GEOLOGIC DRILLING AND MAPPING - COOK AREA, ST. LOUIS COUNTY, MINNESOTA

Minnesota Geological Survey
Open File Report 91-2
by
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These materials are preliminary and have not been reviewed for conformity with Minnesota Geological Survey editorial standards. An MGS information circular containing details of drilling and analyses will be published in coming months.

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Table 1. Principal facts for scientific test holes in the Cook area, west-central St. Louis and northeastern Itasca counties.

Hole Number	Co.(1)	Township-Range-Sec.(2)	Azim.(3)	Drift thickness(4)	Regolith thickness	Sound rock drilled	Sound rock cored	Total depth	Rock types(5)
CD-1	I	61-22-19 BABAB	V	215	0	25	10	250	Carbonate sericite schist (mylonitic felsite)
CD-2A	I	62-22-12 DCADDA	V	65	0	29	0	94	see CD-2B
CD-2B	I	62-22-12 DCADDA	V	70	0	8	1(6)	83	Biotite schist(7) (metagraywacke)
CD-3	S	63-20-30 DDABB	V	90	0	15	10	115	Sillimanite-staurolite-biotite schist(meta-wacke)
CD-4	S	63-20-32 CAAAA	V	78	0	9	10	97	Hornblende-pyroxene monzonite and syenite
CD-5	S	62-21-34 ABBABD	V	113	77	3	10	203	Metagraywacke and slate
CD-6A	S	61-21-4 ADADAC	V	185	0	12	0	197	see CD-6B
CD-6B	S	61-21-4 ADADAD	V	185	0	5	10	200	Tuffaceous metagraywacke and slate
CD-7	S	61-21-15 CCBBB	V	55	0	18	10	83	Pyroxene hornblende biotite monzodiorite
CD-8	S	60-21-9 BBBBAA	V	225	0	31	8	271	Boulders (?); pyroxene monzonite
CD-9	I	59-22-1 BCDBDC	V	43	0	13	8	64	Porphyritic pyroxene quartz monzonite
CD-10	S	60-20-30 BCBCBB	V	31	0	11	12	54	Biotite schist and foliated granodiorite
CD-11A	S	60-20-16 ADAAAD	V	142	0	13	6	161	Boulders - varied rock types
CD-11B	S	60-20-16 ADABAD	V	208	0	8	9	225	Migmatitic, sillimanite-biotite schist(wacke)
CD-12	S	60-20-3 DDDC	V	48	0	5	10	63	Biotite tonalite to trondjhemite
CD-13	S	62-21-22 ADDDAA	V	93	5	4	9	111	Hornblende biotite syenite (cataclastized)
CD-14A	S	61-21-27 BCCCB	V	15	0	9	0	24	see CD-14B
CD-14B	S	61-21-27 BCCCB	V	15	0	27	10	52	Garnet-biotite-muscovite schist (metagraywacke)
CD-17	S	62-19-32 BCBCBD	V	28	0	3	14	45	Hornblende-quartz monzodiorite
CD-19	S	62-19-24 DDDADD	V	62	0	13	10	85	Hornblende-biotite diorite
CD-20	S	62-18-31 CDCCBB	V	43	17	11	10	81	Dacitic crystal-lapilli tuff, sheared
CD-21	S	62-18-29 DCCCC	V	158	0	2	10	170	Quartz-sericite schist (meta-pelite)
CD-22	S	62-18-20 ACDCD	V	28	0	7	10	45	Pillow textured metabasalt (amphibolite)
CD-24	S	62-17-16 CCDDD	V	8	0	9	10	27	Sheared, amphibolitic metabasalt
CD-25	S	62-17-14 BBCBD	V	15	2	5	10	32	Meta-lamprophyre, pyroxene-phyric
CD-29A	S	61-19-25 DDDD	V	86	0	0	0	86	No core
CD-29B	S	61-19-25 DDDD	V	80	0	10	10	100	boulders(?), granite and schist
CD-31	S	60-19-24 CBBBBC	V	46	0	4	10	60	Diabase (texture and composition ~ Proterozoic)
CD-32	S	60-19-34 ADAADA	V	58	0	3	10	71	Banded quartzofeldspathic rock (altered and sheared)
CD-33A	S	60-20-34 CBDDCB	V	32	0	1	0	33	Medium grained granite-granodiorite
CD-33B	S	60-20-34 CCCDDA	V	33	0	7	0	40	Foliated biotite granite
CD-34	S	60-18-23 BCDAB	V	79	0	5	2	86	Pink, massive biotite granite (boulder?)
CD-35	S	60-18-24 DAAAC	V	175	0	13	4	192	Hornblende-biotite monzodiorite
CD-36	S	60-17-22 CDBBAB	V	22	0	9	10	41	Hornblende-biotite schist (metawacke)
CD-37	I	62-22-14 BBBCCA	V	109	4	1	13	127	Argillite and immature graywacke
CD-40	I	61-22-16 CDCBDC	V	135	0	5	7	147	Biotite-chlorite schist (meta-siltstone)
Angled Deep Core Holes									
MGS91-1	S	61-22-19 BAABBC	150/-55	229	10	1	210	450	240-275' graphitic argillite, felsic tuff 275-450' dacite porphyry flows(?)
MGS91-2	S	62-17-16 CDCC	155/-55	8	0	2	151	161	10-103' basalt 103-161' metasiltstone, graywacke

