Dease Lake Geoscience Project, Part IV: Tsaybahe Group: Lithological and Geochemical Characterization of Middle Triassic Volcanism in the Stikine Arch, North-Central British Columbia

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INTRODUCTION

The Tsaybahe group study is one of four integrated projects that comprise the British Columbia Geological Survey Dease Lake Geoscience Project (Logan *et al.*, 2012), which is itself part of Geoscience BC's QUEST-Northwest initiative, a program initiated in 2011 to stimulate exploration in the northwestern part of the province along Highway 37 (Figure 1). Geoscience BC has committed $3.25 million in funding to provide two high-resolution (with a line spacing of 250 m) airborne magnetic surveys (Simpson, 2012), a collection of data on new regional stream sediments and a reanalysis of stream sediment samples (Jackaman, 2012) and new bedrock mapping and related studies (Logan *et al.*, this volume; van Straaten *et al.*, this volume; Moynihan and Logan, this volume; this study). Collectively, these programs provide detailed, high-quality geoscience data that is intended to enhance metallic mineral exploration in an area of prospective geology adjacent to Highway 37, near Dease Lake, in northern British Columbia.

The Dease Lake study area is situated within the Stikine terrane, an extensive subduction-generated island arc magmatic system responsible for recurring calcalkaline and/or alkaline plutonic events and associated Cu-Au mineralization, mainly during the Late Triassic and Early Jurassic. Previous mapping in the area identified two Triassic volcanic-sedimentary assemblages, the Stuhini and Tsaybahe groups (Anderson, 1981, 1983; Read, 1984, Read and Psutka, 1990; Gabrielse, 1998; Evenchick and Thorkelson, 2005). The Stuhini Group is a Late Triassic assemblage that is characterized by pyroxene porphyry breccias, volcaniclastic rocks, and

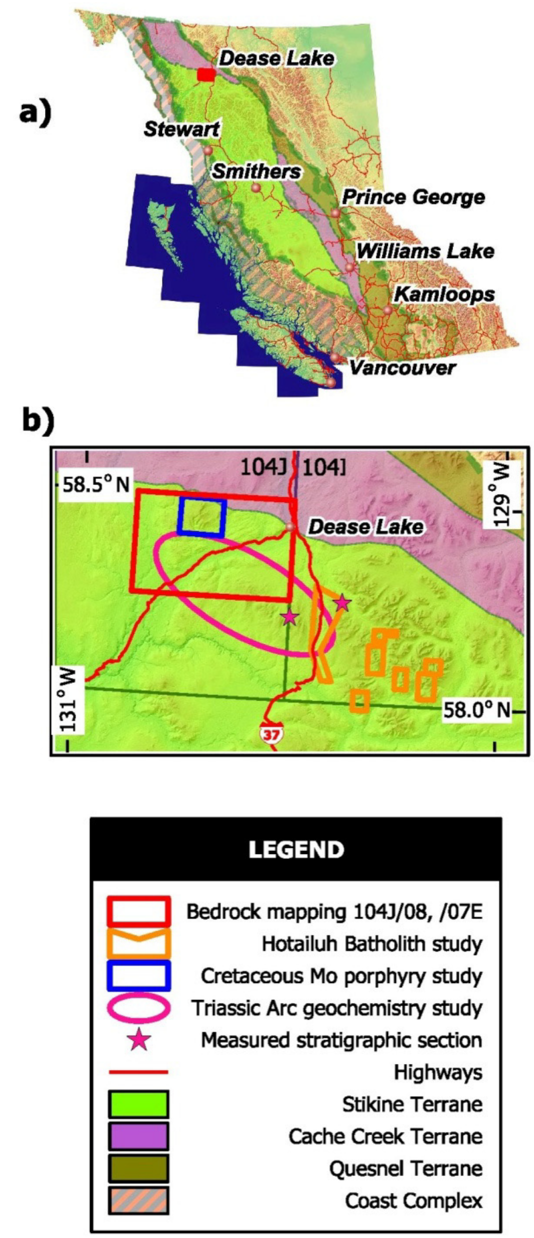

Figure 1. Location of the QUEST-Northwest mapping - British Columbia Geological Survey Dease Lake Geoscience Project on the (a) BC terrane map (after Massey *et al.*, 2005); (b) detailed view straddles NTS 104J and NTS 104I 1:250 000 map areas at Dease Lake, showing the location of the Tsaybahe Group lithological and geochemistry study.

