ANALYSIS OF OPAQUE OXIDES IN PARTIAL HEAVY MINERAL CONCENTRATES FROM GLACIAL DRIFT SAMPLES LAKE COUNTY, MINNESOTA

for

MINERALS DIVISION
MINNESOTA DEPARTMENT OF NATURAL RESOURCES

by

Penelope Morton
Department of Geology
University of Minnesota, Duluth
and
Jayne Reichhoff
Center for Applied Research and Technology Development
Natural Resources Research Center
University of Minnesota, Duluth

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ABSTRACT

Analysis of opaque oxide minerals from partial heavy mineral concentrate samples from glacial drift samples collected over parts of Lake county, northeastern Minnesota has shown that ilmenite, magnetite, and Cr-spinel phases are good indicators of bedrock type. 39 of some 500 samples collected during the summer of 1988 by Minnesota Department of Natural Resources were supplied to University of Minnesota, Duluth for analysis. Samples were collected from till, outwash and ice contact deposits of the Rainy and Superior Lobes that overly basal, middle and upper parts of the Duluth Complex. Basement rocks are troctolite in the west, anorthosite in the central area and volcanic rocks in the east.

Point-counts were made of the samples and selected grains were analyzed using an electron microprobe. It was found that the composition of the ilmenite from samples overlying the troctolite had a higher MgO content than ilmenite overlying the anorthosite. Cr content of magnetite was higher over the troctolitic rocks and lower over anorthositic and volcanic rocks. The presence of chromite$_{ss}$ was found over both troctolite and anorthositic rocks, however, those chromite$_{ss}$ in samples overlying the troctolite had higher average Cr_2O_3 content than those over anorthosite (approximately 26 versus 15%). It is concluded that much of the glacial drift is very local in origin and has not moved very far.

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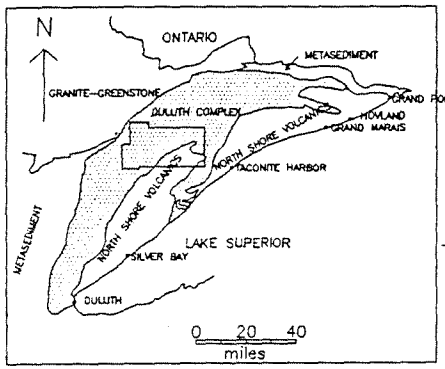
Introduction

During the summer of 1988 the Minnesota Department of Natural Resources (MDNR), Minerals division undertook a large glacial drift geochemical sampling program for strategic minerals in the central portion of Lake County, NE Minnesota (inset, Figure 1) over parts of the basal, middle and upper zones of the Duluth Complex (Buchheit, Malmquist and Niebuhr, 1989). Both glacial overburden and vegetation samples were collected. The glacial drift samples were separated into partial heavy mineral concentrates, silt/clay separates and clay separates as described by Buchheit et al., 1989. Of the heavy mineral concentrate samples, 567 were analyzed for 30 trace and major elements.

On the basis of Cr, Ti, Fe, Pt, and Pd contents, MDNR submitted 39 samples to the UMD geology department and NRRI for identification and analysis of spinel, magnetite and ilmenite. One of the purposes of this project was to determine the mineral source of high Cr contents of these samples as well as determine if the types of Fe-Ti-Cr oxides were representative either of bedrock and/or glacial drift type (Buchheit et al., 1989). The Cr content of the partial heavy mineral concentrates was particularly interesting because of the known correlation of high Pt contents (up to 9 ppm) with Cr-spinels within basal layered troctolite in diamond drill core DU-15 (Sabelin, 1985). It was hoped that Cr-spinel such as that found in DU-15, might prove to be a good path finder mineral for Pt-Pd mineralization.

FIGURE 1



DULUTH COMPLEX UNDIVIDED

RED, GRANOPHYRIC GRANITE AND ADAMELLITE

TROCTOLITE AND ANORTHOSITIC TROCTOLITE COMMONLY LAYERED

GABBRO AND FERROGABBRO

ANORTHOSITIC GABBRO

VOLCANIC ROCKS, UNDIVIDED

UNDIVIDED KEWEENAWAN ROCKS, LITTLE OR NO OUTCROP

CONTACT–METAMORPHOSED MAFIC VOLCANIC ROCKS, PERHAPS MINOR METADIABASE

0 3 6

MILES

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GEOLOGY ADAPTED FROM GREEN, 1982

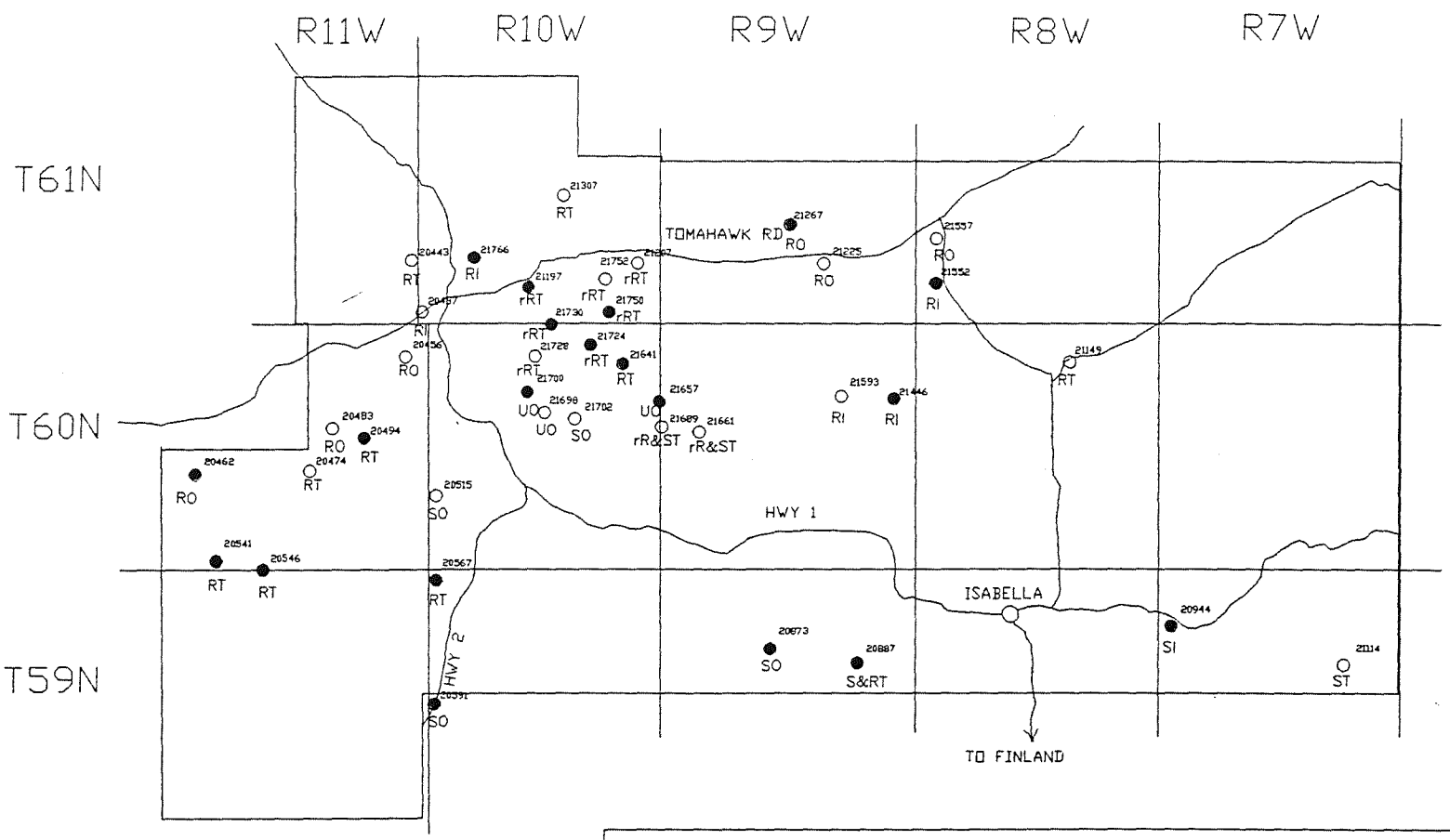
Selection of samples

Of the 567 partial heavy mineral concentrate samples analyzed by MDNR, 42 had Cr contents considered to be anomalous (> 1621 ppm). The anomalous threshold reported by Buchheit et al. (1989) was 2150 ppm but that has been recalculated to be 1621 ppm at the 95th confidence level using a one-tailed test and a log-normal distribution. Of the 39 samples submitted to UMD, 20 had anomalous Cr contents. The other samples were selected on 1. the basis of high Pt and/or Pd contents, 2. areal coverage, 3. high Ti and Fe content and 4. to be representative of all samples, not just anomalous samples. Sample numbers and locations are plotted on Figure 2.

Analytical Techniques

Analysis of the samples was accomplished in two steps: 1. point counting of polished grain mounts and 2. electron microprobe analysis of representative magnetite, ilmenite, chromite and/or spinel phases. Point counts were made with the following mineral groups: 1. silicates, 2. magnetite, 3. magnetite with spinel lamellae, 4. ilmenite, 5. ilmenite, spinel and magnetite together, 6. magnetite with hematite alteration, 7. hematite, 8. ilmenite with spinel inclusions, 9. magnetite and ilmenite together either as lamellae in one another or as extremely fine-grained intergrowth (on the order of 2-3 um; these may be in fact magnetite-ulvospinel intergrowths), 10. simplectites of silicate and oxide, 11. sulfide grains, 12. composite grains composed of rounded chromite grains in silicate gangue, 13. ilmenite with

FIGURE 2



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LOCATION AND TYPE OF HEAVY MINERAL CONCENTRATE SAMPLES SENT TO UMD FOR ANALYSIS OF OPAQUE OXIDES

FOR

PROJECT 262, LAKE COUNTY, MINNESOTA

JUNE, 1989

hematite oxidation or lamellae and 14. spinel. An average of 678 grains were counted on each sample. Point count results are presented in Table 1.

Because these samples were only partial heavy mineral concentrates, there tended to be many silicate grains present in the polished mounts. To see what opaque oxides were in magnetic and non-magnetic fractions, three samples, 20437, 20483 and 20515 were separated in the following manner. First the magnetic fraction of a sample split was taken off by using a hand magnet and the remaining fraction was separated in a Franz magnetic separator. This was further divided into a slightly magnetic fraction and a non-magnetic fraction. Point counts were then performed on a) the magnetic fraction, b) the slightly magnetic fraction, c) the non-magnetic fraction and d) the sample as a whole. Overwhelmingly, the magnetite, magnetite with spinel, and chromite were concentrated in the magnetite fraction. Ilmenite, spinel, and ilmenite with spinel were concentrated in the slightly magnetic fraction, whereas in the non-magnetic fraction, opaque oxides made up less than 1% of the sample. Because, in the case of these three samples, all opaque oxides were well represented in the sample as a whole, it was decided that it would not be necessary to separate the samples, but simply to count the whole sample. If one was interested in making a more Cr rich separate, it would be advisable to use only the magnetic fraction of the partial heavy mineral concentrate. Data from sample 20483 are presented in Table 2.

Table 1: Point Counts of Partial Heavy Mineral Concentrate Samples

Sample	#	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
20437	738	94.04	0.54		2.57	0.54	0.14	1.08			0.27	0.27	0.54			99.99
20443	690	90.87	0.29		2.90	1.01	1.01	1.01	1.59	0.14	1.16					99.98
20456	668	91.17	1.50	0.30	2.40	0.60	0.60	1.65	0.30	0.15	1.35					100.02
20462	640	84.69	1.72	0.63	5.63	2.19	0.78	1.88	0.16	0.47	1.88					100.03
20474	952	93.70	1.05		1.26	0.95	1.16	0.74	0.11	0.42	0.63					100.02
20483	425	59.29	3.29	7.53	15.06	4.71	2.35	2.82		3.29	0.94		0.71			99.99
20494	687	85.32	3.08	1.03	7.34		0.73	0.88	0.44	0.44	0.59		0.15			100.00
20515	471	68.37	2.55	0.85	12.74	0.21	4.03	3.18		6.37	1.06			0.64		100.00
20541	686	87.61	2.33	0.87	2.92	0.44	1.17	2.92		1.02	0.73					100.01
20546	548	91.42	0.36	0.73	3.47	0.36	0.91	1.46	0.18	1.09						99.98
20567	696	86.49	1.15	0.97	5.89	0.14	0.86	1.58	0.43	0.86	0.72				0.90	99.99
20591	745	64.16	3.36	1.21	13.56	1.61	3.89	4.70	0.40	5.50	1.61					100.00
20873	579	93.96	1.38		2.07	0.52	0.86	0.69		0.35	0.17					100.00
20887	580	93.62	2.59		2.93			0.34		0.17	0.34					99.99
20944	762	87.40	3.54		3.02	0.52	2.10	0.92		2.49						99.99
21114	688	95.78	0.87	0.15	2.62		0.15	0.44								100.01
21149	559	93.20	0.89	0.36	3.40		0.72	1.25			0.18					100.00
21197	889	93.03	1.69	0.34	2.02	0.45	1.01	0.22	0.45	0.11	0.67					99.99
21207	722	93.91	1.52	0.14	3.19	0.14	0.42	0.28	0.28		0.14					100.02
21225	576	85.42	1.74	0.52	7.64		1.39	0.35		2.08	0.87					100.01
21267	583	78.56	3.43	0.69	8.58	0.17	1.72	0.86	0.17	3.95	1.89	0.17				100.19
21307	636	95.10	0.79	0.47	1.73	0.16	0.47	0.31	0.31		0.47			0.16		99.97
21446	655	58.17	3.97	0.61	20.15	0.92	3.36	4.58	0.46	7.33	0.46					100.01
21552	613	37.19	10.44	6.04	32.95	2.45	3.75	1.14	1.47	2.28	2.28					99.99
21557	690	58.84	4.20	1.33	23.04	1.42	3.77	2.90	0.72	3.04	0.43				0.29	99.98
21593	614	60.26	5.70	0.98	20.36	0.33	3.09	3.75		4.72	0.81					100.00
21641	1518	81.09	0.72	0.99	7.91	0.86	1.98	1.52		2.04	2.83				0.07	100.01
21657	723	45.37	10.65	2.07	20.06	2.07	6.09	4.84		8.44	0.28	0.14				100.01
21661	552	53.44	5.98	1.27	19.93	0.18	3.80	5.62	0.54	7.25	0.72	0.18		1.09		100.00
21689	589	56.71	3.06	1.36	19.69		4.41	4.07		9.34	1.19			0.17		100.00
21698	732	85.52	4.51	2.19	5.87	0.14	0.55	0.68			0.55					100.01
21700	520	86.70	5.38	0.19	4.81	0.19	1.73	0.58		0.38				0.19		100.15
21702	837	95.22	1.08	0.48	2.39		0.12	0.36	0.12	0.24						100.01
21724	757	89.96	3.70	0.66	3.30		0.26	0.26		0.79	0.92	0.13				99.98
21728	596	85.91	1.68	0.50	7.89	0.17	1.85	0.34		0.67	1.01					100.02
21730	547	83.91	2.74	0.73	8.41	0.18	1.65		0.18	1.10	1.10					100.00
21750	665	92.63	1.35	0.45	3.01	0.15	0.15	0.30			1.95					99.99
21752	700	94.57	1.29	0.14	2.86		0.14	0.71	0.29							100.00
21766	604	78.15	4.80	1.49	10.10		0.66	0.83		1.32	0.50		0.99		1.16	100.00

1. gangue
2. magnetite
3. magnetite/spinel
4. ilmenite
5. ilmenite/magnetite/spinel together
6. magnetite/hematite
7. oxidized grains including hematite
8. ilmenite/spinel
9. magnetite/ilmenite
10. simplectite of oxide and silicate
11. sulfide
12. composite grains consisting of rounded oxides of chromite in a silicate matrix
13. ilmenite/hematite
14. mostly spinel

Electron microprobe analysis of representative minerals was achieved using an updated MAC 400 electron microprobe equipped with a Krisel automation package. An average of 10 grains were analyzed on each sample and each grain was analyzed for FeO, MgO, MnO, TiO_2, SiO_2, Al_2O_3, and Cr_2O_3. Fe_2O_3 content was calculated from stoichiometry. In all, 500 grains were analyzed on 38 samples. These data are presented in Table A-1, Appendix. Photomicrographs were taken of nearly all grains analyzed and representative examples are presented in Plates I to IV.

TABLE 2. Comparison of mineral percentages in magnetic, slightly magnetic fractions and sample 20483 as a whole.

	1	2	3
Gangue	8.54	43.0	59.3
Magnetite	35.5	0.93	3.29
Magnetite/Spinel	27.1	0	7.53
Ilmenite	1.51	52.1	15.1
Magnetite/Ilmenite/ Spinel	5.70	0	4.71
Magnetite/Hematite	7.04	0.47	2.35
Oxidized grains	5.86	1.40	2.82
Ilmenite/magnetite	4.52	0	3.29
Chromite	1.17	0	0.71
Simplectite	3.02	0	0.94
Ilmenite/spinel	0	0.70	0
Ilmenite/hematite/ Spinel	0	0.47	0
Ilmenite/hematite	0	0.93	0

1. Magnetic fraction
2. Slightly magnetic fraction
3. Sample as a whole

Geological Setting

Bedrock Geology

The Duluth Complex consists of dominantly mafic igneous rocks of Keweenawan Age (1.1 Ga.) that are exposed in an arcuate body extending from Duluth north toward Ely, and from there north-eastward toward Hovland (Figure 1). In the west, from Duluth to Hoyt Lakes, the base of the Complex is in sharp contact with Middle Precambrian (1.7 Ga.) slates and greywackes of the Thomson and Virginia Formations and, in some cases, the Biwabik Iron Formation. From Ely northeastward, the footwall rocks of the Complex are Archean (2.7 Ga.) greenstones and granitic rocks. The northern most basal contact is with Middle Precambrian slates and greywackes of the Rove Formation. The upper contact of the Complex is not well defined but is with medium to fine-grained, extrusive rocks of the North Shore Volcanic Group. Rock types in the upper part of the Complex appear to be gradational to the volcanic rocks and therefore, the "upper contact" of the Complex appears to be arbitrary in places and subject to revision (Weiblen and Morey, 1975).

Rocks of the Duluth Complex are divided into an older anorthositic series and a younger troctolitic series (Taylor, 1964; Weiblen and Morey, 1980). From Duluth to Ely, troctolitic series rocks are found at the base of the Complex with anorthositic series rocks exposed to the east and northeast (Bonnichsen, 1972). The troctolitic series are composed of troctolite, augite troctolite, troctolitic gabbro and ferrogabbro. Olivine and plagioclase appear to have crystallized first with pyroxene and oxides later (Foose and Weiblen,

1986). The anorthositic series rocks however, are composed dominantly of gabbroic anorthosite and troctolitic anorthosite. The mafic minerals appear to have crystallized later than the plagioclase. The dominant oxide in both series is ilmenite, although magnetite may also be present.

Within the study area (Figure 1), the troctolitic series rocks are exposed in the northwest, the anorthositic series rocks throughout the middle and North Shore Volcanic Group in the southeast. Through the central part of the area from the southwest to the northeast is an area of Duluth Complex Undivided. In the northwest, Township 61N and ranges 11W and 10W are dominated by outcrop however most of the rest of the area is overlain by a layer (up to 125 feet) of glacial overburden.

Quaternary Geology

According to Wright (1972) the ice protrusions during the Pleistocene were localized by preglacial bedrock lowlands. Within the study area (see figures 8 and 9 in Buchheit et al.,1989) the glacial geomorphology is dominated by the Highland moraine of the Automba phase of the Superior Lobe and the Vermilion moraine of the Rainy lobe. The Vermilion moraine trends approximately 120 degrees and cuts right across the area; the Highland moraine trends at about 050 degrees and they meet at about 50 to 60 degrees near Isabella. In this area the Vermilion moraine is actually made up of three parallel moraines called the outer, inner and third (Vermilion) moraine of Stark (1977). The Rainy lobe has been interpreted to have

advanced from the north and northeast whereas the Superior lobe is interpreted to have advanced from the east (Hobbs, 1988). From Isabella, west toward Birch Lake along Stony Creek is a large area of outwash due the ablation of the Superior lobe (Figure 8, Buchheit et al..1989) and to the south of this outwash is the Toimi drumlin field.

Because the Superior lobe outwash is interpreted to overly the Rainy lobe moraine and glacial drift deposits, there are many areas that are now interpreted to be reworked Rainy till or reworked Rainy/Superior till and/or outwash. There are also areas that are left undivided because their source is not known (Plate 3, Buchheit et al.). The type of glacial drift sample selected for spinel analysis are noted on Figure 2 along with sample location.

