The consequences of climate change in the Arctic and implications for natural resource utilisation

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History of the Northwest Passage sea route, recent climate change, global warming and the opening of the Northwest Passage

The Northwest Passage is a shipping route linking the Atlantic Ocean with the Pacific Ocean, much shorter than current traditional routes via the Suez or Panama canals (Figure 1). For example, from New York to Tokyo via the Northwest Passage is approximately 14,000 km (7,560 nautical miles) compared to 18,200 km (9,830 nautical miles) for the equivalent transit via the Panama Canal. A counterpart route via the north coast of Russia, the Northeast Passage (sometimes also known as the Northern Sea Route) similarly provides a shortened transit – passage via the Suez Canal for Hamburg to Tokyo is 21,000 km (11,340 nautical miles) in comparison to 13,000 km (7,020 nautical miles) along the Northeast Passage. Whilst the suitability of the Northeast vs. the Northwest Passage depends on the port of departure (Europe vs. eastern seaboard of North America), overall the much shorter distances available to shipping travelling via Arctic routes significantly saves both time and money and reduces emissions. For example, it has been estimated by Fednav – the shipping company behind the first cargo ship to travel solo through the Northwest Passage in September 2014 carrying Ni-ore from Deception Bay in Canada to Bayuquan in

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Historically exploration for the Northwest Passage was led by a desire to find a shortcut from Europe to Asia by travelling west (rather than the eastern trade routes) and dates back to the 15th Century. In 1497, John Cabot’s expedition ultimately led to his landing on the eastern seaboard of Canada (historians debate whether this was Cape Breton, Nova Scotia, Newfoundland or Labrador) although he failed to find a passage to Asia (Hunter 2011). This was followed by subsequent exploration by Martin Frobisher (1576 to 1578), Henry Hudson (1609), William Baffin and Robert Bylber (1615-1616) amongst others. The 18th Century saw a break in such expeditions but after the Napoleonic Wars, Captain John Ross undertook his first Arctic expedition to explore for a Northwest Passage in 1818. Perhaps most famously, these historic voyages culminated with Sir John Franklin’s fateful expedition in 1845, again instigated to shorten the sea route between Europe and Asia, thereby linking the Atlantic Ocean with the Pacific Ocean through the Arctic Ocean (Hutchinson 2017). The dramatic failure of Sir John Franklin’s expedition ended in the loss of his two ships, H. M. S. Erebus and H. M. S. Terror near King William Island (Figures 3 and 4) and the deaths of the 129 men on board, despite his expedition being the best equipped Arctic expedition of the time. The inaccuracy of charts and maps of the area (where available for some portions of the eastern part of the passage) and the fact that enormous areas located west of Baffin Island and north of Greenland were uncharted, is largely thought to have been responsible for the failure of these expeditions (Figure 3). At the time, there was also a belief that there was open water between North Greenland and the North Pole. Over the years, 52 search expeditions across extensive areas of the Arctic were organized to try and find Sir John Franklin and his crew – ironically, this led to a significant improvement in knowledge and mapping culminating in final threading of a passage through the labyrinthine seaways (McGoon 2002). Finally in 2014 the ship Erebus, followed by the Terror in 2016, was found at the bottom of Arctic waters on the west coast of the King William Island (Figure 3) – both were well-preserved.

The allure of an Arctic seaway to connect the Pacific and Atlantic Oceans in the northern hemisphere has endured beyond Sir John Franklin, whether for commercial, security or tourism reasons. But what are the consequences of an ice-free or seasonably shipifiable Northwest Passage in terms of exploration and exploitation of natural resources? There has been a recent increase of interest in land-based mineral resources in proximity to the Northwest Passage in the vicinity of Greenland and Arctic Canada. How will interest in such future activities manifest and what considerations are needed in relation to its socio-economic impact and growing concerns for climate change?

With Arctic shipping routes becoming more popular, other considerations besides the choice of Northeast and Northwest passages come to the fore including; the abundance and longevity of sea ice each year; permitting and fees (presently for the Northeast Passage only); the remoteness of the route (there are several ports and bases on the Northeast Passage but very few on the Northwest Passage, with none along the central portions of the passage); and geopolitics (from tensions over sovereignty and national seaways vs. international waters, to President Trump’s stated intent to ‘buy’ Greenland). Further geopolitical focus has been recently raised when the Swiss Polar Institute’s ‘Greenland Circumnavigation Expedition’, intended to navigate around Greenland by sea, was cancelled due to it not receiving the relevant permissions from the Danish Department of Foreign Affairs, possibly due to unease about the role of Russian partners on the expedition (Anner 2019). Whilst the legal, political and maritime complexities embroiled in Arctic sea routes such as the Northwest Passage is beyond the scope of this article, which instead seeks to highlight the topic for discussion within the natural resources community, it ultimately underpins the feasibility of trade and the development and extraction of natural resources in the region.

Seasonal ice coverage in the Arctic has changed dramatically over the past 40 years (Figure 1). It is conceivable that the Northwest Passage will be ice free in late summer in the near future (e.g., Ioo et al. 2009) expanding the September navigability for common open-water ships (Smith & Stephenson 2013) further opening the Northwest Passage as a route through the Arctic. Figure 4 provides photographs of the examples of summer ice in the Arctic Ocean showing large areas covered by pack ice in the Smith Sound in North Greenland. Evidence of a warmer climate in Greenland can clearly seen from the shrinking of glaciers – for example, the glacier in Qaamarujuk Fjord (Figure 5) located near the now moth-
boulders Black Angel mine in central-west Greenland, North of the settlement of Uummannaq (Schlatter 2016; Georgi 1933). It is the perception from personal observations of the first author during 15 seasons of field work in the Greenland Arctic that the summer air temperatures have tangibly risen since the mid-1990s, and crucially such observations are widely supported by scientific studies and literature (Jardine 2019). The recent recorded warming of oceans and rising air temperatures in the Arctic are paired with melting of sea-ice, glaciers and the inland ice – melting in the period 2007 to 2011 has been estimated as 262 Gt/year with the greatest extent of melt seen in the inland ice of the extreme North of Greenland (van As et al. 2016). Warming of air temperatures is also demonstrated by reconstructions for the past ~200 years showing that positive temperature anomalies have predominantly been recorded since the end of the Little Ice Age at about 1860, especially in the areas located in the northern hemisphere (Figure 6). Given Sir John Franklin’s legendary expedition came to an end because of the sea ice conditions towards the end of the Little Ice Age, then the present conditions would likely have facilitated his success.

Geological and natural resources

The seaboard of much of the Northwest Passage in Greenland and the western portions of the Canadian Arctic comprises crust of Proterozoic and Archean ages as well as terranes of Cretaceous-Tertiary and the Mesoproterozoic ages (Figure 7); (Kolb et al. 2016). Such terranes are proven to be prospective for mineralisation of precious metals, diamonds, base metals and ferrous metals for example from large resources in Western Australia and South America (Cawood and Hawkesworth 2015; Robb 2005). Some of these prospective geological terranes have been (and continue to be) explored in the Canadian and Greenland Arctic and in Alaska, and (were) actively mined (e.g., Black Angel, Mary River, Raglan, Ektal and Diavik– see Table 1). These are also prospective regions for rare earth elements (e.g., the Gardar Intrusive Suite in southern Greenland, Kolb et al. 2016) as well as other critical metals, important in the global move towards ‘green’ technology and sustainable growth (Table 1, Figure 2); (Kolb et al. 2016; Petrov and Smerlot 2015). Younger crustal regions, such as those along the western seaboard of the Canadian Arctic and Alaska are prospective for base metals (e.g., Red Dog, Table 1). Somewhat controversially, both the eastern and western portions of the Northwest Passage lie onshore and offshore oil deposits. Table 1 provides a summary of grade and tonnes of significant minerals and mining exploration projects that are located in the vicinity of the Northwest Passage (Figure 2). For further details, the reader is encouraged to refer to the detailed compilation by Boyd et al. (2016) who provide a comprehensive inventory of mineral resources in the Arctic. The Arctic regions, including those along the Northwest Passage seaboard, are widely considered one of the last frontiers on the planet and with increasing interest and accessibility to the region, mining occurrences will undoubtedly be found in these largely unexplored areas. Furthermore, market drivers such as increasing oil and gas prices and unrest in the Middle East may see growing and (certainly contentious) exploration efforts to locate and potentially extract hydrocarbon resources.

Beyond these more ‘traditional’ natural resources, additional opportunities may be identified. The accelerated melting of the Greenland Ice Sheet as well as glaciated areas along the Northwest Passage seaboard and its pristine quality of water presents a potential for capture as mineral water, agricultural and potentially extract hydrocarbon resources. Beyond these more ‘traditional’ natural resources, additional opportunities may be identified. The accelerated melting of the Greenland Ice Sheet as well as glaciated areas along the Northwest Passage seaboard and its pristine quality of water presents a potential for capture as mineral water, agricultural and potentially extract hydrocarbon resources.

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Ole Christiansen, 2019) and in other parts of the Arctic (Welch 2016). Such terranes are proven to be prospective for mineralisation of precious metals, diamonds, base metals and ferrous metals for example from large resources in Western Australia and South America (Cawood and Hawkesworth 2015; Robb 2005). Some of these prospective geological terranes have been (and continue to be) explored in the Canadian and Greenland Arctic and in Alaska, and (were) actively mined (e.g., Black Angel, Mary River, Raglan, Ektal and Diavik– see Table 1). These are also prospective regions for rare earth elements (e.g., the Gardar Intrusive Suite in southern Greenland, Kolb et al. 2016) as well as other critical metals, important in the global move towards ‘green’ technology and sustainable growth (Table 1, Figure 2); (Kolb et al. 2016; Petrov and Smerlot 2015). Younger crustal regions, such as those along the western seaboard of the Canadian Arctic and Alaska are prospective for base metals (e.g., Red Dog, Table 1). Somewhat controversially, both the eastern and western portions of the Northwest Passage lie onshore and offshore oil deposits. Table 1 provides a summary of grade and tonnes of significant minerals and mining exploration projects that are located in the vicinity of the Northwest Passage (Figure 2). For further details, the reader is encouraged to refer to the detailed compilation by Boyd et al. (2016) who provide a comprehensive inventory of mineral resources in the Arctic. The Arctic regions, including those along the Northwest Passage seaboard, are widely considered one of the last frontiers on the planet and with increasing interest and accessibility to the region, mining occurrences will undoubtedly be found in these largely unexplored areas. Furthermore, market drivers such as increasing oil and gas prices and unrest in the Middle East may see growing and (certainly contentious) exploration efforts to locate and potentially extract hydrocarbon resources.

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Communication and trade links globally, which itself could reduce carbon emissions by shortening transportation routes as well as allowing for increased production of key mineral and metal resources to facilitate global development towards a ‘green economy’ and even carbon capture and sequestration. Yet on the other hand, growing access to the Arctic sea routes would inevitably cause further ecological stress (e.g., Miller and Ruiz 2014) and likewise cause further societal pressure on indigenous peoples (e.g., Kaiser et al. 2018) possibility exacerbating geopolitical instability.

Socio-economic and environmental aspects

The first encounter between the indigenous peoples of North-West Greenland and Captain John Ross took place in 1818 at Cape York (Malaurie 1992). Captain John Ross did not expect to find people living in such a remote area and so far north, whereas the indigenous peoples were not aware of other civilizations. Since this historical and non-violent encounter, Arctic regions have become further populated with most habitants located in the Russian Arctic (population approximately 2 million, after “The Arctic Institute Center for Circumpolar Security Studies”, Washington) and comparatively few in the Canadian Arctic (population more than 100,000, Canadian High Commission in London and Greenland (population less than 60,000, after Statistics Greenland) with most being situated on the west coast while the east coast and northern areas remain very sparsely populated. In Greenland, there are fewer hunters each year and this traditional way of living is diminishing – this is in part due to the dramatic loss of the sea-ice on which many houses in the Arctic are built, resulting in the resource of winter and coastal stability. Buildings in the Greenland Example was seen in Qaanaaq in North Greenland (personal communication by Ole Christiansen, 2019) and in other parts of the Arctic (Welch 2014)
that workers from outside of the region would also be needed. It seeks to employ local and indigenous peoples for the workforce, but the multiplier effect. Policies could be put in place to preferentially versa. This applies to all phases from mineral exploration through – including impact on the fauna and flora of the region.

Greenland has basic infrastructure, is one of the world’s northernmost inhabited settlements and the northernmost settlement inhabited by indigenous people (Figure 8). Consequently, such ‘in-ternmost inhabited settlements and the northernmost settlement’. For example, the settlement of Siorapaluk in North-West Arctic communities with populations generally of less than 100 and habitation. From a socio-economic perspective, there are only a few larger towns that are located north of 65° latitude, such as the town of Murmansk on the Northeast Passage and therefore cruise ships along the Northwest Passage will more likely visit very small and runways have become unusable due to melting permafrost, causing changes, challenging traditional hunting and fishing activities and the opening of the Northwest Passage will almost certainly open up areas for increased explora-

However, a fierce debate ensued when this law was passed by the Danish parliament. In Greenland, it is possible that such companies could abide by the minimum wage criteria of Greenland, it is possible that such companies could also deduct food, clothing and other expenses from this salary. This arrangement was formalised in a law intriguingly called “the Chi-neural law”, although officially this law was given the Danish name for large-scale project legislation: Storskalavleen (Nuttall 2012). However, a fierce debate ensued when this law was passed by the Parliament (Kalaallit Nunaami Inatsisartut) in 2012, making it possible to accommodate foreign labour under special conditions (Gad et al. 2018).

