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Current activities of the joint Geological Survey of Canada-Sts'ailes Harrison Lake Project (British Columbia), a flagship project of the GSC's Indigenous Relations Network

*J.W. Haggart, M. Golding, M. Ritchie, R. McMillan, Z. Boileau Morrison,
D. Gibson, J.J. Ryan, G. Williams-Jones, J. Ritchie, M. Côté, R. Bartlett,
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**Geological Survey of Canada
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Critical review

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Current activities of the joint Geological Survey of Canada-Sts'ailes Harrison Lake Project (British Columbia), a flagship project of the GSC's Indigenous Relations Network

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Abstract: Sts'ailes have expressed a strong interest in how local geology influences the distribution of stone tools recovered from archeological sites within and beyond their territorial lands in the watershed of Harrison Lake and the lower Lillooet River in southern British Columbia. In particular, the First Nation community of Sts'ailes has sought to learn more about the formation and geographic distribution of volcanogenic strata which were the likely sources of toolstone used to produce these artifacts. The Geological Survey of Canada is also interested in studying the volcanic and sedimentary succession preserved at Harrison Lake, as well as its deformation history, as it is a key to understanding the Mesozoic geological history of the southern Cordillera. Sts'ailes and the Geological Survey of Canada thus initiated a joint research project to address these lines of inquiry.

Integrated research investigations in 2023 entailed field studies of outcropping Mesozoic sedimentary and volcanic strata to evaluate the overall extent of the succession, as well as fault structures along Harrison Lake. Personnel from Sts'ailes, Geological Survey of Canada, and Simon Fraser University (Department of Earth Sciences) participated in the field program, allowing open exchange of knowledge. Sample collections were made to improve understanding of the composition and textures of the investigated rock units, as well as the litho- and biostratigraphic framework of the sedimentary rocks. Sample types include lithological, paleontological, geochronological, and detrital zircon samples. Planned outputs include maps of the region summarizing local geology, highlighting toolstone occurrences, and incorporating Sts'ailes traditional knowledge.

Résumé : Le peuple Sts'ailes a manifesté un vif intérêt à savoir comment la géologie locale influence la distribution des outils en pierre récupérés dans les sites archéologiques tant sur leurs terres territoriales qu'au-delà, dans le bassin versant du lac Harrison et le cours inférieur de la rivière Lillooet, dans le sud de la Colombie-Britannique. En particulier, la communauté de Première Nation de Sts'ailes souhaitait en apprendre davantage sur la formation et la distribution géographique des strates volcanogènes qui étaient la source probable de la pierre à outils utilisée pour produire ces artefacts. La Commission géologique du Canada souhaite également étudier la succession volcanique et sédimentaire conservée au lac Harrison, ainsi que son historique de déformation, car il s'agit d'éléments clés pour comprendre l'histoire géologique de la Cordillère méridionale au Mésozoïque. Le peuple Sts'ailes et la Commission géologique du Canada ont donc lancé un projet de recherche conjoint pour répondre à ces questions.

Les recherches intégrées menées en 2023 ont consisté en des études sur le terrain des strates sédimentaires et volcaniques affleurantes du Mésozoïque pour évaluer l'étendue globale de la succession, ainsi que les structures de faille le long du lac Harrison. Des membres du personnel des Sts'ailes, de la Commission géologique du Canada et de l'Université Simon Fraser (Département des sciences de la Terre) ont participé à ce programme sur le terrain, au cours duquel un échange ouvert de connaissances a pris place. Des prélèvements d'échantillons ont été effectués pour améliorer la compréhension de la composition et des textures des unités lithologiques étudiées, ainsi que du cadre lithostratigraphique et biostratigraphique des roches sédimentaires. Les types d'échantillons consistaient en des échantillons lithologiques, paléontologiques, géochronologiques ainsi que de zircons détritiques. Les produits prévus de ces activités sont des cartes de la région résumant la géologie locale, mettant en évidence les occurrences de pierre à outils, et intégrant les connaissances traditionnelles des Sts'ailes.

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INTRODUCTION

Objectives of the Indigenous Relations Network

The Geological Survey of Canada's Indigenous Relations Network (IRN) was formed in 2020 as an internal resource within the GSC that encourages, supports, and promotes respectful, collaborative, and mutually beneficial geoscience relationships with Indigenous communities and organizations across Canada. The GSC is committed to bring together, in an integrated and co-operative manner, the scientific and cultural needs and goals of Indigenous communities and organizations, as well as the scientific objectives of the GSC.

When the Sts'ailes community in British Columbia approached the GSC with questions regarding the geological provenance of toolstone from their territory, the IRN was excited to join with the community in a new, indigenous-partnered, collaborative pilot project. The project responds directly to the shifting landscape of federal government geoscience research and is an example of inclusive and meaningful research practices and relationships with Indigenous communities.

Sts'ailes

Sts'ailes [Stuh-hay-lis] people have lived in the Harrison River watershed (Fig. 1) since glaciers retreated at the end of the last ice age, more than 10 000 years ago, and are inextricably connected with its lands and waters. Occupying their homeland throughout the Holocene, the Sts'ailes have witnessed and experienced many transformations in their surroundings, some attributed to natural physical processes and others to supernatural forces. Supernatural transformations include humans being transformed into stone for not living properly — forever afterwards serving as a warning and reminder to generations of Sts'ailes. In addition to having stories with moral teachings attached to them, these places are often named and marked with pictographs, reinforcing their cultural and historical significance. What has only become known more recently is that these important stone outcrops throughout Sts'ailes territory are also where ancestors obtained raw materials for their tools. Sts'ailes' interest in the geology of their territory is therefore connected to their history, culture, teachings, and identity.

