

British Columbia Geological Survey annual program review 2023-2024



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Abstract

This paper provides an overview of current British Columbia Geological Survey (BCGS) geoscience activities and highlights key findings from 2023 projects. Headquartered in Victoria, the Survey is part of the Responsible Mining and Competitiveness Division in the British Columbia Ministry of Energy, Mines and Low Carbon Innovation. 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 research including bedrock and surficial geology mapping programs, regional geochemical surveys, and targeted mineral deposit studies. Like most geological survey organizations around the world, critical minerals, which are essential for low-carbon technologies, are a major theme for the Survey. To inform the Critical Minerals Strategy being developed by the provincial government, the Survey compiled a critical minerals atlas as the initial step in evaluating the critical mineral endowment of the province and in building awareness of critical mineral opportunities for the exploration and mining industries. The Survey also began field projects directed at assessing opportunities through mineral system studies in regions known to contain critical minerals. Both to aid in the search for critical minerals and to inform land-use conversations between multiple parties having diverse interests, the Survey has revitalized the mineral potential modelling of the 1990s. This new modelling takes advantage of about 30 years of new data, knowledge, and advances in GIS applications and computer power to enable statistical analysis of spatial data. The past year has seen further progress of multi-year mapping projects such as detailed mapping in the northwest part of the province in the Kitsault area, along the Stikine arch, and near Atlin.

Responsible for maintaining and developing provincial geoscience and mineral resource databases, the Resource Information Section disseminates data online through web portals, MapPlace geospatial web services, and the BC Data Catalogue. Information managed by the team includes traditional geological maps and reports, geochemical, geophysical, and geological databases, in addition to mineral resource inventory and exploration assessment reports. The databases and webservices are designed to update data, facilitate data mining, and support applications for mineral exploration (particularly for critical minerals), and land-use planning. The team has started projects to modernize information systems and build a geoscience Spatial Data Infrastructure (SDI).

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.

1. Introduction

The British Columbia Geological Survey (BCGS), headquartered in Victoria, is a public geoscience agency in the Responsible Mining and Competitiveness Division of the British Columbia Ministry of Energy Mines and Low Carbon Innovation. BCGS creates and disseminates public geoscience information that supports effective mineral exploration, sound land use management, and responsible governance and attracts investment. The Survey is the primary repository for provincial geoscience knowledge. Maps, reports, and databases are freely available online and are public resources for Indigenous peoples, 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 land use and resource

management decisions that balance economic, environmental, and community interests.

The BCGS consists of three sections: 1) Cordilleran Geoscience; 2) Resource Information; 3) the Mineral Development Office (Fig. 3). 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 Section is also divided into two teams. The Framework Geoscience team is primarily focused on bedrock and surficial geological mapping and targeted foundational geological studies (e.g., magmatic, stratigraphic, structural, metallogenic). The Economic Geology and Geochemistry team conducts thematic studies on the origin of mineral deposits, the spatial and temporal distribution of commodities, mineral systems, exploration tools, and regional geochemistry. Team members also manage in-house laboratory

