British Columbia Geological Survey annual program review 2024-2025

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Recommended citation: Hickin, A.S., Cui, Y., Clarke, G., Ootes, L., and van Straaten, B.I., 2025. British Columbia Geological Survey annual program review 2024-2025. In: Geological Fieldwork 2024, British Columbia Ministry of Mining and Critical Minerals, British Columbia Geological Survey Paper 2025-01, pp. 1-15.

Abstract

This paper provides an overview of current British Columbia Geological Survey (BCGS, the Survey) geoscience activities and highlights key findings from 2024 projects. Headquartered in Victoria, the Survey is part of the Responsible Mining and Competitiveness Division in the British Columbia Ministry of Mining and Critical Minerals. The Survey generates geoscience knowledge and data to inform land use and resource management decisions, and to support the growth of British Columbia as a competitive jurisdiction for mineral exploration.

The Cordilleran Geoscience Section conducts field- and office-based research including bedrock and surficial geology mapping programs, regional geochemical surveys, and targeted mineral deposit studies. Critical minerals continued to be a major theme for the Survey and the Survey launched new multi-year projects to address knowledge gaps and gain insights into the mineral systems that contain critical minerals, the origin, age, and geographic distribution of mineralized rocks, and the spatial distribution of critical minerals within ore bodies. One stream of projects examines the mineral systems that host significant deposits and mines, past and present. These projects are assessing if critical minerals could conceivably be added to production as co- or by-products in the short term. A second stream uses foundational mapping, geochronology, geochemistry, and geophysics to focus on the longer term to identify new deposits and to encourage investment in under-explored critical mineral systems. Public engagement was also a major theme in 2024. Given intersecting and diverse interests about mineral resource development in the province, the Survey engagement program provides unbiased geological information to link everyone living in British Columbia to the knowledge needed to balance exploration and mining, environmental and heritage concerns, and economic realities. The Survey is meeting a heightened demand for geoscience information needed to guide land-use decisions and co-management of mineral resources by increased delivery of Mineral Lands Assessment reports that evaluate the significance of mineral resources in an area and the likelihood of mineral exploration and mining continuing in the future. These reports are aided by renewed mineral potential maps that also serve mineral exploration by indicating areas that are more likely and less likely to host mineralization.

The Resource Information Section is responsible for developing and updating provincial geoscience databases and disseminating data online through our geospatial web service (MapPlace). The Section is also responsible for reviewing mineral assessment reports, compiling mineral occurrences, archiving exploration technical documents, and updating mineral resource inventory data. To improve access to critical minerals information and support ongoing studies, the Survey is enhancing its information systems by updating geoscience and mineral resource databases and modernizing legacy information systems to improve efficiency in data processing, managing databases, and delivering web services. The Geoscience Spatial Data Infrastructure (gSDI) project is integrating geoscience and mineral resource databases into a single unified system ready for applied analytics using machine learning.

The Mineral Development Office (MDO) is the Vancouver base of the Survey. It provides investment intelligence to government and global business and publishes the annual Provincial Overview of Exploration and Mining in British Columbia volume. The MDO is staffed by a group of Regional Geologists who, stationed in exploration centres across the province, track minerals activities and provide geoscience expertise in their jurisdictions.

The Survey was awarded $2 million by the Critical Minerals Geoscience and Data (CMGD) initiative to complete four projects dedicated to advancing critical resource information. As a co-applicant, the Survey was awarded two National Science and Engineering Research Council (NSERC) Alliance Grants intended to support research activities that will advance Canadian knowledge about critical minerals and grow Canadian expertise.

1. Introduction

The British Columbia Geological Survey (BCGS, the Survey), a branch in the Responsible Mining and Competitiveness Division of the British Columbia Ministry of Mining and Critical Minerals, has provided public geoscience services to the people of British Columbia since 1895. Because many modern societal issues centre on the Earth sciences, the need for objective, reliable, evidence-based geoscience provided by the BCGS has become increasingly important. Credible unbiased geoscience is of particular value for the exploration and mining of critical minerals, building relationships with Indigenous Peoples, and informing everyone living in the province about minerals-related issues. Headquartered in Victoria, the Survey creates and disseminates public geoscience information that supports effective mineral exploration, sound land use management, and responsible governance. The Survey

is the primary repository for provincial geoscience knowledge. Maps, reports, and databases are freely available online and are public resources for Indigenous groups, local communities, the minerals industry, public safety agencies, environmental scientists, research organizations, and other government agencies. Current research programs and publications (Figs. 1, 2) continue to define the geological evolution and mineral resources of the province, generating knowledge and data to support decisions that balance economic, environmental, and community interests.

The BCGS consists of three sections: 1) Cordilleran Geoscience; 2) Resource Information; and 3) the Mineral Development Office. The Cordilleran Geoscience Section generates new knowledge through field, laboratory, and office-based research activities including geological mapping programs, regional geochemical surveys, and targeted geological and mineral deposit studies. The Cordilleran Geoscience Section also curates the provincial archive of field samples, enabling the Survey and its partners to re-examine legacy specimens as analytical techniques evolve, and maintains laboratory facilities to process and examine field samples. The Resource Information Section is responsible for developing and updating provincial geoscience databases and disseminating data online through our geospatial web service (MapPlace). The Resource Information Section is also responsible for reviewing mineral assessment reports, compiling mineral occurrences, archiving exploration technical documents, and updating mineral resource inventory data. The Mineral Development Office (MDO) is the Vancouver base of the Survey and provides investment intelligence to government and global business. The MDO is staffed by a group of Regional Geologists who, stationed in exploration

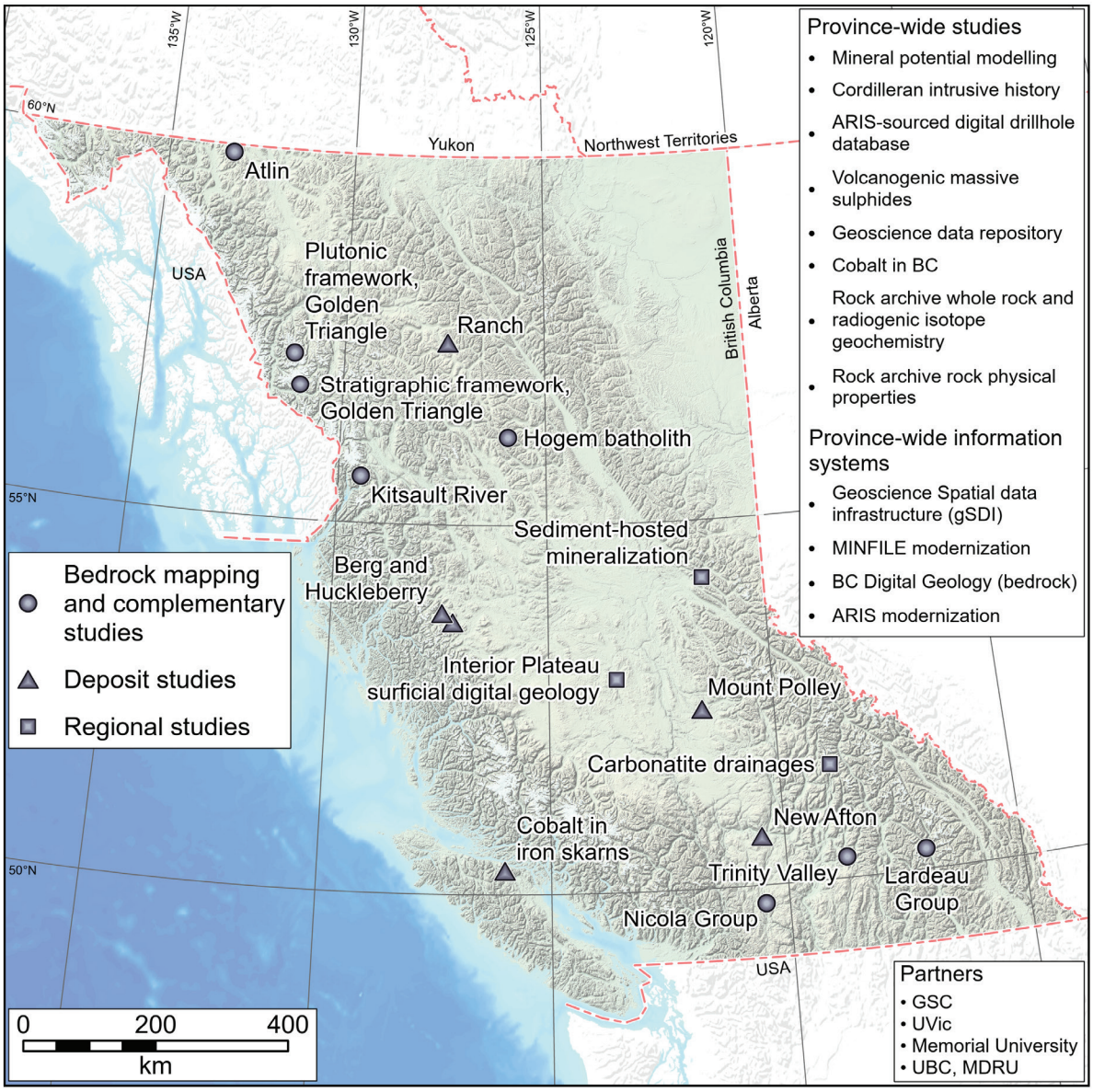
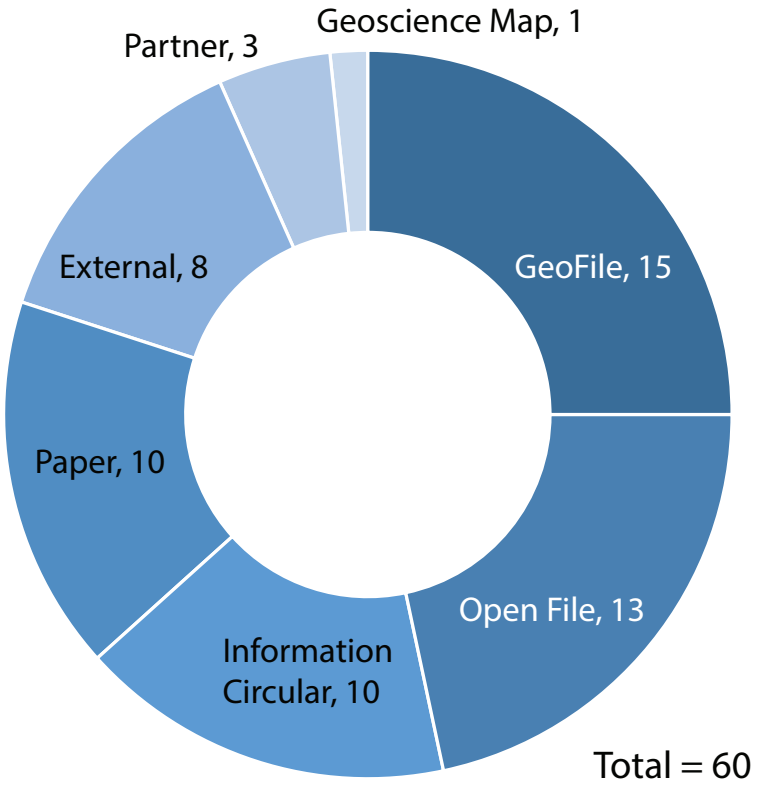


