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Stratigraphy and structures within the Lower to Middle Jurassic Hazelton Group, Takysie Lake and Marilla map areas, central British Columbia[1]

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Abstract: Deformed Hazelton Group rocks in southern Takysie Lake (NTS 93 F/13) and northern Marilla (NTS 93 F/12) map areas consist of maroon to reddish-brown polymictic cobble conglomerate; red, pebbly mudstone; and feldspathic lithic wacke. The strata form the upper plate of a northwest-trending, southwest-dipping reverse fault. The rocks commonly dip moderately to the north, are locally folded about a northwest-trending fold axis, and are penetratively deformed. A closely spaced S_1 cleavage dipping moderately southeast and a less well developed S_2 cleavage dipping steeply west represent the oldest recognized structures in the region.

The lower plate consists of Jurassic Bowser Lake or Cretaceous Skeena groups chert-rich greywacke and polymictic chert- and felsic volcanic-rich conglomerate exhibiting an east-trending, moderately dipping cleavage.

Hanging wall and footwall rocks are intruded by the undeformed (?)Late Cretaceous Skins Lake pluton, constraining the timing of deformation to post-Jurassic and pre-(?)Late Cretaceous.

Résumé : Dans la partie sud de la région cartographique de Takysie Lake (SNRC 93 F/13) et dans la partie nord de celle de Marilla (SNRC 93 F/12), les roches déformées du Groupe de Hazelton se composent de conglomérats polygéniques à blocs, de couleur marron à brun rougeâtre, de shales à cailloux de couleur rouge et de wackes feldspatho-lithiques. Ces strates forment le compartiment supérieur d'une faille inverse de direction nord-ouest, inclinée vers le sud-ouest. Les strates présentent généralement un pendage modéré vers le nord, sont par endroits plissées autour d'axes de plis de direction nord-ouest et présentent une déformation pénétrative. Une schistosité S_1 serrée modérément inclinée vers le sud-est, ainsi qu'une schistosité S_2 fortement inclinée vers l'ouest, mais moins bien développée, sont les plus anciennes structures reconnues dans la région.

Le compartiment inférieur de la faille est constitué de grauwackes riches en chert et de conglomérats polygéniques riches en fragments de chert et de roches volcaniques felsiques qui appartiennent soit au Groupe de Bowser Lake du Jurassique, soit au Groupe de Skeena du Crétacé. Ces roches montrent une schistosité de direction est modérément inclinée vers le sud.

Les roches des deux côtés de la faille sont recoupées par le pluton non déformé de Skins Lake du Crétacé tardif(?), ce qui nous indique que la déformation est postérieure au Jurassique, mais antérieure au Crétacé tardif(?).

[1] Contribution to the Nechako NATMAP Project

INTRODUCTION

The structural style in the northern Nechako River (NTS 93 F) and southern Fort Fraser (NTS 93 K) map areas is dominated by northeast and subordinate northwest-trending Eocene block faults which generally contain undeformed or weakly cleaved or jointed strata (e.g. Anderson and Snyder, 1998; Anderson et al., 1998a, b, c; Struik, 1998; Struik and Whalen, 1999; R.G. Anderson, L.D. Snyder, N. Hastings, S. Wetherup, R. L'Heureux, and L.C. Struik, unpub. map manuscript, 1999). However, there are scattered areas, e.g. Nechako Range (Diakow et al., 1997; Anderson et al., 1998a) and near the Babine Lake area (MacIntyre et al., 1997; MacIntyre, 1998; MacIntyre and Diakow, 1998; Schiarizza and MacIntyre, 1999) where there are records of pre-Eocene deformation preserved.

The detailed mapping project described below, and data from new regional mapping, provide evidence for a Jura-Cretaceous northwest-trending reverse fault of regional scale in southern Takysie Lake (NTS 93 F/13) and Marilla (NTS 93 F/12) map areas which emplaced multiply deformed Lower to Middle Jurassic Hazelton Group volcanic rocks onto well cleaved Jura-Cretaceous siliciclastic rocks of the Bowser Lake or Skeena groups. This study is part of the Nechako NATMAP Project (Fig. 1; Struik and MacIntyre (1999a, b) and references therein) and contributes to the ongoing revision of the Nechako River 1:250 000 scale geological map (Tipper, 1963).