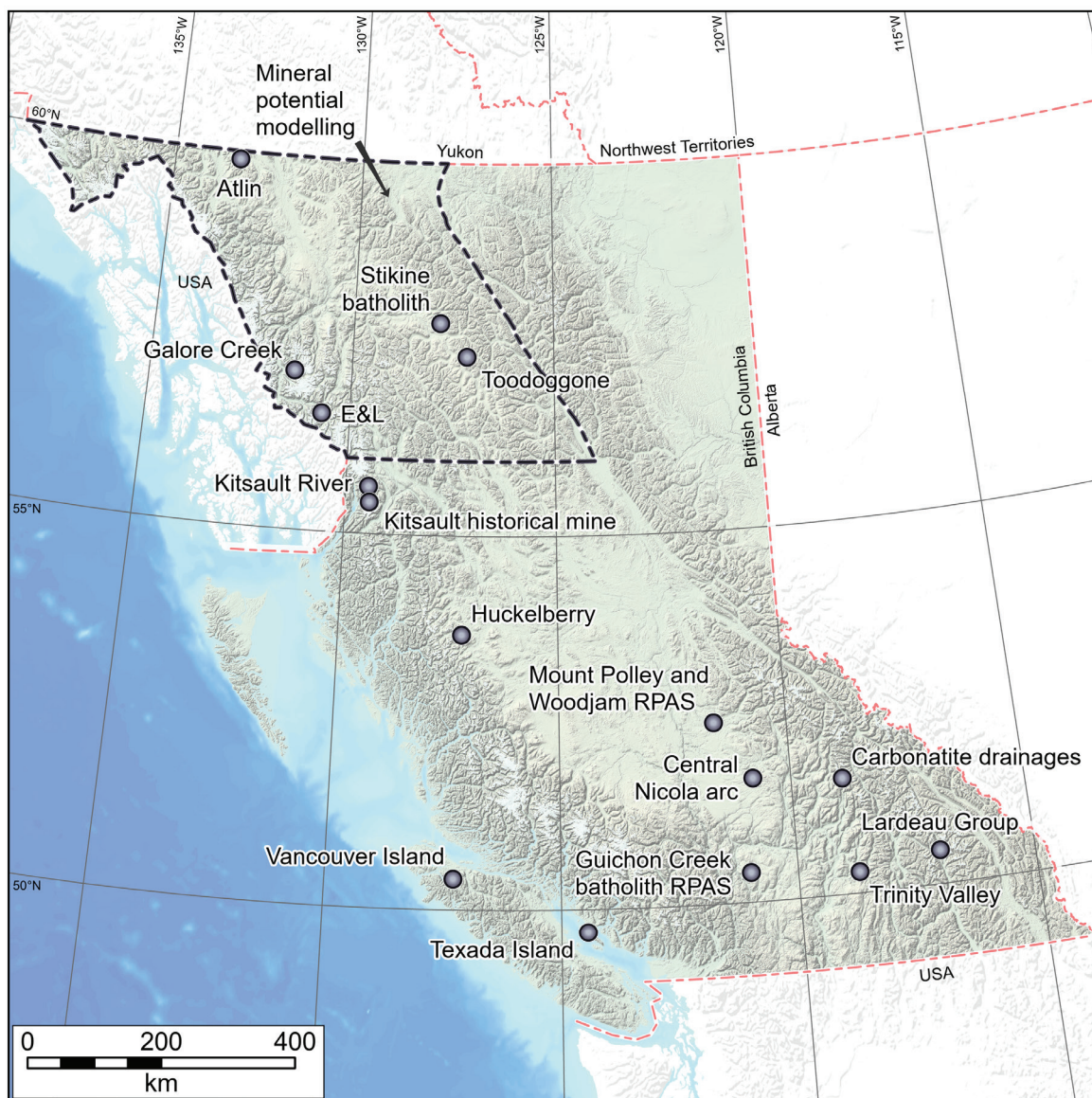
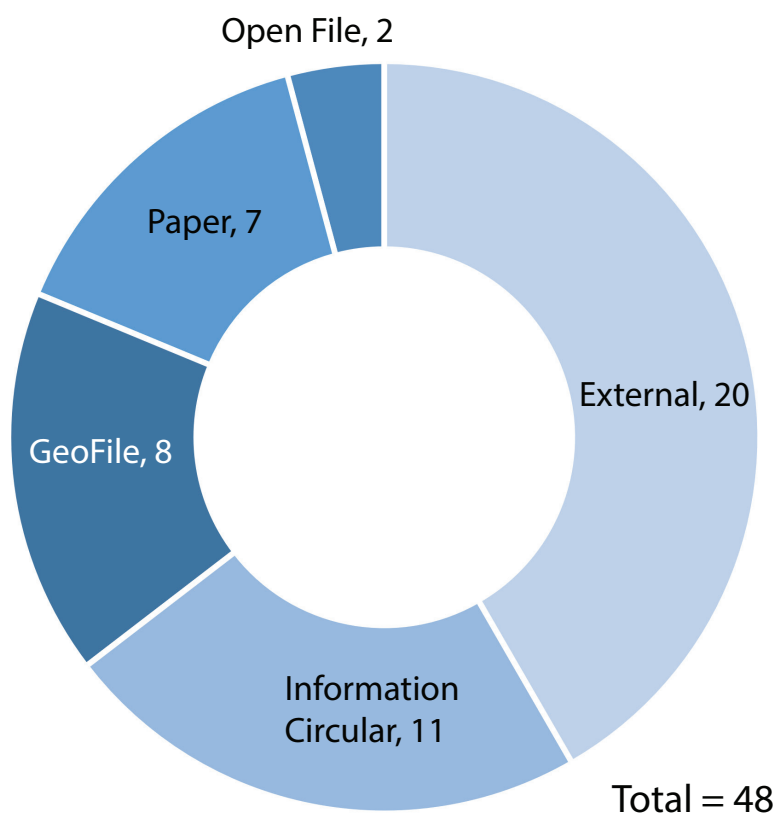


Fig. 1. British Columbia Geological Survey projects in 2023.

facilities and curate the provincial sample archive. The Resource Information Section is responsible for developing and updating provincial geoscience databases and disseminating data online through geospatial web services (MapPlace). The Section is divided into two teams. The Geomatics Information team is responsible for geoscience data and managing databases, publications, geoscience data products, interoperable data sharing, and geospatial web services. The Mineral Resource Information team is 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 centres across the province, track minerals 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., 2024).

