

GEOSCIENCE BC SUMMARY OF ACTIVITIES 2023

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Front cover photo and credit: K. Powers, M.Sc. student at The University of British Columbia, undertaking a 3-D scan of a pyroclastic rock outcrop in the Golden Triangle, east of Stewart, British Columbia. Photo by K. Rubingh.

Back cover photos and credits:

(Left) Bluebunch wheatgrass (*Pseudoroegneria spicata*) growing in pots filled with mine tailings from the historical Afton mine tailings storage facility and covered by subsoil, topsoil and different amendments (i.e., zeolite, leonardite and compost), Thompson Rivers University Research Greenhouse, Kamloops, British Columbia. Photo by B. Bahroudi.

(Centre) J. Dlugosz, M.Sc. student at The University of British Columbia Okanagan, observes an outcrop on the Burgundy Ridge prospect, north-central British Columbia. Photo by C. Beno.

(Right) Sunset over Giga Metals Corporation's Turnagain camp, north-central British Columbia. Photo by K. Broda.

Foreword

Geoscience BC is pleased to once again present results from our ongoing projects and scholarship recipients in our annual *Summary of Activities* publication. This year, we have combined our minerals, energy and water research into one volume, which is available in print and online via www.geosciencebc.com. The papers are divided into three sections, based on Geoscience BC's current research themes:

- 1) Critical Minerals and Metals
- 2) Cleaner Energy
- 3) Geological Carbon Capture and Storage (CCS)

The 'Critical Minerals and Metals' section starts off with Höy and Jackaman introducing a Geoscience BC–BC Geological Survey collaboration to complete geological compilation and selective mapping work in the West Kootenay area. This is followed by Abdale et al. examining the Mount Grace carbonatite and the Cottonbelt Pb-Zn deposit in southeastern British Columbia (BC). Two projects consider exploration for critical metals in north-central BC, with Xu et al. examining hostrocks and alteration at the Lorraine alkalic Cu-Au porphyry deposit, and Broda et al. detailing controls on Ni mineralization at the Alaskan-type Turnagain deposit. Another three papers relate to mineral exploration in BC's highly active northwestern region, with Powers et al. refining stratigraphic classifications within the Hazelton Group, Dlugosz et al. reporting on trace-element mapping of sulphide minerals from the Burgundy Ridge Cu-Au prospect and Johnston et al. considering the stratigraphy of the Stuhini Group in the Galore Creek area. Pamparana et al. investigate high-pressure grinding roll pilot-scale tests and the relationship between operational variables, and Bahroudi et al. investigate the influence of soil amendments and compost, and their potential for improving plant growth and soil fertility in tailings-storage facilities.

The 'Cleaner Energy' section features a paper by Hormozzade Ghalati et al. examining geothermal systems at Mount Meager. Finally, the 'Geological Carbon Capture and Storage (CCS)' section features an update by Nazemi on considerations for CO₂ sequestration in BC's Lower Mainland.

New Projects in 2024

In 2023, Geoscience BC was able to significantly move forward several of our 'Project Concepts' that were introduced previously (Figure 1). Below is a summary of Geoscience BC's projects that will start in early 2024, and Project Concepts that will move ahead as funding is secured.

Critical Minerals and Metals in BC Mine Tailings and Wasterock

Critical minerals and metals are essential to Canada's economic security and essential for the transition to a net-zero emissions economy. Canada's critical minerals list includes 31 minerals and metals, 21 of which are produced in Canada, with potential for further resource development (Government of Canada, 2023). Mine tailings and wasterock resulting from production at current and historical mine sites may contain economic concentrations of critical minerals and metals that were not recoverable or considered valuable at the time of extraction.

This program will selectively test tailings and wasterock to identify if there are economic opportunities to extract further value from these mining byproducts while potentially addressing environmental liabilities. It supports responsible development by industry and is closely aligned with provincial and federal critical minerals objectives, including the 2022 Auditor General's report calling for innovative mechanisms to fund reclamation activities (Auditor General of British Columbia, 2022). It will also incorporate the needs of many Indigenous groups and communities.