Results of Point Counts

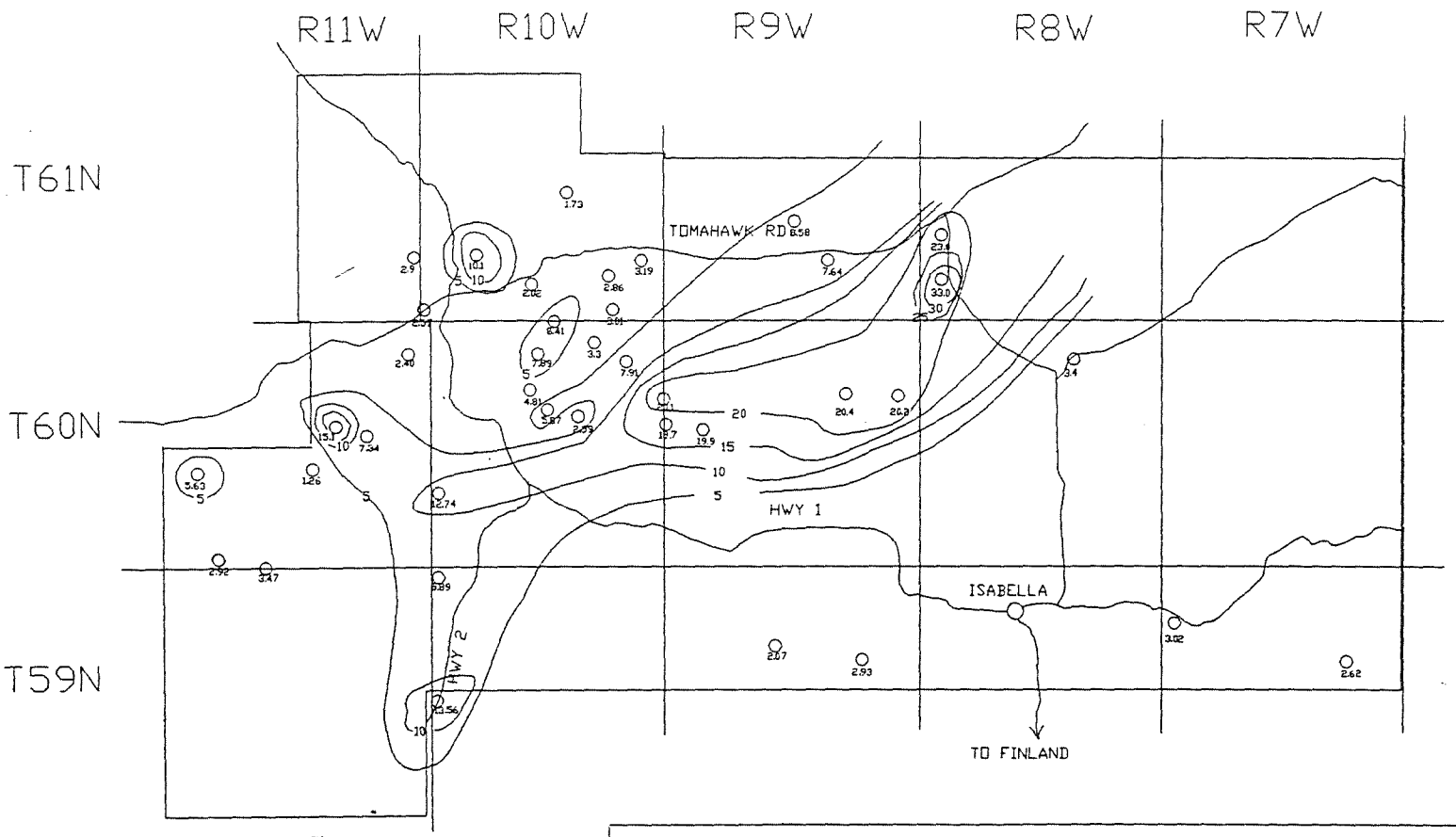
Complete point counts of polished grain mounts of 39 samples are presented in Table 1, along with partial chemical analyses. Gangue minerals in each sample vary from approximately 37 to 95 volume % and these were represented by silicates. They were recognized by their very low reflectivity. Of the other grain types tabulated (except sulfide), they are all varying colors of grey and are recognized by color and their anisotropy (or lack of). The vast majority of the opaque grains are ilmenite and magnetite both as free grains. Most of the grains counted in column 9, Table 1 were classified as magnetite/ilmenite but probably half of them in all cases were composed as a fine-grained mosaic of ulvospinel and magnetite (Plate A, #5).

Ilmenite occurs as free grains, usually well-polished and unaltered. Individual grains may be as angular (Plate A, #1 and 3) or corroded (plate A,#2). They also occur as intergrowths with the silicate minerals, although this was not that common. Five samples had grains that showed hematite alteration such as that shown in Plate A, #6. Crystallographic intergrowths of hematite and ilmenite were rare, however ilmenite/spinel intergrowths are reported in 19 samples.

The distribution of ilmenite in samples is shown in Figure 3. The vast majority of ilmenite is concentrated in a southwest-northeast trend over the central part of the sample area. This trend overlies bedrock that has been mapped as anorthositic series (Figure 1). There is a strong correlation (r= 0.94) between the amount of ilmenite in the heavy mineral concentrate and the percent TiO_2 in the concentrate (Figure 4). This distribution of ilmenite appears to be both a function of the bedrock geology and movement of the glaciers from the northeast to the southwest. There is a correlation (r=0.77) between % magnetite and % ilmenite in the samples (Figure 5) which also suggests a bedrock geological control for the two minerals. They are both known to occur in the Duluth Complex and their correlation is not unexpected.

Magnetite grains are present in five distinct modes (see Plate D): as free grains, as grains with crystallographic intergrowths of spinel (pleonaste), as grains with ilmenite lamellae, as fine-grained intergrowths with ulvospinel and as grains intergrown with hematite. Examples of these are shown in Plate D. Of these groups, free grains are the most common, grains

FIGURE 3



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ILMENITE CONTENT OF HEAVY MINERAL CONCENTRATE SAMPLES SENT TO UMD FOR ANALYSIS OF OPAQUE OXIDES

FOR

PROJECT 262, LAKE COUNTY, MINNESOTA
JUNE, 1989

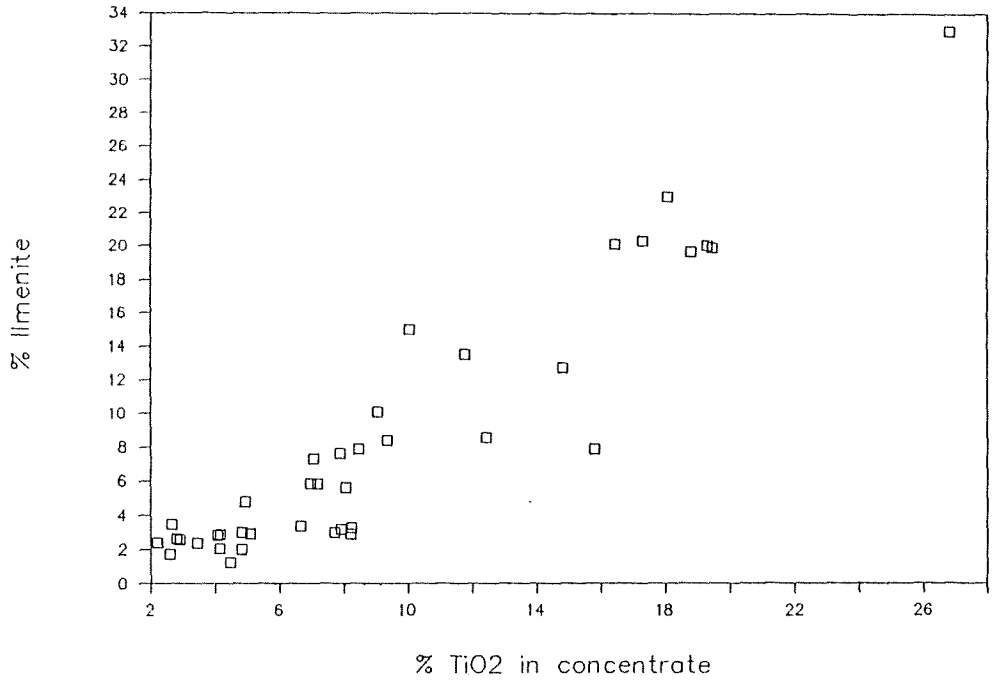


FIGURE 4: Correlation of % ilmenite with % TiO2 in heavy mineral concentrate, r=0.94.

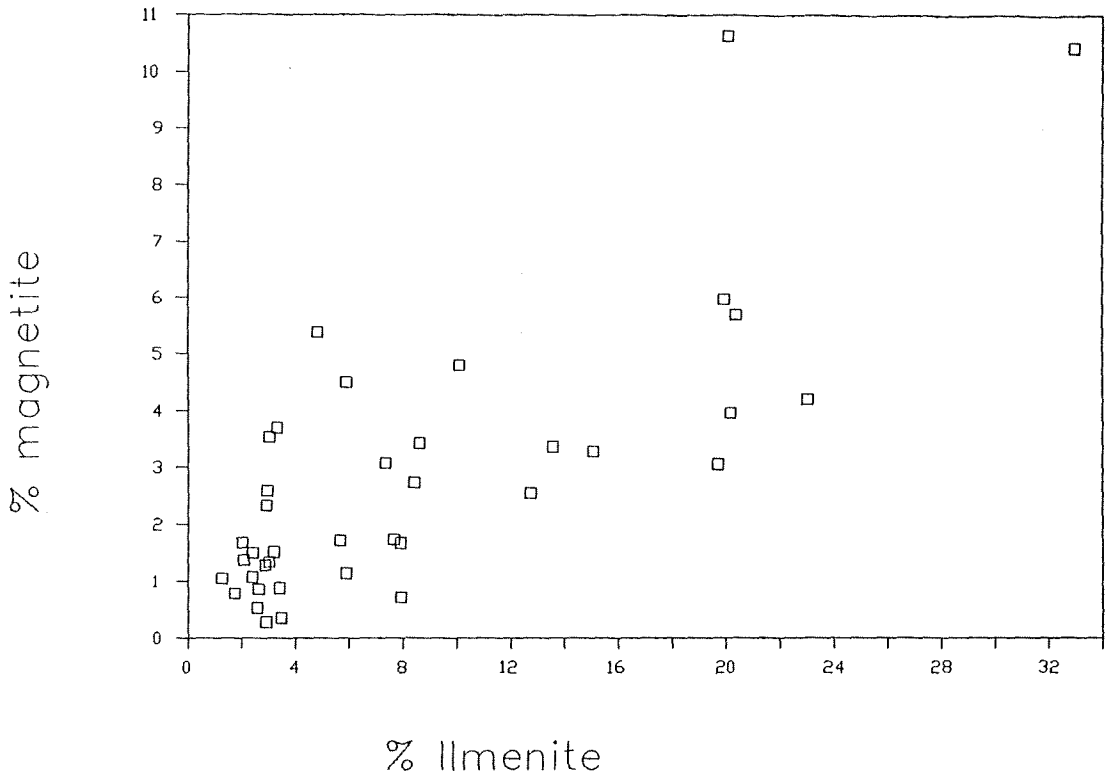


FIGURE 5: Correlation of ilmenite and magnetite in heavy mineral concentrate samples, r=0.77.

intergrown with hematite second, and magnetite with pleonaste third. Magnetite with ilmenite lamellae are grouped with the ulvospinel intergrowths and were only common in those samples that had high TiO_2 contents.

Within the group of magnetite grains intergrown with hematite are grains that have been interpreted to have originated as iron formation grains and not as magnetite that was derived from the Duluth Complex. The main criterion used to identify these grains as iron formation was their granoblastic texture of magnetite and/or hematite with silicate (usually quartz). An example of one such grain can be seen in Plate D, #1, grain t. The grain shown in Plate D #3 is interpreted to be a hematite grain also from iron formation. The distribution of samples with these iron formation grains is shown in Figure 2. They are found throughout the area, especially in the northwest. They are reasonably common in till deposits, but not so evident in the outwash deposits. Because outcrops of iron formation occur to the west and northwest (just outside the study area), it could be interpreted that there was an earlier ice advance from the northwest, before the latest advances of the Rainy and Superior lobes from the north through the east.

Individual grains of chromite and/ or spinel were only recognized in 7 samples (Table 1) however when we did the microprobe analysis, more chromite, Cr-rich magnetite and spinel grains became evident. The reason for this is that dark grey isotropic grains are hard to identify, especially when they sit in an epoxy matrix. When the grains were not free, however, it was easier to identify them. For example, intergrowths with magnetite and/or

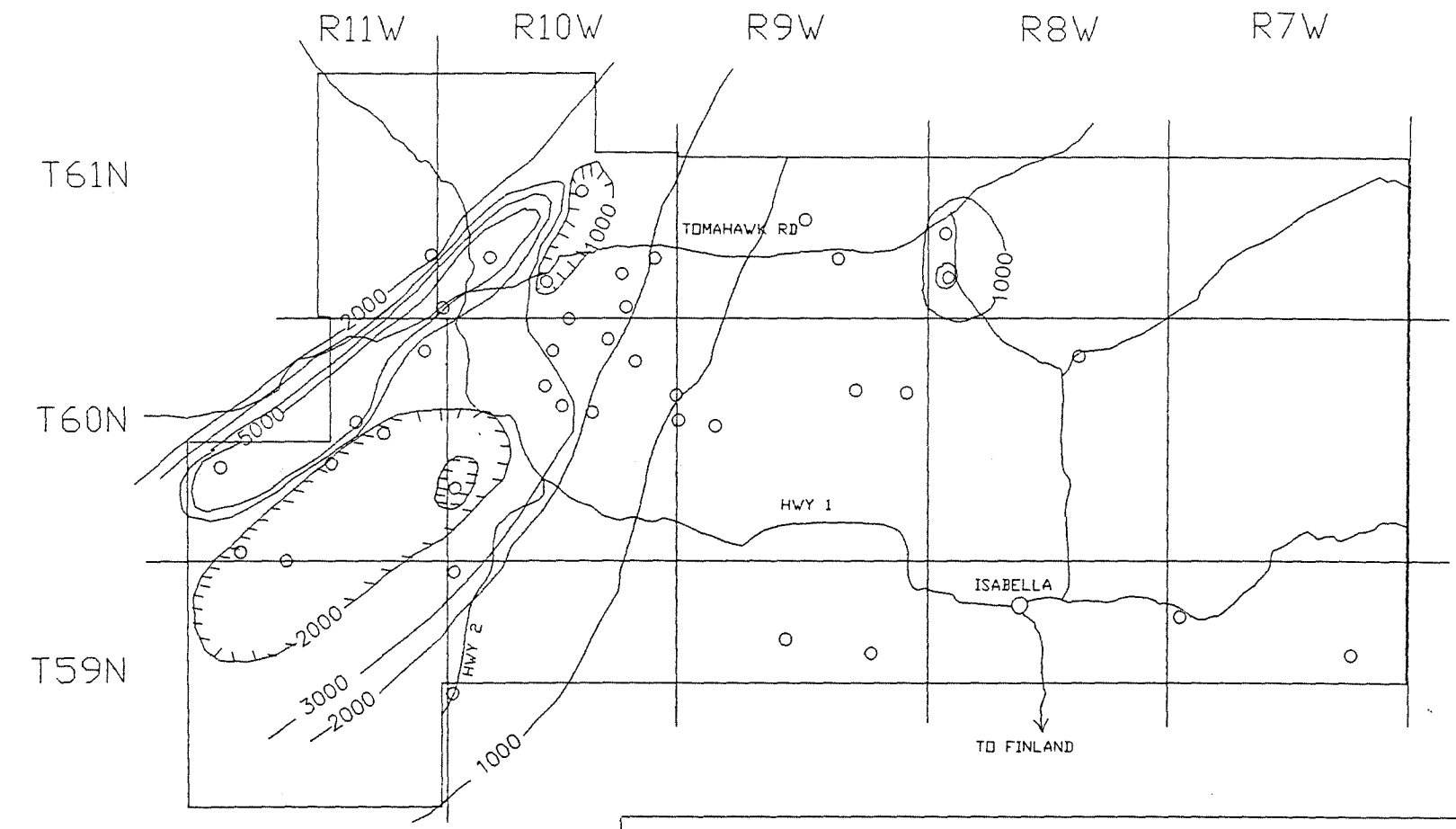
ilmenite were easily identified (Table 1, columns 3,5 and 8) and also when there were spinel grains showing unmixing into two phases (see Plate C, # 5 and 6). For other examples of the chromite/spinel phases see Plate B and C.

The distribution of Cr in the concentrate samples sent for spinel analysis is plotted in Figure 6. Even though there are only 39 samples, this contour diagram is representative of all the heavy mineral samples sent for chemical analysis (Buchheit et al., 1989). Samples with high Cr contents are generally located in the western part of the study area, overlying troctolite and ferrogabbro of the troctolitic series (Figure 1). Likewise in those samples that contained high Cr contents (>3000 ppm), chromites were recognized (Figure 7).

The total of the amounts of magnetite, magnetite with spinel inclusions, magnetite/ilmenite with spinel and chromite and/or spinel is plotted against the Cr content of the sample in Figure 8. There is no correlation between the two ($r=0.24$). However when the percent of magnetite is deleted (Figure 8), the correlation coefficient increases to 0.48. So there appears to be a weak correlation between the total amount of spinel phase (minus the clean magnetite) and the overall Cr content of the sample. It is interesting to note that in Figure 8 one can almost draw two lines indicating that there may be two mineral controls for the Cr content.

Where no chromite and/or Cr-spinels were recognized in the point counts, and the sample had a high Cr content, it was found that in general

FIGURE 6



0 3 6

MILES

SAMPLE LOCATION

2000 CONTOUR OF CR CONTENT IN PPM

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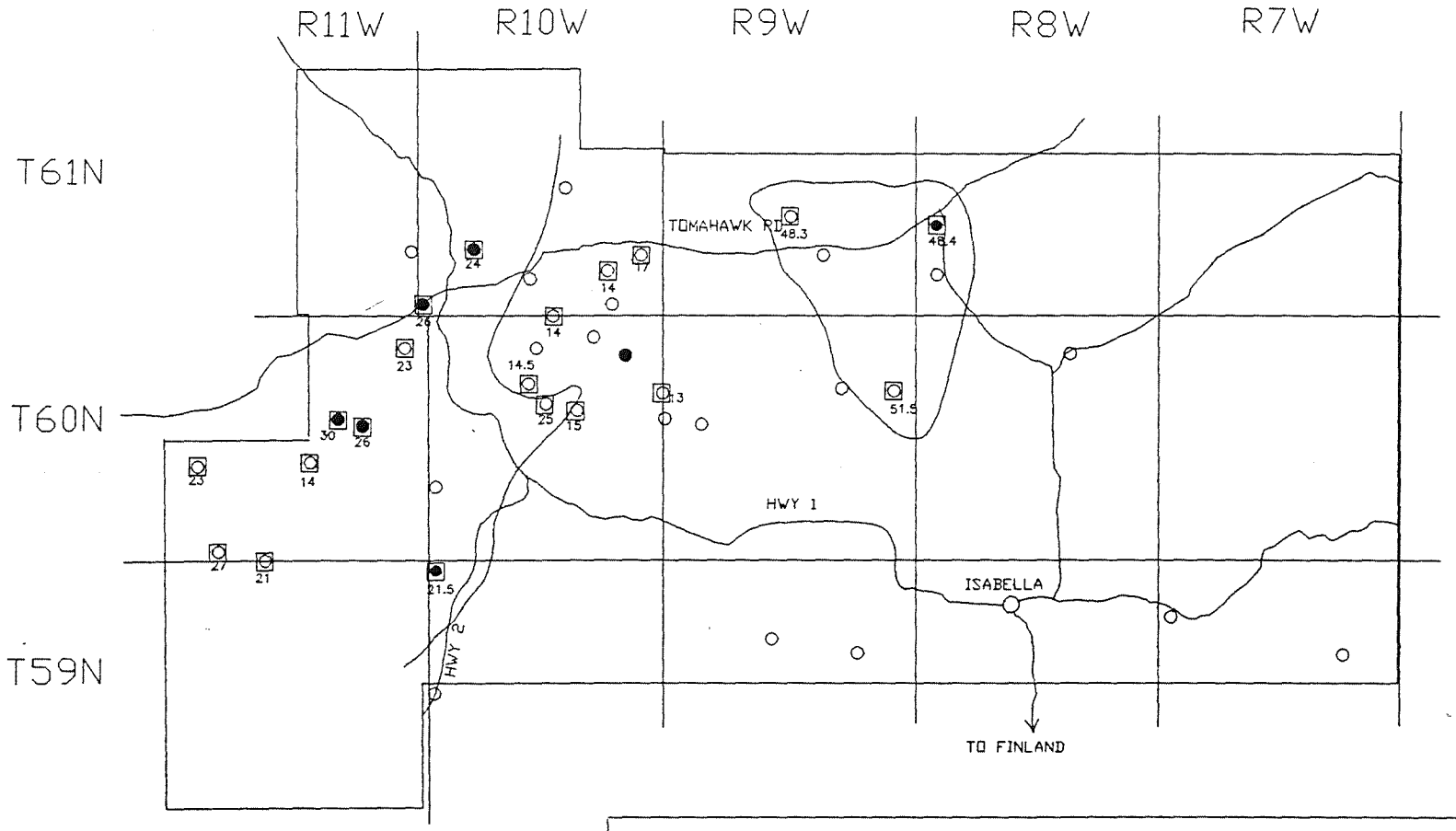
Cr CONENT OF MINERAL CONCENTRATE SAMPLES
SENT TO UMD FOR ANALYSIS OF OPAQUE OXIDES

