

Analysis of CO₂ and O₂ in soil gas over faults and fractures and associated with volcanic massive sulphide and porphyry-style mineralization in British Columbia, Canada

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ABSTRACT

Soil gases over the Mouse Mountain Cu-Au porphyry occurrence, the Mount Milligan Cu-Au deposit, and the Anita Cu-Pb-Zn-Au-Ag VMS mineral property in British Columbia, Canada, were analyzed for carbon dioxide (CO₂) and oxygen (O₂). During each survey, soil gas was analyzed in real-time after being pumped through a hollow steel tube driven roughly 40 cm into the soil. At Mouse Mountain and Mount Milligan, the CO₂ and O₂ concentrations in soil gas were determined with a custom-built measurement system, whereas the commercially available CO2Meter GasLab[®] Pro Multi-Gas CM 1000 Data Logger[™] was used to measure CO₂, O₂, and methane (CH₄) on the Anita property. Duplicate analyses across test sites indicate that CO₂ and O₂ values obtained from the two analytical systems are comparable; however, the CM 1000 Data Logger has a higher O₂ detection limit of 100 ppm, compared to the 10 ppm detection limit for the custom-built system.

Three metrics were calculated for data display and interpretation: ΔCO_2 , ΔO_2 , and $\Delta\text{CO}_2\&\text{O}_2$. The ΔCO_2 and ΔO_2 values represent soil gas CO₂ and O₂ concentrations after compensation for atmospheric CO₂ and O₂ levels. Typically, CO₂ in soil gas increases over a fault with an associated decrease in O₂; therefore, $\Delta\text{CO}_2\&\text{O}_2$ is used as a single measure of the total ΔCO_2 and ΔO_2 variability, providing a higher contrast anomaly. There is a strong spatial correlation of positive ΔCO_2 and negative ΔO_2 soil gas anomalies with fractures that were mapped in a bedrock trench at Mount Milligan and with the faults projected from the bedrock geology at Anita.

At Mouse Mountain, fault locations are inferred from the survey results, assuming a spatial relationship between structure and soil gas chemistry. Soil samples were also collected at Mouse Mountain, which underwent a multi-element geochemical analysis with an inductively coupled plasma mass spectrometer following a water leach. Higher water-soluble sulphur levels spatially associated with a $\Delta\text{CO}_2\&\Delta\text{O}_2$ peak could indicate the release of SO₂, carbon disulphide and carbonyl sulphide from oxidizing, fault-hosted sulphide minerals. The positive relationship suggests that a field analysis of a soil-water leach for SO₄ could be completed in combination with soil gas CO₂ and O₂ measurements to differentiate sulphide mineralized faults from non-mineralized faults. The current research indicates portable CO₂ and O₂ sensors can be effectively used to detect buried structures and, with the addition of other gases, may be used to differentiate mineralized structures.

INTRODUCTION

Identifying bedrock faults that underlie glacial sediments can be challenging, even when supported by surface bedrock mapping, geophysics, and remote sensing. Recently, the analysis of soil gas for mercury (Hg) (Rukhlov et al. 2021), methane (CH₄), carbon dioxide (CO₂) and oxygen (O₂) (Lett et al. 2022) has been used to detect buried faults and associated sulphide minerals beneath residual and transported overburden. Previously, Lovell et al. (1979, 1980) reported higher CO₂ and decreasing O₂ in the soil gas sampled in Ireland over Pb-Zn sulphide-mineralized faults buried beneath thick glacial sediments. McCarthy et al. (1986) also found elevated CO₂ and lower O₂ in the soil gas sampled over the Crandon massive sulphide deposit that is buried under 65 m of glacial sediments in Wisconsin, USA. Highsmith (2004) proposed a model to explain the formation of soil gas CO₂ and O₂ anomalies over geological structures and sulphide-bearing faults. Kesler et al. (1990) studied the dispersion of soil gas from gold deposits. Higher concentrations of CO₂ in soil gas can also be caused through leakage from geological CO₂ storage sites (Annunziatellis et al. 2008).

continued on page 5





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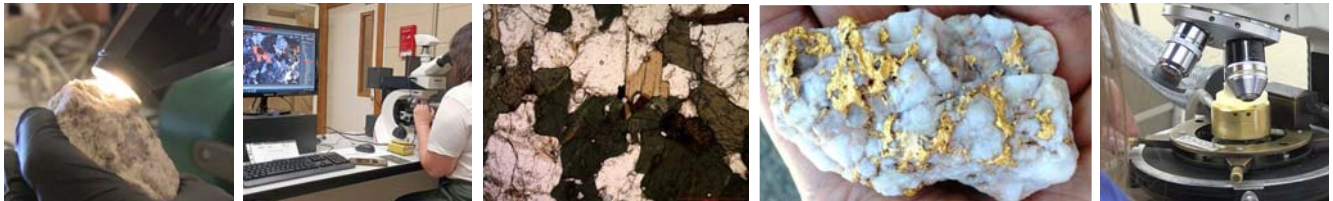
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Note from the Editor

Welcome to the first EXPLORE issue of 2026. This issue features an article describing CO₂ and O₂ in soil gas over faults and fractures and associated with volcanic massive sulphide and porphyry-style mineralization. It was written by Ray Lett, Dave Sacco, and Cameron Knox.

EXPLORE thanks all those who contributed to the writing and/or editing of the first issue in 2026, listed in alphabetical order: E. Ambrose, P. de Caritat, J. Carranza, S. Cook, J. Graham, C. Knox, R. Lett, M. Leybourne, R. Noble, J. Rice, D. Sacco, A. Seyfarth, and R. Zuo.

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TABLE OF CONTENTS

Analysis of CO ₂ and O ₂ in soil gas over faults and fractures and associated with volcanic massive sulphide and porphyry-style mineralization in British Columbia, Canada...	1
Note from the Editor	3
President's message	4
News	
Australia Day Honours 2026: Ravi Anand appointed a Member of the Order of Australia	17
AAG logo design contest	17
In Memoriam: Ian Jonasson	18
2025 Africa regional report on applied geochemistry	18
Articles in past issues of EXPLORE	29
New AAG President and Vice President 2026–2027	30
AAG Councillors	31
Strategic plan and committees within AAG	34
Recently published in Elements	35
Recently published in GEEA	36
Welcome new AAG members	37
Call for AAG medal nominations	37
IAGS 2026: Conference details and call for abstracts	38
Book Release: A History of Geochemistry and Cosmochemistry, from Prehistory to the End of the Classical Period	40
Writing Geochemical Reports, 3 rd Edition	41
Barringer, Back to the Future: airborne geochemistry and many related topics	41
Calendar of events	43
EXPLORE publication schedule	44
AAG contacts.....	44

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President's Message



It is my great honour to take over as President of the Association of Applied Geochemists (AAG). I would like to extend my sincere gratitude to Yulia Uvarova, the Executive, Council, and Committees for their dedicated service and significant contributions over the past two years. I will commit to advancing the AAG and strengthening its role with the support of our members. During my tenure as President, I will focus on (i) increasing AAG membership, (ii) strengthening collaboration and knowledge exchange with government, industry, and academia to improve the influence of AAG, and (iii) supporting the professional development of the next generation of geochemists.

I would also like to warmly welcome Dennis Arne (Past President) and Alexander Seyfarth (Vice President) to join the Executive Council, as well as Paul Morris, John Carranza, Patrice de Caritat, Martiya Sadeghi, and Biming Zhang as Councilors for the term 2026–2027.

A special council meeting was held on January 22, 2026, with a primary focus on the AAG strategic plan created by the 2025 Strategic Plan committee. I would like to thank Mark Arundell (Co-lead), Sam Scher (Co-lead), Brian Townley, Behnam Sadeghi, Ray Lett, and Alexander Seyfarth for their valuable contributions to the creation of a new strategic plan. Council formally approved the new strategic plan after extensive discussion in this meeting. As part of the plan, several committees have been updated, and two new committees will be established. Alexander Seyfarth and Paul Morris were approved to be the Chairs of the Strategic Planning committee and the Website committee, respectively. The Council also discussed the possibilities of establishing lifetime membership and reduced membership fees for applied geochemists from developing countries. I believe the implementation of the strategic plan will advance AAG toward a better future, and I encourage everyone to actively support its implementation. In addition to Paul Morris leading the AAG website redesign team, he is also Chair of the Membership Committee. It is expected that the new AAG website will be completed by the end of 2026.

Congratulations to Prof. Xueqiu Wang and Prof. Cliff Stanley on being awarded the 2024 and 2025 AAG Gold medals, respectively. AAG will continue to select Honourary Fellows (those who have, throughout their career, made distinguished and exceptional contributions to applied geochemistry) and to select a Distinguished Lecturer on a regular basis. In addition, the Council is currently discussing the possible establishment of two new awards aimed at recognizing mid-career and young applied geochemists. The AAG Council has approved that the travel fees for the AAG awardees to attend the IAGS be covered. All AAG awards are conferred through a nomination-based process; without nominations, awards cannot be made. Members are therefore encouraged to nominate qualified colleagues for the AAG awards, including the Gold Medal, Silver Medal, Cameron-Hall Copper Medal, Honourary Fellows, and Distinguished Lecturer, and send your nominations to the Chair of the Awards and Medals Committee (Dennis Arne, arne.dennis@gmail.com).

The 31st International Applied Geochemistry Symposium (IAGS 2026) will be held in Beijing, China, from September 12 to 16, 2026. With the theme “Data-driven geochemical data mining in support of mineral exploration and environmental studies”, IAGS 2026 aims to provide an international platform for advancing applied geochemistry through data science, analytical innovation, and interdisciplinary collaboration. Prof. Qiuming Cheng (China University of Geosciences, Beijing) and I (China University of Geosciences, Wuhan) are the Chair and Secretary of the IAGS 2026. Please visit the IAGS 2026 website <https://iags2026.cugb.edu.cn> and submit your abstracts. During IAGS 2026, two AAG Gold medals and two Cameron-Hall Copper medals will be awarded. I look forward to seeing you in Beijing, China.

Prof. Renguang Zuo

President of the Association of Applied Geochemists



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CO₂ and O₂ in soil gas over faults, fractures and associated with mineralization *continued from p 1*

A secondary effect of the CO₂ migrating to surface may be a change in soil mineral chemistry, such as the formation of secondary carbonate minerals and soil pH anomalies (Smee 1998). Beaubien (2008) reported soil pH as low as 3.5, accompanied by the absence of surface vegetation on a Mediterranean pasture over a natural CO₂ gas vent in the LATERA geothermal field, central Italy. However, Zhao et al. (2017) detected only a modest pH change from 7.91 to 8.17 in the soil sampled over gas vents on the Qinghai-Tibet Plateau, where CO₂ concentrations ranged from 500 to 12 000 ppm. Incidentally, soil SO₄ decreased with increasing soil CO₂. These coincident results may provide additional context for interpreting CO₂ anomalies.

Hale (2010) and, more recently, Plet and Nobel (2023) reviewed soil-gas chemistry and its application to mineral exploration, noting that previous surveys either measured soil gas CO₂ and O₂ concentrations on-site (e.g. Lovell et al. 1980) or collected a soil gas sample for subsequent laboratory analysis (e.g. McCarthy et al. 1986). Real-time soil gas surveys can be valuable to mineral exploration programs because they provide data that can be used to revise and focus programs while work is underway. Unfortunately, past commercial devices for the field-based analysis of CO₂ and O₂ have been cumbersome and expensive. Soil gas can also be sampled, captured and stored in a container on site for later laboratory analysis for CO₂, O₂ and for other elements (e.g. He), but this approach introduces risks of sample contamination during transport and delays the reporting of survey results, which precludes immediate follow-up while still in the field.

A project initiated in 2019 and funded by Geoscience BC led to the development of a portable, real-time soil gas measurement system. The prototype device used small, commercially available sensors from CO₂Meter Inc.™ to measure CO₂ and O₂ in atmospheric air and in soil gas. Subsequently, an improved version of the system, informally named 'SGAS', was developed. The development process is described in Lett et al. (2020, 2022). CO₂Meter Inc.™ has also developed a compact handheld device, the CO₂Meter GasLab® Pro Multi-Gas Sampling CM 1000 Data Logger ('CM 1000 Data Logger'), which measures CO₂, O₂, and CH₄ in soil gas. Herein, we describe the results of analyzing soil gas with both the SGAS and CM 1000 Data Logger systems. The two systems were first tested at an urban site to compare their functionality. Subsequently, the SGAS system was used to complete soil gas surveys over porphyry Cu-Au mineralization at the Mouse Mountain mineral property and at the Mount Milligan Cu-Au mine, and the CM 1000 logger was employed over volcanic massive Cu-Pb-Zn-Au-Ag sulphide mineralization at the Anita volcanic massive sulphide (VMS) mineral property, British Columbia (Fig. 1).

SGAS measurement system

Development and testing of the SGAS system is detailed in Lett et al. (2020, 2022). The sensor unit, housed in a waterproof case, has a SprintIR®-6S 5%CO₂ Smart sensor and a UV Flux 25% Oxygen Smart Flow O₂ sensor mounted on a circuit board (Fig. 2). In addition to CO₂ and O₂ concentrations, sensors also measure barometric pressure, temperature and relative humidity. Each sensor body has an inlet and an exit port to attach flexible PVC tubes. One inlet

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Fig. 1. Mouse Mountain, Mount Milligan, and Anita project locations in British Columbia, Canada.

continued on page 6

CO₂ and O₂ in soil gas over faults, fractures and associated with mineralization *continued from p. 5*

port on the CO₂ sensor manifold is connected by a PVC tube to a corresponding exit port on the O₂ sensor so that the gas can flow continuously into the two linked sensors. Each sensor circuit board is connected by USB cable to a computer equipped with CO2Meter.Inc GasLab 2.1 software, where raw measurements are recorded and can be displayed in real-time.

The CO2Meter GasLab® Pro Multi-Gas CM 1000 Data Logger

The CM 1000 Data Logger is a compact, integrated device that measures CO₂, O₂, CH₄, barometric pressure, temperature, dew point, and relative humidity. The three sensors, the pump, and the data-processing electronics are housed within a single unit (Fig. 3).

The device uses a small, battery-powered micro-pump to draw either atmospheric air or soil gas through its sensor chamber. Carbon dioxide and CH₄ sensors use infrared light absorption at a specific wavelength to measure concentration, whereas O₂ measurement uses fluorescence quenching by oxygen using a light source, a light detector, and a light-sensitive luminescent material. Each CO₂, O₂ or CH₄ sensor measurement is converted into concentration by the CM 1000 Data Logger's internal software, and the results are stored on a micro-SD card for later analysis.

A 25 mm nylon hydrophilic filter with a 0.45 µm pore size between the CM 1000 Data Logger inlet port and the atmospheric air inlet protects the sensors from damage by particulates in the airstream. Luer-Lok™ fittings allow rapid system changes to be made when alternating between sampling atmospheric air or soil gas.

COMPARISON OF ANALYTICAL RESULTS FROM THE SGAS AND CM 1000 DATA LOGGER

The SGAS and the CM 1000 Data Logger were compared by sampling soil gas at eleven different urban locations in Victoria, British Columbia. A typical test involved creating a vertical pilot hole with a 12.7-mm diameter pointed steel rod up to 30 cm into the soil. The soil probe was then driven 5 to 10 cm deeper into the soil before being withdrawn 1 cm to open the retractable tip, allowing soil gas flow. Before connecting the SGAS or the CM 1000 Data Logger to the probe, a small hand pump was used to confirm free flow of soil gas.

For SGAS measurements, the sensors were calibrated with the GasLab® 2.1 software using atmospheric CO₂ (~400 ppm) and O₂ (~209,050 ppm). The O₂ sensor manifold connects with a Luer-Lok™ to a 0.45 µm filter and a PVC tube through which atmospheric gas is sampled. The inlet is placed 100 cm away from the SGAS unit to avoid CO₂ contamination during calibration. Atmospheric CO₂ and O₂ concentrations are measured at 10 s intervals for two mins, during which the calibration occurs. The atmospheric inlet is then disconnected, and the O₂ sensor manifold inlet is connected to the soil probe. Soil gas CO₂ and O₂ concentrations are then pumped through the calibrated sensors and measured at 10 s intervals for another two mins. Typically, CO₂ increases from atmospheric levels and then plateaus, whereas O₂ levels concordantly decrease to a valley over the same interval (Fig. 4). The system is then switched back to measure atmospheric air for another two-minute interval following the soil gas measurements.

The CM 1000 Data Logger is calibrated by internal software to 400 ppm CO₂ and 20.95% O₂. Sampling atmospheric air or soil gas with the CM 1000 Data Logger is similar to the SGAS procedure. The CM 1000 Data Logger inlet port is connected through a 0.45 µm pore-size filter to a 100 cm long PVC tube for atmospheric air sampling. Variables are measured in atmospheric air every five seconds for one minute, and results are stored on the CM 1000 Data Logger's micro-SD card for later processing. The CM 1000 Data Logger inlet port is then connected to the soil probe and soil gas is sampled for one to two minutes. After which, the steel tube is disconnected, and atmospheric air is resampled for approximately one minute. Results are displayed in real-time on the CM 1000 Data Logger's display screen (Fig. 3).

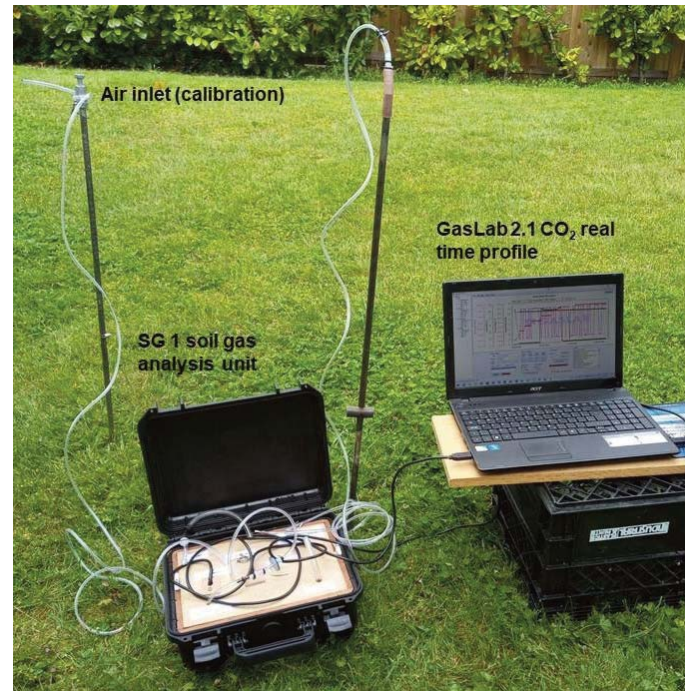


Fig. 2. Purpose-built 'SGAS' soil gas measurement system and laptop computer.



Fig. 3. Display and port hoses on the CO2Meter GasLab® Pro Multi Gas Sampling CM 1000 Data Logger.

