Mineral Exploration Potential Beneath the Chilcotin Group (NTS 092O, P; 093A, B, C, F, G, J, K), South-Central British Columbia: Preliminary Insights from Volcanic Facies Analysis[1]

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KEYWORDS: Chilcotin, Cariboo, basalt, pillow basalt, volcanic lithofacies, lava, exploration potential, hyaloclastite, paleotopography

INTRODUCTION

Basalt of the Chilcotin Group (CG), situated in the Interior Plateau physiographic region of central British Columbia, covers an area of nearly 36 500 km^2. Its distribution is entirely within the region of BC that is most affected by mountain pine bark beetle (MPBB) infestation (Fig 1). The CG is immediately underlain by Paleozoic-Mesozoic basement rocks with high mineral potential (*e.g.*, Quesnel Trough) and Cretaceous-Eocene sedimentary rocks of the Nechako Basin with hydrocarbon potential. Previous workers (*e.g.*, Mathews, 1989) have suggested that the CG can reach thicknesses of approximately 200 m and average approximately 100 m. In addition, the CG is itself partially overlain by late Quaternary glacial deposits of variable (locally ≥200 m) and usually of unknown thickness (*e.g.*, Kerr and Levson, 1997).

The distribution of resources and prospects on the periphery of the CG (Fig 1) makes the potential for unexploited mineral resources extending beneath the CG and the Eocene volcanic cover compelling. However, there is currently little coherent information on the spatial distribution (*e.g.*, thicknesses), the lithostratigraphy (facies variations) and physical properties (density, porosity, magnetic susceptibility and conductivity) of the CG. The incompleteness of geoscience information for this unit is the single greatest impediment to successful exploration for resources beneath the CG, because the thickness of the cover (glacial sediments and basalt) is largely unknown, and the dearth of rock property data for the basalt limits interpretations of geophysical datasets. However, lithostratigraphy enables extrapolation of known geological relationships beneath areas of poor exposure, enabling greater understanding of the CG in a regional context.

This paper reports on results of volcanological field mapping of the lithofacies, thickness variations and basement windows within the CG. The project was funded by Geoscience BC as a 'proof of concept' research program. The goal is to produce 3-D facies and thickness models for the CG that can be used to 1) extrapolate regional geology, metallogeny and structure beneath the CG cover; 2) find more windows to the basement and identify the geophysical signature of that basement geology; 3) delineate areas where the CG is thin and exploration drilling for 'blind' metallic deposits could be feasible; and 4) provide a 3-D representation of physical property variations to allow the signature of the CG to be accurately stripped from total-field geophysical datasets.

Early results from preliminary field investigations in the summer of 2006 include establishing the thickness and lateral thickness variations of the CG and characterizing the variations in lithofacies encountered. The stratigraphy of the CG was examined at 20 locations on the Cariboo, Chilcotin and Fraser plateaus during June, July and August 2006, during which time stratigraphic logs were constructed and a detailed sample suite collected.

GEOLOGICAL SETTING

The Neogene Chilcotin Group (CG) of south-central BC covers an area of approximately 36 500 km^2 (Fig 1). The region is characterized by moderately dissected, valley-incised plateaus that consist mainly of basaltic successions varying in thickness from 5 to 200 m. Estimates of total volume are as high as 3500 km^3 (Bevier, 1983; Mathews, 1989), which would make the CG a medium-sized igneous province (Seth, *in press*). The CG ranges in age from 28 to 1 Ma and is broadly coeval with the voluminous Columbia River flood basalts of Oregon and Washington (*e.g.*, Hooper and Conrey, 1989). Characteristics they share include 1) flat to shallow dipping attitude, 2) massive to columnar jointed character, and 3) olivine-phyric basalt lavas with lesser volumes of pillow basalt and hyaloclastite. Rare intercalated felsic tephra has been collected from stratigraphic sections within the CG (*e.g.*, Bevier, 1983; Mathews, 1989).

ECONOMIC ISSUES

Stratigraphic units within Quesnellia host a high concentration of the most important metal reserves in BC, including the Afton, Gibraltar, Mount Polley and Highland Valley deposits, all of which occur adjacent to the margins of the CG (Fig 1). Exploration has traditionally focused on areas of basement exposed on the periphery of the CG because of the poorly constrained thickness and poorly known areal distribution of basalt lavas and glacial till.

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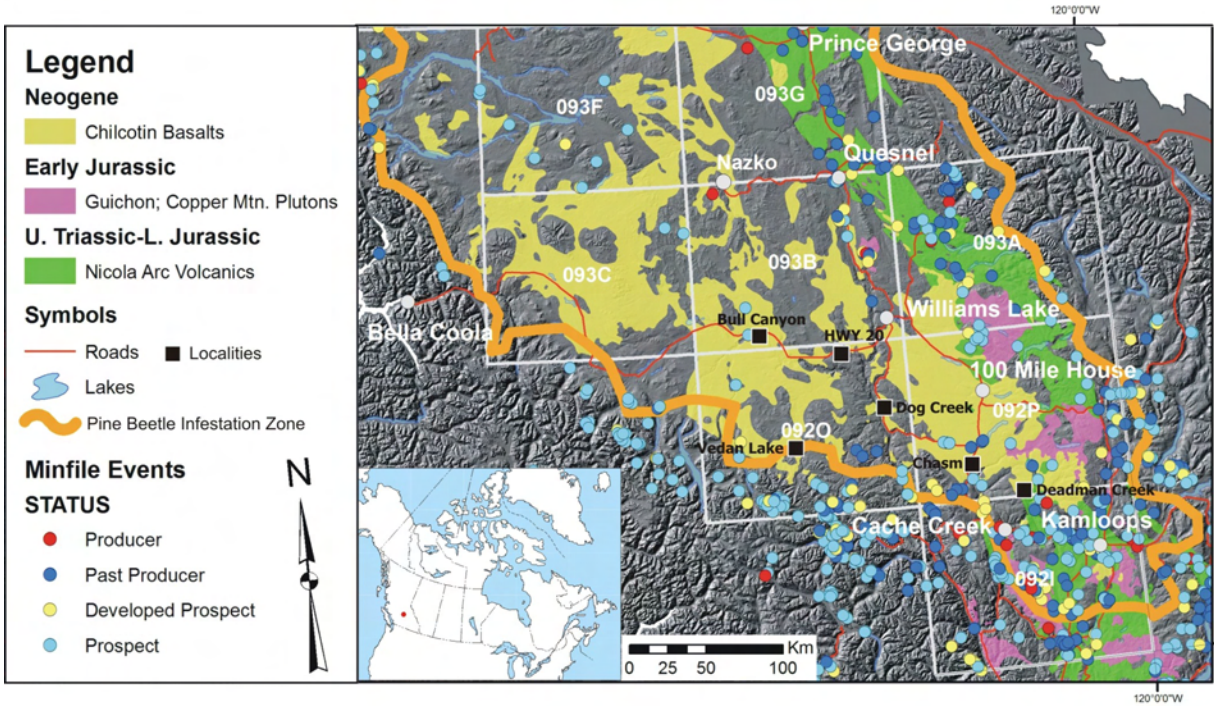