FOR

PROJECT 262, LAKE COUNTY, MINNESOTA
JUNE, 1989

FIGURE 7



0 3 6

MILES

sample location

chromite recognized in point count

25 chromite recognized during probe analysis number is average Cr_2O_3 content

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AVERAGE Cr CONTENT OF CHROMITE
FROM HEAVY MINERAL CONCENTRATE SAMPLES

FOR

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JUNE, 1989

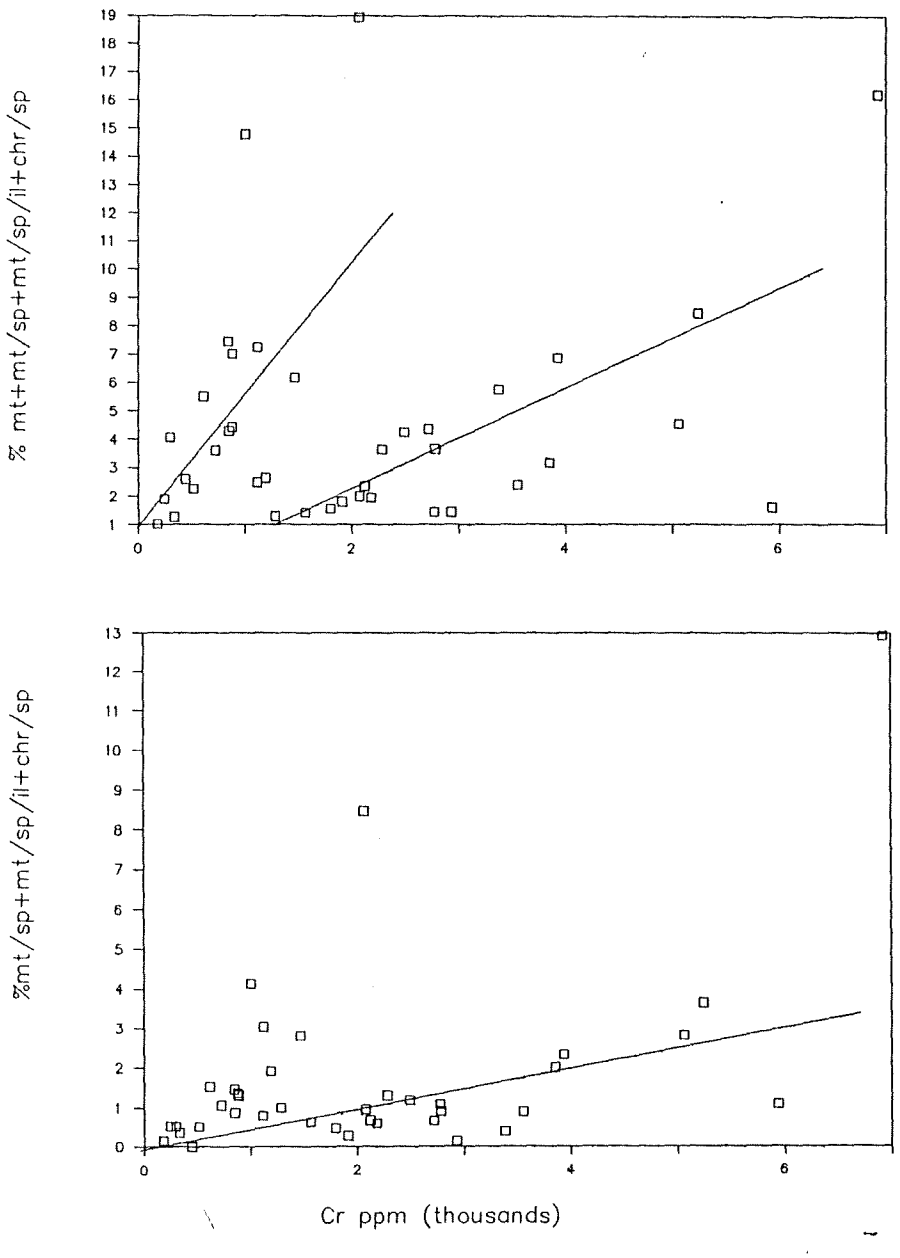


FIGURE 8: Percent Cr-bearing phases versus the amount of Cr in the heavy mineral concentrate (mt=magnetite, sp=spinel, il=ilmenite, chr=chromite)

chromite grains were not identified. With the microprobe analysis this became obvious (Figure 7). Even if no chromite grains were identified during the probe analysis, those samples that had anomalous Cr contents generally contained Cr-rich magnetite. Without the use of the microprobe, simple point counts of partial heavy mineral concentrate samples using a reflecting microscope might not prove very productive.

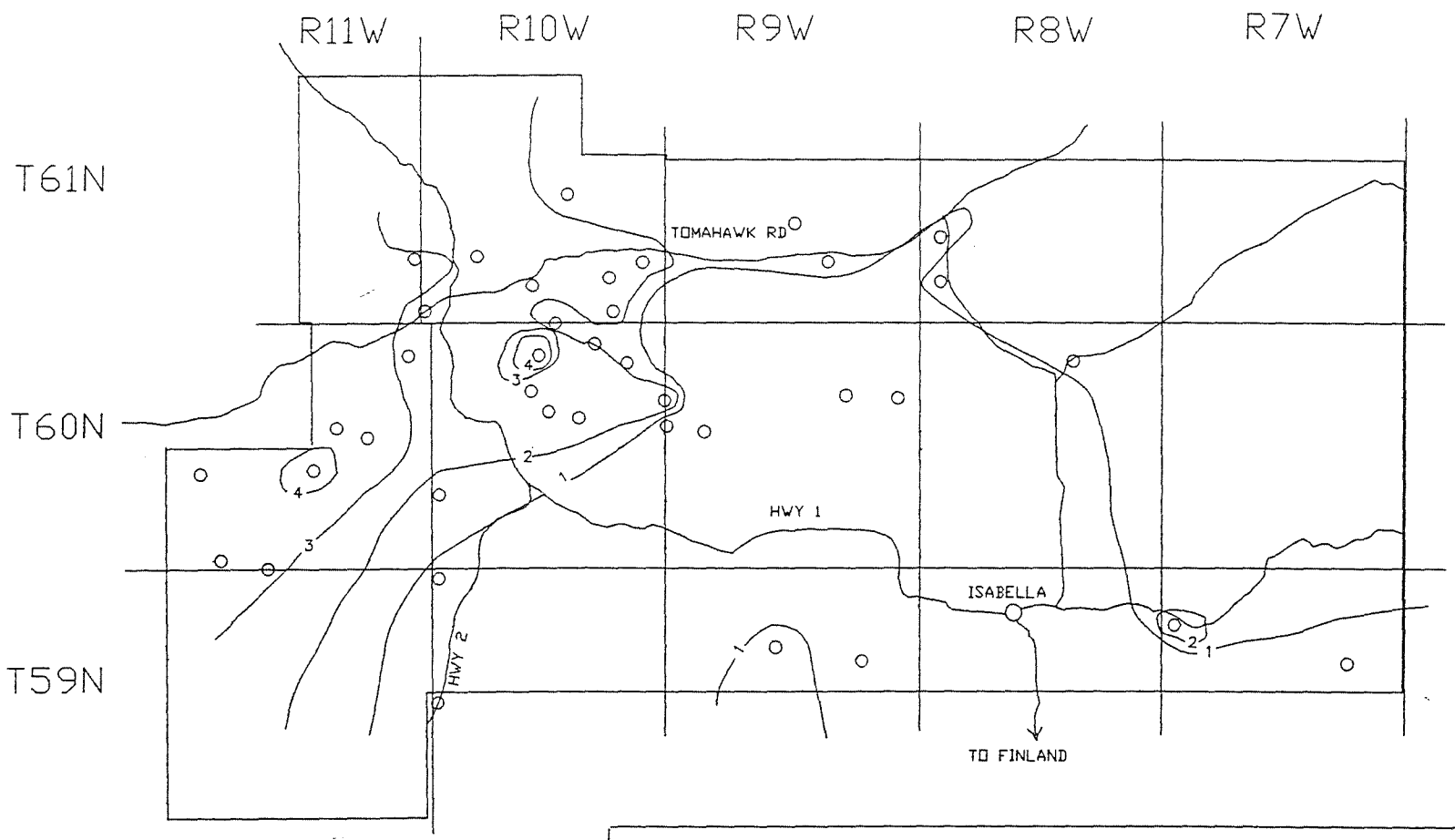
Results of Microprobe Analysis

Ilmenite

In all 218 grains of ilmenite were analyzed (see Table A-1, Appendix). In general ilmenite composition is very uniform. MgO content varies from 0 to 5 wt.% (average 2.2) and TiO_2 content varies from 45 to 52 wt.% (average 49.4). Cr content is very low, averaging 0.13 wt.%. During the point count analysis, it was noticed that approximately half the samples had ilmenite coexisting with chromite and/or spinel. Upon separating analyses of these spinels from free grains, it became obvious that ilmenite that are associated with spinel/chromite, have higher Cr, Ti and Mg contents than those that are not. Average electron microprobe analyses for both types of ilmenite are tabulated in Table 3.

All other ilmenite analyses appeared uniform, however when they were plotted and contoured for average MgO content (Figure 9) and average Mg/Mg+Fe+Mn molecular ratio (Figure 10), it is evident that there is a change in ilmenite composition over the entire area. Ilmenite from the western part of the area has a higher average MgO content and higher molecular ratio than

FIGURE 9



0 3 6

MILES

sample location

contour showing average % MgO in ilmenite

CAD P. MORTON
ANALYSIS P. MORTON
PROBE J. REICHHOFF

CONTOUR LINES SHOWING THE PER CENT MgO IN ILMENITE FROM HEAVY MINERAL CONCENTRATE SAMPLES

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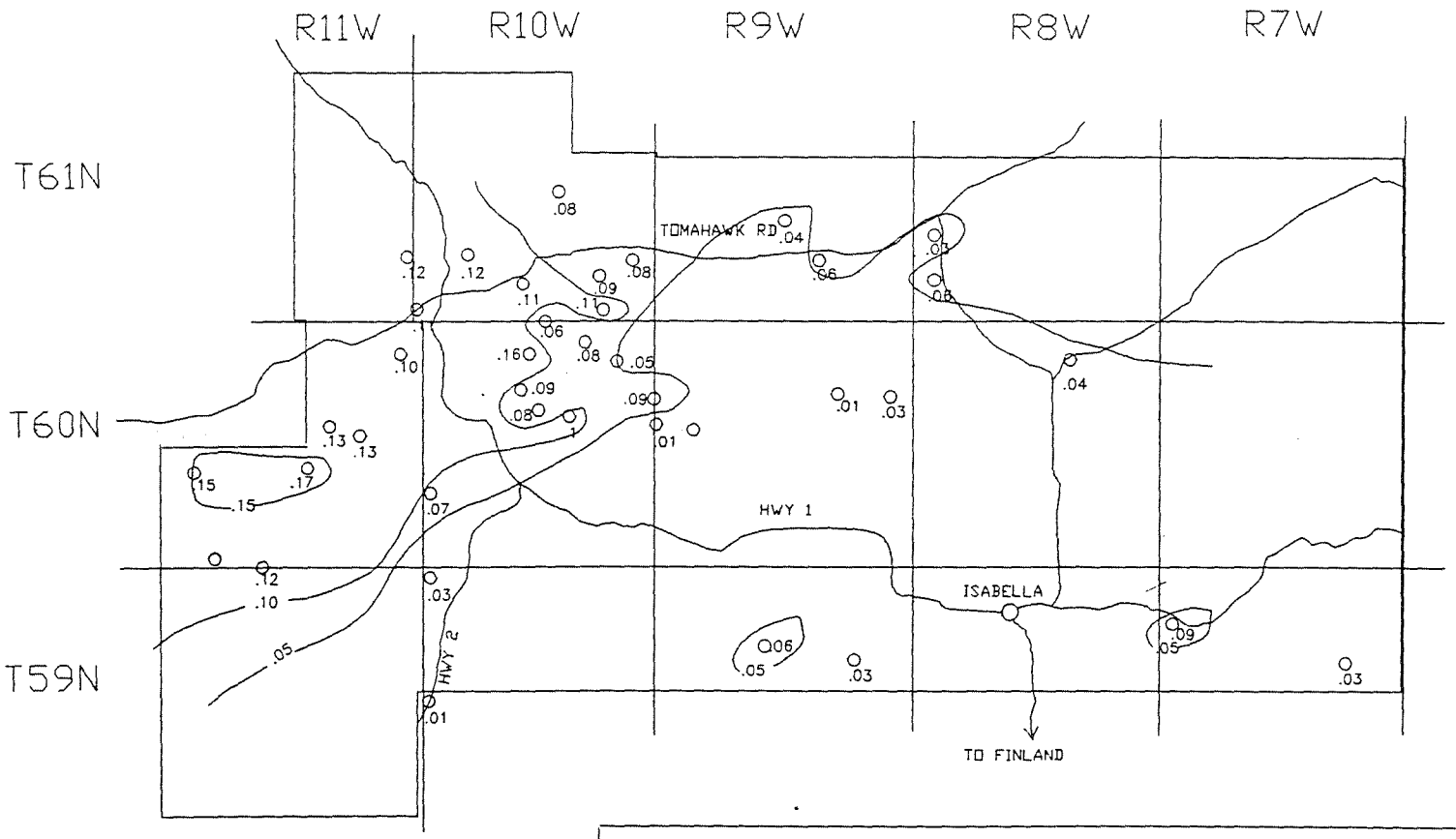
FIGURE 10



0 3 6

MILES

.12 average Mg/Mg+Fe+Mn ratio for sample in moles

.05 contour line representing the average Mg number for ilmenite

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ANALYSIS P. MORTON
PROBE J. REICHHOFF

AVERAGE Mg/Mg+Fe+Mn RATIOS FOR ILMENITE IN HEAVY MINERAL CONCENTRATE SAMPLES

(MOLES)

FOR

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samples to the east. This is most likely a reflection of the bedrock geology, with the microprobe analyses distinguishing those ilmenites that have come from troctolitic and ferrogabbro bodies from those that come from anorthositic series rocks. The correlation between bedrock geology and ilmenite composition is too strong to interpret in any other way.

TABLE 3: Average Chemical Analysis of Ilmenite

	1	2
TiO_2	49.1	53.3
Cr_2O_3	0.11	0.40
MnO	0.58	0.49
FeO	40.2	36.8
Fe_2O_3	6.80	4.05
SiO_2	0.12	0.09
MgO	1.93	5.95
Al_2O_3	0.12	0.12
TOTAL	98.96	101.2

1. Average of 204 analyses of ilmenite not associated with spinel/chromite.
2. Average of 14 analyses of ilmenite occurring as inclusions in spinel/chromite.

Magnetite

Of the 100 magnetite grains analyzed, 90% are classified as titanomagnetite. There is complete solid solution between titanomagnetite, chromite, Cr-spinels and spinel (Haggerty, 1976); however, for purposes of this report, if a grain contained less than 10 wt.% Cr_2O_3, it is called titanomagnetite. If it had more than 10 wt.% , it was grouped with chromite/spinel. This division is arbitrary but when Cr_2O_3 content is plotted against the Mg/Mg+Fe ratio, there is a natural break at 10 wt.% (see Figure 11a), however for Al, there is a complete continuum (Figure 11b).

The three most common types of magnetite grain were 1. free grains, 2. grains with spinel (pleonaste) lamellae and 3. grains with hematite and/or quartz. Average analyses of these three types are shown in Table 4. The grains that were identified as iron formation have very low trace element content and are almost pure magnetite. The other two groups however have high Ti, Cr, and Al contents although these contents are highly variable (check standard deviations). These titanomagnetite grains, with or without pleonaste, are interpreted to be igneous in origin and come from the rocks of the Duluth Complex.

The Cr_2O_3 content of titanomagnetite varies from 0 to 8.7 wt% (median 0.88 wt.%), with an average of 2.48 wt.%. The average for titanomagnetite (group 2, Table 4) is 2.21 % (range 0 to 8.7 %, median 0.38 wt.%) and the average for titanomagnetite with pleonaste is 3.72 %. (range 0.52 to 8 %, median 2.31 wt.%) It could be inferred that the titanomagnetite with

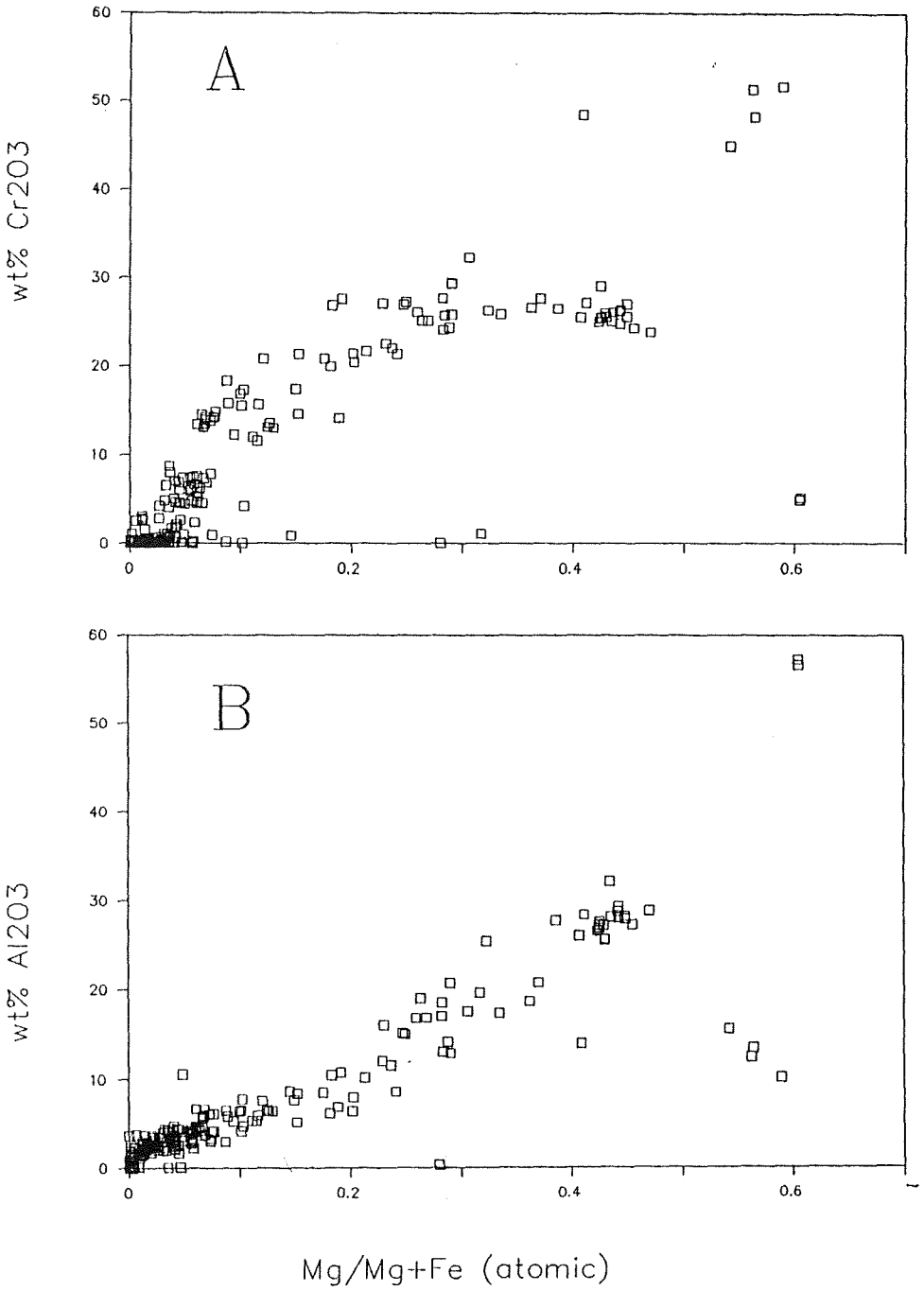


FIGURE 11: Al and Cr content of magnetite and spinel, r=0.82 for A and 0.9 for B.

TABLE 4: Average Chemical Analysis of Magnetite

	1		2		3	
TiO_2	0.10	(0.12)	7.48	(4.22)	5.15	(1.28)
Cr_2O_3	0.09	(0.09)	2.21	(2.68)	3.72	(2.53)
MnO	0.08	(0.06)	0.25	(0.16)	0.18	(0.09)
FeO	30.6	(0.89)	36.8	(4.03)	34.3	(1.52)
Fe_2O_3	68.4	(1.26)	48.2	(7.64)	51.0	(3.37)
SiO_2	0.51	(0.54)	0.26	(0.77)	0.06	(0.08)
MgO	0.16	(0.28)	0.65	(0.44)	0.98	(0.65)
Al_2O_3	0.13	(0.19)	3.11	(1.41)	3.27	(1.59)
TOTAL	100.1		99.02		98.67	

1. Average of 10 grains of iron formation.
2. Average of 74 grains of magnetite without spinel (pleonaste) lamellae.
3. Average of 16 grains of magnetite with spinel (pleonaste) lamellae.

