Preliminary observations on the geology of northeastern Glenlyon area, central Yukon (parts of NTS 105L/10, 14, 15)

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Abstract

Regional bedrock mapping has revised structural and stratigraphic relationships in the northeastern corner of the Glenlyon map area (NTS 105L). Three structural panels, separated by south and southwest dipping thrust faults, subdivide the area. Cambrian (?) to Ordovician metasedimentary and volcanic rocks underlie the southwestern panel and include all exposures southwest of the Duo fault. Ordovician to Silurian (?) siliciclastic and carbonate strata and phyllite units that are intruded by Late Devonian porphyritic rocks underlie the central panel. Silurian (?) to Triassic siliciclastic and carbonate strata in the northern panel occur to the north, and in the footwall of, the Twopete fault. Mid-Cretaceous granitic rocks that crop out near Kalzas Mountain and occur below the surface near Dromedary Mountain intrude the central and northern panels. Northeast-verging folds and thrust faults deform layered rocks in the northeastern Glenlyon area and are offset by north-south oriented, steeply dipping structures with both normal and strike-slip motion.

Upper Devonian Earn Group strata host layered sulphide bodies and polymetallic veins that contain lead, zinc and silver. This mineralization occurs in the footwall of the Twopete fault, a regional structure that originally developed as a Late Devonian synsedimentary fault.

Ordovician and Silurian (?) quartz-rich clastic rocks are unlike coeval basinal facies rocks mapped elsewhere within the Selwyn basin in Yukon. These rocks represent slope facies deposits that mark a transition from basin to platform that is the northern extension of the McEvoy platform–Selwyn basin boundary.

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Introduction

In 2013 the Yukon Geological Survey initiated a multi-year, regional bedrock mapping project in the western Tay River (NTS 105K) and northeastern Glenlyon (NTS 105L) map areas to better understand the geologic history and mineral potential of the region. This paper describes the structure and stratigraphy of the northeastern Glenlyon area and augments preliminary reports from Anvil Lake and Tay Mountain areas.

Geologic Framework

The area of interest lies within the Selwyn basin of central Yukon, north of, and adjacent to, the Tintina fault (Fig. 1). The Selwyn basin refers to a broad region underlain by predominantly deep-water sedimentary rocks that were deposited along the northwestern edge of Laurentia from the Neoproterozoic to Early Devonian (Gordey and Anderson, 1993; Gabrielse, 1967). The basin is bounded by the Mackenzie platform to the northeast and the Cassiar/McEvoy platform to the southwest (Gordey, 2013; Gabrielse, 1967). During the Late Devonian, widespread extension along the Cordilleran margin resulted in the deposition of quartz-rich siliciclastic rocks on top of Selwyn basin strata. Sediment was mostly derived from northern Yukon, but also locally from uplifted basinal strata that were eroded during local block faulting (Gordey et *al.*, 1987; Gordey, 2013). Following this period of extension, the northwestern margin of Laurentia returned to a continental shelf setting where accumulations of marine shelf sediments continued until Late Triassic (Gordey, 2013).

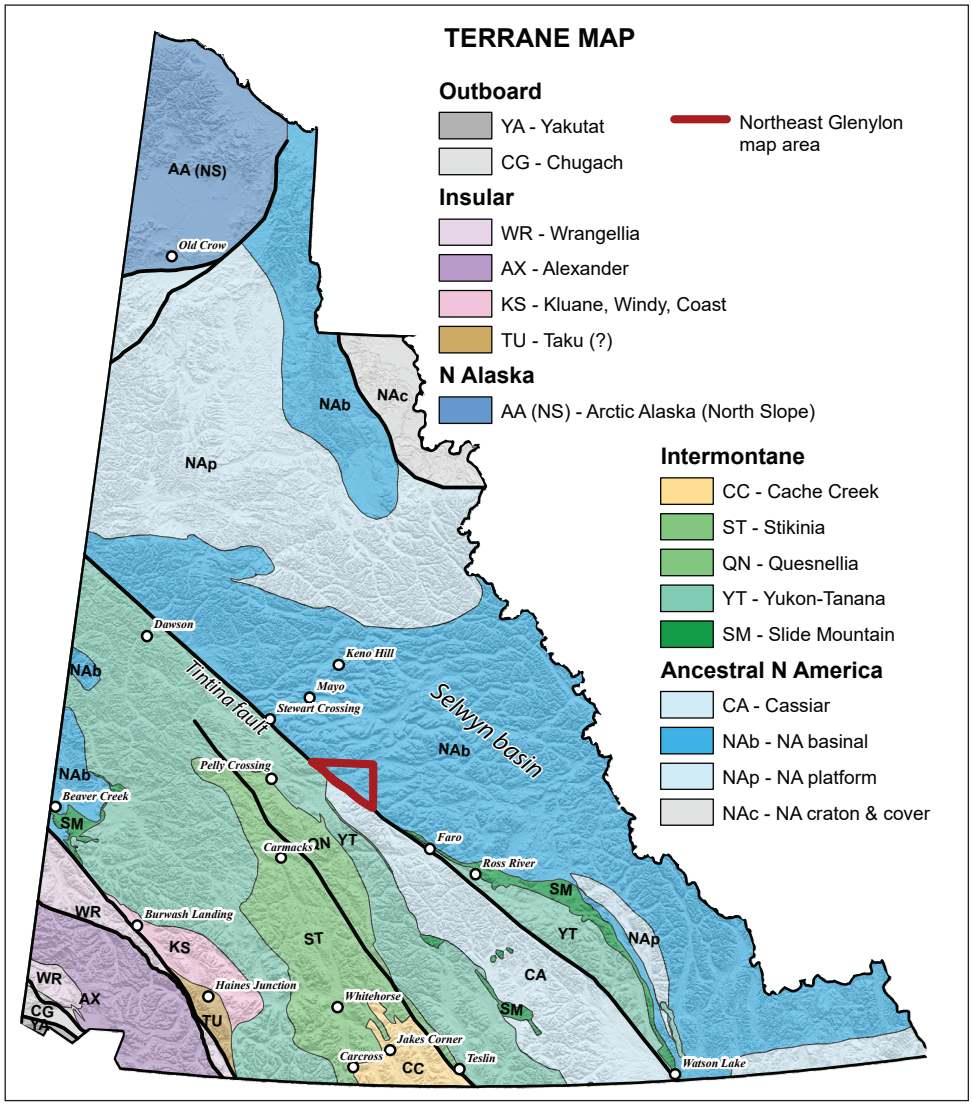

Figure 1. *Geologic terranes of Yukon from (Colpron and Nelson, 2011) showing the outline of the study area (thick red line).*

Northeast-verging folds and thrust faults that comprise the Selwyn fold and thrust belt underlie the map area (referred to as NE Glenlyon area in the rest of the paper). These structures are a result of Middle Jurassic shortening along the northern Cordilleran margin (Colpron *et al.*, 2006; Mair *et al.*, 2006). Mid-Cretaceous post-arc magmatism is widespread throughout the Selwyn basin region (Colpron, 2016b; Rasmussen, 2013). Felsic to intermediate intrusions are generally undeformed and crosscut folds and thrust faults. The Tintina fault, a post-mid-Cretaceous dextral strike-slip fault with 430 km of displacement, cuts off the geology within the NE Glenlyon area to the northwest (Roddick, 1967; Gabrielse *et al.*, 2006).

Stratigraphy

Three structural panels, separated by south and southwest-dipping thrust faults, subdivide the stratigraphy. The Twopete fault is the most prominent structural feature in the area and separates the northern panel of Silurian to Triassic sedimentary rocks from a small, central panel of Ordovician siliciclastic rocks and dark phyllite (Figs. 2 and 3). The Duo fault is subparallel to the Twopete fault and separates these Ordovician siliciclastic rocks from the southern panel of lower Cambrian (?) to Ordovician schist, phyllite and volcanic rocks. Described separately below is the geology of each panel.

Southern Panel – South of Duo fault

Variably exposed volcanic and volcaniclastic rocks and metasedimentary strata that occupy nearly half of the geographic area in NE Glenlyon underlie relatively low-lying terrain north of the Pelly River.

