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PARTICIPATING SOCIETIES

The Mineralogical Society of Great Britain and Ireland is an international society for all those working in the mineral sciences. The society aims to advance the knowledge of the science of mineralogy and its applications, including crystallography, geochemistry, mineralogy, environmental science and economic geology. The society further promotes this through scientific meetings and the publication of scientific journals, both in print and online.

Website: www.minersoc.org
Contact: info@minersoc.org
Society News Editor: Andrea Koziol (akoziol@jauadair.org)

The Clay Minerals Society (CMS) began in 1952 as the Clay Minerals Committee of the US National Academy of Sciences – National Research Council. In 1962, the CMS was incorporated with the primary purpose of stimulating research and disseminating information relating to all aspects of clay science and technology. The CMS holds annual meetings, workshops, and field trips, and publishes Clays and Clay Minerals and the CMS World Series of Lectures. Membership benefits include reduced registration fees to CMS Workshop Lectures, and Elements.

Website: www.clay.org
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Website: www.socminet.it
Contact: secretaria@socminet.it
Society News Editor: Costanza Bonadiman (bd@socminet.it)

The Polish Towarzystwo Mineralogiczne (Mineralogical Society of Poland) was founded in 1969, to bring together professionals and amateurs interested in mineralogy, crystallography, petrology, geochemistry, and economic geology. The society promotes links between the mineralogical sciences, education, and technology through its annual conferences, field trips, information exchange, and publishing. Membership benefits include subscriptions to Mineralogia and Elements.

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THE POWER OF MYSTERIOUS WORDS

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One of the joys of growing up in a little-remarked-upon corner of the upper Midwest USA is that it came with its own secret words and rituals—cricks and bubblers, hotdishes and euchre. The Wisconsin patois served as a daily reminder that humans have a passion for using mysterious languages to express the numinous: cants and glossolalia that describe new things or express new ideas or emotions, and that draw lines, intentionally or otherwise, between the community of “insiders” and everyone else.

Scientists do much the same thing, particularly when wrestling with new, challenging, or hotly debated problems. Quantum mechanics is arguably among the most important and widespread systems of scientific thought, and underlies cell phones and much else in modern life, yet how many of us could provide appropriate definitions of its secret words—‘eigenstate’, ‘nonlocality’, ‘Hilbert space’, and so forth?

But as a maturing scientific discipline winds down its first-order debates and begins to take firm shape, the specialists may tame their jargon, making an abstruse intellectual home ready to receive outside guests. Igneous petrologists are a familiar community that has (mostly) forced its major mysteries into a unified paradigm and tidied up its talk. Time was, competence in the field demanded that you were free in your speech language has been redacted, systematized, and demystified.

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Oldoinyo Lengai (Tanzania) is the only active volcano on Earth that erupts natrocarbonatite lava.

“Rejoice!” I say. Certainty and simplicity are overrated. The author of this issue’s Perspectives piece, Francesco Stoppa, makes an on-point reference to the 19th century conflict between pluto­nists and neptunists. Like that debate from the founding era of the geosciences, the study of carbonatites forces us to confront parts of the rock record that are peculiar, unfamiliar, composed of substances outside our daily experience, and that have formed in environments that don’t fit neatly into accepted categories. Are carbonatites fundamentally igneous or metamorphic rocks? Perhaps “Yes” to both sides. Do they derive from the lithosphere, or are they rooted in processes from the deep mantle? You be the judge. Our authors may struggle with, and sometimes disagree about, these and other first-order questions. But that mysteriousness and uncertainty comes with something special—an opportunity to encounter a subject that is wide open to transformational discovery and reinterpretation.

John Eiler
Principal Editor
FROM THE EDITORS

The Chair of the Executive Committee is responsible for initiating, promoting, and summarizing discussions among members of the committee via e-mail or other means; for communicating with the Executive Editor when needed; and for coordinating an annual meeting with the Executive Editor and Principal Editors.

Daniel (Dan) Frost has been part of the Executive Committee since 2013 as the European Association of Geochemistry (EAG) representative. He has served as the Executive Committee Chair since 2015 and will be stepping down from the Chair position at the end of 2021.

Catherine (Cari) Corrigan was elected to be the next Chair and will begin her term of service in January 2022. Cari has represented the Meteoritical Society (Met Soc) since 2013 and is the editor for the CosmoELEMENTS column.