Figure 1. Shaded relief map of southern and central British Columbia, with important geological units highlighted (including the Chilcotin Group in yellow), the boundary of the mountain pine bark beetle infestation zone and the 1:250 000 NTS map sheet grid (NTS 092O, P; 093A, B, C, F, G, J, K). The economically important Nicola Group and intrusions hosted by it are shown. Key localities mentioned in the text are indicated by black squares.

However, it is highly probable that significant undiscovered mineral deposits are hosted by the basement rocks that underlie the CG, given the distribution of known ore deposits (Fig 1). Furthermore, the upper levels of hydrothermal-mineralization systems, where not eroded during the pre-Miocene (*e.g.*, Eocene unconformity), may have been protected from Holocene glaciation. Finally, burial of pre-CG drainages by basalt lavas offers the potential for discovery of new placer deposits (*e.g.*, Levson and Giles, 1995), especially given the proximity of the CG to the Cariboo goldfield.

The presence of the Chilcotin Group basalt cover makes exploration in this part of BC highly challenging, perhaps challenging enough to consider this a region of frontier exploration**.** However, rising global metal prices and constantly improving geophysical methods for mapping the subsurface ensure that the Chilcotin region remains within BC's exploration reserve. Furthermore, there is strong social interest in finding additional ore reserves (mines) in the MPBB area because of the near-future economic impact of the infestation. This environmental event is having, and will continue to have, a devastating effect on forestry-dependent communities in south-central BC (Fig 1). The MPBB infestation happens to be most intense in an area coincident with the distribution of the CG across the Cariboo, Chilcotin and Fraser plateaus. Stimulating renewed mineral exploration in the region is a short-term means of mitigating the economic impact of forestry decline; finding new ore reserves would provide longer term, sustained economic relief. Our contribution to this effort to renew mineral exploration in the region is to use mapping and modelling of the stratigraphy, volcanology and physical properties of the CG to remove the 'cover' and identify otherwise buried subsurface anomalies.

VOLCANIC STRATIGRAPHY OF THE CHILCOTIN GROUP

Fieldwork during 2006 was focused in the central portions of the CG, north of the Trans-Canada Highway, along Highways 20 and 97 (Fig 1). Previously documented and newly reported outcrop areas were examined across the study region (Farrell *et al.*, in press; Gordee *et al.*, 2007). This paper summarizes and explores the broader scale implications of these studies.

Chasm-Style Lithofacies

CHASM PROVINCIAL PARK (NTS 092P)

A 7 km long canyon at Chasm Provincial Park exposes a thickness of more than 130 m of gently dipping, olivine-phyric basalt lavas at the southern margin of the Cariboo Plateau. The volcanic stratigraphy at Chasm is described in detail in Farrell *et al.* (in press). A layer-cake sequence of 13 laterally continuous lava horizons (Fig 2A) overlies a sequence of hyaloclastite pillow breccia (>15 m thick), capped by fluvial and lacustrine sedimentary rocks of the Lower Miocene Deadman Formation (Read, 1989). The lower succession appears to be laterally restricted to a paleochannel developed in the underlying Eocene Kamloops Group volcaniclastic breccia. The Eocene deposits represent the fill to an even earlier paleochannel developed in a basement of Permo-Triassic limestone of the Cache Creek Terrane. The topmost (and presumably youngest preserved) lava is dated at 9.2 ±0.4 Ma (K-Ar; Mathews, 1989).

Chasm Provincial Park is the type section for a volcanic facies called 'Chasm type' (Farrell *et al.*, in press). The