Like most geological survey organizations around the world, critical minerals, which are essential for low-carbon technologies, are a major theme for the Survey. These minerals are required for electric vehicles, mobile phones, solar panels, wind turbines, electrical transmission lines, batteries, and medical devices, and to manufacture products for national defense. As society places more value on the transition to low-carbon energy, demand for minerals important for energy generation, storage, and transmission will increase. British Columbia is developing its own Critical Minerals Strategy and BCGS is contributing geoscience information that will be foundational for the strategy. The Survey has compiled a critical minerals atlas as the initial step in evaluating the critical mineral endowment of the province and in building awareness of critical mineral opportunities for the exploration and mining



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 2023.

industries (Hickin et al., 2023). In addition, the Survey began field projects directed at assessing opportunities through mineral system studies in regions known to contain critical minerals. These studies are primarily focused on assessing potential critical mineral co- and by-products in the mineral systems that host major producing mines and will assess some of the more underexplored mineral systems in British Columbia such as carbonatites and iron skarns.

As overlapping and potentially competing interests in the provincial land base continue to grow, land use planning has received renewed emphasis in British Columbia. The approach is broad and aims to ensure that all aspects, such as wildlife, forestry, mineral interests, and cultural heritage are considered in land decisions. In 2019, the Province of British Columbia committed to Indigenous reconciliation with the passing of the Declaration on the Rights of Indigenous Peoples Act, which

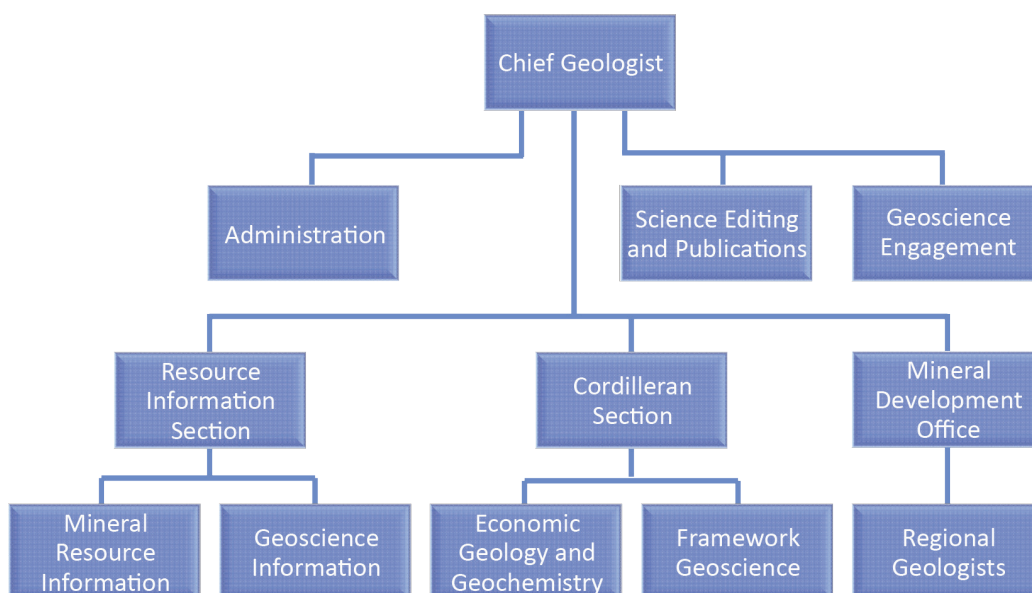


Fig. 3. British Columbia Geological Survey organizational chart.

has the objective of creating paths that respect the rights of Indigenous Peoples. This, combined with other initiatives like establishing Indigenous Protected and Conservation areas (IPCA) where Indigenous governments have the primary role in protecting and conserving ecosystems through Indigenous laws, governance, and knowledge systems, and the Tripartite Framework Agreement on Nature Conservation (Government of British Columbia, 2023), has elevated the need for robust mineral potential information. Building on work it conducted in the 1990s, BCGS has revitalized its mineral potential mapping efforts, taking advantage of about 30 years of new data, knowledge, and advances in GIS applications and computer power to enable statistical analysis of spatial data.

Recognizing the need to provide better outreach and to link geoscience with people and communities, BCGS hired its first Engagement Geoscientist. This position was created to connect Indigenous Peoples, local communities, governments, the minerals industry, and the public to the geology and mineral resources of the province. Developing meaningful relationships with Indigenous communities near where the BCGS conducts fieldwork is a contribution to reconciliation. The Engagement Geoscientist serves as the primary liaison between Survey geologists and communities, supports field programs, and translates technical outputs into consumable information for the public. This position builds geoscience outreach capacity and enhances geoscience literacy by developing materials, presentations, and working directly with non-technical stakeholders and rightsholders.

2. Partnerships

Partnerships continue to be an effective way for the Survey to leverage 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. In addition to inter-Ministry cooperation and working with external commercial service providers, BCGS has partnered with six university laboratories to acquire research-grade analyses for key initiatives such as our rock archive re-analysis. The Survey is working closely with laboratories at the University of British Columbia, University of Victoria, University of Alberta, University of Manitoba, Carleton University, Queens University, University of Windsor, and Memorial University. The Survey is also partnering directly with researchers from several Canadian universities. Since the early 2000s, BCGS has had a formal partnership with the University of Victoria. This partnership continued this year with one project using magnetite as an indicator mineral and another assessing the exhumation history of Hogen batholith. As part of a volcanogenic massive sulphide (VMS) project that will study deposits at several Canadian sites, the Survey is collaborating with Memorial University and other Canadian research institutions on provincial examples. BCGS is working with the Mineral Deposits Research Unit (MDRU) at the University of British Columbia to establish a joint project directed at sedimentary exhalative deposits in British Columbia.

