Preliminary observations on the geology of Tay Mountain Area (parts of NTS 105K/12 and 13, 105L/09 and 16), central Yukon

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ABSTRACT

Regional mapping north and west of Faro is aimed at improving knowledge of the geologic history of the area and at elucidating the host stratigraphy and structures of both precious and base-metal occurrences. The southern part of the Tay Mountain area is underlain by metamorphosed lower Cambrian to Silurian Selwyn basin strata. These are thrust northward over Silurian to Triassic clastic, carbonate and volcanic rocks. The entire succession is intruded by mid-Cretaceous granitic rocks of the Tay River plutonic suite. The area is deformed by folding and north-verging thrust faults and by both east-west and north-south oriented normal faults. There is evidence that north-verging thrust faults are reactivated Devonian normal faults that formed in response to regional extension and controlled the deposition of the Earn Group.

Selwyn basin strata, which are age-equivalent to the Anvil Mine host stratigraphy, crops out extensively south of the Twopete thrust fault. The end of a northwest-trending belt of silver-bearing occurrences is located at Mount Menzie. Folded chert in proximity to calcareous rocks and granitic intrusions are common features of the silver showings in the area.

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INTRODUCTION

In 2013 the Yukon Geological Survey initiated a multi-year, 1:50 000 scale revision mapping project focused on the western edge of the Tay River map area (NTS 105K) and the northeast corner of the Glenlyon area (NTS 105L; *see* Fig. 1). This paper describes stratigraphy and structure of the area, augmenting the preliminary report from Anvil Lake area (Cobbett, 2014) and its final map (Cobbett, 2015). The mapping described herein extends westward to Tay Mountain, including Mount Menzie and the southeast Earn Hills (Fig. 2).

The area includes the northwestern end of a trend of high-grade silver-bearing occurrences on-trend with the Keg deposit (Yukon MINFILE 105K 078; discovered in 1966, assessed through the 1970s) that parallels a NW-trending fold-thrust belt. The mineralized trend is exposed on Twopete Mountain, Mount Menzie and Earn Hills (Fig. 2).

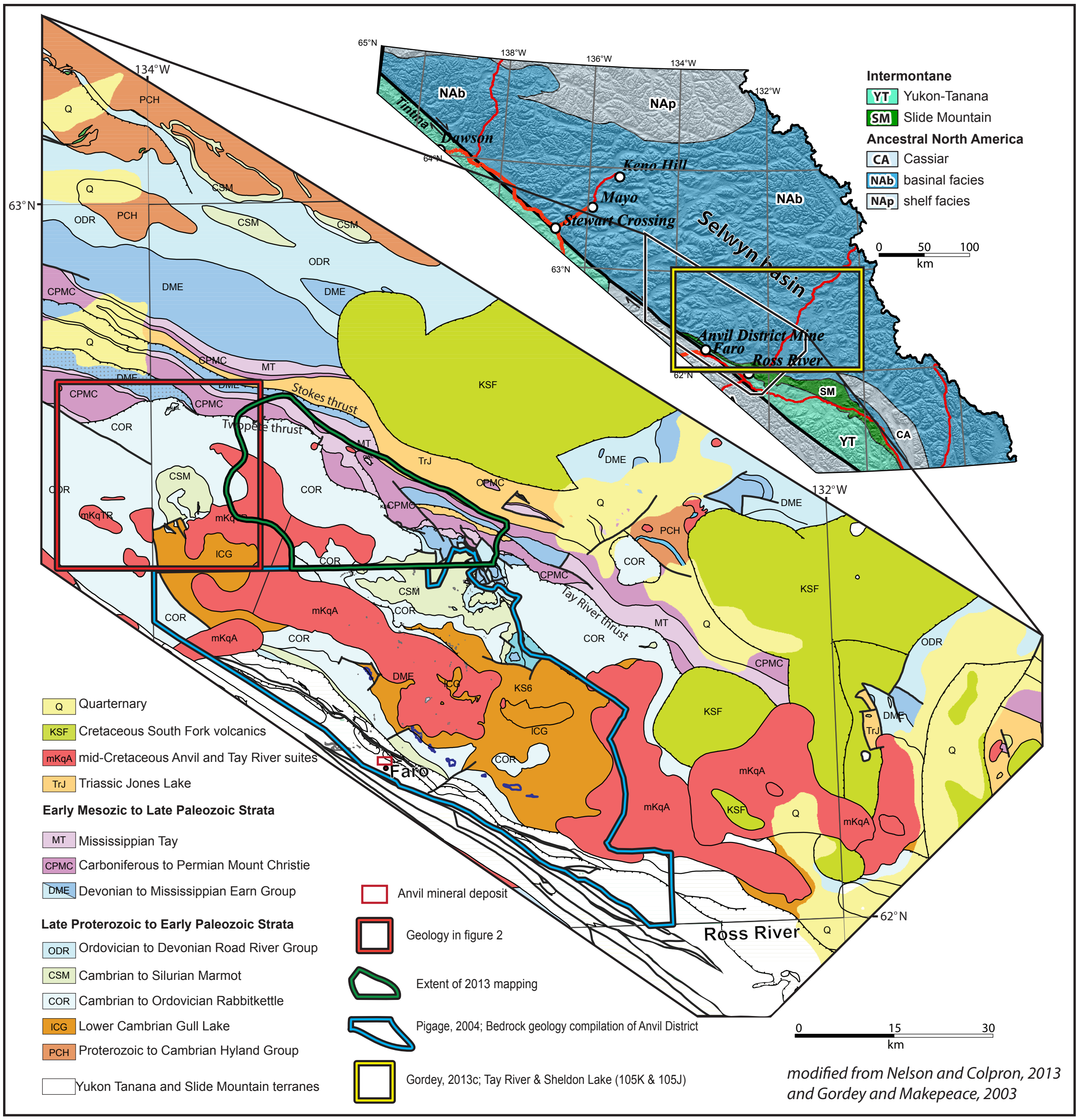


Figure 1. *Geologic terranes (from Nelson et al., 2013) shown in the top right map; mapped area lies in Selwyn basin; previous mapping by Gordey (2013c) outlined in yellow. Larger map shows geology of the Anvil district with coloured outline of previous mapping by Pigage (2004; blue) and Cobbett (2015; green).*

This project has identified previously unrecognized Lower Paleozoic strata that suggest there is potential for SEDEX-style mineralization similar to the Faro Mine within the Tay Mountain area (Figs. 1 and 2). Better understanding of Upper Paleozoic stratigraphy has allowed a re-interpretation of faults, in specific the timing and kinematic history of northeast-verging thrust faults.

GEOLOGIC FRAMEWORK

The area of interest lies in central Yukon, 50 km north of the previously mined Faro deposit (Fig. 1), within the southern part of Selwyn basin. This is a broad region underlain by mostly lower Paleozoic deep water clastic, cherty and less common thin carbonate strata (Gabrielse, 1967; Gordey and Anderson, 1993; Gordey, 2013a). Devonian through Mississippian quartz-rich sandstone, siltstone and conglomerate were deposited unconformably on the lower Paleozoic strata (Abbott *et al.*, 1986; Gordey and Anderson, 1993). Carboniferous through Jurassic clastic rocks that unconformably overlie the Devonian to Mississippian clastic rocks represent a continental shelf setting. Although of regional significance, these two major unconformities are only locally exposed in the area of interest.

The mapped area (hereafter referred to as the Tay Mountain area; Fig. 2) is within the Omenica structural province characterized by north and northeast-verging folds and thrust faults. These structures are linked to northeastward shortening that is generally accepted to have resulted from collision of continental fragments and arc assemblages with the western edge of Laurentia in Middle Jurassic (Colpron *et al.*, 2006; Mair *et al.*, 2006). Parts of these subducted terranes lie beyond the southwest corner of the area of interest and are southwest of the Tintina fault, a post-mid-Cretaceous dextral strike-slip fault (Gabrielse *et al.*, 2006; Roddick, 1967). The structurally thickened Selwyn basin strata are intruded by late Early Cretaceous granitic plutons of the Tay River suite (Gordey and Anderson, 1993; Rasmussen, 2013).

The southern half of the Tay Mountain area is made up of lower Cambrian to Silurian Selwyn basin strata, thrust over Devonian to Triassic strata in the northern half (Fig. 3). The Selwyn basin strata are metamorphosed and range from mildly foliated to completely recrystallized. The late Paleozoic strata are deformed by a northwest trending fold and thrust belt. The Anvil batholith and several small, coeval granitic plugs intrude both successions and impose a contact aureole that ranges from tens of metres to several kilometres in width.

STRATIGRAPHY

Two essentially equivalent lower Paleozoic stratigraphic successions have been used in the area of interest: one extends from regional mapping of the Selwyn basin, the other extends from mapping of the metamorphosed sequence surrounding the Anvil mine district. These units are employed in the south half of the Tay River area; from the stratigraphic oldest, Mount Mye, Vangorda, and Menzie Creek formations. This metamorphic package is unconformably overlain by a relatively unmetamorphosed Devonian through Triassic sequence including several lithologic divisions of the Earn Group, succeeded by the Mount Christie and Jones Lake formations (Fig. 3).