Standard deviations are in brackets

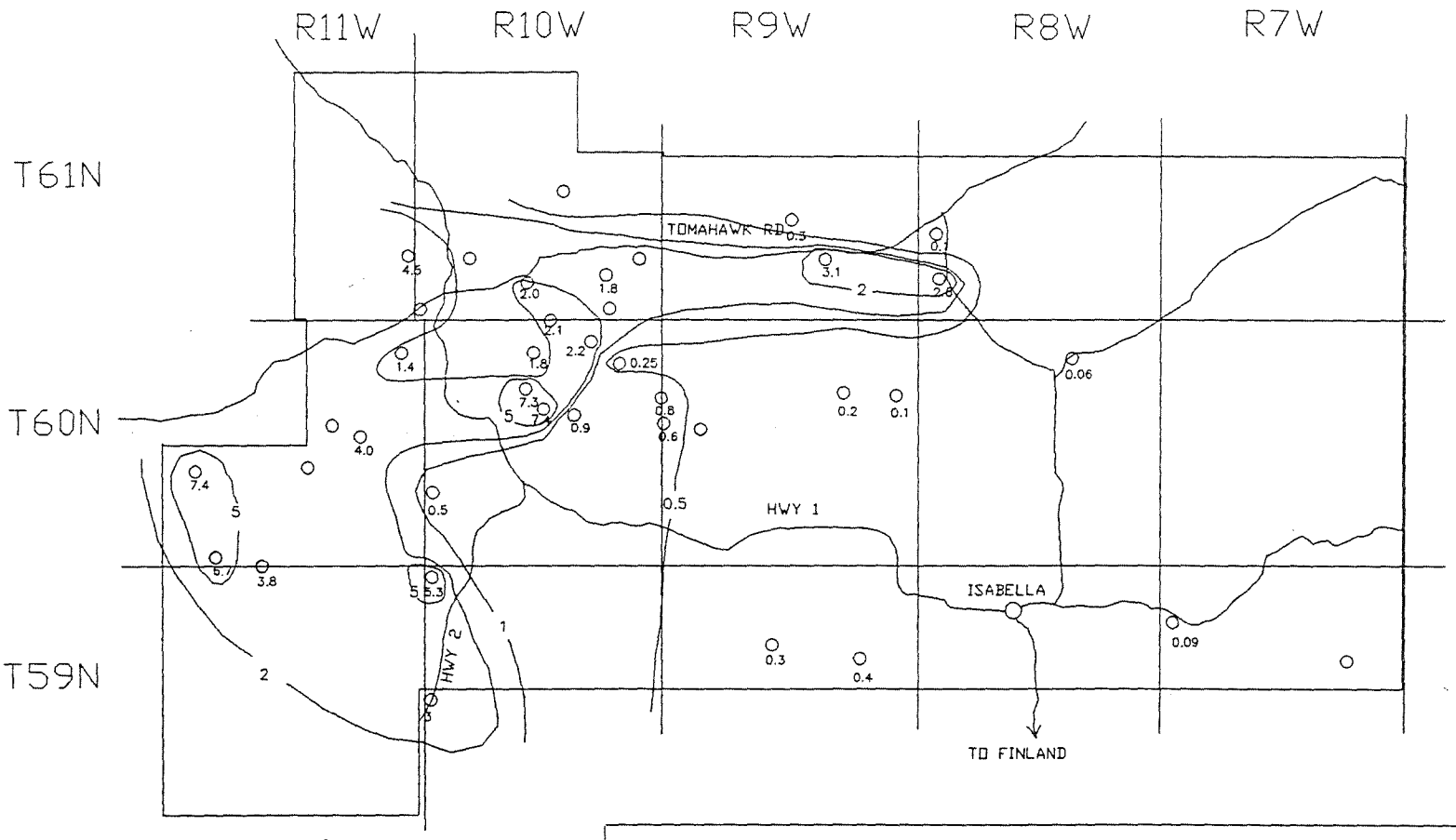
pleonaste has higher Cr content but the arithmetic standard deviations are high. Because the distributions are highly positively skewed as seen by the differences in the means and medians, perhaps Cr content could be considered to be log-normally distributed. This being the case, the differences in the medians is statistically significant, and it could be said that titanomagnetite with pleonaste lamellae has more Cr_2O_3 content than titanomagnetite without lamellae.

The high variability of the TiO_2 and Cr_2O_3 content of both kinds of titanomagnetite is best explained by their distribution over the study area. Average Cr_2O_3 content is plotted and contoured in Figure 12. There is a change in the Cr content of the titanomagnetite from east to west. In the east, the Cr content is low, generally less than 0.5 wt.% whereas in the west it reaches over 7 wt.%. Likewise if we look at the titanomagnetite with the highest Cr_2O_3 content, it can be seen that the same pattern emerges (Figure 13). Here the demarkation between east and west is better defined. The 1% contour almost perfectly outlines the contact between the troctolitic and the anorthositic series rocks. Although not plotted, the opposite distribution can be seen for the TiO_2 content: in the west the average overall TiO_2 content is 5.99 wt.% and in the east it is 7.16 wt.%.

Spinel/Chromite

For purposes of this report all grains with greater than 10 wt.% Cr_2O_3 (except samples 21197 and 21593) are reported in Table 5. The vast

FIGURE 12



0 3 6

MILES

1.5 average Cr203 content of magnetite

2 contour showing % Cr203

CAD P. MORTON
ANALYSIS P. MORTON
PROBE J. REICHHOFF

AVERAGE CHROMIUM CONTENT OF MAGNETITE FROM HEAVY MINERAL CONCENTRATE SAMPLES

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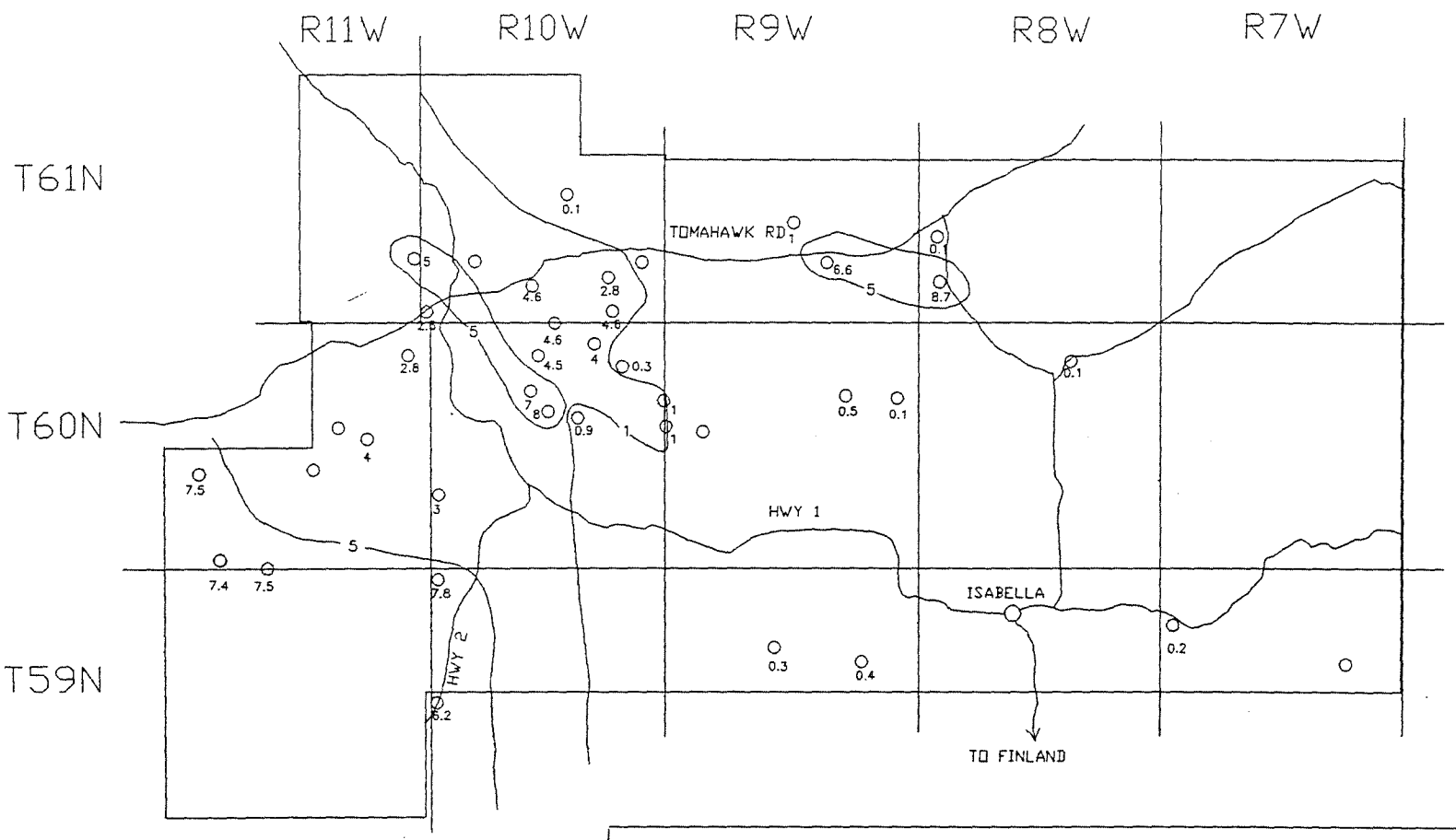
FIGURE 13



0 3 6

MILES

2.4 SAMPLE LOCATION WITH HIGHEST VALUE OF Cr CONTENT IN MAGNETITE

5 % Cr IN MAGNETITE

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ANALYSIS P. MORTON
PROBE J. REICHHOFF

HIGHEST CHROMIUM CONTENT OF MAGNETITE FROM HEAVY MINERAL CONCENTRATE SAMPLES

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majority of them vary in composition from Fe-Ti-rich chromite ($chromite_{ss}$) to Cr-rich pleonaste-magnetite ($pleonaste_{ss}$) solid solution. There appears to be a complete solid solution between the two (Figure 14). The analyses that do not follow the trend are either Al-rich chromite (upper right of figure 14), Cr-poor pleonaste (sample 21197) or ulvospinel (sample 21593).

The average Cr_2O_3 content of $chromite_{ss}$ and $pleonaste_{ss}$ from each sample is plotted on Figure 7. In general samples from the western part of the area (overlying troctolitic rocks) are richer in Cr content than samples overlying the anorthositic rocks. This correlates well with the Cr content of magnetite, the MgO content of ilmenite and the Cr content of the sample itself (compare with Figure 6). The exception is in the north-central part of the area where samples 21267, 21446 and 21557 contain chromites which are much richer in chrome content (>48 wt.%) and contain very little titanium. They might have a different source area.

Co-existing $chromite_{ss}$ and $pleonaste_{ss}$ were found in samples 20456, 21766, 21698 and 20567 (Figure 15a,b,c). These are of particular interest because co-existing $pleonaste_{ss}$ and $titanomagnetite_{ss}$ are found in core DU-15 associated with high platinum metal contents (Sabelin et al., 1986). However, samples from DU-15 are much richer in aluminum and poorer in chromium than those grains found in the heavy mineral concentrates in this study. The co-existing spinel grains analyzed in this study are much closer in composition to Cr-titanomagnetite and Cr-hercynite from the Basal Marginal Zone of the Water Hen intrusion (Mainwaring, 1975).

Table 5: Analyses of chromite and spinel

SAMPLE	POINT	TiO2	Cr_2O_3	MnO	FeO	Fe_2O_3	SiO_2	MgO	Al_2O_3	
20456-01-3	7	7.45	22.08	0.42	30.79	19.56	0.21	5.36	11.57	97.44
20456-01-3	5	1.54	27.08	0.21	22.14	10.92	0.19	10.13	28.29	100.50
20456-01-3	1	9.20	21.42	0.36	32.82	22.89	0.09	4.65	6.42	97.85
20456-01-3	2	10.06	19.95	0.49	33.18	20.50	0.63	4.13	6.12	95.06
20456-01-3	3	1.08	24.88	0.25	21.94	11.79	0.30	9.79	29.31	99.34
20456-01-3	4	1.29	25.11	0.18	22.84	8.42	0.15	9.88	32.16	100.03
20456-01-3	6	8.45	20.45	0.25	33.02	22.65	0.11	4.71	8.00	97.64
20462	5	5.05	25.78	0.31	28.07	20.23	0.04	6.25	13.04	98.77
20462	3	5.03	25.89	0.34	27.83	20.51	0.00	6.40	12.90	98.90
20462	14	4.02	17.36	0.48	30.74	35.11	0.09	3.04	7.64	98.48
20474	10	3.79	14.13	0.32	29.78	41.65	0.16	3.89	6.87	100.59
20483-02	2	4.73	24.14	0.28	28.51	18.11	0.00	6.31	17.02	99.10
20483-02	5	4.59	25.90	0.43	26.52	16.92	0.05	7.50	17.31	99.22
20483-02	6	0.40	44.93	1.91	15.39	5.83	0.22	10.23	15.59	94.50
20483-02	7	5.42	24.37	0.17	28.31	19.44		6.44	14.15	98.30
20483-02	8	5.17	1.09	0.15	28.35	40.11	0.63	7.39	19.68	102.57
20494	4	4.13	25.19	0.43	28.86	19.40	0.00	5.97	16.88	100.86
20494	5	4.44	26.14	0.47	29.54	18.21	0.11	5.81	16.82	101.54
20494	3	2.68	26.61	0.19	24.23	16.90	1.00	7.73	18.75	98.09
20494	6	3.03	27.70	0.36	27.72	16.45	0.09	6.13	18.56	100.04
20541	12	5.33	27.13	0.46	29.89	18.58	0.07	4.98	12.05	98.49
20546	16	4.64	20.80	0.30	32.82	31.42	0.02	2.53	7.60	100.13
20546	14	7.66	21.34	0.40	32.87	20.91	0.15	3.32	8.43	95.08
20437-01-1	3	2.63	26.01	0.13	23.62	11.74	0.12	9.96	27.20	101.41
20437-01-1	2	2.57	25.53	0.39	23.41	11.18	0.06	9.75	27.64	100.53
20437-01-1	1	2.67	26.37	0.28	23.51	12.09	0.04	10.50	28.11	103.57
20437-01-1	6	2.82	25.45	0.29	23.65	11.32	0.20	9.81	27.31	100.85
20437-01-1	5	2.98	25.61	0.22	23.28	12.44	0.00	9.88	25.63	100.04
20437-01-1	4	2.58	25.59	0.30	22.64	10.97	0.10	10.34	27.97	100.49
20437-01-2A	1	1.84	26.52	0.32	24.76	11.71	0.04	8.75	27.78	101.72
20437-01-2A	2	1.72	27.16	0.12	24.34	12.42	0.00	9.57	28.40	103.73
20437-01-4	3	3.13	25.52	0.37	24.62	13.05	0.00	9.50	26.07	102.26
20437-01-4	1	4.04	27.27	0.49	29.00	18.67	0.00	5.41	15.05	99.93
20437-01-4	4	2.89	25.05	0.29	23.96	13.49	0.00	9.88	26.63	102.19
20437-01-4	2	4.80	26.96	0.43	30.08	18.61	0.08	5.54	15.13	101.63
20437-01-5	1	2.39	26.25	0.36	22.77	9.37	0.12	10.14	28.80	100.20
20437-01-5	3	2.34	26.14	0.33	22.92	10.16	0.08	9.95	28.19	100.11
21197	9	0.20	5.20	0.08	17.52	3.97	0.17	15.11	56.67	98.92
21197	8	0.22	4.95	0.15	17.75	4.46	0.08	15.25	57.25	100.11
21207	6	5.77	17.34	0.23	33.74	30.65	0.07	2.17	7.81	97.78
21730	3	5.57	14.25	0.34	34.62	35.78	0.18	1.42	6.63	98.79
21730	2	5.13	13.38	0.11	34.19	36.27	0.04	1.25	6.66	97.03
21752	8	4.83	13.91	0.23	34.34	39.13	0.02	1.39	5.98	99.83
21752	9	5.01	14.37	0.27	34.48	38.87	0.02	1.60	6.17	100.79

Table 5: Analyses of chromite and spinel (cont'd)

SAMPLE	POINT	TiO2	Cr_2O_3	MnO	FeO	Fe_2O_3	SiO_2	MgO	Al_2O_3	
21752	7	5.29	13.80	0.33	34.34	37.95	0.02	1.51	6.09	99.33
21766	9	1.14	29.37	0.40	26.38	15.63	0.04	6.06	20.77	99.79
21766	11	3.49	23.87	0.25	22.13	9.27	0.00	11.04	28.86	98.91
21766	4	3.77	20.81	0.25	30.06	31.40	0.16	3.60	8.54	98.59
21766	10	2.95	27.66	0.13	24.46	13.29	0.15	8.09	20.81	97.54
21766	3	15.17	22.55	0.36	37.16	0.00	0.04	6.25	16.06	97.59
21766	8	1.46	25.23	0.30	27.04	20.22	0.07	5.44	19.03	98.79
21766	1	2.38	26.31	0.16	26.94	11.92	0.23	7.22	25.41	100.57
21766	2	4.32	14.59	0.45	29.81	38.54	0.10	3.00	5.17	95.98
21698	3	6.65	21.72	0.30	32.10	25.99	0.00	4.88	10.23	101.87
21698	5	1.22	29.12	0.16	22.88	11.32	0.00	9.51	26.90	101.11
21700	7	3.10	14.51	0.20	32.81	44.19	0.14	1.27	4.26	100.48
21700	14	2.79	14.19	0.14	31.54	43.68	0.11	1.44	4.13	98.02
21700	6	2.80	14.85	0.34	31.40	43.18	0.11	1.47	4.15	98.30
21702	8	5.41	16.90	0.13	34.13	35.21	0.04	2.12	6.41	100.35
21702	13	3.69	18.34	0.37	32.49	35.93	0.07	1.75	6.46	99.10
21702	2	6.09	12.25	0.28	34.38	39.64	0.07	2.01	5.26	99.98
21702	7	4.48	15.79	0.32	33.46	38.88	0.00	1.84	5.80	100.57
21702	1	6.54	15.69	0.35	33.72	33.74	0.05	2.49	5.94	98.52
21702	11	4.32	12.04	0.36	32.18	43.15	0.00	2.26	5.31	99.62
21702	9	6.34	15.50	0.33	34.37	34.03	0.03	2.17	6.48	99.25
21702	12	4.16	11.64	0.33	31.93	43.90	0.00	2.34	5.31	99.61
20567	17	8.65	21.43	0.29	32.55	25.58	0.13	5.82	8.58	103.03
20567	10	2.55	32.30	0.30	26.68	14.54	0.14	6.61	17.57	100.69
20567	14	2.02	24.34	0.10	22.31	15.02	0.11	10.48	27.26	101.64
20567-02-6	6	5.30	13.54	0.32	33.02	39.31	0.09	2.68	6.44	100.70
20567-02-6	6	5.15	13.01	0.27	32.64	39.75	0.00	2.73	6.42	99.97
20567-02-6	6	5.30	13.07	0.34	32.83	38.87	0.10	2.62	6.64	99.77
20567-03	3	4.39	27.61	0.34	30.65	21.67	0.08	4.08	10.77	99.59
20567-03	3	4.39	26.84	0.43	30.83	22.75	0.15	3.88	10.48	99.75
21267	21	0.48	48.25	0.25	16.09	8.97	0.00	11.70	13.48	99.22
21446	10	0.53	51.69	0.27	14.70	7.83	0.17	11.86	10.23	97.28
21446	11	0.40	51.33	0.26	16.00	6.92	0.46	11.55	12.44	99.36
21593	12	30.60	0.03	0.06	44.00	14.50		9.62	0.33	99.14
21657	6	3.50	13.15	0.32	32.16	40.38	0.28	1.28	5.84	96.91
21657	8	3.56	13.48	0.25	32.46	40.48	2.44	1.32	5.84	99.83
21557	1	0.50	48.43	0.36	21.34	6.41	0.14	8.30	13.95	99.43