CO₂ and O₂ in soil gas over faults, fractures and associated with mineralization *continued from p. 6*

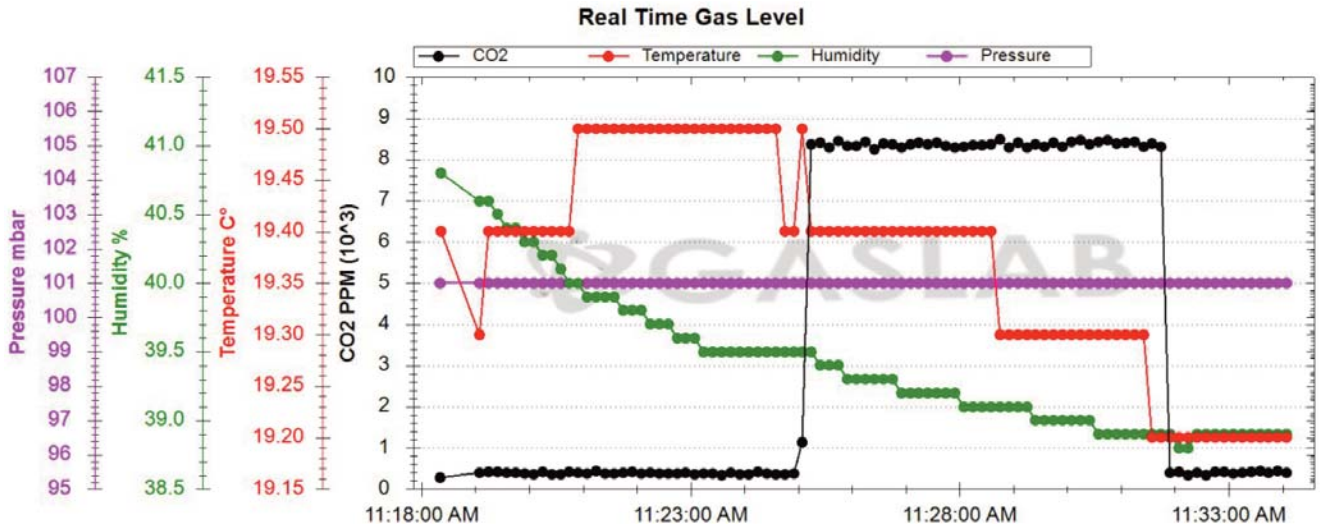


Fig. 4. Measurements of CO₂ in soil gas sampled at 40 cm depth, along with air pressure, humidity, and temperature obtained using the SGAS system at an urban test site in October, 2024.

The mean, range and percent relative standard deviation (%RSD) for CO₂ and O₂ concentrations recorded by the SGAS and the CM 1000 Data Logger at the same sites are presented in Table 1. These results reveal a 2% difference between the mean CO₂ measured by the two systems, but a 43% difference between the mean O₂. This large difference for O₂ may be a function of sensor measurement intervals, as the SGAS sensor can measure O₂ to 10 ppm whereas the CM 1000 Data Logger can only measure to 100 ppm O₂. Combined sampling and sensor precision can be expressed as an average coefficient of variation (%CV_{AVG}) (Abzalov 2008; Smee et al. 2024), where a value of <15% represents good precision, 15–30% represents acceptable precision, and >30% represents poor precision. The %CV_{AVG} calculated from the mean atmospheric air corrected CO₂ and O₂ values in the soil gas sampled with the SGAS and the CM 1000 Data Logger at eleven urban sites is 9.4% for CO₂ and 38.4% for O₂. The large %CV_{AVG} for O₂ indicates poor precision in O₂ measurements between devices, potentially as a function of the different detection limits.

Table 1. Comparison of soil gas analyzed for CO₂ and O₂ by the SGAS system and the CM 1000 Data Logger at urban sites.

System and measurement	Variable	Mean	Min	Max
SGAS	CO ₂ (ppm)	2515	630	7598
SGAS	CO ₂ %RSD	7.7	0.7	26.0
CM 1000 Data Logger	CO ₂ (ppm)	230	80	7600
CM 1000 Data Logger	CO ₂ %RSD	18.1	9.0	28.0
SGAS	O ₂ (ppm)	2610	900	5725
SGAS	O ₂ %RSD	0.6	0.2	1.5
CM 1000 Data Logger	O ₂ (ppm)	4100	100	7300
CM 1000 Data Logger	O ₂ %RSD	1.3	0.1	9.0

continued on page 8

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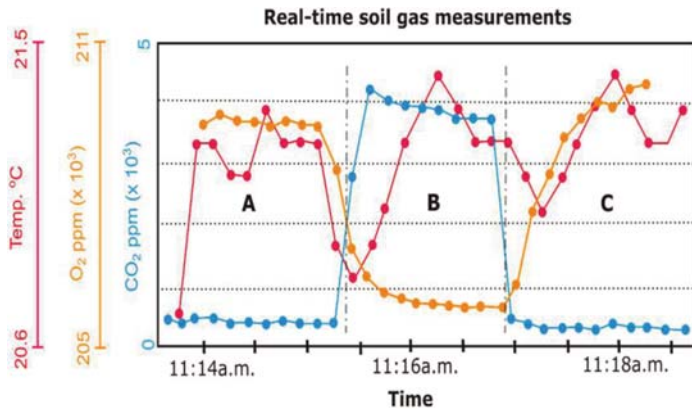


Fig. 5. A simplified example of GasLab 2.1® software display from the temporal analysis of soil gas and atmosphere for CO₂ (blue line), O₂ (orange line), and temperature (red line). The vertical grey lines roughly indicate the transition between atmosphere and soil gas measurements

SOIL GAS DATA PROCESSING

The aim of the data processing is to maximize the contrast between the rise in CO₂ and the reduction of O₂ amongst survey sites to accentuate anomalies. A measurement from a typical site is shown in Figure 5, where the first and last intervals are atmospheric measurements (sections A and C), and the middle interval (section B) is measured in soil gas. In this example, a total of 32 measurements were made over a period of about five minutes.

Soil gas survey results are typically displayed as the net soil gas CO₂ (ΔCO₂) and O₂ (ΔO₂) values, representing the difference between sensor-calibrated atmospheric gas and measured soil gas concentrations (Equations 1 and 2). The atmospheric A and C values in Equations 1 and 2 are mean values for the A and C datasets in Figure 5. The net ΔCO₂&O₂ concentration in soil gas (Equation 3) provides a single variable for the combined variation in CO₂ and O₂ concentrations of the atmosphere and soil gases. The variation of CO₂ and O₂ in the gas emanating from faults may reveal additional information about associated mineralization, therefore ΔCO₂ and ΔO₂ are also evaluated individually.

$$\Delta CO_2 = \text{soil gas } CO_2 - \left[\frac{\text{Atmosphere[A] mean } CO_2 + \text{Atmosphere[C] mean } CO_2}{2} \right] \dots\{1\}$$

$$\Delta O_2 = \text{soil gas } O_2 - \left[\frac{\text{Atmosphere[A] mean } O_2 + \text{Atmosphere[C] mean } O_2}{2} \right] \dots\{2\}$$

$$\text{soil gas } \Delta CO_2 \& O_2 = \Delta CO_2 + \Delta O_2 \dots\{3\}$$

The Mouse Mountain soil gas and soil geochemistry survey

At Mouse Mountain (Fig. 1), soil gas and soil from the interface beneath the Ah (humus) soil horizon and above the B mineral horizon were collected at 33 sites at 10-m intervals along three transects. Disseminated chalcopyrite, pyrite, bornite, magnetite and malachite comprise the mineralized zone associated with a Jurassic calc-alkaline porphyry and a monzonite body. The monzonite intruded into Upper Triassic to Lower Jurassic Nicola Group potassic-altered sedimentary and volcanic rocks (Jonnes and Logan 2007). These rocks are fractured and faulted

continued on page 9

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(Schimann 2014), but the exact location of a previously identified northeast-southwest- trending fault projected south of the Valentine zone is uncertain due to the overlying till veneer (<2 m) masking the bedrock. The survey lines are oriented perpendicular to the projected fault (Schimann 2014) in an area south of the Valentine Cu-Au porphyry-style sulphide mineralized zone (Fig. 6).

The samples collected at the Ah (humus) - B soil horizon interface were analyzed for a range of trace elements, including sulphur by inductively coupled plasma mass/emission spectrometry (ICPMS/ES) following a water leach (Lett et al. 2022). Soil pH was determined on a 1:1 v:v distilled water:soil slurry with a EutechOakion pHTestr^R metre. Analytical results for pH and sulphur reveal a spatial correlation with anomalous soil gas $\Delta\text{CO}_2\&\text{O}_2$ and sulphur (Lett et al. 2020). A higher inverse difference hydrogen (IDH) factor (Smee 1998, 2003, 2009), calculated from soil pH measurements, flanked by soil gas $\Delta\text{CO}_2\&\text{O}_2$ anomalies, suggests that greater CO₂ flow from a fault could be affecting soil chemistry (Fig. 7). Higher water-soluble sulphur levels, up to 10.5 ppm in soil, correspond with $\Delta\text{CO}_2\&\text{O}_2$ peaks along the westernmost N-S-oriented survey line (Fig. 7), which could be explained by sulphur gases such as SO₂ and carbonyl sulphide emanating from oxidizing sulphides associated with the fault (e.g. Hale 2010).

The Mount Milligan soil gas survey

At Mount Milligan, soil gas measurements were collected from 163 sites at 10 m intervals along north-south and southwest-northeast-oriented transects using the SGAS system (Fig. 8). The Mount Milligan survey area is underlain by Upper Triassic andesitic volcanic rocks of the Witch Lake succession (Logan et al. 2010). Centerra Gold Inc. subsequently trenched and completed geological mapping parallel to one of the soil gas survey transects. The mapping revealed monzonite dykes intruded into andesite flows and tuffs that were intersected by several fracture zones and veins (Fig. 8; Fitzgerald et al. 2020). Disseminated pyrite is common in these rocks and chalcopyrite appears in some fracture zones. Regionally, two faults are projected to cross the survey area, although their exact surface traces are uncertain due to overlying glacial sediments.

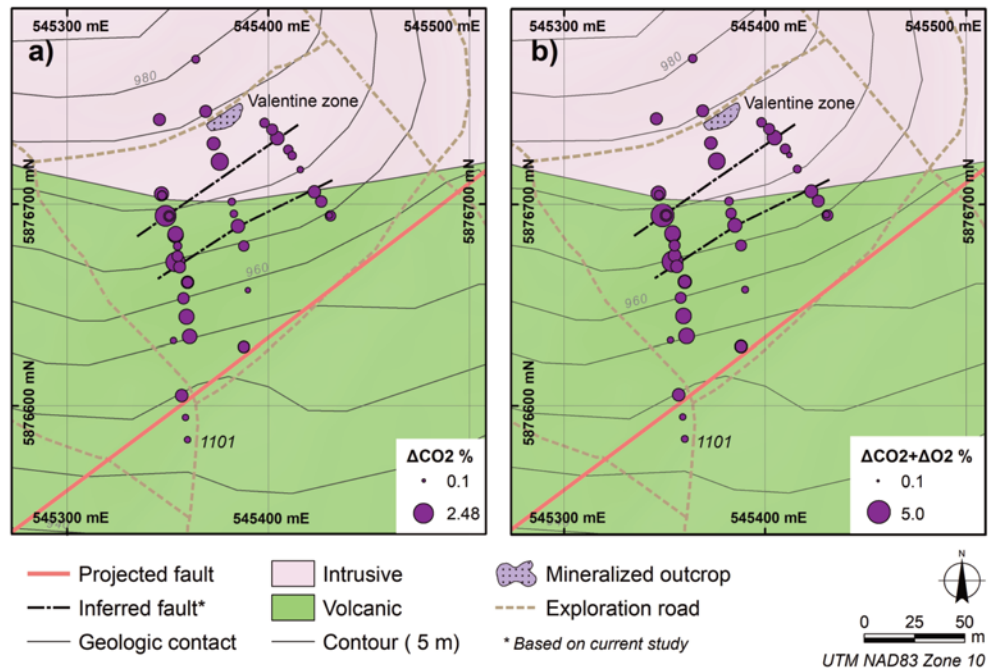


Fig. 6. Mouse Mountain geology (simplified from Schimann 2014), soil gas survey sites, (a) ΔCO_2 and (b) $\Delta\text{CO}_2\&\text{O}_2$ values measured in soil gas. Data displayed using proportional symbols.

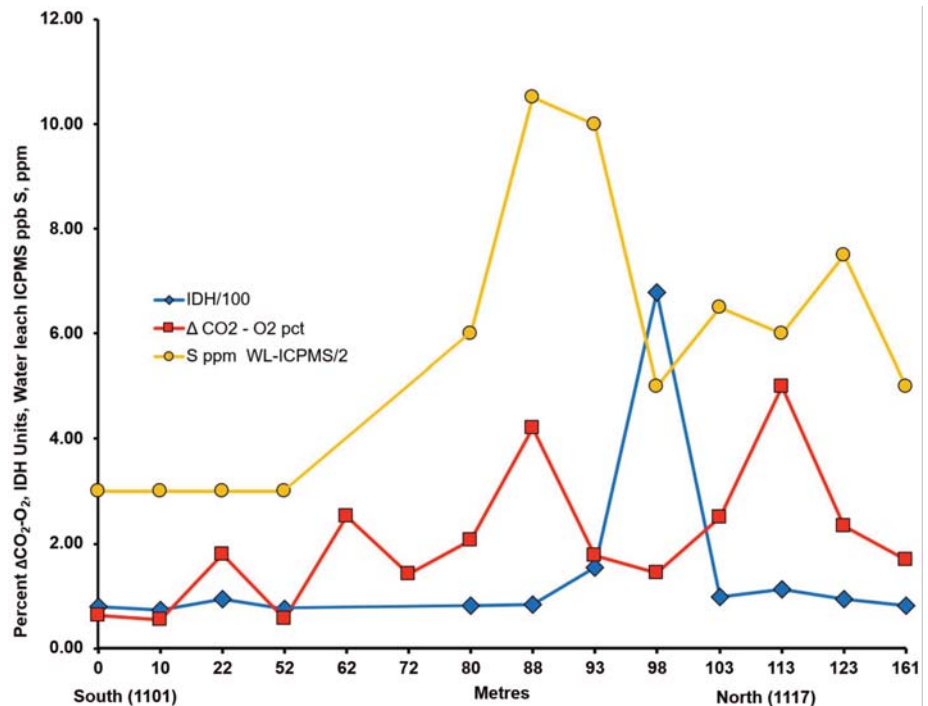
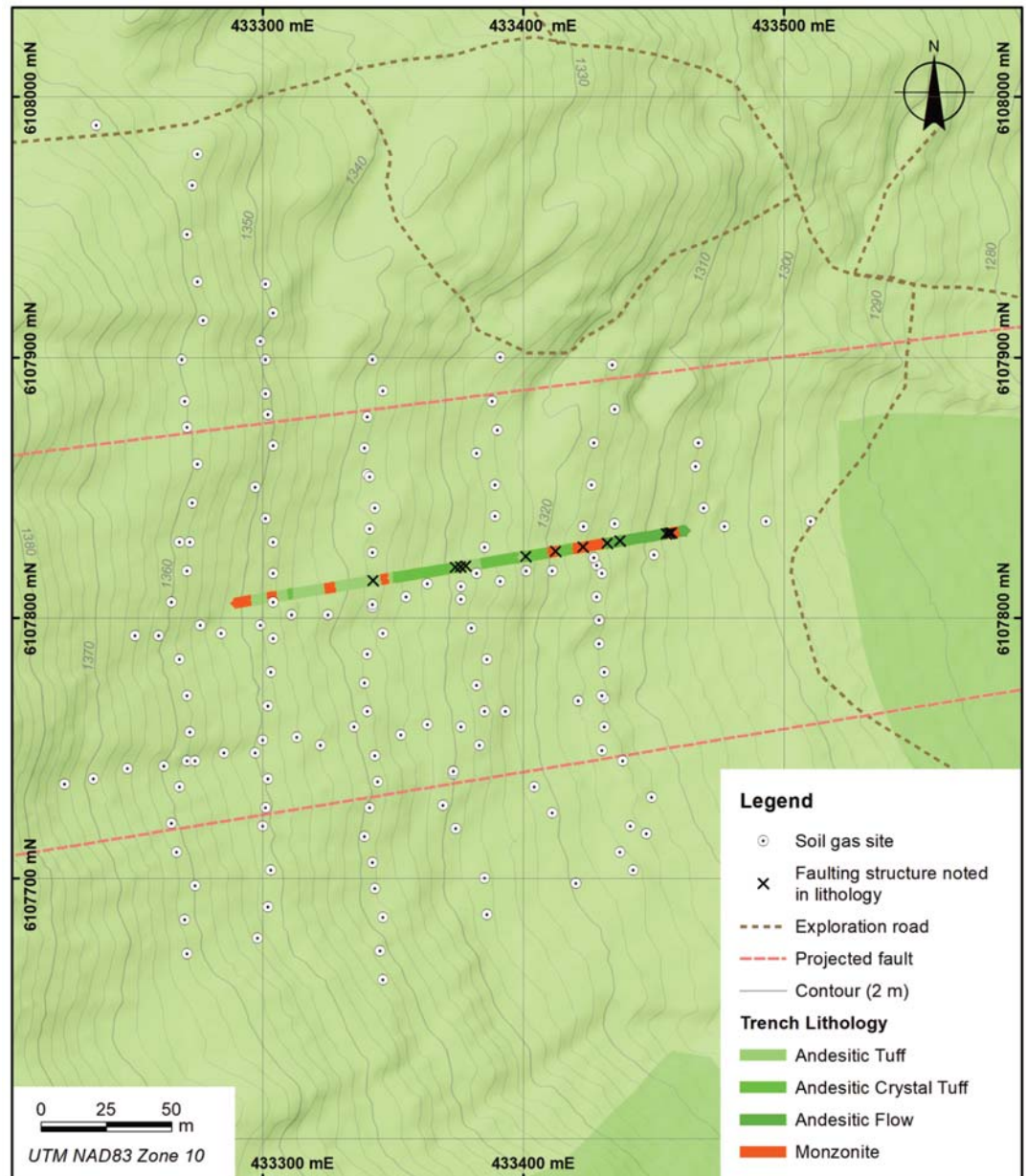


Fig. 7. Soil pH, expressed as inverse difference hydrogen (IDH), $\Delta\text{CO}_2\&\text{O}_2$ % and sulphur concentrations along the westernmost transect. Sulphur values have been divided by two to fit on the same axis.

CO₂ and O₂ in soil gas over faults, fractures and associated with mineralization *continued from p. 9*

Fig. 8. Soil gas measurement and projected fault locations from the 2020 and 2021 surveys on the Mount Milligan mine property and trench lithologies and fracture locations (mapping provided by Centerra Gold Inc.).



The Mount Milligan soil gas survey

At Mount Milligan, soil gas measurements were collected from 163 sites at 10 m intervals along north-south and southwest-northeast oriented transects using the SGAS system (Fig. 8). The Mount Milligan survey area is underlain by Upper Triassic andesitic volcanic rocks of the Witch Lake succession (Logan et al. 2010). Centerra Gold Inc. subsequently trenched and completed geological mapping parallel to one of the soil gas survey transects. The mapping revealed monzonite dykes intruded into andesite flows and tuffs that were intersected by several fracture zones and veins (Fig. 8; Fitzgerald et al. 2020). Disseminated pyrite is common in these rocks, and chalcopyrite appears in some fracture zones. Regionally, two faults are projected to cross the survey area, although their exact surface traces are uncertain due to overlying glacial sediments.

