Preliminary geology of the Pool Creek map area (95C/5), southeastern Yukon[1]

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ABSTRACT

Fieldwork in the northwest corner of Pool Creek map area (NTS 95C/5) during the summer of 2000 distinguished North and South areas with distinct stratigraphies and deformation histories. The South area is underlain mainly by siliciclastic sedimentary rocks (1100 m total thickness in three units) of uncertain age (Proterozoic ?). North area stratigraphy (1800 m total thickness in seven units) ranges in age from Ordovician to Mississippian and consists of an interbedded succession of carbonates, sandstones, siltstones, and shales. Major shale units in the succession are correlated with Road River and Earn groups.

Strata in both areas have been intruded by a north-trending, unfoliated, Eocene (?) syenite. The syenite has a thin contact metamorphic aureole consisting of skarn, gossan, and biotite hornfels.

Deformation in the South area is characterized by broad, northeast-trending, subhorizontal folds, which are likely coeval with syenite intrusion. Units in the North area are deformed into tight, overturned, north-plunging, east-verging folds with a well developed, axial planar, slaty cleavage in the hinge zones. North area deformation probably predates syenite intrusion.

Our fieldwork confirmed previously reported U-Th-REE prospects associated with the syenite and favourable stratigraphy for sedimentary-exhalative targets in the North area.

RÉSUMÉ

Les travaux de terrain exécutés durant l'été 2000 dans l'angle nord-ouest de la région de Pool Creek (95C/5) ont permis de différencier une zone Nord et une zone Sud ayant une stratigraphie et une histoire déformationnelle distinctes. La zone Sud est composée principalement de roches sédimentaires silicoclastiques (trois unités d'une épaisseur totale de 1100 m) d'âge incertain (Protérozoïque). La stratigraphie de la zone Nord (sept unités d'une épaisseur totale de 1800 m) s'échelonne de l'Ordovicien au Mississippien. Elle se compose d'une séquence interstratifiée de carbonates, de grès, de siltites et de shales. On a établi une corrélation entre les principales unités de shales de cette séquence et les groupes de Road River et d'Earn.

Dans les deux zones, les strates ont subies l'intrusion d'une syénite non foliée, d'âge Éocène (?), orientée vers le nord. Cette syénite est entourée d'une fine auréole de métamorphisme de contact comprenant des skarns, des chapeaux de fer et des cornéennes à biotite.

Dans la zone Sud, la déformation se caractérise par de larges plis subhorizontaux de direction nord-est, sans doute contemporains de l'intrusion de syénite. Les unités présentes dans la zone nord sont déformées en plis fermés et déversés plongeant vers le nord et orientés vers l'est accompagnés d'une schistosité ardoisière à plan axial bien développée dans les zones de charnières. La déformation présente dans la zone Nord est sans doute antérieure à l'intrusion de la syénite.

Les travaux de terrain ont confirmé la présence de zones à potentiel pour l'uranium, le thorium et des éléments des terres rares dans et près de la syénite, ainsi qu'une stratigraphie favorable à la présence de cibles sédimentaires-exhalatives dans la zone Nord.

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INTRODUCTION

The Central Foreland NATMAP Project is a multi-disciplinary collaborative mapping project to update the geological mapping of the Foothills of northeastern British Columbia and the Liard Basin region of the southern Northwest Territories and adjacent Yukon Territory. The Yukon Geology Program joined the project during the 2000 field season to begin 1:50 000-scale bedrock mapping in the Pool Creek map area (95C/5), southeastern Yukon. This study will better define the stratigraphy, structure, and mineral and hydrocarbon potential of the area.

This report of the stratigraphy and structure of part of the Pool Creek map area is based on twenty days of fieldwork during the summer, 2000. Descriptions are based on field and hand-sample observations. Selected samples have been submitted for geochemical and chronological analysis. Stratigraphic thicknesses are derived from interpretive cross-sections. Further fieldwork is planned for 2001.

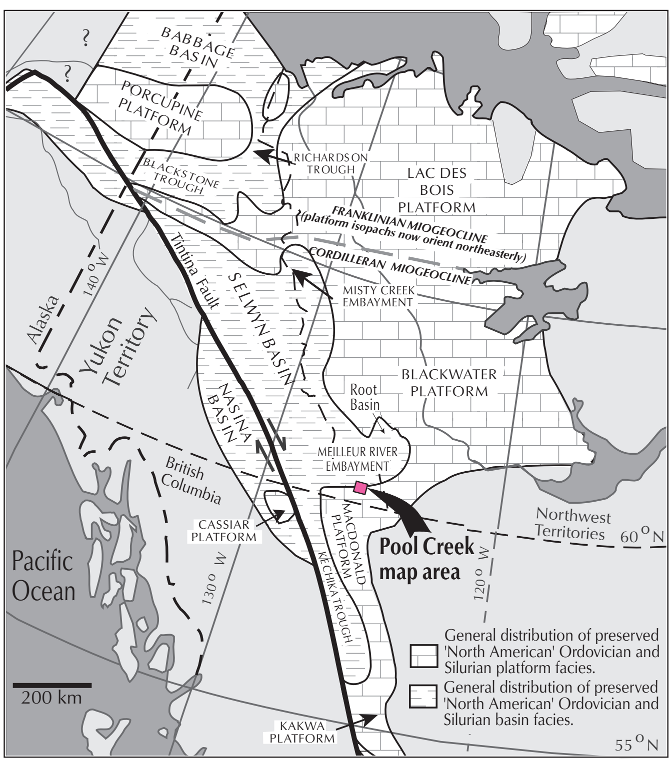


Figure 1. *Location of Pool Creek (NTS 95C/5) map sheet in Yukon Territory. General distribution of platform and basin facies of Cordilleran miogeocline are indicated. Modified from Cecile* et al. *(1997).*

LOCATION AND ACCESS

The field area (Fig. 1) is located 135 km west-northwest of Fort Liard, Northwest Territories, and 165 km east-northeast of Watson Lake, Yukon Territory, within the Liard Plateau physiographic region (Bostock, 1948). Topography consists of low rounded hills with incised stream drainages. Elevations range from 1500 feet (460 m) to 4200 feet (1280 m). The area is heavily forested with a single, north-trending ridge extending above tree line for ten kilometres. Beaver River flows southeast through the area. Bedrock exposure is 10% or less with most outcrop occurring as cliffs along Beaver River.

Access is by helicopter from Fort Liard and by canoe on Beaver River. Fieldwork was completed primarily by foot traverses from base camps on the treeless ridge and along the Beaver River.

PREVIOUS WORK

The Geological Survey of Canada conducted 1:253 440-scale bedrock mapping in La Biche River map area (95C) during 1957 as part of Operation Mackenzie (Douglas and Norris, 1959). The geology of the area was further updated based on fieldwork completed in 1972 (Douglas, 1976).

Mineral exploration between 1973 and 1986 identified U-Th-REE prospects in the contact metamorphic aureole of the Pool Creek syenite, sedimentary exhalative (SEDEX) targets in lower Paleozoic shales, and barite veins in Devonian carbonates (Yukon MINFILE, 1997). Exploration has been limited since 1986. The Beaver River is currently an area of high conservation interest.

REGIONAL GEOLOGY

Pool Creek map area is located in the transition zone (Fig. 1) between lower Paleozoic shallow-water carbonates of Macdonald Platform and lower Paleozoic fine-grained, deep-water, siliciclastic sediments of Meilleur River Embayment in Selwyn Basin (Cecile et al., 1997). These facies belts were deposited within the Cordilleran miogeocline, a depositional prism of sedimentary rocks of Precambrian to Middle Jurassic age along the relatively stable continental margin of western North America (Abbott et al., 1986).

Cecile et al. (1997) recognized a series of northeast-trending lineaments dividing the Cordilleran miogeocline into distinct structural blocks. The most prominent of these features is the Liard Line in northeastern British Columbia, interpreted to be a major crustal transfer fault in the ancient west North American margin. More recently, Morrow and Miles (2000) proposed the existence of a similar northeast-trending Beaver River structure extending through the Pool Creek area. They suggest 15-20 km of dextral strike-slip displacement along the Beaver River structure based on geological and geophysical arguments.

POOL CREEK MAP AREA GEOLOGY

INTRODUCTION

Geological mapping during the 2000 field season was restricted to the northwest corner of the Pool Creek map area (Fig. 2). Ten sedimentary units with a combined thickness of greater than 2900 m and ranging in age from Proterozoic (?) to Mississippian were identified (Fig. 3).

Mapping delineated stratigraphically and structurally distinct North and South areas (Figs. 2, 4, 5). Stratigraphic Units 1-3 (aggregate thickness 1100 m) are restricted to the South area, and stratigraphic Units 4-10 (aggregate thickness 1800 m) occur in the North area. Units in the South area are unfossiliferous and not readily correlated with regional stratigraphy, but may be Proterozoic (?) in age. Units in the North area range from Ordovician through Mississippian (?) and correlate with regional stratigraphy. Strata in both areas (Figs. 2, 4, 5) are intruded by a north-trending Eocene (?) syenite (Pool Creek syenite) which is exposed for a strike length of approximately 7 km.

STRATIGRAPHY

Unit 1

Unit 1 occurs immediately south of the syenite intrusion in the northwest portion of the Pool Creek map area (Fig. 4) and is at least 550 m thick. It is unfossiliferous and its basal contact is not exposed.