The editorial team greatly appreciates all the work that Dan has done on our behalf over the past 6 years. Thank you! And we look forward to working with Cari in the future.

John Eiler, Richard Harrison, Becky Lange, and Jodi Rosso

EXECUTIVE COMMITTEE

Elements is published through the collaboration of 18 participating scientific societies. The Elements editorial team is responsible for the content and the day-to-day management of the magazine. The Elements Executive Committee is responsible for the management of the magazine through financial oversight, approval of editorial appointments, and facilitating a close working relationship between the editorial team and the participating societies.

The Elements Executive Committee consists of members appointed by their respective participating society. Current members of the committee are as follows (in alphabetical order by society): Ryan Noble (AAG), Katerina Dontsova (CMS), Klaus Mezger (DMG), Daniel Frost (EAG), Sasha Turchyn (GS), Alicia Cruz-Uribe (IAG), Orfan Shouakar-Stash (IAGC), Simon Jowitt (IAGOD), Ritsuro Miyawaki (JAMS), Catherine Corrigan (Met Soc), Heather Jamieson (MAC), Barb Dutrow (MSA), Mark Hodson (MSGB), Marek Michalik (PTMIN), Blanca Bauluz (SEM), Sylvie Demouchy (SFCM), Costanza Bonadiman (SIMP), and Jörg Hermann (SGS).

CALL FOR THEMATIC PROPOSALS

Proposal Deadline: 26 February 2022

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International response to COVID-19 has resulted in scientific meetings being canceled or postponed. Check meeting web pages for ongoing updates.

CALENDAR

2022


March 20–24 Spring ACS National Meeting & Exposition, San Diego, CA, USA. Web page: www.acs.org/


April 10–13 AAPG 2021 Annual Convention & Exhibition, Houston, TX, USA. Web page forthcoming

May 2–4 Ancient Venus. Lunar and Planetary Institute (Houston, TX, USA) and on-line. Web page: www.lpi.usra.edu/science/initiatives/venus/

May 8–13 MRS Spring Meeting, Honolulu HI USA. Web page: www.mrs.org/meetings-events/spring-meetings-exhibits/2022-mrs-spring-meeting


May 15–20 ABSICON 2022, Atlanta, GA, USA. Web page: www.agu.org/absicon


July 10–15 Goldschmidt Conference, Honolulu, HI, USA. Web page: 2022.goldschmidt.info/goldschmidt2022/meetingapp.cgi


July 19–21 International Archean Symposium, Perth, WA, Australia. Web page: 6ias.org/

July 24–29 12th International Symposium on the Geochemistry of the Earth’s Surface (GES-12), Zurich, Switzerland. Web page: ges12.com


July 30–August 4 2nd IAGC International Conference (AIG-14 and WRI-17), Sendai, Japan. Web page: www.wri17.com

July 31–August 4 Microscopy & Microanalysis 2022, Portland, OR, USA. Web page forthcoming.

August 6–12 Geoanalysis Conference 2022, Fribourg, Germany. Web page: geoanalysis2021.de/en


August 15–19 12th International Kimberlite Conference, Yellowknife, NT, Canada. Web page: www.12zikca.ca

August 21–25 Fall ACS National Meeting & Exposition, Chicago, IL, USA. Web page: www.acs.org

August 23–26 Internation Symposium on Environmental Geochemistry (ISEG 2022) Moscow, Russia. Web page: iseg2020.org

October 9–12 Geological Society of America National Meeting, Denver, CO, USA. Web page: forthcoming


September 11–15 GeoMinKöln 2022, Cologne, Germany. Web page: www.geominkoeln2022.de

September 12–15 Earth Mantle Workshop (EMAW), Toulouse, France. Web page: emaw2021.sciencesconf.org

September 19–23 Chapman Conference: Distributed Volcanism and Distributed Volcanic Hazards, Flagstaff, AZ, USA. Web page: www.agu.org/Chapmans-Distributed-Volcanism

October 9–12 Geological Society of America National Meeting, Denver, CO USA. Web page: forthcoming

The meetings convened by the societies participating in Elements are highlighted in yellow. This meetings calendar was compiled by Andrea Koziol. To get meeting information listed, please contact her at akoziol@udayton.edu
The EXCITE Network is a European Horizon 2020 infrastructure initiative for scientists working on unravelling the secrets of Earth materials by using electron and X-ray imaging. What we offer? Free-of-charge access to 24 of the world’s best microscopy facilities in nine European countries.