Vangorda formation: calc-silicate schist and amphibolite schist

Schistose calcareous rocks and amphibolite schist of the Vangorda formation crop out in several locations north of the Pelly River and along a moderately exposed ridge south of The Detour river (Fig. 2; Pigage, 2004). Brown weathering, grey-brown, finely foliated calcite-mica schist and light grey marble occur north of the Pelly River. Between the Pelly River and Detour Lakes, dark green and purple, foliated amphibolite schist units are interleaved with the calcite mica schist and calc-silicate schist (Fig. 4a). The map area does not have an exposure of the lower contact, and the upper contact with the Menzie Creek Formation is gradational and drawn at the first occurrence of volcanic rocks. An estimate of minimum thickness is not reported primarily due to limited exposure.

This unit is assigned to the Vangorda formation based on lithological correlations in the Anvil district and its close association with the Menzie Creek Formation (Jennings, 1986; Pigage, 2004). Regionally, the Vangorda formation is interpreted to be a metamorphic equivalent to the Rabbitkettle Formation (Jennings, 1986; Gordey and Anderson, 1993; Pigage, 2004).

Menzie Creek Formation – volcanic facies

Two moderately elevated areas in a broad expanse of subdued topography south of the Duo fault comprise volcanic, tuffaceous and volcaniclastic rocks of the Menzie Creek Formation (Gordey, 2013). Between Horsfall Creek and Duo Creek, dark orange weathering, green, coarse-grained basalt forms crude benches in heavily treed areas. Interbedded with the basalt in this area are volcaniclastic breccia, sandstone and siltstone units. One outcrop from this same region contains clasts of basalt, feldspar crystals and shards of quartz and is likely a crystal-lithic tuff. U-Pb geochronological analysis of a sample of the tuff is being processed in order to determine a crystallization age for this unit. Near Earn River, pyroxene-bearing basalt is interleaved with orange weathering, light green chlorite schist. The NE Glenlyon area does not have exposures of the lower contact of these volcanic piles with the Vangorda formation, but it is inferred to be conformable and gradational based on mapping by Pigage (2004) in the Anvil district.

Menzie Creek Formation – volcanic and sedimentary facies

A large area south of the Duo fault contains amygdaloidal basalt flows, volcaniclastic sandstone and siltstone units that are interbedded with calcareous metasedimentary rocks and grade laterally into volcanic facies of the Menzie Creek Formation. Thick flows to massive bodies of dark orange weathering, green, medium to coarse-grained, pyroxene-bearing basalt

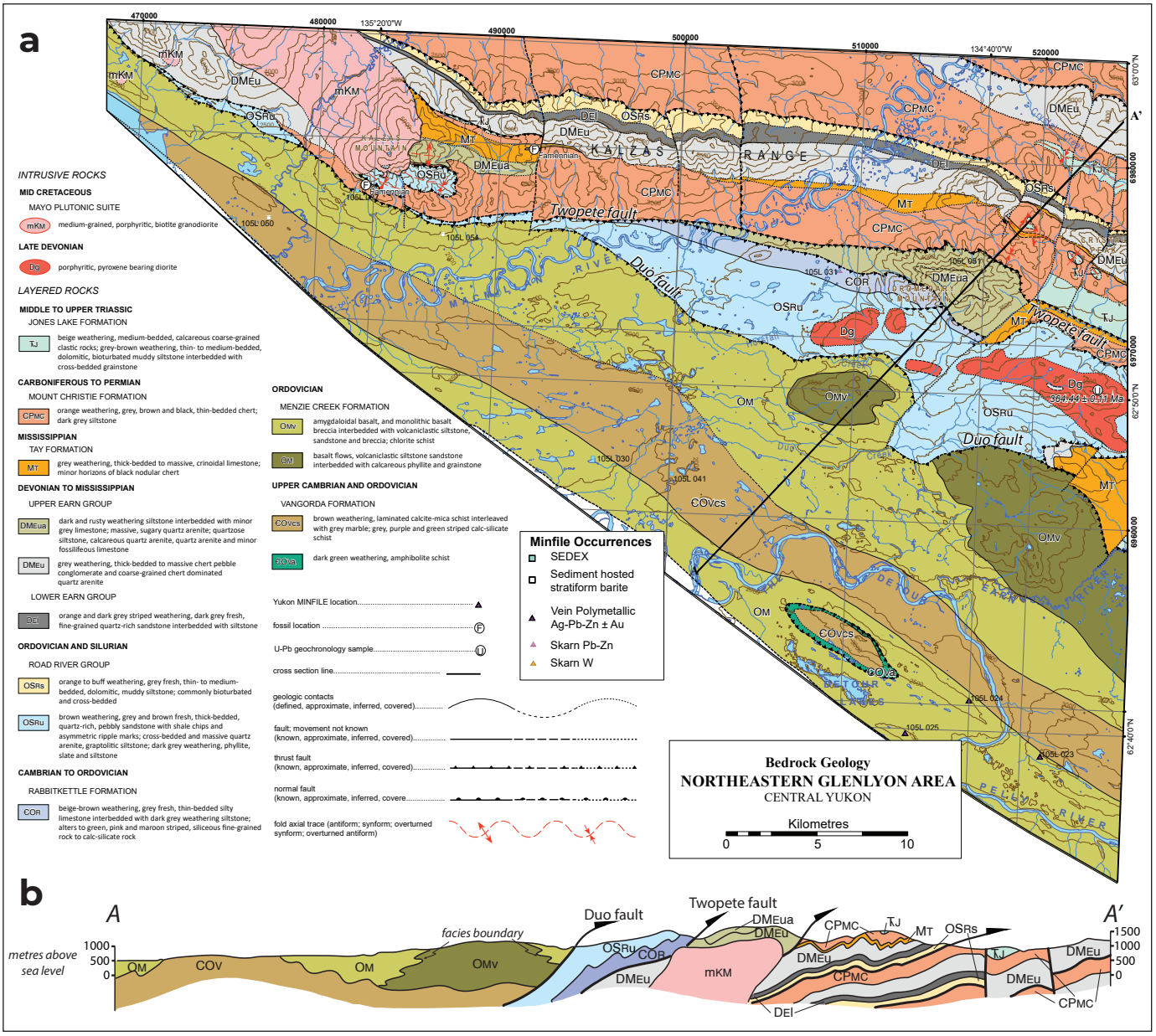

Figure 2. (a) *Bedrock geology of NE Glenlyon area.* ***(b)*** *Cross section A-A'.*

form cliffs throughout this topographically subdued area (Fig. 4b). Flow tops are altered and commonly amygdaloidal, and are typically in contact with laminated fine-grained sedimentary and metasedimentary rocks (Fig. 4c). The sedimentary and metasedimentary rocks include light grey and orange weathering, grey, calcareous phyllite to light grey-brown, thin-bedded, cross-bedded grainstone units that are interleaved with grey-green phyllite. Where primary textures are preserved in the meta-sedimentary rocks the protolith is thin-bedded mudstone to siltstone forming graded beds (Fig. 4d). Calcareous phyllite rarely preserves macrofossils (Fig. 4e). There are no outcrop exposures of the lower contact, but it is inferred to be gradational with the Vangorda formation. Poor exposure and the deformed nature of this succession hinders a thickness estimate for this unit. These rocks are assigned to the Menzie Creek Formation based on lithologic similarities with the type section to the southeast (Gordey, 2013). The depositional environment for this succession is interpreted to be the edge of a platform based primarily on the occurrence of cross-bedded grainstone and graded beds.