The Sts'ailes are a Halkomelem-speaking Coast Salish people, closely related to surrounding Indigenous groups, with whom they have intermarried and traded for millennia. The waterways within their homeland on the southern flank of the Coast Mountains were crucial for long-distance travel and commerce. Abundant resources — and massive salmon runs in particular — made Sts'ailes territory a desirable place to live year-round. Although not commonly recognized today, the geology of Sts'ailes' homeland also provided people with access to a wide array of toolstone materials that

could be used and traded (Ritchie et al., 2022; McMillan et al., 2022). The bedrock geology of Sts'ailes territory is therefore of significant cultural and scientific interest.

Geology of the Harrison Lake region

Bedrock throughout the Sts'ailes territory exposes one of the most intact and well preserved stratigraphic sequences of the southern Canadian Cordillera (Arthur et al., 1993; Mahoney et al., 1995). Mesozoic sedimentary rocks preserved in the Harrison Lake region (Figs. 2, 3) record a depositional history from Late Triassic through Early Cretaceous time and reflect a variety of sedimentary environments. The Harrison Lake Formation of the Harrison terrane is also the most extensive Early to Middle Jurassic arc sequence preserved in the Coast Belt in the southern Canadian Cordillera (Mahoney et al., 1995, Figure 1c) and has been recognized as a likely source of toolstone artifacts of the Sts'ailes peoples (Fig. 4; McMillan et al., 2022; Ritchie et al., 2022). Additionally, the sedimentary rocks of the region contain locally common fossil assemblages which have been studied in order to develop a biostratigraphic framework for this interval of time in the southern Canadian Cordillera.

This contribution summarizes the 2023 activities undertaken by the Geological Survey of Canada (GSC), Pacific Division, in conjunction with the Sts'ailes of Agassiz, British Columbia, as a project under the GSC's Indigenous Relations Network (IRN). We also provide a succinct summary of scientific and other accomplishments, future plans, and some discussions of issues that arose during the course of project activities.

PROJECT TIMELINE

Informal discussions between GSC geologists and Sts'ailes took place over several years during the late 2010s to early 2020s and identified areas of common research interest, but funding opportunities were unavailable at the time. In 2020, the GSC established the Indigenous Relations Network (IRN) program to improve engagement and communication with Indigenous communities in the hope of enhancing geological research-project outcomes. Recognizing the opportunity, GSC geologists and representatives of Sts'ailes formulated a project proposal for IRN consideration in 2021.

Conceptual support of the proposed joint Geological Survey of Canada-Sts'ailes Harrison Lake Project was approved by IRN in mid-2021, with an associated exploratory field trip of GSC and Sts'ailes participants undertaken in September 2021. The field trip provided the first opportunity for the extended GSC team to meet and interact with members of the Sts'ailes community. The project was formally approved by the IRN in 2022 and detailed project planning between Sts'ailes representatives and GSC

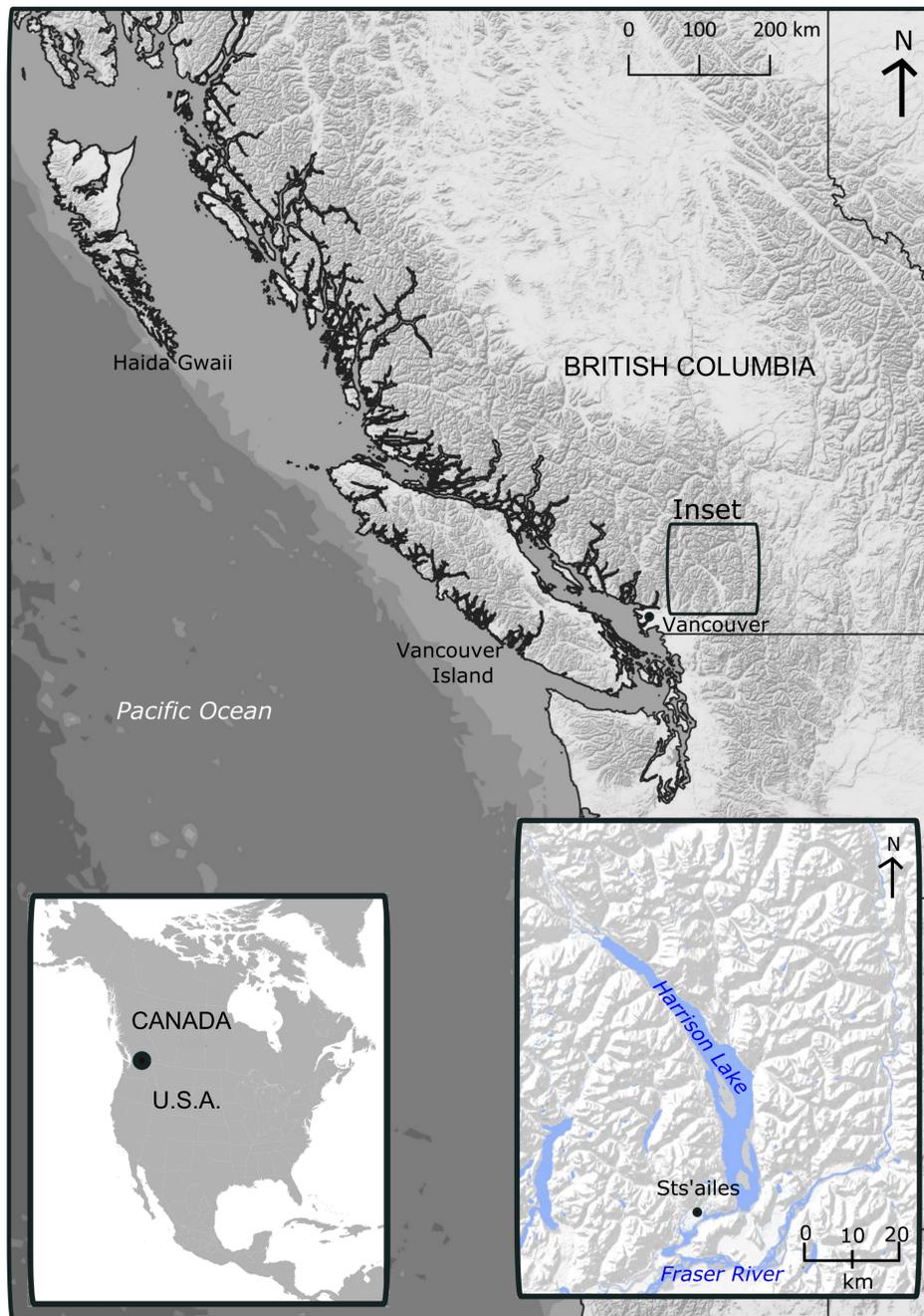


Figure 1. Location map of Harrison Lake region.

