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Pipestone Lake Anorthosite Complex: Geology and Studies of Titanium-Vanadium Mineralization

By H.D.M. Cameron

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By H.D.M. Cameron
Winnipeg, 1992

Energy and Mines

Hon. James E. Downey
Minister

David Tomasson
Deputy Minister

Geological Services

W.D. McRitchie
Director

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INTRODUCTION

Titanium and vanadium are concentrated in massive and disseminated magnetite and ilmenite in gabbro along the northern edge of the Pipestone Lake anorthosite complex (PLAC). This layered anorthosite and gabbro sill extends from the east shore of Cross Lake to the east channel of the Nelson River, a distance of 17.4 km (Fig. 1). The magnetite-rich rocks form two east-trending zones, 50 to 150 metres apart. The narrow northern zone comprises massive magnetite layers or lenses in leucogabbro and the broader southern zone consists of melagabbro that contains disseminated magnetite.

Aeromagnetic maps (Fig. 2) indicate a positive anomaly of greater than 2500 gammas over the length of the PLAC. A 10 km by 0.8 km area over the eastern 3/4 of the PLAC shows a linear high over 3000 gammas with four major peaks of 3500 gammas. Further west, near the east shore of Cross Lake, values of 2500 to 2700 gammas suggest that the massive oxide layers do not extend that far and only melagabbro with disseminated magnetite is present.

Magnetite-bearing rocks are exposed along the shoreline of Pipestone Lake and occur as isolated outcrops inland. Most shoreline outcrops extend only a meter or two above water level. At present, plans are underway, by Manitoba Hydro, to restore Cross Lake and Pipestone Lake to their historic levels. Increasing lake levels by as much as a meter would submerge most exposures of massive magnetite layers.

LOCATION AND ACCESS

The principal area of investigation is located on the south shore of Pipestone Lake on the Nelson River, approximately 14 km southeast of the town of Cross Lake. Access is by boat; the most convenient launching site is at the ferry landing on the Cross Lake road. Some care should be exercised in crossing Pipestone Lake. Extreme shallowness of the water and its high silt content can obscure underwater obstacles. In mid- to late summer the lake becomes heavily weed choked, making boating tedious. Dense reed beds, along margins of the lake, can impede access to shore in many locations.

Provincial Road 373, to Cross Lake, crosses the western end of the PLAC, near the east shore of Cross Lake. An old Noranda drill road, now mostly overgrown, from the Cross Lake road to the central part of the PLAC, provides access for All Terrain Vehicles.

The area south of Pipestone Lake is covered by mature mixed conifer and deciduous boreal forest. Although heavily treed the ground is fairly open and is generally flat, and provides easy walking. Megacrystic anorthosite forms high, resistant ridges inland. Exposure of magnetite-rich rock is generally poor away from the lakeshore. Most areas that have high magnetic responses are covered by overburden and swamp. Contacts of the PLAC with gneisses to the south and Pipestone Lake Group volcanic rocks to the north are obscured by swamp and muskeg.

Compass navigation inland is difficult due to strong magnetic anomalies in the area. Ground magnetometer readings indicate rapid changes over distances of a few metres from background readings of 60 000 to over 100 000 gammas.

PREVIOUS WORK

Tyrrell (1903) conducted several track surveys in the area, one on the lower Minago River in 1896, and another on the east channel of the Nelson River from Norway House to Cross Lake. He described an outcrop of pyrite-bearing anorthosite, intruded by a diabase dyke, located on the east channel, 1.6 km south of Pipestone Lake.

In 1919, Alcock conducted the first detailed geologic mapping in the Cross Lake/Pipestone Lake area. He reported anorthosite on the south shore of Pipestone Lake but did not describe the magnetite-bearing rocks.

Horwood (1934) conducted reconnaissance mapping, which was included in Bell's (1962) 1:250 000 compilation map and report on the Cross Lake map area. Bell described the rocks in some detail, but at that time the primary interest in the magnetite-bearing rocks was for vanadium content. Bell (1978) concentrated mainly on the West Channel anorthosite.

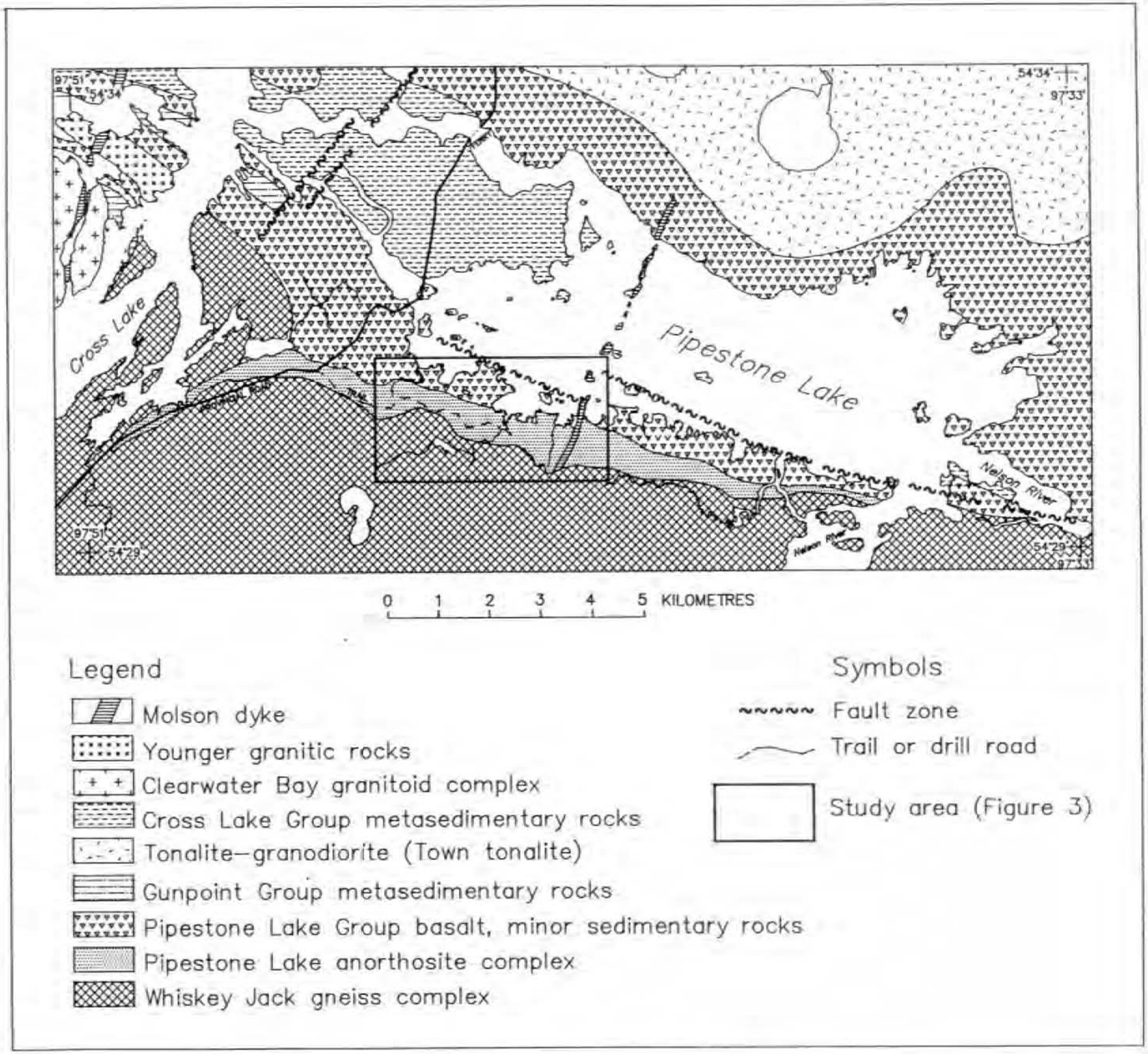


Figure 1: *Location Map. General geology of the Pipestone Lake - Cross Lake area.*

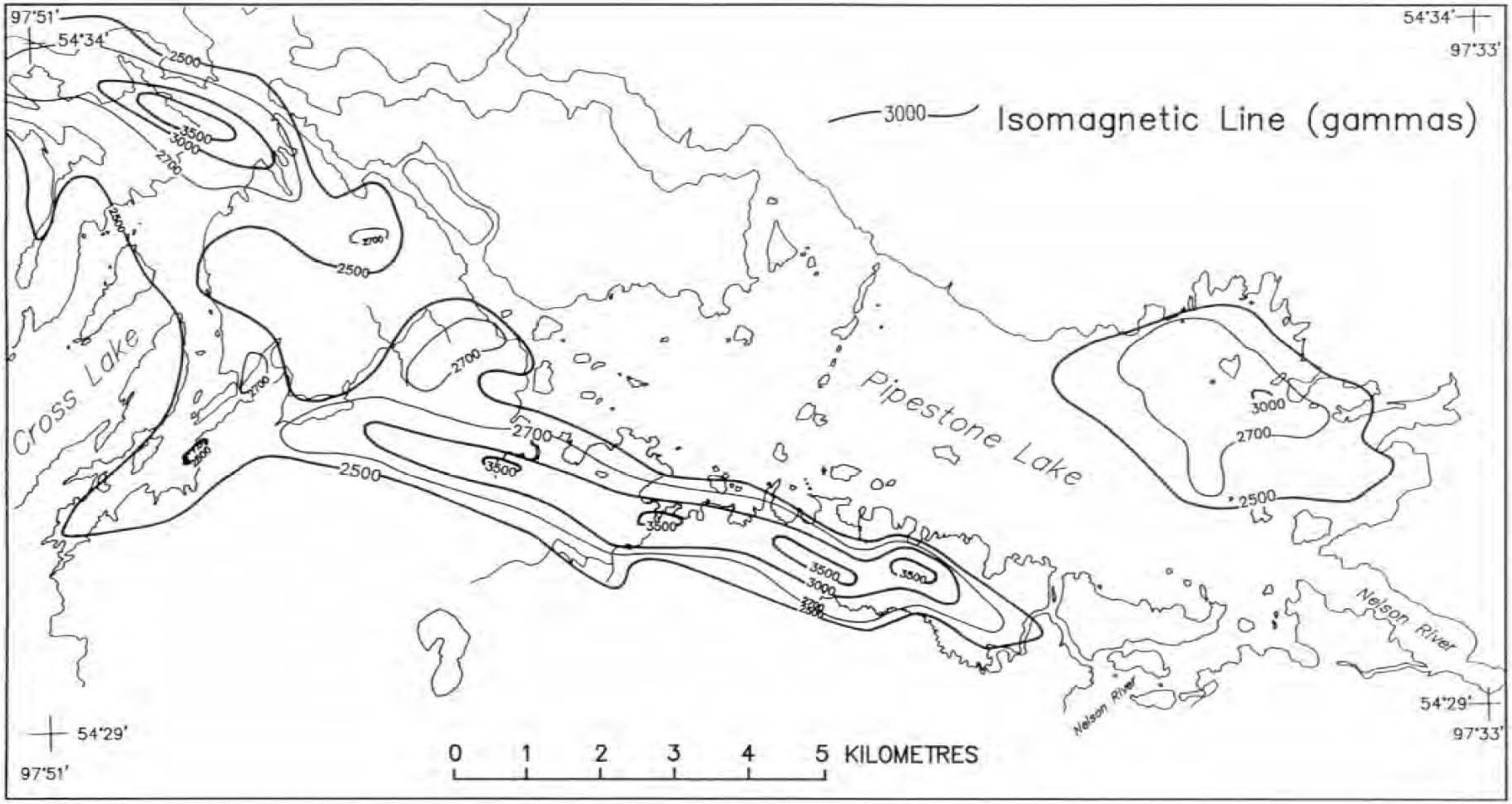
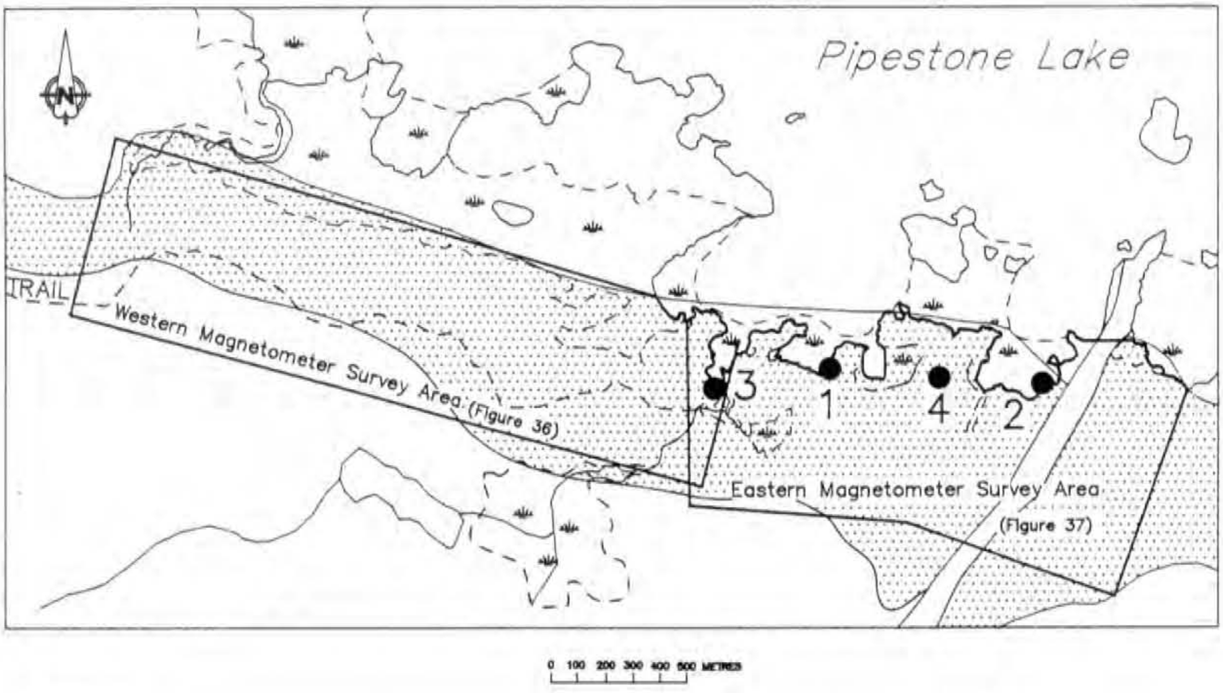


Figure 2: Simplified aeromagnetic map of the Pipestone Lake area.



LEGEND

1 ● Location 1: Massive magnetite layers (Figures 5 and 6).

2 ● Location 2: Massive magnetite layers (Map OF92-1 and Figure 15).

3 ● Location 3: Trench 1, magnetite-bearing melagabbro (Figure 18).

4 ● Location 4: Trench 2, magnetite-bearing gabbros (Figures 26 and 27).

Swamp

Trail or drill road

Pipestone Lake anorthosite complex

Figure 3: Locations in present study.

Rousell (1965) mapped Cross Lake and Pipestone Lake at a scale of 1:63 360. He examined the PLAC, and described several phases of the anorthosite and gabbro. Rose (1967, 1969, 1970, 1973) documented the occurrence as titaniferous magnetite and reported values of 3.2 to 10% titanium and 0.01 to 0.3% vanadium. Magnetic concentrates gave values of 60% iron, 5% titanium and 0.5 to 1.5% vanadium.

Phinney *et al.* (1988) described both the PLAC and the Seine Bay gabbros, in Ontario, which appear to be similar.

EXPLORATION HISTORY

Noranda

The titanium-vanadium occurrence at Pipestone Lake was staked by Noranda Exploration Company, Limited in 1958, as the Lisi claim group. Grab samples gave values of 50% iron and 17% TiO_2 for the massive magnetite layers, and 24% iron and 8% TiO_2 across a 40 foot width of disseminated magnetite in melagabbro. Small amounts of vanadium, pyrite and chalcopyrite were also noted. Noranda sent samples to the Department of Mines and Technical Surveys in Ottawa for analysis and magnetic concentration tests (Jenkins, 1959, 1960). The Noranda crews carried out line cutting, a magnetometer survey, an EM survey, trenching and diamond drilling in 1959, a gravity survey and further drilling and trenching in 1963, and more drilling in 1968 and 1969, for a total of 15 diamond drill holes in the PLAC and the Pipestone Lake Group basalt to the north. Results of the later drilling and surface work were not encouraging and interest in titanium deposits was not strong because deposits in northern Quebec had come into production in the early 1960's.

Noranda drill logs, in the cancelled Assessment files (A.F 91270, 71271 and 92611), indicate 30 cm to 3 m intersections with up to 4 layers or lenses of massive magnetite, and 5 m to 30 m intersections of magnetite-bearing gabbro at depths of 15 m to 50 m.

Information provided by Noranda indicated the existence of 6 trenches in the area between the stream and the large Molson diabase dyke on the south shore of Pipestone Lake (Fig. 3 and 4). During the current project only two of these trenches were found and one of them was heavily overgrown.

The Noranda magnetometer survey extended approximately 3000 m farther east than the survey carried out as part of the present project and indicated that the magnetic anomalies are more or less continuous over this distance. The properties were dropped in 1976.

Concentration studies

Jenkins (1959) of the Department of Mines and Technical Surveys, Ottawa, analyzed 123 lb. of magnetite-rich rock from Pipestone Lake for Noranda and performed magnetic concentration of the samples for titanium recovery. Iron and titanium content ranged from 34.8% Fe and 9.90% TiO_2 to 51.1% Fe and 17.0% TiO_2. A head sample that contained 49.4% Fe, 16.3% TiO_2 and 0.87% V_2O_5 produced a -100 mesh magnetic concentrate that contained 62.7% Fe, 5.22% TiO_2 and 1.68% V_2O_5. The ilmenite concentrate in the nonmagnetic tailing contained 47% TiO_2. Jenkins noted granular graphic and lamellar intergrowths of magnetite and ilmenite, irregular distribution of ilmenite, minor sulphides and a trace of hematite in the samples.

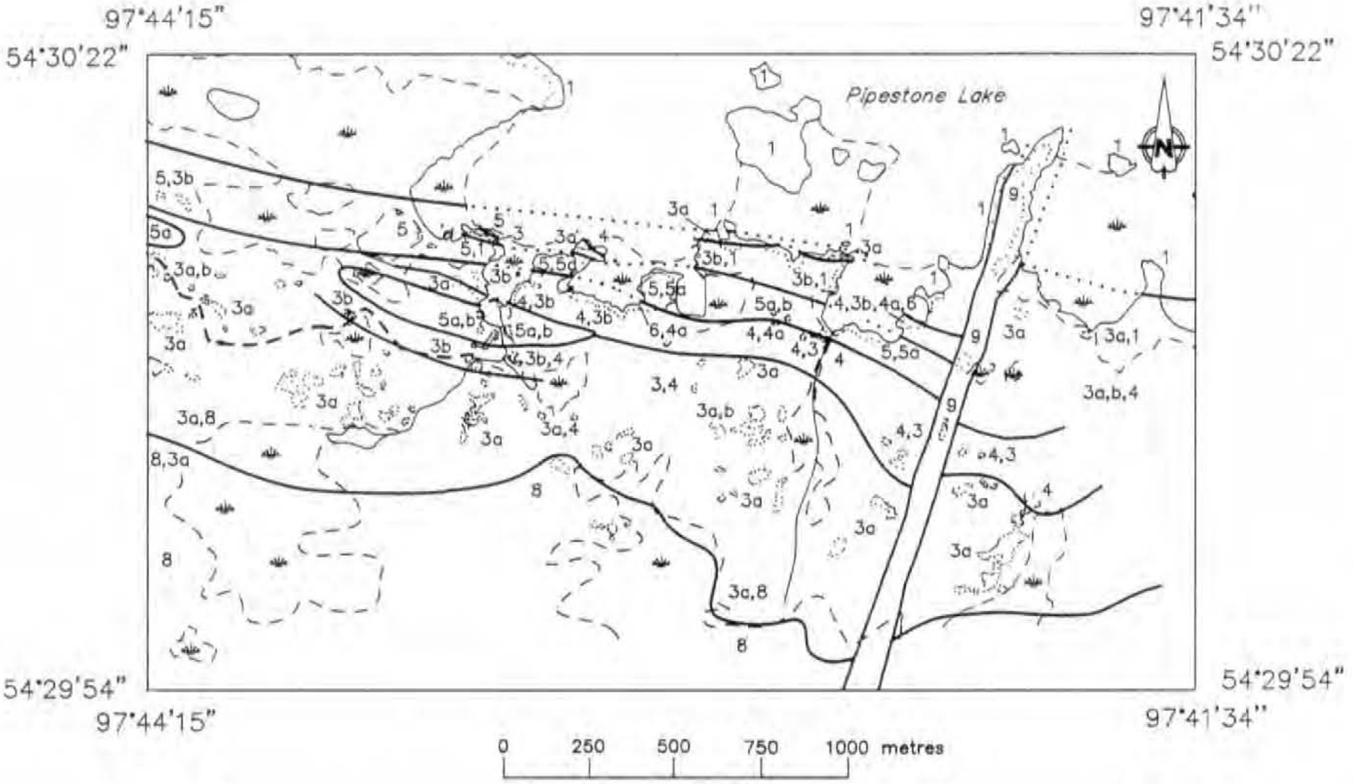
In 1960, Jenkins performed further tests for vanadium recovery on a 685 lb. sample from Pipestone Lake. Mineralized rock containing 33.1% iron, 8.9% TiO_2, and 1.05% V_2O_5 yielded a concentrate that contained 66.3% total iron, 3.95% TiO_2, and 1.74% V_2O_5.

Rose (1967, 1973) described vanadiferous titanomagnetite with intergrown exsolved ilmenite occurring with the interstitial mafic minerals in the PLAC. Samples that contained 0.01 to 0.03% vanadium and 3.2 to 10% titanium produced a concentrate bearing 60% iron, 5% titanium and 0.5 to 1.5% vanadium.

PRESENT WORK

Geological investigation of anorthositic and gabbroic intrusions in the Cross Lake and Pipestone Lake areas began in 1984, in conjunction with the 1: 20 000 Cross Lake supracrustal mapping program (Corkery 1983, 1985; Corkery and Lenton, 1984; Lenton *et al.*, 1986; Corkery and Cameron, 1987;

Corkery *et al.*, 1988). The purpose of the study was to better document the titanium- and vanadium-bearing units that had previously been reported in the PLAC through:



LEGEND

9. Molson diabase
8. Whiskey Jack gneiss complex

Pipestone Lake Group

Pipestone Lake Anorthosite Complex
- * 7. Mafic pegmatite
- 6. Massive magnetite rock
- 5. Melagabbro
  - 5a. Magnetite-bearing melagabbro
  - 5b. Ilmenite-bearing melagabbro
  - * 5c. Chlorite-magnetite schist
  - 5d. Layered porphyritic mesogabbro
- 4. Leucogabbro
  - 4a. Magnetite-bearing leucogabbro
- 3. Anorthosite
  - 3a. Massive to megacrystic anorthosite
  - 3b. Oikocrystic anorthosite

* 2. Ultramafic rocks
1. Pipestone Lake group basalt

* unit not shown in figure

SYMBOLS

Geologic contact assumed, underwater

Area of outcrop

Swamp

Trail

Figure 4: Geology of part of the south shore of Pipestone Lake.

a) detailed mapping of exposures and trenches.
b) geochemical sampling and analyses.
c) ground magnetometer surveys over the central part of the PLAC.
d) general geologic mapping of the PLAC and the adjacent volcanic rocks and gneisses to the north and south respectively.

During 3 months in 1984, the PLAC was mapped, the initial western magnetometer grid and the western magnetometer survey were completed and a mapping and sampling program was carried out on the massive magnetite layers and magnetite-bearing melagabbro at Locations 1 and 3 (Fig.3). An 8000 foot (2440 m) baseline extending west from the stream entering Pipestone Lake (Fig. 3) and along the strike of the magnetic highs shown on existing aeromagnetic maps, bearing 289° was cut. Crosslines, bearing 019°, were established at 1000 foot (300 m) intervals extending up to 500 feet (150 m) north and 1000 to 1500 feet (300 to 450 m) south of the baseline. In subsequent years surveying was carried out in metres.

During 2 months in 1985, crosslines at 150 m intervals were added to the original grid and work began on another magnetometer survey at 15 m spacing over the original grid. The grid was extended 1650 m to the east, using existing cutlines as a baseline and overlapping the earlier survey by approximately 60 m. Crosslines were established at 150 m intervals, extending 330 m south and as far north as the shore of Pipestone Lake (200 to 540 m). Detailed mapping and sampling was carried out at Locations 2 and 4 (Fig.3): an old Noranda trench in layered gabbros and an area where several massive oxide layers were exposed on the shoreline, near the large Molson dyke on the south shore of Pipestone Lake (Fig. 3 and 4).

In 1986 the western grid was reflagged to 2400 m west and crosslines established at 150 m intervals, extending 330 m south and 165 to 225 m north of the baseline. The western magnetometer survey was then repeated, bringing it up to the standard of the 1985 eastern survey. Some additional mapping was carried out in the Pipestone Lake area, during the magnetometer survey, and several weeks were spent in the Minago River and Drunken Lake area, mapping the northern margin of the West Channel anorthosite (Bell, 1978; McRitchie, 1986; Cameron, 1986). No oxide-rich units were found to be associated with the West Channel anorthosite.

In 1987 further stations were added in the western part of the PLAC, near the east shore of Cross Lake.

ACKNOWLEDGMENTS

In addition to continued and extensive support by Tim Corkery and Paul Lenton of Manitoba Energy and Mines, capable field assistance was rendered by B. Barry, C. Bertoule, D. Dowhan, G. Leibrecht, R. Seabrook, in 1984; W. Sherman, in 1985, 1986 and 1987; P. Johannson, B. King and K. Proctor in 1986; and J. Raduay in 1987. Special thanks are extended to Rob Knox, then manager of The Bay / Northern Stores in Cross Lake, who on numerous occasions provided considerable assistance to both the Pipestone and Cross Lake field parties.

AVAILABLE MAPS AND AIR PHOTOGRAPHS

National Topographic Map 63I, Cross Lake, covers the Pipestone Lake area at a scale of 1:250 000. Maps 63I/5, Sugar Falls and 63I/12, Cross Lake, are available at a scale of 1:50 000. Maps, at 1:20 000 scale, 63I/5 NE, McCall Rapids, 63I/12 SW, Cross Lake 63I/12 SE, Wawe Lake, are also available.

In 1985 new vertical aerial photography coverage of the area was flown at a scale of 1:15 840. These may be obtained from the National Air Photo Library in Ottawa.

Aeromagnetic maps 2596G and 2597G at 1:63 360 and 7131G at 1:250 000 may be obtained from Manitoba Energy and Mines.

GEOLOGIC SETTING OF THE PLAC

The Pipestone Lake anorthosite complex (PLAC) is part of the Cross Lake supracrustal belt, which lies near the western edge of the Superior structural province in northern Manitoba. The supracrustal belt lies on the boundary between the Gods Lake domain and the Molson Lake plutonic domain, and crosses into the Pikwitonei granulite domain, to the west.

The Cross Lake belt comprises the Pipestone Lake Group pillowed and massive basalt flows and related sedimentary rocks and includes the Pipestone Lake anorthosite complex, Gunpoint Group felsic volcaniclastic and metasedimentary rocks, Cross Lake Group metaconglomerates and metasandstones with minor felsic and mafic metavolcanic rocks, and late granitic intrusive rocks (Table 1, Fig. 1). Metamorphic grade ranges from greenschist facies, in the east, to granulite facies, in the west.

Table 1: Order of Geological events (Cross Lake Area)
(after Corkery, *et al.*, in press)

14) Late brittle deformation manifested by fault breccia, pseudotachylite and erratic foliation developed in some Molson dykes.
13) Intrusion of Molson dyke swarm; most abundant in the major NE shear zones (1884 Ma).
12) Periodic reactivation of shear zones accompanied by minor folding.
11) Intrusion of granite plugs (2653 Ma) and pegmatites (largely controlled by major shear zones) during the waning stages (2658 - 2637 Ma).
10) Main Kenoran orogenic event: regional metamorphism and deformation, granite plutonism (Town tonalite, 2719) Ma) and folding concomitant with activation of major linear shear zones. Spans the period of deposition of Cross Lake Group (2713 - 2687 Ma). Clearwater Bay complex (2690 Ma).
9) Intrusion of small gabbro dykes and plugs.

Intrusive contact

8) Initiation of high potassium basalt volcanism in Cross Lake Group, contemporaneous with fluvial to marine sedimentation.
7) Deposition of Cross Lake Group alluvial and fluvial conglomerate and sandstone (2709 Ma).

Unconformity

6) Intrusion of hornblende porphyritic gabbro dykes.

Intrusive contact

5) Deformation and metamorphism : produced northeast-trending migmatites that overprinted east-west foliation. Contemporaneous with, to post deposition of, Gunpoint Group (*circa* 2738 Ma).
4) Deposition of the predominantly continental Gunpoint Group fragmental rhyodacite and alluvial, fluvial and marine sediments (2730 Ma).

Unconformity

3) Pipestone Lake Group incorporated into a cratonic land mass during a period of cratonization concomitant with younger Whiskey Jack gneiss complex intrusions (2734 Ma).
2) Deposition of Pipestone Lake Group basalts and subordinate sediments. Intrusion of PLAC with deposition of associated feldspar porphyritic basalts (2760 Ma).
1) Formation of presupracrustal belt cratonic masses of Molson Lake domain, older gneisses of the Whiskey Jack gneiss complex.

U-Pb zircon ages undertaken during the course of the Cross Lake project provide a geochronological framework for the development of the supracrustal belt. Pegmatitic hornblende gabbro from the PLAC yields ages of 2758±3 Ma for pods occurring within leucogabbro, and 2765±7 Ma, for pods in oikocrystic anorthosite (Corkery *et al.*, in press).

The PLAC is a layered anorthosite and gabbro sill, which extends in a broad arc, from the east shore of Cross Lake, south of Pipestone Lake, to the east channel of the Nelson River. The PLAC is approximately 17.4 km long and up to 1.5 km wide and narrows to 100 m at the Nelson River.

The PLAC has been subdivided into several phases (Table 2, Fig. 4) of anorthosite (Unit 3), leucogabbro (Unit 4), melagabbro (Unit 5) massive magnetite (Unit 6) and mafic pegmatite (Unit 7). Magnetite- and ilmenite-bearing subunits, with associated titanium and vanadium mineralization, occur near the contact between the PLAC and Pipestone Lake Group mafic metavolcanic rocks (Fig. 4).

Table 2: Subdivision of units in the study area

Pipestone Lake Group
- Mafic Volcanic Rocks and Associated Intrusive Rocks
  1. Aphyric pillowed and massive flows and related sedimentary rocks
     - 1a. Plagioclase porphyritic pillowed and massive flows
  2. Gabbro and ultramafic rocks
- Pipestone Lake anorthosite complex
  3. Anorthosite
     - 3a. Massive to megacrystic anorthosite
     - 3b. Oikocrystic anorthosite
  4. Leucogabbro
     - 4a. Magnetite-bearing leucogabbro
  5. Melagabbro
     - 5a. Magnetite-bearing melagabbro
     - 5b. Ilmenite-bearing melagabbro
     - 5c. Chlorite-magnetite schist
     - 5d. Layered porphyritic mesogabbro
  6. Massive magnetite rock
  7. Mafic pegmatite

Molson Lake Domain
  8. Whiskey Jack gneiss complex composed of pre Pipestone Lake Group gneiss and younger granite

Proterozoic dykes
  9. Molson diabase

There are four main titanium-vanadium bearing rock types:

Magnetite-bearing leucogabbro (Unit 4a);
Magnetite-bearing melagabbro (Unit 5a);
Ilmenite-bearing melagabbro (Unit 5b); and
Massive magnetite rock (Unit 6)

Oxide-rich phases are well exposed along the shoreline of Pipestone Lake (Fig. 4) but rarely outcrop inland. In the central part of the PLAC the layering strikes 290° to 310° and dips 80° to 85° to the south.

Anorthosite and leucogabbro intrude the basalt at the base of the Pipestone Lake Group and inclusions of basalt and amphibolite occur in leucogabbro and melagabbro along the north contact of the PLAC. A major northwest-trending tectonic zone occurs in the basalts north of the PLAC and the rocks along the south shore of Pipestone Lake are generally sheared. Some 20 cm thick layers of megacrystic anorthosite cataclasite occur in the lower part of the basalts.

The PLAC is flanked to the south by the Whiskey Jack gneiss complex, part of the Molson Lake plutonic domain. Dykes and veins of the youngest granodioritic and granitic phases of the Whiskey Jack gneiss complex intrude the base of the PLAC (Fig. 4). In the eastern part of the PLAC, near the East Channel of the Nelson River, both the PLAC and the Whiskey Jack gneiss complex are sheared along the contact.

Amphibolite inclusions and some mafic banding and schlieren are common. Inclusions of fine grained, light grey, biotite gneiss, which may be derived from sediments or older gneisses of the Molson Lake domain, occur in the southern parts of the PLAC.

The PLAC is intruded by late mafic dykes (Molson swarm). These are generally very fine grained, with no internal fabric, greenish grey weathering and up to 40 cm wide. Some coarser grained diabase dykes are also present, the most notable is a 100 m thick dyke exposed on the south shore of Pipestone Lake.

UNIT DESCRIPTIONS

Pipestone Lake Group basalt (Unit 1)

Interlayered, Pipestone Lake Group aphyric and feldspar phyric pillowed and massive flows occur to the north of the PLAC (geochemical analyses in Appendix A1). Preservation of primary structures such as pillows, vesicles and flow top breccia is variable. Only massive flows are observed in contact with the rocks of the PLAC. Plagioclase porphyritic basalt (Unit 1a), contains characteristic 2 mm to 1 cm white plagioclase in a fine grained greenish-black groundmass; the rock is locally magnetic.

At several locations, along the contact on the east shore of Cross Lake and near the road to Cross Lake, the basalt is extensively altered to garnet-rich rock that contains 10 to 15% 1 to 3 mm garnet porphyroblasts, abundant magnetite and quartz-epidote veining.

Fine grained amphibolite layers and inclusions within the PLAC are interpreted as partially assimilated rafts of basalt.

Ultramafic rocks (Unit 2)

Ultramafic phases are rare. Only a few small occurrences (geochemical analyses in Appendix A2), ranging from 20 cm to 1 m, were observed. The field relations of these rocks are unclear due to poor exposures, however, they appear to be small rafts in leucogabbro and oikocrystic anorthosite.

Ultramafic rocks, with high chromium values, outcrop on islands near the west shore of Pipestone Lake approximately 2 km north of the PLAC, near the contact between the Pipestone Lake Group and Cross Lake Group. They are separated from the Pipestone Lake Group rocks by a major shear zone and are not part of the PLAC (Corkery, in prep.).

PIPESTONE LAKE ANORTHOSITE COMPLEX (Units 3 to 7):

Anorthosite (Unit 3):

Massive to megacrystic anorthosite (Unit 3a)

Massive to megacrystic anorthosite (geochemical analyses in Appendix A3, A4) is the dominant rock type in the PLAC and is characterized by subhedral to euhedral plagioclase megacrysts (An_{70} to An_{80}) that range from 2 to 12 cm (rarely to 25 cm). These megacrysts usually occur as large twinned phenocrysts (not glomeroporphyroblasts), however, some crystal fragments and masses of fragments are present. Cores of the plagioclase megacrysts are typically altered to epidote and few samples show good labradorescence. Exposures of the megacrystic anorthosite show layering on a 10 cm to 2 m scale with variations in grain size, texture and mafic content. Where mafic content is high, abundant garnet (to 2 cm) may develop. Megacrystic anorthosite locally grades into massive anorthosite where plagioclase megacrysts coalesce and mafic content decreases. Layers up to 15 cm thick, with oikocrystic mafic clots, also occur.

Interstitial hornblende ± chlorite form 2 to 4 cm clots, containing traces of disseminated ilmenite and magnetite, make up about 5% of the megacrystic anorthosite. A related phase of hornblende clot anorthosite appears as massive, white anorthosite with 8 mm to 2 cm mafic clots.

Pyrite occurs locally. Several sulphide-bearing samples were submitted for platinum-palladium analyses, but the results were below detection limits of 10 ppb for platinum and 2 ppb for palladium.

Oikocrystic anorthosite (Unit 3b)

Oikocrystic anorthosite (geochemical analyses in Appendix A5) appears to be a transitional phase between megacrystic anorthosite (Unit 3a) and leucogabbro (Unit 4), and is typically recrystallized due to shearing. The anorthosite is white to buff weathering, with a grain size 2 to 8 mm and occurs in layers to about 5 m thick. Plagioclase appears as coalesced masses with interstitial mafic clots. These lenticular hornblende-chlorite clots, 5 to 8 mm by 3 to 15 cm, give a streaked appearance to outcrops.

Some plagioclase megacrysts to 4 cm are still identifiable near megacrystic anorthosite. Crushed plagioclase fragments 8 mm to 2 cm show extensive alteration to epidote.

The anorthosite contains preserved pods and patches of massive and megacrystic anorthosite (Unit 3a) and porphyritic mesogabbro (Unit 5d) and digested inclusions of fine grained basalt and amphibolite.

Layers of foliated leucogabbro and anorthosite are found within the oikocrystic anorthosite. Anorthositic clots, stringers and tension gash fillings are pale greenish yellow weathering due to alteration of feldpars to epidote.

Locally the oikocrystic anorthosite appears to intrude the more mafic gabbroic rocks.

Leucogabbro (Unit 4)

Leucogabbro (geochemical analyses in Appendix A6) is medium grained, foliated and white to light grey weathering with patches (to 10 cm) of pale yellow-green epidote alteration. It generally contains a trace of magnetite, however, rocks along the contacts with massive magnetite layers are usually enriched in oxides. Mafic minerals comprise hornblende ± biotite ± chlorite. Some 1 to 5 cm compositional layering occurs. Local fine grained amphibolite inclusions, probably derived from basalts, are common in the leucogabbro near the northern contact of the PLAC. A sample from one location gave a value of 2120 ppm Cr, which anomalously high for rocks in the PLAC (Appendix A6).

Magnetite-bearing leucogabbro (Unit 4a)

Magnetite-bearing leucogabbro (geochemical analyses in Appendix A7) is light to medium grey buff weathering and medium grained. It occurs adjacent to the massive magnetite layers and contains disseminated magnetite and ilmenite for a distance of 1 to 2 m from the contact with the massive magnetite layers. Plagioclase phenocrysts range from 1 mm to 1 cm. Mafic inclusions range from 1 to 3 mm by 5 to 10 cm. Locally, magnetite-bearing leucogabbro contains abundant 2 to 6 mm garnets.

Analyses of Unit 4 show total iron values of 13 to 56%, 4 to 15% TiO_2 and 0.3 to 0.9% V_2O_5.

Melagabbro, mesogabbro (Unit 5)

Dark grey to black weathering melagabbro (geochemical analyses in Appendix A8) is medium- to-coarse grained and ranges from massive to well foliated. The 1 to 4 mm plagioclase and 3 mm to 1 cm hornblende gives the melagabbro a coarse black and white salt and pepper texture. The gabbro contains mafic rafts and schlieren as well as layers to 50 cm of leuco- to mesogabbro and layers and pods of anorthosite and mafic pegmatite. Small clots of iridescent blue-black ilmenite occur within some of the more feldspathic layers.

Magnetite-bearing melagabbro (Unit 5a)

Magnetite-bearing melagabbro (geochemical analyses in Appendix A9) occurs with the magnetite rock (Unit 6) as 3 to 5 m layers and as a broader zone up to 50 m wide between the magnetite rock and the megacrystic anorthosite (Unit 3a) to the south. The rock contains abundant disseminated magnetite, ilmenite and intergrown ilmenite-chlorite and ilmenite-amphibole as well as traces of pyrite and chalcopyrite. Ilmenite lenses occur in the melagabbro and in leucogabbro veins that intrude the melagabbro. Magnetite-bearing melagabbro contains 23 to 44% total iron (as FeO), 4 to 8% TiO_2 and 0.3 to 0.8% V_2O_5.

Ilmenite-bearing melagabbro (Unit 5b)

A phase of melagabbro, similar to Unit 5a, is associated with the magnetite-bearing gabbros but contains disseminated ilmenite and little or no magnetite (geochemical analyses in Appendix A10). The rock is medium- to coarse-grained and weathers blue black. Because of its low magnetite content the ilmenite-rich gabbro is difficult to recognize in the field. The gabbro gives values of 4 to 5% TiO_2, 18 to 24% total iron as FeO and 0 to 0.02% V_2O_5. Lenses of ilmenite also occur in this phase, however, their exact size and extent is undetermined and they cannot be delineated with a magnetometer.

Chlorite-magnetite schist (Unit 5c)

Coarse grained, greenish black weathering chlorite magnetite schist was noted on several outcrops. The rock occurs as discontinuous layers up to 50 cm wide and as narrower 5 to 10 cm rims on some anorthosite pods.

Layered porphyritic mesogabbro (Unit 5d)

Porphyritic mesogabbro is coarse grained with 1 to 10 mm white feldspar, locally coarsening to 3 cm. Plagioclase cores are altered to epidote. Interstitial needles of hornblende and hornblende-chlorite clots (to 1 cm) occur. The rock is strongly foliated, locally schistose and contains a trace of magnetite.

The porphyritic mesogabbro is well layered at several locations with 4 mm to 10 cm coarse grained mafic and 0.5 to 5 cm felsic layers and also shows 2 cm *lit par lit* feldspathic banding parallel to the foliation.

The this unit grades into megacrystic and massive anorthosite. Locally, nebulitic patches of leucogabbro, oikocrystic anorthosite and lenses of massive anorthosite to 30 by 50 cm occur.

Massive magnetite rock (Unit 6)

Massive magnetite, containing up to 71% (60 to 71%) total iron as FeO, 14 to 20% TiO_2 and 0.8 to 1.5% V_2O_5, occurs as layers or lenses (0.5 m to 3.5 m thick) in leucogabbro, along the contact with the basalts. They are best exposed at Locations 1 and 2 (Fig. 3). The layers are metallic grey to blue-black weathering and occur in a 15 to 20 m wide zone. These massive oxide layers are composed mainly of magnetite, ilmenite and chlorite and have a specific gravity of 3.9 to 4.7 g/cm^3 (Appendix C).

Ilmenite lenses may also occur. They are most readily distinguished in chemical analyses of serial samples taken across the magnetite layers where titanium concentrations occur in bands within the massive oxide layers. These ilmenite lenses are also lower in iron and vanadium.

Mafic pegmatite (Unit 7)

Hornblende-quartz pegmatite (geochemical analyses in Appendix A11) is exposed in outcrops of leucogabbro and megacrystic anorthosite at Location 1 and near Location 3 (Fig. 3). The rock is greenish-black weathering and contains amphibole up to 4 cm. The dykes are up to 50 cm wide and exposed over 5 to 8 m. D. Davis obtained a U-Pb zircon age of 2760 Ma, for this unit (Corkery, *et al.*, in press).

Whiskey Jack gneiss complex (Unit 8)

The Whiskey Jack gneiss complex comprises several phases of older gneissic and megacrystic granodiorite and younger tonalite and granite (geochemical analyses in Appendix A12), which are part of the Molson Lake domain. Older phases in the Whiskey Jack gneiss complex predate the Pipestone Lake Group volcanic rocks and the intrusion of the PLAC. South of Pipestone Lake, multicomponent schlieric gneiss ranging from granodiorite to tonalite, is dominant. Exposure is poor along the contact between the PLAC and the gneisses. A 1.5 km wide zone of strong ductile shearing is exposed on the East Channel of the Nelson River, striking parallel to the contact between the Whiskey Jack gneiss complex and the PLAC. Some large xenoliths of anorthosite occur in the granodiorite and granodiorite dykes and veins intrude the southern margin of the PLAC.

The granodiorite is white to light grey to pink weathering and medium- to coarse-grained. It contains schlieren and rafts of fine grained, light grey biotite gneiss and lenticular amphibolite inclusions up to 10 by 30 cm. Pink hematite stains are common on joint faces. Further description of this unit can be found in Cameron (1989).

Molson diabase dykes (Unit 9)

A major diabase dyke of the Molson swarm (Scoates and Macek, 1978) is exposed on the south shore of Pipestone Lake and extends across the lake as a string of islands. Most of the dyke comprises a coarse grained leucocratic granophyre with a fine- to medium-grained mafic margin along the west side of the dyke (geochemical analyses in Appendix A13). The dyke cuts through the PLAC, as indicated by the ground magnetometer survey (Fig. 37), but contacts are not exposed.

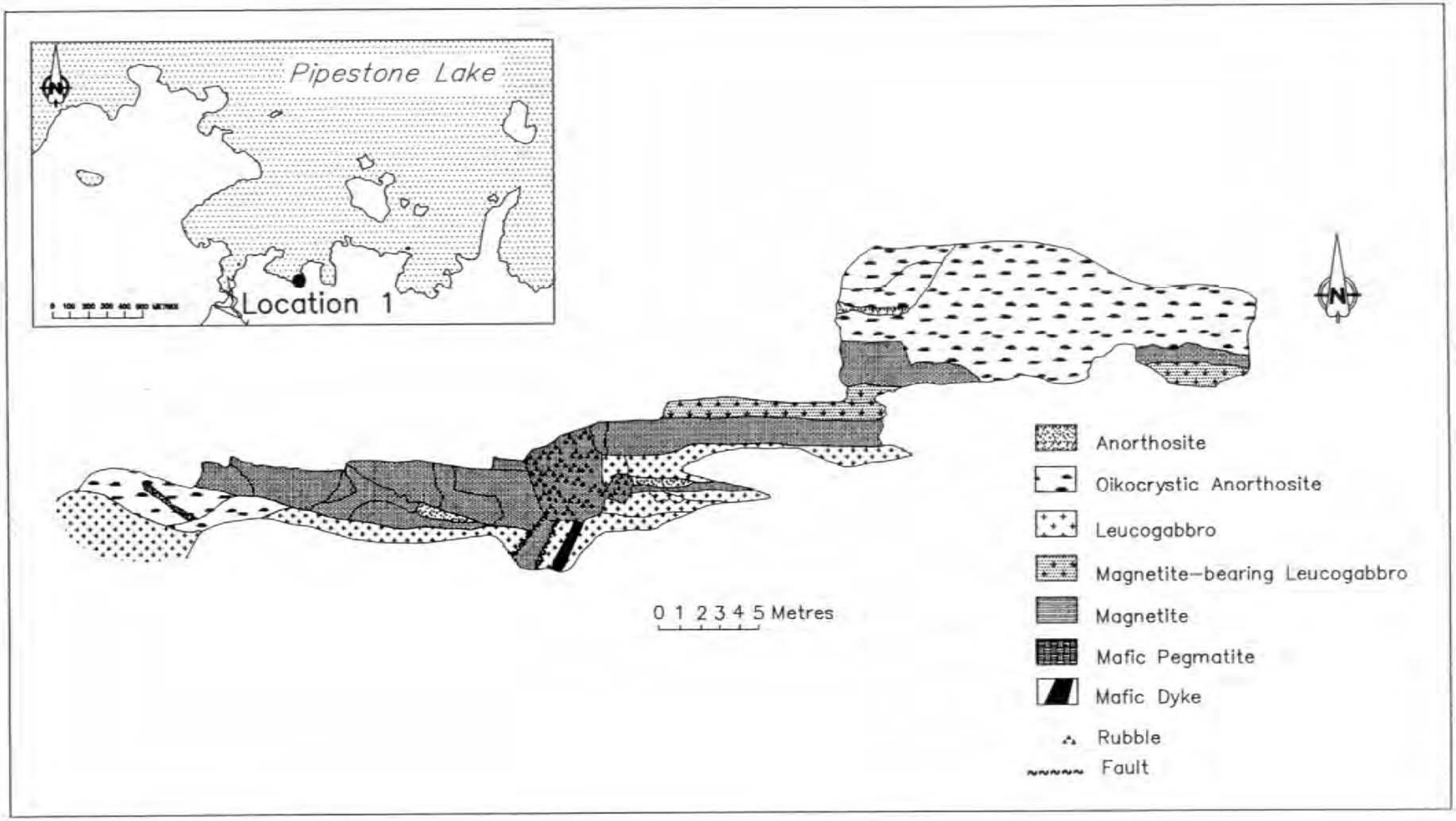


Figure 5: *Location 1. Outcrop map.*

LOCATION STUDIES

Detailed studies were carried out at 4 locations (Fig. 3) in the central part of the PLAC: two on exposures of massive oxide layers in leucogabbro and two at old trenches in magnetite-bearing melagabbro. Outcrop maps were produced for each of the sites, the units were sampled extensively for geochemical analysis and magnetometer surveys were carried out at Locations 2 and 4. Average iron, titanium and vanadium values for each location appear in Table 3.

