New investigations of basal Laberge Group stratigraphy, Whitehorse trough, central Yukon

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ABSTRACT

The tectonic evolution of the Whitehorse trough in central Yukon is largely preserved by the Early to Middle Jurassic Laberge Group, an ~3000-m thick succession of synorogenic clastic strata that unconformably overlies arc and arc marginal rocks of the Lewes River Group. A two-year project was initiated to test a Sinemurian to Toarcian transgression of basal Laberge Group strata westward across the Whitehorse trough and examine the regional relationships between the timing of Jurassic exhumation, sedimentation, and terrane accretion in the northern Canadian Cordillera. Field studies in 2017 targeted basal Laberge Group strata at seven locations in central Yukon. At each field locality, basal Laberge Group strata are known or inferred to unconformably overlie the Povoas formation and multiple units of the Aksala formation. Pre-Early Jurassic unconformities may indicate variable basin topography due to the complex internal stratigraphy of the Lewes River Group, or that regional exhumation and erosion affected the Whitehorse trough prior to Laberge Group sedimentation.

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INTRODUCTION

The early growth of the northern Canadian Cordillera is marked by the late Paleozoic to mid-Mesozoic accretion of the Intermontane terranes to the western Laurentian margin, crustal thickening in the Cordilleran hinterland, and initial subsidence in the Alberta foreland basin (*e.g.,* Cant and Stockmal, 1989; Colpron *et al*., 2007, 2015; Nelson *et al*., 2013). This early growth is in part recorded by the Whitehorse trough, a sedimentary basin that developed on top of the Intermontane terranes in a transitional forearc to wedge-top setting during the Early to Middle Jurassic closure of the Cache Creek Ocean (Nelson *et al*., 2013; Colpron *et al*., 2015). The Whitehorse trough is regionally extensive and spans more than 600 km from the Carmacks region of central Yukon (Fig. 1) to the Dease Lake region of northern British Columbia. The northern apex of the trough near Carmacks is characterized by proximal, marginal marine to fluvial strata of the Tanglefoot formation, whereas the central part of the trough near Whitehorse consists of distal, deep-marine mass-flow deposits of the Richthofen formation, suggesting a deepening of the basin towards the south (*e.g.,* Dickie and Hein, 1995; Tempelman-Kluit, 1984; Lowey, 2004; Lowey *et al*., 2009). Laberge Group strata unconformably overlie several Upper Triassic units of the Lewes River Group (Stikinia; Cairnes, 1910; Tempelman-Kluit, 1984; Dickie and Hein, 1995; Lowey, 2004, 2008; Colpron *et al.,* 2007), which likely reflects the lateral discontinuity of Carnian-Rhaetian rock units in central Yukon (Bordet, 2016a,b, 2017) and/or exhumation of the Intermontane terranes (*e.g.,* Knight *et al*., 2013; Joyce *et al.,* 2015; Colpron *et al.,* 2015), creating topography within the Whitehorse trough prior to Early Jurassic sedimentation.

Previous studies of the Whitehorse trough have mostly focused on the sedimentology and depositional setting of the Laberge Group (*e.g.*, Hart and Radloff, 1990; Dickie and Hein, 1995; Lowey *et al*., 2008; Bordet, 2016a), but relatively few studies (Hart *et al*., 1995) have examined the stratigraphic responses of Jurassic exhumation and erosion or tested relationships between the timing of exhumation, sedimentation and terrane accretion. Recently, Colpron *et al*. (2015) investigated these relationships and hypothesized a westward younging of basal Laberge Group strata across the Whitehorse trough, which may indicate that subsidence followed exhumation and uplift of its western shoulder. A two-year project was initiated in summer 2016 to test the hypotheses of Colpron *et al.* (2015) and constrain the field geology and detrital zircon (U-Pb and Hf isotope) signatures of Laberge Group strata in central Yukon. The objectives of the 2016 field season, summarized by van Drecht *et al.* (2017), focused on the physical stratigraphy and depositional setting of Laberge Group rock units at four localities. The objectives of the 2017 field season, presented in this report, were to identify the contact relationships between basal Laberge Group and underlying Lewes River Group strata in the Mandanna Lake, Conglomerate Mountain, Fish Lake, Takhini subdivision, King Lake, Mount Byng and Mount Slim areas to test the westerly transgression of basal strata hypothesized by Colpron *et al.* (2015). Forthcoming detrital zircon U-Pb and Hf isotope studies will use these stratigraphic constraints to more fully define the provenance and paleodrainage history of Laberge Group rock units and provide new insights on the evolution of the Intermontane terranes.

TECTONIC SETTING

The Intermontane terranes (Yukon-Tanana, Stikinia and Quesnellia) were in proximity to western Laurentia by the Early Triassic (Beranek and Mortensen, 2011) and later imbricated following the Late Triassic-Early Jurassic closure of the Cache Creek Ocean (Mihalynuk *et al*., 1994). The most widely accepted model to explain the imbrication and subsequent geometry of the Intermontane terranes involves the counterclockwise bending and subsequent entrapment of oceanic rock units assigned to the Cache Creek terrane (Mihalynuk *et al*., 1994; Logan and Mihalynuk, 2014; Colpron *et al*., 2015). Late Triassic to Early Jurassic crustal thickening and pluton emplacement in central Yukon was accompanied by rapid exhumation of the Yukon-Tanana, Stikinia and Quesnellia terranes (*e.g.*, Johnston *et al*., 1996). Lower to Middle Jurassic synorogenic strata of the Laberge Group were likely sourced from exhumed plutons and basement rocks assigned to Stikinia.

