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Preliminary Field Results from Kinskuch Lake, Northwestern British Columbia (NTS 103P/11): a Study of the Boundary between the Stuhini and Hazelton Groups

E.A. Miller, Department of Earth, Ocean and Atmospheric Sciences, The University of British Columbia, Vancouver, BC, emilymillergeo@gmail.com

L. Kennedy, Department of Earth, Ocean and Atmospheric Sciences, The University of British Columbia, Vancouver, BC

B.I. van Straaten, British Columbia Geological Survey, Victoria, BC

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Introduction

The Late Triassic and Early Jurassic intrusive suites of the Stikine terrane of British Columbia (BC) are associated with significant Cu-Au-Mo porphyry and intrusion-related mineralization (Nelson et al., 2013; Logan and Mihalynuk, 2014; Campbell and Dilles, 2017). The Stewart mining camp includes the Early Jurassic KSM area Cu-Au porphyry deposits (MINFILE 104B 103, 173, 182 and 191; BC Geological Survey, 2018), the Big Bulk Au-Cu porphyry system (MINFILE 103P 016), the Red Mountain Au deposit (MINFILE 103P 086) and the Brucejack epithermal Au deposit (MINFILE 104B 022).

Porphyry Cu-Au-Mo systems, especially those formed along continental active margins, are generally considered to have formed in a contractional environment (e.g., Sillitoe, 2010). The tectonic environment of porphyry systems formed in island arcs, such as those located within the Stikine terrane of northwestern BC, are not as well understood. Within the Sulphurets area, at the Kerr-Sulphurets-Mitchell (KSM) project, recent geological studies suggest that normal faulting, active sedimentation and olistolith formation accompanied Early Jurassic porphyry emplacement (Nelson and Kyba, 2014; Febbo et al., 2015; Kyba and Nelson, 2015; Febbo, 2016). Febbo (2016) proposed a model where small pull-apart basins along reactivated basement structures localized porphyry Cu-Au-Mo formation at the KSM project, hence, porphyry emplacement did not occur in a purely contractional environment.

To test this model and its applicability to the broader region, in the 2018 field season, 1:20 000 scale structural and stratigraphic mapping of two sites was completed: Kinskuch Lake, surrounding the Big Bulk Au-Cu porphyry system and the Red Mountain Au deposit. Both study areas are located south of the better-studied Sulphurets area. They were selected because they are underlain by similar rocks, also deposited in the Early Jurassic, with mineralization thought to be of comparable age to the rocks studied at KSM.

The aim of this paper is to present preliminary lithological descriptions, stratigraphic sequences and structural elements resulting from the 2018 fieldwork at the Kinskuch Lake site and is part of a M.Sc. research project undertaken by E. Miller. The goals of the fieldwork were to delineate the Late Triassic to Early Jurassic stratigraphy and to record the geometry and kinematics of the structural elements in the area, with the aim of reconstructing the geological setting into which the Big Bulk porphyry system was emplaced. To determine whether porphyry and related mineralization was intruded into extensional pull-apart basins, the following questions will ultimately be addressed by the research:

- What are the ages of porphyry intrusion and mineralization?
- What is the sedimentological/volcanic environment in which the deposit was formed?
- Is there geological evidence for porphyry emplacement contemporaneous with high-energy sedimentation?
- What was the structural architecture during porphyry emplacement?

Regional Geology and Tectonic Setting

The study area is dominated by Late Triassic and Early Jurassic volcano-sedimentary rocks that form part of the Stikine terrane, the largest accreted terrane in BC (2000 by 300 km, Figure 1). The Stikine terrane comprises three unconformity-bounded, island-arc volcano-sedimentary successions that include the upper Paleozoic Stikine assemblage, the Middle to Upper Triassic Stuhini and Takla groups and the uppermost Triassic to Middle Jurassic Hazelton Group (Greig, 1992; Logan et al., 2000; Colpron and Nelson, 2011; Nelson et al., 2013). Mesozoic

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arc-related intrusions include the Late Triassic Stikine and Galore Creek plutonic suites (coeval and comagmatic with the Stuhini Group), as well as the latest Triassic Tatogga and Early Jurassic Texas Creek plutonic suites, which are coeval and comagmatic with the Hazelton Group (Nelson et al., 2018).

The Stuhini Group represents the oldest rocks in the study area and locally comprises Triassic arc-related mafic volcanic rocks typified by the presence of augite and sedimentary rocks.

Generally, the base of the Hazelton Group is a regional unconformity above Triassic and older rocks (Nelson and Kyba, 2014), although locally this contact is paraconformable to conformable (van Straaten and Nelson, 2016). The lower Hazelton Group is a latest Triassic to Toarcian andesitic volcanic sequence with local felsic centres. In the Sulphurets area, the base of the Hazelton Group is represented by granitoid-cobble conglomerate and quartz-rich arkose of the Jack Formation. The overlying rocks are assigned to the Betty Creek Formation (Nelson et al., 2018), consisting mainly of the Unuk River Formation andesite unit, the lowest part of which (andesitic pyroclastic and epiclastic deposits) may correlate with the Hazelton Group volcanic succession at Kinskuch Lake. The upper Hazelton Group in the Sulphurets area (Pliensbachian to Bajocian) includes sedimentary strata of the Spatsizi Formation and bimodal, rift-related volcano-sedimentary rocks of the Iskut River Formation (Gagnon et al., 2012; Nelson et al., 2018).

The Middle Jurassic to mid-Cretaceous sedimentary rocks of the Bowser Lake Group (Evenchick et al., 2007) occupy a large area of the central Stikine terrane east of the Sulphurets area.

During the mid-Cretaceous, strata of the Stuhini, Hazelton and Bowser Lake groups were deformed as part of the sinistral-transpressive Skeena fold-and-thrust belt

