## Minnesota Department of Natural Resources Division of Minerals William C. Brice, Director

# Results from Chemical Analyses and Mineralogical Investigations of Heavy Mineral Concentrate Samples Collected from Glaciofluvial Sediments in Minnesota

Test and Pilot Study Results

Ву

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A Cooperative Project

of the

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and the

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## INTRODUCTION

A pilot study using heavy mineral concentrate samples from glaciofluvial sediments was conducted over a broad area of Minnesota by the Minnesota Department of Natural Resources, Division of Minerals, in cooperation with the U.S. Geological Survey, Branch of Geochemistry in Denver, Colorado. The study examined the heavy mineral fraction of eighty glaciofluvial samples collected from a number of geologically distinctive areas of the state. It evolved from a similar eight-sample test study that was completed in the previous year through a contract with the USGS.

The overall goals of the project were to educate DNR staff in heavy mineral investigative techniques that have been developed and refined by the USGS and to begin to develop heavy mineral baseline data for a portion of the state. The specific pilot study objectives were threefold: 1) to determine reliable. cost-effective sampling methods, concentration techniques, and analytical methods to use in future heavy mineral studies; 2) to determine the presence of heavy minerals of economic value, either semi- or precious metals and stones or industrial minerals, in glaciofluvial deposits that are currently being mined for sand and gravel; and 3) to determine the presence of heavy minerals in glacigenic sediments that could be used as indicator minerals in regional heavy mineral surveys or used to complement future geochemical terrain surveys.

This open-file report summarizes the sampling strategy and the methods of sample preparation and analysis for the pilot and test study samples and presents the results in table format.

### STUDY AREA

The study area consists of a broad rectilinear area that traverses the state from northeast to southwest. The general boundaries of the survey area are delimited by Tower and Norshore Railroad Junction in the north and Ortonville and Granite Falls in the south (Figure 1).

The orientation of the study area was chosen to parallel the southwesterly glacial flow so that the presence or dearth of heavy mineral suites along the flow path could be used to indicate areas of higher mineral potential. It also encompasses several of the state's major bedrock terranes. Appendix A contains a generalized bedrock geologic map of the state. A number of additional sites were selected outside of the study area. Four samples were collected from an area underlain by Paleozoic sedimentary rocks in east-central Minnesota. The intent of selecting these sample sites was to determine how the composition of heavy mineral concentrates varies from the areas underlain by the Precambrian rocks. In addition, the results of the eight-sample heavy mineral test study are included in this report.



Figure 1. Study area location

#### METHODOLOGY

#### Sample Medium and Sampling Strategy

The sample medium and sampling strategy for this pilot study were dictated by the major goals of the study as well as budgetary limitations. The sample medium was determined primarily by study objectives two and three: to collect data on heavy minerals present in sand and gravel pits and to determine the presence of heavy mineral oredeposit indicators present in glacigenic sediments that could be used in future heavy mineral provenance surveys. Because of the somewhat divergent objectives of the study, glaciofluvial sediments were chosen for the sample medium for this initial study. The sampling strategy within the study area was based on the following criteria: 1) to collect samples from sediments of northeastern (Minnesota) provenance, specifically the late Wisconsian deposits of the Superior, Rainy, and Wadena lobes (see Figure 2) because the sediment deposited by these ice lobes tends to be locally or regionally derived; 2) to collect samples with preference toward areas where the drift thickness was less than 100 feet because this would increase the probability that the sediment sampled would reflect local bedrock (Appendix B contains a generalized depth to bedrock map of the state); 3) to collect samples with preference toward ice-contact sediments over outwash sediments because the transport distances for these sediments tend to be shorter; and 4) to collect samples with preference toward active sand and gravel operations. Overall, the final selection of sample sites was often governed by being able to obtain authorization from the pit owner or operator to collect a sample.

Because of the above sampling criteria, sample site locations were not equally distributed within the study area. Figure 3 shows the location of the pilot and test study sample sites. Seventy-eight of the eighty samples collected in the pilot study were from sand/gravel pits. Exceptions include one active stream sediment sample collected in central Minnesota and a pre-concentrated sample supplied by a gravel operator. Seven of the test study samples were collected from sand/gravel pits and one sample was collected just off a roadway with an auger.

#### Sample Collection

Samples were not collected randomly in the pit. Sampling was biased by collecting samples in order to optimize the heavy mineral content of a sample. Therefore, samples are not necessarily characteristic of the gravel pit as a whole. The preferred sediment was sandy pebble-gravel with streaks of heavy minerals. Otherwise, sandy pebble-gravel without heavy mineral streaks or poorly sorted pebbly sand was sampled rather than well sorted sand or gravel or unsorted sediment.

A geologic description of the pit and the material sampled was completed at each site. The description includes the sediment type and variability, bedding, stratigraphy, general pebble lithology, range of grain size, hypothesized glacial lobe, and dimensions of pit. At the each sample location, approximately 6 liters of minus-10-mesh (2mm) material was collected. Prior to the sampling, approximately one foot of sediment was cleared from the pit face before the bulk samples were collected. A plastic scoop was used to collect all samples. The amount of bulk sample collected at each site varied according to the amount of minus-10-mesh material that was in the sediment. The bulk sample was sieved with a stainless-steel 10-mesh screen to acquire a 6 liter sample. The sieving was done in the field when the sample was dry enough to be sieved without sample clumping; if not, the sample was first dried in an oven at 80°C and then sieved in the laboratory.

Archive samples were collected at the same location as the study sample and in the same manner; they were not a split of the study sample. Five archive samples were used as replicate samples in the analyses to check site variability.

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At sites where the glacial lobe was difficult to determine, a pebble sample (minus-16 to plus-4mm) and a sand sample (minus-2 to plus-1mm) were collected for future lithologic studies.

### **Sample Preparation**

The procedure used to reduce the bulk samples to a heavy mineral concentrate is illustrated by the flow chart in Figure 4. Once in the laboratory, the minus-10-mesh sample was passed through a 20mesh (0.83mm) sieve. A rough concentrate of the minus-20-mesh fraction was prepared by utilizing a Wilfley<sup>1</sup> table or by hand panning, used alone or in combination. These methods removed most of the quartz, feldspar, clay-sized material, and organic material from the sample.

After oven-drying, any remaining light minerals were separated by flotation in bromoform (CHBr<sub>3</sub>, specific gravity ~2.85). The resulting heavy mineral fraction was washed with acetone, air-dried, and then divided. One portion of the heavy mineral concentrate was saved for fire assay analysis. The other portion was separated into three magnetic fractions using a modified Frantz Isodynamic Magnetic Separator<sup>1</sup>, in which the pole pieces were mounted horizontally.

<sup>1</sup>Any use of trade names is for descriptive purposes only and does not imply endorsement by the U.S. Geological Survey nor the Minnesota Department of Natural Resources.



Figure 2. Generalized Quaternary geology of Minnesota

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Adapted from the Minnesota Land Management Information Center's MLMIS40 data base, filename QUATGEO.EPP. LMIC created this file by scanning the Quaternary geologic map of Minnesota (Hobbs and Goebel, 1982), converting this file to ARC/INFO polygon coverage, then converting the ARC/INFO coverage to a 40-acre grid-cell EPPL7 file.



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Figure 3. Test and pilot study sample locations, Minnesota

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The final magnetic (C-1), paramagnetic (C-2), and nonmagnetic (C-3) fractions correspond to separator settings of 0.25 amperes and 1.75 amperes. The C-1 fraction consists of ferromagnetic minerals such as magnetite and ilmenite. The C-2 fraction consists of most iron and manganese oxides and ferromagnesian silicates. The C-3 fraction consists of most remaining oxides, sulfides, native metals, and other nonmagnetic ore minerals.

The C-1 fraction was archived but was not analyzed. The C-2 fraction was divided into two splits. One split was pulverized to minus-100-mesh (0.15-mm) in a Braun<sup>1</sup> vertical pulverizer for chemical analysis, and a portion of the other split was used in preparing grain mount thin sections for point count analysis. The C-3 fraction was put through a second bromoform and magnetic clean-up separation to remove any remaining light minerals. After cleanup, the C-3 fraction was divided into two splits. One split was saved for optical mineralogy, and the other split was hand ground, using an agate mortar and pestle, for spectrographic analysis.

### **Chemical Analyses**

Three methods of elemental analysis were used to determine the chemistry of the heavy mineral concentrates: fire assay, semiquantitative emission spectroscopy, and cyanide leach assay.

## Fire Assay

Fire assay procedures were performed on a scientifically split portion of the total heavy mineral concentrate sample, before magnetic separations, to determine low levels of platinum group elements (PGE) and gold in the concentrate samples.

The test study samples were analyzed for PGE and gold using the classical fire assay lead-oxide flux/silver dore' bead method, followed by emission spectroscopic determination of the noble elements in the dore' bead (Adrian and Carlson, 1990). The pilot study samples were analyzed for PGE and gold by the newer fire-assay nickel-sulfide flux/acid digestion method, followed by inductively-coupledplasma/mass spectrographic determination of the noble elements using an isotope-dilution procedure (Meier and others, 1991). The elements and their lower limits of detection are listed in Table 1.

Table 1. Lower limits of detection for the fire assay analysis of heavy mineral concentrates.

Element	Nickel-sulfide flux <sup>1</sup> Lower detection limit parts per billion	Lead-oxide flux <sup>2</sup> Lower detection limit parts per billion
Ruthenium (Ru)	06	100
Rhodium (Rh)	0.5	10
Palledium (Pd)	0.5	1
Iridium (Ir)	0.5	20
Platinum (Pt)	0.5	10
Osmium (Os)	2	200
Gold (Au)	7	1
<sup>1</sup> 10mg sample <sup>2</sup> 15mg sample		
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#### Semiquantitative Emission Spectroscopy

The nonmagnetic and paramagnetic concentrates were analyzed by semiquantitative emission spectroscopy (SQS) for 35 elements. A six-step semiquantitative direct-current arc emission spectrographic method was used (Grimes and Marranzino, 1968). The elements and their lower limits of detection are listed in Table 2.

The SQS method is a solid-sample type of analysis in which the results were obtained by a visual comparison of spectra derived from the sample against spectra obtained from standards made from pure oxides and carbonates. Standard concentrations are geometrically spaced over any given order of magnitude of concentration as follows: 100, 50, 20, 10, and so forth. Samples whose concentrations are estimated to fall between those values are assigned values of 70, 30, 15, and so forth. The precision of the analytical method is approximately plus or minus one reporting interval at the 83% confidence level and plus or minus two reporting intervals at the 96% confidence level (Motooka and Grimes, 1976).

#### Cyanide Leach Assay

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Three archive samples were submitted to Bondar-Clegg's Metallurgical Laboratory in Sparks, Nevada for cyanide assay determinations. The minus-20mesh (0.85-mm) fraction of the archive sample was crushed to 100% passing 48-mesh (0.414-mm). After crushing, 250 gram portions were split out from each sample and pulverized to pass 150-mesh (0.1041-mm). Preg-rob tests were then performed on 30 gram portions of the pulverized material to determine if there were constituents in the sample which would adsorb gold out of a cyanide solution.

Cyanide leaches were then performed on the remaining minus 48- mesh material following a method developed from Lenahan and Murray-Smith, 1986. All leaches were conducted for 48 hours with 10 lb/ton NaCN solution at 50% solids. The pH was adjusted to greater than 10 using sodium hydroxide. Following leaching, the tailings were filtered, washed and dried. A 250 gram split was then taken from the tailings of each test, pulverized, and fire assayed in duplicate.

#### **Mineralogical Techniques**

Four techniques were used to determine the mineralogy of the heavy mineral concentrates: optical mineralogy, X-ray diffraction, point count analyses, and electron microprobe analyses.

## Optical Mineralogy

Optical mineralogical techniques were used to determine the mineralogy of the nonmagnetic (C-3) concentrate samples. The samples were scanned visually using a binocular microscope and a shortwave ultraviolet light to identify mineral grains by their optical and physical properties. Emphasis is placed on optical identification of the ore-related and gemstone minerals.

This visual examination is also utilized as an important supplement to the spectrographic analyses, often identifying single mineral grains or malleable minerals poorly represented in the SQS sample split and man-made contaminants which can give inflated values in the SQS results.

## X-Ray Diffraction

Occasionally, mineralogical determinations using Xray diffraction techniques were used to verify those minerals that were difficult to determine optically or to verify identifications made by visual examination. Several x-ray diffraction techniques were used: single grain mounts using a Gandolfi Camera, powder mounts using a Debye-Scherrer Camera, and glass slide mounts using a manual x-ray powder diffractometer. X-ray crystallography, using single crystals or powder, is mainly concerned with structure analysis. Powder diffractometry is mainly used for the identification of crystalline compounds by their diffraction patterns (Klug and Alexander, 1974).

#### Thin Section Point Counts

Quantitative mineralogical point count analyses were used to determine the mineralogy of the paramagnetic (C-2) concentrate samples. Thin section grain mounts were prepared for each C-2 sample and 500-600 points were counted on each slide to determine the percentage of each mineral. Voids on the slides were counted along with the mineral grains and then subtracted from the total

Lower Detection           Element         Limit           Calcium (Ca)         0.1           Iron (Fc)         0.1           Magnesium (Mg)         0.05           Sodium (Na)         0.5           Phosphorus (P)         0.5           Titanium (TT)         0.005           Silver (Ag)         1           Arsenic (As)         500           Gold (Au)         20           Boron (B)         20           Barium (Ba)         50           Beryllium (Bc)         2           Bismuth (Bi)         20           Cablum (Cd)         50           Cobalt (Co)         20           Corronium (Cr)         20           Copper (Ca)         10           Garmanum (Ga)         10           Germanium (Ge)         20           Lanthanum (La)         100           Molybdenum (Mo)         10           Nickel (Ni)         20           Strontium (Sr)         200           Strontium (Sr)         200           Thorium (Th)         200           Strontium (Sr)         200           Thorium (Th)         200           Strontium (Sr)	entra de la composition de la			1997) 1989	
Detection           Limit           Calcium (Ca)         0.1           Iron (Fe)         0.1           Magnesium (Mg)         0.05           Sodium (Na)         0.5           Phosphorus (P)         0.5           Titanium (TT)         0.005           Sodium (Na)         0.5           Phosphorus (P)         0.5           Titanium (TT)         0.005           Silver (Ag)         1           Arsenic (As)         500           Gold (Au)         20           Borton (B)         20           Barium (Ba)         50           Berylium (Be)         2           Bisnuth (Bi)         20           Cadium (Cd)         50           Copper (Cu)         10           Galium (Ga)         10           Germanium (Ge)         20           Lanthanum (La)         100           Molybdenum (Mo)         10           Nickel (Ni)         20           Stroatium (St)         20           Stroatium (St)         20           Stroatium (St)         20           Thorison (Th)         200           Stroatium (St)         20				Lower	
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Parts per million           Silver (Ag)         1           Arsenic (As)         500           Gold (Au)         20           Boron (B)         20           Barium (Ba)         50           Berglium (Be)         2           Bismuth (Bi)         20           Cadium (Cd)         50           Cobalt (Co)         20           Chromium (Cr)         20           Copper (Cu)         10           Gallium (Ga)         10           Germanium (Ce)         20           Lanthanum (La)         100           Marganese (Mn)         20           Molydenum (Mo)         10           Nickel (Ni)         10           Lead (Pb)         20           Scandium (Sc)         10           Tin (Sa)         200           Scandium (Sc)         10           Lead (Pb)         20           Strontium (Sr)         200           Thorium (Th)         200           Vanadium (V)         20           Tungsten (W)         50           Vittrium (Y)         20           Zine (Zn)         500				0.005	
Silver (Ag)       1         Arsenic (As)       500         Gold (Au)       20         Boron (B)       20         Barium (Ba)       50         Beryllium (Bc)       2         Bismuth (B)       20         Cadium (Cd)       50         Cobalt (Co)       20         Chronium (Cr)       20         Copper (Cu)       10         Galium (Ga)       10         Germanium (Ge)       20         Lanthanum (La)       100         Marganeze (Mn)       20         Nickel (Ni)       10         Nickel (Ni)       10         Lead (Pb)       20         Strontium (Sc)       10         Tin (Sh)       20         Strontium (Sr)       200         Thin (Sh)       20         Strontium (Th)       200         Vanadium (V)       20         Tungsten (W)       50         Zine (Zn)       500	$(x,y) \in \mathcal{X}^{n}$			Parts per million	
Arsenic (As)       500         Gold (Au)       20         Boron (B)       20         Barium (Ba)       50         Beryllium (Be)       2         Bismuth (Bi)       20         Cadium (Cd)       50         Color       20         Chromium (Cr)       20         Copper (Cu)       10         Gallium (Ga)       10         Germanium (Ge)       20         Lantanum (La)       100         Molydenum (Mo)       10         Nickel (Ni)       10         Lead (Pb)       20         Scandium (Sc)       10         Tin (Sn)       20         Strontium (Sr)       200         Tungsten (W)       50         Yttrium (Y)       20         Zinc (Zn)       500         Zirconium (Zr)       20	Silver (Ag)			1	4.1
Gold (Au)       20         Boron (B)       20         Barum (Ba)       50         Beryllium (Bc)       2         Bismuth (Bi)       20         Cadium (Cd)       50         Cobalt (Co)       20         Chromium (Cr)       20         Copper (Cu)       10         Galium (Ga)       10         Germanium (Ge)       20         Lanthanum (La)       100         Marganese (Mn)       20         Molybdenum (Mo)       10         Nickel (Ni)       10         Lead (Pb)       20         Antimony (Sb)       200         Scandium (Sc)       10         Tin (Sn)       20         Strontium (Sr)       200         Tungsten (W)       50         Yttrium (Y)       20         Zine (Zn)       500         Zirconium (Zr)       20	Arsenic (As)			500	
Boron (B)       20         Barium (Ba)       50         Beryllium (Be)       2         Bismuth (Bi)       20         Cadium (Cd)       50         Cobalt (Co)       20         Chromium (Cr)       20         Copper (Cu)       10         Gallium (Ga)       10         Gernanium (Ge)       20         Lanthanum (La)       100         Mangangese (Mn)       20         Molybdenum (Mo)       10         Nickel (Ni)       10         Lead (Pb)       20         Antimony (Sb)       200         Strontium (Sr)       200         Thorium (Th)       200         Vanadium (V)       20         Tungsten (W)       50         Yttrium (Y)       20         Zine (Zn)       500	Gold (Au)			20	
Barium (Ba)       50         Beryllium (Be)       2         Bismuth (Bi)       20         Cadium (Cd)       50         Cobalt (Co)       20         Chromium (Cr)       20         Copper (Cu)       10         Gallium (Ga)       10         Germanium (Ge)       20         Lanthanum (La)       100         Marganese (Mn)       20         Niobium (Nb)       50         Nickel (Ni)       10         Lead (Pb)       20         Antimony (Sb)       200         Scandium (Sc)       10         Tin (Sa)       20         Vanadium (V)       20         Tungsten (W)       50         Yttrium (Y)       20         Zinc (Zn)       500	Boron (B)			20	· · · · · · · · · · · · · · · · · · ·
Beryllium (Be)         2           Bismuth (Bi)         20           Cadium (Cd)         50           Cobalt (Co)         20           Chromium (Cr)         20           Copper (Cu)         10           Gallium (Ga)         10           Germanium (Ge)         20           Lanthanum (La)         100           Manganese (Mn)         20           Molybdenum (Mo)         10           Nickel (Ni)         10           Lead (Pb)         20           Antimony (Sb)         200           Scandium (Sc)         10           Tin (Sa)         20           Strontium (Sr)         200           Vanadium (V)         20           Tungsten (W)         50           Yttrium (Y)         20           Zinc (Zn)         500	Barium (Ba)			50	st e by
Bismuth (Bi)       20         Cadium (Cd)       50         Cobalt (Co)       20         Chromium (Cr)       20         Copper (Cu)       10         Gallum (Ga)       10         Germanium (Ge)       20         Lanthanum (La)       100         Manganese (Mn)       20         Molybdenum (Mo)       10         Nickel (Ni)       10         Lead (Pb)       20         Antimony (Sb)       200         Scandium (Sc)       10         Tin (Sn)       20         Thorium (Th)       200         Vanadium (V)       20         Tungsten (W)       50         Yttrium (Y)       20         Zinc (Zn)       500         Zirconium (Zr)       20	Bervllium (Be)			20	
Latin (cl)       20         Cadium (Cd)       20         Cobalt (Co)       20         Chromium (Cr)       20         Copper (Cu)       10         Gallium (Ga)       10         Germanium (Ge)       20         Lanthanum (La)       100         Manganese (Mn)       20         Molybdenum (Mo)       10         Nickel (Ni)       10         Lead (Pb)       20         Antimony (Sb)       200         Scandium (Sc)       10         Tin (Sn)       20         Strontium (Sr)       200         Vanadium (V)       20         Zinc (Zn)       20         Zinc (Zn)       20	Bismuth (Bi)			20	1 - 4
Cobalt (Co)       20         Chromium (Cr)       20         Copper (Cu)       10         Gallium (Ga)       10         Germanium (Ge)       20         Lanthanum (La)       100         Manganese (Mn)       20         Molybdenum (Mo)       10         Nickel (Ni)       10         Lead (Pb)       20         Antimony (Sb)       200         Scandium (Sc)       10         Tin (Sn)       20         Strontium (Sr)       200         Tungsten (W)       50         Yttrium (Y)       20         Zinc (Zn)       500	Cadium (Cd)			50	
Constructor       20         Chromium (Cr)       20         Copper (Cu)       10         Germanium (Ge)       20         Lanthanum (La)       100         Manganese (Mn)       20         Molybdenum (Mo)       10         Nickel (Ni)       10         Lead (Pb)       20         Antimony (Sb)       200         Scandium (Sc)       10         Tin (Sn)       20         Strontium (Sr)       200         Tungsten (W)       50         Yttrium (Y)       20         Zinc (Zn)       500	Cobalt (Co)			20	
Continuit (cl.)       20         Copper (Cu)       10         Gallium (Ga)       10         Germanium (Ge)       20         Lanthanum (La)       100         Manganese (Mn)       20         Molybdenum (Mo)       10         Nickel (Ni)       10         Lead (Pb)       20         Antimony (Sb)       200         Scandium (Sc)       10         Tin (Sn)       20         Strontium (Sr)       200         Tungsten (W)       50         Yttrium (Y)       20         Zinc (Zn)       20	Chromium (Cr)			20	
Copper (cu)       10         Gallium (Ga)       10         Germanium (La)       100         Manganese (Mn)       20         Molybdenum (Mo)       10         Niobium (Nb)       50         Nickel (Ni)       10         Lead (Pb)       200         Scandium (Sc)       10         Tin (Sn)       200         Strontium (Th)       200         Vanadium (V)       20         Tungsten (W)       50         Yttrium (Y)       20         Zinc (Zn)       20	Conner (Cu)			20	1. j.
Gammin (Ga)       10         Germanium (Ge)       20         Lanthanum (La)       100         Manganese (Mn)       20         Molybdenum (Mo)       10         Niobium (Nb)       50         Nickel (Ni)       10         Lead (Pb)       20         Antimony (Sb)       200         Scandium (Sc)       10         Tin (Sn)       20         Strontium (Sr)       200         Thorium (Th)       200         Vanadium (V)       20         Tungsten (W)       50         Yttrium (Y)       20         Zinc (Zn)       500	Colline (Co)			10	
Cermanum (Ge)       20         Lanthanum (La)       100         Manganese (Mn)       20         Molybdenum (Mo)       10         Nickel (Ni)       50         Lead (Pb)       20         Antimony (Sb)       200         Scandium (Sc)       10         Tin (Sn)       20         Strontium (Th)       200         Vanadium (V)       20         Tungsten (W)       50         Yttrium (Y)       20         Zinc (Zn)       500         Zirconium (Zr)       20	Gamun (Ga)			, 10 	
Lantnanum (La)       100         Manganese (Mn)       20         Molybdenum (Mo)       10         Niobium (Nb)       50         Nickel (Ni)       10         Lead (Pb)       20         Antimony (Sb)       200         Scandium (Sc)       10         Tin (Sn)       20         Strontium (Sr)       200         Thorium (Th)       200         Vanadium (V)       20         Tungsten (W)       50         Yttrium (Y)       20         Zinc (Zn)       500         Zirconium (Zr)       20	Germanium (Ge)			20	
Manganese (Mn)       20         Molybdenum (Mo)       10         Niobium (Nb)       50         Nickel (Ni)       10         Lead (Pb)       20         Antimony (Sb)       200         Scandium (Sc)       10         Tin (Sn)       200         Strontium (Sr)       200         Thorium (Th)       200         Vanadium (V)       20         Tungsten (W)       50         Yttrium (Y)       20         Zinc (Zn)       500         Zirconium (Zr)       20	Lanthanum (La)		· .	100	العالية. ويتطوأ والمالة الموقات
Molybdenum (Mo)       10         Niobium (Nb)       50         Nickel (Ni)       10         Lead (Pb)       20         Antimony (Sb)       200         Scandium (Sc)       10         Tin (Sn)       20         Strontium (Sr)       200         Thorium (Th)       200         Vanadium (V)       20         Tungsten (W)       50         Yttrium (Y)       20         Zinc (Zn)       500         Zirconium (Zr)       20	Manganese (Mn)			20	
Niobium (Nb)       50         Nickel (Ni)       10         Lead (Pb)       20         Antimony (Sb)       200         Scandium (Sc)       10         Tin (Sn)       20         Strontium (Sr)       200         Thorium (Th)       200         Vanadium (V)       20         Tungsten (W)       50         Yttrium (Y)       20         Zinc (Zn)       500         Zirconium (Zr)       20	Molybdenum (Mo)	 		10	
Nickel (Ni)       10         Lead (Pb)       20         Antimony (Sb)       200         Scandium (Sc)       10         Tin (Sn)       20         Strontium (Sr)       200         Thorium (Th)       200         Vanadium (V)       20         Tungsten (W)       50         Yttrium (Y)       20         Zinc (Zn)       500         Zirconium (Zr)       20	Niobium (Nb)	÷		50	en e
Lead (Pb)       20         Antimony (Sb)       200         Scandium (Sc)       10         Tin (Sn)       20         Strontium (Sr)       200         Thorium (Th)       200         Vanadium (V)       20         Tungsten (W)       50         Yttrium (Y)       20         Zinc (Zn)       500         Zirconium (Zr)       20	Nickel (Ni)			10	
Antimony (Sb)       200         Scandium (Sc)       10         Tin (Sn)       20         Strontium (Sr)       200         Thorium (Th)       200         Vanadium (V)       20         Tungsten (W)       50         Yttrium (Y)       20         Zinc (Zn)       500         Zirconium (Zr)       20	Lead (Pb)			20	
Scandium (Sc)       10         Tin (Sn)       20         Strontium (Sr)       200         Thorium (Th)       200         Vanadium (V)       20         Tungsten (W)       50         Yttrium (Y)       20         Zinc (Zn)       500         Zirconium (Zr)       20	Antimony (Sb)			200	an a
Tin (Sn)       20         Strontium (Sr)       200         Thorium (Th)       200         Vanadium (V)       20         Tungsten (W)       50         Yttrium (Y)       20         Zinc (Zn)       500         Zirconium (Zr)       20	Scandium (Sc)			10	n in statistic
Strontium (Sr)       200         Thorium (Th)       200         Vanadium (V)       20         Tungsten (W)       50         Yttrium (Y)       20         Zinc (Zn)       500         Zirconium (Zr)       20	Tin (Sn)			20	
Thorium (Th)       200         Vanadium (V)       20         Tungsten (W)       50         Yttrium (Y)       20         Zinc (Zn)       500         Zirconium (Zr)       20	Strontium (Sr)			200	
Vanadium (V)         20           Tungsten (W)         50           Yttrium (Y)         20           Zinc (Zn)         500           Zirconium (Zr)         20	Thorium (Th)			- 200	154.8 - 1 <sup>4</sup>
Tungsten (W)       50         Yttrium (Y)       20         Zinc (Zn)       500         Zirconium (Zr)       20	Vanadium (V)			20	t di sal
Yttrium (Y) 20 Zinc (Zn) 500 Zirconium (Zr) at an and an	Tungsten (W)			50	
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Zirconium (Zr) and same and same and set of the structure for an 20 and set of Automative Auto	Zinc (Zn)			500	
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Table 2. Lower limits of detection for the spectrographic analysis of heavy mineral concentrates based on a 5-mg sample.

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count before percentages were taken. The Minnesota Geological Survey performed the point counts for the eight test study samples. The preparation for the point count analyses on the pilot study samples is in process.

### Electron Microprobe Analysis

Electron microprobe analyses were performed on the magnetic, paramagnetic, and nonmagnetic fractions of the eight test study heavy mineral concentrates samples. The mineral analyses were carried out at the Institute of Electron Optics, University of Oulu, in Finland. The analyses were performed using a JEOL JCXA 733 electron microprobe equipped with a LINK AN10000 energy dispersive spectrometer, following the method described by Alapieti and Sivonen (1983).

### DESCRIPTIONS OF THE DATA TABLES

General site information, geologic descriptions, and chemical and mineralogical data results were input into a relational database manager at the Minerals Division office in Hibbing, Minnesota. The information presented in Tables 1 - 16 and Appendices C and D were output from the database.

Several general explanations pertain to many of the tables. All tables are related to each other by the DNR sample number. The eight-samples referred to as the test study samples are numbered 20431 and 22631 through 22637. The five-samples which represent replicate sample sites are numbered 24110 through 24114; these samples relate to study samples 23906, 23908, 23911, 23924, and 23927, respectively.

All samples were collected from glaciofluvial sediments and processed in the same manner, except for the following three samples: 1) sample number 23967 was a pre-concentrated heavy mineral concentrate sample that was supplied by a gravel producer, 2) sample number 23969 is possibly a pre-glacial alluvium, and 3) sample number 23971 is an active stream sediment sample. The grain morphology observed by optical examination of the nonmagnetic (C-3) fraction suggests that these samples are not normal glaciofluvial samples. Some anomalous values are indicated in the analytical data results for these samples. Considering the difference in the sample mediums, interpretation of the these data should be considered independently of the glaciofluvial sediment sample data.

Optical examination of the nonmagnetic fraction of the heavy mineral concentrate samples identified contaminants in some of the samples. Fragments of lead shot or brass and copper shell casings or aluminum shavings were observed in sample numbers 22632, 22635, 23901, 23918, 23922, 23931, 23941, 23943, 23944, 23945, 23949, 23950, 23951, 23954, 23968, and 23975. Table 11 lists the specific contaminants seen in each C-3 sample. In some cases these contaminants are also reflected by inflated values in the analytical data results. Therefore, interpretation of the analytical data is best utilized in conjunction with the optical mineralogical data presented in Table 11.

Tables 3 through 5 contain descriptive information for the test and pilot study sample sites. Table 3 lists several location parameters, surface ownership, and gravel pit activity status. Table 4 reorganizes the site numbers by ascending township, range, and section locations. Table 5 presents a geologic description of the sampling site and the material sampled.

Table 6 lists volume and weight measurements of the various sample fractions for the test and pilot study samples.

Tables 7 through 9 present the analytical data results for the heavy mineral concentrate samples. Table 7 displays the fire assay data values for the total heavy mineral concentrate samples (before magnetic separations). The semiquantitative emission spectroscopic data values for the paramagnetic fraction are displayed in Table 8 and for the nonmagnetic fraction are displayed in Table 8 and for the nonmagnetic fraction are displayed in Table 9. The values in Table 7 are given in parts per billion (ppb). In Tables 8 and 9, values determined for the major elements (Ca, Fe, Mg, Na, P, and Ti) are given in weight percent (%); all other values are given in parts per million (ppm). In all three tables, an "N" indicates that a given element was looked for, but was not detected at the lower limit of detection shown for that element. An "L" indicates that the element was observed, but was below the indicated lower limit of detection. If an element was observed and was above the highest reporting value, a "G" was entered following the upper limit of detection.

Table 10 presents the results of the cyanide leach assay for three pilot study archive samples. The archive samples relate to study sample sites 23932, 23935, and 23960.