KEY

(1) County; I= Itasca, S= St. Louis

(2) All townships numbers are north, ranges are west. Quartering system uses letters for quadrants: A=NE 1/4, B=NW 1/4, C=SW 1/4, D= SE 1/4.
The largest quarter is listed first, thus 61-22-19 ABCD can be read as "the SE1/4 of the SW1/4 of the NW1/4 of the NE1/4 of section 19 in township 61N, range 22W.
Hole was drilled near the center of the last quarter listed (i.e., center of D in example above).

(3) Azimuth; CD holes are all vertical (noted V); MGS91-1,2 were inclined in the direction and plunge indicated.

(4) Measurements given in feet.

(5) See Table II for geochemical data. Some funding for chemical analyses provided by the Public Geological Sample Program of the Minnesota Department of Natural Resources.
Rock type is based on cuttings where sound rock cored = 0, quierried where uncertain. Rock name in parentheses is field or protolith name.

(6) CD-2B, cored 78-79 feet; drilled beyond to 83'.

(7) All biotite-bearing schists are quartzofeldspathic.

MGS OPEN-FILE REPORT 91-2 : MAJOR-ELEMENT AND SELECTED MINOR-ELEMENT GEOCHEMICAL DATA FOR BEDROCK OUTCROP SAMPLES

Number	Rock type	SiO2	Al203	CaO	MgO	Na2O	K2O	Fe2O3C	FeO	MnO	TiO2	P2O5	H2O+	CO2	S	LOI	Sum	Fe2O3T	Cr	Rb	Sr	Y	Zr	Nb	Ba
CD-2-80	Biotite schist	68.1	14.7	2.66	2.02	4.17	1.85	0.91	3.5	0.07	0.51	0.12	ND	<0.01	0.03	0.7	99.9	4.80	**0.03**	82	369	<10	123	26	477
CD-3-109	Biotite schist	68.6	16.2	3.99	1.90	4.12	1.22	1.02	1.7	0.03	0.18	0.07	ND	<0.01	0.02	0.85	100.2	2.91	**<0.01**	46	712	<10	62	<10	533
CD-4-92	Hb-px. syenodiorite	62.2	15.0	4.09	1.62	6.57	4.73	2.42	1.4	0.09	0.48	0.24	ND	<0.01	0.02	0.54	99.9	3.98	**<0.01**	94	510	10	246	14	2290
CD-6B-193	Tuffaceous argillite	62.6	16.9	2.06	2.93	5.60	1.71	1.42	3.50	0.08	0.53	0.15	ND	<0.01	0.01	2.08	100.2	5.31	**0.03**	54	821	<10	109	13	679
CD-7-80	Px. monzodiorite	58.5	15.4	5.01	3.58	5.90	3.80	1.66	3.20	0.10	0.48	0.29	ND	0.41	<0.01	1.08	99.7	5.22	**0.01**	79	1470	<10	32	<10	1460
CD-19-84	Epidote-altered diorite	53.6	17.7	7.59	3.26	5.40	1.79	4.18	2.6	0.13	0.71	0.36	ND	0.24	<0.01	1.54	99.5	7.07	**<0.01**	39	1950	<10	110	15	882
CD-20-77	Xtl-lapilli tuff	70.1	15.7	3.81	0.82	5.49	0.84	0.55	0.7	0.04	0.13	0.05	ND	0.66	<0.01	1.77	100.2	1.33	**0.01**	30	636	<10	53	14	313
CD-22-36	Meta-pillow basalt	50.6	15.8	11.5	4.83	2.02	0.19	4.23	6.9	0.22	1.04	0.08	ND	0.08	0.04	2.16	100.4	11.9	**0.03**	12	106	21	69	<10	73
CD-25-30	Porph. lamprophyre	45.7	12.2	9.55	8.02	2.38	1.4	1.68	6.9	0.16	0.80	0.29	ND	6.40	<0.01	9.93	99.9	9.35	**0.05**	52	233	21	66	<10	435
CD-37-114	Meta-argillite	Analyses not yet received																							

CD-2-80 = Hole CD-2, 80 ft. sample depth

*Cr values reported as Wt. % oxides, other minor elements reported in ppm.

