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Critical review

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Abstract: The northern Stevenson Ridge map area is underlain by Paleozoic to Paleogene rocks that locally host Au and Cu-Au mineralization. The northern side of the Dawson Range is characterized by Paleozoic rocks typical of the Yukon-Tanana terrane, including the pre-Devonian Snowcap assemblage, Mississippian Simpson Range suite and Finlayson assemblage, and the Permian Klondike schist and Sulphur Creek plutonic suite of the Klondike assemblage. The Mississippian stratigraphy is intruded by the Triassic Pyroxene Mountain suite and the Early Jurassic Aishihik suite. Late Devonian metamorphosed volcanic, plutonic and sedimentary rocks of the White River assemblage and the Late Triassic Snag Creek gabbro suite occur southwest of the Dawson Range. These rocks are structurally overlain by a thrust sheet of the Early Permian ophiolitic Harzburgite Peak complex. The White River assemblage and the Yukon-Tanana terrane are juxtaposed along the post-Triassic Moose Creek fault, which is partly demarcated by lozenges of peridotite, indicating that it is a fundamental crustal fault. Other major post-Triassic faults imbricate the Yukon-Tanana terrane tectonostratigraphy, and determine the map pattern. These faults likely acted as conduits for Mesozoic fluids and magmatism and have been reactivated throughout the Cordilleran orogenesis. Late Cretaceous and younger faults throughout the area have only modest offsets.

Résumé : Le socle de la partie nord de la région cartographique de Stevenson Ridge est composé de roches du Paléozoïque au Paléogène qui renferment par endroits des minéralisations de Au et de Cu-Au. Le côté nord du chaînon Dawson est caractérisé par des roches du Paléozoïque représentatives du terrane de Yukon-Tanana, comprenant notamment l'assemblage antédévonien de Snowcap, la suite de Simpson Range et l'assemblage de Finlayson du Mississippien, ainsi que le schiste de Klondike et la suite plutonique de Sulphur Creek de l'assemblage de Klondike, tous deux du Permien. La succession stratigraphique du Mississippien est recoupée par des intrusions de la suite de Pyroxene Mountain du Trias et de la suite d'Aishihik du Jurassique précoce. Des roches volcaniques, plutoniques et sédimentaires métamorphisées de l'assemblage de White River du Dévonien tardif et de la suite gabbroïque de Snag Creek du Trias tardif sont présentes au sud-ouest du chaînon Dawson. Ces roches sont surmontées structuralement par une nappe de charriage formée d'unités du complexe ophiolitique de Harzburgite Peak du Permien précoce. L'assemblage de White River et le terrane de Yukon-Tanana sont juxtaposés le long de la faille post-triasique de Moose Creek, qui est en partie délimitée par des losanges de péridotite indiquant qu'il s'agit d'une faille élémentaire de la croûte terrestre. D'autres grandes failles post-triasiques imbriquent les constituants tectonostratigraphiques du terrane de Yukon-Tanana, et en déterminent la configuration cartographique. Ces failles ont probablement servi de conduits pour les fluides et le magmatisme du Mésozoïque, et ont été réactivées au cours de l'orogenèse cordillérienne. Dans l'ensemble de la région, les failles du Crétacé tardif et les failles plus récentes ne présentent que de faibles rejets.

INTRODUCTION

Geology of west central Yukon is characterized by metamorphosed and poly-deformed Paleozoic basement intruded and overlain by relatively undeformed Mesozoic and Paleogene successions. Mineral occurrences and deposits that range in style from orogenic-style gold, intrusion- related gold, and Cu-porphyry are generally associated with Mesozoic magmatism and tectonism (e.g. White Gold, Coffee, Casino, Sonora Gulch mineral deposits); however, these deposits also have a strong co-spatial relationship with their Paleozoic basement. This suggests that the Paleozoic basement (particularly the Klondike assemblage) exerts a strong control on mineralization by either focusing magmatism and fluid flow along basement structures, by providing chemical and structural traps for mineralization, and/or by being the source of some of these metals. Previous studies of this geology have identified domainal distribution of Paleozoic rock assemblages (Tempelman-Kluit, 1974, 1984; Payne et al., 1987; Johnston, 1993, 1995). In some cases, evidence for large-scale thrust faults of probable Jurassic age has been identified (Tempelman-Kluit, 1974; Gordey and Ryan, 2005; MacKenzie and Craw, 2012; Ryan et al., 2013a, b). These thrust faults are commonly overprinted by middle to Late Cretaceous strike-slip and normal faults that have long strike length, but not necessarily significant offset (Ryan et al., 2013b).

In this contribution we summarize the Paleozoic bedrock geology of the northern Stevenson Ridge area which covers parts of NTS 115-J, K, I, P and O (Fig. 1; Ryan et al., 2013a, b and references therein; S. Israel, D.C. Murphy, and R. Cobbett, unpub. map manuscript, 2014) and provide a tectonic framework to evaluate the influence of the Paleozoic geology of Mesozoic and younger magmatism and mineralization. An account of Mesozoic to Paleogene geology of the area will be presented in a subsequent report. The backbone of the Dawson Range is underlain by the middle Cretaceous Whitehorse plutonic suite (e.g. Selby and Creaser, 2001; McKenzie et al., 2013; Zagorevski et al., 2014). In this generally unglaciated terrain (Duk-Rodkin, 1999), exposures of the Paleozoic basement are limited to scattered tors separated by extensive frost-shattered felsenmeer on broad upland ridges. Outcrop is rarely found in the heavily forested valleys or swampy low-lying areas. The present authors' interpretation of Paleozoic geology is aided by aeromagnetic surveys (Hayward et al., 2012) and unpublished geochronological and geochemical data. The Paleozoic tectonostratigraphy of the northern Stevenson Ridge area is herein shown to have a domainal distribution at the regional scale (Fig. 2). Each domain appears to preserve unique magmatic and metamorphic histories, indicating that they underwent distinctly different Paleozoic to Early Mesozoic geological evolution (Zagorevski et al., 2012; Staples et al., in press). The boundaries between these terranes are herein interpreted to be major post-Triassic faults. The identification of these domains and their bounding structures provides a new tectonostratigraphic framework for this part of Yukon, which assists the evaluation of basement controls on younger mineralization.

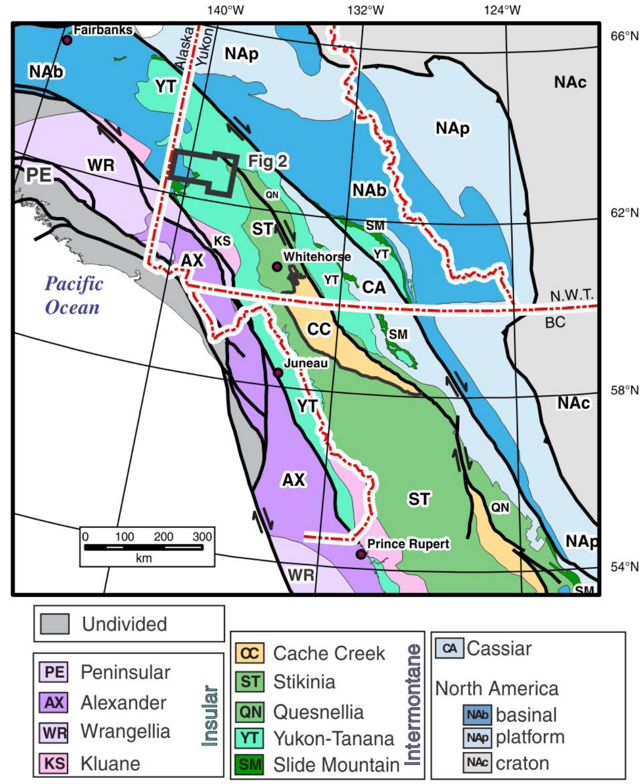

Figure 1. Simplified terrane map of northern Cordillera (*modified from* Colpron and Nelson, 2011). Field study area (Fig. 2) is outlined. It lies with the Yukon-Tanana terrane, with the western third (White River assemblage) assigned to the basinal facies of ancient North America.