Table 3: Average iron, titalum and vanadium values for Locations 1, 2, 3 and 4

Location	No. of Samples	Layer[1]	Width	FeO (wt.%)	TiO_2 (wt.%)	V_2O_5 (wt.%)	Ti/Fe	V/Fe
1	15	North	1.3m	65.43	16.05	1.02	0.19	0.01
	14	Middle	2.0m	61.67	14.43	1.15	0.18	0.01
	24	South	3.4m	58.62	16.36	0.95	0.23	0.01
	78	Average[2]	16m	50.60	12.72	0.82	0.19	0.01
2	4	North	0.6m	51.78	13.93	0.81	0.21	0.01
	9	South	0.8m	64.73	14.93	1.17	0.18	0.01
3	21	(diss.)[3]	14.6m	31.53	5.39	0.51	0.13	0.01
4	20	(diss.)	10.2m	27.84	4.41	0.43	0.12	0.01

LOCATION 1

Massive magnetite layers are exposed in an outcrop of leucogabbro on the south shore of Pipestone Lake. They occur as three layers 1.5 m, 2 m and 3.5 m thick, over a total width of 15 m, and are exposed over a total strike length of approximately 50 m (Fig. 5.). Much of the magnetite-bearing rock is broken and rubbley, possibly due to previous work done on the exposure. Geochemical analyses appear in Appendices B1, B2 and B3.

Continuous sets of samples (serial samples) were taken across all three of the magnetite layers for analysis at predetermined intervals and all major units in the exposure were sampled extensively (Fig. 6). Titanium, vanadium, iron, nickel and chrome contents were plotted for each of the three layers (Fig. 51 to 64, Appendix B3) and the values from all samples were projected onto a single section to provide composite cross-strike profiles of the location (Fig. 7 to 11).

Analyses of serial samples taken across the melagabbro and the massive magnetite layers indicate that the ratios between titanium, iron and vanadium content vary. In some cases all three are directly proportional while in others, titanium shows a dramatic rise with decrease in iron and vanadium values. In general, vanadium values are directly proportional to iron values, suggesting that vanadium is tied to the magnetite, while titanium occurs both with magnetite and as separate ilmenite layers. A plot of Ti/Fe and V/Fe ratios (Fig. 12), for samples taken across the southern oxide layer, shows major peaks of titanium enrichment which correspond with decreases in the vanadium/iron ratios, indicating ilmenite layering within the massive layer. This is not as strongly developed in the middle and northern layers and does not apply to the magnetite-bearing melagabbro at Locations 3 and 4. In most cases chrome and nickel values appear to be independent of the other values.

At Location 1, titanium/iron ratios range from 0.03 to 0.44, averaging 0.18 (Fig. 13). Vanadium/iron ratios range from 0 to 0.02, averaging 0.01 (Fig. 14). A small cluster of samples with high Ti/Fe ratios corresponds with the titanium-rich peaks in Figure 12.

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1 Massive oxide layers (unit 6).

2 Average of 78 samples of massive magnetite (unit 6) and magnetite-bearing leucogabbro (unit 4a).

3 (diss.): Magnetite-bearing melagabbro (unit 5a).

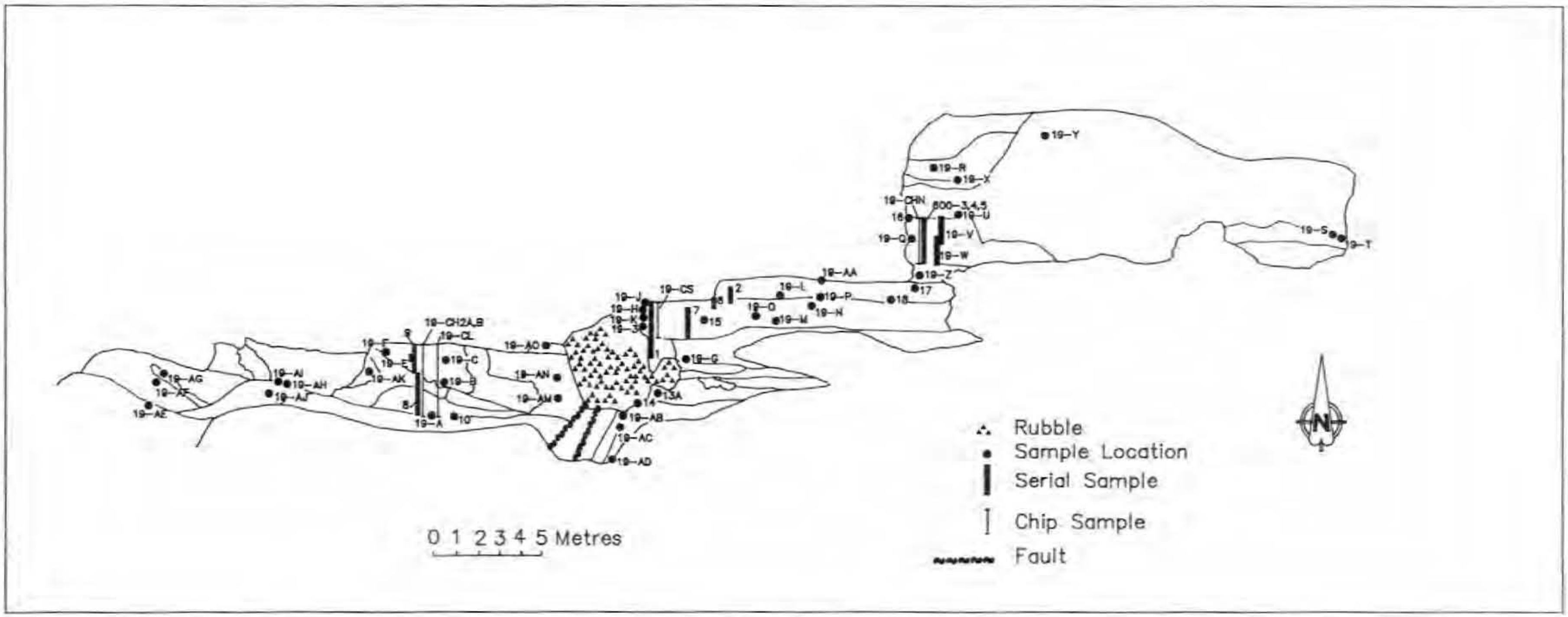

Figure 6: *Location 1. Sample locations.*

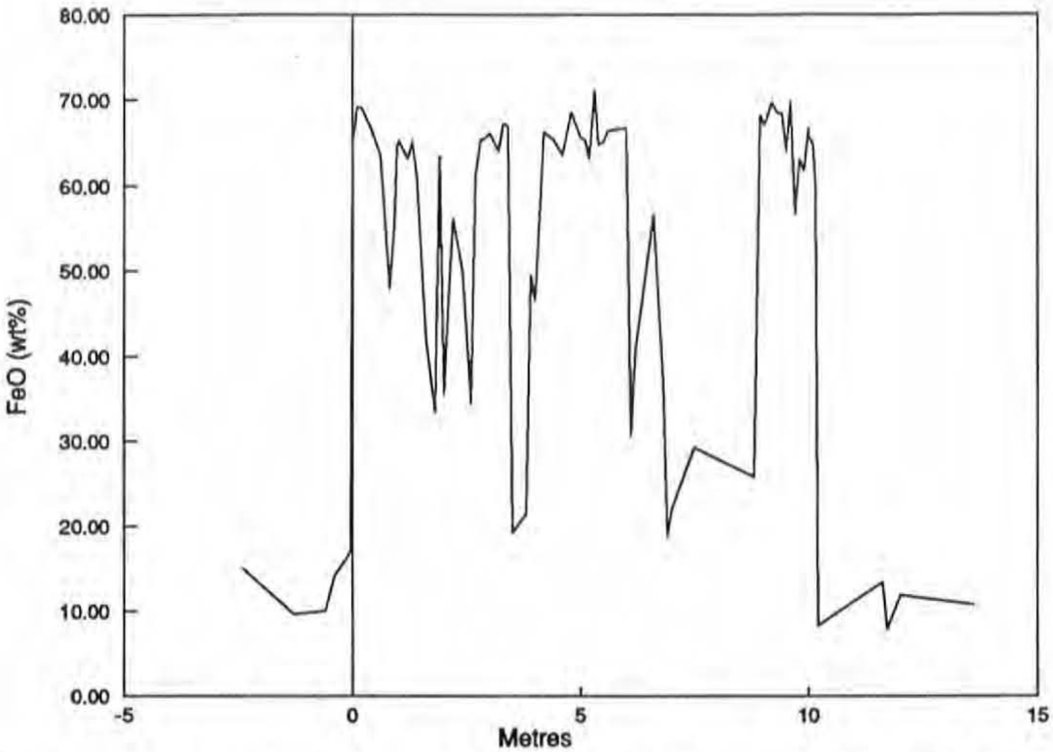

Figure 7: *Location 1. Cross-strike projection of magnetite layers. FeO values. South (left) to north (right). 0 metre line marks the contact of the magnetite layers with the leucogabbro to the south.*

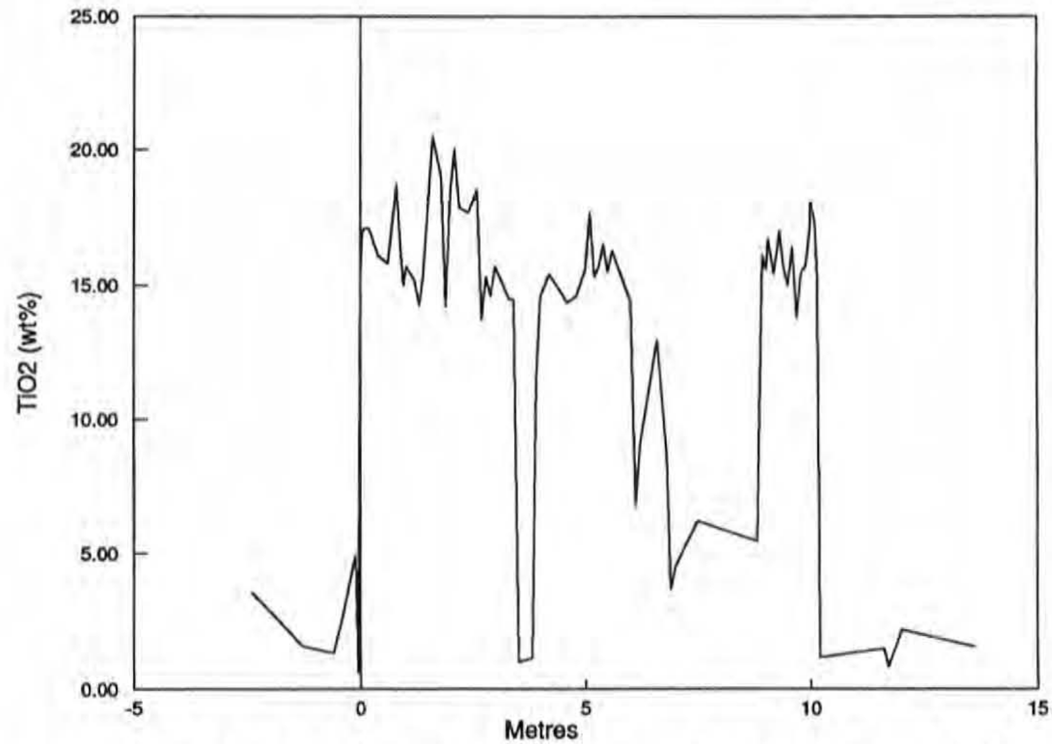

Figure 8: *Location 1. Cross-strike projection of magnetite layers. TiO_2 values. South (left) to north (right). 0 metre line marks the contact of the magnetite layers with the leucogabbro to the south.*

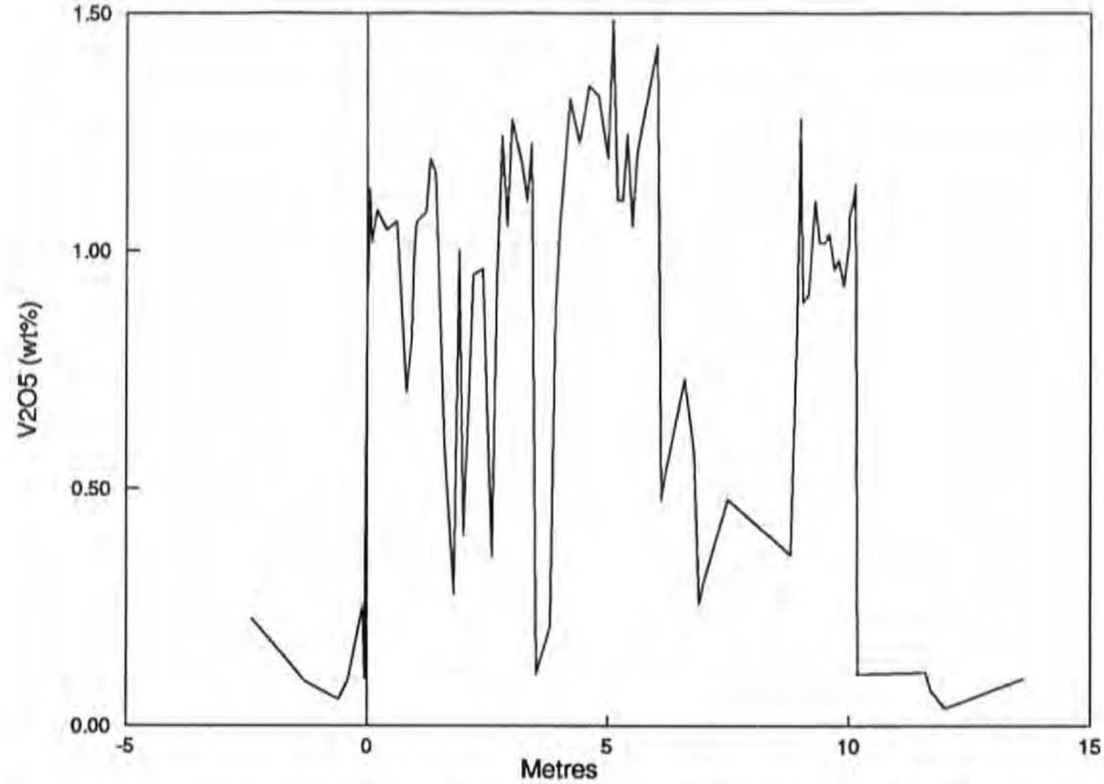

Figure 9: *Location 1. Cross-strike projection of magnetite layers. V_2O_5 values. South (left) to north (right). 0 metre line marks the contact of the magnetite layers with the leucogabbro to the south.*

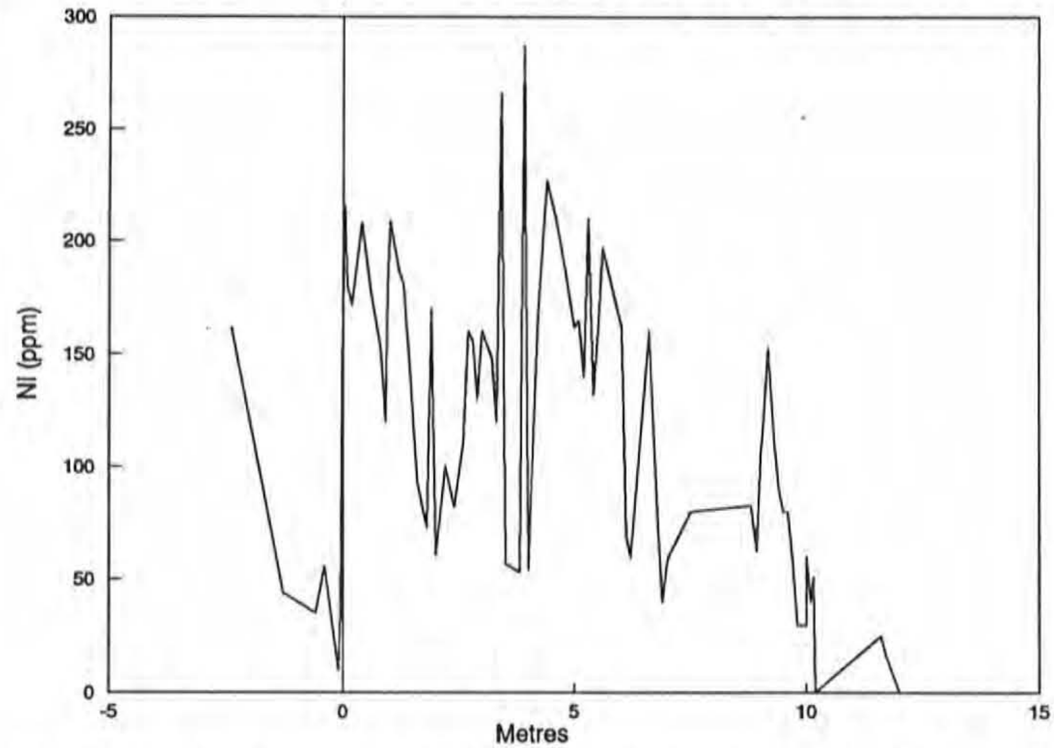

Figure 10: *Location 1. Cross-strike projection of magnetite layers. Ni values. South (left) to north (right). 0 metre line marks the contact of the magnetite layers with the leucogabbro to the south.*

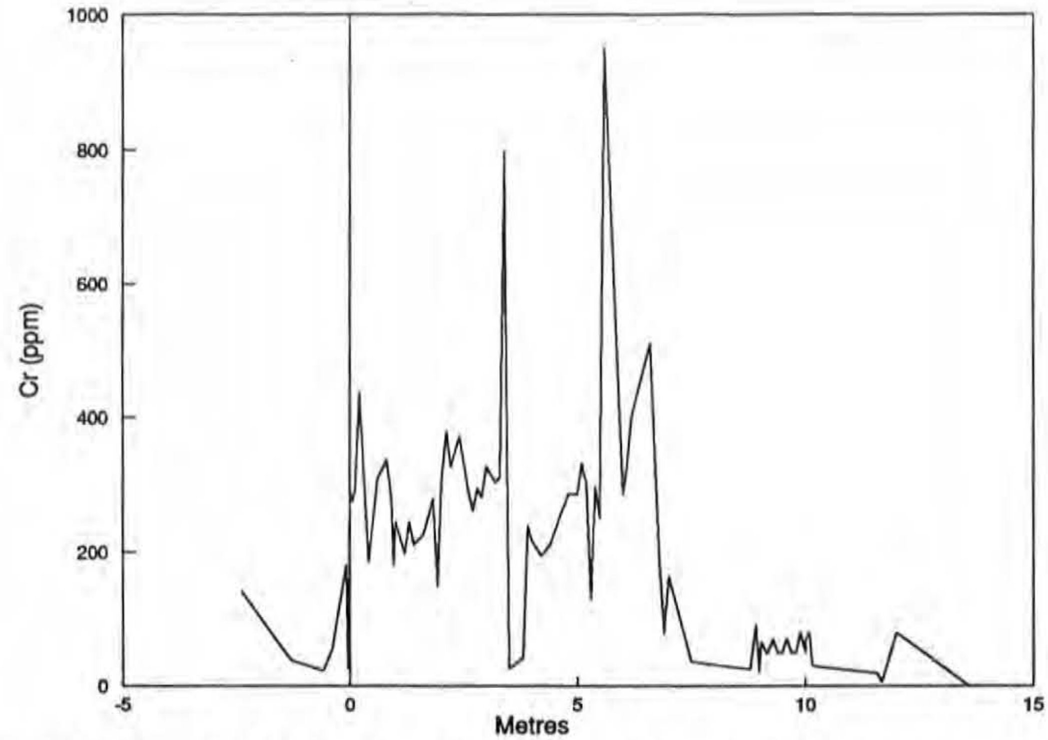

Figure 11: Location 1. Cross-strike projection of magnetite layers. Cr values. South (left) to north (right). 0 metre line marks the contact of the magnetite layers with the leucogabbro to the south.

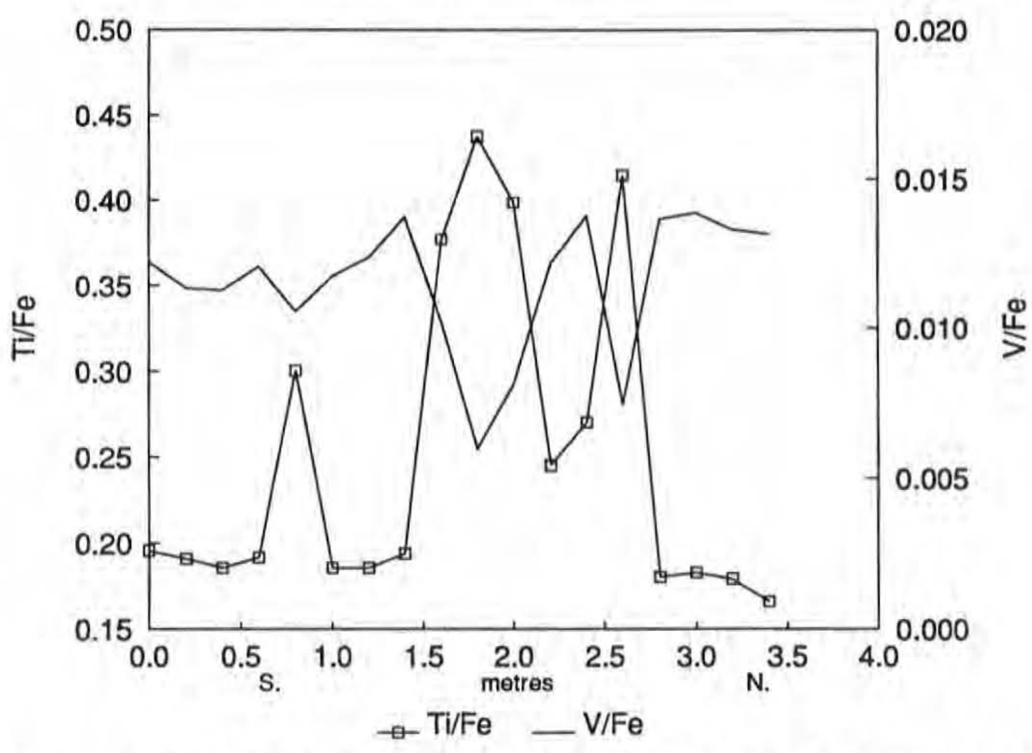

Figure 12: Ti/Fe and V/Fe ratios across southern layer of massive magnetite at Location 1. Ti/Fe peaks coincide with low V/Fe values, indicating ilmenite layers or lenses within the massive magnetite.

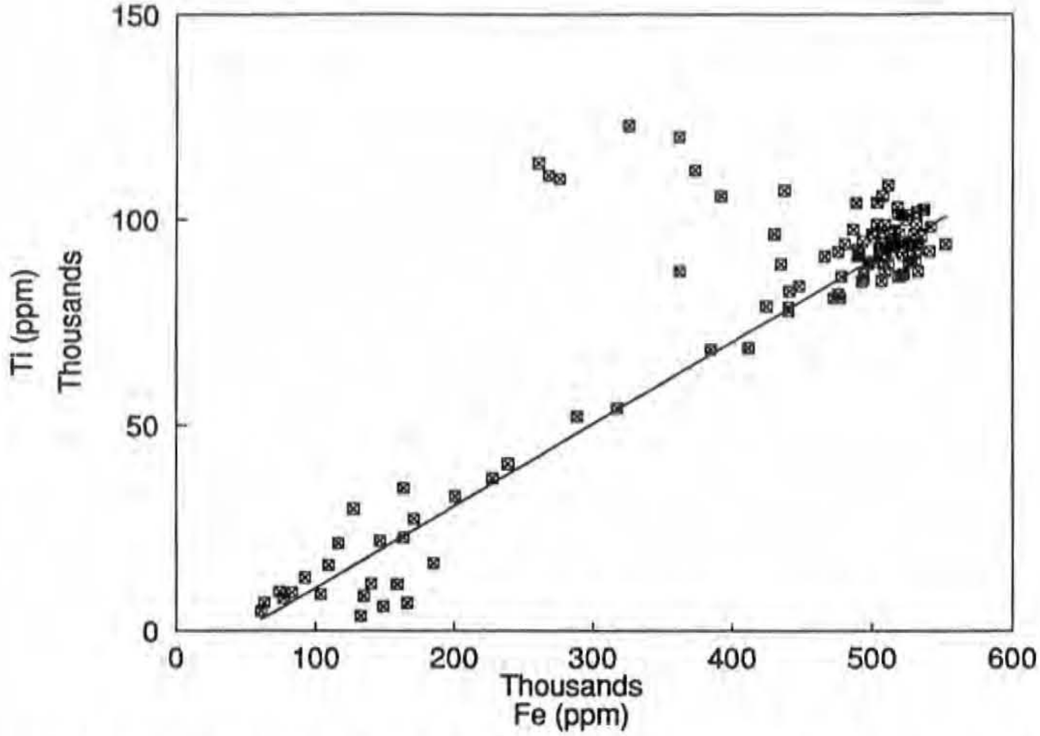

Figure 13: Location 1, massive magnetite layers in leucogabbro. Plot of Ti vs Fe for 119 samples. Population of high Ti and low iron values indicates ilmenite layering. Y-intercept = -19610. X coefficient = 0.20.

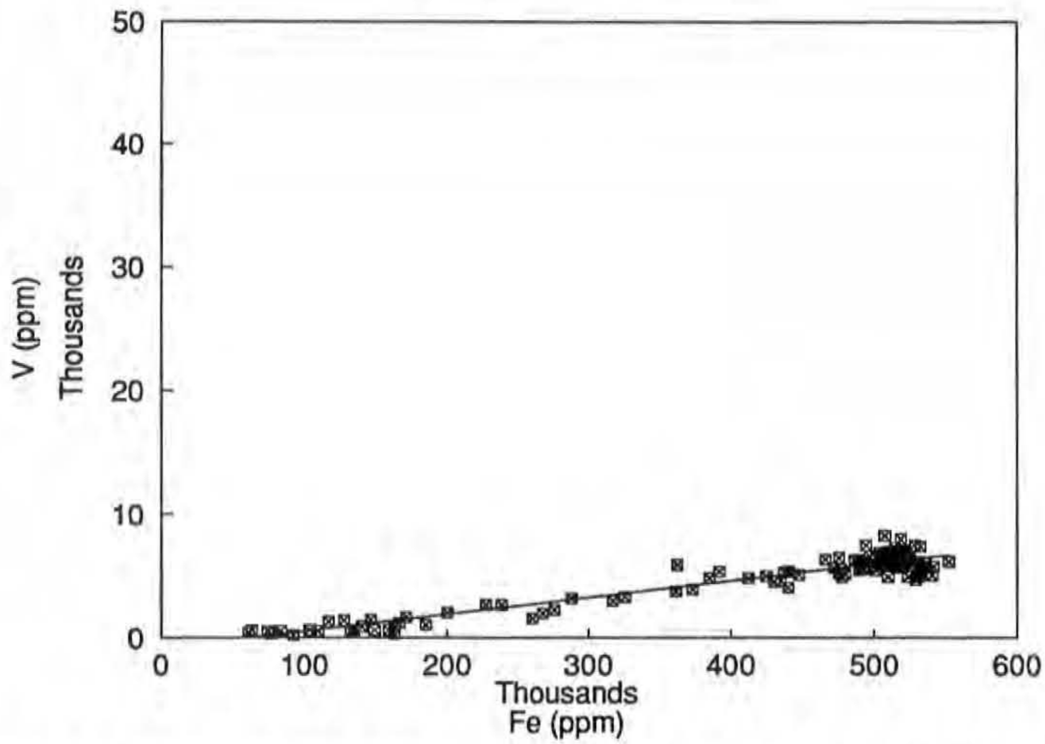

Figure 14: Location 1, massive magnetite layers in leucogabbro. Plot of V vs Fe for 119 samples. Y-intercept = -853. X coefficient = 0.01.

LOCATION 2

Two layers of massive magnetite, 0.5 m to 3 m thick, occur in garnetiferous leucogabbro, south of the basalt/gabbro contact, west of the large Molson dyke on the south shore of Pipestone Lake (Fig. 3). This location was probably underwater when Noranda was active in the area. Magnetite rock is garnetiferous for a distance of 10 cm from the contact with the gabbro and contains discontinuous 3 cm fine grained mafic layers and chloritic lenses.

Detailed mapping of the 40 m by 90 m outcrop area was carried out at a scale of 1:100 (Map OF92-1) and a magnetometer survey was carried out over the area, with readings taken at 1 m intervals (Fig. 15). The intensity of the magnetic anomaly obscures details of the layering but there appear to be 1 to 3 layers of massive oxide, dipping steeply to the south and cut by northwest-trending faults.

Detailed sampling was conducted and sets of serial samples were collected across the oxide layers. Analyses (see Appendix B4, B5, B6) of these samples show little variation in titanium vanadium and iron content across the massive magnetite layers (Fig. 65 to 72, Appendix B6). Geochemical sample locations are shown on Map OF92-1.

Plots of Ti *vs* Fe and V *vs* Fe (Fig. 16 and 17) again show constant ratios, similar to that at Location 1. Ratios at Location 2 range from 0.03 to 0.27 (averaging 0.16) for Ti/Fe and 0 to 0.02 (averaging 0.01) for V/Fe.

LOCATION 3

A trench (15 m by 1.5 m and up to 1 m deep), in magnetite-bearing melagabbro, is located near the southwest corner of Pipestone Lake, to the west of the narrows in a small stream entering the lake (Fig. 3).

The outcrop comprises melagabbro (Unit 5) and magnetite-bearing melagabbro (Unit 5a). Ilmenite clots up to 1 by 4 cm occur in anorthositic veining along the north edge of the exposure. Exposure is poor outside the trench due to heavy vegetation and rubble.

A suite of samples was taken across strike, down the length of the trench and a chip sample was taken along the west edge of the trench (Fig. 18 and Appendix B7, B8).

Plots of titanium, vanadium, iron, nickel and chrome values (Fig. 19 to 23.) show titanium, vanadium and iron to be closely related and nickel and chrome are unrelated.

Samples of magnetite-bearing melagabbro at Location 3 gave ratios of 0.10 to 0.15 (averaging 0.13) for Ti/Fe (Fig. 24) and a constant 0.01 for V/Fe (Fig. 25).

LOCATION 4

A shallow (13 metre long by 1 metre wide) trench in layered leuco- to melagabbro and oikocrystic anorthosite with disseminated oxides is located approximately 300 m west of Location 2 (Fig. 26). Melagabbro and oikocrystic anorthosite contain layers or inclusions of fine grained amphibolite. Twenty-three samples were taken and a magnetometer survey was carried out on a 1 metre grid to identify any small scale variations related to the layering (Fig. 27). Magnetometer readings range from 62 000 to 84 000 gammas and are highest over layers of oikocrystic anorthosite and melagabbro that contain amphibolite banding and disseminated oxides.

Whole rock and trace element analysis of the samples was carried out (Appendix B10, B11) and the results for iron, titanium and vanadium, nickel and chrome were projected onto a profile perpendicular to the layering (Fig. 28 to 32 and Appendix B12).

Titanium/iron ratios at Location 4 range from 0.08 to 0.17 (averaging 0.11 (Fig. 33). As at Location 3, all samples had vanadium/iron ratios of 0.01 (Fig. 34).

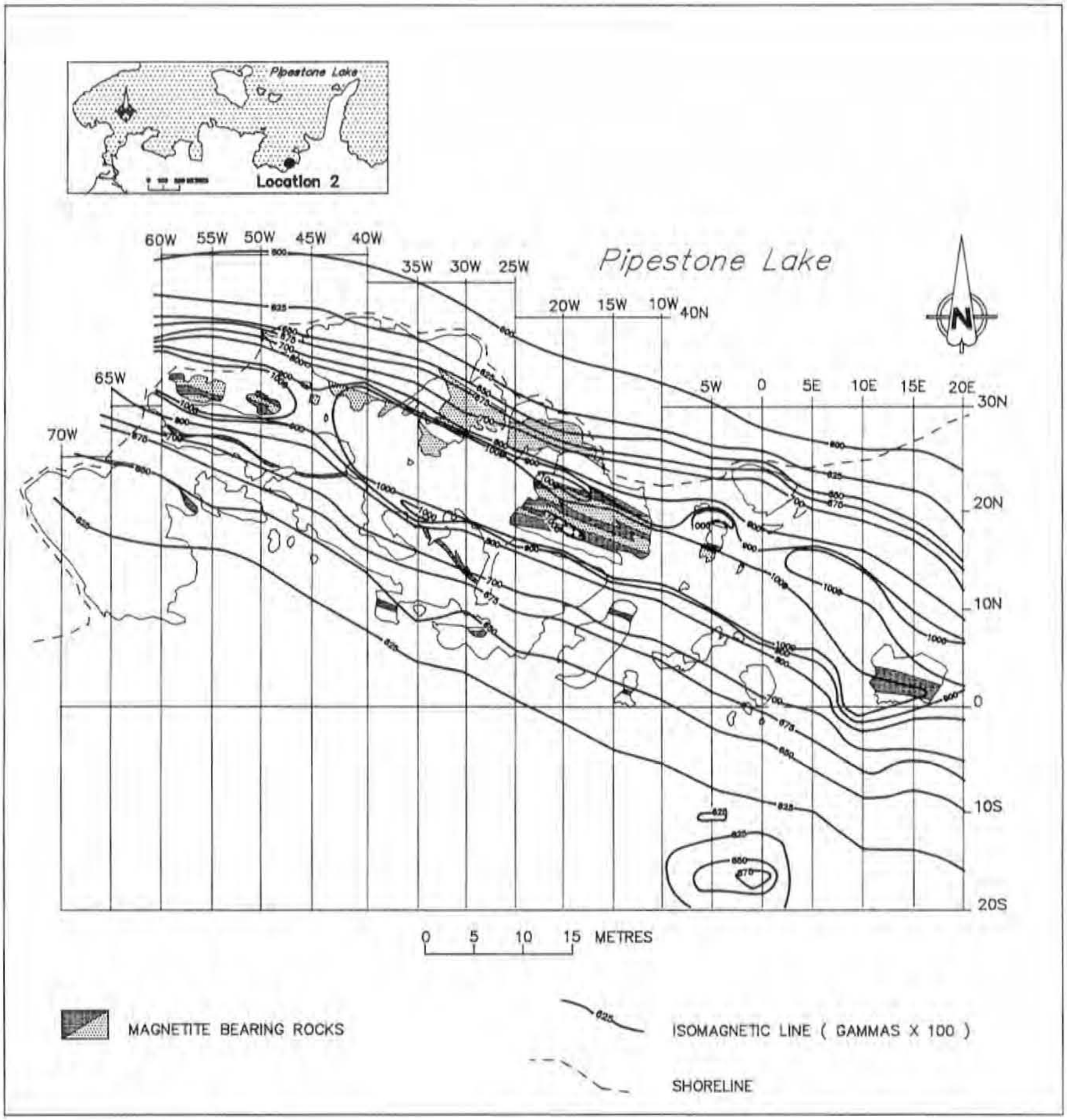

Figure 15: Location 2. Magnetometer survey.

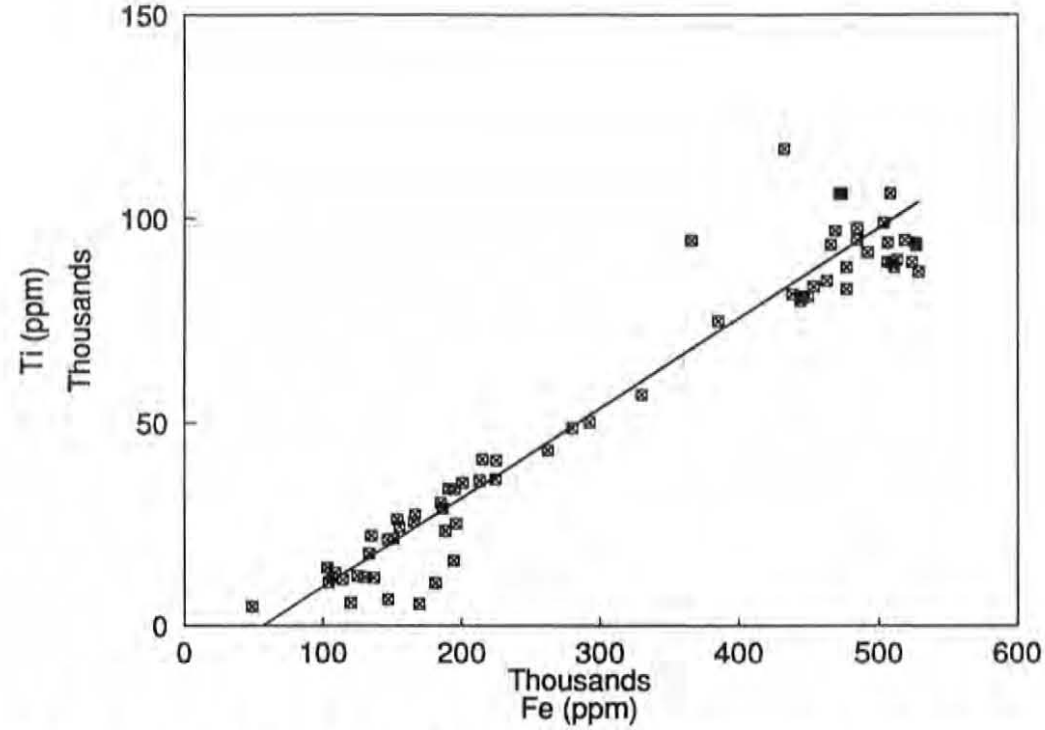

Figure 16: Location 2, massive magnetite layers in leucogabbro and oikocrystic anorthosite. Plot of Ti vs Fe for 69 samples. Y-intercept = -12369. X coefficient = 0.22

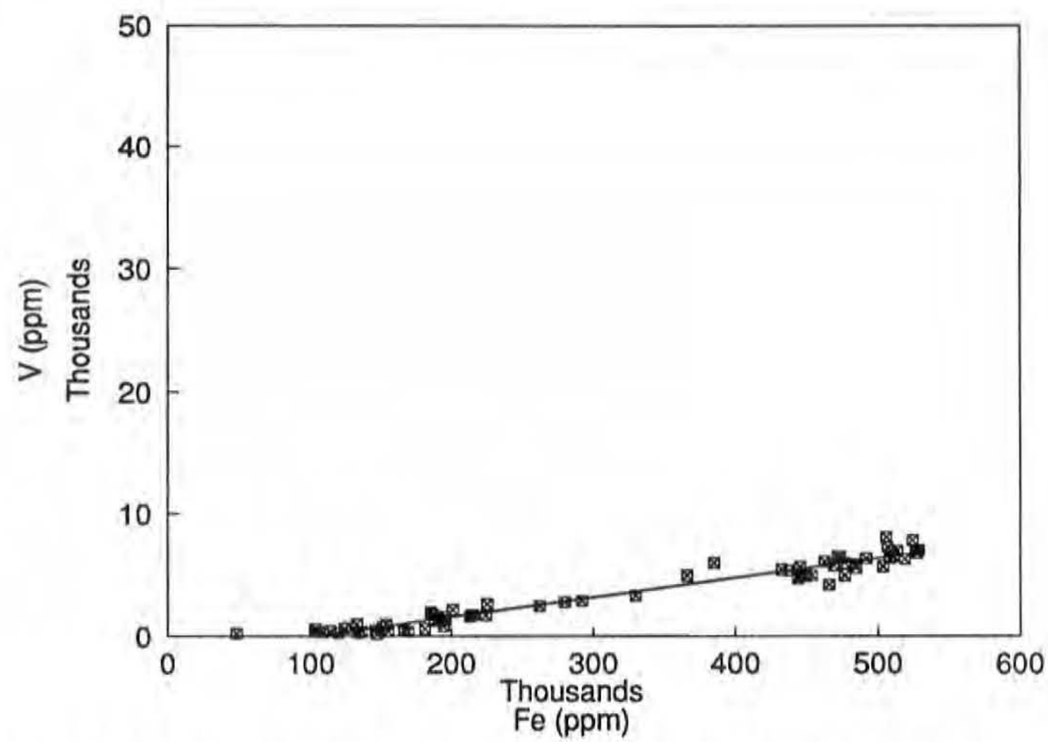

Figure 17: Location 2, massive magnetite layers in leucogabbro and oikocrystic anorthosite. Plot of V vs Fe for 69 samples. Y-intercept = -1607. X coefficient = 0.01.

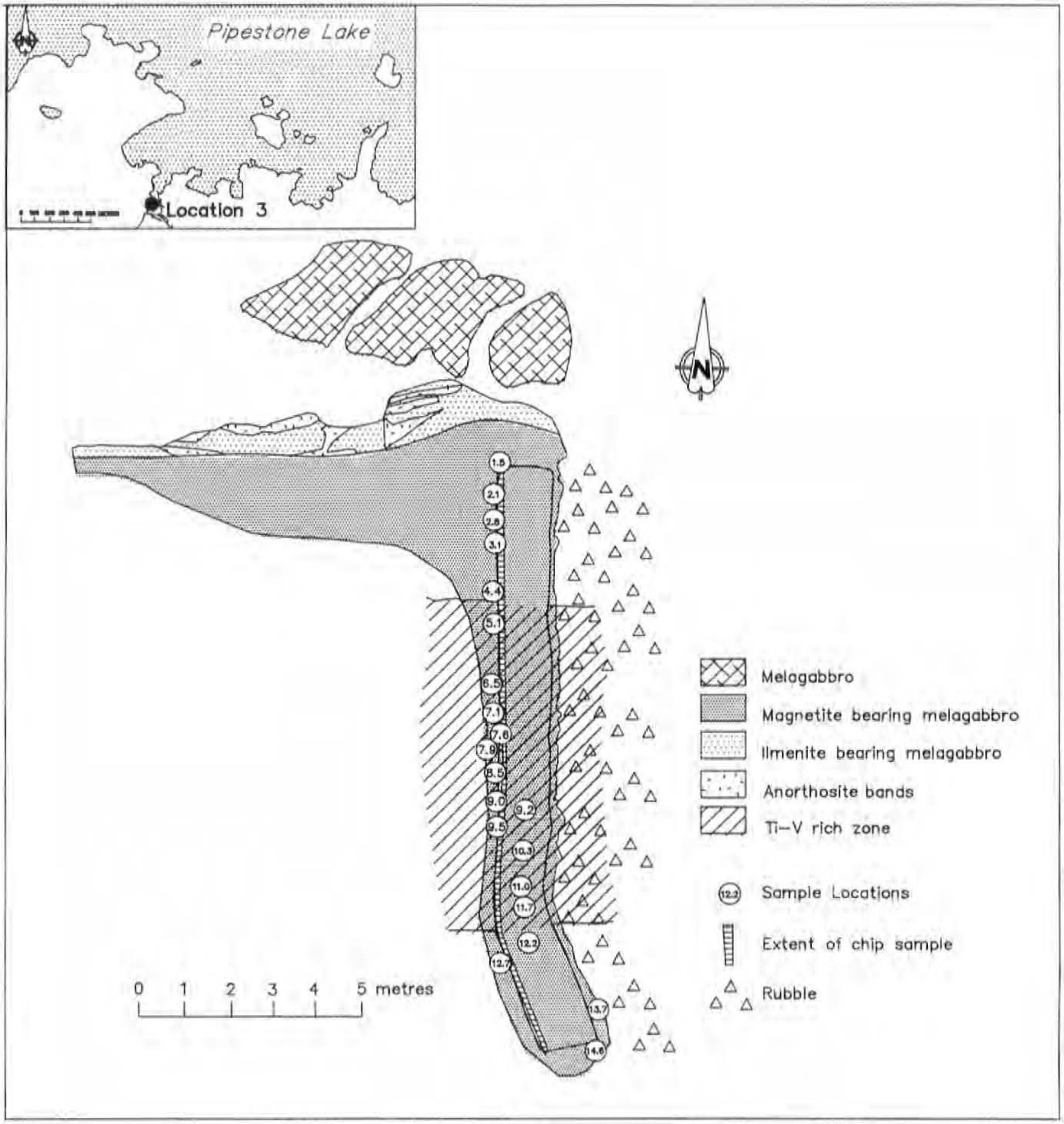

Figure 18: Location 3 (Trench 1). Outcrop map with sample locations.

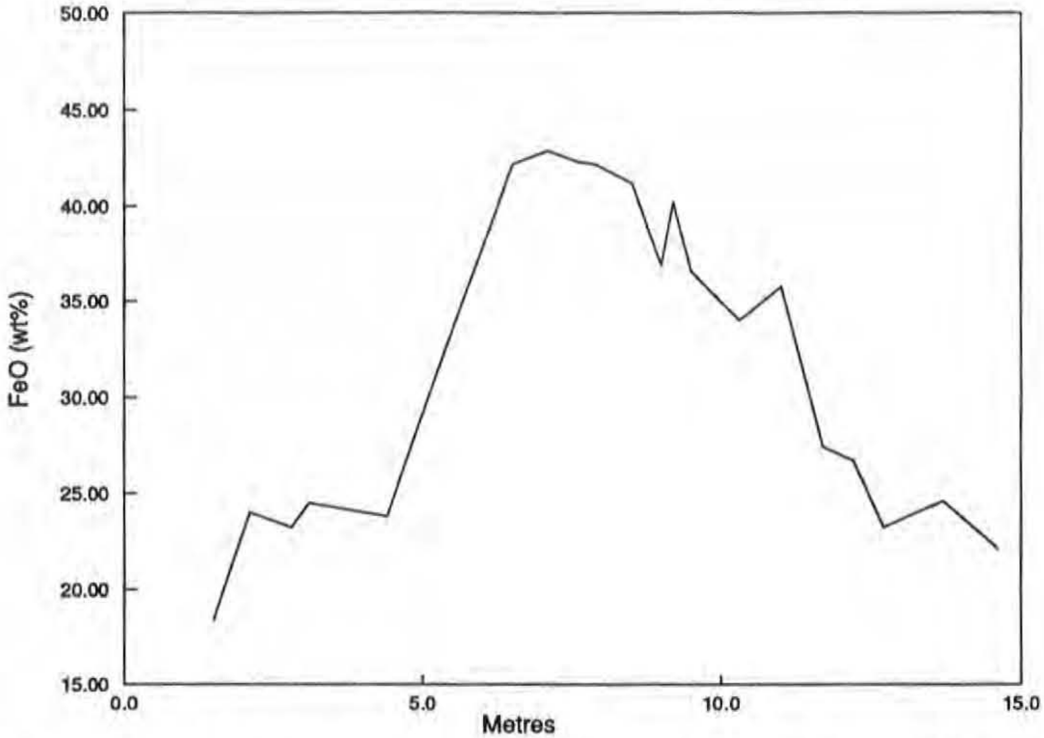

Figure 19: Location 3. Trench in magnetite-bearing melagabbro. FeO values. Samples 68-4-73-1.5 to 73-14.6.

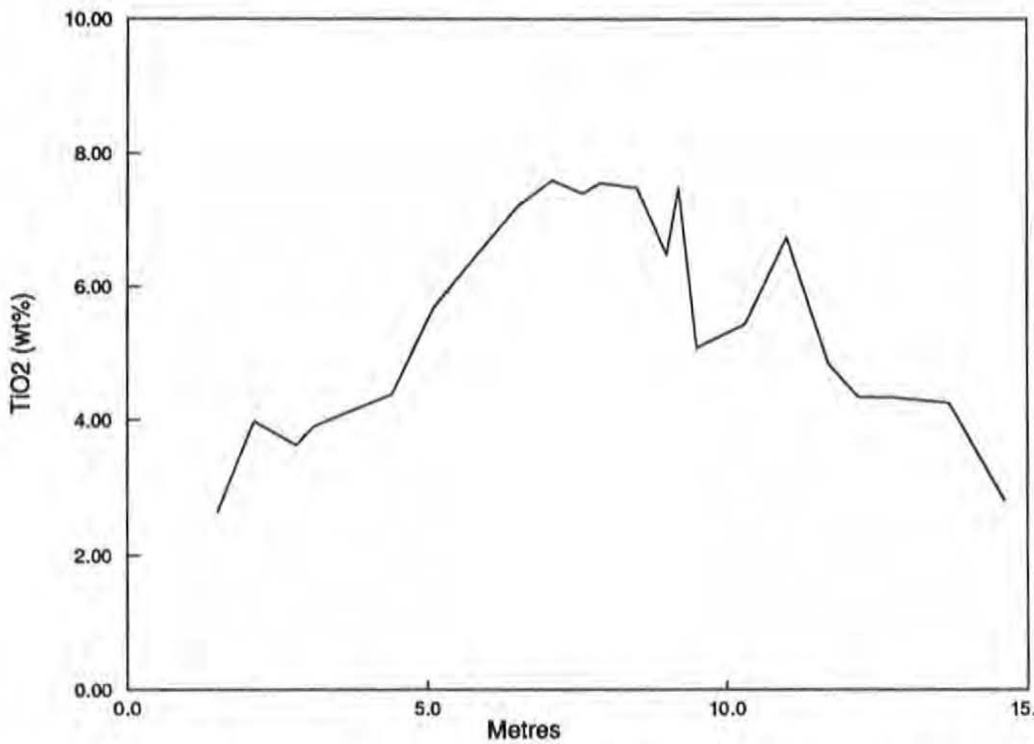

Figure 20: Location 3. Trench in magnetite-bearing melagabbro. TiO_2 values. Samples 68-4-73-1.5 to 73-14.6.

