Geology of the Dezadeash Range and adjacent northern Coast Mountains (115A), southwestern Yukon: Re-examination of a terrane boundary

Jochen E. Mezger[1]
Department of Earth and Atmospheric Sciences, University of Alberta[2]

Mezger. J.E., 2003. Geology of the Dezadeash Range and adjacent northern Coast Mountains (115A), southwestern Yukon: Re-examination of a terrane boundary. *In:* Yukon Exploration and Geology 2002, D.S. Emond and L.L. Lewis (eds.), Exploration and Geological Services Division, Yukon Region, Indian and Northern Affairs Canada, p. 149-163.

ABSTRACT

Granodiorite of the Coast Plutonic Complex intruded metasedimentary rocks in the Dezadeash Range of the northern Coast Belt in the late Mesozoic. Graphitic staurolite–biotite schist, associated with the Kluane Metamorphic Assemblage, underlies the western Dezadeash Range, whereas cordierite–biotite gneiss, previously correlated with the Late Proterozoic – Paleozoic Nisling Assemblage, is exposed in the eastern and southern regions. A terrane boundary was placed in the central Dezadeash Range.

Recent petrographic studies reveal a southeastward increase in metamorphic grade. Prograde appearance of cordierite partly obliterated an older schistosity and caused a fabric change near the postulated terrane boundary. Furthermore, typical continental margin rocks, such as marble and quartzite, are not observed. This suggests that all metamorphic rocks in the Dezadeash Range can be correlated with the Kluane Metamorphic Assemblage, whereas Nisling Assemblage rocks occur in the Coast Mountains to the east. Therefore, the terrane boundary is located in the Dezadeash River valley, further southeast than previously thought.

RÉSUMÉ

Les granodiorites du Complexe Plutonique Côtier se sont emplacés au Mésozoïque tardif dans les roches métasédimentaires du chaînon de Dezadeash dans le nord de la Chaîne Côtière. Les schistes graphitiques à staurotide et biotite de la Série Métamorphique de Kluane se retrouvent dans la partie occidentale du chaînon de Dezadeash, alors que les parties orientale et méridionale comprennent du gneiss à cordiérite et biotite préalablement associé à la Série de Nisling d'âge Protérozoïque tardif à Paléozoïque. Une limite de terrane fut donc placée au coeur du chaînon de Dezadeash.

De nouvelles données pétrographiques montrent cependant que les conditions du métamorphisme augmentent vers le sud-est à travers le chaînon, s'exprimant par l'occurrence de la cordièrite; cette dernière recoupant une ancienne schistosité et, produisant une nouvelle fabrique cristalline à proximité de la supposée limite séparant la Série Métamorphique de Nisling de celle de Kluane. De plus, aucune roche de type marge continentale (marbre, quartzite) n'a pas été observée au sein des ces unités métamorphiques, suggérant que toutes les roches métamorphiques du Chaînon de Dezadeash se rattachent à la Série Métamorphique de Kluane. La Série de Nisling se limite donc à la partie orientale de la Chaîne Côtière et la limite du terrane se retrouve plus au sud dans la vallée de Dezadeash.

[1]*Present address: Johannes Gutenberg-Universität Mainz, Institut für Geowissenschaften, Becherweg 21, 55099 Mainz, Germany, mezger@uni-mainz.de*

[2]*Edmonton, Alberta, Canada T6G 2E3*

INTRODUCTION

The Dezadeash Range is situated at a geomorphological triple junction between the Yukon Plateau, the St. Elias Mountains and northern Coast Mountains in the southwestern Yukon (Fig. 1). It is also located at a contact zone of two metamorphic belts within the Coast Belt of the northern Canadian Cordillera, an extensive graphitic mica schist belt, the Kluane Metamorphic Assemblage, to the northwest and the Nisling Assemblage to the east. Metamorphic rocks comprise graphitic plagioclase-staurolite-biotite schist in the western Dezadeash Range and cordierite-biotite gneiss in the east. Erdmer (1991) located a north-trending terrane boundary in the eastern Dezadeash Range, which is shown on current geological maps: the Tectonic Assemblage Map of the Canadian Cordillera (Wheeler and McFeely, 1991, also shown in Figure 2) and the Yukon Digital Geology map (Gordey and Makepeace, 1999). Results of recent structural, metamorphic and geochemical studies provide no evidence for a major lithological boundary in the Dezadeash Range (Mezger, 1997; Mezger et al., 2001a,b). What had been considered a terrane boundary is identified as a metamorphic mineral isograd in the high-grade gneiss terrane at the southeastern termination of the western mica schist belt, the Kluane Metamorphic Assemblage. The boundary with the Nisling Assemblage is located in the Dezadeash River valley to the east of the Dezadeash Range. The regional structural and metamorphic characteristics of the Dezadeash Range and adjacent Coast Mountains are described here, to complement more general publications that discuss the metamorphic and geochemical evolution of metamorphic rocks of the northern Coast Belt (Mezger et al., 2001a,b).

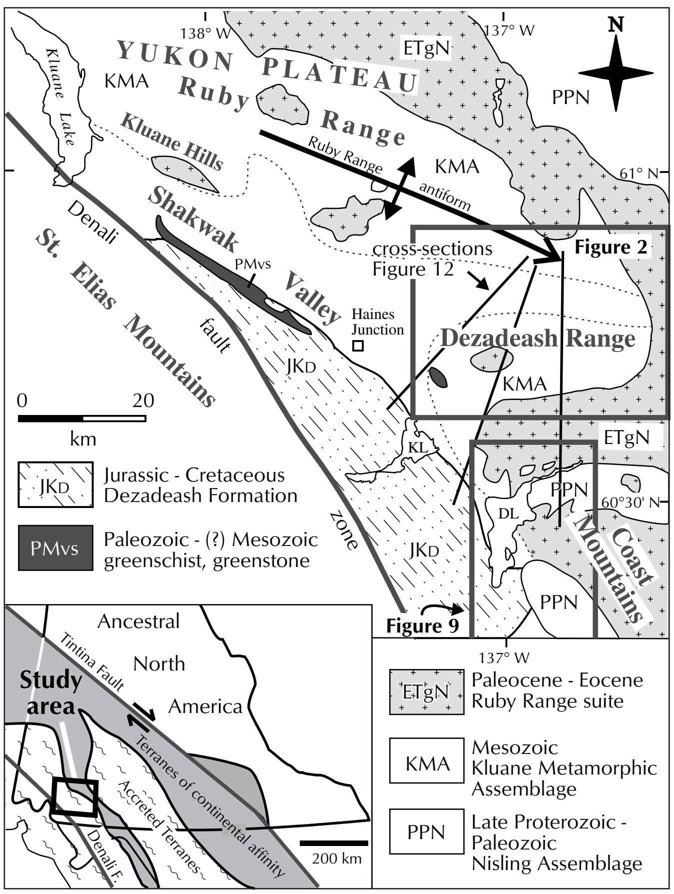


Figure 1. *Tectonic setting of the southwestern Yukon with the major geological and morphological elements. The location of detailed maps and cross-sections of Figures 2, 9 and 12 are shown. Geological notation is from Dodds and Campbell (1992) and Gordey and Makepeace (1999). DL – Dezadeash Lake, KL – Kathleen Lakes*

PREVIOUS GEOLOGICAL STUDIES

Metamorphic rocks east of the Denali fault zone and southwest and west of the early Tertiary plutons of the Ruby Range and the Coast Mountains are labelled 'undivided metamorphic rocks' (Wheeler and McFeely, 1991; Gordey and Makepeace, 1999). This rather meaningless name paraphrases the problems geologists had in determining the tectonic setting of a quite extensive, 150-km-long, northwest-trending belt of metamorphic rocks that form the southwestern flanks of the Ruby and the Dezadeash ranges. These metamorphic rocks are characterized by a monotonous lithology and structural orientation on a local scale, but record a strong regional metamorphic gradient. Distribution of these rocks across three map sheets (115F/G Kluane Lake, 115H Aishihik Lake, 115A Dezadeash), which were mapped over a period of 25 years, resulted in different classifications of the rocks (Kindle, 1949; Muller, 1967; Tempelman-Kluit, 1974).

In a 1912 mining report of the Kluane region McConnell (1905) first described extensive 'dark gray quartz-mica schist' of metasedimentary origin, which he named 'Kluane schists'. He already noticed the lack of limestone and quartzite that distinguishes the 'Kluane schist' from the 'Nasina series', which can be correlated with the Nisling Assemblage. The term 'Yukon Group' was introduced by Cairnes (1914) to include all metasedimentary and meta-igneous rocks along the Yukon-Alaska boundary. It was widely applied by subsequent workers in the Dezadeash (115A), Kluane Lake (115F, G) and Aishihik Lake (115H) map areas (Cockfield, 1927, 1928; Kindle, 1952; Muller, 1967), but various metasedimentary rocks were not differentiated on published geological maps. Muller (1967) subdivided schist into garnet- and staurolite-bearing quartz-biotite schist and gneiss (unit 1), and quartz-sericite schist (unit 2), and noted their high content in graphite and generally uniform lithology.

