

Geoscience knowledge density map of British Columbia, Version 1.0



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Abstract

Maps depicting the spatial distribution of geoscience information are of value for establishing information needed for making land-use decisions, planning new projects, mineral potential modelling, and increasing public awareness of geoscience activities. Although the British Columbia Geological Survey, Geological Survey of Canada and Geoscience BC have a long history of generating public geoscience data, geospatial distributions at the province-wide level have not previously been compiled. Grouping datasets into five categories (maps, thematic, geophysical, geochemical and geochronological, and mineral resource), Version 1.0 of the geoscience knowledge density map of British Columbia represents the first iteration. Using a Python script, data were aggregated using an existing 1:5000 map sheet grid to produce category specific density maps along with a cumulative map. Geoscience information is not equally distributed across the province. High information-density zones correspond to regions of extensive exploration and mining activities and corresponding multidisciplinary public geoscience initiatives.

Keywords: Geoscience knowledge density, compilation

1. Introduction

Publicly funded geological surveys generate large amounts of geoscience data and have long histories of releasing these data in print or online. However, with rare exceptions (e.g., Brazil, de Abreu Cunha et al., 2025; Québec, Daubois and Solgadi, 2025; SIGÉOM, 2026), few jurisdictions provide compilations showing the geospatial distribution of these data. Such compilations are valuable for establishing what and where information is needed for making land-use decisions, planning new projects, mineral potential modelling, and increasing public awareness of geoscience activities. For almost 30 years, the public has been able to access bedrock, surficial, and thematic maps, along with geophysical, geochemical, geochronological, mineral deposit, and mineral potential modelling data generated by the British Columbia Geological Survey (BCGS), the Geological Survey of Canada (GSC) and Geoscience BC (GBC) through MapPlace, the BCGS geospatial web service. Nonetheless, a province-wide spatial compilation of these different types of data has hitherto been lacking. This paper introduces a prototype of the first series of geoscience knowledge density maps for British Columbia. These maps display the spatial distribution of map, thematic, geophysical, geochemical, geochronological, and mineral resource information and we include a derivative cumulative density map that provides a first-order characterization of all geoscience information in the province.

2. Methods

Geoscience knowledge density maps only consider the

geospatial location of the information, not the information itself. This means that a feature is counted by its location independent of its attribute information (e.g., geological unit, map scale, geochemical concentration, age, mineral occurrence type). Following the structure used by de Abreu Cunha et al. (2025), we organized British Columbia geoscience into five categories: map, thematic, geophysical, geochemical and geochronological, and mineral resource (Table 1). We prioritized geological survey datasets because they are extensive, capture more than 100 years of geoscience knowledge, and are stored in formats that can be readily incorporated into geospatial analysis. In some cases, map footprints were available (e.g., Arnold and Ferbey, 2019) and only needed to be updated for recent work. In other cases, such as for continental Lithoprobe seismic lines, no single compilation existed and digitizing from various sources was required.

After compiling and categorizing publicly accessible datasets, we used the British Columbia Geographical System 1:5000 map sheet grid as the framework to aggregate data occurrences. Extending across the entire province, this represents 109,141 map sheets or cells. Following the approach by Daubois and Solgadi (2025), all data categories were assigned an equal weighting. For points and line features, an item was counted if it was partly or fully present in a grid cell. For polygon features, an intermediate dataset was first generated by identifying areas of overlap and counting the features within them. The intermediate dataset was then overlaid on grid cells and assigned a count based on the value occupying the largest area in the grid cell.

Table 1. Summary of the geoscience information considered for generating Version 1.0 of the geoscience knowledge density map of British Columbia.

Category	Description	Source
Geological maps	Surficial geology map	BCGS, GSC, GBC
	Bedrock geology map	BCGS, GSC, GBC
Thematic geoscience	Mineral potential modelling	BCGS, GSC
	Aggregate potential mapping	BCGS, GSC
	Ice flow indicator	BCGS
	Drift thickness	BCGS, GSC
	Landslide inventory map	BCGS, GSC
	Earthquake hazard map	BCGS, GSC, University of Western Ontario
	Geothermal potential map	BCGS
	Karst potential map	BC Ministry of Forests
Geophysics	Airborne gravity	GSC, GBC
	Airborne magnetic	GSC, GBC
	Borehole geophysics	GSC
	Rock petrophysical properties	GSC, BCGS
	Seismic	GSC
Geochemistry and geochronology	Rock geochemistry	BCGS
	Till geochemistry	BCGS, GBC
	Assessment report-sourced surface-sediment geochemistry	BCGS
	Ash geochemistry	BCGS
	Rock geochemistry	BCGS
	Rock geochronology	BCGS
	Regional geochemistry survey (RGS)	BCGS
Mineral resource	Mineral inventory (MINFILE)	BCGS
	Coal inventory (COALFILE)	BCGS
	Assessment report indexing system (ARIS)	BCGS
	Assessment report-sourced drillhole database	BCGS