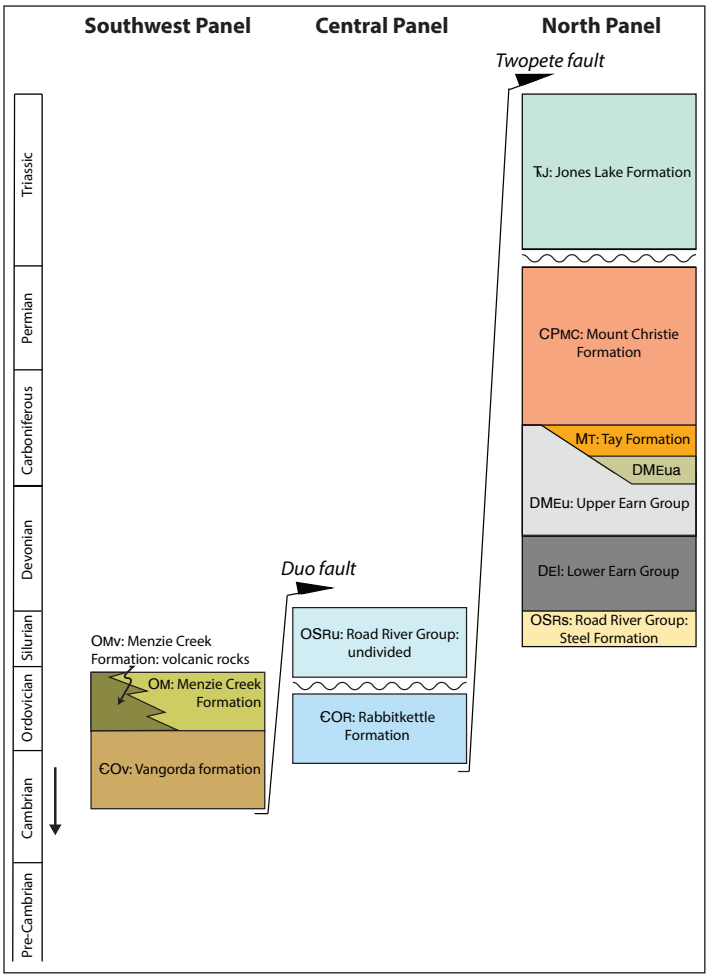

Figure 3. *Stratigraphy of the NE Glenlyon area.*

Central Panel – Between Twopete fault and Duo fault

This fault-bounded panel comprises siliciclastic and carbonate rocks and dark weathering phyllite units that crop out in the central part of the map area. This panel is laterally cut-out where the Duo fault merges with the Twopete fault, both in the northwestern apex of the map area and along its eastern border (Fig. 2).

Rabbitkettle Formation

Variably altered rock units of the Rabbitkettle Formation are well-exposed in the Dromedary Mountain area (Gabrielse *et al.*, 1973). On the southwestern flank of Dromedary Mountain, the Rabbitkettle Formation comprises beige-brown weathering, grey, thin-bedded, silty limestone interbedded with dark grey weathering, maroon-grey siltstone (Fig. 5a). Altered exposures near the top, and along the eastern and southeastern flanks of Dromedary Mountain comprise light pink, green and maroon siliceous siltstone with local limey layers that create a distinctive striped weathering surface. At several localities on Dromedary Mountain light grey weathering, dark grey limestone beds up to 20 cm thick are interbedded with siltstone. The limestone alters to white chalky marble at the peak of Dromedary Mountain.

The contact between the upper Rabbitkettle Formation and younger Earn Group is a fault characterized by rusty weathered scree and several outcrops of ferricrete in the saddle directly north of the Dromedary Mountain peak. The contact between the lower Rabbitkettle Formation and younger Road River Group is exposed on the south side of Dromedary Mountain where it is characterized by black, carbonaceous, highly contorted fault rock. Elsewhere in the map area, between the peak of Dromedary Mountain and Dromedary Creek and between Dromedary Mountain and Macmillan River, the contact is likely unconformable based on previous mapping of the Rabbitkettle/Road River Group contact in Nahanni, Flat River and Glacier Lake areas (Gabrielse *et al.*, 1973; Gordey and Anderson, 1993). A thickness for this succession is not reported because the only exposed contacts are faults.

This unit is assigned to the Rabbitkettle Formation based on lithologic similarities to other parts of the Selwyn basin (Gordey and Anderson, 1993; Gordey, 2013; Gabrielse *et al.*, 1973). The assignment of these rocks to the Rabbitkettle Formation and the interpretation of an unconformable upper contact are subject to change if paleontological reports provide age constraints for this strata.

Road River Group: undivided

Exposed on the south side of Dromedary Mountain, and near Kalzas Mountain, blocky outcrops of quartz-rich clastic rocks containing Ordovician graptolites are interlayered with dark weathering phyllite and siltstone (Gabrielse *et al.*, 1973). Grey to brown, thick-bedded, coarse-grained sandstone with pebble lags and shale chips up to 15 cm-long grade upwards into laminated to massive quartz arenite and graptolitic siltstone on the south side of Dromedary Mountain (Fig. 5b). Exhibited locally in this area are cross-beds and asymmetric

