# British Columbia Geological Survey Sample Archive: An emerging resource for public geoscience

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**Abstract**

The British Columbia Geological Survey (BCGS) Sample Archive is home to rock, mineral, and geochemical samples collected from across the province in the last several decades by BCGS staff and partner organizations. These collections represent a valuable resource for public geoscience, supporting quality control of published data, re-analysis using modern comprehensive and high-precision analytical methods, and new geoscience initiatives. Following a notice to vacate the historic BCGS storage facility at 254 Belleville Street in downtown Victoria, a systematic sorting, rationalizing, and cataloguing of archived samples was undertaken in anticipation of moving the collection to a new site at 1810 Blanshard Street, Victoria. We have catalogued about 30,000 rock and 91,000 geochemical samples thus far. This inventory includes about 25,400 sediment samples from modern drainages collected as part of the Uranium Reconnaissance and Regional Geochemical Survey programs since 1976. Work will continue to make the Archive a modern and reliable resource supporting Cordilleran geoscience with enhanced and accessible digital cataloging.

**Keywords:** Archived sample, hand specimen, drill core, pulp, sediment, till, sieved fraction, heavy mineral concentrate (HMC), indicator mineral, mineralization, MINFILE, Regional Geochemical Survey (RGS), Uranium Reconnaissance Program (URP)

## 1. Introduction

The British Columbia Geological Survey (BCGS) Sample Archive is home to rock, mineral, and geochemical samples collected by BCGS staff and partner geoscience organizations from many locations throughout the province in the last several decades. These samples include rock or sediment pulps, coarsely crushed rock, bulk sediment and sieved fractions, and heavy mineral concentrates and other mineral separates. Some samples come from reclaimed mines or from sites no longer accessible due to flooding, landslides, or land use status (Ramdeen, 2015). Others may require significant resources to re-sample. Catalogued and georeferenced, a physical sample library represents a valuable resource for public geoscience. The archived samples supply material for quality control of published data by replicate analysis, for re-analysis using new, more comprehensive and precise analytical methods, and for new geoscience initiatives.

Geological surveys routinely re-analyze archived samples using modern methods to test for a wider range of analytes with lower detection limits and improved precision (e.g., McMartin et al., 2008; Werdon et al., 2014; Golding et al., 2016). The Uranium Reconnaissance Program and later Regional Geochemical Surveys (RGS) systematically collected modern drainage sediments (stream- and lake-bottom and moss-trapped) and water from across the province since 1976. Early analyses determined concentrations of a few metals in the <0.177 mm fraction of sediments by flame atomic absorption spectrometry (AAS) following a Lefort aqua regia digestion. Uranium determinations were by instrumental neutron activation analysis (INAA) and delayed neutron counting (e.g., Ballantyne et al., 1977). Most of the archived RGS samples (tens of thousands) stored mainly at the Geological Survey of Canada in Ottawa and at BCGS Sample Archive in Victoria have been reanalyzed using multi-element techniques such as modified aqua regia digestion with a combination of inductively coupled plasma atomic emission spectroscopy (ICP-AES) and inductively coupled plasma mass spectrometry (ICP-MS), and INAA (see Lett and Rukhlov, 2017 for an overview). BCGS archive samples have been also extensively used in multidisciplinary studies (e.g., Lett and Jackaman, 2002; Canil and Lacourse, 2011; Mao et al., 2016, 2017; van Geffen and Bluemel, 2017; Johnson and Goldblatt, 2018; Simandl et al., 2021; Paradis et al., 2022a, b; Van der Vlugt et al., 2022).

For almost ten years, the BCGS Sample Archive was housed in the heritage 'Stores Building' (ca. 1912) at 254 Belleville Street in downtown Victoria (Fig. 1). Following notice to vacate this facility, we undertook a systematic sorting, rationalizing, and cataloguing of archived samples in anticipation of moving the collection to the Ministry building at 1810 Blanshard Street. This paper reports our progress updating the Archive activities, highlights key examples where archived materials were used in geoscience initiatives, and describes our next steps in creating digital resources for the Archive to support future research.