The primary lithology is light to dark grey, finely planar-laminated, noncalcareous, fine-grained quartz sandstone (Fig. 6). Laminae are 1-2 mm thick and are spaced approximately 1 cm apart. Typically, the sandstone breaks into angular blocks with smooth bedding plane surfaces. Intervals of dark grey to black quartz sandstone to siltstone up to several metres thick occur locally. Minor intervals up to 1 m thick containing soft sediment deformation folds and intraformational breccias occur throughout the unit. Locally, crosscutting fractures in Unit 1 are stained red by hematite dust. The uppermost 30 m of the unit is a massive, pale grey to white, sugary, quartz sandstone. Bedding in this massive interval is only rarely visible as poorly developed faint colour banding. In one outcrop area, this massive sandstone contains a 0.5-m-thick interval of intraformational conglomerate with poorly sorted quartz sandstone clasts up to 10 cm across in a white sand matrix.

The planar bedding of Unit 1 denotes a quiet depositional environment below wave-base. Deposition is interpreted as near offshore because of the thick accumulation of sand-sized material. Exact water depth in the depositional area cannot be determined. The occurrence of soft sediment deformation features and intraformational breccias indicates local transport on a slight slope.

Unit 1 is stratigraphically the lowest unit mapped in the South area and was assigned to the Carboniferous Mattson Formation by Douglas (1976). However, it differs markedly from the Mattson Formation in colour and lithology and lies stratigraphically below Neoproterozoic (?) strata of Map Unit 3 (see below) without apparent structural interruption. Therefore, Map Unit 1 is tentatively assigned a Proterozoic age.

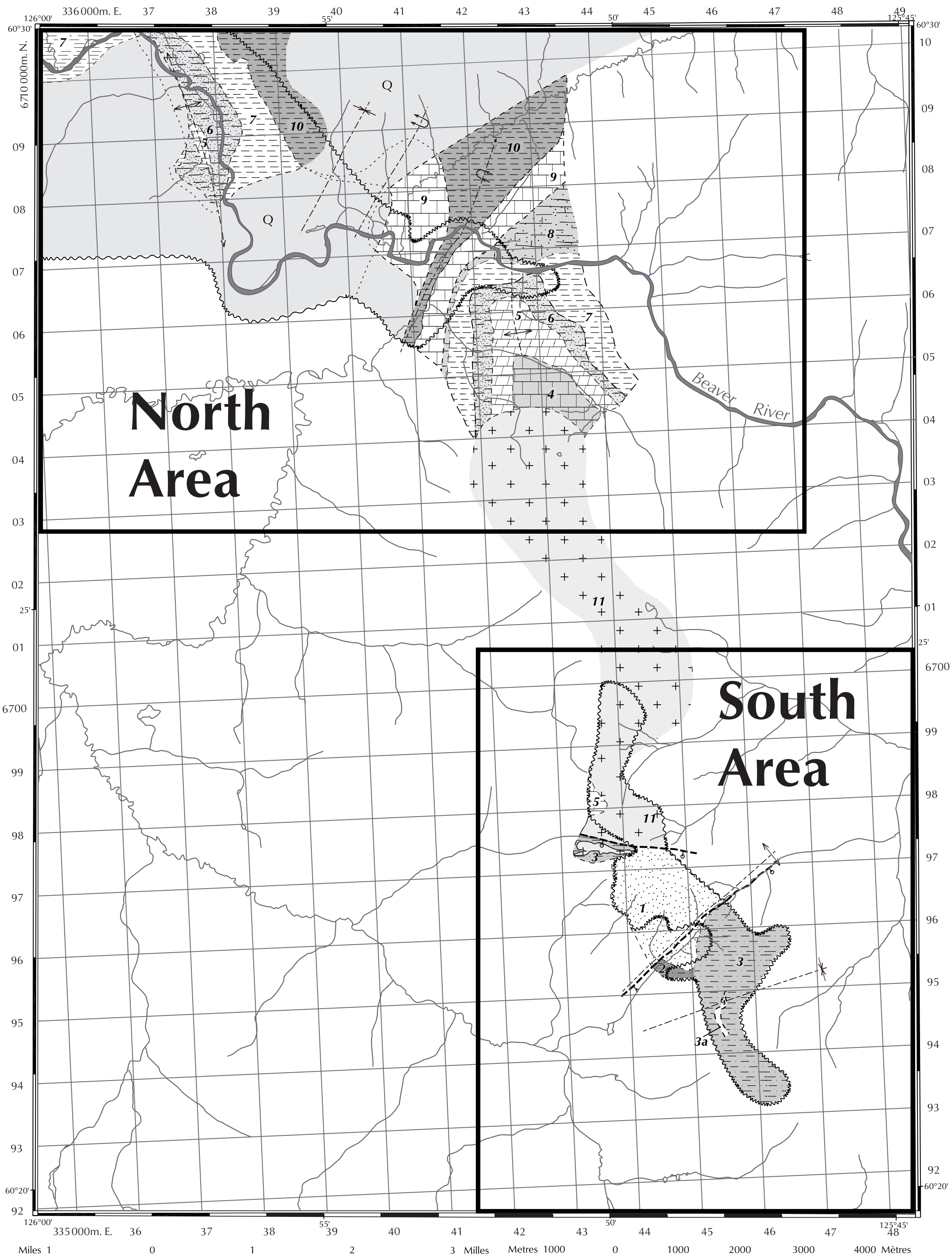
Unit 2

Conformably overlying Unit 1 is black, noncalcareous, finely laminated, fissile, silty shale constituting Unit 2 (Fig. 7). Unit 2 is poorly exposed south and west of Unit 1 in the South area. The shale contains wavy, 1-mm-thick parallel laminae of medium grey, noncalcareous siltstone spaced every 2 to 10 mm.

The base of Unit 2 contains interbeds of Unit 1 lithology up to 20 cm thick over a 5-m interval. The upper contact is not exposed. The Figure 2 unit has an interpreted maximum thickness of 60 m and apparently pinches out to the north. As with Unit 1, the planar bedding indicates deposition in a quiet environment below wave-base. Abundant organic carbon denotes euxinic conditions during deposition.

No fossils were found in Unit 2. Douglas (1976) interpreted it as Devonian Besa River Formation. However it lacks the distinctive weathering character of that formation and occurs without structural interruption beneath Map Unit 3, interpreted as Proterozoic by

Figure 2 legend and caption at right.



LEGEND

QUATERNARY

Q — Unconsolidated alluvium, colluvium and glacial deposits.

EOCENE?

11 — Pink with lesser dark green, medium to coarsely crystalline syenite. Predominantly randomly oriented pink potassium-feldspar crystals with lesser dark green hornblende.

North Area

DEVONIAN to MISSISSIPPIAN
EARN GROUP

10 — Dark grey to black, carbonaceous shale, siltstone, chert and siliceous limestone. Weathers recessively and pale bluish-grey.

MIDDLE DEVONIAN

9 — Buff- to grey-weathering, medium grey, argillaceous limestone. Micritic with the exception of local thin grainstone beds (<10 cm) containing one- and two-holed crinoids. Black calcareous shaly partings between more resistant limestone beds.

8 — Buff-weathered, platy, dark grey siltstone, very fine-grained sandstone and silty shale. Strata are dolomitic, finely micaceous and parallel laminated.

ORDOVICIAN to SILURIAN
ROAD RIVER GROUP

7 — Dark grey to black, graptolitic, locally calcareous, shale or siltstone with lesser very fine-grained sandstone, chert, and limestone. The unit weathers recessively and contains few brachiopods and crinoids.

LOWER PALEOZOIC (AGE UNCERTAIN)

6 — Grey to buff, quartz-rich sandstone to pebbly grit. Grains are subround to round. Contains beds up to 2 m thick of heavily burrowed, slightly dolomitic, very fine-grained sandstone and siltstone.

5 — Mottled light to dark grey dolostone. Micritic to sucrosic, local black chert nodules present. Weathers light brownish-grey to buff.

4 — Grey- to tan-weathering limestone. Massive, finely crystalline, and barren of fossils (after Burt, 1983).

South Area

PRECAMBRIAN TO LOWER PALEOZOIC (AGE UNCERTAIN)

3 — Green to grey, locally greyish-red, banded siltstone with very fine-grained sandstone. Sandstone interbeds (1-5 cm thick) are quartzose, internally laminated, and graded. The unit includes soft sediment deformation and minor green matrix-supported conglomerate beds.

3a — Greyish-red, clast-supported conglomerate. Clasts are subangular to subround, commonly pebble to cobble size (maxium 40 cm across). Clasts are predominantly basalt with lesser amounts of vein quartz, carbonate, and sandstone. The unit is up to 20 m thick.

2 — Black silty shale, platy to fissile. Weathers medium grey to rusty. Contains wavy parallel laminae spaced 2 to 10 mm.

1 — White to light grey quartzite. Very fine-grained to sugary, massive to faintly laminated.

SYMBOLS

Geological contacts (defined, approximate, assumed)

Fault, displacement unknown (defined, approximate, covered)

Normal fault, displacement unknown (approximate)

Limit of mapping

Metamorphic hornfels line (symbol on higher grade side)

Bedding — 52

Dominant foliation (transposition foliation; commonly parallel to compositional layering): inclined, vertical — 62

Fold axial surface trace (anticline: upright, overturned; syncline: upright, overturned)

Line of cross-section — A B

Gossan

Figure 2. Geologic map of northwest corner of Pool Creek map sheet, indicating locations of North and South areas. Grid spacing is 1 km.

Douglas and Norris (1959). Map Unit 2 is therefore provisionally considered to be Proterozoic.

Unit 3

Unit 3 is the most areally extensive unit studied in the South area, underlying the main ridges south of the syenite intrusion. It consists predominately of greyish-green, banded, argillaceous siltstone with thin cream-coloured, locally calcareous, very fine-grained sandstone interbeds. Unit 3 is approximately 500 m thick. The lower contact with Units 1 and 2 is unexposed, but is interpreted as unconformable because Unit 2 is not present on the ridge immediately south of the syenite. The upper contact was not observed.