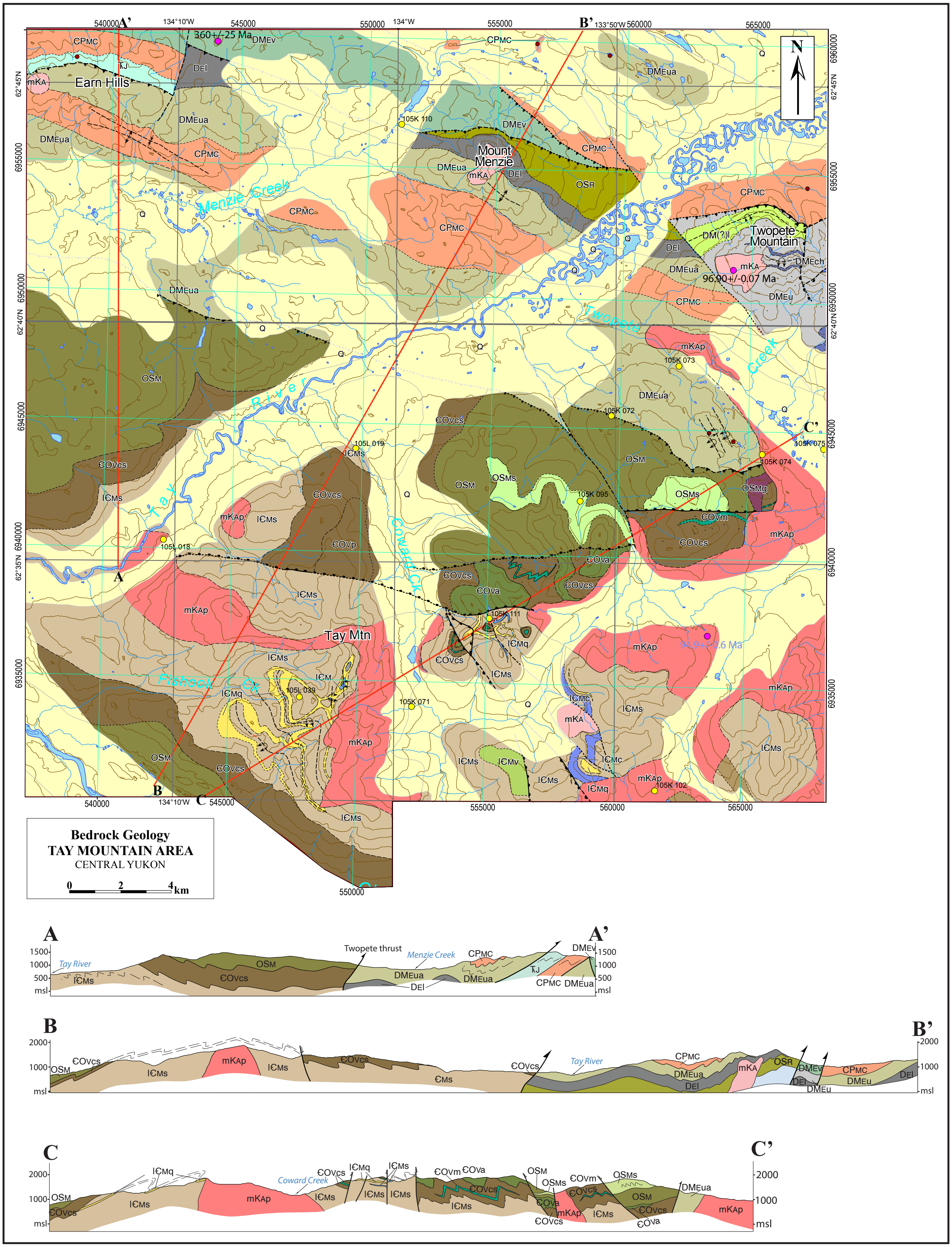
LOWER CAMBRIAN TO SILURIAN ROCKS SOUTH OF TWOPETE THRUST

Meta-clastic, carbonate and volcanic strata in the south half of the mapped area, interpreted to be lower Cambrian to Silurian, were designated as Gull Lake Formation, Rabbitkettle Formation, and overlying Menzie Creek Formation on regional maps (Gordey, 2013b,c). Currently, however, local workers have followed the leads of Jennings and Jilson (1986) and Pigage (2004), employing the informally named Mount Mye (uPCM units) and Vangorda formations (COV units), and Menzie Creek Formation (OSM units) for the equivalent strata within the Anvil District. This informal terminology is adopted here for most of the rocks in the north part of the Anvil district, and the lower-case suffixes for these units indicate predominant lithologies (not necessarily in stratigraphic order within the formation).

MOUNT MYE FORMATION

Blocky outcrops of brown weathered, well foliated mica schist comprise the dominant lithology. On Tay Mountain and along several ridges due east of Tay Mountain (Fig. 2) it is brown and grey on both weathered and fresh surfaces, fine and medium-grained, variably porphyroblastic (cordierite and andalusite) biotite-muscovite schist (Fig. 4a). The schist is interlayered with several other rock types including metavolcanic rocks, quartzite and marble.

a


Bedrock Geology
TAY MOUNTAIN AREA
CENTRAL YUKON
0 2 4 km
N
Earn Hills
Mount Menzie
Twopete Mountain
Tay Mtn
Menzie Creek
Tay River
Twopete Creek
Coward Ck
Fishook Ck
360+/-25 Ma
96.90+/-0.07 Ma
A
A'
B
B'
C
C'
Twopete thrust
Tay River
Menzie Creek
Coward Creek

b

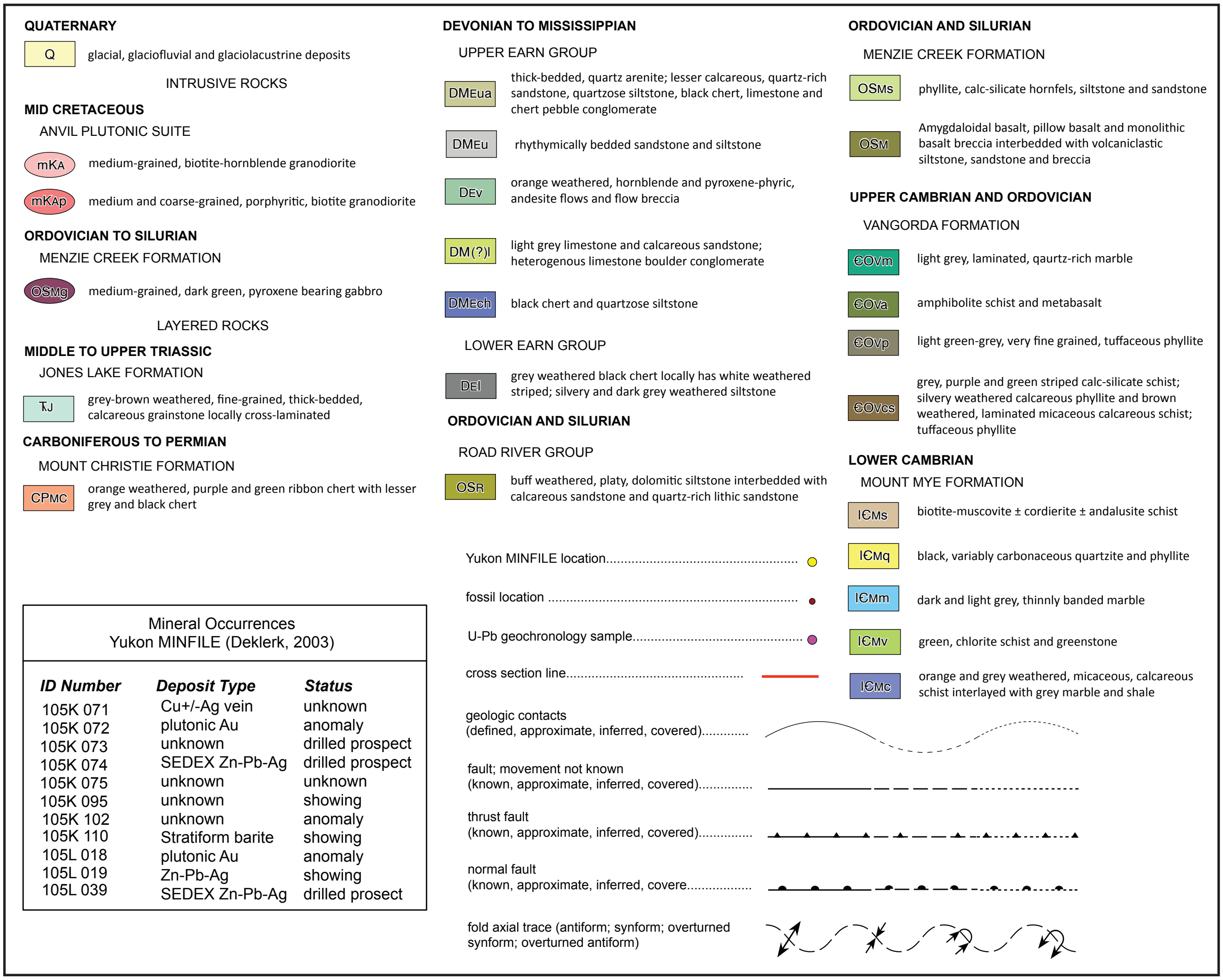


Figure 2. *(a) Bedrock geology sketch map, cross sections and (b) legend of the Tay Mountain area, based upon fieldwork in 2013 and 2015.*

The metavolcanic rocks occur in one locality a couple of kilometres southeast of the head waters of Coward Creek. Here they are green, fine-grained, well foliated chlorite phyllite and schist and dark green, fine-grained, massive greenstone with fine and medium-grained, disseminated biotite and rare pyroxene (?) crystals.