**Fig. 1.** Heritage 'Stores Building' (ca. 1912) at 254 Belleville Street, Victoria.

## 2. Archive materials

The BCGS Sample Archive comprises a physical library of rock, mineral, and solid geochemical samples. Rock samples include raw hand specimens, sawn slabs, drill core, and thin sections. Collected mainly during mapping projects, the samples are representative of rock units, alteration, and mineralization and provide a physical record of past studies that can be referred to many years after the original work. The samples also support other Ministry initiatives such as prospector training. Individually catalogued rock samples are stored in indexed banks (Fig. 2).

Geochemical materials include pulverized rock or sediment, coarsely crushed rock, bulk sediment (stream, lake, moss-trapped, till, soil) and sieved fractions, heavy mineral concentrates and other mineral separates, and vegetation (Fig. 3). The mass of archived bulk samples such as till is typically up to 2 kg, whereas the upper mass limit for processed sample media such as pulp and various fractions is 200 g. In contrast to rock samples, a catalogue of archived geochemical materials captures sequences of unique, five-digit laboratory identifiers (ID) or other sample identifiers along with the corresponding archive box, type of sample media, and other sample metadata (Fig. 4). Sample identifiers are traceable to records in a publicly available source such as a government report or online databases.

## 3. Ongoing activities and current archive inventory

Recognizing the value of the archived samples for future initiatives and the need to accommodate new samples, a decision was made to consolidate the BCGS laboratory facilities and Sample Archive to one site in the basement of the Ministry building at 1810 Blanshard Street. The initial stage of the project involved designing, permitting, and constructing the new facility. To facilitate the move, which has been completed, and improve the Archive, we undertook a systematic rationalizing of samples housed at the heritage 'Stores Building' on Belleville Street. This work included removing waste such as plastic bags, disposing compromised, unlabelled, or redundant materials, sorting materials into indexed cabinets (rocks) or boxes (geochemical samples),

**Fig. 2.** Indexed banks of rock samples at the BCGS Sample Archive.

splitting oversized samples, and logging sample identifiers and other available metadata (Fig. 5). At the time this report was prepared, we have catalogued 29,698 rock samples, 862 bulk till samples, and about 91,000 geochemical samples contained in 1634 catalogued boxes. The latter inventory includes about 25,400 samples (<0.18 mm and >0.18 mm fractions of stream, lake, and moss-trapped sediment) collected by the Regional Geochemical Survey program since 1976 (Fig. 6).

## 4. Examples of using BCGS Sample Archive

Drainage geochemical surveys are rapid and efficient for prospecting large areas for mineral resources. However, lake sediment, till, and vegetation are more commonly sampled in low-relief regions with extensive transported overburden. Starting in 1976, government-managed uranium and regional


**Fig. 3.** Examples of pulverized rock samples (pulps) at the BCGS Sample Archive. A unique, five-digit laboratory identifier (ID) links the original sample ID, analytical, and other metadata captured in the provincial rock lithogeochemistry database. A geochemical sample catalogue captures sequences of sample IDs per tray, along with the corresponding archive box number, type of sample medium, and other sample metadata.

**Fig. 4.** Shelving racks of indexed boxes storing geochemical materials at the BCGS Sample Archive.

geochemical programs collected drainage sediment samples in British Columbia. Typically, hundreds to ca. 1500 samples were collected per 1:250,000-scale map sheet. As analytical methods evolved over time from relatively simple colorimetry and AAS to multi-element techniques (INAA, ICP-AES, and ICP-MS), most of the archived RGS and till samples have been re-analyzed (Lett and Rukhlov, 2017 and references therein).

Lett and Jackaman (2002) examined the platinum geochemical response in different drainage sample media, supplementing new surveys with archived RGS samples from different parts of the province. Re-analysis of archived materials revealed new Au anomalies in the McBride and Prince George areas. Canil and Lacourse (2011) re-analyzed Archive till samples to estimate the composition of juvenile upper continental crust in the Cordillera of British Columbia, and Johnson and Goldblatt (2018) re-analyzed till samples for ammonium, which was used as a proxy for the nitrogen content of the upper continental crust to model the cycling of nitrogen in the Earth system.

