Interest for P and by-products in Europe

Phosphorus is an element that is essential for living plants and animals. It is mostly found as apatite sensu lato, which occurs mainly in sedimentary marine phosphate. It is principally used to produce fertilizers (82% of the production), and is therefore particularly needed to satisfy the growing demand for food related to the growth of the world population. An increase in the phosphorus demand of about 2% per year is expected in the global market (EC 2015).

Most of the phosphorus (80%) is exploited from sedimentary phosphate deposits in North Africa, China, the Middle East, South Africa, the USA and Russia. Reserves are above 1,300,000 Mt for each of these countries, reaching 50,000,000 for the Moroccan deposits (EC 2015). Other phosphorite deposits of potentially economic interest occur on the continental shelf of the Atlantic, Pacific and Indian Oceans (Cook and Shergold 1986; Burnett and Riegs 1990; Valsangkar 2001). Igneous apatite deposits constitute another source of phosphorus, with major deposits being exploited in Finland, Russia, South-Africa, and Brazil (EC 2015).

Phosphate deposits and occurrences are widely distributed in Europe (Fig 1). Their ages vary from the Archean to the Pleistocene. However, Finland is the only country where phosphate rocks are notably produced (869,694 tonnes in 2011; Brown et al. 2013). Consequently, the EU is a net importer of natural phosphates, with an average of 4,000,000 tonnes of natural phosphate-rich material imported per year (EC 2015). In 2014, phosphate rock was added to the list of critical raw materials (CRMs) for the EU (EC 2014). Some of the CRMs represent key elements for the technological progress; in particular, in what concerns the production of carbon-free energy through wind turbines, solar panels, electric vehicles, and other industrial applications (EC 2015). With the CRMs list, the EU policy aims, among others, (1) to ensure European industrial competitiveness through a fair and sustainable supply of raw materials from global markets (EC 2014), and (2) to encourage the domestic production of these raw materials and new mining activities in the EU (EC 2016).

In addition to phosphorus, other CRMs can be recovered from phosphate deposits, such as rare earth elements (REEs) and fluorspar (the commercial name of fluorite). The EU is indeed a significant importer of compounds, metals and alloys of REEs.

Potential of phosphate deposits in Europe

Sophie Decrée1*, Peter M. Ihlen2, Henrik Schiellerup2, Anders Hallberg3, Alecos Demetriades4, Margus Raha5, Alvar Soesoo6

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Number 41  
SOCIETY for GEOLOGY APPLIED to MINERAL DEPOSITS

The 14th Biennial SGA Meeting will be held in Québec City, Canada, August 20–23, 2017. The SGA Québec 2017 Organizing Committee cordially invites you to participate to the first SGA Biennial Meeting to be held in North America and to contribute to an outstanding scientific program with several symposia and special sessions linked with short courses and field trips to famous mineral districts, from Northern Québec to Guiana. The scientific program covers cutting-edge research on major deposit types, large scale geological processes, high precision analytical techniques, the role of governmental geosciences organization in supporting exploration, and societal aspects of mineral resource development. This is a special year as we are celebrating the 175th anniversary of the Geological Survey of Canada, and the 150th anniversary of the foundation of Canada, in 2017.

The up-to-date information about the meeting can be found on our website: www.SGA2017.ca. For any question, please contact us at: info@sga2017.ca

The conference is jointly organized by Université Laval, the Geological Survey of Canada, the Ministère de l’Énergie et des Ressources naturelles du Québec, the Institut national de la Recherche scientifique Centre Eau Terre Environnement, the DIVEX network and Tourisme Québec. It will take place at the Québec City Convention Centre, one of Canada’s top convention destinations, in the heart of the oldest city of North America.

About Québec City

Overlooking the St. Lawrence River from the top of Cap Diamant, Québec City will charm you with its lifestyle, its history and its diversified cuisine. Since 1985, the Old Québec’s historical district has been on UNESCO’s World Heritage List. Cradle of French civilization in North America, the city was founded over four centuries ago and is today a busy seaport, an important center of services and research, a leading cultural city and, of course, the capital of Québec. It is also one of the safest cities in America. Nearby cafes, restaurants, parks and attractions are all yours to discover. We invite you to learn more about Québec at www.quebecregion.com.

SGA Québec 2017 Organizing Committee

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Information for Contributors

Items for publication may be sent to:
SGA News (see address below)
Manuscripts should be sent by e-mail using Microsoft Word for text and Jpeg or Tiff formats for pictures and figures (the latter must be in grey level tones, not colour!). Please always send a paper copy and indicate the format you are using.

Deadline for SGA News No. 42
31 October 2017

SGA News is a publication of SGA (Society for Geology Applied to Mineral Deposits) and appears twice a year.

SGA News can be also read in the SGA homepage on Internet: http://www.e-sga.org

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Registation
The registration is opened since January 15, 2017.

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Important dates
January 15, 2017: Conference Paper (extended abstract) submission and registration
February 28, 2017: Deadline for Conference Paper (extended abstract) submission
February 28, 2017: Deadline for student grant and free fieldtrip/short course application
April 1, 2017: Conference Paper (extended abstract) revision notice
April 15, 2017: Final revised Conference Paper submission (extended abstract)
April 30, 2017: Final acceptance of Conference Paper (extended abstract)
May 15, 2017: Deadline for early-bird registration

Program
SGA Québec 2017 will unfold its detailed schedule for the various sessions, symposia, field trips and workshops in the coming months. We nonetheless have a preliminary menu to offer as an appetizer.

Conference Papers (extended abstracts) Submission
Conference Papers are submitted ONLINE only on the conference website at SGA2017.ca. Abstracts must be prepared using the SGA Québec 2017 template and must follow presentation guidelines. Abstract submissions will be received from January 15 to February 28, 2017. Authors will be informed of acceptance before April 30, 2017.

Symposia
Gold through time and space – SY01 – Benoît Dubé (Geological Survey of Canada); Richard Goldfarb (Colorado School of Mines), Robert Moritz (University of Geneva); Patrick Mercier-Langevin (Geological Survey of Canada)
Throughout Earth’s history, major gold-forming events were highly episodic in response to evolving tectonic settings and magmatic processes, resulting in an uneven endowment in both time and space. This symposium welcomes innovative contributions related to the distribution and formation of gold deposits irrelevant to types, settings, crustal levels, ages and genetic models. Considered presentations may include case studies, broader thematic and conceptual overviews as well as geological and exploration models. The spectrum of deposit types and settings covered through this symposium should provide the audience with an overview of the current understanding and future directions in research and exploration for gold deposits, including ideas on how to better target more prospective/better endowed areas. The symposium will feature a mixture of oral and poster presentations and include a number of keynote presentations.

Migmatic sulfide and oxide ore deposits in mafic and ultramafic rocks – a symposium in memoriam of the work and life of Prof. Hazel Prichard – SY02 – Sarah-Jane Barnes (Université du Québec à Chicoutimi); Michel Houlé (Geological Survey of Canada); Michael Lesher (Laurentian University); James Mungall (University of Toronto)
Mafic and ultramafic rocks contain much of the World’s nickel, platinum-group elements, chrome, vanadium, titanium and phosphorus in the form of layers, pipes or lenses enriched in sulfides, chromite or Fe-oxides hosted by mafic and ultramafic rocks. This symposium welcome submissions: on all aspects of how these deposits form; on whether there is evolution with of the types of deposits with geological setting or time; on new exploration methods for these types of deposits and on how these deposits can be exploited. The symposium will feature a mixture of oral and poster presentations and include a number of keynote presentations.

IOCG-IOA ore systems and their magmatic-hydrothermal continuum: A family reunion? – SY03 – Louise Corriveau (Geological Survey of Canada); Hamid Mumin (Bradon University); Fernando Tornos (Centro de Astrobiologia, CSIC-INTA)
This symposium aims at highlighting our current understanding of IOCG-IOA deposits. It also aims at providing an opportunity to discuss major knowledge gaps and controversial ideas on the footprints, genesis and potential linkages amongst iron oxide-apatite and IOCG deposits, their variants, and certain skarns, porphyry deposits, albitite-hosted uranium or gold and other deposits associated with iron oxide and alkali alteration. Topics such as the critical conditions for ore genesis and linkages between IOCG and other deposits that are associated to IOCG in time and space will be put forward. Addressing these broad topics will provide a solid overview of these systems and trigger discussion on metal and fluid sources, transport and deposition mechanisms, and on the role and effects of deformation, metamorphism and metasomatism. The challenge is to provide a foundation for future breakthroughs and discoveries that will contribute to improve our understanding of these systems at various scales, and therefore help to solve some key questions that surround this enigmatic class of deposits, including those located in high-grade metamorphic terrains. Another objective of this symposium is to demonstrate how this knowledge can be used in exploration.
Critical and precious metal deposits: theory, experiment and nature – a symposium to recognize the work of A.E. Williams-Jones – S04 – Iain Samson (University of Windsor); Robert Linnen (University of Western Ontario); Stefano Salvi (University of Toulouse)

This symposium is being convened to recognize and celebrate the contributions of Dr. A.E. (Willy) Williams-Jones to economic geology and geochemistry. Willy’s research has had a significant impact on our understanding of a wide range of mineralizing processes and mineral deposit types. His contributions have been diverse, ranging from experimental, through theoretical, to field-based studies. We therefore invite presentations on the geochemistry of mineralizing processes, particularly those that integrate field, experimental or theoretical approaches to develop mineral deposit models.

Sessions

Geology, geodynamics and metallogeny of the Rhyacian (2.35 – 2.05 Ga) – S01 – Marc Bardoux (Barrick Gold Corporation); Richard Erns (Carleton University)

The Rhyacian (2300–2050Ma) is a unique geological and metalliferous era. Following a first “Snowball” effect, the terrestrial atmosphere and hydrosphere were oxidizing (erosion and oxidation of sulphides) while fragments of the earlier supercontinent Kenorland converged and a rich biosphere developed on continental margins. The longest LIP cycle (7 stages) started forming on the periphery of Superior and Baltica cratons while gigantic clastic sedimentary sequences were filling basins on the margins of other Archean cratons. At the end of this era, very large gold systems (West Africa, Guiana) formed in the sedimentary basins by tectonic inversions while intracraton, short-lived plume activity created the Bushveld complex (LIPs) and exceptional volumes of Ni-Cu-PGE mineralization. After a big freeze on surface, planet Earth was lithospherically very dynamic in the Rhyacian. We invite innovative papers that will address: 1) milestones of the geological history and geodynamics of the Rhyacian, as well as 2) papers that will specifically address its Au and Ni-Cu-PGE endowment in the perspective of its geological history on a global scale.

Ore-forming magmatic-hydrothermal processes along active margins – S02 – David R. Cooke (University of Tasmania – CODES); Thomas Bissig (University of British Columbia – MDRU)

Porphyry and associated epithermal deposits form by magmatic-hydrothermal processes and are normally emplaced near active plate margins. The latter include a variety of settings including accretionary orogens, island and continental arcs, each with its own combination of magmatic-hydrothermal deposit types. Back-arc or post-orogenic extensional settings may also host porphyry or epithermal deposits, many of which have a distinct alkaline flavour. In this session we seek contributions that describe porphyry and related deposits from a variety of tectonic settings and discuss ore forming processes, from the generation of fertile magmas through to emplacement of Cu (-Au, Mo, Ag) mineralization in the shallow crust. We also invite contributions on how the evolution of the tectonic setting after mineralisation led to preservation of ancient deposits. We particularly welcome papers that put the various porphyry deposit types into their tectonic context.

Exhalative mineral deposits: key controls on the quality (size and/or grade) of deposits and districts – S03 – Steve Piercey (Memorial University); Sarah Gleeson (Helmholtz Center, Postdam)

Ores in sedimentary and volcanic basins (e.g., VMS, SEDEX, Fe, sediment-hosted Cu) provide critical sources of base and precious metals globally. This session will examine controls on the quality of deposits and the various processes that influence size and grade, ranging from cratonic scale to nano-scale. Presentations that range from field-based through to microanalytical studies in areas such as (but not limited to): crustal and basin architecture, magmatism, structure and tectonics, fluid and metal sources, emplacement and depositional mechanisms, paleoceanography and basin redox, and models and modeling of ore forming processes, are encouraged.

