Updates on the Middle Triassic-Middle Jurassic stratigraphy and structure of the Teslin Mountain and east Lake Laberge areas, south-central Yukon

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ABSTRACT

Stratigraphic and structural relationships within Stikinia, and overlap assemblages of the Whitehorse trough, are investigated in the Teslin Mountain and east Lake Laberge areas, south-central Yukon. Regional north-trending faults divide the map area into rock assemblages with distinct structural and stratigraphic characteristics. Volcanic arc rocks of the Middle Triassic Joe Mountain Formation exposed at the southeastern tip of the Laurier Creek fault display an east-trending structural fabric. West of the Laurier Creek fault, the Upper Triassic Lewes River Group was the result of several events of carbonate sedimentation and reef development on the rim of a volcanic arc. Deformation in these strata is characterized by tight, east-verging folds and west-dipping thrust faults. An angular unconformity marks the basal contact of the Early-Middle Jurassic Laberge Group.

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INTRODUCTION

The Teslin Mountain, Lake Laberge, and Lower Laberge areas, northeast of Whitehorse (NTS 105E/2, 3 and 6; Fig. 1) are underlain by arc-related, volcano-sedimentary rocks that are part of Stikinia, the largest of the Intermontane terranes in the Canadian Cordillera. These rocks include the Middle Triassic Joe Mountain Formation (Hart, 1997) and Upper Triassic Lewes River Group (Bostock and Lees, 1938; Lees, 1934; Tempelman-Kluit, 1984, 2009; Tozer, 1958; Wheeler, 1961). They are unconformably overlain by the Early-Middle Jurassic Laberge Group, which defines the Whitehorse trough (Fig. 1; Wheeler, 1961; White *et al.*, 2012). Several post-accretion, Early to Late Cretaceous intrusions intrude the Triassic to Jurassic sequence, and are sometimes associated with mineral occurrences.

This paper introduces the stratigraphy and relationships between the Joe Mountain Formation, the Lewes River Group and the Laberge Group, and builds upon observations, results and interpretations from the Teslin Mountain area (105E/2) presented in Bordet (2016a). Four volcanic and volcaniclastic units were defined as part of the Joe Mountain Formation, and seven units were interpreted as part of the Lewes River Group, mainly describing its basal, volcanic portion. Four distinct overlap assemblages were identified, including rocks of the Laberge Group and Cretaceous intrusive bodies. An unconformable contact was mapped between the Lewes

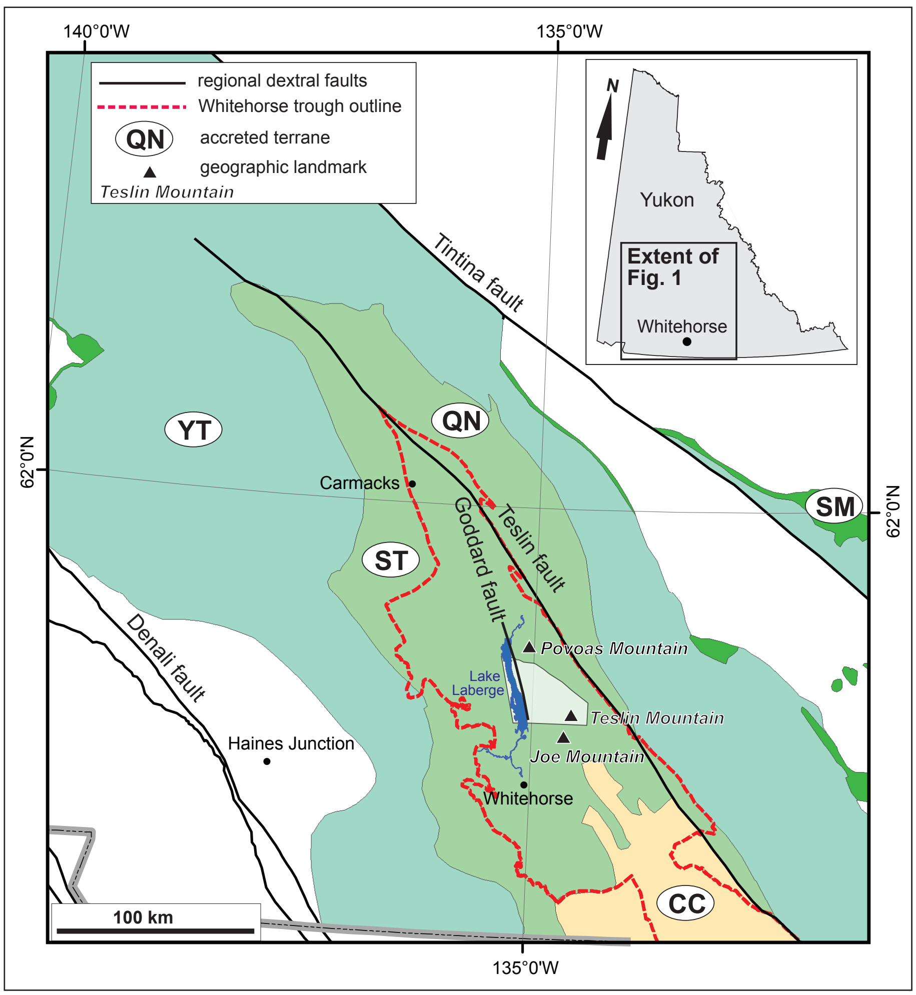


Figure 1. *Terrane map of south-central Yukon. White polygon on figure delineates the mapped area, and includes parts of Teslin Mountain (105E/2), Lake Laberge (105E/3) and Lower Laberge (105E/06) map sheets. Geographic landmarks referred to in text are indicated. Intermontane terranes are ST=Stikinia; QN=Quesnellia; CC=Cache Creek; YT=Yukon-Tanana; and SM=Slide Mountain. Terrane boundaries after Colpron and Nelson (2011). Whitehorse trough outline after Hutchison (pers. comm., 2015).*

River Group and the overlying thick-bedded, cobble-boulder polymictic conglomerate of the Laberge Group.

New bedrock mapping (1:50 000 scale) in 2016 was conducted west and northwest of Teslin Mountain (part of 105E/2), along the east shore of Lake Laberge and on Richthofen Island (parts of the Lake Laberge (105E/3) and Lower Laberge (105E/6) map sheets; Fig. 2). The geology of these areas is dominated by carbonate and clastic sedimentary rocks of the Lewes River Group, unconformably overlain by thin-bedded, mudstone/sandstone turbiditic sequences of the Laberge Group. Prominent north-trending ridges of Upper Triassic massive micritic limestone constitute distinctive stratigraphic markers, but also delineate the structural framework of this area.

The main contribution of this paper is the definition of new field units that form the Lewes River Group carbonate sequence. These are integrated with descriptions of the Lewes River Group volcanic sequence mapped during the 2015 field season (Bordet, 2016a). The internal stratigraphy of the Lewes River Group and unconformable relationship with the overlying Laberge Group are better characterized, and preliminary interpretations on its evolution are provided. New mapping has also allowed for better delineation of the northern contact of the Joe Mountain Formation near Teslin Mountain. Regional faults such as the Laurier Creek and Goddard faults constrain the distribution of Triassic Stikinia rocks and Jurassic and younger overlap assemblages, increasing complexity to pre-existing lateral facies transitions in the stratigraphic sequence. Finally, a north to northwest-trending fold and thrust belt was identified along the east shore of Lake Laberge, characterized by tight east-verging folds ramping up west-dipping thrusts.

TECTONIC SETTING

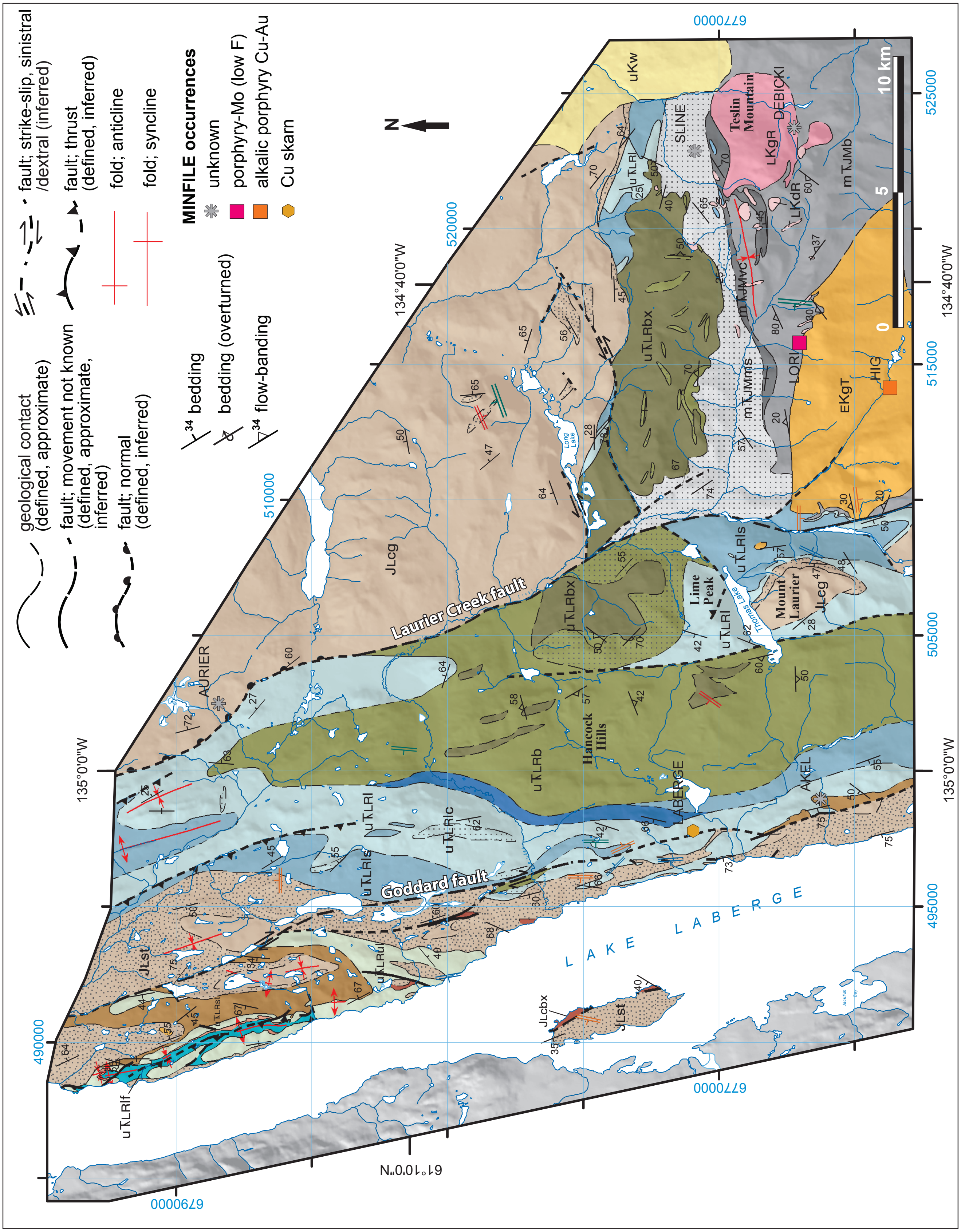
The Intermontane terranes underlie most of southern Yukon and British Columbia (BC) southwest of the Tintina fault (Fig. 1). They represent the largest amalgamation of crustal fragments that accreted to the North American margin during the Mesozoic (Coney *et al.*, 1980). In Yukon, the outer margin of the Intermontane terranes is defined by middle Paleozoic (and older) metasedimentary and metavolcanic rocks of the Yukon-Tanana terrane (Fig. 1; Mortensen and Jilson, 1985; Mortensen, 1992). The core and bulk of the Intermontane terranes comprise Mesozoic volcanic arc rocks of Stikinia and Quesnellia (Fig. 1; Colpron and Nelson, 2011; Wheeler *et al.*, 1991), which are juxtaposed along the Teslin fault north of Whitehorse (Fig. 1). Upper Paleozoic to lower Mesozoic accretionary complex rocks of the Cache Creek terrane (*e.g.*, Monger *et al.*, 1991; Struik *et al.*, 2001) are surrounded by Stikinia and Quesnellia (Fig. 1) and extend south of Whitehorse to northern British Columbia. To date, Cache Creek rocks have not been identified north of Whitehorse (Bickerton *et al.*, 2013).