The sediment cover is a subglacial till veneer (<2 m thick) that thickens downslope to the east. The till is a compact diamicton composed of sandy-silt with angular to sub-rounded pebbles, cobbles, and boulders. On the eastern side of the survey area, the till was locally reworked by glacial meltwater that deposited a discontinuous, thin (20–50 cm), sandy mantle at surface. Brunisolic soil, which is the dominant soil in the local area, commonly has up to 15 cm of organic matter in its upper horizons, and the area supports an immature pine and fir tree forest. There are isolated bedrock outcrops in the western part of the survey grid, and more bedrock outcrops at surface about 150 m to the west of the grid.

Duplicate soil gas measurements were collected at eight of the sites. The %CV_{AVG} calculated from the atmospheric corrected duplicate soil gas CO₂ and O₂ values is 30.3% for ΔCO₂, 29.2% for ΔO₂ and 26.6% for ΔCO₂&O₂, which is bordering on poor precision. This low precision is attributed to local boulder-covered surfaces that precluded a tight seal around the soil probe in some locations.

CO₂ and O₂ in soil gas over faults, fractures and associated with mineralization continued from p. 10

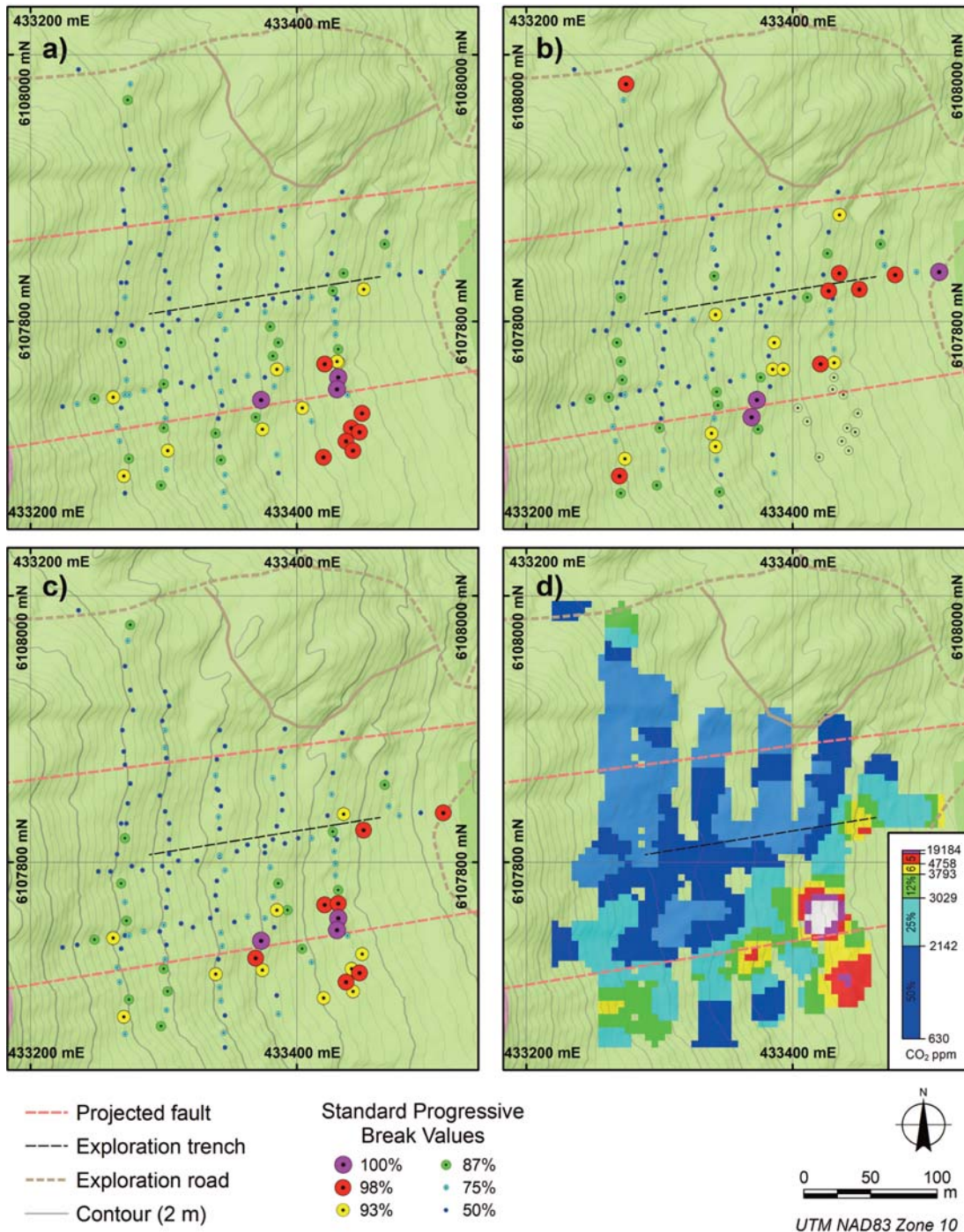


Fig. 9. Soil gas concentrations at the Mount Milligan Mine property. **a)** ΔCO_2 , **b)** ΔO_2 , **c)** $\Delta\text{CO}_2\&\text{O}_2$, and **d)** ΔCO_2 ppm gridded to 10 m pixels based on the maximum of a three-cell search radius smoothed across a two-cell radius. Proportional dot plots are displayed based on progressive percentile breaks. Gridded data symbolized using unequal bin percentile breaks of 30, 60, 80, 90, 95, 98, 99, 100.

Up to 1.9% ΔCO_2 and 2.16% $\Delta\text{CO}_2\&\text{O}_2$ were measured in the soil gas. The highest values are in the southern part of the survey area and are accompanied by lower ΔO_2 levels (Fig. 9). High $\Delta\text{CO}_2\&\text{O}_2$ values mark a target (Fig. 9c) with the centre of the roundel close to the trace of the projected southern fault. The contoured $\Delta\text{CO}_2\&\text{O}_2$ values reveal a trend aligned southwest-northeast that could be associated with this fault, which has a surface projection near the target. Since the fault location is projected to a flat surface from measurements in drill core, it is possible that the soil gas measurements represent a more accurate indication of the fault trace. Low ΔCO_2 and $\Delta\text{CO}_2\&\text{O}_2$ levels in the soil gas sampled in the area over the projected trace of the northern fault could be explained by the actual fault location beyond the survey limit, or that gas flow is inhibited by clay filling the structure.

The CO₂ and O₂ measured in soil gas at sites within a 20-m-wide buffer of the trench were compared to the trench logging results (Fig. 9 and 10). Several intervals of fracturing and veining are reported, including a zone of intense fractures towards the eastern end of the trench (~150–175 m on Fig. 9 and 10). This zone corresponds to sample sites with soil gas ΔCO_2 values over 4000 ppm and $\Delta\text{CO}_2\&\text{O}_2$ values over 8000 ppm, which are both around the 90th percentile of the dataset. Fracturing and/or veining identified at 67 m, 101 m, and ~125–150 m along the trench is also spatially correlative with ΔCO_2 and $\Delta\text{CO}_2\&\text{O}_2$ peaks. These results indicate that there is a correlation between fractures, veining, ΔCO_2

continued on page 12

CO₂ and O₂ in soil gas over faults, fractures and associated with mineralization *continued from p. 11*

and $\Delta\text{CO}_2\&\text{O}_2$. Depletion of O₂ with concomitant CO₂ increases (Fig. 11) suggests sulphide mineralization in some fractured areas, particularly at 175 m.

The Anita soil gas survey

In April and June 2024, soil gas was measured at 40 sites using the CM 1000 Data Logger (Fig. 12) on the Anita property, southern Vancouver Island, British Columbia (Fig. 1). The survey was completed along two transects, crossing northwest-southeast-trending faults and a buried Cu-Pb-Zn-Au-Ag massive sulphide horizon. Soil gas was measured at 15 m intervals from 20 sites along the western transect on April 20th, 2024, and 20 sites along the eastern transect on June 30th, 2024 (Fig. 12).

The property is underlain by felsic and mafic metavolcanic rocks of the McLaughlin Ridge Formation (MRF), which is the uppermost unit of the Paleozoic Sicker Group. The MRF is equivalent to the Myra Formation, which is the host for the sulphide mineralization at the Myra Falls Cu-Pb-Zn mine, central Vancouver Island. Property geology includes tuffs, coarse fragmental volcanic rocks, massive flows, intrusive rocks and minor sedimentary rocks intruded by numerous gabbroic dykes. The volcanic rocks have sericite-, pyrite- and chlorite-alteration, and have undergone several periods of deformation to form the core of a west-northwest-trending, west-plunging anticlinal structure. Numerous late brittle faults, and a southwest-verging reverse fault, thought to be a splay of the Fulford Thrust fracture, crosscut the anticline. A sequence of pyritic (2–50%), moderately to strongly sericitized, Ba-enriched, Na₂O-depleted felsic lapilli tuffs, referred to informally as the 'Anita Active Tuff' (AAT), host up to 25% of sulphide minerals comprising pyrite ± pyrrhotite + sphalerite + chalcopyrite ± galena (Nelles 2024).

The survey area was recently logged, and immature western hemlock and shrubs dominate the surface. Brunisolic soils have developed on a thin subglacial till veneer (<2 m thick), and there are patches of organic-rich soil along a stream channel across the northern part of the survey area.

The CO₂ and O₂ results were processed to calculate ΔCO_2 , ΔO_2 and $\Delta\text{CO}_2\&\text{O}_2$ values. The %CV_{AVG} for the CO₂ and O₂ duplicate samples was 16.9% for soil gas CO₂; 12.74% for atmospheric CO₂; 0.66% for soil gas O₂; and 0.21% for atmospheric O₂, indicating good to acceptable precision.

Strong ΔCO_2 , and $\Delta\text{CO}_2\&\text{O}_2$ anomalies associated with weaker ΔO_2 anomalies occur towards the south end of both transects, with values up to 1.8% ΔCO_2 and 4.9% $\Delta\text{CO}_2\&\text{O}_2$ (Fig. 13). The ΔCO_2 and $\Delta\text{CO}_2\&\text{O}_2$ peaks correspond re-

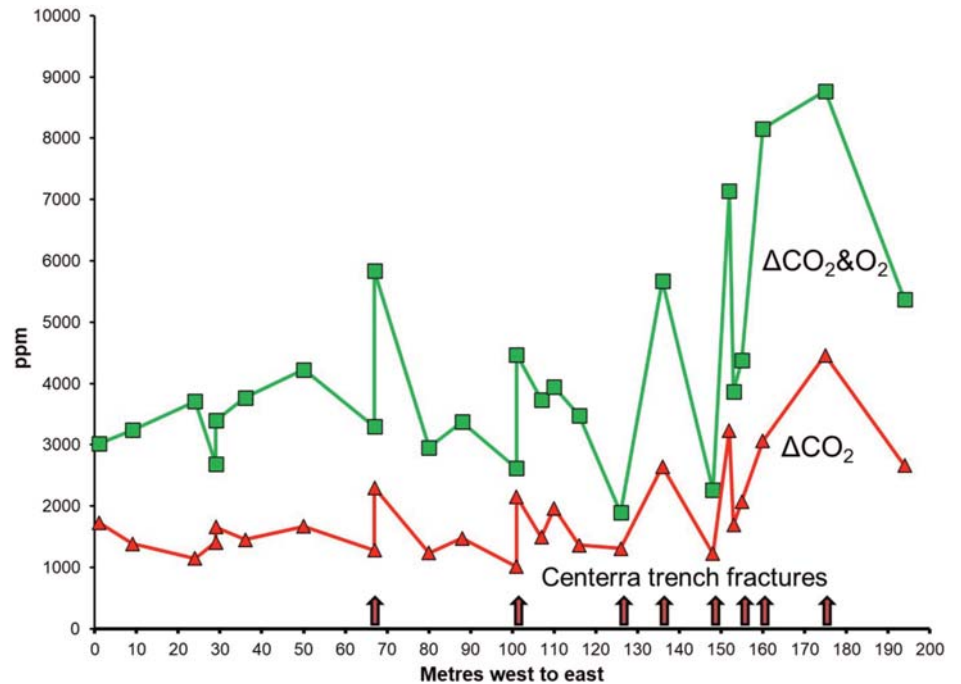


Fig. 10. The variation of ΔCO_2 and $\Delta\text{CO}_2\&\text{O}_2$ in the soil gas at sites within a 20 m wide buffer along the mapped bedrock trench. Trenching was completed after the soil gas measurements.

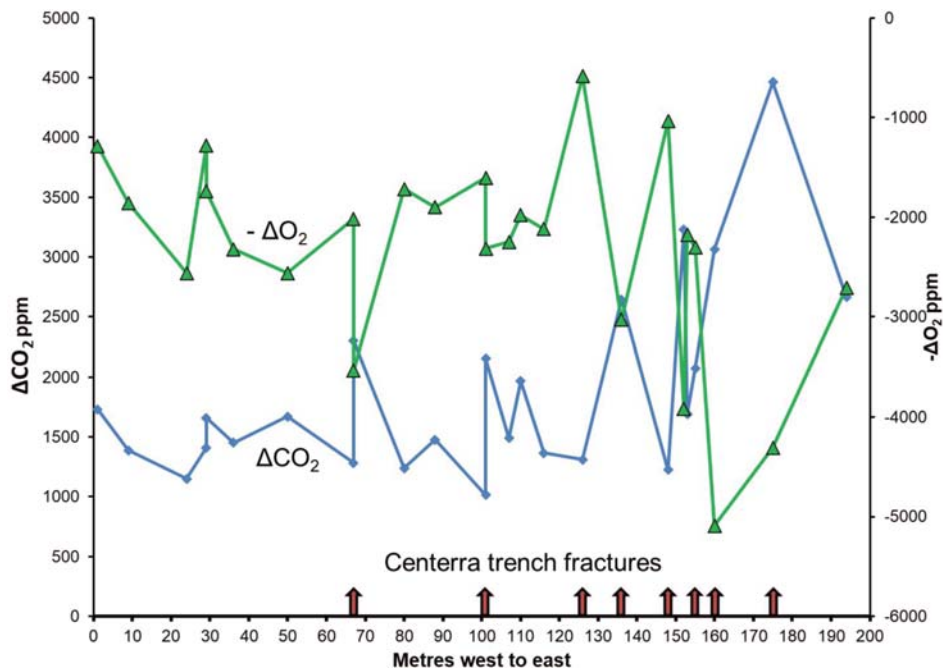


Fig. 11. The variation of ΔCO_2 and the ΔO_2 (expressed as a negative) at sites within a 20 m wide buffer along the mapped bedrock trench demonstrates the increase in CO₂ and concomitant reduction in O₂ associated with fractures. The highest values around 175 m may indicate sulphide mineralization.

CO₂ and O₂ in soil gas over faults, fractures and associated with mineralization *continued from p. 12*

sonably well to the interpreted projection of a northwest- to southeast-trending fault crossing the area. The southern anomaly cluster on the western transect is displaced 35 m north of the interpreted fault trace. The northern displacement of this peak may indicate that the actual fault location is farther north or that gas flows laterally from the fault through the glacial sediment to reach the surface. Similar anomalies on the southern part of the eastern transect suggest the fault may continue east.

Smaller ΔCO_2 , and $\Delta\text{CO}_2\&\text{O}_2$ peaks towards the centre of both transects correspond to the interpreted surface projection of a sulphide mineralized horizon (Fig. 13). At the transects' northern ends, high ΔCO_2 values may result from gas generated from organic soil decomposition along a poorly drained stream draw. No CH₄ was detected in the soil gas.

DISCUSSION

There is a strong spatial correlation of positive ΔCO_2 and negative ΔO_2 soil gas anomaly peaks with the fracturing mapped in a trench at Mount Milligan and the projected faults at Anita. The association between the projected fault trace and soil gas chemistry is more subtle at Mouse Mountain; however, stronger anomalies suggest the occurrence of additional faults or fractures to the north of the projected fault.

There are several external factors that could cause variation in CO₂ and O₂ concentration, such as changes in soil moisture, biological activity, sample depth, landscape and time of day (Hodges et al. 2019). For example, at Anita in April 2024, the atmospheric CO₂ increased from 474 ppm late morning to 783 ppm in early afternoon and then declined to 535 ppm later in the afternoon. Though the diurnal CO₂ variation at Anita would have little effect on anomaly contrast, given the percent CO₂ measured in soil gas, the fluctuation illustrates a need to consider daily background variation when interpreting the results of soil gas surveys. Ideally, a base station monitoring daily CO₂-O₂ fluctuation could be used, but would increase the costs for a survey in terms of equipment and field personnel. Additionally, interference due to an inconsistent seal between the soil probe and sediment could affect measured values, as suggested by the poor precision calculated at Mount Milligan.

Although the results of the Mount Milligan and Anita soil gas



Fig. 12. Collecting soil gas for CO₂, O₂ and CH₄ analysis using the CO₂Meter GasLab® Pro Multi-Gas CM 1000 Data Logger on the Anita property.