Near the top of the Mount Mye formation a dark grey to black, fine-grained, carbonaceous, micaceous quartzite provides a marker horizon within the monotonous mica-schist succession (Fig. 4b). This lithology is exposed on Tay Mountain and in several localities east of Tay Mountain and ranges in thickness from 20-60 metres.

At least two distinct calcareous horizons within the schist lie close to the quartzite. One of these horizons occurs 50 to 100 m stratigraphically below the quartzite unit east of Tay Mountain and is at least 120 m thick. This unit comprises orange and grey weathered, grey fresh, thin-bedded micaceous, calcareous schist thickly interlayered with light grey marble and minor grey shale. In other localities, including Tay Mountain, a dark and light grey striped marble crops out both above and below the quartzite and ranges in thickness from 10 to 30 m (Fig. 4c). The marble looks very similar both above and below the quartzite and could be the same depositional layer. In this case, a fold in the quartzite is necessary to make sense of the map pattern. Adjacent to dikes and sills the marble is replaced by garnet-pyroxene skarn ± semi-massive sulphide.

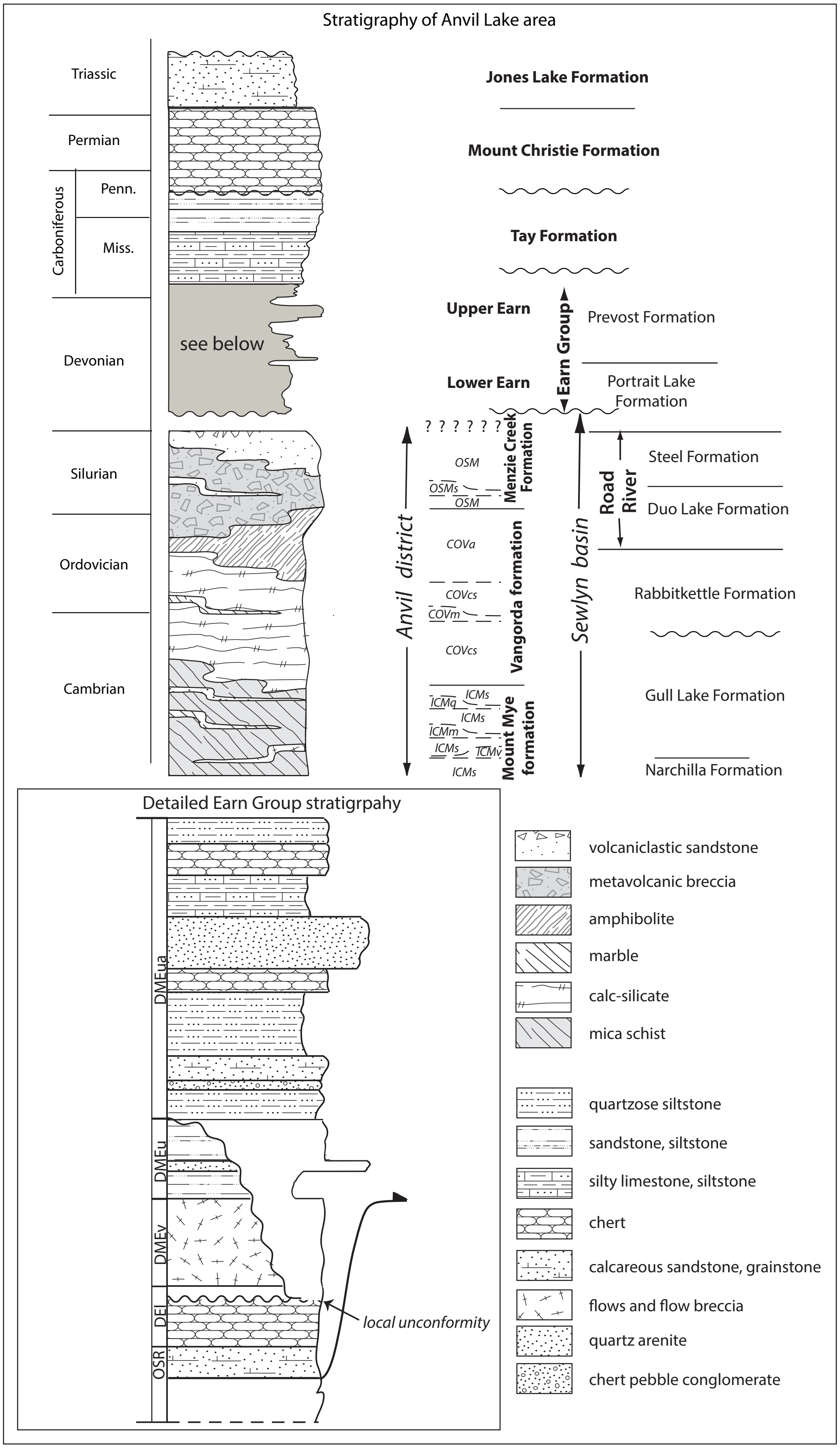


Figure 3. *Representative stratigraphy of the combined Anvil Lake and Tay Mountain areas (adapted from Cobbett, 2014). The Anvil mine district terms (left column) are used for map units in this paper; regionally equivalent Selwyn basin stratigraphy is on the right.*

The base of the Mount Mye formation is nowhere exposed. Approximately one kilometre of Mount Mye formation strata is exposed east of Tay Mountain, and assuming no structural thickening, is estimated to be a minimum thickness of this unit. The contact with the overlying Vangorda formation is unconformable based on visible truncation of strata of the Mount Mye formation, although in the Anvil Lake area a gradational boundary was interpreted (Cobbett, 2014).

This sequence of rocks has been assigned to the Mount Mye formation based on lithologic similarities to those described in the Anvil District by Pigage (2004; Fig. 3). It is interpreted to be regionally equivalent to the Gull Lake Formation and matches well with regional descriptions for the Gull Lake rocks where they have been metamorphosed (Gordey and Anderson, 1993; Gordey, 2013a).

VANGORDA FORMATION

White, chalky weathered, calcareous phyllite, mildly recessive striped calc-silicate schist and resistant, dark grey-green weathered amphibolite schist, which together make up the bulk of the Vangorda formation, crop out in an east-west orientated band across the middle of the area of interest and in the southwest corner. Rock exposures east of Coward Creek are included in the Vangorda formation but the stratigraphy differs and is best described separately.

South of Tay Mountain, the first occurrence of light grey weathered, pinkish-grey fresh, calcareous schist to calc-silicate schist marks the base of the Vangorda formation. Here, the contact between Mount Mye and Vangorda formations is unconformable because the quartzite unit near the top of the Mount Mye stratigraphy is absent beneath the calcareous schist. The Menzie Creek Formation is inferred to lie conformably above the

__Figure 4.__ Field photographs of lower Cambrian Mount Mye formation strata, Tay Mountain area. (a) Typical brown weathered, blocky outcrop of Mount Mye schist east of Tay Mountain. Here the schist is biotite-muscovite schist with porphyroblasts of andalusite. (559814 E, 6932356 N). (b) Well foliated, carbonaceous quartzite that is an important marker horizon in the Mount Mye formation. This outcrop is east of Tay Mountain but similar lithology is exposed on Tay Mountain. (559047 E, 6932004 N). (c) Light and dark grey banded marble east of Coward Creek. (555568 E, 6936512 N).

Vangorda formation to the southwest but this contact was not observed in the field.

North of Tay River the base of the Vangorda formation is marked by the first occurrence of brown weathered, calcareous, mica-rich schist (Fig. 5a). The calcareous rocks that belong to the Vangorda formation are distinctly dark brown and white, finely striped schist versus calcareous rocks that belong to the Mount Mye formation that are grey and always occur interlayered with marble (Fig. 4c). Up stratigraphic section the calcareous schist grades into a calcareous phyllite and then into a calcareous siltstone (Fig. 5b) and becomes interlayered with volcanic rocks of the Menzie Creek Formation. Here the Vangorda formation is 200 m thick. North of Tay Mountain, but on the south side of Tay River, the Vangorda formation comprises brownish-grey weathered, calcareous, micaceous schist (Fig. 5a) and phyllite overlain by light greenish-grey, very fine grained, tuffaceous (?) phyllite (COVp).