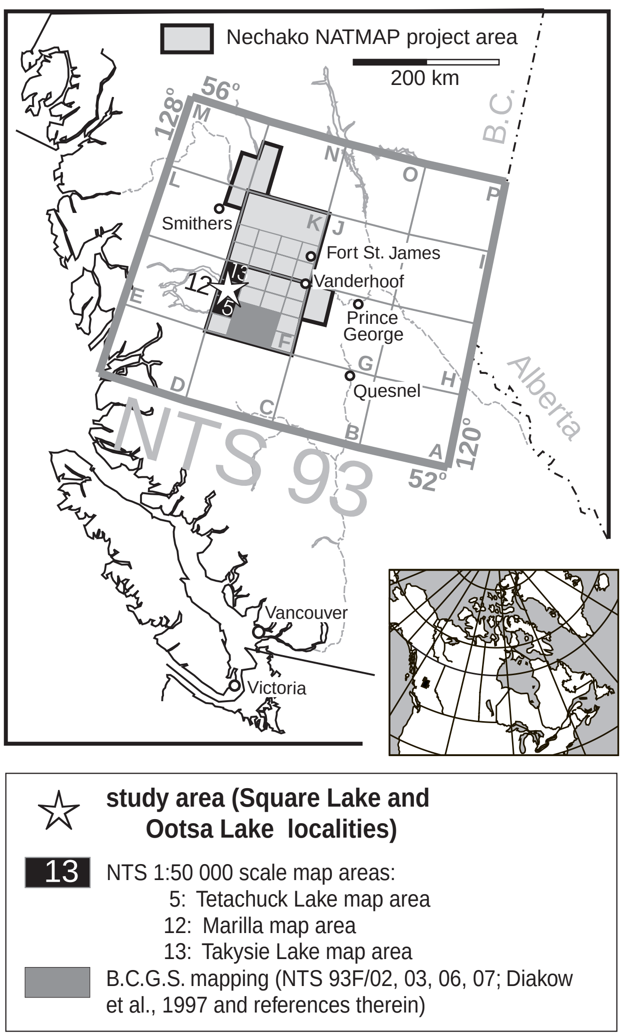


Figure 1. *Location of the study area within the Nechako NATMAP bedrock mapping area.*

PHYSIOGRAPHY, ACCESS, AND FIELD METHODS

The study area is characterized by rolling hills and low relief typical of the Interior Plateau. It straddles part of Ootsa Lake (Nechako Reservoir). It is informally divided into the Square Lake locality (number 1, Fig. 2a) to the north and south Ootsa locality (number 2, Fig. 2a) to the south of Ootsa Lake. Exposure in the study area is poor, with the Lower to Middle Jurassic Hazelton Group and Jura-Cretaceous Bowser Lake or Skeena groups rocks found in areas of low relief. Outcrops are entirely below treeline and the outcrop pattern consists of ribs of conglomerate adjacent to recessive, finer grained siliciclastic strata. Extensive logging and road building enhance the access and exposure. Quaternary sediments, comprising unconsolidated glacial till, fluvial deposits, and poorly sorted alluvium, cover a large portion of the map area, extending over most of the low-lying and/or swampy terrain, especially in the west and south. Consequently, geological contacts are inferred and extrapolated beyond the outcrop distributions shown in Figure 2.

New data reported in this paper was based upon eight traverses by the lead author during a three-week period in late July and early August 1998 as part of a baccalaureate project; it also incorporates regional data collected by other workers during the same period. Representative samples were collected at each outcrop location for use in petrographic, geochemical, and geochronological analyses, as well as for reference and use in making specific gravity measurements. Uranium-lead dating of a basal, crystal-lithic tuff member of the Hazelton Group (*see* Fig. 3) in the upper structural panel and of the postkinematic (?)Late Cretaceous Skins Lake pluton are underway to test the suggested Jura-Cretaceous age for the structures described below.

REGIONAL GEOLOGY

Five stratified units dominate the study area, the reddish-brown weathering, medium- to coarse-grained volcanic rocks of the Lower to Middle Jurassic Hazelton Group; brownish-grey medium- to coarse-grained siliciclastic rocks correlative to Bowser Lake or Skeena groups; minor, felsic and mafic white and grey flow and volcaniclastic rocks of Eocene Endako and Ootsa Lake groups; and massive, mafic volcanic flows of the Neogene Chilcotin Group. Intrusive rocks comprise the grey to brown, porphyritic to seriate rocks

