Updated bedrock geology of the southern Nash Creek area in central Yukon (parts of NTS 106D/2, 3, 6 and 7)

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Abstract

The southern Nash Creek area is located along the northern boundary of the Selwyn basin, and is underlain mainly by the Ediacaran–Cambrian Hyland Group, the Devonian–Mississippian Earn Group and the Mississippian Tsichu Group. Several Au and polymetallic mineral deposits are hosted by the Hyland Group and Paleozoic platformal carbonate rocks in the surrounding region. The southern Nash Creek area is bordered by regional-scale, southeast-striking thrust faults, which include the Dawson thrust to the northeast and the Robert Service thrust to the southwest. Based on stratigraphic relationships identified during 1:50 000-scale bedrock mapping, Hyland Group rocks in the area are considered to belong to the Cryogenian–Ediacaran Yusezyu Formation, the Ediacaran Algae Formation and the Ediacaran–Terreneuvian Narchilla Formation. Earn Group rocks include mainly shale and lesser amounts of interbedded dolostone, sandstone and shale. Tsichu Group rocks mostly comprise quartzite. The Yusezyu and Narchilla formations host (Paleozoic?) gabbro sills, and the Earn and Tsichu groups host gabbro sills that are considered to belong to the Triassic Galena suite. Rocks in the southern Nash Creek area exhibit a northeast-to-southwest-dipping foliation that is axial planar to southeast-trending folds.

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Introduction

This article presents the results of 1:50 000-scale bedrock mapping conducted in 2019 and 2021 in the southern Nash Creek area of central Yukon, which includes parts of NTS sheets 106D/2, 3, 6 and 7. The southern Nash Creek area is located along the northern boundary of the Selwyn basin (Gordey and Anderson, 1993), where the Neoproterozoic–Cambrian Hyland Group is juxtaposed against Paleozoic slope and shelf rocks of the Ogilvie Platform along the Dawson thrust zone (Figs. 1 and 2; Green, 1972a,b; Colpron et *al.*, 2013). The surrounding region hosts several mineral deposits (Fig. 2), including carbonate-hosted intrusion-related Au-Ag (Tiger), epithermal Au-Ag-Cu (McKay Hill), manto Ag-Pb-Zn (Clark), plutonic-related Au (Dublin Gulch), vein polymetallic Ag (Keno) and volcanogenic massive sulphide Cu-Pb-Zn (Marg).

The region was initially mapped at 1:250 000-scale by the Geological Survey of Canada as part of a regional mapping project that included the Nash Creek, Larsen Creek and Dawson areas (Green, 1972a,b). Several 1:50 000 and 1:75 000-scale mapping projects have improved our understanding of regional stratigraphic and structural relationships across the Dawson

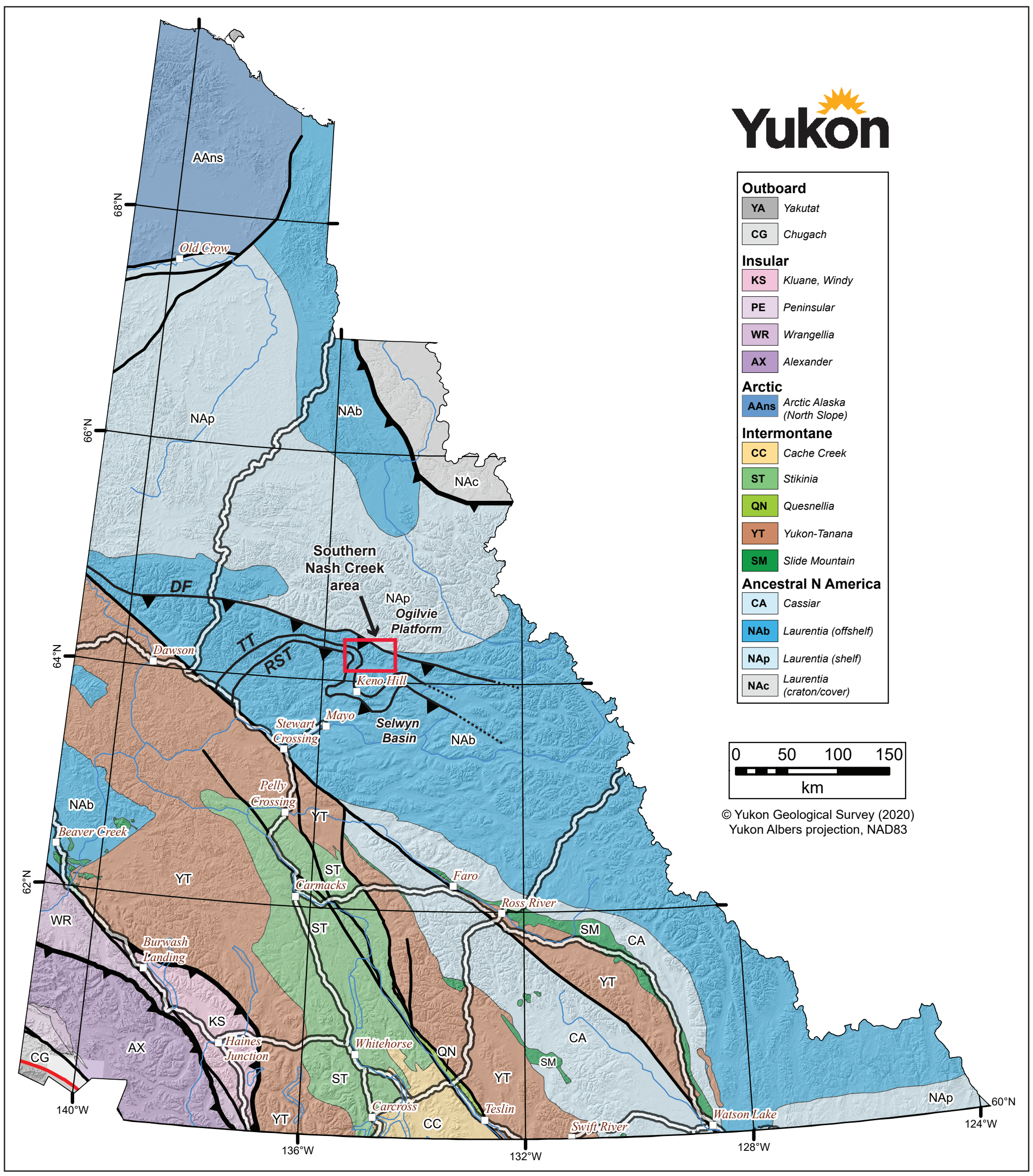

Figure 1. Map of the geological terranes that comprise the northern Cordillera (modified after Yukon Geological Survey, 2021b). The study area (southern Nash Creek) is located in central Yukon, and outlined in red. DF = Dawson fault; TT = Tombstone thrust; RST = Robert Service thrust.

thrust zone in the Ogilvie and Wernecke mountains (Abbott, 1990a,b, 1997a,b,c; Colpron *et al.*, 2013; Moynihan, 2014, 2016a) and across the Tombstone and Robert Service thrust zones in the McQuesten River and Mayo areas (Murphy, 1997; Roots, 1997). However, the southern Nash Creek area has not seen upgraded bedrock mapping until this study, which involved detailed (1:50 000-scale) mapping to address outstanding questions regarding stratigraphy, structural history and mineral potential. The preliminary bedrock map (Fig. 3; Skipton, 2022) and stratigraphic–structural framework presented herein supersede those presented by Skipton and Maw (2021).

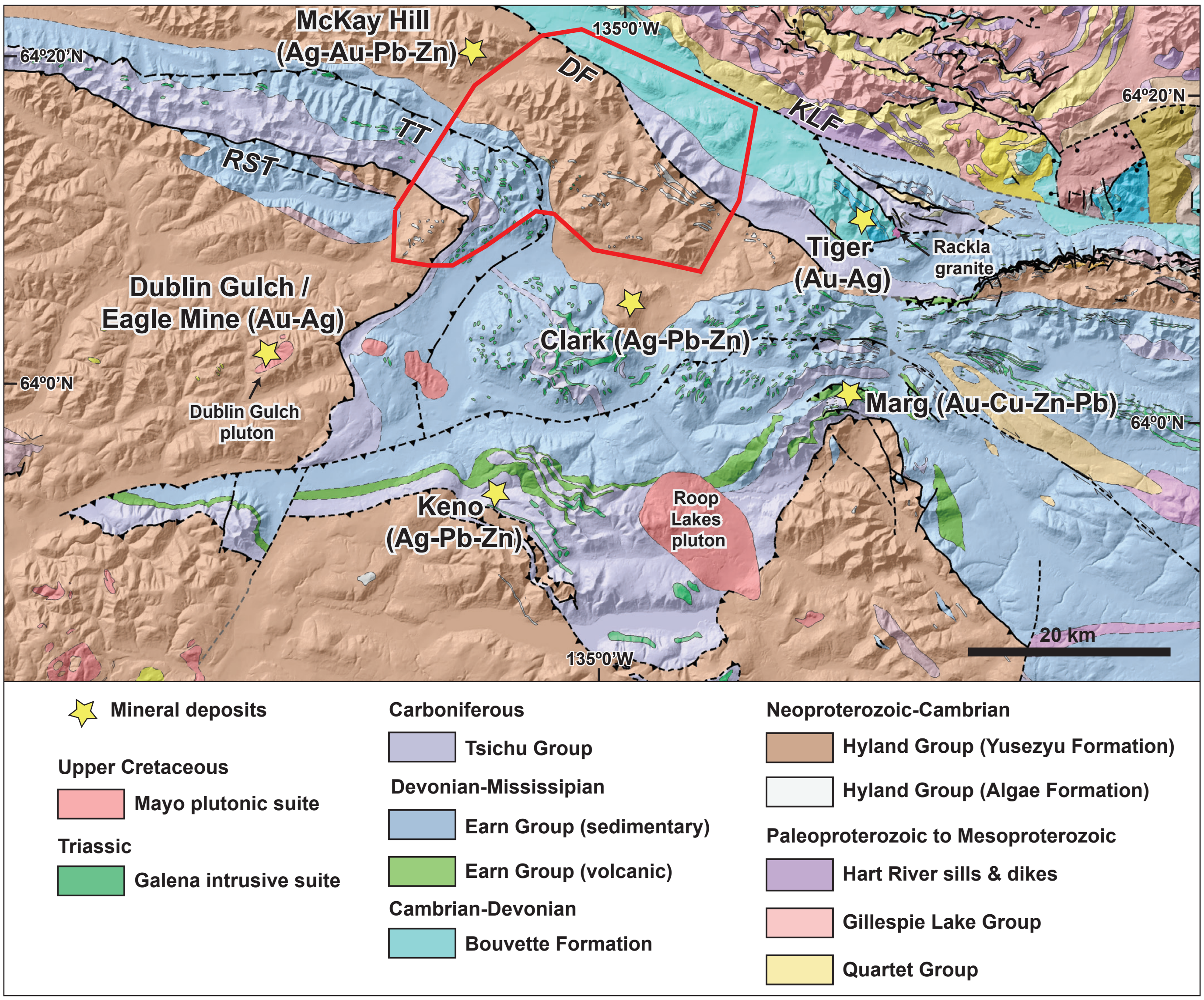

***Figure 2.** Geological map of Paleoproterozoic to Carboniferous sedimentary rocks and younger plutons along the northern margin of the Selwyn basin in the region of the Keno, Tiger and McKay Hill mineral deposits (from the digital compilation map of Yukon; Yukon Geological Survey, 2021a). The area mapped in detail in 2019–2021 (this study) is outlined in red. DF = Dawson fault; TT = Tombstone thrust; RST = Robert Service thrust; KLF = Kathleen Lakes fault.*