East of Coward Creek the base of the Vangorda formation is marked in part by the first occurrence of purplish-brown and beige striped calc-silicate schist (Fig. 5c) and in part by a 1 to 2 m thick layer of green weathered, amphibolite schist. Sandwiched between light grey, light purple and green striped calc-silicate schist, is a grey weathered, light purple fresh, laminated to thin-bedded quartz-rich marble layer (unit COVm; Fig. 5d) 20 to 30 m thick. Locally this unit is tight to isoclinally folded creating over thickened sections that are up to 120 m thick. Conformably above the calc-silicate schist, the Vangorda amphibolite schist exhibits a distinct weathering pattern of white and green stripes which characterizes fine-grained, schistose rock of dominantly actinolite, as well as accessory feldspar and epidote (Fig. 5e). This unit locally includes a finely-foliated dark purple and dark green rock of dominantly amphibole and biotite. Locally, a porphyritic metagabbro or metabasalt is mildly foliated and contains subhedral feldspar crystals in a fine-grained, dark green and black matrix. Blocky outcrops of dark green weathered and fresh, fine-grained schistose rock that has flattened masses of chlorite (after pyroxene?) crops out in several areas right at the contact with the underlying calc-silicate schist. The Vangorda amphibolite unit (COVa) is approximately 100 m thick east of Coward Creek, however because the top of the unit is not exposed, a true thickness of this part of the Vangorda formation could not be ascertained. The Vangorda formation, including both the calc-silicate, marble and the amphibolite schist, is at least 500 m thick. The calc-silicate schist, calcareous phyllite and calcareous schist match descriptions by Pigage (2004) for the Vangorda formation. In combination with its stratigraphic location between the Mount Mye formation and Menzie Creek Formation the lithologic similarity is the basis for the assignment. A similar unit to the amphibolite schist widely exposed south of the Anvil batholith is described by Jennings and Jilson (1986). The Vangorda formation is a variably metamorphosed equivalent to the Rabbitkettle Formation that has been mapped extensively throughout Selwyn basin (Gordey and Anderson, 1993; Cecile, 2000).

MENZIE CREEK FORMATION

Dark weathered, cliffy exposures of volcanic and volcaniclastic rocks crop out in an east-west oriented band across the middle of the mapped area. Menzie Creek Formation is geologically inferred in the southwest corner of the map but this area was not visited.

Dark green weathered and fresh, variably amygdaloidal basalt, pillow basalt and monolithic basalt breccia predominate (Fig. 6a). These rock types are commonly interbedded with chlorite schist, chert, volcaniclastic siltstone and sandstone and volcanic breccia made up of clasts of pyroxene and plagioclase-phyric basalt and andesite and fine-grained tuff in a sandy matrix (Fig. 6b). East of Coward Creek, also interbedded with the volcanic rocks, is a succession of variably metamorphosed dark grey, carbonaceous siltstone, orange-grey, thin-bedded siltstone and sandstone, grey phyllite, green-purple-beige striped calc-silicate and fine-grained, quartzose siltstone and sandstone (unit OSMs on Fig. 2; Fig. 6c).

North of Tay River the Menzie Creek volcanic rocks are in contact with the Vangorda formation (in all other locations this contact is inferred). It is interpreted as gradational because calcareous siltstone is interbedded with dioritic flows and fine-grained, banded tuffs over several hundred metres in thickness. The boundary between the two formations is drawn when the percentage of volcanic rocks is greater than siltstone. Near the confluence of Coward Creek and Tay River, the Menzie Creek Formation comprises several hundred metres of fine to coarse-grained flows or sills of intermediate to mafic composition interlayered with banded tuff and minor calcareous siltstone and phyllite. At the base of one tuff horizon thin beds of light grey, micrite are interlayered with tuffaceous material giving the rock a very distinctive weathered pattern (Fig. 6d).

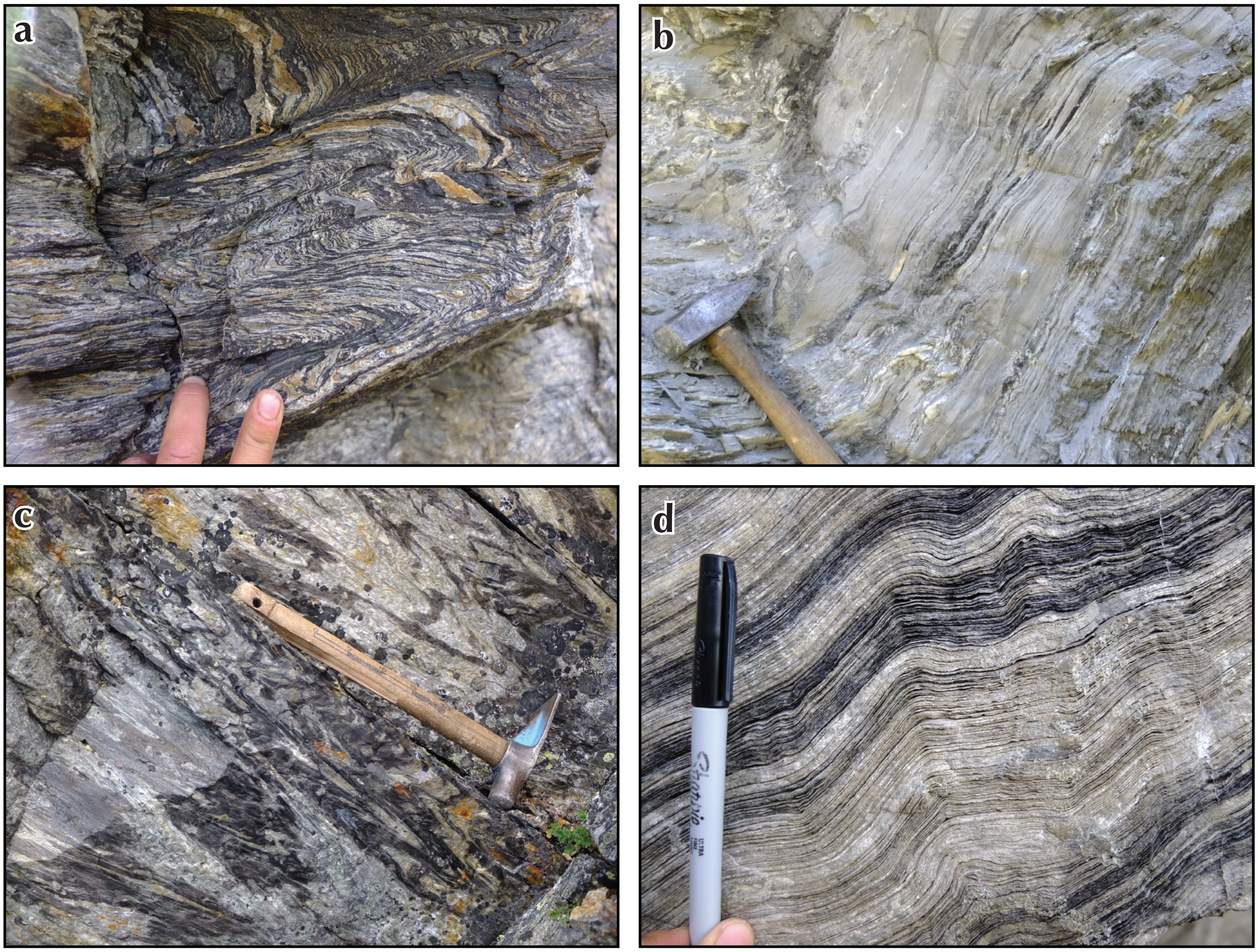


Figure 5. *Field photographs of Cambrian to Ordovician Vangorda formation strata, Tay Mountain area. (a) Calcareous schist comprising micaceous bands (dark layers) between calcite seams (white layers) near the confluence of Coward Creek and Tay River. (548895 E, 6943639 N). (b) Calcareous siltstone to phyllite near the contact between the Vangorda formation and Menzie Creek formation north of Tay River. (543665 E, 6946577 N). (c) Grey, purple and beige striped calc-silicate schist east of Coward Creek. (554940 E, 6937150 N). (d) Laminated, quartz-rich marble with small porphyroblasts of andalusite (several of which are circled in red) east of Coward Creek. (557149 E, 6939325 N). (e) Amphibolite schist comprising layers of feldspar and epidote between seams of amphibole (actinolite?) east of Coward Creek. Steeply-dipping veins that cut the rock on a cm-scale are actinolite. (555173 E, 6938347 N).*

Figure 6. Field photographs of Menzie Creek formation strata, Tay Mountain area. (a) Oblique exposure through pillow basalts east of Coward Creek. (556766 E, 6941240 N). (b) Volcaniclastic breccia: fragments of pyroxene and plagioclase-phyric basalt to andesite in a sandy, tuffaceous matrix. North of Tay River. (540884 E, 6945697 N). (c) Orange-brown to grey, thin-bedded siltstone and sandstone. (555525 E, 6942279 N). (d) Orange-green weathered, very fine grained, thin to medium-bedded tuff interbedded with grey weathered micrite north of Tay River. The tuff horizons are very thickly (10-30 m) interlayered with medium to coarse-grained andesite to basalt flows or diorite to gabbro sills. One such contact is several metres to the left of the photograph. (545643 E, 6947153 N).

