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Lithogeochemical classification of hydrothermally altered Paleoproterozoic plutonic rocks associated with gold mineralization: examples from the Nanortalik Gold Belt of South Greenland and the "Gold Line" of northern Sweden

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Introduction

There is an ongoing debate on the role of various intrusive rocks in the formation of orogenic gold and intrusion-related gold deposits (e.g. Goldfarb & Groves 2015). To classify a deposit and aid in exploration, the genetic relationship between gold mineralization and the local host rock (or a nearby intrusive rock) needs to be established. Here, we use lithogeochemistry of immobile elements to investigate the relationship between gold mineralization in Sweden and Greenland and spatially related intrusive rocks. Lithogeochemical techniques using immobile elements are widely described in the literature and have been successfully applied in mineral exploration for the classification of variably hydrothermally altered host rocks and for advanced chemostratigraphy (e.g. Barrett & McLean 1994). Although lithogeochemical rock classification is well established for the volcanic rocks series of basalt-andesite-dacite-rhyodacite-rhyolite, including those which have experienced intense alteration (Barrett & McLean 1994), suitable rock classification diagrams for altered plutonic rocks, particularly granitoids, are lacking, with the literature heavily biased towards the least altered examples. Rock classification diagrams based on major oxides (e.g. Debon & Le Fort 1982; De la Roche *et al.* 1980) are useful for unaltered rocks, however are inappropriate for altered rocks due to the mobility of major elements during alteration. For example, during alteration K, Na, Ca, Si, Fe, and Mg have been shown to be mobile due to metasomatism as demonstrated by Barrett & McLean (1994) in various case studies mainly from volcanic-hosted massive sulfide deposits (VMS). Other deposit classes such as iron oxide copper-gold (IOCG) are characterized by even stronger element mobility (e.g. Montreuil *et al.* 2013). In this contribution, we discuss how rock classification diagrams based on major elements are unsuitable for hydrothermally altered rocks and suggest more appropriate diagrams based on immobile elements. Here we present an example of classification of altered granitoid rocks and diorite that occur in the gold provinces of northern Sweden and south Greenland, spatially associated with gold mineralization ("Gold Line", Sweden; Nanortalik Gold Belt, South Greenland).

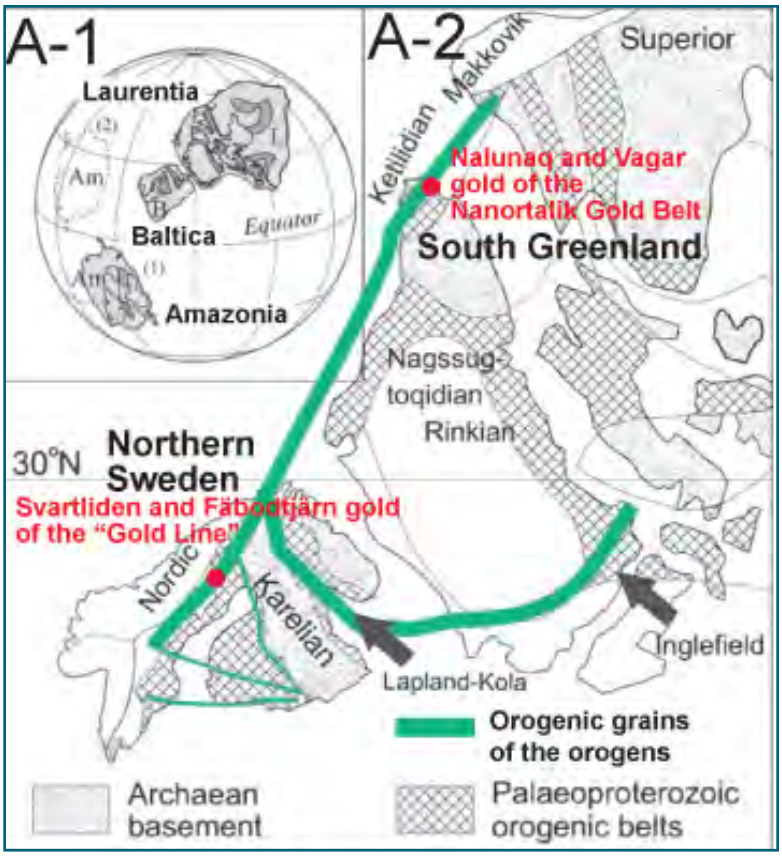

Figure 1. (A-1) Reconstruction of the position of Laurentia, Baltica and Amazonia at about 1.83 Ga. (A-2) The gold occurrences of the Nanortalik Gold Belt in South Greenland and the "Gold Line" in northern Sweden are both located on the orogenic grain of the Norden and Ketilidian orogens (modified after Lahtinen et al. 2008).

Location and geology of the "Gold Line" and the Nanortalik Gold Belt and timing of the gold introduction

The reconstruction of the Laurentia, Baltica and Amazonia continents at about 1.83 Ga (Fig. 1A-1) by Lahtinen et al. (2008) shows that the "Gold Line" is located on the Baltica continent and the Nanortalik Gold Belt is part of the Laurentia continent. Figure 1A-1 also shows the correlation of Paleoproterozoic orogens in Greenland and Fennoscandia and that the gold deposits of the "Gold Line" are part of the orogenic units of the Nordic orogeny (Fig. 1A-2, Fig. 1B) whereas the Nanortalik Gold Belt is part of the Ketilidan orogeny (Fig. 1A-2, Fig. 1C, D).

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EXPLORE

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

Welcome to the third **EXPLORE** issue of 2018. Issue No. 180 includes one technical article that describes lithogeochemical classification of hydrothermally altered Paleoproterozoic plutonic rocks associated with gold mineralization in Greenland and Sweden. It was written by Denis M. Schlatter, Katerina Schlöglova, Réginald Fettweis, Glenn Bark, and Joshua W. Hughes. This issue also includes a summary of the RFG conference in Vancouver in the President's letter and the AAG Medal winners for 2016 and 2017.

EXPLORE thanks all those who contributed to the writing and/or editing of this issue: Steve Amor, Dennis Arne, Al Arsenault, Glenn Bark, Steve Cook, Réginald Fettweis, Joshua Hughes, Chris Lawley, David Leng, Madhu, Raghav, Denis Schlatter, Katerina Schlöglova, Dave Smith, Pim van Geffen, and Peter Winterburn.

Beth McClenaghan
Editor

President's Message

As I write this, it has now been a month since the wrap-up of our 28th IAGS (International Applied Geochemistry Symposium) in Vancouver, Canada as part of the Resources for Future Generations (RFG 2018) conference. This symposium was the first return of the IAGS to Vancouver since the very successful 19th IAGS in 1999, and now – as then – the weather cooperated wonderfully for visitors to the city. The days were warm and sunny, and the venue at the Vancouver Convention Centre was spectacular. The many hours put into the event organizing by the AAG's Local Organizing Committee, headed by Peter Winterburn of MDRU-UBC, paid off with an excellent slate of technical sessions and short courses. The geochemical contributions to the success of RFG 2018 were substantial given the relatively modest membership of our Association. In addition to Peter, the Local Organizing Committee notably included John Gravel, Pim van Geffen, Jamil Sader, John Barr, Chris Benn, and Britt Bluemel, and I would like to take this opportunity to thank them for their hard work in making this meeting successful. I would also like to thank Gwendy Hall and Cliff Stanley for staffing the AAG booth at the conference, helping to publicize the Association to prospective members, as well as providing a venue to sell and distribute AAG publications.

I would like to make special mention of a couple of important AAG events that took place at the 28th IAGS, namely our Gala Dinner and the Annual General Meeting (AGM) of the Association. The Gala Dinner has been a tradition of our symposia since as long as I can remember, and we were particularly fortunate on this evening to hold the dinner in the unique setting of the Vancouver Aquarium in Stanley Park. We kicked off the evening with an aquatic show in the Aquarium Pool before I, as AAG President, had the privilege of presenting the Medals of the Association to three honoured recipients in front of the membership gathered around the pool. I did not realize until after my speech that I was competing with a playful dolphin for attention! Afterwards we gathered for an excellent dinner with our friends and colleagues in the Aquarium exhibit halls. It seemed that the most popular entrée was – what else? – the salmon. A special mention goes out to our sponsors, whose generosity made the Gala Dinner possible. Thank you to our two Gold Sponsors, SGS Minerals and OREAS, and to our bus transportation sponsor, Bureau Veritas Labs.