GEOLOGICAL FRAMEWORK

The geology of the northern Stevenson Ridge area is dominated by the hornblende granodiorite to biotite monzogranite of the middle Cretaceous Whitehorse plutonic suite (Fig. 2). The Dawson Range phase intrudes the contact between Yukon-Tanana terrane rocks to the northeast, and rocks that have been assigned to the White River assemblage to the southwest (Fig. 2; Ryan et al., 2013a). The White River assemblage has been interpreted by Israel and co-workers (S. Israel, D.C. Murphy, and R. Cobbett, unpub. map manuscript, 2014) to be distinct from the Yukon-Tanana terrane. The informal lithostratigraphic nomenclature for this region reflects its complex tectonometamorphic history,the tectonized boundaries between units, and the overall poor exposure. Herein 'assemblage' is utilized for a diverse set of rocks that have loose spatial and/or genetic relationships, and 'suite' is used for consanguineous metaplutonic rocks. 'Complex' is utilized for a set of rocks that have genetic relationships, but formed at different crustal levels. 'Schist' refers to foliated micaceous rocks of monotonous composition.

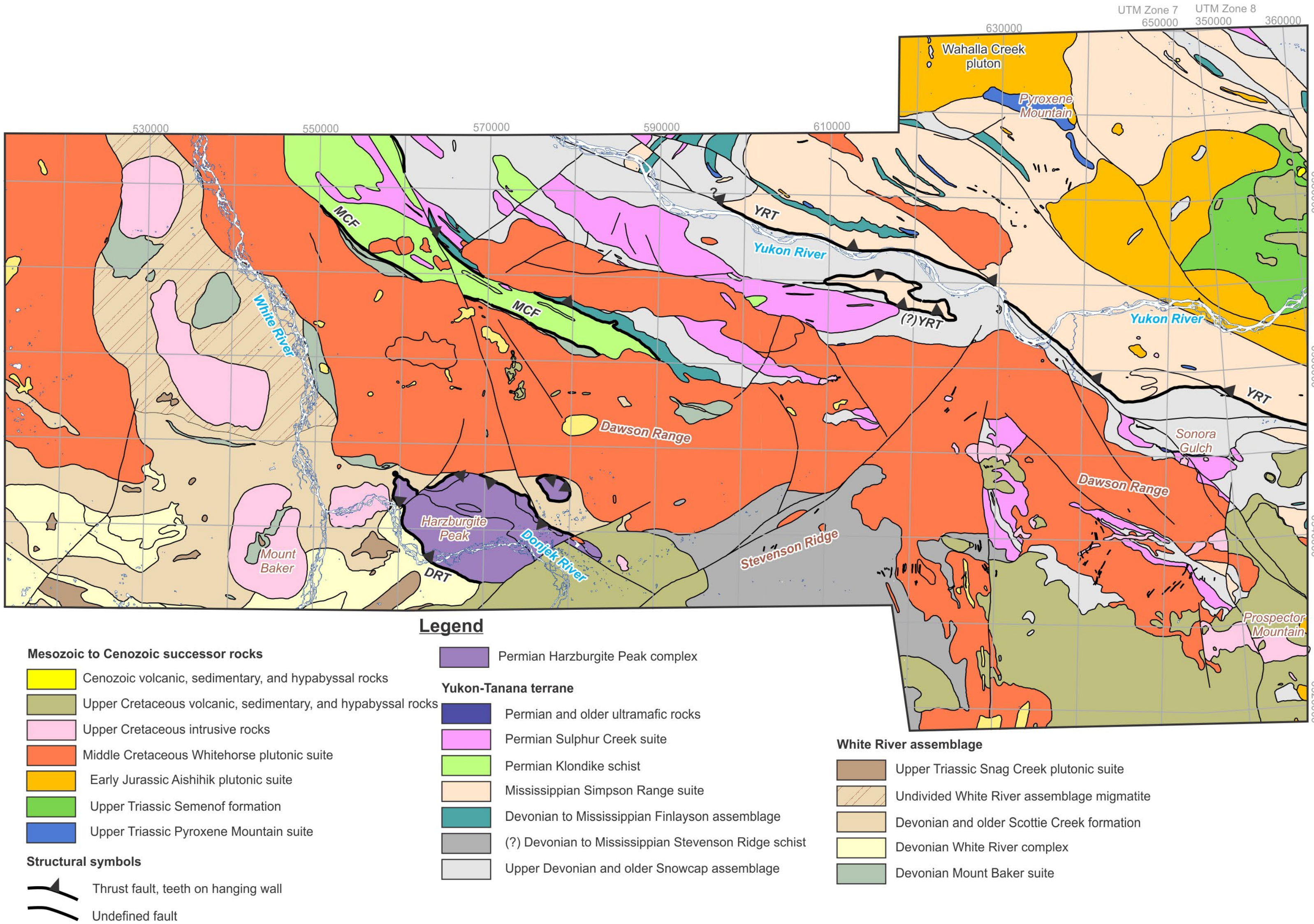

Figure 2. Geology of the northern Stevenson Ridge area (*after* Ryan et al. 2013a, b). Place names used in the text are labelled. The faults that bound the main structural panels (*see also* Fig. 6), are indicated with a heavy line thickness. YRT = Yukon River Thrust, MCF = Moose Creek fault, DRT = Donjek River Thrust

Yukon-Tanana terrane

The Yukon-Tanana terrane (Fig. 1, 2) comprises a complex package of polydeformed and metamorphosed pre-Devonian to Permian rocks. Following Gordey and Ryan (2005), Colpron et al. (2006), Colpron and Ryan (2010), and Ryan et al. (2010), the lithostratigraphy of the Yukon-Tanana terrane in the northern Stevenson Ridge is mapped in four assemblages: Snowcap, Stevenson Ridge (new, described herein), Finlayson, and Klondike, as well as three suites: Simpson Range, Sulphur Creek, and ultramafic.