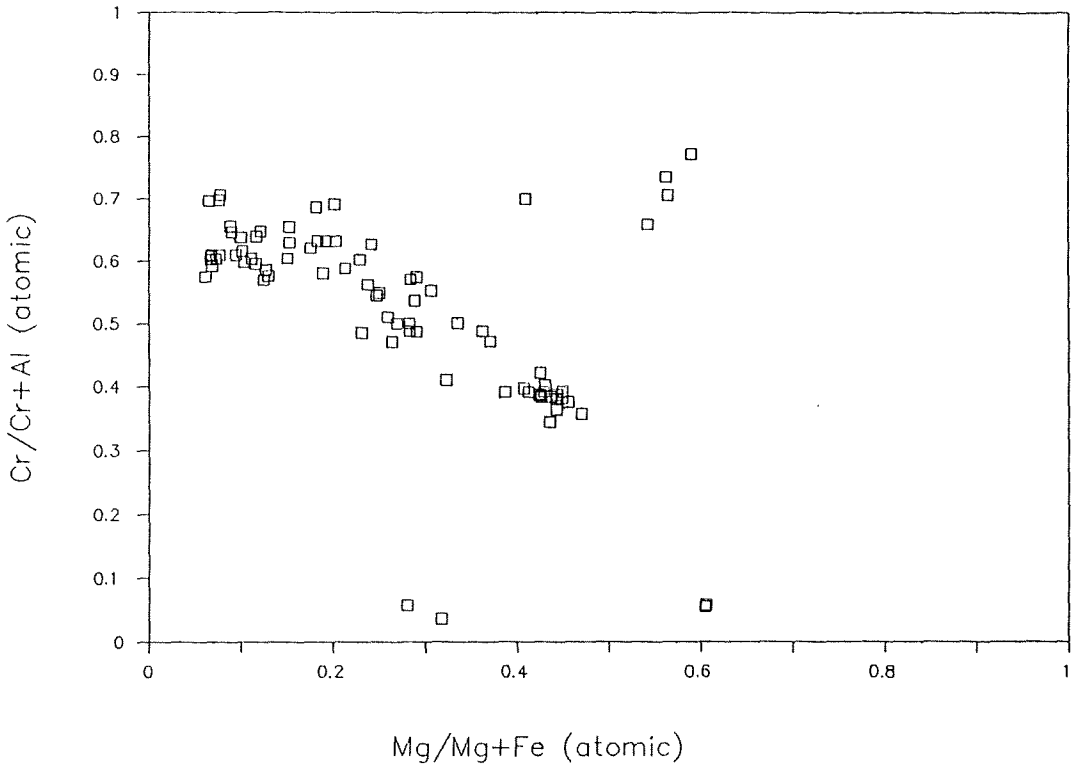

FIGURE 14: Composition of chromite and pleonaste solid solution

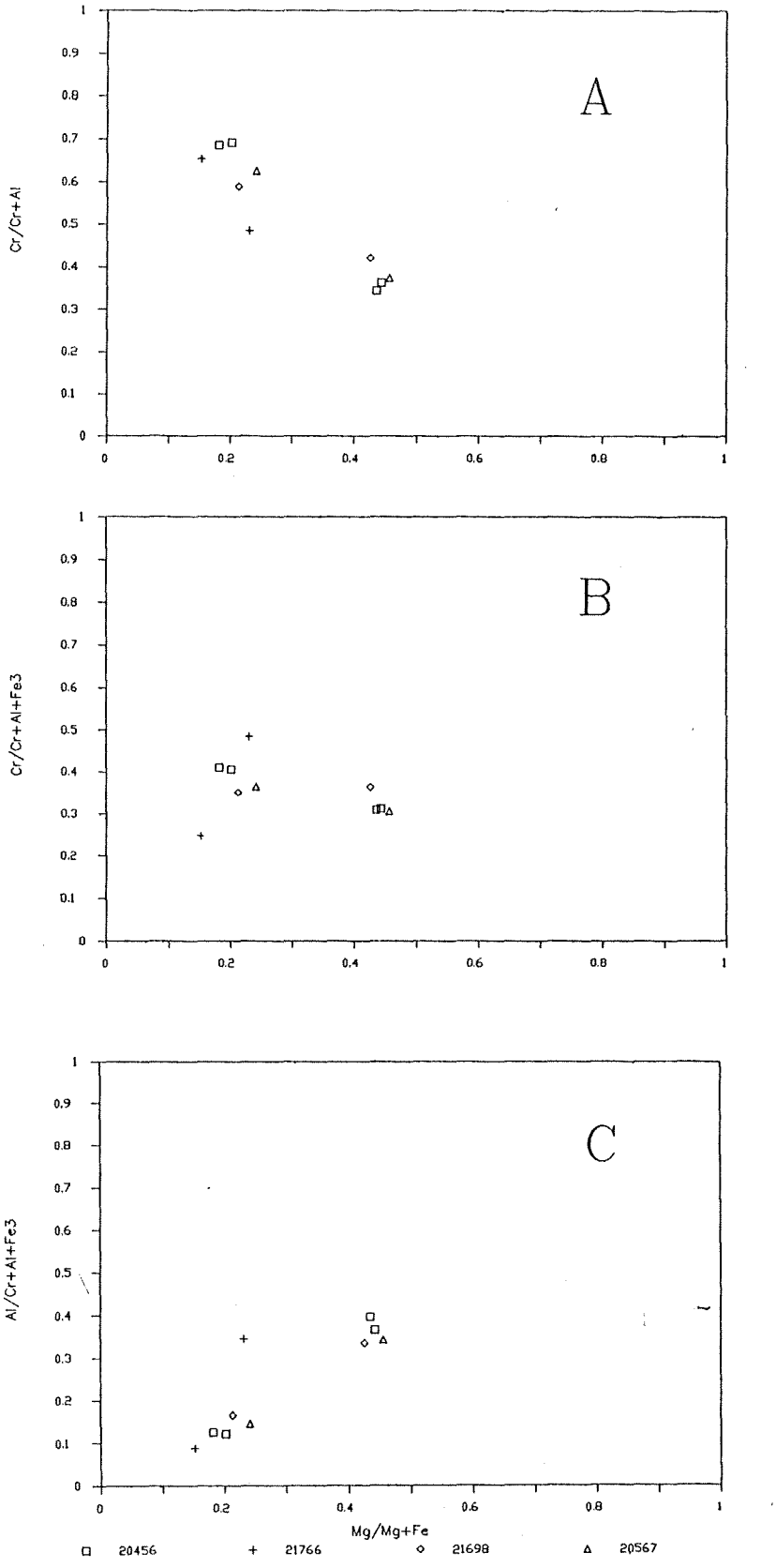

FIGURE 15: Compositions of co-existing spinels plotted in atomic per cent

Conclusions

The results of this study can be summarized into the following points:

1. Partial heavy mineral concentrate samples are an inexpensive, practical means to attain samples to identify opaque oxides. Grain mounts can be made directly from the samples without added separation and preparation.

2. Opaque oxides in heavy mineral concentrate samples are very representative of local bedrock and can be used as geochemical pathfinder minerals. This is true for all types of glacial drift samples collected, whether till, ice contact or outwash. The oxides appear to of local origin.

3. The percent ilmenite is directly related to the overall TiO_2 content however the variation in the composition of the ilmenite is directly related to the bedrock type. The percent magnetite is variable but there is a systematic change in the composition of the magnetite according to area which also must be directly related to the source bedrock. The amount of $chromite_{ss}$ and $pleonaste_{ss}$ is higher in areas of high Cr_2O_3 content, i.e. in the west, however odd grains of each are found throughout all the samples. The composition of the $chromite_{ss}$ and $pleonaste_{ss}$ varies consistently from west to east, probably also a function of bedrock composition.

4. The identification of Cr-spinel phases in polished section grain mounts is difficult using the reflecting microscope. The use of the electron microprobe was necessary to document their existence, therefore this technique is ultimately expensive. The changes in the composition of magnetite and ilmenite could not be validated except

by using the electron microprobe, therefore is one is interested in using opaque oxide phases in glacial overburden to trace bedrock composition, the use of the electron microprobe is necessary. However expensive, it does yield good results.

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PLATE A EXAMPLES OF ILMENITE

Field of view is 0.4 mm except where noted.

1. Typical ilmenite grains in sample 21072. Grain with arrow corresponds to point 14 in Table A-1.

2. Corroded ilmenite grain in sample 21552. Point 11 in Table A-1.

3. Ilmenite grain in sample 20546.

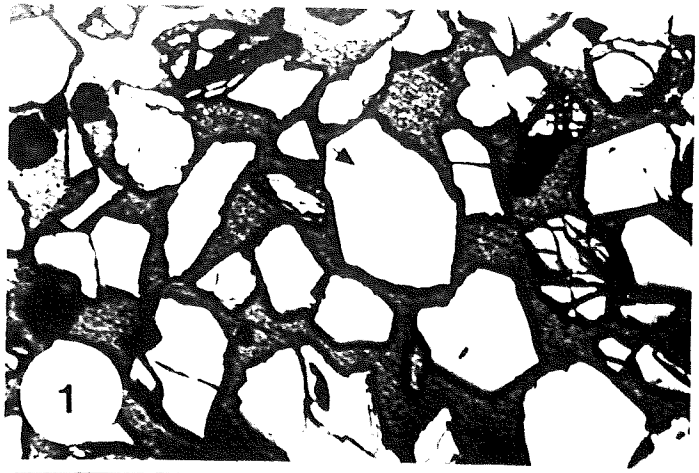
4. Sample 20546. Grain on left is magnetite with hematite alteration, points 10 and 11, Table A-1. Grain on right is ilmenite with silicates (point 9).

5. Sample 20591. Magnetite-ulvospinel intergrowth. Field of view is 0.15 mm.

6. Sample 20591. Ilmenite with hematite/ilmenite alteration.

7 Sample 20443. Bright white Cr-rich magnetite with darker grey ilmenite. Analyses 12 and 13, Table A-1.

8. Sample 20437. Large grain of magnetite with spinel inclusions and well-polished ilmenite on the side. Note the spinel reaction rim between the two. Analyses 1 and 2, circle 3, Table A-1.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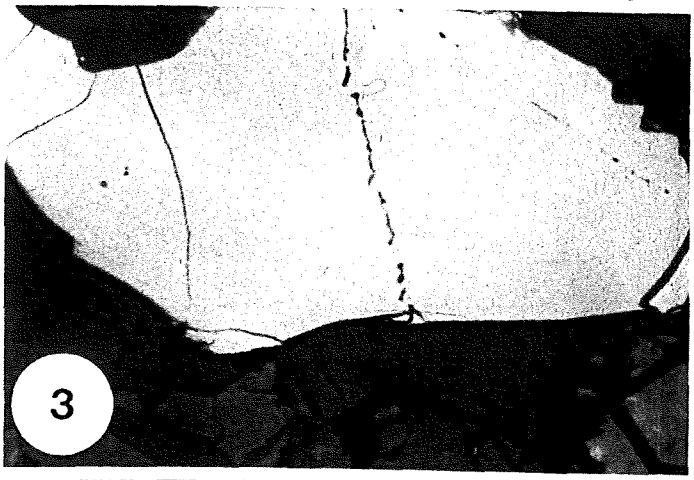
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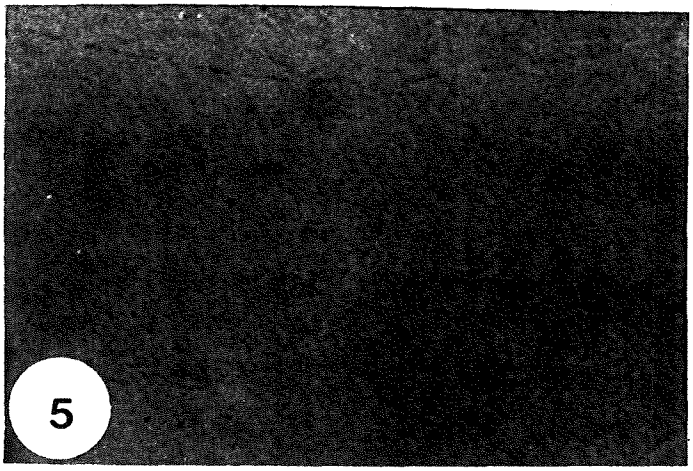
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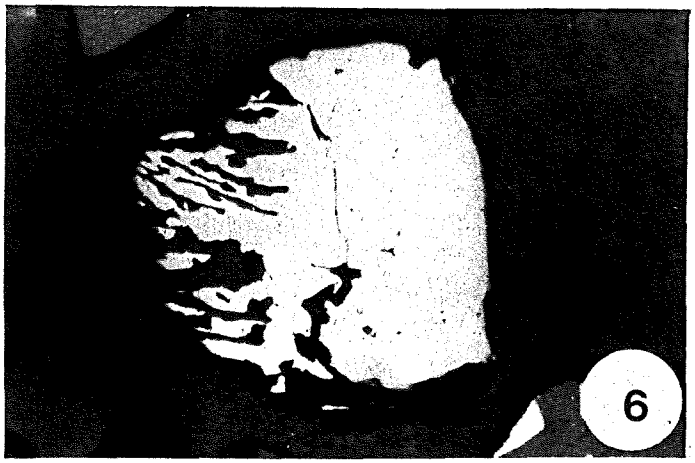
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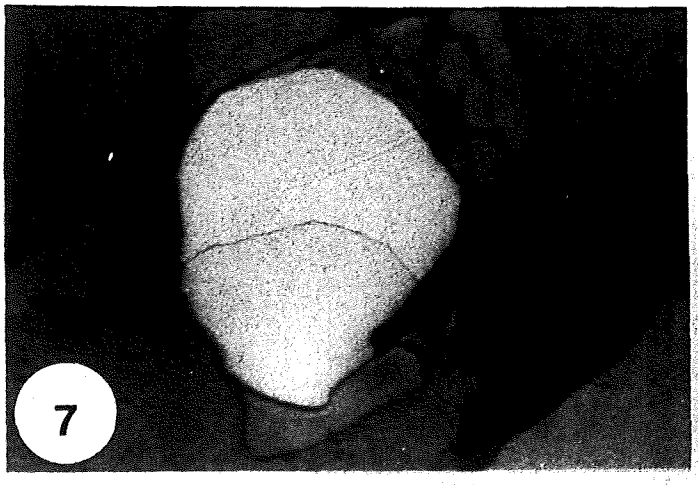
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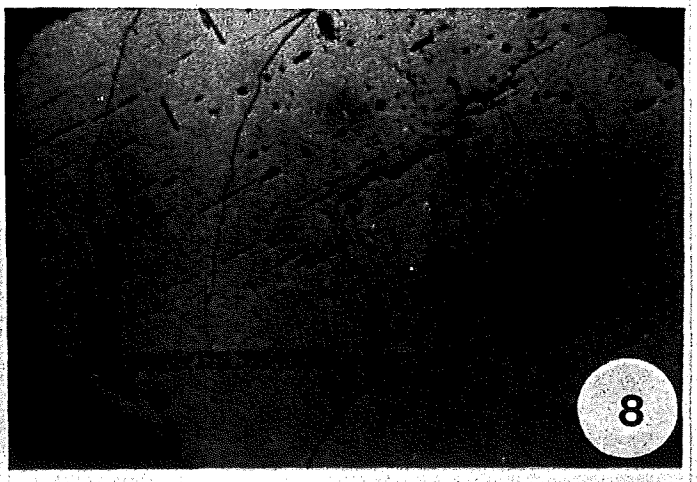
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PLATE B EXAMPLES OF ILMENITE WITH SPINEL

Field of view is 0.4 mm except when noted.

1. Sample 21702. Chromite with ilmenite inclusion. Analyses 2 and 4 respectively in Table A-1.

2. Sample 20462. Chromite (point 3, Table A-1) with ilmenite lamellae.

3. Sample 20567. Ilmenite with dark grey spinel around edges. Analyses 9 and 10, Table A-1.

4. Sample 20437. Two dark grey chromite grains and bright white ilmenite. Corresponds to 20437-01-5, points 1,3 (chromite) and 2 (ilmenite), Table A-1.

5. Sample 20474. Bright white ilmenite (point 11, Table A-1) in iron rich chromite (point 10).

6. Sample 20462. Dark grey chromite (point 14, Table A-1) with ilmenite (point 15) at edge.

7. Sample 20567. Grain of ilmenite (points 11 and 12, Table A-1) with tiny dark grey spinel inclusion (arrow).

8. Dark grey spinel (points 8 and 9, Table A-1) with white ilmenite (point 7).

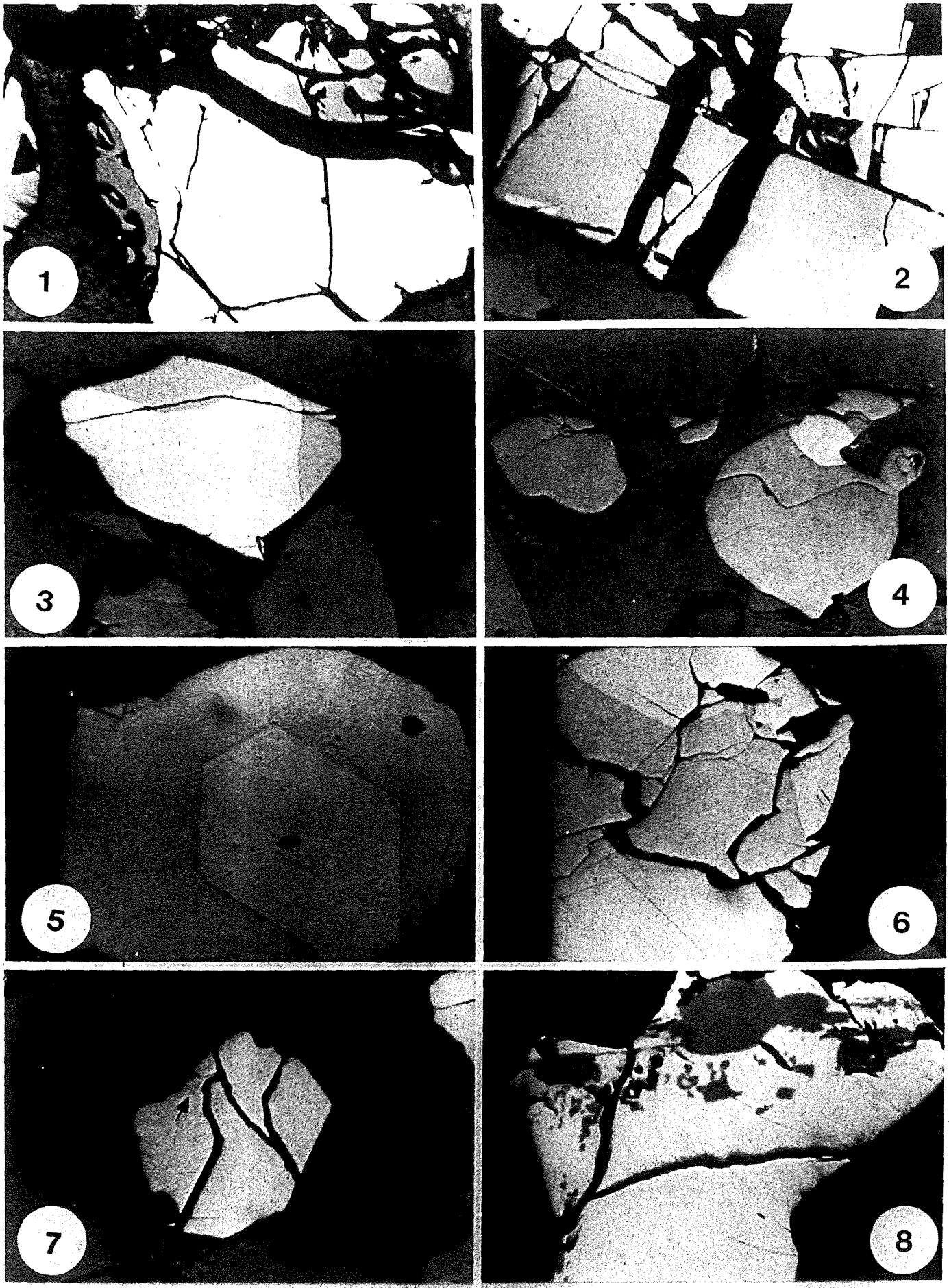
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PLATE C EXAMPLES OF SPINEL

Field of view is 0.4 mm except where noted.

1. Sample 20456. Grain of manganese rich ilmenite on right (points 8 and 9, Table A-1) and grain of light grey Ti-rich (points 6 and 7) chromite coexisting with dark grey Ti-poor chromite.

2. Sample 20437. Composite grain of small euhedral chromites in a silicate matrix. Field of view is 1.5 mm.

3. Sample 21446. Euhedral grain of chromite with 51 wt% Cr_2O_3 (points 10 and 11, Table A-1).

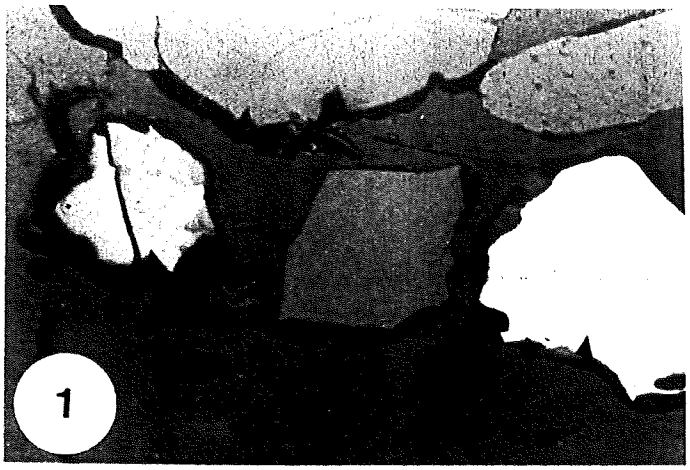
4. Sample 21702. Large anhedral, broken Fe-rich chromite (points 7 and 8, Table A-1).