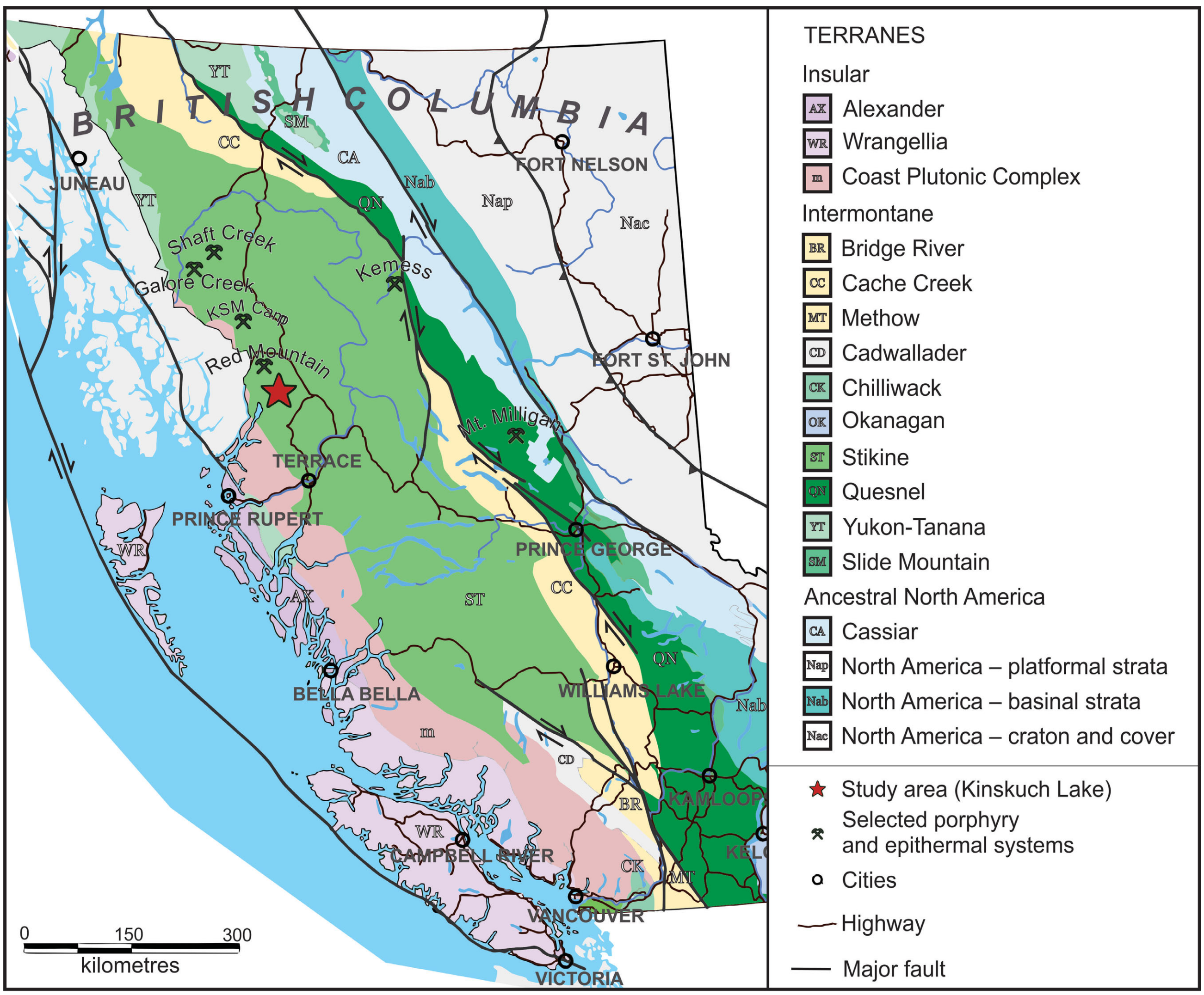

Figure 1: Location of the Kinskuch Lake study area, showing the terranes of British Columbia (Colpron and Nelson, 2011), the KSM project and selected porphyry and epithermal prospects and deposits.

(Evenchick et al., 2007). This resulted in the formation of northwest- and northeast-trending folds and sinistral shear zones.

Fieldwork and Preliminary Observations

The Kinskuch Lake area is underlain by Stuhini Group and Hazelton Group rocks but also includes an intervening transitional unit and a dioritic to monzonitic stock that hosts the Big Bulk Cu-Au porphyry system (Figure 2). The field area is cut by numerous faults and well-bedded rocks (mainly from the Stuhini Group) that are deformed by two generations of folds. Regional metamorphic grade is sub-greenschist.

Three weeks were spent at Kinskuch Lake in July 2018, mapping stratigraphy and structural geology at 1:20 000 scale. Fieldwork goals were to create several stratigraphic sections across the field area, paying attention to changes in the type of sedimentation (i.e., low-energy deposits versus high-energy deposits), bedding orientations, and fold and fault orientations and kinematics. Based on this fieldwork, the Stuhini and Hazelton groups are subdivided into lithostratigraphic units, which are in turn subdivided into facies. The preliminary map presented in Figure 2 shows the divisions down to the unit level, whereas the descriptions and stratigraphic section (Figure 3) depict the generalized distribution of facies within these units. Stratigraphic subdivisions and lithological descriptions presented here are preliminary and may be revised with further study.

Stuhini Group (uTrS)

The oldest rocks within the study area are part of the Stuhini Group and are subdivided into a volcanic and volcanic-derived sedimentary rock unit (uTrSv) and a sedimentary rock unit (uTrSs).

Volcanic and Volcanic-Derived Sedimentary Rock Unit (uTrSv)

The Stuhini Group volcanic and volcanic-derived sedimentary rock unit is the lowest stratigraphic unit in the Kinskuch Lake area. The lower part of this unit is typified by well-stratified, mafic volcanic clast-bearing conglomerate to volcanic-derived, sandstone interstratified with lesser mafic volcanic breccia (uTrSvs). These are overlain by mafic volcanic breccia (uTrSvbx) with rare interstratified volcanic-derived sandstone and minor augite-phyric coherent mafic rocks (uTrSvb).