Uranium deposits: from source to ore – S04 – Eric Potter (Geological Survey of Canada); Julien Mercader (CNRS, Laboratoire GeoRessources)

As exploration shifts to greater depths and geological environments hosting economic uranium deposits evolve, new knowledge and tools are required to recognize the distal expressions of these systems and vector to ore. At the deposit scale, several key factors remain contentious and new research directions and ideas are needed to properly tackle these questions. Addressing these issues, this session is dedicated to uranium ore deposits research, from the recognition of fertile geological terranes and fluid pathways to ore genesis and preservation. Consequently, this session aims to cover a large variety of techniques, methods, models and concepts that will allow better targeting and understanding of uranium deposits. All contributions and topics are welcome, from km-scale geophysical or geochemical data to μm-scale in situ isotopic measurements.

Iron ore – deposit to global scale processes – S05 – James Conliffe (Geological Survey of Newfoundland and Labrador); Steffen Hagemann (University of Western Australia); Kurt Konhauser (University of Alberta)

Sedimentary iron formations are common in Archean and Paleoproterozoic sedimentary successions, and are host to > 90% of the world’s economic iron ore deposits. In addition to their economic importance, sedimentary iron formations can provide information on the co-evolution of life and the surface environment on the early Earth. This session will deal with the sedimentology, stratigraphy and geochemistry of primary iron formations, implications for our understanding of the redox changes affecting the Archean and Paleoproterozoic atmosphere-hydrosphere-biosphere, and current perspectives on the formation of high-grade hypogene and supergene (> 55% Fe) iron ore deposits and districts.

The impact of the supercontinent cycle on ore formation – S06 – David Huston (Geoscience Australia); Bruce Eglington (University of Saskatchewan); Sally Pehrsson (Geological Survey of Canada)

It has been well documented for at least 30 years that the abundance certain types of ore deposits has waxed and waned throughout Earth’s history. This periodicity is currently thought to be related to three processes of change: (1) irreversible changes of the Earth’s atmosphere and hydrosphere, (2) irreversible changes to tectonic processes, and (3) episodic changes in geodynamic processes related to the assembly and break-up of supercontinents. The third process, which has been termed the supercontinent cycle, has an important control on the formation and preservation of a range of mineral deposit types, including volcanic-hosted massive sulphide deposits, orogenic gold and pegmatite deposits, amongst others. With recent greatly improved models for supercontinent formation back to the early Paleoproterozoic, the influence of the tectonic style of assembly on deposit abundance is also being recognized.
This session investigates the influence of supercontinent cycle and secular changes in tectonic style on not only the secular distribution of deposits, but also their characteristics and how changes in these characteristics may influence exploration.

Developments of geochronological methods and their application to date ore forming events – S07 – Fernando Corfu (University of Oslo); Bill Davis ( Geological Survey of Canada); Robert Creaser (University of Alberta); Christopher Lawley ( Geological Survey of Canada)

Geochronology is undergoing a steady progress due to technical improvements in instrumentation, analytical protocols and methodological refinements of the existing isotopic methods. Rapid, microanalytical advances allow dating of complex mineral paragenesis at unprecedented resolution and provide part of the basis for linking mineral textures at the thin section scale to entire mineral systems. In the past decade the U-Pb system has been enriched by the addition of those that present case studies and geometallurgical applications of new tools, techniques and technologies.

From fertility to footprints: New vectoring tools for mineral exploration – S08 – Alan Galley (Consultant); Jamie Wilkinson ( Geology and Imperial College); Alan King ( Consultant)

More effective mineral exploration in deep, remote and/or surficial covered environments requires a scalable approach that can recognize prospective terranes and belts, and the extended footprint of various types of ore systems in both bedrock and covered areas. Once these have been identified, the ability to better target the mineralized core to these systems must be developed. This requires a much more integrated roadmap in the use of both conventional and unconventional exploration tools. This session will endeavour to present international examples focused on achieving this objective.

Geometallurgy: risk reduction through communication, optimization and innovation – S09 – Sylvie Lévesque (COREM); Jean-François Wilhemy (COREM); Éric Pirard (Université de Liège); Julie Ann Hunt (Université de Liège)

Anticipating and managing inherent ore variability in mining operations and processing plants constitutes a challenge that requires the participation of all disciplines involved in the mining value chain. The level of communication between members of this chain is increasing and is leading to the development of new tools and methodologies that improve the level of ore characterisation and understanding of orebodies subtleties, particularly with respect to geometallurgical and processing domains. This session aims at providing the opportunity for all of those involved in the mining value chain (i.e. geologists, metallurgists, mining engineers, environmental engineers, analysts, etc.) to learn about advances and best practices in geometallurgy. Papers dealing with the geometallurgical characterization of ore deposits are welcomed, particularly those that present case studies and geometallurgical applications of new tools, techniques and technologies.

GSC@175: How can government promote exploration success? – S10 – David Huston (Geoscience Australia); Karen Kelley (United States Geological Survey); Patrick Mercier-Langevin (Geological Survey of Canada)

Academic institutions have long been known to play an important role in the development and refinement of models that have been used by the minerals (and petroleum) exploration industry to discover ore deposits. However, less well known is the role of government in exploration. Data and ideas provided by government agencies have played a key role in the discovery of many ore deposits, including major deposits such as Olympic Dam, Red Dog, and Lihir. This session draws together geoscientists from a range of Federal and State/Provincial government agencies to showcase the diverse approaches of these organizations to promote and assist exploration. The purpose of the session is to expose explorationists and academics to the different types of information available from government agencies and to gain feedback from industry and academia as to which approaches are most effective.

Resources development and perception/acceptability: The role of geosciences – S11 – Michel Malo (INRS, Centre Eau Terre Environnement); Michel Jébrak (Université du Québec à Montréal); Yann Gunzburger (Écoles des Mines de Nancy)

Mining development has become an increasingly major source of preoccupation in our society for the last few decades. Thus, the nature of the interactions between developers and the public in general has changed dramatically, more particularly over the past few years. Geoscientists, and perhaps more specifically exploration geologists are at the forefront of a paradigm shift in this context of heightened public awareness. As Qualified Persons, they are instrumental in the selection, definition/development and reporting of any mining project, including its potential impact on humans and the environment. Geologists are even more often than not the first, or among the first people in the field to interact with the local communities. Therefore, the exploration geologist immediate responsibility now goes well beyond the geology of an area or deposit; it also includes the social aspects of a development project, which implies a good understanding of the human and environmental aspects of any exploration and mining project. The session will discuss what are “social responsibility” and “social acceptability” in a resources development context, how it impacts on project development, and what should be the role of geologists and geosciences.

Gem research: Beautiful windows into earth’s interior – S12 – Daniel Marshall (Simon Fraser University); Lee Groat (University of British Columbia); Gaston Guliani (CNRS Nancy)

Gem deposits, like their base and precious metal cousins, possess not only a beautiful array of precious gems, but like all deposits include alteration haloes, primary and secondary mineralisation. This session will explore not only the gems themselves, but new techniques for gem analysis, new exploration strategies, mineralogical data, tectonic settings, unique geology, and formational models for a wide range of gem deposit types based on field and laboratory studies.

General session (posters only) – GS01 – Pierre-Simon Ross (INRS, Centre Eau Terre Environnement); Patrick Mercier-Langevin (Geological Survey of Canada)

Papers that are relevant for the 14th Biennial SGA Meeting but do not fit within the symposia or sessions described above can be submitted to the poster-only general session that will allow for the meeting to cover a broader range of mineral deposits-related topics.
Field trips

A series of pre- and post-conference Field Trips were put together by the SGA Québec 2017 Organizing Committee in order to complement and enhance the scientific program of the 14th Biennial meeting. Eight Field Trips are offered, covering a wide spectrum of mineral deposits within numerous mining districts of Canada, United States, and South America. All field trips have attendance fixed maximum number of participants. Registration is on a first-come first-served basis and no preregistration will be accepted. The organizing committee will ensure that a fair balance of participant’s experience and affiliations is respected for each field trip.

Pre-conference

Physical volcanology and metallogenesis of the Ni-Cu-PGE deposits in the Cape Smith Belt, Québec, Canada – FT01 – Michael Lesher (Laurentian University); Michel Houé (Geological Survey of Canada); James Mungall (University of Toronto)

This field trip provides an overview of the physical volcanology of komatiitic basalt magmatism in the Cape Smith Belt and associated Ni-Cu-PGE deposits. The Raglan (e.g., Katimi) trend will be the main area of focus of this trip, however, the Expo Ungava Ni-Cu-PGE deposits within the South trend may also be visited. Surface tours will include exposures of komatiitic basalts, mineralized komatiitic peridotite lava channels, country rocks, and unmineralized differentiated sills. There will be several underground mine tours and examinations of drill cores.

Iron oxide and alkali alteration, skarn and epithermal mineralizing systems of the Grenville Province, Canada – FT02 – Louise Corriveau (Geological Survey of Canada); Olivier Blein (Bureau de Recherches Géologiques et Minières); Anne-Laure Bonnet (École Polytechnique de Montréal)

This trip will visit iron oxide, skarn, alkali and epithermal alteration zones and associated IOCG and affliliated mineralisation within the Bondy gneiss complex of the southwestern Grenville Province (Québec). Field attributes of this metamasic system metamorphosed to granulite facies markedly contrast with non metamorphosed analog, the most significant difference being the development of widespread garnetites at the expense of magnetite-rich alteration types. An emphasis will be placed on the genetic linkages amongst the varied alteration types and styles of mineralisation, and the field protocols for the identification and exploration of such metamorphosed hydrothermal systems. Additional stops will provide an overview of the Grenvillian and pre-Grenvillian tectono-magmatic evolution of the region and the rheological contrast across its different domains as recorded by styles of magma emplacement and extent of deformation of dyke swarms.

Gold mineralization in the Guiana Shield, Guiana and Suriname, South America – FT03 – Marc Bardoux (Barrick Gold Corporation)

The objective of the “Gold mineralization in the Guiana Shield” field trip is to give participants an overview of the geology and metallogeny of the exceptionally well-endowed Guiana Shield with an emphasis on the geologic setting of gold. This field trip provides an overview of greenstone belts of Guiana and Suriname including three mine visits associated with gold deposits at the Karouni (Guyana), the Rosebel (Suriname), and Merian (Suriname) mines and core review followed by wrap up meeting and discussion on gold deposits on the last day.

Uranium deposits in the Western Athabasca Basin, Canada – FT04 – Eric Potter (Geological Survey of Canada); Sean Bozman (Saskatchewan Geological Survey); Colin Card (Saskatchewan Geological Survey)

The objective of the “Uranium deposits of the western Athabasca Basin” field trip is to give participants an overview of the geological settings, alteration mineralogy, and geophysical signatures of the recent discoveries from the western Athabasca Basin through exploration site visits, outcrop and drill core observations, and evening lectures. This will be achieved through field excursions to the Triple R, Arrow, and Shea Creek uranium deposits of the western Athabasca Basin, Saskatchewan.

Québec fortified city: geological and historical heritage – FT05 – Sébastien Castonguay (Geological Survey of Canada) and Parks Canada guide

This fieldtrip is a walk in old Québec City that provides an overview of the historical and geological heritage of the Québec City region. Inside Québec City’s wall, the military presence echoes a past punctuated by the heat of war drums, and the various building stones testify for a diverse bedrock geology. Québec City, a UNESCO World Heritage Site, is the only city in North America to have retained the major parts of its defence system. This picturesque setting with its splendied views serves as the backdrop for an introduction to the region’s billion-year-old geological evolution and rich history.