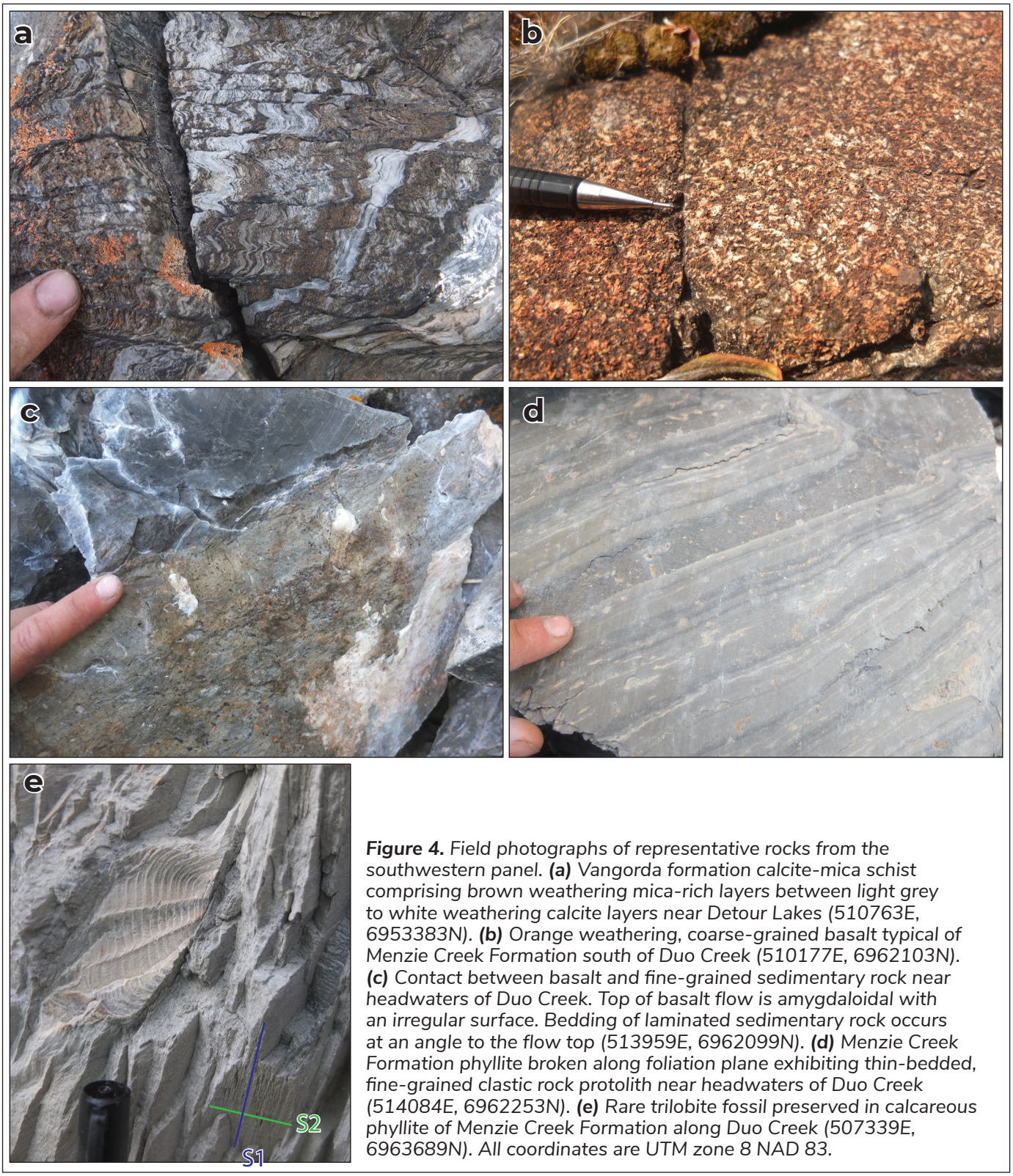

Figure 4. *Field photographs of representative rocks from the southwestern panel.* ***(a)*** *Vangorda formation calcite-mica schist comprising brown weathering mica-rich layers between light grey to white weathering calcite layers near Detour Lakes (510763E, 6953383N).* ***(b)*** *Orange weathering, coarse-grained basalt typical of Menzie Creek Formation south of Duo Creek (510177E, 6962103N).* ***(c)*** *Contact between basalt and fine-grained sedimentary rock near headwaters of Duo Creek. Top of basalt flow is amygdaloidal with an irregular surface. Bedding of laminated sedimentary rock occurs at an angle to the flow top (513959E, 6962099N).* ***(d)*** *Menzie Creek Formation phyllite broken along foliation plane exhibiting thin-bedded, fine-grained clastic rock protolith near headwaters of Duo Creek (514084E, 6962253N).* ***(e)*** *Rare trilobite fossil preserved in calcareous phyllite of Menzie Creek Formation along Duo Creek (507339E, 6963689N). All coordinates are UTM zone 8 NAD 83.*

ripples in the sandstone and fine laminations of sulphide at the base of siltstone beds. Near the headwaters of Duo Creek, orange and grey weathering, grey, rhythmically bedded mudstone to fine-grained sandstone, siltstone with black chert nodules and dark grey siltstone and slate are grouped with this unit. Near Kalzas Mountain, this unit is dominated by dark weathering phyllite and siltstone that commonly exhibit andalusite porphyroblasts. The phyllite is in stratigraphic contact with a variety of interbedded rock types including graptolitic siltstone, quartz-rich sandstone, silty limestone, chert pebble conglomerate and white-weathering marble. The lower contact with the Rabbitkettle Formation is probably unconformable as described above and the upper contact is nowhere exposed. A thickness for this unit is not reported due to the limited exposure, fault-bounded contacts and complicated folding. The occurrence of chert pebble conglomerate within this succession can be confusing due its similarity with analogous Earn Group units. In the absence of exposures of interbedded graptolitic siltstone, this part of the unit could easily be mistaken for the younger group.

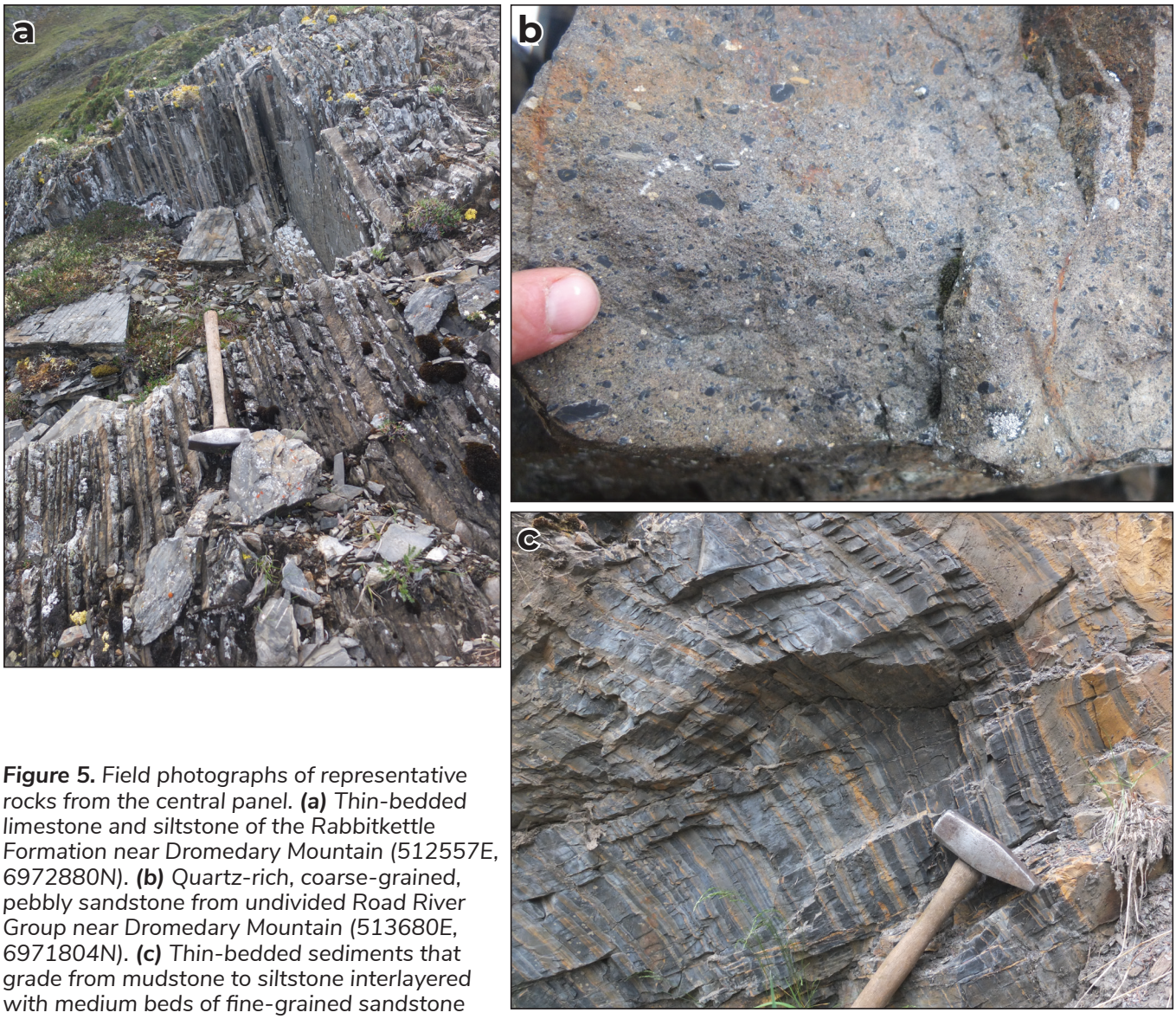

Figure 5. *Field photographs of representative rocks from the central panel.* ***(a)*** *Thin-bedded limestone and siltstone of the Rabbitkettle Formation near Dromedary Mountain (512557E, 6972880N).* ***(b)*** *Quartz-rich, coarse-grained, pebbly sandstone from undivided Road River Group near Dromedary Mountain (513680E, 6971804N).* ***(c)*** *Thin-bedded sediments that grade from mudstone to siltstone interlayered with medium beds of fine-grained sandstone (orange weathering layer in top right corner of photograph). This outcrop is assigned to undivided Road River Group and crops out near the headwaters of Duo Creek (514177E 6964059N). All coordinates are UTM zone 8 NAD 83.*

These rocks are collectively assigned to the Road River Group based primarily on the presence of Ordovician graptolites throughout the succession (Gabrielse et *al.*, 1973). The depositional environment for this unit is interpreted to be above wave-base along a shallow shelf (Gordey and Anderson, 1993).

Northern Panel: Stratigraphy North of the Twopete Fault

Mid to upper Paleozoic siliciclastic rocks, carbonate rocks and chert form a roughly east-west trending belt of strata that crop out north of the Twopete fault (Fig. 2).

Road River Group: Steel Formation

Distinctive orange-brown weathering, grey, thin to medium-bedded, dolomitic siltstone units of the Steel Formation occur as small outcrops within vegetated areas along the northern slopes of the Kalzas Range and Crystal Peak (Fig. 6a; Gordey and Anderson, 1993). The lower contact is nowhere exposed and the upper contact with the lower Earn Group is conformable (Fig. 3). The minimum thickness of the succession is 100 m based on continuous exposure visible on the north slope of Crystal Peak. The lower contact is interpreted to be a thrust fault that places this unit over the Mount Christie Formation. This fault is not well constrained due to lack of outcrop in the area and based on where it has been drawn suggests unit thickness could be up to 200 m (Fig. 2, cross section A-A'). Locally, the siltstone has asymmetric ripples and cross-beds, internal layering characterized by wispy, discontinuous laminations and contains evidence of bioturbation in the form of curvilinear trace fossils approximately 1 cm in width.