The Survey continues to support training the next generation of geoscientists by its summer field assistant hiring program and by supporting graduate student projects. The Survey is co-funding and supervising a M.Sc. project at Simon Fraser University in which remotely piloted aircraft systems (RPAS; also known as unmanned aerial vehicles, UAV or ‘drones’) are used to collect geophysical data that will help assess mineral dispersion in till. Also, Survey staff are helping to supervise two M.Sc. projects at the University of British Columbia that address the context and structural evolution of the Galore Creek and Big Bulk deposits in northwestern British Columbia.

The Survey continues to partner with industry through formal

and informal collaborations and is working with Coast Copper Corp. at the Merry Widow deposit on Vancouver Island and with Galore Creek Mining Corporation at their Galore Creek copper deposit in northwestern British Columbia. The Survey has also initiated collaborations at the E&L property (Garibaldi Resources Corp.), the Huckleberry mine (Imperial Metals; on care and maintenance since 2016), the Kitsault Valley project (Dolly Varden Silver Corp), the historical Kitsault Mo-Ag mine (New Moly LLC), the Berg property (Surge Copper Corp), and skarn mineralization on Texada Island (Acrosa Specialty Metals and Lafarge Canada Inc.).

The BCGS and the Geological Survey of Canada (GSC) have a long history of partnering. Currently BCGS and GSC are collaborating on a Geomapping for Energy and Minerals (GEM-North) project focused on the tectonic assembly of the Intermontane region close to the Yukon-British Columbia border. This project will examine the relationships between tectono-stratigraphic units and determine magmatic, structural and exhumation histories to better understand terrane architecture in three dimensions, which will aid exploration decisions. To help interpret regional airborne geophysics and guide geophysical inversion models, the Survey has partnered with the GSC's Pacific Laboratory to establish the physical properties of rocks held in the BCGS archive. The Survey has also applied for partnership funding with the federal government for several multi-year projects through the Critical Minerals Geoscience and Data initiative.

Canada's Information and Data Management (IDM) Working Group is co-lead by the BCGS and is part of the Canadian National Geological Surveys Committee (NGSC). In support of the Pan-Canadian Geoscience Strategy and co-chaired by BCGS and GSC, the IDM has initiated a pilot project to create a distributed national mineral occurrence database and web service that includes data from nine provincial, territorial, and national geological surveys.

BCGS is committed to working with industry, government, academia, and communities and open to collaboration. Interested parties are encouraged to contact the Survey.

3. Staffing

The Survey remains an organization in transition. In the last year, the Survey has embarked on a hiring campaign to fill vacancies that resulted from retirements, departures, and growth. BCGS is currently staffed by 38 permanent staff (Fig. 4); five vacancies are at various stages of competition. 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. These are excellent opportunities for early career geoscientists to gain experience as they develop skillsets that are valued by the sector.

Early in the year, the Survey restructured slightly, adding a layer of technical leadership to ease our expansion in personnel (Fig. 3). In the Resource Information section, Jessica Norris manages the Mineral Resource Information



Fig. 4. British Columbia Geological Survey staff.

team while Gabe Fortin manages the Geomatics Information team. Don Harrison and Ryan Grundy have accepted positions as Mineral Assessment Geologists responsible for reviewing and approving the assessment reports submitted by industry to retain mineral tenures in good standing. Bronwen Wallace is helping to resolve a backlog of assessment reports while taking on the new role of coordinating systems and website development. Kerri Shaw accepted the Mineral Inventory Geologist position responsible for the BCGS MINFILE database and its modernization.

In the Cordilleran Section, Luke Ootes has been acting Director since the departure of Neil Wildgust in late 2022. Luke has now accepted a permanent posting as the Manager of Economic Geology and Geochemistry team where Curran Wearmouth is the new Mineral Potential Geologist and Matthew Brzozowski is a new Economic Geologist. Bram van Stratten has become the Manager of the Framework Geoscience team and Roddy Campbell joined the team as a Minerals Geologist. The Mineral Development Office appointed Cary Pothorin as the Regional Geologist for the South Central Region, a position that had been vacant for many years. In the Chief Geologists Office, Branch Coordinator Cinthia Kong took leave this year and Jenny Boulet-Marshall filled in. Jenny subsequently accepted another position in government and her position is being filled by Madhur Upadhyay on a temporary assignment. He is being assisted by Di Tang to keep the Branch running smoothly. Also joining the Chief Geologist's Office is Rafael Bacha, the Survey's first Engagement Geoscientist.