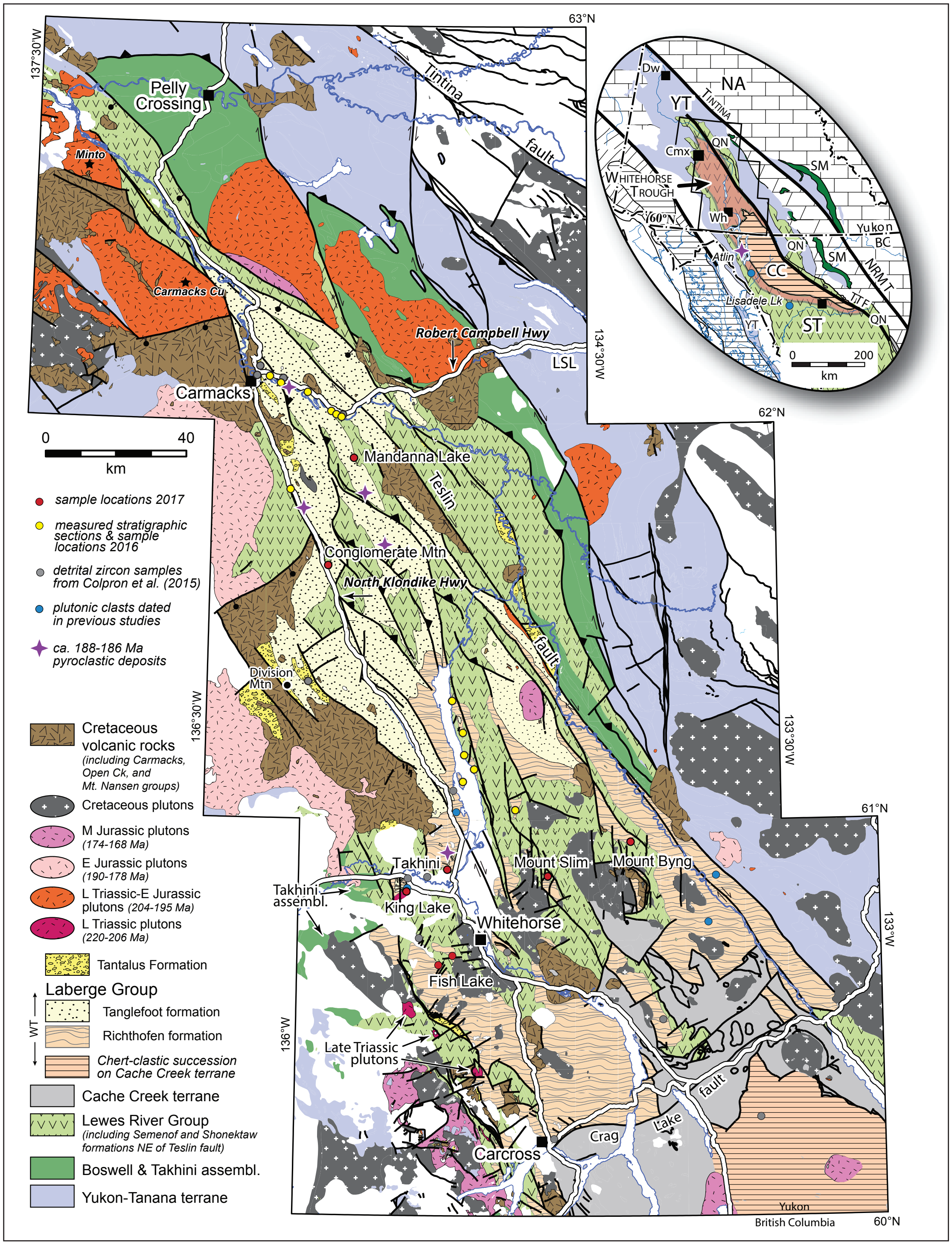

Figure 1. *Regional geology of the Whitehorse trough area modified from Colpron (2015). Locations of 2016 field sites are shown by yellow dots and 2017 field sites are shown by red dots. Field locations on the Robert Campbell Highway represent measured stratigraphic sections. Locations at Mandanna Lake, Conglomerate Mountain, Takhini, King Lake, Fish Lake, Mount Byng, and Mount Slim indicate sampling locations. Grey and blue dots denote detrital zircon sample locations of (Colpron et al. 2015) and previously dated plutonic clasts (Hart et al., 1995). The inset shows the location of the Whitehorse trough relative to the Intermontane terranes of the northern Canadian Cordillera. Abbreviations: CC-Cache Creek terrane; CMx-Carmacks; Dw-Dawson; LSL- Little Salmon Lake; NA-rocks of ancestral North America; NRMT-Northern Rocky Mountain Trench Fault; QN-Quesnellia; SM-Slide Mountain terrane; ST-Stikinia; TTF-Teslin-Thibert fault; Wh-Whitehorse; YT-Yukon-Tanana terrane.*

STRATIGRAPHIC FRAMEWORK

LEWES RIVER GROUP

The stratigraphy of the Lewes River Group is complex due to lateral facies changes from west to east across central Yukon (Wheeler, 1961; Bordet 2016a, 2017). The Povoas formation is the lowermost unit of the Lewes River Group and consists of Carnian basalt and andesite, volcanic breccia, tuff and agglomerate (Fig. 2; Tempelman-Kluit, 1984, 2009). The overlying Carnian-Rhaetian Aksala formation records a break in regional magmatism and is characterized by micritic limestone, fossiliferous limestone, calcareous mudstone-sandstone, lithic sandstone, argillite and calcareous conglomerate (Tozer, 1958; Tempelman-Kluit, 1984; Bordet, 2016a, 2017). Tozer (1958) divided these Upper Triassic rocks into seven limestone units that are regionally interbedded with, or laterally equivalent to Norian-Rhaetian clastic strata, whereas Tempelman-Kluit (1984) divided these rocks into the Casca (lithic sandstone, argillite and conglomerate), Hancock (limestone), and Mandanna members (maroon weathering lithic sandstone, mudstone and conglomerate). Recent mapping by Bordet (2016a,b, 2017) broadly supports the interpretations of Tozer (1958) and argues for the presence of several Norian and younger carbonate units within the Lewes River Group, which implies that not all Upper Triassic carbonate strata are equivalent to the Rhaetian Hancock member. In this paper, the Casca and Hancock members of Tempelman-Kluit (1984) are referred to as green lithic sandstone and limestone of the Aksala formation, respectively, to more accurately reflect the revised stratigraphy of Bordet (2016b, 2017). The Mandanna member nomenclature is used as per Templeman-Kluit (1984) because it does not crop out in the updated map area of Bordet (2016b) and accurately represents the upper Aksala formation.

LABERGE GROUP

The Lower to Middle Jurassic Laberge Group is a 3000 m-thick sedimentary succession that was first described in central Yukon along the shoreline of Lake Laberge (Dawson, 1887). The Laberge Group is divided into the Sinemurian-Bajocian Tanglefoot and Richthofen formations and Pliensbachian Nordenskiöld dacite (Fig 2; Tempelman-Kluit, 1984; Dickie and Hein, 1995; Lowey, 2004). Post-Bajocian fluvio-deltaic rocks of the Tantalus Formation unconformably overlie the Laberge Group in central Yukon (Fig. 2; Hart and Radloff, 1990; Dickie and Hein, 1995; Colpron *et al*., 2015).

