gabbro, Middle Proterozoic; outcrop sample, T. 56 N., R. 8 W., sec. 13, center A; Lake County.
17. C491--Gabbro, medium-grained, intergranular ilmenite; Lax Lake Gabbro, Middle Proterozoic; outcrop sample, T. 56 N., R. 8 W., sec. 6, BC; Lake County.
18. C318--Gabbro, medium-grained, intergranular ilmenite; Lax Lake Gabbro, Middle Proterozoic; outcrop sample, T. 56 N., R. 8 W., sec. 8, DC; Lake County.

Table 11. Samples of Late Cretaceous Age--Whole-Rock Analyses

	1	2	3	4	5	6	7	8
SiO ₂	52.8	24.7	65.2	62.2	40.6	74.0	71.7	57.9
Al ₂ O ₃	28.0	4.51	19.0	12.8	8.83	13.0	14.2	20.1
CaO	0.54	37.1	0.37	4.26	1.88	0.30	0.27	0.64
MgO	0.94	0.96	1.05	2.36	2.73	0.75	1.19	1.48
Na ₂ O	0.22	0.20	0.13	1.12	0.12	0.11	0.08	0.20
K ₂ O	0.96	1.22	2.47	2.13	1.25	2.10	4.11	2.91
Total Fe as Fe ₂ O ₃	2.03	2.07	2.47	4.41	24.6	2.53	3.04	5.01
MnO	<0.01	0.04	0.02	0.11	0.15	0.04	<0.01	0.03
TiO ₂	0.94	0.26	1.21	0.65	0.57	0.99	0.58	0.97
P ₂ O ₅	0.05	0.09	0.09	0.17	0.06	0.07	0.05	0.13
Cr ₂ O ₃	0.01	<0.01	0.01	0.01	0.01	0.01	0.01	0.01
LOI	13.7	28.7	8.16	10.2	19.5	5.85	5.23	10.8
H ₂ O+	7.8	1.0	4.7	2.8	3.2	2.1	3.2	5.2
CO ₂	<0.01	29.0	0.05	3.43	11.8	0.50	<0.01	0.29
S	0.01	0.01	0.05	0.26	6.25	0.04	0.04	0.67
FeO	0.2	0.5	0.7	1.1	14.2	1.3	0.4	1.4
Rb	50	20	130	90	80	110	140	180
Sr	230	80	110	180	70	90	130	120
Y	20	<10	80	40	20	50	30	50
Zr	220	130	310	200	180	370	240	210
Nb	10	20	40	20	30	20	10	10
Ba	260	10	440	770	410	410	440	420
Cr								

Table 11 continued

	9	10	11	12	13	14	15	16
SiO ₂	50.9	16.3	53.6	53.6	57.2	42.8	11.1	52.5
Al ₂ O ₃	1.33	5.08	26.3	9.68	20.2	17.2	4.50	23.3
CaO	3.05	3.57	0.60	0.98	0.68	0.69	1.62	0.52
MgO	1.22	3.67	0.85	1.60	1.43	0.77	1.85	1.28
Na ₂ O	0.13	0.14	0.14	0.20	0.18	0.14	0.15	0.18
K ₂ O	0.28	0.77	1.54	1.59	2.74	1.39	0.60	3.09
Total Fe as Fe ₂ O ₃	25.9	41.7	2.52	18.0	5.03	16.8	50.6	5.55
MnO	0.62	0.53	0.04	0.32	0.07	0.37	0.77	0.06
TiO ₂	0.18	0.33	1.26	0.83	1.02	0.89	0.28	0.98
P ₂ O ₅	1.09	0.76	0.07	0.10	0.12	0.13	0.38	0.11
Cr ₂ O ₃	0.02	<0.01	0.01	0.01	0.01	0.01	<0.01	0.01
LOI	15.2	27.5	13.2	13.2	11.6	19.4	28.6	12.6
H ₂ O+	1.0	1.7	7.6	2.7	4.0	5.8	1.7	5.4
CO ₂	16.4	29.5	4.62	9.97	0.77	7.57	30.4	1.08
S	0.06	0.03	0.07	0.11	0.25	0.11	0.04	0.28
FeO	23.2	37.4	0.6	13.6	2.0	12.5	43.8	2.7
Rb	20	<10	110	100	170	90	60	190
Sr	100	70	140	60	120	70	50	140
Y	20	<10	60	20	40	30	<10	20
Zr	110	70	200	430	220	190	20	140
Nb	10	40	30	40	30	40	20	20
Ba	290	220	360	500	410	320	320	460
Cr								

