2022
ANNUAL REPORT

of the

INTERNATIONAL UNION OF GEOLOGICAL SCIENCES
COMMISSION
ON
GLOBAL GEOCHEMICAL BASELINES

January 2023

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2022 ANNUAL REPORT of the
IUGS COMMISSION ON GLOBAL GEOCHEMICAL BASELINES

URL: http://www.globalgeochemicalbaselines.eu/

1. TITLE OF CONSTITUENT BODY

IUGS Commission on Global Geochemical Baselines (CGGB or Commission), and for the sake of brevity will henceforth be referred to as Commission.

2. OVERALL OBJECTIVES

The mission of the Commission is to:

(i) Develop a Standard Methods Manual for the Global Geochemical Reference Network project.
(ii) Establish a global Geochemical Terrestrial Network (GTN) similar to a geodetic network for levelling existing databases (prime objective).
(iii) Prepare a global geochemical database and its representation in map form, and
(iv) Document the concentration and distribution of chemical elements and species in the Earth's near-surface environment.

The global geochemical database is urgently needed by environmental and natural resource managers throughout the world. To reach this goal, the Commission established an international network of applied geochemists throughout the world in order to provide standards for global-scale geochemical mapping. The Commission also promotes and facilitates the implementation of harmonised sample collection, preparation, quality control, and analysis protocols for geochemical mapping programmes.

Commission activities include:

- ✓ Developing partnerships with countries conducting broad-scale geochemical mapping studies.
- ✓ Providing consultation and training in the form of workshops and short courses to build the capacity for conducting geochemical mapping programmes in countries around the world.
- ✓ Organising periodic international symposia and conferences to foster communication among the geochemical mapping community.
- ✓ Developing standards for global-scale sampling in different morpho-climatic terrains.
- ✓ Developing criteria for certifying those projects that are acceptable for inclusion in a global geochemical database.
- ✓ Acting as a repository for data collected by projects which meet the standards of harmonisation.
- ✓ Preparing complete metadata for the various certified projects, and
- ✓ Preparing a global geochemical database and atlas.

3. RELATED GOALS TO OVERALL IUGS SCIENTIFIC OBJECTIVES

Current IUGS scientific policy objectives relate to global Earth Science issues, such as identification of mineral resources, global climate change, geological hazards, environmental geology and sustainable development. The work of the Commission relates directly to all of these objectives through the establishment of a land-surface global geochemical reference network, providing multi-sample media and multi-element baseline data for a wide variety of environmental and natural resource applications (Darnley *et al.*, 1995). The project is also consistent with:

- The strategic plan published by the IUGS Strategic Planning Committee (2000).
- The International Year of Planet Earth (2007-2009) of *'Earth Sciences for Society'*. (www.yearofplanetearth.org/);
- The objectives of IUGS Resourcing Future Generations initiative (http://iugs.org/index.php?page=resourcing-the-future-initiative), and
- Work of the UNESCO International Centre on Global-Scale Geochemistry (http://www.globalgeochemistry.com/).

4. STRUCTURE AND ORGANISATION

The Commission is led by a Steering Committee, which coordinates the activities of four Technical Committees as well as the contributions made by regional representatives. This organisation structure is continuously under review and when deemed necessary is revised, as additional countries with active geochemical mapping programmes or an interest in establishing such programmes become members.

4.1. STEERING COMMITTEE

The Commission's Steering Committee members for the 2020-2024 period are:

Co-chairs: *1st Co-chair*: Anna Ladenberger, *Geological Survey of Sweden*
2nd Co-chair: Kate V. Knights, *Consultant Geochemist, Dublin, Ireland*
Deputy-chairs: *1st Deputy-chair*: Gloria Prieto, *Servicio Geológico Colombiano*
2nd Deputy-chair: Gloria Simubali, *Geological Survey of Namibia*
Scientific Secretary: Paula Adánez, *Instituto Geológico y Minero de España*
Public Relations and Finance: Ariadne Argyraki, *Department of Geology and Geoenvironment, National and Kapodistrian University of Athens, Hellas*
Treasurer: Christina Stouraiti, *Department of Geology and Geoenvironment, National and Kapodistrian University of Athens*
Advisory Panel: David B. Smith, *United States Geological Survey (retired)*
Patrice de Caritat, *Geoscience Australia*
Alecos Demetriades, *Institute of Geology and Mineral Exploration, Hellas (retired)*

4.2. SAMPLING COMMITTEE

Chair: Alecos Demetriades, *Hellas*

Supervises the development and coordination of sampling protocols in the various climatic and geomorphological provinces throughout the world.

4.3. ANALYTICAL COMMITTEE

Chair: Gwendy Hall, *Canada*

Coordinates the work plan for the analysis of Global Terrestrial Network (GTN) samples, the activities of the laboratories, and the supervision of analytical quality control data.

4.4. DATA MANAGEMENT COMMITTEE

Chair: Timo Tarvainen, *Finland*

Supervises the sampling strategy and progress of the participating countries, manages the database of sample information and analytical results.

4.5. PUBLIC RELATIONS AND FINANCE COMMITTEE

Chair: Ariadne Argyraki, *Hellas*

Advertises and promotes the aims, objectives, and achievements of the project worldwide, including by use of the internet, and takes responsibility for trying to secure funding for the project.

4.6. REGIONAL REPRESENTATIVES

4.6.1. Africa

Theophilus C. Davies, *Department of Geology, Mangosuthu University of Technology, Durban, KwaZulu-Natal, South Africa*
Marthinus Cloete, *Council for Geoscience, Pretoria, South Africa*
J.H. Elsenbroek, *Council for Geoscience, Pretoria, South Africa*
Keith Sheppard, *World Agroforestry Centre (ICRAF), Nairobi, Kenya*
Alhaji Lamin Turay, *Geological Survey Department, Ministry of Mineral Resources, Sierra Leone*

4.6.2. America - North

David Smith, *United States Geological Survey, Denver, USA*
Robert G. Garrett, *Ottawa, Ontario, Canada*
Flor de Maria Harp Iturribarría, *SGM, Pachuca de Soto, Hidalgo, Mexico*
Enrique Espinosa, *SGM, Pachuca de Soto, Hidalgo, Mexico*
Jessica Rivera Perez, *SGM, Pachuca de Soto, Hidalgo, Mexico*

4.6.3. America - South

Carlos Alberto Lins, *CPRM - Geological Survey of Brazil, Recife - PE, Brazil*
João H. Larizzatti, *CPRM – Geological Survey of Brazil, Rio de Janeiro, Brazil*
Juan Pablo Lacassie Reyes, *Servicio Nacional de Geología y Minería, Valdivia, Chile*
Gloria Prieto, *Servicio Geológico Colombiano, Bogotá, Colombia*

4.6.4. Australasia

Patrice de Caritat, Geoscience Australia, Canberra, Australia
Adam Martin, *GNS Science, Avalon, Lower Hutt, New Zealand*

4.6.5. China

Xueqiu Wang, *Institute of Geophysical and Geochemical Exploration, Langfang, China*

4.6.6. Europe

Philippe Négrel, *Bureau de Recherches Géologiques et Minières, Orléans, France*
Anna Ladenberger, *Geological Survey of Sweden, Uppsala, Sweden*
Jasper Griffioen, *Geological Survey of The Netherlands (TNO), Utrecht, The Netherlands*

4.6.7. Indian Subcontinent

Pradip Govil, *National Geophysical Research Institute, Hyderabad, India*

Ashvin Wickramasooriya, *South Eastern University of Sri Lanka, Sammanthurai, Sri Lanka*

4.6.8. Japan

Atsuyuki Ohta, *Geological Survey of Japan, AIST, Tsukuba, Japan*

5. INTERACTION WITH OTHER INTERNATIONAL ORGANISATIONS

5.1. UNESCO INTERNATIONAL CENTRE ON GLOBAL-SCALE GEOCHEMISTRY

In May 2016, the UNESCO International Centre on Global-Scale Geochemistry (ICGG) opened in Langfang, China. The Commission was an active participant in preparing the successful proposal originally submitted to UNESCO in 2009.

One of the most important tasks for the Commission was to establish formal collaboration with the UNESCO Centre. Although there is considerable overlap in the objectives of the Commission and the Centre, the IUGS mandate is quite clear, namely that the Commission takes the lead in establishing the standards for global-scale geochemical mapping, in collaboration with the Centre; whereas, the Centre takes the lead in implementing those standards, in collaboration with the Commission. This relationship is specified in the approved Statutes of the Centre (16 October 2018), *i.e.*,

Article 7: The functions of the Centre shall be to:

- 7.1. Apply the standardised global-scale geochemical methods developed by the IUGS Commission on Global Geochemical Baselines, so as to document the concentration and spatial distribution of chemical elements in the various environmental compartments of the Earth's surface, and to establish global geochemical baselines for monitoring future geochemical changes;
- 7.2. Foster the implementation of global geochemical baseline programmes by securing funds, managing and coordinating these activities according to the scientific guidelines, determined by an External Advisory Committee cooperating with the IUGS Commission on Global Geochemical Baselines.

After the October 2018 meeting of the UNESCO Centre's Governing Board and Scientific Committee (refer to the 2019 Annual Report), it was expected that the collaboration between the Centre and the Commission was going to be smooth as five of the Commission's 2016-2023 Steering Committee members (Dave B. Smith, Alecos Demetriades, Patrice de Caritat, Gloria Prieto, and Gloria Simubali) are also members of the Centre's Governing Board and Scientific Committee, and the Centre's Executive Director (Xueqiu Wang) was the 2nd Co-chair of the Commission until 2020. However, there has been minimal communication and collaboration between the Centre and the Commission. The Centre does not even inform its international Governing Board and Scientific Committee members of its activities except for once every two years just before the scheduled biennial meeting of the Governing Board and Scientific Committee. The disappointment of the international Councillors was expressed during the 3rd Session of the Governing Board and Scientific Committee, which was held virtually on the 10th of December 2021, and was reported in Appendix 2 of the Commission's 2021 Annual report (pages 29 to 35).

It is stressed that the majority of the International Councillors voted against the acceptance of the biannual ICGG report, and the approval of the application to UNESCO for the renewal of the agreement for another six years. Two International Councillors abstained in both counts.

In September 2022, the UNESCO-ICGG Councillors were approached by Professor Zhang Jianping (a palaeontologist at the Geoheritage Research Center, School of the Earth Sciences and Resources, China University of Geosciences), who has been appointed by UNESCO to conduct the periodic evaluation of the ICGG as the renewal application will be assessed by May 2023. It is noted that due to the Covid-19 pandemic the six-year contract between UNESCO and China Geological Survey was extended by one year.

After a long silence, the UNESCO-ICGG Secretariat Director, Dr. Zhang Bimin, sent on the 13th of August 2022 to all Councillors a message to review the "*2021 Annual Report on ICGG Activities*", and information on the activities of the first six months of 2022, and planned activities until the end of the year. Of course, all International Councillors responded positively, and constructive comments and corrections were submitted. The last exchange of electronic messages with the UNESCO-ICGG Secretariat Director was on the 27th of October 2022, and the promised revised version of the "*2021 Annual Report on ICGG Activities*" is still pending.

The following paragraph from page 8 of the draft version of the 2021 annual report is interesting, and most likely explains the reasons that the International Councillors were never consulted during the UNESCO-ICGG's six year operation:

"*Since the establishment of ICGG in 2016, it has successfully held 36 international training courses in and out of China and attracted 856 participants from 52 countries,* ***which has effectively enhanced the international influence of China geochemical technologies***."

As the work that was carried out by ICGG was dictated by the interests of China Geological Survey, and the international Councillors were never consulted during the operation of the ICGG from 2016 to 2022, the recommendation is for IUGS not to support the application of China Geological Survey for the renewal of the agreement with UNESCO. The ICGG can continue its work under the auspices of China Geological Survey, as a Chinese Centre as it has done for the past six years, and not as a UNESCO international centre. For additional information Appendix 2 should be consulted.