Fig. 1. British Columbia Geological Survey projects in 2024.



Papers*: This series is reserved for reviews and final thematic or regional works. Geological Fieldwork, our annual review of field activities and current research, is released as the first Paper of each year.

Geoscience Maps: This series is the BCGS vehicle for publishing final maps.

Open Files: These maps and reports present the interim results of ongoing research, particularly mapping projects.

GeoFiles: These publications enable rapid release of extensive data tables from ongoing geochemical, geochronologic, and geophysical work. As such, they serve the same function as data repositories provided by many journals, providing immediate access to raw data from specific projects.

Information Circulars: These publications provide accessible geoscience information to a broad audience in government, industry, and the general public. Included in the Information Circular series is the annual Provincial Overview of Exploration and Mining in British Columbia.

Contributions to partner publications: This category includes reports, maps, and other products published by another agency such as the Geological Survey of Canada or Geoscience BC, but have received contributions from British Columbia Geological Survey staff.

External publications: These are contributions to the peer reviewed literature and published in a recognized national or international scientific journal.

*The count refers to the total number of articles authored by BCGS personnel in a volume.

Fig. 2. Types and numbers of publications produced by the British Columbia Geological Survey in 2024.

centres across the province, track mineral exploration activities and provide geoscience expertise in their regions. The MDO publishes the annual Provincial Overview of Exploration and Mining in British Columbia volume (Clarke et al., 2025).

2. Critical minerals

Critical minerals continue to be a major theme for the Survey in 2024. Together with strong environment, social, and governance (ESG) performance and the geological potential of the province, the search for critical minerals presents a generational opportunity to support a thriving economy, attract investment, and build meaningful partnerships with Indigenous Peoples. The Critical Minerals Atlas inventory (Hickin et al., 2023, 2024) was the initial step in evaluating critical minerals that might be produced in the province and in building awareness of critical minerals opportunities for the

exploration and mining industries. In 2024, the Survey launched new multi-year projects to address knowledge gaps and gain insights into the mineral systems that contain critical minerals, the origin, age, and geographic distribution of mineralized rocks, and the spatial distribution of critical minerals within ore bodies (Fig. 1).

One stream of projects examines the mineral systems that host significant deposits and mines, past and present. These projects are assessing if critical minerals could conceivably be added to production as co- or by-products in the short term. This stream includes porphyry deposit studies such as at Huckleberry and Berg (Orovan et al., 2025), Kitsault (Miller et al., 2025), Galore Creek (Campbell and van Straaten, 2025), New Afton, and Mount Polley, sedimentary exhalative (SEDEX) deposit studies (Sullivan, Cirque; Graham et al., 2025), a study of cobalt-bearing iron skarns on Vancouver Island and Texada Island (Bain et al., 2025), and continued work on the E&L nickel-copper-platinum group element (PGE) deposit.

A second stream focusses on the longer term to identify new deposits and to encourage investment in under-explored critical mineral systems. These projects include foundational mapping, geochronology, geochemistry, and geophysics. Some of these studies were regional, such as bedrock mapping in the Golden Triangle that focused on volcanogenic massive sulphide (VMS), porphyry, and epithermal deposits (Campbell and van Straaten, 2025, Miller et. al. 2025) and, in the eastern part of the province, evaluating geochemistry and indicator minerals in modern drainages to develop exploration tools for fingerprinting upstream carbonatite-hosted niobium, tantalum, rare earth element (REE), and other critical mineral deposits (Rukhlov et al., 2025a). Many projects are province wide in scope, such as: 1) developing a modernized magmatic framework for critical mineral-bearing intrusive systems using high-precision age and isotopic tracer data to establish the age, emplacement setting, and geographic distribution of both fertile and barren intrusions (Ootes and Wall, 2024); 2) re-analyzing archived samples using modern whole-rock, trace element, and isotopic methods to understand the geological settings important for mineralization, including delivery of the province's first radiogenic tracer isotope data compilation (Han et al., 2025; Rukhlov et al., 2025b); 3) measuring physical properties (density, magnetic susceptibility, porosity) of archived samples to improve geophysical interpretations and enhance fertility assessments remotely; 4) revitalized mineral potential modelling of critical mineral-bearing systems to establish which regions are favourable for hosting mineralization (Wearmouth et al., 2024a, b, c); 5) examining critical minerals in volcanogenic massive sulphide (VMS) deposits (Piercey et al., 2025); 6) examining critical minerals in deposits related to sedimentary rocks (Graham et al., 2025); 7) digitizing assessment reports and creating databases to enable easy extraction of critical mineral occurrences that may have been overlooked in original work (Fortin and Silva, 2025); 8) creating a geoscience data repository (data lake) of historical records to enable machine learning and artificial intelligence interrogation of unrecognized critical mineral-bearing mineral occurrences; 9) reviewing British Columbia cobalt occurrences; and 10) developing an updated compilation of high-resolution aeromagnetic data (Oneschuk et al., 2024).

To improve access to critical mineral information and support these studies, the Survey is enhancing its information systems by updating geoscience and mineral resource databases (e.g., Han and Rukhlov, 2024) and modernizing legacy information systems to improve efficiency in data processing, managing databases, and delivering web services. The Geoscience Spatial Data Infrastructure (gSDI) project is integrating geoscience and mineral resource databases into a single unified system ready for applied analytics using machine learning.

Survey critical mineral geoscience provides the knowledge that will attract investment and inform decisions, enabling British Columbia to responsibly contribute the raw materials needed to transition to a green economy and curb climate change.

3. Engagement

Public engagement is also a major theme for the Survey. Given intersecting and diverse interests about mineral resource development in the province, the Survey engagement program provides unbiased geological information to link everyone living in British Columbia to the knowledge needed to balance exploration and mining, environmental and heritage concerns, and economic realities. Through its engagement program, the Survey is connecting Indigenous Peoples, local communities, government, the minerals industry, and the public to the geology and mineral resources of the province. This work enhances land-use planning and resource co-management, addresses diverse interests about resource development, and helps foster relationships. The Survey strives to be an ally and trusted broker of information and expertise about geological resources to rights holders across the province.

Engagement with Indigenous Peoples is of particular focus. The exploration and mining sector is a significant employer of Indigenous people in the province, and there is growing interest from Indigenous communities and leadership to better understand the mineral endowment of their traditional territories. Thus, the Survey links with Indigenous groups to raise awareness of research projects on their lands, identify opportunities and challenges, and explore partnerships. BCGS also provides Indigenous groups with geoscience knowledge and tools to guide resource management and land-use decisions, endeavors to build trusted relationships in all facets of mineral exploration and mining and works to build a common understanding of the natural history and geological resources in the province by sharing traditional knowledge and Western science (Fig. 3).

