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Mississippian U-Pb dates from Dorsey Terrane assemblages in the upper Swift River area, southern Yukon Territory[1]

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Abstract

The polydeformed Yukon–Tanana terrane in the southwestern half of the Wolf Lake map area (NTS 105 B) includes the Big Salmon Complex and Dorsey Terrane, which has been divided into four assemblages: Ram Creek, Dorsey, Klinkit, and Swift River. Zircons in a granodiorite in the mostly metavolcanic Ram Creek assemblage are broadly Early Mississippian — a signature age for Yukon–Tanana terrane intrusions. Zircons from a metatuff horizon within the dominantly siliciclastic Dorsey assemblage are 355 ± 2.7 Ma, which is similar to some dates from the Finlayson Lake belt (Money Creek thrust sheet), but older than dated volcanic rocks in the Big Salmon Complex (330–325 Ma). The greater age, continental derivation, and metamorphic grade of the Dorsey assemblage suggest that these rocks were both basement and some of the earliest products of the Mississippian arc assemblage that comprises much of the southern Yukon–Tanana terrane.

Résumé

Le terrane polydéformé de Yukon-Tanana, dans la moitié sud-ouest de la région cartographique du lac Wolf (SNRC 105 B) comprend le Complexe métamorphique de Big Salmon et le terrane de Dorsey, qui a été divisé en quatre assemblages : Ram Creek, Dorsey, Klinkit et Swift River. Des zircons provenant d'une granodiorite dans l'assemblage essentiellement métavolcanique de Ram Creek remontent en général au Mississipien précoce (l'âge de signature des intrusions du terrane de Yukon-Tanana). Des zircons provenant d'un horizon de métatuf dans l'Assemblage de Dorsey à dominance silicoclastique datent de 355 ± 2,7 Ma, âge qui se rapproche de certaines datations de la ceinture du lac Finlayson (nappe de charriage de Money Creek), mais qui est plus ancien que les roches volcaniques datées dans le Complexe métamorphique de Big Salmon (330–325 Ma). L'âge plus ancien, la dérivation continentale et le degré de métamorphisme de l'Assemblage de Dorsey laissent supposer que ces roches constituaient à la fois le socle et certains des premiers produits de l'assemblage d'arc du Mississippien qui forme une grande partie du sud du terrane de Yukon-Tanana.

INTRODUCTION

Yukon–Tanana Terrane (Mortensen and Jilson, 1985; Mortensen, 1992b) extends 600 km from east-central Alaska to northern British Columbia (**Fig. 1**). It is a composite of variably metamorphosed successions of sedimentary and mafic, intermediate, and felsic volcanic rocks, with abundant diorite to granitic intrusions, particularly of Mississippian (Early Carboniferous) age (Mortensen, 1992a). Resolving deficiencies in the stratigraphy and determining protolith in the Yukon–Tanana terrane are principal objectives of the central component of the Ancient Pacific Margin NATMAP Project, which is a forum for understanding the tectonic evolution, paleogeography, and metallogeny of rock units that formed along the length of the late Paleozoic and early Mesozoic western margin of ancestral North

America (Thompson et al., 2000). The central component of the NATMAP will produce a revised map covering northern Jennings River (NTS 104-O, in British Columbia) and southern Wolf Lake (NTS 105 B, in Yukon Territory) at 1:250 000 scale, in addition to selected open file maps at 1:50 000 scale (Nelson et al., 2000a, 2001; Mihalynuk et al., 2001a, b).

In this area the western third of Yukon–Tanana terrane is called the Big Salmon Complex (Mulligan, 1963), and the eastern part is referred to as Dorsey Terrane (Monger et al., 1991). Harms and Stevens (1996) separated rocks of Dorsey Terrane into five assemblages — Hazel, Ram Creek, Dorsey, Swift River, and Klinkit — each with distinctive lithological and structural characteristics (Hazel assemblage is now included in Big Salmon Complex; Mihalynuk et al., 1998, 2000; Roots et al., 2000). The other assemblages are first-order map units with an uncertain internal stratigraphy. This paper documents two new dates which indicate the age relationship between the Dorsey assemblage and the adjacent Ram Creek assemblage in Yukon Territory. These assemblages are also compared with their counterparts in northern British Columbia.

REGIONAL SETTING

Yukon–Tanana terrane structurally overlies the ancient continental margin of North America (Early Paleozoic Selwyn Basin in central Yukon Territory, Cassiar Platform in southern Yukon Territory), and is separated from Stikine and Quesnel terranes to the southwest by the Teslin Fault (Gordey and Stevens, 1994; de Keijzer et al., 2000). Yukon–Tanana terrane rocks are in general structurally complex and metamorphosed, in part because they have taken the brunt of deformation during Jurassic–Cretaceous collision of North America with other arcs, oceanic crust, and outboard terranes, and in part due to older events.

The Big Salmon Complex includes a thick greenstone succession, thin felsic units (ca. 325 Ma) and large orthogneiss bodies. It appears to be an arc succession, although its petrochemical nature has not been fully evaluated.

Dorsey Terrane includes the Dorsey assemblage (sheared and high P-T metamorphic rocks; Stevens (1996)) and flanking Ram Creek, Klinkit, and Swift River assemblages (**Fig. 2**) which appear to be Late Paleozoic arc and arc-related sequences. Dorsey and Ram Creek assemblages are chiefly exposed in two areas: 1) in northern British Columbia west of Cassiar Fault; and 2) north of Seagull Batholith in Yukon Territory.

Ram Creek assemblage

In northern British Columbia this unit consists of mafic to intermediate metatuffs with lesser quartz-sericite schist, as well as minor grey argillite, sea-green metachert and marble ("greenstone-intrusive unit" of Nelson et al. (1998)). Intrusions range from gabbro and diorite to tonalite and quartz diorite; one of the quartz diorite samples produced a 356 ± 6 Ma U-Pb zircon date (R. Friedman, pers. comm., 1999). This intrusion lies structurally higher than a quartz-sericite schist sequence with U-Pb zircon dates of 334 ± 6 Ma and 336 ± 4 Ma (Nelson, 2000).

