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GRAPHITE, MUSCOVITE AND HEAVY-MINERAL SANDS EXPLORATION IN LABRADOR

J. Meyer
Mineral Deposits Section

ABSTRACT

In 1989, the industrial-mineral field program in Labrador included exploration for graphite in the Labrador City–Wabush area, sampling of muscovite pegmatites in southeastern Labrador, and reconnaissance sampling for heavy-mineral placers in the Churchill River Valley, west of Goose Bay.

The exploration program for graphite consisted of geophysical and prospecting surveys. A significant prospect was investigated 14 km south of Labrador City, where numerous VLF-EM conductors were identified. Preliminary analysis of a channel sample from a 15-m-long trench, indicates grades of 41 percent carbon, however, the graphite flake-size is small.

INTRODUCTION

The evaluation of the industrial-mineral potential in western Labrador began in 1984, with an investigation of quartzites as a source of high-purity silica, and dolomitic marble for use in the making of self-fluxing iron-ore pellets. Most recent exploration has focused on kyanite, garnet and mica. The discovery of graphite south of Fermont, Québec, led to the 1989 field program, which evaluated the graphite potential on the Labrador side of the border.

An investigation into the potential for heavy-mineral sands in the Churchill River Valley began in 1989, and will continue in the Lake Melville area in 1990. This investigation for heavy-mineral sands was initiated on the basis of potential ilmenite placers being derived from the large anorthosite massifs in the region, and the strong demand for TiO_2 pigments in the paper and paint industries.

GRAPHITE

Exploration for graphite in western Labrador has been stimulated by the recent discovery by Mazarin Incorporated, of a large-flake graphite deposit at Lac Knife, about 27 km south of Fermont, Québec (Figure 1). This 8.5 million tonne deposit averages 16 percent graphite and it may comprise more than 10 percent of the world's known, exploitable flake graphite reserves (Bonneau, 1989). The graphite occurs in fine- to medium-grained quartzofeldspathic gneiss of the upper Knob Lake Group, within the southern part of the Labrador Trough. The Knob Lake Group also hosts three producing iron-ore mines in this area, two on the Labrador side of the border and one on the Québec side.

The Lower Proterozoic Knob Lake Group is interpreted as a platformal to platform–margin succession, which onlaps Archean basement to the west (Rivers and Chown, 1986).

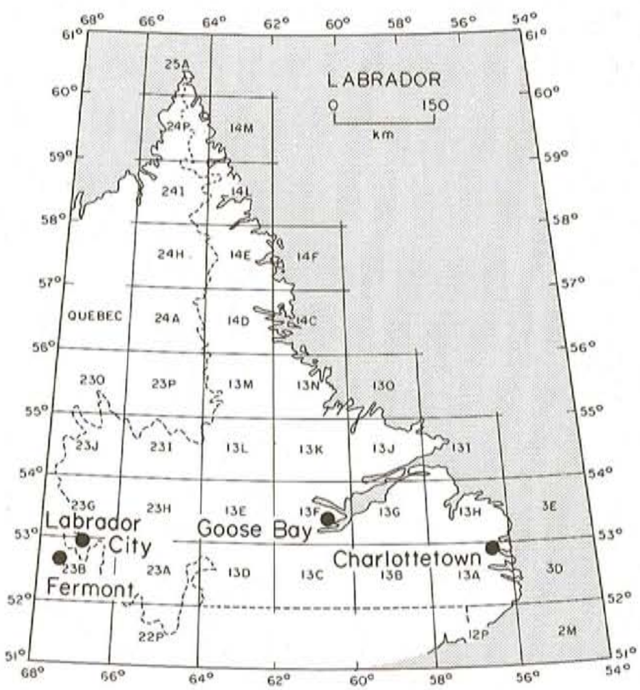

Figure 1. *Location of study areas.*

The stratigraphy of the Knob Lake Group consists of a lower greywacke–shale sequence overlain by dolomitic carbonate, orthoquartzite, iron formation, and an upper greywacke–shale sequence (Figure 2; Rivers, 1983a); the iron formation has been interpreted to be a shallow-water unit. The overlying greywacke–shale sequence (the Menihek Formation) is graphitic near its contact with the iron formation, and may have been initially deposited in a starved basin (Rivers, 1983a).

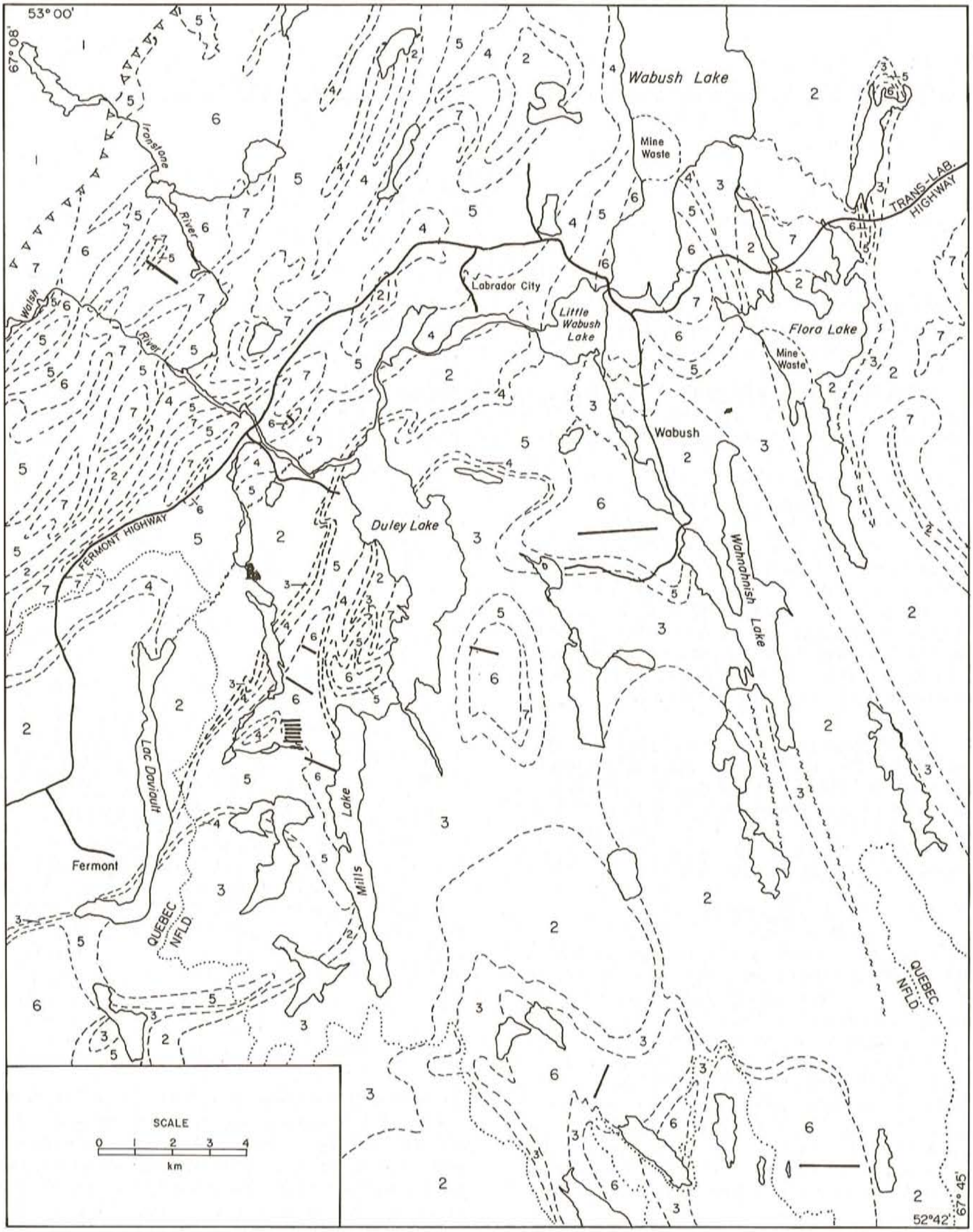

Figure 2. *Geology of the Labrador City–Wabush area (after Rivers, 1985a,b and c).*

LEGEND

MIDDLE PROTEROZOIC

7 Shabogamo Intrusive Suite: *gabbro, norite, amphibolite, diorite and monzonite*

LOWER PROTEROZOIC

KNOB LAKE GROUP

6 Menihek Formation: *dark grey to black schist, phyllite and slate, commonly graphite-bearing; quartzofeldspathic schist and gneiss*

5 Sokoman Formation: *oxide, carbonate, and silicate iron formation*

4 Wishart Formation: *coarse-grained, white quartzite having minor muscovite schist*

3 Denault Formation: *dolomitic and calcitic marble having variable content of quartz and calc-silicate minerals*

2 Attikamagen Formation: *biotite-bearing quartzofeldspathic schist, migmatitic gneiss*

ARCHEAN

1 Ashuanipi metamorphic complex: *mafic and felsic gneisses in granulite facies*

Symbols

Geological contact

Fault

Thrust fault

VLF-EM and total-field magnetic ground traverse

In the southern part of the Labrador Trough, the metamorphic grade of the Knob Lake Group varies from greenschist to upper amphibolite facies, and shows a metamorphic gradient increasing to the south-southeast (Rivers, 1983b). The metamorphic grade of graphitic sediments of the Menihek Formation relates to the development of graphite flakes, which begin to crystallize in the epidote–amphiblite facies (Miyashiro, 1973). The market value of flake graphite is directly dependant on flake size and graphitic carbon content, with large flake (>300 μm, or +50 mesh) and 85 to 90 percent carbon, graphite concentrate selling for \$820 to \$1300 (US) per tonne, (Industrial Minerals, December, 1989).

A geophysical and prospecting survey was undertaken in the vicinity of Labrador City and Wabush, over areas underlain by the Menihek Formation. Combined VLF-EM and total-field magnetic ground surveys, orientated perpendicular to strike, were completed and representative rock samples were collected (Meyer and Kilfoil, 1990). The most northerly traverse was carried out about 6 km northeast of the Julienne Peninsula, on the west side of Shabogamo Lake, over a 1-km-wide, north-trending belt of the Menihek Formation. There were several small VLF conductors noted, and outcrops observed along the shoreline contained 5 to 10 percent amorphous (crytocrystalline) graphite and no appreciable flake material. The most westerly traverse was carried out between the Walsh and Ironstone rivers, about 4 km northwest of the Fermont Highway (Figure 2). There was one VLF conductor, but a coincidental magnetic anomaly suggests a fault contact between the Menihek Formation and a sliver of iron formation (Kilfoil, personnel communication, 1990). Observed subcrop in the area consists of fine grained graphitic schist having a graphite content of less than 5 percent. Traverses were also carried out southeast of Wasbush, and due east of Duley Lake, normal to the axis of synforms containing Menihek Formation rocks. Outcrops observed in these two areas consist of quartz–biotite–garnet $\pm$ kyanite gneiss and schist, having concordant quartz 'veins' and lenses. There are two conductive zones in the northern synform; one coincident with a boggy area and the other near the top of a ridge having non-graphitic rocks exposed nearby. The most southerly traverses were carried out in the area of the Québec–Labrador border, approximately 13 km south of Wabush. There were no major VLF conductors detected in any of these traverses.

The most promising graphite prospect is located 14 km south of Labrador City, and 1 km west of Mills Lake. This prospect was first named the 'Mills Lake sulphide showing' by Greaves (1954), who noted up to 15 percent disseminated sulphides occuring in a fine grained quartz–graphite schist. In 1985, Labrador Mining and Exploration (L.M. & E.) carried out geological and geophysical mapping of the area, following up an airborne EM anomaly (Simpson, 1985). L.M. & E. refer to this prospect as the 'Mart Lake graphite–sulphide showing' and report it to be a probable cause for EM (electromagnetic) conductors near Mart Lake, and noted additional conductors to the north, buried under swamp, bog and glacial overburden.

The Mart Lake graphite showing consists of a 15-m long, 1- to 2-m-wide, north–south trending trench. The deeply weathered, rusty-brown bedrock is massive-looking to foliated, with the foliation trending 055 degrees. Fresh samples of the graphitic rock are sparkly metallic grey, having visible patches of sulphides and quartz. The graphite is dominantly fine to medium crystalline, with 1- to 5-mm patches of dull black, cryptocrystalline graphite. Irregularly distributed sulphides constitute up to 15 percent of the rock, and consist of 1- to 2-mm pyrite crystals and very fine grained patches of pyrite and pyrrhotite. The quartz content ranges up to 15 percent, and is found in small crystalline masses up to 5 mm across, irregular shaped veinlets, and is also finely disseminated. Fine- to medium-crystalline mica is disseminated throughout the rock and is estimated at between 10 and 20 percent. Two other small trenches are exposed within the general vicinity of the main trench and contain very similar material.

Geophysical traverses were carried out along six of the east–west trending cutlines, which form the Mart Lake grid. Several older cutlines east of Narrow Lake, and south of Mart Lake were also traversed. The conductive zones are identified in Figure 3, using Fraser Filter values, whose positive peaks correlate directly to zones of maximum conductivity. The main trench is located 30 m north of line 2, and 200 m west of L.M. & E.'s baseline.

Possible correlations of the positive peaks from the VLF lines can be made using a northeasterly trend, which reflects the local structure. At least 6 conductive zones were identified on the Mart Lake grid. To the north of the grid, the traverse that runs southeast from Narrow lake has 4 strong conductive zones, and several weaker ones. The magnetic response, (Figure 4) indicates a probable fault crossing lines 5 and 6 in a northeasterly trend, separating the conductive zones in the north from those on the grid.

A 25-kg channel sample from the main trench was sent to the Canada Centre for Mineral and Energy Technology (CANMET), in Ottawa, for preliminary beneficiation work. The results of the preliminary analysis show that the sample contains 41.9 percent carbon, and all the flakes are finer than 300 μm (50 mesh; Lamothe, 1989). The highest grade obtained was 81 percent carbon, in the -100 to +200 mesh size fraction (150 and 71 μm), which is considered 'small flake'. To achieve the desired purity level of 90 percent or greater, further grinding would be required, and thus reduce the final flake-size. Markets for powdered graphite (-200 μm) of high purity include automotive brake linings, dry-cell batteries, and lubricants. As a consequence of the high-grade nature of the deposit, CANMET recommends that further field examination be undertaken, especially in consideration of the fact that gneissic graphite ore bodies are not uniform in graphite content and aspect.

MICA

Muscovite-bearing pegmatites have been reported by Gower *et al.*, (1986, 1987) to the northeast of Charlottetown, in southeastern Labrador. The pegmatites intrude the Paradise metasedimentary gneiss belt, and those containing muscovite crystals larger than 5 cm in diameter, were noted during regional mapping of the area. One of the better exposed pegmatites was staked in 1989 by Mr. John Maderic, of Johnston, New York and an examination of this pegmatite was carried out with Mr. Maderic this past summer. The pegmatite is 10-m wide and has an exposed strike length of 50 m. Free-splitting books of sheet muscovite were observed up to 30 cm in diameter and 15-cm thick. Within the space of one hour, over 15 kg of muscovite were collected using a hammer and chisel.

Sheet mica is primarily used in the electrical industry, owing to its unique properties, which include high dielectric strength, uniform dielectric constant, capacitance stability, low power loss, and high electric resistivity (Benbow, 1988). However, since the introduction of solid-state electronics, muscovite has seen these traditional markets diminish. Estimated world production of sheet muscovite for 1983 was 15,000 tonnes (Benbow, 1988), dominantly supplied from India. The prices for sheet mica vary considerably, with the finest quality muscovite selling for over $1000 per pound. It has been suggested that with a price of $10 to $15 per pound for untrimmed, run-of-the-mine mica, a small seasonal operation may be feasible.

HEAVY-MINERAL SANDS

An investigation of the heavy-mineral placer potential of the lower Churchill Valley was begun in 1989. Reconaissance sampling of stratigraphic sections of raised terraces exposed in roadcuts was carried out. Geochemical analysis of the sediments is now underway.

Although the geochemical results are not yet available, initial field results suggest that the area may hold considerable placer potential. Numerous planar and crossbedded laminations of 'black sands' were observed and appeared to be spatially extensive. Futhermore, the geological environment in the lower Churchill Valley favours the formation of placer deposits. Using the requisite factors of a primary bedrock source, a liberation mechanism, a conduit and a depositional sink in placer formation (see Emory-Moore *et al.*, 1988), the following observations can be made:

(1) source: disseminated ilmenite is known to occur within the gabbro–anorthosite massifs and metasedimentary gneisses of the eastern Grenville