Snowcap assemblage

The Snowcap assemblage (Piercey and Colpron, 2009) is a pre-late Devonian siliciclastic rock–dominated sequence named for the type locality on Snowcap Mountain near Little Salmon Lake in central Yukon (100 km east of the area of interest). In the northern Stevenson Ridge area, siliciclastic rocks composed mainly of quartzite, micaceous quartzite, and psammitic quartz-muscovite-biotite (±garnet) schist are assigned to the Snowcap assemblage (Fig. 2, 3a). The quartzite is generally fine grained, banded to massive, grey to white, and locally dark grey. Garnet-bearing pelitic schist is common but not aerially extensive. Quartzite–mudstone–pebble conglomerate horizons occur within the psammitic schist. Marble occurs as decametre-thick lenses within the siliciclastic rocks, as are lenses or layers of amphibolite and garnet amphibolite. The latter are generally interpreted as metamorphosed mafic sills and dykes of unknown age. A quartzite-marble interval near Sonora Gulch yielded a ca. 365 Ma detrital zircon population (N. Joyce, unpub. data, 2013), indicating that some of the metasedimentary rocks assigned to the Snowcap assemblage in the Stevenson Ridge area are the youngest yet dated, demonstrating their maximum age coeval with Late Devonian plutons common in Yukon-Tanana terrane (cf. Colpron et al., 2006).

Finlayson assemblage

Amphibolite that is not intimately associated with the Snowcap assemblage metasedimentary rocks is assigned to the Finlayson assemblage (Fig. 2). In the Finlayson Lake area of east-central Yukon, these rocks comprise a Devonian to Mississippian arc volcanic-plutonic complex (e.g. Colpron et al., 2006). Finlayson assemblage amphibolite in the northern Stevenson Ridge generally contain hornblende-plagioclase±epidote or garnet-hornblende-plagioclase±quartz mineral assemblages, and locally have a chlorite-biotite retrograde metamorphic overprint. Fine- to coarse-grained amphibolite and garnet amphibolite is locally interlayered with marble and siliciclastic metasedimentary rocks along the southwest extent of the Snowcap assemblage. The generally massive nature of some amphibolite layers suggests that these form either flows or sills. Other amphibolite occurrences form rafts or xenoliths within the Simpson Range suite (*see* 'Simpson Range suite' section, below) and comprise coarse, hornblende-garnet-plagioclase garbenschiefer and porphyroblastic schist (Fig. 3b). These rocks are interpreted as metamorphosed fine-grained, altered volcanic and sedimentary rocks that underwent extreme grain-size coarsening during metamorphism. Some amphibolite along the Yukon River locally preserves relict pillows (Fig. 7, Ryan and Gordey, 2001), supporting a mafic volcanic component to this assemblage. The local association of the garbenschiefer with highly aluminous kyanite schist suggests that some amphibolite originated from altered mafic to intermediate volcanic and volcaniclastic rocks and associated sediments. At some localities the Finlayson assemblage amphibolite schist is in structural contact with Snowcap assemblage rocks.

Simpson Range suite

In the Finlayson Lake area of eastern Yukon the Simpson Range suite is dominantly an early Mississippian plutonic component of the Yukon-Tanana terrane (Murphy et al., 2006). A domain of metaplutonic rocks mostly exposed northeast of the Yukon River, and in a small outlying klippe south of the Yukon River is assigned to the Simpson Range suite. Highly foliated to gneissic hornblende-biotite and biotite granodiorite (Fig. 3c) predominate, with minor monzogranite, diorite, gabbro, and recrystallized amphibolite of uncertain protolith. Three samples of orthogneiss in the map area yielded ca. 346 Ma ages (N. Joyce, unpub. data, 2013). The Simpson Range suite intrudes Finlayson assemblage metavolcanic rocks, but appears to be in structural contact with the Snowcap assemblage along the Yukon River Thrust (*see* 'Tectonostratigraphy' section).The interpreted thrust boundary contrasts with the more regional observation within Yukon-Tanana terrane of an intrusive contact between the Simpson Range suite and the Snowcap assemblage (e.g. Gordey and Ryan, 2005; Colpron et al., 2006).

Klondike assemblage

The Klondike region in north-central Yukon is characterized by the Middle–Late Permian volcanic rocks of the Klondike schist and plutonic rocks of the Sulphur Creek suite: these together comprise the Klondike assemblage (e.g. Mortensen, 1992; Gordey and Ryan, 2005). Rocks of similar character and age occur through the central Stevenson Ridge area, north of the bulk of the Dawson Range batholith. The southern extent of the Klondike assemblage is significantly expanded by our mapping (Ryan et al., 2013a, b). Significantly, these rocks are exposed in two distinct structural panels of differing metamorphic grade.