In Yukon Territory, the Ram Creek assemblage is a narrow belt of actinolite+chlorite-muscovite±epidote schist with quartzite, marble, calc-silicate and discontinuous bodies of sheared felsic to intermediate metaplutonic rocks. A steep southwest-dipping thrust separates them from black argillite of Cassiar Platform to the northeast. The Ram Creek assemblage is structurally overlain and appears to be overthrust by the Dorsey assemblage (Stevens and Harms, 1995, p. 120). These authors initially referred to it as the "Imbricate Assemblage" because rock units were interleaved, however one lithological horizon has been traced over 9 km along the belt (Roots et al., 2000). At the northwest end of the belt, south of Ram Creek, chloritic schist interpreted as mafic flow units is interbedded on the metre scale with black phyllitic argillite. Also in this area is a quartz-eye–sericite schist (possibly felsic metatuff; **Fig. 3**).

The granodiorite body sampled for this study is exposed across two spur ridges where it is between 200 m and 300 m wide. It is grey-white weathering and fine- to medium-grained, in contrast to the similarly altered but notably megacrystic Ram stock. The rock is slightly foliated, with partial, streaky replacement of mafic minerals by interconnected, foliated blebs of epidote and chlorite (**Fig. 4**). Pink and white feldspar surrounds, and is interstitial to, grey rounded quartz grains that are 2–4 mm in diameter. In thin section, the quartz has undulose extinction and recrystallized perimeters; plagioclase cores are filled with inclusions; and accessory minerals are apatite, zircon, and pyrite.

Dorsey assemblage

Rocks of the Dorsey assemblage uniformly are more strongly deformed and of higher metamorphic grade than those of Ram Creek assemblage. In northern British Columbia the Dorsey assemblage extends over 55 km and contains five units (Nelson et al., 1998); highly siliceous sedimentary rocks with marble interbeds are present throughout the sequence. The lower part contains amphibolite bodies and ultramafic pods, while the upper part contains chlorite phyllite and quartz-sericite schist (interpreted as intermediate and felsic metatuffs, respectively). Several occurrences of garnet amphibolite and ultramafite schist are retrograde indicators of the original eclogite-facies metamorphism (Nelson, 2000). Deformed plutons yielded three Mississippian U-Pb zircon dates: 340.4 ± 5.5 Ma, 349.9 ± 4.2 Ma, and 355.3 ± 9 Ma (R. Friedman, pers. comm., 1999; *in* Nelson, 2000, p. 117).

In southern Yukon Territory these rocks comprise a 40 km long, northwest-trending belt. The adjacent Ram stock contains inclusions of foliated Dorsey rocks, indicating that deformation was pre-Permian. Two units were recognized by Stevens (1996) and Stevens and Harms (2000). These are 1) mafic gneiss with interleaved siliceous schist and quartzite; that is structurally overlain by 2) muscovite±biotite±plagioclase±tourmaline schist, quartzite, and minor marble. The mafic gneiss is highly foliated, and contains 5–10% leucosome and quartz sweats. The protolith was likely intermediate mafic flows and mafic intrusions. The second unit was probably siliciclastic rocks, and it includes at least three metre thick layers of white to pale yellow quartz±feldspar-muscovite-sericite augen schist, interpreted as felsic metatuff. One of these tuff layers was sampled for this study. South of, and structurally above, the sampled metatuff is a medium- to coarse-grained granitic orthogneiss; its upper contact is slightly discordant to compositional layering of the host quartz-muscovite schist. Metamorphic mineral assemblages and thermobarometry indicate upper amphibolite facies (9–13 kbar; Stevens, 1996), retrograded to chlorite facies.

A 2 m thick layer of slightly rusty, light grey quartz-feldspar augen schist was sampled for this study. The rock has about 5% easily visible quartz grains (up to 2 mm) and white feldspar wisps (**Fig. 5**). Thin sections show subrounded quartz and twinned plagioclase phenocrysts with generally recrystallized edges, in a matrix of fine silica and muscovite. The lack of ribbon texture in the matrix and pristine phenocrysts suggest this is a metatuff, not a mylonitized granite.

ANALYTICAL METHODS

The samples were processed through standard crushing techniques (jaw crusher followed by Bico disk mill) and isolation of zircon was accomplished by Wilfley table, heavy liquid, and magnetic mineral separation. The most stringent cleaning procedures were carried out at each step at the University of Alberta Radiogenic Isotope Facility. Selected mineral grains or fractions (**Table 1**) were dissolved in acids and purified aliquots of uranium and lead were obtained using anion exchange chromatography. The isotopic compositions of U and Pb were determined on a solid source VG354 thermal ionization mass spectrometer in a single collector using either a Faraday or Daly photomultiplier detector. All isotopic ratios were corrected for mass discrimination of 0.09%/amu Pb and 0.16%/amu U. Analyses of a total of ten fractions are listed in **Tables 1** and **2**.

RESULTS

The metatuff from the Dorsey assemblage (sample 99RAS-31-1) yielded abundant zircons with populations of slightly resorbed, faint tan prisms (length-to-breadth ratios of 1.5:1 to 2:1) and faint to light tan broken needles. Some of the broken needle fragments also show signs of resorption.

The U-Pb results for five multigrain (12–40 grains each) zircon fractions are presented in Tables 1 and 2 and diagrammatically in **Figure 6**. The zircon fractions contain moderate to high uranium contents (613–1300 ppm) and consistent Th/U ratios (0.2). Four of these fractions have very similar $^{207}Pb/^{206}Pb$ ages of between 356–359 Ma and a linear regression treatment of these fractions yields an age of 355.6 ± 2.7 Ma (MSWD=1.3). This date is interpreted as the best estimate of the emplacement age for this sample.

The granodiorite from Ram Creek assemblage (sample 99RAS-39-4) also had a good zircon yield. Zircons in this sample were either colourless to faint tan, broken needles or faint tan, euhedral prisms (length to breadth ratios of 1.5:1 to 2:1). Both zircon populations displayed variable degrees of resorption with some inclusions and fractures. Zircon in this sample contains moderate U contents (286–531 ppm) and consistent Th/U (0.6–0.7).