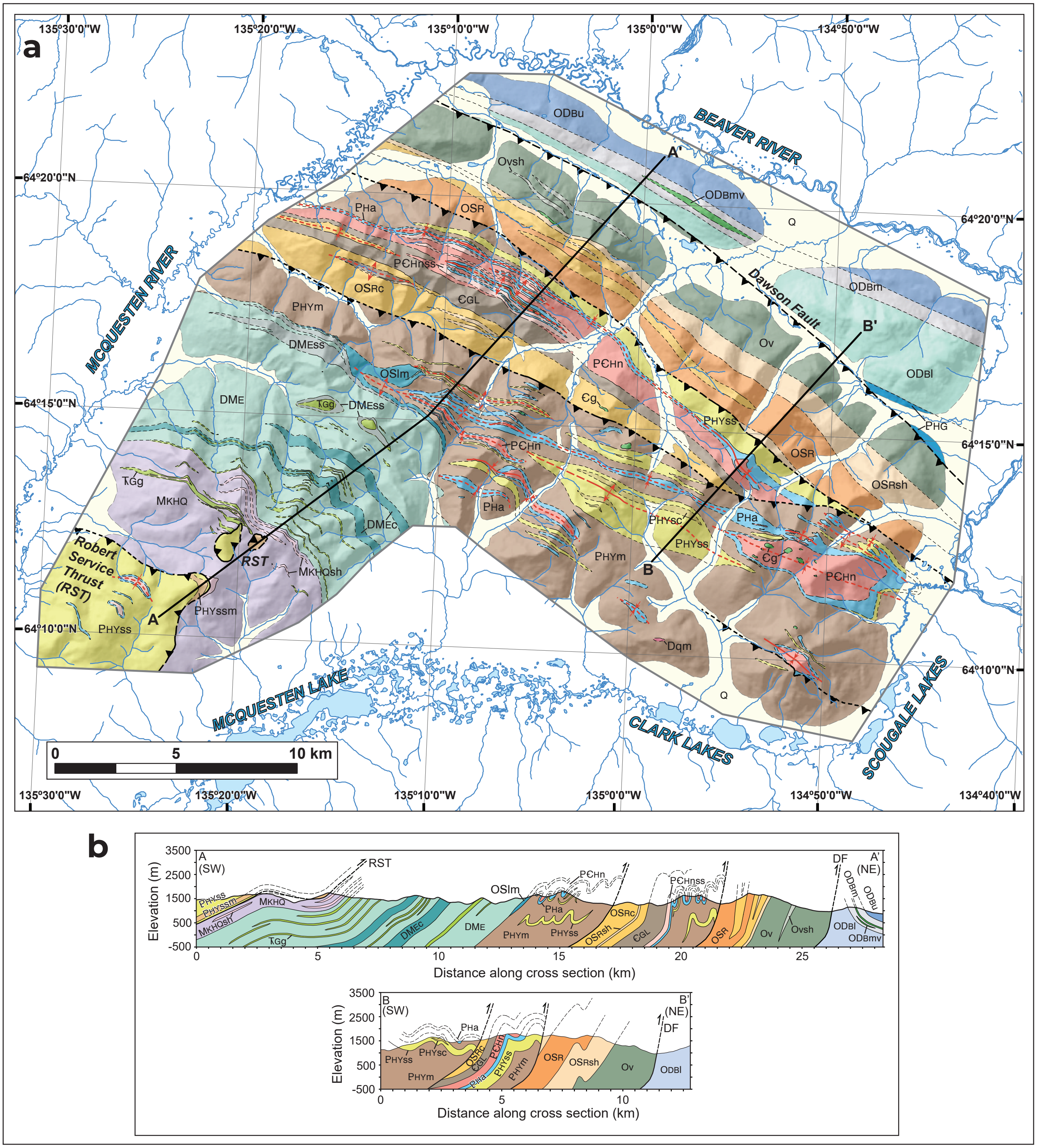

*Figure 3. **(a)** Preliminary geological map of the southern Nash Creek area (parts of NTS 106D/2, 3, 6, 7) based on 1:50 000-scale bedrock mapping conducted in 2019 and 2021 (simplified after Skipton (2022)). Map legend is provided in Figure 3c. **(b)** Cross sections corresponding to the preliminary geological map of the southern Nash Creek area shown in Figure 3a. Figure continued on next page.*

QUATERNARY

Q — **QUATERNARY:** unconsolidated alluvial, colluvial, fluvial and glacial deposits.

TRIASSIC

ŦGg — **GALENA SUITE, GABBRO:** Dark grey to dark green-weathered, dark green gabbro sills; medium-grained; locally fine-grained with plagioclase phenocrysts.

MISSISSIPPIAN

MKHQ — **TSICHU GROUP, KENO HILL QUARTZITE:** Medium to thick bedded grey quartz arenite; medium-grained, crystalline texture; local interbeds of buff to orange-weathered, medium-grained quartz-rich sandstone with dolomite cement; rare interbeds of dark grey shale.

MKHQsh — **TSICHU GROUP, KENO HILL QUARTZITE, shale member:** Dark grey shale; thinly interbedded to laminated; locally light to dark green weathered; locally rich in chlorite ± white mica (schistose); interstratified with Keno Hill Quartzite.

DEVONIAN TO MISSISSIPPIAN

DME — **EARN GROUP, undivided:** Dark grey shale; thinly bedded to laminated; local thin interbeds of grey-brown siltstone ranging to very fine grained sandstone.

DMEc — **EARN GROUP, carbonate member:** Rhythmically interbedded orange-weathered dolostone, white-weathered fine-grained sandstone and dark grey to dark green shale, with local chert interbeds; thinly bedded, locally medium bedded.

DMEss — **EARN GROUP, sandstone member:** Brown-weathered, fine-to-medium-grained, grey-brown quartz arenite; medium-bedded; shiny, sugary-textured fresh surface.

DEVONIAN(?)

Dqm — Medium-grained quartz monzonite with carbonate-quartz alteration.

ORDOVICIAN TO DEVONIAN (?)

ODBu — **BOUVETTE FORMATION, UPPER:** Pale grey to white-weathered, thick-bedded to massive dolostone; fine-to-medium-grained dolomitic sandstone and mudstone; lesser pebble conglomerate with dolostone, mudstone and rare limestone clasts; two-hole and star crinoids are common.

ODBmv — **BOUVETTE FORMATION, MIDDLE, volcanic member:** Dark green to brown weathered vesicular basalt; carbonate-cemented hyaloclastite breccia; volcanic sandstone, grit and pebble to cobble conglomerate.

ODBm — **BOUVETTE FORMATION, MIDDLE, undivided:** Thin to medium-bedded, grey and buff weathered silty limestone; massive, white limestone; grey to light grey bioclastic limestone; local interbedded pale yellow and grey limestone and dolostone.

ODBl — **BOUVETTE FORMATION, LOWER:** Light grey-weathered, massive to medium-bedded, variably dolomitized pale grey limestone, dolostone, oncolitic dolostone; light grey quartzite and sandy dolostone.

ORDOVICIAN TO SILURIAN (?)

OSlm — Fine-grained, medium-bedded, light grey-weathered, fetid grey limestone; commonly contains silica nodules; hosts non-abundant fossils; local pebble conglomerate with a grey limestone matrix.

ORDOVICIAN TO SILURIAN

OSR — **ROAD RIVER GROUP, undivided:** Thinly, rhythmically interbedded, grey-weathered, dark grey to black mudstone, grey siliceous siltstone and chert.

OSRsh — **ROAD RIVER GROUP, shale member:** Grey-green shale to phyllite; dark grey and black shale; minor maroon shale; local interbeds of black mudstone, siliceous siltstone ± chert.

OSRc — **ROAD RIVER GROUP, chert member:** Thin to medium-bedded, dark grey-weathered chert with rhythmic dark grey and light grey interbeds; locally white-weathered; locally massive.

ORDOVIAN (?)

Ov — Dark grey, dark brown and dark green mafic volcaniclastic rocks; lesser dark green amygdaloidal basalt and mafic tuff; minor reddish-brown-weathered intermediate volcaniclastic rocks.

Ovsh — Blue-grey to silver-weathered, dark grey to black shale; interstratified with volcaniclastic rocks (COv).

CAMBRIAN

ЄGL — **GULL LAKE FORMATION:** Thinly, rhythmically interbedded grey-brown to chocolate-brown-weathered siltstone and shale (~50/50%) with grey fresh surfaces; locally siltstone-rich (~70%) and medium-bedded.

CAMBRIAN(?)

Єg — Medium to coarse-grained, brownish-green, clinopyroxene gabbro sills and plugs; local melanocratic hornblende diorite.

NEOPROTEROZOIC (EDIACARAN) TO LOWER CAMBRIAN

PЄHn — **HYLAND GROUP, NARCHILLA FORMATION, undivided:** Dark grey, green and maroon shale; grey and green siltstone to phyllite; minor fine-grained, white, thinly bedded sandstone; rare medium-bedded, brown to grey quartz grit to quartz arenite.

PЄHnss — **HYLAND GROUP, NARCHILLA FORMATION, sandstone member:** Medium-bedded, brown to grey quartz quartz grit sandstone and lesser quartz arenite; local interbeds of dark grey, green and maroon shale and grey-green siltstone to phyllite.

NEOPROTEROZOIC (EDIACARAN)

PHa — **ALGAE FORMATION:** Grey, fine-grained, massive to medium-bedded limestone with local laminations; minor orange-weathered, medium-bedded dolostone.

PHYm — **HYLAND GROUP, YUSEZYU FORMATION, "MIXED" UNIT:** Green and grey siltstone to phyllite; dark grey, green and maroon shale; minor medium-bedded, brown to grey quartz arenite and quartz grit with local quartz-pebble conglomerate.

PHYss — **HYLAND GROUP, YUSEZYU FORMATION, SANDSTONE-DOMINATED UNIT, undivided:** Medium to thickly bedded, brown to grey quartz arenite and quartz grit sandstone with local quartz-pebble conglomerate; rare dark grey and green shale and siltstone to phyllite.

PHYsc — **HYLAND GROUP, YUSEZYU FORMATION, SANDSTONE-DOMINATED UNIT, calcareous member:** Medium to thick-bedded, orange-weathered quartz-rich sandstone with dolomitic cement; local interbeds of grey limestone, orange-weathered dolostone and green-grey shale.

PHYssm — **HYLAND GROUP, YUSEZYU FORMATION, SANDSTONE-DOMINATED UNIT, "mixed" member:** Thinly interbedded siliciclastic and calcareous rocks, including: grey-to-tan quartz grit sandstone; dark grey-green shale to phyllite; orange-weathered quartz grit sandstone with dolomite cement; grey limestone; orange-weathered dolostone.

PHG — **GAMETRAIL FORMATION:** Orange, yellow and grey-weathered dolostone, dolomitic siltstone/sandstone and limestone, commonly planar and or cross-laminated; carbonate-clast breccia and conglomerate; minor maroon shale.

SYMBOLS

Geological contact (defined, approximate, inferred)

Thrust fault (defined, approximate, inferred)

Anticline axial trace (defined, approximate, inferred)

Syncline axial trace (defined, approximate, inferred)

Limit of mapping (this study)

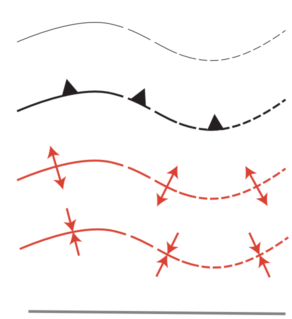

Figure 3 continued. ***(c)*** *Legend corresponding to the preliminary geological map and cross sections of the southern Nash Creek area presented in Figure 3a and 3b.*

Geological setting

The southern Nash Creek area mostly comprises sedimentary rocks that were deposited along the western Laurentian continental margin. These include clastic and carbonate rocks of the Neoproterozoic–Cambrian Hyland Group, which are unconformably overlain by the Devono-Mississippian Earn Group and the Carboniferous to Permian Tsichu Group (Fig. 2; Green, 1972a,b).

The study area forms part of the Selwyn fold belt, which trends NW–SE across central Yukon, and formed in response to Jura-Cretaceous shortening during the Cordilleran orogeny (Gordey and Anderson, 1993). Hyland Group strata have been juxtaposed over Ordovician–Devonian(?) platformal carbonate rocks (Bouvette Formation) across the Dawson thrust, which extends northwest-southeast across central Yukon (Figs. 1 and 2; Yukon Geological Survey, 2021a). Detailed mapping in the Rackla belt (Colpron et *al*., 2013) has shown that the Dawson fault forms the frontal thrust in a series of imbricates that comprise the Dawson fault zone, which has a width of at least ~500 m and up to 2–4 km locally. Movement along the fault zone may have initiated in the Neoproterozoic, with reactivation in the Paleozoic and during Mesozoic (mid-Cretaceous?) shortening associated with Cordilleran orogenesis (*e.g.*, Abbott, 1997a; Colpron et *al*., 2013).

The southern Nash Creek area includes several additional northwest–southeast-striking thrusts. Southwest of the Dawson fault, previous maps show that the Hyland Group has been juxtaposed over the Devonian–Mississippian Earn and Tsichu groups by the Robert Service thrust, and the Earn Group has been repeated by the Tombstone thrust (Figs. 1 and 2; Green and Roddick, 1962; Tempelman-Kluit, 1970; Thompson et *al*., 1990; Anderson, 1987; Roots, 1988; Murphy, 1997). The Robert Service thrust is plugged by the Roop Lakes pluton (Fig. 2; 92.8 ± 0.5 Ma; Roots, 1997). In the Keno and Mayo areas, the hanging wall of the Tombstone thrust is affected by a several-km thick interval of intensely deformed, lower-to-middle-greenschist-facies metasedimentary rocks (Devonian Earn Group, Mississippian Keno Hill Quartzite), termed the Tombstone high-strain zone (Murphy, 1997). Muscovite from the hanging wall of the Robert Service thrust, which is considered to have been overprinted by the Tombstone high-strain zone, yielded $^{40}Ar/^{39}Ar$ dates of *ca.* 104–100 Ma, interpreted as the age of latest Tombstone thrust deformation (Mair et *al*., 2006). The *ca.* 63–59 Ma crystallization age of the post-kinematic Rackla granite (Kingston et *al*., 2010) at the Tiger Au deposit (Fig. 2) may represent a minimum age limit on regional deformation.