geologists took place during the following winter. The project planning was expanded to include the participation of Simon Fraser University (SFU) Department of Earth Sciences. Multiple meetings of the participating project members were held by Teams/Zoom during the winter and spring of 2023 to establish a plan of potential project activities and an integrated funding program from the various participating agencies (GSC, SFU, and Social Sciences and Humanities Research Council (SSHRC) through University of British Columbia and Vancouver Island University). The latter part of the spring of 2023 was spent planning for the

summer field program, and necessary training in support of fieldwork activities (i.e. first aid and firearms) was undertaken at this time. Appropriate Lab Study Agreements were also established through the GSC's Science Lab Network and necessary field equipment purchased. The first of several planned field seasons was initiated in summer 2023.

As conceived, the expected end date for the project was end of fiscal year 2024–25, with follow-up publications and other contributions expected in the subsequent several years.

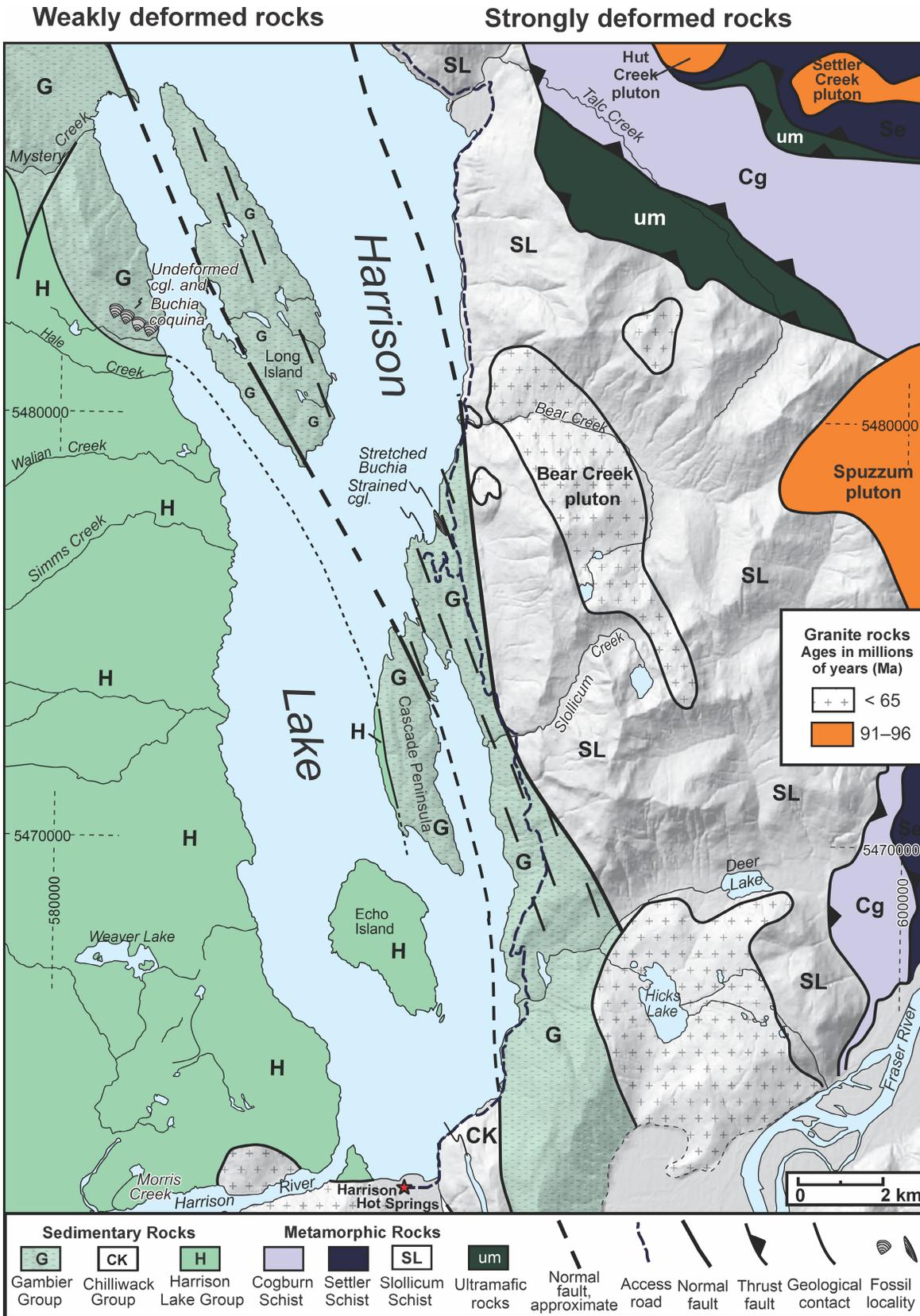


Figure 2. Simplified geologic map of Harrison Lake region (after Gibson and Monger, 2018), showing locations discussed in text, cgl = conglomerate.