Tempelman-Kluit (1974) mapped the Aishihik Lake area (115H) and observed 'remarkably homogeneous' staurolite-, andalusite- and cordierite-bearing mica-quartz schist, which he termed 'hornfelsed schist' (PPsqr). He also noted that absence of marble makes the hornfelsed schist unit "unique in Yukon Plateau and is unlike other rocks in the Yukon Metamorphic Complex" (Tempelman-Kluit, 1974, p. 25). Erdmer (1990; 1991) came to similar conclusions after mapping selected areas in the Ruby Range, the Dezadeash Range and the Coast Mountains. He defined the 'Kluane assemblage' as graphitic mica schist with characteristic plagioclase porphyroblasts with graphite inclusions, conspicuously lacking marble, calc-silicate and quartzite units that are common in the Nisling Assemblage. The Nisling Assemblage is considered to comprise Late Proterozoic-Paleozoic continental margin rocks and correlates with the Nasina Assemblage and the Aishihik metamorphic suite (Johnston and Timmerman, 1994; Johnston et al., 1996). The contact between Kluane and Nisling assemblages was inferred to lie in the eastern Dezadeash Range, based on the absence of graphite in more heterogeneous Nisling rocks to the east (Erdmer, 1991). The terrane boundary was traced north along the Aishihik River valley. This contact was then overprinted by later metamorphism related to the early Tertiary intrusion of the Ruby Range batholith to the north (Erdmer, 1990; Erdmer and Mortensen, 1993).

A comprehensive field study of the 'Kluane schist/ assemblage' was carried out over three seasons by the author to map the extent of the Kluane metamorphic rocks. The term Kluane Metamorphic Assemblage (KMA) was introduced to include ultramafic rocks that are tectonically interleaved with the metasedimentary rocks and have experienced the same deformation (Mezger, 1995, 1997, 2000). In general, the KMA is a homogeneous 12-km-thick metapelitic sequence, ranging in metamorphic grade from greenschist facies along the Kluane Lake shore to the amphibolite-granulite facies transition zone in the eastern Dezadeash Range. Lower grade rocks are mylonitic L-S tectonites with a monoclinic symmetry indicating top-to-the-west sense of shear (Mezger and Creaser, 1996). In rocks of higher metamorphic grade, shear sense indicators are obliterated by contact metamorphism related to the Ruby Range batholith emplacement. Along the metamorphic gradient the rocks change their appearance, which caused previous workers to view the high-grade gneiss as a different unit. Inclusion of schist and gneiss in one assemblage was confirmed by neodymium isotope studies, which show that they are derived from a uniform protolith, distinct from that of other metamorphic assemblages, such as the Aishihik metamorphic suite (Mezger et al., 2001b). Table 1 lists lithologies of the KMA and the Nisling Assemblage.

THE DEZADEASH RANGE

The Dezadeash Range is triangular-shaped with sides 35-40 km long, separated from adjacent mountain ranges by the Dezadeash River in the north and southeast, and the Shakwak Valley in the southwest. The northern Dezadeash Range, dominated by metasedimentary rocks and two intrusive granodioritic stocks, has a rugged topography and rises up to 1200 m above the valley (Fig. 2). In contrast, the southern part of the range, predominantly underlain by massive granodiorite, is lower and has a smoother topography (Fig. 3). Easy direct access into the Dezadeash Range is only possible from the Haines Road at the southwestern end, halfway between Kathleen Lakes and Dezadeash Lake. An apparently non-maintained — at the time of fieldwork in 1995 — dirt road leads onto the southwestern ridges from where the central and eastern Dezadeash Range can also be reached. The northwestern Dezadeash Range is best accessed by helicopter.

STRUCTURAL CHARACTER OF THE NORTHERN DEZADEASH RANGE

Graphitic garnet-staurolite-biotite-plagioclase schist of the northwestern Dezadeash Range possesses a well developed spaced schistosity defined by platy alignment of biotite flakes. Undulating foliation surfaces are common, but well developed folding is not observed in every outcrop. Folds are asymmetrical open to closed, shallowly inclined or recumbent, with amplitudes and wavelengths in decimetre- to metre-range (Fig. 4). Fold axes trend sub-parallel to the general southeastern strike of the schistosity, which dips moderately to steeply (50-80°) towards northeast or southwest. This indicates the

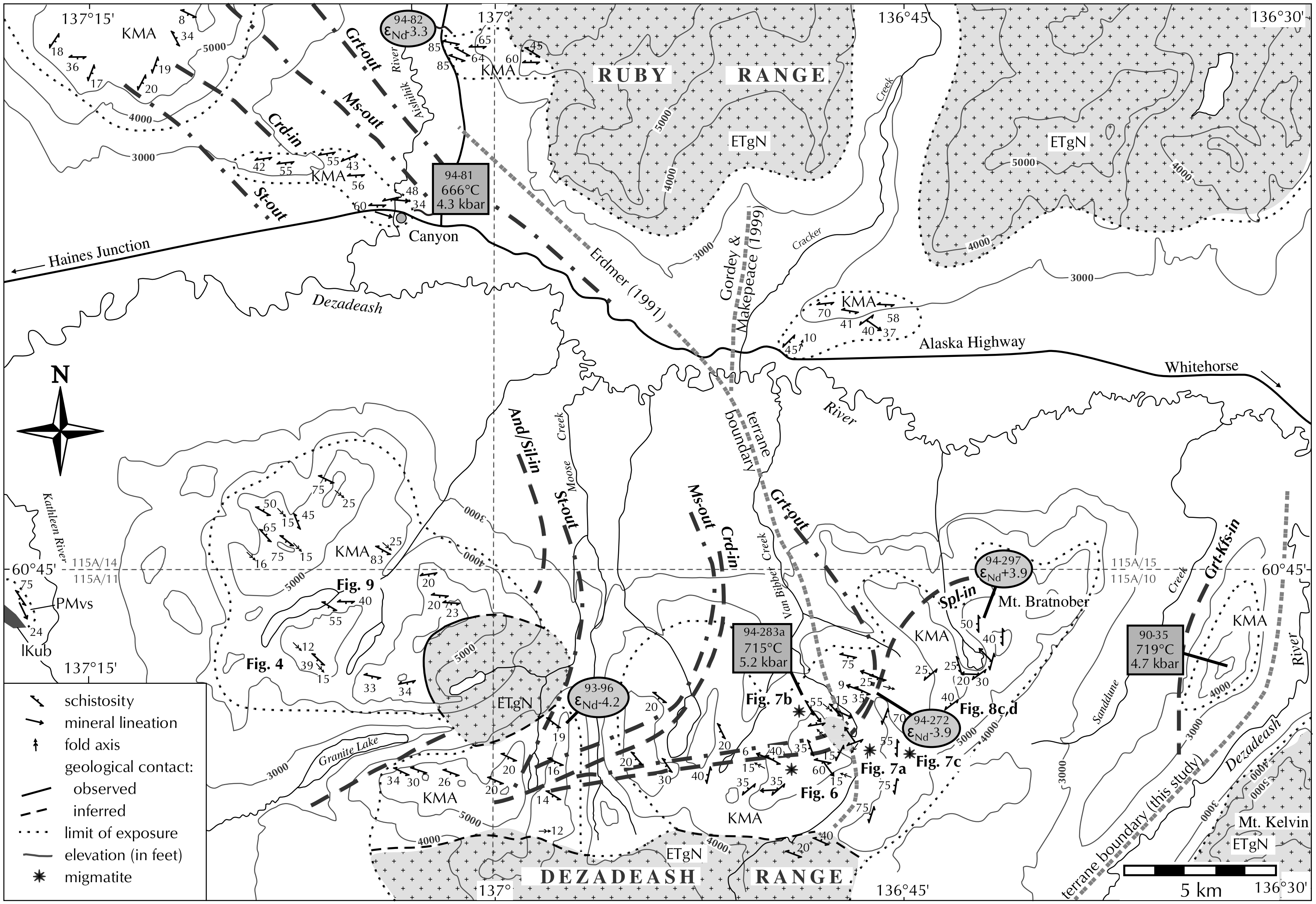


Figure 2. *Geological map of the northern Dezadeash Range and the southeastern Ruby Range, displaying mineral isograds, P-T estimates and neodymium data (shaded boxes and ellipses) of Mezger et al. (2001a,b). Mineral abbreviations are listed in Table 1. KMA-Nisling terrane boundaries proposed by Erdmer (1991), Gordey and Makepeace (1999), and this study are shown. Additional structural data are from Erdmer (1991). Geological signatures (legend) are the same as in Figure 1. 'lKub' denotes late Early Cretaceous pyroxenite (Dodds and Campbell, 1992). Locations of following figures are shown: 4, 6, 7a-c, 8c,d, 9. Figure covers parts of 1:50 000 map areas Mount Bratnober (115A/10), Kathleen Lakes (115A/11), Canyon (115A/14) and Cracker Creek (115A/15).*

Table 1. *Comparision of Kluane Metamorphic and Nisling assemblages lithology.*

Kluane Metamorphic Assemblage	Nisling Assemblage[1]
Ruby Range	
graphitic (Ep)-Chl-Ms-Pl-Qtz schist	
graphitic Grt-St-(And)-Bt-Pl-Qtz schist	
Sil-Crd-Pl-Bt-Qtz gneiss	
olivine serpentinite	
minor interfoliated actinolite hornfels	
Dezadeash Range	**Coast Mountains east of Dezadeash Lake**
graphitic Grt-St-(And)-Bt-Pl-Qtz schist	Spl-Crd-Ky-Bt-Qtz schist
(Spl)-Sil-Crd-Pl-Bt-Qtz gneiss	Ky-Grt-Pl-Bt-Qtz schist
Spl-Kfs-Crd gneiss	Sil-Grt-Pl-Bt-Qtz schist
Spl-Kfs-Grt-Crd-Bt-Qtz gneiss	Sil-Spl-Crd-Grt-Bt-Qtz gneiss
	Grt-Pl amphibolite
	Diopside calc-silicate
	Marble
Mt. Bratnober only	
Orthoamphibole-Bt-Pl-Qtz gneiss	

1: Additional information is from Erdmer (1989; 1990).