The U-Pb results for five zircon fractions are presented in **Tables 1** and **2** and diagrammatically in **Figure 7**. All five fractions are concordant to nearly concordant with a range in $^{207}Pb/^{206}Pb$ ages between 365–343 Ma. Note that three of the analyses (2, 4, 5) have identical $^{206}Pb/^{238}U$ ages of 337–338 Ma. The data may be interpreted in at least two ways.

1. The oldest $^{207}Pb/^{206}Pb$ date of 364.9 ± 5.8 Ma for fraction 3 represents a minimum estimate for the emplacement age for this granodiorite, with all other analyses displaying different degrees of Pb-loss.
2. Alternatively, the consistency in $^{206}Pb/^{238}U$ dates for fractions 2, 4, and 5 could indicate a crystallization age of about 337.5 ± 0.9 Ma (MSWD=0.3). Fractions 3 and 6, which consisted of broken resorbed prisms containing inclusions, may contain some inheritance of slightly older zircon. This granodiorite lies adjacent to a felsic tuff unit, which could be similar in age to rocks that form part of the slightly older Dorsey assemblage, providing a potential source for the older zircon inheritance. Another possibility is that the inherited zircon came from a ca. 357 Ma pluton, such as the one dated in the Ram Creek assemblage in British Columbia (*cf.* Nelson, 2000).

Regardless of the interpretation above, the granodiorite emplacement age is constrained to be between 365 Ma and 337 Ma. It is difficult to accept an emplacement age identical to the $^{207}Pb/^{206}Pb$ date of 343 Ma obtained for concordant analysis 6 as all other fractions have slightly older $^{207}Pb/^{206}Pb$ dates but younger U-Pb ages. The similarity of the U-Pb ages and Th/U ratios for fractions 2, 4 and 5 would require the unlikely combination of an identical inheritance profile in these multigrain fractions and the same proportion of subsequent Pb-loss.

DISCUSSION

The two new dates are within the range of Mississippian ages determined for other volcanic sequences and intrusions in the Yukon–Tanana terrane, including east-central Alaska (Aleinikoff et al., 1986), western Yukon Territory (Mortensen, 1992a), Finlayson Lake belt of east-central Yukon Territory (Mortensen and Jilson, 1985), central Yukon Territory (Colpron, 1999; Gordey et al., 1998; Stevens et al., 1993, 1996), as well as the nearby Big Salmon Complex (Mihalynuk et al., 1998, 2000) and southeastern Dorsey Terrane (Nelson, 2000). The discussion that follows bears upon two previous observations (*see* Nelson et al., 2000b) of the growing geochronological data set.

1. A significant unconformity, with associated regional deformation and felsic plutonism, occurs at 342 Ma in central Yukon Territory (Colpron and Reinecke, 2000; M. Colpron, pers. comm., 2000). In southern Big Salmon Complex regional deformation occurred between 354 Ma and 335 Ma (Mihalynuk et al., 2000). This mid-Mississippian event may coincide with uplift and cooling of eclogite and blueschist at 346 Ma (*see* Erdmer et al., 1998).
2. At least two intervals of felsic volcanism are evident in Yukon–Tanana terrane in Canada. One, at 336–325 Ma, is found in central Yukon Territory, Big Salmon Complex and the Ram Creek assemblage in northern British Columbia. The other, around 362–356 Ma, is recorded in the Finlayson Lake belt (Mortensen, 1992a; Piercey and Murphy, 2000) and in the 357 Ma in the Dorsey assemblage of southern Yukon Territory (this paper).

The 357 Ma metatuff documented here is the first extrusive age for the Dorsey assemblage. Possible subvolcanic roots to the felsic volcanism are the 356.3 ± 6 Ma metatonalite in the Ram Creek assemblage (if the fault between the two assemblages does not have major displacement) and a 355 ± 0.9 Ma pluton in the adjacent lowermost Dorsey Terrane (R. Friedman, pers. comm., 1999 *in* Nelson, 2000).

These two periods of felsic volcanism — one prior to, the other following a regional deformation event — is a significant characteristic of Yukon–Tanana terrane successions. Both earlier and later felsic rocks may be present together in some places — the dated localities are too sparse to determine. The unconformity in Finlayson Lake district was revealed by detailed structural mapping (Murphy and Piercey, 1999); detailed geochronology is required in other places. As-yet-undated felsic metatuff horizons remain in the Ram Creek assemblage and in Big Salmon Complex on Hazel Ridge, both in southern Yukon Territory.

That the Dorsey assemblage is thrust upon Ram Creek assemblage was shown by Nelson (2000) on the basis of an older-over-younger relationship and the abrupt change in metamorphic grade. In Yukon Territory the contact is not exposed, but a thrust is suspected because the Dorsey assemblage represents a deeper level of burial than the structurally underlying Ram Creek assemblage. The two dates presented here are consistent with an older-over-younger relationship, *vis*: Dorsey assemblage contains 357 Ma metatuff juxtaposed with Ram Creek assemblage including a ca. 338 Ma intrusion here, and from Ram Creek assemblage in northern British Columbia that contains 336–334 Ma protoliths. Dorsey assemblage may be in part the basement to a Ram Creek magmatic arc.

In northern British Columbia, Big Salmon Complex and Ram Creek assemblage are both characterized by upper Mississippian felsic volcanic rocks and overlying similar siliciclastic and mafic successions; they are equivalent (Nelson, 2000). The similar age and structural relationship of Ram Creek assemblage in northern British Columbia and southern Yukon Territory suggest that the two assemblages are the same, therefore the Ram Creek assemblage in Yukon Territory should also equate with Big Salmon Complex. This leaves Dorsey assemblage in the headwaters of Swift River flanked by the same younger rocks (with some intervening, probably supracrustal, Klinkit and Swift River assemblage rocks). Although geochemistry has not been completed on Dorsey assemblage rocks in this area, a similar siliciclastic successions in the "Teslin Tectonic Zone" (Stevens et al., 1996, p. 103) (**Fig. 1**) is of continental derivation (indicated by negative εNd at 350 Ma and Precambrian model ages of their Mississippian intrusions; Stevens et al. (1996)). Dorsey assemblage may be continental basement beneath these arcs.

In areas of appreciable structural relief this continental basement may be exposed in patches; it may not be recognized if the strain is inhomogeneous and the protolith composition does not lead to preservation of high-pressure metamorphic mineral assemblages. One such area is east of Logjam Creek where an unusual form of Klinkit assemblage (Stevens and Harms, 2000) may actually be Dorsey assemblage. The succession of siliceous and carbonate sediments has been mapped by Gleeson et al. (2000). A foliated metatonalite intrusion from this area yielded a 353.9 ± 0.9 Ma U-Pb zircon age. This older age and lithological character suggest that it is also part of Dorsey assemblage, and could be basement to Big Salmon Complex immediately adjacent to the west.

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REFERENCES

Aleinikoff, J.N., Dusel-Bacon, C., and Foster, H.L.
1986: Geochronology of augen gneiss and related rocks, Yukon-Tanana terrane, east-central Alaska; Geological Society of America Bulletin, v. 97, p. 626–637.

Colpron, M.
1999: Glenlyon project: Preliminary stratigraphy and structure of Yukon-Tanana terrane, Little Kalzas Lake area, central Yukon (105 L/13); *in* Yukon Exploration and Geology 1998; Exploration and Geological Services Division, Indian and Northern Affairs Canada, p. 63–71.

Colpron, M. and Reinecke, M.
2000: Glenlyon project: Coherent stratigraphic succession of Yukon-Tanana Terrane in the Little Salmon Range, and its potential for volcanic-hosted massive sulphide deposits, central Yukon; *in* Yukon Exploration and Geology 1998; Exploration and Geological Services Division, Indian and Northern Affairs Canada, p. 87–100.

de Keijzer, M., Mihalynuk, M.G., and Johnston, S.T.
2000: Structural investigation of an exposure of the Teslin fault, northwestern British Columbia; *in* Geological Survey of Canada, Current Research 2000-A5, 10 p. (online; http://www.nrcan.gc.ca/gsc/bookstore).

Erdmer, P., Ghent, E.D., Archibald, D.A., and Stout, M.Z.
1998: Paleozoic and Mesozoic high pressure metamorphism at the margin of ancestral North America in central Yukon; Geological Society of America, Bulletin, v. 110, p. 615–629.

Gleeson, T.P., Friedman, R.M., and Wahl, K.
2000: Stratigraphy, structure, geochronology and provenance of the Logjam area, northwestern British Columbia (NTS 104 O/14W); *in* Geological Fieldwork 1999; British Columbia Department of Energy, Mines and Petroleum Resources, p. 295–306.

Gordey, S.P. and Stevens, R.A.
1994: Preliminary interpretation of the bedrock geology of the Teslin area (105 C), southern Yukon; Geological Survey of Canada, Open File 2886, scale 1:250 000.

Gordey, S.P., McNicoll, V.J., and Mortensen, J.K.
1998: New U-Pb ages from the Teslin area, southern Yukon Territory, and their bearing on terrane evolution in the northern Cordillera; *in* Radiogenic Age and Isotopic Studies: Report 11; Geological Survey of Canada, Current Research 1998-F, p. 129–148.

Harms, T.A. and Stevens, R.A.
1996: Assemblage analysis of the Dorsey terrane; *in* SNORCLE and Cordilleran Tectonics Workshop, LITHOPROBE report no. 50, p.199–201.

Jaffey, A.H., Flynn, K.F., Glendenin, L.E., Bentley, W.C., and Essling, A.M.
1971: Precision measurements of half-lives and specific activities of ^{235}U and ^{238}U; Physical Review, v. 4, p. 1899–1906.

Mihalynuk, M.G., Nelson, J., and Friedman, R.M.
1998: Regional geology and mineralization of the Big Salmon Complex (104N NE and 104O SW); *in* Geological Fieldwork 1997; British Columbia Department of Energy, Mines and Employment, p. 6-1–6-20.

Mihalynuk, M.G., Nelson, J.L., 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 104 N/9E,16 & 104 O/12,13,14W); *in* Geological Fieldwork 1999; British Columbia Department of Energy, Mines and Petroleum Resources, p. 27–46.

Mihalynuk, M.G., Nelson, J.L., Gleeson, T.P., Roots, C.F., and de Keijzer, M.
2001a: Geology of Gladys River area (104 N/16), British Columbia; British Columbia Ministry of Energy, Mines and Petroleum Resources, Open File 2001-3, scale 1:50 000.

Mihalynuk, M.G., Nelson, J.L., Gleeson, T.P., Roots, C.F., de Keijzer, M., and Wahl, K.
2001b: Geology of Smart River map-area (104 O/13), British Columbia; British Columbia Ministry of Energy, Mines and Petroleum Resources, Open File 2000-6, scale 1:50 000.

Monger, J.W.H., Wheeler, J.O., Tipper, H.W., Gabrielse, H., Harms, T., Struik, L.C., Campbell, R.B., Dodds, C.J., Gehrels, G.E., and O'Brien, J.
1991: Part B. Cordilleran terranes; *in* Upper Devonian to Middle Jurassic assemblages, Chapter 8 of Geology of the Cordilleran Orogen in Canada, (ed.) H. Gabrielse and C.J. Yorath; Geological Survey of Canada, Geology of Canada, no. 4, p. 281–327 (*also* Geological Society of America, The Geology of North America, v. G-2).

Mortensen, J.K.
1992a: New U-Pb ages for the Slide Mountain Terrane in southeastern Yukon Territory; *in* Radiogenic Age and Isotopic Studies: Report 5; Geological Survey of Canada, Paper 91-2, p. 167–173.
1992b: Pre-mid-Mesozoic tectonic evolution of the Yukon-Tanana terrane, Yukon and Alaska; Tectonics, v. 111, no. 4, p. 836–853.

Mortensen, J.K. and Jilson, G.A.
1985: Evolution of the Yukon-Tanana terrane: evidence from southeastern Yukon Territory; Geology, v. 13, p. 806–810.