Mao et al. (2016) used archived rock samples representing different mineral deposit types and unmineralized rocks to investigate apatite trace-element compositions (Fig. 7). Based on electron probe microanalysis (EPMA), laser ablation (LA)-ICP-MS, and multivariate statistics, they demonstrated that apatite compositions can be used to identify different types of mineral deposits. Follow-up orientation studies by Rukhlov et al. (2016) and Mao et al. (2017) applied the discriminant approach to apatite grains recovered from archived till samples both down-ice from known mineral occurrences and in underexplored 'greenfield' areas with little or no known mineralization in central British Columbia. Detrital apatite grains in till down-ice from known mineral deposits were correctly identified by the discriminant method. The work by Mao et al. (2017) study also helped generate new exploration targets in greenfield areas lacking known mineralization or hosting only minor mineral occurrences. These studies validated the apatite discriminant method and demonstrated its usefulness as a practical exploration tool in grassroots programs. Simandl et al. (2021) and Paradis et al. (2022a, b) studied archived samples of carbonate-hosted sulfide deposits in B.C.

Recently, Van der Vlugt et al. (2022) retrieved a suite of about 1000 archived samples, predominantly Triassic to Jurassic igneous rocks but including a range from Devonian to Quaternary, mainly from Stikine terrane in northwestern