Subduction of the Panthalassa Ocean along the North American margin during the Mesozoic produced volcanic arcs of Stikinia and Quesnellia (Mihalynuk *et al.,* 1994). In south-central Yukon, arc volcanism and arc-related basinal sedimentation are recorded by Middle and Upper Triassic volcanic and sedimentary rocks of Stikinia, namely the Joe Mountain Formation and Lewes River Group (Wheeler, 1961; Hart, 1997).

Continued erosion of Stikinia and Quesnellia arcs and their plutonic roots from the Early to Middle Jurassic resulted in the deposition of up to 3000 m of sediments of the Lower to Middle Jurassic Laberge Group in the Whitehorse trough (*e.g.*, Wheeler, 1961; White *et al.*, 2012; Figs. 1 and 3). The Whitehorse trough extends about 650 km from Dease Lake, BC to north of Carmacks in central Yukon. The Whitehorse trough originally developed as a forearc basin and evolved into a northwest-trending, synorogenic, intermontane piggy-back transpressional basin by Middle Jurassic (Colpron *et al.*, 2015; White *et al.*, 2012).

REGIONAL STRATIGRAPHY

In south-central Yukon, the Middle Triassic Joe Mountain Formation and Upper Triassic Lewes River Group of Stikinia comprise coherent, massive to flow-banded or pillowed, subalkaline tholeiitic to calc-alkaline basalt and basaltic andesite, as well as a range of volcaniclastic units (Hart, 1997; Figs. 2 and 3). In addition, the Lewes River Group comprises a thick sedimentary and volcaniclastic sequence, dominated by thick-bedded limestone, calcareous conglomerate, calcareous sandstone/mudstone, and volcaniclastic sandstone, mudstone and conglomerate (Aksala formation; Wheeler, 1961; Hart, 1997; Tempelman-Kluit, 1984, 2009). A summary of regional mapping work and original stratigraphic descriptions of the Joe Mountain Formation and Lewes River Group are provided in Bordet (2016a).


geological contact (defined, approximate)
fault; movement not known (defined, approximate, inferred)
fault; normal (defined, inferred)
fault; strike-slip, sinistral /dextral (inferred)
fault; thrust (defined, inferred)
fold; anticline
fold; syncline
34 bedding
bedding (overturned)
34 flow-banding
MINFILE occurrences
unknown
porphyry-Mo (low F)
alkalic porphyry Cu-Au
Cu skarn
N
0
5
10 km
Laurier Creek fault
Goddard fault
L A K E   L A B E R G E
Hancock Hills
Lime Peak
Mount Laurier
Teslin Mountain
Long Lake
Thomas Lake
LAURIER
LABERGE
AKEL
SLINE
DEBICKI
LORI
HIG
135°0'0"W
134°40'0"W
61°10'0"N
490000
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LKgR
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mTJMb
mTJMms
mTJMvc
uTLRb
uTLRbx
uTLRl
uTLRls
uTLRlc
uTLRf
uTLRst

UPPER/LATE CRETACEOUS
OPEN CREEK VOLCANIC ROCKS

- **uKw** — dark grey to brown-weathering basalt lava and tephra, chaotic volcanic breccia (~83-78 Ma; Stevens *et al.*,1982; Hart, 1997; Tempelman-Kluit, 2009)

TESLIN MOUNTAIN PLUTON

- **LKgR** — massive, blocky, medium-grained, grey-weathering, pale grey-white granodiorite (~78 Ma; J. Crowley, *pers. comm.,* 2016)
- **LKdR** — tan to grey-weathering, massive, blocky, fine-grained, dark grey-green diorite and quartz diorite

EARLY CRETACEOUS
LAURIER CREEK PLUTON

- **EKgT** — grey to tan-weathering, white to pale pink, equigranular, medium to coarse-grained granodiorite, monzonite, monzodiorite and quartz diorite (~118 Ma; Stevens *et al.*, 1982)

DIKES - EARLY TO LATE CRETACEOUS

- **rhyolite:** pale pink/orange/beige to tan-weathering, massive to blocky or locally foliated rhyolite
- **diorite:** grey-beige weathering, grey fresh, porphyritic

DIKES - JURASSIC (?)

- **gabbro:** brown-weathering, conchoidally fractured, dark grey-green gabbro dikes

LOWER AND MIDDLE JURASSIC
WHITEHORSE TROUGH, LABERGE GROUP

- **JLcg** — grey-brown-rusty to tan-weathering, thick-bedded, dominantly matrix-supported to locally clast-supported, poorly sorted, polymictic pebble to boulder conglomerate
- **JLcbx** — dark grey-green weathering, bright green, thick to medium-bedded, matrix-supported, immature polymictic, chaotic cobble to boulder conglomerate; bright green, fine-grained, non-calcareous volcanic, quartz-rich sandstone matrix
- **JLst** — dark grey-brown weathering, dark grey, thin-bedded, slightly calcareous to non-calcareous, turbiditic mudstone and siltstone (Sinemurian; Hart, 1997)

UPPER TRIASSIC
LEWES RIVER GROUP
Carbonate sequence; Carnian to Norian *(Tozer, 1958)*

- **uTLRst** — rusty-brown weathering, dark grey, thin to medium-bedded, non-calcareous to locally calcareous mudstone
- **uTLRul** — very thick bedded, pale grey to orange weathering, dark grey, micritic limestone
- **uTLRscg** — brown-orange weathering, dark grey-green, non-calcareous, polymictic medium to coarse-grained sandstone and matrix-supported granule conglomerate
- **uTLRlf** — thick to medium-bedded, pale grey limestone mudstone; argillaceous, fossiliferous limestone wackestone (bivalve or brachiopod shells, corals, burrows)
- **uTLRl** — massive to thick-bedded, pale grey-weathering, micritic limestone and bioclastic limestone
- **uTLRlc** — tan-grey weathering, clast-supported (locally matrix-supported), non-sorted, pebble to cobble calcareous conglomerate
- **uTLRls** — orange-brown weathering, thin to medium-bedded, grey, fine-grained, non-calcareous and calcareous laminated sandstone/mudstone
- **uTLRcg** — brown to grey-weathering, brown, matrix-supported polymictic conglomerate and fine to medium-grained sandstone

Volcanic sequence; Carnian and older *(Hart, 1997)*

- **uTLRb** — dark green, flow-banded to pillowed aphyric to pyroxene-phyric basalt and plagioclase-phyric basalt or andesite
- **uTLRbx** — thick-bedded volcanic breccia
- **uTLRvs** — volcaniclastic sandstone and matrix-supported, polymictic cobble conglomerate

MIDDLE TRIASSIC
JOE MOUNTAIN FORMATION

- **mTJMb** — rusty-brown weathering, dark grey-green, fine to medium-crystalline, massive to pillowed aphyric basalt and basaltic andesite
- **mTJMvc** — thick-bedded, polymictic, chaotic volcaniclastic boulder conglomerate; tan-weathering, pale grey-green, medium-bedded volcaniclastic sandstone; dark green to grey, silicified laminated mafic ash tuff (~245 Ma; J. Crowley, *pers. comm.*, 2016)
- **mTJMms** — thin to medium-bedded, slightly calcareous, laminated mudstone and medium to fine-grained, lithic, crystal-rich sandstone, conglomerate
- **mTJMl** — recrystallized lenses of thin-bedded banded calcareous mudstone and sandstone

Figure 2. *Geology of parts of the Teslin Mountain (105E/2), Lake Laberge (105E/3) and Lower Laberge (105E/6) areas based on 1:50 000-scale bedrock mapping conducted during the summers of 2015-2016 (Bordet, 2016a). Mineral occurrences from Yukon MINFILE (2015). Grid in Universal Transverse Mercator coordinates (UTM zone 8, NAD83).*

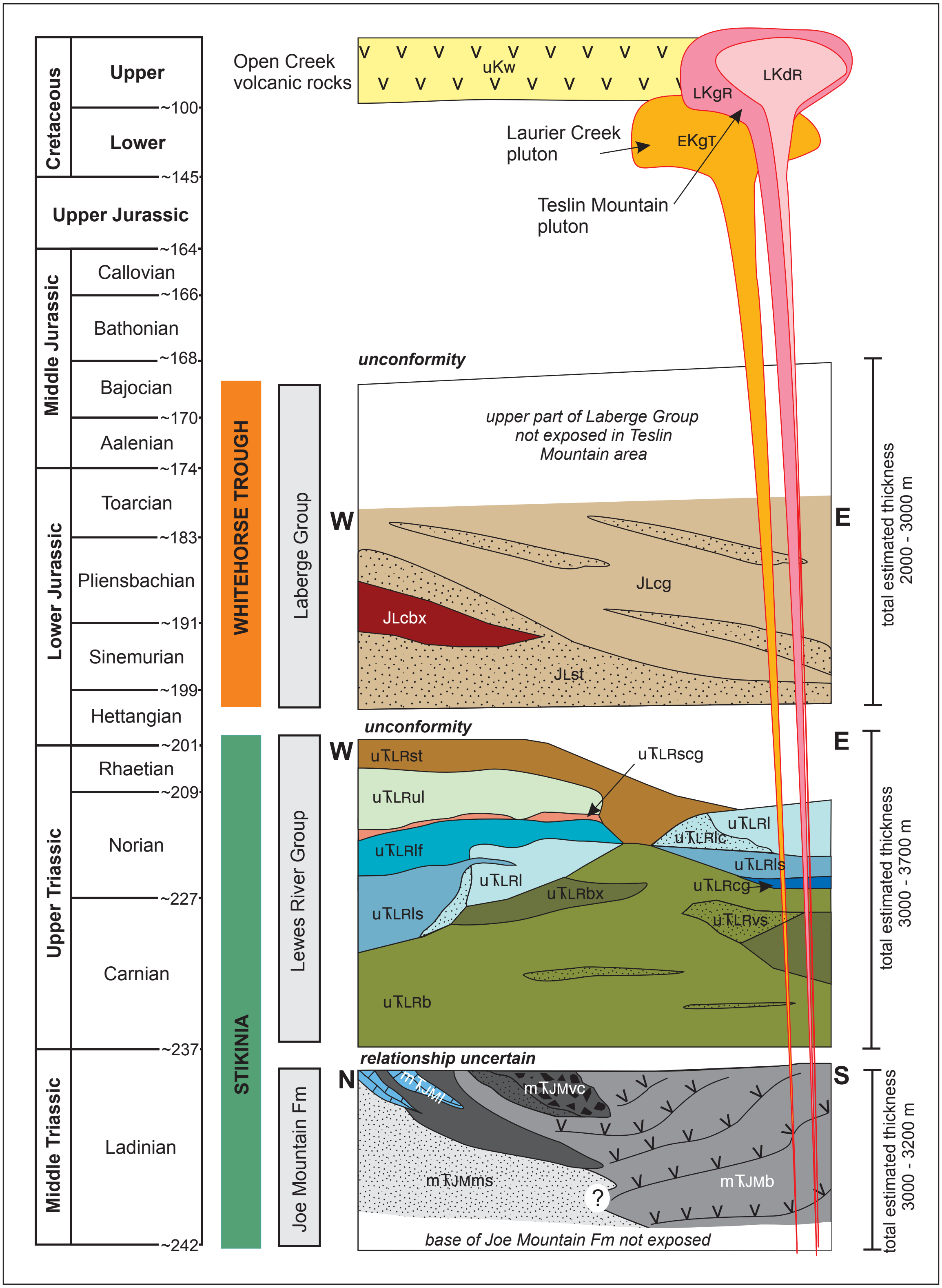

Figure 3. *Schematic stratigraphic relationships in the Teslin Mountain and Lake Laberge areas. See Fig. 2 for description of map unit codes. Unit thicknesses are based on field estimates and map measurements. Whitehorse trough extent after White et al. (2012). Time scale after Cohen et al. (2013).*