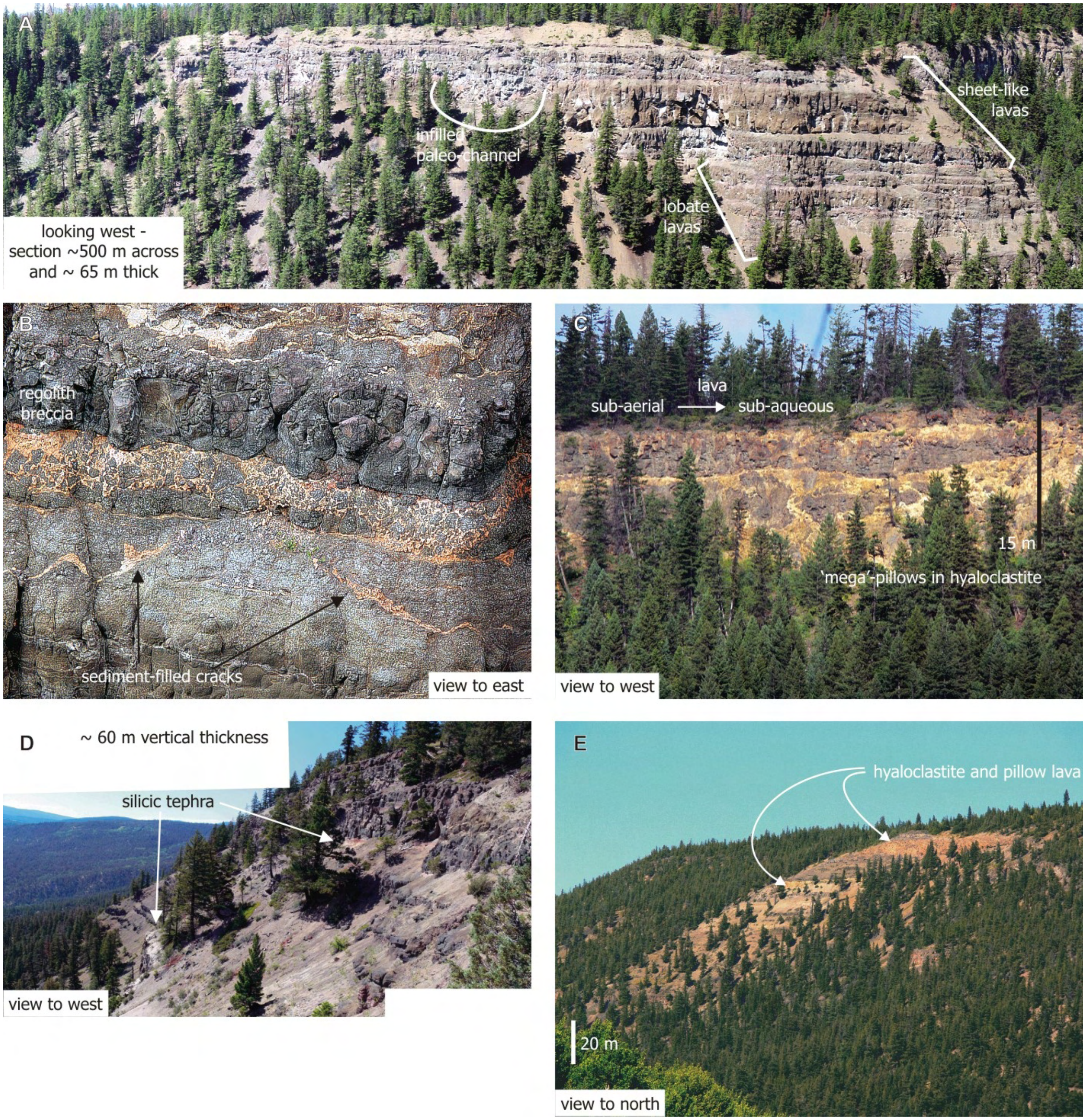

Figure 2: Chasm-style lithofacies: A) tiered subaerial lavas at Chasm separated by orange-red paleosols; the lower lavas are lobate in contrast to the laterally continuous, tabular lavas above; a prominent paleochannel is highlighted in the upper middle; B) close-up of the contact between two lavas depicting the red-black regolith breccia and infilled weathering cracks; C) lateral transition from coherent lava into hyaloclastite pillow breccia, Deadman Creek valley; D) intercalated felsic tephras with tiered lavas, Deadman Creek valley; E) tiered lavas and channel-confined hyaloclastite and pillow lavas, Vedan Lake.

Chasm-type lithofacies is characterized by relatively thick (≤15 m) massive basalt lavas (Fig 2A). Lavas at the base and top of the section tend to be laterally continuous (for >5 km), whereas those in the centre of the section are typically lensoid (<50 m across). All Chasm-type lavas are typically separated by baked red-brown paleosols and erosion surfaces with characteristic regolith breccia (Fig 2B). The regolith breccia consists of monolithic basalt breccia formed *in situ* during soil formation. The vertical cracks filled by paleosol material and sediment are formed by *in situ* fracturing and plant roots (Fig 2B). Each lava has a characteristic internal stratigraphy of a thin (≤1 m) basal vesicular zone, a thick (≤10 m), columnar-jointed, nonvesicular central zone and an upper vesicular, amygdaloidal zone. Thin basal pillow horizons are typical of lavas lower in the section.

Chasm-type lavas are typically larger in volume than those observed elsewhere in the CG; however, they are similar in thickness and internal zonation to those commonly observed in flood basalt provinces elsewhere (*e.g.*, Columbia River, Washington; Hooper and Conrey, 1989). We infer the presence of several paleosols and erosion surfaces between lavas to indicate there were significant repose periods (many thousands of years) between lava emplacements, when soil horizons and presumably vegetation and small rivers had time to become established. Therefore, the Chasm section may represent a considerable period of time from the deposition of basal hyaloclastite onwards; samples have been collected throughout the section for Ar/Ar dating of whole rock samples.

We have not encountered source vents for the lavas at Chasm, or elsewhere in the Chasm-style lithofacies; however, they are similar in age and composition to nearby gabbro plugs (Farquharson and Stipp, 1969), which may represent the eroded remains of small basaltic shield volcanoes from which the lavas were erupted.

DEADMAN CREEK VALLEY (NTS 092I, P)

Basalt lavas of the CG are exposed discontinuously for nearly 20 km along either side of Deadman Creek, at the southern margin of the Cariboo Plateau north of Kamloops Lake (Fig 1). Two successions were observed: 1) a widespread and thin (≤30 m thick) plateau-capping sequence of hyaloclastite and lava, and 2) a thick (~110 m) and spatially restricted sequence of multiple lavas separated by paleosols and intercalated tephra layers. The first succession (*ca.* 9.0 Ma, K-Ar; Mathews, 1989) is characterized by up to four moderately thick (≤10 m), laterally continuous, massive, columnar-jointed lavas overlying and interstratified with hyaloclastite pillow breccia (<30 m thick; Fig 2C). Lava and hyaloclastite are seen to lie unconformably on fluvial and lacustrine sediments of the Lower Miocene Deadman Formation (Read, 1989) and volcaniclastic breccia of the Triassic Nicola Group. The Deadman Formation is restricted to paleochannels developed within the Nicola Group (no Eocene rocks are present), and it appears that the lenses of hyaloclastite are also controlled by the paleotopography.

The second succession occurs near Cultus Lake Ranch (*ca.* 8.2 Ma; Bevier, 1983) and is characterized by at least eight moderate to thick, laterally continuous, strongly weathered basalt lavas outcropping in a prominent south-facing bluff (Fig 2D). This section contains three felsic tephras interstratified between paleosols and overlying lavas (Bevier, 1983). Although the lavas in the section do not show evidence of lateral boundaries, their base is approximately 50 m below the present top of the basement in the adjacent valley sides, suggesting that they infill a broad paleochannel parallel to the present Deadman Creek valley.