The program aims to

- identify suitable mine tailings and wasterock facilities in BC to undertake lab and field-scale studies for critical minerals and metals;
- attract investment to BC by demonstrating an innovative approach to critical minerals and metals research and the collaboration between industry, governments, Indigenous groups, academia and communities;
- foster collaboration, expand research expertise and build capacity and training opportunities across mineral systems and the mining lifecycle; and
- engage the broader minerals industry, from geoscience and exploration to mine development, mineral processing/metallurgy and reclamation.

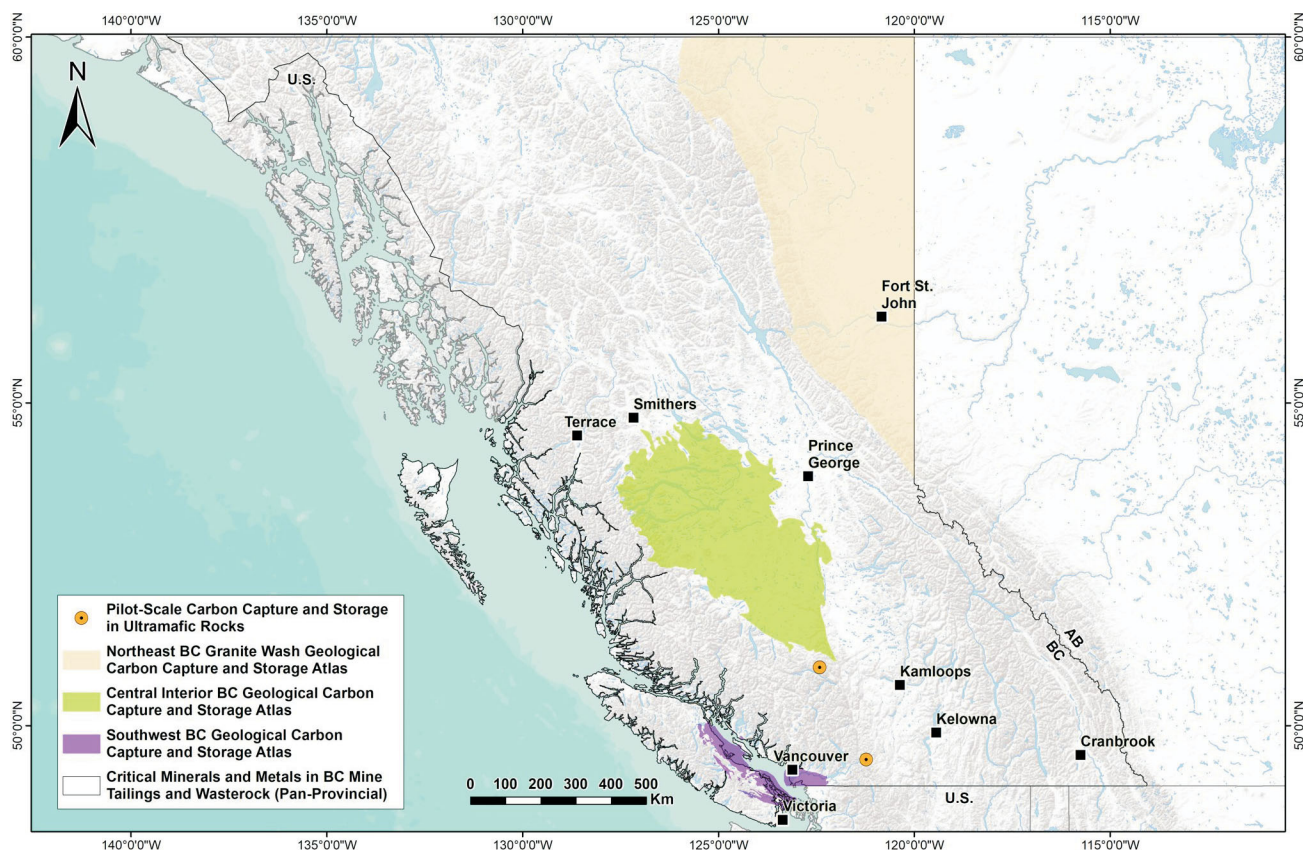


Figure 1. Geoscience BC's 'Project Concepts' under development in 2023.