The Tanglefoot formation (Fig. 2) consists of interbedded sandstone and mudstone, mass-flow conglomerate, pebbly sandstone, and coal with abundant terrestrial plant and marginal marine fossils. The Tanglefoot formation is restricted to the northern apex of the Whitehorse trough and was deposited in a proximal marginal marine to fluvial setting (Lowey, 2004; Hutchison, 2017). The type area for this formation is located at Tanglefoot Mountain, north of Lake Laberge (Lowey, 2004) and good exposures are also present along the Robert Campbell Highway (Fig. 1; van Drecht *et al*., 2017).

The Richthofen formation (Fig. 2) consists of graded siltstone, very fine grained sandstone with mudstone couplets, mass-flow conglomerate, pebbly sandstone, massive sandstone, volcaniclastic rocks and minor limestone (Lowey, 2004; Lowey *et al.,* 2009). Richthofen formation strata are restricted to the central part of the trough and were deposited in a distal mass-flow setting.

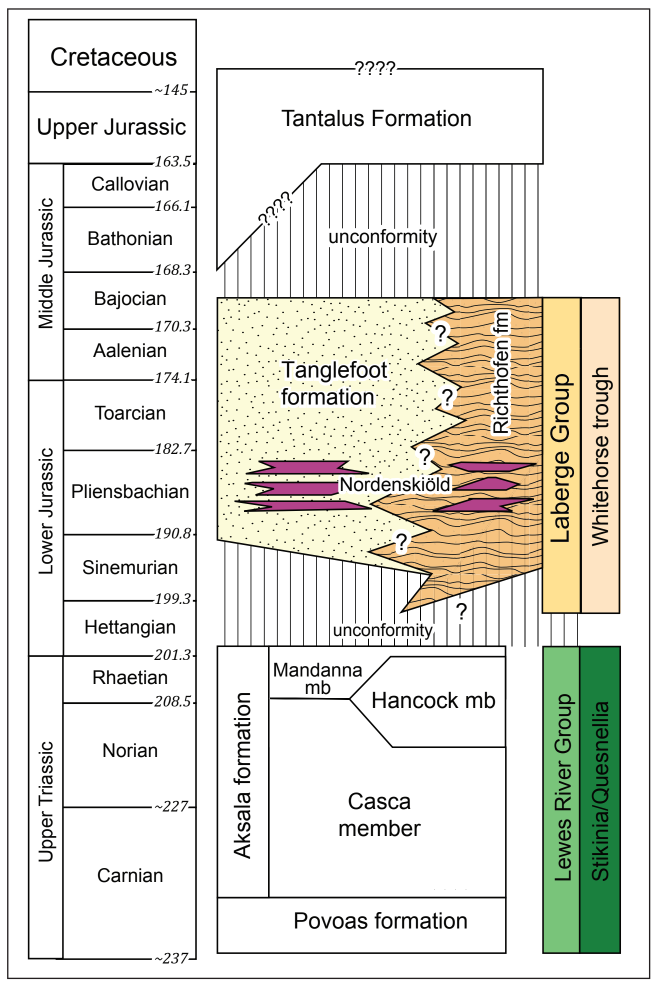

Figure 2. *Schematic stratigraphy of Stikinia, Quesnellia and the Whitehorse trough complied by Colpron et al. (2015).*

The type area is located at the Lake Laberge campground along the western shoreline of Lake Laberge (Tempelman-Kluit, 1984; Lowey, 2004). Good exposures of the Richthofen formation can also be seen along the eastern shoreline of Lake Laberge and flanks of Mount Laurier.

Well-rounded, cobble to boulder, clast to matrix-supported, mass-flow conglomerate units occur throughout the Richthofen and Tanglefoot formations (Hart *et al*., 1995). Sinemurian conglomerate units comprise volcanic and sedimentary (predominantly limestone) clasts, whereas Pliensbachian and younger strata contain a larger proportion of plutonic rock clasts that imply the unroofing of a nearby arc complex (Dickie and Hein, 1995; Hart *et al*., 1995; Shirmohammad *et al*., 2011). In northern British Columbia, Pliensbachian and younger strata of the Whitehorse trough also include metamorphic clasts, which have not been observed in Yukon prior to this field season (Dickie and Hein, 1995; Shirmohammad *et al*., 2011). Laberge Group conglomerate units were likely deposited as debris flows, sheet floods and bar deposits (Dickie and Hein, 1988). Paleocurrent indicators (flute casts, wavy stratification, bar-swash lamination) suggest that sediment transport was from west to east, transverse to the north-to-south deepening direction of the Whitehorse trough as indicated by longitudinal facies changes (Dickie and Hein, 1988, 1995; Hart *et al*., 1995; Lowey, 2004, Lowey *et al.,* 2008).

The Nordenskiöld dacite consists of epiclastic and primary dacitic tuffs and flows (Tempelman-Kluit, 1984) that have been mapped at three stratigraphic levels in the Laberge Group and represent volcanic episodes at 188.1 ± 0.4 Ma, 187. 2 ± 0.4 Ma and 186.5 ± 0.3 Ma (Colpron *et al*., 2007). Zircon U-Pb ages of the Nordenskiöld dacite indicate active volcanism during deposition of the Laberge Group (Colpron and Friedman, 2008).

CONTACT RELATIONSHIPS

Numerous workers, including Cairnes (1910), Cockfield and Bell (1926), Bostock and Lees (1938), Wheeler (1961), Tempelman-Kluit (1984), and Hart and Radloff (1990), have described the contact relationship between the Lewes River and Laberge groups in central Yukon. The contact has been described as a conformity (Bostock and Lees, 1938; Tempelman-Kluit, 1984; Hart and Radloff, 1990), an unconformity (Lowey, 2008), a disconformity (Hart and Radloff, 1990), an angular unconformity (Cockfield and Bell, 1926; Wheeler, 1961; Lowey, 2008), or as changing from a disconformity on the western margin of the basin to a conformity in the central region (Wheeler, 1961). Lowey (2008) proposed that the contact is an unconformity that spans the entire Whitehorse trough, typically marked by basal conglomerate in the Richthofen and Tanglefoot formations.

2017 FIELD STUDIES

The 2017 field season focused on describing the contact relationships between the Lewes River and Laberge groups at Mandanna Lake, Conglomerate Mountain, Fish Lake, Takhini subdivision, King Lake, Mount Byng and Mount Slim (Fig. 1). In the northern apex of the trough, the Tanglefoot formation overlies massive limestone and maroon weathering sandstone of the upper Aksala formation at Mandanna Lake and Conglomerate Mountain. In the central part of the trough the Richthofen formation overlies massive limestone and green sandstone of the Aksala formation and gabbro of the Povoas formation at Fish Lake, King Lake, Mount Byng and Mount Slim.

