Geochemical characterization of Carboniferous volcanic successions from Yukon-Tanana Terrane, Glenlyon map area (105L), central Yukon[1]

Maurice Colpron[2]
Yukon Geology Program

Colpron, M., 2001. Geochemical characterization of Carboniferous volcanic successions from Yukon-Tanana Terrane, Glenlyon map area (105L), central Yukon. *In:* Yukon Exploration and Geology 2000, D.S. Emond and L.H. Weston (eds.), Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p. 111-136.

ABSTRACT

Detailed mapping of Yukon-Tanana Terrane in Glenlyon map area has identified two Carboniferous volcanic successions, and their subvolcanic intrusions. The early- to mid-Mississippian Little Kalzas succession consists predominantly of calc-alkaline volcanic and volcaniclastic rocks which formed in a continental arc setting. Minor alkali basalt occurs stratigraphically below and above the calc-alkaline rocks. The Little Salmon succession, of mid-Mississippian to early Pennsylvanian age, represents a second cycle of continental arc magmatism. It consists of calc-alkaline andesite and volcaniclastic rocks near Little Salmon Lake, but passes laterally along strike to alkali basalt of within-plate affinity. The occurrence of alkaline magmatism within these continental arc sequences suggests episodic rifting of the arc. The occurrence of Mn-rich exhalite within the rifted arc sequence of the Little Salmon succession suggests that this environment may also have been favourable for production and deposition of metal-rich solutions.

RÉSUMÉ

La cartographie de détail du terrane de Yukon-Tanana dans la région de Glenlyon a permis de reconnaître deux successions volcaniques, et leurs intrusions sous-volcaniques, d'âge Carbonifère. La succession de Little Kalzas, du Mississippien précoce à moyen, est composée de roches volcaniques et volcaniclastiques calco-alcalines qui se sont mises en place dans un environnement d'arc continental. Des basaltes alcalins sont présents à la fois dans les strates sous-jacentes et sus-jacentes aux roches calco-alcalines. La succession de Little Salmon, d'âge Mississippien moyen à Pennsylvanien précoce, représente un second cycle de magmatisme d'arc continental. Elle se compose d'andésites calco-alcalines et de roches volcaniclastiques près du lac Little Salmon, mais elle passe latéralement à des basaltes alcalins d'affinité intra-plaque. La présence de magmatisme alcalin au sein des séquences d'arcs continentaux suggère que l'arc volcanique fût sujet à plusieurs épisodes d'extension. La présence de roches exhalatives enrichie en Mn, au sein des roches volcaniques alcalines de la succession de Little Salmon, suggère que cet environnement pourrait aussi être propice à la production et à l'accumulation de solutions riches en métaux.

[1]*Contribution to Ancient Pacific Margin NATMAP project*

[2]*maurice.colpron@gov.yk.ca*

INTRODUCTION

Bedrock mapping of Yukon-Tanana Terrane in Glenlyon map area (105L) was initiated in 1998 to evaluate the possible correlation of Yukon-Tanana Terrane southwest of Tintina Fault with that of massive sulphide-hosting strata in the Finlayson Lake district, northeast of the fault, and to assess the potential of the area to host volcanogenic massive sulphide deposits. The Glenlyon area lies along strike to the south of the Finlayson Lake district when ~425 km of dextral displacement is restored along Tintina Fault (Fig. 1).

To date, 1:50 000-scale mapping has focussed on areas of better exposure in Little Kalzas Lake area, in northwest Glenlyon map area (Colpron, 1998), and near Little Salmon Lake, to the south (Colpron and Reinecke, 2000).

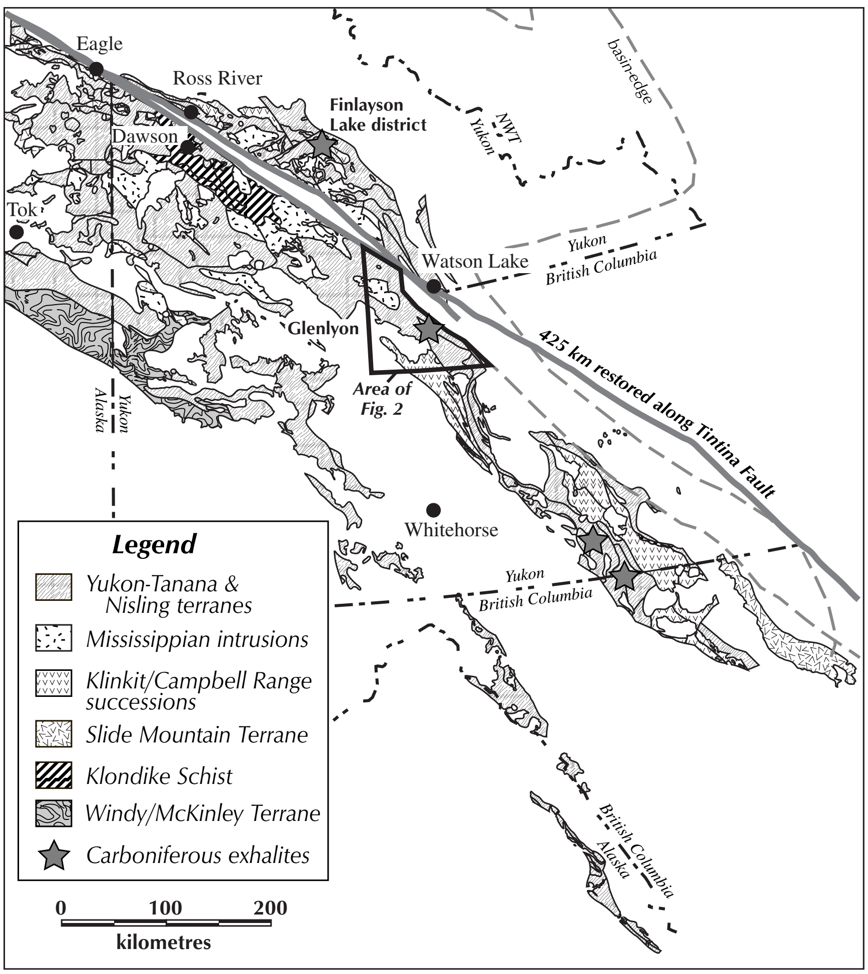


Figure 1. *Distribution of Yukon-Tanana and affiliated terranes (the 'pericratonic' terranes) prior to displacement along Tintina Fault. Location of Glenlyon map area with respect to Finlayson Lake district is shown. Tectonic assemblage map modified after Wheeler and McFeely (1991).*

Detailed mapping in both these areas, augmented by regional reconnaissance and information from limited industry exploration activities, permits a preliminary subdivision of Yukon-Tanana Terrane in Glenlyon map area (Fig. 2). In particular, Carboniferous volcanic successions were identified both in Little Kalzas Lake and Little Salmon Lake areas (Fig. 3; Colpron, 1999a; Colpron and Reinecke, 2000). This paper reviews the stratigraphy of these volcanic successions and presents the results of geochemical analyses of volcanic and subvolcanic rocks (Tables 1-4).

YUKON-TANANA TERRANE IN GLENLYON MAP AREA

Yukon-Tanana Terrane occupies a 30- to 50-km-wide, northwest-striking belt in the centre of Glenlyon map area (Fig. 2; Campbell, 1967; Tempelman-Kluit, 1979). Ongoing geological mapping and geochronological studies have led to the identification of distinct stratigraphic successions and two Mississippian magmatic suites within the terrane (Fig. 3). In northwest Glenlyon, early to mid-Mississippian volcanic rocks of the Little Kalzas succession conformably overlie quartzite of the Pelmac unit (Fig. 3; Colpron, 1999a). The Pelmac unit rests structurally above amphibolite-grade meta-sedimentary and meta-igneous rocks of uncertain age which are found near Tadru and Ess lakes (Fig. 2; Campbell, 1967; U. Schmidt, pers. comm., 1999). The Pelmac unit and overlying Little Kalzas succession (and subvolcanic intrusions of the Little Kalzas suite) were deformed by south-verging folds and metamorphosed to greenschist facies prior to the intrusion of the Tatlmain batholith at ~340 Ma (Colpron et al., 2000).

To the south, mid-Mississippian to early Pennsylvanian volcanic rocks of the Little Salmon succession unconformably overlie two distinct map units (Fig. 3; Colpron and Reinecke, 2000). To the east, the Little Salmon succession rests above the Drury unit, an arkosic grit and

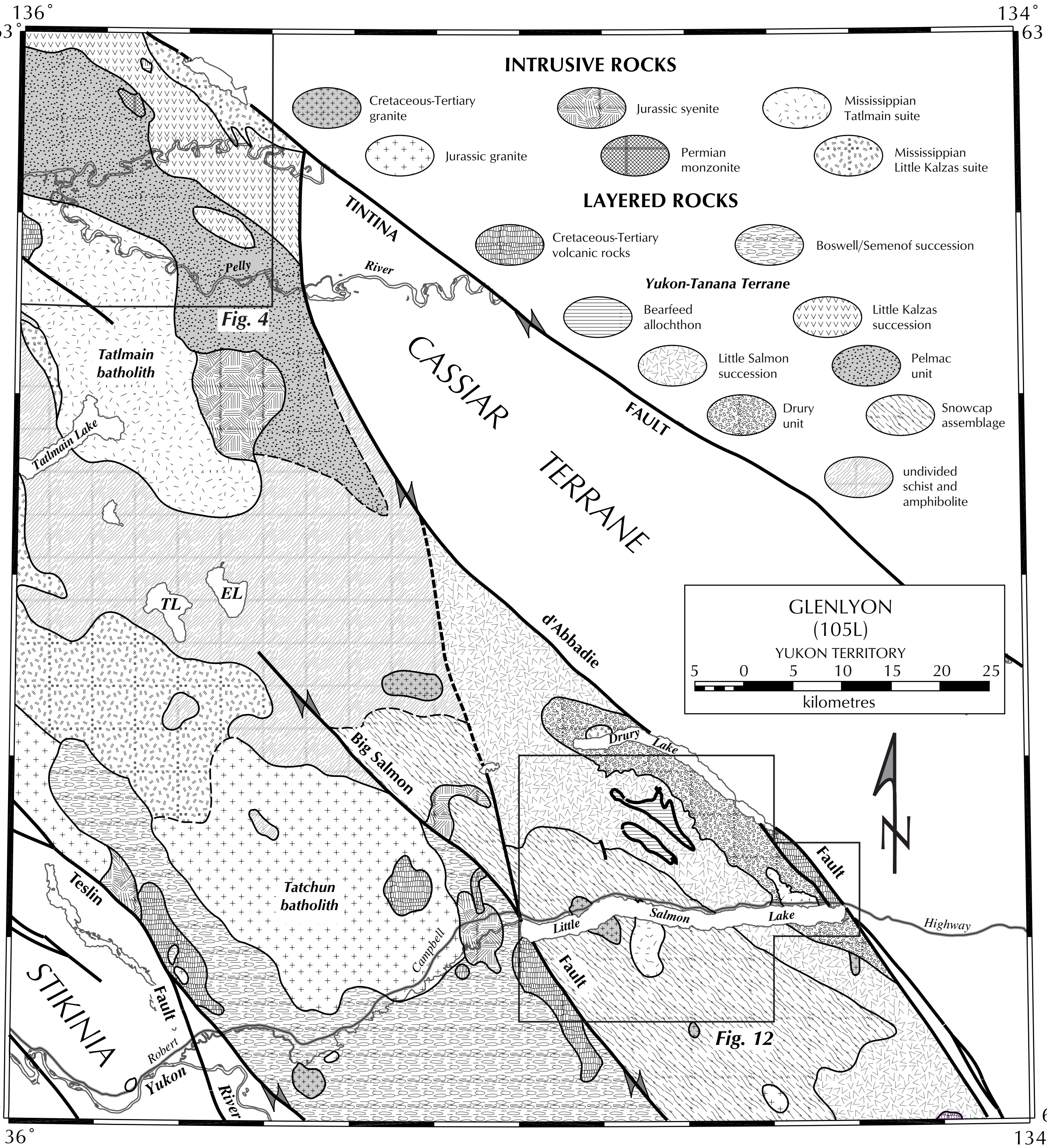


Figure 2. *Preliminary geological compilation of Glenlyon map area, based on detailed mapping in Little Kalzas Lake (Fig. 4) and Little Salmon Lake (Fig. 12) areas (Colpron, 1998; Colpron, 2000), regional reconnaissance of intervening area, as well as mapping by A.M. Carlos (in Garagan, 1990; southwest of Big Salmon Fault), Campbell (1967) and Gordey and Makepeace (1999). TL = Tadru Lake; EL = Ess Lake.*

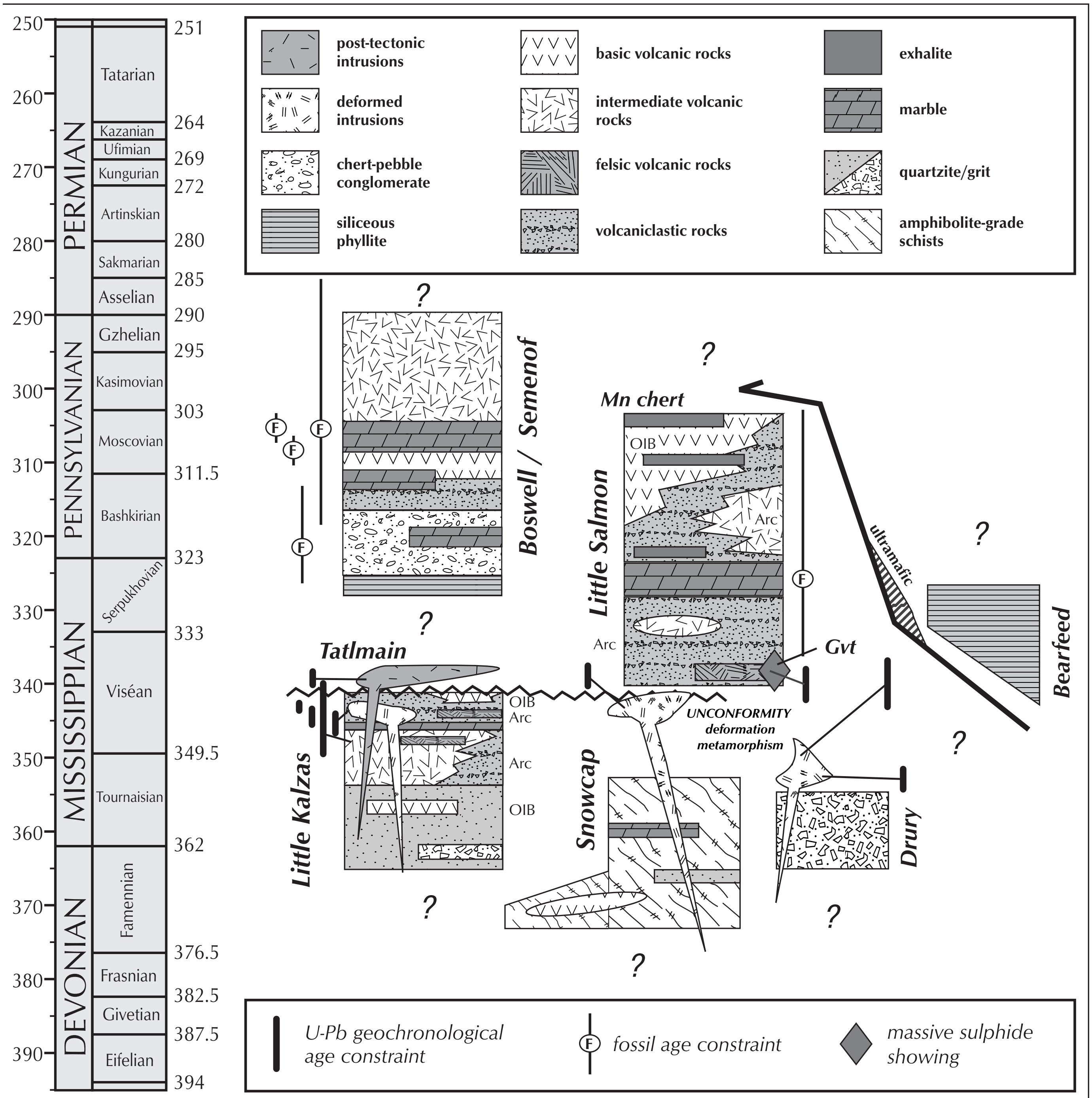


Figure 3. Composite stratigraphic columns for subdivisions of Yukon-Tanana Terrane in Glenlyon map area. Geochemical affinities for volcanic rocks of the Little Kalzas and Little Salmon successions are shown (explanations are given in the text). Stratigraphy of Boswell/Semenof succession (compiled from Tempelman-Kluit in Gordey et al., 1991) is shown for comparison with Pennsylvanian section in Finlayson Lake district (see Murphy, this volume). OIB = ocean island basalt.

quartzite unit which is intruded by early Mississippian granodiorite. To the west, the volcanic rocks overlie a mixture of meta-sedimentary and meta-igneous rocks which record a poly-metamorphic history – the Snowcap assemblage (Colpron, 2000). These rocks are intruded by diorite plutons of the Tatlmain suite (*ca.* 340 Ma) which are likely subvolcanic to the Little Salmon succession. Accordingly, the Snowcap assemblage forms the basement onto which volcanic rocks of the Little Salmon succession were erupted. The relationship between the Snowcap assemblage and similar metamorphic rocks in the vicinity of Tadru and Ess lakes is unknown. They may be part of the same lithotectonic assemblage.