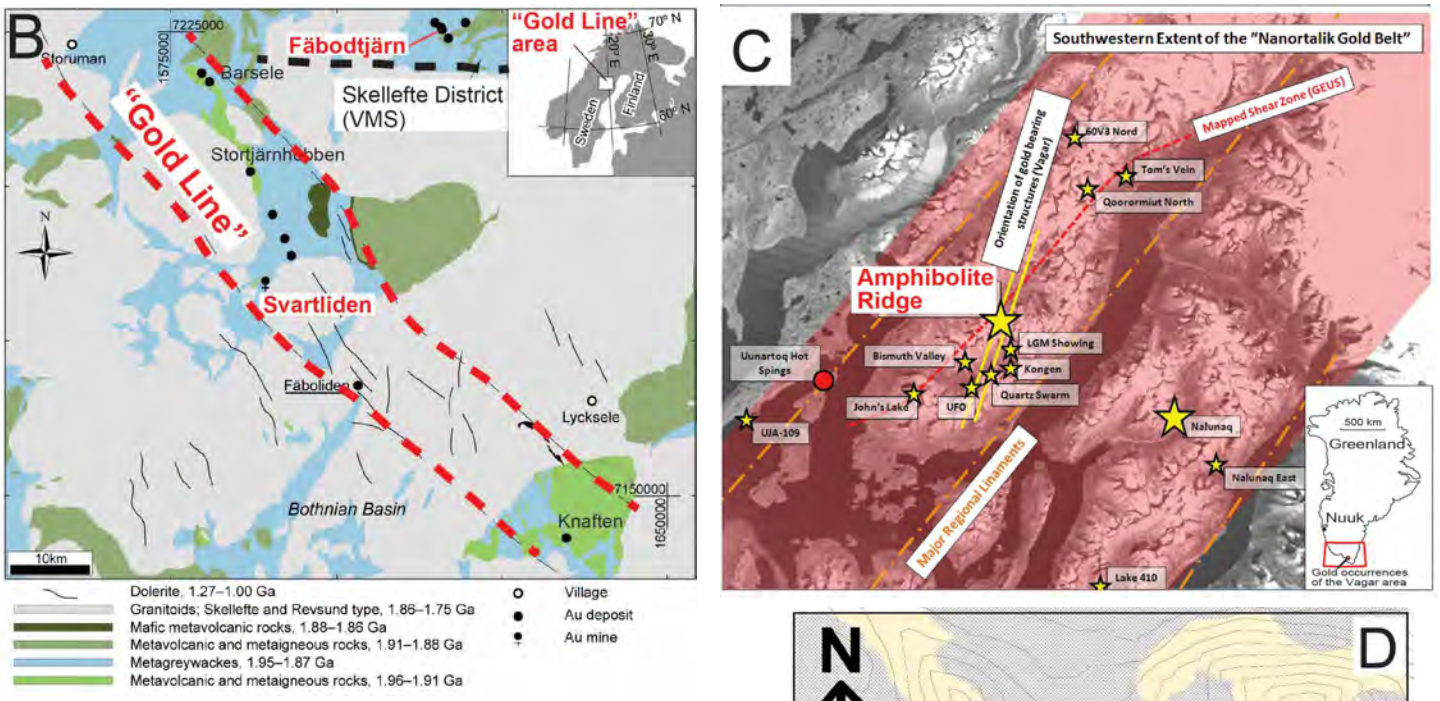
The highlight of the Gala Dinner was, as always, the presentation of the Medals of the Association for scientific achievement and service. Three medals were awarded: a Gold Medal for each of 2016 and 2017, and a Silver Medal for 2016. The Gold Medal is awarded for outstanding scientific contributions and achievement in applied geochemistry. It is the highest award given by the Association of Applied Geochemists. The Silver Medal is awarded in recognition of dedicated service to the Association. All medal nominations are reviewed by the Awards & Medals Committee, which is chaired by the AAG's Past-President. The 2016 Silver Medal was awarded to Dr. David Cohen, of the University of New South Wales, for his long-standing and dedicated service to the AAG. The 2016 Gold Medal was awarded to Professor Reijo Salminen, Geological Survey of Finland (retired), and the 2017 Gold Medal was awarded to Stu Averill, the founder of Overburden Drilling Management Ltd. in Ottawa, Canada. Both David Cohen and Stu Averill were at the dinner to receive their medals in person. Prof. Salminen was unable to make the trip to Vancouver, and his Gold Medal was accepted by his colleague Pertti Sarala, regional councilor for northern Europe, who will present it to him in Finland at a later date on behalf of the AAG. Full citations outlining the many accomplishments of each of our medalists are published elsewhere in this **EXPLORE** issue. I remind all our readers that AAG Medal nominations for 2018 are open, and I encourage you to submit nominations of deserving individuals to the committee for consideration.

Finally, I will also make a few brief comments about our AGM, which was held at the Vancouver Convention Centre during the RFG conference. As AGMs are generally conducted by conference call in those years when no IAGS is held, this was the first face-to-face AGM since the 2015 IAGS in Tucson. The minutes of the AGM, including my Presidents Report, are published elsewhere in this issue so I will not repeat them here. A highlight of the AGM was the presentation by Brian Townley on the draft proposal to hold the 29th IAGS at Vina del Mar, Chile in 2020. Following the completion of official business, the forum was opened to all attending members and we had a good discussion on the problem of declining membership and what steps we might take to counter it. You will be hearing more about this issue and some potential solutions to it over the months to come.

Stephen Cook, *President*

Lithogeochemical classification of hydrothermally altered Paleoproterozoic… *continued from page 1*

Figure 1: (B) Geological map of northern Sweden and location of the Svartliden gold mine and gold occurrences on the "Gold Line," modified after Bark (2008), Bark and Weihed (2012). (C) Location map showing in pinkish pattern the gold occurrences of the Nanortalik Gold Belt in South Greenland (yellow stars); the map also shows the main structural features (modified after Schlatter et al. 2017). (D) Geological map of the Amphibolite ridge area, the gold occurrences of Vein 1 and Vein 2 are indicated by arrows (Geodetic reference: WGS84, Projection: UTM 23N, Contour interval: 50 m. Upper left corner UTM coordinates: Northing: 6711000; Easting Easting: 497500; lower right UTM coordinates:, Northing: 6716000, Easting 500500, map from NunaMinerals A/S, 2013, in Bradley (2013).



The "Gold Line" is ca. 150 km long and 40 km wide NW-SE trending corridor, originally defined by till samples that contained elevated gold contents (Bark & Weihed 2007). The Svartliden gold deposit is located in this corridor whereas the Fäbodtjärn gold occurrence is located at the western margin of the Skellefte District located about 30 km east of the intersection of the "Gold Line" and the NW-SE trending western part of the VMS belt of the Skellefte District in the Vindelgransele area (Sundblad 2003; Allen *et al.* 1996). The geology of the "Gold Line" is dominated by granitoids and diorite of various types and ages, metavolcanic rocks and metagraywackes. Later unmineralized dolerite dykes have intruded the Paleoproterozoic rocks at about 1.26 Ga (Söderlund *et al.* 2006, Figure 1B) providing a time constraint for gold mineralization. The gold mineralization at Svartliden is hosted at the contact between metavolcanic rocks (amphibolite) and graphite-bearing metasedimentary rocks – in thin discontinuous slivers of banded iron formation and arsenopyrite-rich units with calc-silicate alteration (Fig. 2C). The gold lodes at Svartliden are related to second order regional shear structures and the mine sequence is cross-cut by a granite remobilizing the gold (Fig. 2C, Schlöglova *et al.* 2013). Other granites that occur regionally in the Svartliden area are of the Revsund and the Skellefte-Härnö type (Fig. 2B) (Andersson 2012; Billström & Weihed 1996, Schlöglova *et al.* 2013). The gold in Fäbodtjärn is located in a narrow quartz vein, hosted in a sequence of turbiditic greywackes and pelitic sedimentary rocks, spatially close to a diorite intrusion that is also gold mineralized (Öhlander & Markkula 1994; Fettweis 2015) and metamorphosed to greenschist facies (Fig. 2B).

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The Nanortalik Gold Belt in South Greenland is >150 km long and 40 km wide NE-SW trending corridor of gold occurrences and of stream sediments with elevated gold contents that range between 47 and 850 ppb (Steenfelt *et al.* 2016), corresponding to the southern margin of the Julianehåb Igneous Complex. The rocks of the Nanortalik Gold Belt are dominated by Paleoproterozoic granite and granodiorite, diorite, gabbro, metasedimentary and metavolcanic rocks and lesser dolerite, metamorphosed to amphibolite facies (Figs. 1C+D). The plutonic rocks of the Vagar host auriferous quartz veins and are spatially and possibly genetically associated with the gold mineralization (Schlatter *et al.* 2013, 2016). In the "Amphibolite Ridge" area (Figs. 1C+D, Schlatter *et al.* 2018), which is part of the Vagar exploration license, gold is located in quartz Vein 1 which is hosted in granodiorite, whereas the auriferous quartz Vein 2 is located at the lithological contact between diorite and granite (Figs. 1D and 2A). The drill hole profile (Fig. 2A) shows that gold not only occurs in the sheared quartz veins, but large portions of the host granitoid and diorite is also gold-mineralized. These intrusive bodies at Vagar are interpreted to have intruded as relatively shallow bodies based on the field observation of magmatic stoping at the locus of the pluton roof zone (Schlatter *et al.* 2013).

