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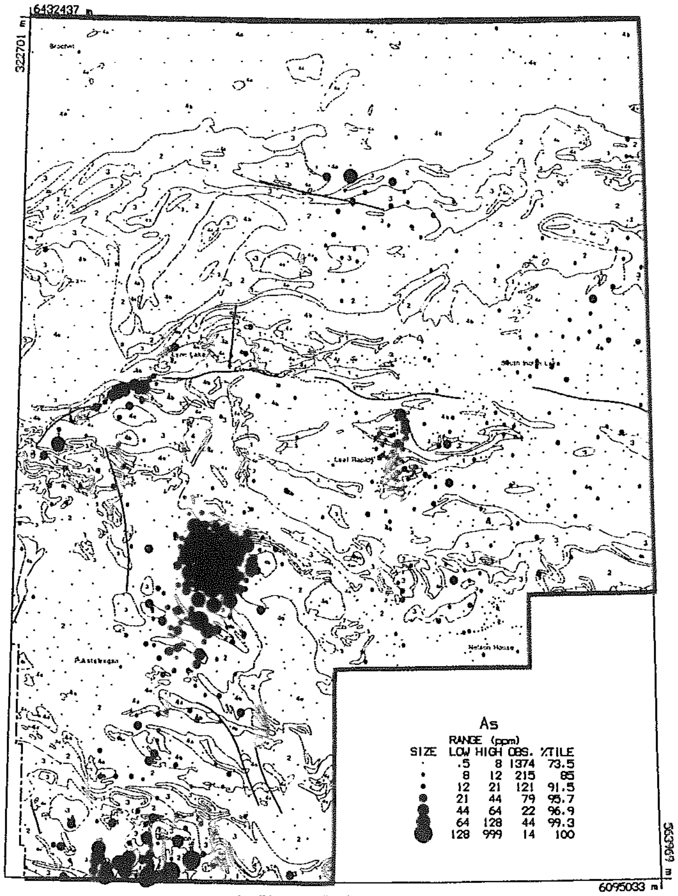
Surficial Geology and Till Composition Northwestern Manitoba



As IN TILL, < 2 MICRON FRACTION

C.A. Kaszycki

1989

Energy, Mines and Resources Canada
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Contribution to Canada-Manitoba Mineral Development Agreement 1984-89, a subsidiary agreement under the Economic and Regional Development Agreement. Project funded by the Geological Survey of Canada.

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Open File 2118

Surficial Geology and Till Composition, Northwestern Manitoba

This Open File publication consists of four parts :

1) Summary Report including a fifty page manuscript summarizing interpretations of till geochemical data, seven sample location maps at 1:250 000 scale covering NTS sheets 64B, C, F, G, 63N and parts of 63 O and K (in pocket), ten computer generated dot maps of trace element concentration in till at 1:1 500 000 for As, Cr, Cu, Fe, Mn, Ni, Pb, Zn for the <2 μm size fraction, and Au and U for the <63 μm size fraction, and three clear film overlays at 1:1 500 000 (bedrock geology, till provenance, and NTS location).

Available from **Ashley Reproductions, Ottawa,** cost $ 40.50

2) Appendix A, Geochemical Data Base, Hard Copy, a computer print out of all geochemical data including: sample location and description; till geochemistry, <2 μm size fraction; till geochemistry, <63 μm size fraction; gold in heavy mineral concentrates; carbonate content, <63 μm and granule size fractions; and striation location and description.

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3) Appendix C, Computer Generated Colour Contour Maps (APPMAP), includes ten colour contour maps of trace element concentration in till at 1:1 000 000 scale, and two clear film overlays (bedrock geology and NTS location). Elements mapped include: As, Cr, Cu, Fe, Mn, Ni, Pb, Zn for the <2 μm size fraction, and Au and U for the <63 μm size fraction.

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4) Appendix A, Geochemical Data Base, Floppy Disk, includes three 5 1/4 inch floppy disks (360K format), or one 3 1/2 inch disk (1.4 Meg format). Data are stored as tab delimited ascii (text) files that can be imported easily by most spreadsheet and wordprocessing software.

Available from **Geological Survey of Canada, Ottawa,** cost $ 35.00

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INTRODUCTION

In 1983, a program of systematic till sampling and surficial geological mapping was begun in northwestern Manitoba. The program was undertaken as part of the joint Canada-Manitoba Mineral Development Agreement, to be carried out over a five year period ending in 1989. The primary objective of the sampling was to map variations in chemical and mineralogical components of till that may be related to bedrock mineralization as an aid to mineral exploration within the area. Detailed surficial geological mapping at a scale of 1:125,0000 was carried out in conjunction with till sampling, in order to develop an understanding of the glacial history of the region and provide the framework for interpretation of compositional data.

Regional till sampling and surficial mapping has been completed for five 1:250,000 map areas, including the Uhlman Lake (64B), Granville Lake (64C), Brochet (64F), Big Sand Lake (64G), and Kississing (63N) NTS map sheets, and till geochemistry reports and preliminary surficial geology maps at a scale of 1:125,000 have been released as GSC Open File Reports (Kaszycki and DiLabio, 1986a,1986b; DiLabio and Kaszycki, 1986; Kaszycki et al., 1986,1989; Kaszycki and Way Nee, 1989a,1989b,1989c) (Fig. 1). Till sampling was also carried out over parts of the Cormorant Lake (63K) and Nelson House (63O) NTS map areas. More detailed sampling was carried out in selected areas, as follow-up studies based on anomalies identified through regional till geochemical surveys (Suttner, 1989; Kaszycki, 1988; Kaszycki et al, 1988; DiLabio and Kaszycki, 1988). In addition detailed profile sampling was carried out wherever exposure permitted, in an effort to evaluate *in situ* geochemical variability in response to both primary sedimentological factors and secondary surface weathering phenomena. Two small sampling projects were also carried out to address environmental issues, one assessing the impact of air-borne pollutants from the smoke stack in Flin Flon (Samson, 1986) on the geochemistry of surficial sediments, and one evaluating the sensitivity of surficial deposits within the region to acidification by acid rain (Samson, 1989).

In conjunction with regional till sampling, detailed sampling projects in the vicinity of known deposits were carried out by the Manitoba Department of Energy and Mines, in order to evaluate the geochemical signature of various types of mineralization within the region, and the scale and form of glacial dispersal related to individual deposits (Nielsen,1982, 1983, 1985, 1986a, 1986b, 1987a, 1987b; Nielsen and Fedikow, 1986, 1987; Nielsen and Gobert, 1988; Nielsen and Graham, 1984, 1985; Nielsen et al., 1985).

A primary objective in regional till sampling is to identify the lithologic components of till that reflect various bedrock sources, and to map out the patterns of glacial dispersal developed through glacial erosion and transport of

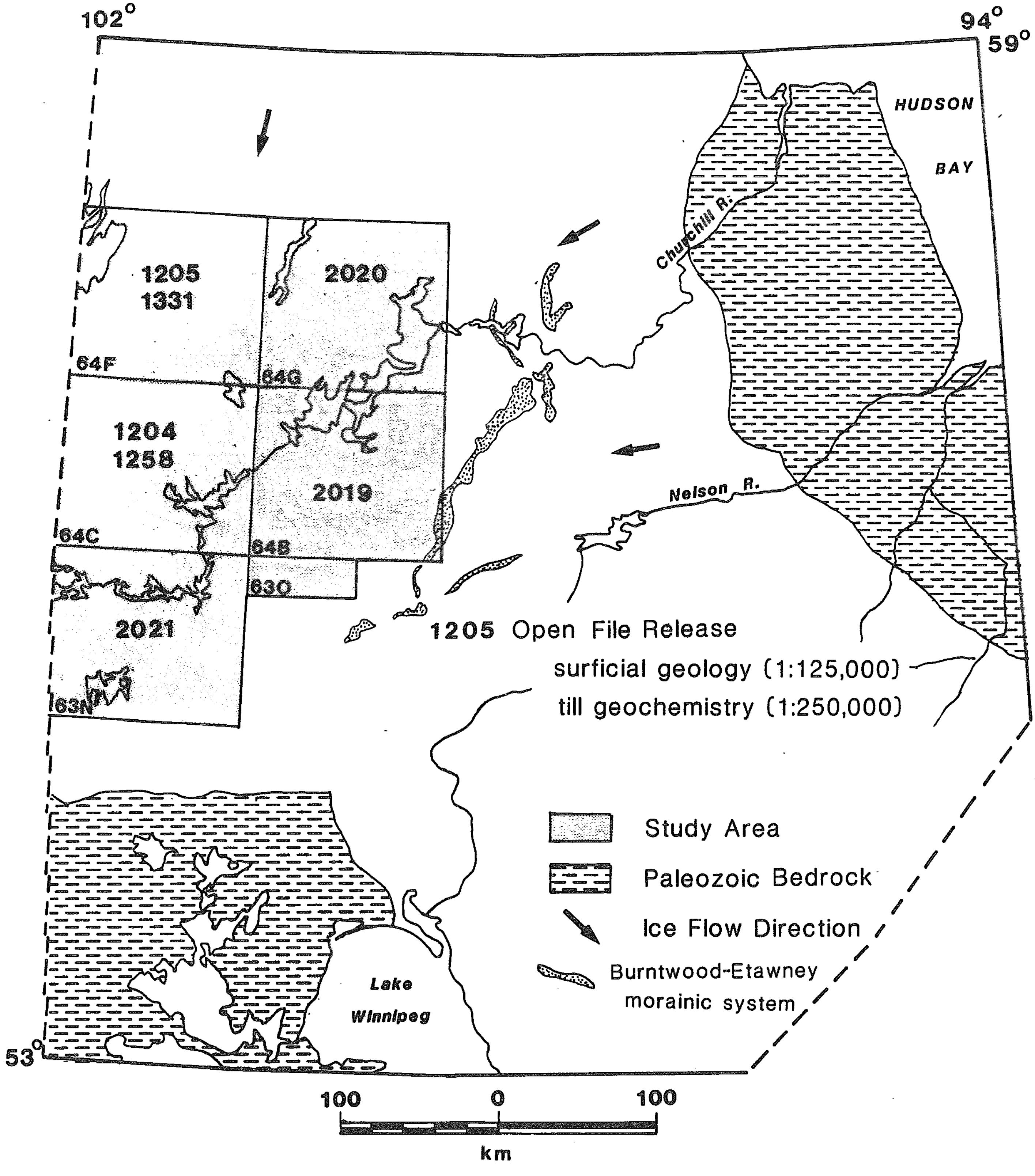


FIGURE 1. Location of study area

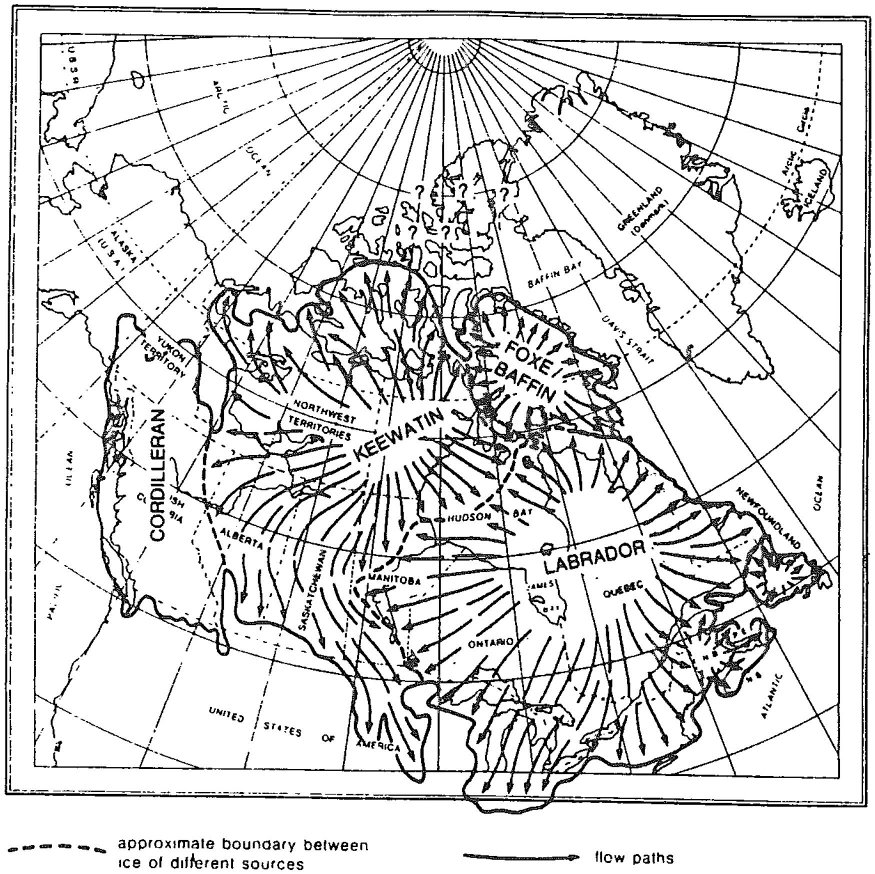


FIGURE 2. Configuration and ice flow patterns of the Laurentide Ice Sheet (from Andrews, 1983; after Prest, 1983)

distinctive bedrock lithologies. These data, combined with detailed surficial geologic mapping can be used to aid in the design and implementation of prospecting programs aimed at locating sources of mineralized erratics and drift. The primary objective of this study is to provide reconnaissance level till geochemical data in order to outline regions with potential for mineralization (primarily base metals and gold), identify areas for further detailed study, and provide the geologic framework for implementation of successful detailed drift prospecting programs within the region.

A complete data base, including geochemical data, sample location and description, and striae location is available either as a print out, or on diskettes accompanying this report (Appendix A). Sample location and striation maps at a scale of 1:250,000 are also included.

Regional Setting

The study area is located within the Churchill structural province of the Canadian Shield, in a region influenced by competing centres of ice flow during the Late Wisconsinan (Fig. 2) (Prest, 1983, 1984; Andrews, 1983). Throughout the extreme western part of Manitoba, Late Wisconsinan ice flow was from a Keewatin ice centre and till in this region is derived predominantly from crystalline shield lithologies. Farther east, ice flow originated from a centre of outflow in Labrador and till in this area contains abundant Paleozoic carbonate erratics derived from Hudson Bay and adjacent lowlands. These variations in regional till provenance significantly influence texture, mineralogical composition and geochemistry of tills throughout the study area.

During ice retreat, inundation by glacial Lake Agassiz resulted in deposition of calcareous laminated silt and clay throughout a large part of Manitoba (Elson, 1967; Nielsen et al, 1981). Extensive clay deposition occurred in the central and eastern parts of the province, as well as along river valleys extending from major inflow channels draining Cretaceous terrane along the western margin of the lake (Teller et al, 1983). The composition of Lake Agassiz clay, therefore, reflects provenance related to distal sediment sources along the western edge of the basin, as well as sediment derived from the two ice masses forming the northern and eastern margins of the lake during deglaciation (Teller, 1976; Langford, 1977; Suttner, 1986).

Contributions to present concepts of surficial geology and Quaternary history within northern Manitoba and adjacent Saskatchewan and District of Keewatin include Elson (1967), Dredge and Nixon (1986), Dredge et al. (1986), Dredge (1981, 1983a, 1983b, 1983c), Dredge and Nielsen (1985, 1986), Klassen (1983, 1986), Aylsworth and Shilts (1985), Shilts et al. (1987), Schreiner (1984, 1986), Schreiner and Alley (1975, 1984), Nielsen et al. (1986), Nielsen and Dredge (1982).

Methodology

Helicopter-supported sampling was carried out at a density of approximately 2-3 samples per 100 km^2 (average sample spacing 7 - 8 km). Sampling density was increased in areas of road access and restricted in areas of extensive clay cover. Shallow surface samples from approximately 1 m depth were collected from hand-dug pits. Initially, relatively small (2.5 kg) samples were collected, in order to maximize the number of samples obtained per helicopter payload. However, as sampling became more difficult and time consuming due to increased clay cover, sample size was increased to 5 kg, enabling a broader range of analytical techniques to be used. Care was taken to sample below the postglacial solum, and almost all samples are classified as oxidized C horizon material (parent material). In general, labile minerals such as sulphides have been weathered from these samples, and in some instances carbonate has been leached.

Till samples were routinely subjected to a number of analytical techniques. In reconnaissance till sampling programs where sample spacing ranges up to 10 km, a large background to anomaly ratio is required in order to resolve geochemical patterns and identify mineralized debris that may have been dispersed and diluted over distances varying from 100's of metres to several kilometres. The clay-sized (<2µm) fraction of all samples was analyzed for trace element composition related to base metal sulphide mineralization because:

1) concentrations of many trace elements are greater in this fraction than in coarser size fractions due to primary enrichment of metal in the structure of phyllosilicates, which dominate this size fraction (Shilts, 1984);

2) it provides a more uniform sampling medium than sample subsplits comprising a wider range in grain size (e.g. minus 80 mesh, which commonly contains variable amounts silt and sand dominated by inert quartz and feldspar), thereby minimizing geochemical trends related to grain size variation in the till (Shilts, 1975).

3) it is known to reflect sulphide mineralization because it will adsorb a representative portion of trace elements released during the weathering of labile minerals (Shilts, 1975, 1984).

Clay separated by centrifugation and decantation was analyzed by Bondar-Clegg Co. Ltd. (in 1983, 1984, 1985, 1986) and by Chemex Labs (1987, 1988) for Cu, Pb, Zn, Ni, Cr, Mn, Fe , Mo, Cd, Co, and Ag, using standard atomic absorption techniques after a hot acid (HNO_3-HCl) leach. Arsenic was analyzed using colourimetric techniques and uranium was determined by fluorimetry (1983, 1984) and by neutron activation with delayed neutron counting (1985, 1986, 1987, 1988). For a complete listing of analytical techniques see Table 1.

In addition, the silt plus clay (<63µm or minus 230 mesh) fraction of most tills was analyzed for Au by direct irradiation neutron activation in a gold plus 33 element package. This size fraction was chosen because of the large sample size required for analysis (>10 g) as well as the fact that gold in this region most commonly occurs as silt size particles, both in bedrock and derived tills (Sopuck et al., 1985; DiLabio, 1985; Brereton et al., 1988). This size fraction was also analyzed for carbonate content using a Leco induction furnace.

Heavy mineral separates were concentrated from selected samples by Overburden Drilling Management Ltd., and grain counts for visible gold were carried out. Heavy separates were then analyzed for Au by fire assay with an atomic absorption finish. In addition, lithological identification of the pebble fraction (2-6 mm) of selected samples was carried out in order to identify regional ice flow indicators as well as potential sources for mineralization observed geochemically within various till fractions.

Beginning in 1985, analytical quality control was monitored by insertion of 10% standards and blind duplicates within each sample batch. Subsets of samples analyzed prior to 1985. were reanalyzed in order to establish reproducibility. In most cases analytical variability fell within the tolerance limits set by analytical laboratories for various techniques. When analytical variability exceeded tolerance limits, samples were resubmitted and re-analyzed.

A complete listing of all geochemical data, including sample location and description accompanies this report and may be obtained either on computer diskette, or as a hard copy print out. Data are available on 5 1/4 inch floppy disks (360K format) and are stored as tab delimited ascii (text) files that can easily be imported by most spreadsheet and word processing software (Appendix A).

SURFICIAL GEOLOGY

Morphological evidence and till composition suggest that during deglaciation the zone of convergence between Keewatin ice and Labradorean ice was located in the Leaf Rapids area . This zone is marked by a discontinuous north-south trending ridge composed of ice contact stratified sediment, termed the Leaf Rapids Interlobate Moraine (LRIM) (Fig. 3). It is hypothesized that during deglaciation a large re-entrant developed in the ice front near the suture between Keewatin and Labradorean ice masses. Ice flow shifted in response to reconfiguration of the ice margin, and drawdown into the embayment produced a zone of convergent ice flow. East of the LRIM, striae record a clockwise rotation of Late Wisconsinan ice flow from approximately 190° - 210° (oldest) to 260° (youngest) and till contains abundant Paleozoic carbonate and Proterozoic greywacke of Hudson Bay and eastern provenance. To the west, striae record a counterclockwise shift in ice flow from 190° - 210° (oldest) to 165° (youngest) and till is dominated by crystalline shield lithologies. Previous interpretations (Klassen 1983, 1986; Dredge 1983; Dredge and Nixon, 1986) suggest that the confluence between Labradorean and Keewatin ice masses during deglaciation is marked by the Burntwood - Etawney morainic system (Elson, 1967) located approximately 100 km east of the LRIM (Figs. 1 and 3). This system as depicted by Klassen (1983, 1986), may represent a large interlobate, or radial kame moraine developed contemporaneously with the LRIM. Alternatively, it may represent a recessional moraine developed after retreat of Labradorean ice from the Leaf Rapids area.

The LRIM extends southward as far as the eastern extension of the Cree Lake Moraine (Fig. 3). The Cree Lake Moraine extends westward through Saskatchewan and into

Table 1
Analytical Techniques

Size Fraction	Preparation	Elements	Extraction	Method	Lab (Year)
<2μm	centrifugation and decantation	Ag†, As, Cd†, Co†, Cr, Cu, Fe, Mn, Mo, Pb, Zn	HNO_3-HCl (3:1)	atomic absorption spectroscopy	Bondar-Clegg (1983, 1984, 1985, 1986) Chemex Labs (1987, 1988)
		U†		neutron activation delayed neutron counting	Bondar-Clegg (1985, 1986) Chemex (1987, 1988)
		U†	HNO_3	fluorimetry	Bondar-Clegg (1983, 1984)
		As	HNO_3-$HClO_4$	colourimetry	Bondar-Clegg (1983, 1984, 1985, 1986) Chemex Labs (1987, 1988)
<63μm	dry seiving	Au, Sb, As, Ba, Br* Cd, Ce*, Cs*, Cr, Co* Eu*, Hf, Ir, Fe, La, Lu*, Mo, Ni, Rb*, Sm*, Sc*, Se, Ag, Na* Ta, Te*, Tb*, Th, Sn* W, U, Yb*, Zn, Zr*		direct irradiation/ instrumental neutron activation analysis	Bondar-Clegg (1983, 1984, 1985, 1986)
		Au		fire assay/ neutron activation	Chemex Labs (1987, 1988)
		$CaCO_3$		Leco induction furnace	Geological Survey of Canada
heavy mineral fraction	preconcentrate on shaker table, heavy liquid separation S.G. 3.3	Au		grain count	Overburden Drilling Management Ltd. (1986, 1987, 1988)
		Au		fire assay/ atomic absorption	Bondar-Clegg (1986) Chemex Labs (1987, 1988)

† data set incomplete, analyses not performed in certain years
* data set incomplete, analyses not offered in Au+ packages in all years

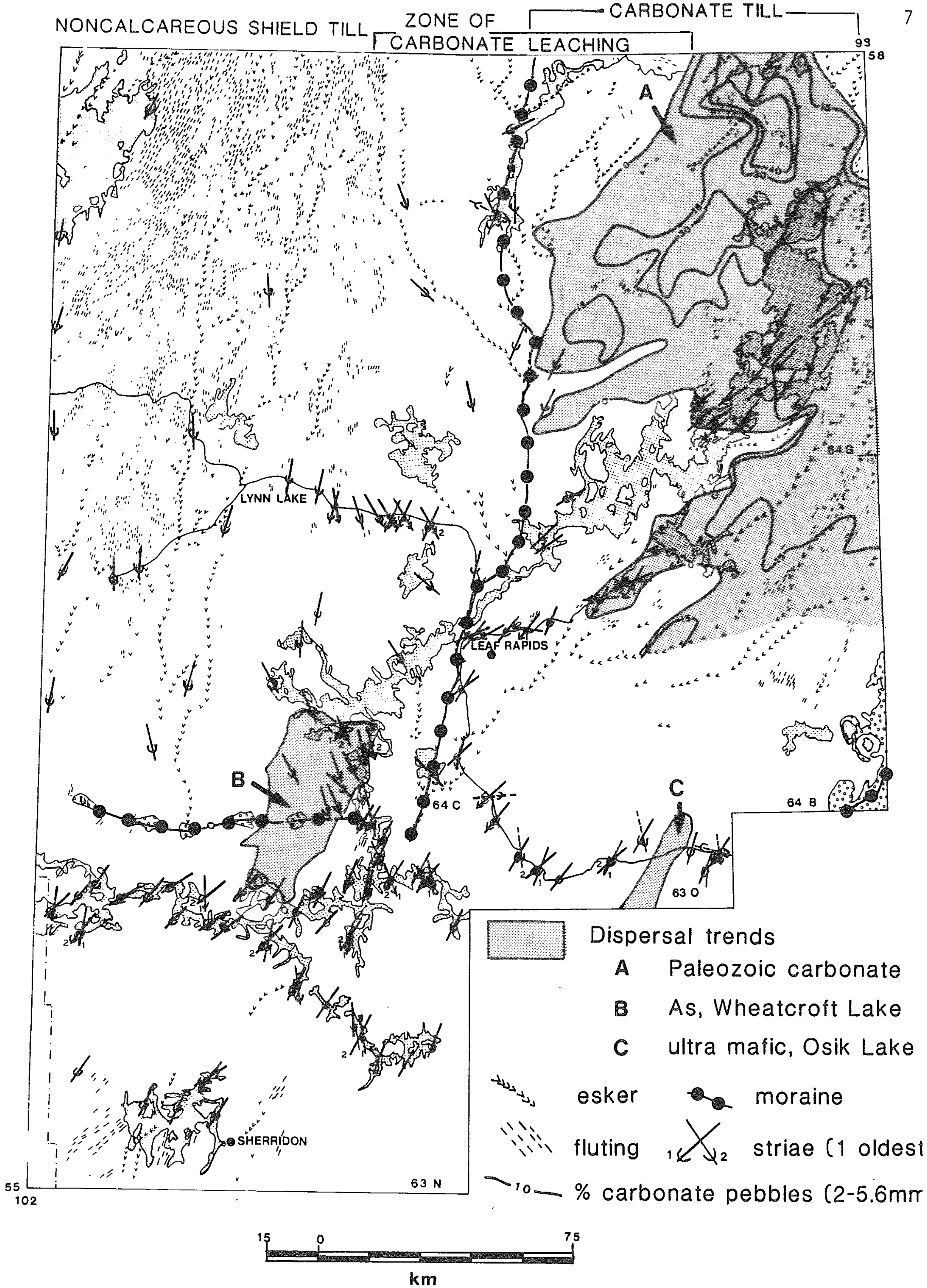


FIGURE 3. Glacial landforms and major dispersal patterns

the Northwest Territories and marks a major ice marginal position during retreat of Keewatin ice (Schreiner, 1984; Schreiner and Alley, 1984). South of the Cree Lake Moraine, there is no evidence for a zone of convergent ice flow during deglaciation, and it is assumed that the embayment between Keewatin and Labradorean ice did not develop until the ice margin had retreated to this position. Dispersal patterns and ice flow indicators south of the Cree Lake moraine suggest that the deglacial zone of convergence between Keewatin and Labradorean ice in the Leaf Rapids area was preceded by a more extensive Main Late Wisconsinan zone of parallel and confluent ice flow between these two ice masses.

Surficial Deposits

Surficial deposits within the study area vary from dominantly fluted till plain in the northwest (NTS 64F) to extensive clay cover in the east and northeast (Fig. 4). This lateral variation in the type of surficial sediment dominating the landscape influences the efficacy of surface till sampling throughout the region. In general, drift cover is thin, characterized by a single till unit forming a discontinuous veneer on bedrock, ranging from 0 - 3 metres in thickness. Thicker till deposits commonly occur as tails on the down-ice (southern) side of bedrock knobs and may fill isolated bedrock depressions. Thick till deposits may also form a blanket, one to several metres in thickness, masking underlying bedrock topography. In these areas, the till surface is commonly fluted, and till is easily obtained by shallow surface sampling (Fig. 5a).

During the regressional phases of glacial Lake Agassiz, till and glaciofluvial deposits (eskers and moraines) were reworked by wave action, producing a boulder lag in some areas, and forming beaches, spits and sand blankets elsewhere (Fig. 5a). These deposits frequently form a thin veneer over till within the western part of the study area. It is important to distinguish between these sandy nearshore deposits and sandy till when sampling within these regions.

In the eastern part of the study area, till is commonly covered by a veneer of Lake Agassiz clay. In some areas, particularly near eskers and moraines, glaciolacustrine deposits may achieve thicknesses in excess of 50 m. Throughout most of the region however, clay is present as a relatively thin veneer, draping topographic highs and filling topographic lows. In these areas, at elevations >1000 ft (~ 300 m) till can usually be sampled near the summits of small hills or knolls beneath 50 to 100 cm of clay (Fig. 5b).

Till and Related Sediments

These deposits comprise unsorted to poorly sorted debris, deposited at the front of or beneath glaciers, or under ice shelves. Till composition varies laterally across the study area. In the east, surface till is silty and calcareous, whereas to the west, surface till is sandy and noncalcareous. The change from silty calcareous till to sandy noncalcareous till is transitional and till in this central transition zone may be sandy to silty and slightly calcareous to carbonate-free. Carbonate concentration in till increases systematically to the northeast, achieving concentrations in excess of 60% in the granule fraction and 35% in the silt plus clay (<63 µm or <230 mesh) size fraction (fig.3). The 0% carbonate contour does not represent the western limit of carbonate dispersal, but rather marks a zone of lower concentration and surface weathering and leaching. West of this contour clay cover is thin and discontinuous and leaching of carbonate is prominent. Samples containing carbonate are found sporadically throughout this region, and carbonate in low concentration (1 - 2%) can be traced in unleached roadcuts up to 30 km west of the Leaf Rapids interlobate moraine. The depth of leaching varies from 1 - 2 metres. The transition from leached to unleached till is not marked by visible colour or textural changes and in shallow surface samples these leached low-carbonate tills are visually indistinguishable from shield tills of Keewatin provenance.