Post-conference

Precious and base metal deposits of the southern Abitibi greenstone belt, Superior Province, Canada – FT06 – Patrick Mercier-Langevin (Geological Survey of Canada), Benoît Dubé (Geological Survey of Canada), Jean Gouttier (Ministère de l’Énergie et des ressources du Québec), Michel Houé (Geological Survey of Canada), Pierre Piot (Ministère de l’Énergie et des ressources du Québec), Howard Poulsen (Consultant), Sonia Prétfontaine (Ontario Geological Survey), Stéphane de Souza (Université du Québec à Montréal), and Valérie Bécu (Geological Survey of Canada)

The objective of the “Precious and base metal deposits of the southern Abitibi greenstone belt” field trip is to give participants an overview of the geology and metallogeny of the exceptionally well-endowed southern part of the Archean Abitibi greenstone belt, with an emphasis on the geological setting and principal characteristics of greenstone-hosted quartz-carbonate Au veins, stockwork-disseminated Au deposits, synvolcanic Au and Au-rich VMS deposits, Cu-Zn-Ag-Au VMS deposits and komatiite-associated Ni-Cu-PGE deposits through exceptional exposures including mine visits, outcrop and drill core observations, and evening lectures.

Stratigraphic and metallogenic context of the Sokoman Iron Formation in the Labrador Trough near Schefferville, Québec-Labrador, Canada – FT07 - James Conilffe (Geological Survey of Newfoundland and Labrador), Carl Bilodeau (Ministère de l’Énergie et des Ressources du Québec), Alex Howe (Consultant)

This fieldtrip provides unique opportunity to visit the Paleoproterozoic Sokoman Formation, host to world-class iron ore deposits, including massive (>5 Gt) taconite deposits and numerous smaller high-grade sedimentary hosted iron ore deposits (site of active mining intermittently since 1954). The fieldtrip would be based in the Schefferville area, and would focus on studies of the regional and stratigraphic setting of the Sokoman Iron Formation, sedimentology and formation of Lake-Superior type banded iron...
formations and genesis of high-grade (> 55% Fe) iron ore deposits. Participants would be taken on a number of tours highlighting the various features of the iron formation as well as the underlying and overlying stratigraphy, and visits to high-grade iron-ore deposits of presumed supergene and hypogene origin. This would be complemented by drill core observations and mine visits (dependent on company activity and permission).

Geologic setting and iron oxide deposits of the mesoproterozoic St. Francois Mountains, Southeast Missouri, USA – FT08 – Warren Day (United States Geological Survey), Cheryl Seege (Missouri Geological Survey), Molly Starkey (Missouri Geological Survey), Thomas Schott (Doe Run Resource Corporation), Anne McCafferty (United States Geological Survey)

The field trip will focus on the regional geologic setting and nature of volcanism for the rocks that host the iron oxide-apatite (IOA) and iron oxide-copper-gold (IOCG) mineral deposits in the Mesoproterozoic St. Francois Mountain terrane of southeast Missouri, USA. The participants will examine drill core from several of the known deposits and visit outcrop examples of the least altered host rocks and the alteration mineral assemblages associated with the IOA and IOCG mineralizing systems. Newly acquired airborne aeromagnetic and radiometric geophysical data will be examined in the context of the regional geology to provide a holistic understanding of the rock type distribution, alteration, and location of known iron ore deposits.

**Short Courses**

**Pre-conference**

Recent advances in the genesis of mafic and ultramafic ore systems – SC1. 2 days pre-conference short course: Friday August 18 and Saturday August 19, 2017. Leader: Stephen J. Barnes (CSIRO), James Mungall (University of Toronto)

High technology metals (REE, Nb-Ta, Li) – SC2. 2 days pre-conference short course: Friday August 18 and Saturday August 19, 2017. Leaders: Iain Samson (University of Windsor), Robert Linnen (Western University), Anthony Williams-Jones (McGill University)

Exploration geophysics – new methods, case studies, modeling – SC3. 2 days pre-conference short course: Friday August 18 and Saturday August 19, 2017. Leaders: Lyal B. Harris (INRS), Bernard Giroux (INRS), Christian Dupuis (Université Laval)

Linkages amongst iron-oxide alkali-altered systems : From metasomatism to orogenic metamorphism – SC4. 1 day pre-conference short course: Saturday August 19, 2017. Leaders: Louise Corriveau (Geological Survey of Canada), Hamid Mumin (Brandon University), Patrick Williams (Clump Mountain Geoscience Pty Ltd)

Detecting the alteration footprint around porphyry copper deposits – SC5. 2 days pre-conference short course: Friday August 18 and Saturday August 19, 2017. Leaders: Peter Hollings (Lakehead University), David Cooke (University of Tasmania, CODES)

Post-conference

Exploration management and targeting with 3D multidisciplinary models – SC6. 1 day post-conference short course: Thursday August 24, 2017. Leader: Gervais Perron (Mira Geoscience)

Field portable instrumentation – SC7. 2 days post-conference short course: Thursday August 24 and Friday August 25, 2017. Leaders: Marc Constantin (Université Laval), Paul Bécard (UQAC), Pierre-Simon Ross, (INRS)

Recent advances in micro-analytical techniques (LA-ICP-MS, CT …) applied to ore deposits – SC8. 2 days post-conference short course: Thursday August 24 and Friday August 25, 2017. Leaders: Sarah-Jane Barnes (UQAC), Charley Duran (UQAC)

**Students**

Students within a broad field of ore deposits research are invited and encouraged to submit abstracts and present their results at the SGA Québec 2017 Meeting. The meeting will offer a great opportunity for students to interact with leading scientists, other young researchers and the industry in an inspired and informal environment. Attractive benefits are being offered to students to encourage their participation in SGA Québec 2017.

**Reduced registration fees**

The registration fee for all students is at a reduced level, SGA student members paying the lowest registration fee.

**Student grants**

To support participation of students at the conference, a limited number of grants are open for SGA students who are senior authors of accepted abstracts. Students from economically disadvantaged countries are prioritized. Student grant application form : Grant-Student-form-SGA2017 (http://sga2017.ca/wp-content/uploads/2016/10/Grant-Student-form-SGA2017dyn.pdf)

**Free registration to field trips**

Several pre- and post-conference field trips are offered. For students, one free registration will be offered per trip. Free excursion application form : FieldTrip-Student-form-SGA2017 (http://sga2017.ca/wp-content/uploads/2016/10/FieldTrip-Student-form-SGA2017dyn.pdf)

**Student Awards**

The best student oral and poster presentations will be awarded a certificate and a prize of 250 Euro.

**Accommodations for students**

Québec City offers many possibilities for low cost accommodations. There are two youth hostels (Auberge internationale de séjour et Auberge de la paix), both in the Old City and less than 10 minutes walking distance from the Conference site. For the more socially-inclined, one can also find lots of Couchsurfing contacts nearby.

**Contacts**

Do not hesitate to contact the representative of the SGA Student Committee, Anna Vymazalová (anna.vymazalova@geology.cz), if you have any questions, comments or suggestions.

**Social events**

August 19: Icebreaker cocktail
August 20: Opening ceremony
August 22: Gala dinner at the glamorous Château Frontenac
August 23: Student awards and Closing ceremony

**Exhibition**

Showcase your organization or products at the meeting. Download our prospectus for more details (SGA2017.ca).

Contact us at info@sga2017.ca
Massimo Chiaradia welcomed all Council members. Jorge Relvas (SGA President) welcomed Council Members and thanked Massimo Chiaradia for organization and the Department of Earth Sciences, University of Geneva for hosting the meeting. Then Council approved suggested agenda.

Minutes of previous Council Meeting (November 14, 2016, Brussels, Belgium)

After checking the actions, the Minutes were unanimously approved.

Reports of officers on Council

- 3.1. Report from President (presented by J. Relvas)
- 3.2. Report from Executive Secretary (presented by J. Pašava)
- 3.3. Report from Treasurer (presented by H. Frimmel)
- 3.4. Report from Promotion Manager (on behalf of P. Eilu presented by J. Pašava)
- 3.5. Report from Chief Editor, SGA News (presented by M. Chiaradia)
- 3.6. Report from Chief Editors, MD (presented by B. Lehmann)
- 3.7. Report from Chief Editor SGA Special Publications (on behalf of J. Slack presented by J. Pašava)
- 3.8. Report from the Chief Editor SGA website (presented by N. Koglin)
- 3.9. SGA Educational Fund (on behalf of K. Kelley presented by J. Pašava)
- 3.10. to 3.14 – Reports from Regional VPs (Asia – on behalf of Huayoung Chen presented by J. Pašava, Australia/Oceania – on behalf of R. Skirrow presented by J. Pašava, Europe – presented by S. Decree, Sub-Saharan Africa – on behalf of L. Greyling presented by H. Frimmel, North America – on behalf of S. Piercey presented by G. Beaudoin)

Council was sorry for all missing Reports.

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

H. Frimmel to transfer EUR 50,000 to the SGA Educational Fund.

J. Pašava and J. Relvas to adapt Guidelines for preparation of SGA Biennial Meetings emphasizing that SGA is a non-profit organization and that LOC has to follow local tax regulations.

J. Pašava to prepare a draft of MOU with LOC SGA 2019 (Glasgow, Scotland, UK).

P. Eilu to contact A. Buettner asking her assistance in preparation of several drafts of layouts for new portable SGA roll ups (Council would expect to have highlighted major benefits for joining SGA, SGA EF, MD and recent collaboration with EAG, which resulted in reduced fee for SGA members when participating at Goldschmidt conferences).

P. Eilu to continue looking after distribution of SGA promotional items upon request of SGA RVP’s and possibly other Council members organizing SGA major and/or co-sponsored geo-events.

M. Chiaradia resigned from the position of the Editor, SGA News. Council greatly appreciated his long-term involvement with SGA (Massimo was involved jointly with L. Fontboté in editing SGA Newsletter since the issue no. 1, which came out in June 1996) and asked him to work on a smooth transfer of SGA News Editorial duties to Jochen Kolb who has been nominated to replace him. Massimo accepted to work in close collaboration with Jochen until the end of his term, in December 31, 2017, and informed that the deadline for contributions to the upcoming SGA News no. 41 is May 15, 2017.

B. Lehmann to prepare a certificate for the “Mineralium Deposita Best Paper Award” according to Council decision. Four papers were suggested by the Mineralium Deposita Editorial Board to be considered by SGA Council and Council members in conflict of interest excused themselves from the presence when discussing and voting on this issue. The winning paper will be announced at the SGA 2017 Award Ceremony in Quebec City.

All Council members to help B. Lehmann and G. Beaudoin to identify suitable theme and authors for “milestone papers” for MD. J. Slack to continue editorial efforts associated with 4 SGA Special Publications, which are at different stages of preparation and report to next Council Meeting (Isotopes in Mineral Exploration; A Hydrothermal History of the Yilgarn Craton and its Relevance to Gold Exploration; Agromining: Farming for Metals; and Supergene Mineral Deposits). The book on “Agromining” will be published and printed in time for display and sale at the 9th International Conference on Serpentinite Ecology (June 2017, Tirana, Albania).

N. Koglin to work with Blueways on introducing new website application for on-line application for SGA membership (approved estimated budget up to EUR 2,400) and website update (approved estimated budget up to EUR 6,500).

N. Koglin to introduce on SGA website by Council revised version of the text promoting the SGA EF which resulted from a joint effort by K. Kelley, A. Vymazalová, J. Relvas and N. Koglin. N. Koglin, J. Pašava, H. Frimmel and Ch. Linge to work jointly on introducing a smooth and safe admission process to SGA via website.

S. Decree to contact EAG to find out if EAG would consider that SGA will look after organization and sponsorship of Mineral Deposit Theme at future Goldschmidt meetings.

R. Skirrow to address SGA Council on possible presence of Council members at the FUTORES II (nobody of Council members attending SGA Council Meeting in Geneva won’t be present at this meeting).

G. Beaudoin to inform S. Piercey on a desire of SGA Council to have manned SGA booth at the upcoming GAC-MAC Meeting (May 2017, Kingston, Canada).

Constitutional and By-Law changes

After introduction by J. Relvas, J. Pašava summarized all major changes which were suggested for revision in the present SGA Statutes and By-laws. Council was thankful for this update and after finalization of both documents approved them for further processing.

Actions: J. Pašava to prepare the final version of the Constitutional changes and send them to N. Koglin who will organize
electronic vote which must be open for 40 days from the day of announcement.

