Ongoing Development of British Columbia's Regional Geochemical Database Using Material Saved from Previous Field Surveys

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Introduction

Reconnaissance-scale regional geochemical surveys (RGS) are designed to produce high-quality information that can be used to guide mineral exploration activities. These government-funded programs have been conducted throughout British Columbia (BC) since the early 1970s. At the outset, stringent methodologies were developed and have been maintained to ensure survey results remain useful and comparable (Ballantyne, 1991; Friske, 1991; Cook, 1997; Levson, 2001; Dunn, 2007). Opportunely, the original survey design included archiving representative splits of all samples collected. Having access to these materials saved from previous RGS field programs has contributed to the long-term viability and utility of the database.

To date, thousands of archived samples have been successfully reanalyzed using modern analytical techniques such as instrumental neutron activation analysis (INAA) and by inductively coupled plasma–mass spectrometry (ICP-MS). The methods are cost effective and provide significant upgrades to original analytical data reports (McCurdy et al., 2014). They provide lower detection levels for base and precious metals as well as pathfinder and rare-earth elements. They also generate improved data continuity between surveys completed at different times and samples analyzed by different commercial laboratories.

In 2017, results of a Geoscience BC–funded reanalysis project will be released for six regions in BC. Previously unavailable trace-metal data determined by ICP-MS will be available for 5579 stream sediment samples. The work represents the ongoing effort of Geoscience BC and government agencies to maintain and upgrade this important geochemical data resource.

BC RGS Projects and Database

More than 100 reconnaissance-scale regional geochemical surveys funded by Geoscience BC and both provincial and federal governments have been conducted in BC since 1976. These projects included the collection of a variety of samples, including

- stream and lake sediments,
- stream and lake water,
- till samples and
- biogeochemical material.

Results of the RGS projects have been compiled into publicly available digital databases that provide site descriptions, details on sample constituents plus analytical determinations for a range of trace metals. Figure 1 shows the provincial distribution of the more than 76 000 samples that have been collected to date. The surveys cover close to 75% of the province at sample-site densities that average from one site per 5 km^2 to one site per 14 km^2.

Since inception, modifications and upgrades have been implemented to improve the utility of the geochemical database. These have included the completion of surveys in areas not previously sampled; infill sampling to increase existing survey density; targeted field surveys using innovative methods; and reanalysis, using up-to-date analytical techniques, of sample pulps saved from older surveys. The availability of these samples has proved to be a valuable resource in generating enhanced analytical information for samples collected during older surveys. In the 1990s, more than 24 000 of these samples were reanalyzed by INAA (Jackaman et al., 1991), and starting in 2005, more than 45 000 samples have been reanalyzed by ICP-MS as part of Geoscience BC–funded initiatives and BC Geological Survey projects (Jackaman, 2011; Jackaman et al., 2015).

BC RGS Sample Storage

Material from more than 76 000 BC RGS samples have been saved, catalogued and stored in secure government facilities located in Ottawa, Ontario and Victoria, BC. This collection includes sediments acquired from stream, lake and till field sites, plus bark, needles and twigs collected from trees. Table 1 lists the type and number of field surveys completed in BC and the total number of samples that have been collected. Figure 1 shows the distribution of these sample sites.

Keywords: *British Columbia, geochemistry, regional geochemical survey, RGS, sample archive, multimedia, multi-element, analytical data, mineral exploration*

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Archived samples are stored in plastic containers that are labelled with each sample's unique identification number and placed sequentially in boxes organized by survey location and year (Figure 2). For each sample type, vials contain a representative split of the processed pulp used during initial laboratory analysis. Depending on the type of sample and year collected, the character of the archived pulp material may vary in fraction size and available weight.

For more recent stream sediment surveys, samples were air-dried and sieved through an –80 mesh screen (<0.177 mm). In surveys completed prior to 1986, the stream sediment samples were air-dried, ball milled and sieved to a –80 mesh (<0.177 mm) fraction. Lake sediment samples were air-dried and then crushed using a ceramic puck mill and sieved through an –80 mesh screen (<0.177 mm). Till-sample pulps were air-dried, crushed and sieved to produce splits of the silt plus clay-sized (<0.063 mm) fraction and in some cases a clay-sized fraction (<0.002 mm) was generated. Tree bark and twigs were macerated and needles were reduced to ash at 475°C. In general, sample weights for archived stream, lake and till pulps average 10–20 g. Based on previous sample recovery projects, approximately 95% of the samples will have more than 2 g of available material.

In addition to the pulps, the archive includes raw unprocessed stream sediment material consisting of coarse gravel, fine sediment and organic constituents. For more recent surveys (i.e., after 1986), a representative sample split of material sieved to –18 mesh (<2 mm) fraction was saved. There are more than 50 000 of these samples that are stored in containers that hold less than 100–400 g of material (Figure 3). For some till surveys, splits of the original till samples were also preserved in the archives (Figure 4).

Table 1. Type and number of Geoscience BC– and government-funded, reconnaissance-scale regional geochemical survey (RGS) programs conducted in British Columbia since 1976.