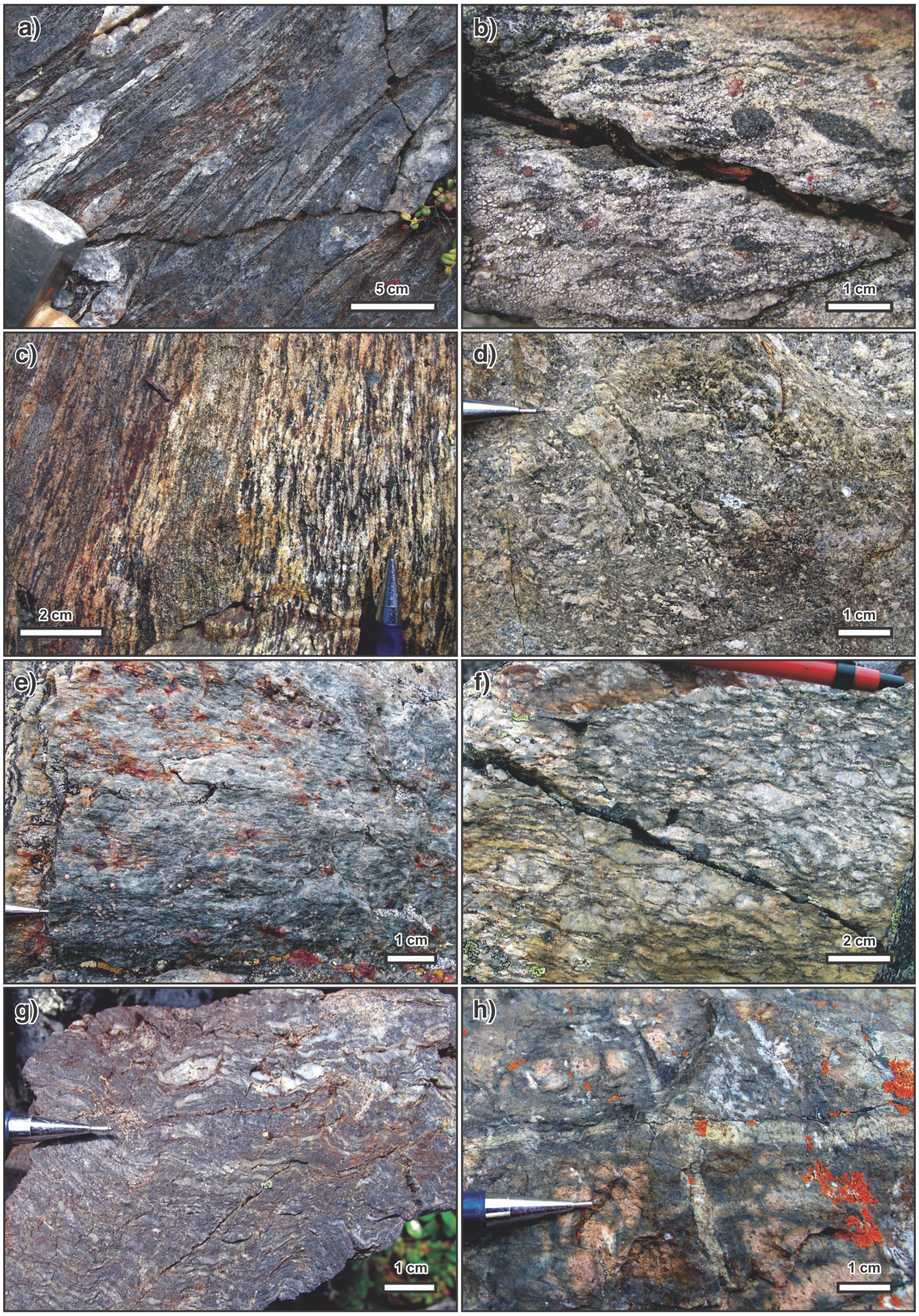

Figure 3. Field photographs of representative lithologies of the Yukon-Tanana terrane in the field area. **a)** Interlayered quartzite and quartzo-feldsparthic schist of the Snowcap assemblage exhibiting F_2 isoclinal folds of bedding and an S_1 foliation; photograph by M. Colpron; 2014-118. **b)** Finlayson assemblage hornblende-garnet-plagioclase schist with hornblende and garnet porphyroblasts overprinting the main foliation; photograph by A. Zagorevski; 2014-124. **c)** Strongly foliated Simpson Range suite hornblende-biotite granodiorite with quartz diorite enclaves; photograph by J. Ryan; 2014-121. **d)** Well preserved felsic lapilli (1–10 cm fragments) tuff of the Klondike schist; photograph by J. Ryan; 2014-117. **e)** Chlorite-sericite phyllonite of the Klondike schist, exhibiting characteristic relict pyrite porphyroblasts; photograph by J. Ryan; 2014-115. **f)** K-feldspar porphyroclastic augen granite of the Sulphur Creek suite; photograph by J. Ryan; 2014-112. **g)** Carbonaceous quartzite of the Stevenson Ridge schist; photograph by J. Ryan; 2014-114. **h)** Serpentinized dunite exposed along the Moose Creek fault separating Klondike schist from the White River assemblage; red growth is lichen; photograph by J. Ryan; 2014-123

Klondike schist

Klondike schist comprises variably deformed greenschist-facies volcanic, hypabyssal, and sedimentary rocks. Locally well preserved quartz and feldspar porphyritic felsic volcanic and volcaniclastic rocks (Fig. 3d) demonstrate a volcanic protolith; however, strongly deformed sericite, chlorite, and quartz-feldspar augen schist and phyllonite predominate. Schist and phyllonite commonly exhibit pitted surfaces indicative of weathered-out pyrite porphyroblasts (Fig. 3e). The metamorphosed lapilli tuff yielded ca. 256–259 Ma crystallization ages (N. Joyce, unpub. data, 2013), confirming their inclusion in this assemblage.

Sulphur Creek suite

Potassic feldspar and quartz porphyritic to equigranular syenogranite to granodiorite, similar to the Sulphur Creek orthogneiss of the Klondike region (Mortensen, 1992), is broadly exposed in two distinct structural panels (*see* 'Tectonostratigraphy' section). Strain varies from moderate foliation to strong gneissosity or phyllonitic foliation. Augen and porphyroclastic textures are common (Fig. 3f) in porphyritic protoliths. In the northern panel, the Sulphur Creek suite intrudes the Snowcap assemblage and associated amphibolite and garnet amphibolite. Granitoid rocks in this belt yielded ca. 262–260 Ma ages (N. Joyce, unpub. data, 2013) consistent with ages of Sulphur Creek suite in Stewart River area (Mortensen, 1992; Ruks et al., 2006). Plastic deformation of K-feldspar augen indicates metamorphic temperatures at amphibolite facies and/or higher grade conditions. In contrast, Sulphur Creek granitoid rocks in the southern panel (panel 3) intrude the Klondike schist. These granitoid rocks were deformed and metamorphosed at greenschist facies where K-feldspar destructive alteration produced quartz-sericite-chlorite phyllonite, and largely obliterated original plutonic texture, making it locally indistinguishable from the Klondike schist. Granitoid rocks in the southern panel generally yield ages that are slightly younger (257–255 Ma), and are similar to the Klondike schist (Breitsprecher and Mortensen, 2004; McKenzie et al., 2013). The present authors interpret the boundary between the amphibolite-facies northern panel and the greenschist-facies southern panel as a thrust fault that postdates peak metamorphism.

Stevenson Ridge schist

The Stevenson Ridge schist comprises a monotonous sequence of grey to black, carbonaceous quartzite (Fig. 3g), psammite and phyllite that are exposed in the south-central part of the area (Fig. 2). The authors interpret their protolith as carbonaceous, siliceous shale, pelite, and chert. The graphitic, quartz-rich composition, general lack of aluminous mica schist, and absence of marble distinguishes the Stevenson Ridge schist from other siliciclastic units in the Stevenson Ridge area (Ryan et al., 2013a). Stevenson Ridge schist is distinguished from the similar carbonaceous quartzite in the Klondike region (Mortensen, 1992; Gordey and Ryan, 2005) by its lack of marble. The nature of the contact between the Stevenson Ridge schist and the adjacent Paleozoic tectonostratigraphic units is uncertain, as the contacts are intruded by the middle Cretaceous Whitehorse plutonic suite or are covered by the volcanic rocks of the late Cretaceous Carmacks Group (Fig. 2).

Ultramafic rocks

Several lenses (tens of metres to about 1 km in thickness) of harzburgite, dunite, orthopyroxenite, serpentinite, talc-tremolite schist, and listwaenite occur within the Snowcap assemblage and along the southwestern edge of the Klondike schist to the west (Fig. 4; Ryan et al., 2013a, b). These ultramafic rocks are diverse in composition and are variably altered (Fig. 3h). Harzburgite locally has well developed foliation and/or lineation defined by orthopyroxene, indicating deformation at very high temperature such as found in the mantle. The Buffalo Pitts peridotite northeast of Sonora

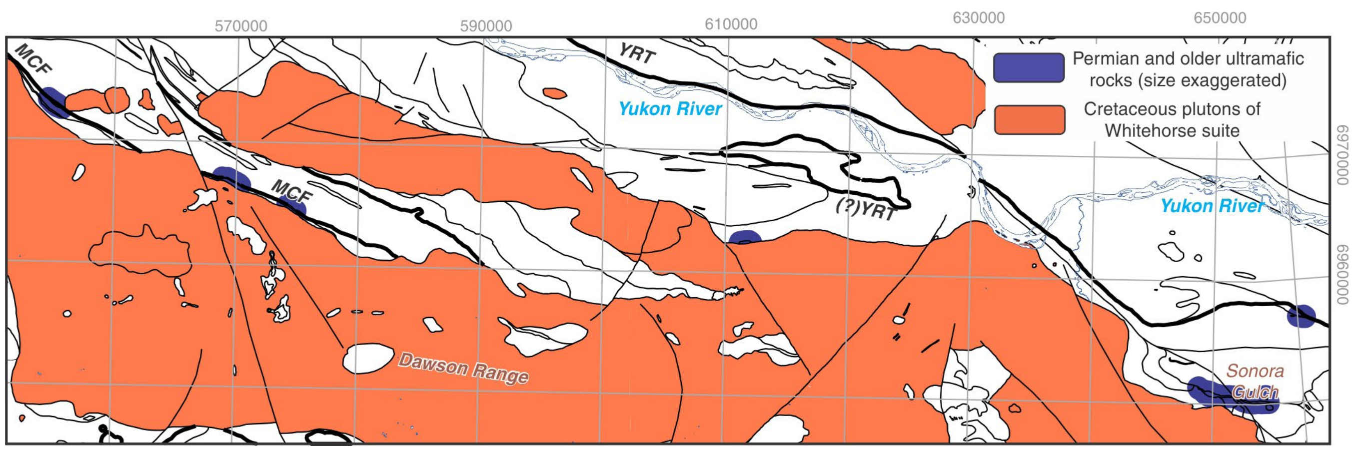

Figure 4. Location of the lozenges of peridotite in the north Stevenson Ridge area. MCF = Moose Creek fault, YRT = Yukon River Thrust