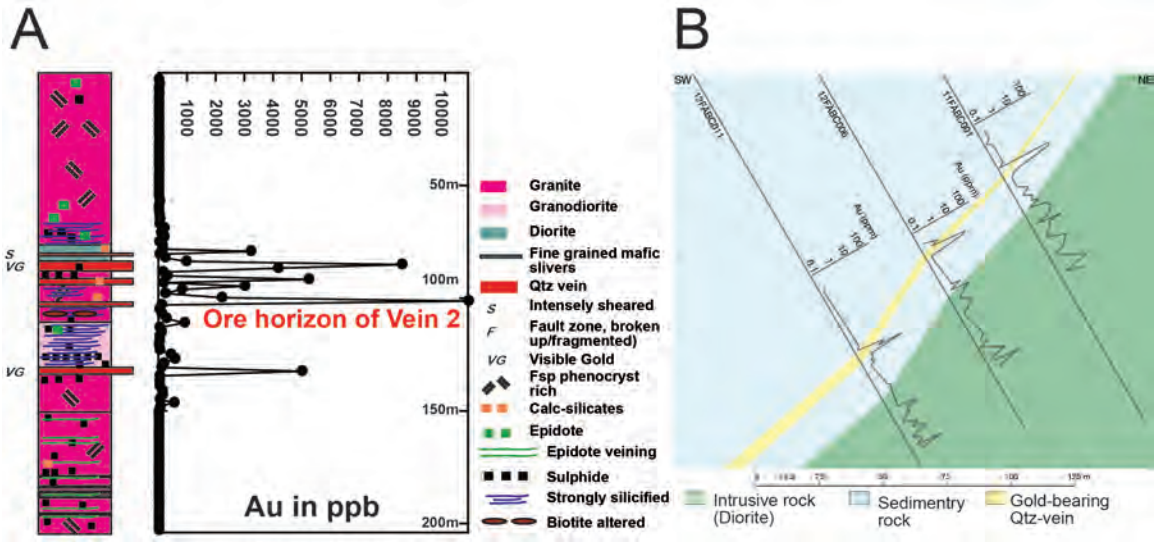

Fig. 2. (A) Tectonostratigraphic column based on drill core log across the ore horizon of the "Vein 2" target on Vagar (modified from Schlatter et al. 2013). Gold assayed by Actlabs. (B) Geological cross section of the Fäbodtjärn gold occurrence of the "Gold Line" area in northern Sweden (modified from Fettweis 2015, Fettweis & Bark 2017).

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The presence of granitoids and diorite, spatially associated with the gold is ubiquitous at Vagar, Svartliden and Fäbodtjärn. Although the gold mineralizing event of all these areas were not directly dated and such age determination remains to be carried out; at Svartliden the crosscutting and unmineralized granite yielded an age of 1.8 Ga (Persson 2011, Schlöglova *et al*. 2013). Therefore the gold mineralization at Svartliden must be older than 1.8 Ga (Figs. 2C, 3) and ore forming events of the VMS deposit of the Skellefte District (Fig. 1B) are dated at 1.9 to 1.87 Ga (Allen et al. 1996). It is conceivable that the VMS in northern Sweden were formed in a back-arc basin in an extensional setting, followed by a compressional regime in which the orogenic gold mineralization formed (Allen *et al.* 2002; see figure 2 of Allen et al. 2002)

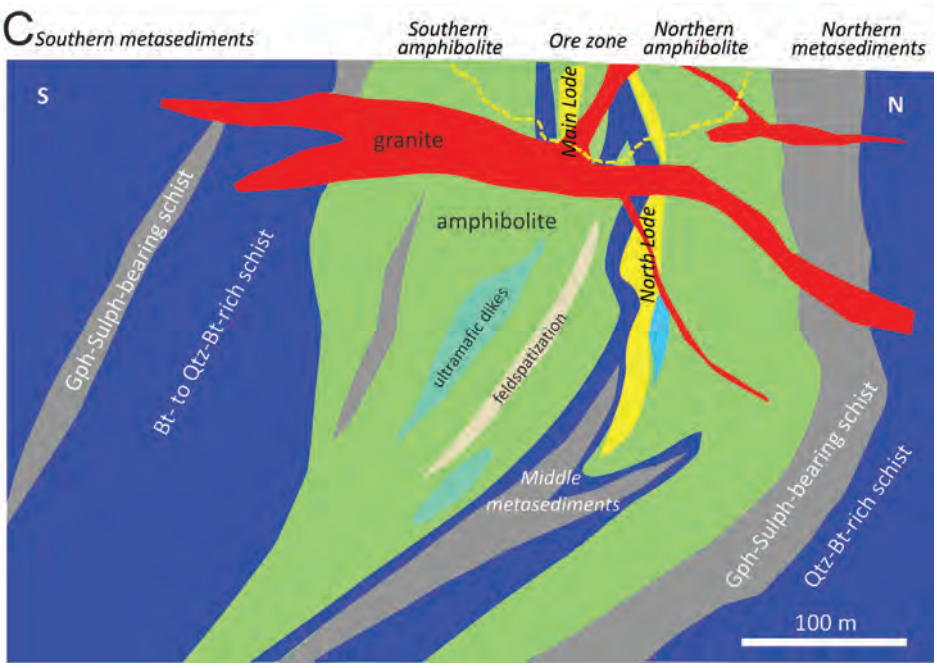

Figure 2: (C) Geological cross section of the Svartliden gold deposit of the "Gold Line" in northern Sweden (modified from Schlöglova et al. 2013).

In South Greenland, gold mineralization within the Nalunaq deposit, which produced 10.65 tonnes (375'600 oz) gold during its nine-year mine life, was directly dated at 1.783 to 1.762 Ga (Bell *et al.* 2017). The age was determined by bracketing the ages of a hydrothermal alteration preceding the gold mineralization and a pegmatite that cross cuts the gold mineralization. The granitoids and diorite that host the Vagar gold occurrences were dated at 1.85 to 1.83 Ga (Steenfelt et al. 2016). In South Greenland to date, no VMS deposits have been found, perhaps reflecting the extensive level of erosion compared to that of northern Sweden. The temporal relation between intrusive rocks and mineralizing events is provided in Figure 3; for more details, see references therein.

Sample collection, analysis and combination of data

The samples from Svartliden were collected for a M.Sc. thesis completed at the Luleå University of Technology (LTU) in Sweden (Andersson 2012) and five samples are from the collections of Dragon Mining Sweden AB (Schlöglova et al. 2013). The samples from Fäbodtjärn were collected during a M.Sc. thesis at the LTU (Fettweis 2015). The samples from the Amphibolite ridge area are from exploration carried out in the Vagar exploration license by the national and partially state-owned mineral exploration company of Greenland, NunaMinerals A/S and their consultants, Helvetica Exploration Services GmbH during field work in 2012 (Schlatter *et al*. 2013; note NunaMinerals A/S was dissolved in 2016). For this study, 47 samples from Vagar were analyzed by code "4Lithoresearch and 4BINAA" using Fusion ICP and ICP/MS for the major elements, trace elements and rare earth elements and gold on 30 g by INAA by the Activation Laboratories (Actlabs) Ltd. (Schlatter et al. 2013). Samples from Svartliden, 35 in number, were analyzed by ALS Chemex Labs Ltd. according to a multi-element characterization package + Au on a 50 g sample, using ICP-AES and LECO combustion analysis and ICP-MS (Andersson 2012; Schlöglova *et al.* 2013). From Fäbodtjärn 12 samples were analyzed by Acme Analytical Laboratories Ltd. where major oxides were quantified by lithium borate fusion with ICP-ES, while refractory and rare earth elements were reported by lithium borate fusion with ICP-MS. Precious met-

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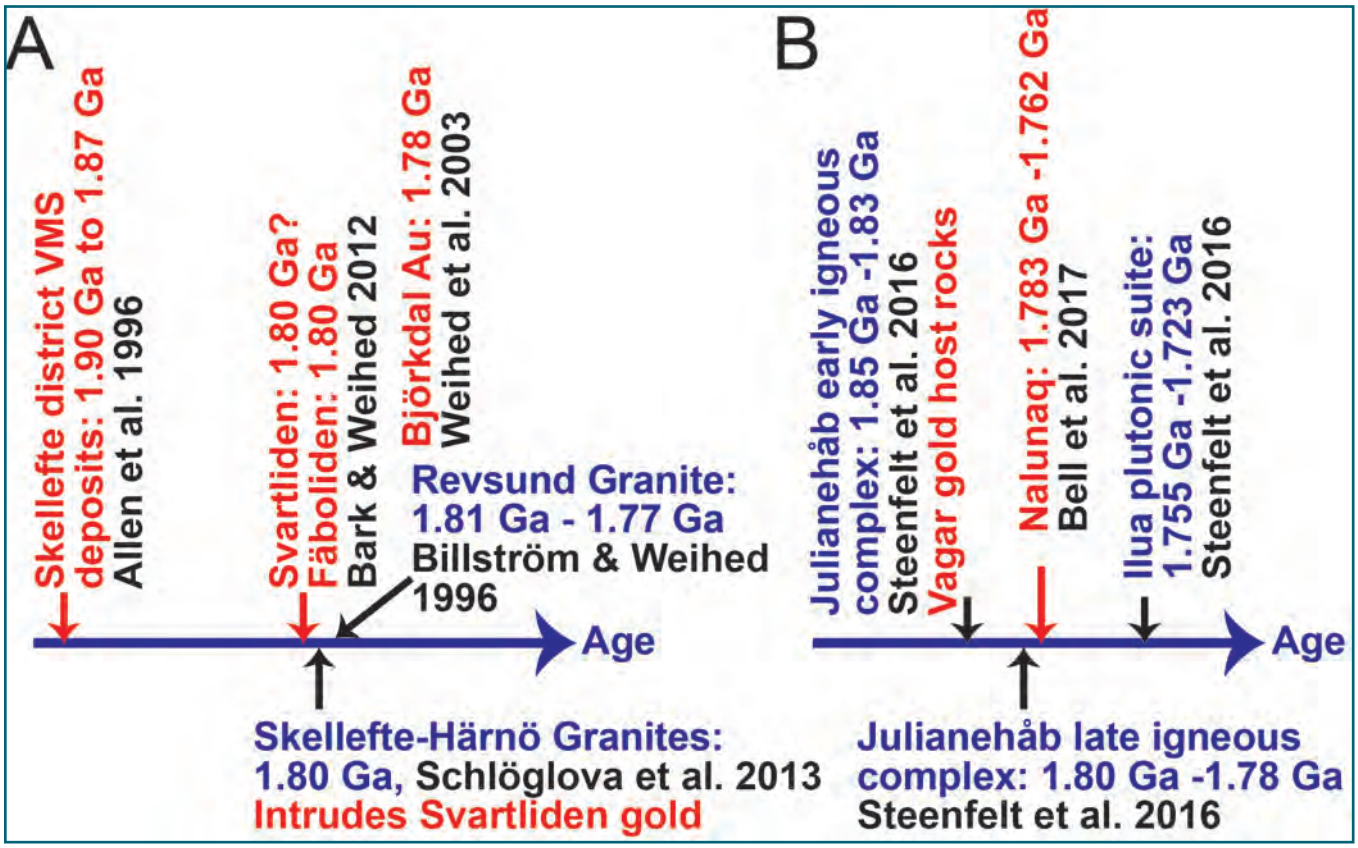

Figure 3. Timing of events of gold introduction and timing of plutonic events in (A) northern Sweden, and (B) in South Greenland (modified from Schlatter et al. 2016).