5.2. INTERFACE WITH OTHER INTERNATIONAL ORGANISATIONS

The Global Geochemical Baselines (GGB) project is closely associated with the work of the EuroGeoSurveys (EGS) Geochemistry Expert Group (GEG; previously the Forum of European Geological Surveys, FOREGS Geochemistry Expert Group). The GGB project also has links with the International Atomic Energy Agency (IAEA) and potential links with the Global Terrestrial Observing System (GTOS). The EGS Geochemistry Expert Group has also established closer links with the European Soil Bureau Network (ESBN) over the past few years, and was actively involved in the European Union's (EU) Soil Thematic Strategy group for the preparation of the EU's Soil Protection Strategy Documents, and the final draft of the pending Soil Protection Directive.

The EGS Secretary General has established links to other European Commission projects, such as the Global Monitoring of Environment and Security (GMES) programme, and Infrastructure for Spatial Information in Europe (INSPIRE), since the Geochemical Atlas of Europe has been produced in a harmonised manner according to IGCP 259 specifications (Darnley *et al.*, 1995) and, therefore, compliant with INSPIRE guidelines.

In 2013, EGS became member of the United Nations Food and Agricultural Organization's (FAO) Global Soil Partnership, since the Geological Surveys of Europe are actively involved in soil geochemical mapping at the continental, regional and local scales.

In 2014, a Memorandum of Understanding (MoU) has been signed by EGS and the European Commission Joint Research Centre at Ispra (northern Italy), and representatives of the two institutions met at the end of January 2014 and finalised the cooperation. The cooperation agreement, because of the two continental-scale projects, FOREGS and GEMAS, included collaboration in continental-scale soil geochemistry in Europe.

In 2022, members of the EGS GEG and GGB Commission have joined technical working groups at EUSO (European Soil Observatory), and participated in the Second EUSO Stakeholders Forum between the 24th and 26th October 2022 (further information is included in the European report in Appendix 3).

In 2014, the Commission established links with the Young Earth Scientists Network during the 1st International Geosciences Congress organised by the Geological Survey of Iran in Tehran (February 2014). This collaboration resulted in the organisation of four two-day workshops on *'Global Geochemical Baselines'* during (i) the 3rd YES Congress in Dar es Salaam, Tanzania (12-13 August 2014) with 59 attendees (see 2014 Annual Report, p.25); (ii) 4th YES Congress in Tehran, Iran (29-30 August 2017), with 48 attendees (see 2017 Annual Report, p.28-34); (iii) RFG2018 in Vancouver, Canada (18 & 22 June 2018) – (see 2018 Annual Report, p.14-16 & 51-63), and (iv) on the occasion of the 5th YES Congress in Berlin (8-9 September 2019) – see 2019 Annual Report, p.18-19). This collaboration is continuing with the organisation of workshops on the occasion of future YES Congresses. There is also an on-going discussion about the establishment of a YES Working Group on Applied Geochemistry. Proceedings of the 5th YES Network Congress '*Rocking the Earth's Future*', held in Berlin, Germany, from 9−13 September 2019, were published in 2022 and can be downloaded from https://doi.org/10.2312/yes19.

EuroGeoSurveys also established cooperation with the Organisation of African Geological Surveys (OAGS) and developed a pan-African geological project proposal (PanAfGeo), which is financed by the European Commission (Directorate-General of Development and International Cooperation) and by a Consortium of 12 European Geological Surveys coordinated by the French Geological Survey (BRGM). The project proposal was presented at a workshop on the 14th August 2014 in Dar es Salaam (Tanzania), and the final version was presented at the OAGS Director's meeting in Gaborone (Botswana), 13-16 October 2014. The three-year joint project (2016-2019) covered a fairly wide range of tasks, starting from the issues of geoscientific mapping and sustainable management of mineral resources to human resources and training needs for OAGS members and their partners through innovative case studies. The first results of this project were presented at a dedicated session of the 35th International Geological Congress (35th IGC) in Cape Town in August 2016, and at the 11th OAGS Annual General Meeting (8-10 November 2018) in Dakar, Senegal, where a collaboration MoU was signed between EGS and OAGS. The PanAfGeo project was completed in 2019, and the final meeting took place from 24-25 October 2019 in Dar es Salaam, Tanzania. One of the EuroGeoSurveys Geochemistry Expert Group and Commission members, Maria João Batista (Laboratório Nacional de Energia e Geologia, Amadora, Portugal) has given geochemistry training in Portuguese in Work Package 4 – Environmental Management of Mines in Tete, Mozambique. The content of the lessons was from basic chemistry to case studies of waste management, also including metal mobility, sampling of solid mine waste material, analytical methods, lixiviation tests, and quality control.

Geochemical mapping was also in the programme of the Geoscientific Mapping, which was coordinated by the Geological Survey of Czech Republic without collaboration with the EuroGeoSurveys Geochemistry Expert Group.

The Commission submitted in August 2015 a joint proposal entitled '*Africa Global-scale Geochemical Baselines for mineral resource and environmental management: Capacity building phase*' to the Group on Earth Observations (AfriGEOSS) in collaboration with the EGS

Geochemistry Expert Group, the Geological Society of Africa and the Organisation of African Geological Surveys. In August 2017, it became obvious that the GEO Group on Earth Observations is not a funding platform, and funding should be sought from other sources. Hence, the AfriGEOSS proposal was discussed with the EGS Secretary General, and Philippe Négrel, Chairperson of the EGS Geochemistry Expert Group discussed with the AfriGEOSS capacity building programme in Phase II of PanAfGeo.

PanAfGeo2 has started in 2021 and is a continuation of the well-established PanAfGeo. Project objectives are to develop a set of knowledge and best practices in exchange programmes for African geoscientists to acquire the state-of-the-art tools and learn new methods and skills in several geoscientific competences. Maria João Batista, a Commission member, is this time in charge of coordination of WP-B – Mineral Resources Assessment (see Appendix 3).

EuroGeoSurveys participated in GEO-CRADLE (Coordinating and integRating state-of-the-art Earth Observation Activities in the regions of North Africa, Middle East, and Balkans and Developing Links with GEO related initiatives towards GEOSS), a European Commission Horizon-2020 funded project, which was recently completed (October 2018). The results of both the FOREGS Geochemical Atlas of Europe and GEMAS (GEochemical Mapping of Agricultural and grazing land Soil of Europe) projects were used by this project.

In North America, the Commission has established links with the North American Soil Geochemical Landscapes project involving the Geological Survey of Canada (GSC), the United States Geological Survey (USGS), and the Servicio Geológico Mexicano (SGM).

In South America, the Commission has established in 2019 a link with the Geochemistry Working Group of the Asociación de Servicios de Geología y Minería Iberoamericanos (ASGMI: http://asgmi.org/en/).

The Commission also interfaces with the National Geochemical Survey of Australia and the China Geochemical Baselines projects.

The Commission contributed to the IUGS initiative's Resourcing Future Generations (RFG) by submitting comments in July 2015 on the White Paper *'Resourcing Future Generations: Mineral Resources and Future Supply'* in collaboration with the EGS Geochemistry and Mineral Resources Expert Groups. Further, it participated with a representative in the RFG workshop in Namibia (24-30 July 2015), and in the writing of the report '*Resourcing Future Generations – A Global Effort to Meet the World's Future Needs Head-on*', and subsequently a paper published in Nature in March 2017 with the title '*Mineral supply for sustainable development requires resource governance*'. In 2018, on the occasion of RFG2018 in Vancouver the Commission organised a session on *'Global-Scale Geochemical Mapping: A Critical Component for Resourcing Future Generations'* (see Section §6.3.3 in 2018 annual report of IUGS-CGGB), and a two-day workshop '*Exploration Geochemistry: From fundamentals to the field*' in collaboration with the Association of Applied Geochemists (see Section §6.3.1 in 2018 annual report of IUGS-CGGB), and the Young Earth Scientists Network, which sponsored the one-day field training workshop.

5.2.1. New collaboration link with FAO's GLOSOLAN project

Following information sent by Fiona Fordyce (IUGS-CGGB United Kingdom member), the Commission joined on the 12th of March 2019 the discussion forum of the Global Soil Laboratory Network (GLOSOLAN: http://www.fao.org/global-soil-partnership/pillars-action/5-harmonization/glosolan/en/). A confidentiality agreement was signed, as this was a requirement for the participation in the GLOSOLAN programme.

GLOSOLAN's main objectives are:

- Make soil information across labs, countries and regions comparable, interpretable;
- Build a set of agreed harmonisation principles;
- Improve quality assurance and control (QA/QC) of soil analyses, and
- Promote information and experience exchange.

The discussion is made through video conferences, and up to now there were two video conferences, and a meeting in the FAO premises Rome on the 28th and 29th October 2019, which it was not attended by the Commission due to lack of funds.

In 2021, GLOSOLAN published a booklet with the title '*Global Soil Laboratory Network - Basic guidelines for preparing a sample for internal quality control*'. These guidelines are useful for the laboratories that will be participating at some stage in the Global Geochemical Reference Network project.

5.2.2. Possible collaboration with the Global Observatory on Pollution and Health

In 2019, the Commission initiated contact with the Global Observatory on Pollution and Health. The Global Observatory was established in 2018 as a collaborative effort among Boston College, the United Nations Environment Program, and the Center for Climate, Health, and the Global Environment at the Harvard T.H. Chan School of Public Health. The primary goal of the Global Observatory is to track efforts to control pollution and prevent pollution-related diseases. Mapping will be an important function of the Global Observatory. Data collected from various sources will be geocoded and entered into a Geographic Information System model for each country. Global-scale geochemical data sets from the IUGS Commission on Global Geochemical Baselines are a potentially important source of information for the Global Observatory. These data sets will provide a better understanding of the natural variation of potentially toxic elements in the Earth's near-surface environment and will provide a baseline against which future changes in the geochemistry caused either by human activities or natural processes may be recognised. Brief articles about the Global Observatory can be found at https://www.bc.edu/bc-web/centers/schiller-institute/programs/global-observatory-on-pollution-and-health.html, and https://www.unenvironment.org/news-and-stories/press-release/un-environment-and-boston-college-establish-global-pollution.

6. ACTIVITIES IN 2022

6.1. 77th IUGS EXECUTIVE COMMITTEE MEETING

The 77th IUGS open Executive Committee (EC) meeting was organised in Paris (France) from the 16th to the 17th of March 2022. Anna Ladenberger (1st Co-chair) represesented the Commission and reported its 2021 activities and planned work for 2022.

6.2. STEERING COMMITTEE VIRTUAL MEETINGS

A virtual Steering Committee meeting was organised on the 4th of May 2022, which was chaired by the 1st Co-chair Anna Ladenberger. At this meeting participated David Smith, Ariadne Argyraki, Alecos Demetriades, Paula Adanez, Kate Knights, Anna Ladenberger, Gloria Prieto and Christina Stouraiti.

A second virtual meeting was organised on the 22nd of June 2022 in order to solve some issues that were not completely clarified in the previous meeting. This meeting was attended by Ariadne Argyraki, Alecos Demetriades, Paula Adanez, Anna Ladenberger, Gloria Prieto and Christina Stouraiti.

6.3. ANNUAL JOINT BUSINESS MEETING

The IUGS Commission on Global Geochemical Baselines organised the Joint Annual Meeting together with the Geochemistry Expert Group of EuroGeoSurveys and the Geochemistry Group of ASGMI (Ibero-American Association of Geological and Mining Surveys).

The three-day physical meeting (13-15 October 2022) was hosted by the Hellenic Survey of Geology and Mineral Exploration and a total of 33 participants from Europe, China and Iran attended in person. The venue was the historical reception hall of the Meropion Philanthropic Foundation, near the Acropolis and Odeon of Herodes Atticus (Athens, Hellenic Republic).

The first day was focused on the activities carried out by the participating groups and future joint collaborations (publications, session proposals to congresses and meetings in 2023). Various anniversaries of the 60th Anniversary of IUGS, the 25th Anniversary of the Commission under the auspices of IUGS, and the 25th Anniversary of the FOREGS Geochemical Atlas of Europe (http://weppi.gtk.fi/publ/foregsatlas/-) were celebrated with praising presentations.

The second day was devoted to presentations of geochemical studies carried out by the geological surveys (Sweden, Finland, Norway, Ireland, United Kingdom, France, Italy, Spain, Portugal, Poland, Denmark, Hellenic Republic, and The Netherlands) and associated partners from the universities in Italy and the Hellenic Republic (Figs. 1a, b).