The Boswell/Semenof succession (Boswell and Semenof formations of Tempelman-Kluit, 1984) is juxtaposed to the Snowcap assemblage along Big Salmon Fault (Fig. 2). It consists of dark grey slate, greywacke and chert-pebble conglomerate, limestone, volcaniclastic rocks and andesitic greenstone of Pennsylvanian age (Fig. 3; Tempelman-Kluit *in:* Gordey et al., 1991; Poulton et al., 1999). Although it is not currently considered part of Yukon-Tanana Terrane (Wheeler et al., 1991 included it in Slide Mountain Terrane; Gordey and Makepeace, 1999 in Quesnel Terrane), the resemblance of Boswell/Semenof succession to recently identified Pennsylvanian strata in Yukon-Tanana Terrane of Finlayson Lake district (Murphy, this volume) requires a re-evaluation of its tectonic setting. Dark grey siliceous phyllite of the Bearfeed allochthon, which sits in klippen overlying the Little Salmon succession (Fig. 2; Colpron, 2000; Colpron and Reinecke, 2000), is possibly correlative with the base of the Boswell/Semenof succession.

Although volcanic rocks of the Little Kalzas and Little Salmon successions are pervasively deformed and generally metamorphosed to greenschist facies (chlorite to biotite grade), the exceptional preservation of primary textures in these rocks warrants the use of protolith nomenclature for their description. It must also be noted that the interpretations of the geochemical data presented in this paper (Tables 1-4) are primarily based on elements which are considered immobile during low-grade metamorphic reactions (e.g. Rollinson, 1993).

LITTLE KALZAS SUCCESSION

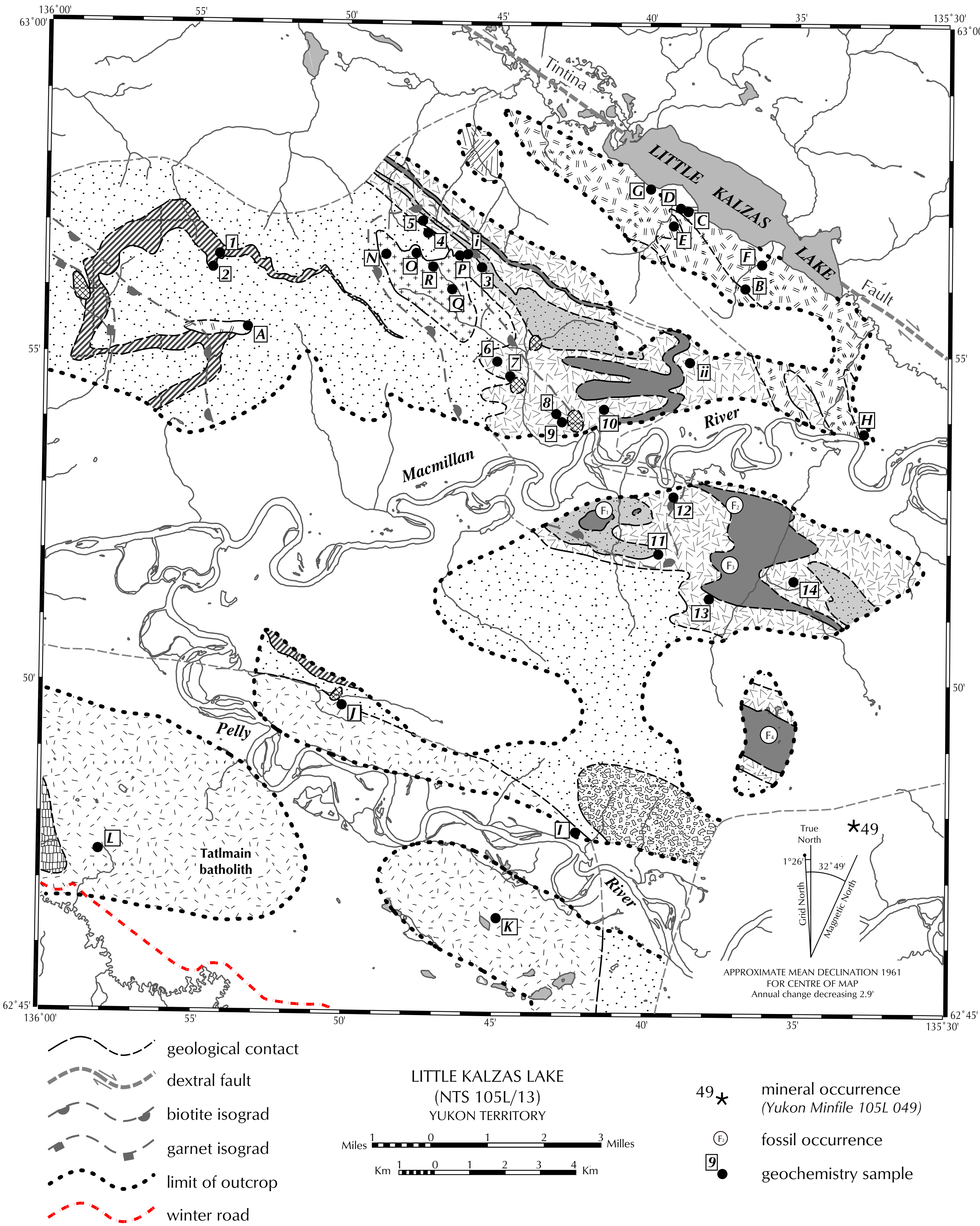
Volcanic rocks of the Little Kalzas succession occupy a northwest-trending belt in the northeast half of Little Kalzas Lake map area (Fig. 4). The volcanic rocks are subdivided by a marble horizon into a lower and an upper unit (units 2-4 of Colpron, 1999a). Below the marble, the volcanic succession consists predominantly of massive, plagioclase-phyric andesite (Fig. 5) and minor rhyolite. The andesite passes both upward and laterally to the southeast into a sequence of volcaniclastic rocks which is dominated by light green epiclastic sandstone and argillite. South of Macmillan River, epiclastic and tuffaceous rocks comprise the bulk of the lower unit. Outcrops of massive andesite occur sporadically within the volcaniclastic rocks.

Above the marble, the Little Kalzas succession consists of a mixture of sedimentary and volcanic rocks (Colpron, 1999a). Carbonaceous phyllite and quartzite are dominant north of Macmillan River. Plagioclase-phyric andesite occurs only locally north of Macmillan River, and a rhyolitic tuff is exposed on the south-facing slope above the river. South of the river, light green epiclastic argillite, sandstone and grit make up the bulk of the upper unit. The sequence is capped by a dolomitic quartzite. Massive basalt outcrops are restricted to a small creek to the southwest of the dolomitic quartzite exposures.

Volcanic rocks also occur within orthoquartzite of the Pelmac unit (Fig. 4). They consist predominantly of light green volcaniclastic sandstone and arkosic grit. Mafic volcanic (flow?) rocks are restricted to a few exposures within the volcaniclastic unit.

Mafic volcanic rocks from both the Pelmac unit and the upper part of Little Kalzas succession plot in the alkaline basalt field on discriminant diagrams (Figs. 6 a,b). They have trace element characteristics of within-plate alkali basalts: they plot in the ocean island basalt (OIB) field on the Th-Zr-Nb diagram (Fig. 6c); they are enriched in TiO_2, P_2O_5, and incompatible elements; and they exhibit a slight positive Nb anomaly relative to Th and La on primitive mantle-normalized plots (Fig. 7b). Basalts of the Pelmac unit have higher Ti/V ratios (Fig. 6b) and have slightly more enriched trace element contents (Fig. 7b) than those of the upper part of the Little Kalzas succession, indicating a higher degree of alkalinity. The geochemical character of these volcanic rocks is typical of a rift environment (e.g. Goodfellow et al., 1995).

Andesites from the Little Kalzas succession plot in the compositional range of basaltic andesites on the trace element-based classification diagram (Fig. 6a). They occupy the calc-alkaline basalt field on the Th-Zr-Nb diagram (Fig. 6c) and exhibit a pronounced negative Nb anomaly and a slight negative Ti anomaly on primitive mantle-normalized multi-element plots (Fig. 7a). Felsic rocks of the Little Kalzas succession are rhyolitic in



136°00'
55'
50'
45'
40'
35'
135°30'
63°00'
Tintina
LITTLE KALZAS LAKE
Fault
Macmillan
River
Pelly
River
Tatlmain batholith
True North
1°26'
32°49'
Grid North
Magnetic North
APPROXIMATE MEAN DECLINATION 1961
FOR CENTRE OF MAP
Annual change decreasing 2.9'
62°45'
geological contact
dextral fault
biotite isograd
garnet isograd
limit of outcrop
winter road
LITTLE KALZAS LAKE
(NTS 105L/13)
YUKON TERRITORY
Miles
Km
49
mineral occurrence
(Yukon Minfile 105L 049)
fossil occurrence
geochemistry sample

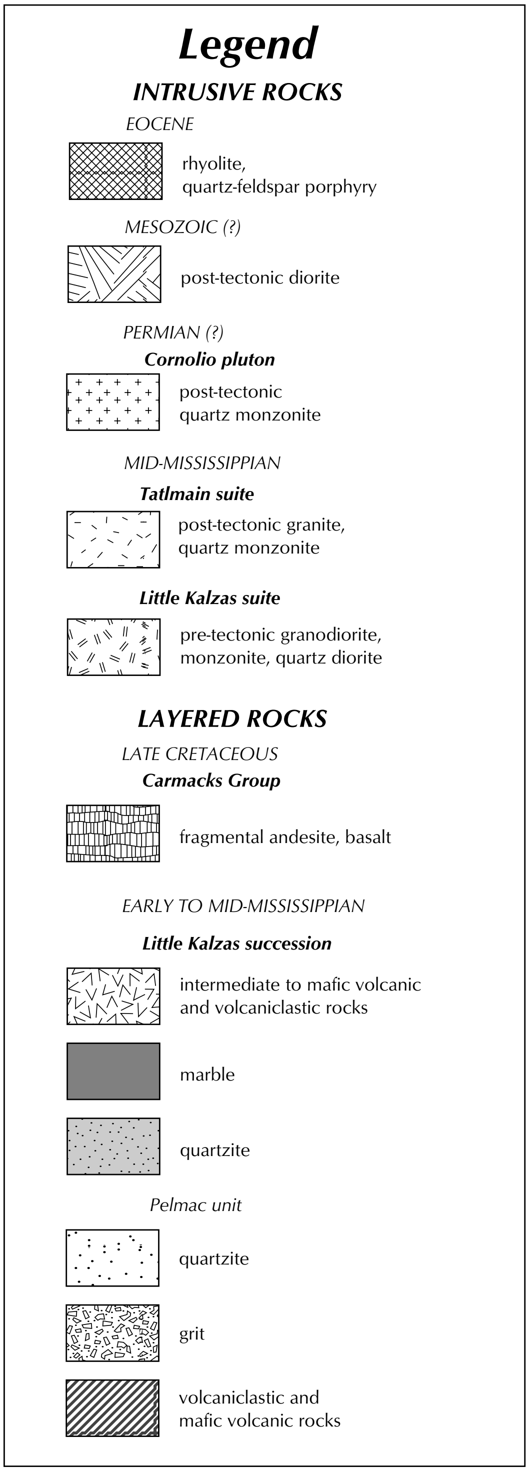


Figure 4. *Geological map of Little Kalzas Lake area. Modified after Colpron (1998). Arabic numerals refer to geochemical analyses listed in Table 1; roman numerals to those in Table 3; capital letters to analyses presented in Table 4.*

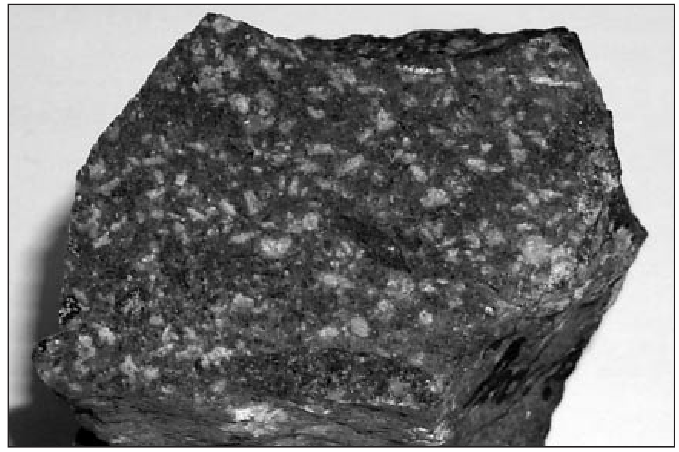


Figure 5. *Plagioclase-phyric andesite, Little Kalzas succession. Hand specimen is approximately 5 cm across.*

composition (Fig. 6a) and plot in the volcanic arc field on the Ta-Yb diagram (Fig. 6d). Their trace element pattern exhibit negative anomalies in Nb and Ti typical of the calc-alkaline magma series. High Th/Yb ratios for the andesites (Fig. 8) and the ubiquitous Proterozoic inheritance in zircons from comagmatic felsic rocks (J.K. Mortensen, pers. comm., 1999) suggest contamination from (or melting of) a crustal source. Together, these geochemical charateristics suggest a continental arc setting for the Little Kalzas succession.

LITTLE KALZAS INTRUSIVE SUITE

Granitoid rocks of the Little Kalzas intrusive suite are broadly coeval with volcanic rocks of the Little Kalzas succession (343-346 Ma; Colpron et al., 2000) and are likely their subvolcanic equivalent. They form a large intrusive complex southwest of Little Kalzas Lake and occur as a small pluton intruding quartzite and volcaniclastic rocks of the Pelmac unit in the northeastern part of the map area (Fig. 4). The dominant phase of the Little Kalzas suite consists of a fine- to medium-grained biotite (± hornblende) diorite, which is intruded by a tonalitic phase (Figs. 9, 10a). These rocks are strongly foliated and contain abundant xenoliths of country rocks. Both dioritic and tonalitic phases of the Little Kalzas suite have peraluminous compositions (Fig. 10b). Along Macmillan River, the Little Kalzas suite is represented by a metaluminous potassium-feldspar megacrystic granite (Fig. 10 a,b). The Little Kalzas suite occupies the volcanic arc field on discriminant diagrams (Fig. 10 c,d) and exhibits trace element patterns typical of arc granites (Fig. 11a). The rare earth element patterns illustrate the differentiated nature of the Little Kalzas suite (Fig. 11b).

LITTLE SALMON SUCCESSION

The Little Salmon succession is exposed in a 4- to 8-km-wide belt which extends northwesterly from the eastern part of Little Salmon Lake (Fig. 12). It occupies a broad synclinorium and rests with apparent unconformity on arkosic grit and quartzite of the Drury unit to the northeast, and on metamorphic rocks of the Snowcap assemblage to the southwest (Fig. 3; Colpron and Reinecke, 2000). The Little Salmon succession is structurally overlain by an allochthonous sheet of dark grey siliceous phyllite with subordinate graded sandstone, conglomerate and marble (Bearfeed allochthon; Fig. 12). Rocks of the Bearfeed allochthon may correlate with the basal part of Boswell/Semenof succession (Tempelman-Kluit *in:* Gordey et al., 1991).