Tables 11 through 16 present the mineralogical data results for the heavy mineral concentrate samples. Table 11 displays the optical mineralogy data for the nonmagnetic fraction. Table 12 provides a description of the ore-related, rock forming, and accessory minerals observed optically in the nonmagnetic fraction. Table 13 displays the quantitative mineralogical point count percentage data for the paramagnetic fraction. Tables 14 through 16 present the electron microprobe data results for the C-1, C-2, and C-3 fractions of the test study samples. The mineralogical and chemical data results are displayed in Table 14 for apatite minerals, in Table 15 for monazite minerals, and in Table 16 for miscellaneous minerals. The chemical data values are given in weight percent of the element or weight percent of the oxide.

Appendices C and D present an interpretation of the underlying bedrock for the test and pilot study sample sites. Appendix C lists the underlying bedrock map unit symbol and depth to bedrock for the study sites as interpreted from various maps and well log data. Appendix D provides an explanation of the bedrock map unit symbols utilized in Appendix C.

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Appendices E and F present maps portraying the site locations where gold, platinum, or palladium values were detected by chemical analysis or optical examination of the heavy mineral concentrate samples. Appendix E displays the site locations where gold values were detected by one or more of the following methods: fire assay (data values > = 100ppb), semiquantitative emission spectroscopy (data values > = 100ppm), or observed optically. Appendix F displays the site locations where platinum or palladium values were detected by fire assay analysis (data values > = 4ppb).

## ACKNOWLEDGEMENTS

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We are grateful to Mr. Paul Theobald, U.S. Geological Survey, who was instrumental in providing direction to the study and for coordinating the U.S. Geological Survey involvement, making this cooperative project possible.

Special thanks are due to Mr. J.D. Lehr, Minnesota Department of Natural Resources, for his assistance with the quaternary geology of Minnesota and the broad direction he provided for the field work.

We would also like to express our appreciation to the many private landowners and gravel pit operators who allowed us access to their property to collect the samples for this study.

In addition, the following individuals and public agencies are acknowledged for their valuable contributions to this study: Mr. Tim Cowdery, for providing the geologic descriptions at many of the sample sites. Mr. Bob Carlson and Mr. Al Meier, U.S. Geological Survey, for providing the fire assay analyses. Mr. Tuomo T. Alapieti, Department of Geology, and Mr. Seppo J. Sivonen, Institute of Electron Optics, both at the University of Oulu in Finland, for providing the electron microprobe analyses. Ms. Jane Cleland, Minnesota Geological Survey, for providing the mineralogical point count analyses. The Natural Resources Research Institute, Coleraine, Minnesota, for providing the use of their Wilfley table.

Finally, we would like to thank the many other individuals who offered suggestions and assistance throughout the course of this study.

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# DATA TABLES

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DNR Sample Number	USGS Sample Number	County	USGS Quad	Latitude	Longitude	TWP RNG SEC	Location	Surface Ownership	Pit Activity	Remarks
20431	D-349932	Lake "	Slate Lake West	47 42 38	91 41 59	60 11W 3	SE NE NE SE	Federal		Test study sample.
22631	D-349925	Cass	Tobique	47 2 28	94 5 23	141 27W 10	NW SE NW SW	County	Active	Test study sample.
22632	D-349926	Crow Wing	Cross Lake	46 44 33	94 3 56	138 27¥ 26	SW SW NE NW	Private	Active	Test study sample.
22633	D-349927	Morrison	Motley SE	46 15 38	94 33 30	132 31W 11	NW SW SW NW	Private	Active	Test study sample. Same sample site as 22634.
22634	D-349928	Morrison	Motley SE	46 15 38	94 33 30	132 31W 11	NW SW SW NW	Private	Active	Test study sample. Same sample site as 22633.
22635	D-349929	Mille Lacs	Milaca NE	45 52 49	93 32 21	39 269 11	NE SE SE SE	County	Active	Test study sample.
22636	D-349930	Роре	Glenwood	45 41 40	95 29 16	126 38W 29	SE SW SW NW	Private	Active	Test study sample.
22637	D-349931	Cass	Jack Lake	47 3 12	94 29 53	141 30W 5	SE SW SE	Federal	Active	Test study sample.
23901	D-372285	Crow Wing	Merrifield	46 25 59	94 8 53	134 28¥ 12	NE SW NW SE	Private	Inactive	
23902	D-372290	Crow Wing	Riverton	46 25 43	94 3 55	46 30W 36	SE SW NE NE	Private	Active	
23903	D-372295	Cass	Pillager	46 20 17	94 23 34	133 30W 13	NW SE NE NE	Private	Intermittently active	
23904	D-372300	Crow Wing	Garrison	46 20 44	93 50 52	45 28¥ 26	SE SE SW SW	Private	Active	
23905	D-372305	Aitkin	Spirit Lake	46 28 29	93 41 6	46 26W 18	NW NW NW NW	Private	Active	
23906	D-372310	Aitkin	Glen	46 29 47	93 30 38	46 25₩ 4	SW NE NW SW	Private	Active	Archive sample was used for replicate sample 24110.
23907	D-372315	Aitkin	Thor SE	46 16 40	93 20 42	44 24¥ 23	SE NW SW SW	County	Inactive	
23908	D-372320	Mille Lacs	Isle	46 11 4	93 27 33	43 25¥ 23	NE SW SW SE	Private	Active	Archive sample was used for replicate
22000	D-777725	Monnioon	Willman	// E /D	07 55 30	12 2011 70		Deivoto	Inactiva	Sample 24111.
23010	D-372323	Coniton		40 3 42	93 53 20	42 204 30		Private	Inactive	
23710	D-372330	Aithin	Unicht	40 43 21	92 32 9	47 178 22		State	Inductive Intermittently active	Archive sample was
23711	0-372200	ATCKIN	wright	40 44 49	93 2 1	47 224 11	NE 32 32 NE	State	Internationally active	used for replicate sample 24112.
23912	D-372291	Carlton	Cromwell West	46 40 41	92 53 15	48 20W 4	SE NW NE NW	Private	Intermittently active	
23913	D-372296	Carlton	Sawyer	46 40 36	92 37 59	48 18¥ 4	NW SW NE NW	County	Abandoned	
23914	D-372301	St. Louis	Brookston	46 50 17	92 35 47	50 18W 11	NW NW NW NW	State	Active	
23915	D-372306	St. Louis	Adolph	46 50 10	92 20 39	50 16w 10	NE NE NE NE	Private	Active	*
23916	D-372311	St. Louis	Twig	46 53 34	92 20 30	51 16W 23	SE NW NW NW	County	Active	

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Table 3. Site locations, surface ownership, and sand/gravel pit activity information for the test and pilot study samples.

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Table 3. Site locations, surface ownership, and sand/gravel pit activity information for the test and pilot study samples...continued

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DNR Sample Number	USGS Sample Number	County	USGS Quad	Latitude	Longitude	TWP RNG SEC	Location	Surface Ownership	Pit Activity	Remarks
23917	D-372316	St. Louis	Shaw	47 0 19	92 16 52	52 154 7	SE NE SE NE	County	Abandoned	
23918	D-372321	St. Louis	Independence	46 53 43	92 29 17	51 174 15	SW SE SW SW	Private	Intermittently active	
23919	D-372326	Carlton	Heikkila Creek	46 36 26	92 53 53	48 20W 32	NW NW NE NE	State	Intermittently active	
23920	D-372331	Aitkin	Split Rock Lake	46 25 9	93 7 55	45 221 4	NW NW NE NW	State	Intermittently active	
23921	D-372287	St. Louis	Fredenburg	46 58 23	92 13 5	52 15W 27	SE NE NE NE	Private	Active	
23922	D-372292	St. Louis	Boulder Lake	47 13 27	92 6 5	55 14W 27	SE SE NE NW	State	Inactive	
23923	D-372297	St. Louis	Pequaywan Lake	47 9 41	91 53 57	54 12W 18	SE NE NE SE	County	Active	
23924	D-372302	Lake	Brimson	47 15 21	91 50 48	55 12W 15	NW NE NW NE	Private	Intermittently active	Archive sample was
	• • • • •									used for replicate
										sample 24113.
23925	D-372307	Lake	Whyte	47 21 55	91 44 28	56 11W 4	SE NE NW	Private	Active	
23926	D-372312	St. Louis	Whiteface Reservoir	47 22 23	92 9 34	57 14W 31	NE SE SW SE	Federal	Intermittently active	
23927	D-372317	St. Louis	Skibo	47 29 20	91 59 31	58 13W 21	SE SW SW SE	County	Inactive	Archive sample was
		ta da series de la composición de la co		<ul> <li><sup>1</sup> Comparison</li> </ul>	200 - 120 20	n 1997 - Alexandria 1997 - Alexandria	e na se se	2.2		used for replicate sample 24114.
23928	D-372322	St. Louis	Biwabik NE	47 39 19	92 18 26	60 16W 25	SE SW SE NE	Private	Active	•
23929	D-372327	St. Louis	Isaac Lake	47 40 13	92 6 25	60 14W 22	SW SW NW NE	Private	Inactive	
23930	D-372332	St. Louis	Тожег	47 46 58	92 17 9	61 15W 8	NW NW SW NW	Private	Intermittently active	
23931	D-372288	St. Louis	McKinley	47 36 47	92 29 49	59 17W 10	SW NE SW NW	Private	Abandoned	
23932	D-372293	St. Louis	Britt	47 39 36	92 36 24	60 18W 27	NE SW NE NE	Private	Active	ineq.
23933	D-372298	Crow Wing	Nisswa	46 30 46	94 18 27	135 29¥ 14	SW NW NW NW	State	Active	·
23934	D-372303	Crow Wing	Nisswa	46 37 15	94 16 14	136 29W 1	SE SW NE SE	Private	Active	
23935	D-372308	Crow Wing	Trommald	46 36 35	9479	136 27¥ 8	NE NW NW SW	County	Inactive	11 <sup>111</sup> 11
23936	D-372313	Crow Wing	Emily	46 40 8	93 56 60	137 26W 22	NW NW SE NE	Private	Active	
23937	D-372318	Cass	Mitchell Lake	46 50 52	94 2 24	139 27¥ 13	NE SE SE SW	State	Inactive	
23938	D-372323	Cass	Edna Lake	46 50 22	93 50 20	139 25W 21	SE SE SE NE	State	Inactive	
23939	D-372328	Cass	Casino	46 23 56	94 30 26	134 30W 19	SE SE SE SW	Private	Abandoned	
23940	D-372333	Morrison	Lincoln	46 <b>13</b> 8	94 38 20	132 31W 30	SE NW SE NW	Private	Inactive	
23941	D-372289	Morrison	Randall East	46 5 4	94 27 52	130 30¥ 9	SW NE NE SW	<u>у</u> й	Active	
23942	D-372294	Morrison	Randall East	46 1 54	94 26 32	130 30W 34	SE SE NE NW	Private	Intermittently active	
23943	D-372299	Morrison	Pierz	45 58 44	94 5 29		SE NW SW NW	Private	Active	<u>.</u>
23944	D-372304	Morrison	Killman	46 2 23	93 58 37	41 29W 14	SW NW NW NW	Private	Inactive	-
23945	D-372309	Morrison	Ramey NE	45 58 4	93 50 52	40 28W 16	NW NE NW NW	Private	Inactive	۲
23946	D-372314	Mille Lacs	Onamia	46 4 28	93 42 15	42 27W 36	SW SW NW SW	State	Intermittently active	÷ 1

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Table 3. Site locations, surface ownership, and sand/gravel pit activity information for the test and pilot study samples...continued

S.S.S	1. 1. j.	to the second second	"就来你还是"	<ul> <li>Solit</li> </ul>	$M \in \mathbb{N}$	S		1 A.	$(x_1, \dots, x_n) \in \mathcal{A}_{n-1}$	
DNR	USGS		and and a state of the second	i i i					194	
Sample	Sample		USGS			11. 17.1		Surface	Pit	
Number	Number	County	Quad	Latitude	Longitude	TWP RNG SEC	Location	Ownership	Activity	Remarks
23947	D-372319	Crow Wing	Platte Lake	46 12 54	93 55 16	43 28W 7	SW SE SW SE	Private	Active	
23948	D-372324	Crow Wing	Brainerd	46 20 21	94 12 28	45 31W 36	SW SW NW	Private	Active	
23949	D-372329	Crow Wing	Lastrup NW	46 14 45	94 11 44	44 31W 36	SW NE SW SE	Private	Active	
23950	D-372334	Morrison	Freedhem	46 6 17	94 10 31	42 30W 19	NW SW NW SE	Private	Intermittently active	
23951	D-372335	Morrison	Swanville	45 57 47	94 37 51	129 31W 19	SE SW	Private	Active	
23952	D-372339	Todd	Burtrum	45 51 52	94 42 7	128 32W 27	SW SE NE SW	Private	Inactive	
23953	D-372343	Morrison	Bowlus	45 47 57	94 24 21	127 30W 24	SW NE SW NW	Private	Active	
23954	D-372347	Morrison	Little Falls West	45 53 45	94 24 10	128 30W 13	SE SW NE SW	Private	Active	
23955	D-372351	Todd	Staples	46 15 11	94 50 12	132 33W 9	SE SW SE SE	Private	Active	
23956	D-372355	Todd	Eagle Bend	46 9 16	95 0 16	131 34¥ 18	SW SW NE SE	Private	Abandoned	
23957	D-372359	Todd	Browerville SW	46 6 36	94 53 53	131 34W 36	NW NE SE SE	Private	Inactive	
23958	D-372336	Todd	Rose City	46 2 35	9580	130 35W 30	NE SW SW NE	Private	Abandoned	
23959	D-372340	Роре	Glenwood	45 39 23	95 24 34	125 38W 2	NW SE SE SE	State	Abandoned	2.20
23960	D-372344	Kandiyohi	Mount Tom	45 20 32	95 2 30	122 35W 26	SW NE SE SW	Private	Active	
23961	D-372348	Stearns	Avon	45 35 45	94 26 40	125 30W 34	SE NE SW NW	Private	Inactive	
23962	D-372352	Stearns	St. Stephen	45 38 38	94 20 28	125 29¥ 16	NE NE NW NW	Private	Inactive	
23963	D-372356	Stearns	Holdingford	45 42 59	94 26 20	126 30W 22	NW NW NW NE	Private	Intermittently active	
23964	D-372360	Morrison	Little Falls East	45 58 26	94 15 27	40 31W 7	SW SE NW SW	Private	Active	
23965	D-372337	Todd	Lake Osakis	45 57 7	95 2 26	129 35W 25	NE SW NW SW	Private	Abandoned	5
23966	D-372341	Kandiyohi	Spicer	45 12 24	94 59 25	120 34W 18	SE NW SW NE	Private	Active	
23967	D-372345	Роре	Lake Simon	45 25 20	95 15 24	123 37W 36	SW NE SE NE	Private	Active	Concentrate sample
6		-						<b>04</b> • 4 • •	••••	supplied.
23968	D-372349	Pope	Starbuck	45 32 33	95 31 58	124 39W 14	SW SE SE SW	State	Inactive	
23909	D-372353	Big Stone	Ortonville	45 15 50	96 24 7	121 46W 20	SE NW	Private	• • • •	
23970	D-372357	Kandiyohi	New London	45 18 10	94 54 36	121 34W 11	NE NW NE SE	State	Inactive	
23971	D-372361	Morrison	Royalton	45 50 41	94 21 54	127 29¥ 5	SW SE NW NW	Private		
23972	D-372338	Dakota	Farmington	44 43 33	93 11 26	115 20W 35	SW SE NW	Private	Active	
23973	D-372342	Washington	Hudson	44 57 19	92 48 39 <sub>1</sub>	29 20W 33	NW NW SE	Private	Active	
23974	D-372346	Sherburne	Elk River	45 20 33	93 34 4	33 26W 22	NE NW NW	Private	Active	
23975	D-372350	Hennepin	Osseo	45 6 25	93 25 11	119 22W 24	NE SW NW NW	Private	Active	
24110	D-372354	Aitkin	Glen	46 29 47	93 30 38		SW NE NW SW	Private	Active	24110 is archive sample of 23906.
24111	D-372358	Mille Lacs	Signal States	<sub>450</sub> 46 11 .4	93 27 33	43 25¥ 23	NE SW SW SE	Private	Active states and	24111 is archive ' sample of 23908.

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Sample Number	Sample Number	County	USGS Quad		Latitude	Longitude	TWP RNG SEC	Location	Surface Ownership	Pit Activity	Remarks
24112	D-372362	Aitkin	Wright		46 44 49	93 5 1	49 22W 11	NE SE SE NE	State	Intermittently active	24112 is archive sample of 23911.
24113	D-372364	Lake	Brimson		47 15 21	91 50 48	55 12W 15	NW NE NW NE	Private	Intermittently active	24113 is archive sample of 23924.
24114	D-372363	St. Louis	Skibo		47 29 20	91 59 31	58 13W 21	SE SW SW SE	County	Inactive	24114 is archive

Table 3. Site locations, surface ownership, and sand/gravel pit activity information for the test and pilot study samples...continued

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sample of 23927.

				DNR Samole	USGS Samole
TWP	RNG	SEC	Location	Number	Number
29	20W	33	NW NW SE	23973	D-372342
33	26¥	22	NE NW NW	23974	D-372346
39	26₩	11	NE SE SE SE	22635	D-349929
40	28W	16	NW NE NW NW	23945	D-372309
40	30W	9	SE NW SW NW	23943	D-372299
40	31¥	7	SW SE NW SW	23964	D-372360
41	29W	14	SW NW NW NW	23944	D-372304
42	27W	36	SW SW NW SW	23946	D-372314
42	28W	30	NW NW SW NE	23909	D-372325
42	30W	19	NW SW NW SE	23950	D-372334
43	25W	23	NE SW SW SE	24111	D-372358
43	25W	23	NE SW SW SE	23908	D-372320
43	28₩	7	SW SE SW SE	23947	D-372319
44	24W	23	SE NW SW SW	23907	D-372315
44	31₩	36	SW NE SW SE	23949	D-372329
45	22W	4	NW NW NE NW	23920	D-372331
45	28¥	26	SE SE SW SW	23904	D-372300
45	31W	36	SW SW NW	23948	D-372324
46	25₩	4	SW NE NW SW	24110	D-372354
46	25W	4	SW NE NW SW	23906	D-372310
46	26W	18	NW NW NW NW	23905	D-372305
46	30W	36	SE SW NE NE	23902	D-372290
48	18W	4	NW SW NE NW	23913	D-372296
48	20W	4	SE NW NE NW	23912	D-372291
48	20W	32	NW NW NE NE	23919	D-372326
49	19W	22	NW NE NW NW	23910	D-372330
49	22₩	11	NE SE SE NE	23911	D-372286
49	22₩	11	NE SE SE NE	24112	D-372362
50	16W	10	NE NE NE NE	23915	D-372306
50	18W	11	NW NW NW NW	23914	D-372301
51	16₩	23	SE NW NW NW	23916	D-372311
51	. 17W	15	SW SE SW SW	23918	D-372321
52	15W	7	SE NE SE NE	23917	D-372316

## Table 4. Sample site numbers arranged by ascending township, range, and section locations

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TWP	RNG	SEC	Location	DNR Sample Number	USGS Sample Number
	1511			27021	n_770287
52	120	19	SE NE NE SE	23721	0-372207
24 EE	121	10	SE NE NE SE	23723	0-372291
22 55	121	10	NW NE NW NE	24113	0-372304
)) 55	121	כו סס	NW NE NW NE	23724	0-372302
22 5/	14,9	<u> </u>	SE SE NE NW	23922	0-312292
20 57	11W	4	SE NE NW	23923	0-372307
57	14W	21	NE SE SW SE	23920	D-372312
20	1.5W	21	SE SW SW SE	24114	D-372303
58	128	21	SE SW SW SE	23921	D-372317
27	179	10	SW NE SW NW	23931	D-372200
60	11W	3	SE NE NE SE	20431	D-349932
60	14W	22	SW SW NW NE	23929	D-372327
60	16₩	25	SE SW SE NE	23928	U-3/2322
60	18W	21	NE SW NE NE	23932	U-3/2293
61	15W	8	NW NW SW NW	23930	D-372332
115	209	35	SW SE NW	25972	D-372338
119	229	24	NE SW NW NW	23975	D-372350
120	34W	18	SE NW SW NE	23966	D-372341
121	34W	11	NE NW NE SE	23970	D-372357
121	46W	26	SE NW	23969	D-372353
122	35₩	26	SW NE SE SW	23960	D-372344
123	37₩	36	SW NE SE NE	23967	D-372345
124	39W	14	SW SE SE SW	23968	D-372349
125	29W	16	NE NE NW NW	23962	D-372352
125	30W	34	SE NE SW NW	23961	D-372348
125	38W	2	NW SE SE SE	23959	D-372340
126	30W	22	NW NW NW NE	23963	D-372356
126	38W	29	SE SW SW NW	22636	D-349930
127	29¥	5	SW SE NW NW	23971	D-372361
127	30W	24	SW NE SW NW	23953	D-372343
128	30W	13	SE SW NE SW	23954	D-372347
128	32₩	27	SW SE NE SW	23952	D-372339
129	31W	19	SE SW	23951	D-372335

Table 4. Sample site numbers arranged by ascending township, range, and section locations...continued

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	• *		$\mathbb{L}^{(n)} = \frac{1}{2} \mathbb{E}^{n - 1} = \mathbb{E}^{n + 1} \mathbb{E}^{n - 1}$	DNR	USGS
			25 LEN 7	Sample	Sample
TWP	RNG	SEC	Location	Number	Number
·			<u>~</u>		
129	35W	25	NE SW NW SW	23965	D-372337
130	30W	9	SW NE NE SW	23941	D-372289
130	30W	34	SE SE NË NW	23942	D-372294
130	35W	30	NE SW SW NE	23958	D-372336
131	34W	18	SW SW NE SE	23956	D-372355
131	34W	36	NW NE SE SE	23957	D-372359
132	31W	11	NW SW SW NW	22634	D-349928
132	31W	11	NW SW SW NW	22633	D-349927
132	31W	30	SE NW SE NW	23940	D-372333
132	33W	9	SE SW SE SE	23955	D-372351
133	30W	13	NW SE NE NE	23903	D-372295
134	28W	12	NE SW NW SE	23901	D-372285
134	30W	19	SE SE SE SW	23939	D-372328
135	29W	14	SW NW NW NW	23933	D-372298
136	27¥	8	NE NW NW SW	23935	D-372308
136	29W	1	SE SW NE SE	23934	D-372303
137	26W	22	NW NW SE NE	23936	D-372313
138	27¥	26	SW SW NE NW	22632	D-349926
139	25W	21	SE SE SE NE	23938	D-372323
139	27¥	13	NE SE SE SW	23937	D-372318
141	27W	10	NW SE NW SW	22631	D-349925
141	30¥	5	SE SW SE	22637	· D-349931

Table 4. Sample site numbers arranged by ascending township, range, and section locations...continued

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Sample Number	Glacial Lobe	Landform	Sediment Type	Site Description	Sample Location	Sample Description	Remarks
20431	Rainy	Esker	Ice-contact		Just off roadway, sample collected from surface to 5 foot depth with an auger		
22631	Wadena	Outwash plain	Outwash	Pebbly sand, well stratified. Granite and greenstone pebbles dominant. Some limestone, red rhyolite and red sandstone present.	Sample taken 10 feet down pit face, 1 foot below the Fe-oxide-rich zone	Pebbly sand	
22632	Rainy	Outwash plain	Outwash	Poorly sorted pebbly sand, dark brown. No bedding observed. Abundant Superior lobe lithologies present, i.e. red sandstone and some agates. No shale or limestone.	• •	Poorly sorted pebbly sand	Looks like Rainy lobe deposit with a strong Superior lob component.
22633	Superior	Esker	Ice-contact	Sandy pebble-gravel most common sediment present. Some sorted sand also present. Generally a fairly coarse deposit. Abundant Superior lobe lithologies present. Also, abundant pinkish argillite present (locally derived?).		Pebble gravel	Same sample site as 22634; supraglacial esker.
22634	Superior	Esker	Ice-contact	Sandy pebble-gravel most common sediment present. Some sorted sand also present. Generally a fairly coarse deposit. Abundant Superior lobe lithologies present. Also, abundant pinkish argillite present		Sand '	Same sample site as 22633; supraglacial esker.
				(locally derived?).		and the second sec	T

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Sample Number	Glacial Lobe	Landform	Sediment Type	Site Description	Sample Location	Sample Description	eroza 
22635	Superior	Esker	Ice-contact	Poorly sorted sandy pebble and cobble gravel. Some sorted sand also present. Cobble gravel appears to form core of esker. Abundant Superior lobe lithologies present. No shale or limestone. Some iron-formation (local?).		Sandy pebble gravel?	Tunnel valley esker.
22636	Wadena	Stagnation moraine	Ice-contact	5 to 12 feet of yellowish-brown loamy till containing shale (Des Moines lobe till) overlying stratified sand and pebbly sand, moderately to poorly sorted. Pebble lithologies include granite, red sandstone, agate, gabbro and dolomite. No shale.	Sample taken 5 feet below Des Moines till	Pebbly sand?	
22637	Wadena	Stagnation moraine	Ice-contact	Poorly sorted sand and pebbly sand. Contains approximately 40% supracrustals, 50% granite and 5% carbonate, agates, red sandstone and felsite. No shale.	۰ ۱	Pebbly sand?	
23901	Rainy	Kame	Ice-contact	Moderately to well sorted sand and gravel. Flanks of kame overlain by dark brown sandy diamicton. Many Superior lobe lithologies present (agate, rhyolite). Also, pinkish-tan phyllite common. No large boulders present.	2 meters above pit floor	n an an an Rei Gea Na Stàit	
23902	Rainy	Collapsed outwash plain	Outwash	0.5 to 1.5 meters sandy diamicton, dark reddish-brown overlying moderately to well sorted sand and	South pit - west exposure, 7 meter high section	Coarse sand, cross-bedded	

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DNR Sample Number	Glacial Lobe	Landform	Sediment Type	Site Description	Sample Location	Sample Description	Remarks
				gravel, stratified and cross-bedded, uncollapsed bedding.		· · · · · · · · · · · · · · · · · · ·	- Ann an Ann
23903	Rainy	Outwash plain	Outwash	Large (160 acre) pit. Well sorted medium sand fining upward, overlying, with sharp contact, sand and gravel, poorly to well sorted. Common pebble lithologies include red sandstone, basalt, limestone. Iron-formation, pinkish phyllite, shale and graywacke also present. Generally a lithologically mixed deposit. Interpretation: Rainy lobe outwash plain overlain by near-shore lacustrine deposits.	From stockpile of crushed gravel	1/4" to 100" mesh crushed product	
23904	Superior	Stagnation moraine	Ice-contact	1.5 to 2 meters reddish-brown sandy diamicton (Superior lobe till) overlying poorly sorted sand and gravel with interbedded sand, silt and clay, well to poorly sorted.	Immediately below till (approximately 2 meters below surface)	Sand and gravel	
23905	Superior	Stagnation moraine	Ice-contact	Tan, fine-grained diamicton, non-calcareous, overlying stratified sand and gravel, with interbedded silt and clay, well sorted. Pebble lithologies include rhyolite, agate, red sandstone, granophyre and metasedimentary rocks.	Lower pit, SW face of SE main pit. Face 3.5 meters high. Sample taken 1 meter above pit bottom, 30cm in from disturbed face.	Medium sand and fine gravel, cross-bedded	
23906	Superior	Kame	Ice-contact	Interbedded poorly to well sorted gravel, sand, silt, clay and reddish to yellow diamicton.	3 meters above pit floor, 12 meters below surface	Sand and gravel, moderately to poorly sorted, stratified,	•

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DNR Sample Number	Glacial Lobe	Landform	Sediment Type	Site Description	Sample Location	Sample Description	Remarks
23907	Superior	Esker	Ice-contact	Collapsed bedding. Abundant Superior lobe lithologies present. 0.3 meters tan, loamy diamicton, non-calcareous overlying moderately sorted gravel and well sorted sand with some interbedded sandy diamicton, red.	3 meter high face in SW corner of pit	with interbedded diamicton (avoided in sampling) Sand and gravel	
23908	Superior	Stagnation moraine	Ice-contact	5 meter high exposure of interbedded sand, gravel, silt, clay and red, sandy diamicton ranging from well sorted clay, silt and sand to very poorly sorted sandy, cobble- and boulder-gravel. Collapsed bedding.	SE pit, south face	Very well sorted medium sand with fine gravel layers	
23909	Superior	Esker	Ice-contact	East face, closest to road, 2 meters high. Reddish-brown sandy diamicton, 0.5 to 0.7 meters thick, overlying poorly sorted medium gravel, cross-bedded; fine to medium sand, well sorted; and sandy gravel, moderately sorted.	East face, closest to road approximately 1.5 meters below surface	Moderately sorted sandy gravel	·
3910	Superior	Kame	Ice-contact	North face 9 meters high. Red, sandy diamicton, 1 to 1.5 meters thick, overlying poorly sorted, medium gravel and well sorted sand.	North face	Very poorly sorted coarse gravel	
3911	Superior	Esker	Ice-contact	SW face, 4 meters high. Poorly sorted sandy gravel. Stratified and fine to medium gravel, cross-bedded. Granophyre, felsite	SW face, approximately 3.5 meters below surface	Fine to medium gravel	

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DNR Sample Number	Glacial Lobe	Landform	Sediment Type	Site Description	Sample Location	Sample Description	Remarks
				and agate present.			
23912	Superior	Stagnation moraine	Ice-contact	Red sandy diamicton, 0 to 2 meters thick, overlying fine to medium, well sorted sand with fine gravel; very-coarse gravel, very poorly sorted; and fine to medium sand, very-well sorted. Collapsed bedding. Abundant Superior lobe lithologies, including red sandstone, also abundant light gray phyllite.	S₩ face	Fine to medium sand, with fine gravel, well sorted	•
23913	Superior	Outwash plain	Outwash	Medium gravel, moderately to poorly sorted, stratified overlying well sorted, medium sand. Abundant granophyre, also porphyritic rhyolite.	West face, north side of pit	Medium gravel, moderately to poorly sorted	Very poor exposure
23914	Superior	Esker	Ice-contact	10 meter high exposure. Very coarse gravel, very poorly sorted; overlying medium gravel; overlying interbedded sand (medium, well sorted) and medium gravel, moderately to poorly sorted. Horizontal stratification. Red sandy diamicton present in west face. Superior lobe lithologies, especially agate, abundant. Red sandstone present. NE corner, north face, within upper 2 meters.			۰.
23915	Superior	Stagnation moraine	Ice-contact	Red sandy diamicton, 1 to 2 meters thick overlying very coarse gravel,	Lowest part of pit - 20 feet (?) below	Fine gravel, well sorted, with lenses	•

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 Land Conservation and American States and American States and American States and American States Table 5. Geologic descriptions of the sand/gravel pits and the material sampled for the test and pilot study samples...continued

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DNR Sample Number	Glacial Lobe	Landform	Sediment Type	Site Description	Sample Location	Sample Description	Remarks
		:,		poorly sorted and fine gravel, well sorted, with lenses of well sorted fine sand. Collapsed bedding. Abundant agate, granophyre, porphyritic felsite and some red sandstone.	land surface.	of well sorted fine sand	
3916	Superior	Stagnation moraine	Ice-contact	Diamicton, 1 to 1.5 meters thick, overlying very-fine to coarse gravel, sand and silt, stratified.	South central wall of pit	Fine to medium pebble gravel	
23917	Superior	Outwash plain	Outwash	Interbedded sand and gravel, ranging from fine sand to medium gravel, poorly to well sorted, horizontal stratification and cross-bedding. Granophyre, agate, porphyritic felsite abundant. No metasediments or red sandstone.	East face	Fine gravel	
3918	Superior	Stagnation moraine	Ice-contact	Stratified sand and gravel ranging from coarse gravel, very-poorly sorted to fine sand, well sorted. Total thickness 15 meters.	Lowest face, 5 meters high	Medium gravel, stratified	
919	Superior	Drumlin	Ice-contact	Red, sandy diamicton, 1 meter thick, overlying interbedded medium to fine gravel, sand and silt.		Medium to fine gravel, stratified	
<b>5920</b>	Superior	Esker	Ice-contact	Red, sandy diamicton overlying interbedded gravel and sand, cross-bedded to stratified. Agate, red sandstone, granophyre,	South face 2 meters below land surface, 2 meters above pit floor	Medium gravel	
				porphyritic felsite present.		47.33	