4. Cordilleran Geoscience Section

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

4.1. Critical minerals

Jurisdictions in Canada and around the world are developing strategies to ensure critical minerals supply chains are robust and resilient. As a contribution to British Columbia’s CleanBC Roadmap to 2030, Hickin et al. (2023) prepared an atlas (Fig. 5) that inventories commodities in the province that appear on the Canadian critical minerals list or on those of key trading partners.

Part of province-wide studies directed at critical minerals, Hickin et al. (2024) provide an overview of six mineral systems that are important to British Columbia’s critical minerals inventory, including: porphyry, volcanogenic massive sulphide, deep-water basin and platformal base metal, magmatic mafic to ultramafic, carbonatite, and iron skarn. Orovan et al. (2024) examined core at the past-producing Kitsault mine and recognized features (e.g., unidirectional solidification textures) that might record permeable structures that focused ore-bearing fluids. Brzozowski and Zaborniak (2024) examined core at the E&L magmatic Ni-Cu-PGE sulphide deposit that provided textural evidence indicating that sedimentary rock assimilation contributed to the sulphide saturation history of the E&L magma and shallow-level volatile exsolution, sulphide liquid transport through conduit plumbing, and subsequent metal remobilization. Using geochemical data collected as part of Regional Geochemical Survey (RGS)

programs, Rukhlov et al. (2024) define a multivariant ‘critical mineral index’ to assess prospectivity for carbonatite-hosted critical metals in the British Columbia alkaline province. Detailed data from carbonatites in the Blue River area, including the Upper Fir Nb-Ta deposit, served to develop this critical mineral index. Data from the Aley carbonatite complex were used to examine downstream dispersion from a known deposit. Ongoing field investigations were conducted at the past-producing Huckleberry Mine (Cu-Mo) and on Vancouver and Texada islands investigating Fe-skarns and their potential to host critical minerals.

Both to aid in the search for critical minerals and to support current land-use decisions the Survey has revitalized its mineral potential mapping work of the 1990s. This new work takes advantage of about 30 years of new data, knowledge, advances in GIS applications, and computer power to enable statistical analysis of spatial data using weights of evidence modelling (Fig. 6; British Columbia Geological Survey, 2023). A comparison of results between work done in the 1990s and the current work for an area that includes a large part of the northern British Columbia indicates that the new work largely corroborates the old and that both are of value for assisting mineral exploration and land-use decisions (Wearmouth et al., 2024).

4.2. Northern British Columbia

Based on the initial season of a two-year field-based project along the British Columbia-Yukon border, Mihalyuk et al. (2024) presented the initial results of mapping in the Gladys Lake area near Atlin, reassigning ophiolitic rocks previously considered part of Cache Creek terrane to Atlin terrane and describing what might be distal ultramafic-associated massive sulphide (UAMS) mineralization (Fig. 7). van Straaten et al. (2023) released GIS, structural, magnetic susceptibility, and other digital data to support the recently published map (van Straaten et al., 2022) of the Dease Lake area, and van Straaten (2024) synthesized stratigraphic and geochronologic work focused on the upper part the Hazelton Group along the Stikine arch in northern Stikinia with particular focus on the Stikine batholith, Mount Blair, Spatsizi (Fig. 8), and Yehiniko Lake areas, providing detailed maps, composite stratigraphic sections, lithological descriptions, contact relationships, and preliminary geochronological data. In the Kitsault area, an ongoing multi-year Survey program (Miller et al., 2023; Fig. 9) continues to expand regional bedrock mapping coverage to better understand the stratigraphic, magmatic, structural, metallogenic, and tectonic framework of this region. In the Toadoggone area, new mapping initiatives are underway (e.g., Ootes, 2023) to help compare the stratigraphy and intrusive history established in the more western parts of Stikinia (e.g., van Straaten, 2024). Jones et al. (2023) presented new igneous zircon Hf-O data from Hogem batholith (north-central Quesnel terrane) that indicate predominantly juvenile magmatic sources with minimal contribution by Ancestral North America crust. Milidragovic et al. (2023a) presented detrital