TANGLEFOOT FORMATION

Mandanna Lake

The Laberge Group overlies limestone of the Aksala formation to the southwest of Mandanna Lake (Fig. 1; zone 08V, 459834 E, 6857184 N, NAD83), ~30 km southeast of Carmacks (Colpron *et al.,* 2007). Basal Laberge Group strata at this locality consist of massive, brown, cobble to pebble, clast to matrix-supported, polymictic conglomerate of the Tanglefoot formation. Conglomerate clasts are dominantly felsic plutonic and volcanic rocks with lesser amounts of sedimentary rocks. Clasts are subrounded to rounded, poorly sorted and range in size from 2 to 20 cm (Fig. 3a). Dark blue-grey, massive, medium to coarse-grained, poorly sorted sandstone underlies the ~3 m-thick conglomerate unit and dips to the northeast (Fig. 3b). This outcrop represents probable basal Laberge Group as limestone crops out west of this locality, but the contact is covered and not directly observed. The contact is inferred to be unconformable.

Conglomerate Mountain

Tanglefoot formation conglomerate overlies maroon weathering sandstone of the upper Aksala formation at Conglomerate Mountain, ~110 km north of Whitehorse along the North Klondike Highway (Fig. 1; zone 08V, 453930 E, 6833117 N, NAD83). At this locality, maroon weathering, medium to coarse-grained, poorly sorted, massive to burrowed sandstone of the Mandanna member dips towards the southeast (Fig. 5a,b). A thick unit of massive, brown, matrix to clast-supported, polymictic cobble to boulder conglomerate of the Tanglefoot formation overlies the Mandanna member (Fig. 4a). The overlying conglomerate is composed of subrounded to rounded, poorly sorted, volcanic and plutonic clasts with minor sedimentary clasts that range in size from 0.3 to 127 cm (Fig. 5c). Felsic plutonic rocks make up the greatest fraction of the boulder-sized clasts, whereas volcanic and sedimentary clasts make up finer clast sizes. The matrix is buff coloured, medium to coarse-grained, poorly sorted sandstone (Fig. 5d). The contact at Conglomerate Mountain is covered but interpreted to be unconformable.

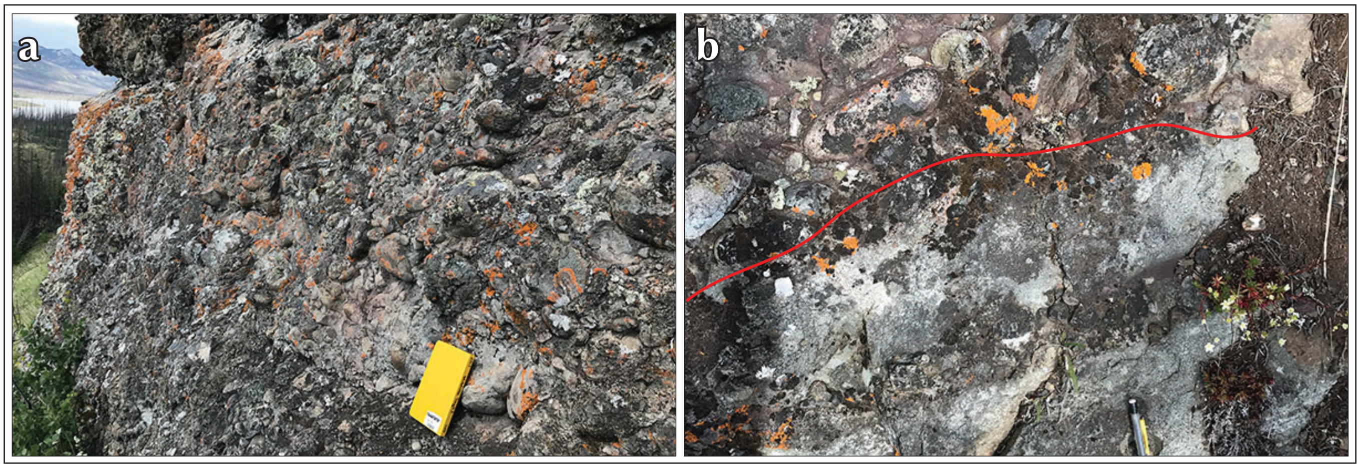

Figure 3. *Field photographs of the Tanglefoot formation at Mandanna Lake.* ***(a)*** *Poorly sorted cobble to boulder conglomerate; and* ***(b)*** *annotated photo of the contact between conglomerate (top) and medium to coarse-grained sandstone (bottom).*

