Rotosonic Drill Core Descriptions and Interpretation of Glacial Sediment and Saprolite, Northeastern Aitkin County, Minnesota

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The following drill core descriptions are based on the observations made by the Minnesota Department of Natural Resources (MnDNR) geologists during their review of fifteen (15) rotosonic drill cores obtained by a mineral exploration company working on active State non-ferrous metallic mineral leases in Northeastern Aitkin County, Minnesota.

The MnDNR is testing the effectiveness of a geochemical exploration technique in an area of known copper-nickel mineralization in bedrock in Aitkin County, Minnesota. In case studies outside of Minnesota, the soil gas hydrocarbon (SGH) procedure developed by Activation Laboratories, Ltd. (ActLabs) has delineated mineralized bedrock targets buried under thick layers of overburden. The goal of this MnDNR project is to test the method's efficacy in an area of known bedrock mineralization that is overlain with layers of both saprolite and clay-rich glacial sediments. The project combines SGH surface soil sampling with a characterization of existing rotosonic drill cores of the overburden. A more detailed introduction to this project and links to previously released data is available at http://www.dnr.state.mn.us/lands_minerals/mpes_projects/project394.html.

In March 2013, the MnDNR collected twenty-two (22) samples of saprolite and till from eleven (11) existing rotosonic drill cores within the project area. These samples were submitted to Overburden Drilling Management Ltd (ODM) for heavy mineral concentrate and silt+clay fraction separations. These processed materials were then sent by ODM to ActLabs for third-party geochemical analysis. These analytical results were released to the public in June and July of 2013.

In August 2014, MnDNR geologists gained access to four additional rotosonic drill cores. The unconsolidated sediments and saprolite layers within each drill core were visually logged, and the sediments were associated with distinct glacial advances (as characterized in Figure 5 of Jennings and Kostka, 2014). Samples of saprolite were collected from each of these drill cores. These samples will be shipped to ActLabs for geochemical analysis; the pending analytical laboratory results will be provided in a future data release.

The drill core descriptions and glacial lobe associations provided below were made for the purpose of classifying the samples of saprolite and glacial sediments for the geochemical survey. This review was also made in order to construct cross-sections and identify specific intervals of clay-rich sediments that might have influenced the results obtained by collecting overlying surface sediment samples for the SGH survey. These cursory observations are not intended for other purposes.

13TK0170

Sonic ID#		13TK0170	
Date logged		8/19/2014	
Logged by:		Don Elsenheimer (Description); Carrie Jennings (Interpreted Associations)	
Comments		Saprolite Sample TK0170-S from 115 to 120ft.	
from	to	Description	Interpreted Association
0	2	Brown organics	Holocene
2	2.5	Olive-brown sandy silt	St. Louis Sublobe mottled till, with reddish sections reworked Superior Lobe sediments
2.5	17	Brown silty sand, poorly sorted, tr gravel (till). Clasts mostly rounded mafics	
17	27.5	Brown sand, well-sorted	Lacustrine clay with a twig; Glacial Lake Aitkin-Upham I
27.5	30	Brown silty sand	
30	32.5	Brown silty sand w tr gravel, cobbles	Rainy Lobe Till Brainerd Sublobe of the Rainy Lobe
32.5	37.5	Light gray fine-grained sand w silt, tr gravel, cobble. One cobble sonic-cored gabbro	
37.5	40	Brown silty sand, tr gravel (till)	
40	42.5	Light gray sand with silt	
42.5	45	Light gray cobble-rich sand and gravel	
45	47	Dark gray silty sand, tr gravel, cobble	
47	50	Brown silty sand	
50	59	Brown medium sand, well-sorted	Glacio-fluvial sediments. Silt lens at 59ft. rip-up clast Superior Lobe
59	59.5	Greenish-brown clay	
59.5	67.5	Reddish-brown medium sand, well-sorted.	
67.5	70.5	Light-brown coarse sand, tr gravel	
70.5	79	Brown coarse sand w gravel	
79	100	Reddish-brown medium sand, tr gravel	
100	102	Ultramafic cobbles in brown sand matrix.	
102	105	Mottled red/gray silty sand, tr gravel	
105	110	Brown coarse sand with gravel	
110	112	Brown sandy silt, trace gravel	
112	120	Brown saprolite	Saprolite 112-125ft might be older gray till; hard to determine if there are clasts of more than one rock type.
120	122	Yellowish-brown saprolite	
122	125	Dark-brown saprolite	
125	145	Reddish-brown saprolite	
145	150	Dark reddish-brown saprolite	
150	155	Missing core	
155	158	Brown saprolite	
158	160	Greenish-brown saprolite	
160	EOB	Bedrock	

