

Lifting the lid on analytical methods for water analysis

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INTRODUCTION

Water is one of the most powerful geochemical media available to geoscientists, and with enough time can dissolve almost any natural material. The unique nature of the hydrosphere to interact with all other environmental spheres (i.e. pedosphere, biosphere, lithosphere, and atmosphere; Miller 1979) makes it an incredibly useful tool for understanding the mobility of elements in nature from source to sink throughout the water cycle (Stumm and Morgan 1970).

As water moves through this cycle, from precipitation to ground infiltration, water collects in streams, wetlands, lakes, and groundwater aquifers, it flows through a wide range of materials and permeable strata (Yang et al. 2021). Throughout its journey, water picks up chemical fingerprints from both natural and anthropogenic materials it encounters. When analyzed using appropriate methods, water can reveal the presence of mineralization, track environmental change, and help delineate geochemical patterns across entire regions (Painter et al. 1994).

For over four decades, the Geological Survey of Canada (GSC) Analytical Method Development Laboratory, renamed the Inorganic Geochemical Research Laboratory (IGRL) in 2010, has been at the forefront of designing methods and protocols for natural waters collection, preservation, and analysis. Landmark studies by Hall and collaborators (Hall 1979, 1988, 1992, 1993, 1998; Hall and Vaive 1992; Hall and Pelchat 1993; Hall et al. 1996, 2002, 2006) established modern standards for water sampling and analysis, and the GSC has steadily advanced these methods as analytical technologies evolved. The GSC's research laboratory has successfully bridged the gap between field and laboratory method development, ensuring that modern ultra-trace analysis methods are combined with best practice in field sampling.

This article provides an overview of the methods and tools used for the analysis of water, with guidance on best practices for sample collection and handling to assure high-quality results.

FIELD PROTOCOLS: GETTING THE SAMPLE RIGHT

The quality of water geochemical data is correlated to quality of field sampling, where adherence to consistent best practices is essential for obtaining reliable and defensible results (e.g. Hall and Pelchat 1993; Hall 1998; Hall et al. 2002). At each sampling location, the GSC collects two water samples in 60 mL bottles (Fig. 1A): one filtered and acidified sample for dissolved element analysis and one unfiltered, unacidified sample for bulk water chemistry. This two-bottle approach enables comparison between dissolved and total recoverable metal concentrations while also allowing assessment of the effects of filtration and preservation on analytical results. To monitor sampling reproducibility and contamination, field duplicate samples, consisting of two independent collections at a field site, and field blanks, prepared by processing deionized water as a sample, are inserted at a rate of 10% of the total sample population..

Several factors influence the stability and integrity of collected water samples. One of the most important considerations is bottle selection. The use of 60 mL high-density polyethylene (HDPE) bottles (Fig. 1) is recommended because they are chemically resistant, lightweight, durable, inexpensive, and suitable for low-level trace metal analyses (Hall 1998; Hall et al. 2002). These bottles do not require extensive pre-cleaning and are typically prepared by rinsing with deionized water and, when appropriate, a small volume of sample water



Fig. 1. (A) Water filtration in a mobile field laboratory set up in the back of a vehicle using **(B)** GSC water filtration and collection protocols developed by Hall (1998).

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Note from the Editor

Welcome to the third EXPLORE issue of 2026. This issue features an article describing the analysis of regional geochemistry water samples at the Geological Survey of Canada and was written by Pierre Pelchat, Lilianne Pagé, and James Kidder.

EXPLORE thanks all those who contributed to the writing and/or editing of this issue, listed in alphabetical order: E. Ambrose, J. Carranza, S. Cook, J. Graham, J. Kidder, R. Lett, M. Leybourne, Lilianne Pagé, P. Pelchat, J. Rice, A. Voinot and R. Zuo. EXPLORE thanks all of its advertisers for their financial support of the publication of this newsletter.

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President's Message



The 31st International Applied Geochemistry Symposium (IAGS 2026) will be held in Beijing from September 12–16. The symposium is chaired by Professor Qiuming Cheng from the China University of Geosciences (Beijing), with myself serving as Secretary-General from the China University of Geosciences (Wuhan). IAGS 2026 will feature six keynote speakers, 17 sessions, more than 100 oral and poster presentations, two workshops, and one panel discussion. The central theme of IAGS 2026 is “Data-driven geochemical data mining in support of mineral exploration and environmental studies.” The symposium aims to provide an international platform for advancing applied geochemistry through data science, analytical innovation, and interdisciplinary collaboration. We have now entered the era of big data and artificial intelligence (AI). Big data represents a novel approach to problem-solving that emphasizes the multidimensional interrelationships among variables, enabling data to “speak” and yield new and insightful answers. Concurrently, AI serves as an innovative data mining method with robust

nonlinear modeling capabilities, allowing for in-depth exploration and the discovery of hidden patterns. The integration of big data's innovative thinking with AI's advanced mining techniques is reshaping the paradigm of mineral exploration. I am confident that big data analytics and AI will help us achieve a deeper understanding of the mechanisms behind geochemical anomalies and improve the identification of those associated with mineralization.

Regarding future events, a nomination to host the 32nd International Applied Geochemistry Symposium (IAGS 2028) in Kingston, Ontario, Canada has been endorsed by the AAG Symposia and Events Committee. This nomination will be discussed and considered for approval at the upcoming AAG council meeting in late September.

In addition, the new AAG logo has been finalized and approved by the AAG Council. The winning design was co-created by Beth McClenaghan and Gwendy Hall. We extend our sincere gratitude to them for their wonderful work. Henceforth, the new AAG logo will appear on all AAG products, including our new website and EXPLORE. The logo is unveiled in this issue of EXPLORE.

Finally, I encourage all AAG members to nominate qualified colleagues for the Association's awards, including Honorary Fellowship, as well as the Gold, Silver, and Cameron-Hall Copper Medals. Please submit your nominations to the Chair of the Awards and Medals Committee, Dr. Dennis Arne (arne.dennis@gmail.com), prior to December 1.

Prof. Renguang Zuo

President of the Association of Applied Geochemists



CALL FOR AAG MEDAL NOMINATIONS

Significant contributions to applied geochemistry or service to AAG are recognised by award of either the AAG Gold or Past Presidents' (Silver) medals respectively. The history of how the medals came about and the formulation of guidelines for their award are discussed in the April 1992 issue of EXPLORE, issue 75, which can be found on the AAG website under Publications/EXPLORE newsletter/1990–1994.

Guidelines for nominating individuals for either medal are posted in 'The Association' section of the AAG website (www.appliedgeochemists.org) under the 'Awards' area. Past discussions of the guidelines indicated that the process for nominating individuals for either medal was a little cumbersome, to the extent that some nominations were not being made, and others took an unnecessarily long time to resolve. With this in mind, the 2012–2013 Awards & Medals Committee (Chair: Paul Morris. Committee members Eion Cameron, Pertti Sarala, and Chris Benn) revisited the guidelines to make the nomination process a little friendlier, with a more concise time frame for resolution. The revised guidelines for nominations are presented below.

3.0 NOMINATIONS

- 3.1 To be eligible for consideration for either award, nominations must be received by the Chairman of the Awards and Medals Committee on or before December 1st of any year.
- 3.2 For acceptance by the Awards and Medals Committee, nominations must be signed by a minimum of four (4) Fellows (voting members) of the Association in good standing.
Nominations should include the following:
 - (a) A one-page recommendation from each of the four nominators;
 - (b) A resume or curriculum vitae of the nominee;
 - (c) An itemized list of the outstanding scientific achievements (Gold Medal) or the dedicated service to the Association (Silver Medal) of the nominee (maximum two pages).

Since members of the Awards Committee may not have personal knowledge of the nominee, the completeness and quality of the nomination will be critical in terms of evaluation and selection.

Nominations for either medal can be made any time to arne.dennis@gmail.com and will be considered in the year of the nomination provided they are received prior to December 1.

Dennis Arne
AAG Past President
Chair, Awards and Medals Committee

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immediately before collection. Bottle quality is routinely monitored through batch testing, in which one bottle from every batch of 72 is filled with a blank solution and analyzed alongside field samples to assess potential contamination.

The filtration system is another critical component of sample collection. The collection of the dissolved constituents of water samples is best achieved using a pre-rinsed 60 mL all-polypropylene syringe fitted with a 0.45 μm Sterivex cartridge filter (Fig. 1B) containing a Durapore membrane (Hall 1998). The absence of rubber components minimizes the risk of trace metal contamination, while the polypropylene and Durapore materials reduce analyte adsorption. This filtration system provides a simple and effective means of obtaining representative dissolved-phase samples at the point source.

Sample preservation is equally important for maintaining sample integrity between collection and laboratory analysis (Hall et al. 1996, 2002, 2006). For dissolved metal analyses, filtered samples should be acidified immediately after filtration, where possible, with ultrapure nitric acid to a final concentration of approximately 0.4% HNO_3 . This level of preservation is generally sufficient to maintain elemental stability for at least one month at room temperature. In waters containing elevated concentrations of organic matter or colloidal material, acidification levels of up to 1% HNO_3 may be required, as some of the acid is consumed during the oxidation of organic constituents. Appropriate preservation helps prevent metal precipitation, adsorption to container walls, and other processes that may alter dissolved metal concentrations during storage and transport. Once collected, waters are stored under refrigerated conditions until transported back to GSC IGRL laboratories in Ottawa for analysis. Samples are transported in sealed coolers with ice packs. To test for potential sources of contamination during transportation, travel blanks consisting of preprepared aliquots of ultrapure deionized water are included in each sample batch.

Combining the use of appropriate sample bottles, contamination-free filtration, immediate preservation, and rigorous quality control procedures help ensure that dissolved metals remain in solution and that analytical results accurately reflect environmental conditions at the time of sampling. Consistent application of these practices is fundamental to generating high-quality water geochemical data suitable for research, monitoring, and mineral exploration applications.