Stratigraphy

The southern Nash Creek area mainly consists of siliciclastic and carbonate rocks that occupy several southwest-dipping thrust panels (Figs. 3 and 4). Based on lithofacies mapping and comparisons with stratigraphic relationships in the broader Selwyn basin (*e.g.*, the eastern Wernecke Mountains, the Hyland River area, the Ogilvie Mountains, the McQuesten River and Mayo areas; Abbott, 1997a,b,c; Murphy, 1997; Roots, 1997; Colpron et *al*., 2013; Moynihan, 2014, 2016b), most of the rocks are considered equivalent to the Cryogenian–Terreneuvian Hyland Group, the Cambrian Gull Lake Formation, the Ordovician–Silurian Road River Group, the Devonian–Mississippian Earn Group, and the Mississippian Tsichu Group. These stratigraphic correlations are preliminary, and may be refined following additional bedrock mapping and geochronology.

Ediacaran Hyland Group: Yusezyu, Algae, Narchilla and Gametrail formations (ⱣHYm, ⱣHYss, ⱣHYsc, ⱣHYssm, ⱣHa, ⱣЄHn, ⱣЄHnss, ⱣHG)

Ediacaran to Lower Cambrian strata of the Hyland Group are extensive in the study area, and predominantly include Cryogenian–Ediacaran sandstone and fine-grained siliciclastic rocks of the Yusezyu Formation. Based on lithofacies associations, the Yusezyu Formation has been divided into four units. The heterogeneous "mixed" unit (ⱣHYm) consists of approximately equal proportions of green-grey siltstone and grey, green or maroon shale, with lesser amounts of medium-bedded brown-grey quartz grit sandstone (Fig. 5a), quartz arenite and rare quartz-pebble conglomerate. The sandstone-dominated unit

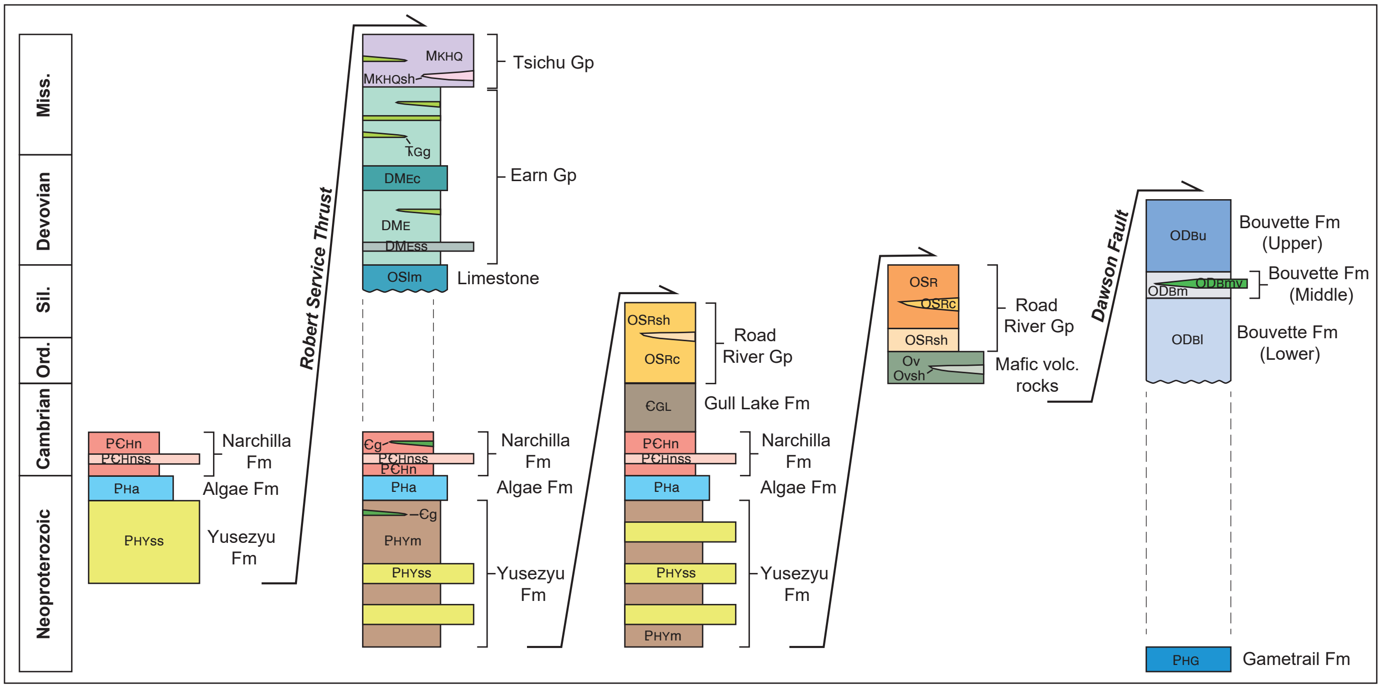

Figure 4. *Schematic diagram illustrating the preliminary stratigraphic framework and thrust relationships in the southern Nash Creek area.*

(PHYss) in the Yusezyu Formation includes medium to thick-bedded, brown-grey quartz arenite and quartz grit sandstone with local quartz-pebble conglomerate and rare interbeds of grey-green shale and siltstone. Field relationships suggest that the sandstone-dominated unit forms laterally discontinuous layers at different stratigraphic levels within the "mixed" unit, and may represent channel-fill deposits. In places, the sandstone-dominated unit contains calcareous rocks (calcareous member; PHYsc), including medium to thick-bedded, orange-weathered quartz-rich sandstone with dolomite cement and lesser interbeds of grey limestone, orange-weathered dolostone and green-grey shale. In the hanging wall of the Robert Service thrust, the sandstone-dominated unit of the Yusezyu Formation contains ~20–40 m-thick intervals of thinly interbedded siliciclastic and calcareous rocks ("mixed" member; PHYssm). These interbedded rocks include grey-to-tan-coloured quartz grit sandstone, dark green-grey siltstone to phyllite, orange-weathered quartz grit sandstone with dolomite cement, grey limestone and orange-weathered dolostone.

The Yusezyu Formation is overlain by fine-grained grey limestone of the Algae Formation (PHa) along a sharp contact. The limestone exhibits a light grey weathering colour that is distinctive from the overlying Narchilla and underlying Yusezyu formations, which have dark grey-brown weathering colours overall (Fig. 5c,e,f). The Algae Formation limestone is massive to medium bedded (Fig. 5c), laminated in places, and locally contains minor proportions of orange-weathered dolostone interbeds. The Algae Formation in the study area has an estimated observed thickness of ~30 to 50 m, although the thickness is poorly constrained in several places due to complex folding.

The Narchilla Formation (undivided; PЄHn) overlies the Algae Formation along a sharp contact, and comprises fine-grained siliciclastic rocks, including dark grey, green and maroon shale and grey-green siltstone to phyllite (Fig. 5d). It contains lesser amounts of fine-grained white, thinly bedded sandstone, interbedded green-grey to white fine-grained sandstone and siltstone, and rare interbeds of brown-grey quartz grit to quartz arenite. The Narchilla Formation locally contains relatively thick sandstone-rich horizons (sandstone member; PЄHnss), which dominantly comprise medium-bedded brown-grey quartz grit sandstone (Fig. 5b) and lesser quartz arenite.

Southwest of the Tiger Au deposit (Fig. 2), preliminary mapping by the author and others (S. Israel, R. Cobbett, pers. comm. 2021) has shown that the Bouvette Formation (discussed below) unconformably overlies the Gametrail Formation (PHG). The Bouvette and Gametrail formations are inferred to extend northwest along-strike in the Beaver River valley (Fig. 3). The Gametrail Formation is composed of mostly orange, yellow and grey-weathered dolostone that is typically planar or cross-laminated, as well as carbonate-clast breccia and conglomerate. Based on stratigraphic relationships defined in the eastern Rackla belt (Moynihan, 2014), the Gametrail Formation is considered to underlie the Yusezyu Formation.

Cambrian Gull Lake Formation (ЄGL)

The Gull Lake Formation (ЄGL) overlies the Narchilla Formation (PЄHn, PЄHnss) along a sharp contact (Fig. 6a). It consists of thinly, rhythmically interbedded light to dark grey weathering siltstone and dark grey to brown weathering shale (Fig. 6b). The fresh surfaces of shale beds are dark grey, and those of siltstone are

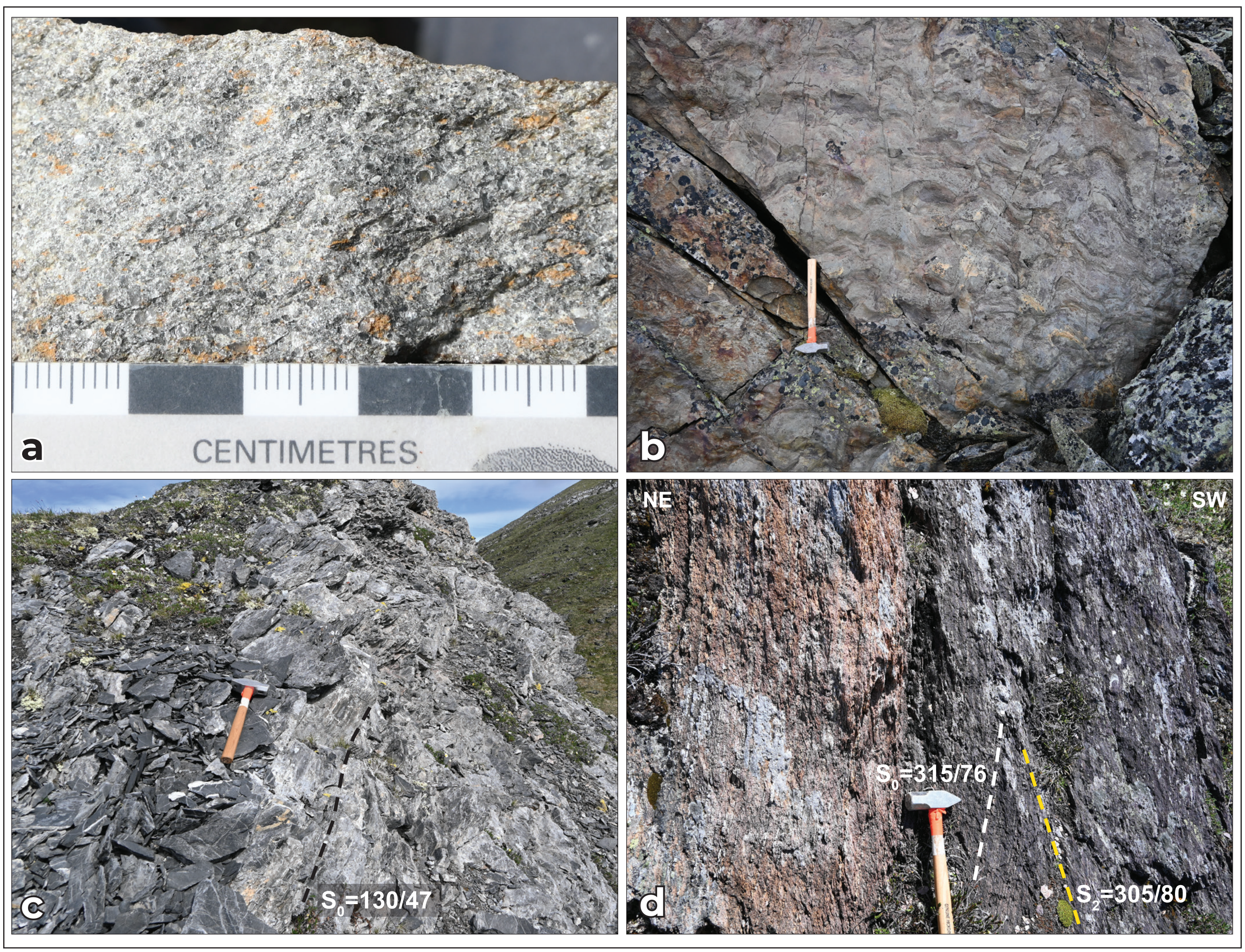

Figure 5. *Field photographs of the Ediacaran to Lower Cambrian Hyland Group. Planar structural orientations are indicated in right-hand-rule format here and throughout the manuscript.* ***(a)*** *Fresh surface of quartz grit sandstone (Yusezyu Formation, "mixed" unit, PHYm).* ***(b)*** *Ripple marks on the bedding plane of quartz grit sandstone (Narchilla Formation, sandstone member, PЄHnss).* ***(c)*** *Light to dark-grey weathered, thin to medium-bedded limestone with calcite veining (Algae Formation, PHa).* ***(d)*** *Thinly bedded beige siltstone (left) and dark grey to maroon shale (right), with a well-developed foliation (S_2) oriented at an angle to bedding (Narchilla Formation, PЄHn). Figure continued on next page.*