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DNR Sample Number	Glacial <sup>S</sup> Lobe	een oppeling politics as Landform	Sediment Type	Site Description	Sample Location	Sample Description	Remarks
23921	Superior	Stagnation moraine	Ice-contect	Exposure 16 meters high. Yellow-brown sandy diamicton, 0.75 meters thick, overlying sand and gravel, poorly to well sorted, stratified and collapsed bedding. Abundant porphyritic felsite and red sandstone.	Main pit, south face	Fine to medium gravel, cross-bedded	ŗ
23922	Rainy	Outwash plain	Outwash	4 meter high exposure. Yellow-brown sandy diamicton, 1 meter thick, overlying medium to fine gravel, poorly sorted. Faintly stratified. Granophyre, porphyritic felsite, basalt, slate and granite present.	East face, left side	Medium to fine gravel, poorly sorted	
23923	Superior Ra W	Outwash plain	Outwash	Moderately coarse to fine gravel and coarse sand, moderately to poorly sorted. Mostly basalt, felsite, gabbro; few porphyritic felsite pebbles, rare agate.	NW face	Coarse sand and fine gravel	Outwash plain is collapsed.
23924	Superior	Outwash plain	Outwash	3 meter high exposure. Brown, sandy diamicton, 0 to 0.3 meters thick, overlying fine to medium gravel, poorly sorted, stratified. Felsite, basalt, granite, some red sandstone and granophyre.	West face, near surface	Fine pebbly gravel	TAL
23925 <sup>6</sup> • • • •		Stagnation moraine	Ice-contact	Yellow-brown sandy diamicton, 1.5 meters thick, overlying fine to coarse gravel, poorly to well sorted, with lenses of coarse sand. Boulders are gabbro. Other	SE pit, south face	Fine gravel	

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DNR ample umber	Glacial Lobe	te that state states a state of the <b>Landform</b>	Sediment Type	Site Description	Sample Location	Sample Description	Remarks
<u> </u>	Ally,,,			lithologies: granophyre, red sandstone, porphyritic felsite, basalt, granite, slate and some			
385	auparie:	$(1+1) = \sum_{i=1}^{n} (1+1) = \sum_{i=1}^{n} (1+1$		agate.			
3926	Rainy	Valley train	Outwash	Sand and gravel, ranging from fine sand to coarse gravel, poorly to moderately well sorted. Basalt,	North pit, NW face	Fine gravel and coarse sand, moderately sorted	
				gabbro, felsite, granite present.		۳	enel inclusion
23927	Rainy	Outwash plain	Outwash	Yellow-brown, sandy diamicton, 0.5 to 1.5 feet thick overlying stratified sand and gravel, ranging from medium sand, well sorted, to	South end of pit, east face	Medium sand, well sorted and fine gravel, moderately well sorted	Galangan plann is
·		ν.		coarse gravel moderately sorted. Lithologies include: basalt, gabbro, granite, gneiss, felsite.		an Na Santa ay	
3928	Rainy	Outwash fan	Ice-contact	4 meter high exposure. Yellow-brown, sandy diamicton, 0.5 meters thick overlying very coarse	North pit, east side, south face	Interbedded coarse sand, very well sorted and coarse	
				gravel, poorly sorted, with interbedded sand, very fine to coarse, well sorted. Lithologies present: granite, greenstone,		sandy gravel, poorly sorted	
3 <b>3</b> 65 -	tititite (1931).	per presidente de la companya de la		gneiss, schist, metasediments,	· · · · · · · · · · · · · · · · · · ·	an a	
		et an an a		gabbro and fron formation.	e e e e	an a	no a construction de la
23929	Rainy Birolyst	Outwash plain	Outwash	3-meter-high exposure. Medium sand to medium gravel, well sorted. Lithologies present: granite,	North face	Medium gravel, well sorted	in the second
£®`\ J	h se colta to c	, Nacional de la composition		schist, metasediments, porphyritic felsite, greenstone, gabbro, gneiss.			•

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DNR Sample Number	Glacial Lobe	Landform	Sediment Type	Site Description	Sample Location	Sample Description
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23930	Rainy	Outwash fan	Ice-contact	12-meter-high exposure. Interbedded medium to coarse gravel, poorly sorted, and fine sand to fine gravel, well sorted. Lithologies include: gabbro, metasediments, basalt, iron formation, schist and granite.	SW pit, center of north face	Fine gravel
23931	Rainy	Outwash fan	Ice-contact	Interbedded fine sand, very-well sorted; fine gravel; and coarse gravel, poorly sorted, with fine sand lenses. Collapsed bedding. Lithologies include: granite, greenstone, gneiss, gabbro, iron formation and metasediments.	NW pit, north face	Medium gravel, very well sorted
23932	Rainy	Stagnation moraine	Ice-contact	Interbedded medium to coarse gravel and medium sand, moderately to well	West side of pit, north face	Fine gravel with pebbles and cobbles,
•				sorted. Lithologies include: granite, gabbro, gneiss, metasediments, greenstone, schist,		well sorted
	·	:		felsite.		
23933	Rainy	Outwash plain	Outwash	Medium to fine gravel, very-poorly sorted and medium sand, moderately well sorted, cross-bedded,	NE pit, south face	Fine gravel and coarse sand, well sorted, cross-bedded
ny magana 19 malay na 19 milay na	(6 <b>66</b>	annan an a		collapsed. Lithologies include: agate, red sandstone, granite, gabbro, metasediments, porphyritic felsite, basalt.	•.	- larteste nationalise 2
23934	Rainy	<b>Outwash plain</b>	Outwash	Interbedded medium gravel to medium sand, moderately well sorted,	SW pit, east face	Medium sand with heavy mineral bands,

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onn ample umber	Glacial Lobe	Landform	Sediment Type	Site Description	Sample Location	Sample Description	Remarks
	·			horizontal stratification. Lithologies include: granite, gabbro, schist, greenstone, porphyritic felsite, some red sandstone, agate and granophyre.	· · ·	well sorted	
3935	Rainy	Outwash plain	Outwash	Medium sand, with pebbly beds, very well sorted, cross-bedded.	Main pit, south face	Pebbly, medium sand, cross-bedded	
	] '9-4/₹			metasediments, schist, granite, gabbro, felsite, basalt.		1944年代(第二) 1944年(第二)	
3936	Rainy	Stagnation moraine	Ice-contact	Interbedded fine gravel to fine sand, moderately well sorted. Some interbedded clay. Collapsed bedding. Lithologies include:	South pit, NE face	Interbedded medium sand and fine gravel, collapsed bedding	
	na Josef Astro			granite, slate, basalt, red sandstone, granophyre, felsite, gabbro, vein quartz.			
5937 ·	Rainy	Outwash plain	Outwash	Interbedded medium gravel, poorly sorted, massive and coarse sand, well sorted. Lithologies include: granite, gabbro, metasediments, folgite booglt optist graiss	North part of pit, NW face	Coarse sand, well sorted	а. А.
(34.2C)	器4733A	$\sqrt{2} = \frac{1}{2} \left( \frac{1}{2} + \frac{1}{2} \right) = \frac{1}{2} \left( \frac{1}{2} + \frac{1}{2} \right) = \frac{1}{2} \left( \frac{1}{2} + \frac{1}{2} \right) = \frac{1}{2} \left( \frac{1}{2} + \frac{1}{2} \right)$	x <sup>2</sup>	retsite, basatt, scrist, gneiss.			
3938	Rainy	Stagnation moraine	Ice-contact	Fine to coarse sand, pebbly, well	West face	Coarse pebbly sand,	
- 2019 Sur Pri a Sur Cris	6190141 1.0208			sorted, cross-bedded. Lithologies include: granite, gabbro, felsite, granophyre, schist, basalt.	and An an ann	moderately to poorly sorted, iron cemented	je ter∰ µy
2 <b>3939</b>	Rainy	Outwash plain	Outwash	Interbedded poorly sorted pebbly sand, and well sorted medium sand with pebble layers. Massive.	West face	Pebbly coarse sand, moderately to poorly sorted massive	на, на 1993 (р. 21, т. — А

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DNR Sample Iumber	Glacial Lobe	Landform	Sediment Type	Site Description	Sample Location	Sample Description	Remarks
<u> </u>	· · · · · · · · · · · · · · · · · · ·			Lithologies include: red sandstone, granite, gabbro, basalt,		ι	
				porphyritic rhyolite, gneiss,			
				State.		11.11.11.14、CC 24日本 1	
3940	Superior	Stagnation moraine	Ice-contact	Sandy loam diamicton, 0.5 to 1 meter thick, overlying a generally fining downward sequence of interbedded gravel, sand, silt, clay and diamicton. Lithologies include: gneiss, granite, gabbro,	North side, NW face	Pebbly sand	
				basalt, rhyolite, red sandstone,		11、19、11、精制11月1日	
n san ni An th	Contraction of the		• ·			n gan tarata tar	
3941	Rainy	Outwash fan	Ice-contact	Interbedded fine sand, moderately to very-well sorted and gravel.	SW pit, SW face, 3 meters above pit floor	Coarse gravel, moderately sorted	
23942	Superior	Esker	Ice-contact	Interbedded sequence of fine to coarse gravel, fine to medium sand, silt and clay. Stratified,	SE pit, NW end, north face	Fine gravel, well sorted, cross-bedded	
				cross-bedded and massive.			
3943	Superior	Valley train	Outwash	Interbedded and stratified. Sandy pebble gravel and pebbly sand, ranging from very poorly to moderately well sorted - A few	South end of pit, 15 to 20 feet high face, 8 feet below disturbed land	Interbedded sandy pebble gravel and pebbly sand, very	-
				cobbles and boulders interspersed	surface	well sorted	and the second
	1779 S V	t and		in more poorly sorted beds; 10 to		and the second sec	in the second
		98543 1		15 feet thick, overlying sand, fine			
				to coarse, moderately to well			÷
				sorted, cross-bedded, >5 feet			
• •			e de la composition de la comp	TNICK. Pebble lithologies:			

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DNR Sample Number	Glacial Lobe	Landform	Sediment Type	Site Description	Sample Location	Sample Description	Remarks
				Also some granite, gabbro, gneiss and greenstone.		<ul> <li>Diskanistika (Serie)</li> <li>Diskanistika (Serie)</li> <li>Diskanistika (Serie)</li> <li>Diskanistika (Serie)</li> </ul>	
23944	Superior	Esker <sup>ali</sup> (1997)	Ice-contact	10 feet high exposure of sandy, cobbly pebble-gravel, poorly to very poorly sorted. Sand matrix ranges from very fine to very	North part of pit, approximately 5 feet below land surface.	Sandy, cobbly pebble-gravel, poorly to very poorly sorted.	_
Na Wil	ટ્રે પ્રેઝર ત્ર કે ઉત્ત	4		coarse, slightly silty, coarse skewed. Massive. Pebble lithologies: basalt, felsite, red sandstone, granite, gneiss, and			
6367 i	aw suk	a se		greenstone.		and the second	
23945	Superior	Outwash fan	Íce-contact	Sandy pebble gravel, very poorly sorted, 3 feet thick, overlying sand, very fine to very coarse, poorly sorted, 3 feet exposed. Pebble lithologies: basalt, felsite, granite, greenstone, and gneiss.	South end of pit, approximately 3 feet below land surface	Sandy pebble gravel, very poorly sorted	
23946	Rainy	Unknown	Outwash	Yellowish-brown (Alborn) till overlying reddish-brown (Pierz) till overlying sandy pebble gravel, poorly to very poorly sorted, massive to stratified, 12 to 24 inches thick; overlying very fine	South end of pit	Sandy pebble gravel, poorly to very poorly sorted, massive to stratified	· •
in con Selfer Can	n an			to very coarse sand, slightly pebbly, poorly to well sorted, cross-bedded, 6 to 8 feet thick. Pebble lithologies in interval		na (1997) San (1997)	1844-2011 1964-2
japis s	1100年48月2日 1	ja ku tap un an ta		sampled: basalt, greenstone, gabbro, granite, gneiss, graywacke, limestone, red sandstone and	an an an Maria ang an ang ang ang ang ang ang ang ang	ан ал ( <sup>1</sup> <b>1993)</b>	Ţ

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DNR Sampte Iumber	Glacial Lobe	Landform	Sediment Type	Sediment Site Type Description		Sample Description	Remarks
<u>, , , , , , , , , , , , , , , , , , , </u>				felsite also present, but not common.			
3947	Rainy	Outwash plain	Outwash	Interbedded sandy pebble gravel, poorly to very poorly sorted, weakly stratified and very-fine to	NW portion of pit, 4 feet below land surface	Sandy pebble gravel, poorly to very poorly sorted,	
9 ( <u>1</u> 1) -	Alexandre en este en es	; *		very-coarse sand, moderately to poorly sorted. Pebble lithologies: greenstone, granite, gneiss, slate, iron formation.		Weakly Stratified	
3948	Rainy	Outwash plain	Outwash	Pebbly sand, very-fine to very-coarse, poorly sorted, overlying very-fine to fine silty sand, well sorted. In general, very sandy pit. Bedding slightly	In upper portion of pit approximately 8 feet below land surface	Pebbly sand, very fine to very coarse, poorly sorted, weakly stratified	
\$\$\$\$\$	19994A	$y \in [a_{i,j}]^{(k) \times (k)}$		collapsed. Pebble lighologies: granite, gneiss, greenstone, red sandstone, basalt, graywacke, iron formation and granophyre.			
3949	Rainy	Outwash fan iso	Ice-contact	12 to 36 inches of silty sand, very fine to fine (eolian), overlying sandy fine pebble gravel, poorly sorted, massive with thinly bedded fine to the state of the state state	Approximately 5 feet below land surface in north portion of pit	Sandy, fine pebble gravel, poorly sorted, massive	
3433	32 . UA	Mar di	a secondaria	feet thick; overlying very compact		8. 1.2. T	a sa kabupatén ng kabupatén Managéné ng kabupatén ng kabupatén ng kabupatén ng kabupatén ng kabupatén ng kabupa
7780925. 17. 15 (*) DY 7	ŭlacia: Lobe			rainy lobe till, 8 feet thick; overlying rainy lobe sand and gravel, 6 to 8 feet thick. Pebble lithologies: granite, gneiss, greenstone, basalt, graywacke, iron formation felsite red sandstone		:::::::::::::::::::::::::::::::::::::	in a start for the start of the

Table 5. Geologic descriptions of the sand/gravel pits and the material sampled for the test and pilot study samples...continued

Table 5. Geologic descriptions of the sand/gravel pits and the material sampled for the test and pilot study samples...continued

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UNR Sample Iumber	Glacial Lobe	Landform	Sediment Type	Site Description	Sample Location	Sample Description	Remarks
3950	Rainy	Kame	Ice-contact	50 foot high exposure of interbedded sand and sandy pebble gravel. Pebble lithologies:	South end of pit, approximately 15 feet below land	Fine pebbly sand, medium to very coarse, poorly	
	5 m <b>4 ( 1</b> A			granite, iron formation (very common), greenstone, basalt, graywacke, gneiss, red sandstone and felsite present, but not common.	surface	sorted, massive	: ež:
3951	Rainy	End moraine	Ice-contact	Interbedded coarse to very coarse sandy pebble gravel, poorly sorted; and fine to coarse sand, moderately to well sorted, stratified. Bedding slightly collapsed. Pebble	East end of pit	Coarse to very coarse sandy fine pebble gravel, poorly sorted, weakly stratified	
2019	Raint	i georgi unazor de la ca		lithologies: granite, gneiss, greenstone, graywacke, red sandstone, basalt. Limestone present, but not abundant.	· · · ·		
3952	Superior	Stagnation moraine	Ice-contact	Pebbly sand, very fine to very coarse, poorly to very poorly sorted, weakly stratified. Very	4 feet below land surface	Pebbly sand, very fine to very coarse, poorly to very	
	转展于公人	ατις τη		fine to very coarse pebbles and some cobbles present. Pebble lithologies: granite, gneiss, basalt, felsite, graywacke, limestone, dolomite, granophyre,		poorly sorted	
erași (- )	<b>T</b> (503)	C. 10 1929		agate.			e Oktor - A
3953 <sup>-</sup>	Wadena	Unknown	Ice-contact	Interbedded sandy pebble gravel, very poorly sorted; pebbly sand, poorly sorted and sand.	East side of pit, approximately 4 feet below land surface	Very fine to fine pebbly sand, ranging from very fine to	
್ಷಣ್ಣನ ತೈಕ್ಷಿ	<b>903768</b> 200 1	<b>G</b> ARD <b>G</b> ARD (1997) <b>19</b> 00 (1997) (1977) (1977) (1	e Maria de Carlos de Carlos Maria de Carlos de Car	Stratified-pebble lithologies: granite, limestone, dolomite (quite		coarse, poorly sorted, weakly	

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Table 5. Geologic descriptions of the sand/gravel pits and the material sampled for the test and pilot study samples...continued

DNR Sample Number	Glacial Lobe	Landform	Sediment Type	Site Description	Sample Location	Sample Description	Remarks
53672	MET DE	······································		common), gneiss, greenstone, basalt, graywacke.		stratified	
23954	Vadena	Unknown	Outwash	3 to 3.5 feet of Pierz till overlying crudely interbedded sandy, very-fine to medium pebble gravel and very-fine to medium pebbly sand, medium to very coarse, moderately to poorly sorted.	North end of pit, approximately 7 feet below land surface and 4 feet below contact with overlying till	Sandy, very-fine to medium pebble gravel and very-fine to medium pebbly sand, medium to very coarse, moderately	
lus forma	12010-000-000			Pebble lithologies: limestone and dolomite (common), granite, gneiss, greenstone, basalt, graywacke.		to poorly sorted	ga ka sala (ga ki) Makeo ka (ga ki)
23955	Wadena	Valley train	Outwash	Interbedded silt, sand and gravel, well to poorly sorted, horizontal	Central pit, south face	Sandy, pebble, medium gravel,	N BELL (COMPANY) Barang (COMPANY) Barang (COMPANY)
	n, Angon () - Pr	•		stratification. Lithologies include: abundant limestone. Also, basalt, phyllite, porphyritic felsite.		poorly sorted, massive	en de gelegie a s
23956	Wadena	Valley train	Outwash	0.6 meters loamy sand, reddish color, overlying pebbly gravelly		Pebbly, gravelly sand, poorly sorted	
• , • ?	ktore i n			sand, poorty sorted, weakty stratified. Lithologies include: abundant limestone. Also, gneiss, granite, basalt, schist, felsite.		n an Roman Angla Million an Angla Million an Angla	
23957		Valley train	Outwash	Interbedded sandy gravel, fine to medium, moderately to poorly sorted, cross-bedded, stratified; and sand, medium to coarse, pebbly, moderately to well sorted, massive, cross-bedded. Lithologies include:	East central face	Fine gravel, moderately sorted, cross-bedded	· · · · · ·

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Table 5. Geologic descriptions of the sand/gravel pits and the material sampled for the test and pilot study samples...continued

DNR Sample Number	Glacial Lobe	Landform	Sediment Type	Site Description	Sample Location	Sample Description	Remarks
	-			gabbro, gneiss, felsite, basalt.			
23958	Wadena	Outwash plain	Outwash	Medium sand, pebbly, moderately poorly sorted overlying fine to coarse pebbly sand and sandy fine	South face	Fine sandy gravel, 1.2 meters below land surface access	an taon
	<b>an</b> tain Sealain Sealain			gravel, moderately poorly sorted, stratified. Lithologies include: limestone, gneiss, granite, greenstone, gabbro.		an thomas in An an	
23959	Wadena	Stagnation moraine	Ice-contact	Medium sandy gravel, cobbly and coarse sand. Poorly to moderately	North face, 8 meters from pit floor	Sandy, cobbly gravel, poorly	West side of pit at lower (approximately
an an taon 1997 - Santa 1997 - Santa		, , ,		well sorted. Lithologies include: abundant limestone. Also, gneiss, phyllite, schist, granite, basalt, gabbro.		sorted argonize	6 meters) elevation is Des Moines Lobe outwash. Abundant Pierre Shale.
23960	Wadena	Stagnation moraine	Ice-contact	Brown, clayey diamicton, 0.4 meters thick, overlying sandy, pebbly, cobbly, bouldery gravel, very poorly sorted, horizontal stratification. Lithologies	South face		200 201 2010 2010
		jog − 1.4		include: abundant limestone. Also, granite, gabbro, schist, gneiss, 2 pieces Pierre Shale.	· .	Crest 31	
23961	Wadena	Unknown	Outwash	Red, sandy diamicton, 1 meter thick overlying stratified sand and	East face, south end of settling pond	Fine gravel	
	- · · · · · · · · · · · · · · · · · · ·			gravel. Lithologies include: granite, limestone, gabbro,			
		, t		felsite, red sandstone, greenstone, iron formation.			
23962	<b>Vadena</b>	Unknown	Ice-contact	Yellowish-brown, sandy diamicton, O	· · ·	Gravel, very poorly	

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Table 5. Geologic descriptions of the sand/gravel pits and the material sampled for the test and pilot study samples...continued

DNR		<u></u>		<del></del>			
Sample Number	Glacial Lobe	Landform	Sediment Type	Site Description	Sample Location	Sample Description	Remarks
				to 2 meters thick, overlying very-poorly sorted gravel and well sorted fine sand and silt. Stratified. Lithologies include: limestone, granite.		sorted, weakly stratified	
<b>23963</b>	Superior ମୁଧ୍ୟରେଥିଲେ	Valley train	Outwash	Sandy, pebbly gravel, very poorly sorted. Lithologies include: abundant limestone. Also, granite, gneiss, sandstone, porphyritic felsite, basalt.	South face	Sandy, pebbly gravel, very poorly sorted	Described as mixed Superior/Wadena lobe by T. Cowdery.
23964	Superior	Stagnation moraine	Ice-contact	Interbedded fine sand to gravel, moderately sorted, cross-bedded, stratified, collapsed. Lithologies include: red sandstone, agate, granophyre, iron formation,	East pit, east side	Medium to fine gravel, moderately sorted, massive	
22 Q-23	Electronic (		•	granite, gabbro, basalt, felsite.			
23965	Wadena	Stagnation moraine	Ice-contact	Interbedded very-fine sand, well sorted, cross-bedded; and fine gravel, moderately sorted; overlying clay loam diamicton with	North pit, NE corner	Fine gravel, moderately sorted	Much shale littering the pit area. Must be from Des Moines lobe till that has
17691	14834-14 14834-14	an a		no shale. Lithologies include: graywacke, basalt, granite, gabbro, iron formation, felsite and abundant limestone.			been removed by gravel operation.
23966	Des Moines	Stagnation moraine	Ice-contact	Coarse gravel, poorly sorted; overlying yellow-tan clay loam diamicton overlying medium gravel to fine sand with some interbedded silt, well sorted. Lithologies	East central pit, west face	Medium to fine gravel, moderately sorted	€£98€ U)
11 A 11	<b>.</b>			include: limestone, Pierre Shale,			

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Table 5. Geologic descriptions of the sand/gravel pits and the material sampled for the test and pilot study samples...continued