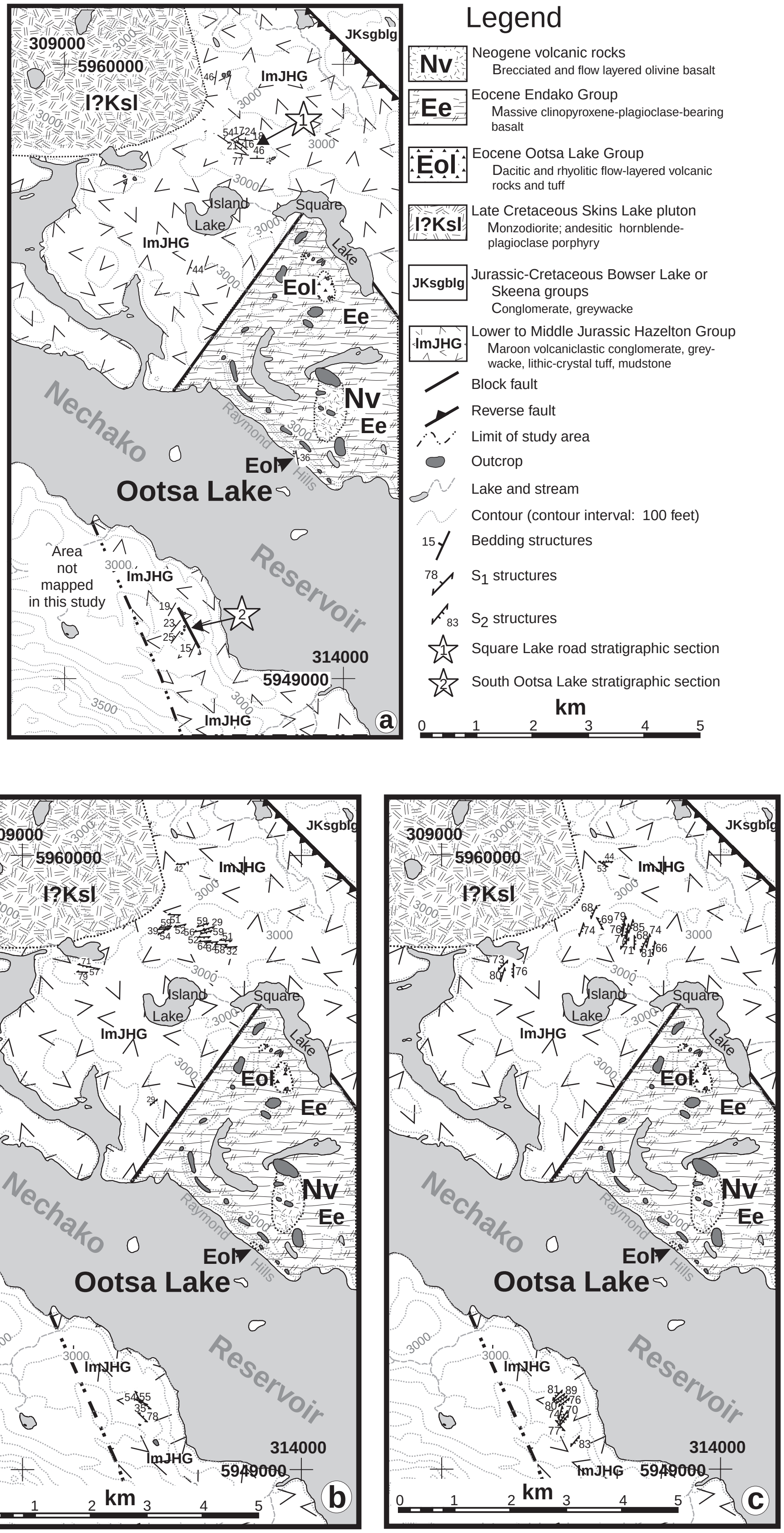


Figure 2. *Geological map of the study area (this study; R.G. Anderson, unpub. data, 1998);* ***a)*** *bedding structures and location of measured stratigraphic sections shown;* ***b)*** *S_1 structures shown; and* ***c)*** *S_2 structures shown.*