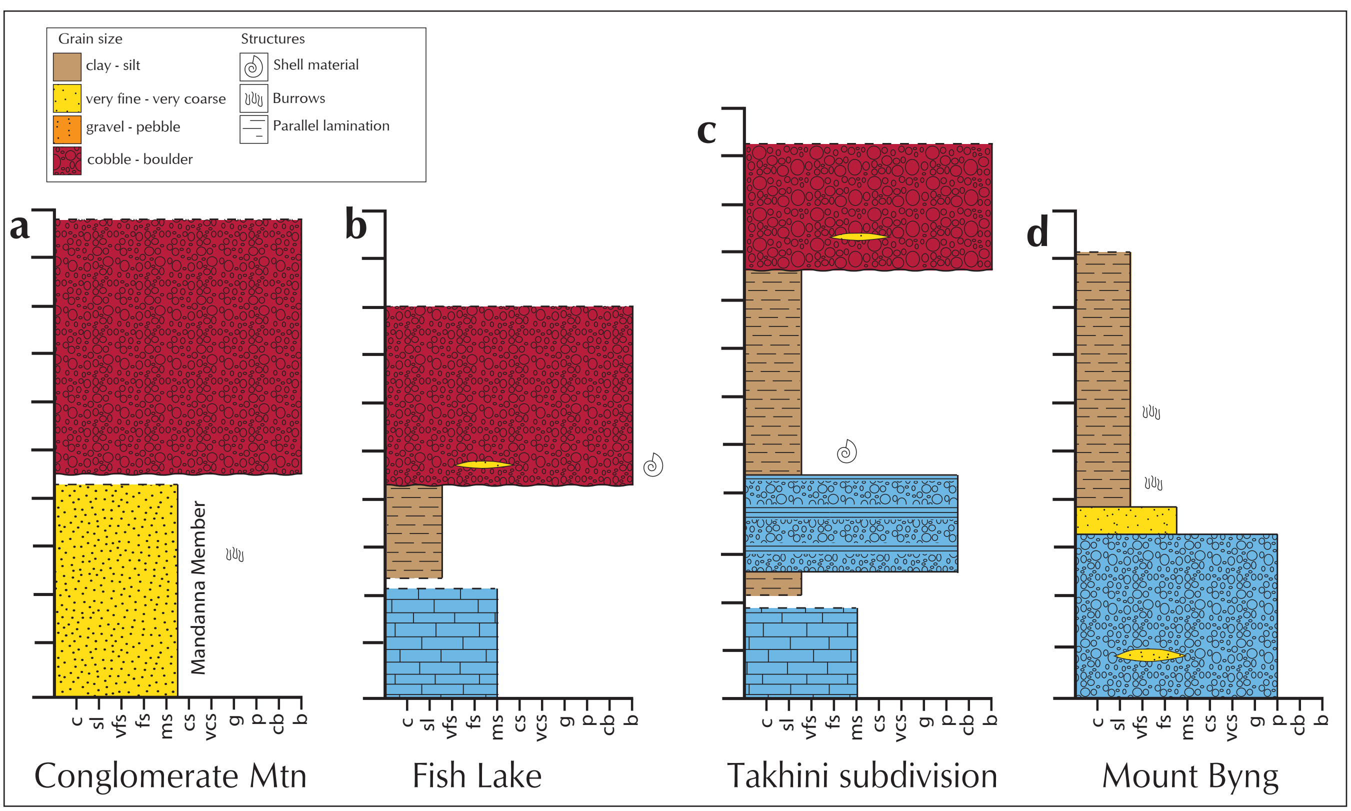

Figure 4. *Schematic stratigraphy at* ***(a)*** *Conglomerate Mountain,* ***(b)*** *Fish Lake,* ***(c)*** *Takhini subdivision, and* ***(d)*** *Mount Byng. Grain size abbreviations: c=clay, sl=silt, vfs=very fine grained, fs=fine-grained, ms=medium-grained, cs=coarse-grained, vcs=very coarse grained, g=granule, p=pebble, cb=cobble, b=boulder.*

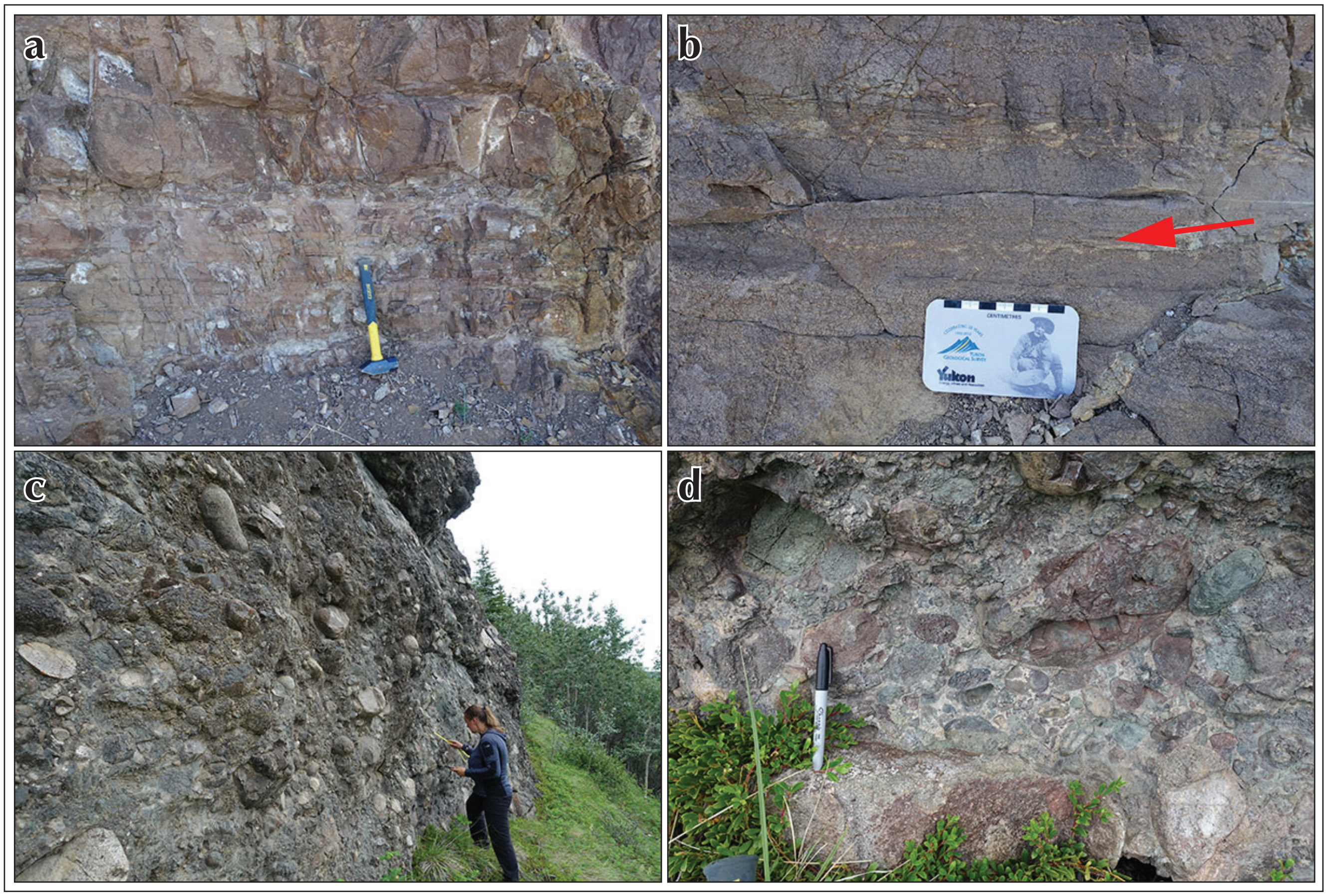

Figure 5. *Field photographs of the Tanglefoot formation at Conglomerate Mountain.* ***(a)*** *Medium to coarse-grained, poorly sorted, massive Mandanna formation sandstone;* ***(b)*** *example of burrows in the Mandanna formation;* ***(c)*** *outcrop scale photo of Laberge Group polymictic pebble to boulder conglomerate; and* ***(d)*** *fresh surface of Laberge Group polymictic pebble to boulder conglomerate.*