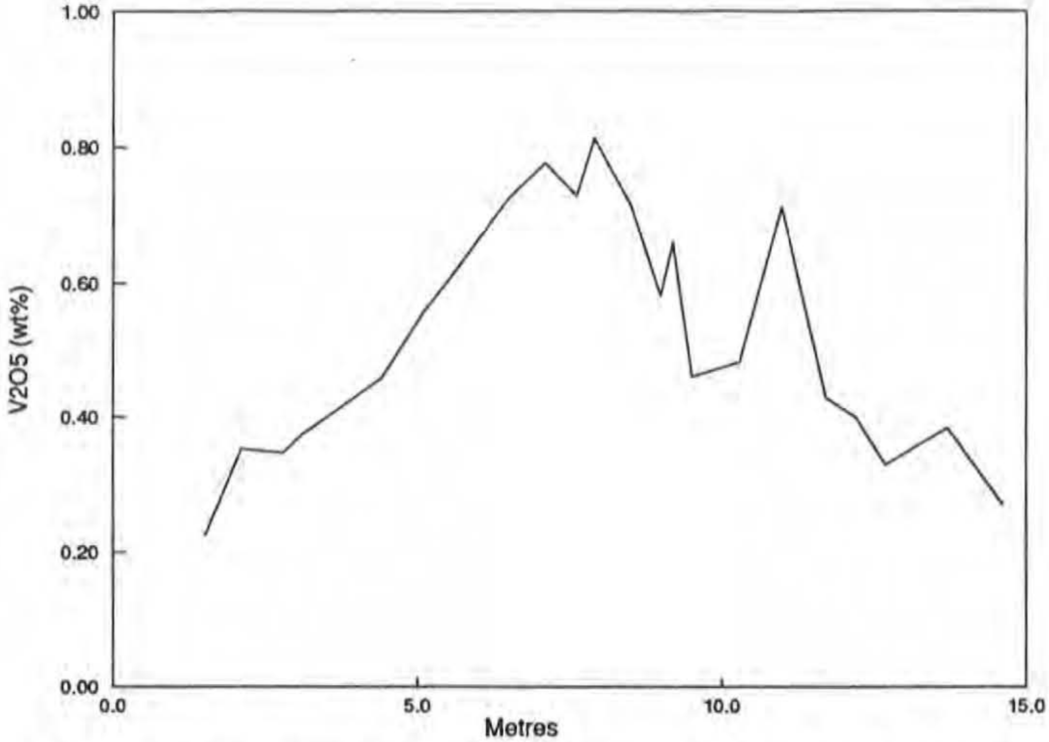

Figure 21: Location 3. Trench in magnetite-bearing melagabbro. V_2O_5 values. Samples 68-4-73-1.5 to 73-14.6.

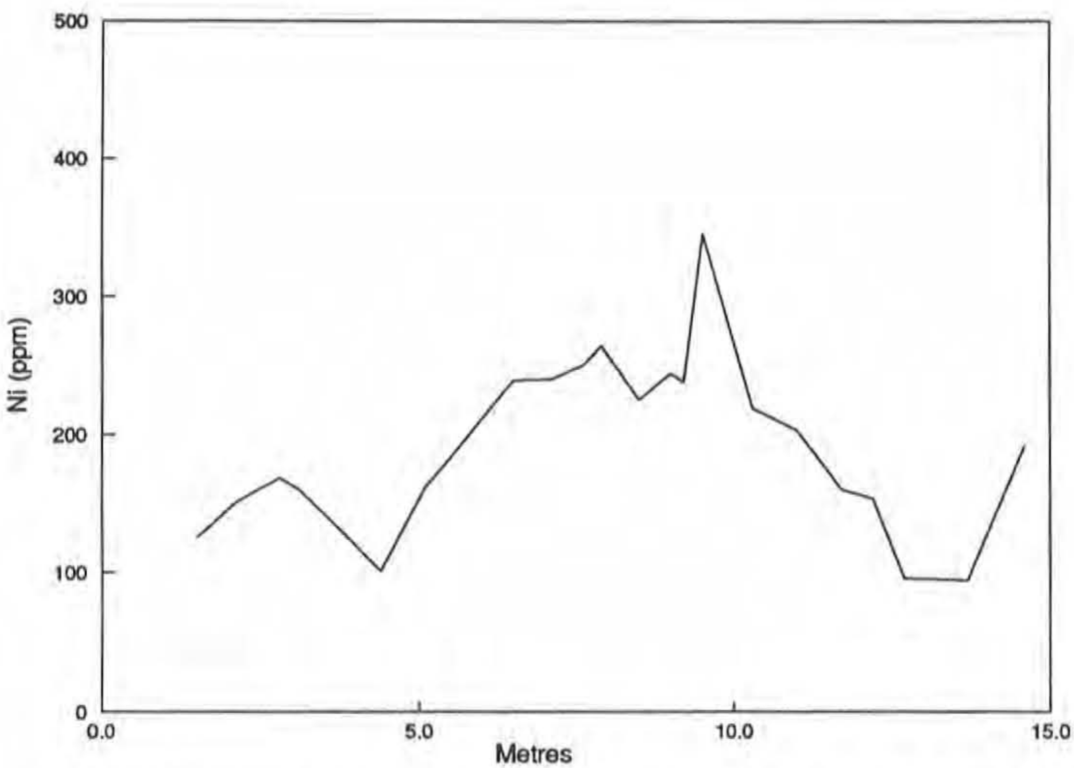

Figure 22: Location 3. Trench in magnetite-bearing melagabbro. Ni values. Samples 68-4-73-1.5 to 73-14.6.

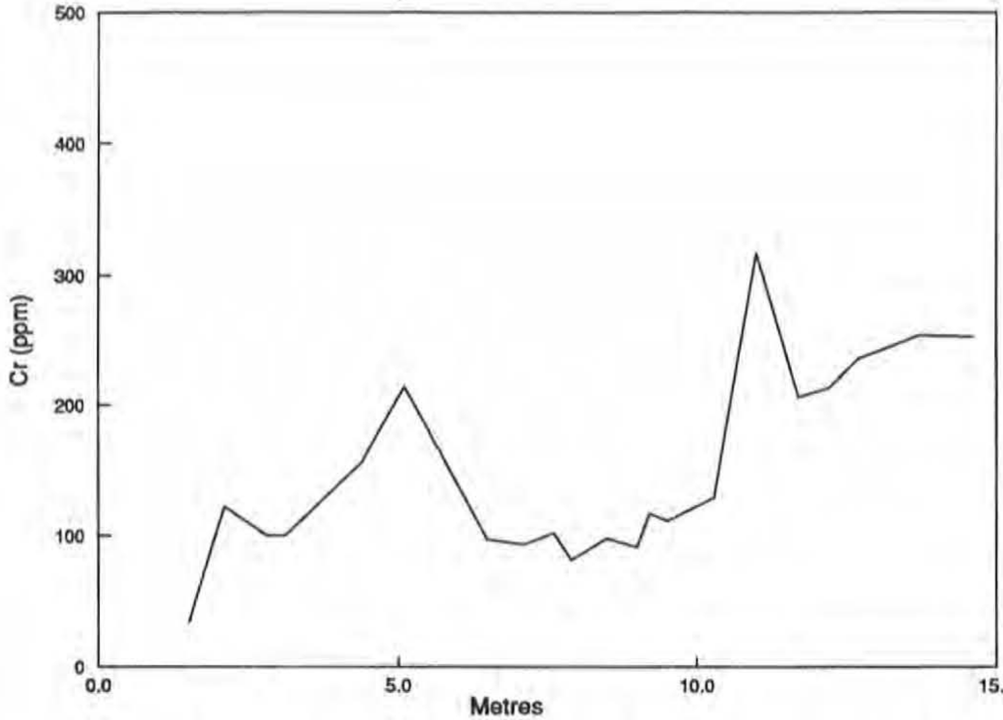

Figure 23: Location 3. Trench in magnetite-bearing melagabbro. Cr values. Samples 68-4-73-1.5 to 73-14.6.

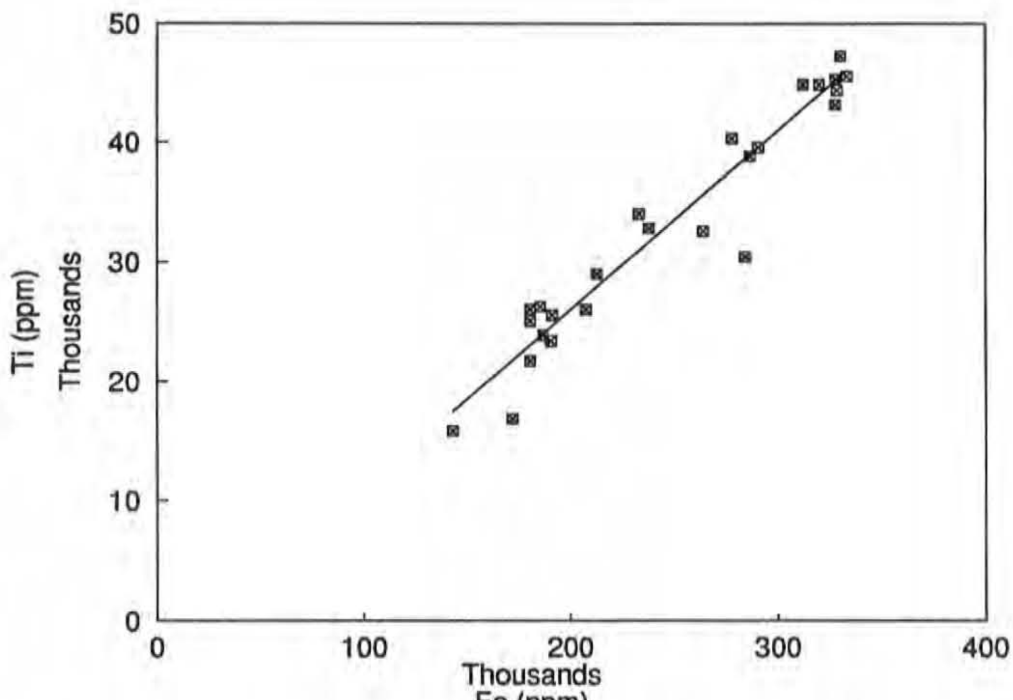

Figure 24: Location 3, trench in melagabbro and magnetite-bearing melagabbro. Plot of Ti vs Fe for 26 samples Y-intercept = -4004.65. X coefficient = 0.15.

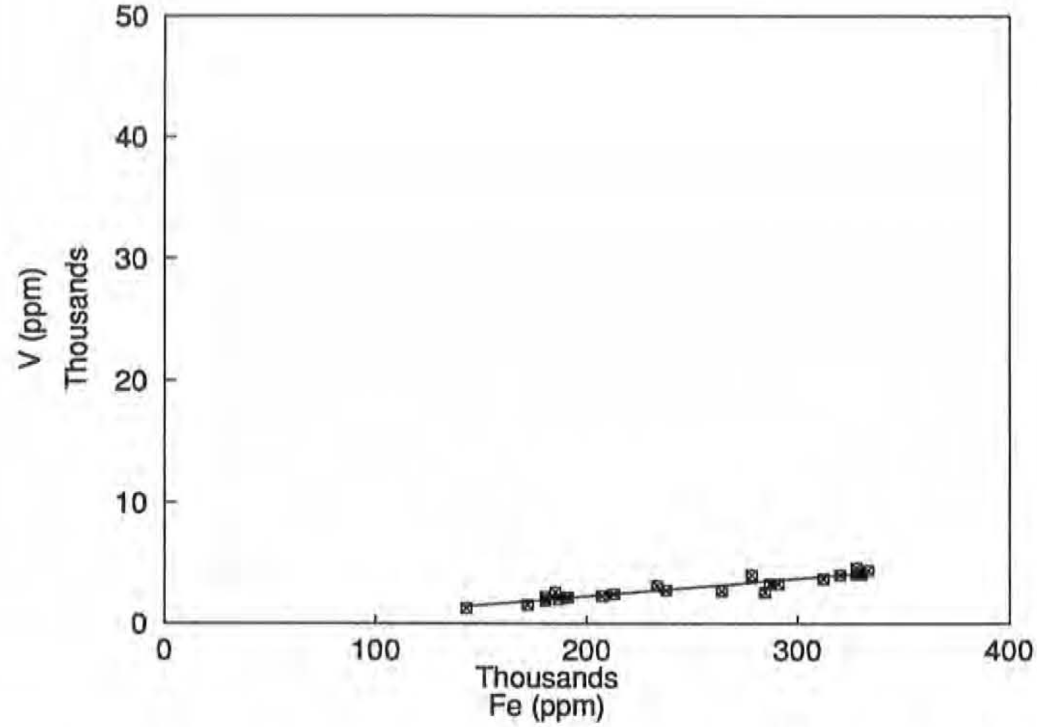

Figure 25: Location 3, trench in melagabbro and magnetite-bearing melagabbro. Plot of V vs Fe for 26 samples. Y-intercept = -685. X coefficient = 0.01.

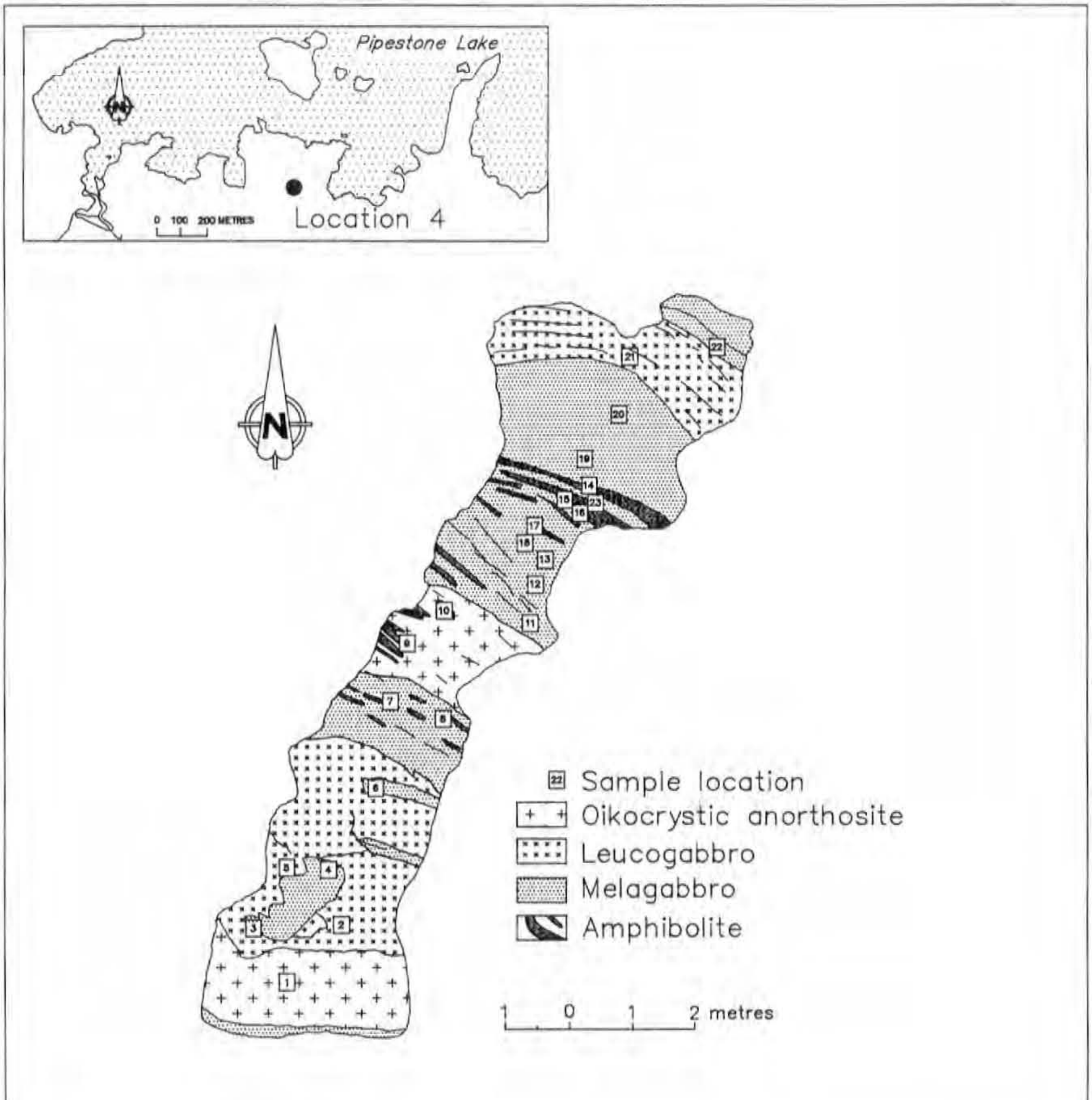

Figure 26: Location 4 (Trench 2). Outcrop map with sample locations.

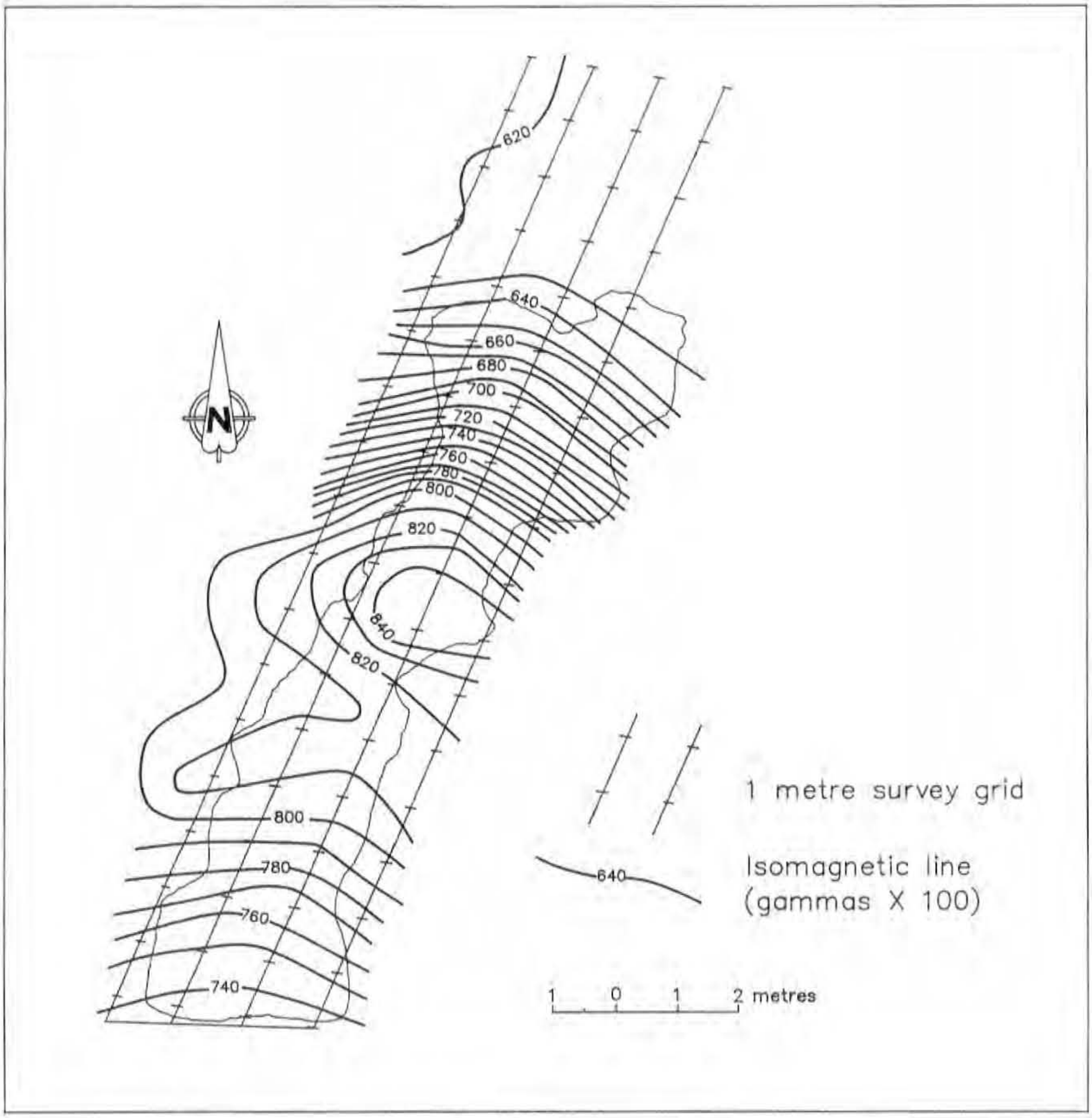

Figure 27: Location 4 (Trench 2). Magnetometer survey.

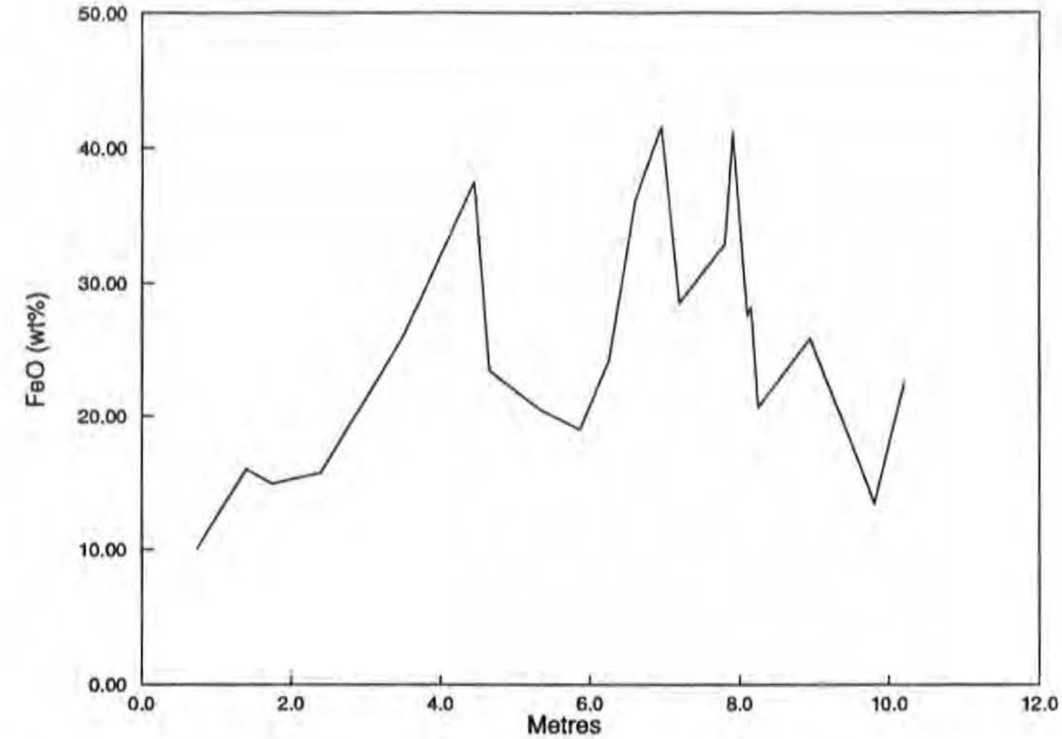

Figure 28: Location 4. Trench in layered gabbro that contains disseminated oxides. FeO values. Projection of samples 68-5-585-1 to 585-23.

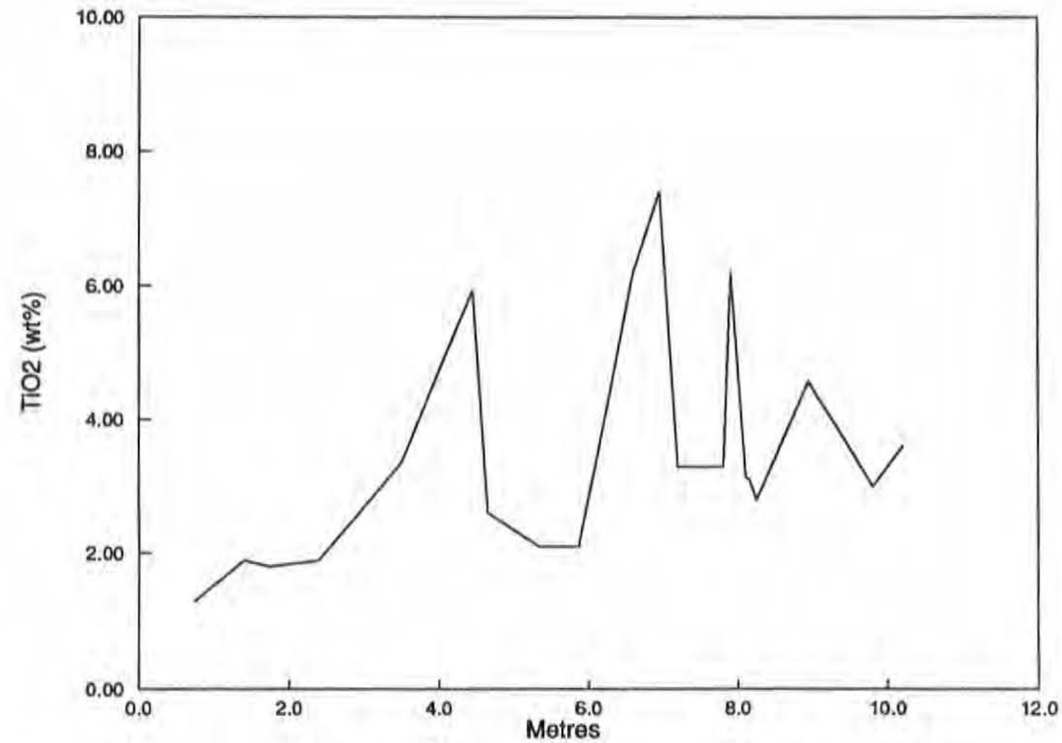

Figure 29: Location 4. Trench in layered gabbro that contains disseminated oxides. TiO_2 values; Projection of samples 68-5-585-1 to 585-23.

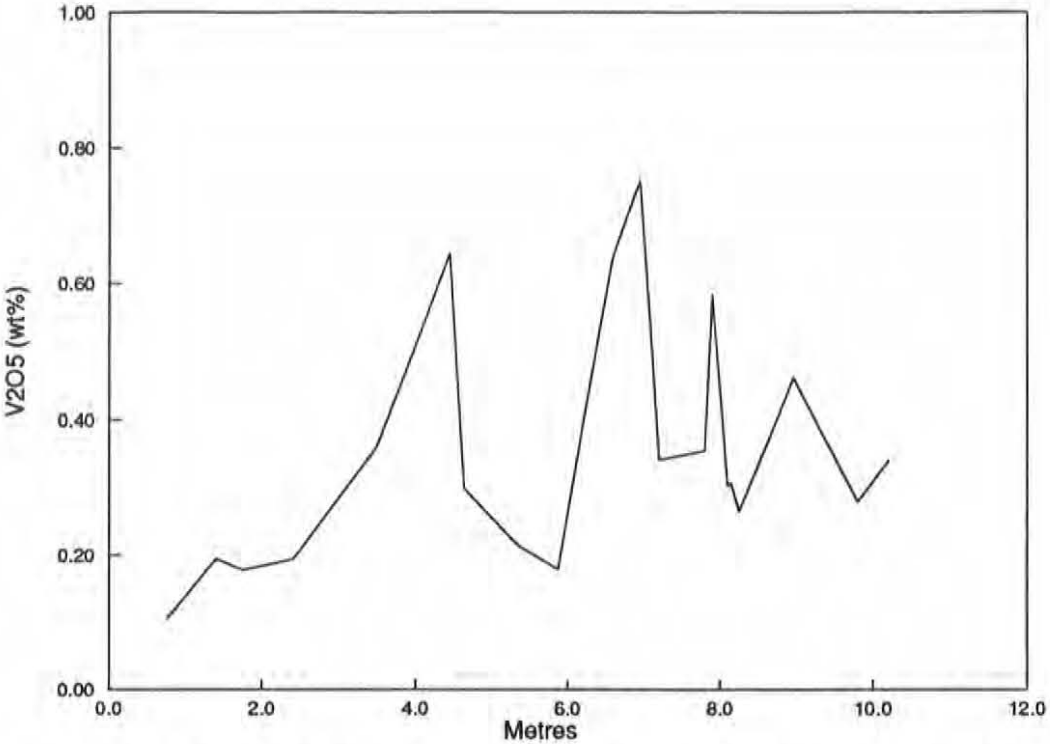

Figure 30: Location 4. Trench in layered gabbro that contains disseminated oxides. V_2O_5 values. Projection of samples 68-5-585-1 to 585-23.

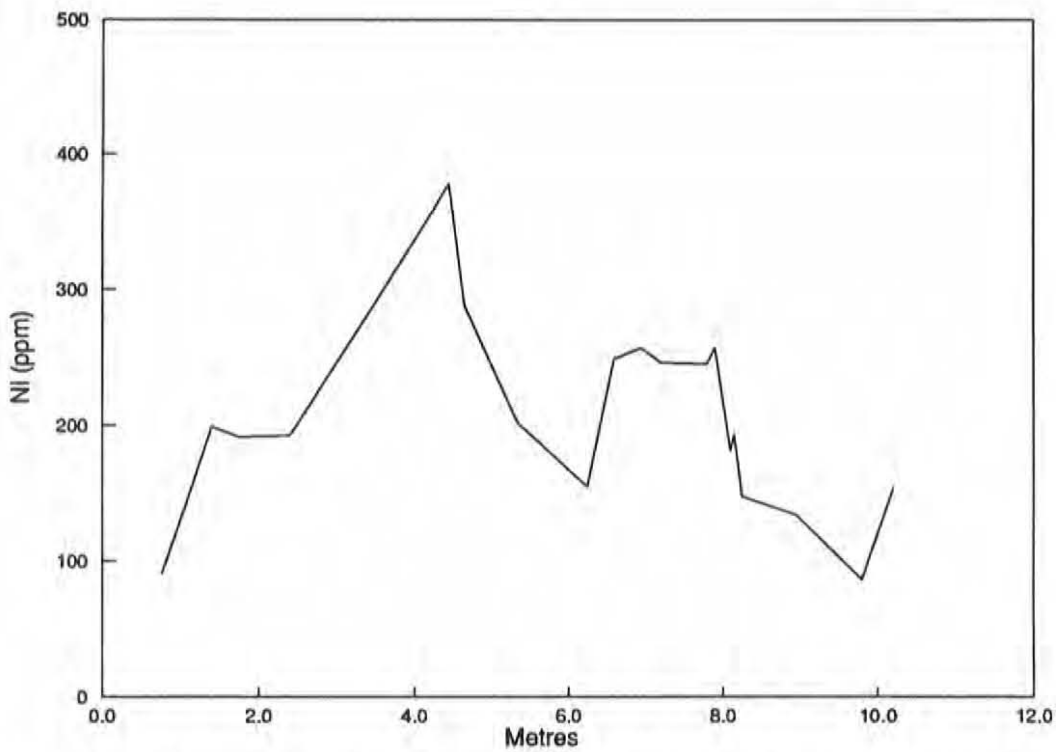

Figure 31: Location 4. Trench in layered gabbro that contains disseminated oxides. Ni values. Projection of samples 68-5-585-1 to 585-23.

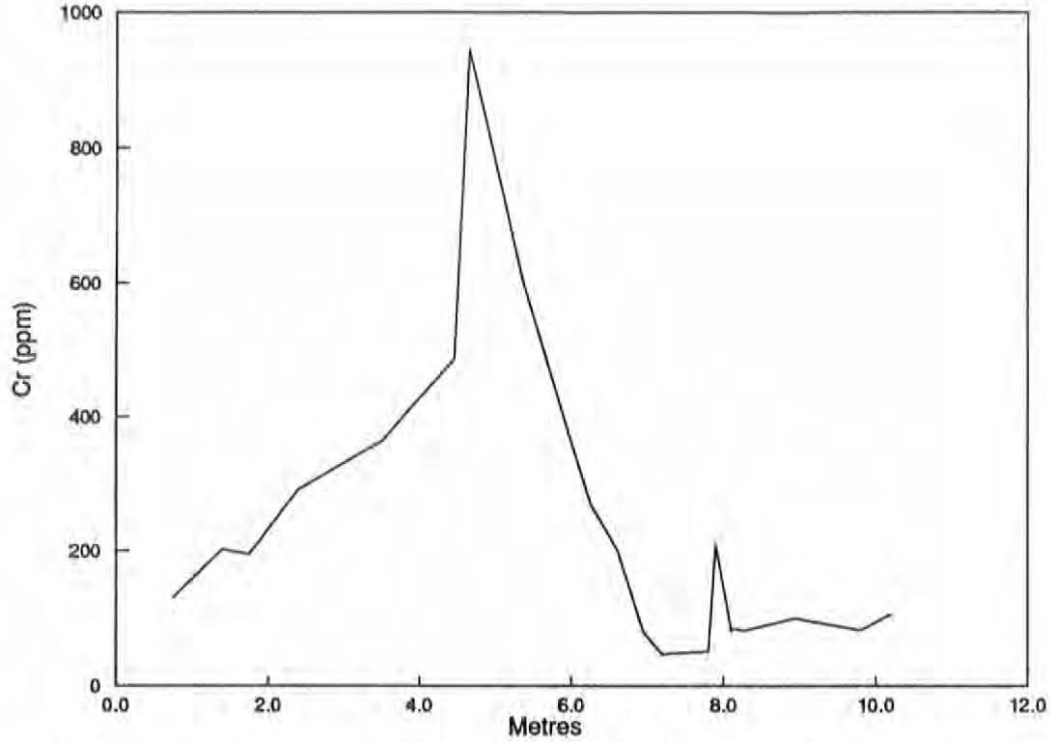

Figure 32: *Location 4. Trench in layered gabbro that contains disseminated oxides. Cr values. Projection of samples 68-5-585-1 to 585-23.*

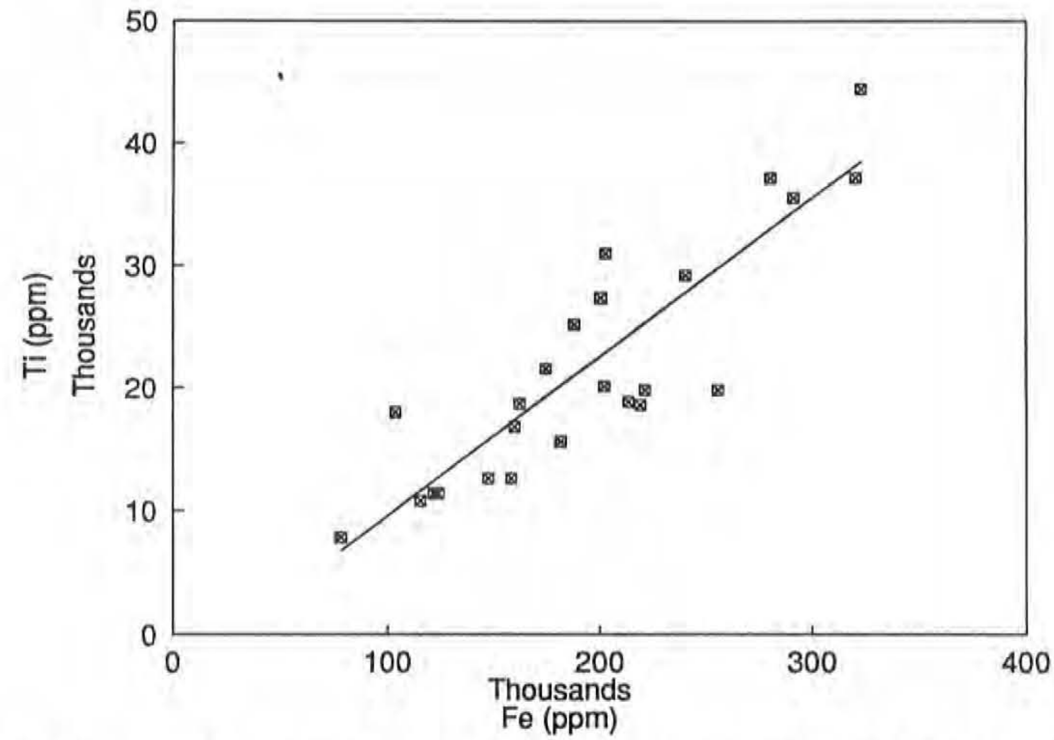

Figure 33: *Location 4, trench in melagabbro and magnetite-bearing melagabbro. Plot of Ti vs Fe for 24 samples. Y-intercept = -3468. X coefficient = 0.15.*

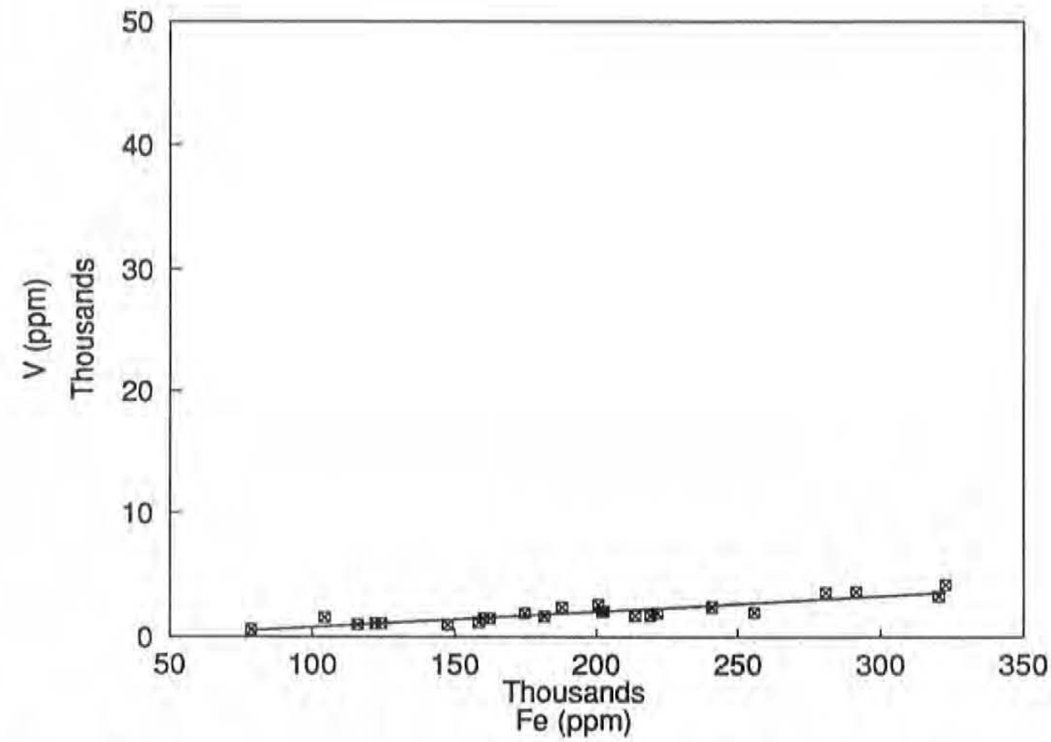

Figure 34: Location 4, trench in melagabbro and magnetite-bearing melagabbro. Plot of V vs Fe for 24 samples. Y-intercept = -476. X coefficient = 0.01.

OTHER OCCURRENCES OF OXIDE-RICH ROCKS IN THE PLAC

Magnetometer data and outcrops and trenches, previously described, indicate that the concentration of oxide-rich zones in the PLAC occur near the top of the PLAC. Twenty-eight samples of oxide-bearing gabbros from 22 other locations outside the study area, along the northern margin of the PLAC (Fig. 35), were analyzed for titanium, vanadium and total iron (Table 4) to check the lateral continuity of the oxide enrichment. Most contained disseminated magnetite and ilmenite. Few other occurrences of massive magnetite were noted. Values range from 13.10 to 63.97% total iron (as FeO) (average 24.17), 1.5 to 15.3% TiO_2 (average 4.94) and 0 to 1.10% V_2O_5 (average 0.22). Whole rock and trace element analyses for these rocks appear in Appendices B9 and B10. The wide distribution of these oxide-rich rocks, from Cross Lake to the east channel of the Nelson River, suggests that the titanium- and vanadium-rich layers are extensive. Because of the poor exposure a complete magnetometer survey would have to be carried out over the entire PLAC to confirm the continuity of the magnetite-bearing layers. Breaks in the linear highs on the existing survey (Fig. 36 and 37) indicate a certain degree of faulting and/or folding of the magnetite-bearing layers.

Table 4: Titanium, vanadium and iron values for oxide-bearing gabbros in the Pipestone Lake anorthosite complex

Sample number[1]:	Rock type	FeO%	TiO_2%	V (ppm)	V_2O_5%
8300-3A	magnetite-bearing melagabbro (Unit 5a)	24.44	4.20	1349	0.24
8300-2	mesogabbro (Unit 5d)	13.10	3.22	224	0.04
8301	magnetite-bearing mesogabbro (Unit 5a)	16.72	3.39	393	0.70
8103-1A	magnetite-bearing	36.05	11.79	3286	0.58
8103-1B	melagabbro (Unit 5a)	45.42	9.07	4893	0.87
8104-1A	ilmenite-bearing melagabbro (Unit 5b)	18.18	4.65	118	0.02
8138-2	ilmenite-bearing melagabbro (Unit 5b)	21.45	4.64	153	0.02
8140-1	ilmenite-bearing melagabbro (Unit 5b)	23.78	4.28	71	0.01
8141-2	ilmenite-bearing melagabbro (Unit 5b)	21.15	4.60	145	0.02
8147	ilmenite-bearing melagabbro (Unit 5b)	18.38	2.60	0	0.00
49	melagabbro (Unit 5)	20.40	4.96	230	0.04
8257	massive magnetite	19.03	1.50	835	0.15
	(Unit 6)	25.13	0.23	80	0.01
		20.70	2.72	995	0.18
74	melagabbro (Unit 5)	19.60	4.62	289	0.05
556	melagabbro (Unit 5)	22.90	3.27	1649	0.29
8258-2	magnetite-bearing melagabbro (Unit 5a)	63.97	15.30	6138	1.09
558	magnetite-bearing melagabbro (Unit 5a)	16.3	1.90	1054	0.19
81-3A	layered mesogabbro to melagabbro (Unit 5)	20.80	4.51	182	0.03
81-3B	layered mesogabbro (Unit 5d)	18.50	3.75	76	0.01
9-1	ilmenite-bearing melagabbro (Unit 5b)	22.80	4.90	596	0.10
600-20	ilmenite-bearing melagabbro (Unit 5b)	21.00	5.80	298	0.05

22-2	magnetite-bearing melagabbro (Unit 5a)	27.10	4.95	2510	0.44
92	magnetite-bearing melagabbro (Unit 5a)	42.40	7.86	4260	0.76
65-1B	melagabbro (Unit 5)	17.90	2.69	930	0.17
8165-1	leucogabbro to mesogabbro (Unit 4a)	16.91	4.47	131	0.02
8166	magnetite-bearing melagabbro (Unit 5a)	22.45	3.27	1673	0.30
583-1	magnetite-bearing melagabbro (Unit 5a)	20.60	4.15	641	0.11
582-1A	magnetite-bearing melagabbro (Unit 5a)	23.90	4.67	1977	0.35

1 Sample locations are shown in Figure 35.

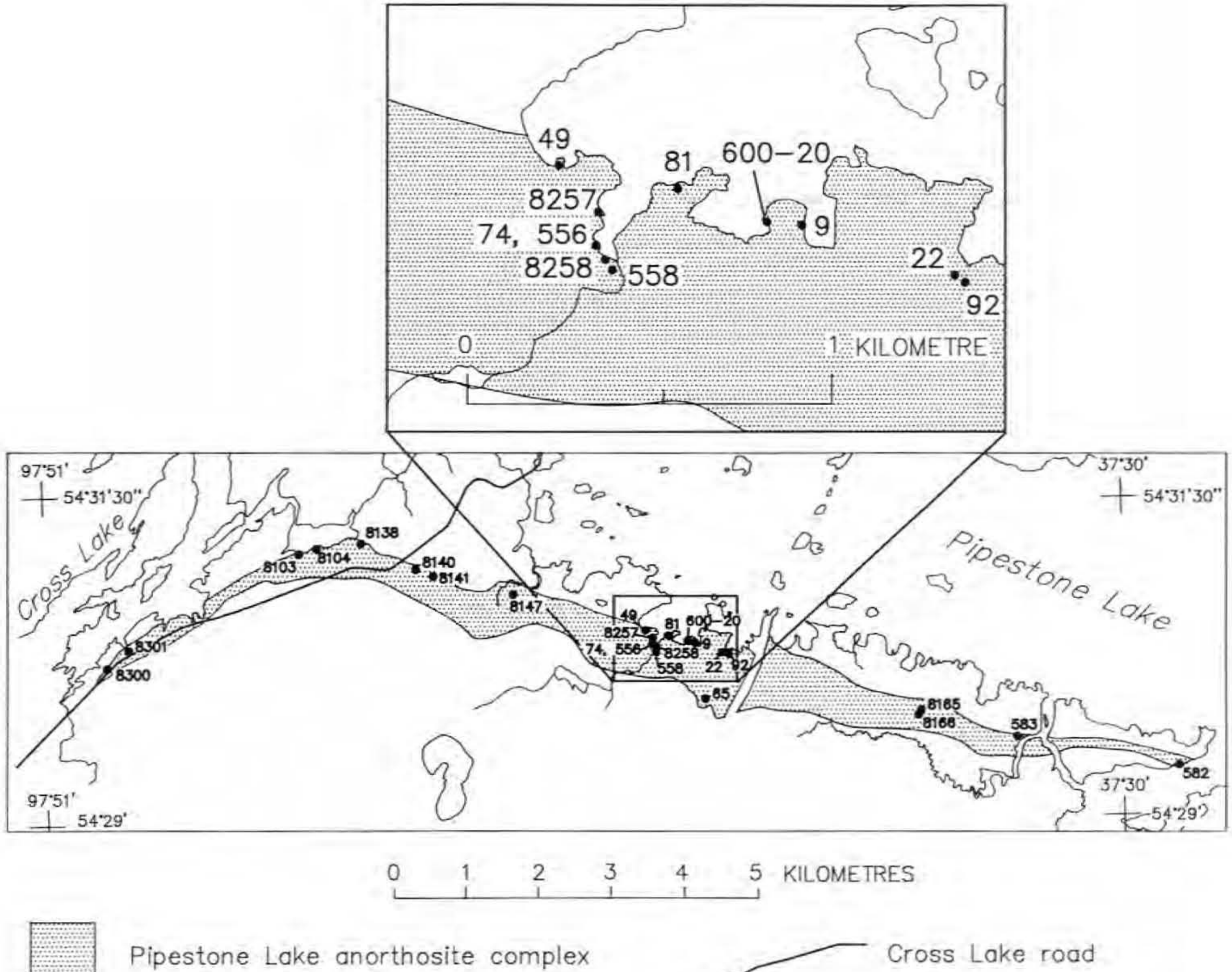

Figure 35: *Locations of other occurrences of magnetite-bearing rocks in the Pipestone Lake anorthosite complex.*

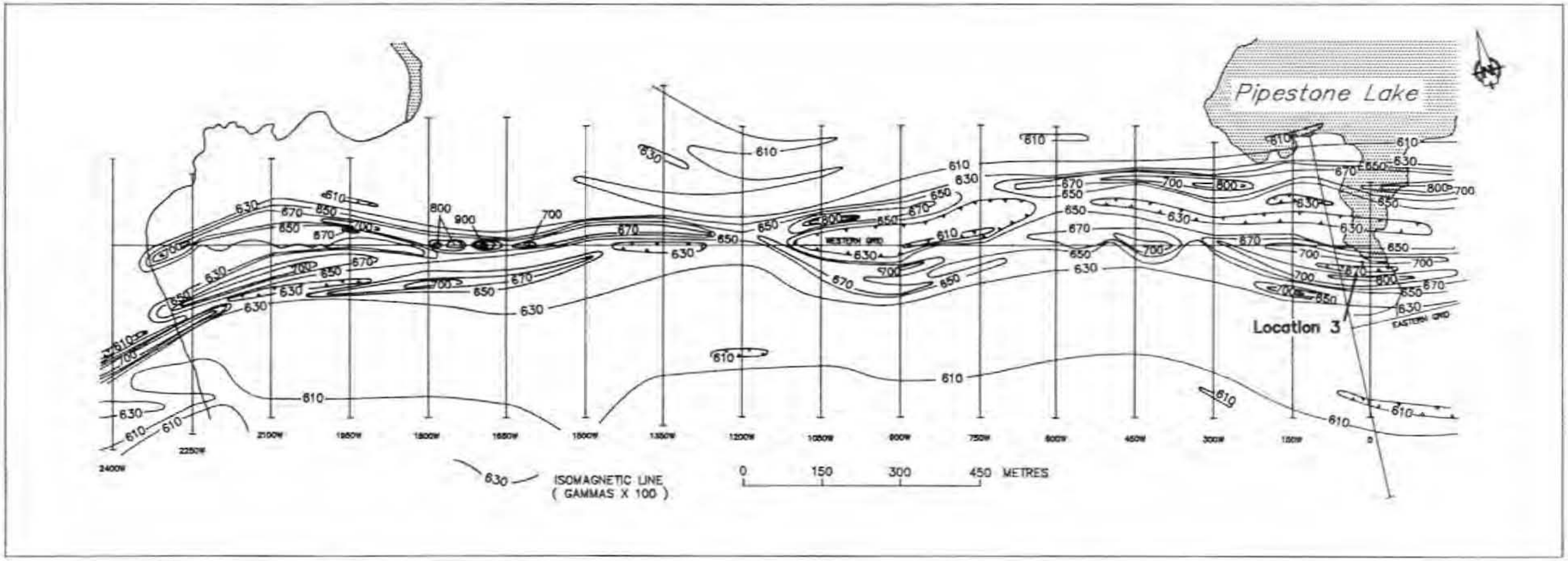

Figure 36: *Ground magnetometer survey of the project area (west half).*

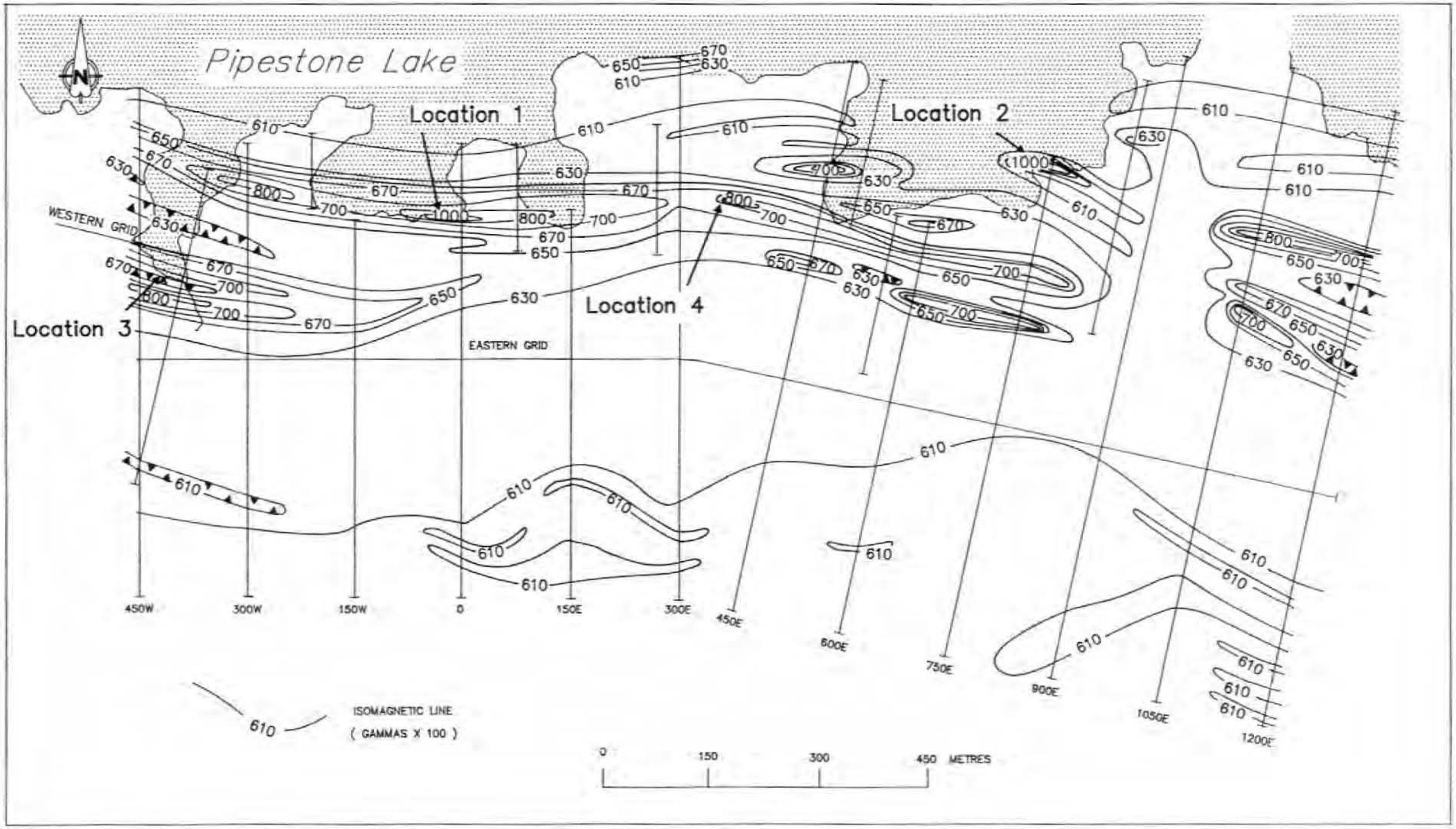

Figure 37: *Ground magnetometer survey of the project area (east half).*

MAGNETOMETER SURVEY

A Scintrex model MP2 proton precession magnetometer with a sensitivity of 1 gamma was used to conduct ground magnetometer surveys over the central part of the PLAC, south of Pipestone Lake. Readings were taken at 15 m intervals on the crosslines and the baseline and duplicate readings and times were recorded at 90 m intervals. Diurnal fluctuations ranged from 0 to 300 gammas. Total baseline length was 4050 m and crosslines 150 m apart extended 330 m south and 120 to 570 m north of the baseline.