This unit is assigned to the Steel Formation based on lithologic similarities elsewhere in the Selwyn basin and its stratigraphic position below the lower Earn Group (Gordey and Anderson, 1993; Gordey, 2013). The depositional age is uncertain, but must be older than Upper Devonian based on fossils in the Earn Group to the southeast (Blodgett, 2015, 2016; Orchard, 2016). A sub-wave base, quiet water environment typical of a continental slope is likely the setting during deposition of the Steel Formation.

Earn Group: lower

Orange and dark-grey weathering, recessive, fine-grained siliciclastic rocks of the lower Earn Group are exposed on the northern slopes of Crystal Peak and Kalzas Range. This unit is well-bedded and forms thin stripes of alternating orange and dark grey weathering beds that correspond to fine-grained, quartz-rich sandstone interbedded with siltstone (Fig. 6b). The percentage of quartz-rich beds and the thickness of these beds both increase up-section. The thickness of this unit is well constrained at 300 m based on a measured section on the northern slope of Crystal Peak. The lower contact with the Steel Formation is conformable and abrupt and the upper contact with the upper Earn Group is gradational and drawn where siltstone is absent (Fig. 3). Near the upper Earn/lower Earn contact, one horizon of quartz arenite has spheres of pyrite up to 2 cm in diameter at the top of the bed.

This succession is assigned to the informal lower Earn Group mainly based on its stratigraphic position between the Steel Formation and the upper Earn Group. In other parts of the Selwyn basin, the Earn Group is divided into the Portrait Lake and Prevost formations, however, the strata mapped in the NE Glenlyon area are not easily correlated with these two units. The age of the lower Earn Group is pre-Upper Devonian based on macro-fossils found in the upper Earn Group (Orchard, 2016, 2017; Blodgett, 2015, 2016). Near Anvil Lake, southeast of the map area, both macro and microfossils indicate the lower Earn Group is Emsian to Givetian (Blodgett unpublished; Blodgett 2015). The depositional setting of the lower Earn Group is interpreted to be a deep-water basin where continent-sourced, quartz-rich detritus was periodically shed between periods of low sedimentation.

Earn Group: upper undivided

Resistant outcrops of upper Earn Group chert pebble conglomerate comprise the central and western parts of the Kalzas Range, prominent peaks north and northeast of Dromedary Mountain and all of Crystal Peak. Light grey to dark grey, very thickly bedded, pebble conglomerate to coarse-grained sandstone describes the majority of this unit (Fig. 6c). Commonly found at the very top of some of the beds

of conglomerate is a cross-bedded, medium-grained quartz arenite unit. The lower contact with the lower Earn Group is gradational and well constrained on both the north slope of Kalzas Range and Crystal Peak. The upper contact with the Tay Formation is conformable and abrupt and well constrained in the eastern-half of the mapped area. Near Kalzas Mountain and on Dromedary Mountain, the upper contact with a unit called the Earn Group upper arenite (described below) is conformable. The thickness of this unit varies across the map area from 600 m on Crystal Peak to 900 m on Kalzas Range, two places where both the upper and lower contacts are well constrained. In areas with limited exposure, the thickness is inferred to be as thin as 250 m. The clasts within the conglomerate consist of multi-coloured chert, including light brown, light and dark grey, black and rare turquoise, and range in size from 0.5 to 5 cm. The conglomerate units are clast-supported with interstitial matrix of quartz and chert sand. Subrounded chert grains along with up to 15% quartz grains and less than 5% shale grains comprise sandstone of the Upper Earn Group.

This succession is assigned to the upper Earn Group based on fossils found southeast of the mapped area that indicate Frasnian to Famennian depositional ages (Blodgett, 2016). The source for the conglomerate is likely high standing fault blocks of Selwyn basin strata such as Neoproterozoic quartz sandstone of the Hyland Group and Road River Group chert (Gordey, 2013; Gordey and Anderson, 1993). Late Devonian to Mississippian chert pebble conglomerate is mapped in many places in the Selwyn basin and is interpreted to be the result of widespread extension throughout the Selwyn basin and bounding platforms (Gordey, 2013; Gordey et *al*., 1987; Gordey and Anderson, 1993).

Earn Group: upper arenite

Variably altered, fine-grained sedimentary rocks of the Earn Group upper arenite formation are found on Dromedary Mountain and near Kalzas Mountain, and include siltstone, calcareous sandstone, quartz arenite and minor limestone. Rusty-orange and dark grey, variably siliceous siltstone comprises most of the outcrops north of the Twopete fault on Dromedary Mountain (Fig. 2). Light grey weathering, white, fine to medium-grained, sugary textured quartz arenite lies stratigraphically above the siltstone. Grey silty limestone forms minor interbeds approximately 2 m thick within the dark siltstone.

Several exposures near Kalzas Mountain include quartzose siltstone, calcareous and non-calcareous quartz arenite and minor fossiliferous siltstone. Rusty to grey weathering, quartz-rich, massive to very thin bedded siltstone is interbedded with beige, sugary, fine and medium-grained quartz arenite. Dark blue-grey, medium to coarse-grained quartz-rich sandstone, comprising grains of chert and distinct rounded grains of vitreous quartz, crop out in a heavily treed area east of the McArthur batholith. Rare exposures of white weathering marble and calcareous quartz-arenite are interbedded with quartz-rich siltstone near the edge of the pluton. Lastly, light grey, recrystallized limestone is interbedded with grey-brown fossiliferous siltstone south of Kalzas Mountain.

The lower contact with the Earn Group chert pebble conglomerate is not exposed, but is assumed to be conformable. The upper contact in most places is conformable with the Tay Formation. This unit is approximately 1200 m thick on Dromedary Mountain. This estimate is a minimum thickness because the succession is bounded by thrust faults. Near Kalzas Mountain this unit is thinner, with an estimated thickness of 300 m. Disseminated pyrite and pyrrhotite are common in siltstone and occur as parallel stringers that make the rock look layered. Exposures on Dromedary Mountain have abundant quartz veins cutting the quartz sandstone and tremolite is a common alteration product in limestone. Here, much of the rock is altered by silica and associated hydrothermal minerals that have not been identified. Pelitic rocks on Kalzas Mountain commonly display porphyroblasts of andalusite.

This unit has been assigned to the Earn Group and been given an informal formation name ‘upper arenite’ (Campbell, 1967). This name was introduced during this multi-year study to describe this distinct package of rocks that crop out from Anvil Lake to Kalzas Mountain (Cobbett, 2016b). Two Late Devonian (Famennian) macrofossils confirm the age of this unit to Late Devonian (preliminary report by Blodgett). The age is further constrained by the overlying Tay Formation that has been dated as Tournaisian (Blodgett, 2016; Gordey, 2013).

Figure 6. *Field photographs of representative rocks from the north panel.* ***(a)*** *Orange and brown weathering, dolomitic siltstone of the Steel Formation on north side of Kalzas Range. Centre of the photograph shows ripple marks on a bedding surface (490616E, 6981968N).* ***(b)*** *Orange and dark grey weathering, thin and medium-bedded siltstone and sandstone from the lower Earn Group on the north slope of Kalzas Range (501427E, 6980985N).* ***(c)*** *Upper Earn Group chert pebble conglomerate from Crystal Peak (524872E, 6976014N).* *Continued on next page.*

Tay Formation

Light grey, resistant outcrops of fossiliferous limestone of the Tay Formation form small prominent peaks in areas of heavy vegetation throughout the area (Gordey, 2013). Grey, massive to thick-bedded, fossiliferous limestone with black chert horizons that forms semi-continuous lozenges describes most of the outcrops in the region (Fig. 6d). Near Kalzas Mountain, this succession is a dark grey silty limestone interbedded with a variably fossiliferous siltstone that alters to white weathering marble and slate within a contact aureole of the McArthur batholith. The lower contact with the Earn Group is conformable and abrupt. The upper contact is interpreted to be conformable, however there is one section of the map area where the Tay Formation limestone was not found. This missing stratigraphy is interpreted to represent a small area that did not see the build-up of carbonate and instead accumulated fine-grained siliciclastic rocks indistinguishable from those of the overlying Mount Christie Formation. The tightly folded nature of this unit hinders accurate thickness estimates in many places. Based on areas where the Tay Formation is well constrained and not

folded, such as Crystal Peak, the maximum thickness is approximately 100 m. Crinoid fossils are very common in the limestone.