PRE-ANALYTICAL HANDLING OF INCOMING WATER SAMPLES

Samples arriving at the GSC's IGRL in Ottawa are stored under controlled cool and dark conditions before sorting and cleaning. Unacidified sample aliquots are separated, sorted, and chilled in refrigerated conditions with minimal light exposure. Decades of GSC research have revealed that many metals can be lost due to adsorption onto container walls if samples are not preserved appropriately (Hall 1998). Preservation tests (Fig. 2) indicate that metals can be lost quantitatively to adsorption within a matter of less than two months. Of most concern are elements such as Fe, Mn, Al (Fig. 2), Ti, and Pb, which can show losses of more than 50%. However, adsorption can be reversed by acidifying the samples and letting them stand, resulting in >90% recovery in solution after about a week (Fig. 2). As a result, if the



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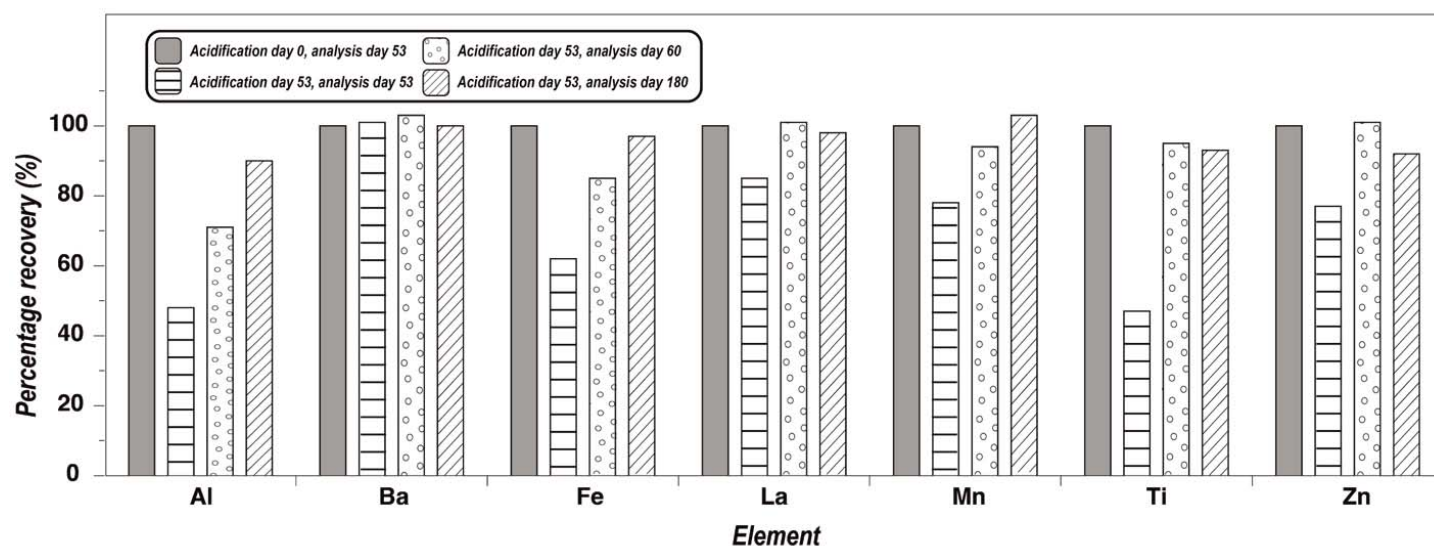


Fig. 2. Percentage element recoveries according to preservation and analysis timeline variation.

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samples are not acidified in the field, they must be acidified immediately upon arrival at the laboratory. The field- or laboratory-acidified samples are stored at room temperature under a vented enclosure on a class 100 bench for a minimum of 3 weeks. The longer stabilization time ensures more accurate and reproducible dissolved metal concentrations, which is critical for regional surveys and long-term datasets.

LABORATORY ANALYTICAL WORKFLOW

Filtered Unacidified and Unfiltered Unacidified Split

Within a few days of arrival in the lab, alkalinity, conductivity, and pH are measured using a Man-Tech PC-Titrate™ system equipped with a Titra-Sip™ module. Total organic carbon (TOC) is subsequently determined using a Shimadzu TOC-L analyzer employing a 680°C catalytic combustion oxidation method with non-dispersive infrared (NDIR) detection. Results are reported as dissolved organic carbon (DOC).

Conductivity measurements are used to estimate the dilution factors (Fig. 3A) required for subsequent anion analyses and, later, ICP analyses (Fig. 3B). As a general guideline, samples with conductivity values below 1,000 $\mu\text{S}/\text{cm}$ are analyzed undiluted. Samples with conductivity values between 1,000 and 2,000 $\mu\text{S}/\text{cm}$ are analyzed at a 10-fold dilution. Samples exceeding 2,000 $\mu\text{S}/\text{cm}$ are initially diluted 100-fold and reanalyzed at a lower dilution, if

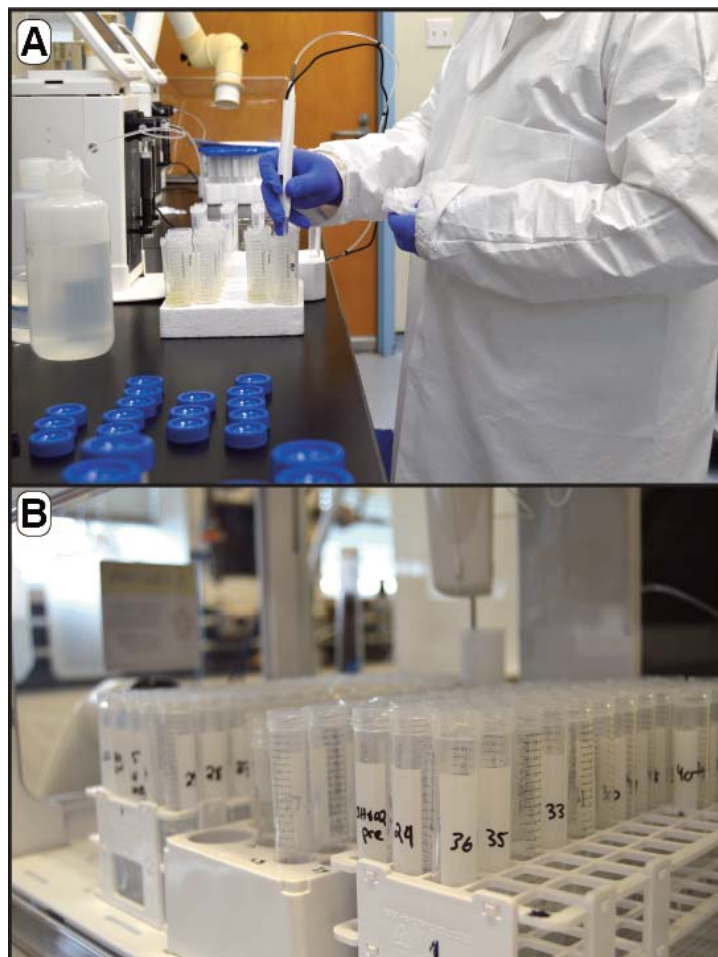


Fig. 3. (A) Sample dilution being performed in a GSC clean lab environment, and (B) samples loaded onto an autosampler ready for ICP-MS (inductively coupled plasma-mass spectrometry) analysis.

necessary. This approach improves analytical efficiency while minimizing contamination and maintenance requirements for the instrumentation.

Anion concentrations, including bromide, chloride, fluoride, nitrate, phosphate, and sulphate, are determined using a Dionex ICS-2100 ion chromatograph equipped with an AS-AP autosampler. Separation is achieved using an AS18 analytical column and a three-step potassium hydroxide (KOH) gradient elution ranging from 12 to 52 mM.

Quality assurance and quality control (QA/QC) procedures are applied throughout the analytical process. Method blanks and Environment and Climate Change Canada (ECCC) reference waters (ASSIN-02, LON-18, MISSISSIPPI-14 and MAURI-17) with certified concentrations for the measured parameters are analyzed at a frequency of one per 40 samples to assess analytical limits of quantification and precision, respectively. In addition, replicate sample analyses are performed at a frequency of one per 20 samples to assess analytical repeatability on unknown samples.

Filtered Acidified and Unfiltered Acidified Split

Acidified samples are initially analyzed using a Spectro Arcos inductively coupled plasma optical emission spectrometer (ICP-OES) (Fig. 4) to quantify major and trace elements and

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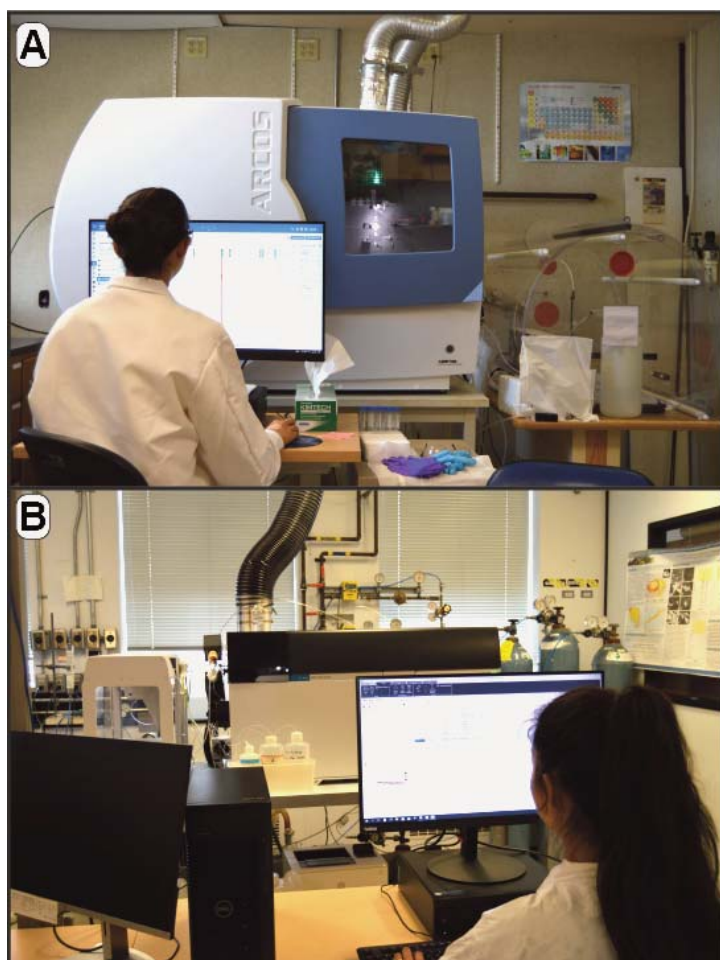


Fig. 4. (A) Analysis performed using a Spectro Arcos ICP-OES, and **(B)** analysis performed on an Agilent QQQ-ICP-MS.

evaluate the overall matrix loading. Samples are then analyzed using an Agilent 8900 triple quadrupole inductively coupled plasma mass spectrometer (ICP-MS/MS, also called QQQ ICP-MS or TQ-ICP-MS) for trace element determination.