The Little Salmon succession is dominated by volcaniclastic rocks (both epiclastic and tuffaceous, Colpron and Reinecke, 2000). A prominent marble unit of late Mississippian – early Pennsylvanian age (E.W. Bamber *in:* Colpron and Reinecke, 2000) occurs in the lower part of the Little Salmon succession (Figs. 3, 12). Dacite and quartz-feldspar porphyry mark the base of the sequence

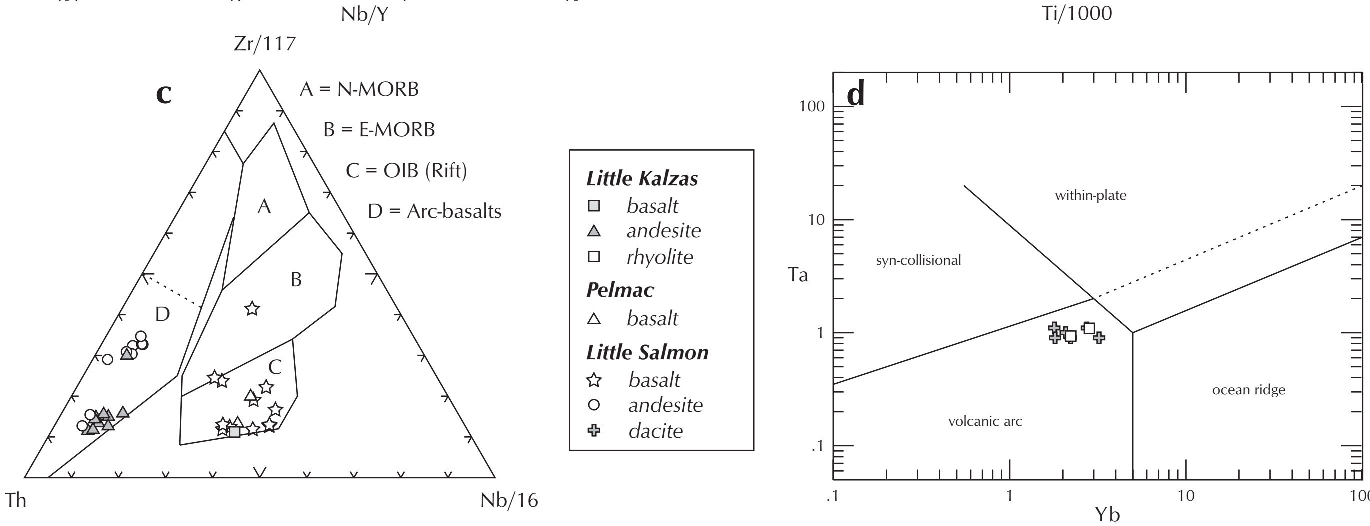


Figure 6. *Discriminant diagrams for volcanic rocks of Yukon-Tanana Terrane in Glenlyon map area. (a) Zr/Ti-Nb/Y diagram of Winchester and Floyd (1977) as modified by Pearce (1996). (b) Ti-V diagram of Shervais (1982). IAT = island arc tholeiite; BON = boninite; OFB = ocean-floor basalt; MORB = mid-ocean ridge basalt; BAB = back-arc basin. (c) Th-Zr-Nb diagram of Wood (1980). MORB = mid-ocean ridge basalt; N-MORB = normal MORB; E-MORB = enriched MORB; OIB = ocean island basalt. (d) Ta-Yb diagram of Pearce et al. (1984) for felsic volcanic rocks of the Glenlyon area. Analytical data are presented in Tables 1-3.*

near Little Salmon Lake, along the western flank of the synclinorium (Fig. 12). A small sulphide occurrence is present at the base of the felsic volcanic unit (Colpron, 1999b). Zircons from the quartz-feldspar porphyry yielded a U-Pb age of ca. 340 Ma (Colpron et al., 2000).

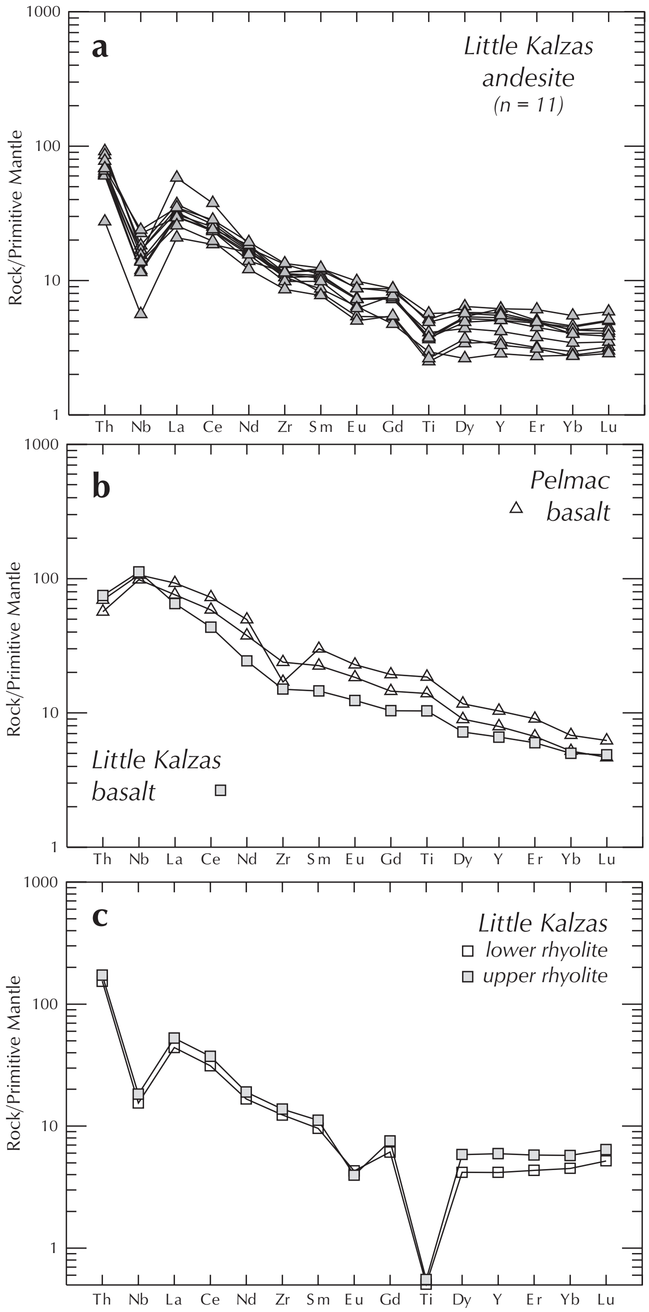


Figure 7. *Primitive mantle-normalized multi-element diagrams for volcanic rocks of the Little Kalzas succession. Primitive mantle values are from Sun and McDonough (1989). Analytical data are presented in Tables 1 and 3.*

Volcanic rocks of intermediate composition (with subordinate mafic and felsic phases) form prominent exposures on the south-facing slopes overlooking Little Salmon Lake (Fig. 12). These rocks are generally massive; pillow structures were observed at only one locality. Intermediate volcanic rocks grade laterally into tuffaceous rocks and epiclastic phyllite and sandstone. Along strike to the northwest, they occur as isolated lenses within the volcaniclastic rocks.

A distinctive plagioclase-phyric volcanic unit of intermediate composition is ubiquitous above the marble in the northwestern exposures of the Little Salmon

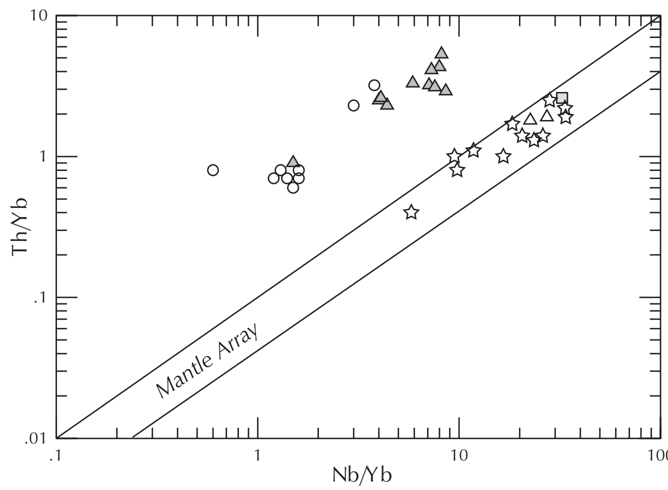


Figure 8. *Th/Yb vs. Nb/Yb diagram for intermediate and mafic volcanic rocks of Yukon-Tanana Terrane in Glenlyon map area. Legend for symbols is shown in Figure 6. Enrichment in Th/Yb ratio (relative to mantle array) indicates either crustal contamination or subducted slab metasomatism.*

Figure 9. *Tonalite dyke intruding diorite, Little Kalzas intrusive suite.*

succession (Figs. 12, 13a). It contains up to 40-50% coarse (up to 3 cm), subhedral to euhedral plagioclase crystals in a fine-grained chloritic matrix. The abundance and large size of the plagioclase crystals suggest that these rocks may represent high-level subvolcanic intrusions. However, fine intercalations of dolostone and epiclastic sandstone with the crystal-rich volcanic rocks indicate that at least part of this unit has an extrusive origin.

In the northwestern part of the map area (Fig. 12), the Little Salmon succession comprises a higher proportion of mafic flows and agglomerates. Plagioclase- and hornblende-phyric basalts are dominant lithologies. The basalts commonly display well-preserved pillow structures (Fig. 13b). Fragmental units, including pillow breccias and mass-flow deposits (poorly sorted, polymictic breccia with sericitic and/or hematitic matrix), are common adjacent to basaltic flow units. The basalts are intercalated with lapilli tuffs and reworked volcaniclastic rocks.

Two cherty horizons occur in the upper part of the Little Salmon succession in the nortwestern part of the map area (Fig. 14). These siliceous rocks can be traced for up to 4 km along strike (Colpron, 2000). They were originally mapped as rhyolite on account of their very fine grain size and massive appearance (Colpron, 2000). However, their high silica (80-95% SiO_2), low potassium (<0.25% K_2O), and low zirconium (<50 ppm Zr) contents do reflect a rhyolitic composition (Colpron, unpublished data). The lower horizon is light grey to light green and commonly contains brown-weathering dolomitic pods. Adjacent

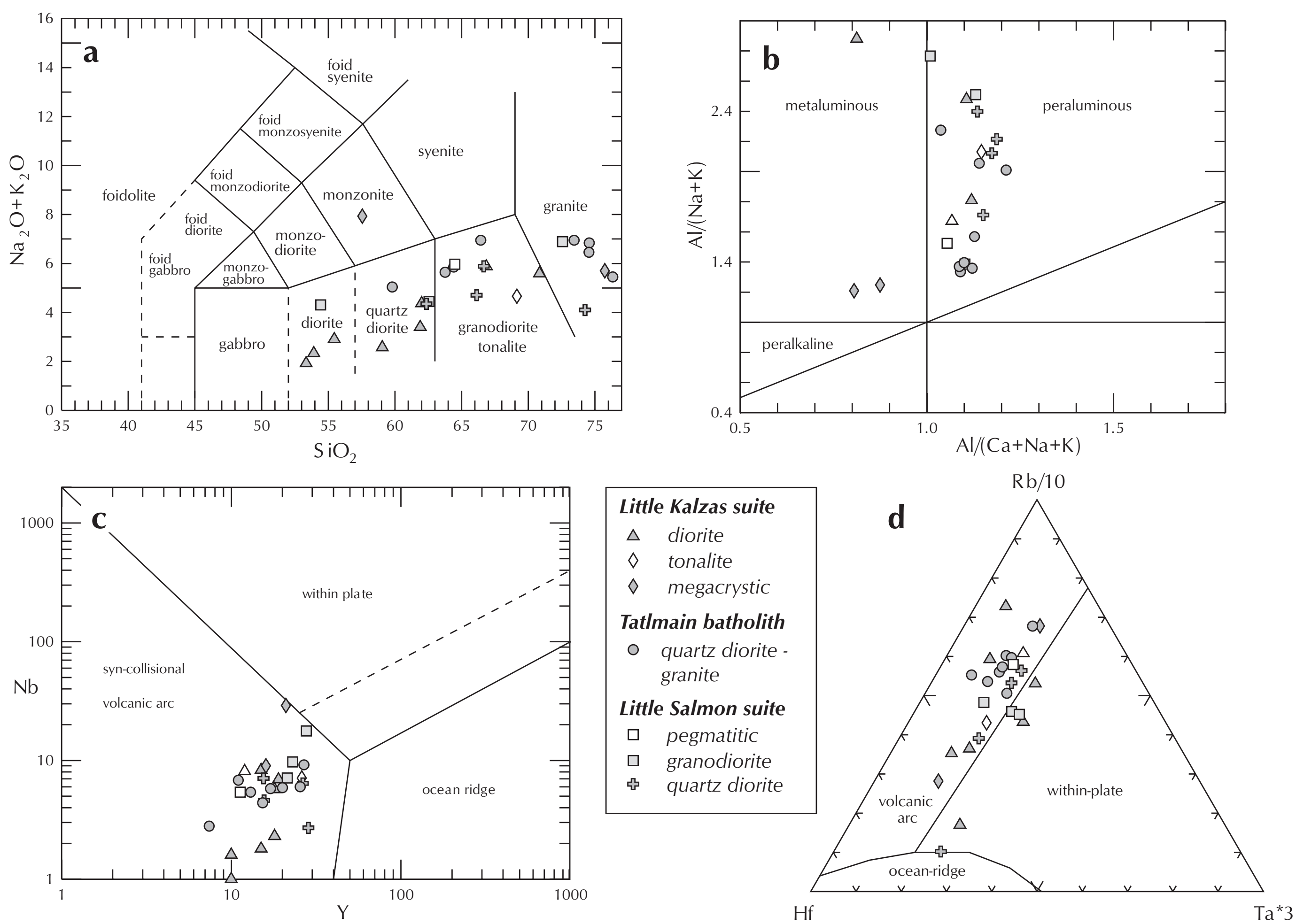


Figure 10. *Discriminant diagrams for Mississippian granitoids of Yukon-Tanana Terrane in Glenlyon map area. (a) Total alkalis – silica diagram of LeBas et al. (1986) adapted for plutonic rocks using the nomenclature of Le Maitre et al. (1989). (b) Shand's index diagram of Maniar and Piccoli (1989). (c) Nb-Y diagram of Pearce et al. (1984). (d) Hf-Rb-Ta diagram of Harris et al. (1986). Analytical data are listed in Table 4.*

basalt exposures also contain dolomitic pods. The upper siliceous horizon is light grey, purple and pink in colour and is gradationally overlain by a 50-cm-thick red piemontite (Mn-rich epidote) chert horizon. This horizon is interpreted as an exhalative unit. It is restricted to a single locality in the map area (Fig. 12).

Intermediate rocks of the Little Salmon succession are andesitic in composition (Fig. 6a). They plot in the calc-alkaline arc field on the Th-Zr-Nb diagram (Fig. 6c). The felsic rocks have dacitic to trachy-andesitic compositions (Fig. 6a) and plot in the volcanic arc field on a Ta-Yb diagram (Fig. 6d). Both andesites and dacites have trace