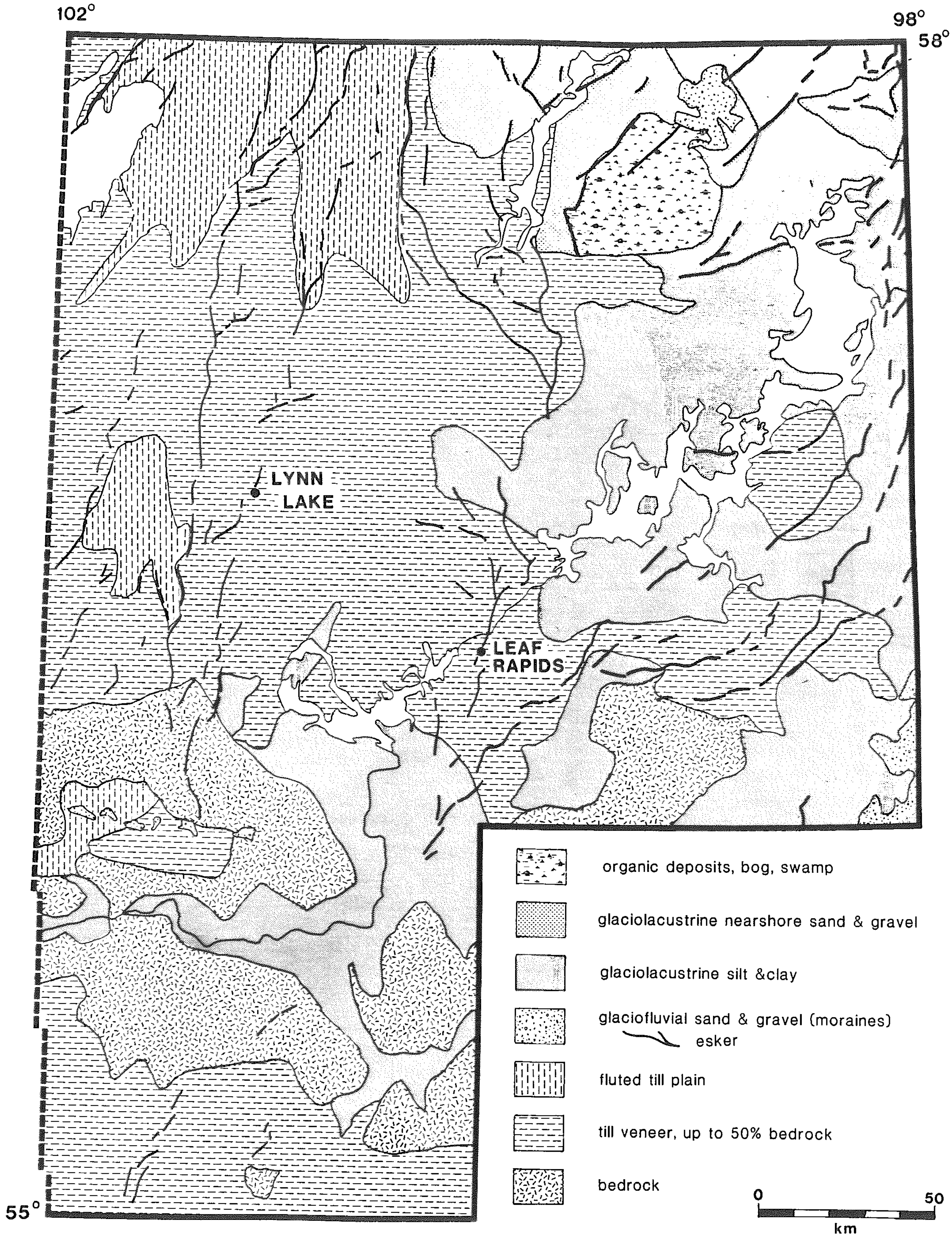


FIGURE 4. Generalized surficial deposits map

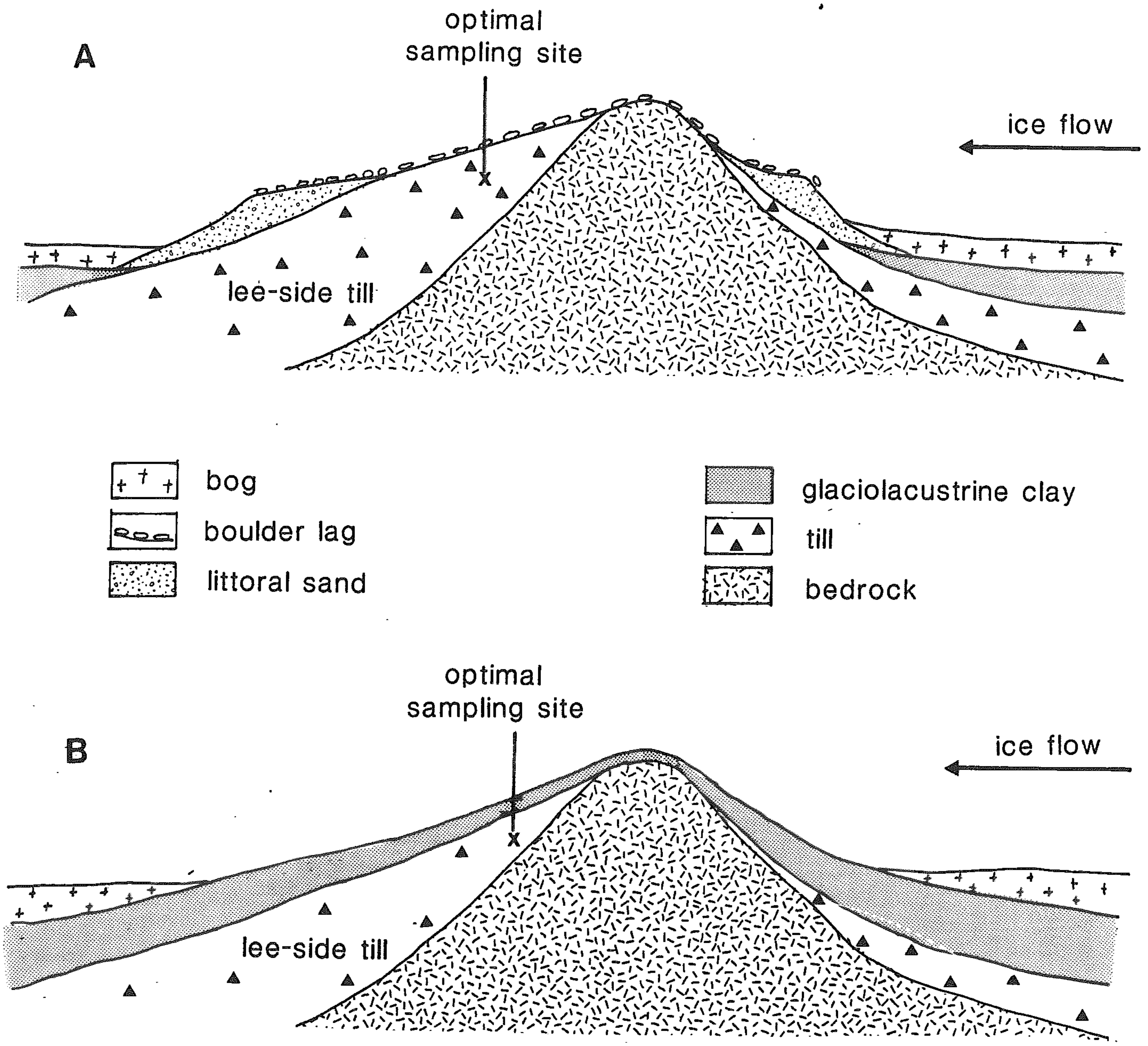


FIGURE 5. Schematic representation of common sedimentary sequences;
A) till dominated terrain (from Nielsen and Graham, 1984)
B) clay dominated terrain

Three compositionally distinct tills have been recognized:

Sandy Till
This till dominates the western part of the study area (NTS 63N, 64C and 64F) and contains a large proportion of debris derived from crystalline shield lithologies. Matrix grain size composition averages 70% sand, 23% silt, and 7% clay. Matrix carbonate composition of sandy till is generally 0% but may range up to 5%.

Silty Till
Till in the eastern part of the study area (NTS 64B and 64G) is silty and contains a large proportion of calcareous debris derived from Paleozoic carbonate lithologies flooring Hudson Bay and adjacent lowlands. Matrix carbonate content ranges from 5 to 35%, increasing systematically to the northwest (Fig. 3). Matrix grain size composition averages 49% sand, 36% silt, and 15% clay. Sediment may be leached of carbonate up to a depth of 2.5 m, particularly in areas of thin drift where drainage is controlled by bedrock topography and clay cover is minimal.

Clayey Till
A clay-rich till has been observed at several sites within the region. Grain size composition of till matrix averages 42% sand, 32% silt and 26% clay. This unit usually overlies silty or sandy till and the contact may or may not be marked by a thin unit of Lake Agassiz clay. In the eastern part of the study area, this unit is enriched in carbonate with respect to underlying silty till. Distribution is extremely sporadic, and it is interpreted as a product of minor ice marginal fluctuations during deglaciation. Increased clay content reflects incorporation of underlying Lake Agassiz clay. Because the geochemistry of the fine fraction of this till unit reflects the composition of lacustrine sediments rather than underlying bedrock, its was not included in regional geochemical analyses, and should be avoided in any drift prospecting program.

Ice-Contact Glaciofluvial Deposits

These deposits are composed of interstratified sand, gravel, cobbles and diamicton (flow till), well to poorly sorted, deposited by meltwater flowing in contact with, or proximal to glacier ice. Thickness is variable, ranging from 5 to 50 metres. This material commonly forms eskers, kames, crevasse fillings, ice-contact deltas and recessional, end and interlobate moraines. Eskers and moraines comprise fining upward sequences composed of a core of glaciofluvial cobble gravel, which is overlain in turn by crossbedded granular sand, ripple drift cross-laminated fine sand and silt, and capped by laminated silt and clay and/or reworked foreshore beach sand and gravel (Ringrose and Large, 1977).

Glaciolacustrine Deposits

These deposits comprise massive to laminated sand, silt and clay, deposited in glacial Lake Agassiz. Thickness is variable, ranging from a thin veneer to thick sequences forming planar surfaces commonly mantled with peat. Thickest deposits usually occur in the vicinity of eskers and moraines, where sedimentation rates were high. Nearshore and littoral sediments were deposited during the regressional phases of Lake Agassiz.

Nearshore and littoral sediments
These sediments are composed of well sorted sand, gravel and cobbles reworked from underlying glaciofluvial deposits or till. Nearshore deposits may occur as a blanket grading basinward into undifferentiated silt and clay, or as one or a series of ridges, 1 to 4 m in height, forming beaches, bars and spits. These features are commonly well developed on wave-washed glaciofluvial deposits, but are also a common feature on wave washed-flutes and drumlinoid ridges.

Offshore sediments
Laminated silt, clay and sand ranges in thickness from a veneer to several tens of metres. Thick accumulations form planar surfaces characterized by extensive peat

cover. In general, clay cover increases from west to east, ranging from absent in the northwestern part of the study area, to a continuous clay blanket in the east and southeast. Clay cover is also thicker along major river valleys (Churchill River, Rat River) where sediment was input through major inflow channels draining Cretaceous terrane to the west.

Ice Flow Indicators

Ice flow indicators include erosional landforms such as striations and roches moutonées, and depositional landforms such as flutes and crag and tail features. Depositional landforms primarily reflect late glacial ice flow patterns. In contrast, striae record not only late glacial shifts in ice flow but a history of previous ice flow events as well. Several ice flow events have been documented based on the striation record within the region (Fig. 6; sample location and striae maps in folder). These will be discussed chronologically, from oldest to youngest.

The oldest striae in the region trend approximately due west and have been observed at only two sites. Extrapolation of this flow event is tenuous, however it is possible that these striae correlate with those observed in the Lac La Ronge area of Saskatchewan (Johnston,1978; Schreiner, 1984) and may reflect a pre-Main Late Wisconsinan advance of Labradorean ice across the Prairies postulated by Prest and Nielsen (1987) and Prest (in press) to account for the distribution of distinctive greywacke erratics derived from eastern Hudson Bay.

A second set of old striae trend to the southeast with orientations ranging from 175° to 140°. Cross-cutting relationships have not been observed between these and westerly trending striae. In this case relative age has been based on frequency of observation (southeasterly trending striae are more common, approximately 30 observations). These striae are distributed throughout the study area suggesting that prior to the latest ice flow event the entire region was occupied by ice of Keewatin provenance.

Southeasterly striae are crosscut by striae indicating flow to the southwest ranging from 190° to 210°. At some sites the range in striae orientation suggests that the shift from southeasterly to southwesterly ice flow was transitional and was not interrupted by a non-glacial event. This southwesterly ice flow direction is regionally pervasive and is interpreted as the main Late Wisconsinan ice flow event.

The youngest striae in the region record late glacial shifts in ice flow related to style of deglaciation and ice marginal configuration. South of the Cree Lake Moraine, the youngest striae exhibit a westward shift in ice flow, possibly suggesting deglaciation from west to east or from southwest to northeast. North of the Cree Lake Moraine, the youngest ice flow indicators record a late glacial zone of convergent ice flow marked by southeasterly striae west of the Leaf Rapids Interlobate Moraine and southwesterly to westerly striae east of the moraine. In the extreme northeastern part of the study area, the orientation of fluting indicates a complex deglacial ice flow history. Flutes trending northwest-southeast are crosscut by eskers trending northeast-southwest, suggesting that deglaciation of this region was characterized by minor readvances or surges of both Keewatin and Labradorean ice.

Stratigraphy

The stratigraphic succession observed within the study area is, in general, related to late glacial and deglacial depositional events. Stratigraphic observation is limited to exposures in road cuts, borrow pits and river cuts. It is possible that older units are preserved as isolated pockets within bedrock troughs, however, it is impossible to document this stratigraphy without the aid of a stratigraphic drilling program. In general, only one till unit is present as a relatively thin veneer on bedrock throughout most of the area. Thick till deposits occur on the down-ice side of

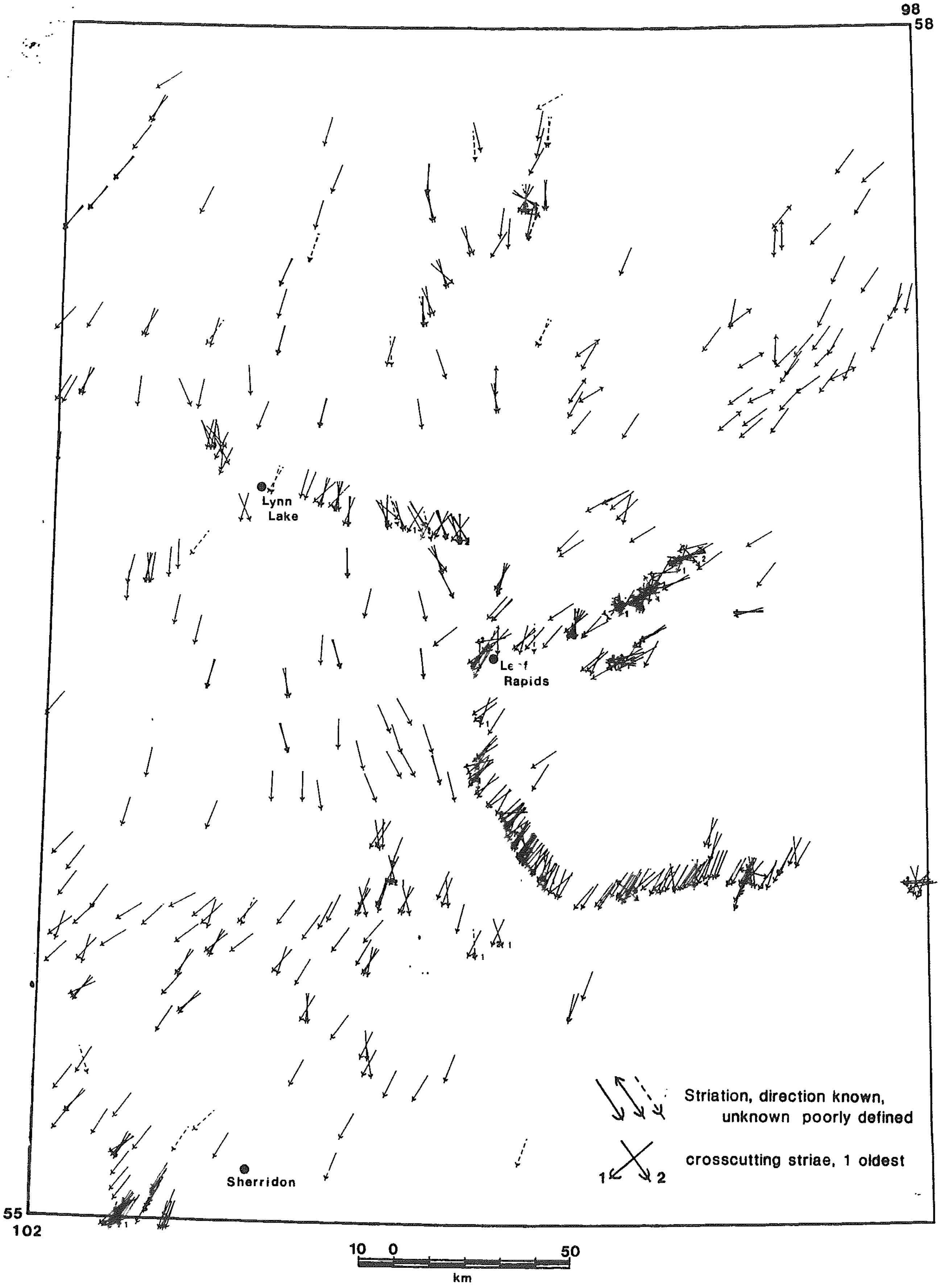


FIGURE 6. Striation Map

bedrock knobs. These lee-side 'tills' are sedimentologically complex, comprising interbedded till and glaciofluvial sand and gravel. In most cases however, these glaciofluvial beds were deposited subglacially and they do not represent stratigraphic boundaries marking till units deposited by multiple ice flow events.

In the northeastern part of the study area (64G, N1/2) sections exposed along the South Seal and Muskwegi Rivers, exhibit multiple till stratigraphies. Two distinct till units have been identified along the South Seal River. The upper till is sandy, silty and calcareous, and the lower till is clay-rich and calcareous. These two tills are separated by glaciolacustrine laminated silty fine sand and clay. The lower till overlies glaciolacustrine sediment and the upper till is capped by Lake Agassiz clay. Along the Muskwegi River, the stratigraphic sequence comprises Lake Agassiz clay, over sandy, silty calcareous till over glaciolacustrine sediment; the lower till, if present, is not exposed. This stratigraphy is interpreted to represent minor readvances or surges of both Keewatin and Labradorean ice masses during deglaciation. The absence of organics and weathering horizons argues against deposition over a prolonged time interval.

GLACIAL DISPERSAL

The shape, size and geochemical expression of dispersal trains is a function of a number of variables including:

1) size, aspect and erodibility of the source area;

2) geochemical character of lithologies down-ice and rate of dilution of mineralized debris;

3) ice dynamics;

4) patterns of subglacial and ice marginal sedimentation;

5) surface weathering; and

6) sampling density, and scale of observation.

Assuming appropriate sampling and analytical control, the geochemistry of surficial sediments in glaciated terrain should reflect sample to sample variations created by the agency of glacial erosion and transport. Dispersal trains can be grouped into two broad end members:

Type I, characterized by a systematic decrease in concentration of source material both longitudinally along the axis of the train and laterally toward the margins of the train; and

Type II, characterized by uniformly large concentration of source material both longitudinally and laterally across the train.

Type I trains reflect continuous glacial erosion and incorporation of bed material down-ice from the source resulting in systematic dilution of source debris. The size and shape of these trains reflects regional ice flow history ranging from ribbon to plume shapes (Shilts, 1976) in regions characterized by unidirectional ice flow to irregular ameboid or star shapes in areas influenced by shifting ice flow directions (Stea et al., 1988). This type of dispersal is generally represented by a concentration curve that exhibits a negative exponential decay with distance from source, characterized by a 'head' of high concentration near source and a 'tail' of lower concentration in the down-ice direction (Shilts, 1976) (fig.7a).

Type II trains represent ice dynamic conditions characterized by entrainment and transport of debris throughout a single ice flow event with little to no dilution in the down ice direction. Concentration curves do not exhibit a negative exponential decay with distance from source, but rather maintain a constant concentration in the down-ice direction with an abrupt decrease both towards the sides of the train and near the limit of transport (Fig. 7b).

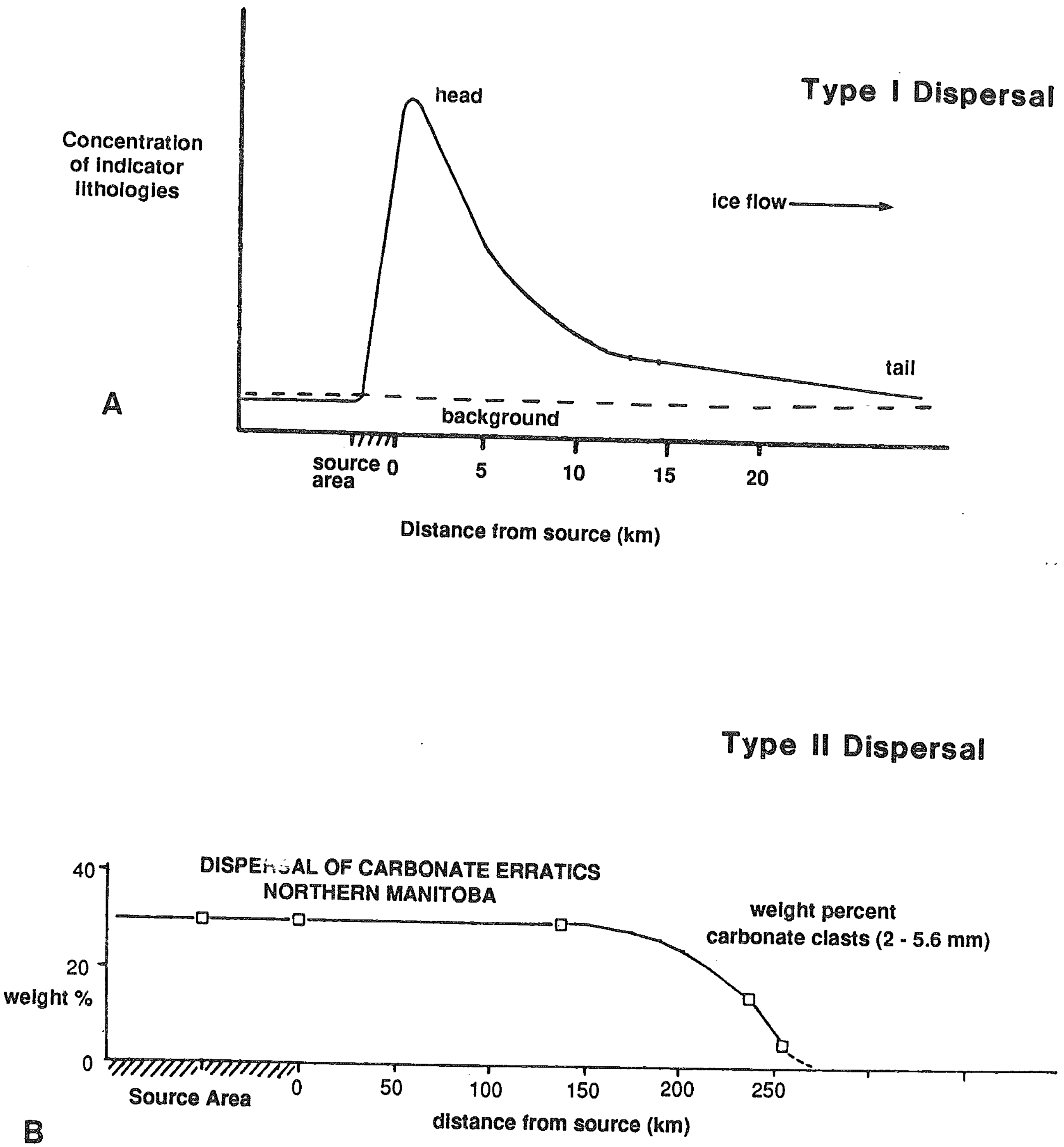


FIGURE 7. Generalized dispersal curves

Both types of dispersal can be mapped at scales that vary from regional (100's km) to local (1-10's km) to detailed (<1 km) (Shilts, 1984). Design and implementation of effective drift prospecting programs requires knowledge of regional ice flow history and of the influence of various ice flow events on drift composition and glacial dispersal at all scales. In this study, reconnaissance level till sampling (average spacing 7 - 8 km) enables definition of dispersal trains at both the regional and local scale.

Regional Dispersal (100's km)

Regional dispersal trains cover areas of 1,000's of square kilometers and are of importance in drift prospecting in that they can significantly influence the geochemical signal from local bedrock lithologies and the expression of smaller scale dispersal trains derived from local sources that lie within them. In the Lynn Lake - Leaf Rapids region, the distribution of Paleozoic carbonate in till marks the edge of a regional dispersal train extending from Hudson Bay, approximately 200 km across the Canadian Shield (fig. 3). Dispersal trends in highly calcareous till are oriented approximately 230°, parallel to deglacial ice flow indicators, suggesting that in the northeastern part of the study area, most carbonate was transported into the area during deglaciation and disintegration of the ice sheet. However, carbonate is also present in small quantities (<5%) within a local ultramafic dispersal train trending 210° (Fig. 3), suggesting that carbonate, in low concentrations, was also being transported into the region during the main Late Wisconsinan ice flow event.

Exotic debris may hinder interpretation of regional till geochemistry by influencing background concentrations and the resolution of local geochemical anomalies. In some instances far-travelled debris may be geochemically impoverished with respect to local bedrock, the net result being a 'negative' dispersal train and a geochemical suppression of local mineralization (Klassen and Shilts, 1977; Shilts, 1984). Alternatively, geochemically distinctive debris may be spread over a large area characterized by inert bedrock lithologies, leading to an incorrect assessment of mineral potential for the region. At this scale, type II dispersal trains my present a severe impediment to drift prospecting as till within them is composed almost exclusively of allochthonous debris and may not reflect underlying bedrock composition at all.

Regional trains are derived from bedrock sources that are relatively easily eroded, such as Paleozoic basins and supracrustal sequences of sedimentary and volcanic rocks. In general, the geochemical expression of glacial dispersal at this scale is independent of till facies. Where relief is subdued and drift is relatively thin, composition is uniform throughout all till facies, and sampling may be carried out without rigorous facies identification. In areas of pronounced bedrock relief however, till composition may be facies-dependent and care should be taken to correctly identify till facies when sampling.

Local Dispersal (1 - 10's km)

Local scale dispersal trains (10's km) reflect regionally pervasive ice flow events that produced significant erosion and transport of local debris. In areas of thin drift cover, till composition is generally independent of till facies,, although the geochemical signature of mineralization may be enhanced within basal facies, particularly near the source of dispersal. Locally, samples within the tail of these trains may be geochemically depleted producing 'holes' or geochemical depressions within the train. These local compositional variations may be facies dependent reflecting a larger proportion of far-travelled debris within ablation facies, and/or an increase of local, geochemically inert, bedrock material in basal facies. Conversely, local geochemical 'highs' within the tail of these trains may reflect a larger proportion of far-travelled source material in ablation facies, or more commonly, contribution from local, geochemically enriched, bedrock sources within the train.

It is this scale that is most significant in reconnaissance till sampling as the detection of the tails of these trains provides an indication of local mineralization within the region. In the Lynn Lake - Leaf Rapids region, local dispersal trains have been identified at several sites (Fig. 3). At this scale the dominant dispersal direction is to the southwest at approximately 200° - 210°, parallel to the main Late Wisconsinan ice flow direction. At Wheatcroft Lake (Fig. 3), a zone of As-enriched till extends from a zone of sulphide mineralization south of Granville Lake, southwestward over a distance of at least 60 km. Within the northern part of this train (closest to source) the dominant striae orientation is southeastward, parallel to a late glacial shift in ice flow. This southeastward ice flow however, has had no observable affect on glacial dispersal at this scale.

The shape of local scale trains is a function of regional ice flow history, ranging from ribbon or plume shaped in regions characterized by a relatively simple ice flow history, to irregular ameboid or star shapes in areas influenced by several different ice flow events. The relative influence of different ice flow directions on the shape of a dispersal train is a function of the duration and erosive power of ice flow, as well as the degree of exposure of source lithologies at any given time. In some instances the local striation record may be dominated by relatively short-lived deglacial events (such as at Wheatcroft Lake), that have not significantly influenced glacial dispersal at this scale. Under these conditions, it is necessary to have a knowledge of regional ice flow history, in order to effectively evaluate potential sources for mineralized debris.

Detailed Dispersal (<1 km)

At a very detailed scale (< 1 km), typically used in mineral exploration, the geochemical expression of glacial dispersal may be facies dependent, particularly in areas of thick till cover, and care should be taken to describe till facies as thoroughly as possible. Because transport distance is short, dispersal trends may reflect late glacial shifts and/or topographic deflection of ice flow, rather than main Late Wisconsinan ice flow trends. Detailed or property-level drift prospecting programs should be designed to accommodate known main Late Wisconsinan dispersal directions as well as local deviations in ice flow related to both topography and deglacial history.

Sulphide mineralization within the study area generally occurs as relatively thin stratiform deposits (Baldwin, 1980) with small areas of surface exposure. The size of source area for glacial erosion and dispersal, therefore is relatively small. This, coupled with irregular bedrock topography and resistant bedrock lithologies results in dispersal trains that are short and/or poorly developed. Detailed studies of till geochemistry and glacial dispersal with the Lynn Lake - Leaf Rapids area have been carried out by Erik Nielsen, Manitoba Department of Energy and Mines (Nielsen, 1987; Nielsen and Fedikow, 1986, 1987; Nielsen and Graham, 1985). Results of this work indicate that down-ice transport of material derived from areas of known mineralization cannot be traced farther than 1 - 2 km. Based on these observations it is apparent that the sampling density employed in reconnaissance level programs is unlikely to result in the intersection of these small scale dispersal trains. Geochemical trends and dispersal patterns identified in this study likely reflect geochemically enriched bedrock units with potential for hosting small volcanogenic sulphide bodies, rather than the small sulphide bodies themselves.

BEDROCK GEOLOGY AND MINERALIZATION

Bedrock lithologies within the region can be grouped into four major domains: metasediments and gneisses of the Kisseynew Sedimentary Gneiss Belt; metasediments and gneisses of the

Southern Indian Gneiss Belt; and metasediments and metavolcanics of the Lynn Lake - Rusty Lake Greenstone Belt, and granitic intrusives of the Chipewyan Batholith (Figs. 8 and 9). Lithologies in all domains, with the exception of the Chipewyan Batholith, are intruded by felsic to mafic plutonic bodies classified as younger plutonic rocks (post-Sickle intrusives), plutonic rocks of indeterminate age, and older plutonic rocks (pre-Sickle intrusives).

Kisseynew Gneiss Belt

The Kisseynew Gneiss Belt is flanked to the north and south by the Lynn Lake - Rusty Lake Greenstone Belt and Flin Flon - Snow Lake Greenstone Belt respectively. The belt is characterized by a bilateral symmetry of rock types and metamorphic grade (Baldwin, 1980, Bailes and McRitchie, 1978). The centre of the belt is underlain by greywacke and derived gneisses and migmatites of the Burntwood River Metamorphic Suite (BRMS) (unit 2). The northern and southern flanks of the belt are underlain by quartzofeldspathic gneisses and migmatites derived from arkose, sandstone, conglomerate termed the Sickle Group and Missi Metamorphic Suite respectively (unit 3). The Sickle Group conformably overlies the BRMS along the northern margin of the belt, the contact marked by interbedded metavolcanics (amphibolites) and metasediments. To the south, rocks of the Missi Metamorphic Suite are thought to overlie the BRMS, although lithostratigraphic relationships are poorly defined and correlation is controversial. Bands of metavolcanics and amphibolites have been observed to mark the contact between the BRMS and Missi Metamorphic Suite within this region (Zwanzig, 1984), however stratigraphic relationships are poorly defined and some of these units may be part of the Amisk Group forming the Flin Flon - Snow Lake Greenstone Belt to the south (G. Ostry, pers. com., 1989). Mineralization within the Kisseynew Gneiss Belt is associated primarily with the contact between the BRMS and overlying quartzofeldspathic lithologies (Sickle Group and Missi Metamorphic Suite). Mineralization is conformable, stratiform and widespread, occurring as disseminated and massive iron sulphide, with minor chalcopyrite, arsenopyrite and sphalerite at or close to the Sickle Group - BRMS contact The zone most favourable for mineralization is that containing amphibolite at the top of the BRMS and meta-arkosic rocks in the lower part of the Sickle Group (Baldwin, 1980). At the southern margin of the basin, it has been postulated that known Au mineralization occupies a stratigraphic position similar to that of known massive sulphide occurrences associated with a thin unit of volcanogenic and sedimentary rocks at the contact between the BRMS and Missi Metamorphic Suite. Known Au mineralization is associated with galena, arsenopyrite, chalcopyrite, and minor amounts of pyrrhotite and pyrite (Gale and Ostry, 1984).