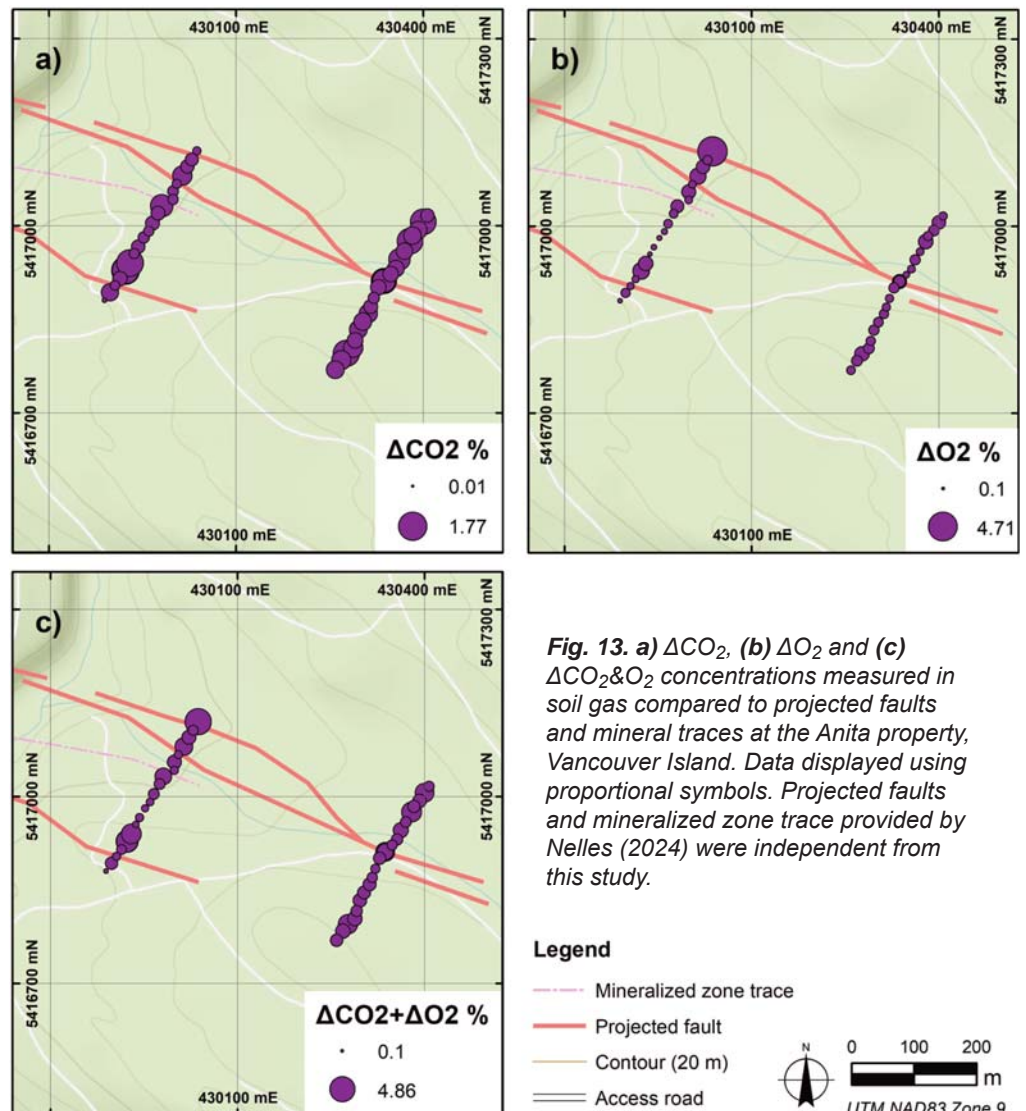
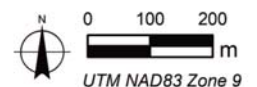


Fig. 13. a) ΔCO_2 , (b) ΔO_2 and (c) $\Delta\text{CO}_2\&\text{O}_2$ concentrations measured in soil gas compared to projected faults and mineral traces at the Anita property, Vancouver Island. Data displayed using proportional symbols. Projected faults and mineralized zone trace provided by Nelles (2024) were independent from this study.

Legend

- Mineralized zone trace
- Projected fault
- Contour (20 m)
- Access road



CO₂ and O₂ in soil gas over faults, fractures and associated with mineralization *continued from p. 13*

surveys suggest the detection of faults and fractures, it is unclear if the results distinguish between structures that host sulphide mineralization from those that are barren. Detecting Hg vapour (e.g. Rukhlov 2022) or gaseous sulphur species (e.g. Hale 2010; Plet et al. 2021) could improve the ability of soil gas surveys to discriminate between sulphide mineralized and non-mineralized structures.

Experiments by Plet et al. (2021) and Hinkle et al. (1990) demonstrated that CO₂, SO₂, carbonyl sulphide (COS), and carbon disulphide (CS₂) are generated from aerobic and anaerobic weathering of different sulphide minerals, including pyrite and chalcopyrite. Research by Cox et al. (2013) into the biodegradation of CS₂ in soil revealed COS formed first (Equation 4) followed by H₂S (Equation 5) and ultimately H₂SO₄ (Equation 6).



Water-soluble sulphur levels in soils of up to 10.5 ppm associated with a ΔCO₂&O₂ peak at Mouse Mountain could reflect SO₄ in the soil from oxidation of fault-hosted sulphide minerals to CS₂ and eventually H₂SO₄. An analysis of a soil water leach for SO₄ could provide a basis to differentiate soil gas CO₂ and O₂ anomalies associated with sulphide mineralization from barren faults. Soil pH at Mouse Mountain appears to have a relationship with higher ΔCO₂&O₂ as suggested by Beaubien (2008); however, the number of pH determinations is insufficient to confirm the relationship.

CONCLUSIONS

Two systems, the SGAS and the CM 1000 Data Logger, were used to measure CO₂ and O₂ in soil gas. A comparison of soil gas analyzed for CO₂ and O₂ using the SGAS and the CM 1000 Data Logger systems show similar results, although O₂ is less sensitive when measured with the CM 1000 Data Logger. The lower sensitivity may be due to a 10 ppm SGAS O₂ sensor detection limit compared to the 100 ppm O₂ detection limit of the CM 1000 Data Logger.

Soil gas surveys over the Mount Milligan Cu-Au deposit and the Anita Cu-Pb-Zn-Au-Ag VMS mineral property reveal some spatial relationship between mapped faults and elevated ΔCO₂ and ΔCO₂&O₂ and negative ΔO₂. At Mouse Mountain, additional potential fault locations have been interpreted from the results of the soil gas survey. Additionally, higher sulphur in soil water extracts corresponding to the elevated ΔCO₂ and lower ΔO₂ in the soil gas may indicate sulphur gases emanating from weathering sulphides migrating along faults to the surface. It is concluded that both the commercial and purpose-built real-time soil gas measurement systems provide a promising methodology for detect the surface trace of buried structures. With additional survey refinements and the inclusion of additional variables (e.g. soil pH, or geochemistry; other soil gases such as SO₂, Hg), it may also be possible to detect which structures are associated with sulphide mineralization.

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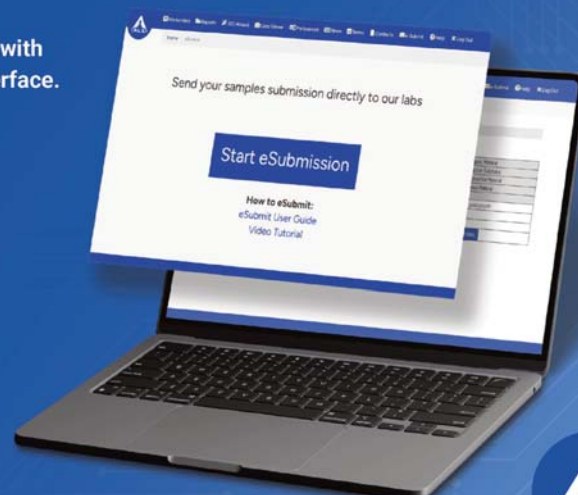
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CO₂ and O₂ in soil gas over faults, fractures and associated with mineralization *continued from p. 14***ACKNOWLEDGEMENTS**

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News

Australia Day Honours 2026



This year's Australia Day Honours recognised Australians advancing science and public service, including AAG Fellow and past Gold Medal winner Ravi Anand. On January 26, 2026, **Dr. Ravinder (Ravi) Anand** was appointed a Member of the Order of Australia (AM). CSIRO Honourary Fellow and former Chief Research Scientist, Ravi Anand was appointed a Member of the Order of Australia (AM) for significant service to earth science and mineral resources, regolith exploration and applied geochemistry.

Ravi's career spans soil science in India to leading regolith research in Australia. He completed his PhD at the University of Western Australia and soon after joined CSIRO in 1987. He then set about transforming mineral exploration in Australia's weathered terrains and became a global authority in regolith geology and geochemical exploration. Ravi developed a framework that enables explorers to understand and record regolith geochemistry, and his research on laterite formation and sampling strategies contributed to major gold discoveries, including the Bronzewing, Jundee, and Nimary mines, collectively worth over \$2 billion. These discoveries drew on methods from the CSIRO AMIRA 'Yilgarn lateritic environments' projects led by Ravi and Ray Smith, now core to the exploration toolkit in arid and semi-arid terrains. Ravi's team later researched mechanisms of metal migration in regolith, showing vegetation and termites can play an active role in indicating buried mineralisation. With more than 330 publications, Ravi's legacy is defined by both scientific impact and mentorship — training hundreds of geologists and supporting generations of students.

Congratulations Ravi!



Ravi logging drill core.



Dr. Ravi Anand (AM) making regolith notes in the Yamarna terrain of Western Australia.



Ravi explaining geochemistry concepts on a field trip.

AAG Logo Design Contest

The Association of Applied Geochemists (AAG) is looking to update/redesign its logo and we want your help to reimagine it. Submit your design ideas to the AAG Business Office by attaching your design (pdf, png, or jpeg file) in an email to office@appliedgeochemists.org.

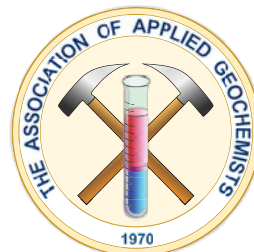
The AAG is an international geoscience organisation of professionals in industry, academia and government with a principal focus on mineral exploration and the associated fields of environment and analysis. Our new logo, which will be used on the AAG website, social media platforms, EXPLORE newsletter, at AAG-sponsored events, and on the AAG gold, silver and copper medals, should reflect these three fields of focus.

The new designs will be voted on by AAG Members. AAG Council will make the final selection of the new logo, taking into account the voting results and advice from the website design company. The AAG reserves the right to change the colours and fonts of the winning design; the new logo will become the property of the Association.

The winning designer will receive a free one-year full membership to the Association and a bronze medal bearing the new AAG logo with their name engraved on it as the logo design winner.

Submission Deadline:

April 30, 2026



In Memoriam

Ian Roy Jonasson, Ph.D. 1939-2026

We are deeply saddened by the death of our good friend and colleague Ian Jonasson at the Victoria Heart Hospital, Melbourne, Australia on March 8, 2026, surrounded by close family. Ian was born in Castlemaine, Australia, in 1939. He completed his BSc. Honours degree in Chemistry at the University of Melbourne in 1962 and received his PhD in Physical Chemistry from the University of Adelaide in 1968, after which he stayed on for a year for post-doctoral studies. In 1969, Ian was granted a post-doctoral fellowship at the Geological Survey of Canada and so moved to Ottawa with his wife Pat and their three children, Kirsten, Karina and Andrew. Their fourth child, Nick, was born in Ottawa. He joined the Geochemistry Section of the Economic Geology and Geochemistry Division to work on the development of geochemical prospecting methodologies for surficial environments.

During these early years, Ian worked with Bob (R.W.) Boyle on major reviews of the geochemistry of As, Hg, and Sb for the National Research Council of Canada to support the development of environmental regulations. With his transfer to a permanent position as a research scientist in 1970, he became increasingly interested in the geochemistry and mineralogy of metallic mineral deposits, and in 1986 he joined the Mineral Deposits group. He quickly focused on the Howard's Pass SEDEX-type Zn-Pb mineral systems and the geochemical characterization of the associated sulphides. This introduction to syngenetic massive sulphide deposits led Ian to the mysteries of ancient volcanic-hosted massive sulphide systems and their modern equivalents off Canada's west coast. His interest in offshore research grew with the new mandate for Canada to better determine the extent of its offshore economic zone. As part of a decade-long partnership with U.S. and German colleagues, Ian participated in over a dozen research expeditions around the world, including diving in research submarines to the deepest parts of the ocean to study hydrothermal vents.

Ian's wide-ranging interests, vast curiosity and almost photographic memory resulted in lasting collaborations with fellow researchers on such topics as diverse as rhenium and molybdenum in magmatic-hydrothermal ore deposits and biological interactions at black smoker vents. He generously shared his vast knowledge of geochemistry, assisting a great number of graduate students both intellectually and with project funds. For his contribution to the science, Ian was recognized by having a new mineral (jonassonite) and a deep-sea vent animal (*Bathycmaea jonassoni*) officially named in his honour.

In his later years at the Geological Survey of Canada, Ian adopted the mineral deposit sample collection in order to ensure that it was properly catalogued for use by future geoscientists. His handwriting can be recognized on hundreds of cabinets and trays in the GSC's vast mineral collection. He retired from the GSC in 2006 but continued to work on the sample collection as emeritus for a number of years.

Ian was pre-deceased in 2015 by his wife of 50 years, Patricia Kathryn Jonasson (née Daly) and survived by his children Kirstin, Karina, Andrew, and Nick, son-in-law Peter Schaub, daughter-in-law Monika, five grandchildren and loving partner Judy Davine. His life will be celebrated by friends and family this month in Melbourne, Australia.

Alan Galley, Doreen Ames and Mark Hannington



2025 AFRICA REGIONAL REPORT ON APPLIED GEOCHEMISTRY

APPLIED GEOCHEMISTRY HIGHLIGHTS: TRENDS AND ISSUES IN AFRICA, 2024 TO 2025

T.C. Davies

AAG Regional Councillor for Southern Africa

SUMMARY

Applied Geochemistry (AG) activities in Africa during 2024 and 2025 have focused on activities of relevance to public health, climate change and resource management. Public health activities have engendered studies on the circulation of toxic elements in geomedical systems (water, soil and air) affecting agriculture and the food chain; thus, leading to diverse nutritional diseases due to trace element imbalances. Research projects in these interconnected areas leverage new technologies (AI, *synchrotrons) and address data gaps, with key trends including improved stewardship of mining waste such as 'acid mine drainage' (AMD), using technologies such as AI and bioremediation. The use of integrated geophysics

continued on page 19

2025 Africa regional report *continued from p.18*

for minerals and improving geochemical data generation for exploration gained ground during the period under review (2024–2025), despite challenges experienced in funding, infrastructure development, and data accessibility.

Key events and meetings with significant Applied Geochemistry constituents during 2024 and 2025 include the 39th Society for Environmental Geochemistry and Health (SEGH) Conference in Nigeria (01–04 July, 2024), the 30th Colloquium of African Geology (CAG30) in Kenya (23–27 September 2025), and the First International Edition of the Scientific Forum Entangling Geosciences and Chemistry (SciFo-EGC) Conference (EGC 6) in Cameroon (24–26 October 2024). New infrastructure developments focused on setting up modern analytical facilities, such as the new commercial geochemistry laboratory in Walvis Bay, Namibia, which was launched by the global testing giant SGS to support the mining industry.

INTRODUCTION

Applied Geochemistry (AG) activities in Africa during the period of 2024 and 2025 (ranked in Table 1) have focussed on urgent issues such as attainment of improved clinical diagnosis of environmental diseases through better understanding of the link between geochemistry and disease causation (Medical Geochemistry) using advanced modelling; managing the geochemical circulation of toxic elements in the water, soil and air environment in as far as it (element circulation) affects the geochemical integrity of agricultural systems for food security, and development of new geochemical data and technology (AI, big data) for mineral exploration, though hampered by resource availability and skill gaps.

GEOCHEMISTRY AND HEALTH (MEDICAL GEOLOGY)

Most of the diseases studied within the realm of Medical Geology are actually “geochemical diseases”, for they occur because of differences in the nature, dynamics of circulation and concentration levels of chemical elements, as well as the interplay of other biogeochemical factors (e.g. pH, bioavailability, bioaccessibility) of the elements involved in metabolic perturbations in the human body. As a result of the increasing awareness of the important role of geochemical variables in agricultural systems and the food chain as probable aetiological co-factors for certain environmental diseases in Africa (see, e.g., Davies 2022, 2024), research and other geoscientific activities in *Environmental Geochemistry and Health* (Medical Geology) (ranked topmost in Table 1) continued to upsurge during the period of 2024 and 2025.

Table 1. Ranking Africa’s recent (2024 to 2025) Applied Geochemistry Output (based on AI-assisted internet searches on 30.11.2025).

Rank	Area of Activity (Field campaigns; Research projects; Scientific meetings; Publications; etc.)	Output, 2024–2025	
		Number of Hits Returned by Bing Search Engine Using Keywords: “Africa”; “2024”; “2025”; “X”; “Africa” (as of 30.11.2025)	%
1	Geochemistry and Health (Medical Geology)	11,300,000	13.8
2	Climate Change Chemistry	9,240,000	11.2
3	Chemistry of Water Pollution	9,160,000	11.1
4	Geochemistry in Agriculture	9,140,000	11.1
5	Chemistry of Air Pollution	7,820,000	9.5
6	Chemistry of Soil Pollution	6,160,000	7.5
7	Geochemical Data and Analysis	5,920,000	7.2
8	Marine Geochemistry	3,250,000	4.0
9	Mapping for Geochemical Database Compilation	3,170,000	3.9
10	Geochemistry in Mineral (Ore) Exploration and Identification	3,170,000	3.9
11	Urban Geochemistry	3,150,000	3.8
12	Analytical Geochemistry	3,060,000	3.7
13	Geochemistry in Waste Management [including Wastewater Treatment *(AMD)]	2,920,000	3.6
14	Extraterrestrial Geochemistry	2,630,000	3.2
15	Isotope Geochemistry, Inorganic- and Biogeochemical Processes	2,080,000	2.5
Total		82,170,000	100.0

*AMD = Acid Mine Drainage; *X = Area of Activity (as in Column 2)

***Note:** Synchrotrons are powerful cyclic particle accelerators that bend high-energy electrons using synchronised magnetic fields, causing them to emit intense, brilliant light (synchrotron radiation), ranging from infrared to X-rays. Synchrotrons are used in diverse scientific research like biology, medicine, materials science and palaeontology. Africa does not yet have its own synchrotron light source, but the Continent’s scientists are gaining synchrotron access through international collaborations and training programmes like the UK’s START project, and initiatives by organisations such as UNESCO and the African Light Source (AFLS) project.

continued on page 20

2025 Africa regional report *continued from p. 19*

Africa's key Geochemistry and Health events during the period of 2024 and 2025 include the 39th Society for Environmental Geochemistry and Health (SEGH) Conference in Nigeria (01–04 July 2024), which focused on interdisciplinary research on Geochemistry and Health, featuring presentations, networking, and a field trip to lithium (Li) mines. Major themes in the SEGH Conference included emerging contaminants, climate change impacts, geo-health policy, and building capacity through student workshops and international collaboration, and bridging geology, medicine, and public health for better urban and rural health outcomes.

Other major activities during the period under review include the 30th Colloquium of African Geology (CAG30) in Nairobi, Kenya (23–27 September 2025), and the First International Edition of the Scientific Forum Entangling Geosciences and Chemistry (SciFo-EGC) Conference (EGC 6) in Yaoundé, Cameroon (24–26 October 2024). The establishment of the Jose A. Centeno International Centre for Medical Geology (JACMEDGEO) at the Nasarawa State University (NSUK) in Keffi, Nigeria, for African and international students took place on 29 February 2025 and admitted its first class of students on 19 June 2025. The academic degree programmes include degrees in Postgraduate Diploma (PGD) in Medical Geology; Master of Science (M.Sc.) in Medical Geology; and Doctor of Philosophy (Ph.D.) in Medical Geology.

A new book, *Medical Geology of Africa: A Research Primer* (Davies 2024), was published by Elsevier in late 2024 to reiterate the link between geochemistry and public health in Africa and expose important gaps in knowledge in this rapidly evolving field. As the link between geochemical cofactors and myriads of environmental diseases in Africa becomes clearer and more firmly established, we will continue to see a rise in research activities in Medical Geology.

CLIMATE CHANGE CHEMISTRY

From 2024 to 2025, activities incorporating African climate chemistry focussed on green solutions, e.g., the 'Elsevier Challenge' for implementing green and sustainable chemistry solutions in the Global South; assessing contaminant impacts from extreme weather, and the development of sustainable materials. The "Climate Chance Africa Summit" (27–28 October 2025) held in the Republic of Benin dwelt on the key climate chemistry theme of "Renewable Energies, Adaptation, Biodiversity: Challenges and Perspectives". In the context of growing climate emergency, pressure on energy access, and the urgent need to accelerate a sustainable transition, this Summit brought to the fore African solutions for a just, inclusive, and locally relevant energy transition.