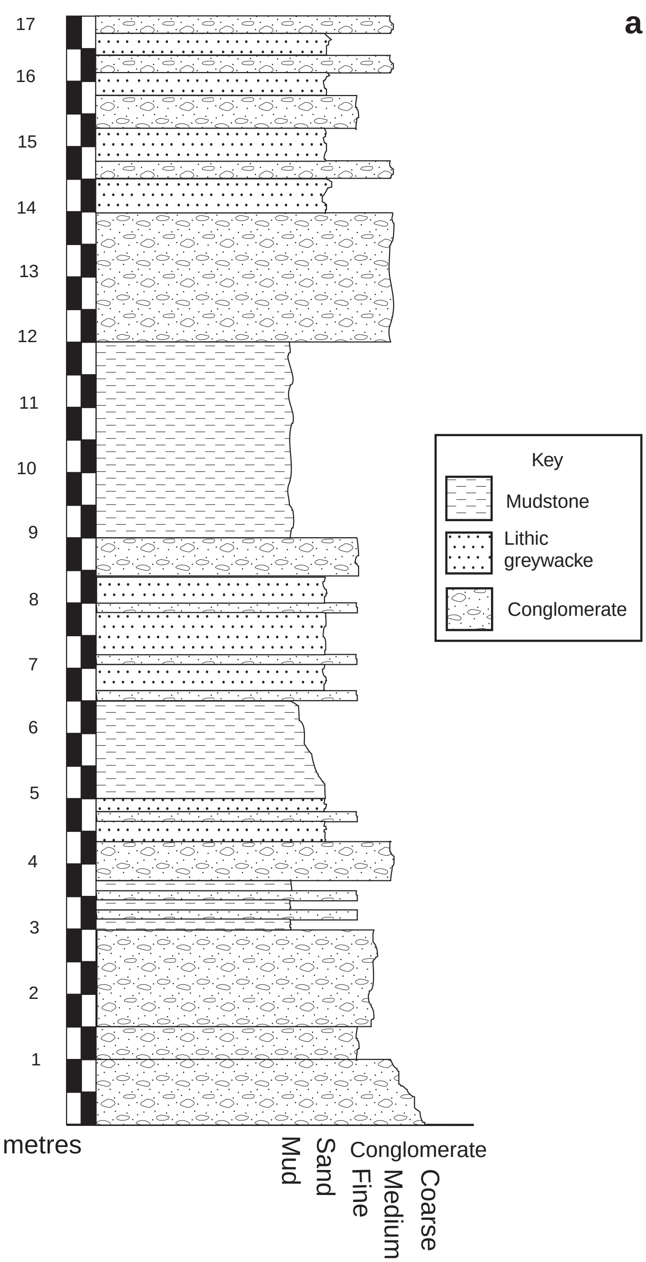
of the (?)Late Cretaceous Skins Lake pluton and satellitic intrusions which intrude the Hazelton Group rocks and their structures.

STRATIFIED UNITS

Lower to Middle Jurassic Hazelton Group (unit lmJHG*)*

Basaltic, andesitic, and rhyolitic pyroclastic rocks and flows, as well as breccia, tuff, and flows of feldspar-phyric andesite of the Hazelton Group are considered to be the oldest units in the Takysie Lake, Marilla, and Tetachuck Lake map areas and are locally further divisible into the Middle Jurassic Naglico formation (*see* Diakow et al., 1997; Quat and Struik, 1999; Billesberger et al., 1999). In the study area, Hazelton Group rocks are mainly exposed in the south Ootsa Lake and to a lesser extent in the Square Lake area (Fig. 2). The unit (Fig. 3) strongly resembles rocks in the Uncha Mountain area (Barnes and Anderson, 1999) and well dated Lower Jurassic rocks at the base of Cutoff Butte (Anderson et al., 1998a) but has few similarities with Lower Jurassic Entiako or Middle Jurassic Naglico formations rocks to the south described in detail by Quat and Struik (1999).

Hazelton Group rocks in the study area include maroon- to reddish-brown-weathering mudstone and conglomerate, with subordinate dacitic, plagioclase-phyric, crystal-lithic tuffaceous greywacke and reworked tuff (Fig. 3, 4). Mudstone subunits occur in the Square Lake and south Ootsa localities and comprise a maroon, pebbly mudstone containing 5–10% subangular to subround clasts. The clasts resemble those in the conglomeratic subunits in rock type and relative proportions and are set in a mud, or less common, sand matrix. The mudstone subunit best exhibits the regional, millimetre-spaced, S_1 fissile cleavage.