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als on 0.5 g samples and base metals were leached in hot modified aqua regia and analyzed by either ICP-ES or ICP-MS (Fettweis 2015). The data for the 94 samples from northern Sweden and South Greenland were combined (Schlatter *et al*. 2017), interpreted and plotted using the commercial software IgPet (Rock Ware, https://www.rockware.com).

Geochemical classification based on major oxides and immobile elements

The granitoid and diorite samples from all three areas (Fig. 4) were separated into samples containing less than or equal 10 ppb gold, and those greater than 10 ppb gold. Samples containing less than or equal 10 ppb gold comprise the least altered samples with gold contents similar to the crustal average and the samples that contain greater than 10 ppb gold represent hydrothermally altered samples that have interacted significantly with gold-bearing hydrothermal fluids and correspond to moderately to strongly altered rocks. This threshold of 10 ppb gold allows discrimination between least altered and altered gold mineralized samples as shown from a large geostatistical study from the Nalunag gold mine involving 233 least and 181 altered mafic rocks (Schlatter & Kolb 2011). Samples from each study area were plotted on major oxides diagrams (Figs. 4A, 4B, 4C) to demonstrate the difficulty in classifying hydrothermally altered granitoids and diorite using such diagrams. In this study and later in the text, for simplicity, we group the granite and granodiorite in the "*granitoid*" class and the quartz-diorite, quartz-monzodiorite and quartzmonzonite in the "*diorite*" class. For example, on the diagram by Debon & le Fort (1983); (Fig. 4A), it is observed that the rocks from the three study areas are not discriminating well on the diagram. Only the Fäbodtjärn samples plot mainly in the fields of quartz-monzodiorite, whereas the granitoids and diorite from Vagar plot across a range of different rock types. The geochemical classification of de la Roche (1980) that is also based on major oxides also shows large variations of rock types and the samples are not well differentiated (Fig. 4B). Finally, the diagram by Hughes (1973; Fig. 4C) that is widely used to discriminate samples into K-altered, Na-altered and least altered samples was applied to the Vagar, Svartliden and Fäbodtjärn. Samples cannot be discriminated between hydrothermally altered rock samples (filled symbols) from the least altered samples (unfilled symbols). However, on a discrimination diagram applying immobile element ratios, which was initially used to classify volcanic rocks (Pierce 1996; Fig. 4D), most samples from Vagar, Svartliden and Fäbodtjärn discriminate in tight clusters, regardless of the alteration intensity of the rock. Diorite from Fäbodtjärn plot into a distinct field, and the Vagar granitoid and diorite samples plot in two distinct fields which agrees with two different rock types (Fig. 4D). The altered granites from Svartliden are also clustered in a distinct field, which is not seen from the diagrams based on major oxides (Figs. 4A+B). Diagrams based on immobile element ratios (Fig. 4E) shows a tight clustering for the samples from the Svartliden Revsund granite and the granitoids and diorite from Vagar plot in two distinct fields, corresponding to two different granitoids and diorite occurring at Vagar. The group of Vagar samples with low Al_2O_3/TiO_2 and Zr/Al_2O_3 ratios are in the same field as the diorite samples from Fäbodtjärn (Fig. 4E) and it is conceivable that these correspond to quartz-monzodiorite, however this pattern needs be confirmed by petrography. A diagram based on the immobile elements Zr and Y is used to discriminate between tholeiitic, transitional, and calc-alkaline magmatic affinity mainly in the context of volcanic rocks (Barrett & MacLean 1994; Fig. 4F). However, this diagram is here used for discrimination of the different granitoids and diorite in this study: the Vagar rocks fall into the calc-alkaline field, the rocks from Fäbodtjärn are in the transitional field, and the three subtypes of Svartliden granitoids cluster in three distinct fields (Fig. 4F).

The geochemical assessment of the 94 granitoids and diorite has shown that these rocks are best classified in diagrams based on immobile elements (Fig. 4D, E, F). The preliminary classification diagrams based on the immobile elements Zr and Y discriminate the calc-alkaline Vagar granodiorite samples from the Svartliden and the Fäbodtjärn samples (Fig. 4F), and classification based on the immobile element ratios Al_2O_3/TiO_2 and Zr/Al_2O_3 (Fig. 4E) allow the discrimination of granitoids and diorite of different areas and two geochemically discrete granitoids and diorite at Vagar, a feature which is not apparent from major oxides diagrams (Figs. 4A and B). This lithogeochemical technique has the potential to be used in distinguishing favorable granodiorite compositions associated with gold mineralization within the study areas and thus providing a useful vector for future gold exploration.

Discussion and Conclusions and further suggested work

It is conceivable that the granodiorites predate the orogenic gold at Vagar and possibly also the diorites at Fäbodtjärn and thus "fertile" granodiorites and diorites reflect the fact they are suitable chemical or structural traps. Perhaps the composition of the Vagar granitoid and diorite, hosting significant gold mineralization (e.g. quartz veins up to 2533 ppm Au and granodiorite up to 14.4 ppm Au) and with high Al_2O_3/TiO_2 ratio (Fig. 4E), is more reactive with an auriferous fluid than other granitoids and diorite, and thus represent a more favorable

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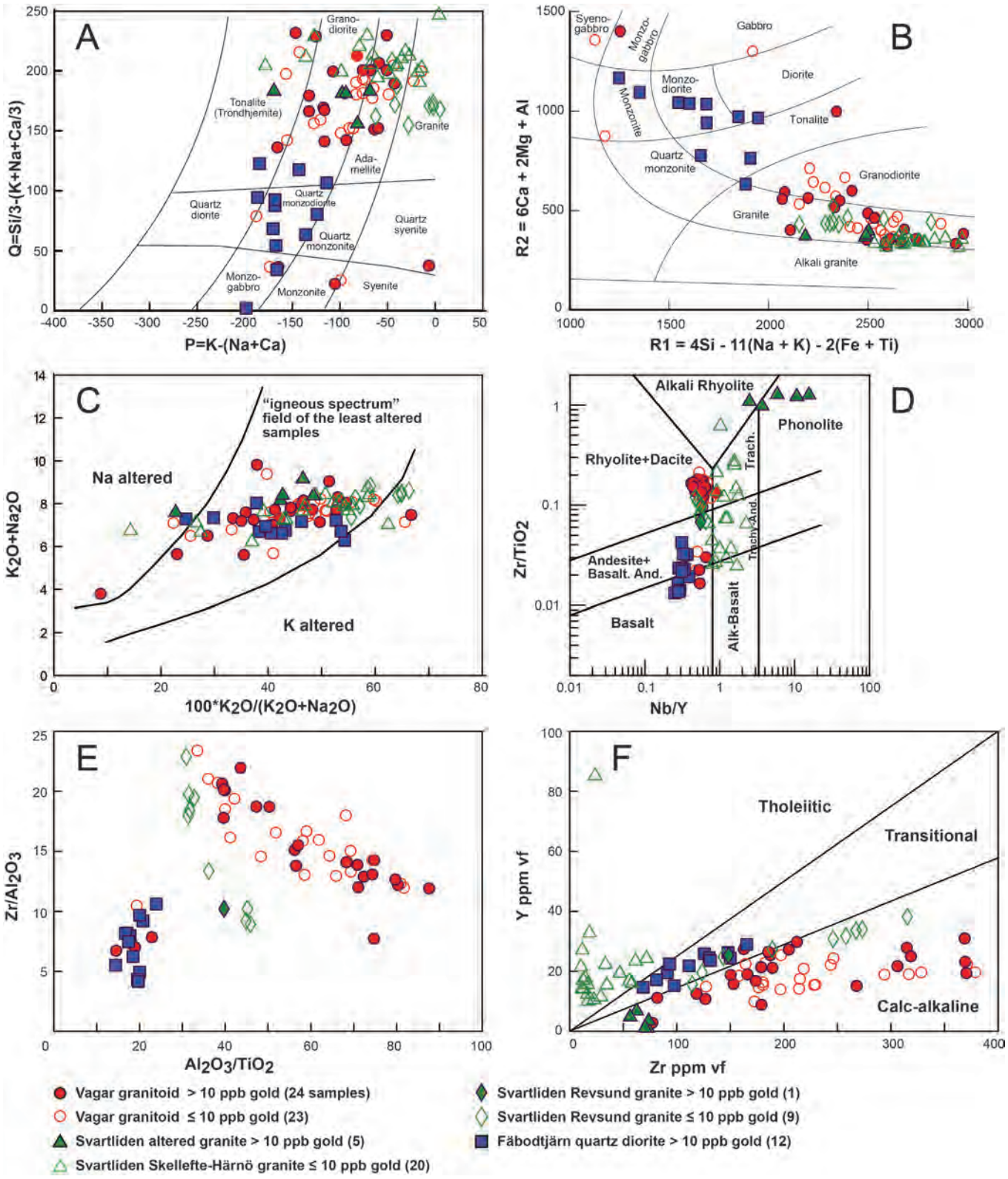