The first phase of the program will compile information related to legacy and operating minesites across BC. Targeted information will include deposit type, geology, alteration, geochemistry, metallurgy, mineralogy, known infrastructure and proxy studies. First Nations input will be sought and integrated with technical criteria where possible, and guidance will be provided by Geoscience BC's Indigenous Relations and Reconciliation Advisory Council. Outcomes of the first phase include a public GIS database and report, identification of priority sites (approximately four) for technical investigation, and scoping for later phases, which will include collecting new data to support the development of site investigation models, and evaluating and recommending economic and environmental approaches that could be taken at each site.

Geoscience BC is planning to launch this program in January 2024. The first phase will be funded by Arca, New Gold Inc. and Geoscience BC, and supported with in-kind resources provided by government and academic partners. Future phases will depend on securing additional funding and in-kind resource support.

Northeast BC Granite Wash Geological Carbon Capture and Storage Atlas

The Northeast BC Granite Wash Geological CCS Atlas project will assess the carbon-storage potential of the Granite Wash, with a focus on the geology in the Peace River arch (Fort St. John and Dawson Creek areas in northeastern BC). The primary focus of the project is to identify and map the regional distribution, reservoir characteristics and deep saline aquifer CCS storage potential of the Granite Wash clastic rocks, particularly in the Peace River arch and its northern flank region. The results will help determine to what extent northeastern BC has a CCS sequestration zone equivalent in reservoir characteristics and CO₂ potential storage capacity to the Basal Cambrian Sands used for storage at Shell Canada Limited's Quest CCS project in Alberta. The project will identify and catalogue all relevant geoscience reports; identify and review all available well logs and well data; acquire, where possible, regional seismic data to tie to well data and assist with mapping; generate regional mapping of the Granite Wash; assess Granite Wash CO₂ potential storage capacity; and provide a preliminary public report and atlas (similar to our completed Northeast BC Geological Carbon Capture and Storage Atlas project) for use by industry, governments, Indigenous groups, academia and communities to guide decisions and further research requirements.

Foundational funding for this project has been provided by the BC Ministry of Energy, Mines and Low Carbon Innovation. A critical component of the project is industry collaboration and in-kind support in the form of seismic data to allow regional mapping of the sparsely drilled Granite Wash. Geoscience BC is planning to publicly launch this project in early 2024, with findings released in March 2026.

Central Interior BC Geological Carbon Capture and Storage Atlas

A CCS atlas is also in the works for BC's central interior. The first phase of the Central Interior BC Geological Carbon Capture and Storage Atlas project will be to undertake a preliminary assessment of the geological CCS potential of the ~75 000 km² Nechako Basin, including assessing technical risks and identifying data gaps (BC Ministry of Energy, Mines and Low Carbon Innovation, 2002). The project will identify and catalogue all pertinent existing geoscience data and studies, and provide a preliminary public report and atlas for use by industry, governments, Indigenous groups, academia and communities. The primary focus of the project is to assess the CCS storage potential of deep saline aquifers. The structural and sedimentary framework of the basin will be characterized by compiling and re-interpreting existing geoscience data and reports for the Nechako Basin, including data from previous Geoscience BC-supported and other public geoscience research, predominantly focused on seismic, gravity and magnetotelluric studies. The project will build on previous research done by Petrel Robertson Consulting Limited for the BC government (Hayes, 2002). A key deliverable is a preliminary atlas identifying and quantifying CCS potential, similar to the *Northeast BC Geological Carbon Capture and Storage Atlas*, which is being used to inform CCS decisions and potential investment in northeastern BC. There is a shortage of existing data for the Nechako Basin, so it is expected that this phase will also recommend further research. Foundational funding for this project has been provided by the BC Ministry of Energy, Mines and Low Carbon Innovation and, at the time of writing, we have preliminary commitments of funding from Enbridge Inc. and Foresight Canada. Geoscience BC is planning to publicly launch this project in early 2024, with findings made public in late 2024 or early 2025.