On the third day an excursion to the Lavreotiki peninsula was organised, with a visit to the ancient lead, zinc and silver mines, 6th to 4th century BC ore beneficiation plants (Figs. 1c, d) and the 19th to 20th century smelter. The minutes of this meeting are in Appendix 1.

(a) (b)

(c) (d)

Figure 1. Photographs taken during the Joint Annual Meeting: (a) group photograph; (b) meeting room with participants, and (c & d) the excursion to the Lavreotiki peninsula.

6.4. OTHER MEETINGS AND WORK PERFORMED

6.4.1. Monthly IUGS E-Bulletin publication

Since May 2021 the IUGS E-Bulletin editorial team encouraged Commissions, Task Groups and Initiatives to send a concise report of their activities. The Commission has responded when having important any news to transmit. The contributions are in the following E-Bulletins:

- IUGS E-Bulletin No. 187 – June 2022 (p.4)
- IUGS E-Bulletin No. 188 - July 2022 (p.7-8)
- IUGS E-Bulletin No. 191 – October-November 2022 (p.11-12)
- IUGS E-Bulletin No. 192 – December 2022 (p.8-9)

The Commission would like to acknowledge Gurmeet Kaur, Giusseppe di Kapua and Dolores Pereira for doing a great communication job.

6.4.2. Video for the Women in Geoscience Day

As part of the UN International Day of Women and Girls in Science (11th February 2022), and International Women's Day (8th March 2022), the Commission's 1st Co-chair, Anna Ladenberger (Fig. 2) was interviewed about her experience in working as applied geochemist and major challenges that female scientists have to face when working in the field under difficult conditions and at remote regions (https://www.iugs.org/scges; https://iugs60.org/iugs-women-in-geoscience-event/).

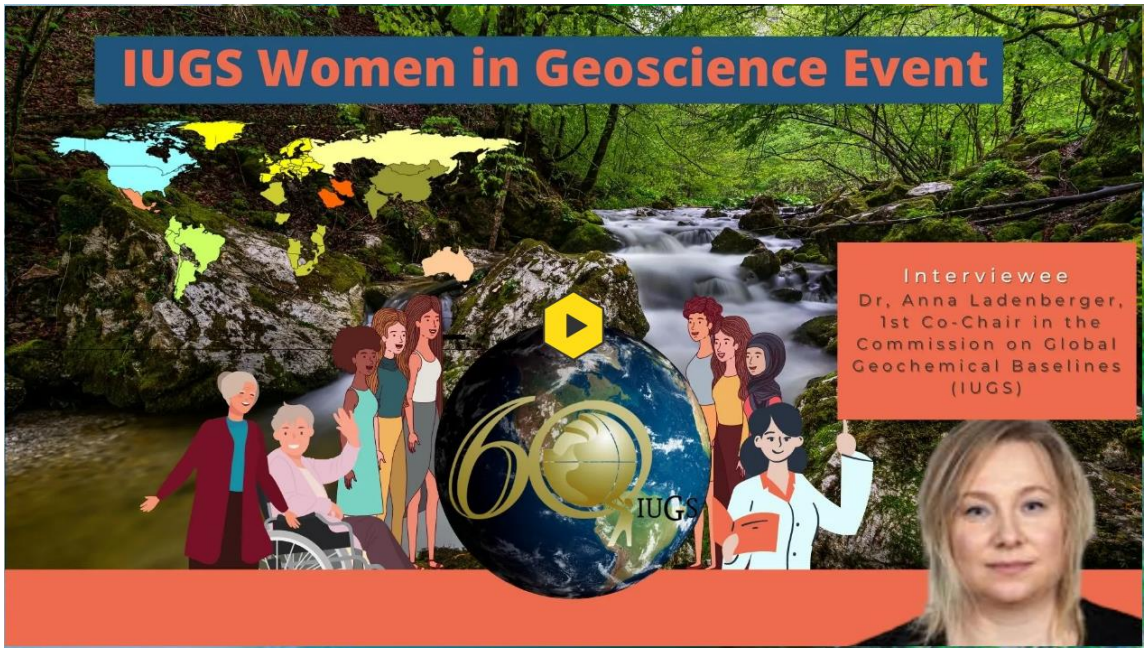


Figure 2. Banner image of IUGS Women in Geoscience Event with Anna Ladenberger's (1st CGGB Co-chair) at the bottom right-hand corner.

6.4.3. Video for the IUGS World Water Day Event

On the 22nd March, World Water Day (Fig. 3), Alecos Demetriades (Chair of Sampling Committee and Advisory Panel member of the Commission's Steering Committee) made a presentation about work done by the CGGB related to water studies. Comparison of the chemical composition of mineral bottled water with the corresponding element concentrations in the upper continental crust and human blood (Fig. 4), problems of harmonised geochemical data around the World and their interoperability. He presented results of the work about the Geochemistry of European Bottled Water as a proxy to groundwater geochemistry (European Groundwater

Geochemical Atlas). He showed striking similarities between stream and groundwater geochemistry.

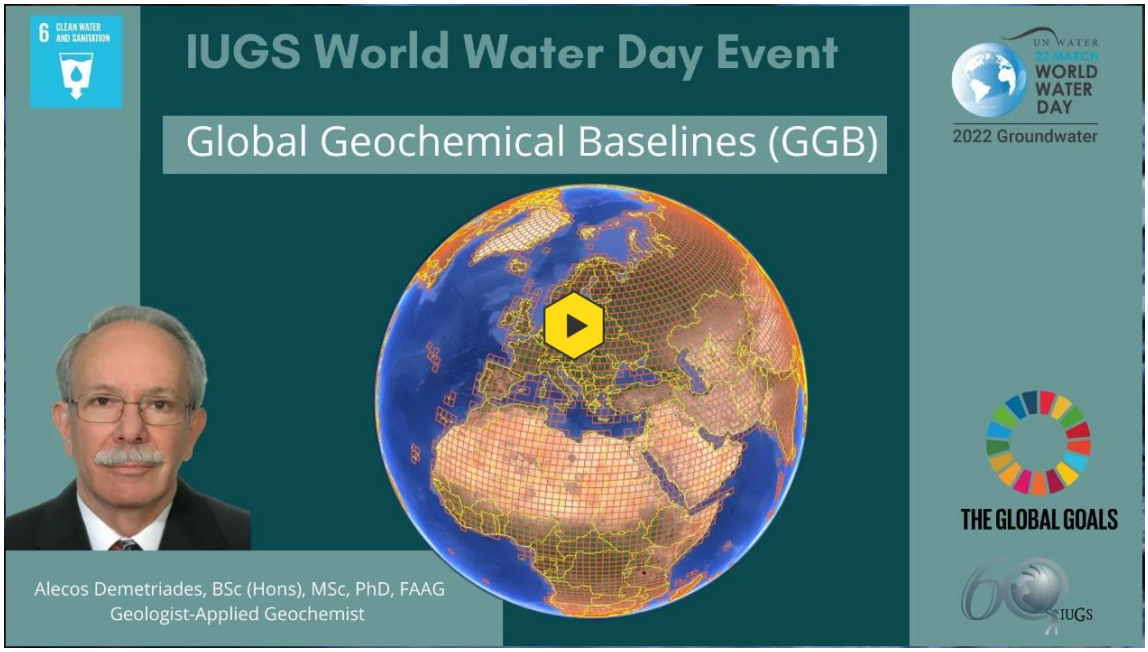


Figure 3. Banner image of IUGS World Water Day Event with Alecos Demetriades (Commission's Chair of Sampling Committee) at the bottom left-hand corner.

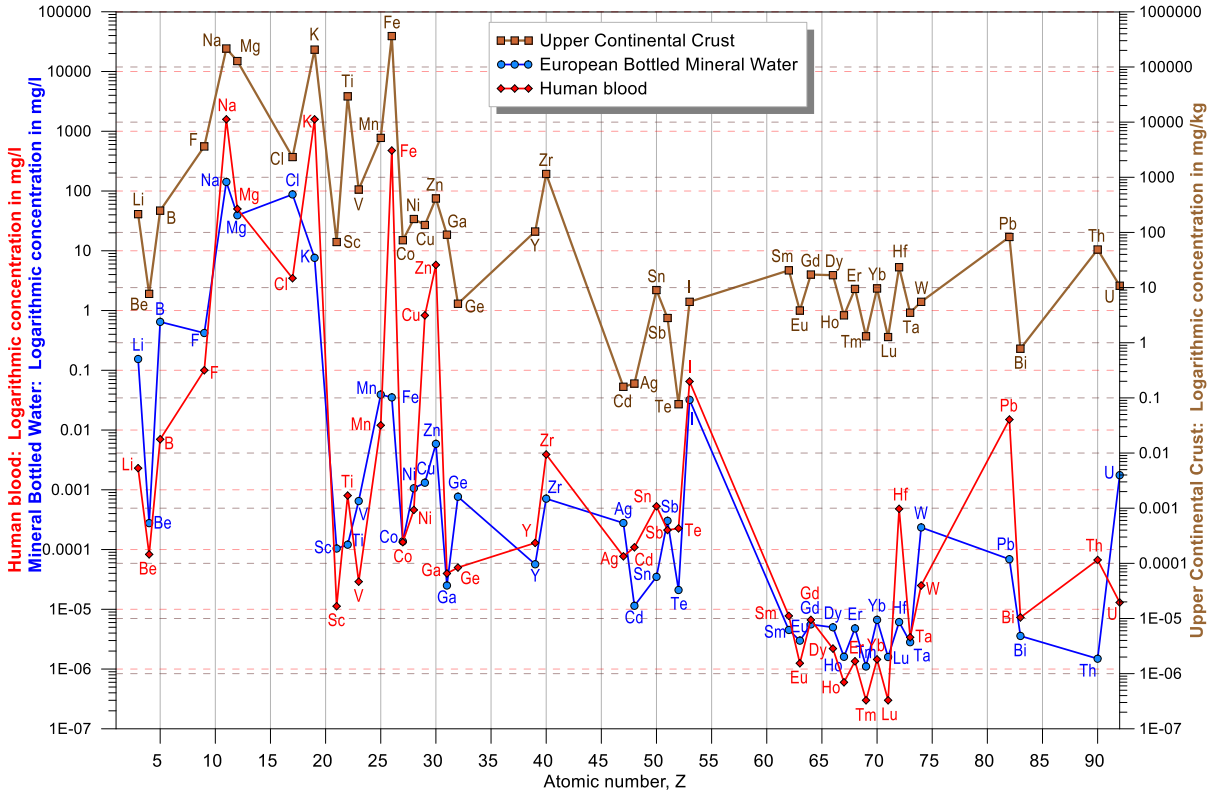


Figure 4. Graph showing the relationship between selected major and trace element mean concentrations in the upper continental crust, human blood and groundwater. Their similar trend indicates that there is a close relationship among the data sets, although there is a significant difference in magnitude. Data sources: Upper Continental Crust (Reimann et al., 2004, Table 11.1, p.105); Human blood (ALS Global, 2021). Drawn with Golden Software's Grapher™ v20 by Alecos Demetriades, Hellenic Institute of Geology and Mineral Exploration (IGME) & IUGS Commission on Global Geochemical Baselines (IUGS-CGGB).

6.4.4. ASGMI conference "Geochemistry for Social Development"

Anna Ladenberger (Commission's 1st Co-chair) delivered an invited lecture '*Geochemical mapping in Europe: Geochemistry Expert Group EGS contribution to more sustainable resources management*". The conference was hosted by the Geological Survey of Colombia (19-23 September 2022). The lecture can be downloaded from the following pCloud hyperlink: https://u.pcloud.link/publink/show?code=kZ1RjeVZDyCKXHL9hz447exJcgKcWXA6zSI7.

6.4.5. 150th Anniversary of the Swedish Geological Society Conference

As the FOREGS Geochemical Atlas of Europe is celebrating its 25th anniversary, a poster was presented with the title '*The FOREGS Geochemical Baselines Project – 25 years of European-wide geochemical mapping*' (Fig. 5) by Timo Tarvainen, Reijo Salminen, Alecos Demetriades, Tarja Hatakka, Anna Ladenberger, Kaj Lax and the FOREGS Project Team (17th-19th August 2022); https://geologiskaforeningen.se/en/programme-and-sessions/.