ample umber	Glacial		Sediment	Site	Sample	Sample	
mber	Lobe	Landform	Туре	Description	Location	Description	Remarks
	2			granite, gneiss, gabbro, basalt.			
			_				and the second second
967	Wadena	Stagnation moraine	Ice-contact	Interbedded medium gravel to fine	North pit, SE face	Pre-concentrated	
				sand, moderately poorly sorted to		sampled supplied by	sant ang
				Well sorted. Lottapsed Dedding.		sand/gravel operator	· · · · · · · · · · · · · · · · · · ·
				granite best chist chvolite		· · · · · · · · · · · · · · · · · · ·	
680	MARTINE	(1,1,1,2,1,2,1,2,1,2,1,2,1,2,1,2,1,2,2,1,2,2,1,2		anaise slate			
				grieros, stater			
968	Wadena	Stagnation moraine	Ice-contact	Yellow-tan clay loam till	NE face, 1.75 meters	Medium to fine	
				containing Pierre shale, 0.5 meters	below top	gravel, well sorted,	
		ĩ		thick; overlying medium to fine		massive	
		· .		gravel, moderately well sorted.		wer als see 47 Å	
	<ul> <li>Sector stress, if you</li> </ul>	· · ··		Lithologies include: limestone,			
1971	the second second second			basalt, slate, gabbro, granite,			
				gneiss, schist, porphyritic			
				rhyolite.			
~~~		••-•	• • • •			1913-69	$\mathbb{R}^{N_{\mathrm{reg}}}$ , $\mathbb{C}^{\mathrm{reg}}$
<b>70</b> 7	Unknown	Unknown	Outwash	Yellow-tan clay loam diamicton, U.8	NW pit, NE side,	Medium to fine "salt	
84.00 Q 1.12	enhara (c.	• 15 1 1 F	1. A.	fine cond to clover silt; fine	free	and peppern gravet,	1970), <b>1986</b> , 1996, 5
				Healt and nanner# sand well		indenately softed	1
			-	sorted, and medium to fine "salt			
				and pepper" gravel, moderately			14. T
				sorted. Lithologies include:			
				gneiss, granite, gabbro, limestone,		erra di si sincialis k	
· ·				slate, basalt, Pierre Shale.		in a set <b>1998, 1998, 1</b> 997, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 10 − 2008, 1008, 1008, 1008, 1008, 1008, 1008, 1008, 1008, 1008, 100	na a se a la seconda de la La seconda de la seconda de
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970	Wadena	Stagnation moraine	Ice-contact	Interbedded pebbly sand, well	East end of pit,	Pebbly sand	
	C.,			sorted, massive; and fine gravel,	north face		
		- <b></b>		well sorted. Lithologies include:		an an an an the second of the second	n to gen - câsaganditan ang - c' catorona
		·		granite, limestone, greenstone,			
<. 46 T	an <sub>an</sub> ana a	en e	• • • • • • • • • • • • • • •	gneiss, state, rare Pierre Shale.		2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000 - 2000	
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Table 5. Geologic descriptions of the sand/gravel pits and the material sampled for the test and pilot study samples...continued

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DNR Sample Number	Glacial Lobe	Landform	Sediment Type	Site Description	Sample Location	Sample Description	Remarks
23971	94.997 x.	Active stream	Alluvium	Site approximately 100 yards south of bridge in bed of Hay Creek. Active stream river gravels. Drill core information indicates creek crosses zoned pegmatites.	Downstream side of an exposed boulder in middle of Hay Creek. Sample collected from approximately the top 4 inches of stream sediments.	River gravels	
23972	Superior	Outwash plain	Outwash	12 to 24 inches of loess overlying interbedded sandy pebble gravel and pebbly sand, ranging from moderately to very poorly sorted. Better sorted units cross-bedded. Pebble lithologies: basalt, felsite, red sandstone, granite, gneiss, graywacke and limestone.	Southeastern portion of pit approximately 15 feet below disturbed land surface	Very-fine to fine pebbly sand, ranging from medium to very coarse, moderately to well sorted, cross-bedded	lage (1) (1) ( <sup>1</sup> ) ( <sup>1</sup> ) ( <sup>1</sup> ) ( <sup>1</sup> ) ( <sup>1</sup> ) (1) ( <sup>1</sup> ) ( <sup>1</sup> ) ( <sup>1</sup> ) ( <sup>1</sup> ) ( <sup>1</sup> ) ( <sup>1</sup> ) ( <sup>1</sup> ) ( <sup>1</sup> ) ( <sup>1</sup>
23973		Stagnation moraine	Ice-contact	Interbedded pebbly sand and sandy, cobbly pebble-gravel, coarser beds are more poorly sorted and massive while finer units are stratified and cross-bedded. Pebble and cobble lithologies: Paleozoic carbonate (locally derived?), basalt, red sandstone, felsite, gabbro, granite, gneiss, graywacke.	Western part of pit, approximately 20 to 25 feet below land surface	Very fine to medium pebbly sand, very-fine to very-coarse, moderately to poorly sorted, well stratified	
23974 Map Bab m Bab and Bab an	Superior results extension	Outwash fan	I ce- contact	Interbedded sandy pebble gravel; sandy, cobbly pebble gravel; pebbly sand; and sand; ranging from well to very-poorly sorted. Finer units stratified and cross-bedded, coarser units massive. Pebble and	NW part of pit approximately 35 to 40 feet below original land surface	Very-fine to fine pebbly sand, fine to very coarse, moderately to poorly sorted	ски ју се 19 - мај за стори се

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					1 a 24	the so ideals	
DNR Sample Number	Glacial Lobe	Landform	Sediment Type	Site Description	Sample Location	Sample Description	Remarks
				cobble lithologies: granite, gneiss, basalt, felsite, graywacke, red sandstone, greenstone.			
23975	Superior	Stagnation moraine	Ice-contact	Interbedded sand, pebbly sand, sandy pebble gravel. Pebble lithologies: basalt, red	Approximately 10 to 15 feet below original land	Very-fine to medium pebbly sand, fine to very coarse, coarse	274
	Mark Barran			sandstone, graywacke, granite, gneiss, felsite.	surface	skewed poorly to very poorly sorted, crudely stratified	
24110	Superior	Kame .	Ice-contact	Interbedded poorly to well sorted gravel, sand, silt, clay and reddish to yellow diamicton. Collapsed bedding. Abundant Superior lobe litholgies present.	3 meters above pit floor, 12 meters below surface	Sand and gravel, moderately to poorly sorted, stratified, with interbedded diamicton (avoided in sampling)	This sample is the replicate (archive sample) of sample number 23906.
24111	Superior	Stagnation moraine	Ice-contact	5 meter high exposure of interbedded sand, gravel, silt, clay and red, sandy diamicton ranging from well sorted clay, silt and sand to very poorly sorted sandy, cobble- and boulder-gravel. Collapsed bedding.	SE pit, south face	Very well sorted medium sand with fine gravel layers	This sample is the replicate (archive sample) of sample number 23908.
24112	Superior	Esker	Ice-contact	SW face, 4 meters high. Poorly	SW face,	Fine to medium	This sample is the
la de la composition de la contrate de la contrate de la contrate de	("Q56 078339.	nadaran san ang san		fine to medium gravel, cross-bedded. Granophyre, felsite and agate present.	meters below surface	yı aver Aşaşı	sample) of sample number 23911.
24113	Superior	Outwash plain	Outwash	3 meter high exposure. Brown,	West face, near	Fine pebbly gravel	This sample is the
Table 9	ranion:	adal in families for the	gan in the second	sandy diamicton, 0 to 0.3 meters thick, overlying fine to medium		** Eth Markel	replicate (archive sample) of sample
					·		
Colorada - K	ina paratra dal	Briten (nStal) (Second of State		particular descendentes descendentes descendentes barrentes descendentes descendentes descendentes descendentes	nder i traditi (pister distant deserversista discussionada kan		

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Table 5. Geologic descriptions of the sand/gravel pits and the material sampled for the test and pilot study samples...continued

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Table 5. Geologic descriptions of the sand/gravel pits and the material sampled for the test and pilot study samples...continued 3

DNR Sample Number	Glacial Lobe	Landform	Sediment Type	Site Description	Sample Location	Sample and Description	Remarks
		17 - 13		gravel, poorly sorted, stratified. Felsite, basalt, granite, some red		5 xx 2 5	number 23924.
24114	Rainy	Outwash plain	Outwash	Yellow-brown, sandy diamicton, 0.5	South end of pit,	Medium sand, well	This sample is the
naver Naver Naver		1		to 1.5 feet thick overlying stratified sand and gravel, ranging from medium sand, well sorted, to	east face	sorted and fine gravel, moderately well sorted	replicate (archive sample) of sample number 23927.
en de la companya de La companya de la comp				coarse gravel moderately sorted. Lithologies include: basalt, gabbro grapite gneiss felsite.			
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DNR ample umber	Bulk <sup>1</sup> Sample Volume Liters	Bulk Sample Weight <sup>2</sup> grams x 10 <sup>3</sup>	-10 mesh Volume <sup>3</sup> Liters	-10 mesh Weight grams x 10 <sup>3</sup> y	-20 mesh Volume <sup>3</sup> Liters	-20 mesh Weight grams x 10 <sup>3</sup>	C-1 Weight <sup>4</sup> grams	C-2 Weight <sup>4</sup> grams	C-3 Weight <sup>4</sup> grams	Total HMC Weight grams
0431				9.1			126.7	316.9	1.86	445.5
2631				9.8			31.6	95.8	3.94	131.3
2632		Mar a		8.9			15.8	50	0.55	66.4
2633				6.2			10.6	34.5	0.74	45.8
2634				9.8			21.4	68.8	· 2	92.2
2635				7.9			71.4	142.2	1.34	214.9
2636				7.6			29.2	53.8	3	86
2637				7.9	4		8.5	46.8	0.9	56.2
3901	6.5	12	6		÷ • 5	9.8	16.1	64.2	1.47	81.8
3902	7.5	14	6		5	9	31.3	113.3	0.77	145.4
3903	8	15	6		4	7.5	15	54.1	1.04	70.1
3904	8	15	6		3	5.9	76.1	160.4	1.88	238.4
3905	7.5	14	6		5	8.3	29.5	98.5	0.72	128.7
3906	8	15	6		3	5.3	23	80.6	0.76	104.4
5907	6.5	12	6		5	7.8	19.6	53.9	0.37	73.9
5908	7	13	6		. 5	8	100.9	263.1	1.98	366
5909	8.5	16	6		4	5.7	15.1	49	0.28	64.4
3910	30	57	6	<b></b>	2	2.9	27.7	56.7	0.16	84.6
5911	11	20	6	n ann an sao	and a characteristic and a	4.4	45.1	106.8	0.33	152.2
3912	6.3	12	6		4	7.4	41.6	118.8	1.21	
3913	9	17	6	alimine and a side	4	6.8	15.7	50.7	1.07	67.5
3914	11	21	6		3	5.2	40.3	103.6	, 0.24	144.1
3915	9	17	6		4	7.6	40.7	111	0.43	152.1
3916	11	21	· 6		4	6.1	122.7	189.8	0.84	313.3
3917	10	19	6		4	6.5	84.1	199.2	0.3	283.6
3918	10	19	6		4	6.9	115.8	179.2	0.13	295.1
3919	8	15	6		- 4	7.1	36.7	141.1	0.98	178.8
3920	9	17	6		. 5 4	7.3	20	54.7	0.41	75.1
3921	12	23	6		4	7.3	72.4	168.3	0.85	241.6
3922	11	21	6		4	6	133.1	324.8	0.31	458.2

Table 6. Volume and weight measurements of various sample fractions for the test and pilot study samples

Note: Heavy mineral concentrates produced from -10 mesh material for test study samples and from -20 mesh material for pilot study samples. Approximate volume of bulk material screened to produce 6-7 liters of -10 mesh material. <sup>2</sup>Bulk sample weight calculated from bulk sample volume using 1.9g/cc as average specific gravity of sand/gravel. <sup>3</sup>Volume measurements are approximate. <sup>4</sup>C-1, C-2, and C-3 weights were recalculated to total concentrate weight before fire assay sample split.

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Table 6. Yolume and weight measurements of various sample fractions for the test and pilot study samples...continued

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DNR Sample Number	Bulk <sup>1</sup> Sample Volume Liters	Bulk Sample Weight <sup>2</sup> grams x 10 <sup>3</sup>	-10 mesh Volume <sup>3</sup> Liters	-10 mesh Weight grams x 10 <sup>3</sup>	-20 mesh Volume <sup>3</sup> Liters	-20 mesh Weight grams x 10 <sup>3</sup>	C-1 Weight <sup>4</sup> grams	C-2 Weight <sup>4</sup> grams	C-3 Weight <sup>4</sup> grams	Total HMC Weight grams
23923	8	15	6		5 S	9.1	148.1	299.3	0.14	447.5
23924	8	15	6		5	7.3	153.1	282.9	0.43	436.4
23925	8	15	6		4	6.3	103.3	221.8	0.54	325.6
23926	8.3	16	6		4	6	80.7	165.1	0.43	246.2
23927	7.5	14	6		5	7.5	158.9	299.7	1.4	460
23928	15	29	6		5	7.9	18.4	95.3	1.45	115.2
23929	11	21	6		4	6.1	24.3	102.1	0.97	127.4
23930			6		4	5.7	3.6	37.5	0.75	41.9
23931	9	17	6		3	4.6	6.6	39.7	0.6	46.9
23932	12	22	6		3	4.3	7.5	45	0.68	53.2
23933	8.5	16	6		3	5.2	5.9	25.1	0.79	31.8
23934	6.5	12	6		5	8.9	458.4	639	7.68	1105.1
23935	× 8	15	6		4	7.2	1.3	10.7	0.61	12.6
23936	7.5	14	6		4	7.4	13	47	0.82	60.8
23937	11	21	6		3	4.4	16.5	40.9	0.44	57.8
23938	7.5	14	6		4	7.1	10	35.3	1.3	46.6
23939	8.5	16	6		4	7.2	13.7	46.6	0.46	60.8
23940	8.5	16	6		4	6.6	11.4	38.8	0.29	50.5
23941	11	21	6		2	3	6.5	24.5	0.73	31.7
23942			6		3	5.5	9.2	19.7	0.43	29.3
23943	25	48	7		2	3.9	39.6	85.3	0.37	125.3
23944	21	39	6		3	5.2	19.4	64.7	0.39	84.5
23945	10	19	6		4	6.3	27.8	79.1	0.38	107.3
23946	· <b>11</b>	<sup>435</sup> 21	6		4	6.5	16.3	65.6	0.73	82.6
23947	13	25	7		. 4	6	21.2	71.7	0.57	93.5
23948	7.5	14	6		4	7.4	9.5	43.3	0.25	53.1
23949	15	29	7		4	5.7	8.7	23.5	0.59	32.8
23950	11	21	6		. 3	4.6	28.4	71.8	0.37	100.6
23951	15	29	6		3	5.4	32.1	78.1	0.73	110.9
23952		21	6		3	6	45.3	114.4	0.92	160.6
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Note: Heavy mineral concentrates produced from -10 mesh material for test study samples and from -20 mesh material for pilot study samples. <sup>1</sup>Approximate volume of bulk material screened to produce 6-7 liters of -10 mesh material. <sup>2</sup>Bulk sample weight calculated from bulk sample volume using 1.9g/cc as average specific gravity of sand/gravel. <sup>3</sup>Volume measurements are approximate. <sup>4</sup>C-1, C-2, and C-3 weights were recalculated to total concentrate weight before fire assay sample split.

Table 6. Volume and weight measurements of various sample fractions for the test and pilot study samples...continued

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DNR Sample Number	Bulk <sup>1</sup> Sample Volume Liters	Bulk Sample Weight <sup>2</sup> grams x 10 <sup>3</sup>	-10 mesh Volume <sup>3</sup> Liters	-10 mesh Weight grams x 10 <sup>3</sup>	-20 mesh Volume <sup>3</sup> Liters	-20 mesh Weight grams x 10 <sup>3</sup>	C-1 Weight <sup>4</sup> grams	C-2 Weight <sup>4</sup> grams	C-3 Weight <sup>4</sup> grams	Total HMC Weight grams
33683	Υ			······································					9033	34012
23953	11	21	6		5	9.4	33.1	153	4.12	190.2
23954	18	33	6		2	3.2	9	36.5	0.19	45.7
23955	14	27	6		4	7	7.6	31.7	0.57	39.9
23956	9	17	6		4	6.5	4.4	19.1	0.52	24
23957	10	ុ19	6		3	5.4	3.8	24.4	0.56	28.8
23958	12	23	6		2	3.9	4.2	19.4	0.19	23.8
23959	4) **		6		4	7	4.1	20.1	0.33	24.5
23960	11	20	6		4	6.5	46.9	69.8	1.79	118.5
23961	9.8	19	6		: 3	5.3	10.8	42.5	1.46	54.8
23962 <sup>5</sup>	9	17	8		6	10.5	18.2	78.2	1.6	98
23963	11	21	6		4	6.2	7.2	31	1.81	40
23964	16	30	6		3	5.6	23.2	58.6	0.62	82.4
23965	24 - S	4 . L	6		4	7.1	13.7	42.6	1.04	57.3
23966	11	21	6		3	5.6	6.5	38.2	0.94	45.6
23967		1	6				6.1	114.3	17.98	138.4
23968	13	25	6		2	2.7	5.7	28.2	0.15	34.1
23969	14	26	6		4	7.4	13.2	65	12.21	90.4
23970	7	13	6		5	9	13.4	46.2	1.63	61.2
23971	14	27	6		5	8.3	16.4	75.5	1.54	93.4
23972	11	21	7		4	7.6	14.9	35.4	0.29	50.6
23973	9	17	7		6	10.7	26.7	88.8	0.93	116.4
23974	8.5	.16	7		5	8.2	19	60.7	0.38	80.1
23975	17	32	7		3	4.6	18.9	48.5	0.69	.681
24110	8	15	6		4	6.4	34.2	99.8	0.77	134.8
24111	7	13	6		4	7.8	70.1	208.9	1.75	280_8
24112	10	19	6		3	4.5	33.3	73.8	0.2	107.3
24113	8	15	6		4	6.3	149.7	306.8	0.29	456.8
24114 <sup>4</sup>	9	17	6		5	7.6	144	348.4	1.55	494
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$(n-q_1^{1}) \in \mathbb{R}^{n}$	· · ·								- 小川市 - 「	and i Cara
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- * Q	10 A. M. C. A.	2							an a the	4 1 M M 2 1 1 1 1

Note: Heavy mineral concentrates produced from -10 mesh material for test study samples and from -20 mesh material for pilot study samples. <sup>1</sup>Approximate volume of bulk material screened to produce 6-7 liters of -10 mesh material. <sup>2</sup>Bulk sample weight calculated from bulk sample volume using 1.9g/cc as average specific gravity of sand/gravel. <sup>3</sup>Volume measurements are approximate. <sup>4</sup>C-1, C-2, and C-3 weights were recalculated to total concentrate weight before fire assay sample split.

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DNR	6° V		* . 				
Sample Number	Ru ppb	Rh ppb	Pd ppb	Ir ppb	Pt ppb	0s ppb	Au ppb
20431	100N	10N	11	20N	10N	200N	1L.
22631	100N	10N	1L,	20N	10N	200N	10
22632	100N	10N	1L,	20N	10N	200N	1L -
22633	100N	10N	1L	20N	10N	200N	100
22634	100N	10N	1L	20N	10N	200N	2
22635	100N	10N	11.	20N	10N	200N	300
22636	100N	10N	1N	20N	10N	200N	50
22637	100N	10N	1N	20N	10N	200N	300
23901	0.6L	0.5L	1.8	0.5L	2.6	2L	7L
23902	0.6L	0.5L	2.6	0.5L	2.3	2L	7L
23903	1	0.5L	1.5	0.6	2	2L	7L
23904	0.6L	0.5L	2.2	0.5L	2.4	2L	7L
23905	0.6L	0.5L	2.4	0.5L	3	2L	7L
23906	0.6L	0.5L	2.6	0.5L	2.5	2L	7L
23907	0.6L	0.5L	3.5	0.5L	3.6	2L	7L
23908	0.6L	0.5L	2.2	0.5L	4.1	2L	7L.
23909	0.6L	0.5L	2.8	0.5L	2	2L	7L
23910	0.6L	0.5L	4.2	0.5L	3.8	2L	10
23911	0.6L	0.5L	3.4	0.5L	3.4	2L	7L
23912	0.6L	0.5L	1.8	0.5L	2.3	2L	7L
23913	0.6	0.5L	3	0.5L	3.8	2L	24
23914	0.7	0.5L	3.3	0.5L	3.4	2L	7L
23915	0.6L	0.5L	5.3	0.5L	5.3 ·	2L	7L
23916	0.6	0.5L	4.4	0.5L	5.1	2L	730
23917	0.8L	0.7L	4	0.7L	3.6	3L	10L
23918	0.8	0.5L	5	0.5L	4.9	2L	7L
23919	0.6L	0.5L	3	0.5L	3.3	2L	7L
23920	0.6L	0.5L	2.6	0.51	3	2L	7L
23921	0.6	0.5L	4.9	0.5L	4.8	2L	7L
23922	0.8L	0.7L	3.4	0.7L	2.6	3L	10L

Table 7. Analytical results for the total heavy mineral concentrate samples (before magnetic separations) determined by fire assay analysis [N, not detected at the limit of detection shown; L, detected but below the limit of detection shown]

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...continued next page...

Note: Test study samples 20431 and 22631-22637 were analyzed using a lead-oxide flux; all other samples were analyzed using a nickel-sulfide flux.

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DNR Sample		e si		<i>41</i> ,	-		
Number	Ru ppb	Rh ppb	Pd ppb	Ir ppb	Pt ppb	Os ppb	Au ppb
23923	0.6L	0.5L	3.7	0.5L	2.8	2L	26
23924	0.6L	0.5L	2.8	0.5L	3.9	2L	7L
23925	0.6L	0.5L	2.3	0.5L	1.8	2L	7L
23926	0.6L	0.5L	2.6	0.5L	5	2L	7L
23927	0.6L	0.5L	1.7	0.5L	1.6	2L	7L
23928	0.6L	0.5L	2	0.5L	2.6	2L	7L
23929	0.6L	0.5L	2.2	0.5L	2	2L	7L
23930	0.6L	0.5L	1.7	0.5L	2.1	2L	44
23931	0.6L	0.5L	2	0.5L	2.4	2L	7L
23932	0.6L	0.5L	1.4	0.5L	1.4	2L	4700
23933	0.6L	0.5L	2	0.5L	2.7	2L	9.9
23934	0.6L	0.5L	2.8	0.51	2	2L	7L
23935	1L	11	2	1L	2	5L	10000
23936	0.6L	0.5L	1.3	0.5L	2.2	2L	34
23937	0.6L	0.5L	1.8	0.5L	1.9	2L	7L
23938	0.8	0.5L	1.9	0.5L	2.4	2L	7L :
23939	0.6L	0.5L	1.6	0.5L	2.2	2L	7L
23940	0.6L	0.5L	1.5	0.5L	2.5	2L	7L
23941	0.6L	0.5L	2.6	0.5L	4.5	2L	7L -
23942	0.6L	0.5L	2.6	0.5L	2.7	2L	7L
23943	0.6L	0.5L	2.9	0.5L	2.5	2L	7L
23944	0.6L	0.5L	2.6	0.5L	2.2	2L	7L
23945	0.6L	0.5L	2.6	0.5L	2.9	2L	· 7L
23946	0.6L	0.5L	2.4	0.5L	2.2	2L	7L
23947	0.6L	0.5L	2.1	0.5L	3	2L	7L
23948	0.6L	0.5L	2	0.5L	2.3	2L	7L
23949	0.6L	0.5L	1.7	0.5L	2	2L	960
23950	0.7	0.5L	2.4	0.5L	2.9	2L	7L
23951	0.6L	0.5L	2.5	0.5L	2.7	2L	71
23952	0.7L	0.6L	2.2	0.6L	2.8	31	101

Table 7. Analytical results for the total heavy mineral concentrate samples (before magnetic separations) determined by fire assay analysis [N, not detected at the limit of detection shown; L, detected but below the limit of detection shown]...continued

Note: Test study samples 20431 and 22631-22637 were analyzed using a lead-oxide flux; all other samples were analyzed using a nickel-sulfide flux.

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DNR Sample Number	R	n bbp	Rh ppb	Pd ppb	Ir ppb	Pt ppb	0s ppb	Au ppb		•			محمد المحمد ا محمد المحمد ا	
23953		0.6L	0.5L	2.6	0.5L	1.4	2L	530						
23954		0.6L	0.5L	1.1	0.5L	2	2L	7L				- 11 - 11		
23955		0.6L	0.5L	0.8	0.5L	1.5	2L	7L						
23956		0.6L	0.5L	1.1	0.5L	1.7	2L	8L						
23957	2	0.6L	0.5L	0.8	0.5L	1.6	2L	7L				<i>p</i>		
23958		0.6L	0.5L	8	0.5L	1.3	2L	8L_						
23959	a data	0.6L	0.5L	<b>1.4</b>	0.5L	1.6	2L			$D_{\rm el}^{\rm eff}$	 6			
23960	a <b>B</b> ail	0.6L	0.5L	0.6	0.5L	1.3	2L	1700				julij Ro	245	
23961		0.6L	0.5L	1.5	0.5L	1.8	2L	7L .				· •		
23962		0.6L	0.5L	1	0.5L	1.6	2L	7L						
23963	S	0.6L	0.5L	1	0.5L	1.9	2L	780				•		. 5
23964	2 ~	0.6L	0.5	1.7	0.5L	2.1	2L	7L						2 1
23965	3	0.6L	0.5L	0.8	0.5L	1.6	2	7L				Vác	.0	: :
23966	3	0.6L	0.5L	1	0.5L	1.6	2L	7L					\$£.	
23967	e.	0.6	0.5L	280	0.5L	15	2L	13000				÷		
23968	2	0.6L	0.5L	1.6	0.5L	2	2L	7L						
23969	2	0.6L	0.5L	1.4	0.5L	1.8	2L	11				2000 2000	300	
23970	5	0.6L	0.5L	0.8	0.5L	1.2	2L	7L				an ta' an Tao an		
23971	.*	0.6L	0.5L	0.9	0.5L	1.6	2L	1000				2. S. S.		
<sup>3</sup> 23972	5	0.6L	0.5L	2.5	0.5L	2.1	2L	7L -					3-1	44
23973	5	0.7	0.5L	3.4	0.5L	2.8	2L	7L					4 (14) 1	
23974	3	0.6L	0.5L	4.2	0.5L	2.7	2L	7L				1 H <b>2</b> 1 H 1	10	
23975		0.6L	0.5L	3	0.5L	3.2	<b>2L</b>	7L	• •			1999 V.	-847 - 1 13	
24110	5	0.6L	0.5L	2.6	0.5L	2.6	2L	7L				- 15	2.9 3.6	
24111	0.	0.9	0.5	2.1	0.5L	3.2	2	7L					E.F	
¨ 24112 <sup>¯™</sup>	• • • • • • • • •	0.6L	0.5L	3.1	0.5L	4.4	2L	7L				ь.	Fat	
24113	с. С.	0.7L	0.7L	2.8	0.7L	3.2	3L	10L		-			5 <del>1</del> 1	
24114	¢,V	0.6L	0.5L	1.9	0.5L	1.7	2L	7L						

Table 7. Analytical results for the total heavy mineral concentrate samples (before magnetic separations) determined by fire assay analysis [N, not detected at the limit of detection shown; L, detected but below the limit of detection shown]...continued

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Note: Test study samples 20431 and 22631-22637 were analyzed using a lead-oxide flux; all other samples were analyzed using a nickel-sulfide flux. Mineralogical observations indicate that the following samples do not appear to be normal glaciofluvial samples: 23967 (pre-concentrated sample); 23969 (maybe a pre-glacial alluvium); and 23971 (active stream sediment sample).

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Table 8. Analytical results for the paramagnetic (C-2) fraction of the heavy mineral concentrate samples determined by semiquantitative emission spectroscopy [N, not detected at the limit of detection shown; L, detected but below the limit of detection shown; G, determined to be greater than the value shown]

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DNR														
Sample	Ca		Fe	Mg	Na	Ti	Ag	В	Ba	Be	Co	Cr	Cu	Ga
Number	*		<b>X</b>	*	· X	*	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
20431	0.7	• • • •	20	10	0.5N	2	1N	20N	50L	2N	200	300	50	10N
22631	2		20	2	0.5N	2G	1	50	70	2N	70	500	50	10N
22632	2	· · ·	20	3	0.5N	2G	1N <sup>-</sup>	50	100	2N	100	500	70	10N
22633	3		20	3	0.5N	2G	1N	30	200	2N	100	300	150	10L
22634	2	9°.Y	20	5	0.5N	2G	1N	50	200	2N	100	300	50	10L
22635	2	in the second	20	.5	0.5N	2	1N	20	100	2N	100	300	50	10
22636	2	0.44	15	5	<sup>9</sup> 0.5N	2	1N	100	100	2L	50	500	20	10
22637	2	6.144	20	3	0.5L	2	1N	100	150	2L	70	500	50	10
23901	2	្នា	20	5	0.5L	2G	1N	70	300	2N	100	500	70	20
23902	2	्न २१ 	10	5	0.5L	2G	11	50	200	2L	70	500	50	10
23903	5	-0°-₹	20	5	0.5L	2	1N	70	300	2N	100	700	20	30
23904	2	0."%"	10	-5	0.5N	2	1N	50	150	2N	100	300	70	10
23905	3	() () () () () () () () () () () () () (	10	5	0.5L	2G	1N	50	200	2N	70	300	50	10L
23906	5	್ಷ ನ ಕಾರ್ಯ	15	5	0.5L	2G	1N .	70	200	2N	100	300	50	10
23907	2	(5136) 62800	20	5	0.5L	2G	1N	50	150	2N	100	500	50	10
23908	2	61 VI	10	7	0.5L	2	1N	50	100	2N	70	300	50	10
23909	2	M WI	20	5	0.5L	2	1N	70	200	2N	50	500	50	20
23910	3	्। <del>२</del> ७ जनस	20	7	0.5L	2	1N	30	200	2N	100	300	70	20
23911	5	Sal ng ti an na share	10	7	0.5L	2G	1N	20	150	2N	100	500	50	5
23912	2	ting": Satistic	15	5	0.5L	2	1N	30	100	2N	70	500	50	10
23913	5	in an	20	5	0.5N	2G	1N	100	200	· 2N	100	300	20	15
23914	2	Valia. National	20	7	0.5L	2	1N	20	150	2N	70	300	50	15
23915	2		10	7	0.5L	2G	1N	50	150	2N	100	300	70	10
23916	3	23° 479	10	7	0.5L	2G	1N	30	100	2N	100	300	70	10
23917	2	0.77	10	7	0.5L	2	1N	30	100	2N	100	300	70	10L
23918	5		10	7	0.5L	2	1N	20L	100	2N	70	500	100	15
23919	2	IN CHIEF	10	5	0.5L	2	1N	50	200	2N	100	500	70	10L

Note: The following elements were also analyzed but were not detected at the detection limit shown in (): P (0.5%), As (500 ppm), Au (20 ppm), Bi (20 ppm), Cd (50 ppm), Ge (20 ppm), Sb (200 ppm), W (50 ppm), Zn (500 ppm), Pd (5 ppm), and Pt (20 ppm),

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DIR         Kn         No         Nb         Ni         Pb         Sc         Sn         Sr         Th         V         Y         Zr           Number         Ppm         Ppm <td< th=""><th><del></del></th><th></th><th></th><th></th><th></th><th></th><th></th><th>•</th><th></th><th></th><th></th><th></th><th></th><th></th></td<>	<del></del>							•						
Sample         La         Mn         Mo         Nb         Ni         Ppm	DNR		.:									341) 2411		
Number         ppn         ppn<	Sample	La	Mn	Мо	Nb	Ni	Pb	Sc	Sn	Sr	Th	٧	Ŷ	Zr
22431         100L         3000         10N         50N         500         20N         30         200N         200N         200N         200         20N         100           22631         300         7000         10N         50         70         30         50         20N         300         200N         300         200N         300         100         150           22632         150         5000         10N         50L         100         20         50         20N         300         200N         300         100         150           22634         100         500L         100         20         50         20N         300         200N         200         70         200           22634         100         500L         150         30         50         20N         200L         200N         200         50         200           22637         200         7000         10N         50L         150         50         20         20N         200         200N         200         200         200N         200         200N         200         100         200         200N         200         100         200	Number	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
20431         100L         3000         10M         50M         500         20M         30         20M         20M<	in the base of the	<u> </u>			·	·		· ·	···			1983-19 	30	
22631         300         7000         10N         50         70         30         50         20N         500         20N         200         200         200           22632         150         5000         10N         50L         100         20         50         20N         300         200N         300         100         150           22633         100         5000         10N         50L         100         20L         50         20N         200N         200         70         200           22635         100         300         10N         50L         150         30         50         20N         300         200N         200         70         200           22635         500         7000         10N         50         100         30         50         20N         300         20N         200         100         200         200         200         100         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200	20431	100L	3000	10N	50N	500	20N	30	20N	200N	200N	200	20N	100
22632         150         5000         10N         50L         100         20         50         20N         300         200N         300         70         200           22633         100         5000         10N         50L         100         20L         50         20N         200N         200N         200         70         200           22635         100         3000         10N         50L         150         30         50         20N         200N         200         50         20N           22635         500         5000         10N         50         100         30         50         20N         200N         200         100         200           22637         200         7000         10L         50L         150         50         20         20N         200         200N         200         100         200           23904         150         50L         150         20         20N         200         200N         200         70         150           23904         150         500         10N         50L         100         20         20N         200N         200N         200         70	22631	300	7000	10N	50	70	30	50	20N	500	200N	200	200	200