One of the authors (R. MacNaughton) measured a 372-m-thick stratigraphic section through part of Unit 3 (Figs. 4 and 8). The measured section is dominated by three facies associations outlined below.

Facies Association 1 (green argillite) is dominated by thin-laminated, medium- to dark-green-weathering siltstone and argillite with thin-laminated, pale-green- to greenish-grey-weathering siltstone interbeds (Fig. 9). The siltstone interbeds are 1-5 cm thick and make up 5-50% of the unit. These two lithologies constitute 80% or more of the facies association's total volume. Pale greenish-grey-weathering, very fine sandstone locally comprises up to 20% of this facies association, but more commonly accounts for less than 10%. Sandstone occurs as sharp-based stringers, laminae, or very thin (rarely thin) beds and is commonly normally graded. Parallel lamination and current ripple cross-lamination occur sporadically. Soft-sediment deformation is common and ranges from loading and convolute bedding, to intraformational truncation surfaces and slump masses (containing slump folds) up to several metres thick. Slump folds are commonly isoclinal and oriented at a low angle to bedding (Fig. 10). This facies association accounts for over half of the total thickness of the measured section.

In an outcrop outside the measured section, this facies contains a 15-m-thick interval where the dominant argillaceous siltstone is maroon instead of green. The

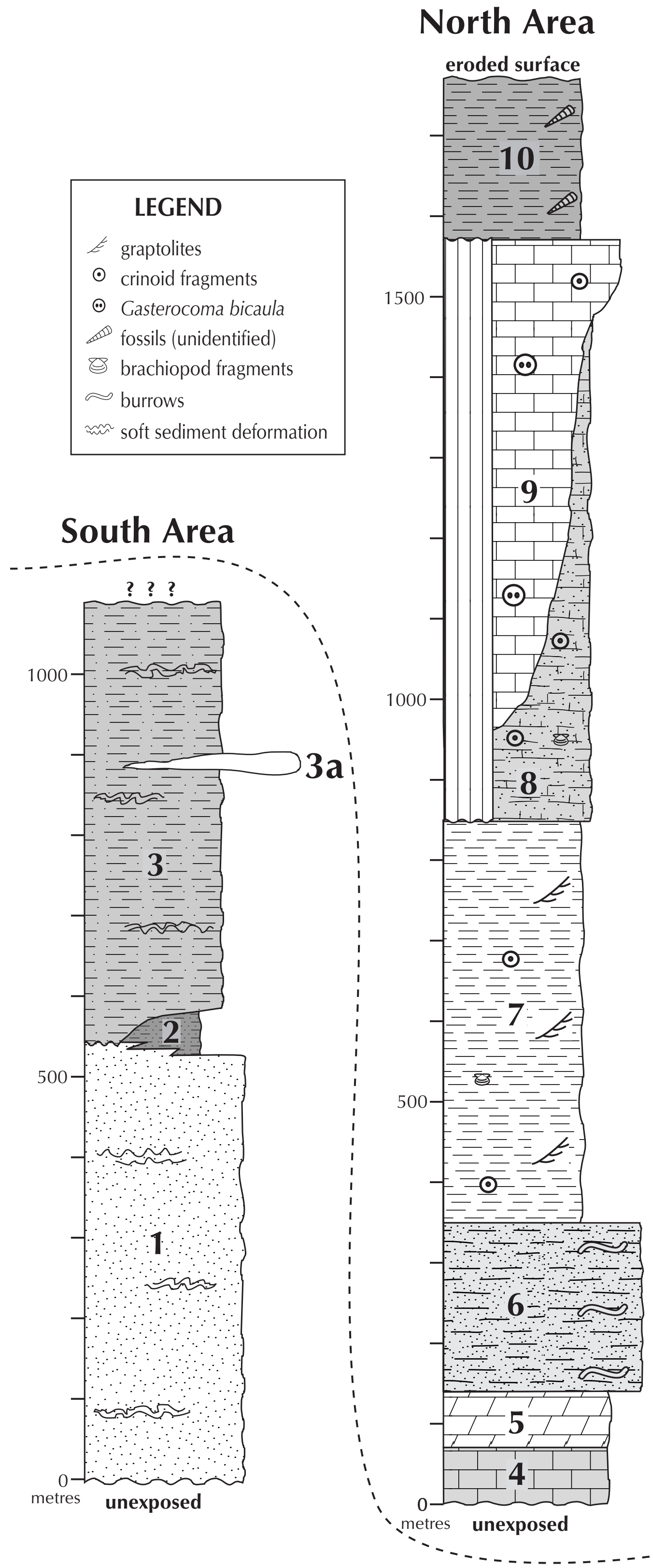


Figure 3. *Generalized stratigraphic section of Pool Creek sedimentary units. Units 1-3 occur in the South area. Units 4-10 occur in the North area. For patterns and unit descriptions, see legend from Figure 2. Wavy line and vertical line pattern indicate unconformity.*

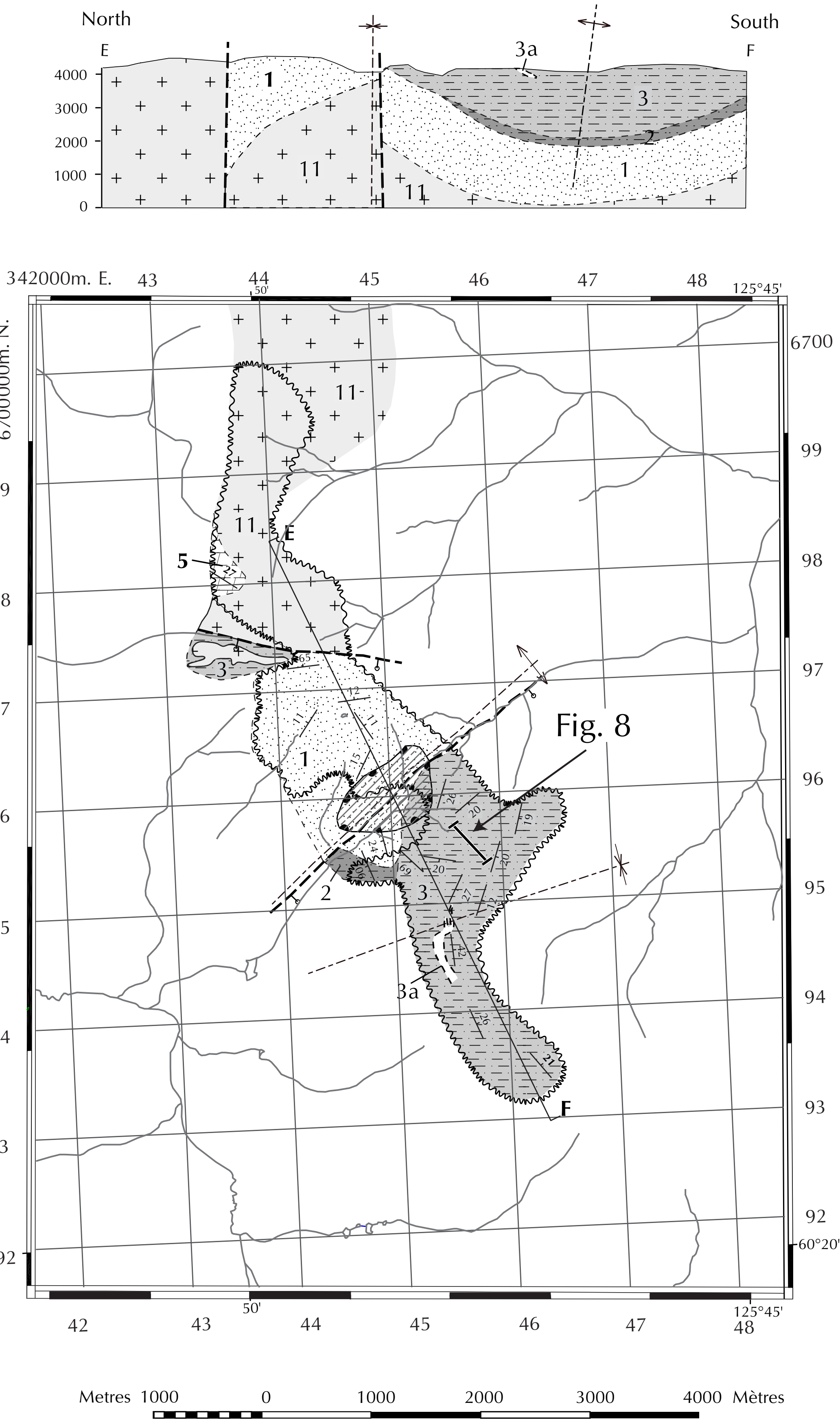


Figure 4. Geologic map with cross-section E-F of South area. Grid spacing is 1 km. For patterns and unit descriptions, see legend from Figure 2.