MGS OPEN-FILE REPORT 91-2 : MINOR-ELEMENT GEOCHEMICAL DATA FOR BEDROCK DRILL-CORE SAMPLES (ppm)

Sample Number	Rock Type	Ag	As	Au	Cu	Hg	Mo	Pb	Sb	Tl	Zn	Bi	Cd	Ga	Se	Te
CD-1-243	Pyrite-sericite schist	2.65	9.47	0.003	29.1	0.133	0.512	48.4	0.462	<.49	186.	<.245	0.215	1.68	<.98	<.49
CD-2-78	Pyritic tuff-wacke	0.158	1.89	0.007	335.	<.098	1.54	4.57	<.245	<.49	44.3	<.245	<.098	6.97	<.98	<.49
CD-68-190	Tuffaceous argillite	0.046	2.04	0.003	16.7	<.099	1.16	3.50	<.247	<.494	66.8	<.247	<.099	9.19	<.988	<.494
CD-6B-200	F.gr. intermed. intrusive	0.029	1.25	0.002	2.89	<.094	0.373	2.54	<.235	<.471	95.7	<.235	<.094	12.1	<.942	<.471
CD-21-160	Chl-ser. schist	0.142	23.6	0.002	51.8	<.096	1.13	10.4	<.241	<.482	70.1	0.280	<.096	6.81	<.963	<.482
CD-21-164	Chl. sch. (meta-argillite)	0.150	14.0	0.005	74.2	<.098	2.35	7.98	<.246	<.492	65.2	0.293	0.108	6.37	<.984	<.492
CD-22-38	Metabasalt	0.051	<.949	0.002	116.	<.095	1.45	0.671	<.237	<.472	39.9	<.237	<.095	3.58	<.949	<.472
CD-22-44	Metabasalt	0.161	2.47	0.006	147.	<.096	0.617	6.36	0.449	<.48	32.0	<.24	<.096	5.20	0.962	<.48
CD-25-22	Meta-lamprophyre	0.147	3.15	0.004	169.	<.098	0.933	1.09	<.246	<.491	46.4	<.246	<.098	5.21	<.982	<.491
DD91-1-257	Pyritic tuff, argillite	Analyses not yet received as of 6/25/91														
DD91-1-266	Graphitic argillite	Analyses not yet received as of 6/25/91														
DD91-1-337	Ank-fuch-seric schist	Analyses not yet received as of 6/25/91														
DD91-1-412	Silicified felsic tuff	Analyses not yet received as of 6/25/91														
DD91-1-439	fsp-phyric fels. tuff	Analyses not yet received as of 6/25/91														

CD-1-243 = Drill hole CD-1, 243 ft. sample depth.

PRELIMINARY GEOLOGIC MAP OF ARCHEAN BEDROCK, SOUDAN-BIGFORK AREA, NORTHERN MINNESOTA.

SCALE 1:100,000

Minnesota Geological Survey
Open-File Report 91-3

compiled by

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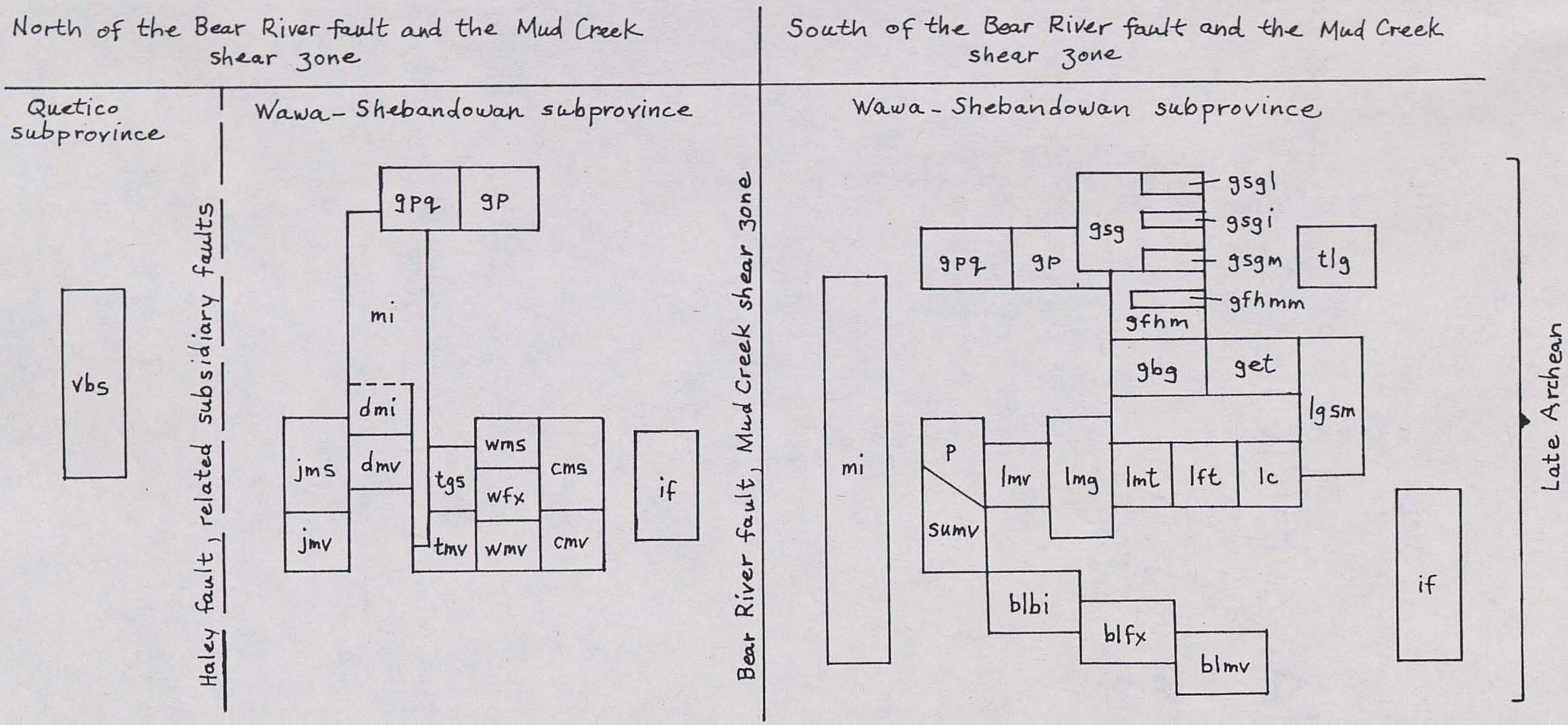
NOTE: The interpretation portrayed on the geologic maps in this report is based to a large degree on data from published geologic maps, all at scale 1:48,000 or larger, supplemented by selective remapping and reinterpretation by the compiler. The published works (see bibliography) constitute the fundamental data base, and should be consulted for details.