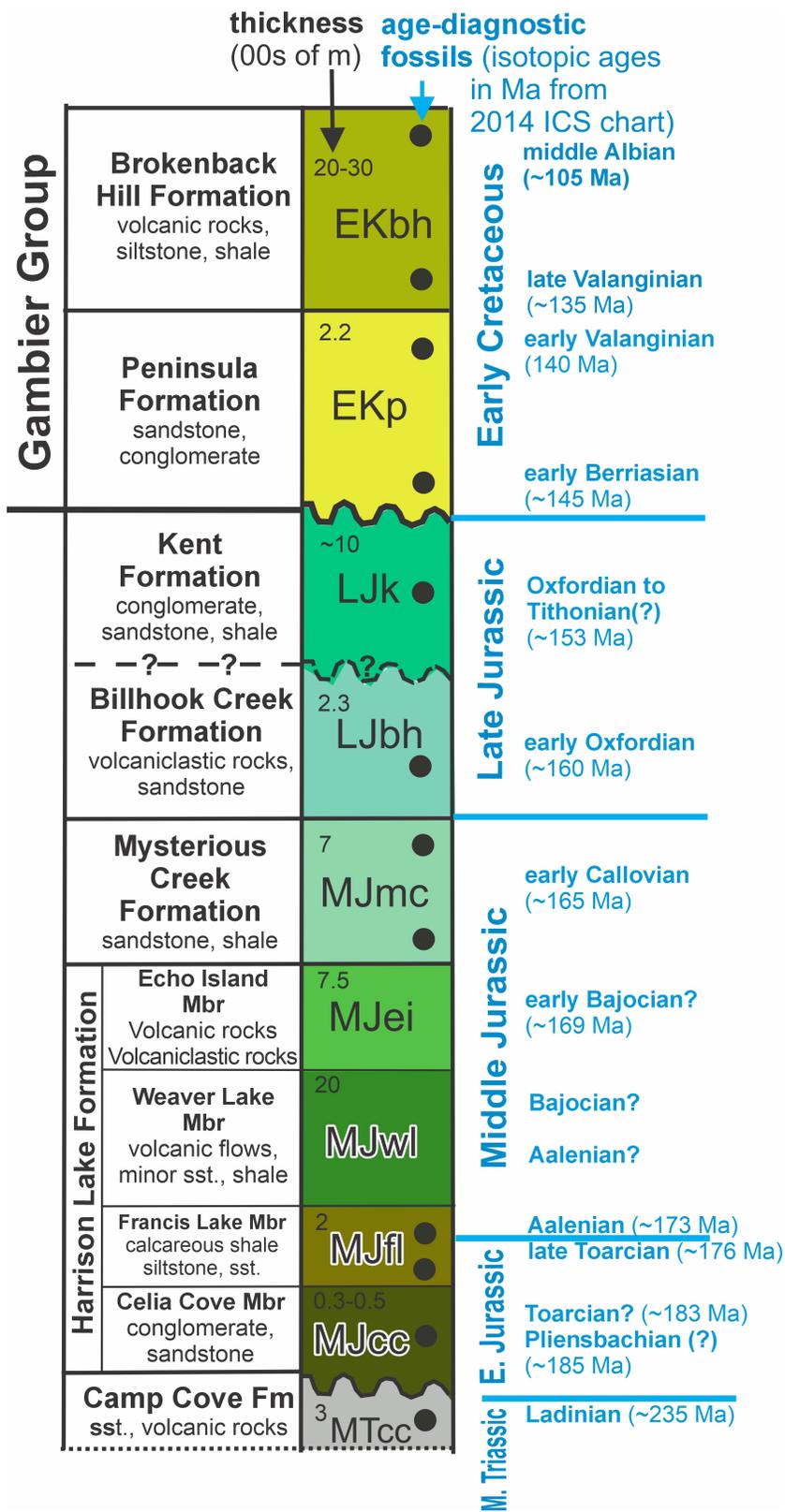


Figure 3. Simplified stratigraphic column of sedimentary and volcanic rocks exposed along the west side of Harrison Lake (*modified after* Gibson and Monger, 2018, Figure 17). Fm = Formation; Mbr = Member; sst. = sandstone.