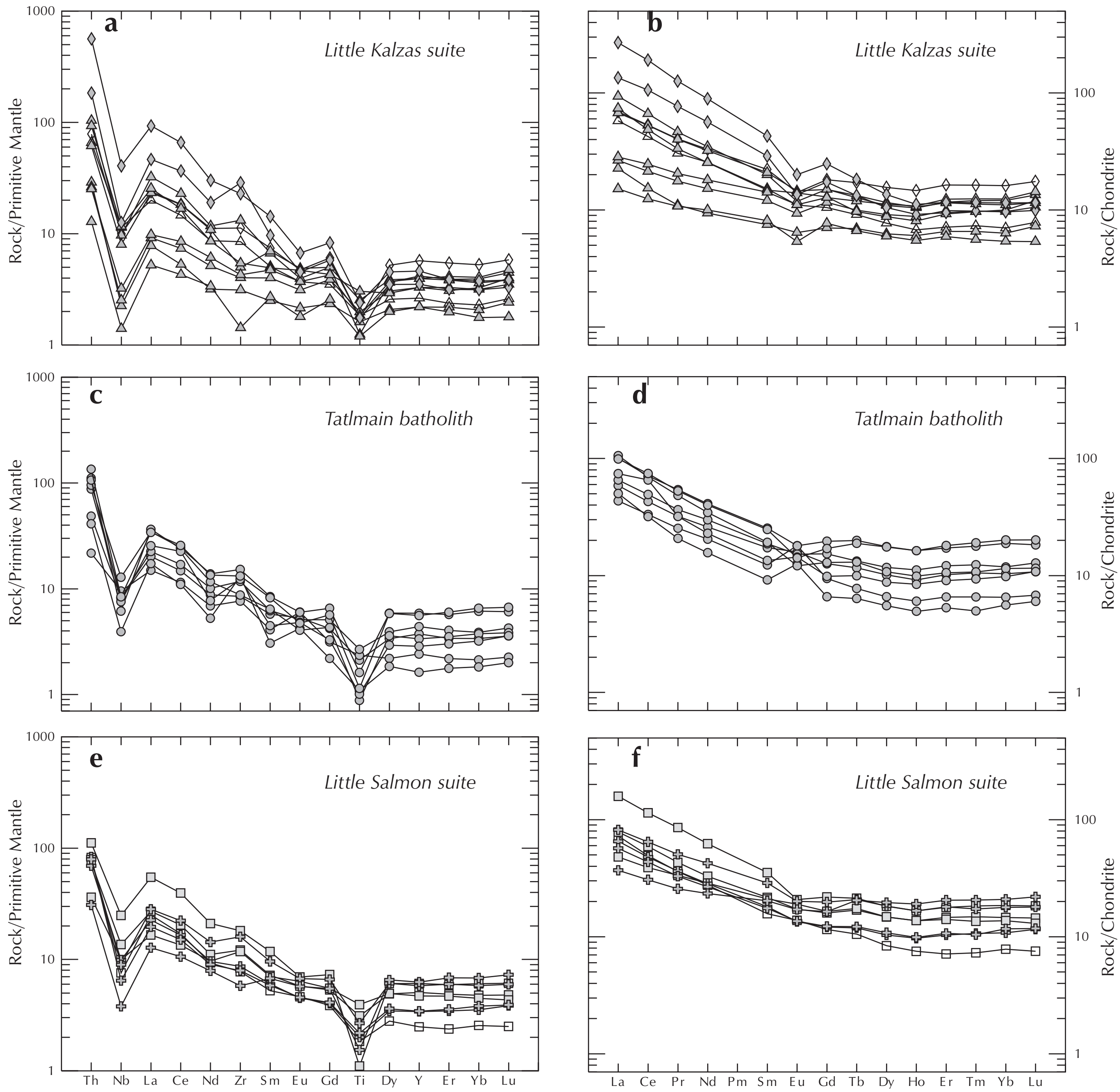
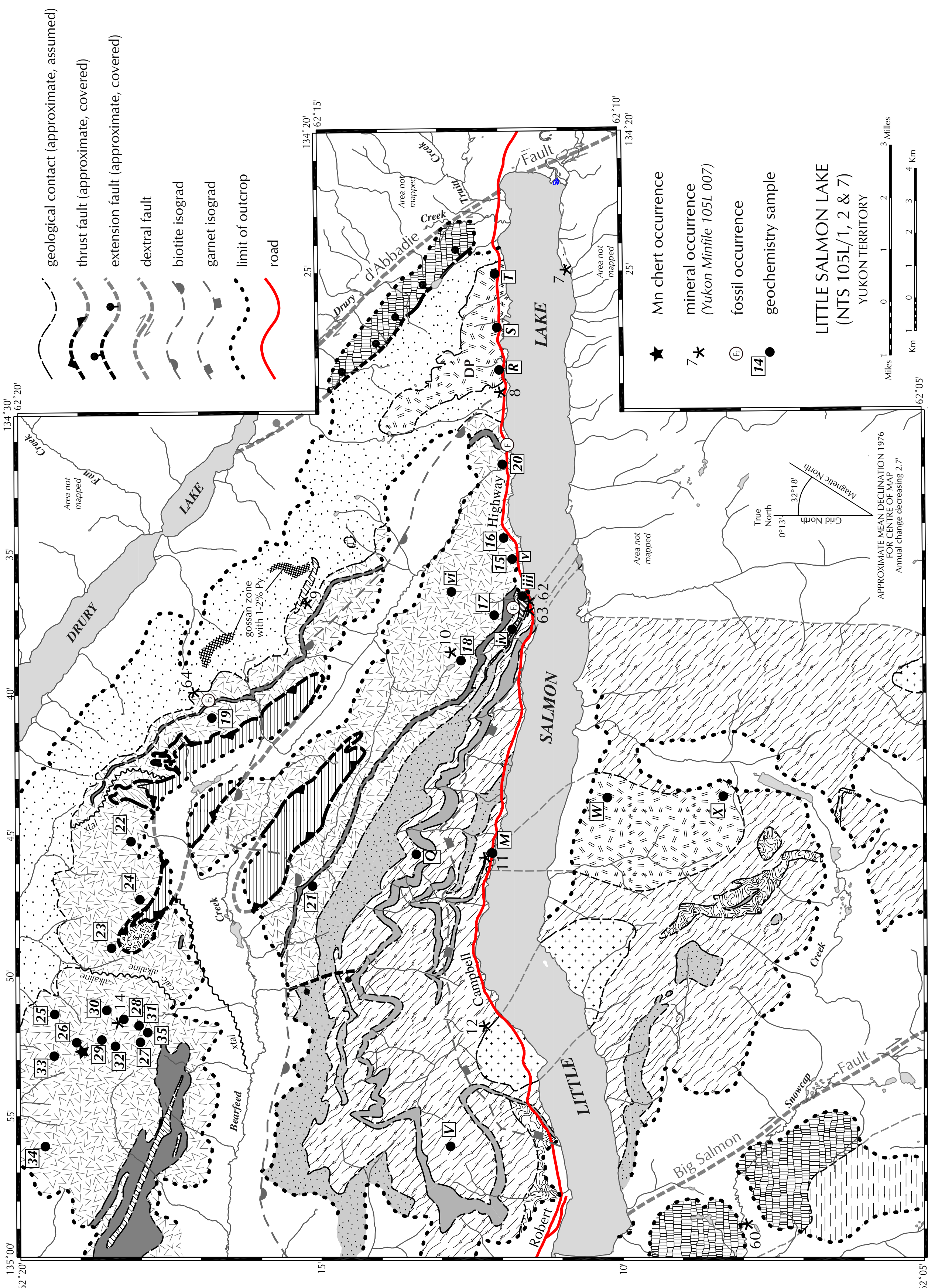


Figure 11. *Primitive mantle-normalized multi-element diagrams (a,c,e) and chondrite-normalized rare earth element patterns (b,d,f) for Mississippian granitoids of Yukon-Tanana Terrane in Glenlyon map area. Primitive mantle values are from Sun and McDonough (1989). Chondrite values are from McDonough and Sun (1995). Analitical data is given in Table 4. Legend for symbols is shown in Figure 10.*


geological contact (approximate, assumed)
thrust fault (approximate, covered)
extension fault (approximate, covered)
dextral fault
biotite isograd
garnet isograd
limit of outcrop
road
Mn chert occurrence
mineral occurrence
(Yukon Minfile 105L 007)
fossil occurrence
geochemistry sample
LITTLE SALMON LAKE
(NTS 105L/1, 2 & 7)
YUKON TERRITORY
APPROXIMATE MEAN DECLINATION 1976
FOR CENTRE OF MAP
Annual change decreasing 2.7'
LITTLE SALMON LAKE
DRURY LAKE
Campbell Highway
d'Abbadie Fault
Big Salmon Fault
gossan zone
with 1-2% Py
Area not mapped

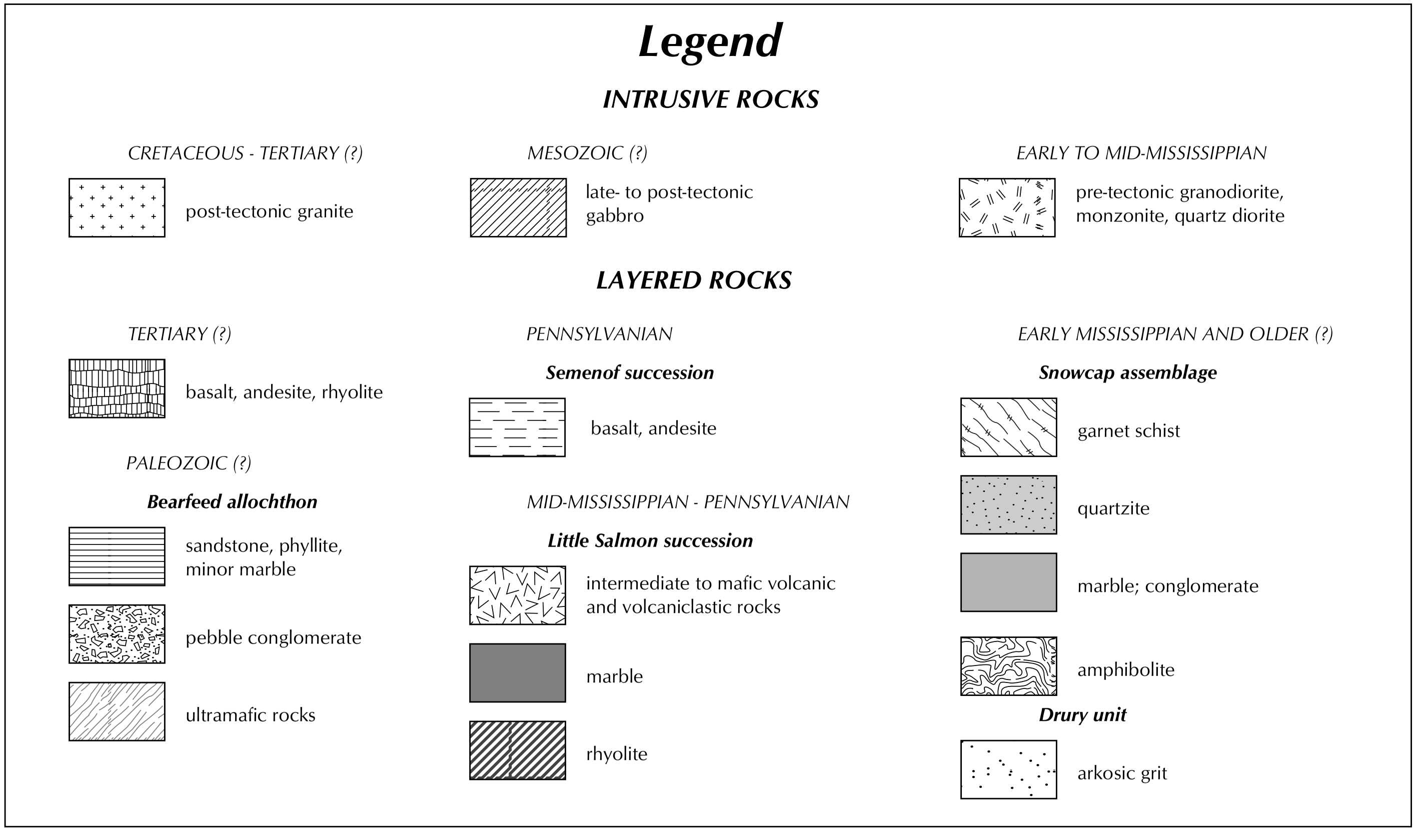


Figure 12 (left). *Geological map of Little Salmon Lake area (Colpron, 2000). Wavy line labelled 'xtal' indicates the southern extent of crystal-rich (plagiocalse-phyric) volcanic rocks. Wavy line labelled 'alkaline/calc-alkaline' indicates approximate location of transition between calc-alkaline (to the southwest) and alkaline compositions (to the northwest). Arabic numerals refer to geochemical analyses presented in Table 2; roman numerals to those in Table 3; capital letters to analyses shown in Table 4. DP = Drury pluton.*

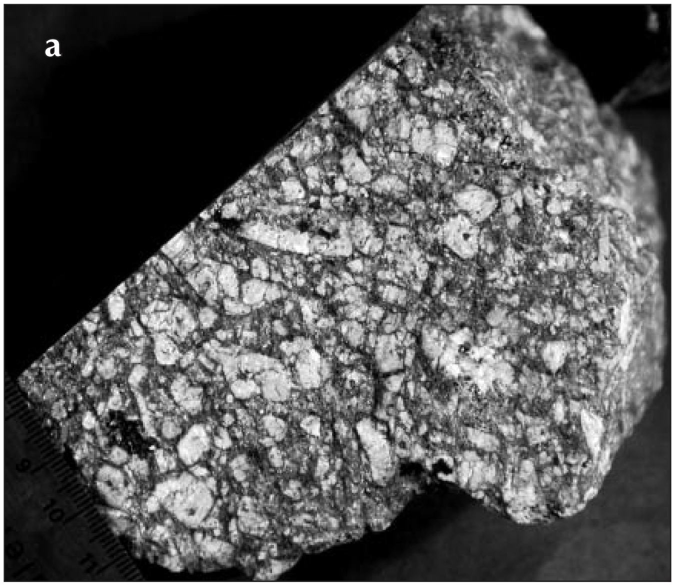


Figure 13. *(a) Plagioclase-phyric volcanic unit, Little Salmon succession. Hand specimen is approximately 9 cm across. (b) Pillow basalt, Little Salmon succession.*

element patterns characteristic of calc-alkaline magmas (Figs. 15 a,c). The dacite displays a distinctive positive Zr anomaly relative to Nd and Sm on primitive mantle-normalized multi-element plots (Fig. 15c). Proterozoic inheritance in zircons from the felsic rocks (J.K. Mortensen, pers. comm., 1999) and elevated Th/Yb ratios in the andesites (Fig. 8) indicate interaction of the magma with continental crust. These rocks probably formed in a continental arc setting.

The mafic rocks are basalts of subalkaline to alkaline affinities (Fig. 6 a,b). They plot in the ocean island basalt (OIB) field of the Th-Zr-Nb diagram (Fig. 6c) and have trace element patterns typical of alkali basalts (Fig. 15b). These geochemical characteristics are typical of rift environments (e.g. Goodfellow et al., 1995).

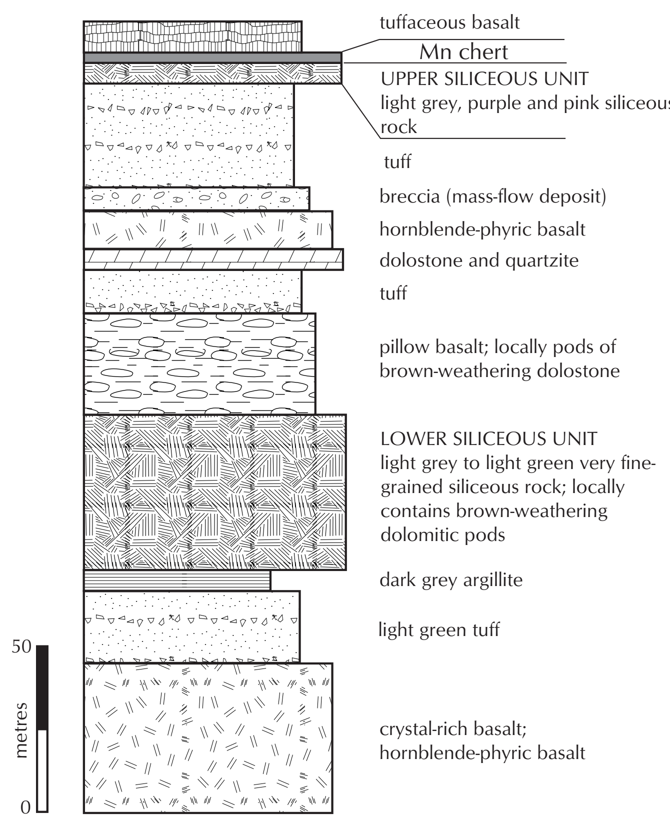


Figure 14. *Stratigraphy of the upper part of Little Salmon succession in northwestern Little Salmon Lake map area.*

TATLMAIN BATHOLITH AND LITTLE SALMON SUITE

The post-tectonic Tatlmain batholith intrudes deformed early Mississippian strata of Yukon-Tanana Terrane in northwest Glenlyon (Fig. 2). A Late Triassic – Early Jurassic age was assigned to the Tatlmain batholith based on biotite K-Ar cooling dates in Carmacks map area (Fig. 16; Stevens et al., 1982; Tempelman-Kluit, 1984). Preliminary U-Pb zircon age data indicate a mid-Mississippian age (ca. 340 Ma; Colpron et al., 2000). Tatlmain batholith is an undeformed, homogeneous, coarse-grained biotite (± hornblende) quartz diorite to granite over its entire area (Figs. 10a, 16). The only compositional variation observed in Tatlmain batholith is in the amount of mafic minerals present; biotite, and less commonly hornblende, represent 5-15% of the rock. Tatlmain batholith imposes a metamorphic aureole on quartzite and calc-silicate rocks of the Pelmac unit south of Pelly River. Near Diamain Lake, the coarse-grained granite contains xenoliths of foliated, fine-grained granodiorite similar to the main phase of the 343-346 Ma Little Kalzas suite (Figs. 16, 17).

