

DRIFT PROSPECTING FOR GOLD IN THE TINTINA TRENCH

by

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ABSTRACT

Two tills and related deposits are the products of at least two ice advances over the Tintina Trench near Ross River, Yukon Territory. These ice advances are termed the McConnell and pre-McConnell glaciations. Erosional remnants provide evidence of the pre-McConnell glaciation and indicate that the ice was flowing to the west or northwest. The onset of McConnell glaciation was marked by an early ice advance out of the Lapie River valley, which was followed by a general ice flow toward the west or northwest along the Tintina Trench. During the retreat of the McConnell glacier, an ice tongue advanced up the Lapie River valley, blocking the drainage and forming a glacial lake.

To develop and apply drift prospecting techniques in the Tintina Trench, 204 till samples were collected over the study area. The silt plus clay size fraction was analysed for Au and the clay fraction was analysed for 30 elements. Only the Au, Ag, Hg and Sb results are discussed in this paper. The geochemical data for till down-ice from the Grew Creek Au-Ag mineralization (MINFILE 105K 009) show a dispersal train for gold, but not for pathfinder elements such as Ag, As, Hg and Sb. A possible relationship between Au and Tertiary volcanic rocks is illustrated. However, closer-spaced samples would have to be taken to verify this hypothesis, since the length of the Au dispersal train is about 500 m, much smaller than the sampling interval.

RÉSUMÉ

Deux tills et les sédiments qui s'y rattachent ont été produits par un moins deux avancés glaciaires dans la dépression de Tintina dans la région de Ross River au Territoire du Yukon. Ces deux avancés sont appelées glaciations de McConnell et pré-McConnell. Les seuls évidences de la Glaciation pré-McConnell sont des restants d'érosion selon lesquels la glace se serait écoulée hors de la vallée de la Rivière Lapie et au point culminant de cette glaciation l'écoulement était généralement vers le nord-ouest et l'ouest dans la dépression de Tintina. Pendant la retrait de ce lobe glaciaire, une langue de glace s'est avancée en remontant la pente dans la vallée de la Rivière Lapie ce qui créa un lac glaciaire dans cette même vallée.

Deux cent quatre échantillons de till ont été ramassés de façon à développer et appliquer les techniques de prospection à l'aide de sédiments glaciaires dans la dépression de Tintina. La fraction silt et argile a été analysée pour une série de 30 éléments. Seuls les résultats pour l'Ag, As, Hg et Sb sont discutés dans cet article. Les données géochimiques permettent de définir un train de dispersion d'or, mais pas d'argent, d'arsenic, de mercure ou d'antimoine, en aval glaciaire d'une minéralisation d'argent et d'or au Ruisseau

Grew (MINFILE 105K 009). Une relation possible entre l'or et les roches volcaniques Tertiaire est illustrée. Cependant, un échantillonnage plus serré serait nécessaire pour vérifier cette hypothèse puisque le train de dispersion d'or possède une longueur d'environ 500 m, c'est-à-dire une longueur beaucoup plus courte que la distance entre chacun des échantillons.

INTRODUCTION

The discovery of a Tertiary epithermal gold-silver prospect (MINFILE 105K 009) in the Tintina Trench, Yukon Territory, has raised interest in the potential for analogous deposits buried by drift elsewhere along this structurally controlled depression (e.g. Duke, 1986; Duke and Godwin, 1986; Jackson et al., 1986). Jackson et al. (1986) cited circumstantial evidence linking the occurrence of placer gold, ice flow directions and Tertiary volcanics along the Tintina Trench. This relationship could not be tested by conventional exploration techniques (e.g. bedrock mapping, bedrock geochemistry, geophysics) because of the locally thick and fairly continuous glacial drift cover. For that reason, a drift prospecting study was carried out. The study conducted during the summer of 1987 consisted of three components: (1) a detailed study of the Quaternary geology of the area, including stratigraphy; (2) identification of ice flow configurations through the investigation of glacial dispersal of rock fragments; and (3) the interpretation of reconnaissance geochemical mapping of gold. This paper reports the results of the drift prospecting study.

SETTING

The study area (Fig. 1) is a narrow band centred on the Tintina Trench extending from Wolverine and Finlayson Lakes to just southeast of the town of Faro. It includes parts of Quiet Lake, Finlayson Lake and Tay River NTS map sheets (105F, 105G and 105K respectively). Two major roads cross the area: the Robert Campbell Highway, along which most of the till sampling has been done, and the Canol Road. Tintina Trench is bounded by the Pelly Mountains to the southwest and the Pelly and Macmillan Plateaus to the northeast. Differences in elevation between Tintina Trench and the surrounding terrain are significant. Elevations in the Trench range from 760 to 910 m, with a few high areas reaching 1070 m. The Pelly Mountains range in elevation from 1220 to 1830 m, with the highest peak reaching 2353 m in the Wolverine Lake area. Plateau surfaces vary in elevation from 910 to 1370 m.

Economic Geology

Several bedrock mineral occurrences and placer gold deposits have been found in the study area from exploration work conducted by private companies and prospectors. Most of the detailed exploration has occurred around the Grew Creek gold-silver prospect (MINFILE 105K 009) located halfway between the towns of Faro and Ross River. Rocks

preserved in a graben at Grew Creek consist of felsic volcanic and volcanoclastic units overlain by interbedded coarse clastic sediments, basaltic flows and basaltic volcanoclastic beds (Duke, 1986; Duke and Godwin, 1986). Two zones of mineralization have been defined on the property: the Main and Tarn Zones. Intensive silicic and argillic hydrothermal alteration characterize Grew Creek mineralized rocks. High grade gold and silver mineralization occurs in chalcedonic quartz and K-feldspar veins which were intruded during volcanism (Duke and Godwin, 1986). Although both gold and silver are enriched in samples from boreholes, mineralized outcrops are characterized by high gold levels only (T. Christie, oral presentation, Geoscience Forum, Whitehorse, Yukon, 1988).

PREVIOUS WORK

Multiple glaciations in Yukon were first proposed by Bostock (1934) in the Carmacks area. Later, Bostock (1966) described two series of end moraines and other glacial deposits related to four different glacial stages: (1) the youngest McConnell glaciation (Wisconsinan age), (2) the more extensive Reid glaciation (Illinoian(?), Hughes, 1987), and (3) the oldest two pre-Reid glaciations. On the basis of air photo interpretation and limited ground observations, Hughes et al. (1969) reported that the Cordilleran Ice Sheet flowed west to northwest over the study area during the McConnell glaciation. Campbell (1967) gave the name "Selwyn Lobe" to this sector of the Cordilleran Ice Sheet. Hughes et al. (1969) suggested that: "a stage of alpine glaciation preceded the McConnell advance in mountainous areas lying within the limits of the ice sheet." Duke-Rodkin et al. (1986) reconstructed the profile of the Selwyn Lobe using the inferred McConnell age moraines and ice marginal channels associated with nunataks in the Glenlyon and Tay River map areas (105L and 105K). Jackson (1989) described the paleogeology of the Selwyn Lobe and the Quaternary stratigraphy of parts of the study area. He also mapped the regional Quaternary geology of the Pelly Mountains and Tintina Trench area (Jackson, 1986a; 1986b; 1987). Ward (1989) reported on the Quaternary stratigraphy and history of an area that extends along the Pelly River in Glenlyon and Carmacks map-areas.

QUATERNARY STRATIGRAPHY

The two most complete stratigraphic sections (Section 076 and 044) are exposed in the deeper valleys of the study area, i.e. the Pelly and Lapie River valleys. Other sections reveal key information for the Quaternary history. These sections are described below.