Gulch (Fig. 4) is the only peridotite that has been studied in detail (Johnston et al., 2007). This peridotite preserves spinel rimmed by plagioclase, indicating rapid exhumation of the mantle rocks, such that they were juxtaposed with quartzite. The preservation of gabbro and layered orthopyroxenite indicates that the peridotite was exhumed along a complex structure that sampled mantle, and lower crustal and middle crustal lithologies. A crystallization age for the gabbro of ca. 262 Ma led Johnston et al. (2007) to suggest that this mantle was exhumed and juxtaposed with the Snowcap quartzite in the Permian.

White River assemblage

The White River assemblage is treated here as a tectonostratigraphic domain that includes rocks ranging from pre-Devonian to Triassic in the area southwest of the Whitehorse suite plutons (Fig. 2), and were previously included as part of the now defunct "Windy-McKinley" terrane (*see* Murphy et al., 2009). It comprises the Scottie Creek formation, the Mount Baker suite, the White River complex, and the Snag Creek gabbro suite. Characteristic of the assemblage are shallowly dipping, tabular intrusive sheets of the Late Triassic Snag Creek suite gabbro and diabase (ca. 230–228 Ma, by Murphy et al. (2009); Fig. 5a). The state of deformation and metamorphism of these sills varies significantly, ranging from highly strained amphibolite to macroscopically undeformed greenstone. Murphy et al. (2009) correlated these sills to a gabbroic suite that intrude early Devonian schist in the Delta district, Alaska (Dashevsky et al., 2003; Dusel-Bacon et al., 2006) and the Galena suite (McQuesten and Mayo areas, Yukon: cf. Murphy (1997)). This correlation suggests that the White River assemblage may be correlative to parautochthonous rocks of North America and with Selwyn Basin stratigraphy (Murphy et al., 2009).

Scottie Creek formation

The Scottie Creek formation (Murphy et al., 2009) comprises psammitic muscovite-biotite schist, quartzite, and pebble conglomerate. Resistant quartzite is typically exposed on ridges, whereas psammitic schist appears to underlie much of the low lying areas. In the northwestern part of the map area, Scottie Creek formation is probably migmatized due to anatectic melting that resulted in contorted layers of mica-rich melanosome and garnet-bearing quartzofeldspathic leucosome. The migmatite (Fig. 5b) represents some of the highest grade metamorphic rocks in the region. The unit is compositionally similar to the Snowcap assemblage described in an earlier section; however, the Scottie Creek formation lacks Permian intrusions that are characteristic of Yukon-Tanana terrane. A quartzite sample yielded a youngest detrital zircon grain of 488 Ma and a quartzofeldspathic schist within the migmatite domain yielded a detrital zircon age of ca. 365 Ma (both from N. Joyce, unpub. data, 2013). These suggest this formation is contemporaneous with the White River complex.

White River complex

The White River complex comprises highly strained metavolcanic rocks and minor carbonaceous schist that have been metamorphosed to greenschist to amphibolite facies. They include amygdaloidal andesitic to basaltic flows (Fig. 5c), quartz and feldspar hypabyssal porphyries, and rhyolite. A rhyolite sample yielded a U/Pb zircon crystallization age of ca. 368 Ma (N. Joyce, unpub. data, 2013). This age overlaps within error with the youngest detrital zircon grains in the siliciclastic rocks assigned to the Scottie Creek formation, suggesting that the latter may have been deposited contemporaneously with the White River complex. Murphy et al. (2009) reported an age of ca. 363 Ma for a sample of crystal-lithic meta-tuff of the White River complex. The range of ages for White River assemblage, including Scottie Creek formation, overlap well with ages of metavolcanic units in the Big Delta district of eastern Alaska (Dashevsky et al., 2003; Dusel-Bacon et al., 2006).

Mount Baker suite

Orthogneiss derived from interlayered monzogranite, granodiorite, tonalite, diorite, and gabbro comprise the Mount Baker suite. Well defined foliation and significant grain-size reduction (Fig. 5d) indicate a high degree of strain and metamorphic recrystallization. These rocks resemble the Mississippian Simpson Range suite to the northeast; however an age of ca. 375 Ma (N. Joyce, unpub. data, 2013) indicates that the Mount Baker suite is distinctly older. This age is similar to those reported from the Butte assemblage of eastern Alaska that Dusel-Bacon et al. (2006) interpreted as part of the parautochthonous, continental margin assemblage of the North American craton. The contact between the Mount Baker suite and the Scottie Creek formation is not exposed, but is presumed to be structural.

Harzburgite Peak complex

The Harzburgite Peak complex (Canil and Johnston, 2003; Escayola et al., 2012) comprises a shallowly dipping, internally imbricated thrust sheet of harzburgite, dunite, gabbro, and diabase. It caps the ridges along the west-trending segment of the Donjek River (Fig. 2) and corresponds to a prominent high-intensity magnetic anomaly (*see* Hayward et al., 2012). Harzburgite Peak complex structurally overlies the White River assemblage mafic and felsic volcanic rocks. Harzburgite units are fresh to serpentinized and locally display a high-temperature foliation defined by orthopyroxene. Dunite forms a minor component, locally crosscutting harzburgite. Escayola et al. (2012) interpreted the dunite and associated chromitite to have formed by reactive flow of hydrous melts through mantle peridotite slabs. The main harzburgite massif overthrusts gabbro and diabase of the Harzburgite Peak complex. Diabase is fine grained and generally massive. In some areas, several generations of diabase sills and dykes can be identified (Canil and Johnston, 2003; Escayola et al., 2012); however, a sheeted dyke complex is not evident (Fig. 5e). Medium-grained, massive to foliated gabbro is locally cut by tholeiitic trondhjemite dykes that yielded a ca. 284 Ma crystallization age (N. Joyce, unpub. data, 2013), constraining the age of the Harzburgite Peak complex. The Permian age of the Harzburgite peak complex conflicts in part with the Mississippian age of the Slide Mountain ocean rocks (e.g. Nelson, 1993), indicating that either the Slide Mountain ocean was long lived or it formed as part of distinct tectonic events.