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As this issue of *Elements* clearly demonstrates, carbonatites are unique and fascinating igneous rocks, with incredibly diverse mineralogy, that also represent vital resources of critical metals, such as the rare earth elements and niobium. Although carbonatites are now known worldwide, much of the early work to identify them was done in Africa, particularly around Oldoinyo Lengai (Tanzania) led by the late John Barry Dawson (1932–2013). Barry was a professor at the University of Edinburgh (UK) when one of us (KG) was there during the 1990s doing a PhD on alkaline igneous rocks and carbonatites; his interest and enthusiasm for the subject was infectious. Barry’s initial work on Oldoinyo Lengai, and his recognition of it as a carbonatite volcano, was done when he was a geologist for the Geological Survey of Tanganyika, around the time of Tanzanian independence. This was a time when colonial attitudes still strongly governed the way geological work was done in Africa, and the early papers on carbonatites abound with names of former colonies such as Rhodesia, Nyasaland, and South-West Africa.

The Geological Survey of Tanganyika was part of the Directorate of Colonial Geological Surveys, an organisation established in 1947 and based in London (Dixey 1957). This organisation provided geologists, geophysicists, geochemists, and mineral resource experts to geological survey organisations across Africa. Most of the geoscientists were graduates from British universities; reports from the time draw a tacit distinction between the skilled expatriate geologists and the local staff (who were rarely, if ever, mentioned). Part of the directorate’s work was to understand mineral resources in what were once British colonies, and Dixey’s 1957 review stated that it “paid particular attention to carbonatite complexes and has done much to stimulate interest in these potentially economic deposits.”

In 1958, the directorate was renamed the Overseas Geological Surveys, which later became integrated as the Overseas Division of the Institute of Geological Sciences in 1964. The institute eventually evolved into the British Geological Survey (BGS), which continues to deliver international geoscience and environmental science research and partnerships, in which the present authors are heavily involved. A 1977 review of the work of the Overseas Division noted baldly that “in most newly independent countries, there are few experienced indigenous geologists to staff a geological survey” (IGS Overseas Division 1977). Clearly, this situation was in large part a consequence of the colonial approach, which had offered few, if any, opportunities for local geologists to gain training and experience. For the rest of the twentieth century, the response to this continued to be the secondment of expatriate geologists to work in overseas geological surveys. However, this was accompanied by a gradual increase in training and development opportunities for local colleagues.

At the BGS, we have been working for some time to move on from this colonial legacy. We now focus on building and sustaining partnerships with African geological surveys and their geologists, working together to exchange knowledge, expertise, and skills. However, remnants of the colonial approach undoubtedly still remain across the geosciences and more widely. There is still far too much evidence of “parachute science”, whereby UK and other scientists from the Global North design and win projects, visit African sites, collect data, and write papers without involving African colleagues beyond the arrangement of logistics (North et al. 2020). International support for geological surveys and other geoscience organisations in Africa is all too often short-term: equipment may be purchased and data gathered, but there is limited support for the management, maintenance, and use of those assets once the international funds are no longer flowing. Changes in international aid budgets and focus, for example due to COVID-19 (Brown 2021), can have a significant impact on geoscience organisations in lower- and middle-income countries. There is a need for sustainable, long-term international funding, as illustrated by Swedish support for national research systems (Fellesson and Mählck 2017).

We discussed this text with our colleague Prince Cuffey, Director of the Geological Survey within Sierra Leone’s National Minerals Agency. He agreed with many of the points made here and emphasised that partnerships need sustainable funding to ensure meaningful progress. He also made an important point: he, like many other leaders in African geoscience institutions, has experience across the different sectors, having previously worked for exploration and mining companies. All too often, those companies were headquartered overseas, not in the country where they were actively working; when they closed their operations, their data and information left the country with them. Prince gave the example of Sierra Leone’s carbonatites. As a company geologist, he was involved in geochemical exploration over aeromagnetic anomalies that marked carbonatites, so he knows the dataset exists, but the company left Sierra Leone without ever submitting their data to the Geological Survey. This happens time and again, and it is vital that geoscientists ensure that datasets collected in one country are also delivered to the appropriate institution in that country.

The “colonisation” of geoscience calls for us all to address the factors over which we have influence, i.e., those that may sustain or create additional inequalities. This is an opportunity for geoscience organisations—including the BGS—to critically reflect on how UK colonial history shaped our discipline, and on subsequent progress. We also need to consider the attitudes and challenges that remain today in our organisations and the way in which we undertake our work in former colonial countries. Many of us have inadvertently made mistakes at times, which we need to recognise, reflect on, and learn from. Developing this deeper understanding of the issue, and openly acknowledging our history, will enable us to confront unequal power relations and inequality in accessing knowledge, data, and resources. It will also improve our organisational practice in equality, diversity, and inclusion, as well as our engagement with external partners in science that itself can support international development. Ultimately, we aspire to sustainable, equitable partnerships with African geoscience organisations, so that together we can continue excellent research—on carbonatites and on many other topics!

REFERENCES
During my doctoral studies, in the late 1980s, I realised that the Italian kamafugites (kalsilite melilitites) had to be related to carbonatite magmatism. I started a detailed study of the kama­  fugitic sites, and I explored remote areas deep in Italy’s Apennine mountains. When I found the Polino carbonatite, I put a few drops of acid on it, and the rock reacted. I have a vivid memory of my heart beating faster. I had found it! My fellow geologists were somewhat sceptical, but the late Professor Giorgio Marinelli (1922–1993) encouraged me and predicted many new carbonatite discoveries. He was right. Overcoming my Latin temperament, I focused on the concept that carbonatites, however unusual as rocks, cannot be dismissed as simple geological oddities but require detailed and comprehensive study. I am fond of all the history that marked my latest 40 years of life, and it reminds me of the many friends and mentors that I have had, especially when I was a young researcher. Sadly, some of them are no longer with us. I am so grateful to them, and I consider it a life-changing experience to have met them.

CARBONATITES: BACKGROUND

The “carbonatite saga” parallels the Plutonist vs. Neptunist querelle of the 18th and 19th centuries concerning the pyrogenic versus chemical origins of igneous rocks. In the mid-19th century, minerals in alkali rocks attracted mineralogists, who considered them fascinating examples of rocks containing minerals that combined calcium silicates and carbonates. These minerals occur in skarns, which are thermally metamorphosed rocks formed at contacts between silicate magma and limestone. Skarns may contain perfectly faceted crystals and, despite their marginal importance and volume, monopolised European mineralogical studies. On this basis, the concept of magma–limestone inter­ actions was applied to carbonatitic and alkaline igneous rocks, which led to the subsequent crystallisation of feldspathoids (e.g., sodalite, hauynie, leucite, nepheline, kalsilite) instead of feldspars.

Limestone assimilation became a fashionable model. Most distinguished geologists of the day discussed the role of limestone in the origin of feldspathoidal rocks. For example, Alfred Rittmann (1893–1980) proposed that Mount Vesuvius volcano leucitites form by dolomitic limestone assimilation into a trachytic magma. Not everyone agreed: Whitman Cross (1854–1949) rejected Daly’s model based on the geological observation that the melilite-bearing rocks of Hawaii (USA) formed in the absence of limestones and sub­alkaline rocks.

The person often credited with the first compelling hypothesis that these limestones are, in fact, igneous was Waldemar Brøgger (1851–1940). Although Brøgger was initially a proponent of Daly’s assimilation model, he changed his mind after studying the Norway’s Fen alkaline complex. He advanced the idea that limestones associated with alkaline silicate rocks are not sedimentary. Instead, he proposed them to be igneous rocks that he referred to as carbonatites. This was a radical idea that was strongly opposed. James Shand (1882–1957), one of the most famous alkaline rock petrologists of the time, did not believe in the igneous origin of carbonatites. Norman Bowen (1887–1956) suggested that carbonatites are non­igneous metasomatic and hydrothermal rocks. Likewise, William Pecora (1913–1972) concluded that carbonatites formed by carbonate solutions derived from alkaline magmas.

Never­theless, the field evidence overwhelmingly supported the idea that carbonatites were igneous, and an increasing number of “limestones” were recognised as igneous carbonatites.


The most intense effort in studying carbonatites took place between 1950 and 2000. Based on experimental petrology, an increasing number of Russian and US scientists became supporters of the carbonate magma­ rionic origin. Field observations of carbonatites on Alnö Island (Sweden) by Harry von Eckermann (1886–1969) supported the seminal experimental work of Peter Wyllie and his co-authors, leading to the conclusion that wollastonite and calcite can crystallise in a magmatic environment. Numerous geological, mineralogical, petrographic, geochemical, and isotope studies confirmed the magmatic genesis of carbonatites and their associated alkaline rocks, such as melilitites and foidites. Many experimental studies have suggested that carbonatites can be generated in several different ways, including by primary mantle melting, differentiation of carbonate from silicate melts, liquid immiscibility, and crystal fractionation. Beginning in the late 1970s, a new generation of scientists demonstrated that carbonatic liquids are largely immiscible at crustal pressures and form conjugate pairs, with silicate liquids starting from CO2-rich, mafic­alkaline parental melts. The thermobarometric geochemical work of Russian petrologists on melt inclusions in carbonatite-hosted minerals was particularly important in demonstrating the igneous genesis of alkaline silicate and carbonatite rocks.

Mantle metasomatism plays a considerable role in the evolution of carbonatites, and for many years it was believed that metasomatism involved solely the lithosphere. In recent decades, based on the study of mantle xenoliths and inclusions in diamonds, the idea of deep mantle metasomatism has developed. Carbonatite specialists from Europe, Russia, North America, Brazil, and China met at the Euro–Carb workshops, which were held in Italy, the Canary Islands, and the Kola Peninsula in 2002 and 2003. These meetings started an international discussion that is ongoing and have promoted new ideas about the economic potential of European carbonatites (e.g., Stoppa et al. 2016).
THE IMPORTANCE OF THE EXTRUSIVE CARBONATITES: THE CASE HISTORY OF ITALY

A completely new insight into the origins of carbonatites came from observations of extrusive carbonatite volcanism, including the 1960 eruption of Oldoinyo Lengai (Tanzania), the discovery of tear-drop lapilli-stone at Kaisersruhl (Germany), and the carbonatitic tuffs and bombs found at Fort Portal and Katwe-Kikorongo (both in Uganda). These studies corroborated the decades-earlier intuition of David Bailey (1931–2012) concerning the existence of extrusive carbonatites at Rufunsa (Zambia). Extrusive carbonatites preserve astonishing evidence of rapid cooling from high-temperature carbonate liquids, as well as having high-pressure aragonite inclusions. Studies of volcanic carbonatites have revealed a new type of alkaline carbonate consisting of sodium- and potassium-rich calcium carbonates. The rapid transformation of these ephemeral phases to form Ca-carbonatites led to the generalisation that initially all extrusive carbonatites were alkaline. Supporting evidence now includes the existence of wide alkali-rich fenite aureoles around most carbonatite intrusions and alkali-carbonate inclusions in extrusive carbonate minerals.

Although carbonatites are now accepted as igneous, the role played by mantle and crustal silicate material reaction and contamination was somewhat forgotten or ignored, overshadowed by the new enthusiasm that all carbonatites are igneous. Calcite carbonatite rocks were often erroneously interpreted as forming from melts of equivalent composition, and any oxide or silicate crystals were inferred as having crystallised from the carbonatite magma itself, without clear evidence. The unexpected discovery of extrusive carbonatites in Italy, within the Quaternary extensional intermountain belt, opened a new front of discussion. These rocks are very primitive silica-rich carbonatites with high Cr–Ni contents, mantle nodules, and high incompatible element contents. As deduced by the presence of abundant mantle debris, the magmas were initially propelled, at the mantle level, by violent CO₂ release with sufficient force to bring the magma and xenoliths to the surface at high speeds. This produces a fluidised mantle-rock breccia immersed in an immiscible mixture of mafic alkaline silicate and carbonate droplets. Passing through the lithosphere, specific concentric-shelled lapilli are formed in the conduit by the attachment of melt droplets to mantle xenolith fragments. These silica-rich carbonatites are important for their primitive character (high-Mg content and abundant mantle debris), because most experimental work indicates that melting of carbonated peridotite produces magnesian carbonatite melts with silica. The so-called “Italian silicocarbonatites”, with their primitive compositions, are invariably associated with potassic undersaturated rocks called kamafugites, while the geochemical and isotopic equilibrium between the two rock types indicates genesis by immiscibility at crustal levels. Notably, Italian carbonatites contain monticellite and wollastonite as mantle debris and carbonatite–liquid low-pressure reaction minerals. This is consistent with experimental work showing assimilation of silicate rock by carbonatite magma.

A more recent discovery is that Italian late-stage carbonatites are strongly enriched in fluorite, baryte, light rare earth element phases, Nb, V, and Sc (Fig. 1) (Stoppa et al. 2019). The discovery of carbonatites in Italy initiated vigorous discussion about their geodynamic context. Strong opinions arose from those who consider that Italian alkaline magmatism is related to subduction, because carbonatites are typically associated with intracontinental rifting but only rarely with intraplate oceanic islands. However, most of the papers about Italian carbonatites attribute this magmatism to upwelling of mantle asthenosphere and stretching of the lithosphere that is related to the Tyrrenhian opening, possibly controlled by a mantle plume of deep origin. Some authors have invoked Reginald Daly’s petrogenetic theory for these rocks; others oppose that view.

REFERENCES


A FINAL SURPRISE

Recent studies have proffered the idea that carbonatites can react with silicates (accidental mantle and crustal debris or felsic country rocks) to produce a suite of calcium silicate minerals that include diopside, wollastonite, monticellite, and andradite: assemblages that are typically found in skarns. However, whilst these minerals often appear to be nephrycysts that crystallised directly from the carbonatite melt, it seems more likely that the carbonatite melt was instead a diffusive medium in which SiO₂ derived from the silicate rocks was transported into the carbonatite system and sequestered in the skarn-like mineral assemblage. In this model, carbonatite rocks are hybrid rocks that result from a traditional magmatic crystallisation of carbonate minerals and from contamination by silicate material. This model now better explains field and thin-section observations and reverses Daly’s hypothesis based on reactions proposed by Rittman. It explains the specific crystal chemistry of the carbonatite minerals and their textural relationship, which are entirely different from those of skarns. The reactions that form the carbonatite-hosted skarn assemblages follow the same thermodynamics that govern the formation of true skarns hosted in sedimentary carbonate rocks. However, there is a fundamental difference: the liquid magma is carbonatitic, not siliceous. Essentially, this is not a skarn per se, but rather an “antiskarn”.

Sometimes there are circular thoughts in science, which reconcile old theories with new ones but that acknowledge observations developed over a century. In the end, one of the processes concomitant to the formation of calc-silicate assemblages in carbonatites is a metasomatic antiskarn reaction, which is precisely the opposite of what was proposed a century ago by Daly.
Michael Anenburg is an experimental petrologist. He is an Australian Research Council Linkage post-doctoral fellow at the Australian National University, after obtaining his PhD at the same place. Michael’s interests include the thermodynamics, petrology, and geochemistry of rare earth elements, carbonatites, and other exotic terrestrial melts; platinum group elements; and various topics in igneous and hydrothermal petrology. By using experimental petrology methods, he is developing petrological and geochemical tools for porphyry copper and gold exploration. Michael occasionally dabbles in the materials chemistry aspects of experimental and natural geological minerals.

Sam Broom-Fendley is a NERC Industrial Innovation independent research fellow at the Camborne School of Mines (University of Exeter, UK), where he gained his PhD in 2015. His scientific interests centre on understanding how mineral deposits, especially those of the rare earth elements, form from carbonatites. To this end, he collaborates extensively with mineral exploration companies and combines field and petrographic observations with mineralogical and geochemical analyses to unravel both the large- and the small-scale processes that are responsible for mineralisation. She uses the state-of-the-art instruments, including laser ablation (MC)-ICP-MS to unravel the complex geological processes that are hidden in mineral grains at the microscopic scale. Wei Chen is also interested in developing new in situ elemental and isotopic analytical techniques.

Wei Chen is an associate professor at the China University of Geosciences (Wuhan, China). She received her doctorate at the University of Notre Dame (Indiana, USA) in 2014. She is a geochemist by training, but also combines mineralogy and petrology. She is interested in the origin and evolution of carbonatite and associated mineral resources. By training, but also combines mineralogy and petrology. She is interested in the origin and evolution of carbonatite and associated mineral resources. Wei Chen is also interested in developing new in situ elemental and isotopic analytical techniques.

Andrew A. Christy was Senior Curator of Minerals at the Queensland Museum and was Lecturer in Mineralogy at the University of Queensland from 2016 to 2019, after having a career that included studies on high-pressure phase transitions, short-range order in crystal structures, ultra-high pressure metamorphism, magnetic carbon nanoflakes, and diamond. He is an expert on mineral exploration and has performed multidisciplinary research in the field of mineralogy and petrology of alkaline igneous rocks that are rich in carbon, including mantle diamonds and impact diamonds. He runs the Haskel experimental laboratory at University College London (UK) to simulate the Earth’s mantle where diamond may moderate carbon in melts and fluids. He promotes sustainability for subsurface resources, working with industry to address societal concerns about the environment. This includes carbon capture storage initiatives combined with subsurface energy operations, funded via the Horizon2020 European research programmes “S4CE” and “SXT”. He is a strong supporter of developing multidisciplinary networks to empower emerging talents of early career researchers through national and international research programmes.

Anna G. Doroshkevich has been working on carbonatites since her undergraduate studies in the Buryat State University (Russia) and did her PhD thesis on rare earth element (REE) carbonatites and alkali-silicate rocks from southern Siberia. Since 2016, she has been the head of the laboratory for alkaline magmatism and related ore-forming processes at the Sobolev Institute of Geology and Mineralogy (Novosibirsk, Russia). She is a renowned research leader in the fields of igneous petrology, mineralogy, geochemistry, and the isotopic geochemistry of alkaline-carbonatite complexes and associated REE and Nb ore deposits. Her numerous hobbies include pole dancing, rafting, mountain climbing, fishing, mushroom hunting, and reading.

Holly A. L. Elliott’s research focuses primarily on ore deposits associated with magmatic, volcanic, and hydrothermal processes. She has investigated the relationship between diatreme volcanism and Pb–Zn mineralization in the ‘Irish Ore Field’ whilst at the University of Southampton (UK). Most recently, Holly has been investigating the feasibility of using fenitization as an exploration indicator for rare earth element deposits as part of the European Union–funded Horizon 2020 HiTech Alkcarb project, whilst employed at the Camborne School of Mines (University of Exeter, UK). Holly now continues her research as a lecturer of ore deposit geology in the Environmental Sciences department of the University of Derby (UK).

Emma R. Humphreys-Williams obtained her MSci from University of Durham (UK) and her PhD from the University of Bristol (UK) and currently runs the Chemical Laboratories at the Natural History Museum (UK). Apart from developing methods for the elemental analysis of natural science samples, her research focuses on the composition and evolution of the mantle source of carbonatites, with an interest in deciphering the geochemistry of primitive melts that form rapidly erupted carbonatites. She has recently created a digital version of Alan Woolley’s catalogue of alkaline rocks and carbonatites (see www.alkarb.com).

A. Lynton Jaques is an honorary Associate Professor at the Research School of Earth Sciences, Australian National University. He obtained his PhD in 1980 from the University of Tasmania (Australia) for studies in experimental petrology. Prior to retirement, he was Chief Scientist at Geoscience Australia, Australia’s national geoscience research and information agency, holding a number of positions over his career. He researches the petrology of lamproites, kimberlites, and associated alkaline rocks, carbonatites, diamonds, and the structure, composition, and evolution of the lithospheric mantle.

Adrian P. Jones studies the mineralogy and petrology of alkaline igneous rocks that are rich in carbon, including mantle diamonds and impact diamonds. He runs the Haskel experimental laboratory at University College London (UK) to simulate the Earth’s mantle where diamond may moderate carbon in melts and fluids. He promotes sustainability for subsurface resources, working with industry to address societal concerns about the environment. This includes carbon capture storage initiatives combined with subsurface energy operations, funded via the Horizon2020 European research programmes “S4CE” and “SXT”. He is a strong supporter of developing multidisciplinary networks to empower emerging talents of early career researchers through national and international research programmes.

Vadim (Dima) S. Kamenetsky graduated from Moscow State University (Russia) in 1983 and earned his PhD from the Russian Academy of Sciences in 1991. He held several postdoc positions in France and Australia, and professorships in Germany and Australia. His petrological and geochemical studies on magmatic immiscibility are powered by the application of melt/fluid inclusion techniques and in situ analytical methods. His studies of melt and fluid formation for a variety of ultramafic, basalitic, and felsic magmas in different tectonic environments is supplemented by research on related ore deposits, such as those at Olympic Dam (Australia) and Norilsk (Russia). He is most renowned for research on the primary melts of Kimberlites and carbonatites.
Bruce A. Kjarsgaard obtained his BSc from the University of Guelph (Canada) and his PhD from Manchester University (UK), followed by post-doc positions in Manchester and at the Geological Survey of Canada. Bruce is a research scientist at the Geological Survey of Canada in Ottawa and an adjunct professor at the University of Alberta (Canada). His interest in carbonatites is fueled by relating results from experiments with petrology and economic geology studies. He also likes to integrate data for regional and global carbonatite data compilations.

Sergey V. Krivovichev is a Director General of the Kola Science Centre, Russian Academy of Sciences, which is located in the city of Apatity, just a few dozen kilometers away from the famous Kola mineral localities, including the Khibiny and Lovozero alkaline massifs. He is a full professor in the Department of Crystallography, Institute of Earth Sciences, St. Petersburg State University (Russia). In 2015–2016, he served as the President of the International Mineralogical Association and currently is the President of the Russian Mineralogical Society. His research interests include structural and descriptive mineralogy, inorganic crystal chemistry, crystallography, nuclear materials, and applications of complexity theory to natural and artificial objects.

Igor V. Pekov is Professor of Mineralogy at Lomonosov Moscow State University (Russia) and is a corresponding member of the Russian Academy of Sciences. He works on the mineralogy and geochemistry of alkaline rocks, the mineralogy and crystal chemistry of rare elements, the mineralogy of volcanic fumaroles and the oxidation zone of ore deposits, the crystal chemistry of zeolite-like materials, and researches the history of mineralogy. He is the senior author on 150 papers that report a new mineral species, a co-author on 120 other papers reporting new mineral species, and has had the great honour of having a new mineral named after him.

Anna V. Spivak has been working at the D.S. Korzhinskii Institute of Experimental Mineralogy, Russian Academy of Sciences, since 2001, after graduating from the Irkutsk State Technical University (Russia). In 2005, she defended her thesis “Growth, Properties and Morphology of Diamond Crystals from Carbonate Melts” at Moscow State University. In 2016, she defended her thesis “Genesis of Superdeep Diamond and Primary Inclusions in the Substance of the Earth’s Lower Mantle (Experimental Studies)” at Moscow State University and was awarded a Doctor of Science in Geology and Mineralogy. Anna Spivak’s scientific interests are focused on studying mantle systems and the physico-chemical conditions of diamond formation.

Suzette Timmerman is a Banting post-doctoral fellow at the University of Alberta (Canada). She obtained her PhD at the Australian National University for her work on helium isotope compositions of the transition zone and on sub-continental lithospheric mantle through time using diamond samples. Her interests include volatile recycling, the influence of recycled material on the composition of the mantle through time, diamond formation, and craton formation and evolution. Her current research is on tracking the Earth’s deep carbon cycle through dating of superdeep mineral inclusions and stable isotope analyses.

Gregory M. Yaxley is Professor of Experimental Petrology at the Australian National University (ANU). Greg obtained his BSc (Hons) and PhD from the University of Tasmania (Australia). He held a postdoctoral fellowship at the Australian National University and held an Alexander von Humboldt Fellowship at the Goethe University (Germany) before joining the faculty at the Research School of Earth Sciences at ANU. He was awarded a Marie-Curie International Incoming Fellowship at Bristol University (UK) in 2015. His research interests include high-pressure experimental and natural sample investigations of Earth’s deep volatile cycles.

Sabin Zahirovic is a researcher and lecturer at the University of Sydney (Australia), with a research focus on plate tectonics, geodynamics, and paleogeography. He received his PhD in 2015 and has been using the open-source and cross-platform GP licenses software (www.gplates.org) to build regional and global digital plate tectonic reconstructions. This digital community infrastructure has enabled Sabin and others to study the plate–mantle system, the role of the deep Earth in driving surface geography, as well as the mantle and tectonic perturbations to the planetary “deep” carbon cycle.

Anatoly N. Zaitsev is Professor of Mineralogy at St. Petersburg State University (Russia) and Scientific Associate at the Natural History Museum (London, UK). He has researched the mineralogy of carbonatites, of phosphorites, and of alkaline rocks from the Kola Peninsula (Russia) and the Gregory Rift (Tanzania). Recently, he started work on Tanzania’s Laetoli tuffs, their 3.66 Ma *Australopithecus afarensis* footprints, and the spatially associated basaltic rocks, including those from Ngorongoro (Tanzania). He has been awarded prestigious Alexander von Humboldt, Marie Curie and Fulbright fellowships. The mineral $REE_2Fe^{2+}TiO_4(OH)_2$ was named after him (anzaite-Ce) in recognition of his contribution to the study of REE minerals.