The top of the Menzie Creek Formation is not exposed within the mapped area. A minimum thickness of 500 m is estimated based on thickness of volcanic and volcaniclastic rocks exposed both north of Tay River and east of Coward Creek. The rocks have been assigned to the Menzie Creek Formation based on lithologic similarity to those described by Pigage (2004).

SILURIAN TO TRIASSIC ROCKS NORTH OF TWOPETE THRUST

ROAD RIVER GROUP

Buff weathering, platey dolomitic siltstone, greater than 400 m thick is exposed along the base of the north slope of Mount Menzie. This unit comprises thick beds of beige weathered, dolomitic siltstone with trace fossils, light green-grey weathered, fine-grained calcareous sandstone and dark grey, medium-grained quartz-rich lithic sandstone. The lower contact has been interpreted to be a thrust fault, as previously described and mapped by Gordey (2013), hindering a true thickness determination. The basis for the assignment of these rocks to the Road River Group is their similarity to descriptions of the Steel Formation (upper Road River Group) by Gordey (2013) and by the similarity of these rocks to ones observed north of Mount Mye that contain Middle Ordovician to early Silurian fossils (Gordey, 2013).

Alternatively these rocks are a variation of upper Earn Group and the lower contact with the Earn Group volcanic rocks is stratigraphic.

LOWER EARN GROUP

Recessive dark weathering chert and siltstone that are altered to beige weathered, purple hornfels near the contact with granodiorite near the peak of Mount Menzie crop out in a narrow band across Mount Menzie and locally on the eastern side of Earn Hills. The chert is dark grey and black and commonly shows white stripes on weathered surfaces (Fig. 7a). Locally, the chert is interbedded with a dark grey and silver weathered siltstone to fine-grained sandstone. On the east end of Earn Hills several outcrops and subcrops of siltstone and fine-grained sandstone have also been assigned to the lower Earn Group. At this location, brown weathered, thick-bedded, fine-grained sandstone commonly contains concretions and is interbedded with laminated and sometimes rhythmically bedded siltstone.

Although obscured by vegetation, the lower contact with the Steel Formation is interpreted to be conformable. The upper contact is an unconformity based on missing Earn Group quartz-rich clastic rocks (DMEu) and the occurrence of chert conglomerate at the base of Earn Group upper arenite (DMEua) (Fig. 3). The conglomerate has clasts of white weathered chert, presumably sourced from the underlying unit (Fig. 7b). The lower Earn Group is approximately 300 m thick near Mount Menzie, the only location where both upper and lower contacts are well constrained. The chert has been assigned to the lower Earn Group based on similar rocks mapped east of the area that contain late Early Devonian to early Middle Devonian fossils (Cobbett, 2015), however, based on the minor occurrence of chert in the Steel Formation,

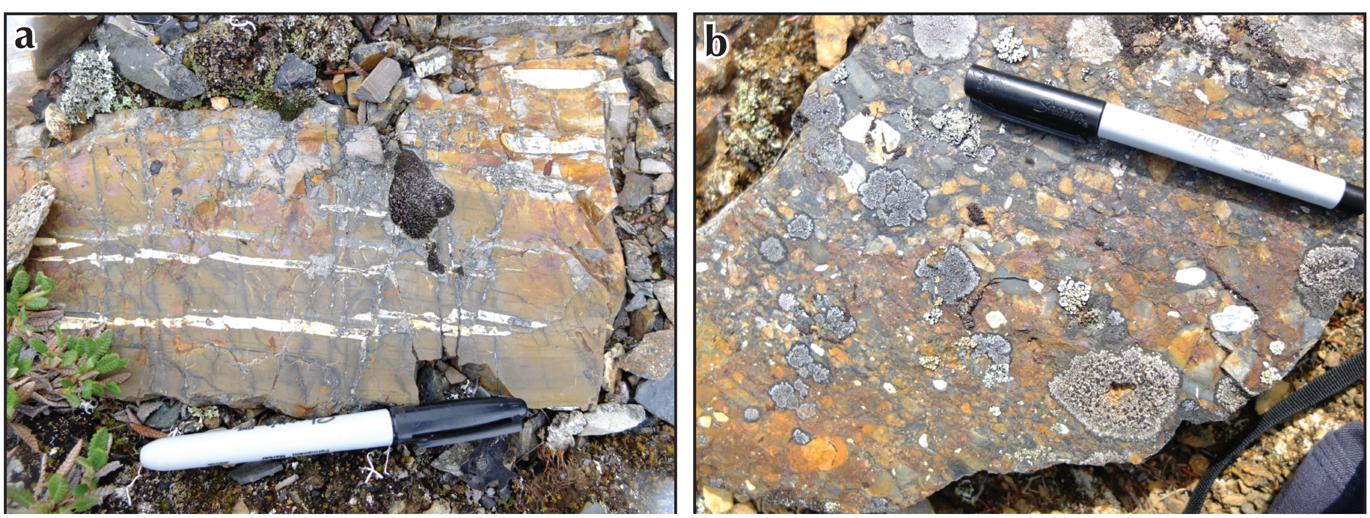


Figure 7. *Field photographs of Earn Group. (a) Lower Earn Group black chert with distinct white stripes on the weathered surface. (554980 E, 6956244 N). (b) Chert pebble conglomerate near the base of the Earn Group upper arenite (DMEua) that has clasts of white weathered, black chert. (555742 E, 6953305 N).*

assignment to this underlying unit cannot be ruled out (Gordey and Anderson, 1993; Gordey, 2013a). In the case where the Road River Group assignment is incorrect and the underlying rocks are upper Earn Group then the lower contact of this unit is a thrust fault.

VOLCANIC ROCKS WITHIN THE EARN GROUP

Rounded knobs north of Mount Menzie and Earn Hills are underlain by intermediate volcanic and volcaniclastic rocks that occur as lenses within the upper Earn Group (unit DMEv). Orange-weathering, hornblende and pyroxene-phyric, andesite flows and breccia predominate (Fig. 8a). Grey-green fresh, thin-bedded chert interbedded with green volcaniclastic siltstone crops out in one locality north of Mount Menzie. This unit is fault bounded and lacks internal structure. Its assignment to Earn Group is based on an unpublished Late Devonian U-Pb zircon age by J.K. Mortensen which is referenced in Gordey (2013a) as a personal communication. Additional volcanic layers, including felsic tuffs, are intercalated within the Upper Earn Group.

UPPER EARN GROUP

The stratigraphy documented in this section applies to the mapped area, except for Twopete Mountain, where unit DMEu was described in detail by Cobbett (2014) and is labelled as DME in that document.

Resistant, grey weathered, thick-bedded, quartz-rich sandstone (unit DMEua) crops out in both swampy and thickly treed areas between Tay River and Earn Hills. The arenite varies from a clean, medium-grained quartz arenite (Fig. 8b) to a grey chert-pebble conglomerate with a tuffaceous matrix (Fig. 8c) and also includes calcareous, medium-grained, quartz-rich sandstone. Lesser amounts (but still comprising significant portions of the upper arenite unit) of grey, medium-bedded to massive quartzose siltstone, grey and black chert, and siltstone interbedded with limestone and dark grey shale crop out on Earn Hills, Mount Menzie and south of Twopete Creek. Rare outcrops of volcanic rocks in the form of highly altered plagioclase-phyric basalt or andesite and beige weathered, felsic welded tuff (Fig. 8d) are found along Menzie Creek, south of Earn Hills. The lower contact is described above and the upper contact is not exposed but is well-constrained both on Mount Menzie and Earn Hills and is interpreted to be conformable. The thickness of this unit on Mount Menzie is approximately 350 m but may be as much as 800 m thick based on cross section interpretation (Fig. 2).

This succession has been assigned to the Earn Group upper arenite unit (DMEua) because of its lithologic similarities with this unit to the east where is has been well constrained by fossil ages and geochronology (Cobbett, 2015). It was originally interpreted to be Carboniferous to Permian in age and sit stratigraphically between the Tay Formation and the Mount Christie Formation (former unit CPa; Cobbett, 2014). New fossil and geochronological age dates show this succession to range in age from upper Devonian to lower Mississippian (unpublished data; Cobbett, 2015) and is therefore in part contemporaneous with the Tay Formation. Separating the lower Mississippian strata (Tay Formation) from the Upper Devonian strata (Upper Earn Group) is not possible within the Tay Mountain area because they always occur together in folded successions and because of repeating similar lithologic units that crop out in both levels of stratigraphy. In summary, the Earn Group upper arenite unit includes the Tay Formation northwest of Anvil Creek (Cobbett, 2015).

MOUNT CHRISTIE FORMATION

Orange weathering, purple and green banded chert cores a regional-scale syncline that trends west-northwest along the southern exposure of both Earn Hills and Mount Menzie (Fig. 2). The chert is dominantly green and maroon coloured with lesser black and grey interbeds (Fig. 9a). The maroon chert commonly has abundant siltstone interbeds. The very northwestern corner of the area of interest is shown on previous regional maps as Mount Christie Formation but has not been visited in the course of our investigation. Both the upper and lower contacts are reported as unconformable (Gordey, 2013a). A thickness could not be estimated based on the absence of upper exposures of this unit and its folded nature.