Mulligan, R.
1963: Geology of Teslin map-area, Yukon Territory; Geological Survey of Canada, Memoir 326, 96 p.

Murphy, D.C. and Piercey, S.J.
1999: Finlayson project: geologic evolution of Yukon-Tanana terrane and its relationship to Campbell Range belt, northern Wolverine map area, southeastern Yukon; *in* Yukon Exploration and Geology 1998, (ed.) C.F. Roots and D.S. Emond; Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p. 47–62.

Nelson, J.L.
2000: Ancient Pacific Margins Part VI: Still heading south: Potential VMS hosts in the eastern Dorsey Terrane, Jennings River (104O/1; 7,8,9,10); *in* Geological Fieldwork 1999; British Columbia Ministry of Employment and Investment, Geological Survey Branch, Paper 2000-1, p. 107–126.

Nelson, J.L., Harms, T.A., and Mortensen, J.
1998: Extensions and affiliates of the Yukon-Tanana terrane into northern British Columbia; *in* Geological Fieldwork, 1997; British Columbia Ministry of Employment and Investment, Geological Survey Branch, Paper 1998-1, p. 7-1–7-12.

Nelson, J.L., Harms, T., Roots, C., Mihalynuk, M., Friedman, R.M., and de Keijzer, M.
2001: Geology of north-central Jennings River map area, 104 O/14E and 15, British Columbia; British Columbia Ministry of Energy, Mines and Petroleum Resources, Open File 2001-6, scale 1:50 000.

Nelson, J.L., Harms, T., Zantvoort, W., Gleeson, T., and Wahl, K.
2000a: Geology of southeastern Dorsey Terrane, 104 O/7,8,9,10; British Columbia; British Columbia Ministry of Energy, Mines and Petroleum Resources, Open File 2000-4, scale 1:50 000.

Nelson, J.L., Mihalynuk, M.G., Murphy, D.C., Colpron, M., Roots, C.F., Mortensen, J.K., and Friedman, R.M.

2000b: Ancient Pacific Margin Part II: 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; p.79–86; and *in* Geological Fieldwork 1999; British Columbia Ministry of Employment and Investment, Geological Survey Branch, Paper 2000-1, p. 19–26.

Piercey, S.J. and Murphy, D.C.

2000: Stratigraphy and regional implications of unstrained Devono-Mississippian volcanic rocks in the Money Creek thrust sheet, Yukon-Tanana Terrane, southeastern Yukon; *in* Yukon Exploration and Geology 1999; Exploration and Geological Services Division, Indian and Northern Affairs Canada, p. 67–78.

Roots, C.F., de Keijzer, M., and Nelson, J.L.

2000: Wolf Lake project: Revision mapping of Dorsey Terrane assemblages in the upper Swift River area, southern Yukon and northern BC; *in* Yukon Exploration and Geology 1999, (ed.) D.S. Emond and L.H. Weston; Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p. 115–125.

Stacey, J.S. and Kramers, J.D.

1975: Approximation of the terrestrial lead isotope evolution by a two-stage model; Earth and Planetary Science Letters, v. 26, p. 57–76.

Stevens, R.A.

1996: Dorsey Assemblage: Pre-mid-Permian high temperature and pressure metamorphic rocks in the Dorsey Range, southern Yukon Territory; *in* SNORCLE and Cordilleran Tectonics Workshop, LITHOPROBE report no. 50, p. 70–75.

Stevens, R.A. and Harms, T.A.

1995: Investigations in the Dorsey terrane, part 1: stratigraphy, structure and metamorphism in the Dorsey Range, southern Yukon Territory and northern British Columbia; *in* Current Research 1995-A; Geological Survey of Canada, p. 117–127.

2000: Bedrock geology of the Dorsey Range, southern Yukon Territory and northern British Columbia; Geological Survey of Canada, Open File 3926, scale 1:100 000.

Stevens, R.A., Erdmer, P., Creaser, R.A., and Grant, S.L.
1996: Mississippian assembly of the Nisutlin assemblage: evidence from primary contact relationships and Mississippian magmatism in the Teslin Tectonic Zone, part of the Yukon-Tanana terrane of south-central Yukon; Canadian Journal of Earth Sciences, v. 33, p. 103–116.

Stevens, R.A., Mortensen, J.K., and Hunt, P.A.
1993: U-Pb and ^{40}Ar-^{39}Ar geochronology of plutonic rocks from the Teslin suture zone, Yukon Territory; *in* Radiogenic Age and Isotopic Studies, Report 7; Geological Survey of Canada, Paper 93-2, p. 83–90.

Thompson, R.I., Nelson, J.L., Paradis, S., Roots, C.F., Murphy, D.C., Gordey, S.P., and Jackson, L.E.
2000: Ancient Pacific Margin NATMAP Project, year one; *in* Geological Survey of Canada, Current Research 2000A-1 (online; http://www.nrcan.gc.ca/gsc/bookstore).