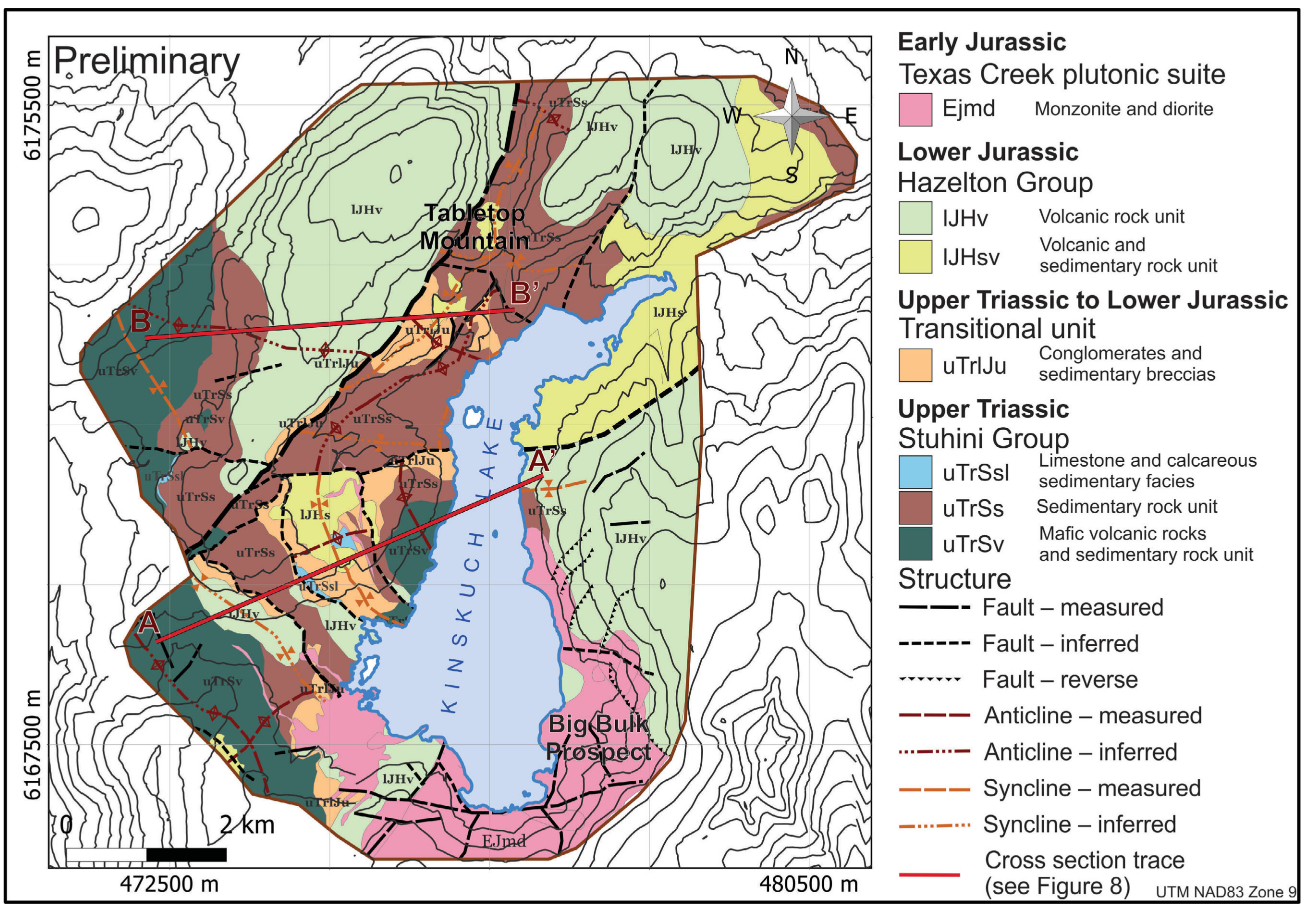

Figure 2. Preliminary geological interpretation for the Kinskuch Lake area, northwestern British Columbia, based on mapping completed in 2018, location of Big Bulk porphyry mineralization, referenced geographic features (including Kinskuch Lake and Tabletop Mountain) and cross-section traces for the schematic sections presented in Figure 8.

Volcanic Breccia and Volcanic-Derived Sedimentary Facies (uTrSvs)

This facies is characterized by grey to green weathering, rhythmically bedded, mafic volcanic-derived sedimentary rocks (Figure 4a). It typically forms 10–20 m thick, fining-upward sequences progressing from basal clast- to matrix-supported pebble conglomerate (with 30–70% round augite-phyric volcanic clasts in an augite crystal-bearing sandy matrix) to sandstone to siltstone. Generally, each fining-upward sequence is underlain by the volcanic breccia as described in facies uTrSvbx (Figure 4b).

Volcanic Breccia Facies (uTrSvbx)

This is a monomictic volcanic breccia with 30–70% clast- to matrix-supported, subangular to angular volcanic clasts (1–40 cm). The volcanic clasts contain 10–40% blocky augite phenocrysts (2–5 mm, locally up to 8 mm in diameter), up to 15% feldspar phenocrysts (1–4 mm in diameter)

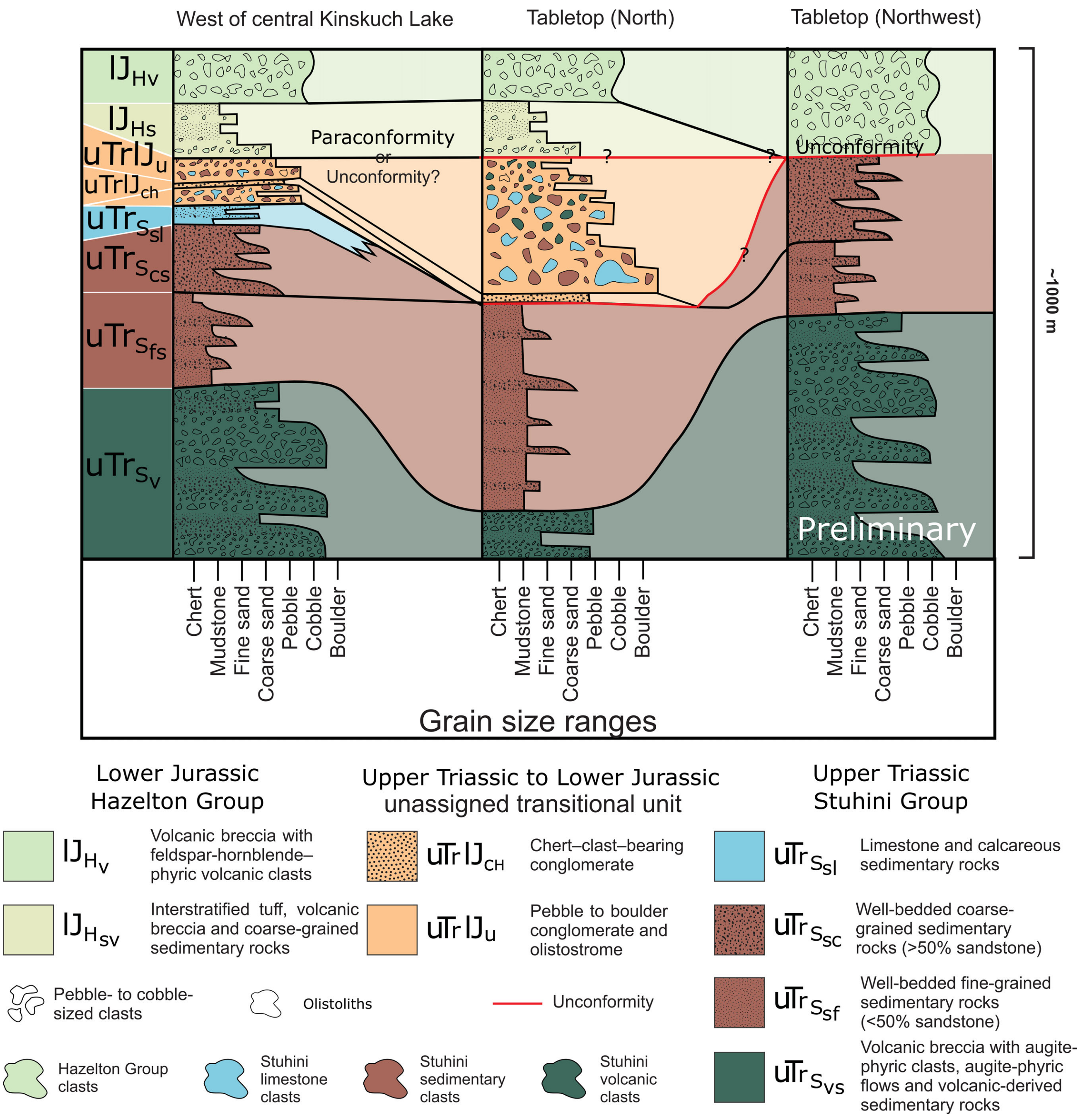

Figure 3. Preliminary Kinskuch Lake area schematic stratigraphic columns, showing the stratigraphic variation from just west of central Kinskuch Lake across Tabletop Mountain to the north and to the far west of the study area, west of Tabletop Mountain.