Maps and explanation are preliminary and have not been reviewed for conformity with Minnesota Geological Survey editorial standards. A thoroughly reviewed and edited version of the geologic maps, with additional explanatory and interpretive material, will be published by the Minnesota Geological Survey in coming months.

MAP EXPLANATION

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

gp	gpq

Granitoid plutonic rocks, synkinematic to late kinematic. Includes a broad range of quartz-poor to quartz-absent compositions between syenite and diorite (gp), together with lesser amounts of quartz-bearing monzogranite and granodiorite (gpq). Pyroxenite and hornblende pyroxenite are present in variable amounts, typically in close association with the quartz-poor granitoid types. Fabric development varies from place to place within and between plutons. Primary flow fabrics are most prominent in marginal facies, whereas secondary fabrics tend to be partitioned into discrete zones of ductile to brittle shear.

Plutons of quartz-absent or quartz-poor rock types:

SL =Side Lake pluton (monzodiorite)
M =Morcom pluton (monzodiorite)
LL =Lost Lake pluton (syenite, monzonite, diorite)
I =Idington pluton (monzodiorite, pyroxenite)
L =Linden pluton (syenite)
R =Rice River pluton (mesodiorite)
CA =Cook Airport pluton (diorite)
BL =Bello Lake pluton (monzonite, quartz monzonite)
CL =Coon Lake pluton (syenite)

Plutons of quartz-bearing rock types:

SG =Stingy Lake pluton (monzogranite)
ST =Sturgeon pluton (granite)
E =Effie pluton (granite)
D =Daisy Bay pluton (granodiorite)

U =Unnamed pluton of granitoid composition; identified on basis of geophysical signature.

tlg

Trondhjemite, tonalite, and leucogranite. Light gray to white, medium-to coarse-grained biotite-bearing rocks in discrete plutons that intrude the Embarass tonalite gneiss (get)

GIANTS RANGE BATHOLITH (SYNKINEMATIC TO LATE KINEMATIC)

gsg

Shannon Lake granite. Biotite granite, pink to gray, medium-grained. Forms large mass in south-central part of map sheet and abundant dikes of aplitic, granitic, and pegmatitic texture that invade all other units of the Giants Range intrusive sequence. Intrudes the Idington pluton south of Idington Station. gsgi: Shannon Lake Granite that contains abundant inclusions of monzodiorite from the Idington pluton. gsgm: Magnetic facies of the Shannon Lake Granite that is richer than most of the unit in ferromagnesian minerals an Fe-Ti oxides. gsgl: Discrete body of Shannon Lake Granite that is interpreted from its aeromagnetic signature to be late-stage intrusion.

gfhm

Farm Lake hornblende monzonite and quartz monzonite. Monzonite and quartz monzonite, biotite- and hornblende-bearing, generally coarse-grained and weakly foliated. Varies gradationally in modal proportions of mafic minerals, quartz, and Fe-Ti oxides, and thus varies in its regional aeromagnetic signature. Inferred to correlate with the Farm Lake facies of the Giants Range batholith as mapped to the southeast of Ely by Green (1970). gfhmm: Magnetic facies of the Farm Lake hornblende monzonite.