J. Pašava to send the final text of the SGA By-Laws to Council members for their vote (must be taken at least 60 days after the receipt of the final proposal).

**Report from the Chairman of the Nominating Committee**

The Report was presented by J. Relvas. After discussion Council approved suggested nominations of two Auditors who will be auditing SGA books for 2015-2016. Council also appreciated presentation of the status Report on nominations of SGA officers for SGA 2017 ballot and recommended to implement suggested changes. Action: J. Relvas to work jointly with the members of the Nominating Committee on finalization of the list of nominated officers for 2017 ballot and to submit the final version for Council approval in due time.

**SGA 2017 – update**

The Report was presented by G. Beaudoin (Chair of the LOC). Abstract submission which was closed on March 6, 2017 resulted in submission of 422 abstracts with available 224 twenty minutes slots including keynote presentations and rest will be presented as posters (displayed for all 4 days of the meeting). A. Vymazalová reported the receipt of 75 applications from 25 countries for student support. After discussion Council approved the presented report with great thanks.

Actions: G. Beaudoin to keep SGA GA for 1.5 hrs.

J. Pašava to check bibliographic data proposed by LOC for Proceedings so that they would be acceptable for ISI Thomson Reuters coverage.

A. Vymazalová and J. Relvas to prepare a proposal for the distribution of SGA student support.

**SGA 2019 – update**

The Report prepared by A. Boyce (Chair, SGA 2019 LOC) was presented by D. Banks. The LOC decided to select a Professional Conference Organizing Agency (presently interviewing 3 PCO agencies). After discussion Council approved the Report with great thanks and the following motions:

D. Banks agreed to act as SGA Liaison with the SGA 2019 LOC.

J. Pašava to prepare a draft of MOU between SGA and LOC SGA 2019 for comments and signature.

A. Boyce to plan the beginning of the SGA 2019 Meeting after Goldschmidt 2019 (earliest on August 26, 2019).

J. Relvas to interact with EAG President to suggest that for the future, there might be a better articulation between both Societies regarding the scheduling of their meetings in order to avoid overlapping in time.

A. Boyce to prepare a draft of SGA 2019 flyer for Council approval, subsequent printing and distribution to SGA 2017 participants (the latter in collaboration with G. Beaudoin).

A. Boyce to present an invitation to the SGA 2019 Meeting (Glasgow, August 2019) at the Closing and student awards ceremony of the SGA 2017 in Quebec City.

**Progress report on membership drive from the last SGA Council Meeting**

J. Pašava presented this Report on behalf of P. Eilu. The Society had 1220 paying members (to December 31, 2016). During the past six months, we received 207 new members: 1 corporate, 25 regular and 181 student members. It is important to attract student members to become regular members and to make regular membership more attractive. After discussion Council approved the report with great thanks and the following motions:

J. Relvas to address all RVPs with a request for their collaboration regarding non-renewing members.

**Status of development of SGA Student and Young Scientist network including requests for Chapters 2017 budgets**

The Reports were presented by A. Vymazalová . SGA has 11 student Chapters (Baltic, Barcelona, Colombia-Bucaramanga, Colombia-Bogota, Laval, Nancy, Morocco, Peru, Prague, Siberia and recently approved NW Russian). Council approved a proposal for a creation of a new Chapter in Turkey. A proposal for establishing Student Chapter in China is in preparation and indications on interest in getting one in Bolivia. After discussion Council approved the Reports with great thanks and also Chapter budgets for 2017 (Baltic – 4000 EUR, Barcelona – 2000 EUR, Colombia-Bogota – 800 EUR, Nancy – 2000 EUR, Morocco – 700 EUR, Prague – 4000 EUR, Siberia – 3000 EUR, and Turkey – 500 EUR).

Actions: A. Vymazalová to inform SGA Chapters about approved 2017 budgets.

**SGA Awards – update**

The report which was prepared by S. Piercey (Chair of the Award Committee) was presented by J. Pašava. After discussion Council approved the Report with great thanks.

Action: J. Pašava to distribute received nominations for SGA Awards to SGA Council members for electronic vote and inform J. Relvas on successful candidates.

J. Relvas to inform successful candidates on Council decision and to ask for their acceptance to get the awards.

H. Frimmel to organize award certificate for a winner of the SGA-Newmont Gold Medal.

B. Lehmann to prepare award certificate for a winner of the SGA Best MD paper award and SGA Young Scientist Award.

**Requests for sponsorship**

- **Prague Chapter – Short Course on Gold Deposits – May 2018** – D. Groves (in preparation)
- **Vth International Conference "Ultramafic-mafic Complexes, Geology, Structure, Ore Potencial (September 2–6, 2017 Gre- myachinsk, Russia) – E. Kislov et al – request of EUR 2000 for SGA student participation and keynote speaker support – Council approved this request**

**Any other business**

- **4th Short Course on African Metallogeny – 2017. Update on the development of the Short Course was provided by H. Frimmel based on a detailed info from P. Muchez and his team. Presently, forty participants (mostly representing academic institutions) subscribed to the course and Council greatly appreciated efforts of P. Muchez and his team in organizing this important economic geology educational event. The second Circular was distributed to applicants.**
• SGA presence at the IAGOD 2018 Symposium – update. The letter offering SGA activities at the IAGOD 2018 Symposium was sent to the IAGOD President on November 21, 2016. SGA will wait for a reply from IAGOD on what would be acceptable so that we could start working with IAGOD on a successful meeting.

• SGA presence at Goldschmidt 2017 – possible SGA promotion via Springer booth or independent SGA booth – active involvement of SGA officers attending the Conference. Action: P. Eilu to discuss with A. Buettner and relevant Council members details on SGA promotion via Springer booth at the upcoming Goldschmidt 2017 (Paris) conference.

• Program of the SGA General Assembly (August 21, 2017 Québec City) – J. Pašava. The suggested program was presented by J. Pašava and Council approved it with great thanks:
  1 – Report of the President (J. Relvas)
  2 – Report of the Treasurer (H. Frimmel)
  3 – Report of the Executive Secretary on major past and future SGA activities (J. Pašava)
  4 – Report of the SGA Vice-President on SGA EF (K. Kelley)
  5 – Report on activities of SGA Chapters (Representatives of Chapters)
  6 – Presentation of the list of officers nominated for SGA 2017 ballot (J. Relvas)
  7 – Various

Action: A. Vymazalová to inform Representatives of SGA Chapters to prepare brief (up to 2 min.) presentations on Chapter highlights.

Date and place of the next SGA Council meeting
(August 19, 2017 Québec City, Canada – 9–16 hrs., preceded by a joint Council dinner on August 18, 2017).

Informative list of past activities
• 11th „Ore deposit model and exploration” workshop in China (November 6–11, 2016 Guiyang, China)
• 4th Freiberg Short Course in Economic Geology (IOCG and IOAD), Freiberg, Germany, December 7–10, 2016 – T. Seifert/J. Gutzmer; EUR 2,000 approved for SGA student participants.

Informative list of future activities
• proEXPLO 2017 – May 8–10, 2017 Lima, Peru – E. Ferrari et al. – SGA sponsored: D. Moncada SGA keynote speaker and SGA promotion with help of the Peruvian Student Chapter
• 4th SGA-SEG-UNESCO-IUGS Short Course on African Metallogeny – Rwanda (June 5–9, 2017 Kigali, Rwanda) – P. Muchez et al.
• FUTORES II Conference (4–7th June 2017 Townsville, Australia). D. Leach approved as SGA keynote speaker (USD 3,000), free booth from LOC
• Vth International Conference “Ultramafic-mafic Complexes, Geology, Structure, Ore Potential” (September 2–6, 2017 Greymachinsk, Russia) – E. Kislov et al – request of EUR 2000
• Subduction Related Ore Deposits (September 23–26, 2017 Trabzon, Turkey – I. Uysal et al. – SGA sponsored – SGA keynote speaker (J. Relvas) and EUR 1000 for SGA student members support
• XXXV UNESCO-SEG-SGA Curso Latinoamericano de Metallogenia (November 2017 Buenos Aires, Argentina) – a long-term support of USD 2500 approved via a joint SEG-SGA agreement
• RFG 2018 (June 16–21, 2018 Vancouver, Canada) – SGA session organized by J. Gutzmer.
• 15th IAGOD Symposium (August 28–31, 2018 Salta, Argentina) – invitation from IAGOD to suggest a mode of SGA presence
**LIST OF NEW SGA MEMBERS (January 1, 2017 – May 31, 2017)**

65 Regular and 277 Student Members applied for membership during this period

### REGULAR MEMBERS

- Mr. Anthony Franco De Toni Québec CANADA
- Mr. Michael Michaud Ontario CANADA
- Mr. Richard Beckley Cottesloe AUSTRALIA
- Mr. Julio César Zárate Huillca Lima PERU
- Ms Christine Vaillancourt Ottawa CANADA
- Mr. Ian Bliss Ottawa CANADA
- Mr. Peter W. Stewart Dundas CANADA
- Prof. Christian Schardt Duluth USA
- Dr. Nicole Hurtig Wheat Ridge USA
- Mr. Steven Hollis Dublin IRELAND
- Dr. Hugh de Souza Toronto CANADA
- Dr. Antonio Benedicto West Saskatoon CANADA
- Mr. Daniel Habek East Saskatoon CANADA
- Mr. Tassos Grammatikopoulos Lakefield CANADA
- Mr. David Quirt Warman CANADA
- Dr. Richard Ernst Ottawa CANADA
- Mr. Ryan Taylor Denver USA
- Dr. Bjorn von der Heyden Matera SOUTH AFRICA
- Ms Lucie Mathieu Chicoutimi CANADA
- Mr. Réjean Girard Québec CANADA
- Mr. John Charlton Quebec CANADA
- Dr. Sheida Makvandi Montréal CANADA
- Mr. Khalifa Eldursi Saskatchewan CANADA
- Dr. Richard Ernst Ottawa CANADA
- Mr. David Quirt Warman CANADA
- Mr. Gary Hurst Bisley United Kingdom
- Prof. Eric Pirard Liège BELGIUM
- Dr. Li Zenghua Saskatchewan CANADA
- Mrs Sylvie Levesque Quebec CANADA
- Mrs. Amina Wafik Marrakech MOROCCO
- Mr. Nick Proulx Vancouver CANADA
- Mr. Ngouan Herve Ekra Abidjan IVORY COAST
- Prof. Xiaoming Sun Guangzhou PR CHINA
- Dr. Ria Mukherjee Johannesburg SOUTH AFRICA
- Dr. Steve Barnes Kensington AUSTRALIA
- Dr. Esa Heilimo Kuopio FINLAND
- Dr. Perumala Venkata Sunder Raja Telangana State INDIA
- Miss Suzanne Byron Vancouver CANADA
- Mr. Pedro Jugo Sudbury CANADA
- Mr. William Howard Calgary CANADA
- Miss Johanna Paadar Kittilä FINLAND
- Mrs. Keiko Hattori Ottawa CANADA
- Mr. Giovanni Mongelli Potenza ITALY
- Mr. John Hanchar St. John’s CANADA
- Mr. Carlos Villanes Lima PERU
- Mr. Patrick Kroup Dreisen GERMANY
- Ms Audrey Bouvier London CANADA
- Mr. Marcus Harden Georgetown GUYANA
- Mr. James Conliffe St. John’s CANADA
- Miss Violeta Ramos Maia PORTUGAL
STUDENT MEMBERS