The sensitivity of this and accordingly the social licence to operate is one that is crucial to the viability and success of any future projects. The mineral industry must also abide by their re-sponsibility to the environment, especially when operating in such sensitive Arctic areas. Coupled, regulators must have a place in forming practical legislation for the exploration and mining indus-

The closing statement of the Arctic regions have undergone significant changes since Captain John Ross and Sir John Franklin’s expeditions towards the end of the Little Ice Age and the search for the Northwest Passage. Since then, the indigenous population has encountered significant cultural, technological, environmental and climatic changes, challenging traditional hunting and fishing activities and ways of life. With the continued opening of the NorthWest Passage further changes and challenges are to be expected, such as a new route trade between Europe and the western Americas with China and other Asian and Australian consumers of minerals and raw materials. Yet there are likely to be commercial beneficiaries, such as shipping and cruise line operators that could utilize a sea-ice-free Northwest Passage. From a greener global economy, but on the other hand exemplifies the problems of climate change caused by industrialisation and such commercialization. We ask, what are the socioeconomic and environmental factors at play in this scenario? Are there means by which careful and sympathetic use of the Northwest Passage can facilitate a positive side-effect of ice loss caused by the warming? Such means would require an open and interdiscipli-


News of the Society

Society of Economic Geologists

SGA Ordinaty Council Meeting, Glasgow, Scotland, UK, August 26, 2019

Adrian Boyce (host of the meeting) welcomed all Council members on behalf of the LOC of the 15th SGA Biennial Meeting and the University of Glasgow. Karen Kelley (SGA President) welcomed all Council members and thanked A. Boyce for organization of the meeting. Then Council approved suggested agenda.

Minutes of previous Council Meeting (April 15, 2019, Pamukkale, Turkey)

After checking the actions, the Minutes were unanimously approved.

Reports of officers on Council
3.1. Report from President
3.2. Report from Executive Secretary
3.3. Report from Treasurer
3.4. Report from Promotion Manager
3.5. Report from Chief Editor, SGA News
3.6. Report from Chief Editors, Mineralium Deposita
3.7. Report from Chief Editor SGA Special Publications
3.8. Report from the Chief Editor SGA website
3.9. SGA Educational Fund
3.10. to 3.16. Reports from Regional Vice Presidents (Asia, Australia/Oceania, Europe, North Africa and Middle East, Sub-Saharan Africa, North and South America)

Council was sorry for missing Report of the RVP-Asia and RVP-North Africa and Middle East.

After discussion, Council approved the presented reports with great thanks and suggested the following actions:

I. PALEA to prepare a draft of Minutes from SGA Ordinaty Council Meeting and SGA Extraordinary General Assembly and articles on News of the Society, SGA GA and SGA Awards for upcoming SGA News.

3.1. Report to send pdf files of newly designed banners for SGA promotion to all council members and student chapters. They can print them out and use them where appropriate.
3.2. Report to adapt SGA website to make SGA-IUGS-UNESCO activities more visible.
3.3. Report to continue looking after distribution of NEXA Resources among gold sponsors of the SGA Educational Fund and also names and links to new SGA Chapters.
3.6. Report to work jointly with SGA Educational Fund and also names and links to new SGA Chapters.
3.7. Report to continue editorial efforts associated with two SGA Special Publications, which are at different stages of preparation and report to next Council Meeting (Isotopes in Economic Geology, Metallogenesis, and Exploration; and Supergene Mineral Deposits), one proposed book on “Economic Mineral Deposits of Nigeria” and one Springer Briefs Book Series on Mineral Deposits (Li-Be-B pegmatites of western Maine, USA).

SGA News Chief-Editor. J. Kole should then check incoming Student Chapter contributions as soon as possible after their receipt to eventually return them back in case they would need major language or content improvements. This would give extra time to contributors for corrections and resubmission.

All Council Members to help B. Lehmann and G. Beaudoin to identify suitable theme and authors for “milestone papers” for Mineralium Deposita.

J. SLACK to continue editorial efforts associated with two SGA Special Publications, which are at different stages of preparation and report to next Council Meeting (Isotopes in Economic Geology, Metallogenesis, and Exploration; and Supergene Mineral Deposits), one proposed book on “Economic Mineral Deposits of Nigeria” and one Springer Briefs Book Series on Mineral Deposits (Li-Be-B pegmatites of western Maine, USA).

N. KOLIN to work jointly with I. PITCAIN on setting up a storage place for SGA documents at SGA website for Council members (access via a password).

N. KOLIN in collaboration with I. PITCAIN to adapt SGA website to make SGA-IUGS-UNESCO activities more visible.

N. KOLIN in collaboration with I. PITCAIN to update a form on donations to SGA Educational Fund and also names and links to new SGA Chapters.

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SGA 2021 – update (T. Christie)

The report was presented by T. Christie. The 16th SGA Biennial Meeting will be held in Rotorua, New Zealand from November 15 to November 18, 2021. The LOC was established and the PCO Conferences & Events was selected to participate in the organization of the meeting. LOC of the SGA 2021 prepared for the SGA 2019 Meeting in Glasgow the following items: (1) SGA 2021 booth in the exhibition area, (2) SGA 2021 concertina brochure, (3) SGA 2021 First Circular which is available on line and by (4) SGA 2021 Second Circular which was presented during Student Award and Closing Ceremony. The conference website www.sga2021.org is in operation.

The report was presented by A. Boyce. The 6th Short Course on African Metallogeny – Ivory Coast – update (B. Orberger): The report was presented by J. Palava. The course title is “Gold deposits: from Exploration to Mining” and the first circular was already distributed. The course will be held from August 23 to 27, 2021 in Abidjan, Ivory Coast. The program covers general topics on gold deposits world-wide, in particular in West Africa, then focus on exploration (methods including drilling, targeting, vectoring of mineralization) and new technologies developed for speeding up exploration, mining and processing. The LOC is chaired by B. Orberger (SGA Council member) and composed of people from Abidjan, Yamoussoukro (Ivory Coast) and Toulouse (France) including university professors, researchers, exploration geologists, board of excellence centres of education and representatives of women in mining. There will be several lecturers from five countries (France, Ivory Coast, Belgium, Germany and Australia). Eight sponsors (UNESCO, IUGS, Regional Mineralogy Society, Brussels) provide funds for the students and lecturers. Council greatly appreciated efforts by Beate Orberger, Ghislain Tourigny and LOC, expressed once more thanks to Lenka and David for their work and invitation to help in the preparation of the course and approved the report with great thanks.

Progress report on membership drive from the last SGA Council Meeting (J. Relvas et al.)

The report was presented by J. Relvas. During the period from March 18 to August 6, 2019, SGA accepted 113 new members: 31 regular, 80 student members, 1 senior member and 1 corporate member. About 71% of the new student members were brought to the SGA by the action of student chapters, especially the Turkish, Hungarian, Indian and the Austrian student chapters. The membership balance as of July 31, 2019 (1,366 members) remained quite stable relative to the end of 2018 (1,362 members). The decrease of regular print members, consistently noticed since 2013, was accompanied by a concomitant increase of the digital members, especially the student members, which compensated also the loss of five senior members. When put in the context of the membership drive trends observed during the last 10 years, this overall membership stabilization goes against the general trend, recognized since 2011, for the total number of members to increase in the odd years (biennial meetings) and to decrease in the even years, which is indeed good news. For future, we need to continue our membership drive campaigns for the SGA at the centers of education in order to attract new members. Following discussion, Council approved the report with great thanks and the following motions:

• 10th Anniversary All Russian Conference for Young Scientists.

Any other business

The report was presented by D. Huston, K. Kelley, R. Skirrow: The report on the First SGA Field Conference in Cloncurry and Mount Isa, Queensland (July 20-24, 2020) was presented by D. Huston. After discussion of tentative schedule and budget, Council approved the request to present the conference in 2022 and to resubmit a revised budget following basic principles of African Metallogeny Courses to J. Palava who will administrate it within SGA.

The report was presented by J. Palava. The course title is “Gold deposits: from Exploration to Mining” and the first circular was already distributed. The course will be held from August 23 to 27, 2021 in Abidjan, Ivory Coast. The program covers general topics on gold deposits world-wide, in particular in West Africa, then focus on exploration (methods including drilling, targeting, vectoring of mineralization) and new technologies developed for speeding up exploration, mining and processing. The LOC is chaired by B. Orberger (SGA Council member) and composed of people from Abidjan, Yamoussoukro (Ivory Coast) and Toulouse (France) including university professors, researchers, exploration geologists, board of excellence centres of education and representatives of women in mining. There will be several lecturers from five countries (France, Ivory Coast, Belgium, Germany and Australia). Eight sponsors (UNESCO, IUGS, Regional Mineralogy Society, Brussels) provide funds for the students and lecturers. Council greatly appreciated efforts by Beate Orberger, Ghislain Tourigny and LOC, expressed once more thanks to Lenka and David for their work and invitation to help in the preparation of the course and approved the report with great thanks.

Action: B. Orberger and T. Christie to continue working with LOC on the preparation of the course.

SGA Mobility Grant - update (T. Aiglsperger) The report was presented by T. Aiglsperger. In order to attract student members to become regular members and to make regular membership more attractive, SGA Council approved with great thanks: (1) updated proposal including a condition that application must be submitted at least three months ahead of planned travel; and (2) selection procedure by the selection committee composed of T. Aiglsperger and S. Petersen.

Action: T. Aiglsperger to finalize the document and send it to N. Koglin.

SGA News – useful link pages (N. Koglin, I. Pitcairn).

This issue was introduced by N. Koglin and I. Pitcairn to inform all SGA members about the “useful links” tab from web pages.

55th SGA Anniversary in 2020 (J. Palava): This issue was introduced by J. Palava and Council approved that a special logo on SGA 55 Anniversary will be placed on SGA website, cover pages of SGA News and Mineralium Deposita. Additionally, a set of 25 special invited papers will be published in Mineralium Deposita that will be made freely accessible to SGA membership for a period of minimum eight weeks (better four months – a subject of negotiation with Springer).
12 SGA News
Celebrating 55th SGA Anniversary
Number 46 February 2020

13 SGA News
Celebrating 55th SGA Anniversary
Number 46 February 2020

News of the SGA General Assembly
August 29th, 2019, Kelvin Gallery, University of Glasgow, Glasgow, Scotland, UK

Jan Palava1 (SGA Executive Secretary)
1 Czech Geological Survey, Geologicalijk 6, 152 00 Praha 5, Czech Republic, jan.palava@geologie.cz

The General Assembly was opened by the SGA Executive Secretary, Jan Palava at 11.30 and closed at 12.40. Following Article VII, Section 2 of the SGA Constitution, it was found that there was no quorum reached in the room and the Executive Secretary called immediately for Extraordinary General Assembly and presented suggested Agenda, which was approved. The meeting was attended by over 150 people.

Report of the President (J. Kelley)
The President’s report covered the period from the previous SGA General Assembly (August 21, 2017 Quebec City, Canada) to date. The President highlighted that SGA has become a globally recognized society with large membership (1,366 members in more than 50 countries), which is financially healthy and contributes to the training of the next generation of economic geologists through the SGA Educational Fund. She also emphasized vibrant and growing student chapters and the high impact factor (3.4 in 2018) for the flagship scientific journal Mineralium Deposita (54 of Mineralogy and 23 of Geochronology and Geophysics), highly-ranked special publications, cutting-edge workshops and short courses offered by SGA. Widely attended, high-quality Biennial Meetings have become a traditional and important part of SGA since 1991 and she thanked all SGA members who do not serve on Council (as per SGA Constitution) for their presentations.

These reports were approved by the General Assembly.

Jan Palava

Report on the SGA Educational Fund (D. Huston)
The SGA Educational Fund was established in May 2013. The objective of the SGA Educational Fund has been and remains to provide financial support for training the next generation of economic geologists. SGA Educational Fund sponsorship should be a seal of approval of the scientific validity of the training activities in relation to understanding mineral deposit formation and how to explore for new mineral deposits. The specific objectives are:

1. to support student participation at national and international scientific meetings organized or sponsored by SGA;
2. to support student participation on field trips, workshops and short courses sponsored by the SGA;
3. to support SGA-sponsored student activities.

D. Huston (Chair of the SGA Educational Fund Committee) thanked all members of this Committee (J. Kelley and D. Leach) that is responsible for the management of the funds, including granting funds according to the objectives of the SGA Educational Fund and approval of SGA Council.

Thanks to generous contributions from the Geological Survey of Sweden, SGA, AngloGold Ashanti, Sinotech, NEKA Resources, Tintina Resources, BHP Billiton, Barrick Gold, H. Frimmel (Germany) and J. Slack (USA), we were able to support 79 students from 20 countries and 3 young professionals at this SGA 2019 Meeting. This support also enabled students participation in the Gold Short Course (Prague, May 2018), Freiberg Metallurgy Course (Freiberg, December 2018), Goldschmidt (Barcelona, August 2019) and many other educational events including the African Metallurgy Conference (Mouanda, Gabon, 2018). The report was approved by the General Assembly. J. Palava then thanked D. Huston and his team for looking after donations to SGA EF.