gbg

Britt granodiorite. Biotite-hornblende granodiorite, medium-grained, light gray to grayish-pink, variably lineated and foliated. Contains ubiquitous hornblende-rich inclusions that typically are smaller than 10 cm in size and are ovoid to discoid in shape. The contact zones of the granodiorite against metabasalt, well exposed northeast of Britt, are choked with wallrock xenoliths and very strongly lineated. The granodiorite in the Wasson pluton mapped by Jirsa (1990) is very similar to the granodiorite near Britt, and the two bodies are here correlated.

get

Embarrass tonalite and tonalite gneiss. Strongly heterogenous unit composed of variably deformed tonalitic intrusive rocks and their metamorphosed hosts. The most abundant variants are (1) biotite-hornblende tonalite gneiss, medium-grained, modally layered; (2) biotite tonalite gneiss, coarse grained, strongly foliated; (3) leucocratic trondhjemite gneiss; and (4) amphibolite gneiss. This unit is in more or less gradational contact with migmatitic rocks of unit gsm.

gsm

Schist-rich migmatite and paragneiss. Strongly heterogenous unit composed of biotite schist paleosome and granitic to tonalitic leucosome. The proportion of paleosome to leucosome and the composition of the leucosome phase vary abruptly from place to place, but in general the leucosome decreases in amount and becomes more potassic in composition toward the north. The paleosomatic schist is a biotite- or biotite plus hornblende-bearing, layered rock of sedimentary derivation that is identical in appearance to unmigmatized metasedimentary rock in adjacent map unit lmg.

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mi

Mafic intrusive rocks. Form dikes, sills in supracrustal sequences throughout the region. Includes rocks of lamprophyric, komatitic, and diabasic composition and of more than one age.

p

Dacite porphyry, quartz- and plagioclase phyric, medium- to light gray. Weakly to strongly deformed in D_2 and metamorphosed under conditions of the greenschist facies. forms dikes and sills in supracrustal sequences throughout the region; mapped only where especially prominent near the east end of Lake Vermilion.

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LAKE VERMILION FORMATION

Img

<u>Metagraywacke and metapelite</u>, thin- to thick-bedded, dark- to medium-gray on fresh surfaces. Graywacke component reflects felsic volcanic (dacitic) provenance. Graded bedding, other primary structures characteristic of turbiditic deposition, are widely preserved. Metamorphosed chiefly to chlorite-bearing mineral assemblages in north half of map area and to biotite-bearing assemblages in south half. Locally contains staurolite in the area southwest of Cook, northeast of Sturgeon lake. Grades into units <u>lmt</u> and <u>lft</u> with increasing content of felsic volcanic detritus.

lmt

<u>Mixed tuffaceous and sedimentary rocks</u>. Includes dacite tuff, residemented dacite tuff, dacite-derived graywacke, and minor quantities of fine-grained shale, silt, and ash, intimately interstratified. Original volcanic and sedimentary features have survived strong deformation and low-grade metamorphism to varying degrees. Rocks that contain a high component of dacitic detritus weather almost white, but are gray to dark gray on fresh surfaces.

lft

<u>Felsic tuff and resedimented felsic tuff</u>. Includes clastic rocks of dacitic composition and provenance that range from essentially primary volcanic products to well bedded rocks having the attributes of subaqueous mass-flow deposits. The commonest rock types contain clasts in the fine- to coarse-sand size range and thus are tuffs or reworked tuffs; these are interbedded with lesser amounts of tuff-breccia, agglomerate, conglomerate, and fine-grained ash-rich rocks and also with porphyritic, variably flow-banded dacitic rocks interpreted as local flows. Quasi-conformable sills of dacite porphyry (unit <u>p</u>) are locally abundant. Low grade metamorphism has produced widespread white mica, chlorite, and carbonate in rocks of this unit, but metamorphic effects in general are less pronounced than in finer-grained, less massive rocks.

lc

<u>Conglomerate and conglomerate-bearing sequences</u> of metasedimentary rocks, variably metamorphosed. Unit includes two distinct kinds of rock: (1) essentially monomict lithic conglomerates within mass-flow sequences of dacitic wacke and associated rocks, and (2) polymict lithic conglomerates that reflect a varied, commonly local, provenance. The clasts in the monomict conglomerate are predominantly dacite and dacite porphyry; those in the polymict variant include metabasalt, iron-formation, chert, quartzite, lamprophyre, and lineated granodiorite identical to the Britt granodiorite (unit <u>gbg</u>). Conglomerate beds typically are interstratified with finer-grained clastic rocks of felsic volcanic provenance.

lmv

<u>Mafic metavolcanic rocks</u>. pillowed metabasalt, massive metabasalt, and compositionally equivalent hypabysal rocks, typically of thoelitic composition. Occur as isolated thin sequences within voluminous sequences of lithic dacitic wacke and allied tuffaceous and pelitic rocks, and also in a thick, continuous sequence in the vicinity of Pfeiffer Lake and Big Rice Lake. Rocks are chemically similar to those in the Upper member of the Ely Greenstone (Schulz, 1980) and may represent the waning or distal products of Upper Ely volcanism.