Using understandable materials tailored for different audiences, the Engagement Geologist communicates technical information to people and communities across the province (Fig. 4).

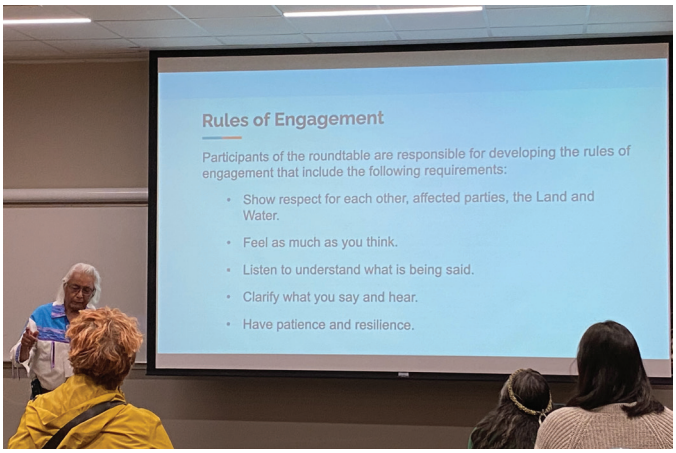


Fig. 3. Copper Joe Jack presenting the Land and People's Relationship Model at the Stenistolw Conference, 2024.

Fig. 4. Public engagement at the 2024 AME Roundup conference.

4. Land-use planning and mineral potential modelling

Land-use decisions and co-management of natural resources require high-quality information, including geological data. These data are necessary to establish the mineral interests in an area and to evaluate the potential economic opportunities for the province, Indigenous groups, and industry. The Survey is meeting a heightened demand for these data by increased delivery of Mineral Lands Assessment reports. These reports establish the geologic context of mineralization in an area, review historical and recent mining and exploration activities, detail known mineral occurrences, summarize active mineral rights, and provide results of mineral potential models that estimate the likelihood of undiscovered occurrences. Based on past and current data, Mineral Lands Assessment reports evaluate the significance of mineral resources in an area and the likelihood of mineral exploration and mining continuing in the future.

The renewed mineral potential mapping being carried out at the Survey (Wearmouth et al., 2024a; Fig. 5) is being used to evaluate the provincial endowment of critical minerals. This modelling is a key component to guide land-use and investment decisions and assist in conversations between parties with diverse interests. Coupled with advances in computing technology, the new modelling takes advantage of information gained since the 1990s and adopts a mineral systems approach to consider the components that control generating deposits. Amenable to machine learning as new data become available, the modelling uses multiple geological features as proxies for complete mineral systems to create maps that portray the relative ranking of mineral potential. Preliminary mineral potential modelling maps have been completed for large parts of northwestern (Wearmouth et al., 2024b) and northeastern (Wearmouth et al., 2024c) British Columbia. These maps indicate areas that are more likely and less likely to host mineralization, information needed by decision makers considering possible future exploration interests, economic opportunities, and proposed changes in land use.

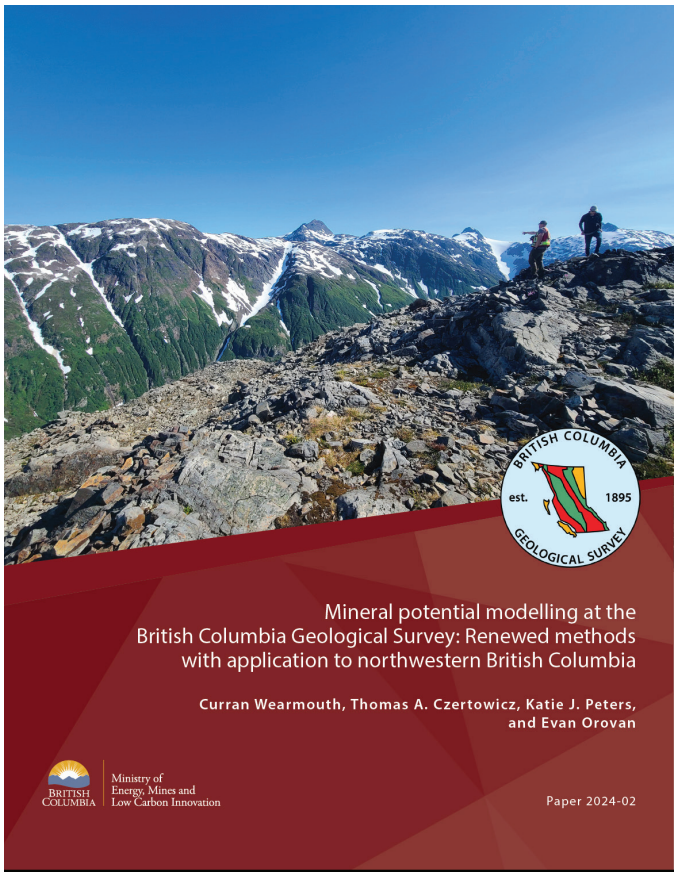


Fig. 5. Mineral potential modelling methods. See Wearmouth et al. (2024a).

5. Partnerships

Partnerships continue to be an effective way for the Survey to lever its resources. Working with other geoscience professionals, agencies, and industry, these partnerships extend across a wide spectrum of collaboration, all with the aim of enhancing public geoscience.

The Geological Survey of Canada (GSC) and BCGS continue to benefit from strong ties. The Survey, GSC, and Geoscience BC cooperated to update and level the provincial aeromagnetic map, which includes all new high-resolution data that have been collected since the mid-2000 (Oneschuk et al., 2024). BCGS and GSC continue to work together on analyzing rock physical properties from the BCGS and GSC rock sample archives. These physical properties provide the link between remote geophysical surveys and in-situ bedrock, thus improving geophysical and geological interpretations. Analyses include density, magnetic susceptibility, and porosity measurements. The physical properties database now incorporates more than 21,000 samples with the intention of reaching a total of 29,000 by the end of 2025/26. This large dataset will enhance the accuracy of geophysical inversions and provide a classification tool to help assess fertility remotely. The Survey has had long-term collaborations with GSC geologists using indicator minerals to help detect mineralization buried in drift-covered areas (e.g., Ferbey et al., 2017). This collaboration continued with Plouffe et al. (2024) examining detrital epidote in subglacial tills derived from alteration haloes at the Highland Valley Copper, Gibraltar, Mount Polley, and Woodjam porphyry copper deposits.

The Critical Minerals Geoscience and Data (CMGD) initiative was launched in 2023, and BCGS was awarded approximately $2 million to complete four projects in the next three years. This initiative is dedicated to advancing critical mineral resource information by providing essential knowledge and data. One project builds on recently published work of Rukhlov et al. (2024) to evaluate areas prospective for rare metals such as niobium, tantalum, and rare earth elements (REE) through re-analysis of archived stream-sediment samples (Rukhlov et al., 2025a). Another project is directed at populating a province-wide drillhole database by extracting information from assessment reports submitted by the mineral exploration industry (Fortin and Silva, 2025). This pilot project is intended to generate a provincially maintained database of drillholes and assays, which will enable explorationists to minimize duplicating work. Many intrusions across the province are temporally and spatially related to mineralized systems. These systems formed during relatively narrow geological time windows; thus high-precision geochronology is needed to increase exploration success (e.g., Ootes and Wall, 2024). The third project aims to triple the amount of modern, high-precision U-Pb zircon age data using chemical abrasion isotope dilution mass spectrometry (CA-TIMS) and associated trace elements and isotopes ($\delta^{18}O$; εHf). These data will be available to the public to enable better modelling of critical mineral potential of intrusive rocks in British Columbia. The fourth CMGD project is a geoscience data repository (data lake) initiative for the Canadian Cordillera. Under this project, British Columbia is collaborating with Yukon to develop a new, comprehensive, integrated database that will contain scanned historical data with optical character recognition (OCR) to enable machine learning applications search for unrecognized critical mineral-bearing occurrences contained in assessment reports.

As co-applicants, BCGS and collaborators were successfully awarded two National Science and Engineering Research Council (NSERC) Alliance Grants. These grants are intended to provide support for research activities that will advance Canadian knowledge, models, processes, tools, and technologies that support data-driven decisions of domestic critical mineral value chains and grow Canadian expertise. One grant, focusing on the mineralogy and genesis of critical mineral-bearing volcanogenic massive sulphide (VMS) deposits, the enrichment of critical elements in these deposits, and the processes that lead to enrichment, was awarded to Memorial University of Newfoundland. The work, reported on by Piercey et al. (2025), will provide information on critical element mineral residence, siting, and textures and will use both existing sample suites from archives, and new samples from deposit sites. The end goal of this project will be to provide refined descriptive, genetic, exploration, and development models for critical metal-bearing VMS deposits and in so doing provide an updated metallogenic model for this deposit type that can be used in British Columbia, all of Canada, and globally. Complementing ongoing BCGS activities (Graham et al., 2025, see below), a second grant was awarded to the Mineral Deposit Research Unit (MDRU), University of British Columbia and will focus on sedimentary exhalative (SEDEX) and Mississippi Valley Type (MVT) mineral systems.