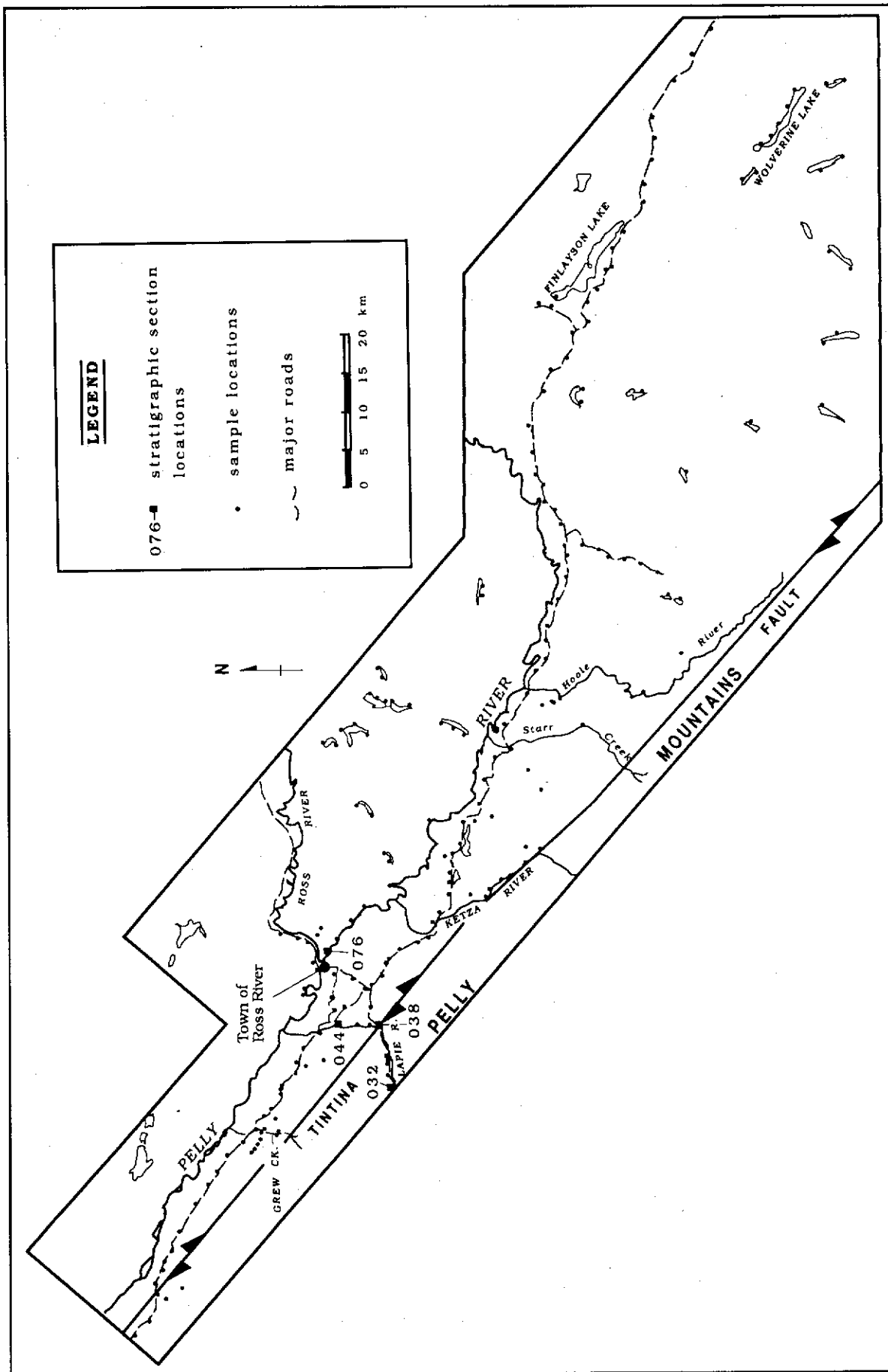


Figure 1. Location map of study area showing major stratigraphic sections and sample locations.

Section 076

This section is exposed along the Pelly River, 3 km due east of the town of Ross River (Fig. 1). Access is possible by helicopter or by motorized canoe. It has been reported by Jackson (1989) and is equivalent to his section 14686S-1.

The lowest unit exposed at this section is till deposited prior to McConnell glaciation (Fig. 2). It is overlain by glaciolacustrine sediments and horizontally stratified gravels. The gravel sequence coarsens upward, suggesting that it was deposited in front of the advancing glacial ice during McConnell glaciation. The overlying unit is the McConnell age till which is overlain essentially by the same sequence of sediments as below it: glaciolacustrine sediments and stratified gravels. These glaciolacustrine sediments are confined to the Pelly River valley and are omnipresent in sections along the river downstream from the town of Ross River. The stratified gravel above these glaciolacustrine sediments is tentatively identified as outwash gravel deposited in front of the retreating McConnell glacier on the basis of stratigraphic correlation with other exposures of outwash gravel along the Pelly River. At the top of the section, the White River Tephra (Lerbekmo et al., 1975) is exposed in a well sorted fine sand and silt unit thought to be eolian in origin.

Erratics in pre-McConnell and McConnell tills at this section include a large amount of metasediments and clastic sediments with rare ultramafic, quartz and calcareous clasts. These lithologies are interpreted as being derived from allochthons to the southeast (Tempelman-Kluit, 1977, Maps 105F and G). Since clast lithologies in the two tills are similar, ice flow directions were probably toward the west to northwest in the Pelly River valley during pre-McConnell and McConnell glaciations.

Fabrics have been measured in both tills at this section (Fig. 2 and Table 1). The a-axes of clasts are dominantly oriented northwest-southeast in the pre-McConnell till. Pebbles in the McConnell till at this site do not have an obvious preferred orientation (Table 1). This divergent orientation probably results from reworking of the drift by gravity flow after its deposition.

Section 044

Section 044 is exposed along the Lapie River, about 8 km southwest of the town of Ross River (Fig. 1). A bush road connects the top of the section with the Campbell Highway. The section was first reported by Jackson (1989), and is equivalent to his section 7686S-2.

As illustrated in Figures 2 and 3, the stratigraphy at this section is very similar to that exposed in Section 076 along the Pelly River. The oldest unit exposed is a poorly sorted, clast-supported, bouldery gravel, which is thought to be alluvial in origin. The interpretation of this unit is complicated by its relatively small exposure. A sharp erosional contact separates this gravel from the overlying pre-McConnell till. The contact between the till and the overlying outwash gravel sequence is

abrupt. The outwash deposit is characterized by numerous beds of gravel, sand and diamicton. These beds of diamicton are thought to be gravity flow deposits because they are draped over the underlying units. Two cycles were defined in the outwash gravel without any major break between the two: a fining upward sequence going from the base of the unit to the middle of it, and a coarsening upward sequence in the upper part. This suggests that these gravels were deposited during retreat of the pre-McConnell glacier and advance of the McConnell ice or simply during fluctuations of the retreating pre-McConnell ice front. They are overlain by one to two metres of McConnell till. Finally, the section is capped by another two metres of outwash gravel and sand. White River Tephra is exposed at the top of the section in colluvium.

Clastic sedimentary and metasedimentary rocks are in the same ratio and by far the most abundant lithologies in both tills at this section. These lithologies indicate a provenance to the east or southeast (Tempelman-Kluit, 1977, Maps 105F and G) during McConnell and pre-McConnell glaciations.

Four till fabrics were measured at this section (Fig. 3 and Table 1). Pebble orientations seem to be parallel and transverse to the ice flow direction inferred from till lithologies. Clasts may have been transported with the a-axes parallel to the ice-movement direction re-oriented after deposition due to deformation by the active glacier (Boulton, 1970; Amark, 1986).

Section 038

This section is exposed along the South Canal Road at the front of the Pelly Mountains (Fig. 1). At this section, the McConnell till reaches a thickness of 18 metres and is overlain by 25 metres of ice-contact gravels (Fig. 4). Abrupt contacts and rapid grain size variation between individual beds, and abundant faulting characterize the ice-contact gravels at this section.

Till pebble lithologies were identified at three levels (Fig. 4). Lithologies are mostly clastics with variable proportions of calcareous and metasedimentary clasts. The lowest part of the till is enriched in calcareous sedimentary clasts and depleted in metasedimentary clasts compared to the upper part. This stratigraphic change in lithologies within the same till unit could be explained by two hypotheses:

- (1) Ice might always have flowed parallel to the Tintina Trench, and the dominance of calcareous clasts in the lower portion simply reflects local bedrock. In other words, changes in clast lithologies could simply reflect flow lines in the glacier.
- (2) On the other hand, the lower portion of the till, which is mostly enriched in calcareous sediment, might have been deposited by a valley glacier which flowed out of Lapie River valley where the major sources of calcareous bedrock are located (Tempelman-Kluit, 1977, Map 105F).