Although it is not fully understood how the two successions in the Deadman Creek valley relate temporally or spatially, they are both Chasm-style lithofacies associations, characterized by thick lavas with multiple breaks in the stratigraphy, and both appear to be distributed along contemporary drainage systems.

CHILKO AND TASEKO RIVER VALLEY AREAS (NTS 092O)

Chasm-style lavas are exposed along the sides of Vedan and Elkin lakes (~150 m thick), Chilko Canyon (~40 m thick, *ca.* 6.8 Ma; Mathews, 1989) and Cardiff Mountain (~70 m thick, *ca.* 6.6 Ma; Mathews, 1989), at the southern margin of the Chilcotin Plateau (Fig 1).

The sequence along Vedan and Elkin lakes comprises at least 11 poorly exposed, Chasm-style lavas (Fig 2E): vesicular and amygdaloidal bases and tops, massive columnar-jointed centres and well-developed paleosol horizons and regolith breccias (*e.g.*, Fig 2B). An erosional unconformity (paleochannel) cuts through at least 15 m of Chasm-style lavas and is infilled by 1) a fluvial conglomerate containing metasedimentary clasts, possibly sourced from the adjacent Chilcotin and Pacific ranges, that are composed of Mesozoic and Upper Paleozoic rocks of the Tyaughton-Methow Basin and the Cadwallader-Methow Terrane (Schiarizza *et al.*, 2002); 2) fluvially reworked hyaloclastite containing rounded metasedimentary cobbles; 3) hyaloclastite pillow breccia; and 4) dense pillow lava. This sequence is overlain by more Chasm-style lavas that are, in turn, incised by a hyaloclastite-filled paleochannel. The lavas appear to be distributed along a broad paleovalley incised into basement metasedimentary rocks, therefore suggesting the re-establishment of fluvial drainage throughout the emplacement of the lavas, as evidenced by the fluvial conglomerate and reworked hyaloclastite.

Cardiff Mountain comprises at least three horizontal Chasm-style lavas overlying a basement of Mesozoic metasedimentary rocks and capped by a prominent 40 m high bluff, composed of a distinctive and different lava lithofacies. The uppermost lava preserves a superb example of entablature and colonnade jointing, and is nonvesicular throughout. Approximately six very strongly weathered, horizontal Chasm-style lavas are exposed along 500 m of Chilko Canyon; however, we do not yet understand its stratigraphic position or its relationship to paleotopography.

Bull Canyon–Style Lithofacies

CHILCOTIN RIVER VALLEY (NTS 092O; 093B)

Thick sequences of CG basalt (<80 m) outcrop along the Chilcotin River valley and Highway 20 (Fig 1). These stratigraphic sections are volumetrically dominated by hyaloclastite, pillow lava and breccia, and minor peperite. These deposits are overlain by lesser thicknesses of flat-lying lavas identical to those of the Chasm-style lithofacies (*e.g.*, Fig 3A). The Bull Canyon–style lithofacies is best exposed at Bull Canyon Provincial Park (Fig 1) and is fully described and interpreted by Gordee *et al.* (2007). The section exposed at this locality is characterized by intercalated vesicular lava, hyaloclastite, pillow lava, pillow breccia, and fluvial and/or lacustrine sedimentary rocks with peperite (Fig 3B, C). The subaqueous sequences are spatially confined to a paleochannel subparallel to the present-day Chilcotin River. As recognized by Gordee *et al.* (2007), the Bull Canyon–style lithofacies represents dominantly subaqueous depositional conditions. We suggest that the subaqueous succession results from the advance of subaerial lavas into water, where deltas of hyaloclastite are built outwards into deeper water at the front of an advancing lava. The drainage system re-established itself many times following disruption (including possible damming) by lava emplacement, as evidenced by the repeated sequences of hyaloclastite overlain by lava exposed in cliffs