The ICP-OES (Fig. 4A) and ICP-MS (Fig. 4B) analyses are performed independently by dedicated analysts using separate calibration standards, including independently prepared primary standards. This approach provides an additional level of quality assurance through independent verification of elemental concentrations (external reproducibility). Calibration standards are matrix-matched to the sample matrix (1% HNO₃) to minimize matrix-related analytical bias. A subset of elements is measured by both ICP-OES and ICP-MS to allow cross-comparison of results, with a target agreement of $\pm 5\%$ between the two techniques for most analytes of interest.

Comprehensive quality assurance and quality control (QA/QC) procedures are incorporated throughout the analytical workflow. Procedure blank samples are analyzed at a frequency of one per 40 samples to monitor potential contamination. Randomized replicate samples are included at a rate of one per 20 samples to assess analytical precision and repeatability. In addition, the certified reference water NRC SLRS-6 is analyzed on both instruments every 40 samples to

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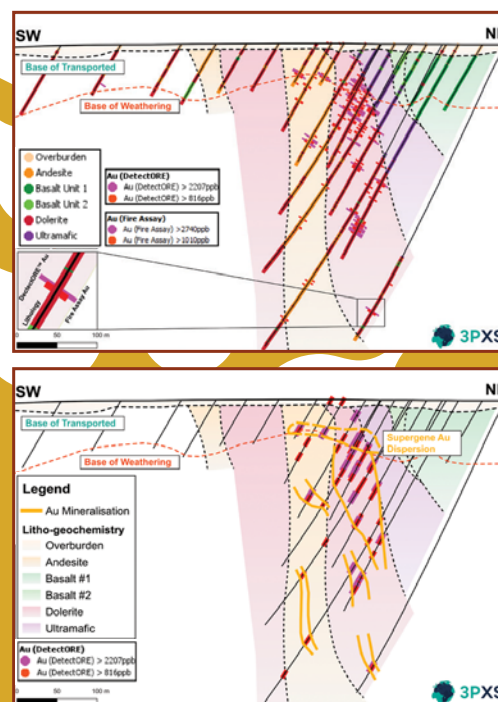
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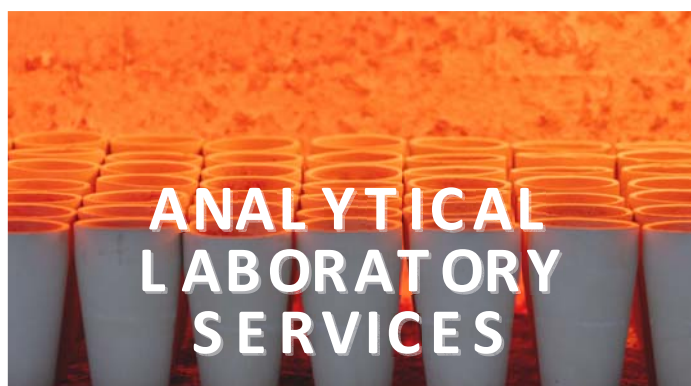
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verify analytical accuracy and inter-instrument comparability. To further strengthen data quality, additional well characterized reference waters provided by Environment and Climate Change Canada (ECCC; e.g., TMDA-51.6 for ICP-OES and TM-26.5 or TM-9.3 for ICP-MS) are analyzed on each instrument at the same frequency.

40 YEAR JOURNEY...

Over the past 40 years, the GSC has analyzed a wide range of natural waters for geochemical and environmental applications (McClenaghan et al. 2022). These include regional geochemical survey waters, such as the National Geochemical Reconnaissance (NGR), which collects systematic reconnaissance-scale datasets to inform environmental baselines or support mineral exploration through the release of pre-competitive data (McCurdy et al. 2014). These survey programs often aim at collecting samples in the hundreds or thousands from lakes and streams (Fig 5). Data are subsequently released as raw data or interpreted products in GSC open file reports and scientific journal papers (e.g. Friske et al. 1993, 2004, 2006a,b; McCurdy 1997; Cook et al. 1999; Day et al. 2005a,b, 2012, 2013; McCurdy et al. 2009, 2013, 2014; McCurdy and McNeil 2014; McNeil et al. 2015, 2017; Tremblay et al. 2016; Zhang et al. 2025) (Fig. 6). These data are available through the GSC data portal, Canadian Database of Geochemical Surveys (CDoGs) (Adcock and Spirito 2024) at https://geochem.nrcan.gc.ca/cdogs/content/main/home_en.htm and via the NRCan Open S&T Repository (OSTR) at <https://ostrnrcan-dostrncan.canada.ca/home>.

The GSC has also conducted extensive studies of environmental waters near mineral deposits and mine sites,



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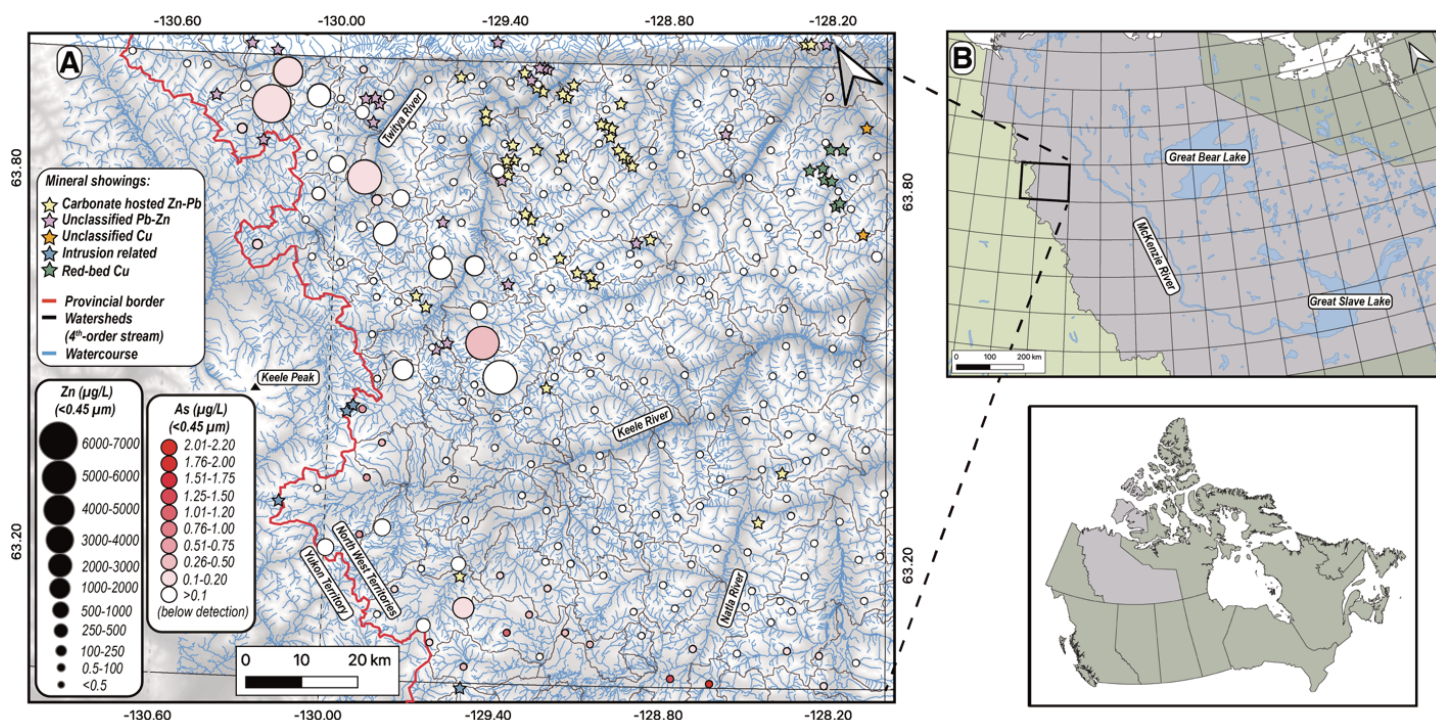


Fig. 5. (A) Dissolved concentrations of Zn characterized by size and As by colour, from stream water samples collected from Macmillan Pass – Sekwi Mountain, NWT. Presented data are from GSC Open File 4949 (Day et al. 2005a). Mineral occurrences and classification are from NTGS (2026). **(B)** Study location indicated by the grey polygon within the NTS grid system for Canada (105P).

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including investigations of acid rock drainage under the GSC's environmental geoscience programs (e.g. Desbarats and Dirom 2007; Desbarats et al. 2010; Parsons et al. 2001, 2012, 2013; McNeil et al. 2016; Gammon 2018; Parsons 2019). It has also studied metal mobility as an exploration tool (e.g. Hall 1992; Hall and McConnell 1994), more recently under the GSC's Targeted Geoscience Initiative (TGI), Critical Mineral Geoscience and Data (CMGD), as well as and Geo-mapping for Energy and Minerals (GEM) programs (McClenaghan et al. 2015; McNeil et al. 2018; Kidder et al. 2025, 2026; Voinot et al. 2026). Additional specialized water analyses have included snow and ice (Krachler et al. 2005; Zheng et al. 2006, 2014), groundwater (Desbarats and Dirom 2007; Desbarats et al. 2017), high arctic lake and groundwater dynamics (Faucher et al. 2022, 2026), and unique environments, such as Burning Lake and underwater fumaroles (Grasby et al. 2025, 2026).

From the early days of ICP-MS analysis using the Sciex Elan 250 to the present, major technological advances have transformed the GSC's analytical capabilities. Detection limits have steadily improved to sub-ppt levels for some elements, and modern interference-removal techniques have significantly enhanced data quality. The GSC's IGRL laboratory is now equipped with a high-resolution sector-field ICP MS coupled to a desolvation nebulizer, providing a powerful platform for analyzing challenging matrices and achieving ultra-trace detection performance.