The Lower to Middle Jurassic Laberge Group includes shallow marine to fluvial and coal-bearing sandstone, conglomerate and shale of the Tanglefoot formation exposed in the northern part of the Whitehorse trough (Hart, 1997; Lowey, 2005, 2008; Tempelman-Kluit, 1984, 2009). To the south, deep-marine turbidite and mass-flow conglomerate of the Richthofen formation are partly coeval and laterally equivalent to the Tanglefoot formation (e.g., Lowey, 2005; Tempelman-Kluit, 1984, 2009). The Nordenskiöld facies, a distinct crystal-lithic tuff (Tempelman-Kluit, 1984, 2009), occurs at multiple stratigraphic levels in both the Richthofen and Tanglefoot formations, and represents at least three distinct volcanic events between 188 and 186 Ma (Colpron and Friedman, 2008).

Other overlap assemblages include Early Cretaceous Open Creek volcanic rocks (Tempelman-Kluit, 1984, 2009), and intrusive bodies related to the Teslin and Rancheria plutonic suites (Fig. 3; Colpron *et al.*, 2016; and discussion below).

UPDATES ON TRIASSIC STRATIGRAPHY (STIKINIA)

The southeastern part of the field area, around Teslin Mountain, is dominated by coherent pillowed basalt, mafic volcaniclastic conglomerate and sandstone, and minor carbonate rocks of the Middle Triassic Joe Mountain Formation, crosscut by Early and Late Cretaceous intrusions (Fig. 2). To the north, the Joe Mountain Formation is unconformably overlain by mafic volcaniclastic rocks of the Upper Triassic Lewes River Group. Another angular unconformity marks the basal contact of the Lower to Middle Jurassic Laberge Group. Between Laurier Creek fault and the east shore of Lake Laberge, the Lewes River Group is characterized by a basal mafic volcanic sequence, overlain by a thick calcareous to clastic sedimentary sequence (Fig. 2). The contact between the Lewes River Group and the Laberge Group is marked also by an angular unconformity.

JOE MOUNTAIN FORMATION (MIDDLE TRIASSIC)

Map units of the Middle Triassic Joe Mountain Formation around Teslin Mountain were previously defined by Bordet (2016a). They include: 1) a unit of dark grey, grey-green aphyric basalt (mTJMb); 2) a volcaniclastic sequence including poorly sorted volcanic conglomerate, mafic tuff and volcanic sandstone (mTJMvc); and 3) a south-dipping sedimentary sequence including mudstone/sandstone (mTJMms) and lenses of carbonate rocks (mTJMl). New observations are presented here, but unit descriptions remain unchanged and the reader is referred to Bordet (2016a, b) for complete descriptions.

The thickness of the Joe Mountain Formation is estimated at ~3000 m (Fig. 3), including a ~1000 m-thick sedimentary sequence to the north, and a cumulative thickness of 2000-2300 m for the basalt and volcaniclastic sequence (Bordet, 2016a). Previous thickness estimates indicate at least 3200 m for the Joe Mountain Formation type section at Joe Mountain (Hart and Hunt, 1994; Hart, 1997).

Extent of Joe Mountain Formation west of Teslin Mountain

New exposures of aphyric basalt and plagioclase-phyric basaltic-andesite (mTJMb) were mapped during the 2016 field season. East of the Laurier Creek fault, Joe Mountain Formation basalt underlies the Lewes River Group carbonate sequence, and both are intruded by monzonite and monzodiorite of the Laurier Creek pluton (EKgT) (Fig. 4a). The contact between Joe Mountain Formation basalt and the overlying Lewes River Group carbonate sequence is folded (Fig. 4b), and is likely a stratigraphic disconformity.

West of Teslin Mountain, thin to medium-bedded, finely laminated, pale green to tan-weathering mafic tuff and volcanic mudstone/sandstone (mTJMvc) represents the western continuity of a thick volcaniclastic sequence mapped at Teslin Mountain, which includes poorly sorted volcaniclastic conglomerate, volcaniclastic sandstone and mafic tuff (Bordet, 2016a). It is underlain by rusty brown-weathering, grey, very finely laminated, calcareous to non-calcareous mudstone/sandstone (mTJMms), a relationship also previously recognized at Teslin Mountain (Bordet, 2016a). The Laurier Creek fault marks the westernmost boundary of these units.

Age and interpretation

Recent mapping better defines the extent of the Joe Mountain Formation west of Teslin Mountain, and its western boundary is marked by the Laurier Creek fault. Coherent, massive aphyric microcrystalline basalt appears to be underlain by a series of fine-grained, thin-bedded mudstone/sandstone. This suggests the existence of a sedimentary basin prior to, or coeval with, basaltic volcanism. Thin-laminated, fine-grained mudstone/sandstone indicates deposition under water.

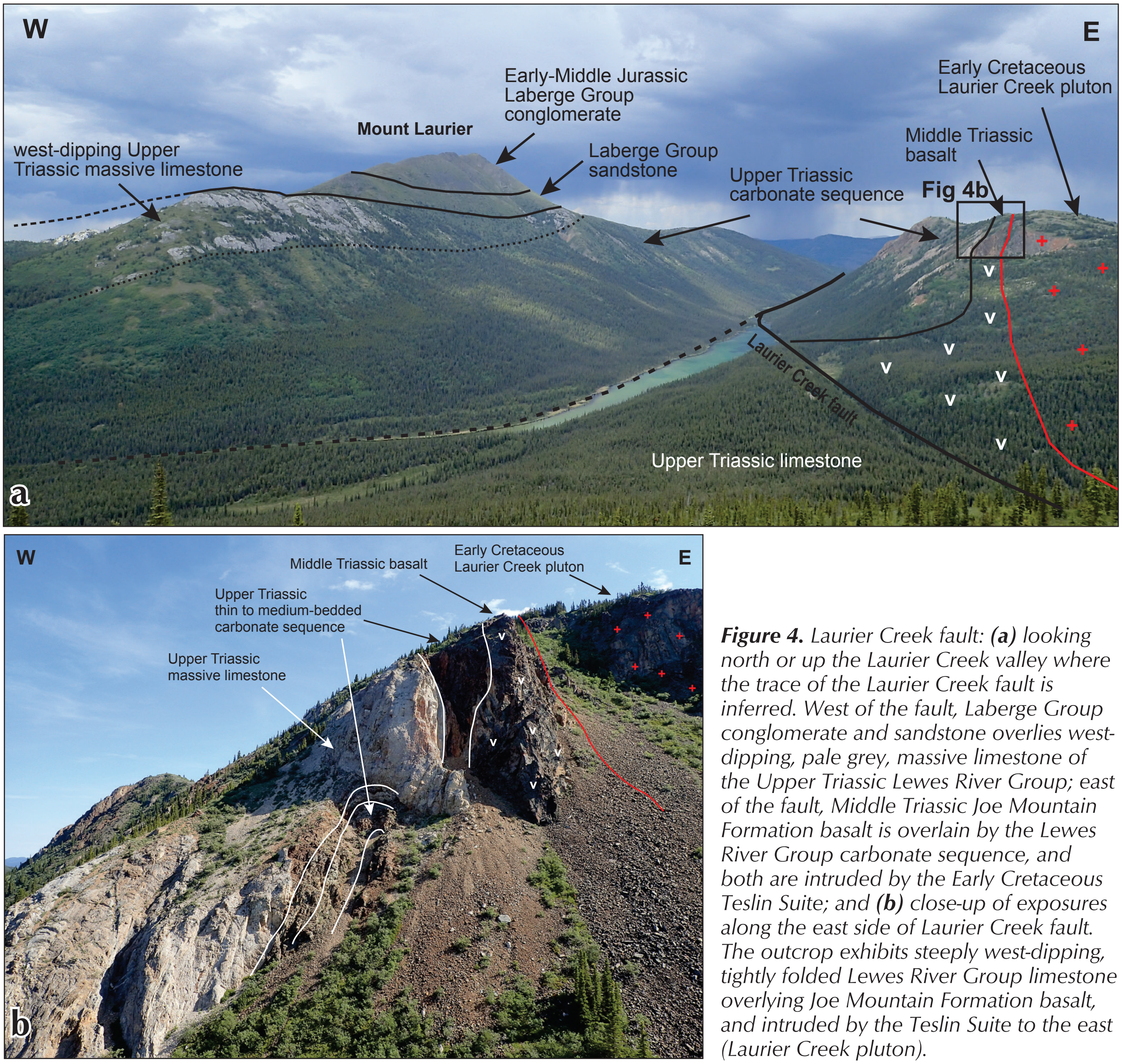

Figure 4. *Laurier Creek fault:* ***(a)*** *looking north or up the Laurier Creek valley where the trace of the Laurier Creek fault is inferred. West of the fault, Laberge Group conglomerate and sandstone overlies west-dipping, pale grey, massive limestone of the Upper Triassic Lewes River Group; east of the fault, Middle Triassic Joe Mountain Formation basalt is overlain by the Lewes River Group carbonate sequence, and both are intruded by the Early Cretaceous Teslin Suite; and* ***(b)*** *close-up of exposures along the east side of Laurier Creek fault. The outcrop exhibits steeply west-dipping, tightly folded Lewes River Group limestone overlying Joe Mountain Formation basalt, and intruded by the Teslin Suite to the east (Laurier Creek pluton).*

A preliminary U/Pb zircon age of ~245 Ma (J. Crowley, *pers. comm.,* 2016) was obtained from the laminated mafic tuff of the Joe Mountain Formation volcaniclastic sequence (mT̄JMvc) at Teslin Mountain. The outcrop comprises brown to grey-weathering, fine to coarse-grained, laminated volcanic sandstone/mudstone. This new date confirms a Middle Triassic age for the Joe Mountain Formation. It is compatible with Ladinian conodont ages obtained at Joe Mountain, about 15 km south of the present study area (Hart and Orchard 1996; Hart 1997).