Mount Christie Formation

Patchy exposures of orange weathering chert scree of the Mount Christie Formation occur along subdued, heavily vegetated ridges and within incised gullies on the southern slopes of Kalzas Range and northeast of Dromedary Mountain (Gordey and Anderson, 1993). Orange and grey weathering, black to grey and grey-brown, thin-bedded chert is interbedded with grey siltstone and silty chert (Fig. 6e). Grouped with the Mount Christie Formation are dark grey and black shale and siltstone that comprise many small mossy outcrops within the northern half of the mapped area (Fig. 2). The upper and the lower contacts are not exposed in the NE Glenlyon area. The lower contact is inferred to be conformable and the upper contact is inferred to be unconformable (Fig. 3). Limited exposure of this unit hinders accurate thickness estimates, but inferred values range from 175 m near the western end of Kalzas Range to 800 m in the northeast corner of the map area. Many sections probably fall somewhere between these two extreme values.

This succession of rocks has been assigned to the Carboniferous to Permian Mount Christie Formation based on lithologic similarities with exposures of this unit to the southeast where it has been well dated with conodonts and radiolarians (Gordey and Anderson, 1993; Cordey, 2016, 2017; Orchard, 2017; Gordey, 2013).

Jones Lake Formation

Beige and grey-brown weathering, well-bedded, calcareous siliciclastic rocks of the Jones Lake Formation comprise isolated outcrops across the area (Gordey and Anderson, 1993).

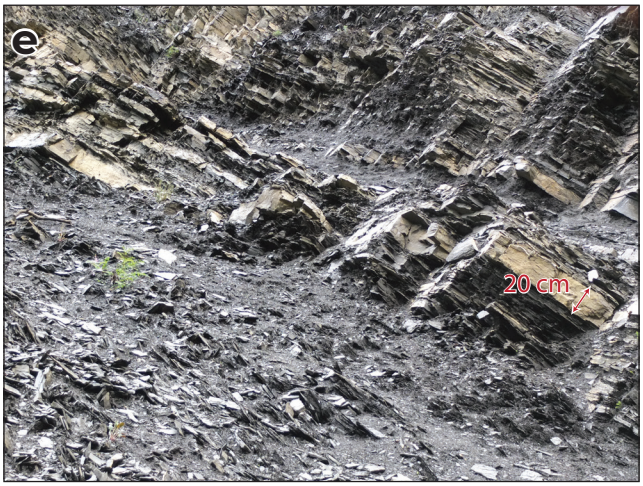

***Figure 6** continued. **(d)** Medium-bedded chert from the Mount Christie Formation on south slope of Kalzas Range (500069E, 6979014N). **(e)** Beige and grey weathering, thin and medium-bedded calcareous siltstone and fine-grained sandstone of the Jones Lake Formation from the south slope of Kalzas Range (502155E, 6978277N). **(f)** Tay Formation limestone with bed of black chert (hammer partly covers chert bed; 491649E, 6979598N). All coordinates are UTM zone 8 NAD 83.*

Grey-brown, medium-bedded siltstone, calcareous fine-grained, quartz sandstone, packstone and calcareous pebbly conglomerate comprise one single outcrop along the western end of Kalzas Range. Similarly, one outcrop on the south slope of the eastern end of the Kalzas Range contains brown weathering, grey, thin to medium-bedded, dolomitic, bioturbated, muddy siltstone that is interbedded with cross-bedded grainstone (Fig. 6f). Northeast of Dromedary Mountain, this unit consists of beige weathering, medium-bedded, silty limestone interbedded with calcareous siltstone. The lower contact with the Mount Christie Formation is not exposed in the NE Glenlyon area, but is well constrained at the western end of Kalzas Range and on the south slope of Crystal Peak where it is inferred to be unconformable. An erosional top to this unit makes a full thickness estimate impossible. An inferred minimum thickness is 150 m.

This unit is assigned to the Jones Lake Formation based on lithologic similarities to this unit in the Tay River area where it has been dated by Middle to Late Triassic micro and macrofossils (Gordey, 2013; Orchard, 2016, 2017; Gordey and Anderson, 1993). These rocks look very similar to the Steel Formation and without fossil and/or stratigraphic constraints could easily be confused with this unit.

Intrusive Rocks

Late Devonian Intrusive Rocks

Several intermediate porphyritic intrusions were mapped south and east of Dromedary Mountain. At outcrop-scale these intrusions are orange and grey weathering, green-grey, fine and medium-grained pyroxene diorite. Thin section analysis shows variably altered mafic minerals (augite and amphibole (?)) in a groundmass with feldspar and minor quartz.

This suite is Late Devonian (*ca.* 364 Ma) based on a preliminary U-Pb zircon age from east of Dromedary Mountain (Yukon Geochronology, 2018). Other intrusions of this age have been discovered southeast of this area during previous mapping (YGS Geochron, 2018).

McArthur batholith

The southeastern tip of the McArthur batholith crops out on Kalzas Mountain. Light grey weathering, salt and pepper, medium and coarse-grained biotite granodiorite to tonalite at this location has phenocrysts of plagioclase up to 5 cm long. A metamorphic contact aureole is mapped along the end of the batholith and ranges in size from 800 m to 2 km.

This body is part of the Mayo plutonic suite (98–93 Ma) based on two U-Pb zircon ages collected 30 km to the northwest, near Grey Hunter Peak (Colpron *et al.*, 2016a).

Structure

Three structural domains divide the area and correspond to the three panels used to subdivide the stratigraphy. The northern domain includes areas north of the Twopete fault, the central domain represents the area between Twopete and Duo faults, and the southwestern domain includes areas southwest of the Duo fault. In general, the NE Glenlyon area is deformed by a northwest-trending fold and thrust belt that affects Triassic and older rocks. Thrust faults are offset by steeply dipping, north-south oriented faults that have both strike-slip and dip-slip displacement.

Northern Domain

Silurian (?) to Triassic strata north of the Twopete fault are deformed by northeast-verging, open to closed folds that are primarily interpreted from changes in bedding orientation across the region. Outcrop-scale folds exhibited locally in carbonate stratigraphy of Jones Lake and Tay formations confirm this interpretation (Fig. 7a). On Kalzas Mountain, Tay Formation marble and slate are isoclinally folded multiple times creating a structurally thickened section within the contact aureole of the McArthur batholith.

On the northern slope of Dromedary Mountain, a sliver of upper Earn Group is thrust over the Mount Christie Formation to the northeast. This thrust fault joins the Twopete fault west of Dromedary Mountain and is not mapped crossing a steep fault east of Dromedary Mountain. North of the Twopete fault, the Steel Formation is thrust over Mount Christie Formation

along a south-dipping thrust fault that continues to the southeast (Cobbett, 2016a). In the northwestern corner of the map area, the upper Earn Group is thrust over the Mount Christie Formation along a south-dipping thrust fault (Fig. 2).

A series of steeply-dipping, north-trending faults offset strata, folds and thrusts within this domain. East-side down normal motion is interpreted as the dominant movement along one of these structures in the middle of the domain. All other faults are likely a combination of dip-slip and strike-slip movement. The small north-trending fault near Kalzas Mountain offsets a klippe of the Twopete fault and is crosscut by the McArthur pluton constraining the age of movement to post-Triassic and pre-mid-Cretaceous (Fig. 2).