The massive sulphide Cu-Zn deposit at Sherridon is the site of the only producing mine to have operated within the Kisseynew gneiss belt.

Lynn Lake - Rusty Lake Greenstone Belt

The Lynn Lake - Rusty Lake Greenstone Belt marks the northern margin of the Kisseynew Gneiss Belt. It is composed of metamorphosed volcanic, and volcanoclastic sedimentary rocks of the Wasekwan Group (unit 1), which have been intruded by mafic to felsic plutons (units 4a and 4b respectively) (Gilbert et al., 1980). Wasekwan Group rocks are unconformably overlain by sandstone and conglomerate of the Sickle Group, and are thought to be stratigraphically equivalent to at least the upper part of the BRMS, composed of interbedded amphibolite and greywacke. The Lynn Lake greenstone belt has been subdivided into the northern belt, hosting the Agassiz Metallotect (Fedikow, 1983), and the southern belt, including the Johnson Shear. Mineralization within the Lynn Lake - Rusty Lake Greenstone Belt is widespread. At several localities Cu-Zn sulphide mineralization is hosted by Wasekwan Group metasediments and

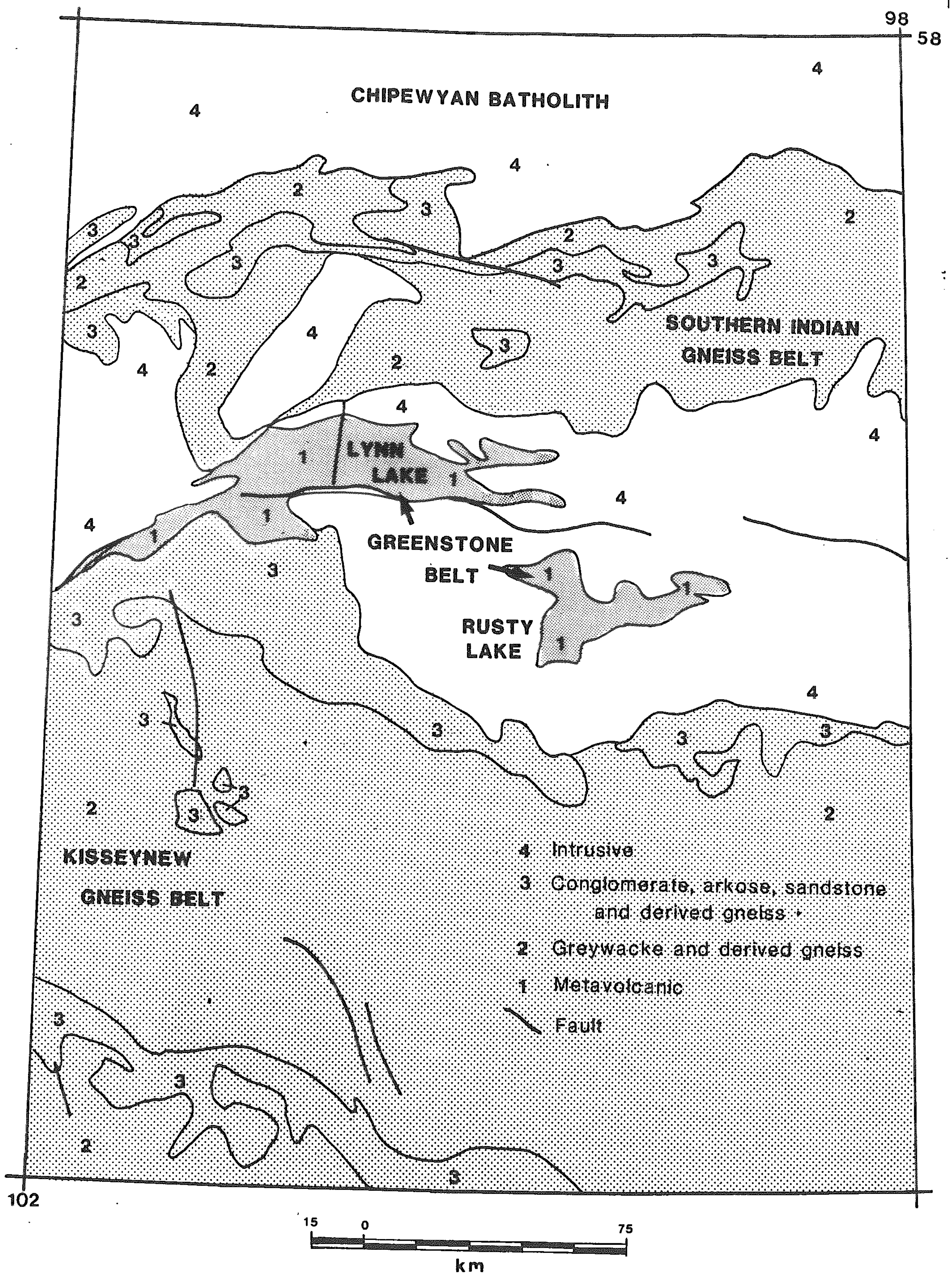


FIGURE 8. Lithologic domains

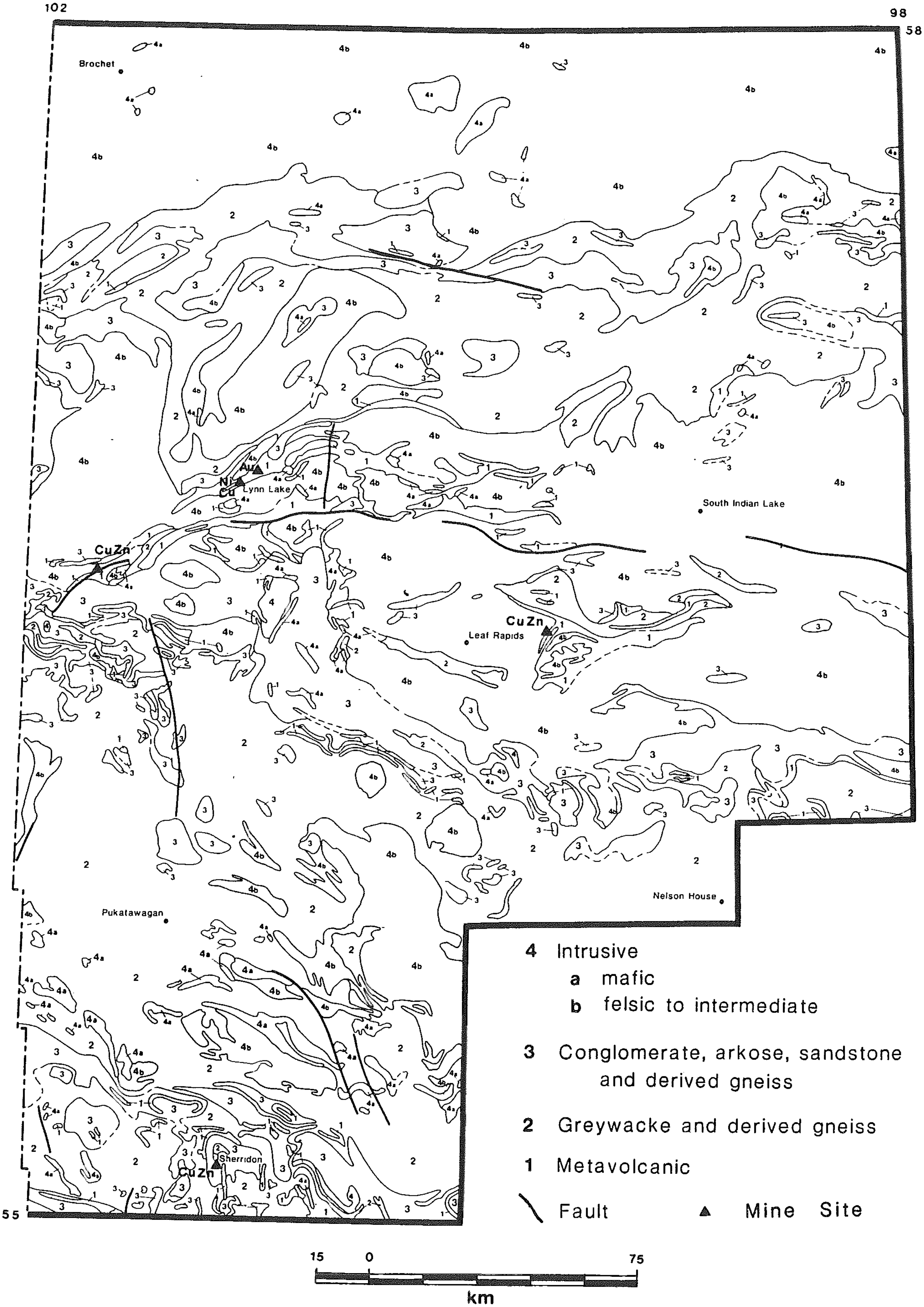


FIGURE 9. Generalized bedrock geology
(from Manitoba Mineral Resources Division, Map 79-2)

metavolcanics, and Cu-Ni mineralization is associated with gabbro intrusions (Gilbert et al., 1980). Stratabound disseminated to solid sulphide mineralization in felsic fine grained sediments and volcanic fragmental rocks is a particularly prevalent style of mineralization. Sulphide mineralization is also associated with quartz veins in siltstone, iron formation, intrusive bodies and contacts, and fracture systems (Ferreira and Baldwin, 1984). Within the northern belt, Au mineralization is stratabound, associated with thinly interbedded siltstone, iron formation and ultramafic komatiites within the Agassiz Metallotect (Fedikow, 1986). In the southern belt, most Au deposits are structurally controlled, developed within quartz veins in metavolcanic or felsic intrusive rocks associated with the Johnson Shear Zone (Richardson and Ostry, 1986; Fedikow et al., 1986).

Past and present mineral producers within the Lynn Lake - Rusty Lake Greenstone Belt include: Fox Mine (Cu-Zn); Ruttan Mine (Cu-Zn); Lynn Lake Mines (Ni-Cu); and the MacLellan Mine (Au).

Southern Indian Gneiss Belt

The Southern Indian Gneiss Belt is lithologically similar to the Kisseynew Gneiss Belt and was derived from an equivalent stratigraphic succession comprising greywacke, thin volcanic and mafic metasediments, overlain by arkosic rocks. However, metavolcanic units are localized and have been observed only in the Reindeer lake area (Schledewitz, 1983; McRitchie,1977; Schledewitz and Cameron, 1982). Mineral occurrences are rare but generally occur as massive and disseminated sulphides within metagreywacke and volcanogenic sediments (Gale et al., 1980)

Chipewyan Batholith

Intrusive rocks of the Chipewyan Batholith flank the Southern Indian Gneiss Belt to the north and form the youngest rocks in the area. This domain is composed of a large volume of granitic intrusive lithologies, primarily a pink megacrystic granite (unit 4b). No known sulphide mineralization has been documented within this area.

TILL GEOCHEMISTRY

Two major factors influence the geochemical signature of surface till in any region: 1) lithic composition, specifically the proportion of local to far-travelled debris; and 2) the surface weathering environment. The effects of surface weathering can be minimized by sampling till below the postglacial solum. Given appropriate sampling control, trace element composition in till should reflect, to a first approximation, variations in lithic composition. In this discussion, regional till geochemistry refers to background variations in trace element concentration related to either the lithologic composition of till and or surface weathering conditions. The discussion of local till geochemistry focusses on subregions defined by anomalous trace element concentrations, in an attempt to identify mineralized zones, and the lithologic setting for mineralization within unexplored parts of the region.

Regional Geochemical Trends

Regional till geochemistry within the area is influenced by: 1) till provenance, more specifically carbonate content; and 2) regional bedrock trends. Summary statistics and a correlation matrix for trace elements are presented in Tables 2 and 3. Correlation calculations were restricted to sample populations with trace element concentration ranging from the 10th to the 90th percentile values, in order to minimize the influence of anomalously high and anomalously low samples. The population size for each correlation pair averages 1000 samples, requiring in an "r" coefficient of only .081 for significance at the 99% confidence level. Clearly, the very large number of significantly correlated pairs reflects the large population size and a significant degree of intercorrelation among variables. Consequently, an "r" coefficient of .3 was arbitrarily selected to distinguish

Table 2.
Summary Statistics for Total Population

	As <2um ppm	Co <2um ppm	Cr <2um ppm	Cu <2um ppm	Fe <2um %	Mn <2um ppm	Mo <2um ppm	Ni <2um ppm	Pb <2um ppm	Zn <2um ppm	As <63um ppm	Au <63um ppb	U <63um ppm
Artihmetic Mean	11.6	16.3	83	65	4	438	1.9	47	13	105	3.3	3.6	3.7
Geometric Mean	6.4	15	73.6	51	3.9	380	1.5	41	12	95	1.9	2.1	3.4
Mode	4	•	•	40	4.2	480	1	42	14	100	0.2	1	3.5
10th Percentile	2	10	36	22	2.5	188	1	21	8	50	0.6	1	1.9
50th Percentile	6	16	76	50	4.1	380	1	43	13	102	2	2	3.5
90th Percentile	20	23	138	117	5.4	760	3	69	19	155	6.4	7	5.3
95th Percentile	43	26	158	152	5.9	850	4	79	21	180	13	10	6
Minimum	1	1	10	3	0.7	46	0.5	1	1	11	0.2	0.5	0.9
Maximum	322	85	325	653	23	1900	37	2390	176	1350	72.9	92	21
St. Dev.	22.3	6	40.6	54.3	1.3	234	1.9	61	6.4	51	5	6.2	1.6
N	1966	1518	1983	1983	1983	1983	1620	1983	1983	1983	1508	1767	1508

* • denotes multimodal distribution

Table 3.
Correlation Matrix

	As <2um ppm	Co <2um ppm	Cr <2um ppm	Cu <2um ppm	Fe <2um %	Mn <2um ppm	Ni <2um ppm	Pb <2um ppm	Zn <2um ppm	As <63um ppm	Au <63um ppb	U <63um ppm	CaCO3 %
As <2um ppm	1												
Co <2um ppm	0.106	1											
Cr <2um ppm	0.133	0.278	1										
Cu <2um ppm	0.198	0.282	*0.33*	1									
Fe <2um %	0.174	*0.321*	0.233	0.266	1								
Mn <2um ppm	0.046	0.035	-0.142	0.042	0.218	1							
Ni <2um ppm	0.143	*0.515*	*0.591*	*0.41*	0.28	0.046	1						
Pb <2um ppm	0.116	0.174	-0.017	0.016	0.057	-0.009	0.035	1					
Zn <2um ppm	0.099	*0.359*	0.293	0.214	*0.408*	*0.343*	*0.479*	0.067	1				
As <63um ppm	*0.496*	0.041	0.115	0.049	0.111	0.099	0.153	0.112	0.102	1			
Au <63um ppm	0.129	0.069	0.226	0.17	0.074	-0.061	0.172	-0.007	0.121	0.181	1		
U <63um ppm	0.055	0.051	0.215	0.129	-0.094	*-0.298*	0.06	0.051	0.013	-0.01	0.178	1	
CaCo3 <63um %	-0.005	0.009	*-0.326*	*-0.201*	-0.011	*0.589*	-0.04	-0.074	*0.21*	*0.145*	*-0.198*	*-0.496*	1

* Analyses restricted to those data falling between 10th and 90th percentile concentrations
* Italic denotes correlation coefficients with a >>99% significance level

strongly correlated pairs from weakly correlated pairs. Ni exhibits a strong positive correlation with Co,Cr,Cu, and Zn. Of this assemblage, Ni, Cr, and Cu are strongly intercorrelated, as are Ni, Cr, Co, and Zn. Zn also exhibits a strong positive correlation with Fe, Mn, and $CaCO_3$, suggesting that exotic Paleozoic carbonate influences till geochemistry on a regional scale. This is further exemplified by the strong negative correlation between $CaCO_3$ and U, Au, Cu, and Cr, suggesting that, for some trace elements, elevated carbonate concentration may mask the signature of local bedrock.

Background Variations

In general, simple statistical techniques treating the entire data set as one sample population are inadequate to identify variations in background related to till provenance and/or regional variations in bedrock lithology. In order to more fully evaluate these relationships, the sample population was subsplit on the basis of bedrock lithology and till provenance, and summary statistics computed for individual subpopulations (Tables 4 & 5). Trace element concentrations greater than 95th percentile values were not included in calculation of mean values. Subpopulation means and 50th percentile values for each rock type and provenance group were then compared to values for the total population and significant differences identified (Table 4a&b, 5a&b).

Bedrock Lithology;
Bedrock lithologies were grouped into five categories: intrusives, extrusives, metagreywacke, other metasediment, and gneiss. Intrusive lithologies range from felsic to mafic, but approximately 90% of all samples in this group are underlain by felsic to intermediate lithologies. The extrusive category also comprises felsic to mafic lithologies, but is dominated by mafic volcanics forming the Lynn Lake - Rusty Lake Greenstone Belt. Metagreywackes comprise subaqueous metasedimentary rocks of the BRMS in the Kisseynew Gneiss Belt and equivalent lithologies in the Southern Indian Gneiss Belt. Other metasediments comprise terrestrial metasedimentary rocks of the Sickle Group and Missi Metamorphic Suite of the Kisseynew Gneiss Belt and equivalent lithologies of the Southern Indian Gneiss Belt. The gneiss category is dominated by lithologies identified as paragneiss and biotite gneiss of sedimentary origin. This group therefore, represents high grade metamorphic equivalents of both metagreywacke and other metasediment. In addition, map to map variations in scale, lithologic description and terminology result in overlap between lithologies termed gneiss and those termed metagreywacke and metasediment. As a result, this category should be considered a composite of several different lithologic types.

Arithmetic means and 50th percentile concentrations for each bedrock type were compared to corresponding values for the total population. The following generalizations can be made concerning lithologically controlled variations in background concentration:

1) Till derived from intrusive lithologies is depleted in most base metals, Au and U, compared to the total population;

2) Till sampled over extrusive lithologies is enriched in Cu and depleted in Pb compared to the total population;

3) Till sampled over metagreywacke is significantly enriched in Cr, Ni, Co, U, and Cu, Zn, compared to the total population;

4) Till derived from other metasediments is not significantly different from the total population, except for a slight enrichment in Au; and

5) Till sampled over gneiss is significantly enriched in Cr, Ni, Co, U, and As, compared to the total population.

In general, till derived from intrusive lithologies (granitic) is geochemically inert, producing the lowest background values for most base metals and gold. Elevated

SUMMARY STATISTICS FOR TILL ON DIFFERENT BEDROCK TYPES

Table 4a.
Arithmetic Mean for Till on Different Bedrock Types

	As <2um ppm	Co <2um ppm	Cr <2um ppm	Cu <2um ppm	Fe <2um %	Mn <2um ppm	Mo <2um ppm	Ni <2um ppm	Pb <2um ppm	Zn <2um ppm	As <63um ppm	Au <63um ppb	U <63um ppm	N #
Intrusives	*5.7*	*14.1*	*67*	*49*	3.8	*432*	1.5	*37*	12	*92*	*1.8*	*2.1*	*3.2*	857
Extrusives	7.1	15.2	69	*78*	4.1	445	1.7	43	*10*	98	2.2	2.7	3.4	112
Metagreywacke	8.8	*16.5*	*94*	66	4.1	363	1.6	*51*	12.5	*112*	2.8	2.9	*3.8*	284
Metasediment	9.3	15.7	75	62	3.9	431	1.6	42	11	92	2.7	*3.7*	3.2	108
Gneiss	*12.2*	*16.9*	*100*	*72*	3.9	*341*	*1.8*	*48*	13	107	*3.2*	3.1	*3.7*	444
Total	7.8	15.3	80	59	3.9	401	1.6	43	12	100	2.4	2.6	3.5	1805

* Italic denotes sample mean significantly different from that of the total population, based on analysis of variance (99% significance level)
* Only concentrations less than the 95th percentile value for each subpopulation were used in calculation

Table 4b.
50th Percentile Concentrations for Till on Different Bedrock Types

	As <2um ppm	Co <2um ppm	Cr <2um ppm	Cu <2um ppm	Fe <2um %	Mn <2um ppm	Mo <2um ppm	Ni <2um ppm	Pb <2um ppm	Zn <2um ppm	As <63um ppm	Au <63um ppb	U <63um ppm	N #
Intrusives	5	15	68	46	4.1	400	1	39	13	99	1.8	1	3.4	857
Extrusives	5	17	72	*79*	4.3	430	2	44	*11*	100	1.7	2	3.4	112
Metagreywacke	6	17	*96*	*62*	4.2	330	1	*52*	13	*113*	2.2	3	3.8	284
Metasediment	6	15	75	53	4.1	390	1	44	12	93	2.2	3	3.4	108
Gneiss	7	17	*102*	54	4	317	2	48	13	106	2.4	3	3.8	444
Total	6	16	76	50	4.1	380	1	43	13	102	2	2	3.5	1805

* Italic denotes median values that are significantly different from that of the total population

Table 4c.
95th Percentile Concentrations for Till on Different Bedrock Types

	As <2um ppm	Co <2um ppm	Cr <2um ppm	Cu <2um ppm	Fe <2um %	Mn <2um ppm	Mo <2um ppm	Ni <2um ppm	Pb <2um ppm	Zn <2um ppm	As <63um ppm	Au <63um ppb	U <63um ppm	N #
Intrusives	*20*	23	*136*	*129*	5.8	891	4	*66*	21	173	*6.5*	8	5.8	857
Extrusives	43.5	26.4	*132*	158	6.3	781	3	75	*16*	173	10.7	10.3	*4.4*	112
Metagreywacke	47.5	26	*176*	169	6.2	780	5	*89*	20	188	14.5	10	6.6	284
Metasediment	*63.4*	*39*	*139*	*208*	6.1	812	4	85	19	*166*	14.4	*30.5*	5.3	108
Gneiss	*79*	28	*180*	*186*	5.7	800	5	*89*	*24*	176	*16*	10	6.1	444
Total	43	26	158	152	5.9	850	4	79	21	180	13	10	6	1805

* Italic denotes values that are significantly different from that of the total population

SUMMARY STATISTICS FOR SUBPOPULATIONS BASED ON TILL PROVENANCE

Table 5a.
Arithmetic Mean for Subpopulations based on Till Provenance

TILL PROVENANCE		As <2um ppm	Co <2um ppm	Cr <2um ppm	Cu <2um ppm	Fe <2um %	Mn <2um ppm	Mo <2um ppm	Ni <2um ppm	Pb <2um ppm	Zn <2um ppm	As <63um ppm	Au <63um ppb	U <63um ppm	N #
Hudson Bay Basin	Leached	6.6	*15.4*	75.8	49.7	*4.4*	462	1.7	39	*13.5*	102	2.1	2.4	3.2	170
	< 5% CaCO3	6	13.7	78.8	48.7	4.2	405	1.9	37	12.6	96	2.2	2.6	3.2	43
	> 5% CaCO3	6.5	*15.3*	*64.9*	43.5	4.1	*686*	1.7	38	12.8	*110*	2.3	*1.8*	*1.9*	190
Canadian Shield	Noncalcareous	7.2	*8.9*	74.2	53.8	*3.7*	*335*	2	*31*	*11.3*	*74*	1.7	2.8	*3.9*	169
	Total	6.7	13.9	71.8	48.7	4.1	484	1.8	36	12.6	96	2.1	2.4	3	572

* Italic denotes sample mean significantly different from that of the total population, based on analysis of variance (99% significance level)
* Only concentrations less than the 95th percentile value for each subpopulation were used in calculation

Table 5b.
50th Percentile Concentrations for Subpoplations based on Till Provenance

TILL PROVENANCE		As <2um ppm	Co <2um ppm	Cr <2um ppm	Cu <2um ppm	Fe <2um %	Mn <2um ppm	Mo <2um ppm	Ni <2um ppm	Pb <2um ppm	Zn <2um ppm	As <63um ppm	Au <63um ppb	U <63um ppm	N #
Hudson Bay Basin	Leached	6	16	72.5	45.5	4.4	480	2	38.5	14	100	1.9	1	3	170
	< 5% CaCO3	5	14	76	42	4.2	410	2	36	14	96	2.1	3	3.2	43
	> 5% CaCO3	6	15	64	40	4.2	*720*	2	38	13	108	2.1	1	*1.8*	190
Canadian Shield	Noncalcareous	5	*8*	74	47	3.9	*294*	2	*29*	*11*	*72*	*1.2*	3	*3.8*	169
	Total	6	15	68	42	4.2	520	2	36	13	100	1.8	1	2.9	572

* Italic denotes median value that is significantly different from that of the total population

Table 5c.
95th Percentile Concentrations for Subpopulations based on Till Provenance

TILL PROVENANCE		As <2um ppm	Co <2um ppm	Cr <2um ppm	Cu <2um ppm	Fe <2um %	Mn <2um ppm	Mo <2um ppm	Ni <2um ppm	Pb <2um ppm	Zn <2um ppm	As <63um ppm	Au <63um ppb	U <63um ppm	N #
Hudson Bay Basin	Leached	14	25	113	*144*	6	920	4	65	21	*172*	4.3	8	5.4	170
	< 5% CaCO3	9	18.4	105	*143*	6.7	*715*	3	72	23	142	5	10	5.2	43
	> 5% CaCO3	12	19	*93*	*72*	5.2	1000	3	*49*	*16*	158	*3.6*	*5*	*2.9*	190
Canadian Shield	Noncalcareous	*30*	*14*	*151*	123	6.1	*636*	*6*	68	19	149	*5.7*	*11*	6	169
	Total	15	21	114	117	5.7	920	4	61	19	152	4.3	8	5.4	572

* Italic denotes value that is significantly different from that of the total population

background concentration for Co, Ni and Cr found in till derived from metagreywacke and gneiss reflects a mafic sediment source, likely the Flin Flon - Snow Lake and Lynn Lake - Rusty Lake greenstone belts. The enrichment of Cu and Zn within the greywacke group may reflect the increased potential for disseminated and massive sulphide within this rock type (Baldwin, 1980). Elevated As concentration in till sampled over gneiss may be related, in part, to glacial dispersal rather than primary enrichment within this lithology (see Fig.11.).

Till Provenance;
Carbonate content has been determined only for samples in the northeast and west central parts of the study area; bedrock in these areas is dominated by intrusive lithologies. The following generalizations can be made regarding geochemical trends related to till provenance:

1) Shield derived till is significantly depleted in Co, Fe, Mn, Ni, Pb, and Zn compared to the total population, and enriched in uranium;

2) Calcareous till (>5% $CaCO_3$) is enriched in Co, Mn, and Zn and depleted in Cr, Au, and U, compared to the total population;

3) Leached calcareous till (noncalcareous) is enriched in Co, Fe, and Pb compared to the total population.

Till provenance influences regional geochemistry in two ways: 1) glacial dispersal of large amounts of Paleozoic debris dilutes the debris contribution from local sources and background values may be either enhanced or diminished depending upon the concentration of various trace elements in exotic debris relative to local bedrock; and 2) the near-surface weathering environment and soil water pH are significantly influenced by carbonate content, resulting in regional variations in trace element mobility. In areas dominated by calcareous till, soil water pH is alkaline (pH 7.5 - 8.5) reducing the mobility of many trace elements (Samson, 1989). In shield till, soil water pH is acid (ph 5.5 - 4.5) resulting in increased mobility and lower background concentrations for most trace elements in near-surface samples (Samson, 1989). In addition to alkaline surface environment, higher Mn and Zn concentrations observed in calcareous tills may also reflect primary mineralogical enrichment related to glacial dispersal, possibly siderite-rhodochrosite and/or sulphide derived from Paleozoic lithologies. The fact that calcareous tills are are depleted in Cr, Au, and U suggests that Paleozoic debris may significantly mask the geochemical signature of local bedrock lithologies for certain trace elements.

These lithologic and provenance-controlled trends in background concentration significantly influence the resolution of geochemical anomalies on a regional scale. Anomalous concentrations (>95th percentile) for some trace elements vary significantly between lithologic groups and in relation to the total population (Tables 4c &5c). In particular, 95th percentile values for As, Au, Cu and Co are much higher in till derived from metasediment than corresponding values for other lithic groups or the total population Because the computer mapping techniques employed in this report treat the entire data set as one sample population rather than several, anomalies based on 95th percentile concentration may be over-represented within lithic groups characterized by elevated background concentrations and under-represented in those with low background concentration. It is important to interpret geochemical anomalies with these variations in mind.