RICHTHOFEN FORMATION

Fish Lake

Basal Laberge Group strata crop out in the Fish Lake area ~16 km southwest of Whitehorse and are inferred to overlie the Mandanna member sandstone and Aksala formation limestone (Fig. 1; zone 08V, 485805 E, 6721676 N, NAD 83). At this locality, the contact is covered and not directly observed; basal strata are inferred by the proximity to limestone. The ridge west of Fish Lake comprises massive, brown, matrix-supported, pebble to cobble, poorly sorted, polymictic conglomerate that overlies dark blue, very fine to fine-grained sandstone of the Richthofen formation (Fig. 4b). Conglomerate units at this locality consist of subrounded to rounded clasts of felsic plutonic, volcanic and metamorphic rocks that range in size from 1 to 8 cm (Fig. 6a). Plutonic and volcanic clasts are the most abundant; three foliated mafic rock clasts were also observed (Fig. 6b,c). A recrystallized ammonite (Fig. 6d) from a dark blue, medium-grained sandstone lens near the contact with the Lewes River Group was collected for biostratigraphic analysis. Fine-grained maroon clasts are also present in the sandstone lens, which likely indicates proximity to the Mandanna member, although it does not crop out at this locality. Along the southern end of the ridge, very fine grained, dark blue Richthofen formation sandstone with buff coloured laminae underlies the conglomerate and is locally intruded by rhyolite dikes. Basal Laberge Group strata also crop out along the eastern side of Fish Lake (Fig. 1; zone 08V, 488343 E, 6724611 N, NAD 83). This locality is characterized by pebble to cobble, subrounded to rounded, poorly sorted, polymictic (felsic plutonic and volcanic) conglomerate with fine to medium-grained sandstone lenses, comparable to strata immediately west. The contact at Fish Lake is interpreted to be unconformable.

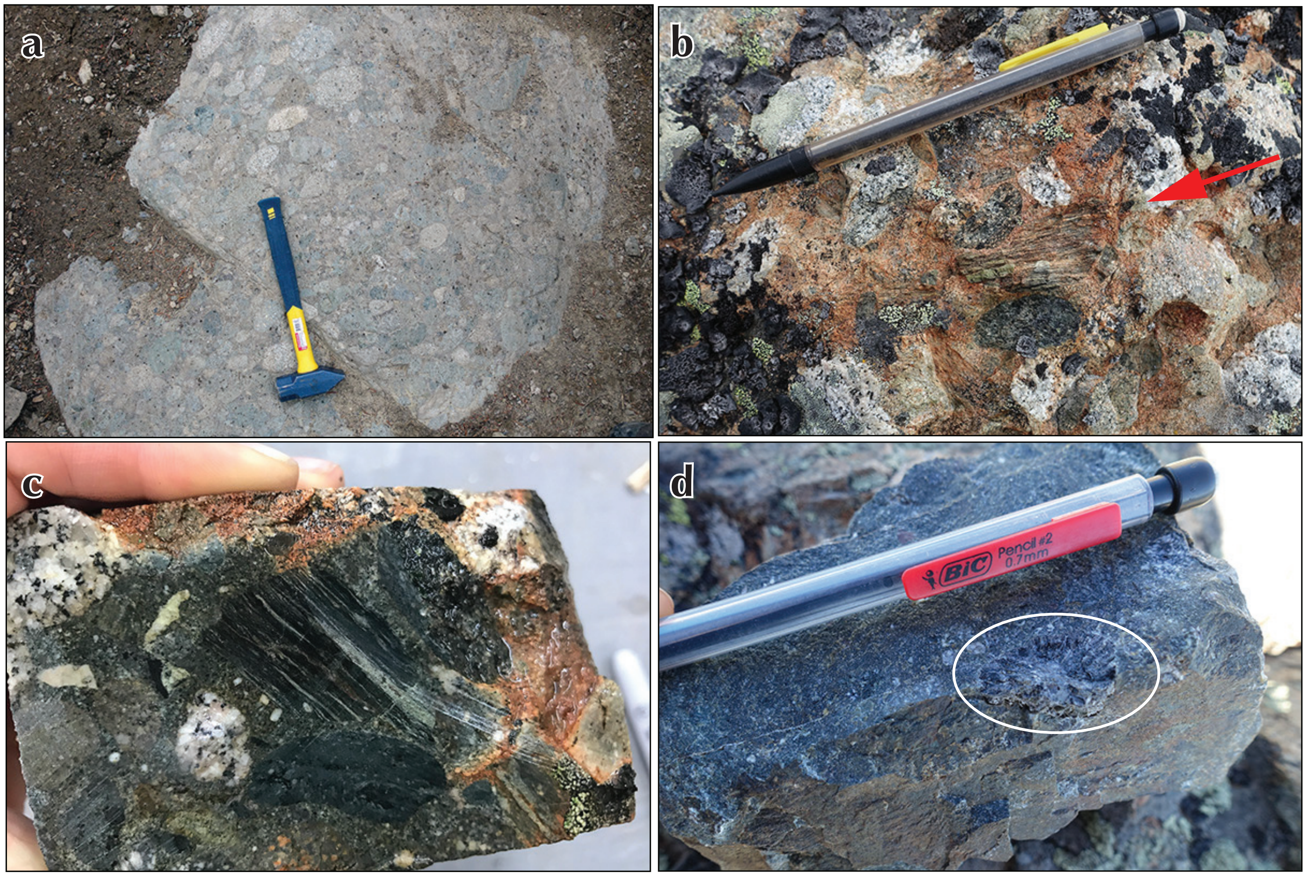

Figure 6. *Field photographs of the Richthofen formation at Fish Lake.* ***(a)*** *Laberge Group polymictic pebble to cobble conglomerate;* ***(b)*** *foliated mafic clast in the conglomerate annotated by red arrow;* ***(c)*** *fresh surface of the same clast from b; and* ***(d)*** *ammonite fossil in dark blue medium-grained sandstone lens.*

Takhini subdivision

Basal Laberge Group strata overlie limestone of the Askala formation in the Takhini subdivision area (Figs. 1 and 4c; zone 08V, 488086 E, 6748844 N, NAD 83). The base of this section consists of monomictic limestone conglomerate and laminated limestone (Fig. 7a). Conglomeratic beds range from 14 to 28 cm thick, whereas laminated beds range from 7 to 10 cm thick. Conglomerate clasts are white to dark blue in a dark blue carbonate matrix (Fig. 7a). The limestone unit is overlain by dark blue, very fine to fine-grained, mudstone/sandstone couplets and pebble to cobble, rounded to subrounded, poorly sorted conglomerate of the Richthofen formation (Fig. 7b) that is intruded by fine-grained intermediate dikes. Ammonite and gastropod fossils occur in very fine to fine-grained sandstone beds directly overlying limestone beds. The contact at Takhini subdivision is interpreted as unconformable.

King Lake

Basal Laberge Group strata crop out near King Lake ~20 km northwest of Whitehorse (Fig. 1). At this locality, crystal (quartz, feldspar) lithic tuff of the Nordenskiöld dacite nonconformably overlies Late Triassic gabbro of the Povoas formation (zone 08V, 474374 E, 6742564 N, NAD 83; Fig. 8a,b). Poorly sorted, polymictic pebble to cobble conglomerate of the Richthofen formation (Fig. 8c) overlies the tuff and is the dominant lithology that makes up the prominent ridges around King Lake. Subrounded to rounded clasts range from 1 to 8 cm. Conglomerate units at this locality are very weathered and typically not well exposed, but the clasts appear to be volcanic and felsic plutonic rocks.