The survey results (Fig. 36 and 37) show two discontinuous parallel positive anomalies, separated by a low, forming a broad saddle up to 260 m wide that straddles the western baseline. The southern band is 60 to 150 m across with peaks of 65 000 to 75 000 gammas and corresponds to the distribution of the magnetite-bearing melagabbro. The northern band is approximately 60 m wide with peak heights of 70 000 to over 100 000 gammas. Major peaks are 10 to 30 m wide. This zone is associated with the massive magnetite layers and magnetite-bearing leucogabbro. Profiles of the magnetometer data indicate that the units are nearly vertical or steeply dipping to the south.

Background readings over the unmineralized anorthosite to the south rise gradually from 60 000 to 63 000 gammas, over a distance of 300 m. North of the magnetic highs the readings drop rapidly back to below 61 000 gammas over 50 m.

A major peak of 90 000 gammas occurs between 1650W and 1800W on the western baseline. No bedrock is exposed in this area and diamond drilling would be required to obtain samples of the source of the anomaly.

In the eastern part of the grid, the high lies north of the baseline and is 150 to 300 m wide. Up to three magnetic bands lie within the zone. Toward the eastern end of the survey area a 100 m wide Molson diabase dyke has intruded the PLAC, truncating the magnetic highs.

CONCLUSIONS

Detailed mapping indicates that massive magnetite occurs in layers 1 to 3 metres thick, with exposed strike lengths of 55 to 84 meters. Leucogabbro is enriched in TiO_2 and V adjacent to the magnetite layers, giving an overall width of mineralization of approximately 15 metres.

Melagabbro and layered leuco- to melagabbro, containing disseminated magnetite and ilmenite are exposed in two 15 m long trenches. Other trenches, known to exist, could not be found.

Geochemical analyses show that massive magnetite layers contain 60 to 70% total iron (as FeO), 14 to 20% TiO_2 and 0.08 to 1.5% V_2O_5. Analyses of gabbro containing disseminated oxides give values of 13 to 58% total iron (as FeO), 4 to 15% TiO_2 and 0 to 0.8% V_2O_5.

Serial samples taken across the massive magnetite layers indicate that the variation in total iron content is generally less than 20%, 5% TiO_2 and 0.5% V_2O_5. Variations in the iron, titanium and vanadium values in magnetite-bearing melagabbro are similar.

Vanadium content is directly proportional to the iron values in all four of the detailed study areas with a constant V/Fe ratio of 0.01 (Fig. 14, 17, 25, and 34). Similarly the Ti/Fe ratios are constant at 0.15 for the disseminated magnetite-bearing occurrences. A higher Ti/Fe ratio (0.22) observed in the massive layers may be due to thin titanium-rich ilmenite layers in the massive magnetite. These ilmenite layers are indicated by the distinct increase of titanium with coincident decrease in vanadium on the Ti/Fe - V/Fe ratio graph (Fig. 12). As well, ilmenite layers are interpreted to cause the population of higher Ti/Fe ratios, in the most titanium-rich analyses, on Figures 13 and 16 and unidentified thin laminations of ilmenite may elevate the Ti/Fe ratios in these oxide layers.

Ilmenite, in most samples, is not magnetic. CANMET probe analysis indicate TiO_2 is concentrated in ilmenite and V_2O_5 in magnetite, with very little TiO_2 within the magnetite itself. It should therefore be possible to prepare separate titanium and vanadium concentrates by magnetic separation. Earlier tests by the Bureau of Energy and Mines (Jenkins, 1959,1960) for Noranda Mines Ltd. indicate that treatment of the oxides looked promising.

Magnetometer surveys indicate that the multiple layers and lenses of magnetite-rich units lie close to the northern contact of the PLAC. Highs of over 65 000 gammas are nearly continuous for over 4000 metres and continue past the eastern and western limits of the survey.

Sporadic outcrops of oxide-rich layers have been documented in 22 other locations along the PLAC. These, along with the magnetometer survey and magnetic anomalies encountered at numerous locations on the north flank of the PLAC, while mapping, indicate possible continuity over much the 17.4 km length of the PLAC. However, this needs to be proven with further exploration.

A complete magnetometer survey and intensive diamond drilling program would be necessary to verify the continuity of the oxide-rich rocks and to calculate a reasonable estimate the amount of titanium- and vanadium-rich rock present in the entire PLAC. In addition, beneficiation studies, trace element studies and microprobe work would have to be carried out to determine what grades of concentrates can be obtained and what incompatible elements, such as manganese and phosphorus, would affect production of titanium and vanadium.

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APPENDICES

Representative samples were collected for all other units in the PLAC. Three-hundred-eighty-seven rock samples were submitted to Manitoba Energy and Mines Analytical Laboratory for whole rock, and trace element analysis. Of these, 221 were submitted for whole rock and trace element analysis and 166 for trace element analysis only. Ninety-four were analyzed only for total iron (as FeO), titanium, vanadium, nickel and chrome. Analytical methods included colorimetric, atomic absorption and extraction fusion. No concentrates were prepared from the titanium- and vanadium-rich samples.

Eight selected samples were submitted to Nuclear Activation Services for analysis for platinum, palladium and gold, using DC plasma. Detection limits for Au were 2 ppb; Pt, 10 ppb; and Pd, 2 ppb. All returned values below detection limits for Pt and Pd, 5 were below detection limits for Au and 3 gave values between 11 and 46 ppb Au.

Appendix A presents the whole rock and trace element analyses for major units in the PLAC. Sample locations for each table are shown in Figures 38 to 50.

Appendix B contains the analyses for each of the four locations described previously. For Locations 1 and 2, analyses of chip samples (Appendices B1 and B4, respectively) are followed by whole rock and trace element analyses of major units (B2 and B5) and analyses of serial samples taken across each of the oxide-rich layers (B3 and B6). The latter analyses of individual layers are followed by cross-strike plots of iron, titanium, vanadium, nickel and chrome values for each layer.

For Locations 3 and 4, whole rock analyses (B7 and B10) precede tables which summarize FeO, TiO_2, V_2O_5, Ni and Cr values down the length of the trenches (B8 and B11). Plots of these values appear in Figures 19 to 23 and 28 to 32.

Continuous sets of samples were taken across all massive magnetite layers at Locations 1 and 2. These were analyzed at intervals determined by the overall length of sample and the thickness of the layer. The results were plotted to produce profiles of titanium, vanadium, iron, nickel and chrome values across each layer (Fig. 51 to 72). The analyses appear in Appendices B3 and B6.

In addition, specific gravities were measured for representative samples of the massive magnetite and the gabbros (Appendix C).

Appendix A - Tables of whole rock and trace element geochemical analyses of major units:

A1. Pipestone Lake Group volcanic and sedimentary rocks (Unit 1)

Sample[1]	87-1	113-8A	541-1B	541-2B	555	8320	8145-2	8192-B
SiO_2	34.10	31.30	39.70	32.10	30.70	65.00	58.40	61.90
Al_2O_3	4.60	4.00	6.00	4.50	4.70	12.88	12.60	18.00
Fe_2O_3	3.06	1.49	3.55	2.30	2.60	1.13	4.03	0.97
FeO	9.08	8.82	10.30	8.43	10.30	11.39	11.16	2.96
CaO	23.22	26.62	18.02	15.37	25.90	0.80	5.51	3.91
MgO	6.43	6.36	6.93	10.65	7.16	4.17	2.61	2.17
Na_2O	1.21	0.33	1.88	0.15	0.48	0.46	1.45	3.83
K2O	0.20	0.08	0.12	1.30	0.06	0.47	0.19	3.87
TiO_2	1.21	1.18	1.57	1.15	1.38	1.22	1.37	0.75
P_2O_5	0.10	0.09	0.14	0.09	0.12	0.29	0.52	0.29
MnO	0.41	0.44	0.43	0.25	0.39	0.31	0.34	0.05
H_2O	1.31	1.72	1.44	2.05	1.61	1.20	1.07	0.94
S	0.02	0.04	0.05	0.05	0.03	0.03	0.16	0.10
CO_2	14.42	16.87	9.75	20.20	14.95	0.09	0.23	0.17
Other	0.33	0.40	0.40	0.31	0.51	0.04	0.04	0.32
O=S	-0.01	-0.02	-0.02	-0.02	-0.01	-0.01	-0.06	-0.04
Total	99.69	99.72	100.26	98.88	100.88	99.47	99.62	100.19
Ni (ppm)	669	768	782	687	768	0	0	61
Cr	919	1513	1173	826	2100	0	0	187
Cu	236	151	298	214	167	20	33	54
Zn	118	104	133	91	81	141	231	122
Pb	0	0	0	0	41	0	0	30
Rb	15	0	5	8	0	17	0	189
Sr	144	53	105	50	70	7	47	822
Ba	159	96	211	111	130	72	27	1054
Li	12	13	14	27	14	26	12	55
Be	2	2	3	0	0	3	0	3
V	183	187	242	185	252	0	0	100
FeO (T)	11.83	10.16	13.49	10.50	12.64	12.41	14.79	3.83
TiO_2	1.21	1.18	1.57	1.15	1.38	1.22	1.37	0.75
V2O5	0.03	0.03	0.04	0.03	0.04	0.00	0.00	0.02

1 Sample locations are shown in Fig. 38. Sample 87-1, 113-8A, 541-1B, 541-2B, 555, mafic conglomerate in basalt, south shore Pipestone Lake; 8320, garnetite on anorthosite-basalt contact, Cross Lake road; 8145-2, garnet-hornblende greywacke, in basalt, north of the Cross Lake road; 8192-B, garnet-hornblende greywacke, Minago River.

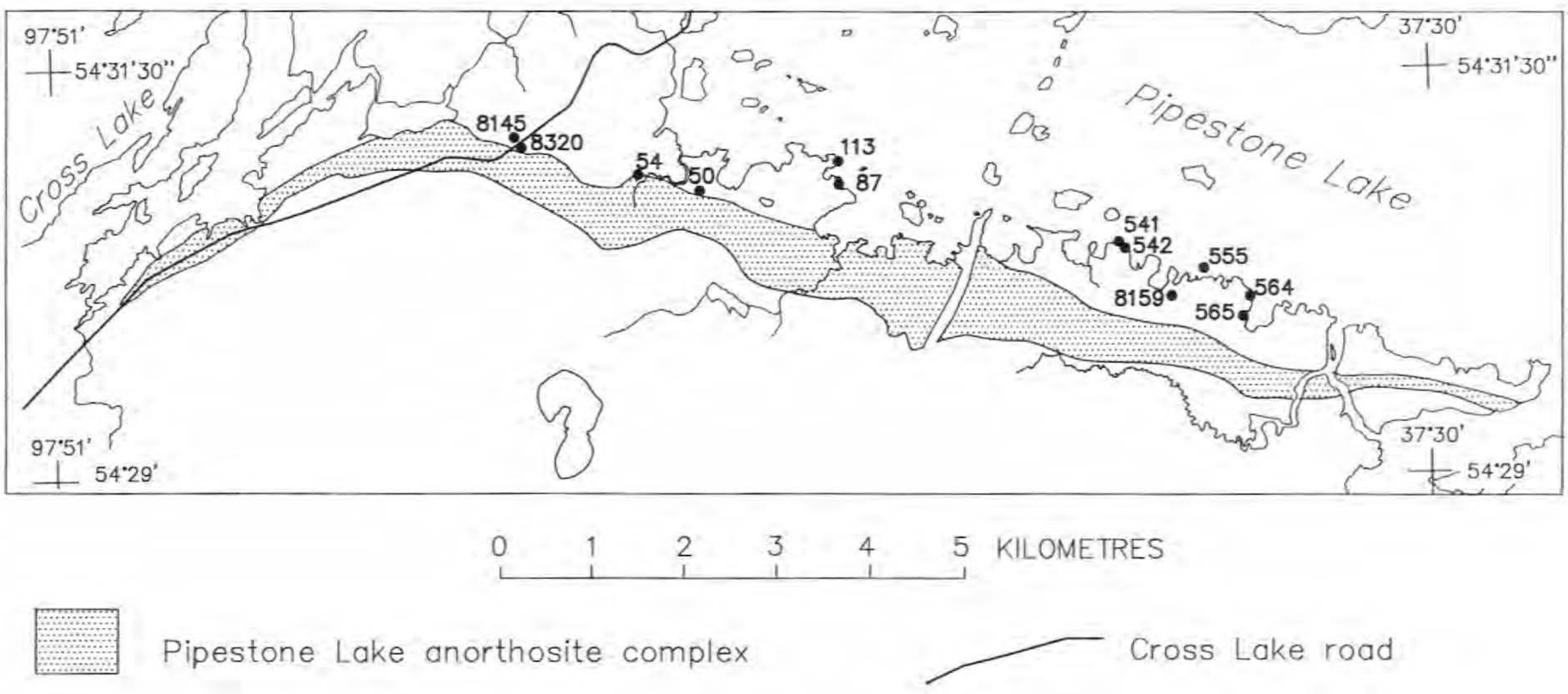

Figure 38: *Sample locations for geochemical analyses shown in Appendix A1.*

Metavolcanic rocks, massive flows/gabbros (Unit 1):

Sample[1]	50	565-2	8159	542-2	564-2	54
SiO_2	47.80	48.90	49.00	48.40	44.20	67.10
Al_2O_3	15.20	15.00	14.14	14.40	17.20	11.65
Fe_2O_3	2.46	3.40	2.79	3.60	1.20	3.81
FeO	10.79	10.30	11.08	9.50	7.00	6.77
CaO	11.31	10.42	8.76	7.66	10.73	3.91
MgO	4.36	5.47	6.92	7.50	12.38	0.37
Na_2O	2.44	2.30	2.48	4.54	1.03	3.96
K2O	0.36	0.36	0.18	0.21	0.29	0.35
TiO_2	3.62	1.39	1.60	0.56	0.20	0.62
P_2O_5	0.26	0.11	0.15	0.04	0.01	0.35
MnO	0.19	0.21	0.18	0.23	0.14	0.05
H_2O	1.19	1.54	1.79	2.52	4.01	0.47
S	0.02	0.07	0.03	0.01	0.00	0.00
CO_2	0.56	0.07	0.42	1.18	0.16	0.11
Other	0.07	0.13	0.16	0.20	0.14	0.05
O=S	-0.01	-0.03	-0.01	0.00	0.00	0.00
Total	100.62	99.64	99.67	100.55	98.69	99.57
Ni (ppm)	0	69	36	92	276	6
Cr	0	184	149	88	327	0
Cu	26	45	106	150	25	35
Zn	119	108	114	100	61	44
Pb	0	0	38	32	29	8
Rb	10	5	10	12	0	3
Sr	125	113	122	318	85	76
Ba	248	98	125	444	90	164
Li	28	11	22	21	35	10
Be	2	0	2	2	2	4
V	0	422	230	246	64	0
FeO (T)	13.00	13.36	13.59	12.74	8.08	10.20
TiO_2	3.62	1.39	1.60	0.56	0.20	0.62
V2O5	0.00	0.04	0.08	0.04	0.01	0.00

1 Sample 50, basalt; 565-2, feldspar phyric basalt (Unit 1a); 8159, massive basalt, east Pipestone; 542-2, gabbro dyke in mafic conglomerate; 564-2, gabbro in basalt; 54, felsic volcanic rock.

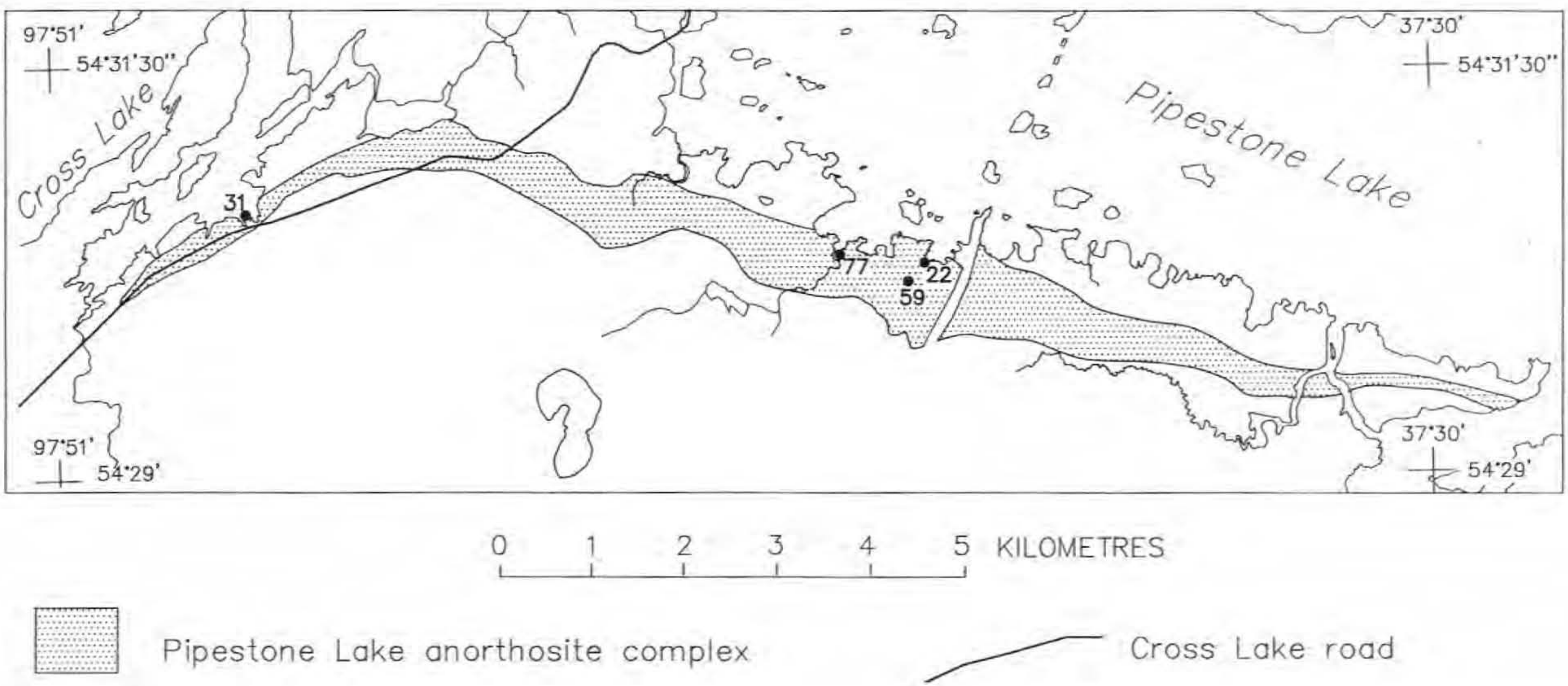

Figure 39: *Sample locations for geochemical analyses shown in Appendix A2.*

A2. Ultramafic rocks (Unit 2):

Sample[1]	22-4	22-5	31-3	59-2	77	117A
SiO_2	33.30	38.60	40.80	44.50	44.30	39.60
Al_2O_3	15.50	25.10	5.51	13.59	7.40	4.40
Fe_2O_3	9.74	9.35	12.27	2.42	4.98	8.16
FeO	16.14	8.99	11.86	11.92	8.86	3.88
CaO	8.12	10.84	4.33	10.00	8.09	3.94
MgO	10.15	1.33	19.74	13.20	19.95	29.28
Na_2O	1.03	2.17	0.45	1.16	0.46	0.07
K2O	0.20	0.30	0.10	0.17	0.07	0.01
TiO_2	2.79	2.95	0.25	0.35	1.04	0.28
P_2O_5	0.01	0.01	0.07	0.01	0.09	0.02
MnO	0.19	0.10	0.23	0.24	0.21	0.14
H_2O	3.28	0.54	3.59	2.51	4.13	9.05
S	0.06	0.01	0.00	0.00	0.02	0.02
CO_2	0.14	0.10	0.43	0.12	0.27	0.18
Other	0.46	0.69	0.11	0.18	0.11	0.99
O=S	-0.02	0.00	0.00	0.00	-0.01	-0.01
Total	101.09	101.08	99.74	100.37	99.97	100.01
Ni (ppm)	274	109	335	198	887	1548
Cr	577	1837	13	300	2210	5220
Cu	64	18	16	18	127	35
Zn	146	83	142	115	127	83
Pb	0	0	0	0	40	0
Rb	2	10	2	3	0	0
Sr	11	142	9	14	4	0
Ba	154	310	129	439	3	21
Li	9	9	9	7	5	11
Be	4	5	1	1	0	0
V	1572	1865	42	178	314	118
FeO (T)	24.90	17.40	22.90	14.10	13.34	11.22
TiO_2	2.79	2.95	0.25	0.35	1.04	0.28
V2O5	0.28	0.33	0.01	0.03	0.06	0.02

1 Sample locations are shown in Figure 39.

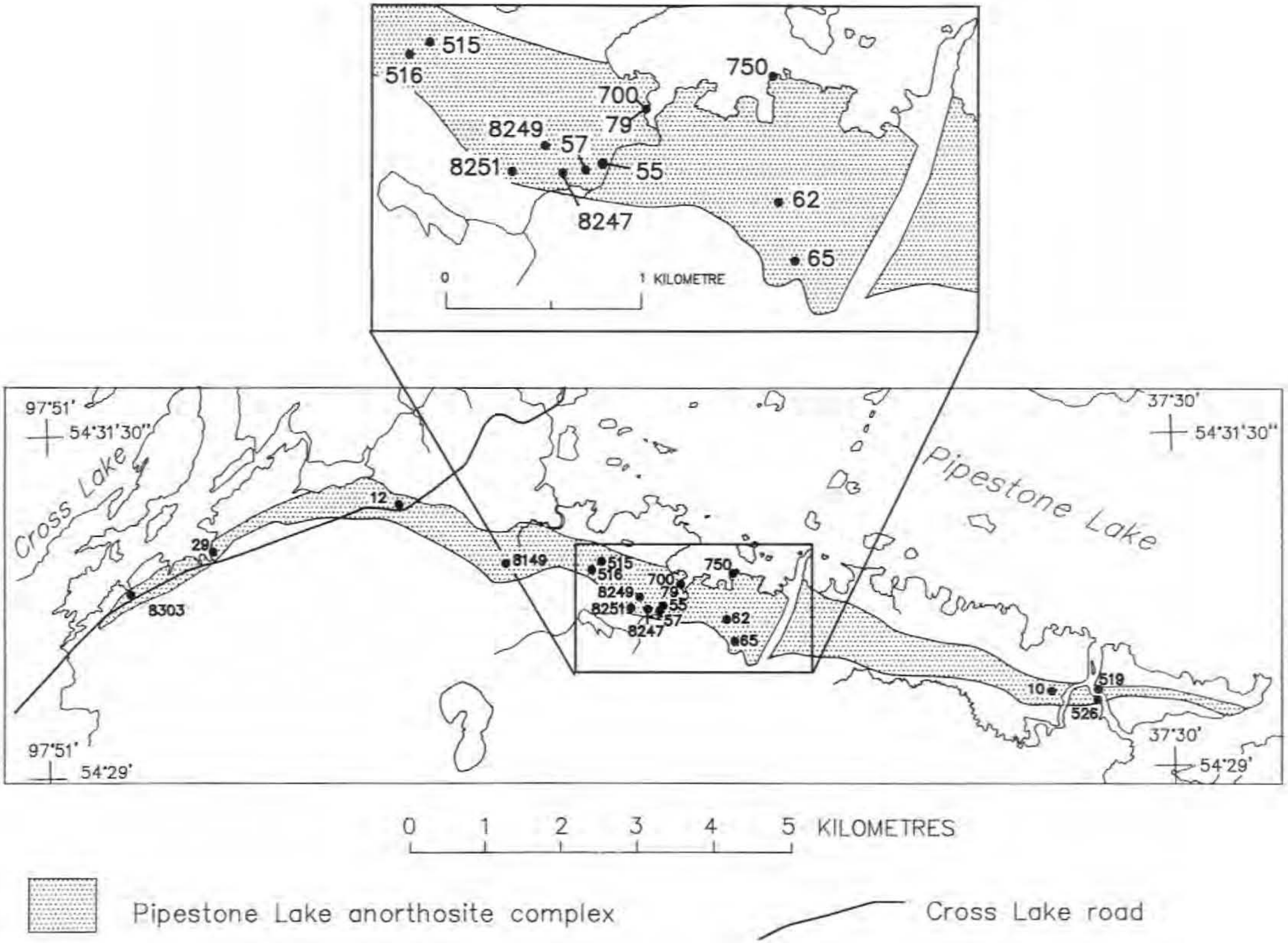

Figure 40: *Sample locations for geochemical analyses shown in Appendix A3.*

A3. Megacrystic anorthosite (Unit 3a):

Sample[1]	10	12-1	29-1D	55	57	62	65-1A
SiO_2	49.10	47.90	45.70	47.70	48.30	49.20	46.70
Al_2O_3	30.30	23.30	26.50	27.80	25.90	25.00	23.10
Fe_2O_3	0.24	1.11	1.81	1.10	1.21	1.61	1.64
FeO	1.35	4.25	6.64	2.85	4.36	4.45	6.51
CaO	14.09	13.52	11.91	13.77	13.47	11.29	12.80
MgO	1.36	5.83	1.98	2.31	3.16	3.74	5.01
Na_2O	2.50	1.56	2.58	2.39	2.26	3.46	2.02
K2O	0.75	0.52	0.56	0.44	0.31	0.44	0.61
TiO_2	0.09	0.20	1.18	0.33	0.63	0.32	0.68
P_2O_5	0.03	0.01	0.01	0.03	0.01	0.01	0.01
MnO	0.03	0.10	0.10	0.06	0.08	0.09	0.14
H_2O	0.86	1.51	1.05	0.76	0.58	1.52	1.44
S	0.01	0.01	0.07	0.00	0.00	0.03	0.05
CO_2	0.22	0.09	0.09	0.21	0.14	0.17	0.24
Other	0.04	0.17	0.39	0.11	0.14	0.12	0.16
O=S	0.00	0.00	-0.03	0.00	0.00	-0.01	-0.02
Total	100.97	100.08	100.54	99.86	100.55	101.44	101.09
Ni (ppm)	28	94	79	23	42	39	73
Cr	77	343	990	6	90	33	166
Cu	16	65	209	24	14	42	85
Zn	18	53	111	45	50	49	83
Pb	6	0	0	3	0	0	0
Rb	18	8	9	5	4	11	10
Sr	164	151	173	187	150	146	141
Ba	40	386	294	421	380	385	340
Li	13	51	44	15	10	14	30
Be	0	4	5	5	4	5	4
V	34	99	687	111	249	162	222
FeO (T)	1.57	5.25	8.27	3.84	5.45	5.90	7.99
TiO_2	0.09	0.20	1.18	0.33	0.63	0.32	0.68
V2O5	0.01	0.02	0.12	0.02	0.04	0.03	0.04

1 Sample locations are shown in Figure 40.

Megacrystic anorthosite (Unit 3a):

Sample	515C	516A	519-3	700-A	79	750-E
SiO_2	49.30	46.80	48.30	46.90	49.00	47.00
Al_2O_3	21.70	20.50	22.00	27.10	28.00	23.20
Fe_2O_3	1.80	1.90	1.70	1.10	0.93	1.80
FeO	4.70	5.80	6.50	2.90	2.89	5.70
CaO	12.56	11.25	10.14	11.51	13.37	12.83
MgO	4.08	4.87	3.87	2.59	1.64	3.33
Na_2O	2.61	2.63	3.28	3.09	2.76	2.34
K2O	0.30	0.33	0.43	0.95	0.40	0.36
TiO_2	0.36	0.94	0.95	0.19	0.30	0.41
P_2O_5	0.04	0.01	0.10	0.02	0.01	0.01
MnO	0.09	0.12	0.17	0.05	0.05	0.08
H_2O	1.34	2.39	1.27	1.75	0.72	0.92
S	0.01	0.05	0.02	0.00	0.00	0.00
CO_2	0.15	0.51	0.41	0.40	0.34	0.16
Other	0.11	0.15	0.12	0.08	0.05	0.07
O=S	0.00	-0.02	-0.01	0.00	0.00	0.00
Total	99.15	98.23	99.25	98.63	100.46	98.21
Ni (ppm)	31	35	21	0	0	11
Cr	103	94	139	33	0	31
Cu	17	111	16	10	7	7
Zn	48	52	137	33	36	59
Pb	44	42	50	37	9	29
Rb	9	14	12	7	8	0
Sr	167	139	98	201	141	157
Ba	75	145	75	99	43	55
Li	17	26	21	26	16	25
Be	3	3	3	5	0	3
V	228	358	246	107	76	112
FeO (T)	6.32	7.51	8.03	3.89	3.73	7.32
TiO_2	0.36	0.94	0.95	0.19	0.30	0.41
V2O5	0.04	0.06	0.04	0.02	0.01	0.02

Megacrystic anorthosite (Unit 3a):

Sample	8149-1A	8247	8251-1B	8303
SiO_2	48.10	47.60	47.80	48.60
Al_2O_3	28.69	24.20	24.50	27.31
Fe_2O_3	1.36	1.31	1.54	0.82
FeO	1.51	4.39	4.55	2.21
CaO	13.13	13.68	13.10	12.92
MgO	1.47	3.52	3.92	2.54
Na_2O	2.91	2.21	2.53	2.53
K2O	1.38	0.57	0.42	0.67
TiO_2	0.13	0.37	0.60	0.22
P_2O_5	0.02	0.00	0.01	0.07
MnO	0.05	0.09	0.10	0.03
H_2O	1.88	1.25	1.07	1.28
S	0.00	0.00	0.01	0.00
CO_2	0.10	0.34	0.15	0.69
Other	0.10	0.09	0.10	0.08
O=S	0.00	0.00	0.00	0.00
Total	100.83	99.62	100.40	99.97
Ni (ppm)	33	25	40	71
Cr	14	189	41	28
Cu	34	10	30	10
Zn	26	49	58	28
Pb	0	15	0	0
Rb	35	13	11	23
Sr	240	160	185	248
Ba	290	52	67	177
Li	29	17	14	27
Be	0	0	7	0
V	62	194	229	0
FeO (T)	2.73	5.57	5.94	2.95
TiO_2	0.13	0.37	0.60	0.22
V2O5	0.01	0.03	0.04	0.00

Sulphide-bearing megacrystic anorthosite (Unit 3a):

Sample	526-1	8249	8249-E	8249-F1	8249-F2
SiO_2	50.10	45.40	48.00	47.00	48.70
Al_2O_3	28.90	25.60	20.90	27.00	30.20
Fe_2O_3	0.54	2.28	2.29	2.12	0.66
FeO	0.71	5.39	5.51	3.14	1.02
CaO	12.89	14.09	13.79	14.03	13.12
MgO	0.92	2.64	5.43	1.99	0.89
Na_2O	2.34	1.81	1.40	2.21	2.84
K2O	1.46	0.40	0.29	0.44	1.16
TiO_2	0.10	0.37	0.40	0.10	0.29
P_2O_5	0.02	0.00	0.01	0.02	0.01
MnO	0.02	0.09	0.10	0.06	0.03
H_2O	1.59	1.46	1.55	1.27	1.14
S	0.05	0.17	0.19	0.11	0.00
CO_2	0.39	0.17	0.25	0.29	0.39
Other	0.06	0.11	0.17	0.16	0.05
O=S	-0.02	-0.07	-0.08	-0.04	0.00
Total	100.07	99.91	100.20	99.90	100.50
Ni (ppm)	15	39	53	17	8
Cr	8	18	177	16	0
Cu	31	208	434	662	7
Zn	26	52	73	50	19
Pb	0	0	0	0	17
Rb	53	9	6	8	42
Sr	206	144	120	189	215
Ba	114	30	63	68	91
Li	27	21	26	31	21
Be	6	0	5	7	0
V	0	358	235	148	71
FeO (T)	1.20	7.44	7.57	5.05	1.61
TiO_2	0.10	0.37	0.40	0.10	0.29
V2O5	0.00	0.06	0.04	0.03	0.01

A4. Massive anorthosite (Unit 3a):

Sample[1]	12-2B	35	44	45	51	52	80
SiO_2	49.90	48.80	48.30	49.90	50.30	50.30	55.00
Al_2O_3	30.60	28.40	27.10	25.00	28.60	29.10	26.60
Fe_2O_3	0.44	1.12	1.62	1.11	0.90	0.56	0.13
FeO	0.54	1.92	2.58	2.30	2.23	1.50	1.74
CaO	13.51	12.56	13.54	14.60	11.74	11.29	8.47
MgO	0.41	1.55	1.66	3.19	0.81	1.25	0.63
Na_2O	2.90	2.66	2.82	2.47	3.83	3.67	5.48
K2O	0.65	0.59	0.41	0.25	0.67	0.97	0.69
TiO_2	0.08	0.28	0.82	0.24	0.23	0.34	0.21
P_2O_5	0.03	0.02	0.03	0.01	0.01	0.05	0.01
MnO	0.03	0.03	0.06	0.07	0.03	0.02	0.02
H_2O	0.61	1.67	1.04	0.63	0.91	1.38	0.74
S	0.00	0.06	0.02	0.01	0.01	0.02	0.00
CO_2	0.14	0.07	0.14	0.12	0.16	0.18	0.37
Other	0.04	0.09	0.13	0.12	0.12	0.09	0.04
O=S	0.00	-0.02	-0.01	0.00	0.00	-0.01	0.00
Total	99.88	99.80	100.26	100.02	100.55	100.71	100.13
Ni (ppm)	0	18	25	30	8	13	0
Cr	0	33	31	179	56	12	0
Cu	24	108	54	32	44	15	5
Zn	10	45	38	33	24	17	23
Pb	0	7	10	0	0	0	0
Rb	48	7	7	4	6	19	12
Sr	148	167	150	134	177	178	190
Ba	43	220	429	385	465	351	76
Li	12	20	9	8	33	39	18
Be	0	6	7	4	5	6	0
V	19	42	219	100	125	61	15
FeO (T)	0.94	2.93	4.04	3.30	3.04	2.00	1.86
TiO_2	0.08	0.28	0.82	0.24	0.23	0.34	0.21
V2O5	0.00	0.01	0.04	0.02	0.02	0.01	0.00

1 Sample locations are shown in Figure 41.

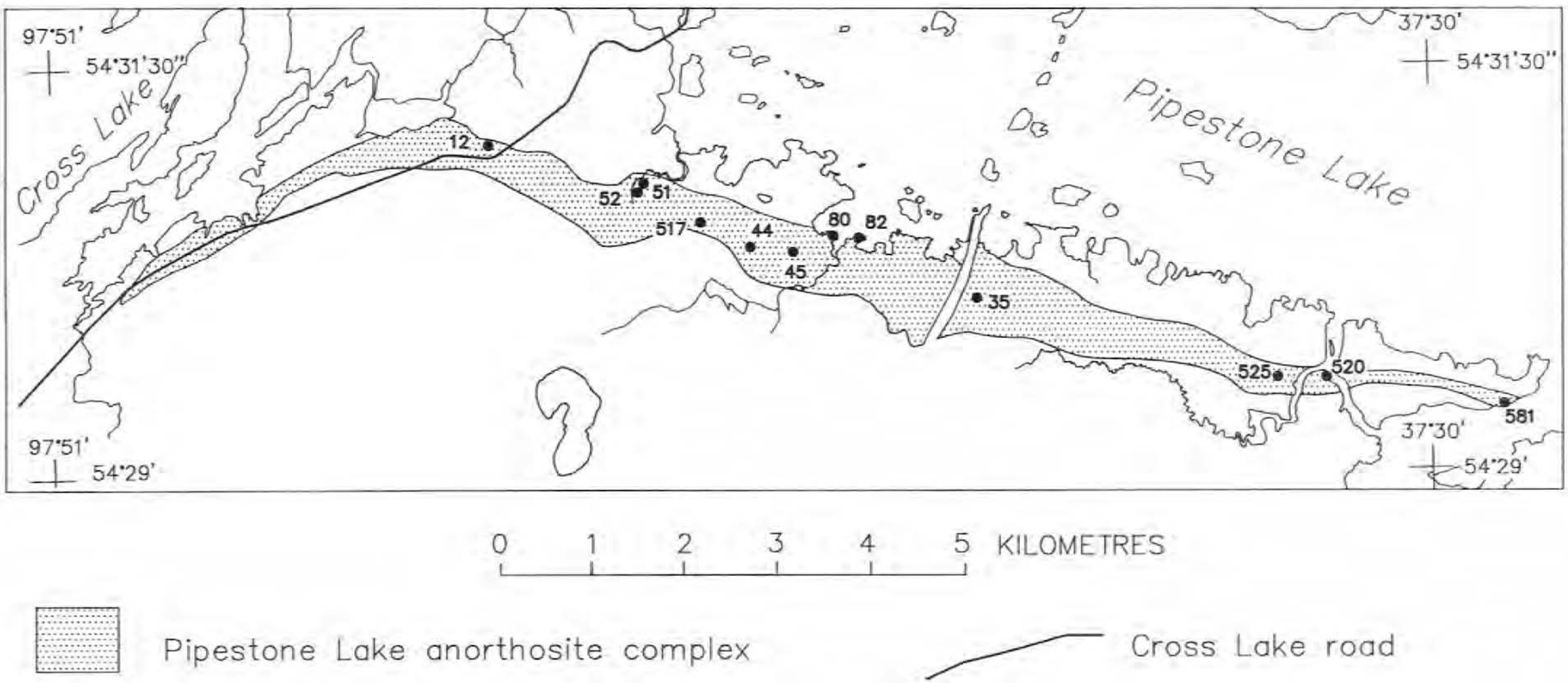

Figure 41: *Sample locations for geochemical analyses shown in Appendix A4.*

Massive anorthosite (Unit 3a):

Sample[2]	82-1	517-2	525	581-1	8330-1A	520-2A	520-2B
SiO_2	58.10	50.00	45.50	48.60	47.20	40.10	40.40
Al_2O_3	23.70	28.70	28.20	25.10	27.47	16.20	15.70
Fe_2O_3	0.51	0.10	0.80	1.80	1.31	11.10	10.60
FeO	2.16	0.90	0.80	3.90	2.93	3.30	3.30
CaO	6.73	12.01	14.78	10.90	14.32	20.40	20.82
MgO	0.94	0.85	1.34	1.68	2.99	3.37	3.46
Na_2O	6.49	3.58	2.01	3.98	1.98	0.21	0.18
K2O	0.86	0.54	2.01	0.46	0.49	0.05	0.04
TiO_2	0.21	0.11	0.12	0.75	0.32	1.81	1.52
P_2O_5	0.03	0.02	0.03	0.09	0.03	0.30	0.34
MnO	0.03	0.02	0.03	0.07	0.09	0.14	0.14
H_2O	0.45	0.85	2.19	1.50	0.73	1.80	1.95
S	0.00	0.00	0.01	0.09	0.00	0.04	0.01
CO_2	0.19	0.78	1.25	0.35	0.05	0.15	0.12
Other	0.04	0.05	0.06	0.06	0.05	0.29	0.28
O=S	0.00	0.00	0.00	-0.04	0.00	-0.02	0.00
Total	100.44	98.51	99.13	99.29	99.96	99.24	98.86
Ni (ppm)	0	0	13	0	43	0	11
Cr	0	0	9	450	17	0	0
Cu	7	8	16	38	10	10	12
Zn	21	6	19	29	55	39	41
Pb	8	51	51	38	0	43	37
Rb	9	10	45	11	18	9	10
Sr	171	234	190	198	119	2050	1950
Ba	67	84	123	172	95	110	90
Li	18	13	14	31	18	8	9
Be	0	4	4	4	0	2	3
V	24	0	0	0	0	122	123
FeO (T)	2.62	0.99	1.52	5.52	4.11	13.29	12.84
TiO_2	0.21	0.11	0.12	0.75	0.32	1.81	1.52
V2O5	0.00	0.00	0.00	0.00	0.00	0.02	0.02

2 Sample locations are shown in Figure 41. Samples 520-2A, -2B, Epidote pod in anorthosite, east channel of the Nelson River.