Central Domain

This structural domain is a fault-bounded panel of Cambrian (?) to Ordovician strata intruded by Late Devonian granitic rocks. Near the Twopete fault, close folds in thin-bedded limestone of Rabbitkettle Formation have well-developed axial planar cleavage. The high angle, bedding-cleavage intersection in the hinges breaks the rock into small cube-shaped pieces that were subsequently altered and rotated (?) creating brecciated hinge zones (Fig. 7b). East of Dromedary Mountain, laminated siltstone and fine-grained sandstone units of Road River Group are deformed into cm-scale folds with well-developed axial planar cleavage. In both these areas, axial planar cleavage dips moderately to steeply to the southwest.

In one locality on the southwestern flank of Dromedary Mountain, cross-beds and asymmetric ripples indicate an overturned bed is folded into an upright antiform (Fig. 7c). Vergence indicators are absent in this particular outcrop, likely because the thick beds comprising coarse-grained strata are not easily cleaved or folded, making it difficult to fully interpret these rocks. One interpretation of this configuration is that the outcrop preserves the bottom limb of an anticline or the top limb of a syncline of a northwest-verging recumbent fold pair that was subsequently folded into an upright anticline.

Included in the central domain near Kalzas Mountain, a klippe of the Twopete fault places Road River Group strata over upper Paleozoic rocks. Fine-grained clastic rocks are recrystallized into phyllite and slate within the hanging wall of the klippe. More competent rocks, such as chert pebble conglomerate, exhibit a well-developed foliation defined by stretched and slightly flattened chert clasts (Fig. 7d). The McArthur batholith plugs the thrust fault klippe. Axial planar foliation dips moderately to nearly vertically east-southeast and defines the main layering in phyllite and slate.

Southwest Domain

The region south of the Duo fault encompasses the structurally most complex and mostly poorly exposed part of the area. Rocks within this domain range from undeformed (massive basalt) to polydeformed (folded calcite-mica schist) in large part due to the competency of the host lithology, but also with distance away from the Duo fault (rocks are more deformed farther from the fault to the southwest). Near the fault, fine-grained sedimentary rocks have a well-developed slatey cleavage and bedding is typically preserved. Volcanic and volcaniclastic rocks are undeformed and only rarely is there a secondary fabric developed. Between 2 and 7 km from the Duo fault, for example near Earn River and along the upper parts of Duo Creek, layered rocks are typically recrystallized to phyllite. Local preservation of bedding occurs near thick sections of basalt and in areas where layered rocks are non-calcareous. Rare exposures of calcareous phyllite exhibit a crenulation cleavage that overprints the dominant foliation (Fig. 7e). Foliations dip moderately to steeply to the southwest. Exposures south of Kalzas Mountain show similar structural grade despite their close proximity (0–2 km) to the Twopete/Duo faults. The dominant foliation near Kalzas Mountain dips steeply north-northeast. Layered rocks become fully recrystallized into schist more than 7 km from the Duo fault. Near Detour Lakes, layered rocks exhibit an early dominant foliation tightly folded to form a secondary foliation (Fig. 4a). In this area, volcanic and volcaniclastic rocks exhibit weakly to moderately developed foliation. Both early and late foliations are variably oriented with no discernible pattern. Near Detour Lakes a southwest-dipping klippe places Vangorda formation over the Menzie Creek Formation (Fig. 2).

Figure 7. *Field photographs of structural features from northeastern Glenlyon area.* ***(a)*** *Close folding of Triassic Jones Lake Formation from north panel. Cross-beds indicate both limbs of this fold are upright (502155E, 6978277N).* ***(b)*** *Tight folding of Ordovician Rabbitkettle strata showing well-developed axial planar cleavage from central panel. Intersection between bedding and cleavage creates brecciated hinge zones (512557E, 6972880N).* ***(c)*** *Tight folding of thick-bedded sandstone of undivided Road River Group from central panel. Cross-bedding and asymmetric ripple marks suggest both limbs of the anticline are overturned (yellow arrows point in younging direction; 513532E, 6971568N).* ***(d)*** *Foliated chert pebble conglomerate of undivided Road River Group from central panel (485784E, 6977384N). Calcareous phyllite of Menzie Creek Formation from southwestern panel. This outcrop exhibits a dominant foliation (S1) crenulated into a secondary foliation (S2). Bedding (S0) is weakly preserved as a linear feature visible on S1 planes (507339E, 6963689N). All coordinates are UTM zone 8 NAD 83.*

Mineralization

A variety of mineralization types occur within the mapped area including SEDEX (Yukon MINFILE 105L 030, 037, 041), sediment-hosted stratiform barite (Yukon MINFILE 105L 050, 054), polymetallic vein Ag-Pb-Zn ± Au (Yukon MINFILE 105L 023, 024, 025) and skarn (Yukon MINFILE 105L 031, 035).

Historical exploration efforts focused on mineralization discovered in and around the Dromedary Mountain area and on the south side of Kalzas Mountain. Late Devonian strata host pyrite and pyrrhotite dominated layered sulphide bodies that contain minor lead, zinc and silver (Caulfield and Weber, 1997; Carlson, 1981). Previous workers have proposed a syngenetic origin for this mineralization. Late Devonian strata also hosts polymetallic veins with lead, zinc and silver. Both types of mineralization occur in the direct footwall of the Twopete fault.

Discussion

Coarse siliciclastic rocks of the undivided Road River Group that crop out in the central panel are unlike coeval deep-water strata elsewhere in the Selwyn basin (Gordey, 2013; Gordey and Anderson, 1993). We propose these coarse siliciclastic rocks were deposited along a shallow shelf adjacent to a platform located to the southwest in present day coordinates. The Duo fault (Twopete fault to the southeast) likely coincides with the platform-basin boundary that links up with the McEvoy platform–Selwyn basin boundary in the southern part of the Sheldon Lake map area (105J) and into the Frances Lake map area (105H; Fig. 8; e.g., Gordey, 2013). The McEvoy platform in these regions includes Silurian to Devonian siltstone, sandstone and carbonate (Gordey, 2013). If the central panel strata mapped in the NE Glenlyon area are genetically linked to platformal rocks, it suggests parts of the McEvoy platform may be as old as Ordovician. In the NE Glenlyon area, thick carbonate rocks typical of a platform have been eroded away south of the Twopete and Duo faults.