And: andalusite; Bt: biotite; Chl: chlorite; Crd: cordierite; Ep: epidote; Grt: garnet; Kfs: potassium-feldspar; Ky: kyanite; Ms: muscovite; Pl: plagioclase; Qtz: quartz; Sil: sillimanite; Spl: spinel; St: staurolite.

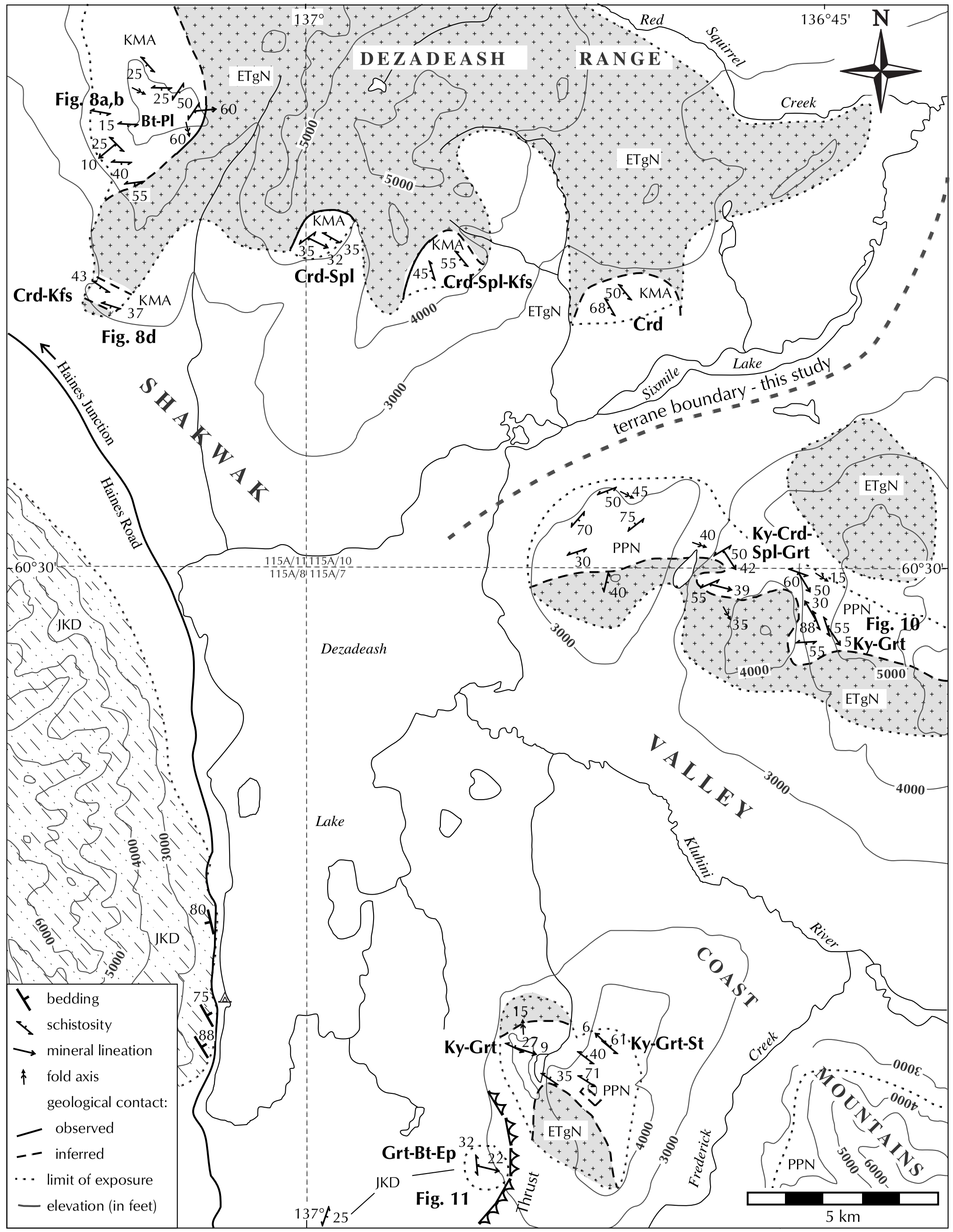


Figure 3. *Geological map of the southern Dezadeash Range and the Dezadeash Lake area. Legend as in Figure 1. Minerals on the map list only the characteristic metamorphic phases; their abbreviations are listed in Table 1. Detailed geological maps of areas adjacent to the south and east were published by Lowey (2000) and Erdmer (1990), respectively. Locations of following figures are shown: 8a,b, 10, 11. Figure covers parts of 1:25 000 map areas Mush Lake (115A/6), Kluhini River (115A/7), Mount Bratnober (115A/10) and Kathleen Lakes (115A/11).*

existence of several southeast-trending and southwest-verging syn- and antiforms with wavelengths of several hundred metres to a few kilometres (Fig. 2). The lack of marker horizons and discontinuous exposure prevent further distinction. The strike of schistosity is similar to that of east-striking biotite-cordierite gneiss exposed 8 km to the north, at the southern limb of the Ruby Range antiform (Figs. 1,2,5). It remains unclear if the structural sequence is continuous or disrupted by an east-striking fault located in the Dezadeash River valley.

Steeply southwest-dipping hornblende-chlorite schist is exposed near Kathleen River, in the Shakwak valley 5 km to the west. Originally mapped as 'Yukon Group' by Kindle (1952), these rocks can be correlated with chlorite schist of the PMvs unit that underlies the Kluane Ranges west of Haines Junction (Dodds and Campbell, 1992). Immediately to the west, serpentinized pyroxenite (lKub)

Figure 4. *Recumbent, similar fold in staurolite-biotite schist of the western Dezadeash Range. Fold axis plunges to southeast. Length of rock hammer is 30 cm.*

was drilled for asbestos on the REX claim (Yukon MINFILE, 2001, 115A 032).

The orientation of schistosity in the Dezadeash Range gradually becomes moderately (15-35°) south-dipping near the vicinity of the massive granodiorite stock of the Moose Creek valley (Fig. 2). The granodiorite is exposed on both sides of the valley and structurally underlies the schist. Over the next 10 km towards the east, the schistosity retains moderate dip angles, but its dip direction gradually changes to the southwest. The character of the rocks changes from schist to gneiss. Isoclinal folds and small-scale shear zones are indicative of higher strain deformation than in the western range (Fig. 6).

A small granodiorite stock cross-cutting the cordierite gneiss is exposed at the southwestern slope of an unnamed lake in the Van Bibber Creek valley (Fig. 2). Dip direction and angle of the cordierite gneiss vary strongly in the vicinity of the granodiorite, and it displays shallow dips close to the contact. Mineral lineation, which is commonly observed in the gneiss, and axes of isoclinal folds show scattering of plunge directions. The character of the contact varies. Intruded granodiorite can display intrusion-parallel foliation discordant with schistosity of the cordierite gneiss float, which contains leucosome veins perpendicular to schistosity (Fig. 7a). These fabrics can be interpreted as an early stage of migmatization. At another locality the gneiss shows schlieren and stromatic textures characteristic of migmatization (Fig. 7b). An older more mafic plutonic rock, possibly an amphibolite or diorite, forms boudinaged layers within granodiorite sills cross-cutting the cordierite gneiss (Fig. 7a). Nearby, massive coarse-grained granitic rocks intrude fine-grained amphibolite (Fig. 7c).

The eastern ridges of the Dezadeash Range are underlain by moderately to steeply northwest-dipping cordierite gneiss. Metre-thick sills and dykes of granodioritic composition cross-cut the gneiss. Erdmer (1991) described several phases of cross-cutting granite pegmatite and aplite. West of Mt. Bratnober, an orthoamphibole-biotite-plagioclase-quartz schist of unknown thickness crops out. It has a well developed schistosity which is oriented parallel to nearby cordierite gneiss. The main granodiorite, cropping out at the southwestern end of the ridge, displays a northeast-dipping foliation near the intrusive contact (Fig. 2). This indicates that the granodiorite underlies the cordierite gneiss to the north.