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basalt flows (Anderson, 1983). The underlying Early to Middle Triassic Tsaybahe group was defined by Read (1984) as a succession of cherty volcanic-rich sediments and crowded augite porphyry breccias containing Early and Middle Triassic fossils. The two units are strikingly similar in terms of lithology and are difficult to differentiate in the field.

This project is designed to compare and contrast the lithostratigraphic features, detrital zircon geochronology, and volcanic geochemistry of the Stuhini and Tsaybahe groups, thereby providing insight into the stratigraphic relationships and tectonic evolution of this part of the Stikine terrane. This paper reports the initial results of the senior authors B.Sc. thesis project currently underway at the University of Wisconsin–Eau Claire under the supervision of Professor J.B. Mahoney.

OBJECTIVES

Regional geologic mapping and tectonic reconstructions require accurate differentiation of the Stuhini and Tsaybahe successions in the field. The Dease Lake area is characterized by poor outcrop exposure making the accurate differentiation of the Stuhini and Tsaybahe groups more challenging. This project focuses on two well-exposed stratigraphic sections including a section north of the Cake Hill pluton, first described by Anderson (1981, 1983), and a second section on the north flank of Thenatlodi Mountain, mapped by Read (1984; Figure 1).

The stratified rocks north of the Cake Hill pluton have a complex history of age assignment. Anderson (1981, 1983) mapped these augite porphyry-bearing strata as the Late Triassic Stuhini Group in the upper plate of the Hotailuh thrust fault, which was interpreted to structurally overly a thin section of Lower Jurassic strata unconformably overlying the Late Triassic Cake Hill pluton. Subsequent work (Gabrielse, 1998) suggested that this strata was stratigraphically correlative with the informal Middle Triassic Tsaybahe group, a succession of volcanic and sedimentary rocks containing abundant coarse pyroxene porphyry breccias and Early and Middle Triassic fossils exposed to the west in Gnat Pass and further south in the Stikine River (Read, 1984; Read and Psutka, 1990). This stratigraphic and age uncertainty is the rationale behind the present investigation.

Definitive lithologic characteristics identified in these sections will be used as a reference for comparison to younger Stuhini assemblage. Analytical methods include detailed stratigraphy and sedimentology, petrography, detrital zircon geochronology, and whole rock geochemistry of the volcanogenic intervals.

Measured Sections

The stratigraphic section adjacent to the north margin of the Cake Hill pluton is located about 5 km east of Gnat Pass (NTS 104I/05, Figure 1). It was initially described by Anderson (1981, 1983; section 714) as a 1 km thick, north-dipping succession in the hangingwall of the Hotailuh fault. Anderson (1981) interpreted the rocks to be the Late Triassic Stuhini Group in thrust contact with a thin sliver of Toarcian sedimentary rocks overlying the Late Triassic Cake Hill pluton.

In this investigation, the section was subdivided into five members (Figures 2, 3). The lowest, first member (~320 m) is characterized by gray, thin to medium bedded, medium grained volcanic lithic arenite with abundant sedimentary structures including Ta-Te Bouma sequences and syndepositional folds (Figure 4a), intercalated with lesser white plagioclase porphyry volcanic pebble conglomerate, siltstone and minor argillite. Henderson and Perry (1981) describe a rich biota of Early Toarcian bryozoan, scleractinid corals, ammonites, foraminifera and pelecypods from arenaceous carbonate beds in the lower portion of the section, which was inferred to lie below the Hotailuh fault. The first member coarsens upward gradationally into the second member (~250 m) which consists of medium to thick bedded, medium to coarse grained tuffaceous volcanic lithic arenite intercalated with granule to pebble volcanic conglomerate with minor, yet distinctive, light gray siliceous ash tuff beds (Figure 4b). This member fines upwards into medium bedded siltstone of the third member (~170 m) that is intruded by augite and bladed plagioclase porphyry dikes and sills at low angles to the bedding. The intrusions have chilled margins and contain rare chloritic and calcsilicate xenoliths of country rock. The third member has an abrupt upper contact with volcanic rocks of the fourth member (~60 m), which consists of monomict, boulder conglomerate with clasts of plagioclase-rich, augite porphyritic basalt (Figure 4c). The fourth member grades upward into the fifth member (~200+ m) that is composed of locally columnar jointed augite porphyry flows and volcanic breccias characterized by angular, lapilli to block-sized augite porphyry fragments (Figure 4d). The fifth member elsewhere apparently forms extensive massifs (*e.g.* Thenatlodi Mountain and areas to the southeast) and isolated knobs throughout the map area.