Since 2003, the British Columbia Ministry of Mining and Critical Minerals has had a formal partnership with the University of Victoria (UVic). In 2023, BCGS and UVic's School of Earth and Ocean Science initiated two research projects directed at critical minerals. The first project is evaluating magnetite as a porphyry indicator mineral and establishing a workflow for use in critical mineral exploration (Morris et al., 2025). The second project is assessing the post-emplacement exhumation of the Hogem batholith in north-central British Columbia using apatite fission track data to clarify the porphyry potential of various phases of the intrusive complex (Fig. 6; Wang et al., 2025).

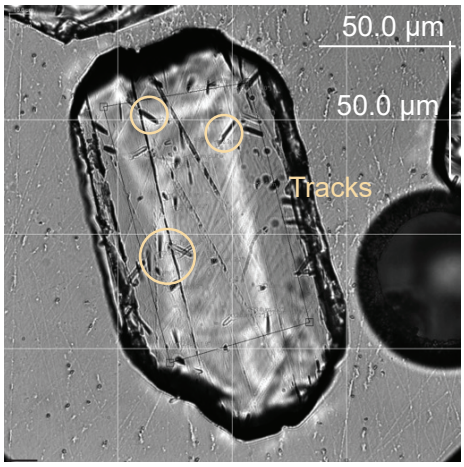


Fig. 6. Fission tracks in apatite, Hogem batholith. See Wang et al. (2025).

BCGS also works directly with industry partners, sharing data and logistics in the field. These formal and informal agreements enable access to industry samples (usually core) and data that can be compiled to provide regional links between properties within a camp, district, or mineral belt. Sharing logistics reduces costs for the BCGS enabling more resources to be directed at generating data and optimizing research.

6. Cordilleran Geoscience Section

Section geologists collect fundamental geoscience data through single and multi-year field-based programs complemented by laboratory and office-based studies. These programs include regional-scale mapping, mineral deposit studies, and new mineral exploration method development. Section expertise encompasses tectonics, structural geology, stratigraphy, petrology, metallogeny, Quaternary and surficial geology, critical minerals, and geochemistry.

6.1. British Columbia rock archive

The BCGS archive is home to rock, mineral, and geochemical samples collected from across the province (Rukhlov et al., 2023). These collections represent a valuable resource for public geoscience, supporting re-analysis using modern comprehensive and high-precision analytical methods for new geoscience initiatives. Since 2023, BCGS has catalogued more than 150,000 samples and 100s of samples are being re-analyzed for whole rock major and trace elements and radiogenic isotope geochemistry. Geochemical analysis is a basic geological tool for classifying and understanding the geological settings important for mineralization. However, not all rocks in the archive have the modern high-precision whole rock major and trace element analyses that provide essential information for critical minerals and their host deposits. In addition, radiogenic isotopic systems serve as lithospheric tracers to characterize geological terranes and lithospheric architecture to aid predictive exploration targeting. BCGS has compiled a database of more than 1400 rock samples with isotope analyses from the literature (Han et al., 2025; Rukhlov et al., 2025b). In 2023 through early 2025, new analyses include results from more than 350 samples related to porphyry copper-gold-molybdenum mineralization.

6.2. Mineral systems assessment

6.2.1. Cobalt mineral systems

Cobalt has been identified as an essential battery metal, but knowledge about cobalt that could conceivably be recovered as a co-product or by-product in the province is limited. A review of cobalt currently in progress is aimed at: 1) characterizing cobalt mineral deposits globally, 2) highlighting cobalt occurrences in the province; and 3) identifying favourable geology for cobalt-bearing deposits in the province. Continuing work on iron skarns, which commonly contain cobalt, Bain and de Waal (2025) used scanning electron microscopy-mineral liberation analysis (SEM-MLA) data to examine the distribution and minerology of cobalt in occurrences on Vancouver Island and Texada Island.

6.2.2. Porphyry and epithermal mineral systems

Porphyry deposits are major global sources of copper and molybdenum, both on the 2024 version of the Canadian critical minerals list (NRCan, 2024). These deposits may also contain minor amounts of companion metals that are on the critical minerals lists of many political jurisdictions and that could conceivably be by-products of primary commodity mining (e.g., bismuth, the platinum group elements (PGE), rhenium, tellurium, and tungsten). Recent studies at the Survey have focussed on porphyry epithermal systems including the Kisault Mo deposit (Orovan et al., 2024), and the Huckleberry and Berg Cu-Mo deposits (Orovan et al., 2025). A substantial component of the annual provincial mineral exploration expenditure is devoted to porphyry and porphyry-related occurrences in the northwest part of the province, particularly in the loosely defined area informally known as the Golden Triangle (Clarke et al., 2025). The Survey has had a continuous presence in the region for many years (e.g., Nelson et al., 2018, 2022; Miller et al., 2020; Nelson and van Straaten, 2020; Hunter et al., 2022; van Straaten, 2024) and continues with work by Miller et al. (2025) and Campbell and van Straaten (2025) directed at establishing stratigraphic, magmatic, geochronological, and tectonic frameworks to guide exploration (see below).

Emphasizing the need for high-precision U-Pb zircon geochronology by chemical abrasion isotope dilution thermal ionization mass spectrometry (CA-TIMS) to resolve temporal uncertainties arising from less precise laser ablation inductively coupled plasma mass-spectrometry (LA-ICP-MS) in rapidly evolving regions, Ootes and Wall (2024) presented new data indicating that the Toodoggone Formation in the north central part of the province post-dates crystallization of the main phases of the Black Lake intrusive suite, and that epithermal mineralization in the Toodoggone Formation cannot be temporally linked to these intrusive rocks. Mihalynuk et al. (2025) also present new CA-TIMS data from the Nicola arc in south central British Columbia, an area of prolific porphyry mineralization, to establish the time of deposition of key units in the Nicola Group (e.g., Fig. 7), concluding that this mineralization is bracketed to 222.0 and 202.6 Ma, and that the Nicola arc was largely extinguished by 201.3 Ma.

6.2.3. Geochronology of intrusive magmatic rocks

Establishing the radiometric ages of rocks is essential to understanding the geological evolution of the province, including the origin and context of mineral deposits. Because magmatic deposits are restricted in time and space, the Survey has embarked on a project to develop a modernized framework for intrusive systems, which are commonly spatially and temporally related to deposits containing critical minerals. This project, with support from Critical Minerals Geoscience and Data (CMGD) program funding, is yielding new high-precision U-Pb radiogenic ages using single zircon (CA-TIMS) and isotopic tracer data to establish the age, emplacement setting,

Fig. 7. Geochronologic sampling of the Nicola Group, Shrimpton Formation. See Mihalynuk et al. (2025).

and geographic distribution of both fertile and barren intrusions. New CA-TIMS results are reported and used in Ootes and Wall (2024), Mihalynuk et al. (2025), Bailey et al. (2025), Campbell and van Straaten (2025), and Miller et al. (2025). At the conclusion of the project, we expect to add a total of 120 new ages thereby tripling the amount of high-precision data available in the province. Both zircon trace element, $\delta^{18}O$, and εHf will be collected by micro-analyses before TIMS analyses, building out an expansive modern publicly available dataset.

6.2.4. Sedimentary rock mineral systems

British Columbia and Yukon contain several sedimentary basins with significant deposits of lead, zinc, and silver as primary commodities. These basins may also contain lesser, but possibly recoverable, quantities of cobalt, indium, gallium, and germanium elements that are on many global critical minerals lists. However, the tonnage, grade, and ratios of these companion metals remains largely unknown and thus their economic and strategic significance is unclear. This National Science and Engineering Research Council (NSERC)-supported project, conducted in collaboration with the University of British Columbia's Mineral Deposits Research Unit (MDRU), is operating from the basin to mineral scales to address: 1) the controls that depositional environments and basin history play on critical metal endowment; 2) the controls on the relative enrichment of companion critical elements relative to lead and zinc, which are typically spatially and temporally associated in the form of galena and sphalerite; and 3) the opportunities for critical minerals recovery in historically producing mine tailings. Findings from the project will be used to inform decisions made by mineral explorationists and guide government about possible opportunities at historical mining operations.

In the initial report of the project, Graham et al. (2025) examine sedimentary exhalative (SEDEX) archived samples from the historical Sullivan mine (Belt-Purcell basin, Mesoproterozoic, southeastern British Columbia) and the Cirque project (Kechika trough, Upper Devonian, northeastern British Columbia), providing preliminary results of bulk-rock geochemical analyses to assess the critical companion metal content of Sullivan ore and Cirque mineralization in the context of mineral potential mapping of the northeastern part of the province that highlights prospectivity for SEDEX deposits.