Regional Trends

To assist in interpretation and presentation of till geochemical data, two different computer mapping techniques were employed. Lazerdot, developed by Wyatt Geoscience, displays data as a series of scaled inset symbols, providing graphic display of interval data at all sample sites with no statistical smoothing. Mapping intervals were selected by a combination of techniques, including log/probability cumulative frequency plots of the entire

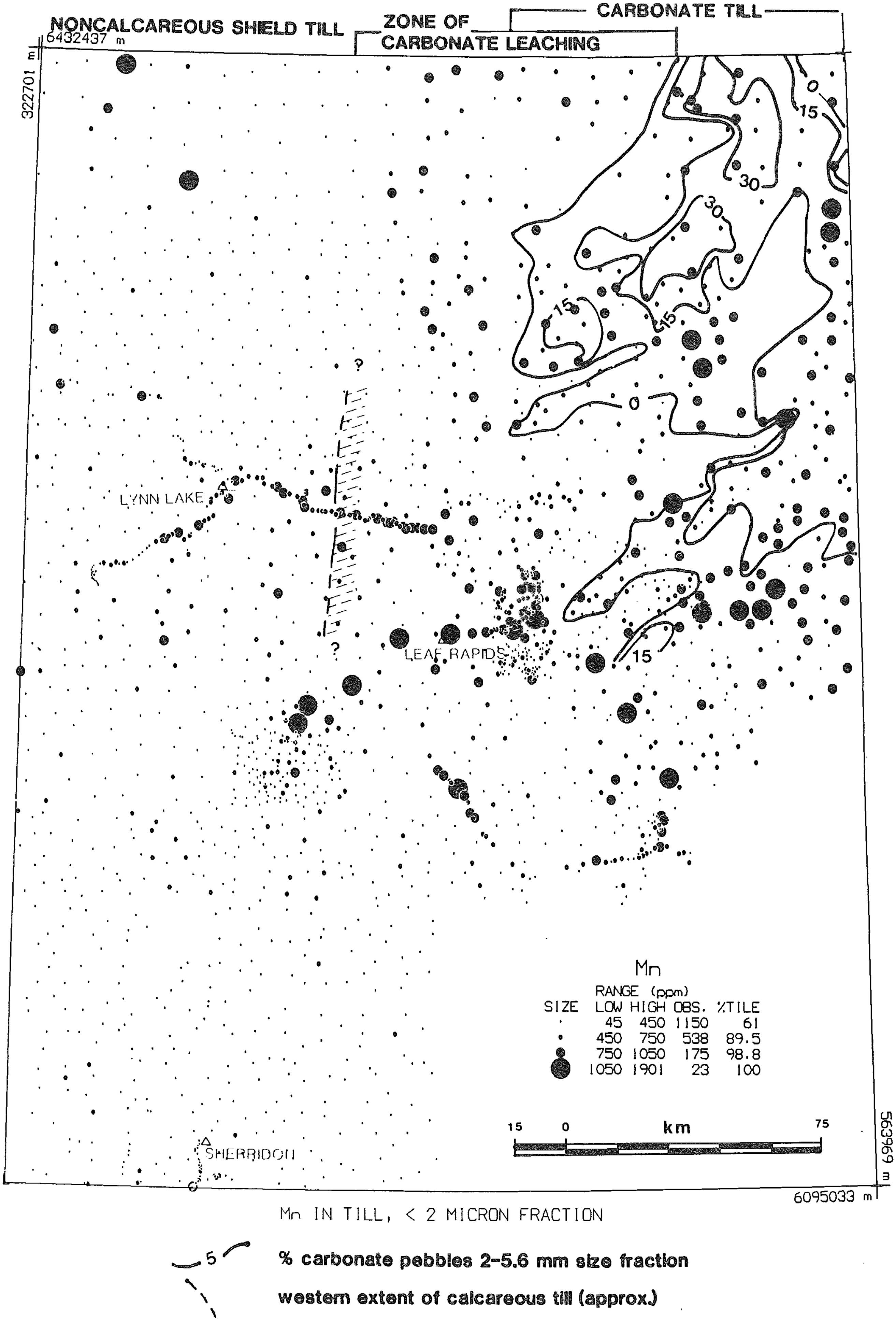


FIGURE. 10. Regional distribution of Mn in till, in relation to till provenance

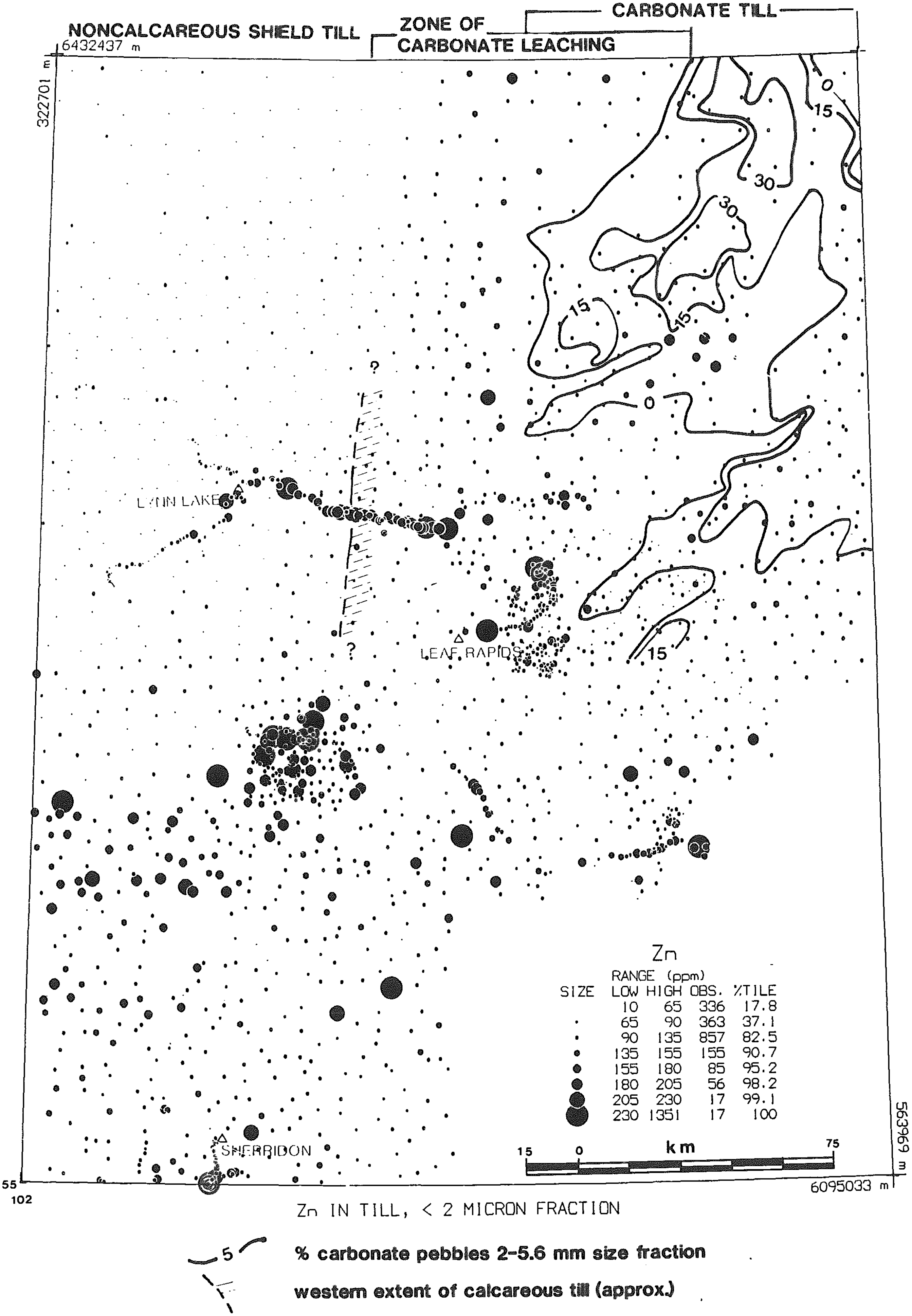
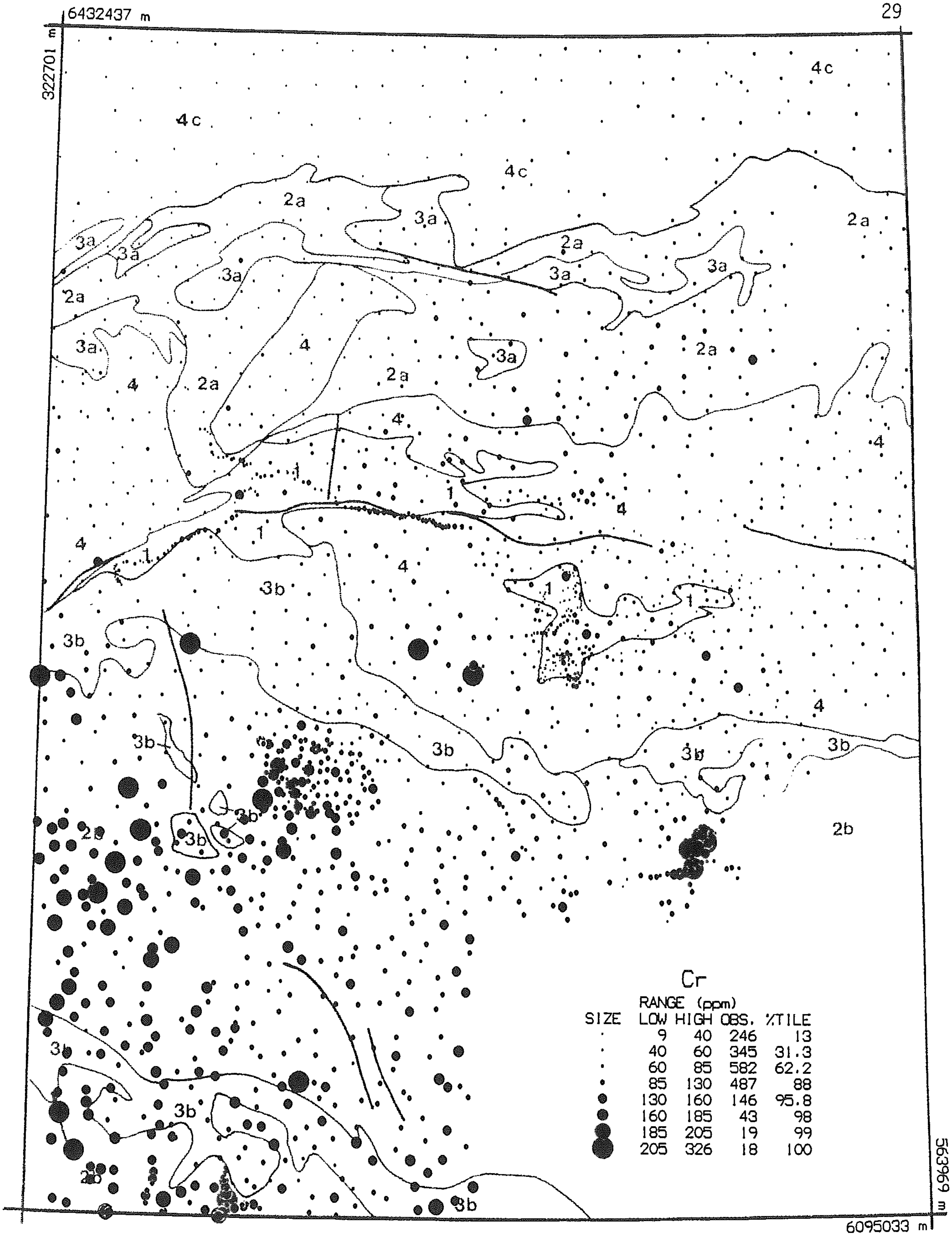


FIGURE 11. Regional distribution of Zn in till, in relation to till provenance



Cr IN TILL, < 2 MICRON FRACTION

15 0 75
km

FIGURE 12. Regional distribution of Cr in till, in relation to lithologic trends

data set, and 50th percentile values for subsets based on regional bedrock geology. APPMAP, developed by D. J. Ellwood of the Resource Geochemistry and Geophysics Division (GSC), generates a colour contour map based on a moving average calculation, and provides a smoothed interpretation of point data. Contour intervals are simply program default contours, selected to subdivide background concentrations into four groups of equal sample coverage. Both types of maps are available in this report (Appendices B and C respectively).

The most significant aspect of regional till composition within the study area is the lateral variation from sandy, non-calcareous till in the western part of the region, to silty, calcareous till in the east. In northwestern Manitoba, Paleozoic carbonate has been dispersed approximately 300 km across the Canadian Shield. The influence of regional dispersal on till geochemistry is illustrated by the distribution of Mn and Zn in the clay fraction of till (Figs. 10 & 11). In general, manganese concentration is higher in the region dominated by till of Hudson Bay provenance (both calcareous and leached tills), than in areas characterized by Shield-derived tills. Similar relationships are observed for Zn, except that Zn concentration is also elevated in the southwestern part of the study area, reflecting lithologically controlled trends related to the distribution of greywacke and gneiss of the Kisseynew Gneiss Belt.

Geochemical patterns related to regional lithologic trends are well illustrated by Cr (Fig. 12). Background concentration is elevated in the southwestern part of the study area underlain by gneiss and greywacke of the Kisseynew Gneiss Belt. This geochemical enrichment however, is not observed for similar lithologies forming the Southern Indian Gneiss Belt. Similar trends are also observed for Ni, Cu and to a lesser extent Au (Appendices B and C).

Local Geochemical Trends

At a local scale (several to 10's of km), geochemical patterns are manifest as zones of anomalously high trace element concentration, reflecting potentially mineralized areas within regional bedrock lithologies. These patterns may be elongated in a direction parallel to ice flow, reflecting glacial erosion and transport of mineralized debris. In these cases the aerial distribution of geochemically enriched debris may far exceed that of potentially mineralized source rocks. More commonly however, local anomalies exhibit irregular patterns closely reflecting the outcrop area of geochemically enriched source rocks.

Glacial Dispersal

Arsenic is the only element for which well developed dispersal trains can be mapped. Figure 13 illustrates four well developed As dispersal trains and one zone of elevated As concentration. Three of the four dispersal trains exhibit well defined head and tail relationships, trending approximately 200°-210°, parallel to the Main Late Wisconsinan ice flow direction, and relatively uninfluenced by late glacial shifts in ice flow. In general, all zones of elevated As concentration correlate with the contact between terrestrial metasediments (unit 3) and underlying metagreywackes (unit 2) and/or metavolcanics (units 1). These trains can be traced for distances varying from 50 to 100 km. The large distances over which As-enriched till has been transported down-ice from source reflects either, a large single source, significantly enriched in arsenopyrite, or the cumulative effect of glacial dispersal from a number of small sources within the train. In either case it is significant that As enrichment occurs only at specific sites along the contact between units 2 and 3, suggesting unusual mineralogical conditions within these areas. The most common site of deposition of disseminated sulphide along this contact is in the amphibolites marking a transition zone from the metagreywackes of the BRMS (unit 2) and overlying Sickle Group lithologies (unit 3), and in

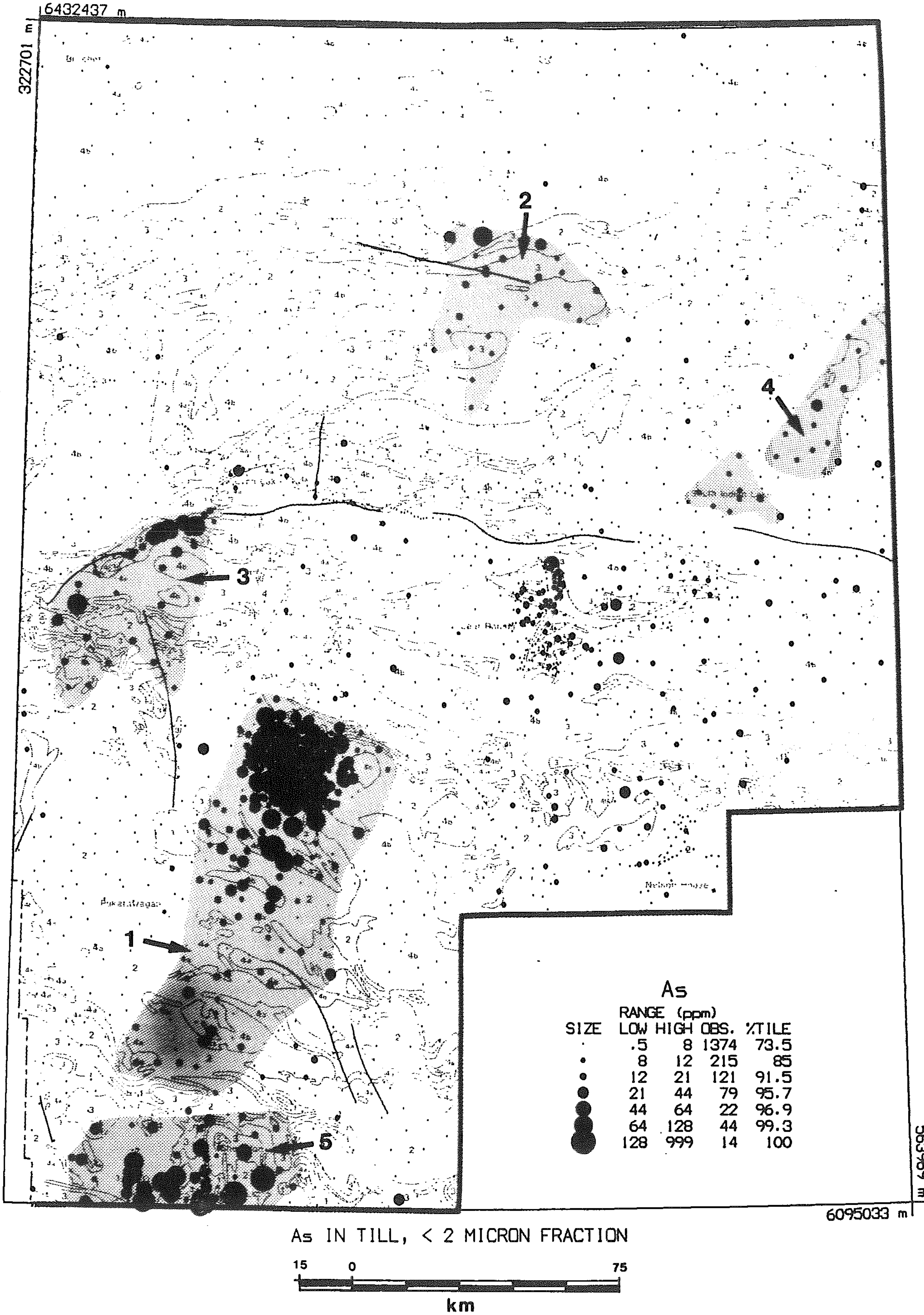


FIGURE 13. Regional distribution of arsenic in till

interlayered graphitic metagreywackes and amphibolites at the top of the BRMS (Baldwin, 1980). Arsenopyrite may be associated with stratiform syngenetic Cu mineralization at the base of the Sickle Group related to changes in redox conditions at the contact, organic complexing and the increase in graphite-bearing metagreywacke near the stratigraphic top of the BRMS , and/or tectonism at stratigraphic contacts often associated with Au mineralization.

At Wheatcroft Lake (zone 1), a zone of known Cu sulphide mineralization coincides with the head of the dispersal train (Baldwin, 1980). No other sulphide occurrences have been documented south of this belt, suggesting dispersal results from erosion and transport from a single large source near the head of the train. The source likely represents a broad zone of widely disseminated arsenopyrite at the contact between metasediments of the Sickle Group (unit 3) and metagreywackes of the BRMS (unit 2). Several samples from this region are also anomalous with respect to Cu, Zn, U and Au (Appendices B and C). Although none of these elements exhibits a pattern related to glacial dispersal, the assemblage of anomalies may suggest that As mineralization may be, in part, related to Cu mineralization in meta-arkose and metaconglomerate of the Sickle Group. However, Au anomalies in this area appear to be more closely associated with felsic intrusives than sulphide occurrences (Kaszycki et al., 1988).

Similarly, the Le Clair Lake dispersal train (zone 2), appears to be derived from a single large sources located at or near the contact between terrestrial metasediments (unit 3) and metagreywacke (unit 2) within the Southern Indian Gneiss Belt. No other trace element anomalies are associated with As dispersal in this area. The head of this dispersal train lies up-ice (ie. north and east) of the only known sulphide mineralization in the region. Disseminated sulphides occur within a shear zone along the northern margin of Le Clair Lake (Schledewitz, 1983), but have not been documented elsewhere. Detailed till sampling has been carried out in the vicinity of the shear zone at Le Clair Lake (Nielsen, 1985) however, results have not been published.

The Wilmot - Gemmell Lake dispersal train (zone 3), may reflect, in part, the occurrence of numerous small sulphide source known to occur within the dispersal area. As and Cu mineralization has been documented at several sites within this area, and the head of the train outlines a zone of arsenopyrite-bearing mafic tuff and quartzite, associated with known Au mineralization (Richardson and Ostry, 1987). Till within parts of this As dispersal train is also enriched in Cu (Appendices B and C), but no Au anomalies have been identified.

The source for the South Indian Lake - Missi Rapid dispersal train (zone 4) is not well defined. As-enriched debris may represent sulphide mineralization within metasediments (unit 3) and metagreywackes (unit 2) outcropping south of Missi Rapid (Gale et al., 1980). The head of the train is located just south of a thin band of volcanogenic sediments that contain massive sulphide strata (Gale et al., 1980). The southward extension of this train in the South Indian Lake area is tenuous, but the lack of an obvious source in this area, suggests that elevated As concentration may be the result of dispersal from the northeast.

The zone of elevated As concentration in the Sherridon area (zone 5) again reflects sulphide mineralization associated with the contact between metasediments (unit 3) and metagreywacke (unit 2) along the southern margin of the Kisseynew gneiss belt. Au and Cu anomalies are also observed within this region (Appendices B and C). Any southward extension of this zone is unknown. Comparison with detailed bedrock mapping (Schledewitz, 1988a, 1988b), suggests a correlation between elevated As and Cu concentration and outcrop of quartzofeldspathic gneisses of the Missi Metamorphic Suite.

The only other geochemical evidence for glacial dispersal on a local scale was observed at Osik Lake, where till enriched in both Ni and Cr (Fig. 3; Appendices B and C) extends approximately 30 km down-ice form a previously unknown ultramafic source body, located within Osik Lake (DiLabio and Kaszycki, 1988).

Local Bedrock Trends

In general, regional geochemical anomalies exhibit irregular patterns thought to reflect areas of mineralization within regional lithologic units. On a local scale, these regional anomalies represent higher background concentrations associated with potentially mineralized zones. The lack of dispersal associated with anomalies may be the result of a number of factors including, rapid dilution of debris in the down-ice direction, small anomaly to background ratio, and size aspect and erodibility of source area. Regional geochemical anomalies have been grouped into zones. Anomalous zones are identified by clusters of samples containing anomalous concentrations of a specific trace element. However, not all samples within zone boundaries are anomalous with respect to a given element, and in cases of a zone defined by multi-element anomalies, not all samples are anomalous with respect to all elements.

The distribution of regional Au anomalies (Fig. 14) reflects both regional variations in bedrock lithology, as well as zones within lithic units containing elevated Au concentrations. Referring to Table 4c, it is evident that definition of Au anomalies as >95th percentile concentration based on the entire data population, results in over-representation of anomalies in areas dominated by terrestrial metasediments. Interpretation of anomalous zones therefore, must take into account regional variations in background concentration with respect to bedrock lithology, and 95th percentile values for each lithic type.

Two different types of lithologic setting for Au anomalies can be identified:

1) anomalies occurring within terrestrial metasediments (unit 3), and/or near the contact between metasediments and metagreywacke (unit 2);

2) anomalies occurring at or near contacts between units 2 or 3 and felsic intrusives (unit 4b).

Six zones of anomalous Au concentration have been identified. The largest of these (zone 1) encompasses the western extent of Sickle Group rocks (unit 3) within the region. Most samples within this zone contain Au concentrations ranging from 80th to 90th percentile values, reflecting the higher background concentration for Au observed for till derived from metasedimentary rocks. The 95th percentile value for the metasediment subgroup (Table 4c), suggests that only samples containing >30 ppb Au should be considered truly anomalous within this zone. Au anomalies are scattered, but in general, occur near the contact between metasediment and intrusive lithologies, possibly indicating a tectonically controlled depositional setting.

Au anomalies within zone 2 (Wheatcroft Lake) occur within metagreywacke (unit 2). 95th percentile values for Au within till sampled over this lithologic unit suggest that samples containing Au in concentrations >10 ppb may be considered anomalous. Au anomalies are scattered, occurring south of the only known Au showing within the region (Barry, 1965). When compared with 1:50,000 bedrock maps for the area (Barry, 1965; Barry and Gait, 1966; Cranstone, 1968, Godard, 1966; and Pollack, 1966) it can be seen that approximately 50% of all Au anomalies are located near the margin of felsic intrusives, again suggesting a tectonically controlled mineralization (Kaszycki et al., 1988).

Within zones 3 and 4 Au anomalies appear to coincide with the contact between units 2 and 3. Bedrock mapping at 1:50,000 within these regions does not indicate any association with intrusive lithologies (Schledewitz, 1988a; Baldwin et al.,

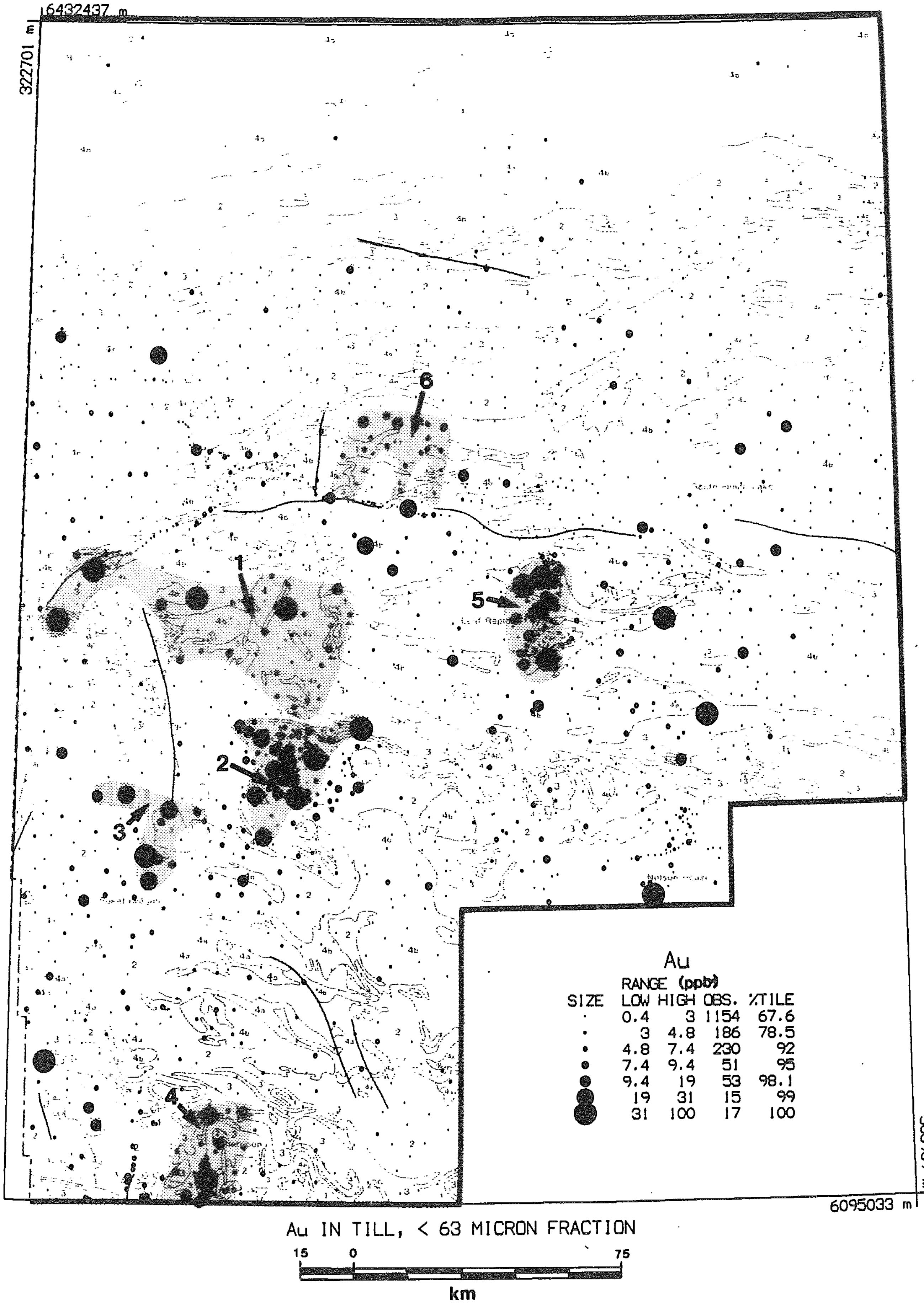


FIGURE 14. Distribution of Au anomalies in till

1979), suggesting that Au may be sediment-hosted. However, faulting is common along these lithologic contacts, and Au may be associated with lithostratigraphically controlled fault zones. Detailed follow-up sampling is presently underway in the Kississing Lake area (zone 4) (Nielsen and Gobert, 1988, in prep) in order to more clearly define the nature and possible source(s) for Au and associated As and Cu anomalies within this region.

Zone 5 corresponds to the Rusty Lake Greenstone Belt. Au anomalies are scattered throughout this region. Comparison with detailed mapping (Baldwin, 1982, 1988; Steeves and Lamb, 1972) does not reveal any systematic mode of occurrence. Within zone 5, detailed sampling has been carried out in the Ruttan area, located in the central part of zone 5 (Nielsen, 1985, 1986a, 1987), and in the Darrol Lake area, located in the southeastern part of zone 5 (Nielsen, 1987; Nielsen and Gobert, 1988; and Kaszycki. 1988). Geochemical results from these studies have not yet been published in full. In the Ruttan area, a well defined Au anomaly is centred on the Vol fault, with four samples containing >20 grains of visible gold per 5 kg sample (Nielsen, 1986a; pers. com., 1987). Till in this region is also anomalous with respect to As. The delicate nature of most Au grains indicates that they are locally derived and have not undergone extensive glacial transport, suggesting that Au mineralization in this area may be fault-controlled. In the Darrol Lake area, the distribution of Au in till is sporadic, although 75% of Au-bearing samples occur in till overlying mafic metavolcanic rocks, or near the contact between mafic and felsic units (E. Nielsen, pers. com., 1988). Most gold grains are abraded and Au in till likely reflects regional background.

Zone 6 is located north of the Lynn Lake Greenstone Belt in the Barrington Lake area. The largest Au concentrations in this zone occur within felsic intrusives north of the greenstone belt. Using the 95th percentile value for till derived from intrusive lithologies (8 ppb), four samples, containing anomalous Au ranging up to 16 ppb, define the head of what appears to be a dispersal train trending approximately 20 km to the southwest at ~210°. The tail of the train crosses onto the Lynn Lake greenstone belt, forming three plumes characterized by Au concentrations of 6 - 7 ppb, or within the 85 to 90th percentile range for the intrusive category. The westernmost plume encompasses the Farley Lake gold deposit. At this site, Au is preferentially concentrated in the fine silt size fraction and Au concentration in the minus 200 mesh (<74μm) till fraction averages 12 ppb (Brereton et al., 1988). It is possible that Au concentration within the tail of the train reflects contribution from this and similar mafic extrusive sources within the train (Baldwin et al., 1985), however, the trend of the plumes, plus the systematic decrease in Au concentration down-ice suggests dispersal by glacial ice. A source for Au near the head of the train is unknown, but may be associated with faults or fracture zones within intrusive bodies, or contacts with unmapped metasedimentary or volcanic lithologies within the region. Detailed surface till sampling within the Farley lake area (Nielsen and Graham, 1985) identified several scattered Au anomalies within the heavy mineral fraction of till, but the <63μm fraction was not analyzed for Au and direct comparison with results of regional surveys is not possible.

Multi-Element Trends

Multi-element combinations of regional geochemical anomalies have been recognized by superimposing the distribution of anomalies for several trace elements. The result is a map illustrating the co-occurrence of regional anomalies (Fig. 15). Multi-element trends encompass both local scale dispersal and local bedrock trends. For example, the large area of As-enriched till forming the Wheatcroft Lake dispersal train is characterized by a sub-region near the head of the train that is anomalous with respect to Cu, Zn, U, and Au (zone 1). Only As is sufficiently enriched within bedrock over a large enough area to form a dispersal train.