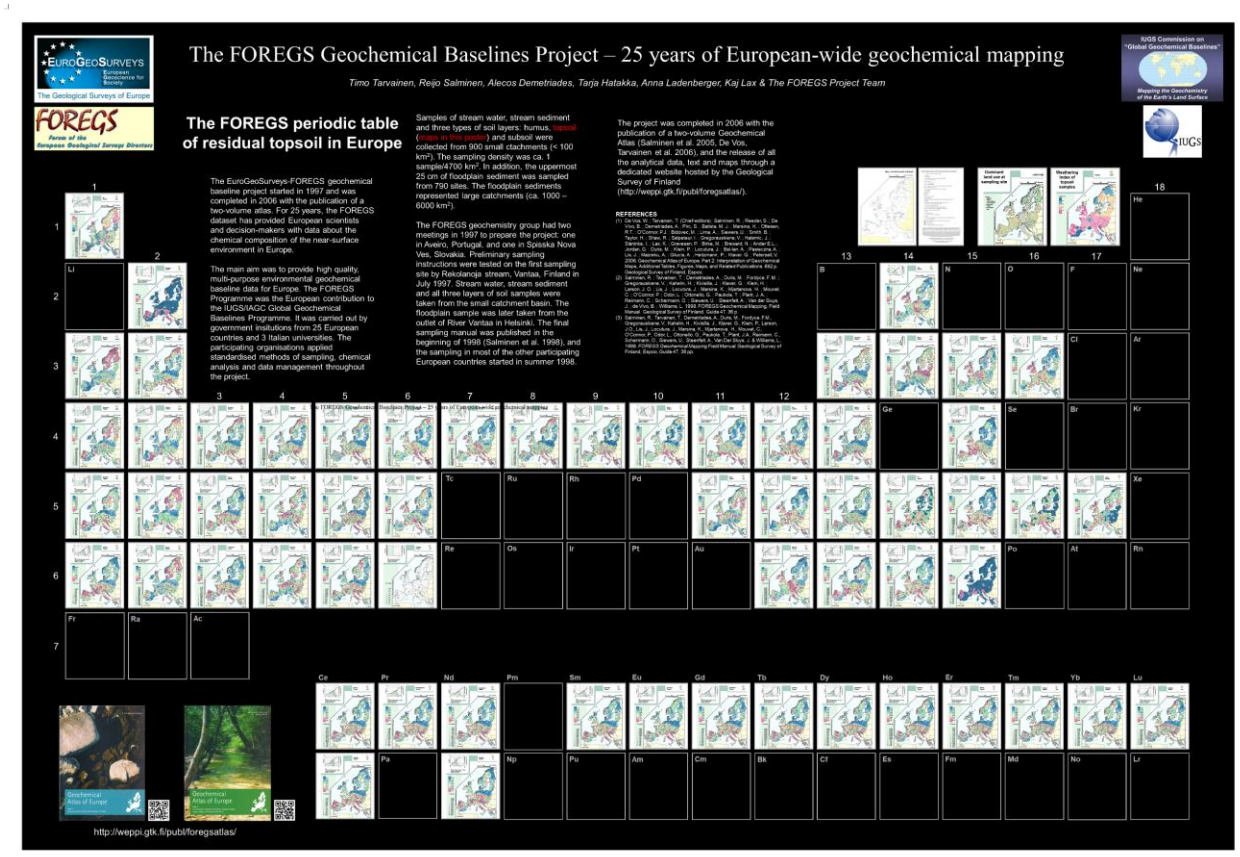


Figure 5. Periodic table showing element distribution maps in residual topsoil in Europe (geochemical maps are from the FOREGS Geochemical Atlas of Europe).

6.4.6. Article in Explore

The two Commission Co-chairs (Anna Ladenberger and Kate V. Knights) have written a short article about the '*International Union of Geological Sciences Manual of Standard Methods for Establishing the Global Geochemical Reference Network*', which was published in the September issue No. 196 of Explore (p. 27), the Newsletter of the Association of Applied Geochemists (https://www.appliedgeochemists.org/sites/default/files/documents/Explore%20issues/EXPLORE196-September2022.pdf).

6.4.7. IUGS Earth Science Festival

CGGB organised a virtual event at the IUGS Earth Science Festival with the title '***A planetary health check on Global Geochemical Baselines. Assessing the geochemistry of life's most vital resources***' (Fig. 6), which was held on the 10th of October 2022. The first part of the event comprised two invited talks given by Prof. Hassina Mouri about the impact of water quality on human health, and Prof. Mark Macklin gave an overview of the impacts of metal mining on river systems using floodplain sediments. In the second part, speakers from the IUGS Commission on Global Geochemical Baselines presented the concept of the Global Geochemical Baseline studies and the recently published '*International Union of Geological Sciences Manual of Standard Methods for Establishing the Global Geochemical Reference Network*', as well as examples of applications.

The programme is given below:

1st Part (chaired by Anna Ladenberger and Prof. John Ludden, IUGS President)

- Overview of impacts of water quality on human health by Prof. Hassina Mouri.
- Metal mining impacts on river systems: a first global assessment using floodplain sediments by Prof. Mark G. Macklin

2nd Part (chaired by Gloria Namwi Simubali)

- Introducing the need: The role of global geochemical baselines in the 21st century by Anna Ladenberger
- The history of Global Geochemical Baselines by David Smith
- Standardisation of sampling and analytical methods for the development of a harmonised global geochemical database by Alecos Demetriades
- Development of reference materials by Kate V. Knights
- Preparing data for seamless geochemical maps by Christopher C. Johnson
- The role of geochemistry in forensics by Patrice de Caritat

The Commission's presentations can be downloaded from the following pCloud hyperlink: https://u.pcloud.link/publink/show?code=kZwQjeVZwsUfpkB8pShUkM6Dan2plLDEOX8X.

The Commission acknowledges the assistance of Jane Huuse for the organisation of the event.

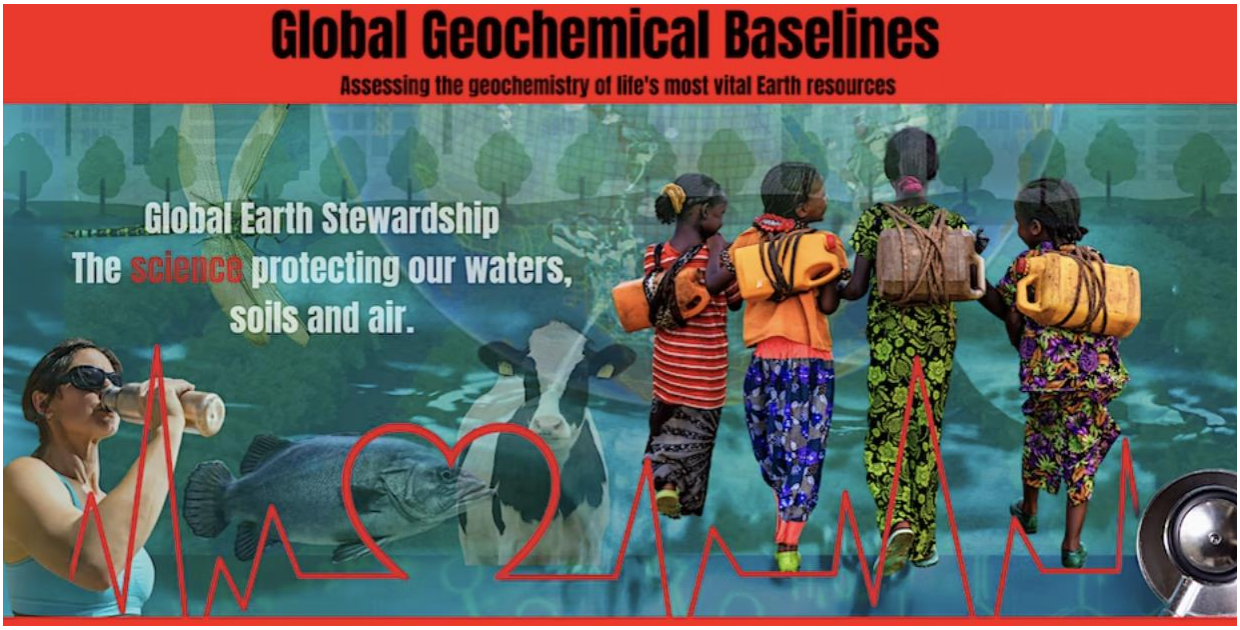


Figure 6. Global Geochemical Baselines promotional page for IUGS Earth Science Festival.

6.5. INTERNATIONAL CONFERENCES: SESSIONS AND WORKSHOPS

6.5.1. Spread of information regarding relevant events

The Commission is acting as a networking information channel among Societies, Universities, Institutes, *etc.* by spreading information about their activities to all CGGB members. During 2022, the Commission has circulated information for the following events:

- ✓ 21st January 2022: free webinar organised by the CoDA Association "*Independent Component Analysis for Compositional Data*" (https://www.coda-association.org/en/coda-info/past-activities/webinar-independent-component-analysis-for-compositional-data-2022-01-21/).
- ✓ 26th January 2022, IUGS: *Geotherma*l (https://iugs60.org/energy-transition-series/).
- ✓ 28th January 2022: *Celebrating 50 years of the Society for Environmental Geochemistry & Health*: Special Issue of Environmental Geochemistry & Health, 2021 (https://youtu.be/02eHjyqXNK0).
- ✓ 1st February 2022: *British Academy Workshop 3* - Dr Olivier Humphrey provides his experience in developing his online presence as an early career researcher. Followed by information to get the most out of referencing tools to help with your report/paper writing. Including – Endnote, Mendeley and Zotero (https://segh.net/seghlive-videos; https://youtu.be/5heo3z26G5c).
- ✓ 28th February 2022: *Home Biome SEGH Capacity Building Seminar* (https://youtu.be/bD0LxMut1c0).
- ✓ 16th March 2022, AGI: *Critical Minerals Mapping Initiative Update. Presenters will provide the latest updates to the critical mineral portal* (www.criticalminerals.org), the Critical Minerals in Ores database (CMiO), and its underlying deposit classification system. New critical mineral research and modelling results were presented (https://youtu.be/EUiVGW_FQKM).
- ✓ 17th March 2022: REFLECT Webinar - *European Geothermal Fluid Atlas*. Within the framework of the EU-funded project REFLECT (https://www.reflect-h2020.eu/2022/02/24/reflect-webinar-european-geothermal-fluid-atlas/).
- ✓ 8th April 2021, EFG: *EU Strategy to Secure Access to Mineral Raw Materials* (https://youtu.be/OTExdqIknv0).
- ✓ 20th April 2022, SEGH: *Environmental Pollution in Asia Workshop* (https://youtu.be/xRTx1OeaA1E).
- ✓ 6th May 2022, SEGH: *Measurement Uncertainty arising from Samplings: an introduction for Early Career Researchers* by Mike Ramsey (https://youtu.be/4jDAqG5t7Oc).
- ✓ 30th June 2022, EuroGeoSurveys: *National Geodata Delivery Solutions* (https://www.swissgeol.ch/en).
- ✓ 5th July 2022, SEGH: *Quality Measurements for scientific writing outputs* by Michael Watts (https://youtu.be/tH1s-2N5X5g).
- ✓ 16th September 2022, SEGH: *Status of heavy metals contamination in environmental compartments from Pakistan* by Muhammad Zaffar Hashmi (https://youtu.be/aKqkkeKYY8E).
- ✓ 21st October 2022, EFG: *Responsible mining for the energy transition: Cornish Lithium* (https://youtu.be/EtnylyF21mM).

- ✓ 26th October 2022: free webinar organised by the CoDA Association "*Multi-way compositional data: coordinates, interpretation, and open challenges*" (https://www.coda-association.org/en/coda-info/past-activities/webinar-multy-way-coda-2022-10-26/).
- ✓ 27th October 2022: *SEGH Americas Seminar* (https://youtu.be/eBhnVkuK-IA).
- ✓ 28th October 2022, SEGH: *Example of environmental geochemistry research at the Anthropocene - Air PM pollution & human health* by Xiangdong Li (https://youtu.be/B_XC7FgT0FM).
- ✓ 9th November 2022: *DDE Open Science Forum* (https://www.iugs.org/_files/ugd/f1fc07_8ef2fb21788d487f84078b2550a439d8.pdf?index=true).
- ✓ 15th November 2022, EFG: *Tackling the 21st Century Water Quality Challenges for Managed Aquifer Recharge* (https://eurogeologists.eu/efg-webinar-tackling-the-21st-century-water-quality-challenges-for-managed-aquifer-recharge/).
- ✓ 16th November 2022: *SER announces publication of a world first Standard for Mining Restoration: International Principles & Standards for the Practice of Ecological Restoration*, 2nd Edition (https://www.ser.org/page/SERStandards/International-Standards-for-the-Practice-of-Ecological-Restoration.htm).
- ✓ 16th November 2022: *SEGH Americas Seminar* (https://youtu.be/44izHVYYRwE).
- ✓ 18th November 2022, GTK: *What are the Raw Materials Supply Bottlenecks to the Green Transition? The Need for a New Plan* (https://youtu.be/gck4gM1HzrU).