Geological Survey of Canada Project 990002

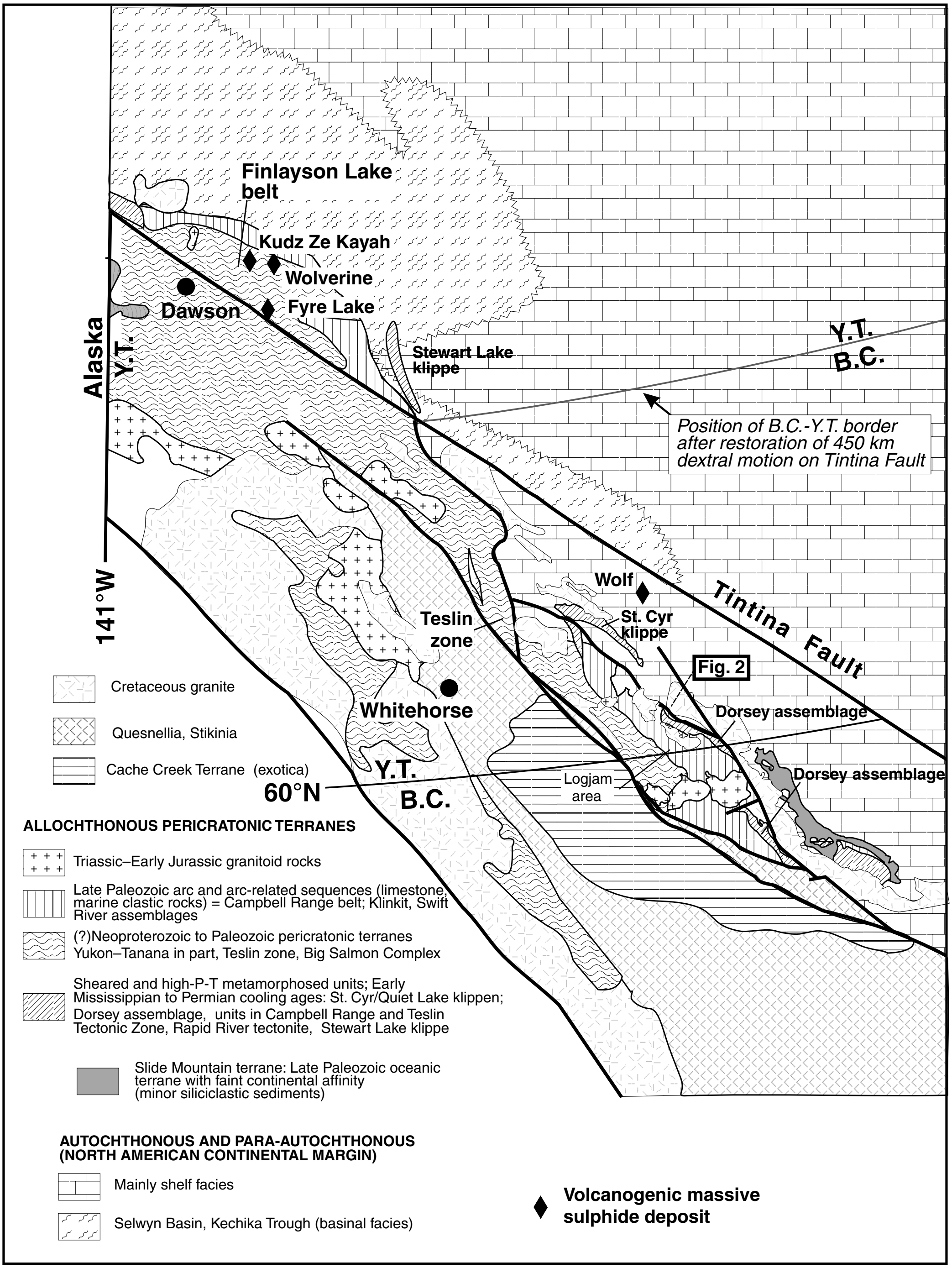

Figure 1. Generalized terrane map of northern British Columbia and Yukon Territory prior to about 450 km of dextral displacement along Tintina Fault

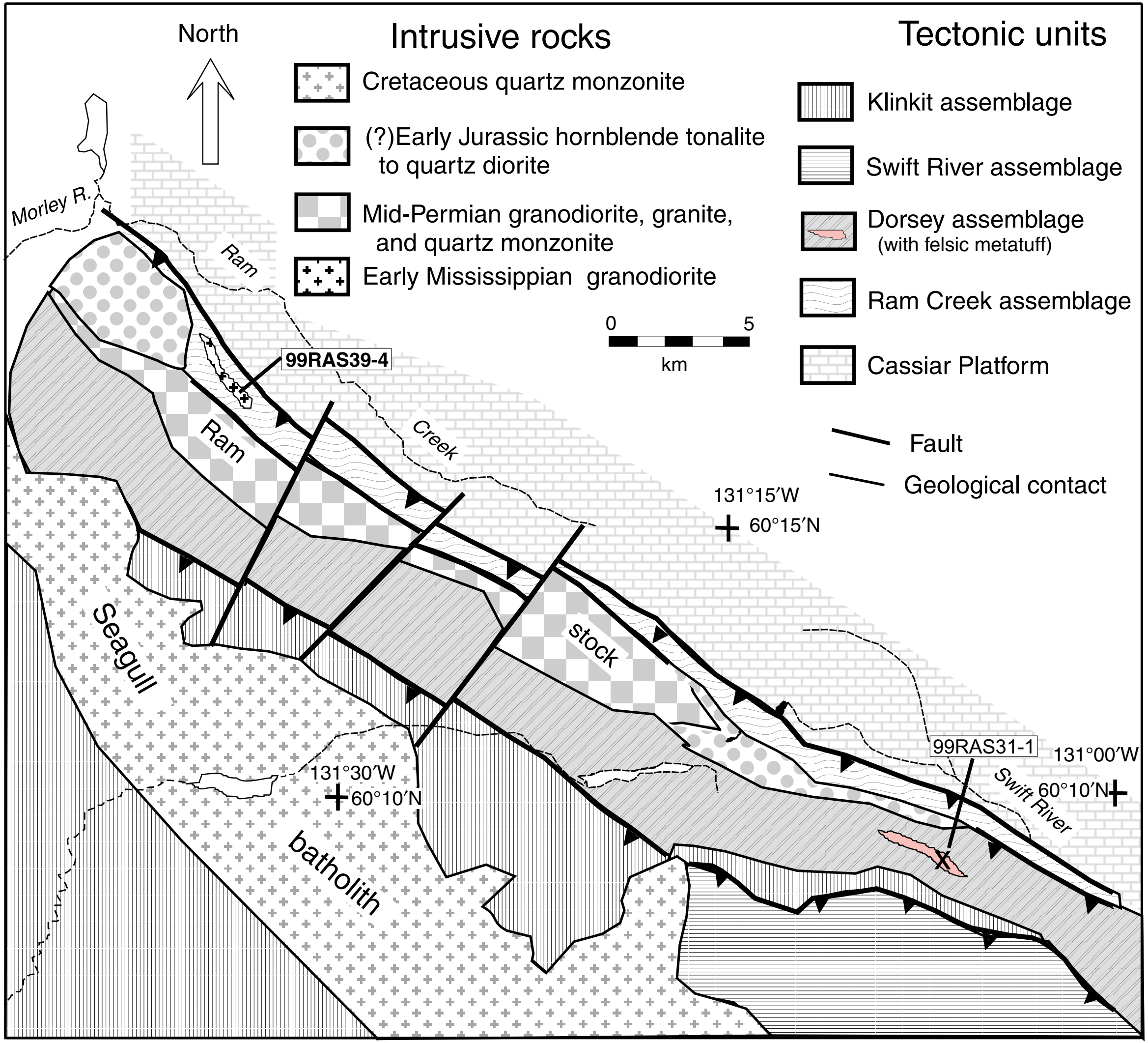

Figure 2.