...AND THE FUTURE

The GSC continues to innovate, with several active and emerging research directions in surface-water geochemistry. With improved limits of detection, it is now possible to evaluate sample preservation strategies for platinum group element (PGE) analysis, as pre-concentration techniques are no longer required to achieve reliable results. Ongoing work coupling ion chromatography (IC) with ICP-MS for metal-dissolved organic matter (DOM) speciation is opening new pathways for

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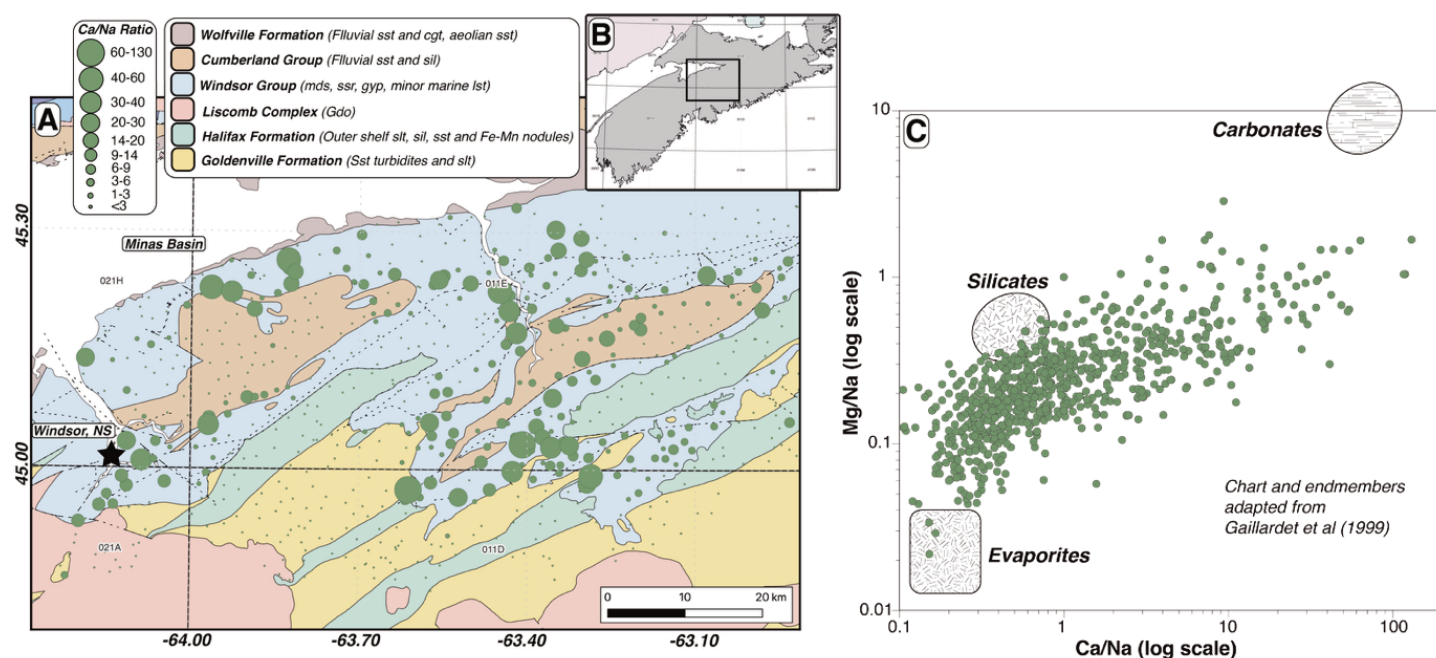


Fig. 6. (A) Map of Ca/Na ratios in dissolved ($<0.45 \mu\text{m}$) stream waters collected from the Wolfville and Kennetcook areas, Nova Scotia (Zhang et al. 2025) in eastern Canada. (B) Location of panel A within Nova Scotia, (C) Ratios of Mg/Na vs Ca/Na with endmember source compositions (after Gaillardet et al. 1999).

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exploration geochemistry by providing deeper insight into metal mobility, complexation, and transport in natural waters. Additional research areas include the application of machine learning for geochemical anomaly detection and the ultra-trace determination of critical minerals in surface waters. Collectively, these advances will help ensure that Canada remains at the forefront of geochemical research and analytical innovation.

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REFERENCES

- Adcock, S.W. and Spirito, W.A. 2024. The Canadian Database of Geochemical Surveys: Historical Overview and Current Challenges. Geological Survey of Canada, Current Research, 2024-1. <https://doi.org/10.4095/332490>
- Cook, S.J., Jackaman, W., Friske, P.W.B., Day, S.J.A., Hall, G.E.M. and Coney, A.M. 1999. Geochemistry of alkaline lake waters of the northern Kechika Trough, British Columbia (NTS 94M/2, 3, 4, 5, 6, 12; 104P/8, 9, 10, 15, 16). Geological Survey of Canada, Open File 3704. <https://doi.org/10.4095/214712>
- Day, S.J.A., Lariviere, J.M., Friske, P.W.B., Gochner, K.M., MacFarlane, K.E., McCurdy, M.W. and McNeil, R.J. 2005a. National Geochemical Reconnaissance (NGR): Regional stream sediment and water geochemical data, Macmillan Pass - Sekwi Mountain, Northwest Territories. Geological Survey of Canada, Open File 4949. <https://doi.org/10.4095/221062>
- Day, S.J.A., Lariviere, J.M., Friske, P.W.B., McNeil, R.J., Cairns, S.R. and McCurdy, M.W. 2005b. Regional stream sediment and water geochemical data, lower Willowlake River area, Northwest Territories (parts of NTS 95-I and 95 J) including analytical, mineralogical and kimberlite indicator mineral data from silts, heavy mineral concentrates and waters. Geological Survey of Canada, Open File 4674. <https://doi.org/10.4095/216675>
- Day, S.J.A., Falck, H., McCurdy, M.W. and McNeil, R.J. 2012. Regional stream sediment and water geochemical data, Cranswick River area, Northwest Territories (parts of NTS 106F and G). Geological Survey of Canada, Open File 6721. <https://doi.org/10.4095/288025>
- Day, S.J.A., Wodicka, N. and McMartin, I. 2013. Preliminary geochemical, mineralogical and indicator mineral data for heavy mineral concentrates and waters, Lorillard River area Nunavut (parts of NTS 56-A, -B, and -G). Geological Survey of Canada, Open File 7428. <https://doi.org/10.4095/293113>
- Desbarats, A.J. and Dirom, G.C. 2007. Temporal variations in the chemistry of circum-neutral drainage from the 10-level portal, Myra Mine, Vancouver Island, British Columbia. *Applied Geochemistry*, 22, 2, 415–435. <https://doi.org/10.1016/j.apgeochem.2006.09.008>
- Desbarats, A.J., Parsons, M.B., Percival, J.B., Kwong, Y.T.J. and Beauchemin, S. 2010. Characterization of the flow and chemistry of Adit Drainage, Bralorne Mine, Bralorne, B.C. Geological Survey of Canada, Open File 6345. <https://doi.org/10.4095/261502>
- Desbarats, A.J., Pal, T., Mukherjee, P.K. and Beckie, R.D. 2017. Geochemical evolution of groundwater flowing through arsenic source sediments in an aquifer system of West Bengal, India. *Water Resources Research*, 53(11), 8715–8735. <https://doi.org/10.1002/2017wr020863>
- Faucher, B.F., LeBlanc, A.-M., Utting, N. and Blade, M. 2022. Assessment of physicochemical properties in lentic surface water bodies of the Rankin Inlet area (Nunavut) for sublacustrine open talik detection. Geological Survey of Canada, Open File 8898. <https://doi.org/10.4095/330212>
- Faucher, B.F., LeBlanc, A.-M., Kidder, J.A., Benoît, N., Girard, É., Lacelle, D. and Voth, B. 2026. Hydrochemical variability in subarctic lakes near Rankin Inlet, Nunavut: insights from the ice-off period. Geological Survey of Canada, Open File 9324e. <https://doi.org/10.4095/ppdr59a3b4>

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Lifting the lid on analytical methods for water analysis *continued from p. 9*