22A33         100         5000         10N         501         100         20         50         20N         300         20N         300         70         200           22A34         100         5000         10N         501         100         201         200         200N         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200 </td <td>22632</td> <td>150</td> <td>5000</td> <td>10N</td> <td>50L</td> <td>100</td> <td>20</td> <td>50</td> <td>20N</td> <td>300</td> <td>200N</td> <td>300</td> <td>100</td> <td>150</td>	22632	150	5000	10N	50L	100	20	50	20N	300	200N	300	100	150
22634         100         500         10N         50L         100         20L         50         20N         200         200         70         200           22635         100N         3000         10N         50L         150         30         50         20N         200L         200N         200         50         200           22635         500         5000         10N         50         100         30         50         20N         300         200N         200         150         300           22637         200         7000         10N         50L         150         50         20         20N         200         200N         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         100         300         200         200         200         200         200         100         200         200         200         200         200         200         200         150         2300         100         50         200         200         200         200         200         200         200         200 <td>22633</td> <td>100</td> <td>5000</td> <td>10N</td> <td>50L</td> <td>100</td> <td>20</td> <td>50</td> <td>20N</td> <td>300</td> <td>200N</td> <td>300</td> <td>70</td> <td>200</td>	22633	100	5000	10N	50L	100	20	50	20N	300	200N	300	70	200
22633         100N         3000         10N         50L         150         30         50         20N         200L         200N         200         50         200           22635         500         5000         10N         50         100         30         50         20N         300         20N         200         150         300           22637         200         7000         10N         50         150         50         20N         200         200         200         100         200         200         200         200         200         100         200         200         200         200         200         70         150         50         20         20N         200         20N         200         70         150         50         20         20N         200         20N         200         70         150         50         20         20N         200         200         200         70         150         50         20         20N         200         200         70         150         2390         150         50         20N         200         20N         200         20N         200         20N         200 <td< td=""><td>22634</td><td>100</td><td>5000</td><td>10N</td><td>50L</td><td>100</td><td>20L</td><td>50</td><td>20N</td><td>200</td><td>200N</td><td>200</td><td>70</td><td>200</td></td<>	22634	100	5000	10N	50L	100	20L	50	20N	200	200N	200	70	200
22636         500         500         10N         50         100         30         50         20N         300         200         150         300           22637         200         700         10N         50         100         30         50         20N         500         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200	22635	100N	3000	10N	50L	150	30	50	20N	200L	200N	200	50	200
2237         200         7000         10N         50         100         30         50         20N         500         20N         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200         200	22636	500	5000	10N	50	100	30	50	20N	300	200N	200	150	. 300
23901         150         1000         101         501         150         50         20         20N         200         200         200         50         100           23902         150         7000         101         501         150         50         20         20N         200         200N         200         200N         200         70         150           23903         100         7000         10N         501         100         20         20         20N         300         200N         200         200         200         200         200         200         70         150           23904         150         5000         10N         501         150         20         20         20N         200         20N         200         70         150           23905         150         5000         10N         501         100         20N         50         20N         200         20N         200         70         150           23906         100L         5000         10N         501         100         20         20         20N         200         20N         200         70         150	22637	200	7000	10N	50	100	30	50	20N	500	200N	200	100	200
23902         150         7000         10L         50L         150         50         20         20N         200         200         70         150           23903         100         7000         10N         50L         100         20         20         20N         300         200N         200         100         150           23904         150         5000         10N         50         100         30         20         20N         200         200N         200         200         70         150           23905         150         5000         10N         50L         100         20N         50         20N         200         200N         200N         200         70         150           23905         150         5000         10N         50L         100         20N         50         20N         200N         200N         200         70         200           23907         100L         5000         10N         50L         100         20         30         20N         200N         200         200         100         200           23910         100L         5000         10N         50L         150<	23901	150	10000	10L <sup>2</sup>	50L	150	50	20	20N	200	200N	200	50	100
23903       100       7000       10N       50L       100       20       20       20N       300       200N       200       100       150         23904       150       5000       10N       50       100       30       20       20N       200L       200N       200       70       150         23905       150       5000       10N       50L       150       20       20       20N       200       200N       200       70       150         23905       150       5000       10N       50L       100       20N       50       20N       200       200N       200       50       200       200       200       70       150         23907       100L       5000       10N       50L       100       20       20       20N       200N       200N       200       70       200         23907       100L       5000       10N       50L       100       20       20       20N       200L       200N       200       50       150         23909       100L       5000       10N       50L       150       20N       200       20N       200       200       100 </td <td>23902</td> <td>150</td> <td>7000</td> <td>10L</td> <td>50L</td> <td>150</td> <td>50</td> <td>20</td> <td>20N</td> <td>200</td> <td>200N</td> <td>200</td> <td>70</td> <td>150</td>	23902	150	7000	10L	50L	150	50	20	20N	200	200N	200	70	150
23904       150       5000       10N       50       100       30       20       20N       200N       200       70       150         23905       150       5000       10N       50L       150       20       20       20N       200       200N       200       70       150         23905       150       5000       10N       50L       100       20N       50       20N       200       20N       200       200N       200       50       200       200       200       50       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200 <td< td=""><td>23903</td><td>100</td><td>7000</td><td>10N</td><td>50L</td><td>100</td><td>20</td><td>20</td><td>20N</td><td>300</td><td>200N</td><td>200</td><td>100</td><td>150</td></td<>	23903	100	7000	10N	50L	100	20	20	20N	300	200N	200	100	150
23905150500010N50L150202020N20020N2007015023906100N500010N50L10020N5020N200N200N2007020023907100L500010N50L10020L2020N200N200N2007020023908100L500010N50L100203020N200L200N2005015023909100L500010N50L100202020N200L200N20010020023910100L500010N50L100202020N200L200N20010020023910100L500010N50L150201520N200L200N20010020023911100N300010N50L15020L2020N200L200N200N2003015023912100N500010N50L15020L2020N200N200N2003015023913100N500010N50L15020L3020N200N200N2005015023914100N500010N50L15020N3020N200N200N2005015023915100N5000	23904	150	5000	10N	50	100	30	20	20N	200L	200N	200	70	150
23906100N500010N50L10020N5020N200200N2005020023907100L500010N50L10020L2020N200N200N2007020023908100L500010N50L100203020N200L200N2005015023909100L500010N50L100202020N200L200N20010020023910100L500010N50L150201520N200200N20010020023911100N500010N50L20020N5020N200200N20010020023912100N500010N50L20020N5020N200N200N2003015023913100L300010N50L150202020N200N200N2003015023914100N500010N50L15020L3020N200N200N2005020023915100N500010N50L15020L3020N200N200N200505023915100N500010N50L15020N3020N200N200N200505023916100N500010N </td <td>23905</td> <td>150</td> <td>5000</td> <td>10N</td> <td>50L</td> <td>150</td> <td>20</td> <td>20</td> <td>20N</td> <td>200</td> <td>200N</td> <td>200</td> <td>70</td> <td>150</td>	23905	150	5000	10N	50L	150	20	20	20N	200	200N	200	70	150
23907100L500010N50L10020L2020N20N20N2007020023908100L500010N50L100203020N200L200N2005015023909100L500010N50L10020202020N200200N20010020023910100L500010N50L150201520N200200N20010020023911100N300010N50L20020N5020N200200N2002007015023912100N500010N50L20020N2020N200N200N2003015023913100L300010N50L150202020N200N200N2003015023914100N500010N50L15020L3020N200N200N2005020023915100N500010N50L15020L3020N200N200N2005015023916100N300010N50L15020N3020N200N200N2005020023917100N500010N50L15020N3020N200N200N2005020023918100N	23906	100N	5000	10N	50L	100	20N	50	20N	200	200N	200	50	200
23908100L500010N50L100203020N200L20N2005015023909100L500010N50L100202020N200200N20010020023910100L500010N50L150201520N200200N20010020023911100N300010N50L20020N5020N200200N2007015023912100N500010N50L15020L2020N200200N2003015023913100L300010N50L15020L2020N200N200N2003015023914100N500010N50L15020L3020N200N200N2005020023915100N500010N50L15020L3020N200N200N2005015023916100N500010N50L15020N3020N200N200N2005015023917100N500010N50L15020N3020N20N200N2005015023916100N500010N50L15020N3020N20N200N2005020023917100N500010N <td>23907</td> <td>100L</td> <td>5000</td> <td>10N</td> <td>50L</td> <td>100</td> <td>20L</td> <td>20</td> <td>20N</td> <td>200N</td> <td>200N</td> <td>200</td> <td>70</td> <td>200</td>	23907	100L	5000	10N	50L	100	20L	20	20N	200N	200N	200	70	200
23909100L500010N50L100202020N20020020010020023910100L500010N50L150201520N200200N20010020023911100N300010N50L20020N5020N200200N2007015023912100N500010N50L10020L2020N200200N20030015023913100L300010N50L150202020N200N200N20030015023914100N500010N50L15020L3020N200N200N2005020023915100N500010N50L15020L3020N200N200N2005020023916100N300010N50L15020N3020N200N200N2005015023917100N500010N50L15020N3020N200N200N2005020023918100N500010N50L150203020N200N200N2005020023919100L500010N50L150203020N200N200N200N2005020023918100L5000<	23908	100L	5000	10N	50L	100	20	30	20N	200L	200N	200	50	150
23910100L500010N50L150201520N20020N20020010020023911100N300010N50L20020N5020N200200N2007015023912100N500010N5010020L2020N200200N2003015023913100L300010N50L150202020N200N200N2003015023914100N500010N50L15020L3020N200N200N2005020023915100N500010N50L15020L3020N200N200N2005020023916100N300010N50L15020N3020N200N200N2005015023917100N500010N50L15020N3020N200N200N2005020023918100N500010N50L15020L3020N200N200N2005020023918100L500010N50150203020N200N200N2005020023919100L500010N50150203020N200N200N2005020023919100L5000<	23909	100L	5000	10N	50L	100	20	20	20N	200	200N	200	100	200
23911100N300010N50L20020N5020N200200N2007015023912100N500010N5010020L2020N200N200N2003015023913100L300010N50L150202020N200N200N20010015023914100N500010N50L15020L1520N200L200N2005020023915100N500010N50L15020L3020N200N200N2005015023916100N300010N50L10020L3020N200N200N2005015023917100N500010N50L15020N3020N200N200N2005020023918100N500010N50L10020L3020N200N200N2005020023918100L500010N50150203020N200N200N2005020023919100L500010N50150203020N200N200N2005020023919100L500010N50150203020N200N200N2005020023919100L500010N <td>23910</td> <td>100L</td> <td>5000</td> <td>10N</td> <td>50L</td> <td>150</td> <td>20</td> <td>15</td> <td>20N</td> <td>200</td> <td>200N</td> <td>200</td> <td>100</td> <td>200</td>	23910	100L	5000	10N	50L	150	20	15	20N	200	200N	200	100	200
23912100N500010N5010020L2020N200200N2003015023913100L300010N50L150202020N200N200N20010015023914100N500010N50L150201520N200L200N2005020023915100N500010N50L15020L3020N200N200N2005015023916100N300010N50L10020L3020N200N200N2005015023917100N500010N50L15020N3020N200N200N2005020023918100N500010N50L15020L3020N200N200N2005020023919100L500010N50150203020N200N200N20050200	23911	100N	3000	10N	50L	200	20N	50	20N	200	200N	200	70	150
23913100L300010N50L150202020N20N20N20010015023914100N500010N50L150201520N200L200N2005020023915100N500010N50L15020L3020N200N200N2005015023916100N300010N50L10020L3020N200N200N2005015023917100N500010N50L15020N3020N200N200N2005020023918100N500010N50L15020L3020N200N200N2005020023919100L500010N50150203020N200N200N20050200	23912	100N	5000	10N	50	100	20L	20	20N	200	200N	200	30	150
23914100N500010N50L150201520N200L200N2005020023915100N500010N50L15020L3020N200N200N2005015023916100N300010N50L10020L3020N200N200N2005015023917100N500010N50L15020N3020N200N200N2005020023918100N500010N50150203020N200N200N2005020023919100L500010N50150203020N200N200N20050200	23913	100L	3000	10N	50L	150	20	20	20N	200N	200N	200	100	150
23915100N500010N50L15020L3020N200N200N2005015023916100N300010N50L10020L3020N200N200N2005015023917100N500010N50L15020N3020N200N200N2005020023918100N500010N50L15020L3020N200N200N2005020023919100L500010N50150203020N200N200N20050200	23914	100N	5000	10N	50L	150	20	15	20N	200L	200N	200	50	200
23916100N300010N50L10020L3020N200N200N2005015023917100N500010N50L15020N3020N200N200N2005020023918100N500010N50L10020L3020N200N200N2005020023919100L500010N50150203020N200N200N20050200	23915	100N	5000	5 10N	50L	150	20L	30	20N	200N	200N	200	50	150
23917100N500010N50L15020N3020N200N200N2005020023918100N500010N50L10020L3020N200N200N2005020023919100L500010N50150203020N200N200N20050200	23916	100N	3000	10N	50L	100	20L	30	20N	200N	200N	200	50	150
23918100N500010N50L10020L3020N200N200N2005020023919100L500010N50150203020N200N200N200N20050200	23917	100N	5000	10N	50L	150	20N	30	20N	200N	200N	200	50	200
23919 100L 5000 10N 50 150 20 30 20N 200N 200N 200 50 200	23918	100N	5000	10N	50L	100	20L	30	20N	200N	200N	200	50	200
	23919	100L	5000	10N	50	150	20	30	20N	200N	200N	200	50	200

Table 8. Analytical results for the paramagnetic (C-2) fraction of the heavy mineral concentrate samples determined by semiquantitative emission spectroscopy [N, not detected at the limit of detection shown; L, detected but below the limit of detection shown; G, determined to be greater than the value shown]...continued

...continued next page...

Note: The following elements were also analyzed but were not detected at the detection limit shown in (): P (0.5%), As (500 ppm), Au (20 ppm), Bi (20 ppm), Cd (50 ppm), Ge (20 ppm), Sb (200 ppm), W (50 ppm), Zn (500 ppm), Pd (5 ppm), and Pt (20 ppm).

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Table 8. Analytical results for the paramagnetic (C-2) fraction of the heavy mineral concentrate samples determined by semiquantitative emission spectroscopy

shown]...continued

DNR	1007										1. S.	2.	50 C
Sample	Ca	Fe <sup>~n</sup>	Mg	Na	Ti	Ag	В	Ba	Be	Со	Cr	Cu	Ga
Nümber	*	<b>X</b>	× X	*	*	ppm	ppm	ppm	ppm	ppm	ppm	<b>ppm</b>	ppr
in a sec	5 99 2 G		· · · · · · · · · · · · · · · · · · ·	<u> </u>					· · · · · · · · · · · · · · · · · · ·	·····	1 (S.J.A) 2 (A)	1873 - 1914 - 1914 - 1914 - 1914 - 1914 - 1914 - 1914 - 1914 - 1914 - 1914 - 1914 - 1914 - 1914 - 1914 - 1914 - 1914 -	
23920	1.5	10 👘	5	0.5L	2G	1N	50	150	2N	100	500	50	101
23921	∛2 <sup>°</sup> *	10	5	0.5L	2	1N	30	150	2N	100	300	70	10
23922	3	<b>10</b> ° 50	7	0.5L	2	1N	20L	100	2N	70	300	° <b>7</b> 0	10
23923	·2 64	10	7	0.5L	2	1N	20	100	2N	100	200	70	10
23924	3%	10	10	0.5L	2	1N	50	150	2N	100	300	70	10
23925	12 <i>01</i>	15	-7	0.5L	2	1N	20	100	2N	70	200	30	10
23926	- <b>2</b> 01	15	7	0.5	2	1N	20	150	2N	100	500	50	10
23927	2.01	10	10	0.5L	2	1N	20	70	2N	100	200	30	10
23928	. <b>3</b> 01 	10	5 10/800-10-10-10-10-10-10-10-10-10-10-10-10-1	0.5	1.5	1N	30	100	2L	50	500		20
23929	10	10 🖤	<b>35, 47</b> 4	0.5	2 <sup>100</sup>	11	50	200	2N	70	500	50	15
23930	20	10	5	0.5	1	1	50	200	2L	100	200	100	15
23931	100	20	7	0.5	1.5	1N	20	200	2L	100	500	20	30
23932	30	20	5	0.5L	1.5	1N	70	200	2	50	500	<sup>*</sup> 50	50
23933	20	20	5	0.5L	2	18	100	200	2L	70	300	50	15
23934	0.5	20	1.5	0.5N	2G	18	30	70	2N	50	500	50	10
23935	2	15	5	0.5	2	1N	70	150	2N	50	500	20	10
23936	ି <b>5</b> ି	30	5	0.5L	2G	1N	100	200	2N	100	500	20	10
23937	2	20	5	0.5	2G	1N	50	200	2N	70	300	50	15
23938	2	20	5	0.5L	2G	1N	50	200	2L	70	300	50	15
23939	2	10	5	0.5L	2G	1N	70	200	2N 1	100	500	70	15
23940	-5	20	<b>5</b>	0.5L	2	·	50	150	2N	70	500	20	10
23941	7	20	5	0.5L	2	1N	30	200	2N	100	500	30	15
23942	2	20	5	0.5L	2	1N	50	100	2N	70	500	20	10
23943	2	10	5	0.51	2G	1N	50	150	2N	70	300	70	15
23944	້ 2	20	5	0.5L	2	1N	50	100	2N	50	300	30	10
23945	2	15	5	0.5L	2	1N	50	150	2N	70	500	70	10
			-	<b>A F</b>	-	<b></b>		450		-			

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Note: The following elements were also analyzed but were not detected at the detection limit shown in (): P (0.5%), As (500 ppm), Au (20 ppm), Bi (20 ppm), Cd (50 ppm), Ge (20 ppm), Sb (200 ppm), W (50 ppm), Zn (500 ppm), Pd (5 ppm), and Pt (20 ppm).

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Table 8. Analytical results for the paramagnetic (C-2) fraction of the heavy mineral concentrate samples determined by semiquantitative emission spectroscopy [N, not detected at the limit of detection shown; L, detected but below the limit of detection shown; G, determined to be greater than the value shown]...continued

	M <b>E</b>													,
DNR	2									·				
Sample	La	Mn .	Mo	Nb	Ni	Pb	ан. Ал	Sc	Sn	Sr	Th	. <b>V</b>	Y.	Zr
Number	ppm	ppm	ppm	ppm	ppm	ppm		ppm	ppm	ppm	ppm	ppm	ppm	ppm
23920	100L	3000	10N	50	100	20		30	20N	200N	200N	200	70	150
23921	100N	5000	10N	50	100	20L		50	20N	200N	200N	200	50	150
23922	100N	5000	10N	50N	150	20N		30	20N	200N	200N	200	50	150
23923	100N	5000	10N	50L	150	20N		30	20N	200N	200N	200	50	150
23924	100N	5000	10N	50	150	20L		30	20N	200N	200N	200	70	150
23925	100N	3000	10N	50L	150	20N		30	20N	200L	200N	200	50	100
23926	100N	5000	10N	50L	200	20N		30	20N	300	200N	200	30	100
23927	100N	5000	10N	50L	200	20N		20	20N	200	200N	200	50	100
23928	100L	5000	10N	50N	100	20		30	20N	500	200N	200	70	100
23929	100	5000	10N	50	150	20		30	20N	300	200N	200	70	150
23930	100	5000	10N	50N	150	50		20	20N	500	200N	200	50	100
23931	200	7000	10N	50L	150	20		20	20N	500	200N	150	100	150
23932	200	7000	10N	50L	100	50		20	20N	300	200N	200	100	200
23933	100L	7000	10N	50L	100	30		20	20N	300	200N	200	100	150
23934	200	5000	10N	50	50	50		20	20N	200N	200N	300	100	150
23935	150	5000	10N	50L	100	20		30	20N	300	200N	200	100	150
23936	100	5000	10N	50L	100	20		30	20N	200	200N	200	100	100
23937	150	5000	10N	50L	100	20		20	20N	200	200N	200	100	150
23938	100	7000	10N	50L	150	20		15	20N	200	200N	200	100	150
23939	150	5000	10N	50	. 100	30		20	20N	300	200N	200	70	200
23940	100	5000	10N	50	100	20L		20	_ 20N	200L	200N	200	70	100
23941	100N	5000	10N	50L	100	20L		20	20N	200	200N	200	100	100
23942	100	5000	10N	50	100	20L		30	20N	200	200N	200	70	100
23943	100	7000	10N	50L	100	20L		20	20N	200L	200N	200	100	150
23944	100	7000	10N	50L	100	20		30	20N	200L	200N	200	100	100
23945	100	5000	10N	50L	100	20L		30	20N	200	200N	200	50	100
23946	100L	5000	10N	50	100	20L		30	20N	200	200N	200	50	150

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Note: The following elements were also analyzed but were not detected at the detection limit shown in (): P (0.5%), As (500 ppm), Au (20 ppm), Bi (20 ppm), Cd (50 ppm), Ge (20 ppm), Sb (200 ppm), W (50 ppm), Zn (500 ppm), Pd (5 ppm), and Pt (20 ppm).

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Table 8.	Analytical results for the paramagnet	c (C-2) fraction of the heavy mineral	concentrate samples deter	mined by semiquantitative emission spectrosco	у
	[N, not detected at the limit of detec	tion shown; L, detected but below the	limit of detection shown;	G, determined to be greater than the value	
	shown]continued				

DNR	2.8° 2° 1		s .,					· · · · · · · · · · · · · · · · · · ·			1. <sup>11</sup>	· · · · · · · · · · · · · · · · · · ·	
Sample	Ca	Fe	Mg	Na	Ті	Ag	В	Ba	Be	Co	Cr	رەد Cu	Ga
Number	X	*	x	×	*	ppm	ppm	ppm	ppm	ppm	mqq	ppm	ppm
23947	5	20	5	0.5L	2G		70	200	2N	100	500	70	30
23948	2	20	5	0.5L	2	1N	70	200	2N	70	500	50	20
23949	2	20	5	0.5L	2G	1N	50	200	2N	100	500	70	10
23950	3	20	5	0.5L	2	1N	20	200	2L	70	300	50	20
23951	2	10	5	0.5L	2	1N	50	200	2N	70	300	50	* 10
23952	3	10	5	0.5L	2	1N	70	150	2N	100	500.	70	10
23953	2	15	3	0.5L	2	1N	100	150	2L	50	500,	,50	20
23954	2	20	5	0.5L	2	1N	70	150	2N	70	500	20	10
23955	2	30	5	0.5L	2G	1N	150	300	2N	100	500	50	15
23956	3	20	.7	0.5	2	1N	150	300	2L	50	500	50	15
23957	5	20	7	0.5L	2	1N	100	300	2N	70	500	50	30
23958	7	20	7	0.5	2	1N	50	200	2N	100	500	15	30
23959		20	5	0.5	2	1N	70	200	2L	70	500	30	20
23960	2	20	5	0.5L	2G	· 1N	70	150	2N	50	700	20	15
23961	2	20	5	0.5L	2G	1N	100	200	2N .	70	500	50	15
23962	2	20	5	0.5L	2	1N	200	150	2N	100	500	50	20
23963	2	15	5	0.5L	2	1N .	100	200	2N	70	500	70	15
23964	2	20	5	0.5L	2G	1N	50	150	2N	70	500	50	10L
23965	2	10	5	0.5L	2G	1N	50	200	2N	70	700	30	20
23966	2	20	5	0.5L	2	1N	100	200	2N	50	500	30	20
23967	0.1L	30	0.5	0.5N	2G	1N	20L	70	2N	50	2000	20	10L
23968	5	20	5	0.5	2	1N	50	500	2L	70	500	70	50
23969	5	20	5	0.5L	2	1N	100	500	2N	70	500	50	20
23970	5	20	5	0.5L	2	1N	100	300	2N	70	700	50	20
23971	2	20	5	0.5L	2G	1N	100	200	2N	50	700	50	15
23972	5	20	- 5	0.5L	2G	1N	50	300	2N	100	500	20	20
23973	2	20	5	0.5L	2G	1N	70	100	2N	70	500		101

Note: The following elements were also analyzed but were not detected at the detection limit shown in (): P (0.5%), As (500 ppm), Au (20 ppm), Bi (20 ppm), Cd (50 ppm), Ge (20 ppm), Sb (200 ppm), W (50 ppm), Zn (500 ppm), Pd (5 ppm), and Pt (20 ppm). Mineralogical observations indicate that the following samples do not appear to be normal glaciofluvial samples: 23967 (pre-concentrated sample); 23969 (maybe a pre-glacial alluvium); and 23971 (active stream sediment sample).

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TADLE 8. ANALYTICAL RESULTS TOP	the paramagnetic (C-2) fraction of the heavy	mineral concentrate samples determined by semiquantitative emissi	on spectroscopy
[N, not detected at th	e limit of detection shown; L, detected but b	elow the limit of detection shown; G, determined to be greater tha	in the value
shown]continued			

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DNR													
Sample	La	Mn	Мо	Nb	Nī	Pb	Sc	Sn	Sr	Th	V	Y	Zr
Number	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
23947	100L	7000	10N	50	100	20	30	20N	200	200N	200	100	150
23948	150	5000	10N	50	150	20L	20	20N	200	200N	200	100	150
23949	150	5000	10N	50L	100	20L	20	20N	200	200N	200	100	70
23950	100L	5000	10N	50L	150	20	20	20N	200	200N	200	100	200
23951	100	5000	10N	50L	100	30	20	20N	200	200N	200	100	150
23952	100,	5000	10N	50	100	20	30	20N	200	200N	200	70	150
23953	200	5000	10N	50	70	30	30	20N	300	200N	200	100	300
23954	150	5000	10N	50L	100	50	50	20N	200	200N	200	100	100
23955	200	7000	10N	50L	100	50	15	20N	200	200N	200	100	100
23956	200	7000	10N	50L	100	30	15	20N	300	200N	200	70	200
23957	200	7000	10N	50L	100	20	15	20N	300	200N	200	150	200
23958	200	5000	10N	50	100	30	20	20N	500	200N	200	100 .	150
23959	150	5000	10N	50L	100	20	20	20N	500	200N	200	100	150
23960	300	7000	10N	50	100	50	20	20L	200	200L	200	150	150
23961	100	5000	10N	50	100	20	10	20N	200	200N	200	70	150
23962	150	5000	10N	50	100	50	30	20N	200	200N	200	100	150
23963	200	5000	10N	50L	100	50	30	20N	300	200N	200	100	100
23964	100	5000	10N	50	100	20N	30	20N	200	200N	200	100	150
23965	200	7000	10N	50	100	50	30	20N	500	200N	200	100	200
23966	200	7000	10N	50L	100	30	20	20N	500	200N	200	100	150
23967	1000	5000	10N	50L	20	70	20	20N	200N	200	200	200	1000
23968	200	7000	10	50L	100	50	20	20N	200	200N	200	100	100
23969	100	7000	10	50L	100	20L	20	20N	300	200N	200	100	100
23970	200	7000	10N	50	100	20	30	20N	500	200N	200	100,	100
23971	200	7000	10N	50	100	50	15	20N	200	200N	200	100	100
23972	200	7000	10N	50L	100	30	20	20N	200	200N	200	100	100
23973	100L	5000	10N	50L	100	20	20	20N	200L	200N	200	50	200

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Note: The following elements were also analyzed but were not detected at the detection limit shown in (): P (0.5%), As (500 ppm), Au (20 ppm), Bi (20 ppm), Cd (50 ppm), Ge (20 ppm), Sb (200 ppm), W (50 ppm), Zn (500 ppm), Pd (5 ppm), and Pt (20 ppm). Mineralogical observations indicate that the following samples do not appear to be normal glaciofluvial samples: 23967 (pre-concentrated sample); 23969 (maybe a pre-glacial alluvium); and 23971 (active stream sediment sample).

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Table 8. Analytical results for the paramagnetic (C-2) fraction of the heavy mineral concentrate samples determined by semiquantitative emission spectroscopy IN, not detected at the limit of detection shown; L, detected but below the limit of detection shown; G, determined to be greater than the value shown]...continued

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Number		X	*	2	*	ppm va	•	ppm	ppm	ppm	ppm	<b>PP</b> m	ppm		ppm
23974	2	15	7	0.5L	2G	1N		50	200	2N	100	300	50		10
23975	ŠĴ0	20	7	0.5L	2G	1N		30	200	2N	100	500	20	۰ <sup>(</sup> ۲	10
24110	2	20	7	0.5L	2	1N	1.	50	200	2N	50	300	70	• • • •	20
24111	1.5	20	5	0.5L	2	1N		70	100	2N	70	300	50	1997) 1997 - 1	10
24112	<b>3</b> 3	15	7	0.5L	2	11		20	150	2N	50	300	50	-2-	20
24113	2	15	5	0.5L	2	1N	•	20	100	2N	70	200	50		10
24114	2	20	7	0.5L	2	1N		20	100	2N	70	200	30		10
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Sample	La	Mn	Mo	Nb	Nī	Pb		Sc	Sn	Sr	Th	<b>. V</b>	Y		Zr
Number	PPM	ppm	ppm	ppm	ppm	<b>pp</b> m		ppm	ppm	ppm	<b>ppm</b>	ppm	PPm		ppn
23974	100	5000	10N	50L	150	20L	÷.,	50	20N	200L	200N	200	70		200
23975	100L	5000	10N	50L	100	20L		30	20N	200	200N	200	100		150
24110	100N	5000	10N	50L	100	20L		20	20N	200L	200N	200	50	intro .	150
24111	100	5000	10N	50	100	20		20	20N	200L	200N	200	100	Later	200
24112	100	5000	101	50L	150	30		20	20N	200L	200N	200	50	A. C.	200
24113	100N	3000	10N	50L	100	20N		20	20N	200N	200N	200	50	1.1	150
24114	100N	5000	10N	50L	200	20N		20	20N	200	200N	200	50	5-14 - 1 1	100
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24 F - 13	j. 1-											-	<i></i>		1917

1.12 1. 1.14 5.80 2400 Note: The following elements were also analyzed but were not detected at the detection limit shown in (): P (0.5%), As (500 ppm), Au (20 ppm), Bi (20 ppm), Cd (50 ppm), Ge (20 ppm), Sb (200 ppm), W (50 ppm), Zn (500 ppm), Pd (5 ppm), and Pt (20 ppm).

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Table 9. Analytical results for the nonmagnetic (C-3) fraction of the heavy mineral concentrate samples determined by semiquantitative emission spectroscopy [N, not detected at the limit of detection shown; L, detected but below the limit of detection shown; G, determined to be greater than the value shown]

1	1253										an shirt an	71 5 ac	* 1