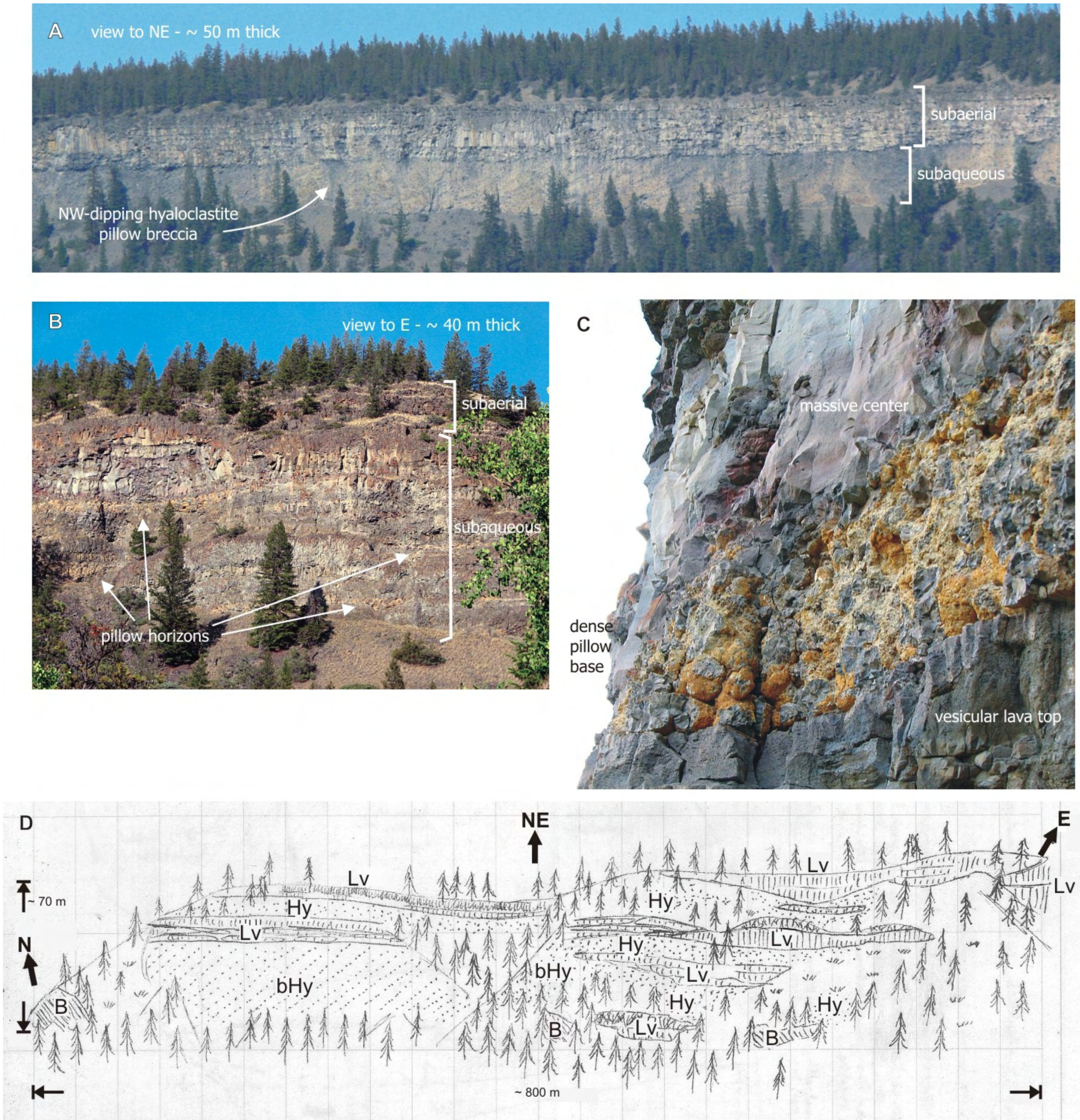

Figure 3: Bull Canyon–style lithofacies: A) subaerial lavas overlying foreset beds of hyaloclastite and hyaloclastite pillow breccia, near Hanceville; B) interstratified subaqueous lavas, pillow breccia and hyaloclastite, overlain by subaerial lavas, Bull Canyon; C) close-up of the densely packed pillow lava at the base of a lava, Bull Canyon; D) field sketch depicting the recurrence of significant depths of water during emplacement of at least four lavas, Anahim Flats Indian Reserve. Abbreviations: B, basement; Hy, hyaloclastite; bHy, bedded hyaloclastite; Lv, lava.

along Highway 20 (*e.g.*, Anahim Flats Indian Reserve, Fig 3D).

Dog Creek–Style Lithofacies

FRASER RIVER (NTS 092O)

Exposures of subaerial CG basalt along the Fraser River Canyon display a distinctive lithofacies: the Dog Creek–style lithofacies, named after the valley where it is best exposed (Farrell *et al.*, in press). These subaerial lava sequences are spatially restricted to valleys (Alkali Creek, Canoe Creek, Dog Creek and Harper Creek; Fig 1) along the margins of the present-day Fraser River valley. They appear to be considerably younger (<3 Ma; Mathews, 1989) than the lavas forming the Chasm-style lithofacies found in the surrounding area (*e.g.*, Chasm Provincial Park). The lavas are laterally confined to long-lived paleodrainages (parallel to present-day valleys) cut into limestone of the Cache Creek Terrane.

All occurrences of Dog Creek–style lithofacies show evidence of contemporaneous rivers (a glacier and a glacier-fed stream; Mathews and Rouse, 1986) in the form of associated hyaloclastite deposits and sedimentary rocks. Excellent exposures along Dog Creek (>90 m thick) display two distinctive types of lava (Fig 4A): 1) thick (≤10 m) nonvesicular lavas exhibiting colonnade and entablature jointing and in narrow channels (Fig 4B); and 2) more voluminous, thin (≤3 m), lenticular, highly vesicular (highly inflated) lavas (Fig 4C). The thin lavas form laterally extensive, composite sheets of up to 50 stacked lavas without distinct intervening paleosols. The only breaks in lava emplacement recorded are short-lived channels filled by hyaloclastite and 'thick' lavas, and a glacial-sedimentary succession at the top of the section (Mathews and Rouse, 1986). The absence of paleosol horizons suggests sustained and rapid lava emplacement without significant repose periods. Furthermore, the presence of a volcanic bomb between two lavas (Fig 4D) and possible welded spatter (Farrell *et al.*, in press) suggest that the 'thin' lavas are proximal to their source.

DISCUSSION

Diverse Lava Morphologies and Types

Three lithofacies end-members, identified in early mapping at Chasm, Dog Creek and Bull Canyon, occur spatially and temporally throughout the CG. Characteristic features of the three lithofacies end-members are summarized/synthesized in Table 1 and Figure 5.

Chasm-style lavas exhibit many characteristics (Table 1) observed in flood basalt provinces elsewhere (*e.g.*, the Columbia River Province in Washington State and the Deccan Traps in India). They all exhibit thick (>5 m), subaerial and laterally extensive, large-volume tabular lavas (tens to hundreds of square kilometres). Each lava typically exhibits an internal stratification defined by zones of high and low vesicularity, significant columnar jointing and well-developed contacts between lavas (Fig 5). Therefore, such lavas are inferred to represent periodic (thousands to hundreds of thousands of years) emplacements of large magma volumes, at low mean effusion rates.

Large-volume (>1 km^3) lava emplacement events are rare in recorded history (*e.g.*, Laki, 1783–1785), and theories for their emplacement have been controversial. Recent work, however, has started to provide some understanding of how large-volume lava fields are formed. Observations on the emplacement of small-volume Hawaiian pahoehoe lavas documented the pulsating inflation and deflation of the lava beneath a solid and insulating upper carapace. This has led to development of the SWELL hypothesis (<u>s</u>tandard <u>w</u>ay of <u>e</u>mplacing <u>l</u>arge <u>l</u>avas; *e.g.*, Self *et al.*, 1998). By analogy with small inflated lavas, it is thought that large-volume lavas (*e.g.*, Chasm-style lavas) are produced by the gradual inflation of initially thin vesicular lava (<1 m thick) by through-flow of degassed (nonvesicular) magma that causes the characteristic vesicular zonation observed (vesicular upper and lower margins, and a columnar-jointed, nonvesicular interior). We infer Chasm-style lavas to have formed by this process.