- Friske, P.W.B., McCurdy, M.W., Gross, H., Day, S.J.A., Lynch, J.J. and Durham, C.C. 1993. A detailed lake sediment and water geochemical survey, central Labrador. Geological Survey of Canada, Open File 2650. <https://doi.org/10.4095/184073>
- Friske, P.W.B., Pronk, A.G., McCurdy, M.W., Day, S.J.A., McNeil, R.J., Allard, S. and Boldon, R. 2004. National Geochemical Reconnaissance (NGR): Regional stream sediment and water geochemical data, northeastern New Brunswick (NTS 210/9). Geological Survey of Canada, Open File 1831. <https://doi.org/10.4095/215455>
- Friske, P.W.B., McNeil, R.J., McCurdy, M.W., Wilson, R.S. and Day, S.J.A. 2006a. Geochemical data from a national geochemical reconnaissance stream sediment and water survey in the area of Old Crow, northern Yukon Territory (parts of NTS 116J, 116K, 116N, 116O, 116P, 117A and 117B). Geological Survey of Canada, Open File 5319. <https://doi.org/10.4095/222427>
- Friske, P.W.B., McNeil, R.J., McCurdy, M.W., Wilson, R.S. and Day, S.J.A. 2006b. Geochemical data from a national geochemical reconnaissance stream sediment and water survey in the Yukon Portion of the Flat River Map Area, southeast Yukon Territory (parts of NTS 95E). Geological Survey of Canada, Open File 5329. <https://doi.org/10.4095/222434>
- Gaillardet, J., Dupré, B., Louvat, P. and Allègre, C.J. 1999. Global silicate weathering and CO₂ consumption rates deduced from the chemistry of large rivers. *Chemical Geology*, **159**(1-4), 3–30. [https://doi.org/10.1016/S0009-2541\(99\)00031-5](https://doi.org/10.1016/S0009-2541(99)00031-5)
- Gammon, P.R. 2018. SOURCES: waterborne contamination in the oil sands region. In: Jacob, N., Kao, H., Galloway, J.M., Parsons, M.B., White, D.J., Larmagnat, S.N., Rivard, C., Gammon, P.R. and Savard, M.M. (ed.), Public presentations of May 8th, 2018: Environmental Geoscience Program, current status of research projects, May 2018. Geological Survey of Canada, Scientific Presentation, 88, 108–124. <https://doi.org/10.4095/308301>
- Grasby, S.E., Crowley, J.L., Mohr, M.T., Percival, J.B., Ardakani, O.H., Galloway, J., Bringue, M. and Yuan, W. 2025. Oceanic anoxic event 3 in Arctic Canada - Arc volcanism and ocean fertilization drove anoxia. *Geological Society of America Bulletin*, **137**(1-2), 411–426. <https://doi.org/10.1130/B37632.1>
- Grasby, S.E., Smith, I.R., Yuan, W. and Sheremet, A. 2026. Release of toxic-metal acid brines related to slumping of Cretaceous mudstones—Smoking Hills (Ingniryuat), Arctic Canada. *Geology*, **54**(4), 296–300.
- Hall, G.E.M. 1979. A study of the stability of uranium in waters collected from various geological environments in Canada. In: Current Research Part A. Geological Survey of Canada, Paper, 79-1A, 361–365. <https://doi.org/10.4095/104865>
- Hall, G.E.M. 1988. The determination of Pt and Pd in waters. *EXPLORE*, **64**, 12–13. <https://www.appliedgeochemists.org/publications/explore-newsletter>
- Hall, G.E.M. 1992. Hydrogeochemical exploration in the Baie Verte area, Newfoundland. Newfoundland and Labrador Mineral Development Division, Report Of Activities, 16, 53–54.
- Hall, G.E.M. 1993. Capabilities of production-oriented laboratories in water analysis using ICP-ES and ICP-MS. *Journal of Geochemical Exploration*, **49**(1-2), 89–121. [https://doi.org/10.1016/0375-6742\(93\)90040-s](https://doi.org/10.1016/0375-6742(93)90040-s)
- Hall, G.E.M. 1998. Cost-effective protocols for the collection, filtration and preservation of surface waters for detection of metals and metalloids at ppb (?g -1-1) and ppt (ng -1-1) levels phase I: evaluation of bottle type, bottle cleaning, filter and preservation technique. Canada Centre For Mineral and Energy Technology, Aquatic Effects Technology Evaluation Program Report, 3.1.3, 149. <https://doi.org/10.4095/306940>
- Hall, G.E.M. and McConnell, J.W. 1994. Hydrogeochemical surveys in Newfoundland - geological mapping with REEs in lake waters. *EXPLORE*, **83**, 1–10. <https://www.appliedgeochemists.org/publications/explore-newsletter>
- Hall, G.E.M. and Pelchat, J.C. 1993. Determination of palladium and platinum in fresh waters by inductively coupled plasma mass spectrometry and activated charcoal preconcentration. *Journal of Analytical Atomic Spectrometry*, **8**(8), 1059–1065. <https://doi.org/10.1039/ja9930801059>
- Hall, G.E.M. and Vaive, J.E. 1992. Application of a field portable anodic stripping voltammeter to the analysis of sulphide-selective leaches and waters. *Chemical Geology*, **97**, 295–306. [https://doi.org/10.1016/0009-2541\(92\)90083-h](https://doi.org/10.1016/0009-2541(92)90083-h)
- Hall, G.E.M., Vaive, J.E. and Pelchat, J.C. 1996. Performance of ICP mass spectrometric methods used in the determination of trace elements in surface waters in hydrogeochemical surveys. *Journal of Analytical Atomic Spectrometry*, **11**, 779–786.
- Hall, G.E.M., Pelchat, J.C., Pelchat, P. and Vaive, J.E. 2002. Sample collection, filtration and preservation protocols for the determination of 'total dissolved' mercury in waters. *Analyst*, **127**(5), 674–680.
- Hall, G.E.M., Vaive, J.E. and Parsons, M.B. 2006. Preservation of As III and As V in surface and ground waters. *Acta Geochimica*, **25**, 197–197.
- Kidder, J.A., Beckett-Brown, C.E., Voinot, A. et al. 2025. Using $\delta^{65}\text{Cu}$ and $\delta^{34}\text{S}$ to determine the fate of copper in stream waters draining porphyry mineralization: Implications for exploration targeting. *Chemical Geology*, **673**, 122527. <https://doi.org/10.1016/j.chemgeo.2024.122527>
- Kidder, J.A., Parkhill, M.A., Grenier, A., Harvey, B.J., Charmi, C., Tawbe, B. and Pelchat, P. 2026. Effects of diurnal cycling on metal(oid) concentrations and physicochemistry of a small stream in the Bathurst Mining Camp. *ACS ES&T Water*, **6**, 2949–2968. <https://doi.org/10.1021/acsestwater.5c01437>
- Krachler, M., Zheng, J., Koerner, R., Zdanowicz, C., Fisher, D. and Shoty, W. 2005. Increasing atmospheric antimony contamination in the northern hemisphere: snow and ice evidence from Devon Island, Arctic Canada. *Journal of Environmental Monitoring*, **7**(12), 1169–1176.
- McClenaghan, M.B., Parkhill, M.A., Pronk, A.G. et al. 2015. Geochemical and indicator mineral data for stream sediments and waters around the Sisson Sn-W-Mo deposit, New Brunswick (NTS 21-J/06, 21-J/07). Geological Survey of Canada, Open File 7756. <https://doi.org/10.4095/297246>

Lifting the lid on analytical methods for water analysis *continued from p. 10*

- McClenaghan, M.B., Spirito, W.A., Day, S.J., McCurdy, M.W., McNeil, R.J. and Adcock, S.W. 2022. Overview of surficial geochemistry and indicator mineral surveys and case studies from the Geological Survey of Canada's GEM Program. *Geochemistry: Exploration, Environment, Analysis*, **22**(1), geochem2021-070. <https://doi.org/10.1144/geochem2021-070>
- McCurdy, M.W. 1997. Interpretation of geochemical data from lake sediments and waters over Precambrian rocks in northeastern Alberta. In: Macqueen, R.W. (ed), *Exploring for Minerals in Alberta: Geological Survey of Canada geoscience contributions, Canada-Alberta Agreement on Mineral Development (1992–1995)*. Geological Survey of Canada, Bulletin 500, 133–154. <https://doi.org/10.4095/209210>
- McCurdy, M.W. and McNeil, R.J. 2014. Geochemical data from stream silts and surface waters in the Pine Point Mining District, Northwest Territories (NTS 85-B). Geological Survey of Canada, Open File 7577. <https://doi.org/10.4095/293913>
- McCurdy, M.W., Kjarsgaard, I.M., Day, S.J.A., McNeil, R.J., Friske, P.W.B. and Plouffe, A. 2009. Indicator mineral content and geochemistry of stream sediments and waters from northeast British Columbia (NTS 94A, 94B, 94G, 94H, 94I, 94K, 94N, 94O, 94P). Geological Survey of Canada, Open File 6311. <https://doi.org/10.4095/261331>
- McCurdy, M.W., Rainbird, R.H. and McNeil, R.J. 2013. Exploring for lead and zinc using indicator minerals with stream silt and water geochemistry in the Canadian Arctic Islands: an example from Victoria Island, Northwest Territories. In: Paulen, R.C. and McClenaghan, M.B. (eds), *New Frontiers for Exploration in Glaciated Terrain*. Geological Survey of Canada, Open File 7374, 65–70. <https://doi.org/10.4095/300293>
- McCurdy, M.W., Spirito, W.A., Grunsky, E.C., Day, S.J.A., McNeil, R.J. and Coker, W.B. 2014. The evolution of the Geological Survey of Canada's regional reconnaissance geochemical drainage sediment and water surveys. *EXPLORE*, **163**, 1–10. <https://www.appliedgeochemists.org/publications/explore-newsletter>
- McNeil, R.J., Alpay, S. and Grenier, A. 2015. Environmental geoscience investigations surrounding the former Aldermac mine, Abitibi, Quebec: Regional surveys of surface water and sediment geochemistry. Geological Survey of Canada, Open File 7595. <https://doi.org/10.4095/296832>
- McNeil, R.J., Alpay, S. and Grenier, A. 2016. Geochemical characteristics and spatial extent of metal contamination in surface water and aquatic sediments downstream of the Aldermac site. In: Alpay, S. (ed), *Multidisciplinary Environmental Science Investigations Surrounding the former Aldermac Mine, Abitibi, Quebec: The Lac Dasserat study workshop summarized*. Geological Survey of Canada, Open File 7993, 29–36. <https://doi.org/10.4095/297760>
- McNeil, R.J., Williamson, M.-C. and Day, S.J.A. 2017. Drainage geochemistry surveys, Axel Heiberg Island, Nunavut. In: Williamson, M.-C. (ed), *GEM 2 High Arctic Large Igneous Province (HALIP) Activity: workshop report*. Geological Survey of Canada, Open File 8151, 27–33. <https://doi.org/10.4095/300707>
- McNeil, R.J., Day, S.J.A. and Williamson, M.-C. 2018. Geochemical, mineralogical and indicator-mineral data for stream silt sediment, water and heavy-mineral concentrates, East Fiord area, western Axel Heiberg Island, Nunavut (part of NTS 59-G). Geological Survey of Canada, Open File 7779. <https://doi.org/10.4095/306606>
- Miller, W.R. 1979. Application of hydrogeochemistry to the search for base metals. In: Hood, P.J. (ed), *Geophysics and Geochemistry in the Search for Metallic Ores*. Geological Survey of Canada, Economic Geology Report 31, 479–487.
- Northwest Territories Geological Survey (NTGS). Mineral Showings Database. Government of the Northwest Territories. <https://app.nwtgeoscience.ca/> Accessed July 10th, 2026.
- Painter, S., Cameron, E.M., Allan, R. and Rouse, J. 1994. Reconnaissance geochemistry and its environmental relevance. *Journal of Geochemical Exploration*, **51**(3), 213–246. [https://doi.org/10.1016/0375-6742\(94\)90008-6](https://doi.org/10.1016/0375-6742(94)90008-6)
- Parsons, M.B. 2019. Geoenvironmental characteristics of gold and critical metal deposits. In: Jacob, N., Parsons, M.B., Rivard, C., Savard, M.M., Larmagnat, S.N., Outridge, P.M., White, D.J., Kao, H. and Lintern, G. (eds), *Public Presentations of May 21st, 2019: Environmental Geoscience Program, current status of research projects (phase 2014–2019)*. Geological Survey of Canada, Scientific Presentation, 104, 5–18. <https://doi.org/10.4095/314918>
- Parsons, M.B., Bird, D.K., Einaudi, M.T. and Alpers, C.N. 2001. Geochemical and mineralogical controls on trace element release from the Penn Mine base-metal slag dump, California. *Applied Geochemistry*, **16**(14), 1567–1593.
- Parsons, M.B., Leblanc, K.W.G., Hall, G.E.M., Sangster, A.L., Vaive, J.E. and Pelchat, P. 2012. Environmental geochemistry of tailings, sediments and surface waters collected from 14 historical gold mining districts in Nova Scotia. Geological Survey of Canada, Open File 7150. <https://doi.org/10.4095/291923>
- Parsons, M.B., Little, M.E., Desbarats, A.J., Percival, J.B., LeBlanc, K.W.G., Vaive, J.E. and Pelchat, P. 2013. Baseline geochemistry and controls on mine drainage composition in the Bridge River Mining District, British Columbia. Geological Survey of Canada, Open File 6435. <https://doi.org/10.4095/292203>
- Stumm, W. and Morgan, J.J. 1970. *Aquatic Chemistry* (Vol. 1022). New York: Wiley - Interscience.
- Tremblay, T., Day, S.J.A., Shirley, J., Smith, K.A. and McNeil, R.J. 2016. Geochemical, mineralogical and sedimentological results from till, stream and lake sediments and water samples in the Sylvia Grinnell Lake area, Baffin Island, Nunavut. Canada-Nunavut Geoscience Office, Summary of Activities, 2016, 13–25. <https://ostrnrcan-dostnrcan.canada.ca/entities/publication/3a8b9a07-2dbb-4cb1-bb43-d357926683c2>
- Voinot, A., Mloszewska, A.M., Rossiter, S., Moore, L., Chan, S., Lintell, M. and Day, S.J.A. 2026. Seeing the forest for the trees: white spruce (*Picea glauca*) tree bark as a biogeochemical indicator of a lithium occurrence in southwestern New Brunswick, Canada. *Science of The Total Environment*, **1013**, 181240.
- Yang, D., Yang, Y. and Xia, J. 2021. *Hydrological cycle and water resources in a changing world: A review*. *Geography and Sustainability*, **2**(2), 115–122.