LEWES RIVER GROUP (UPPER TRIASSIC)

Mapping conducted during the summer of 2016 covered areas dominantly underlain by the Upper Triassic Lewes River Group. As a result, the internal stratigraphy of the group was refined, some unit names were reattributed, and individual unit descriptions were modified to reflect extended geographic coverage or the addition of a new lithology. The following unit descriptions supersede those presented in Bordet (2016a).

The Lewes River Group is divided into a basal mafic volcanic sequence (~1000 m thick), a lower carbonate sequence (>1200 m thick) and an upper carbonate sequence (1000-1500 m thick). The total thickness of the group was determined to be >3000 m based on field estimates and map measurements (Fig. 3). Previous thickness estimates for the Lewes River Group are between 2100 m (Tozer, 1958) and greater than 3000 m (Hart, 1997).

Mafic volcanic sequence

The volcanic sequence of the Lewes River Group is exposed in the central part of the map area, along a north-trending belt west of Lime Peak and Mount Laurier and in the Hancock Hills, and east of the Laurier Creek fault (Fig. 2). These rocks were mapped during the summer of 2015 and described by Bordet (2016b). Revisions of the volcaniclastic units are presented here. For field photographs, see Bordet (2016a).

Between the Laurier Creek and Goddard faults, in the Hancock Hills, coherent, flow-banded and pillowed basalt (uTrLRb) dominate. The unit comprises coherent dark green-grey to rusty brown-weathering, dark green, finely crystalline, flow-banded to pillowed aphyric to pyroxene-phyric basalt and plagioclase-phyric basalt or andesite. Phenocrysts include plagioclase (1-5%), pyroxene (1%), and olivine (<1%). Coherent basalt is interbedded with volcanic breccia (uTrLRbx):

- Thick-bedded (1-5 m), tan to rusty to grey-weathering, dark green, matrix-supported polymictic volcaniclastic conglomerate and breccia includes poorly sorted, subangular to subrounded, red oxidized, pyroxene or plagioclase-phyric basalt/andesite, vesicular to massive andesite, and lapilli-size angular fragments of grey-green to red aphanitic volcanic rock. Subangular, lapilli-size clasts dominate, and larger clasts (20-30 cm) are subrounded. The matrix is a fine-grained, grey to green volcaniclastic sandstone, with grains ranging from ash to lapilli size and disseminated plagioclase and pyroxene crystals. This unit forms a thick sequence east of the Laurier Creek fault (Fig. 2), where it is locally interbedded with coherent volcanic mafic rocks and volcaniclastic sandstone.
- A pale green, matrix-supported volcanic breccia with subrounded, pyroxene-phyric basalt blocks forms beds up to 10-20 m thick.

Coherent basalt is also interbedded with various volcanic sandstone and conglomerate units (uTrLRvs):

- Beige to brown weathering, pale grey-green, medium-grained volcaniclastic sandstone and matrix-supported, polymictic cobble conglomerate, have a locally calcareous, plagioclase-rich, mafic sandstone matrix. The conglomerate includes subangular to subrounded clasts (up to granule size) of dark green volcanic clasts, dark grey mudstone, beige fine-grained glassy rhyolite(?), finely vesicular plagioclase-phyric volcanic rock and plagioclase-rich sandstone.
- In places, quartz-rich (1-2%), brown-weathering, dark grey-green, fine to medium-grained volcaniclastic sandstone lenses are interbedded with the polymictic volcanic breccia.
- A grey-weathering, pale to dark grey-green, fine to medium-grained pyroxene, lithic, mafic sandstone is locally interbedded with the pale green volcanic breccia. It contains dark grey, lithic volcanic lapilli and pyroxene crystals.

No occurrences of the Lewes River Group mafic rocks were observed west of the Goddard fault, except for a sliver of coherent, plagioclase-pyroxene-phyric, basalt-andesite in a valley bottom that parallels the inferred trace of the Goddard fault (*see* discussion below).

Carbonate sequence

The region between the Hancock Hills and the east shore of Lake Laberge is characterized by a succession of deformed sedimentary rocks that overlie the mafic volcanic sequence. In particular, north to northwest-trending ridges of pale grey-weathering, micritic limestone (Fig. 2) constitute visibly prominent stratigraphic marker beds and structural features. Detailed mapping in 2016 allowed the breakdown of a single carbonate sedimentary unit of the Lewes River Group (uTrLRl of Bordet, 2016a) into eight distinct units (Fig. 2). These can be further divided into a lower and an upper carbonate sequence, based on spatial distribution and stratigraphic relationships between units.

Lower carbonate sequence (uTrLRcg, uTrLRls, uTrLRl and uTrLRlc)

Polymictic conglomerate (uTrLRcg), thin to medium-bedded calcareous mudstone/sandstone (uTrLRls), thick-bedded micritic limestone (uTrLRl) and limestone conglomerate/breccia (uTrLRlc) are mapped in the south and central part of the map area, east of Mount Laurier and Laurier Creek fault, and around Lime Peak.

Brown to grey-weathering, brown, polymictic calcareous pebble conglomerate and fine to medium-grained sandstone (uTrLRcg) is mapped west of the Hancock Hills. The conglomerate is matrix-supported, with rounded pebbles of limestone, basalt and chert (Fig. 5a). It overlies Upper Triassic basalt and underlies massive micritic limestone, and is laterally equivalent to uTrLRls. This conglomerate unit likely represents a local disconformity at the base of the carbonate sequence, and its spatial distribution is restricted to the area immediately west of the Hancock Hills.

Thin to medium-bedded calcareous mudstone and sandstone (uTrLRls) is exposed west and northwest of the Hancock Hills, and east of Mount Laurier. Exposures along the Laurier Creek fault display a range of lithology overlying Joe Mountain Formation basalt, including:

- North-dipping, orange to brown weathering, thin to medium-bedded, non-calcareous and calcareous, fine-grained, laminated sandstone/mudstone, and coarse, calcareous sandstone to angular limestone pebble conglomerate (Fig. 5b), interbedded with fine-grained volcanic sandstone.
- A 3 to 5 m-thick, poorly sorted, matrix-supported limestone conglomerate, with unsorted, rounded limestone clasts of all sizes in a calcareous matrix. Towards the base of the sequence, this conglomerate is increasingly polymictic, with rounded pebbles to cobbles of limestone (90%), hornblende-phyric andesite or other volcanic and intrusive clasts (10%). It is interbedded with tan to grey weathering coarse sandstone with occasional limestone boulders or cobbles.

Massive to thick-bedded, pale grey-weathering, micritic and fossiliferous limestone is particularly well exposed at Lime Peak (uTrLRl; Fig. 5c; Yarnell *et al.,* 1999), as well as along a north-trending belt that extends north and west of the Hancock Hills. It overlies Middle and Upper Triassic volcanic rocks, or is interfingered with other thin-bedded calcareous units. In the centre of the map area, massive limestone is interbedded with tan to grey weathering, clast-supported (locally matrix-supported), non-sorted, pebble to cobble calcareous conglomerate (uTrLRlc; Fig. 5d), which also includes lenses of tan to orange weathering, fine-grained calcareous sandstone. The conglomerate comprises subrounded to subangular limestone mudstone clasts in a pale yellow-weathering, medium-grained, calcareous sandstone matrix.

Upper carbonate sequence (uTrLRlf, uTrLRscg, uTrLRul and uTrLRst)

The northwestern part of the map area is characterized by a distinctive succession of carbonate rocks, although, as in other areas, the framework is marked by north to northwest-trending ridges of pale grey micritic limestone.

The following units form the core of an anticlinorium along the east shore of Lake Laberge: a medium-bedded (30-50 cm), argillaceous, fossiliferous (Fig. 6a; bivalve or brachiopod shells, corals and burrows) limestone wackestone; a thin-bedded, calcareous sandstone and mudstone; and a thick to medium-bedded, pale grey micritic limestone including lenses of rusty-weathering, dark grey, calcareous mudstone (uTrLRlf; Fig 6b). These rocks are overlain by 5-10 m of brown to orange-weathering, dark grey-green, non-calcareous, medium to coarse-grained sandstone with polymictic, matrix-supported granule conglomerate (uTrLRscg; Fig. 6c). A characteristic of this clastic lithology is its high magnetic susceptibility (2-13 S.I.). Overlying this sequence is a very thick-bedded, pale grey to orange-weathering, dark grey, finely to coarsely crystalline, micritic limestone (uTrLRul; Fig. 6d), which is interbedded with minor bioclastic wackestone (Fig. 6e; corals, bivalve shells/brachiopods and crinoids), and minor calcareous sandstone and conglomerate.

Rusty brown-weathering, dark grey, thin (1-5 cm) to medium-bedded (up to 25 cm), non-calcareous to locally calcareous mudstone (uTrLRst; Fig. 6f) is mapped to the northwest of the map area (Fig. 2), and apparently underlies the limestone. However, bedding is interpreted to be overturned on the east side of the ridge, therefore this unit overlies the Lewes River Group carbonate sequence. Further east, this unit forms the core of a synclinorium, and is unconformably overlain by fine-grained sandstone/mudstone and conglomerate of the Laberge Group.