Report on Activities of Student Chapters (A. Vymazalová et al.)
A. Vymazalová (SGA Vice-President of Student Affairs) guided this part of the SGA General Assembly, when representatives of the following 15 student chapters presented their past and future activities: Baltic Chapter (Krysztof Foltyn), Barcelona Chapter (Julia Farre de Pablo), Black Forest – Alpine Chapter (Alannah Brett), California Chapter (Deborah Dwyer), Colombia-Bucaramanga Chapters (Mathéo Espinel), Laval Chapter (Francois-Xavier Masson), Moscow Chapter (Nikolay Trofinov), Nancy Chapter (Francois Turlin), North-West Russia Chapter (Anton Kutyrev), Peru Chapter (Diego Briones), Serbia Chapter (Katarina Cherdantseva), Turkey Chapter (Diyar Isil), UK Chapter (Amy Benites), Prague Chapter (Marek Tuhý), Siberia Chapter (Maria Cherdantseva), and many other educational events including the African Metallurgy Conference (Mouanda, Gabon, 2018). The report was approved by the General Assembly. J. Palava then thanked D. Huston and his team for looking after donations to SGA EF.

Report on the Treasurer (H. Frimmel)
H. Frimmel presented the Financial Report covering the period from August 2017 to July 2019. The Treasurer reported that the SGA account on 31 December 2016 was € 783,030.65 (including € 4,017.34 brought forward by various SGA offices) and on 31 July 2019, it was € 783,045.20 in SGA offices, showing that the Society is financially healthy. The balance on the account of the SGA Educational Fund on 31 July 2019 was € 91,599.88. All SGA books for the Years 2017 and 2018 were audited by two SGA members who do not serve on Council (as per SGA Constitution). These were Prof. Dr. G. Bögg and Dr. S. Höhn who did not find any discrepancies with the accounting. J. Palava thanked the SGA Treasurer for keeping Society finances in such a good shape.
If anyone thinks that this is a eulogy, they would be mistaken. Dick's career has been centered on prodigious field-based inves-
tigations over more than five decades, and yet he shows little real indication of slowing down, with a good part of the year still spent on field assignment.

Coupled with Dick's extraordinary insight, his observations in the field have led to numerous new interpretations, many sub-
sequently demonstrated to be correct, often at the end of a drill hole. However, the best observations and interpretations are of
some – unless you are communicating this and it is communicated where Dick's mastery of language comes to the fore. He merges a focused
picture of the 

Dick's well known fluency in Chinese, with which he is very comfortable, has been in large part due to frequent travel and 

Fig. 1: Presentation of the SGA-Newmont Gold medal during the Opening Ceremony of the 15th SGA Biennial Meeting in Glasgow, UK. Richard H. Sillitoe – recipient of the award (in the middle) with K. Kelley – SGA President (right) and J. Pašava – SGA Executive Secretary (left). Photo by L. Meinert.

The following acceptance speech was delivered by Richard H. Sillitoe:

Thank you, Karen and Jan, I received the news that I'd been awarded the SGA-

Newmont Gold Medal for 2019 while in the small coastal town of Puerto San Julián in Palawan, southernmost Philippines – where Charles Darwin and the Beagle made a

It is a great honor to have been selected by the SGA to receive the Newmont Gold Medal for 2019, which is the highest honor that can be conferred by the SGA.

For the younger people in the audience, I should back up a bit and fill you in on Dick's early career. While completing a B.Sc. Honours degree in Geology at London University, he supplemented his student stipend with some part-time copywriting. However, on graduation, he was offered a Ministry of Overseas Development Fellowship to investigate supergene oxidation and enrichment of
copper deposits in Chile; fortunately for us, this is what he chose. Three years later, in the summer of 1968, he was back in

In other words, Newmont Goldcorp has been instrumental in securing the deep copper resources that will be needed for our future low-carbon society.

If these scientific and economic benefits of fieldwork are accepted, then the obvious question is how can we ensure that the next generation of students are similarly

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The following citation was prepared and presented by LaFlamme.

The acceptance speech was presented by Crystal LaFlamme.

The following citation was prepared and presented by Marco Fiorentini.

The following citation was prepared and presented by Georges Beaudoin.

The following acceptance speech was delivered by Crystal LaFlamme:

The following acceptance speech was delivered by David Leach:

The following acceptance speech was delivered by Dr. Franci Sauge from France in 2015.

The second recipient of the SGA-KGHM Krol Medal became Dr. Maurice Page from France.

The third recipient of this prestigious Society award became Dr. David Leach from USA who was nominated by G. Beaudoin. After introducing the recipient’s name, the award was presented by K. Kelley (SGA President) and J. Palava (SGA Executive Secretary). Acceptance speech was delivered by Dr. D. Leach (USA) through video.

The following citation was prepared and presented by Georges Beaudoin:

President Kelley, members of the SGA and delegates to the 15th SGA Biennial Meeting have the honor to present the 2018 SGA-KGHM Krol Medal as

The following citation was prepared and presented by Michael J. Stewart.

The following citation was prepared and presented by Marco Fiorentini.

The following citation was prepared and presented by Dr. Arturo Relvas.

From there, I thought to bring the open style of research back to Canada to the University of Western Australia where I did a postdoc in developing isotopic techniques for ore deposit research. Under the past helm of Cam McCuaig and now Georges Beaudoin, I got me hooked. Although not a supervisor, Dave Lentz acted like a mentor to me at this time and encouraged me to stay in academia.

I’m grateful that I’m involved in research at a time when it is inclusive to many from different backgrounds, of different genders and of different experience levels. This is especially the case at the Centre for Exploration Targeting at the University of Western Australia where I also hold a postdoc in developing isotopic techniques to apply to ore deposit research. Under the past helm of Cam McCuaig and now Georges Beaudoin, I got me hooked. Although not a supervisor, Dave Lentz acted like a mentor to me at this time and encouraged me to stay in academia.

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The following citation was prepared and presented by Marco Fiorentini.

In Australia, she also developed a strong relationship with industry and succeeded in changing the status of an academic. There, visiting scientists are plenty and doors are always open to apply to ore deposit research. Under the past helm of Cam McCuaig and now Georges Beaudoin, I got me hooked. Although not a supervisor, Dave Lentz acted like a mentor to me at this time and encouraged me to stay in academia.

The following citation was prepared and presented by Michael J. Stewart.

Many excellent candidates were nominated and considered for the award this year. It is actually great to remark the outstanding scientific caliber that characterizes the research pursuit of young scientists and early career researchers in our discipline. The presence of so many students among us today is a testament to the vibrant community we are part of. However, ultimately a decision had to be made.

The following citation was prepared and presented by Marco Fiorentini.

The following acceptance speech was delivered by Crystal LaFlamme:

Dr. LaFlamme developed some of the new key working hypotheses that allow us to utilize subtle (but measurable) isotopic anomalies as tracers to trace former processes with unprecedented confidence. The work of Dr. LaFlamme is in the field of multiple sulfur isotope systems and represents a new benchmark in the visualisation of processes that up until a few months ago could not even be thought possible.

In mid 2018, Crystal was awarded a very prestigious Canada Research Chair Tier 2 at UWA in Australia as well as significant funding from the Canadian Foundation for Innovation to boost her research program into the future. Without further ado, it is my pleasure to present to you the 2019 SGA Young Scientist winner: Dr. Crystal LaFlamme.

While working in Australia, I have been making major contributions to the field of isotope geochemistry applied to mineral system science.

It is my great pleasure to stand in front of you today to present the award for the 2019 SGA Young Scientist of the Year. As you all know this award is offered biennially to a young scientist who contributed significantly to the understanding of mineral deposits.

Dr. LaFlamme developed some of the new key working hypotheses that allow us to utilize subtle (but measurable) isotopic anomalies as tracers to trace former processes with unprecedented confidence. The work of Dr. LaFlamme is in the field of multiple sulfur isotope systems and represents a new benchmark in the visualisation of processes that up until a few months ago could not even be thought possible.

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The following acceptance speech was delivered by David Leach:

Dr. LaFlamme developed some of the new key working hypotheses that allow us to utilize subtle (but measurable) isotopic anomalies as tracers to trace former processes with unprecedented confidence. The work of Dr. LaFlamme is in the field of multiple sulfur isotope systems and represents a new benchmark in the visualisation of processes that up until a few months ago could not even be thought possible.
The SGA Award for the Best Student Oral and Poster Presentation

In order to encourage students to participate in the SGA activities and to reward excellence in their scientific work, the best oral and poster presentations given by students were awarded.

A Scientific Committee constituted by Thomas Aigelsperger, David Banks, Marco Fiorentini, David Holwell, Jochen Kolb, Patrick Ledra, Sven Petersen, Iain Pitracl, Björn von der Heyden and Anna Vymazalová based on high quality and scientific merit of the student's presentations decided to attribute the awards to three students for oral presentations and three students for poster presentations (each of them received a certificate and prize of 250 EUR). The Committee evaluated 103 oral and 106 poster presentations.

The SGA Award for the Best Student Oral and Poster Presentation

The award (established in 1999) is presented every two years at the Biennial Meetings and consists of a citation, certificate, EUR 1,500 and travel expenses for the first author associated with the presentation.

Based on pre-selection of five papers by the Chief Editors of Mineralium Deposita and after Council vote, it was decided that the paper by


The best student oral presentations:

LAURA PETRELLA: Naturally occurring Au nanoparticles associated with high-grade mineralization at the world-class Callie deposit, Northern Territory, Australia.

SIBELLE NASCIMENTO: Geoenvironmental characterisation of the King River Delta: A combined geophysical, geochemical and mineralogical approach.

WILLEM KRIEGER: Field and geochemical constraints on the origin of massive magnetite layers of the Bushveld Complex, South Africa.

The best student poster presentations:

MASON GROBBELE: In-situ Cu isotope systematics of the Copperbelt (DRC, Zambia): variations in different scales.

MONICA ÁREDA LÓPEZ: Characterization of serpentinites in Timla and Antioquia (Colombia): analyzing their CO2 sequestering potential through carbonation processes.

OLGA N. FILIMONKOVA: The state of platinum in pyrrhotite studied by X-ray absorption spectroscopy of synthetic crystals.

On behalf of SGA, we wish to congratulate once more to all awardees!
special thanks goes to Adrian Boyce, the chairman of the meet –
universities in the UK and the British Geological Survey. A very
social events and other activities possible. These include BHP,
sponsoring organizations to the SGA EF include The Geological
27,000 Euros were spent to support attendance by 70 students and
tries attended the meeting and more than 200 presentations were by
and industry scientists to come together with a common goal of
education, research and career development of students through
port these well-established entities, but at the same time, we need
to create new opportunities.

One of the remarkable aspects of SGA is its ability to support the
education, research and career development of students through participation in field trips and workshops, and to attend our Bien-

The success of the Glasgow Meeting was the result of the efforts
of some Council members and Regional Vice-Presidents but also
generously supported by a number of external sources. The financial
support was crucial to ensure that the meeting was accessible to the wide
range of participants attending.

Additionally, the SGA Executive Committee has continued to
the SGA Field Conference, which will be held every two years in
different locations around the world. The conference will
provide a platform for students and early-career researchers to
present their work and network with established geoscientists.

As part of the new initiatives, SGA will continue to
advocate for open access publishing and support
researchers in navigating the challenges associated with
open access. We encourage all members to engage with these
initiatives and contribute to the growth and development of the
SGA community.

The SGA Executive Committee has recently approved
the creation of new positions to further expand our
representation and outreach. These positions include
Executive Secretary and Director of Communications,
which will be filled in the coming months. These positions
will play a critical role in advancing SGA’s mission and
engaging with our members, partners, and the broader
geoscience community.

In conclusion, SGA continues to evolve and innovate,
embracing new opportunities and challenges. We look forward
with excitement to what the future holds for our society and
its members.

Karen D. Kelley1 (SGA President 2018-2019)

1 U.S. Geological Survey, Denver, CO 80225, kdkeley@usgs.gov

David Huston1 (SGA President 2019-2020)

1 Geoscience Australia, GPO Box 378, Canberra, ACT, Australia, david.huston@ga.gov.au

As detailed in Karen Kelley’s comments above, SGA is currently in
very sound health as a consequence of the hard work of the out-
going Executive and Council. Because the Society is in sound
financial shape, we have begun to roll out some new initiatives that
will continue in the next two years, including celebrating SGA’s
55th Anniversary in 2020. Despite its current healthy status, our
Society faces many other important challenges and opportunities.

In the medium to long term, however, the effects of open access
on scientific publishers and, in particular scientific societies, is not
clear. Council is and has been considering these possible conse-
quences. The two new initiatives described above are the start of
this process. Another part of this process is identifying from our
membership other ideas whereby more value can be given to mem-
bership. To make sure that we can find ideas through as much of
the society as possible, Council has set up a sub-committee, headed
by the Vice President David Banks, to seek ideas. This committee
will have representatives from industry, academia (both academics
and students) and government. This is your opportunity to seed
ideas into SGA to benefit you and other SGA members, so contact
David if you want to be a member of the sub-committee or if you
have ideas that SGA Council should pursue.