Mrs. Sarah Speight Lincoln CANADA
Miss Anna Firstova St-Petersburg RUSSIA
Mr. Igor Yakovlev Novosibirsk RUSSIA
Mr. Jose Alejandro Franco Victoria Bogota COLOMBIA
Mr. Camilo Uribe New Mexico USA
Mr. Jerry Olajide-Kayode Ibadan NIGERIA
Mr. Marc Anselme Kamga Ibadan NIGERIA
Mr. Yong-hua Cao Guangzhou CHINA
Mr. Zeinab Azadbakht Regina CANADA
Mr. Daniel Gerger Saskatoon CANADA
Mr. Mark Grant Ottawa CANADA
Ms Jessica Stromberg Ontario CANADA
Mr. Morteza Rabei Regina CANADA
Mr. Jeong Geuk Kang Seoul KOREA
Ms. Taylan Akin Pamukkale TURKEY
Mr. Denis Ponomarev Novosibirsk RUSSIA
Ms. Merve Aydin Istanbul TURKEY
Ms. Yagmur Seda Ozkorkmaz Istanbul TURKEY
Mr. Matthew Valetich Canberra AUSTRALIA
Mr. Thomas Dols Oulu FINLAND
Mr. William Keyser Adelaide AUSTRALIA
Mr. Jon Gustafsson Lund SWEDEN
Mr. Olüsegün Gbenga Olisa Ibadan NIGERIA
Adriel Sencía Gutiérrez Lima PERU
Lidbert Alarcón Lima PERU
Luis Alejandro Velasquez Martínez Lima PERU
Guido Yersson Almanza Olarte Lima PERU
Carlos Arroyo Huaraeca Lima PERU
Arturo Ufrey Panaghiu Ticona Lima PERU
Wualdo Armindo Blas Salazar Lima PERU
Leonardo Rey Castro Neira Lima PERU
Jorn Miguel Ccalluco Aldazabal Lima PERU
Mayra Stephany Ccanchi Santiago Lima PERU
Celia Ancasi Lima PERU
Richard Migorac Chacon Ccanchi Lima PERU
Jorge Luis Coaguila Heredia Lima PERU
Jomar Darte Guerra Puyo Lima PERU
Frederieks Henry Diaz Salas Lima PERU
Edileb Chipana Pari Lima PERU
Daniela Elaina Olivares Castro Lima PERU
Elisabeth Chira Sona Lima PERU
Juan Pablo Elliott Romero Lima PERU
Emely Ferata Chimo Lima PERU
Hanny Judith Farfan Nina Lima PERU
Karen Flores Contreras Lima PERU
Luisa Stephany Gonzalez Moreno Lima PERU
Guillermon Gabriel Mayna Gonzales Lima PERU
Carlos Alberto Gutierrez Alcantara Lima PERU
José Antonio Guzmán Vizarreta Lima PERU
Jessica Katherine Ramos Flores Lima PERU
Kadima Mejia Zanabria Lima PERU
Kenny Abelardo Ramos Quispe Lima PERU
Eder Elliott Lajo Aquirre Lima PERU
Alexandra Gabriela Loza Condori Lima PERU
Viroglio Lino Huachaca Lima PERU
Eduardo Adolfo Lupaca Adco Lima PERU
Marily Rosabeth Maldonado Manrique Lima PERU
Ana Paolaa Mamani Chuquitarqui Lima PERU
Mary Carmen Carpio Llica Lima PERU
Williams Rafael Mata Rimac Lima PERU
Miguel Humberto Quintana Hernandez Lima PERU
Geraldine Stephanie Peralta Valdivia Lima PERU
Porfirio Cáceres Quispe Lima PERU
Chris Anthony Quispe Huamani Lima PERU
Carlos Quillahuanmuñoz Lima PERU
Milagros Yoselyn Quispe Carpio Lima PERU
Rene Alvaro Hualalpa Laura Lima PERU
Renzo Miguel Velasco Gonzales Lima PERU
Kevin Leopoldo Retamozlo Astupiñan Lima PERU
Richard Anthony Cabana Aguirre Lima PERU
Amanda Guadalupe Rodriguez Diaz Lima PERU
Raul Cesar Rodriguez Echevarria Lima PERU
Ronald Roberto Risco Pinedo Lima PERU
Valery HJoana Rosas Alvarez Lima PERU
Eduardo Percy Salcedo Mendoza Lima PERU
Samuel Cecilio Chucuya Mamani Lima PERU
Obdelia Ruty Sanca Yanque Lima PERU
Sarela Milagros Moriano Huillica Lima PERU
Seidy Ariana Torres Vargas Lima PERU
Jheiner Sotomollo Puclla Lima PERU
Hammer Edmundo Sulca Berdejo Lima PERU
Jhon Oliver Trebejo Inocente Lima PERU
Nilton Cesar Begazo Cansaya Lima PERU
Abraham Armando Velarde Valenzuela Lima PERU
Carmen del Rosario Villasante Huayhua Lima PERU
Roel Jocsan Yana Calizaya Lima PERU
Mr. Julian Dube Quebec CANADA
Mr. Stefano Caruso Crawley AUSTRALIA
Miss Maria Smirnova Moscow RUSSIA
Miss Maria Turova Moscow RUSSIA
Miss Natalia Lebedeva Moscow RUSSIA
Miss Araceli Sánchez Lima PERU
Mr. M'Hamed El Janaiti Marrakesh MOROCCO
Mr. Jean de Dieu Ndikumana Ibadan NIGERIA
Bîhter Hepvîdînî Istanbul University TURKEY
Duygu Isbil Istanbul University TURKEY
Aykat Eke Istanbul University TURKEY
Mukhtar Umerykhan Istanbul University TURKEY
Yoel Baris Ozzelik Istanbul University TURKEY
Ms. Karahin Deniz Ccanchi Istanbul University TURKEY
Ms. Karahin Sanem Cerem Istanbul University TURKEY
Ms. Seyna Uzuner Istanbul University TURKEY
Seymur Künarioluoglu Pamukkale University TURKEY
Maral Horoz Pamukkale University TURKEY
Mr. Nikita La Cruz Ann Arbor USA
Miss Brigitte Gélinas Ontario CANADA
Mr. Constantin Rossberg Freiberg GERMANY
Ms. Nuria Ali Nairobi KENYA
Mr. Paul Leach Cape Town South Africa
Miss Maposholi Mokhethi Lesotho South Africa
Mr. Mustafa Selman Arsay Denizli TURKEY
Mr. Mehmet Tufan Denizli TURKEY
Mr. Ömer Faruk Özkaya Denizli TURKEY
Mr. Irem Akoz Denizli TURKEY
Mr. Öktay Canbaz Denizli TURKEY
Mr. Ceyhun Yenipinar Denizli TURKEY
Mr. Muge Sezen Denizli TURKEY
Mr. Hüseyin Yenipinar Denizli TURKEY
Mr. Hüseyin Yenipinar Denizli TURKEY
Mr. Mehmet Keleş Denizli TURKEY
Mr. Huseyin Yenipinar Denizli TURKEY
Mr. Ömer Faruk Özkaya Denizli TURKEY
Mr. Irem Akoz Denizli TURKEY
Mr. Öktay Canbaz Denizli TURKEY
Mr. Ceyhun Yenipinar Denizli TURKEY
Mr. Muge Sezen Denizli TURKEY
Mr. Hüseyin Yenipinar Denizli TURKEY
Mr. Mehmet Keleş Denizli TURKEY
Bin Xiao Guangzhou CHINA
Jinseng Han Guangzhou CHINA
Yu Zhang Guangzhou CHINA
Chuan Lv Guangzhou CHINA
Biao Liu Guangzhou CHINA
Ganghong Chen Guangzhou CHINA
Ganghong Zhou Guangzhou CHINA
Kang Min Guangzhou CHINA
Songtao Li Guangzhou CHINA
Wanting Ge Guangzhou CHINA
Wendou Dong Guangzhou CHINA
Xiaoyu Li Guangzhou CHINA
Xu Zhao Guangzhou CHINA
Yan Liu Guangzhou CHINA
Zheng Chu Guangzhou CHINA
Chao Wu Guangzhou CHINA
Chao Xu Guangzhou CHINA
Potential of phosphate deposits in Europe

In Europe (about 8,000 tonnes per year). Fluorspar, which is mainly used in the production of hydrofluoric acid, is imported to the EU at a level reaching 8–15 times the weight in export (EC 2015).

It has recently been put into the forefront that phosphate deposits represent a potential source of REEs (Christmann 2014; Ihlen et al. 2014; Emsbo et al. 2015; Goodenough et al. 2016). A recent evaluation of the USA sedimentary phosphate deposits even showed that their total REE contents are probably higher than any known resource (Emsbo et al. 2015). The total REE oxide concentration in sedimentary phosphorite can reach 0.15% (Notholt 1980; Christmann 2014). Almost all the REEs are contained in carbonate fluorapatite (francolite), where they substitute for Ca in the lattice (Jarvis et al. 1994; Emsbo et al. 2015). The variation in their concentration is commonly attributed to changes in ocean chemistry (e.g., Lécuyer et al. 2004; Emsbo et al. 2015). Magmatic apatite usually contains more than 0.35% REEs (Ihlen et al. 2014). The igneous apatite deposits generally have lower grades than their sedimentary counterparts, but the content of unwanted contaminants is normally lower (Ihlen et al. 2014; Ahokas 2015). Apart from the endowment in REEs in these deposits (whether they are sedimentary or igneous in origin; Fig 2), the key potential for production of REEs from apatite deposits is the easy extraction, compared to most conventional REE prospects (Pereira and Bilal 2012; Emsbo et al. 2015). This extraction is feasible during the production of phosphoric acid, as well as from phosphoric acid waste and from fluorophosphate (Christmann 2014, and references therein). Moreover, this process causes less damage to the environment (Emsbo et al. 2015).

Beside the REEs, phosphate rocks can contain up to 3–4% of F. The recovery of fluorine compounds is possible with all of the existing technologies in phosphate processing. Accordingly, phosphate rocks represent another possible source of fluorine (McKelvey 1967; Gorecki 1994). Fluorine is commonly recovered as fluorosilicic acid, although processes transforming it into calcium fluoride do exist (McKelvey 1967; Ayres et al. 2001). In western USA, a $V_2O_5$ concentration reaching 0.2% has been documented in phosphate rocks. Through dedicated extraction processes a recovery of 85% of the vanadium is obtainable (Notholt et al. 1979; Notholt 1980). Uranium may be recovered from the huge amount of fluorophosphate produced by phosphate rock processing (Notholt et al. 1979; EC 2015). A content ranging from 0.005 to 0.02% U is common in sedimentary marine phosphate deposits (Notholt et al. 1979). Phosphogypsum itself has been considered as a possible substitute for natural gypsum, and could theoretically be used for the same purpose. However, its high trace element contents (e.g., U, Th, and Cd) would need to be removed by processing (Ayres et al. 2001). Nevertheless, phosphogypsum was used in plasterboard and in the cement industry in the past (Notholt et al. 1979).

In addition, it must be emphasized that black shale, which can contain significant amounts of elements, such as Be, Sb, V, Co, Ni, Mo, PGM, Cr and Zn (e.g., Huyck 1989), often host sedimentary phosphorite in the Paleozoic formations (Notholt et al. 1989). They are also interesting in regard to (precious) metals, which they may host (McKelvey 1967). It is worth mentioning that Be, Sb, Co, PGM, and Cr are also among the critical raw materials identified by the European Commission (2014).

Sedimentary phosphate deposits / occurrences

Most of the economic phosphorite deposits are considered to have formed on stable shelves and platforms below 500 m depth and at low paleolatitudes. They are commonly present as stratified deposits, with a thickness of more than 6 meters and with a $P_2O_5$ grade varying between 10 and 35% (Notholt 1980, and references therein). Phosphate is mostly present under the form of a carbonate fluorapatite called francolite. The latter generally occurs as (elongated) pellets shaped spherical-ovoid nodules. Apatite can also be enriched in authigenic microcrystalline phosphorite mud or forming nodular phosphates in conglomerate (Notholt 1980, and references therein). Deposits and occurrences presented below are listed according their age and stratigraphic distribution.

Paleoproterozoic sedimentary phosphate deposits are restricted to the Fennoscan- dian Shield, where the most important and exploited deposit is located in the vicinity of Lampinsaari, in Finland. This deposit is composed of lenticular beds of apatite-bearing dolomite, skarn and apatite-rich gneiss (Notholt and Brasier 1986). It comprises a resource of nearly 39 million tonnes grading at 2.6% $P_2O_5$ (Notholt et al. 1989) and yielding more than 230 ppm REE in the apatite concentrates (Rehtijärv 1983). Paleoproterozoic phosphorites are also present in the Grythytte Slate in Bergslagen.
whereas Neoproterozoic phosphorites occur in the basal arenitic sequence of the Visingsö Formation in Sweden (Notholt and Brasier 1986), and as pebbles and clasts in the Biskopasen sub-marine fan in Norway (Ihlen et al. 2014).