A second stratigraphic section containing similar stratigraphy was examined on the north flank of Thenatlodi Mountain located approximately 14 km southwest of the previous stratigraphic section (NTS 104J/01, Figure 1). This section is intruded by a northwest trending biotite-hornblende quartz monzonite apophysis from the Three Sisters pluton (*ca.* 170 Ma), which interrupts stratigraphic continuity and apparently removes significant intervals of the stratigraphy. However, the Thenatlodi section is interpreted to be stratigraphically correlative with the section north of the Cake Hill pluton, as it contains lithologically similar strata with the same stratigraphic architecture. Unlike the Cake Hill section, the Thenatlodi section contains a lowermost member (~200+ m) characterized by argillite, siltstone, and carbonate intervals.

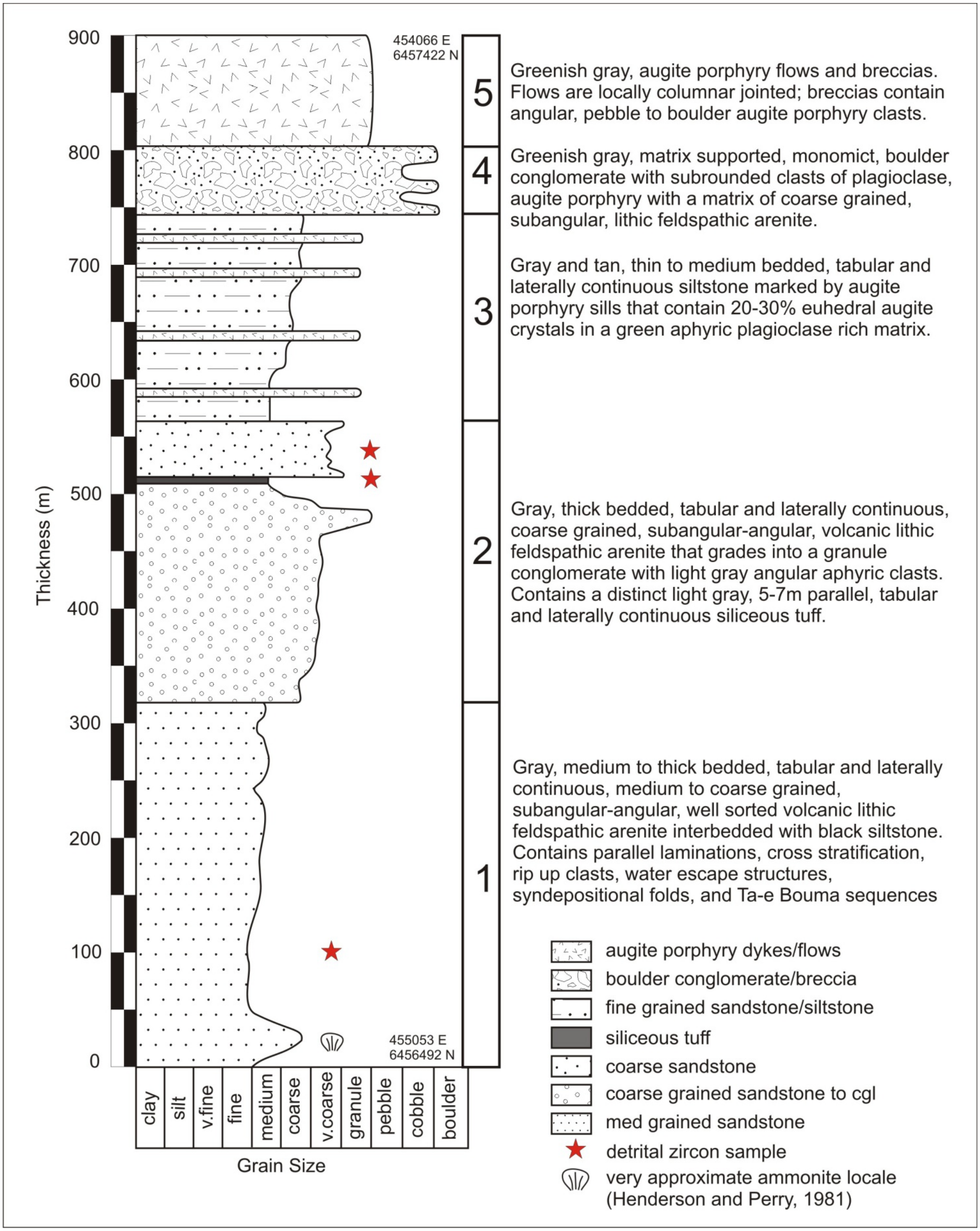

Figure 2. Schematic stratigraphic column for sedimentary and volcanic rocks overlying Cake Hill pluton measured east of Gnat Pass.

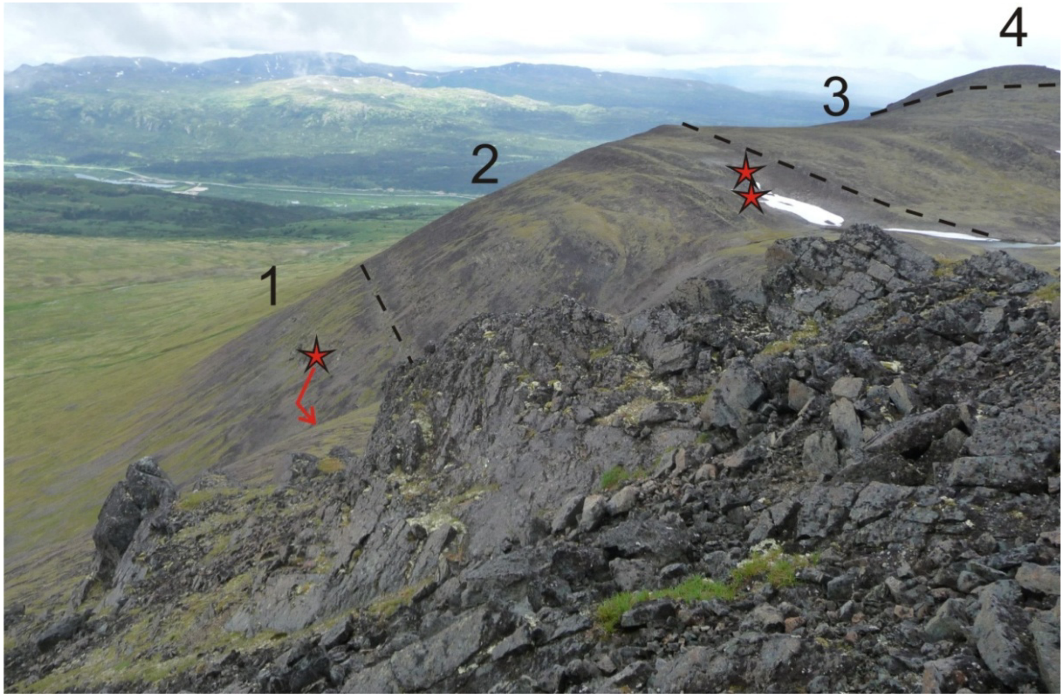

Figure 3. View looking west across the trace of the reference section north of Cake Hill pluton. Gnat Pass and Highway 37 are visible in the background. Down-faulted pyroxene porphyritic breccia of member 4 occupies foreground. Red stars show approximate location of detrital zircon sample sites.