Ongoing Project Concepts in 2024

Pilot-Scale Carbon Capture and Storage in Ultramafic Rocks

Storing CO₂ through mineralization has many advantages over sequestration in sedimentary basins, most notably the permanency of storage because, once the CO₂ reacts with the rock below surface, it forms a mineral that is stable over geological timescales. The process of mineralizing CO₂ is also extremely safe. In Iceland, it has been demonstrated that the CO₂ dissolved in water reaches instant solubility, trapping upon contact with basalt, and more than 95% of the CO₂ turns into carbonate minerals in less than two years. Therefore, it cannot leak back up to surface and long-term monitoring is therefore unnecessary (e.g., Snæbjörnsdóttir et al., 2020).

This project concept would demonstrate the feasibility of using ultramafic rocks for storage via shallow injection and carbon mineralization. Technical partners on the proposed project include Carbfix hf. and The University of British Columbia's (UBC) CarbMin Lab. Altered ultramafic rocks, specifically serpentinites, have high potential for carbon mineralization as they contain reactive minerals and high amounts of Mg that bind with CO₂ to form stable carbonate minerals. Current and previous work, including models, experiments and natural analogues, show that serpentinites can sequester high amounts of CO₂ (e.g., 0.0563 Gt CO₂/km³ of serpentinite; Mitchinson et al., 2020). Serpentinites may provide a closer-to-emission-source alternative to other geological CO₂ storage options for emitters.

Two candidate locations (each one the site of a different ultramafic unit) for a pilot-scale test have been identified in BC by K. Steinhorsdottir (UBC). This project would select one of these locations, work with the BC Energy Regulator to permit project activities, drill injection and monitoring wells, and run a test injection for up to three months to mineralize up to 500 t of CO₂. Monitoring and verification of the mineralization will be tracked for up to two years. Design of the injection program could be supported through the collection of airborne geophysical data, downhole sampling and analysis of the injection well, and baseline environmental data.

Geoscience BC would also undertake an engagement program with First Nations, communities, industry and governments to both educate and develop an understanding of the potential of carbon mineralization and its application to inform development decisions. Geoscience BC and FortisBC have committed funding to the project, and Geoscience BC has applied for a significant funding contribution from Natural Resources Canada.

Southwest BC Geological Carbon Capture and Storage Atlas

Geoscience BC is also looking to partner on potential carbon-storage research activities in BC's Lower Mainland region. The Georgia Basin overlies up to 6 km of sedimentary strata that have been partially evaluated for hydrocarbon potential and natural-gas-storage projects, but with no major development. These same strata are prospective for deep-saline-aquifer CCS but, at present, the understanding of their potential is limited. There is a need to gather, analyze, interpret and model existing available geoscience data to understand the sequestration potential of southwestern BC.

The Lower Mainland region has significant sources of greenhouse-gas emissions. Identifying and technically assessing viable CO₂-sequestration capacity in the region, coupled with potential clean-energy geothermal technology, close to high-volume emission sites, would provide critical missing information to help inform decision-making by government, Indigenous groups, communities and industry to achieve net-zero goals.

Geoscience BC Publications in 2023

Geoscience BC released the following six reports in 2023:

- Eight technical papers in the **Geoscience BC Summary of Activities 2022: Minerals** volume (Geoscience BC Report 2023-01)
- Seven technical papers in the **Geoscience BC Summary of Activities 2022: Energy and Water** volume (Geoscience BC Report 2023-02)
- **Drift Prospecting in the Central Interior Copper-Gold Research Projects Area**, by D.A. Sacco, W. Jackaman and B. Janzen (Geoscience BC Report 2023-03)
- **Northeast BC Geological Carbon Capture and Storage Atlas**, by Canadian Discovery Ltd. (Geoscience BC Report 2023-04)
- **Kootenay Lake Geothermal Project - Phase Two: Geological, Geochemical and Geospatial Investigations into the Geothermal Potential of the East Shore of Kootenay Lake – Summary Report, January 2023**, by G. MacMahon, R. McQuarrie, D. Gatto and S. Humphries (Geoscience BC Report 2023-06)
- **Geochemical Reanalysis of Archived Till Samples, CICGR Project, Interior Plateau, Central BC (parts of NTS 093A, B, G, J, K, O)**, by W. Jackaman, D.A. Sacco and R.E. Lett (Geoscience BC Report 2023-07)