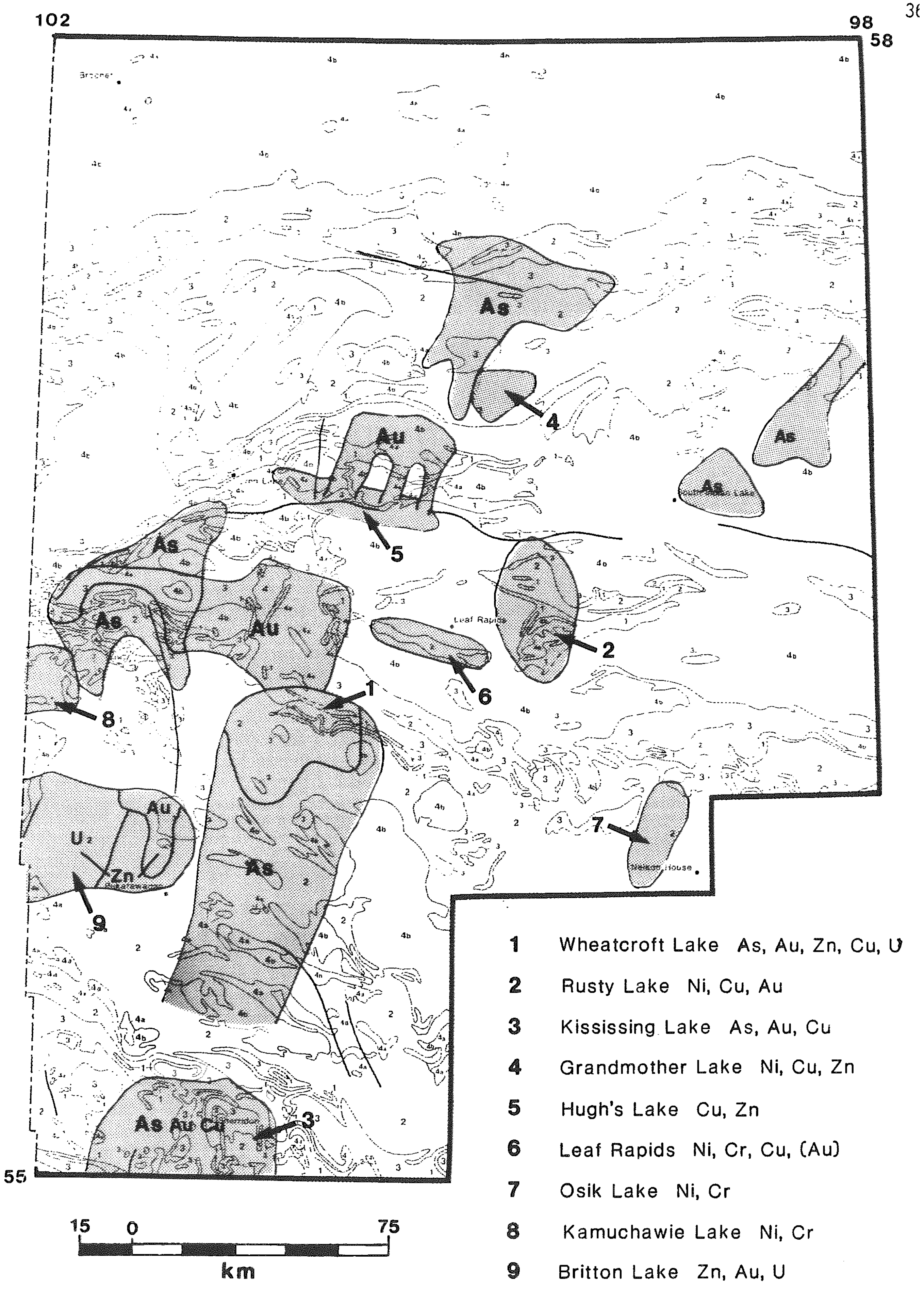


FIGURE 15. Distribution of multi-element anomalies in till

Other trace element anomalies represent areas of potential mineralization. Cu, Zn anomalies likely reflect sediment-hosted disseminated sulphide mineralization within metagreywacke. Au, on the other hand, is more closely related to felsic intrusives, possibly suggesting a tectonically controlled source (Kaszycki et al., 1988).

Other multi-element anomalies include:

Zone 2; Ni, Cu, Au, over the Rusty Lake Greenstone Belt. Detailed sampling has been carried out within the Ruttan and Darrol Lake areas (Nielsen, 1987, 1986a, 1986b);

Zone 3; Cu, As, Au, associated with sulphide mineralization near the contact between metagreywacke and metasediments in the Sherridon - Kississing Lake area. Follow-up sampling at a scale of 1:50,000 is presently being carried out (Nielsen and Gobert, 1988, in prep).

Zone 4; Ni, Cu, Zn associated with biotite gneiss of metasedimentary origin (metagreywacke) in the Grandmother Lake area;

Zone 5; Cu, Zn, associated with the Johnson shear along the eastern extension of the Lynn Lake Greenstone Belt. Detailed work within parts of this region have been carried out by Nielsen (1985);

Zone 6; Ni, Cr, Cu, (Au), associated with greywacke and calc-silicate rock just south of Leaf Rapids;

Zone 7; Ni, Cr, associated with glacial dispersal of ultramafic debris from Osik Lake (DiLabio and Kaszycki, 1988);

Zone 8; Ni, Cr, associated with the contact between metagreywacke (unit 2) and other metasediments (unit 3) in the Kamuchawie Lake area;

Zone 9; Zn, Au, U, associated with metagreywacke (unit 3) in the Britton Lake area.

CONCLUSIONS AND RECOMMENDATIONS

Surficial mapping and regional till sampling within the Lynn Lake-Leaf Rapids-Sherridon areas has provided a body of information necessary for the successful implementation of drift prospecting programs in northwestern Manitoba. Surficial geology within this region is relatively simple, characterized by a single thin till unit. Surface till sampling may be complicated or impeded by the presence of Lake Agassiz clay, particularly in the northeast and eastern parts of the study area. In these areas till sampling is most efficient at elevations >1000 ft (~300 m), where till may obtained on topographic highs from beneath a thin veneer of clay. Till composition varies laterally across the study area, ranging from sandy shield derived till of Keewatin provenance in the west, to silty calcareous till of Hudson Bay provenance in the east. These provenance related shifts in till composition have significantly influenced regional variations in trace element concentration and the resolution of geochemical anomalies.

Several ice flow directions have been documented within the study area. Striae reflecting the main Late Wisconsinan ice flow event trend 200°-210°, but these may be crosscut or obscured by younger striae representing late glacial shifts in ice flow during deglaciation. Local dispersal patterns (10's to 100 km) trend 200°-210°, parallel to main Late Wisconsinan ice flow. Dispersal at this scale has not been affected by late glacial shifts in ice flow. It is possible however, that at a detailed scale (<1 km), dispersal patterns may have been influenced by short-lived deglacial ice flow patterns and/or deflection of ice flow around bedrock obstructions. Drift prospecting programs at this scale should be designed to accommodate known Late Wisconsinan dispersal directions as well as local deviations related to both topography and deglacial history.

Surface till samples are classified as oxidized C horizon material from which labile minerals such as sulphides have been weathered. The fine fraction (<2μm) of the till was considered to be the most appropriate for trace element analysis related to sulphide mineralization, because the concentration of many elements is greater in this size fraction than in coarser size fractions due to primary enrichment of metal within the structure of phyllosilicates, and because of the increased adsorption capacity of clay-sized particles. The silt plus clay fraction (<63μm) was considered to be the most useful for Au analysis on a regional basis because the large sample size required (>10 g) is easily recovered from a relatively small sample (2.5 kg), as well as the fact that gold in this region most commonly occurs as silt sized particles, both in bedrock and tills. Both visual inspection and geochemistry of the heavy mineral fraction are also effective methods of Au analysis. However, the large sample size required (>5 kg), coupled with the relatively high cost of sample preparation and analysis, did not make this a viable analytical tool in this study. In addition, due to oxidation of sulphides, the geochemistry of the heavy mineral fraction of near-surface samples does not reflect base metal mineralization.

Analytical strategies for samples collected using reverse circulation drilling techniques vary significantly from those outlined above. A major limitation of this sampling procedure is the loss of fine (<63μm) material. However, analysis of the heavy mineral fraction is effective for both Au and base metals, as samples are generally unoxidized and sulphides have not been weathered. It should be noted that in addition to mapping geochemical patterns, identification of lithologies comprising the coarse (>2 mm) size fraction of till is an extremely valuable tool for deciphering potential sources of metalliferous debris, and should constitute a major component of drift prospecting programs at all scales.

Because sulphide mineralization within the study area generally occurs as relatively thin stratiform deposits (Baldwin, 1980) with small areas of surface exposure, the size of source area for glacial erosion and dispersal is relatively small. This, coupled with irregular bedrock topography and resistant bedrock lithologies results in dispersal trains that are short and/or poorly developed. Results of detailed work indicate that down-ice transport of material derived from areas of known mineralization cannot be traced farther than 1 - 2 km (Nielsen, 1987; Nielsen and Fedikow, 1987, 1986; Nielsen and Graham, 1985). Based on these observations it is apparent that the sampling density employed in this study (7 - 8 km spacing) is unlikely to result in the intersection of these small dispersal trains. Rather, geochemical trends and dispersal patterns reflect regional variations in background concentration related to till provenance and bedrock trends. Regional anomalies identify geochemically enriched bedrock units with potential for hosting small volcanogenic sulphide bodies, rather than the small sulphide bodies themselves.

Simple statistical techniques treating the entire data set as one sample population are inadequate to identify variations in background related to till provenance and/or changes in bedrock lithology. In order to more fully evaluate these relationships, the total sample population should be subdivided on the basis of bedrock type and till provenance. In addition, interpretation of regional anomalies must take into account variations in background concentration with respect to regional bedrock lithologies, and 95th percentile values for each lithic type.

Regional geochemical trends reflect the combined influence of till provenance and regional lithologic trends. Calcareous tills are enriched in Mn and Zn and depleted in Cr, Au, and U, suggesting that Paleozoic debris may significantly mask the geochemical signature of local bedrock lithologies for certain trace elements.

At a local scale (several to 10's of km), geochemical patterns are manifest as zones of anomalously high trace element concentration, reflecting potentially mineralized areas within regional bedrock lithologies. These patterns may be elongated in a direction parallel to ice flow, reflecting glacial erosion and transport of mineralized debris. In these cases the areal distribution of geochemically enriched debris may far exceed that of potentially mineralized source rocks. More commonly however, local anomalies exhibit irregular patterns closely reflecting the outcrop area of meta-enriched source rocks.

The only element for which well developed dispersal trains can be mapped with any degree of frequency is As. In general, all zones of elevated As concentration correlate with zones of disseminated sulphide mineralization, commonly located at the contact between terrestrial metasediments (unit 3) and underlying metagreywacke (unit 2) and/or metavolcanics (unit 1). It is significant however, that extensive As-enrichment in till occurs only at specific sites along this contact, suggesting that mineralogical conditions possibly associated with base metal and/or Au mineralization exist within these areas.

The distribution of regional Au anomalies reflects, both regional variations in bedrock lithology, as well as zones within bedrock units containing elevated Au concentration. Two different types of Au anomaly can be identified: 1) those occurring within terrestrial metasediments (unit 3) and/or near the contact between metasediments and metagreywacke (unit 2), possible reflecting stratabound Au mineralization; and 2) those occurring at or near the contacts between units 2 or 3, and felsic intrusives (unit 4b), possibly reflecting higher background associated with tectonically controlled mineralization.

Nine areas containing multi-element regional geochemical anomalies have been identified. These encompass both local glacial dispersal and local bedrock trends, and may represent an important step toward identification of the nature and scale of geochemical haloes associated with base metal and Au mineralization within the region. To date, detailed follow-up sampling has been, or is presently being carried out in the Wheatcroft Lake area, Kississing Lake area and the Rusty Lake area . More detailed work is required however, to identify adequately the nature of mineralization associated with these anomalies, specifically that associated with large As anomalies.

ACKNOWLEDGEMENTS

Thanks are extended to R. N. W. DiLabio for guidance and field support during the initial stages of this project. Erik Nielsen, R. N. W. DiLabio, W. W. Shilts, and R. A. Klassen provided enlightening discussion on many related topics. D. J. Ellwood of the Geological Survey, developed the computer program (APPMAP) used to produce colour computer contour maps. Phil Wyatt, of Wyatt Geoscience, Ottawa, developed the LAZERDOT software. Rob Burns and Steve Courtney provided much able assistance with database management. Air photo interpretation was carried out by Vincent Way Nee. Special thanks to all those who assisted in the field.

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APPENDIX A

GEOCHEMICAL DATA BASE

The geochemical data base accompanying this report is available on diskette and/or as a hard copy print out. Data are available on 5 1/4 inch floppy disks (360K format) and are stored as tab delimited ascii (text) files that can easily be imported by most spreadsheet and word processing software. The data base includes sample location and description, striation location and description, till geochemical data for the <2 μm size fraction, till geochemical data for the <63 μm size fraction (Au + 33 elements), gold concentration in the heavy mineral fraction (for selected samples), and carbonate content in the <63 μm and granule (2-5.6 mm) size fractions (for selected samples). In addition to samples used to produce regional geochemical maps, the data base includes all profile samples collected from exposures along roads and rivers to assess *in situ* vertical variability in till geochemistry. In some instances, samples of surficial materials other than till were collected (ie. nearshore sand and gravel), either by mistake or because till was not present at a particular site. These samples were not include in regional mapping but are presented in the data base and can be identified easily within the sample location and description file. Seven sample location maps at 1:250,000 scale (NTS 63B, 64C, 64F, 64G, 63O, 63N, 63K) also accompany this report.

The data base has been broken into the following files:

File Name	Description of Data	# of Records
Desc.dat	Sample Location and Description	3003
Clay.dat	Till Geochemistry, <2μm Size Fraction	2797
M250A.dat	Till Geochemistry, <63μm Size Fraction	2173
M250B.dat	Till Geochemistry, <63μm Size Fraction	2173
AuHeav.dat	Gold in Heavy Mineral Concentrates	395
Carbon.dat	Carbonate Content, <63μm and Granule Size Fractions	680
Striae.dat	Striation Location and Description	802

The first page of each file contains several lines of text describing format and descriptive codes used (see pages A1 - A7).

Sample Location and Description

File Name: Desc.dat
Geological Survey of Canada, Terrain Sciences Division
NW Manitoba, Data Base, UTM Grid Zone 14
Sample Location and Description

Sample: nine character code (e.g. 83DDA0006) identifying year (83), grid (DDA) and sample number (0006)
Location: Universal Transmercator Grid Reference (UTM), includes grid zone, easting, northing, NTS map sheet reference number and name
Sediment: Type of sediment sampled at specific locations
Rplot: A flag (0 or1) to identify a sample that is plotted in regional geochemical mapping
    0 - indicates sample is not plotted at a regional scale
    1 - indicates sample that is plotted at a regional scale
Section: Stratigraphic section indicator, a flag to identify samples collected as part of a series from a stratigraphic section
    0 - indicates sample is not from a section
    1 - sampled in stratigraphic succession from top to bottom, 1 is top, 2...
Depth: Depth of the sample from the surface of the sample site, recorded to two decimal places and measured in metres
Bedrock: Refers to bedrock geology at sample site as determined from regional bedrock maps (see separate listing for bedrock codes)
Colour: Subjective field description of sample colour

Sample	Zone	Easting	Northing	NTS	Sheet	Sediment	Plot	Section	Depth (m)	Bedrock	Colour	Comments
83DDA0006	14	435000	6314000	64C	GRANVILLE LAKE	Till	1	0	0.6	GRDR	olive brown	sandy
83DDA0007	14	430500	6315000	64C	GRANVILLE LAKE	Till	1	0	0.4	GRDR	olive	sandy
83DDA0008	14	430500	6311000	64C	GRANVILLE LAKE	Till	1	0	0.5	GRDR		sandy
83DDA0009	14	430500	6308000	64C	GRANVILLE LAKE	Till	1	0	0.5	BSLT	olive	sandy
83DDA0010	14	428500	6307000	64C	GRANVILLE LAKE	Till	1	0	0.35	GRDR		sandy
83DDA0011	14	430000	6302000	64C	GRANVILLE LAKE	Till	1	0	0.4	BSLT	olive brown	
83DDA0012	14	434000	6302000	64C	GRANVILLE LAKE	Till	1	0	0.35	BSLT	olive	sandy
83DDA0013	14	434500	6299500	64C	GRANVILLE LAKE	Nearshore sand,gravel	0	0	0.45	QRZD	orange brown	pebbly sand
83DDA0014	14	432000	6295500	64C	GRANVILLE LAKE	Till	1	0	0.4	BSLT	olive brown	reworked
83DDA0015	14	430500	6290500	64C	GRANVILLE LAKE	Glaciolacustrine	0	0	0.5	GRNT	brown	clayey silt
83DDA0016	14	428500	6293000	64C	GRANVILLE LAKE	Till	1	0	0.45	GRNT	olive	sandy silty
83DDA0017	14	422500	6296500	64C	GRANVILLE LAKE	Till	1	0	0.5	GRNT	olive brown	silty sandy
83DDA0018	14	424000	6303500	64C	GRANVILLE LAKE	Till	1	0	0.35	BSLT	olive brown	sandy
83DDA0019	14	419000	6309000	64C	GRANVILLE LAKE	Till	1	0	0.25	GBBR	olive	frozen
83DDA0020	14	421500	6311500	64C	GRANVILLE LAKE	Glaciolacustrine	0	0	0.45	QRZD	brown	sandy silt
83DDA0021	14	422000	6315500	64C	GRANVILLE LAKE	Till	1	0	0.35	BSLT	olive brown	frozen
83DDA0022	14	419000	6317500	64C	GRANVILLE LAKE	Till	1	0	0.5	GRDR	olive brown	
83DDA0023	14	414500	6311500	64C	GRANVILLE LAKE	Till	1	0	0.3	GRDR	olive brown	
83DDA0024	14	415000	6307000	64C	GRANVILLE LAKE	Till	1	0	0.45	BSLT	olive	silty sandy
83DDA0025	14	415000	6301000	64C	GRANVILLE LAKE	Till	1	0	0.5	GRDR	olive brown	sandy
83DDA0026	14	414500	6297500	64C	GRANVILLE LAKE	Till	1	0	0.4	GRNT	olive brown	sandy
83DDA0027	14	410500	6298500	64C	GRANVILLE LAKE	Till	1	0	0.4	GRDR	olive brown	silty sandy
83DDA0028	14	412500	6316000	64C	GRANVILLE LAKE	Till	1	0	0.5	GRDR	olive brown	sandy
83DDA0029	14	408000	6317000	64C	GRANVILLE LAKE	Till	1	0	0.55	GRNT	olive brown	
83DDA0030	14	407000	6311000	64C	GRANVILLE LAKE	Till	1	0	0.45	BSLT	orange brown	sandy
83DDA0031	14	406500	6306500	64C	GRANVILLE LAKE	Till	1	0	0.5	BSLT	olive brown	sandy
83DDA0032	14	405000	6300500	64C	GRANVILLE LAKE	Till	1	0	0.5	GRDR	olive	sandy
83DDA0033	14	401000	6306000	64C	GRANVILLE LAKE	Till	1	0	0.5	GRDR	olive	sandy
83DDA0034	14	400500	6313500	64C	GRANVILLE LAKE	Till	1	0	0.5	GBBR	olive	sandy
83DDA0035	14	399500	6316500	64C	GRANVILLE LAKE	Till	1	0	0.5	GRDR	olive	sandy
83DDA0036	14	397500	6311000	64C	GRANVILLE LAKE	Till	1	0	0.55	BSLT	olive	sandy
83DDA0037	14	396000	6307000	64C	GRANVILLE LAKE	Till	1	0	0.65	GRDR	olive	sandy
83DDA0038	14	399000	6301000	64C	GRANVILLE LAKE	Nearshore sand,gravel	0	0	0.65	QRZD	red brown	beach
83DDA0039	14	391500	6312500	64C	GRANVILLE LAKE	Till	1	0	0.4	BSLT	olive brown	silty sandy
83DDA0040	14	388500	6316500	64C	GRANVILLE LAKE	Nearshore sand,gravel	0	0	0.55	GRCK	red brown	pebbly sand
83DDA0041	14	385000	6313500	64C	GRANVILLE LAKE	Till	1	0	0.65	MGCK	olive	sandy,reworked
83DDA0042	14	387500	6307000	64C	GRANVILLE LAKE	Till	1	0	0.55	BSLT	olive	
83DDA0043	14	384000	6299000	64C	GRANVILLE LAKE	Till	1	0	0.4	GRDR	olive	
83DDA0044	14	377500	6317500	64C	GRANVILLE LAKE	Till	1	0	0.6	GRNT	olive brown	sandy
83DDA0045	14	371500	6318000	64C	GRANVILLE LAKE	Till	1	0	0.6	GRNT	olive brown	sandy pebbly
83DDA0046	14	368500	6318000	64C	GRANVILLE LAKE	Till	1	0	0.6	GRNT	olive	sandy
83DDA0047	14	351000	6317500	64C	GRANVILLE LAKE	Nearshore sand,gravel	0	0	0.6	GRNT	red brown	gravelly sand
83DDA0048	14	346500	6318000	64C	GRANVILLE LAKE	Nearshore sand,gravel	0	0	0.65	QRZD	red	sand
83DDA0049	14	341500	6319500	64C	GRANVILLE LAKE	Till	1	0	0.5	GRDR	olive	sandy
83DDA0050	14	336000	6320000	64C	GRANVILLE LAKE	Till	1	0	0.5	GRDR	red brown	sandy
83DDA0051	14	329000	6320500	64C	GRANVILLE LAKE	Till	1	0	0.55	GRDR	olive	sandy
83DDA0052	14	321000	6320500	64C	GRANVILLE LAKE	Till	1	0	0.5	GRDR	olive sandy	
83DDA0053	14	318000	6314000	64C	GRANVILLE LAKE	Nearshore sand,gravel	0	0	0.55	QRZD	red brown	pebbly sand
83DDA0054	14	320500	6311000	64C	GRANVILLE LAKE	Till	1	0	0.45	GRNT		very stoney
83DDA0055	14	326000	6311500	64C	GRANVILLE LAKE	Till	1	0	0.4	GRDR	olive	sandy
83DDA0056	14	332000	6312000	64C	GRANVILLE LAKE	Nearshore sand,gravel	0	0	0.6	QRZD	red	sand
83DDA0057	14	338500	6312000	64C	GRANVILLE LAKE	Till	1	0	0.45	GRNT	olive	sandy
83DDA0058	14	345500	6311500	64C	GRANVILLE LAKE	Till	1	0	0.5	GRNT	olive brown	sandy
83DDA0059	14	354500	6309500	64C	GRANVILLE LAKE	Till	1	0	0.55	GRNT	olive	sandy
83DDA0060	14	368500	6304000	64C	GRANVILLE LAKE	Till	1	0	0.55	MGCK	olive	sandy
83DDA0061	14	361500	6304000	64C	GRANVILLE LAKE	Nearshore sand,gravel	0	0	0.65	GRCK	red brown	gravelly sand
83DDA0062	14	357000	6304500	64C	GRANVILLE LAKE	Till	1	0	0.65	MGCK		sandy
83DDA0063	14	351000	6302500	64C	GRANVILLE LAKE	Till	1	0	0.55	GRNT	olive	sandy
83DDA0064	14	346500	6302500	64C	GRANVILLE LAKE	Till	1	0	0.7	GRDR	olive	sandy
83DDA0065	14	341500	6301000	64C	GRANVILLE LAKE	Till	1	0	0.65	GRDR	olive	sandy
83DDA0066	14	336000	6302000	64C	GRANVILLE LAKE	Till	1	0	0.6	GRDR	olive	
83DDA0067	14	330500	6302500	64C	GRANVILLE LAKE	Nearshore sand,gravel	0	0	0.7	QRZD	red brown	sand
83DDA0068	14	325000	6303000	64C	GRANVILLE LAKE	Till	1	0	0.6	GRNT	olive	
83DDA0069	14	320500	6302500	64C	GRANVILLE LAKE	Till	1	0	0.7	GRNT	olive brown	sandy

File Name: Clay.dat
Geological Survey of Canada, Terrain Sciences Division
NW Manitoba Data Base, UTM Grid Zone 14
Till Geochemistry, <2µm Size Fraction
Clay.dat - Ag, As, Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, Pb, U, Zn

Rplot - a flag to indicate samples included in regional geochemical mapping
0 - indicates samples that are not plotted at a regional scale
1 - indicates samples that are plotted at a regional scale

Ag aa - trace element and type of analysis
ppm - unit of measurement
0.1ppm - detection limit (D. L.); samples below detection are recorded as 1/2 detection limit

Sample	Rplot	Easting	Northing	Ag aa ppm	As col ppm	Cd aa ppm	Co aa ppm	Cr aa ppm	Cu aa ppm	Fe aa %	Mn aa ppm	Mo aa ppm	Ni aa ppm	Pb aa ppm	U dna ppm	U fl ppm	Zn aa ppm
D.L.				0.1ppm	2ppm	0.2ppm	1ppm	2ppm	1ppm	0.1%	1ppm	1ppm	2ppm	2ppm	0.5ppm	0.1ppm	1ppm
83DDA0006	1	435000	6314000	0.1	4		12	104	50	5.30	525	2	35	15		1.20	98
83DDA0007	1	430500	6315000	0.1	3		9	61	35	3.80	405	1	31	16		0.05	124
83DDA0008	1	430500	6311000	0.05	2		6	81	42	4.40	290	3	20	12		0.05	67
83DDA0009	1	430500	6308000	0.1	2		10	104	44	4.30	365	1	30	12		0.30	76
83DDA0010	1	428500	6307000	0.2	1		10	113	250	9.20	445	17	25	9		0.05	118
83DDA0011	1	430000	6302000	0.05	1		6	81	62	3.70	230	1	23	8		2.10	59
83DDA0012	1	434000	6302000	0.05	4		11	105	54	6.10	405	2	28	12		1.20	109
83DDA0013	0	434500	6299500	0.05													
83DDA0014	1	432000	6295500	0.05	3		8	88	120	5.30	210	3	27	8		0.50	58
83DDA0016	1	428500	6293000	0.05	3		12	84	42	5.00	690	1	34	12		0.05	116
83DDA0017	1	422500	6296500	0.05	4		12	82	46	4.90	465	1	28	15		0.50	97
83DDA0018	1	424000	6303500	0.05	1		3	25	54	2.40	140	2	8	18		0.05	49
83DDA0019	1	419000	6309000	0.05	2		12	77	93	4.90	650	3	22	9		1.20	104
83DDA0021	1	422000	6315500	0.05	2		9	74	28	3.90	325	1	22	10		0.30	89
83DDA0022	1	419000	6317500	0.05	5		9	72	26	5.30	280	2	21	16		2.00	78
83DDA0023	1	414500	6311500	0.05	6		11	85	24	6.00	395	3	25	16		0.30	98
83DDA0024	1	415000	6307000	0.1	1		11	58	41	3.60	610	1	20	8		0.50	84
83DDA0025	1	415000	6301000	0.05	3		11	94	47	5.20	445	1	26	13		0.50	114
83DDA0026	1	414500	6297500	0.05	7		10	88	57	5.50	430	1	25	15		1.20	87
83DDA0027	1	410500	6298500	0.05	5		12	104	50	5.60	705	1	35	12		1.40	124
83DDA0028	1	412500	6316000	0.05	1		10	106	21	4.00	440	3	24	9		0.80	64
83DDA0029	1	408000	6317000	0.05	5		11	80	29	4.90	370	0.5	26	14		0.30	79
83DDA0030	1	407000	6311000	0.05	15		6	61	23	4.80	185	3	14	12		0.05	52
83DDA0031	1	406500	6306500	0.1	2		12	110	49	6.30	630	1	30	11		2.90	124
83DDA0032	1	405000	6300500	0.1	16		19	88	82	5.10	1050	1	32	14		1.40	110
83DDA0033	1	401000	6306000	0.1	3		14	71	30	4.10	545	1	22	11		0.80	75
83DDA0034	1	400500	6313500	0.1	2		16	69	60	4.70	550	2	24	10		0.05	90
83DDA0035	1	399500	6316500	0.05	2		10	54	26	3.20	315	2	21	9		0.05	65
83DDA0036	1	397500	6311000	0.05	3		10	52	20	3.50	300	3	18	12		0.80	60
83DDA0037	1	396000	6307000	0.05	1		5	22	22	1.50	220	0.5	9	6		0.05	36
83DDA0038	0	399000	6301000	0.05													
83DDA0039	1	391500	6312500	0.1	5		11	84	90	4.70	260	3	32	11		0.30	81
83DDA0040	0	388500	6316500	0.05													
83DDA0041	1	385000	6313500	0.1	2		6	74	20	2.50	230	2	22	10		0.05	41
83DDA0042	1	387500	6307000	0.1	2		8	59	20	3.40	385	0.5	19	10		0.05	71
83DDA0043	1	384000	6299000	0.05	6		11	87	39	5.50	305	2	25	12		3.10	64
83DDA0044	1	377500	6317500	0.1	4		9	70	32	3.70	270	3	28	11		2.10	55
83DDA0045	1	371500	6318000	0.2	4		7	53	40	3.90	250	2	20	14		2.90	67
83DDA0046	1	368500	6318000	0.1	3		8	52	34	3.20	235	1	26	10		0.80	60
83DDA0047	0	351000	6317500	0.05													
83DDA0048	0	346500	6318000	0.05													
83DDA0049	1	341500	6319500	0.1	3		7	46	32	2.70	270	1	19	14		1.60	46
83DDA0050	1	336000	6320000	0.1	5		3	50	16	4.10	50	4	7	15		12.50	26
83DDA0051	1	329000	6320500	0.1	3		8	60	98	3.20	260	3	26	14		1.60	61
83DDA0052	1	321000	6320500	0.3	3		8	76	20	2.90	200	3	23	14		1.40	62
83DDA0053	0	318000	6314000	0.05													
83DDA0054	1	320500	6311000	0.2	2		8	106	20	4.60	585	2	27	32		0.05	80
83DDA0055	1	326000	6311500	0.4	3		7	52	44	2.80	205	3	20	14		4.70	41
83DDA0056	0	332000	6312000	0.05													
83DDA0057	1	338500	6312000	0.1	2		5	27	17	1.60	200	2	11	6		0.05	28
83DDA0058	1	345500	6311500	0.1	2		8	72	112	4.80	320	7	30	14		7.20	63
83DDA0059	1	354500	6309500	0.2	4		11	57	32	2.80	300	2	28	11		0.80	63
83DDA0060	1	368500	6304000	0.05	3		12	59	78	3.80	455	1	30	13		3.00	79
83DDA0061	0	361500	6304000	0.05													
83DDA0062	1	357000	6304500	0.05	10		8	103	74	5.10	220	5	31	14		2.30	59
83DDA0063	1	351000	6302500	0.05	2		6	29	22	1.90	190	0.5	15	10		0.80	33
83DDA0064	1	346500	6302500	0.05	3		6	48	51	2.30	255	1	18	7		2.30	45
83DDA0065	1	341500	6301000	0.1			6	31	23	1.50	250	1	13	10		1.20	36
83DDA0066	1	336000	6302000	0.05	1		7	36	24	2.00	285	2	15	8		0.30	41
83DDA0067	0	330500	6302500	0.05													
83DDA0068	1	325000	6303000	0.1	6		2	49	26	3.70	103	3	8	13		5.20	24
83DDA0069	1	320500	6302500	0.05	3		5	36	40	2.30	193	2	14	8		2.10	36
83DDA0070	1	317500	6306000	0.1	4		10	53	45	3.10	245	3	22	10		0.05	49
83DDA0071	1	325000	6308000	0.1	2		11	55	39	4.00	375	2	23	9		0.05	76
83DDA0072	1	336000	6307500	0.1	2		10	37	23	2.30	475	2	14	8		2.50	43
83DDA0073	0	344000	6307000	0.05													
83DDA0074	1	350500	6317000	0.1	2		5	38	25	1.80	225	3	18	8		0.70	34
83DDA0075	0	362000	6297000														