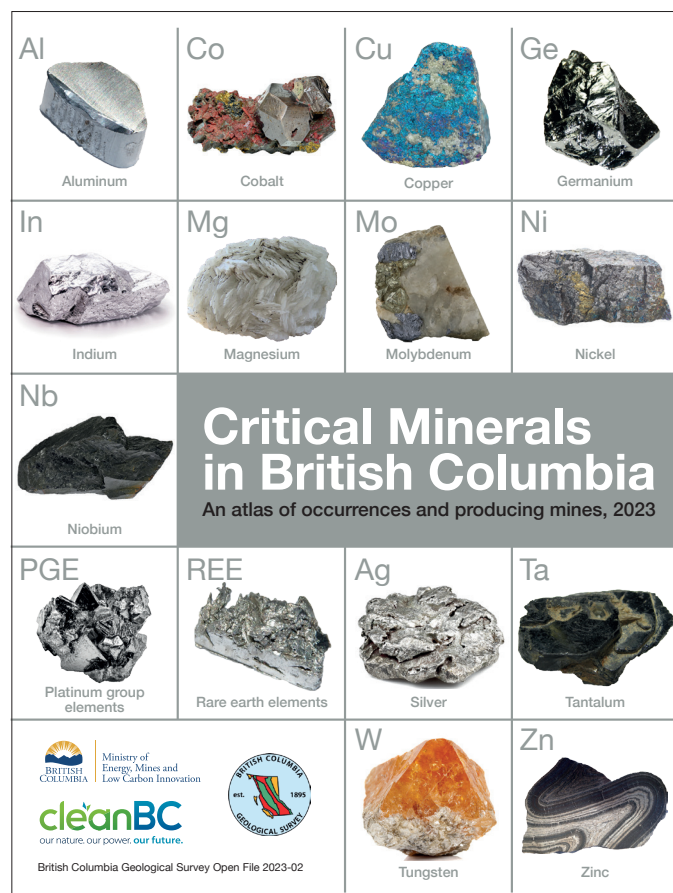


Fig. 5. British Columbia critical minerals atlas; see Hickin et al. (2023).

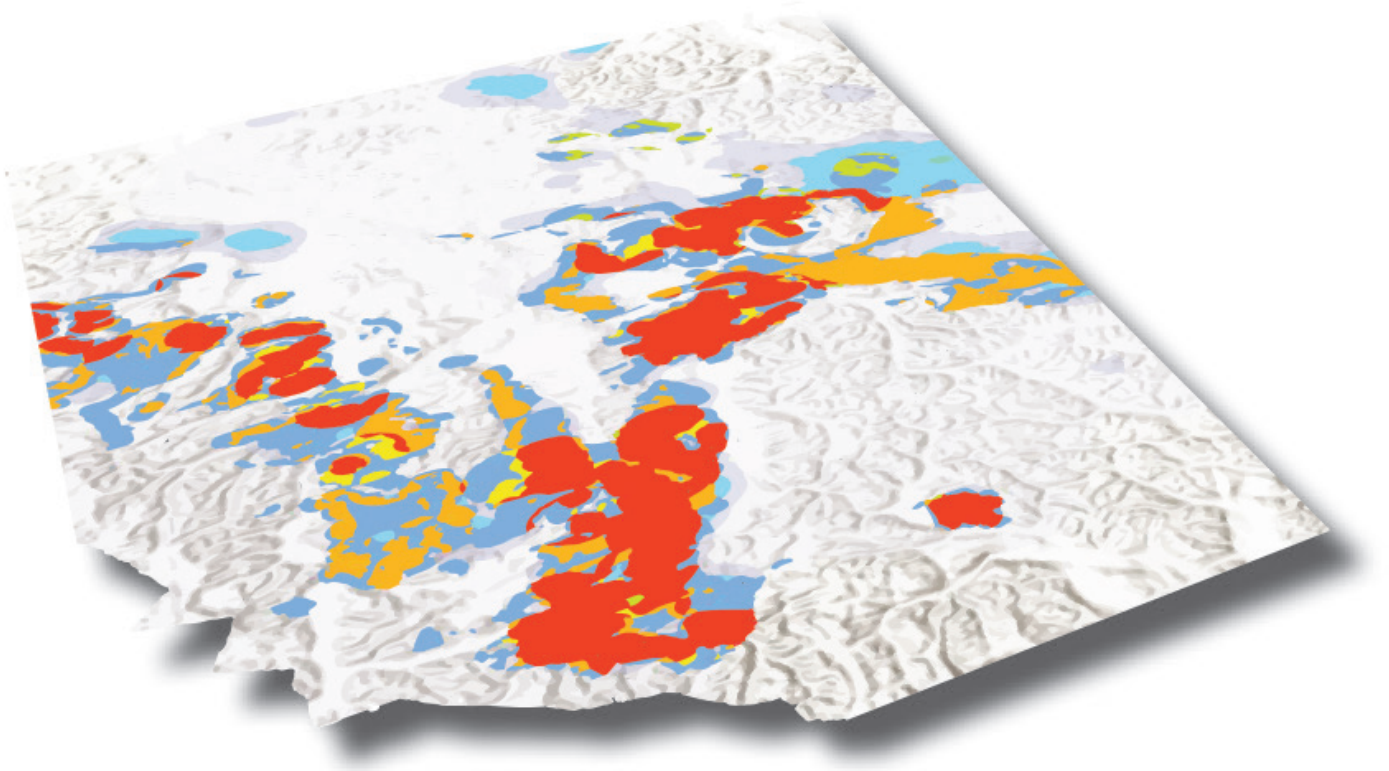


Fig. 6. Mineral potential model displaying relative prospectivity; greatest in red. See Wearmouth et al. (2024).