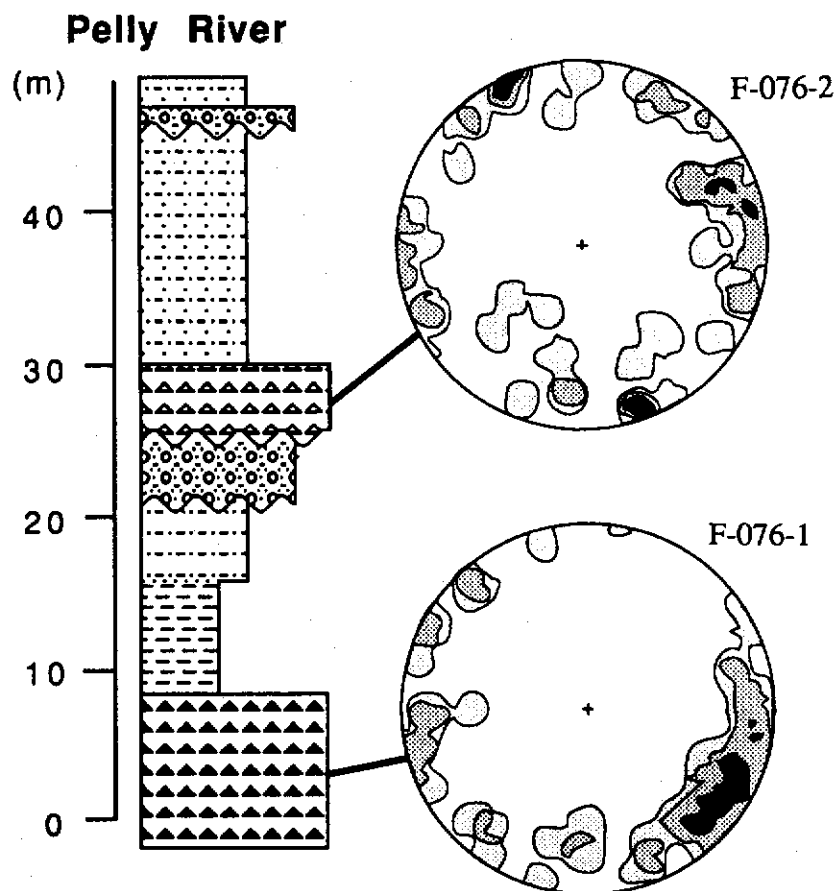
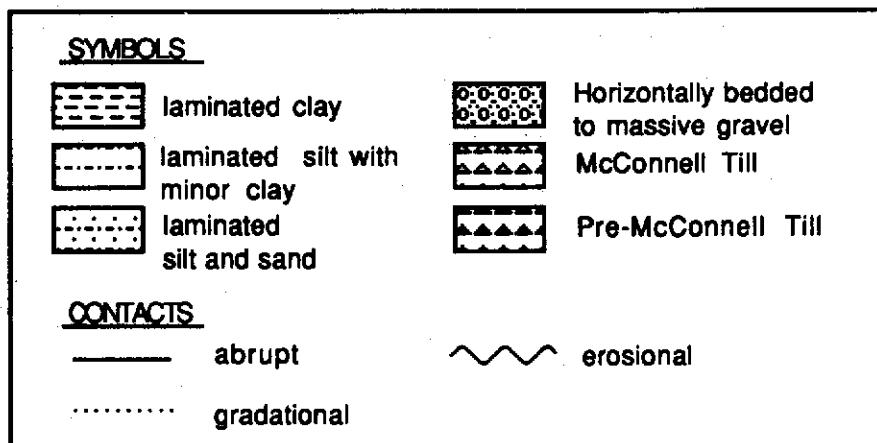


Figure 2. Stratigraphic column of section 076 with equal-area stereographic plots of long axes of stones (50 measurements in each case). See text for description.

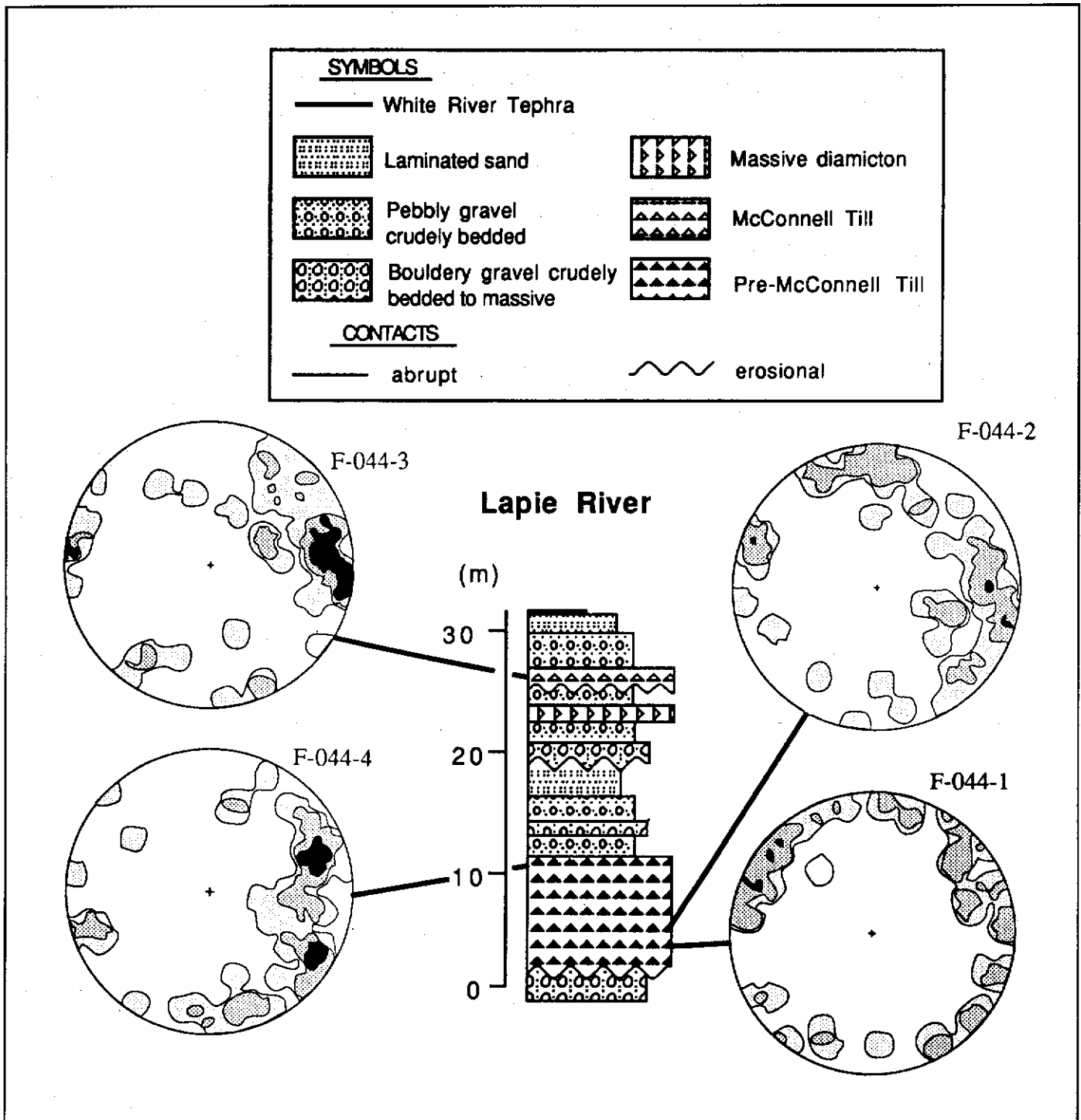


Figure 3. Stratigraphic column of section 044 with equal-area stereographic plots of long axes of stones (50 measurements in each case).

The greater abundance of metasediments in the upper part of the till could indicate a provenance from the Tintina Trench (Tempelman-Kluit, 1977, Maps 105F and G).

Till fabrics were measured at each of the three pebble sampling sites (Fig. 5 and Table 1). If clast a-axes are parallel to ice flow direction (which was the case for most

fabrics measured in the McConnell till in the Tintina Trench), the till fabrics indicate an initial ice flow out of Lapie River valley, followed by flow parallel to the Tintina Trench. This supports hypothesis (2). However, the possibility remains that the a-axes in the lower fabrics are perpendicular to the ice flow direction, whereas the a-axes in the upper fabric are

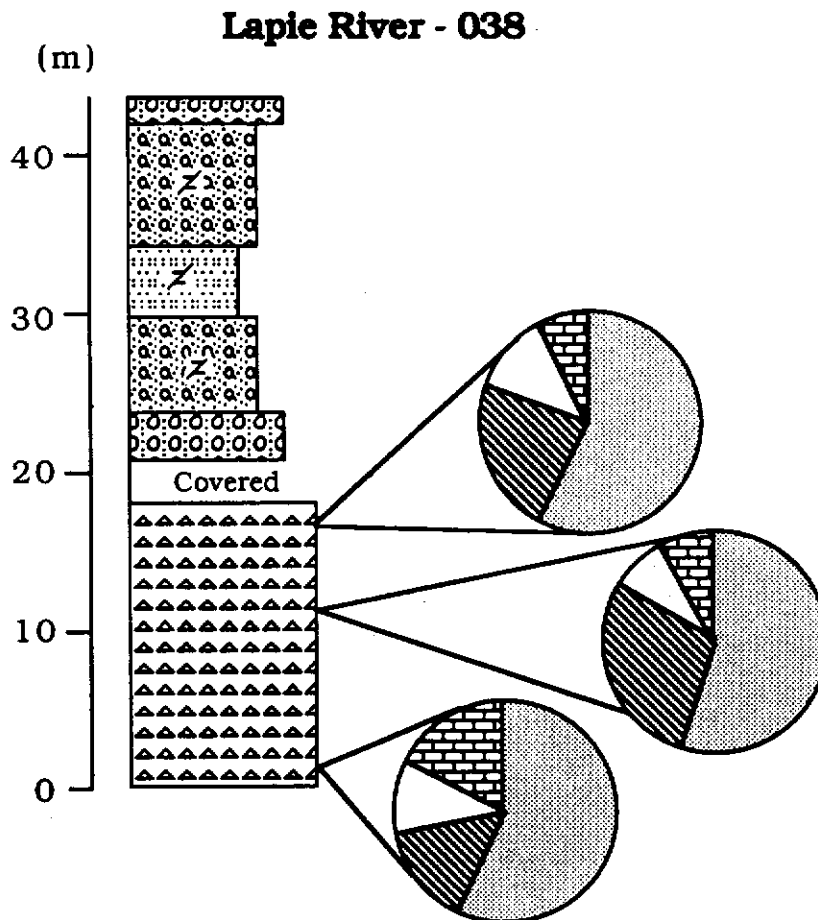
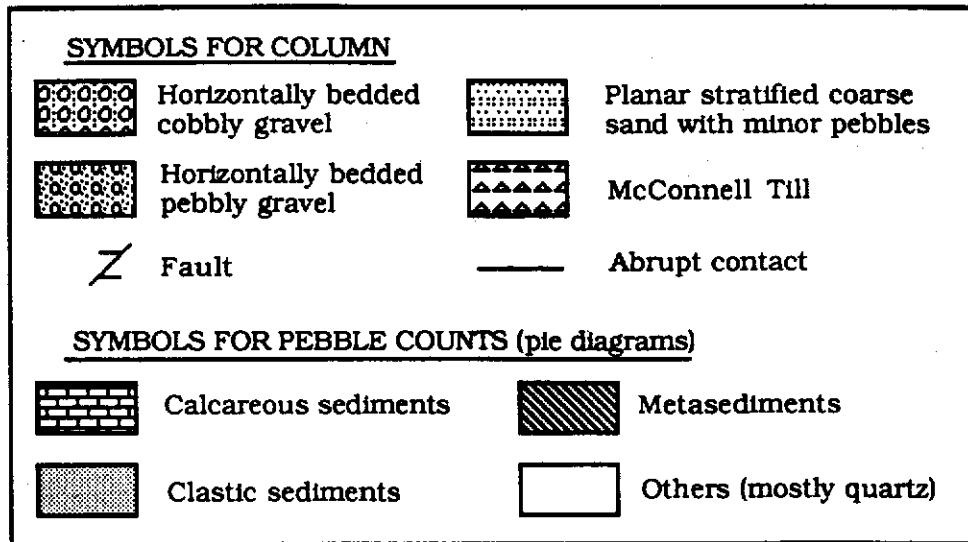


Figure 4. Composite stratigraphic column of section 038 with pie diagrams representing percentages of each lithology at three levels in till.

Lapie River - 038

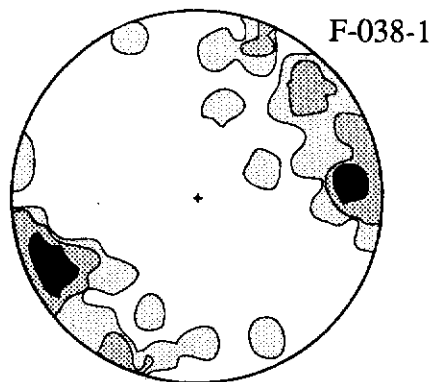
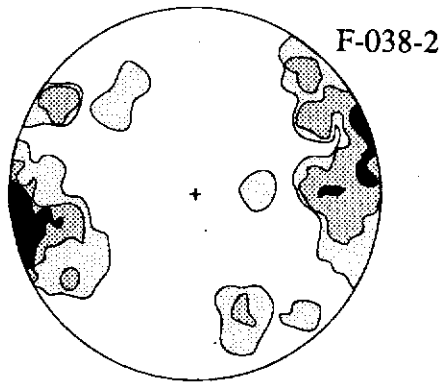
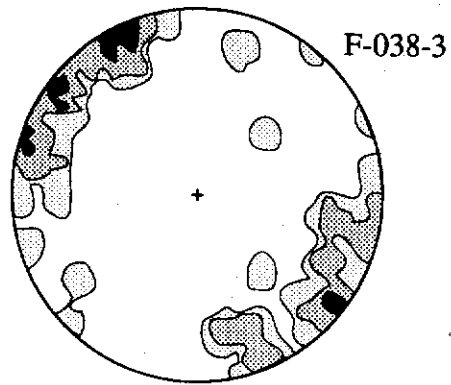
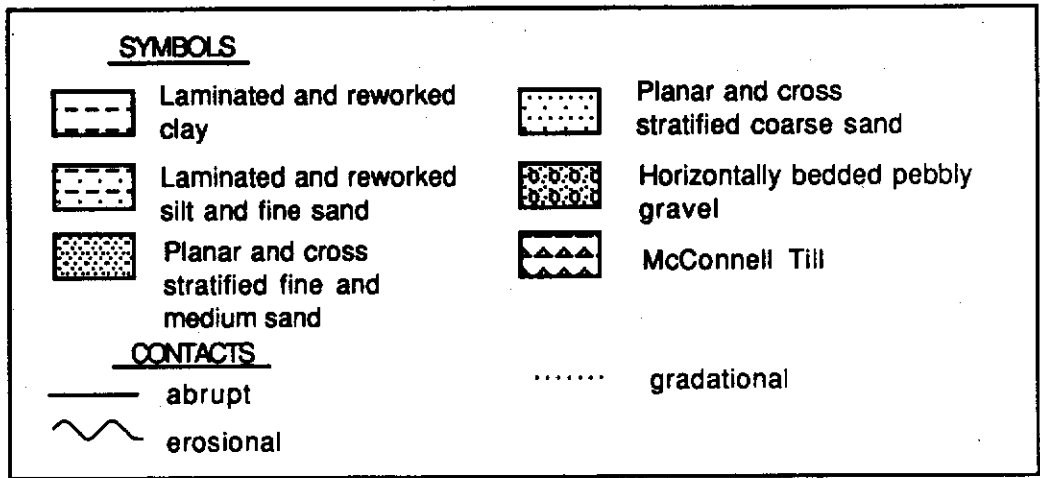


Figure 5. Equal-area stereographic plots of long axes of stones at section 038 (50 measurements in each case). Fabric locations are the same as pebble counts (see Figure 4).



Lapie River valley

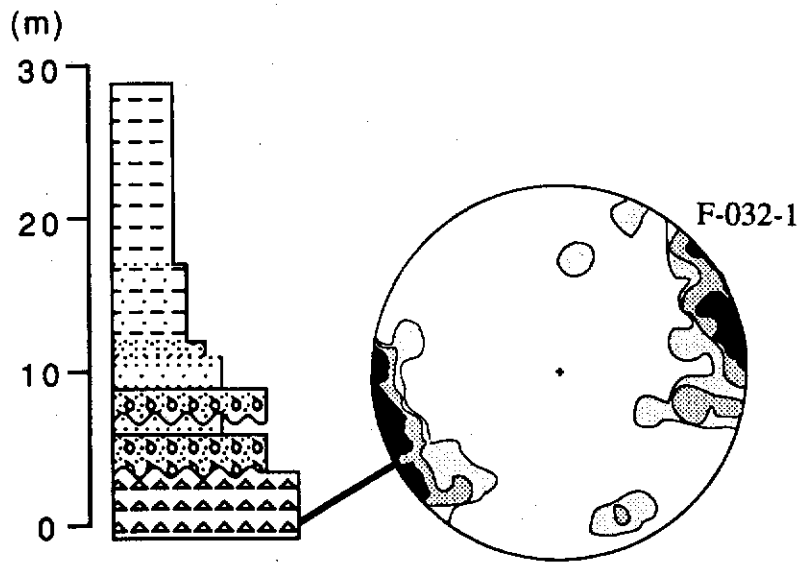


Figure 6. Stratigraphic column of section 032 with equal-area stereographic plot of long axes of stones (30 measurements).

parallel to it. Clast a-axes transverse to ice flow direction have been reported by Amark (1986) and Boulton (1970), among others.

Section 032

Section 032 is located along the South Canol Road in the Pelly Mountains (Fig. 1). The stratigraphy exposed at this section is depicted in Figure 6. About 4 m of McConnell age till is exposed at the bottom of this section. A single till fabric analysis reveals that elongated clasts have a preferred orientation parallel to the Lapie River valley (Fig. 6 and Table 1). A few cobbles of South-Fork Volcanics were recovered from the till. These could have been derived from outcrops of South-Fork Volcanics in the Macmillan Plateau (Gordey, 1988) or from unconsolidated sediments in the Tintina Trench (Plouffe, 1989). The till is overlain by stratified sand and gravels. A paleocurrent toward the west-southwest was measured on planar-cross stratified laminations in a well sorted sand bed. Pebbles of Tertiary rhyolite with a provenance to the northeast in the Tintina Trench (Tempelman-Kluit, 1977, Map 105F) were found in these gravels. Glaciolacustrine silt and clay overlie the gravels. These have been reworked by gravity flow; primary laminations are rare and discontinuous.

The stratified gravels are interpreted as subaqueous outwash fan deposits in a glacial lake which was dammed by ice advancing up Lapie River valley, based upon their stratigraphic position beneath glaciolacustrine sediments and their topographic location below the lowest possible outlet for the glacial lake. The water level elevation of this glacial lake was controlled by the ice dam, and the water drainage divide between the Lapie and Rose Rivers which is located higher in the Pelly Mountains at about 1080 m; gravels at this section are at about 945 m.

QUATERNARY HISTORY

The only clue about conditions prior to the pre-McConnell glacier event comes from the lowest gravels exposed at Section 044, which indicate a period of fluvial aggradation. Information gathered from the only two exposures of pre-McConnell till in the area unequivocally indicate that ice flowed toward the west to northwest during the pre-McConnell glaciation. Occurrences of pre-McConnell till are probably erosional remnants, and most of the drift was stripped off during the following glacial event. During deglaciation a glacial lake formed in the Pelly River valley and lasted for a long enough period of time to accumulate the thick sequences of laminated silt and clay now exposed at Section 076 (Fig. 2). During that time, areas adjacent to the Pelly River valley were characterized by glaciofluvial aggradation (Jackson, 1989). As part of the paraglacial processes (Jackson et al., 1982), major streams such as the Pelly River evolved from braided to meandering as the sediment load decreased (Jackson, 1989).

Assuming a-axes in Section 038 till fabrics are parallel to ice flow directions, a valley glacier flowed northward out of the Lapie River valley at the onset of McConnell glaciation.

However, more field information is needed to verify this hypothesis. At the peak of the McConnell glaciation, ice flow in the Selwyn Lobe was west to northwest over the area, as indicated by till lithologies and till fabrics. At the end of the McConnell glaciation, an ice tongue advanced up the Lapie River valley from part of the Selwyn Lobe which still occupied Tintina Trench, blocking the Lapie River drainage and damming a glacial lake at about 1040 m, as estimated from the highest occurrence of glaciolacustrine sediments (Jackson, 1989). This is documented by clasts of South Fork Volcanics found in the McConnell till and Tertiary rhyolites in McConnell gravel, which were transported at least 9 km up valley from the mountain front.

Late glacial events were essentially the same for pre-McConnell and McConnell glaciations. During the retreat of the McConnell glacier, a glacial lake formed in the Pelly River valley under conditions similar to the pre-McConnell glacial retreat (Jackson, 1989).

TILL GEOCHEMISTRY SAMPLING AND ANALYSIS

In order to achieve the primary objective (drift prospecting study), 204 till samples were collected during the 1987 field season (Fig. 1). Samples were collected with the aid of a pick and shovel from river bank sections, road cuts, old trenches and hand dug pits. Care was taken to collect samples below the postglacial solum. In areas of easy access, like along the Campbell Highway, the distance between till samples averages 2 km.

Laboratory Procedures

Dry sieving was performed on till samples to separate the silt plus clay size fraction ($<63 \mu\text{m}$). The clay fraction ($<2 \mu\text{m}$) of till samples was separated by centrifuge, using standard procedures of the sedimentary laboratory of the Geological Survey of Canada. Determination of the silt/clay ratio was done by pipette analysis as described by Folk (1968). Till samples were wet sieved in order to separate the 125 to 250 μm size fraction. Heavy minerals were separated from this size range fraction with a shaking table and methylene iodide (s.g. 3.3) in the laboratory of Overburden Drilling Management Ltd., Nepean, Ontario. Geochemical analyses on clay and silt plus clay size fractions were done by Acme Analytical Laboratories Ltd., Vancouver, B.C. The clay fraction was analysed for Ag, As and Sb by ICP/MS (inductively coupled plasma mass spectrometry) after a hot (HCl-HNO₃-H₂O) acid leach using 0.5 g samples and Hg was analysed by flameless atomic absorption. The highest concentrations of most metals are found in the clay size fraction of oxidized till because (1) phyllosilicates have a primary metal enrichment within their structure, and (2) metals released by weathering of labile minerals are scavenged by colloidal particles such as clay minerals, oxides and hydroxides (Shilts, 1984). The $<63 \mu\text{m}$ fraction was analysed for gold by atomic absorption using 10 g samples with a detection limit of 1 ppb. The silt plus clay size fraction was

analysed for gold, since Dilabio (1985) demonstrated that gold is preferentially enriched in the fine fractions of oxidized till. In the case of unoxidized till, such as samples collected from the measured sections, "gold is most abundant in grain size fractions that reflect the grain size of the glacially liberated and comminuted native gold and oxide or sulfide host minerals" (Dilabio, 1985). At Grew Creek (MINFILE 105K 009), the only well known Au mineralization in the area, gold occurs in bedrock as native particles with an average diameter of 7.5 μm (J.L. Duke, pers. comm., 1988). Consequently, assuming similar mineralization elsewhere into the Tintina Trench, it is likely that in unoxidized till gold is concentrated in the silt and finer size fractions. Using coarser fractions for analysis would dilute the gold content and reduce any anomaly contrast. Heavy minerals were analysed for Au by neutron activation at Bondar-Clegg & Co. Ltd, Ottawa, Ontario. The clay size fraction was also analysed for base metals and heavy minerals for a series of gold pathfinder elements; these results are discussed in Plouffe (1989).

RESULTS AND DISCUSSION

Several methods are presented in the literature to calculate a threshold for geochemical exploration (see Rose et al., 1979; Sinclair, 1974). However in this case, because of the scale of the geochemical survey, the 90th percentile was considered anomalous. In the case of Au in the silt plus clay size fraction of till, the 90th percentile is equivalent to 7 ppb.

Au in the silt plus clay size fraction of till

Textural analyses were performed on a series of samples to verify any possible relationships between the Au and silt contents, i.e. to determine if gold was preferentially concentrated in the silt size fraction compared to the clay size fraction. As illustrated in Figure 7, the correlation between the variables is very low. It is concluded that (1) size distribution of the $<63 \mu\text{m}$ fraction does not affect gold values in this case, and (2) Au must be present in the clay fraction, probably bound as complexes to oxides, hydroxides and/or clay minerals (see Boyle, 1979; Boyle et al., 1975). At this point, there is a lack of data to indicate if gold in the silt plus clay size fraction is detrital and/or chemically remobilized. Detailed work on gold particles recovered from this fraction (e.g. fineness) could clarify whether their mode of transportation was detrital or chemical.

Forty-seven till samples were analysed twice in order to estimate the precision of the analytical method. These samples were chosen at random throughout the entire set of 204 samples. Results obtained after the first and second analyses are depicted in Figure 8 (using a graphic technique modified from Shilts, 1975). Vertical shading indicates values above background (>7 ppb or 90th percentile) after the first analysis; horizontal shading indicates values above background after the second analysis. Samples which returned anomalous values from both analyses are in the cross-hatched field. Finally, background samples are represented by dots in the

clear field. Also shown in Figure 8 is a slope of 1, which is used here as a fast way to verify the precision of the analytical method. Since several samples plot well off the line, one can say that the precision is low. Samples falling in the cross-hatched field are most likely related to true anomalies. However, samples in the vertical and horizontal fields are not necessarily false anomalies because the analytical method has a poor precision. The poor precision of the analytical method for the silt plus clay size fraction is attributable to (1) heterogeneity of the samples, and (2) most measurements, even anomalous ones, are close to the detection limit of 1 ppb (Thompson and Howarth, 1976). Consequently, in order to evaluate whether a high value is worth following up or not, its spatial location with respect to other anomalies, geological setting and reproducibility should all be considered.

Transport distance of anomalous concentrations of gold in till

In the Grew Creek area, where at least two mineralized zones are known, detailed till sampling was conducted to determine the distance of transport of anomalous concentrations of gold from the source of mineralization (Fig. 9). Assuming that the dispersal train depicted in Figure 9 is derived from a unique source, i.e. the Main Zone, a single sample collected 250 m from the mineralization would have been recognized as anomalous (above the 90th percentile or 7 ppb) compared to the samples within the entire area. Furthermore, if the 75th percentile is declared anomalous (5 ppb), mineralization could be recognized as far away as 500 m. From these data, it is concluded that mineralization similar to Grew Creek might remain undetected with the sample interval of 2 km employed along the Campbell Highway. Any serious Au prospecting for epithermal deposits similar to Grew Creek along the Tintina Fault requires a till sample interval ≤ 500 m measured parallel to ice flow direction. More work is required in order to define the width of the gold dispersal train at Grew Creek. This would help define a reliable sampling interval measured perpendicular to ice flow direction.

Au geochemical map

A geochemical map for gold in the silt plus clay size fraction is depicted in Figure 10. High gold values are concentrated in the northwestern part of the study area between Ketz River and Grew Creek. The Grew Creek gold-silver deposit is well reflected in this size fraction of till, as indicated by a series of anomalies directly over and northwest of the Tarn and Main Zones (Fig. 9). Anomalies were also detected near gold occurrences reported by Kindle (1946; p.24) (MINFILE 105F 044,045) along the Lapie River. Abundant high values occur over and in proximity to Tertiary felsic and intermediate volcanic bedrock mapped by Tempelman-Kluit (1977) along the Tintina Fault Zone (MINFILE 105F 062,075,076). They represent a good prospecting target for buried hydrothermal systems similar to

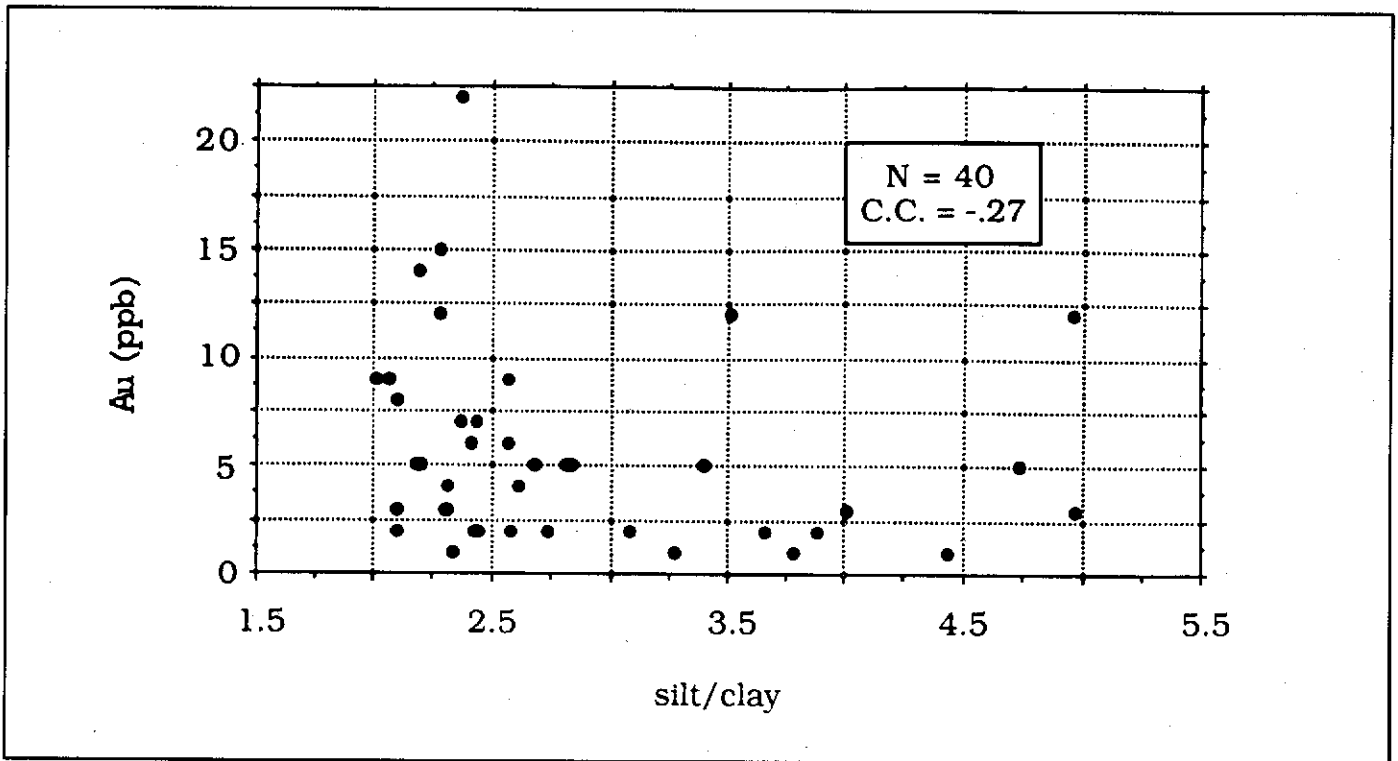


Figure 7. Correlation graph of Au content and silt/clay ratio of the silt plus clay size fraction of till (C.C. = correlation coefficient).

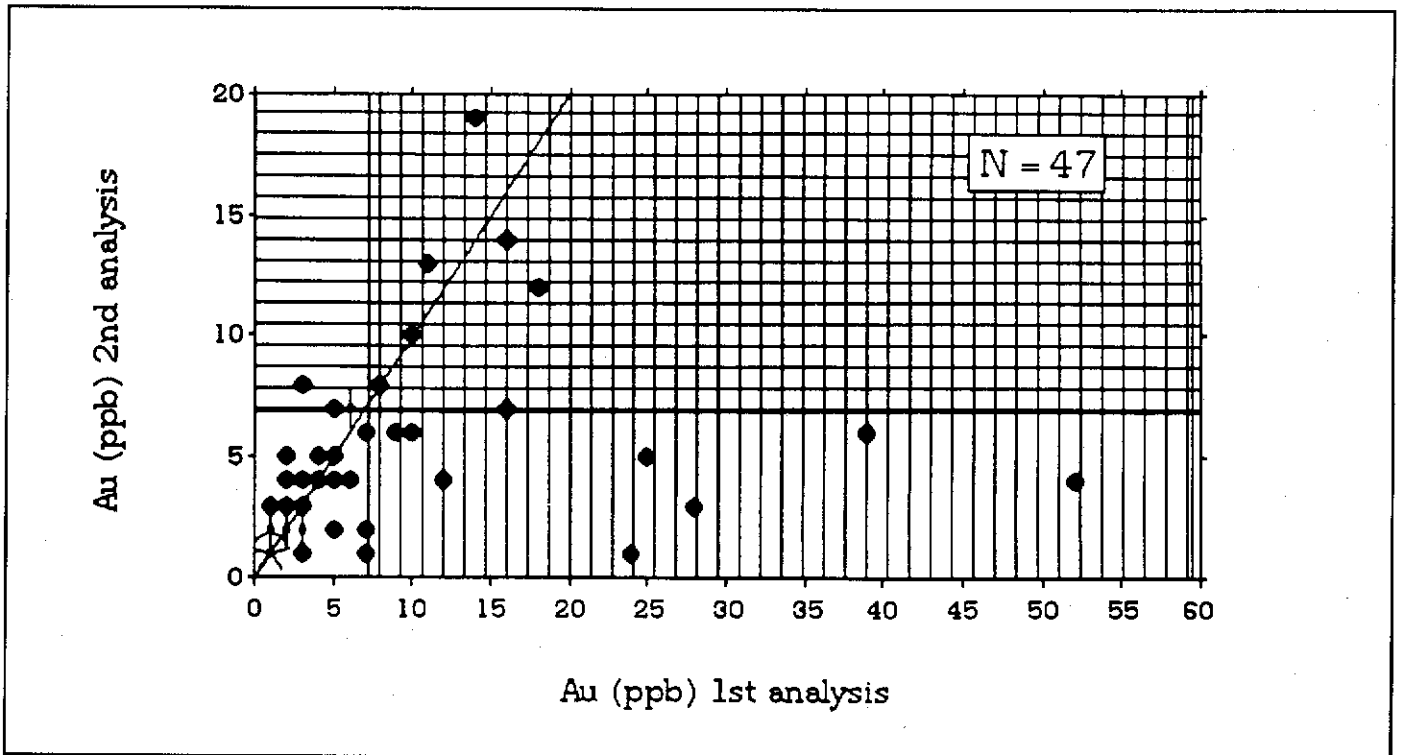


Figure 8. Graph showing results of duplicate analyses (using a graphic technique modified from Shilts (1975)).

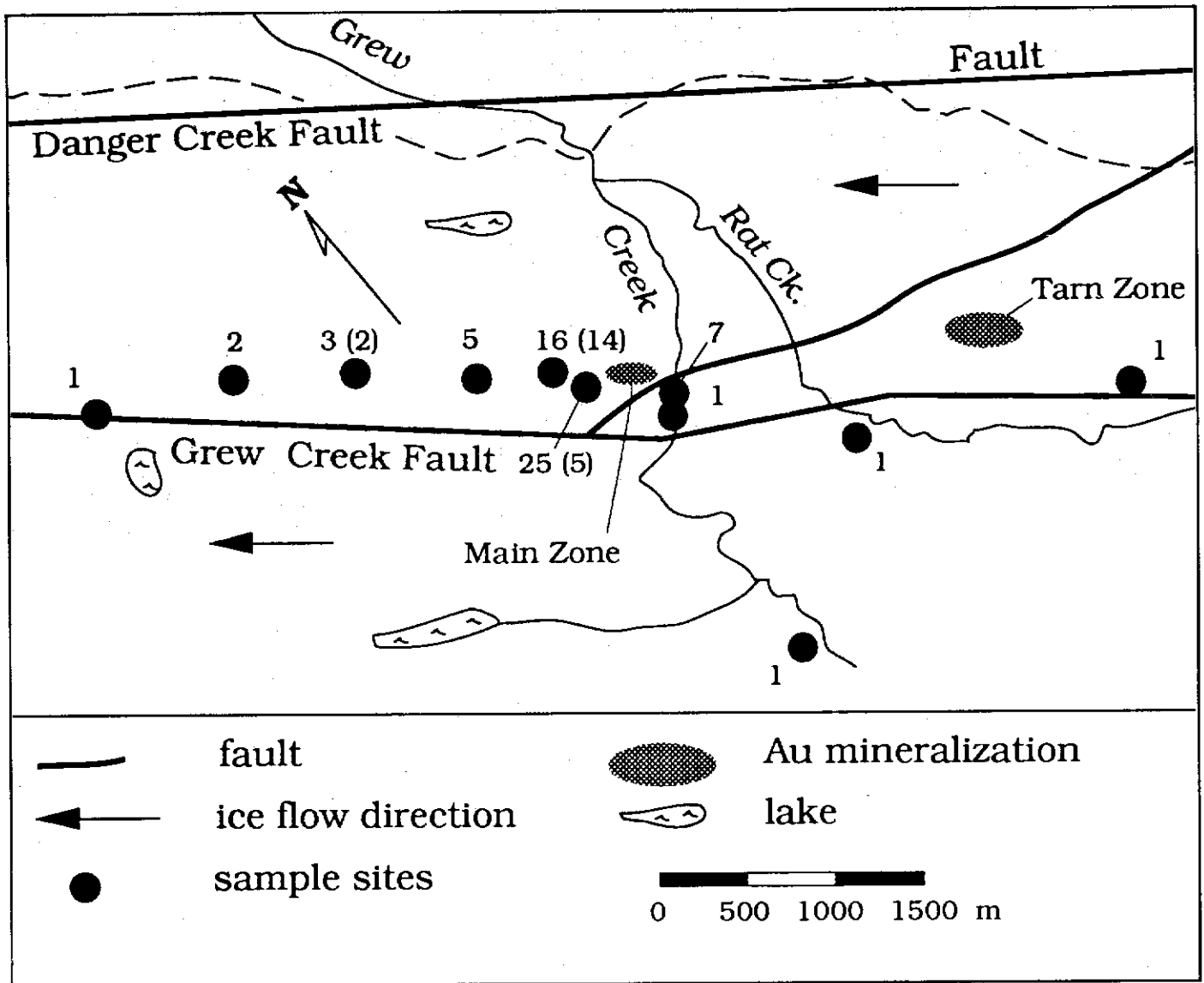


Figure 9. Detailed view of glacial dispersal of gold in the silt plus clay size fraction of till near the Grew Creek mineralization. Concentrations are in ppb, and values in parentheses represent duplicate analyses. Location of mineralized zones and faults from Duke and Godwin (1986).

the Grew Creek mineralization. Follow-up work on the anomalies near the Lapie River valley should be undertaken with special care because of the more complex ice flow patterns presented in the first part of this paper.

Jackson et al. (1986) suggested a link between Paleogene volcanism and the source of placer gold in the area. Values above the 75th percentile over and northwest of some of these volcanic bodies (Ketz River (105F 062), Starr Creek (105G 103,106) and northeast of Ross River) support this hypothesis (Fig. 10). To verify this hypothesis, more till sampling in closer proximity to these volcanic bodies is needed, since the transport distance of anomalous gold concentrations in till was found to be fairly short, in the order of 250 to 500 m. Follow-up of any of these anomalies should be undertaken

with special care and as a first step, an attempt should be made to reproduce the results presented here.

Gold Pathfinders

Four common gold pathfinders were analysed to determine their possible use for drift prospecting in the study area. They are Ag, As, Hg and Sb. Correlation coefficients calculated for these elements and for gold are depicted in Table 2. Correlation of gold with each of these elements is very low, hence the use of these gold pathfinders in till exploration is not recommended in this area. This poor correlation reflects the bedrock geochemistry of Grew Creek, where at shallow depths (outcrop level), gold mineralization is

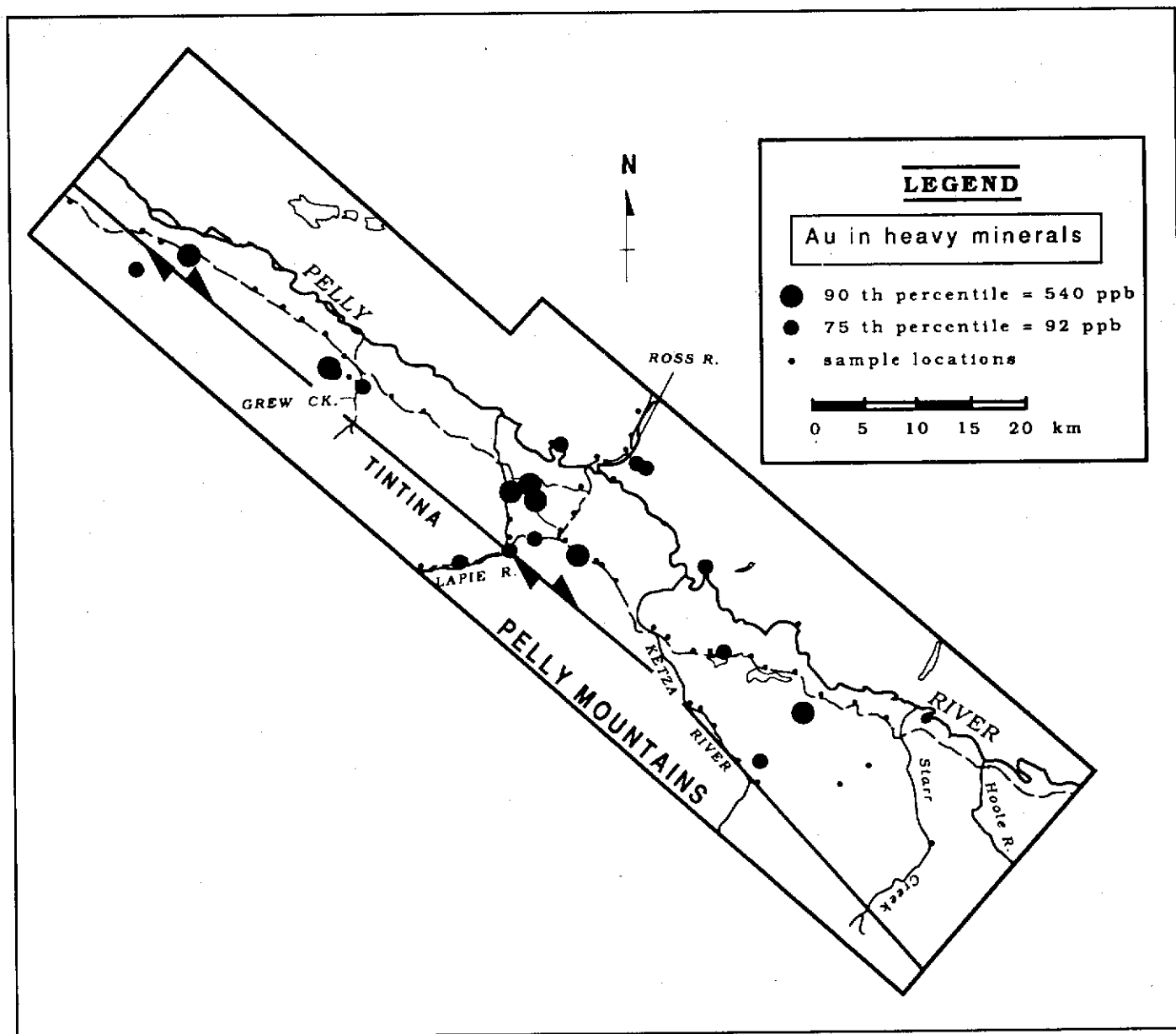


Figure 11. Gold abundance in heavy mineral concentrate from till in the northwest part of the study area.

not associated with high As, Ag, Hg or Sb concentrations (T. Christie, oral presentation, Whitehorse Geoscience Forum, 1988). Geochemical maps showing the distribution of Ag, As, Hg and Sb concentrations over the area are presented in Plouffe (1989).

Use of heavy minerals for gold exploration

The use of heavy mineral concentrates in drift prospecting for gold was originally thought to be useful in the Tintina Trench, but with certain site specific limitations¹. Two examples of site specific limitations are the following: (1) most of the gold at Grew Creek is attached to quartz with a minor amount bound in pyrite (Duke and Godwin, 1986;

Duke, 1986); gold in quartz is not recovered in the heavy mineral concentrate, and (2) surficial samples, as collected in reconnaissance surveys, are oxidized (except for certain areas where samples are collected in sections). Thus, gold in sulphides can be released, and reprecipitated or fixed in finer size fractions. In both cases, gold would go undetected in heavy mineral concentrates.

Heavy mineral separations, (s.g. ≥ 3.3) on the 125 to 250 μm size fraction, were done only for samples of the northwestern region to test the reliability of this fraction for gold exploration in the Tintina Trench. No visible gold grains were seen in heavy mineral concentrates under a binocular microscope. However, as shown in Figure 11, the Grew Creek deposit is reflected in the gold content of heavy mineral

Fabric	V1	V2	V3	S1	S2	S3
F-032-1	072 01	162 18	339 72	0.802	0.147	0.051
F-038-1	057 01	147 15	323 75	0.701	0.192	0.107
F-038-2	262 01	172 22	354 68	0.714	0.164	0.123
F-038-3	307 04	217 01	116 86	0.703	0.206	0.090
F-044-1	286 03	017 11	179 79	0.544	0.390	0.066
F-044-2	112 12	017 23	227 64	0.518	0.374	0.108
F-044-3	080 16	347 11	224 70	0.667	0.222	0.110
F-044-4	098 20	188-02	282 70	0.591	0.317	0.092
F-076-1	116 06	207 13	002 75	0.686	0.268	0.047
F-076-2	090 03	181 03	315 85	0.507	0.387	0.106

Table 1. Eigenvalues and eigenvectors of till fabrics calculated with the stereonet program (v. 3.6 by R.W. Allmendinger), following Mark (1973) eigenvalue method. Note that these values should be interpreted with care since as presented by Woodcock (1977), bimodal and multimodal data (which is the case for the till fabrics presented here) can result in the eigenvectors falling between modes. V1, V2 and V3 represent the trend and plunge of the eigenvectors; V1 being the direction of maximum clustering, and V3 that of normal clustering. S1, S2 and S3 are the respective normalized eigenvalues.

concentrates from McConnell till, in a few samples down-ice from the known mineralization. Likewise, heavy minerals show patterns of gold enrichment similar to those observed in the silt plus clay size fraction along the Campbell Highway close to the Lapie River (Fig. 10) (MINFILE 105F 044,045). Dispersed anomalous gold values (above the 90th percentile), not associated with known mineralization, occur throughout the area (Fig. 11). Some of these anomalies lie close to documented MINFILE occurrences (105F 050,051,060). Most of the bedrock in the study area is not particularly enriched in heavy minerals. Consequently, till derived from it has the same characteristics. That explains why several till samples yielded only small amounts of heavy minerals. In some instances, like certain samples down-ice from the Grew Creek mineralization, not enough heavy minerals were recovered for geochemical assays. In order to obtain a representative amount of heavy minerals for geochemical analysis (>5 g), much larger till samples would have to be taken. This can represent a practical problem in a reconnaissance survey where numerous samples have to be collected over wide areas and have to be carried long distances by the sampler.

Correlation coefficients					
	Au	Ag	As	Sb	Hg
Au	1				
Ag	-.04	1			
As	-.071	.283	1		
Sb	-.105	.2	.357	1	
Hg	.14	.445	.295	.232	1

Table 2. Correlation coefficients of gold with arsenic, antimony, mercury, and silver.

Based on these observations, it can be concluded that heavy minerals could be used for reconnaissance-level gold exploration in the Tintina Trench, if sample size does not represent a practical problem. In follow-up surveys, where samples are recovered from below the zone of oxidation (from sections or overburden drill cores), heavy minerals may be particularly efficient in detecting mineralization.

CONCLUSIONS

Based on till lithologies and till fabrics, glacier ice flowed west to northwest over the area during McConnell and pre-McConnell glaciations. However, at the onset of McConnell glaciation, a valley glacier might have flowed initially out of the Lapie River valley. More field information is needed to further verify this hypothesis. At the end of McConnell glaciation, an ice tongue flowed up gradient into the Lapie River valley. Within the study area, the silt plus clay size fraction of till is reliable for gold exploration since it reflects known gold mineralization at Grew Creek and is not influenced by textural parameters. On the other hand, reproducibility of gold analyses of the <63 μm size fraction is very low because of the heterogeneity of the samples and the fact that gold levels in this size fraction are low, i.e. close to detection limit, where precision is low. The problem of poor reproducibility can be solved in part by duplicate analyses.

High gold values in the silt plus clay size fraction of till in proximity to Tertiary volcanics support the hypothesis that these rocks could be a source of placer gold as proposed by Jackson et al. (1986). However, since the transport distance of anomalous gold in till was found to be fairly short (250 to 500 m), more detailed sampling close to these volcanic bodies would be needed to detect any gold mineralization. The use of Ag, As, Hg and Sb as pathfinder elements for gold exploration is not recommended because their correlation with gold is very poor in surficial samples. Heavy minerals could

be used for reconnaissance-level gold exploration in the Tintina Trench with certain site specific limitations.

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1. 'site specific limitations' is used in the sense of Shilts (1978).