Till Geochemistry, <63um Size Fraction

File Name: M250A.dat
Geological Survey of Canada, Terrain Sciences Division
NW Manitoba Data Base, UTM Grid Zone 14
Till Geochemistry, <63µm Size Fraction
M250A.dat - Ag, As, Au, Ba, Br, Cd, Ce, Co, Cr, Cs, Eu, Fe, Hf, Ir, La, Lu, Mo

Rplot - a flag to identify samples used in plotting regional geochemical maps
0 - indicates that the sample is not plotted at a regional scale
1 - indicates that the sample is plotted at a regional scale

Ag naa - element and type of analysis
ppm - unit of measurement
2ppm - detection limit; values below detection have been recorded as 1/2 the detection limit

Sample	Rplot	Easting	Northing	Ag naa ppm	As naa ppm	Au naa ppb	Ba naa ppm	Br naa ppm	Cd naa ppm	Ce naa ppm	Co naa ppm	Cr naa ppm	Cs naa ppm	Eu naa ppm	Fe naa %	Hf naa ppm	Ir naa ppb	La naa ppm	Lu naa ppm	Mo naa ppm
D.L.				2ppm	0.5ppm	2ppb	50ppm	0.5ppm	2ppm	5ppm	5ppm	20ppm	0.5ppm	1ppm	0.20%	1ppm	50ppb	2ppm	0.2ppm	1ppm
83DDA0006	1	435000	6314000	1.00	0.90	8.00	960.00		1.00		10.00	58.00			2.60	14.00	25.00	75.00		0.50
83DDA0007	1	430500	6315000	1.00	3.20	5.00	650.00		1.00		7.00	59.00			2.60	10.00	25.00	45.00		0.50
83DDA0008	1	430500	6311000	1.00	1.10	5.00	860.00		1.00		7.00	44.00			2.60	13.00	25.00	53.00		0.50
83DDA0009	1	430500	6308000	1.00	1.40	7.00	740.00		1.00		18.00	210.00			4.30	8.00	25.00	44.00		0.50
83DDA0010	1	428500	6307000	1.00	0.20	5.00	750.00		1.00		31.00	38.00			7.20	3.00	25.00	12.00		0.50
83DDA0011	1	430000	6302000	1.00	0.90	3.00	860.00		1.00		6.00	36.00			2.50	12.00	25.00	48.00		0.50
83DDA0012	1	434000	6302000	1.00	1.60	4.00	840.00		1.00		7.00	57.00			3.10	12.00	25.00	58.00		0.50
83DDA0013	0	434500	6299500	1.00	1.60	22.00	810.00		1.00		7.00	45.00			3.20	15.00	25.00	68.00		0.50
83DDA0014	1	432000	6295500	1.00	0.80	4.00	870.00		1.00		8.00	45.00			2.70	16.00	25.00	63.00		0.50
83DDA0016	1	428500	6293000	1.00	1.80	3.00	850.00		1.00		9.00	42.00			2.60	10.00	25.00	52.00		0.50
83DDA0017	1	422500	6296500	1.00	2.20	6.00	850.00		1.00		10.00	56.00			3.50	11.00	25.00	58.00		0.50
83DDA0018	1	424000	6303500	1.00	1.00	7.00	720.00		1.00		6.00	35.00			2.40	10.00	25.00	37.00		0.50
83DDA0019	1	419000	6309000	1.00	0.90	6.00	950.00		3.00		9.00	48.00			2.90	11.00	25.00	55.00		0.50
83DDA0021	1	422000	6315500	1.00	1.60	16.00	840.00		1.00		8.00	32.00			2.60	13.00	25.00	44.00		0.50
83DDA0022	1	419000	6317500	1.00	1.10	8.00	950.00		1.00		7.00	46.00			2.90	16.00	25.00	60.00		0.50
83DDA0023	1	414500	6311500	1.00	1.20	7.00	950.00		1.00		8.00	49.00			3.00	17.00	25.00	70.00		0.50
83DDA0024	1	415000	6307000	1.00	1.00	4.00	880.00		1.00		2.00	36.00			2.50	14.00	25.00	66.00		0.50
83DDA0025	1	415000	6301000	1.00	1.30	1.00	970.00		1.00		5.00	50.00			3.00	14.00	25.00	76.00		0.50
83DDA0026	1	414500	6297500	1.00	2.20	1.00	860.00		1.00		8.00	41.00			2.80	12.00	25.00	46.00		0.50
83DDA0027	1	410500	6298500	1.00	2.90	4.00	860.00		1.00		9.00	58.00			2.60	10.00	25.00	54.00		0.50
83DDA0028	1	412500	6316000	1.00	1.10	11.00	930.00		1.00		6.00	38.00			2.70	18.00	25.00	68.00		0.50
83DDA0029	1	408000	6317000	1.00	1.20	1.00	910.00		1.00		8.00	33.00			2.60	14.00	25.00	59.00		0.50
83DDA0031	1	406500	6306500	1.00	0.90	6.00	910.00		1.00		8.00	58.00			2.70	16.00	25.00	73.00		0.50
83DDA0032	1	405000	6300500	1.00	3.00	4.00	880.00		1.00		7.00	66.00			2.40	12.00	25.00	43.00		0.50
83DDA0034	1	400500	6313500	1.00	0.20	7.00	960.00		1.00		6.00	38.00			1.90	16.00	25.00	60.00		0.50
83DDA0035	1	399500	6316500	1.00	0.20	1.00	960.00		1.00		2.00	31.00			2.20	19.00	25.00	65.00		0.50
83DDA0037	1	396000	6307000	1.00	0.20	1.00	990.00		1.00		2.00	30.00			1.70	16.00	25.00	62.00		0.50
83DDA0038	0	399000	6301000	1.00	0.60	1.00	840.00		1.00		6.00	49.00			3.20	40.00	25.00	150.00		0.50
83DDA0040	0	388500	6316500	2.00	1.10	853.00	930.00		3.00		9.00	100.00			5.10	38.00	25.00	190.00		1.00
83DDA0041	1	385000	6313500	1.00	0.20	3.00	870.00		1.00		2.00	31.00			1.40	16.00	25.00	50.00		0.50
83DDA0042	1	387500	6307000	1.00	0.60	5.00	780.00		1.00		2.00	35.00			1.80	12.00	25.00	77.00		0.50
83DDA0043	1	384000	6299000	1.00	1.00	5.00	830.00		1.00		2.00	36.00			1.90	14.00	25.00	50.00		0.50
83DDA0044	1	377500	6317500	1.00	0.60	1.00	850.00		1.00		2.00	10.00			1.50	16.00	25.00	52.00		0.50
83DDA0045	1	371500	6318000	1.00	0.60	1.00	790.00		1.00		2.00	27.00			1.40	15.00	25.00	61.00		0.50
83DDA0046	1	368500	6318000	1.00	0.20	1.00	890.00		1.00		2.00	43.00			1.60	17.00	25.00	65.00		0.50

File Name: M250B.dat
Geological Survey of Canada, Terrain Sciences Division
NW Manitoba Data Base, UTM Grid Zone 14
Till Geochemistry, <63µm Size Fraction
M250B.dat - Na, Ni, Rb, Sb, Sc, Se, Sm, Sn, Ta, Tb, Te, Th, U, W, Yb, Zr, Zn

Rplot - a flag to identify samples used in plotting regional geochemical maps
0 - indicates that the sample is not plotted at a regional scale
1 - indicates that the sample is plotted at a regional scale

Na naa - element and type of analysis
% - unit of measurement
0.02% - detection limit; values below detection have been recorded as 1/2 the detection limit

Sample	Rplot	Easting	Northing	Na naa %	Ni naa ppm	Rb naa ppm	Sb naa ppm	Sc naa ppm	Se naa ppm	Sm naa ppm	Sn naa ppm	Ta naa ppm	Tb naa ppm	Te naa ppm	Th naa ppm	U naa ppm	W naa ppm	Yb naa ppm	Zr naa ppm	Zn naa ppm
D.L.				0.02%	20ppm	5ppm	.1ppm	.2ppm	5ppm	0.1ppm	100ppm	0.5ppm	0.5ppm	10ppm	0.2ppm	0.2ppm	1ppm	2ppm	200ppm	100ppm
83DDA0006	1	435000	6314000		27		0.05		2			0.8			29.20	5.40	0.5			50
83DDA0007	1	430500	6315000		22		0.4		2			0.9			16.00	2.80	0.5			50
83DDA0008	1	430500	6311000		10		0.1		2			0.9			19.00	3.80	0.5			50
83DDA0009	1	430500	6308000		74		0.1		2			0.6			14.00	2.80	1			50
83DDA0010	1	428500	6307000		10		0.1		2			0.2			4.10	0.90	0.5			50
83DDA0011	1	430000	6302000		10		0.1		2			0.9			16.00	3.10	0.5			50
83DDA0012	1	434000	6302000		10		0.1		2			0.9			21.40	4.00	1			50
83DDA0013	0	434500	6299500		10		0.05		2			0.8			26.30	4.50	0.5			50
83DDA0014	1	432000	6295500		10		0.1		2			0.8			23.70	4.30	0.5			50
83DDA0016	1	428500	6293000		10		0.1		2			1.1			17.00	2.90	1			50
83DDA0017	1	422500	6296500		10		0.2		2			1.1			20.00	3.00	1			50
83DDA0018	1	424000	6303500		10		0.2		2			1.1			13.00	2.80	0.5			50
83DDA0019	1	419000	6309000		10		0.1		2			1			17.00	3.10	0.5			50
83DDA0021	1	422000	6315500		10		0.1		2			0.9			17.00	3.20	1			50
83DDA0022	1	419000	6317500		10		0.1		2			1			23.30	4.00	2			50
83DDA0023	1	414500	6311500		10		0.1		2			1.2			26.80	4.30	1			50
83DDA0024	1	415000	6307000		10		0.1		2			1.2			21.90	3.60	0.5			50
83DDA0025	1	415000	6301000		10		0.2		2			1.1			25.80	3.70	0.5			50
83DDA0026	1	414500	6297500		27		0.1		2			0.9			17.00	2.80	0.5			50
83DDA0027	1	410500	6298500		10		0.2		2			1.1			20.90	3.30	1			50
83DDA0028	1	412500	6316000		10		0.05		2			0.8			26.40	4.30	0.5			50
83DDA0029	1	408000	6317000		10		0.05		2			0.9			23.80	3.50	0.5			50
83DDA0031	1	406500	6306500		23		0.1		2			1.2			25.80	4.40	0.5			50
83DDA0032	1	405000	6300500		10		0.2		2			0.8			16.00	2.70	0.5			50
83DDA0034	1	400500	6313500		10		0.05		2			0.9			21.70	3.60	0.5			50
83DDA0035	1	399500	6316500		10		0.4		2			0.9			26.30	4.20	0.5			50
83DDA0037	1	396000	6307000		10		0.05		2			0.9			22.70	3.60	0.5			50
83DDA0038	0	399000	6301000		10		0.05		2			1.3			62.40	8.50	0.5			50
83DDA0040	0	388500	6316500		21		0.1		3			1.8			97.00	11.00	3			50
83DDA0041	1	385000	6313500		10		0.05		2			0.7			20.80	3.50	1			50
83DDA0042	1	387500	6307000		10		0.1		2			0.8			31.70	4.20	0.5			50
83DDA0043	1	384000	6299000		10		0.05		2			0.8			19.00	3.60	0.5			50
83DDA0044	1	377500	6317500		10		0.05		2			0.8			22.00	3.80	1			50
83DDA0045	1	371500	6318000		10		0.05		2			0.7			25.60	4.30	0.5			50
83DDA0046	1	368500	6318000		10		0.05		2			0.9			29.60	4.60	0.5			50

Gold in Heavy Mineral Concentrates

File name: AuHeav.dat
Geological Survey of Canada, Terrain Sciences Division
NW Manitoba Data Base, UTM Grid Zone 14
Heavy Mineral Concentrates prepared by Overburden Drilling Management Limited
Gold grain counts - Overburden Drilling Management Limited
Geochemical analyses, fire assay followed by atomic absoprtion - Bondar Clegg and Chemex Labs

Table Feed - weight of <10 mesh sample passed over shaker table
Weight - weight of heavy concentrate retreived after heavy liquid separation
Au (ppb) - Au content determined by geochemical analysis
Below detection - 1 indicates value below detection for sample weight analyzed, concentration recorded is 1/2 detection limit;
no entry in this column indicates Au concentration above detection limit
V. G. - visible gold
Shape - shape of gold grains; d = delicate, i = irregular, a = abraded
V. G. ppb - estimated concentration of Au based on number and size of gold grains

Sample	Easting	Northing	Table feed (kg)	Weight (gr)	Au ppb FA/AA	Below Detection	V.G. (# grains)	Shape	VG ppb (est.)	Remarks
83dda0302	373850	6299850	1.9	6	105					
83dda0303	373850	6299850	2	8.2	35					
83dda0304	373850	6299850	2.4	6.8	90					
83dda0305	373850	6299850	1.9	1.3	65					
83dda0306	373850	6299850	1.7	5.1	85					
83dda0307	373850	6299850	1.3	2.9	255					
83dda0363	409050	6294100	1.5	6.8	200					
83dda0364	409050	6294100	1.5	5	85					
83dda0365	409050	6294100	1.5	7.5	75					
83dda0366	409050	6294100	1.7	7.1	40					
83dda0367	409050	6294100	1.3	6.9	45					
83dda0368	409050	6294100	1.9	11.7	30					
83dda0369	409050	6294100	1.5	9.8	95					
83dda0370	409050	6294100	1.8	8.9	10					
85kda0225	451075	6253475	2.1	5.7	150					
85kda0227	462825	6256900	2.3	4.3	380		1	a	494	
85kda0270	518275	6296550	2.5	7.2	40					
85kda0278	528700	6305950	2.5	6.3	80					
85kda0282	484000	6269250	2.8	2.7	70					
85kda0290	493250	6258250	2.8	8.4	30					
85kda0293	478575	6257650	2.4	3.3	110					
85kda0294	486850	6256575	2.6	4.5	70					
85kda0300	515025	6263900	3.5	7.4	20					
85kda0303	505850	6290600	2.2	7.4	20					
85kda0354	539310	6314920	2.6	5.5	25					
85kda0409	495720	6281780	1.7	5.5	25					
85kda0418	487870	6276800	2.2	5.5	150					
85kda0434	468650	6261500	2.2	2.8	60					
85kda0435	463140	6262870	0.2	4.6						
85kda0454	552330	6322140	2.6	6.2	50					
85kda0455	558110	6327610	2.3	0.4	40					
86sda0100	392400	6233550	0.6	9.3	5	1				
86sda0101	388150	6233850	1.4	11.5	5	1				
86sda0102	391500	6228900	1.6	8.1	5	1				
86sda0105	379600	6228550	2	12.9	20					
86sda0106	392450	6233250	0.5	9.6	5	1				
86sda0107	379000	6228650	1.3	12.5	5	1				
86sda0108	377400	6228825	1.7	7.4	80					
86sda0109	377150	6228850	0.4	4.9	10	1				
86sda0110	382875	6224175	1.9	5.3	10	1				
86sda0111	382875	6224175	1.2	2.3	12.5	1				
86sda0112	382875	6224175	0.8	1.2						
86sda0113	382575	6219100	1.4	10.6	2900					
86sda0114	384775	6217225	2.3	9.1	5	1				
86sda0115	382825	6214500	1.5	8.7	190					
86sda0116	383200	6210725	2.4	13.3	5	1				
86sda0117	384450	6208600	2	8	5	1				
86sda0118	386775	6209400	2	5.1	420					
86sda0119	386775	6209400	1.4	2.2	10000		1	i	2244	

File name: Carbon.dat
Terrain Sciences Division Geological Survey of Canada
Manitoba Data Base, UTM Grid Zone 14
Calcium Carbonate Equivalent, <63um size fraction
Frequency % Carbonate Pebbles, 2 - 5.6 mm size fraction
All zero values have been assigned a value of .01%

Total Carbon = % carbon of total sample
Organic Carbon = % carbon after treatment in hot HCl
Carbonate Carbon = Total Carbon - Organic Carbon
% CaCO3 Equivalent = (Carbonate Carbon / 12) X 100

Sample	Easting	Northing	Total Carbon <63 µm	Organic Carbon <63 µm	Carbonate Carbon <63 µm	% CaCo3 Equivalent <63 µm	% Carbonate Pebbles 2 - 5.6 mm
83DDA0006	435000	6314000	0.23	0.12	0.11	0.92	
83DDA0007	430500	6315000	1.71	0.38	1.33	11.08	
83DDA0008	430500	6311000	1.21	0.96	0.25	2.08	
83DDA0009	430500	6308000	0.27	0.19	0.08	0.67	
83DDA0010	428500	6307000	0.31	0.19	0.12	1.00	
83DDA0011	430000	6302000	0.41	0.27	0.14	1.17	
83DDA0014	432000	6295500	0.28	0.20	0.08	0.67	
83DDA0016	428500	6293000	0.83	0.06	0.77	6.42	
83DDA0017	422500	6296500	0.33	0.17	0.16	1.33	
83DDA0018	424000	6303500	0.96	0.86	0.10	0.83	
83DDA0019	419000	6309000	0.15	0.03	0.12	1.00	
83DDA0021	422000	6315500	0.97	0.95	0.02	0.17	
83DDA0022	419000	6317500	0.32	0.23	0.09	0.75	
83DDA0023	414500	6311500	0.51	0.45	0.06	0.50	
83DDA0024	415000	6307000	0.05	0.05		0.01	
83DDA0025	415000	6301000	0.05	0.05		0.01	
83DDA0026	414500	6297500	0.23	0.16	0.07	0.58	
83DDA0027	410500	6298500	0.05	0.05		0.01	
83DDA0028	412500	6316000	0.23	0.08	0.15	1.25	
83DDA0029	408000	6317000	0.20	0.08	0.12	1.00	
83DDA0030	407000	6311000	2.46	2.00	0.46	3.83	
83DDA0031	406500	6306500	0.05	0.05		0.01	
83DDA0032	405000	6300500	0.05	0.05		0.01	
83DDA0033	401000	6306000	0.05	0.05		0.01	
83DDA0034	400500	6313500	0.05	0.05		0.01	
83DDA0035	399500	6316500	0.05	0.05		0.01	
83DDA0036	397500	6311000	0.15	0.04	0.11	0.92	
83DDA0037	396000	6307000	0.05	0.05		0.01	
83DDA0039	391500	6312500	0.33	0.20	0.13	1.08	
83DDA0041	385000	6313500	0.23	0.09	0.14	1.17	
83DDA0042	387500	6307000	0.05	0.05		0.01	
83DDA0043	384000	6299000	0.18	0.06	0.12	1.00	
83DDA0044	377500	6317500	0.30	0.25	0.05	0.42	
83DDA0045	371500	6318000	0.05	0.05		0.01	
83DDA0046	368500	6318000	0.05	0.05		0.01	
83DDA0049	341500	6319500	0.20	0.18	0.02	0.17	
83DDA0050	336000	6320000	2.10	1.86	0.24	2.00	
83DDA0051	329000	6320500	0.05	0.05		0.01	
83DDA0052	321000	6320500	0.05	0.05		0.01	
83DDA0054	320500	6311000	0.42	0.32	0.10	0.83	
83DDA0055	326000	6311500	0.05	0.05		0.01	
83DDA0057	338500	6312000	0.05	0.05		0.01	
83DDA0058	345500	6311500	0.12	0.06	0.06	0.50	
83DDA0059	354500	6309500	0.05	0.05		0.01	
83DDA0060	368500	6304000	0.05	0.05		0.01	
83DDA0062	357000	6304500	0.05	0.05		0.01	

Sample	Easting	Northing	Total Carbon <63 µm	Organic Carbon <63 µm	Carbonate Carbon <63 µm	% CaCo3 Equivalent <63 µm	% Carbonate Pebbles 2 - 5.6 mm
83DDA0063	351000	6302500	0.05	0.05		0.01	
83DDA0064	346500	6302500	0.11	0.05	0.06	0.50	
83DDA0065	341500	6301000	0.05	0.05		0.01	
83DDA0066	336000	6302000	0.05	0.05		0.01	
83DDA0068	325000	6303000	0.18	0.13	0.05	0.42	
83DDA0069	320500	6302500	0.05	0.05		0.01	
83DDA0070	317500	6306000	0.05	0.05		0.01	
83DDA0071	325000	6308000	0.23	0.08	0.15	1.25	
83DDA0072	336000	6307500	0.05	0.05		0.01	
83DDA0074	350500	6317000	0.21	0.15	0.06	0.50	
83DDA0076	354000	6294500	0.05	0.05		0.01	
83DDA0077	347000	6296000	0.05	0.05		0.01	
83DDA0078	340000	6299000	0.05	0.05		0.01	
83DDA0079	334000	6296000	0.27	0.23	0.04	0.33	
83DDA0081	317500	6293000	0.05	0.05		0.01	
83DDA0082	323000	6292000	0.05	0.05		0.01	
83DDA0083	330500	6290000	0.38	0.27	0.11	0.92	
83DDA0084	338500	6290500	0.14	0.06	0.08	0.67	
83DDA0085	350000	6290000	0.05	0.05		0.01	
83DDA0086	370000	6289000	0.62	0.54	0.08	0.67	
83DDA0088	383500	6289500	0.05	0.05		0.01	
83DDA0090	389000	6289000	0.05	0.05		0.01	
83DDA0091	401000	6288000	0.05	0.05		0.01	
83DDA0092	346000	6289000	0.05	0.05		0.01	
83DDA0093	335000	6286500	0.27	0.19	0.08	0.67	
83DDA0095	323500	6280000	0.05	0.05		0.01	
83DDA0096	331500	6280000	0.05	0.05		0.01	
83DDA0097	332000	6271500	0.05	0.05		0.01	
83DDA0098	342500	6269000	0.05	0.05		0.01	
83DDA0099	342500	6269000	0.05	0.05		0.01	
83DDA0100	342500	6269000	0.05	0.05		0.01	2.00
83DDA0101	342500	6269000	0.05	0.05		0.01	
83DDA0102	342500	6269000	0.05	0.05		0.01	
83DDA0103	342500	6269000	0.05	0.05		0.01	
83DDA0104	342500	6269000	0.05	0.05		0.01	
83DDA0105	342500	6269000	0.15	0.09	0.06	0.50	
83DDA0106	358500	6271500	0.05	0.05		0.01	
83DDA0107	359500	6280500	0.05	0.05		0.01	
83DDA0108	369000	6281000	0.05	0.05		0.01	
83DDA0111	345000	6261500	0.05	0.05		0.01	
83DDA0112	338000	6263000	0.21	0.13	0.08	0.67	
83DDA0113	331500	6266000	0.05	0.05		0.01	
83DDA0114	327000	6274500	0.05	0.05		0.01	
83DDA0115	316500	6274500	0.05	0.05		0.01	
83DDA0117	321000	6265000	0.22	0.12	0.10	0.83	
83DDA0118	318500	6256500	1.09	0.80	0.29	2.42	
83DDA0119	326000	6261500	0.17	0.13	0.04	0.33	
83DDA0120	321000	6276000	0.05	0.05		0.01	
83DDA0122	328000	6254500	1.07	0.81	0.26	2.17	
83DDA0123	334000	6256500	0.11	0.11		0.01	
83DDA0124	338500	6258000	0.05	0.05		0.01	
83DDA0125	396000	6281500	0.35	0.20	0.15	1.25	
83DDA0126	402000	6281500	0.05	0.05		0.01	
83DDA0128	412500	6281000	0.05	0.05		0.01	
83DDA0129	417500	6288000	0.40	0.04	0.36	3.00	
83DDA0130	417500	6288000	0.05	0.05		0.01	
83DDA0131	424000	6283000	0.55	0.40	0.15	1.25	
83DDA0132	436000	6284000	0.36	0.14	0.22	1.83	
83DDA0136	368000	6274500	0.05	0.05		0.01	

File Name: Striae.dat
Terrain Sciences Division Geological Survey of Canada
NW Manitoba Data Base, UTM Grid Zone 14
Striation Location and Description

Definition 1 - well defined
2 - poorly defined

Sense 1 - known
2 - unknown

Age 0 - no age relationship
1 - oldest
2 - younger
3 - youngest

Sample	Zone	Easting	Northing	NTS	Direction	Definition	Sense	Age
83DDA5000	14	318000	6314000	64C	182	1	1	0
83DDA5001	14	404500	6269000	64C	192	1	1	0
83DDA5002	14	356500	6262000	64C	192	1	1	0
83DDA5003	14	391500	6256000	64C	182	1	1	0
83DDA5004	14	360000	6249500	64C	197	1	1	0
83DDA5004	14	360000	6249500	64C	192	1	1	0
83DDA5006	14	360250	6316850	64C	192	1	1	0
83DDA5007	14	361600	6316850	64C	182	1	1	0
83DDA5008	14	337150	6274700	64C	182	1	1	0
83DDA5009	14	344150	6279650	64C	187	1	1	0
84DDA5000	14	316300	6241700	64C	214	1	1	0
84DDA5001	14	409000	6236500	64C	152	1	1	0
84DDA5002	14	414700	6238400	64C	147	1	1	0
84DDA5003	14	412500	6230900	64C	157	1	1	0
84DDA5004	14	396000	6232400	64C	177	1	1	0
84DDA5005	14	380600	6231400	64C	157	1	1	0
84DDA5005	14	380600	6231400	64C	162	1	1	0
84DDA5007	14	342800	6225000	64C	187	1	1	0
84DDA5008	14	402000	6226400	64C	162	1	1	0
84DDA5009	14	411700	6223800	64C	147	1	1	0
84DDA5010	14	415600	6224100	64C	147	1	1	0
84DDA5011	14	421300	6230800	64C	157	1	1	0
84DDA5012	14	423600	6222300	64C	162	1	1	0
84DDA5012	14	423600	6222300	64C	157	1	1	0
84DDA5014	14	427800	6217500	64C	162	1	1	0
84DDA5015	14	405000	6217400	64C	152	1	1	0
84DDA5016	14	385900	6217900	64C	177	1	1	0
84DDA5017	14	377200	6218100	64C	177	1	1	0
84DDA5018	14	336300	6211300	64C	192	1	1	0
84DDA5019	14	360100	6210200	64C	197	1	1	0
84DDA5020	14	435500	6224000	64C	252	1	1	0
84DDA5021	14	437700	6228500	64C	217	1	1	0
84DDA5022	14	430900	6289400	64C	142	1	1	0
84DDA5022	14	430900	6289400	64C	147	1	1	0
84DDA5024	14	429200	6289600	64C	162	2	1	0
84DDA5025	14	425500	6290800	64C	152	1	1	0
84DDA5025	14	425500	6290800	64C	162	1	1	0
84DDA5027	14	418700	6293800	64C	142	1	1	0
84DDA5027	14	418700	6293800	64C	147	1	1	0
84DDA5029	14	412100	6294700	64C	162	2	1	0
84DDA5030	14	419500	6322000	64F	167	1	1	0
84DDA5031	14	364650	6309325	64C	202	1	1	0
84DDA5032	14	363625	6310750	64C	180	1	1	0
84DDA5033	14	363650	6312000	64C	147	1	1	0
84DDA5034	14	363425	6313600	64C	202	1	1	0
84DDA5035	14	362775	6315625	64C	167	1	1	0
84DDA5036	14	362050	6316150	64C	132	1	1	0
84DDA5037	14	361200	6316750	64C	187	1	1	0
84DDA5038	14	359810	6316775	64C	147	1	1	0
84DDA5039	14	359175	6316750	64C	157	1	1	0
84DDA5040	14	357825	6328300	64F	187	1	1	0
84DDA5041	14	353450	6328725	64F	152	1	1	0
84DDA5042	14	340700	6329300	64F	182	1	1	0
84DDA5043	14	337950	6279300	64C	190	1	1	0
84DDA5044	14	342850	6279550	64C	182	1	1	0
84DDA5044	14	342850	6279550	64C	172	1	1	0
84DDA5044	14	342850	6279550	64C	190	1	1	0
84DDA5047	14	348900	6281200	64C	180	1	1	0
84DDA5048	14	351350	6283350	64C	177	1	1	0
84DDA5049	14	357050	6286500	64C	212	2	1	0
84DDA5050	14	369850	6296250	64C	192	1	1	0
84DDA5050	14	369850	6296250	64C	152	1	1	0
84KDA5053	14	325725	6332400	64F	202	1	1	0
84KDA5053	14	325725	6332400	64F	192	1	1	0
84KDA5055	14	325725	6332400	64F	207	1	1	0
84KDA5056	14	320910	6330050	64F	204	1	1	0
84KDA5056	14	320910	6330050	64F	204	1	1	0
84KDA5057	14	319250	6330600	64F	207	1	1	0
84KDA5058	14	430700	6289500	64C	177	1	1	2
84KDA5058	14	430700	6289500	64C	212	1	1	1
84KDA5058	14	430700	6289500	64C	172	1	1	2
84KDA5061	14	429200	6289400	64C	147	1	1	0
84KDA5061	14	429200	6289400	64C	162	1	1	0