5. Sample 20567. Dark grey Al-rich chromite with light grey Fe-Ti-rich chromite plus a bright white ilmenite lamellae. Corresponds to points 14, 17 and 15, Table A-1 respectively.

6. Sample 20456. Light grey Ti-Fe-rich chromite with co-existing dark grey Al-rich chromite. Corresponds to points 1 and 2 vs 3 and 4 respectively.

7. Sample 20483. Magnetite with spinel lamellae on left and a grain of chromite on right.

8. Sample 20567. Grain of chromite. Corresponds to analyses 20567-03, grain 3, Table A-1.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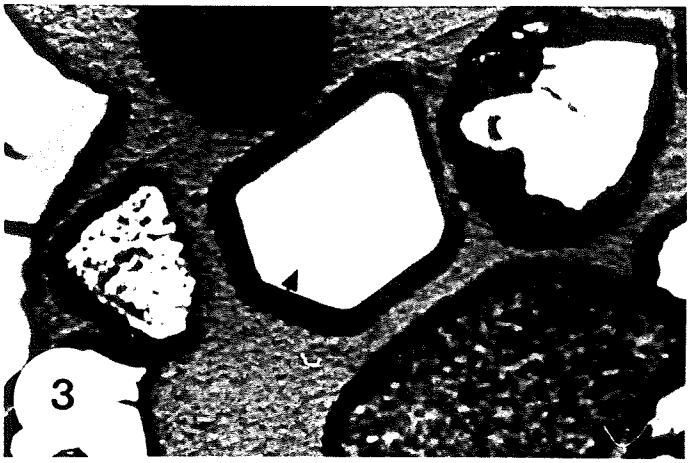
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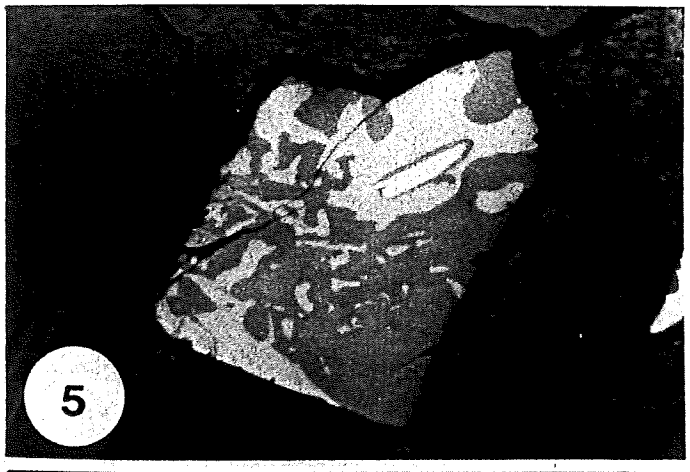
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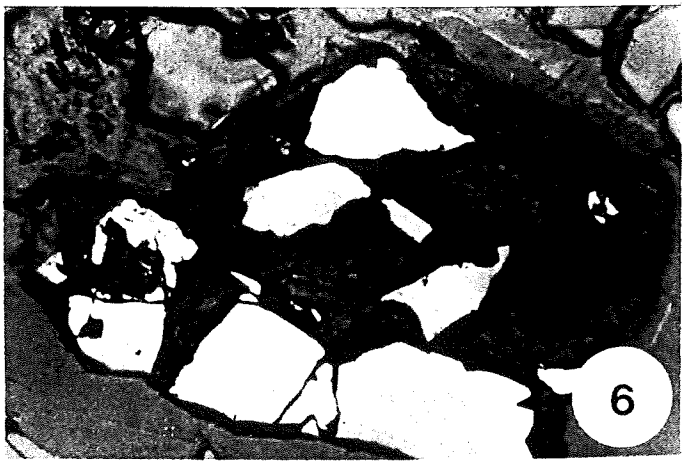
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PLATE D EXAMPLES OF MAGNETITE

Field of view is 0.4 mm except where noted.

1. Sample 20515. S is a magnetite grain with ilmenite lamellae. T is a mottled grain of magnetite and hematite, probably iron formation. U is a grain of magnetite ulvospinel intergrowth.

2. Sample 20462. S is a grain of magnetite with hematite alteration and t is magnetite with dark grey spinel lamellae.

3. Sample 20462. Grain of iron formation, hematite.

4. Sample 20483. Dark grey chromite (with arrow), light grey magnetite with pleonaste inclusions and a grain of simplectite in the upper right corner. Field of view is 1.5 mm.

5. Sample 20443. Cr-rich magnetite (analyses 14, 15 and 16, Table A-1). Note dark grey spinel as inclusions.

6. Sample 21702. Magnetite (points 5 and 6, Table A-1) with pleonaste inclusions.

7. Sample 20515. Magnetite and orthopyroxene simplectite, corresponds to circle 6, analyses 1 and 2, Table A-1.

8. Sample 20474. Magnetite with hematite alteration.

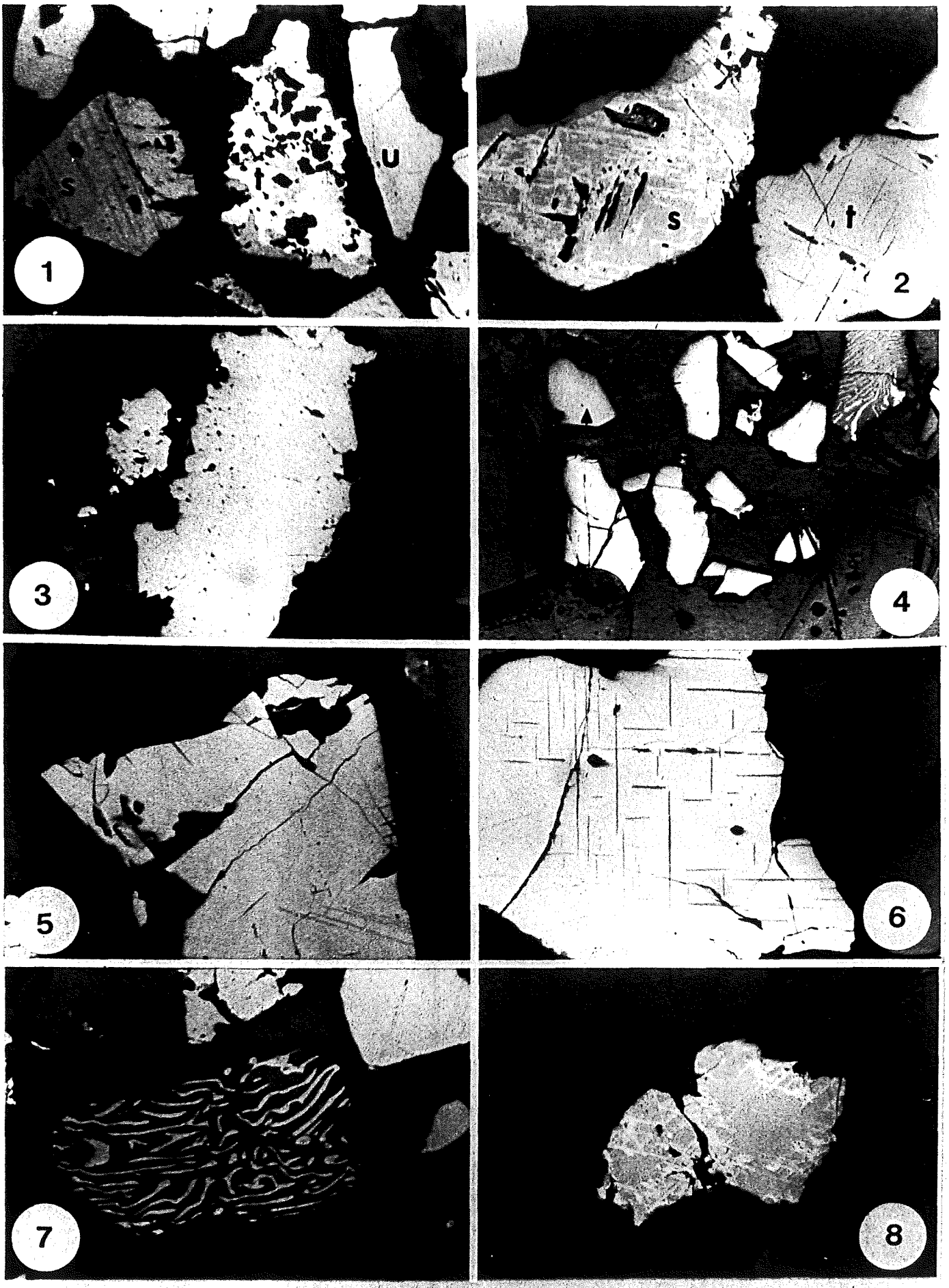
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Table A-1: All opaque oxide microprobe analyses

SAMPLE NAME	POINT	NAME AND NOTES	TiO2	Cr2O3	MnO	FeO	Fe2O3	SiO2	MgO	Al2O3	TOTAL
20437-01-1	1	Spinel	2.67	26.37	0.28	23.51	12.09	0.04	10.50	28.11	103.57
20437-01-1	2	Spinel	2.57	25.53	0.39	23.41	11.18	0.06	9.75	27.64	100.53
20437-01-1	3	Spinel	2.63	26.01	0.13	23.62	11.74	0.12	9.96	27.20	101.41
20437-01-1	4	Spinel	2.58	25.59	0.30	22.64	10.97	0.10	10.34	27.97	100.49
20437-01-1	5	Spinel	2.98	25.61	0.22	23.28	12.44	0.00	9.88	25.63	100.04
20437-01-1	6	Spinel	2.82	25.45	0.29	23.65	11.32	0.20	9.81	27.31	100.85
20437-01-2A	1	Spinel	1.84	26.52	0.32	24.76	11.71	0.04	8.75	27.78	101.72
20437-01-2A	2	Spinel	1.72	27.16	0.12	24.34	12.42	0.00	9.57	28.40	103.73
20437-01-3	1	Magnetite	6.35	2.15	0.15	34.87	50.42	0.00	0.86	2.09	96.89
20437-01-3	2	Magnetite	5.80	2.31	0.23	34.18	52.21	0.00	1.19	2.22	98.14
20437-01-4	1	Spinel	4.04	27.27	0.49	29.00	18.67	0.00	5.41	15.05	99.93
20437-01-4	2	Spinel	4.80	26.96	0.43	30.08	18.61	0.08	5.54	15.13	101.63
20437-01-4	3	Spinel	3.13	25.52	0.37	24.62	13.05	0.00	9.50	26.07	102.26
20437-01-4	4	Spinel	2.89	25.05	0.29	23.96	13.49	0.00	9.88	26.63	102.19
20437-01-4	5	Ilmenite	50.08	0.30	0.67	39.04	6.53	0.33	2.89	0.13	99.97
20437-01-4	6	Orthopyroxene	0.18	0.13	0.43	17.66	0.00	54.55	27.50	1.15	101.60
20437-01-4A	1	Ilmenite	51.50	0.11	0.48	41.21	3.37	0.00	2.59	0.02	99.28
20437-01-5	1	Spinel	2.39	26.25	0.36	22.77	9.37	0.12	10.14	28.80	100.20
20437-01-5	2	Ilmenite	56.02	0.32	0.44	35.15	1.90	0.00	8.29	0.13	102.25
20437-01-5	3	Spinel	2.34	26.14	0.33	22.92	10.16	0.08	9.95	28.19	100.11
20443	1	Magnetite	5.84	5.05	0.36	34.67	45.89	0.06	0.80	4.21	96.88
20443	4	Ilmenite	51.20	0.01	0.49	40.68	3.35	0.00	2.73	0.08	98.54
20443	8	Ilmenite	50.68	0.30	0.40	39.27	6.87	0.00	3.31	0.20	101.03
20443	10	Ilmenite	49.20	0.14	0.49	37.40	5.81	0.00	3.57	0.16	96.77
20443	12	Ilmenite	49.60	0.02	0.71	40.00	3.82	0.18	2.16	0.08	96.57
20443	13	Magnetite	4.66	4.81	0.18	33.84	48.28	0.09	0.61	3.94	96.41
20443	14	Magnetite	5.50	4.61	0.23	33.30	45.70	0.09	1.20	4.34	94.97
20443	15	Magnetite	5.59	4.54	0.34	34.25	47.62	0.11	1.24	4.24	97.93
20443	16	Magnetite	5.83	4.78	0.29	34.50	46.72	0.16	1.14	4.40	97.82
20443	17	Ilmenite	48.48	0.13	0.26	37.73	7.09	0.08	3.14	0.12	97.03
20456-01-1	1	Ilmenite	50.76	0.17	0.39	42.20	4.79	0.05	1.71	0.09	100.16
20456-01-1	2	Magnetite	4.45	2.63	0.34	34.65	54.60	0.04	0.21	2.28	99.20
20456-01-1	3	Magnetite	3.88	2.75	0.18	33.91	55.46	0.00	0.51	2.46	99.15
20456-01-2	1	Ilmenite	9.50	5.30	0.28	5.80	75.29	0.06	1.38	4.60	102.21
20456-01-2	1	Magnetite	9.50	5.30	0.28	37.86	39.59	0.06	1.38	4.60	98.57
20456-01-3	1	Spinel	9.20	21.42	0.36	32.82	22.89	0.09	4.65	6.42	97.85
20456-01-3	2	Spinel	10.06	19.95	0.49	33.18	20.50	0.63	4.13	6.12	95.06
20456-01-3	3	Spinel	1.08	24.88	0.25	21.94	11.79	0.30	9.79	29.31	99.34
20456-01-3	4	Spinel	1.29	25.11	0.18	22.84	8.42	0.15	9.88	32.16	100.03
20456-01-3	5	Spinel	1.54	27.08	0.21	22.14	10.92	0.19	10.13	28.29	100.50
20456-01-3	6	Spinel	8.45	20.45	0.25	33.02	22.65	0.11	4.71	8.00	97.64
20456-01-3	7	Spinel	7.45	22.08	0.42	30.79	19.56	0.21	5.36	11.57	97.44
20456-01-3	8	Ilmenite	47.99	0.22	5.23	37.86	4.09	0.15	0.00	0.13	95.67
20456-01-3	9	Ilmenite	47.55	0.18	5.43	37.26	4.39	0.09	0.00	0.09	94.99
20456-01-4	1	Ilmenite	51.39	0.27	0.62	40.27	3.04	0.13	2.98	0.08	98.78
20456-01-4	2	Ilmenite	50.38	0.07	0.53	38.92	5.46	0.06	3.28	0.05	98.75
20456-01-4	3	Ilmenite	49.86	0.00	0.51	36.85	5.93	0.05	4.19	0.04	97.43
20456-01-4	4	Ilmenite	49.17	0.10	0.33	35.68	7.51	0.26	4.60	0.11	97.76
20456-01-4	6	Ilmenite	12.82	0.00	0.55	8.71	68.20	6.30	1.27	3.05	100.90
20456-01-4	6	Magnetite(?)	12.82	0.00	0.55	38.24	35.32	6.30	1.27	3.05	97.55
20456-01-5	2	Magnetite	0.00	0.00	0.09	29.07	67.26	0.47	0.60	0.04	97.53
20456-01-5	5	Magnetite(?)	14.39	0.05	0.75	42.06	34.85	0.21	0.03	1.88	94.22
20456-01-5	5	Ilmenite	14.39	0.05	0.75	12.12	68.19	0.21	0.03	1.88	97.62
20456-0-5	1	Magnetite	0.02	0.14	0.01	29.18	67.78	0.55	0.80	0.11	98.59
20462	1	Ilmenite	47.54	0.35	0.41	33.62	10.39	0.06	4.89	0.04	97.30
20462	2	Ilmenite	10.92	0.02	0.35	5.29	77.19	0.06	2.34	4.17	100.34
20462	2	Magnetite	10.92	0.02	0.35	36.91	41.98	0.06	2.34	4.17	96.75
20462	3	Spinel	5.03	25.89	0.34	27.83	20.51	0.00	6.40	12.90	98.90
20462	5	Spinel	5.05	25.78	0.31	28.07	20.23	0.04	6.25	13.04	98.77
20462	6	Orthopyroxene	0.29	0.02	0.50	19.55	50.18		27.90	0.89	99.33
20462	8	Hematite	0.65	0.06	0.00	0.00	97.43	1.35	0.32	0.61	100.42
20462	10	Hematite	0.25	0.00	0.02	0.00	100.90	0.00	0.02	0.25	101.44
20462	11	Hematite	0.23	0.00	0.09	0.00	99.50	0.07	0.00	0.38	100.27
20462	13	Hematite	1.13	0.04	0.14	0.00	93.35	0.00	1.30	0.82	96.78
20462	14	Spinel	4.02	17.36	0.48	30.74	35.11	0.09	3.04	7.64	98.48
20462	15	Ilmenite	51.51	0.29	0.48	35.76	5.02	0.19	5.65	0.09	98.99
20462	16	Ilmenite	46.08	0.09	0.42	38.09	10.07	0.20	1.64	0.18	96.77
20462	17	Hematite	0.00	0.06	0.14	0.00	98.97	0.77	0.00	0.02	99.96
20462	18	Ilmenite	50.78	0.43	0.50	37.74	5.90	0.00	4.16	0.09	99.60
20462	19	Magnetite	6.75	7.37	0.19	34.84	41.55	0.13	1.39	4.58	96.80
20462	20	Magnetite	6.07	7.55	0.23	34.65	43.94	0.08	1.25	4.11	97.88
20474	9	Ilmenite	50.19	0.24	0.44	37.09	5.52	0.07	4.26	0.07	97.88