The Society is presently in great shape, largely due to SGA Coun-
cils past and present. Thank you to Karen and the outgoing Council
members for their hard work. Despite the Society’s health, we face
challenges in the next few years that require new perspectives. In
the next two years and beyond, Council will work actively to meet
these challenges and provide SGA membership with new and use-
ful initiatives to enhance the value of SGA membership.
Reports from the SGA Student Chapters

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<tr>
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<th>President</th>
<th>E-mail</th>
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Baltic Student Chapter’s North Macedonia – Kosovo field trip

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In August 2019, the SGA Baltic Student Chapter organized a field trip to various mineral deposits and occurrences of the Balkan Peninsula, located in the Republic of North Macedonia and the Republic of Kosovo (Figure 1). This part of the Balkan consists of four main geotectonic units – Serbo-Macedonian Massif, Vardar Zone, Pelagonian Metamorphic Complex (PMC) and Dinardes/Hellenides, which generally form parallel, NNW-SSE trending belts (Shar & Robertson 2006, Hyseni et al. 2010). Three of them contain rocks of Precambrian and Paleozoic age (SKMM, VM, PC). The Serbo-Macedonian Massif, located in the east, comprises metamorphic rocks like gneiss and schist. Our main focus was the Pelagonian Metamorphic Complex, containing mica schist, gneiss, marble and granite, which hosts alkali pegmatite, an atypical rock association we wanted to study. The second unit of our interest, Vardar Zone, is a fundamental suture between SMM and Dinardes (Mesozoic rocks with Alpine deformation). The VZ contains Paleozoic crystalline schist and phyllite, Triassic sedimentary rocks and volcanoclastic rocks, a Jurassic ophiolitic sequence, Cretaceous melange of serpentinites, and Late Cretaceous sedimentary rocks like gneiss and schist. Our main focus is to link them within the so-called Trepça Mineral Belt, related to Oligocene-Miocene volcanic activity of anesitic, trachytic and latic composition (Hyseni et al. 2010). Polymetallic deposits of this region show significant economic potential and historically, they constitutes one of the very important ore districts of Europe, however nowaday the political and economic situation hinders exploration and mining efforts. On the first day of our trip, we visited Alinći (41°14’53.1”N 21°28’31.4”E), which is located close to Prilep - 11 km to the southwest. The area it built up of gneiss, xenite,
At the Sivec Mine (Figure 3) of the Pelagonian Metamorphic Complex, we were able to look at a variety of exotic minerals, such as zoisite, kosmanite, and muscovite, Sivec marbles host a variety of sulfides (Figure 5) and carbonates (especially sphalerosite). The mine is one of numerous places around the village (41°13'58.6"N 21°35'44.6"E), 20 km south of Prilep. The raw material exploited here is snow-white dolomite marble (Figure 3) of the Pelagonian Metamorphic Complex, used as decorative and technical stone (Boev et al. 2005). The reason why this place brought our attention was ruby (boev et al. 2005). The group had the opportunity to see one of the ore bodies and to collect samples (Figure 6).

The last visited locality was an outcrop of alteration zone with weathered mineralization in Muzhik village (42°55'48.1"N 20°57'10.5"E), just 2 km from the Trepça Mine. It is a central place among numerous fossil deposits around the mine, which is marked with remnants of old mining activity sometimes dating back to Roman times. The ore is dominated by arsenopyrite, pyrite, and chalcopyrite (Węgrzywnicz et al. 2019). However, the most interesting thing about this locality is the occurrence of bismuth-sulfosalts in the form of needle-like crystals up to 2 cm in size. These are bismuthinite and cosalite with minor (only microscopically visible) pekoite, knupkaite and aikinite – rare derivatives of the bismuthinite – aikinite series (Węgrzywnicz et al. 2019).

We would like to thank Prof. Jaroslav Pršek for help with organizing the field trip. References:


Krzysztof Foltyn1, Sławomir Mederski1

Student Chapter

Celebrating 10 years of the SGA Baltic

Fig. 1: Shortcourse participants with keynote speakers.

SGA Baltic Student Chapter was formed in 2009 as a result of an initiative of professors Adam Piestrzyński (AGH) and Pasi Eila (GTK). Eventually, this led to a fruitful long-term collaboration between students from three universities in three different countries (AGH University of Science and Technology in Kraków, Luleå University of Technology and University of Oulu).

At the beginning, the concept of annual chapter meetings in each country has been developed and since 2009, tens of students have the opportunity to visit local mines (e.g. Kırıma and Aitik in Sweden, Kemi and Pyhäslammi in Finland, and Pomožany and Rudna in Poland), show results of their own research projects and attend numerous short courses. Six people served as presidents of research projects and attend numerous short courses. Six people served as presidents of the chapter and ensured that the last ten years were full of activities: Sosniska M., Minz F., Kołodziejczyk J., Zych F., Zygo W. and Foltyn K.

To celebrate the anniversary, a special annual chapter meeting was organized at AGH University of Science and Technology in Kraków, where everything started ten years ago with the first Baltic Chapter meeting. Over the years, the event (already 11th) grew and this year, we gathered more than 40 participants, not only from AGH University, Luleå University of Technology and University of Oulu, but also from Masaryk University Brno, Charles University in Prague, Montana- universität Leoben, University of Lorraine, Saint Petersburg State University, National University of Engineering – Peru, University of Nairobi and Mandalay University (Figure 1). The main theme of this year’s meeting was “sedimentary rock-hosted ore deposits”, with short courses and field trips focused on this type of ore deposits.

On Monday (21st of October), participants attended a field trip to the Połkowice–Sieroszewice mine in order to see the famous Cu-Ag Kupferschiefer deposit. The copper-silver ore is hosted in three distinct lithologies of Permian age: the Weiss legendes sandstone, the Kupferschiefer (copper-bearing shale) and the Zechstein dolomite. Besides the typical lithological profile, participants had the opportunity to see the so-called “sandstone elevation”, where the shale is thinning and has a thickness of only 2.3 cm. Apart from the Cu-Ag ores, the underground mine is extracting also salt rocks, which occur 20-30 metres above the ore horizon. Students have the possibility to walk along a comprehensive profile of Zechstein rocks representing a cyclothem sequence: the Kupferschiefer, dolomite, anhydrite and salt rocks.

Tuesday was dedicated to zinc deposits and a full day short course started with lectures given by Prof. Sarah Gleeson (GIZ Potsdam), who focused on deposits known as SHMS (Sediment hosted massive sulfide deposits) or SEDEX (Sedimentary exhalative deposits). The general overview of this class of deposits was followed by detailed examination of examples including the Macmillan Pass District in the Selwyn Basin in Canada, the famous Red Dog district in Alaska and the Mesoproterozoic Zn deposits in Mt Isa in Australia. We finished the day with a lecture by Prof. Murray Hitzman (ICRAG Dublin) about the Irish Zn-Pb orefield. Wednesday lectures were focused on copper. Prof. Murray Hitzman gave a general introduction to the sedimentary rock-hosted stratiform copper ore system and then presented a wide range of case studies: Kupferschiefer in Poland and Germany, White Pine in the USA, the Chu-Sarysu Basin in Kazakhstan and the Central African Copperbelt. To end the day on a high note, the exhibition of superb specimens, collected through many years of investigating Kupferschiefer deposit, was prepared by Prof. Adam Piestrzyński (Figure 2).

Participants had the opportunity to see many different styles of mineralization and spectacular examples of ore textures. On Thursday (24th of October), participants visited the Mississippi Valley-type deposit in the Okisku-Pozórosa underground mine, the last operating Zn-Pb mine in Poland. The ore is located in the dolomites of the Lower Muschelkalk (middle Triassic) formed as a result of dolomitization of carbonates into “ore-bearing dolostones”. Ore occurs as lenses, stratiform layers, breccias and collapse breccias cemented by sulfides. The ore district is famous for its excellent examples of “Schalenblende” – dark and light bands of collomorph sphalerite, usually accompanied by galena and marcasite (Figure 3).

The afternoon session started with Prof. Stanisław Mikulski (Polish Geological Institute) addressing to the Baltic Chapter members on behalf of the SGA Council. Prof. Dariusz Węgiel (AGH) gave a short lecture about the application of organic matter investigation to Kupferschiefer Cu-Ag deposit and then, for something completely different, Roland Butler (Millrock Resources Inc.) gave a talk about nickel sulfide deposits at Voisey’s Bay (Canada), which aimed at inspiring students to choose a career in mineral exploration. The collaboration between AGH University of Science and Technology in Kraków, Luleå University of Technology in Sweden, University of Oulu in Finland and TU Bergakademie Freiberg in Germany resulted in a new MSc exchange programme in mineralogy that was funded by the EIT Raw Materials. It was a topic of a next talk by Władysław Zygo (AGH) who presented opportunities offered for students by ExpòTre, highlighted this year activities and encouraged students to apply for this programme. Just before the end of the Baltic Chapter meeting, ExpòTre (explore.agh.edu.pl) and (Targ)3 organized at AGH a two-day short course led by Tobias Bauer (LTU) aimed to provide an overview of structural geology and field techniques for more comprehensive understanding and characterization of structural control on mineralization.

Friday morning (October 24th), the last day of the meeting, was dedicated to student presentation, with talks covering topics such as the Cu-Ag deposit in Shan Plata (Myanmar), Cu-Mo porphyries (Peru), Cu-Co mineralization from Kunene (Namibia), Bi mineralization from the Vardar Zone (Kosovo), Secondary U mineralization from Jáchymov (Czech Republic) and environmental impact assessment of a Pb, Zn smelter from Kabwe (Zambia).

Last but not least was the GeoQuiz. Participants were divided into three competing groups and set of fun quest aimed to check their knowledge of ore deposits, mineralogy and metal production. Another ExpÒTre activity started and students were encouraged to participate in a short course “Strati-form deposits – exploration techniques, data analysis and interpretation, geological modelling, resource calculation” led by Władysław Zygo (AGH) and Andrzej Gądek (mining consultant).

We would like to express sincere gratitude to all the people whose help and dedication made this event possible. We would like to thank our keynote speakers: Prof. Sarah Gleeson and Prof. Murray Hitzman for sharing their experience and knowledge with us. We are grateful to Prof. Jacek Matsykaswicz, Dean of the Faculty of Geology, Geophysics and Environmental Protection at AGH as well as Prof. Anna Siwik, AGH Vice-Rector for Student Affairs for their financial support. We appreciate the effort of Tomasz Chral and Artur Kuczak, mining geologist from the Polkowice-Sieroszewice Mine and Tomasz Wójcik, mining geologist from the Pomorzany Mine. We would like to acknowledge SGA support via the Keynote Speaker Program.

Fig. 2: Exhibition of specimens from the Cu-Ag Kupferschiefer deposit.

Fig. 3: Typical example of Zn-Pb ore from the Pomorzany Mine: banded sphalerite with marcasite and galena.
Mineral deposits of the Erzgebirge: A field trip report (Black Forest – Alpine Student Chapter)

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The Black Forest – Alpine Student Chapter organised its second field trip on 10th – 15th June 2019, which explored the active and historic mine sites of the Erzgebirge (Ore Mountains), in Germany (DE) and the Czech Republic (CZ). The six day long field trip offered numerous opportunities for 16 students and two staff members to explore and discuss geological setting and genetic processes leading to greisen, skarn and other hydrothermal ore mineralisations.

Beginning in the southwestern part of the Fichtelgebirge-Erzgebirge antcline, we eased into the local geology by visiting the texturally impressive contact between redwitzite (diortite to gabbro) and G1 granite with K-feldspar megacrysts of late Varican age (Figure 1a), near the town of Marktredwitz (the name-sake and type-locality of the redwitzite). Then in Soos (CZ), from the safety of a board-walk, we observed CO2 upwelling through peat and diatreme layers in the Tertiary Cheb Basin (Figure 1b). Helium isotope work indicates a mantle source for the CO2, which fits with the intratemplate earthquake swarms common in the western Eger rift, remnants of volcanism and asthenosphere cooling. With the smell of the mantle in our nostrils, we arrived at Boží Dar (CZ; this translates to an impressive meaning of God’s Gift) and Prof. David Dolejš provided a general introduction to the geology and ore deposits of the Erzgebirge region, while we enjoyed our first taste of Czech beer.

The second day started with a comprehensive tour through the alteration zones of a typical greisen at Krásno (CZ). For comprehensive tour through the alteration zones Erzgebirge region, while we enjoyed our first taste of Czech beer.

On the third day, we observed fracture-controlled greisen at Geyer Finge (collapsed mine workings; DE) localised along horizontal and vertical veins and in places historically sampled by miniature channel samples for Sn content (Figure 3a). Additionally, we observed the marginal pegmatite (“Stockscheider”), where impressive feldspar megacrysts grew out of melt at the contact to the older granite wall-rock. The greisen at Geyer is also intersected by late, low-temperature hematite-quartz veins. The group also visited a range of magnetite-diopside skarns at the St. Christoph mine (Breitenbrunn, DE; Figure 3b), a young amethyst vein at Horní Hálze (CZ) as well as the coarse fluorite-barite veins in the active (since 2013) Niederschlag mine (DE).

On the fourth day, stunning skarn and fluorite-barite ores at the historic Polica mine and Hämmerlein Sn-deposit (DE) were observed. Natural drainage into lower level mine workings means the visitors mine is impeccably dry and without secondary supergene alteration products; perfect conditions for viewing the multistage ore deposition. The oldest stage is skarn mineralisation of metacarbonate horizons in the micaschist of the Joachimsthal group, producing magnetite and sphalerite (containing cadmium and indium) and garnet-amphibole skarn (Figure 4a). Subsequent greisenisation, caused by Variscan granitic intrusions, concentrated Sn and W in the skarn layers, enriched Sn in the surrounding mica “stockschiefer”, and in NE-SW striking veins.