DNR	[10 <b>%</b>	· · ·				· · · · · · · · · · · · · · · · · · ·					$ \begin{array}{c} \nabla_{\mathbf{x}} & \mathcal{O}^{\mathbf{x}} & \mathcal{O}^{\mathbf{x}} \\ \bullet & \cdot & \nabla_{\mathbf{x}}^{\mathbf{x}} & \nabla_{\mathbf{x}}^{\mathbf{x}} \end{array} $	цî.	
Sample	∿ /rø Ca	Fe	Ma	Na	P	Ti	Aq	As	Au	В	Ba	Be	Bi
Number	*	*	x	*	×	x	ppm	ppm	ppm	ppm	<b>Ppm</b>	ppn but	ppm
20431	10	1.5	2	0.5L	2	2G	- 1	500N	20N	50	70	2N	20N
22631	5	1	0.2	0.5N	5	2G	1N	500N	20N	50	100	2L	20L
22632	5	1	0.5	0.5L	5	2G	1	500N	20N	100	150	10	20N
22633	10	1.5	1	0.5L	7	2G	1N	500N	20N	100	200	2N	20N
22634	7	2	2	0.5L	2	2G	1N	500N	20N	200	200	2N	20N
22635	10	1	2	0.5L	7	2G	2	500N	20N	200	700	2N	50
22636	10	0.5	0.5	0.5N	5	2G	1N	500N	20N	150	700	2L	20N
22637	10	0.5	0.2	0.5N	7	2G	1N	500N	20N	150	500	20	20N
23901	20	0.5	0.3	0.5L	10	2G	- 1N	500N	20N	100	300	2N	20N
23902	20	0.5	0.2	0.5N	10	2G	1N	500N	20N	100	200	2N	20N
23903	20	0.5	0.5	0.5L	10	2G	1N	500N	20N	100	500	100	20N
23904	20	0.2	0.5	0.5L	20	2G	1N	500N	20N	100	700	2N	20N
23905	30	0.7	1.5	0.5L	15	2G	1N	500N	20N	200	700	2	20N
23906	10	0.5	0.5	0.5L	10	2G	1N	500N	20N	100	1000	2N	20N
23907	30	0.7	1.5	0.5L	15	2G	1N	500N	20N	500	300	2N	20N
23908	20	0.2	0.5	0.5L	20	2G	1N	500N	20N	100	200	2L	20N
23909	30	0.5	1.5	0.5	20	2G	1N	500N	20N	100	300	3	20N
23910	30	1	1	0.5L	10	2G	1N	500N	20N	50	150	2N	20N
23911	30	.0.7	2	0.5	20	2G	1N	500N	20N	300	500	2N	20N
23912	30	0.3	1	0.5L	20	2G	. <b>1</b> N	500N	20N	100	200	2N	20N
23913	20	0.5	· 1	0.5L	10	2G	· 1N	500N	20N	100	200	2N	20N
23914	20	1	1	0.5L	10	2G	i 1N	500N	20N	70	500	2N	20N
23915	50	0.7	2	0.5L	20	2G	1N	500N	20N	200	500	2N	20N
23916	30	0.3	1	0.5L	20	2G	7	500N	20N	100	200	2L	20N
23917	20	0.3	1	0.5L	20	2G	. 1N	500N	20N	100	100	2N	20N
23918	20	0.5	3	0.5L	20	2G	11	500N	20N	100	200	2N	20N
23919	30	0.5	2	0.5N	20	2G	1N	500N	20N	300	500	2L	20N
23920	20	0.5	1.5	0.5N	15	2G	1N	500N	20N	500	300	2N	20N

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Note: The following elements were also analyzed but were not detected at the detection limit shown in ( ). Cd (50 ppm), Ge (20 ppm), Pd (5 ppm), and Pt (20 ppm).

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Table 9. Analytical results for the nonmagnetic (C-3) fraction of the heavy mineral concentrate samples determined by semiquantitative emission spectroscopy [N, not detected at the limit of detection shown; L, detected but below the limit of detection shown; G, determined to be greater than the value shown]...continued

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DNR		19 g						4.5	1. A.		***** ? \%{;	17 F 1979	1 (A) 1 (A)
Sample	Co	Cr	Cu	Ga	La	Mn	Mo	Nb	Nî	Pb	Sb	Sc	Sn
Number	<b>ppm</b>	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
20431	30	200	15	20	200	700	10N	50	100	50	200N	20	20
22631	20N	150	20	10L	500	500	10N	50L	10N	70	200N	50	20
22632	20N	200	5000	20	300	500	10N	50	50	500	200N	20	50
22633	30	200	50	20	200	700	10N	50	30	100	200N	20	150
22634	20	200	20	30	200	700	10N	50L	50	200	200N	50	100
22635	20L	150	70	20	500	500	10N	50	20	50000	500	30	100
22636	20N	200	10L	10L	500	500	10N	50L	10N -	100	200N	70	50
22637	20N	150	10	20	200	300	10N	50L	10N	700	200N	50	50
23901	20N	200	10N	10	300	500	10N	50L	10N	30	200N	20	20L
23902	20N	200	10L	10	300	200	10N	50L	10	50	200N	50	300
23903	20N	200	10L	20	200	300	10N	50L	10N	70	200N	30	200
23904	20N	200	10L	10	300	700	10N	50L	10N	70	200N	30	150
23905	20N	200	10	20	500	1000	10N	50	10N	70	200N	50	30
23906	20L	200	20	20	300	500	e, 10N	50L	10N	100	200N	30	100
23907	20N	200	10	15	500	1000	10N	50L	10N	70	200N	70	150
23908	20N	200	100	10	300	1000	10N	50L	10N	70	200N	20	300
23909	20N	200	10	30	500	1000	10N	50	10N	70	200N	50	20
23910	20N	150	15	20	300	300	10N	50L	30	100	200N	20	20L
23911	20N	200	10	30	500	1000	10N	50	10N	300	200N	30	30
23912	20N	200	10L	15	300	500	10N	50L	10N	70	200N	20	100
23913	20N	200	300	15	300	700		50L	10N	300	200N	20	200
23914	20L	300	10	. 20	300	500	10N	50L	30	50	200N	20	20L
23915	ZON	200	10	20	500	700	10N	50L	10L	70	200N	50	100
23916	ZON	200	20	10	300	500	10N	. 50L	10N	50	200N	20	50
23917	20N	200	10	20	500	500	10N	50N	10N	70	200N	15	201
23918	20N	200	200	30	300	300	10N	50L	10N	300	200N	20	20
23919	20N	200	10L	15	500	1000	10N	50	10N	70	200N	50	100
23920	20N	200	10L	10	500	1000	10N	50L	10N	70	200N	50	70
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	is' und p	er de la composition de la composition La composition de la c	•				200 - 17	1.2	$\mathbf{d}_{b,q}^{k};$			e a nyaka ana	•
Note: 1	he followin	ng elements	were also	analyzed b	ut were not dete	ected at ti	ne detectio	on limit shown	in (). Cd (	50 ppm) Ge	(20 nnm) Pri	444 (1990) 8000 (5 mm) 8	ya shi ka shi arti
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	t (20 ppm).	1	100					•		•			
	t (20 ppm).	•	Ξ. ģ		•					•	· · ·		

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Table 9. Analytical results for the nonmagnetic (C-3) fraction of the heavy mineral concentrate samples determined by semiquantitative emission spectroscopy [N, not detected at the limit of detection shown; L, detected but below the limit of detection shown; G, determined to be greater than the value shown]...continued

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C > 24P Q	1,6	26 							·
DNR	50	1. J.							
Sample	ŝr	Tĥ	v	Υ.W.	Y :	Zn	Zr		
Number	ppm	ppm	ppm	ppm	ppm	ppm	ppm		
20431	500	200N	150	50N	150	500N	2000G		
22631	500	200N	200	50N	300	500N	2000G		
22632	700	200N	150	50N	200	5000	2000G		
22633	700	200N	150	50N	200	500N	2000G		
22634	700	200N	150	50N	200	500N	2000G		
22635	700	200N	150	50N	300	500N	2000G	· .	
22636	500	200N	150	50N	300	500N	2000G		
22637	500	200N	150	50N	300	500N	2000G		
23901	500	200N	100	50N	300	500N	2000G		
23902	1000	200N	100	50N	200	500N	2000G		
23903	700	200N	100	50N	300	500N	2000G		
23904	500	200N	150	50N	500	500N	2000G		
23905	500	200N	150	50N	300	500N	2000G		
23906	1000	200N	150	50N	500	500N	2000G		
23907	500	200N .	100	50N	300	500N	2000G		
23908	<sup>9</sup> 500	200N	100	50N	500	500N	2000G		
23909	500	200N	100	50N	200	500N	2000G		
23910	700	200N	100	50N	500	500N	2000G		
23911	500	200N	150	50N	300	500N	2000G		
23912	700	200N	100	50N	500	500N	2000G		
23913	700	200N	100	50N	500	500	2000G		
23914	700	200N	100	50N	500	500N	2000G		
23915	500	200N	100	50N	500	500N	20006		
23916	500	200N	100	50N	500	500N	2000G		
23917	500	200N	100	50N	300	500N	2000G		
23918	500	200N	100	50N	500	500N	20006		
23919	500	200N	150	50N	500	500N	20006		
23920	500	200N	150	50N	300	500N	2000g		

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Note: The following elements were also analyzed but were not detected at the detection limit shown in ( ). Cd (50 ppm), Ge (20 ppm), Pd (5 ppm), and Pt (20 ppm).

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Table 9:""Analytical results for the nonmagnetic (C-3) fraction of the heavy mineral concentrate samples determined by semiquantitative emission spectroscopy [N, not detected at the limit of detection shown; L, detected but below the limit of detection shown; G, determined to be greater than the value shown]...continued

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DNR	-299	50	Na	No	D	τ;	A.a.	Ac	Airi	P	Po	Ro	Ri
umber	<b>x</b> 00	2	ng X	ž	r X	11 2	ng DDM	DOM	DOM	DOM	DOM	DOM	20
SS - N	3.95	in fair a				~		PP		••••••	FF""		
921	2050	0.2	1	0.5N	20	2G	1N	500N	20N	200	200	2N	20
922	50 <sup>00</sup>	0.3	0.5	0.5	20	2G	1N	500N	20N	50	150	2N	20
923	20	0.5	0.5	0.5L	20	2G	1N	500N	20N	50	150	2N	20
924	30	0.3	0.7	0.5L	20	2G	1N	500N	20N	150	200	2N	20
925	30	0.2	0.7	0.5L	20	2G	1N	500N	20N	30	150	2N	20
926	30 <sup>000</sup>	0.2	0.3	0.5L	15	2G	1N	500N	20N	50	200	2N	20
927	20	0.2	0.2	0.5L	20	2G	1N	500N	20N	50	150	2N	20
928	50 <sup>00</sup>	0.5	0.7	0.5	20	2G	11	500N	20N	50	300	2N	20
929	20	0.5	0.5	0.5	10	2G	1N	500N	20N	30	200	2N	20
5930	20	0.7	0.5	0.5	7	2G	1L	500N	20N	30	300	2L	20
931	2000	0.7	0.7	0.5L	10	2G	1N	500N	20N	50	1500	5	20
932	3000	0.5	0.5	0.5L	20	2G	1N	500N	20N	20	200	2N	20
933	1500	0.5	0.7	0.5	5	2G	11	500N	20N	50	300	2N	20
934	2000	0.2	0.2	0.5N	10	2G	1N	500N	20N	50	150	2N	20
935	2000	0.7	0.5	0.5L	7	2G	5	500N	150	70	200	2N	20
936	5000	0.5	0.5	0.5L	20	2G	1N	500N	20N	200	300	2N	20
937	2000	0.5	0.3	0.5L	15	2G	1N	500N	20N	50	100	2N	20
938	20	0.5	0.5	0.5L	7	2G	11	500N	100	100	150	2N	10
939	3008	0.7	0.7	0.51	20	2G	1N	500N	20N	200	200	2L	20
940	20 <sup>00</sup>	0.5	0.3	0.5L	15	26	1N	500N	201	70	500	2N	20
941	20 <sup>00</sup>	1	2	0.5	3	- 2G ·	1N	500N	300	100	500	2N	
942	2000	1.5	2	0.5L	3	26	11	500N	201	300	1000	21	21
943	15	0.5	0.5	0.5N	- 15	26	1N	500N	201	50	700	· 2N	20
944	30	0.5	0.5	0.51	10	26	11	500N	200	100	200	21	21
945	10	0.5	0.5	0.5L	10	26	1N	500N	201	100	200	21	20
946	30	0.5	1.5	0.5L	20	26	1N	500N	201	200	500	21	20
947	20	0.5	0.3	0.5	7	26	1N	5000	20N	100	300	21	20
5948	20	0.7	1	0.5	20	26		500N	201	300	300	21	20
		•••	•	U.J.L	EU	20	14	JOON	204	300	300	211	20
	1.7622-1.2	• 57	1.5										
	a state	n in the second			•						. (F. 1972)	$\frac{1}{2} = -\frac{1}{2} e^{i\omega t} t^{-\frac{1}{2}} = \frac{1}{2}$	un estres
te. 1	the followin	a elemente	Here also a	nalyzad but u			the detection	limia chour i		F0		ise sou e	MN / C <2 C
, iei 1		a crements	NCIC 8150 8	Hatyacu DUC W	ere not det	ected at	une detection	CHAIL SHOWN 11	ιι, μ. υα (	ou ppm), Ge	(20 ppm), Pd	(> ppm),	and
. 1	r (co point	• • •	·				• • •			•			••

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Table 9. Analytical results for the nonmagnetic (C-3) fraction of the heavy mineral concentrate samples determined by semiquantitative emission spectroscopy [N, not detected at the limit of detection shown; L, detected but below the limit of detection shown; G, determined to be greater than the value shown]...continued

	1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999						-						
DNR	10t						•						, <u>, , , , , , , , , , , , , , , , , , </u>
Sample	Co	Cr	Cu	Ga	La	Mn	Mo	Nb	Ni	Pb	Sb	Sc	Sn
Number	<b>ppm</b> <sup>2</sup>	bbu	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
23921	20N	150	10	15	300	300	10N	50L	10N	70	200N	20	200
23922	20N	150	10	30	500	500	10N	50N	10N	5000	200N	10	150
23923	20N	150	10	15	300	300	10N	50L	10N	70	200N	20	150
23924	20N	200	15	15	500	500	10N	50L	10N	70	200N	20	100
23925	20N	200	10L	15	500	500	10N	50L	10N	70	200N	10	100
23926	20N	150	10L	20	300	300	10N	50L	10N	200	200N	10	20
23927	20N	200	- 10	20	500	500	10N	50L	10N	100	200N	10	20
23928	20N	200	10	20	700	500	10N	50L	10N	100	200N	50	30
23929	20N	150	² <b>1</b> 0	20	300	300	10L	50	10N	70	200N	20	20
23930	30	200	10	30	200	500	10N	50	10L	100	200N	20	20
23931	20L	200	15	20	300	500	10L	50	10N	70	200N	15	20
23932	20N	200	10L	20	700	500	10N	50L	10N	70	200N	15	201
23933	20N	200	10	20	200	700	10N	50	10N	50	200N	20	20
23934	20N	300	10N	20	300	300	10N	50N	10N	100	200N	50	150
23935	20N	200	10L	20	200	500	10N	50	10N	2000	200	20	20
23936	20N	300	10L	20	500	700	10N	50L	10N	100	200N	100	50
23937	20N	200	10	20	200	500	10N	50L	10N	70	200N	20	20
23938	20N	150	10L	15	200	500	10N	50	10N	50	200N	20	201
23939	20N-	300	10L	50	500	700	10N	50	10N	100	200N	50	1000
23940	20N	200	10L	20	200	500	10N	50L	10N	70	200N	20	150
23941	<b>20</b> %	300	20	30	200	1500	10N	50	50	100	200N -	20	20
23942	20	300	20	15	300	1000	10N	50L	70	70	200N	20	201
23943	20N <sup>9</sup>	200	10	15	300	300	10N	50L	10N	700	200N	20	50
23944	20N	200	10	20	300	300	10N	50L	100	150	200N	30	70
23945	20N	200	10	20	500	300	10N	50L	10N	500	200N	50	100
23946	20N	200	10	20	500	1000	10N	50	10L	70	2001	50	200
23947	20N	200	10	20	300	300	10N	50L	100	70	2001	30	300
23948	20N	300	10	30	500	1000	10N	50	101	70	2004	50	500
						1000			104	70	ZUUN	20	50

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Note: The following elements were also analyzed but were not detected at the detection limit shown in (). Cd (50 ppm), Ge (20 ppm), Pd (5 ppm), and Pt (20 ppm).

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Table 9.14 Analytical results for the nonmagnetic (C-3) fraction of the heavy mineral concentrate samples determined by semiquantitative emission spectroscopy [N, not detected at the limit of detection shown; L, detected but below the limit of detection shown; G, determined to be greater than the value shown]...continued

1. S	i del an 2 s												45	$\frac{c_{s}}{t_{s}^{2}}\frac{c_{s}}{c_{s}}$ .
DNR	n shekara Mana a	ta di seconda di second Seconda di seconda di se								•••			.35	t de Depen
Sample	Sr	Th	<b>V</b>	W	Ϋ́	Zn	Zr					S. (M	20	Sau
Number	ppm	ppm	ppm	ppm	ppm	ppm	ppm			÷			ž.	4.6
, P	984° (											3047	30	201
23921	500	200N	100	50N	500	500N	2000G							
23922	300	200N	100	50N	500	500N	2000G					2006	50	
23923	200	200N	100	50N	500	500N	2000G		:			28,8	2.5	
23924	200	200N	100	50N	500	500N	2000G		·.			36-73		1. Sec. 1.
23925	300	200N	100	50N	500	500N	2000G						94) 1	¥.
23926	300	200N	150 <sup>i</sup>	50N	300	500N	2000G						50	1 1
23927	200	200N	150	50N	500	500N	2000G					$\{\mathcal{E}_{i_1}, \mathcal{E}_{i_2}\}$	24	
23928	2000	200N	150	50N	500	500N	2000G							• *
23929	1000	200N	100	50	200	500N	2000G					Ny 1	7 3 C 1 S	<b>\$</b> 11
23930	700	200N	100	50N	150	500N	2000G					11 - A.A A.A.	100	
23931 <sup>2</sup>	500	200N	100	50N	200	500N	2000G					2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	50	1 40 - 1 10 - 10
23932	3000	200N	100	50N	200	500N	2000G					na di n Katala		÷.,
23933	500	200N	100	50N	200	500N	2000G			·				2 - S • S
23934	200	200N	100	50N	500	500N	2000G				2°	1.18		
23935	500	200N	100	50N	200	500N	2000G							
23936	500	200N	150	50N	500	500N	2000G						64	
23937	700	200N	100	50N	200	500N	2000G					7 (37 K	17	
23938	700	200N	100	50N	200	500N	2000G					* · · *	str.	
23939	500	200N	100	50N	200	500N	2000G					a da ana ana ana ana ana ana ana ana ana	• •	
23940	700	200N	100	50N	300	500N	2000G				• *		, ¥.	
23941	500	200N	100	50N	150	500N	2000G				÷.,	×	1,15	
23942	700	200L	100	50N	150	500N	2000G		•				· 1	<i>v</i>
23943	700	200N	100	50N	200	500N	2000G							
23944	700	200N	100	50N	300	500N	2000G							н н. н. н. н
23945	1000	200N	100	50N	300	500N	.2000G						$\{ f_{i}, f_{i} \}_{i \in I_{i}}$	
23946	500	200N	150	50N	300	500N	2000G						41	25 A 2
23947	1000	200N	100	50N	500	500N	2000G							
23948	500	200N	100	50L	300	500N	2000G					е	an an annaichtean	
	T we at the f	Cash					•							
	in' that c	1971 - 249 - 14	state (12)	4		. · · ·	the star	1. j. j. j.	and a second	• • •	elekseye es	化合合物 化硫酸	A. 13494 101	R. M. Conta
Note: T	he followin	a elements	were also an	nalvzed but w	ere not d	atected at +	ha dataati		chour in d	>	· • · · · · · · · · · · · · · · · · · ·		19月1日1日(1995)	n n Seljgeaner S
P	t (20 ppm).	• • • • • • • • • • • • • • • • • • •				cievieu ai (	ne uerecti		ынин 111 (	). Ca (S	ou ppm), Ge	(20 ppm), Pc	ι (5 ppm), ε	ind
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generation of the second s	n da an an anna Anna an an anna	fan an de stalf fan en en en ser	passional a pro- Residence de la Res	chica ang pila ainanda nina mala katalikandak	aj kiru Si kiron	ali dana na k Si dana na ka	Norse de G George Served	RC (1997) - AN REFERENCES	ka sa sa sa sa sa ka waxaa sa s	Kin ol Taliji Isoberezeli	(konservente)) Stanservente)	part the second se	istenia) (istenia versional conserva-	ang kanatan Kanatan

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Table 9.<sup>12</sup> Analytical results for the nonmagnetic (C-3) fraction of the heavy mineral concentrate samples determined by semiquantitative emission spectroscopy [N, not detected at the limit of detection shown; L, detected but below the limit of detection shown; G, determined to be greater than the value shown]...continued

<u></u>	- AV	5.91					- 1				<b>⊀</b> 1	Part -	
DNR	្រាត់	5 - 4 <u>1</u> 1									tang ta	4 () 14 ()	1
Sample	Ca	Fe	Mg	Na	Ρ	ті	Ag	As	Au	В	Ba	Be	Bi
Nümber	*	×	<b>X</b> (	×	×	*	ppm	ppm	ppm	ppm	ppn	<b>ppm</b>	ppm
23949	20	0.7	0.7	0.5L	10	2G	11	500N	100	100	150	2N	20N
23950	20 <sup>%</sup>	0.7	0.7	0.5L	10	2G	1N	500N	20L	70	500	2L <sup>20</sup>	20N
23951	20	0.5	0.5	0.5L	10	2G	1N	500N	20N	50	700	2N	20N
23952	30	0.2	1.5	0.5	15	2G	1N	500N	20N	100	200	2N	20N
23953	30 *	0.2	0.5	0.5N	20	2G	1N 1	500N	20N	100	200	2.5	~ 20N
23954	20	0.5	0.5	0.5L	10	2G	- 1N	500N	20N	70	300	5 5	20N
23955	<b>30</b> %	0.5	0.7	0.5L	20	2G	1N	500N	20N	150	300	2	20N
23956	50 <sup>%</sup>	0.7	1.5	0.5L	20	2G	1N <sup>1</sup>	500N	20N	150	300	2N	20N
23957	30 <sup>-2</sup>	0.5	0.7	0.5L	20	2G	1N	500N	20N	50	200	2N	20N
23958	20	0.5	0.5	0.5L	15	2G	1N	500N	20N	30	100	2N (	20N
23959	15 <sup>3</sup>	0.3	1 5	0.5N	10	2G	1N	500N	20N	30	200	2N	20N
23960	30	0.5	2	0.5N	15	2G	1N	500N	20N	100	1000	2	20N
23961	20	0.5	1	0.5L	10	2G	1N	500N	20N	100	500	2N <sup>2</sup>	20N
23962	20	0.5	0.5	0.5N	10	2G	1N	500N	20N	150	200	3	20N
23963	<b>30</b> %	0.5	1	0.5L	15	2G	1N //	500N	20N	100	500 <sup>12</sup>	2N 0	20N
23964	50	0.5	<sup>1</sup>	0.5L	15	2G	1N	500N	20N	200	300	2N 0	20N
23965	20	0.2	0.3	0.5N	15	2G	1N	500N	20N	70	3000	2N -	20N
23966	30-	0.5	1	0.5L	20	2G	1N	500N	20N	200	1000	2	20N
23967	80.5	0.1	0.05L	0.5N	1	2	20	500N	1000G	20	300	2N	20N
23968	20	0.5	0.5	0.5L	10	2G	1N	500N	20N	20	500 <sup>8</sup>	2N	20N
23969	24	30	0.5	0.5N	· · <b>1</b>	· 1	1N (	500	20N	20L	10000G	2N 9	20N
23970	20%	0.5	0.5	0.5L	10	2G	1N	500N	20N	<b>70</b>	500	2N 5	20N
23971	20	10	0.5	0.5N	5	2G	1N	500N	20N	50 <sup>se</sup>	500 <sup>%</sup>	2L	20N
23972	20	0.5	0.5	0.5L	10	ZG	1N	~ 500N	150	100	500	7	20N
23973	<b>20</b> 0	0.5	0.5	0.5N	10	2G	1N	500N	20N	100	150	2L	20N
23974	20	0,.7	1.5	0.5L	10	2G	1N	500N	20N	150	300	2N	20N
23975	20	0.7	1	0.5L	7	2G	1N	500N	20N	50	500	2L	20N
24110	15	0.5	0.7	0.5L	10	2G	1N	500N	20N	100	500	2L	100

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Note: The following elements were also analyzed but were not detected at the detection limit shown in (). Cd (50 ppm), Ge (20 ppm), Pd (5 ppm), and Pt (20 ppm). Mineralogical observations indicate that the following samples do not appear to be normal glaciofluvial samples: 23967 (pre-concentrated sample); 23969 (maybe a pre-glacial alluvium); and 23971 (active stream sediment sample).

Table 9. Analytical results for the nonmagnetic (C-3) fraction of the heavy mineral concentrate samples determined by semiquantitative emission spectroscopy [N, not detected at the limit of detection shown; L, detected but below the limit of detection shown; G, determined to be greater than the value shown]...continued

<u> </u>				····									- 15	
ù DNR ⊇	30	£ -1		2 a			•		ţ				3. É	
Sample	Co	Cr	Cu	Ga	La	Mn		Mo	Nb	Ni	Pb	Sb	Sc	Sn
Number	<b>PPM</b> Note	ppm	ppm	ppm	ppm	ppm	ľ,	ppm	ppm	ppm	ppm	mqq	ppm	ppm
23949	20N	200	10	15	300	500		10N	50L	10N	20	200N	20	20L
23950	20N	200	10	30	200	300		10N	50L	20	1500	200N	20	20
23951	20N	150	10	20	300	200		10N	50	10N	5000	200L	20	20
23952	20N	200	10L	50	200	500		10N	50	10N	70	200N	10	<sup>5</sup> 30
23953	20N 2	300	10L	15	200	300		10N	50L	10N	70	200N	50	100
23954	20N	200	10	15	200	500	i di se	10N	50L	10N	<sup>60</sup> 70	200N	20	20
23955	20N	300	10L	20	500	700		10N	50	10N	70	200N	<sup>5</sup> 70	300
23956	20N	200	10	30	500	700		10N	50L	10N	70	200N	50	20
23957	20N	300	10	20	500	700	•	10N	50L	10N	70	200N	50	20
23958	20N	200	10L	10	200	1000		10N	50L	10N	100	200N	20	20
23959	20N	100	10L	10	150	300		10N	50	10N	70	200N	15	201
23960	20N	200	10L	20	500	700		15	50	10N	150	200N	50	1000
23961	20N	200	10L	10	200	700	÷.,	10N	50	10N	70	200N	850	30
23962	20N	200	10L	20	300	500		10N	50L	10N	100	200N	50	- 70
23963	20N	<b>500</b> /	10L	20	200	700		10	50L	10N	100	200N	<b>3</b> 0	20
23964	20N	300	10L	20	500	700		10N	50L	10N	150	200N	<sup>5</sup> 50	50
23965	20N	200	10N	10	200	500		10N	50L	10N	50	200N	<sup>5</sup> 30	300
23966	20	300	30	30	500	1000	· .	10N	50L	10N	200	200N	70	30
23967	20N	100	ି 10L	10L	2000	100		10N	50N	10L	<sup>la</sup> 100	200N	<sup>5</sup> 20	500
23968	20N	200	÷ 10L	15	200	500		10	50	10N	50	200N	20	20L
23969	50	20N	100	10N ·	150	500		15	50N	100	100	200N	10L	201
23970	20N	150	10L	10	300	500	•	10N	50	10N	150	200N	30	20
23971	20	150	ê <b>3</b> 0	10L	200	500		10N	50L	.50	100	200N	్ 30	30
23972	20N	200	10L	20	200	500		10N	50L	10N	50	200N	30	20
23973	ZON	200	10	10	500	300		10N	50	10N	50	200N	30	50
23974 <sup>.</sup> "	20N	200	15	10L	300	500		10N	50	10N	50	200N	<sup>6%</sup> 20	<sup>×</sup> 50
23975	20N	150	10	15	300	500		10N	50	10N	50	200N	20	20
24110	20L	200	10L	20	500	500		10N	50L	10N	70	200N	20	100
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Note: The following elements were also analyzed but were not detected at the detection limit shown in (). Cd (50 ppm), Ge (20 ppm), Pd (5 ppm), and Pt (20 ppm). Mineralogical observations indicate that the following samples do not appear to be normal glaciofluvial samples: 23967 (pre-concentrated sample); 23969 (maybe a pre-glacial alluvium); and 23971 (active stream sediment sample).

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Table 9.<sup>370</sup> Analytical results for the nonmagnetic (C-3) fraction of the heavy mineral concentrate samples determined by semiquantitative emission spectroscopy [N, not detected at the limit of detection shown; L, detected but below the limit of detection shown; G, determined to be greater than the value shown]...continued

DNR	1.1						
Sample	Sr	Th	v	W	Y	Zn	۲Ľ
Number	ppm	PPm	ppm	ppm	ppm	ppm	ррп
23949	700	200N	100	50N	200	500N	2000G
23950	700	200N	150	50N	200	500N	2000G
23951	1000	200N	100	50N	300	500N	2000G
23952	200	200N	100	50N	300	500N	2000G
23953	200	200N	150	50N	300	500N	2000G
23954	700	200N	100	50N	200	500N	2000G
23955	500	200N	100	50N	300	500N	2000G
23956	500	200N	100	50N	200	500N	2000G
23957	500	200N	100	50N	200	500N	2000G
23958	500	200N	100	50N	300	500N	2000G
23959	200N	200N	100	50N	150	500N	2000G
23960	500	200N	100	100	300	500N	2000G
23961	500	200N	150	50L	200	500N	2000G
23962	700	200N	150	50N	500	500N	2000g
23963	700	200N	150	50N	300	500N	20006
23964	500	200N	100	50N	300	500N	20000
23965	500	200N	100	50N	200	500N	2000G
23966	500	200N	150	50N	300	500N	20000
23967	200N	200N	100	50N	700	500N	20000
23968	8500	200N	100	50N	200	500N	20000
23969	<b>500</b>	200N	50	50N	100	500	20000
23970	500	200N	100	50N	200	500N	20000
23971	3.500	200N	100	50N	200	500N	20000
23972	700	200N	100	50N	200	500N	20000
23973	500	200N	100	50N	500	500N	20000
23974	<b>700</b>	200N	100	50N	200	500N	20000
23975	700	200N	100	50N	200	500N	20000
24110 -	1000	200N	100	50N	300	5008	20000

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Note: The following elements were also analyzed but were not detected at the detection limit shown in (). Cd (50 ppm), Ge (20 ppm), Pd (5 ppm), and Pt (20 ppm). Mineralogical observations indicate that the following samples do not appear to be normal glaciofluvial samples: 23967 (pre-concentrated sample); 23969 (maybe a pre-glacial alluvium); and 23971 (active stream sediment sample).

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Table 9. Analytical results for the nonmagnetic (C-3) fraction of the heavy mineral concentrate samples determined by semiquantitative emission spectroscopy [N, not detected at the limit of detection shown; L, detected but below the limit of detection shown; G, determined to be greater than the value shown]...continued

DNR	<b>0</b> -1	Ee	Ma	Ne	n	τ;	1. 1 1 - 1	<b>1</b> 0	Ac	<b>A</b> 11	R	Ra	Be	Bi
umber		7e X	ng X	Na %	۶ ۲	*	• • •	bbw	ppm	ppm	ppm	ppm	ppm	ppm
4111	30)00	0.2	0.5	0.5L	20	2G		-1N	500N	20N	200	150	2L	20N
4112	2010.0	0.5	0.7	0.5L	10	2G		1N	500N	20N	100	200	2L	20N
4113	<b>30</b> 166	0.2	1	0.5L	20	2G		1N	500N	20N	70	100	2L	20N
4114	50 30	0.3	0.3	0.5L	20	2G		1N	500N	20N	50	100	2N	20N
1.12	11,000						de la							-1 <b>7.</b> 1
-1 - 1	75 A. C		$\overline{T}$											
 						· · · · · · · · · · · · · · · · · · ·	<u></u>	. ·						
ONR	2940													
ample	Co	Cr	Cu	Ga	La	Mn	2. 	Mo	Nb	Ni	Pb	Sb	Sc	Sn
umber	<b>pp</b> m	ppm	ppm	ppm	ppm	ppm		ppm	ppm	ppm	ppm	bbu	ppm	ppm
4111	20N	200	10L	10	300	500		10N	50L	10N	70	200N	20	70
112	20N	200	10	50	500	300	i den Set	10N	50L	10N	50	200N	20	200
113	20N	200	10L	20	300	500	1	10N	50L	10N	50	200N	15	30
4114	20N	200	_10	20	300	500		10N	50	10N	70	200N	15	20
	$\sum_{i=1}^{m}  A_i _{i=1}^{i}$													
• • • •	<ul> <li>A state of the sta</li></ul>	· · ·		. *										¥4
DNR	1991	······································					· .							
ample	Sr	• Th	<b>V</b>	W	Y	Zn	Zr				•			· •
umber	mqq	ppm	ppm	ppn	ppm	ppm	ppr	n						
4111	200	200N	150	50N	300	500N	2000	 DG						
4112	1000	200N	100	50N	500	500N	2000	DG						
4113/*	200	200N	100	50N	500	500N	2000	DG						
4114	300	200N	150	50N	300	500N	2000	DG						
	ipadag of all mapping fragments	200 1												
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	177° 6433 -		$z_{ij} = \frac{1}{2} \left( \frac{1}{2} - \frac{1}{2} \right)^{-1} = \frac{1}{2}$				÷					14.4 P	tel 1905 - po	19.5
lote: 1	he <sup>s</sup> followin	ng elements	were also a	nalyzed but	were not d	etected at t	he det	ection	limit shown i	n (). Cd (	50 ppm), Ge	(20 ppm), P	d (5 ppm), a	nd
P	τ (20 ppm).	•		· .		-				*1				

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DNR Semple Number	Sample Weight Grams	Preg-rob Test	Cyanide Leach Au opt*	Fire Assay Tailings Au opt*		
23932 23935 23960	1861 1824 1695	Negative Negative Negative	<0.002 <0.002 <0.002	<0.002 <0.002 <0.002		
ningen Newself Newself Newself Newself		·				,
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Table 10. Analytical results for cyanide leach assay of three pilot study archive samples

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1. 18 - 12 - 16 g	sin diligi in territori i			C	Pre-Related Min	nerals			
DNR							•		
Sample Number	Gold Grains	Scheelite Grains	Powellite Grains	Arsenopyrite %	Barite %	Cassiterite %	Chalcopyrite %	Marcasite %	Pyrite X
0431								· · · · · · · · · · · · · · · · · · ·	
2631									<1
2632									
2633									<1
2634									<1
2635		1			*				*
2636		2							
2637	1	1							
3901	1								
3902		2			2				
3903		3							<1
3904		6							
3905									
3906		1							<1
3907					<1				
3908		4							
3909									
3910									<1
3911		2			<1				ي العادي
3912		1							
3913									
3914		3			· ·				<b>&lt;1</b>

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## Table 11. Optical mineralogy data results for the non-magnetic (C-3) fraction of the heavy mineral concentrate samples

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See South	Gross Percentages of Rock-Forming and Accessory Minerals											Rock	Phosphatic
Sample Number	Andalusite %	Apatite %	Corundum X	Kyanite X	Mangano Diopside %	Rutile %	Sillimanite %	Sphene %	Spinel %	Tourmaline %	Zircon %	Silicate Minerals	Shell Fragments
20431		15				25	<u> </u>	35			20	P	
22631		30		<1		20		15			30	P	
22632		20		10		25		25			15	P	
22633		25		2		25		25			20	P	
22634	<1	15		<1		30		30			25	P	
22635		30				20		20			20	P	
22636		25		10		10		10			35	P	
22637		30		10		15		15			25	P	
23901	<1	30		5		5	5	20		5	30		Ρ
23902	30	30		2		2		2		2	30		
23903	30	30		2		2		2		2	30		
23904	5	50		5		5		10		5	20		
23905	2	30		2		2	2	30			30		Р
23906	2	30		2	<1	2	2	30			30		
23907	2	40		2	<1	2	2	20		2	30		
23908	4	50		4		4	4	10		4	20		
23909	10	30		6		6	6	20	<1		20		P
23910	4	30		4		4	4	30		4	20		
23911	3	30		3		3		30			30		
23912	4	50		4		4	4	10		4	20		
23913	<1	30		7		7	7	10		<1	30		
23914	15	30		-5	• *	5	5	10		· .	30		
23915	2	40		2	<1	2	2	20			30		
23916	30	30		5		5	5	5		<1	20		
23917	40	30				2	2	2		2	20		
23918	· · · · · · · · · · · · · · · · · · ·	30		2		2	2	2		<1	30		
23919	<b>8942</b> ∕s St	30		2	<1	2	2	30			30		
23920	87. <b>12</b> (* 14	40	1 <sup>1</sup>	2		2	2	20			30		
23921	2	50	19	2		2	2	10			30		
23922	50	10	an the	2		2	20	5		<1	10		
23923		30		5		5	5	5			20		1997 - A. 1999 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 19

Table 11. Optical mineralogy data results for the non-magnetic (C-3) fraction of the heavy mineral concentrate samples...continued

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Note: P = present