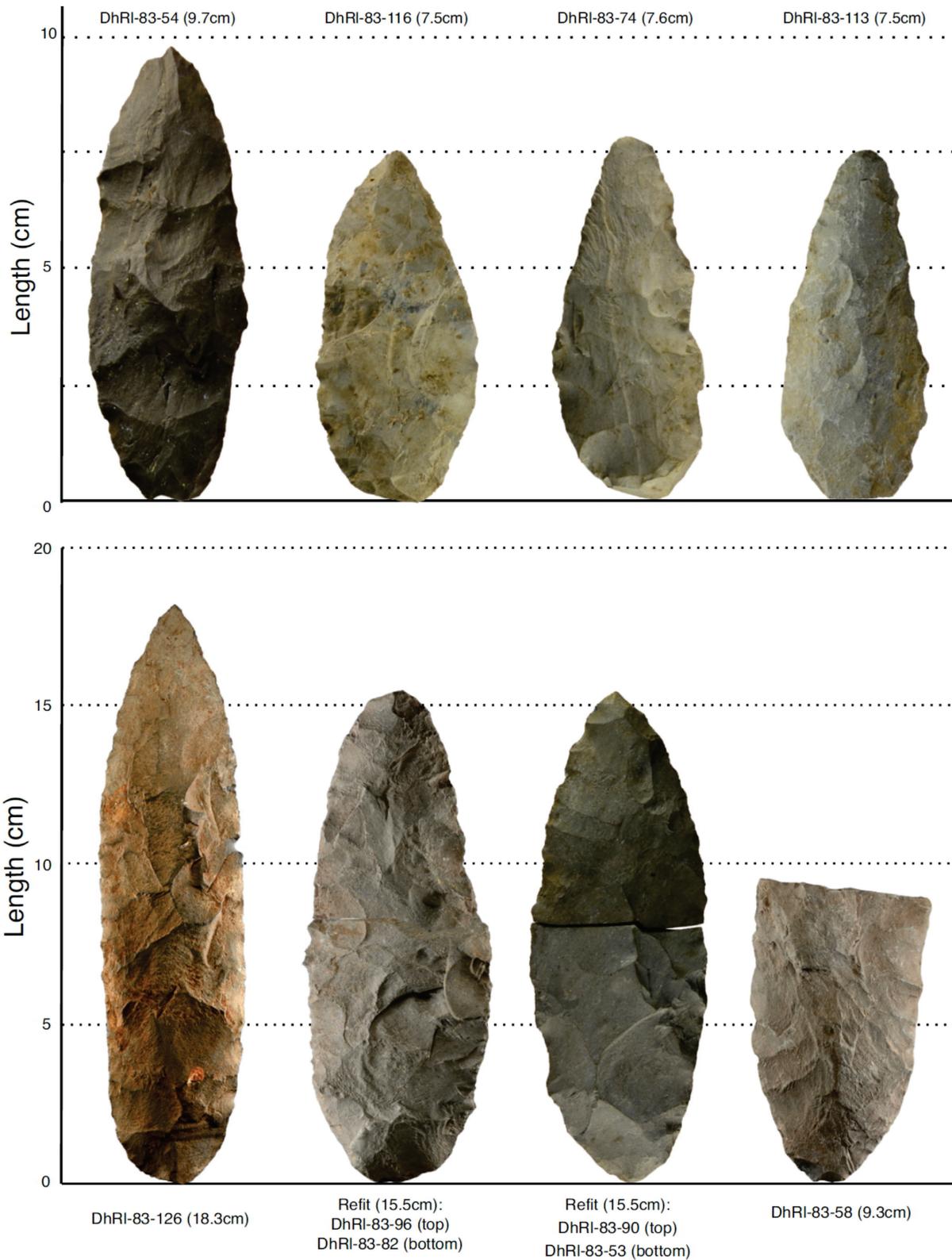


Figure 4. Photographs of select leaf-shaped (top) and large (bottom) bifaces analyzed in this study from YâçkEtEl. Note how some of the specimens exhibit sedimentary structures and sulphide mineral vacancies in their weathered surfaces (e.g. DhRI—83:116 and DhRI-83:74). *Modified from Ritchie et al. (2022).*

2023 ACTIVITIES

Fieldwork was concentrated along the shore of Harrison Lake and along forest service access roads on both west and east sides of the lake (Fig. 2). Fieldwork was undertaken in several multi-day blocks in July, August, and September, for a total of 32 person-days for GSC personnel. Travel to/from Vancouver to the Harrison Lake region was undertaken primarily utilizing the GSC-Vancouver vehicle, or sometimes private vehicle. Unfortunately, some important road networks were not accessible to the GSC vehicle as they have been decommissioned; it is hoped that quad all-terrain vehicles will be able to access at least some of these areas in the future. A large motorboat was provided by Sts'ailes and allowed critical high-speed access to the shoreline of Harrison Lake (Fig. 5). Unusually low lake and river levels in the latter part of the summer allowed access to large areas of the shoreline, further benefitting investigations.

Project participants were able to use the Sasquatch Crossing Eco-Lodge in Harrison Mills as a base camp (including breakfasts), provided courtesy of Sts'ailes; additional meals and food supplies were purchased locally or eaten at local restaurants in Harrison Mills and Agassiz, further supporting local communities.

The 2023 scientific field program proceeded in exceptionally fine form. Although hot at times, the weather allowed an optimum amount of fieldwork for the time available. Collections made during the field program included:

- approximately 60 lithological samples
- 5 macrofossil samples
- 9 conodont microfossil samples
- 11 radiolarian microfossil samples
- 7 U-Pb geochronological samples

- 32 detrital zircon samples
- 6 geochemical samples
- 25 thin-section samples.

Archeological investigations

In many archeological contexts around the globe, stone tools are the main type of recovered artifact due to their preservation potential and extensive use by humans for at least 2.6 million years. Some materials used to manufacture stone tools, such as obsidian (volcanic glass), have been used by archeologists for decades to link objects found in archeological sites back to their geological sources, primarily using trace-element geochemistry. While the efficacy of this approach for investigating relationships among people and landscapes is well documented, the application of similar techniques to assess the geological source of stone tools composed of non-glassy aphanitic lithologies is not so straightforward. This is related to the inability of archeologists to do optical petrography and destructive geochemistry on archeological materials due to limitations related to sample preparation and alteration. As a result, the petrogenesis of aphanitic archeological toolstones is difficult to ascertain when examining only the artifacts themselves, resulting in challenges when attempting to produce adequate and reliable baseline data for sourcing stone tools.

In southwestern British Columbia, both volcanic glass and non-glassy aphanitic toolstones are common in archeological sites, including those throughout Sts'ailes territory (Fig. 6). M. and J. Ritchie, who work for Sts'ailes, partnered with R. McMillan in 2018 to explore the availability of toolstone-grade aphanitic lithologies along accessible waterways within the territory. This partnership was supported by the University of British Columbia Indigenous/Science Research Excellence Cluster, as well as a subsequent SSHRC Partnership Development Grant



Figure 5. Work boat provided by the Sts'ailes Guardians and the Xwiléxmet team in support of project activities on Harrison Lake. Photograph courtesy of M. Ritchie.