A data count was prepared for each information category to produce category-specific density maps, which we then combined to produce a cumulative map. To perform the data aggregation, we developed a Python script using ArcPy and Pandas libraries. Three data classification methods were evaluated: equal intervals, natural breaks, and geometric intervals. Given the skewed distribution of knowledge density, we considered the geometric intervals approach to be the most informative for distinguishing between areas with low, moderate, and high knowledge density. For geoscience knowledge categories where several grid cells had a low (<2) knowledge density, the lowest classification category was manually set to 0 to create a distinction between low and no information available.

3. Results

The geoscience knowledge density maps (Figs. 1, 2) provide easy-to-understand representations of where and what types of geoscience data are available across the province. The geochemical and geochronology category (Fig. 1d) has the highest knowledge density because it includes 86,000 rock geochemistry sample locations, 65,000 regional geochemistry survey locations, 10,000 till geochemistry sample locations, and the location of 8700 samples with age determinations. Cumulative geoscience information is not equally distributed (Fig. 2), with high-density areas in the south-central and northwestern parts of the province related to past and current intensive mining and exploration activities and in the East Kootenay and Peace River coalfields of the Rocky Mountains.

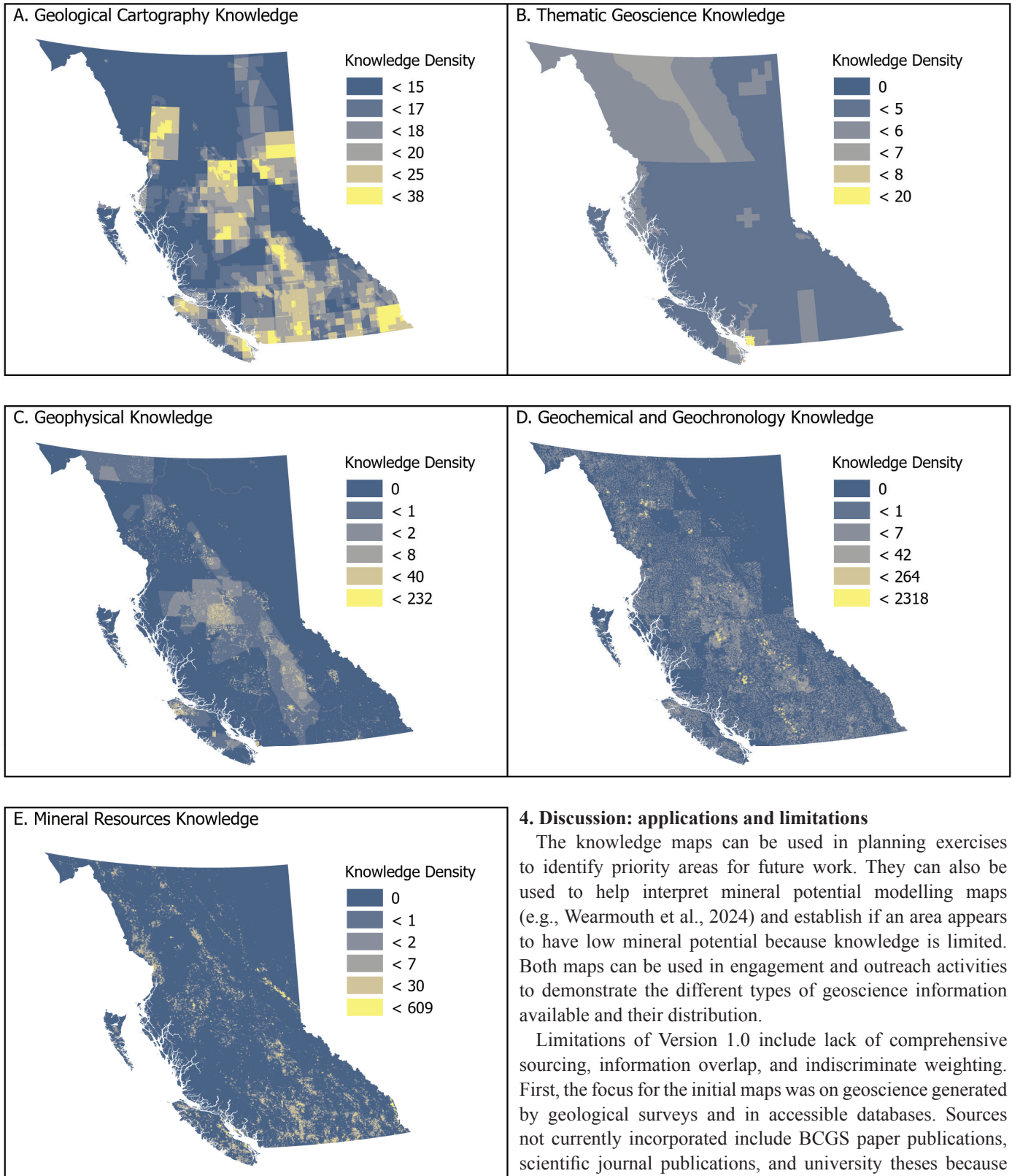


Fig. 1. Geoscience knowledge density map for five data categories. The knowledge density scale refers to the number data occurrences per 1:5000 grid cell using a geometric interval classification.

4. Discussion: applications and limitations

The knowledge maps can be used in planning exercises to identify priority areas for future work. They can also be used to help interpret mineral potential modelling maps (e.g., Wearmouth et al., 2024) and establish if an area appears to have low mineral potential because knowledge is limited. Both maps can be used in engagement and outreach activities to demonstrate the different types of geoscience information available and their distribution.

Limitations of Version 1.0 include lack of comprehensive sourcing, information overlap, and indiscriminate weighting. First, the focus for the initial maps was on geoscience generated by geological surveys and in accessible databases. Sources not currently incorporated include BCGS paper publications, scientific journal publications, and university theses because spatial compilations of these discrete geoscience contributions are lacking. For example, approximately 2600 BCGS publications other than maps are currently undergoing footprint