and up to 5% calcite-filled amygdules (1–3 mm in diameter) set in a dark green to black aphanitic groundmass. The matrix is fine-grained and mafic, with 10–40% euhedral augite crystals (2–5 mm in diameter) and is dark green to grey weathering, dark green to black on fresh surfaces (Figure 4b). The breccia also contains rare interstratified sandstone beds.

Augite-Phyric Coherent Mafic Facies (uTrSvb)

These green to black mafic coherent rocks contain 20–30% augite phenocrysts (2–4 mm, locally 5–8 mm) and up to 5% calcite-filled amygdules (1–3 mm). This facies was only observed in the southwestern portion of the map as massive, 1–5 m thick, bedding-parallel layers within dominantly mafic volcanic breccia, and it may represent flows or sills.

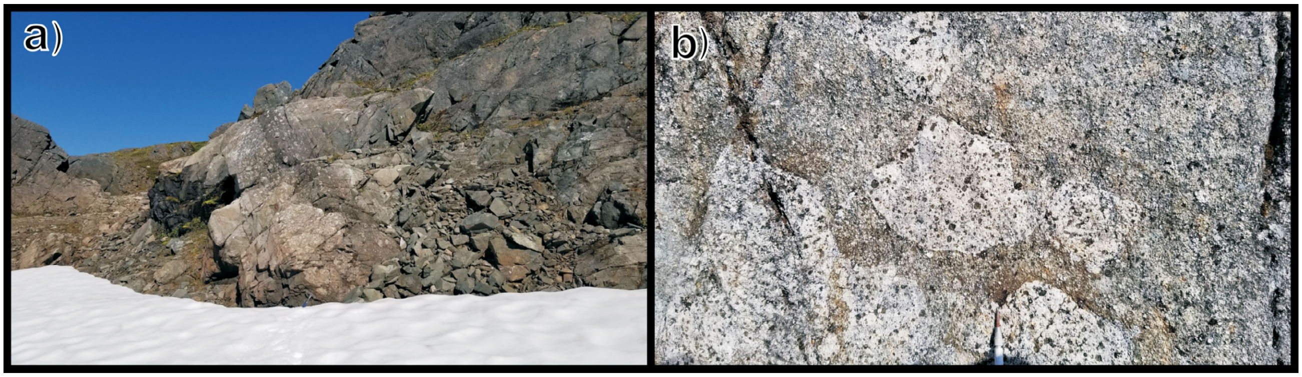

Figure 4. Stuhini Group volcanic and volcanic-derived sedimentary rocks in the study area: **a)** well-stratified volcanic breccia and volcanic-derived sedimentary rocks (uTrSvs; UTM NAD83 Zone 9, 472194E, 6172116N; looking west); **b)** volcanic breccia with angular augite-phyric clasts (uTrSvbx; 473840E, 6168792N).