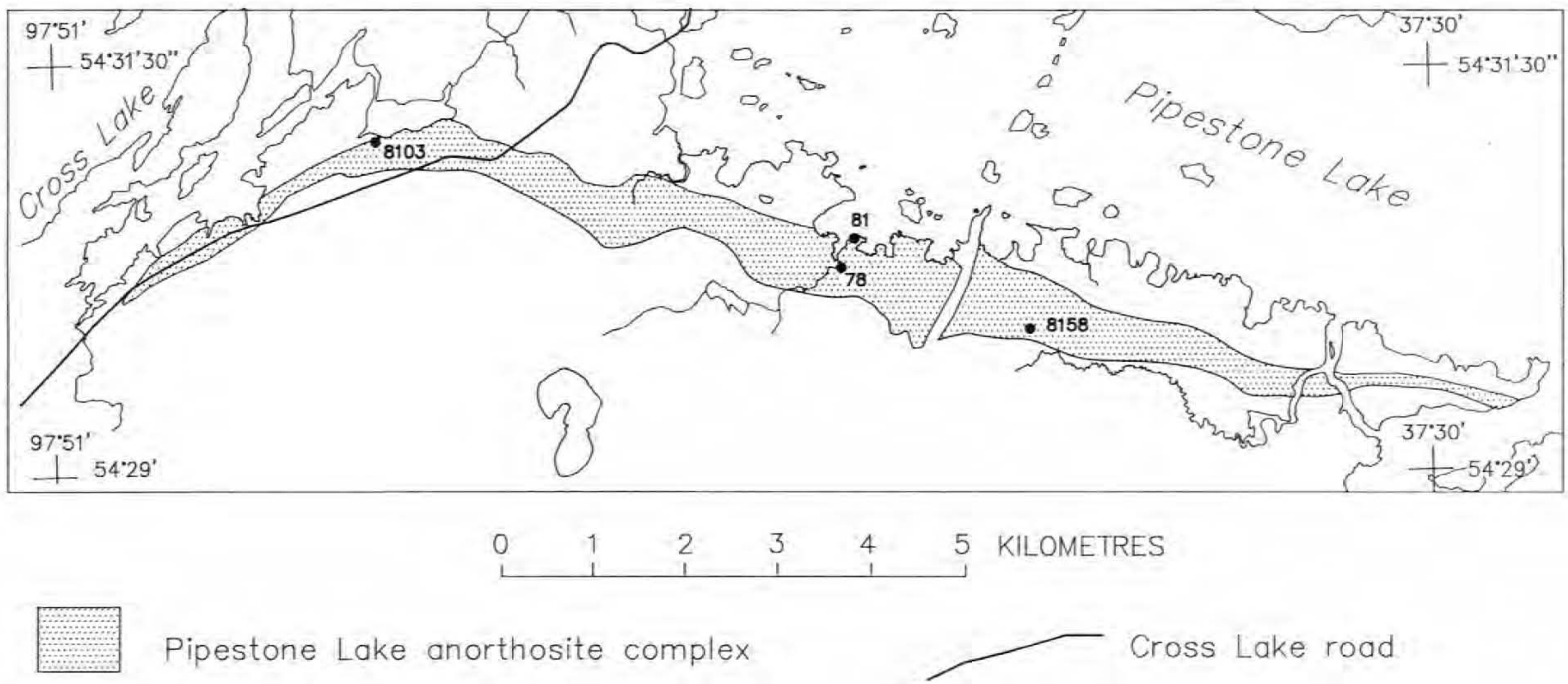

Figure 42: *Sample locations for geochemical analyses shown in Appendix A5.*

A5. Oikocrystic anorthosite (Unit 3b):

Sample[1]	78	81-1	8103-2A	8158
SiO_2	49.70	53.00	47.20	49.60
Al_2O_3	28.50	22.60	24.60	28.36
Fe_2O_3	1.02	1.69	2.00	0.92
FeO	1.70	6.32	5.14	1.53
CaO	13.51	8.29	10.60	11.16
MgO	1.34	1.28	2.70	1.99
Na_2O	2.72	4.92	3.15	3.28
K2O	0.34	0.40	0.37	1.25
TiO_2	0.29	0.94	1.15	0.16
P_2O_5	0.03	0.17	0.03	0.03
MnO	0.03	0.08	0.08	0.05
H_2O	0.69	0.60	2.44	1.85
S	0.02	0.00	0.01	0.00
CO_2	0.24	0.19	0.23	0.33
Other	0.05	0.06	0.09	0.08
O=S	-0.01	0.00	0.00	0.00
Total	100.17	100.54	99.79	100.59
Ni (ppm)	0	0	23	22
Cr	0	0	91	93
Cu	31	3	19	7
Zn	18	50	59	43
Pb	8	18	0	0
Rb	10	9	16	33
Sr	135	180	198	217
Ba	47	167	121	207
Li	18	8	20	35
Be	0	0	0	0
V	90	56	287	0
FeO (T)	2.62	7.84	6.94	2.36
TiO_2	0.29	0.94	1.15	0.16
V2O5	0.02	0.01	0.05	0.00

1 Sample locations are shown in Figure 42.

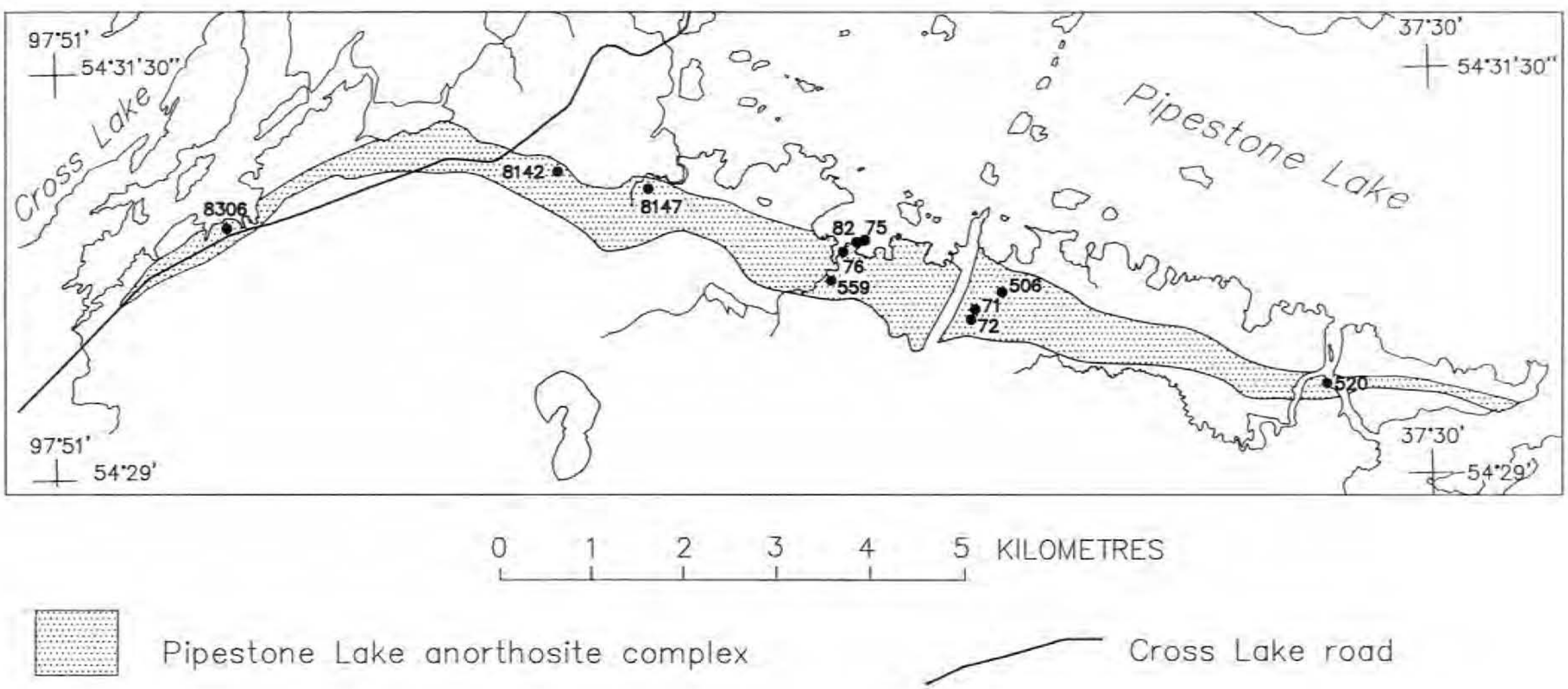

Figure 43: *Sample locations for geochemical analyses shown in Appendix A6.*

A6. Leucogabbro (Unit 4):

Sample[1]	75	82-2	72-2	76A	76B	71	506
SiO_2	53.60	47.80	46.30	48.50	49.20	48.90	42.50
Al_2O_3	17.80	16.70	23.40	23.90	23.90	25.40	24.70
Fe_2O_3	2.41	0.76	1.28	1.94	2.14	1.26	6.40
FeO	7.88	12.70	7.20	6.51	5.97	4.21	6.10
CaO	7.96	9.22	11.37	11.91	11.79	12.93	12.04
MgO	1.55	3.69	6.62	2.55	2.45	3.28	1.27
Na_2O	4.43	3.63	1.93	2.80	2.78	2.66	2.57
K2O	0.45	0.43	0.17	0.34	0.32	0.37	0.12
TiO_2	2.14	3.34	0.14	1.37	1.23	0.47	2.07
P_2O_5	0.99	0.90	0.01	0.03	0.02	0.03	0.01
MnO	0.11	0.18	0.12	0.10	0.09	0.08	0.07
H_2O	0.86	1.04	1.72	0.79	0.70	1.23	0.64
S	0.07	0.00	0.06	0.00	0.00	0.02	0.02
CO_2	0.14	0.17	0.00	0.10	0.03	0.14	0.17
Other	0.12	0.06	0.06	0.15	0.08	0.14	0.57
O=S	-0.03	0.00	-0.02	0.00	0.00	-0.01	-0.01
Total	100.48	100.62	100.36	100.99	100.70	101.11	99.24
Ni (ppm)	12	15	103	23	26	52	58
Cr	0	0	0	44	0	150	2120
Cu	96	0	111	36	3	45	18
Zn	53	78	69	52	34	48	54
Pb	0	35	22	0	18	5	36
Rb	0	14	0	3	10	2	8
Sr	134	117	131	163	121	146	178
Ba	534	68	4	429	51	324	74
Li	12	12	5	12	9	15	6
Be	4	0	0	5	0	5	3
V	111	113	62	286	227	213	1162
FeO (T)	10.05	13.38	8.35	8.26	7.90	5.34	11.86
TiO_2	2.14	3.34	0.14	1.37	1.23	0.47	2.07
V2O5	0.02	0.02	0.01	0.05	0.04	0.04	0.21

1 Sample locations are shown in Figure 43.

Leucogabbro (Unit 4):

Sample	520-3	559	8142-1	8147-2	8306
SiO_2	49.40	47.50	50.20	48.90	48.90
Al_2O_3	15.60	25.40	21.70	22.70	23.96
Fe_2O_3	2.80	1.40	2.86	1.63	1.80
FeO	10.80	3.20	3.69	6.55	5.87
CaO	7.65	14.22	10.66	10.83	11.31
MgO	5.22	2.78	2.16	2.87	2.88
Na_2O	3.10	2.48	4.09	3.25	3.39
K2O	0.27	0.33	0.34	0.35	0.58
TiO_2	1.67	0.16	1.13	0.97	0.82
P_2O_5	0.15	0.01	0.15	0.03	0.03
MnO	0.31	0.07	0.06	0.09	0.08
H_2O	2.27	0.81	1.71	1.13	0.82
S	0.04	0.00	0.00	0.10	0.04
CO_2	0.08	0.11	0.03	0.21	0.03
Other	0.17	0.06	0.07	0.08	0.16
O=S	-0.02	0.00	0.00	-0.04	-0.02
Total	99.51	98.53	98.85	99.65	100.65
Ni (ppm)	28	24	6	24	80
Cr	235	39	24	13	46
Cu	47	10	8	79	138
Zn	182	35	43	63	54
Pb	39	32	12	14	0
Rb	10	5	7	7	8
Sr	101	180	158	173	176
Ba	93	125	47	42	227
Li	22	24	13	19	18
Be	2	3	0	0	0
V	410	0	235	304	380
FeO (T)	13.32	4.46	6.26	8.02	7.49
TiO_2	1.67	0.16	1.13	0.97	0.82
$V2O_5$	0.07	0.00	0.04	0.05	0.07

A7. Magnetite-bearing leucogabbro (Unit 4a):

Sample[1]	8257	8257-1A	8257-1C	29-1A	500-2C
SiO_2	43.50	41.10	36.90	45.80	38.20
Al_2O_3	10.90	4.90	17.20	18.40	16.80
Fe_2O_3	3.14	12.41	6.03	7.76	9.40
FeO	16.20	13.96	15.27	13.00	13.10
CaO	8.92	4.79	9.63	6.89	10.06
MgO	10.70	17.06	7.31	1.28	4.08
Na_2O	0.82	0.13	1.30	3.09	2.02
K2O	0.28	0.02	0.41	0.41	0.25
TiO_2	1.50	0.23	2.72	1.53	3.95
P_2O_5	0.01	0.01	0.01	0.15	0.02
MnO	0.26	0.23	0.25	0.41	0.17
H_2O	2.95	4.14	2.78	1.30	1.09
S	0.00	0.04	0.08	0.10	0.18
CO_2	0.24	0.05	0.14	0.36	0.09
Other	0.22	0.03	0.36	0.09	0.49
O=S	0.00	-0.02	-0.03	-0.04	-0.07
Total	99.64	99.08	100.36	100.53	99.83
Ni (ppm)	100	92	180	0	104
Cr	178	22	941	0	84
Cu	11	52	146	57	290
Zn	145	113	115	146	99
Pb	0	0	0	52	41
Rb	18	0	19	24	12
Sr	8	0	34	270	118
Ba	65	0	42	147	100
Li	12	0	10	13	17
Be	3	0	0	0	2
V	835	80	995	23	2133
FeO (T)	19.03	25.13	20.70	19.98	21.56
TiO_2	1.50	0.23	2.72	1.53	3.95
V2O5	0.15	0.01	0.18	0.00	0.38

1 Sample locations are shown in Figure 44. Samples 8257, 8257-1A, -1C, magnetite-chlorite schist in megacrystic anorthosite; 29-1A garnet-magnetite leucogabbro, east shore Cross Lake; 500-2C magnetite-bearing leucogabbro, near Location 4 (Trench 2).

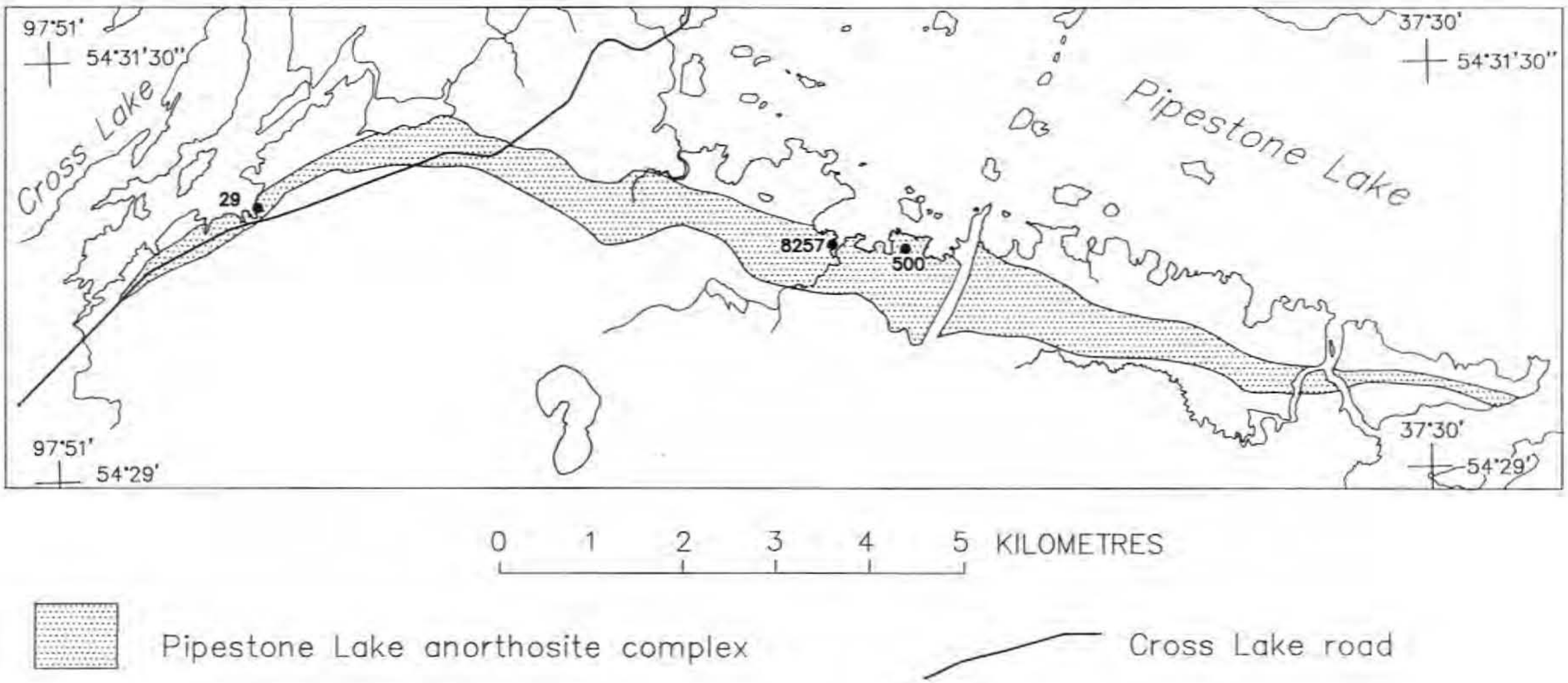

Figure 44: *Sample locations for geochemical analyses shown in Appendix A7.*

A8. Melagabbro (Unit 5):

Sample[1]	3	9-1	600-20	49	65-1B	74	556	8155-3B
SiO_2	44.30	39.20	41.50	42.10	43.30	42.70	39.80	46.00
Al_2O_3	7.56	13.65	11.60	12.40	11.81	13.20	9.00	17.63
Fe_2O_3	6.21	6.81	5.10	3.21	3.55	3.58	9.10	1.89
FeO	8.21	16.67	16.40	17.51	14.71	16.38	14.70	8.23
CaO	8.05	9.20	9.23	10.20	12.46	10.03	11.25	11.60
MgO	19.44	5.83	5.79	5.74	8.04	5.88	9.15	9.68
Na_2O	0.51	1.89	1.77	1.80	0.91	1.86	0.96	1.51
K2O	0.08	0.25	0.20	0.22	0.38	0.24	0.16	0.24
TiO_2	1.10	4.90	5.80	4.96	2.69	4.62	3.27	0.21
P_2O_5	0.08	0.03	0.04	0.06	0.01	0.05	0.05	0.01
MnO	0.21	0.29	0.31	0.31	0.26	0.29	0.25	0.18
H_2O	4.05	1.54	1.44	1.27	2.07	1.31	1.97	1.99
S	0.00	0.04	0.05	0.00	0.17	0.02	0.04	0.00
CO_2	0.10	0.08	0.12	0.22	0.07	0.10	0.51	0.09
Other	0.53	0.18	0.11	0.10	0.28	0.12	0.35	0.13
O=S	0.00	-0.02	-0.02	0.00	-0.07	-0.01	-0.02	0.00
Total	100.43	100.54	99.44	100.10	100.64	100.37	100.54	99.39
Ni (ppm)	956	0	0	0	86	0	85	184
Cr	2239	0	0	0	79	0	21	329
Cu	31	56	38	16	146	27	62	27
Zn	131	169	167	176	147	192	143	85
Pb	0	0	22	53	0	54	31	0
Rb	2	5	12	19	8	18	10	6
Sr	26	72	103	117	69	121	31	140
Ba	113	277	80	57	282	74	71	60
Li	11	9	9	6	13	8	11	15
Be	2	3	2	0	0	0	0	0
V	198	596	298	230	930	289	1649	117
FeO (T)	13.80	22.80	21.00	20.40	17.90	19.60	22.89	9.93
TiO_2	1.10	4.90	5.80	4.96	2.69	4.62	3.27	0.21
V2O5	0.04	0.11	0.05	0.04	0.17	0.05	0.29	0.02

1 Sample locations are shown in Figure 45.

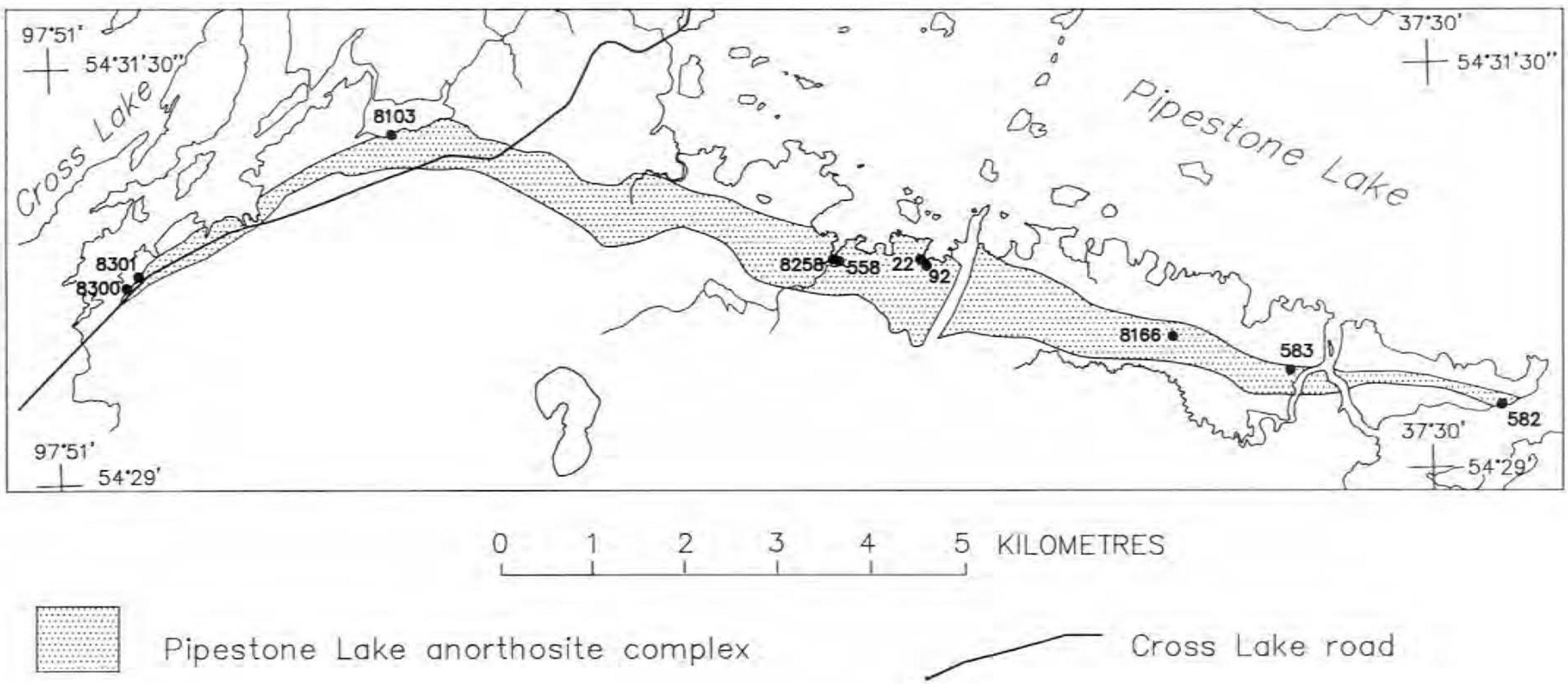

Figure 45: *Sample locations for geochemical analyses shown in Appendix A8.*

A9. Magnetite-bearing melagabbro (Unit 5a)

Sample[1]	22-2	92	558	582-1A	583-1
SiO_2	31.90	21.50	43.40	37.90	40.20
Al_2O_3	20.80	14.20	13.60	11.30	12.60
Fe_2O_3	14.88	23.04	5.30	9.20	4.90
FeO	13.71	21.67	11.50	15.60	16.20
CaO	8.66	5.28	11.27	10.21	9.80
MgO	1.75	2.93	8.55	6.39	5.78
Na_2O	1.73	0.91	1.66	1.21	1.84
K2O	0.38	0.19	0.22	0.23	0.23
TiO_2	4.95	7.86	1.90	4.67	4.15
P_2O_5	0.02	0.02	0.04	0.01	0.06
MnO	0.15	0.20	0.21	0.24	0.26
H_2O	1.06	1.66	1.93	1.73	1.51
S	0.03	0.07	0.06	0.21	0.38
CO_2	0.07	0.12	0.00	0.02	0.32
Other	0.65	0.91	0.27	0.41	0.18
O=S	-0.01	-0.03	-0.02	-0.08	-0.15
Total	100.73	100.53	99.89	99.25	98.26
Ni (ppm)	125	242	111	6	0
Cr	711	55	32	13	0
Cu	39	82	125	86	102
Zn	113	251	112	122	153
Pb	0	75	31	27	24
Rb	16	25	11	6	5
Sr	125	84	79	78	130
Ba	265	34	91	83	73
Li	20	8	23	16	13
Be	6	0	0	0	0
V	2510	4260	1054	1977	641
FeO (T)	27.10	42.40	16.27	23.88	20.61
TiO_2	4.95	7.86	1.90	4.67	4.15
V2O5	0.45	0.76	0.19	0.35	0.11

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1 Sample locations are shown in Figure 46.

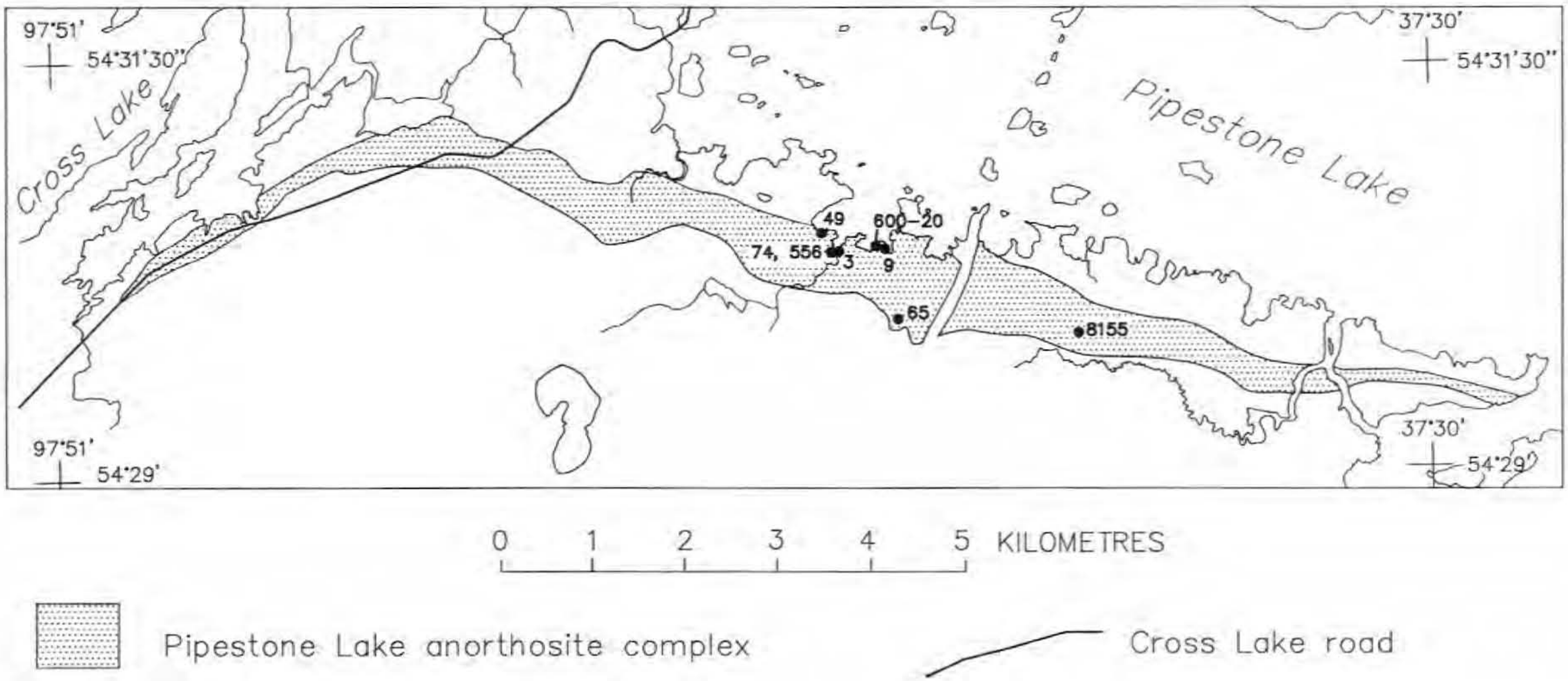


Figure 46: *Sample locations for geochemical analyses shown in Appendix A9.*

Magnetite-bearing melagabbro (Unit 5a):

Sample	8103-1A	8103-1B	8166	8258-2	8300-3A	8301-1
SiO_2	22.60	17.50	40.40	5.90	40.10	44.30
Al_2O_3	14.20	11.80	11.40	4.50	13.34	13.28
Fe_2O_3	17.61	25.53	9.31	37.47	11.99	4.30
FeO	20.20	22.45	14.07	30.25	13.65	12.85
CaO	6.15	5.85	10.50	1.42	6.30	9.63
MgO	2.59	2.37	6.67	2.39	4.39	4.97
Na_2O	0.84	0.18	1.46	0.18	2.38	2.11
K2O	0.35	0.12	0.17	0.04	0.83	1.20
TiO_2	11.79	9.07	3.72	15.30	4.20	3.39
P_2O_5	0.00	0.01	0.02	0.00	0.20	1.30
MnO	0.24	0.25	0.21	0.31	0.21	0.24
H_2O	2.41	3.32	1.79	1.24	1.81	1.53
S	0.12	0.03	0.23	0.01	0.26	0.14
CO_2	0.00	0.00	0.11	0.03	0.07	0.24
Other	0.70	0.96	0.33	1.23	0.37	0.20
O=S	-0.05	-0.01	-0.09	0.00	-0.10	-0.06
Total	99.75	99.43	100.30	100.27	100.00	99.62
Ni (ppm)	163	230	61	158	143	20
Cr	172	111	19	292	14	0
Cu	152	62	111	73	185	89
Zn	187	192	139	483	166	192
Pb	0	0	0	0	0	0
Rb	30	11	5	0	21	32
Sr	134	154	81	0	244	314
Ba	50	63	25	21	240	431
Li	26	17	10	5	19	21
Be	0	0	0	3	0	0
V	3286	4893	1673	6138	1349	393
FeO (T)	36.05	45.42	22.45	63.97	24.44	16.72
TiO_2	11.79	9.07	3.72	15.30	4.20	3.39
V2O5	0.59	0.87	0.30	1.10	0.24	0.07

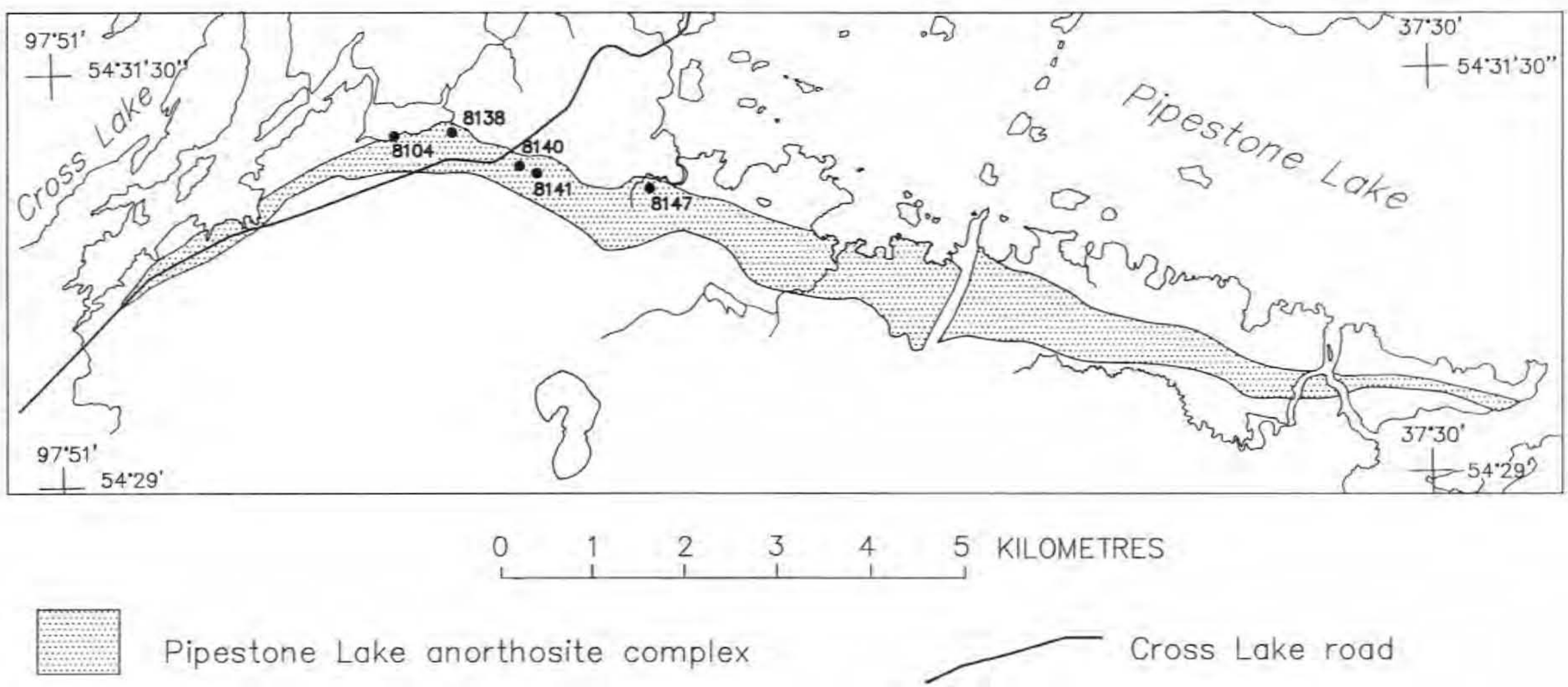


Figure 47: *Sample locations for geochemical analyses shown in Appendix A10.*

A10. Ilmenite-bearing melagabbro (Unit 5b)

Sample[1]	8104-1A	8140-1	8141-2	8147-1	8138-2
SiO_2	44.10	41.10	40.60	48.60	43.10
Al_2O_3	13.60	12.10	12.40	11.80	11.30
Fe_2O_3	3.76	5.69	4.33	3.87	5.15
FeO	14.80	18.66	17.25	14.90	16.82
CaO	8.77	8.63	9.52	8.71	9.02
MgO	4.95	4.62	5.60	2.41	5.18
Na_2O	2.34	1.92	2.33	3.22	1.86
K2O	0.30	0.39	0.35	0.30	0.31
TiO_2	4.65	4.28	4.60	2.60	4.64
P_2O_5	0.10	0.11	0.30	0.99	0.09
MnO	0.25	0.34	0.29	0.26	0.31
H_2O	1.81	1.79	1.55	1.33	1.57
S	0.04	0.13	0.00	0.15	0.09
CO_2	0.45	0.05	0.03	0.07	0.03
Other	0.05	0.04	0.05	0.02	0.06
O=S	-0.02	-0.05	0.00	-0.06	-0.04
Total	99.95	99.80	99.20	99.17	99.49
Ni (ppm)	0	0	0	0	0
Cr	0	0	0	0	0
Cu	44	53	17	32	52
Zn	107	134	87	89	116
Pb	0	0	0	0	0
Rb	7	7	6	7	6
Sr	104	71	76	108	65
Ba	96	73	56	69	96
Li	14	8	9	4	11
Be	0	0	0	0	0
V	118	71	145	0	153
FeO (T)	18.18	23.78	21.15	18.38	21.45
TiO_2	4.65	4.28	4.60	2.60	4.64
V2O5	0.02	0.01	0.03	0.00	0.03

1 Sample locations are shown in Figure 47.

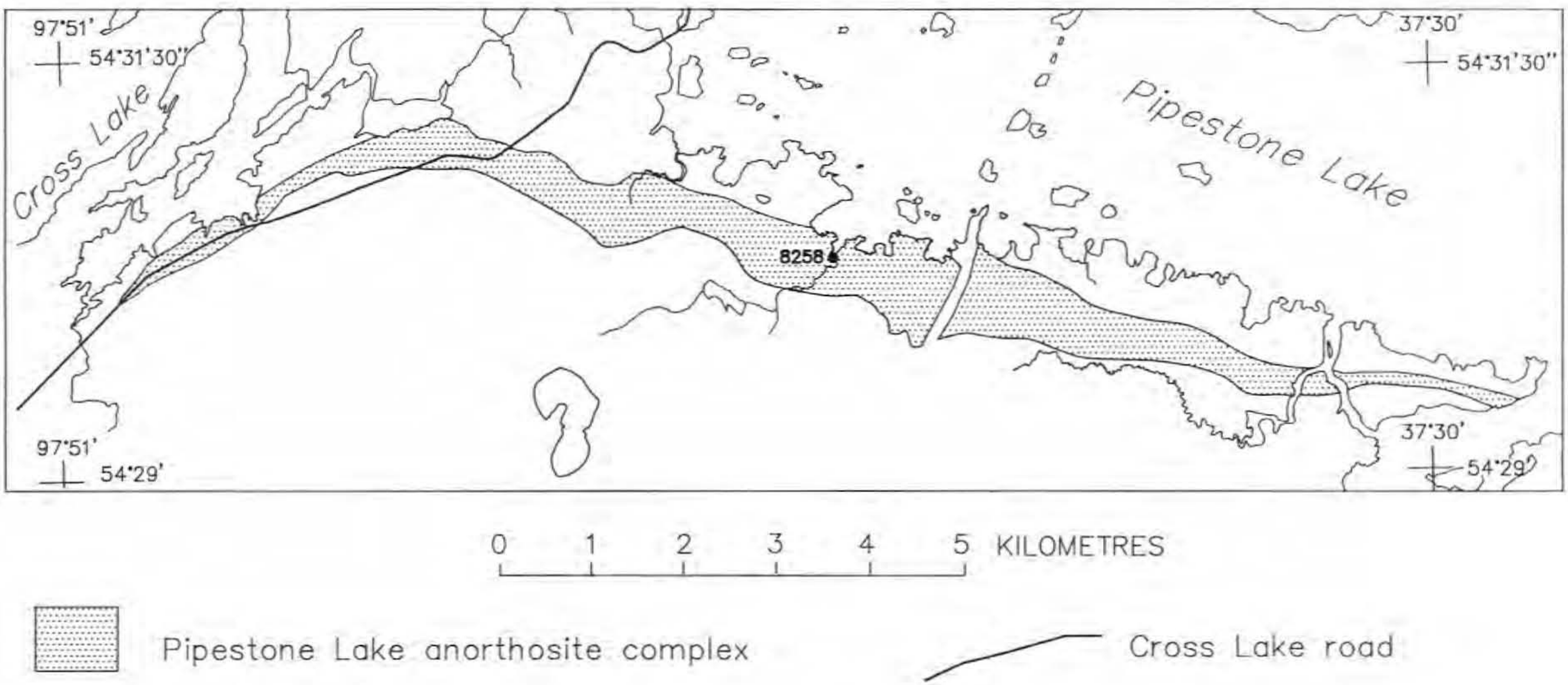


Figure 48: *Sample locations for geochemical analyses shown in Appendix A11.*

A11. Mafic pegmatite (Unit 7):

Sample[1]	8258	8258-1
SiO_2	44.30	44.90
Al_2O_3	9.90	10.30
Fe_2O_3	4.70	5.21
FeO	11.58	11.70
CaO	10.55	11.22
MgO	12.03	11.30
Na_2O	1.14	1.17
K2O	0.17	0.18
TiO_2	1.10	1.10
P_2O_5	0.00	0.01
MnO	0.21	0.23
H_2OO	2.82	2.36
S	0.00	0.00
CO_2	1.03	0.41
Other	0.20	0.24
O=S	0.00	0.00
Total	99.73	100.33
Ni (ppm)	88	110
Cr	49	58
Cu	9	6
Zn	119	146
Pb	10	0
Rb	0	5
Sr	9	10
Ba	0	53
Li	10	10
Be	0	2
V	1005	1036
FeO (T)	15.81	16.39
TiO_2	1.10	1.10
V_2O_5	0.18	0.18

1 Sample locations are shown in Figure 48.

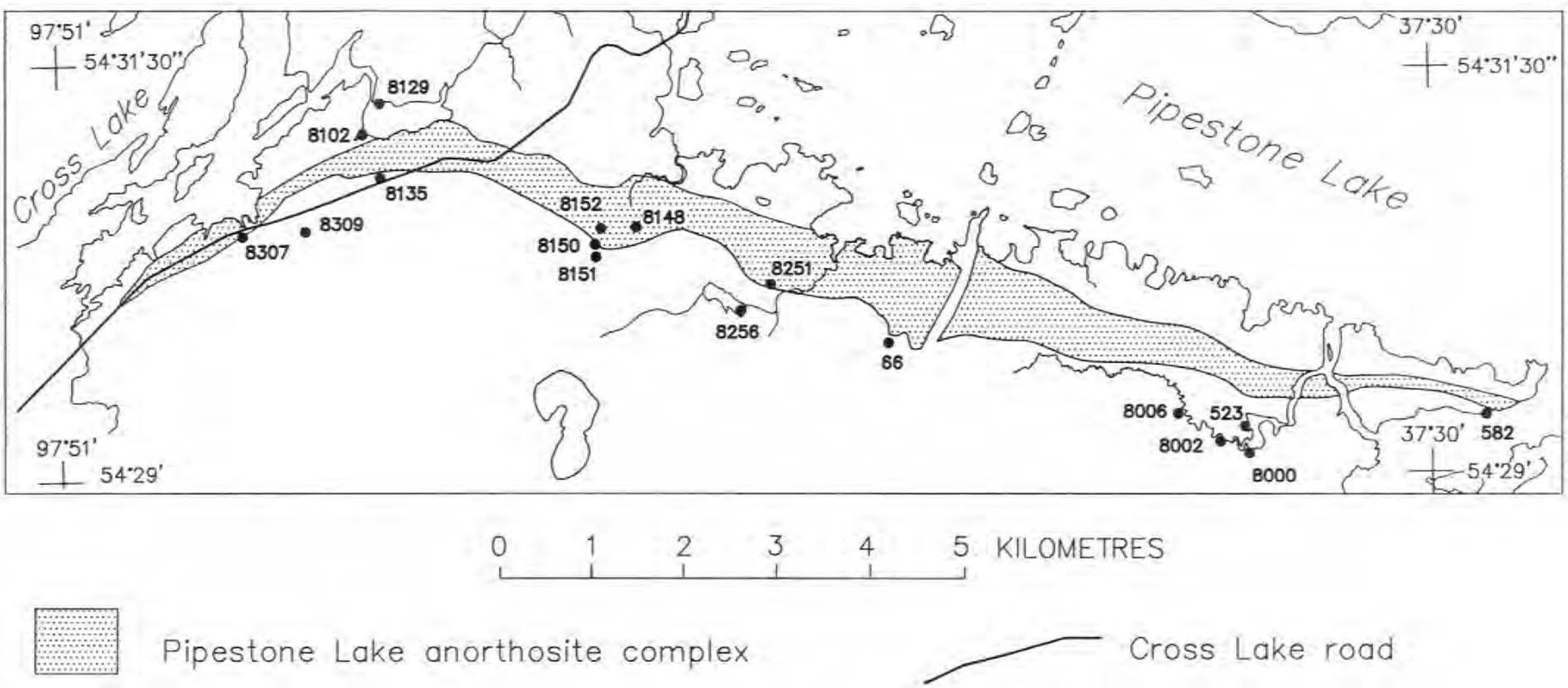


Figure 49: *Sample locations for geochemical analyses shown in Appendix A12.*

A12. Whiskey Jack gneiss complex (Unit 8):

Sample[1]	66B	523	582-3	8000	8002	8006-2
SiO_2	74.10	74.60	73.80	71.80	70.40	61.00
Al_2O_3	13.44	13.50	14.30	14.40	14.30	16.00
Fe_2O_3	0.52	0.20	0.60	0.60	0.99	1.73
FeO	1.73	0.40	0.60	1.42	2.24	3.88
CaO	2.37	1.52	1.16	3.43	3.38	5.36
MgO	0.55	0.34	0.24	1.03	1.36	2.28
Na_2O	4.09	3.15	4.21	4.37	4.03	4.02
K2O	2.07	4.91	3.45	1.60	1.86	2.00
TiO_2	0.24	0.07	0.07	0.29	0.28	0.94
P_2O_5	0.06	0.02	0.03	0.06	0.10	0.35
MnO	0.05	0.01	0.02	0.03	0.05	0.07
H_2O	0.45	0.35	0.45	0.77	0.97	1.06
S	0.00	0.00	0.00	0.02	0.00	0.02
CO_2	0.15	0.10	0.07	0.02	0.09	0.19
Other	0.12	0.25	0.12	0.13	0.06	0.11
O=S	0.00	0.00	0.00	-0.01	0.00	-0.01
Total	99.94	99.42	99.12	99.96	100.11	99.00
Ni (ppm)	4	0	0	9	13	19
Cr	0	0	0	19	21	22
Cu	14	5	3	29	7	29
Zn	68	11	15	52	81	111
Pb	12	63	61	10	13	0
Rb	65	71	71	47	82	48
Sr	106	232	86	583	178	307
Ba	691	1782	842	330	179	253
Li	13	14	14	35	27	30
Be	5	2	3	4	0	0
V	0	0	0	0	0	106
FeO (T)	2.20	0.58	1.14	1.96	3.13	5.44
TiO_2	0.24	0.07	0.07	0.29	0.28	0.94
$V2O_5$	0.00	0.00	0.00	0.00	0.00	0.02

1 Sample locations are shown in Figure 49 Sample 66B is an inclusion of grey biotite gneiss in tonalite; 523, gneissic tonalite from the creek on the East Channel of the Nelson River; 582-3, Whiskey Jack porphyry from the large island in the East Channel of the Nelson River; 8000, 8002 and 8006-2 are granodiorite from the creek on the East Channel of the Nelson River.

Whiskey Jack gneiss complex (Unit 8):

Sample[2]	8102-1	8129	8135	8148	8150-1A	8151
SiO_2	66.80	74.40	71.10	65.60	75.40	73.40
Al_2O_3	12.40	11.40	15.07	16.64	13.00	13.71
Fe_2O_3	1.49	1.13	0.74	1.30	0.37	0.83
FeO	7.17	1.53	1.61	2.55	0.63	1.28
CaO	3.46	1.27	3.26	4.97	1.44	2.60
MgO	0.63	0.07	0.87	1.35	0.30	0.53
Na_2O	3.56	2.60	4.03	3.56	4.49	3.85
K2O	1.69	5.07	2.02	0.98	2.49	2.19
TiO_2	0.61	0.31	0.26	0.46	0.06	0.19
P_2O_5	0.11	0.03	0.09	0.17	0.02	0.06
MnO	0.13	0.04	0.04	0.07	0.01	0.02
H_2O	1.04	0.63	0.68	1.65	0.73	0.65
S	0.01	0.01	0.00	0.00	0.00	0.00
CO_2	0.07	0.07	0.09	0.19	0.26	0.10
Other	0.23	0.47	0.10	0.07	0.10	0.30
O=S	0.00	0.00	0.00	0.00	0.00	0.00
Total	99.40	99.03	99.96	99.56	99.30	99.71
Ni (ppm)	6	0	16	18	0	0
Cr	0	0	10	14	0	0
Cu	14	8	13	15	44	12
Zn	141	60	55	63	26	22
Pb	0	25	12	0	22	0
Rb	51	96	59	29	47	22
Sr	381	141	188	189	100	308
Ba	1409	3950	512	242	600	2248
Li	29	12	23	27	20	19
Be	0	2	0	0	3	0
V	0	0	0	0	0	0
FeO (T)	8.51	2.55	2.28	3.72	0.96	2.03
TiO_2	0.61	0.31	0.26	0.46	0.06	0.19
V_2O_5	0.00	0.00	0.00	0.00	0.00	0.00

2 Sample locations are shown in Figure 49. Sample 8102-1 is a tonalite from the East shore of Cross Lake; 8129, ilmenite-bearing hornblende granodiorite from the East shore of Cross Lake; 8135 Whiskey Jack tonalite ; 8148, tonalite from the west Pipestone Lake area near the south contact of the PLAC; 8150-1A, granodiorite from the west Pipestone Lake area; 8151, gneissic tonalite on the south contact.

Whiskey Jack gneiss complex (Unit 8):

Sample[3]	8152-2A	8251-2B	8256	8307-2	8309
SiO_2	74.30	76.00	68.90	69.60	65.50
Al_2O_3	13.80	12.50	14.20	15.71	16.56
Fe_2O_3	0.26	0.27	1.38	0.52	1.46
FeO	0.55	0.59	2.53	2.42	2.67
CaO	2.29	1.40	3.14	3.32	4.50
MgO	0.23	0.92	1.24	1.00	0.93
Na_2O	3.88	4.22	3.73	3.92	4.22
K2O	3.06	2.29	3.15	2.00	1.50
TiO_2	0.01	0.02	0.45	0.37	0.55
P_2O_5	0.02	0.02	0.13	0.13	0.16
MnO	0.02	0.04	0.07	0.05	0.04
H_2O	0.60	0.95	0.90	0.62	1.10
S	0.02	0.01	0.01	0.00	0.01
CO_2	0.28	0.78	0.10	0.05	0.09
Other	0.05	0.04	0.12	0.10	0.10
O=S	-0.01	0.00	0.00	0.00	0.00
Total	99.36	100.05	100.05	99.81	99.39
Ni (ppm)	0	9	0	0	0
Cr	0	0	8	0	8
Cu	32	10	14	7	24
Zn	19	13	75	76	58
Pb	23	0	14	0	10
Rb	52	44	92	56	50
Sr	80	31	171	199	293
Ba	225	399	642	460	326
Li	10	18	30	30	17
Be	2	2	0	0	0
V	0	0	66	0	68
FeO (T)	0.78	0.83	3.77	2.89	3.98
TiO_2	0.01	0.02	0.45	0.37	0.55
V2O5	0.00	0.00	0.01	0.00	0.01

3 Sample locations are shown in Figure 49. Sample 8152-2A, sheared tonalite, western Pipestone Lake area; 8251-2B, granodiorite vein intruding anorthosite near south contact of the PLAC with Whiskey Jack gneiss complex; 8256, tonalite gneiss south of contact; 8307-2, Whiskey Jack tonalite (gneissic); 8309, Whiskey Jack granodiorite.