6.2.5. Volcanogenic massive sulphide (VMS)

Volcanogenic massive sulphide (VMS) deposits are important sources of metals, including copper and zinc as primary commodities, and numerous minor element that are important for electrification of the energy and transportation sectors. Using archived samples from across the province (e.g., Fig. 8), Piercey et al. (2025) provide the first progress report of a

Fig. 8. Historical Hidden Creek deposit workings of volcanogenic massive sulphides in the Anyox camp. See Piercey et al. (2025).

collaborative National Science and Engineering Research Council (NSERC)-funded project at Memorial University of Newfoundland with results from bulk-rock geochemistry, reflected light microscopy, and scanning electron microscopy-mineral liberation analysis (SEM-MLA) that reveal the mineralogy and residence of companion critical metals such as antimony, bismuth, cobalt, indium, nickel, tellurium, and tin.

6.2.6. Carbonatites

Carbonatites and related rock types host niobium-tantalum-rare earth elements (REE) deposits, and the Survey is assessing under-explored opportunities for these commodities. Recent work has been directed at whole rock lithogeochemistry and (Sr-Nd-Pb) isotopic data from the: Mount Copeland nepheline syenite (ca. 800 Ma); Ren carbonatite (ca. 692 Ma); Little Chicago (Fig. 9) and Felix carbonatites (ca. 500 Ma); Three Valley Gap carbonatite (ca. 380 Ma); and a recently discovered carbonatite occurrence at Boulder Mountain (ca. 360 Ma).

Fig. 9. Example of tectonically layered, light-toned dolomite-calcite carbonatite and dark-toned clinopyroxene-amphibole-phlogopite rock (fenite) crosscut by light-toned calcite veins; Little Chicago occurrence, Blue River area, east-central British Columbia. See Rukhlov et al. (2025a).

Building on recently published work (Rukhlov et al., 2024), the lithogeochemistry of bulk stream sediment and panned heavy mineral concentrate samples downstream of known carbonatite and alkaline-rock occurrences in the British Columbia carbonatite belt is further examined by Rukhlov et al. (2025a). Both lithogeochemistry and indicator minerals enable assessing watersheds upstream of drainage sampling sites and thus identify new prospective areas. Combined with automated mineralogy the results presented by Rukhlov et al. (2025a) will guide the province-wide re-analysis of archive samples.

6.3. Geological mapping

Geological mapping is the most fundamental form of geological research and remains core to BCGS activities. Miller et al. (2025) continued work in the southern part of the Golden Triangle (Kitsault River area) with new mapping, U-Pb zircon geochronology, and stratigraphic studies to provide a framework for understanding the geological setting of the Hazelton Group (Fig. 10) and establish the geological setting of latest Triassic to Early Jurassic VMS, epithermal, and porphyry mineralization. Miller et al. (2025) report that the lower part of the Hazelton Group records a period of prolific volcanism that almost completely overlaps with ages returned from the Texas Creek plutonic suite which hosts and is coeval with porphyry copper-gold mineralization and epithermal gold mineralization in the Kitsault River area, and that rocks in the upper part of the Hazelton Group are coeval with VMS and epithermal silver-zinc-lead mineralization. Working in the northern part of the Golden Triangle (Telegraph Creek and Oweegee dome areas), Campbell and van Straaten (2025) report on the first year of a project to establish the framework for Paleozoic to Eocene plutonism (Fig. 11) and related major porphyry and porphyry-related deposits (e.g., Schaft Creek, Galore Creek, Copper Canyon) providing detailed descriptions and 16 previously unpublished U-Pb zircon ages from four Late Triassic to late

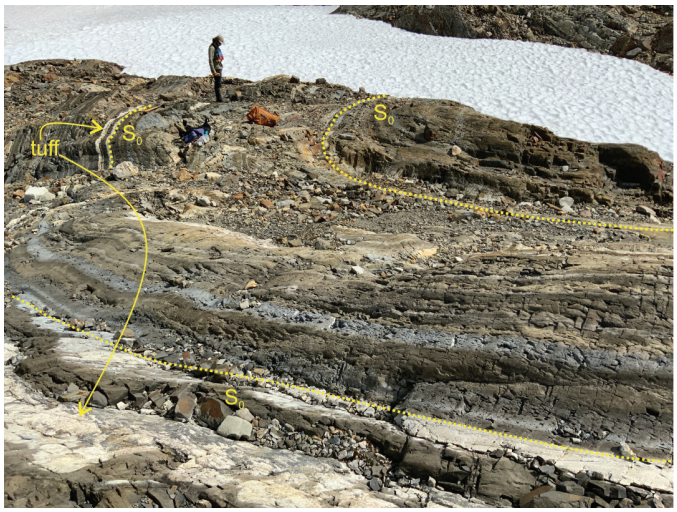


Fig. 10. Folded siltstone, sandstone, limestone, and light-weathering tuff beds. Hazelton Group, Smithers Formation, unnamed volcano-sedimentary unit. See Miller et al. (2025).

Fig. 11. Fine- to medium-grained hornblende diorite in contact with porphyritic diorite containing blocky poikilitic hornblende. Stikine plutonic suite unnamed dioritic pluton east of Mess Creek. See Campbell and van Straaten (2025).

Early Jurassic plutonic suites (Stikine, Galore, Texas Creek, and Cone Mountain). Also in the northern part of the Golden Triangle, Sauvé et al. (2025) produced a Quaternary geology map of the Red Chris mine area (Fig. 12). Working in the southeastern part of the province, Höy and Jackaman (2024a, b) released bedrock maps for the Castlegar and Rossland-Trail areas, a partnership with Geoscience BC. Wilson et al. (2024) produced a series of nine maps depicting the distribution, lithostratigraphy, geochemistry, geochronology, and petrography of Pleistocene and Holocene glaciovolcanic units in Garibaldi volcanic belt of southwestern British Columbia.

Large tracks of British Columbia's bedrock are covered by thick sequences of Quaternary and Holocene sediments, especially in the Interior Plateau. These sediments and their related geomorphology have been mapped at various scales and for a variety of purposes (e.g., Quaternary geology maps, soil maps, terrain maps). In 2024, the Survey updated its Quaternary geology map index compilation by scanning and indexing all available Quaternary geology-related maps (Veness et al., 2024). This is the initial phase of a multiyear project to create a fully attributed digital Quaternary Geology map for the Interior Plateau. Completing a long-term project in the Interior Plateau, Elia et al. (2024a) used remotely piloted aircraft (drone) to map surficial sediments using lidar, Ferbey et al. (2024) quantified potassium concentrations in surface sediments using drone-mounted gamma-ray spectrometry, and Elia et al. (2024b) investigated surface sediment composition using a drone-mounted magnetometer (Fig. 13).

Fig. 12. Rats tail in pebbly sandstone, near Red Chris mine; arrow shows the sense of ice flow. See Sauvé et al. (2025).

Fig. 13. DJI Matrice 600 Pro aircraft mounted with a GSMP-35U magnetometer (DRONEmag) flying from right to left at a height of about 7.5 m above ground level. See Elia et al. (2024b).

7. Resource Information Section

The Resource Information Section manages province-wide geological and mineral resource databases and their disseminations via web services, including the digital coverage of bedrock geology (BC Digital Geology), assessment report index system (ARIS), mineral inventory (MINFILE), coal information (COALFILE), geochemical and geophysical surveys, and collections of previously unpublished private documents donated by government, universities, industry, and individuals (Property File). The Survey operates a few dozen information systems to update these databases and deliver them through web portals and MapPlace, the BCGS geospatial web service. As part of the Survey's digital transformation efforts, information systems are being re-engineered to build the foundation of a geoscience Spatial Data Infrastructure (gSDI), to improve efficiency in operating and updating databases, further digitalize analytical-ready geoscience information, and enable interoperable data sharing. The Survey continues digital data capturing from sources such as assessment reports.

7.1. Geoscience Spatial Data Infrastructure

The BC Geological Survey has a plan to build the foundation of a geoscience Spatial Data Infrastructure (gSDI) in the next three years. Geoscience and mineral resource data are inherently interconnected, both in terms of context and data lifecycle. The

Survey's current geoscience infrastructure consists of disparate databases and applications developed in the past 20 years. These systems, built on a range of outdated or legacy technologies are increasingly difficult to maintain, and lack interconnections. To streamline data updates and facilitate the creation of new data products and web services these databases must be cohesively linked on a unified platform.

7.2. MapPlace

MapPlace is the Survey's geospatial web service that allows users to discover, visualize, search, and generate summary reports and maps from province-wide geoscience databases. Easy access to geoscience maps and data is crucial for making informed decisions on mineral exploration, mining, environmental protection, and land-use management. MapPlace serves as a platform to facilitate data mining and analysis of geoscience information in the context of other data such as mineral titles, assessment reports, land ownership, public infrastructure, and topographic base maps. Some of the data layers and applications are specifically developed to enable research and analytics for mineral exploration and prospecting. In 2024, MapPlace was migrated to a new web server with an upgrade to MapGuide Open Source version 4.0, which restored some of the third-party topographic and imagery services (e.g., Google Maps).