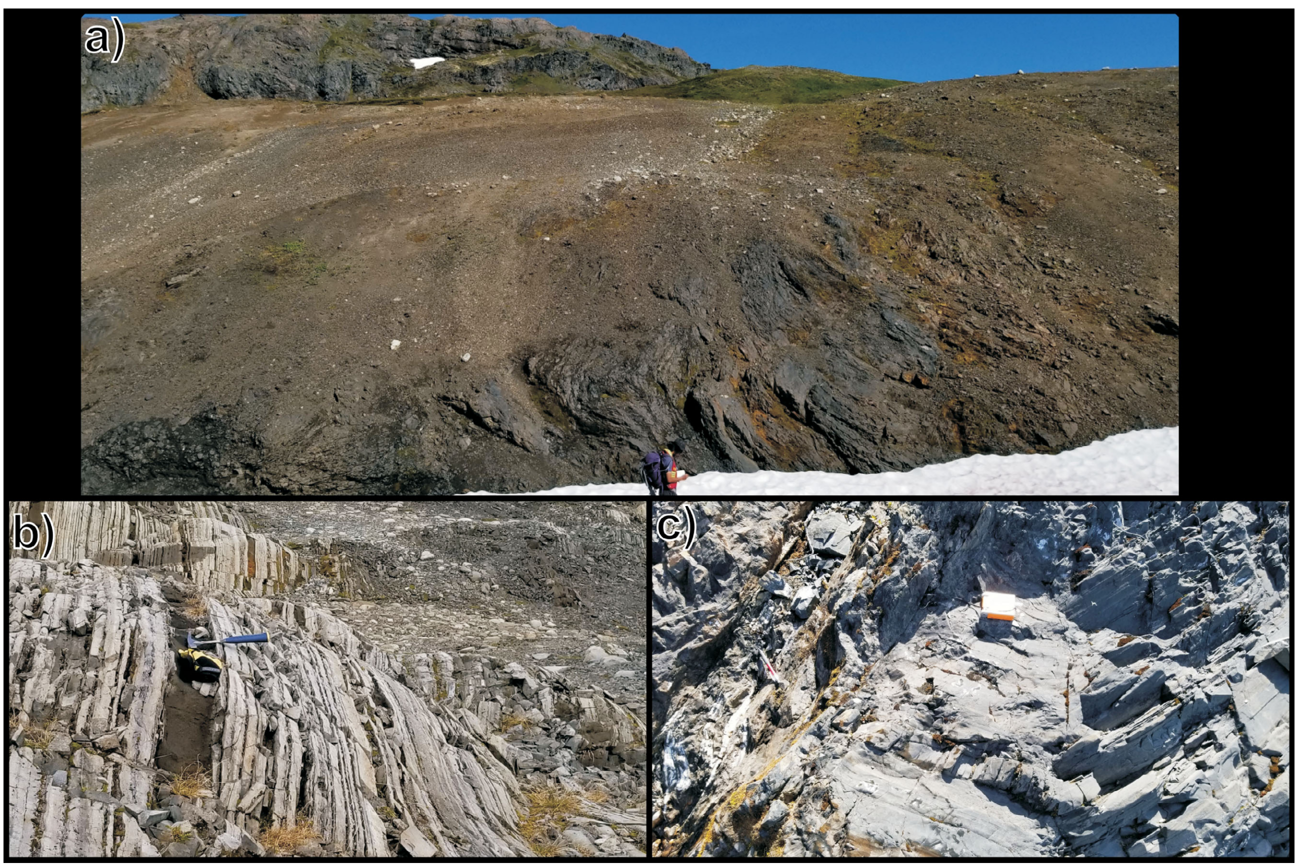

Figure 5. Stuhini Group sedimentary rocks in the study area: **a)** strongly deformed, well-stratified fine-grained sedimentary rocks (uTrSsf) underlying coarser cliff-forming sedimentary rocks in background (uTrSsc; UTM NAD83 Zone 9, 475930E, 6173794N; photo taken facing east); **b)** well stratified, coarse-grained sedimentary rocks (uTrSsc), white weathering feldspathic sandstone interbedded with black recessively weathering argillite (475014E, 6169985N; photo taken facing north); and **c)** a fault-related fold hinge in grey weathering calcareous siltstone to sandstone (uTrSsl) showing carbonate vein fill in fault (476883E, 6170665N; photo taken looking east).

Sedimentary Rock Unit (uTrSs)

Stuhini Group sedimentary rock unit includes interstratified argillite, chert, feldspathic sandstone, conglomerate, limestone and calcareous sandstone and siltstone. Quartz is absent in all rock types. The exact stratigraphic superposition varies across the area, but generally follows the following pattern: basal augite-phyric volcanic clast-bearing conglomerate facies (uTrSsac), overlain by well-bedded, predominantly fine-grained sedimentary facies (uTrSsf), grading upward into a package of similar, but predominantly coarser grained sedimentary facies (uTrSsc), which is capped by limestone and calcareous sedimentary facies (uTrSsl). A stratified chert facies (uTrSsch) occurs locally, generally near the top of the well-bedded sedimentary rocks (uTrSsf).

Heterolithic Conglomerate Facies (uTrSsac)

A thin massive conglomerate, just a few metres thick, is locally observed at the base of the Stuhini Group sedimentary unit, directly overlying the volcanic unit. It is a heterolithic pebble to cobble conglomerate, predominantly clast supported, with rounded to angular, augite-phyric volcanic

Figure 6. Conglomerates from the unassigned transitional unit (uTrlJu): **a)** mafic volcanic clast-bearing conglomerate (uTrlJa; UTM NAD83 Zone 9, 476579E, 6172416N); **b)** heterolithic conglomerate (uTrlJh; 475243E, 6172200N); **c)** sandstone and limestone clast-bearing conglomerate (uTrlJs; 476017E, 6172826N); **d)** fragment from a 50 m diameter fossiliferous limestone sampled at 476579E, 6172416N (uTrlJs); **e)** angular chert-clast–bearing sedimentary breccia (uTrlJch; 475695E, 6179268N).

clasts, sandstone clasts and bedded sedimentary clasts, in a fine-grained feldspathic sandstone matrix.

Fine-Grained Sedimentary Facies (uTrSsf)

Fine-grained sedimentary rocks of the Stuhini Group exhibit black to dark grey to orange weathering (dark grey on fresh surfaces). This sedimentary facies is composed of >50% well-bedded argillite to mudstone (locally graphitic) interbedded with lesser siltstone and very fine to fine-grained sandstone and minor medium-grained sandstone. Rare (<5%) coarse-grained sandstone and pebbly sandstone was seen in the coarse-grained sedimentary facies (uTrSsc). Bed thicknesses are variable, but predominantly very thin to medium (<1–20 cm). The fine-grained sedimentary rocks often display metre- to decimetre-scale tight folds and it is likely that this package has, at least locally, been structurally thickened (Figure 5a).

Stratified Chert Facies (uTrSsch)

The stratified chert is distinctive but only observed at two localities in the study area: in the sedimentary unit near the central-west shore of Kinskuch Lake, and directly underlying coarse-grained sedimentary facies under Tabletop Mountain to the northwest of Kinskuch Lake. The chert is grey and distinctly glassy in appearance, is stratified on a millimetre to centimetre scale and is occasionally interstratified with mudstone and siltstone. It is generally fractured, faulted and boudinaged, suggesting that the chert was a relatively strong package during deformation.

Coarse-Grained Sedimentary Facies (uTrSsc)

The coarse-grained sedimentary facies is predominantly dark grey and weathers to variable shades of buff, orange and grey. It comprises >50% well-bedded siltstone, lithic sandstone, feldspathic sandstone and pebbly sandstone, with <50% argillite and mudstone (Figure 5b). These sequences show normal grading with load structures and crossbedding observed locally. Bed thickness varies from very thin to thin bedded (2–10 cm) to locally medium bedded (up to 30 cm). Pebbly sandstone is generally matrix supported with 3–10% angular and often ‘flame-like’ argillite clasts (3 to 5 mm), likely derived from unconsolidated Stuhini Group argillite. In general, this sedimentary facies represents increasing proportions of higher energy sediment influx compared to the underlying fine-grained sedimentary facies (uTrSsf) but is otherwise very similar in character and composition.

Limestone and Calcareous Sedimentary Facies (uTrSsl)

The limestone and calcareous sedimentary rocks weather pale to medium grey with a distinctive recessive to pitted chalky weathering surface (Figure 5c). The limestone is generally massive and is commonly fossiliferous. It is interbedded with, and overlain by, medium- to fine-grained, very thin to thin-bedded calcareous sandstone and siltstone. The limestone and calcareous sedimentary facies is only observed locally within the area and has limited along-strike continuity; it is unclear how much of this is due