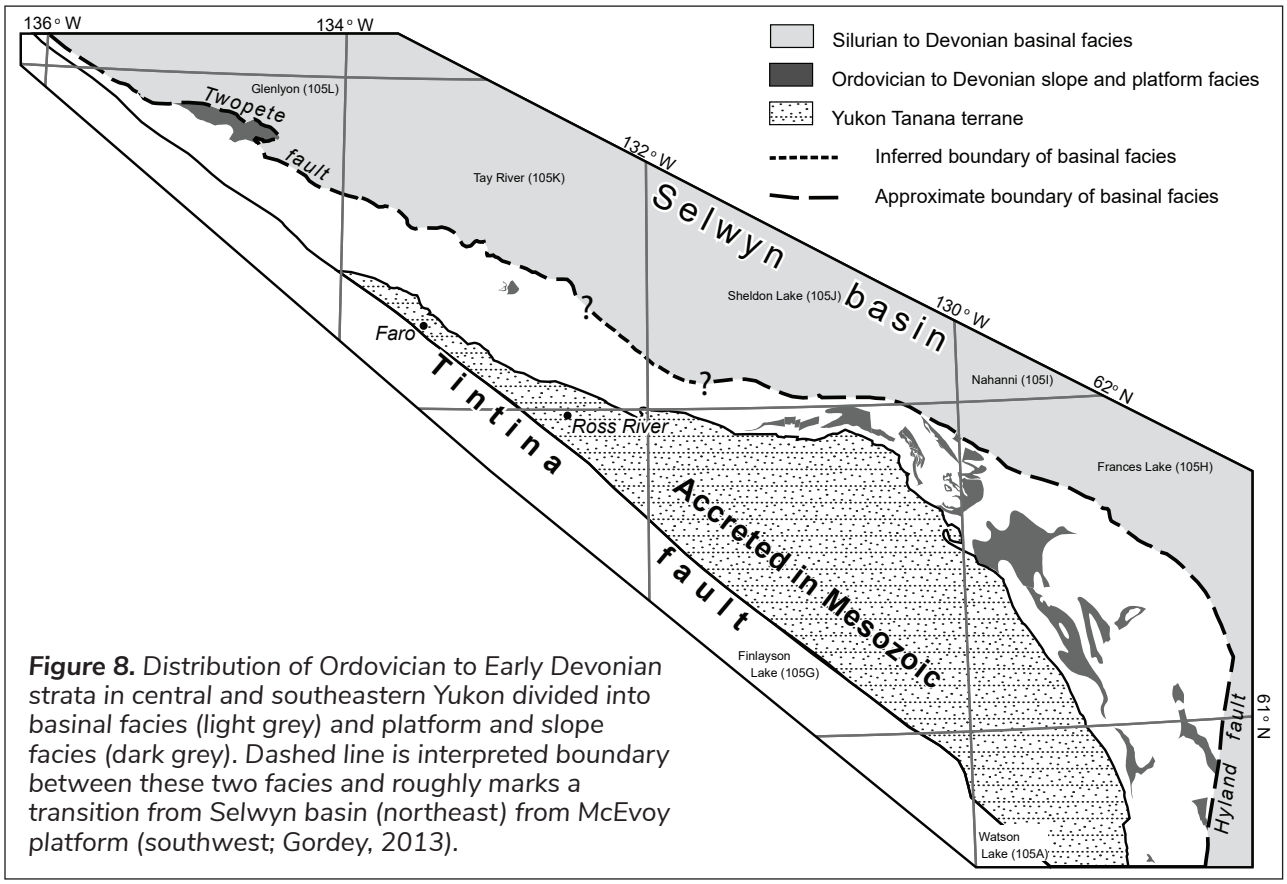

Figure 8. *Distribution of Ordovician to Early Devonian strata in central and southeastern Yukon divided into basinal facies (light grey) and platform and slope facies (dark grey). Dashed line is interpreted boundary between these two facies and roughly marks a transition from Selwyn basin (northeast) from McEvoy platform (southwest; Gordey, 2013).*

We propose heat from a buried pluton caused the alteration and hornfelsing of rocks on Dromedary Mountain. The regional aeromagnetic map delineates a magnetic high surrounding a circular magnetic low centred roughly on Dromedary Mountain (Fig. 9). The magnetic low is delineating a granitic body similar to the magnetic low that is coincident with the McArthur pluton. The magnetic high is delineating a pyrrhotite-rich contact aureole that leaks into the Twopete fault creating the eye-shaped magnetic high. The pluton is the source for hydrothermal fluids that silicify and alter rocks on both sides of the Twopete fault on Dromedary Mountain.

A syngenetic origin for the layered sulphide bodies hosted in Upper Devonian strata near Kalzas and Dromedary mountains is proposed. Several faults mapped southeast of the Glenlyon area, including the Twopete fault, were active in the Late Devonian and controlled the deposition of the upper Earn Group, which includes volcanic rocks in southeastern areas (Cobbett, 2016b). The Twopete fault in the NE Glenlyon area was a synsedimentary structure in the Devonian that facilitated the migration of mineralizing fluids to the surface where sulphide was deposited or replaced as stratabound layers. The timing and style of mineralization is comparable to the Tom and Jason deposits near Macmillan Pass in eastern Yukon where Late Devonian to Mississippian strata host significant syngenetic base metal mineralization (Yukon MINFILE, 2018). Late Devonian synsedimentary faults controlled the deposition of the Earn Group near Macmillan Pass and are spatially coincident with the Tom and Jason deposits (Abbott *et al.*, 1990; Abbott, 2013)

Summary

The main results from mapping in the NE Glenlyon area are:

1. The recognition and accurate mapping of the Twopete fault in the NE Glenlyon area, a major structural boundary that continues for approximately 100 km to the southeast (Cobbett, 2016b, 2014).

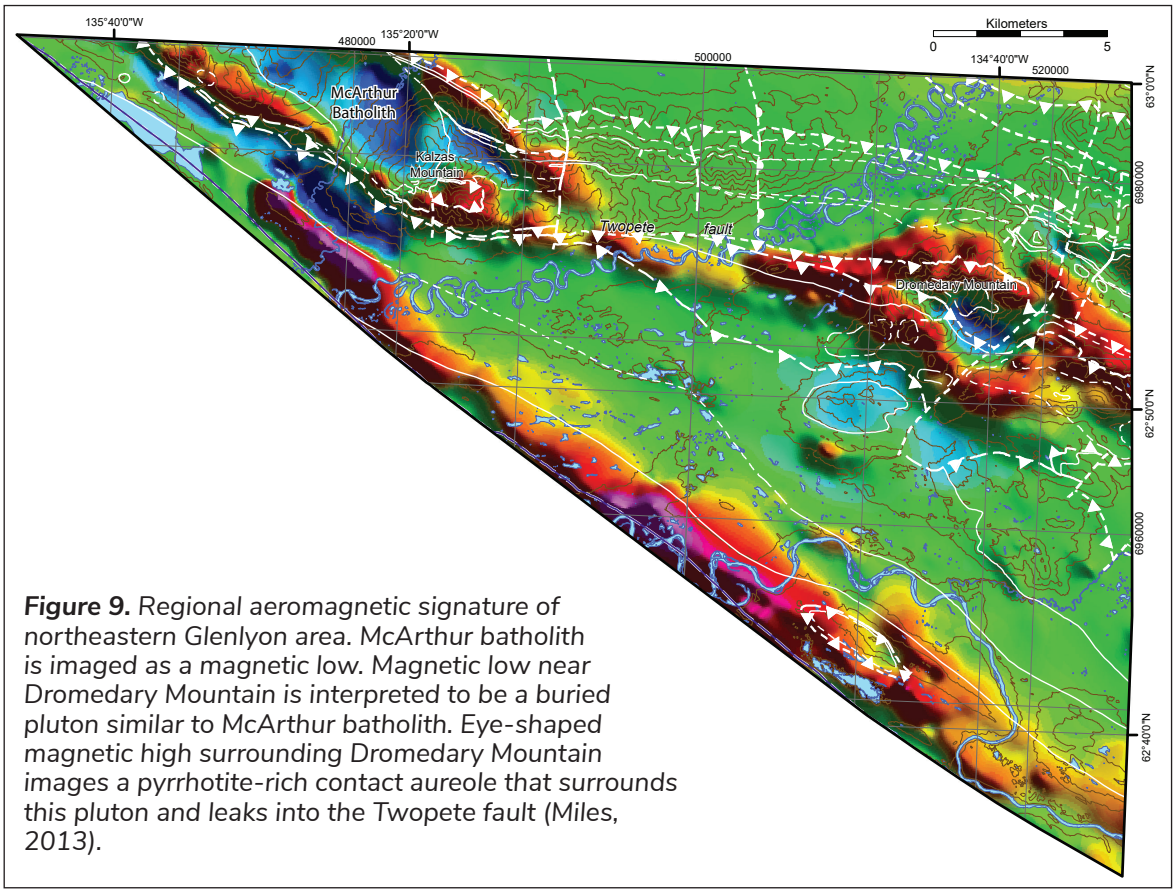

Figure 9. *Regional aeromagnetic signature of northeastern Glenlyon area. McArthur batholith is imaged as a magnetic low. Magnetic low near Dromedary Mountain is interpreted to be a buried pluton similar to McArthur batholith. Eye-shaped magnetic high surrounding Dromedary Mountain images a pyrrhotite-rich contact aureole that surrounds this pluton and leaks into the Twopete fault (Miles, 2013).*

2. Discovery of Ordovician to Silurian (?) coarse siliciclastic rocks, dark weathering phyllite and graptolitic siltstone that represent slope facies representing a platform to basin transition similar to the McEvoy platform–Selwyn basin transition in southeastern Yukon.
3. Upper Devonian strata hosts syngenetic mineralization discovered near Kalzas Mountain and Dromedary Mountain in the direct footwall to the Twopete fault.

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