Sample	Zone	Easting	Northing	NTS	Direction	Definition	Sense	Ag
84KDA5063	14	425400	6290800	64C	202	1	1	0
84KDA5063	14	425400	6290800	64C	157	1	1	0
84KDA5063	14	425400	6290800	64C	217	1	1	0
84KDA5066	14	418000	6292300	64C	147	1	1	2
84KDA5066	14	418000	6292300	64C	207	1	1	1
84KDA5068	14	413600	6293300	64C	162	1	1	0
84KDA5068	14	413600	6293300	64C	162	1	1	0
84KDA5068	14	413600	6293300	64C	162	1	1	0
84KDA5068	14	413600	6293300	64C	152	1	1	0
84KDA5072	14	399350	6294750	64C	182	1	1	0
84KDA5072	14	399350	6294750	64C	197	1	1	0
84KDA5072	14	399350	6294750	64C	177	1	1	0
84KDA5075	14	396300	6299050	64C	172	1	1	0
84KDA5075	14	396300	6299050	64C	192	1	1	0
84KDA5075	14	396300	6299050	64C	182	1	1	0
84KDA5078	14	396500	6299000	64C	187	1	1	0
84KDA5078	14	396500	6299000	64C	219	1	1	0
84KDA5078	14	396500	6299000	64C	192	1	1	0
84KDA5078	14	396500	6299000	64C	187	1	1	0
84KDA5082	14	392450	6300150	64C	187	1	1	0
84KDA5082	14	392450	6300150	64C	187	1	1	0
84KDA5082	14	392450	6300150	64C	222	1	1	0
84KDA5082	14	392450	6300150	64C	197	1	1	0
84KDA5086	14	388500	6302000	64C	197	1	1	0
84KDA5087	14	378700	6303900	64C	192	2	1	0
84KDA5087	14	378700	6303900	64C	207	2	1	0
84KDA5089	14	421500	6290500	64C	202	1	1	0
84KDA5089	14	421500	6290500	64C	162	2	1	0
84KDA5091	14	424250	6281000	64C	137	1	1	0
84KDA5091	14	424250	6281000	64C	162	1	1	0
84KDA5091	14	424250	6281000	64C	152	1	1	0
84KDA5094	14	426750	6274120	64C	152	1	1	0
84KDA5094	14	426750	6274120	64C	147	1	1	0
84KDA5096	14	419875	6268120	64C	162	1	1	0
84KDA5096	14	419875	6268120	64C	162	1	1	0
84KDA5098	14	419750	6252000	64C	172	1	1	0
84KDA5098	14	419750	6252000	64C	167	1	1	0
84KDA5100	14	395540	6254875	64C	157	1	1	0
84KDA5100	14	395540	6254875	64C	162	1	1	0
84KDA5102	14	398700	6280400	64C	177	1	1	0
84KDA5102	14	398700	6280400	64C	172	1	1	0
84KDA5104	14	381300	6246700	64C	162	1	1	0
84KDA5104	14	381300	6246700	64C	172	1	1	0
84KDA5106	14	350800	6267800	64C	187	1	1	0
84KDA5107	14	440800	6267350	64B	217	1	1	0
84KDA5108	14	442250	6266700	64B	222	1	1	0
84KDA5108	14	442250	6266700	64B	217	1	1	0
84KDA5110	14	439050	6258350	64B	257	1	1	2
84KDA5110	14	439050	6258350	64B	212	1	1	1
84KDA5110	14	439050	6258350	64B	257	1	1	2
84KDA5113	14	426200	6259450	64B	227	1	1	0
84KDA5113	14	426200	6259450	64B	227	1	1	0
84KDA5113	14	426200	6259450	64B	227	1	1	0
84KDA5113	14	426200	6259450	64B	227	1	1	0
84KDA5117	14	448500	6258350	64B	217	1	1	0
84KDA5117	14	448500	6258350	64B	192	1	1	0
84KDA5117	14	448500	6258350	64B	227	1	1	0
84KDA5120	14	377500	6313250	64C14	202	1	1	0
84KDA5120	14	377500	6313250	64C14	212	1	1	0
84KDA5122	14	375300	6322000	64F	197	1	1	0
84KDA5123	14	371600	6331900	64F	172	1	1	0
84KDA5124	14	380500	6343000	64F	192	1	1	0
84KDA5124	14	380500	6343000	64F	192	1	1	0
84KDA5124	14	380500	6343000	64F	187	1	1	0
84KDA5127	14	381000	6353200	64F	192	1	1	0
84KDA5127	14	381000	6353200	64F	192	1	1	0
84KDA5127	14	381000	6353200	64F	192	1	1	0
84KDA5130	14	382000	6361800	64F	197	1	1	0
84KDA5130	14	382000	6361800	64F	202	1	1	0
84KDA5132	14	390000	6368600	64F	197	2	1	0
84KDA5132	14	390000	6368600	64F	192	2	1	0
84KDA5134	14	391500	6377800	64F	192	1	1	0
84KDA5134	14	391500	6377800	64F	192	1	1	0
84KDA5136	14	396600	6387700	64F	197	1	1	0
84KDA5136	14	396600	6387700	64F	197	1	1	0
84KDA5138	14	394300	6401000	64F	192	1	1	0
84KDA5139	14	349500	6415800	64F	232	1	1	0
84KDA5140	14	346500	6407900	64F	212	1	1	0
84KDA5140	14	346500	6407900	64F	202	1	1	0
84KDA5140	14	346500	6407900	64F	212	1	1	0
84KDA5140	14	346500	6407900	64F	212	1	1	0
84KDA5144	14	341900	6400000	64F	212	1	1	0
84KDA5144	14	341900	6400000	64F	212	1	1	0
84KDA5144	14	341900	6400000	64F	212	1	1	0
84KDA5147	14	336700	6391500	64F	217	1	1	0
84KDA5147	14	336700	6391500	64F	212	1	1	0
84KDA5147	14	336700	6391500	64F	217	1	1	0
84KDA5150	14	329400	6383300	64F	217	1	1	0
84KDA5150	14	329400	6383300	64F	212	1	1	0
84KDA5150	14	329400	6383300	64F	217	1	1	0

Lithologic Codes (from Garrett, 1974, GSC Paper 74-52)

SRPN	SERPENTINITE
SNKN	SHONKINITE
SDCG	SODIC•GRANITE
SPSR	SPESSARTITE = MALCHITE
SPLT	SPILITE
SYNT	SYENITE
SGBR	SYENOGABBRO
TPHR	TEPHRA = VOLCANIC ASH
TPRT	TEPHRITE = FELDSPATHOIDAL BASALT
TSCN	TESCHENITE = ALKALI GABBRO
TRLT	THERALITE = NEPHELINE GABBRO
THLT	THOLEIITE
TLCB	THOLEIITIC•BASALT
TRCD	TRACHYANDESITE = LATITE
TCBL	TRACHYBASALT
TRCT	TRACHYTE
TRCL	TROCTOLITE
TDJM	TRONDJHEMITE
TUFF	TUFF
VCTF	VITRIC•TUFF
VGST	VOGESITE
VCCB	VOLCANIC•BRECCIA
WDTF	WELDED•TUFF
MPRK	METAMORPHIC•ROCK
AMPB	AMPHIBOLITE
APBG	AMPHIBOLITE•GNEISS
APBS	AMPHIBOLITE•SCHIST
ACSC	ANDALUSITE•CORDIERITE•SCHIST
ADSC	ANDALUSITE•SCHIST
AGGS	AUGEN•GNEISS
BCGL	BASIC•GRANULITE
BCSC	BASIC•SCHIST
BGNS	BIOTITE•GNEISS
BSCS	BIOTITE•SCHIST
BCMB	BRUCITE•MARBLE
CAPB	CALCAREOUS•AMPHIBOLITE
CCGC	CALCAREOUS•GREENSCHIST
CLCC	CALCSILICATE
CCCG	CALCSILICATE•GNEISS
CRCK	CHARNOCKITE
CLSC	CHLORITE•SCHIST
CARK	CORDIERITE•ANTHOPHYLLITE•ROCK
CDSC	CORDIERITE•SCHIST
DPDG	DIOPSIDE•GNEISS
DRGS	DIORITE•GNEISS
GRSC	GARNET•SCHIST
GRGS	GARNET•GNEISS
GCPS	GLAUCOPHANE•SCHIST
GNSS	GNEISS
GRNL	GRANULITE = LEPTITE
GRNG	GRANITE•GNEISS
GRCS	GREENSCHIST
HBLD	HORNBLENDITE
HBDG	HORNBLENDE•GNEISS
HBRG	HYBRID•GNEISS
JDIT	JADEITE
LPLG	LITPARLIT•GNEISS
MGGC	MAGNESIAN•GREENSCHIST
MRBL	MARBLE
MARK	META•ARKOSE
MDBS	META•DIABASE
MTDR	META•DIORITE
MGBR	META•GABBRO
MGCK	META•GREYWACKE
MSDM	META•SEDIMENT
MVCC	META•VOLCANIC
MCSC	MICA•SCHIST
MGMT	MIGMATITE
MCVS	MUSCOVITE•SCHIST
NPLG	NEPHELINE•GNEISS
ORGS	ORTHOGNEISS
PRGS	PARAGNEISS
PCSC	PELITIC•SCHIST
PLLT	PHYLLITE
QZSS	QUARTZ•SERICITE•SCHIST
QSBS	QUARTZ•SERICITE•BIOTITE•SCHIST
SCST	SCHIST
SCSC	SERICITE•SCHIST
SLMG	SILLIMANITE•GNEISS
SLTE	SLATE
SPSN	SOAPSTONE
SLSC	STAUROLITE•SCHIST
SPCS	SULPHIDIC•SCHIST
TCSC	TALC•SCHIST
HRFL	HORNFELS
ADHF	ADALUSITE•HORNFELS (C.F. CHIASTOLITE)
BCHF	BASIC•HORNFELS
CCHF	CALCSILICATE•HORNFELS = SKARN = TACTITE
CDHF	CORDIERITE•HORNFELS
SKRN	SKARN
SPSC	SPOTTED•SCHIST
SPDS	SPOTTED•SLATE
CCLS	CATACLASITE
BRCC	BRECCIA
GOUG	GOUGE
MLNT	MYLONITE
PLNT	PHYLLONITE
SMRK	SEDIMENTARY•ROCK
ANDR	ANHYDRITE
ARNT	ARENITE = PSAMMITE = SANDSTONE
ACSL	ARENACEOUS•SHALE
ARGL	ARGILLITE
AGCL	ARGILLACEOUS•LIMESTONE
AGCS	ARGILLACEOUS•SANDSTONE
ARKS	ARKOSE = ARKOSIC ARENITE
BCSL	BENTONITIC•SHALE
BMSD	BITUMINOUS•SANDSTONE = TAR SAND
BMSL	BITUMINOUS•SHALE = OIL SHALE
BCKS	BLACK•SHALE
CLCR	CALCARENITE
CLCS	CALCAREOUS•SHALE
CLCD	CALCIRUDITE
CBCS	CARBONACEOUS•SHALE
CHRT	CHERT
CIFM	CHERT•IRON•FORMATION = TACONITE
CRLM	CHERT•LIMESTONE
CLAY	CLAY
CLIR	CLAY•IRONSTONE
COAL	COAL
CGLM	CONGLOMERATE
DTMT	DIATOMITE
DLMT	DOLOMITE = DOLOSTONE
DMLM	DOLOMITIC•LIMESTONE
EVPR	EVAPORITE
FPCA	FELDSPATHIC•ARENITE (INCLUDES ARKOSE)
FPGK	FELDSPATHIC•GRAYWACKE
FPWK	FELDSPATHIC•WACKE
GRCK	GRAYWACKE
GRSD	GREENSAND
GPSM	GYPSUM
HLIT	HALITE
IRFM	IRON•FORMATION
JPRD	JASPEROID
LGNT	LIGNITE
LMSN	LIMESTONE = CALCILUTITE
LMDM	LIMEY•DOLOMI⁻ = CALC-DOLOMITE
LCAR	LITHIC•ARENITE
LCGK	LITHIC•GRAYWACKE

SRMW	STREAM◆WATER
LKWR	LAKE◆WATER
SPGW	SPRING◆WATER
WLWR	WELL◆WATER
DDHW	DIAMOND◆DRILL◆HOLE◆WATER
SMSM	STREAM◆SEDIMENT
LKSM	LAKE◆SEDIMENT
SPGS	SPRING◆SEDIMENT
HVML	HEAVY◆MINERAL
SOIL	SOIL
GLCM	GLACIAL◆MATERIAL
TILL	TILL I.E. LOCAL TILL
TPDT	TRANSPORTED◆TILL = EXOTIC TILL
GCSM	GLACIOLACUSTRINE◆SEDIMENT
EKSM	ESKER◆SEDIMENT
GSSN	GOSSAN
ROCK	ROCK
IGRK	IGNEOUS◆ROCK
ACIV	ACID◆INTRUSIVE
AEXV	ACID◆EXTRUSIVE
IMIV	INTERMEDIATE◆INTRUSIVE
IEXV	INTERMEDIATE◆EXTRUSIVE
BCIV	BASIC◆INTRUSIVE
BEXV	BASIC◆EXTRUSIVE
AKRK	ALKALIC◆ROCK
UMFC	ULTRAMAFIC
AGLM	AGGLOMERATE
ALSK	ALASKITE = LEUCOGRANITE
ALBT	ALBITITE
ALKB	ALKALI◆BASALT (C.F. HAWAIITE)
ALKG	ALKALI◆GRANITE
ALKS	ALKALI◆SYENITE (C.F. BOSTONITE)
AKDB	ALKALI◆DIABASE
ALNT	ALNOITE
ALMB	ALUMINOUS◆BASALT
ANDS	ANDESITE
AKRM	ANKARAMITE = AUGITE BASALT
ANRS	ANORTHOSITE
AGSN	AUGITE◆SYENITE
BSLT	BASALT
BSNT	BASANITE = OLIVINE TEPHRITE
BNTN	BENTONITE
BGRN	BIOTITE◆GRANITE
CMPN	CAMPTONITE
CRBN	CARBONATITE
CLPX	CLINOPYROXENITE
CRNN	CRINANITE
CLTF	CRYSTAL◆TUFF
DCIT	DACITE
DIBS	DIABASE
DORT	DIORITE
DLRT	DOLERITE
DUNT	DUNITE
ECLG	ECLOGITE
ESXT	ESSEXITE
FPPP	FELDSPAR◆PORPHYRY
FLST	FELSITE
FNIT	FENITE
FLBC	FLOW◆BRECCIA
GBBR	GABBRO
GLSS	GLASS

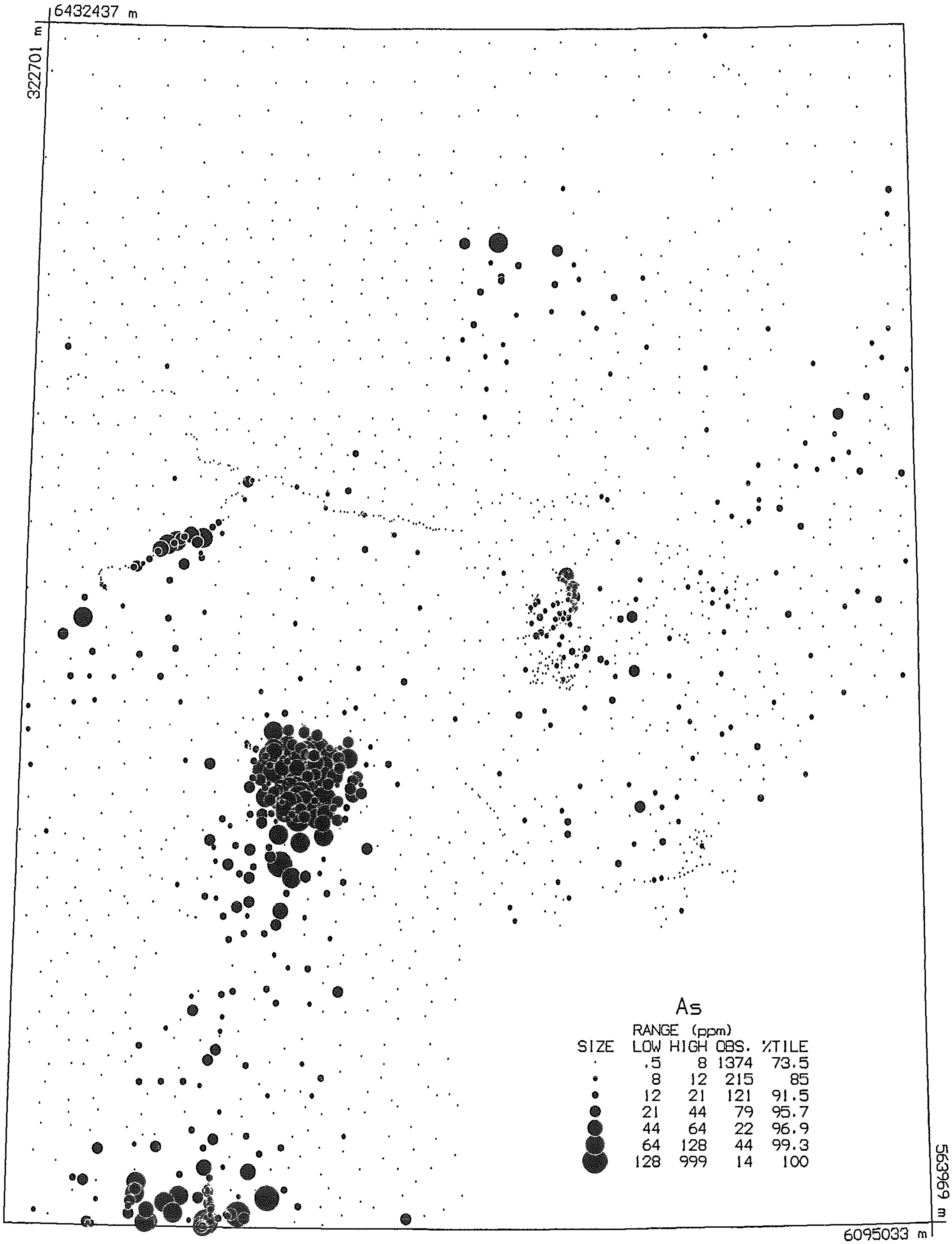
GRNT	GRANITE
GRDR	GRANODIORITE
GRPR	GRANOPHYRE
GRNS	GREENSTONE
HZBG	HARZBURGITE = SAXONITE
IJLT	IJOLITE
IGMB	IGNIMBRITE
JCPG	JACUPIRANGITE
KNLN	KENTALLENITE = MELANO-MONZONITE
KRPR	KERATOPHYRE
KRSN	KERSANTITE
KMBL	KIMBERLITE = MICA PERIDOTITE
LMPP	LAMPROPHYRE
LPTF	LAPILLI◆TUFF
LCTF	LITHIC◆TUFF
LGRT	LUGARITE
MLGN	MALIGNITE
MNTT	MINETTE
MNCQ	MONCHIQUITE = FOURCHITE
MNZN	MONZONITE = SYENODIORITE
MGRT	MUGEARITE
MCVG	MUSCOVITE◆GRANITE
NPLB	NEPHELINE◆BASALT
NPGB	NEPHELINE◆GABBRO
NPLS	NEPHELINE◆SYENITE = FOYAITE
NDMK	NORDMARKITE = QTZ ALKALI-SYENITE
NORT	NORITE
ODNT	ODINITE
OBCG	ORBICULAR◆GRANITE
OBSD	OBSIDIAN
OLVB	OLIVINE◆BASALT = PICRITE BSLT = OCEANITE
OLVD	OLIVINE◆DIORITE
OVDB	OLIVINE◆DIABASE
OVGB	OLIVINE◆GABBRO
OVNP	OLIVINE◆NEPHELINITE = NEPHELINE BASALT
OLVN	OLIVINE◆NORITE
ORPX	ORTHOPYROXENITE
OCTT	OUACHITITE
PRDT	PERIDOTITE
PRKN	PERKNITE
PNLT	PHONOLITE
PCRT	PICRITE
PLLV	PILLOW◆LAVA
PCSN	PITCHSTONE
PPBG	PORPHYROBLASTIC◆GRANITE
PCLC	PYROCLASTIC
PRXD	PYROXENE◆DIORITE
PRXN	PYROXENITE
QZBL	QUARTZ◆BASALT
QZDB	QUARTZ◆DIABASE
QRZD	QUARTZ◆DIORITE = TONALITE
QZFP	QUARTZ◆FELDSPAR◆PORPHYRY
QZGB	QUARTZ◆GABBRO
QZMZ	QUARTZ◆MONZONITE = ADAMELLITE
QRZN	QUARTZ◆NORITE
QZPP	QUARTZ◆PORPHYRY
RKVG	RAPAKIVI◆GRANITE
RDCT	RHYODACITE = QUAPTZ-LATITE = DELLENITE
RYLT	RHYOLITE
RBKG	RIEBECKITE◆GRANITE
SCOR	SCORIA

LCWK	LITHIC◆WACKE
MARL	MARL
MDSN	MUDSTONE = CLAYSTONE
NVCL	NOVACULITE
OGCG	OLIGOMICTIC◆CONGLOMERATE
ORQZ	ORTHOQUARTZITE
PLIT	PELITE = LUTITE
PSPR	PHOSPHORITE
PRCL	PORCELLANITE
PMCG	POLYMICTIC◆CONGLOMERATE
QRTZ	QUARTZITE
QZZS	QUARTZOZE◆SHALE
RUDT	RUDITE = PSEPHITE
SNDS	SANDSTONE
SPPL	SAPROPEL

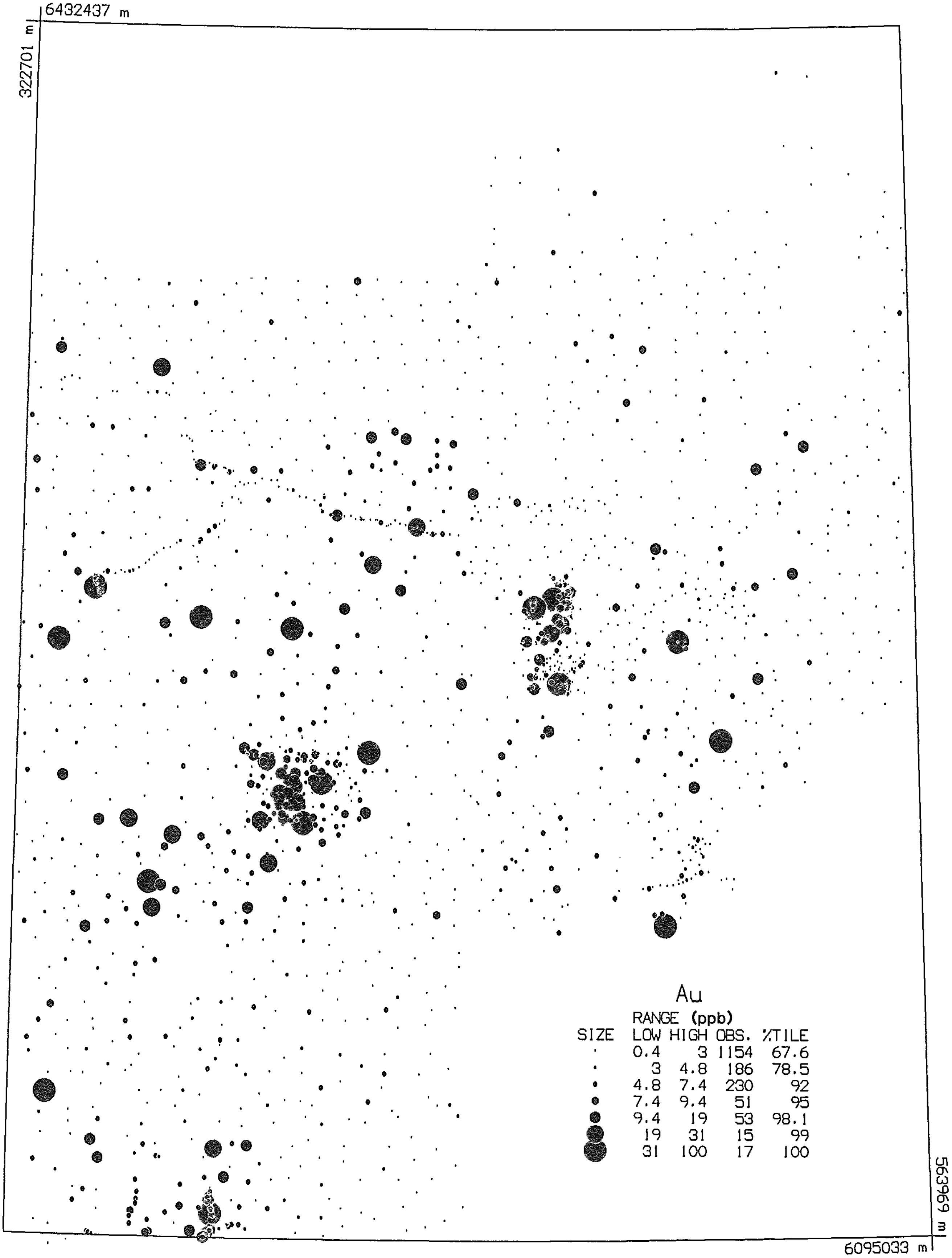
SLCS	SELENITIC◆SHALE
SHLE	SHALE
SLSN	SILTSTONE
SMDM	STROMATOLITIC◆DOLOMITE
SBGK	SUBGRAYWACKE
TLLT	TILLITE
TRVR	TRAVERTINE
WCKE	WACKE = IMPURE ARENITE
MRLZ	MINERALIZATION
MVSP	MASSIVE◆SULPHIDE
SCKK	STOCKWORK
VEIN	VEIN
ALRZ	ALTERATION◆ZONE
CNSN	CHINA◆STONE
GRSN	GREISEN

APPENDIX B

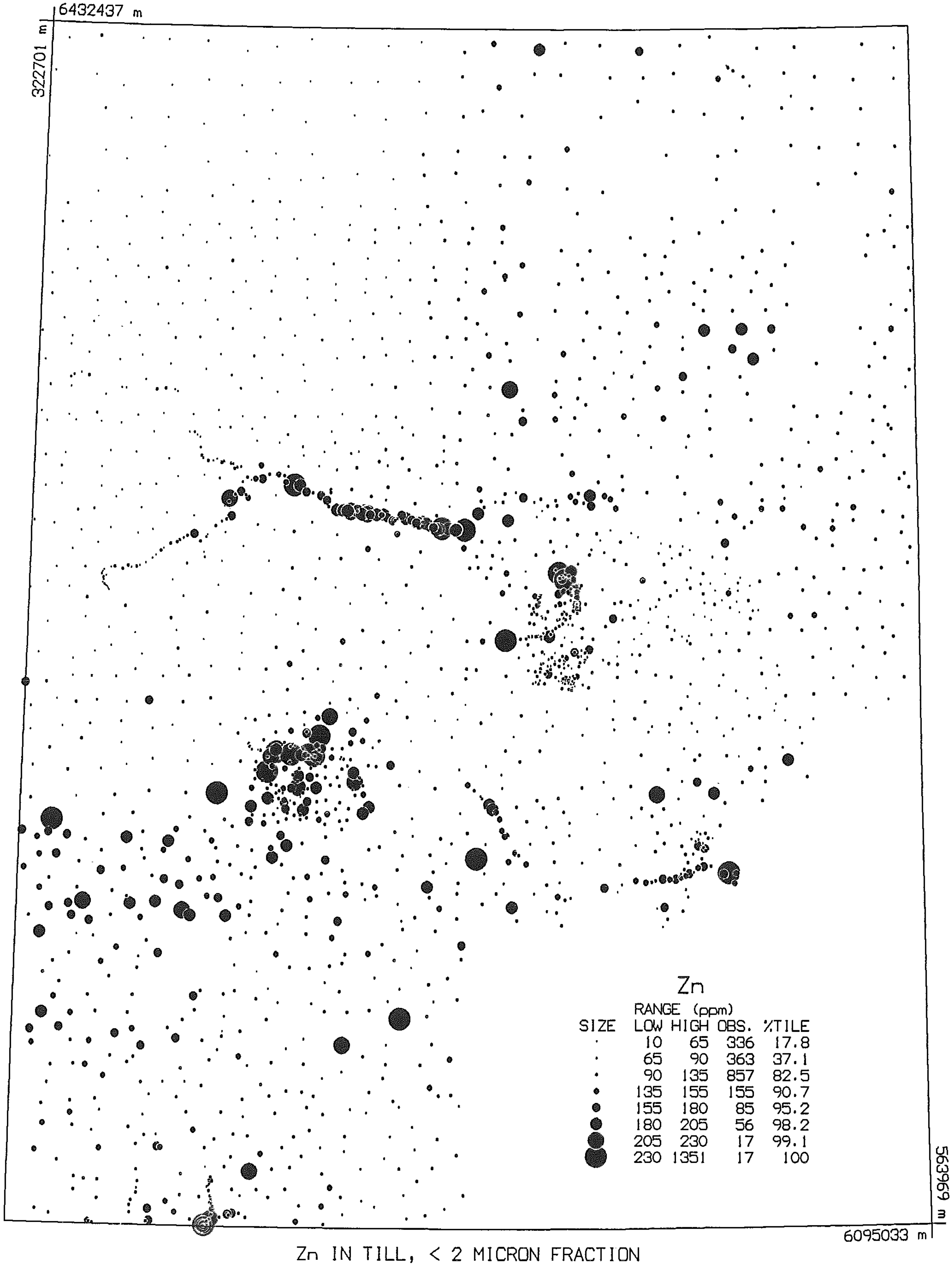
Computer Generated Dot Maps (LAZERDOT) for Selected Trace Elements (includes bedrock and topographic overlays)