Lifting the lid on analytical methods for water analysis continued from p. 11

Zhang, J., Pelchat, P., Hall, G.E.M., McClenaghan, M.B. and Kidder, J.A. 2025. Stream water geochemical data from central Nova Scotia (NTS 11-D, E, 21-A and H). Geological Survey of Canada, Open File 9246. <https://doi.org/10.4095/pxy78nmhsb>

Zheng, J., Fisher, D., Blake, E., Hall, G., Vaive, J., Krachler, M., Zdanowicz, C. Lam, J., Lawson, G. and Shoty, W. 2006. An ultra-clean firn core from the Devon Island Ice Cap, Nunavut, Canada, retrieved using a titanium drill specially designed for trace element studies. *Journal of Environmental Monitoring*, 8(3), 406–413.

Zheng, J., Pelchat, P., Vaive, J., Bass, D. and Ke, F. 2014. Total mercury in snow and ice samples from Canadian High Arctic ice caps and glaciers: A practical procedure and method for total Hg quantification at low pg g⁻¹ level. *Science of the Total Environment*, 468, 487–494. <https://doi.org/10.1016/j.scitotenv.2013.08.078>



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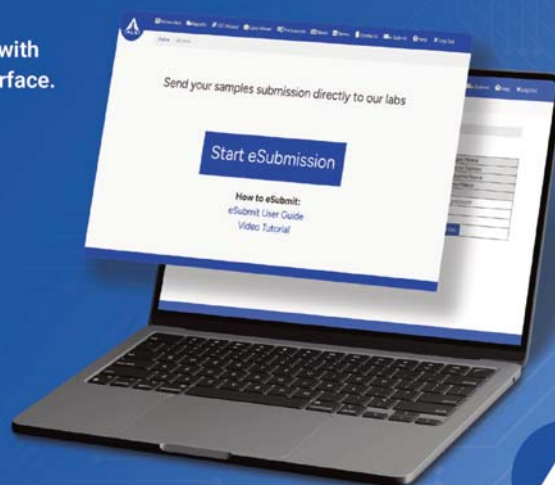


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News

AAG's New Logo!

AAG has a new logo! It will be used on AAG products including the EXPLORE newsletter front cover and the AAG medals. It will be available to all AAG members to download as a PDF file from the new website for use on posters, oral presentations and AAG booth displays. The winning design was created by Beth McClenaghan and Gwendy Hall.



Exploration Geochemistry Course, November 2026

This comprehensive online course consists of 3 stand-alone modules. It is designed for mineral exploration professionals and geology postgraduate students looking develop their knowledge and skills in exploration and applied geochemistry. The aim of the complete 3-day short course is to equip participants to confidently design, implement and interpret diverse data sets from geochemical exploration programs while ensuring “fit for purpose” data quality and data management. Examples will be drawn from publicly available data sources from Canada, Australia and Sudan, with detailed data sets from the central Victorian goldfields used for data integration exercises.

Module 1: Data Acquisition, Quality Assessment & Management

11–12 November 2026

Module 1 of the course is also relevant for database professionals wishing to know more about the collection of geochemical data and the assessment of its quality, as well as for more seasoned geologists wishing to review recent advances in the collection, analysis, QA/QC and management of data.

Module 2: Exploratory Data Analysis using ioGAS

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Module 3: Integration of Geochemical, Mineralogical and Geological Data

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Course Leader: Dennis Arne

Dennis has over 40 years' experience in geology and applied geochemistry globally. He has overseen regional geochemical exploration programs in the Yukon, Nunavut and northern Quebec in Canada, the USA, eastern Australia, Suriname, Sudan and Laos. Dennis was Managing Director and Principal Consultant – Geochemistry of CSA Global Canada until late 2017, General Manager and Principal Consultant – Geochemistry for Revelation Geoscience (purchased by CSA Global in 2012), Principal Consulting Geochemist with ioGlobal (now Reflex Geochemistry) and formerly Senior Geochemist with Geoscience Victoria (now Geological Survey of Victoria, Australia). Dennis is currently director and principal consulting geochemist at Telemark Geosciences. He is a member of the Australian Institute of Geoscientists, a Fellow and Past-President of the Association of Applied Geochemists, is a Registered Professional Geoscientist (Geochemistry) in Australia and a registered Professional Geoscientist in British Columbia.

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Summary of 2026 GAC-MAC Workshop SC01

Surficial Geochemistry and Indicator Mineral Methods in Mineral Exploration

The annual joint meeting of the Geological Association of Canada and the Mineralogical Association of Canada (GAC-MAC) was held in St. John's, Newfoundland, from May 26th to 29th, 2026. A 2-day short course titled Surficial Geochemistry and Indicator Mineral Methods in Mineral Exploration was held just prior to the GAC-MAC meeting on May 24th and 25th. Jointly organized by Sarah Hashmi of the Geological Survey of Newfoundland and Labrador and Roger Paulen, Jessey Rice, Alexandre Voinot and Lyndsay Moore of the Geological Survey of Canada. The course featured a series of presentations covering surficial exploration fundamentals and case studies, as well as a field trip demonstrating sampling techniques in surficial exploration.

The theme of the workshop was the application of Quaternary geology to mineral exploration in glaciated terrain and included case studies on surficial (till and vegetation) geochemistry and indicator mineral methods. Fundamentals were discussed as well as recent case studies in indicator mineral chemistry, biogeochemistry, automated mineralogy and machine learning applications in surficial geochemistry. In total there were 24 participants and 15 speakers, making for a diverse discussion.

Introductory talks covering fundamental concepts were presented by organizers. Roger Paulen discussed fundamental glacial dynamics, erosion and deposition processes, ice-flow indicators and glacial transport directions in the field. Jessey Rice provided a thorough overview of best practice methods for till survey design and sampling applied to till geochemistry and indicator minerals. Both contributors highlighted the utility of high-resolution digital elevation models (DEM) and light detection and ranging (LiDAR). The morning of the first day included three additional presentations. Sarah Hashmi presented an overview of humus sampling for grassroots mineral exploration and presented examples from a gold study in Newfoundland and rare earth element (REE) mineralization in southeast Labrador. Matthew Leybourne (Queen's University) discussed the role of aqueous geochemistry in mineral exploration, including strategies across diverse mineral systems and the promising advances in non-traditional (Fe, Cu, Zn, Se, Li, B, Mo) isotopes. The last presenter of the morning was Alexandre Voinot, who presented a holistic overview of conventional isotopes applied to drift across Canada, highlighting strengths and weaknesses across mineralization styles. The afternoon of day 1 featured 4 speakers with discussion turning to mineralogy, machine learning and quality assurance and quality control (QA/QC). Mike Michaud (Overburden Drilling Management Ltd.) provided a case study outlining the use of gold grains in till to map out a glacial dispersal train in the Kamloops district of central British Columbia. Jonathan Tremblay (IOS Geosciences Inc.) discussed the latest technological developments in automated scanning electron microscope (SEM), including a case study of automated mineralogy applied to drift sampling at the Borden gold deposit, Ontario. Mohammad Parsa (Geological Survey of Canada) presented a strategy for interpreting surficial geochemistry data using machine learning algorithms including a case study from the Hackett River volcanogenic massive sulphide (VMS) deposit in Nunavut looking at lake sediment geochemistry. The final talk of the day was presented by Cliff Stanley (retired; Acadia University), who provided a thorough overview of the principals and application of QA/QC in sampling programs in glaciated terranes including accuracy and precision.

The second day of the workshop continued the discussion on mineralogy and featured 7 talks and a field trip. Peter Dimmell (Krinor Resources) discussed case studies investigating gold grains in till sites across the island of Newfoundland. Dylan Abbott (Equinox Gold) presented an intriguing summary of the applications of terrain mapping integration into the vast till geochemistry and indicator mineral programs at the (now producing) Valentine Lake Mine, Newfoundland. Derek Wilton (consulting geologist) provided a summary of his work with Altius Minerals applying automated mineralogy to mineral prospects. Roger Paulen presented the results of REE indicator mineral studies at Strange Lake in northern Labrador, and Brazil Lake, Nova Scotia. Réjean Girard (IOS Geosciences Inc.) discussed polynormalization as a strategy to reduce variance by removing the effect of dominant variables in geochemical data. Steve Piercey (Memorial University of Newfoundland) expanded on the topic of indicator mineral methods, describing recent advances in mineral chemistry and mineral isotope research in indicator minerals and their application to exploration. The final talk of day 2 was presented by Lyndsay Moore, who discussed pyrite chemistry as an exploration tool and touched on various examples of trace element ratios as fertility indicators.

The afternoon of the second day featured a field trip with sites just outside the city of St. John's. The participants were able to observe typical glacial sediment deposits and learned how to determine suitable and unsuitable sampling material. Sarah Hashmi demonstrated the ideal workflow for sampling humus, and Jessey Rice provided hands-on guidance for till sampling.

The short course provided a valuable opportunity to hear from some of the leading experts in applied Quaternary geology, till geochemistry and advanced indicator mineral methods. Having opportunities such as this for researchers and explorationists to engage directly with surficial geologists and geochemists is invaluable for improving exploration success going forward. The content of this short course will be published as an Open File Report by the Geological Survey of Newfoundland and Labrador at a future date.