JONES LAKE FORMATION

Grey-brown weathered, thickly bedded calcareous clastic strata crop out along the northern edge of the plateau that makes up the top of Earn Hills. In most places this is a grainstone with rare cross-beds that indicate upright orientation (Fig. 9b). The grainstone has been assigned to the Jones Lake Formation based on its lithologic similarity to exposures east of the mapped area that contain Triassic fossils. Additionally a Triassic fossil locality is approximately 2 km along strike to the west (Gordey, 2013a).

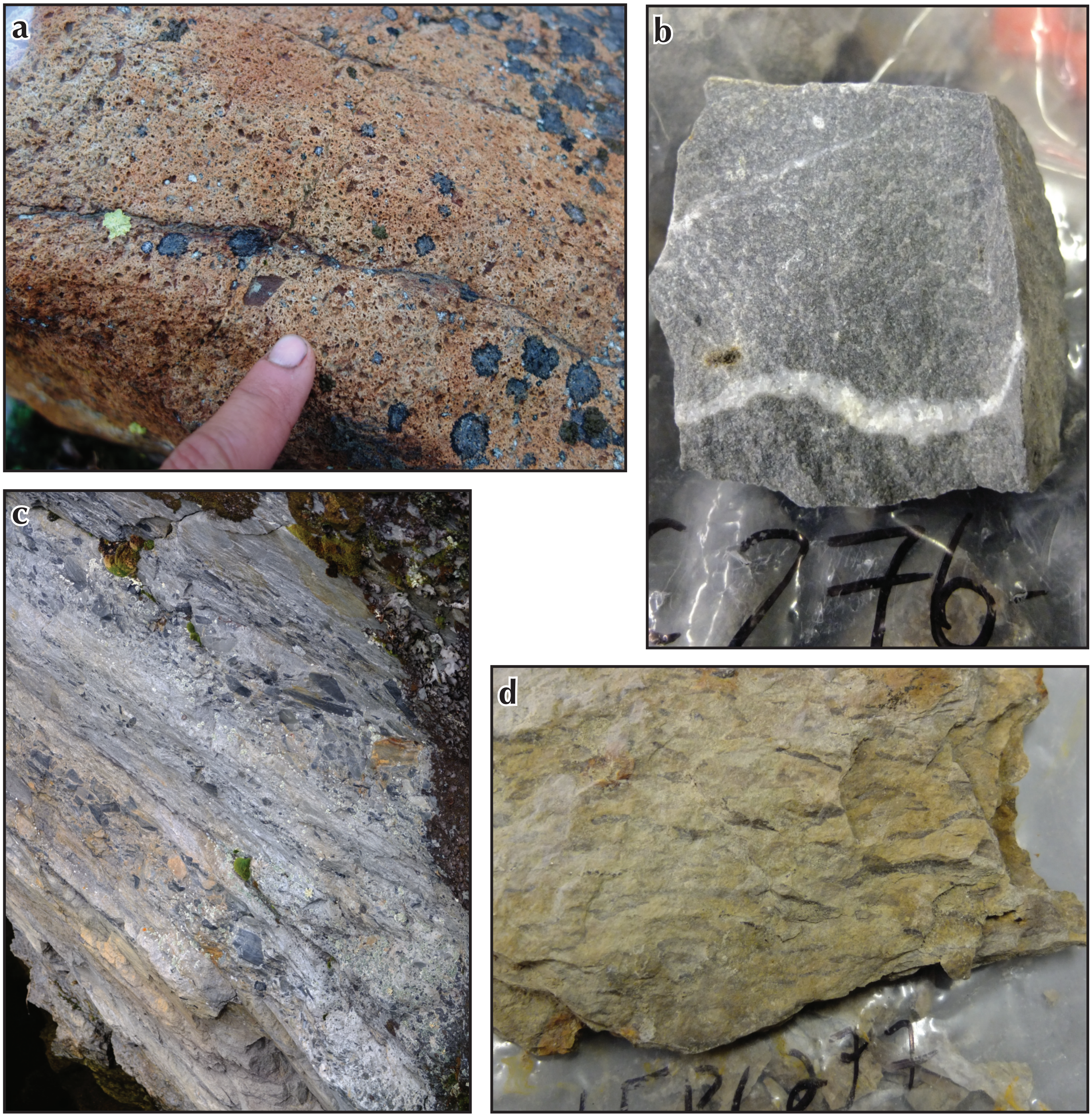


Figure 8. *Field photographs of Earn Group strata, north of Tay Mountain. (a) Orange-brown volcaniclastic rock (*DMEv*) from a rounded knob northwest of Mount Menzie and north of Earn Hills. (543990 E, 6959477 N). (b) Medium-grained, massive quartz arenite (*DMEu*, south of Earn Hills. 542269 E, 6950785 N). (c) Chert pebble conglomerate interbedded with quartz arenite (543510 E, 6953874 N). (d) Beige weathered and fresh welded tuff characterized by fiamme (flattened pumice shards) in a soft, clay-like matrix. From the heavily treed area along Menzie Creek (543628 E, 6950512 N).*

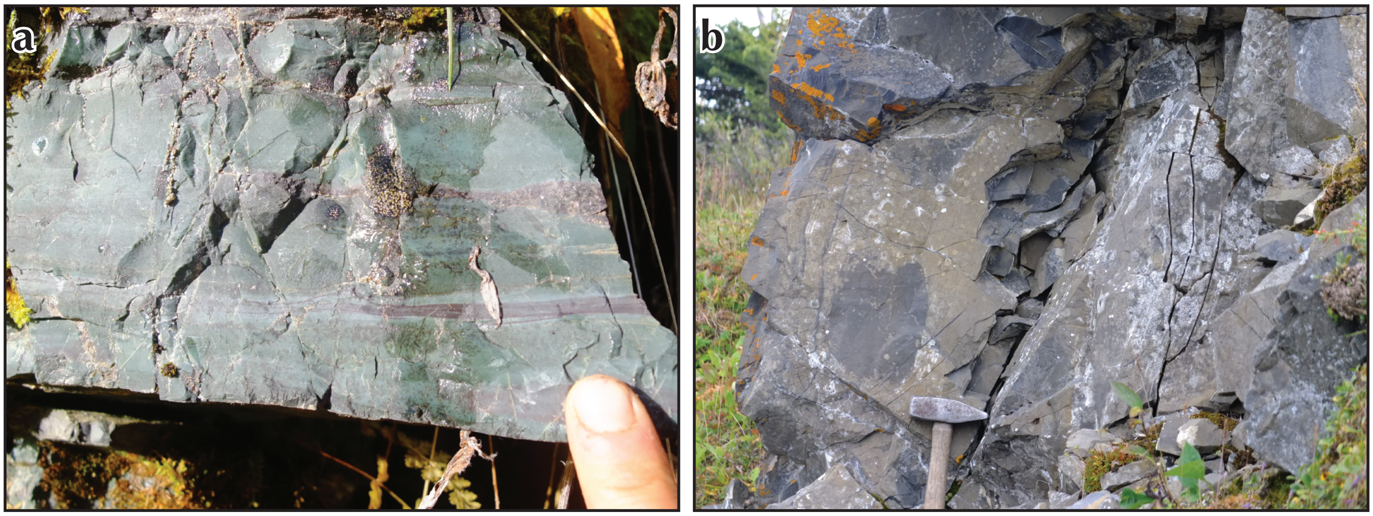


Figure 9. *Field photographs of Carboniferous to Triassic strata, Earn Hills area. (a) Typical green and maroon chert of Mount Christie Formation south side of Earn Hills. (540726 E, 6955886 N). (b) Grey-brown weathered, grey fresh, thick-bedded grainstone in nearly vertical beds that crop out along the northern edge of the plateau on Earn Hills (540776 E, 6958288 N).*

A regional unconformity between the Jones Lake Formation and Mount Christie Formation has been documented (Gordey, 2013a) but was not observed during this investigation. Instead the upper contact is a thrust fault with a hanging-wall of locally brecciated black, carbonaceous, mottled siltstone that is interpreted as the Earn Group. The lower contact is as shown on regional maps. A thickness estimate is not possible for the Jones Lake Formation in this area.

INTRUSIVE ROCKS

Pre-Cretaceous Intrusive Rocks

Several small mafic bodies are the only pre-Cretaceous intrusive rocks that were identified in the area. A green, medium-grained gabbro (unit OSMg) intrudes the contact between Vangorda calc-silicate and Menzie Creek basalt breccia south of Twopete Creek (Fig. 2). Dark green to black, medium-grained, highly magnetic, augite-phyric pyroxenite that has been partially altered to serpentinite intrude the Vangorda amphibolite schist. This 10 by 10 m exposure is located about 3 km east of Coward Creek and is too small to depict on Figure 2.