13TK0171

Sonic ID#		13TK0171	
Date logged		3/19/2013	
Logged by:		Dennis Martin, Don Elsenheimer (Description); associations by Elsenheimer based on Jennings' review of proximal drill cores	
Comments		Till sample TK0171-T from 92.5-97.5ft Saprolite sample TK0171-S from 102.5-107.5ft	
From (feet)	**To (feet)**	**Description**	**Interpreted Association**
0	5	Missing core	
5	12.5	2.5ft loss. Upper half dark brown organics.	Holocene
		Bottom half brown sand.	Lacustrine sediments
12.5	36	Brown sand	Lacustrine sediments
36	37.5	Brown till with sand lens	Brainerd Sublobe of the Rainy Lobe
37.5	50	No recovery	
50	57	2ft. loss. Brown till with brown sand lens	
57	67.5	Brown till with 1ft sand lens 57-58.5	
67.5	75	Brown sand	
75	81	Tan till with cobbles	
81	83.5	Gravel or washed till	
83.5	84	Tan till lens	
84	85.5	Tan gravel or washed till	
85.5	89	Reddish-brown silty sand	Superior Lobe
89	97.5	Light brown till	
97.5	102.5	Mix of reddish-brown till and dark brown saprolite	
102.5	108.5	Grayish brown saprolite with small red lenses. Rounded clasts - possibly weathered in place	Saprolite
108.5	112	More bedrock than saprolite	
112	119	Ultramafic bedrock with strands of native copper.	
EOB			

13TK0174

Sonic ID#		13TK0174	
Date logged		8/19/2014	
Logged by:		Don Elsenheimer (Description); Carrie Jennings (Interpreted Associations)	
Comments		Saprolite sample TK0174-S 127.5 to 135ft.	
from	to	Description	Interpreted Association
0	3	Brown sand w silt lenses	1 -5ft St. Louis Sublobe w/ carbonate clasts.
3	5	Yellowish-brown coarse sand with cobble layer 3 - 3.5 feet	
5	12.5	Compact tannish clay	5 - 22ft. Silty diamict. St. Louis Sublobe
12.5	17.5	Compact brown silty clay	
17.5	24	Brown fine sand with siltier lenses	
24	25	Grayish-brown silt	22 - 37ft. Lacustrine sediments (Glacial Lake Aitkin-Upham I)
25	26	Brown clay	
26	30	Brown fine sand w silt lenses	
30	35	Grayish-brown silt	
35	37.5	Brown silty sand, tr gravel (till)	
37.5	46	Gray sandy silt, tr gravel, compact (till)	37 - 59ft. Rainy Lobe till. Base is fluvial (coarse/aggregate rich). Sharp contact with underlying Superior Province sediments.
46	50	Brown sandy silt with tr gravel, compact	
50	52.5	Gray till	
52.5	56	Brown till	
56	59	Brown rocky sand, coarse (90% gravel 57.5-58.5)	
59	72	Reddish-brown coarse sand, tr gravel	Superior Province 105 - 110ft deeply weathered till with saprolite mottling.
72	90	Reddish-brown silt with sand, tr gravel.	
90	110	Reddish-brown sand with gravel. Coarse-grained. Mottled red/dk bn silt w gravel clasts, 107-108ft	
110	112	Weathered crumbly duricrust, lt. brown	Saprolite
112	117	Fragmented brown duricrust	
117	122	Solid core of brown duricrust (sawed)	
122	125	Missing core	
125	127.5	Dk brown pisolitic duricrust	
127.5	134	Gray saprolite	
134	135.5	Reddish-gray saprolite	
135.5	140	Reddish-tan saprolite	
140	145	Tan saprolite with red highlights	
145	169	Ultramafic bedrock with qtz veins, native copper stringers	
EOB			