In addition, the following journal articles and theses related to Geoscience BC projects were published this year:

- **Compositional signatures of gold from different deposit types in British Columbia, Canada**, by R. Chapman, J.K. Mortensen and R. Murphy (Minerals, v. 13, no. 8)
- **Arthropod recovery in post-mine reclaimed sites**, by C. Gervan (M.Sc. thesis, Thompson Rivers University)
- **Response of soil geochemical properties and microbial communities to long-term storage in two mine operations in the Interior of British Columbia**, by A. Fischer (M.Sc. thesis, Thompson Rivers University)
- **The use of the Roben Jig for preparation of clean coal samples of Western Canadian coals via density separation**, by M. Mackay, M. Holuszko, R. Leeder, J. Halko, H. Dexter and V. Barwaj (CIM Journal, v. 14, no. 2)
- **Analysis of fluid flow pathways in the Mount Meager Volcanic Complex, southwestern Canada, utilizing AMT and petrophysical data**, by F. Hormozzade Ghalati, J.A. Craven, D. Motazedian, S.E. Grasby, E. Roots, V. Tschirhart, Z. Chen and X. Liu (Geochemistry, Geophysics, Geosystems, v. 24, no. 3)
- **A 500 ka record of volcanism and paleoenvironment in the northern Garibaldi Volcanic Belt, British Columbia**, by M.A. Harris, J.K. Russell, A. Wilson and B. Jicha (Canadian Journal of Earth Sciences, v. 60, no. 4)
- **Magnetotelluric imaging of the magmatic and geothermal systems beneath Mount Meager, southwestern Canada**, by C. Hanneson and M.J. Unsworth (Canadian Journal of Earth Sciences, v. 60, no. 10)

All releases of Geoscience BC reports, maps and data, as well as related external publications, can be found through our website. Most final reports and data can also be viewed or accessed through our Earth Science Viewer at <https://gis.geosciencebc.com/esv/?viewer=esv>.

Membership

Geoscience BC membership opportunities make it easy for a wide range of partners to learn about new project concepts, as well as support, provide input, network and stay up to date on Geoscience BC minerals, energy and water research. Corporate, Individual, Student and Associate memberships provide a variety of opportunities to suit industry, academia, commu-

nities, Indigenous groups and governments as we work toward shared goals. Geoscience BC launched the membership program early in 2022 and, as of mid-December 2023, has more than 180 members.