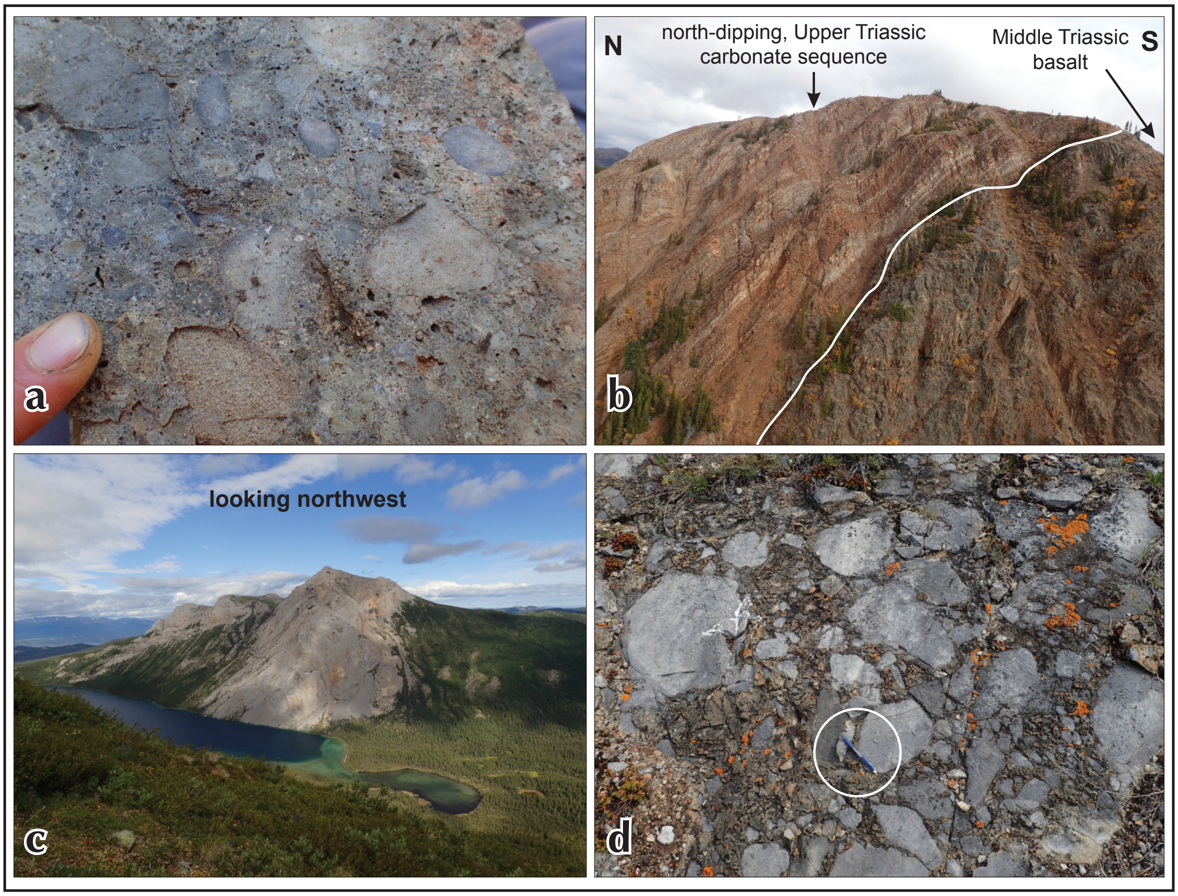

Figure 5. *Lewes River Group lower carbonate sequence:* ***(a)*** *pebble conglomerate of unit* uTLRcg*;* ***(b)*** *north-dipping sequence of medium-bedded calcareous sandstone, mudstone and conglomerate (*uTLRls*) overlying Joe Mountain Formation basalt exposed east of Laurier Creek fault;* ***(c)*** *looking northwest towards Thomas Lake (foreground) and Lime Peak. Lime Peak comprises several generations of reefal limestone attributed to unit* uTLRl*; and* ***(d)*** *clast-supported calcareous conglomerate of unit* uTLRlc*, comprising subrounded to subangular micritic limestone clasts in a tan to grey weathering, calcareous sandstone matrix (blue pen in centre of photo for scale, denoted by circle).*

Interpretation and age

Early mapping and stratigraphic section measurements by Tozer (1958), north of Povoas Mountain (Fig. 1), identified seven formations within the Lewes River Group carbonate sequence, with strata younging from west to east. These sedimentary strata overlie andesite exposed west of Povoas Mountain (Tozer, 1958). Based on correlations between measured sections, Tozer established that the carbonate sequence includes at least three levels of pale grey, massive limestone, which therefore represent distinct chronostratigraphic units.

In the Teslin Mountain and Lake Laberge areas, mafic volcanic rocks exposed in the Hancock Hills also form the lowest stratigraphic level in the Lewes River Group. These rocks are equivalent to Unit 1 of Tozer (1958), and to the Povoas formation introduced by Tempelman-Kluit (1984; terminology described in Bordet, 2016a). The relationship between the Lewes River Group mafic sequence and Joe Mountain Formation basalt (exposed at Teslin Mountain) remains unclear, as no contact between the two coherent volcanic sequences has been mapped.

The thick (~2000-2500 m) carbonate sequence overlying mafic volcanic rocks can be divided into eight map units, comprising multiple beds of massive, thick-bedded, micritic, pale grey limestone, interbedded with thin to medium-bedded, calcareous to non-calcareous, mudstone and sandstone. Two distinct sequences are identified:

- Thick-bedded, massive, micritic limestone, calcareous conglomerate, and thin-bedded calcareous mudstone/sandstone directly overlie Lewes River

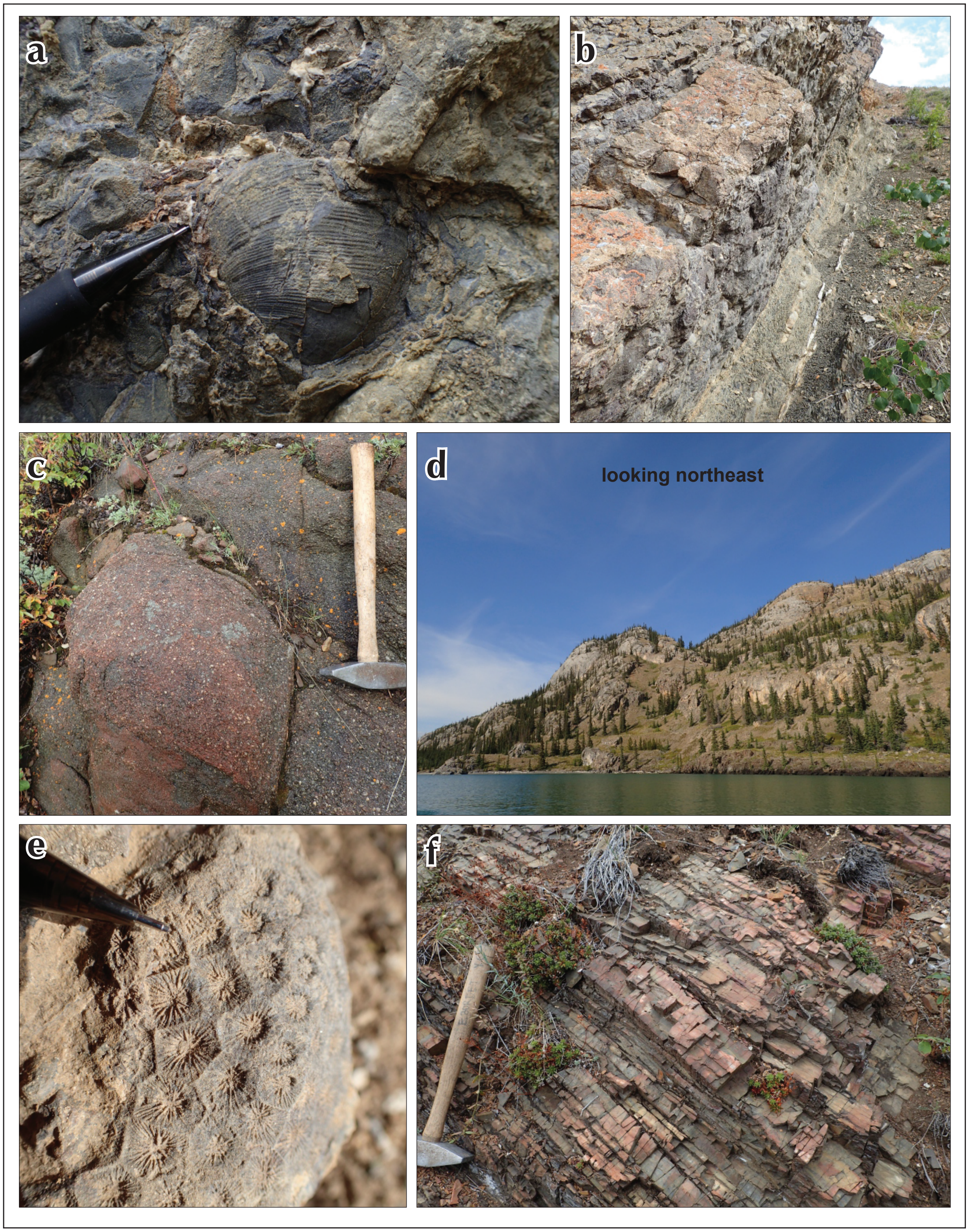

Figure 6. *Lewes River Group upper carbonate sequence:* ***(a)*** *shell fossil (bivalve or brachiopod) in calcareous mudstone wackestone (part of unit* uTrLRlf*);* ***(b)*** *partly fossiliferous, medium-bedded calcareous mudstone of unit* uTrLRlf*;* ***(c)*** *brown-weathering, non-calcareous, medium-grained sandstone and granule conglomerate of unit* uTrLRscg*; this sequence is about 5-10 m thick and underlies unit* uTrLRul*;* ***(d)*** *thick-bedded micritic limestone beds (*uTrLRul*) form a north-trending ridge along the east shore of Lake Laberge (lake in the foreground);* ***(e)*** *Scleratinian coral fossil from a fossiliferous interval of unit* uTrLRul*; and* ***(f)*** *west-dipping, rusty-weathering, thin to medium-bedded mudstone/sandstone strata of unit* uTrLRst.

Group basalt (Fig. 2) or Joe Mountain Formation basalt (Figs. 3 and 4b), from south of Mount Laurier to north of the Hancock Hills. At Lime Peak (Fig. 5c), the accumulation of several generations of reefs (Reid, 1980) contributed to a cumulative thickness of over 500 m of this reef complex. These strata are inferred to represent the lowest stratigraphic level and oldest rocks of the Lewes River Group carbonate sequence; they are referred to as the lower carbonate sequence.

- Along the east shore of Lake Laberge, thick-bedded, massive micritic limestone is underlain by clastic and carbonate rocks, including a distinctive fossiliferous unit and a clastic granule conglomerate and sandstone unit. No contact with the underlying basalt is mapped, therefore this sequence is inferred to overlie the lower carbonate sequence. It represents the highest stratigraphic level and youngest rocks of the Lewes River Group carbonate sequence.

Based on available fossil ages (Bordet, 2016b), the Lewes River Group carbonate sequence was deposited during the Late Triassic, dominantly during the Norian (Hoover, 1991; Senowbari-Daryan, 1990; Orchard, 1995; Orchard, *pers. comm.,* 2016). It is interpreted to have developed on the margin of a volcanic arc forming a topographic highland. Massive micritic limestone strata represent reef buildup structures (Reid, 1980; Yarnell, 1999), whereas calcareous conglomerate likely represents a high-energy zone along the slope in front of the reef. Other fine-grained, thin-bedded, more argillaceous units are interpreted as forming in deeper parts of the basin, or in shallow lagoons located between the reef and the arc. Continuous erosion of the arc provided a steady supply of volcanic material throughout the Late Triassic, and until the onset of Laberge Group sedimentation in the Jurassic.

OVERLAP ASSEMBLAGES

WHITEHORSE TROUGH – LABERGE GROUP

New observations from the Lake Laberge map sheet (105E/03)

Fine grained, thin-bedded clastic sedimentary rocks of the Early to Middle Jurassic Laberge Group (JLst) overlie the carbonate sequence of the Lewes River Group along the east shore of Lake Laberge. This fine-grained lithology contrasts with Laberge Group east of Laurier Creek fault and at Mount Laurier, which includes thick-bedded, polymictic pebble to boulder conglomerate exposed along steep ridges and cliffs (JLcg; complete description in Bordet, 2016a).

JLst comprises dark grey to brown-weathering, thin bedded, slightly calcareous to non-calcareous, dark grey turbiditic mudstone and siltstone, exposed along the west shore of Lake Laberge, on Richthofen Island and as a discontinuous strip along the east shore of Lake Laberge. JLst was previously described at the base of the Laberge Group conglomerate, or as interbeds within the conglomerate unit (Bordet, 2016a, b). New mapping suggests that this unit is prevalent and much thicker towards the west end of the map area, and conglomerate units only occur as interbeds. This unit unconformably overlies various units of the Upper Triassic Lewes River Group. Dark grey, thin-laminated mudstone displays interbeds of pale yellow-weathering sandstone with angular mudstone intraclasts (Fig. 7a). Load structures are also common between sandstone beds and underlying mudstone, and generally indicate a stratigraphic polarity to the west (Fig. 7b).