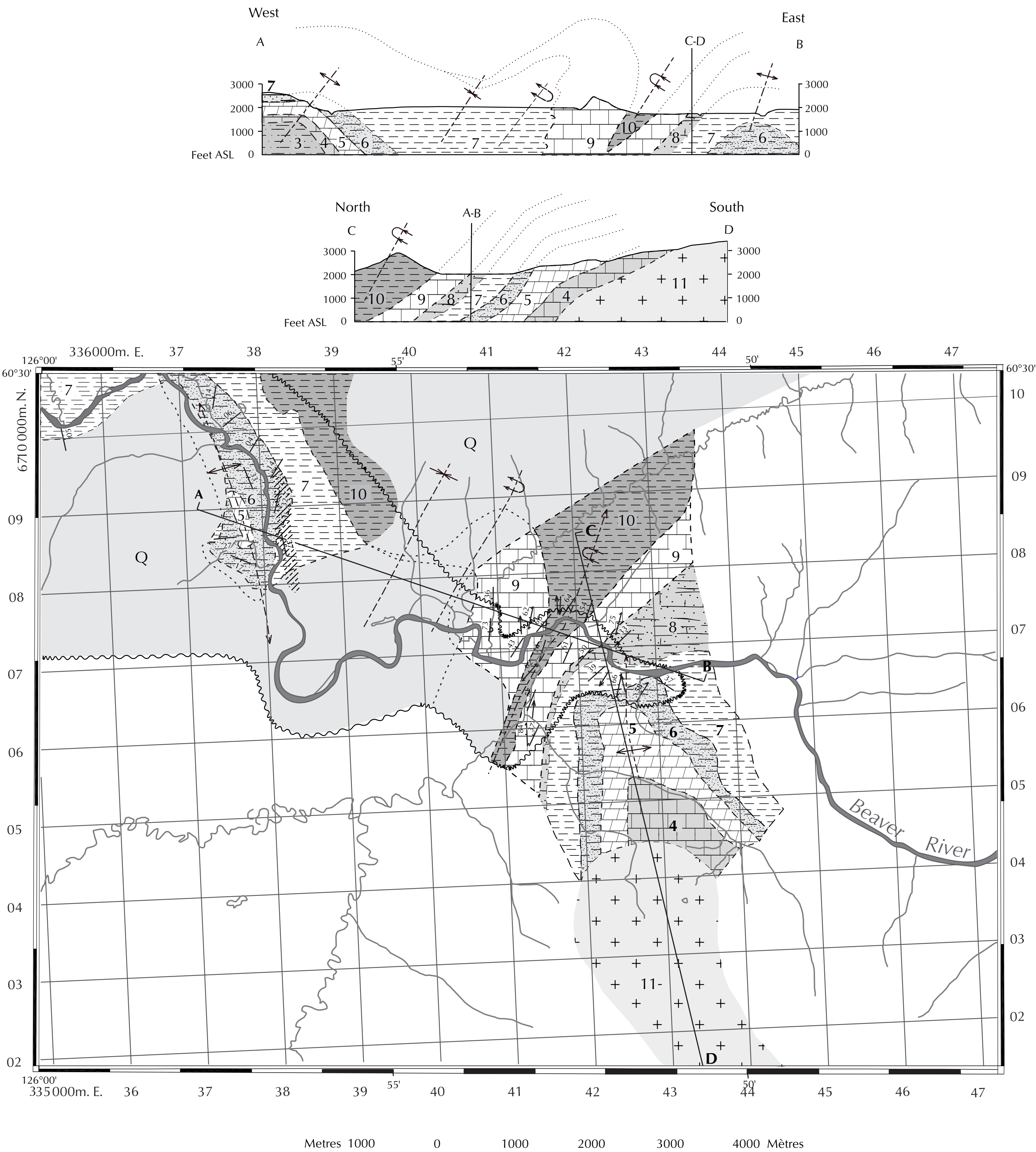


Figure 5. Geologic map with cross-sections A-B and C-D of North area. Grid spacing is 1 km. For patterns and unit descriptions, see legend from Figure 2.

Figure 6. *Finely laminated quartz sandstone of Unit 1. Pencil in centre of Figure is 14 cm long.*

Figure 7. *Finely laminated, black siltstone and black and dark grey, very fine-grained sandstone of Unit 2. Scale is graduated in centimetres.*

maroon variant has sharp upper and lower contacts with more typical green argillite.

On the ridge immediately south of the syenite intrusion, a unit of thin-banded, fine-grained, calcareous, cream and green or grey calc-silicate rock has been observed. This unit overlies Unit 1 quartz sandstones and is tentatively interpreted as a contact-metamorphosed equivalent of a calcareous interval within this facies association.

Facies Association 2 (sandy argillite) is similar to Facies Association 1, differing mainly in containing a higher percentage (up to 50% or more) of very fine-grained sandstone as very thin to thin beds (locally medium bedded). Minor beds of granule-conglomeratic sandstone are also present. The sandstone beds are sharp- to erosionally based and commonly normally graded (rare beds show inverse grading) with rare parallel lamination or current ripple cross-lamination. Well developed slump horizons up to several metres thick occur locally, as do load casts and convolute bedding.

Facies Association 3 (breccia) is characterized by granule to pebble to (less commonly) cobble breccia. The breccia is poorly sorted and ungraded (Fig. 11), although in rare cases oblate clasts are oriented roughly sub-parallel to bedding. Beds display sharp bases, generally with little (up to 10 cm locally) or no basal relief. Rare examples of upper surface relief (up to 3 cm) have also been recognized. Matrix varies from silty and muddy to sandy, and beds vary from matrix supported to clast supported, more commonly the former. In some beds, clasts are predominantly intraformational, consisting mainly of angular argillite fragments. Other beds contain abundant allochthonous clasts, including volcanic material and microbially laminated carbonate. Some breccia beds were observed to pass laterally into slumped horizons or into successions of argillite cut by intraformational truncation surfaces.

The depositional setting of the green argillite association was in quiet water, as indicated by the fine grain size and lack of high-energy physical structures. The lack of wave-produced structures is consistent with deposition below wave-base. A similar setting prevailed during deposition of the sandy argillite facies, except that the supply of sandy sediment was greater. The sharp-based, normally graded sandstone beds strongly resemble distal tempestites (e.g., Brenchley, 1985).

The prevalence of slumping suggests deposition on a slope (Dalrymple and Narbonne, 1996). This, combined with the common presence of distal tempestites and the absence of wave-formed structures, is consistent with deposition in a slope-shelf transition or uppermost slope setting.

The massive, unsorted character of the breccia beds suggests deposition from debris flows, providing further evidence for a slope setting. The presence of volcanic material in many of the breccias may reflect a tectonically active setting, as may the prevalence of slumping in the succession.

Map Unit 3 corresponds to Unit 1 of Douglas and Norris (1959), which they correlated with the Proterozoic Apekunni Formation of southern Alberta based on lithologic similarity. No body or trace fossils were

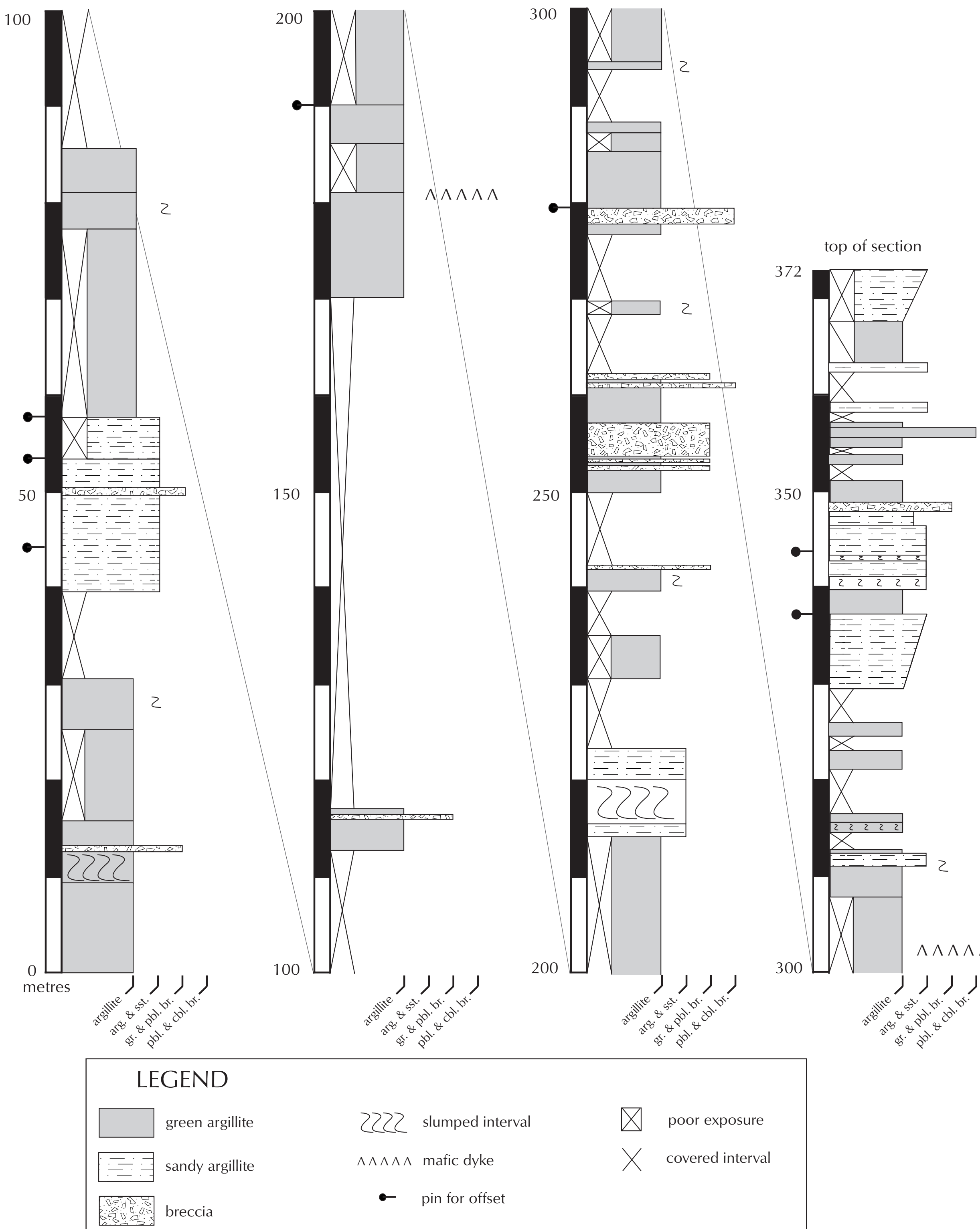


Figure 8. *Measured stratigraphic section through the best exposed part of Unit 3. Pins to left of stratigraphic column indicate levels at which lack of exposure necessitated an offset of the measured section. Base of section is at coordinates: 345620 E, 6695764 N (UTM NAD83); top of section is at NTS coordinates: 345903 E, 6695412 N (UTM NAD83); arg = argillite; sst = sandstone; gr = granule; pbl = pebble; cbl = cobble; br = breccia.*

observed during the 2000 field season. The correlation of Douglas and Norris (1959) is provisionally adopted, pending further data.