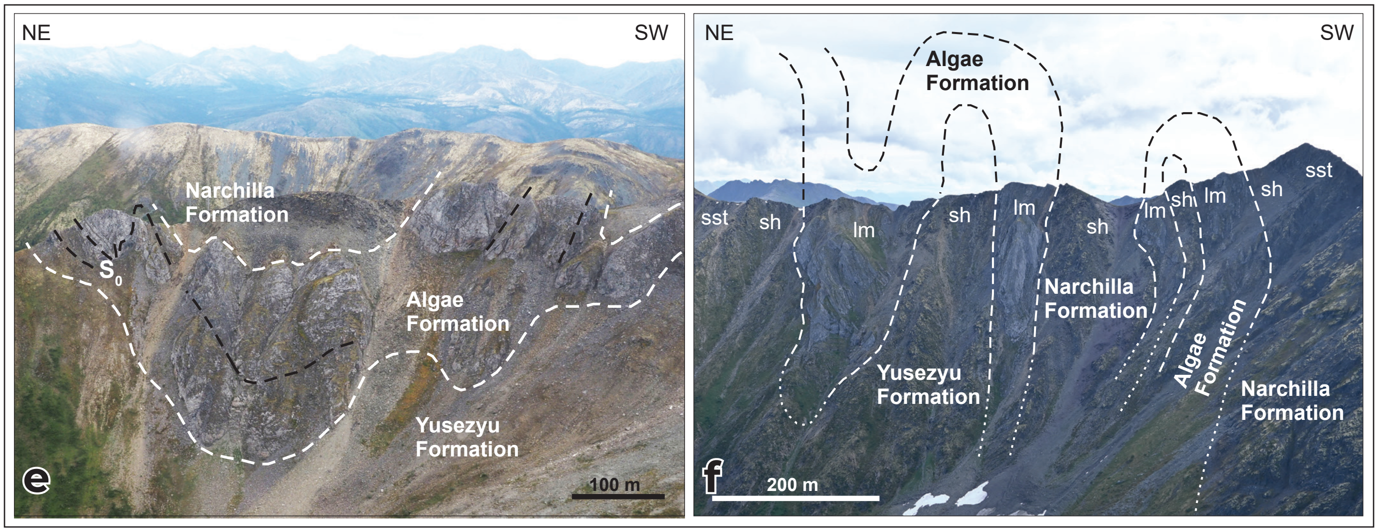

***Figure 5** continued. **(e)** F2-folded strata of the Yusezyu, Algae and Narchilla formations with a broadly synclinal geometry. Smaller folds occur within the limbs of the syncline, including a synclinal chevron fold in the northeastern limb (left side of photo). White dashed lines indicate geological contacts and black dashed lines delineate bedding. **(f)** Steeply dipping, isoclinally folded strata of the Yusezyu, Algae and Narchilla formations. Bedding orientations measured along the ridgetop range from ~80° NE to 80° SW. The rock types mapped along the ridgetop are indicated as follows: sh = grey, green and/or maroon shale and lesser grey siltstone; sst = grey to brown quartz arenite and/or quartz grit; lm = grey limestone. White lines represent geological contacts as mapped along the ridgetop (dashed pattern) or as inferred from remote observations (dotted pattern). Black dashed lines represent interpreted pre-erosional geological contacts.*

typically light grey. Shale beds weather recessively relative to the siltstone beds, giving the unit a ridged appearance in outcrops. The unit forms both ridgetops and saddles, but in both cases generally forms scree slopes, which exhibit a distinctive chocolate-brown colour from a distance (Fig. 6a). Siltstone and shale are typically in equal proportions, but the unit is locally siltstone-rich (up to ~70%).

Ordovician (?) volcanic rocks (Ov)

Volcanic rocks (Ov) crop out in the northeastern part of the map (Fig. 3). They consist of dark green and dark grey-brown-weathered volcaniclastic rocks and lesser amounts of mafic volcanic rocks, and are locally interstratified with silver-weathered shale with a black fresh surface (Ovsh). The volcaniclastic rocks comprise a fine-to-medium-grained mafic matrix that surrounds subrounded to angular pebble-to-cobble-sized clasts of mostly mafic-to-intermediate volcanic rocks (Fig. 6c). The matrix of some volcaniclastic rocks has an intermediate composition and weathers reddish-brown with a grey fresh surface (Fig. 6d). The volcanic sequence also includes fine-grained basalt and mafic volcanic breccia, some of which contain medium-to-coarse-grained phenocrysts of pyroxene, hornblende or plagioclase. Some volcanic rocks contain calcite-filled amygdules, and the volcanic sequence has been pervasively altered by calcite and chlorite.

The sequence of volcanic rocks (Ov) is overlain by the Road River Group (discussed below) along a sharp contact, and the lower limit of the volcanic sequence is inferred to be the Dawson fault (discussed below).

The volcanic rocks mapped here (Ov) are lithologically similar to and located along-strike from those exposed on McKay Hill to the northwest (Fig. 2), suggesting that they are part of the same volcanic sequence. The age of the volcanic rocks (Ov) is yet to be determined, but they are estimated to be younger than Middle Ordovician, based on preliminary identification of fossils from limestone interbedded with volcanic rocks in the McKay Hill area (R. Cobbett, pers. comm. 2021).

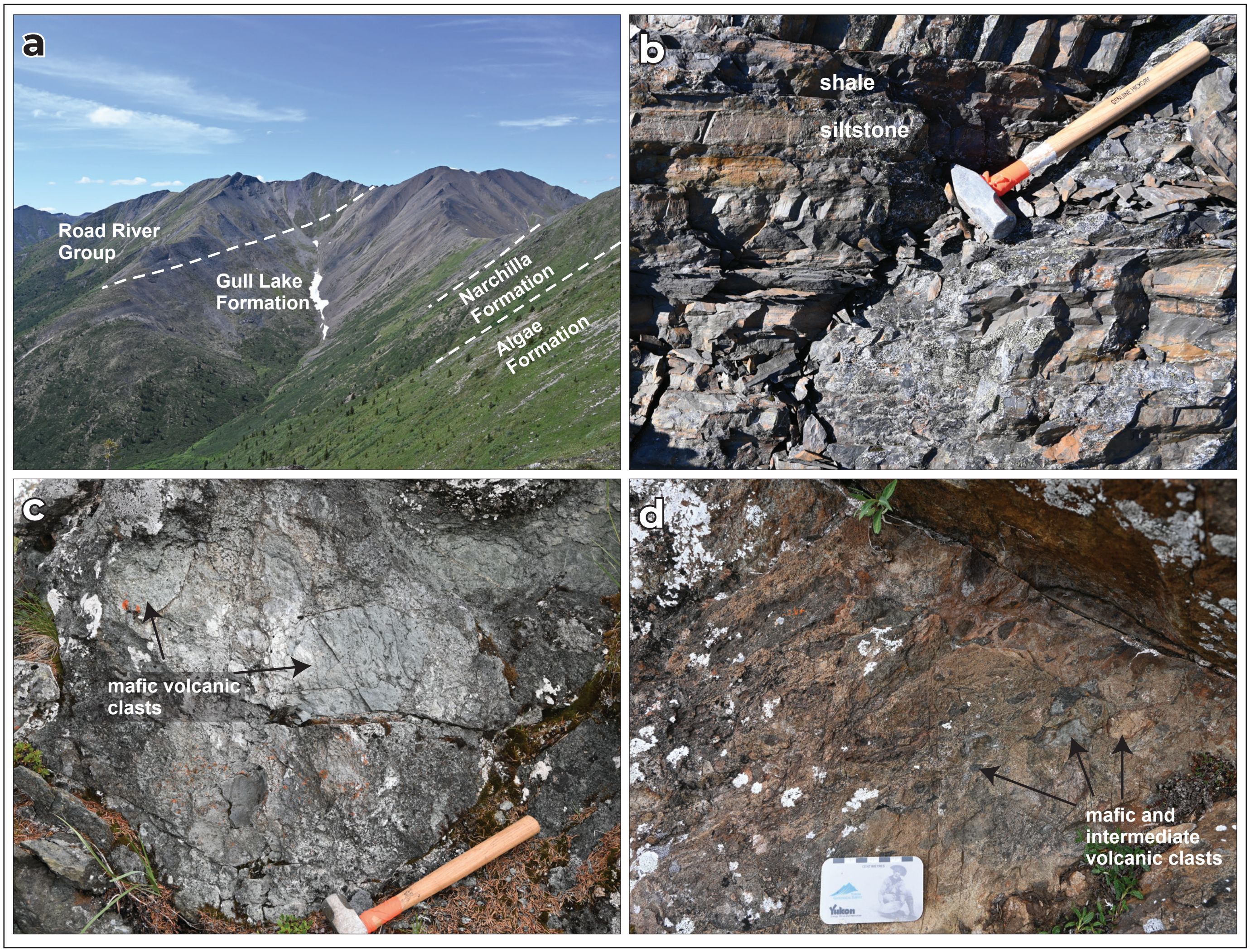

Figure 6. *Field photographs of the Cambrian Gull Lake Formation and Ordovician(?) volcaniclastic rocks.* ***(a)*** *Chocolate-brown-weathered scree slopes formed by the Gull Lake Formation (*ЄGL*), overlain by chert and shale of the Road River Group (*OSRc*,* OSRsh*) and underlain by siliciclastic and carbonate rocks of the Hyland Group. Horizontal field of view is ~2 km.* ***(b)*** *Thin, rhythmic interbeds of dark grey to brown-weathered siltstone and dark grey shale in the Gull Lake Formation.* ***(c)*** *Volcaniclastic rock comprising green-weathered clasts of hornblende-porphyritic mafic volcanic clasts in a green-grey-weathered sandy mafic matrix (*Ov*).* ***(d)*** *Volcaniclastic rock comprising black, light brown and light grey-weathered mafic and intermediate clasts in a reddish-brown-weathered intermediate matrix (*Ov*).*

Ordovician to Silurian Road River Group (OSR, OSRc, OSRsh)

The Road River Group is exposed in two southeast-striking bands across the northern third of the map area (Fig. 3). The undivided unit of the Road River Group (OSR) comprises thinly, rhythmically interbedded, grey-weathered mudstone with dark grey to black fresh surfaces, grey siliceous siltstone and chert (Fig. 7a,b). These rocks locally contain ~250–400 m-thick horizons of chert (chert member; OSRc), which is the dominant lithology in southwestern exposures of the Road River Group in the study area. The chert member of the Road River Group consists of thin-to-medium-bedded chert with rhythmic dark grey and light grey ~1–3 cm-thick interbeds (Fig. 7c,d). It generally exhibits a dark grey weathering colour (Fig. 7c), but is locally light grey to white-weathered. In places, the chert member is medium-to-thick-bedded and the beds are internally massive. The Road River Group (OSR, OSRc) locally contains ~100 m to ~1.5 km-thick interstratifications of shale (shale member; OSRsh), which includes grey-green shale to phyllite, dark grey to black shale, and local maroon shale.