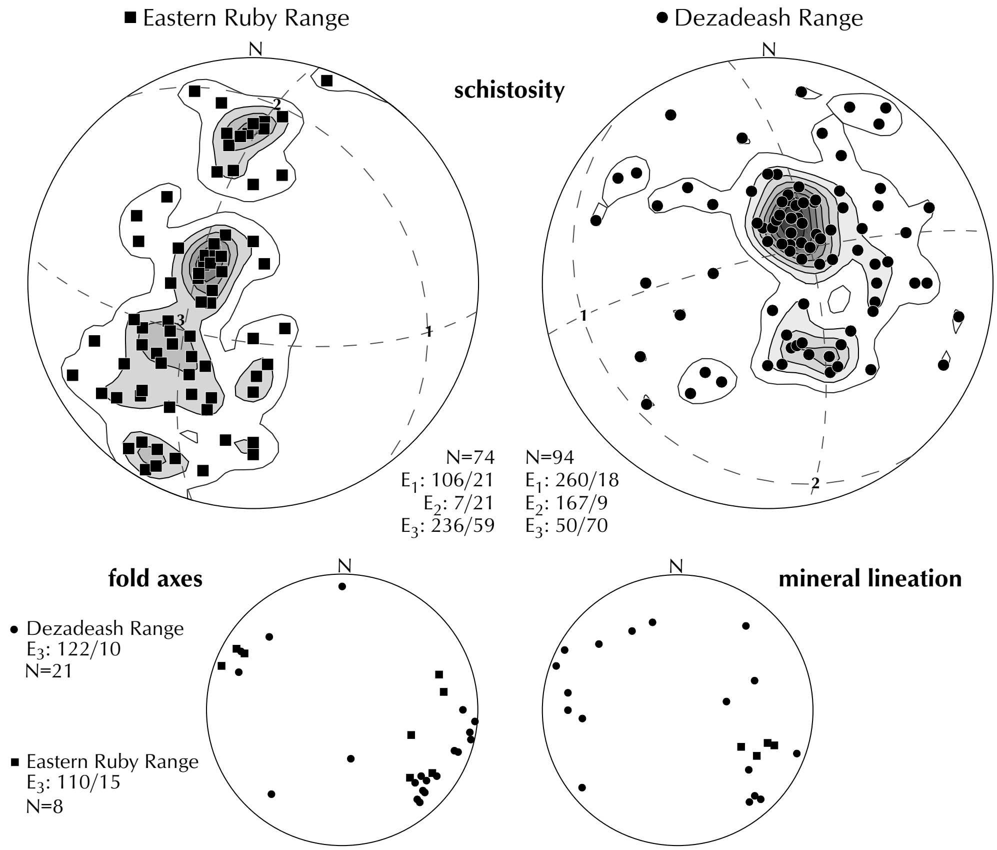


Figure 5. *Equal area stereographic lower hemisphere projection of structural data of the Kluane Metamorphic Assemblage in the Dezadeash Range and the southeastern Ruby Range. Smoothed Gaussian contouring with intervals of 2 sigma. 'E' denotes eigenvectors.*

In comparison with the Ruby Range, where poles to schistosity form a girdle with a shallow east-plunging fold axis, the foliation is more widely scattered in the Dezadeash Range (Fig. 5). The scattering of foliation and lineation can be attributed to the occurrence of granodiorite intrusions, which postdate fabric development and deflect them during emplacement. Similar deviation of structural fabrics around intrusions can be observed in the Ruby Range (e.g., Garnet Creek, Killermun Lake; Mezger, 1997). In the Dezadeash Range, shallowing of foliation has been observed around the Moose Creek stock in the west, and especially in the contact zone of the small Van Bibber Creek granodiorite. Other small-scale perturbations may be related to doming of plutons, which are not exposed at the surface. Several cross-cutting metre-sized granodiorite sills and dykes may indicate the presence of unexposed plutons.

METAMORPHIC CHARACTER OF THE NORTHERN DEZADEASH RANGE

The metamorphic grade in the northern Dezadeash Range increases from west to east, and to the contact with the granodiorite in the southeast. The northwestern ridges are underlain by a graphitic garnet-staurolite-biotite-quartz schist with plagioclase porphyroblasts that are characteristic throughout the Kluane Metamorphic Assemblage (similar to Fig. 8a,b). Muscovite and chlorite are minor phases. Garnets in the so-called staurolite zone

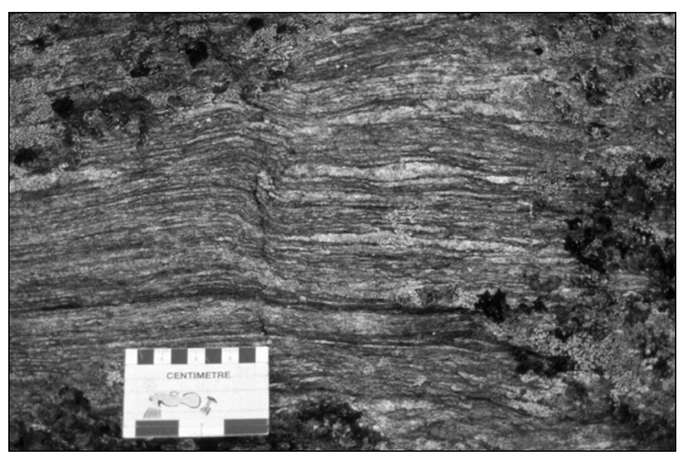
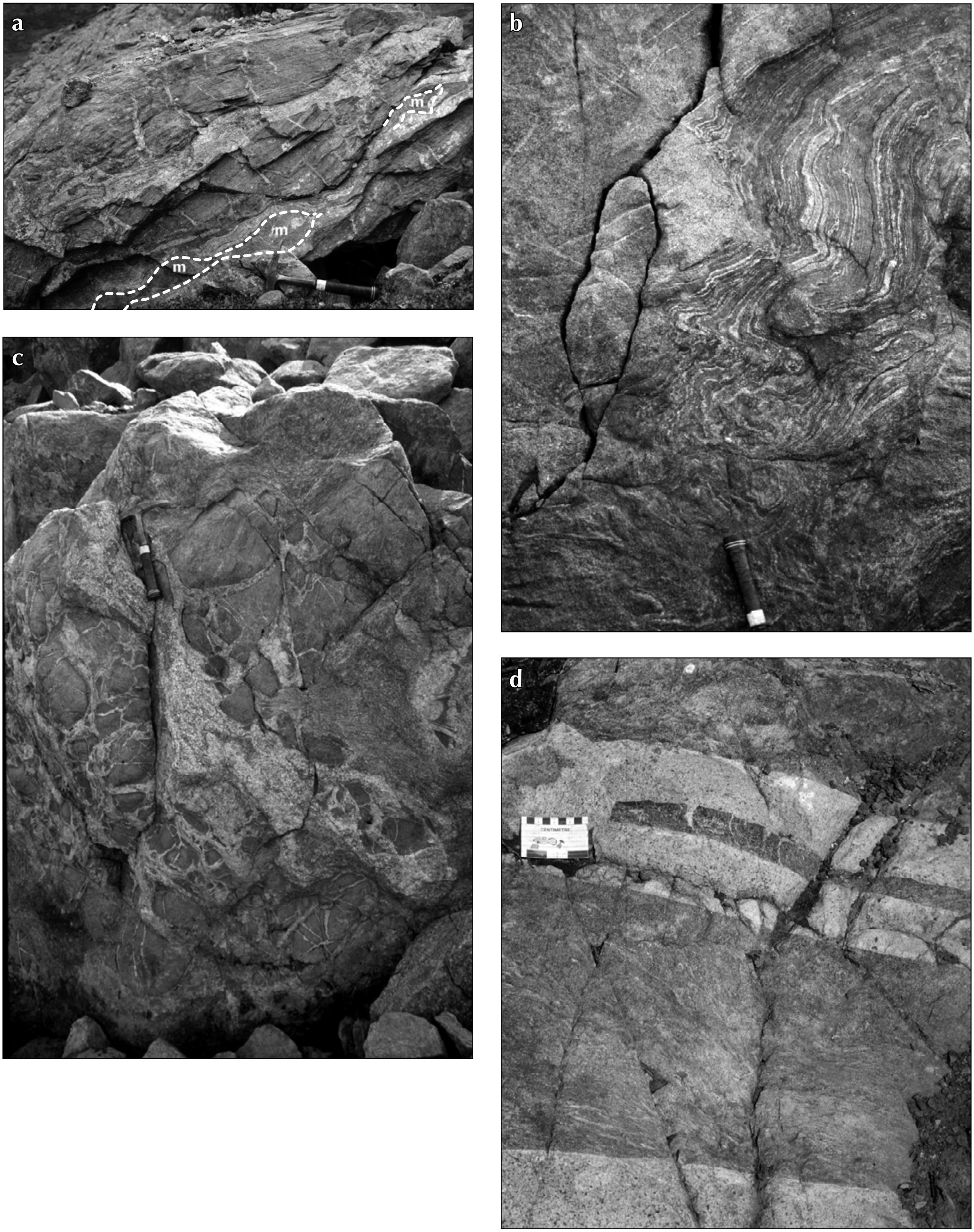