25th November 2022, SEGH: I*nternational Union of Geological Sciences Manual of Standard Methods for Establishing the Global Geochemical Reference Network* by Alecos Demetriades (https://youtu.be/_qKBpUg2SF4; download slides from: https://segh.net/seghlive-fellows#4509d28e-af2f-469d-9923-c35471f7aa2a, and the original Microsoft PowerPoint presentation can be downloaded from the following pCloud hyperlink: https://u.pcloud.link/publink/show?code=kZMSjeVZ8FXn0QJ6Rmu0mSKYKfeD4QrTtDQX.

- ✓ 7th December 2022: *5th Workshop on the Global Black Soil Critical Zone Geo-ecological Survey (BASGES) – IGCP 665 project* (the presentations can be downloaded from the following pCloud hyperlink: https://u.pcloud.link/publink/show?code=kZ6q4eVZTus6MxuSReVtni8MvlMt906PLghX).

6.5.2. 16th International Congress of the Geological Society of Greece

The "*International Union of Geological Sciences Manual of Standard Methods for Establishing the Global Geochemical Reference Network*" was presented by Alecos Demetriades on Monday, 17th October 2022 (Figs. 7 & 8), as an invited lecture at the "Geochemistry, Mineralogy, Petrology and Volcanology" session of the 16th International Conference of the Geological Society of Greece, which was held at the conference centre of the University of Patras from the 17th to the 19th of October 2022. Over seventy geoscientists attended the lecture. Among them were many undergraduate and postgraduate students, as well as senior geoscientists – lecturers, professors and former General Directors of the Hellenic Institute of Geology and Mineral Exploration. The presentation made a good impact on the attendees with many questions asked directly after the lecture and discussions continued during the coffee and lunch breaks.

The Conference is held every three years since the early 1980s. This year's successful event had over 600 delegates that contributed over 400 abstracts accessible by using the hyperlink: https://gsg2022.gr/wp-content/uploads/2022/10/GSG2022_Book-_Of_Abstracts_V3_compressed.pdf.

The PowerPoint presentation and the extended abstract can be downloaded from the following pCloud hyperlink: https://u.pcloud.link/publink/show?code=kZyLTDVZoDBHIuCRjz7N5g3K5fwTL7Ima2D7.

Figure 7. Alecos Demetriades (Chairperson of the Sampling Committee and Advisory Panel member of the Commission's Steering Committee) delivering the keynote talk about the IUGS Manual of Standard Methods. The session conveners from left to right are: Petros Koutsovitis (University of Patras), Ariadne Argyraki (National and Kapodistrian University of Athens and Commission Steering Committee member) and Vasileios Melfos (Aristotle University of Thessaloniki).

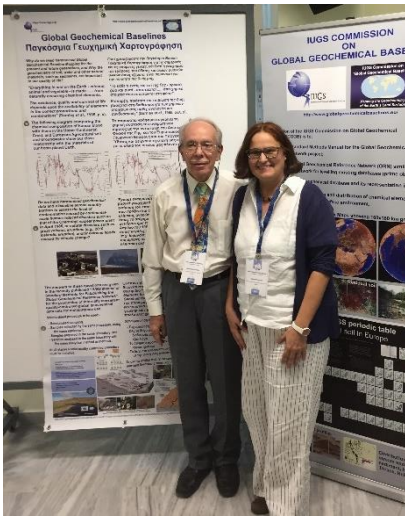


Figure 8. Alecos Demetriades (left) and Ariadne Argyraki (right) in front of the bilingual poster describing concisely the IUGS Manual of Standard Methods (left), and roll-up banner of the IUGS Commission on Global Geochemical Baselines (right). The poster and banner were displayed in the session room, and afterwards were moved to the conference centre's entrance hall and stayed there until the end of the conference in order to be seen by delegates.

6.6. MANUAL OF STANDARD METHODS FOR ESTABLISHING THE GTN

The mandate of the Commissions of the International Union of Geological Sciences (IUGS) is to set standards in their own discipline. Therefore, the obligation of the Commission on Global Geochemical Baselines (CGGB) is to provide the standards for establishing the Global Geochemical Reference Network. The *International Union of Geological Sciences Manual of Standard Methods for Establishing the Global Geochemical Reference Network* presents (Fig. 9), for the first time, a comprehensive overview of the standardised geochemical methods that should be employed across the land surface of the Earth to map the distribution of chemical

elements in various media. Applying these methods will produce internally consistent quality-controlled data sets for each sampling medium for multipurpose use. The Manual provides extensive information on sampling protocols for rock, residual soil, humus, stream water, stream sediment, overbank and floodplain sediments. There are also chapters discussing sample site selection; sample preparation; quality control procedures, including the development of project reference materials; analytical methods; data management; map preparation; project management; and information on how to level existing geochemical data sets. Any applied geochemist carrying out a geochemical mapping project at any scale should find a wealth of useful information within the pages of this Manual.

The Manual: Demetriades, A., Johnson, C.C., Smith, D.B., Ladenberger, A., Adánez Sanjuan, P., Argyraki, A., Stouraiti, C., Caritat, P. de, Knights, K.V., Prieto Rincón, G. & Simubali, G.N. (Editors), 2022. ***International Union of Geological Sciences Manual of Standard Methods for Establishing the Global Geochemical Reference Network***. IUGS Commission on Global Geochemical Baselines, Athens, Hellenic Republic, Special Publication, 2, xliv, 515 pages, 375 figures, 35 Tables, 5 Annexes and 1 Appendix, ISBN: 978-618-85049-1-2; **https://doi.org/10.5281/zenodo.7307696**.

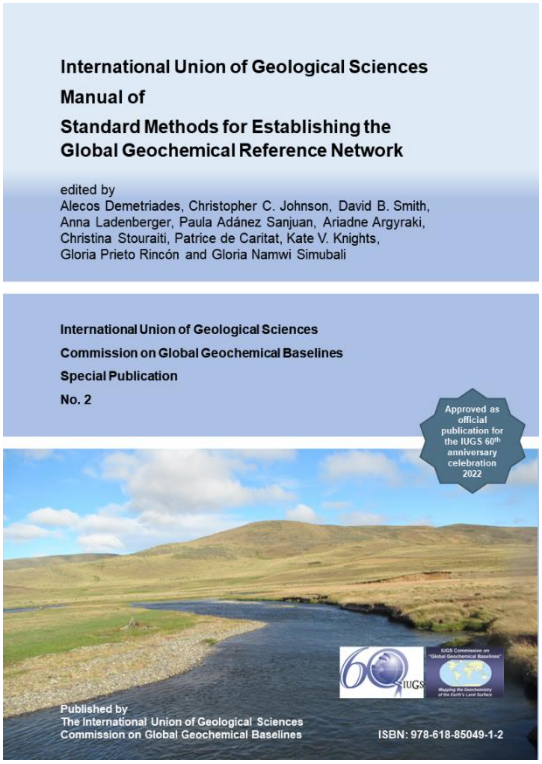


Figure 9. Front cover of the "International Union of Geological Sciences Manual of Standard Methods for Establishing the Global Geochemical Reference Network".

Apart from the main text of the Manual, a few Chapters are complemented by useful supplementary material, *i.e.*:

- Chapter 2 Supplementary material
- Chapter 2 Annexe A2.1 Supplementary material
- Chapter 3.2 Annexe A3.2.1 Supplementary material
- Chapter 7 Supplementary material
- Chapter 8 Supplementary material

The Manual of Standard Methods is truly an international effort, and the IUGS-CGGB would like to thank all the contributors, reviewers and providers of material for their engagement and dedication:

- The 51 contributors from 25 countries from Austria (4), Canada (1), Chile (3), China (1), Columbia (2), Cyprus (1), Finland (4), France (1), Germany (1), Hellas (4), Honduras (2), Ireland (1), Italy (1), Lithuania (1), Mexico (1), Namibia (1), Norway (1), Peru (2), Portugal (1), Russian Federation (2), Slovakia (2), Spain (4), Sweden (2), United Kingdom (3), United States of America (2) are:- Peter Filzmoser, Robin Friedrich, Edith Haslinger, Harald Loishandl-Weisz, Thomas Rosmann, Gwendy E.M. Hall, Felipe Astudillo, Juan Pablo Lacassie Reyes, Pablo Sebastian Oliva Vicentelo, Xueqiu Wang, Adrián Pérez Avila, Gloria Prieto Rincón, Zomenia Zomeni, Mikael Eklund, Tarja Hatakka, Reijo Salminen, Timo Tarvainen, Ignace Salpeteur, Manfred Birke, Ariadne Argyraki, Michalis Salahoris, Christina Stouraiti, Karina Maribel Cerna Guillen, Francy Michell Medina, Kate V. Knights, Stefano Albanese, Virgilija Gregorauskien, Laura Cecilia Tristán Capetillo, Gloria Namwi Simubali, Jim Bogen, César De La Cruz Poma, Luis Vargas Rodriguez, Maria João Batista, Igor Bogatyrev, Igor Savin, Pavol Lučivjanský, Daniela Mackovych, Alejandro Bel-Ian, Juan Locutura, Iván Martín, Paula Adánez Sanjuan, Anna Ladenberger, George Morris, Fiona M. Fordyce, Christopher C. Johnson, T. Robert Lister, David B. Smith, and Steven M. Smith.
- The 23 reviewers from 13 countries Canada (3), China (1), Croatia (1), Finland (1), France (1), Germany (1), Hellas (4), Ireland (1), Norway (3), Spain (1), Sweden (2), United Kingdom (2) and United States of America (2) are:- Raymond E. Lett, Alexei S. Rukhlov, Robert G. Garrett, Xin Lin, Josip Halamic, Reijo Salminen, Philippe Negrel, Jorg Matschullat, Evgenia Kontogianni, Paraskevi-Maria Kourgia, Zacharenia Kypritidou, Helen Karamanos, Kate Knights, Marianne Langedal, Belinda Flem, Clemens Reimann, Paula Adanez Sanjuan, Martiya Sadeghi, George Morris, Michael H. Ramsey, Peter Rostron, Laurel Woodruff and Federico Solano.
- The 10 colleagues from 5 countries that provided material Canada (3), Finland (2), Germany (1), Mongolia (1) and United Kingdom (3) are:- Juanxia He, Xiaoyuan Geng, Robert G. Garrett, Antti-Jussi Lindroos, Maija Pennanen, Peter Schad, Ochirbat Batkhishig, Michael Watts, Paul Everett and James North.

Last but not least the IUGS Executive Committee Councillors John Ludden (President), Hassina Mouri (Vice President), Daekyo Cheong (Vice President), Stanley C. Finney (Secretary-General), Hiroshi Kitazato (Treasurer), Qiuming Cheng (Past President), Silvia Peppoloni (Councillor), Claudia Inés Mora (Councillor), Jennifer McKinley (Councillor), and Ludwig Stroink (Councillor) are thanked for approving the publication of this Manual as the official 60th IUGS Anniversary publication, and finally the current and past two Presidents, John Ludden (2020-2024), Qiuming Cheng (2016-2020) and Roland Oberhänsli (2012-2016) for signing the Foreword.