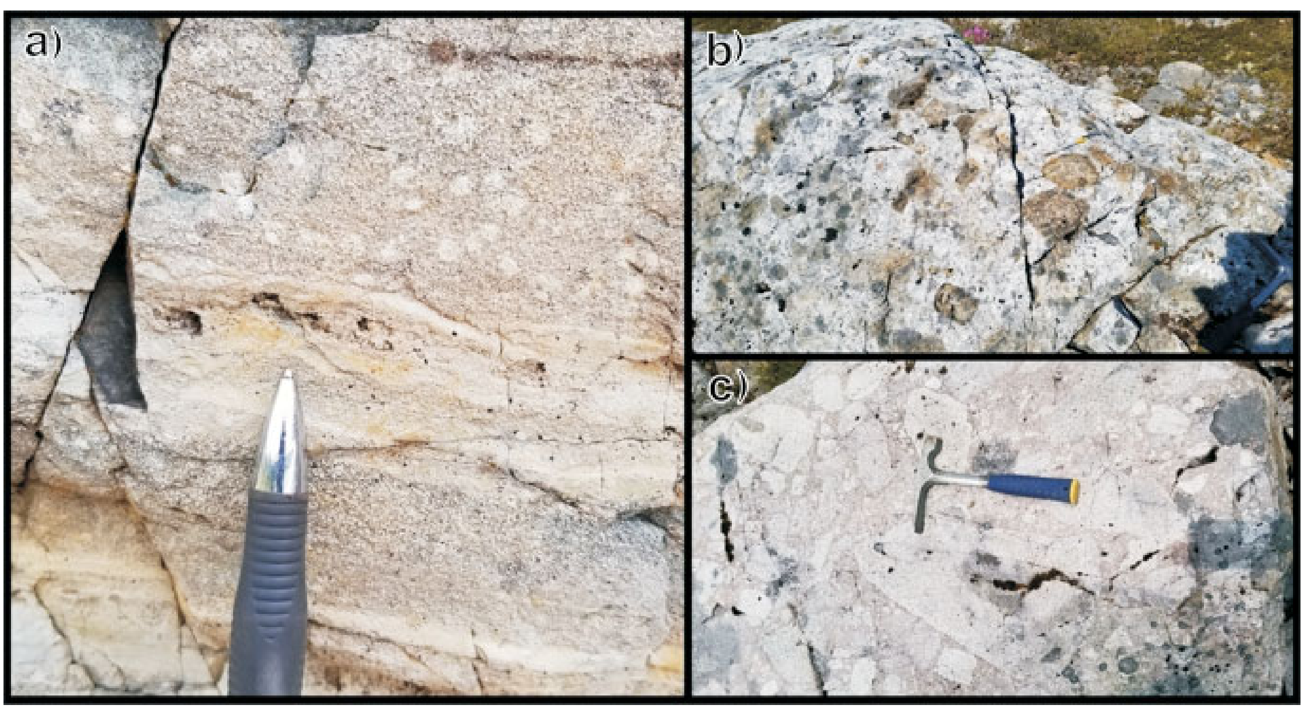

Figure 7. Hazelton Group volcanic and sedimentary rocks: **a)** interbedded sandstone, siltstone and feldspar-crystal tuff (lJHsvt; UTM NAD83 Zone 9, 477193E, 6171770N; photo taken looking northwest); **b)** volcanic breccia containing significant Stuhini Group sedimentary clasts (lJHvh; 474381E, 6169968N); **c)** monomictic volcanic breccia (lJHvbx) with angular ‘jigsaw’ poorly sorted juvenile pebble to cobble clasts (475626E, 6173255N).

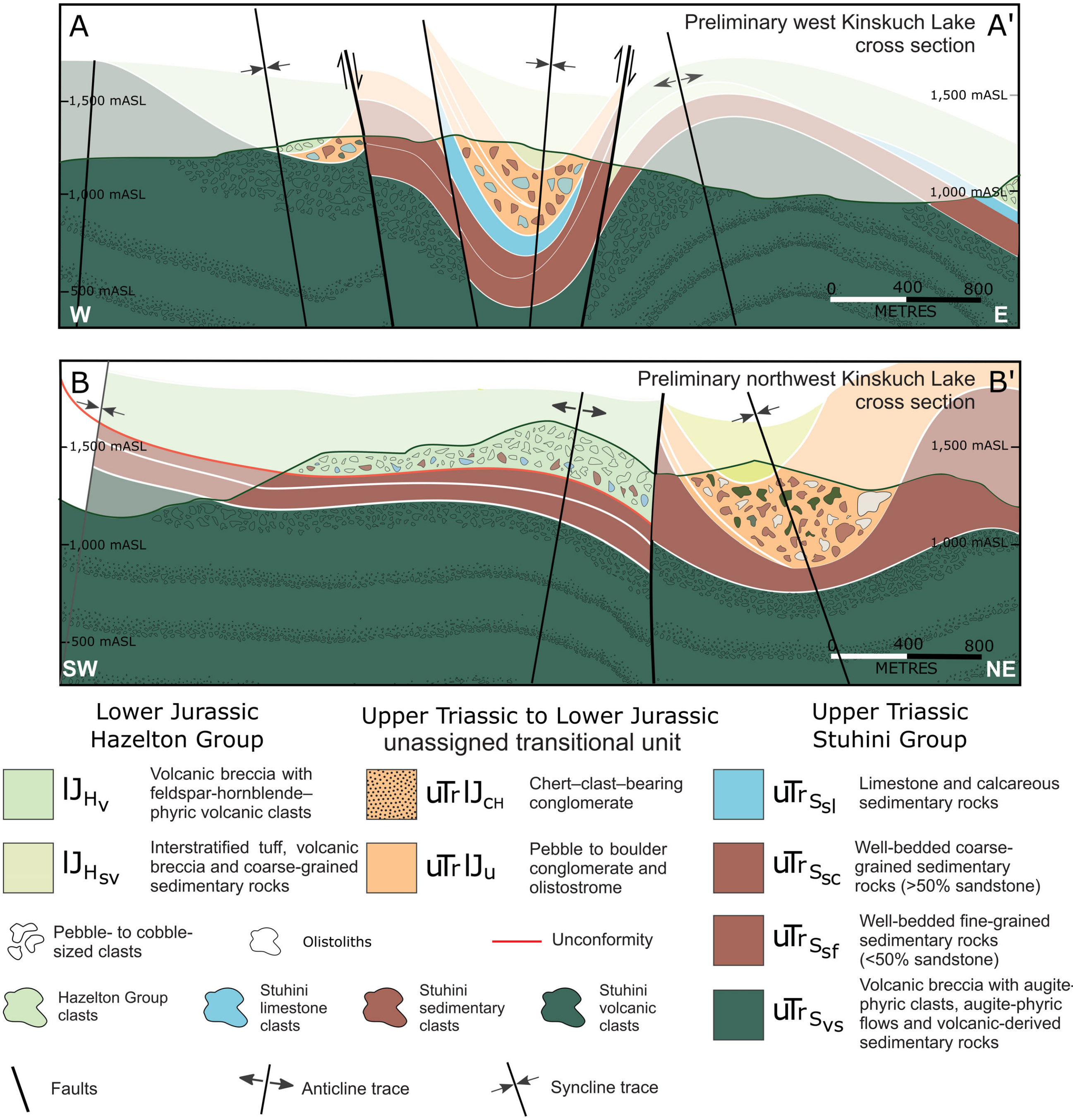

Figure 8. Preliminary schematic cross sections for traces A-A' and B-B' in Figure 2. Cross section A-A' is orthogonal to F_1 folds and north-trending faulting. It shows the apparent thinning of the Stuhini Group limestone unit and coarse-sediment unit. Cross section B-B' is somewhat oblique to the trends, displaying the broad F_2 folds in the southwestern portion of the section and a tighter F_1 syncline in the north-eastern portion of the section.

to lateral facies changes, postdepositional erosion and/or subsequent deformation.