1944 A.S. Contaminants DNR 5 M Sample Aluminum Brass Copper Lead Number Particles Particles Particles Particles Remarks 20431 22631 22632 1 Contamination possibly from brass shell casing 22633 22634 22635 1 10 Contamination from leadshot 22636 22637 23901 5 Probably contains and alusite 23902 23903 23904 Probably contains andalusite 23905 23906 Probably contains mangano diopside (fluoresce pale blue-white) 23907 Probably contain mangano diopside (fluoresce pale blue-white) 23908 20 23909: < 3 a, Confirmed clear spinel which occurs as colorless, octahedral crystals 23910 'n 239119 23912 15 23913 44 12 Probably contains and alusite and tourmaline 23914 . \* 23915S Confirmed mangano diopside 23916 Probably contains tourmaline - 5 23917 23918 12 Probably contains tourmaline 1,121,2610 11.11.175.018 23919<sup>36</sup> á, Probably contains mangano diopside 1110860 11 23920 资料的自己的 目前 1010 1 1 2011 23921 44.67 23922 3 Probably contains tourmaline and the state of the state of the state 23923 ۲ (2) (25 c.) (3 konesisterede \$2000000

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Table 11. Optical mineralogy data results for the non-magnetic (C-3) fraction of the heavy mineral concentrate samples...continued

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## Table 11. Optical mineralogy data results for the non-magnetic (C-3) fraction of the heavy mineral concentrate samples...continued

523 ND:	9 44 20 5 20 6					Ore-Related Min	merals	. •	4. 4.	
minte	955 913	Cold	Scheelite	Pouellite	Arsononvrite	Rerite	Cassiterite	Chalcopyrite	Marcasite	Pyrite
mber	5	Grains	Grains	Grains	X X	*	*	*	2 <b>%</b>	*
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938	49	2	÷ _ 1						ŗ	
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952 057			5						· · · ·	
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774										<1

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SRAGE DNR S				Gros	s Percentages of Ro	ock-Forming	g and Accessor	y Mineral	S			Rock Forming	Phosphatic
Sample	Andalusite	Apatite	Corundum	Kyanite	Mangano Diopside	Rutile	Sillimanite	Sphene	Spinel	Tourmaline	Zircon	Silicate	Shell
lumber	<b>%</b> i	*	*	*	×	%	%	%	*	×	<b>%</b> -	Minerals	Fragments
23924	30	10		3		3	3	30		<1	20		
3925	30	20		5		10	5	30					
3926	10	3		3		3	30	40			10		
3927	30	20	3	3		3		30			10		
3928	2.	40		2	<1	2	2	20			30		
3929	5	30		5		5	5	30			20		5 c.
3930	5	30		5		5	5	15			30	P	
3931	<b>5</b> a	30		5		5	5	15			30		
3932		30		5		5	5	15			30		
3933	30	30		2		2	2	2		<1	30		
3934	10	30		3		3	3	20		<1	30		
3935		30		5		5.	5	15			30		
3936	<1	40		3	<1	3	3	20			30		
3937		30		5		5	5	15			30		
3938		30		5		5	5	15			30		
3939		40		3		3	3	20			30		1
3940		30		5		5	5	15		<1	30		P
3941	20	40	2	1		1	1	15		<1	20		
3942	10	40		1		1	. 1	15		<1	30		1420
3943	10	40		3		3	3	10			30	P	< .
3944	2	50	2	2		2	2	10			30		
3945	10	30		- 3		3 .	3	30			20		
3946	2	50		2		2		20			20	P	Р
3947 <sup>.</sup>	30	30		3		3		3			30		
3948	2	40		2		2	2	20			30		Р
3949		30		5		5	5	15		<1	30		
<b>3950</b> -	2	Se 30 S		2		10	2	10			40	P	••
3951 -	10	30		2		2	2	30			20	<b>-</b>	P
3952	15	30	ব	5		5	5	10			30		•
3953	15	30		3		3		15			30		
3954		50		2		2	2	10			30	P P	P
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Table 11. Optical mineralogy data results for the non-magnetic (C-3) fraction of the heavy mineral concentrate samples...continued

Contaminants DNR Sample Aluminum Brass Copper Lead Number Particles Particles Particles Particles Remarks 23924 Probably contains tourmaline 23925 23926 23927 Corundum confirmed 23928 Mangano diopside confirmed 23929 23930 Red and black schist fragments 23931 3 23932 23933 Probably contains tourmaline 23934 Tourmaline confirmed 23935 23936 Probably contains andalusite, mangano diopside confirmed 23937 23938 23939 Cassiderite confirmed 23940 Probably contains tourmaline 23941 5 Probably contains tourmaline 23942 Probably contains tourmaline 23943 3 23944 3 2 Corundum confirmed 23945 2 23946 23947 23948 23949 3 Probably contains tourmaline 25 23950 2 . 7 23951 6 1.35 3 2 23952 Corundum confirmed 23953 23954

Table 11. Optical mineralogy data results for the non-magnetic (C-3) fraction of the heavy mineral concentrate samples...continued

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				C	Dre-Related Mi	nerals			
ample umber	Gold Grains	Scheelite Grains	Powellite Grains	Arsenopyrite %	Barite %	Cassiterite %	Chalcopyrite X	Marcasite %	Pyrite %
955	<u> </u>	4			1.0				
956		1							
<i>.</i> 957									<1
5958 1950									
959 960	7	0				- 4			,
900	2	y 1	1			<1			
1901		2							-1
963		2							<1
i964		-							
3965					<1				
\$966									
5967	+20	+20			. *				<1
968									
3969		+6		<1	<1		<1	<1	80
3970									
<i>i</i> 971									30
5972	1	1							
973		1							
3974		2			н 1				
975		•							
4110		2							
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Table 11. Optical mineralogy data results for the non-magnetic (C-3) fraction of the heavy mineral concentrate samples...continued

DNR				Gros	s Percentages of Ro	ck-Formin	g and Accessor	y Mineral	<b>S</b>	• ·		Rock Forming	Phosphatic
Sample	Andalusite	Apatite	Corundum	Kyanite	Mangano Diopside	Rutile	Sillimanite	Sphene	Spinel	Tourmaline	Zircon	Silicate	Shell
Number	x	*	x	*	*	*	*	*	*	*	*	Minerals	Fragments
23955	2	40		2		2	2	20			30		
23956	2	30		2	<1	2	2	30			30		P
23957	2	30		2		2	2	30			30		Ρ
23958	30	30		2		2	2	2			30	و بغر مراجع	<ul> <li>A strategy and strategy and strategy</li> </ul>
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23960	10	30		3		3	3	20			20		P
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23962	30	30		3			3	3			30		
23963		40		3		10	3	10			30	P	P
23964	2	40		2		2	2	20			30	Real Providence	÷.
23965	20	50		3		3	3				20		Р
23966	2	40		2		2	2	20			30		P
23967	<1	20		<1		<1					80	· · · · · ·	-64
23968	2	30		2		15	2	15			30		P
23969	2	2		2		2					2		
23970	3	30		3		15	3	15			30		
23971		30	2	2		2	2	10	<1		20		Р
23972	3	30		3		15	3	15			30		Р
23973	20	30		3		3	3	10			30		
23974	20	30		3		3	3	10			30		Р
23975		30		5		10	5	20			30		Р
24110	3	30		3		10	3	20			30		P
24111	10	30		5		10	5	10			30		
24112	2	30		2		2	2	30			30	· .	
24113	10	30		5		10	5	10			30		
24114	10	30		5		10	5	10			30		

Table 11. Optical mineralogy data results for the non-magnetic (C-3) fraction of the heavy mineral concentrate samples...continued

...continued next page...

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## Table 11. Optical mineralogy data results for the non-magnetic (C-3) fraction of the heavy mineral concentrate samples...continued

		Contan	ninants									
DNR	·	D	<b>6</b>	المعط				. · · ·				
sample Number	Particles	Brass Particles	Particles	Lead Particles	Pemarks							
31. J. J. S.	P							······				
23955	ł0									5 - 1 12 - 1		
23956	÷.				Mangano diopside conf	irmed						
23957	10					•				· .		
23958`	2	· ·,										
23959		•••										5.
23960	55	• •			Cassiterite confirmed					1.1		że.
23961										1		
23962	\$	2										њ. С.
23963										1		52
23964	4									21		
23965												
23966												٤
23967	*	;			Pre-concentrated samp	le supplied b	y sand/gravel	operator, s	sample does	not appe	ear to be	normal
1. generation (* 1. sec. 1. sec					glaciofluvial sample,	sample very	fine rounded	grains, doz	ens of gold	grains		۰.
	· · ·									1. A		
23968	- 4									1.10		
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23968 23969	4				Sample does not appea stallactic-like forme	r to be norma d pysodomorph	al glaciofluvi ns after organ	al sample; ; ic material	grain morph , chalcopym	nology of rite confi	pyrite ap irmed	pears as
23968 23969 23970	аса <b>4</b> 17 Х.	•			Sample does not appea stallactic-like forme	r to be norma d pysodomorph	al glaciofluvi ns after orgar	al sample; ; ic material	grain morpł , chalcopyw	nology of rite confi	pyrite ap irmed	pears as
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23968 23969 23970 23971 23972 23973 23974 23975 23975 24110	20 20 20 20 20 20 20 20 20 20 20 20 20 2				Sample does not appea stallactic-like forme Active stream-sedimen	r to be norma d pysodomorph nt sample, com	al glaciofluvi ns after organ rundum confirm	al sample; ic material wed, clear s	grain morph , chalcopyn pinel octa	nology of rite confi nedral cry	pyrite ap irmed ystals con	pears as firmed
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Table 12. Description of the ore-related, rock forming, and accessory minerals observed optically in the nonmagnetic (C-3) fraction of the heavy mineral concentrate samples

#### ORE-RELATED MINERALS

- Arsenopyrite, FeAsS The arsenopyrite is grayish-black, granular, and intimately associated with pyrite. Sample number 23969 containing arsenopyrite was composed of 80% pyrite.
- Barite, BaSO<sub>4</sub> Barite occurs as single euhedral crystals or as broken cleavage fragments, mostly white, and some showing multiple growth lines. The edges of some crystals show jagged dissolution features.
- Cassiterite, SnO<sub>2</sub> Cassiterite occurs as pale yellow to brownish-black irregular grains with adamantine to greasy luster.
- Chalcopyrite, CuFeS<sub>2</sub> Chalcopyrite occurs as oxidized fine granular material in pyrite and appears to be locally derived.
- Gold, Au Gold is found as flattened grains or scales with rounded to ragged edges. The usual color is yellow, but some scales show a brownish to orange-red tarnish. The largest gold grain observed was less than 0.5mm. Orerelated minerals associated with gold are scheelite and powellite.

Marcasite, FeS<sub>2</sub> - Marcasite occurs as stalactic masses and in concentric structures with pyrite in sample number 23969.
 Powellite, CaNO<sub>4</sub> - The physical properties of powellite are similar to scheelite but the fluorescent color under shortwave ultraviolet is a brillant lemon-yellow inclining to yellowish-white with increasing substitution of tungsten for molybdenum. Powellite is formed through the oxidation of molybdenite and is often associated with scheelite.

**Pyrite;** FeS<sub>2</sub> - The pyrite occurs as isolated cubes, tarnished reddish-brown. In sample number 23969, the pyrite appeared to be pseudomorphs after organic matter.

Scheelite, CaNO, - Scheelite is found is granular grains with few euhedral faces, inclines to an adamantine luster and white to yellowish-white color. The scheelite is best identified under short-wave ultraviolet light where the fluorescent color is a vivid blue-white.

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#### ROCK-FORMING AND ACCESSORY MINERALS

Andalusite, Al<sub>2</sub>SiO<sub>5</sub> - The andalusite is usually prismatic to nearly square in form and ranges in color from flesh-red to pale violet, many showing dark inclusions.

Apatite,  $Ca_5F(PO_4)_3$ 

**Corundum, Al<sub>2</sub>O<sub>3</sub>** - The corundum is in rough angular pieces and typically dark smoky blue to pale blue color, some showing dark inclusions.

Kyanite, Al<sub>2</sub>SiO<sub>5</sub>

Manganoan diopside, (Ca,Mn)(Mg,Fe,Mn)[Si<sub>2</sub>0<sub>6</sub>]

Rutile, TiO,

Sillimanite, Al<sub>2</sub>SiO<sub>5</sub>

Sphene, CaTiSiO<sub>6</sub>

Spinel, MgAl<sub>2</sub>O, - The spinel occurs in colorless to pale blue octahedrons.

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Tourmaline, Na(Fe<sup>+2</sup>, Mg)<sub>3</sub>Al<sub>6</sub>(BO<sub>3</sub>)<sub>3</sub>(Si<sub>6</sub>O<sub>18</sub>)(OH)<sub>4</sub>

Zircon, ZrSiO4

Rock-forming silicate minerals

Phosphatic shell fragments

DNR Sample Number	Hornblende	Olivine	Epidote	Pyroxene	Garnet	Opaques	Iron Formation	Met/Ign Rock Fragments	Feldspar	Sphene	Biotite	Staurolite	Actinolite	Tourmaline	Quart
20431 22631 22632 22633 22634 22635 22636 22636	2.24 7.21 13.67 12.44 11.57 29.64 25.91	61.79 5.42 5.53 3.75 10.14 14.94 0.45 3.63	7.11 14.63 3.13 5.9 5.76 8.43 16.29 21.31	2.64 5.96 14.18 17.96 15.21 16.87 4.3 2.42	0.2 20.33 7.21 8.58 5.3 2.17 24.89 14.53	20.73 31.17 17.55 17.16 17.05 30.12 13.12 14.04	4.3 24.04 12.06 14.75 1.93 2.26 4.6	4.06 19.47 19.57 18.43 13.25 8.37 13.32	3.66 0.48	0.41 0.68 0.24	0.27 0.46	0.72 0.8	0.96 0.54 0.23 0.24	0.23	1.22
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Table 13. Quantitative mineralogical point count percentage data results for the paramagnetic (C-2) fraction of the heavy mineral concentrate test study samples

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DNR	HM	in an	Grain Size in	· · · · · · · · · · · · · · · · · · ·	W	eight %	of Elen	nent			Weigl	nt % of	Oxide			Total
Number	Fraction	Mineral	Hicrometers	Remarks	F	F=0	Cl	Cl=0	BaO	CaO	Fe0	MgO	MnO	P2 <sup>0</sup> 5	Sr0	Wt. %
20431	C-3	Apatite			5.73	2.41	0.02	0.00	0.01	54.90	0.00	0.01	0.05	41.70	0.01	100.0
20431 <sup>®</sup>	C-3	Apatite			5.43	2.29	0.39	0.09	0.02	54.03	0.38	0.10	0.95	41.04	0.05	100.0
20431	C-3	Apatite					1.30			51.84				41.23		94.37
20431	C-3	Apatite			3.73	1.57	1.78	0.40	0.00	54.59	0.23	0.07	0.05	41.47	0.06	100.0
20431	C-3	Apatite			5.32	2.24	0.02	0.00	0.00	55.05	0.03	0.00	0.00	41.81	0.02	100.0
22631	C-3	Apatite			4.38	1.84	0.01	0.00	0.00	55.22	0.02	0.00	0.00	41.94	0.27	100.0
22631	C-3	Apatite			5.09	2.14	0.11	0.02	0.00	55.03	0.01	0.02	0.10	41.80	0.00	100.0
22631	C-3	Apatite			5.04	2.12	0.01	0.00	0.04	55.07	0.04	0.02	0.05	41.83	0.03	100.0
22631	C-3	Apatite	•		3.71	1.56	0.03	0.01	0.01	55.50	0.04	0.00	0.05	42.16	0.08	100.0
22632	C-3	Apatite	•		4.50	1.89	0.80	0.18	0.00	54.86	0.18	0.04	0.03	41.67	0.00	100.0
22632	C-3	Apatite			5.52	2.33	0.10	0.02	0.01	54.79	0.23	0.02	0.06	41.62	0.00	100.0
22632	C-3	Apatite			5.37	2.26	0.00	0.00	0.00	55.01	0.01	0.00	0.01	41.79	0.07	100.0
22632	C-3	Apatite			4.93	2.08	0.22	0.05	0.00	55.04	0.03	0.00	0.04	41.81	0.05	100.0
22633	C-3	Apatite			4.40	1.85	0.14	0.03	0.00	54.99	0.23	0.11	0.06	41.77	0.19	100.0
22633	C-3	Apatite			6.08	2.56	0.00	0.00	0.05	54.57	0.02	0.00	0.05	41.45	0.34	100.0
22633	C-3	Apatite			4.77	2.00	0.01	0.00	0.00	54.97	0.00	0.00	0.00	41.75	0.51	100.0
22633	C-3	Apatite			5.80	2.44	0.42	0.10	0.00	54.40	0.31	0.23	0.36	41.32	0.00	100.0
22634	C-3	Apatite			4.84	2.04	0.02	0.00	0.04	55.16	0.04	0.01	0.05	41.89	0.00	100.0
22634	C-3	Apatite			4.17	1.76	0.02	0.00	0.00	55.27	0.04	0.01	0.00	41.98	0.28	100.0
22634	C-3	Apatite			3.67	1.54	0.03	0.01	0.00	55.51	0.03	0.01	0.07	42.16	0.08	100.0
22634	C-3	Apatite			3.68	1.55	0.15	0.03	0.01	55.49	0.06	0.02	0.04	42.14	0.00	100.0
22635	C-3	Apatite			4.80	2.02	0.01	0.00	0.00	54.68	0.00	0.00	0.02	41.53	0.99	100.0
22635	C-3	Apatite			4.65	1.96	0.00	0.00	0.00	55.24	0.01	0.00	0.00	41.96	0.11	100.0
22635	C-3	Apatite			3.17	1.33	0.15	0.04	0.00	55.62	0.03	0.00	0.07	42.25	0.07	100.0
22635	C-3	Apatite			3.55	1.49	1.15	0.26	0.00	54.98	0.20	0.01	0.06	41.76	0.06	100.0
22636	C-2	Apatite		Inclusion in monazite.						53.34				41.17		94.51
22636	C-2	Apatite	10x10	Apatite inclusion in fibrous						54.66				41.70	· • · · · ·	96.36
y Tai Galia	guard for	• •		REE-carbonate? (22636, No. 7)												
22636	C-3	Apatite			5.69	2.39	0.02	0.01	0.03	54.81	0.07	0.02	0.14	41.63	0.00	100.0
22636	C-3	Apatite			4.17	1.75	0.01	0.00	0.00	55.41	0.03	0.01	0.05	42.09	0.00	100.0
22636	C-3	Apatite			5.99	2.52	0.22	0.05	0.00	54.72	0.03	0.00	0.05	41.56	0.00	100.0
22636	C-3	Apatite			5.38	2,63	0.01	0.00	0.00	55.00	0.00	0.00	0.07	41.78	0.03	100.0
22637	C-3	Apatite			5.96	2.51	0.02	0.00	0.03	55.57	0.00	0.00	0.03	41.45	0.47	100.0
22637 -	C-3 86	Apatite			5.37	2.26	0.06	0.01	0.00	55.12	0.00	0.01	0.04	41.78	0.00	100.0
22637	C-3	Apatite			5.22	2.20	0.07	0.02	0.01	55.00	· 0.08	0.01	0.06	41.77	0.00	100.0
22637	C-3	Apatite			5.64	2.37	0.19	0.04	0.01	54.83	0.03	0.00	0.05	41.64	0.03	100.0

# Table 14. Nineralogical and chemical data results for apatites identified by electron microprobe analysis for the heavy mineral concentrate test study samples

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		- 長むのアッシュー - 「								3	
able 15	. Minera	logical and	chemical data results for monazites identified	by electron microphobe ar	nalysis for	the heavy	mineral c	oncentra	ate test	study	sampl
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व्यः संस्थाः इ.स. १९११	· · ·	5						an ar a Starta	i inter	- 48 - 62,5 	• •
	HM								2.114	e e	
amole	Conc.	(. <sup>12</sup> )							. •		
umber	Fraction	Mineral	Remarks								
0/74 -					<u></u>		·		· · · · ·		
04318	C-3	Monazii	e A uttnium-nich venictu of monorite commi	un in the commin which not					~ *		
04310	0.7	Monazi	A VITTUM-FICH VARIETY OF MONAZITE OCCURTI	ng in the sample which rep	presents the	e Duluth Co	mplex are	8.			
04310	C-3	Monazii					11 A.	et al.			
04510	C-3	Monazi		е. Т							
26318	C-1	Monazi	e Inclusion in magnetite							- 154 	
26315	C-1	Monazi	e Inclusion in magnetite							· ·	
26310	C-2	Monazi	e							an de la composition de la composition Composition de la composition de la comp	
2631d	C-2	Monazi	e								892
2631e	C-2	Monazi	e Inclusion in ilmenite.					14 440 1	1.94	i ta Line	1.11
2631f	C-2	Monazi	e					1.			1.00
2631g	C-3	Monazi	e						ر این کامبر ا	6 (B)	1 e 1
2631h	C-3	Monazi	:e	20					変動の		
2632a	C-1	Monazi	e In contact with titanium magnetite			• •	1	€1-c2	· · · · ·	· · ·	÷
2632b	C-2	Monazi	e				· · · ·		$\sim \xi^{+}$	010 t	
2632c	C-2	Monazi	ie in the second se						- 1		
2632d	C-3	Monazi	te							*	
2633a	C-3	Monazi	te					*			
2634a	C-1	Monazī	te Inclusion in magnetite						1.1		
2634b	C-2	Monazi	te						1.14		. *
2634c	C-2	Monazi	te Inclusion in hematite?	:					1.2.30	المريد الم	
22634d	C-2	Monazi	te Inclusion in hematite (?). Ce-rich variety						:*a	2.54	
2634e	C-3	Monazi	te in the second s	- 						81 J.L	
22634f	C-3	Monazi	te	- 1				1. A.			
22635a	C-3	Monazi	te								
22636a	C-1	Monazi	te							10 <b>1</b> 0 - 0	
2636b	C-2	Monazi	te								
2636	 C-2	Monazi	 te Point 2 of 3 on 100v50 micromoton						n e e e e e e e e e e e e e e e e e e e		
26364	12612 1201	Monazi	ta "						:		
226360	C-2	Monazi		9							
20205	C-2	Monari									
22474	0-6 	Monari	to Deint 1 of 7 on /EuDO missionstants								
120309	0-2	Monazi	Le Foint i of 3 on 45x80 micrometer grain.								
	6-2 •*	Monazi	te Point 2 of 3 on 45x80 micromèter grain.	2		.*		r. + ;		ана Алана Ала	
20301	U-2	Monazi	te				- 1				
226366 22636f 22636g 22636h 22636h	C-2 C-2 C-2 C-2 C-2 C-2 C-2	Monazi Monazi Monazi Monazi Monazi	te te Point 1 of 3 on 45x80 micrometer grain. te Point 2 of 3 on 45x80 micrometer grain. te			·*			• •		n a ser a Ser a ser

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DNR	Grain								We	ight %	of Oxide	es								<u></u>	
Sample Number	Size in Micrometers	As <sub>2</sub> 03	Bi02	СаО	CeO2	Fe0	6d <sub>2</sub> 03	<sup>Ho</sup> 2 <sup>O</sup> 3	<sup>La</sup> 2 <sup>0</sup> 3	Nd203	P2 <sup>0</sup> 5	PbO	Pr0 <sub>2</sub>	sio <sub>2</sub>	<sup>Sm</sup> 2 <sup>0</sup> 3	<sup>SO</sup> 3	Sr0	Th02	<sup>U0</sup> 2	<sup>Y</sup> 2 <sup>0</sup> 3	Vt. %
20431a				0.83	29.00	<del></del> .		1.04	13.79	9.47	27.51	0.72	2.89	1.25	1.05	<i>.</i>		9.88	**.*	·	97.4
20431ь				1.31	27.77				14.88	8.90	28.46	0.91	2.36		0.77			7.38	1.05	2.39	96.2
20431c				0.21	32.56				8.54	15.24	28.49	0.44	4.48		1.13			0.24			91.3
20431d				1.16	29.70				15.39	11.26	29.39	1.31	4.24		0.71			5.60			98.8
22631a	6x3			.56	28.65				12.72	9.95	26.08	2.26	3.53	2.38				12.19			98.37
22631b	13x8			1.17	33.54				17.99	9.28	28.47	.49	4.00	1.52				(5.41			101.9
22631c	12x13			1.68	27.70				14.75	9.62	29.74	0.84	2.58					5.67	2.60		95.19
22631d	100x40			1.36	29.61				15.89	10.01	29.52	0.96	2.93					6.61			96.93
22631e	12x13			0.54	25.55	1.58	2.17		11.49	14.63	30.17	0.72	2.82		2.27			2.60			94.60
22631f	150x50			0.68	29.46				15.27	10.16	27.45	1.49	4.37	1.58				10.01			100.5
22631g				0.63	31.81				16.97	9.74	28.28	1.16	3.85	0.78				6.26			99.5
22631h		•••		1.36	26.36				15.67	6.73	27.49	1.61	1.31	1.40	1.08	,		12.11			95.1
22632a	15x25	5.1		.93	32.83				15.77	11.16	28.28		3.53	.55		1.96		1.41			96.45
22632b	100x150			1.23	29.25				14.73	9.03	30.43	1.22	3.49					6.95			96.37
22632c	60x40		2 <sup>1</sup> -	0.72	25.90		1.77		12.73	14.37	30.27		3.91		2.24			3.49			95.43
22632d	$\sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{i$		0.66	1.35	29.67				13.79	10.81	29.68	1.23	2.81		1.52			7.48			99.0
22633a	$\sum_{i=1}^{n-1} \cdots \sum_{i=1}^{n-1}$		an shi na shi G	1.06	29.55		1.01		15.73	10.56	29.49	0.70	2.91		1.51			4.82			97.4
22634a	7x5			1.49	27.38				14.72	8.18	28.31	1.77	3.06	.63		a .		10.76			96.33
22634b	100x60			0.70	30.78	0.23			15.79	9.63	27.76	0.88	2.21	0.78				4.91			93.71
22634c	35x20	1.86		0.23	26.47	2.11	1.36		10.06	17.83	29.16		3.83	0.54	3.68			0.36			97.55
22634d	12x15	· * .		1.08	64.36					· ·	24.89										90.34
22634e	•		11	0.52	31.46				17.82	9.84	28.86	1.24	2.89	0.96	1.13			4.86			99.6
22634f				1.39	28.60				13.75	11.45	30.88	1.05	3.60		1.10			5.64			97.4
22635a	**			0.90	29.34				17.80	11.97	29.77		3.44		1.47			1.31			96.0
22636a	35x100			.81	30.31				17.29	8.65	27.33	1.11	2.61	1.27				10.24			99.66
22636b	100x50			1.34	23.99				12.54	8.16	24.55	2.50	3.00	2.39				15.36			93.87
22636c	100x50			1.33	29.04				15.97	8.37	28.24	1.51	2.21	0.36				8.87			95.95
22636d	30x40			0.84	29.79		1.96		12.65	12.98	30.50	0.71	3.88		1.66			3.65			98.66
22636e	6x5			0.27	31.09	2.02	1.42		13.28	12.44	30.24		2.47					0.39			93.86
22636f	150x70			1.27	28.21				14.79	10.15	29.79	0.53	2.79					5.61	•		93.57
22636g	45x80			1.29	26.10				13.86	8.37	27.36	1.27	2.26	1.09				10.57		2.57	94.77
22636h	45x80			0.65	22.22		1.65		8.76	11.34	23.70	2.31	3.83	3.26	1.56			19.25		2.33	100.8
22636 i	6x3		۰.	1.20	28.86				17.23	7.70	27.73	÷	3.47	0.43			1.82	7.99		2	96.45

Table 15. Mineralogical and chemical data results for monazites identified by electron microprobe analysis for the heavy mineral concentrate test study samples ...continued

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NR 24	<b>U</b> IIM								a sal			
mole	Conc			÷.					· .			
mber	Fraction	Mineral	Remarks									
536 J	C-2 100	Monazite	With two inclusions, thorianite a	and apatite	<u></u>				n dan series and series		÷	
36k	C-3	Monazite							l In			
37a	C-2	Monazite	Core; same grain in all 5 analyse	es of 22637a-e					1. 1. 1. 1. 1.			
37b	C-2	Monazite	Zone 1; same grain in all 5 analy	/ses of 22637a-e					• Š			
37c	C-2	Monazite	Zone 2, Th-rich; same grain in a	ll 5 analyses of 2263	7а-е						-	•
37d	C-2	Monazite	Rim 1; same grain in all 5 analys	ses of 22637a-e					te î ĝis		<b>.</b>	
37e	C <sup>2</sup> 2 <sup>00</sup> 0	Monazite	Rim 2; same grain in all 5 analys	ses of 22637a-e								
537f	C-2	Monazite	Inclusion in magnetite?, high Fe	, which is probably a	it least partly	derived fro	om surroundin	gs.	1997 - 1997 1997 - 1997 - 1997 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1		1.00	).
537g	C-2	Monazite	Inclusion in silicate.		t.				9 (S)		÷.	
537h	C-2	Monazite	Zoned monazite, Th-rich, same gra	ain as 22637i							6	:
37i	C-2	Monazite	Zoned monazite, Th-rich, same gra	ain as 22637h					1.13		144	k <sup>1</sup>
37j	C-3***	Monazite	Nd-rich <sup>®</sup> monazite occurring as a	20x20 micrometer incl	usion in ruti	le.			1.95		۰ ۳۰۰۰	ŝ.
37k	C-3	Monazite	Nd-rich monazite occurring as a	20x20 micrometer incl	usion in ruti	le.						
371 192	C-3	Monazite	Inclusion in apatite, Th-rich, h	igh silica could indi	icate a mixtur	e of monazito	e and thorite	-	÷.			
	1.0%Ex		d ve									
6 N	15410		and the second	· · ·					÷			
14	100-40				2				5.22			
₹1 <sup>4</sup>	17847		4		•				2 T.	5120	1997 - 1997 1997 - 1997	
236	1520				4							-
<b>R</b> (*)	QX7.				· · · ·				$(1_{2})$		ration (* 1977) Stand	
P 2N			•	•					9.70		283 - ÓS	ŧ.
327 - S									3125	ž		÷
8 C.				· · · · · · · ·						1.55	512 - SCI	÷
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	$e^{i \frac{1}{2}}$											
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DNR	Grain		<b>v</b> ) -		1				We	eight %	of Oxid	es									
Sample	Size in		н н 1																		Total
Number	Micrometers	As <sub>2</sub> 03	BiO2	CaO	CeO2	Fe0	Gd <sub>2</sub> 03	<sup>Ho</sup> 2 <sup>O</sup> 3	La203	Nd203	P2 <sup>0</sup> 5	Pb0	Pr02	si02	<sup>Sm</sup> 2 <sup>0</sup> 3	<sup>so</sup> 3	Sr0	Th02	<sup>U0</sup> 2	۲ <sub>2</sub> 03	Wt. %
22636 j	70x70			0.67	31.76	·			16.45	10.19	29.45	·····	3.27	0.53	1.04			4.15			97.54
22636k	N. C.		0.55	0.89	31.56				15.48	10.96	28.83	1.27	3.48					6.91			100.0
22637a	1999 av 199	•	14.5	0.41	28.67				15.90	9.17	27.19	1.08	1.96	1.16				6.76		1.43	93.77
22637b		•. •		0.40	29.20				15.35	10.32	27.91	1.09	3.26	1.11				6.70		2.14	97.53
22637c	R. 1.2			0.61	27.74				14.57	9.92	25.35	2.22	4.33	2.50				13.87			101.1
22637d	1 × 1	,		0.29	31.59				15.24	10.26	27.84	1.06	3.97	0.83	1.40			5.50		1.77	99.80
22637e	1. J. 1.	•		1.10	31.94				17.70	9.78	29.05	0.95	3.67					1.64			95.86
22637f	15x5			0.85	27.37	8.20	1.48		9.57	16.76	27.77	0.80	4.74		3.06			0.67			101.3
22637g	30x15				21.93				7.78	13.67	24.51	1.95	2.25	2.52	1.78			11.92		3.19	91.54
22637h				0.84	24.47				11.65	8.56	22.40	2.78	2.69	3.63				18.99			96.05
22637i				1.83	26.33				12.82	9.68	28.50	1.61	3.64					10.17		1.95	96.57
22637 j	20x20				16.81		3.44	0.75		33.15	34.35		4.56		6.94						100.0
22637k	20x20				16.44		2.91			31.53	30.43		5.63		6.91			0.28			100.0
226371	8			4.93		1.64			1.53		10.53	2.65		8.31				66.81	3.60		100.0
	C - D																	11111111	1		
11 - A -																					
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$(M_{i}) \in \mathcal{C}$	1	1 - 18 B 18	1.1																		
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$\int_{\mathbb{R}^{n}}  h_{i} ^{2} dx = \int_{\mathbb{R}^{n}}  h_{i} ^{2} dx = \int_{\mathbb$			•																		
1911-12	(*************************************	$\beta_{\mathbf{y}} \neq 0$	• •																		
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Table 15. Mineralogical and chemical data results for monazites identified by electron microprobe analysis for the heavy mineral concentrate test study samples ...continued

DNR Sample	HM Conc.	2			#**** <u>********************************</u>
Number	Fraction	Mineral	Remarks		
20431a	C-1	Baddeleyite	Inclusion in Ti-magnetite		
20431b	C-1	Baddeleyite	Inclusion in Ti-magnetite		
20431c	C-1	Baddeleyite			
20431d	C-1	Baddeleyite	Inclusion in ilmenite		
20431e	C-1	Baddeleyite	Inclusion in ilmenite		
20431f	C-1	Baddeleyite	Inclusion in ilmenite		Rî.
20431g	C-3	Baddeleyite	Very pure, 100.05 wt.% Zr02.		
20431h	C-3	Baddeleyite	Apatite, 10x10 micrometer, occurs as an inclusion in this baddeleyite grain.		
20431i	C-3	Baddeleyite/thorianite	A solid solution or mixture between baddeleyite and thorianite.		
20431 j	C-3	Thorite	This grain contains also some 'lighter phase'.		
20431k	C-3	Microlite?	A tantalum-bearing mineral. This mineral is probably microlite, a member of the	e pyrochiore group.	
20431l	C-3	Galena			1
22631a	<sup>500</sup> C-1	Unknown	Inclusion in magnetite, all elements analyzed		
22632a	C-2	Baddeleyite	Inclusion in ilmenite.	,	
22632b	C-2	Baddeleyite	Inclusion in ilmenite.		$a = \frac{1}{2}$
22632c	· C-2	Native silver	Si and Fe from surrounding matrix?, all elements analyzed.		
22633a	20% C-1	Thorite ?	Inclusion in magnetite		
22633b	<sup>2,59</sup> C-1	Baddelevite	In the core of the magnetite		•
22633c	C-1	Zircon	In the rim of the magnetite	•	inter a state of the
22633d	C-1	Baddelevite	Inclusion in ilmenite	2.51	Al Taking La Ang San San San Maring San San
22633e	C-1	Baddelevite	Inclusion in ilmenite	t <sub>e</sub> i e	9
22633f	C-1	Baddelevite	Inclusion in ilmenite		9. 10 19 <b>68</b> - 19
22633g	C-3	Tin-Lead-copper allov?		1	1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 19
22633h	C-3	Thorite	$e^{-i\omega t} = e^{-i\omega t} e^$		
22634a	30°C-2	Baddelevite	Inclusion in ilmonite	$r = f_{\alpha}$	
22635a	C-1	Raddelevite	Inclusion in felderer (2) which is inclusion in Ti-momentite	an a	a a terretaria
22635b	ANT CHING	Raddelevite	Inclusion in ilmonito		· · · ·
226350	ais ~ m	Baddalevite	Inclusion in ilmonite		