ORIGINAL WORD FILES & FIGURES and POWERPOINT PRESENTATIONS: Since, the Manual is important to applied geochemists all over the world, and there is also interest in its translation to different languages, for each Chapter and Annexe the original Microsoft Word® files, all original figures, and Microsoft PowerPoint® files are provided in a zip file. The latter files can be used for teaching purposes. These files will be found at: https://www.globalgeochemicalbaselines.eu/content/182/chapter-files-word-text-original-figures-powerpoint-presentations-/, and their hyperlinks are:

Chapter 1: General Introduction
Chapter 2: Global Terrestrial Network Grid Cells, Selection of Sample Sites, and Sample Types to be Collected

Chapter 2: Supplementary material
- Annexe A2.1: Geodetic Levelling of Existing Geochemical Data Sets
  Annexe A2.1: Supplementary material
- Annexe A2.2: Parametric Levelling of Existing Geochemical Data Sets

Chapter 3: Sampling Methods: Introduction
Chapter 3.1: Rock Sampling
Chapter 3.2: Residual Soil and Humus Sampling
- Annexe 3.2.1: Residual Soil and Humus Sampling: The Soils of the World
- Annexe 3.2.2: Residual Soil and Humus Sampling: Soil Profiles

Chapter 3.3: Stream Water Sampling
Chapter 3.4: Stream Sediment Sampling
Chapter 3.5: Overbank and Floodplain Sediment Sampling
- Annexe 3.5.1: Overbank and Floodplain Sediment Sampling: Profiles

Chapter 4: Sample Preparation and Storage
Chapter 5: Development of Reference Materials for External Quality Control
Chapter 6: Geoanalytical Methods and Requirements
Chapter 7: Quality Control Procedures
Chapter 7: Supplementary material
Chapter 8: Data Conditioning Methods: Generating Time Independent Geochemical Data
Chapter 8: Supplementary material
Chapter 9: Data Management and Map Production
Chapter 10: Project Management

IMPORTANT NOTE: The Manual was made available to the international community on the 20th of June 2022. As some minor mistakes were found, these have been corrected and a new version with the same name was uploaded to the website on the 2nd of September 2022. In case anybody has downloaded it before this date, please delete the file from your hard disc before downloading the corrected version. In case you have printed it, there is an Errata file where you can see the corrections made.

6.7. TWO ADDITIONAL PUBLICATIONS

6.7.1. R-scripts for the generation of random sampling sites

The Global Geochemical Reference Network consists in total of 19,833 grid cells of 160x160 km that cover the whole globe. The land surface of the Earth is covered by 7356 grid cells (Global Terrestrial Network, GTN), and the marine surface by 12,477 grid cells (Global Marine Network, GMN). Planning the sampling campaigns in both realms requires the generation of random sampling points within each of the 160x160 km grid cell. For this purpose, three R-scripts are made available for the generation of 5-, 8- and 16-random sampling points within each 160x160 km grid cell. The three R-scripts can be used to generate random sampling points within any other size rectangular grid cell. The following publication provides the R-scripts, instructions for their use, and the format of the input and output files:

He, J. & Geng, X., 2022. R-scripts for Generation of 5, 8 and 16 Random Sampling Points Within Predefined Rectangles. IUGS Commission on Global Geochemical Baselines, Athens, Hellenic Republic, Special Publication, 3, vi, 14 pp., 5 Figures, 3 Appendices, Supplementary material, ISBN: 978-618-85049-2-9; https://doi.org/10.5281/zenodo.7307202 (Fig. 10).

Web page: https://www.globalgeochemicalbaselines.eu/content/185/ebook-r-scripts-for-generation-of-5,-8-and-16-random-sampling-points-/

Hyperlink to download the eBook:
https://www.globalgeochemicalbaselines.eu/datafiles/file/He_Geng_2022_IUGS-CGGB_R-scripts_for_generation_of_5-8-16_random-sampling-points.pdf

Hyperlink to web page to download the software programs:
https://www.globalgeochemicalbaselines.eu/content/196/r-scripts-for-the-generation-of-5,-816-random-sampling-points-within-predefined-rectangles-/

The R-scripts can be used for the generation of random points within the 160x160 km grid cells, but also any other size rectangular grid cell if, of course, one plans to take random samples within predefined rectangles.

Figure 10. Outside cover of Special Publication No. 3 "R-scripts for Generation of 5, 8 and 16 Random Sampling Points Within Predefined Rectangles".

In the Supplementary material the following files are provided, and can be downloaded from different web pages of the IUGS Commission on Global Geochemical Baselines website: -

(a) Executable R-scripts:

- randomSampling5PointsOnGrids.R (R script for the generation of 5 random points).
- randomSampling8PointsOnGrids.R (R script for the generation of 8 random points).
- randomSampling16PointsOnGrids.R (R script for the generation of 16 random points).

The source code of the 5, 8 and 16 random sampling points are in Appendices 1, 2 and 3, respectively.

The three executable R-scripts for the generation of 5-, 8- and 16-random points in predefined rectangles over the terrestrial and marine surfaces are in a zip file:

'IUGS-CGGB_R-scripts_Generation_5-8-16_random_points.zip', which can be downloaded from the 'Publications/Software Programs' web page.

(b) Global Reference Network grid cells of 160x160 km files:

- IUGS-CGGB_19833_GRN_160x160km_grid_cells.xlsx (Microsoft Excel® workbook file with the 19,833 grid cells of the Global Reference Network each of 160x160 km).
- IUGS-CGGB_GRN_19833_160x160km_grid_cells.zip (same as above but in a Google Earth kml file format). When unzipped the file name is: IUGS-CGGB_19833_GRN_160x160km_grid_cells.kml.

The above two files can be downloaded from the 'Sampling/GTN 160x160 km' web page.

(c) Global Terrestrial Network grid cells of 160x160 km files:

- IUGS-CGGB_7356_GTN_160x160km_grid_cells.xlsx (Microsoft Excel® workbook file with the 7356 grid cells of the Global Terrestrial Network each of 160x160 km).
- IUGS-CGGB_7356_GTN_grid_cells_160x160km.zip (same as above but in a Google Earth kml file format). When unzipped the file name is: IUGS-CGGB_7356_GTN_grid_cells_160x160km.kml.

The above two files can be downloaded from the 'Sampling/GTN 160x160 km' web page.

(d) Randomly selected sampling points in each Global Terrestrial Network grid cell of 160x160 km files:

- IUGS-CGGB_5-random-points_per_GTN_160x160km-grid-cell.xlsx (Microsoft Excel® workbook file with 5 random points in each of the 7356 grid cells of 160x160 km totalling 36,780 random sampling points).
- IUGS-CGGB_5-random-points_per_GTN_160x160km-grid-cell.zip (same as above but in a Google Earth kml file format). When unzipped the file name is: IUGS-CGGB_5-random-points_per_GTN_160x160km-grid-cell.kml.
- IUGS-CGGB_8-random-points_per_GTN_160x160km-grid-cell.xlsx (Microsoft Excel® workbook file with 8 random points in each of the 7356 grid cells of 160x160 km totalling 58,848 random sampling points).
- IUGS-CGGB_8-random-points_per_GTN_160x160km-grid-cell.zip (same as above but in a Google Earth kml file format). When unzipped the file name is: IUGS-CGGB_8-random-points_per_GTN_160x160km-grid-cell.kml.
- IUGS-CGGB_16-random-points_per_GTN_160x160km-grid-cell.xlsx (Microsoft Excel® workbook file with 16 random points in each of the 7356 grid cells of 160x160 km totalling 117,696 random sampling points). It is noted that this sampling density is not recommended for the Global Geochemical Reference Network.
- IUGS-CGGB_16-random-points_per_GTN_160x160km-grid-cell.zip (same as above but in a Google Earth kml file format). When unzipped the file name is: IUGS-CGGB_16-random-points_per_GTN_160x160km-grid-cell.kml.

The above six files can be downloaded from the 'Sampling/Sampling Design' web page.

(e) Global Marine Network grid cells of 160x160 km:

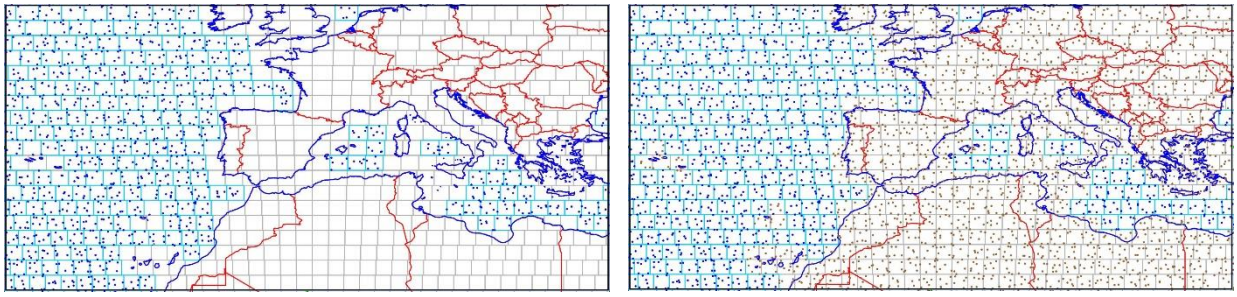
- IUGS-CGGB_12477_GMN_160X160km_grid_cells.xlsx (Microsoft™ Excel workbook file with the 12,477 grid cells of the Global Marine Network each of 160x160 km).
- IUGS-CGGB_12477_GMN_160x160km_grid_cells.zip (same as above but in a Google Earth kml file format. When unzipped the file name is: IUGS-CGGB_12477_GMN_160x160km_grid_cells.kml).

The above two files can be downloaded from the 'Sampling/GMN 160 x 160 km' web page.

The following files are necessary for the planning of the Global Marine Network random sampling campaign:

- IUGS-CGGB_19833_GRN_160x160km_grid_cells.xlsx (File is the same as in (b)).
- IUGS-CGGB_19833_GRN_160x160km_grid_cells.zip (File is the same as in (b)).
- IUGS-CGGB_7356_GTN_160x160km_grid_cells.xlsx (File is the same as in (c)).
- IUGS-CGGB_7356_GTN_grid_cells_160x160km.zip (File is the same as in (c)).
- IUGS-CGGB_5-random-points_per_GTN_160x160km-grid-cell.xlsx (File is the same as in (d)).
- IUGS-CGGB_5-random-points_per_GTN_160x160km-grid-cell.zip (File is the same as in (d)).
- IUGS-CGGB_8-random-points_per_GTN_160x160km-grid-cell.xlsx (File is the same as in (d)).
- IUGS-CGGB_8-random-points_per_GTN_160x160km-grid-cell.zip (File is the same as in (d)).

The reason that the Global Terrestrial Network (GTN) files are required for planning the Global Marine Network (GMN) random sampling is pictorially explained in the following two figures. Figure 11a shows the five random sampling points in the marine realm, and Figure 11b the five random sites within the 160x160 km grid cells of both the marine and terrestrial parts. It is obvious from these two figures that some of the random sampling points in coastal GTN grid cells fall in the sea (or water bodies in general). As these coastal GTN grid cells are not in the GMN database, the only way to have a complete set of random sampling points in the marine realm is to plot on the same map the two databases.



(a) (b)

Figure 11. (a) Five random points in each GMN grid cell of 160x160 km in the marine realm, and (b) Five random points in the GMN and GTN grid cells.

(f) Randomly selected sampling points in each Global Marine Network grid cell of 160x160 km:

- IUGS-CGGB_5-random-points_per_GMN_160x160km-grid-cell.xlsx (Microsoft Excel® workbook file with 5 random points in each of the 12,477 grid cells of 160x160 km totalling 62,385 random sampling points).
- IUGS-CGGB_8-random-points_per_GMN_160x160km-grid-cell.xlsx (Microsoft Excel® workbook file with 8 random points in each of the 12,477 grid cells of 160x160 km totalling 99,816 random sampling points).

The above two files can be downloaded from the 'Sampling/GMN 160 x 160 km' web page.

6.7.2. ROBCOOP4A.EXE

Vassiliades, E., 2002. ***Program ROBCOOP4A for Estimation of Balanced Classical and Robust Analysis of Variance: Instructions for Use and Source Code***. IUGS Commission on Global Geochemical Baselines, Athens, Hellenic Republic, Special Publication, 4, vi, 42 pp., 12 Figures, 4 Tables, 2 Appendices, Supplementary material, ISBN: 978-618-85049-3-6; https://doi.org/10.5281/zenodo.7307388 (Fig. 12).