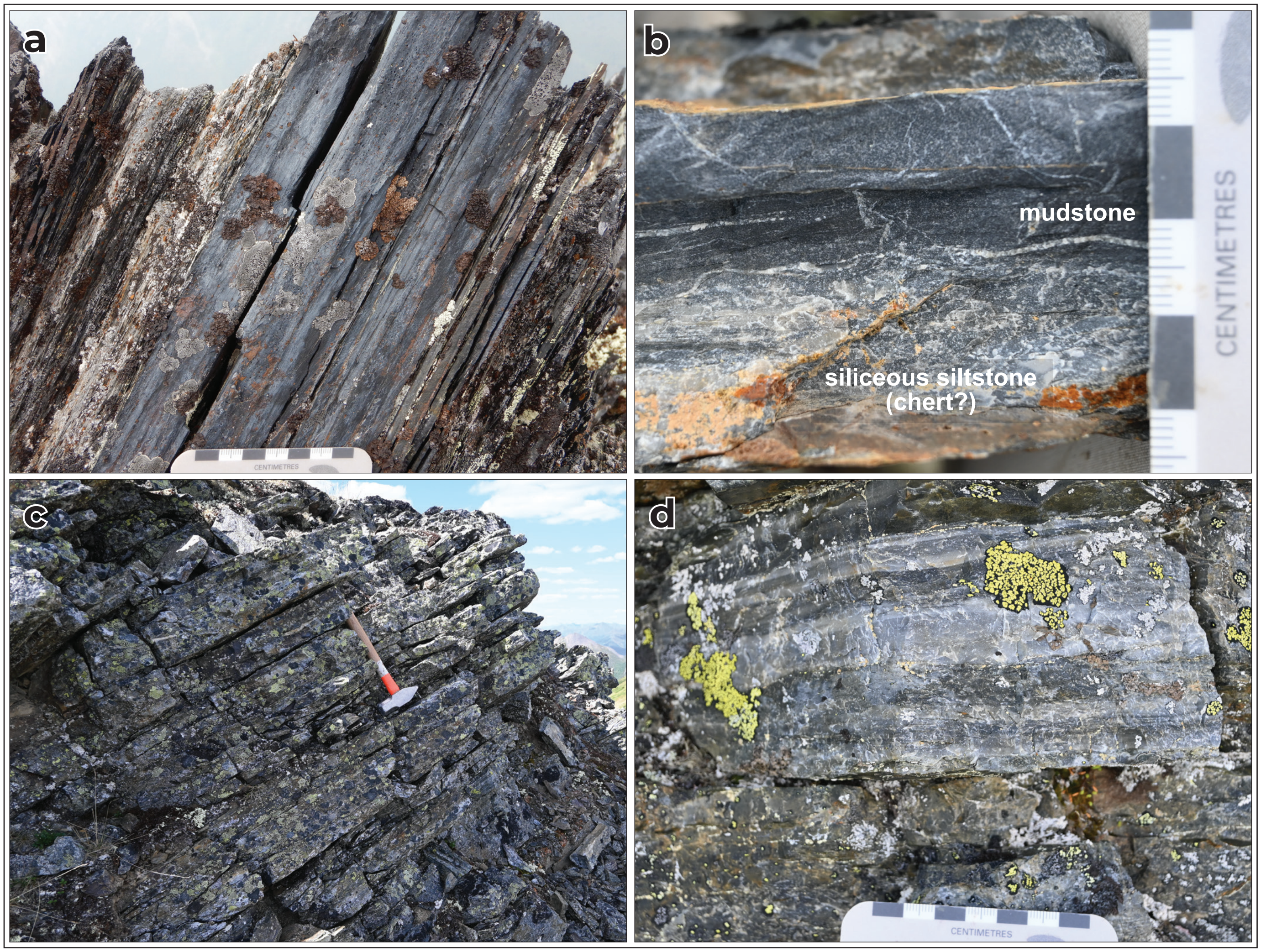

Figure 7. Field photographs of the Ordovician to Silurian Road River Group. ***(a)*** *Thinly bedded to laminated dark grey to light grey mudstone with minor light grey siltstone interbeds (*OSR*).* ***(b)*** *Thinly interbedded black mudstone and light grey siliceous siltstone (chert?;* OSR*).* ***(c)*** *Thin-to-medium-bedded, dark grey-weathered chert (*OSRc*).* ***(d)*** *Thin-to-medium-bedded chert with thin, rhythmic, dark and light grey interbeds (*OSRc*).*

Ordovician to Silurian (?) limestone (OSlm)

This unit (OSlm) is exposed in the west-central part of the map area. It consists of fine-grained, medium-bedded grey limestone, and is distinguished from the Algae Formation primarily on the presence of fossils (Fig. 8a,b). Fossils are not abundant and are generally poorly preserved, but preliminary fossil identifications of gastropods and brachiopods suggest a possible Late Ordovician to Silurian age for the limestone (R. Blodgett, pers. comm., 2021). Part of this limestone was initially mapped in the 1960s and interpreted as Permian based on fossil identifications, although it was noted that the fossils "are poorly preserved and the identifications are uncertain" (Green, 1972b). Unlike the Algae Formation, the fossiliferous limestone has a strong fetid odour and contains black silica nodules (Fig. 8a), white-weathered bedding-parallel bands of diagenetic silica (Fig. 8c) and local chert beds. In places, it also contains pebble-conglomerate beds up to ~0.5 m thick, which comprise a fine-grained grey limestone matrix surrounding quartz pebbles and dark grey chert clasts (Fig. 8d).

Where mapped, the limestone overlies sandstone, siltstone and shale ("mixed" unit; PHYm) of the Yusezyu Formation (Hyland Group). The contacts of the limestone are covered, and bedding orientations are concordant with those in underlying and overlying strata (the Hyland and Earn groups, respectively). The limestone appears to pinch out to the southeast and northwest, along the contact between the Hyland and Earn groups.

Ordovician to Devonian (?) Bouvette Formation (ODBl, ODBm, ODBmv, ODBu)

The Bouvette Formation consists of carbonate platformal rocks and forms limited exposures in the Beaver River valley in the northeastern part of the map area (Fig. 3). These exposures consist of light grey weathered limestone with a fine-to-medium-grained crystalline fresh surface. The limestone contains abundant quartz and(or) carbonate veins, and has a weak reaction to 10% hydrochloric acid, consistent with pervasive dolomitization. Based on lithological similarities and stratigraphic relationships in the Bouvette Formation along-strike to the east (e.g., Tiger deposit area; Fig. 2; Abbott, 1990a; Colpron *et al.*, 2013; Yukon Geological Survey, 2021a) and northwest (Castle Mountain area; Cobbett, 2020, 2022), the limestone encountered in this study in the Beaver River valley is inferred to be the lower Bouvette Formation of Cobbett (2022; ODBl).

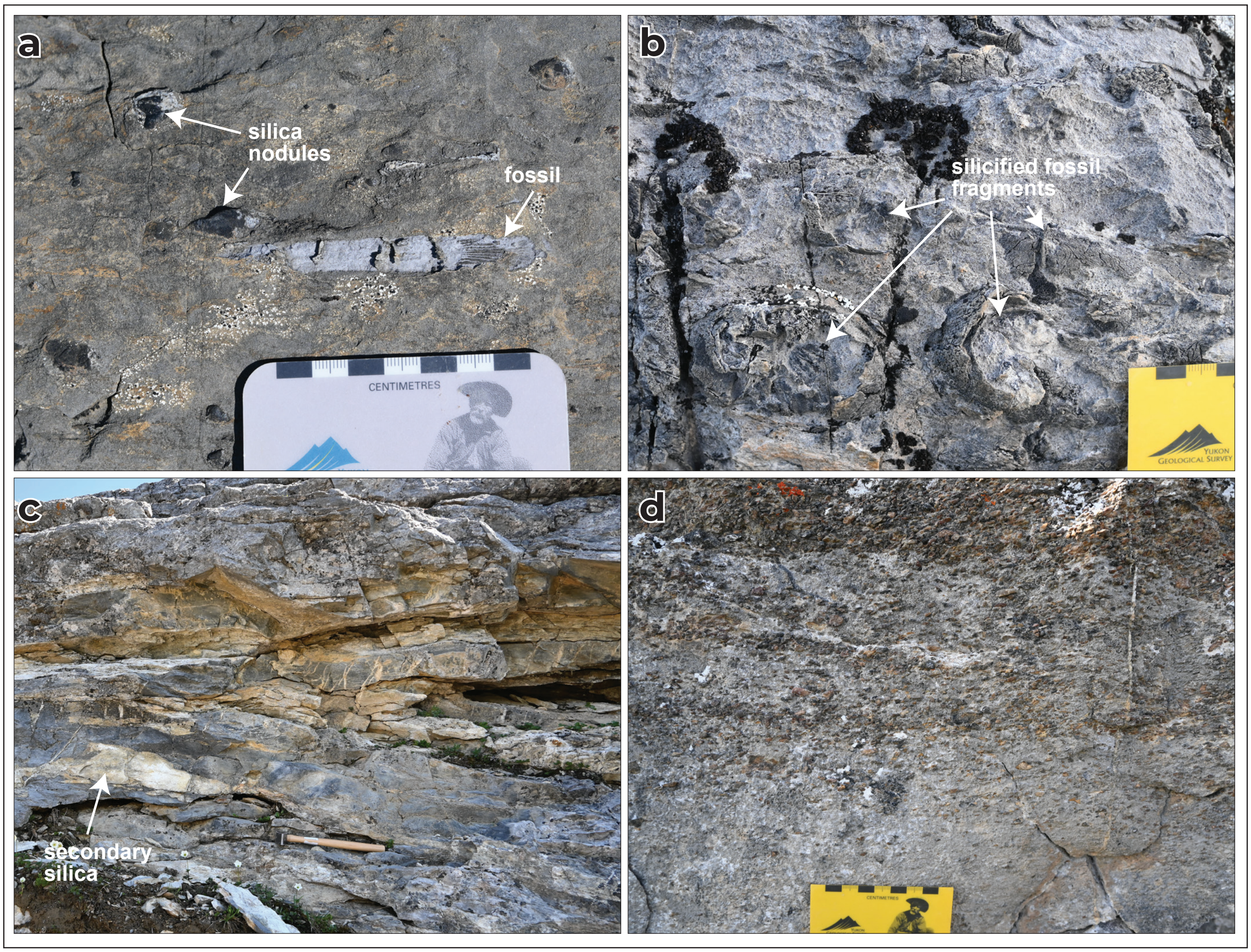

Figure 8. *Field photographs of fossiliferous limestone of estimated Ordovician-Silurian age (OSlm).* ***(a)*** *Grey limestone containing black chert nodules and a partial coral fossil.* ***(b)*** *Light grey limestone containing silicified fossil fragments.* ***(c)*** *Medium-bedded, fine-grained grey limestone with white-weathered, discontinuous, bedding-parallel bands of silica alteration.* ***(d)*** *Pebble-conglomerate interbed, comprising mostly quartz pebbles and chert clasts in a fine-grained, light grey limestone matrix.*

Mafic volcanic rocks (ODBmv) occur in isolated hilltop outcrops in the Beaver River valley (Fig. 3) and comprise fine-grained mafic volcanic breccia with hornblende phenocrysts. Although their contacts are unconstrained, the location of these rocks suggests that they represent a volcanic interval within the Bouvette Formation, perhaps equivalent to similar mafic volcanic rocks in the middle Bouvette Formation near the Tiger deposit (Abbott, 1990a; Colpron *et al.*, 2013; Yukon Geological Survey, 2021a), at Castle Mountain (Cobbett, 2020, 2022), and in the southern Wernecke Mountains (Ambrose and Bowie, 2020).

The middle (ODBm) and upper (ODBu) parts of the Bouvette Formation (*e.g.*, Cobbett, 2022) were not encountered during mapping, but are inferred to lie in the Beaver River valley (Fig. 3), based on along-strike stratigraphic relationships in the Tiger and Castle Mountain areas (Cobbett, 2022). In those areas, the upper Bouvette Formation mainly consists of grey to buff-weathered limestone and dolostone, and contains abundant two-hole and star-shaped crinoids, coral and bivalve fossils (*e.g.*, Colpron *et al.*, 2013; Cobbett, 2020, 2022).

Devonian to Mississippian Earn Group (DME, DMEss, DMEc)

The Devonian to Mississippian Earn Group occurs in the southwestern part of the map area, overlying the fossiliferous limestone (OSlm) along an inferred stratigraphic contact (pending fossil identification and age interpretation of the limestone; discussed above). The unconformity between the Earn and Hyland groups was not encountered during mapping in the study area, but has been documented on previous regional maps (*e.g.*, Green, 1972a).

The Earn Group (undivided; DME) mostly consists of homogeneous, dark grey, thinly interbedded to laminated shale (Fig. 9a). It locally contains minor amounts (<10%) of thin-to-medium-sized grey-brown siltstone interbeds, which range in grain size to very fine grained sandstone. A ~1–2 m-thick bed of medium-grained, white-weathered, beige quartz arenite was observed at one locality. Neither chert nor chert-pebble conglomerate were observed, in contrast to the Earn Group in the surrounding region (*e.g.*, Tiger area and Rackla belt; Abbott, 1990a; Colpron *et al.*, 2013).

Thick (~200–500 m) intervals of fine-to-medium-grained quartz arenite (sandstone member; DMEss) occur within the lower part of the Earn Group shale (DME). The sandstone is medium-bedded, grey-brown weathered and exhibits a grey-brown fresh surface with a shiny, sugary texture. Based on its apparent stratigraphic level and the occurrence of interbeds of similar sandstone within Earn Group shale (DME), the sandstone member may represent discrete sandstone deposits in the Earn Group.

Farther south, near the middle of the Earn Group sequence exposed in the map area, there are two ~350 m-thick intervals of rhythmically interbedded dolostone, sandstone, dark grey-green shale and minor chert (carbonate member; DMEc). This unit is thin-to-medium-bedded and has a distinctive, orange-and-white striped appearance (Fig. 9a,b). Dolostone beds are orange-weathered and have a grey fresh surface with a medium-grained crystalline texture. Sandstone beds are very fine grained, and white-weathered with a grey fresh surface. This unit has gradational stratigraphic contacts with underlying and overlying Earn Group shale.