A conglomerate unit (JLcbx) is exposed east of Richthofen Island and on the east shore of Lake Laberge (Bordet, 2016b; Fig. 2). It is composed of dark grey-green weathering, bright green, thick to medium-bedded, matrix-supported, immature, polymictic, poorly-sorted cobble to boulder conglomerate (Fig. 7c) locally interbedded with thin-bedded, lenticular mudstone/sandstone. The matrix is composed of pale green, fine-grained, non-calcareous volcanic sandstone with up to 3-4% quartz eyes. Subrounded clasts include pale grey micritic limestone, plagioclase-phyric rhyolite, andesite (Fig. 7d) and dark grey mudstone.

Interpretation and age

Recent mapping suggests lateral facies changes within the Laberge Group from west to east. East of the Laurier Creek fault, Laberge Group units are dominated by cobble to boulder polymictic conglomerate. The lithology west of Laurier Creek fault, along Lake Laberge and on Richthofen Island, is dominated by fine-grained, thin-bedded turbiditic mudstone/sandstone, locally interbedded with granule to cobble polymictic conglomerate. This lithology is related to relatively deep-basin sedimentation. The thick mudstone/sandstone sequence to the west is interpreted as a submarine fan system, and the conglomerate unit is interpreted to represent submarine fan channel deposits (Dickie and Hein, 2005; Lowey, 2005, 2008). Limited conglomerate exposures within the turbiditic

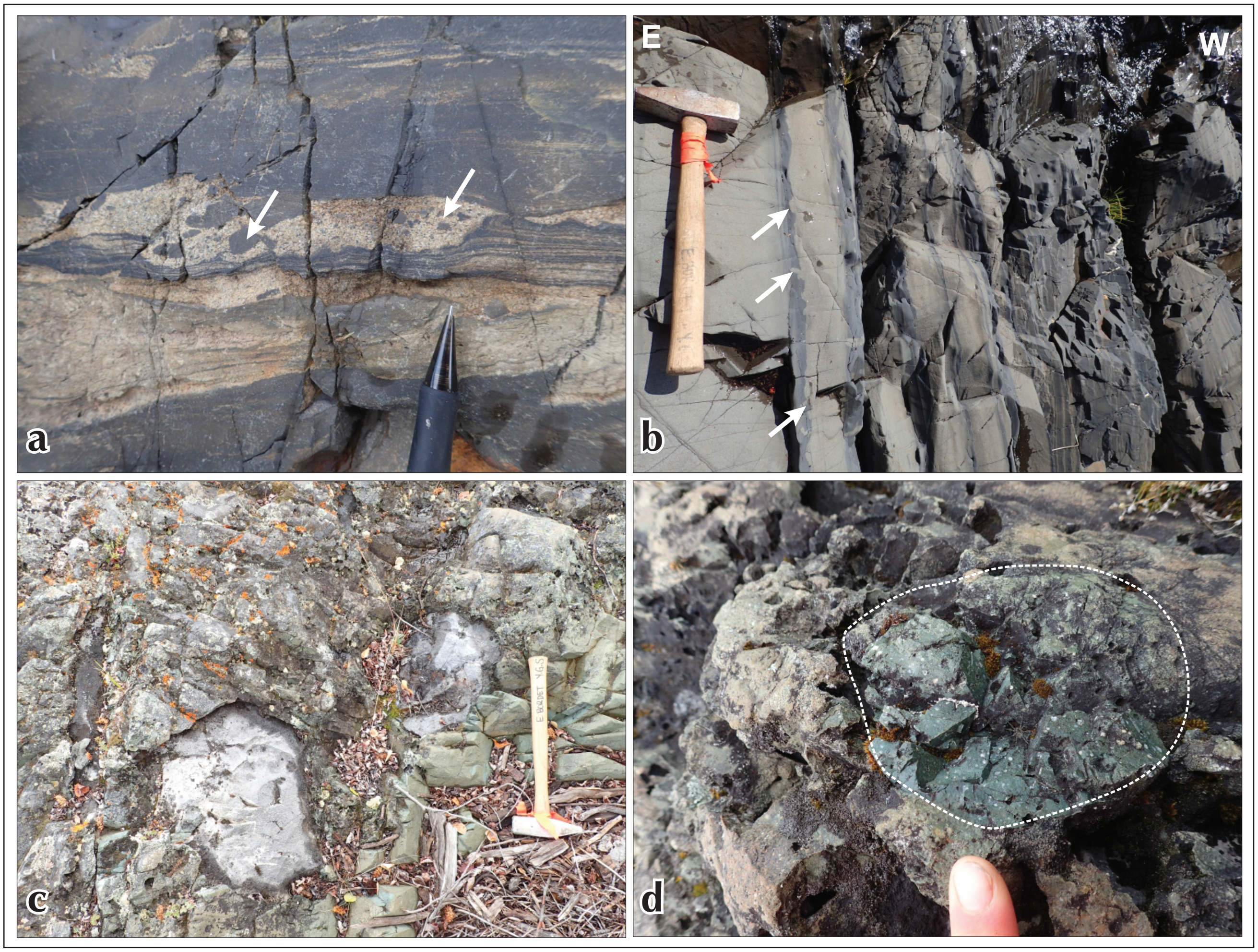

Figure 7. *Lithology of the Laberge Group:* ***(a)*** *sandstone/mudstone interbeds in* JLst *unit; angular clasts of mudstone (white arrows) have been ripped off during deposition of the sandstone;* ***(b)*** *load structures (white arrows) in a steep, west-dipping, slightly calcareous sandstone with dark grey mudstone interbeds;* ***(c)*** *cobble-boulder conglomerate mapped along the east shore of Richthofen Island (*JLcbx*), displaying clasts of pale grey micritic limestone (presumably from Upper Triassic Lewes River Group), as well as andesite and fine-grained mudstone clasts, in a distinctive, bright, dark green matrix; and* ***(d)*** *close-up of a plagioclase-phyric andesite clast in unit* JLcbx *conglomerate.*

sequence to the west may be the result of localized channel activity. Detrital zircon signatures within rocks of the Laberge Group range from the Late Triassic-Early Jurassic (~220-180 Ma; Colpron *et al.*, 2015).

The deposition of Laberge Group sediments in the Early Jurassic was likely controlled by pre-existing Triassic topography. Massive micritic limestone beds of the Lewes River Group constitute present-day, prominent topographic features, and their reefal origin suggests that they were probably already shaping the landscape during the Late Triassic and Early Jurassic. These reefs formed buttresses, constraining the deposition of both Upper Triassic argillaceous sediments, and Laberge Group turbiditic or deltaic fan deposits. This unconformable relationship is obvious at the contact between Lewes River Group thick-bedded limestone (uT̄LRl), and overlying thin-bedded, turbiditic strata of the Laberge Group (JLst). However, fine-grained, thin-bedded units of the Lewes River Group (uT̄LRst) and overlying strata of the Laberge Group are very similar, sometimes making it difficult to differentiate them in the field. Attribution of these strata to two different units is based on the recognition of an angular unconformity marked by opposite bedding relationships, and contrasting geometry and intensity of deformation between Lewes River and Laberge groups, especially along the eastern shore of Lake Laberge.

IGNEOUS ROCKS

Igneous rocks in the map area include plutons of Early and Late Cretaceous age, and a series of dikes likely associated with these two intrusive suites.

*Laurier Creek pluton (*EKgT*)*

Grey to tan-weathering, white to pale pink, equigranular, medium to coarse-grained granodiorite, monzonite, monzodiorite and quartz diorite form a ~5 by 12 km intrusion to the southwest of Teslin Mountain (Fig. 2). It intrudes mainly Joe Mountain Formation aphyric massive basalt, but also the Lewes River Group sedimentary succession to the west. The northeast contact of this intrusion with Joe Mountain Formation basalt was mapped by Bordet (2016a). The following description is based on recent observations along the northern and western contacts of the intrusion with Joe Mountain Formation and Lewes River Group rocks. The intrusion is characterized by:

- Equigranular, medium to coarse-grained granodiorite, which includes plagioclase (50%), biotite (25-30%), quartz (15%) and hornblende (up to 5%).
- Equigranular, medium to coarse-grained monzonite and monzodiorite containing hornblende and lesser biotite to the west (up to 20-25%; Fig. 8a), and biotite (5-7%) and lesser hornblende (1-2%) towards the centre of the intrusion, in a plagioclase-rich groundmass. The rock displays locally up to 1-5% quartz (1-2 mm) and possible K-feldspar. A weak internal foliation is locally measured.
- Various dike phases are associated with the main intrusion, including a tan to yellow-weathering, pale pink, equigranular, fine to medium-grained quartz-rich granitoid composed of quartz (over 50%), plagioclase (45%), biotite (5%) and hornblende-rich veins.

East of Mount Laurier, the contact between the monzodiorite and carbonate rocks of the Lewes River Group is marked by the development of skarn, and characterized by garnet crystals 1-2 cm in diameter in a pale green carbonate matrix (Fig. 8b).

*Teslin Mountain pluton (*LKgR *and* LKdR*)*

Joe Mountain Formation massive basalt at Teslin Mountain is intruded by a ~4 by 3 km massive, blocky, medium-grained, grey-weathering, pale grey to white monzodiorite (LKgR; Fig. 8c). It contains plagioclase (40-60%), K-feldspar (up to 15%), biotite (10-15%), hornblende (10-20%) and quartz (1-3%). Another phase comprises tan to grey-weathering, massive, blocky, fine-grained, dark grey-green diorite (1-2% quartz; Fig. 8d) and quartz diorite (up to 5-10% quartz), which contain plagioclase (10-15% and locally up to 50%), biotite or hornblende (5-15%; LKdR).

Dikes

About thirty dikes crosscut the entire stratigraphy, including Joe Mountain Formation basalt, Lewes River Group volcanic and carbonate sequence, and the Laberge Group. Three different dike compositions are reported.

Pale pink/orange/beige to tan-weathering, massive to blocky or locally foliated rhyolite dikes are most common. They display a fine to medium-crystalline, pale pink to grey groundmass, and contain up to 10-60% plagioclase. Phenocrysts include K-feldspar (5-25%), quartz (1-10%) and hornblende or biotite (1-5%). Grey to beige-weathering, grey, porphyritic diorite dikes are also widespread (Fig. 8e). They display a grey-green, aphanitic to finely crystalline equigranular groundmass. Phenocrysts include plagioclase (5 mm to 2 cm; 10-15%, and up to 25%), hornblende (1-5%, and up to 10%; laths up to 1 cm) and quartz (<1%).

Brown-weathering, conchoidally fractured, dark grey-green gabbro dikes with pyroxene (1-2%) and plagioclase (5%) in a fine crystalline, dark grey groundmass are less common. They are spatially concentrated along the east shore of Lake Laberge, and crosscut massive micritic limestone of the Lewes River Group (Fig. 8f), as well as thin-bedded mudstone at the base of the Laberge Group. Most importantly, these gabbro dikes appear to be folded along with the Upper Triassic-Jurassic sequence.

Interpretation and age

The Laurier Creek pluton, located between Mount Laurier and Teslin Mountain, is assigned to the Teslin Suite (123-115 Ma; Colpron *et al.*, 2016) based on a previous date of *ca.* 118 Ma (K/Ar biotite; Stevens *et al.*, 1982).