Table 11 continued

	17	18	19	20	21	22	23	24
SiO ₂	61.0	55.4	60.9	5.91	59.4	53.0	38.0	41.8
Al ₂ O ₃	16.6	21.0	18.4	2.05	24.2	19.9	15.8	17.7
CaO	1.69	0.71	0.52	3.48	0.28	1.81	12.3	6.66
MgO	1.19	1.43	1.42	4.35	0.55	1.44	1.14	1.28
Na ₂ O	0.17	0.21	0.25	0.13	0.06	0.23	0.16	0.23
K ₂ O	2.45	2.84	3.03	0.30	1.40	2.69	2.17	2.26
Total Fe as Fe ₂ O ₃	5.55	5.56	5.29	52.6	3.35	6.78	6.08	7.41
MnO	0.25	0.07	0.02	0.74	0.06	0.03	0.01	0.01
TiO ₂	1.10	1.01	0.99	0.13	1.51	0.84	0.56	0.69
P ₂ O ₅	0.14	0.12	0.11	0.10	0.05	0.21	0.17	0.18
Cr ₂ O ₃	0.01	0.01	0.01	<0.01	0.03	0.01	<0.01	0.01
LOI	10.2	11.8	9.31	30.4	9.62	13.4	22.7	22.2
H ₂ O+	4.3	5.6	4.4	1.3	6.2	4.7	7.7	7.8
CO ₂	2.25	0.45	0.23	35.5	<0.01	0.82	8.60	4.39
S	0.04	0.18	0.78	0.09	0.05	3.14	5.10	6.38
FeO	3.1	1.6	1.4	42.5	0.5	1.3	1.5	1.8
Rb	130	160	190	<10	70	170	140	140
Sr	100	130	100	10	20	200	270	140
Y	70	50	40	<10	30	40	10	30
Zr	280	240	230	10	290	150	100	120
Nb	50	40	30	20	20	10	20	30
Ba	460	420	430	210	420	440	240	310
Cr								

Table 11 continued

	25	26	27	28	29	30	31	32
SiO ₂	61.8	8.26	53.7	61.53	20.04	58.81	64.33	25.50
Al ₂ O ₃	18.9	2.65	3.73	15.37	4.82	19.66	18.56	3.25
CaO	0.29	2.66	15.5	0.71	25.82	0.64	0.25	4.28
MgO	1.10	0.50	0.32	1.30	0.57	1.33	1.03	2.31
Na ₂ O	0.34	0.08	0.22	0.35	0.22	0.38	0.23	0.04
K ₂ O	2.41	0.36	0.77	2.97	1.18	3.61	2.96	0.71
Total Fe								
as Fe ₂ O ₃	3.70	47.0	5.76	5.28	1.93	5.02	3.15	34.89
MnO	<0.01	10.0	1.37	0.05	0.03	0.04	0.03	1.80
TiO ₂	0.99	0.30	0.42	0.760	0.200	0.800	1.130	0.170
P ₂ O ₅	0.09	0.78	0.14	0.19	0.20	0.21	0.12	1.42
Cr ₂ O ₃	0.01	28.0	18.3	12.32	40.17	10.27	9.13	23.26
LOI	10.8							
H ₂ O+	4.9	2.1	0.9	3.24	2.61	2.59	1.94	0.53
CO ₂	<0.01	29.6	14.6	0.23	17.70	<0.01	0.10	
S	0.25		0.10	1.32	2.07	0.48	0.23	0.35
FeO	0.1			1.01	1.39	1.25	0.86	30.00
Rb	150	<10	30					
Sr	100	30	120					
Y	30	<10	10					
Zr	270	20	190					
Nb	40	<10	10					
Ba	390	350	1540					
Cr		50	10					

Table 11 continued

	33	34	35	36	37
SiO ₂	51.97	52.87	57.97	50.90	29.85
Al ₂ O ₃	18.80	19.72	18.79	20.16	11.22
CaO	1.64	1.33	0.85	1.07	17.42
MgO	1.28	1.30	1.37	1.48	1.23
Na ₂ O	0.28	0.39	0.60	0.60	0.75
K ₂ O	3.02	3.31	3.30	3.92	2.13
Total Fe as Fe ₂ O ₃	7.75	6.94	5.77	6.51	3.66
MnO	0.03	0.03	0.04	0.04	0.05
TiO ₂	0.660	0.700	0.810	0.750	0.360
P ₂ O ₅	0.19	0.20	0.17	0.18	0.11
LOI	14.53	13.29	10.62	12.43	30.43
H ₂ O+	3.31	3.14	2.68	2.82	3.32
CO ₂	0.72	0.52	0.21	0.59	12.20
S	3.81	3.17	1.17	1.91	2.01
FeO	1.90	1.39	1.39	1.65	2.16
Rb					
Sr					
Y					
Zr					
Nb					
Ba					
Cr					

1. KS1-1--Shale; unnamed formation, Late Cretaceous; sample depth 168 ft., drill hole SQ-1, T. 109 N., R. 31 W., sec. 18, CD; Brown County.
2. KS1-2--Siltstone; unnamed formation, Late Cretaceous; sample depth 213 ft., drill hole SQ-1, T. 109 N., R. 31 W., sec. 18, CD; Brown County.
3. KS4-1--Shale; unnamed formation, Late Cretaceous; sample depth 494 ft., drill hole SQ-4, T. 104 N., R. 36 W., sec. 8, CD; Jackson County.