13TK0176

Sonic ID#		13TK0176	
Date logged		8/19/2014	
Logged by:		Don Elsenheimer (Description); Carrie Jennings (Interpreted Associations)	
Comments		Saprolite sample TK0176-S from 135 to 140ft.	
from	to	Description	Interpreted Association
0	2.5	Dark brown organics	Peat (Holocene)
2.5	5	Brown sand fine-med, fining upwards	St. Louis Sublobe of the Koochiching Lobe
5	8	Brown sand, tr gravel. Medium grained.	
8	10	Brown fine sand w silt. No clasts/gravel.	
10	15	Brown hard-packed clay	
15	16	Brown clayey silt. Plastic	
16	17.5	Brown coarse sand, well-sorted.	
17.5	20	Brown hard-packed clay	
20	21	Brown coarse sand	
21	22.5	Brown silt with sand	
22.5	27.5	Brown silty sand with sand lenses	
27.5	37.5	Brown clayey silt, compact.	Lacustrine Sediments Glacial Lake Aitkin Upham I
37.5	47.5	Gray sandy silt, tr gravel. Compact enough to form hockey puck cores	Brainerd Sublobe of the Rainy Lobe
47.5	50	Gray fine sand, well-sorted.	
50	52.5	Reddish-brown coarse sand, tr gravel	Superior Lobe glacio-fluvial
52.5	55	Reddish-brown sandy silt	
55	85	Reddish-brown coarse sand, tr gravel	
85	87.5	Reddish-brown fine-med sand, tr gravel	
87.5	103	Reddish-brown fine sand w lenses of siltier and sandier material	
103	107.5	Mostly olive brown till w gravel. Areas of reddish-brown sand at base possible reworked underlying material	Superior Lobe till
107.5	110	Dark brown till - hard-packed. Silty sand with gravel, cobbles (older till)	Weathered rock
110	120	Dark brown duricrust w pisolites	Duricrust
120	122.5	Brown duricrust	
122.5	125	Reddish-brown duricrust, more decomposed	
125	127.5	Yellowish-brown duricrust	
127.5	130	Dark brown saprolite	
130	132.5	Yellowish-brown saprolite	May be weathered Cretaceous sediments
132.5	145	Brown saprolite	Saprolite
145	150	Reddish-brown saprolite	
150	155	Missing	
155	169	Ultramafic bedrock w/ native copper stringers	
EOB			

13TK0177

Sonic ID#		**13TK0177**	
Date logged		3/20/13; Re-logged with interpreted associations 8/20/14	
Logged by:		Dennis Martin, Don Elsenheimer; Associations by Carrie Jennings	
Comments		Till sample TK0177-T from 90 to 95ft. Saprolite sample TK0177-S from 127.5 to 132.5ft.	
From (feet)	To (feet)	Description	Interpreted Association
0	3	Dark brown organic-rich material	Holocene
3	7.5	Brown sand within siltier lenses	3 - 10 ft. St. Louis Sublobe of the Koochiching Lobe
7.5	14.5	Brown clay-rich till	
14.5	25	Brown silty sand with lenses of brown till	10 - 37 feet. Lake Sediments Glacial Lake Aitkin-Upham I
25	26.5	Brown sand	
26.5	28	Brown till, clay rich	
28	30	Brown sand	
30	34.5	Brown till very clayey pebble poor	
34	35.5	Brown sand	
35.5	37.5	Brown stony till ////////// Big Transition to underlying layer \\\\\\\\\\	
37.5	50	Greenish-gray till. Cobbley, stone-rich. Denser – compacted? Sand lens 47.5 to 48.5 feet.	Till Brainerd Sublobe of the Rainy Lobe
50	65	Siltier brown till. Very compacted. Greenish cast (might be older till?)	
65	77.5	Brown sand. Gravel lens @ 70ft. Coarsening with depth. ////////// Big Transition to underlying layer \\\\\\\\\\	Glacio-fluvial sediments Brainerd Sublobe of the Rainy Lobe
77.5	79.5	Red till sandy (hematite color)	Superior Province Till
79.5	81	Red sand	
81	87.5	Red sandy till with sand lenses	
87.5	90	Red sand	Superior Province glacio-fluvial sediment
90	97.5	Red sandy till	Superior Province Till
97.5	108	Red sand	
108	117.5	Red sandy till ///// Transition \\\\\\\\\\	
117.5	128	Dark brown/blackish-brown saprolite. Cunks of duracrust. Piezolytic (reddish-brown balls). Drill broke through 117 ft and carried chunks down with it? (no duracrust chunks below.	Saprolite
128	134	Finer grained softer saprolite. Dark brown, no duracrust.	
134	138	Fine-grained saprolite. Transition from dark brown to reddish brown. Discrete red streaks at 135ft.	