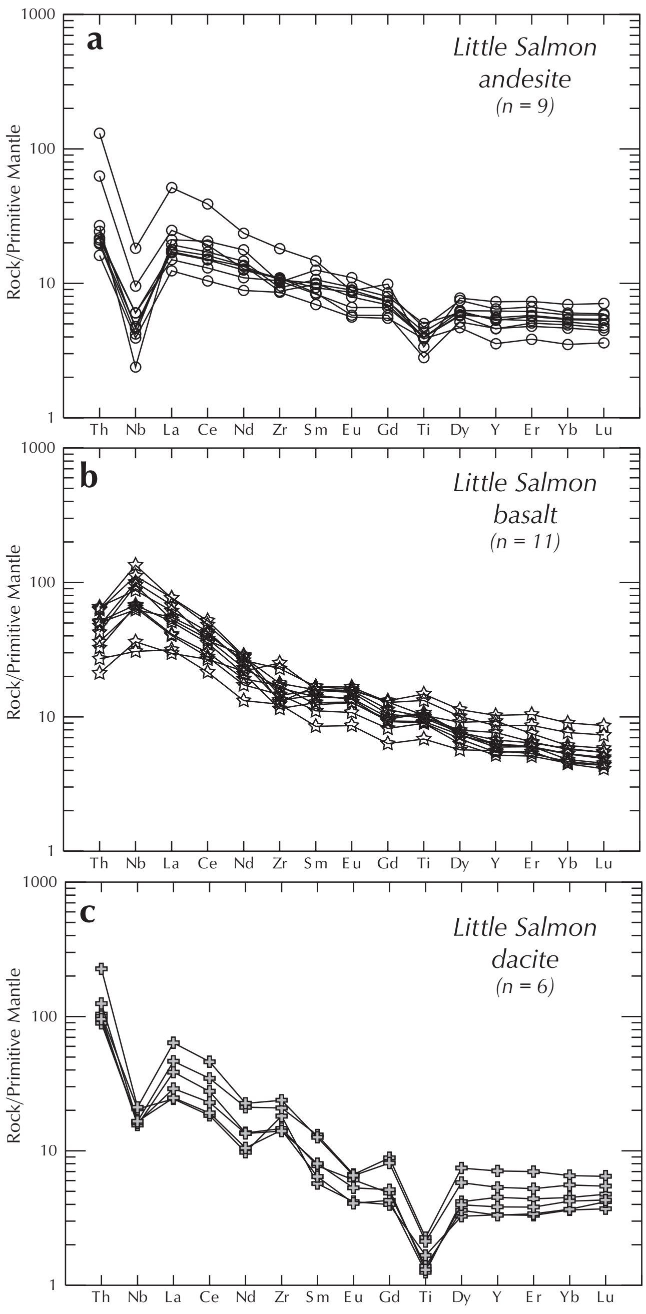


Figure 15. *Primitive mantle-normalized multi-element diagrams for volcanic rocks of the Little Salmon succession. Primitive mantle values are from Sun and McDonough (1989). Analytical data are presented in Tables 2 and 3.*

The Tatlmain granite has a peraluminous composition and plots in the volcanic arc field of discriminant diagrams (Fig. 10 b-d). Trace element and rare earth patterns also suggest a magmatic arc setting (Fig. 11 c,d). Primitive-mantle multi-element patterns for Tatlmain batholith (Fig. 11c) exhibit positive Zr anomalies similar to those of felsic volcanic rocks in the Little Salmon succession (Fig. 15c). The correspondence between the composition and age of the Tatlmain batholith and the base of Little Salmon succession strongly suggests that they are comagmatic.

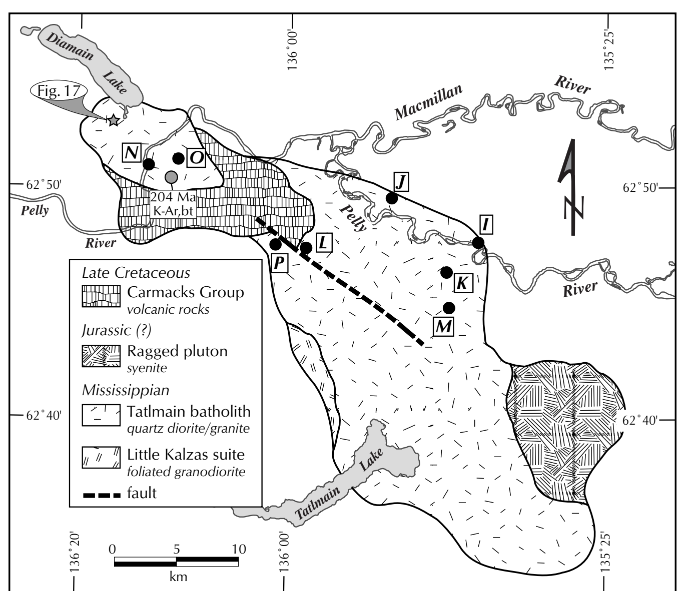


Figure 16. *Location map for geochemistry samples from Tatlmain batholith. Analytical data are presented in Table 4. K-Ar biotite date is from Stevens et al. (1982) and Tempelman-Kluit (1984). Location of outcrop displayed in Figure 17 is indicated.*

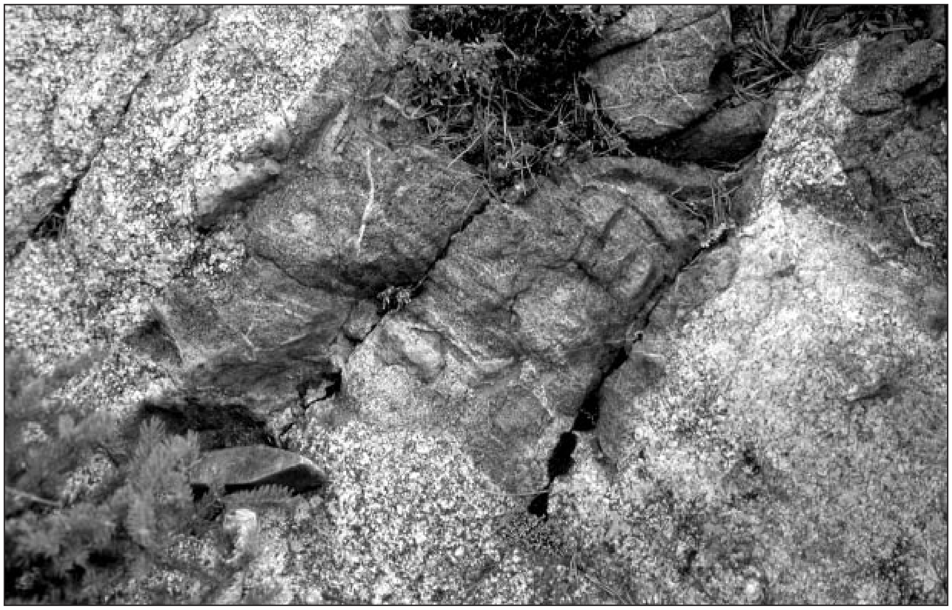


Figure 17. *Xenolith of foliated granodiorite (Little Kalzas intrusive suite) in undeformed, coarse-grained granite of the Tatlmain batholith. Outcrop location is shown in Figure 16.*

Near Little Salmon Lake, units underlying the Little Salmon succession (Drury unit and Snowcap assemblage) are intruded by plutons which have preliminary U-Pb ages similar to that of Tatlmain batholith (J.K. Mortensen, pers. comm., 2000). These intrusions are included in the Little Salmon suite. At the east end of Little Salmon Lake, a granodiorite pluton intrudes the Drury unit (Drury pluton; Fig. 12). Zircons from this pluton yielded a discordant U-Pb age of 353 ± 1.4 Ma (Oliver and Mortensen, 1998). Preliminary results on another sample from the Drury pluton suggest that its age may be somewhat younger (ca. 340 Ma; J.K. Mortensen, pers. comm., 2000). The Drury pluton consists of variably foliated, homogeneous, fine- to medium-grained, equigranular biotite ± hornblende granodiorite. Skarn is locally developed in calcareous rocks of the Drury unit near the contact with the pluton.

A large body of quartz diorite to granodiorite intrudes the Snowcap assemblage near the centre of Little Salmon Lake (Fig. 12). The rock is moderately to strongly foliated, fine- to medium-grained, and contains hornblende and, locally, biotite. Muscovite is a common constituent of this rock; it probably formed as a result of low grade metamorphism of original potassium-feldspar in the granodiorite. A skarn is present along the northern margin of this pluton; a nearby sample of hornblende granodiorite also contains traces of molybdenite.

A sill of very coarse-grained (pegmatitic), foliated hornblende tonalite is also included in Little Salmon intrusive suite. It consists almost exclusively of plagioclase and hornblende, with hornblende commonly occurring as crystals up to several centimetres long.

All intrusive bodies of the Little Salmon suite have peraluminous compositions (Fig. 10b) and trace element characteristics of volcanic arc magmas (Figs. 10 c,d, 11 e,f). Trace element and rare earth patterns for Little Salmon suite (Fig. 11 e,f) are similar to those of Tatlmain batholith (Fig. 11 c,d), and dacite of the Little Salmon succession (Fig. 15c). Granitoids of the Little Salmon suite are considered comagmatic with the Tatlmain batholith and subvolcanic to calc-alkaline rocks of the Little Salmon succession due to their similar chemistry and preliminary U-Pb ages.

DISCUSSION

Ongoing bedrock mapping, geochronological and geochemical studies have outlined two distinct magmatic suites within Yukon-Tanana Terrane in Glenlyon map area (Figs. 2, 3). The early to mid-Mississippian Little Kalzas suite (Fig. 3) consists primarily of calc-alkaline andesites and minor alkali basalts (Fig. 6), and subvolcanic diorites (Fig. 10) which are interpreted to have formed in a continental arc setting. The slightly younger Tatlmain/ Little Salmon suite (mid-Mississippian to early Pennsylvanian; Fig. 3) intrudes previously deformed rocks of Little Kalzas succession and represents a second arc cycle. It consists of calc-alkaline andesites and alkali basalts (Fig. 6), and subvolcanic intrusions ranging in composition from quartz diorite to granite (Fig. 10). Volcanic rocks from both the Little Kalzas and Little Salmon successions have mixed calc-alkaline and alkaline (OIB) geochemical signatures (Figs. 6, 7, 15). In the Little Kalzas succession, alkali basalt both underlies and overlies the calc-alkaline volcanic rocks. In the Little Salmon succession, alkali basalt appears to be laterally continuous with the calc-alkaline andesite (Fig. 12). The occurrence of alkaline rocks within continental arc sequences of Yukon-Tanana Terrane is most reasonably interpreted to indicate episodic rifting of the arc. It is also noteworthy that the two main pulses of arc magmatism documented here are punctuated by an episode of contractional deformation (Fig. 3; Colpron et al., 2000). Taken together, stratigraphic, structural, geochronological and geochemical data suggest that Yukon-Tanana Terrane originated in a dynamic continental arc setting which was punctuated by episodes of arc rifting and arc shortening.

IMPLICATIONS FOR VOLCANOGENIC MASSIVE SULPHIDE EXPLORATION

Little Salmon succession hosts a small sulphide occurrence at its base and has exhalative rocks (Mn chert) intercalated with alkali basalts higher up in the section (Figs. 3, 12). The geochemical data presented here clearly shows that arc magmatism in Yukon-Tanana Terrane of Glenlyon map area was punctuated by arc-rifting events. Episodes of arc rifting have been recognized as a significant factor in generation and preservation of volcanogenic massive sulphide deposits (e.g., van Staal et al., 1991; Syme et al., 1996). The occurrence of Mn-rich exhalative rocks in the rifted arc sequence at Little Salmon (Fig. 12) clearly shows that hydrothermal systems were operational during arc rifting. Occurrences of similar Mn-rich exhalite (of possible mid-Mississippian to early Pennsylvanian age) are scattered along the length of Yukon-Tanana Terrane in southern Yukon and northern British-Columbia (Fig. 1; Yukon MINFILE, 1997, 105C 017; Mihalynuk et al., 2000; Nelson et al., 2000), an area which, so far, has received little exploration attention on account of its complex and poorly understood geology. Ongoing studies along this belt are now providing an evolving stratigraphic context which can help focus exploration strategies in this largely under-explored host for volcanogenic massive sulphides (Nelson et al., 2000; Colpron and Yukon-Tanana Working Group, this volume).

COMPARISON WITH FINLAYSON LAKE DISTRICT

Volcanic rocks of the Little Kalzas succession are broadly coeval with felsic volcanic rocks hosting the Wolverine deposit (ca. 345 Ma; S.J. Piercey, pers. comm., 2000; Nelson et al., 2000; Colpron and Yukon-Tanana Working Group, this volume). However, the Little Kalzas succession represents a continental arc, whereas the Wolverine succession formed in a back-arc environment (Piercey et al., 2000). It is uncertain at present whether these tectonic environments shared a common paleogeographic setting. Granitoids from both the Little Kalzas intrusive suite, in Glenlyon area, and the Simpson Range plutonic suite, in Finlayson Lake district, have similar compositions (Piercey et al., 1999) and ages (Mortensen, 1992) and may provide the link between these two regions.

Perhaps the best possible link between Yukon-Tanana stratigraphy northeast of Tintina Fault and that of the terrane southwest of the fault lies in the apparent age and lithologic correspondence between the Pennsylvanian Boswell/Semenof succession (Tempelman-Kluit *in:* Gordey et al., 1991) and the Pennsylvanian section of the Finlayson Lake district (Murphy, this volume).

ACKNOWLEDGEMENTS

The results presented here are based on mapping and sampling of volcanic rocks in Glenlyon area over the past three field seasons, during which the assistance of Alana Rawlings, Melanie Reinecke and Reid Kennedy were appreciated. Discussions with Steve Piercey, Don Murphy, Jim Mortensen and Jan Peter have influenced various aspects of this project. The manuscript has benefited from critical reviews by Steve Piercey and Don Murphy, and editorial comments by Leyla Weston.

REFERENCES

Campbell, R.B., 1967. Geology of Glenlyon map-area, Yukon Territory (105 L). Geological Survey of Canada, Memoir 352, 92 p.

Colpron, M., 1998. Preliminary geological map of Little Kalzas Lake area, central Yukon (NTS 105L/13). Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, Open File 1998-3, 1:50 000 scale.

Colpron, M., 1999a. Glenlyon Project: Preliminary stratigraphy and structure of Yukon-Tanana Terrane, Little Kalzas Lake area, central Yukon (105L/13). *In:* Yukon Exploration and Geology 1998, C.F. Roots and D.S. Emond (eds.), Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p. 63-72.

Colpron, M., 1999b. A new mineral occurrence in Yukon-Tanana Terrane near Little Salmon Lake, central Yukon (NTS 105L/2). *In:* Yukon Exploration and Geology 1998, C.F. Roots and D.S. Emond (eds.), Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p. 255-258.

Colpron, M., 2000. Geological map of Little Salmon Lake (parts of NTS 105L/1, 2 & 7), central Yukon (1:50 000 scale). Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, Open File 2000-10, 1:50 000 scale.

Colpron, M. and Reinecke, M., 2000. Glenlyon Project: Coherent stratigraphic succession from Little Salmon Range (Yukon-Tanana Terrane), and its potential for volcanic-hosted massive sulphide deposits. *In:* Yukon Exploration and Geology 1999, D.S. Emond and L.H. Weston (eds.), Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p. 87-100.

Colpron, M., Murphy, D.C. and Mortensen, J.K., 2000. Mid-Paleozoic tectonism in Yukon-Tanana Terrane, northern Canadian Cordillera: record of intra-arc deformation. Geological Society of America, Cordilleran Section, Abstracts with Programs, vol. 32, no. 6, p. A-7.

Colpron, M. and Yukon-Tanana Working Group, 2001 (this volume). Ancient Pacific Margin – An update on stratigraphic comparison of potential volcanogenic massive sulphide-hosting successions of Yukon-Tanana Terrane, northern British Columbia and Yukon. *In:* Yukon Exploration and Geology 2000, D.S. Emond and L.H. Weston (eds.), Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p. 97-110.

Garagan, T., 1990. 1989 exploration report on the Snowcap project; magnetometer and VLF-EM surveys on the Goo claim. Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, Assessment Report 092835, 11 p.

Goodfellow, W.D., Cecile, M.P. and Leybourne, M.I., 1995. Geochemistry, petrogenesis, and tectonic setting of lower Paleozoic alkalic and potassic volcanic rocks, Northern Canadian Cordillera Miogeocline. Canadian Journal of Earth Sciences, vol. 32, p. 1236-1254.

Gordey, S.P. and Makepeace, A.J., 1999. Yukon Digital Geology. S.P. Gordey and A.J. Makepeace (comp.), Geological Survey of Canada Open File D3826, Exploration and Geological Services Division, Yukon, Indian and Northern Affairs, Canada, Open File 1999-1 (D).

Gordey, S.P., Geldsetzer, H.H.J., Morrow, D.W., Bamber, E.W., Henderson, C.M., Richards, B.C., McGugan, A., Gibson, D.W. and Poulton, T.P., 1991. Part A. Ancestral North America, Upper Devonian to Middle Jurassic Assemblages (Chapter 8). *In:* Geology of the Cordilleran Orogen in Canada, H. Gabrielse and C.J. Yorath (eds.), Geological Survey of Canada, Geology of Canada, No.4, p. 221-329. *(also Geological Society of America, The Geology of North America, vol. G-2)*.

Harris, N.B.W., Pearce, J.A. and Tindle, A.G., 1986. Geochemical characteristics of collision-zone magmatism. *In:* Collision tectonics, M.P. Coward and A.C. Reis (eds.), The Geological Society, Special Publication No. 19, p. 67-81.

Le Bas, M.J., Le Maitre, R.W., Streckeisen, A. and Zanettin, B., 1986. A chemical classification of volcanic rocks based on the total alkalis-silica diagram. Journal of Petrology, vol. 27, p. 745-750.

Le Maitre, R.W., Bateman, P., Dudek, A., Keller, J., Lameyre, J., Le Bas, M.J., Sabine, P.A., Schmid, R., Sorensen, H., Steckeisen, A., Woolley, A.R. and Zanettin, B., 1989. A classification of igneous rocks and glossary of terms. Blackwell Scientific Publications, Oxford, 193 p.

Maniar, P.D. and Piccoli, P.M., 1989. Tectonic discrimination of granitoids. Geological Society of America Bulletin, vol. 101, p. 635-643.

McDonough, W.F. and Sun, S.S., 1995. The composition of the Earth. Chemical Geology, vol. 120, p. 220-253.

Mihalynuk, M.G., Nelson, J., Roots, C.F., Friedman, R.M. and de Keijzer, M., 2000. Ancient Pacific Margin Part III: Regional geology and mineralization of the Big Salmon Complex (NTS 104N/9E, 16 & 104O/12,13,14W). *In:* Geological Fieldwork 1999, B.C. Ministry of Energy and Mines, Paper 2000-1, p. 27-45.

Mortensen, J.K., 1992. Pre-Mid-Mesozoic tectonic evolution of the Yukon-Tanana terrane, Yukon and Alaska. Tectonics, vol. 11, p. 836-853.

Murphy, D.C., 2001 (this volume). Yukon-Tanana Terrane in southwestern Frances Lake area (105H/3,4 and 5), southeastern Yukon. *In:* Yukon Exploration and Geology 2000, D.S. Emond and L.H. Weston (eds.), Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p. 217-233.

Nelson, J.L., Mihalynuk, M.G., Murphy, D.C., Colpron, M., Roots, C.F., Mortensen, J.K. and Friedman, R.M., 2000. Ancient Pacific Margin: A preliminary comparison of potential VMS-hosting successions of the Yukon-Tanana Terrane, from Finlayson Lake district to northern British Columbia. *In:* Yukon Exploration and Geology 1999, D.S. Emond and L.H. Weston (eds.), Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p. 79-86.

Oliver, D.H. and Mortensen, J.K., 1998. Stratigraphic succession and U-Pb geochronology from the Teslin suture zone, south central Yukon. *In:* Yukon Exploration and Geology 1997, Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p. 69-75.

Pearce, J.A., 1996. A user's guide to basalt discrimination diagrams. *In:* Trace element geochemistry of volcanic rocks: Applications for massive sulphide exploration, D.A. Wyman (ed.), Geological Association of Canada, Short Course Notes, Volume 12, p. 79-113.

Pearce, J.A., Harris, N.B.W. and Tindle, A.G., 1984. Trace element discrimination diagrams for the tectonic interpretation of granitic rocks. Journal of Petrology, vol. 25, p. 956-983.

Piercey, S.J., Hunt, J.A. and Murphy, D.C., 1999. Lithogeochemistry of meta-volcanic rocks from Yukon-Tanana Terrane, Finlayson Lake region, Yukon: Preliminary results. *In:* Yukon Exploration and Geology 1998, C.F. Roots and D.S. Emond (eds.), Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p. 125-138.

Piercey, S.J., Murphy, D.C., Mortensen, J.K. and Paradis, S., 2000. Arc-rifting and ensialic back-arc basin magmatism in the northern Canadian Cordillera: evidence from the Yukon-Tanana Terrane, Finlayson Lake region, Yukon. *In:* Slave-Northern Cordillera Lithospheric Evolution (SNORCLE) and Cordilleran Tectonics Workshop, F. Cook and P. Erdmer (eds.), Lithoprobe Report no. 72, p. 129-138.

Poulton, T., Orchard, M.J., Gordey, S.P. and Davenport, P., 1999. Selected Yukon fossil determinations. *In:* Yukon Digital Geology, S.P. Gordey and A.J. Makepeace (comp.), Geological Survey of Canada Open File D3826, Exploration and Geological Services Division, Yukon, Indian and Northern Affairs, Canada, Open File 1999-1.

Rollinson, H.R., 1993. Using geochemical data: evaluation, presentation, interpretation. Longman, 352 p.

Shervais, J.W., 1982. Ti-V plots and the petrogenesis of modern and ophiolitic lavas. Earth and Planetary Science Letters, vol. 59, p. 101-118.

Stevens, R.D., Delabio, R.N. and Lachance, G.R., 1982. Age determinations and geological studies: K-Ar isotopic ages, Report 15. Geological Survey of Canada, Paper 81-2, 56 p.

Sun, S.S. and McDonough, W.F., 1989. Chemical and isotopic systematics of oceanic basalts: implications for mantle composition and processes. *In:* Magmatism in ocean basins, A.D. Saunders and M.J. Norry (eds.), Geological Society of London, Special Publication 42, p. 313-345.

Syme, E.C., Bailes, A.H., Stern, R.A. and Lucas, S.B., 1996. Geochemical characteristics of 1.9 Ga tectonostratigraphic assemblages and tectonic setting of massive sulphide deposits in the Paleoproterozoic FlinFlon Belt, Canada. *In:* Trace element geochemistry of volcanic rocks: applications for massive sulphide exploration, D.A. Wyman (ed.), Geological Association of Canada, Short Course Notes Volume 12, p. 279-327.

Tempelman-Kluit, D.J., 1979. Transported cataclasite, ophiolite and granodiorite in Yukon: evidence of arc-continent collision. Geological Survey of Canada, Paper 79-14, 27 p.

Tempelman-Kluit, D.J., 1984. Geology, Laberge (105E) and Carmacks (105I), Yukon Territory. Geological Survey of Canada, Open File 1101, 1:250 000 scale.

van Staal, C.R., Winchester, J.A. and Bédard, J.H., 1991. Geochemical variations in Middle Ordovician volcanic rocks of the northern Miramichi Highlands and their tectonic significance. Canadian Journal of Earth Sciences, vol. 28, p. 1031-1049.

Wheeler, J.O. and McFeely, P., 1991. Tectonic assemblage map of the Canadian Cordillera and adjacent parts of the United States of America. Geological Survey of Canada, Map 1712A, 1:2 000 000 scale.

Wheeler, J.O., Brookfield, A.J., Gabrielse, H., Monger, J.W.H., Tipper, H.W. and Woodsworth, G.J., 1991. Terrane Map of the Canadian Cordillera. Geological Survey of Canada, Map 1713A, 1:2 000 000 scale.

Winchester, J.A. and Floyd, P.A., 1977. Geochemical discrimination of different magma series and their differentiation products using immobile elements. Chemical Geology (Isotope Geoscience Section), vol. 20, p. 325-343.

Wood, D.A., 1980. The application of a Th-Hf-Ta diagram to problems of tectonomagmatic classification and to establishing the nature of crustal contamination of basaltic lavas of the British Tertiary volcanic province. Earth and Planetary Science Letters, vol. 50, p. 11-30.

Yukon MINFILE, 1997. Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada.

Table 1. *Geochemistry of mafic and intermediate volcanic rocks from the Little Kalzas succession.*

1 SAMPLE[1] unit[2]	2 98MC028B Pbslt	3 98MC029B Pbslt	4 98MC061A LKand	5 98MC066B LKand	6 98MC067 LKand	7 98MC086 LKand	8 98MC087 LKand	9 98MC088 LKand	10 98MC089 LKand	11 98MC091 LKand	12 98MC153 LKand	13 98MC156 LKand	14 98MC162B LKand	98MC172 LKbslt
SiO_2	47.42	46.37	66.97	54.97	59.17	58.18	69.82	53.36	64.60	53.25	50.32	71.22	55.87	47.75
Al_2O_3	12.37	15.61	14.60	16.29	18.48	15.37	14.17	17.11	15.04	15.55	16.74	12.12	16.60	16.14
Fe_2O_3	11.08	13.96	4.24	9.00	5.84	7.32	2.98	10.92	6.42	8.82	11.22	3.93	8.73	10.69
MnO	0.19	0.18	0.15	0.17	0.17	0.17	0.02	0.21	0.62	0.15	0.14	-0.01	0.14	0.17
MgO	4.72	5.23	1.99	3.92	1.84	2.57	0.77	3.90	1.32	4.57	7.89	0.73	4.64	6.55
CaO	6.31	3.55	3.05	8.55	4.55	4.95	0.15	4.53	1.35	6.47	1.61	0.37	3.58	7.80
Na_2O	5.27	4.77	3.09	2.76	3.82	1.04	4.62	5.17	3.16	2.84	4.55	0.68	2.23	2.85
K_2O	0.01	0.05	4.33	2.55	5.11	6.58	2.97	0.64	4.39	2.33	1.64	7.70	3.51	2.92
TiO_2	3.02	4.01	0.54	0.83	0.83	0.89	0.64	1.11	0.79	0.81	1.23	0.57	1.06	2.24
P_2O_5	0.75	1.18	0.23	0.42	0.34	0.30	0.14	0.27	0.38	0.37	0.41	0.28	0.38	0.63
LOI	9.07	5.55	1.34	1.31	0.70	2.08	2.97	2.90	1.89	4.52	4.08	1.21	3.25	3.04
TOTAL	100.20	100.47	100.55	100.77	100.86	99.44	99.26	100.11	99.96	99.68	99.81	98.82	99.99	100.75
V	126	161	130	237	214	221	176	244	224	192	223	101	190	240
Cr	-10	-10	43	11	90	76	52	-10	59	30	539	49	26	104
Co	21	29	9	161	24	17	197	26	18	166	32	9	18	46
Ni	-10	-10	-10	39	-10	-10	115	-10	35	70	343	-10	-10	69
Cu	20	22	22	31	75	39	26	123	-10	49	64	17	25	54
Zn	68	83	49	80	242	80	72	94	620	90	126	45	155	121
Ga	19	27	15	20	22	18	16	19	18	18	19	13	19	20
Ge	1.5	1.3	1.3	1.9	1.3	1.4	1.2	0.9	1.9	1.3	2.2	1.4	1.7	1.5
As	-5	-5	-5	7	-5	-5	65	-5	17	10	-5	-5	6	-5
Rb	1	2	107	68	127	185	81	15	110	36	63	157	77	69
Sr	240	154	112	828	318	108	74	135	192	638	87	46	499	372
Y	36.0	47.0	16.0	24.0	23.0	19.0	13.0	28.0	28.0	23.0	26.0	15.0	25.0	30.0
Zr	267	190	129	118	148	126	118	129	125	110	128	96	150	168
Nb	70.0	76.0	12.0	8.5	13.0	12.0	11.0	4.0	10.0	8.2	16.0	9.8	17.0	80.0
Mo	0	1	0	6	0	1	52	1	0	6	1	0	0	12
Ag	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
In	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
Sn	2.0	2.0	1.0	1.0	1.2	0.9	4.4	4.7	1.2	0.9	1.3	0.9	1.4	1.6
Sb	1.13	0.88	0.53	1.79	0.49	0.32	3.21	0.58	1.41	4.49	0.75	1.04	0.73	0.68
Cs	-0.1	0.1	4.8	3.5	6.5	8.6	2.0	1.1	3.1	0.8	4.9	3.0	4.5	1.9
Ba	51	32	827	1322	1786	995	1228	606	839	1681	229	1261	1652	611
Hf	5.9	4.5	3.2	3.1	3.7	3.2	2.9	3.5	3.0	2.8	3.2	2.5	3.7	4.0
Ta	4.36	5.35	0.80	0.51	0.88	0.75	0.72	0.25	0.65	0.48	0.90	0.69	1.02	4.42
W	0.5	3.4	0.3	1.7	0.7	0.5	5.6	1.5	0.6	1.6	0.5	0.8	0.8	0.5
Tl	-0.05	0.06	0.45	0.44	0.50	0.57	2.46	0.16	0.66	1.02	0.30	0.59	0.31	0.86
Pb	-5	6	8	27	37	5	285	-5	49	51	6	-5	10	1
Bi	-0.05	0.13	0.12	0.25	0.14	0.07	0.89	0.21	0.09	0.22	0.19	0.07	0.09	0.00
Th	4.82	5.90	7.78	5.27	7.28	5.39	5.87	2.33	5.19	5.12	6.59	5.58	5.80	6.36
U	1.04	2.32	2.98	2.03	2.04	2.10	2.41	0.85	1.97	1.96	1.88	1.34	2.52	1.30
La	52.1	63.6	22.2	21.3	25.4	23.7	39.9	14.3	20.5	20.5	20.2	17.6	24.0	44.8
Ce	104.0	129.0	41.4	44.4	48.8	46.4	66.8	32.9	42.1	41.3	42.6	34.8	50.2	77.3
Pr	12.16	15.63	4.78	5.43	5.67	5.47	6.91	4.59	5.05	4.99	5.58	3.97	6.13	8.30
Nd	51.0	67.1	18.9	22.4	23.5	23.0	24.8	21.9	21.8	21.1	24.9	16.4	26.1	33.0
Sm	9.95	13.30	3.61	4.77	4.89	4.83	3.85	5.26	4.61	4.37	5.43	3.44	5.50	6.46
Eu	3.08	3.83	0.91	1.23	1.22	1.24	1.08	1.48	1.22	1.04	1.66	0.84	1.46	2.08
Gd	8.64	11.50	3.19	4.48	4.32	4.33	2.82	4.93	4.46	4.60	5.18	3.25	5.18	6.18
Tb	1.31	1.66	0.46	0.69	0.68	0.60	0.35	0.82	0.68	0.66	0.77	0.49	0.77	0.96
Dy	6.60	8.61	2.51	3.95	3.84	3.24	1.94	4.73	3.95	3.61	4.27	2.71	4.19	5.30
Ho	1.18	1.57	0.49	0.77	0.75	0.62	0.41	0.96	0.79	0.72	0.82	0.50	0.80	0.99
Er	3.20	4.33	1.52	2.35	2.31	1.81	1.31	2.92	2.42	2.15	2.38	1.49	2.35	2.88
Tm	0.444	0.600	0.237	0.330	0.354	0.267	0.209	0.438	0.358	0.314	0.340	0.220	0.318	0.414
Yb	2.56	3.36	1.46	2.11	2.22	1.69	1.37	2.70	2.26	1.99	2.11	1.35	1.97	2.47
Lu	0.344	0.460	0.237	0.328	0.368	0.258	0.222	0.434	0.375	0.300	0.311	0.212	0.285	0.360
Easting[3]	**454070**	**453904**	**461435**	**459960**	**459776**	**461850**	**462254**	**463518**	**463712**	**464840**	**466464**	**466841**	**467851**	**470241**
Northing	**6979247**	**6979016**	**6978786**	**6979788**	**6980105**	**6976099**	**6975747**	**6974587**	**6974532**	**6974783**	**6970635**	**6972325**	**6969422**	**6969873**

Analytical Method: Samples were prepared using a ceramic mill and analyzed for major, trace and rare-earth elements (REE) at Activation Laboratories in Ancaster, Ontario. Major element concentrations were determined by fusion X-ray fluorescence (XRF). Trace elements and REE were analyzed by inductively coupled plasma mass spectrometry (ICP-MS) at research detection limits.

Notes: [1]Samples are located with arabic numerals in Figure 4. [2]Unit and rock codes: *P* = Pelmac unit, *LK* = Little Kalzas succession. *bslt* = basalt, *and* = andesite. [3]UTM Zone 8, NAD27.

Table 2. *Geochemistry of mafic and intermediate volcanic rocks from Little Salmon succession.*

SAMPLE[1] unit[2]	15 99MC027-3 LSand	16 99MC028 LSand	17 99MC045 LSand	18 99MC081 LSand	19 99MC153 LSand	20 99MC030 LSbslt	21 99MC109 LStuff	22 00MC016 LSand	23 00MC023 LSand	24 00MC035 LSand
SiO_2	65.93	65.33	60.50	53.70	58.53	49.20	66.28	58.41	71.78	54.57
Al_2O_3	12.28	14.66	14.68	16.43	14.38	15.21	13.40	14.10	11.72	15.96
Fe_2O_3	7.88	7.14	9.68	11.34	9.41	12.79	6.93	9.55	5.15	11.46
MnO	0.16	0.12	0.19	0.22	0.19	0.17	0.15	0.16	0.12	0.22
MgO	2.95	2.25	3.93	4.09	3.10	4.05	2.11	3.20	2.53	3.23
CaO	4.09	2.37	3.24	5.56	5.86	8.13	1.22	5.96	1.42	5.56
Na_2O	2.70	1.60	4.22	5.60	3.46	4.60	5.57	2.86	2.90	3.50
K_2O	1.06	3.84	0.59	0.77	1.16	1.16	1.11	0.87	1.57	2.08
TiO_2	0.86	0.73	0.95	1.09	0.86	3.20	0.84	0.86	0.61	1.02
P_2O_5	0.21	0.24	0.22	0.24	0.20	0.51	0.17	0.18	0.14	0.31
LOI	2.77	2.38	2.65	1.79	3.37	1.92	1.10	2.51	2.24	2.39
TOTAL	100.89	100.66	100.83	100.82	100.51	100.93	98.89	98.65	100.18	100.30
V	190	100	255	209	259	312	105	181	108	305
Cr	-20	59	-20	-20	-20	-20	-20	-20	65	-20
Co	16	11	24	8	24	36	14	19	11	28
Ni	-15	29	16	-15	18	31	-15	-20	-20	-20
Cu	97	61	128	36	158	49	52	75	53	95
Zn	86	82	87	-30	87	74	65	109	103	93
Ga	14	18	17	4	13	18	5	19	16	21
Ge	1.3	1.5	1.4	-0.5	1.8	1.4	0.6	1.4	0.8	1.5
As	-5	-5	-5	-5	-5	-5	-5	-5	7	-5
Rb	27	125	9	11	15	22	22	15	45	35
Sr	277	313	945	278	385	261	41	588	92	359
Y	25.3	33.2	28.3	24.6	20.9	46.6	16.2	24.1	21.0	29.3
Zr	117	203	121	104	98	282	96	119	123	114
Nb	4.3	13.0	4.3	3.0	3.4	25.8	2.8	3.3	6.8	1.7
Mo	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Ag	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
In	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
Sn	-1.0	2.0	-1.0	-1.0	-1.0	2.0	-1.0	1.1	1.5	1.1
Sb	0.70	0.20	0.50	-0.20	0.40	0.60	-0.20	0.71	0.59	1.19
Cs	1.6	4.7	0.5	0.8	0.4	0.5	0.9	0.4	1.7	0.7
Ba	791	3630	369	403	1040	222	575	536	1250	1120
Hf	3.0	5.2	3.2	3.1	3.0	6.2	2.6	3.5	3.7	3.6
Ta	0.30	0.90	0.20	0.20	0.20	1.70	0.20	0.30	0.68	0.18
W	0.2	1.0	-0.2	-0.2	0.2	0.2	-0.2	-0.5	-0.5	-0.5
Tl	0.15	0.44	-0.05	-0.05	0.11	0.06	0.10	0.07	0.23	0.13
Pb	-5	10	6	-5	5	5	-5	13	7	10
Bi	-0.06	0.14	-0.06	-0.06	0.06	-0.06	-0.06	0.58	0.18	0.32
Th	1.79	11.10	1.85	1.67	1.71	1.80	1.37	2.07	5.33	2.28
U	0.66	3.46	0.69	0.61	0.61	0.46	0.42	0.65	1.68	0.67
La	10.3	35.4	11.6	13.3	12.2	20.4	8.5	11.8	17.0	14.5
Ce	23.1	69.0	26.5	30.3	28.6	47.6	18.5	26.9	34.3	36.5
Pr	3.31	8.14	3.73	4.25	3.98	6.56	2.64	3.79	4.15	4.94
Nd	14.9	31.9	17.0	19.8	18.4	29.6	12.0	18.1	17.3	24.0
Sm	3.69	6.52	4.12	4.73	4.37	7.10	3.09	4.44	3.77	5.56
Eu	1.11	1.48	1.44	1.57	1.50	2.63	0.94	1.33	0.97	1.85
Gd	3.94	5.88	4.36	4.75	4.41	7.86	3.28	4.12	3.44	5.07
Tb	0.73	1.02	0.79	0.79	0.74	1.44	0.59	0.78	0.64	0.95
Dy	4.30	5.73	4.62	4.48	4.23	8.35	3.45	4.57	3.80	5.50
Ho	0.90	1.16	0.96	0.87	0.81	1.67	0.65	0.92	0.76	1.11
Er	2.77	3.52	2.96	2.54	2.43	5.01	1.84	2.72	2.30	3.20
Tm	0.418	0.533	0.452	0.389	0.362	0.707	0.273	0.393	0.336	0.469
Yb	2.68	3.43	2.87	2.54	2.42	4.44	1.73	2.65	2.29	2.97
Lu	0.400	0.524	0.430	0.361	0.346	0.637	0.267	0.392	0.330	0.439
Easting[3]	**521633**	**522302**	**519972**	**518588**	**516754**	**524585**	**511508**	**512505**	**509479**	**511140**
Northing	**6895854**	**6896054**	**6896492**	**6897686**	**6905239**	**6896178**	**6902265**	**6907918**	**6908078**	**6907253**

Analytical Method: Samples were prepared using a ceramic mill and analyzed for major, trace and rare-earth elements (REE) at Activation Laboratories in Ancaster, Ontario. Major element concentrations were determined by fusion X-ray fluorescence (XRF). Trace elements and REE were analyzed by inductively coupled plasma mass spectrometry (ICP-MS) at research detection limits.

Notes: [1]Samples are located with arabic numerals in Figure 12. [2]Unit and rock codes: *LS* = Little Salmon succession, *and* = andesite, *bslt* = basalt, *tuff* = tuff of intermediate compostion.
[3]UTM Zone 8, NAD27.

Table 2. *Continued.*

SAMPLE[1] unit[2]	25 MRT025 LSbslt	26 MRT028B LSbslt	27 MRT013 LSbslt	28 MRT018 LSbslt	29 MRT031 LSbslt	30 00MC042 LSbslt	31 00MC045 LSbslt	32 00MC057 LSbslt	33 00MC061 LSbslt	34 00MC124 LShbsl	35 00MC129 LSpbsl
SiO_2	44.80	44.79	46.31	45.87	45.71	48.58	47.35	43.90	46.57	43.07	42.59
Al_2O^3	17.13	16.29	14.93	16.14	17.72	19.02	17.33	16.02	17.30	16.15	18.78
Fe_2O^3	11.45	9.97	11.01	13.08	12.52	12.17	12.49	10.65	11.51	10.12	9.68
MnO	0.18	0.21	0.23	0.21	0.38	0.14	0.15	0.20	0.18	0.15	0.21
MgO	6.73	4.40	7.15	4.46	4.81	2.98	4.64	8.39	4.60	8.17	3.81
CaO	9.84	11.70	7.30	6.00	9.06	5.16	5.06	9.73	7.82	11.76	11.79
Na_2O	2.03	2.14	2.99	4.26	1.93	2.85	4.79	1.30	3.35	1.30	3.48
K_2O	0.47	1.19	0.03	1.33	1.69	2.30	0.61	1.84	0.68	1.81	0.65
TiO_2	2.31	1.95	2.31	2.22	2.16	2.37	2.87	1.95	2.12	2.00	1.48
P_2O_5	0.63	0.86	0.55	0.36	0.72	0.97	0.73	0.58	0.71	0.52	0.36
LOI	3.80	5.20	6.77	5.18	3.82	2.87	3.46	3.99	3.92	3.71	7.26
TOTAL	99.36	98.70	99.58	99.09	100.49	99.41	99.48	98.56	98.75	98.77	100.10
V	206	258	198	220	248	216	250	213	193	242	145
Cr	183	296	95	331	406	326	53	372	26	154	122
Co	33	38	32	45	35	45	42	35	30	34	36
Ni	52	105	53	95	92	90	-20	250	59	78	-20
Cu	19	47	28	-10	79	49	20	56	57	64	32
Zn	61	60	69	106	117	217	124	71	62	55	145
Ga	16	15	15	11	18	19	22	20	20	17	18
Ge	1.7	1.7	1.3	1.4	3.2	1.8	1.6	1.0	2.1	1.9	1.1
As	-5	-5	-5	-5	1	7	-5	-5	-5	8	-5
Rb	11	25	-2	29	37	45	14	36	14	33	11
Sr	629	1130	539	168	674	436	775	714	976	956	665
Y	28.3	23.6	30.6	42.2	34.9	61.8	39.2	24.8	28.6	27.1	25.5
Zr	184	164	192	144	199	106	256	149	162	129	139
Nb	68.0	46.2	47.7	71.4	95.9	43.8	44.6	62.2	79.8	48.5	21.9
Mo	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Ag	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
In	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
Sn	2.0	1.0	1.0	19.0	2.0	1.2	2.0	1.4	1.5	1.2	1.4
Sb	0.70	0.40	-0.20	0.60	0.95	1.32	0.68	1.13	1.98	2.20	0.68
Cs	0.5	0.6	-0.1	1.1	1.6	2.2	0.7	1.1	0.7	0.7	0.6
Ba	147	240	41	364	568	374	181	582	318	547	97
Hf	4.3	3.9	4.3	3.6	4.5	3.2	6.3	3.9	3.5	3.2	3.3
Ta	4.10	2.90	3.00	4.60	5.45	4.12	4.08	5.42	6.34	4.24	2.06
W	0.4	0.2	-0.2	0.5	0.5	4.2	-0.5	-0.5	0.6	-0.5	-0.5
Tl	0.08	0.11	-0.05	0.36	0.53	0.68	0.08	0.16	0.10	0.07	0.07
Pb	-5	-5	-5	-5	-5	-5	5	-5	-5	-5	-5
Bi	-0.06	-0.06	-0.06	-0.06	-0.06	0.13	0.12	-0.10	0.13	-0.10	-0.10
Th	3.62	3.08	2.78	4.06	5.45	3.67	4.27	5.59	5.33	4.36	2.30
U	1.16	0.58	0.84	0.72	1.08	1.34	1.04	1.53	1.12	0.97	0.59
La	36.4	27.7	28.3	46.5	52.5	66.5	37.9	42.2	52.7	35.0	21.7
Ce	67.4	49.7	53.4	65.6	86.0	71.3	72.7	76.5	92.3	62.9	38.2
Pr	7.83	5.75	6.33	9.61	9.77	13.88	8.31	8.20	9.85	7.01	4.24
Nd	31.3	23.4	26.0	39.0	37.6	57.8	35.6	33.9	38.5	28.4	17.9
Sm	6.24	4.92	5.48	7.48	7.07	11.01	7.47	6.44	6.99	5.69	3.78
Eu	2.31	1.81	2.14	2.80	2.64	4.05	2.70	2.27	2.56	2.16	1.45
Gd	5.92	4.90	5.70	7.71	6.77	11.02	7.63	5.50	6.27	5.56	3.77
Tb	0.99	0.81	1.03	1.18	1.08	1.89	1.30	0.93	1.07	0.90	0.67
Dy	5.40	4.67	5.65	6.72	5.87	10.78	7.41	5.06	5.64	5.42	4.19
Ho	1.01	0.86	1.10	1.30	1.13	2.09	1.45	0.93	1.03	1.04	0.85
Er	2.85	2.45	3.08	3.61	3.13	5.79	4.15	2.65	2.90	2.88	2.56
Tm	0.402	0.352	0.442	0.483	0.438	0.742	0.593	0.347	0.381	0.401	0.370
Yb	2.61	2.24	2.87	3.02	2.83	4.45	3.77	2.21	2.37	2.63	2.30
Lu	0.362	0.323	0.402	0.432	0.405	0.625	0.542	0.303	0.334	0.369	0.325
Easting[3]	**507275**	**506507**	**506541**	**507052**	**506543**	**507520**	**507146**	**506634**	**506342**	**503363**	**506853**
Northing	**6909940**	**6909340**	**6907594**	**6907914**	**6908532**	**6908527**	**6907726**	**6908337**	**6909909**	**6910206**	**6907685**

Analytical Method: Samples were prepared using a ceramic mill and analyzed for major, trace and rare-earth elements (REE) at Activation Laboratories in Ancaster, Ontario. Major element concentrations were determined by fusion X-ray fluorescence (XRF). Trace elements and REE were analyzed by inductively coupled plasma mass spectrometry (ICP-MS) at research detection limits.

Notes: [1]Samples are located with arabic numerals in Figure 12. [2]Unit and rock codes: *LS* = Little Salmon succession, *bslt* = basalt, *hbsl* = hornblende-phyric basalt, *pbsl* = plagioclase-phyric basalt. [3]UTM Zone 8, NAD27.

Table 3. *Geochemistry of felsic volcanic rocks from Little Kalzas and Little Salmon successions.*

	i	ii	iii	iii	iii	iv	v	vi
SAMPLE[1]	98MC063	98MC125	99MC001a	99MC001b	99MC001c	99MC156	99MC027-2	99MC090
unit[2]	LKrhy	LKtuff	LSqfp	LSqfp	LSqfp	LSqfp	LSdac	LSdac
SiO_2	76.03	75.19	70.94	73.53	68.82	68.55	69.25	66.85
Al_2O_3	12.93	13.56	15.86	13.29	14.67	13.68	14.00	15.26
Fe_2O_3	0.94	1.31	1.16	1.15	1.19	1.98	4.61	4.55
MnO	0.03	-0.01	0.02	0.03	0.04	0.06	0.09	0.10
MgO	1.00	0.85	1.32	1.18	1.42	0.84	1.22	1.42
CaO	0.41	0.04	1.69	2.09	3.06	3.60	3.06	1.33
Na_2O	1.58	0.09	1.19	2.66	0.71	2.73	1.52	5.22
K_2O	6.82	6.40	4.27	2.51	4.30	2.70	3.02	2.40
TiO_2	0.11	0.12	0.36	0.27	0.30	0.28	0.49	0.46
P_2O_5	0.03	0.04	0.07	0.06	0.08	0.07	0.09	0.16
LOI	0.88	1.79	3.17	3.13	4.30	4.06	1.79	0.84
TOTAL	100.77	99.39	100.05	99.93	98.86	98.56	99.15	98.59
V	9	-5	33	28	30	44	47	48
Cr	-10	-10	-20	-20	-20	27	31	37
Co	1	-1	2	-1	-1	2	4	6
Ni	-10	-10	-15	-15	-15	-15	-15	-15
Cu	-10	-10	-10	-10	-10	-10	26	16
Zn	27	21	-30	-30	-30	-30	51	60
Ga	14	17	17	14	16	10	20	13
Ge	1.1	0.9	0.8	1.1	1.1	1.3	1.5	1.2
As	-5	-5	-5	-5	-5	-5	-5	5
Rb	175	151	129	84	129	79	99	77
Sr	96	20	78	75	92	101	378	115
Y	19.0	27.0	15.2	20.5	15.1	17.4	32.2	24.3
Zr	138	154	203	160	164	157	233	266
Nb	11.0	13.0	14.6	11.8	11.1	11.5	11.8	15.0
Mo	0	0	-2	-2	-2	-2	-2	-2
Ag	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
In	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
Sn	-0.5	2.1	3.0	2.0	3.0	2.0	5.0	2.0
Sb	0.66	0.13	-0.20	-0.20	-0.20	-0.20	0.60	-0.20
Cs	1.9	1.8	2.8	1.9	2.9	2.1	1.7	2.5
Ba	1257	2615	797	511	771	838	4000	1540
Hf	4.1	4.3	5.1	4.0	4.3	4.0	5.9	6.9
Ta	0.93	1.09	1.10	0.90	0.90	1.00	0.90	1.10
W	0.3	9.7	0.9	0.7	0.8	0.6	1.0	0.6
Tl	0.40	0.35	0.28	0.31	0.44	0.28	0.44	0.33
Pb	34	-5	-5	-5	8	-5	12	14
Bi	0.06	0.11	0.08	-0.06	0.27	-0.06	0.14	0.12
Th	13.10	14.70	8.82	7.57	8.49	8.11	10.60	19.20
U	2.39	3.11	1.65	1.36	1.71	1.83	3.74	5.22
La	30.3	36.2	16.7	17.0	26.5	19.9	31.9	43.8
Ce	55.6	66.4	32.5	33.9	49.1	40.6	61.5	81.8
Pr	6.07	6.99	3.59	3.84	5.23	4.76	7.46	8.61
Nd	22.6	25.7	13.2	14.2	18.4	18.2	28.5	30.5
Sm	4.26	4.95	2.53	2.85	3.44	3.56	5.80	5.59
Eu	0.72	0.67	0.70	0.68	1.02	0.89	1.12	1.10
Gd	3.65	4.50	2.37	2.55	2.89	3.06	5.28	4.83
Tb	0.55	0.73	0.41	0.48	0.47	0.54	0.94	0.75
Dy	3.08	4.31	2.40	3.08	2.66	2.92	5.48	4.27
Ho	0.63	0.87	0.50	0.66	0.53	0.58	1.10	0.82
Er	2.08	2.78	1.59	2.11	1.63	1.83	3.36	2.51
Tm	0.351	0.452	0.248	0.332	0.258	0.289	0.509	0.412
Yb	2.22	2.83	1.79	2.22	1.81	2.08	3.22	2.74
Lu	0.384	0.475	0.274	0.352	0.309	0.318	0.478	0.404
Easting[3]	460677	467222	520405	520405	520405	519543	521633	520669
Northing	6979195	6976148	6895490	6895490	6895490	6895886	6895854	6897517

Analytical Method: Samples were prepared using a ceramic mill and analyzed for major, trace and rare-earth elements (REE) at Activation Laboratories in Ancaster, Ontario. Major element concentrations were determined by fusion X-ray fluorescence (XRF). Trace elements and REE were analyzed by inductively coupled plasma mass spectrometry (ICP-MS) at research detection limits.

Notes: [1]Samples are located with roman numerals in Figures 4 and 12. [2]Unit and rock codes: *LK* = Little Kalzas succession, *LS* = Little Salmon succession, *rhy* = rhyolite, *tuff* = rhyolitic tuff, *qfp* = quartz-feldspar porphyry, *dac* = dacite. [3]UTM Zone 8, NAD27.