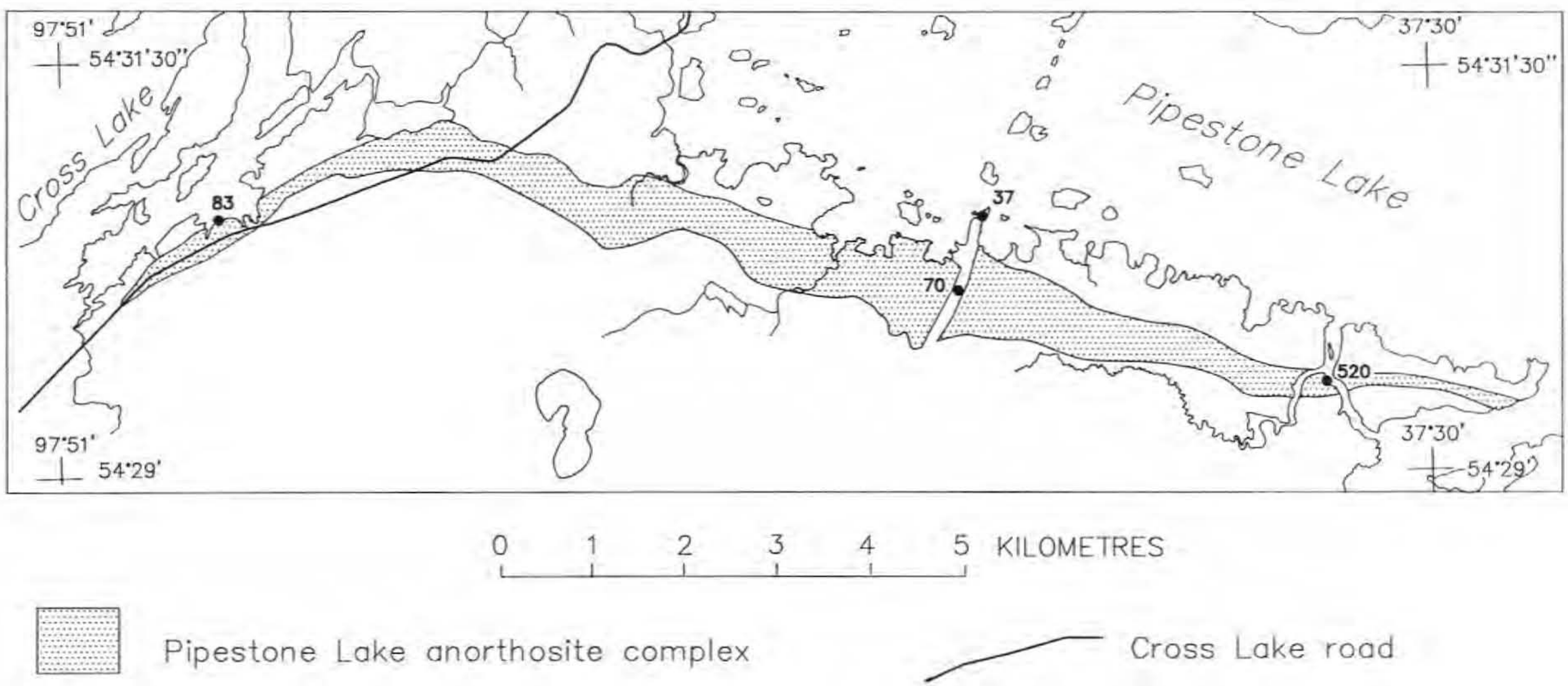


Figure 50: *Sample locations for geochemical analyses shown in Appendix A13.*

A13. Molson diabase (Unit 9):

Sample[1]	37-1A	37-1C	37-1D	70	83	520-1A
SiO_2	57.90	50.70	48.50	57.50	46.90	49.00
Al_2O_3	15.40	17.30	14.70	16.50	17.00	14.10
Fe_2O_3	1.93	2.14	2.78	2.14	2.63	6.00
FeO	8.35	10.37	12.20	9.07	11.16	9.60
CaO	7.41	9.27	9.40	6.80	9.32	7.32
MgO	1.11	2.40	4.99	1.14	3.88	4.63
Na_2O	3.33	2.85	2.37	3.59	2.61	3.57
K2O	0.64	0.47	0.37	0.30	1.41	0.41
TiO_2	1.10	1.75	1.78	1.11	3.09	2.03
P_2O_5	0.27	0.19	0.12	0.28	1.32	0.16
MnO	0.16	0.18	0.21	0.18	0.20	0.24
H_2O	1.74	1.85	2.11	2.10	0.98	1.68
S	0.05	0.11	0.11	0.01	0.17	0.00
CO_2	0.10	0.09	0.14	0.07	0.10	0.10
Other	0.07	0.14	0.19	0.10	0.20	0.17
O=S	-0.02	-0.04	-0.04	0.00	-0.07	0.00
Total	99.54	99.77	99.93	100.89	100.90	99.01
Ni (ppm)	0	15	60	4	0	8
Cr	0	9	65	0	0	165
Cu	79	183	213	26	84	8
Zn	147	119	145	123	200	91
Pb	0	9	5	4	48	49
Rb	10	10	8	4	89	10
Sr	155	129	93	130	321	133
Ba	88	203	175	389	426	83
Li	13	9	9	9	16	16
Be	5	4	3	4	0	2
V	64	293	481	59	294	564
FeO (T)	10.09	12.30	14.70	11.00	13.53	15.00
TiO_2	1.10	1.75	1.78	1.11	3.09	2.03
V_2O_5	0.01	0.05	0.09	0.01	0.05	0.10

1 Sample locations are shown in Figure 50.Station 37 is the large dyke on Pipestone Lake. 1A is a leucocratic phase of the diabase, part of the tonalitic granophyre; 1C is the finer grained mafic margin on the west side of the dyke, quartz diorite composition; 1D is the mafic marginal phase; 70 is the leucocratic phase of the same dyke, further south, tonalitic; 83, medium grained diorite to gabbro, East shore of Cross Lake; 520-1A leucodiorite, east channel of the Nelson River.

Appendix B: Tables of whole rock and trace element analyses of rocks at locations 1, 2, 3 and 4

Location 1: (Station 68-4-19/ 68-5-600)
B1. Location 1: Chip samples

Sample[1]	19-CH2A	19-CH2B	19-CHN	19-CL	19-CS
FeO (T)	68.30	55.90	68.40	61.50	68.60
TiO_2	15.00	14.90	16.50	14.40	15.50
V_2O_5	0.92	0.83	0.89	0.88	0.97
V (ppm)	5150	4664	4966	4925	5448
Ni	139	158	142	185	153
Cr	311	173	42	305	303

1 Sample locations are shown in Figure 6. Massive magnetite (Unit 6) layers in leucogabbro. 19-CH2A south layer, taken over 3 metres; 19-CH2B south layer, over 3 metres; 19-CHN north layer over 2 metres; 19-CL south layer, over 3 metres; 19-CS centre layer, over 1.75 metres.

B2. Location 1: Whole rock and trace element analyses:

Sample[1]	19-3	19-A	19-B	19-C	19-D	19-F	19-G	19-H
Unit	6	6	6	6	6	6	4a	6
SiO_2	3.09						42.10	
Al_2O_3	4.36						17.00	
Fe_2O_3	39.55						4.52	
FeO	32.41						15.13	
CaO	0.18						10.12	
MgO	2.74						6.09	
Na_2O	0.10						1.88	
K2O	0.00						0.35	
TiO_2	15.70						0.98	
P_2O_5	0.00						0.02	
MnO	0.34						0.19	
H_2O	1.39						2.28	
S	0.01						0.00	
CO_2	0.10						0.07	
Other	1.53						0.19	
O=S	0.00						0.00	
Total	101.50						100.92	
Ni (ppm)	220	170	120	170	130	160	57	80
Cr	217	290	280	150	280	260	26	360
Cu	0						6	
Zn	389						130	
Pb	147						0	
Rb	20						6	
Sr	0						85	
Ba	0						269	
Li	6						15	
Be	0						4	
V	7540	5000	4600	5600	5900	5300	612	5700
FeO (T)	68.00	65.60	55.30	63.40	65.50	61.20	19.20	66.90
TiO_2	15.70	15.50	16.10	14.20	14.60	13.70	0.98	15.60
V_2O_5	1.35	0.89	0.82	1.00	1.05	0.95	0.11	1.02

1 Sample locations are shown in Figure 6. Sample 19-3 magnetite, centre layer; 19-A magnetite, south contact; 19-B magnetite with leucogabbro, 1 m north of south contact; 19-C magnetite, 2 m north of south contact; 19-D magnetite , 3 m north of south contact; 19-F centre layer, west end, 30 cm south of north edge of outcrop; 19-G magnetite-bearing leucogabbro; 19-H centre layer, west end, 40 cm south of north contact.

Location 1: Whole rock and trace element analyses:

Sample[2]	19-J	19-K	19-L	19-M	19-N	19-O	19-P	19-Q
Unit	6	6	4a	6	6	6	4a	6
SiO_2		8.90		3.53				2.46
Al_2O_3		8.30		4.29				4.02
Fe_2O_3		29.89		38.74				41.21
FeO		29.70		31.84				30.02
CaO		1.96		0.20				0.07
MgO		3.01		2.67				2.17
Na_2O		0.11		0.01				0.02
K2O		0.14		0.07				0.05
TiO_2		13.15		14.40				15.60
P_2O_5		0.01		0.01				0.00
MnO		0.27		0.31				0.33
H_2O		2.34		1.37				1.09
S		0.60		0.01				0.16
CO_2		0.10		0.03				0.02
Other		1.15		1.55				1.39
O=S		-0.24		0.00				-0.06
Total		99.39		99.03				98.55
Ni (ppm)	110	196	160	162	160	210	60	105
Cr	280	447	510	285	250	130	400	21
Cu		286		18				55
Zn		185		301				558
Pb		124		0				0
Rb		22		4				5
Sr		31		0				0
Ba		18		31				25
Li		8		7				8
Be		0		1				1
V	5800	5480	4100	8020	5900	6200	3000	7156
FeO (T)	68.80	56.60	56.60	66.70	65.10	71.10	40.80	67.10
TiO_2	16.00	13.15	13.00	14.40	15.50	15.70	9.02	15.60
V2O5	1.04	0.98	0.73	1.43	1.05	1.11	0.54	1.28

2 Sample locations are shown in Figure 6. Sample 19-J centre layer, west end, north contact; 19-K centre layer, west end, 1 m south of north contact; 19-L magnetite-bearing leucogabbro north of centre layer; 19-M centre layer, 15 cm north of south contact; 19-N centre layer, 1 m south of north contact; 19-O centre layer, 30 cm north of south contact; 19-P transition zone, magnetite-bearing leucogabbro to centre magnetite layer; 19-Q north layer, centre, 90 cm from north contact.

Location 1: Whole rock and trace element analyses:

Sample[3]	19-R	19-S	19-T	19-U	19-X1	19-X2	19-Y	19-Z
Unit	4	6	6	6, 4a	4, 3	4, 3	4, 3b	4a
SiO_2			3.97		49.50	46.50	48.50	31.50
Al_2O_3			4.36		24.00	19.30	19.30	17.40
Fe_2O_3			37.38		2.17	3.40	2.29	12.44
FeO			31.56		5.95	10.29	8.66	18.11
CaO			0.45		10.09	10.16	11.30	7.05
MgO			2.60		2.03	4.28	4.29	3.46
Na_2O			0.02		4.17	3.27	2.64	1.78
K2O			0.05		0.30	0.32	0.37	0.28
TiO_2			15.20		0.81	1.48	1.55	6.20
P_2O_5			0.00		0.04	0.03	0.02	0.03
MnO			0.33		0.08	0.15	0.15	0.16
H_2O			1.71		0.96	1.13	1.17	1.95
S			0.07		0.00	0.00	0.00	0.12
CO_2			0.09		0.15	0.07	0.12	0.03
Other			1.32		0.14	0.18	0.15	0.57
O=S			-0.03		0.00	0.00	0.00	-0.05
Total			99.08		100.39	100.56	100.51	101.03
Ni (ppm)	0	80	90	60	17	25	0	80
Cr	80	80	30	70	6	20	0	37
Cu			46		11	3	9	53
Zn			393		61	101	94	186
Pb			0		0	0	23	0
Rb			5		5	3	8	8
Sr			0		215	126	159	99
Ba			73		169	222	5	163
Li			10		24	11	8	11
Be			2		6	5	0	4
V	200	5800	6848	6000	408	626	549	2670
FeO (T)	11.88	66.20	65.20	65.80	7.90	13.35	10.72	29.30
TiO_2	2.17	15.70	15.20	18.10	0.81	1.48	1.55	6.20
V2O5	0.04	1.04	1.22	1.07	0.07	0.11	0.10	0.48

3 Sample locations are shown in Figure 6. 19-R, leucogabbro; 19-S, magnetite, north layer, east end, on north contact with leucogabbro; 19-T, magnetite, north layer, east end, on north contact with leucogabbro; 19-U, magnetite rock to leucogabbro, north layer, north contact with leucogabbro; 19-X1 and X2, leucogabbro to anorthositic gabbro on north contact of north magnetite layer; 19-Y, foliated leucogabbro to oikocrystic anorthosite, north of magnetite layers; 19-Z, magnetite-bearing leucogabbro.

Location 1: Whole rock and trace element analyses:

Sample[4]	19-AA	19-AB	19-AC	19-AD	19-AE	19-AF	19-AG-1	19-AG-2
Unit	4a	9	9	4	4	3b	7	7
SiO_2	37.10		40.80	47.90	41.80	47.40	42.20	42.60
Al_2O_3	20.30		18.30	23.10	21.50	23.70	9.86	10.90
Fe_2O_3	6.11		5.47	2.32	3.11	2.11	4.70	6.07
FeO	16.50		12.48	7.87	12.24	7.67	16.77	15.00
CaO	8.94		13.10	10.65	9.93	10.94	9.96	10.49
MgO	2.69		4.75	2.82	3.18	2.66	8.84	9.06
Na_2O	2.13		0.97	3.39	2.70	3.28	0.99	1.02
K2O	0.30		0.53	0.33	0.25	0.31	0.20	0.22
TiO_2	4.55		1.41	1.32	3.56	1.57	3.80	1.90
P_2O_5	0.18		0.03	0.03	0.03	0.03	0.07	0.01
MnO	0.21		0.18	0.12	0.18	0.11	0.28	0.22
H_2O	1.28		2.36	0.73	0.96	0.78	2.05	2.51
S	0.07		0.04	0.00	0.36	0.02	0.00	0.01
CO_2	0.08		0.05	0.03	0.10	0.12	0.43	0.21
Other	0.40		0.23	0.12	0.32	0.16	0.23	0.19
O=S	-0.03		-0.02	0.00	-0.14	-0.01	0.00	0.00
Total	100.81		100.68	100.73	100.08	100.85	100.38	100.41
Ni (ppm)	59	80	91	35	162	44	137	130
Cr	163	130	68	23	141	39	215	171
Cu	45		135	7	227	21	5	16
Zn	143		136	80	83	75	153	179
Pb	0		0	0	39	0	0	0
Rb	5		18	3	13	2	2	11
Sr	113		91	165	165	155	8	13
Ba	165		336	143	42	162	141	75
Li	12		12	12	10	12	11	14
Be	5		3	6	0	6	2	3
V	1681	900	600	306	1260	520	761	613
FeO (T)	22.00	18.06	17.40	9.96	15.04	9.57	21.00	20.46
TiO_2	4.55	1.92	1.41	1.32	3.56	1.57	3.80	1.90
V_2O_5	0.30	0.16	0.11	0.05	0.22	0.09	0.14	0.11

4 Sample locations are shown in Figure 6.Sample 19-AA, magnetite-bearing garnetiferous leucogabbro; 19-AB, fine grained mafic dyke (Molson diabase); 19-AC, gossan in fine grained mafic dyke; 19-AD, leucogabbro; 19-AE leucogabbro; 19-AF, oikocrystic anorthosite; 19-AG-1, 19-AG-2 mafic pegmatite.

Location 1: Whole rock and trace element analyses

Sample[5]	19-AH	19-AI	19-AJ	19-AK	19-AM-2	19-AN	19-AO
Unit	6	6	4	6	6	6	6
SiO_2			43.90	4.79		16.60	
Al_2O_3			21.10	4.45		5.23	
Fe_2O_3			1.41	37.21		19.45	
FeO			12.84	31.72		29.00	
CaO			10.06	0.56		3.71	
MgOO			4.18	2.69		3.96	
Na_2OO			2.28	0.08		0.51	
K2O			0.23	0.04		0.19	
TiO_2			2.67	14.23		20.05	
P_2O_5			0.09	0.01		0.02	
MnO			0.19	0.31		0.45	
H_2O			0.96	1.50		0.89	
S			0.00	0.01		0.05	
CO_2			0.14	0.07		0.08	
Other			0.15	1.33		0.81	
O=S			0.00	0.00		-0.02	
Total			100.20	99.00		100.98	
Ni (ppm)	180	10	56	181	180	79	120
Cr	290	180	55	244	180	378	310
Cu			12	82		43	
Zn			117	363		249	
Pb			38	0		0	
Rb			13	0		7	
Sr			135	0		4	
Ba			38	71		136	
Li			9	7		7	
Be			0	2		2	
V	5700	1400	538	6686	5500	3812	6200
FeO (T)	69.10	16.43	14.11	65.20	64.50	46.50	67.20
TiO_2	17.10	4.95	2.67	14.23	15.00	20.05	14.50
V2O5	1.02	0.25	0.10	1.19	0.98	0.68	1.11

5 Sample locations are shown in Figure 6. Sample 19-AH, south layer, magnetite rock, south contact; 19-AI, south layer, magnetite rock, south contact; 19-AJ, garnetiferous leucogabbro; 19-AK, south layer, 1 metre north of south contact; 19-AM-2, south layer, 1 metre north of south contact; 19-AN, magnetite, south layer, 2 metres north of south contact; 19-AO magnetite, north edge of south layer.

Location 1: Whole rock and trace element analyses:

Sample[6]	10	13A	14	15	16B	17A	17B	18
Unit	3b	4a	9	6	6	4a	4a	4a
SiO_2	38.00	14.60	36.00	2.80	6.00	40.50	25.80	31.80
Al_2O_3	18.00	10.10	13.60	4.70	7.30	19.30	14.40	17.70
Fe_2O_3	8.60	27.00	7.00	36.80	33.10	6.10	16.00	8.60
FeO	9.40	25.20	17.50	32.20	30.20	13.40	22.70	23.00
CaO	15.80	3.73	6.90	0.07	1.15	9.12	5.41	6.83
MgO	4.55	2.59	9.40	2.30	2.88	3.21	3.00	2.42
Na_2O	0.09	0.41	0.92	0.02	0.04	2.67	1.05	0.91
K2O	0.06	0.14	0.16	0.02	0.02	0.24	0.20	0.19
TiO_2	0.60	11.43	2.75	17.66	15.21	3.67	8.70	6.78
P_2O_5	0.03	0.03	0.02	0.01	0.01	0.03	0.02	0.02
MnO	0.10	0.32	0.26	0.37	0.34	0.15	0.32	0.38
H_2O	4.31	1.61	3.77	1.41	2.25	1.40	1.97	1.12
S	0.01	0.03	0.14	0.01	0.03	0.08	0.09	0.15
CO_2	0.10	0.10	0.07	0.05	0.09	0.14	0.05	0.09
Other	0.17	1.00	0.31	1.61	1.19	0.33	0.67	0.58
O=S	0.00	-0.01	-0.06	0.00	-0.01	-0.03	-0.04	-0.06
Total	99.82	98.28	98.74	100.03	99.80	100.31	100.34	100.51
Ni (ppm)	36	287	204	165	51	40	74	69
Cr	27	238	146	330	33	78	183	324
Cu	8	79	301	27	50	54	49	56
Zn	58	211	174	364	175	127	181	123
Pb	20	12	18	0	0	26	26	34
Rb	13	7	7	0	0	12	9	8
S	256	27	11	0	14	148	76	110
Ba	126	100	108	45	50	110	57	75
Li	22	16	15	6	8	13	17	20
Be	2	0	2	0	0	2	3	3
V	550	4900	1048	8320	6387	1427	3230	2662
FeO (T)	17.14	49.49	23.80	65.31	59.98	18.89	37.10	30.74
TiO_2	0.60	11.43	2.75	17.66	15.21	3.67	8.70	6.78
$V2O_5$	0.10	0.87	0.19	1.49	1.14	0.25	0.58	0.48

6 Sample locations are shown in Figure 6. Sample 10, epidote-rich oikocrystic anorthosite, south of south magnetite layer; 13A, coarsely porphyritic magnetite-bearing gabbro, south of centre magnetite layer; 14, chloritic, mesocratic fine grained mafic dyke, possible Molson diabase, intruded along a fault, cross cutting the exposure; 15, massive magnetite, centre layer, 87 cm north of south contact; 16B, foliated magnetite, north contact of north layer; 17A and B magnetite-bearing leucogabbro, south of north layer; 18, magnetite-rich garnetiferous leucogabbro, north contact of centre layer.

B3. Location 1: Serial samples

Sample[1]	E1-A	E1-B	E1-C	E1-D	E2-A	E2-B	E2-C	E2-D	E2-E
cm	0	5	10	15	20	25	30	35	40
FeO (T)	67.10	67.90	63.60	60.80	61.40	53.00	65.80	67.70	67.60
TiO_2	15.30	15.00	14.50	13.50	13.50	11.50	14.90	15.20	15.00
V_2O_5	1.09	1.07	1.05	1.02	1.00	0.87	1.11	1.11	1.16
V (ppm)	6100	6000	5900	5700	5600	4900	6200	6200	6500
Ni	170	150	120	130	120	150	150	210	110
Cr	220	220	220	220	220	210	290	310	260

1 Sample locations are shown in Figure 6. Serial sample, south magnetite layer (Unit 6). Samples 68-4-19-E1 and E2 taken near north edge of south layer over 45 cm at 5 cm intervals.

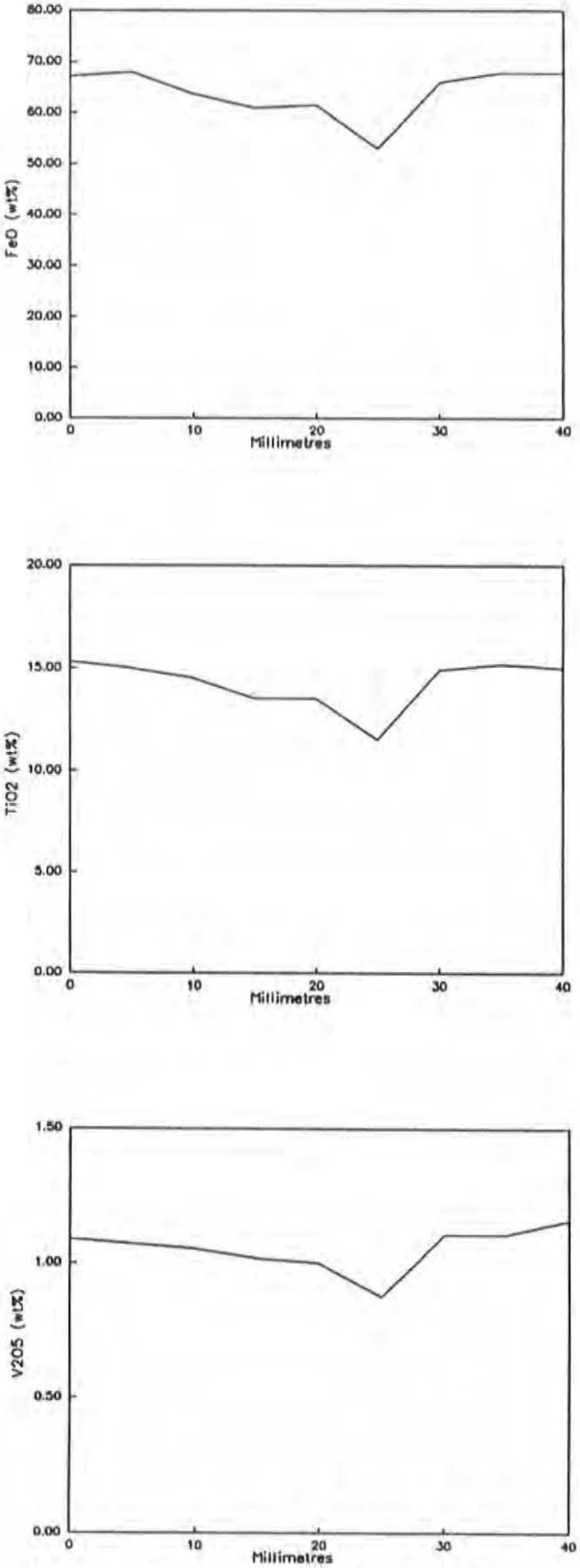
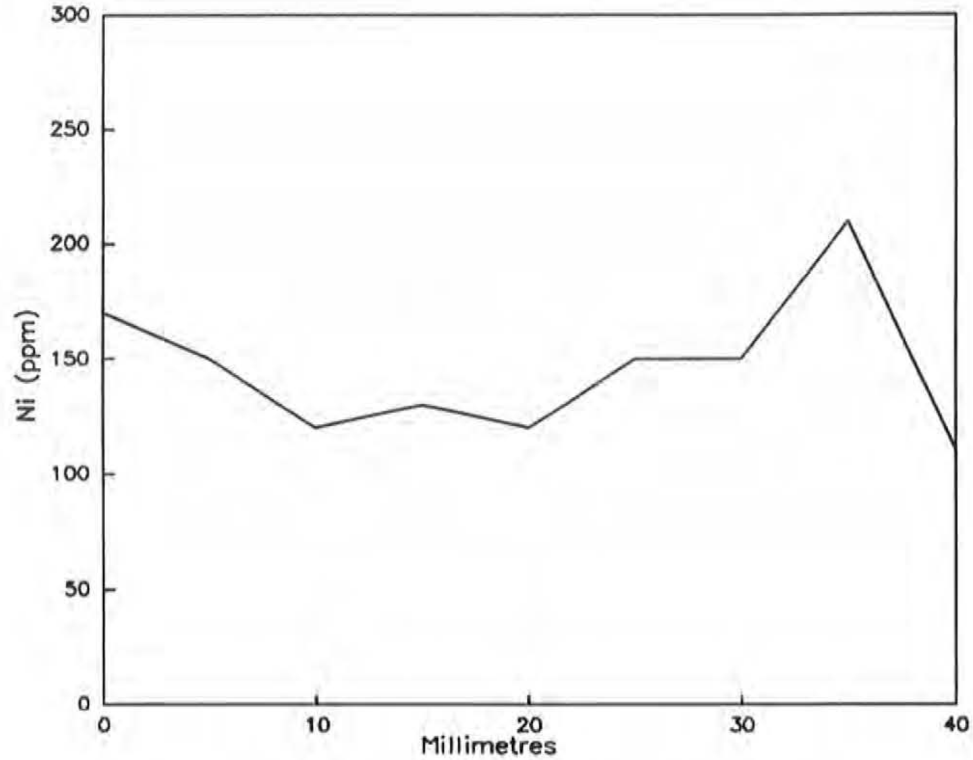


Figure 51: Location 1. South magnetite layer, FeO, TiO_2 and V_2O_5 values (small scale variations). Serial samples 68-4-19-E1-A to E2-E.



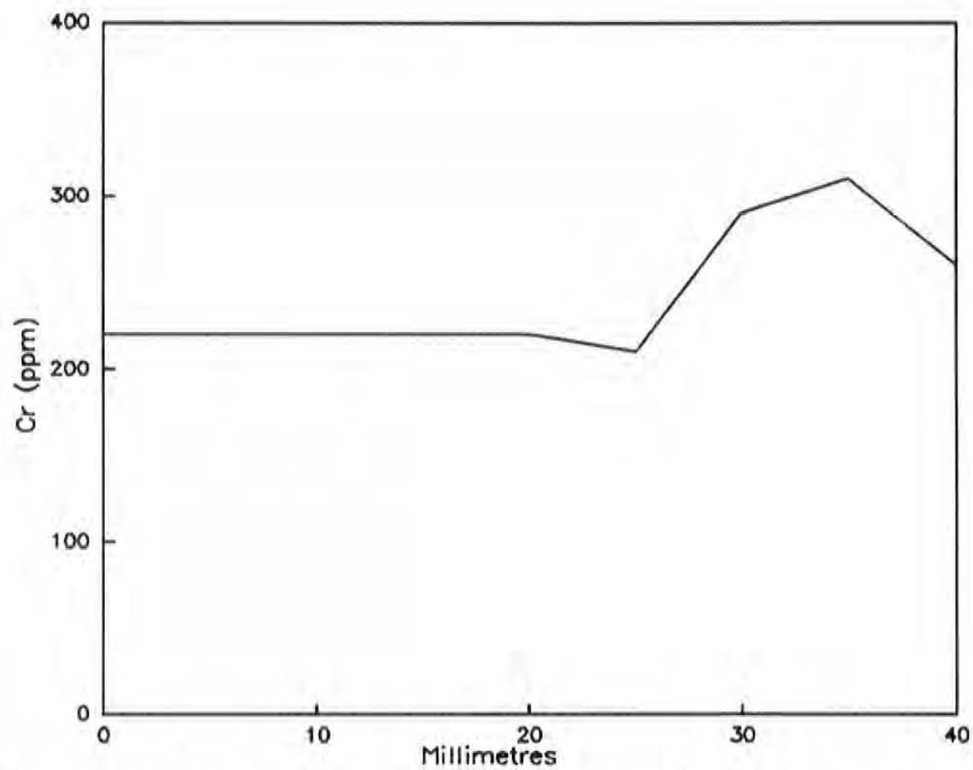


Figure 52: Location 1. South magnetite layer, Ni and Cr values(small scale variations). Serial samples 68-4-19-E1-A to E2-E.

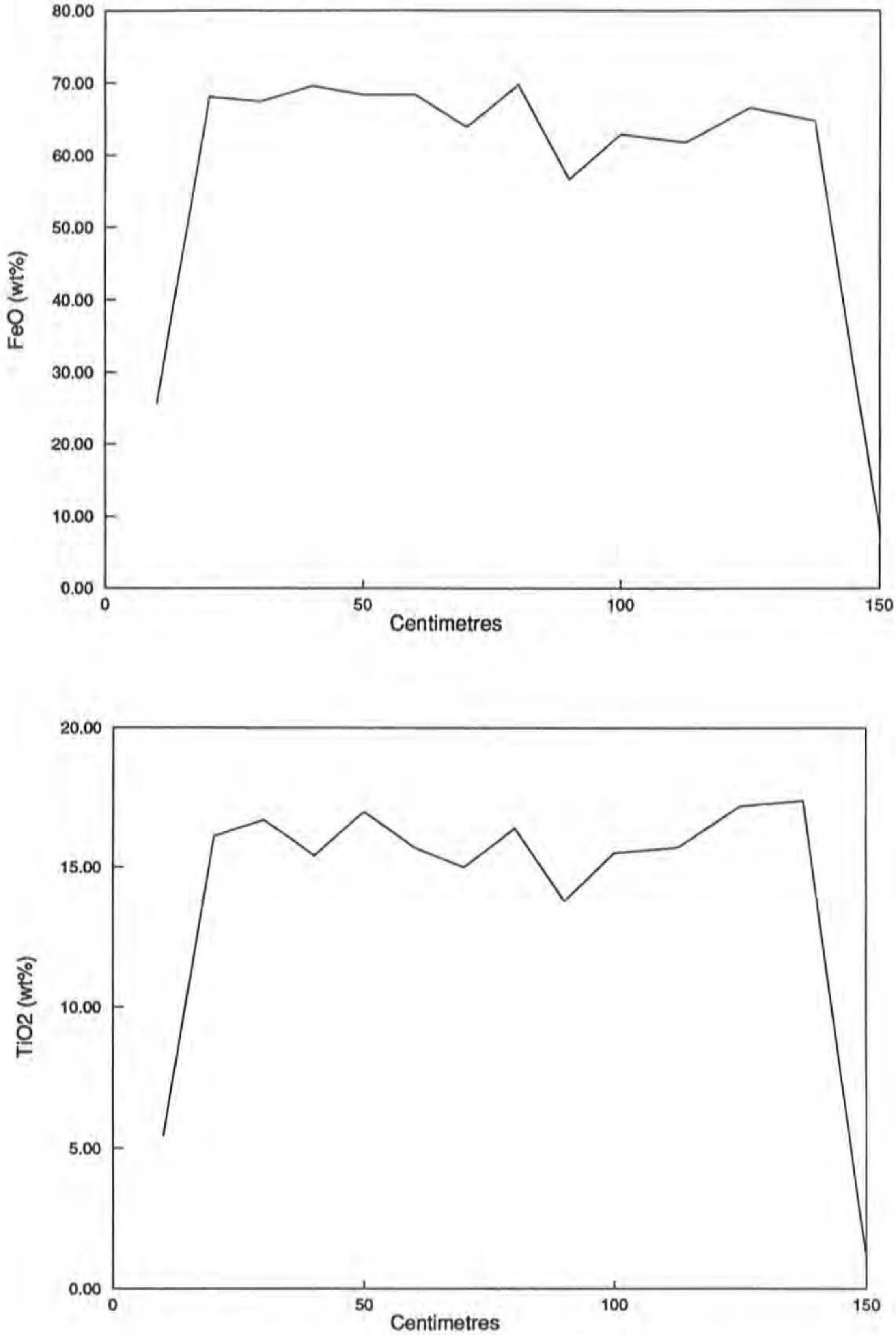


Figure 53: Location 1. North magnetite layer, FeO and TiO_2 values. Serial samples 68-4-19-V-1 to V-10 and W-1 to W-4. South (left) to north (right).

Location 1: Serial samples:

Sample[1]	V-1	V-2	V-3	V-4	V-5	V-6	V-7
cm	10	20	30	40	50	60	70
Ni (ppm)	0	40	30	30	30	60	80
Cr	30	80	50	80	50	50	70
V	600	6200	5700	5200	5500	5400	5800
FeO (T)	8.20	64.80	66.60	61.80	63.00	56.70	69.70
TiO_2	1.14	17.40	17.20	15.70	15.50	13.80	16.40
V_2O_5	0.11	1.11	1.02	0.93	0.98	0.96	1.04

Sample	V-8	V-9	V-10	W-1	W-2	W-3	W-4
cm	80	90	100	112.5	125	137.5	150
Ni (ppm)	80	90	110	153	118	63	83
Cr	50	50	70	48	66	91	25
V	5700	5700	6200	5087	5000	4750	2009
FeO (T)	64.00	68.40	68.40	69.60	67.40	68.10	25.80
TiO_2	15.00	15.70	17.00	15.40	16.70	16.10	5.46
V_2O_5	1.02	1.02	1.11	0.91	0.89	0.85	0.36

1 Sample locations are shown in Figure 6. Serial sample of north magnetite layer. Samples 68-4-19-V and W. Taken across strike from north to south. Sample V-1 is anorthosite (Unit 3), sample V-2 to W-2 are magnetite (Unit 6), W-3 magnetite- bearing leucogabbro (Unit 4a), W-4 leucogabbro (Unit 3). Samples taken at 10 cm intervals.

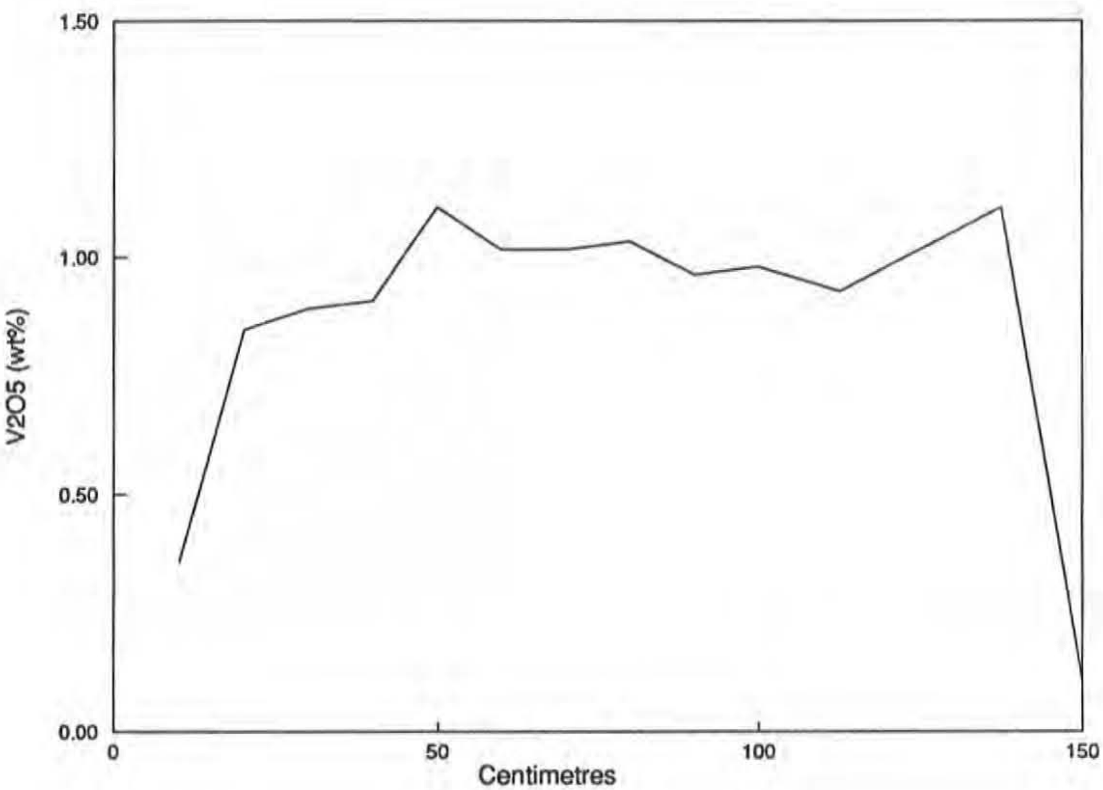


Figure 54: Location 1. North magnetite layer, V_2O_5 values. Serial samples 68-4-19-V-1 to V-10 and W-1 to W-4.

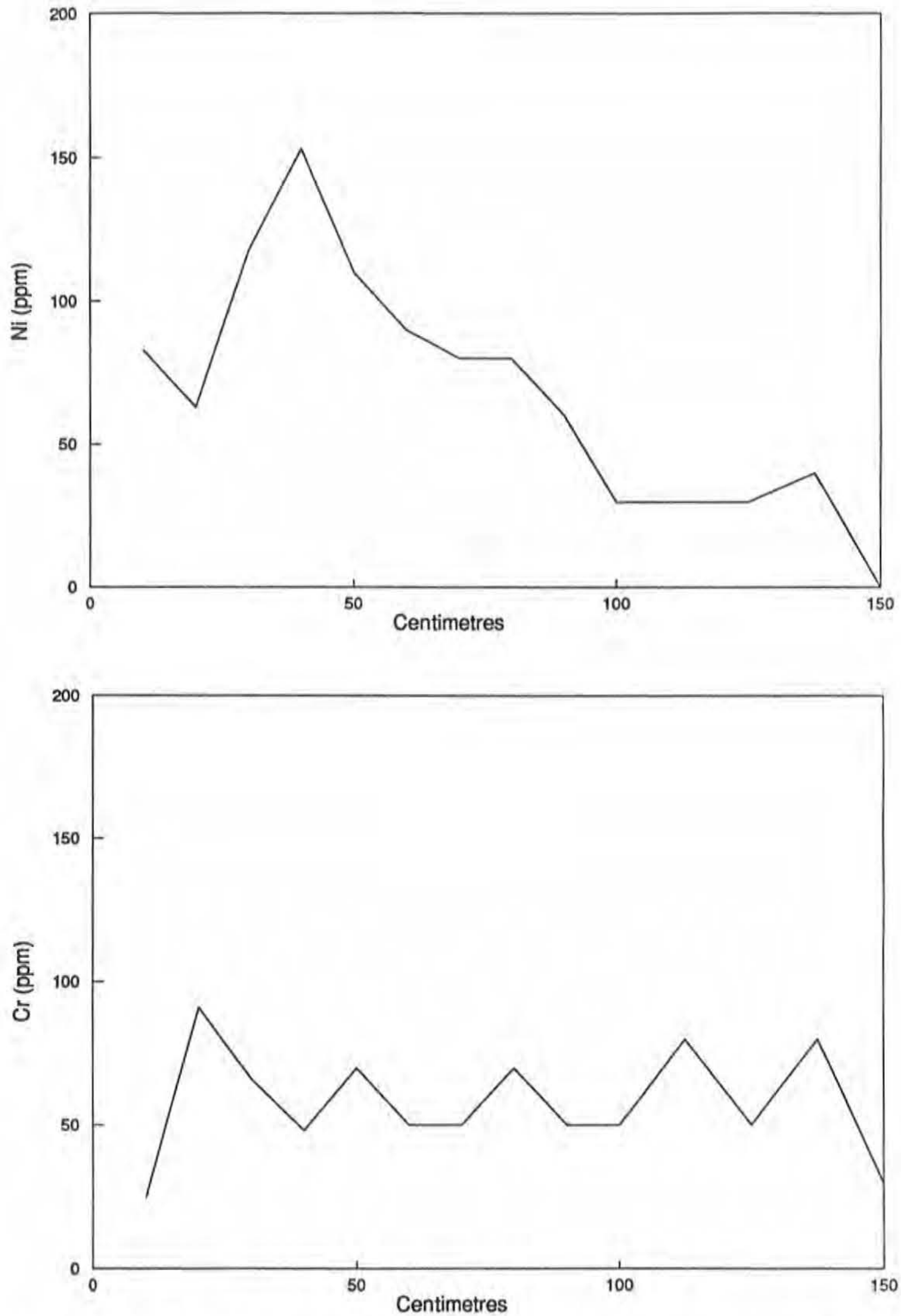


Figure 55: Location 1. North magnetite layer, Ni and Cr values. Serial samples 68-4-19-V-1 to V-10 and W-1 to W-4. South (left) to north (right).

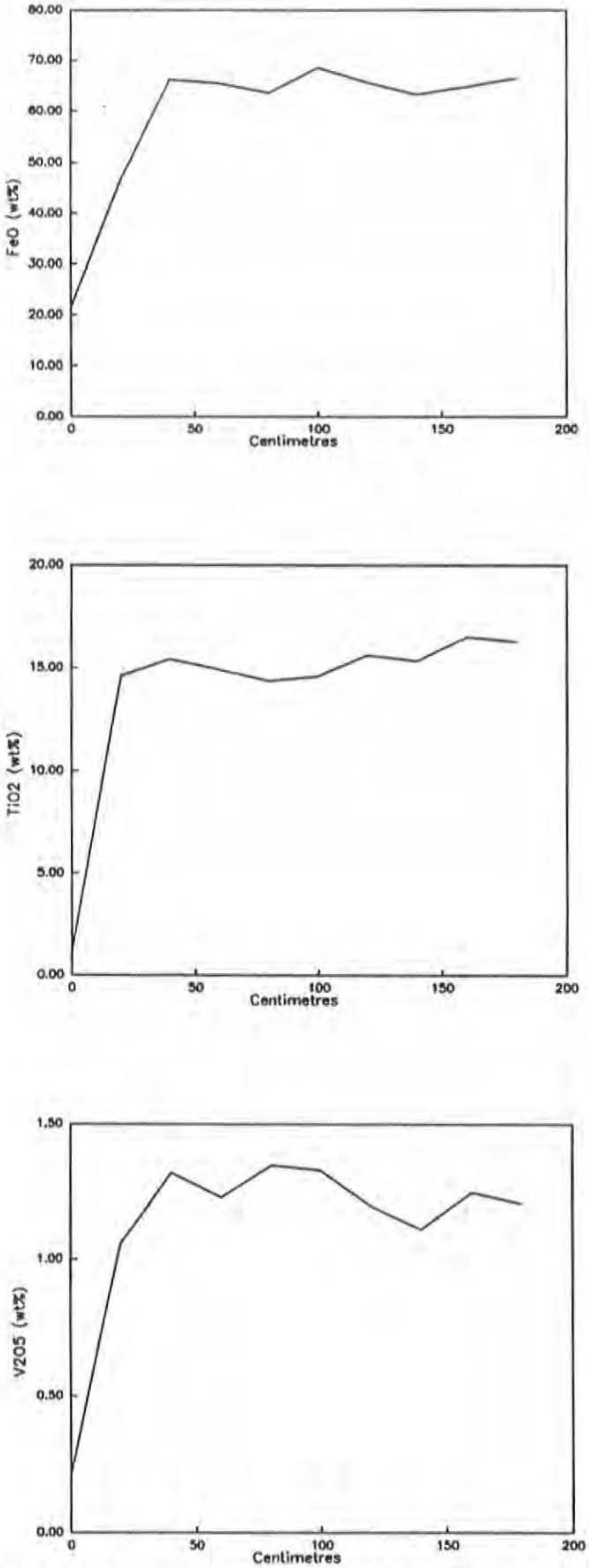


Figure 56: Location 1. Centre magnetite layer, FeO, TiO_2 and V_2O_5 values. Serial samples 68-5-600-1A to 1Y. South (left) to north (right).

Location 1: Serial samples:

Sample[1]	1A	1B	1D	1F	1I	1L	1O	1R	1V	1Y
cm	0	20	40	60	80	100	120	140	160	180
SiO_2	3.10					4.80				39.10
Al_2O_3	4.90					4.60				16.60
Fe_2O_3	37.80					36.60				5.20
FeO	32.40					30.70				16.70
CaO	0.18					0.46				10.17
MgO	2.42					3.58				7.09
Na_2O	0.03					0.05				1.31
K2O	0.03					0.03				0.31
TiO_2	16.26					14.34				1.12
P_2O_5	0.01					0.02				0.10
MnO	0.31					0.31				0.25
H_2O	0.53					1.89				2.46
S	0.76					0.08				0.00
CO_2	0.08					0.12				0.13
Other	1.47					1.46				0.26
O=S	-0.30					-0.03				0.00
Total	99.98					99.01				100.80
Ni (ppm)	197	132	140	162	187	210	227	168	54	53
Cr	950	296	300	285	285	252	212	194	217	43
Cu	469	23	27	43	33	55	97	129	223	9
Zn	282	294	317	317	354	291	289	256	197	138
Pb	0	0	0	0	0	0	0	0	0	13
Rb	0	4	0	0	5	0	5	5	10	12
Sr	0	0	0	0	0	10	0	0	7	19
Ba	20	0	0	0	0	0	0	0	26	89
Li	10	9	11	12	9	13	10	11	13	24
Be	0	2	3	2	0	0	2	0	0	0
V	6748	6975	6214	6695	7425	7536	6877	7385	5943	1160
FeO (T)	66.41	64.80	63.20	65.60	68.50	63.63	65.40	66.20	46.60	21.38
TiO_2	16.26	16.50	15.30	15.60	14.60	14.34	14.90	15.40	14.60	1.12
$V2O_5$	1.20	1.25	1.11	1.20	1.33	1.35	1.23	1.32	1.06	0.21

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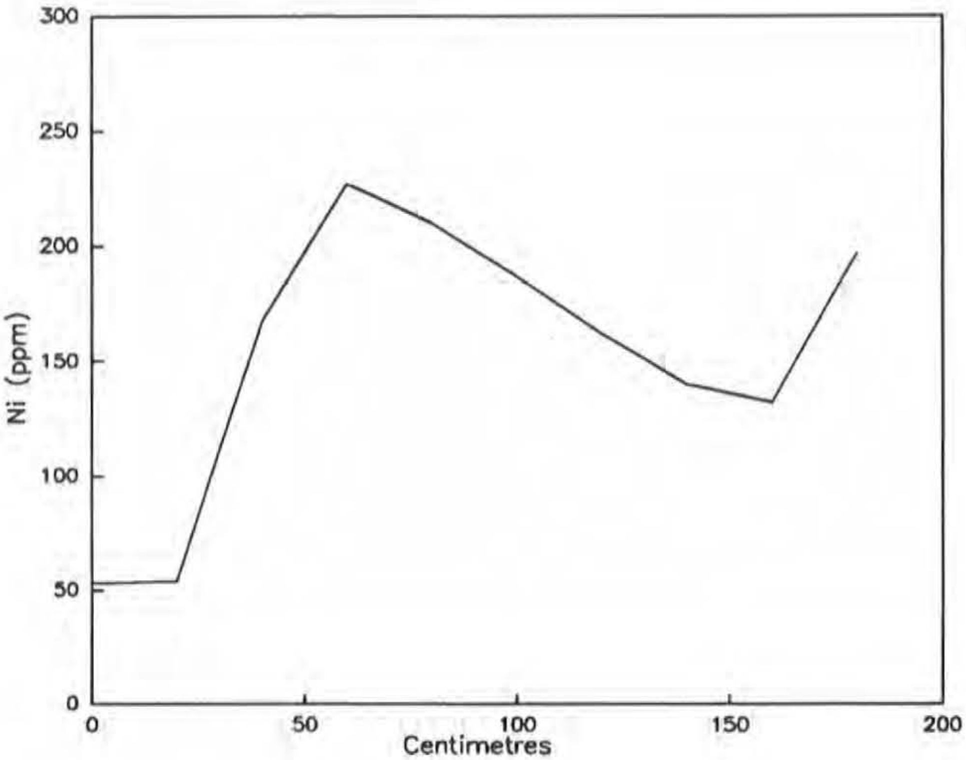
1 Sample locations are shown in Figure 6. Location 1: 68-5-600-1 A to Y. Serial sample across centre magnetite layer (Unit 6). North (left) to south (right), over 190 cm. Sample interval 20 cm.



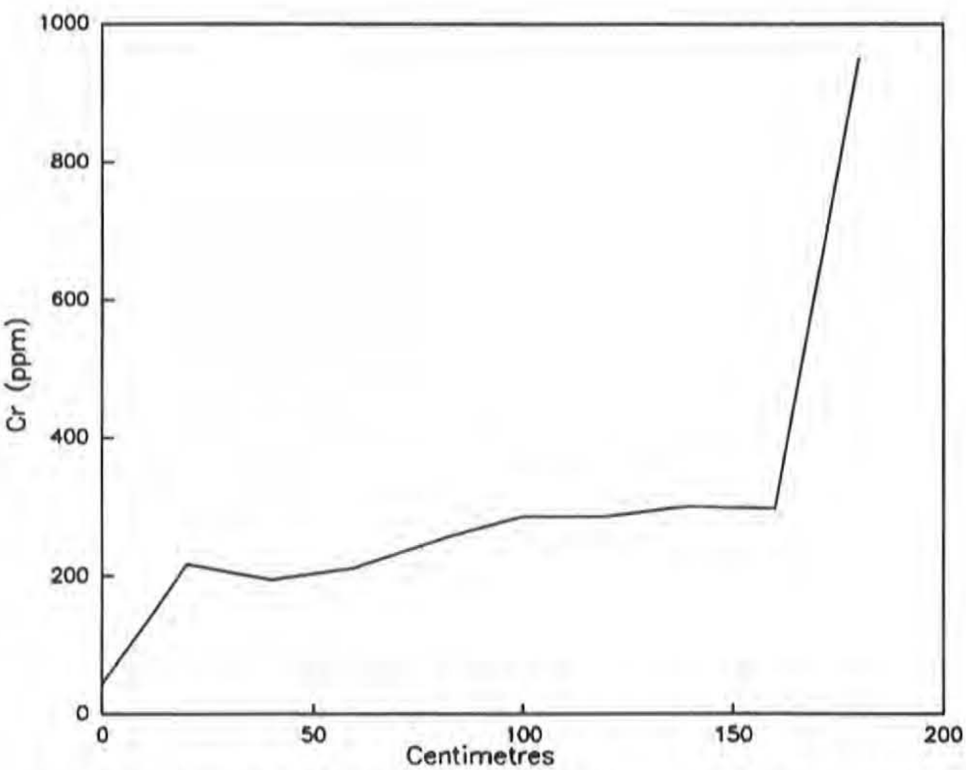


Figure 57: Location 1. Centre magnetite layer, Ni and Cr values. Serial samples 68-5-600-1A to 1Y. South (left) to north (right).