Figure 4. Lithogeochemical plots based on (A) major oxides defining rock types after Debon & Le Fort (1983). (B) Major oxides defining rock types after de la Roche et al. (1980). (C) Major oxides assessing hydrothermal alteration after Hughes (1973). (D) Immobile element ratios defining rock types after Pearce 1996. (E) Immobile element ratios plot discriminating rock types; five samples from the altered granites from Svartliden and the 20 Svartliden Skellefte-Härnö granite samples are plotting outside the diagram because the Al_2O_3/TiO_2 ratios are above 100. (F) Immobile elements assessing the affinity after Barrett & MacLean (1994). vf = volatile free basis. For (A) to (F): At Svartliden, six altered samples contain between 11 and 203 ppb gold and 29 least altered samples contain 10 ppb gold. At Fäbodtjärn twelve moderately to strongly altered samples have gold contents between 13 and 2531 ppb. At Vagar 24 moderately to strongly altered samples have gold contents between 14 and 3200 ppb and 23 least altered samples have less than 10 ppb gold. Granitoids and diorite carrying gold above 10 ppb are discriminated (filled symbols) from those that are barren (non-filled symbols).

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chemical host for gold mineralization. Another scenario is that the more competent granitoid and diorite (compared to surrounding metasedimentary rocks) simply is a rheologically more favorable site for gold deposition during deformation, providing fluid pathways during strain partitioning. Alternatively, the granitoids and diorite are genetically associated with the gold mineralization as it has been discussed elsewhere in the cases of gold deposits related to reduced granitic intrusions (Thompson & Newberry 2000).

At Svartliden, the contact of the Fe-rich metavolcanic rocks and metasediments located in a large shear zone serves as a fluid conduit and chemical trap for the mineralization. The granitic intrusion clearly postdates the mineralization and it is likely not genetically linked to the gold introduction into the system, while heat from the granite remobilizing some of the gold and enriching but also obliterating locally the ore grade (Fig. 2C). Near the Svartliden gold deposit, Fäbodtjärn diorite also occur adjacent to the gold occurrences (Fig. 1B). However, it is unclear if these intrusives are genetically related to the gold mineralizing events and/or if the intrusive bodies could have triggered hydrothermal alteration systems. Additional work that is currently carried out on the "Gold Line" includes sampling and geochemical analysis of rocks that are located outside of the hydrothermal alteration zones. New data from these fresh (least altered) rocks will be combined with the data of their altered equivalent in order to calculate mass changes caused by hydrothermal alteration (Barrett & MacLean 1994). This, in turn, will identify the elements that have the most discriminating power for distinguishing altered and the least-altered samples. More work, e.g. detailed structural geology and isotopic dating studies (U-Pb, Ar-Ar, and/or Re-Os dating) is required to conclude whether the granites are genetically related to the gold mineralization. From Svartliden some stable isotope oxygen/hydrogen data from the granites have been collected (Andersson 2012), however these data are not coupled to the gold mineralization and no conclusions can be drawn in this respect. From Vagar in South Greenland, which is an early stage exploration project, no isotopic data are available. High field strength elements-bearing phases, e.g. synchesite, allanite and monazite identified in SEM-BSE images and EDS analyses of gold bearing samples from Vagar (Schlatter et al. 2013), suggest that the hydrothermal fluid introduced REE elements together with the gold, making REE a possible pathfinder for gold exploration in the Vagar area together with the Bi and Te that is enriched at Vagar and As at Nalunaq. In the "Gold Line", on the other hand, the gold mineralization is marked by strong enrichment in As and Sb.

Acknowledgements

The data from Fäbodtjärn presented here are from the M.Sc. thesis by Fettweis (2015) and some data from Svartliden are from the M.Sc. thesis by Andersson (2012). We would like to thank the authors for being able to use their data for new interpretations in this study. Fäbodtjärn represents also a module of the ARN Project in sub-project "Ore geology". The ARN project "Alternative mineral raw materials in northern Sweden" is an EU project hosted at the LTU and we would like to thank ARN for organizing stimulating workshops and field excursions where, among other topics, possible geological correlations between South Greenland and northern Sweden were debated. We would like to extend our thanks to the chief-editor of **EXPLORE**, Beth McClenaghan and the reviewer, Chris Lawley, who have suggested changes that have substantially improved the paper.

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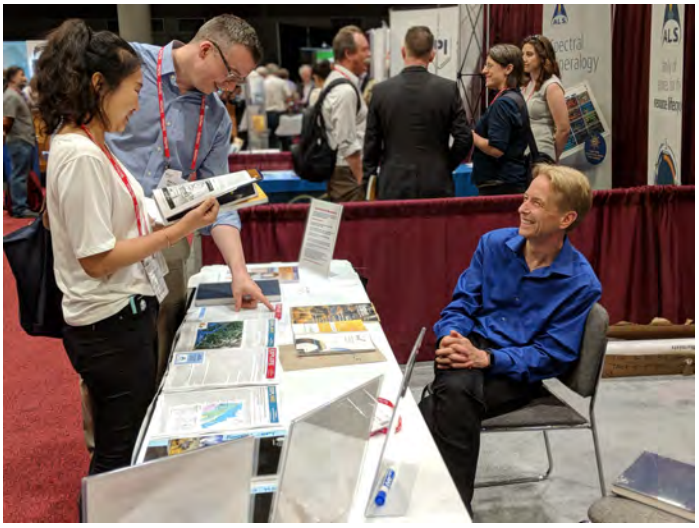
RESOURCES FOR FUTURE GENERATIONS-28TH

Events held a

Field Trips...

Gala Dinner at the Vancouver Aquarium...

IAGS, VANCOUVER, CANADA, JUNE 16-21, 2018



at the Vancouver Convention Center...

Vancouver Aquarium Pool...

Minutes of the 2018 Annual General Meeting of the Association of Applied Geochemists held at the International Applied Geochemistry Symposium Vancouver, B.C., Canada, June 18, 2018

I. Call to Order – Establishment of Quorum

President Cook called the Annual General Meeting (AGM) to order at approximately 5:15 PM local time. Thirty-two Fellows were present; the required number of Fellows for an AGM is 15.

II. Approval of 2017 AGM minutes

The minutes of the 2017 AGM were distributed prior to the 2018 AGM.

It was moved (E. Weiland) and seconded (D. Smith) that the minutes from the 2017 AGM be accepted. President Cook asked for a vote on the motion and it passed unanimously.

III. President's report (S. Cook)

The following report was submitted by email from President Cook:

As we convene our first live public AGM here since the 2015 Tucson symposium, I first want to thank the Association for the honour of serving as your President for 2018 and 2019. Ryan Noble has left some very large shoes to fill, and I will look to do so to the best of my abilities. I also want to publicly welcome Dennis Arne to the role of Vice-President.

I will begin with a summary of the membership of the Association, current as of last week. We presently have a total of 381 members, comprising 131 Fellows, 238 Regular Members, and 12 Students. These totals include 20 new members for 2018 (5 students and 15 regular members). We are hopeful that the 28th IAGS will generate additional renewals and new memberships to match the 2017 total of 403 members, particularly given the AAG's prominence at RFG 2018. A highlight of our Symposia is the awarding of the Gold and Silver Medals of the Association to honoured members. Ryan Noble will expand on this shortly in his role as Past President and Chair of the Awards & Medals Committee, and those of you who have secured tickets for the AAG Gala Dinner at the Vancouver Aquarium later this week will be able to see the medal presentations first-hand. Nominations are now open for the 2018 Medals, so I would encourage all of you to submit nominations of deserving individuals to the Committee.

I would like to quickly summarize some current developments in the Association, particularly those regarding people involved in key roles. Please refer to the most recent issue of EXPLORE (no. 179) for further information on some of these changes:

- Dr. Scott Wood is assuming the role of Editor-in-Chief of GEEA, effective August 1, 2018, following the untimely passing of Kurt Kyser.
- Graham Sylvester has agreed to take over as AAG Elements coordinator from Dennis Arne, who will overlap with Graham for the next few months. Please discuss any ideas for future contributions to Elements with Graham.
- Paul Morris has stepped down as long-time Chair of the Education Committee. Councillor David Murphy has volunteered to take on this important role.
- Nigel Radford has provided notice that he is stepping down from his role as Chair of the Membership Committee. We will be looking for a volunteer to step into Nigel's shoes and fill this role.