The Teslin Mountain pluton was previously correlated with the Casino Suite, a plutonic phase equivalent to volcanic strata of the Mount Nansen Group (Tempelman-Kluit, 1984, 2009). This original assignment is based on the fact that the Joe Mountain volcanic strata at Teslin Mountain were originally attributed to the mid-Cretaceous Mount Nansen Group by Tempelman-Kluit (1984). Later, the Teslin Mountain pluton was assigned to the Whitehorse

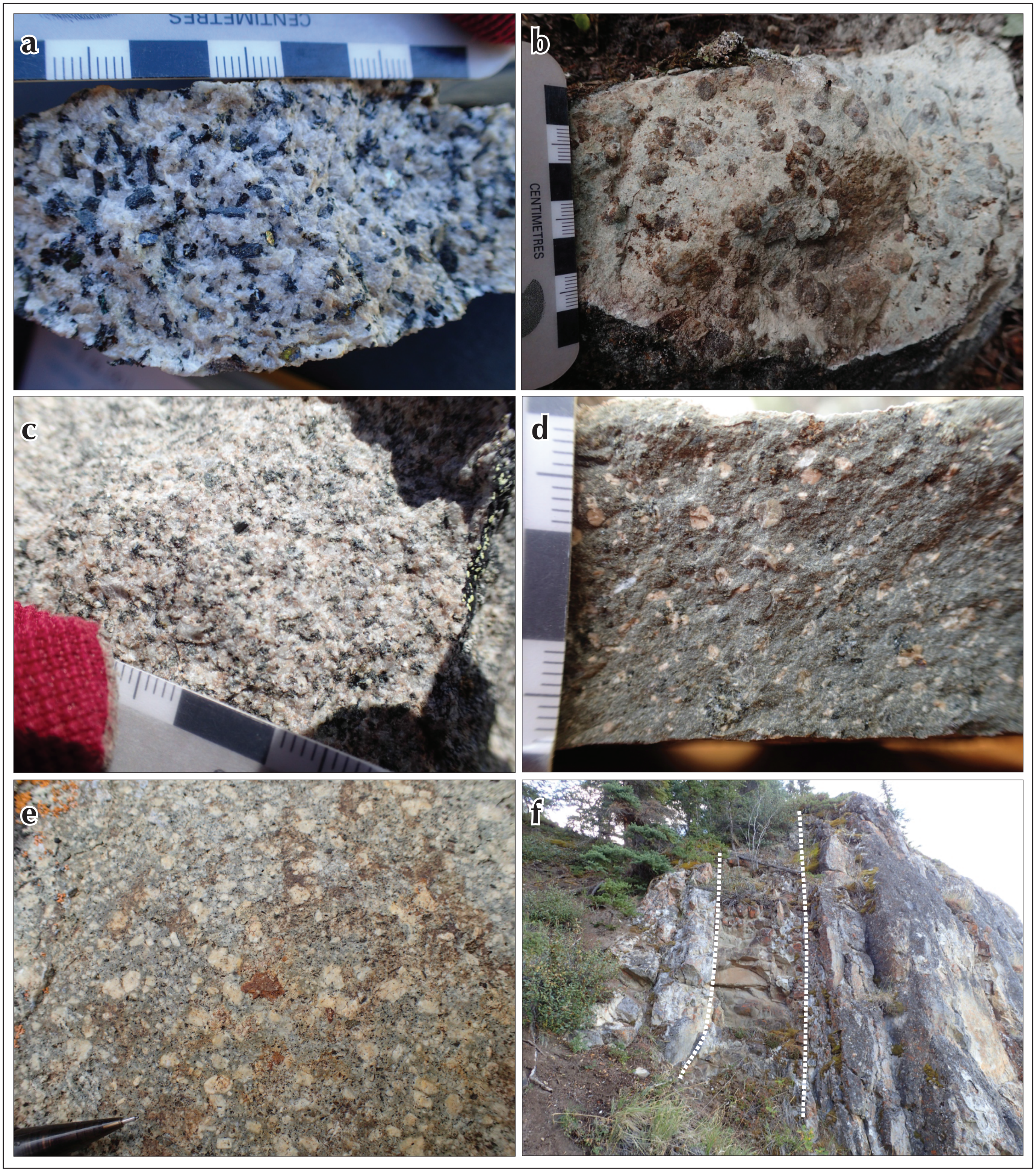

Figure 8. *Intrusive units:* ***(a)*** *coarse-crystalline, equigranular, hornblende-biotite-phyric monzodiorite of the Laurier Creek pluton (*EKgT*);* ***(b)*** *skarn (cm-scale garnet crystals in a pale green calcareous matrix) resulting from contact metamorphism between the Laurier Creek pluton through Upper Triassic limestone;* ***(c)*** *medium-crystalline, equigranular, granodiorite of the Teslin Mountain pluton (*LKgR*);* ***(d)*** *hornblende-plagioclase-phyric diorite at Teslin Mountain (*LKdR*);* ***(e)*** *plagioclase-hornblende-phyric diorite dike; and* ***(f)*** *pyroxene-plagioclase-phyric gabbro dike intruding Upper Triassic massive micritic limestone.*

Suite by Gordey and Makepeace (2001). A preliminary U/Pb zircon age of ~78 Ma was obtained for the Teslin Mountain pluton as part of this study (J. Crowley, *pers. comm.,* 2016). Based on geographic proximity and geological context, an association with the Rancheria plutonic suite exposed east of the Teslin fault (82-77 Ma; Colpron *et al.*, 2016) is proposed. The Open Creek volcanic rocks (Fig. 2; Tempelman-Kluit, 2009) constitute likely volcanic equivalents of this intrusive suite.

Rhyolite and diorite dikes mapped throughout the area are likely related to Early or Late Cretaceous intrusive events. However, since rocks of the Rancheria and Teslin suites are of very similar composition, further analyses are required to establish a possible distinction between these dikes.

Gabbro dikes may be subsequent to Laberge Group deposition, but folding indicates that they predate the Middle Jurassic deformation event that affected Upper Triassic and Laberge Group strata. The only other volcanic event coeval with Laberge Group deposition is represented by the Nordenskiöld facies, a Lower Jurassic crystal-lithic tuff unit (Colpron and Friedman, 2008; Tempelman-Kluit, 1984, 2009). Regionally, the development of the Whitehorse trough was coeval with renewed arc volcanism and a period of extension and subsidence in Stikinia recorded by the Hazelton Group in north-central British Columbia (Monger *et al.*, 1991; Evenchick and Thorkelson, 2005; Gagnon *et al.*, 2009, 2012).

STRUCTURE

Major faults dissect the Triassic to Jurassic stratigraphy of the map area, and folding is prevalent and particularly evident along the east shore of Lake Laberge. Two dominant structural trends are identified. North to northwest-trending thrust and normal faults, and east-verging tight folds which prevail in the western portion of the map area, between the east shore of Lake Laberge and Laurier Creek fault. East of the Laurier Creek fault, bedding measurements consistently indicate an east-trending structural fabric. Structures associated with these two distinct structural domains are reviewed below.

FAULTS

Laurier Creek fault

The Laurier Creek fault is a north to northwest-trending structure that separates the map area into two structural domains. To the east, east-striking strata of the Middle Triassic Joe Mountain Formation, Upper Triassic Lewes River Group and Jurassic Laberge Group, define a north-younging succession. To the west of Laurier Creek fault, a north-trending structural fabric prevails within the generally west-younging, volcano-sedimentary sequence of the Lewes River Group. The Laurier Creek fault marks the western boundary of the Joe Mountain Formation in the Teslin Mountain area.

The Laurier Creek fault has a marked topographic expression, particularly in the steep valley that bounds Mount Laurier to the east (Fig. 4a). At this location, an outcrop of brecciated limestone that is part of the lower carbonate sequence of the Lewes River Group is exposed at the valley bottom, a few metres away from exposures of the Joe Mountain Formation basalt, the oldest rocks identified in the field area. The fault follows Laurier Creek for ~20 km and extends further north, forming a structural contact between the Lewes River and Laberge groups. Near the Aurier prospect (Fig. 2), a fault contact is mapped between rusty-weathering, thick-bedded limestone of the Lewes River Group and thin-bedded, dark grey mudstone of the Laberge Group.

Rocks of the Laberge Group are in contact with older rocks of the Lewes River Group along the Laurier Creek fault to the north, which suggests an east-side-down motion at this location. However, towards the south, the oldest part of the stratigraphy is exhumed, and the fault juxtaposes rocks of the Joe Mountain Formation to the east with younger rocks of the Lewes River Group and Laberge Group to the west. This complex pattern results either from strike-slip motion along the Laurier Creek fault, and/or reactivation of a pre-existing structure. The map pattern east of Laurier Creek fault may result from deposition of volcanic and sedimentary strata on a north-facing slope. The latest displacement along the Laurier Creek fault may be Late Cretaceous or younger, as it exhumed Early and Late Cretaceous intrusive bodies.

A north-trending fault is inferred west of Mount Laurier and Lime Peak (Fig. 2). It juxtaposes Lewes River Group volcanic rocks to the west, with Lewes River Group massive limestone and overlying Laberge Group conglomerate at Mount Laurier to the east. This fault has a marked topographic expression west of Mount Laurier. It is possible that it extends further north, and eventually connects to the Laurier Creek fault north of the Hancock Hills, but such a relationship has not been confirmed.

Goddard fault

The Goddard fault is a north to northwest-trending structure that cuts across the entire map area, located between 1.5 and 3.5 km east of Lake Laberge. Its regional extent is >100 km, along which a dextral motion is inferred (Colpron, 2011). In the map area, the Goddard fault cuts across the carbonate sequence of the Lewes River Group, as well as the Jurassic Laberge Group. It has a topographic expression indicated by steep cliff faces bounded by limestone and calcareous conglomerate ridges. The fault zone is exposed at a few locations within kilometres northeast of the mouth of Laurier Creek.

One location at the bottom of a narrow valley displays a sliver of steeply dipping, blocky, vesicular, pyroxene-phyric basalt interbedded with clast-supported limestone conglomerate (Fig. 9a). On either side of the valley, steep rock faces of Lewes River Group limestone conglomerate are exposed (Fig. 2). The other location is an outcrop of dark grey limestone breccia intersected by a steep (65° W to subvertical), north-striking, cataclasite. Elongated subangular limestone cobbles to boulders are aligned in a brown-weathering, dark grey, non-calcareous mudstone matrix (Fig. 9b).

Figure 9. *Structural features: **(a)** sliver of interbedded basalt and calcareous conglomerate along the Goddard fault; **(b)** elongated, deformed limestone boulders (white outline) in a thin-bedded mudstone matrix along the Goddard Fault; and **(c)** Richthofen Island fault scarp and quartz vein (inset) cutting through thin-bedded mudstone/sandstone sequence of the Laberge Group.*

Other faults

Several minor thrust faults intersecting the Upper Triassic sequence or rocks of the Laberge Group were mapped along the east shore of Lake Laberge. Orientations vary from north to northwest-striking (Bordet, 2016b). Other north to northwest-striking, west-dipping thrust faults are inferred in the northeast part of the map area. They crosscut the upper carbonate sequence of the Lewes River Group, and are associated with east-verging anticlines. Most of these faults parallel the Goddard and Laurier Creek faults, suggesting that small-scale structures are the result of structural imprint of these major fault systems.