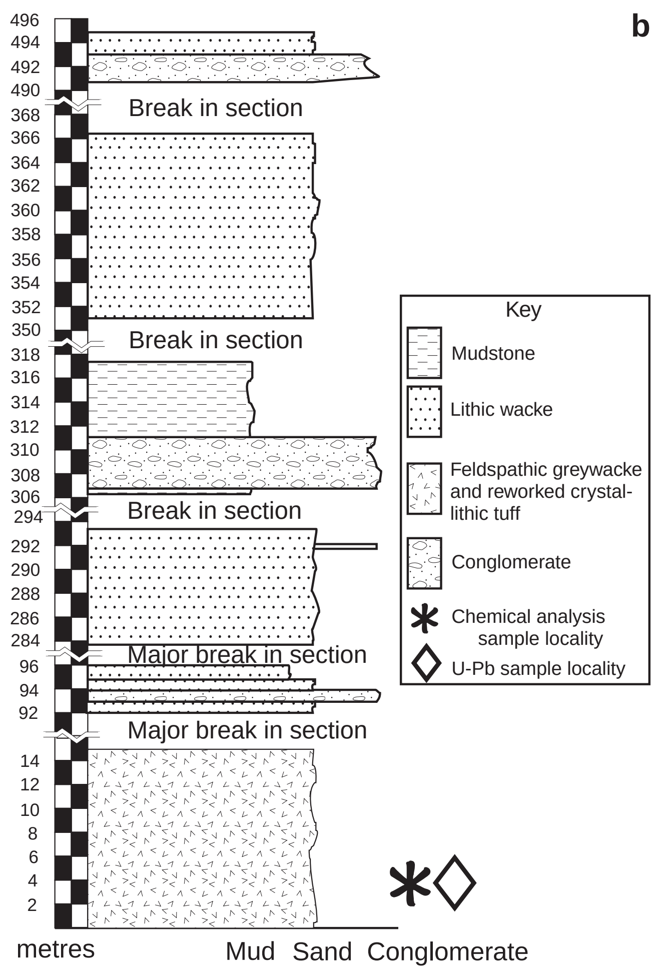
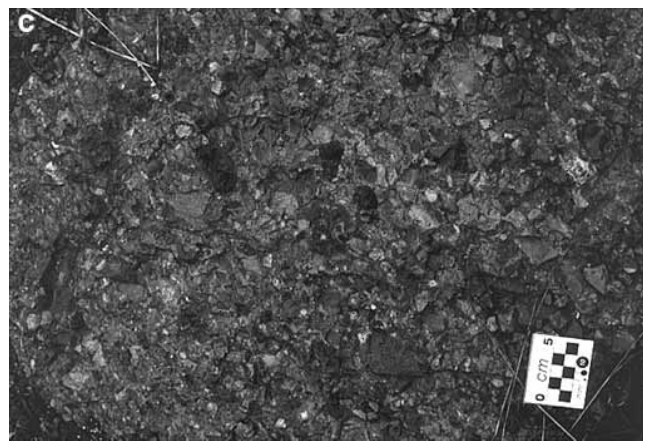


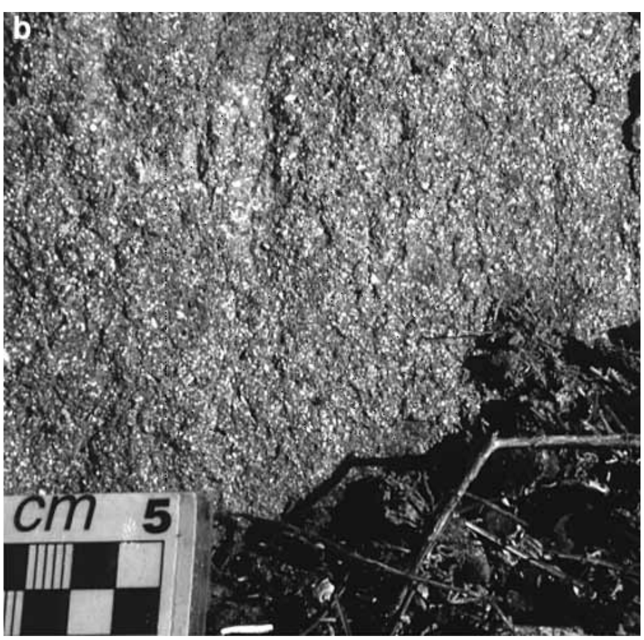
***Figure 3.** Measured stratigraphic sections in the **a)** Square Lake (base of section zone 10, UTM 311729E, 5958810N); and **b)** south Ootsa (base of section zone 10, UTM 311019E, 5949800N) localities in the study area.*

Rust-red, matrix-supported, volcanic pebble-conglomerate beds (Fig. 4), best exposed in the south Ootsa locality, range in thickness from 5 cm to 150 cm. They are generally lenticular, occurring as large (5–10 m long) channels within the mudstone, and represent channel-fill deposits. The conglomerate is commonly moderately organized, and locally displays fining-upward sequences (Fig. 4a). Subangular to subround clasts range in size from medium sand to cobble, with pebble sizes dominating, and are set in a sand to mud matrix that resembles the lithic wacke. The clasts are predominately felsic porphyritic volcanic flow rocks (20–60%) and chert (30–70%). Mafic volcanic flow rock clasts are less common.

Maroon, medium sand to pebble, subangular, feldspathic lithic greywacke and reworked crystal-lithic tuff (Fig. 4b) are poorly sorted and medium bedded (beds 10–30 cm thick). The rock contains dominant subhedral plagioclase (1–35%, 1–3 mm) with minor amounts of anhedral quartz (1–2%, 0.25–0.5 mm) and subhedral hornblende (1–10%, 0.25–0.5 mm). The lithic fragments are mostly mafic volcanic rocks (30–70%) with some felsic volcanic rocks (1–25%).