The Africa Centre for Energy Policy (ACEP) inaugurated the Africa Climate Academy from 07 to 11 October 2024. This Academy is an educational platform designed to foster a change in thinking in the understanding and discourse surrounding climate change, energy transition, and its implications for Africa.

The "African Green Chemistry School and Environmental Sustainability" (GreenChemAfrica) represents a pivotal initiative aimed at addressing critical environmental challenges and promoting sustainable chemical practices across the African region. This School which was held from 21 to 27 April 2024 in Mohammed VI Polytechnic University, Benguerir, Morocco, focussed on programmes dealing with green chemistry and sustainability, emphasising the need for environmentally friendly chemical processes in the Africa region. It offered participants from across the African continent a world-class educational experience designed to stay up to date with the latest advances in green chemistry and environmental sustainability. High level training offered to PhD students, postdocs, and professionals on green chemistry solutions for environmental challenges positioned them to contribute effectively towards putting Africa at the forefront of sustainable technological innovation, creating pathways for more resilient and environmentally conscious development strategies.

CHEMISTRY OF WATER POLLUTION

Activities regarding water pollution chemistry in Africa from 2024 to 2025 focussed on addressing issues that range from poor handling of industrial and mining waste, agricultural runoff (agrochemicals, sewage), urban pollution, and climate change impacts. These issues are driving research, policy, and technological solutions like water quality monitoring,

continued on page 21



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improved treatment at wastewater treatment plants (WWTPs), sustainable farming practices, and better governance under frameworks like the Africa Water Vision for 2025, aimed at securing clean water amidst increasing demand and scarcity.

A detailed itemisation of the key focus areas of research on water chemistry and pollution in Africa during 2024 to 2025 runs as follows: (i) Chemical Contaminants: Investigating specific pollutants from mining (toxic metals), agriculture (pesticides, fertilizers), pharmaceuticals, and emerging contaminants (microplastics); (ii) Impact on Aquatic Ecosystems: Assessing chemical effects on biodiversity, nutrient cycles (N, P), and water quality parameters (BOD); (iii) Climate Change Nexus: Studying how altered rainfall (wetter or drier scenarios) affects pollutant loads and water quality; (iv) Research and Monitoring: Deploying advanced analytical techniques (e.g. spectroscopy, chromatography) for water analysis, tracking pollution sources; (v) Technology and Innovation: Developing affordable water treatment technologies (e.g. bio-filters, advanced oxidation) for rural/urban areas; (vi) Geochemical Modelling: Studies are using geochemical modelling to analyse groundwater quality for sustainable management, particularly in arid and semi-arid regions; (vii) Geochemical Evolution: Research continues on the geochemical evolution and mechanisms influencing groundwater chemistry in different regions of Africa; (viii) Policy and Governance: Strengthening national water policies, promoting integrated water resource management (IWRM), and regional cooperation (Africa Water Vision 2025); (ix) Sustainable Practices: Promoting agroecology, reducing chemical fertilizer use, improving waste management (sewage treatment, solid waste) and (ix) Capacity Building: Training water professionals, raising public awareness about water hygiene.

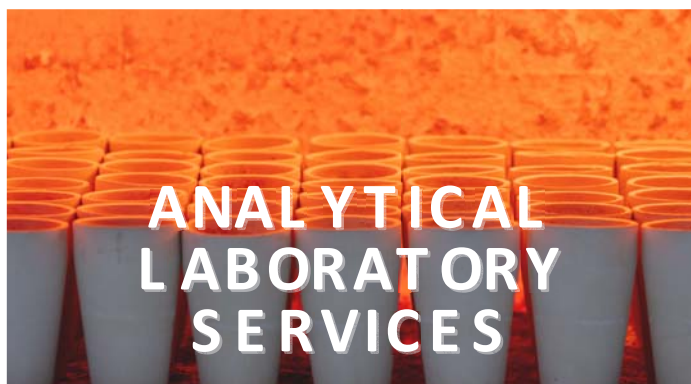
GEOCHEMISTRY IN AGRICULTURE

Geochemistry activities in African agriculture (2024–2025) centred around soil health, nutrient management (especially P), toxic metal pollution, and climate adaptation. Major events such as the AU's Africa Fertilizer and Soil Health (AFSH) Summit held in Kenya (7–9 May 2024) set forth cogent action plans.

Research explored advanced techniques (spectroscopy, modelling) to assess element mobility, predict risks, and develop sustainable solutions for food security, often targeting critical mineral resources and trace elements in soils and water. The 10-Year AFSH Action Plan and Soil Initiative for Africa (SIA), which aims to reverse soil degradation, triple fertilizer production (organic/inorganic) by 2034, and improve farmer access to recommendations for better soil health, productivity, and food security, was advanced. A listing of key research areas on geochemistry in African agriculture (2024–2025) runs as follows:

- i) *Soil Health and Fertility* focused on 'phosphorus'. Events like the Sustainable Phosphorus Summit (SPS8 in Ghana, 30 September to 03 October 2025) dwelt on sustainable phosphorus use in agriculture, food security, and the environment, and aimed to build an African Sustainable Phosphorus Network (ASPN) for better management (see Manzeke-Kangara et al. 2025).
- ii) *Assessment of Toxic Metal (TM) Pollution* was carried out on soils, crops, and water from fertilizers, wastewater, and mining. Risks to human health were evaluated using modelling and advanced speciation techniques (XAS). Advanced X-ray Absorption Spectroscopy (XAS) techniques using synchrotron light provided element-specific insights into the oxidation state, coordination, and local structure of elements in complex samples.
- iii) *Nutrient Cycling*: Studies investigate the effect of rainfall, weathering and land use on nutrient (major ions, trace elements, REEs) distribution and crop uptake in various watersheds.
- iv) *Precision Agriculture*: Using V-NIR spectroscopy and advanced methods to characterise soil properties for better fertilizer/amendment decisions.
- v) *Elemental Tracing*: Using Rare Earth Elements (REEs) as tracers for soil processes and pollution.
- vi) *Molecular Speciation*: Understanding metal forms in soil using synchrotron techniques (XAS) to predict bioavailability and toxicity.
- vii) *Integrated Hydrogeochemistry*: Linking soil, rock, and water chemistry to understand nutrient generation and depletion in agricultural areas (see, e.g., Jokam Nenkam et al. 2022; Kpiebaya et al. 2025).

continued on page 22



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2025 Africa regional report *continued from p. 21*

- viii) *Geochemical Modelling*: Applying chemometrics to understand groundwater quality and pollution sources (geogenic/anthropogenic) affecting agriculture.
- ix) *Climate-Smart Agriculture*: Integrating geochemical understanding to mitigate climate impacts on soil nutrients and productivity.

CHEMISTRY OF AIR POLLUTION

Activities related to the chemistry of air pollution in Africa for 2024 and 2025 were centred around capacity building (WMO training), leveraging global policy (UNEA-6), scientific conferences, intensive research into sources (Nigeria, South Africa, Egypt) and health impacts [PM_{2.5}, hazardous air pollutants (HAP)], and implementing solutions like clean cooking fuels, better monitoring (satellites, low-cost sensors), green innovation technologies to reduce carbon and PM_{2.5} emissions, particularly in industries like cement production, steel manufacturing, and petrochemical plants which are major sources of pollutants in Africa, and enhanced data integration for policy action against rising heat and pollution risks. Key themes involve addressing indoor and outdoor sources, integrating health data, and establishing strong regional policies for sustainable development.

A detailed listing of the key activities and themes (2024–2025) runs as follows:

- *Policy and Governance*: The UNEA-6 Resolution (2024) landmark UN resolution acknowledged air quality challenges in Africa, boosting efforts like the Africa Clean Air Program (SEI). The WHO Global Conference (March 2024) and Roadmaps: Renewed commitments for 50% reduction in air pollution health impacts by 2040, updated global strategies.
- *Research and Data*:
 - i) *Source Apportionment*: Studies identified key pollutants from vehicles, industry (artisanal refining), dust (Cairo), and biomass burning (Nigeria, SA). Other studies examine the chemistry of specific pollutants, such as polychlorinated naphthalenes (PCNs) in Southern and West Africa, identifying sources like open waste burning and industrial emissions; and the health impacts of fine particulate matter (PM_{2.5}) in West Africa, e.g., in Nigeria.
 - ii) *Health Impact Studies*: Focus on PM_{2.5} effects on children (Nigeria) and integration of electronic health records
 - iii) *Monitoring*: Calls for better spatio-temporal trends using satellites, high-quality monitors, and low-cost sensors, especially in under-monitored areas like Nigeria.
- *Capacity Building and Training*:
 - During September 2024 the World Meteorological Organisation (WMO) organised a number of Training Webinars on air quality prediction and modelling for Africa, covering processes, models, and observation.
- *Solutions and Interventions*:
 - i) *Clean Cooking*: Promoting cleaner fuels to reduce Household Air Pollution (HAP).
 - ii) *Green Infrastructure*: Planting trees, green roofs to cool cities and filter air (Kigali example).
 - iii) *Data Integration*: Using advanced techniques to link pollution data with health outcomes and policy.

Key Challenges and Future Focus (2025+)

- i) *Bridging Data Gaps*: Fragmented monitoring needs systematic expansion.
- ii) *Toxic Elements*: Addressing persistent toxic chemical pollution in water, soil, and food chains.
- iii) *Climate-Health Nexus*: Understanding how rising heatwaves intensify pollution risks.
- iv) *Policy Implementation*: Translating global commitments into effective national policies, especially for industrial/agricultural emissions.

Key Conferences and Events

Several major conferences and workshops in 2024 and 2025 addressed air quality challenges and solutions in Africa:

- i) The sixth session of the *United Nations Environment Assembly* (UNEA-6) took place from 26 February to 01 March 2024 at the United Nations Environment Programme (UNEP) headquarters in Nairobi, Kenya. UNEA-6 concluded with the adoption of 15 resolutions to advance collaborative action on the triple planetary crisis of climate change, nature and biodiversity loss, and pollution and waste.
- ii) *African Union Summit*: The 38th AU Summit held in Addis Ababa, Ethiopia from 15–16 February 2025 saw the adoption of critical strategies for clean and sustainable energy and transport pathways, including the African Green Hydrogen Strategy and the African Energy Efficiency Strategy and Action Plan.
- iii) *CLEAN-Air Forum 2025*: The third annual forum was held in Nairobi, Kenya, from July 15–17, 2025, under the theme "Partnerships for Clean Air Solutions". It served as a key platform for knowledge sharing and collaboration on air pollution in African cities.
- iv) *ESG and Climate Africa Summit*: This summit held from 26 to 27 November 2025 in Nairobi, Kenya featured discussions on integrating environmental, social, and governance principles, including climate change mitigation and renewable energy sources, to promote sustainable development.
- v) *African Society for Air Quality (ASAQ) Annual Seminar*: This seminar was held online from 03 to 04 December 2025

2025 Africa regional report *continued from p. 22*

and brought together scientists to discuss air quality research, including topics like pollutants and sources, monitoring advances, and health impacts.

CHEMISTRY OF SOIL POLLUTION

Activities in African soil pollution chemistry (2024–2025) focussed on the identification of sources (mining, waste, agriculture), analysing contaminants (toxic metals, hydrocarbons, pesticides) using advanced techniques, assessing risks to health and environment. Development of sustainable remediation (phytoremediation, bioremediation) and policy solutions featured prominently in addressing the issues. Ongoing research by universities (in Ghana, Nigeria, Kenya) and organisations (AU, UNEP) tackle issues ranging from urban dumps to agricultural runoff; and the development of sustainable policies to manage major pollutants like toxic metals and hydrocarbons.

Key Themes and Activities (2024–2025)

- i) *Assessment and Mapping*: Field surveys, remote sensing, and GIS were used to map polluted sites, especially around industrial zones, mining areas, and intensive farms.
- ii) *Contaminant Characterisation*: Detailed chemical analyses (AAS, ICP-MS, GC-MS) were employed to identify specific toxic metals (Pb, Cd, As), PAHs, pesticides, and emerging contaminants.
- iii) *Health and Ecological Risk*: Studies linking soil pollution to human health (food chain), water contamination, and ecosystem health were widely conducted.
- iv) *Remediation Technologies*: Developing and testing cost-effective, context-specific solutions like using local plants (phytoremediation) or microbes (bioremediation).
- v) *Policy and Management*: Advocating for better waste management (4Rs: Reduce, Reuse, Recycle, Restore), stricter industrial regulations, and sustainable agriculture practices.

Examples of Research Focused Areas in Africa

- *Mapping Initiatives*: Numerous studies are underway to map pollution hotspots and assess ecological and human health risks.
- *Southern Africa (South Africa, Zambia)*: Mining legacy sites, toxic metals and coal ash contamination.
- *West Africa (Nigeria, Ghana)*: Artisanal mining (Hg, Pb), e-waste, oil spills (hydrocarbons). Researchers are also conducting extensive soil sampling and analysis in areas impacted by artisanal gold mining in the Sudan.
- *East Africa (Kenya, Ethiopia)*: Agricultural runoff (pesticides), urban plastic pollution and industrial zones.
- *Advanced techniques*, including machine learning (ML) are being used to identify the sources and distribution of toxic elements in Nigeria and Ghana (see, e.g., Kwayisi et al. 2024; Kazapoe et al. 2025).
- *Remediation Research Projects and Green Initiatives*: Implementation of cleanup efforts often involving “green remediation” (GR) or “sustainable remediation” (GSR) practices aim to minimise the environmental footprint of the cleanup process itself (see Otunola et al. 2025). Large-scale initiatives like the ongoing clean-up in the Niger Delta of Nigeria and the multi-national Great Green Wall Initiative to combat desertification and land degradation in the Sahel region, are major focal points for land restoration. Some African governments have begun enforcing financial guarantees from mining companies in 2024 to ensure funds are available for post-operation site rehabilitation.
- A significant research need is the development of a comprehensive, continent-wide soil information system (SIS) for effective monitoring and data sharing (see Kome et al. 2025).

Conferences and Knowledge Sharing

Academic and professional bodies are organising events which collectively aim to address the significant challenges posed by increasing waste generation and disposal and industrial expansion on soil health across the Continent. These meetings discuss research findings and plan future strategies on soil pollution in Africa. The 3rd International Congress on Natural Resources and Sustainable Development (RENA'2025) which took place in El Jadida, Morocco from 18 to 20 December 2025, brought together experts to discuss environmental protection and sustainable solutions.

GEOCHEMICAL DATA AND ANALYSIS

Key trends in geochemical data analytics in Africa during 2024 and 2025 have heavily involved the leveraging of AI and ML for critical mineral exploration (lithium, cobalt, rare earths) driven by global energy transition (see, e.g., Davies et al. 2025; Fu et al. 2025), alongside vital groundwater quality and environmental health studies for sustainability. These activities have integrated analytical techniques such as XRF, ICP-MS, and remote sensing to map anomalies and guide resource development, with a push for better data generation and policy frameworks to support mineral development.

Integration with Policy and Climate Resilience

Geoscience data are increasingly being used to inform strategies for sustainable development, climate change mitigation, and infrastructure planning. This involves developing geological models to facilitate geothermal energy development and subsurface CO₂ storage, aligning with global initiatives like the Africa Water Vision and the UN's Sustainable Development Goals (SDG 6).

2025 Africa regional report *continued from p. 23*

Regional Examples and Drivers

- *Nigeria*: Focus on natural hydrogen potential, leveraging gas infrastructure, with studies highlighting data gaps.
- *South Africa/DRC*: Continued leadership in mineral production, with efforts to move beyond extraction to value addition.
- *Broader Africa*: Driven by initiatives like the Africa Mining Vision and partnerships (EU/US) for secure mineral supply chains, addressing underinvestment in geoscience.

Conferences and Workshops (2024–2025)

Several events are bringing together geoscientists to share findings and methodologies.

- *Marine Data 4 Africa Workshop*: Hosted by the Copernicus Marine Service, this Workshop was held from 03–05 March 2025 and explored key coastal and oceanographic phenomena across the eastern, western, and southern coasts of Africa.
- *CAG30 (30th Conference of African Geoscientists)*: This conference which was held from 22 to 25 September 2025 in Nairobi, covered a wide range of topics including mineral exploration, geothermal development, and AI in geosciences in Africa.
- *ISS ESGS 2025*: The International Conference on Environmental, Social, Governance and Sustainability (ISS ESGS 2025) was held from 15 to 19 December 2025 in Cape Town, South Africa focussed on environmental, social, governance, and sustainability issues within the resource sector, highlighting a dynamic field increasingly focussed on sustainable resource management and leveraging innovative data science techniques.

MARINE GEOCHEMISTRY

Major activities in marine geochemistry in Africa for 2024 and 2025 include international events such as conferences and training schools, research initiatives under the UN Ocean Decade, and published studies on the geochemistry of African coastal regions and the ocean floor.

- Marine Data 4 Africa 2025 (Copernicus/Africa)*, a two-day workshop held from 03 to 05 March 2025 to explore African marine data, covering currents, waves, and geochemical aspects across coasts, featuring topics like kelp geochemistry in Namibia and cyclone impacts in Mozambique.
- The GEOTRACES Summer School* held in Cape Town, South Africa from 17 to 21 November 2025 is a major international training event for PhD and early career researchers on marine biogeochemistry, focusing on trace elements and isotopes, covering global cycles with regional applications, fostering collaboration, and launching the new GEOTRACES data product.
- The BGP Oceans Empowering Nigeria*, an intensive training which took place in Lagos, Nigeria in 11 and 12 December 2024 on marine fauna monitoring, part of the Ocean Decade initiatives.

Research Focus Areas in Marine Geochemistry during 2024 and 2025

- Coastal Dynamic*: Studying upwelling in the Gulf of Guinea and heatwaves in the Agulhas Current.
- Establishing geochemical baselines* for marine ecosystems (e.g. Namibian kelp).
- Impact studies*, such as assessing the effects of tropical cyclones (like Chido in 2024) on marine environments and sustainable aquaculture, and rising satellite data for development.

Several research papers published between 2024 and 2025 focussed on marine and environmental geochemistry in specific African regions, e.g., studies on the distribution and ecological risk of toxic metals in river sediments on the Atlantic Coast of Cameroon and Nigeria (see Tiabou et al. 2024); research on the geochemical behaviour and provenance of surface sediments off the coast of Sierra Leone (Hu et al. 2024) and investigations into the geochemistry of Late Cretaceous to Paleogene sedimentary formations in the Anambra Basin, Nigeria, to understand depositional environments (Omietimi et al. 2024).

MAPPING FOR AFRICA GEOCHEMICAL DATABASE COMPILATION

Research efforts continued in 2024 and 2025 to develop methodologies for using existing hydrogeological and lithological data from databases to improve existing geological maps in highly weathered regions of Sub-Saharan Africa.