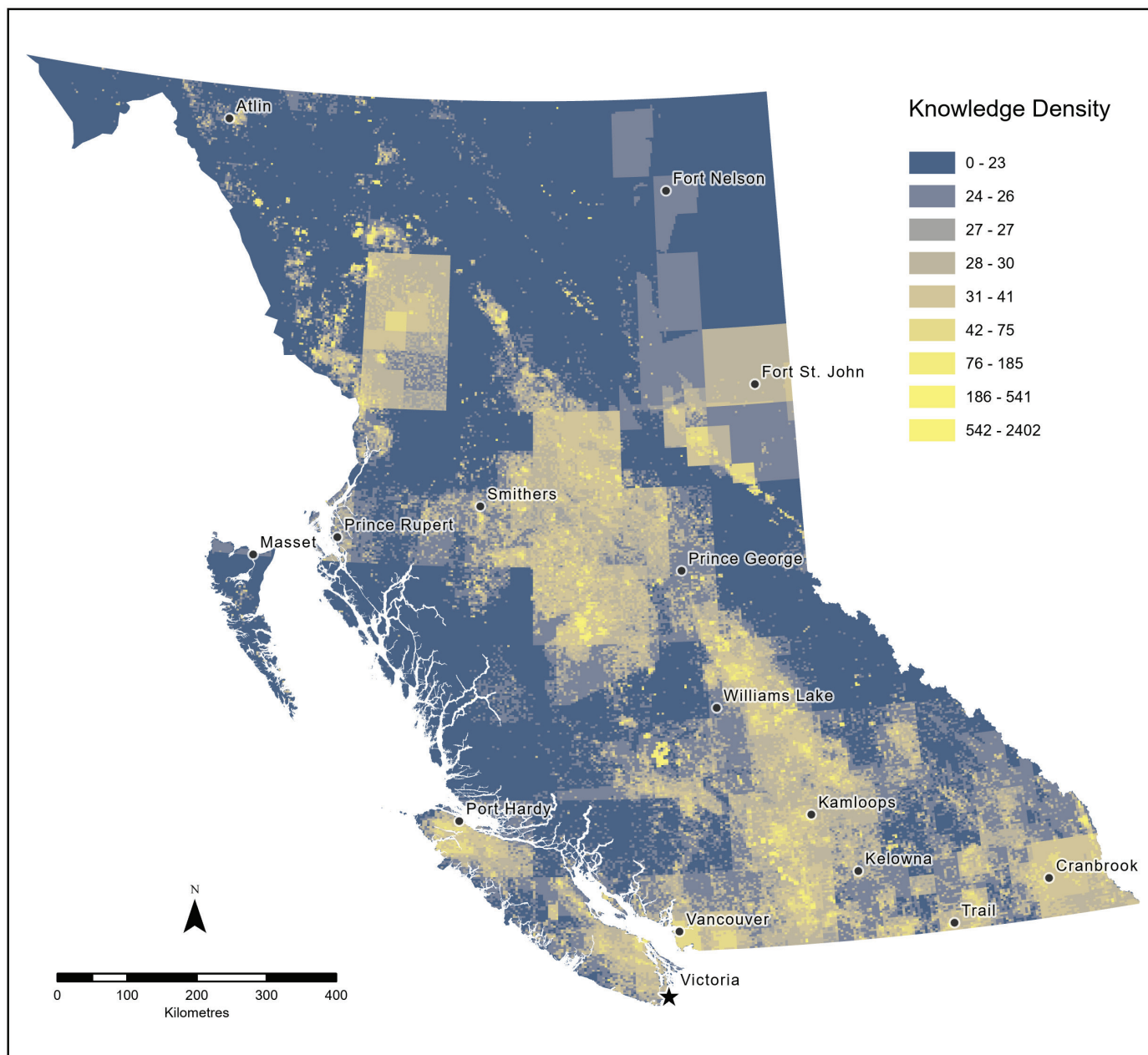


Fig. 2. Version 1.0 of the geoscience knowledge density map for British Columbia. This map is the cumulative version of the five categories shown in Figure 1. The knowledge density scale refers to the number of data occurrences per 1:5000 grid cell using a geometric interval classification.

digitization. Furthermore, much geological, geochemical, and geophysical data from exploration and mining companies is privately held. Moreover, Version 1.0 does not include any data from oil and gas companies held by the British Columbia Energy Regulator (BCER); if these data were included, the knowledge density in the northeastern part of the province would increase dramatically. Second, considerable overlap between the datasets was noted during the compilation of information from different sources. For example, Assessment Report Indexing System reports are represented by a single point location in the mineral resources knowledge category, but

data from these reports are also included as separate surface-sediment geochemistry sample points (Norris and Fortin, 2019) or drill hole location points (Fortin and Silva, 2025). Although efforts were made to reconcile such overlaps, some may persist, potentially skewing knowledge density in some areas. Third, we did not discriminate weighting between and within categories; a point occurrence is given the same weight as a polygon representing a study area. This has potential to skew density on the maps toward point data such as in the case of geochemical or geochronological point data in a single map area.

5. Future work

There are many opportunities to expand and improve on Version 1.0. Current plans for the next version include incorporating additional datasets such as the provincial groundwater wells database, which contains approximately 130,000 entries with information about the type and thickness of surficial geology units and depth to bedrock (British Columbia Ministry of Water, Land and Resource Stewardship, 2026), the British Columbia Energy Regulator well database (2026), which contains approximately 39,000 entries with geological and production information, and the footprints for BCGS publications other than maps. Future work could also consider varied weighting for the different datasets. For example, a map that represents the compilation and interpretation of multiple data sources (desktop, field, laboratory) could have a higher weighting than a single geochemical sample point. Similarly, different weighting could be applied to map footprints based on their scale.

6. Conclusion

This study represents the first attempt in understanding the spatial distribution of geological information in British Columbia. Version 1.0 of the geoscience knowledge density map illustrates the spatial distribution of publicly accessible geoscience data generated by BCGS, GSC and GBC. High information-density zones correspond to areas of extensive exploration and mining activities and corresponding large multidisciplinary public geoscience programs. Future versions could be improved by incorporating additional datasets, further eliminating overlapping entries, and developing a weighting formula that accounts for data sources and geometry.

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