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if

Iron formation. Laminated cherty iron-formation, most commonly magnetite- and hematite-bearing, typically in units a few meters thick. Sulfide-rich iron-formation occurs locally but is seemingly sparse. The iron-formation units are intimately interbedded with thin units of felsic to mafic volcanic and volcaniclastic rocks. As mapped, this unit includes the major iron-formation of the Soudan Iron-formation Member of the Ely Greenstone in the Tower-Soudan area (Sims and Southwick, 1985) as well as iron formations within other volcanic and sedimentary units throughout the region. It has no time-stratigraphic implications.

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SHERRY LAKE-UPPER ELY GREENSTONE SEQUENCE

sumv

Metabasalt, typically pillowed, monotonously uniform, generally of thoelitic composition. Pillows are of medium to small size and have smooth, ovoid shapes and thin rinds. Vesicles generally are lacking. This unit includes the Upper member of the Ely Greenstone in the Tower-Soudan area (Schulz, 1980; Sims and Southwick, 1985), and metabasalts of the Sherry Lake area (Jirsa, 1988). Metabasalts of the Britt structure near Pfeiffer Lake (Jirsa and others, 1991) are similar, but occupy a somewhat higher stratigraphic position and are here included in unit lmv. A distinctive unit of breccia underlies pillowed flows assigned to unit sumv north of Armstrong Creek in the northeast part of the map area; this breccia is provisionally assigned to unit sumv despite some uncertainty as to its origin and affinity.

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BEAR LAKE - LOWER ELY GREENSTONE SEQUENCE

blmi

Mafic and intermediate volcanic and volcaniclastic rocks interstratified with minor but ubiquitous thin interbeds of iron-formation. Includes pillowed flows, rubbly flow-top breccias, and various kinds of fine-grained fragmental rocks such as palagonite tuff and aquagene tuff. Some originally permeable rocks have undergone silicification and carbonate alteration. Rocks of this unit were included in the Soudan Iron-Formation member of the Ely Greenstone by Sims and Southwick (1985).

blfx

Felsic and intermediate volcanic and volcaniclastic rocks with minor but ubiquitous thin interbeds of iron-formation. Most rocks originally were fine-grained clastic materials of one type or another; as a group they were weak structurally and have been deformed locally into scaly chlorite-sericite schists in which original structures and textures are not well preserved. Unit passes upward and laterally into unit blbi and also into unit if. Rocks of this unit were included in the Soudan Iron-Formation member of the Ely Greenstone by Sims and Southwick (1985).

blmv

Metabasalt, massive to pillowed, locally with interbeds of flow-top rubble and pillow breccia. Flows tend to be thick, commonly with massive basal and intermediate zones and pillowed upper portions. The pillows tend to be bulbous and irregular in shape, with well vesiculated interiors and rare gas cavities toward their upper surface. Composition ranges from thoelitic to calc-alkalic. This unit includes the Lower member of the Ely Greenstone in the Tower-Soudan area (Schulz, 1980; Sims and Southwick, 1985) and metabasalt of the Bear Lake area in Itasca County (Jirsa, 1988). Its upper contact with units blfx and blbi is somewhat gradational , reflecting a temporal cessation of basaltic volcanism and a switch to dacitic activity.

JOY LAKE SEQUENCE

jms

Sedimentary and felsic volcanic rocks. Volcanic conglomerate, graywacke, and graphitic slate interbedded with and transitional to units of dacitic, rhyolitic, and quartz latite tuff, tuff-braccia, and breccia. Rare amygdaloidal flows of felsic composition occur in close association with the felsic volcaniclastic rocks.

jmv

Mafic to intermediate volcanic rocks. Most common rocks are tholeiitic metabasalt, pillowed, amygdaloidal, light greenish-gray; these are interstratified with minor amounts of felsic tuffaceous and sedimentary rocks including conglomerate.

DEER LAKE SEQUENCE

dmi

Gabbroic sills. Differentiated sills of two fundamentally distinct but intimately associated types: Hornblende-rich sills include all gradations among hornblende gabbro, hornblendite, and hornblende quartz diorite; pyroxene-rich sills include all gradations between pyroxene gabbro and pyroxenite. The sills typically exhibit modal layering on a scale of several centimeters or decimeters; the pyroxene-rich group contains equigranular, ophitic, and porphyritic textural variants. These sills constitute the Deer Lake Complex as defined by Berkley and Himmelberg (1978).

dmv

Mafic and ultramafic volcanic rocks. Flows of high-Mg tholeiitic metabasalt and basaltic komatiite, the latter with spinifex texture. Interfingered with, and probably comagmatic with, sills of the Deer Lake Complex (unit dmi).