TECTONOSTRATIGRAPHY

The geology of the northern Stevenson Ridge area comprises five structural panels (Fig. 6), with distinct tectonostratigraphic units and geological histories. Panels 1 to

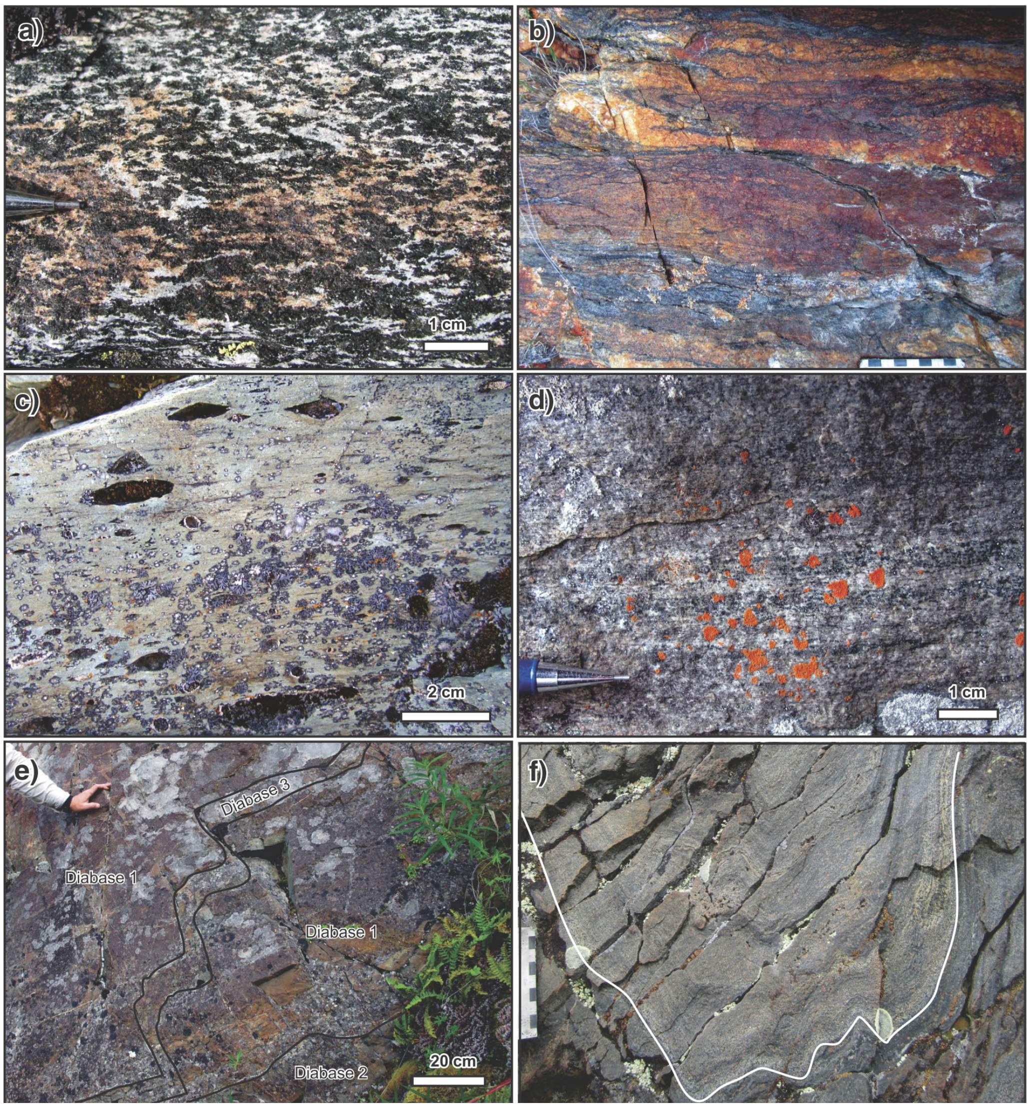

Figure 5. Representative photographs of the White River assemblage. **a)** Foliated hornblende gabbro of the Triassic Snag Creek suite; lineated hornblende and strained plagioclase crystals indicate deformation at amphibolite facies; photograph by J. Ryan; 2014-116. **b)** Possible sheath fold in granitic leucosome in Scottie Creek formation migmatite; scale is in centimetres; photograph by A. Zagorevski; 2014-113. **c)** Foliated greenschist facies amygdaloidal basalt member of the White River complex; photograph by A. Zagorevski; 2014-119. **d)** Highly strained tonalite orthogneiss of the Mount Baker suite; red growth is lichen; photograph by J. Ryan; 2014-122. **e)** Polyphase intrusions of diabase (contacts are outlined) in the Harzburgite Peak complex; photograph by J. Ryan; 2014-120. **f)** Upright, closed F_2 folds of S_1 foliation in garnet amphibolite of the Finlayson assemblage; scale is in centimetres; photograph by A. Zagorevski; 2014-125

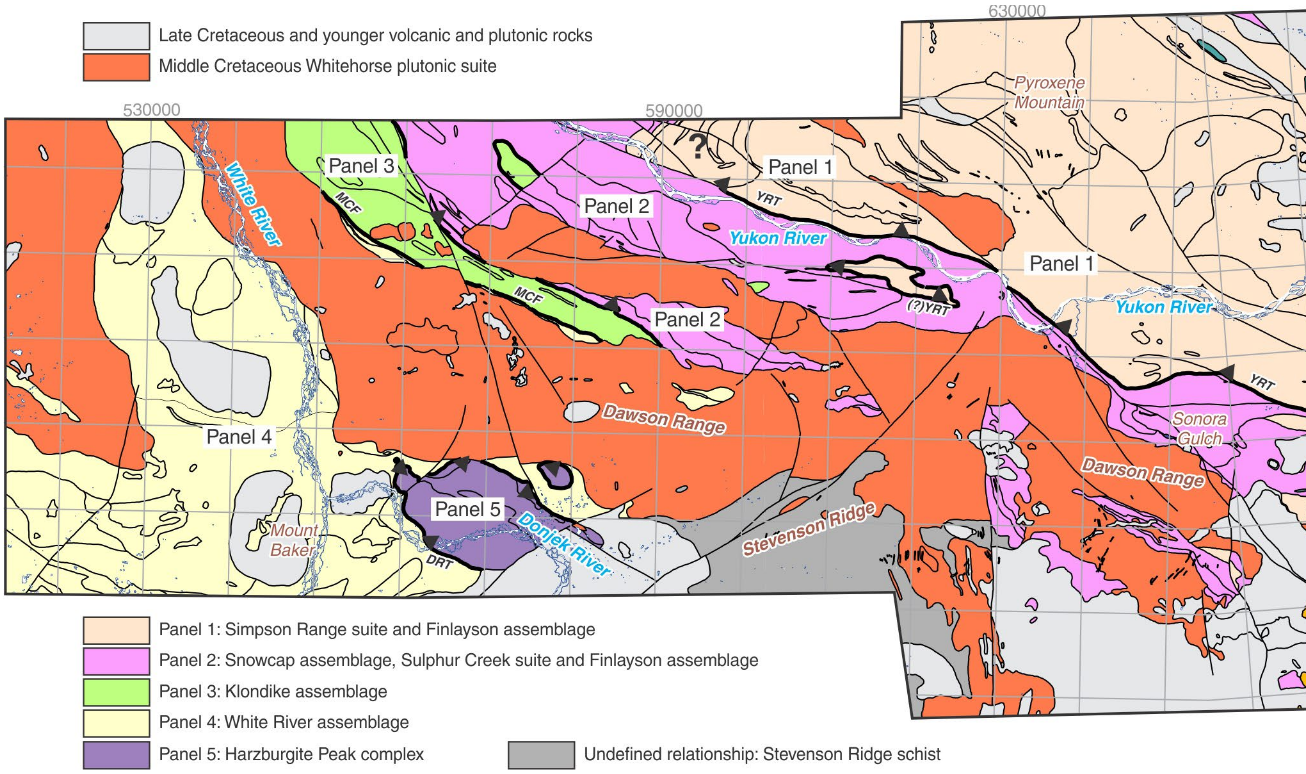

Figure 6. Distribution of structural panels relative to the mid-Cretaceous Whitehorse plutonic suite in the northern Stevenson Ridge area. MCF = Moose Creek fault, YRT = Yukon River Thrust, DRT = Donjek River Thrust

3 define fundamental crustal blocks of Yukon-Tanana terrane, whereas panel 4 comprises a fundamental crustal block of the White River assemblage. They are separated by the Moose Creek fault (Fig. 6). Panel 5 is the Harzburgite Peak complex, emplaced on top of the White River assemblage as a distinct thrust sheet.