7.3. ARIS assessment reports and database

Results of mineral exploration are submitted by industry as assessment reports to the government in compliance with the Mineral Tenure Act Regulation. After a one-year confidentiality period, the assessment reports become freely available to the public. The Survey manages these reports in the Assessment Report Indexing System (ARIS) database with a web interface to search them by locations, mineral occurrences, commodities, claims, and work types. ARIS contains more than 40,660 reports dating back to 1947. All the assessment reports are available online as PDF documents through the ARIS website, and more than 800 of them contain data (e.g., geochemical analyses and geophysical surveys) in common digital data formats that can be readily used.

The ARIS team reviewed and approved 1313 assessment reports in 2024. The large number of submitted reports was partially a backlog accumulated in 2023 from the Chief Gold Commissioner's Time Extension (protection) Order of March 2020 during COVID-19.

The Survey has set up an Assessment Report and Digital Data Submission portal, to encourage inclusion of digital files such as spreadsheets, databases, GIS maps, and grids in report submissions. Explorationists will benefit because digital data can be easily retrieved, integrated, and recast for specific needs. Digital submission will also enable the Survey to better maintain province-wide databases and create derivative products that use past results to guide future exploration. Both assessment reports and digital data can be uploaded through the ARIS data submission page.

7.4. MINFILE mineral occurrence database

MINFILE is a database containing geological, location, and economic information for more than 16,160 mineral, coal, and industrial mineral mines, deposits, and occurrences in British Columbia. In addition to spatial and non-spatial search and visualization on MapPlace, a dedicated web search interface is available to query the database and retrieve details such as geological setting, deposit type, mineralogy, age, commodity, host rock, resources, production, and source of information. Query results are available to download as summary reports, spreadsheets, and Google Earth files (KML). MINFILE/pc is a portable extract of the MINFILE database with a built-in search interface and printable reports. The Survey has transformed part of the MINFILE mineral occurrence data to be compliant with the Open Geospatial Consortium (OGC) standard EarthResourceML Lite schema and mapped the contents using the vocabularies adopted by the International Union of Geological Sciences (IUGS) Commission for the Management and Application of Geoscience Information (CGI). The EarthResourceML Lite-compliant mineral occurrence data is accessible via the OneGeology portal and open standard-based interface such as the OGC Web Mapping Service (WMS) and Web Feature Service (WFS) specification. These OGC-compliant web services are available to be part of the Canadian adoption of the EarthResourceML Lite standard with other Canadian jurisdictions.

In 2024, the Survey started a system modernization of the MINFILE database and will develop a new web application compliant to the current government technology standard. The new system will become one of foundational components in the geoscience Spatial Data Infrastructure. A subset of the MINFILE data is available on the BC Critical Minerals Explorer web application for the public to view the mineral occurrences that to critical mineral in the province.

7.5. British Columbia Digital Geology

In 2024, the Survey started a system modernization project to deploy the BC Digital Geology database from a working prototype to a corporate database environment, eventually to be one of foundational system components in the geoscience Spatial Data Infrastructure. The project will refine the workflow, improve the system architecture, and extend the data models to support the operation, data integration, and creation of data products. The Survey offers province-wide digital coverage of bedrock geology including details from field mapping, with a typical regional compilation at a scale of 1:50,000. A geospatial frame data (GFD) model is used to simplify the compilation and integration of new regional mapping into the BC Digital Geology database (Cui, 2021). Bedrock geology is standardized with consistent stratigraphic coding, ages, and rock types to enable computations, and is available for download in GeoPackage and Esri shapefile formats. Customized bedrock geological maps and legends can be explored, and data downloaded as Google Earth file (KML) by spatial and non-spatial queries via MapPlace. The BCGS

has transformed digital geology to the GeoSciML Lite schema and mapped the contents using the vocabularies adopted by the International Union of Geological Science (IUGS) Commission for the Management and Application of Geoscience Information (CGI). The GeoSciML Lite-compliant digital geology is accessible via the OneGeology portal and open standard-based interface such as Web Mapping Service (WMS) and Web Feature Service (WFS) specification, to enable interoperable data sharing and analytics.

7.6. Other databases

The Survey also manages dozens of other databases. COALFILE includes a collection of assessment reports, dating back to 1900. Property File is a collection of spatially referenced archived reports, maps, photos, and technical notes documenting mineral exploration activities in British Columbia since the late 1800s. The provincial geochemical databases hold field and geochemical data from multi-media surveys by the Geological Survey of Canada, the BCGS, and Geoscience BC. The databases are updated regularly and contain results from the Regional Geochemical Survey program, till surveys, and lithogeochemical samples. Accompanying the physical relocation and rationalization of the BCGS Sample Archive in 2022, a modern digital inventory was created for integration with other provincial datasets (Rukhlov et al., 2023).

7.7. Digital data capturing

The Survey continues digital data capturing from assessment reports. In addition to some of the geochemical data from surface sediment samples in assessment reports, work has commenced to capture drillhole digital data from assessment reports, including collar information, major lithology, and sample intervals with assays (Fortin and Silva, 2025).

8. Mineral Development Office (MDO)

Mining contributes greatly to the economy of British Columbia, and exploration is the backbone of mining. More than 1000 exploration and mining companies are headquartered in Vancouver. In addition, the exploration and mining industry is particularly important for northern communities and some Indigenous groups, employing more than 40,000 people. Between 2019 and 2023, the total value of mining production was $63.4 billion, and the exploration expenditure was $2.8 billion. For 2024, the forecast value of mine production is $16.5 billion, and the exploration expenditure is estimated at $552 million (Clarke et al., 2025).

The Mineral Development Office (MDO) is the Vancouver base of the British Columbia Geological Survey. Regional Geologists (Table 1) are part of the MDO and are stationed at exploration centres across the province (Smithers, Prince George, Kamloops, Vancouver) where they provide geoscience expertise and monitor local industry activities. Public geoscience is one of the principal enablers of grassroots mineral exploration, the backbone of mining. The MDO provides technical information and investment intelligence to global business, government, and Indigenous groups.

Table 1. British Columbia Regional Geologists.

Regional Geologist	Office	Region
Nate Corcoran	Smithers	Northwest
Hassan Heidarian	Prince George	Northeast and North Central
Cary Pothorin	Kamloops	South Central
	Cranbrook	Southeast
Bruce Northcote	Vancouver	Southwest

The Mineral Development Office serves mineral resource decision making by: linking exploration and mining companies to provincial mineral and coal information; conducting an annual expenditure and drilling survey to analyze short- and long-term industry trends (EY LLP, 2025); producing the annual Provincial Overview of Mining and Exploration volume, a summary of mining and exploration projects, activities, production and expenditures (Fig. 14; Clarke et al., 2025), responding to requests from government and Indigenous groups for mineral resource data needed for land-use planning and to support decision makers; and providing mineral resource, project, and technical data to government groups.

The Mineral Development Office promotes British Columbia as a preferred jurisdiction for mineral exploration by providing

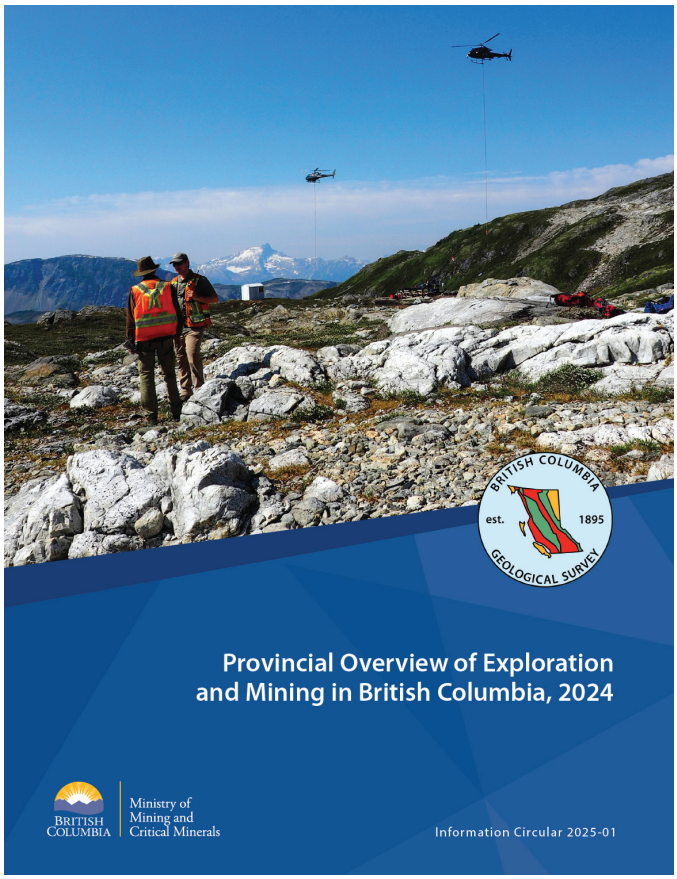


Fig. 14. Provincial Overview of Mining and Exploration in British Columbia annual volume, Information Circular 2025-01 (see Clarke et al., 2025).

information to international trade offices and meeting with global industry representatives seeking technical discussions about potential projects.