THISTLEDEW LAKE SEQUENCE

tmv

Mafic volcanic rocks. Flows, typically pillowed, chiefly of Fe-tholeiite composition; interbeds of fragmental metabasalt. Flow sequence contains many sills that are chemically similar to the volcanic rocks and inferred to be comagmatic with them; the sills are mapped as unit mi.

tgs

Graywacke, slate, dacitic tuff; local thin units of interbedded chert and graphitic argilite.

WILSON LAKE SEQUENCE

wms

Sedimentary and felsic volcanic rocks. Diverse unit composed of volcanigenic graywacke, slate, reworked tuff, conglomerate, and graphitic argillite that are interbedded with and grade into sequences of felsic to intermediate agglomerate, breccia, tuff, and flows. Thin layers of magnetite-chert iron-formation are interbedded with the sedimentary and volcanic rocks on all scales; the most prominent iron-formations are mapped as unit if.

wfv

Felsic and intermediate volcanic rocks. Flows, tuff, and agglomerate of dacitic, rhyolitic, and andesitic composition. Flows are feldspar- and quartz-phyric, medium to light gray-green where fresh, and white where weathered. Unit is interbedded with mafic volcanic rocks of unit wmv.

wmv

Mafic to intermediate volcanic rocks. Basaltic unit of transitional chemistry, from Mg-tholeiite toward the base to Fe-tholeiite and calc-alkalic andesite toward the top. Mg-tholeiites form thick flows, massive to pillowed, with local antobrecciated zones. Fe-tholeiites and andesites form multiple units of thin flows; the rocks are amygdaloidal and variolitic, and contain inter-pillow material that is locally rich in magnetite and chert.

COOK SEQUENCE

cms

Graywacke and argillite. Texturally and compositionally immature metasedimentary rocks of probable volcanic provenance.

cmv

Mafic volcanic rocks. Metabasalt, massive to pillowed, of Mg- and Fe-tholeiite composition. Zones of iron-carbonate alteration were metamorphosed to magnetite-bearing assemblages during main-stage deformation; these stand out as node-like positive magnetite anomalies.

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vbs

Biotite schist closely associated with layered migmatite and paragneiss. The paleosome of migmatitic rocks is biotite schist, locally with garnet; the neosome is trondhjemite and leucogranite.

MAP SYMBOLS

Geologic contact, inferred; rarely exposed.

Geologic contact, gradational or subjective, imprecisely located.

Fault, displacement chiefly strike-slip in the sense indicated by arrows.

Fault, displacement chiefly dip-slip; upthrown, downthrown blocks indicated by U, D respectively.

fault, inferred, imprecisely located

Fault, speculative

Axial surface trace of first-generation major fold (F_1), showing direction of plunge

Axial surface trace of second-generation major fold (F_2), showing direction of plunge.

<u>Note</u>: Axial traces shown without indication of closure or sense of overturning, due to lack of space.

REFERENCES

References cited in explanation

Berkley, J.L., and Himmelberg, G.R., 1978, Cumulus mineralogy and petrology of the Deer Lake Complex, Itasca County, Minnesota: Minnesota Geological Survey Report of Investigations 20-A, p. A1-A18.

Green, J.C., 1970, Lower Precambrian rocks of the Gabbro Lake quadrangle, northeastern Minnesota: Minnesota Geological Survey Special Publication Series SP-13, 96 p plates.

Jirsa, M.A., 1988, Geologic map of the Sherry Lake quadrangle, Itasca County, Minnesota: Minnesota Geological Survey Miscellaneous Map Series M-64, scale 1:24,000.

Jirsa, M.A., 1990, Bedrock geologic map of northeastern Itasca County, Minnesota: Minnesota Geological Survey Miscellaneous Map Series M-68, scale 1:48,000.

Jirsa, M.A., Boerboom, T.J., Chandler, V.W., and McSwiggen, P.L., 1991, Preliminary bedrock geologic map of the Cook to Side Lake area, west-central St. Louis County, Minnesota: Minnesota Geological Survey Open-File Report 91-1, scale 1:48 000 + explanatory booklet.

Schulz, K.J., 1980, The magmatic evolution of the Vermilion greenstone belt, NE Minnesota: Precambrian Research, v. 11, p. 231-245.

Sims, P.K., and Southwick, D.L., 1985, Geologic map of Archean rocks, western Vermilion district, northern Minnesota: U.S. Geological Survey Miscellaneous Investigations Series, Map I-1527, scale 1:48,000.

References used in compilation of the geologic map

Griffin, W.L., 1969, Embarrass quadrangle, St. Louis County, Minnesota: Minnesota Geological Survey, Miscellaneous Map Series M-6, scale 1:24,000.

Jirsa, M.A., 1990, Bedrock geologic map of northeastern Itasca County, Minnesota: Minnesota Geological Survey Miscellaneous Map Seres M-64, scale 1:48,000.