Anvil batholith

Two large bodies of light grey, medium and coarse-grained biotite granodiorite intrude the southern and central part of the area. The exposures form an irregular map pattern with some steep contacts while others appear nearly horizontal based on their relationship to topography. Most of these rocks are porphyritic with feldspar phenocrysts up to 2 cm long and exhibit no foliation, however, several traverses crossed sections of granodiorite that were non porphyritic and sometimes foliated. Contacts between these variations in the batholiths are not continuously exposed. The Anvil batholith (Pigage and Anderson, 1985) has been assigned to the Tay River plutonic suite (99-95 Ma) based on a U-Pb zircon date from the southeast corner of the mapped area (Fig. 2; Mortensen *et al.*, 2000; Pigage, 2004).

Medium-grained biotite granodiorite north of the main plutons (Fig. 2) are coeval, based on preliminary geochronology. These small bodies have a metamorphic contact aureole that range in diameter from 0.5 to 2.0 km.

The Anvil batholith is predominantly undeformed except several isolated outcrops where the batholith is weakly foliated. Marginal contacts with the schistose rocks are sharp and intrusive rocks cut both the early foliation and the dominant foliation (Fig. 10a) constraining the age of schistosity to pre 99 to 95 Ma.

STRUCTURE

Early Paleozoic strata (south part of the map area) are here considered structural domain 1, and Late Paleozoic and Early Mesozoic strata (north part of the map area) constitute structural domain 2 (Fig. 11). Domain 1, further subdivided into 3 geographic regions, is characterized by several overprinting foliations in mica schist, calcareous schist, calc-silicate schist and marble, and a penetrative foliation in amphibolite schist and carbonaceous quartzite. The dominant foliation (late foliation, S_{n+1} on Fig. 11 and below) in the mica schist is defined by muscovite and biotite seams between microlithons of quartz that range in width from mm-scale to cm-scale. Where the microlithons are 0.5 cm and wider an early foliation (Sn) can be seen in outcrop. This early foliation is always tightly folded and sits at a high angle to the dominant foliation (Fig. 10b). It also comprises seams of mica between quartz microlithons. A late crenulation cleavage (S_{n+2}) deforms the dominant foliation in the mica schist but is only locally exhibited (Fig. 10b).

The dominant foliation in the calcareous schist of domain 1 is defined by thin laminations of quartz, calcite and mica. In the calc-silicate schist the foliation is accentuated by stripes of various colours including purple, beige, brown and light green. Typical mineral assemblages for calc-silicate rocks mapped near the Anvil mine are quartz, tremolite-actinolite, plagioclase, biotite ± diopside, calcite and epidote (Jennings and Jilson, 1986). The dominant foliation in the marble is defined by quartz laminae between thin layers of calcite. The marble, calcareous schist and the calc-silicate schist only rarely show evidence of an early foliation. Similar to the mica schist, it is exhibited as small micro-folded schistose layers between folai of the dominant foliation. The penetrative foliation in the amphibolite schist is defined by laminations of epidote and feldspar between seams of amphibole (commonly actinolite; Fig. 10c).

The volcanic and volcaniclastic rocks within this domain range from undeformed to well-foliated. Thick-bedded basalt, pillow basalt, chert and banded tuff interbedded with micrite north of the Tay River are undeformed at least at outcrop-scale (Fig. 6a,d). Volcaniclastic siltstone and sandstone and volcanic breccia of the Menzie Creek Formation are well foliated but bedding is still observable in most outcrops (Fig. 10d). Chlorite schist and meta-tuffs of the Menzie Creek Formation are commonly pervasively foliated where primary features are obliterated.

Within domain 1 several sub-domains have been identified on the basis of variations in late foliation orientations which roughly coincide with opposing flanks of the Anvil batholith (Fig. 11). The late foliations are axial planar to map-scale folds within the southwest and southeast sub-domains. In the southwest sub-domain the late foliations generally dip shallowly to moderately southwest. In both the southeast and north sub-domains the late foliation has a wider range of orientations but generally dips moderately to the east-northeast. This change in orientation is represented graphically on cross sections B-B′ and C-C′ of Figure 2 which shows a doming of this structure roughly centred on the pluton underlying Tay Mountain.

Domain 2 encompasses Late Paleozoic to Early Mesozoic rocks that are faulted against Early Paleozoic strata in the southern part of the map area (Fig. 11). Primary textures are always preserved in rocks within Domain 2. In most places, bedding is open to tightly folded in outcrop and closely folded on a regional scale. Folds are asymmetric and cylindrical, and have a steeper northeast-dipping limb that is sometimes overturned and a shallower southwest-dipping limb (Fig. 2).

The thrust fault that separates domain 1 from domain 2 is a northwestward continuation of the Twopete thrust fault; it separates Selwyn basin strata from Late Paleozoic strata. Gordey (2013c) interpreted this structure as a low angle thrust that was rooted in a detachment fault to the southwest, probably of Jurassic age. A re-interpretation of the origin of this structure as a reactivated Devonian normal fault is the reason it is drawn as a steep reverse fault in the cross sections (Fig. 2). The thrust faults that bound the volcanic rocks in the very northern part of the mapped area are also interpreted as reactivated Devonian normal faults that possibly localized volcanism during deposition of the Earn Group.

Normal faults display two trends: roughly north-south and east-west. The north-south oriented group crops out in domain 2 both on Earn Hills and Twopete Mountain and crosscut thrust faults. Estimates of offset across these normal faults range from 300 to 1000 m. The east-west oriented group crops out in the centre of the mapped area within sub-domain 1_N and accommodates north-side down movement juxtaposing younger rocks on the north side from older rocks on the south side. These faults are cut by the Anvil batholith but offset strata as young as Silurian constraining the timing of movement from post Silurian to pre mid-Cretaceous. An estimate of offset is not possible without detailed stratigraphic knowledge of the Selwyn basin strata in this area.

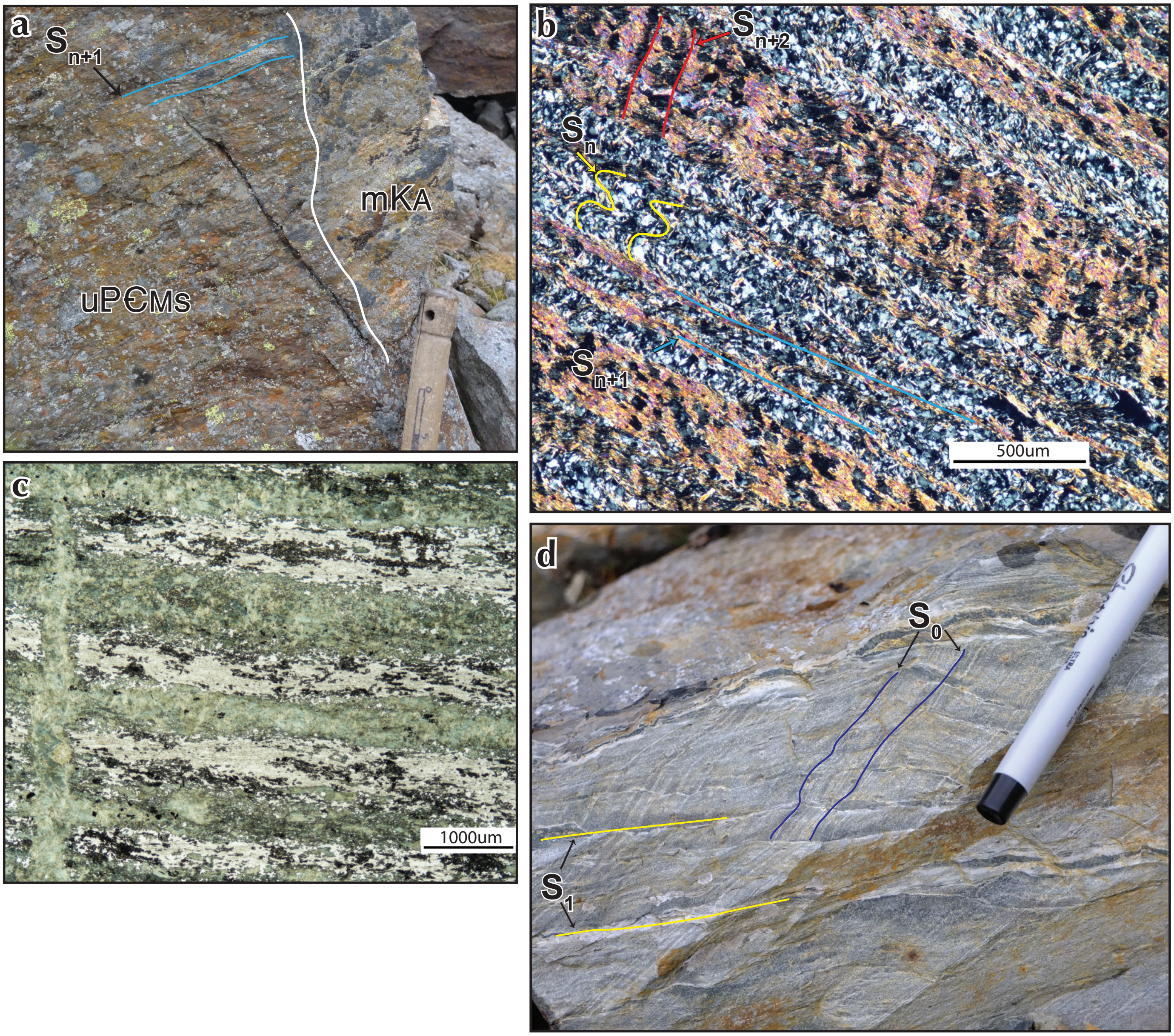


Figure 10. *Microphotographs (b, c) and field photographs (a, d) of metamorphosed Anvil district rocks. (a) Brown weathered mica schist of Mount Mye formation cut by Tay River pluton. Blue lines trace late foliation and white line traces out margin of granodiorite. Hammer handle at lower right shows a 5 cm long scale bar (558848 E, 6933152 N). (b) Biotite-muscovite-cordierite schist of Mount Mye formation that exhibits three phases of deformation. (547265 E, 6942325 N). (c) Amphibolite schist comprising layers if actinolite (green) between feldspar and epidote (lighter layers) and cut by actinolite vein. (555173 E, 6938347 N). (d) Volcaniclastic sandstone that exhibits both bedding (dark blue lines) and foliation (yellow lines). (554007 E, 6943790 N).*