Figure 6. *Lichen-framed coarse-grained cordierite gneiss of the eastern Dezadeash Range, characterized by discontinuous, centimetre-thick, lens-shaped quartz layers and poorly defined cleavage domains. A small vertical shear zone is developed in the centre. Scale bar is in centimetres.*


a
m
m
m
b
c
d

show strong compositional zoning, with increasing almandine (iron-rich end member) component (60-72%) and decreasing grossular (calcium-rich end member) component (25-8%) from core to rim, indicative of heating during decompression (Mezger, 1997; Mezger et al., 2001a). Garnet rims show signs of corrosion and replacement by staurolite (Fig. 9). Geothermobarometric calculations of these samples produce errors too large to provide reliable pressure and temperature estimates (Mezger, 1997). East of Granite Lake, andalusite and fibrolitic sillimanite are first observed, and slightly further east, staurolite and chlorite disappear completely (Fig. 2). Primary muscovite decreases in abundance from 5 vol.% to less than 1 vol.%. From these observations the following reaction can be inferred:

(1) Ms + Chl + Qtz + St = And/Sil + Bt + H_2O

The major textural change occurs with the appearance of cordierite. Cordierite forms colourless, anhedral porphyroblasts up to 4 mm in size that can be distinguished from plagioclase by yellow alteration rims composed of pinite, a fine-grained white mica. Cordierite can make up as much as 20 vol.% of the rock. Potassium feldspar makes its first prograde appearance, but its distinction is difficult and generally only possible with an electron microprobe. A notable decrease in the biotite, sillimanite and garnet abundance, and the final disappearance of muscovite, can be observed. Cordierite mantling garnet, potassium-feldspar and cordierite in contact with biotite, and embayed biotite grain boundaries are textural indicators for the following reactions (Mezger et al., 2001a):

(2) Bt + Sil + Qtz = Crd + Kfs + L

(3) Grt + Sil + Qtz = Crd

(4) Ms + Qtz = Kfs + Sil + L

Rocks within the cordierite zone that do not contain cordierite, because of unfavourable whole rock geochemistry, i.e., insufficient magnesium, commonly have abundant fibrolitic sillimanite (up to 20 vol.%). Garnets are rare in the cordierite zone and differ from those of the staurolite zone above: they show very little zoning, and have high almandine (80) and low grossular (<5) contents (Mezger, 1997). Mg-numbers for cordierite range from 50-60%. The transition from staurolite to cordierite zone does not affect plagioclase composition: grains are unzoned and have oligoclase-andesine composition (An27-30). A sample south of the Van Bibber Creek granodiorite (94-283a) yielded P-T estimates of 715°C and 5.2 kbar. (For detailed information on mineral composition and thermobarometry see Mezger et al. (2001a)). Randomly growing new biotite (reaction 1) and the prograde appearance of cordierite, which partly replaces biotite (reaction 2), obliterate the distinct schistosity of the staurolite zone rocks. Minute graphite inclusions are not observed, due to dissolution and either escaped through metamorphic fluids or precipitation at grain boundaries. Thus the rock attains the appearance of a dark-brown-weathering gneiss (Figs. 6, 8c). Migmatization (L), inferred from reactions (2) and (4), can be observed in several outcrops on the ridges west and south of the Van Bibber Creek intrusion (Fig. 7b).

Cordierite porphyroblasts have inclusions of small (10-20 μm) green cubes or worms of hercynite, a Zn-rich spinel. It is commonly associated with inclusions of fibrolite (Fig. 8d) and garnet in cordierite, suggesting the reaction (Mezger et al., 2001a):

(5) Sil + Grt = Crd + Spl

Garnet is conspicuously absent in the eastern ridge of the Dezadeash Range, being consumed by reactions (3) and (5). Inclusion-free, subhedral second generation garnet is observed on the isolated ridge between Sanddune Creek and Dezadeash River, immediately west of the granodiorite massif, according to reaction (Mezger et al., 2001a):

(6) Bt + Sil + Pl + Qtz = Grt + Crd + Kfs + L

The highest grade assemblage of the Kluane Metamorphic Assemblage consists of garnet, biotite, K-feldspar,

Figure 7 *(previous page). Nature of the gneiss-granodiorite contact.* ***(a)*** *At the southern margin of the Van Bibber Creek plug, the granodiorite-cordierite gneiss interface is discrete. Centimetre-thick leucosomes cut the gneiss perpendicular to schistosity. Flow foliation is developed in granodiorite between gneiss floats. A boudinaged dioritic layer (m) can be observed in the lower part of the outcrop.* ***(b)*** *Massive granodiorite in contact with migmatitic gneiss at the northern contact of the Van Bibber Creek plug.* ***(c)*** *Granitic pegmatite cross-cutting massive amphibolite? near (a).* ***(d)*** *Massive granodiorite in sharp contact with cordierite-K-feldspar gneiss at the foot of the southwestern Dezadeash Range. Outcrop along mining road, 2 km east of the Haines Road.*

plagioclase, sillimanite, and hercynite as inclusions in cordierite and quartz. It marks the transition from the upper amphibolite to the lower granulite facies (Bucher and Frey, 1994). Calculated temperature and pressure are 717°C at 4.7 kbar (sample 90-35; Mezger et al., 2001a).

Traced on a map, the mineral isograds show a convergence and deflection to the south, where the higher grade cordierite-spinel-bearing assemblages parallel the contact with the southern granodiorite (Fig. 2). Widening of the isograds towards the north suggests that a heat source, the postulated intrusions that are also responsible for deflection of the schistosity, is located below the surface. The observed mineral assemblages and inferred mineral reactions are the same as those observed in the Ruby Range, where they outline a 5-km-thick contact aureole related to the intrusion of the Ruby Range batholith in the Paleocene/Eocene (Erdmer and Mortensen, 1993; Mezger et al., 2001a). In the Dezadeash Range and the eastern Ruby Range, the isograds cross-cut the foliation, indicating that formation of the antiform predated the intrusion (Fig. 2).