13TK0177, continued.

From (feet)	To (feet)	Description	Interpreted Association
138	145	Reddish brown saprolite	Saprolite
145	148.5	Very red saprolite	
148.5	155	Green saprolite	
155	168	Green ultramafic bedrock, with thin white quartz/cc(?) veins, and strands of native copper	
	EOB		

13TK0178

Sonic ID#		13TK0178	
Date logged		8/19/2014	
Logged by:		Don Elsenheimer (Description); Carrie Jennings (Interpreted Associations)	
Comments		Saprolite sample TK0178-S from 145 to 150ft.	
From (feet)	To (feet)	Description	Interpreted Association
0	7.5	Dark brown organics	Peat (Holocene)
7.5	10	Yellowish brown sand, coarse. Tr gravel	One fluvial sequence, with coarse sand fining up. St. Louis Sublobe
10	12.5	Greenish-brown silty sand, tr gravel	
12.5	15	Brown silty sand, tr gravel	Diamicton clay, silt loam matrix. Oxidized brown over unoxidized gray. St. Louis Sublobe
15	17.5	Hard-packed lit bn/tan sandy silt, tr gravel	
17.5	20	Brown sand, fine-medium	17.5 to 37.5 feet Lacustrine sand and silt. Glacial Lake Aitkin Upham I
20	22.5	Coarse brown sand	
22.5	25	Fine-grained brown sand	
25	32.5	Tan/light-brown fine sand	
32.5	37	Tan fine sand/silt	
37	41	Tan medium sand	37.5 - 52.5 feet Pinkish-gray till, diamict, rocky. Sandy loam matrix, oxidized on top, unoxidized on bottom. Rainy Lobe
41	45	Tan/lt. brown silty sand w gravel, tr cobbles	
45	52	Brown silty sand with gravel, tr cobble (till)	
52	65	Brown sand, fine-medium grained	52.5-90 ft. Brown fluvial sand, fining-up sequence. North Shore Volcanic clasts; Superior Lobe sequence. Ice-distal 52.5-80, Ice-proximal 80-90ft
65	91	Gray silty sand w/ gravel, tr cobble (till)	
91	101	Reddish brown clay, hard-packed	90-110ft. Superior Lobe till.
101	102	Reddish brown sand, trace gravel	
102	115	Reddish-brown medium sand, tr gravel	
115	120	Reddish-brown clay	110-125ft. Separate diamict; multiple pulses of Superior Lobe
120	126	Reddish-brown sand, tr gravel	
126	127	Ground-up duricrust	Saprolite
127	131	Dark-brown duricrust	
131	132	Dark-brown saprolite	
132	143	Yellowish-brown saprolite	
143	145	Brown saprolite	
145	147.5	Reddish-brown saprolite	
147.5	150	Yellowish-brown saprolite	
150	165	Mottled reddish-green saprolite	
165	167	Yellowish-brown saprolite	
167	177.5	Mottled reddish-green saprolite	
177.5	189	Ultramafic bedrock with secondary veining with native copper	
EOB			

13TK0179

Sonic ID#		13TK0179	
Date logged		3/19/2013	
Logged by:		Dennis Martin, Don Elsenheimer (Description); associations by Elsenheimer based on Jennings' review of proximal drill cores	
Comments		Till sample TK0179-T from 72.5 to 77.5ft. Saprolite sample TK0179-S from 98 to 102.5ft.	
From (feet)	**To (feet)**	**Description**	**Interpreted Association**
0	4.2	Dark-brown organics	Holocene (peat)
4.2	7	Brown silty sand	St. Louis Sublobe
7	27.5	Brown clay-rich sediments, with coarse sand 26-26.5 feet	Lacustrine sediments Glacial Lake Aitkin Upham I
27.5	41.5	Light brown clay with laminates. Sandy lenses.	Lacustrine sediments Glacial Lake Aitkin Upham I
41.5	77.5	Reddish-brown till w trace gravel, cobbles	Superior Lobe till
77.5	97	Lost core; 5 ft material over 19.5ft interval. Within 5ft material, 0.5ft reddish-brown till, 0.5-4ft dk red-brown sand w pebbles, 4-5ft iron-cemented saprolite	Superior Lobe till (0-0.5) Superior Lobe fluvial (0.5 - 4) Saprolite (4-5)
97.5	98	Iron-cemented saprolite	Saprolite
98	107.5	Dark gray/green material. No bedding/transport. Weathered bedrock in place (saprolite).	
107.5	117.5	Dark gray saprolite	
117.5	122.5	Silty clay-rich low bulk density material	
122.5	142.5	Greenish-brown saprolite. Weathered in-place.	
142.5	154	Brown weathered bedrock/saprolite. Bedrock chungs beginning at 143ft.	
EOB			