The program ROBCOOP4A can be used to estimate the balanced classical and robust analysis of variance parameters (*i.e.*, sampling, analytical, geochemical), measurement uncertainty and the expanded uncertainty factor. It can process up to 500 variables determined on 2000 samples by 4 analyses (2 for the routine and 2 for the field duplicate samples). As the source code is provided the program can be translated into other languages. In case, any colleague translates the program into another language, please send the translation to the Commission in order to make it available to other colleagues through the Commission's website.

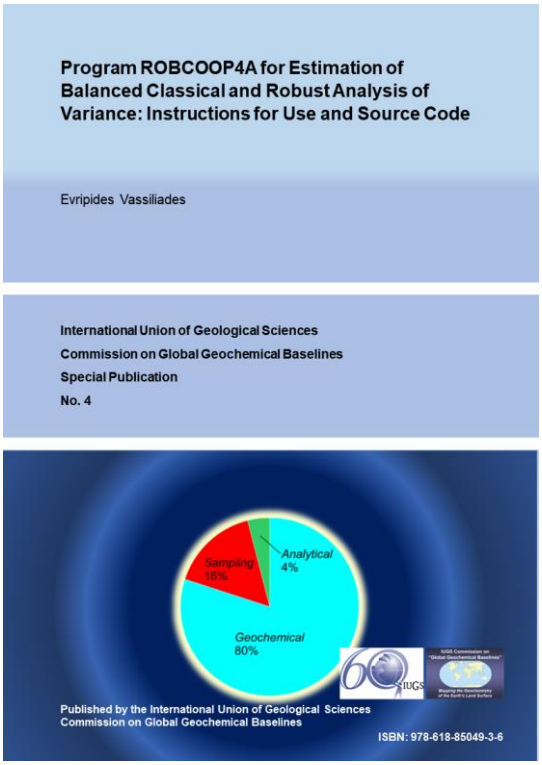


Figure 12. Front cover of Special Publication No. 4 Program "ROBCOOP4A for Estimation of Balanced Classical and Robust Analysis of Variance: Instructions for Use and Source Code".

- Web page: https://www.globalgeochemicalbaselines.eu/content/191/ebook-program-robcoop4a-for-estimation-of-classicalrobust-anova/
- Hyperlink to download the eBook directly: https://www.globalgeochemicalbaselines.eu/datafiles/file/Vassiliades_2022_IUGS-CGGB_ROBCOOP4A_Instructions_and_source-code.pdf
- Hyperlink to web page to download software programs: https://www.globalgeochemicalbaselines.eu/content/199/robcoop4a-/

6.8. GLOBAL BLACK SOIL PROJECT

The 5th Workshop on Global Black Soil Critical Zone Geo-ecological Survey (BASGES – IGCP665) was virtual and was organised on the 7th of December 2022. One presentation was delivered by Alecos Demetriades, Commission's Steering Committee member (Table 1).

Table 1. Virtual 5th BASGES workshop presentations with the addition of the USA presentation delivered at the 2nd BASGES workshop. The red numbered presentations can be downloaded from the following pCloud hyperlink: https://u.pcloud.link/publink/show?code=kZ6q4eVZTus6MxuSReVtni8MvlMt906PLghX.

No.	*Presentation title*	*Presenter*
01	Achievements of IGCP665	*Huimin Dai*
02	Global Black Soil Geochemistry: the progress made so far	*Alecos Demetriades*

No.	Presentation title	Presenter
03	Soil health assessment approaches and indicators-A review and preliminary practice on the Black Soil	*Limei Zhang*
04	Remote sensed analysis to soil organic carbon in global black soil area using new soil spectral indices	*Shengbo Chen*
05	Study on soil environmental risk and regionalization in typical black soil area of Jilin Province	*Yang Wang*
06	Application of hyperspectral technique in soil property monitoring - a case study of Black Soil organic matter monitoring	*Ruichun Chang*
07	Using field-, airborne- and satellite-based soil spectroscopy for the spatial assessment of soil organic carbon and aggregate stability	*Pu Shi*
08	Application of mechanochemically activated phosphorite (MAP) in Black Soil	*Nana Fang*
09	USGS Soil Site Sampling for Spectral Analysis (presented in the 2nd BASGES Workshop)	*Douglas Howard*

6.8.1. Requirements that must be fulfilled by the Shenyang Centre of CGS

The requirements that should be fulfilled before the start of the Global Black Soil project are now in the hands of the Shenyang Centre of China Geological Survey. They were presented and discussed at the 3rd Black Soil Workshop in November 2019, and have been repeated at the 4th virtual Black Soil Workshop in 2021, and these are:

1) Preparation of two large Black Soil project reference samples – Secondary Reference Materials (SRMs). The recommendation was the preparation of two 1000 kg SRMs, finally two 100 kg SRMs were prepared, and they now need to undergo an international ring test, and for this purpose the Commission has contacted laboratories in other countries. Due to the Covid-19 pandemic and restrictions the ring test was not possible, and it is hoped that this will be carried out in 2023. Further, according to the quality control specifications of the recently published '*International Union of Geological Sciences Manual of Standard Methods for Establishing the Global Geochemical Reference Network*' five project reference materials of different chemical compositon should be prepared.
2) Preparation of one large Black Soil project blank reference sample. This has not been prepared, and remains a requisite.
3) Compilation of a detailed protocol of the analytical methods that will be used for the analysis of the Black Soil project samples. This has not been prepared, and remains a requisite.
4) Decision where the Global Black Soil project samples are going to be prepared, and permanently stored. This is another important requisite, and the recommendation, following discussions, with other Commission members is that the sample preparation must be carried out in an agreed single facility, otherwise it will be very difficult to control the quality of sample preparation.
5) Decision where the Global Black Soil project samples are going to be analysed, and by which analytical methods and for which determinands. The samples are supposed to be analysed at the laboratories of the Shenyang Centre of China Geological Survey. However, the laboratory procedures that will be used need to be discussed and finalised.
6) Purchase of field and laboratory equipment by the Black Soil Project Management, and distribution to all participating countries. This condition is still outstanding, and will be tackled when the number of participating countries and number of field sampling teams is known.
7) Field training of representatives from each participating country, and start of field sampling campaign with a deadline to be agreed. This condition is still outstanding and cannot proceed until conditions 1 to 5 are fulfilled.

6.9. COMMISSION'S WEBSITE

The Commission's website is updated on a regular basis. Google analytics has updated its platform for the collection of data, and has sent a new code that should be added to every website page. This work was done during November 2022 by the Web hosting company at no cost. Figure 13 shows the Google Analytics statistics for 2022. The update of Google analytics provides statistics of user visits for each web page of the Commission's website. Table 2 shows the number of users of the top 20 web pages from the 14th of November to the 31st of December 2022. It is impressive that in 47 days 164 users have visited the web page of the "*International Union of Geological Sciences Manual of Standard Methods for Establishing the Global Geochemical Reference Network*".

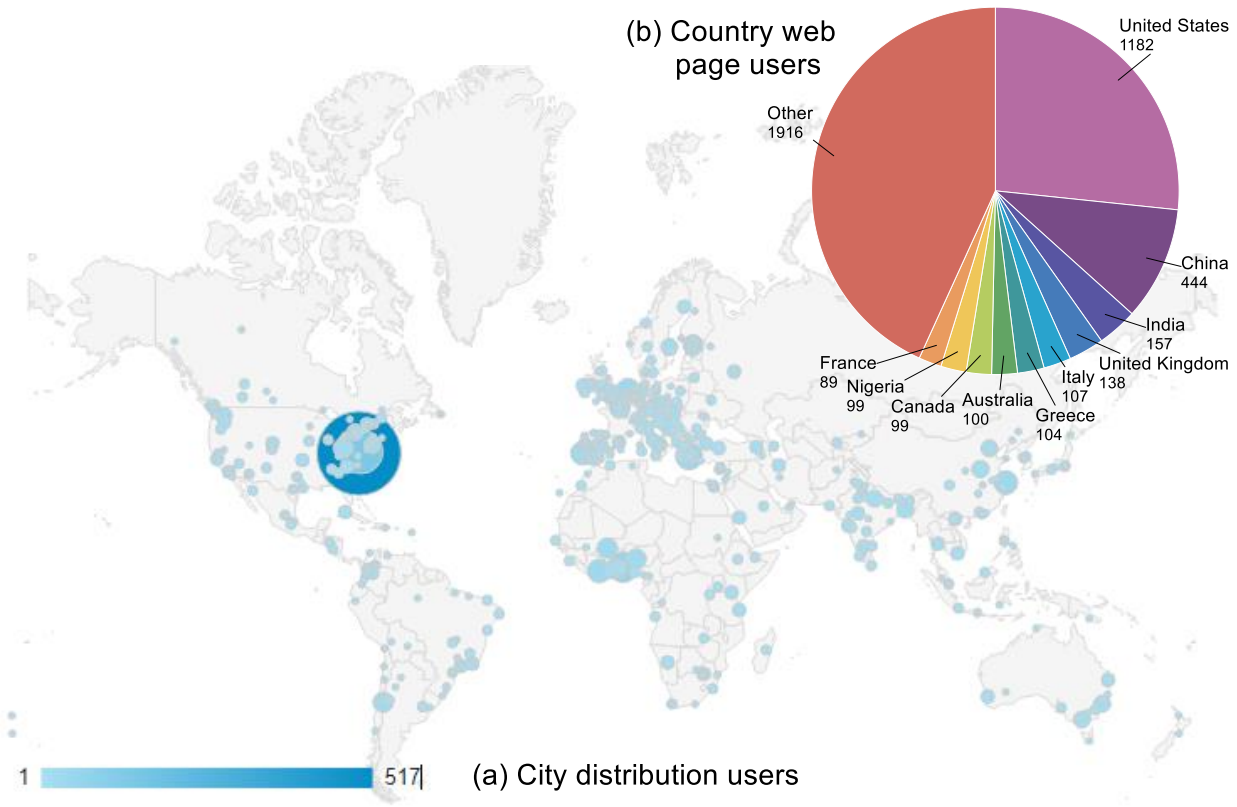


Figure 13. Shows (a) a screen shot of Google Analytics city location map of sessions from the 1st of January to the 31st of December 2022, and (b) a pie chart of the total users from the top 10 countries. The global distribution of the 4435 users compared to the 4,153 users in 2021 has changed considerably from 73 countries in 2021 to 142 countries in 2022, and 1047 cities in 2021 to 1123 cities in 2022. These changes are very impressive.

Table 2. Google analytics table from the web page users from the 14th of November to the 31st of December 2022.

Page title and Screen class	***Users***
Home	216
IUGS Manual of Standard Methods for Establishing the Global Geochemical Reference Network	164
GTN 160x160 km	57
Publications	53
Members	51
Black Soil Project Manual	48
Annual Reports	26
eBook: Program ROBCOOP4A for Estimation of Classical & Robust ANOVA	21
eBook: R-scripts for Generation of 5, 8 and 16 Random Sampling Points	20
Recent Publications	17

Page title and Screen class	*Users*
Steering Committee	16
Chapter 3.2 Annexe A3.2.1 Supplementary material	14
Chapter 2 Supplementary material	13
Global or Geochemical Reference Network	13
Workshops	13
Chapter files: Word text; Original figures; PowerPoint presentations	11
Conferences	11
Field methods for Regional Surveys	11
Levelling of existing data	11
Links	11

6.10. ONE GEOCHEMISTRY INITIATIVE

On the 5th of October 2022, Professor Lesley Wyborn (http://orcid.org/0000-0001-5976-4943), after reading the "*International Union of Geological Sciences Manual of Standard Methods for Establishing the Global Geochemical Reference Network*", contacted Anna Ladenberger and Kate V. Knights (CGGB Co-chairs) and Patrice de Caritat (Steering Committee member) with the comment that "*The work in this manual is highly relevant as we seek to make geochemical data FAIR and both human and machine actionable*". She informed us that she is "*currently involved in the OneGeochemistry initiative that is taking action to develop and promote global community-driven data conventions and best practices necessary to build a global network of high-quality, trusted geochemical data*", and was seeking support. On the 10th of November 2022 the Commission provided a letter of support for the OneGeochemistry initiative's application to become a Working Group within CODATA (the Committee on Data of the International Science Council), and the application was successful as can be seen here: https://codata.org/initiatives/decadal-programme2/worldfair/onegeochemistry-wg/.