22635d	100 M	Raddel evite	Inclusion in cilicate		
22635e	C-1	Raddelevite	Inclusion in ilmonito	get game www.g. w	
226369	C-1	linknoun			
226345	n-2 <sup>-4</sup> -		Point 3 of 3 on 100450 minumeter and		•
226360	v-د مورد م	211CUI	FUNIL 3 OF 3 ON HUX30 MICROMETER GRAIN.	e vi competition éste	s kraife on aire.
220300	6-2	REC-Carbonate(/)	ribrous rare earth element-carbonate(?), LOW 69.7 Wt. % total could suggest CO3	ion instead of oxyge	:n <b>.</b>

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Table 16. Mineralogical and chemical data results for miscellaneous minerals identified by electron microprobe anaysis for the heavy mineral concentrate test study samples

-5. ( <u>)</u> -6													
DNR Sample	Grain Size in					Weight X	6 of Elemen	nts					
Number	Micrometers	Ag	Bi	Cu	Fe	Pb	Pt	S	Si	Sn	W		
20431a	60x15									· · · · · · · · · · · · · · · · · · ·			
20431b	50x50											$\sum_{i=1}^{n} (i = 1)^{n-1}$	
20431c	35x22												
20431d	30x5												
20431e	60x3												
20431f	5x25												
20431g	600x650												
20431h	70x65												
20431i													
20431]	1100x800												
20431k	a An an											and the second	Sec. 1
204311						90.68		12.37					
22631a	5x6					-80	55.36				40.47		
22632a	25x7												
22632b	20x5												
22632c		92.63			2,23				0.58				- -
22633a	4x2												
22633b	10x6												
22633c	15x15												
22633d	25x6												
22633e	10x18												
226336	97												
226330	701			1 77		9 05				88 70			
22633h						0.75				00.70			
22636	75.05											·	
22475-	25.0												
220338	2320												
220330	2588												
220330	15×10												
220320	16X8					<i>i</i> .							
22055e	5x12												
22636a	1.5x2		84.58	7.08	8.06			3.03					
22636b	100x50												
22636c	200x60												

Table 16. Mineralogical and chemical results for miscellaneous minerals identified by electron microprobe analysis for the heavy mineral concentrate test study samples...continued

...continued next page...

NR	が行き 19×10						Weight	% of Ox	des									
nber opson	Al <sub>2</sub> 03 BaO	CaO	CeO2	CuO	<sup>Dy</sup> 2 <sup>0</sup> 3	Er2 <sup>0</sup> 3	FeO	6d203	Hf02	<sup>La</sup> 2 <sup>0</sup> 3	₩n0	Nb205	Nd203	P205	PbO	Proz	Se02	sio <sub>2</sub>
431a				- ····· ·					1.15									
431b									.49									
431c									1.46									
431d	, ., .,																	
431e	(****;																	
431f	<u> 《</u> 》第40																	
431g	12×12																	
431h	gi (getini) a tanan																	
431 i	4 3 C														3.87			0.77
431 j	0.93	0.84	2.40				2.48						2.13	1.68	1.63			17.2
431k	an ann i Stòrach	13.17					0.45				1.60	3.24						
431ľ	in the second																	
631a -									1. 1. 2					8 - No.4		ie deletado		t si si si
632a (70)																	•	
032D	Thorses														s franke.	te de l'Ale	n i jeda	
032C	an a	2 07																
0338 4775	4 1 Lat	2.83	.80				4.27						1.51	3.89	2.02			14.00
477	States - 1																	
6336	.: ****								.85									31.29
6320	2003																	
477f	$M^{2}$ $\sim$																	
6330	- e t																÷	
633h		2 80	1 25				1 9/							7 35	4 9/			40.4
6349	No. 1	2.07	1.4.5				1.04							(.2)	1.04			10.3
635a	Ň								1 48									
635b	with the set of the								67									
635c									1 36									
635d			\$						1 43									
635e									1 00									
636a									1.07									
636b	1																	30 //
636c	n a christer 🥈	3.93	29.95			· · ·	2.52		·	20,92			7 31		e porte	3 0/	en Angela	0.4
-																0.04		0.0

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Table 16. Mineralogical and chemical data results for miscellaneous minerals identified by electron microprobe analysis for the heavy mineral concentrate test 536262 study samples...continued

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DNR					Weight	: % of 0	kides						
Sample												Total	
umber	soz	Sr0	<sup>Ta</sup> 2 <sup>0</sup> 5	ThO2	<sup>T 10</sup> 2	<sup>U0</sup> 2	v205	<sup>Y</sup> 2 <sup>0</sup> 3	Yb203	ZnO	Zr02	Wt. %	
0431a								<u> </u>			105.2	106.4	
204316											104.9	105.4	
20431c											104.1	105.5	
20431d											96.16	96.16	
20431e											91.07	91.07	
20431f											102.4	102.4	
20431g											100.0	100.0	
20431h					0.53						<b>99.</b> 18	99.7	
20431 i		1.02		37.82		9.97	•				42.90	96.4	
20431 j	1.03			65.25								95.6	
20431k	1.01	19 - Sa	77.92		0.44							96.8	
204311	17. 17 1	чњ. <sup>1</sup>										103.0	
22631a	<b>.</b>											96.64	
22632a	Č - j		•.						•		100.0	100.0	
22632b	G-1	1.000	· · ·								98.67	98.67	1
22632c	$Q_{2,2}$	:										95.45	
22633a	19 - 19 1 - 2			60.52				5.56				95.44	
22633b	1. 3		·								96.19	96.19	
22633c	1. <sup>10</sup> .	1.1									67.74	99.87	
22633d	5 - 5 5 - 5										98.97	98.97	
22633e	<b>C</b> - 3										100.5	100.5	
22633f		e.	i -			· · · · ·		•	· .		93.52	93.52	
22633g	· · · · · ·	ŧ.										99.4	
22633h	194 (S			53.23		6.55					4.26	89.2	·
22634a	۰۰ می ب	· · · ·	. *						12		<b>99.</b> 17	99.17	
22635a											100.5	102.2	
22635b	$\frac{1}{2} = \frac{1}{2} \left( \frac{1}{2} + \frac{1}{2} \right)^{-1}$	, <b>-</b>									100.8	101.5	
22635c	$(1, \frac{1}{2}) < 1$										101.7	103.1	
22635d											101.8	103.2	
22635e											101.0	102.1	
22636a												102.7	
22636b	et av s	en a <sup>7</sup> t≵									65.39	95.80	
22636c 🐑	and the set	da en el como	: • •	1.14								69.70	

Table 16. Mineralogical and chemical data results for miscellaneous minerals identified by electron microprobe analysis for the heavy mineral concentrate test study samples...continued

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 Table 16. Mineralogical and chemical data results for miscellaneous minerals identified by electron microprobe analysis for the heavy mineral concentrate test

 study samples...continued

DNR Sample Number	HM Conc. Fraction	Mineral	Remarks				
22636d	C-2	Unknown	Point 3 of 3 on 45x80 microme	ter grain, t	his could be a mixture b	between zircon and something else.	
22636e	C-2	Unknown	Very small grain, this could	be a composi	te grain of vanadinite a	and something else.	
22636f	C-2	Galena	Inclusion in monazite, all el	ements analy	zed.		
22636g	C-2	Pyrite	FeS2 inclusion in the monazit	e with Pbs,	all elements analyzed.		
22636h	C-2	Unknown					
22636 i 🗉	C-2	Thorianite	Inclusion in monazite				
22636 j	C-2	Xenotime					
22636k	C-3	Barite					
22636l	C-3	Uraninite					
22637a	C-1	Unknown	In magnetite, most probably A	b-Fe-oxide.	Extra Fe in the analys	is from surrounding magnetite.	
22637ь	C-1	Unknown	In magnetite, most probably i	b-Fe-oxide.	Extra Fe in the analys	is from surrounding magnetite.	
22637c	C-1	Unknown	In magnetite, most probably A	b-Fe-oxide.	Extra Fe in the analys	is from surrounding magnetite.	
22637d	C-1	Unknown			·		
22637e	C-1	Unknown	Inclusion in magnetite				
22637f	C-1	Baddeleyite	In contact with magnetite				
22637g	- C-2	Zircon	Inclusion in silicate.				
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557753							
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State -							
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DNR	Grain Size in					Weight X	of Elem	ents		<u></u>		
Number	Micrometers	Ag	Bi	Cu	Fe	Pb	Pt	S	Si	Sn	u	
22636d	45x80			<u> </u>						· · · · · · · · · · · · · · · · · · ·		<u> </u>
22636e	2x2											
22636f	1x1					86.91		13.06				
22636g	7x6				46.01			51.77				
22636h												
226361												
22636 j	30x15											
22636k												
226361	40.45											
2203/8	10X15											
220370	7.80											
226376	223											
22637e	7x5											
22637f	30x20											
22637a	7x6											
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Table 16. Mineralogical and chemical results for miscellaneous minerals identified by electron microprobe analysis for the heavy mineral concentrate test study samples...continued

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DNR								Weight	% of Oxi	des									
lumber	۸۱ <sub>2</sub> 03	BaO	CaO	CeO2	CuO	<sup>Dy</sup> 2 <sup>0</sup> 3	Er2 <sup>0</sup> 3	Fe0	Gd203	Hf0 <sub>2</sub>	La203	MnO	Nb205	Nd203	P205	PbO	Pr02	Se02	sio <sub>2</sub>
2636d	2.49		1.28	1.37				38.47						0.72	1.99	0.52			14.59
2636e					1.62			3.28								55.46			
2636f																			
2636g			40.74	o 7/							F 07								
2030N	20.17		12.31	Y.34				12.21			5.07			2.00		10 97		2.71	32.90
2636 i						4.16	3 01		1.78						31.22	10.07			
2636k		63.20				4.10	5.01		1.70						31122				
26361																27.14			
2637a								15.49								92.72			
22637ь	:							12.74								96.13			
22637c	· .							15.95								89.75			
22637d								24.31								76.11			
2037e								29.17		4 74						79.56			
22637a								1 11		1.20									31 21
			,																01121
s																			
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Table 16. Mineralogical and chemical data results for miscellaneous minerals identified by electron microprobe analysis for the heavy mineral concentrate test study samples...continued

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DNR					Weigh	t % of 0;	kides					
Sample Number	so3	Sr0	<sup>Ta</sup> 2 <sup>0</sup> 5	Th02	Ti02	<sup>U0</sup> 2	v <sub>2</sub> 05	<sup>Y</sup> 2 <sup>0</sup> 3	<sup>Yb</sup> 2 <sup>0</sup> 3	ZnO	Zr0 <sub>2</sub>	Total Wt. %
22636d	······			1.85							18.26	81.58
22636e							20.25			16.04		96.68
22636f												99.98
22636g												97.79
22636h		1.59										98.39
22636i				84.18		9.22						104.2
22636 j								61.97	2.71			104.8
22636k	34.87	0.85										98.9
226361				7.59		59.08		3.47				97.3
22637a												108.2
22637b												108.8
22637c												105.7
22637d												100.4
22637e												108.7
22637f											103.6	104.9
22637g											65.95	98.27

Table 16. Mineralogical and chemical data results for miscellaneous minerals identified by electron microprobe analysis for the heavy mineral concentrate test study samples...continued

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Adrian, B.M., and Carlson, R.R., 1990, A method for semiquantitative spectrographic analysis of fire assay dore' beads for the platinum-group elements and gold, *in* Zientek, M.L., and Page, N.J., Consultancy services in platinum-group mineral exploration for the Directorate of Mineral Resources (Indonesia): U.S. Geological Survey Open-file Report 90-527, p. 196-202.

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## **EXPLANATION**

MAJOR P	RECAMI	BR	IAN TERRANES OF	MIN	NESOTA
TECTONIC ELE	DMENT		PRINCIPAL ROCK TYPES		AGE
Midcontinent rift	system ,		en en el	l La jug	
late- and post-rift	• Pms •		Fluvial and lacustrine clastic sedimentary rocks	o saandi Lookala o Iowoo	Middle Proterozoic; 1100
			sedimentary deposits		പ്രാത്രായ അവരം പ്രവർത്തായി. എവര്ത്തം പ്രാത്രം പ്രം
Sloux Quartzite basins	··· Peq ·		Fluvial, sand-dominated redbed sequences in basins that may be fault-controlled	e sundi I	Early Proterozoic; probably between 1760 and 1630 Ma
Penokean orogen					
loredeeps	-Pef-		Turbiclitic graywacke-shale sequences		
fold-and-thrust belt	Pet		Passive-margin metavolcanic and meta- sedimentary rocks, tectonically imbricated		Early Proterozoic; mainly between 2200 and 1760 Ma
intrusion-dominated magmatic terrane	APei -		Syn- to post-kinematic intrusions of granitoid rocks into complex metamorphic terrane		
Superior craton	<u></u>				
Greenstone-granite ter	Tane			12.1	
Wabigoon subprovince	"Alvi	E	Arc-like volcanoplutonic sequences; syn- to post-kinematic granitoid intrusions		
Quetico subprovince	· AIS -	ccretio	Turbidite-dominated metasedimentary rocks (accretionary complex?); granitoid intrusions		plutonic belts mainly 2750-2695 Ma; Ouetico belt
Wawa- Shebandowan subprovince		tonic a	Arc-like volcanoplutonic sequences; syn- to post-kinematic granitoic intrusions		2690-2650 Ma
"quiet zone"		e of tec	Poorly known belt of rocks comparable to Wawa-Shebandowan; regionally retrograded		Syntectonic plutonism, 2688 Ma (unpub. data, Z.E. Peterman)
Gneiss terrane		e u o			
Benson block	Amgi	sequ	Poorly known terrane composed of gneiss and abundant granitoid intrusions		Middle and late
Montevideo block	Amg2	nferred	Amphibolite- to granulite-grade gneiss of plu	rtonic	Archean; complex history spans interval 3550 to 2550 Ma
Morton block		-V	and supracrustal derivation; granitoid intrusic	ons .	

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Major structural discontinuities

Malmo discontinuity (Early Proterozoic): Separates supracrustal panels of Penokean fold-and-thrust belt from deeper crustal zone to south

Vermilion fault zone (late Archean): Obliquely cuts and displaces subprovince boundaries within the Superior craton

.

Great Lakes tectonic zone (GLTZ; late Archean with probable Proterozoic reactivation): Separates high-grade gneissic terranes at southern margin of the Superior craton from classic greenstone-granite terrane of lower metamorphic grade on the north

Appleton geophysical lineament (AGL; late Archean with probable Proterozoic reactivation): Separates Benson and Montevideo blocks in gneiss terranes

APPENDIX A. Generalized bedrock geologic map of Minnesota



APPENDIX A. Generalized bedrock geologic map of Ninnesota

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Map and explanation taken from: Southwick, D.L., and Morey, G.B., Precambian geologic framework <u>in</u> Minnesota, in Proceedings - U.S. - U.S.S.R. - Canada - joint seminar on Precambrian geology of the Southern Canadian Shield and the Eastern Baltic Shield, August 21-23, 1990: University of Minnesota, Duluth.

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APPENDIX B. Generalized depth to bedrock map of Minnesota

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Adapted from the Minnesota Land Management Information Center's MLMIS40 data base, filename DEPTHCRP.EPP. LMIC created this file by digitizing the state depth to bedrock map (Olson and Mossler, 1982), converting this file to ARC/INFO polygon coverage, then converting the ARC/INFO coverage to a 40-acre grid-cell EPPL7 file. The ARC/INFO coverages were modified by the Minnesota Pollution Control Agency to create closed polygon coverage where none existed on the original map. 

APPENDIX C. Underlying bedrock map unit symbols and depth to bedrock for the test and pilot study sample sites (see Appendix D for explanation of map unit symbols) [Data interpreted from available well logs and maps as shown in Appendix C and D] 3

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DNR Sample Number	Depth to Underlying Bedrock	Source of Depth Data		Underlying Bedrock Map Unit Symbol
20431	<100	Olsen and Mossler,	1982/well logs	Yda
22631	100-300	Olsen and Mossler,	1982/well logs	Pvt
22632	200-300	Olsen and Mossler,	1982/well logs	Ams
22633	100-200	Olsen and Mossler,	1982/well logs	Pua
22634	100-200	Olsen and Mossler,	1982/well logs	Pua
22635	<100	Olsen and Mossler,	1982/well logs	Xg
22636	200-400	Olsen and Mossler,	1982/well logs	Agn
22637	200-400	Olsen and Mossler,	1982/well logs	Agr
23901	100-200	Olsen and Mossler,	1982	Psa
23902	100-200	Olsen and Mossler,	1982	Psa
23903	100-200	Olsen and Mossler,	1982	Pgvi
23904	200-300	Olsen and Mossler,	1982	Pgví
23905	100-200	Olsen and Mossler,	1982	Pq
23906	<100	Olsen and Mossler,	1982	Pav
23907	<100	Olsen and Mossler,	1982	AITC
23908	100-200	Olsen and Mossler,	1982	P1W
23909	<100	Disen and Mossier,	1982	APII Dut
23910	<100	Olsen and Mossier,	1902	PVL
23911	<100	Olsen and Mossler,	1082	PVC
23912	<100	Olcon and Mossier,	1902	Put
23913	<100	Olsen and Mossler	1982	Pvt
23015	<100	Olsen and Mossler,	1982	Xsq
23016	<100	Oisen and Mossler.	1982	Xsg
23017	<100	Olsen and Mossler,	1982	Xsg
23918	<100	Olsen and Mossler,	1982	Pvt
23919	<100	Olsen and Mossler,	1982	Pvt
23920	<100	Olsen and Mossler,	1982	Pps
23921	<100	Olsen and Mossler,	1982	Ydt
23922	<100	Olsen and Mossler,	1982	Ydt
23923	<100	Olsen and Mossler,	1982	Ynbn
23924	<100	Olsen and Mossler,	1982	Ydt
23925	<100	Olsen and Mossler,	1982	Ydt
23926	<100	Olsen and Mossler,	1982	Xsg
23927	<100	Olsen and Mossler,	1982	Ydt
23928	<100	Olsen and Mossler,	1982	Agr
23929		Olsen and Mossler,	1982	Agr
23930	<100	Olsen and Mossler,	1982	Afv
23931	<100	Olsen and Mossler,	1982	Agr
23932	<100	Olsen and Mossler,	1982	Agr
23933	i i i i i i i i i i i i i i i i i i i	Olsen and Mossler,	<b>1982</b>	
23934	100-300	Olsen and Mossler,	1982	Anvs
23935	100-300	Olsen and Mossler,	1982	Amys Order Con
23936	200-300	Olsen and Mossler,	1982 - Strate baselike	s Los PVC inter agentados
23937	200-300	Olsen and Mossler,	1982	Pvt

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APPENDIX C. Underlying bedrock map unit symbols and depth to bedrock for the test and pilot study sample sites (see Appendix D for explanation of map unit symbols) [Data interpreted from available well logs and maps as shown in Appendix C and D]...continued

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V. 4			Underlying
DNR	Depth to	Source	Bedrock
Sample	Underlying	of Depth	Nap Unit
Number	Bedrock	Data	Symbol
23038	200-300	Olsen and Mossler 1982	
23730	100-300	Olsen and Mossier, 1982	Pua
23040	100-200	Olsen and Mossier, 1982	Pua
230/1	<100 200	Olsen and Mossler, 1982	Pavi
230/2	<100	Olsen and Mossler, 1982	Plf
230/3	<100	Disen and Mossier, 1982	APh
23743	<100	Olsen and Mossler, 1982	APh
23045	<100	Olsen and Mossier, 1982	APh
230/6	<100	Olsen and Mossler 1982	APh
23740	100-200	Disen and Mossier 1982	Pvda
230/8	<100 200	Olsen and Mossier, 1982	Psa
23040	<100	Olsen and Mossler, 1982	Pvda
23950	<100	Olsen and Mossler, 1982	APh
23051	100-200	Olsen and Mossler, 1982	Plf
23052	100-200	Olsen and Mossler, 1982	Plf
23053	100-200	Olsen and Mossler, 1982	Plf
23954	<100	Olsen and Mossler, 1982	Plf
23955	100-200	Olsen and Mossler, 1982	At
23956	200-300	Olsen and Mossler, 1982	Pua
23057	200-300	Olsen and Mossler. 1982	Pua
23958	300-400	Olsen and Mossler, 1982	Amvs
23959	200-300	Olsen and Mossler, 1982	Agn
23960	200-400	Olsen and Mossler, 1982	K
23961	100-200	Olsen and Mossler, 1982	ĸ
23962	100-200	Olsen and Mossler, 1982	ĸ
23963	<100	Olsen and Mossler, 1982	APgn
23964	<100	Olsen and Mossler, 1982	Plf
23965	300-400	Olsen and Mossler, 1982	APgn
23966	300-400	Olsen and Mossler, 1982	Agr
23967	200-300	Olsen and Mossler, 1982	K
23968	100-200	Olsen and Mossler, 1982	Agn
23969	<100	Olsen and Mossler, 1982	Agr
23970	200-300	Olsen and Mossler, 1982	ĸ
23971	<100	Olsen and Mossler, 1982	Plf
23972	<100	Olsen and Mossier, 1982	0
23973	<100	Olsen and Mossler, 1982	0
23974	100-200	Olsen and Mossler, 1982	C
23975	100-200	Olsen and Mossler, 1982	C
24110	<100	Olsen and Mossler, 1982	Pdv
24111	100-200	Olsen and Mossler. 1982	Piw
24112	<100	Olsen and Mossler. 1982	Pvt
24113	<100	Olsen and Mossier, 1982	Ydt
24114	<100	Olsen and Mossier, 1982	Ydt
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APPENDIX D. Explanation of bedrock map unit symbols (as shown in Appendix C)

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Bedrock	1		Bedrock		
lap Unit	Bedrock	Bedrock	Мар	Мар	
ymbol	Age	Terrane	Unit	Source	
Piw	Early Proterozoic	Penokean	Granite - light-gray to light pinkish-gray,	Southwick and others, 19	88, 1:250,000
			medium-grained, equigranular to porphyritic		
			biotite granite.		
Pvt	Early Proterozoic	Penokean	Animikie Group, Virginia and Thomson Formations -	Southwick and others, 19	88, 1:250,000
		-	medium- to dark-gray, rhythmically interbedded		
			argillite, argillaceous siltstone, and	:	
			feldspathic to lithic graywacke; graywacke beds		
			are thicker, coarser, and more abundant in the		
			southeastern part of the map area than elsewhere.		
	and the second second		Metamorphic grade ranges from sub-greenschist	age - same	
			facies near the Mesabi range to mid-greenschist		
	<i>a</i> .		facies in the most strongly deformed rocks in		ja Auro Star
			eastern Carlton County.		
				- 一切 一切 機構 - 一切 - 一切 機構 - 一切 - 一	
Pua	Early Proterozoic	Penokean	Animikie Group, Unnamed argillaceous rocks of the	Southwick and others, 19	88, 1:250,000
			Long Prairie basin - medium- to dark-gray,		
			rhythmically interbedded argillite, siltstone,		
			and graywacke in central and western parts of		
			basin; coarse-grained, massive-bedded graywacke		
			and polymictic paraconglomerate occur locally		1-3h
			along eastern basin margin. Deformation and		
			metamorphic recrystallization (under		and the second se
	sa ji ji	• .	greenschist-facies conditions) increase from NW		
			to SE.		
Psa	Early Proterozoic	Penokean	Unnamed Metasedimentary Rocks - inferred from	Southwick and others, 1	988, 1:250,000
	· · ·		geophysical data and meager drilling control to		
			consist mainly of slate, argillite, and	• • •	
	na shekara a shekara		metasiltstone.		
			しいしき 御堂が 教育 教教会会学 かくやや きた		
Pq	Early Proterozoic	Penokean	Mille Lacs Group, Dam Lake quartzite (informal	Southwick and others. 1	988, 1:250,000
-	<u>.</u>		usage) - gray to light-gray, massive to		• • • • • • • • • •
			thick-bedded quartzite.		
					۲
Pgvi	Early Proterozoic	Penokean	Mille Lacs Group, Unnamed unit of metasedimentary	Southwick and others. 1	988. 1:250.000
-	•		······		,,
			·		
			n an		1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1
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# APPENDIX D. Explanation of bedrock map unit symbols (as shown in Appendix C)...continued

Bedrock				
Map Unit Symbol	Bedrock Age	Bedrock Terrane	Map Unit	Nap Source
		conditions.		
Pvdg	Early Proterozoic	<b>Pen</b> okean	Mille Lacs Group, Unnamed unit of metabasalt and metadiabase - fine- to medium-grained metabasalt (metamorphosed to greenschist- and lower emphibalite-facies assemblages) and equipranular	Southwick and others, 1988, 1:250,000
x - 1	n Baile (n. 1977) A		to ophitic metadiabase. Diabase locally dominant, presumably as subvolcanic sills and thick flows. Interbedded pelitic schist is locally abundant.	
Pps	Early Proterozoic	Penokean	Mille Lacs Group, Unnamed pelitic schist - quartz-mica schist, locally containing garnet, staurolite, and aluminosilicate minerals. Poorly constrained as to detailed lithology and areal	Southwick and others, 1988, 1:250,000
Pdv	Early Proterozoic	Penokean	extent in western part of inferred subcrop. Nille Lacs Group, Unnamed metadiabase and metabasalt - similar to and probably cogenetic with hypabyssal rocks in units Pvdg, Pgvi, and	Southwick and others, 1988, 1:250,000
			Pbs; forms lenticular bodies, interpreted to be chiefly sills, within and between those units and within the Dam Lake quartzite.	
Plf	Early Proterozoic	Penokean	Mille Lacs Group, Little Falls Formation - light-gray to dark-gray, quartz-rich slate, argillite, and schist. Metamorphic grade increases from NW to SE; coarse-grained,	Southwick and others, 1988, 1:250,000
• .			megacrystic garnet-staurolite schist is widespread in southern half of outcrop/subcrop belt.	<i></i>
· . ·			belt.	

APPENDIX D. Explanation of bedrock map unit symbols (as shown in Appendix C)...continued

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Bedrock Mon Unit	Padaaak	Pedroek	Bedrock	
Symbol	Age	Terrane	map Unit	нар Source: На или на жив живница (станка)
Aph	Archean to Early Proterozoic	Penokean	Hillman Migmatite - light- to dark-gray, medium- to coarse-grained, foliated biotite-garnet-cordierite schist, hornblende schist, and biotite-feldspar-quartz granofels migmatized by tonalitic neosome.	Southwick and others, 1988, 1:250,000
$\lambda_{i}^{(1)}$	$\sum_{i=1}^{n} \frac{\partial x_i}{\partial x_i} \sum_{i=1}^{n} \frac{\partial x_i}{\partial x_i} = \sum_{i=1}^{n} \frac{\partial x_i}{\partial x_i} \sum_{i=1}^{n} \frac{\partial x_i}{\partial x_i} = \sum_{i=1}^$			
Apgn	Archean to Early Proterozoic	Penokean	Gneissic Rocks, Undivided - predominantly gneiss of quartzofeldspathic composition, including granitic to tonalitic varieties; lithology and age are poorly known in the map area.	Southwick and others, 1988, 1:250,000
At ::	Late Archean	Algoman	Tonalite - light-gray to medium-gray, medium-grained, biotite-hornblende tonalite and leucotonalite. Moderately to strongly foliated; locally altered extensively to epidote, chlorite, albite, sericite.	Southwick and others, 1988, 1:250,000
Ams	Late Archean	Algoman	Metamorphosed Sedimentary Rocks, Undivided - gray, brown-weathering, medium-grained, biotite-bearing schists derived chiefly from interbedded graywacke and pelite.	Southwick and others, 1988, 1:250,000
Amvs	Late Archean	Algoman	Metamorphosed Volcanic and Sedimentary Rocks, Undivided - includes pillowed greenstone, intermediate to felsic tuffaceous rocks, and associated volcaniclastic and epiclastic sedimentary rocks. Metamorphosed under	Southwick and others, 1988, 1:250,000
			greenschist-facies conditions.	
Атс	Middle to Late Archean	Ancient gneiss	McGrath Gneiss - pinkish-gray, medium- to coarse-grained gneiss of granitic composition.	Southwick and others, 1988, 1:250,000
چ د الدي <sup>دهر</sup> دري د مرد د	·		biotite-rich; contains zones of abundant microcline augen and layers of inclusions of biotite schist.	· · · · · · · · · · · · · · · · · · ·
<b>K</b> 87 - 8 - 4 N	Cretaceous El control	Mesozoic	Cretaceous rocks, undivided - includes dark-colored marine shale overlying white to	Morey and others, 1982, 1:1,000,000

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APPENDIX D. Explanation of bedrock map unit symbols (as shown in Appendix C)...continued

Bedrock			Bedrock	
Map Unit	Bedrock	Bedrock	Мар	Мар
Symbol	Age	Terrane	Unit	Source
			brown sandstone and variegated shale of	······································
			terrestrial origin.	
0	Ordovician	Paleozoic	Ordovician rocks, undivided - dominantly	Morey and others, 1982, 1:1,000,000
			carbonate rocks with lesser amounts of quartzose	
	1. 1.		sandstone, siltstone, and shale.	
С	Cambrian	Paleozoic	Cambrian rocks, undivided - dominantly quartzose	Morey and others, 1982, 1:1,000,000
	- 17 -		and glauconitic sandstone and siltstone with	
			lesser amounts of carbonates.	
Ynbn	Middle Proterozoic	Keweenawan	North Shore Volcanic Group - basalt and related	Morey and others, 1982, 1:1,000,000
	· · · · · · · · · · ·		rocks having normal magnetization.	
Ydt	Middle Proterozoic	Keweenawan	Troctolitic and gabbroic rocks of Duluth and	Morey and others, 1982, 1:1,000,000
	27 		Beaver Bay Complexes.	
Vdo	Middle Destances	Kausanaura	Access state achieves and presidential produces of	N
108		Keweenawan	Anorthositic, gaboroic, and perioditic rocks of	Morey and others, 1982, 1:1,000,000
			Dututh and Beaver Bay complexes.	
Xa	lover Proterozoic	Penokean	Granitoid rocks - includes Stearns Granitic	Norey and others 1982 1+1 000 000
		i chorcun	Complex of central Minnesota	
Xsa	Lower Proterozoic	Penokean	Siste metagraywacke, and associated metavolcanic	Morey and others 1982 1:1 000 000
	na an ann an Anna ann an An The anna anna anna anna anna anna anna an		rocks - includes Viriginia, Thomson, and Rabbit	
			Lake Formations of the Animikie Group, and	
	nene 20. s. j. De 20. s. j. Stationer		associated unnamed iron-formations.	
Agr	Archean	Algoman	Granitoid rocks - includes Saganaga, Lac La	Morey and others, 1982, 1:1,000,000
-	i de la companya de l La companya de la comp	-	Croix, and Giants Range Granites of northern	
			Minnesota and the Odessa, Sacred Heart, and Fort	
	entre de la companya de la companya La companya de la comp		Ridgely Granites of southwestern Minnesota.	
Afv	Archean	Algoman	Metamorphosed felsic volcanic rocks - includes	Morey and others, 1982, 1:1,000,000
			pyroclastic rocks, hypabyssal intrusions, and	
			rare flows.	
Agn	Archean	Ancient gneiss	Migmatitic gneiss, amphibolite, and granite - may	Morey and others, 1982, 1:1,000,000
			include younger rocks in poorly exposed areas of	
			central Minnesota.	

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