Mississippian Tsichu Group: Keno Hill Quartzite (MKQH, MKHQsh)

The Mississippian Keno Hill Quartzite (MKHQ) occurs in the southwestern part of the map area, above the Earn Group (Fig. 3). It comprises homogeneous, medium-to-thick-bedded, medium-grained quartz arenite with a light to dark grey weathered surface (Fig. 9c). Beds are internally massive and exhibit a light grey fresh surface with an equigranular crystalline texture (Fig. 9d). Locally, the sandstone contains minor (<5%) clasts of dark grey fine-grained shale or chert (Fig. 9d). In many places, it includes minor (<2%) interbeds of orange-weathered, medium-grained quartz-rich sandstone with dolomite cement. The Keno Hill Quartzite tends to form prominent ridges and talus piles, which exhibit a distinctive, steel-grey weathering colour from a distance (Fig. 10c). Dark grey shale (MKHQsh) forms ~30–70 m-thick intervals that are interstratified with the quartzite. The shale is locally green-weathered and rich in chlorite ± white mica (phyllitic).

Intrusive rocks

Cambrian (?) gabbro (Ꞓg)

Gabbro intrusions (Ꞓg) were emplaced into siltstone and shale of the Narchilla and upper Yusezyu formations, forming discontinuous sills and plugs with maximum dimensions estimated to be ~150 m at the bedrock surface. Gabbro is medium-grained, locally foliated, and has been extensively replaced by greenschist-facies minerals (chlorite, actinolite, epidote) and carbonate alteration (see Fig. 7 in Skipton and Maw (2021)). Igneous textures have been preserved locally, and relics of igneous clinopyroxene crystals are visible in thin section. In places, igneous hornblende occurs instead of clinopyroxene, indicating that the intrusions have a compositional range from gabbro to melanocratic hornblende diorite. As the intrusions are hosted by the Narchilla Formation, they are inferred to be Terreneuvian or younger. Whole-rock geochemical compositions suggest that the gabbro and hornblende

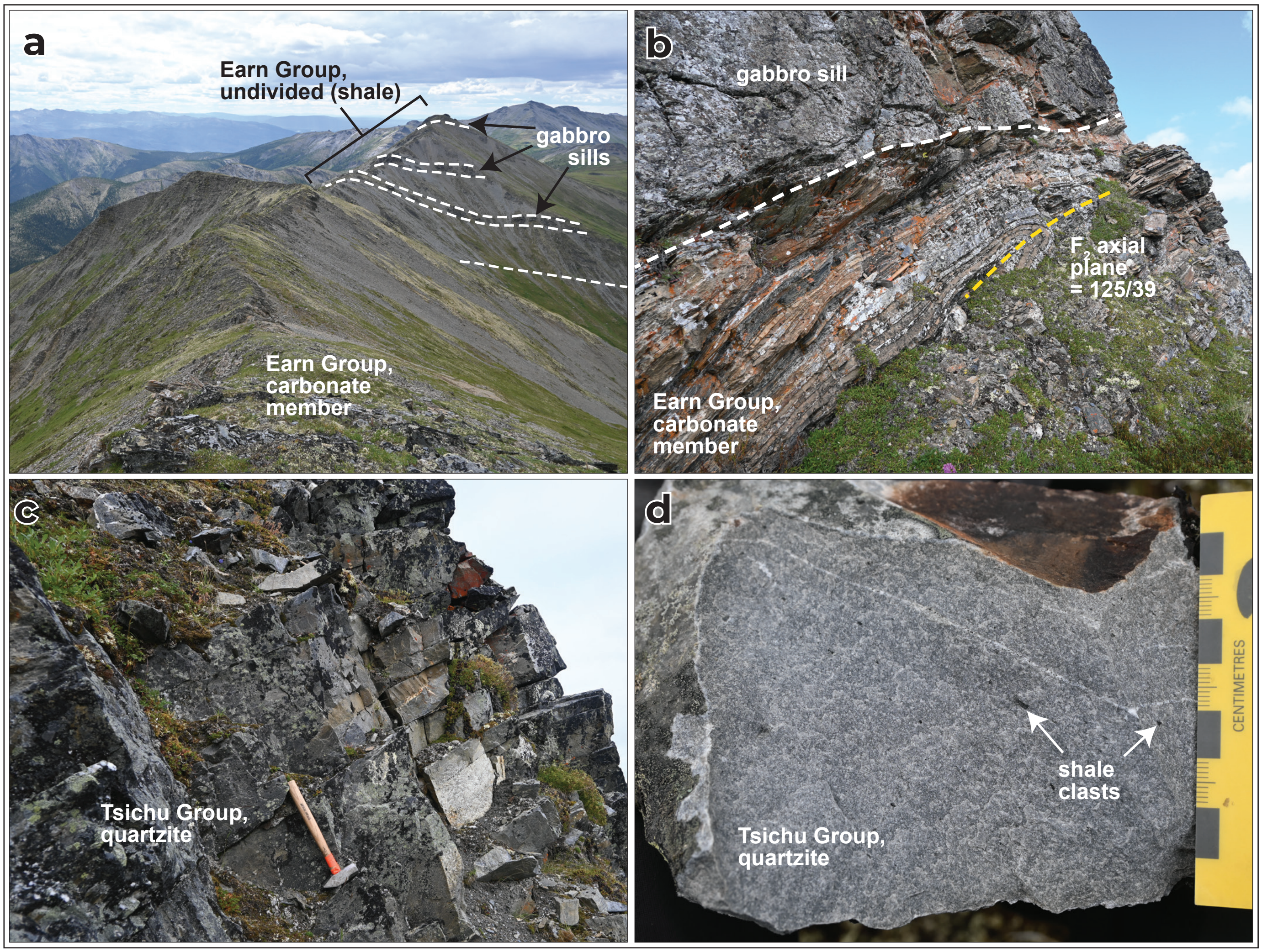

Figure 9. *Field photographs of the Devonian-Mississippian Earn Group, the Mississippian Tsichu Group and Triassic gabbro sills (Galena suite). White dashed lines indicate geological contacts.* ***(a)*** *Rhythmically interbedded carbonate, sandstone and dark grey shale in the Earn Group (carbonate member, DMEc) in the foreground of the photo, overlain by dark grey shale of the Earn Group (DME), which hosts several gabbro sills (Galena suite, ŦGg). Horizontal field of view is ~1 km.* ***(b)*** *Isoclinally folded (F2), rhythmically interbedded orange-weathered carbonate, white-weathered sandstone (± chert) and dark grey shale of the Earn Group (carbonate member, DMEc), hosting a gabbro sill (Galena suite). Photo was taken looking towards the northwest.* ***(c)*** *Medium-bedded, dark grey-weathered quartzite in the Tsichu Group (Keno Hill Quartzite, MKHQ).* ***(d)*** *Light grey fresh surface of quartzite in the Tsichu Group (MKHQ). Figure continued on next page.*

diorite intrusions have alkali basaltic compositions that are transitional between those of typical oceanic island basalt and enriched mid-ocean ridge basalt (Skipton and Maw, 2021). Preliminary geochemical comparisons with Cambrian and younger mafic to intermediate rocks in the region suggest that the gabbro and diorite intrusions are distinct from the Triassic Galena suite sills (Skipton and Maw, 2021). Instead, they may share affinity with Paleozoic sills, dikes and volcanic rocks (Dempster volcanics), such as those in the Upper Hart River area (Abbott, 1997c).

Devonian(?) quartz monzonite (Dqm)

Foliated quartz monzonite (Dqm) occurs in the southern part of the map area, hosted in siltstone of the Yusezyu Formation mixed unit. The quartz monzonite has a pitted, orange-brown weathered surface and a green-grey fresh surface. It consists of medium to coarse-grained K-feldspar, plagioclase feldspar and minor quartz. It has undergone pervasive carbonate, quartz and sericite alteration and hosts abundant carbonate (± quartz) veins (see Fig. 7 in Skipton and Maw (2021)). The intrusion's extent is poorly defined, mainly owing to poor outcrop exposure. The age of the intrusion is unknown, but it may share affinity with felsic rocks in the surrounding region (Fig. 2), such as the Rackla granite (*ca.* 63–59 Ma; Kingston *et al.*, 2010), Dublin Gulch pluton (*ca.* 93.5–92.8 Ma; Murphy, 1997), or *ca.* 380–378 Ma felsic volcanic rocks in the Earn Group (Murphy, 1997).

Triassic Galena suite: gabbro sills (ŦGg)

Gabbro sills of the Triassic Galena suite (ŦGg) are emplaced in the Devonian–Mississippian Earn Group (Fig. 9a,b) and the Mississippian Tsichu Group in the southwestern part of the map area (Fig. 3). The sills form prominent 'ribs' of outcrop that stand out from recessively-weathered Earn Group host rocks, including shale (DME; Fig. 9a) and the carbonate member (DMEc; Fig. 9b). Where hosted in the Tsichu Group, the sills have a similar weathering habit and colour to the Keno Hill Quartzite (MKHQ), and anastomose within and between shale horizons (MKHQsh).

The gabbro sills mostly range from ~2 to 15 m in thickness, but are locally up to ~60 m thick. Gabbro sills are dark grey-weathered with a dark green fresh surface, and are generally medium-grained and equigranular (Fig. 9e). In places, particularly near intrusion margins, they are fine-grained and locally contain euhedral to subhedral, ~2–5 mm-sized plagioclase phenocrysts (Fig. 9f).

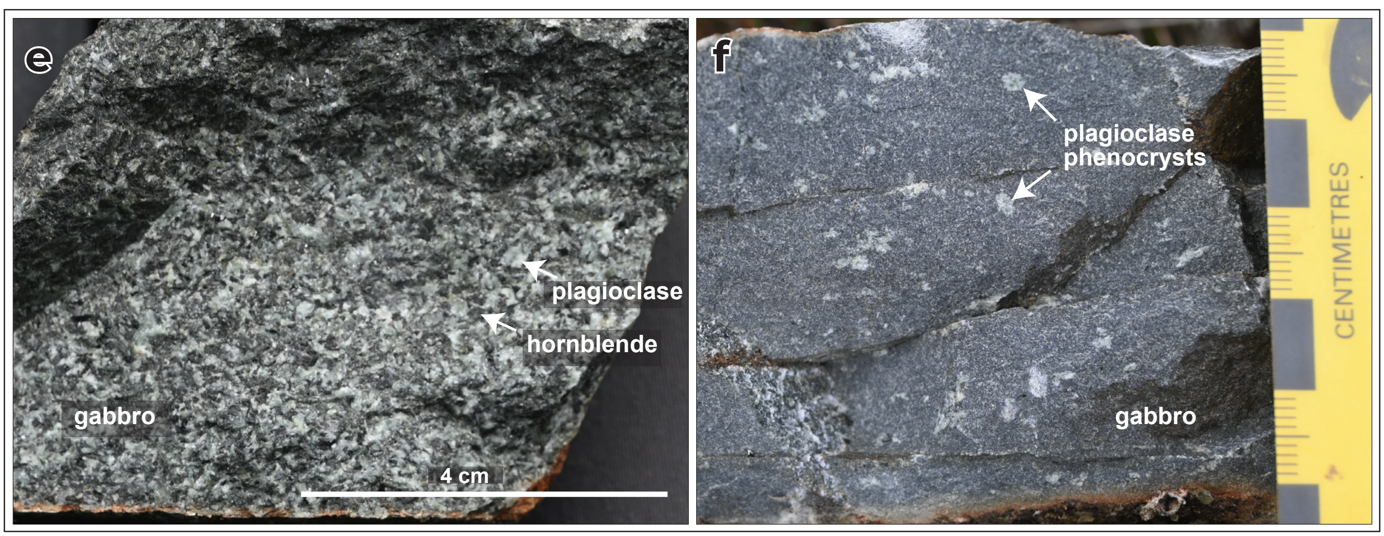

***Figure 9** continued. **(e)** Medium-grained gabbro (ŦGg) containing subhedral plagioclase and hornblende. **(f)** Fine-grained gabbro (ŦGg) with clusters of subhedral to euhedral plagioclase phenocrysts.*

Deformation

The mapped area records a complex compressional deformation history that produced a predominantly NW–SE-striking, SW-dipping structural architecture. The area includes at least five southeast-striking thrust sheets, from the hanging wall of the Robert Service thrust in the southwest to the footwall of the Dawson fault in the northeast (Figs. 3 and 4). Compression resulted in significant folding, crenulation lineations, and a regional lower-greenschist-facies foliation. For ease of discussion in this report, these folds and fabrics are grouped together within the same generation of deformation (D_2) throughout the mapped area.

Foliations (S_1 and S_2)

Two regional foliations were identified during mapping (S_1 and S_2). An early foliation (S_1) is defined by very fine grained white mica and chlorite aligned parallel to bedding in sedimentary rocks. Bedding and S_1 typically dip towards the southwest, but are northeast-dipping in places due to reorientation by subsequent folding (F_2, discussed below). The early, bedding-parallel foliation (S_1) may record burial during initial crustal thickening.