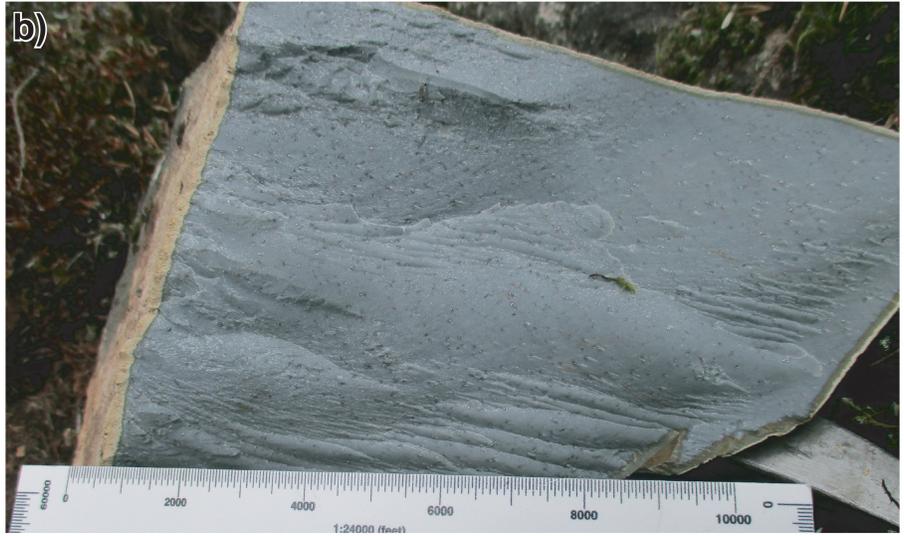


Figure 6. Field and laboratory photographs of Sts'ailes source materials and specimens. **a)** and **b)**: bluish cherty volcanoclastic rocks from Echo Island. **c)**: specimen from Echo Island showing relationship of cherty and coarser grained facies exhibiting soft sediment deformation. **d)** and **e)**: bluish black and purplish cherty volcanoclastic rocks from the west shore of Echo Island. **f)**: outcrop and float specimens of volcanoclastic rocks from Morris Creek. Photographs a and b courtesy of K. Purdue. Photographs c–f courtesy of R. McMillan.

and Postdoctoral Fellowship. This is a crucial component of archeological investigations in the territory, as the craft of stone tool manufacture was one of the first components of traditional knowledge that was lost for many communities after European contact and the introduction of metal tools. Field surveys between 2018 and 2021 were conducted throughout Sts'ailes territory, focusing primarily on the volcanic rocks and related volcanogenic sedimentary strata of the Lower Jurassic Harrison Lake Formation. High-quality toolstone materials, likely composed primarily of silicified waterlain volcanic ash (tuff), were identified in numerous locations along Echo Island, the southwestern shore of Harrison Lake, and near to the modern day Sts'ailes community at the confluence of Harrison River and Morris Creek. These toolstones were analyzed for elemental compositions and used as baseline data to reassociate a suite of approximately 160 archeological stone tools from a key workshop site (Ritchie et al., 2022) to toolstone outcrops within a few kilometres of the archeological site (McMillan et al., 2022). These results, along with others that are still forthcoming, show that Sts'ailes ancestors readily accessed and used raw geological materials from outcrops along waterways within their own territory to locally manufacture stone tools that are found in Sts'ailes archeological sites as well as other sites downstream from Sts'ailes along the Fraser River (Ritchie et al., 2022). These preliminary investigations lead to the realization that there is significant variability of toolstone material throughout the territory that could only be properly documented and geologically mapped at a landscape scale.

By locating additional sites in the Sts'ailes ancestral territory where these toolstones were collected (ancestral quarries), the source material can be better characterized and the lateral extents and exposures of these facies can be documented, producing a broader view of where Sts'ailes people had access to this valuable resource.

Volcanic stratigraphy and geochemistry

Stone artifacts recovered from ancestral Sts'ailes archeological sites exhibit compositional and geochemical traits consistent with locally available silicified, aphanitic, tuffaceous lithologies (McMillan et al., 2022; Ritchie et al., 2022). Research to date has suggested a volcanogenic origin of these toolstones, and forthcoming research will include more detailed petrological investigations of these lithologies within their geological, depositional, and tectonic contexts.

The Harrison Lake Formation (Figs. 3, 7) represents a classic oceanic-arc development sequence (Larue et al., 1991), although ϵNd values of the Harrison Lake Formation indicate variable sediment provenance, including mixing of both volcanogenic material and the more evolved continental detritus, resulting in two-component mixing within the basin and arc system (Mahoney et al., 1995). The base of the Harrison Lake Formation shows a transition from locally derived conglomerates of the Celia Cove Member and calcareous fine-grained sedimentary strata of the Francis Lake Member to the initiation of volcanic activity represented by the intermediate flows and pyroclastic activity of the Weaver Lake Member. The evolution from explosive to effusive flows, and the large melt volume produced by this onset of volcanic activity resulted in the Weaver Lake Member being the thickest of the members included in the Harrison Lake Formation. As the volcanism matured, finely banded epiclastic and volcanoclastic lithologies became more prominent, forming the Echo Island Member. Volcanism waned in the early Bathonian, and a hiatus is observed by a change in deformation and fossil ages in the subsequent interbedded sedimentary rocks of the Mysterious Creek Formation.

Volcanic stratigraphy of the Harrison Lake Formation was last defined in 1995. As a future component of the project, R. McMillan and others plan to recontextualize this sequence through finer-resolution geological mapping and geochemical study. The stratigraphic relationships elucidated in this work will serve as a framework for understanding localities, quantities, and distributions of the toolstone lithologies that are of interest to Sts'ailes heritage and further document their longstanding relationships with traditional Sts'ailes landscapes.

Mesozoic biochronology and stratigraphy

Triassic stratigraphy/biochronology

Along the southwest end of Harrison Lake, Triassic chert and calcareous siltstone assigned to the Camp Cove Formation (Fig. 2, 3) were examined and sampled for microfossils and detrital zircon. The age of this package of rock is poorly constrained, and its relationship to the surrounding rocks is uncertain. Thick chert sequences hold promise for age dating by radiolarians, and coarse siltstone can be suitable for age dating by detrital zircon geochronology. Chert



Figure 7. Outcrops of volcanic and volcaniclastic rocks of Lower Jurassic Harrison Lake Formation at Echo Island. Beds shown are predominantly volcaniclastic lithologies and dip gently to west (left of photo). The outcrop is associated with nearby archeological sites which have produced artifacts. Photograph courtesy of M. Ritchie.

geochemistry may provide linkages between these rocks and others in southern British Columbia, clarifying the terrane affiliations of this unit.