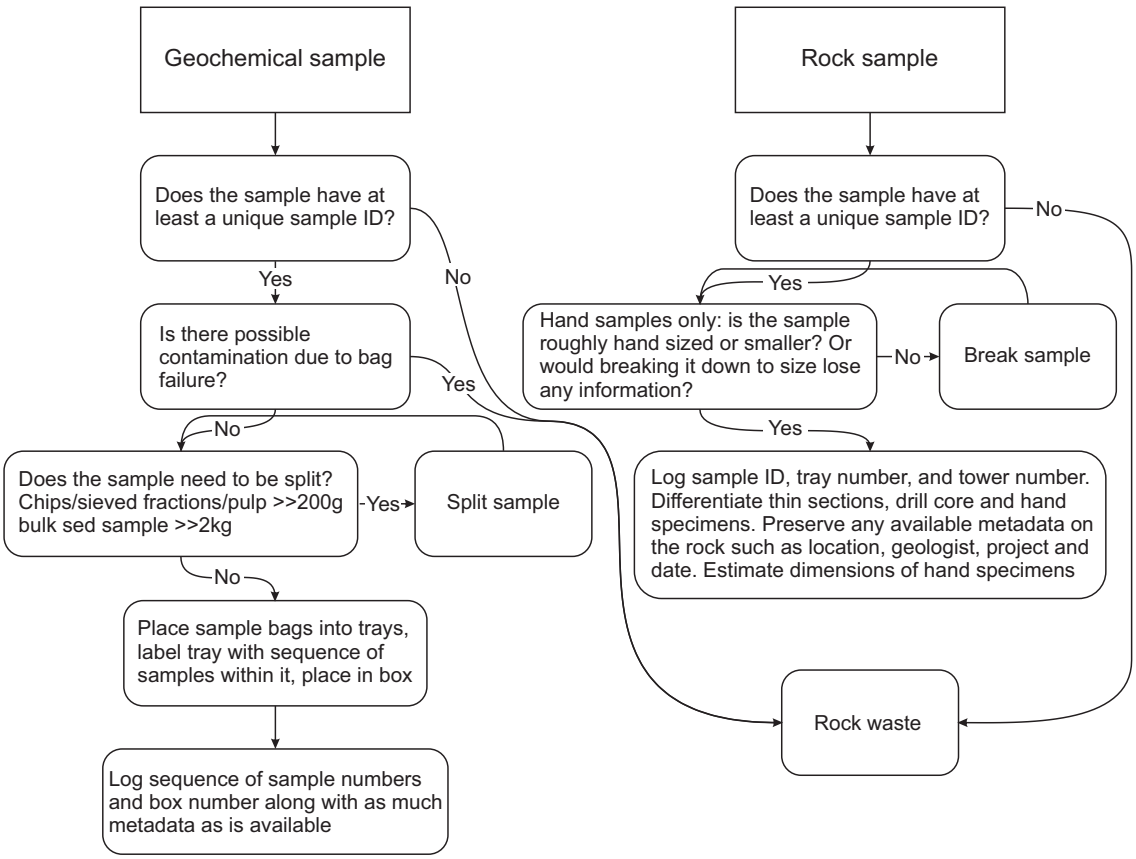


**Fig. 5.** Flow chart for sorting samples of the BCGS Sample Archive.

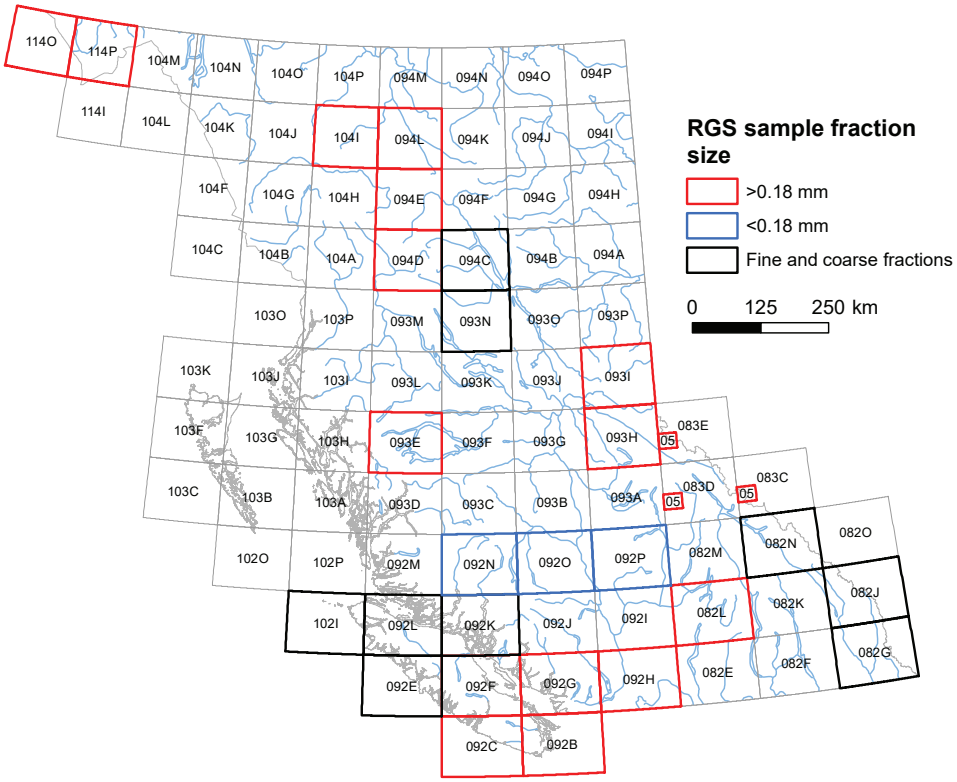


**Fig. 6.** Footprint of Regional Geochemical Surveys (RGS) with materials available in the BCGS Sample Archive.

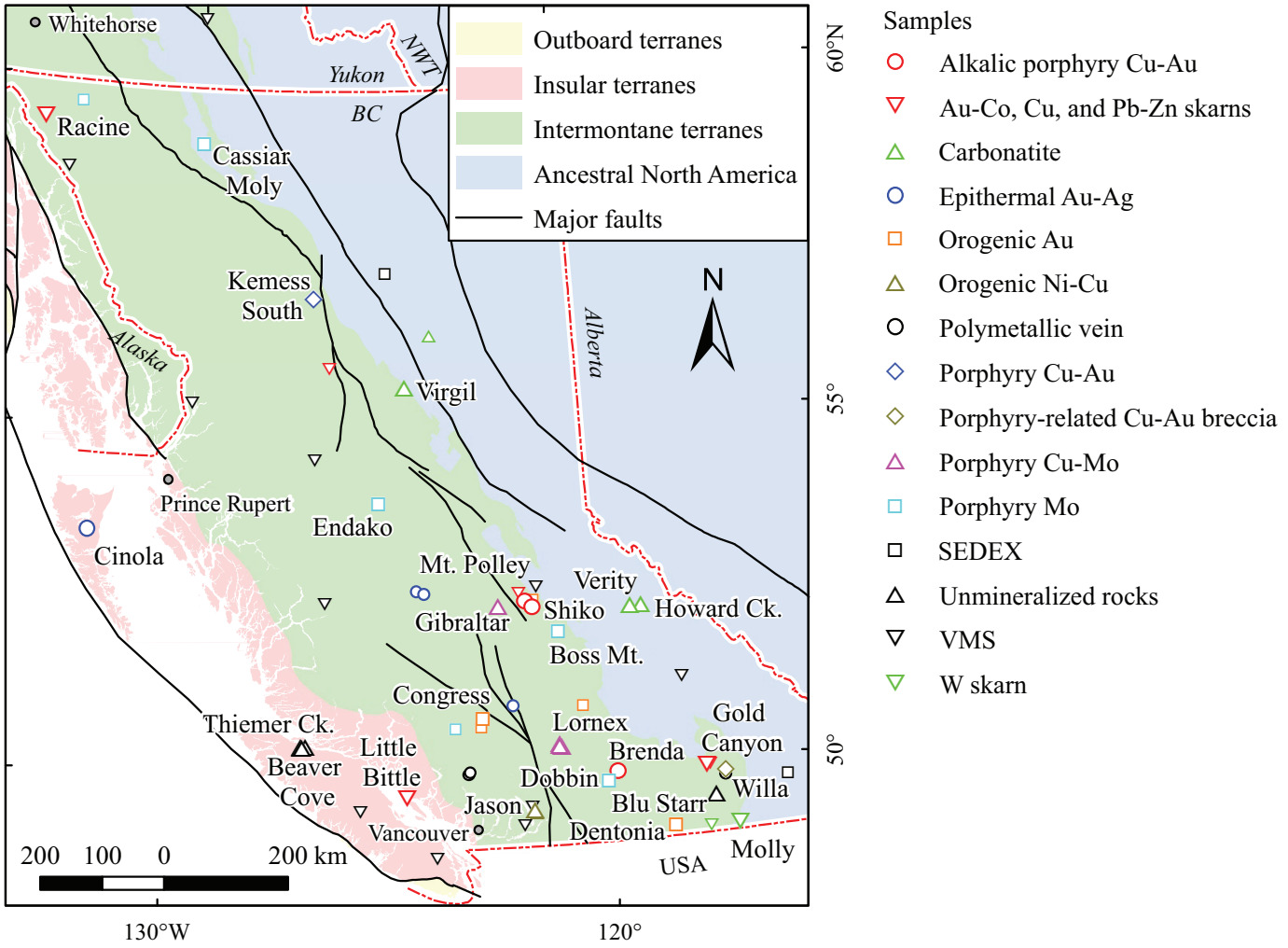


**Fig. 7.** Sample location map from Mao et al. (2016). Larger symbols represent samples that yielded apatites investigated.

British Columbia. Financially supported by Newcrest Mining Ltd., re-analysis of these samples involved determinations for up to 60 analytes using four-acid digestion with a combination of ICP-AES and ICP-MS for ultra-low minimum detection limits. In addition, about 500 samples that lacked modern 'total' determinations were re-analyzed for 56 analytes using lithium-borate fusion with ICP-AES or ICP-MS finish with ultra-low minimum detection limits, and for loss on ignition. Rigorous QA/QC of the new data was achieved using 87 blind quality controls. The study also developed a new, comprehensive metadata structure that captured full bedrock geological unit and sample information from the original sources.

## 5. Next steps and conclusion

The BCGS Sample Archive is the most comprehensive collection of geological samples in the province. Following the initial cataloguing of the archived materials, this project further aims to integrate the digital inventory with other provincial datasets such as lithogeochemistry, geochronology, rock physical properties, MINFILE, archived Ministry laboratory records, and BC Digital Geology in an interoperable database environment. Linked via sample identifiers, querying these datasets will facilitate efficient retrieval of archived materials suitable for specific studies. New protocols will set specific requirements and procedures to archive new samples and to access BCGS archived materials.

The digital database for the Archive, to be integrated with the MapPlace interface, will capture material availability, type (e.g., hand specimen, pulp, specific fraction, indicator minerals), indexed storage box or tray, and images (field and indoor photographs, 3D, hyperspectral, UV-light, transmitted- and reflected-light photomicrographs, X-ray maps, cathodoluminescence, back-scatter electron) for a given georeferenced location. Additional sample attributes populated from related datasets will include measured properties (e.g., assay results, absolute age), preparation and analytical methods, sample and rock unit descriptions, published source(s), and other metadata.

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