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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

Contents

The consequences of climate change in the Arctic and implications for natural resource utilisation 1
News of the Society 9
News of the SGA General Assembly 13
SGA Awards at the 15th SGA Biennial Meeting in Glasgow, Scotland 14
President's Corner 20
Reports from the SGA student chapters 22
Baltic Student Chapter's North Macedonia – Kosovo field trip 23
Celebrating 10 years of the SGA Baltic Student Chapter 26
Mineral deposits of the Erzgebirge: A field trip report (Black Forest – Alpine Student Chapter) 28
SGA Student Chapter Colombia-Bucaramanga 31
First National Meeting of the SGA Student Chapter Peru 33
SGA Student Chapter Prague geological and mineralogical trip to the Eastern Alps 34
Prague SGA Student Chapter visiting Columbia-Bogotá SGA Student Chapter: Mineral deposits of Columbia 36
Report from the SGA Turkey Student Chapter 2019 38
SGA UK Chapter trip to the Scottish Highlands – visits to ancient Pb-Zn workings and a modern gold mine 40
Workshops, Conferences and Short Courses 42
Workshop on Gemstone Deposits in Prague 42
Report on the SGA-sponsored session on "New Mineral Exploration Challenges" at Goldschmidt 2019, Barcelona, Spain, 18th –23rd August 2019 43
Gold Deposits: from Exploration to Mining 6th SGA-SEG-UNESCO-IUGS Short Course on African Metallogeny 44
The 15th SGA Biennial Meeting in Glasgow, Scotland 46
People 50
Homage to Steven Donald Scott, June 4, 1941 – June 11, 2019 50

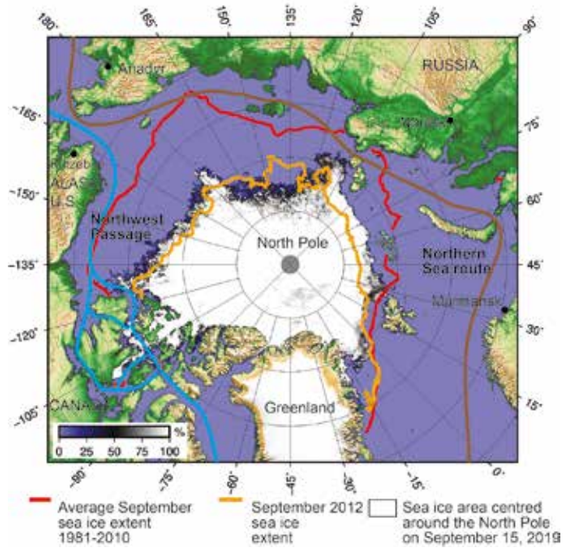

Fig. 1: Location of the Northwest Passage and the Northern Sea Route. Route via Greenland, Northern Canada, US, the Northwest Passage in blue; Route via the North coast of Russia; the Northeast Passage in brown. September is the month when yearly Arctic minimum sea ice extent is reached. In the year 2019, the lowest extent of sea ice was 3.8 million square kilometers (on 3rd, and 14-18th September). The sea ice concentration is derived daily from satellite data with the method described by Spreen et al. (2008). The figure also shows the dramatic decrease of the sea ice that recorded during the period 1981-2010. Sea-ice data and figures are used with the permission of the University of Bremen (https://seaice.uni-bremen.de/arctic-sea-ice-minima/). The small scale bar refers to the proportion of ice (white) and water (blue).

China (without an escort from icebreakers) – over 1,000 tonnes of greenhouse gas emissions were saved by this shorter route for this voyage alone. Besides the obvious environmental benefit saving fossil fuels, this also significantly reduced the cost of fuel for the journey and avoided expensive escort and port fees required along more mainstream canal routes.

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 Bylot (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 2 and 3) 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 to 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 (McGoogan 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[1].

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 shippable 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?

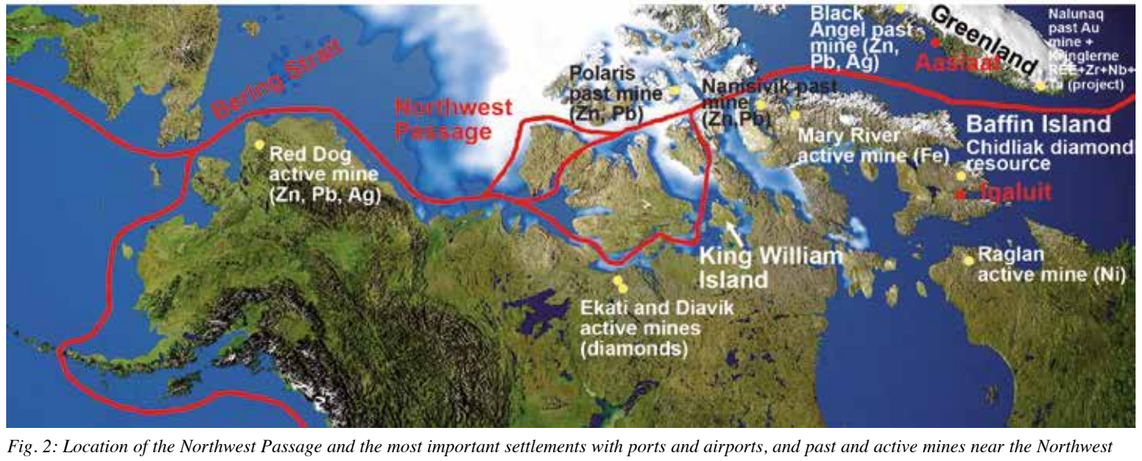

Fig. 2: Location of the Northwest Passage and the most important settlements with ports and airports, and past and active mines near the Northwest Passage. Modified from Wikipedia: https://en.wikipedia.org/wiki/Northwest_Passage#/media/File:Northwest_passage.jpg. Popular Northwest Passage routes. Based on a NASA image that is in the public domain.

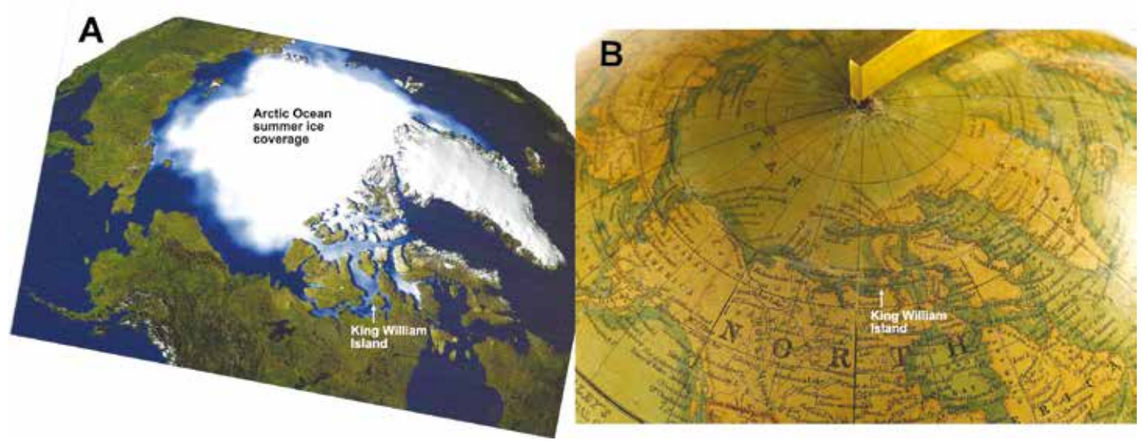

Fig. 3: (A) NASA satellite image of summer Arctic ice coverage reveals that there is no open water North-West of Greenland. (Data source: Satellite observations. Credit: NASA Scientific Visualization Studio, copyright-free NASA image) (B) Photograph of the globe of the world from 1845 showing open water in a large area around the North Pole (modified after Hutchinson 2017). Arrows on A and B show the location on King William Island. It was north of this island that the ships of Sir John Franklin were abandoned, recently found in Terror Bay South of King William Island (wreck of the Terror) and West of Adelaide Peninsula (wreck of the Erebus). The image "GLP0081 (S0361), Terrestrial table globe" is printed with the permission of the National Maritime Museum, Greenwich, London.

Fig. 4: Photograph of the pack-ice in North Greenland taken on board of the sailing vessel Rembrandt van Rijn in 2015 when the first author was also part of the crew. Photograph by courtesy of Plana; published with the permission of the photographer.

With Arctic shipping routes becoming more popular, other considerations between 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., Boé 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 is clearly seen from the shrinking of glaciers – for example, the glacier in Qaamarujuk Fjord (Figure 5) located near the (now moth-

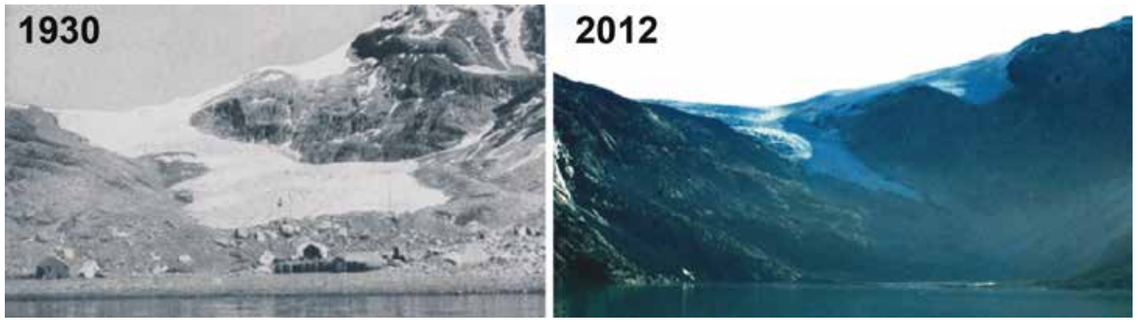

Fig. 5: The same glacier of the Qaamarujuk Fjord. (A) Photograph during summer of 1930, see Georgi (1933). (B) Photographs during summer 2012, see Schlatter (2016). While this glacier has almost reached the ocean in 1930 and Alfred Wegener crossed this glacier to reach the Inland Ice, in 2012 large portions of the glacier has melted.

balled) 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 melting 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.

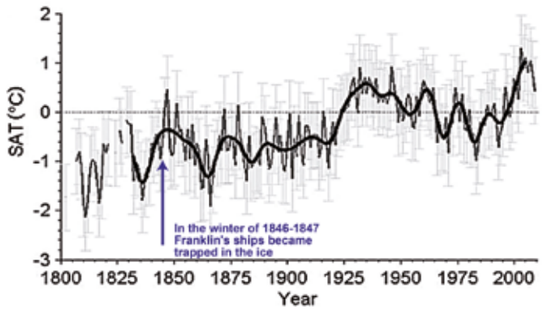

Fig. 6: History of the temperature of the last 200 years. Extended annual mean surface air temperature (SAT) record for the Atlantic Arctic boundary region based on composite land station records. Ninety-five percent confidence limits are shown. Decadal-scale variations are emphasized with a two-way Butterworth low-pass filter constructed to remove frequencies higher than 0.1 cycles per year (black line). The early 20th century warming episode and the recent temperature increase are evident. Figure and figure caption modified from Overland et al. (2011); superimposed is the instance of the winter 1846/1847, when Franklin's ship got trapped in the ice. Figure is used with the permission from Open Academia, registered in Sweden with Company Number 559109-1383.

Geology 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 Africa (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, Ekati 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 Smelror 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 along onshore and offshore oil deposits. Table 1 provides a summary of grade and tonnage of significant mines and mineral 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, more mineral occurrences will undoubtedly be found in these largely underexplored 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 water and industry usage. Further opportunities may come from hydropower (especially with augmented capacity from the melting of the Inland Ice) and other sources of renewable energy such as tidal, wind and wave power. Mud and glacial rock flour produced by the Greenland Ice Sheet represent another natural resource, highly valued as a cropland additive due to its fertilizing properties for improving arable land quality (Bennike et al. 2019; Gunnarsen et al. 2019), and intriguingly with the potential to be used as a carbon-sink for CO_2 capture and storage (e.g., Sarkar et al. 2018). This mud was also successfully tested for producing bricks and expanded clay aggregates and as cement-replacing filler for local construction material production (Belmonte 2015). Together, the natural resources (including metals, water and wind, and industrial minerals such as the anorthosite mined by Hudson Resources Inc. in West Greenland) of the Arctic, particularly along the Northwest Passage, could play an important role in the near future. However, in times of irreversible and overturning climate change comes responsibility – both to the environment and society on a local and global scale. On the one hand, the Northwest Passage and other Arctic sea routes are becoming more viable to access allowing for more efficient 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 ingenious peoples (e.g., Kaiser et al. 2018) possibility exacerbating geopolitical instability.

*Tab. 1: List of mines and mineral exploration projects located near the Northwest Passage, providing the mined/explored commodities, their grades and tonnages as well as information regarding the shipping of the commodities. The location of the mines and mineral exploration projects can be found in figure 2. Data from Boyd et al. (2016), Goodfellow (ed.) (2007), Melia et al. (2017); * shipping information, personal communication John L. Pedersen, 2019; Mt=million tons.*

Country	Project	Main commodity	Date	Shipping season	Shipping demand
Canada	**Polaris**	Zinc 20.1 Mt @13.4% Zn, 3.6% Pb	1971-2002	3 months	1 ice-breaking bulk carrier
Canada	**Raglan**	Nickel >1000 Mt @1.2% Ni	1997-present	8 months	1 ice-breaking bulk carrier
Canada	**Mary River** Milne Inlet	Iron ore >400 Mt @65% Fe	2015-present	Year-round	estimated 3 ice-breaking bulk carriers
Canada	**Ekati**	Diamonds >50 million carats of diamonds	1998-present	Access by winter road	no access to water
US/Alaska	**Red Dog**	Zinc >11 Mt @20% Zn, 5.6% Pb, 90 g/t Ag	1987-present	4 months	23 ship calls/year
Greenland	**Black angel**	Zinc 13.6 Mt @12.3% Zn, 4% Pb, 29 g/t Ag	1973-1990	7 months	1 bulk carrier * (4 to 5 ships/year)
Greenland	**Nalunaq**	Gold 0.713 Mt @15 g/t gold	2004-2014	Gold doré produced on site and sent out by air	ships for infrastructure in the summer season
Greenland	**Kringlerne**	Tantatalum, niobium, REE, zircon 4300 Mt @0.65% Total Rare Earth Oxide, 0.2% Nb_2O_3, 1.8% Zr_2O_5 *(inferred resource)*	*exploration*	*under investigation exploitation license under review*	*under investigation exploitation license under review*
Russia	**Norilsk** Talnakh groups of deposits	Nickel 1309 Mt @ 1.77% Ni, 3.57% Cu, 0.061% Co 9.5 g/t PGE (including 1.84 g/t Pt, 7.31 g/t Pd)	1930s-present	Year-round since 2005	5 ice breaking container ships

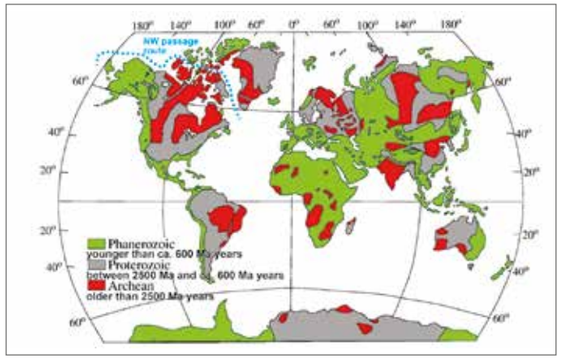

Fig. 7 Distribution of the continental crust and its ages. Superimposed, the approximate route of the Northwest Passage. Modified after Kerrich and Polat (2006). Figure is used with the permission from Elsevier, Licence Number 4703710320540

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[2]) and comparatively few in the Canadian Arctic (population more than 100,000, Canadian High Commission in London[3]) and Greenland (population less than 60,000, after Statistics Greenland[4]) 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 hunters for seals and halibut fishing are reliant for access by dog sledges and skidoos (Ford and Goldhar 2012). Other consequences of the warming are the melting of permafrost and frozen sediment on which many houses in the Arctic are built, resulting in twisted houses and structural instability of buildings as recently seen in Qaanaaq in North Greenland (personal communication by Ole Christiansen, 2019) and in other parts of the Arctic (Welch

and Orlinsky 2019). In the Canadian Arctic, ice roads and airport runways have become unusable due to melting permafrost, causing problems with transportation, infrastructure, communication and trade, including at the Jericho mine – a diamond mine located in Canada's Nunavut territory now under care and maintenance; the short season of the ice roads in 2006 was one of a number of factors that led to its closure (Sevunts 2012).

In recent years, there has been rapid growth in a market for cruise ship tourism in Arctic areas (e.g., Stewart et al. 2013) as well as yachts, and this has particularly been the case along the Northwest Passage. Aside from the increased CO_2 and other emissions from this expansion in activity, it is possible that this will have a negative impact in the form of waste overboard and littering although legislation is generally very effective for larger commercial shipping required to adhere to the International Convention for the Prevention of Pollution from Ships (MARPOL[5]). A recent study has already highlighted the presence of microplastic in sea ice (Peeken et al. 2019) although this is likely also sourced from local industry 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

Fig. 8: Photograph of the village of Siorapaluk in North-West Greenland taken in 2015 on board of the sailing vessel Rembrandt van Rijn, when the first author was also part of the crew. Photograph by courtesy of Plana (2015); published with the permission of the photographer.

Arctic communities with populations generally of less than 100 habitants. For example, the settlement of Siorapaluk in North-West 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 'invasions' of (increasingly more frequent) cruise ship-based tourists pose new challenges to the people, infrastructure and environment – including impact on the fauna and flora of the region.

The very small population of the Arctic regions will also present radical challenges to the likely growth and development of natural resources along the seaboard of the Northwest Passage and vice versa. This applies to all phases from mineral exploration through to mining and rehabilitation. With the development of any large mining project, a large number of workers is needed throughout the ramp-up to production and thereafter during mining and via the multiplier effect. Policies could be put in place to preferentially seek to employ local and indigenous peoples for the work force, but the balance of numbers involved in such operations together with the need for highly specialised roles means that it is most likely that workers from outside of the region would also be needed. It is questionable how well a relatively large foreign workforce will integrate with the indigenous population and what proportion of the total workforce could be indigenous people for future mining operations. What considerations do such radical changes in immigration and emigration require? How do local people envision their roles and future lives in potential sites of exploitation? What steps should be taken so that the voices of indigenous peoples are heard in democracies such as Greenland and Canada (Nuttall 2012)? In a pre-emptive move, the public of Greenland discussed how an influx of approximately 3,000 Chinese workers, in connection with the opening of a future Isua iron-ore mine, could affect the Nuuk region. In particular, the considerations around salaries were discussed. Whilst Chinese 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 Chinese law", although officially this law was given the Danish name for large-scale project legislation: Storskalaloven (Nuttall 2012). However, a fierce debate ensued when this law was passed by the Greenland parliament (Kalaallit Nunaanni 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 responsibility 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 industry tailored to the polar region. Nonetheless, legislation passed by regulators must have the full support of citizens, unlike the case highlighted in Greenland.

Closing statement

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 trade route between Europe and the western Americas with China and other Asian and Australasian 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 making such routes logistically feasible and profitable. Increased local commerce and opportunities will likely also come with this. In particular, the opening of the Northwest Passage will almost certainly open up areas for increased exploration for mineral resources and raw materials, with access via this seaway and other Arctic sea routes bringing commodities to market and the prospect of wealth to the associated seaboard (Schlatter et al. 2018; 2019). The opening of the Northwest Passage on the one hand points to new commercial possibilities that may be harnessed for 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 global warming? Such means would require an open and interdisciplinary discussion between researchers, policy makers, industry, and above all, local communities, on all aspects of benefit and disadvantages.

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Footnotes

1) The successful searches for Terror and Erebus were led by the Arctic Research Foundation and subject of a recent exhibition at the National Maritime Museum in Greenwich, UK (Hutchinson, 2017, Palin, 2018).
2) https://www.thearcticinstitute.org/countries/russia/
3) https://www.canadainternational.gc.ca/united_kingdom-royaume_uni/bilateral_relations_bilaterales/arctic-arctique.aspx?lang=eng
4) Grønlands Statistik, 2018, Intaleeqqap Aqqutaa 1, Postboks 1025, DK-3900 Nuuk; http://www.stat.gl/
5) http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx

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News of the Society

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

Jan Pašava[1] (SGA Executive Secretary)

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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 motions:

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

J. Relvas 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.

J. Relvas/S. Decrée to continue looking after distribution of SGA promotional items upon request of SGA Regional Vice President´s and possibly other Council members and SGA Student Chapters organizing SGA major and/or co-sponsored events.

All Council Members who help in promoting SGA and signing up new SGA members to make sure that the latest application forms including GDPR and credit card payment requirements are used. In particular, the name of the applicant MUST BE THE SAME as the name of the credit card holder. We cannot process payments in the future, for which we do not have the explicit authority of the credit card holder. It is also important to use latest version of application forms (attached to website), asking for 3 digit credit card security code.

A. Vymazalová to inform representatives of SGA Chapters that they need to have language of their contributions to SGA News checked by the chapter's scientific advisor before mailing out to SGA News Chief-Editor. J. Kolb 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 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. Koglin to work jointly with I. Pitcairn on setting up a storage place for SGA documents at SGA website for Council members (access via a password).

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

N. Koglin in collaboration with I. Pitcairn to update a form on donations to SGA Educational Fund and also present versions of SGA membership application on-line forms to enable members to donate sponsorship money to SGA Educational Fund.

N. Koglin in collaboration with I. Pitcairn and J. Kolb to adapt SGA website for e-submission of contributions to SGA News.

N. Koglin in collaboration with I. Pitcairn to reserve www.sga2023.com, www.sga2025.com and www.sga2027.com addresses for future SGA Biennial Meetings.

N. Koglin in collaboration with I. Pitcairn to highlight info on SGA website on possibilities of open access publishing for selected countries and institutions.

N. Koglin in collaboration with I. Pitcairn to add Dr., Prof., titles as an option when filling up SGA membership application form and to remove useful links from website.

N. Koglin in collaboration with I. Pitcairn to add a logo of NEXA Resources among gold sponsors of the SGA Educational Fund and also names and links to new SGA Chapters.

J. Pašava in collaboration with N. Koglin, I. Pitcairn and Ch. Linge to organize SGA 2019 ballot prior to October 15, 2019.

B. Lehmann to promote conditions of open access publishing in Mineralium Deposita in Guidelines to Authors and to send the same text to J. Kolb for publishing in SGA NEWS. We have to make sure that SGA members are well informed on conditions of open access publishing in Mineralium Deposita.

B. Lehmann to look at recent statistics on how many papers affected by open access publishing in Mineralium Deposita.

D. Huston in collaboration with D. Banks and T. Christie to set up a strategy for seeking sponsorship for SGA 2021 Meeting (Rotorua, New Zealand) considering asking for donations to SGA Educational Fund in odd years of the biennial meetings.

S. Decrée to continue her deserving SGA liaison activities with EAG and GS and keep SGA EC informed on any progress and in

collaboration with G. Graham to contact Goldschmidt 2020 Mineral Deposit Theme leader for possible SGA active involvement (sponsorship of SGA keynote(s) and student members at selected sessions).

Huayong Chen in collaboration with X. Sun and Yucai Song (nominated new Regional Vice President Asia) and other Chinese SGA members to continue promoting SGA at suitable events and to try to set up a new Student Chapter in China.

R. Skirrow to continue working jointly with D. Huston and other Australian SGA members on SGA promotion at the 6th International Archean Symposium (Perth, July 2020) and SGA sponsorship of a session on Archean mineral systems.

D. Huston and R. Skirrow to prepare a revised budget of the planned First SGA Field Conference at Cloncurry and Mt. Isa, Queensland, Australia (July 2020) and report to SGA ES who will distribute it for comments to Council.

A. Boyce to send one set of Proceedings from SGA 2019 Meeting to J. Pašava who will ask Clarivate Analytics for their indexing.

All Council Members to continue providing D. Huston and D. Banks with names of relevant officers in mining companies who should be contacted to consider donations to SGA Educational Fund.

G. Touringy to continue collaboration with SGA Student Chapter Ivory Coast and working jointly with B. Orberger and LOC on preparation of the 6th Short Course on African Metallogeny. Council greatly appreciated newly reported sponsorship from UNESCO.

G. Graham to work with K. Kelley and other SGA North American members to secure SGA promotion in the SEG-SGA short course on ore deposits at Colorado School of Mines by organizing an evening event for students (EUR 1,000 approved by Council). It is important to explain relationship between Mineralium Deposita and SGA and to demonstrate that SGA is a truly international society, which is also attractive for students and young scientists.

E. Ferrari in collaboration with K. Kelley and J. Relvas to continue coordination related to SGA participation (SGA booth) at the SEG 2019 Conference in Santiago (Chile) in October 2019 and his deserving efforts related to SGA Student Chapters in the region of South America. Identification of the most appropriate meetings where the Society could be promoted (with help of Student Chapters) and attract new membership is desired.

Report from the Chairman of the Nominating Committee (K. Kelley)

Karen Kelley presented the final list of officers nominated for SGA 2019 ballot, which was approved by Council.

SGA 2019 – update (A. Boyce)

The report was delivered by A. Boyce. The meeting attracted a record number of participants - over 680 from 60 countries. SGA and LOC greatly appreciated patron sponsorship by BHP and other significant contributions from Gold sponsors (AngloAmerican, Agnico Eagle, Boliden and City of Glasgow), Silver sponsors (Dalradian, Rio Tinto and Coeur Mining) and Bronze sponsors (Glasmin, NERC and the University of Glasgow). Three hundred oral and 200 poster presentations were presented and summarized in four proceedings volumes. Seven short courses and two pre-conference and two post-conference field trips were organized. Ice-breaker reception in the Hunterian Museum opened by the Rt. Hon. Lord Provost of Glasgow, Student-Industry networking party at Cottiers Theatre and Conference Gala dinner offered in the stunning Kelvingrove Art Gallery and Museum were part of the meeting. Council highly appreciated all efforts by A. Boyce (Chair of LOC) and his dedicated team and accepted the report with great thanks.

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 this 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 (4) SGA 2021 presentation – invitation to this meeting which was presented during Student Award and Closing Ceremony. The conference website www.sga2021.org is in operation.

Council approved per rollam a request to provide seed money to LOC/SGA 2021 in the amount of EUR 5,000 (info to LOC on August 8, 2019). After discussion Council approved the report with great thanks and the following motions:

- T. Christie with LOC to continue working on preparation of the 16th SGA Biennial Meeting (2021) and to report to next Council meeting.
- T. Christie to prepare a text on the 16th SGA Biennial Meeting for upcoming SGA News and submit it to J. Kolb by October 31, 2019.
- J. Relvas/S. Decrée with All Council Members to help with advertising of the 16th SGA Biennial Meeting (2021).
- T. Christie to plan for 20 min. oral presentations at SGA 2021 Meeting and offer pre-ordering of hard copies of Proceedings volumes.

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, the Russian and the Colombian 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 regular electronic members and by a slight increase of 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 ensure that, in addition to the increase of the student membership, the expected decrease of the "regular print" curve could be overcome by a larger increase of the "regular electronic" subscriptions. After discussion Council approved the report with great thanks and the following motion:

J. Relvas/S. Decrée in collaboration with Ch. Linge to address All Regional Vice Presidents with a request for their help regarding non-renewing members.

Status of development of SGA Student and Young Scientist network (A. Vymazalová)

The report was presented by A. Vymazalová. SGA has 19 student Chapters: Baltic, Barcelona, Black-Forest-Alpine, Brazil, Colombia-Bucaramanga, Colombia-Bogota, Ivory Coast, Laval, Moscow, Morocco, Nancy, NW-Russia, Peru, Prague, Siberia, Turkey, UK, Urals and Western Cape, three of them were created this year (Moscow, Ivory Coast and Urals). She also presented an application for establishing a new SGA Areandina Student Chapter, which was after discussion approved by Council with an initial budget of EUR 500. There will be 14 Student Chapter Representatives at the Glasgow meeting and each will present one slide at the General Assembly.

Regarding the student support for Glasgow meeting:

- In total SGA received 110 applications for student grants, among them 70 students from 29 countries were supported and one professional. In total EUR 27,657 will be distributed to students (registration fees, travel grants and awards for best student oral/poster presentation).
- In addition, SGA received 17 applications for free short course (six awarded) and 23 applications for free field trip (seven awarded but three trips cancelled so four 4 students awarded).
-

The SGA Network on Facebook is still popular - it has 1,499 "likes" and 1,542 followers, about 200 followers more compared to the last year. After discussion, Council approved the report with great thanks and the following motions:

A. Vymazalová to inform President of the new Areandina Student Chapter on Council approval including 2019 budget.

A. Vymazalová to adapt application for student grants for the 16th SGA Biennial Meeting (2021) so that only students who paid their membership fee for two consecutive years are eligible to apply.

Requests for sponsorship

- XXVth ECROFI Meeting (June 25-27, 2019 Budapest) - a total budget of up to EUR 1,500 approved by Council to support SGA keynote speaker (Matthew Steele-MacInnis). Additionally, EUR 250 (travel grant) was approved for M. Komarova - President, SGA Moscow Chapter.
- 10th Anniversary All Russian Conference for Young Scientists." (May 27 - June 1, 2019 Ekaterinburg-Miass, Russia) – sponsorship to SGA keynote speaker (A. Vymazalová) approved with a total budget of up to EUR 1,000
- SGA Student Chapter participation in the IV. Piura Geological Week (September 28-29, 2019 Piura, Peru) – requested USD 1,200
- First Annual Meeting of the SGA Peru Student Chapter (October 25-26, 2019 Lima, Peru) – requested USD 800

Council greatly appreciated all activities organized by Peruvian Chapter and after discussion on both new requests for sponsorship from Peru approved a total budget of EUR 1,500 for both events.

Action: J. Pašava to inform E. Ferrari on Council decision.

Any other business

- SGA new initiatives - update (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 Report with great thanks and recommended to resubmit a revised budget following basic principles of African Metallogeny Courses to J. Pašava who will administrate it within SGA.
- The 6th Short Course on African Metallogeny – Ivory Coast - update (B. Orberger): The report was presented by J. Pašava. The course title is "Gold deposits: from Exploration to Mining" and the first circular was already distributed. The short course will be held at the INP HB, Yamoussoukro (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 seven lecturers from five countries (France, Ivory Coast, Canada, Germany and Australia). Eight sponsors (UNESCO, IUGS, Perseus, GeoDrill, Royal Eijkelkampb, BRGM, EAG and SEG) provided funds for the students and lecturers. Council greatly appreciated efforts by Beate Orberger, Ghislain Tourigny and LOC, expressed once more great thanks to Lenka and David Baratoux and other members of LOC for their invaluable help in the preparation of the course and approved the report with great thanks.

Action: B. Orberger and G. Tourigny 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 committee composed of T. Aiglsperger and S. Petersen.

Action: T. Aiglsperger to finalize the document and send it to N. Koglin/I. Pitcairn for display at website and to J. Kolb for publishing in upcoming SGA News (deadline October 31, 2019).

- Website – useful link pages (N. Koglin, I. Pitcairn): This issue was introduced by N.Koglin and I. Pitcairn and Council decided to remove all information under the "useful links" tab from website.
- 55th SGA Anniversary in 2020 (J. Pašava): This issue was introduced by J. Pašava and Council approved that a special logo on SGA 55 Anniversary will be placed on SGA website, cover page of SGA News and Mineralium Deposita. Additionally, a set of 55 most influential papers published in Mineralium Deposita will be made freely accessible to SGA membership for a period of minimum eight weeks (better four months – a subject of negotiation with Springer).

Actions: B. Lehmann and G. Beaudoin to select 55 most influential Mineralium Deposita papers to secure free temporary access to SGA membership for a period of 4 months as a part of celebration of 55 SGA Anniversary in 2020.
J. Relvas/S. Decrée to prepare a proposal for SGA 55 Anniversary logo and submit it to J. Pašava for SGA administration by October 20, 2019.
J. Pašava to send the final version of the logo to B. Lehmann, J. Kolb and N. Koglin/I.Pitcairn.

- SGA-Springer collaboration (K. Kelley, S. Goodchild – Associate Editor, Earth Sciences, Geography, Environment, Springer): This issue was introduced by J. Pašava who welcomed S. Goodchild from Springer and reminded a traditionally very good collaboration between SGA and Springer when collaborating with A. Buettner and her predecessors. Three major issues including lowering fees for open access publishing in Mineralium Deposita for SGA members, SGA promotional budget and organization of joint booths were discussed. S. Goodchild recommended using existing agreements with individual countries for open access publishing during 2020 and to revisit this issue in late 2020/early 2021, confirmed annual SGA promotional budget in the amount of EUR 2,000 and suggested case by case decisions on sharing booth with SGA. He also offered to arrange for free access of 55 selected most influential papers published in Mineralium Deposita to SGA members during 2020 when Society will be celebrating 55 Anniversary.

Actions: J. Relvas/S. Decrée to use promotional budget from Springer in 2019 and 2020 for replacing SGA promotional items and based on interaction with SGA Regional Vice Presidents and S. Goodchild (Springer) to arrange for SGA promotion via a joint Springer-SGA booth whenever possible.

Date and place of the next SGA Council meeting (March 30 – April 2, 2020 Warsaw, Poland).

The precise venue will be announced in due time.

Informative list of past activities

- XXXVI UNESCO-SEG-SGA Curso Latinoamericano de Metalogenia (23-25 May 2019 Lima, Peru and field trip, 26-29 May), the PUCP university (directly after PROEXPLO 2019)
- 10th Anniversary All Russian Conference for Young Scientists" (May 27 - June 1, 2019 Ekaterinburg-Miass, Russia) – sponsorship to SGA keynote speaker (A. Vymazalová) approved with a total budget of up to EUR 1,000
- XXVth ECROFI Meeting (June 25-27, 2019 Budapest) - a total budget of up to EUR 1,500 approved by Council to support SGA keynote speaker (M. Steele-MacInnis)
- Goldschmidt 2019 Conference (August 18-23, Barcelona, Spain). Following our Memorandum of Understanding, S. Decrée proposed and Council approved that 3,000 € can be spent (1) to cover the travel expenses of an invited speaker and (2) to sponsor SGA student participants, which would need to be nominated by session chairs (selected six sessions)
- The 15th SGA Biennial Meeting (August 27-30, 2019 Glasgow, Scotland, UK) – A. Boyce et al.

Informative list of future activities

- SEG 2019 (October 7-10, 2019 Santiago, Chile) – K. Kelley et al. - free booth and SGA speaker (J. Hanchar) confirmed by LOC
- Conference on Information Technologies in Earth Sciences and Applications for Geology, Mining and Economy ITES & MP-2019 (October 14-19, 2019 Moscow, Russia) – EUR 1,000 approved for SGA student participation or SGA keynote speaker (SGA promotion will be coordinated by E. Naumov)
- The 6th Short Course on African Metallogeny (October 28 – November 1, 2019 Yamoussoukro, Ivory Coast) – B. Orberger, G. Tourigny et al.
- 9th Russian young-scientists scientific school New knowledge in ore-forming processes (November 25-29, 2019 Moscow, Russia) – Council approved regular future sponsorship of SGA student members with a total budget of up to 1,000 EUR and advised LOC to come back with request(s) for additional support for SGA keynote speakers if needed.
- MAESA 2019: Earth Sciences and Sustainable Development (30 November – 1 December 2019, Novotel Hotel, Yangon) – SGA sponsored (promotion of the meeting without any financial obligations)
- 17th Freiberg Short Course in Economic Geology „Iron and Manganese Ore Deposits" (December 1-4, 2019 Freiberg, Germany) – M. Burisch et al - SGA student support approved (EUR 2,000)
- Annual workshop series on ore deposits 2020/Mines "The Geology of Hydrothermal Ore Deposits" (2020 Golden, Colorado USA) – SGA sponsored – G. Graham, D. Leach et al.
- 38th IGC (March 2-8, 2020 New Delhi, India) – SGA sponsors the Theme 28: "Ore Forming Processes and Systems" – J. Pašava - SGA link
- The First SGA Field Conference (July 20-24, 2020 Cloncurry and Mount Isa, Queensland, Australia) – D. Huston et al.
- SEG 2020 (September 12-19, 2020 - Whistler, Canada)
- The 16th SGA Biennial Meeting (November 14-18, 2021 Rotorua, New Zealand) – T. Christie et al.

News of the SGA General Assembly

August 29th, 2019, Kelvin Gallery, University of Glasgow, Glasgow, Scotland, UK

Jan Pašava[1] (SGA Executive Secretary)

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The General Assembly was opened by the SGA Executive Secretary, Jan Pašava 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 (K. Kelley)

The President´s report covered the period from the previous SGA General Assembly (August 21, 2017 Québec 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 (#5 of Mineralogy and #23 of Geochemistry and Geophysics), highly-ranked special publications and 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 invited SGA membership to the 16th SGA Biennial Meeting, which will by held in Rotorua, New Zealand in November 2021. She also mentioned that the call for bids for SGA 2023 Biennial Meeting will be launched through the SGA website shortly. She also presented a list of nominated officers for the upcoming SGA ballot, which was proposed by the Nomination Committee and approved by SGA Council. The ballot will be distributed to SGA Membership by mid-October 2019. Finally, she thanked all SGA officers for their hard voluntary work, which has resulted in the strong development of the Society. Two new initiatives were introduced during her presentation, with more information to come in the next months. One is the SGA mobility grant that will offer an opportunity for all regular members to apply for money (up to 1,000 Euros) to travel to a laboratory facility that is managed by an SGA member. The second new initiative is a Field Conference in Mount Isa, Austalia in July, 2020. The SGA website will provide more information on both new initiatives. J. Pašava then thanked the present SGA President for her extraordinary work for SGA.

Report of the Treasurer (H. Frimmel)

H. Frimmel presented the Financial Report covering the period from August 2017 to July 2019. The balance of 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 € 787,045.09 (plus € 7,877.20 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. Borg and Dr. S. Höhn who did not find any discrepancies with the accounting. J. Pašava then thanked the SGA Treasurer for keeping Society finances in such a good shape.

Report of the Vice-President 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 to find new mineral deposits. Specific objectives are:

1. to support student participation at national and international scientific meetings organized or sponsored by the 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 (K. 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, NEXA Resources, Tintina Resources, BHP Billiton, Barrick Gold, H. Frimmel (Germany) and J. Slack (USA), we were able to support 79 students from 29 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 Metallogeny Course (Freiberg, December 2018), Goldschmidt (Barcelona, August 2019) and many other educational events including the African Metallogeny Course (Moanda, Gabon, 2018). The report was approved by the General Assembly. J. Pašava 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), Colombia-Bogota and Colombia-Bucaramanga Chapters (Matheo Espinel), Laval Chapter (Francois-Xavier Masson), Moscow Chapter (Nikolay Trofimov), Nancy Chapter (Francois Turlin), North-West Russia Chapter (Anton Kutyrev), Peru Chapter (Diego Benites), Prague Chapter (Marek Tuhý), Siberia Chapter (Maria Cherdantseva), Turkey Chapter (Duygu Isbil), UK Chapter (Amy Jo Miles) and Urals Chapter (Sergei Fedorov). J. Pašava then thanked A. Vymazalová and J. Relvas for their efforts related to organization of student issues and all SGA Student Chapter representatives for their presentations.

Other Business

No other business was raised by the SGA members present.

These reports were approved by the General Assembly.

SGA Awards at the 15th SGA Biennial Meeting in Glasgow, Scotland

Jan Pašava[1] (SGA Executive Secretary)

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Similarly, as at past SGA Biennial Meetings, the Awards Ceremony was a part of Opening Ceremony at the 15th SGA Biennial in Glasgow. The following SGA awards were presented during the Opening Ceremony, which was held on August 27, 2017 from 9.00 to 11.00 and attended by A. Boyce (Chair of the LOC-SGA 2019), K. Kelley (SGA President), J. Pasava (SGA Executive Secretary), I. Butler (Vice-Chair, LOC-SGA 2019) and G. Jenkin (Chair, Scientific Program, LOC-SGA 2019):

The SGA-Newmont Gold Medal

The SGA-NEWMONT Gold Medal was established in 2006 to be awarded biannually primarily in recognition of a full career in performance of „unusually" original work in the mineral deposit sector, which shall be broadly interpreted to encompass major contributions to (1) the science through research and (2) the development of mineral resources through mine geology, exploration and discovery. The award consists of a citation, pure gold medal and travel to the Biennial meeting for the presentation.

The first recipient of this most prestigious award was Dr. Zdeněk Johan (France) at the 9th SGA Biennial Meeting in Dublin, Ireland (2007).

The second recipient of the SGA-Newmont Gold Medal became Dr. Shunso Ishihara (Japan) at the 10th SGA Biennial Meeting in Townsville, Australia (2009).

The third recipient of the SGA-Newmont Gold Medal became Dr. David Groves at the 11th SGA Biennial Meeting in Antofagasta, Chile (2011).

The fourth recipient of the SGA-Newmont Gold Medal became Dr. Michel Cuney at the 12th SGA Biennial Meeting in Uppsala, Sweden.

The fifth recipient of the SGA-Newmont Gold Medal became Dr. Steve D. Scott at the 13th SGA Biennial Meeting in Nancy, France.

The sixth recipient of the SGA-Newmont Gold Medal became Dr. David Leach at the 14th SGA Biennial Meeting in Quebec City, Canada.

The seventh recipient of the SGA-Newmont Gold Medal became Dr. Richard H. Sillitoe who was nominated by B. Lehmann and R. Goldfarb and finally selected by SGA Council out of four candidates. After introduction and explanation of the history of the medal by J. Pašava, citation was presented by J. Hedenquist. The medal was presented by K. Kelley (SGA President) and J. Pašava (SGA Executive Secretary). Then R. Sillitoe, who accepted the award presented the acceptance speech. The following citation was prepared and delivered by Jeffrey H. Hedenquist (University of Ottawa):

President Kelley, Executive Secretary Pašava, ladies and gentlemen, Richard H. Sillitoe, the leading practitioner in the profession of economic geology, is being recognized today with the SGA Newmont Gold Medal; this is a momentous event.

Dick's early work was in South America, which led to the publication of a dozen papers prior to the mid 1970s, by the time he was 30. They covered a wide variety of topics related to mineralogy and ore deposits as well as earth processes such as tectonics, volcanism and weathering. Many of these papers presented ideas that were new at the time and like all iconoclasts, Dick suffered push-back from numerous establishment figures. Who was this British upstart, still wet behind the ears?

These publications included the first observations for a relationship between subduction and porphyry copper deposits, a decade before petrologists started to think about subduction recycling. Dick also argued for a genetic association between volcanism and the hydrothermal systems that form porphyry ore deposits – a contentious issue at the time – after observing variably-eroded volcanoes while flying south along the Cordillera and subsequently ground-truthing some of them. At the end of this formative period, Dick started to consult in mineral exploration, soon becoming involved with the discovery of a variety of ore deposits. His work with industry, while at the same time publishing in leading journals – a dichotomy to some – continues to this day. His published record, over 140 papers in international journals and books at last count, extends from first descriptions of ore deposits, or their reinterpretation, through ore-formation and Earth processes, to reviews. One of his more notable overviews, simply entitled Porphyry Copper Systems, has been cited well over 1,600 times since 2010. In addition to a publication record of which any academic would be proud – with manuscripts penned in his free time, largely on aeroplanes – he has written over 950 technical reports for clients.

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 London writing when the director of the Chilean Geological Survey unexpectedly showed up and Dick, being the only Spanish speaker available in the department, was assigned to assist. This fortuitous meeting led to Dick being offered a position in Chile – as Dick says, his only real job – until events three years later led to his departure. This is when the next fortuitous opportunity came by, to advise on a copper project. Dick has never looked back, consulting on nearly 1,000 field-based assignments on numerous commodities and ore deposit types in over half the world's countries for more than 300 companies, plus four international organizations and seven governments.

I first met Dick while a research student, when I drove him to the top of a rhyolite dome that had recently been split by a basaltic eruption. Given the steep and slippery slope, I opted for the momentum that speed provides. About half way up - knuckles white from gripping the roll bar - Dick firmly suggested that I slow down. That was the start of his long influence on me, in which he has served as an example to aspire to. I know numerous others who also have had their careers significantly influenced by this itinerant geologist.

If anyone thinks that this is a eulogy, they would be mistaken. Dick's career has been centered on prodigious field-based investigations 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 assignment.

Coupled with Dick's extraordinary insight, his observations in the field have led to numerous new interpretations, many subsequently demonstrated to be correct, often at the end of a drill hole. However, the best observations and interpretations are of little consequence unless they are communicated and this is where Dick's mastery of language comes to the fore. He merges a focused discipline – second to none – with the ability to write clearly and concisely, whether it be a company report or an article in Nature. Dick's thorough knowledge of the literature is legendary and his notable recall allows him to build on previous observations and ideas by others, which he cites scrupulously. These are the reasons why I started with the adjective "momentous" to describe today's ceremony, as SGA is recognizing the importance of field work, observation, scholarship and communication. I trust that some of the younger members of the audience may see a way forward, following Dick's example.

Fig. 1: Presentation of the SGA-Newmont Gold medal during the Opening Ceremony of the 15th SGA Biennial Meeting in Glasgow, Scotland, 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 Patagonia, southernmost Argentina – where Charles Darwin and the Beagle made landfall in 1834. Perhaps I got the award for contributions to discovery, for writing a few well-received papers in my spare time or a bit of both. Nonetheless, I felt honoured and thrilled to get it although one of my proposers later told me that he felt relieved.

I'd love to regale you with some good stories of life on the road as a geological consultant in 100 countries and for more years than I care to remember (or admit), but time constraints and the formality of the occasion unfortunately prevent it. Some of you may have conducted fieldwork in Afghanistan (where I was visited by Kalashnikov-toting tribesmen while sleeping under the stars), Dominica (almost washed away in a thunderstorm), Greenland (living on an ice-breaker), Madagascar (using Mr Oppenheimer's blue suede-lined private helicopter), North Korea (confronted by a phalanx of tanks on straying into the DMZ) or Tibet (a two-day property inspection extended to three weeks by diabolical weather); however, I suspect no one has had the pleasure of working in all of them.

On occasions like this, it seems customary to address a topic of greater significance than one's own professional life. I've chosen to say a few words about the continuing importance and benefits of geological fieldwork, over and above the obvious ones of seeing the world, enjoying the natural environment and staying reasonably fit without an expensive gym membership. My proposition is that mapping and drill core logging of many mineral deposits and prospects throughout single metallogenic provinces or, even better, globally enables appreciation of geological features, relationships and processes that are rarely apparent from detailed, single-deposit studies, especially when these are predominantly laboratory based. Using examples with which I'm most familiar, recognition of the significance of advanced argillic lithocaps, alteration-mineralization telescoping and diatreme breccias in porphyry copper systems or the linkages between porphyry copper and epithermal deposits requires comparative studies for their proper appreciation. Subsequent detailed analytical studies of individual localities can then enhance understanding and contribute further to genetic interpretation.

Furthermore, I would argue that it is precisely such overarching features and concepts that, once they have become familiar to the exploration community, advance comprehension of mineral systems and as a direct consequence, increase the effectiveness of exploration and lead to discovery. In terms of the above examples, deep drilling for porphyry copper deposits beneath advanced argillic lithocaps and high-sulphidation epithermal mineralization is fast becoming commonplace in attempts to secure 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 obviously we need future generations of field-oriented economic geologists who are broadly experienced and capable of making the observations that can lead to new ways of looking at familiar and supposedly well-understood ore deposit types. Suitable candidates will need to develop competency in the many rapidly expanding facets of the core earth-science disciplines as well as familiarity with a broad spectrum of ore deposit types and their potential interrelationships. And, of course, an awareness of financial, mining, metallurgical, social, environmental and safety issues is also mandatory. The recent graduates who are most likely to fill this future role are those committed to being exposed to as much geology and mineralization as possible, to travel widely and to take the rough with the smooth. Garnering the credentials to become an economic geology consultant is certainly an effective way of satisfying these requirements as well as the adage: 'the best geologists are the ones who've seen the most rocks', to which I would add 'especially if they're mineralized'.

My geological life has been devoted to and motivated by fieldwork: trying to learn as much as possible about mineralized rock relationships in arc terranes and elsewhere and their direct application to exploration and discovery. I commend this career path to any young aspiring geologist able to cope – indeed flourish – with an unconventional lifestyle. Fieldwork led to my receiving this prestigious medal for which I'm indebted to the SGA as well as to the literally thousands of field geologists of well over 100 nationalities who have guided and inspired me on the outcrop, in the core shed and after work. And, of course, thanks to Newmont Goldcorp for kindly donating part of its 2019 gold production.

The SGA Young Scientist Award

Originally SGA Young Scientist Award (2003-2006) then the SGA-Barrick Young Scientist Award (2007-2015) changed back to the SGA Young Scientist Award from 2017. The award is offered biannually to a young scientist who has contributed significantly to the understanding of mineral deposits. It consists of a citation, certificate, EUR 1,500 and travel expenses to the place of the Biennial Meeting for the presentation. The award is given for contributions to economic geology and the recipient must be less than 40 years of age on January 1 of the year in which the award is presented.

The first recipient of this award was Dr. Noreen Vielreicher (Australia) – 2003

The second recipient of this award was Dr. Alexandre Raphael Cabral (Brazil) – 2005

The third recipient of this award was Dr. Gilles Levresse (France) - 2007

The fourth recipient of this award was Dr. David Holwell (UK) - 2009

The fifth recipient of this award was Dr. Kalin Kouzmanov (Bulgaria) - 2011

The sixth recipient of this award was Dr. David Dolejš (Czech Republic) – 2013

The seventh recipient of the SGA Young Scientist Award was Dr. Huayong Chen (China) – 2015

The eighth recipient of this award was Dr. Sarah Dare (Canada) – 2017

The nineth recipient of the the SGA Young Scientist Award became Dr. Crystal LaFlamme who was nominated by G. Beaudoin and finally selected by SGA Council out of five candidates. After introduction and explanation of the history of the award by J. Pašava, citation was read by M. Fiorentini. The award was presented by K. Kelley (SGA President) and J. Pašava (SGA Executive Secretary). The acceptance speech was presented by Crystal LaFlamme.

The following citation was prepared and presented by Marco F. Fiorentini (University of Western Australia):

Good morning everybody, my name is Marco Fiorentini and I am an Associate Professor in Mineral Systems and Early Earth processes at the Centre for Exploration Targeting. This is an applied research centre based at the University of Western Australia.

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 will know this award is offered biennially to a young scientist who contributed significantly to the understanding of mineral deposits.

Many excellent candidates were nominated and considered for the award this year. It is actually great to remark the outstanding scientific calibre that characterises 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. And the winner of this year's SGA Young Scientist Award is Dr. Crystal Laflamme.

Crystal received her PhD in Canada in 2014 and arrived to UWA in early 2015 with a strong background in field mapping, tectonics and radiogenic isotope systems. During her post-doctoral appointment with us, she grew tremendously and became one of the world leaders in the application of stable isotope techniques to monitor the evolution of fluids and magmas in a wide range of mineral systems.

In Australia, she also developed a strong relationship with industry and successfully integrated isotope techniques towards a better understanding of the global volatile and metal cycle during supercontinent amalgamation and breakup. With the philosophy that applied science and fundamental research are ultimately two sides of the same coin, Dr. LaFlamme was able to translate findings from her industry-funded research into a number of high-impact publications, pushing the boundaries of science and pioneering some of the analytical techniques that are used to measure multiple sulfur isotopes.

This successful field of research has enabled Dr. LaFlamme to attract top quality students during her appointment at UWA. Her excellence in supervision of students is reflected in their remarkable accomplishments and the award of very competitive scholarships to carry out postgraduate studies. Furthermore, in her relatively short career to date, Dr. LaFlamme has also developed collaborative work with many institutions worldwide, completing fieldwork and analytical work in numerous globally.

Dr. LaFlamme has all the characteristics of an emergent research leader. She was able to proactively take the opportunity of the post-doctoral appointment at

Fig. 2: Presentation of the SGA Young Scientist Award during the Opening Ceremony of the 15th SGA Biennial Meeting in Glasgow, Scotland, UK (from left to right: J. Pašava – SGA Executive Secretary, Crystal LaFlamme (awardee), K. Kelley – SGA President). Photo by D. Drummond.

UWA and transform it into a trampoline to become one of the most renown thought leaders in the field of isotope geochemistry applied to mineral system science. Dr. LaFlamme developed some of the new key working hypotheses that allow us to utilise subtle (but measurable) isotopic anomalies as tracers to track ore forming processes with unprecedented confidence. The work of Dr. LaFlamme's in the field of multiple sulfur isotopes 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 Laval University in Canada 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.

The following acceptance speech was delivered by Crystal LaFlamme:

Thank you Marco for those kind and encouraging words. And thank you to Marco, Georges Beaudoin and David Groves for nominating me. I'm humbled to receive this award and feel that I can only do so by recognising the people that have contributed to my research program. I started my academic career on large government mapping projects in the Canadian arctic where I completed an MSc at Memorial University of Newfoundland and PhD at the University of New Brunswick. I quickly learnt that science and the outdoors were the perfect combination. Also, I noticed that the best geologists were just those that had seen the most outdoors and rocks. It 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 of Targeting at the University of Western Australia where I did a postdoc in developing isotopic techniques to apply to ore deposit research. Under the past helm of Cam McCuaig and now the current leadership of Steve Rowins, this research centre really is the perfect environment for collaboration between industry geologists and researchers of various backgrounds. There, visiting scientists are plenty and doors are always open for discussion and ideas. I learned to work closely with students, postdocs and researchers in order to build on each others expertise and also how to check my ego at the door. Specifically, thank you to Marco Fiorentini, Nicolas Thébaud and Steffen Hagemann as well as many others, for involving me in your projects and helping me to develop my own.

From there, I thought to bring the open style of research back to Canada to Université Laval where I'm now an assistant professor and Canada Research Chair in sulfur isotope geochemistry, but honestly it already existed under the leadership of Georges Beaudoin. He has done a great job of bringing colleagues together of all sorts of different disciplines to work together on problems affecting the mining cycle. I've been on maternity leave since May, so I missed the Canadian field season this year, but my colleagues helped me keep my research program alive this summer. Further I have three great independent students that are here – Laura, Dennis and Michael. Thank you. We all want to have a good work-life balance these days, whether male or female, with kids or without, so I look forward to picking up the slack for others in the future.

Finally, thank you to my husband. He took time off work to come here with our four month old baby, so that I could be here to collect this award. He jokingly said if you're in your 30s and you win an award with the word Young in the title – you should go accept it in person. We had a nice few days exploring this beautiful country. Thank you to the SGA, I humbly accept this award but do so in recognising the many named and unnamed people that have been a part it.

The SGA-KGHM Krol Medal

The objective of this new award is to recognize outstanding service to the Society. The medal is to be awarded to worthy candidates at SGA Biennial Meetings and also on ad hoc basis.

This award was for the first time presented at the SGA 2015 Anniversary Meeting in Nancy. The medal is named after Gerardus L. Krol (1912-1984) who played a key role in the foundation and development of the Society and became its first President. The award consists of a medal minted from three troy ounces of pure silver, citation and travel to the place of presentation of the award.

The first recipient of this award became Dr. Francis Saupé from France in 2015

Fig. 3: Presentation of the SGA-KGHM Krol Medal during the Opening Ceremony of the 15th SGA Biennial Meeting in Glasgow, Scotland, UK (from right to left: G. Beaudoin – on behalf of D. Leach, the recipient of the award, K. Kelley – SGA President, J. Pašava – SGA Executive Secretary). Photo by D. Drummond.

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

The third recipient of this prestigious Society award became Dr. David Leach from USA who was nominated by G. Beaudoin. After introduction of the award and citation presented by G. Beaudoin, the award was presented by K. Kelley (SGA President) and J. Pašava (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, I am particularly honored to present the 2019 SGA-KGHM Krol Medal as I was President of the Society when the Medal was established and first presented to Francis Saupé in 2015, in presence of the Krol family.

The medal is named after Gerardus L. Krol, who played a key role in the foundation and development of the Society and was elected its first President. So, it is most appropriate to award this medal in recognition of service to the SGA in the name of one of its founders and first president. The SGA-KGHM Krol Medal is minted from three troy ounces of pure silver. The face of the medal shows a portrait of Gerardus Krol, whereas the reverse shows the logos of the SGA and KGHM.

It is thus my privilege to introduce you the awardee of the 2019 SGA-KGHM Krol Medal, Dr David Lamar Leach. I would like to note that this nomination was supported by the current President, Dr. Karen Kelley and 3 past-Presidents, Dr. Jorge Kelvas, Dr. Hartwig Frimmel and Dr. Fernando Tornos.

David Leach's involvement with the SGA started more than 30 years ago as Regional Vice-President North America from 1996 to 2002. In this position, he launched the "North American Initiative" for the purpose of increasing the profile of the SGA in North America. During this time, SGA booths started appearing in major scientific and industry meetings, such as the PDAC in 1999. From 2003 to 2004, David was Vice-President of the SGA, becoming President in 2005. That period turned the corner of making the SGA a truly international scientific society, largely under the relentless impulsion from David. This included the then risky endeavour of organizing our flagship SGA Biennial Meeting in Beijing.

After rising to the top of the SGA leadership, David continued his service to the society as treasurer from 2006 until 2011. During this period, the SGA treasury grew to a level where the SGA has financial stability and the capacity to undertake new initiatives and to provide ample support to student activities.

Thus, during the 15 years of his SGA council membership, David was pivotal in the transformation of the SGA into a major, international scientific society, first enlarging from its European roots to America and then towards Asia. He recognized the need for financial stability and reached this in order to give the SGA the means to its mission. This was only possible because of David's profound attachment to the well-being of the SGA, which continues to this day as he gives his time freely to promote, enthusiastically, the SGA during meetings, short courses and other scientific activities. I, for one, was enrolled into SGA Council at the urging of David, like many others I should say. For many years I had the privilege of witnessing David's dedication to the advancement of the SGA, still ongoing to this day. There is, therefore no better candidate for our prestigious SGA-KGHM Krol Medal than Dr David Leach. Please, welcome with me the awardee, Dr David Leach.

The following acceptance speech was delivered by David Leach:

Thank you, George, for your most kind introduction. President Kelley, SGA Council and members. I am deeply honored to receive the important SGA-KGHM Krol Medal. It is a great disappointment I cannot be here to personally thank the SGA Council for this award and to thank all of you for your participation in the SGA Biennial Meeting. SGA has been one of the most rewarding experiences in my professional life. I have immensely enjoyed working with many personal friends, research associates and students who serve SGA and the geological community. I was most fortunate to be a Council member at an exciting point in SGA's progression from a mainly European-based professional organization to a strong and robust international society. A most gratifying experience for me was seeing the large growth

Fig. 4: Karen Kelley (SGA President) who presented the SGA-KGHM Krol Medal to David Leach in his house in Denver. Photo by S. Leach.

in student participation in the Society and the Biennial Meetings. This was also a period that the first corporate funding initiative provided support for students to attend the conference and to present their research.

The SGA-KGHM Krol Medal is about serving and giving to the Society and therefore, it reflects on the complete team, the council, editors, student leaders and technical volunteers who worked together to create a brighter future for SGA. I cannot mention all of the people who worked with me and were instrumental in SGA's growth, but here are some that I especially want to thank. I am forever indebted to Jan Pašava for his dedication, wisdom and stewardship of the SGA Council – he continues to be the rock of our Society. Anna Vymazalová nurtured and guided the early growth of student participation and my tenure as Treasurer was made easier by Sabine Lange and Peter Herzig. Others include Rich Goldfarb, Georges Beaudoin and Jorge Relvas who were instrumental in building corporate support for student activities.

We can take so much pride in SGA's accomplishments. However, the future of our Society, the growth of our student members and our prestigious journal depends on each of us to look forward and search for how we can further contribute to SGA's journey and to the science of ore deposits. The SGA-KGHM Krol Medal means so much to me, coming from this Society and these members, who have been such an important part of my life. Thank you!

The SGA Award for the Best Paper in Mineralium Deposita

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 receipt of the award.

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

Rottier B., Kouzmanov K., Casanova V., Bouvier A.S., Baumgartner L.P., Walle M., Fontboté L. (2018) Mineralized breccia clasts: a window into hidden porphyry-type mineralization underlying the epithermal polymetallic deposit of Cerro de Pasco (Peru). Mineralium Deposita 53: 919-946, will receive the award.

After introduction by J. Pašava and citation by B. Lehmann, the award was presented by B. Lehmann (Chief Editor, Mineralium Deposita, European Office), G. Beaudoin (Chief Editor Mineralium Deposita, North American Office) and J. Pašava (SGA Executive Secretary). On behalf of the authors, the award was accepted by B. Rottier.

The SGA Awards 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 Ledru, Sven Petersen, Iain Pitcairn, 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.

Fig. 5: Presentation of the award for the best paper in Mineralium Deposita during the Opening Ceremony of the 15th SGA Biennial Meeting in Glasgow, Scotland, UK (from left to right: J. Pašava – SGA Executive Secretary, B. Rottier - awardee, K. Kelley (SGA President) and B. Lehmann – Chief Editor Mineralium Deposita, European Office). Photo by D. Drummond.

The best student oral presentations:

Laura Petrella: Naturally occuring Au nanoparticles associated with high-grade mineralization at the world-class Callie deposit, Northern Territory, Australia.

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

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

The best student poster presentations:

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

Mónica Ágreda López: Characterization of serpentinites in Tlima and Antioquia (Colombia): analyzing their CO_2 sequestering potential through carbonation processes.

Olga N. Filimonova: 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!

Fig. 6: Presentation of student awards during the Closing Ceremony of the 15th SGA Biennial Meeting in Glasgow, Scotland, UK (front row from left to right: Samvel Hovakimyan on behalf of Marion Grosjean - best poster presentation, Olga Plotinskaya on behalf of Olga Filimoniva - best poster presentation, Monica Ágreda López - best poster presentation, Alexandra Escobar on behalf of Sibele Nascimento - best oral presentation, Laura Petrella - best oral presentation, Willem Kruger - best oral presentation; second row from left to right (members of the Conference Student Awards Committee): D. Holwell, P. Ledru, I. Pitcairn, D. Banks, J. Kolb and A. Vymazalová (Chair of the Committee). Photo by A. Boyce.

Coming soon....
The SGA Mobility Grant

SGA Mobility Grant

Get ready for SGA networking! Do you know about a SGA member who runs a laboratory that could answer open questions of your research? Then the SGA Mobility Grant can help to bring you together! The SGA Mobility Grant offers an opportunity for regular SGA members to apply for money to travel to a facility with SGA background. Applicants have to be in good standing for at least 3 continuous years (i.e. paid up membership fees; up to 2 years of student membership count) and apply by sending their request following a template to the SGA Mobility Grant coordinator (thomas.aiglsperger@ltu.se). The template will be available soon on our homepage.

Learning and sharing! That's the spirit of the SGA Mobility Grant.

President's Corner

The past is the key to the future

Karen D. Kelley[1] (SGA President 2018-2019)

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If you believe that "the past is the key to the future", that is very good news for SGA, because as my term as President comes to an end and I reflect on the past two years, I see only signs of a healthy, growing, globally-recognized Society. SGA has so much to be proud of, from being a leader in training the next generation of economic geologists, to the vibrant and growing student chapters, to our flagship journal and highly ranked special publications and to cutting-edge workshops, short courses and high-quality Biennial Meetings. To continue on this path, we need to maintain and support 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 Biennial Conferences. In 2018-2019, SGA organized the highly successful annual metallogeny short courses in Latin America and Africa and sponsored student activities and regional meetings, workshops and short courses on many continents in partnership with affiliated organizations including EAG, GS, IAGOD, IUGS and SEG. Additionally, numerous local organizing bodies from universities, government agencies and industry have made these possible. Continued professional development is a major goal of SGA, and the best way to foster this is through these types of opportunities.

A highlight in 2019 was the 15th SGA Biennial Meeting in Glasgow, Scotland. This was an opportunity for academic, government and industry scientists to come together with a common goal of mineral resource science. More than 700 participants from 60 countries attended the meeting and more than 200 presentations were by students, either as talks or posters. A primary goal of the Society is to ensure that the scientific level remains strong at these meetings and the exceptional program of scientific presentations at the 15th Biennial meeting assured that this goal was met.

Through our SGA Educational Fund (SGA EF), more than 27,000 Euros were spent to support attendance by 70 students and one regular member at the Glasgow Conference. This would not have been possible without the SGA Educational Fund sponsoring organizations, so we sincerely thank you for your support. The sponsoring organizations to the SGA EF include The Geological Survey of Sweden, SGA, Sinotech, AngloGold Ashanti Australia, Tintina Resources, BHP, Barrick Gold and Nexa Resources. In addition, there were many sponsors of the conference that made social events and other activities possible. These include BHP, AngloAmerican, Agnico Eagle, Boliden, Rio Tinto, Dalradian, Glasmin, the City of Glasgow, University of Glasgow, Coeur Mining and NERC, along with many exhibitors.

The success of the Glasgow Meeting was the result of the efforts of many people on the local organizing committee (LOC), who did a fantastic job and we thank them for their time and energy during the organization process. The LOC members were from numerous universities in the UK and the British Geological Survey. A very special thanks goes to Adrian Boyce, the chairman of the meeting and David Banks (SGA Councilor) who was the SGA liaison. Together, Adrian and David coordinated efforts of the LOC, but also coordinated with the SGA Executive Council. A big thank you is also extended to the session's chairpersons, keynote speakers, presenters and delegates for their active participation in the meeting and willingness to share their knowledge, research results and expertise. In April 2018, the Council voted in favour of the Rotorua, New Zealand bid to organize the 16th SGA Biennial Meeting in 2021. Preparations have already begun and we can all look forward to what will surely be another major success.

The level of enthusiasm shown in 2018 and 2019 by our nineteen SGA student chapters (5 new in 2018-2019) is impressive. Most of the student chapters were very active, but some highlights included multiple-day field trips that were successfully organized by the Barcelona - Siberia, Columbia - Prague, North-West Russia - Baltic chapters (accompanied by members from the Alpine-Black Forest chapters) and the all-day symposium organized by the student chapter in Turkey that coincided with our Council meeting in Denizli in April, 2019. The enthusiasm shown by these students is contagious, and we highly encourage the formation of new chapters. Institutions with active chapters benefit from students taking advantage of training opportunities (short courses, workshops, field trips) available via SGA, whereas SGA grows its membership and contributes to the next generation of economic geologists in the workforce. It is a win-win situation for all.

Our flagship journal continues to be a source of pride for SGA. The Mineralium Deposita (MD) chief editors Bernd Lehmann and Georges Beaudoin and their editorial team are to be congratulated for their excellent work. The impact factor of MD remained high over the past two years; the impact factor was 3.37 in 2017 and 3.40 in 2018, the highest impact factor of economic geology journals. This is due to the journal's high-quality standards. Our Special Publication Series (Series editor John Slack) has also seen success, first with a book titled "Mineral Deposits of North Africa" and most recently with "Agromining", published in 2019. These books both have had over 14,000 downloads and were among the top 25% of all Springer e-books. As per the agreement between Springer and SGA, all members are able to buy Springer publications with 40% discount.

As part of our commitment to create new opportunities, two new initiatives were proposed in 2018-2019 and will be further developed in the coming months. See David Huston's article in this SGA News for more information.

As 2019 comes to a close, we must say good-bye and give sincere thanks to some Council members and Regional Vice-Presidents whose terms are ending. We also have a "changing of the guard" for our website manager (Iain Pitcairn will replace Nikola Koglin) and promotion manager (Sophie Decrée will replace Jorge Relvas). We thank Nikola and Jorge for their dedication to these positions and welcome Iain and Sophie to these very important positions.

It has been an honour and a pleasure to serve as the 2018-2019 SGA President. I would like to thank all members of Council and the SGA Executive Committee for supporting me in this role over the past two years, and to all SGA members who have helped make SGA the outstanding Society that it is. I especially want to thank Jan Pašava (Executive Secretary), who might be the most organized and motivated person I have ever met, Hartwig Frimmel (Treasurer), who assures the SGA finances are intact, Anna Vymazalová (Vice-President, Student affairs) who continues to motivate and assist students all over the world, and Jorge Relvas, who preceeded me as President and helped me "get my feet wet" as President, and who worked tirelessly as our Promotion Manager for the past two years.

And last, I congratulate the newly elected (or re-elected) Council members and extend a warm welcome to David Huston, who will be taking over as President of SGA in 2020-2021. I have no doubt that SGA will continue to deliver exceptional value to its members and the broader geoscience community in the years to come.

A bright future from a strong past

David Huston[1] (SGA President 2019-)

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As detailed in Karen Kelley's comments above, SGA is currently in very sound health as the consequence of the hard work of the outgoing Executive and Council. Because the Society is in very 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 and many other scientific societies face a number of challenges over the next decade. More on this later, but first to some of the new initiatives that were approved over the last two years and will be implemented in the next two years.

The first new program is the Mobility Grant program, which provides travel support for SGA members (both students and professionals) to undertake research in laboratories run by other SGA members. Grants of up to 1000 € will be provided to support for travel and accommodation and meals while at the laboratories. The research conducted must be relevant to the study of mineral deposits or metallogenesis and a brief report describing the research must be presented to SGA Council. Applications will be considered by Council on an ad hoc basis and can be submitted at any time. To be eligible, the applicant must have been an SGA member for three years, two years of which can be as a student member.

The second new initiative is the SGA Field Conference, which will be held every two years in off years between the SGA Biennial Meetings. The inaugural field conference will be held in Mount Isa and Cloncurry, Queensland on 20-24 July 2020. The conference will have a Gordon conference-like format with morning lectures and discussions and afternoon field excursion. The topics of the conference will be controversies related to and exploration for iron-oxide copper-gold and sediment-hosted zinc-lead-silver and copper-cobalt deposits. The intent is to bring academia, industry and government geologists together to discuss these topics in a less formal and more open format than the biennial conferences.

In addition to these two new initiatives, SGA will continue to advance our current educational and professional support activities. In particular, the SGA Educational Fund will continue to support attendance of students at SGA-sponsored events and student chapters. As detailed in Karen's report, in 2018-2019, five new student chapters were opened. We want to continue this expansion, particularly into regions that currently have very few SGA student chapters.

Now to a major challenge that faces SGA and other scientific societies. There is currently a major push by governments, particularly from the European Union, to provide open access to publicly-funded research. We anticipate that this trend is irreversible and that in the medium term most or all research will be published with open access (i.e. freely available to anybody). This trend will have major impacts on scientific publishers, including Springer, publisher of Mineralium Deposita, and by implication, scientific societies. Currently, this is an advantage to SGA and Mineralium Deposita as Springer has negotiated agreements with a number of EU governments that allows researchers supported by those governments open access publication without direct costs to the researchers.

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 consequences. 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 membership. To make sure that we canvas for 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 Councils 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 useful initiatives to enhance the value of SGA membership.

Fig. 1: David Huston President of the SGA

Reports from the SGA student chapters

SGA chapter	President	E-mail	Website/Facebook	Chapter e-mail	Foundation
Prague	Štěpán Jaroměřský	jaromers@natur.cuni.cz	http://sga.cuni.cz/ https://www.facebook.com/SGA-Student-Chapter-Prague-155355499351/	chapter_prague-user-group@natur.cuni.cz	2002
Baltic	Krzysztof Foltyn	kfoltyn@agh.edu.pl	http://www.sga.agh.edu.pl/ https://www.facebook.com/groups/balticsga/		2009
Siberia	Anna Devyatiyarova	anna13502@gmail.com	www.sib-sga.com	SiberianChapter@yandex.ru	2011
Barcelona	Ariana Carrazana di Lucia	ariana.carrazana@ub.edu	www.bcn-sga-seg.cat/index.php https://www.facebook.com/Bcn-SGA-SEG-Student-Chapter-520047141415889/	student.chapter.ub.sga@gmail.com	2012
Colombia-Bucaramanga	Juan Pablo Jaimes Bermudez	juanjaimesb21@gmail.com	https://www.facebook.com/capitulos-gauis/	sga.uis.bucaramanga@gmail.com	2012
Nancy	Margarita Melfou	margarita.melfou7@etu.univ-lorraine.fr	sganancy.wordpress.com	sga.nancy@gmail.com	2013
Peru	Raíd André Merino Ortíz	rvelascog@uni.pe	https://www.facebook.com/SGAPeru-StudentChapter/	sgastudentchapter.peru@gmail.com	2013
Colombia-Bogota	Valentina Bocanegra Olivera	vbocanegrao@unal.edu.co	http://www.sgabogota.org/ https://www.facebook.com/sgaunalbogota/	sga.unalbogota@gmail.com	2015
Morocco	Said Ilmen	said.ilmen@edu.uca.ma	https://www.facebook.com/SGA-Moroccan-Student-Chapter-1561030220797534/	sgachapter.marrakech@gmail.com	2015
Laval	François-Xavier Masson	francois-xavier.masson.1@ulaval.ca	http://segulaval.ca		2016
Western Cape	Jorgina Akushika	jorginaakushika@gmail.com			2017
North-West Russia	Evgenyi Eremenko	st013196@student.spbu.ru	https://nw-sga.com		2017
Turkey	Fatih Ozbas	fatih.ozbas@istanbul.edu.tr	www.pau.edu.tr/sgatrstudent	sga.turkey@gmail.com	2017
Black Forest-Alpine	Lars Wihanto	larswiha@hotmail.de	bfa2sga.wordpress.com www.facebook.com/groups/849362358568835		2017

SGA chapter	President	E-mail	Website/Facebook	Chapter e-mail	Foundation
Brazil	Julia de Souza Pimenta	juliaspim@gmail.com	fdeabreu4.wixsite.com/website-1		2018
United Kingdom	Jo Miles	amyles86@bgs.ac.uk			2018
Ivory Coast	Sahy Anthelme Veh	vehsahy@gmail.com			2019
Moscow	Maria Komarova	ivanchenko.marija@gmail.com			2019
Urals	Daria Kiselova	podarenka@mail.ru			2019
Colombia-Areandina	Juan Carlos Vargas	jvargas71@estudiantes.areandina.edu.co			2019

Baltic Student Chapter's North Macedonia – Kosovo field trip

Aneta Drzymała[1], Aleksandra Furtak[1], Radosław Mróz[1], Karolina Szczurek[1], Dominika Szurynowska[1], Jakub Węgrzynowicz[1]

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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).

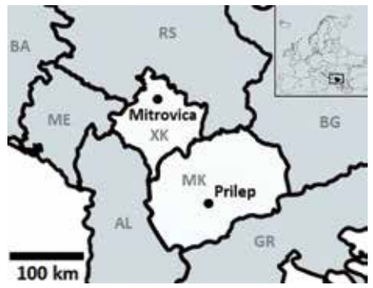

Fig. 1: Contour map showing location of visited places.

This part of the Balkan consists of four main geotectonic units – Serbo-Macedonian Massif (SMM), Vardar Zone (VZ), Pelagonian Metamorphic Complex (PMC) and Dinarides/Hellenides, which generally form parallel, NNW-SSE trending belts (Sharp & Robertson 2006, Hyseni et al. 2010). Three of them contain rocks of Precambrian and Paleozoic age (SKMM, VZ, PMC). 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 Dinarides (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, clastic rocks and volcanic rocks and most importantly for us, numerous Pb-Zn deposits. They occur within the so-called Trepça Mineral Belt, linked with Oligocene-Miocene volcanic activity of andesitic, trachytic and latitic composition (Hyseni et al. 2010). Polymetallic deposits of this region show significant economic potential and historically, they constituted one of the very important ore districts of Europe, however nowadays the political and economic situation hinders exploration and mining efforts.

On the first day of our trip, we visited Alinci (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, syenite,

Fig. 2: Student collecting arfvedsonite specimens and one of those specimens, with typical needle-like crystals.

Fig. 3: View of the Sivec Mine.

Fig. 4: Kyanites from Bonche.

marble and muscovite schist with plenty of pegmatites. Syenite occurs as a magmatic body, 3 km x 2 km in size, with fine-grained structure and a massive texture. The colour of the rock is grayish white. Syenite is composed of microcline, albite, quartz, augite, aegirine, biotite, sphene, apatite, zircon and arfvedsonite (Šijakova-Ivanova et al. 2018). The last mineral was the reason for our visit. It is a rare sodium amphibole ($[Na][Na_2][Fe^{2+}4Fe^{3+}]Si_8O_{22}(OH)_2$), which crystallizes in the monoclinic prismatic crystal system and typically occurs as fibres or needles (Figure 2). It was found both, in syenite and pegmatite. Since arfvedsonite is common for this locality, the quartz crystals are ful of needles of this mineral (Jovanovski et al. 2003).

During the second day of the excursion, we visited the Sivec mine (41°24'41.3"N 21°34'58.8"E) in the vicinity of the town of Prilep. The main raw material exploited here is snow-white dolomitic 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 - the national gemstone of Macedonia. It's a pink to blood-red colored gemstone, a variety of the mineral corundum (Al_2O_3). It is possible to find specimens up to several centimetres in size, although rubies here are rarely of gemstone quality. Besides rubies and muscovite, Sivec marbles host a variety of exotic minerals, such as zoisite, kosmanite, diaspore, fluorite and almandine (Boev et al. 2005). The group had the opportunity to walk through disused parts of Sivec mine and waste dumps and look for rubies.

Next day the group headed to Bonche village (41°13'58.6"N 21°35'44.6"E), 20 km south of Prilep within the Pelagonian Metamorphic Complex, where we were looking for another mineral often found in metamorphic rocks – kyanite. It is an aluminosilicate ($Al_2(SiO_4)O$), which is a polymorph of andalusite and silimanite. Sometimes called also disthene, it is a result of high pressure metamorphism. These conditions occurred in deep subduction zone during the Late Paleozoic (Sharp & Robertson 2006). The deep blue colour of this mineral is caused by Fe(II)-Fe(III) charge species. In an outcropping mica schist, we found a lot of kyanite (Figure 4), usually small (up to few centimeters in size) but with preserved crystal habits. The mineral is associated with staurolite and garnet, which are generally weathered.

During the fourth day of our field trip, we visited the Trepça Mine (42°56'18.9"N 20°54'58.2"E), located 9 km northeast of Mitrovica. A few decades ago, the mine used to be the most profitable company in Kosovo and one of the biggest Pb and Zn producers in Europe with approx. 3.5 Mt of ore mined annually. The mine operates on the Stan Terg Pb-Zn deposit, which is placed in the center of the 80-km-long Trepça Mineral Belt, within the Vardar tectonic zone (Hyseni et al. 2010). Stan Terg is the largest among several Pb-Zn deposits of the TMB. The mineralization in this area is linked to Oligocene-Miocene magmatism, which resulted in skarn, hydrothermal replacement, listwaenite-type and vein mineralization (Kołodziejczyk et al. 2017). It is hosted mostly within Triassic marble in several elongated orebodies. The ore is dominated by galena, sphalerite, pyrite, pyrrhotite, arsenopyrite, with minor chalcopyrite, tetrahedrite, Sn-minerals, Bi-minerals, Ag-minerals and native elements (Kołodziejczyk et al. 2017). The mine is well-known amongst mineral collectors for its world-class specimens of sulfides (Figure 5) and carbonates (especially sphalerite, arsenopyrite, marcasite, pyrrhotite, bournonite, calcite, rhodochrosite and dolomite). We visited the 11th level (the lowest one, approx. 720 m deep) of the mine, where we 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 Mazhiq village (42°55'48.1"N 20°57'10.5"E), just 2 km from the Trepça Mine. It is one of numerous places 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 (Węgrzynowicz 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, krupkaite and aikinite – rare derivatives of the bismuthinite – aikinite series (Węgrzynowicz et al. 2019).

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

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Fig. 5: Sphalerite with pyrite and quartz from the Trepca Mine.

Fig. 6: Participants of the field trip at the entrance to the Trepça Mine.

Celebrating 10 years of the SGA Baltic Student Chapter

Krzysztof Foltyn[1], Sławomir Mederski[1]

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SGA Baltic Student Chapter was formed in 2009 as a result of an initiative of professors Adam Piestrzyński (AGH) and Pasi Eilu (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. Kiruna and Aitik in Sweden, Kemi and Pyhäsalmi in Finland, and Pomorzany and Rudna in Poland), show results of their own 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: Sośnicka 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, Montanuniversität 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 Polkowice-Sieroszowice 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 Weissliegendes 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

Fig. 1: Shortcourse participants with keynote speakers.

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

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 (GFZ 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 Olkusz-Pomorzany 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).

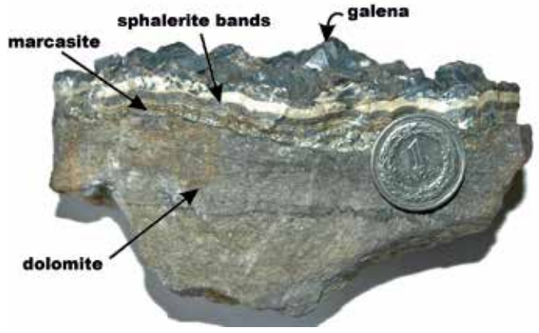

Fig. 3: Typical example of Zn-Pb ore from the Pomorzany Mine: banded sphalerite with marcasite and galena.

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 Więcław (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 exploration funded by the EIT RawMaterials. It was a topic of a next talk by Władysław Zygo (AGH) who presented opportunities offered for students by EXplORE, highlighted this year activities and encouraged students to apply for this programme. Just before the Baltic Chapter meeting, EXplORE (explore.agh.edu.pl) and iTarg3t 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 25th), the last day of the meeting, was dedicated to student presentation, with talks covering topics such as the Cu-Ag deposit in Shan Plateau (Myanmar), Cu-Mo porphyries (Peru), Cu-Co mineralization from Kunene (Namibia), Bi mineralization form 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 EXplORE activity started and students were encouraged to participate in a short course "Stratiform 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 Matyszkiewicz, 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 Chrul and Artur Kuczak, mining geologist from the Polkowice-Sieroszowice Mine and Tomasz Wójcik, mining geologist from the Pomorzany Mine. We would like to acknowledge SGA support via the Keynote Speaker Program.

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 anticline, we eased into the local geology by visiting the texturally impressive contact between redwitzite (diorite to gabbro) and G1 granite with K-feldspar megacrysts of late Variscan 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 CO_2 upwelling through peat and diatomite layers in the Tertiary Cheb Basin (Figure 1b). Helium isotope work indicates a mantle source for the CO_2, which fits with the intraplate 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!

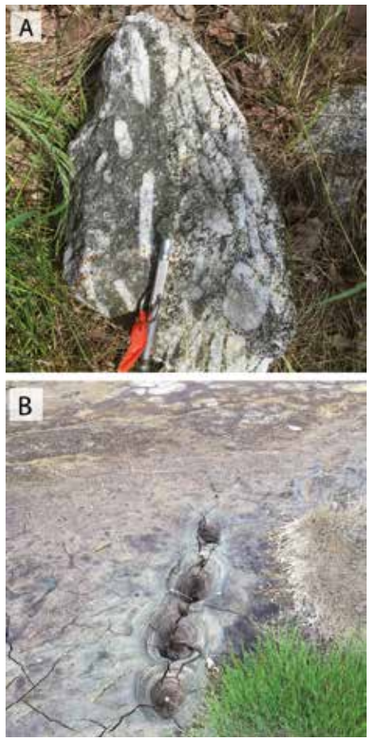

Fig. 1: (A) Contact between redwitzite (left) and porphyritic G1 granite (right); (B) CO_2 degassing vents.

The second day started with a comprehensive tour through the alteration zones of a typical greisen at Krásno (CZ). Fortunately, the Kámen fault causes the host granite and the overlying greisen system to be exposed adjacently. The lower part of the system, in the Krásno quarry (Fig. 2a), reveals an evolved zinnwaldite granite with feldspathite alteration zones, which are currently extracted for the ceramics industry (http://www.kmkgranit.cz/en/200/contacts/). To the SE, the historic open pit of Vysoký Kámen exhibits the zinnwaldite-quartz greisen alteration. Then another historic 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 Svornost mine in Jáchymov or Joachimsthal (Figure 2c), the town that gave name to the dollar currency. This district was historically mined for silver, then uranium and is well known for the discovery of radium by Marie Curie. We viewed the "midnight" and "morning", multi-element veins, mineralised with Ag-U-B-Co-Ni-As and were careful to triple-wrap our native arsenic samples. An epic timespan of rock types from early Variscan schist and lamprophyre to Tertiary volcanic rocks could be collected at the Zalesí mine dump near Jáchymov, where we discussed their chronological order and significance to mineralisation and the regional geology (Figure 2d).

On the third day, we observed fracture-controlled greisen at Geyer Pinge (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 granitic wall-rock. The granite 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 Halže (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 Pöhla 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 micaschist and in NE-SW striking veinlets.

Fig. 2: (A) Feldspathites in the active quarry at Krásno; (B) Wolframite + quartz vein cross-cutting the quartz greisen in the Hub stock; (C) Chapter members outside the Svornost mine, Jáchymov; (D) Rock types – schist, granite, porphyry, lamprophyre, alteration zones and ore veins – studied in Zálesí.

Uranium-bearing, NW-SE trending veins of the Gera-Jáchymov type formed during late Variscan renewed fault tectonics, and in post-Variscan time, the U was remobilised into pitchblende alongside Bi-Co-Ni-Ag enrichments. U was historically mined, with ~1,200 metric tons recovered. Here, we took the opportunity for a group picture (Figure 4b) with the German miners greeting, "Glück Auf!". With a sound understanding of skarn mineralisation, we visited Zlatý Kopec (magnetite-sulfide mine dump) and young, low-temperature quartz-manganese oxide veins at Horní Blatná, an excellent day was topped off with a classic Czech "řezané pivo" (half dark and half pilsner, mixed beer) and plenty of svíčková with knedlíky.

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 gre-

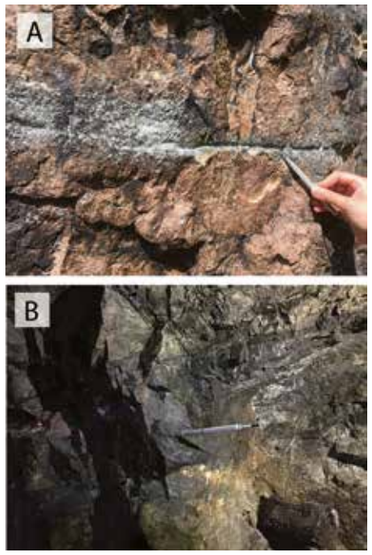

Fig. 3: (A) Historic channel sample along fracture-controlled greisen vein (Geyer Pinge); (B) Magnetite skarn holding up a magnetic scratcher (St. Christoph, Breitenbrunn).

Fig. 4: (A) Amphibole-garnet skarn (Hämmerlein deposit); (B) Chapter members wishing you Glück Auf, outside the Pöhla mine.

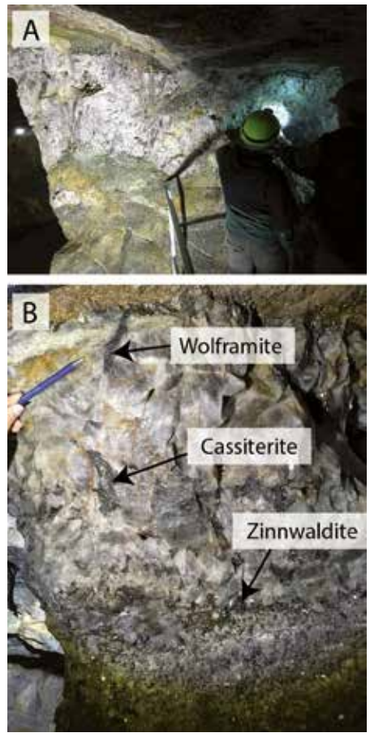

Fig. 5: (A) Coarse-grained zinnwaldite + quartz vein with surrounding massive greisen alteration; (B) Wolframite and cassiterite with quartz and zinnwaldite in one of the greisen veins (Tiefer Bünau Stollen, Zinnwald).

Fig. 6: (A) Kiesige Blei vein containing galena, chalcopyrite, sphalerite and pyrite (Reiche Zeche mine); (B) Chapter members looking at the Sadisdorf core, together with Albert Gruber and Matthias Bauer from Lithium Australia.

isenisation of the granite and coarse veining (> 3 cm long crystals of zinnwaldite ± wolframite ± topaz; 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 SEG Student Chapter Freiberg, we finished the day with an excellent BBQ, Freiberg beer and many ore-iferous discussions.

With an early start on our final day, we headed to see the research mine Reiche Zeche in the Freiberg mining district. Here, we observed two of the Ag-bearing Freiberg veins; the older, high-temperature (~200 – 350°C) and low salinity "kb" (Kiesige Blei) veins (Fig. 6a), and the younger, lower-temperature, high-salinity (~20 wt.% NaCl) "fb" (fluorite-barite) veins. The latest hypothesis for their formation points towards an epithermal system, however a deep heat source is yet to be found. Our eyes were also caught by the in-situ bioleaching experiment that aims to explore less energy-intensive alternatives for ore extraction, in this case leaching indium from sphalerite. At the final stop of the trip, we visited the core shed of Lithium Australia to see their recent (2018) drill core through the Sadisdorf Li-greisen deposit (Figure 6b). Previously mined for Sn, Sadisdorf is now considered an unconventional Li-deposit, with the main lithium ore mineral zinnwaldite, which could be a supply for Li batteries in the European electric car industry. This active project provided an interesting exploration outlook to the end of a successful field trip.

The field trip was organised by Lisa Richter and Prof. David Dolejš, with financial support from SGA and the help of many enthusiastic local guides. We would like to thank all those that contributed and those who drove the long distances and particularly the SGA for supporting this chapter activity.

SGA Student Chapter Colombia-Bucaramanga

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The Industrial University of Santander SGA-UIS Student Chapter formed by 52 student members from different years, carried out successfully all activities proposed 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.

Fig. 1: Meeting run by Jaime Andres Cortes.

Creation and balancing of structural cross section course

A two-day theoretical-practical course was conducted by the geologist Julian 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.

Earth Science Week

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-UIS, 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-UIS 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.

Fig. 2: X-Ray diffraction meeting and how maps and contour lines are generated, made in a sandbox that records the topography and generates a map.

Fig. 3: Geology institute, National Autonomous University of Mexico.

International field trip – México 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

Fig. 4: National seismological service of Mexico, National Autonomous University of Mexico.

Fig. 5: Visit to El Nopal mine, Guanajuato.

Fig. 6: Peña de las Monjas Geosite, Comarca Minera Geopark.

Fig. 7: Basaltic Prisms Geosite.

University of Mexico (UNAM) and with the University of Guanajuato. There was a two-week field trip, in which the geological, geomorphological, tectonic, mineralogical and metalliferous configurations of the visited areas were understood.

In the first place, the facilities and laboratories of the UNAM campus was visited, and the people in charge explained their operation and use procedures. A talk about the Comarca Minera geopark was held, carried out by the teacher Charles Cannet and by the geologist Miguel Ángel Cruz Pérez.

The Guanajuato University also offered its support and various activities were carried out with this institute, visiting the Mineralogical Museum of Guanajuato Eduardo Villaseñor Söhle located on the university campus. A field trip was made, where the configuration of the mining district of Guanajuato, the veta Madre (Mother vein) and the regional-scale structures was studied. Subsequently, the El Nopal mine was visited, where the processes of exploration and underground mining and safety techniques that should be present were observed.

In the last instance, UNESCO World Geopark Comarca Minera was visited. It is located in the state of Hidalgo, includes nine towns which are: Atotonilco el Grande, Epazoyucan, Huasca de Ocampo, Mineral del Chico, Mineral de la Reforma, Mineral del Monte, Omitlan de Juárez, Pachuca de Soto and Singuilucan. Of the 31 geosites present, five geosites were visited: Peña del Cuervo, Peña de las Monjas, Basaltic Prisms, Peña del Aire and El Reloj Monumental. In this tour, it is observed how science and common people can work together for a mutual purpose.

First National Meeting of the SGA Student Chapter Peru

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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. This format of lecture-talk-discussion facilitated the exchange across different academic levels and allowed attracting new members to the chapter.

Fig. 3: Talk by Diego Benites, PhD student and member of the student chapter, on the topic: "Mineralogy of ore from the Ayawilca project, Pasco, Peru".

Fig. 1: Master lecture presented by Dr. Lisard Torró i Abat, on the topic: "Indium in Bolivian polymetallic veins: mineralogical expression and distribution in the Huari Huari and Ánimas - Chocaya – Siete Suyos deposits".

Fig. 2: Round table discussion with MSc Eugenio Ferrari (center), Ronald Gutierrez (left), César Aguirre (right) on the subject: "The Profile of Junior Geologists and the training required by the mining industry".

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.

Fig. 4: Group photo of the speakers and student members of the chapter.

SGA Student Chapter Prague geological and mineralogical trip to the Eastern Alps

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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 Hohe Tauern window.

Fig. 1: Our group of members on the trip, photo by Ľubomír Kyrc.

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 at 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 Habach formation (metavolcanic and metapelitic rocks with serpentinite) is a part of the Hohe Tauern, 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 Habach 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 Habach 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 Kriml. Geologically, it is situated in the northern rim of the Tauern window. Knapenwand series is a part of the Habach formation, which is well known for mineralization with crystals of epidote which grow in places, where fissures intersect with an aplite vein (https://www.mindat.org/loc-270.html). The series consists of metamorphosed basic and intermediate magmatic rocks forming coarse-grained amphibolite, metagabbro, epidote amphibolite and biotite-chlorite schist (Seemann et al., 1993). Crystals of epidote were mined by the Zukunftkollegium Neukirchen. Another locality is the old copper mine Hochfeld (Figure 2). During a period from 1500 to 1864 A.D., mainly copper but also silver and gold were mined. The stratiform sulfide mineralization is related to a biotite-chlorite schist with varying amount of quartz. The Cu-Fe-sulfide mineralization which was mined contains low amounts of Zn, Pb, Au, Bi, Se, Te, Mo and W. The ore consits of 50% chalcopyrite, 35% pyrite/marcasite, 15% pyrrhotite, galenite, sphalerite and more (Seemann et al., 1993).

Fig. 2: Adit of the Hochfeld mine, photo by B. Píšová.

4th Day - Granatenkögel

Granatenkögel is situated at the border of Austria and Italy, close to the village of Obergurgl. 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-Stubai-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-Brixlegg. 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 clastic metasedimentary rocks and alkalic 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 tyrolite, olivenite, azurite and malachite.

We are thankful for the financial support from Severočeské doly, a. s., Vitana a. s., Vršanská Uhelná a. s., Eurovia a. s. and KOTOUČ ŠTRAMBERK, spol. s r.o..

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Fig. 3: Glacier valley, photo by B. Píšová.

Fig. 4: Amphibolitic gneiss with garnets, photo by B. Píšová.

Prague SGA Student Chapter visiting Columbia-Bogotá SGA Student Chapter: Mineral deposits of Columbia

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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 – Boyaca (Figure 1). SedEx are 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 deposits are the most important sources of lead, zinc and barite. These ores are processed for tungsten, copper, silver, gold and bismuth as well.

Fig. 1: One of the reconnaissance adit in the Chiquinquirá SedEx deposit. Photo by Š. Jaroměřský.

This deposit is located high in the mountains of the northern side of central Colombia. The 10-year-old exploration galleries designated for researching copper in the past surround the site. There are abundant chalky sedimentary rocks, in which there are minerals of copper such as chalcopyrite. We also found some beautiful examples of barite crystals. It is a fairly extensive site, but because of the steep slope and dense fog, we stayed on the upper parts of this deposit. It was a nice introduction to Colombian geology and nature.

2nd day:

On the second day, our emerald trip started in the Las Pavas 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-dolomite veins containing pyrite, ankerite, albite and quartz. These veins are the product of hydrothermal fluids that disrupt the massif and the interactions of the metasomatic fluid with subsequent deposition in the fractures formed by these calcite-dolomite veins. It is likely that metasomatic 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.

Fig. 2: River St. Magdalena- Muzo. Photo by D. Brém.

Fig. 3: Fine emerald crystals from Muzo. Photo by E. Vrňatová

3rd day:

On the third day, we had a scheduled visit to El Líbano Tolima, the El Porvenir gold mine, an epithermal gold deposit (Figure 4). This mine is processing sulfide ores like pyrite, containing relatively large amounts of gold (up to 1,000 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 porphyries into the Paleozoic slate on the eastern wing of the Colombian 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 porphyries. 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-Triassic plutonic rocks, known as the Payande Stock, are situated on the eastern edge of the Colombian 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 our backpacks and hammers. The road was not difficult, except from the ford 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 a passage 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 tonalites, 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.

Fig. 4: One of the eight entraces to the El Porvenir gold mine. Photo by J. Hofmann.

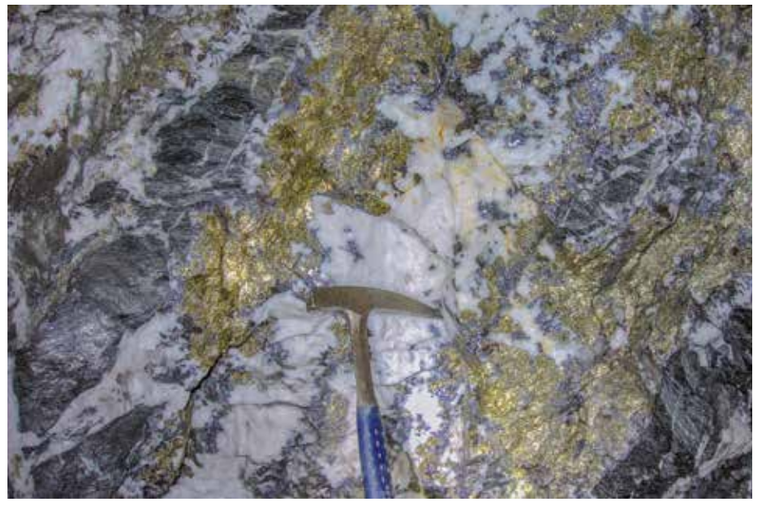

Fig. 5: El Porvenir gold mine - quartz vein with chalkopyrite and molybdenite. Photo by D. Brém.

Fig. 6: Photo of our group in the El Porvenir gold mine.

Fig. 7: Tasting of Colombian fruit delicacies by J. Bašus, Photo by Štěpán Jaroměřský

5th day:

On the fifth day, we were back in Bogóta and we had a planned tour of the geological section at the Universidad Nacional de Colombia. 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 Severočeská doly.

I think that this fieldtrip to Columbia 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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Fig. 1: Group photo of all participants with invited speakers.

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 undergraduated and master/PhD students, the rest was 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 Tectonometallogenic System".

The third talk was given by Dr. Sven Petersen from (Fugure 3; 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"

Fig. 3: Lecture by Sven Petersen from Geomar Helmholtz Centre.

Fig. 2: Lecture by Dr. David Huston from Geoscience Australia.

Fig. 4: Dr. Karen Kelly from USGS gave a talk on Pebble porphyry deposit

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.

Fig. 5: Lecture by David A. Banks from Leeds University.

Fig. 6: Dr. Georges Beaudoin from Laval University gave a talk on Indicator Minerals for Exploration.

Fig. 7: View of the audience attentively listening to talks.

Fig. 8: All participants had lunch together at colloquium.

Fig. 9: Group photo with invited speakers and our academic advisors.

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

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To launch the SGA Students and Young Scientist 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.

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).

Ancient Pb-Zn deposits

Discovered in the early 15th century and forgotten until rediscovery in the early 1700s, the lead-zinc workings at Tyndrum struggled due to its extreme remoteness. During the 18th and 19th centuries, ore often took five weeks to reach Glasgow by a combination of horse and carriage and boat - a journey of only 1.5 hours by car today! Completion of the railway in 1873 connecting Glasgow to Tyndrum meant faster transportation of both processed ore and supplies for the miners who often had travelled from afar. Lack of fresh water during harsh winters and the now-ancient workings demand on peat supplies for fuel, limited mining to warmer, drier months of the year.

Many companies and individuals struggled to make any profit from the now-ancient workings resulting in the lease of the mine being transferred many times throughout its history, with a brief abandonment in the 1790s. One such lease actually included a £200 gown for the wife of the local landowner. These frequent lease changes led to fluctuations in the mine's output, with the annual production of Pb decreasing through its life, as Pb ore dwindled in both quantity and quality. Other metals, including small amounts of Ag, began production in 1857. However by the 1870s, most of the easily accessible ore had been mined and tailings were reworked during and shortly after World War I. Lead bars were exported as far away as Russia. Mining and processing ceased production 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).

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).

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) in the Measured, Indicated and Inferred categories of 541,000 tonnes at 14.3 g/t Au and 59.7 g/t Ag and Proven and Probable Reserves (JORC 2012) of 555,000 tonnes at 11.1 g/t Au and 47.7 g/t Ag for 198,000 oz Au and 851,000 oz Ag (https://www.scotgoldresources.com/about-us).

After a brief introduction to the deposit and regional geology by our host and one of their geologists, Charlie King, we examined a recent core (Figure 3) and were given an insight into a day in the life of a geologist. This was followed by a short drive to the mine adit for the underground tours to commence.

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

Underground, we were introduced to the local mineralisation of the Dalradian Supergroup and were shown the different types of mineralisation and evidence for tectonic activity in the area. The mining engineer, Stanley Lister, told us how they were going to extend the adit to reach the ore and how the extraction and stoping of the deposit was going to be undertaken. The various methods of stabilising the adit and adit walls were described, as was the method by which the blasting of the rocks was achieved.

We were also shown surface outcrops of Au-bearing quartz veins in-situ. Viewing the surrounding landscape, Charlie showed us the regional setting of the deposit (Figure 4) and the mother vein - the large, mostly barren, quartz vein believed to be a splay from the Tyndrum fault (Figure 5). We discussed the challenges of collecting core and doing fieldwork in remote and peat-dominated terrains.

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

After a fantastic day-trip to the Scottish Highlands, we headed back to Glasgow in time for the Ice Breaker of SGA2019!

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.

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.

Fig. 5: View of the mother vein from the top of the hill above the mine.

Workshops, Conferences and Short Courses

Workshop on Gemstone Deposits in Prague

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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-member scientists was supported by SGA grants.

The workshop commenced with a talk by Dr. Evan Smith (GIA, 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. Gaston Guiliani (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 gemstones from pegmatite deposits provided an overview on pegmatite origin, classification and formation of their gemstones, with specific examples on the most important features affecting their presence and quality.

The workshop attracted 22 participants, including nine SGA members. After the successful series of talks followed by interesting questions and answers, the discussion continued at an informal dinner in a nearby restaurant. The workshop brought together participants from 12 countries with various fields of expertise (e.g., economic geology, gemology, mineralogy). Similar workshops are planned in the future, as they allow fruitful discussion from various angles and promote understanding of the specific deposit types by a wider geological community.

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

Fig. 2: Gaston Giuliani is presenting corundum deposits.

Fig. 3: The Capoeira 1 pegmatite, Brazil, deposit of the famous Paraíba tourmaline gemstone.

Report on the SGA-sponsored session on "New Mineral Exploration Challenges"

Goldschmidt 2019, Barcelona, Spain, 18th – 23rd August 2019

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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 118+119 from 16h00 to 17h15, only to continue thereafter at the poster session. In the room, Zié Ouattara and Anthony Williams-Jones chaired the session, where they welcomed six speakers coming from Switzerland, Canada, China, Cameroon and Egypt. The discussions were about deposits of copper (Chuquicamata), diamond (Kelvin kimberlite), tungsten - molybdenite (Yangchuling deposit), iron (Ntem BIF Complex) and ilmenite (Abu Ghalaga 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 BIF in Cameroon and the use of lead in Uranium exploration.

In the morning of the 22nd August 2019 in the room 118+119, 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-polymetallic deposits and the application of whole rock and zircon geochemistry 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 the 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.

Fig. 1: Zié Ouattara and Anthony Wiiliams-Jones chairing the session 5b on 21st August 2019.

Fig. 2: Zié Ouattara conducting the discussions on 22nd August 2019.

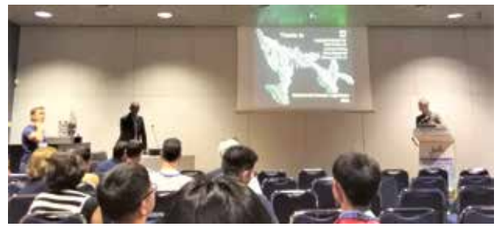

Fig. 3: Zié Ouattara conducting the discussion after the brilliant talk of Professor Hartwig Frimmel on 22nd August 2019.

Fig. 4: Professor Hartwig Frimmel and Zié Ouattara evaluating the session after the tough job on 22nd August 2019.

Gold Deposits: from Exploration to Mining 6th SGA-SEG-UNESCO-IUGS Short Course on African Metallogeny

Beate Orberger[1], Lenka Baratoux[2], Ghislain, Tourigny[3], David Baratoux[2], Lionel Boya[4]

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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 October to 1st of November. Yamoussoukro 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 neighbouring countries. Gold is mined at Tongo (Randgold), Bonikro (Newcrest), Ity (La Mancha) and Angovia (XX) and represents one of the most important resources in Ivory Coast. The Yaouré mine (Perseus Mining) will start production in 2020. Gold production almost doubled within two years from 13t in 2013 to 23.5t of Au in 2015. A two-fold production is foreseen until 2025 from about 25t to 50t (Commodities News, 12/18; 2h17pm, Reuters). Gold in the Birimian Greenstone belts is of orogenic type and occurs in quartz veins, or in sheared carbonate rocks, as auriferous skarn, intrusion related or as placers.

The short course gathered 130 participants from eight countries. Ten exploration and mining companies and the geological surveys of Ivory Coast, Ghana, Niger, Burkina Faso sent delegates to join the meeting.

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 (Directeur Général, INP-HB), Lenka Baratoux, Beate Orberger)

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.

In the view of increasing Gold exploration and mining in 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 (Lionel Boya), gold deposits in 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) vectoring gold mineralization through indicator minerals (Stéphane Perrouty, Laurentian University, Canada); (ii) the importance of the regolith for geochemical gold exploration: (iii) the role of geophysics for large scale gold exploration; and (iv) the necessity of smart adaptive cross disciplinary exploration (Simon Bolster, consultant, Portable ppb, Australia).

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

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.

Fig. 4: Short course T-shirt designed by the SGA student chapter Ivory Coast.

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.

Fig. 6: Lenka Baratoux and Sati Eudes Tegan explained the regional geology. Microdiorite xenoliths are found in granite.

Fig. 7: Jochen Kolb explains the possible relationship of the cross-cutting vein system in metabasalts. Pillow basalts form tens of meter thickness.

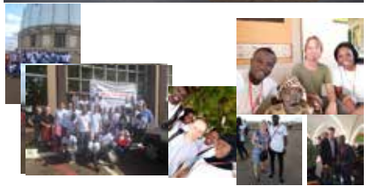

Fig. 9: A visit of the famous "Basilique de Notre de Dame de la Paix" was a cultural highlight of the short course.

Fig. 8: 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.

For the practical training, a comprehensive field guide was well prepared by A. Kouamelan, L. Baratoux, G. Tourigny, L. Boya, N. Meriaud 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 mineralized and unmineralized rocks. G. Tourigny, A. Cisse and their colleagues from Perseus explained the regional geology, the alteration mineralogy 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, metatuffs, metabasalts and altered pillow lavas.

Back to Abidjan, all short course participants were invited for Mining Drinks 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. 10: The 6th Short Course on African Metallogeny was closed with an official ceremony and a gala dinner hosting a local dancing group.

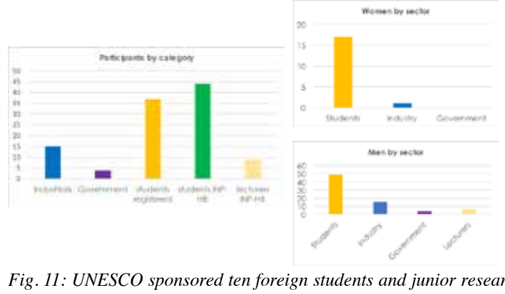

Fig. 11: UNESCO sponsored ten foreign students and junior researchers (Senegal, Cameroon, Algeria, Nigeria) and seven Ivorian students. Eleven students were sponsored by IUGS, two students by EAG, one each by BRGM and Royal Eijkelkamp.

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 27-30, 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 ore discovery, gold – from orogenesis to alluvial, economics of ore deposits, sustainable development of ore deposits, magmatic hydrothermal systems: from porphyry to epithermal, economics of mineral deposits, the changing face of metal extraction – geology, biology, and geometallurgy, 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).

Fig. 1: Opening ceremony and welcome address given by Adrian Boyce, the Chair of the Local Organizing Committee.

Fig. 2: Tribute for Jeremy Richards, given by Jamie Wilkinson and David Cooke.

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 barite mine at Foss, Aberfeldy and the gold mine at Cononish near Tyndrum; the Kerry 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, Scotgold Resources, GreenOre Gold and the Lochaber Geopark. And it was much enjoyed by all participants!

Fig. 3: Attendees at Knockan Crag, just above the Moine Thrust, in the middle of some classic Northwest Highland geology.

Fig. 4: Attendees discussing the gold prospect at Kerry Road near Loch Maree in the Northwest Highlands, together with Gavin Berkenheger from GreenOre Gold.

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 ran 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).

Fig. 5: Attendees at the outcrops close to the Cononish gold mine in the Central Highlands, with staff from Scotgold Resources.

Fig. 6: In the core yard of Boliden Exploration Department, Navan.

Fig. 7: Bill Sheppard explains the Avoca Cu mineralization.

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, Eibhlin Doyle and Sean McClenaghan examining the Avoca open pits and remediation sites (Figure 7). The varying styles of hydrothermal alteration and base metal mineralization were discussed, with Sean McClenaghan 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. Eibhlin 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 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 Güven on the Lisheen deposit, the morning was spent at the Lisheen core store. John Güven presented mineralized sections from the Main Zone, Derryville 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).

The next day of the fieldtrip was led by Richard Unitt, Mike Sweeney and Robbie Galvin at the Copper Coast UNESCO Geopark, Co. Waterford. Outcrops of the ore-hosting Ordovician rocks were visited at Trawnamoe, the main Stage Lode and Stage Cove. The mining history of the area, and efforts to promote it, were presented by Mike Sweeney and Robbie Galvin at the partially restored Tankardstown engine house. The group also spent some time after lunch examining the exhibits in the Copper Coast Interpretative Centre in Knockmahon.

Fig. 8: John Güven presenting Lisheen core.

Fig. 9: In the Magcobar pit, Silvermines, with Colin Andrew.

Following a long drive to Navan the previous evening, the last day of the field trip started with a lecture on the discovery and geology of the Navan deposit by John Ashton at the Boliden mine site. The group then divided into two, with a surface trip by Ian Farrelly and an underground mine visit for the rest of the party. The field trip ended with an examination of recently drilled cores from ongoing exploration in the Tara Deep deposit presented by Rob Blakeman and Ian Farrelly.

The trip was blessed with dry, often sunny, weather and a succession of hearty dinners in hotels around the country. Participants benefited from the expertise of the leaders at each site; they are all thanked for their excellent contributions to a memorable field trip.

The Skellefte Belt field trip

Led by Tobias Bauer, Nils Jansson and Mac Fjellerad Persson

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-5th September and covered the volcanostratigraphy and the structures related to Paleoproterozoic base and precious metal deposits in the Skellefte district, northern Sweden. The visits included active mines and historic mine sites, recently acquired drill core from cur-

Fig. 10: Tobias Bauer and Nils Jansson showing the regional geological framework of VMS deposits in the Skellefte district.

Fig. 11: Underground visit at the Kristineberg mine operated by New Boliden.

rent exploration prospects and outcrops in the field. Besides numerous field visits, we visited also the Maurliden open pit mine, the Kristineberg underground mine (both base metals, New Boliden), the Björkdal mine (orogenic Au, Mandalay ressources) 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.

Fig. 12: Nils Jansson (Luleå University of Technology) explaining 1.9 Ga pillow basalts as part of the volcanic stratigraphy on a field stop in Malå.

Fig. 13: Drill core display from Kanberget deposit at the core facility in Boliden.

Fig. 14: Icebreaker reception in the Hunterian Museum, University of Glasgow. The Lord Provost of Glasgow welcomes all attendees to the Conference and to Glasgow.

Fig. 15: Delegates at the dinner in the Centre Hall with the elaborate Pipe Organ.

Fig. 16: View from above balcony of table set up for the Gala Dinner.

PEOPLE

Homage to Steven Donald Scott, June 4, 1941 – June 11, 2019

Jan M. Peter[1]

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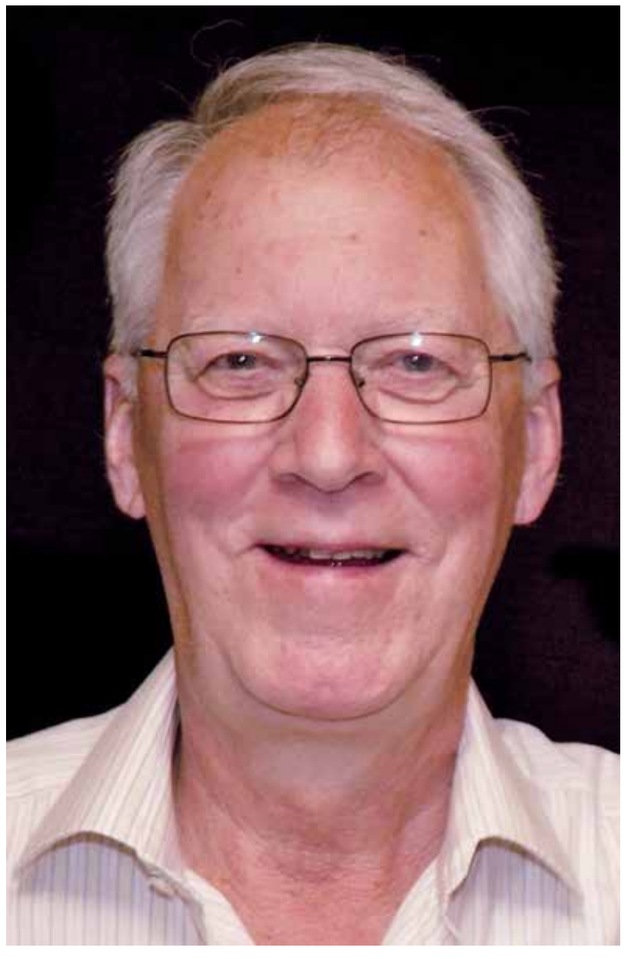
Toronto, Canada, on June 11, 2019 due to complications from leukemia. He is survived by his wife Joan, his children Donald and Susan, his grandchildren Jacqueline and Hunter, his sisters, nieces, nephews and his extended family.



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 Past 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 formational 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 enigmatic 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 (Scripps Institution of Oceanography, Université de Bretagne Occidentale, L'Institut Français de Recherche pour 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 and procured outside research funding from Scotiabank for the namesake Scotiabank Marine Geology Research Laboratory in the Geology Department at 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/Bursary 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.

SGA News

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http://www.e-sga.org

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Inaugural SGA Field Conference

Mount Isa and Cloncurry, Queensland, 20-24 July 2020

Australian Government Geoscience Australia

Queensland Government

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

	Morning	Afternoon
Monday, 20th July	Eastern Succession geology; Ernest Henry geology; what is an IOCG?	
Tuesday, 21st July	Magmatic and other contributions to IOCG deposits; exploration case histories	Eastern Succession geology and mineral deposits
Wednesday, 22nd July	Cloncurry to Mt Isa geological traverse	Picnic, Lake Moondarra
Thursday, 23rd July	Western Succession geology; George Fisher geology; basin-hosted mineral systems	
Friday, 24th July	Timing of basin-hosted mineralisation; exploration case histories	Western Succession geology and mineral deposits

www.mountisamines.com.au

Confirmed speakers

Mark Barton (University of Arizona), Tony Belperio (Minotaur Exploration), Karol Czarnota (Geoscience Australia), Kathy Ehrig (BHP), Joséphine Gigon (Univerité de Lorraine), George Gibson (Australian National University), Murray Hitzman (ICRAG, University College Dublin), Dan Johnson (Aeon Metals), Karen Kelley (United States Geological Survey), Douglas Kreiner (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)

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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/

HYC: Large et al. (1998)

Ernest Henry

Technical Program

Four days of oral and poster presentations with themes including:

- Ore-forming processes
- Specific mineral systems
- New research and exploration developments
- Geometallurgy
- Sustainable mining and environmental issues
- Social license

Trade Exhibition

A Trade Exhibition will be held for companies to exhibit their products and services.

Workshops/Short Courses

The meeting will offer a wide variety of workshops and short courses before and after the main conference. Those interested in offering workshops or short course please contact the organising committee.

Provisional Field Trips

New Zealand

- Epithermal environments of the North Island – 6 days
- Orogenic gold deposits of the South Island – 6 days
- White Island and Tarawera – 1 day
- Rotorua volcanology – 1 day

Australia

- Orogenic gold deposits of Victoria
- VMS deposits in Tasmania

Other field trips are being considered, e.g. Fiji, Indonesia, New Caledonia

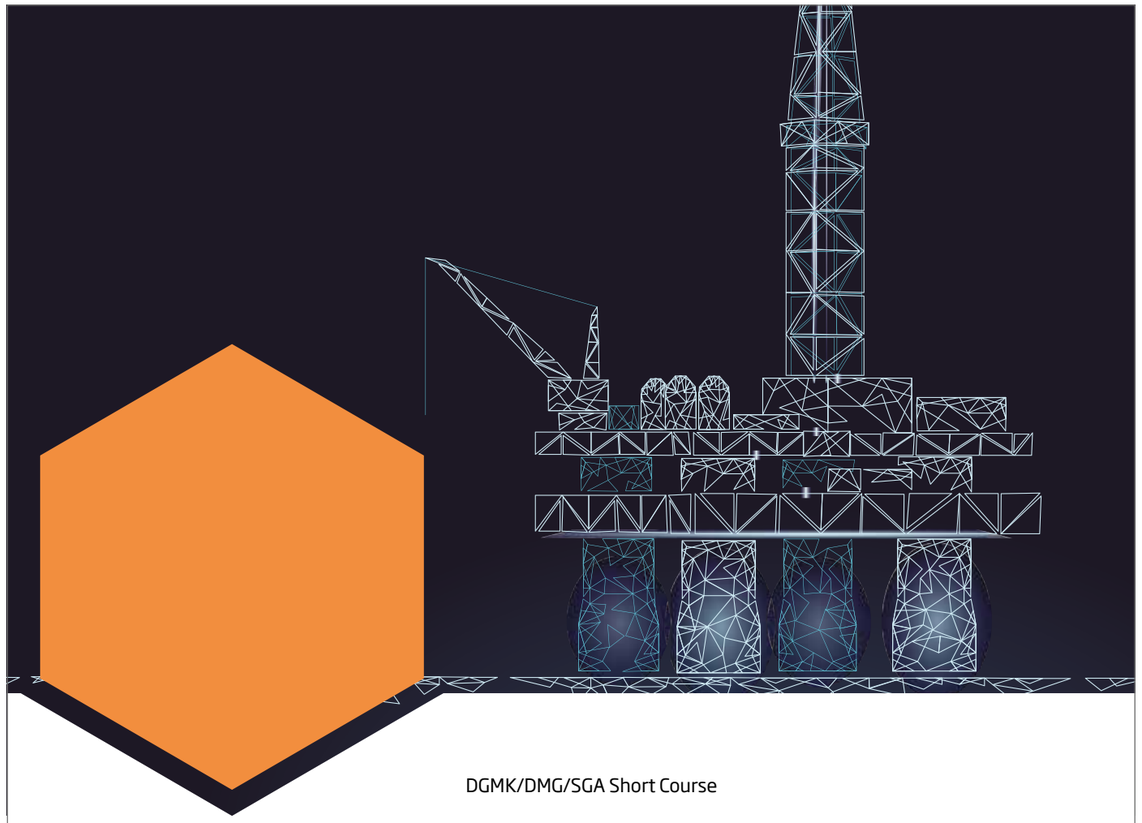
Evening Social Programme

- Sunday 14 November: Welcome Function – Icebreaker
- Monday 15 November: Industry/Student Evening
- Tuesday 16 November: Maori concert and Hangi
- Wednesday 17 November: Gala Dinner
- Thursday 18 November: Farewell Function Dinner

Accompanying Persons Programme

A full programme of tours will be offered during the days of the conference.

For more information contact Conferences and Events: sga2021@confer.co.nz W: www.sga2021.org
To discover things to see and do in Rotorua and New Zealand, go to NewZealand.com



DGMK/DMG/SGA Short Course

From Concept to Oil - The E&P Lifecycle

Exploration and Production Division

26. - 28. May 2020 in Würzburg

DMG Deutsche Mineralogische Gesellschaft

Society for Geology Applied to Mineral Deposits

DGMK

Guide to authors for the SGA News

Jochen Kolb; chief editor SGA News

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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

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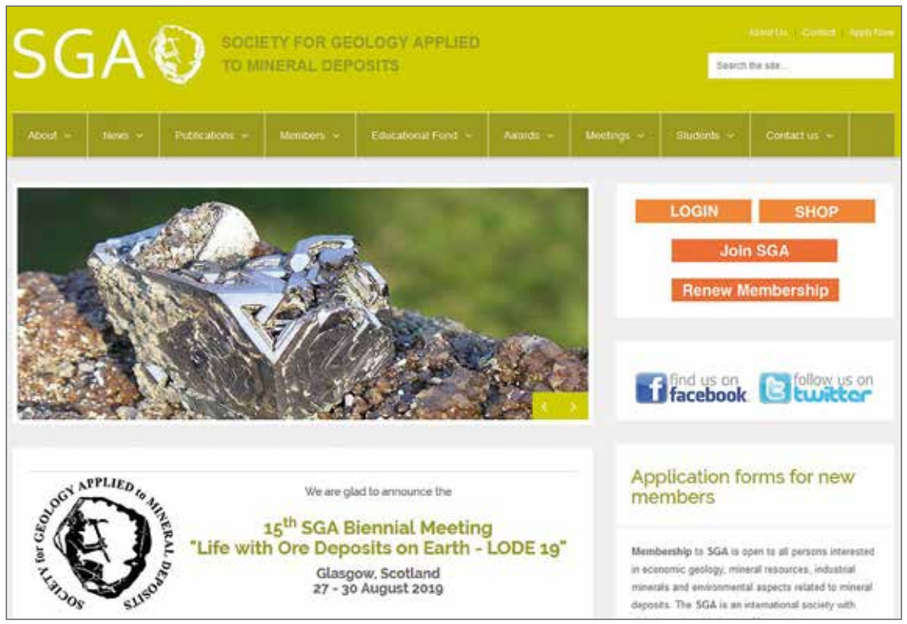

SGA
Society for Geology Applied to Mineral Deposits

New Members from September 30, 2018 until March 17, 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

Senior members 1:
France 1

Corporate members 1:
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

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SGA membership forms can also be downloaded in 5 different languages from the home page of our website www.e-sga.org

Business Card
Staple HERE

SGA

Society for Geology Applied to Mineral Deposits (www.e-sga.org)

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! -

Last name*	
First name*	
Title	
Postal address*	
Phone	
e-mail*	
Academic degrees	

*** mandatory fields**

Select your Membership Dues*

- ☐ 75.00 EUR Regular Member (Printed copy + online access **Mineralium Deposita** and **SGA News**)
- ☐ 60.00 EUR Regular Member (Online access only **Mineralium Deposita** and **SGA News**)
- ☐ 10.00 EUR Student Member (Online access only **Mineralium Deposita** and **SGA News**, certificate required)
- ☐ 60.00 EUR Student Member (Printed copy + online access **Mineralium Deposita** and **SGA News**, certificate required)
- ☐ 60.00 EUR Senior Member (Printed copy + online access **Mineralium Deposita** and **SGA News**, after retirement, certificate required)
- ☐ 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.

Donation for the SGA Educational Fund

- ☐ I want to donate _____ EUR to the SGA Educational Fund and
  - ☐ agree that my (or company) name as donor will be published in SGA media/conferences
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*** ☐ I agree to the SGA data privacy policy as published at https://e-sga.org/contact-us/data-privacy-policy**

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Send the membership application form to:

Dr. Jan Pašava, SGA Executive Secretary, Czech Geological Survey, Klárov 131/3, CZ-118 21 Praha 1, CZECH REPUBLIC
Phone: ++(420)-2-51085506, Fax: ++(420)-2-51818748, e-mail: secretary@e-sga.org.

Please note that bank charges will not be covered by SGA.

Version June 2018