Tuffaceous feldspathic wacke contains medium sand- to coarse pebble-sized, subangular to subround clasts set in a sand to silt matrix. The clast composition is 0–10% lithic fragments, which are mostly mafic volcanic rocks (50–90%), with some porphyritic felsic volcanic rocks (1–25%). The rock is poorly sorted and locally contains thin (1 mm) parallel crosslamination. The wacke comprises mainly subhedral plagioclase (typically 1–35% and no more than 90%, 1–3 mm) and lesser anhedral quartz (1–2%, 0.25–0.5 mm) and subhedral hornblende (1–10%, 0.25–0.5 mm), and rare magnetite and muscovite.





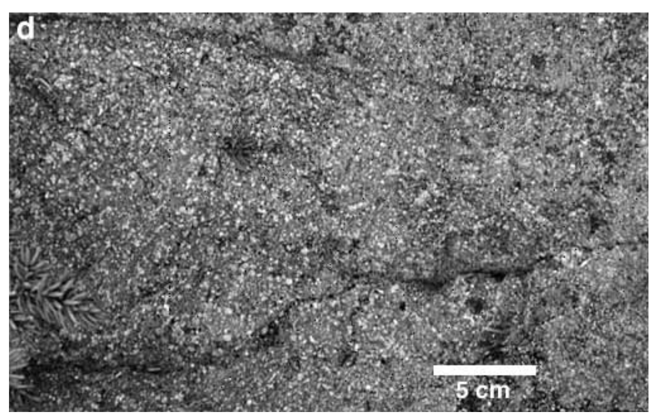


Figure 4. *Principal sub-Eocene rock types in hanging wall and footwall of reverse fault in study area;* ***a)*** *volcanic conglomerate and* ***b)*** *feldspar-phyric crystal-lithic tuff of Hazelton Group in upper structural plate in the south Ootsa locality;* ***c)*** *polymictic conglomerate of Bowser Lake or Skeena groups in footwall rocks northwest of the study area on Eakin Settlement road;* ***d)*** *porphyritic andesite of Skins Lake plutonic suite near locality where it crosscuts S_1 and S_2 structures in hanging wall rocks.*

Jura-Cretaceous siliciclastic rocks of Bowser Lake or Skeena groups (unit JKsgblg*)*

Unfossiliferous, medium- to coarse-grained, medium-bedded, intercalated conglomerate, grit, greywacke, and minor siltstone characterize the siliciclastic rocks in the footwall (Fig. 2, 4c). They are poorly exposed but occur in scattered exposures to the northwest and northeast of the study area. Variegated chert and felsic volcanic rock pebbles are the main clast types in the conglomerate. They are set in a greenish-grey chert-rich greywacke to grit matrix which strongly resembles the thin (10–30 cm thick) intercalated greywacke beds. The strata are folded into a moderately tight, north-northeasterly trending syncline in the footwall of a regional-scale reverse fault.

Tertiary volcanic rocks (units Eol *and* Ee*)*

Tertiary volcanic rocks, including members of the Ootsa Lake Group (unit Eol) and more extensive Endako Group (unit Ee), are common in the Square Lake locality and are assumed to overlie the Hazelton Group rocks although no contacts are exposed. Dacite and rhyodacite flows, and reworked, monolithic tuff are the most common rock types in the Ootsa Lake Group. The dacite contains feldspar, biotite, and hornblende phenocrysts. The rhyodacite is highly altered and fractured but not as penetratively deformed as the Hazelton Group rocks.

Aphanitic basaltic andesite flows and hyaloclastite breccia typical of the Endako Group form extensive cliffs and underlie Raymond Hill just north of the Ootsa Lake reservoir in the southern Square Lake locality (Fig. 2). The rocks are massive to flow layered and characterized by a hackly fracture and variously oriented, well developed jointing. Microphenocrysts of plagioclase, pyroxene, and olivine, and 5–15% limonite-filled amygdules are typical. The Endako Group rocks locally overlie rocks of the Ootsa Lake Group and except for steeply dipping, closely spaced jointing of diverse trend, also lack the penetrative structures which characterize the Hazelton Group rocks in the hanging wall.

*Neogene basalt (*Nv*)*

Brecciated and flow-layered basalt forms the youngest rocks in the area. These rocks are massive to flow banded, locally columnar jointed, and are characterized by basal volcanic breccia overlain by massive (>20 m) basalt flows. These units generally have a hackly appearance, and tend to form large, prominent cliffs. The rock is characterized by an aphanitic to porphyritic texture with microphenocrysts of plagioclase, pyroxene and olivine.