Jirsa, M.A., Boerboom, T.J., Chandler, V.W., and McSwiggen, P.L., 1991, Preliminary bedrock geologic map of the Cook to Side Lake area, west-central St. Louis County, Minnesota: Minnesota Geological Survey Open-File Report 91-1, scale 1:48,000 + explanatory booklet.

Ojakangas, R.W., and Sims, P.K., 1977, Lost Lake quadrangle, St. Louis County, Minnesota: Minnesota Geological Survey, Miscellaneous Map Series M-17, scale 1:24,000.

Sims, P.K., and Southwick, D.L., 1985 , Geologic map of Archean rocks, western Vermilion district, northern Minnesota: U.S. Geological Survey Miscellaneous Investigation Series, Map I-1527, scale 1:48,000.

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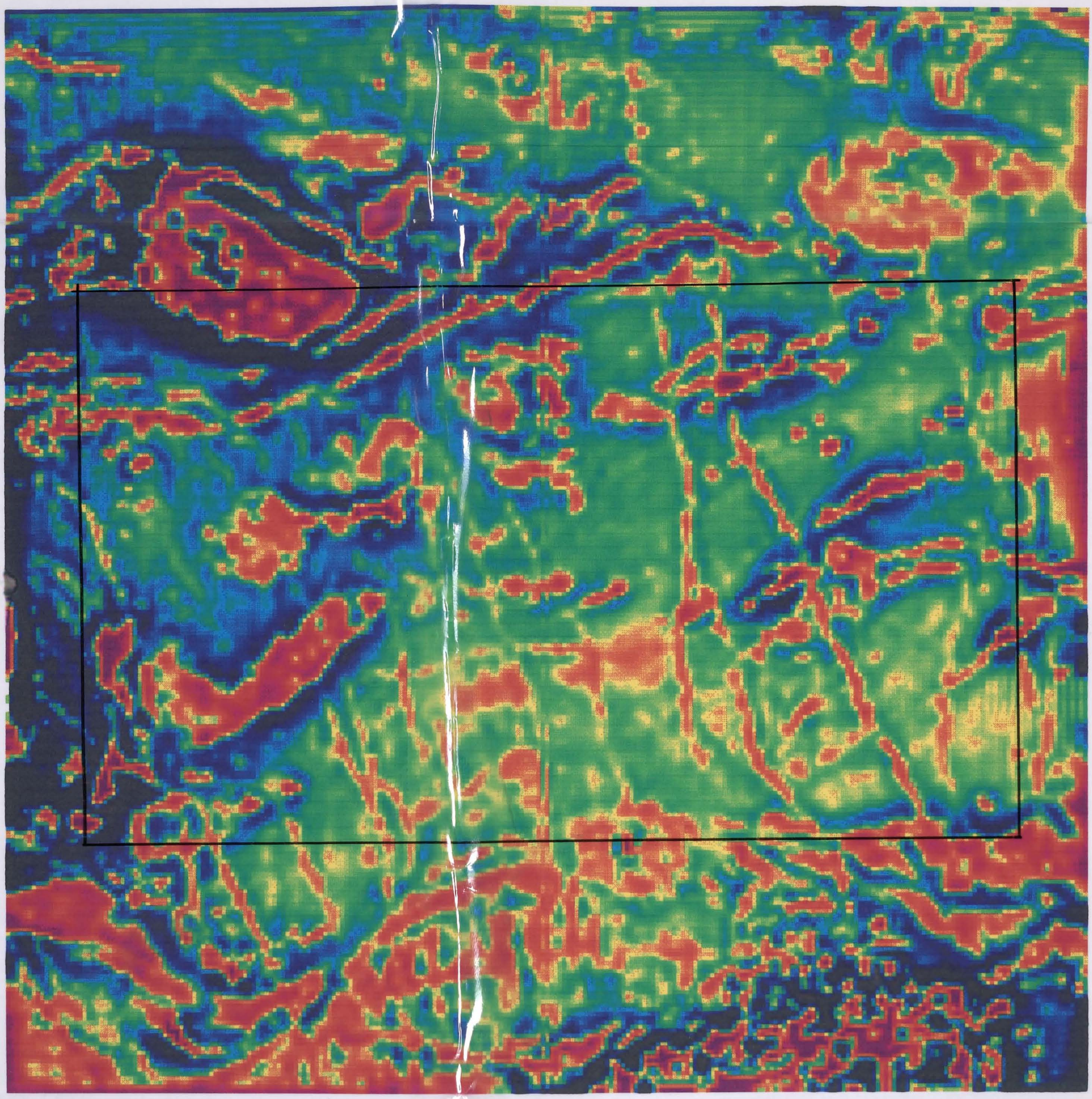

COOK AREA (WITHIN RECTANGLE)
REDUCED TO POLE FIRST VERTICAL DERIVATIVE
AEROMAGNETIC MAP (approximately 1:250,000)