20474	10	Spinel	3.79	14.13	0.32	29.78	41.65	0.16	3.89	6.87	100.59
20474	11	Ilmenite	53.54	0.27	0.58	29.41	9.57	0.06	10.18	0.10	103.71
20483	1	Ilmenite	48.04	0.11	0.49	35.66	11.72	0.00	3.95	0.19	100.16
20483	2	Ilmenite	48.48	0.11	0.35	37.93	9.49	0.02	2.98	0.00	99.36
20483	3	Ilmenite	47.37	0.20	0.33	37.75	9.90	0.00	2.53	0.11	98.19
20483	3	Ilmenite	48.43	0.25	0.30	38.50	9.57	0.05	2.66	0.05	99.81
20483	4	Ilmenite	48.04	0.16	0.34	36.83	10.91	0.05	3.38	0.05	99.76
20483	5	Ilmenite	48.39	0.01	0.65	42.40	6.01	0.04	0.76	0.09	98.35
20483-02	2	Spinel	4.73	24.14	0.28	28.51	18.11	0.00	6.31	17.02	99.10
20483-02	3	Ilmenite	50.70	0.21	0.29	41.80	6.12	0.04	1.96	0.12	101.24
20483-02	4	Orthopyroxene	0.14	0.09	0.43	17.31	0.00	52.18	23.96	1.10	95.21
20483-02	5	Spinel	4.59	25.90	0.43	26.52	16.92	0.05	7.50	17.31	99.22
20483-02	6	Spinel	0.40	44.93	1.91	15.39	5.83	0.22	10.23	15.59	94.50
20483-02	7	Chromite	5.42	24.37	0.17	28.31	19.44		6.44	14.15	98.30
20483-02	8	Spinel	5.17	1.09	0.15	28.35	40.11	0.63	7.39	19.68	102.57
20483-02	9	Orthopyroxene	0.30	0.07	0.41	19.88	0.00	53.54	24.67	1.00	99.87
20483-02	10	Magnetite	10.82	2.14	0.27	38.42	40.45	0.20	0.96	2.45	95.71
20483-02	10	Ilmenite	10.82	2.14	0.27	7.74	74.71	0.20	0.96	2.45	99.29
20483-02	11	Ilmenite	10.39	2.16	0.25	7.45	76.09	0.22	0.92	2.16	99.64
20483-02	11	Magnetite	10.39	2.16	0.25	38.15	41.91	0.22	0.92	2.16	96.16
20483-02	12	Ilmenite	52.43	0.07	0.88	31.55	7.18	0.07	8.25	0.18	100.61
20494	1	Magnetite	7.59	4.03	0.16	37.66	46.44	0.00	0.77	3.95	100.60
20494	2	Ilmenite	47.63	0.13	0.44	40.49	8.90	0.04	1.06	0.15	98.84
20494	3	Chromite	2.68	26.61	0.19	24.23	16.90	1.00	7.73	18.75	98.09
20494	4	Chromite	4.13	25.19	0.43	28.86	19.40	0.00	5.97	16.88	100.86
20494	5	Chromite	4.44	26.14	0.47	29.54	18.21	0.11	5.81	16.82	101.54
20494	6	Chromite	3.03	27.70	0.36	27.72	16.45	0.09	6.13	18.56	100.04
20494	8	Ilmenite	49.76	0.38	0.00	35.25	9.30	0.00	5.33	0.24	100.26
20494	9	Magnetite	0.00	0.16	0.01	31.32	69.51	0.26	0.00	0.06	101.32
20494	10	Ilmenite	50.06	0.25	0.36	38.52	7.02	0.14	3.44	0.09	99.88
20515-01-2	1	Magnetite	4.02	3.02	0.17	33.80	55.00	0.00	0.21	1.40	97.62
20515-01-2	3	Magnetite (?)	22.57	0.02	0.89	50.40	20.50	0.24	0.04	2.21	96.87
20515-01-2	3	Ilmenite	22.57	0.02	0.89	19.30	55.10	0.24	0.04	2.21	100.37
20515-01-2	4	Ilmenite	19.07	0.02	0.17	15.90	61.80	0.11	0.60	2.67	100.34
20515-01-2	4	Magnetite	19.07	0.02	0.17	47.10	27.10	0.11	0.60	2.67	96.84
20515-01-2	6	Magnetite	14.03	0.16	0.32	44.60	41.80	0.16	0.20	1.73	103.00
20515-01-2	8	Hematite	0.01	0.04	0.00	0.00	100.30	0.46	0.05	0.06	100.92
20515-01-2	10	Ilmenite	17.29	0.24	0.24	15.10	65.80	0.80	0.11	1.17	100.75
20515-01-2	10	Magnetite	17.29	0.24	0.24	45.80	31.60	0.80	0.11	1.17	97.25
20515-01-3	1	Hematite	0.14	0.00	0.00	0.00	100.20	0.51	0.18	0.02	101.05
20515-01-3	2	Magnetite	0.27	0.00	0.07	31.44	69.28	0.34	0.05	0.00	101.45
20515-01-3	3	Magnetite	18.65	0.00	0.41	45.50	28.90	0.06	1.54	2.86	97.92
20515-01-3	3	Ilmenite	18.65	0.00	0.41	13.61	64.30	0.06	1.54	2.86	101.43
20515-01-3	4	Ilmenite	49.11	0.00	0.46	39.80	7.04	0.26	2.20	0.16	99.03
20515-01-3	5	Magnetite	10.11	0.20	0.32	39.70	45.70	0.14	0.63	3.34	100.14
20515-01-4	3	Magnetite	0.07	0.07	0.18	31.51	70.72	0.11	0.16	0.09	102.91
20515-01-4	4	Ilmenite	51.79	0.09	0.56	44.80	4.16	0.00	0.65	0.00	102.05
20515-01-5	1	Hematite	0.00	0.13	0.07	0.00	99.90	0.04	0.00	0.00	100.14
20515-01-6	1	Orthopyroxene in sim	0.00	0.00	0.65	25.85	0.00	51.55	21.72	0.76	100.53
20515-01-6	2	Magnetite in simplec	6.42	0.00	0.30	37.00	55.71	0.38	0.51	2.32	102.64
20515-01-6	3	Magnetite	14.82	0.13	0.24	36.60	43.00	0.06	1.25	3.31	99.41
20515-02-1	6	Ilmenite	46.91	0.00	0.36	37.01	7.65	0.07	2.70	0.13	94.83
20515-02-1	7	Ilmenite	46.33	0.10	0.54	37.82	6.69	0.00	1.85	0.12	93.45
20515-02-1	8	Ilmenite	45.19	0.05	0.43	34.37	10.60	0.00	3.27	0.12	94.03
20515-02-1	11	Ilmenite	47.36	0.00	0.71	39.78	5.75	0.07	1.17	0.10	94.94
20515-02-1	12	Ilmenite	47.35	0.13	0.38	39.04	5.07	0.00	1.77	0.02	93.76
20515-02-1	13	Ilmenite	47.67	0.02	0.41	39.06	3.53	0.00	1.90	0.13	92.72
20515-02-1	14	Ilmenite	48.36	0.11	0.41	38.40	4.66	0.11	2.62	0.11	94.78
20515-02-1	15	Ilmenite	10.64	0.00	0.31	9.15	76.11	0.16	0.06	0.06	96.49
20515-02-1	15	Magnetite	10.64	0.00	0.31	38.34	43.61	0.16	0.06	0.06	93.18
20515-02-1	16	Ilmenite	48.59	0.00	0.56	40.10	5.26	0.12	1.70	0.05	96.38
20515-02-2	1	Ilmenite	50.78	0.11	0.54	43.42	1.22	0.00	0.95	0.04	97.06
20515-02-2	2	Ilmenite	49.70	0.00	0.53	42.71	1.66	0.00	0.81	0.09	95.50
20515-02-2	3	Ilmenite	47.24	0.00	0.61	41.13	4.36	0.02	0.41	0.05	93.82
20515-02-2	4	Ilmenite	47.59	0.00	0.42	41.23	3.70	0.17	0.64	0.00	93.75
20515-02-2	5	Ilmenite	49.77	0.09	0.46	39.28	3.93	0.05	2.81	0.04	96.43
20515-02-2	6	Ilmenite	49.18	0.29	0.41	38.75	4.00	0.07	2.84	0.12	95.66
20541		Orthopyroxene sim	0.34	0.08	0.33	18.23	0.00	50.93	27.40	0.68	97.99
20541		Magnetite simplectit	4.17	5.96	0.11	32.68	48.36	1.46	1.06	3.76	97.56
20541	4	Magnetite	5.36	7.37	0.38	33.03	42.96	0.11	1.07	4.13	94.41
20541	5	Hematite	0.02	0.00	0.00	0.00	96.62	0.70	0.20	0.07	97.61
20541	12	Spinel	5.33	27.13	0.46	29.89	18.58	0.07	4.98	12.05	98.49
20546	3	Magnetite w sp lam	2.77	7.53	0.23	31.40	49.50	0.00	1.06	3.91	96.40
20546	4	Magnetite w il lam	17.51	0.13	0.33	48.00	36.14	0.10	0.03	0.87	103.11
20546	6	Ilmenite	49.21	0.27	0.44	38.58	6.70	0.40	2.93	0.05	98.58
20546	7	Ilmenite	49.05	0.48	0.43	38.11	6.91	0.00	3.12	0.04	98.14

20546	8	Ilmenite	52.40	0.23	0.60	40.31	2.41	0.17	3.48	0.00	99.60
20546	9	Ilmenite	49.27	0.43	0.40	36.52	8.45	0.24	4.14	0.10	99.55
20546	10	Magnetite with hemat	0.09	0.08	0.13	30.00	66.40	0.18	0.00	0.15	97.03
20546	11	Hematite	0.10	0.09	0.00	0.00	98.04	0.18	0.00	0.18	98.59
20546	12	Ilmenite	47.60	0.01	4.00	38.60	6.36	0.00	0.09	0.13	96.79
20546	13	Ilmenite	47.70	0.18	0.53	37.30	7.85	0.15	2.83	0.10	96.64
20546	14	Spinel	7.66	21.34	0.40	32.87	20.91	0.15	3.32	8.43	95.08
20546	16	Spinel	4.64	20.80	0.30	32.82	31.42	0.02	2.53	7.60	100.13
20546	17	Ilmenite	49.35	0.20	0.46	35.28	7.07	0.13	4.84	0.05	97.38
20567	9	Ilmenite	54.71	0.25	0.37	34.87	3.21	0.11	7.83	0.17	101.52
20567	10	Spinel	2.55	32.30	0.30	26.68	14.54	0.14	6.61	17.57	100.69
20567	11	Ilmenite	53.14	0.30	0.54	39.63	4.77	0.02	4.27	0.13	102.80
20567	12	Ilmenite	53.02	0.23	0.55	38.81	4.83	0.08	4.66	0.10	102.28
20567	14	Spinel	2.02	24.34	0.10	22.31	15.02	0.11	10.48	27.26	101.64
20567	15	Ilmenite	56.69	1.20	0.50	31.45	2.91	0.00	10.67	0.23	103.65
20567	17	Chromite	8.65	21.43	0.29	32.55	25.58	0.13	5.82	8.58	103.03
20567	18	Magnetite	4.35	1.51	0.17	35.00	57.90	0.04	0.26	1.56	100.79
20567-02-4	1	Ilmenite	46.02	0.00	0.78	40.09	12.02	0.09	0.28	0.04	99.32
20567-02-4	2	Ilmenite	45.30	0.04	0.80	39.48	12.79	0.04	0.25	0.00	98.70
20567-02-4	3	Ilmenite	46.80	0.04	0.83	40.62	11.88	0.09	0.35	0.07	100.68
20567-02-4	4	Ilmenite	46.41	0.01	0.80	40.39	11.92	0.09	0.30	0.05	99.97
20567-02-5	1	Magnetite	6.25	6.11	0.33	35.33	44.85	0.06	0.93	4.34	98.20
20567-02-5	2	Magnetite	6.03	5.76	0.23	34.62	44.96	0.08	1.25	4.72	97.65
20567-02-6	6	Chromite	5.30	13.07	0.34	32.83	38.87	0.10	2.62	6.64	99.77
20567-02-6	6	Chromite	5.15	13.01	0.27	32.64	39.75	0.00	2.73	6.42	99.97
20567-02-6	6	Chromite	5.30	13.54	0.32	33.02	39.31	0.09	2.68	6.44	100.70
20567-02-8		Magnetite	4.10	7.82	0.30	32.30	48.86	0.10	1.43	3.04	97.95
20567-03	1	Ilmenite	48.03	0.03	0.46	39.44	9.65	0.10	1.84	0.09	99.64
20567-03	2	Magnetite	16.06	4.23	0.30	28.90	43.60	0.38	1.87	4.73	100.07
20567-03	2	Ilmenite	16.06	4.23	0.30	10.80	65.36	0.38	1.87	4.73	103.73
20567-03	3	Spinel	4.39	27.61	0.34	30.65	21.67	0.08	4.08	10.77	99.59
20567-03	3	Spinel	4.39	26.84	0.43	30.83	22.75	0.15	3.88	10.48	99.75
20591	1	Ilmenite	48.88	0.03	0.53	42.94	6.68	0.13	0.27	0.00	99.46
20591	2	Magnetite	7.33	0.09	0.22	36.97	50.22	0.19	0.34	2.87	98.23
20591	3	Quartz	0.11	0.00	0.00	0.68	0.00	97.91	0.00	0.49	99.19
20591	5	Magnetite	4.91	2.63	0.00	34.64	55.70	0.14	0.92	1.70	100.64
20591	6	Orthopyroxene	0.05	0.00	0.35	31.52	0.00	37.19	33.50	0.00	102.61
20591	7	Ilmenite	51.01	0.03	0.55	42.25	3.76	0.10	1.72	0.02	99.44
20591	8	Ilmenite	51.61	0.00	0.61	45.17	1.31	0.08	0.35	0.02	99.15
20591	12	Magnetite	5.21	6.19	0.17	34.47	47.95	0.07	1.13	4.02	99.21
20873	1	Ilmenite	49.96	0.00	0.37	40.99	5.64	0.00	2.00	0.12	99.08
20873	3	Ilmenite	49.71	0.48	0.43	40.84	6.14	0.20	1.92	0.04	99.76
20873	4	Magnetite	6.16	0.30	0.18	36.28	52.24	0.19	0.02	2.59	97.96
20873	5	Ilmenite	50.14	0.13	0.96	43.51	4.47	0.08	0.34	0.00	99.63
20873	6	Ilmenite	49.04	0.20	0.44	41.10	6.51	0.05	1.43	0.00	98.77
20873	7	Hematite	0.07	0.00	0.09	0.00	96.73	1.00	0.09	0.13	98.11
20873	8	Hematite	0.00	0.07	0.01	0.00	99.48	0.77	0.00	0.00	100.33
20887	2	Ilmenite	49.77	0.00	0.61	43.49	5.76	0.15	0.36	0.08	100.22
20887	3	Ilmenite	52.14	0.02	0.52	46.00	2.00	0.21	0.20	0.13	101.22
20887	4	Ilmenite	48.33	0.00	0.43	40.40	7.16	0.06	1.47	0.09	97.94
20887	6	Ilmenite	50.69	0.03	0.70	43.82	4.56	0.10	0.56	0.11	100.57
20887	7	Magnetite	6.90	0.35	0.25	37.31	50.35	0.11	0.14	3.74	99.15
20887	8	Ilmenite	51.16	0.11	0.53	42.92	3.48	0.05	1.43	0.05	99.73
20944	1	Orthopyroxene	0.00	0.05	0.04	38.89		36.77	27.23	0.00	102.98
20944	2	Ilmenite	47.29	0.00	0.48	35.87	13.00	0.02	3.46	0.14	100.26
20944	3	Magnetite	13.67	0.09	0.43	42.60	39.48	0.38	0.78	2.94	100.37
20944	4	Ilmenite	36.53	0.11	1.96	29.99	31.29	1.86	0.49	0.66	102.89
20944	5	Magnetite	0.00	0.00	0.00	30.55	68.03	1.83	0.00	0.00	100.41
20944	6	Ilmenite	46.99	0.00	0.60	39.24	9.80	0.04	1.35	0.13	98.15
20944	8	Ilmenite	46.84	0.00	0.39	39.10	10.21	0.08	1.47	0.09	98.18
20944	9	Ilmenite	11.53	0.12	0.00	9.12	78.03	0.24	0.70	3.43	103.17
20944	9	Magnetite	11.53	0.12	0.00	40.98	42.36	0.24	0.70	3.43	99.36
20944	11	Magnetite/il lam	5.98	0.00	0.21	34.60	52.40	0.00	0.64	2.30	96.13
20944	12	Magnetite/HEM LAM	10.96	0.18	0.29	39.87	43.10	0.88	0.59	2.93	98.80
21114	1	Ilmenite	50.74	0.00	0.28	44.04	4.43	0.00	0.73	0.10	100.32
21114	2	Ilmenite	49.67	0.05	0.54	43.58	3.58	0.13	0.30	0.00	97.85
21114	3	Ilmenite	48.85	0.09	0.49	43.07	5.50	0.07	0.20	0.16	98.43
21114	4	Ilmenite	49.78	0.00	0.67	43.16	4.68	0.15	0.52	0.09	99.05
21114	5	Ilmenite	49.09	0.04	0.56	40.51	6.00	0.08	1.72	0.04	98.04
21149	1	Ilmenite	48.88	0.00	1.36	42.33	7.13	0.21	0.14	0.00	100.05
21149	2	Ilmenite	47.15	0.02	0.48	40.27	7.89	0.08	0.92	0.00	96.81
21149	3	Ilmenite	47.90	0.13	0.46	39.74	8.97	0.00	1.61	0.56	99.37
21149	5	Ilmenite	48.29	0.18	0.49	38.49	8.29	0.14	2.49	0.11	98.48

21149	6	Ilmenite	49.23	0.00	0.56	43.18	6.00	0.00	0.29	0.16	99.42
21149	7	Magnetite	16.42	0.06	0.27	46.95	33.66	1.93	0.00	3.61	102.90
21149	8	Hematite	0.04	0.00	0.05	0.00	98.37	1.10	0.00	0.15	99.71
21197	1	Ilmenite	49.42	0.28	0.46	38.57	7.87	0.07	3.03	0.11	99.81
21197	2	Ilmenite	48.83	0.08	0.27	38.81	6.95	0.08	2.71	0.02	97.75
21197	3	Ilmenite	47.92	0.02	0.75	39.87	8.90	0.07	1.38	0.16	99.07
21197	4	Magnetite	4.57	4.61	0.19	33.70	49.80	0.08	0.81	3.65	97.41
21197	5	Ilmenite	43.93	2.27	0.63	31.25	10.66	0.05	4.27	6.29	99.35
21197	6	Ilmenite	48.68	0.38	0.44	39.39	2.65	0.05	2.21	4.71	98.51
21197	7	Ilmenite	52.19	0.12	0.59	38.03	4.12	0.13	4.66	0.20	100.04
21197	8	Spinel	0.22	4.95	0.15	17.75	4.46	0.08	15.25	57.25	100.11
21197	9	Spinel	0.20	5.20	0.08	17.52	3.97	0.17	15.11	56.67	98.92
21197	10	Magnetite	7.09	0.63	0.32	36.13	49.45	0.20	0.66	3.38	97.86
21197	11	Magnetite	9.04	0.61	0.34	38.04	45.08	0.09	0.77	4.21	98.18
21197	11	Ilmenite	9.04	0.61	0.34	6.41	80.29	0.09	0.77	4.21	101.76
21197	12	Ilmenite	48.35	0.11	0.28	37.53	7.79	0.04	3.18	0.13	97.41
21197	13	Ilmenite	48.88	0.00	0.26	37.77	7.72	0.16	3.32	0.14	98.25
21207	2	Ilmenite	49.83	0.23	0.23	39.39	5.99	0.07	2.91	0.18	98.83
21207	5	Ilmenite	49.56	0.04	2.54	41.92	3.73	0.07	0.04	0.08	97.98
21207	6	Chromite	5.77	17.34	0.23	33.74	30.65	0.07	2.17	7.81	97.78
21207	7	Ilmenite	47.76	0.55	0.51	38.65	7.09	0.14	2.12	0.14	96.96
21207	8	Ilmenite	49.23	0.44	0.50	39.40	7.22	0.00	2.45	0.08	99.32
21207	9	Ilmenite	49.29	0.00	0.43	40.07	6.12	0.08	2.14	0.24	98.37
21207	10	Ilmenite	52.20	0.00	0.15	45.04	1.19	0.00	0.98	0.00	99.56
21207	12	Ilmenite	49.76	0.12	0.30	40.79	5.57	0.18	2.05	0.07	98.84
21207	13	Ilmenite	50.29	0.08	0.48	37.11	7.03	0.07	4.28	0.16	99.50
21207	14	Ilmenite	46.70	0.00	0.44	38.41	10.91	0.13	1.76	0.04	98.39
21225	1	Ilmenite	47.72	0.14	0.35	41.43	6.69	0.02	0.63	0.09	97.07
21225	2	Ilmenite	50.14	0.00	0.41	42.96	4.93	0.07	0.96	0.02	99.49
21225	3	Magnetite	9.95	0.13	0.32	40.61	48.87	0.19	0.41	2.50	102.98
21225	4	Magnetite	3.23	2.50	0.06	34.71	58.64	0.00	0.10	2.31	101.55
21225	5	Ilmenite	47.52	0.00	0.46	39.09	11.80	0.99	1.78	0.09	101.73
21225	7	Magnetite	9.04	0.00	0.16	39.74	48.85	0.07	0.28	3.13	101.27
21225	8	Ilmenite	46.84	0.38	0.32	37.04	13.42	0.02	2.67	0.21	100.90
21225	9	Magnetite	9.01	6.63	0.25	39.26	43.33	0.13	1.35	4.44	104.40
21225	10	Magnetite	8.46	6.16	0.30	37.42	42.18	0.05	1.41	4.49	100.47
21267	4	Ilmenite	48.74	0.08	0.43	42.52	7.89	0.16	0.49	0.13	100.44
21267	5	Ilmenite	50.75	0.00	0.48	42.92	6.11	0.27	1.25	0.19	101.97
21267	6	Magnetite	8.19	0.04	0.17	38.70	51.12	0.32	0.36	2.56	101.46
21267	7	Ilmenite	48.13	0.00	0.37	40.52	8.48	0.04	1.34	0.04	98.92
21267	8	Magnetite	9.06	0.10	0.15	39.40	48.69	0.16	0.50	3.18	101.24
21267	9	Ilmenite	51.77	0.43	0.26	41.87	3.48	0.05	2.48	0.10	100.44
21267	10	Ilmenite	49.79	0.14	0.69	43.88	6.72	0.07	0.11	0.12	101.52
21267	11	Ilmenite	53.58	0.00	0.25	47.90	0.79	0.08	0.01	0.18	102.79
21267	13	Ilmenite	50.53	0.04	0.34	42.58	6.69	0.00	1.41	0.23	101.82
21267	14	Ilmenite	50.45	0.00	0.36	42.43	7.20	0.00	1.44	0.04	101.92
21267	15	Orthopyroxene	0.20	0.01	0.55	26.49		49.48	21.30	0.72	98.75
21267	16	Ilmenite	49.35	0.00	0.41	41.54	8.48	0.16	1.36	0.13	101.43
21267	17	Magnetite	0.00	0.07	0.13	31.13	69.45	1.17	0.02	0.11	102.08
21267	18	Ilmenite	49.64	0.00	0.56	42.70	7.35	0.00	0.75	0.12	101.12
21267	19	Magnetite	11.75	0.14	0.30	42.71	45.49	0.15	0.29	2.70	103.53
21267	20	Magnetite	4.04	1.07	0.12	35.70	60.50	0.32	0.03	1.33	103.11
21267	21	Chromite	0.48	48.25	0.25	16.09	8.97	0.00	11.70	13.48	99.22
21307	1	Ilmenite	46.10	0.07	2.76	38.64	7.84	0.36	0.01	0.11	95.89
21307	2	Ilmenite	48.30	0.12	3.03	40.04	7.67	0.00	0.18	0.11	99.45
21307	3	Ilmenite	49.00	0.25	0.43	38.42	7.60	0.07	2.92	0.24	98.93
21307	4	Magnetite	0.13	0.11	0.07	30.60	67.50	0.08	0.00	0.06	98.55
21307	5	Hematite	0.00	0.02	0.07	0.00	98.41	0.08	0.04	0.09	98.71
21307	6	Hematite	0.00	0.16	0.08	0.00	97.28	0.12	0.02	0.18	97.84
21307	7	Ilmenite	46.80	0.05	0.31	38.36	7.90	0.31	1.91	0.10	95.74
21307	8	Ilmenite	48.57	0.09	0.43	39.62	8.55	0.00	2.03	0.04	99.33
21307	11	Ilmenite	48.68	0.14	0.48	38.10	9.06	0.19	2.91	0.07	99.63
21307	12	Ilmenite	48.61	0.31	0.25	39.77	5.93	0.04	2.07	0.09	97.07
21307	13	Ilmenite	49.73	0.03	0.33	38.97	5.91	0.00	3.04	0.13	98.14
21307	15	Ilmenite	47.00	0.03	0.42	37.95	10.79	0.07	2.18	0.14	98.58
21307	16	Ilmenite	47.54	0.08	0.45	39.30	8.42	0.13	1.68	0.16	97.76
21446	1	Ilmenite	48.28	0.00	0.97	42.24	6.77	2.35	0.11	0.08	100.80
21446	2	Hematite	0.00	0.14	0.04		97.06	0.98	0.10	0.06	98.38
21446	3	Magnetite	6.05	0.11	0.82	35.94	57.18	0.21	0.01	0.26	100.58
21446	5	Ilmenite	48.64	0.00	0.45	40.89	7.28	0.00	1.34	0.16	98.76
21446	8	Hematite	12.05	0.30	0.15		87.05	0.08	0.10	0.09	99.82
21446	9	Ilmenite	49.03	0.00	0.32	42.11	5.72	0.05	0.93	0.00	98.16
21446	10	Chromite	0.53	51.69	0.27	14.70	7.83	0.17	11.86	10.23	97.28
21446	11	Chromite	0.40	51.33	0.26	16.00	6.92	0.46	11.55	12.44	99.36
21446	12	Ilmenite	49.19	0.01	0.70	42.38	6.35	0.00	0.64	0.10	99.37