In fine-grained siliciclastic rocks, the S_2 foliation is defined by aligned fine-grained white mica (± chlorite), which commonly forms a crenulation cleavage. In carbonate rocks and sandstone, S_2 is less pervasive and typically presents as a spaced cleavage. In general, S_2 dips towards the southwest or northeast, and is oblique to bedding (and S_1) at angles up to 90° (Fig. 5d). S_2 is interpreted to have formed as an axial planar cleavage to F_2 folds (Fig. 10d), and the variable dip directions of S_2 are interpreted as the result of cleavage fanning and refraction in rocks of contrasting competencies. The S_2 foliation is parallel to S_1 in some F_2 fold limbs (described in detail in Skipton and Maw (2021)).

Folds (F_2)

F2 folds occur from the micro-scale to map-scale, have northwest–southeast-striking axial planes, and fold axes that plunge shallowly to moderately towards the northwest or southeast. F_2 crenulations have wavelengths as small as 0.25 mm, and form northwest or southeast-plunging crenulation lineations (L_2; see Fig. 10d in Skipton and Maw (2021)). At the outcrop-scale, F_2 folds generally have wavelengths of ~10–60 cm (Fig. 10b,d,f). Larger folds are common, with wavelengths ranging from tens of metres to ~3 km (Figs. 3b and 5e,f). F_2 folds form several different types: open (Figs. 5e and 10a) to isoclinal (Figs. 5f, 9b and 10d), symmetric and asymmetric (Fig. 10b,f), cylindrical and non-cylindrical, harmonic and disharmonic (Fig. 10f), upright (Fig. 5e,f) to inclined

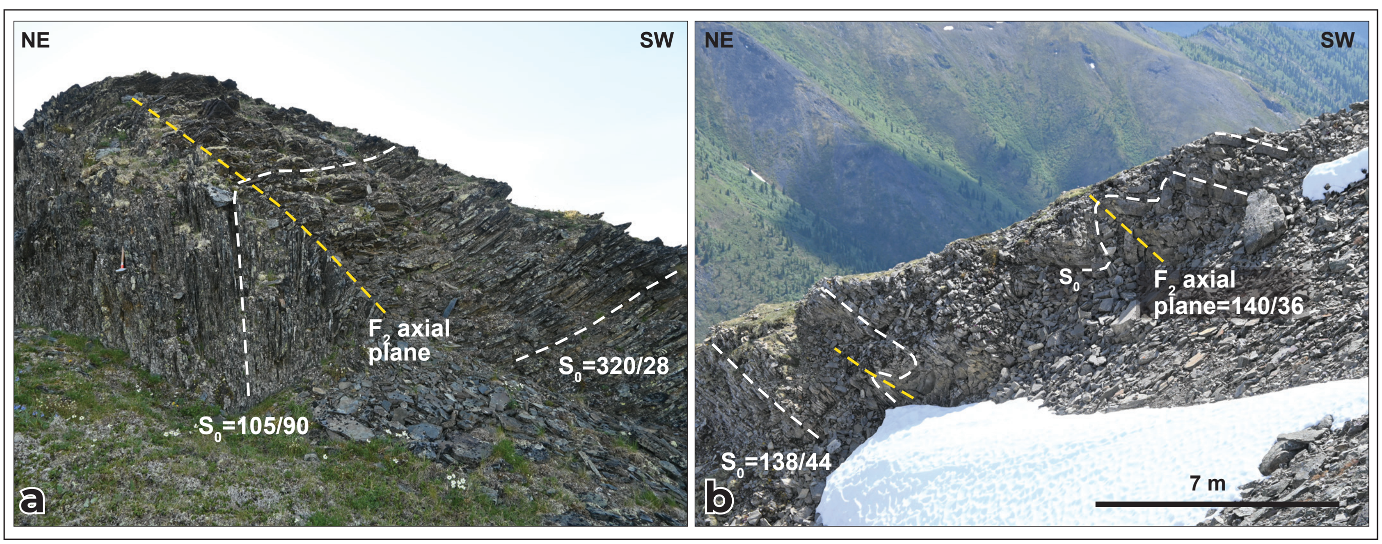

***Figure 10.** Field photographs of deformation structures. Deformation fabrics are indicated by yellow dashed lines. Linear fabric orientations are indicated in plunge-trend notation here and throughout the manuscript. **(a)** Thinly interbedded black mudstone and chert (Road River Group, OSR) folded by an open southwest-dipping anticline; **(b)** Asymmetric, tight, southwest-dipping folds of limestone beds (Algae Formation, PHa), suggesting vergence towards the northeast. Figure continued on next page.*

(Fig. 10a,b,d,f), and chevron (Fig. 5e). The northeastern limbs of asymmetric F_2 folds are short and steeply-dipping (Fig. 10b,f), suggesting northeast vergence, consistent with the southwestern dip of F_2 axial planes.

In folded sequences of the Hyland Group, map-scale folds have preserved upper stratigraphic levels in synclinal keels (e.g., the Algae and Narchilla formations; Figs. 3 and 5e,f) and revealed lower stratigraphic levels in antiformal cores (e.g., Yusezyu Formation; Figs. 3 and 5f). In areas where fold closures are covered or have been eroded away, large-scale folds are interpreted from the repetition of stratigraphy, together with the presence of parasitic folds on the micro-to-outcrop-scale and the associated axial planar cleavage (S_2). Several units are discontinuous along-strike (Fig. 3a) as a result of non-cylindrical map-scale folds with northwest or southeast-plunging axes, in combination with lateral facies changes and topographic relief.

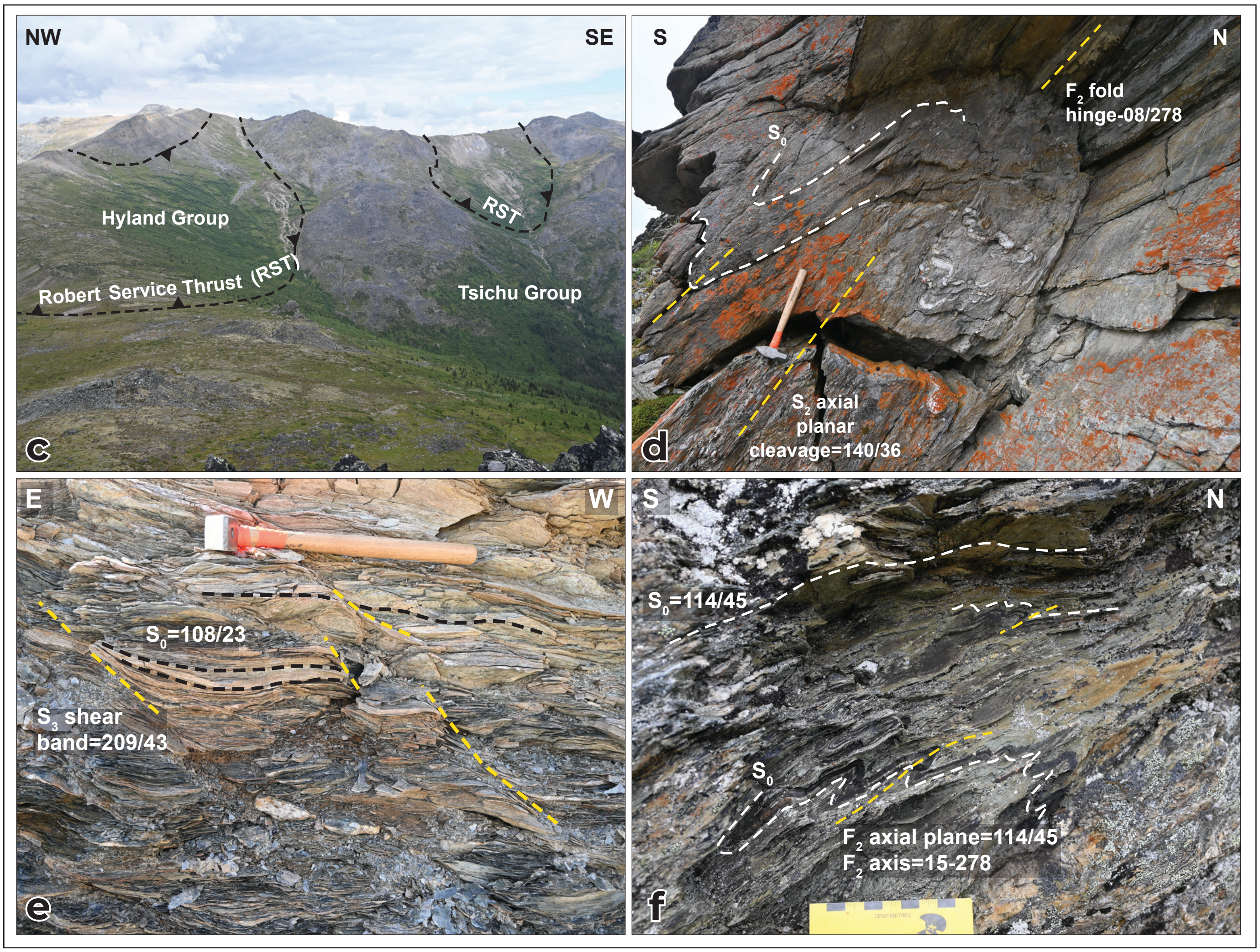

***Figure 10** continued. **(c)** Tan-weathered quartz grit sandstone and phyllite (Hyland Group, Yusezyu Formation,* PHYss, PHYssm*) in the hanging wall of Robert Service thrust klippen, juxtaposed over grey-weathered quartzite (Tsichu Group, Keno Hill Quartzite,* MKHQ*) in the footwall (horizontal field of view is ~1.7 km). **(d)** South-dipping isoclinal anticline in quartz grit sandstone (Hyland Group, Yusezyu Formation,* PHYss*) in the hanging wall of the Robert Service thrust, with numerous parasitic folds and well-developed axial planar cleavage. **(e)** Thinly interbedded dark green phyllite and orange-weathered dolostone and quartz grit with carbonate cement (Hyland Group, Yusezyu Formation,* PHYssm*) with west-dipping shear bands in the hanging wall of the Robert Service thrust zone. **(f)** Tight, disharmonic, asymmetric folds of bedding (and S_1) in interbedded dark grey mudstone and grey-green phyllite (Earn Group,* DME*) in the footwall of the Robert Service thrust. South-dipping axial planes and steep, short northern limbs indicate vergence towards the north.*

Thrusts

Robert Service thrust

Initially mapped by Green (1972a), the locations of the Robert Service thrust and klippen have been refined based on the detailed mapping conducted in this study (Figs. 3a and 10c). The Robert Service thrust juxtaposes Ediacaran–Lower Cambrian Hyland Group rocks over the Mississippian Keno Hill Quartzite (MKHQ). Bedding orientations and the presence of klippen indicate that the thrust surface dips shallowly to moderately toward the south-southwest overall, and has been folded by an open anticline-syncline pair with west-to-northwest-striking axial planes (Fig. 3b).

Rocks in the Robert Service thrust hanging wall are intensely deformed, especially within a few hundred metres above the thrust. They exhibit a strong S_2 foliation that is defined mainly by aligned muscovite (± chlorite), and is axial planar to moderately south–southwest-dipping F_2 folds (Fig. 10d). Bedding orientations are variable, but generally dip shallowly to moderately towards the south–southwest. In places, hanging wall rocks have been affected by post-S_2 west-dipping shear bands (S_3) that imply top-to-the-west movement (Fig. 10e).

In the footwall of the Robert Service thrust, the Earn Group (DME, DMEc) and the margins of gabbro sills (T̄Gg) are strongly foliated, and the Earn Group locally contains isoclinal folds with well-developed S_2 axial planar cleavage (Fig. 9b). Earn Group shale within ~100 m below the thrust exhibits tight, disharmonic, asymmetric, north-vergent F_2 folds of bedding and the early bedding-parallel (S_1) foliation (Fig. 10f).

Tombstone thrust

In the mapped area, the Tombstone thrust was previously inferred to occur in the Earn Group near its northeastern (basal) contact (Fig. 2). However, detailed mapping across well-exposed rocks in the area where the fault trace was previously inferred (and several kilometres on either side of it) yielded no apparent structural evidence for the thrust or its associated high-strain zone. Structural fabrics include a southwest-dipping foliation and southeast-plunging crenulation lineations and fold axes, which are typical of those elsewhere in the study area (discussed above; see also Skipton and Maw (2021)). In particular, the previously inferred location of the Tombstone thrust lacks northwest-vergent structures, which are considered diagnostic of the thrust and its associated high-strain zone in the Keno and Mayo areas (e.g., Murphy, 1997). Minor occurrences of west-dipping shear bands (Fig. 10e) in the Robert Service thrust zone may signify an overprint of strain related to the Tombstone thrust, but additional investigation is required to test this hypothesis.