Finally, I would like to acknowledge the important contributions of the Executive, Council, the Regional Councillors and those who continue to play an important, often behind-the-scenes, role in the business of the Association. Gwendy Hall and Dave Smith have been, and continue to be, key and inexhaustible contributors. The public faces of the Association, such as the recently-redesigned website under Tom Meuzelaar and Gemma Bonham-Carter, and EXPLORE under Beth McClenaghan's guidance, continue to be important and high-quality vehicles for the dissemination of information on both the Association's activities as well as the discipline of geochemistry. Al Arsenault anchors the AAG business office, and all of our Councillors and Regional Councillors collectively channel the democratic will of the membership. I would encourage all AAG members to turn to the last page of EXPLORE and familiarize themselves with the names of all our Councillors, Regional Councillors, Committee members and Coordinators. It goes without saying that the future success of the AAG rests on the willingness of the membership at large to get involved and to remain involved in the many undertakings of the Association. To that end I'll conclude my remarks here today with a challenge to each and every AAG member, to join us in working together for the advancement of applied geochemistry. *END OF SUBMITTED REPORT*

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Minutes of the 2018 Annual General Meeting… *continued from page 16*

IV. Treasurer's report and GEEA update (G. Hall)

The following report was submitted by email from G. Hall:

The AAG is financially healthy. Our investments at Raymond James (previously 3Macs), as of the end of May, stand at $821,545 CAD (holdings are 85% CAD, 15% US). This is up from last year when we had $788,566 CAD.

Our currents accounts stand at:
$67,626 CAD
$98,893 US

Our main source of income is from the sales of GEEA. Our net profit is up again this year, at $37,722 US (GSL receives the same). In the now distant past, our IAGS meetings were a significant source of revenue; we should return to that happy state. Our office costs about $25,000-30,000 p.a. to run. Explore pays for itself.

The AAG support for students, to partially fund their attendance at IAGSs continues, as does their extremely low membership rate ($10).

We spent about $15k CAD at Blue Eclipse in Ottawa to move the website platform over to Drupal from the clunky Joomla. It looks terrific now and should be much easier to manage.

Just over 40 soft cover copies of the Barringer book remain; we have them on sale at RFG2018. Peter Bradshaw also has some copies to sell. *END OF SUBMITTED REPORT*

In discussing GEEA, G. Hall thanked Benedetto De Vivo for is valuable contributions to the journal as Co-Editor in Chief. She then introduced Scott Wood, the new Editor-in-Chief for GEEA. Scott stated that he was honored to take on the challenge and looked forward to leading the journal.

V. EXPLORE (P. Van Geffen)

The June 2018 issue of EXPLORE has been electronically distributed. Hardcopies are still being sent to libraries as requested. AAG members should feel free to distribute EXPLORE to interested colleagues. There is sufficient material in hand for the remaining issues of 2018; AAG members are encouraged to submit articles for 2019 issues. EXPLORE needs photos from the current IAGS at RFG2018. As always, EXPLORE is looking for new advertisers.

VI. Symposia (D. Cohen, B. Townley)

The following report was submitted by email from D. Cohen:

1. RFG

By the time of the meeting, the RFG will be in full swing. Many thanks to all the AAG members who have contributed to the many AAG-sponsored sessions, the dinner and the field trips. The RFG committee has commended the AAG for being one of the most active contributors outside the main organising associations. It has been the best option outside of organising an independent IAGS, while the exploration industry recovers from the trough.

2. Chile 2020 bid

The (abridged) draft proposal is available from the Chair of the LOC, Brian Townley, to hold the 29th IAGS in Viña del Mar. Brian will have copies of the full draft version (with all the pictures and more details about the venue and main host organisation).

Brian has formed a substantial LOC and has investigated suitable venues. There is government support on offer. While the budget is draft, it seems suitably conservative.

At the Council meeting we will be seeking feedback on the proposal and, in effect, the green light for the LOC to present a final proposal ASAP for consideration (and approval) by Council at its next meeting.

3. Australian Geoscience Council Convention

The AAG is a co-sponsor of the AGCC, by virtue of its membership of the AGC. The AGCC will be held 14-18 Oct in Adelaide.

Deadline for submission of abstracts has passed (but you can definitely sneak one in if you hurry). To date there have been 275 abstracts submitted and over 220 registered to attend. This is quite good 4 months out and we are on target to run a slight surplus. There is a 3-minute rapid fire thesis-style competition for students. The AAG will host sessions.

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Minutes of the 2018 Annual General Meeting… *continued from page 17*

I would propose that the AAG consider providing some funds for travel by students presenting geochemical papers, to be advertised just around AAG members. Suggestion along the lines of 15 students @ $500, which will cover internal return airfares and a contribution to accommodation.

(As a note, I will be taking on the role of President of the AGC next year). *END OF SUBMITTED REPORT*

Brian Townley then gave a few more details about the proposed 2020 IAGS in Chile. He was actually approached by the Viña del Mar tourism department about holding an IAGS in their city. Viña del Mar is about 1 hour from Santiago and is the most popular beach resort in Chile. The Local Organizing Committee currently consists of 9 professionals with another 3-4 to be added in the near future. The venue will offer wonderful opportunities for field trips and recreation.

VII. Medal winners (R. Noble)

The medals will be presented at the gala dinner at the Vancouver Aquarium on Wednesday, June 21. The 2016 Gold Medal will be awarded to Reijo Salminen, the 2017 Gold Medal to Stu Averill, and the 2016 Silver Medal to David Cohen. All AAG members were encouraged to nominate deserving individuals for both the Gold and Silver Medals to be awarded in 2020.

VIII. Other Business/Open Forum

President Cook opened the AGM for questions and comments from the AAG membership. A lively discussion took place primarily focusing on how to reverse the declining membership in the Association. General themes included the need for (1) a more dynamic web site including on-line lectures and short courses and (2) a greater presence on social media to attract younger applied geochemists. It was pointed out that AAG released a strategy document, approved by Council on September 13, 2017, that made recommendations regarding these issues. The final version of the AAG Strategic Plan was included in the minutes of the AAG Council meeting held on June 14, 2017 and can be downloaded from the AAG website.

IX Adjournment

President Cook thanked all attendees for their participation and declared the 2018 Annual General Meeting adjourned at approxmately 6:20 PM local time.

Dave Smith
Secretary, AAG

AAG Councillor Elections

Each year the Association of Applied Geochemists (AAG) needs motivated and energetic AAG Fellows to stand for election to the position of "Ordinary Councillor." Fortunately, each year some of our most outstanding Fellows are ready, willing, and able to meet this challenge. If you are a regular Member with enthusiasm to be involved, convert your membership status and look to make a bigger contribution to the AAG (see the website for details).

Councillor Job Description

The affairs managed by Council vary from reviewing and ranking proposals to host our biennial Symposium to approving applications for new membership to developing marketing strategies for sustaining and growing our membership. These affairs are discussed and decisions made at Council teleconferences usually held 3-4 times per year. Each teleconference lasts about 1 hour. In addition, there is often a running email discussion about a selected issue or two between each teleconference. So for a commitment of about 5 hours of your time per year, you can help influence the future of your Association. If you have more time to commit, there are committee assignments and voluntary efforts that greatly benefit the Association.

Qualifications and length of term

The only qualification for serving as Councillor is to be a Fellow in good standing with the Association. Please note the difference between being a Member of AAG and being a Fellow. A Fellow is required to have more training and professional experience than a Member. Consult the AAG web site, Membership section, for further details. If you are not currently a Fellow and have an interest in serving on Council, please go through the relatively painless process of converting to Fellowship status in AAG.

Each Councillor serves a term of two years and can then stand for election to a second two-year term. The By-laws forbid serving more than two consecutive terms, although someone who has served two consecutive terms can stand for election again after sitting out for at least one year. Elections are usually held in Oct-Nov of the year for a term covering the following two years. Our next election will be in October-November 2018 for the term of 2019-2020.

How to get on the ballot

If you are interested in placing your name into consideration for election to AAG Council, simply express your interest to the AAG Secretary (Dave Smith, email: dsmith@usgs.gov) by October 26, 2018 and include a short (no more than 250 words) written summary of your career experience. This summary should include the following:

- Your name
- Year that you became a Fellow of AAG
- Earth science degrees obtained, year of graduation of each, and institution of each
- Employment—list major employers and state years worked for each, e.g. 1980-1990, and type of work
- Position held as part of AAG or other past contributions to AAG
- 1-2 sentences about your professional experiences in applied geochemistry

All that is asked is that you bring energy and ideas to Council and are willing to share in making decisions that will carry the Association forward into a successful future. We look forward to hearing from you.

Stephen Cook
President, Association of Applied Geochemists

Recently Published in Elements

Volume 14, no. 3,
Terroir: Science Related to Grape and Wine Quality

This volume of Elements will be dear to the hearts of many us and a must read in preparation for the next IAGS in Chile! The AAG contribution to this edition introduces our councillors entering their final year of their 2-year term. The AAG news contribution for issue 4 will introduce the AAG Councillors who began their 2-year terms in 2018.

Dennis Arne

Exploration Geochemistry Course

GEOL 5806 Exploration Geochemistry
05 December 2018: ioGAS Tutorial (optional)
06-15 December 2018: 10-day course

This 10-day course addresses the principles and methods of lithogeochemical and surficial geochemical exploration, including planning, sampling, analysis, QAQC, data handling, plotting (using ioGAS), and interpretation. It includes case histories, applications to magmatic Cr and Ni-Cu-(PGE) sulfide deposits, porphyry Cu deposits, volcanic-associated Cu-Zn-(Pb) deposits, Archean lode gold deposits, sedimentary-exhalative Pb-Zn-Cu deposits, and diamond deposits, and a variety of exploration relevant laboratory exercises.