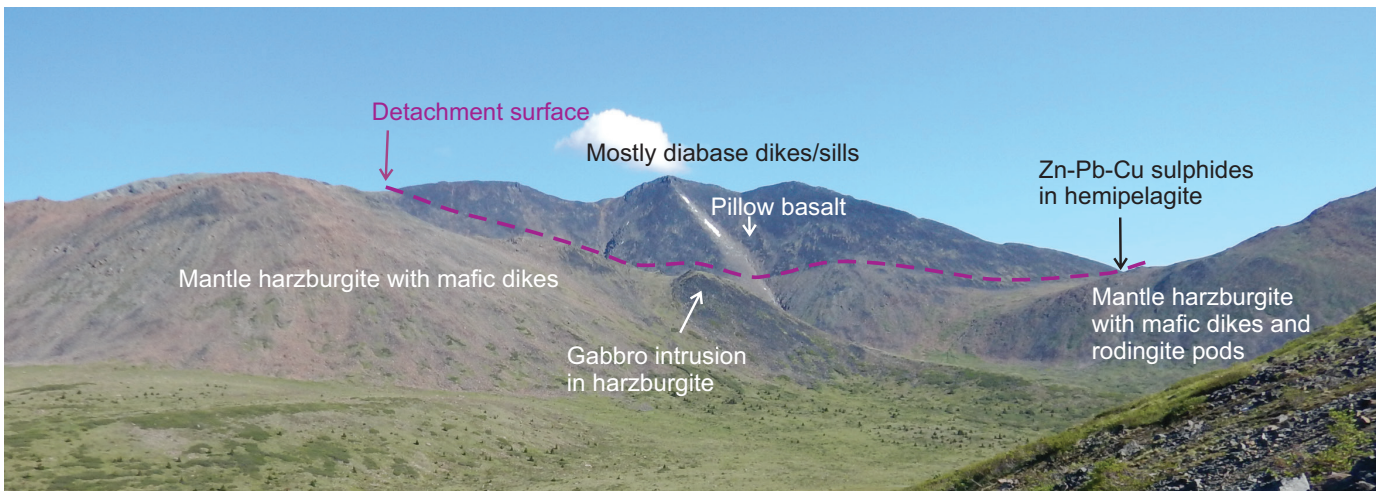


Fig. 7. View of intraoceanic detachment surface (dashed purple line) where mantle was exhumed to just below the sea floor. Hemipelagite samples with Zn-Pb-Cu sulphides, possible distal ultramafic-associated massive sulphide (UAMS) deposits, were collected from above the detachment (sample site beneath arrow). See Mihalynuk et al. (2024).

zircon U-Pb, Lu-Hf, and trace element data to document that the Cunningham formation in north-central British Columbia is a latest Triassic overlap succession linking Cache Creek terrane to Stikinia. Milidragovic et al. (2023b) examined the sulphur isotopic composition of primary sulphides at the Polaris Alaskan-type ultramafic-mafic intrusion, concluding that the sub-arc mantle contributed subducted sulphate.

4.3. Southern British Columbia

Elia et al. (2023) summarized the remotely piloted aircraft system (RPAS) platforms and sensors that were used to acquire spectrometer, magnetometer, and lidar data in the Mount Polley mine, Woodjam prospect, and Guichon Creek batholith areas and the methods for processing RPAS survey data, as an aid for mapping surficial geology and drift prospecting.



Fig. 8. At base, augite-plagioclase-phyric flow several m thick with highly vesicular flow overlain by 1 m-thick bed of volcanic breccia with common spatter clasts, overlain by 4 m-thick augite-plagioclase-phyric flow. Upper Hazelton Group, Horn Mountain Formation, Sister Mary mafic to intermediate volcanic unit in the Spatsizi area. See van Straaten (2024).



Fig. 9. Dark mafic volcanic rocks of the Stuhini Group (Late Triassic) on right cut by hornblende-phyric diorite dike of the Hyder plutonic suite (Eocene) near the eastern margin of the Coast Plutonic complex. Kitsault River area, near Mt. Camber, view to the northwest.

Elia et al. (2024) applied RPAS-acquired lidar data to map surficial sediments in the Interior Plateau, and Ferbey et al. (2024) applied RPAS-acquired radiometric data to quantify potassium concentrations in these sediments. Geological investigations and data compilation continues in the Cadwallader terrane near the Chilcotin River (Schiarizza and Friedman, 2023), the central Nicola arc north of Kamloops, the Lardeau Group north and west of Kootenay Lake (Mihalynuk et al., 2023), and the Trinity Valley area east of Vernon.

4.4. Sample archive

Rukhlov et al. (2023) reported on the inventory of the Survey's sample archive. In tandem with updates to rock

geochemical (Han and Rukhlov, 2024) and geochronological datasets (e.g., Ootes et al., 2024) the archive is being used to obtain and build a province-wide whole rock radiogenic isotope database (Sm-Nd, Rb-Sr, Lu-Hf, Pb-Pb). In partnership with the Geological Survey of Canada (Pacific), the Survey is continuing to advance the provincial rock petrophysical database by collecting magnetic, gravity, and porosity data from archived hand samples.