Specific activities related to Africa Geochemical Database (AGD) compilation in 2024 to 2025 centred around the integration of new data (Nigeria, Angola), leveraging AI/digital platforms (Global Geochemical Baselines), and creating prospectivity maps for critical minerals. Much effort was directed towards the fulfilment of other major pan-African initiatives, national geological survey projects, and international cooperation programmes. These include, capacity building and the use of advanced analysis (XRF, ICP-MS) to map elemental distributions for health, environment, and mining. Major initiatives involve the USGS with Angola, UNESCO-IGCP, and national geological surveys, expanding digital tools like the Digital Chemical Earth platform for continental-scale resource assessment.

A detailed listing of primary activities relevant to the AGD compilation during the 2024 to 2025 period runs as follows:

- Angola Mineral Resource Assessment*: The USGS established an MOU with the Angola Geological Institute (IGEO) in November 2023 focusing on scientific cooperation, geological mapping, and assessing Angola's critical mineral potential (like rare earth elements) to attract investment, aligning with Angola's mining diversification beyond diamonds.

2025 Africa regional report *continued from p. 24*

- ii) *African Union (AU) Strategy Implementation:* Following the African Forum on Mining in March 2025, the AU reinforced the importance of reliable geological data. Activities under the overarching Africa Green Minerals Strategy involve: Strengthening national and regional geoscientific institutions to expand geological mapping and mineral resource assessments; and the development of a robust geological and mineral information systems to support the African Mining Vision and attract investment. The full strategy document is available from the African Union.
- iii) *Pan-African Efforts:* Initiatives under Earth Observations (GEO), the PanAfGeo+ Programme focusses on global baseline networks and data sharing. The third phase of this Project (PanAfGeo+) commenced in 2024 and is expected to run till 2029. Activities focus on (1) Integrating new themes such as geospatial data and digital transformation. (2) Strengthening the capacity of African geoscientific institutions through training in geoscientific information management, and (3) Consolidating the network of European and African geological surveys to enhance data sharing and management protocols.
- iv) *Nigeria:* Ongoing studies use stream sediments for baseline data, mapping contamination, and identifying mineral potential in West Africa. The Nigeria Geological Survey Agency (NGSA) indicated specific areas for proposed geochemical data acquisition in its 2024 plans, often in collaboration with international partners.
- v) *Geochemical exploration in Cameroon:* A study on stream sediment geochemistry in Cameroon was conducted to explore base metals and assess pollution risks in aquatic ecosystems.

Main Applications of a Complete AGD

- i) *Mineral Exploration:* Identifying new deposits (base metals, REEs, precious metals).
- ii) *Environmental Health:* Baseline mapping for urban contamination, agriculture, and health assessments.

Methods and Technologies

- i) *Sampling:* Stream sediments, soils, rocks, water.
- ii) *Analysis:* ICP-MS, XRF, AAS for elemental analysis.
- iii) *Mapping:* GIS, geochemical anomaly delineation, multivariate statistics.

Key Output

Key products include (i) digital geochemical atlases; (ii) prospectivity maps; and (iii) datasets for resource assessment and as motivation for inauguration of new infrastructure and projects, e.g., the Namibia Geochemistry Laboratory. In September 2025, a new geochemistry laboratory was launched in Walvis Bay, Namibia, to provide analytical services for the mining industry. Despite the apparent successes experienced during the period under review (2024 to 2025) many of the challenges in the AGD compilation remain (see Davies 2025).

GEOCHEMISTRY IN MINERAL (ORE) EXPLORATION AND IDENTIFICATION

African mineral exploration geochemistry moved towards high-technology, data-intensive methods to efficiently find critical minerals, supported by national strategies and increasing private sector interest driven by global energy shifts. Key activities during the 2024 and 2025 include detailed geochemical mapping [not necessarily within the AGD guidelines (Darnley et al. 1995)], identification of hydrothermal systems, and integration of diverse data streams (geophysics, remote sensing) to de-risk exploration for investors, particularly for battery minerals and base metals. The period saw a significant trend toward using geochemical data to identify areas with high potential for critical minerals like Rare Earth Elements (REE), Tantalum (Ta), Niobium (Nb), Uranium (U), and Platinum (Pt).

Techniques such as X-ray Fluorescence (XRF) spectrometry were leveraged for rapid elemental analysis, utilising big data for better targeting. Isotope (Pb, Se) geochemistry and water analyses were applied, and novel methods explored for critical minerals (Li, Ni, Co), with major government investment in Nigeria and a continental push for data-driven discovery driven by energy transition demand.

Advanced analytical techniques engendering multivariate statistical processing, such as principal component analysis (PCA) are now used to interpret large geochemical datasets, which helps in identifying litho-geochemical signatures and mapping bedrock geology even under lateritic cover. Geochemical analysis is focussing on "pathfinder" elements associated with mineralisation, such as As, Sb, Cu, Bi, and Co to predict the location of gold deposits.

Deep seabed mineral resources exploration was also well underway during 2024 and 2025. The International Seabed Authority (ISA) held seminars and released reports in 2024 and 2025 discussing the challenges and opportunities for collaborative research on mineral resources in the South and Equatorial Atlantic Ocean, which involves extensive marine scientific research and geochemical analysis.

Countries such as Côte d'Ivoire, the Democratic Republic of the Congo (DRC) and Zambia are exploring for Li, Co, Ni, Au and other metals, using geochemical mapping and advanced techniques. Studies in Nigeria are using stream sediment and soil geochemistry to locate gold mineralisation and associated elements, and to map bedrock lithologies for exploration purposes (See, e.g., Ngozi-Chika and Mhlongo 2025). Studies focus on Au, base metals (Cu, Pb) in areas like Zamfara using XRF for deposit delineation, and lithium extraction methods.

2025 Africa regional report *continued from p. 25*

Geochemical mapping in west-central Nigeria has identified placer deposits with potential for Au, REE, Ta, Nb, U, and Pt, and has helped identify areas of anthropogenic contamination. Research on groundwater in Nigeria has used geochemical data to understand the sources of dissolved solids and the influence of factors like fertilizer use on water chemistry (Jolaosho et al., 2024).

Integrated Surveys for Gold: Integrated geological, geophysical, and geochemical surveys were conducted in north-central Nigeria's schist belts (e.g. Owu and Zamfara) to characterize and identify gold mineralisation using techniques like ICP-OES and fire assay on rock and soil samples. Geochemical studies also in Nigeria, emphasised the value of using modern techniques like X-ray fluorescence (XRF) for rapid elemental analysis and applying remote sensing imagery with specific band ratios to map alteration minerals related to different ore types, such as hematite and magnetite deposits in Kogi State.

Research published in 2024 and 2025 highlights several active areas of geochemical exploration across Africa, particularly in Nigeria and Zambia:

Lithium Exploration in Nigeria: There was a notable escalation in the exploration and extraction of lithium ore activities in Nigeria during 2024 due to high global demand for electric vehicle battery materials.

Research explored the use of hydrogeochemistry as an effective tool for detecting deeply emplaced mineral occurrences. A case study examined the application in exploring Iron Oxide Copper Gold (IOCG) deposits in the Kitumba district of west-central Zambia.

Research in the Central African Copperbelt is exploring the potential of using phytogeochemistry (geochemistry of plants) as a technique for mineral exploration. Research is being published on the organic geochemistry of various Nigerian frontier basins, assessing their potential for oil and gas generation. The African Energy Chamber's 2025 outlook also discusses high-impact drilling and the potential of African hydrocarbon basins.

Groundwater and stream water are being assessed for mineral signatures. The use of field portable tools is gaining prominence in multielement analysis for immediate results.

Government investment and policy is exemplified by Nigeria which is allocating significant funds (approximately US \$630M) for exploration to generate quality data, aligning with the African Union's (AU's) Africa Mining Vision (AMV). "The African Union's (AU) Africa Mining Vision (AMV), adopted in 2009, is a strategic framework to transform Africa's mineral wealth from a curse into a driver for inclusive, sustainable development by ensuring transparent, equitable, and optimal exploitation for broad-based growth, integrating mining into local economies, and creating robust value chains."

Future-oriented research lies in investigating metal mobility, survival of indicator minerals, and improving interpretation software (GIS).

In the broader African context the aim of applying regional geochemical surveys is to identify unseen deposits, leveraging the support of national geological surveys, and meeting critical mineral demands. In this pursuit, a number of challenges remain, chiefly, the lack of quality geological data which hinders private investment; the need for more trained exploration geochemists and integrating big data analytics with new geochemical data generation.

Several specific courses and conferences related to geochemistry in mineral exploration took place in Africa during 2024 and 2025. Additionally, numerous research and exploration projects utilising advanced geochemical techniques were active across the continent.

Specific Professional Development Opportunities, Courses and Conferences in Africa during 2024 and 2025:

- i) *Geochemical Exploration: Methods and Analysis of Data (Short Course):* This 5-day classroom and field course, led by Yann Itard (in French), was held during 13–17 October 2025, in Saly, Senegal as part of the Agate Project training initiatives.
- ii) *Professional Training Course (Agate Project):* A separate session of professional training course was held in Nairobi, Kenya, from September 29 to October 3, 2025.
- iii) The 3rd International Congress on Natural Resources and Sustainable Development (RENA'2025): This congress was held at Chouaib Doukkali University in El Jadida, Morocco, in December 2025.
- iv) *SASUF (South Africa-Sweden University Forum) Satellite Events (Online/Hybrid):* A specific event held on 13–14 May 2024 focussed on "Critical Raw materials (Mineral to Metals): Challenges and Opportunities", bridging South Africa and Sweden in research and innovation.

URBAN GEOCHEMISTRY

Urban geochemistry activities in Africa (2024–2025) focussed on toxic metal pollution, soil health, and geochemical mapping for developing baseline data for understanding element distribution, crucial for environmental management and land use planning. Urban studies on human health linked geochemical findings to public health impacts, especially for vulnerable populations; and addressing challenges unique to African megacities.

Research and publications focussed on toxic metal contamination and environmental health risks. Examples of research include studies on road dust in Cairo, which assessed toxic metals, contamination levels (using Igeo, EF), and calculate carcinogenic risks for children and adults (see, e.g., Mostafa et al. 2024).

2025 Africa regional report *continued from p. 26*

Major urban planning initiatives and conferences highlighted challenges (funding, data) and advocated for collaborations in African urban geochemistry. Key events like the SEGH conference in Nigeria (01–04 July 2024) and PanAfGeo training in Dakar, Senegal, from 01 to 12 July 2024 addressed critical challenges such as land degradation, public health risks, and the need for better data, especially in megacities such as Cairo, linking local studies to global sustainability goals. Sustainable development initiatives integrated urban geochemistry into broader goals concerning climate change, biogeochemical cycles, and ecosystem health. Other major conferences and events include the following:

- i) *"Africa's Urbanisation Dynamics 2025 Report" Launch*: The OECD, AfDB, Cities Alliance, and UCLG Africa launched a major report and hosted associated webinars on 06 March 2025. While focussing on urban planning and policy, this initiative provided the foundational data for future urban geochemistry studies regarding sustainable city expansion, infrastructure, and resource management.
- ii) *3rd International Congress on Natural Resources and Sustainable Development (RENA'2025)* took place in December 2025 in El Jadida, Morocco, with the aim of fostering collaboration on environmental challenges and sustainable solutions, including resource management.
- iii) *World Environment Expo Kenya* was held in Nairobi on 16 to 17 December 2025, focussing on the environmental protection industry in Africa, renewable energy, and sustainable practices.

Future perspectives include increased collaboration between academia, research centres and governments, addressing data gaps and promoting multidisciplinary projects in urban areas and integrating urban geochemistry into global discussions on climate change and environmental health. Development of scientific frameworks emphasised understanding of sources, transport, and fate of chemicals in cities in order to inform future research.

ANALYTICAL GEOCHEMISTRY

During 2024 and 2025, the application of modern Analytical Geochemistry methods continued to be hampered by a shortage of highly skilled personnel and accessible modern analytical technology. Analytical work during the period under review focussed heavily on the critical minerals, assessing the extent of their potential for the energy transition (lithium, cobalt, etc.) and for driving advanced exploration. These analyses highlighted skill gaps but also leveraged new technologies (AI/ML in data, automation) in tackling environmental issues like Acid Mine Drainage (AMD) using modern analytical methods like ICP-MS, XRF, and isotope analysis, with conferences and new projects emerging in Nigeria, Kenya, South Africa, and beyond.

Key events and projects (2024–2025) include the aforementioned geochemistry laboratory expansion by SGS which has launched a new geochemistry laboratory for the mining industry in Namibia and are expanding services in South Africa.

Several key conferences and short courses related to analytical geochemistry took place in Africa during the 2024–2025 period, organised by professional bodies like the Pan Africa Chemistry Network (PACN) Congress (29–31 October 2024, Nairobi, Kenya) and the 45th National Convention of the South African Chemical Institute (SACI-45) 2025 (30 November to 05 December 2025) held in Johannesburg, South Africa. The African Minerals and Geosciences Centre (AMGC) regularly offer a range of training services in the mineral industry, including courses on specific analytical techniques (e.g. spectrometric analysis, gold analysis, quality control) and field methods like GIS and sampling.

GEOCHEMISTRY IN WASTE MANAGEMENT [INCLUDING WASTEWATER TREATMENT (AMD)]

During 2024 and 2025, African extraterrestrial geochemistry and astrochemistry activities were centred around the leveraging of Earth Observation (EO) for terrestrial challenges (water and food security), building capacity [European Space Agency (ESA) Fellowships, African Academy of Sciences (AfAS) events], and exploring extreme environments as Mars analogues (Nigeria, Namibia) for future life-detection. Other major initiatives like ESA's EO Africa R&D calls and UNESCO geoscience projects drove collaboration and elicited funding for African-led research into space resources and fundamental astrochemistry.

EXTRATERRESTRIAL GEOCHEMISTRY

During 2024 and 2025, African extraterrestrial geochemistry and astrochemistry activities were centred around the leveraging of Earth Observation (EO) for terrestrial challenges (water and food security), building capacity [European Space Agency (ESA) Fellowships, African Academy of Sciences (AfAS) events], and exploring extreme environments as Mars analogues (Nigeria, Namibia) for future life-detection. Other major initiatives like ESA's EO Africa R&D calls and UNESCO geoscience projects drove collaboration and elicited funding for African-led research into space resources and fundamental astrochemistry.

ISOTOPE GEOCHEMISTRY, INORGANIC- AND BIOGEOCHEMICAL PROCESSES

During 2024 and 2025, notable African research projects that leverage isotope tools include those for critically addressing environmental challenges. These projects were supported by a fitting regional infrastructure and aligned with global shifts towards sustainable inorganic and biogeochemical research. Major research projects on isotope geochemistry and

2025 Africa regional report *continued from p. 27*

biogeochemistry such as the BIOGRIP initiative [<https://www.biogrip.ac.za/about-biogrip> (Accessed 19.12.2025)], featured huge components on water security, mineral interactions and mining impacts [University of Cape Town, University of Stellenbosch, University of the Free State and North West University, all in South Africa], and linked environmental isotopes ($\delta^{18}\text{O}$, $\delta^2\text{H}$) to seasonal hydrology in diverse regions like Cameroon, revealing rapid wet season recharge and dry season evaporation. Central themes include monitoring natural/anthropogenic inputs, water-mineral-microbe interactions, and advancing green chemistry in inorganic processes, driven by African research platforms and global trends in chemical research for sustainable development.

CONCLUSION

In essence, 2024 and 2025 saw Africa's Applied geochemistry sector predominated by activities centred around the geochemical circulation of nutritional and potentially toxic elements in the water, soil and air environment in the context of environmental health and disease causation through diet. The period under review also witnessed modernisation of the tools of Applied Geochemistry, focussing on data-intensive, technologically advanced methods to unlock strategic minerals and secure water resources for sustainable development, moving from basic analysis to predictive modelling and AI-driven exploration.

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Articles in Past Issues of EXPLORE

5 years ago EXPLORE 190 (March 2021)

Sinclair: Australia's first caesium deposit: discovery and exploration implications
(<https://doi.org/10.70499/UKGR2420>)

and

Recent applied geochemistry research in Africa contributed towards understanding causal cofactors of diseases of unknown aetiology (<https://doi.org/10.70499/TDUQ1370>)

10 years ago EXPLORE 170 (March 2016)

Overview of indicator mineral research at the Geological Survey of Canada - an update
(<https://doi.org/10.70499/BXDR8533>)

15 years ago EXPLORE 150 (March 2011)

Age, tectonic setting, litho-geochemistry and hydrothermal alteration of volcanogenic massive sulfide mineralization in the Chahgaz region, South Sanandaj-Sirjan zone of Iran (<https://doi.org/10.70499/KOZC4432>)

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Geochemical exploration in the former Soviet Union

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



New AAG President and Vice President for 2026–2027

Renguang Zuo, AAG President

Professor Renguang Zuo completed his Ph.D. in mathematical geosciences at the China University of Geosciences (CUG) in 2009. Professor Zuo is currently a full professor at the State Key Laboratory of Geological Processes and Mineral Resources and the Vice President of the Academic Committee of CUG.

Professor Renguang Zuo became a Fellow of the Association of Applied Geochemists (AAG) in 2016, and has held several positions within AAG, including Councillor in 2017–2018, 2019–2020, and 2022–2023, Vice President in 2024–2025, and a member of the editorial board for *Geochemistry: Exploration, Environment, Analysis* (2017– present). He was a Councillor of the International Association for Mathematical Geosciences (IAMG) (2020–2024).

Professor Renguang Zuo has received fellowship status from the Society of Economic Geologists and the Geological Society of London. He has been heavily involved in the editorial boards of several SCI-indexed journals, including *Natural Resources Research*, *Computers & Geosciences*, *Ore Geology Reviews*, *Journal of Geochemical Exploration*, *Journal of Earth Science*, and *Applied Geochemistry*.

Professor Renguang Zuo's research mainly focuses on big data analytics and machine learning-based mineral prospectivity mapping (MPM) and geochemical mapping. Professor Zuo have published over 160 peer-reviewed journal papers and 6 books and book chapters. He has been the guest editor of 8 special issues in international high-quality journals. Professor Zuo's publications have been cited more than 11,000 times with an H-index of 60 (according to Google Scholar). Professor Zuo was selected as the IAMG Distinguished Lecturer in 2025, and awarded the AAG Gold Medal in 2023. Professor Zuo also received the inaugural Kharaka Award from the International Association for GeoChemistry in 2015.



Alexander Seyfarth, AAG Vice President

Alexander Seyfarth is an X-ray spectroscopist with over 20 years of experience with XRF and XRD. Alexander holds a Diploma in Mineralogy from University Giessen (1996). Starting as an Application Scientist in Germany with Siemens, he was transferred to the US where he is now a proud citizen, still living in the Midwest (Wisconsin).

As the resident "Geoscientist" he travelled within the Americas to mine sites, cement plants, and quarries and presented application and theory-based talks at trade shows and conferences for Bruker and Thermo Fisher Scientific in various functions. With a group of other XRF trainers, he continued the XRF course from the University of Western Ontario and moved it to Hamilton College; expanding it also back to its roots in South Africa.