The modular course is designed for geoscientists employed full-time in the mineral exploration industry, industry professionals needing professional development and accreditation, and graduate students from Laurentian and other universities.

The 10-day intensive modular course covers fundamentals and advances in concepts and techniques applicable to mineral exploration and is equivalent to a regular 3-credit full-term course, including lectures, hands-on laboratory exercises, computer-based problem sets. In order to minimize impact on regular courses taught during the academic terms, the modular course is taught outside of the academic term. It runs on consecutive days for maximum convenience to visiting students and industry participants.

The course will be taught by our award-winning faculty and internationally-recognized outside experts.

Live Webcast Option

The modules are available to non-students via live webcast from our state-of-the-art Executive Learning Centre, which provides an immersive experience if remote participants have high-speed fibre connections and use high-quality headsets. Students enrolling for credit must enrol in the on-campus course so that they can complete the laboratory exercises, but the remote option may be preferable for non-students. Contact the course coordinator if you are interested in this option.

Non-student cost: $2500 plus HST for the full course
$300 + HST per day, or $75 plus HST per 90-minute lecture.
Group rates are also available.

Contact Prof Michael Lesher mlesher@laurentian.ca for additional information
Contact Ms Roxane Mehes rmehes@laurentian.ca to register

AAG Medal Award Winners

Reijo Salminen, *AAG 2016 Gold Medal*

AAG Medal winners: 2016 Silver Medal winner David Cohen, 2017 Gold Medal winner Stu Averill, and Pertti Sarala accepting the 2016 Gold Medal on behalf of Reijo Salminen.

The 2016 Gold Medal for outstanding contributions to exploration geochemistry was awarded to Professor Reijo Salminen, Geological Survey of Finland (retired). Professor Salminen has had a long and successful career in geochemical research in Finland and Europe, beginning in the late 1960's and culminating as research professor (geochemistry) in the Geological Survey of Finland (GTK) from 1997-2010. During this time he led numerous national and international geochemical mapping projects in Finland, the Barents region and elsewhere in Europe, managing large collaborative projects. He participated in the GTK's international geochemical mapping projects, including fact-finding, project planning and implementing missions, in Tanzania, Uganda, Nigeria, Russia and Norway. He has run undergraduate and post-graduate courses in the universities of Helsinki and Turku and supervised graduate theses.

Professor Salminen was a pioneer in developing geochemical mapping at different scales, particularly in the use of glacial till, and a leader of national and international geochemical mapping projects. His work has been widely acclaimed by the international geological community. His impressive publication record includes some 36 refereed scientific papers, and as leader and/or editor of 15 geochemical atlases and books. He is, or has been, a member of the editorial boards of scientific journals, including 'Geochemistry: Exploration, Environment, Analysis'. His leadership roles on international collaborative projects have included Chair of the European subcommittee of the IUGS/IAGC Working Group on Global Geochemical Baselines, and the Forum of Geological Surveys of Europe/EuroGeoSurveys Geochemistry Working Group (FOREGS) 1996-2006. Professor Salminen has remained active in international geochemical projects since his retirement in 2010, and he is a worthy recipient of the 2016 Gold Medal.

Stu Averill, *AAG 2017 Gold Medal*

The 2017 Gold Medal for outstanding contributions to exploration geochemistry was awarded to Stuart (Stu) Averill, the founder of Overburden Drilling Management Ltd. (ODM) and an innovator in applied geochemical methods. Stu has had a several-decades-long career of achievement in applied research, particularly in the development and application of innovative indicator mineral and gold grain methods to mineral exploration.

Over the past 45 years, he has made important contributions to mineral exploration methods in the glaciated terrain of Canada and globally through his research and development at ODM in Ottawa. His extensive achievements include the initiation and improvement of rudimentary heavy mineral laboratory separation procedures to concentrate indicator minerals from surficial sediments, making them more effective and practical for exploration, and the expansion of indicator mineral methods and suites to span a wide variety of deposit styles, from kimberlite-hosted diamonds to magmatic massive sulphide deposits. Stu also developed a gold grain shape and surface texture classification scheme that is now used worldwide, and he has discovered or delineated indicator mineral dispersal trains for more than 20 mineral deposits in North America and Chile.

During his long and successful career, Stu has been a generous collaborator with other scientists in government, industry, and academia, and a willing mentor to students and junior geoscientists. He has contributed numerous presentations and technical articles to IAGS Symposia and EXPLORE, respectively. He is internationally acclaimed for his body of work, and is a most deserving recipient of the 2017 Gold Medal.

David Cohen, *AAG 2016 Silver Medal*

The Association of Applied Geochemists' Silver Medal is awarded to those who voluntarily devote extraordinary time and energy to the affairs of the AAG. The 2016 Silver Medal was awarded to Dr. David Cohen of the University of New

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AAG Medal Award Winners… *continued from page 21*

South Wales for his dedicated service to the Association. This reward is a reflection of his long-standing and continued service, particularly related to symposia coordination, student awards, Council and Presidential duties, and his ongoing drive to provide education and training to younger geoscientists.

David has served as a Councillor or council member almost continually from 2000 to the present, including the Executive Council during his four years as Vice-President (2006-2007) and President (2008-2009). He has held the position of Symposia Coordinator for more than 9 years, and has been a prolific educator and geochemical short course organizer at innumerable IAGS and other geological conferences. He has also been a driving force behind the AAG student awards which are often organized in parallel with the IAGS. David has consistently been a strong advocate for student awards as a means of fostering young scientists and retaining them as members of the AAG. He is also the Association's representative on the Australian Geoscience Council, a position he has held since 2008. More recently, David has served on the Strategy Committee tasked with understanding where the AAG is with respect to its members, and developing a future strategy to ensure the longevity of the Association over the coming decades. He is a worthy recipient of the 2016 Silver Medal.

Stephen Cook
AAG President

Geochemistry
EXPLORATION, ENVIRONMENT, ANALYSIS

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Handbook of Exploration and Environmental Geochemistry

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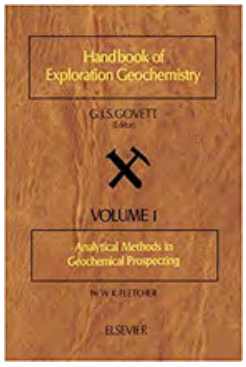

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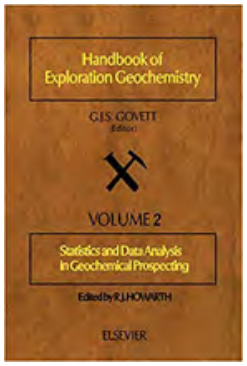

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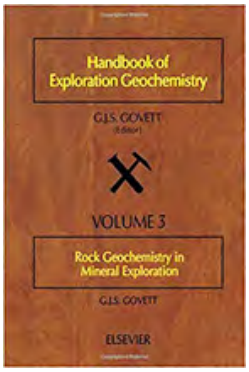

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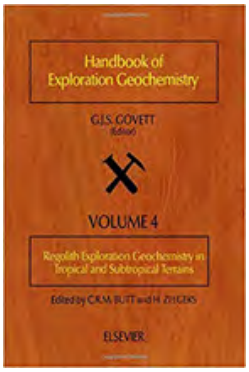

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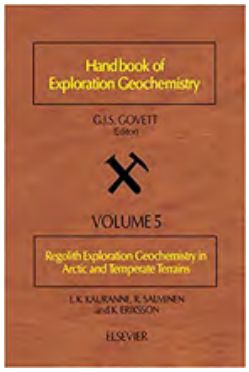

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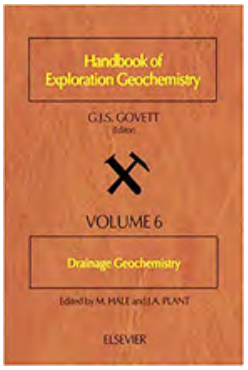

Geochemical Remote Sensing of the Sub-surface
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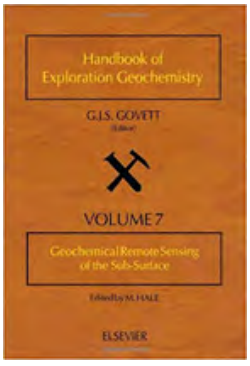

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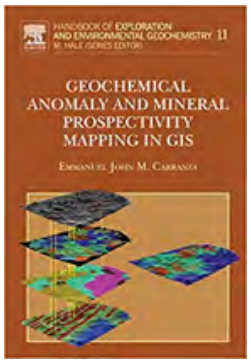