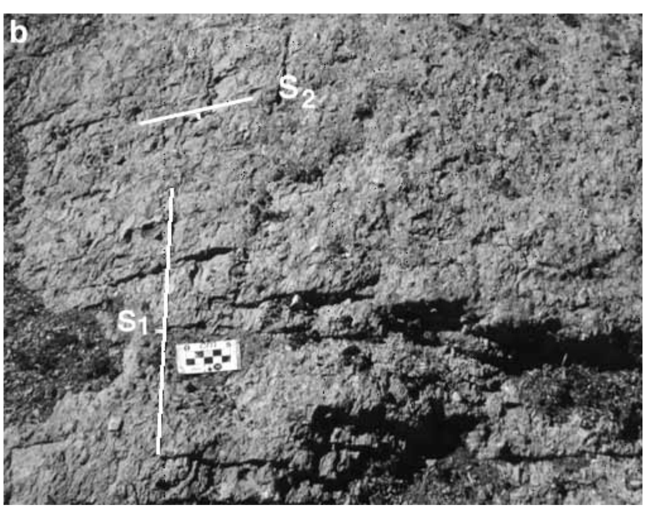


Figure 5. *Typical structures in deformed Hazelton Group rocks in hanging wall;* ***a)*** *bedding in conglomerate-mudstone facies of Hazelton Group;* ***b)*** *view northwest to S_1 schistosity crosscut by northeasterly trending S_2 structures; and* ***c)*** *view north to typical, centimetre-spaced, S_2 structures developed in crystal-lithic tuff in Square Lake area.*

PLUTONIC ROCKS

(?)Late Cretaceous Skins Lake porphyry (unit l?KSl*)*

A porphyritic to seriate monzodiorite intrusion (unit l?KSl, Fig. 2, 4d) occurs in the Square Lake locality and crosscuts the Hazelton Group rocks and their deformation structures. The monzodiorite is composed of plagioclase, hornblende, and traces of magnetite, and is relatively unaltered. The north-northwest-trending, tabular intrusion is satellitic to the extensive (?)Late Cretaceous Skins Lake porphyry pluton centred around Skins Lake to the west. Neither the pluton nor the satellitic intrusion are yet dated but may belong to the ca. 80–75 Ma suite described in the Tetachuck Lake area immediately to the south of the study area (Billesberger et al., 1999; Friedman et al., 2000).

STRUCTURE

Hazelton Group rocks in the study area have been subject to at least two separate pre-Eocene deformational events. Bedding in the Hazelton Group rocks in the study area has various trends but mainly dips to the southwest or northeast (Fig. 2a, 5a, 6a). Poles to bedding define a girdle on an equal area stereonet indicating the rocks were folded about a shallowly northwest-plunging fold axis (Fig. 6a).

Well developed, easterly trending S_1 and northeasterly trending S_2 planar structures may be related via a shared deformational event due to their common co-existence but are not obviously related to the inferred northwest-trending regional folding event, as either axial planar or as joint surfaces perpendicular to the fold axis. The dominant S_1 slaty cleavage in the hanging wall Hazelton Group rocks is characterized by its millimetre spacing, easterly trend, and moderately southerly dip and is common in all lithofacies (Fig. 2b, 5b, 6b). The S_2 fabric, in contrast, is defined by centimetre- to decimetre-spaced, north-northeast-trending surfaces which dip steeply to the northwest and southeast (Fig. 2c, 5c, 6c), essentially perpendicular to S_1. Both commonly occur together and their orientations may be due to a common deformational event in which compression was directed from the northwest and southeast and extension from the northeast and southwest. Alternatively, coexistence of the planar structures may a simple artifact of compositional control and they may be unrelated.

The inferred two-event structural history is unique to the Hazelton Group rocks found in the hanging wall of the reverse fault that extends northwest at least from northern Marilla to southwestern Takysie map areas. The fault is not exposed in the study area, but its location is narrowly bracketed in localities along the Eakin Settlement road to the northwest, in southwestern Takysie Lake map area. There, augite-phyric volcaniclastic rocks of the Middle Jurassic Naglico formation of the Hazelton Group are underlain by a basal maroon mudstone which contains penetrative, millimetre-scale, southwesterly dipping cleavage and is the hanging wall unit immediately southwest of the inferred reverse fault contact with subvertical, footwall greywacke