On the fifth day, we headed to the eastern Erzgebirge, excited to see the Zinnwald mine, the type-locality of the Li-bearing mica, zinnwaldite. Although historically mined for Sn, interest has renewed in Zinnwald’s lithium resource in the wolframite-cassiterite-bearing zinnwaldite-quartz greisen, which exhibits both massive greisen and feldsparic alteration zones, which are currently extracted for the ceramics industry (http://www.jmkgranit.cz/en/200/contacts/). To the SE, the historic open pit of Vysoký Kámen exhibits the zinnwaldite-quartz greisen alteration. Then another historical collapse pit to the NE exposes the top of the cupola – a quartz greisen with Cu-W mineralisation (Figure 2b). In the afternoon, we visited the Svoronost mine in Jáchymov or Joachimsthal (Figure 2c), after the historic Cu-W mineralisation, in which the Joachimsthal group, producing magnetite and sphalerite (containing cadmium and indium) and garnet-amphibole skarn (Figure 4a). Subsequent greisenisation, caused by Variscan granitic intrusions, concentrated Sn and W in the skarn layers, enriched Sn in the surrounding mica “stockschiefer”, and in NE-SW striking veins.
isolation of the granite and coarse veining (>). 3 cm long crystals of zinnwaldite ± wolframite ± tourmaline (Figure 5). This day also highlighted some possible variations and open questions about more unusual greisen-related alteration and mineralisation: with a molybdenite-quartz greisen at the Prokop stock and a copper-mineralised greisen of the Mahler vein (both near Krupka; CZ).

On arrival in Freiberg, we enjoyed an overview talk about the Freiberg mining district, in particular the current interests in silver and indium resources, by Matthias Burisch (TU Bergakademie Freiberg) and thanks to the SGA for supporting this field trip. We also received financial support from SGA and the help of Prof. David Dolejš, with financial support from SGA and the help of Prof. David Dolejš.

A two-day theoretical-practical course was offered by Lisa Richter and Prof. David Dolejš, with financial support from SGA and the help of Prof. David Dolejš. This was about the geological chapters of the Industrial University of Santander.

For the first time, this year the Earth Science Week was held, in which all the active geological chapters of the Industrial University of Santander, including the SGA-US, worked together to bring geology to society. A few regional schools were invited and students from sixth to eleventh grade attended. Talks, meetings, games and activities with the aim of teaching students the importance of geology in our daily life were developed.

The SGA-US chapter participated with a stand of different minerals and rocks, explaining the formation process of each sample and their importance in the society. Also, a model was presented explaining the mineral extraction process in an open pit mine.

International field trip – Mexico 2018

The SGA – UIS chapter made the third international field trip to Mexico. We had the opportunity to carry out activities with the geologists of the National Autonomous University of Mexico for 2018. The activities include different lectures, geological meetings, courses and field trips.

Regular Meetings

Throughout the year, lectures and meetings were developed by students of last year, two times per week and were about general topics like basic geology and specific topics like configuration and development of the Colombian mineral deposits. Initially these activities were planned for first semester students; nevertheless, students of different semesters took advantage of these activities and with their help and interest, multiple topics were debated.

Creation and balancing of structural cross section course

A two-day theoretical-practical course was conducted by the geologist Julaian David De Bedout Ordoñez. This was about the development of structural cross sections with real data from our country, also the instructor made a review of the geotectonic development of our Andean mountain range and how this influenced the development of the mineral deposits that have been found in Colombia.

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Celebrating 55th SGA Anniversary

The SGA-UIS chapter thanked all those that contributed and those who drove the long distances and particularly the SGA for supporting this chapter activity. We also like to thank all those that contributed and those who drove the long distances and particularly the SGA for supporting this chapter activity.

The SGA-UIS chapter would like to thank all those who contributed and those who drove the long distances and particularly the SGA for supporting this chapter activity.
On 25th and 26th October 2019, the First National Meeting of the SGA Peru Student Chapter was held at the Pontifical Catholic University of Peru (PUCP), in the city of Lima. Students from eleven Peruvian universities represented by the SGA Peru Student Chapter met with PhD, magisters and engineers of the local mining sector to fraternize and share results and advances of their research projects associated with a variety of mineral deposits.

The main event of the national meeting took place in the morning of the first day and included keynote lectures by MSc José Arce on induced polarization analysis technologies, PhD Jean Vallance on links between organic matter and gold-bearing arsenian pyrite at Shahuindo, PhD Lisard Torró on indium mineralization in Bolivian polymetallic veins and MSc Andrés Yparraguirre on fluid inclusions of the La Paz Batholith. The keynote presentations were followed by a round table discussion on the topic “The Profile of Junior Geologist and the training required by the mining industry”. The round table was directed by the industry sponsor of the chapter and Regional Vice-President of the SGA, Bsc MBA Eugenio Ferrari and involved the distinguished participation of MSc Donald Gutierrez (Peru Country Manager at Freeport-McMoRan) and MSc Cesar Aguirre (Peru Country Manager at Teck Resources Limited) as panelists. In the afternoon, student members from various universities (UNA-Puno, UNC-Cajamarca, UNDAC-Pasco, UNI-Lima, UNMSM-Lima, UNP-Piura, UNSAAC-Cusco and PUCP-Lima), presented several research projects related to a variety of Peruvian mineral deposits.

The second day was for the union and organization of the Chapter. In the morning, former presidents of the chapter shared their experiences during their years in charge, the issues they faced and the way how they solved them. The day culminated with the meeting of the student members of the chapter, Dr. Lisard Torró (academic advisor) and BSc MBA Eugenio Ferrari (industrial sponsor). The meeting served to establish a strategic plan for 2020 and the election of the student chapter leadership for the same period. Additionally, Cusco was elected to hold the Second National Meeting in October 2020.

This first national meeting of the SGA Peru Student Chapter was, certainly a meeting full of emotions, knowledge and experiences that will surely be unforgettable for all.
The 2019 field trip organized by SGA Student Chapter Prague took place at the end of June.

It took eight participants (Figure 1) to some world-famous localities, such as Hallstatt, Habachtal, Untersulzbachtal, Granatenkögel and Schwaz. In these localities, we visited geological units of the Eastern Alps known as the Greywacke zone, Austroalpine nappes, Penninic nappes and Hohentauern window.

1st Day - Hallstatt

The city of Hallstatt is famous for salt mining since the Neolithic. The most significant period of mining is dated to c. 800 – 450 BC and concerns also another nearby region (Hallein). The city was declared as one of the World Heritage Sites in Austria by UNESCO in 1997 and is in the origin of the term “Hallstatt culture” based on its rich archeological record.

2nd Day - Habachtal

Habachtal emerald deposit has been known since Roman times. This locality provides the best emeralds in Europe and it is the only location where emeralds of gem quality occur. The mine has been active until these days, owing to the Steiner family that has been irregularly mining the precious stones. The Habachtal formation (metamorphic and metamafic rocks with serpentinite) is a part of the Hohentauern, which represent the Variscan basement of the Alps. The emeralds result from syn- and post-tectonic growth within the Blackwall biotite schist shear zone situated at the contact of the Central gneiss and the Habachtal formation. Remarkably, these emeralds are not associated with pegmatite dykes. The chromium they contain comes from serpentinites, while the beryllium comes from mica schists (Zwann, 2006). The emeralds mostly appear in the form of automorphic hexagonal columns of up to 4-5 cm in size. The emeralds can be found in the Habachtal valley under the adit, where they are transported by water. When we were close to the mine, we were stopped by the weather and the amount of snow.

3rd Day - Untersulzbachtal

Going from Habachtal, this locality is the next valley in the direction of Krinol. Geologically, it is situated in the northern rim of the Tauern window. Knapenwand series is a part of the Habachtal formation, which was mined contains low amounts of Zn, Pb, As, Bi, Se, Te, Mo and W. The ore consists of 50% chalcocite, 35% pyrite/marcasite, 15% pyrrhotite, galenite, sphalerite and more (Seemann et al., 1993).

4th Day - Granatenkögel

Granatenkögel is situated at the border of Austria and Italy, close to the village of Oberburgl. On the slope of the mountain, there is a locality with garnets, which can be collected from the deluvium. The locality is famous for the size and the quality of the garnets. It is located in the Ötztal-Stubaier-Schneeberg metamorphic complex with Lower Palaeozoic protoliths, which experienced five metamorphic stages (Sölva et al., 2005). The way to the locality goes through a typical glacier valley (Figure 3). We went through the moraines, saw many types of rocks (Fig. 4) and porphyroclasts of garnets.

5th Day - Schwaz

We visited the old mining district of copper called the Schwaz-Brigell. It is located at the western margin of the East-Alpine Greywacke zone. This district presents the Palaeozoic basement. It is made up principally of the metagranitic Kellerjoch gneiss and Upper Ordovician to Silurian elastic metasedimentary rocks and alkaline volcanic rocks. These are capped by the Schwaz dolomite, a unit of Devonian platform carbonates up to 800 m thick. This cover was folded and metamorphosed at ~ 300°C and 2 kbar during the Hercynian orogeny (Pirkl, 1961). Schwaz is a locality of secondary minerals of copper, such as tyroline, olivenite, azurite and malachite.

We are thankful for the financial support from Severočeské doly, a. s., Vitana a. s., Vírský Chvalkoval, a. s., Eurovia a. s. and KOTOUČ STRÁMKERK, spol. s r.o..

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As every year, the Prague Chapter participated in several fieldtrips with other chapters. This year, we managed to negotiate several daily fieldtrips with the SGA Student Chapter Columbia-Bogotá, which focused on emerald and gold deposits. The main target was to visit the world famous emerald deposit near the town of Muzo. The whole program was lead and very well prepared by the Colombia-Bogotá Chapter. The Prague chapter was represented by 10 members and the field trip lasted from March 19 to 25.

1st day: On the first day, we visited a sedimentary-exhalative deposit (SedEx) near Chiquinquirá. Bogotá (Figure 1). SedEx’s ore deposits formed by a release of ore-bearing hydrothermal fluids. Subsequently, they must be released into a water reservoir, resulting in the precipitation of stratiform ore. SedEx’s deposits are the most important sources of lead, zinc and barite. These ores are processed for tungsten, copper, silver, gold and bismuth as well.

2nd day: On the second day, our emerald trip started in the Las Pávaz area. We had accommodation in the town of Muzo, from where a very narrow path led through the local mountains. Muzo itself is well known for its emerald deposits.

Emeralds are usually found in calcite-do-lomite veins containing pyrite, ankerite, albite and quartz. These veins are the product of hydrothermal fluids that disrupt the mafic and the interactions of the metamorphic fluid with subsequent deposition in the fractures formed by these calcite-dolomite veins. It is likely that metamorphic fluids come from shale formations near Muzo, which are probably the source of vanadium, which is the cause of the unique color of local emeralds.

Firstly, we headed to the Rio Magdalena where we could find some samples in the river or meander scrolls (Figures 2 & 3). Only one member of our chapter was lucky enough to find a small sample in the shale. We even investigated one closed mine, which might be reopened in the near future.

3rd day: On the third day, we had a scheduled visit to El Libao Tolima, the El Porvenir gold mine, an epithermal gold deposit (Figure 3). This mine is processing sulfide ores like pyrite, containing relatively large amounts of gold (up to 1.00 ppm). The grains of gold in the ore are mainly included in sulfides and silicates. The mineralization of gold is probably caused by the penetration of porphyrites into the Paleozoic slate on the eastern wing of the Colomban Andes. It is believed that the mineralization of gold occurred in three early stages of intrusion, which are accompanied by sodic-calcic hydrothermal alteration and the late phase of penetration of porphyrites. The samples contain high quartz and chalcopyrite content (Figure 5).

We travelled to the mine a long way on a car’s hull. Then, we went through the inspection, which was waiting for us in front of the mine. The whole mine is active and so we could only be there in the pause period. The whole visit was fantastic and very engaging (Figure 6). At the end, everyone could take only one sample of the size of a fist.

4th day: On the fourth day, we visited the garnet-bearing Cu-skarn Payandé deposit. The post-Triasic plutonic rocks, known as the Payande Stock, are situated on the eastern edge of the Colomban central Cordillera near San Luis-Tolima. The quarry could not be reached directly by our bus, so we had to stretch our legs. At least, we were accompanied by a car that eased us from the road to the front across the river, where we had to take off our shoes and wade. The reason why we drove, there were skarn outcrops, where large and beautiful crystals of andradite are located. Other minerals, like hematite, azurite, quartz, calcite, chlorite, magnetite and sphalerite are also found here. Petrology and mineralogy is very interesting in this deposit, as there are signs of the existence of hydrothermal fluids and changing contacts with individual minerals. We saw the beautiful mineralization of copper. There are also several zones to see. The first zone corresponds to tonalities, the second to endoskarns and the third to exoskarns. There is also a prograde zone containing garnet and pyroxene. In the retrograde zone, iron oxides, iron sulphates and copper are found. This was our last locality in the area.

5th day: On the fifth day, we were back in Bogotá and we had a planned tour of the geological section at the Universidad Nacional de Colomibia. We went through some local classrooms and looked at a few samples from the local collections. We also examined a few rocks which we saw during the fieldtrip under the microscope and finally, we listened to short presentations from Prague Chapter and Bogota Chapter. After exploring the area, we went to the city to taste a bite of all possible and impossible fruits on the world-famous market Plaza de Paloquemao (Figure 7). Then, we moved to the Gold Museum in Bogota and the largest Emerald Museum in the world. Unfortunately, this day, the Emerald Museum was closed, so we had to visit another day.