Triassic rocks of the Camp Cove Formation were investigated extensively on the western side of the lake. The rocks of this formation are exposed primarily along roadcuts of the main forest service road, and several branch roads, including both minor forest service roads and BC Hydro powerline access roads. Additional outcrop is preserved sparsely on the shores of Harrison Lake, between Celia Cove and Camp Cove.

The depositional age of the Camp Cove Formation is very poorly constrained, with only two fossil age dates from near the southern end of the outcrop belt. The conodonts and radiolarians from these closely associated localities indicate a Middle to Late Triassic age, tentatively considered initially to be Anisian to Ladinian (Arthur, 1987; Cordey et al., 1988; Arthur et al., 1993; Cordey, 1998), but subsequently revised to Ladinian to earliest Carnian (F. Cordey, pers. comm., 2024). The lack of other diagnostic fossils in the formation means that the full age range of the unit is unknown. This limits our understanding of the relationship between the Camp Cove Formation and other chert deposits in the southern Cordillera (e.g. the Bridge River Group of the Bridge River terrane; Arthur et al., 1993; Cordey, 1998), and therefore its terrane assignment is uncertain (most recently, the formation has been considered to be part of the

Nooksack-Harrison terrane; e.g. Gibson and Monger, 2018). The age of the formation also has particular relevance to the question of the source region for chert clasts in the overlying Celia Cove Member of the Harrison Lake Formation. The age of these clasts is likely late Ladinian to early Carnian (Arthur et al., 1993), and therefore consistent with the ages obtained from the Camp Cove Formation.

The Camp Cove Formation consists primarily of fine-grained sandstone, siltstone, and thick layers of chert (Fig. 8). Twelve detrital zircon samples were collected from sandstone beds within the unit, covering its full thickness. Several of the siltstone layers reacted strongly with hydrochloric acid, indicating the presence of significant carbonate cement; these horizons were sampled for conodont analysis (six samples total). Additionally, thick beds (≥ 50 cm) of chert were encountered on a BC Hydro service road near the southern end of the outcrop belt, forming a section many tens of metres thick. Four samples were collected from this section for radiolarian analysis.

The overlying Lower Jurassic Celia Cove Member (Fig. 3) is a polymictic conglomerate, primarily containing clasts of Lower Permian limestone (thought to be sourced from the neighbouring Pennsylvanian-Permian Chilliwack Group (Monger, 1966, 1986; Arthur et al., 1993)) and Middle-Late Triassic chert. The provenance of this latter facies is uncertain, although potential sources include the underlying Camp Cove Formation or the nearby Bridge River Group;



Figure 8. Upper Triassic bedded chert of the Camp Cove Formation, southwest Harrison Lake (see Figures 2, 3). Yellow line shows trend of bedding, which dips gently to the west, away from the camera.

however, deposition of the Bridge River Group continued into the Middle Jurassic (Potter, 1986), and it would be expected that Jurassic clasts would also be present in the Celia Cove Member if the Bridge River Group were the source. Several clasts of both limestone and chert were collected from a well exposed section of the formation along a roadcut that was previously investigated by Arthur et al. (1993); three samples of these clasts were submitted for conodont analysis, and four samples for radiolarian analysis. An additional outcrop of the Celia Cove Member was investigated on the western shore of Harrison Lake, from which a sample of the matrix was collected for detrital zircon analysis, to help constrain the depositional age of the conglomerate. Currently, the depositional age of the member is poorly dated as Late Triassic to Toarcian, based on the age of the constituent clasts and the bounding units.

Middle Jurassic through Cretaceous stratigraphy/biochronology

Considerable time was spent reviewing the geology of the Upper Jurassic-Cretaceous stratigraphic sequence preserved along the west side of Harrison Lake, as the previously accepted age control on the succession is inadequate (see summary in Arthur et al., 1993). Earlier field studies showed that the succession is composed, overall, of a thick assemblage (ca. 750–1000 m) of andesitic volcanic rocks with minor intercalated clastic horizons, the Brokenback Hill Formation (Fig. 3, 9). These volcanic rocks are considered coeval with the volcanic succession of Gambier Island and Howe Sound area which hosts the Britannia massive sulphide deposit. Interestingly, work on this project has recognized that the volcanic assemblage in the Harrison Lake area is capped by a thick (ca. 400 m) interval of

massive dark-coloured marine argillaceous strata of Early Cretaceous age that has correlatives in numerous other areas of the British Columbia western Cordillera. Several of the volcanoclastic horizons within the Lower Cretaceous succession have been identified as potential toolstone sites by the Sts’ailes archeologists, and the relationship to other toolstone sites of similar lithology, but apparently different age, is also under investigation.

The fossil collections made by C.H. Crickmay in the 1920s (see Crickmay, 1925, 1930) have served as the basis of the biostratigraphic framework for the Upper Jurassic and Cretaceous succession of the Harrison Lake region; limited additions to this framework have been added by Jeletzky (in Arthur et al., 1993). Unfortunately, the precise location of the Crickmay general fossil collections is uncertain and efforts are underway to locate these so that they can be used in future research. During 2023, a number of collections of ammonites and trigoniid bivalves were made from poorly dated stratigraphic intervals within the Brokenback Hill Formation and indicate the presence of Hauterivian and Albian strata at these localities. Detrital zircon samples were collected at these levels as well as other, unfossiliferous, levels to provide estimates of minimum age of deposition. Calcareous concretions were found only rarely within the argillites of the upper part of the formation, and these did not produce determinable radiolarians or other microfossils (F. Cordey, pers. comm., 2024). Integrating molluscan fossil data with detrital zircon assemblages will be used to improve understanding of the sedimentation and volcanic history of the Early Cretaceous volcanic arc assemblage.