Unit 3a

A distinctive greyish-red, clast-supported, poorly to moderately sorted, crudely bedded conglomerate forms a laterally discontinuous subunit 3(a) about 300 m above the base of Unit 3. Clasts in the conglomerate are subround to subangular, ranging from pebbles to cobbles (Fig. 12). The conglomerate is polymictic with clasts of basalt (75%), pale grey to white vein quartz (5%), carbonate (5%), sandstone, and other unidentified material (15%). The matrix is predominantly greyish-red, very fine-grained, poorly sorted sandstone. The conglomerate can be traced for a strike length of approximately 600 m and ranges up to 20 m in thickness. It does not occur in the area of the measured section, but would project into the section's uppermost part.

The source for the basalt clasts forming Unit 3a has not been identified; observed units in the Pool Creek area do not contain any exposed basalt flows. Regionally, basaltic volcanism in the northern Cordillera occurs during Proterozoic, Cambrian, Ordovician, and Devonian times (Gabrielse and Campbell, 1991; Goodfellow et al., 1995).

Figure 9. *Greyish-green, banded siltstone with thin, cream, very fine-grained sandstone interbeds from Facies Association 1 of Unit 3. Scale is graduated in centimetres.*

Figure 10. *Isolated sedimentary slump folds in Unit 3. Hammer handle at right of outcrop (at tip of arrow) is approximately 30 cm long.*

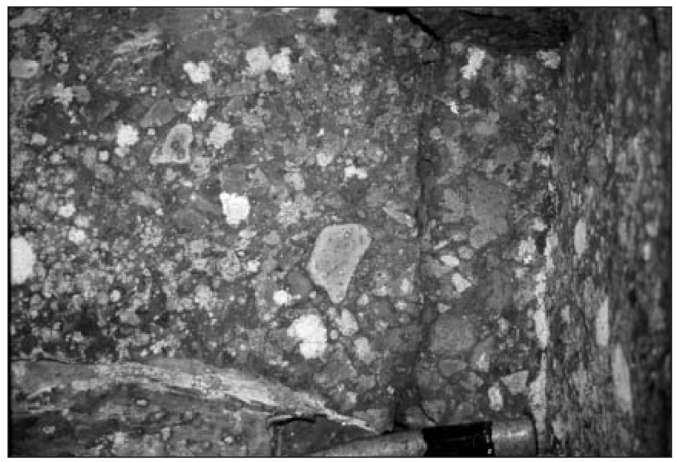


Figure 11. *Thin unit of breccia (Facies Association 3 of Unit 3). Light coloured fuzzy patches are lichen. Hammer head for scale is at bottom of figure.*

Figure 12. *Discontinuous, clast-supported, greyish-red conglomerate of Unit 3a. Clasts are subround to subangular and predominantly basalt. The matrix ranges from buff, coarse-grained sandstone to very fine-grained, greyish-red sandstone. Scale is graduated in centimetres.*

Unit 4

Unit 4 is exposed on the ridge crest immediately north of the syenite intrusion and consists of a massive, finely crystalline, nonfossiliferous, grey limestone with an interpreted thickness of 70 m. It was not observed during the 2000 field season. The description and thickness are based on earlier mineral exploration property geological mapping on the BEAV claims (Burt, 1983).

The limestone is tentatively correlated with Sunblood Formation (Kingston, 1951) on the basis of stratigraphic position and lithologic similarity. Sunblood Formation ranges from early Whiterockian (early Middle Ordovician) to Kirkfieldian (late Middle Ordovician) in age and is correlative with Haywire Formation of Gordey and Anderson (1993). Both Sunblood and Haywire formations are shallow-marine, platform-carbonate strata with extensive exposures in the Yukon and the Northwest Territories, north and west of the Pool Creek area (Gordey and Makepeace, 1999).

Unit 5

Unit 5 was observed in scattered outcrops along a small stream flowing east into the Beaver River in the North area, and along the southwest margin of the syenite intrusion in the South area. It consists of thinly bedded, tan-weathering, very fine-grained, sucrosic, laminated to massive dolostone (Fig. 13). Individual beds range in thickness from 2 to 50 cm and are slightly undulating. The lowermost exposures contain ovoid black chert nodules up to 15 cm across. The unit's lower contact is unexposed, and the upper contact is conformable with Unit 6. It has an interpreted thickness of 60 m.

Unit 5 is also tentatively correlated with Sunblood Formation on the basis of general stratigraphic position and lithologic similarity. Age, correlations, and depositional environments are as described for Unit 4.

Unit 6

Along the Beaver River, Unit 6 is composed of scattered outcrops and small knobs of sandstone and pebbly grit with lesser interbeds of bioturbated dolomitic siltstone and dark grey shale. It has an aggregate thickness of approximately 200 m. The lower contact is conformable and marked by an abrupt change from dolostone to sandstone. The upper contact is not exposed in the map area but is considered to be conformable.

The predominant lithology is a quartz-rich, noncalcareous, thick-bedded, medium- to coarse-grained, light to dark grey or tan sandstone to pebbly grit (Fig. 14). Beds are thin to thick (2-200 cm), massive and blocky, well indurated, and planar to undulating. Grit intervals are generally 5-100 cm thick. The grit is poorly sorted and contains up to 60-70% rounded, white and bluish quartz pebbles up to 10 mm across. The sandstone is generally fine to coarse grained, sucrosic, with 5-10% rusty to black opaque grains. It typically weathers light grey to brownish-grey with local rusty stain, yellow jarosite coating, or off-white, opaque calcite coating.

The sandstone contains intervals up to 2 m thick of light grey, dolomitic, bioturbated fine sandstone to siltstone

Figure 13. *Thinly bedded, tan-weathering, fine-grained dolostone with black chert nodules up to 5 cm across (Unit 5).*

Figure 14. *Quartz-rich, thick-bedded, medium- to coarse-grained sandstone of Unit 6. Beds dip into the figure and extend from upper right to lower left.*

(Fig. 15). These intervals are recessive and contain minor discontinuous, dark grey shaly partings. Dark grey to black, noncalcareous shale forms a third lithotype occurring in minor amounts (less than 20%) as thin beds up to 2 m thick.

Unit 6 is distinctive and constitutes a useful marker horizon. It is considered to be Late Ordovician because it lies conformably between Middle Ordovician Unit 5 (Sunblood Formation) and Ordovician-Silurian Unit 7 (Road River Group). It represents a transitional environment between platform carbonate sedimentation (Unit 5) and euxinic, basinal sedimentation (Unit 7).

Unit 7

Unit 7 forms recessive scree slopes and scattered outcrops along Beaver River in the North area. It consists of interbedded black, locally calcareous, silty shale and siltstone, black bedded chert, and black, laminated, argillaceous limestone, and has an interpreted thickness of approximately 500 m (Fig. 16). The different lithologies of Unit 7 are interbedded on a scale of metres to tens of metres.

The siltstone and shale are thinly bedded (2-20 mm), platy, weather light to medium grey, and locally have yellow jarositic or white coatings. Bedded cherts consist of 5- to 10-cm, parallel laminated chert beds with 1-3 cm shaly interbeds. Limestone is dark grey with thin light grey interbands. Locally the chert, siltstone, and shale contain tan-weathering dolostone nodules. Sandstone is very fine-grained, medium grey, finely micaceous, and finely laminated. Straight and spiral graptolites occur on bedding planes throughout the unit. Other macrofossils include crinoid columns and rare brachiopods.

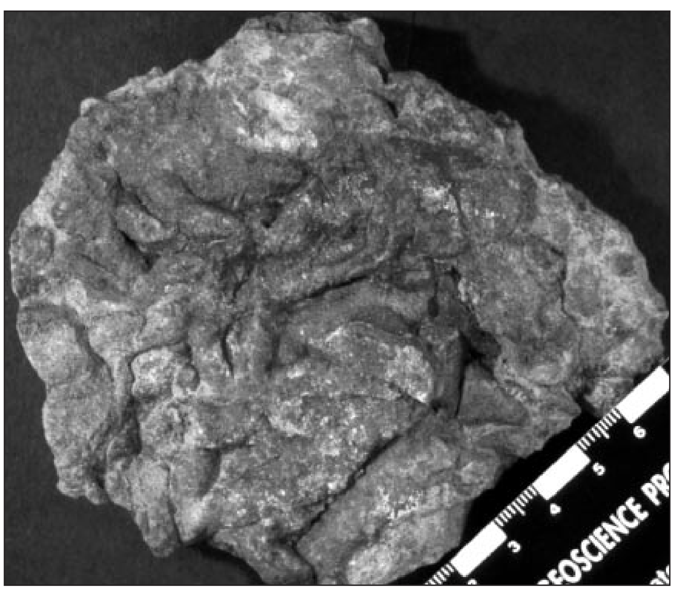


Figure 15. *Close-up of bedding plane surface of bioturbated, dolomitic, very fine-grained sandstone to siltstone. Burrows are randomly oriented on the bedding plane surface. Scale is graduated in centimetres.*

Lower and upper contacts are not exposed. Unit 6 consistently underlies Unit 7, suggesting a conformable lower contact. Immediately south of Beaver River, Unit 7 is conformably overlain by Unit 8. In the northernmost part of the map area, Unit 7 is directly overlain by Unit 10. This contact between units 7 and 10 will be discussed further in the section describing Unit 10.