Finally, we would like to thank all the leaders of this fieldtrip, especially Ivan Mateo Espinel Pachón and all the SGA Student Chapter Columbia-Bogotá members for an amazing organization and for ensuring everything needed for the success of the fieldtrip. In general, I think that the cooperation between student chapters is the best form of studying. Also, I would like to express great thanks to the SGA, as it would not be organized without their support and many thanks to all our sponsors, such as Vitana or Severošedelíčky.

I think that this fieldtrip to Colombia strengthened the connection between our SGA student chapters and we hope that despite the distance between Prague and Colombia, we will continue to collaborate and exchange experiences.
Report from the SGA Turkey Student Chapter 2019

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The SGA Turkey Student Chapter was founded in 2017. The community has 20 student members. Our first activity was held in Pamukkale University (PAU) Teknokent Conference Hall (Denizli, Turkey) at 14th April 2019. In total, 70 participants joined the Colloquium (Figure 1). Most of the attendees were undergraduate and master/PhD students, the rest were from mining companies. The opening speech was made by Prof. Dr. Gülcan Bozkaya (PAU), who is the academic advisor of the SGA Turkey Student Chapter.

The second talk was given by Dr. David Huston from Geoscience Australia (Figure 2). It was about the „Secular Variations of Tectonomagmatic System“.

The third talk was given by Dr. Sven Petersen from Geomar Helmholtz Centre-Germany. The topic of his speech was „Seafloor minerals: A potential Future Mineral Resource?“.

The afternoon session begun with Dr. Karen Kelly’s talk, who is President of the SGA. She gave a talk about the „Pebble Porphyry Cu-Mo Deposit, USA“ (Figure 4). The second speaker at the afternoon session was Dr. David A. Banks from Leeds University-UK (Figure 5). The topic of his speech was „New Developments in Understanding Gold Deposits“.

Prof. Dr. Georges Beaudoin from Laval University-Canada gave two talks (Figure 6). His talk’s titles were „Stable Isotopes in Orogenic Gold Deposits“ and „Indicator Minerals for Exploration“.

We had many good feedbacks from all of the participants. On behalf of the students, we are very grateful to have had the chance to listen and improve our knowledge by the great speakers (Figure 7-9). The SGA Turkey Student Chapter would like to thank all invited speakers, the board of the SGA and especially Anna Vymazalová and Jan Pašava, without them it would not have been possible to make our first student chapter’s activity. We look forward to meet with all SGA members at next activities in Turkey.

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SGA UK Chapter trip to the Scottish Highlands – visits to ancient Pb-Zn workings and a modern gold mine

Lewis Banks1 and Jo Miles1

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To launch the SGA Students and Young Scientists Chapter for the UK and to celebrate the SGA conference coming to ‘home turf’, the chapter organised a one-day field trip to the Scottish Highlands prior to SGA2019. Led by Lewis Banks and Jo Miles, this trip took ten SGA members (Figure 1) from across Europe and North Africa to visit an ancient mine and workings for the Pb-Zn deposits found near Tyndrum and to a modern Au deposit, about to commence production.

Ancient Pb-Zn deposits

Discovered in the early 15th century and forgotten until rediscovery in the early 1700s, the lead-zinc workings at Tyndrum were reworked during and shortly after the 1790s. One such lease actually included a £200 gown for the wife of the local landowner, to be worn only on special occasions! Mining had ceased by 1928, leaving a historic landscape similar to the present day. The ore-bearing vein runs NE-SW and truncates against the late Caledonian sinistral strike-slip Tyndrum-Gren-Fyne fault that is thought to provide the pathway for the high-temperature fluids delivering the metals. These fluids rose under very high pressure and at a high velocity, hence mineralisation is not simple. This resulted in spectacular hand specimens of mineralised Pb-Zn-Cu quartz veins, easily found in the terraced tailings heaps surrounding the old workings.

We spent the morning exploring the tailings heaps and collecting specimens of the local mineralisation (Figure 2).

Modern Au mine

After lunch, the group headed Scotgold’s Cononish orogenic Au deposit, the first commercially mined gold in Scotland beginning operations in 2016. Cononish has a resource estimate (in accordance with the JORC Code 2012) of 555,000 tonnes at 11.1 g/t Au and 2012) of 555,000 tonnes at 11.1 g/t Au and 2012) of 555,000 tonnes at 11.1 g/t Au and 2012) of 555,000 tonnes at 11.1 g/t Au and 2012) of 555,000 tonnes at 11.1 g/t Au and 2012) of 555,000 tonnes at 11.1 g/t Au and 2012) of 555,000 tonnes at 11.1 g/t Au and 2012) of 555,000 tonnes at 11.1 g/t Au and 2012) of 555,000 tonnes at 11.1 g/t Au and 2012) of 555,000 tonnes at 11.1 g/t Au and 2012) of 555,000 tonnes at 11.1 g/t Au.

We are planning to run a core logging workshop in autumn/winter. Please register your interest at sgastudent.co.uk.

Acknowledgements

We would like to thank Scotgold for both, their time and effort in hosting us for the afternoon and SGA for the funding to allow this trip to go ahead.

Further information

If you are a UK PhD student or Early Career Researcher (within first 5 years) and not a member of the UK Chapter, please sign up at sgastudent.co.uk.

We are planning to run a core logging workshop in autumn/winter. Please register your interest at sgastudent.co.uk.

If you are a UK PhD student or Early Career Researcher (within first 5 years) and not a member of the UK Chapter, please sign up at sgastudent.co.uk.

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Fig. 1: Photograph of the attendees and organisers of the trip with employees of Scotgold, Charlie King, Stanley Lister and Maurits Vandenberg. Taken at Scotgold mine. (Photo by Stefan Horn).

Fig. 2: Terraced tailings heaps with fantastic hand specimens of the local mineralisation with a view across north Tyndrum (Photos by Aileen Doran and Stefan Horn).

Fig. 3: Participants looking at Scotgold core from the Cononish deposit.

Fig. 4: Charlie King explaining the regional setting of the Cononish deposit next to a recent spoil heap.

Fig. 5: View of the mother vein from the top of the hill above the mine.
On the 14th September 2019, Charles University (Albertov) hosted a workshop on gemstone deposits. The workshop was held as part of the 9th European Conference on Mineralogy and Spectroscopy (11-13th September) meeting, which was attended by 109 scientists from 20 countries. The workshop organization was sponsored by the Mineralogical Association of Canada, and the participation of young SGA-members was supported by SGA grants.

The workshop commenced with a talk by Dr. Evan Smith (GLA, New York, USA) with the title “Diamonds: growth in the mantle and its deposits at surface”; showing complex origin of diamonds and their host rocks. The next talk by Dr. Lee A. Groat (UBC, Vancouver, Canada) on emerald and its deposits presented a new classification of emerald deposits, examples of specific deposit types, exploration strategies and considerations for Colombian-style deposits. The first afternoon talk by Dr. Guston Giuliani (Université Paul-Sabatier, Toulouse and Université de Lorraine, Nancy, France) on the topic “The geology and genesis of gem corundum deposits”, provided an excellent overview of various sources of gem corundum, with numerous field examples from worldwide localities and gemstone areas, including eastern Africa and south-eastern Asia. The final talk by Dr. Jan Cempírek (Masaryk University, Brno, Czech Republic) on the topic “The geology and classification of emerald deposits, examples of specific deposit types by a wider geological and economic background”.

Fig. 1: Group photo from the workshop, Charles University, Prague (photographed by Jakub Trubá).

The discussion revolved around the use of geochemical inversion of alteration mineral, iron isotopes, Au-Cu deposits, U-Pb dating, IOA deposits, pyrite-polymerallic deposits and the application of whole rock and zircon geochronology to regional and local exploration. A special highlight was the keynote presentation. Professor Hartwig Frimmel gave a memorable talk about the setting of giant ore deposits through Earth history with the focus on gold.

On the 22nd August 2019, this session was re-activated to take part in the session; 3 flash talks, 18 posters and 17 presentations were finally accepted. Even more enthusiasm and interest were expressed after it had become official that the keynote speaker will be Professor Hartwig Frimmel.

In the objectives to share our knowledge of the practical aspects of the genesis of ore deposits and how that can be used in the implementation of successful exploration initiatives, the session 5b entitled “New Mineral Exploration Challenges” sponsored by the SGA (Society for Geology Applied to Mineral Deposits) has been executed at the Goldschmidt conference held this summer in Barcelona, Spain, from 18th to 23rd August 2019.

Once the schedule of this session within the framework of the Goldschmidt conference has been announced, numerous people with an interest in mineral deposits from all over the world submitted papers in order to take part in the session; 3 flash talks, 18 posters and 17 presentations were finally accepted. Even more enthusiasm and interest were expressed after it had become official that the keynote speaker will be Professor Hartwig Frimmel.

In the afternoon of the 21st August 2019, the first round of the debate started in the room 11B+11C from 16h00 to 17h15, only to continue thereafter at the poster session.

In the room, Zié Ouattara and Anthony Williams-Jones chaired the session, they welcomed six speakers coming from Switzerland, Canada, China, Cameroon and Egypt. The discussions were about deposits of copper (Chuquicamata), diamond (Kelvin kimberlite pipes) - molybdenite (Yangchuling deposit), iron (Ntem BF Complex) and ilmenite (Abu Ghalaqa mine). The poster session helped to continue the discussion on a wide variety of papers including orogenic gold of India, gold veins in China, rutile in Korea, the Kouambo BF in Cameroon and the use of lead in Uranium exploration.

In the afternoon of the 22nd August 2019, in the room 11B+11C, the second and final round of the debate took place from 08h30 to 11h30 about the “New Mineral Exploration Challenges”. Zié Ouattara, chairing the session, welcomed eleven speakers from England, Australia, China, Iran, France, India, Germany, Russia and Spain.

The discussion revolved around the use of the synchrotron spectrometry and the fractal dimension in the discovery of new ore deposits. Then it moved on to topics of geochemical inversion of alteration mineral, iron isotopes, Au-Cu deposits, U-Pb dating, IOA deposits, pyrite-polymerallic deposits and the application of whole rock and zircon geochronology to regional and local exploration. A special highlight was the keynote presentation. Professor Hartwig Frimmel gave a memorable talk about the setting of giant ore deposits through Earth history with the focus on gold.

On the 22nd August 2019, this session on mineral exploration challenges attracted more than 400 people, on average 37 people per talk.

At the end of the session, more than 65 people were in the room, discussing and exchanging ideas and this observation brought to chair a sentiment of great achievement.

I am grateful to the Goldschmidt organizers for accepting my session proposal and the technicians during the session execution. I also want to thank all the authors for their submission to session 5b and especially Professor Hartwig Frimmel for his great contribution and expertise.
Gold Deposits: from Exploration to Mining
6th SGA-SEG-UNESCO-IUGS Short Course on African Metallogeny

Beate Orberger¹, Lenka Baratoux², Ghislain, Tourigny³, David Baratoux², Lionel Boya⁴

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³ Perseus Mining, Australia
⁴ Université Félix Houphouët-Boigny, Ivory Coast

The 6th Short Course on African Metallogeny was held in Yamoussoukro, at the INP-HB (Institut National Polytechnique Félix Houphouët-Boigny), Ivory Coast, the 28th of November, 2017. The short course was held in Yamoussoukro, at the INP-HB, which is the capital of Ivory Coast, located at about three hours NW of Abidjan.

The INP-HB also hosts the African Center of Excellence “Mines and Mining Environments” (CEA-MEM), funded by the World Bank from 2016 to 2024. The CEA-MEM, coordinated by Prof. Alphonse Yao, seeks to provide high level research and training of a new generation of researchers and engineers in the field of exploration, mining, groundwater management and water treatment. Furthermore, INP-HB has signed with IRD in 2017 a contract of scientific and technical collaboration in the field of mineral exploration and environment. The INP-HB is also the main institution involved in the International Laboratoire MINERWA (Laboratory for Responsible Mining in West Africa), led by Alphonse Yao and David Baratoux.

Gold exploration and mining is increasing in Ivory Coast. The country hosts a major part of the high gold potential Birimian Greenstone Belts, which outcrop mainly in seven countries, Burkina Faso, Ghana, Senegal, Mali, Guinea, Niger and Ivory Coast. Ivory Coast is still underexplored compared to its neighboring countries. Gold is mined at Tongro (Rangelgold), Bonkô (Newcrest), Ily (La Mancha) and Angovia (XX) and represents one of the most important resources in Ivory Coast. The Yaouré mine (Perseus Mining) will start the mining operation in 2020. Gold production almost doubled within two years from 13t in 2013 to 23.5t of Au in 2015. A mine visit to Yaouré, about 50 km west of Yamoussoukro. Perseus Mining, owner since 4/2016, performed intensive drilling (72,000 m in total), to start the mining operation in 2020. Perseus kindly laid out several metres of drill cores showing the alteration and mineralized rocks. G. Tourigny, A. Cisse and their colleagues from Perseus explained the regional geology, the alteration mineralization of the complex quartz-carbonate vein system associated with faults in metabasalt. Gold mineralization is also associated with fault-controlled quartz-tourmaline-chlorite-carbonate veins in granodiorite. On the second field day, we studied outcrops of the granitoids, metabasalt, and altered pillow lavas. Back to Abidjan, all short course participants were invited for a “lunch and Drake” at X & M Supplier before leaving to the airport.

Foreign PhD and MSc students as well as junior scientists from Cameroon, Nigeria, Senegal and Algeria could join the meeting thanks to generous sponsoring of UNESCO. Local students obtained scholarships from our generous sponsors INP-HB, UNESCO, EAG, IUGS Association, Royal Eijkelkamp and BRGM.