Summary of 2026 GAC-MAC workshop SC01: surficial geochemistry and indicator mineral methods in mineral exploration

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Sarah Hashmi giving a lecture.



Roger Paulen and Jessey Rice demonstrating indicators in the surface material that help to determine the quality of a till sampling site.



Sarah Hashmi demonstrating the recommended humus sampling process.



Short course organizers demonstrating the recommended till sampling procedure.



Group photo of participants at the final field stop on day 2.

A History of Geochemistry and Cosmochemistry, from Prehistory to the End of the Classical Period

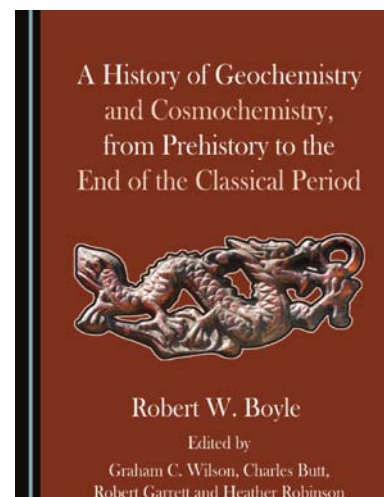
Since Mendeleev outlined the modern periodic table in 1869, many new uses have been found for the 92 naturally occurring elements. This book travels back in time to describe the utilization of materials familiar (gold, copper, iron) and arcane (arsenic, boron, red ochre) and their practical history (mining, metallurgy, and crafts), with evidence from archaeology and geology. Together with the technological developments, author Robert Boyle portrays the advances in our understanding of materials science which led to modern geological and environmental sciences. It is a source book valuable to students of history and archaeology, mining and metallurgy, as well as to geologists, mineralogists and geochemists everywhere.

About the author, Bob Boyle (1920–2003)

Bob was a pioneer of the application of geochemistry to mining geology and mineral exploration. He was an eminent geochemist with a long career at the Geological Survey of Canada where he initiated the Geological Survey of Canada's regional geochemistry program in 1957. His publications spanned various mineral-deposit types and a wide spectrum of precious and base metals. Bob was a founding member of the Association of the Applied Geochemists in the 1970s, and was awarded the Association's highest honor, the Gold Medal, in 1999 in recognition of his lifetime of outstanding achievement in exploration geochemistry. Among Bob's many achievements and awards was his induction into the Canadian Mining Hall of Fame in 1997.

The book is available at:

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There are no AAG news items in this issue of ELEMENTS.



Volume 22, Number 4, Stromatolites and Other Microbialites

This issue of ELEMENTS examines the most recent advances in stromatolite research from a combined geobiology, mineralogy, and (isotope) geochemistry viewpoint. It also emphasizes the exigent need to protect these endangered microbial ecosystems on a fast-changing modern Earth.

There are three AAG news items in this issue of ELEMENTS: (1) profile of AAG President 2026–2027 Renguang Zuo; (2) profile of AAG Vice-President 2026–2027 Alexander Seyfarth; and (3) abstract of an article that appeared in issue 210 (March 2026) of the EXPLORE Newsletter of the AAG.

John Carranza

Reminder: AAG members can access past issues of Elements at <http://elementsmagazine.org/member-login/> using their e-mail address and AAG member ID



Recently published

Geochemistry: Exploration, Environment, Analysis

Volume 26, Number 3, 24 August 2026

Research Article

New analyses of lake sediments from eastern Labrador: implications for exploration

S. Amor, R.C. Paulen, A. Hinchey, J.M. Rice, M. McCurdy and H. Campbell

<https://doi.org/10.1144/geochem2025-047>

Thematic Collection: Reviews in Exploration Geochemistry

A workflow for the analysis of multivariate exploration geochemical data

E. Grunsky, P. de Caritat, D. Arne, N. Caciagli and S. Scher

<https://doi.org/10.1144/geochem2025-077>

Thematic Collection: Multi-scale Geochemical Mapping for Mineral Resource Management

Regional geochemical background field simulation and anomaly separation based on random forest and multi-source environmental factors

Mi Tian, Xueqiu Wang, Jian Zhou, Binbin Sun, Chao Wu, Yining Zhou, Qinghai Hu, Hui Wu, Chan Chang and Yu Qiao

<https://doi.org/10.1144/geochem2025-068>

Distribution and behaviour of rare earth elements in stream sediments from SE Spain: lithological and supergene controls

M. Sánchez-García, P. Adánez-Sanjuán and C. Fernández-Leyva

<https://doi.org/10.1144/geochem2026-004>

Geochemical baselines and prospecting of lithium in southeastern Brazil: low-density stream sediment mapping across Minas Gerais and the Araçuaí Fold Belt

L.S.C. Guerra, M.G.P. Leite, E.D. Marques, M.A.G. Fajardo and E.P. Viglio

<https://doi.org/10.1144/geochem2025-057>

Thematic Collection: Data Science and Geochemistry for Tomorrow's Resources

Spatial distribution and enrichment mechanisms of rubidium and caesium in salt lakes of the Qinghai–Tibet Plateau

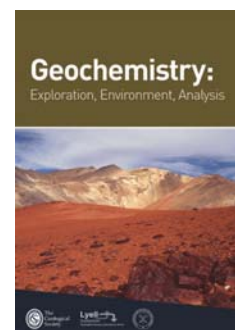
Linhua He

<https://doi.org/10.1144/geochem2025-080>

LocatOre: pathways to mineral discoveries through computer-based modelling of geochemical data – case studies of chlorite vectoring at the Batu Hijau and Ujina porphyry copper deposits

S.A. Cooke, M.J. Cracknell, M.J. Baker, L. Zhang, I. Belousov, and D.R. Cooke

<https://doi.org/10.1144/geochem2025-010>



Articles in Past Issues of EXPLORE

5 years ago EXPLORE 192 (September 2021)

Geochemistry of LCT pegmatites in part of Northeastern Nasarawa state, Northcentral Nigeria; A. Chukwu, S.C. Obiora and T.C. Davies. <https://doi.org/10.70499/SPQU4159>

10 years ago EXPLORE 172 (September 2016)

Basic indicator mineral math: Why visual analysis of the entire heavy mineral fraction of large sediment samples is required on indicator mineral exploration programs in glaciated terrains. S.A. Averill and R.G. Huneault. (<https://doi.org/10.70499/AEEF3898>)

15 years ago EXPLORE 152 (September 2011)

Responses in lake sediments and waters to occurrences of rare earths and rare metals in the Canadian Shield. S. Amor. (<https://doi.org/10.70499/AGDQ5231>)

20 years ago EXPLORE 134 (September 2006)

Recent advances in base metal indicator mineralogy: An update from Overburden Drilling Management Limited. S. Averill. (<https://doi.org/10.70499/MQJF7510>)

30 years ago EXPLORE 93 (October 1996)

Regional distribution of heavy metals in humus and till near a base metal smelter at Flin Flon, Manitoba, Canada. I. McMartin and P.J. Henderson

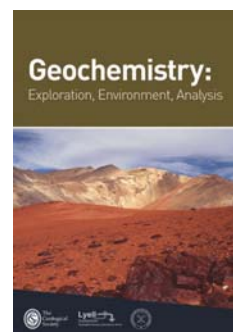
<https://www.appliedgeochemists.org/explore-newsletter/explore-issues>



GEEA Reviews in Exploration Geochemistry Thematic Issue Update

This thematic issue, consisting of state-of-the-art reviews on various topics of exploration geochemistry, is one of the most popular collections that GEEA has ever published. Its popularity demonstrates the global appetite for textbook-style information on exploration geochemistry - a topic rarely taught in most geology or geoscience programs. However, the field is still very relevant for the mineral resource industry, as a high level of interest in continuing education short courses in exploration geochemistry has been indicated in recent years. In addition, there have been no recent textbooks that specifically cover the broad field of exploration geochemistry, leaving a vacuum of recent and relevant information on the many sub-topics that comprise this field.

The AAG authors of these papers are current or recently retired practitioners and experts in their respective fields. The review articles in this series capture their respective expertise and practical experience gathered over many decades of experience, and provide a valuable resource for those undertaking exploration geochemistry for years to come. Thus far, the issue contains nine papers and is available for free download (Open Access). The final two papers to be added to this issue will be published in late 2026–early 2027.



Access the thematic issue at <https://www.lyellcollection.org/topic/collections/reviews-in-exploration-geochemistry>

Application of humus geochemistry to mineral exploration in glaciated terrain: a review

S. Hashmi, A. Voinot and M.B. McClenaghan

<https://doi.org/10.1144/geochem2025-065>

A workflow for the analysis of multivariate exploration geochemical data

E. Grunsky, P. Caritat, D. Arne, N. Caciagli and S. Scher

<https://doi.org/10.1144/geochem2025-077>

Practical applications of quality assurance and quality control in mineral exploration, resource estimation and mining programmes: a review of recommended international practices

B.W. Smee, L. Bloom, D. Arne, and D. Herberlein

<https://doi.org/10.1144/geochem2023-04>

Stream sediment geochemistry in mineral exploration: a review of fine-fraction, clay-fraction, bulk leach gold, heavy mineral concentrate and indicator mineral chemistry

M.E. Doherty, K. Arndt, Z. Chang, K. Kelley and O. Lavin

<https://doi.org/10.1144/geochem2022-039>

Review of till geochemistry and indicator mineral methods for mineral exploration in glaciated terrain

M.B. McClenaghan, R.C. Paulen, I.R. Smith, J.M. Rice, A. Plouffe, I. McMartin, J.E. Campbell, M. Lehtonen, M. Parsa, and C.E. Beckett-Brown

<https://doi.org/10.1144/geochem2023-013>

Soil gases in mineral exploration: a review and the potential for future developments

C. Plet and R.R.P. Noble

<https://doi.org/10.1144/geochem2023-008>

Review of regional lake sediment geochemistry methods for mineral exploration in glaciated terrain

M.B. McClenaghan, S.J. Cook, M.W. McCurdy, C.E. Beckett-Brown, S.J.A. Day, R.J. McNeil and M. Parsa

<https://doi.org/10.1144/geochem2026-006>

Exploratory data analysis of geochemical exploration data

D. Arne and R. Garrett

<https://doi.org/10.1144/geochem2025-037>

A review of hydrogeochemical techniques for mineral exploration: history, present and future

J.A. Kidder, N. Reid, R.R.P. Noble, M.I. Leybourne, J. Buskard, R.J. Howell, A. Stoltze and R.G. Garrett

<https://doi.org/10.1144/geochem2024-065>

Reminder

Students publishing first authored-papers in GEEA are eligible for FREE open access publishing, meaning their paper is free to download for everyone.