Acknowledgments

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Contents

Critical Minerals and Metals

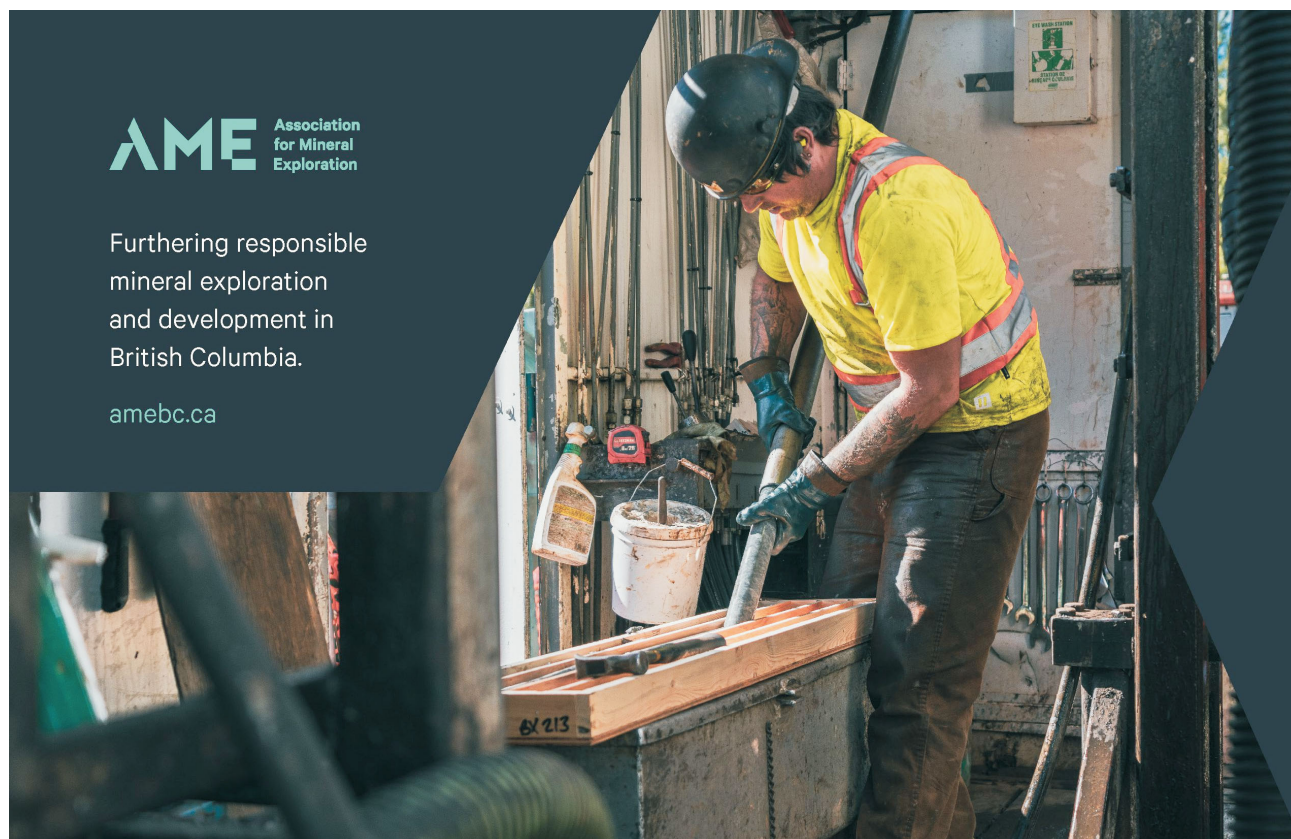
- T. Höy and W. Jackaman:** Geology of the West Kootenay area, southern British Columbia: regional compilation and mineral potential. 1
- L. Abdale, J. Nelson and L.A. Groat:** Testing the relationship between the Cottonbelt lead-zinc deposit and the carbonatite-syenite province of the Frenchman Cap dome area, southeastern British Columbia. 3
- H. Xu, S. Barker, F. Bouzari, C. Harraden and M. Manor:** Characterizing hostrocks and alteration footprints at the Lorraine alkalic copper-gold porphyry deposit, north-central British Columbia 11
- K.R. Broda, A.E. Williams-Jones and O.V. Vasyukova:** Controls on the nickel mineralization of the Alaskan-type Turnagain deposit, north-central British Columbia 23
- K.M. Powers, K.E.L. Rubingh and S.L.L. Barker:** Stratigraphic classification and geochronology within the Hazelton Group, Stewart mining camp, northwestern British Columbia 33
- J. Dlugosz, K.P. Larson, C.J.M. Lawley, C.J. Beno and D.C. Petts:** Trace-element mapping by laser ablation–inductively coupled plasma–mass spectrometry of sulphide minerals from the Burgundy Ridge copper-gold alkalic porphyry prospect in the Golden Triangle, northwestern British Columbia 47
- R.J. Johnston, L.A. Kennedy, K.A. Hickey and B.I. van Straaten:** Revisiting the stratigraphy of the alkalic Stuhini Group in the Galore Creek area, northwestern British Columbia 59
- G. Pamparana, B. Klein and M.G. Bergerman:** Effect of the specific pressing force, material moisture content and roll speed on throughput of the high-pressure grinding roll: pilot-scale test on Copper Mountain mine ore, south-central British Columbia 67
- B. Bahroudi, J. Singh and L.H. Fraser:** Application of zeolite, leonardite and compost as a tool for mine reclamation: a greenhouse study using tailings from the historical Afton mine in south-central British Columbia. 79

Cleaner Energy

- F. Hormozzade Ghalati, J.A. Craven, D. Motazedian and S.E. Grasby:** Petrophysical analysis of geothermal systems at Mount Meager, southwestern British Columbia. 93

Geological Carbon Capture and Storage (CCS)

- M. Nazemi:** Key considerations for carbon dioxide sequestration in the Lower Mainland, southwestern British Columbia 101



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