The short course gathered 130 participants from Ivory Coast and its neighboring countries, the program of the 6th short course covered fundamental topics: gold deposits worldwide (Jochen Kolb, KIT, Germany), geology of Western Africa and Ivory Coast (Yacouba Coulibaly, Université Félix Houphouët-Boigny) and geodynamic setting of the West African craton and its importance for gold mineralization (Lenka Baratoux, IRD, France). Regional gold exploration was introduced by (i) scanning gold mineralization through indicator minerals and exploration (David Baratoux, IRD, Toulouse), (ii) portable XRF for gold analyses for exploration (S. Bolster) and (iii) sonic drilling and coupled and combined analytical sensors for on-line-real-time exploration (Beate Orberger, Catura Geoprojects, GEOPS-UPS, France). The final presentation by S. Perrouty, introduced modeling approaches for exploration (72,000 m in total), to start the mining operation in 2020. The Yaouré mine (Perseus Mining) will start the mining operation in 2020.

The 6th Short Course on African Metallogeny was closed with an official ceremony and a gala dinner hosting a local dancing group.

For the practical training, a comprehensive field guide was well prepared by A. Kousavela, L. Baratoux, G. Tourigny, L. Boya, N. Mertaud and S. E. Tegan. The SGA Vice president of Sub-Saharan Africa (Ghislain Tourigny, Perseus Mining) organized a mine visit to Yaouré, about 50 km west of Yamoussoukro. Perseus Mining, owner since 4/2016, performed intensive drilling (72,000 m in total), to start the mining operation in 2020. Perseus kindly laid out several metres of drill cores showing the artifical intelligence applied to exploration and demonstrated the importance of reliable data for modeling. The sessions were chaired by students and numerous discussions followed the presentations.

For Responsible Mining in West Africa, led by Alphonse Yao and David Baratoux.

New innovative exploration technologies were introduced such as (i) multi-scale analysis of the distribution of chemical elements and exploration (David Baratoux, IRD, Toulouse), (ii) portable XRF for gold analyses for exploration (S. Bolster) and (iii) sonic drilling and coupled and combined analytical sensors for on-line-real-time exploration (Beate Orberger, Catura Geoprojects, GEOPS-UPS, France). The final presentation by S. Perrouty, introduced modeling approaches including recent developments in the field of artificial intelligence applied to exploration and demonstrated the importance of reliable data for modeling. The sessions were chaired by students and numerous discussions followed the presentations.

Back to Abidjan, all short course participants were invited for a “lunch and Drake” at X & M Supplier before leaving to the airport.

Thanks to our sponsors, this largest SGA short course ever held on the continent, was a great success.

Fig. 1: INP-HB, Yamoussoukro, Ivory Coast. Prof. Alphonse Yao, coordinator of the CEA-MEM and participants.

Fig. 2: Registration organized by the SGA student chapter Ivory Coast; Opening Ceremony and interviews, organizers and participants during the conference and field trips for the 6th short course.

Fig. 3: Lecturers from topleft to bottom right: J. Kolb, Y. Coulibaly, L. Baratoux, S. Bolster, D. Baratoux, S. Perrouty.

Fig. 4: A “movie project” co-financed by INP-HB-IRD-SGA was born at this short course and we will share the link hopefully soon. Interviewing lecturers, organizers and participants during the conference and field trips for the 6th short course movie.

Fig. 5: Study of Perseus drill cores. Ghislain Tourigny explains alteration zones, the minerals, which are vectoring gold mineralization as well as barren and fertile facies.

For Responsible Mining in West Africa, led by Alphonse Yao and David Baratoux.

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For Responsible Mining in West Africa, led by Alphonse Yao and David Baratoux.
The 15th SGA Biennial Meeting in Glasgow, Scotland

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The 15th Biennial SGA Meeting took place at the beautiful University of Glasgow, Scotland campus from August 27-31, 2019. There were 700 attendees from 60 countries around the world. A total of 75 students were given financial support through the Educational Fund program to attend, and there was a record 300 talks and 200 posters.

The program included several themes: Mineral resources for green growth, co-evolution of life and ore deposits, advances in the understanding of hydrothermal processes, new techniques for metal recovery, from oreogenesis to alluvial, economics of ore deposits, sustainable development of ore deposits, magmatic hydrothermal systems: from porphyry to epithermal, economics of mineral deposits, the changing systems: from porphyry to epithermal, and new discoveries – new views: advances in the science of mineral exploration. In addition, seven short courses were offered, and four field trips. The Opening Ceremony included SGA awards, plenary speakers, and a special tribute for three fellow SGA members who have passed recently, including Don Sangster, Steve Scott, and Jeremy Richards (Figures 1 and 2).

Classic Geology and mineral deposits of the Scottish Highlands field trip

Led by Kathryn Goodenough and Normon Moles

Twenty attendees participated in this pre-conference field trip that included a circuit around much of the Highlands, with visits to the battle mine at Foss, Aberfeldy and the gold mine at Cononish near Tyndrum; the Ferry Road gold deposit at Loch Maree; and the historic mines at Strontian (Figures 3-5). Some classic Scottish geology stops in the NW Highlands were also part of the trip. The trip was supported by M-I Swaco, Scotchgold Resources, Greenore Gold and the Lochaber Geopark. And it was much enjoyed by all participants! (Figures 6 and 7).

Irish base metals field trip

Led by Julian Menuge and Steve Hollis

A pre-conference field trip to base metal deposits in Ireland was sponsored by the Geological Survey Ireland and run from the 21st to 26th of August 2019. The field trip was attended by sixteen participants from Australia, France, China, Slovakia, Columbia, Chile and Canada (Figure 6). Following the collection of field trip participants from Dublin, the first evening was spent at the Woodenbridge Hotel, Avoca, with a lecture on the geology and exploration history of the Avoca Cu deposit by Bill Sheppard. The second day of the field trip was led by Bill Sheppard, Eibhlín Doyle and Sean McClennyaghan examining the Avoca open pits and remediation sites (Figure 7). The varying styles of hydrothermal alteration and base metal mineralization were discussed, with Sean McClennyaghan also presenting research findings on the timing of gold mineralization at Avoca, all well illustrated by drill core brought from GSI’s core store by Pat O’Sullivan and Mike Bywater. Eibhlín Doyle then led the group to sites that highlighted the significant efforts made by EMD to remediate acid mine drainage from the old mine workings.

The morning of the next day was spent examining carbonate-quartz vein systems of The Burren, Co. Clare, and their possible link to Irish-type deposits. The Sheshodonell mine workings were visited as well as karst features of The Burren. The afternoon was spent at the Lisheen core store by Pat O’Sullivan and Mike Sweeney and Robbie Galvin at Knockanrow (K-zone) and Shallee workings as well as efforts to promote it, were presented by Sean McClenaghan also discussing with the Avoca Cu mineralization.

The morning of the next day was spent examining carbonate-quartz vein systems of The Burren, Co. Clare, and their possible link to Irish-type deposits. The Sheshodonnell mine workings were visited as well as karst features of The Burren. The afternoon was spent with Mark Holdstock presenting Group Eleven Resources’ drill cores from regional exploration targets near Stonepark, Co. Limerick. Mineralized and unmineralized sections of the local stratigraphy were examined, including a number of diatremes. After driving to Horse and Jockey in the evening, Colin Andrew gave a comprehensive lecture on the Silvermines deposit. Following a post-breakfast lecture from John Givien on the Lisheen deposit, the morning was spent at the Lisheen core store. John Givien presented mineralized sections from the Main Zone, Derryvyle and Island Pod orebodies, and from the Lisduff oolite (Figure 8). Following a short drive to Silvermines, Co. Tipperary, the afternoon was spent studying mineralisation and host rocks in the Magcobar open pit, Knockanrow (K-zone) and Shallee workings with Colin Andrew (Figure 9).

A field trip to the Skellefte district in Sweden was jointly organized by Luleå University of Technology and New Boliden. The field trip was run 1st-2nd September and covered the volcanostratigraphy and the structures related to Paleoproterozoic base and precious metal deposits in the Skellefte district, northern Sweden. The visits covered the volcanostratigraphy and the structures related to Paleoproterozoic base and precious metal deposits in the Skellefte district, northern Sweden. The visits covered the volcanostratigraphy and the structures related to Paleoproterozoic base and precious metal deposits in the Skellefte district, northern Sweden. The visits covered the volcanostratigraphy and the structures related to Paleoproterozoic base and precious metal deposits in the Skellefte district, northern Sweden. The visits covered the volcanostratigraphy and the structures related to Paleoproterozoic base and precious metal deposits in the Skellefte district, northern Sweden. The visits covered the volcanostratigraphy and the structures related to Paleoproterozoic base and precious metal deposits in the Skellefte district, northern Sweden.
rent exploration prospects and outcrops in the field. Besides numerous field visits, we visited also the Munnrilen open pit mine, the Kristineberg underground mine (both base metals, New Boliden), the Björkdal mine (orogenic Au, Mandalay resources) and the Varuträsk pegmatite mineralization (Figures 10-13).

Icebreaker

The ice-breaker reception on Monday, August 26th was held in the Hunterian Museum at the University of Glasgow. The reception was supported by the Glasgow City Council, with a welcome given by Glasgow’s Lord Provost Councillor Eva Bolander. The venue allowed all attendees to tour the museum, which features stunning permanent displays of archaeology, paleontology, geology and zoology among other items (Figure 14).

Gala Dinner

The gala dinner was held on Thursday, August 29th in the stunning Kelvingrove Art Gallery and Museum. Delegates were treated to an evening of good food, fine wine, entertainment and an experience that only Glasgow can offer. The Kelvingrove museum has 22 galleries and prior to dinner, delegates could tour the range of exhibits. The dinner was held in the Centre Hall, with a beautiful view of the Pipe Organ (Figures 15 and 16). It was truly magnificent.
Homage to Steven Donald Scott,
June 4, 1941 – June 11, 2019

Jan M. Peter1

Toronto, Canada, on June 11, 2019 due to complications from leukemia. He is survived by his wife Joan, his children Donald and Susan, his grandchildren Jacqueline and Hunter, his sisters, nieces, nephews and his extended family.

Steve was an Emeritus Professor in the Department of Earth Sciences at the University of Toronto, where he had been for his entire academic career. He completed his B.Sc. in 1963 and his M.Sc. in 1964 (both from the University of Western Ontario) and his Ph.D. in 1968 from Pennsylvania State University, where he studied under Hu Barnes.

Steve was an internationally renowned economic geologist, who also enriched the lives of many through education, outreach and mentoring. As a testament to Steve’s scientific research impact, he recently received the highest honour and lifetime achievement awards of the World’s two leading scientific societies in the field of Economic Geology, the SGA-Newmont Gold Medal (2015) of the Society for Geology Applied to Mineral Deposits (SGA) and the Penrose Gold Medal (2016) of the Society of Economic Geologists (SEG). Indeed, Steve’s work has garnered eleven other top awards and medals in his fields throughout his academic career, including the Lindgren Award and Silver Medal of the Society of Economic Geologists, the Hunt President’s Medal of the Mineralogical Association of Canada, the Michael J. Keen Medal of the Geological Association of Canada, the Haddon Forrester King Medal of the Australian Academy of Sciences, the Bancroft Award of the Royal Society of Canada, the Duncan R. Derry Medal of the Mineral Deposits Division of the Geological Association of Canada and the Moore Medal of the International Marine Minerals Society.

There are two main themes to Steve’s lifetime of scientific research contributions. The first of these is experimental sulfide, oxide and silicate mineral petrology that focused on specific minerals present in metallic mineral deposits. These theoretical and experimental studies provided (and continue to provide) the fundamental understanding of hydrothermal ore deposit formation and post-formational conditions (temperature, pressure, sulfur and oxygen activity). Steve built on this by applying these findings to specific mineral deposits around the World.

The second theme is the study of base-metal sulfide deposits presently forming in many places on the World’s ocean floor from so-called “black smoker” vents. Steve was the first to recognize that these deposits are modern counterparts (analogues) to so-called “volcanogenic massive sulfide” (VMS) deposits that provide much of the World’s copper, zinc, lead, precious and other by-product metals. Steve was the first economic geologist to participate in a manned submersible dive using the deep submergence vehicle Alvin in 1982 to observe these deposits first-hand in Guaymas Basin, Gulf of California (Mexico). That experience hooked him into exploring for (and discovering) and studying these genetically distinct deposits, firstly off the west coast of North America and then elsewhere in the southwest Pacific.

Steve has focused on many facets of seafloor hydrothermal deposits, including their tectonic setting, geology, geochemistry of mineralization and host rocks, precious and other metal enrichment mechanisms, mineralogy, geotechnical properties, biological controls on mineralization, fluid properties and metal sources, including magmatic input, associated hydrothermal sediments, hydrocarbon generation and vent fauna.

His co-discovery of the large and high-grade Solwara 1 seafloor massive sulfide deposit offshore Papua New Guinea sparked a push to mine these deposits and the Canadian company Nautilus Minerals and other such ventures garnered financial and other interest from major mining companies such as Placer Dome, Teck Resources and Anglo American. Since then, we are in a hiatus for a global debate and introspection to better understand the environmental implications of such future mining activities.