Location 1: Serial samples:

Sample[1]	600-3D	600-3A	600-4B	600-4A	600-5C	600-5A
cm	0	25	45	60	80	100
SiO_2	4.40			2.60		3.70
Al_2O_3	3.80			5.30		3.90
Fe_2O_3	35.90			36.30		37.90
FeO	30.60			32.80		30.20
CaO	0.47			0.19		0.03
MgO	2.63			2.35		3.24
Na_2O	0.04			0.06		0.03
K2O	0.03			0.02		0.02
TiO_2	17.36			16.47		16.12
P_2O_5	0.02			0.03		0.02
MnO	0.36			0.33		0.31
H_2O	2.07			1.16		2.11
S	0.06			0.09		0.49
CO_2	0.10			0.07		0.06
Other	1.18			1.34		1.21
O=S	-0.02			-0.04		-0.20
Total	99.00			99.07		99.14
Ni (ppm)	84	79	78	111	100	121
Cr	32	22	28	32	52	126
Cu	73	42	36	33	31	158
Zn	130	395	513	441	342	227
Pb	0	0	0	0	0	0
Rb	5	9	10	10	0	12
Sr	0	0	0	0	0	0
Ba	23	0	108	25	35	30
Li	8	13	29	8	10	8
Be	0	0	0	0	0	0
V	6366	6494	6580	7017	6653	6310
FeO (T)	62.90	67.00	67.60	65.46	66.40	64.30
TiO_2	17.36	16.90	16.90	16.47	16.20	16.12
V_2O_5	1.14	1.16	1.17	1.25	1.19	1.13

1 Sample locations are shown in Figure 6. Samples 68-5-600-3, -4, and -5. North magnetite layer (Unit 6), 1 metre thick. North to south. Sample spacing as shown.

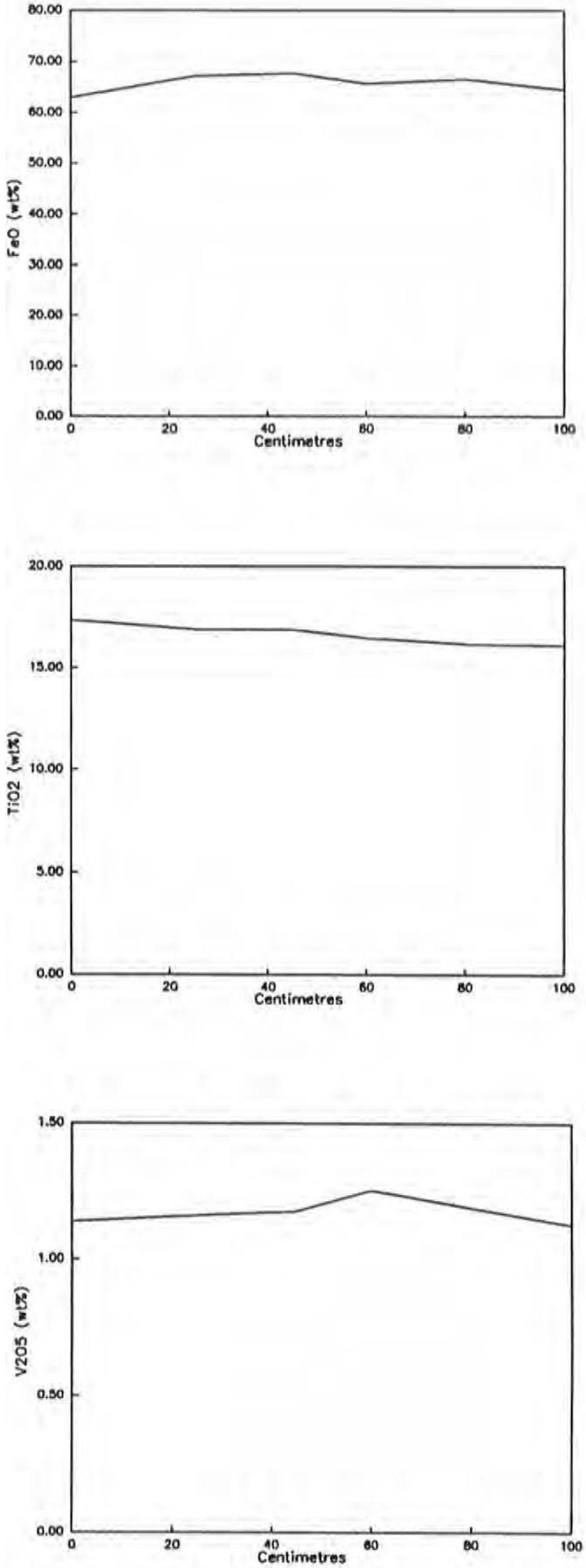
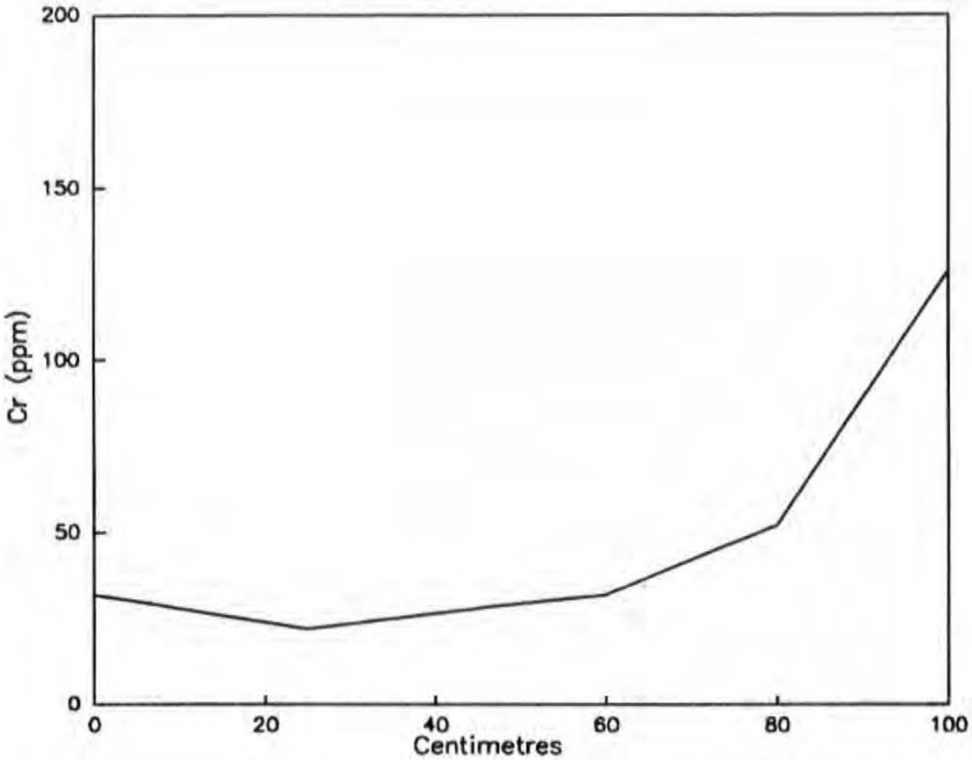


Figure 58: Location 1. North magnetite layer, FeO, TiO_2, and V_2O_5 values. Serial samples 68-5-600-3-A to 3-D, 4-A and B and 5-A to 5-D. South (left) to north (right).



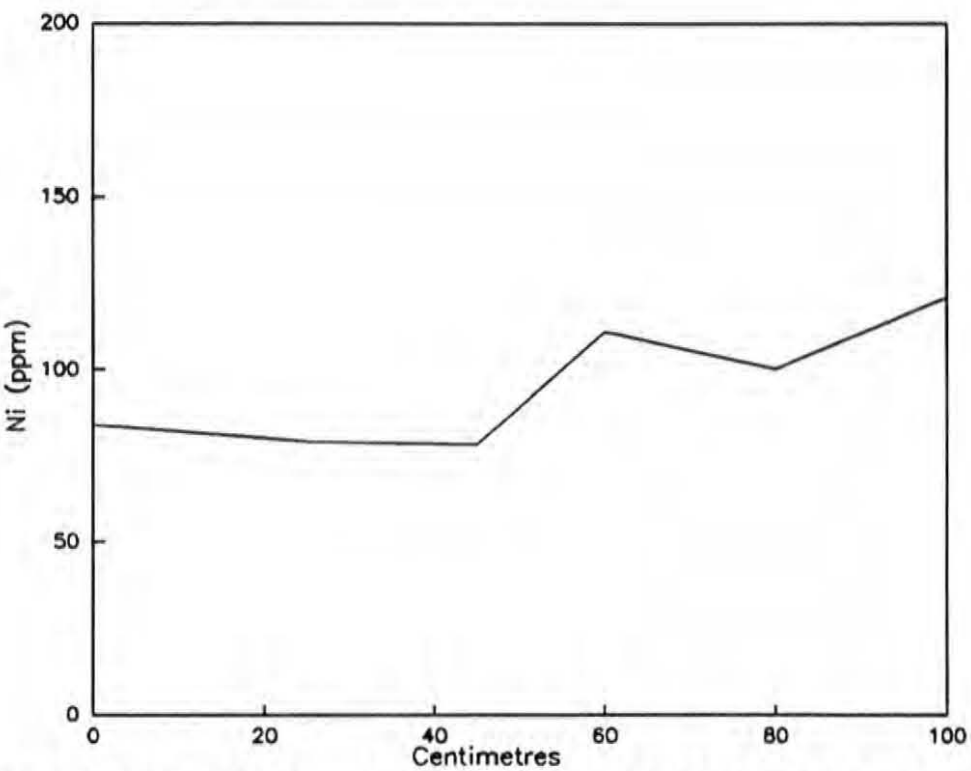
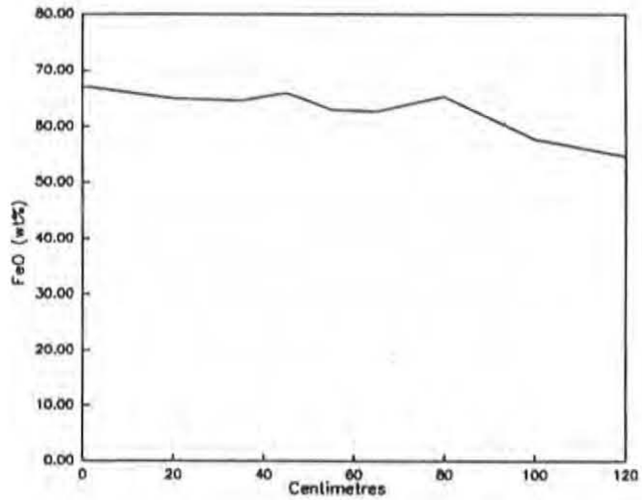
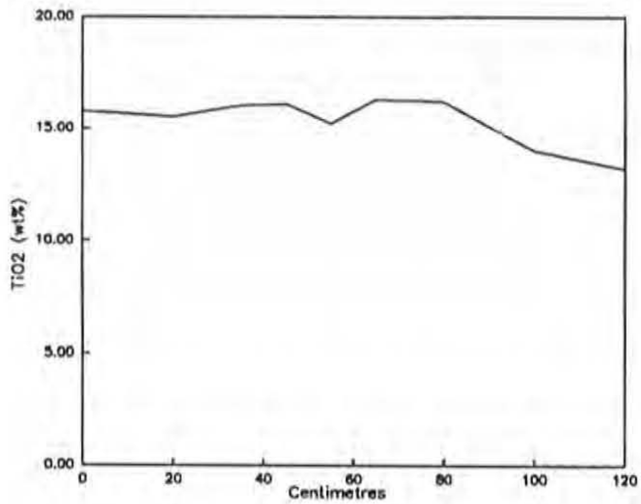


Figure 59: Location 1. North magnetite layer, Ni and Cr values. Serial samples 68-5-600-3-A to 3-D, 4-A and B and 5-A to 5-D. South (left) to north (right).





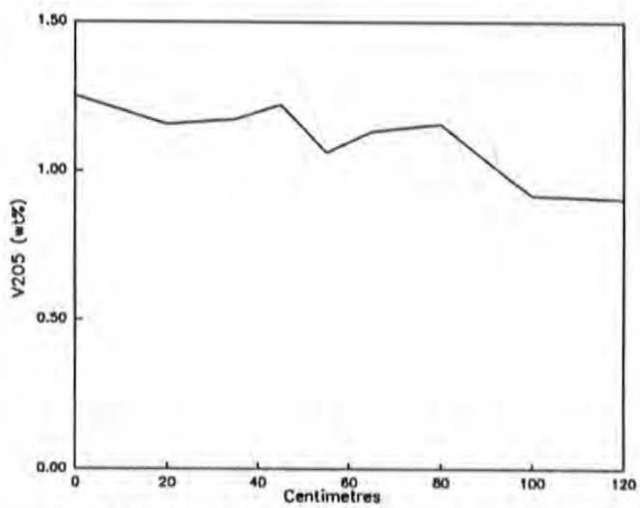
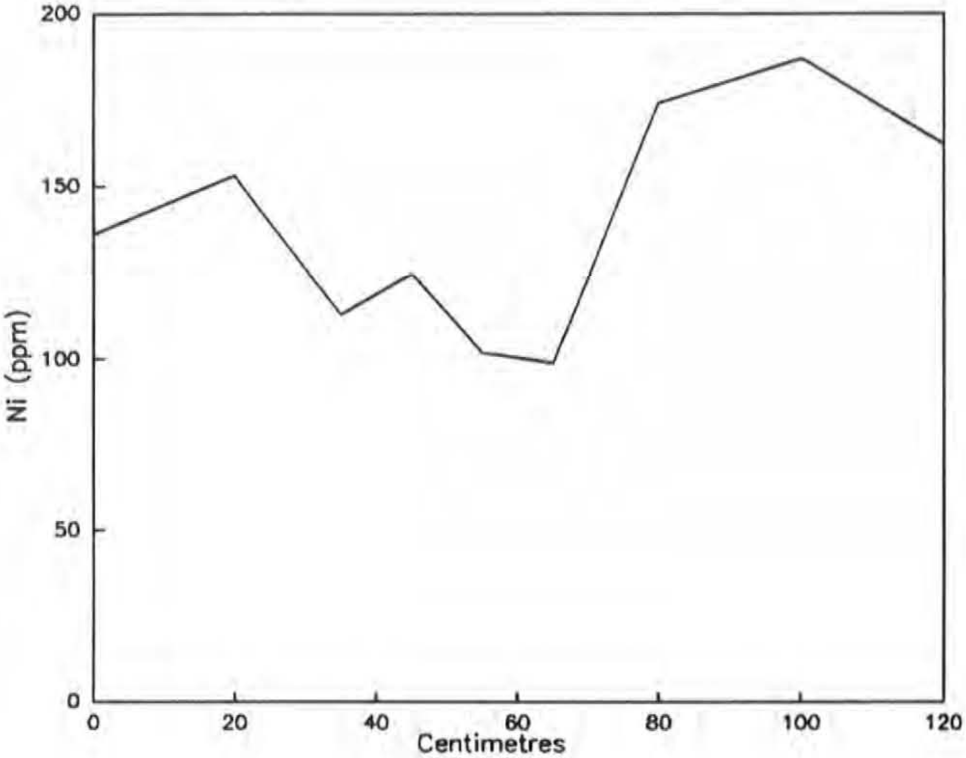


Figure 60: Location 1. Centre magnetite layer, FeO, TiO_2 and V_2O_5 values. Serial samples 68-5-600-2-A to 2-E, 6-A and 6-B, and 7-A to 7-M. South (left) to north (right).

Location 1: Serial samples:

Sample[1]	2A	2C	2E	6A	6B	7A	7F	7J	7M
cm	0	20	35	45	55	65	80	100	120
SiO_2	11.10	00.00	00.00	00.00	00.00	3.40	00.00	00.00	2.80
Al_2O_3	8.30					3.60			3.60
Fe_2O_3	29.00					37.60			39.00
FeO	28.50					32.20			32.10
CaO	2.68					0.20			0.08
MgO	2.85					2.75			2.53
Na_2O	0.17					0.03			0.03
K2O	0.18					0.02			0.02
TiO_2	13.18					16.08			15.77
P_2O_5	0.02					0.01			0.01
MnO	0.29					0.32			0.32
H_2O	2.33					1.53			1.30
S	0.43					0.05			0.07
CO_2	0.32					0.17			0.07
Other	1.07					1.33			1.37
O=S	-0.17					-0.02			-0.03
Total	100.25					99.27			99.04
Ni (ppm)	162	187	174	99	102	125	113	153	136
Cr	523	566	904	860	467	252	282	281	294
Cu	235	303	257	83	22	41	51	100	56
Zn	224	190	222	249	279	353	315	269	359
Pb	0	0	0	0	0	0	0	0	0
Rb	14	14	9	0	0	15	0	0	22
Sr	41	29	0	0	6	0	7	6	0
Ba	62	37	0	83	149	28	82	78	33
Li	16	17	14	17	32	10	19	22	0
Be	0	0	0	0	0	0	0	0	0
V	5053	5130	6476	333	5941	6848	6566	6475	7017
FeO (T)	54.59	57.60	65.30	62.60	63.00	66.03	64.50	65.00	67.19
TiO_2	13.18	14.00	16.20	16.30	15.20	16.08	16.00	15.50	15.77
V_2O_5	0.90	0.92	1.16	1.13	1.06	1.22	1.17	1.16	1.25

1 Sample locations are shown in Figure 6. Centre magnetite layer (Unit 6). North to south. Starting in magnetite-bearing leucogabbro (Unit 4a), contact with magnetite layer at 24 cm.



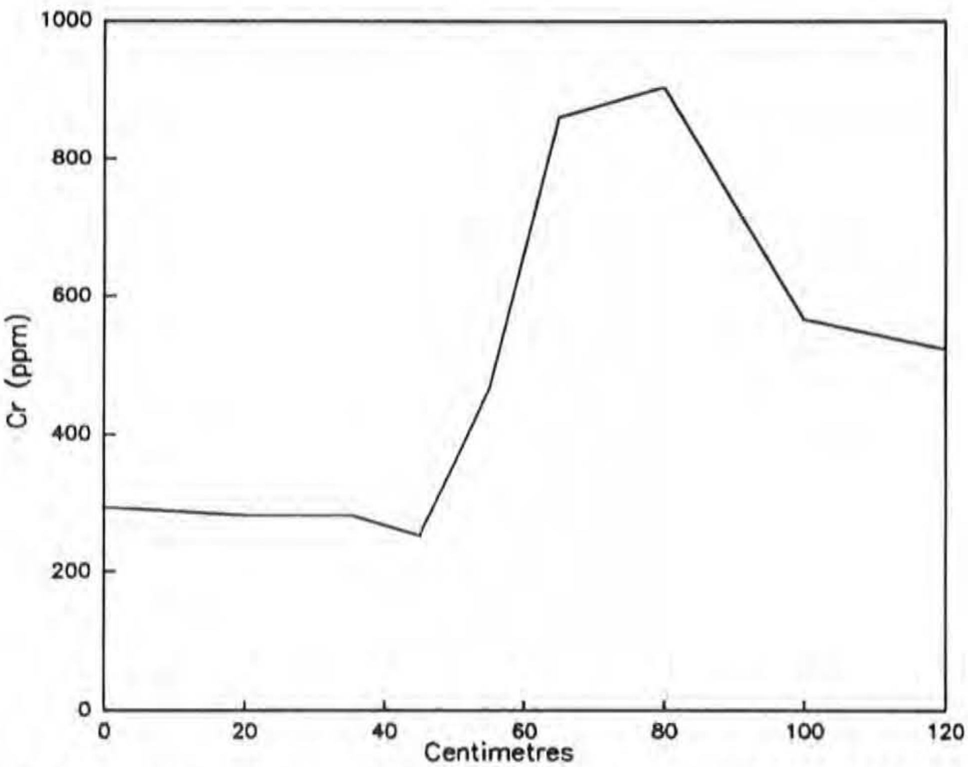
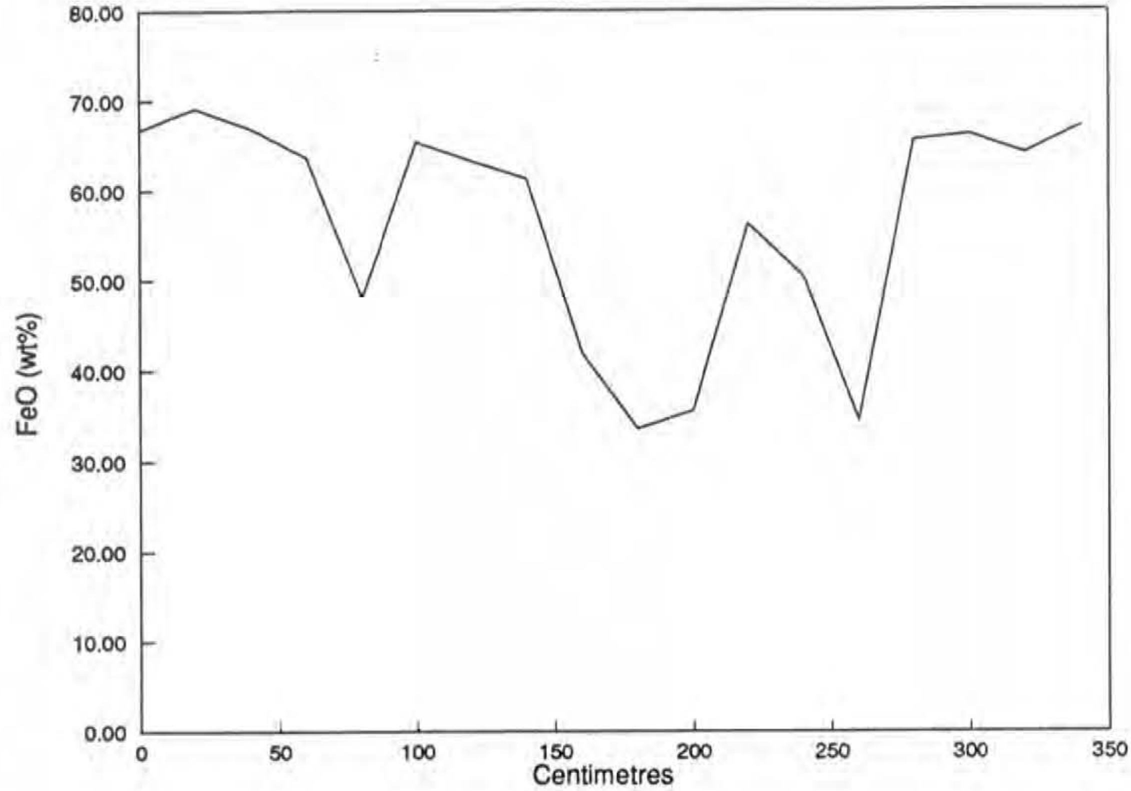


Figure 61: Location 1. Centre magnetite layer, Ni and Cr values. Serial samples 68-5-600-2-A to 2-E, 6-A and 6-B, and 7-A to 7-M. South (left) to north (right).

Location 1: Serial samples:

Sample[1]	8A	8C	8G	8I	8K	8L	8P	8S	8W
cm	0	20	40	60	80	100	120	140	160
SiO_2	3.10				15.20			7.40	
Al_2O_3	3.50				4.30			4.60	
Fe_2O_3	37.80				22.80			34.10	
FeO	32.70				27.50			30.50	
CaO	0.23				3.28			1.31	
MgO	2.11				4.53			3.18	
Na_2O	0.04				0.38			0.16	
K2O	0.02				0.10			0.06	
TiO_2	16.92				18.69			15.39	
P_2O_5	0.01				0.01			0.01	
MnO	0.35				0.44			0.34	
H_2O	1.48				1.46			1.66	
S	0.08				0.00			0.06	
CO_2	0.10				0.13			0.07	
Other	1.25				0.82			1.27	
O=S	-0.03				0.00			-0.02	
Total	99.66				99.64			100.09	
Ni (ppm)	216	172	208	176	153	209	186	151	93
Cr	275	435	185	307	335	244	197	211	225
Cu	54	28	55	22	25	43	56	49	98
Zn	327	819	244	357	335	294	307	385	185
Pb	0	0	0	0	0	0	0	0	18
Rb	17	0	0	0	22	5	5	6	0
Sr	0	0	0	6	7	0	0	6	8
Ba	25	0	0	0	45	0	48	0	26
Li	0	4	3	4	0	5	7	11	7
Be	0	0	0	0	0	0	0	0	0
V	6328	6083	5855	5950	3939	5948	6060	6532	3310
FeO (T)	66.71	69.00	66.80	63.50	48.02	65.20	63.10	61.18	41.90
TiO_2	16.92	17.10	16.10	15.80	18.69	15.70	15.20	15.39	20.50
V2O5	1.13	1.09	1.05	1.06	0.70	1.06	1.08	1.17	0.59

1 Sample locations are shown in Figure 6. Samples 600-8 and 600-9: Serial samples across south magnetite layer (Unit 6), from south to north, 20 cm sample interval over 3.6 metres.



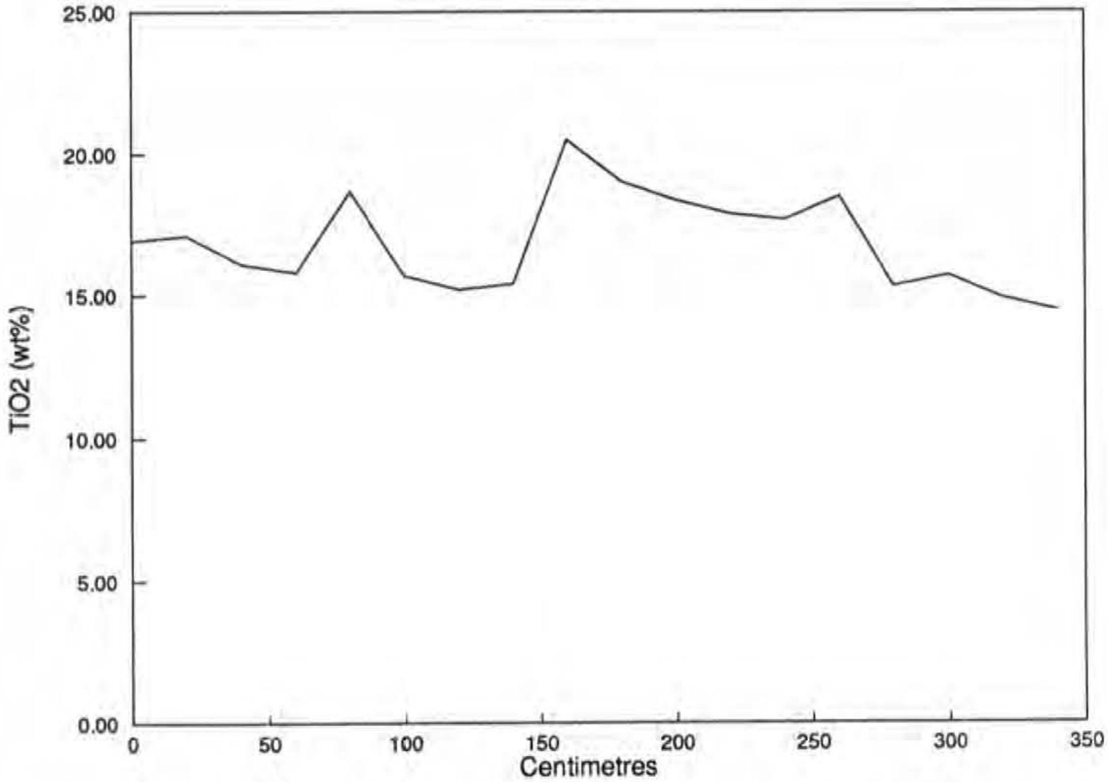


Figure 62: Location 1. South magnetite layer, FeO and TiO_2 values. Serial samples 68-5-600-8-A to 8-AC and 9-A to 9-J. South (left) to north (right).

Sample	8Y	8AA	8AC	9A	9C	9E	9G	9H	9J
cm	180	200	220	240	260	280	300	320	340
SiO_2		23.70	10.10	14.20					3.30
Al_2O_3		6.20	3.80	4.10					3.80
Fe_2O_3		11.60	29.20	24.70					39.60
FeO		25.10	29.90	28.20					31.40
CaO		5.46	2.41	3.46					0.11
MgO		5.79	3.07	3.51					2.36
Na_2O		0.62	0.30	0.38					0.04
K2O		0.17	0.09	0.12					0.03
TiO_2		18.36	17.87	17.66					14.44
P_2O_5		0.02	0.11	0.06					0.01
MnO		0.42	0.37	0.37					0.28
H_2O		1.50	1.12	1.14					1.93
S		0.01	0.01	0.00					1.05
CO_2		0.13	0.04	0.05					0.79
Other		0.49	1.07	1.08					1.48
O=S		0.00	0.00	0.00					-0.42
Total		99.57	99.46	99.03					100.20
Ni (ppm)	73	61	100	82	110	156	160	148	266
Cr	277	300	325	371	289	293	325	302	799
Cu	41	32	32	45	120	28	39	26	504
Zn	184	182	380	290	188	433	427	385	223
Pb	0	0	0	0	23	0	0	0	0
Rb	0	8	6	22	4	0	4	0	5
Sr	13	13	8	9	17	0	0	0	0
Ba	20	91	58	82	74	0	51	75	48
Li	10	10	11	9	11	7	17	13	17
Be	0	2	0	0	0	0	0	3	0
V	1558	2246	5324	5394	1997	6947	7135	6635	6863
FeO (T)	33.50	35.54	56.17	50.43	34.40	65.40	66.10	64.00	67.03
TiO_2	19.00	18.36	17.87	17.66	18.50	15.30	15.70	14.90	14.44
V2O5	0.28	0.40	0.95	0.96	0.36	1.24	1.27	1.18	1.23

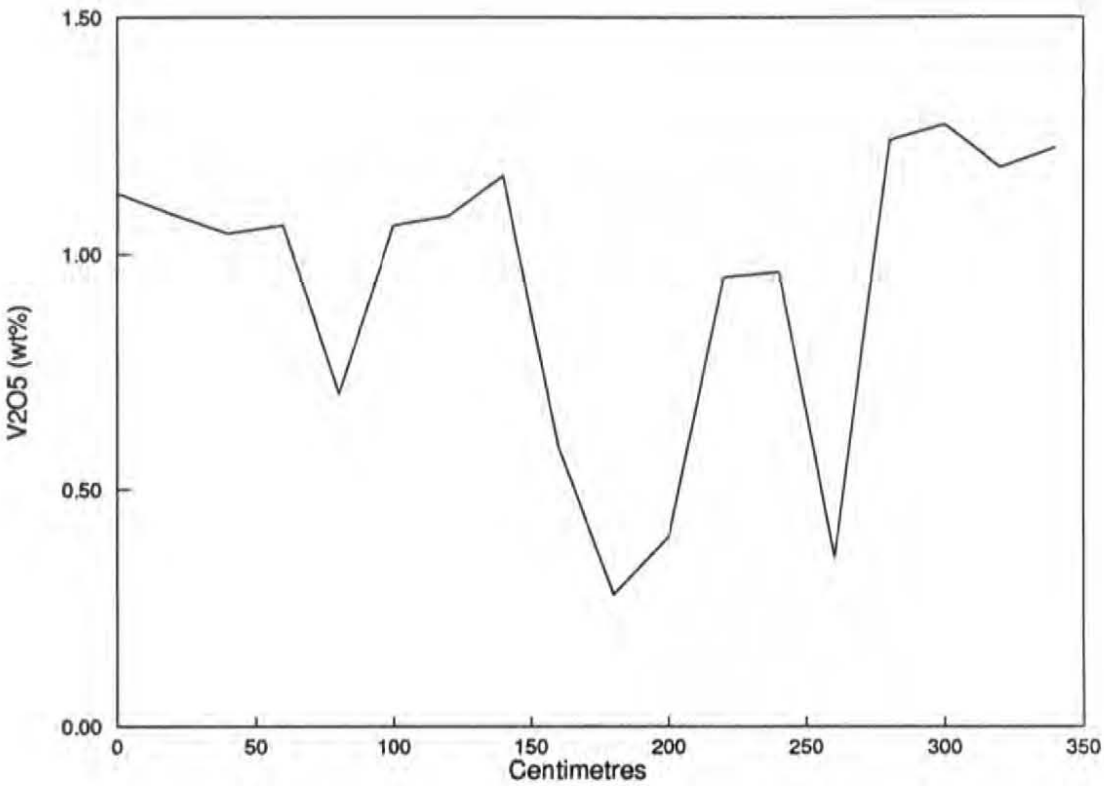
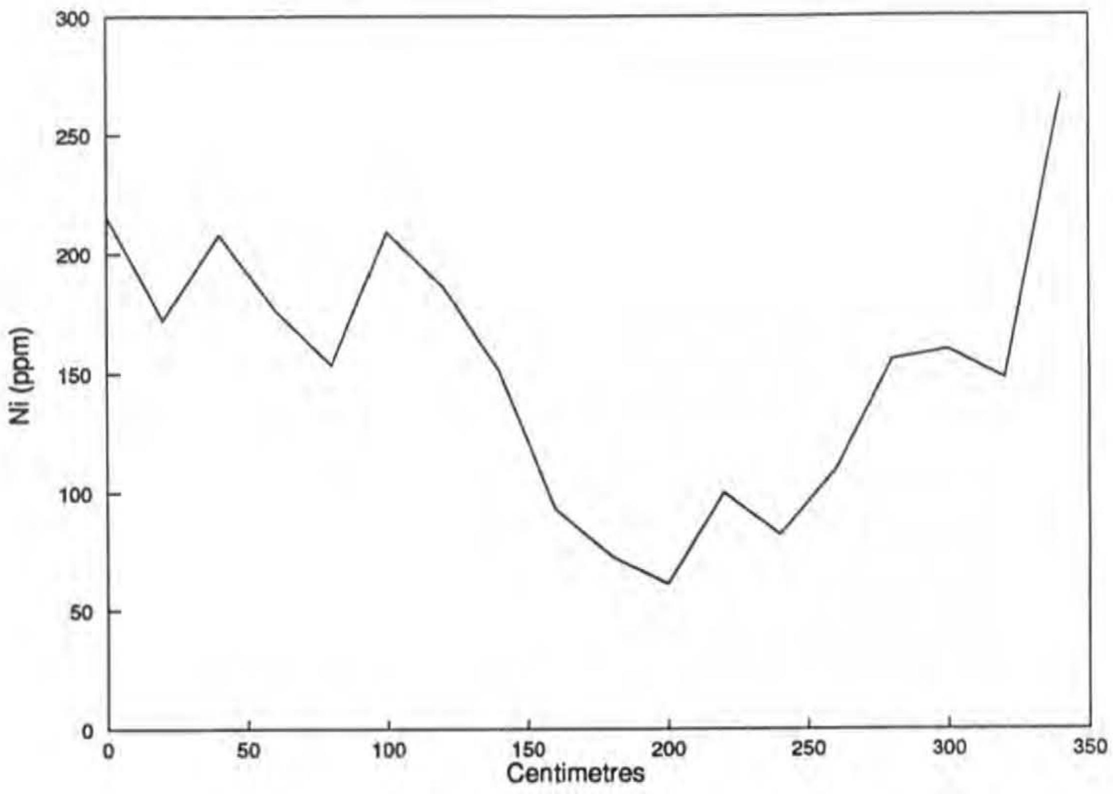


Figure 63: Location 1. South magnetite layer, V_2O_5 values. Serial samples 68-5-600-8-A to 8-AC and 9-A to 9-J. South (left) to north (right).



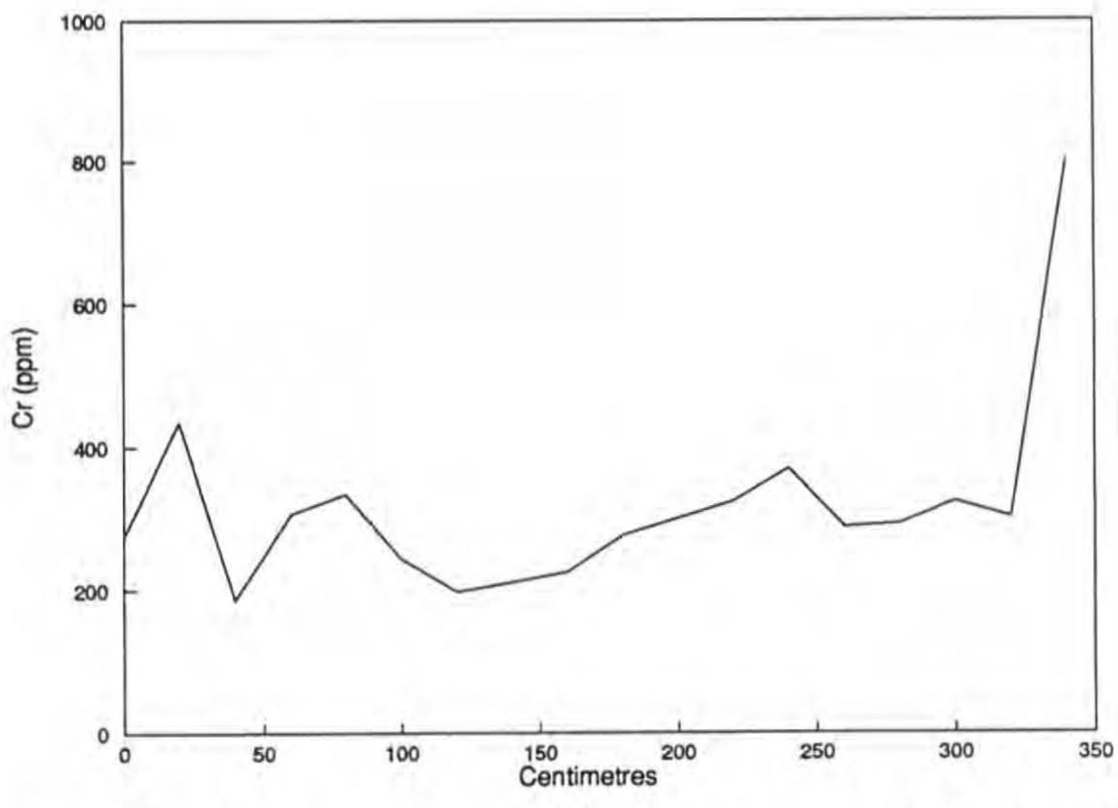


Figure 64: Location 1. South magnetite layer, Ni and Cr values. Serial samples 68-5-600-8-A to 8-AC and 9-A to 9-J. South (left) to north (right).

B4. Location 2: Chip samples:

Sample[1]	90CH	CH-1	CH-2	CH-3	CH-4	CH-5
Unit	6	5, 1a	5, 1a	1a	6	6
FeO (T)	61.40	17.53	17.29	19.92	62.40	60.00
TiO_2	13.80	1.98	3.72	4.09	16.30	15.60
V_2O_5	0.88	0.07	0.05	0.07	1.00	0.75
V (ppm)	4956	400	300	400	5600	4200
Ni	176	70	30	0	30	0
Cr	316	130	60	0	40	20

Sample	CH-6	CH-7	CH-8	CH-9	CH-10
Unit	6	5a	5, 1a	6	5c
FeO (T)	61.40	24.53	18.77	65.80	18.85
TiO_2	14.70	5.66	3.55	14.70	1.10
V_2O_5	1.07	0.25	0.09	1.16	0.04
V (ppm)	6000	1400	500	6500	200
Ni	90	0	20	150	70
Cr	320	0	40	280	60

1 Sample locations are shown on Map OF92-1. Sample 90CH, magnetite, east end of exposure, over 140 cm; CH-1, melagabbro, basalt, over 4 metres; CH-2, melagabbro, basalt, over 5 metres; CH-3, basalt, over 2 metres; CH-4, magnetite layer, 57 cm; CH-5, magnetite layer, 74 cm; CH-6, magnetite layer, 1 metre; CH-7, melagabbro, disseminated magnetite, 2 metres; CH-8, melagabbro, basalt, 2 metres; CH-9, magnetite layer, 75 cm; CH-10, magnetite chlorite schist.

B5. Location 2: Whole rock and trace element analyses:

Sample[1]	90-2	90-3A	90-3B
Unit	6	4a	4a
SiO_2	4.13	35.70	35.70
Al_2O_3	4.80	20.60	20.30
Fe_2O_3	36.61	7.18	5.78
FeO	32.26	17.34	18.80
CaO	0.20	8.97	8.72
MgO	3.12	2.21	3.02
Na_2O	0.06	1.87	1.75
K2O	0.07	0.39	0.36
TiO_2	15.70	5.09	4.85
P_2O_5	0.01	0.08	0.03
MnO	0.37	0.22	0.26
H_2O	1.63	1.27	1.35
S	0.14	0.13	0.09
CO_2	0.03	0.08	0.08
Other	1.44	0.48	0.43
O=S	-0.06	-0.05	-0.04
Total	100.51	101.56	101.48
Ni (ppm)	175	61	58
Cr	232	202	166
Cu	86	58	54
Zn	315	122	135
Pb	0	0	0
Rb	0	13	10
Sr	0	150	91
Ba	110	364	319
Li	8	12	12
Be	1	4	5
V	7294	1928	1773
FeO (T)	65.20	23.80	24.00
TiO_2	15.70	5.09	4.85
V_2O_5	1.30	0.34	0.32

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1 Sample locations are shown on Map OF92-1. Sample 90-2, magnetite; 90-3A, magnetite-garnetiferous leucogabbro contact; 90-3B, garnetiferous leucogabbro.

Location 2: Whole rock and trace element analyses.

Sample[2]	508-1	508-2	508-3	508-6	508-9A	508-10A	508-11
Unit	5c	5c	4	5a	1a	5c	5c
SiO_2	40.50	39.00	47.70	33.40		42.50	
Al_2O_3	6.10	8.20	14.50	12.90		4.80	
Fe_2O_3	10.40	10.10	3.60	8.70		11.90	
FeO	15.60	16.10	11.50	19.80		12.60	
CaO	8.33	9.54	9.80	8.01		9.56	
MgO	12.28	9.85	5.99	5.16		13.37	
Na_2O	0.48	0.67	2.20	1.53		0.40	
K2O	0.10	0.15	0.28	0.19		0.11	
TiO_2	2.70	4.21	1.91	6.86		1.77	
P_2O_5	0.03	0.04	0.16	0.02		0.04	
MnO	0.31	0.31	0.20	0.28		0.24	
H_2O	2.57	1.98	1.65	2.64		2.73	
S	0.03	0.01	0.00	0.23		0.03	
CO_2	0.07	0.12	0.08	0.08		0.08	
Other	0.26	0.36	0.14	0.37		0.18	
O=S	-0.01	0.00	0.00	-0.09		-0.01	
Total	99.75	100.64	99.71	100.08		100.30	
Ni (ppm)	90	99	51	10	12	111	176
Cr	308	424	161	10	11	182	58
Cu	102	169	15	133	74	43	108
Zn	128	127	94	163	190	109	139
Pb	13	23	0	22	21	42	21
Rb	0	0	0	0	8	5	4
Sr	13	13	74	56	82	10	7
Ba	146	126	82	32	123	46	23
Li	20	10	13	12	14	11	3
Be	2	0	3	2	0	0	0
V	818	1291	416	1736	504	611	363
FeO (T)	24.96	25.19	14.74	27.63	21.30	23.31	21.80
TiO_2	2.70	4.21	1.91	6.86	4.30	1.77	0.90
V2O5	0.15	0.23	0.07	0.31	0.09	0.11	0.06

2 Sample locations are shown on Map OF92-1. Sample 508-1, 508-2, magnetite chlorite schist; 508-3, leucogabbro; 508-6, fine grained magnetite-bearing melagabbro; 508-9A, feldpsar phyric basalt; 508-10A,

Location 2: Whole rock and trace element analyses

Sample[3]	508-12	508-15	508-16	508-18A	508-18B	508-20	508-22
Unit	6	1a	1a	5a	1	5	1
SiO_2		48.70		34.70	47.10		41.90
Al_2O_3		14.70		15.10	14.90		15.40
Fe_2O_3		3.60		6.40	3.20		4.40
FeO		10.80		19.30	12.50		13.10
CaO		9.37		8.32	8.58		11.63
MgO		5.28		5.87	6.96		5.55
Na_2O		2.83		1.44	2.70		1.29
K2O		0.22		0.21	0.17		0.45
TiO_2		2.18		5.64	0.96		2.99
P_2O_5		0.23		0.03	0.07		0.03
MnO		0.21		0.30	0.19		0.22
H_2O		1.43		2.21	1.84		1.59
S		0.07		0.08	0.04		0.07
CO_2		0.12		0.08	0.07		0.15
Other		0.15		0.34	0.17		0.32
O=S		-0.03		-0.03	-0.02		-0.03
Total		99.86		99.99	99.43		99.06
Ni (ppm)	118	50	84	6	98	27	113
Cr	608	173	180	37	278	38	285
Cu	62	58	78	110	60	5	213
Zn	234	122	125	146	130	137	117
Pb	17	34	23	19	13	24	26
Rb	11	5	8	0	0	7	15
Sr	97	154	130	17	170	87	104
Ba	57	101	87	53	69	59	183
Li	7	9	11	19	20	9	21
Be	0	3	0	3	3	0	0
V	6008	349	384	1581	308	963	1019
FeO (T)	49.60	14.04	13.70	25.06	15.38	19.70	17.10
TiO_2	12.50	2.18	2.00	5.64	0.96	4.40	2.99
V_2O_5	1.07	0.06	0.07	0.28	0.05	0.17	0.18

3 Sample locations are shown on Map OF92-1. Sample 508-12, magnetite; 508-15, 508-16 feldspar phyric basalt; 508-18A, magnetite-bearing melagabbro; 508-18B, basalt; 508-20, melagabbro; 508-22, basalt.

Location 2: Whole rock and trace element analyses

Sample[4]	508-25	508-33	508-34	508-41	508-42	508-43
Unit	5a	5, 5d	3b	4	5d	5
SiO_2	41.30	41.80	42.40	48.70		
Al_2O_3	11.80	13.90	15.60	24.60		
Fe_2O_3	5.10	4.40	3.90	1.80		
FeO	16.80	15.40	14.30	4.60		
CaO	9.79	9.60	10.05	11.70		
MgO	6.05	5.97	6.90	1.52		
Na_2O	1.47	2.10	1.66	3.44		
K2O	0.27	0.25	0.30	0.19		
TiO_2	4.59	3.58	2.19	0.81		
P_2O_5	0.04	0.04	0.07	0.04		
MnO	0.31	0.26	0.24	0.07		
H_2O	1.75	1.78	1.65	0.74		
S	0.24	0.01	0.11	0.06		
CO_2	0.21	0.13	0.07	0.16		
Other	0.14	0.23	0.24	0.09		
O=S	-0.10	0.00	-0.04	-0.02		
Total	99.76	99.45	99.64	98.50		
Ni (ppm)	0	12	111	22	82	110
Cr	0	103	176	19	149	163
Cu	87	15	138	33	101	156
Zn	184	136	132	38	95	152
Pb	42	0	0	19	21	20
Rb	7	5	6	4	7	10
Sr	77	96	74	194	93	102
Ba	126	323	125	111	100	99
Li	10	59	11	12	12	11
Be	0	3	3	3	0	0
V	435	750	778	211	411	650
FeO (T)	21.39	19.36	17.81	6.22	13.40	16.70
TiO_2	4.59	3.58	2.19	0.81	1.80	2.00
V_2O_5	0.08	0.13	0.14	0.04	0.07	0.12

4 Sample locations are shown on Map OF92-1. Sample 508-25, magnetite-bearing melagabbro; 508-33, meso- to melagabbro; 508-34, oikocrystic anorthosite; 508-41, anorthositic leucogabbro; 508-42, mesogabbro; 508-43, melagabbro.

Location 2: Whole rock and trace element analyses

Sample[5]	508-45	508-46A	508-46B	508-47	508-48	508-49A	508-49B
Unit	5	6	6	6	6	4a	4a
SiO_2	44.10						6.10
Al_2O_3	16.40						4.10
Fe_2O_3	4.20						32.70
FeO	12.20						31.60
CaO	9.80						1.14
MgO	6.77						2.31
Na_2O	1.87						0.14
K2O	0.24						0.04
TiO_2	2.06						17.69
P_2O_5	0.05						0.01
MnO	0.22						0.37
H_2O	1.52						1.55
S	0.19						0.06
CO_2	0.08						0.05
Other	0.23						1.23
O=S	-0.08						-0.02
Total	99.85						99.07
Ni (ppm)	111	67	51	69	241	73	49
Cr	170	71	36	43	354	38	29
Cu	182	74	21	37	36	21	21
Zn	119	193	258	338	265	332	341
Pb	15	11	0	0	10	21	0
Rb	7	11	5	5	0	0	18
Sr	104	174	0	12	0	0	0
Ba	133	105	43	60	0	0	95
Li	15	19	5	11	6	7	11
Be	3	0	0	0	0	0	2
V	674	2639	6361	5755	7813	6526	6474
FeO (T)	15.98	28.90	65.40	60.40	67.50	60.80	61.02
TiO_2	2.06	6.80	17.70	16.20	14.90	17.70	17.69
V2O5	0.12	0.47	1.14	1.03	1.39	1.17	1.16

5. Sample locations are shown on Map OF92-1. Sample 508-45, melagabbro; 508-46A, 508-46B, 508-47, 508-48, magnetite; 508-49A, 508-49B, magnetite-bearing leucogabbro.