13TK0180

Sonic ID#		13TK0180	
Date logged		3/19/2013	
Logged by:		Dennis Martin, Don Elsenheimer (Description); associations by Elsenheimer based on Jennings' review of proximal drill cores	
Comments		Saprolite sample TK0180-S taken from 110-115ft.	
From (feet)	To (feet)	Description	Interpreted Association
0	5	Gray silty-clayey till. No organics at top of core	St Louis Sublobe
5	7.5	Gray sand	Lacustrine sediment, Glacial Lake Aitkin Upham I
7.5	35	Brownish-gray silt. Oxidized brownish tint. Sand lens 34.5-35.5	
35.5	37.5	Unoxidized gray silt	
37.5	53	Compact gray till. Large cobbles at 48ft and 53ft.	Brainerd Sublobe of the Rainy Lobe
53	63.5	Under cobble at 53ft, sandier brownish-gray till.	
63.5	77.5	Missing core	
77.5	103	Reddish-brown sand. -80ft, siltier lens -81ft, clean gravel lens -92.5, 95ft, sand lenses 96-103ft, cover covered by thin layer of darker material	Superior Lobe
103	108	Older gray till, incorporates chuncks of saprolite	Old Gray Till
108	113	Greenish-black saprolite	Saprolite
113	117.5	Ground up top of bedrock (ultramafic)	
117.5	121	Solid bedrock	
121	129	Softer grayish-brown saprolite	
EOB			

13TK0182

Sonic ID#		**13TK0182**	
Date logged		3/19/2013	
Logged by:		Dennis Martin, Don Elsenheimer (Description); associations by Elsenheimer based on Jennings' review of proximal drill cores	
Comments		Till sample TK0182-T from 85.5 to 90.5ft. Saprolite sample TK0182-S from 107.5 to 112.5ft.	
From (feet)	**To (feet)**	**Description**	**Interpreted Association**
0	4	Organic-rich material	Holocene
4	11	Brown sand	St. Louis Sublobe of the Koochiching Lobe
11	14	Brown silty sand	
14	15	Brown sand	
15	17.5	Missing core	
17.5	36.5	Brown silty clay	Lacustrine sediments
36.5	37.5	Brown sand	
37.5	66	Brown till	Brainerd Sublobe of the Rainy Lobe
66	71.5	Reddish-brown sand	Superior Lobe
71.5	73.5	Brown sandy silt	
73.5	82	Reddish-brown silt	
82	85	Reddish-brown sand	
85	89	Saprolite-rich brown till	
89	90	Sand lens within saprolite-rich till	
90	107.5	Brown saprolite-rich till. Boulder at 106.5ft	
107.5	130	Dark bluish-black saprolite with sulfides (pyrite)	Saprolite
130	136	Mottled saprolite brown/bluish-black	
136	150	Hematite-rich saprolite	
150	166	Dark bluish-black saprolite with sulfides.	
166	179	Bedrock (ultramafic)	
EOB			

13TK0185

Sonic ID#		**13TK0185**	
Date logged		3/21/2013	
Logged by:		Dennis Martin, Don Elsenheimer (Description); associations by Elsenheimer based on Jennings' review of proximal drill cores	
Comments		Till sample TK0185-T from 88.5 to 93.5ft. Saprolite sample TK0185-S from 120-125ft.	
From (feet)	**To (feet)**	**Description**	**Interpreted Association**
0	1.5	Dark organics	Holocene
1.5	12.5	Gray silty till	St. Louis Sublobe of the Koochiching Lobe
12.5	17.5	Gray till (not as silty)	
17.5	20	Gray silt	Lacustrine Sediments
10	26	Gray silty clay, with sand lens at 22ft.	
26	67	Gray compact till, stonier. Fewer clasts from 45 to 52.5ft.	Brainerd Sublobe of the Rainy Lobe. Glacio-fluvial sediments at the base.
67	70	Coarse brown sand	
70	72.5	Brown gravelly sand with silt lens at 70ft	
72.5	93.5	Reddish-brown till. Fine sand, few clasts	Superior Province
93.5	95	Reddish-brown sand and gravel.	
95	111.5	Reddish-brown sand	
111.5	117.5	Reddish-brown till, grading darker color towards base, where it incorporates underlying saprolite.	
117.5	157.5	Greenish-black saprolite w reddish-brown streaks/clumps. Larger reddish-brown saprolite clump at 129ft.	Saprolite
157.5	170	Ultramafic bedrock with thin white qtz veins. Ground-up top of bedrock surface at 157.5 before drill bit was changed.	
EOB			