Some fossils that have been found in association with stone tools at archeological sites have been identified, and will provide a useful line of investigation in helping establish locations where people quarried. In addition, a discussion



Figure 9. Brokenback Hill, along the west side of Harrison Lake (see Figures 2, 3), comprising siliceous volcanic rocks and associated coarse-clastic sedimentary interbeds of the Lower Cretaceous Brokenback Hill Formation. The interval shown in the photograph dips moderately to the northeast (right in photo) and represents approximately 350 m of the lower part of the formation, comprising mostly intermediate volcanic lithologies.

of the scientific importance of fossil collections was had with members of the Sts'ailes community and ideas were presented on how to store and highlight such collections as educational tools for the use of the community, while maintaining their traditional scientific values. Finally, efforts have been initiated to identify collections of fossils from Sts'ailes traditional territory held in various institutions and to hopefully see these collections repatriated.

Regional geology and structural history

On the east side of Harrison Lake, metamorphosed sedimentary rocks and igneous intrusions were examined in a preliminary fashion. The relationship between these rocks and their appreciably less metamorphosed equivalents on the west side of the lake remains uncertain. Samples were collected for geochemistry from meta-cherts (to compare with the Triassic cherts mentioned above), and for geochronology from crosscutting igneous intrusions (to constrain the timing and degree of fault displacement in the area), and for microstructural and petrological evaluation of fault- and shear-zone rocks.

Within the Cogburn Group on the east side of the lake, several meta-chert horizons are present among the mix of metamorphosed oceanic rocks that make up this unit (Gibson and Monger, 2018). These outcrop as thin-bedded ribbon-cherts (Fig. 10), now metamorphosed to quartzite. The stratigraphic affinity of these metamorphosed cherts is uncertain; they could be related to the cherts of the Bridge River Group to the east (as proposed by Monger, 1989 and Schiarizza et al., 1997), or to the cherts of the Camp Cove Formation on the west side of the lake. All three units may possibly be related. Due to the metamorphosed nature of these rocks, the recovery of radiolarian microfossils is unlikely; therefore, two samples were collected from near Big Silver Creek for whole-rock geochemistry. Cherts from different

terranes in the Cordillera can have specific geochemical signatures, and these new data may help to fingerprint the tectonic provenance of these cherts, and the Cogburn Group as a whole. The meta-cherts are also of interest to us for their potential as a toolstone, but they appear to be too compositionally layered and recrystallized through metamorphism to have made useful tools.

A subsidiary study examined the regional structures in the Harrison Lake region, including terrane-bounding faults, the Harrison Lake dextral-reverse oblique-slip fault zone of Monger (1986), and the Butter Creek and Breakenridge oblique reverse fault zones of Brown et al. (2000). Fault and shear zone activity in the Harrison Lake region has been identified previously as comprising Late Jurassic to Early Cretaceous, mid-Cretaceous, and post-mid-Cretaceous events (Brown et al., 2000; Mitrovic, 2013). The latter event accommodated an enormous jump in metamorphic grade eastward across the north end of Harrison Lake (pumpellyite-chlorite facies on the west side; amphibolite facies on the east). Other similarly oriented smaller brittle to brittle-ductile faults that affect this region are also thought to relate to motion along the Harrison Lake fault zone, some which likely serve as conduits for upward migration of hydrothermal fluids that feed hot springs found in the region. We hope to better constrain the timing of faulting in the area through modern techniques, and to assess how recently fault activity has occurred.

PLANNED OUTPUTS

A number of contributions are also planned for the Sts'ailes community, including:

- a set of educational tools for the teaching of geology in the Sts'ailes schools;

Figure 10. Folded thin-bedded ribbon meta-chert within Cogburn Group, east side of Harrison Lake. Pencil for scale.



- a map showing the overlapping geological, archeological, and cultural information from the Harrison Lake area that can be used by members of the community, including for land use planning (to be led by R. McMillan, in conjunction with Sts'ailes high school students); and
- drafting geological information for a Sts'ailes historical atlas.

An important object of the project is to provide opportunities for Sts'ailes youth and elders to contribute to the development of the GIS maps. Youth will be provided opportunities to participate in the field research program as field assistants and have the opportunity for training in GIS and geological field methods. Opportunity will be made for elders to share their histories so that these cultural contributions can be integrated into the GIS maps that are produced.

FUTURE PLANS

In addition to participating in the geoscience research investigations, Sts'ailes will continue to support community/educational trips in which members of the community (including youth and elders) join geologists for a day to investigate some of the rocks in the area, and to share knowledge of both geological and cultural significance. Similarly, the idea of hiring a helicopter to bring elders to important but difficult to access cultural sites has been broached. Such a trip will also allow project participants to conduct research at the same time. Planning discussions are presently underway to address as many of these objectives as possible.

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CONCLUSIONS

The joint Geological Survey of Canada-Sts'ailes Harrison Lake Project is the first formal project of the GSC's Indigenous Relations Network. The project has been formulated as a collaborative effort between the GSC and the Sts'ailes to integrate aspects of original geoscience research within the context of the broader cultural objectives of the Indigenous community. The initial fieldwork season of the project was undertaken in 2023 and resulted in a significant increase in lithological and paleontological samples from the Harrison Lake region. Most importantly, co-ordinated field excursions of GSC geologists and members of the Sts'ailes community allowed very fruitful discussions of the cultural aspects of landscape studies and their relationship with traditional scientific investigation. This has undoubtedly laid a positive groundwork for continued cooperation between the Indigenous community and the broader GSC research program.

The successful collaboration to date between the Sts'ailes and GSC demonstrates that new, jointly planned approaches to scientific and cultural research can work very well. In

this particular case, shared communication and discussions amongst Indigenous community representatives and GSC research scientists resulted in formulation of a research program of mutual interest to all parties. As a result, all parties have learned more, and the depth of understanding for everyone has been greatly enhanced. We hope this collaborative and organic approach to geoscience research will become more widely applied within the GSC.

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