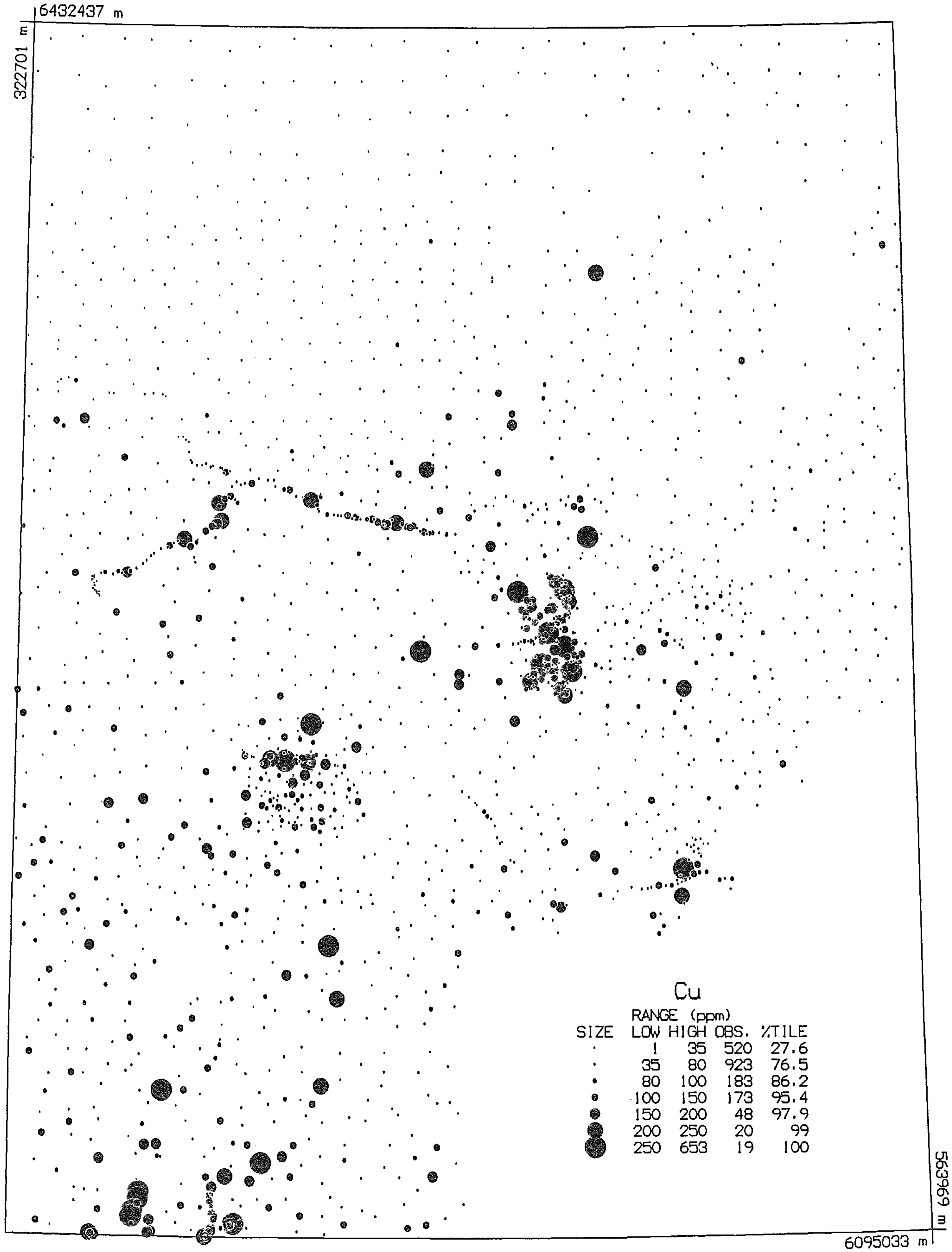
As IN TILL, < 2 MICRON FRACTION



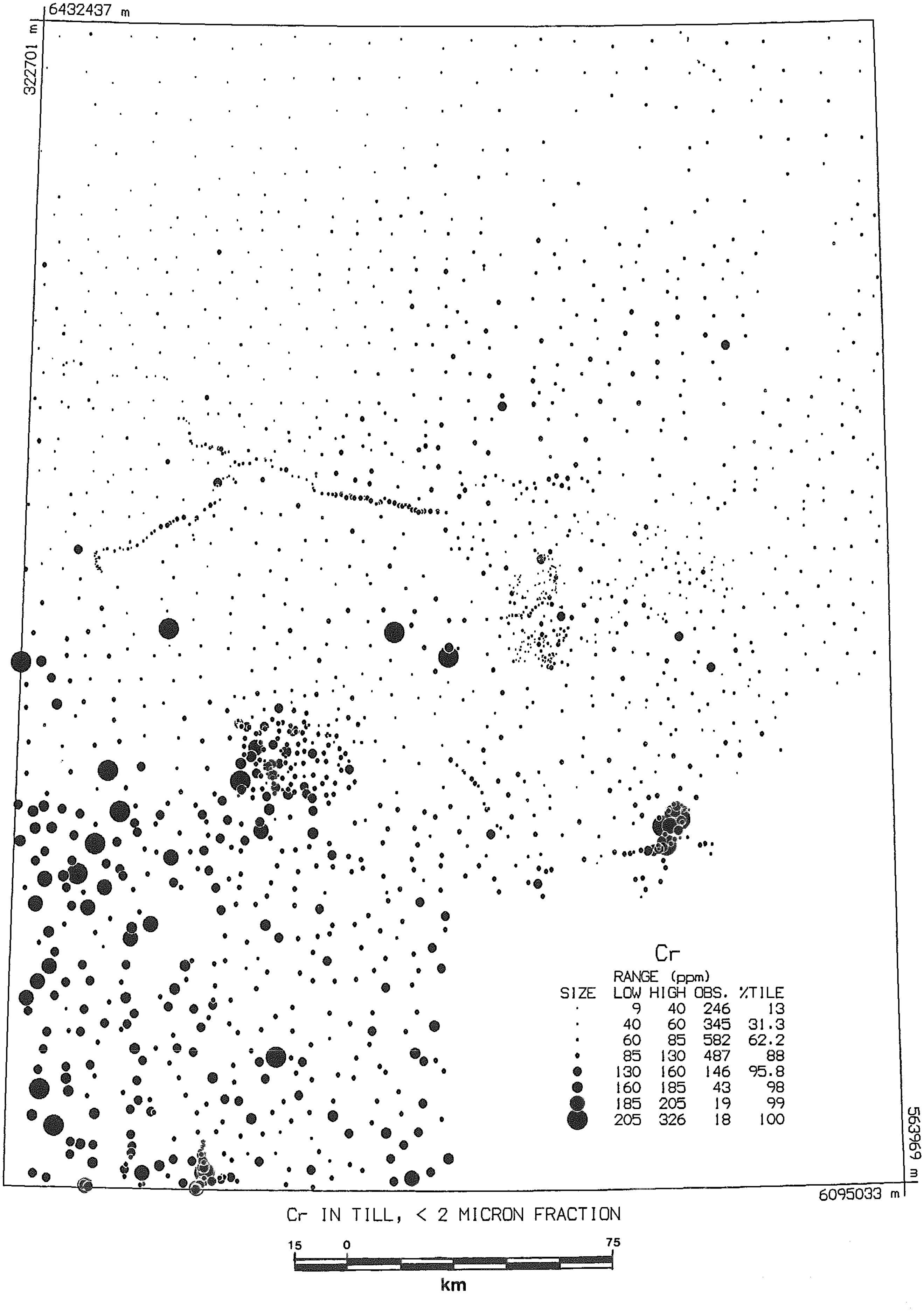
Au IN TILL, < 63 MICRON FRACTION



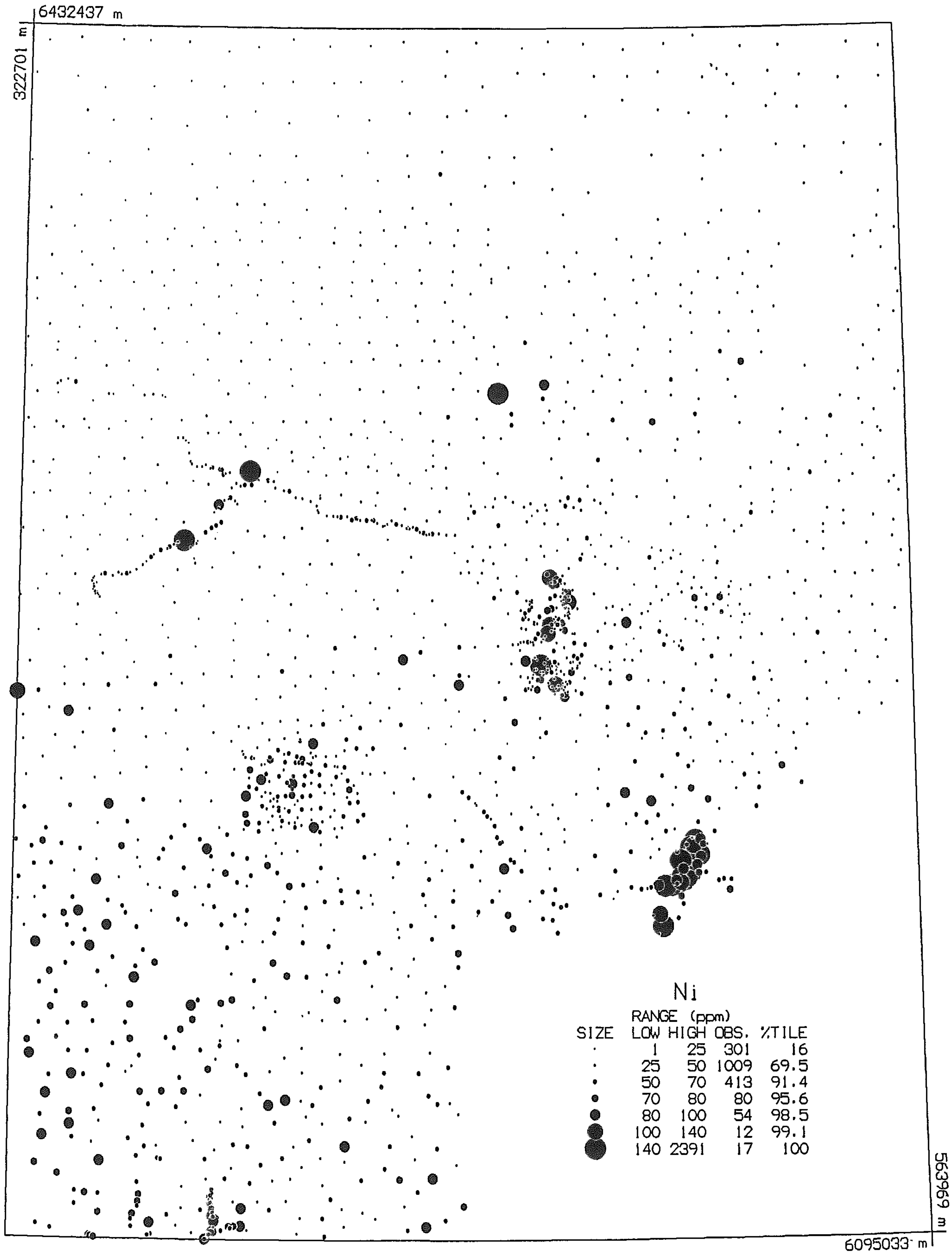
Zn IN TILL, < 2 MICRON FRACTION



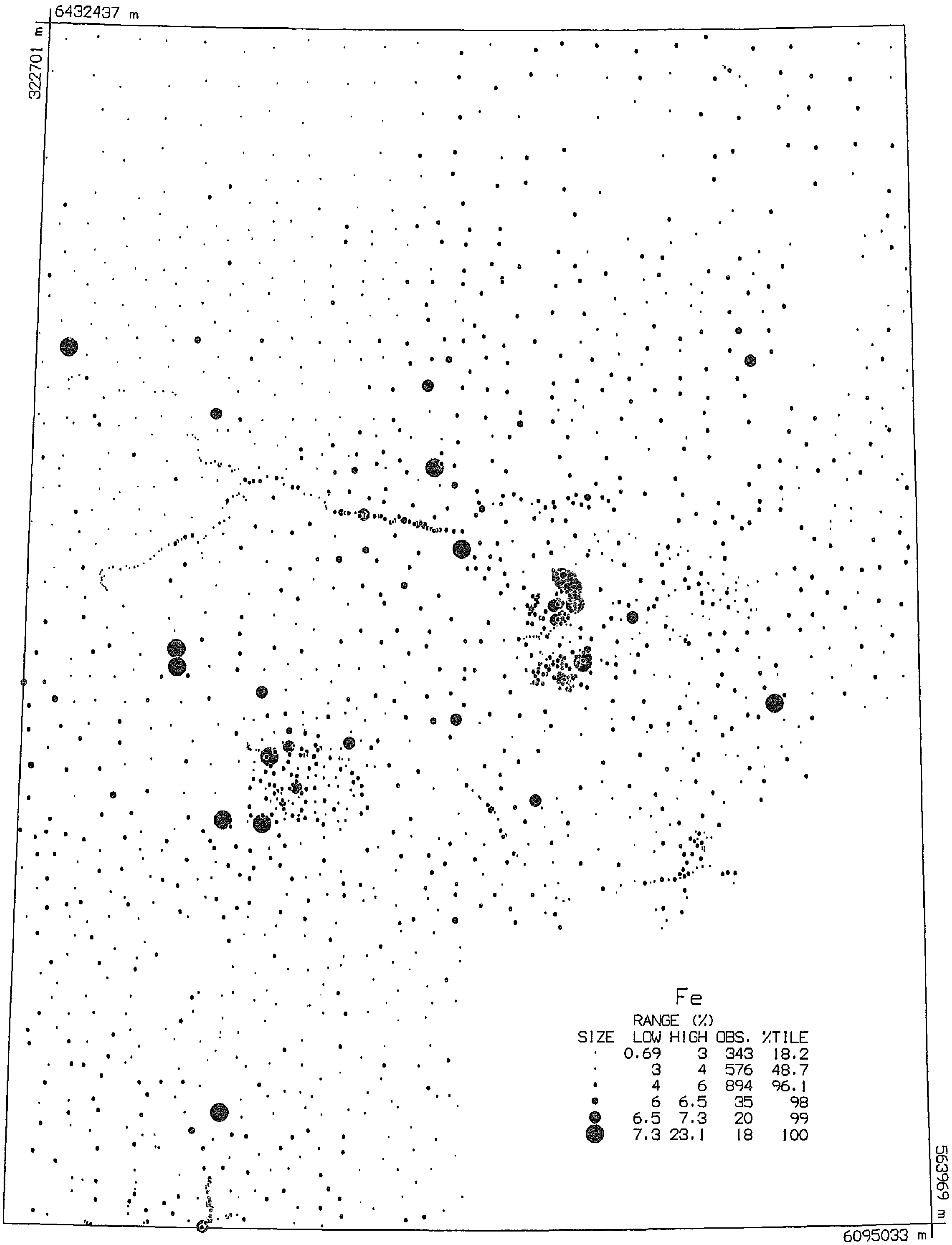
Cu IN TILL, < 2 MICRON FRACTION



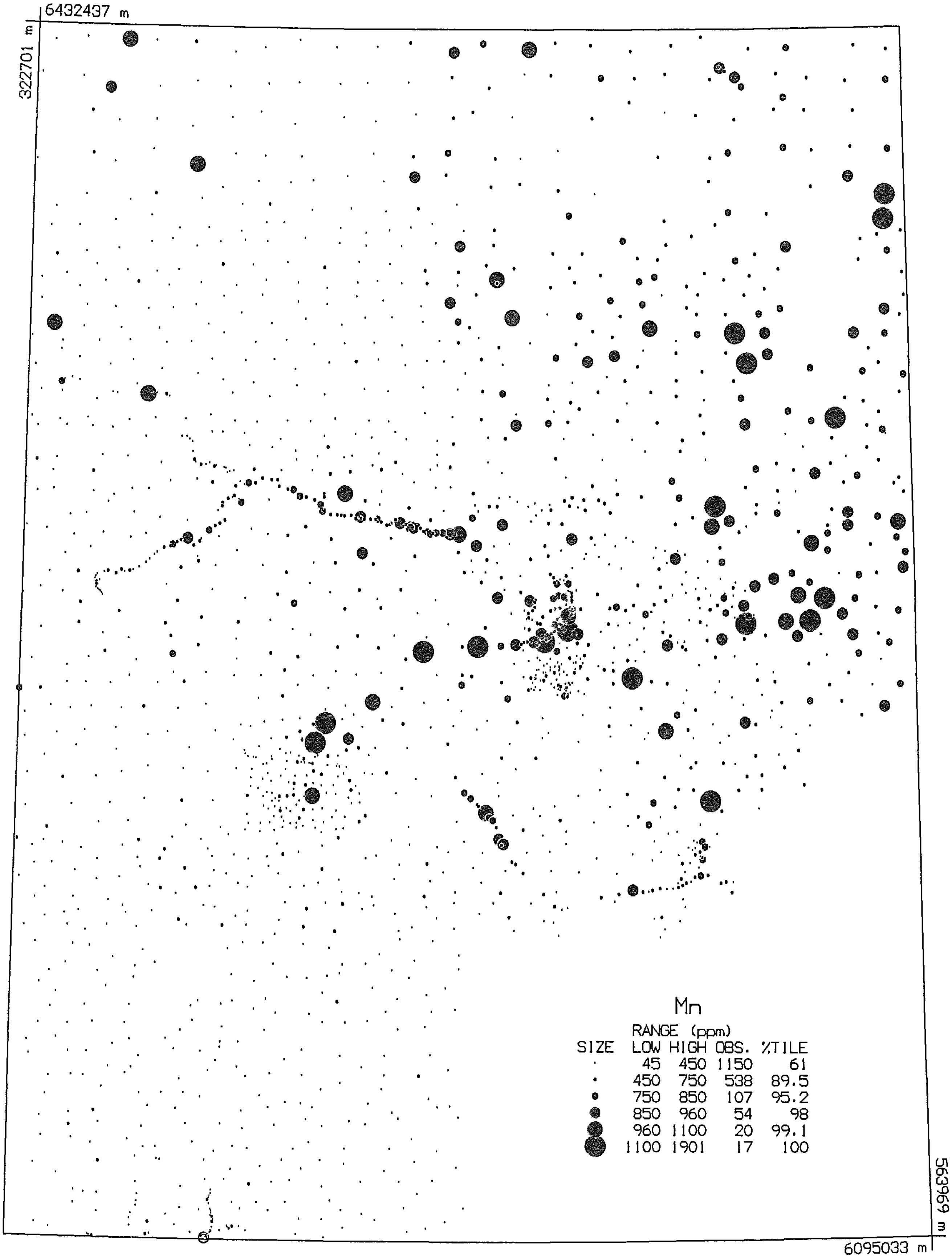
Cr IN TILL, < 2 MICRON FRACTION



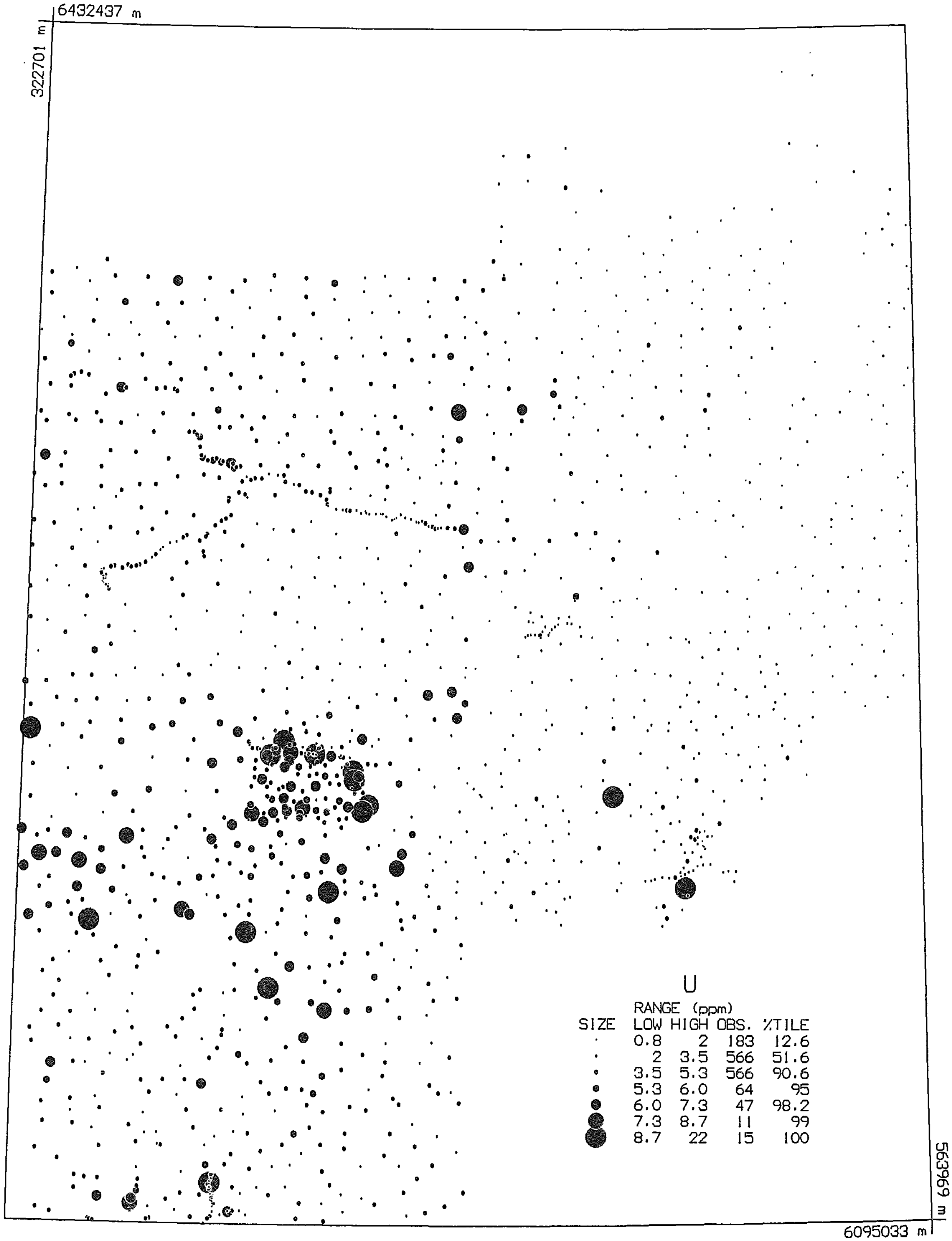
Ni IN TILL, < 2 MICRON FRACTION



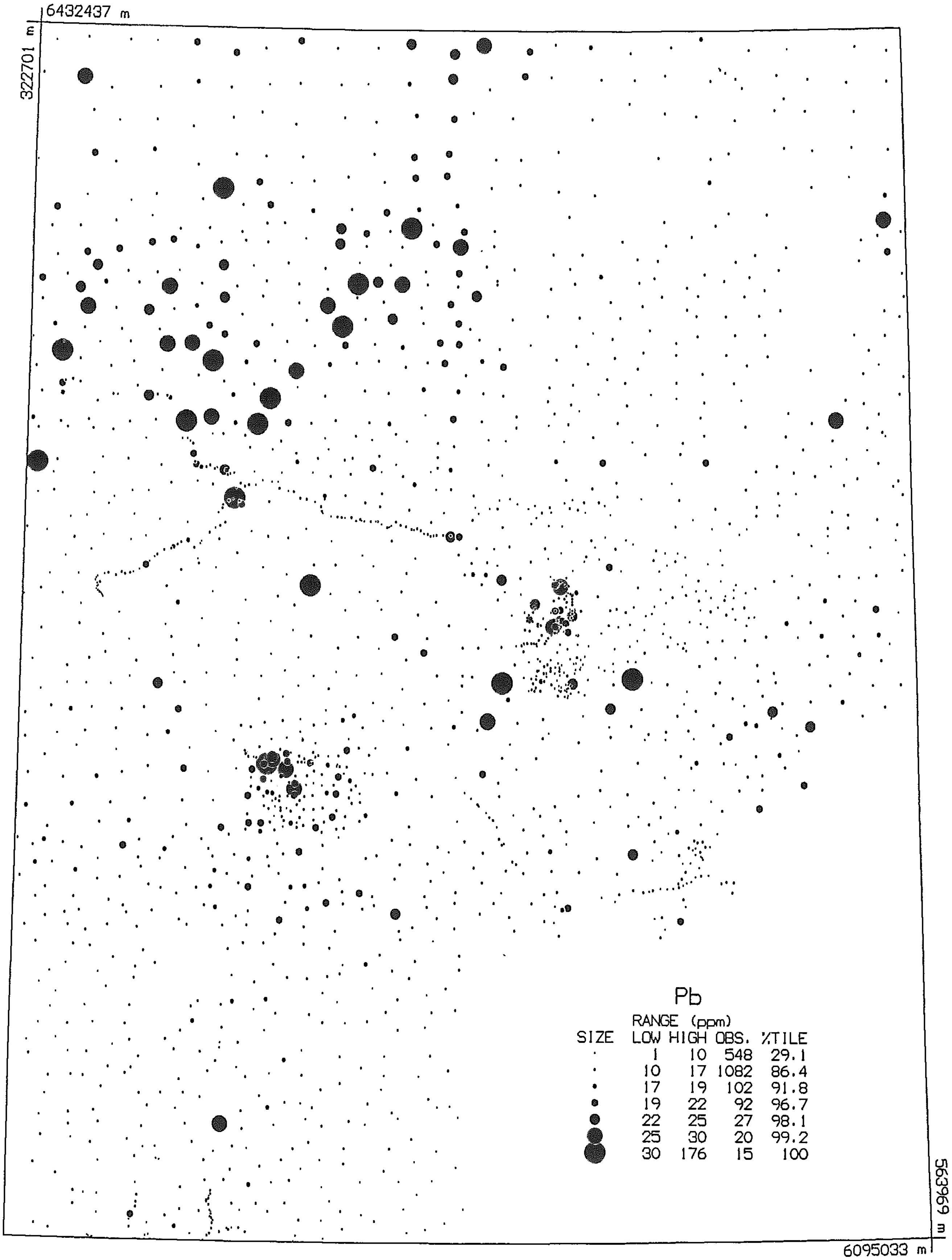
Fe IN TILL, < 2 MICRON FRACTION



Mn IN TILL, < 2 MICRON FRACTION



U IN TILL, < 63 MICRON FRACTION



Pb IN TILL, < 2 MICRON FRACTION

Reproduce this sheet as a transparency
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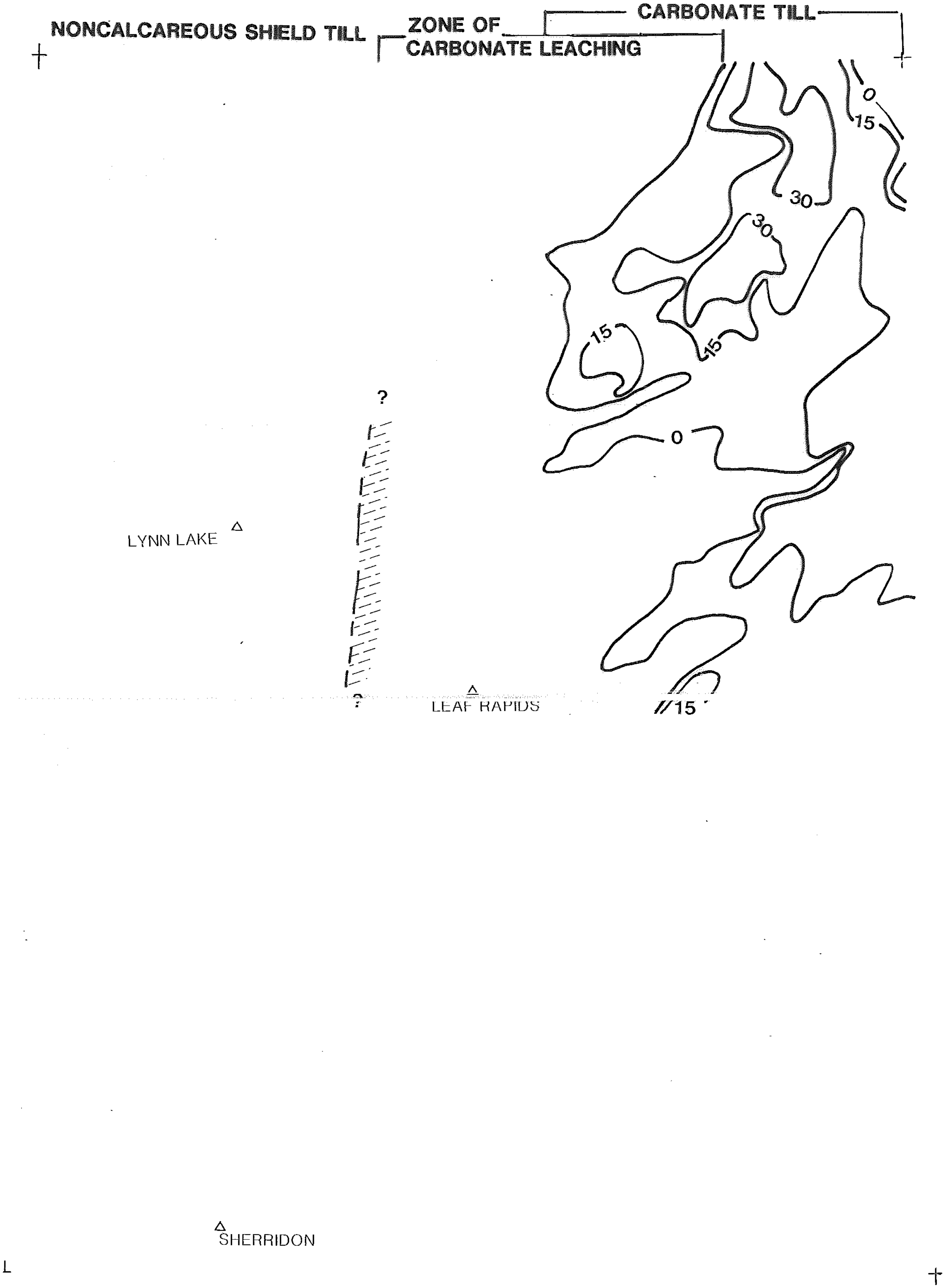

5 % carbonate pebbles 2-5.6 mm size fraction

western extent of calcareous till (approx.)

Reproduce this sheet as a transparency
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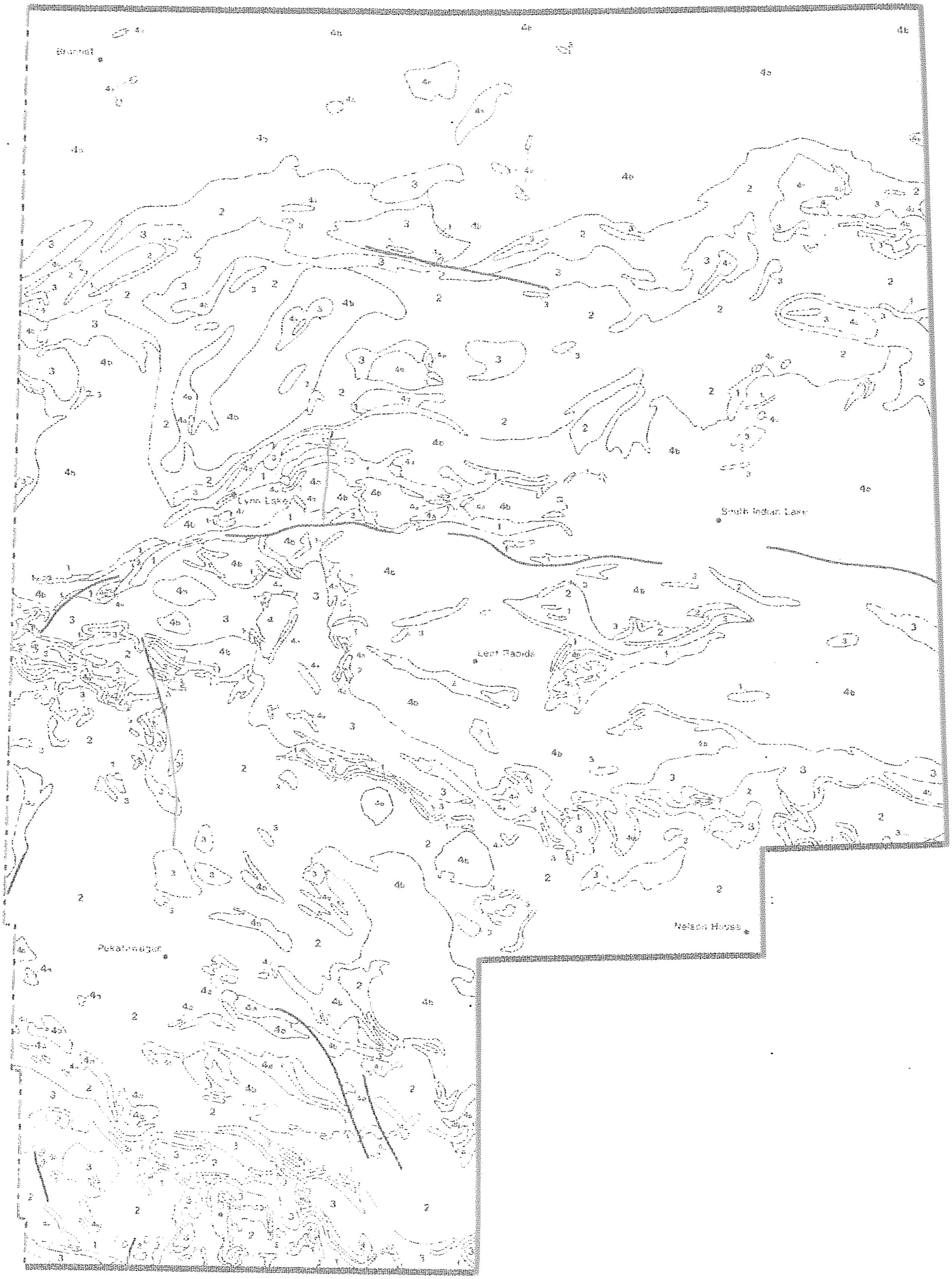

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SAMPLE LOCATION