21446	13 Magnetite	12.98	0.11	0.17	41.48	38.83	0.00	0.97	3.61	98.15
21446	13 Ilmenite	12.98	0.11	0.17	9.77	74.14	0.00	0.97	3.61	101.75
21552	2 Ilmenite	48.19	0.29	0.41	40.05	7.60	0.14	1.61	0.07	98.36
21552	3 Ilmenite	50.17	0.37	0.34	42.51	6.47	0.10	1.27	0.09	101.32
21552	6 Magnetite	4.10	8.70	0.19	33.74	46.40	0.07	0.70	4.05	97.95
21552	7 Ilmenite	51.92	0.13	0.34	41.26	5.17	0.05	2.85	0.04	101.76
21552	8 Magnetite	8.52	1.05	0.32	37.24	48.23	0.08	0.73	1.97	98.14
21552	9 Magnetite	8.46	0.30	0.36	36.82	48.16	0.02	0.66	1.96	96.74
21552	10 Magnetite	5.02	0.20	0.13	34.47	54.18	0.00	0.71	3.43	98.14
21552	11 Ilmenite	49.06	0.11	0.21	40.44	8.09	0.00	1.94	0.10	99.95
21552	12 Magnetite	0.38	0.30	0.12	31.52	67.52	0.14	0.00	0.70	100.68
21557	1 Chromite	0.50	48.43	0.36	21.34	6.41	0.14	8.30	13.95	99.43
21557	2 Ilmenite	50.80	0.27	0.43	41.96	3.23	0.09	1.84	0.00	98.62
21557	3 Ilmenite	50.39	0.09	0.29	44.55	4.16	0.04	0.26	0.14	99.92
21557	4 Ilmenite	48.45	0.00	0.50	41.92	6.19	0.13	0.64	0.13	97.96
21557	5 Ilmenite	49.91	0.00	0.58	43.62	4.13	0.02	0.38	0.04	98.68
21557	6 Ilmenite	51.14	0.11	0.69	43.88	4.18	0.00	0.79	0.07	100.86
21557	7 Magnetite	15.88	0.00	0.96	43.43	33.37	0.58	0.27	1.90	96.39
21557	7 Ilmenite	15.88	0.00	0.96	12.83	67.44	0.58	0.27	1.90	99.86
21557	9 Magnetite	10.54	0.18	0.34	38.40	42.45	1.95	0.21	1.44	95.51
21557	9 Ilmenite	10.54	0.18	0.34	8.76	75.45	1.95	0.21	1.44	98.87
21557	10 Ilmenite	51.14	0.15	0.35	44.10	2.22	0.60	0.86	0.16	99.58
21557	11 Magnetite	2.44	0.08	0.05	31.62	60.46	0.00	1.05	2.79	98.49
21593	2 Ilmenite	49.40	0.03	0.70	43.34	6.52	0.13	0.21	0.00	100.33
21593	3 Magnetite	15.38	0.45	0.30	44.65	35.01	0.00	0.39	2.92	99.10
21593	4 Ilmenite	47.12	0.12	0.52	41.35	9.12	1.36	0.28	0.14	100.01
21593	7 Magnetite	14.54	0.04	0.39	43.55	38.90	0.00	0.51	1.73	99.66
21593	8 Ilmenite	50.29	0.00	0.71	43.99	4.57	0.00	0.29	0.19	100.04
21593	10 Ilmenite	47.73	0.11	0.49	41.44	9.23	0.00	0.55	0.00	99.55
21593	11 Magnetite	0.65	0.03	0.06	32.20	67.84	0.15	0.00	0.87	101.80
21593	12 Ulvospinel	30.60	0.03	0.06	44.00	14.50		9.62	0.33	99.14
21593	13 Orthopyroxene	0.84	0.00	0.66	17.90		52.90	24.80	0.58	97.68
21593	14 Ilmenite	49.27	0.04	0.58	42.86	7.43	0.20	0.48	0.10	100.96
21593	15 Magnetite	14.17	0.13	0.16	42.98	39.47	0.06	0.11	0.11	97.19
21593	15 Ilmenite	14.17	0.13	0.16	12.30	73.54	0.06	0.11	0.11	100.58
21593	16 Magnetite	7.44	0.34	0.22	38.58	51.71	0.11	0.30	3.66	102.36
21593	17 Ilmenite	49.70	0.07	1.04	43.24	5.44	0.00	0.22	0.22	99.93
21641	2 Ilmenite	47.26	0.17	0.95	40.73	7.98	2.09	0.45	0.00	99.63
21641	4 Ilmenite	48.10	0.10	0.54	38.37	9.73	0.00	2.43	0.09	99.36
21641	9 Magnetite	6.87	0.38	0.34	35.50	48.80	0.10	0.58	3.45	96.02
21641	14 Ilmenite	48.38	0.15	0.29	38.88	8.09	0.00	2.43	0.16	98.38
21641	15 Ilmenite	49.93	0.03	0.51	43.12	3.78	2.30	0.71	0.08	100.46
21641	16 Magnetite	8.52	0.12	0.05	38.50	47.69	0.00	0.46	3.66	99.00
21641	17 Ilmenite	48.23	0.25	0.66	42.30	4.87	0.26	0.24	0.11	96.92
21641	19 Ilmenite	49.62	0.00	0.48	43.40	1.44	0.00	0.41	0.07	95.42
21657	9 Ilmenite	47.10	0.09	0.36	39.30	7.67	0.00	1.50	0.00	96.02
21657	1 Magnetite	0.57	0.97	0.05	31.58	54.08	0.00	0.91	10.63	98.79
21657	2 Magnetite	4.52	0.65	0.00	34.24	53.72	0.25	0.45	3.52	97.35
21657	3 Ilmenite	50.75	0.00	0.13	39.64	3.46	0.06	3.29	0.16	97.49
21657	4 Hematite	4.56	0.04	0.08		93.47	1.11	0.00	0.88	100.14
21657	6 Chromite	3.50	13.15	0.32	32.16	40.38	0.28	1.28	5.84	96.91
21657	8 Chromite	3.56	13.48	0.25	32.46	40.48	2.44	1.32	5.84	99.83
21657	10 Ilmenite	46.60	0.22	0.53	38.70	9.40	0.00	1.52	0.09	97.06
21689	1 Magnetite	2.06	1.02	0.05	31.80	57.71	0.04	0.57	3.95	97.20
21689	2 Magnetite	16.16	0.09	0.21	45.58	35.48	0.06	0.36	1.99	99.93
21689	4 Ilmenite	48.27	0.02	0.70	42.52	4.89	0.00	0.10	0.09	96.59
21689	5 Ilmenite	48.25	0.14	0.66	42.31	6.85	0.09	0.23	0.00	98.53
21689	6 Ilmenite	48.63	0.00	0.76	42.73	3.87	0.10	0.13	0.05	96.27
21698	1 Ilmenite	49.95	0.00	0.66	43.96	5.46	0.06	0.16	0.02	100.27
21698	2 Ilmenite	49.66	0.31	0.45	38.76	7.37	0.00	3.05	0.00	99.60
21698	3 Chromite	6.65	21.72	0.30	32.10	25.99	0.00	4.88	10.23	101.87
21698	4 Ilmenite	50.60	0.18	0.43	40.00	6.74	0.09	2.84	0.18	101.06
21698	5 Cr-Spinel	1.22	29.12	0.16	22.88	11.32	0.00	9.51	26.90	101.11
21698	6 Ilmenite	55.11	0.73	0.43	36.77	1.63	0.17	6.93	0.13	101.90
21698	7 Magnetite	3.29	7.42	0.17	32.87	51.38	0.11	0.93	3.13	99.30
21698	8 Ilmenite	48.71	0.18	0.41	37.47	9.66	0.04	3.32	0.20	99.99
21698	9 Magnetite	4.36	8.00	0.33	34.07	48.33	0.02	0.72	3.36	99.19
21698	10 Ilmenite	51.20	0.00	0.38	40.93	5.70	0.00	2.65	0.14	101.00
21698	11 Ilmenite	51.25	0.00	2.11	43.72	2.80	0.07	0.13	0.00	100.08
21698	12 Magnetite	3.86	6.83	0.28	33.03	51.02	0.00	1.37	3.79	100.18
21698	13 Olivine	0.13	0.07	0.26	25.10	0.00	37.74	39.41	0.00	102.71
21700	1 Ilmenite	48.91	0.00	0.54	38.21	7.19	0.00	2.93	0.05	97.83
21700	2 Magnetite	5.76	0.52	0.20	34.90	52.50	0.16	0.32	2.13	96.49

21700	3	Magnetite	5.07	0.59	0.05	33.90	52.30	0.00	0.30	2.38	94.59
21700	5	Ilmenite	50.83	0.08	0.20	41.35	5.12	0.13	2.33	0.16	100.20
21700	6	Chromite	2.80	14.85	0.34	31.40	43.18	0.11	1.47	4.15	98.30
21700	7	Chromite	3.10	14.51	0.20	32.81	44.19	0.14	1.27	4.26	100.48
21700	8	Ilmenite	53.73	0.66	0.48	41.14	2.02	0.20	3.75	0.16	102.14
21700	9	Ilmenite	49.77	0.00	0.36	40.24	4.36	0.04	2.33	0.10	97.20
21700	10	Magnetite	4.87	6.53	0.25	34.11	45.88	0.00	0.64	4.34	96.62
21700	12	Magnetite	4.18	6.89	0.18	33.34	47.14	0.08	0.86	4.42	97.09
21700	13	Ilmenite	50.64	0.32	0.35	39.14	5.89	0.00	3.39	0.12	99.85
21700	14	Chromite	2.79	14.19	0.14	31.54	43.68	0.11	1.44	4.13	98.02
21700	15	Magnetite	4.48	7.03	0.27	33.67	46.02	0.00	0.80	4.71	96.98
21700	16	Ilmenite	52.52	0.12	0.57	41.00	3.76	0.19	3.17	0.21	101.54
21700	17	Ilmenite	50.51	0.04	0.34	44.59	6.51	0.07	0.27	0.11	102.44
21702	1	Chromite	6.54	15.69	0.35	33.72	33.74	0.05	2.49	5.94	98.52
21702	2	Chromite	6.09	12.25	0.28	34.38	39.64	0.07	2.01	5.26	99.98
21702	4	Ilmenite	52.05	0.18	0.79	38.41	4.01	0.21	4.26	0.14	100.05
21702	5	Magnetite	3.71	0.88	0.03	31.47	52.80	0.00	3.01	8.62	100.52
21702	6	Magnetite	4.98	0.92	0.19	33.14	53.99	0.00	1.49	3.34	98.05
21702	7	Chromite	4.48	15.79	0.32	33.46	38.88	0.00	1.84	5.80	100.57
21702	8	Chromite	5.41	16.90	0.13	34.13	35.21	0.04	2.12	6.41	100.35
21702	9	Chromite	6.34	15.50	0.33	34.37	34.03	0.03	2.17	6.48	99.25
21702	10	Ilmenite	49.92	0.20	0.35	39.21	7.99	0.09	2.99	0.04	100.79
21702	11	Chromite	4.32	12.04	0.36	32.18	43.15	0.00	2.26	5.31	99.62
21702	12	Chromite	4.16	11.64	0.33	31.93	43.90	0.00	2.34	5.31	99.61
21702	13	Chromite	3.69	18.34	0.37	32.49	35.93	0.07	1.75	6.46	99.10
21702	14	Ilmenite	45.83	0.15	0.44	37.25	13.04	0.06	1.97	0.09	98.83
21724	1	Ilmenite	48.82	0.00	1.02	42.47	6.76	0.05	0.22	0.02	99.36
21724	2	Magnetite	7.36	0.15	0.24	35.69	53.30	0.21	1.91	2.97	101.83
21724	3	Orthopyroxene	0.04	0.00	0.43	27.95		34.13	35.98	0.02	98.55
21724	4	Ilmenite	46.95	0.05	0.53	38.05	10.02	0.00	2.04	0.05	97.69
21724	6	Ilmenite	46.98	0.00	0.48	37.73	10.07	0.00	2.27	0.08	97.61
21724	7	Hematite	6.34	0.63	0.00		88.54	0.52	0.02	1.05	97.10
21724	8	Hematite	1.41	0.52	0.00		95.90	0.04	0.16	0.82	98.85
21724	9	Magnetite	5.46	4.18	0.23	35.22	51.57	0.08	0.54	2.07	99.35
21724	11	Ilmenite	47.63	0.14	0.36	38.22	9.66	0.04	2.38	0.07	98.50
21724	12	Ilmenite	47.99	0.22	0.42	36.97	10.47	0.07	3.23	0.04	99.41
21728	1	Ilmenite	48.74	0.18	0.31	37.44	9.44	0.00	3.41	0.08	99.60
21728	2	Ilmenite	47.05	0.20	0.44	38.46	10.08	0.34	1.91	0.00	98.48
21728	3	Magnetite	7.86	4.51	0.21	37.51	44.97	0.15	1.01	4.34	100.56
21728	4	Ilmenite	46.43	0.17	0.41	32.25	13.22	0.18	5.10	0.14	97.90
21728	5	Ilmenite	49.12	0.18	0.38	34.35	11.88	0.00	5.29	0.12	101.32
21728	6	Ilmenite	47.79	0.52	0.37	36.48	10.49	0.00	3.43	0.23	99.31
21728	7	Magnetite	6.02	0.56	0.20	34.80	51.31	0.11	0.51	2.52	96.03
21728	8	Magnetite	1.77	0.19	0.00	32.94	65.05	0.21	0.18	1.10	101.44
21730	1	Magnetite	5.49	0.65	0.12	34.37	52.84	0.08	0.83	2.93	97.31
21730	2	Chromite	5.13.38	0.11	34.19	36.27	0.04	1.25	6.66	97.03	
21730	3	Chromite	5.57	14.25	0.34	34.62	35.78	0.18	1.42	6.63	98.79
21730	4	Magnetite	9.95	1.84	0.34	38.84	44.54	0.00	0.93	2.94	99.38
21730	5	Ilmenite	49.25	0.05	0.34	43.66	5.46	0.00	0.16	0.02	98.94
21730	6	Ilmenite	51.21	0.00	0.48	40.29	6.71	0.05	2.96	0.05	101.75
21730	7	Ilmenite	50.66	0.13	0.39	40.19	6.13	0.11	2.79	0.12	100.52
21730	8	Magnetite	4.72	4.66	0.12	34.02	51.68	0.00	0.89	2.60	98.69
21730	9	Ilmenite	51.51	0.26	0.37	40.01	4.59	0.00	3.33	0.08	100.15
21730	10	Ilmenite	51.02	0.04	0.52	43.07	3.19	0.00	1.28	0.08	99.20
21730	11	Magnetite	3.43	1.09	0.36	33.53	58.31	1.02	0.03	1.53	99.30
21730	12	Ilmenite	49.81	0.09	0.56	42.85	5.95	0.06	0.77	0.00	100.09
21750	1	Magnetite	6.87	4.50	0.17	35.32	45.43	0.04	1.04	3.50	96.87
21750	2	Magnetite	6.39	4.55	0.38	35.36	49.43	0.09	1.39	3.66	101.25
21750	3	Ilmenite	47.18	0.00	0.40	35.82	10.84	0.00	3.48	0.24	97.96
21750	4	Ilmenite	48.22	0.09	0.38	37.43	8.66	0.16	3.11	0.08	98.13
21750	5	Ilmenite	48.77	0.12	0.41	37.49	7.07	0.07	3.34	0.16	97.43
21750	6	Ilmenite	50.21	0.14	0.34	40.99	7.33	0.04	2.14	0.14	101.33
21750	7	Ilmenite	49.18	0.12	0.34	37.43	8.22	0.07	3.62	0.13	99.11
21750	8	Ilmenite	51.55	0.12	0.50	42.64	5.94	0.04	1.80	0.13	102.72
21750	9	Ilmenite	50.81	0.04	0.50	41.47	6.89	0.10	2.08	0.09	101.98
21750	10	Ilmenite	50.52	0.21	0.21	41.69	7.41	0.09	1.98	0.13	102.24
21750	11	Ilmenite	50.38	0.02	0.28	41.44	6.78	0.04	2.01	0.11	101.06
21750	12	Ilmenite	49.82	0.09	0.29	40.71	8.33	0.05	2.13	0.18	101.60
21750	13	Ilmenite	51.71	0.06	0.45	39.71	6.99	0.02	3.55	0.14	102.63
21750	14	Ilmenite	50.80	0.00	0.41	41.86	5.60	0.13	1.91	0.08	100.79
21750	15	Ilmenite	51.00	0.20	0.56	38.86	5.48	0.10	3.61	0.09	99.90
21750	16	Ilmenite	51.50	0.13	0.46	39.87	5.53	0.00	3.35	0.05	100.89
21752	3	Ilmenite	50.51	0.02	0.39	42.55	5.51	0.10	1.39	0.16	100.63
21752	4	Ilmenite	49.14	0.33	0.38	36.85	10.49	0.19	3.90	0.02	101.30
21752	6	Magnetite	6.88	0.84	0.12	37.26	52.12	0.09	0.79	3.71	101.81
21752	7	Chromite	5.29	13.80	0.33	34.34	37.95	0.02	1.51	6.09	99.33
21752	8	Chromite	4.83	13.91	0.23	34.34	39.13	0.02	1.39	5.98	99.83

21752	9	Chromite	5.01	14.37	0.27	34.48	38.87	0.02	1.60	6.17	100.79
21752	10	Ilmenite	49.80	0.11	0.39	40.34	7.54	0.05	2.27	0.05	100.55
21752	11	Magnetite	2.24	2.80	0.11	33.48	61.34	0.11	0.20	1.49	101.77
21752	12	Magnetite	5.99	1.65	0.17	35.76	52.44	0.13	0.78	3.15	100.07
21752	13	Ilmenite	48.97	0.17	0.26	38.67	8.60	0.00	2.86	0.04	99.57
21752	14	Ilmenite	49.92	0.05	0.50	40.30	8.47	0.00	2.29	0.24	101.77
21752	15	Ilmenite	51.55	0.27	0.32	40.33	5.82	0.36	3.20	0.23	102.08
21752	16	Ilmenite	49.57	0.00	0.36	42.68	7.18	0.16	0.86	0.04	100.85
21752	17	Ilmenite	49.58	0.00	0.38	41.45	8.44	0.11	1.54	0.14	101.64
21766	1	Chromite	2.38	26.31	0.16	26.94	11.92	0.23	7.22	25.41	100.57
21766	2	Chromite	4.32	14.59	0.45	29.81	38.54	0.10	3.00	5.17	95.98
21766	3	Chromite	15.17	22.55	0.36	37.16	0.00	0.04	6.25	16.06	97.59
21766	4	Chromite	3.77	20.81	0.25	30.06	31.40	0.16	3.60	8.54	98.59
21766	5	Ilmenite	51.02	0.62	0.41	34.95	2.96	0.08	5.90	0.00	95.94
21766	8	Chromite	1.46	25.23	0.30	27.04	20.22	0.07	5.44	19.03	98.79
21766	9	Chromite	1.14	29.37	0.40	26.38	15.63	0.04	6.06	20.77	99.79
21766	10	Chromite	2.95	27.66	0.13	24.46	13.29	0.15	8.09	20.81	97.54
21766	11	Chromite	3.49	23.87	0.25	22.13	9.27	0.00	11.04	28.86	98.91
21766	12	Ilmenite	48.12	0.21	0.38	37.75	4.14	0.27	2.88	0.05	93.80