The topography of Richthofen Island is marked by a north-trending fault scarp along the east shore of the island (Fig. 9c). The fault crosscuts thin to medium-bedded mudstone/sandstone of the Laberge Group. Along the fault scarp, rocks are rusty weathered and crosscut by a network of north-trending quartz and carbonate veins (Fig. 9c, inset). At the base of the fault scarp, along the east shore of the island, the mapped sequence includes a cobble to boulder conglomerate (JLcbx; Fig. 7c) overlying or interbedded with the thin-bedded mudstone/sandstone sequence of unit JLst (Fig. 7b). An east-side-down motion is inferred along this fault.

FOLDS

Steep, west-dipping to subvertical limestone beds of the Lewes River Group represent the limbs of tight, east-verging folds along a narrow, north to northwest-trending belt (maximum 2 km wide) along the east shore of Lake Laberge (Bordet, 2016b). The difference of competency between different strata within the carbonate sequence creates disharmonic folding. Thick-bedded micritic limestone is generally featureless, but thin to medium-bedded carbonate interbeds locally illustrate the nature and intensity of folding affecting these strata. Folds are generally north to northwest-trending, tight and east-verging.

MINERALIZATION

The Teslin Mountain and Lake Laberge mapsheets comprise several mineralized prospects, such as Cu skarn, alkalic porphyry Cu-Au, and porphyry Mo (Fig. 2, Table 1). In addition, the Joe Mountain mapsheet to the south (105D/15) comprises several vein-related prospects hosted in the Joe Mountain Formation basalt (Hart, 1997). Several of these occurrences were visited during the summers of 2015 and 2016.

Eighteen assay samples were collected in host rocks containing disseminated sulphides or pervasive veining associated with oxidation or alteration at the outcrop scale. Most samples were collected in the vicinity of previously reported Yukon MINFILE occurrences. Samples were submitted to the Bureau Veritas Minerals processing facility in Whitehorse, Yukon, and analyzed at their laboratory in Vancouver, BC. Analytical procedures included splitting, crushing and pulverizing of 250 g of rock samples through a 200 mesh screen. Analysis of Au was done by fire assay fusion and an atomic absorption spectroscopy (AAS) finish. Nine other elements (Mo, Cu, Pb, Zn, Ag, As, Sb, BI, Hg) were tested by Aqua Regia digestion with and inductively coupled plasma mass spectrometry (ICP-MS) finish.

Table 1. *Reported Yukon MINFILE occurrences within the map area.*

MINFILE Number	Name	Easting	Northing	Occurrence type	Symbol
105E 006	LABERGE	497766	6770987	Cu Skarn	⬢
105E 024	HIG	514103	6763712	alkalic porphyry Cu-Au	■
105E 025	LORI	515771	6767061	porphyry Mo (Low F-Type)	■
105E 036	AURIER	502443	6788485	unknown	❋
105E 039	AKEL	498934	6766283	unknown	❋
105E 038	SLINE	522844	6770905	unknown	❋
105E 050	DEBICKI	523708	6767260	unknown	❋

Assay results are reported in Table 2. Most samples display concentrations below the detection limits for Mo, Ag, As, Sb, Bi and Hg. Au and Cu concentrations are not significant. Out of the 18 samples tested, only two show noticeable values and are briefly discussed here:

Sample 15EB-043-1 was collected west of Joe Mountain near the Joe Creek (Yukon MINFILE 105D 197) and Grumpy (Yukon MINFILE 105D 203) Au-quartz vein prospects. The sample was collected at an outcrop of brown-weathering, dark green basalt, intersected by a small fault zone along which the rock is altered to pale green chlorite or oxidized. Disseminated sulphides are seen along this small-scale structure. The sample returned over 0.1% Zn, 279 ppm As and 1.2 ppm Ag. Other reported mineral occurrences in this area include the Ace (Yukon MINFILE 105D 051) polymetallic veins prospect (Ag-Pb-Zn ± Au), and the Hartless Joe high-grade epithermal Au-Ag active prospect (rock chip sample at 60 g/t Au, 554 g/t Ag, 5.01% Pb, and 0.35% Cu over 1.2 m; Strategic Metals, 2016).

Sample 16EB-225-1 was collected less than 2 km from the eastern shore of Lake Laberge, in the vicinity of the Laberge skarn prospect (Yukon MINFILE 105E 006). The rock is a rusty weathered, calcareous mudstone that is overlain by limestone conglomerate, and intruded by a medium-crystalline rhyolite dike. The sample returned 2.8 ppm Ag, but less than 1% is reported for Cu, Zn, Mo and Pb. The geological setting in this part of the map area, with interplay between Cretaceous dikes, Lewes River Group carbonate rocks and volcanic mafic rocks, may be a favourable location for skarn mineralization.

DISCUSSION AND CONCLUSIONS

Mapping during the 2016 field season allowed refinement of Stikinia Middle to Upper Triassic stratigraphy in south-central Yukon, as well as clarification of the relationship with the Lower to Middle Jurassic Laberge Group. Interpretation of the stratigraphy is obscured by lateral facies transitions and deformation.

Joe Mountain Formation basalt and volcaniclastic rocks exposed around Teslin Mountain form the lowest stratigraphic level in the area. A preliminary age of ~245 Ma (U/Pb; J. Crowley, *pers. comm.*, 2016) confirms the Middle Triassic age of the Joe Mountain Formation. Attribution of unit m$\overline{T}$JMms to the Middle or Upper Triassic sequence remains a problem. It was previously thought to be part of the Lewes River Group because it apparently underlies volcaniclastic rocks of the Lewes River Group to the north, but recent mapping indicated that it also underlies the Joe Mountain Formation basalt to the south. Sandstone/mudstone units are calcareous to non-calcareous, and likely result from sedimentation in individual small basins along the rim of the Joe Mountain volcanic arc. Previous attempts at recovering detrital zircons from this sequence were not successful.

The internal stratigraphy of the Upper Triassic Lewes River Group was refined based on new mapping conducted along the east shore of Lake Laberge. A thick carbonate sequence (2000-2700 m) overlies Upper Triassic mafic volcanic rocks. Multiple levels of massive reefal limestone and fossiliferous limestone, interbedded or laterally equivalent to various fine to medium-grained, thin-bedded, mudstone/sandstone sequences were identified, supporting the stratigraphic framework previously proposed by Tozer (1958). The Lewes River Group carbonate sequence is interpreted to have developed on the margin of the volcanic arc highland formed by the Lewes River arc. Reefs and shallow-water fossiliferous carbonate rocks originated along the rim of the volcanic arc, while continuous erosion of the arc provided a continuous supply of volcanic material throughout the Late Triassic, and until the onset of Laberge Group sedimentation in the Jurassic.

An unconformable angular relationship was mapped at several localities between the Lewes River Group and the overlying Laberge Group. New facies were identified as part of the Laberge Group, showing a lateral transition from the polymictic conglomerate mapped east of the Laurier Creek fault, towards a fine-grained turbiditic sequence dominating the east shore of Lake Laberge. Deposition of Laberge Group and subsequent erosion was heavily controlled by pre-Laberge topography of the reefs. This controls the current map pattern, and was later enhanced by compressional deformation.

Stratigraphic relationships within the Lewes River Group are complicated by Late Triassic, Jurassic and Cretaceous deformation events. East-verging, tight folds, and west-dipping, north to northwest-trending thrust faults are mapped within the upper carbonate sequence of the Lewes River Group along the east shore of Lake Laberge. These structures contrast with those of the northern Whitehorse trough, characterized by northwest-striking, southwest-verging folds and thrust faults that are dissected by northwest and north-striking strike-slip faults (White *et al.*, 2012).

Table 2. *Assay analytical results. Analysis of Au is done by fire assay fusion and an atomic absorption spectroscopy finish. Mo, Cu, Pb, Zn, Ag, As, Sb, BI, Hg are tested by Aqua Regia digestion with an inductively coupled plasma mass spectrometry finish. UTM coordinates are from zone 8, NAD83.*

	UTM COORDINATES																
	EASTING	NORTHING	Weight	Au (ppm)	Mo (ppm)	Mo (%)	Cu (ppm)	Cu (%)	Pb (ppm)	Pb (%)	Zn (ppm)	Zn (%)	Ag (ppm)	As (ppm)	Sb (ppm)	Bi (ppm)	Hg (ppm)
Detection limits			0.01	0.005	1	0.0001	1	0.0001	2	0.0002	2	0.0002	0.1	5	2	2	0.01
15EB-004-1	508670	6754569	0.65	-	-	-	12	0.0012	31	0.0031	60	0.0060	0.3	-	-	-	-
15EB-043-1	515103	6753804	0.52	0.056	187	0.0187	598	0.0598	56	0.0056	1111	0.1111	1.2	279	9	-	0.01
15EB-045-1	514774	6752947	0.8	-	-	-	116	0.0116	3	0.0003	74	0.0074	0.3	7	-	-	-
15EB-056-1	516572	6753538	0.66	0.206	-	-	20	0.0020	-	-	125	0.0125	-	-	-	-	-
15EB-144-1	521599	6767067	0.62	0.007	-	-	25	0.0025	-	-	46	0.0046	-	-	-	-	-
15EB-285-1	513090	6793619	0.55	0.008	9	0.0009	146	0.0146	4	0.0004	16	0.0016	0.1	-	-	-	-
15EB-285-2	513090	6793619	0.34	0.008	3	0.0003	89	0.0089	4	0.0004	52	0.0052	-	-	-	-	0.01
15EB-435-2	520893	6771263	0.51	0.006	-	-	22	0.0022	-	-	66	0.0066	-	-	-	-	-
16EB-007-1	510126	6763237	0.56	0.01	-	-	226	0.0226	-	-	36	0.0036	0.1	-	-	-	-
16EB-032-1	509519	6765413	0.48	0.011	1	0.0001	125	0.0125	15	0.0015	39	0.0039	0.1	-	-	-	-
16EB-074-1	511098	6768272	0.57	0.007	1	0.0001	171	0.0171	3	0.0003	41	0.0041	0.6	-	-	-	-
16EB-076-1	511032	6767763	0.75	0.008	-	-	105	0.0105	4	0.0004	52	0.0052	0.1	-	-	-	-
16EB-084-1	516255	6766565	0.53	-	1	0.0001	3	0.0003	12	0.0012	10	0.0010	-	-	-	-	-
16EB-088-1	514494	6767795	0.62	0.009	-	-	53	0.0053	4	0.0004	62	0.0062	-	9	-	-	-
16EB-202-1	497094	6774710	0.83	-	-	-	21	0.0021	2	0.0002	83	0.0083	-	-	-	-	-
16EB-225-1	498195	6772755	1.02	0.02	30	0.0030	662	0.0662	74	0.0074	67	0.0067	2.8	15	-	14	0.11
16EB-364-2	500154	6788604	0.28	-	-	-	37	0.0037	2	0.0002	27	0.0027	-	-	-	-	0.04
16EB-521-1	491201	6774353	0.66	0.01	-	-	11	0.0011	9	0.0009	27	0.0027	-	16	-	-	0.02

Note: "-" stands for below detection limit values.

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