9. Staffing

BCGS is currently staffed by 36 permanent employees (Fig. 15) but six vacancies remain, resulting from retirements, departures, and growth. Competitions continued in 2024 to fill these vacancies. In addition to its complement of permanent staff, the Survey hires 8-12 seasonal or term employees each year, usually university students or recent graduates, to aid safe fieldwork or to assist in targeted projects.

BCGS had several personnel changes in 2024. Marc-André Brideau accepted the directorship of the Cordilleran Geoscience Section, and Audrey Graham joined the Survey as a Mineral Deposits Geologist. We welcome Pablo Silva, a new hire who joined the Resource Information Section as geomatics geoscientist, as did Fiona Katay who returned to the Survey. Matthew Brzozowski and Wyatt Bain have accepted academic positions, while Evan Orovan and Paulina Marczak are pursuing opportunities outside the Survey. After more than four decades serving as a field geologist at the BCGS, Paul Schiarizza retired in 2024. We are extremely grateful to Paul for his dedication, good humour, and the contributions he made to better understand the geology of British Columbia.

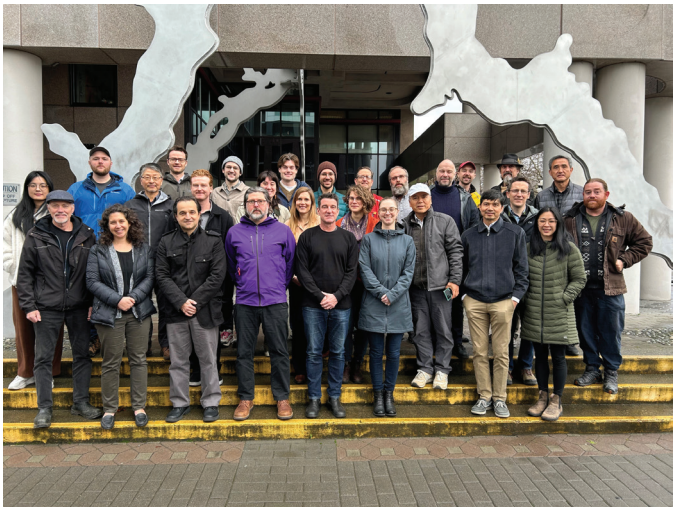


Fig. 15. British Columbia Geological Survey staff.

Acknowledgment

We thank George Owsiacki of Total Earth Science Services (Victoria) for desktop publishing this volume.

References cited

Bailey, L., Kim, R., Takaichi, M., Logan, J., Crowley, J., Friedman, R., Wall, C., van Straaten, B.I., and Campbell, R., 2025. U-Pb geochronology data for intrusive rocks in the Schaft Creek and Galore Creek areas, northwestern British Columbia. British Columbia Ministry of Mining and Critical Minerals, British Columbia Geological Survey GeoFile 2025-14, in press.

Bain, W.M., de Waal, F., and Goudie, D.J., 2025. Co-Te mineralization in iron skarns on Vancouver Island and Texada Island. In: Geological Fieldwork 2024, British Columbia Ministry of Mining and Critical Minerals, British Columbia Geological Survey Paper 2025-01, pp. 153-175.

Campbell, R.W., and van Straaten, B. I., 2025. New data on Late Triassic to late Early Jurassic plutonic suites in the northern Golden Triangle region of northwest British Columbia. In: Geological Fieldwork 2024, British Columbia Ministry of Mining and Critical Minerals, British Columbia Geological Survey Paper 2025-01, pp. 49-72.

Clarke, G., Northcote, B.K., Corcoran, N.L., Pothorin, C., Heidarian, H., and Hancock, K., 2025. Exploration and Mining in British Columbia, 2024: A summary. In: Provincial Overview of Exploration and Mining in British Columbia, 2024. British Columbia Ministry of Mining and Critical Minerals, British Columbia Geological Survey Information Circular 2025-01, pp. 1-60.

Cui, Y., 2021. A geospatial frame data model to simplify digital map compilation and integration. British Columbia Ministry of Energy, Mines and Low Carbon Innovation, British Columbia Geological Survey Paper 2021-03, 20 p.

Elia, E.A., Ferbey, T., and Ward, B.C., 2024a. Mapping surficial sediments in the Interior Plateau using remotely piloted aircraft system lidar. British Columbia Ministry of Energy, Mines and Low Carbon Innovation, British Columbia Geological Survey Open File, 2024-03, 12 p.

Elia, E.A., Ferbey, T., Campagne, T., Best, M., Shives, R.B.K., and Ward, B.C., 2024b. Investigating surface sediment composition in the Interior Plateau using a remotely piloted aircraft system magnetometer. British Columbia Ministry of Energy, Mines and Low Carbon Innovation, British Columbia Geological Survey Open File 2024-07, 11 p.

EY LLP, 2025. British Columbia mineral and coal exploration survey 2024 report, in press.

Ferbey, T., Plouffe, A., and Hickin, A.S., (Eds.), 2017. Indicator minerals in till and stream sediments of the Canadian Cordillera. Geological Association of Canada, Special Paper, Volume 50, Mineralogical Association of Canada, Topics in Mineral Sciences, Volume 47, 250 p.

Ferbey, T., Elia, E.A., Shives, R.B.K., Martin-Burtart, N., Best, M., and Ward, B.C., 2024. Quantifying potassium concentrations in Interior Plateau surface sediments using remotely piloted aircraft system gamma-ray spectrometry. British Columbia Ministry of Energy, Mines and Low Carbon Innovation, British Columbia Geological Survey Open File 2024-04, 19 p.

Fortin, G., and Silva, P.L., 2025. Assessment report drillhole database: Development and initial data release. British Columbia Ministry of Mining and Critical Minerals, British Columbia Geological Survey GeoFile 2025-11, in press.

Graham, A.C., Wearmouth, C.D., Northcote, B., and Ootes, L., 2025. A preliminary assessment of critical companion elements in SEDEX deposits of eastern British Columbia: Examples from the historic Sullivan mine and the Cirque project. In: Geological Fieldwork 2024, British Columbia Ministry of Mining and Critical Minerals, British Columbia Geological Survey Paper 2025-01, pp. 141-152.

Han, T., and Rukhlov, A.S., 2024. Update of rock geochemical database at the British Columbia Geological Survey. British Columbia Ministry of Energy, Mines and Low Carbon Innovation, British Columbia Geological Survey GeoFile, 2024-09, 5 p.

Han, T., Ootes, L., Rukhlov, A.S., and Angelo, T., 2025. Radiogenic isotope compilation. British Columbia Ministry of Mining and Critical Minerals, British Columbia Geological Survey GeoFile 2025-08, in press.

Hickin, A.S., Orovan, E.A., Brzozowski, M.J., McLaren, K., Shaw, K.L., and Van der Vlugt, J., 2023. Critical minerals in British Columbia: An atlas of occurrences and producing mines, 2023. British Columbia Ministry of Energy, Mines and Low

Carbon Innovation, British Columbia Geological Survey Open File 2023- 02, 102 p.

Hickin, A.S., Ootes, L., Orovan, E.A., Brzozowski, M.J., Northcote, B.K., Rukhlov, A.S., and Bain, W.M., 2024. Critical minerals and mineral systems in British Columbia. In: Geological Fieldwork 2023, British Columbia Ministry of Energy, Mines and Low Carbon Innovation, British Columbia Geological Survey Paper 2024-01, pp. 13-51.

Höy, T., and Jackaman, W., 2024a. Geology of the Rossland-Trail map sheet (NTS 082F/04). Geoscience BC Map 2024-02-01, British Columbia Ministry of Mining and Critical Minerals, British Columbia Geological Survey Open File 2024-12, 1:50,000 scale.

Höy, T., and Jackaman, W., 2024b. Geology of the Castlegar map sheet (NTS 082F/05). Geoscience BC Map 2024-02-02, British Columbia Ministry of Mining and Critical Minerals, British Columbia Geological Survey Open File 2024-13, 1:50,000 scale.

Hunter, R.C., Sebert, C.F.B., Friedman, R., and Wall, C., 2022. Revised stratigraphy and geochronology of the Hazelton Group, host rocks for volcanogenic mineralization in the Kitsault River area, northwest British Columbia. In Geological Fieldwork 2021, British Columbia Ministry of Energy, Mines and Low Carbon Innovation, British Columbia Geological Survey Paper 2022-01, pp. 63-81.

Mihalynuk, M.G., Wall, C., and Zagorevski, A., 2025. Time of deposition refinements for key stratigraphic intervals of the Nicola Group, southern British Columbia. In: Geological Fieldwork 2024, British Columbia Ministry of Mining and Critical Minerals, British Columbia Geological Survey Paper 2025-01, pp. 105-118.