Panel 1

This structurally highest panel is dominantly comprised of Mississippian Simpson Range suite plutons and rafts of Finlayson assemblage metavolcanic rocks (Fig. 2, 6). Simpson Range and Finlayson assemblage exhibit polyphase deformation. The dominant foliation (S_1) is defined by hornblende and biotite (Fig. 3c), indicating deformation at amphibolite-facies conditions. Retrogression of hornblende-biotite to sericite-chlorite is locally pervasive. S_1 foliation is tightly to isoclinally folded by small to regional scale F_2 folds into a composite S_{1-2} transposition foliation, which in turn is folded by open F_3 to F_4 folds.

The age of S_{1-2} composite foliation is in part constrained to be older than the Triassic Pyroxene Mountain suite (northeast; Fig. 2), which have been dated to be ca. 218 Ma (N. Joyce, J.J. Ryan, M. Colpron, D.C. Murphy, and C.J.R. Hart, unpub. manuscript, 2014). The pyroxenite-gabbro sills of this suite, as well as Early Jurassic Aishihik suite plutons, lack the penetrative S_{1-2} foliation that is characteristic of the Simpson Range suite, suggesting that they intruded after D_1 and D_2. This is supported by the age of post S_{1-2} metamorphism in rafts of garnet-kyanite schist within the Simpson Range granite in the northeastern part of the mapped area (Aishihik suite; Fig. 2). Porphyroblasts that overgrew the main transposition foliation in these rocks record 7.5 kbar pressure at ca. 195 Ma (Berman et al., 2007). The age of the F_3 to F_4 folding is poorly constrained and penetrative fabric is generally not observed in those folds. The Ar/Ar hornblende and biotite cooling ages suggest that panel 1 rocks were exhumed to shallow crustal level by ca. 185 Ma (Knight et al., 2013; N. Joyce, J.J. Ryan, M. Colpron, D.C. Murphy, and C.J.R. Hart, unpub. manuscript, 2014).

The easternmost side of the mapped area is underlain by Triassic volcanic rocks of the Semenof formation (Ryan et al., 2010, 2013a), which are intruded by the Aishihik suite (Fig. 2). These volcanic rock are broadly cospatial with the Pyroxene Mountain suite intrusions, and the present authors thus consider them to be their volcanic equivalent. The Semenof formation volcanic rocks lack visible evidence of the intense Jurassic metamorphism recorded by kyanite schist south of Walhalla Creek pluton (Berman et al., 2007) and may thus form a separate structural panel.

Panel 1 is separated from panels interpreted to be structurally lower by the Yukon River Thrust. This shallowly dipping ductile zone emplaces the Mississippian Simpson Range suite over Snowcap and Klondike assemblage rocks. Permian plutonic rocks and Snowcap assemblage metasedimentary rocks are absent in panel 1, whereas Triassic plutonic rocks and Mississippian granitoid rocks are absent from panel 2. This contrast of plutonic suites across this structure suggests that the Yukon River Thrust has significant displacement, and was active after the emplacement of the Late Triassic Pyroxene Mountain suite. Steeply dipping post-mid-Cretaceous faults significantly affect the map distribution of shallowly dipping Yukon River Thrust (Fig. 2; Ryan et al., 2013a).

Panel 2

Panel 2 is dominated by the Snowcap assemblage and Permian Sulphur Creek suite augen granite that lie structurally below the Yukon River Thrust (Fig. 2, 6). At the interpreted structural base of the panel is Finlayson assemblage amphibolite and garnet amphibolite. This contact continues to the northwest into the Stewart River map area (Gordey and Ryan, 2005)

Peridotite and dunite slivers are rare. They occur throughout the Snowcap assemblage at various scales (e.g. Johnston et al., 2007; Bennett et al., 2010; MacKenzie et al., 2014; Buitenhuis, 2014). The contacts between the ultramafic rocks and the Snowcap assemblage are structural, but have not been clearly observed. Johnston et al. (2007) argued that the Buffalo Pitts peridotite represents tectonically exhumed mantle structurally emplaced into the Snowcap assemblage in the Permian. If correct, the earliest deformation in panel 2 included pre-Permian extension, which the present authors interpret to have been focused along crustal-scale detachment faults. This early extensional deformation is now extensively overprinted by Permian and younger deformation and metamorphism.

Metamorphic grade in panel 2 is middle-amphibolite facies. This is indicated by hornblende±garnet mineral assemblage in metabasite and crystal plastic deformation of K-feldspar phenocrysts in the Sulphur Creek suite augen granite (Fig. 3f). The main high-strain S_1 foliation is pervasive in the Sulphur Creek suite and indicates Permian or younger deformation at amphibolite facies, consistent with the findings of Berman et al. (2007) in the Stewart River area. Similar to panel 1, S_1 foliation is affected by at least two episodes of later folding that the present authors interpret to be Jurassic to pre-mid-Cretaceous (cf. Allan et al., 2013). In fact, the Permian rocks tend to have more prominent folding of the main foliation (Fig. 5f) than does the Mississippian rocks, perhaps indicative that they were subjected to a distinct deformation history prior to being juxtaposed along thrust faults of probable Jurassic age. These younger folds have prominent axial planar crenulation cleavage in the Permian rocks, perhaps because they are more schistose than the Mississippian rocks.

Panel 3

Paleozoic rocks of panel 3 are dominated by metavolcanic rocks of the Klondike assemblage, with lesser intrusive sheets of Sulphur Creek suite. In contrast to panel 2, the metamorphic grade in panel 3 does not exceed greenschist facies. Fabric development in the altered volcanic rocks is characterized by formation of chloritic and/or sericitic phyllonite and schist. Similarly, Sulphur Creek suite granitoid rocks were subjected to fluid-assisted alteration of K-feldspar phenocrysts to sericite and development of sericite schist and phyllonite with quartz porphyroclasts. As in the type locality of Klondike schist in the Klondike region 100 km to the north, Klondike schist in panel 3 hosts abundant quartz veining, demonstrating significant strain-induced silica mobility during alteration of these Permian rocks. Panel 3 is almost certainly internally imbricated, but the overall intense deformation and lack of marker horizons makes the identification of these thrusts difficult (MacKenzie et al., 2014).

The marked difference in metamorphic grade between amphibolite-facies panel 2 and greenschist-facies panel 3 indicates that the juxtaposing thrust, here termed the Moose Creek fault, among others, postdates peak metamorphic and has significant displacement. The age of thrusting is poorly constrained: it is post-Permian to pre-mid-Cretaceous, the age of the crosscutting Dawson Range batholith. The authors postulate that it is of Early to Middle Jurassic age.