Stuhini Group or Hazelton Group (uTrlJ)

Transitional Unit (uTrlJu)

Rocks of the transitional unit are not currently assigned to either the Stuhini Group or the Hazelton Group. The transitional unit consists of pebbly sandstone, conglomerate and olistostromal deposits with cobbles, boulders and olistoliths up to at least 50 m in diameter.

The transitional unit is composed of four conglomerate facies differentiated primarily based on dominant clast composition; contacts appear to be gradational. They show significant lateral and vertical variability in matrix composition, clast size and clast angularity. Particularly where this unit is thick (e.g., below Tabletop Mountain), there are local sandstone-filled, crossbedded channels ranging from 20 cm up to 2 m in width cutting the mostly massive, poorly sorted conglomerate facies.

Mafic Volcanic Clast-Bearing Conglomerate Facies (uTrlJa)

This facies is a pebble to cobble to rare boulder conglomerate with subrounded, predominantly augite-phyric clasts and lesser limestone and other sedimentary clasts in a feldspathic to lithic sandstone matrix (Figure 6a). Within this conglomerate there are relatively large areas, up to at least 20 m in width and of unknown lateral continuity in size, of mafic volcanic breccia that are difficult to distinguish from the bulk of the conglomerate due to similar weathering characteristics. These may be extremely large clasts or mass flow deposits intercalated with the conglomerate.

Heterolithic Conglomerate Facies (uTrlJh)

A very poorly to poorly sorted heterolithic pebble, cobble to rare boulder conglomerate, this facies includes clasts up to 40 cm in diameter. Matrix- to locally clast-supported, this conglomerate contains 40–70% subrounded to angular sandstone, limestone, augite-phyric volcanic, feldspar-phyric volcanic, mudstone, bedded sedimentary and maroon rare aphanitic clasts in a feldspathic to lithic sandstone matrix (Figure 6b). Relative proportions of rock types of the clasts are highly variable, but sandstone, limestone and augite-phyric volcanic clasts typically predominate.

Sandstone Clast-Bearing Conglomerate Facies (uTrlJs)

A very poorly sorted pebble, cobble to rare boulder conglomerate includes clasts averaging 5–10 cm, but with limestone olistoliths up to 50 m in diameter in some localities. Clast- to matrix-supported, this conglomerate has 40–75% subrounded to subangular sandstone clasts and subordinate limestone, argillite and mudstone clasts, in a variably feldspathic to lithic sandstone matrix (Figure 6c). Locally, this facies is olistostromal with limestone boulders and olistoliths up to 50 m in diameter; this limestone is often fossiliferous (Figure 6d). Most sandstone clasts are composed of feldspathic to lithic sandstone of similar composition to the matrix, but some contain significant augite. At a single outcrop, below Tabletop Mountain, a large portion (~30%) of the sandstone clasts contain detrital biotite.

Chert-Clast–Bearing Conglomerate to Sedimentary Breccia Facies (uTrlJch)

The chert-clast–bearing conglomerate to sedimentary breccia is a generally poorly sorted, clast-supported heterolithic pebble (0.5–5 cm) conglomerate containing 5–20% angular grey chert fragments (Figure 6e). The chert is accompanied by clasts derived from the Stuhini Group sedimentary unit, including thinly bedded argillite (uTrSsf), sandstone, siltstone and granule to pebble conglomerate (uTrSsc). Rounding is variable, from subrounded to angular, with argillite generally showing more rounding than the more resistant fragments. The matrix of the conglomerate is a fine-grained feldspathic sandstone to siltstone.

Hazelton Group (lJH)

The Hazelton Group at Kinskuch Lake comprises a volcanic and sedimentary unit (lJHsv), which is overlain by a volcanic unit (lJHv) comprised primarily of volcanic breccia.

Volcanic and Sedimentary Rock Unit (lJHsv)

This unit is composed of roughly equal proportions of sedimentary and volcanic rocks. It is the most variable of the two Hazelton Group units recognized in the area and is not always present at the base of the group. The authors distinguished three facies that are commonly interbedded; any one of these lithological packages can form the base of the Hazelton Group at a given locality. The exact stratigraphic superposition varies across the area, but generally follows the following pattern: basal conglomerate to sedimentary breccia facies (lJHsvcon) or interbedded sandstone and tuff facies (lJHsvt), overlain by well-bedded to locally massive, coarse-grained sandstone and siltstone facies (lJHSsvs), capped by conglomerate and sedimentary breccia facies (lJHsvcon).

Heterolithic Conglomerate and Sedimentary Breccia Facies (lJHsvcon)

This unit is primarily a mixture of massive to crudely stratified heterolithic conglomerate containing rounded to subrounded pebbles and rare cobbles of crowded feldspar-hornblende–phyric volcanic rock, sandstone and argillite. It is clast to matrix supported with a feldspathic sandstone matrix. This conglomerate is locally interstratified with more typical massive Hazelton Group monomictic volcanic breccia described below as facies lJHvbx.

Interbedded Sandstone and Tuff Facies (lJHsvt)

This facies includes well-bedded, distinctively pale-weathering siltstone to coarse-grained sandstone (Figure 7a) that may contain up to 5% quartz granules, with significant (up to 40% of the rock volume) very thin to thin interbeds of crystal tuff containing broken angular to euhedral feldspar crystals.

Coarse-Grained Sandstone and Siltstone Facies (lJHsvs)

This is a medium- to coarse-grained sandstone and siltstone that is thin bedded to lesser medium to thick bedded and locally massive with rare mudstone interbeds. It appears similar to Stuhini Group coarse-grained sedimentary rocks (uTrSsc) but is conformably above right-way-up Hazelton

Group conglomerate beds (lJHsvcon) and may contain hornblende crystals or hornblende-phyric clasts (pending petrographic confirmation).

Volcanic Rock Unit (lJHv)

The Hazelton Group volcanic rock unit comprises three facies that occur in a generally predictable sequence as presented below, although interfingering is common and not all facies are present in all stratigraphic sections observed across the study area. The heterolithic volcanic breccia facies, for example, is only observed where the unit of volcanic and sedimentary rocks is thin to absent, and the volcanic unit occurs near the base of the Hazelton Group.

Heterolithic Volcanic Breccia Facies (lJHvh)

The heterolithic volcanic breccia contains clast- to matrix-supported accessory clasts and hornblende-feldspar–phyric juvenile clasts set in a hornblende and feldspar crystal-rich matrix. The accessory clasts include bedded mudstone, sandstone and limestone, likely derived from underlying Stuhini Group rocks (Figure 7b). This lithological package is similar to the monomictic volcanic breccia (lJHvbx) but is differentiated by the presence of accessory clasts.