Unit 7 is correlated with Lower Cambrian to Lower Devonian Road River Formation in the Richardson Mountains (Jackson and Lenz, 1962). Similar Ordovician-Silurian graptolitic shales are present in several areas in Selwyn Basin leading Gabrielse et al. (1973) to suggest the name Road River Formation be extended to all these shales. Gordey and Anderson (1993) raised Road River to group status because two formations can be recognized within it in the Nahanni area. In Flat River and Glacier Lake map areas, Road River Formation ranges from Caradocian (late Middle Ordovician) to Early Devonian in age. Regionally upper and lower contacts are diachronous. The depositional environment is a relatively deep, euxinic, quiet basin. Bedded cherts are probably biogenic, forming from radiolarian detritus.

Unit 8

Unit 8 outcrops along Beaver River immediately north of the syenite intrusion. It consists of interbedded, buff-

Figure 16. *Black, thinly bedded, silty shale of Unit 7 (Road River Group). Pen in centre of Figure is 13 cm long.*

Figure 17. *Buff-weathering, platy, siltstone, very fine-grained sandstone and dark grey, fissile shale of Unit 8. Hammer for scale in right centre of figure.*

weathering, dolomitic, micaceous, platy siltstone and very fine-grained sandstone, alternating with dark grey, fissile, silty shale (Fig. 17). Black chert and resistant, lensoidal, dolomitic sandstone also occur in minor amounts. The interbedded siltstone and sandstone are finely planar parallel laminated, with beds of 5 to 20 mm thickness occurring in intervals up to 4 m thick. Lensoidal sandstone occurs in beds up to 50 cm thick and contains crinoids and other broken fossil debris. The silty shale is medium to dark grey, noncalcareous, gritty, and finely micaceous. It typically grades upward to buff siltstone.

Slightly further east (just outside the mapped area), Unit 8 becomes a massive dolostone (Burt, 1983). The unit's thickness increases from 100 to 600 m from west to east. The unit is absent in the extreme northwest corner of the map area. Upper and lower contacts are not exposed but are tentatively interpreted as conformable. The occurrence of micaceous clastic sediments and rapid thickening toward the east into a massive dolostone suggests this unit represents a succession of clastic debris sediments deposited westward off a shallow carbonate platform margin. The age of Unit 8 is broadly constrained to be Silurian-Devonian by its position above Ordovician-Silurian Unit 7 and below Middle Devonian Unit 9.

Unit 9

Unit 9 forms cliff outcrops in the central part of the North area, but is absent in the northwest corner of the map area. It consists dominantly of dark grey to black, medium- to thick-bedded, argillaceous limestone with thin dark grey shale or light grey siltstone interbeds (Fig. 18). The uppermost 20 m of the unit is more resistant and forms steep cliff outcrops. The maximum thickness of Unit 9 is approximately 600 m, thinning to the east in conjunction with the thickening of Unit 8. The lower contact is conformable and is marked by the first appearance of abundant, medium-bedded limestone. The upper contact is marked by a sharp transition to the fine-grained, siliceous shale of Unit 10. The absence of Unit 9 in the northwest corner of the map area suggests that the upper contact is unconformable.

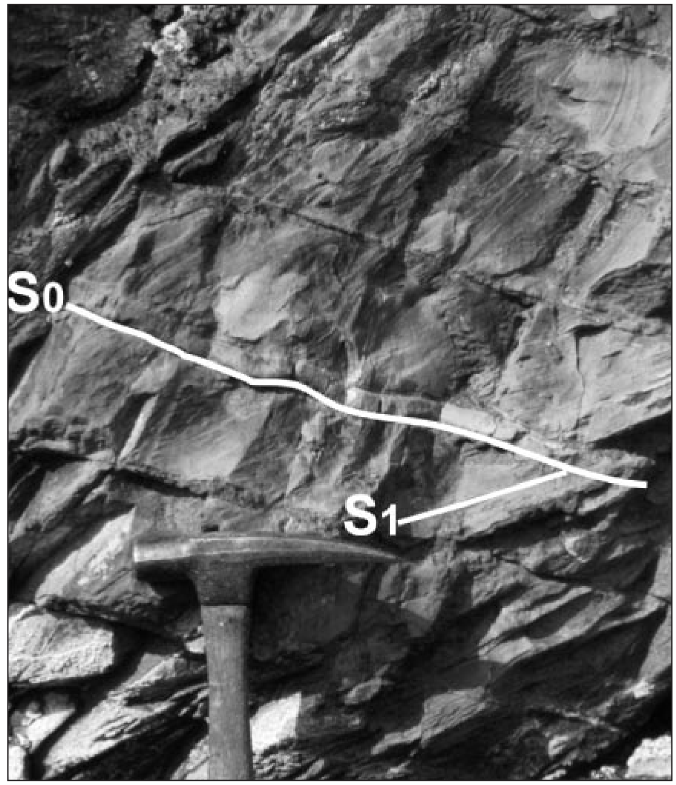


Figure 18. *Looking north at thin- to medium-bedded, dark grey, micritic, argillaceous limestone of Unit 9. S_0 bedding dips gently from left to right, and S_1 slaty cleavage dips gently from right to left.*

Limestone beds are 10-50 cm thick with shaly partings (Fig. 18). Locally, the limestone beds contain thin black chert nodules or black chert beds. Generally, the limestone is micritic; sparse grainstones up to 10 cm thick contain fossil debris crinoid columns with single and twin axial canals. The resistant limestone at the top of the unit contains undulatory beds 2-150 cm thick with platy to fissile, recessive, medium to dark grey, calcareous shale and siltstone with minor 30- to 40-cm-thick sandstone interbeds. The shale interbeds are parallel laminated on a millimetre scale.

The presence of crinoid columns with twin axial canals constrains Unit 9 within upper Lower Devonian to upper Middle Devonian age (Dunn and Kendall, 1978). The argillaceous nature of the limestone and its rhythmic bedding indicate a quiet water, offshelf depositional environment.

Unit 10

Unit 10 occurs as cliff outcrops along streams and as scree slopes on ridges in the North area. It consists of black silty shale interbedded with black bedded chert. In the northwest corner of the North area, it overlies Unit 7, and in the north central part of the North area, it rests on Unit 9. The upper contact is not observed in the map area. The minimum estimated thickness for Unit 10 is 200 m.

The silty shale is platy to thinly bedded (2-10 mm thick), noncalcareous, siliceous, and typically subcrops as bluish-grey- to light brownish-grey-weathering scree slopes (Fig. 19). Fresh surfaces are greyish-black with faint, medium grey, parallel planar laminae. The black bedded chert interbeds consist of 2-10 cm chert beds separated by shaly partings. Silty shale and chert are interbedded on a scale of metres to tens of metres with proportions of the two lithologies varying widely between outcrops. Large, dark grey limestone concretions up to 2 m across were observed within the siliceous shale in the lowermost part of Unit 10. Greyish-black, light to medium grey weathering, blocky, micritic limestone occurs as a minor lithology within this unit.

Figure 19. *Thin-bedded, siliceous, silty shale of Unit 10. Scale is graduated in centimetres.*

Unit 10 is correlated with Devonian-Mississippian Earn Group (Gordey et al., 1982) and Besa River Formation (Kidd, 1963). The pale grey- to white-weathering colour is characteristic for Earn Group. Exposures in Pool Creek area however, do not contain the chert-pebble conglomerates typical of Earn Group within Selwyn Basin strata farther to the northwest. Straight cephalopod (?) fossils of unknown age were observed in Unit 10 in the map area. At least a part of the unit is constrained to be younger than Middle Devonian because it overlies the Middle Devonian Unit 9. The lower contact is interpreted as being an unconformity since Unit 10 overlies Unit 9 in the central part of the North area, and Unit 7 in the northwest part of the North area.

Abundant black shale and black bedded chert denote a deep water, euxinic, basinal depositional setting. The presence of carbonate nodules indicates water depths do not reach the calcite compensation level. Cherts are inferred to be biogenic even though radiolarians are not readily visible in hand sample.

IGNEOUS ACTIVITY

Unit 11 (Pool Creek Syenite)

The map area is intruded by a north-trending, unfoliated syenite (Unit 11) consisting of medium to coarsely crystalline, randomly oriented, pink potassium-feldspar, with lesser dark green hornblende. Unit 11 is exposed for a strike length of 7 km along the one ridge above tree line and has informally been called the Pool Creek syenite (Harrison, 1982). Syenite dykes and sills occur in country rocks immediately adjacent to the intrusion. Linear, intensely clay-altered zones within the syenite weather to soft, white scree slopes. These zones are typically 3-5 m wide and can extend for tens of metres.

An isolated intrusive plug of similar composition immediately north of the Pool Creek map area has an average K-Ar date on three biotite separates of 53.1 ± 1.8 Ma (Harrison, 1982; Stevens et al., 1982), corresponding to an early Eocene age.

Basalt

Thin, dark green, fine-grained to aphanitic, noncalcareous basaltic dykes up to one metre in width crosscut the syenite intrusion and Unit 3. Marginal contacts of the dykes are sharp. The dykes are not mappable at 1:50 000 scale.

STRUCTURE AND METAMORPHISM

In the North area, sedimentary units are deformed into tight to slightly overturned, east-verging, north-plunging folds (see cross-section AB in Figure 5). Hinge zones of the folds contain a well developed, axial planar, slaty cleavage, which dips moderately northwestward at approximately 55° with an average strike of 240°. Measured fold axes have an average trend and plunge of 007/14.