Panel 4

Panel 4 comprises the White River assemblage, a distinct crustal domain of poorly exposed greenschist- to amphibolite-facies rocks extensively inundated by mid-Cretaceous to Paleocene magmatism (Fig. 2). The Triassic Snag Creek suite gabbro intrusions locally display strong foliation developed at amphibolite facies, indicating that some of the deformation is post-Triassic. Metasedimentary rocks in the window beneath the mid-Cretaceous Dawson Range batholith (i.e. the area west of White River, but poorly exposed) show complex fabrics and evidence of in situ (anatectic) and injection melts. The co-spatial relationship between the Dawson Range plutonic rocks and the migmatite domain suggests a causal relationship, and that this domain was subjected to strong thermal overprint in the Cretaceous. Locally, granitic apophyses that the present authors attribute to the Dawson Range phase clearly crosscut the leucosome layering, indicating that the foliation may predate the 100 Ma Dawson Range batholith. The age of the fabric may be more akin to Aptian fabrics in the parautochthonous rocks of the Mount Burnham area of eastern Stewart River (cf. Staples et al., 2013).

The northern margin of panel 4 is in structural contact with panel 3 along the Moose Creek fault. The Moose Creek fault is a steep structure characterized by juxtaposition of White River assemblage amphibolite, metasedimentary rocks, and peridotite with the greenschist-facies volcanic rocks of the Klondike schist (panel 3). This structure is truncated or obliterated by the mid-Cretaceous Dawson Range batholith, thus the juxtaposition of panels 3 and 4 is in part pre-middle Cretaceous. Gabbro sills of the Snag Creek suite do not occur north of the Moose Creek fault, thus implying that motion on the Moose Creek fault is post-Late

Triassic. Ryan et al. (2013b) inferred that the Moose Creek fault emplaced White River assemblage on the Klondike schist of Yukon-Tanana terrane, based upon the contrast in metamorphic grade and juxtaposition of crustal and mantle lithologies. With the present data the kinematics on this fault zone remain equivocal.

Panel 5

The Harzburgite Peak complex comprises a distinct structural nappe that is observed to structurally overlap panel 4. The remnants of this nappe are exposed as klippen at Harzburgite peak and surrounding hills, suggesting that the basal thrust (Donjek River Thrust on Fig. 7) is shallowly dipping. Aeromagnetic expression (Hayward et al., 2012) is consistent with the known exposure; ultramafic rock does not appear to underlie adjacent areas. The age of the thrusting is presumed to be post-Triassic, as no sills of the Snag Creek suite were observed within the Harzburgite Peak complex.

DISCUSSION

The distinct lithological and magmatic associations within the panels attest to the composite nature of this portion of Yukon-Tanana terrane, and its structural relationship with the more parautochthonous, composite White River assemblage (Fig. 7). The presence of Triassic and Jurassic magmatism within Mississippian panel 1 suggests that it may be an extension of plutonic Stikinia with its Paleozoic basement. If so, the rocks of this panel may provide the geological link to Triassic magmatism in Alaska (i.e. Taylor Mountain batholith: Dusel-Bacon et al. (2009)).

The identification of these nappes and the common presence of mantle-derived ultramafic rocks along their bounding structures (Fig. 7) indicate these structures are fundamental crustal breaks in this part of the Canadian Cordillera. These structures probably represent a first-order tectonostratigraphic framework that controls younger magmatism and mineralization. For example, the spatial and temporal coincidence of the Moose Creek fault with the axis of the Dawson Range batholith suggests that it forms a crustal-scale structure that controlled the emplacement of magmas and associated mineral deposits. There is also a strong spatial coincidence between the rocks of Klondike assemblage and several known Middle Jurassic to Upper Cretaceous mineral occurrences in the area (e.g. Boulevard, Coffee, White Gold, Casino, Sonora Gulch), suggesting that in addition to strong basement control, there may also be controls imposed by chemical traps, structural traps, and/or pre-existing metal enrichment (perhaps during a Permian alteration or metamorphism).

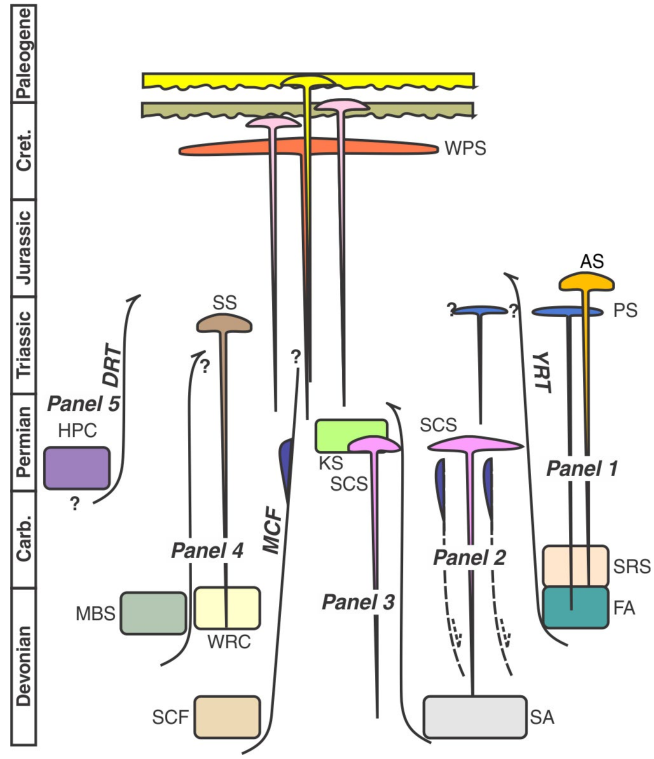

Figure 7. Schematic tectonostratigraphic relationships in the northern Stevenson Ridge area. SA = Snowcap assemblage, FA = Finlayson assemblage, SRS = Simpson Range suite, SCS = Sulphur Creek suite, KS = Klondike schist, SCF = Scottie Creek formation, WRC = White River complex, MBS = Mount Baker suite, HPC = Harzburgite Peak complex, SS = Snag Creek suite, PS = Pyroxene Mountain suite, AS = Aishihik suite, WPS = Whitehorse plutonic suite, YRT = Yukon River Thrust, MCF = Moose Creek fault, DRT = Donjek River Thrust, Carb. = Carboniferous, Cret. = Cretaceous

CONCLUSIONS

Paleozoic rocks of the northern Stevenson Ridge area are metamorphosed and strongly deformed, but reveal the characteristics of three sedimentary-volcanic assemblages of Yukon-Tanana terrane, as well as four plutonic suites. These are exposed in five internally imbricated structural panels with distinct lithological and magmatic associations. These are bound by faults with interpreted post-Triassic to pre–mid-Cretaceous movement. Well constrained structural breaks include the basal thrust of the Harzburgite Peak ophiolite complex that emplaces mantle onto supracrustal lithologies, and the Moose Creek fault that juxtaposes harzburgite tectonite with greenschist-facies felsic volcanic rocks of the Klondike assemblage. This work brings greater recognition to the Yukon River Thrust, which juxtaposes Mississippian granitoid rocks with Snowcap assemblage that hosts Permian plutons (cf. Tempelman-Kluit, 1974).

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