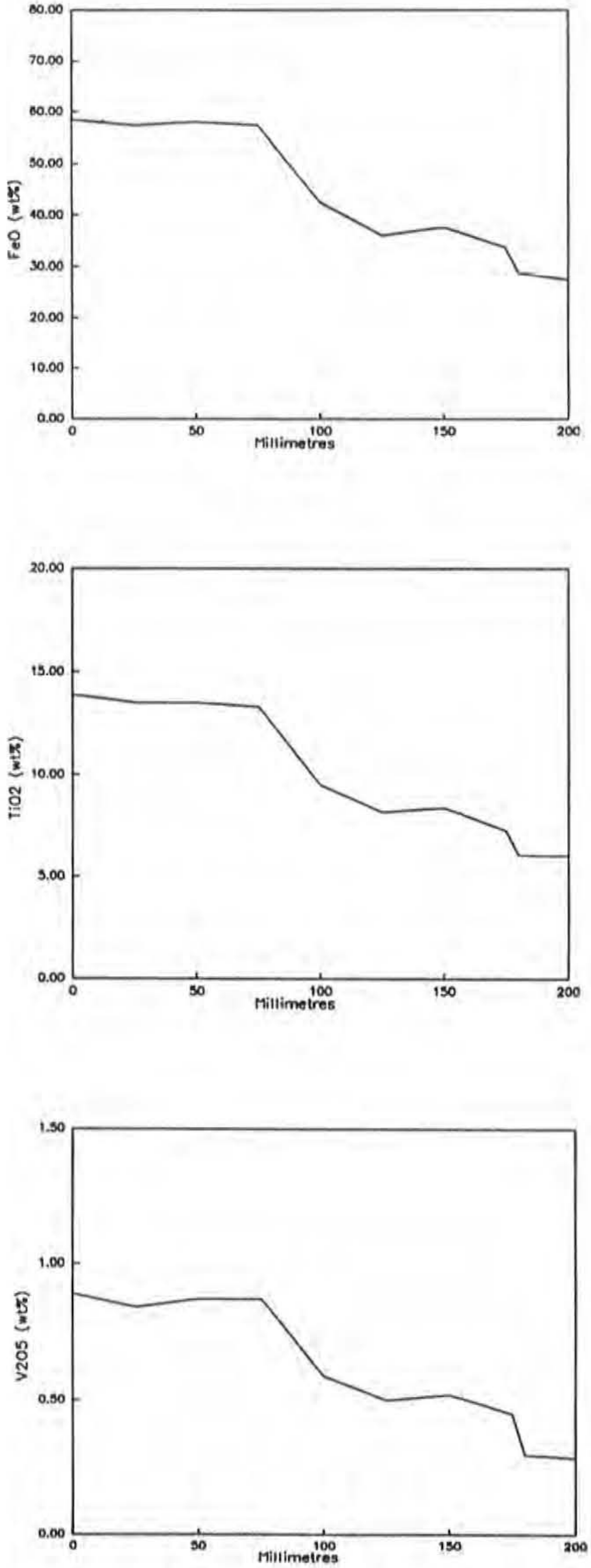

Figure 65: Location 2. South magnetite layer. FeO, TiO_2 and V_2O_5 values (small scale variations). Serial samples 68-4-90-AF-1 to AF-10.

Location 2: Whole rock and trace element analyses

Sample[6]	508-50	508-61	508-62	508-63	508-65
Unit	6	4a	4a	6	6, 4a
Ni (ppm)	71	75	33	191	185
Cr	41	265	63	329	592
Cu	170	58	10	47	159
Zn	143	160	102	211	214
Pb	0	25	31	0	0
Rb	0	8	26	4	4
Sr	7	139	210	0	34
Ba	36	60	147	0	38
Li	5	14	18	8	14
Be	2	5	2	3	0
V	4962	2135	620	8088	5359
FeO (T)	47.10	25.80	13.30	65.10	56.40
TiO_2	15.80	5.90	2.40	14.90	13.60
V_2O_5	0.89	0.38	0.11	1.44	0.96

B6. Location 2: Serial samples:

Sample No. 68-4-90-AF[1]

	AF-1	AF-2	AF-3	AF-4	AF-5	AF-6	AF-7	AF-8	AF-9	AF-10
mm	0	25	50	75	100	125	150	175	180	200
FeO (T)	58.40	57.20	57.90	57.20	42.40	36.00	37.60	33.70	28.80	27.40
TiO_2	13.90	13.50	13.50	13.30	9.49	8.14	8.38	7.23	6.05	5.99
V_2O_5	0.89	0.84	0.87	0.87	0.59	0.50	0.52	0.45	0.30	0.29
V (ppm)	5000	4700	4900	4900	3300	2800	2900	2500	1700	1600
Ni	320	120	120	130	80	40	60	30	20	20
Cr	580	540	540	590	480	380	410	360	260	290

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1 Garnetiferous magnetite layer (Unit 6), southeast end of exposure.

6 Sample locations are shown on Map OF92-1. Sample 508-50, magnetite; 508-61, 508-62, magnetite-bearing leucogabbro; 508-63, magnetite; 508-65, magnetite to magnetite-bearing leucogabbro.

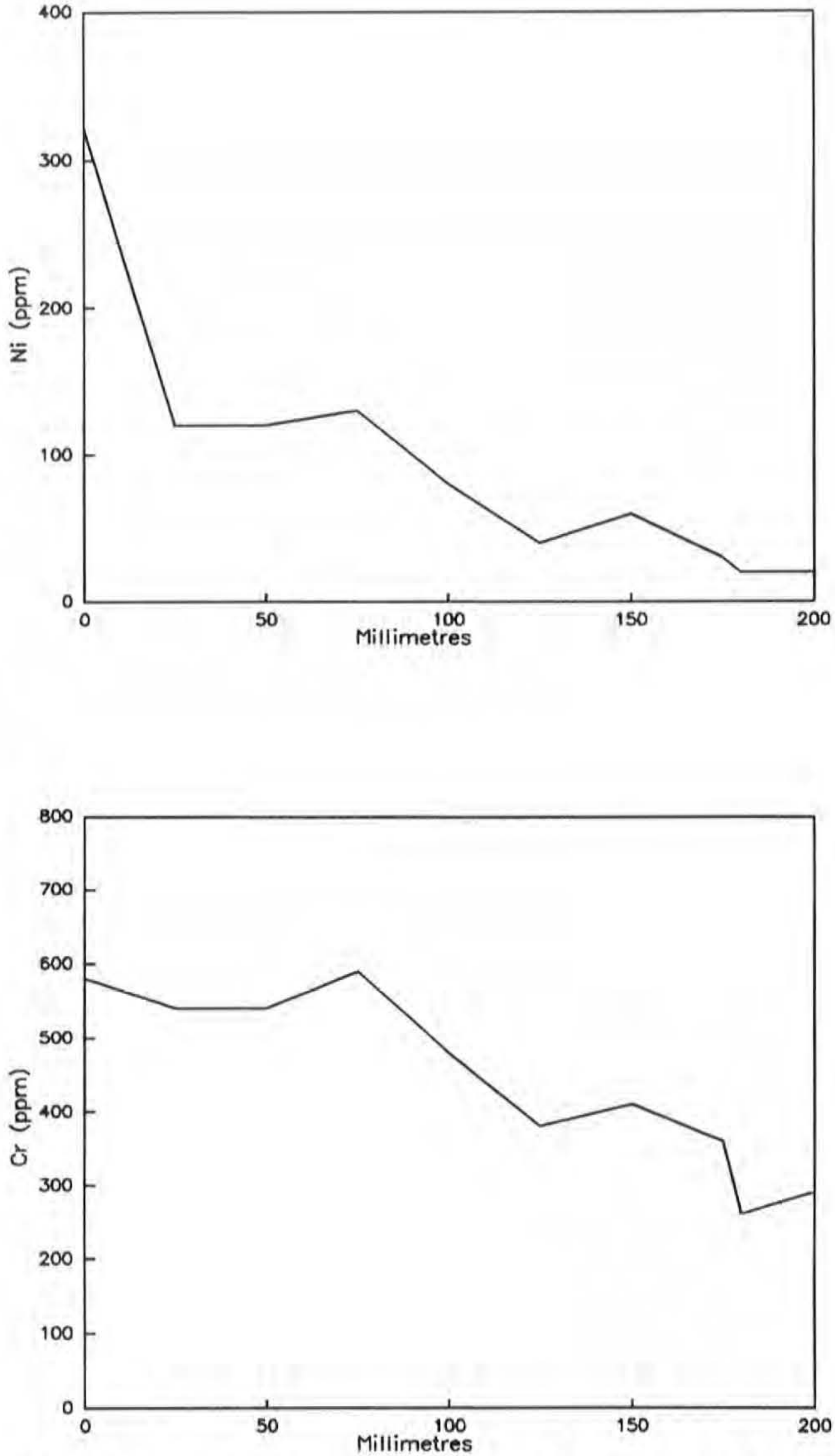
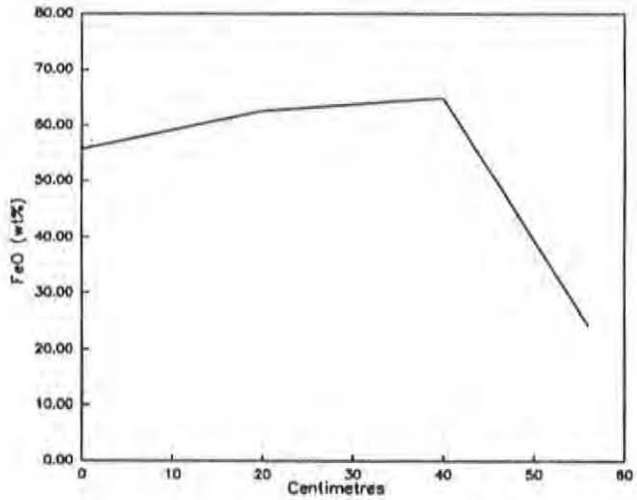


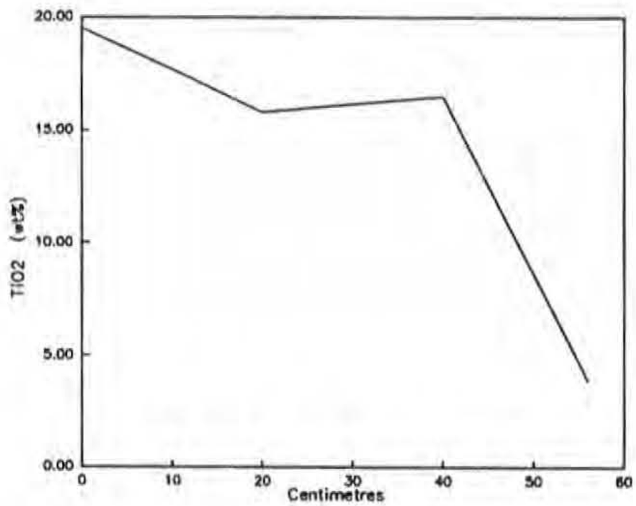
Figure 66: Location 2. South magnetite layer. Ni and Cr values (small scale variations). Serial samples 68-4-90-AF-1 to AF-10.

Location 2: Serial samples:

Sample[1]	508-54A	580-54F	508-54J	508-54L
cm	0	20	40	56
SiO_2	8.50			34.90
Al_2O_3	6.50			16.00
Fe_2O_3	26.70			6.20
FeO	31.70			18.60
CaO	1.77			8.92
MgO	2.41			6.43
Na_2O	0.25			1.38
K2O	0.07			0.31
TiO_2	19.52			3.91
P_2O_5	0.01			0.06
MnO	0.37			0.31
H_2O	1.56			2.37
S	0.24			0.14
CO_2	0.03			0.03
Other	1.05			0.28
O=S	-0.10			-0.06
Total	100.58			99.78
Ni (ppm)	69	82	64	19
Cr	89	34	40	28
Cu	87	37	56	47
Zn	300	276	389	181
Pb	0	16	14	0
Rb	11	0	0	5
Sr	0	0	0	19
Ba	61	0	0	144
Li	8	7	8	25
Be	0	0	0	3
V	5435	5890	5711	1217
FeO (T)	55.72	62.40	64.80	24.18
TiO_2	19.52	15.80	16.50	3.91
V_2O_5	0.97	1.05	1.02	0.22

1 Serial sample: North layer magnetite layer (Unit 6), west end of outcrop, 56 cm, south to north.





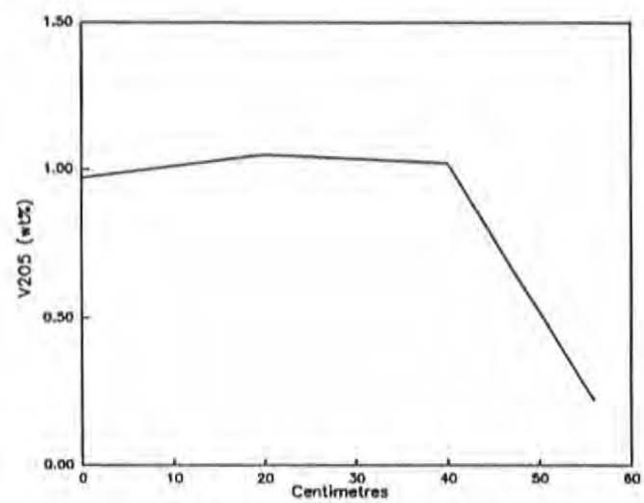
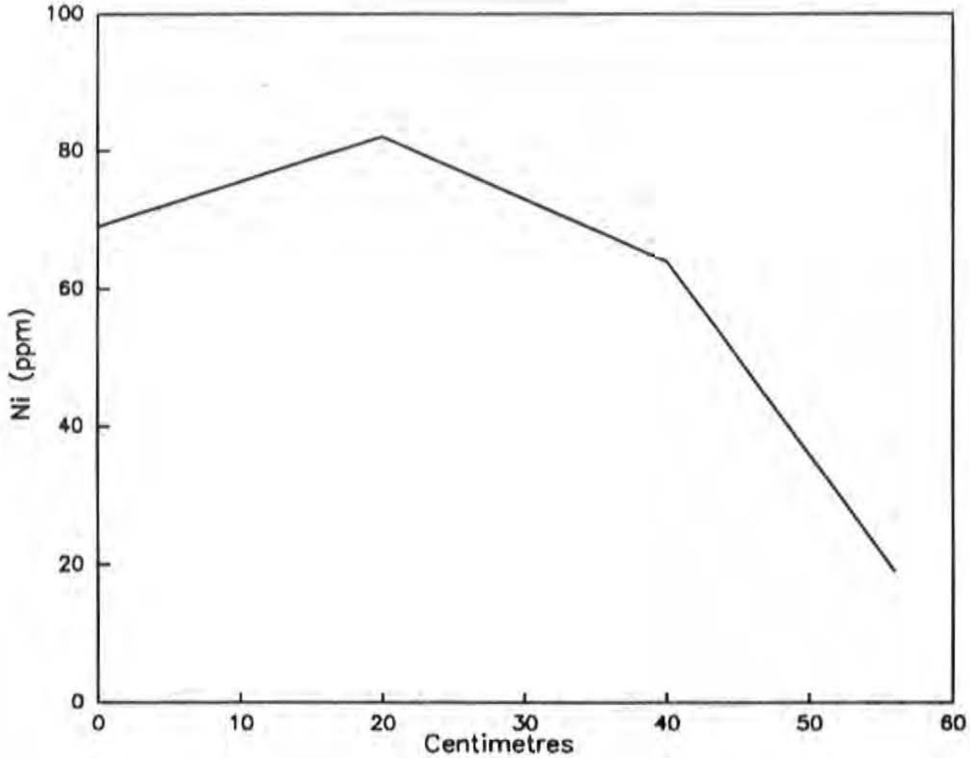


Figure 67: Location 2. North magnetite layer. FeO, TiO_2 and V_2O_5 values. Serial sample 68-5-508-54-A to 54-L. South (left) to north (right).



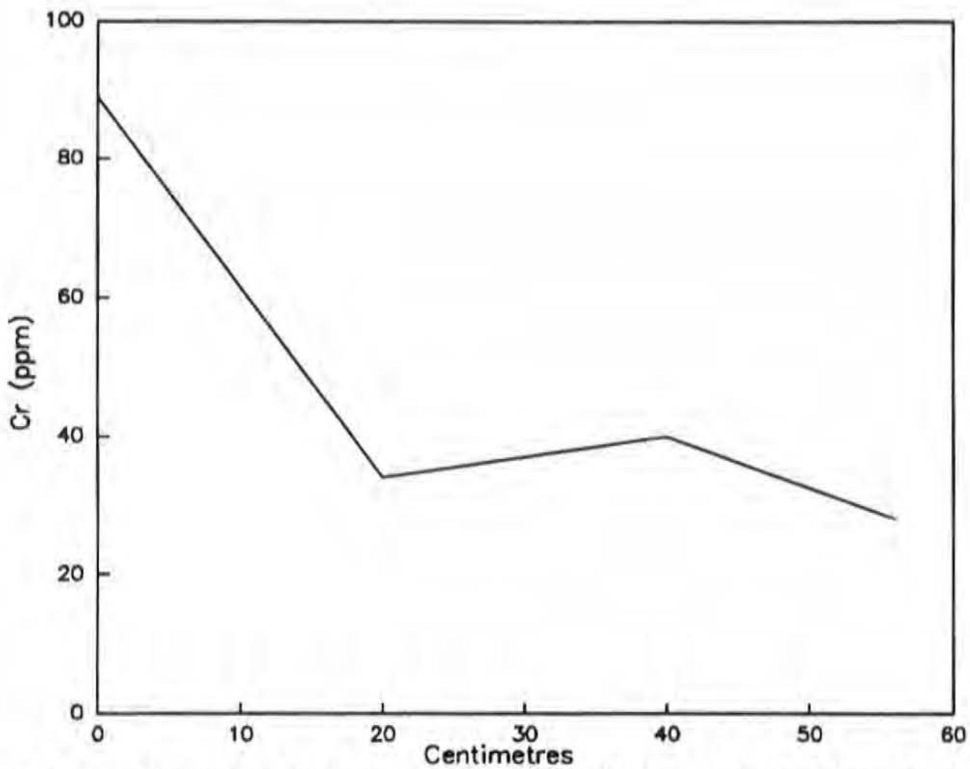


Figure 68: Location 2. North magnetite layer. Ni and Cr values. Serial sample 68-5-508-54-A to 54-L. South (left) to north (right).

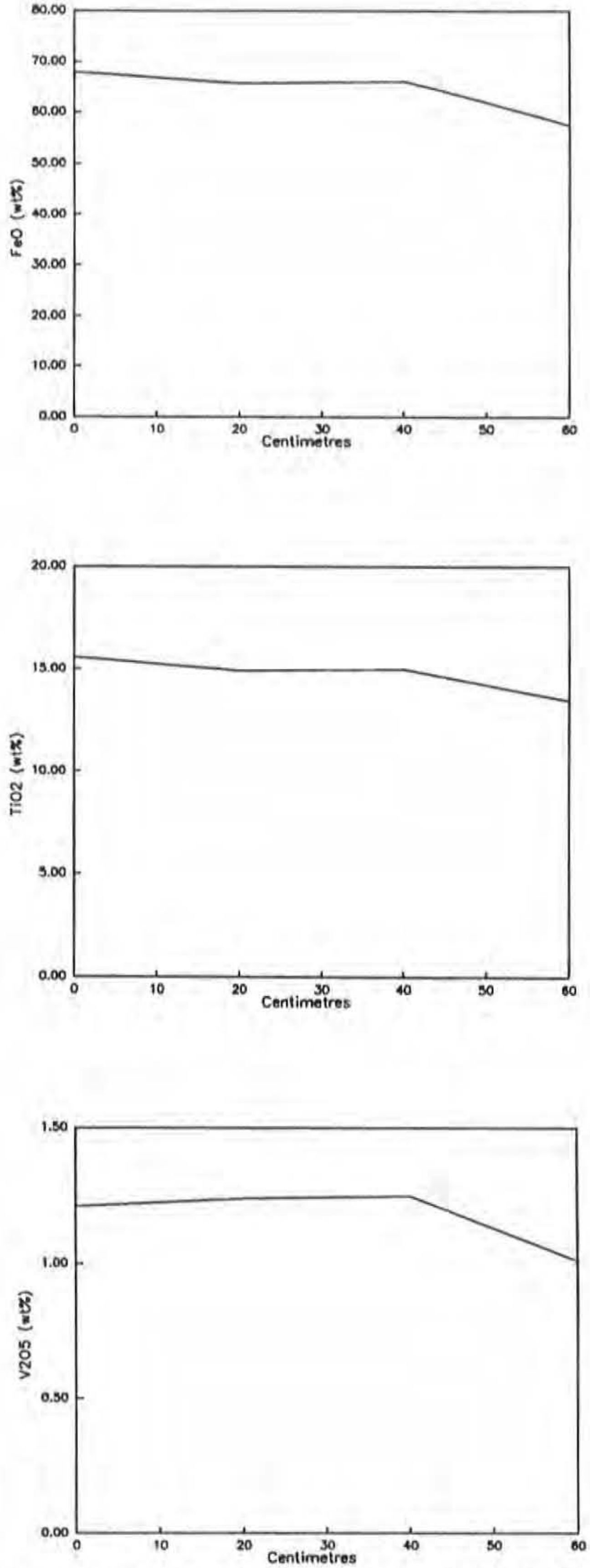


Figure 69: Location 2. South magnetite layer. FeO, TiO_2 and V_2O_5 values. Serial sample 68-5-508-55-A to 55-P. South (left) to north (right).

Location 2: Serial samples:

Sample[1]	508-55A	508-55E	508-55J	508-55P
cm	0	20	40	60
SiO_2	2.80			9.10
Al_2O_3	3.50			6.90
Fe_2O_3	40.50			31.20
FeO	31.50			29.30
CaO	0.12			1.70
MgO	2.37			3.07
Na_2O	0.04			0.04
K2O	0.02			0.03
TiO_2	15.57			13.44
P_2O_5	0.01			0.01
MnO	0.33			0.28
H_2O	1.44			3.48
S	0.01			0.45
CO_2	0.07			0.05
Other	1.36			1.18
O=S	0.00			-0.18
Total	99.64			100.05
Ni (ppm)	255	284	293	177
Cr	348	290	332	585
Cu	34	28	26	173
Zn	396	256	405	184
Pb	0	0	0	0
Rb	21	0	0	10
Sr	0	0	0	18
Ba	91	0	0	70
Li	8	7	9	9
Be	0	0	0	2
V	6753	6929	6988	5667
FeO (T)	67.94	65.60	66.10	57.37
TiO_2	15.57	14.90	15.00	13.44
V2O5	1.21	1.24	1.25	1.01

1 Serial sample: South magnetite layer east end of outcrop, 60 cm, south to north.

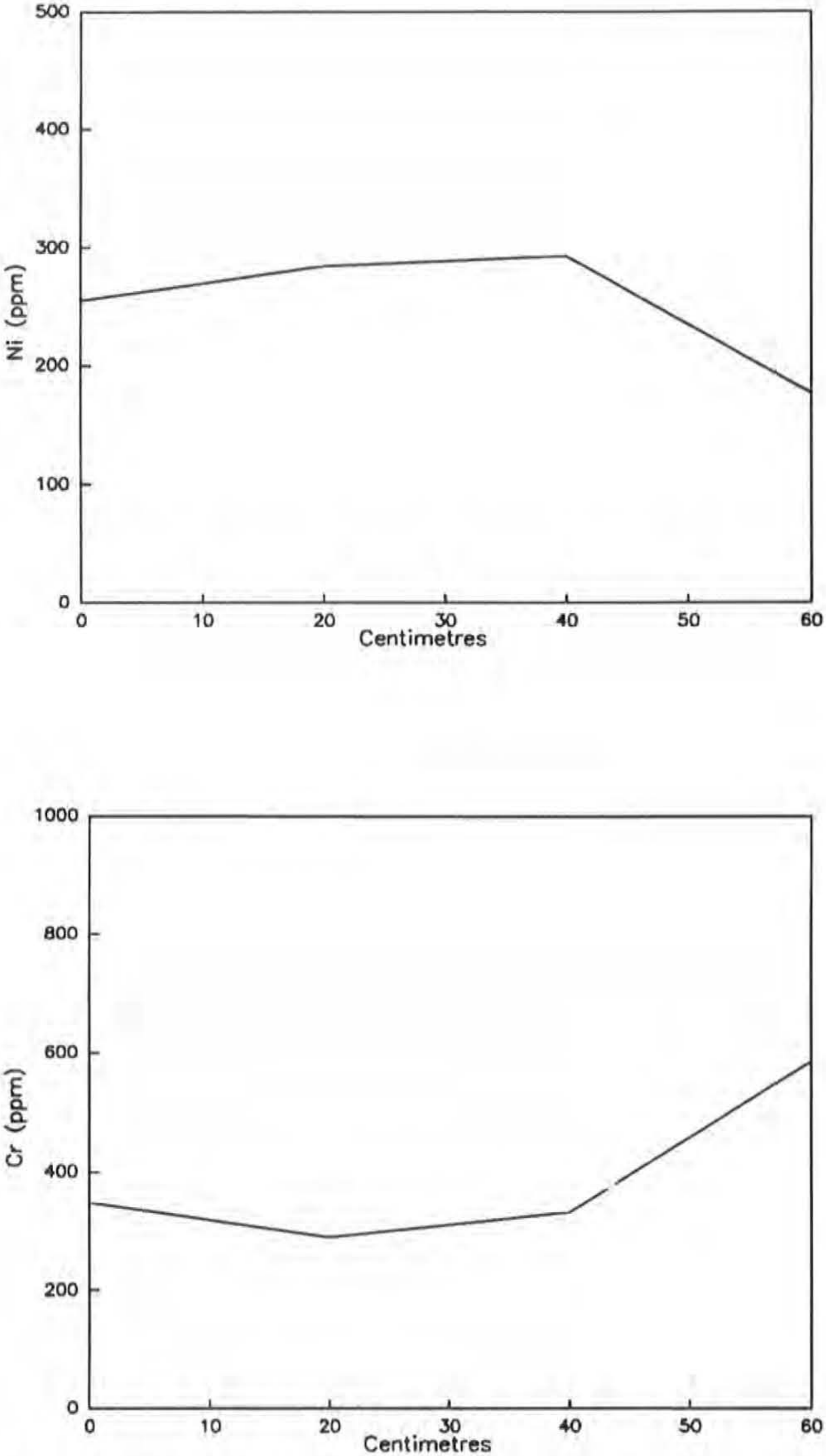


Figure 70: Location 2. South magnetite layer. Ni and Cr values. Serial sample 68-5-508-55-A to 55-P. South (left) to north (right).

Location 2: Serial samples

Sample[1]	508-58A	508-58C	508-58G	508-58K	508-58R
cm	0	20	40	60	80
SiO_2	6.80				
Al_2O_3	6.60				
Fe_2O_3	34.10				
FeO	28.90				
CaO	0.82				
MgO	3.57				
Na_2O	0.06				
K2O	0.05				
TiO_2	14.13				
P_2O_5	0.01				
MnO	0.28				
H_2O	2.85				
S	0.39				
CO_2	0.14				
Other	1.25				
O=S	-0.16				
Total	99.79				
Ni (ppm)	120	147	159	250	304
Cr	626	294	290	297	539
Cu	172	24	35	32	109
Zn	176	164	129	170	159
Pb	0	0	0	0	0
Rb	10	0	0	0	0
Sr	12	0	0	0	0
Ba	61	0	22	0	0
Li	13	13	8	8	7
Be	0	0	0	0	0
V	6080	6371	6305	7066	7056
FeO (T)	59.58	63.30	66.80	68.10	67.80
TiO_2	14.13	15.30	15.80	14.50	15.70
V2O5	1.09	1.14	1.13	1.26	1.26

1 Serial sample: South magnetite layer, west end of outcrop, 84 cm, north to south. Sample 508-58A, melagabbro (Unit 5); 508-58C through 508-58R, magnetite (Unit 6).

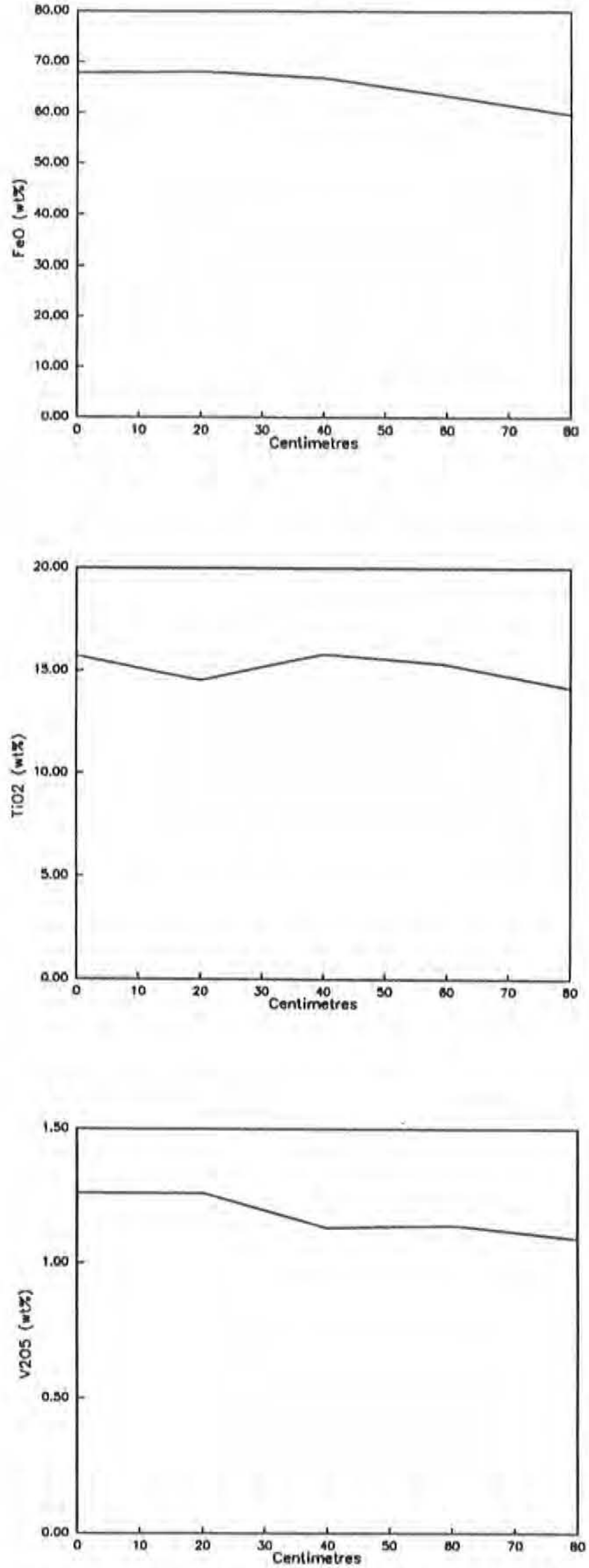
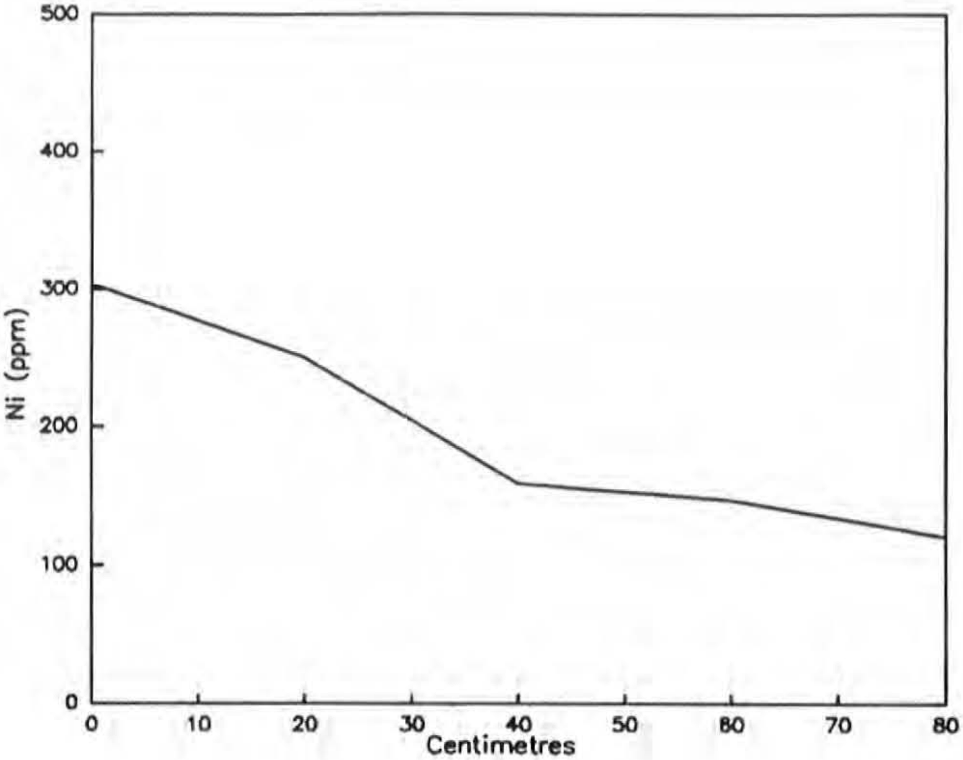
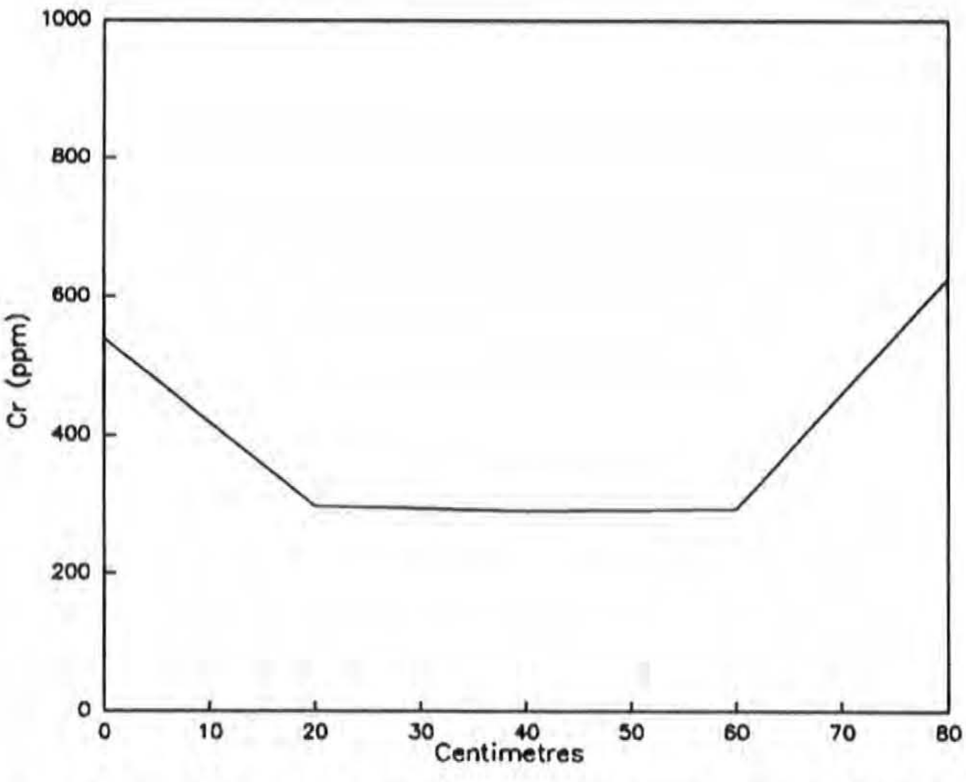


Figure 71: Location 2. South magnetite layer. FeO, TiO_2 and V_2O_5 values. Serial sample 68-5-508-58-A to 58-R. South (left) to north (right).





Location 2. South magnetite layer. Ni and Cr values. Serial sample 68-5-508-58-A to 58-R. South (left) to north (right).

B7. Location 3: Whole rock and trace element analyses

Sample[1]	73-4.4	73-7.9	73-11.0
SiO_2	35.60	21.60	25.60
Al_2O_3	18.70	14.10	17.30
Fe_2O_3	10.07	21.23	29.27
FeO	14.74	23.10	9.46
CaO	9.43	4.79	5.16
MgO	3.77	4.04	3.28
Na_2O	2.10	0.85	1.34
K_2O	0.23	0.26	0.40
TiO_2	4.38	7.56	6.73
P_2O_5	0.03	0.02	0.01
MnO	0.20	0.21	0.18
H_2O	1.01	2.08	2.23
S	0.07	0.02	0.04
CO_2	0.07	0.07	0.07
Other	0.58	0.95	0.87
O=S	-0.03	-0.01	-0.02
Total	100.95	100.87	101.92
Ni (ppm)	101	264	203
Cr	156	81	317
Cu	64	31	38
Zn	126	248	147
Pb	0	79	0
Rb	4	20	5
Sr	118	53	99
Ba	353	37	297
Li	12	12	36
Be	3	0	3
V	2563	4560	3992
FeO (T)	23.80	42.20	35.80
TiO_2	4.38	7.56	6.73
V_2O_5	0.46	0.81	0.71

1 Whole rock analyses of melagabbro containing disseminated magnetite and ilmenite (Unit 5a, b).

B8. Location 3: Summary of FeO, TiO_2, V, Ni and Cr values

Sample No.[1]	(Metres) (N. to S.)	FeO(T) (Wt.%)	TiO_2 (Wt.%)	V (ppm)	V_2O_5 (Wt.%)	Ni (ppm)	Cr (ppm)
73C		30.60	5.48	2715	0.48	174	126
73-1.5	1.5	18.40	2.64	1259	0.22	126	34
73-2.1	2.1	24.00	3.98	1974	0.35	151	122
73-2.8	2.8	23.20	3.62	1938	0.35	169	100
73-3.1	3.1	24.50	3.90	2096	0.37	160	100
73-4.4	4.4	23.80	4.38	2563	0.46	101	156
73-5.1	5.1	30.00	5.68	3125	0.56	162	214
73-6.5	6.5	42.20	7.20	4061	0.73	239	97
73-7.1	7.1	42.90	7.60	4354	0.78	240	93
73-7.6	7.6	42.30	7.40	4086	0.73	250	102
73-7.9	7.9	42.20	7.56	4560	0.81	264	81
73-8.5	8.5	41.20	7.48	4015	0.72	225	98
73-9.0	9.0	36.90	6.48	3258	0.58	244	91
73-9.2	9.2	40.20	7.48	3700	0.66	238	117
73-9.5	9.5	36.60	5.08	2578	0.46	345	111
73-10.3	10.3	34.00	5.44	2705	0.48	219	129
73-11.0	11.0	35.80	6.73	3992	0.71	203	317
73-11.7	11.7	27.40	4.84	2402	0.43	160	206
73-12.2	12.2	26.70	4.34	2242	0.40	154	213
73-12.7	12.7	23.20	4.34	1839	0.33	96	236
73-13.7	13.7	24.60	4.26	2149	0.38	95	254
73-14.6	14.6	22.10	2.81	1514	0.27	192	253

B9. Location 4: Chip samples

Sample[2]	CH-1	CH-2	CH-3
FeO (T)	30.95	20.91	26.09
TiO_2	4.87	3.12	5.17
V_2O_5	0.43	0.27	0.37
V (ppm)	2400	1500	2100
Ni	150	180	180
Cr	100	390	400

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1 Sample locations are shown in Figure 18. Magnetite-bearing melagabbro (Unit 5a). Samples were taken from north to south at the intervals indicated. 73C, chip sample.

2 Sample locations are shown in Figure 26. Sample CH-1, 1.65 to 6 metres north; CH-2, 6 to 17 metres north; CH-3, layered, oxide-rich melagabbro.

B10. Location 4: Whole rock and trace element analyses

Sample[1]	585-1	585-2	585-3	585-4	585-6	585-7	585-8
Unit	3b	4, 5	5	5	5	5	5
SiO_2					33.20	25.30	
Al_2O_3					16.70	13.20	
Fe_2O_3					11.20	18.30	
FeO					15.90	21.00	
CaO					7.24	6.22	
MgO					6.66	5.75	
Na_2O					1.50	0.95	
K2O					0.17	0.20	
TiO_2					3.35	5.93	
P_2O_5					0.02	0.01	
MnO					0.17	0.22	
H_2O					2.71	2.32	
S					0.15	0.28	
CO_2					0.09	0.09	
Other					0.52	0.83	
O=S					-0.06	-0.11	
Total					99.52	100.49	
Ni (ppm)	91	191	199	192	290	378	289
Cr	131	194	202	291	365	486	944
Cu	119	284	240	310	280	292	198
Zn	63	92	99	89	134	167	161
Pb	34	27	26	40	28	19	16
Rb	6	8	8	11	4	4	8
Sr	194	131	121	140	72	21	9
Ba	42	79	60	75	23	27	53
Li	13	16	14	12	12	13	17
Be	3	2	2	3	0	0	0
V	593	990	1087	1082	2017	3616	1667
FeO (T)	10.10	14.90	16.00	15.70	25.98	37.47	23.40
TiO_2	1.30	1.80	1.90	1.90	3.35	5.93	2.60
V_2O_5	0.11	0.18	0.19	0.19	0.36	0.65	0.30

1 Sample locations are shown in Figure 26. Sample 585-1, oikocrystic anorthosite to leucogabbro; 585-2, banded leuco- and melagabbro; 585-3, melagabbro; 585-4, melagabbro; 585-6, melagabbro; 585-7, banded melagabbro; 585-8, banded melagabbro.

Location 4: Whole rock and trace element analyses.

Sample[2]	585-9	585-10	585-11	585-12	585-13	585-14	585-15	585-16
Unit	4, 5	3, 4	5	5	5	5, 4	5, 4	5, 4
SiO_2						33.50		
Al_2O_3						10.10		
Fe_2O_3						12.40		
FeO						16.30		
CaO						6.56		
MgO						11.83		
Na_2O						0.78		
K2O						0.11		
TiO_2						3.14		
P_2O_5						0.02		
MnO						0.19		
H_2O						3.23		
S						0.08		
CO_2						0.03		
Other						0.38		
O=S						-0.03		
Total						98.62		
Ni (ppm)	201	174	155	249	257	181	193	245
Cr	604	409	269	200	80	81	85	50
Cu	77	232	59	111	26	144	147	117
Zn	163	143	118	162	173	154	158	212
Pb	40	27	26	17	11	24	24	38
Rb	49	30	6	6	6	0	4	0
Sr	13	113	133	82	50	9	10	6
Ba	332	268	44	46	28	0	55	63
Li	14	19	14	13	22	7	6	5
Be	0	2	2	0	2	0	0	0
V	1198	994	2383	3586	4212	1693	1719	1983
FeO (T)	20.40	19.00	24.20	36.10	41.50	27.46	28.20	32.90
TiO_2	2.10	2.10	4.20	6.20	7.40	3.14	3.10	3.30
V2O5	0.21	0.18	0.43	0.64	0.75	0.30	0.31	0.35

2 Sample locations are shown in Figure 26. Sample 585-9, leucogabbro with melagabbro bands; 585-10, anorthosite, leucogabbro; 585-11, 12, 13, melagabbro; 585-14, 15, 16, melagabbro with leucogabbro.

Location 4: Whole rock and trace element analyses.

Sample[3]	585-17	585-19	585-20	585-21	585-22	585-23
Unit	5, 4	5	5	4, 5d	5	5a, b, 1
SiO_2			34.90			
Al_2O_3			14.20			
Fe_2O_3			11.80			
FeO			15.20			
CaO			10.11			
MgO			5.61			
Na_2O			1.24			
K2O			0.16			
TiO_2			4.56			
P_2O_5			0.02			
MnO			0.20			
H_2O			1.22			
S			0.15			
CO_2			0.20			
Other			0.56			
O=S			-0.06			
Total			100.07			
Ni (ppm)	246	148	134	86	154	257
Cr	47	81	100	82	106	210
Cu	56	240	244	137	309	94
Zn	165	135	124	93	128	191
Pb	32	45	37	18	19	32
Rb	8	5	5	5	5	5
Sr	6	93	90	153	92	0
Ba	102	112	43	63	96	62
Li	15	14	11	10	20	5
Be	0	0	0	4	2	0
V	1910	1478	2582	1560	1907	3269
FeO (T)	28.50	20.60	25.82	13.40	22.50	41.20
TiO_2	3.30	2.80	4.56	3.00	3.60	6.20
V_2O_5	0.34	0.26	0.46	0.28	0.34	0.58

3 Sample locations are shown in Figure 26. Sample 585-17, melagabbro with leucogabbro; 585-19, melagabbro; 585-20, melagabbro; 585-21, banded leucogabbro; 585-22, melagabbro; 585-23, mafic bands.

B11. Location 4: Summary of FeO, TiO_2, V_2O_5, Ni and Cr content

Sample[1]	Metres (S. to N.)	FeO(T) (Wt.%)	TiO_2 (Wt.%)	V (ppm)	V_2O_5 (Wt.%)	Ni (ppm)	Cr (ppm)
585-1	0.75	10.1	1.30	593	0.11	91	131
585-3	1.40	16.0	1.90	1087	0.19	199	202
585-2	1.75	14.9	1.80	990	0.18	191	194
585-4	2.40	15.7	1.90	1082	0.19	192	291
585-6	3.50	26.0	3.35	2017	0.36	290	365
585-7	4.45	37.5	5.93	3616	0.65	378	486
585-8	4.65	23.4	2.60	1667	0.30	289	944
585-9	5.35	20.4	2.10	1198	0.21	201	604
585-10	5.87	19.0	2.10	994	0.18	174	409
585-11	6.25	24.2	4.20	2383	0.43	155	269
585-12	6.60	36.1	6.20	3586	0.64	249	200
585-13	6.95	41.5	7.40	4212	0.75	257	80
585-17	7.20	28.5	3.30	1910	0.34	246	47
585-16	7.80	32.9	3.30	1983	0.35	245	50
585-23	7.90	41.2	6.20	3269	0.58	257	210
585-14	8.10	27.5	3.14	1693	0.30	181	81
585-15	8.10	28.2	3.10	1719	0.31	193	85
585-19	8.25	20.6	2.80	1478	0.26	148	81
585-20	8.95	25.8	4.56	2582	0.46	134	100
585-21	9.80	13.4	3.00	1560	0.28	86	82
585-22	10.20	22.5	3.60	1907	0.34	154	106

1 Sample locations are shown in Figure 26.

Appendix C: Specific gravity

Megacrystic anorthosite

Sample No.	S.G.
4	3.0
74-4a	2.9
700a	2.7

Oxide layers and oxide bearing gabbros

Sample No.	Rock type	S.G.
74-1	melagabbro	3.2
90-2	magnetite	4.4
508-58a	magnetite	3.7
585-3	melagabbro	2.9

Location 1 (Stations 68-4-19 and 68-5-600)

Sample No.	Rock type	S.G.
19c	magnetite	4.3
19-3	magnetite	4.5
600-3A	magnetite	3.7
600-6b	magnetite oikocrystic anorthosite	3.9
600-17	magnetite-bearing leucogabbro	3.2
600-18	garnetiferous magnetite-bearing leucogabbro	3.2
600-20	melagabbro	3.0

Serial Samples:
Centre Layer: massive magnetite

Sample No.		S.G.
	North	
600-1a	0 (cm)	4.6
b	20	4.4
c		4.5
d	40	4.4
e		4.6
f		4.5
g	60	4.5
h		4.6
i	80	4.6
j		4.4
k		4.4
l	100	4.4
m		4.5
n		4.5
o	120	4.4
p		4.5
q		4.5
r	140	4.5
s		4.4
t		3.6
u		3.4
v	160	3.8
w		3.7
x		3.3
y	180	3.3
	South	

South Layer: massive magnetite

Sample No.	South	S.G.
600-8a	0 (cm)	4.6
b		4.6
c	20	4.6
d		4.7
e		4.7
f		4.5
g	40	4.5
h		4.4
i	60	4.1
j		4.3
k	80	4.4
l	100	4.5
m		4.4
n		4.5
o		4.4
p	120	4.4
q		4.5
r		4.4
s	140	4.4
t		4.4
u		4.3
v		4.2
w	160	3.8
x		3.8
y	180	3.7
z		3.9
aa	200	3.8
ab		4.2
ac	220	4.3
600-9a	240	4.1
b		3.8
c	260	3.8
d		4.2
e	280	4.5
f		4.5
g	300	4.6
h	320	4.5
i		4.5
j	340	4.5
North		

Station 68-4-73 (Trench 1):
Specific gravities of magnetite-bearing melagabbro.

Sample No.	S.G.
73-1.5	3.2
73-2.1	3.3
73-2.8	3.3
73-3.1	3.3
73-4.4	3.3
73-5.1	3.3
73-6.5	3.6
73-7.1	3.6
73-7.9	3.6
73-8.5	3.7
73-9.0	3.5
73-9.2	3.6
73-9.5	3.5
73-10.3	3.5
73-11.0	3.5
73-11.7	3.2
73-12.2	3.3
73-12.7	3.2
73-13.7	3.2
73-14.6	3.3