Survey type	Number of surveys	Number of samples
Stream	66	56 256
Lake	15	9 180
Till	18	9 898
Tree	5	1 412
Total	**104**	**76 746**

The archived unprocessed samples have not been included in any systematic reanalysis initiatives and remain an underutilized resource. The availability of this material provide opportunities to apply analytical instruments such as a Mineral Liberation Analyzer (MLA) or automated scanning electron microscopy systems (QEMSCAN®) for mineral identification. These units can conduct automated mineralogy investigations significantly more quickly and

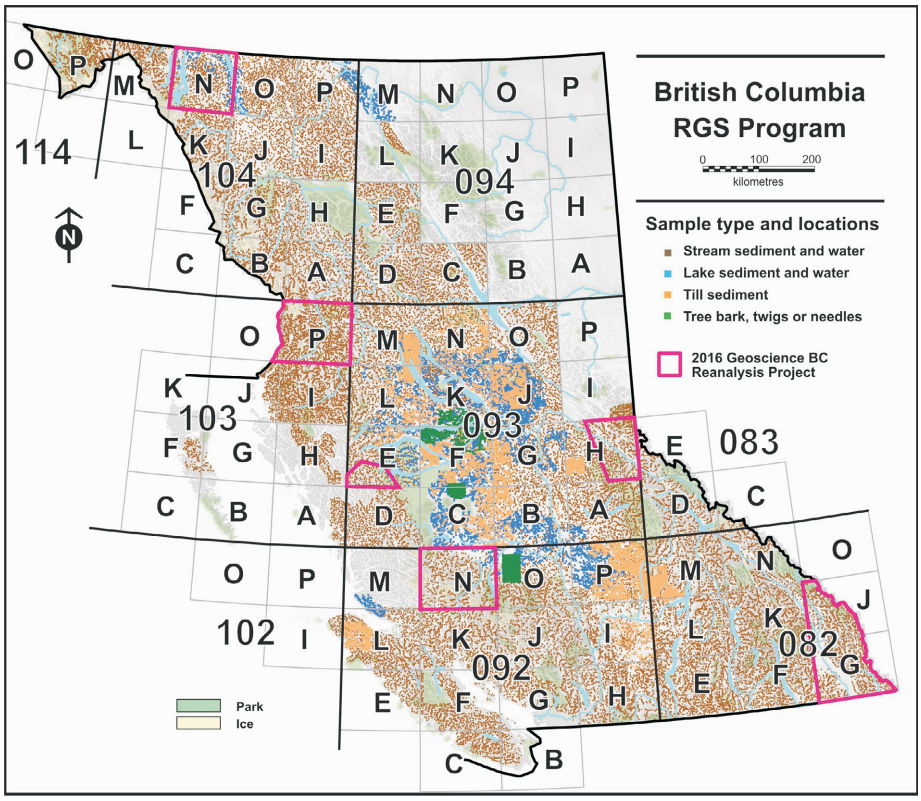

Figure 1. Distribution of all British Columbia regional geochemical survey (RGS) samples and location of survey areas targeted by the 2016 reanalysis project.

effectively than traditional non-automated methods (Page, 1991; Sylvester, 2012; Mackay et al., 2015). These applications are relatively new but have the potential to generate mineralogical information that could complement the existing trace-metal database.

Figure 2. Geological Survey of Canada's sample archive facility in Ottawa, Ontario, showing an example of warehoused regional geochemical survey (RGS) stream sediment pulps. The samples are stored in plastic vials, which are contained in boxes that hold 79 samples. Each box is placed in a metal cabinet.

Figure 3. Geological Survey of Canada's sample archive facility in Ottawa, Ontario, showing an example of a raw unprocessed regional geochemical survey (RGS) stream sediment sample collected in 1977.

Current RGS Database Upgrades

In 2016, as part of Geoscience BC's ongoing commitment to maintaining the BC RGS database, a total of 5579 RGS stream sediment pulps were recovered from archive storage in Ottawa. Permission to access these samples was provided by Natural Resources Canada (NRCan). The sample splits plus inserted quality-control reference materials were delivered to the Bureau Veritas Minerals laboratory (Vancouver, BC), where they will be analyzed for 56 minor and trace elements by ICP-MS following aqua-regia digestion. Results from this project are scheduled to be released in early 2017.

Recovered sample pulps originated from surveys conducted prior to 1986 in NTS map areas 093E, 093H, 103O, 103P and 104N (Figure 1). At that time, initial analytical results using an aqua-regia digestion and atomic absorption spectrometry (AAS) reported less than 20 elements in stream sediments. Also included in this reanalysis project are stream sediment pulps from NTS map areas 082G, 082J and 092N. Completed in the early 1990s, analytical results from these surveys also included a relatively limited number of elements determined by AAS. Table 2 provides the location and count of samples included in the 2016 ICP-MS reanalysis work, along with a list of remaining RGS stream sediment samples located outside of designated park land and other restricted areas that have not been analyzed by ICP-MS.