The Bull Canyon–style lithofacies (Gordee *et al.*, 2007) is inferred to represent the subaqueous equivalent of the Chasm-style lithofacies. It is suggested that large volumes of lava were emplaced into active drainage systems (*e.g.*, rivers and lakes), intermittently filling them and finally burying them, and grading into subaerial lavas identical to those in the Chasm-style lithofacies (Fig 5). The diversity of subaqueous volcaniclastic deposits and lavas is attributed to interplay between rates of lava emplacement and the fluvial flux. For example, low lava fluxes, relative to the fluvial system, will produce hyaloclastite that is easily washed downstream. In contrast, where the lava effusion rates are equal to or exceed the fluvial flux, pillow lava and hyaloclastite will rapidly grade into massive lava that infills and buries the drainage system.

The Dog Creek–style lithofacies is inferred to be a different expression of subaerial basalt effusion, distinct from the widespread Chasm-style (Fig 5). Specifically, it is suggested that the succession at Dog Creek, and therefore that lithofacies, is proximal to the volcanic vent (*i.e.*, source). This interpretation is based on the presence of volcanic bombs and possible welded spatter textures. However, a vent has not been identified. The Dog Creek–style lithofacies was highly channellized in narrow paleovalleys that contained a long-lived river (*e.g.*, hyaloclastite and pillow lavas; Fig 5), which was fed by a glacier for some period of time (*e.g.*, proglacial sediments and till). It is inferred that the channel was intermittently filled and redirected by lavas; such lavas became overthickened and exhibit the entablature jointing thought to be characteristic of cooling lavas that have water flowing over their tops (*e.g.*, Long and Wood, 1986). The volumetrically dominant lavas are thin, highly vesicular (inflated) and do not exhibit well-developed contacts, suggesting that they were formed rapidly (high flux rate) and close to source (Table 1). These lavas are envisaged as being pahoehoe lavas, which typically form as rapidly growing 'fields' on the flanks of volcanoes.

Pre–Chilcotin Group Paleotopography

One of the main insights to result from the field program is that the pre–Chilcotin Group paleotopography is of critical importance to the distribution, style and thickness of the CG basalt cover. Without exception, the locations examined demonstrate the importance of paleodrainages in controlling the three-dimensional architecture of the CG. The field study shows that

- all sections of thickness greater than approximately 50 m are topographically restricted to (*e.g.*, Bull Canyon–style), or significantly thicker in (*e.g.*, Chasm-style), proven or inferred paleochannels;

TABLE 1. SUMMARY CHARACTERISTICS OF LITHOFACIES STYLES IN THE CHILCOTIN GROUP.

Parameter	Chasm-style	Bull Canyon- style	Dog Creek- style
Paleoenvironment	subaerial	subaqueous	subaerial
Areal distribution	plateau	valley-confined	valley-confined
Flow-unit thickness	5- 10 m	<5 m	1 m
Flow-unit volume	large	small	small
Vesicularity	low	variable	very high
Eruption history	periodic	continuous	continuous
Eruption rate (integrated)	low	high to low	very high
Vent facies (proximal/distal)	?	?	proximal

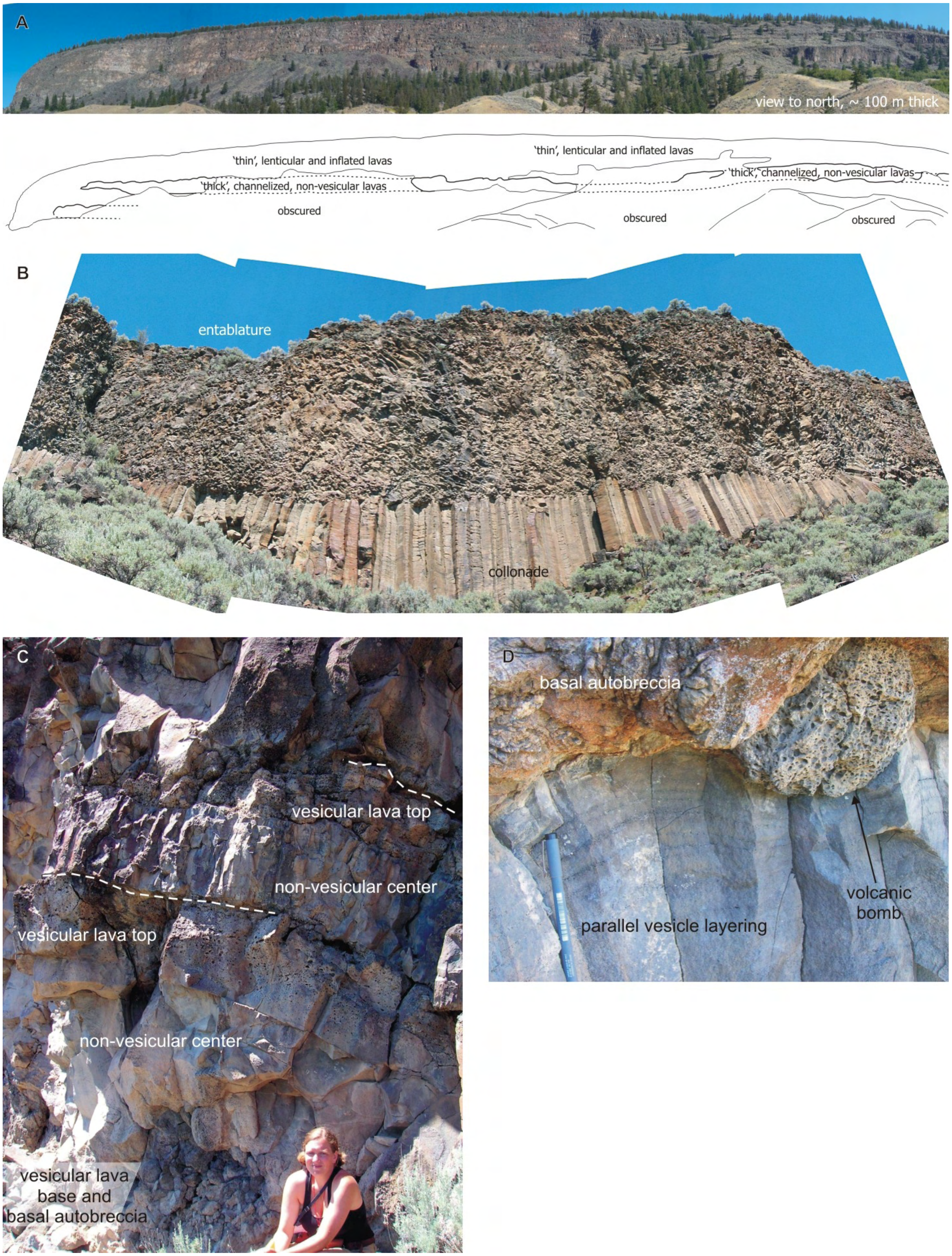

Figure 4: Dog Creek–style lithofacies: A) panorama and simplified internal stratigraphy in cliffs at Dog Creek that display two styles of lava (thin, lenticular and highly vesicular lavas and 30 m thick, channellized, nonvesicular lavas with characteristic colonnade and entablature jointing); B) colonnade and entablature jointing; C) internal layering typical of thin inflated pahoehoe lavas, defined by vesicular bases and upper surfaces, and massive centres; sitting person is 80 cm high; D) lava bomb on the upper surface of lavas indicates that they are proximal to a vent; pen is 15 cm long.