Lower Paleozoic phosphorites, which constitute the majority of phosphorites in Europe, testify the presence of a phosphogenic province within the Avalon and the Baltic Platforms. These phosphorites are associated with glauconitic sediments or black shale (Notholt and Brasier 1986). Cambro-Ordovician phosphorites are ubiquitous and include the Early Cambrian Fontanarejo deposit in Spain (Alvaro et al. 2015), which consists of phospharenite and phospharenorudite (Gabaldon et al. 1987). The resources are of about 2,000,000 tonnes (Notholt et al. 1989), with about 190 ppm REE (Alvaro et al., 2015). The Lower-Middle Cambrian phosphorites of Scania (Sweden) comprise phosphorite clasts in basal conglomerates and in limestone beds. The phosphate clasts contain up to 1300 ppm REE. The Lower Cambrian phosphorites of La Montagne Noire (France) are made of phosphatic limestone, which is locally embedded in black shale, and contains up to 525 ppm REE (Alvaro et al. 2015). Cambrian phosphatic conglomerate was reported at Avevagge and Steinsviken in Norway (Notholt and Brasier 1986; Ihlen et al. 2014). Other Middle(-Upper) Cambrian phosphate horizons are described in the Frankenwald (Germany; Ludwig 1969 in Notholt and Brasier 1986), in the Stavelot-Venn Massif (Belgium, Germany; Graulich 1980; Paproth and Zimmerle 1980), and in southwestern France (Guérangé-Lozes and Alabouvette 1999). Ordovician phosphorites, under the form a metamorphosed...
holt et al. 1979, 1989). In Ireland (County Clare), Upper Carboniferous sedimentary phosphate rocks occurring in a condensed sequence were exploited with the production of 105,000 tonnes of phosphate. However, the deposit has estimated resources of 1.25 million tonnes at 20–25% P₂O₅ (Notholt et al. 1979). In the north Pyrenean fault zone (France), a chert bed of variable thickness (from a few to 20 meters) contains phosphate nodules (Notholt et al. 1979). In Germany, phosphorite nodules and layers are hosted within Dinantian black shale and chert in the area of the Rhenish Schiefergebirge and Harz Mountains (Paproth 1980). Ordovician glauconite-phosphorite shale is described in the Tasjo Lake area (Sweden; Notholt et al. 1989). Middle-Late Ordovician phosphatic concretions in terrigenous successions are also reported in France (Armorican Massif) and in Sardinia (Italy; Dabard and Loi 2012).

Phosphorites are encountered in Germany in association with shale, chert, and/or volcanic rocks of Silurian and Devonian age (Prapoth and Zimmerle 1980). Carboniferous sedimentary phosphate deposits have been described in Ireland, France, Spain, UK, Romania and Germany (Notholt et al. 1979, 1989). In Ireland (County Clare), Upper Carboniferous sedimentary phosphate rocks occurring in a condensed sequence were exploited with the production of 105,000 tonnes of phosphate. However, the deposit has estimated resources of 1.25 million tonnes at 20–25% P₂O₅ (Notholt et al. 1979). In the north Pyrenean fault zone (France), a chert bed of variable thickness (from a few to 20 meters) contains phosphate nodules (Notholt et al. 1979). In Germany, phosphorite nodules and layers are hosted within Dinantian black shale and chert in the area of the Rhenish Schiefergebirge and Harz Mountains (Paproth 1980). Ordo
and Zimmerle 1980). Analyzes of these phosphorite deposits including the Pörmitz phosphorite yield about 0.20% total REE+Y oxides (Struckmeier 1974 in Prapoth and Zimmerle 1980) and from 15 to 140 ppm of REE+Y in the Harz phosphorite deposits (Benda et al. 1962 in Prapoth and Zimmerle 1980).

Triassic phosphorite is rarely developed and is only present in Germany and Hungary (Paproth and Zimmerle 1980; Notholt et al. 1989). An important sedimentary phosphate unit of Upper Cretaceous age occurs throughout the Paris and Mons basins (France and Belgium). It is known that a significant phosphogenic episode prevailed at that time on the NE margins of the Anglo-Paris Basin (Jarvis 1992). In the Mons and Paris Basins, the deposits consists of phosphatic chalk (5–20% P₂O₅), enriched pockets of residual phosphates (24–39% P₂O₅), and phosphatic chalk infills (12–30% P₂O₅) (Monchiardini 1989; Robaszkynski 1989). The total resources in the Mons Basin have been estimated at 600–900 million tonnes of phosphatic chalk averaging between 8 and 10.5% P₂O₅ (Robaszkynski 1989), whereas those in the Paris Basin would reach 12-15 million tonnes at 7–14% P₂O₅ (Monchiardini 1989). In the UK, phosphorite deposits of a Mesozoic age are widespread (Notholt et al. 1979). The Cretaceous phosphate chalk at Taplow is considered to have an economic potential. Although the full extent of the deposit is not known, an estimation of the resources of its southwestern part yield 500,000 tonnes (Notholt et al. 1979). In addition, phosphatic nodules are concentrated in Cenomanian condensed glauconitic marls (Cambridge Greensand), with resources of 246,000 tonnes of crude phosphate rocks (Notholt et al. 1979). Other Mesozoic phosphorites occur in the Germany, the Iberian Peninsula, Poland (phosphates in massive limestone; Krajewski 1981), Hellas (as phosphorite and laminated/breciated phosphatized limestone in the Ionian zone extending from Epirus in the north to Aetolakarnania in the south; Tzifas et al. 2014), Ukraine (Kholodov 2008), and in the Balkan countries (phosphate-carbonate-chert horizons – with up to 30% P₂O₅ – in Albania and all over the Ionian zone; Ciko et al. 1999). In Lower Saxony (Germany), phosphate nodules beds are hosted in rocks from Upper Triassic to Middle Oligocene in age (Paproth and Zimmerle 1980). The most significant occurrence, the Lengede-Broitstedt deposit, is associated with iron ore and constitutes an economic source of phosphorus, with a grade of about 4% P₂O₅. It is thought to be derived from reworked Cretaceous deposits (Notholt et al. 1979). In Bavaria (Oberpfalz district), one of these comprise a soft phosphatic bed (associated with iron ore), that is commonly less than one meter thick and contains an average of 20% P₂O₅. The quantity of phosphorite is estimated to exceed 30,000 tonnes (Notholt et al. 1979). In the Jurassic and Cretaceous carbonate rocks of the Subbetic Zone (in Spain) glauconite and Ca phosphate pellets have been reported with size and morphology being controlled by the bioclasts (Jimenez-Millan et al. 1998). In East Greenland (Jameson Land and Scoresby Land), black shale of Jurassic age hosts phosphatic nodules (Notholt et al. 1979).

Tertiary sedimentary phosphate deposits/occurrences are present in Italy, Hellas, (Steurburg and Nolf 1986; Louwye et al. 2010; Marquet and Herman 2012), Germany, and the UK (Notholt et al. 1989). In the region of Salento (Italy), the Miocene phosphate-rich sedimentary rocks (cf. Föllmi et al. 2015) commonly show a relatively low grade (3–4% P₂O₅). However, 60 million tonnes of phosphatic limestone, with a content of 7–8% P₂O₅ are reported. In the same area, Upper Pliocene (?) nodular phosphate deposits could account for additional 10 million tonnes at grades in the range 10.5–20.5% P₂O₅ (Notholt et al. 1979). Oligo-Miocene nodule-rich phosphatic formations also occur in Sicily (Cultrone et al. 2008). At Donnalucata, resources of 7 million tonnes at about 15% P₂O₅ have been estimated (Notholt et al. 1979). In Germany, the Lahn phosphate deposits, which are often accompanied by Lower Tertiary Fe and Mn oxide ores, occur as lenses and partly as accumulation in dissolution cavities. They are spatially associated with weathered mafic pyroclastic rocks, which are thought to be the source of phosphorus (Germann et al. 1979; Notholt et al. 1979). The deposit would account for 750,000 tonnes of crude phosphate rocks with contents above 20% P₂O₅ (Notholt et al. 1979). A Lower Eocene deposit comprising septarian-type phosphate nodules in clay is known in northern Germany (Prapoth and Zimmerle 1980). In addition, offshore Neogene phosphate occurrences are described along the Galicia coast (Lucas et al. 1978).

Igneous phosphate deposits/occurrences

The igneous apatite deposits are mostly related to alkaline complexes and carbonatite, and to massif-type anorthosite and monzonitic complexes (the latter two complexes carrying apatite-iron-titanium oxide, AITO, ores; Notholt et al. 1979; Ihlen et al. 2014; Goodenough et al. 2016). Most of these deposits are located within the Fennoscandian Shield. However, occurrences of igneous-related apatite deposits are also reported in Scotland where the pyroxenite of the Silurian Loch Borralan alkaline complex contains 2.31% P₂O₅ (Notholt and Highley 1981), and in Spain where post-Variscan hydrothermal quartz-apatite veins occur in the Central Iberian Zone (Vindel et al. 2014). In addition, small apatite-bearing carbonatite deposits are encountered in the Kaisersthul volcanic complex (Notholt et al. 1979). Deposits and occurrences in the Fennoscandian Shield presented hereafter are listed by country.

In Finland, the Siilinjärvi deposit is related to an Archean carbonate complex. It accounts for 1617 million tonnes of phosphate rocks (Ahokas 2015; Yara 2016), with REEs as by-products of apatite (Goodenough et al. 2016). Apatite concentrates from Siilinjärvi exhibit total REE contents ranging from 2986 to 3820 ppm (Hornig-Kjarsgaard 1998). The phosphate reserves associated with the Devono-carboniferous Sokli carbonatite complex (Vartiainen and Woolley 1974) reaches 190 million tonnes (Ahokas 2015). Total REE contents measured in two apatite concentrates at Sokli are 4108 and 5569 ppm (Hornig-Kjarsgaard 1998). Besides Siilinjärvi and Sokli, phosphate deposits occur in the Paleoproterozoic gabbros of southern Ostrobotnia (Ahokas 2015; Kärrkäinen and Appelqvist 1999). At Kauhajärvi, low-grade Fe-Ti-P resources comprise igneous layers of 2 to 30 meters in thickness with 1 to 8% apatite (Kärrkäinen and Appelqvist 1999).

In Sweden, apatite iron ores (AOI) are found in the northern Norrbotten district, northern Sweden, and in the Bergslagen district, south central Sweden. In the Bergslagen district, Paleoproterozoic AIO (magnetite and/or hematite) are hosted in felsic volcanic rocks. The Grängesberg mine produced 133 Mt with 44.5% Fe and 3.18% P₂O₅ during its lifetime. Estimated resources are 148 Mt. The apatite in the ores always carries REE, though very little have been recovered and resource estimates for the REE have not been published (Hallberg et al. 2016; Jonsson et al. 2013). In the northern Norrbotten district, the deposits at Kirunavaara and Malmberget have produced more than 1500 Mt with c. 60% Fe and 1.37% P₂O₅ during the last 110 years. Smaller deposits account for c. 100 Mt at...
similar grades. Reserves and resources for the district are estimated at 2372 Mt of AIO ore (Hallberg et al. 2016). The ore is present as breccias and massive strata-bound bodies, together with intermediate types (Martinsson et al. 2016). Enrichment in REEs is observed in most of the ores, which commonly have total REE contents of 2000-7000 ppm, mainly concentrated in apatite (Frietsch and Perdahl 1995). Further to the north-east, in the Norbotten greenstone, the Tjavelk magnetite skarn iron deposit accounts for 6.8 Mt, with an average content of about 2.98% P₂O₅ (Hallberg et al. 2016). In Sweden, apatite also occurs in association with alkaline complexes, as in the Neoproterozoic Alnö alkaline massif or the Kalix area (Kresten et al. 1977). The analyzes of the apatite concentrates from the Alnö complex yield high total REE contents ranging from 3752 and 5220 ppm (Hornig-Kjarsgaard 1998). The Neoproterozoic to Cambrian alkaline complexes of the Seiland Igneous Province carry intrusions that can be enriched in apatite. For instance, the Tappeluft pegmatitic gabbro exhibits P₂O₅ contents ranging from 1.88 to 4.29%. The carbonate massif rimmed by hornblende clinopyroxenite dykes that pertain to the Lillebukt Complex both contain an average content of about 3% P₂O₅. In these rocks, apatite is characterized by an enrichment inREE of a few thousands ppm (Ihlen et al. 2014). The late Ordovician-Silurian Misvaerdal Complex measuring 8 km², pyroxenite is the main carrier of apatite, with an average P₂O₅ content of 2.38% for the whole massif. Certain pyroxenite-phases have estimated resources up to 30 Mt at 4.1% P₂O₅. Apatite shows total REE contents ranging from 1234 to 11,180 ppm (Ihlen et al. 2014). Another part of the Norwegian apatite deposits is associated with the Neoproterozoic anorthositic complexes. In the Rogaland Anorthosite Province, apatite occurs abundantly in the noritic Bjerkreim-Sokndal layered intrusion (BKSK), which contain 3 cyclic cumulative zones enriched in apatite, ilmenite and vadaniferous magnetite. The apatite rich zones are persistent for up to 10 kilometers along strike, with a thickness of several tens of meters (up to 170 meters). The average content in apatite is about 7.8–10.2%, depending on the zones position in the intrusion (Ihlen et al. 2014). The BKSK has resources of above 300 Mt, with averages in the range 8.0–10.2% apatite, 12.4–15.2% ilmenite and 6.9–10.6% V-magnetite for the individual cumulative zones. A maximum total REE content of 0.23% is reported for the apatite (Ihlen et al. 2014). Other Norwegian titaniferous phosphate deposits occur in monzonitic complexes. In the Paleoproterozoic Lofoten-Vesteralen Mangerite Complex, P₂O₅ contents of veins and dykes of nelsonite range between 2.75 and 4.23%, with a total REE content in apatite concentrates reaching almost 5000 ppm (Ihlen et al. 2014). In the Permian Larvik Plutonic Complex of the Oslo Paleorift, phosphate grade in patchy ultramafic apatite-ilmenite-magnetite ores is about ~4.5% P₂O₅. The Kodal deposit is a 20 m wide and 1900 m long zone of small-massive pyroxenoid oxide lenses. It has resources of 70 Mt, grading at 4.9% P₂O₅. The total REE content of apatite from deposits associated with monzonite is generally above 6000 ppm, which makes REE an interesting by-product (Ihlen et al., 2014; Goodenough et al. 2016). Finally, apatite is present in Kirunatype AIO ores and in metamorphic deposits. In the Mesoproterozoic Softestad deposit, where the ore is dominated by magnetite, it may contain up to 8% P₂O₅. Remaining resources at Softestad amount to ~0.5 Mt, containing 55% Fe and 3.9% P₂O₅ (Ihlen et al., 2014, and references therein). In the Bamble-Lillesand Block, apatite veins and lenses, from one decimeter to a few meters in thickness, are associated with regional metasomatism (Ihlen et al. 2014). About 250,000 tonnes of apatite have been produced in this area. Their REE content depends on the apatite type, but is normally about 5000–6000 ppm (Ihlen et al. 2014). An enigmatic apatite deposit is present at Rossavika, with pseudo-carbonatitic lenses yielding from 7.63 to 21.34% P₂O₅, and a low total REE content (measured in one sample) of 3806 ppm (Ihlen et al. 2014).

In Greenland, apatite occurrences occur in association with alkaline and carbonatite complexes as, for example, in the Qaqarsuq and the Precambrian Gronnedal-Ika complexes (Notholt et al. 2014; Arvanitidis and Goodenough 2014; Paulick et al. 2015). Large REE resources are related to these complexes where part of these elements is hosted by apatite (Paulick et al. 2015; Goodenough et al. 2016). Potential for undiscovered apatite-iron oxide (AIO) and iron oxide-copper-gold (IOCG) also exist in Greenland (Paulick et al. 2015).

Prospects

It appears from this short review that much attention should be paid to the phosphate deposits in Europe. This is particularly true for the sedimentary phosphorite occurrences/deposits the majority of which have not been studied in any detail since the 1970–80’s. The evaluation of the economic potential of the phosphate deposits (and their host-rocks), whether they are of sedimentary or igneous-related origin, in order to also determine their potential for by-products. In addition, the development of new - or at least more efficient - metalurgical technologies and processes would enhance the recovery of these by-products.

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Marquet R, Herman J (2012) Reinvestigation of the invertebrate fauna of the Boom Clay Formation and the Ruisbroek Sand Member (Oligocene, Rupelian) of
For the SGA Student Chapter Colombia-Bogotá, 2016 was year full of activities such as fieldtrips, lectures for students, conferences, among others. The Student Chapter was committed to teach concepts about mineral deposits to all students regardless of their level of knowledge on the subject. This was accomplished through the program Young Learners in Ore Deposits, which was held every Friday starting on February 12th. In order to have an equilibrated group of students, the program started its first session with the basics concepts of economic geology and the main ore deposit types. Soon after the first sessions, the program started to deal with some of the main types of mineral deposits namely: chromites, Platinum group deposits, diamonds, nickel and copper deposits; and hydrothermal deposits. All of the mentioned sessions where given by the president, Héctor Ricardo Campos and vice-president, José Ricardo Tenjo. In order to prepare the chapter members for the first fieldtrip of 2016 to La Mina porphyry project the program paid special attention to porphyry Deposits.

On the other hand, two conferences were held in March 3rd and May 5th, respectively. Our conference cycle started with “Mining and Environment in Sensitive Ecosystems” given by Carlos Sarmiento from the “Instituto de Investigación de Recursos Biológicos Alexander Von Humboldt” and was followed by “Remote Sensors in Mining: Applications in Exploration, Exploitation and Mining Processing” given by the Geologist MSc, and PhD student Adriana Guatame from Delft University, Netherlands.

The first fieldtrip of 2016 was held from June 10th until June 13th. Nine student members of the Chapter visited one of the greatest Au/Cu porphyry Mineralization in Colombia, located in the Antioquia Department, is an exploration project managed by Bellhaven Copper & Gold Inc, called “La Mina Project”. The accompaniment was given by the geologists William Púlido and Oscar Dávila, who offered us their knowledge, and taught us about this type of mineralization. Additionally, we performed
SGA-chapter vice president Daniel Felipe Franco followed the program with a lecture on Industrial Minerals, and soon after the geologist and SEG member MSc. Andrés Felipe González gave a speech on IOCG Deposits. The next session was focused on preparing the student chapter members for the fieldtrip to “La Esmeralda” and “Río Frío” mines, in the Tolima Department, Colombia. The first one is a large scale limestone and marble deposit, the second one is a Cu Skarn deposit. The student and SEG member Julian Medina was in charge of a lecture on Genesis of Skarn Deposits, and was also our main guide throughout our fieldtrip. The program was followed by a series of lectures about: VMS Deposits, given by the SGA-chapter treasurer Pablo Enrique Porras; carbonatites, given by the ex-president Héctor Campos and finally a lecture of Environmental Remediation of Open Pit Mining given by the geology student Laura Alejandra Hernández.

A new conference cycle was also opened in the first semester of 2017 starting on February 1st with “Remediation of Mining and Environment in Eastern Germany” given by Dr. Friedrich-Carl Benthaus, from the LMBV Strategy and Development Lausitzer und Mitteldeutsche Bergbau-Verwaltungsgesellschaft mbH. Subsequently the geological survey of the outcrops and the mineralogical characterization of this deposit. Furthermore, we had the opportunity to work with drilling cores and make an exercise of well logging. At the end, it turned up to be a highly rewarding fieldtrip.

A second fieldtrip was made from September 17th to September 20th. This time, a group of fourteen student SGA members visited an Au/Cu High-Sulfidation Epithermal Deposit at the Vetas-California Mining District, located in the Santander Department. This deposit is currently an exploration project managed by Eco Oro Minerals Corp., and is called “Angostura Project”. The accompaniment was made by the geologist MSc Edgar Castiblanco, who offered us his knowledge at this type of mineralization. During the fieldtrip we performed the geological survey of the outcrops and mineralogical characterization of the deposit. We had the opportunity to get access to the main exploration tunnel, we recognized typical hydrothermal alterations, and we were allowed to collect samples. Furthermore, we attended a presentation given by the main exploration geologist of Eco Oro Minerals Corp, Alfonso Silva Duarte, before start logging drilling cores.

The last fieldtrip of 2016 year was held on November 1th, which was a one day fieldtrip to visit a copper mineralization related to a Sediment Hosted deposit located in the outskirts of the small town of Chiquinquirá. This deposit used to be an exploration project, but nowadays there are only abandoned tunnels, thanks to which we were able to take a close look to the mineralization of interest. We performed the geological survey of the outcrops and mineralogical characterization of this deposit by taking samples, making thin and polished sections, and geochemical analyses.

The year 2017 started with the planning of the activities to be carried out in the program Young Learners in Ore Deposits. The program began with a four-hour long mineralogy course directed by the geology student Iván Mateo Espinel, who is a SGA-SEG member with two years of experience in charge of the mineralogical collection of the Geoscience Department. This mineralogy course was a total success, this first event had a high attendance. Then the SGA-chapter president Ricardo Tenjo resumed the program with a lecture on general concepts of economic geology, which was followed by a series of lectures including: Granitoids and Related Mineralization, Ultramafic Hosted Magnesite Deposits, Mississippi Valle Type Depots and an introduction to Skarn Deposits. Furthermore, we had the opportunity to work with drilling cores and make an exercise of well logging. At the end, it turned up to be a highly rewarding fieldtrip. A second fieldtrip was made from September 17th to September 20th. This time, a group of fourteen student SGA members visited an Au/Cu High-Sulfidation Epithermal Deposit at the Vetas-California Mining District, located in the Santander Department. This deposit is currently an exploration project managed by Eco Oro Minerals Corp., and is called “Angostura Project”. The accompaniment was made by the geologist MSc Edgar Castiblanco, who offered us his knowledge at this type of mineralization. During the fieldtrip we performed the geological survey of the outcrops and mineralogical characterization of the deposit. We had the opportunity to get access to the main exploration tunnel, we recognized typical hydrothermal alterations, and we were allowed to collect samples. Furthermore, we attended a presentation given by the main exploration geologist of Eco Oro Minerals Corp, Alfonso Silva Duarte, before start logging drilling cores.

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Session of the Young Learners in Ore Deposits Program performed by the student Mateo Espinell.

1st Meeting of Student Chapters of Geosciences Department, National University of Colombia (UNAL).

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News from the Bucaramanga Student Chapter – Deposits Of The Coast And Peruvian Mountain

González P, Danilo A. Hernández B, Javier E.
School of Geology, Faculty of Chemical Engineering, Universidad industrial de Santander, Bucaramanga, Colombia; email: sgacolombia@gmail.com

The „I International Exchange SGA Perú – SGA Bucaramanga (Colombia)“ was an activity organized and managed by the two student chapters mentioned above. The version carried out in Peru began on September 12, 2016 with the conferences: „Types of Peruvian deposits and their distribution“ by Ing. Geologist (Ph.D) Rolando Carrascal Miranda, and „Peru Metalogenic Map: Production, reserves, and gold, silver and copper resources„, in charge of the ing. Geologist Jorge Acosta Ale. In addition to the intervention of the presidents of the chapters involved in the activity: Jesus Vilca De la Cruz (SGA Perú) and Danilo González Pacheco (SGA Bucaramanga - Colombia).

The field trip was made to show different examples of mineralizations occurring in Peru, their field relationships, mineral alterations, and manifestations of ore minerals. Porphyry deposits of Copper, VMS, Skarn and “Cordilleranos type” were also visited, as well as a review of the geological units of the mineralizations and their geological history.

The porphyry of Toro Mocho, is a porphyry of copper, related to miocene intrusive, characterized by dioritic, granodioritic and quartzomonzonitic stocks, overlaying by cordilleran veins. Porphyry is characterized by three stages of alteration defined as quartz veins with biotite and potassium feldspar, quartz – molybdenite veins, quartz – pyrite – sericite – molybdenite, quartz – molybdenite – pyrite. and quartz - pyrite – sericite veins, respectively. Cut by veins of mesothermal deposits containing Cu, Zn, Pb, Ag. (Benedetti, 2007).
The VMS (Perubar) deposit was an open-pit mine for the exploitation of barite, which was later characterized by the deepening of the mining operations, later characterized as VMS by the occurrence of metals in Cu, Zn and Pb sulphides in lenticular bodies. The Skarn of Cerro de Pasco forms part of a group of deposits of limestone replacement by processes of continental volcanic exhalation located on a rim of diatreme, the limestones are part of the mesozoic sedimentary belt, characteristically show typical alterations like the silicification, sericitization, Argilitization, alunitization, propylitization and epidotization, whose ores are located in lenticular bodies of Pb - Zn, Ag – Pyrite, Cu, Ag.

The Cordilleran deposits are structurally linked to tectonic orientations that favor the conditions for the generation of high law sharp veins, constituted by quartz and base metals, such as Cu, Zn, Pb, Ag with a thin halo of hydrothermal alteration, exploited in underground mining , As in the Pacoya mine.

References

News from the Bucaramanga Student Chapter – Visit To The Western Emerald Frame And Saline Dome, Andean Region, Colombia

González P, Danilo A. Hernández B, Javier E.
School of Geology, Faculty of Chemical Engineering, Universidad industrial de Santander, Bucaramanga, Colombia; email: sgacolombia@gmail.com

In the framework of the “Academic Exchange SGA Peru - SGA Colombia” organize by the SGA student chapters from Peru and Bucaramanga, Colombia, a field trip was coordinate and carried out by the student chapter’s board of directors of the host university from August 22 to 27 of 2016, to the towns of Pauna and Zipaquirá, located in Boyacá and Cundinamarca departments respectively. These with the purpose of visiting the main emerald region of Colombia, as well as the great saline dome located in the central Colombian region.

As a preamble to the field trip, Professor Msc. Jesús Hernando Mendoza, gave a conference at the Universidad Industrial de Santander about the geological context of Colombia, in order to offer a previous geological knowledge of the region to the students of the SGA Peru chapter and let them know the economic importance in the mining development of Colombia.

The start of the field trip took place on August 23, with a stop at the Chicamocha Canyon, located about ~ 53 km from the city of Bucaramanga, where the different geological structures were observed, as well as a brief description of the units of the area. In the Chicamocha canyon we observed outcrops of the Chicamocha schist unit defined by Mantilla et al., (2016) as metapiramites, metapelites and metabasites.

The visit to the Western Emerald frame was held on August 24 and 25 in the municipality of Pauna, in the department of Boyacá, located ~ 149 km from Tunja, the capital of the department and about 304 km from the city Of Bucaramanga. In this first part we visited the mine „La Pita“, located ~ 2 hours from Pauna, by car in the mining district of Maripi. The visit to the mine was guided by the main geologist of the mine, and person in charge of the processes of exploration, exploitation and mineral benefit. As well as accompaniment of two of the five foremen of the mine. The mine is located towards the western side of the River Minero, as well as the main fault that bears the same name of the river. During the three days of the visit, the geologists of the mine shared the geological model of the deposit, tunnel maps and mine levels, as well as the processes related to the extraction, benefit and commercialization of emeralds in Colombia and the world.

Photo 1: Assistants of the student chapters SGA Peru and SGA Bucaramanga, Colombia; To the conference “Geology of Colombia and its metallogenic provinces” dictated by professor Msc. Jesus Hernando Mendoza.
Photo by: Authors.

Photo 2: Panoramic view of the Chicamocha canyon, photo taken from the viewpoint “Parque Natural Chicamocha”.
Photo by: Authors.

Number 41  August 2017
The mineralization is located in the Muzo Formation (hauterivian – barremian) defined as a calcareous formation, composed of micrite, with intercalations of calcareous loddolite, as well as in a segment with black shales with concretions of micrites With pyrite (Ortega, 2007). The veins containing the emeralds are found as a product of the hydrofracturation in the rocks of the Muzo Formation, and for this sector they are structurally controlled by the Rio Minero fault. The veins are mainly composed of calcite, in addition to pyrite and sometimes emeralds. After finishing the visit to the western emerald frame, we went to the municipality of Zipaquirá, in the department of Cundinamarca, at a distance of ~ 130 km from the municipality of Pauna and ~ 44.8 km from the nearest city, Bogota, capital of the department And Colombia. There we went to the old salt mine, now cathedral of salt. The salt mine was formed about 200 million years ago, and a elevation to the surface in the late tertiary period about 30 million years ago. This salt dome was formed due to the rise of the salt through the sedimentary layers, of the crust, through a mechanism known as diapirism. The cathedral is an old salt mine, approximately ~ 200 m deep, this exploitation began with the ancient indigenous groups settled in the region of the salt dome 500 years ago. Later what was being exploited in the last century was discovered by Alexander Von Humbolt in 1801, who estimated reserves of one million cubic meters of halite. In 1816 salt extraction was started from the hand of the miner Jacobo Wesner by subterranean galleries, later the levels „Guasá” (1834) and „Potosí” (1876) were opened. For 1978 the current level of extraction „Fabricalta” was opened under the supervision of Ing. Jorge Castelblanco. The extraction systems used in this mine have been chambers and pillars, long chambers and the most modern method, dissolution in situ. For the year 1932, it was decided to build a cathedral, which was modified and expanded in 1991. Currently the cathedral is a reference tourist site in Colombia and the world, attracting thousands of people for their geological evolution and mainly for their religious interest.

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The members of the SGA Bucaramanga student chapter, we would like to thank to the board of the SGA, as well as especially Anna Vymazalová and Jan Pasava, for all the support they have offered us over the years, without them it would not have been possible this field trip.

References
**FORTHCOMING EVENTS**

* marks a new entry

### 2017

**July 16–21**

**July 24–26**
Iron Ore 2017, Perth, Australia. Contact: Rachel Magill; Phone: 03 96586100; Email: r_magill@ausimm.com.au; Event website: http://www.ironore.ausimm.com.au/

**July 25–August 3**
Summer school “Impacts and their role in the evolution of Life”, Kuressaare, Estonia. Contact: Wolf Geppert; Phone: 08723691155; Email: wgeppert@hotmail.com; Event website: http://www.nordicastrobiology.net/Impacts2017

**August 4–9**
EMSMD – Magmatism of the Earth and related strategic metal deposits, Mias, Russia. Contact: Victor Zaytsev; e-mail: alkaline.conference@gmail.com; http://emsmd.ru/

**August 13–18**
Goldschmidt Conference, Paris, France. Contact: http://goldschmidt.info/2017/

**August 14–18**

**September 17–20**
SEG 2017: Ore Deposits of Asia: China and Beyond, Beijing, China. Contact: http://www.seg2017.org

**September 23–26**
Subduction Related Ore Deposits, Trabzon, Turkey. Contact: I. Uysal, uysal.ibrahim@gmail.com

**September 25–27**

**September 25–28**
granites2017@benalla, Benalla, Victoria, Australia. Contact: http://www.benallageology17.com.au

**October 2–6**
International Earth Science Colloquium on the Aegean Region, IESCA-2017, Izmir, Turkey. Contact: http://iesca.deu.edu.tr/

**October 22**

**October 22–25**
The Geological Society of America (GSA) 2017 Annual Meeting, Seattle, United States. Contact: http://www.geosociety.org/meetings/

**November 4–7**
The Geological Society of America (GSA) 2018 Annual Meeting, Indianapolis, United States. Contact: http://www.geosociety.org/meetings/

### 2018

**August 4–5**

**August 5–10**

**August 13–17 (Co-sponsored by SGA)**

**September 2 – 6**
Ultramafic–Mafic Complexes: Geology, Structure, Ore Potential, 5th International Conference, Gremyachinsk, Lake Baikal, Russia. Contact: E.V. Kislov, evg-kislov@yandex.ru

**September 2 – 9**
18th Annual Conference of International Association for Mathematical Geosciences (IAMG2017), Perth, Australia. Contact: http://www.iamg2017.com

### 2019

**August**
15th SGA Biennial Meeting, Glasgow, Scotland, UK. Contact: A. Boyce, email: Adrian.Boyce@glasgow.ac.uk

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The SGA website

Nikola Koglin, Chief Editor SGA website
Lehrstuhl für Geodynamik und Geomaterialforschung, Julius-Maximilians-Universität Würzburg, Am Hubland, 7074 Würzburg
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L. Azevedo, A. Soares
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Y.A. Litvin

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>> January 15, 2017: Abstract submission opening date
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>> February 28, 2017: Deadline for SGA Student grant applications
    Deadline for SGA Student free field-trip applications
    Abstract submission closing date

>> April 1, 2017: Abstract revision notice
>> April 15, 2017: Final revised abstract
>> April 30, 2017: Final acceptance
>> May 15, 2017: Deadline for early-bird registration

>> August 19, 2017: Icebreaker cocktail
>> August 20, 2017: Opening Ceremony; Student-Industry Event
>> August 21, 2017: SGA General Assembly
>> August 22, 2017: Gala Dinner, Château Frontenac
>> August 23, 2017: Closing Ceremony

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Symposia

SY01: Gold through time and space
SY02: Magmatic sulfide and oxide ore deposits in mafic and ultramafic rocks
SY03: IOCG-IOA ore systems and their magmatic-hydrothermal continuum: A family reunion?
SY04: Mineral deposits: theory, experiment and nature - a symposium to recognize the work of A.E. Williams-Jones

Sessions

S01: Geology, geodynamics and metallogeny of the Rhyacian (2.35 - 2.05 Ga)
S02: Ore-forming magmatic-hydrothermal processes along active margins
S03: Exhalative mineral deposits: key controls on the quality (size and/or grade) of deposits and districts
S04: Uranium deposits: from source to ore
S05: Iron ore - deposit to global scale processes
S06: The impact of the supercontinent cycle on ore formation
S07: Developments of geochronological methods and their application to date ore forming events
S08: From fertility to footprints: New vectoring tools for mineral exploration
S09: Geometallurgy: risk reduction through communication, optimization and innovation
S10: GSC@175: How can government promote exploration success?
S11: Resources development and perception/acceptability: The role of geosciences
S12: Gem research: Beautiful windows into earth's interior
GS01: General session - posters only
Short courses

- SC1: Recent advances in the genesis of mafic and ultramafic ore systems
- SC2: High technology metals (REE, Nb-Ta, Li)
- SC3: Exploration geophysics – new methods, case studies, modeling
- SC4: Linkages amongst iron-oxide alkali-altered systems: from metasomatism to orogenic metamorphism
- SC5: Detecting the alteration footprint around porphyry copper deposits
- SC6: Exploration management and targeting with 3D multidisciplinary models
- SC7: Field portable instrumentation
- SC8: Recent advances in CT and LA-ICP-MS applied to mineral exploration

Field trips

- FT01: Physical volcanology and metallogenesis of the Ni-Cu-PGE deposits in the Cape Smith Belt, Québec, Canada
- FT02: Iron oxide and alkali alteration, skarn and epithermal mineralizing systems of the Grenville Province, Canada
- FT03: Gold mineralization in the Guyana Shield, Guyana and Suriname, South America
- FT04: Uranium deposits in the Western Athabasca Basin, Canada
- FT05: Québec fortified city: geological and historical heritage
- FT06: Precious and base metal deposits of the southern Abitibi greenstone belt, Superior Province, Canada
- FT07: Stratigraphic and metallogenic context of the Sokoman Iron Formation in the Labrador Trough near Schefferville, Québec-Labrador, Canada
- FT08: Geologic setting and iron oxide deposits of the mesoproterozoic St. Francois Mountains, Southeast Missouri, USA