Steve forged strong international ties with like-minded researchers at research institutions around the World (Gifithun Institute of Oceanography, Université de Bretagne Occidentale, L’Institut Français de Recherche for l’Exploitation de la Mer, Woods Hole Oceanographic Institution, Leibniz Institute of Marine Sciences at Kiel University, National Oceanography Centre Southampton and Commonwealth Scientific and Industrial Research Organisation, to name a few of the key players). To facilitate his ocean research, Steve doggedly solicited donations from students, postdoctoral fellows and visiting researchers and procured outside research funding from the Canadian government, the University of Toronto, for which he served as director. He brought undergraduate and graduate students, postdoctoral fellows and visiting researchers from around the globe to work with him. Several of his students (and their students) are now vigorously pursuing similar research.

Steve was not only a tireless and highly successful researcher (he published over 200 journal articles and book chapters in leading international publications), but also served selflessly on scientific societies and bodies, including the International Marine Minerals Society, Canadian Scientific Submersible Facility and the Canadian Ocean Drilling Program. He was a consummate educator and raconteur. He has delivered countless keynote and guest lectures at various venues about his seafloor discoveries around the World and in doing so, promoted science education and a passion for science, technology and engineering in the next generation of researchers. Since his “retirement” in 2006, Steve continued to be active in research and education, and consulted to the mineral resource industry, specializing in the genesis and potential mining of modern seafloor sulfide deposits.

Lastly, and most importantly, Steve was a kind, gentle person and a true friend to many. He is greatly missed.

Donations can be made to the Graduate Student Scholarship/Hunany Fund in Honour of Emeritus Professor Steven D. Scott and Joan Scott at the University of Toronto, Department of Earth Sciences (https://donate.utoronto.ca/give/show/47) and this would be a fitting legacy.
Inaugural SGA Field Conference
Mount Isa and Cloncurry, Queensland, 20-24 July 2020

The SGA (Society for Geology Applied to Mineral Deposits) is holding its inaugural field conference in the North Australian Zinc Belt, which hosts three of the world’s ten largest Zn-Pb-Ag deposits and emerging Cu-Co deposits, as well as a world-class iron oxide copper-gold district. The conference will address fundamental questions on the origin of these deposits:

1. What is an IOCG deposit?
2. How important are magmatic contributions to IOCG deposits?
3. What is the relative importance of syngenetic, diagenetic and epigenetic processes in the formation of sediment-hosted Zn-Pb-Ag and Cu-Co deposits?
4. Are sediment-hosted Zn-Pb-Ag and Cu-Co deposits linked to other basin-hosted deposits (e.g. unconformity-related U) in basin-hosted mineral systems?

In addition, case histories for the discovery of these deposits in the Zinc Belt, Cloncurry district, and elsewhere will be presented. These deliberations will be complemented by afternoon field trips visiting the Ernest Henry and George Fisher mines as well as regional geological sites.

Preliminary program

**Monday, 20th July**
Morning: Eastern Succession geology; Ernest Henry geology; what is an IOCG?
Afternoon: Exploring contribution to IOCG deposits; exploration case histories

**Tuesday, 21st July**
Morning: Magmatic and other contributions to IOCG deposits; exploration case histories
Afternoon: Eastern Succession geology and mineral deposits

**Wednesday, 22nd July**
Morning: Cloncurry to Mt Isa geological traverse
Afternoon: Picnic, Lake Moondarra

**Thursday, 23rd July**
Morning: Western Succession geology; George Fisher geology; basin-hosted mineral systems
Afternoon: Timing of basin-hosted mineralisation; exploration case histories

**Friday, 24th July**
Morning: Western Succession geology and mineral deposits
Afternoon: Timing of basin-hosted mineralisation; exploration case histories

Confirmed speakers

Mark Barton (University of Arizona), Tony Belperio (Minotaur Exploration), Karol Czarnota (Geoscience Australia), Kathy Ehrig (BHP), Joséphine Gigon (Université de Lorraine), George Gibson (Australian National University), Murray Fitzman (ICRAG, University College Dublin), Dan Johnson (Aeon Metals), Karen Kelley (United States Geological Survey), Douglas Kreimer (United States Geological Survey), Ross Large (CODES, University of Tasmania), David Leach (formerly United States Geological Survey), Adam Simon (University of Michigan), Stephan Thiel (Geological Survey of South Australia), Rick Valenta (University of Queensland)

Contacts

David Huston (David.Huston@ga.gov.au); Vladimir Lisitsin (Vladimir.Lisitsin@dnrm.qld.gov.au);
client.services@ga.gov.au

Registration

$AU2000 (professional); $AU800 (student; requires proof of status). A total of 60 places (including speakers) are available on a first-come first-served basis. Register at http://geoscienceaustr.neto.com.au/conference/

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Arabian Plate and Surroundings: Geology, Sedimentary Basins and Georesources

Reihe: Regional Geology Reviews

- Adds new insights on the Regional Geology of the Middle East, North Africa and the Arabian Peninsula domains
- Highly interesting to researchers and companies involved in the exploration of georesources
- Contains important maps at a regional scale such as the geotectonic map of the Arabian Peninsula

This book focuses on the evolution of sedimentary basins of the Arabian Plate and its surroundings. Because these sedimentary basins developed in various tectonic settings, from extensional or transtensional to flexural, transpressional or compressional, their sedimentary sequences provide unique records of the regional geology. Georesources of the Arabian Plate are also described here, including petroleum potential, reservoirs, water resources, fresh water and deep saline aquifers, as well as materials and ore deposits. The book is made by a set of papers authored by geoscientists working in both academia and industry. Numerous chapters describe some regional important geologic features and selected sedimentary basins from the Middle East, North Africa and the Arabian Peninsula domains. Other chapters focus on georesources. A particular focus is given to the geology of Saudi Arabia. This book is an important contribution to the geology of the Arabian Peninsula and its surroundings. In view of the strategic and economic importance of the regional geology and georesources of the Arabian Plate and Surroundings, this volume will constitute an important reference for a wide range of geoscientists interested in the geology of this region, especially those active in petroleum geosciences and related industry. Ultimately, readers will discover important thematic maps in this book.
Mineral Resources

From Exploration to Sustainability Assessment

Reihe: Springer Textbooks in Earth Sciences, Geography and Environment

- Equips students to handle the diverse situations in mineral resource exploration, evaluation and exploitation
- Outlines each of the varied exploration methodologies and how to interpret the geochemical database results
- Numerous step-by-step examples help the reader to learn quickly about mineral resource evaluation
- Summarizes the basic guidelines to evaluate mining projects EIA's worldwide
- Outlines each of the main mining software programs for geological exploration and mining design

This comprehensive textbook covers all major topics related to the utilization of mineral resources for human activities. It begins with general concepts like definitions of mineral resources, mineral resources and human societies, recycling mineral resources, distribution of minerals resources across Earth, and international standards in mining, among others. Then it turns to a classification of mineral resources, covering the main types from a geological standpoint. The exploration of mineral resources is also treated, including geophysics methods of exploration, borehole geophysical logging, geophysical methods, drilling methods, and mineral deposit models in exploration. Further, the book addresses the evaluation of mineral resources, from sampling techniques to the economic evaluation of mining projects (i.e., types and density of sampling, mean grade definition and calculation, Schütz's estimator, evaluation methods – classical and geological, economic evaluation – NPV, IRR, and PI) estimation of risk, and software for evaluating mineral resources. It subsequently describes key mineral resource exploitation methods (open pit and underground mining) and the mineral processing required to obtain salable products (crushing, grinding, sorting, ore separation, and concentrate dewatering. Also with some text devoted to tailings dams). Lastly, the book discusses the environmental impact of mining, covering all the aspects of this very important topic, from the description of diverse impacts to the environmental impact assessment (EIA), which is essential in modern mining projects.

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Potassic Igneous Rocks and Associated Gold-Copper Mineralization

Reihe: Mineral Resource Reviews

- Offers an essential guide to the plethora of alkaline rock nomenclatures, in an updated and expanded edition
- Summarizes the geological and mineralogical characteristics of world-class gold and copper deposits
- Includes a wealth of color photographs of mineral deposits

This book reviews the geochemical and petrological characteristics of potassic igneous rock complexes, and investigates the various tectonic settings in which these rocks occur. The authors provide an overview and classification of these rocks and elucidate the geochemical differences between barren and mineralized potassic igneous complexes. High-K rocks are genetically associated with a number of epithermal gold and porphyry copper-gold deposits. In recent years, there has also been growing recognition of an association of such rocks with iron oxide-copper-gold (IOCG) deposits, intrusion-related gold deposits (IRGIs) and Carlin-type gold deposits. This fifth updated and expanded edition incorporates new data and references from world-class copper and gold deposits worldwide. It also includes the latest publications on the petrogenesis of High-K magmatism and related mineral deposits. Numerous new representative ore photographs of the mineral deposits described are also included in the new edition. As such, the book offers a valuable guide not only for academic petrologists working on alkaline rocks, but also for exploration geologists prospecting for epithermal gold and/or porphyry copper-gold deposits in modern and ancient terrains.

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Guide to authors for the SGA News

Jochen Kolb; chief editor SGA News

Institute of Applied Geosciences, Karlsruhe Institute of Technology, Adenauerring 20b, 76131, Karlsruhe, Germany; editor-sga-news@e-sga.org

There are three types of submission: (1) regular article; (2) reports of SGA student chapters; and (3) reports related to SGA. Regular articles should present scientific studies of the geology, mineralogy and geo-chemistry of mineral deposits or other topics related to mineral deposits. Reports of SGA student chapters should represent detailed description of activities. They must be reviewed by the scientific supervisor of the respective chapter prior to submission. Make sure that the field reports include the exact location (coordinates if available) of each station described. There is no restriction to the length of a contribution, but it should be concise and informative. All figures should be informative and of good quality. The language of SGA News is British English and all contributions need to be formatted as such. When submitting a text, do not include figures or tables and their captions. Present the latter at the end of the Word file and submit the figures separately, instead.

Title and affiliations
Every submission needs to provide: (1) a concise and informative title; (2) the name(s) of the author(s); (3) the affiliation(s) and address(es) of the author(s); and (4) the e-mail address of the corresponding author.

Text formatting
Manuscripts need to be submitted in Word. Use a normal, plain font (10-point Times) for text. Format the text as little as possible. For emphasis, use the format tools of Word (e.g., italics or capitals). Do not use the shift button for capitalizing a whole word. Do not use field functions, tab stops or other commands for indents, or the space bar. Do not insert extra lines between paragraphs; use the Word formatting tools instead. Use the table function, not spreadsheets, to make tables. Abbreviations should be defined at first mention and used consistently thereafter. Please always use internationally accepted signs and symbols for units (SI units).

References
SGA News uses the style that is also used in Mineralium Deposita. Check https://www.springer.com/earth+sciences+and+geography/geology/journal/126?detailsPage=pltci_1060362 for further information.

Figures and Tables
All figures and tables are to be numbered using Arabic numerals. They should always be cited in text in consecutive numerical order. The format in the text is “(Figure 1; Table 1)”. For table and figure captions use “Fig. 1: xxxxx.” and “Tab. 1: xxxxx.” Figures need to be submitted as separate files in jpg-format. They need to be formatted to fit the column format of SGA News: (1) 4 cm wide or (2) 8.3 cm wide for the 3-column part and 6.1 cm wide for the 2-column part. Make sure that the figures are of good quality.

The SGA website
http://www.e-sga.org

SGA SOCIETY FOR GEOLOGY APPLIED TO MINERAL DEPOSITS

New Members from September 30, 2018 until March 31, 2019

124 Student, 39 Regular members, one Senior and one Corporate member applied for membership from March 17, 2019 until November 1, 2019.

Student members 124:
Australia 3
Austria 1
Brazil 1
Cameroon 3
Canada 3
China 1
Colombia 10
Finland 4
Germany 4
Ghana 1
Ivory Coast 15
Mexico 1
Nigeria 2
Peru 6
Poland 10
Russia 34
Senegal 1
Singapore 1
Suriname 1
Spain 13
Sweden 2
Tanzania 1
Turkey 10
United Kingdom 2
USA 2

Regular members 39:
Argentina 1
Australia 6
Canada 3
Chile 2
Colombia 1
Czech Republic 1
Norway 1
Philippines 1
Poland 1
Russia 2
South Africa 1
Spain 2
United Kingdom 6
USA 2

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France 1

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Sweden 1

Applications to SGA for meeting sponsorship must be submitted to Jan Pašava, SGA Executive Secretary. Please contact Jan Pašava for forms and further information.

Ideas and Suggestions for SGA-sponsored activities are welcome and should be addressed to Jan Pašava or any other member of the Council (see e-sga.org for list of members).

Dr. Jan Pašava
SGA Executive Secretary

Czech Geological Survey
Klárov 131/3
CZ-118 21 Prague 1
Czech Republic

Tel.: +420 2 5108 5506
Fax: +420 2 518 18 748
email: jan.pasava@geology.cz
APPLICATION FORM FOR NEW MEMBERS

I would like to become a member of the Society for Geology Applied to Mineral Deposits and to receive my personal access to Mineralium Deposita. Membership fees will be due after acceptance of the membership application. - Note that incomplete forms and those that are not legible will NOT be processed! -

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Academic degrees

Select your Membership Dues*

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☐ 300.00 EUR Corporate Member (includes 3 printed copies of Mineralium Deposita) (for industry only, no academic)

Applications until September 30th will be processed for the current year. From October 1st membership starts with the following year.

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☐ I want to donate ________ EUR to the SGA Educational Fund and
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Send the membership application form to:
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Version June 2018