Distribution of rock units in northern Dorsey Terrane, showing sample sites (*modified from* Stevens, 1996).

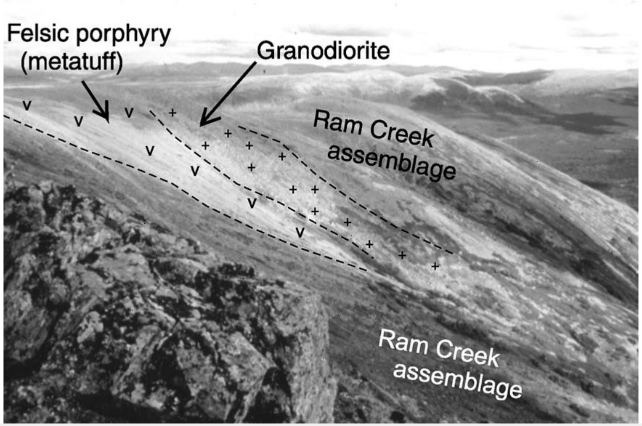

Figure 3. Northward view of ridge crest in Ram Creek assemblage, showing quartz-sericite schist in contact with the 344 Ma granodiorite.

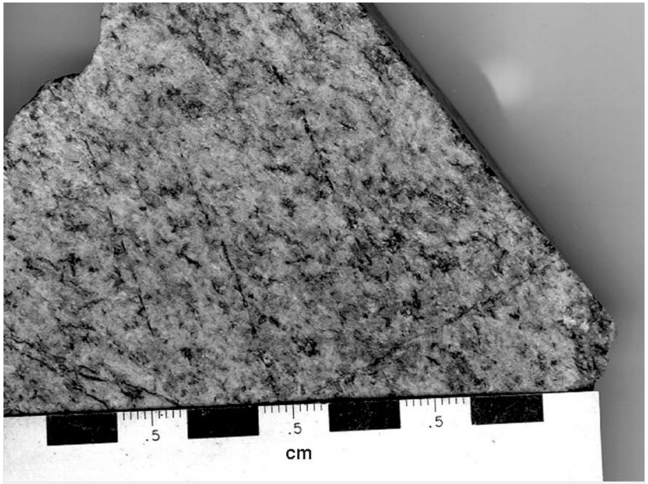

Figure 4. Sawn slab of foliated granodiorite (sample 99RAS-39-4) in Ram Creek assemblage. Dark green, slightly foliated specks are chloritized hornblende; purplish (darker grey) blotches are recrystallized quartz; black lines are open joints.

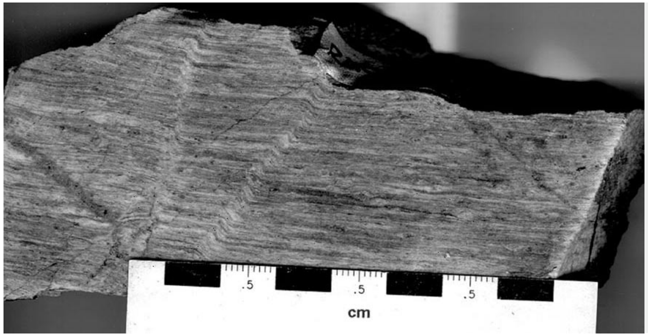

Figure 5.

Sawn slab of quartz-feldspar augen schist (felsic metatuff; sample 99RAS-31-1) from the Dorsey assemblage. Grey specks and white dots are quartz and feldspar phenocrysts respectively.

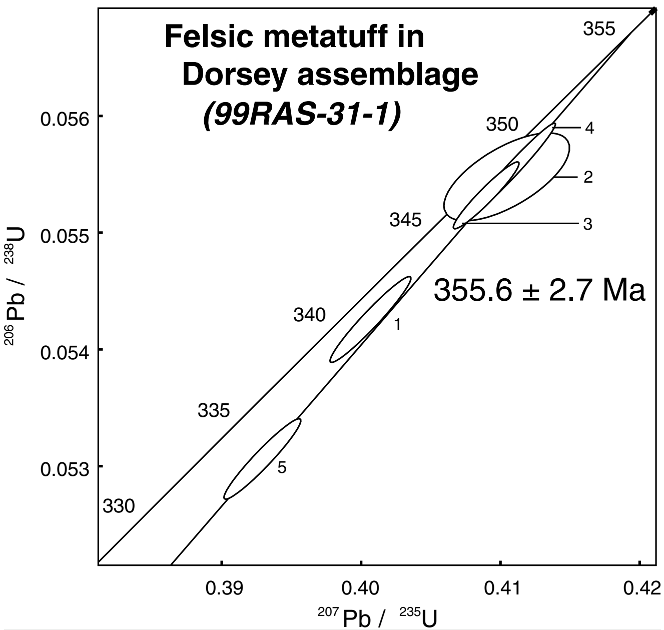

Figure 6. Concordia plot with 2-sigma error estimates for five zircon fractions from felsic metatuff in Dorsey assemblage.

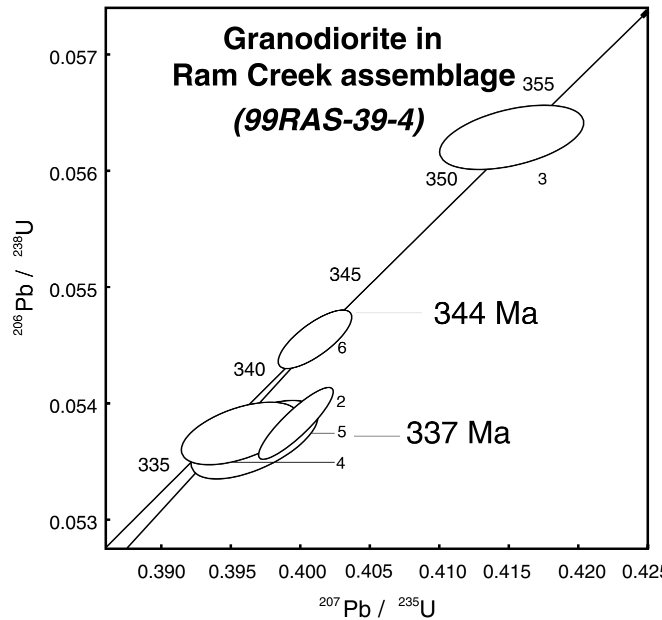

Figure 7. Concordia plot with 2-sigma error estimates for five zircon fractions from granodiorite in Ram Creek assemblage.

Table 1. Descriptions and location information for Dorsey Terrane samples in Table 2.

Zircon fraction	Description[a]	Location data
99RAS-31-1 Q-F augen schist, Dorsey assemblage		
1	53 broken.needles, faint to light tan, subhedral to euhedral, slightly resorbed; >2:1 length:width; M1	Sample 99RAS-31-1 collected from outcrop at 1510 m at UTM zone 8 380880E 6670210N
2	35 prisms (about 2:1 length:width), faint tan, subhedral, slightly resorbed; M2	
3	70 broken needles, faint to light tan, euhedral, slightly resorbed; M2	
4	95 broken needles, faint tan, euhedral, slightly resorbed; NM2	
5	107 good broken euhedral prisms, light tan, translucent; NM4	
99RAS-39-4 granodiorite in Ram Creek assemblage		
2	39 broken prisms (about 2:1 length:width), faint tan, euhedral; M1	Sample 99RAS-39-4 collected from rubble-covered plateau at 1600 m at UTM zone 8 358750E 6686140N
3	40 faint tan to colourless broken prisms, inclusions resorbed; NM0	
4	21 faint tan prisms, euhedral; 1.5:1 length:width; inclusions, fractures	
5	12 euhedral prisms, tan to translucent, colourless inclusions	
6	16 broken needles, slightly resorbed, euhedral prisms	

[a]NM: nonmagnetic at the indicated angle of side tilt using a Frantz isodynamic separator; M = magnetic; 0, 1, 2, or 4 are the angles of tilt.

Table 2. Uranium-lead analytical data for two samples from Dorsey Terrane.

Zircon fraction	Weight (mg)	Concentration (ppm) U	Pb	Th	Th[a] /U	Pb[b] (pg)	$^{206}Pb/^{204}Pb^c$	Atomic ratios (± 2s error) $^{206}Pb/^{238}U^d$	$^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$	Apparent age (± 2s error; Ma) $^{206}Pb/^{238}U$	$^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$	Per cent discord-ance
99RAS-31-1 Q-F augen schist, Dorsey assemblage														
1	21.2	1091	58	248	0.2	18	4400	0.0543 ± 3	0.401 ± 2	0.0536 ± 1	340.6 ± 1.8	342.1 ± 1.8	352.6 ± 3.6	3.5
2	12.0	933	56	196	0.2	78	516	0.0555 ± 3	0.410 ± 4	0.0537 ± 4	348.0 ± 1.8	349.2 ± 2.6	356.8 ± 15.2	2.5
3	40.2	613	33	129	0.2	18	4697	0.0553 ± 2	0.409 ± 2	0.0537 ± 1	347.1 ± 1.4	347.1 ± 1.4	357.0 ± 3.2	2.8
4	20.6	1300	70	289	0.2	11	8524	0.0556 ± 3	0.411 ± 3	0.0537 ± 1	348.5 ± 2.0	349.5 ± 1.8	356.4 ± 2.8	2.3
5	32.6	653	34	132	0.2	20	3644	0.0531 ± 2	0.393 ± 2	0.0537 ± 1	333.3 ± 1.8	336.5 ± 1.6	358.7 ± 3.8	7.3
99RAS-39-4 granodiorite in Ram Creek assemblage														
2	28.8	286	17	182	0.6	9	2953	0.0583 ± 3	0.400 ± 2	0.0539 ± 1	338.0 ± 1.6	341.4 ± 1.6	364.9 ± 5.8	7.6
3	11.5	406	29	272	0.7	47	370	0.0563 ± 2	0.415 ± 4	0.0535 ± 5	353.0 ± 1.4	352.6 ± 3.0	350.1 ± 20.6	-0.9
4	16.3	337	22	240	0.7	42	460	0.0537 ± 2	0.396 ± 3	0.0534 ± 4	337.5 ± 1.4	338.5 ± 2.6	345.6 ± 16.6	2.4
5	3.4	531	33	365	0.7	9	724	0.0537 ± 2	0.397 ± 4	0.0536 ± 4	337.1 ± 1.6	339.3 ± 2.8	353.9 ± 17.0	4.9
6	9.7	383	23	240	0.6	7	1783	0.0546 ± 2	0.401 ± 2	0.0533 ± 2	342.4 ± 1.2	342.4 ± 1.6	342.5 ± 8.0	0.0

Notes:
Uranium decay constants used are those of Jaffey et al. (1971): $^{238}U = 1.55125 \times 10^{-10}$ year $^{-1}$; $^{235}U = 9.8485 \times 10^{-10}$ year^{-1} and $^{238}U/^{235}U = 137.88$.
Isotopic composition of common Pb in excess of blank calculated using the two-stage average crustal Pb model of Stacey and Kramers (1975).
[a] Th calculated from ^{208}Pb abundance and U-Pb age, and assumes all ^{208}Pb derived from ^{232}Th decay.
[b] Total common Pb in analysis.
[c] Corrected for spike and fractionation.
[d] Corrected for spike, blank, and fractionation.