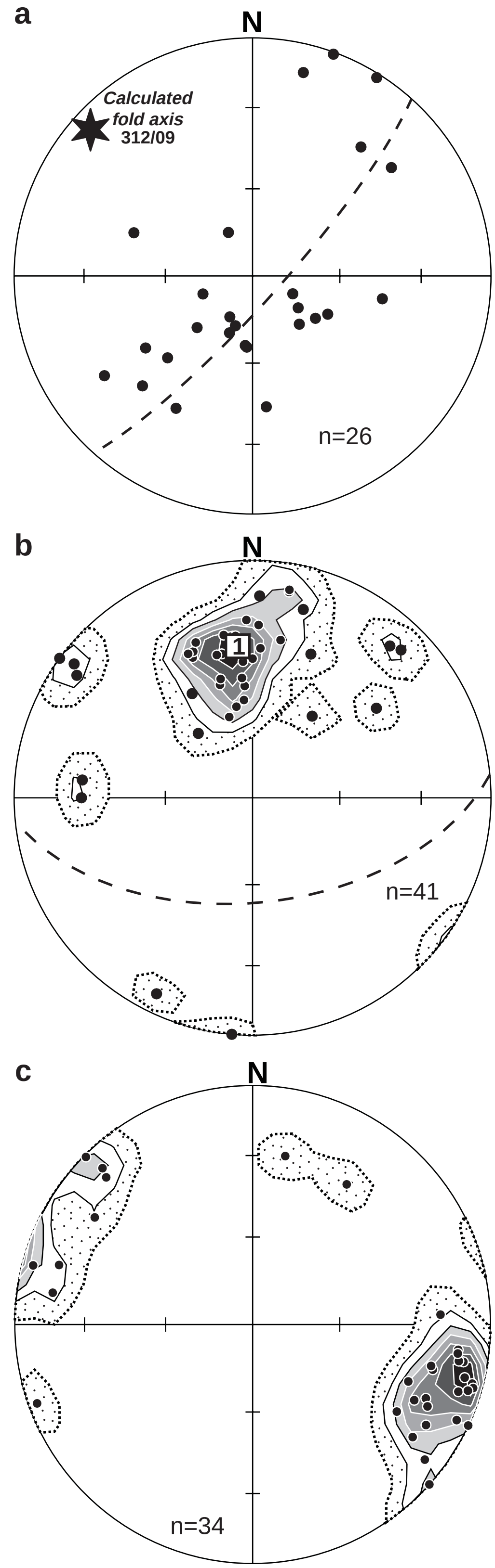


***Figure 6.** Equal area stereonet projections of orientations of poles to **a)** bedding, **b)** S_1 cleavage, and **c)** S_2 cleavage structures. In Figures 6b and c, contours are in counts above zero, and are 0, 2, 4, 6, 8, 10, and 12, respectively; the dashed line in Figure 6b is best fit plane to average poles to the S_1 cleavage data cluster (labelled as number 1).*

and conglomerate beds of the Middle to Upper Jurassic Bowser Lake Group or Lower Cretaceous Skeena Group. The younger rocks have a well developed, moderately south-dipping cleavage.

More mapping might help resolve the anomalous structural orientations with respect to the regional fault and test the relationship between inferred northwest-trending folding and easterly trending S_1 and northeasterly trending S_2 structures; however, resolution of these outstanding questions may be precluded by inadequate exposure in the study area.

Elsewhere to the east, the Hazelton and Bowser Lake groups rocks are weakly deformed or massive (Lane, 1995; Anderson and Snyder, 1998; Barnes and Anderson, 1999). An exception is along the Red Road in southwestern Big Bend map area (Anderson et al., 1998a) and farther south in the Nechako Range (Diakow et al., 1997) deformed Callovian Bowser Lake Group containing gently southwesterly plunging stretching lineations are crosscut by undated dioritic or hornblende-phyric porphyry intrusions considered to be Late Cretaceous (Diakow et al., 1997). Although the structural styles are dissimilar, evidence for a Jura-Cretaceous deformation is locally preserved throughout the northern Nechako River map area.

CONCLUSIONS

The Hazelton Group near western Ootsa Lake in the northwestern Nechako River map area consists of intercalated conglomeratic channel deposits, mudstone, lithic wacke, and tuffaceous feldspathic wacke which are overlain by younger Tertiary volcanic units. The Hazelton Group rocks have undergone two periods of deformation, resulting in the rocks being folded about a shallowly northwest-plunging fold axis and developing two later, nearly perpendicular sets of cleavage. The volcanic rocks and the deformation structures are crosscut by a satellitic monzodiorite apophysis of the nearby (?)Late Cretaceous Skins Lake pluton which help constrain the deformation to Middle Jurassic to (?)Late Cretaceous.

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