Table 11 continued

4. KS5-1--Shale, silty; unnamed formation, Late Cretaceous; sample depth 401 ft., drill hole SQ-5, T. 102 N., R. 26 W., sec. 11, DD; Jackson County.
5. KS7-1--Siltstone, sulfide-bearing; unnamed formation, Late Cretaceous; sample depth 840 ft., drill hole SQ-7, T. 105 N., R. 43 W., sec. 34, CD; Murray County.
6. KS8-1--Shale, unnamed formation, Late Cretaceous; sample depth 176.5 ft., drill hole SQ-8, T. 107 N., R. 31 W., sec. 11, BC; Watonwan County.
7. KS10-1--Regolith derived from siltstone; unnamed formation, pre-Late Cretaceous; sample depth 534 ft., drill hole SQ-10, T. 104 N., R. 35 W., sec. 4, DA; Jackson County.
8. KS11-1--Shale; unnamed formation, Late Cretaceous; sample depth 339 ft., drill hole SQ-11, T. 105 N., R. 37 W., sec. 6, CC; Cottonwood County.
9. KS11-2--Sandstone; unnamed formation, Late Cretaceous; sample depth 396 ft., drill hole SQ-11, T. 105 N., R. 37 W., sec. 6, CC; Cottonwood County.
10. KS11-3--Siltstone; unnamed formation, Late Cretaceous; sample depth 473 ft., drill hole SQ-11, T. 105 N., R. 37 W., sec. 6, CC; Cottonwood County.
11. KS11-4--Shale; unnamed formation, Late Cretaceous; sample depth 539 ft., drill hole SQ-11, T. 105 N., R. 37 W., sec. 6, CC; Cottonwood County.
12. KS11-5--Shale/siltstone; unnamed formation, Late Cretaceous; sample depth 513 ft., drill hole SQ-11, T. 105 N., R. 37 W., sec. 6, CC; Cottonwood County.
13. KS12-1--Shale; unnamed formation, Late Cretaceous; sample depth 340 ft., drill hole SQ-12, T. 105 N., R. 37 W., sec. 29, CD; Cottonwood County.
14. KS12-2--Shale, silty; unnamed formation, Late Cretaceous; sample depth 466 ft., drill hole SQ-12, T. 105 N., R. 37 W., sec. 29, CD; Cottonwood County.
15. KS12-3--Siltstone; unnamed formation, Late Cretaceous; sample depth 493 ft., drill hole SQ-12, T. 105 N., R. 37 W., sec. 29, CD; Cottonwood County.

Table 11 continued

16. KS12-4--Shale; unnamed formation, Late Cretaceous; sample depth 517 ft., drill hole SQ-12, T. 105 N., R. 37 W., sec. 29, CD; Cottonwood County.
17. KS13-1--Shale, silty; unnamed formation, Late Cretaceous; sample depth 131 ft., drill hole SQ-13, T. 107 N., R. 33 W., sec. 23, AD; Watonwan County.
18. KS04-11--Shale; unnamed formation, Late Cretaceous; sample depth 52 ft., drill hole SP4204T-1, T. 111 N., R. 41 W., sec. 8, AA; Lyon County.
19. KS09-21--Shale; unnamed formation, Late Cretaceous; sample depth 62 ft., drill hole SP4209T-2, T. 112 N., R. 41 W., sec. 32, DD; Lyon County.
20. SKTR-A4--Shale; Dakota Formation, Late Cretaceous, Cenomanian; outcrop sample, T. 127 N., R. 29 W., sec. 8, CA; Morrison County.
21. SKTR-A1--Nodule; Dakota Formation; Late Cretaceous, Cenomanian; outcrop sample, T. 127 N., R. 29 W., sec. 8, CA; Morrison County.
22. KSBH--Shale; Carlile Shale, Late Cretaceous, Turonian; sample depth 75 ft., drill hole R2-85-29, T. 120 N., R. 47 W., sec. 33, DD; Grant County, South Dakota.
23. KSFP--Shale; Carlile Shale, Late Cretaceous, Turonian; sample depth 110 ft., drill hole R2-85-29, T. 120 N., R. 47 W., sec. 33, DD; Grant County, South Dakota.
24. KSLT-NP--Shale; unnamed formation, Late Cretaceous; sample depth 10 ft., north pit, T. 125 N., R. 49 W., sec. 1, BA; Traverse County.
25. KSLT-SP--Shale; unnamed formation, Late Cretaceous; sample depth 10 ft., south pit, T. 124 N., R. 49 W., sec. 23, BD; Big Stone County.
26. KSOP-1--Siltstone, sideritic; unnamed formation, Late Cretaceous; outcrop sample, T. 122 N., R. 29 W., sec. 20, DD; Stearns County.
27. KSOP-2--Concretion; unnamed formation, Late Cretaceous; pit sample, T. 109 N., R. 35 W., sec. 26, AD; Brown County.