13TK0186

Sonic ID#		13TK0186	
Date logged		3/20/2013	
Logged by:		Dennis Martin, Don Elsenheimer (Description); associations by Elsenheimer based on Jennings' review of proximal drill cores	
Comments		Till sample TK0186-T from 145 to 150ft. Saprolite sample TK0186-S from 165 to 170ft.	
From (feet)	To (feet)	Description	Interpreted Association
0	5	Dark brown organic matter	Holocene
5	17	Brown silt, with silty sand lens from 15-15.5ft.	St. Louis Sublobe of the Koochiching Lobe
17	20	Brown silty clay	Lacustrine sediments
20	22	Reddish-brown silty clay	
22	25	Brown silt	
25	35	Lost core	
35	42.5	Brown till	Brainerd Sublobe of the Rainy Lobe
42.5	52	Compact reddish-brown till. Higher percentage of clasts than above.	
52	56.5	Sandier till. Not as compact.	
56.5	59	Reddish-brown sand, tr gravel.	
59	70	Greenish-brown sandy till	
70	74	Greenish-brown sand	
74	75.5	Gravelly sand, chunk of washed till at 76ft.	
75.5	78	Greenish-brown silty sand	
78	97	Brown stony till	
97	102	Reddish-brown gravelly sand	Superior Lobe deposits
102	108.5	Red sand	
108.5	127.5	Red till, very silty and clast-poor	
127.5	129	Sandier till lens	
129	135	Red silty till	
135	141	Red sandy silt	
141	145	Red silty sand	
145	158	Compact red silty till	
158	165	Reddish silty till with ripped-up chunks of dark gray saprolite	
165	170	Bluish-green saprolite	Saprolite
170	178	Greenish-black saprolite	
178	199	Ultramafic bedrock	
EOB			

13TK0187

Sonic ID#		13TK0187	
Date logged		3/21/2013	
Logged by:		Dennis Martin, Don Elsenheimer (Description); associations by Elsenheimer based on Jennings' review of proximal drill cores	
Comments		Till sample TK0187-T from 97.5 to 102.5ft Saprolite sample TK0187-S from 142 to 148ft.	
From (feet)	**To (feet)**	**Description**	**Interpreted Association**
0	5	3ft of material over 5ft interval. 0.5ft of organics in "shallow" 2.5ft long bag; gray till with roots in "deeper" bag. High organic content to 4ft.	Holocene
5	12	Brown oxidized till	St. Louis Sublobe
12	20.5	Grayish-brown sand	Lacustrine sediments
20.5	56	Compact grayish-brown till. 29-31ft: gravely sand lens 37.5-41 sand-rich lenses 48ft: 12-inch diameter cobble 48-56: rockier till	Brainerd Sublobe of the Rainy Lobe
56	57.5	Coarse clean gravel	
57.5	62.5	Pea gravel, clean. Salt/pepper mix of clasts	
62.5	90	Reddish-brown fine sand.	Superior Lobe
90	94	Reddish-brown silt	
94	97.5	Reddish-brown fine sand	
97.5	106	Reddish-brown till. Sand lens 100-101ft. Chunks of gray till start to appear at 103.5ft (underlying gray till at 115ft)	
106	113.5	Reddish-brown sand	
113.5	117.5	Gray till (older?)	Old Gray Till
117.5	120	Gray till darkens in color with depth as it incorporates underling dark brown duricrust	
120	139	Dark brown pisolitic duricrust. Missing 5ft of material between 122.5-132.5ft.	Saprolite
139	165	Greenish-black saprolite (softer)	
165	171	Ultramafic bedrock	
171	178	Softer, more weathered bedrock	
EOB			