Summary

During the last decade, Geoscience BC–funded projects have established the agency as a leader in the development and maintenance of the BC RGS database. Building on the significant contributions by the Geological Survey of Canada (GSC) and the BC Geological Survey (BCGS), Geoscience BC has furthered the utility of this geochemical re-

Figure 4. Geological Survey of Canada's sample archive facility in Ottawa, Ontario, showing an example of a raw unprocessed split of a till sample originally collected in 1997.

source through new field surveys and sample reanalysis initiatives. To date, Geoscience BC–funded projects have included the collection of 14 253 new RGS samples, the reanalysis by INAA of 1152 RGS samples and the reanalysis by ICP-MS of more than 44 500 RGS samples. This information further augments the highly regarded BC RGS geochemical database that is routinely used as a standalone mineral exploration tool and as a complementary resource to other exploration activities. Providing an expanded suite of metals that outlines geochemical anomalies and regional geochemical trends (e.g., the Mo distribution shown in Figure 5) helps focus exploration. Reanalysis initiatives have produced a multi-element geochemical database that offers contiguous provincial coverage. This coverage further pro-

Table 2. List of previous stream sediment regional geochemical survey (RGS) programs targeted in the 2016 Geoscience BC Reanalysis Project, and list of remaining RGS datasets that do not include stream sediment results determined by inductively coupled plasma–mass spectrometry (ICP-MS).

NTS map area	Survey name	Survey year	Sample count	ICP-MS release year
082G, J	Southern Rockies	1990	1526	2017
092N	Waddington	1991	714	2017
093E	Whitesail Lake	1986	63	2017
093H	McBride	1984–1985	646	2017
104N	Atlin	1977	862	2017
103O, P	Nass River	1978	1768	2017
		Total	**5579**	
104M, 114P	Skagway	1992	973	Future
092K, L	Bute Inlet	1988	1312	Future
092F, G	Vancouver	1989	951	Future
		Total	**3236**	

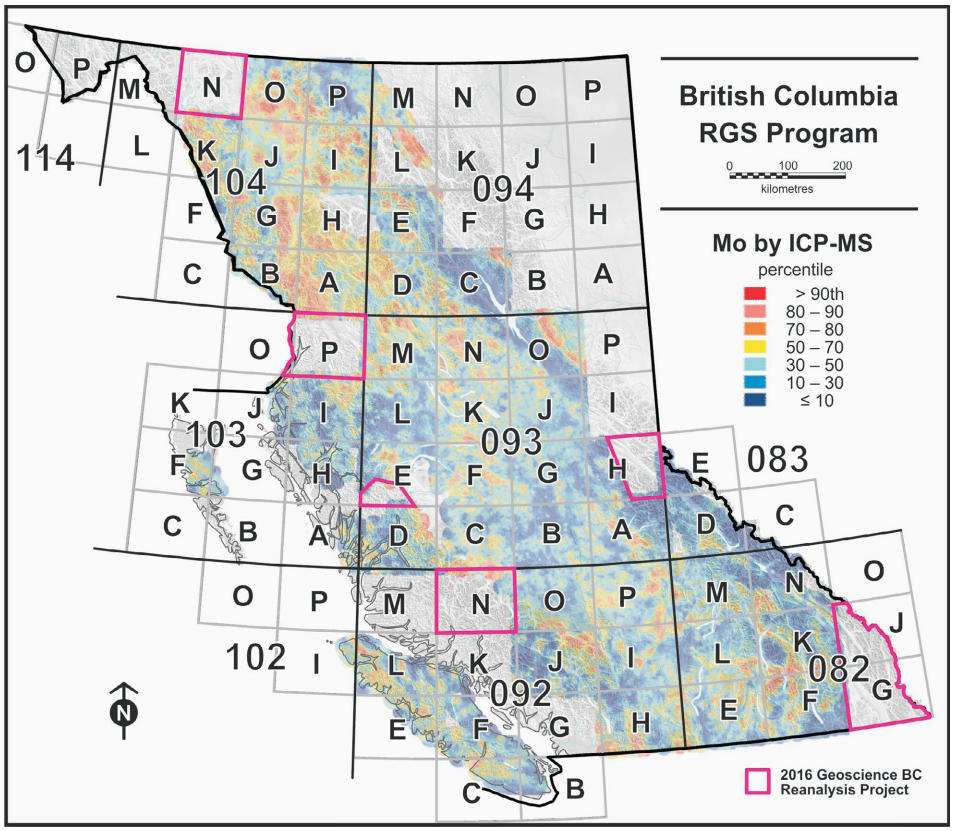

Figure 5. Geochemical distribution of Mo determined by aqua-regia digestion followed by inductively coupled plasma–mass spectrometry (ICP-MS) for stream, lake, till and tree samples from regional geochemical surveys. Threshold values are based on percentiles that were determined separately for each sample type.

motes the utility of the information to assist in the identification new areas of mineral potential, reassess known mining camps and support other complementary exploration work such as geophysical surveys, geological mapping and environmental evaluations.

Acknowledgments

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