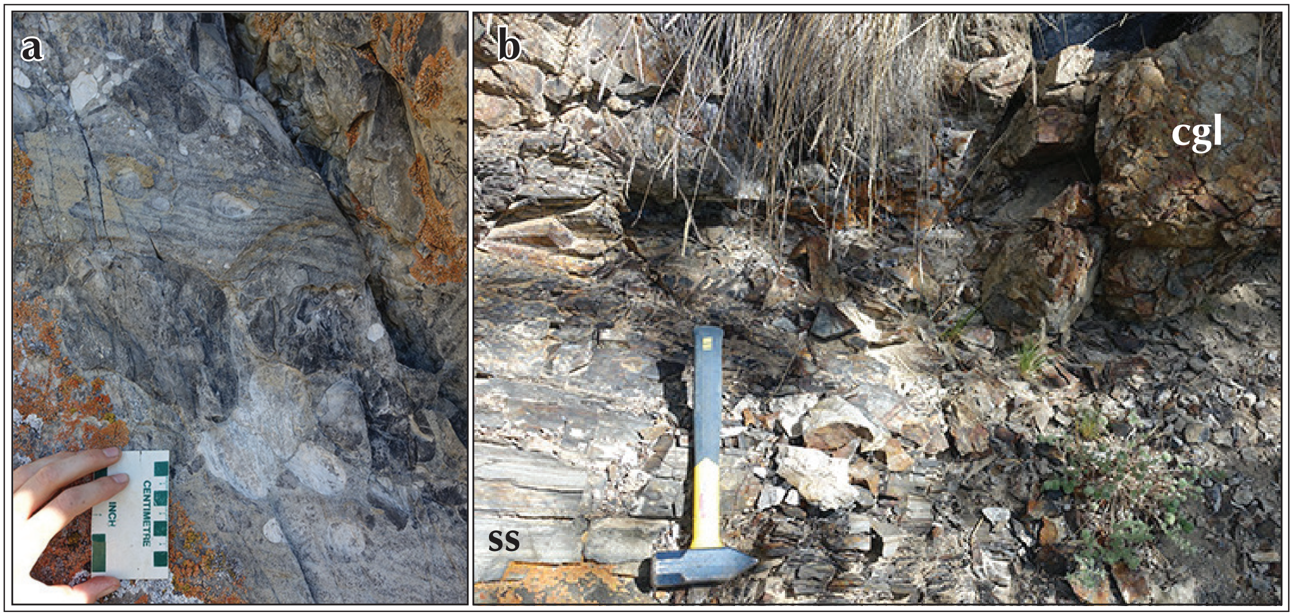

Figure 7. Field photographs of the Richthofen formation at Takhini subdivision. ***(a)*** Monomictic limestone conglomerate and laminated limestone; and ***(b)*** contact between dark blue very fine to fine-grained sandstone and mudstone couplets and pebble to boulder conglomerate.

Figure 8. Field photographs of the Richthofen formation at King Lake. ***(a)*** Contact between Nordenskiöld dacite crystal lithic tuff and Povoas formation gabbro; ***(b)*** fresh surface of crystal lithic tuff; and ***(c)*** Laberge Group polymictic pebble to cobble conglomerate.

Mount Byng

Northeast of Mount Byng, the Richthofen formation overlies limestone that is currently mapped as undifferentiated Aksala formation (Fig. 4d; zone 08V, 539547 E, 6757952 N, NAD 83; Hart and Radloff, 1990). The base of this section consists of light grey-blue, pebble to cobble, poorly sorted, clast to matrix-supported, limestone conglomerate (Fig. 9a). Subrounded to rounded limestone clasts that range in size from 1 to 7 cm are the most abundant components in the conglomerate. Subrounded to rounded, pebble-sized, dark grey volcanic porphyry clasts are less abundant. The limestone unit is overlain by dark grey-blue, very fine to fine-grained Richthofen formation sandstone with buff coloured laminations. Richthofen formation strata at this location are comparable to those in other areas of the Whitehorse trough and typically characterized by fining-up mudstone and sandstone couplets (Fig. 9b) with rare burrows. Couplets range in thickness from 0.5 to 3 cm, with very fine grained material making up darker coloured beds and the fine-grained sand characterizing buff coloured beds. Contacts between beds are often wavy and buff coloured beds locally pinch and swell (Fig. 9c). The contact between the Laberge Group and Lewes River Group at Mount Byng is interpreted to be unconformable.

Mount Slim

Basal Laberge Group strata crop out at two localities southeast of Mount Slim, located ~20 km northeast of Whitehorse. In this area, the Richthofen formation overlies volcaniclastic sandstone and limestone of the Aksala formation. At the first locality, dark grey mudstone and buff coloured sandstone couplets of the Richthofen formation overlie green, fine to medium-grained sandstone mapped as the Casca member (Fig. 1; zone 08V, 517754 E, 6746129 N, NAD 83; Hart and Radloff, 1990; Fig 10a). Nearby dikes give the weathered surface of Richthofen formation strata a rusty, red-brown colour. At the second locality, the Richthofen formation unconformably overlies grey-blue limestone of the Aksala formation (zone 08V, 514475 E, 6751661 N, NAD 83). Dark grey, 0.2 to 2 cm unlined burrows are abundant at this locality and typically occur in buff-coloured beds (Fig. 10b,c). Smaller burrows are parallel to bedding, whereas larger burrows are vertical (Fig. 10b,c). Burrowed mudstone and sandstone couplets at this location resemble Richthofen formation strata described along the eastern shore of Lake Laberge during the 2016 field season (van Drecht *et al.*, 2017). The contacts between the Laberge Group and Lewes River Group in the Mount Slim area are interpreted to be unconformable.