The maximum age of deformation in the North area is post-Carboniferous because Unit 10 is deformed. The minimum age of deformation is pre-Eocene because the Pool Creek syenite is unfoliated and therefore post-tectonic.

In contrast to the structural style in the North area, primary sedimentary bedding in the South area is warped into broad, open, sub-horizontal, northeast-trending folds (see cross-section EF in Figure 4) with no associated cleavage development. The mapped anticline in the South area has a northeast-trending, steep normal fault in the hinge zone, suggesting brittle faulting slightly post-dates folding.

Douglas (1976) inferred a westward-verging thrust (Beaver River Thrust) that emplaced Proterozoic strata above the

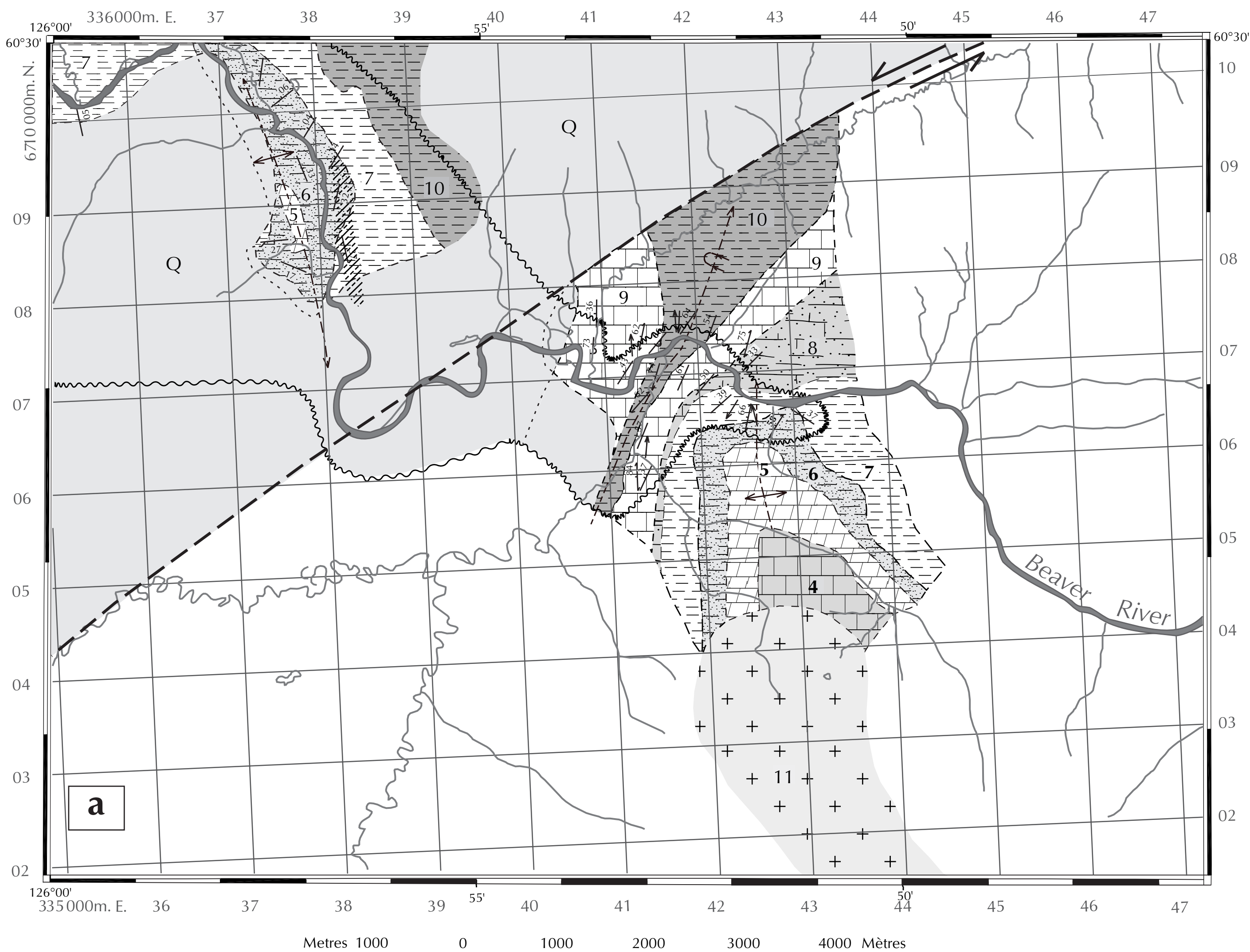


Figure 20. *Two possible structural interpretations for sinistral offset of lower contact of Unit 10 in the North area. (a) Lower contact offset approximately 2 km by northeast-trending fault. (b) Lower contact offset approximately 2 km by northward-trending anticline-syncline fold couplet. Grid spacing is 1 km. For unit descriptions, see legend from Figure 2.*

Paleozoic Mattson and Besa River formations in the South area. Strata in the South area previously mapped as Mattson and Besa River formations (Units 1 and 2 in this report) differ markedly from these units and have probably been misidentified. Units 1 and 2 occur stratigraphically below Unit 3 without structural interruption and are probably of Proterozoic age. The Beaver River Thrust is not needed to explain the distribution of units within the map area.

Skarn, gossan, and biotite hornfels comprise the contact metamorphic aureole of the main syenite body and the syenite dykes and sills in the South area. The spatial association of the aureoles with northeast-trending faults suggests that intrusion of the syenite and contact metamorphism of the sedimentary units was broadly coeval with the development of the northeast-trending folds and faults. Therefore, the open folds in the South area are tentatively considered to be Eocene.

Minor calcareous members within Unit 3 contain metamorphic garnet, epidote and chlorite forming an extensive, poorly defined metamorphic halo broadly associated with the Pool Creek syenite intrusion. Tremolite has also been tentatively identified in carbonate clasts collected from breccia beds high in Unit 3. Metamorphism in the South area may have reached higher temperatures than is readily apparent from hand sample and outcrop inspection.

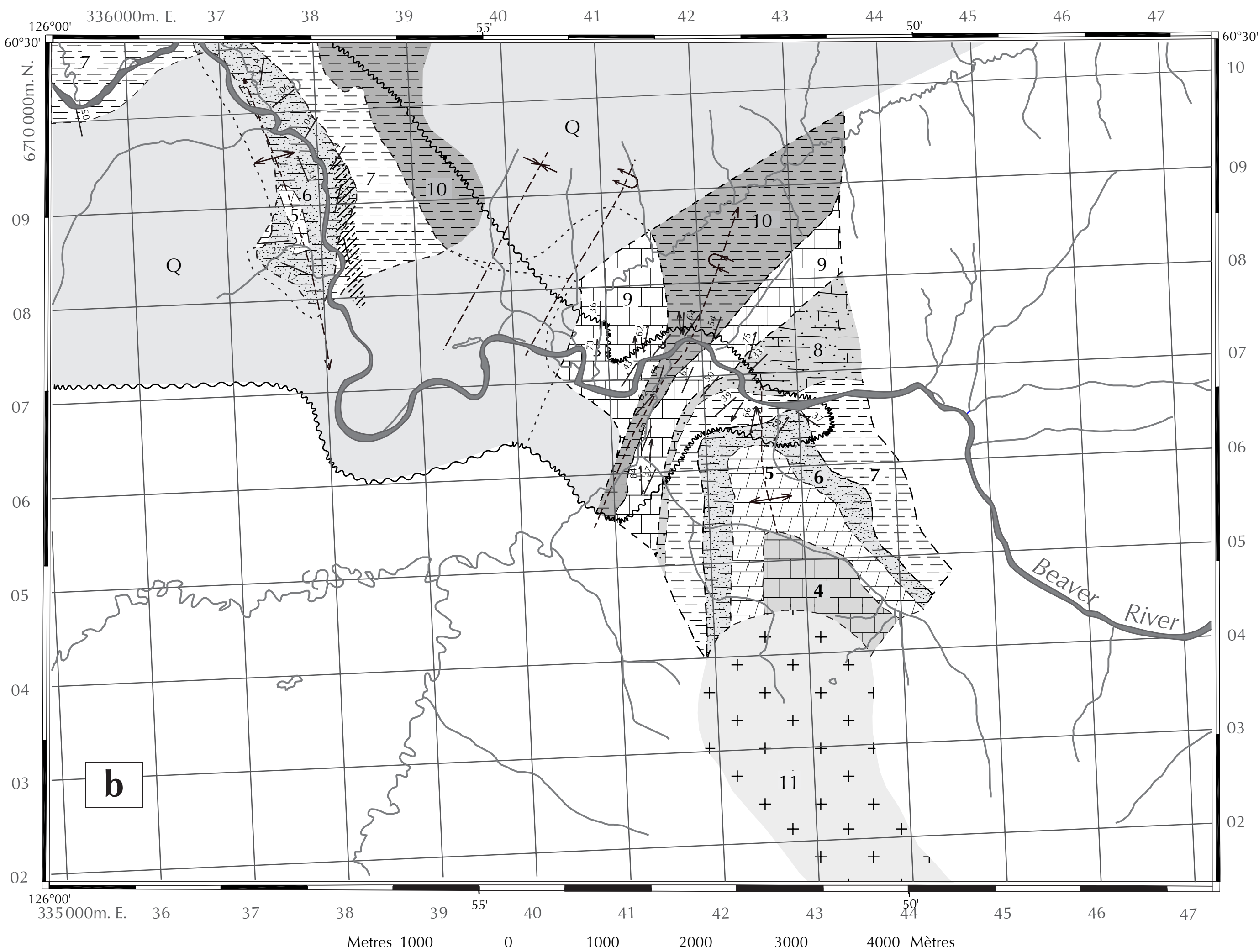


Figure 20. continued

BEAVER RIVER STRUCTURE

Morrow and Miles (2000) proposed the existence of the Beaver River structure, a major, northeast-trending, crustal, dextral strike-slip fault with 10-20 km of offset during Laramide deformation. They considered the Beaver Fault (mapped by Douglas, 1976) as being the surface expression of this structure. Additional evidence for the Beaver River structure includes deflections of Laramide fold structures and terminations to trends in the residual total field magnetic and Bouger gravity anomaly geophysical maps.