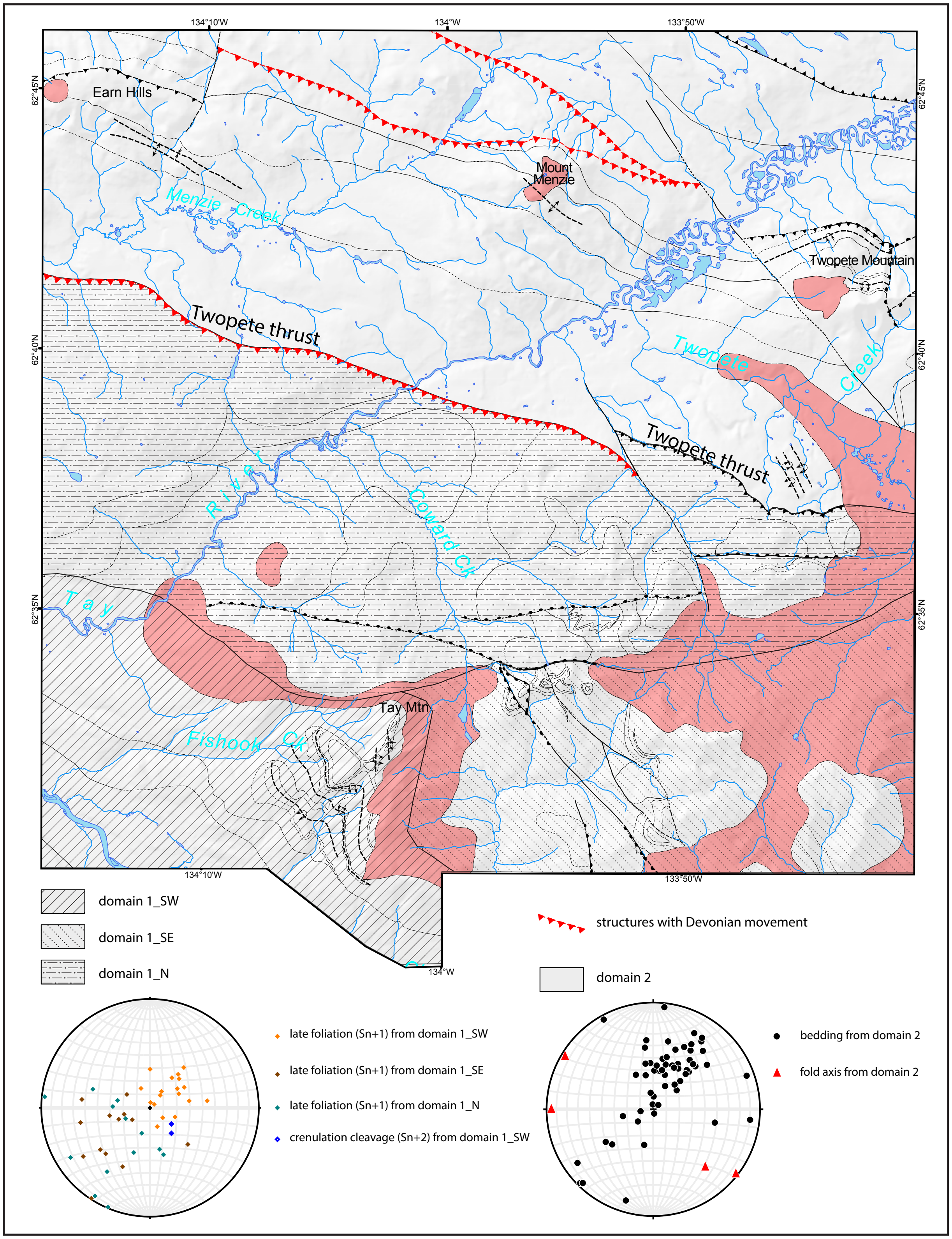


Figure 11. Structural domains and data from the field measurements (equal area projection, lower hemisphere stereonets). Diamonds (domain 1 stereonet) are poles to foliations and crenulation cleavages. Circles (domain 2 stereonet) are poles to bedding. Triangles (domain 2 stereonet) are fold axis measurements. Map shows faults in heavy black lines and faults that are reactivated Devonian structures in heavy red lines. Fold axial traces are shown by dashed black lines and contacts are shown by fine black lines.

DISCUSSION

The Twopete thrust fault and several other north-verging thrusts that daylight in the northern part of the mapped area are here re-interpreted as reactivated Devonian normal faults (Figs. 2 and 11). This interpretation is based upon the deduction of the deposition of upper Earn Group clastic rocks in graben and/or half-grabens that lay north of the Twopete fault during Devonian extension (Colpron and Nelson, 2009). During Jura-Cretaceous shortening the graben-bounding normal faults were reactivated as reverse faults and accommodated the thrusting of Selwyn basin rocks over Earn Group strata. Further, the normal faults may have acted as conduits for Devonian volcanism whose deposition was also controlled by graben and half-graben features.

There is an abundance of volcanism in the stratigraphy (lower Cambrian, upper Cambrian through Silurian and late Devonian) that suggest a long-lived crustal anomaly, such as a deep-seated fracture system.

MINERALIZATION

The map area lies to the northwest of the Anvil Mine district and to the west of the Keg deposit (Yukon MINFILE 105K 078). The Anvil Mine is a deformed SEDEX deposit with mineralized horizons straddling the boundary between the Mount Mye and the Vangorda formations (Jennings and Jilson, 1986; Pigage, 2004). Mineralization at the Keg deposit has been described as a Ag-Pb-Zn ± Au (polymetallic) vein system and also as a skarn or porphyry related system (Yukon MINFILE, 2015).

Other types of occurrences located within the area of interest include SEDEX Zn-Pb-Ag (Yukon MINFILE 105K 074, 105L 039), Cu-Ag vein (Yukon MINFILE 105K 071), Cu-Zn-Ag skarn (Yukon MINFILE 105K 111), sediment-hosted stratiform barite (105K 110), plutonic-related gold (Yukon MINFILE 105L 018, 105K 072) and several anomalies (Yukon MINFILE 105K 102, 105K 073) and unknown types (Yukon MINFILE 105K 073, 105K 074, 105L 019).

New mapping shows that there is more Anvil Mine host stratigraphy than was previously shown on regional maps. Mineralization examined during this mapping project within domain 1 (Selwyn basin rocks) was restricted to semi-massive sulphide lenses associated with marble horizons within the Mount Mye formation. These occur where the marble is in contact with amphibolite schist and where granodiorite dikes cut marble layers.

The Keg deposit is part of a northwest trending belt of silver-bearing mineral occurrences that has been delineated based on the prospecting of numerous soil geochemistry anomalies (www.silverrangeresources.com) in 2011 and 2012. The farthest northwest mineralized occurrence within this trend is located at Mount Menzie (Fig. 2). Generally, the silver-bearing mineral occurrences are located where chert and quartz arenite are tightly folded and in close proximity to calcareous rocks (Cobbett, 2014). Several of the occurrences also coincide with small granitic intrusions and/or steep faults. This NW-trending belt of Late Paleozoic rocks that is periodically intruded by granitic plugs and deformed by steep structures is prospective for silver and other base-metals within the Tay Mountain area and continues outside the area of interest to the northwest.

SUMMARY

The main results from mapping in the Tay Mountain area are:

1. Lower Cambrian to Silurian strata crop out extensively in the vicinity of Tay Mountain and extend the Anvil Mine host stratigraphy at least as far as this region;
2. The Tay River plutonic suite cuts the late foliation in the schistose rocks south of the Twopete thrust indicating that the metamorphism responsible for creating the schistosity in the Mount Mye and Vangorda formations is pre 99-95 Ma; and
3. Silver occurrences are spatially associated with competent late Paleozoic strata, in particular folded chert assigned to the Mount Christie Formation and within the Earn Group.

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