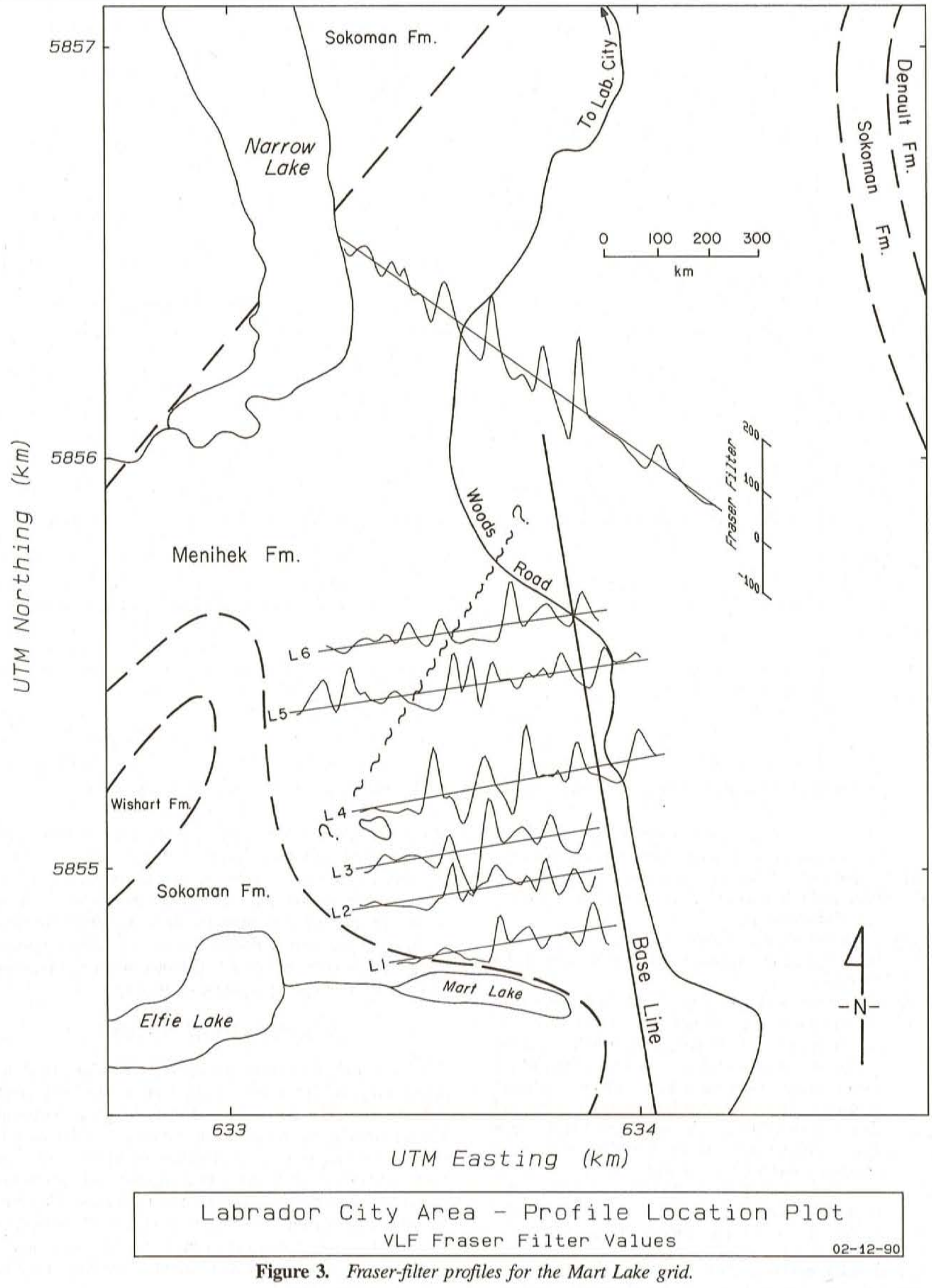

Figure 3. *Fraser-filter profiles for the Mart Lake grid.*

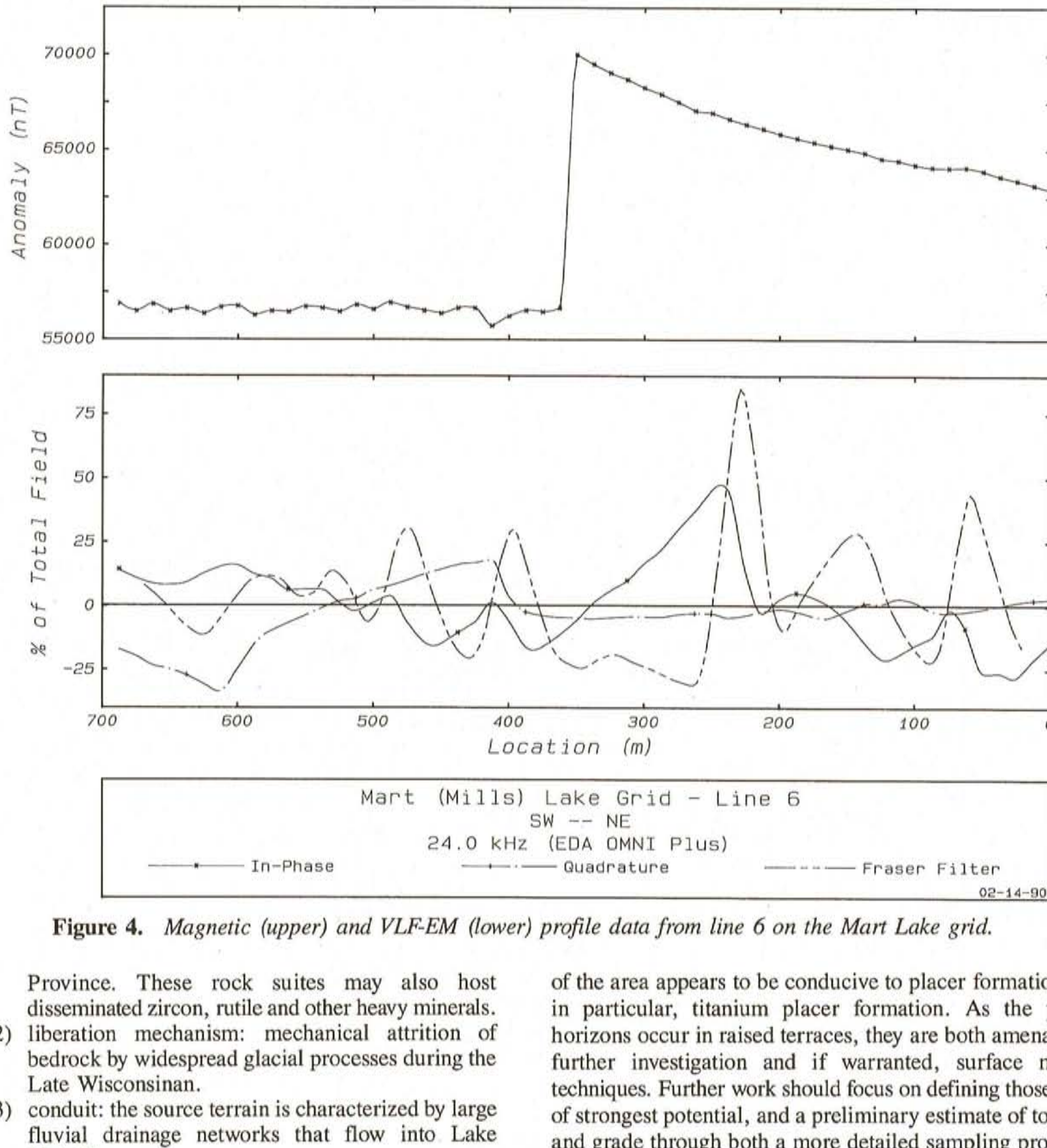

Figure 4. *Magnetic (upper) and VLF-EM (lower) profile data from line 6 on the Mart Lake grid.*

Province. These rock suites may also host disseminated zircon, rutile and other heavy minerals.

(2) liberation mechanism: mechanical attrition of bedrock by widespread glacial processes during the Late Wisconsinan.

(3) conduit: the source terrain is characterized by large fluvial drainage networks that flow into Lake Melville.

(4) depositional sink: postglacial sea level has regressed by as much as 90 m in the Lake Melville area. The occurrence of extensive postglacial deltaic, estuarine and littoral sands within the terrace deposits attests to an ample sediment supply, which was most probably derived through base-level lowering and fluvial downcutting. The observed black sands within these sediments indicate the presence of effective sorting mechanisms at the time of deposition. Sediment reworking may have been the result of tidal currents, particularly in the lake-like expansions of the river valleys (Kindle, 1924).

In summary, the lower Churchill Valley is characterized by numerous occurrences of black sand horizons. The geology of the area appears to be conducive to placer formation and in particular, titanium placer formation. As the placer horizons occur in raised terraces, they are both amenable to further investigation and if warranted, surface mining techniques. Further work should focus on defining those areas of strongest potential, and a preliminary estimate of tonnage and grade through both a more detailed sampling program, and where necessary, geophysical profiling.

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