Welcome New AAG Members

REGULAR MEMBERS

Regular Members are non-voting members of the Association and are currently engaged in the field of applied geochemistry at the time of their application and have been active for at least two years prior to the date of joining.

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FELLOWS

Fellows are voting members of the Association and are actively engaged in the field of applied geochemistry. They are Regular AAG Members who are nominated to be a Fellow by a Fellow of the Association by completing the Nominating Sponsor's Form. Consider becoming a Fellow of the AAG.

STUDENT MEMBERS

The Association also has student memberships. These members are students who are enrolled in an approved course of instruction or training in a field of pure or applied science at a recognized institution.



Association of Applied Geochemists

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Free Publications Available from the Association of Applied Geochemists' Website

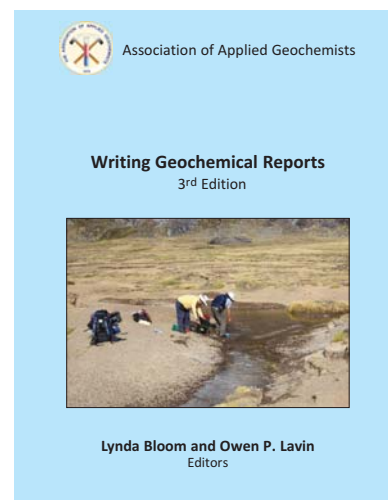
Writing Geochemical Reports, 3rd Edition Guidelines for surficial geochemical surveys Edited by Lynda Bloom and Owen Lavin

The Association of Applied Geochemists has developed international standards for writing geochemical reports that provide clear instructions for reporting geochemical results, together with the requisite supporting information to evaluate these results for accuracy, integrity and credibility.

The target audience for these guidelines is anyone charged with reporting geochemical results, which includes, but is not limited to, company geoscientists, external consultants and contractors, government scientists, and university scientists and students. The guidelines focus on preparation of an electronic publication that provides a systematic and permanent record of the work performed and take into account the ability to bundle text, tables, figures, images, and oversized maps into one electronic file. The third edition of this guide was released in 2022 and expands the original mandate of Writing Geochemical Reports (1st and 2nd editions) to include multiple types of geochemical surveys with survey-specific recommendations.

The guide may be downloaded free of charge from the AAG website:

<https://www.appliedgeochemists.org/publications>



Barringer

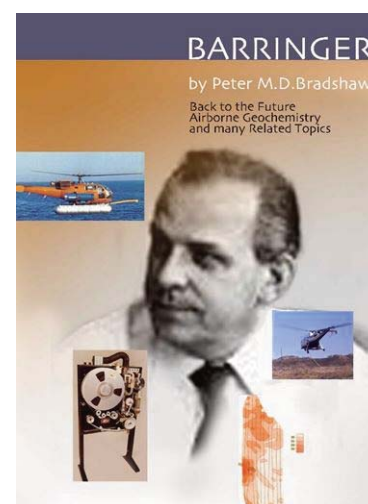
Back to the Future: Airborne Geochemistry and many Related Topics by Peter M.D. Bradshaw

The 1960s and 70s were marked by an explosion in mineral exploration and remote sensing technology. A leader throughout this period was Dr. Anthony (Tony) Barringer and his team at Barringer Research Ltd. (BRL). The highly successful airborne geophysical methods created at BRL are well known while the contributions to exploration geochemistry and many other fields are not. This book documents the many advances in geochemical theory, as well as the ground, airborne and remote sensing techniques plus analytical methods that were conceived and developed under the leadership of Tony Barringer. Innovative concepts backed by pioneering research funded by BRL on the movement of metals in rock, soil and vegetation remain important areas of investigation.

Tony Barringer's ability to bring together a diverse team including geologists, geochemists and physicists with electrical, optical and aeronautical engineers under one roof, provide leadership, a highly stimulating environment and financial support, was truly remarkable. This led to ground breaking advances in a number of different fields, including: exploration geochemistry for minerals and oil and gas; environmental monitoring from the ground, aircraft and space; and civilian and armed forces security. The underlying scientific principles for many of the inventions, now upgraded with modern electronics, are still considered state of the art. One of the many inventions from the BRL "incubator" described in this book is Ionscan, the drug and explosive screening device used in most airports today, which was conceived and developed by BRL in conjunction with technology for the detection of mineral deposits.

The book may be downloaded free of charge from the AAG website:

<https://www.appliedgeochemists.org/publications>





CALENDAR OF EVENTS

International, national, and regional meetings of interest to colleagues working in exploration, environmental and other areas of applied geochemistry. These events also appear on the AAG web page at: www.appliedgeochemists.org.

2026

- 12–16 September** **31st International Applied Geochemistry Symposium. Beijing, China.** <https://iags2026.cugb.edu.cn>
- 16–18 September 23rd Congreso Peruano de Geología (23rd Peruvian Congress of Geology). San Borja, Lima, Peru. <https://www.congresosgpe.org.pe>
- 21–25 September 13th Argentine Hydrogeology Congress (and 9th Hispano-Latin American Seminar on Current Topics in Groundwater Hydrology). Mar del Plata, Buenos Aires, Argentina. <https://congresohidrogeologia.mdp.edu.ar>
- 30 September – 3 October Society of Economic Geologists, SEG 2026. Salt Lake City, Utah, USA. <https://www.segweb.org/SEG-2026/SEG-Conference/SEG-2026/Home.aspx>
- 4–5 October International Conference on Gas Geochemistry, Tbilisi, Georgia. <https://waset.org/gas-geochemistry-conference-in-october-2026-in-tbilisi>
- 11–14 October Geological Society of America, Annual Meeting. Denver, Colorado, USA. <https://connects.geosociety.org/>
- 19–20 October International Conference on Mineralogy, Petrology, and Geochemistry ICMGP. Kathmandu, Nepal. <https://waset.org/conferences-in-october-2026-in-kathmandu/program>
- 27–29 October Society of Economic Geologists Critical Minerals Forum, Vancouver, British Columbia, Canada. https://seg.org/calendar_events/critical-minerals-forum
- 22–26 November GARD2026: Groundwater Arsenic Research Days 2026. Monte Verità, Ascona, Switzerland. <https://gard2026.ethz.ch/>
- 25–27 November Geo-Research Scholars Meet 2026, Wadia Institute of Himalayan Geology Dehradun, Uttarakhand, India. <https://ngrsm2026.in/>
- 1–4 December 21st Freiberg Short Course in Economic Geology: Carbonatites and their Critical Mineral Systems. Freiberg, Germany. <https://tu-freiberg.de/node/7426>
- 7–11 December American Geophysical Union, AGU26. San Francisco, California, USA. www.agu.org/annual-meeting
- 10–11 December International Conference on Earth Science ICES. London, England. <https://waset.org/earth-science-conference-in-december-2026-in-london>

2027

- 12–14 January Future Minerals Forum. Riyadh, Saudi Arabia. www.futuremineralsforum.com
- 14–15 January International Conference on Isotope Hydrology and Geochemistry. Zurich, Switzerland. <https://waset.org/isotope-hydrology-and-geochemistry-conference-in-january-2027-in-zurich>
- 25–28 January Association of Mining and Mineral Exploration BC (AMEBC) Cordilleran Round Up 2027 Convention. Vancouver, British Columbia, Canada. <https://roundup.amebc.ca/>
- 7–10 March Prospectors and Developers Association of Canada, PDAC 2027. Toronto, Ontario, Canada. <https://pdac.ca/convention-2027>
- 27 April–1 May Geological Society of Nevada (GSN 2027) Symposium. Reno, Nevada, USA. <https://www.gsnv.org/events/gsn-2027-symposium/>
- 6–7 April Kamloops Exploration Group (KEG) Symposium 2027. Kamloops, British Columbia, Canada. <https://www.keg.bc.ca/conference/>
- 6–10 June 19th European Microbeam Analysis (EMAS) European workshop, 2027: Modern development and applications in microbeam analysis. Lausanne, Switzerland. <https://www.microbeamanalysis.eu/>
- 20–25 June Water-Rock Interaction-19 /Applied Isotope Geochemistry-16 (IAGC-4). Beijing, China, <https://wri19.scimeeting.cn>
- 11–16 July Goldschmidt Conference 2027. Paris, France. <https://www.eag.org/events/goldschmidt/>
- 29 August – 2 September 19th Society for Geology Applied to Mineral Deposits, SGA, Biennial Meeting. Perth, Western Australia, Australia. <https://www.e-sga.org/events/biennial-meetings>
- 17–20 October Geological Society of America Annual Meeting. Montréal, Québec, Canada. <https://www.geosociety.org/GSA/Events/>

2028

- 12–20 August 8th International Geological Congress. Calgary, Canada. <https://www.igc2028canada.org>
- 8–11 October Geological Society of America Annual Meeting. Portland, Oregon, USA. <https://www.geosociety.org/GSA/Events/>

The status of the meetings here was confirmed at the time of publication, but users of the listing are strongly advised to carry out their own research to confirm the validity of an announcement. Please let us know of your events by sending details to Ray Lett (Raylett@shaw.ca).



EXPLORE Publication Schedule

Quarterly newsletters are published in March, June, September, December

• **Deadlines** for submission of articles or advertisements:

March newsletter: January 15

June newsletter: April 15

September newsletter: July 15

December newsletter: October 15

- **Manuscripts** should be double-spaced and submitted in digital format using Microsoft WORD®. Articles should be between 2000 and 3000 words. Do **not** embed figures or tables in the text file.
- **Photos** (colour or black and white) should be submitted as separate high-resolution (minimum 300 dpi at the scale of reproduction) PNG, TIFF, JPEG or PDF files.
- **Figures** should be submitted as separate EPS, PDF or original software (e.g. CDR, AI) files.
- **Tables** should be submitted as separate digital files in Microsoft EXCEL® format (i.e. XLS).
- All scientific/technical articles will be reviewed. Contributions may be edited for clarity or brevity.
- Formats for headings, abbreviations, scientific notations, references and figures must follow the Guide to Authors for *Geochemistry: Exploration, Environment, Analysis* (GEEA) that are posted on the GEEA website at:
<https://www.geolsoc.org.uk/geea-authorinfo>
- An **abstract** of about 250 words must also be submitted that summarizes the content of the article. This abstract will be published in the journal *Elements* in the Society News page in the back of each issue.

Submissions should be sent to the Editor of **EXPLORE**:

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