The Beaver Fault, as interpreted by Douglas (1976), trends northeast through the North area in the northwest corner of the Pool Creek map sheet. Our detailed mapping during the 2000 field season traces stratigraphy and fold structures continuously north-south across the previously mapped location of the Beaver Fault. Although exposure in this area is limited, there is no possibility for a strike-slip fault with 10-20 km of dextral displacement occurring in post-Ordovician time in this portion of the Pool Creek map sheet. Figure 20 compares two possible structural interpretations for the North area. In Figure 20a, a northeast-trending fault with approximately two kilometres of sinistral displacement of the lower contact of Unit 10 is interpreted. In contrast, Figure 20b interprets the apparent sinistral displacement of the lower Unit 10 contact as being caused by a north-plunging, anticline-syncline fold pair. The interpretation presented in Figure 20b is preferred.

ECONOMIC POTENTIAL

Previous mineral exploration in the Pool Creek map sheet identified uranium, thorium, and REE prospects in the syenite intrusion and associated dykes, and in the contact aureole (Yukon MINFILE, 1997). Surface showings were pod shaped and could not be traced laterally or downdip.

During the 2000 field season, gamma ray scintillometry surveys (total counts and potassium counts) were completed over some of the earlier identified prospects (A. Fonseca, pers. comm., 2000). These new surveys indicate that zones of high gamma ray radiation are limited to the syenite pluton and associated dykes. Skarns do not contain greatly anomalous gamma ray counts.

In the North area, previous mineral exploration focused on identifying and evaluating base metal sedimentary-exhalative (SEDEX) targets (Yukon MINFILE, 1997). The northwest corner of the map sheet contains a large ferricrete gossan immediately east of the Beaver River with anomalous values for zinc, cobalt, and nickel (Cathro, 1983). No tightly constrained source for the ferricrete gossan has been identified.

Areas of the Yukon to the northwest contain significant stratiform zinc-lead-silver-barite deposits in Earn Group and Road River Group strata (Abbott et al., 1986). Geological mapping during the 2000 field season confirmed that the North area contains appropriate stratigraphy for SEDEX targets. Previous exploration work in the Pool Creek area has not fully evaluated and tested this suitable stratigraphy. Although no prospects or showings were identified during fieldwork, exploration potential remains for areas underlain by Units 7 and 10.

Dark grey to black, very fine-grained siliciclastic strata were sampled from various units in the Pool Creek map sheet to determine their thermal maturation. Thermal Alteration Indices (TAI) assessed from spore colouration indicated values of 5 or greater, correlative with a vitrinite reflectance value of at least 4.0%R_o (Utting, 2000). Hydrocarbon potential (oil and gas) is therefore unlikely in the western portion of the map area because the rocks have been thermally altered beyond the gas window (low grade metamorphic rocks).

SUMMARY

Fieldwork in the Pool Creek map sheet during the summer 2000 distinguished North and South areas with distinct stratigraphy and structural deformation histories. The South area stratigraphy consists dominantly of quartz-rich clastic sedimentary rocks of uncertain age (Proterozoic ?). Deformation in the South area is characterized by broad, northeast-trending, sub-horizontal folds.

In contrast, the North area stratigraphy consists of carbonates with interbedded sandstone, siltstone, and shale. The stratigraphic succession ranges in age from Ordovician to Mississippian. Major shale units in the sequence are correlated with Road River Group and Earn Group. Sedimentary units in the North area have been deformed into tight to overturned, north-plunging, east-verging folds. Hinge zones of the folds contain a well developed, axial planar, slaty cleavage.

North and South areas have been intruded by a north-trending, coarsely crystalline, unfoliated, potassium-feldspar-hornblende syenite. K-Ar dating of biotite separates from a similar intrusive plug immediately north of the Pool Creek area results in an early Eocene date

(53.1 ± 1.8 Ma). Small dykes and sills of syenite extend into the country rock in the immediate vicinity of the main syenite intrusion.

Contact metamorphic effects related to the syenite intrusion and associated dykes and sills include biotite hornfels, calc-silicate rock, and gossan. Contact metamorphism appears to be associated with northeast-trending folds and faults of the South area, and is later than the pervasive folding in the North area. North area folding is therefore post-Mississippian and pre-Eocene. Broad northeast-trending folding and metamorphism is early Eocene.

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REFERENCES

Abbott, J.G., Gordey, S.P. and Tempelman-Kluit, D.J., 1986. Setting of stratiform, sediment-hosted lead-zinc deposits in Yukon and northeastern British Columbia. *In:* Mineral Deposits of Northern Cordillera, J.A. Morin (ed.), Canadian Institute of Mining and Metallurgy, Special Volume 37, p. 1-18.

Bostock, H.S., 1948. Physiography of the Canadian Cordillera, with special reference to the area north of the fifty-fifth parallel. Geological Survey of Canada, Memoir 247, 106 p.

Brenchley, P.J., 1985. Storm influenced sandstone beds. Modern Geology, vol. 9, p. 369-396.

Burt, P., 1983. Geological, geochemical and geophysical report of work performed during June and July of 1983 on the BEAV 1 to 180 claims. Unpublished Assessment Report #091486, Mineral Resources Directorate, Yukon, Indian and Northern Affairs Canada, 46 p.

Cathro, R.J., 1983. Report on geological and geochemical surveys conducted July 12–August 17, 1982. TRANZ 1-4 claims, YA68631-YA68644. Unpublished Assessment Report #091459, Mineral Resources Directorate, Yukon, Indian and Northern Affairs Canada, 9 p.

Cecile, M.P., Morrow, D.W. and Williams, G.K., 1997. Early Paleozoic (Cambrian to Early Devonian) tectonic framework, Canadian Cordillera. Bulletin of Canadian Petroleum Geology, vol. 45, no. 1, p. 54-74.

Dalrymple, R.W. and Narbonne, G.M., 1996. Continental slope sedimentation in the Sheepbed Formation (Neoproterozoic, Windermere Supergroup), Mackenzie Mountains, NWT. Canadian Journal of Earth Sciences, vol. 33, p. 848-862.

Douglas, R.J.W., 1976. Geology of La Biche River map area (95C), District of Mackenzie. Geological Survey of Canada, "A" Series Map 1380A (scale 1:250 000).

Douglas, R.J.W. and Norris, D.K., 1959. Fort Liard and La Biche map-areas, Northwest Territories and Yukon. Geological Survey of Canada, Paper 59-6, 23 p.

Dunn, C.E. and Kendall, A.C., 1978. *Gasterocoma* from the Givetian of Manitoba and Saskatchewan. Bulletin of Canadian Petroleum Geology, vol. 26, no. 1, p. 159-161.

Gabrielse, H., Blusson, S.L. and Roddick, J.A., 1973. Geology of Flat River, Glacier Lake and Wrigley Lake map-areas, District of Mackenzie and Yukon Territory. Geological Survey of Canada, Memoir 366 (Parts I and II), 421 p.

Gabrielse, H. and Campbell, R.B., 1991. Upper Proterozoic assemblages, Chapter 6. *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. 125-150.

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 Cordilleran Miogeocline. Canadian Journal of Earth Sciences, vol. 32, p. 1236-1254.

Gordey, S.P., Abbott, J.G. and Orchard, M.J., 1982. Devono-Mississippian (Earn Group) and younger strata in east-central Yukon. *In:* Current Research, Part B, Geological Survey of Canada, Paper 82-1B, p. 93-100.

Gordey, S.P. and Anderson, R.G., 1993. Evolution of the northern Cordilleran Miogeocline, Nahanni map area (105I), Yukon and Northwest territories. Geological Survey of Canada, Memoir 428, 214 p.

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).

Harrison, J.C., 1982. Petrology of the 'Ting Creek' alkalic intrusion, southeast Yukon. Unpublished MSc thesis, University of Toronto, Ontario, 299 p.

Jackson, D.E. and Lenz, A.C., 1962. Zonation of Ordovician and Silurian graptolites of northern Yukon, Canada. American Association of Petroleum Geologists Bulletin, vol. 46, p. 30-45.

Kidd, F.A., 1963. The Besa River Formation. Bulletin of Canadian Petroleum Geology, vol. 11, no. 4, p. 369-372.

Kingston, D.R., 1951. Stratigraphic reconnaissance along the upper South Nahanni River, NWT. American Association of Petroleum Geologists Bulletin, vol. 35, no. 11, p. 2409-2426.

Morrow, D.W. and Miles, W.C., 2000. The Beaver River structure: A cross-strike discontinuity of possible crustal dimensions in the southern Mackenzie Fold Belt, Yukon and Northwest territories, Canada. Bulletin of Canadian Petroleum Geology, vol. 48, no. 1, p. 19-29.

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 81-02, 56 p.

Utting, J., 2000. Palynological study of 10 samples from the lower Paleozoic and Proterozoic of Yukon; submitted by T. Allen, Mineral Resource Branch, Whitehorse, Yukon (NTS 95C/5, Pool Creek). Paleontological Report, 8-JU-00, 4 p.

Yukon MINFILE, 1997. LaBiche River – 95C. Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada.