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QUATERNARY EXPLORATION AND SURFICIAL MAPPING IN THE LETITIA LAKE AREA, LABRADOR

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ABSTRACT

Investigations in the Letitia Lake area focused on 1:50,000 scale terrain mapping of the northern half of 13L/1 and the southern portion of 13L/8 and detailed Quaternary exploration around Two-Tom Lake. Terrain mapping focused on ground verifying an air photograph interpretation; till sampling and locating ice flow indicators. Evidence of three flows was found, all probably related to the Late Wisconsin, with the latest flow being generally west to east (072-080). Detailed studies followed up a previously reported radiometric anomaly that was confirmed by an airborne scintillometer survey. A ground program, consisting of bedrock and boulder mapping, identified two distinct, mineralized, syenite-gneiss, boulder trains and several areas of previously unmapped mineralized bedrock. In addition, a ground scintillometer survey was used to enhance the airborne survey, and a biogeochemical program was initiated with the aim of defining dispersal patterns.

INTRODUCTION

The Letitia Lake area (Figure 1) has been the focus of significant exploration activity since 1956 when Kennco Exploration Ltd. discovered the Mann deposits, following a stream geochemistry survey (Brummer, 1957; Evans and Dujardin, 1961). The Mann # 1 deposit is thought to contain over 6.8 million tonnes of BeO, although problems with beneficiation renders the deposit uneconomic under present conditions (Gaines, 1977).

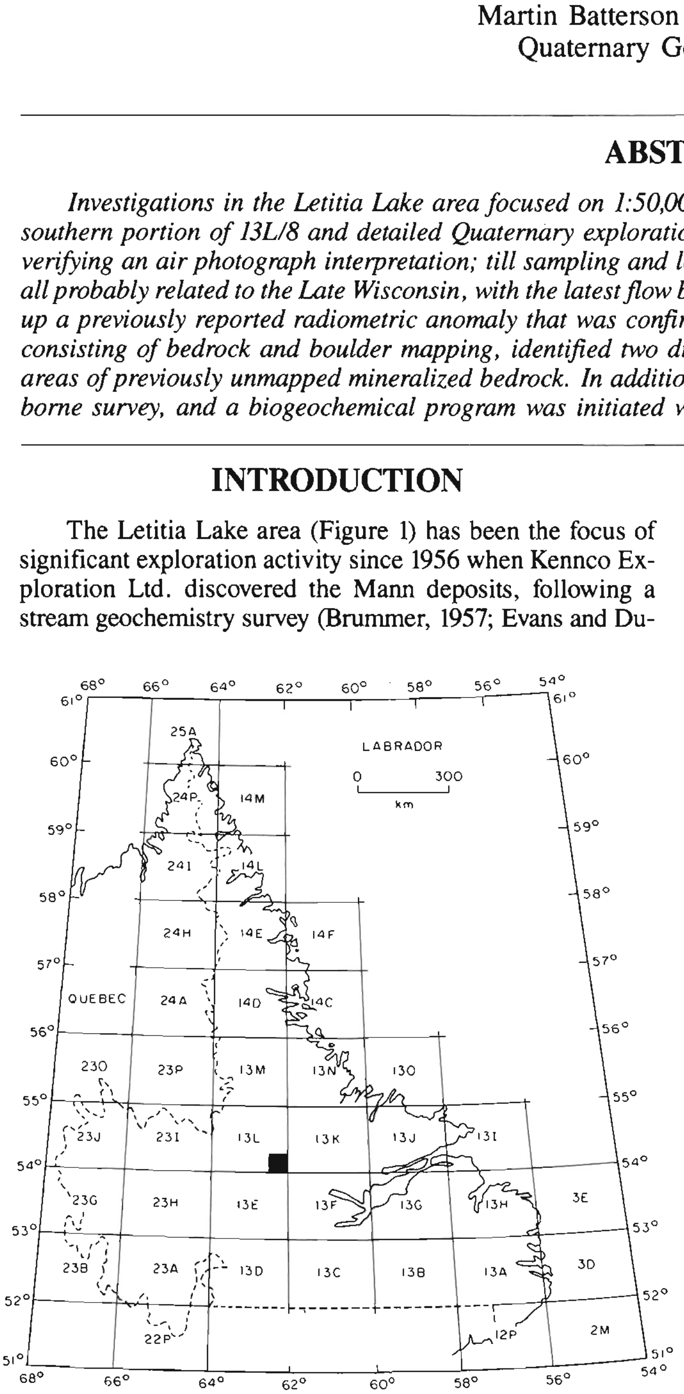


Figure 1: *Location of field area.*

Interest in other areas around Letitia Lake was generated by a Barringer airborne radiometric survey which identified a series of anomalies (Boniwell, 1967). One of these, around Two-Tom Lake (Figure 2), received some attention when Brinex followed up on a report that rock types in the area contained over 2 percent total rare earths, and up to 1 percent Nb and 1 percent Be (Westoll, 1971). However, Brinex was unable to reproduce these values and therefore concluded that the area was uneconomic. Nevertheless, interest in the Letitia Lake region has been rekindled with two companies, Richard Gaines and Maritec, acquiring claims in the Mann deposit area. This exploration activity, the possibility of locating other mineralized sources in the Two-Tom Lake area, and the opportunity for discerning dispersal patterns prompted this current project.

Scope of Project

Quaternary research activity in Labrador has traditionally been negligable. Recently, however, the Newfoundland Department of Mines and Energy and the Geological Survey of Canada have introduced programs. The federal survey has concentrated on 1:250,000 mapping, while the provincial department has carried out 1:50,000 scale terrain mapping, supplemented by detailed Quaternary exploration programs. This current project focuses on two specific aspects of the Letitia Lake area: 1) regional till sampling and terrain mapping of a 480 km² area comprising the northern half of map area 13L/1; the southern portion of map area 13L/8 was studied to generate an overview of dispersal patterns and ice flow directions, and 2) a detailed, drift-exploration survey

This project is a contribution to the Canada-Newfoundland Mineral Development Agreement, 1984-1989

in the Two-Tom Lake area. Each aspect will be discussed separately.

Regional Setting

Letitia Lake (54° 15′ N 62° 20′ W) is situated 160 km northwest of Goose Bay, Labrador. Access is by fixed-wing aircraft or helicopter. Physiographically, the area may be subdivided into two broad regions (Lopoukhine *et al.*, 1977). The 'Postville Land Region', north of Letitia Lake, is an area of parallel bedrock ridges up to 500m in elevation, and broad, glacially-enlarged valleys. The 'Nipishish Lake Land Region' to the south is a plateau area dominated by glacial sediments, bedrock outcrops and numerous areas of bogs. Both regions have a continental climatic regime, are within the boreal forest zone (Rowe, 1972), and lie within the zone of discontinuous permafrost.

General Geology

The Letitia Lake area lies just south of the boundary between the Churchill and Grenville provinces, along the southern margin of the Grenville Front. The area has been studied in detail by Thomas (1981) and Curtis and Currie (1981), and the following description is based on their work (Figure 2). The Letitia Lake Group underlies the Letitia Lake region, including the Two-Tom Lake area. The group consists of massive quartz-feldspar porphyry at its base, overlain by a sequence of porphyritic rhyolite, banded rhyolite, crystal tuff and ignimbritic tuff, and an upper regolith derived from the underlying units. The Letitia Lake Group is in fault contact to the north with rocks of the Seal Lake Group. The Seal Lake Group consists of siltstone, shale, argillite and interbedded chert of the Wuchusk Lake Formation, and porphyry-cobble conglomerate, quartzite and basaltic flows of the Bessie

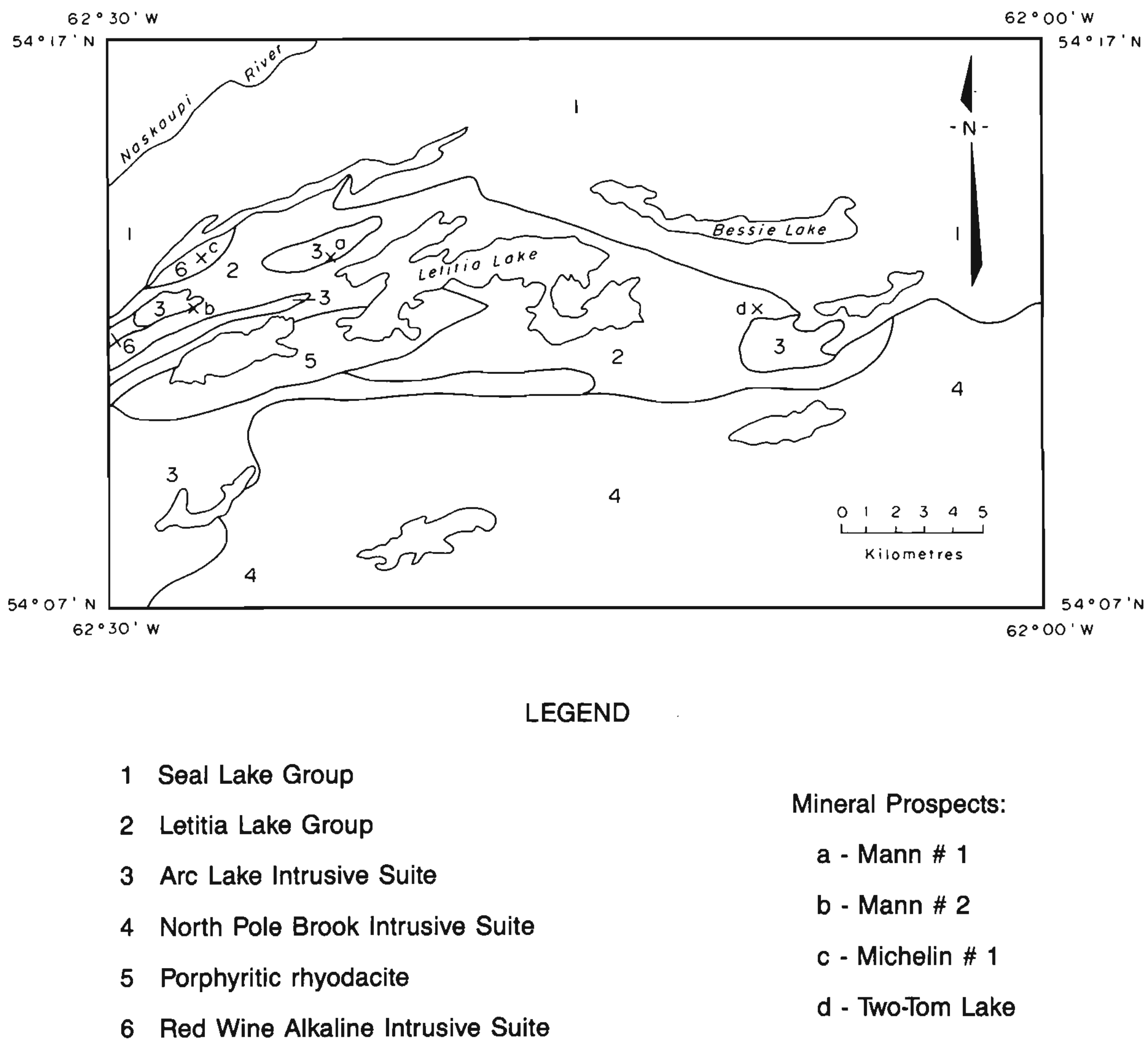


Figure 2: *Generalized geology of the Letitia Lake area.*

Lake Formation. Alkali syenites, alkali feldspar porphyry and peralkaline granite of the Arc lake Intrusive Suite, and granodiorite-quartz monzonite, biotite granite and diorite of the North Pole Brook Intrusive Suite occur south of the Letitia Lake Group.

Mineral Deposits

Four mineral prospects occur within the study area. The Mann # 1 deposit, located within the Arc Lake Intrusive Suite, has anomalous radioactivity and contains an average ore grade of 0.35 to 0.40 percent BeO, within barylite and eudidymite minerals. Niobium is an important secondary mineral. The Mann # 2 deposit, located 5.6 km southwest of Mann # 1, is within an Arc Lake Intrusive Suite inlier, and contains similar minerals. Assay values are lower than the Mann # 1 deposit (Brummer, 1957). The Michelin # 1 property occurs to the north of Mann # 2 deposit and is developed within the green pyroxene-aenigmatite gneiss of the Red Wine Alkaline Intrusive Suite. It has anomalous radioactivity and contains low assay values of Nb_2O_3 (Robinson and Cruft, 1958). The fourth prospect, in the vicinity of Two-Tom Lake, was identified through an airborne radiometric survey and comprises several areas of radioactive boulders. The boulders are predominantly alkali gneiss (Deane, 1970) and occur within the quartz-feldspar porphyry terrane of the Letitia Lake Group. The main mineralization is REE (Rare Earth Elements) bearing minerals, and Be and Nb minerals are accessories (Westoll, 1971). Of the four prospects, none are considered to be economic at present. However, if retrieval techniques are improved, the economic status of the area may be enhanced.

LETITIA LAKE: THE QUATERNARY ENVIRONMENT

Terrain Analysis

An interpretation of the surficial geology was made of map sheet 13L/1 and the southern portion of 13L/8 using 1:50,000 scale black and white airphotos. The resultant map was extensively field checked and is summarized in Figure 3. It shows that the terrain may be subdivided into five broad categories, similar to those defined by Fulton *et al.*, (1975). The area north of Letitia Lake is almost entirely dominated by bedrock ridges underlain by the Seal Lake Group, although numerous areas of till veneer occur between the ridges. South of Letitia Lake, the change in rock types is reflected by a change in topography, to an undulating plateau containing numerous areas of bog, scattered outcrops, and till of varying thickness, generally having a fluted appearance. The major valleys, notably the Red Wine and Naskaupi Rivers, are dominated by glaciofluvial outwash deposits. The outwash facies vary from sand plains of varying thickness which commonly flank well-defined eskers that reach heights of 3 to 5 m. The Letitia Lake valley is an exception to the outwash-dominated valleys. Although eskers are evident here, they are generally poorly developed, dissected and covered with a veneer of large boulders, many greater than 2 m in diameter. Till of varying thickness, locally exceeding 3 m, commonly has a ridged or hummocky surface expression. Numerous erosional channels, which enter the valley from its northern and southern margins, are also developed.

Sampling Methods

Till sampling was carried out over the study area for two purposes: 1) to determine dispersal patterns through geochemical analyses, especially from areas of known mineralization, and 2) to generate data on transport distances and directions through lithological analyses.

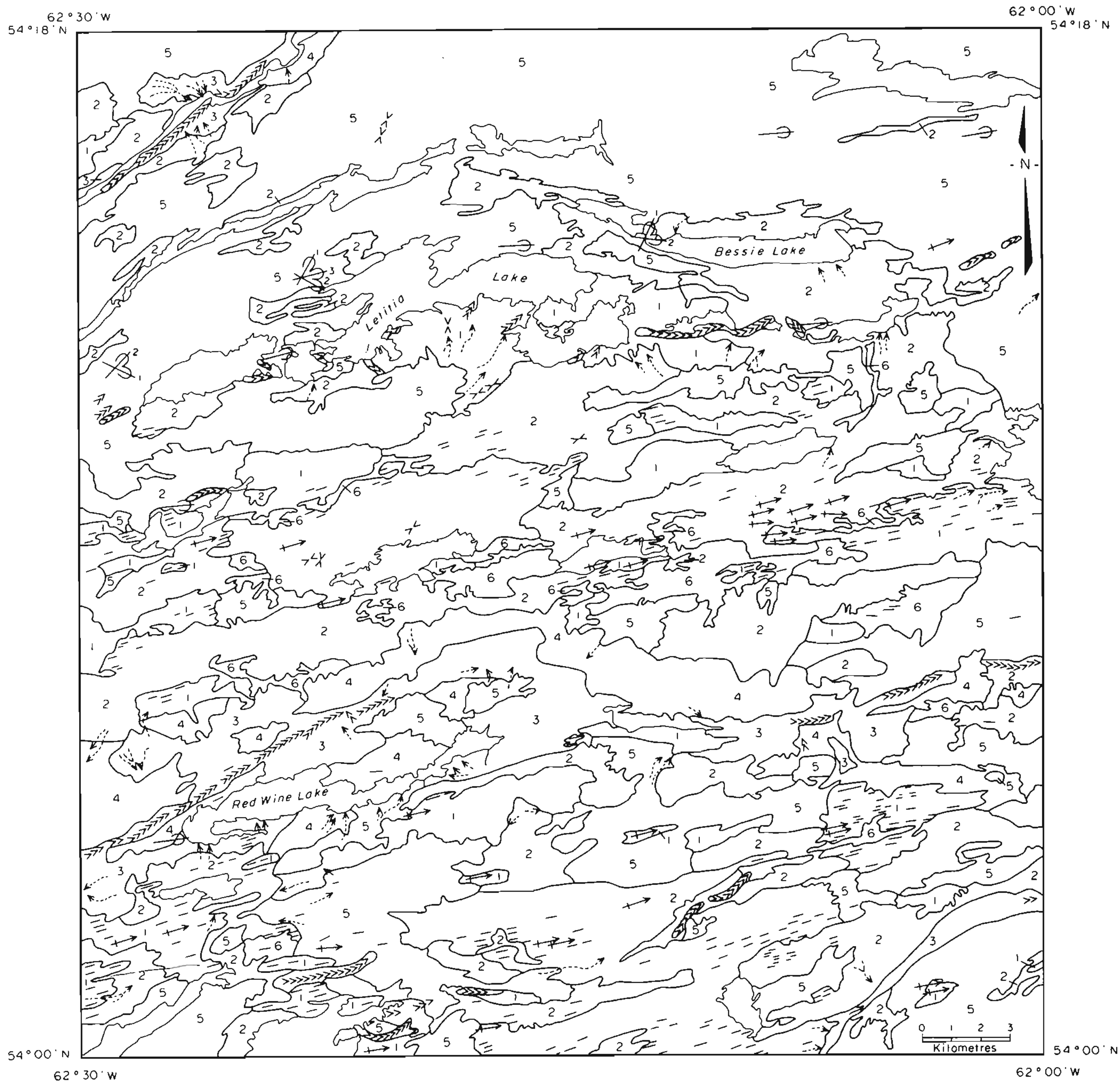
The sampling program was completed during a two week period on a 2 x 2 km grid. At each site, a sample was taken of the least oxidized horizon at the base of a pit. If possible, this was the C horizon, although commonly either iron-staining, large boulders or bedrock interrupted the pit, in which case either the BC or B horizon was sampled. At several sites, where a complete soil profile was observed, samples of each soil horizon were taken. At each site, lithological samples comprising 50 to 100 pebbles were taken from the coarser than 16 mm size fraction. These were identified with the aim of matching them with known source areas. In total, 225 till samples from 195 sites were collected.

Bedrock outcrops in the vicinity of each site were examined for glacial striations or other ice flow directional indicators, e.g., crescentic gouges, and their azimuth measured. In total 15 sites revealed such information.

Preliminary Interpretation of Glacial History

Previous workers have considered the Letitia Lake area only in a regional sense, and no detailed Quaternary work has been undertaken since the area lies in the central part of the Labrador sector of the Laurentide dispersal area. Prest *et al.* (1968) describes the general dispersal pattern of Late Wisconsin ice as flowing through the Labrador Trough and then trending approximately eastward or northeastward, probably following the line of least resistance along the Grenville Front (Rogerson, 1981). Recession is poorly understood in this part of Labrador. Ives (1960) suggests that ice on the Northern Labrador plateaux stagnated and down-wasted, while in the larger valleys gravity drainage helped maintain an active ice flow. In the Central Labrador region, the lack of recessional features may be an indication of stagnation.

Several observations are significant in a discussion of glacial advance and retreat within the study area. Evidence from directional indicators, notably striae (Figure 3), show that three ice flow events affected the area. The earliest flow, preserved in the lee of later events, trends 046. The consistency of this trend throughout the area, oblique to the topographic grain, suggests that it was a major event. The second flow ranges from 096/098 in the south to 114 in the north. The dominant flow event, based on striae and glacial landform evidence, is 074 in the north and ranges to 080 in the south. Earlier striae are always preserved in the lee of later events and crossing striae were rarely observed. The lack of a glacial stratigraphy and dateable material means the age of each of these flow events is open to conjecture. However, the fact that no set of striae showed any evidence of weathering and that each was observed within glacial polish suggests that all flows could be related to the same



LEGEND

1 Till (>3m)

2 Till (<4m)

3 Glaciofluvial outwash (>3m)

4 Glaciofluvial outwash (<3m)

5 Mostly bedrock

6 Organics

Meltwater channel

Esker (direction known/ direction unknown

Fluted / lineated till

Crag and tail

Glacial striae (1=oldest)

Figure 3: *Surficial geology map of the Letitia Lake area*

event, presumably the Late Wisconsin. All glacial landforms, e.g., flutes, crag and tails, are consistent with the last ice flow event, and it is expected therefore that patterns of geochemical and lithological dispersal should also be consistent with this flow.

Recession of the Laurentide ice sheet produced large quantities of meltwater. This is reflected by the extensive outwash deposits and eskers within both the Naskaupi and Red Wine River valleys, which coalesce to the east and exit into Grand Lake. It is perhaps due to its proximity to the altitudinally lower Naskaupi Valley, and the resultant drawdown, that the Letitia Lake valley shows evidence of only minor outwash and esker deposits. Apparently, Letitia Lake was an area of ice stagnation. Meltwater channels entering the valley add to the complexity of deposits here. Features within the valley, such as hummocky till, randomly oriented till ridges (crevasse fillings?), numerous meltwater channels, and poorly defined and discontinuous eskers, are consistent with ice-stagnation topography. The Letitia Lake valley is completely covered by a surface mantle of large (commonly greater than 2 m in diameter), angular boulders of predominantly local origin. However, few such boulders are noted on the plateau area to the south. A suggested explanation for this is that as glacial ice entered the head of the Letitia Lake basin, the subsequent movement down a concave surface resulted in an extending-flow regime. This regime enhanced erosion of the substrate and large blocks were quarried and entrained. Upon stagnation, the boulders were deposited upon the surface. The large amounts of meltwater caused winnowing of material from around the boulders, resulting in the present terrain. The lack of recessional features on the plateau implies that deglaciation was through a downwasting process.

TWO-TOM LAKE: DETAILED QUATERNARY EXPLORATION

Two-Tom Lake is situated within the Letitia Lake valley 5 km east of Letitia Lake. Physiographically, the area is a boulder-strewn lowland. Till appears to be generally less than 3 m thick; there are numerous small bogs and a well developed esker. Geologically, the area is dominated by quartz-feldspar-porphyry of the Letitia Lake Group. However, to the northeast of Two-Tom Lake, a northwest-southeast trending contact with the Bessie Lake Formation is inferred through aeromagnetic data (Sanger, 1971). An exploration program was adopted that would not only highlight areas of mineralization but also provide ice flow dispersal data. This facet of the project has four distinct components: an airborne scintillometer survey, a ground scintillometer survey, a biogeochemical survey and boulder tracing.

Airborne Scintillometer Survey

The purpose of this survey was to determine, in general, radiometrically anomalous areas that may reflect areas of

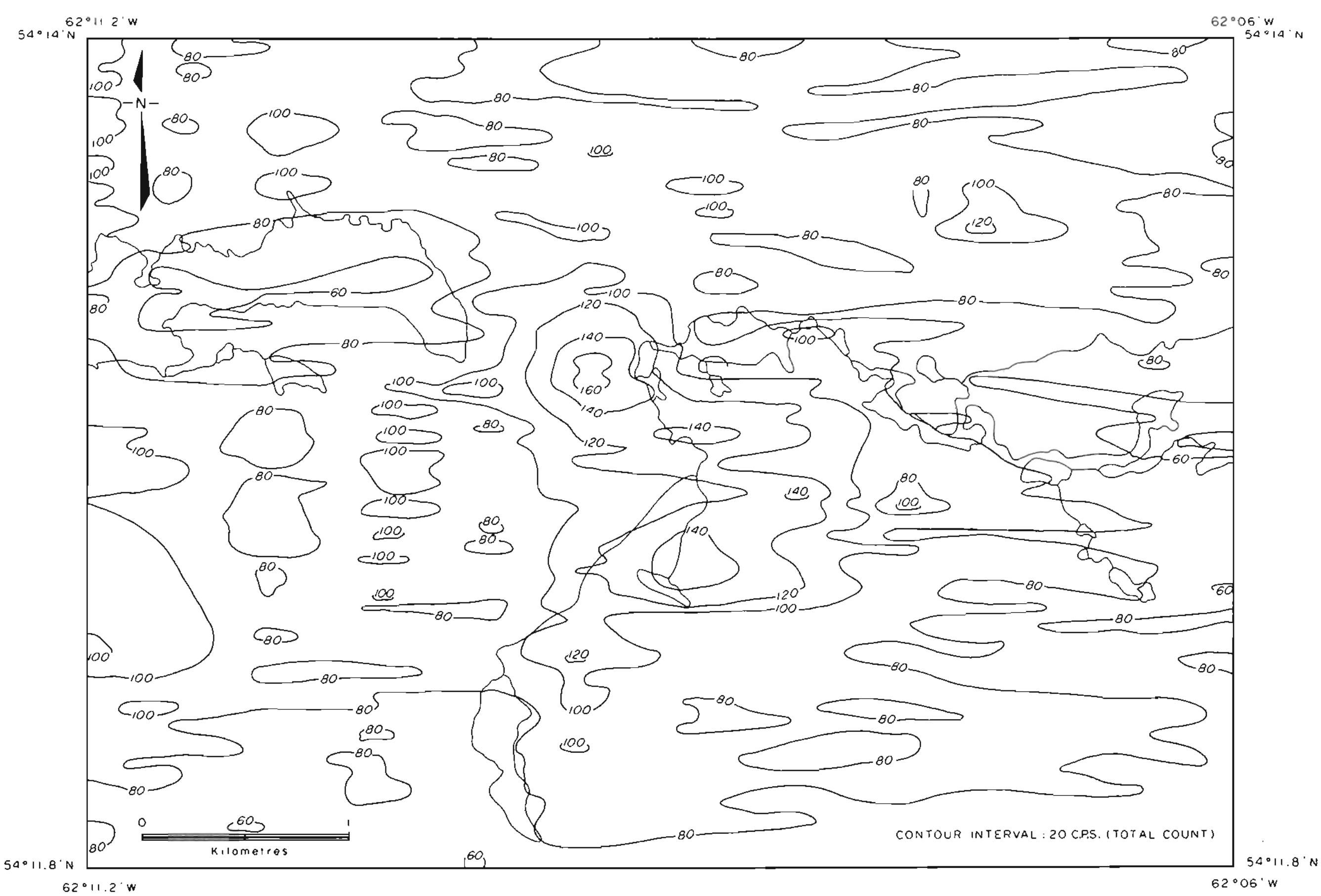


Figure 4: *Airborne scintillometer map of the Two-Tom Lake area.*

mineralization. The survey was completed using an EDA differential spectrometer, hand-held within a Bell 207B helicopter, flying at 100 km per hour, at an average height of 150 m. Readings were recorded every 1 second and subsequently transferred to a base map by calibrating values between known points (Figure 4).

The survey reveals several points of note: the major lows correspond to the lakes; patterns are elongated in a roughly west to east direction consistent with the regional glacial flow direction; a series of anomalies are present, the highest in the vicinity of Two-Tom Lake.

Ground Surveys

A survey grid was established on the basis of the airborne survey and reconnaissance ground traversing was done to determine the distribution of radioactive boulders. A 090 base line was established for a total length of 1200 m. Perpendicular grid lines were established every 100 m along the base line and extended an average of 500 m north and south with stations every 50 m. In total, 259 station sites were selected.

At each station a scintillometer reading was recorded (average of five), and the surrounding terrain mapped for

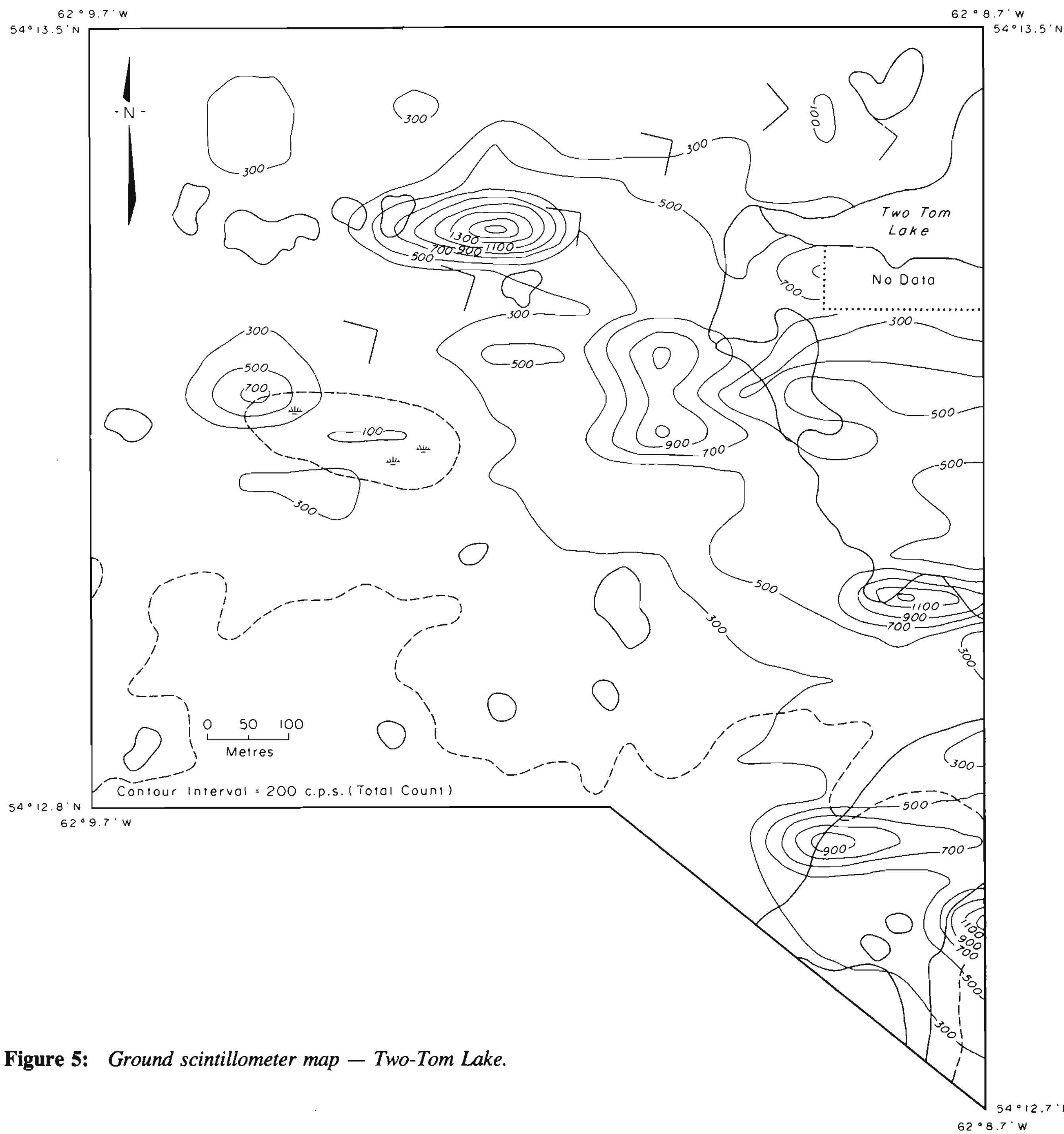


Figure 5: *Ground scintillometer map — Two-Tom Lake.*

bedrock outcrops, terrain type and mineralized boulders. Representative samples of both boulders and bedrock were taken for analyses. In all, 80 samples were collected.

The bouldery nature of the surface mantle and the discontinuous nature of the till made a till sampling program impractical. As an alternative, a biogeochemical method was selected. This method has been applied with moderate success by Dunn (1981, 1983) in the Athabasca basin in Saskatchewan, and by Kovalevsky (1972) in Russia. Dunn showed that, in general, highest values are attained from either black spruce *(Picea mariana)* twigs or Labrador tea *(Ledum groenlandicum)* roots. There is no shortage of the former in the Two-Tom Lake area. Samples were collected at every station following the methods outlined by Dunn (1981), i.e., 100 to 200 g of spruce twigs, approximately 25 cm in length (last 10 years of growth), were taken over a two day period in order to reduce the seasonal variations in chemistry noted in trees. The samples were air dried for 4 to 6 weeks in the laboratory, at which time the needles had fallen off. The twig samples were than ashed overnight in a furnace at 500°C.

Initial Results

The ground scintillometer survey (Figure 5) reveals the same general distribution of anomalous areas that were identified through the airborne survey. However, the ground survey does produce more detail in that it highlights a major anomaly in the southeast corner of the Two-Tom Lake area, and several highs to the north, east and west of this anomaly. These radiometric anomalies coincide almost perfectly with the distribution of mineralized boulders, which either occur singularly or as boulder clusters. A contoured percentage of the distribution of these mineralized boulders is shown in Figure 6.

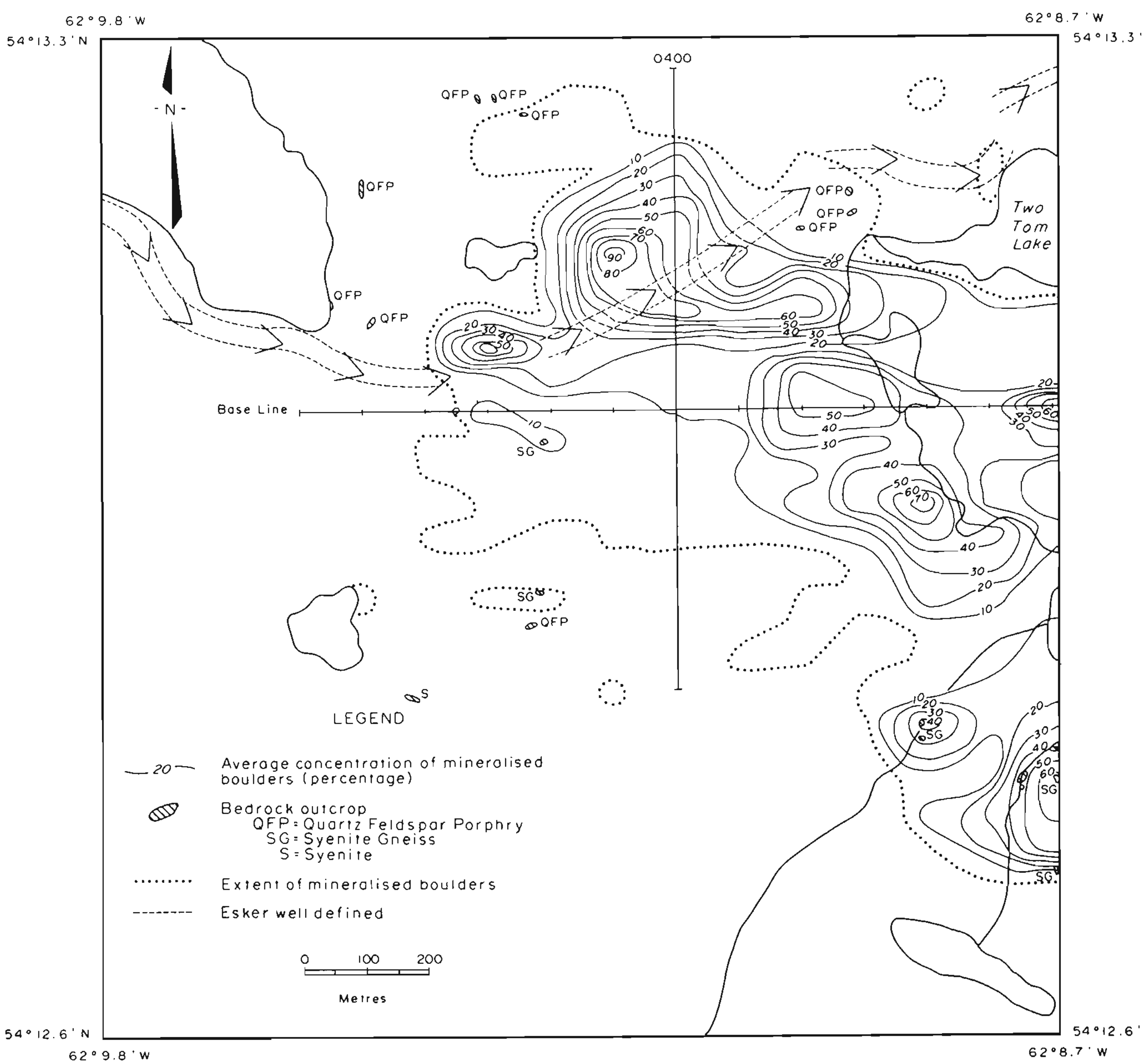


Figure 6: *Distribution of mineralized boulders around the Two-Tom Lake project.*

Two distinct dispersal trains are apparent from Figure 6. The southernmost train is composed of 90 percent foliated and banded syenite gneiss (sample number 854951, Table 1). Approximately 8 percent of the train is a gray-colored syenite gneiss containing a well developed gneissic fabric (sample number 854960). The remaining 2 percent of the train is composed of a medium grained syenite gneiss (sample number 854954), similar to the Mann # 1 host rocks.

The central dispersal train consists of three separate highs, each related to syenite gneiss of various textures. The southern and eastern highs consist of rocks designated as sample number 854960 and sample number 854951 respectively in Table 1. The western high predominantly contains a light gray to green syenite gneiss (sample number 854956) that is medium to coarse grained, but is less foliated and less radioactive (1000 cps) than the others. Dispersed throughout the train (up to 20 percent of total boulders) is a dark green, fine grained, massive, unfoliated rock type (sample number 854955) that is volcanic in appearance and has given readings up to 2600 cps. Several other varieties of syenite gneiss were also identified in the dispersal train, but all are of a minor nature.

The northernmost train is dominated (80 percent) by rocks described under sample number 854951 (Table 1). However, locally significant are those rock types represented by sample numbers 854954, 854955 and 854956 (Table 1). Of note, however, is the discovery within this train of a highly mineralized syenite-gneiss boulder producing greater than 60,000 cps.

It must be noted that although there are physical contrasts between syenite gneisses in the Two-Tom lake area and eight subdivisions have been made, chemical trends (yet to be determined) may not correspond to these subdivisions. Nevertheless, at least two major trains exist in the area.

SUMMARY

The type of exploration approach used in the Two-Tom Lake area has proved to be successful. An initial airborne scintillometer survey highlighted the areas of potential, and a ground survey detailed the distribution of the anomaly-forming boulders. The boulders are varieties of syenite gneiss, some similar to those associated with the Mann # 1 deposit.

Bedrock outcrops are sparse within the survey area, although several are exposed in a stream associated with the southernmost train. Farther into the valley, the bouldery nature of the terrain masks all but a few outcrop occurrences. From the location of bedrock and the extent of the dispersal trains, it is apparent that the K-value, i.e., the distance between outcrop and the first occurrance of boulders derived from that outcrop, is probably less than 100 m, and that most (probably 90 percent) of the boulders were deposited within 600 m of their source. It is therefore likely that the bedrock source from which the mineralized boulders were derived is within a zone similar to, but larger than, that outlined by Westoll (1971), probably in the order of 200 m wide and greater than 1500 m long.

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Table 1: Description of some rock types in the Two-Tom Lake area.

Sample Number	Rock Type	Grain Size	Color	Physical Characteristics	Total Counts Per Second
854951	Syenite gneiss	Medium	Gray, Brown	Pink felsic bands, foliated	5000 (boulders)/ 6000 (outcrop)
854954	Syenite gneiss	Medium	Brown	Black streaks of amphibole (Mann type)	10,000 (boulders)
854955	Volcanic(?) rock	Fine	Dark green	Massive, non-foliated	2600 (boulders)
854956	Syenite gneiss	Medium to Coarse	Light gray, Green	Moderately foliated	1000 (boulders)
854960	Syenite gneiss	Fine to Medium	Gray	Well developed gneissic foliation	4500 to 5000 (boulders)

was reviewed by Maryann Mihychuk, Byron Sparkes and Doug Vanderveer.

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