Thrusts located between the Robert Service and Dawson thrusts

In the thrust panel that forms the footwall to the Robert Service thrust, Hyland Group strata have been juxtaposed above the younger Road River Group (OSRc, OSRsh), along an interpreted steeply-dipping thrust fault (Figs. 3 and 4). Farther northeast, an additional steeply-dipping thrust fault is interpreted to have juxtaposed the Hyland Group over the Road River Group (OSR, OSRc, OSRsh; Figs. 3 and 4).

Map-scale variations in fold patterns (e.g., open vs. isoclinal) and stratigraphic dips (e.g., shallow southwest vs. subvertical) within and between different thrust sheets suggest that protracted thrusting and variably overlapping strain footprints may have produced distinct structural domains. For example, in the northwestern part of the thrust panel that forms the footwall to the Robert Service thrust, Earn and Hyland Group strata dip moderately towards the southwest, and the Hyland Group forms several tight-to-isoclinal map-scale F_2 folds (Fig. 3). To the southeast, Hyland Group rocks in the same thrust panel form upright, open map-scale F_2 folds (Figs. 3 and 5e) and have variable southwest–northeast-dipping bedding orientations.

In contrast, the Road River Group, Gull Lake Formation (ЄGL) and Hyland Group that occupy the thrust sheet in the middle of the map dip subvertically. Bedding orientations range from ~80° NE to ~80° SW, varying about tight-to-isoclinal F_2 folds with subvertical axial planes (Figs. 3 and 5f). In the thrust sheet to the northeast (which forms the hanging wall to the Dawson fault, discussed below), bedding in the Road River Group and volcanic rocks (Ov, Ovsh) mostly dips steeply towards the southwest, but orientations are variable due to tight F_2 folds.

Dawson thrust

The frontal Dawson thrust is inferred to lie along the southeastern edge of the Beaver River valley (Fig. 3a), coinciding with a distinct linear signature on aeromagnetic maps of Kiss (2020; see also Fig. 9 in Skipton and Maw (2021)). In the region surrounding the study area, the Dawson Fault separates the Ediacaran–Lower Cambrian Hyland Group in the hanging wall from the Ordovician–Devonian(?) Bouvette Formation in the footwall (Fig. 2; Green and Roddick, 1972; Colpron *et al.*, 2013). Previous maps of the study area document the same relationship (Green and Roddick, 1972), or include the Mississippian Tsichu Group locally in the immediate footwall (Fig. 2; digital compilation map of Yukon; Yukon Geological Survey, 2021a). Based on the detailed mapping presented herein, rocks formerly assigned to the Tsichu Group in the footwall of the Dawson fault here are considered to belong to the Ordovician–Silurian Road River Group. The latter rocks are underlain, at least in part, by volcanic rocks of possible Ordovician age (Ov), which may have been thrust over the Bouvette Formation along the frontal Dawson fault (Figs. 3 and 4). The Dawson fault cuts at similarly young stratigraphic levels west of the study area in the Ogilvie Mountains, where it has juxtaposed the Gull Lake Formation over the Road River Group (Abbott, 1997b). These relationships demonstrate the complexity of the Dawson fault zone, whereby rocks of different stratigraphic levels and ages appear to have been transported in the hanging wall.

It is important to note that the Bouvette Formation is known to unconformably overlie older rocks in the region surrounding the study area (e.g., in the southern Wernecke Mountains and eastern Rackla belt; Colpron *et al.*, 2013; Moynihan *et al.*, 2019; Ambrose and Bowie, 2020). Therefore, it is possible that the contact between the Bouvette Formation and the volcanic rocks (Ov) is an unconformity, rather than the frontal Dawson fault. It also remains uncertain what role the Kathleen Lakes strike-slip fault (Fig. 2; Roots, 1990; Abbott, 1990a) may have played in the juxtaposition of different-aged rock units in the Beaver River valley.

In an alternative scenario, the frontal Dawson fault may lie farther southwest in the study area, where the Hyland Group overlies the Road River Group (OSR; Fig. 3).

Metamorphism

The southern Nash Creek area has been regionally metamorphosed at lower-greenschist-facies conditions (chlorite zone; e.g., Spear, 1993). Metamorphic assemblages in siliciclastic rocks are characterized by very fine grained white mica and chlorite (± epidote ± calcite). Phyllite and siltstone in the southeastern part of the mapped area locally contain chloritoid porphyroblasts up to 1.5 mm long. Metamorphic minerals in carbonate rocks include recrystallized calcite and/or dolomite, minor fine-grained white mica and, rarely, fine-grained tremolite. Metamorphic mineral assemblages in gabbro and diorite include chlorite, epidote, actinolite, calcite and white mica (± titanite ± apatite). Throughout the map area, the S_1 and S_2 foliations are defined by lower-greenschist-facies minerals, suggesting that they formed during regional lower-greenschist-facies metamorphism.

In siliciclastic rocks within few hundred metres of the Robert Service thrust, metamorphic white mica (± chlorite) is generally more abundant than elsewhere. The metamorphic mineral assemblages suggest lower-greenschist-facies conditions, similar to the rest of the mapped area.

Some mafic-to-intermediate intrusions (Ꞓg, ƬGg) are surrounded by narrow (≤1–2 m) contact metamorphic aureoles. The aureoles are subtly different from the host rocks, and are characterized by a lighter green or grey colour and higher contents of white mica and chlorite. Rarely, the aureoles contain ~1–2 mm-wide, grey, oval-shaped aggregates of chlorite and quartz, which may represent former porphyroblasts (e.g., cordierite).

Mineralization

Located between several Au and polymetallic mineral deposits (Fig. 2), the study area has been classified as "prospective" to "highly prospective" in mineral potential models (Bullen, 2020). Stratigraphic units mapped here are known to host mineral deposits in the surrounding region. For example, the Hyland Group hosts the past-producing polymetallic manto-style Clark deposit (Fig. 2). The McKay Hill polymetallic vein deposit (Fig. 2) is hosted by a sequence of volcanic and sedimentary rocks (Cobbett, 2022) that may be equivalent to those mapped in the study area (Ov).

Quartz veins are relatively common in the mapped area, and typically contain calcite, white mica and/or chlorite. Sulphides are rare and generally comprise pyrite, although several veins contain a reddish-brown material, which may be a product of weathering or alteration of sulphides (Fig. 11a). Some wall rocks exhibit gossanous weathering. Quartz veins are predominantly hosted by the Narchilla and Yusezyu formations in the Hyland Group (Fig. 11a), by chert in the Road River Group (OSRc) and by the Keno Hill Quartzite (MKHQ; Fig. 11b). Less commonly, they are hosted by gabbro (Єg) and by the Algae Formation (ⱣHa) where it has been intruded by gabbro (Skipton and Maw, 2021). The quartz veins dominantly strike northwest–southeast, parallel to the regional structural grain, but they have variable orientations and locally form networks. As some vein surfaces are lineated (L_2; Fig. 11b), regional D_2 deformation outlasted vein emplacement in some cases.

Assay results from grab-samples of several quartz veins and altered (e.g., silicified or gossanous) rocks are presented in Table 1. A southeast-dipping quartz vein hosted in quartz arenite (Narchilla Formation, ⱣЄHnss) contains blue and green minerals (azurite and malachite?; Fig. 11a) and yielded anomalously high contents of Au, Ag, Cu, Zn and other elements (sample 21DS-050-1-1; Table 1).

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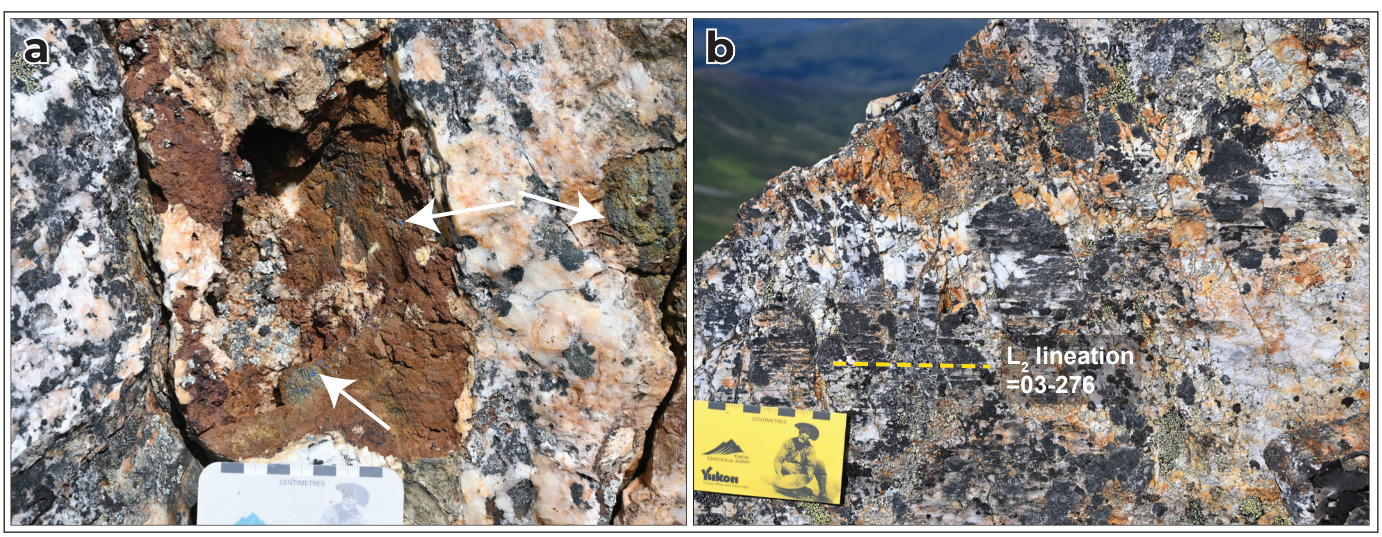

Figure 11. *Field photographs of quartz veins.* ***(a)*** *Quartz vein containing a reddish-brown alteration material and blue and green minerals (azurite and malachite?; indicated by white arrows). The quartz vein orientation is 055/62 and the vein is hosted in quartz arenite (Narchilla Formation, sandstone member,* ⱣЄHnss*).* ***(b)*** *Quartz vein surface exhibiting well-developed* L_2 *lineations. The quartz vein is hosted in quartzite (Tsichu Group, Keno Hill Quartzite,* MKHQ*).*

Table 1. *Assay results from rock samples collected during geological mapping in the southern Nash Creek area.*

Sample	Rock type	Latitude	Longitude	Au (ppm)	Ag (ppm)	As (ppm)	Bi (ppm)	Cd (ppm)	Cu (ppm)	Pb (ppm)	Sb (ppm)	Zn (ppm)
21DS-050-1-1	Quartz vein	64.299684	-135.084658	5.58	71.1	4310	32.1	73.2	22300	3980	>10000	10250
21DS-056-1-2	Altered siltstone	64.293649	-135.140764	0.02	0.87	25.5	0.286	0.325	142	21.7	52.8	153
21DS-094-1-1	Altered mafic volcaniclastic rock	64.340803	-135.104251	<0.01	0.151	6.41	0.066	0.416	85.6	7.75	51.5	71.8
21DS-098-1-3	Altered chert	64.298977	-135.200566	0.01	0.076	14.45	0.118	0.475	93.3	9.62	10.6	28.6
21DS-176-1-2	Altered quartzite with quartz veins	64.214353	-135.354614	<0.01	0.1	17.6	0.043	0.157	67.4	3.7	22.7	243
19DS-012-2-1	Quartz vein	64.210713	-134.886781	<0.01	0.003	4.75	0.035	0.023	0.84	2.44	0.32	59.3
19DS-040-1-2	Gabbro with quartz vein	64.201451	-134.830385	<0.01	0.03	12.7	0.079	0.126	43.7	52.5	0.47	314
19DS-042-1-2	Altered siltstone	64.203576	-134.819603	0.01	0.024	0.68	0.484	<0.005	11.9	2.36	0.18	35
19DS-058-1-2	Quartz vein	64.1671	-134.842987	<0.01	0.009	1.43	0.105	0.013	2.1	3.08	0.54	82
19DS-058-1-3	Quartz vein	64.1671	-134.842987	<0.01	0.01	1.28	0.105	0.068	9.58	4.49	0.72	72.1
19DS-136-1-1	Limestone with quartz veins	64.255204	-135.101553	0.01	0.018	7.51	0.021	0.038	59.4	0.6	0.05	94.1

Notes: Geochemical analyses were performed by ALS Geochemistry (Whitehorse, Yukon) using the following methods: Au, fire assay and atomic absorption spectroscopy (AAS); Ag, As, Cu, Pb, Sb, Zn, four acid digestion with inductively-coupled plasma mass spectrometry (ICP-MS).

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