Table 4. *Geochemistry of Mississippian granitoids from Glenlyon map area (105L).*

	A	B	C	C	C	D	E	F	G	H	H	I	J
SAMPLE[1]	**98MC035**	**98MC111**	**98MC101A**	**98MC101C**	**98MC101D**	**98MC102**	**98MC104**	**98MC108**	**98MC119**	**98MC196A**	**98MC196D**	**98MC188**	**98MC190**
unit[2]	**LKd**	**LKt**	**LKd**	**LKd**	**LKd**	**LKd**	**LKd**	**LKd**	**LKd**	**LKmg**	**LKmg**	**Ttlm**	**Ttlm**
SiO_2	66.86	69.14	55.45	53.91	70.84	61.90	53.34	62.00	59.05	75.74	57.56	63.76	64.41
Al_2O_3	14.31	14.43	12.40	14.51	14.33	15.44	9.02	15.73	15.81	10.29	14.65	16.85	17.33
Fe_2O_3	3.90	4.47	8.40	8.70	2.78	6.76	8.68	7.58	7.94	2.37	6.52	4.81	5.20
MnO	0.14	0.08	0.17	0.15	0.04	0.12	0.21	0.12	0.14	0.05	0.11	0.10	0.12
MgO	1.59	1.04	10.26	8.39	0.79	2.44	12.48	2.15	4.28	1.22	2.13	1.38	1.23
CaO	3.59	4.31	8.12	8.85	3.61	5.46	12.16	5.83	7.59	2.60	4.50	4.87	4.20
Na_2O	3.86	3.22	1.46	1.36	5.07	2.62	1.71	3.05	2.13	4.13	1.92	3.88	3.31
K_2O	2.01	1.44	1.44	0.97	0.52	0.78	0.21	1.32	0.44	1.57	6.01	1.76	2.54
TiO_2	0.40	0.38	0.35	0.43	0.27	0.55	0.26	0.66	0.40	0.38	0.52	0.46	0.51
P_2O_5	0.16	0.08	0.08	0.11	0.06	0.15	0.05	0.14	0.04	0.07	0.36	0.15	0.19
LOI	4.17	1.32	2.41	3.18	1.91	2.27	2.49	1.51	3.01	2.44	6.11	1.30	1.95
TOTAL	100.99	99.90	100.53	100.56	100.23	98.49	100.61	100.09	100.82	100.85	100.39	99.32	100.99
V	79	51	165	162	33	119	256	106	184	35	80	55	42
Cr	31	-10	371	312	-10	36	308	-10	-10	24	27	-10	-10
Co	9	8	39	15	5	14	41	13	26	5	13	7	8
Ni	27	-10	237	28	-10	11	56	54	-10	13	24	10	-10
Cu	31	11	-10	36	12	35	26	-10	-10	-10	29	-10	-10
Zn	37	49	68	12	29	66	62	55	72	37	96	46	81
Ga	14	15	12	9	15	18	8	15	16	11	17	16	19
Ge	1.3	1.2	1.2	-0.5	1.0	1.1	1.5	1.0	1.3	0.8	1.3	1.2	1.3
As	7	-5	-5	-5	-5	-5	-5	-5	-5	6	7	-5	-5
Rb	67	38	39	25	11	22	4	40	11	40	263	48	91
Sr	137	163	95	128	181	236	87	250	170	133	151	277	302
Y	12.0	26.0	10.0	15.0	19.0	18.0	10.0	15.0	18.0	16.0	21.0	17.0	11.0
Zr	95	126	35	45	148	56	16	61	48	321	256	95	86
Nb	8.1	7.1	1.6	1.8	6.9	5.7	1.0	8.3	2.3	9.0	29.0	5.8	6.8
Mo	0	0	0	0	0	0	1	0	0	0	1	0	0
Ag	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
In	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
Sn	0.6	1.2	-0.5	-0.5	0.5	1.2	-0.5	0.6	0.8	0.9	3.8	0.9	1.3
Sb	0.31	0.67	0.63	0.21	0.84	0.59	0.75	0.80	0.90	0.49	2.59	0.09	0.59
Cs	1.5	0.6	0.4	0.4	0.4	0.2	-0.1	0.3	0.1	0.7	8.1	1.4	10.0
Ba	434	602	409	299	248	258	37	568	160	384	696	571	855
Hf	2.5	3.5	1.1	1.3	3.8	1.6	0.5	1.8	1.6	8.2	6.0	2.6	2.3
Ta	0.61	0.51	0.12	0.14	0.53	0.43	0.06	0.58	0.14	0.67	2.17	0.39	0.68
W	1.6	0.4	0.3	0.2	0.3	0.4	0.4	0.5	0.2	0.3	3.7	-0.2	-0.2
Tl	0.31	0.22	0.20	0.06	0.05	0.10	0.65	0.20	0.08	0.24	2.75	0.19	0.73
Pb	-5	5	-5	-5	6	6	-5	-5	-5	7	33	-5	9
Bi	0.13	0.09	0.14	0.09	0.10	0.13	0.24	0.24	0.08	0.13	0.49	-0.05	-0.05
Th	5.59	6.67	2.46	2.23	8.84	5.23	1.09	7.91	2.14	15.60	47.80	4.13	1.85
U	1.73	1.98	0.66	0.57	2.13	1.47	0.26	1.36	0.51	2.00	5.49	0.52	0.86
La	13.7	16.4	5.4	6.3	22.2	16.0	3.6	17.5	6.7	31.9	63.8	13.9	10.3
Ce	26.0	32.6	9.4	13.1	40.7	32.4	7.6	29.8	15.1	65.0	117.0	26.3	20.4
Pr	2.83	3.76	1.02	1.64	4.31	3.73	1.00	3.10	1.90	7.12	11.70	2.98	2.35
Nd	11.7	15.1	4.3	7.0	15.9	14.7	4.6	11.6	8.3	25.8	40.8	11.9	9.4
Sm	2.25	3.29	1.11	1.78	2.96	3.09	1.20	2.19	2.10	4.28	6.34	2.56	1.82
Eu	0.62	0.80	0.36	0.53	0.67	0.82	0.30	0.79	0.62	0.76	1.13	0.90	1.02
Gd	2.09	3.61	1.40	2.31	2.99	2.98	1.53	2.57	2.54	3.45	4.93	2.51	1.88
Tb	0.33	0.62	0.25	0.36	0.46	0.48	0.24	0.35	0.43	0.48	0.66	0.42	0.28
Dy	1.90	3.84	1.54	2.25	2.69	2.85	1.47	2.16	2.75	2.58	3.34	2.49	1.62
Ho	0.37	0.80	0.33	0.48	0.57	0.58	0.30	0.44	0.59	0.50	0.61	0.50	0.33
Er	1.14	2.62	1.05	1.58	1.87	1.84	0.95	1.48	1.98	1.52	1.86	1.63	1.05
Tm	0.181	0.402	0.162	0.242	0.297	0.278	0.138	0.239	0.308	0.242	0.286	0.260	0.162
Yb	1.13	2.60	1.02	1.56	1.94	1.78	0.87	1.61	2.00	1.55	1.85	1.67	1.05
Lu	0.193	0.431	0.179	0.260	0.331	0.284	0.132	0.296	0.352	0.244	0.284	0.265	0.167
Easthing[3]	**454681**	**468695**	**467101**	**467101**	**467101**	**466921**	**466687**	**469184**	**466184**	**472019**	**472019**	**464186**	**457289**
Northing	**6977134**	**6978122**	**6980418**	**6980418**	**6980418**	**6980434**	**6979916**	**6978820**	**6980951**	**6974068**	**6974068**	**6962848**	**6966486**

Analytical Method: Samples were prepared using a ceramic mill and analyzed for major, trace and rare-earth elements (REE) at Activation Laboratories in Ancaster, Ontario. Major element concentrations were determined by fusion X-ray fluorescence (XRF). Trace elements and REE were analyzed by inductively coupled plasma mass spectrometry (ICP-MS) at research detection limits.

Notes: [1]Samples are located with capital letters in Figures 4 and 16. [2]Unit and rock codes *LK* = Little Kalzas suite, *d* = *granodiorite*, *t* = tonalite, *mg* = K-feldspar megacrystic phases, *Ttlm* = Tatlmain batholith (quartz diorite to granite). [3]UTM Zone 8, NAD27.

Table 4. *Continued.*

SAMPLE[1] unit[2]	K 98MC195 Ttlm	L 99MC065 Ttlm	M 00TTL001 Ttlm	N 00TTL003 Ttlm	O 00TTL007 Ttlm	P 00TTL010 Ttlm	Q 99MC070 LSpg	R 99MC034 LSgd	S 99MC035 LSgd	T 99MC036 LSgd	U 99MC014 LSqd	V 00MC106 LSqd	W 00MC214 LSqd	X 00MC215 LSqd
SiO_2	59.80	66.43	76.33	74.56	73.44	74.55	64.50	62.56	54.43	72.57	66.13	62.36	66.66	74.26
Al_2O_3	16.79	13.97	12.63	13.52	14.05	13.35	13.28	16.24	17.32	14.06	14.60	15.44	14.59	12.82
Fe_2O_3	5.77	3.21	2.39	2.21	2.26	2.28	6.10	6.79	7.92	2.80	5.41	6.07	4.77	3.09
MnO	0.10	0.09	0.04	0.05	0.05	0.05	0.11	0.13	0.13	0.04	0.10	0.12	0.08	0.04
MgO	2.99	1.05	0.53	0.43	0.43	0.64	3.70	2.07	5.00	0.41	2.22	2.50	1.82	1.03
CaO	6.52	1.61	2.33	1.69	1.98	1.91	2.87	5.84	8.07	1.93	4.11	5.30	3.07	3.71
Na_2O	3.14	3.72	2.97	3.62	3.88	3.43	3.87	2.95	2.99	3.94	2.95	2.30	4.17	3.85
K_2O	1.90	3.23	2.48	3.22	3.07	3.03	2.10	1.49	1.32	2.95	1.76	2.05	1.71	0.25
TiO_2	0.58	0.35	0.24	0.19	0.22	0.25	0.40	0.67	0.85	0.24	0.43	0.47	0.58	0.33
P_2O_5	0.13	0.10	0.06	0.06	0.07	0.06	0.10	0.15	0.16	0.05	0.10	0.11	0.16	0.07
LOI	2.05	6.92	0.49	0.76	0.62	0.95	3.64	1.69	2.18	0.97	2.52	1.98	2.79	0.93
TOTAL	99.77	100.68	100.48	100.31	100.07	100.50	100.67	100.60	100.38	99.96	100.30	98.70	100.41	100.39
V	145	40	36	13	12	27	126	117	193	10	103	134	75	50
Cr	25	-20	-20	-20	-20	-20	24	-20	-20	-20	28	-20	-20	-20
Co	16	6	7	3	3	4	8	11	21	2	8	13	10	6
Ni	-10	-15	-20	-20	-20	-20	-15	-15	-15	-15	4	-20	-20	-20
Cu	31	-10	-10	-10	-10	-10	-10	10	-10	-10	41	22	24	37
Zn	37	36	41	42	46	35	72	58	79	31	19	66	47	-30
Ga	16	11	13	15	17	16	8	17	16	16	14	17	20	15
Ge	1.1	1.2	0.8	1.0	1.0	1.0	1.4	1.1	1.6	1.6	1.3	1.0	0.9	0.8
As	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5
Rb	55	104	63	74	79	79	55	45	41	75	50	58	46	4
Sr	254	183	165	135	152	155	59	282	362	256	243	241	221	145
Y	20.0	26.8	7.4	15.3	13.0	25.5	11.3	23.0	21.4	27.7	15.5	15.6	26.4	28.5
Zr	132	171	147	98	138	148	87	136	132	203	97	89	179	65
Nb	5.9	9.2	2.8	4.4	5.4	6.0	5.4	9.7	7.1	17.7	7.1	4.6	6.4	2.7
Mo	0	-2	-2	-2	-2	-2	-2	-2	-2	5	49	-2	-2	-2
Ag	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
In	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
Sn	0.8	1.5	-1.0	1.0	1.2	1.1	2.0	1.0	-1.0	1.0	-1.0	-1.0	1.8	-1.0
Sb	0.21	0.25	0.21	-0.20	-0.20	0.21	-0.20	-0.20	-0.20	-0.20	0.85	0.89	0.33	0.52
Cs	0.5	1.1	1.0	1.1	1.0	0.9	2.2	0.6	0.3	1.0	0.6	1.3	1.0	0.9
Ba	557	768	1460	1510	1900	835	1030	928	610	1460	529	677	940	266
Hf	3.5	4.6	4.2	3.2	4.0	4.9	2.5	3.2	3.2	5.2	2.7	2.6	5.1	2.6
Ta	0.42	0.75	0.30	0.60	0.63	0.94	0.50	0.70	0.40	1.30	0.55	0.63	0.69	0.31
W	0.3	0.4	-0.5	-0.5	-0.5	-0.5	0.4	-0.2	0.3	-0.2	2.5	1.0	0.8	-0.5
Tl	0.17	0.40	0.24	0.26	0.34	0.30	0.29	0.15	0.21	0.24	0.20	0.21	0.18	-0.05
Pb	-5	7	13	12	17	11	-5	-5	6	5	3	7	9	-5
Bi	-0.05	-0.06	0.12	-0.10	-0.10	0.14	-0.06	-0.06	-0.06	-0.06	0.02	0.27	0.76	0.14
Th	7.46	8.12	3.51	9.46	9.05	11.51	7.01	6.36	3.07	9.47	5.90	7.08	6.74	2.62
U	1.17	1.65	0.72	1.07	1.11	2.52	1.29	1.60	0.93	2.39	1.77	2.00	2.02	0.80
La	15.5	23.8	11.9	25.1	17.6	23.5	17.2	18.6	11.4	37.6	15.5	13.5	19.4	8.8
Ce	30.2	43.6	19.6	42.6	40.2	45.7	30.2	36.2	23.9	70.1	29.4	26.7	39.6	18.8
Pr	3.39	5.03	1.93	4.49	2.97	4.90	3.34	4.00	3.10	7.95	3.37	3.05	4.69	2.38
Nd	13.7	18.8	7.2	15.8	10.5	18.3	12.6	15.0	13.1	28.5	13.0	12.2	19.4	10.7
Sm	2.77	3.76	1.36	2.85	1.99	3.66	2.33	3.20	3.11	5.23	2.67	2.59	4.26	3.00
Eu	0.86	1.01	0.71	0.68	0.81	0.80	0.78	0.97	1.07	1.17	0.76	0.77	1.13	0.96
Gd	3.05	3.91	1.31	2.57	1.96	3.39	2.30	3.18	3.28	4.35	2.41	2.44	3.94	3.26
Tb	0.48	0.72	0.23	0.47	0.36	0.68	0.38	0.61	0.63	0.77	0.43	0.44	0.75	0.74
Dy	2.89	4.35	1.36	2.65	2.16	4.32	2.06	3.62	3.64	4.48	2.55	2.66	4.49	4.82
Ho	0.61	0.89	0.27	0.54	0.46	0.89	0.41	0.75	0.75	0.91	0.53	0.54	0.91	1.04
Er	1.94	2.75	0.85	1.69	1.45	2.89	1.14	2.34	2.25	2.85	1.66	1.71	2.88	3.29
Tm	0.305	0.440	0.123	0.265	0.231	0.471	0.180	0.366	0.334	0.453	0.264	0.257	0.427	0.509
Yb	1.91	3.03	0.90	1.85	1.58	3.24	1.26	2.35	2.21	2.98	1.74	1.88	2.87	3.36
Lu	0.315	0.450	0.148	0.284	0.266	0.496	0.185	0.355	0.320	0.452	0.285	0.289	0.442	0.539
Easting[3]	**461657**	**450404**	**461850**	**437710**	**440230**	**447950**	**512555**	**527427**	**528634**	**530450**	**512637**	**503529**	**514153**	**514331**
Northing	**6960458**	**6962447**	**6957600**	**6969210**	**6969650**	**6962770**	**6899034**	**6896357**	**6896362**	**6896473**	**6896607**	**6898002**	**6892490**	**6889312**

Analytical Method: Samples were prepared using a ceramic mill and analyzed for major, trace and rare-earth elements (REE) at Activation Laboratories in Ancaster, Ontario. Major element concentrations were determined by fusion X-ray fluorescence (XRF). Trace elements and REE were analyzed by inductively coupled plasma mass spectrometry (ICP-MS) at research detection limits.

Notes: [1]Samples are located with capital letters in Figures 12 and 16. [2]Unit and rock codes: *Ttlm* = Tatlmain batholith (quartz diorite to granite), *LS* = Little Salmon suite, *pg* = pegmatitic horn blende tonalite, *gd* = granodiorite, *qd* = quartz diorite. [3]UTM Zone 8, NAD27.