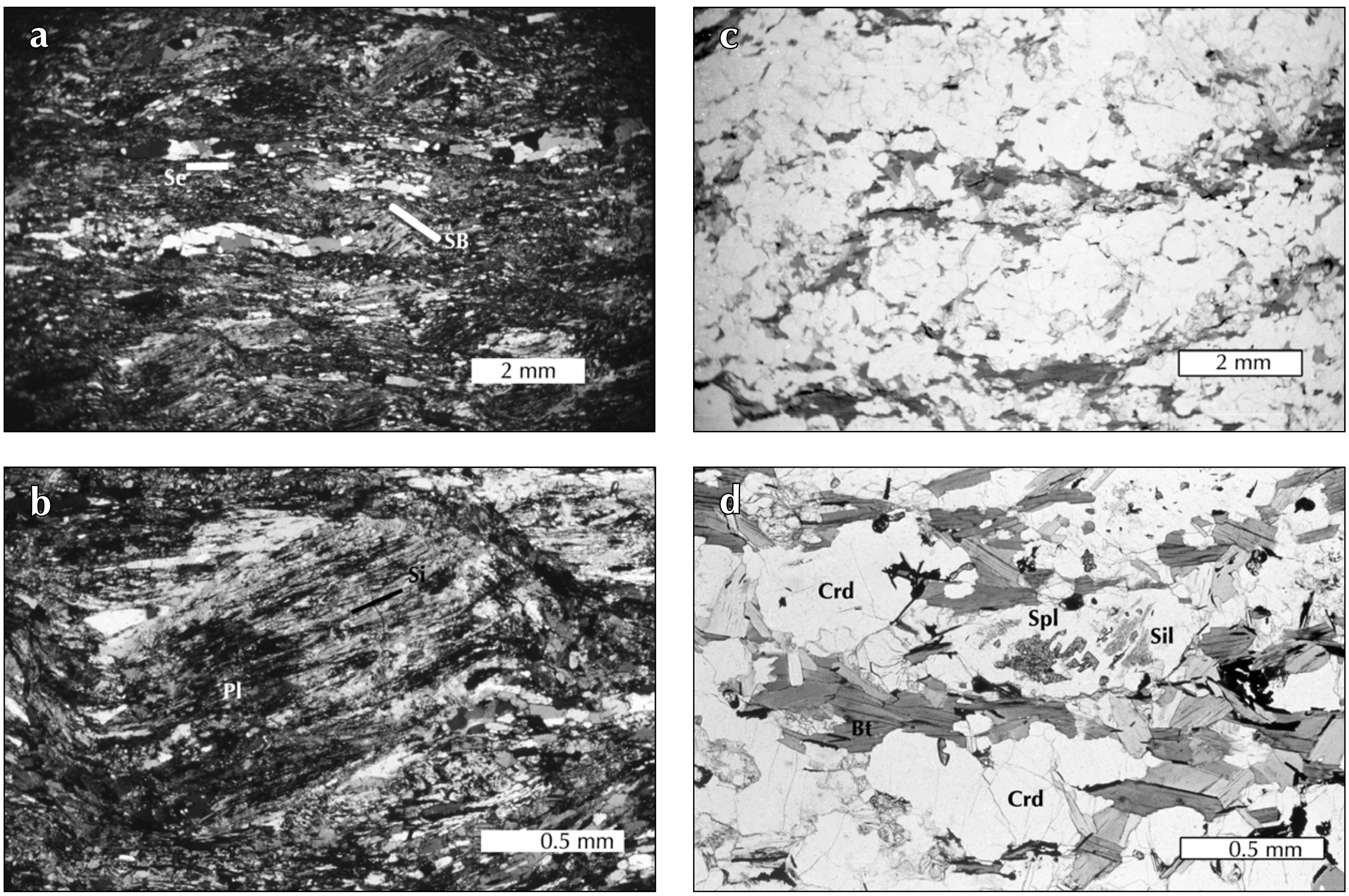


Figure 8. *Photomicrographs illustrating the textural differences between low-grade plagioclase-biotite-quartz schist (a, b) of the western Dezadeash Range and high-grade biotite-cordierite gneiss (c, d) of the eastern part. Both are shown at the same scale for comparison.* ***(a)*** *Fine-grained, well foliated schist with discontinuous layers of coarse quartz. Pervasive graphite dust results in the dark appearance of the schist. Shear bands (SB) are developed around plagioclase porphyroblasts.* ***(b)*** *Enlargement of the lower left corner of (a) showing graphite inclusion trails in plagioclase that preserve an older schistosity (Si) and are at an angle with the external main foliation (Se), indicating relative counterclockwise rotation.* ***(c)*** *Post-kinematic biotite and cordierite are larger and grow randomly. The rock has a gneissic appearance. Graphite has disappeared or has precipitated in large opaque concentrates at grain boundaries. Small green cubes of hercynite (Zn-spinel) nucleate in cordierite porphyroblasts* ***(d)****. Note that the photographs of (a) and (b) are taken with crossed polarized light, enhancing the darker appearance of the sample, in contrast to (c) and (d) which were taken with plane polarized light. Mineral abbreviations are the same as in Table 1.*

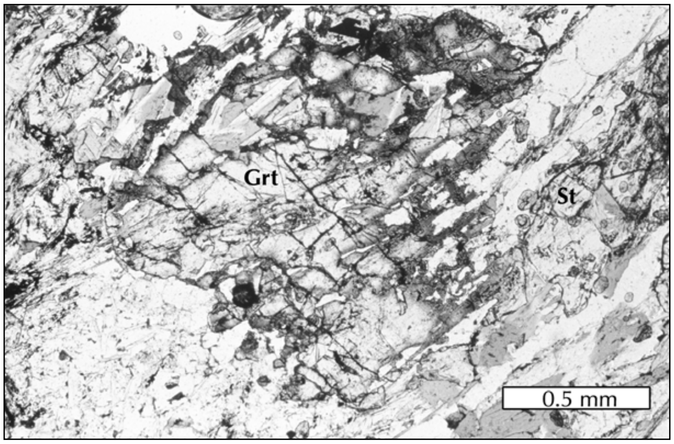


Figure 9. *Photomicrograph of a garnet porphyroblast of a typical staurolite-garnet-biotite-quartz schist from the western Dezadeash Range with strongly corroded rim, partly replaced by staurolite. Inclusions of graphite dust give the garnet a dirty appearance. Plane-polarized light. Mineral abbreviations are the same as in Table 1.*

GEOLOGY OF THE SOUTHERN DEZADEASH RANGE

The southern Dezadeash Range differs from the northern part in that it is mostly underlain by massive, equigranular biotite-hornblende granodiorite. Metamorphic rocks only crop out on a western ridge and in small isolated areas along the southern slopes of four southward-extending ridges, at elevations below 1500 m (Fig. 3). At the western ridge, dark bluish grey graphitic biotite-plagioclase-quartz schist occurs with characteristic graphite inclusions in plagioclase porphyroblasts (Figs. 8a,b). Muscovite is only a minor constituent. Schistosity and mineral lineation are well developed. The schist is very similar to those underlying the northwestern Dezadeash Range. The foliation varies from steeply southeasterly dipping to moderately south-dipping. The mineral lineation trends approximately easterly. East-southeasterly plunging, west-verging open folds are common, as well as small crenulation folds with a similar plunge direction. Isoclinal folds were observed in some outcrops. The contact with the overlying granodiorite is sharp.

The metamorphic rocks that crop out on the southern slope are brownish weathering, equigranular, fine-grained (<0.5 mm) cordierite-biotite-plagioclase-quartz gneisses. Hercynite was observed in the cordierite of some samples. Potassium-feldspar was determined with the aid of an electron microprobe. A gneissic foliation is well developed, dipping generally to the southwest, at angles of 35-68°. Mineral lineations are not common. The contact with the granodiorite is intrusive in nature, and generally fabric-parallel (Fig. 7d). The granodiorite itself is not foliated. Metre-sized granodiorite sills within the gneiss close to the contact have been observed. These rocks are very similar to the cordierite zone rocks of the northeastern Dezadeash Range, and were assigned to the Nisling Assemblage by Erdmer (1991).

GEOLOGY OF THE COAST MOUNTAINS EAST OF DEZADEASH LAKE

The hills south of the Dezadeash River and Sixmile Lake zone are underlain by an east-southeast-trending 2-km-wide belt of graphitic garnet-kyanite-biotite-quartz schist. This schist differs from the metamorphic rocks in the Dezadeash Range in that it includes kyanite, and garnet grains are not corroded (Fig. 10). The schist dips moderately to steeply south, forming a metasedimentary septum within massive medium-grained granodiorite of the Coast Mountains, which crop out north and south of the kyanite-biotite schist belt. Near the contact with the schist, a contact-parallel foliation is developed in the granodiorite. Mineral lineation in the schist is well developed and trends southeasterly. A further 8-10 km east, biotite-sillimanite-garnet schist is interlayered with calc-silicate rock and biotite amphibolite, and forms a close southeast-plunging regional antiform. Erdmer (1989; 1990) assigned these rocks to the Nisling Assemblage and correlated them to assemblages found near Kusawa Lake to the southeast.

Kyanite-garnet schist forms a 2-km-wide southeast-striking belt on an isolated hill between Dezadeash Lake and Frederick Creek, southwest of the Shakwak Valley (Fig. 3). Schistosity dips moderately to steeply to the northwest, with a subhorizontal southeast-trending mineral lineation. Spectacular centimetre-sized garnets and kyanite can be found along the main eastern ridge. The schist is bounded by massive granodiorite. Granodiorite occurring as sills within the schist possess a foliation parallel to that of the schist. At the southeastern foot of that hill, a fine-grained, graphitic garnet-biotite-epidote schist with strong top-to-the-west shear-sense indicators dips eastwards underneath the kyanite schist (Fig. 11). It is interpreted as metamorphosed Dezadeash Formation (Mezger, 1997). The contact is inferred to be a thrust, perhaps the northern continuation and termination of the Tatshenshini shear zone, which is linked to the Coast shear zone in the south, and was supposed to be active from 75 to 55 Ma (Lowey, 2000).

DISCUSSION

A terrane boundary between the Kluane Metamorphic and Nisling assemblages was inferred to be located on a ridge south of the Van Bibber Creek granodiorite stock (Fig. 2). Erdmer (1991) originally traced the boundary northwest into the Ruby Range where it crosses the Aishihik River 3 km north of the Aishihik Road junction, to include metamorphic rocks east of Aishihik River to the Nisling Assemblage. On the digital Yukon Geology map, the terrane boundary continues straight north following Cracker Creek (Gordey and Makepeace, 1999). The reason for proposing a terrane boundary was the apparent lithological heterogeneity of rocks in the eastern Dezadeash Range: among others, the absence of graphite. The contact was thought to be a sharp and foliation-parallel fault, welded by metamorphism (Erdmer, 1991).

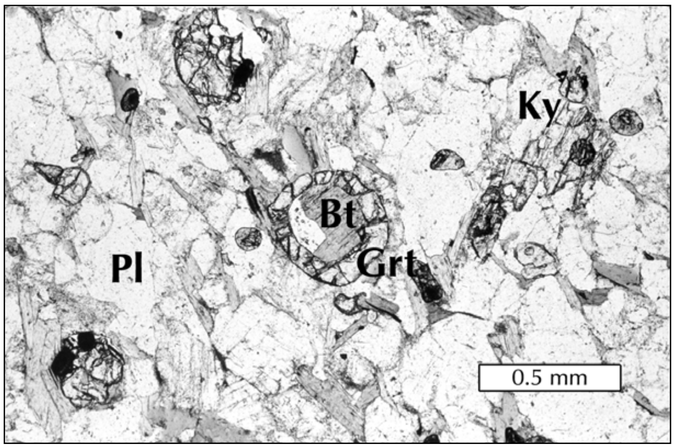


Figure 10. *Photomicrograph of kyanite-garnet-plagioclase schist of the Nisling Assemblage east of Dezadeash Lake with distinct atoll garnets. Plane polarized light. Mineral abbreviations are the same as in Table 1.*