Feldspar±Hornblende Crystal Tuff and Lapilli Tuff Facies (lJHvt)

Crystal tuff with variable feldspar±hornblende crystal content is observed only locally within the monomictic volcanic breccia facies and is not present across the entire study area. Locally, the tuff closely resembles the matrix of the volcanic breccia and can contain up to 5% lapilli- to block-sized accessory sedimentary fragments, or juvenile clasts similar to those of the monomictic volcanic breccia. This package can be very similar in appearance and weathering character to intrusive rocks in the Big Bulk porphyry system, making differentiation difficult.

Monomictic Volcanic Breccia Facies (lJHvbx)

The predominant rock type of the highest stratigraphic levels of the Hazelton Group throughout the study area is the monomictic volcanic breccia. It is a massive, poorly to very poorly sorted volcanic breccia that has a typically densely packed euhedral to angular hornblende and feldspar crystal-rich matrix with 40–70% hornblende-feldspar–phyric volcanic clasts (Figure 7c). This facies shows significant lateral and vertical variation in both clast size and proportion of clasts to matrix. Clasts range from lapilli to block sized, rarely as large as 10 m.

Intrusive Units

The predominant intrusive unit in the study area is a multiphase stock that hosts the Big Bulk Cu-Au porphyry system in the southern part of the study area. This unit is provisionally correlated with the Early Jurassic Texas Creek Plutonic Suite, and likely represents the intrusive equivalents of lower Hazelton Group volcanic rocks. Three separate dike sets are also recognized; one is probably related to the Big Bulk stock and the other two may be considerably younger. The complete characterization of the intrusive units awaits petrological, geochemical and geochronological study.

Multiphase Big Bulk Diorite to Monzonite Unit (EJmd)

The multiphase Big Bulk diorite to monzonite can be characterized as hornblende diorite, hornblende monzonite and hornblende-biotite monzonite. It ranges from equigranular to sparsely porphyritic to crowded porphyritic and locally includes intrusive breccia. Porphyritic varieties contain 10–30% lath-shaped plagioclase phenocrysts (1–2 mm), 5–15% acicular hornblende phenocrysts (1–2 mm), locally up to 30% K-feldspar phenocrysts and rarely up to 10% distinctive porphyritic platy biotite books in a predominantly fine-grained (<1 mm) feldspar-hornblende–dominated groundmass ranging from plagioclase dominant to a nearly 1:1 ratio of plagioclase:K-feldspar. Alteration is variable and includes weak sericitization, chlorite alteration, patchy epidote alteration and intense quartz-sericite-pyrite alteration that strongly obscures original textures and composition and displays the local development of significant cleavage associated with folding and imbricate thrust faulting.

Early Jurassic Dioritic Dikes (EJdyk)

Observed extending radially from the Big Bulk stock, these dikes are typically dioritic with 10–30% strongly elongated lath-shaped plagioclase phenocrysts that often show radial ‘flower’ textures and 10–15% acicular hornblende phenocrysts in a fine to very fine grained groundmass of mainly hornblende and plagioclase. They contain up to 3% disseminated pyrite and locally patchy chlorite-epidote replacement of mafic minerals.

Late Dioritic Dikes (E?d)

Texturally and compositionally similar to the Jurassic dikes but lacking alteration and sulphides, these dikes are generally traceable for up to several kilometres of strike length. The age of these dikes is unknown; they could be part of the Eocene Hyder plutonic suite.

Late Mafic Dikes (E?m)

Dark green, recessive weathering aphanitic dikes commonly show chilled margins and/or flow banding along their margins. These dikes are only rarely observed, may be traced for up to 100 m, and occur within east-west-trending, steeply dipping faults. They cut the Big Bulk stock, as well as Stuhini Group and lower Hazelton Group rock units. Locally these dikes contain up to 5% calcite-filled amygdules and appear to be significantly less deformed and altered than surrounding rocks, suggesting that this is one of the youngest rock units represented in the area.

Preliminary Structural Observations

Two generations of folds were observed at Kinskuch Lake, with F_1 trending mainly northerly and F_2 represented by open folds with easterly trending axial traces. Map-scale faults show a similar orthogonal pattern, with north to northeast and west to northwest trends.

Rock type exerts a significant control on structural style, with deformation expressed primarily as faulting in the strong units (i.e., volcanic breccia [lJHvbx] and granitoid intrusions [EJmd]) that predominate the east side of Kinskuch Lake, whereas the well-stratified rocks on the west side of the lake display a combination of folds and faults. Furthermore, on the west side of the lake, the fine-grained sedimentary facies locally display abundant metre- to decimetre-scale tight folds, whereas the more competent sandstone facies only display larger-scale folds (>50 m wavelength). Axial planar cleavage occurs only locally, within some of the argillite and in areas of strong phyllic alteration. Overall cleavage is very poorly developed except locally within some of the argillite packages and in areas of strong phyllic alteration.

The preliminary cross-sectional interpretation of the fold and faulting pattern in the west portion of the Kinskuch Lake study area is shown in Figure 8. It illustrates the thinning of several units across the area and shows the contrast between the clearly unconformable contact between Hazelton Group volcanics and Stuhini Group sedimentary rocks in the far west of the study area and displays a potentially paraconformable or conformable contact between Stuhini Group and the conglomerate to olistostromal transitional unit nearer to Kinskuch Lake.

Discussion and Future Work

There is significant variation in stratigraphic architecture within the Stuhini Group and lower Hazelton Group across the field area. These variations could be explained by lateral facies changes, differential erosion levels at the boundary between the Hazelton and Stuhini groups, distance from volcanic vents and sediment sources and/or the effects of synsedimentary faults or other topographic disruption causing localized deposition of higher energy deposits.

The transitional unit represents a dramatic change in sedimentation style from the well-stratified sedimentary rocks that characterize the underlying Stuhini Group. The transitional unit olistostromal deposits and conglomerate may have resulted from basin instability and/or tectonic uplift in the latest Triassic to Early Jurassic and may correlate with similar units observed in the KSM area by Kyba and Nelson (2015) and Febbo (2016).

The next steps in this research include

- compiling a similar preliminary summary of the Red Mountain Au deposit area;
- conducting lithogeochemistry and petrography to accurately characterize the volcanic and intrusive units;
- completing component analysis for accurate characterization and correlation of sedimentary, volcanic-derived sedimentary and volcanic units;
- determining biostratigraphy and isotope geochronology to assess the age, stratigraphic position and provenance of units; and
- analyzing in detail the structural data including petrographic studies.

In addition, in 2019, the Big Bulk area will be mapped at a scale of 1:5000 (or more detailed) to assess the role of imbricate faulting and folding on the distribution of porphyry-related Cu-Au mineralization and better define the emplacement environment and relationship to pre-existing and/or syn-intrusion faults. Also, a palinspastic restoration of conditions prior to Cretaceous deformation will be attempted to more accurately represent the structural environment into which the Cu-Au porphyry system was emplaced.

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