He is an Associated Volunteer Researcher with the Colorado School of Mines as of 2021 for direct XRF core scanning and hyperspectral imaging. Since 2017, Alexander has been back full-time in the geochemistry world as Global Technical Manager for XRF with SGS Natural Resource Division and is active in both SGS internal technical formation as well as externally with a focus on the new and smaller devices, such as PXRF and Micro Libs. His professional interest lies in research, promoting, and expanding XRF (and LIBS on solids) within the community as well as modern gamma activation analysis for gold assaying.

His focus for AAG volunteer work will be within the training and education of future geochemists as well as promoting and establishing best practices for new types of instrumentation leveraging his extensive contacts with the various instrument vendors. His experience in social media and marketing can be applied to AAG's LinkedIn outreach as well as promoting AAG on the web.



AAG Councillors

2026–2027 Councillors

John Carranza

John Carranza was exploration geologist/geochemist, Mines & Geosciences Bureau, Philippines, 1983–2001; has a Ph.D. on mineral potential mapping (TU Delft, Netherlands), 2002. He has expertise in geochemistry for mineral exploration and ore genesis research, spatial mathematics/statistics for predictive modelling of mineral resources, and remote sensing for geological/mineral exploration. John was Assistant Professor (for GIS Predictive Modeling in Geological/Mineral Exploration) at the University of Twente, Netherlands, 2003–2012; was Associate Professor (for Computational Modeling Applied to Exploration/ Mining Geology) at the James Cook University, Australia, 2013–2016; was Professor of Geological Sciences at the University of KwaZulu–Natal, South Africa, 2017–2021; is Professor of Economic Geology at the University of the Free State, South Africa, 2022– present. He has supervised to completion theses of 18 Ph.D. and 37 M.Sc. candidates, most of which were about mineral prospectivity analysis and exploration geochemistry.



John has delivered 15 invited keynote/plenary lectures at international geoscience conferences, all of which relate to either mineral prospectivity analysis or exploration geochemistry. He has delivered 40 invited special topic lectures/presentations to academe/industry/ government, all but one of which relate to mineral prospectivity analysis or exploration geochemistry. He has published more than 320 papers in international peer-reviewed geoscience journals and more than 95 papers in international conference proceedings. In 2008, he published the book *Geochemical Anomaly and Mineral Prospectivity Mapping in GIS*. He has convened 22 sessions at international geoscience conferences, all of which relate to either mineral prospectivity analysis or exploration geochemistry. He has edited 15 geoscience journal special/thematic issues, 5 on mineral exploration geochemistry, and 3 on geochemistry and the genesis of mineral deposits. He has been Editor-in-Chief of *Natural Resources Research* since 2012, was Senior Associate Editor for *Geochemistry: Exploration, Environment, Analysis* (2010–2023), and was Associate Editor of *Journal of Geochemical Exploration* (2010–2025) and *Ore Geology Reviews* (2011–2025). Per Google Scholar, he has an H-index of 87 and has been cited more than 24,500 times.

Patrice de Caritat

Patrice's university training is in geology, mineralogy and geochemistry, and his research interests include environmental, exploration and isotope geochemistry, hydrogeochemistry, low-density geochemical/mineralogical mapping, forensic chemistry, and soil microbiome research. He is an Adjunct Professor at the John de Laeter Centre, Curtin University, and Visiting Fellow at the Research School of Earth Sciences, Australian National University (ANU). He previously held senior professional positions at Geoscience Australia, the Australian Federal Police, and the Geological Survey of Norway.

Patrice has been a Fellow of the Association of Applied Geochemists (AAG) since 2005, Associate Editor for their journal *Geochemistry: Exploration, Environment, Analysis* (2017–2023), and AAG Councillor (2011–12, 2013–14, 2019–22, 2024–25) and Society News Editor for *ELEMENTS* (2011–2015). Patrice holds a Lic Sci (B.Sc. Hons) degree from the University of Louvain (Belgium) and a Ph.D. from the ANU. He has published over 200 scientific papers, reports, chapters, and books (Google Scholar H-index 49).



Behnam Sadeghi

Dr. Behnam Sadeghi is the Chief Executive Geoscientist (Data & AI) and Head of Department at Erity Pty Ltd, Australia, where he leads the development and deployment of data-driven and AI-enabled solutions for mineral exploration and resource decision-making. He holds a PhD in Geosciences from University of New South Wales and has over 18 years of experience in academia and industry, including work as a Principal Consultant Geologist. Previously, Behnam was a Research Fellow at the Australian Resource Research Centre within CSIRO, and a Fulbright Research Scholar at the Earth and Planets Laboratory of the Carnegie Institution for Science, Washington, D.C., USA. Specializing in mineral exploration with a focus on critical minerals and the energy transition, his expertise spans geochemistry (exploration, urban and environmental systems), mathematical geosciences (fractal and multifractal modeling, and compositional data analysis), geostatistics for simulation and spatial uncertainty quantification, and advanced GIS and geospatial data analytics. He is particularly recognized for integrating geological knowledge with data science and AI to deliver interpretable, decision-focused solutions. Dr. Sadeghi is a Fellow of the Association of Applied Geochemists, the Australian Institute of Geoscientists (AIG) and the Australasian Institute of Mining and Metallurgy. He is a lifetime member of the International Association for Mathematical Geosciences and a Registered Professional Geoscientist in Information Geoscience with AIG.



2026–2027 Councillors *continued from p. 31*

Martiya Sadeghi

Martiya is a senior state geologist at the Geological Survey of Sweden (SGU), with 30 years of extensive experience in applied geochemistry and geochemistry of ore deposits or ore deposit modelling. His work focuses on critical metals and minerals, including the application of artificial intelligence and numerical methods to improve mineral prospectivity mapping and advance the understanding of mineral systems.

He currently serves as Editor-in-Chief of the *Journal of Geochemical Exploration* and is a Fellow of both the Society of Economic Geologists (SEG) and the Association of Applied Geochemists (AAG). He is also a member of the EU Critical Raw Materials (CRM) Board Subgroup on Exploration and is actively involved in several international and European research projects.

Martiya has authored more than 100 papers in international peer-reviewed journals, along with several book chapters and monographs. In addition, he has produced over 100 governmental reports, maps, exploration reports, and technical presentations. His professional interests include advancing applied geochemistry as a cornerstone of mineral systems analysis, promoting methodological innovation, and strengthening the role of geochemistry in addressing global challenges related to resource security and the energy transition.



Bimin Zhang

Bimin is a geochemist with over 20 years of experience in exploration geochemistry. His career spans cutting-edge theoretical research, core technology development, and international scientific collaboration. He serves as a Professor and Doctoral Supervisor at the Institute of Geophysical and Geochemical Exploration, Chinese Academy of Geological Sciences, and holds the position of Secretary-General of the UNESCO International Centre on Global-scale Geochemistry. He is a recognized expert in the application of nanogeochemistry and deep-penetrating geochemical techniques for exploring deep-seated mineral resources. His current focus includes mineral resource exploration in covered regions, while leading the organization of the "Chemical Earth" International Big Science Program to advance global geochemical mapping and cooperation. He also integrates artificial intelligence technologies into mineral resource assessment and environmental studies.

Bimin earned his Ph.D. from the Chinese Academy of Geological Sciences and his M.Sc. from China University of Geosciences (Beijing). He is a Fellow of the Association of Applied Geochemists (AAG) and chairs the Exploration Geochemistry Committee of the Geological Society of China. Additionally, he also contributes to the academic community as an Associate Editor for several professional journals, including *Geochemistry: Exploration, Environment, Analysis* (GEEA) and *Acta Geoscientica Sinica*.



2025–2026 Councillors

Pedro Acosta-Góngora

Dr. Pedro Acosta-Góngora is a researcher with the Geological Survey of Norway. His current area of research is focused on the application of geostatistical tools to ore genesis-related, predictive mapping (mineral potential and ecological) and geochemical anomaly identification studies. Derived from this work, Dr. Acosta-Góngora was part of the team that won the prestigious Frank Arnott Award (2018) given by the Prospectors and Developers Association of Canada (PDAC).

He holds a B.Sc. in Geology from the University of Costa Rica, a M.Sc. in Mineral Engineering with emphasis in mineral exploration from the New Mexico Institute of Mining and Technology, and a Ph.D. in Earth and Atmospheric Sciences from the University of Alberta, Canada. Dr. Acosta-Góngora has worked as a member of multidisciplinary research teams across all sectors, including the mining industry, academia, and government. He has extensive fieldwork experience that includes bedrock and various types of geochemical mapping surveys at local and regional scales across several countries. His early career was oriented to study the ore genesis of different of hydrothermal (IOCG, polymetallic vein-hosted and metasomatic uranium) and magmatic (Ni-Cu-PGE) deposit types using a wide range of geochemical tools (e.g. isotopic geochemistry, fluid inclusions, and concentration of major and trace elements in minerals and rocks).

He has been a short course instructor of applied geochemistry for mineral exploration at international conferences (PDAC and SGA). The results of his scientific contributions have been presented at national and international conferences and published principally as peer-reviewed papers (e.g. *Economic Geology*, *Journal of Geochemical Exploration*), book chapters, and open file reports (Canadian and Norwegian geological surveys).



2025–2026 Councillors *continued from p. 32*

Aaron Baensch

Aaron is an executive geoscientist and technologist with 25+ years of international experience, spanning technology development, research, commercialization, global business development, strategy, investment, consulting, mining operations, mineral exploration and space. Aaron is also a strong advocate and promoter of sustainability, diversity and STEM pathways for the next generations entering the resources industry.

Aaron's passion is centred on deep engagement and collaboration with the Mining Equipment, Technology & Services (METS), Research and Space sectors. This draws on his deep domain experience in material characterization, sensors, IIoT, analytics, AI/ML, space, robotics and automation. This is combined with over a decade of direct exploration and mining operational experience. Aaron has spent the last 15+ years focusing on a wide range of technologies, including the adaption of analytical systems used by NASA on the Mars Curiosity Rover. He was also an embedded researcher and project manager at MinEx CRC and the Deep Exploration Technologies CRC where he holds several patents for novel technologies.

Professionally, Aaron is a proud graduate of the Western Australian School of Mines, Kalgoorlie (WASM) and holds a Bachelor of Science in Mineral Exploration & Mining Geology with 1st Class Honours. He is a Registered Professional Geoscientist, as well as a Fellow of the AusIMM, AIG, SEG and AAG. Aaron is also a qualified snowboard instructor and you can find him hitting up the slopes during the winter in the USA, Canada, New Zealand and Australia, as well as 4WD-ing, boating and fishing with his family and friends throughout the warmer months.



Ray Lett

Ray obtained a B.Sc. from University of London, UK, in 1968, an M.Sc. from University of Leicester, UK in 1970, and a Ph.D. from the University of British Columbia in 1979. He is a geochemical consultant and university sessional lecturer in geochemistry and economic geology at the University of Victoria, Canada. He was a laboratory supervisor and senior geochemist for the British Columbia Geological Survey between 1990 and 2010. Prior to that, he was a geochemist for Barringer Research/Magenta from 1980 to 1990 and an exploration geochemist/geologist for Amax Exploration/Fox Geological/BP Minerals in Vancouver, BC, between 1970 and 1979. Ray served as AAG Secretary from 1980 to 1985 and as a Councillor from 1990 to 1992, 1999 to 2000, 2006 to 2009, and 2015 to 2017. He has also served as a member of the AAG Education Committee between 2010 and 2022, as well as the Strategy Committee in 2016 and 2017. Ray retired after 20 years with the BC Geological Survey, and he now spends his time consulting, teaching (part-time) undergraduate university courses in geochemistry and economic geology, and serving on various geoscience committees.

With more than 50 years of experience as a geochemist, Ray has been fortunate to see the development of applied geochemistry from the fairly simple methods used in the 1960s to the more varied and complex sampling and data analysis techniques available today. He is convinced that many technological advancements can be attributed to ideas generated from the Association's international symposia, from publications in the journal *GEEA (Geochemistry: Exploration, Environment, and Analysis)* and from articles in the *EXPLORE* newsletter. True, sources of information are valuable, but people are even more important, so it is even more vital today that Members and Fellows encourage younger geoscientists to consider a career in applied geochemistry and join the Association.



Paul Morris

Paul Morris holds a BA (Geography) and a B.Sc. (Hons Geology) from the University of Otago, New Zealand and a PhD in geology from Victoria University of Wellington. He held post-doctoral research and teaching positions at the University of Sydney, and Shimane University (Japan) specializing in the geochemistry of igneous rocks and more recently regolith. In 2018, he retired from the Geological Survey of Western Australia after a career of 29 years, the last 22 years as Chief Geochemist.

Paul joined AAG (then AEG) in 1999, and has served on numerous AAG committees and AAG Council. He was AAG President from 2010–2011 and symposium co-chair for the 2005 IGES meeting in Perth, Australia. Paul was awarded the AAG Silver Medal in 2021.



continued on page 34

Support your association
BECOME A VOLUNTEER!

2025–2026 Councillors *continued from p.33*

Anna Petts

Anna graduated from the University of Melbourne, Australia in 2002 with a B.Sc. (Hons) in Geology, and commenced a Ph.D. at the University of Adelaide in 2004 with support from the Cooperative Research Centre for Landscape Environment and Mineral Exploration (CRCLEME) with Dr. Steve Hill and Lisa Worrall as her supervisors. Anna received her Ph.D. in 2009 — final title of her research project was ‘Termitaria as regolith landscape attributes and sampling media in northern Australia’.

Prior to commencing her Ph.D. studies, Anna worked as an exploration geologist with Iluka Resources (2003) in their Murray Basin Mineral Sands project; from 2008 to 2016 Anna was first an exploration geologist and then project geologist for Flinders Diamonds/Flinders Mines, primarily the Pilbara Iron Ore Project (mostly channel iron and detrital iron deposits plus hematite ore within basement) in the Hamersley Iron Province of Western Australia, plus also VHMS-style Ni and Cu exploration in the Windimurra Igneous Complex in Central Western Australia. In addition, Anna also has experience in diamond exploration in South Australia’s Nackara Arc and Flinders Ranges. She has also worked as a contract geologist with Euro Exploration Services on projects that included Prominent Hill’s IOCG exploration (then Minotaur), as well as later near mine exploration logging. Recently, her work with the Geological Survey of South Australia has included collaborating with CSIRO to undertake regional UltraFine+ soil and biogeochemical sampling and hydrogeological sampling. She has also collaborated with MinEx CRC to provide report-quality portable XRF downhole geochemistry for the National Drilling Initiative Delamerian and Northern Gawler projects.

Throughout her career, Anna has primarily been interested in the practical application of geochemical techniques to improve exploration outcomes in the field. Anna has designed and led portable XRF programs in the field and at the core library, and hopes to continue to promote sustainable and low-impact surface geochemical methods for better understanding the distribution of metals in the regolith and cover.



Strategic Plan and Committees within the AAG

AAG Council has approved the first steps (e.g. Horizons) in our strategic planning to transition AAG into the future in order to grow membership, to improve services, and to provide value to our members.

More information about the strategic plan can be found at

<https://www.youtube.com/watch?v=AbmjY07h7d4>

As part of this plan, AAG has recognized the need to divide the steps into separate activities/tasks, for which we have identified committees to carry these out. Committees are the place where the real work is done, and findings, plans, and recommendations are presented to the Council for approval by vote. The committee chairs are nominated by the president and approved by Council. Any AAG member in good standing can be part of a committee if they are willing to volunteer and invest their time and effort. It is not glorious, nor does it get you a lapel pin or special standing. However, volunteering to be part of a committee is an opportunity to have direct input into the growth of, and improvements to, the organization and be an agent for real change. If you would like to volunteer, contact the AAG Business Office at

office@appliedgeochemists.org.

Please have a look at the following committees with the respective named chair and their tasks:

Strategic Plan Committee

Chair: *Alexander Seyfarth (VP AAG)*

Members: *Ray Lett, Brian Townley, Behnam Sadeghi and the chairs of the other 6 committees*

Mandate: *After evaluation of current membership data, polling and an email survey, a proposal was presented in 2025 to the council, and from there, a set of goals and stages was approved in a special council meeting in January 2026, coinciding with a new chair appointment. This committee drives the process, but also relies on the committees below, which are essential for the plan to succeed.*

Governance Committee

Chair: *John Carranza*

Members: *Cliff Stanley, Juan Carlos Ordoñez, Behnam Sadeghi, Martiya Sadeghi, Maria Joao Batista, Yihui Xiong*

Mandate: *Review and revise the Association bylaws (last updated in 2014) with respect to functions and succession planning, review our Code of Ethics, establish a privacy policy, and create a grievance/complaint process which is not in the current bylaws. People with experience in association, management and business processes are especially valuable for this process.*

Strategic plan and committees

continued from page 34

Website Committee

Chair: *Paul Morris*

Members: *Gwendy Hall, Beth McClenaghan, Elizabeth Ambrose, Cliff Stanley, Behnam Sadeghi*

Mandate: *Select a new platform/host for public-facing and internal website, including design to enable mobile device access; enabling more interactive and media content, e.g., streaming and podcasts, as well as membership portal and service improvements. Review current content and create new content.*

Education Committee

Chair: *Aaron Bensch*

Members: *Eric Weiland, Eric Grunsky, James Kidder, Ray Lett*

Mandate: *Support the professional development of the next generation of geochemists.*

Award and Medal Committee

Chair: *Dennis Arne*

Members: *Theo Davies, Pertti Sarala, Chris Benn, Anna Petts*

Mandate: *Provide nomination and vetting for AAG awards and medals, as well as propose new award opportunities.*

Membership and Mentorship Committee

Chair: *Paul Morris*

Members: *Patrice de Caritat, Pedro Acosta-Góngora*

Mandate: *Devise services, deliverables, and features for membership and facilitate new membership acquisition and retention. Drive membership into younger demographics and expand geographic reach. Organize mentorship opportunities and pair up with early career and student members.*

Symposium, Events Show Committee

Chair: *Ryan Noble*

Members: *Alex Voinot, Aleksandra Mloszewski, Pedro Acosta-Góngora, Bimin Zhang*

Mandate: *Facilitate proposal and organization of AAG's biennial symposium (IAGS) and other events in which AAG co-sponsors or participates.*

Alexander Seyfarth

Chair, Strategic Plan Committee



Recently Published

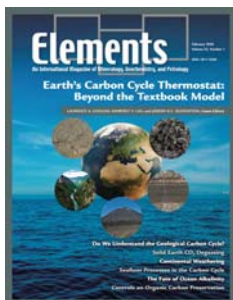
Elements

Volume 21, Number 6, December 2025

The Variscan Orogeny in Europe – Understanding Supercontinent Formation

This issue of ELEMENTS reviews the Variscan orogen, which formed during 380–300 Ma through several accretionary and collisional cycles, terminating with the formation of the Pangea supercontinent – the youngest and best-understood supercontinent on Earth.

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



Volume 22, Number 61 February 2026

Earth's Carbon Cycle Thermostat: Beyond the Textbook Model

This issue of ELEMENTS discusses many alternative or additional processes that may be similarly or more essential in controlling Earth's carbon cycle, features developments in our knowledge of controls on the long-term carbon cycle, as well as stresses the huge remaining uncertainties regarding these controls in the present and the past.