5. Resource Information Section

The BC Geological Survey collects, compiles, and disseminates provincial public geoscience that supports effective mineral exploration, sound land use management, and responsible governance. This public geoscience includes geological maps, reports, thematic studies, and the province-wide digital coverage of bedrock geology (BC Digital Geology). It also includes databases for mineral assessment reports (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 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.

5.1. Geoscience spatial data infrastructure (gSDI)

Geoscience data need to be managed coherently because they are inherently related to each other. The Survey currently operates geoscience databases and applications built in the last two decades, mostly in discrete systems of varying legacy or obsolete technologies and, in most cases, the ability to link interpretations to raw data or observations are lacking. The Survey has been making efforts to build a gSDI to manage all geological and mineral resource data together as sub-systems in the same environment using common data and system components and well-defined interfaces across service boundaries. In 2022, ARIS was modernized as a first step towards a gSDI; in 2023 the Survey has been working on opportunities to modernize MINFILE and BC Digital Geology.

5.2. MapPlace

MapPlace is the BCGS geospatial web service to discover, visualize, search, and generate summary reports and maps from province-wide geoscience databases. Easy access to, and analysis of, geoscience maps and data are fundamental to inform decisions on mineral exploration, mining, environmental protection, and land-use management. MapPlace provides a platform to facilitate data mining and analysis of geoscience information in the context of all other relevant data such as mineral titles, assessment reports, land ownership, public

infrastructure, aquifers, and topographic base maps. Some of the data layers and applications are specifically developed to enable research and analytics for mineral exploration and prospecting.

5.3. 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. 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 metadata to search the locations, mineral occurrences, commodities, claims, and work types as documented in the reports. ARIS contains more than 40,300 reports dating from 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. In addition to the search interface on the ARIS website and MapPlace, a copy of the ARIS metadata is available through the BC Data Catalogue.

The BCGS 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. In addition, the Survey continues to digitally extract information for our assessment report-sourced surface sediment geochemical database (ARSSG), and has started digital extraction of drillhole collar and core geochemical data from assessment reports.

5.4. MINFILE mineral occurrence database

MINFILE is a database containing geological, location, and economic information for more than 16,100 mineral, coal, and industrial mineral mines, deposits, and occurrences in British Columbia. In 2023, more than 195 new occurrences and 900 updates were added to the database. 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, production, and source of data. Query results are available to download as summary reports, spreadsheets, and KML. MINFILE/pc is a portable extract of the MINFILE database with a search interface and printable reports. The BCGS has transformed part of the MINFILE mineral occurrence data to the EarthResourceML Lite schema and mapped the contents using the vocabularies adopted by the 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 Web Mapping Service (WMS) and Web Feature Service (WFS) specification. In 2023, the BCGS has been working with other participating Canadian provincial, territorial and the federal geological surveys to develop a national mineral occurrence database and web service that are compliant with a Canadian adoption of the EarthResourceML standard.

5.5. British Columbia Digital Geology

The BCGS 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 (Cui et al., 2017). 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 KML by spatial and non-spatial queries via MapPlace. The BCGS has transformed the digital geology to the GeoSciML Lite schema and mapped the contents using the vocabularies adopted by the 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.

5.6. Other databases

The Survey also manages dozens of other databases. COALFILE includes a collection of assessment reports dating from 1900. Property File is a collection of spatially referenced archived reports, maps, photos, and technical notes documenting mineral exploration activities in British Columbia from 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 lithochemical 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).

6. Mineral Development Office

The mining industry contributes greatly to the economy of British Columbia. Particularly important for northern communities and First Nations, the mineral exploration, mining, and related sectors employ more than 35,000 people. For 2023, the forecast value of mine production in British Columbia is \$15.9 billion (Clarke et al., 2024).

Mineral exploration is the backbone of mining and an

estimated \$643.5 million was spent on exploration in 2023. More than 200 companies have projects in British Columbia and these projects are monitored by the Mineral Development Office (MDO) and its Regional Geologists. The MDO is the Vancouver base of the British Columbia Geological Survey. It links the more than 1100 exploration and mining companies headquartered in Vancouver to provincial mineral and coal information. The MDO distributes Survey data and provides technical information and expertise about mineral opportunities to the domestic and international investment community. The MDO monitors the activities of the mining and exploration sectors and produces the Provincial Overview of Exploration and Mining in British Columbia, an annual volume that summarizes activities in the different regions of the province (see e.g., Clarke et al., 2024). The British Columbia Regional Geologists (Table 1) represent the provincial government on geological matters at a regional level, and capture information on industry activity in their jurisdictions. Within their communities, the Regional Geologists provide information on exploration trends, possible investment opportunities, land use processes, First Nation capacity building, and public outreach.

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

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