Table 11 continued

28. KC2-6--Shale; Graneros Shale, Late Cretaceous; sample depth 820 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
29. KC2-10--Limey shale; Greenhorn Limestone, Late Cretaceous; sample depth 787 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
30. KC2-23, Shale; Carlile Shale, Late Cretaceous; sample depth 691 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
31. KC2-30--Shale; Niobrara Shale(?), Late Cretaceous; sample depth 585 ft., drill hole Coteau 2, T. 110 N., R. 44 W., sec. 33, DC; Lincoln County.
32. K186-6--Rock stringer; Niobrara Shale(?), Late Cretaceous; sample depth 74-80 ft., drill hole KNF-186, T. 111 N., R. 41 W., sec. 36, DD; Lyon County.
33. K186-12--Shale; Carlile Shale, Late Cretaceous; sample depth 160-170 ft., drill hole KNF-186, T. 111 N., R. 41 W., sec. 36, DD; Lyon County.
34. K186-17--Shale; Greenhorn Limestone(?), Late Cretaceous; sample depth 203 ft., drill hole KNF-186, T. 111 N., R. 41 W., sec. 36, DD; Lyon County.
35. K186-19--Shale; Graneros Shale/Dakota Sandstone, Late Cretaceous; sample depth 302 ft., drill hole KNF-186, T. 111 N., R. 41 W., sec. 36, DD; Lyon County.
36. K286A-4--Shale; Carlile Shale, Late Cretaceous; sample interval 130-135 ft., drill hole KNF-286A, T. 114 N., R. 44 W., sec. 24, AA; Yellow Medicine County.
37. K286A-8--Shaly Limestone; Carlile Shale-Greenhorn Limestone, Late Cretaceous; sample interval 185.5 ft., drill hole KNF-268A, T. 114 N., R. 44 W., sec. 24, AA; Yellow Medicine County.

Table 12. Samples of Uncertain Age--Whole-Rock Analyses

	1	2	3	4	5
SiO ₂	47.9	49.0	48.9	50.5	59.8
Al ₂ O ₃	15.2	24.8	12.5	12.5	15.1
CaO	8.85	0.33	5.80	8.79	3.94
MgO	7.57	2.40	5.86	5.42	3.18
Na ₂ O	1.37	0.27	2.51	2.16	6.51
K ₂ O	0.86	10.1	1.06	0.50	3.17
Total Fe as Fe ₂ O ₃	12.9	6.52	16.1	16.5	6.11
MnO	0.17	0.07	0.20	0.22	0.13
TiO ₂	1.35	0.85	1.31	1.35	0.66
P ₂ O ₅	0.12	0.02	0.13	0.14	0.39
LOI	3.70	4.31	5.62	1.93	1.31
Cl	<50				
H ₂ O+	2.4	2.6	3.5	2.0	0.9
CO ₂	0.12	0.01	0.12	0.01	0.37
S	0.02	0.43			
FeO	8.1				
Rb	40	250	30	40	70
Sr	600	<10	120	100	200
Y	20	<10	20	30	10
Zr	40	20	50	50	170
Nb	30	20	30	20	20
Ba	350	2160	260	180	430
Cr	170	4510	140	50	40

1. P-1--Metabasalt; unnamed formation, Precambrian; sample depth 225 ft., Minnesota Geological Survey drill hole P-1, T. 134 N., R. 30 W., sec. 11, ACBABB; Cass County.
2. E-941--Volcanic rock(?), dark greenish gray, aphanitic; unnamed formation, Precambrian; sample depth 941.4 ft., drill hole E-1, T. 112 N., R. 46 W., sec. 7, DC; Lincoln County.

Table 12 continued

3. HB-1-671.3--Augite gabbro; unnamed formation, Precambrian; sample depth 671.3 ft., Minnesota Geological Survey drill hole HB-87-1, T. 142 N., R. 35 W., sec. 6, DDCDCA; Hubbard County.
4. HB-1-678.3--Augite gabbro; unnamed formation, Precambrian; sample depth 678.3 ft., Minnesota Geological Survey drill hole HB-87-1, T. 142 N., R. 35 W., sec. 6, DDCDCA; Hubbard County.
5. HB-4-724--Syenite; unnamed formation, Precambrian; sample depth 724.0 ft., Minnesota Geological Survey drill hole HB-4, T. 142 N., R. 37 W., sec. 22, DBCCBC; Becker County.



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