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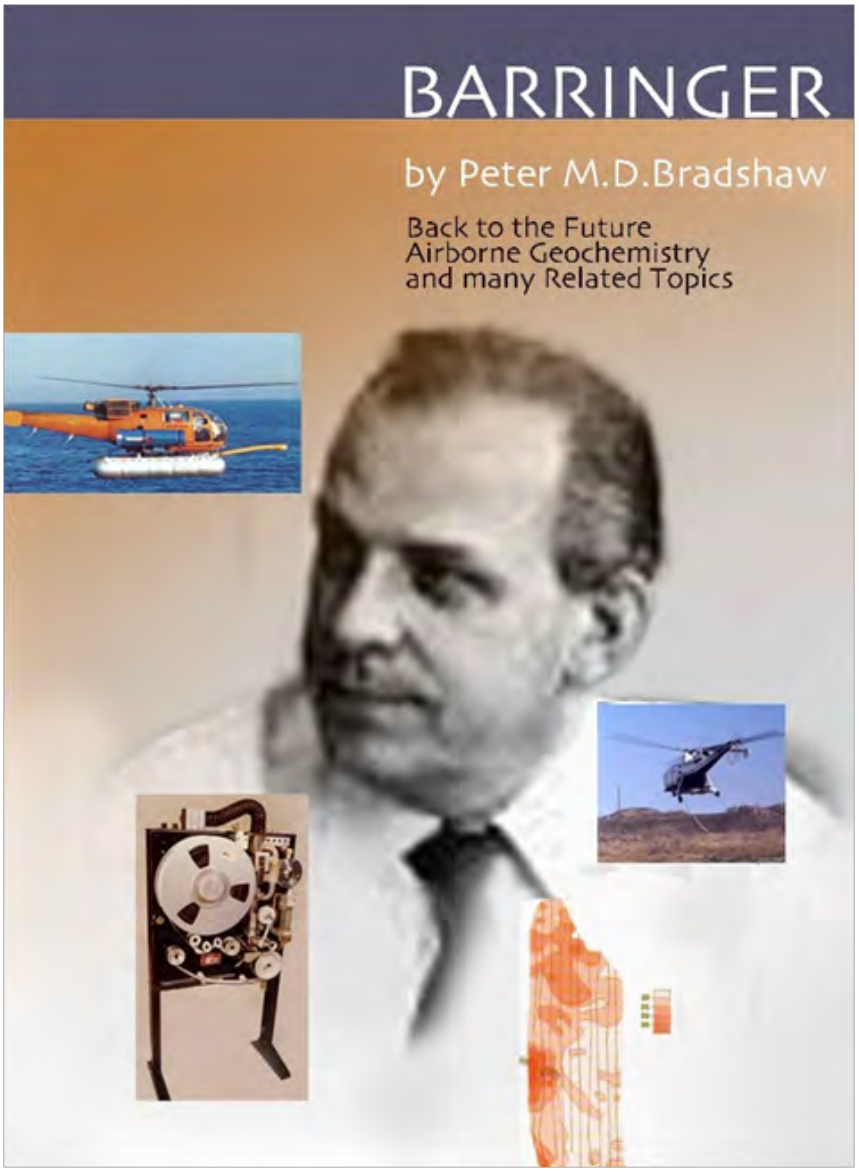

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The 1960's and 70's were marked by an explosion in mineral exploration and remote sensing technology. A leader throughout this period was Dr. Anthony (Tony) Barringer and his team at Barringer Research Ltd. (BRL). The highly successful airborne geophysical methods created at BRL are well known while the contributions to exploration geochemistry and many other fields are not. This book documents the many advances in geochemical theory, as well as the ground, airborne and remote sensing techniques plus analytical methods that were conceived and developed under the leadership of Tony Barringer. Innovative concepts backed by pioneering research funded by BRL on the movement of metals in rock, soil and vegetation remain important areas of investigation. Tony Barringer's ability to bring together a diverse team including geologists, geochemists and physicists with electrical, optical and aeronautical engineers under one roof, provide leadership, a highly stimulating environment and financial support, was truly remarkable. This led to ground breaking advances in a number of different fields, including: exploration geochemistry for minerals and oil and gas; environmental monitoring from the ground, aircraft and space; and civilian and armed forces security. The underlying scientific principles for many of the inventions, now upgraded with modern electronics, are still considered state of the art. One of the many inventions from the BRL "incubator" described in this book is Ionscan, the drug and explosive screening device used in most airports today, which was conceived and developed by BRL in conjunction with technology for the detection of mineral deposits.

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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.

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2018

16-21 SEPTEMBER	IWA World Water Congress & Exhibition 2018. Tokyo Japan. Website: tinyurl.com/ybpmakrc
16-21 SEPTEMBER	European Planetary Science Congress 2018. Berlin Germany. Website: www.epsc2018.eu
17-25 SEPTEMBER	13th International Symposium on Nuclear and Environmental Radiochemical Analysis: ERA13. Cambridge UK. Website: tinyurl.com/y9tbav7m
22-25 SEPTEMBER	SEG 2018. Keystone CO USA. Website: www.seg2018.org
23-27 SEPTEMBER	10th International Conference on Environmental Catalysis. Tianjin China. Website: tinyurl.com/yazebbz5
14-18 OCTOBER	Australian Geoscience Council Convention. Adelaide SA Australia. Website: tinyurl.com/zqxc6n2
17-18 OCTOBER	Finex 2018. London UK. Website: londonfinex.com
25-26 OCTOBER	Sampling 2018. Lima Peru. Website: www.encuentrometalurgia.com/Sampling-2018
29-30 OCTOBER	ICESCC 2018: 20th International Conference on Earth Science and Climate Change. Paris France. Website: tinyurl.com/y9b6l3mr
29-31 OCTOBER	12th Fennoscandian Exploration and Mining. Levi Finland. Website: fem.lappi.fi/en
4-7 NOVEMBER	GSA 2018 Annual Meeting. Indianapolis IN USA. Website: tinyurl.com/yb859e9n
12-15 NOVEMBER	XIII Latin American Symposium on Environmental Analytical Chemistry. La Serena Chile. Website: tinyurl.com/yc92c5jk
12-15-NOVEMBER	1st Conference of the Arabian Journal of Geoscience. Hammamet Tunisia . Website: www.cajg.org
27-30 NOVEMBER	SEG-WMS Senior Exploration Management Short Course. Littleton CO USA. Website: tinyurl.com/y8ubokh5
2-7 DECEMBER	American Exploration & Mining Association (AEMA) Annual Meeting. Spokane WA USA. Website: www.miningamerica.org/2018-annual-meeting
4-8 DECEMBER	American Exploration & Mining Association (AEMA) Annual Meeting. Reno NV USA. Website: www.miningamerica.org/2018-annual-meeting
10-14 DECEMBER	AGU Fall Meeting. Washington DC USA. Website: tinyurl.com/yclg7sut
13-14 DECEMBER	ICGG 2018 : 20th International Conference on Gas Geochemistry. Bangkok Thailand. Website: tinyurl.com/ycw4ma8v

2019

6-9 JANUARY	International Soil Science Meeting. San Diego CA USA. Website: tinyurl.com/y9oorlm4
10-11 JANUARY	ICCEEST 2019 : 21st International Conference on Chemical, Ecological, Environmental Science and Technology. Singapore. Website: tinyurl.com/y7yo7r6r
24-25 JANUARY	21st International Conference on Organic Geochemistry and Geochemical Engineering. Paris France. Website: tinyurl.com/y7et6aa7
3-8 FEBRUARY	European Winter Conference on Plasma Spectrochemistry. Pau France. Website: winterplasma19.sciencesconf.org
26-28 FEBRUARY	Janet Watson Meeting 2019: From core to atmosphere: Deep carbon. London UK. Website: www.geolsoc.org.uk/jwatson19
3-6 MARCH	Prospectors and Developers Association of Canada Annual Convention. Toronto ON Canada. Website: www.pdac.ca/convention
10-14 MARCH	Minerals, Metals & Materials Society Annual Meeting & Exhibition. San Antonio TX USA. Website: www.tms.org/tms2019

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11-14 MARCH	SIAM Conference on Mathematical & Computational Issues in the Geosciences. Houston TX USA. Website: www.siam.org/Conferences/CM/Main/gs19
7-12 APRIL	EGU General Assembly. Vienna Austria. Website: www.egu2019.eu
3-5 MAY	International Conference on Geographical Information Systems Theory, Applications and Management. Heraklion Greece. Website: www.gistam.org
6-9 MAY	9th World Conference on Sampling and Blending. Beijing China. Website: www.wcsb9.com
3-8 JUNE	8th International Workshop on Compositional Data Analysis. Terrassa Spain. Website: tinyurl.com/y7prnhoo
24-27 JUNE	Quantitative Microanalysis 2019. Minneapolis MN USA. Website: tinyurl.com/y8fayprt
21-26 JULY	16th International Symposium on Water-Rock Interaction. Tomsk Russia. Website: wri16.com
22-23 JULY	6th Annual International Conference on Geology & Earth Science. Athens Greece. Website: www.atiner.gr/geology
25-31 JULY	INQUA 2019. Dublin Ireland. Website: www.inqua2019.org
18-23 AUGUST	Goldschmidt 2019. Barcelona, Spain. Website: goldschmidt.info/2019
27-30 AUGUST	15th Biennial Meeting of the Society for Geology Applied to Mineral Deposits. Glasgow UK. Website: www.sga2019glasgow.com
8-13 SEPTEMBER	14th International Conference on Mercury as a Global Pollutant. Krakow Poland. Website: www.mercury2019krakow.com/gb
27-30 OCTOBER	6th International Conference on Selenium in the Environment and Human Health. Yangling/Xi'an China. Website: icsehh2019.csp.escience.cn

2020

2-8 MARCH	36th International Geological Congress. Delhi India. Website: 36igc.org
20-24 MAY	Geological Society of Nevada 2020 Symposium Vision for Discovery: Geology and Ore Deposits of the Basin and Range. Sparks NV USA. Website: www.gsnv.org/2020-symposium
17-21 AUGUST	34th International Geographical Congress. Istanbul, Turkey. Website: www.igc2020.org/en
24-28 AUGUST	Eurosoil 2020. Geneva, Switzerland. eurosoil2020.com

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