13TK0188

Sonic ID#		13TK0188	
Date logged		3/20/2013	
Logged by:		Dennis Martin, Don Elsenheimer (Description); associations by Elsenheimer based on Jennings' review of proximal drill cores	
Comments		Till sample TK188-T taken from 105-110ft; Saprolite sample TK188-S from 130-135ft.	
From (feet)	**To (feet)**	**Description**	**Interpreted Association**
0	4.5	Dark brown organic matter	Holocene
4.5	10	Gray silt	St. Louis Sublobe
10	15	Gray till	
15	32.5	Missing core. Five feet of material over 17.5 foot interval.	Lacustrine sediments
		Change half-way between gray silty clay to reddish-brown till	Brainerd Sublobe of the Rainy Lobe
32.5	55	Reddish-brown till. Silty	
55	57	Sandier, stonier reddish-brown till	
57	60	Transition from reddish brown to gray till	
60	72	Gray till	
72	102.5	Reddish-brown sand. Gravel-rich zones at 91ft., 97ft.	Superior Lobe
102.5	107	Reddish-brown till.	
107	120	Gray till	Old Gray Till
120	127	Coarse gray sand	
127	129	Gray till	
129	148	Bluish-black saprolite	Saprolite
148	150	Greenish-gray saprolite, transition to weathered rock. Could be ground up bedrock surface before rotosonic bit was changed.	
150	153	Bedrock. Softer weathered bedock zones 160-162 and 166-167. Final boring depth not recorded.	
EOB			

13TK0192

Sonic ID#		**13TK0192**	
Date logged		3/20/2013	
Logged by:		Dennis Martin, Don Elsenheimer (Description); associations by Elsenheimer based on Jennings' review of proximal drill cores	
Comments		Frozen core, brought into heated area and plastic sleeves removed a few hours before logging. Core still frozen when log was taken, limiting descriptions. Sample TK0192-T from 105-110ft. Sample TK0192-S from 125-130ft.	
From (feet)	**To (feet)**	**Description**	**Interpreted Association**
0	3.5	Dark brown/black organics	Holocene
3.5	7.5	Grayish-brown silt	St. Louis Sublobe, Koochiching Lobe
7.5	8.5	Grayish-brown sand	
8.5	12.5	Grayish-brown silt	
12.5	17.5	Grayish-brown till	
17.5	27	Gray sand	Lacustrine Sediments
27	40	Grayish-brown till	Brainerd Sublobe of the Rainy Lobe
40	97	Gray till. Sandy interval at 60ft	
97	121	Reddish-brown sandy till.	Superior Lobe
121	145	Dark brownish-black saprolite	Saprolite
145	149	Duricrust. Weathered bedrock has native copper strings and larger "nuggets" at 148	
EOB			

13TK0193

Sonic ID#		13TK0193	
Date logged		3/21/13; Re-logged with interpreted associations 8/20/14	
Logged by:		Dennis Martin, Don Elsenheimer; Associations by Carrie Jennings	
General comments		Till sample TK0193-T from 80 to 85ft. Saprolite sample TK193-S1 from 112.5 to 117.5ft. Saprolite sample TK193-S2 from 117.5ft. to 122.5ft.	
from	to	Description	Interpreted Association
0	2	Dark brown organic-rich soil, with 1" diameter tree root.	0 - 5ft. Holocene
2	12.5	Oxidized reddish-gray till	5 - 12ft. St. Louis Sublobe
12.5	24	Reddish-gray fine sand. Oxidation zone ends approx.. 17.5 ft.	12 - 33ft lacustrine sediments Glacial Lake Aitkin Upham I
24	28	Gray till.	
28	29	Gray silty sand	
29	32.5	Gray sand	
32.5	41.5	Sandy, stony till	33 - 55 ft. Brainerd Sublobe of the Rainy Lobe
41.5	52	Compact gray till	
52	52.5	Gray sand	
52.5	77.5	Brown (LSR) sand.	55 - 97.5 Superior Lobe
77.5	94	Compact brown (LSR) till	
94	97.5	Brown (LSR) sand	
97.5	102.5	Old gray till with chunks of saprolite	May be unoxidized Superior Lobe till
102.5	108	Greenish-black saprolite	Saprolite
108	112.5	Ground-up black duracrust	
112.5	117.5	Greenish black saprolite	
117.5	145	Iron-rich saprolite (reddish-black)	
145	EOB	Ultramafic bedrock, white quartz veins	