- most sections contain some of hyaloclastite, pillow lava or fluvial to lacustrine sedimentary deposits, indicative of interactions between lava emplacement and fluvial drainages (*e.g.*, Dog Creek, Vedan lake); and
- clearly demonstrable paleochannels coincide with many present-day drainages (*e.g.*, Dog Creek).

It is not surprising that many drainages appear to have re-established themselves and cut through the CG lavas, given the generally thin nature of the lavas (typically <100 m) compared to the relief of the present-day catchment areas (*e.g.*, posteruption surfaces have ~500 m relief). Understanding the importance of topography for the distribution and nature of the CG has the potential to greatly improve our models for the architecture of this volcanic province and our ability to predict the thickness of basalt cover. The literature shows some of the thickest recorded sections of CG to be between 100 and 200 m (*e.g.*, Bevier, 1983; Dostal *et al.*, 1996). This may have led to a paradigm that the CG forms a homogeneous tabular sheet that is everywhere greater than 100 m thick (Fig 6, scenario 1), even though Mathews (1989) demonstrated some sections to be within paleolows. If this paradigm is true, then the Chilcotin region must be considered as a frontier exploration region because of the technical challenges in identifying and testing targets in the deep (>100 m) subsurface.

However, our preliminary results suggest that the thickness of CG basalt is highly variable and that thickness variations are mainly a response to paleotopography. The implication is that the CG is, in fact, far from tabular in three dimensions. It is much more probable that the CG basalt distributions are irregular in extent and thickness (Fig 6, scenarios 2 and 3). Furthermore, the common coincidence of present-day drainage systems with pre and syn-CG drainages suggests that, where paleodrainages existed, there are now descendent drainages. One implication of this is that the areas between the present-day exposures of CG basalt are 'paleoplateaus' that feature relatively thin (0–30 m) basalt covers (Fig 6).

These suggestions are still speculative and are the focus of next year's fieldwork.

SIGNIFICANCE FOR FUTURE MINERAL EXPLORATION

In light of our initial results, the exploration potential of the Chilcotin, Cariboo and Fraser plateaus should be re-evaluated. Previous evaluations assumed a more or less uniform and thick basalt cover that buried economically important rock types (Fig 6, scenario 1). The high-risk costs of blind-drilling through thick basalt and the subjectiveness of interpreting basalt-covered basement geology on the basis of geophysical datasets have ensured that the exploration potential of the CG has been ranked low.

However, our results may lead to an upgrading of the exploration potential by 1) improving knowledge of the three-dimensional distribution of the CG and 2) providing a georeferenced sample suite for physical property measurements. The former, which is the subject of this paper, suggests that the three-dimensional distribution is very irregular and strongly influenced by paleotopography (Fig 6, scenarios 2 and 3). This allows for potential mineral deposits to be closer to the surface beneath a thinner basalt cover, and therefore easier and cheaper to investigate. Subsequent fieldwork may identify basement windows where basalt is totally absent. Our model for the architecture of the CG is to be supplemented by a comprehensive and georeferenced sample suite for which physical properties (magnetic susceptibility, density, porosity, electrical conductivity, etc.) are being measured. These results are intended to help constrain models derived from geophysical datasets.

We are optimistic that our results and future research will improve exploration potential beneath the CG and encourage other academic, government and industrial researchers to investigate the CG, ultimately with the goal of developing economic mineral deposits and increasing our knowledge of volcanism in BC.

CONCLUSIONS

Preliminary field investigations in the Cariboo-Chilcotin region of south-central British Columbia are revealing a diverse range of lithofacies types within the Neogene Chilcotin Group basalt. Stratigraphic sections throughout the region exhibit lithofacies architectures (*e.g.*, thickness variations, lithofacies associations) consistent with lava emplacement into, and the burial of, mature paleochannels

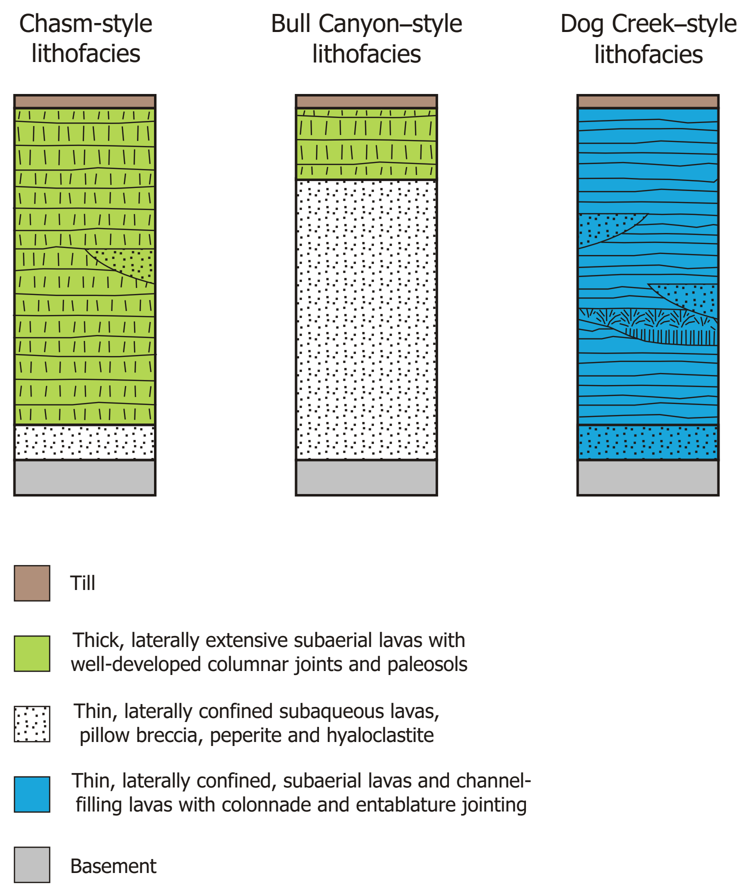

Figure 5: Schematic stratigraphic logs depicting the facies components (and their relative proportions) of the Chasm-style, Bull Canyon–style and Dog Creek–style lithofacies.

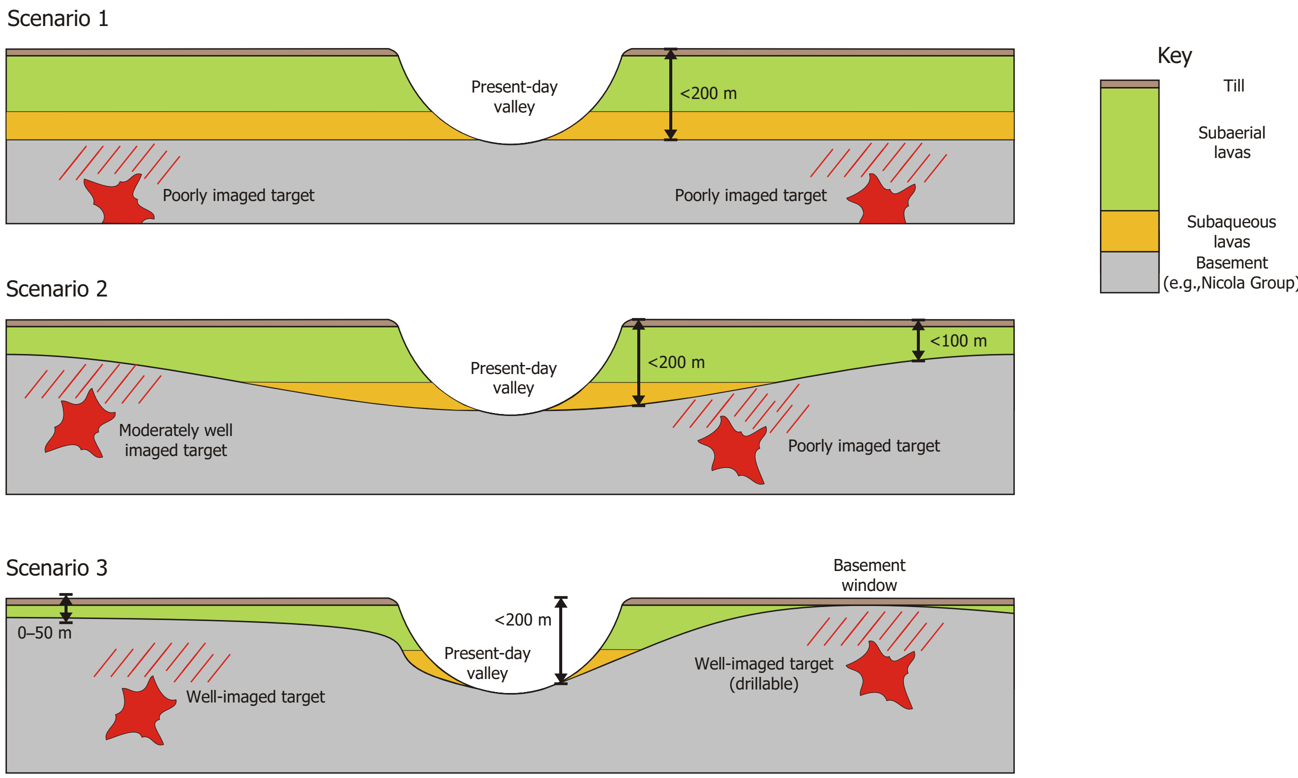

Figure 6: Schematic summary profiles through the Chilcotin Group, emphasizing the control of volcanic architecture on economic resource potential in the Nicola Group. Scenario 1: uniformly thick CG (low paleorelief), resulting in poor exploration potential due to deeply buried metallogenic bodies and attenuated geophysical signals. Scenario 2: broad paleovalleys infilled by CG (moderate paleorelief), resulting in poor to moderate exploration potential due to relatively thin CG cover over some mineral deposits. Scenario 3: narrow paleovalleys (high paleorelief), resulting in moderate to good exploration potential where some mineral deposits are very close to the surface beneath minimal or zero basalt cover, and are more clearly identified in geophysical surveys, soil geochemistry and economic test drilling. It is proposed that the distribution of the Chilcotin Group is a combination of scenarios 2 and 3, offering significantly better exploration prospects than previously thought. This is a simplified conceptual diagram that does not represent the possible presence of Eocene volcanic rocks (*e.g.*, Kamloops Group) or Mesozoic sedimentary rocks (*e.g.*, the Bowser Basin) that may occur between the CG and the basement.

with sustained rivers and bodies of standing water. Sections are typically dominated by locally thick subaqueous facies (*e.g.*, pillow basalt, hyaloclastite, peperite), overlain by relatively thin subaerial plateau lavas. Differences in volcanic style and lithofacies architecture within the Chilcotin Group indicate that there is no single and unique type section that can be inferred as being representative of the entire group, and that previous regional-scale interpretations and conclusions must therefore be re-examined.

The following is a summary of results and conclusions:

- The Chilcotin Group is an irregularly distributed cover of basalt lavas and associated volcaniclastic deposits.
- The thickest sections (>50 m) are confined to paleodrainages; elsewhere, the CG is inferred to be relatively thin (<50 m).
- Three lithofacies end-members were identified; a proximal subaerial facies (Dog Creek–style), an areally extensive subaerial facies (Chasm-style) and its subaqueous equivalent (Bull Canyon–style).
- The Dog Creek and Bull Canyon–style lithofacies are confined to paleodrainages.
- The exploration potential of the CG is improved by recognition of its irregular three-dimensional shape, allowing for thinner basalt cover over a wider area than previously thought.

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