Figure 9. *Field photographs of the Richthofen formation at Mount Byng.* ***(a)*** *Pebble to cobble limestone conglomerate;* ***(b)*** *Richthofen formation mudstone and sandstone couplets; and* ***(c)*** *example of wavy contacts between mudstone and sandstone couplets.*

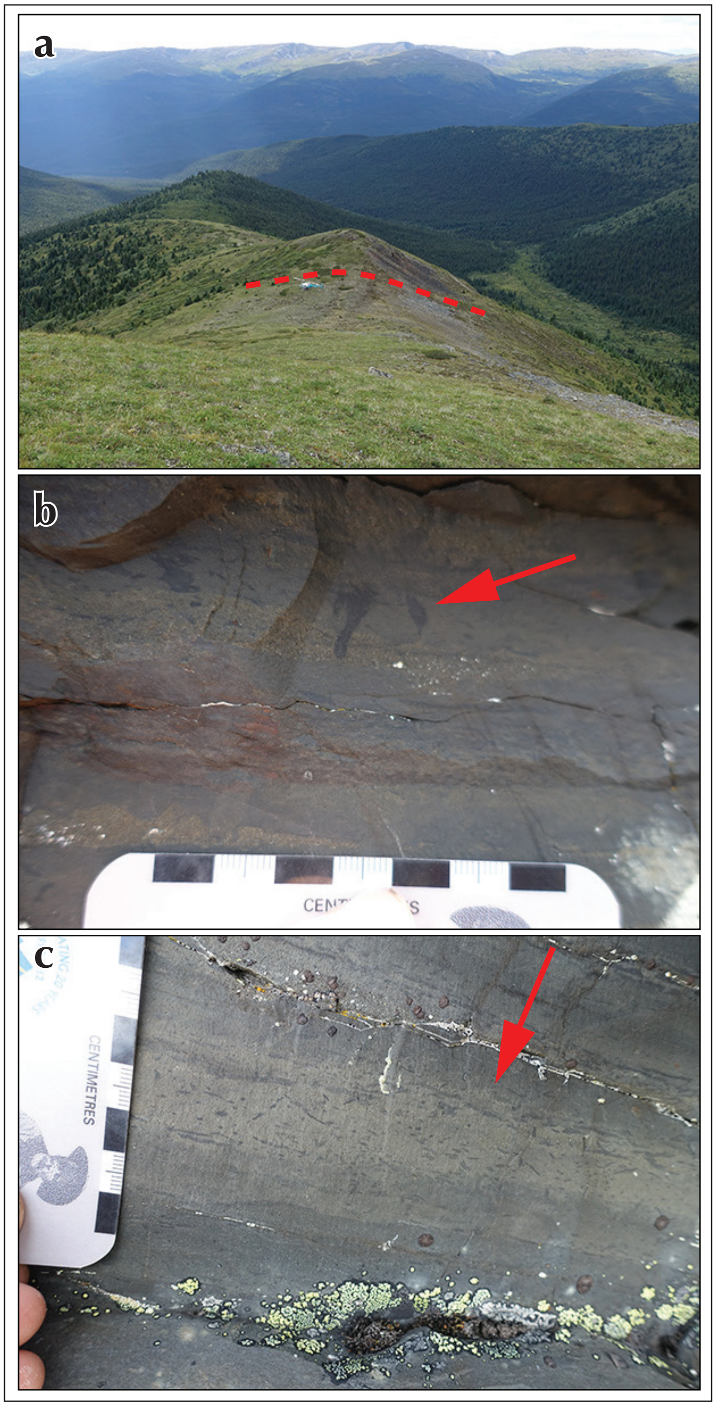

Figure 10. *Field photographs of the Richthofen formation at Mount Slim.* ***(a)*** *Rusty, red weathering Richthofen formation (near helicopter; above red line) overlying sandstone of the Askala formation (foreground; below red line);* ***(b)*** *vertical burrows in Richthofen formation mudstone and sandstone couplets; and* ***(c)*** *horizontal burrows in Richthofen formation mudstone and sandstone couplets.*

CONCLUSIONS

The Laberge Group-Lewes River Group contact observed at various locations during summer 2017 is apparently unconformable, which is consistent with a period of latest Triassic-earliest Jurassic erosion and/or nondeposition across the Whitehorse trough (*e.g.,* Lowey, 2008). The Laberge Group overlies multiple Carnian to Rhaetian units of the Lewes River Group, likely due to a combination of the complex internal stratigraphy and/or exhumation of the Whitehorse trough shoulders, creating topography prior to Early Jurassic sedimentation in central Yukon. The Lewes River Group is interpreted as a volcanic arc complex that formed a topographic high and was fringed by reef buildups and shallow lagoons (Bordet, 2017). The complex paleotopography created by the Late Triassic volcanic arc was further enhanced by the widespread exhumation and erosion, suggested by the unconformable relationships with the overlying Laberge Group. Variable paleotopography within the Lewes River Group in the latest Triassic-earliest Jurassic likely influenced paleodrainage pathways during Early to Middle Jurassic Laberge Group deposition.

In the northern apex of the trough, basal Tanglefoot formation rocks overlie the Norian-Rhaetian carbonate sequences of the Aksala formation at Mandanna Lake and Rhaetian Mandanna member at Conglomerate Mountain. In the central region of the trough, basal Richthofen formation rocks overlie carbonate sequences of the Aksala formation at Takhini subdivision and Fish Lake as well as clastic rocks of the Aksala formation at Mount Slim and the Carnian Povoas formation at King Lake. This suggests that latest Triassic-earliest Jurassic exhumation and erosion of the Lewes River Group may have been greater on the western flank of the trough to expose mafic volcanic rocks of the Povoas formation, prior to Laberge Group sedimentation. The contact between the Povoas formation gabbro and basal Laberge Group strata at King Lake may also suggest that exhumation was followed by rapid subsidence, allowing basal Laberge Group strata to transgress west.

Proximal Tanglefoot formation strata at Mandanna Lake and Conglomerate Mountain are consistent with deposition in a submarine mass-flow fan setting. Distal strata of the Richthofen formation described at Fish Lake, Takhini subdivision, King Lake, Mount Byng and Mount Slim are indicative of turbiditic facies and consistent with deposition in a distal submarine fan setting. Although rare, the foliated mafic rock clasts at Fish Lake suggest that these Laberge Group units may represent Pliensbachian or younger conglomeratic beds, as metamorphic rock fragments are only observed in such strata in northern British Columbia (Shirmohammad *et al.,* 2011). This may indicate a potentially younger depositional age for basal strata at this locality, relative to basal strata in the western region of the trough. It is uncertain whether limestone conglomerate at the Takhini subdivision and Mount Byng field localities belong to the uppermost Lewes River Group or basal Laberge Group.

Stratigraphic constraints and detrital zircon U-Pb and Hf isotope studies of samples collected during the 2016 and 2017 field seasons will be used to test the Sinemurian to Toarcian transgression of basal Laberge Group strata westward across the Whitehorse trough. Isotopic studies will also be used to more fully define the depositional age, provenance and paleodrainage history of Laberge Group rock units and provide new insights on the evolution of the Intermontane terranes in the northern Canadian Cordillera.

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