Figure 4. Sedimentary characteristics of the measured section located north of Cake Hill pluton. (a) soft sediment deformation and basal scour features common in the thin-bedded intervals of Member 1. (b) thin to medium bedded, medium to coarse grained volcanic lithic arenite of Member 2, note distinct light grey siliceous tuff interbeds. (c) monomict volcanic (augite porphyry) boulder conglomerate of Member 4. (d) angular volcanic breccia within Member 5. Note reaction rims on volcanic clasts, indicating elevated temperatures during deposition.

Detrital Zircon Geochronology

Detrital zircon samples were collected from the section north of the Cake Hill pluton (n=3) and from the section on Thenatlodi Mountain (n=2). Relatively homogenous, medium to coarse grained volcanic lithic arenite was targeted, along with a quartz-bearing siliceous tuff located in the upper portion of the first reference section (member 3; ~520 m; Figure 2). Zircon was separated at the University of Wisconsin-Eau Claire and analyzed by LA-ICPMS at the LaserChron laboratory at the University of Arizona. Both samples from the Thenatlodi Mountain section were barren; however, all three samples from the section north of the Hotailuh fault yielded sufficient zircon for analysis.

The zircon populations from all three samples contained bimodal peaks; Middle to Late Triassic (*ca.* 220-230 Ma) and Early to Middle Jurassic (*ca.* 170-185 Ma; Figure 5). The presence of Early to Middle Jurassic detrital zircons within strata believed to be Triassic in age requires significant structural and stratigraphic revision of previous interpretations. These volcanic and sedimentary rocks are much younger than originally interpreted, and are correlative with the Early to Middle Jurassic Hazelton Group, not the Triassic Tsaybahe or Stuhini groups. This age assignment indicates that the Hotailuh thrust fault is not required because the entire section is an upright stratigraphic sequence of Early to Middle Jurassic strata unconformably overlying the Cake Hill pluton.

Stratigraphic similarities between these strata and those exposed on Thenatlodi Mountain suggest that the Hazelton Group is much more widespread than previously interpreted in the region.

Geochemistry

Whole rock geochemical analyses, including major, trace and select REE analyses, are in progress on volcanogenic rocks from the measured sections and

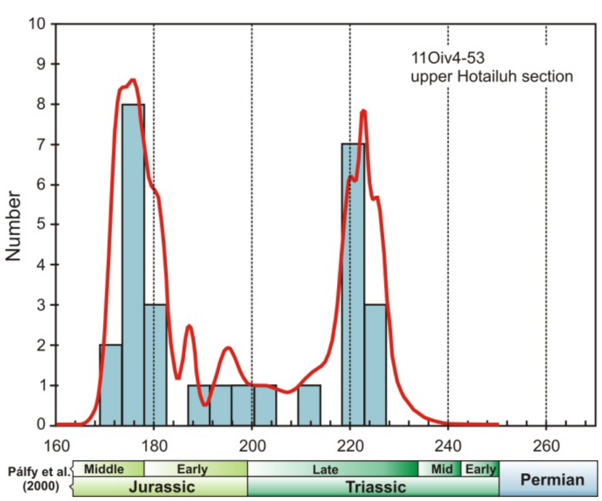

Figure 5. Detrital zircon populations for sample 11Oiv4-53 collected from quartz-bearing tuff of horizon 2 (see Figures 2 and 3).

collections made during the regional bedrock mapping program (Logan *et al.*, this volume). The primary objective is to compare and contrast the geochemical character of pyroxene porphyritic volcanic rocks in the region now recognized to include; Middle Jurassic Hazelton as well as Early-Middle and Late Triassic Tsaybahe and Stuhini groups respectively.

CONCLUSIONS

Detrital zircon populations from a sedimentary dominated volcaniclastic section east of Gnat Pass indicate the strata are much younger than previously realized. Here, Early to Middle Jurassic rocks nonconformably overly the Late Triassic Cake Hill pluton in a north dipping, upright, bedded section which eliminates the necessity for the Hotailuh fault.

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