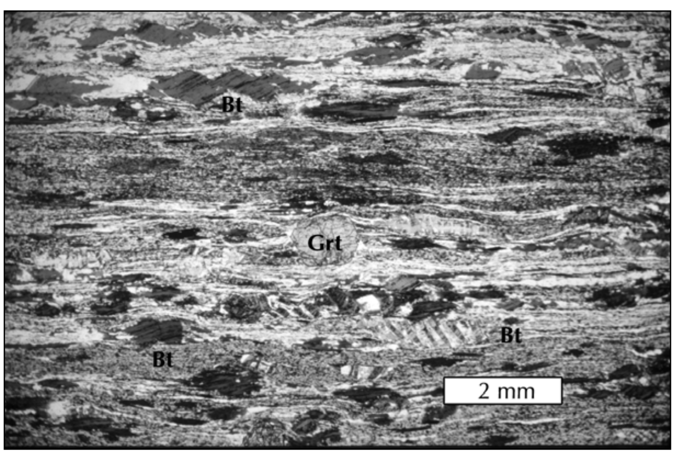


Figure 11. *Photomicrograph of graphitic garnet-biotite-epidote schist from the foot of the Coast Mountains south of Dezadeash Lake. Biotite porphyroblasts display curved graphite inclusion trails and domino structures that indicate top-to-the-left sense of shear. The schist, which has a well developed mineral lineation, structurally underlies kyanite-garnet Nisling Assemblage schist to the east and is assigned to the Dezadeash Formation (Mezger, 1997). Mineral abbreviations are the same as in Table 1.*

As discussed above, the postulated boundary lies within the cordierite zone, close to the spinel-in and garnet-out isograd. Petrographic observations suggest a prograde metamorphism related to intrusion of the granodiorite resulted in changes of rock fabric and mineral assemblages. Continental margin-derived metamorphic rocks, e.g., marble, calc-silicate rock and quartzite, are not observed in the Dezadeash Range. Neodymium isotope studies and whole rock geochemistry have shown that samples of the Kluane Metamorphic Assemblage (KMA) in the Dezadeash Range and the southern Ruby Range outside the postulated terrane boundary have signatures (ϵNd -3.3 to -3.9) within the range of the KMA to the west. These values suggest that the sedimentary protolith derived from mixing juvenile with evolved sources. The orthoamphibole gneiss west of Mt. Bratnober has an ϵNd-value (+3.9) similar to island arc volcanic rocks, and is interpreted to be metamorphosed volcanoclastic sediment. Samples of the Aishihik metamorphic suite near Aishihik Lake, correlated with the Nisling Assemblage, have ϵNd values of -29 to -20, characteristic of an ancient cratonic source (Mezger et al., 2001b).

The amphibolite layers intruded by granodiorite and boudinaged at the contact with cordierite gneiss in the Van Bibber Creek stock (Figs. 7a,b) are observed elsewhere at the margin of the Ruby Range batholith. Leucocratic granodiorite and granitic pegmatite intruded foliated tonalite and quartz diorite at the western shore of Talbot Arm of Kluane Lake (Mezger, 2000). Similar dioritic rocks were reported by Johnston (1993) from the northern margin of the Ruby Range batholith near Aishihik Lake, and yielded crystallization ages of 90-70 Ma, pre-dating the Paleocene/Eocene emplacement age of the main granodiorite body of the Ruby Range batholith (Erdmer and Mortensen, 1993). Mafic plutonic rocks are interpreted as the magmatic precursor of the Coast Plutonic Complex and form the 'Great Tonalite Sill' (Ingram and Hutton, 1994).

The metamorphic rocks east and southeast of the Dezadeash Range are distinct from KMA schist and gneiss by their garnet-kyanite assemblage, which indicates higher pressures during prograde metamorphism than in the KMA, where andalusite replaces staurolite. This suggests that the boundary between KMA and Nisling Assemblage, between back-arc basin- and continental margin-derived metasedimentary rocks, is located in and obscured by the northeast-trending valley of the Sixmile Lake and Dezadeash River. Mezger (1997) suggested that it is a post-intrusive reverse fault.

The contrast of high-grade gneiss in the southwestern Dezadeash Range with unmetamorphosed shale of the Dezadeash Formation at Kathleen Lakes, does not support Eisbacher's hypothesis that the KMA is metamorphosed Dezadeash Formation (Eisbacher, 1976). This is confirmed by neodymium isotope studies (Mezger et al., 2001b). The present juxtaposition of the KMA with the Dezadeash Formation and the greenschist (PMvs) is the result of reactivation of a Paleocene or older northeast-dipping thrust, along which the KMA was underplated by the Dezadeash Formation and exhumed, into a steeply southwest-dipping reverse fault (Mezger, 1997). This process of uplift is presently continuing, evident in the steep front of the Kluane Ranges (Lowe et al., 1993).

Three north- to northeast-trending cross-sections through the western, central and eastern Dezadeash Range show the correlation of structural style of the KMA with the presence of granodiorite intrusion (Fig. 12). In the northwestern Dezadeash Range, where the KMA schist is undisturbed by plutons, the schist is at its lowest grade and its structural style is similar to that in the Ruby Range. In the central and eastern Dezadeash Range, metamorphic rocks are underlain, and in part overlain, by the granodiorite of the Coast Plutonic Complex. Deflection of foliation near granodiorite stocks exposed at lower structural levels suggests that interleaving of plutonic and metamorphic rocks is primary and not tectonic in origin. The widely spaced mineral isograds in the eastern Dezadeash Range indicate that plutonic rocks are present underneath the surface, and possibly connect with the Ruby Range batholith north of the Alaska Highway. In the southern Dezadeash Range, where

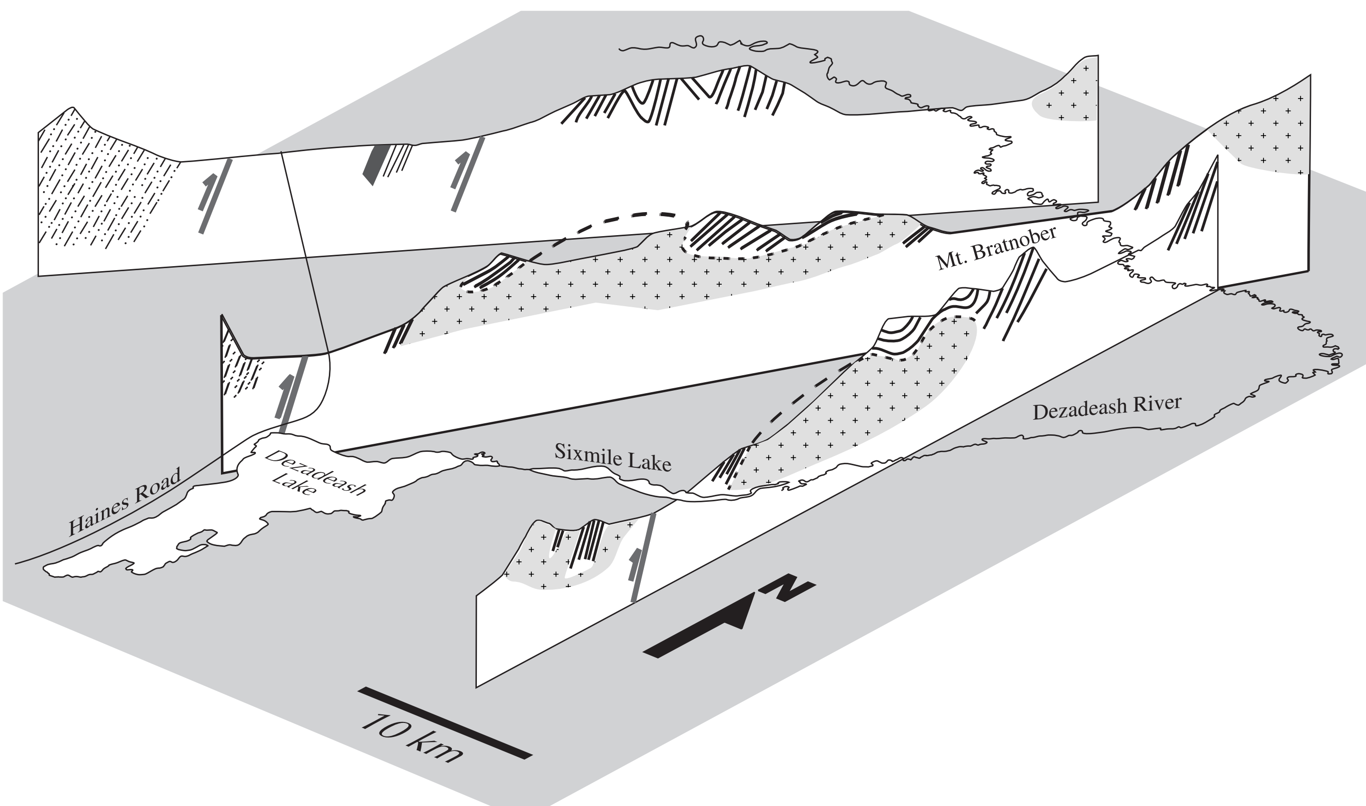


Figure 12. *Three-dimensional arrangement of schematic cross-sections through the western, central and eastern Dezadeash Range. Elevation is approximately exaggerated twice. Location of cross-sections and legend are shown in Figure 1.*

deeper erosion has exposed the granodiorite core, the cordierite gneiss occurrences are reduced to small relict roof pendants. In contrast to the Ruby Range, in the Kluane Lake region, where the KMA constitutes a 12-km-thick sequence of mica-quartz schist, they form relatively thin discontinuous high-grade gneiss sheets in the eastern and southern Dezadeash Range.

CONCLUSIONS

Plutonic rocks of the Ruby Range batholith and the Coast Plutonic Complex underlie most parts of the central, southern and eastern Dezadeash Range, and are overlain by metamorphic rocks of the Kluane Metamorphic Assemblage (KMA). Intrusion of the granodiorite resulted in disturbance of the structural orientation, with local deviation of foliation, and in thermal overprinting of the previously regionally metamorphosed mylonitic schist. Mapped mineral isograds show a change of metamorphic grade from staurolite-zone amphibolite facies to the second garnet isograd, the transition between amphibolite and granulite facies. The prograde appearance of cordierite changed the rock fabric from a mylonitic L-S tectonite to coarse-grained gneiss. New biotite and cordierite overgrew and obliterated the mylonitic fabric. This transition, which can be followed into the Ruby Range to the northwest, was considered to be a terrane boundary between the KMA and the Nisling Assemblage, of cratonic North American affinity, to the east (Erdmer, 1991; Wheeler and McFeely, 1991; Gordey and Makepeace, 1999). The data presented in this study show there is no evidence for a terrane boundary within the Dezadeash Range. The eastern and southern Dezadeash Range is underlain by high-grade gneiss of the KMA. Rocks of the Nisling Assemblage occur to the southeast of the Dezadeash Range, and are characterized by a different metamorphic evolution than the KMA in the Dezadeash Range.

ACKNOWLEDGEMENTS

Fieldwork for this paper was carried out in 1993-95 as part of a PhD thesis under the supervision of Philippe Erdmer, Tom Chacko and Rob Creaser, to whom the author expresses gratitude for their support and guidance. The logistical support and hospitality of the staff of the Yukon Geoscience Office, and lively discussions, are gratefully acknowledged. Rob Brown, Kevin Deck and Brys Francis provided excellent field assistance. Kluane Helicopters is thanked for safe transportation. Financial support by the Canadian Circumpolar Institute and the Geological Society of America to the author, and by NSERC through P. Erdmer, is acknowledged. Critical review by Paul Bons, Eberhard Karls University Tübingen, Germany, improved the original draft version. Moa Zahid and Jean-Luc Régnier provided the French translation of the abstract.

REFERENCES

Bucher, K. and Frey, M., 1994. Petrogenesis of Metamorphic Rocks. 6th Edition. Springer Verlag, Berlin, New York, 318 p.

Cairnes, D.D., 1914. Geology of a portion of the Yukon-Alaska boundary, between Porcupine and Yukon rivers. Geological Survey of Canada, Summary Report for 1912, p. 9-11.

Cockfield, W.E., 1927. Aishihik Lake District, Yukon. Geological Survey of Canada, Summary Report 1926A, p. 1A-13A.

Cockfield, W.E., 1928. Dezadeash Lake area, Yukon. Geological Survey of Canada, Summary Report 1927 A, p. 1A-7A.

Dodds, C.J. and Campbell, R.B., 1992. Geology of the SW Dezadeash map area (115A), Yukon Territory. Geological Survey of Canada, Open File 2190, 1 sheet, 1:250 000 scale.

Eisbacher, G.H., 1976. Sedimentology of the Dezadeash flysch and its implications for strike-slip faulting along the Denali Fault, Yukon Territory and Alaska. Canadian Journal of Earth Sciences, vol. 13, p. 1495-1513.

Erdmer, P., 1989. The Nisling Schist in eastern Dezadeash map area, Yukon. Current Research, Part E, Geological Survey of Canada, Paper 89-1E, p. 139-144.

Erdmer, P., 1990. Studies of the Kluane and Nisling assemblages in Kluane and Dezadeash map areas, Yukon. Current Research, Part A, Geological Survey of Canada, Paper 90-1E, p. 37-42.

Erdmer, P., 1991. Metamorphic terrane east of Denali fault between Kluane Lake and Kusawa Lake, Yukon Territory. Current Research, Part A, Geological Survey of Canada, Paper 91-1A, p. 37-42.

Erdmer, P. and Mortensen, J.K., 1993. A 1200-km-long Eocene metamorphic-plutonic belt in the northwestern Cordillera: Evidence from southwest Yukon. Geology, vol. 21, p. 1039-1042.

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

Ingram, G.M. and Hutton, D.H.W., 1994. The Great Tonalite Sill: Emplacement into a contractional shear zone and implications for Late Cretaceous to early Eocene tectonics in southeastern Alaska and British Columbia. Geological Society of America Bulletin, vol. 106, p. 715-728.

Johnston, S.T., 1993. The geologic evolution of Nisling assemblage and Stikine terrane in the Aishihik Lake area, southwest Yukon. Unpublished Ph.D. thesis, University of Alberta, Edmonton, 270 p.

Johnston, S.T. and Timmerman, J.R. 1994. Geology of the Aishihik Lake and Hopkins Lake map areas (115 H6/7), southwestern Yukon. *In:* Yukon Exploration and Geology 1993, S.R. Morison (ed.), Exploration and Geological Services Division, Yukon Region, Indian and Northern Affairs Canada, p. 93-110.

Johnston, S.T., Mortensen, J.K. and Erdmer, P., 1996. Igneous and metaigneous age constraints for the Aishihik metamorphic suite, southwest Yukon. Canadian Journal of Earth Sciences, vol. 33, p. 1543-1555.

Kindle, E.D., 1949. Dezadeash map-area, Yukon (Second Preliminary Account). Geological Survey of Canada, Paper 49-24A, 34 p.

Kindle, E.D., 1952. Dezadeash map-area, Yukon Territory. Geological Survey of Canada, Memoir 268, 68 p.

Lowe, C., Seemann, D.A., Hearty, D.B. and Halliday, D.W., 1993. New regional gravity data from the southern Yukon and Northwest Territories. Geological Survey of Canada Current Research, Part E, Paper 93-1E, p. 23-31.

Lowey, G.W., 2000. The Tatshenshini shear zone (new) in southwestern Yukon, Canada: Comparison with the Coast shear zone in British Columbia and southeastern Alaska and implications regarding the Shakwak suture. Tectonics, vol. 19, p. 512-528.

McConnell, R.G., 1905. The Kluane Mining District. Geological Survey of Canada Annual Report 16, p. 1A-18A.

Mezger, J.E., 1995. The Kluane Metamorphic Assemblage, SW Yukon – first steps towards developing a tectonic model. Cordilleran Tectonics Workshop Meeting 1995, Ottawa-Carleton Geoscience Centre, February 10-12, 1995, p. 11.

Mezger, J.E., 1997. Tectonometamorphic evolution of the Kluane metamorphic assemblage, SW Yukon: evidence for Late Cretaceous eastward subduction of oceanic crust underneath North America. Unpublished Ph.D. thesis, University of Alberta, Edmonton, Alberta, 306 p.

Mezger, J.E., 2000. "Alpine-type" ultramafic rocks of the Kluane metamorphic assemblage, southwest Yukon: Oceanic crust fragments of a late Mesozoic back arc basin along the northern Coast Belt. *In:* Yukon Exploration and Geology 1999, D.S. Emond and L.H. Weston (eds.), Exploration and Geological Services Division, Yukon Region, Indian and Northern Affairs Canada, p. 127-138.

Mezger, J.E. and Creaser, R.A., 1996. Backarc basin setting of the Kluane Metamorphic Assemblage and sinistral strike-slip along a proto-Denali fault: Evidence from isotope and microtectonic studies in the SW Yukon. Geological Society of America Abstracts with Programs, vol. 28(7), p. A312.

Mezger, J.E., Chacko, T. and Erdmer, P., 2001a. Metamorphism along a late Mesozoic accretionary continental margin: a case study from the northern Coast Belt of the North American Cordillera. Journal of Metamorphic Geology, vol. 19, p. 121-138.

Mezger, J.E., Creaser, R.A., Erdmer, P. and Johnston, S.T., 2001b. A Cretaceous back arc basin in the Coast Belt of the northern Canadian Cordillera: evidence from geochemical and neodymium isotope characteristics of the Kluane metamorphic assemblage, southwest Yukon. Canadian Journal of Earth Sciences, vol. 38, p. 91-103.

Muller, J.E., 1967. Kluane Lake map-area, Yukon Territory (115G, 115F E1/2). Geological Survey of Canada, Memoir 340, 137 p.

Tempelman-Kluit, D.J., 1974. Reconnaissance geology of Aishihik Lake, Snag and part of Stewart River map-areas, west-central Yukon (115A, 115F, 115G and 115K). Geological Survey of Canada, Paper 73-41, 97 p.

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 sheet, 1:2 000 000 scale.

Yukon MINFILE, 2001. Exploration and Geological Services Division, Yukon Region, Indian and Northern Affairs Canada.