Miller, E.A., Kennedy, L.A., and van Straaten, B.I., 2020. Geology of the Kinskuch Lake area and Big Bulk porphyry prospect: Syndepositional faulting and local basin formation during the Rhaetian (latest Triassic) transition from the Stuhini to the Hazelton Group. In: Geological Fieldwork 2019, British Columbia Ministry of Energy, Mines and Petroleum Resources, British Columbia Geological Survey Paper 2020-02, pp. 77-99.

Miller, E.A., Ferri, M.D., van Straaten, B.I., and Wall, C., 2025. Stratigraphic framework, structural setting, and timing of VMS, epithermal, and porphyry mineralization in the Kitsault River area, northwest British Columbia. In: Geological Fieldwork 2024, British Columbia Ministry of Mining and Critical Minerals, British Columbia Geological Survey Paper 2025-01, pp. 17-47.

Morris, R., Canil, D., and Lacourse, T., 2025. An optimized rapid analytical workflow for applying magnetite as an indicator mineral for porphyry copper deposits. In: Geological Fieldwork 2024, British Columbia Ministry of Mining and Critical Minerals, British Columbia Geological Survey Paper 2025-01, pp. 93-103.

Nelson, J.L., and van Straaten, B.I., 2020. Recurrent syn- to post-subduction mineralization along deep crustal corridors in the Iskut-Stewart-Kitsault region of western Stikinia, northwestern British Columbia. In: Sharman, E.R., Lang, J.R., and Chapman, J.B., (Eds.), Porphyry Deposits of the Northwestern Cordillera of North America: A 25-Year Update. Canadian Institute of Mining and Metallurgy Special Volume 57, pp. 149-211.

Nelson, J., Waldron, J., van Straaten, B., Zagorevski, A., and Rees, C., 2018. Revised stratigraphy of the Hazelton Group in the Iskut River region, northwestern British Columbia. In: Geological Fieldwork 2017, British Columbia Ministry of Energy, Mines and Petroleum Resources, British Columbia Geological Survey Paper 2018-1, pp. 15-38.

Nelson, J.L., Van Straaten, B., and Friedman, R., 2022. Latest Triassic-Early Jurassic Stikine-Yukon-Tanana terrane collision and the onset of accretion in the Canadian Cordillera: Insights from Hazelton Group detrital zircon provenance and arc-back-arc configuration. Geosphere, 18, 670-696. Doi: 10.1130/GES02444.1.

NRCan (Natural Resources Canada), 2024. Critical Minerals List. Government of Canada. <https://www.canada.ca/en/campaign/critical-minerals-in-canada/critical-minerals-an-opportunity-for-canada.html> (last accessed December 27, 2024)

Oneschuk, D., Hayward, N., Fortin, G., and Hickin, A.S., 2024. Residual total magnetic field and first vertical derivative of the magnetic field: Compilations of British Columbia. British Columbia Ministry of Energy, Mines and Low Carbon Innovation, British Columbia Geological Survey Open File 2024-08. Also published as Geological Survey of Canada Open File 9222, 1:500,000 scale. <https://doi.org/10.4095/p1xpddgswc>

Ootes, L., and Wall, C., 2024. High-precision U-Pb zircon igneous crystallization and detrital zircon maximum depositional ages from the Toodoggone region, north-central British Columbia. British Columbia Ministry of Energy, Mines and Low Carbon Innovation, British Columbia Geological Survey Open File 2024-06, 10 p.

Orovan, E.A., Zaborniak, K., and Hooker, K., 2024. Textural evidence for ore fluid transport and the magmatic to hydrothermal transition at the past-producing Kitsault Mo-Ag mine. In: Geological Fieldwork 2023, British Columbia Ministry of Energy, Mines and Low Carbon Innovation, British Columbia Geological Survey Paper 2024-01, pp. 53-64.

Orovan, E.A., Ebert, S., Baldazzi, P., Saxton, D., and Goudie, D.J., 2025. Critical minerals at the Berg and Huckleberry porphyry deposits, British Columbia, using scanning electron microscropy-mineral liberation analysis (SEM-MLA). In: Geological Fieldwork 2024, British Columbia Ministry of Mining and Critical Minerals, British Columbia Geological Survey Paper 2025-01, pp. 73-84.

Piercey, S.J., Pietruszka, D., and Goudie, D., 2025. Critical metals in volcanogenic massive sulphide (VMS) deposits in British Columbia: A progress report. In: Geological Fieldwork 2024, British Columbia Ministry of Mining and Critical Minerals, British Columbia Geological Survey Paper 2025-01, pp. 189-201.

Plouffe, A., Lee, R.G., Byrne, K., Kjarsgaard, I.M., Petts, D.C., Wilton, D.H.C., Ferbey, T., and Oelze, M., 2024. Tracing detrital epidote derived from alteration halos to porphyry Cu deposits in glaciated terrains: The search for covered mineralization. Economic Geology, 119, 305-329. <https://doi.org/10.5382/econgeo.5049>

Rukhlov, A.S., Coats, B., Van der Vlugt, J., Beaupre-Olsen, I.J., and Zaborniak, K., 2023. British Columbia Geological Survey Sample Archive: An emerging resource for public geoscience. In: Geological Fieldwork 2022, British Columbia Ministry of Energy, Mines and Low Carbon Innovation, British Columbia Geological Survey Paper 2023-01, pp. 85-90.

Rukhlov, A.S., Cui, Y., Cunningham, Q., Fortin, G., and Anderson, C., 2024. Geochemical signals of carbonatite-related critical metals in provincial stream sediments. In: Geological Fieldwork 2023, British Columbia Ministry of Energy, Mines and Low Carbon Innovation, British Columbia Geological Survey Paper 2024-01, pp. 97-122.

Rukhlov, A.S., Ootes, L., Creaser, R.A., Cunningham, Q.F., de Waal, F.S., and Wenger, D.K., 2025a. British Columbia carbonatites revisited: New whole rock Sr-Pb-Nd isotopic insights and drainage prospectivity trends. In: Geological Fieldwork 2024, British Columbia Ministry of Mining and Critical Minerals, British Columbia Geological Survey Paper 2025-01, pp. 119-139.

Rukhlov, A.S., Ootes, L., and Han, T., 2025b. British Columbia radiogenic isotope compilation (Sr-Nd-Hf-Pb): Introduction and examples of utility. In: Geological Fieldwork 2024, British Columbia Ministry of Mining and Critical Minerals, British Columbia Geological Survey Paper 2025-01, pp. 177-188.

Sauvé, M., Ward, B., and Ferbey, T., 2025. Surficial geology of the Kinaskan Lake area, British Columbia (parts of NTS 104G/08, 09, 16, and 104H/12, 13). British Columbia Ministry of Mining and Critical Minerals, British Columbia Geological Survey Geoscience Map 2025-01, 1:50,000 scale.

van Straaten, B.I., 2024. Upper Hazelton Group stratigraphy along the Stikine arch, northwestern British Columbia. In: Geological Fieldwork 2023, British Columbia Ministry of Energy, Mines and Low Carbon Innovation, British Columbia Geological Survey Paper 2024-01, pp. 149-177.

Veness, H., Elia, E.A., and Ferbey, T., 2024. A digital update of Open File 1992-13: Surficial geology map index of British Columbia. British Columbia Ministry of Mining and Critical Minerals, British Columbia Geological Survey Open File 2024-09, 2 p.

Wang, X., Jiao, R., and Ootes, L., 2025. Apatite fission track data from northern Hogem batholith, Quesnel terrane, north-central British Columbia: A progress report. In: Geological Fieldwork 2024, Ministry of Mining and Critical Minerals, British Columbia Geological Survey Paper 2025-01, pp. 85-91.

Wearmouth, C., Czertowicz, T.A., Peters, K.J., and Orovan, E., 2024a. Mineral potential modelling at the British Columbia Geological Survey: Renewed methods with application to northwestern British Columbia. British Columbia Ministry of Energy, Mines and Low Carbon Innovation, British Columbia Geological Survey Paper 2024-02, 28 p., in press.

Wearmouth, C., Czertowicz, T.A., Peters, K.J., and Orovan, E., 2024b. Preliminary mineral potential maps for the porphyry, volcanic massive sulphide, and magmatic mafic-ultramafic mineral systems, northwestern British Columbia. British Columbia Ministry of Energy, Mines and Low Carbon Innovation, British Columbia Geological Survey Open File 2024-05, 1:800,000 scale, in press.

Wearmouth, C., Czertowicz, T.A., and Peters, K.J., 2024c. Preliminary mineral potential maps for the SEDEX and MVT mineral systems, northeastern British Columbia. British Columbia Ministry of Energy, Mines and Low Carbon Innovation, British Columbia Geological Survey Open File 2024-11, 1:500,000 scale, in press.

Wilson, A.M., Russell, J.K., and Harris, M.A., 2024. Glaciovolcanism in the Garibaldi volcanic belt: Nine geological maps from southwestern British Columbia, Canada. British Columbia Ministry of Mining and Critical Minerals, British Columbia Geological Survey Open File 2024-10, 64 p.