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

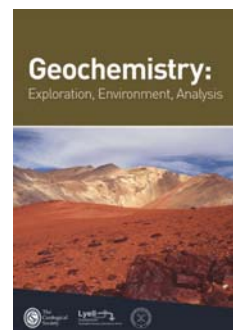
Reminder: AAG members can access past issues of Elements at
<http://elementsmagazine.org/member-login/>
 using their e-mail address and AAG member ID

John Carranza

Recently Published

Geochemistry: Exploration, Environment, Analysis

Volume 26, Issue 1, March, 2026



Research Article

Using sediment chemical fractions and multivariate statistics on water to identify sources, mobility, and bioavailability of aluminum in the Florida River near Durango, Colorado

E.L. Gray, Z.M. Shepard, J.R. Nichols, J. Kugle, J. Evangelitsi, T. Chaya and B.S. Linhoff

<https://doi.org/10.1144/geochem2025-007>

Accumulation coefficient for exploration feature selection: a tool for ranking geochemical indicators and use in prospectivity mapping

S. Ghasemzadeh, M. Yousefi and O.P. Kreuzer

<https://doi.org/10.1144/geochem2025-050>

Optimization of a ligand-based simultaneous extraction protocol for 57 soil elements using response surface methodology: applications in mineral exploration and environmental geochemistry

A.A. El Mouddeh, A. Barbouchi, B. Aznag, K. Naji, I. Benzakour | Abdelaziz Bacaoui and A. Yaacoubi

<https://doi.org/10.1144/geochem2025-055>

Advancing gold mineralization detection in northern New Brunswick through portable X-ray and micro-X-ray fluorescence spectrometry with multivariate compositional data analysis and clustering for pathfinder elements and alteration analysis

F. Mami Khalifani, D.R. Lentz and J.A. Walker

<https://doi.org/10.1144/geochem2024-058>

Monazite chemistry as an exploration tool for Cloncurry-style iron oxide–copper–gold deposits

T. Batch, C. Tiddy, A. Brotodewo, D. Giles, C. Dhnaram and V. Lisitsin

<https://doi.org/10.1144/geochem2025-021>

Modelling regional geochemistry and As–Bi–Co–Cu–Fe–Ni mineralization using G-BASE in the Lake District, UK

A. Eskdale, A. Gough, S. Johnson and M. Webb

<https://doi.org/10.1144/geochem2025-006>

Thematic Collection

Data science and geochemistry for tomorrow's resources

Applications of machine vision and machine learning for deposit characterization at the Castelo de Sonhos paleoplacer gold deposit, Brazil

M. Trott, F. Bretas, B. Bluemel, R. Lipson, D. Boyce, S. Sattarzadeh and S. Azad

<https://doi.org/10.1144/geochem2025-053>

Geochemical exploration for Au using groundwater in the deep Canadian Shield

D. Richard, S. Rafini and J. Walter

<https://doi.org/10.1144/geochem2025-005>

Thematic Collection

Biogeochemical methods in mineral exploration:

A dedication to Colin Dunn

Black spruce (*Picea mariana*) Mobile Metal Ion (MMI™) bark geochemistry case study over the Triple J gold zone, McFaulds Lake ('Ring of Fire') area, Northern Ontario, Canada

R.D. Dyer

<https://doi.org/10.1144/geochem2025-023>

Biogeochemical patterns surrounding the Sunny Corner Ag–Pb–Zn and Thackaringa cobaltiferous pyrite deposits: implications for exploration

E.J. Cohen, J. Vohra, K. Ostowari, I.T. Graham, N.F. Rutherford and D.R. Cohen

<https://doi.org/10.1144/geochem2025-025>

GEEA NEWS

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.

Dr Cassady Harraden

University of British Columbia
434 Dunbar Street
Vancouver, British Columbia
Canada V6S 2G2
Membership #4602

Allen Ronk

3 Jamieson Street
Pemberton, WA 6260
Australia
Membership #4609

Dr Alexandre Voinot

Geological Survey of Canada
Natural Resources Canada
601 Booth Street
Ottawa, Ontario
Canada K1A 0E8
Membership #4604

Dr Niall Groome

Mineral Resource Geochemist
Earth AI
G4/48 Cooper Street,
Strathfield, NSW 2135
Australia
Membership #4605

Martin McCurdy

Exploration Geochemist (retired)
160 Aylmer Avenue
Ottawa, Ontario
Canada K1S 2Y4
Membership #4606

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.



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.

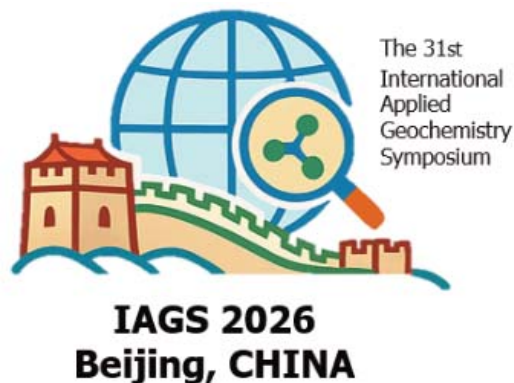
Nominations for either medal can be made any time to arne.dennis@gmail.com and will be considered in the year of the nomination provided they are received prior to December 1.

Dennis Arne
AAG Past President
Chair, Awards and Medals Committee



31st International Applied Geochemistry Symposium (IAGS 2026)

The Local Organizing Committee (LOC) and the Association of Applied Geochemists (AAG) look forward to welcoming you to the 31st International Applied Geochemistry Symposium (IAGS 2026), Beijing, China. This conference has the theme “Data-driven geochemical data mining in support of mineral exploration and environmental studies”. The symposium will showcase recent advances in data analytics, machine learning, and geochemical interpretation that are transforming the fields of mineral exploration and environmental geoscience. Join us in Beijing to share, learn, and collaborate on the latest scientific and technological developments in applied geochemistry.



Aim of IAGS 2026

IAGS 2026 will highlight the transformative role of data science in applied geochemistry, emphasizing the use of advanced analytical and computational tools to unlock new insights from geochemical data. We aim to foster cross-disciplinary exchange and practical applications to address current challenges in exploration, environmental protection, and sustainable resource development.

Dates to remember

IAGS2026 will formally commence on September 12th and run through September 16th for the Scientific Program at the Geosciences International Conference Centre, CUGB. The 12th and 15th of September will not have scheduled Scientific Program events to make room for tours and workshops.

Wednesday April 15, 2026	Abstracts Close
Friday May 15, 2026	Program Announced Including Workshops & Field Trips
Monday May 18, 2026	Early Bird Registrations Open
Friday July 31, 2026	Early Bird Registrations Close/Full Price Opens
Saturday September 12, 2026	Symposium Begins

Conference fees

The IAGS and AAG will provide membership registration for IAMG members. Students and participants from some developing countries will be able to apply for a bursary to support travel to IAGS 2026. Please check the conference website regularly for application details.

TICKET TYPE	EARLY BIRD		STANDARD	
	Member	Non-Member	Member	Non-Member
All inclusive	650	800	700	900
Sponsor / Exhibitor	450	450	450	450
Symposium	550	750	600	800
Student	250	250	300	300
Gala Dinner	100	100	100	100
N.B. Price is in USD				

All Inclusive registration:

Includes 3-day conference and gala dinner

Sponsor/Exhibitor registration:

3-day conference only

Symposium registration:

3-day conference only

Student registration:

3-day conference only

Gala Dinner registration:

Dinner only

Visa information

If you are planning on attending IAGS 2026 from overseas, please consider the various options before going through the registration phase. China has some restrictive immigration laws, and we don't want you to get stuck if you are considering a visit to China to attend the conference.

The visa that you will have to apply for depends on your passport. We have provided the following link, but please make sure you read the information thoroughly before starting the process of your visa application.

<https://www.visaforchina.cn/> or <https://cs.mfa.gov.cn/wgrlh/lhqz/lhqzjjs/>

Good luck with this process, and make sure you are aware of the visa processing time, to make sure it's finalized before the conference.

Latest Updates

If you would like regular information, and all the latest updates for IAGS 2026, please sign up for our mailing list by clicking the following link <https://forms.gle/px9KHJ7EKpG5xiBr8>

31st International Applied Geochemistry Symposium (IAGS 2026) *continued from p. 38*

Call for Abstracts

The 31st International Applied Geochemistry Symposium (IAGS 2026) will be held in **Beijing, China**, from **September 12 to 16, 2026**. Since its inception, IAGS has been dedicated to advancing applied research and technological innovation in geochemistry, with broad applications in mineral exploration, environmental monitoring, GeoHealth, and sustainable resource development.



Conference Theme

Data-driven geochemical data mining in support of mineral exploration and environmental studies

Abstract Submission Information

- Abstract Submission Opens: *March 15, 2026 (anticipated)*
- Online Abstract Submission Portal:
<https://iags2026.cugb.edu.cn/AbstractSubmission/CallforAbstracts/index.htm>

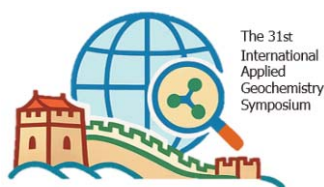
Researchers are warmly invited to submit abstracts aligned with the conference theme or the special sessions listed below.

Sessions

- 1. AI-driven Geochemical Anomaly Mapping**
 Convenors: *Emmanuel John Carranza, Renguang Zuo, Martiya Sadeghi*
- 2. Gold Mineralization Processes and Geochemical Exploration Techniques**
 Convenors: *Qingfei Wang, Qihai Shu, Lin Yang*
- 3. Geochemical Information on Elemental Data and GeoHealth**
 Convenors: *Qingjie Gong, Dawen Liu, Weixuan Fang*
- 4. A Decadal (2015–2025) View of Trends and Issues in Applied Geochemistry Research in Africa**
 Convenors: *Theophilus Clavell Davies, Alfred M. Msomi, K'tso Nghargbu, Akobundu Amadi*
- 5. Predictive Geochemistry for Mineral Exploration: Machine Learning and Multisource Data Integration**
 Convenors: *Pedro Acosta-Góngora, Behnam Sadeghi, Wenlei Wang, Martiya Sadeghi*
- 6. Pre-Analysis Treatment of Geochemical Data: Understanding Data Character and Constraints Before Analysis**
 Convenor: *Cliff Stanley*
- 7. Mesozoic Mineralization in Eastern China**
 Convenors: *Li Tang, Kunfeng Qiu, Hao Zou, Wenbo Li, Xinfu Zhao, Qihai Shu, Haidong Zhang, Haocheng Yu, Huawen Cao*
- 8. Nutrients and Contaminants in Soils and Soil Health Implications**
 Convenors: *Min Peng, Tao Yu, Dong-Xing Guan, Chunlei Huang, Xu Liu*
- 9. Exploration Geochemistry of Strategic Non-metallic Minerals**
 Convenors: *Hao Zou, Chunlian Wang, Qihai Shu, Haoyang Zhou, Pengqiang Shang, Huawen Cao, Qiuming Pei*
- 10. Geochemical Tracing Mechanisms of Uranium Deposits and Application Examples**
 Convenors: *Hao Song, Chunying Guo, Yinhang Cheng, Jun Zhong, Zhaobin Yan, Zenghua Li, Hui Rong, Hu Huang, Jincheng Luo, Shuiyuan Yang*
- 11. Digital Chemical Earth: Big Data and AI Enabling New Insights into Resources and the Environment**
 Convenors: *Bimin Zhang, Xueqiu Wang, David Cohen, Anna Ladenberger, Chaosheng Zhang, Zimeng Wang, Bingli Liu*
- 12. Rare Earth Element Geochemical Exploration**
 Convenors: *Xueqiu Wang, Jian Zhou, Yan Liu, Binfeng Chen*
- 13. Advances in Compositional Data Analysis: Theory and Applications in Geochemistry**
 Convenors: *Yue Liu, Shuyun Xie, Martiya Sadeghi, John Carranza, Qinglin Xia, Daojun Zhang*
- 14. Geochemistry and GeoHealth**
 Convenors: *Dawen Liu, Emmanuel Arhin, Qingjie Gong, Weixuan Fang, Qifeng Tang, Siwen Liu, Taotao Yan, Tao Yu, Qingye Hou, Futian Liu*
- 15. Geochemistry and Ecological Restoration**
 Convenors: *Tingning Zhao, Fangbai Li, Zhongke Bai, Xiaodong Ji, Longlong Zhang, Yuanying Huang*
- 16. Geoanalysis and Geochemical Mapping**
 Convenors: *Jianbo Shi, Wengeng Cao, Shengfeng Ma, Jinfeng Bai, Feng Guo, Yi Huang, Xuelin Dong*

31st International Applied Geochemistry Symposium (IAGS 2026)*continued from p. 39***17. Methods Development in Geochemical Mapping Towards More Efficient Mineral Exploration**Convenors: *Pertti Sarala, Martiya Sadeghi, Chaosheng Zhang, Bimin Zhang, Anna Ladenberger***18. Advanced Integration of Data–Mathematics–Computation and Intelligent Prediction of Extreme Geological Events (Workshop)**Convenors: *Qiuming Cheng, Fan Xiao, Alik Ismail-Zadeh, Emmanuel John Carranza, Shaun Lovejoy***19. Using pXRF (Workshop)**Convenor: *Alexander Seyfarth*

On behalf of the Local Organising Committee (LOC), we warmly invite researchers, industry professionals, and students worldwide to participate in IAGS 2026. We look forward to welcoming the global applied geochemistry community to Beijing for an engaging and forward-looking symposium.



IAGS 2026
Beijing, CHINA

If you have any questions, please contact:

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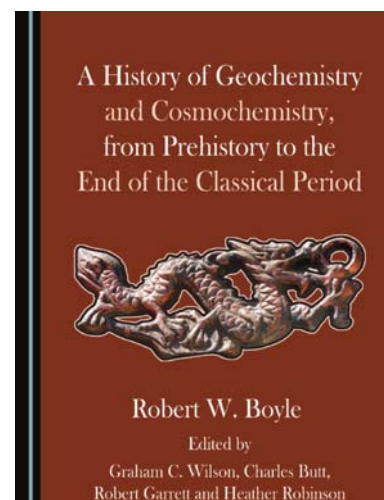


A History of Geochemistry and Cosmochemistry, from Prehistory to the End of the Classical Period

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:

<https://www.cambridgescholars.com/product/978-1-5275-7614-8>

Free Publications Available from the Association of Applied Geochemists' Website

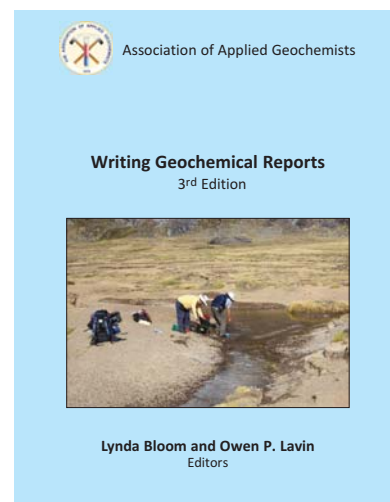
Writing Geochemical Reports, 3rd Edition Guidelines for surficial geochemical surveys Edited by Lynda Bloom and Owen Lavin

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>



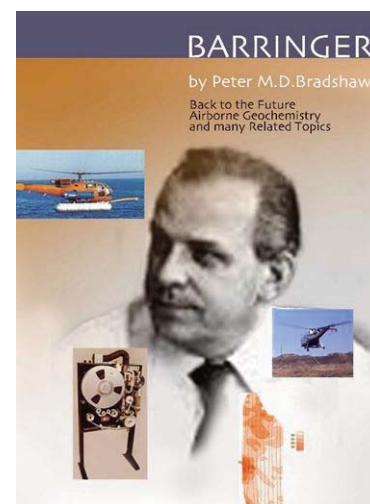
Barringer Back to the Future: Airborne Geochemistry and many Related Topics by Peter M.D. Bradshaw

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 lonscan, 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

- 16–20 March The 57th Lunar and Planetary Science Conference (LPSC). Woodlands Waterway Marriott Hotel, The Woodlands, Texas, USA. <https://www.hou.usra.edu/meetings/lpsc2026/>
- 23–26 March 7th workshop on Electron probe micro-analysis. Athens, Greece. <https://sites.google.com/view/epma-athens2026>
- 26–27 March 16th International Association on the Genesis of Ore Deposits (IAGOD) Quadrennial Symposium. Porto, Portugal. <https://iagod2026.inporto.events/>
- 26–27 March Geological Society of Namibia, Uranium back to the Future. Swakopmund, Namibia. <https://geolsoenamibia.org/uranium-conference-2026/>
- 14–15 April Kamloops Exploration Group (KEG) Conference. Kamloops, British Columbia, Canada. <https://www.keg.bc.ca/conference/>
- 30 April–May 1 International Conference on Geochemistry and Isotope Geology (ICGIG). Vancouver, Canada. <https://internationalconferencealerts.com/eventdetails.php?id=100211141>
- 24–29 May Gordon Research Conference, Geochemistry of Mineral Deposits. Avinguda de l'Hotel Castelldefels, Barcelona, Spain. www.grc.org/geochemistry-of-mineral-deposits-conference/2026/
- 26–28 May Geological Association of Canada (GAC®) Mineralogical Association of Canada (MAC) Annual Meeting. St. John's, Newfoundland and Labrador, Canada. <https://gac.ca/events/gac-mac-annual-meeting/>
- 12–17 July Goldschmidt 2026 Conference. Montréal, Québec, Canada. <https://conf.goldschmidt.info/goldschmidt/2026/goldschmidt/2026/meetingapp.cgi>
- 23–24 July 5th International Congress on Earth and Geological Sciences. Vienna, Austria. <https://unitedresearchforum.com/geology-earthscience/>
- 2–7 August Gordon Research Conference, Organic Geochemistry, Holderness School, Holderness, New Hampshire, USA. Website: <https://www.grc.org/organic-geochemistry-conference/2026/>
- 30 August – 2 September 16th Quadrennial IAGOD (International Association on the Genesis of Ore Deposits) symposium. Porto, Portugal. Website: <https://iagod.org/>
- 12–16 September **31st International Applied Geochemistry Symposium. Beijing, China. <https://iags2026.cugb.edu.cn>**
- 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>
- 11–14 October Geological Society of America, Annual Meeting. Denver, Colorado, USA. https://www.geosociety.org/GSA/GSA/Events/Annual_Meeting.aspx

2027

- 25–28 January Association of Mining and Mineral Exploration BC (AMEBC) Cordilleran Round Up 2027 Convention. Vancouver, British Columbia, Canada. <https://www.roundup.amebc.ca>
- 6–10 June 19th EMAS European workshop, 2027: Modern development and applications in microbeam analysis. Lausanne, Switzerland. www.microbeamanalysis.eu/
- 11–16 July Goldschmidt Conference 2027. Paris, France. <https://www.geochemsoc.org/events/goldschmidtconference/>
- 17–20 October Geological Society of America Annual Meeting. Montréal, Québec, Canada. <https://www.geosociety.org/GSA/Events/>



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**:

Beth McClenaghan

Email: bethmcclenaghan@sympatico.ca

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