6.11. DIGITAL OBJECT IDENTIFIER (DOI) FOR PUBLICATIONS

During the collaboration with Professor Lesley Wyborn from the OneGeochemistry Initiative in October 2022 (see Section §6.10), we were informed that a DOI can be obtained from Zenodo without any charge. Table 3 displays the Commission's four publications, and the number of downloads until the 31st December 2022.

Table 3. Date of acquisition of DOIs for Commission's 2022 publications, and the number of recorded downloads until the end of 2022.

DOI acquisition date	*Publication*	*Number of downloads from the DOI acquisition date to 31/12/ 2022*
1/11/2022	Demetriades, A., Dai, H., Liu, K., Savin, I., Birke, M., Johnson, C.C., Argyraki, A. (Editors), 2020. *International Union of Geological Sciences Manual of Standard Geochemical Methods for the Global Black Soil Project*. International Union of Geological Sciences, Commission on Global Geochemical Baselines, Special Publication No. 1, Athens, Hellas, 107 pages, 49 figures, 4 Tables, and 4 Appendices, ISBN: 978-618-85049-0-5; https://doi.org/10.5281/zenodo.7267967.	101
9/11/2022	Demetriades, A., Johnson, C.C., Smith, D.B., Ladenberger, A., Adánez Sanjuan, P., Argyraki, A., Stouraiti, C., Caritat, P. de, Knights, K.V., Prieto Rincón, G. & Simubali, G.N. (Editors), 2022. *International Union of Geological Sciences Manual of Standard*	117

DOI acquisition date	*Publication*	*Number of downloads from the DOI acquisition date to 31/12/ 2022*
	Methods for Establishing the Global Geochemical Reference Network. IUGS Commission on Global Geochemical Baselines, Athens, Hellenic Republic, Special Publication, 2, xliv, 515 pages, 375 figures, 35 Tables, 5 Annexes and 1 Appendix, ISBN: 978-618-85049-1-2; https://doi.org/10.5281/zenodo.7307696	
9/11/2022	He, J. & Geng, X., 2022. *R-scripts for Generation of 5, 8 and 16 Random Sampling Points Within Predefined Rectangles*. IUGS Commission on Global Geochemical Baselines, Athens, Hellenic Republic, Special Publication, 3, vi, 14 pp., 5 Figures, 3 Appendices, Supplementary material, ISBN: 978-618-85049-2-9; https://doi.org/10.5281/zenodo.7307202	43
9/11/2022	Vassiliades, E., 2002. *Program ROBCOOP4A for Estimation of Balanced Classical and Robust Analysis of Variance: Instructions for Use and Source Code*. IUGS Commission on Global Geochemical Baselines, Athens, Hellenic Republic, Special Publication, 4, vi, 42 pp., 12 Figures, 4 Tables, 2 Appendices, Supplementary material, ISBN: 978-618-85049-3-6; https://doi.org/10.5281/zenodo.7307388	46

6.12. WORK OF COMMISSION'S COMMITTEES

6.12.1. Sampling, Analytical & Data Management Committees

During 2022 members of the Sampling, Analytical and Data Management Committees were busy in making the final editing of the relevant chapters of the *'International Union of Geological Sciences Manual of Standard Methods for Establishing the Global Geochemical Reference Network'* (see Section §6.6), and discussing the promotional campaign.

6.12.1.1. Conversion of computer programs to 32- & 64-bit windows platform

The conversion of computer programs used by the Division of Geochemistry and Environment of the Hellenic Institute of Geology and Mineral Exploration, presently the Hellenic Survey of Geology and Mineral Exploration, by the in-house retired computer programmer, Evripides Vassiliades, is still ongoing. It is noted that the work of conversion of Fortran IV programs in Davis (1973) to the 32- and 64-bit Microsoft Windows® platforms by SimplyFortran is voluntary, and a deadline cannot be placed when there are personal problems and family commitments. Presently, the Merge program is ready for running on 32- and 64-bit computers. The plan is to publish these programs in 2023.

6.12.2. Public Relations and Finance Committee

The Public Relations and Finance Committee's main work was the updating of the Commission's website in collaboration with the web hosting company where necessary. *For example*, (a) the visual improvement of drop-down windows, and (b) the uploading of some files to the web hosting company's server.

In the work schedule is included still the exploitation of a few options for obtaining sponsorships. However, due to the Covid-19 pandemic, and the problems caused to many potential sponsors this work was postponed to better future times.

During 2022, a major activity of the Public Relations and Finance Committee was informing all Commission members about webinars and conferences of interest as is indicated in Section §6.5.1.

Constant updates of all Commission's activities as well as links to related topics of other organisations are also uploaded on the social media pages of CGGB (Twitter: @CGGB_IUGS and Facebook: @CGGBIUGS). A steady increase of follower numbers is noted for 2022, reaching 131 (+12) followers in Twitter, 629 (+52) followers in Facebook and 12 subscribers to our YouTube channel.

6.13. ASSISTANCE TO MEMBERS AND WORKSHOP PARTICIPANTS

This year due to the continued Covid-19 pandemic there were a few requests for assistance by Commission members, *e.g.*, (a) Department of Geochemistry and Environment of the Hellenic Survey of Mining and Mineral Exploration for the planning and execution of a regional soil geochemical baseline orientation survey, and (b) Geological Survey of India (Bengaluru) for the interpretation of urban geochemistry results.

6.14. PUBLICATIONS

Three publications directly related to the Global Geochemical Baselines project were published this year (see Section §6.5, Section §6.5.1 & Section §6.5.2). However, there are publications for the continental-, regional- and local-scale projects carried out in different continents. These will be found in Appendix 3. Also, the ASGMI Geochemistry Group circulated the provisional Geochemical Handbook, which will be finalised and published in 2023.

The Commission submitted one-page reports, which were published in the IUGS E-Bulletin (see Section §6.4.1).

7. REGIONAL REPORTS

Regional reports were provided from Africa and collaboration projects in the continent, America North (Mexico), America South (Brazil, Chile, Colombia), Asia (China, Japan), Australasia (Australia and New Zealand), and Europe (EuroGeoSurveys Geochemistry Expert Group). These reports are in Appendix 3: Regional Reports.

8. NEW MEMBERS

In 2022, the Commission made 12 new members from China (1), Czech Republic (1), Germany (1), Hellenic Republic (6), India (1), Romania (1), and United Kingdom (1). Although some members retire and do not send a contact E-mail address, the number of members is growing year by year. In total, the Commission has 214 members in 73 countries (see Members list in Commission's web page, and their countries are shown in Figure 14.

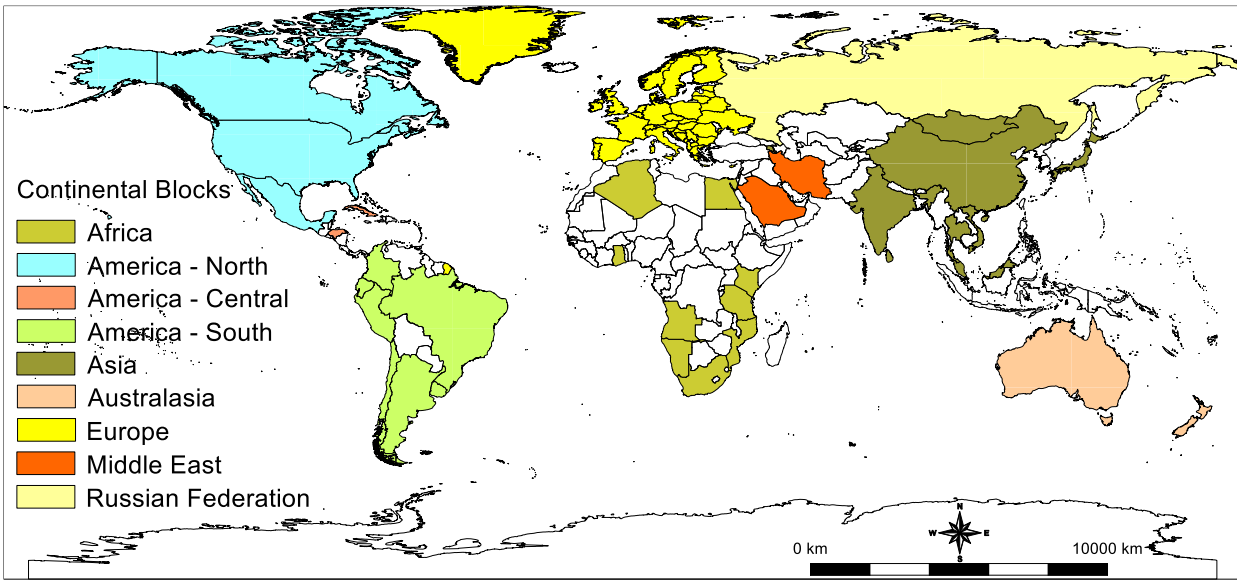


Figure 14. Map showing countries with Commission members. The different colours represent continental blocks. The Russian Federation has its own colour because it is in two continental blocks, Europe and Asia. Map plotted with Golden Software's MapViewer™ v8 by Alecos Demetriades, I.G.M.E. & IUGS-CGGB.

9. IUGS FUNDING FROM 2003 TO 2022

Funding from IUGS has consisted of US$1500 per year for 2003 to 2008; US$4000 for 2009 and 2010; US$5000 for 2011 and 2012; no funding for 2013; US$5000 for 2014, 2015 and 2016; US$4500 for 2017; US$4000 for 2018; US$2800 for 2019; US$2800 for 2020, US$4000 for 2021 and US$6000 was the annual allocation for 2022.

Additional amounts allocated were: (i) US$3500 for the two-day Workshop organised on the occasion of the 5th YES Congress in Berlin in September 2019, and (ii) US$3200 for the 36th IGC in Delhi in March 2020.

9.1. ALLOCATED FUNDS LOST FROM THE 36TH IGC, DELHI, INDIA

The postponement of the 36th IGC in Delhi resulted in the loss of IUGS allocated funds, *i.e.*,

- Registration fees paid were US$521.32, and the refund was US$398.49, *a loss of US$122.83*.
- Return airline fare Athens-New Delhi-Athens was US$1,179.29, and the refund was US$882.29, *a loss of US$297.00*.
- Hotel booking and transfer from and to airport, and from hotel to venue through the 36th IGC desk was *US$1,120.30*. This amount has not been refunded. According to information from the hotel, the payment was never received from the IGC 36 organisers, and there was no reservation.
- India visa cost was US$80.00, which is lost too.

The total amount lost from the cancellation of the 36th IGC due to Covid-19 is: *US$1,620.30*.

10. USAGE OF IUGS 2022 ALLOCATION

Usage of allocated 2022 fund of US$6,000 and outstanding 2021 balance of US$7,981.20, making an overall total of **US$13,981.20** is shown in Table 4.

Table 4. Expenses incurred during 2022.

Expenses incurred	***US$***
Bank charges on the transfer of the IUGS 2022 allocation	3.79
Printing of *International Union of Geological Sciences Manual of Standard Methods for Establishing the Global Geochemical Reference Network* and sending by DHL to Anna Ladenberger for submission to the Executive Committee	274.99
Anna Ladenberger's (Commission's 1st Co-chair) expenses for participation at the 77th EC meeting in Paris (US$799.35) plus bank transfer charges (US$42.18)	841.53
Printing and hard binding of *International Union of Geological Sciences Manual of Standard Methods for Establishing the Global Geochemical Reference Network*	230.59
(a) Printing and hard binding the *International Union of Geological Sciences Manual of Standard Geochemical Methods for the Global Black Soil Project*; printing and binding of (b) *R-scripts for Generation of 5, 8 and 16 Random Sampling Points Within Predefined Rectangles*, and (c) *Program ROBCOOP4A for Estimation of Balanced Classical and Robust Analysis of Variance: Instructions for Use and Source Code*, plus their DVD labels, and DVD long case covers	184.74
Payment of hotel expenses (US$525.26), transportation from airport to hotel (US$99.791), and daily allowance (US$249.479) for the participation of Paula Adánez Sanjuan (Scientific Secretary) at the annual October 2022 meeting in Athens, Hellenic Republic	874.53
Expenses for the organisation of the three-day joint annual meeting (13 to 15 October 2022) in Athens, Hellenic Republic (34 participants) - the amount includes break coffees/tea/juices/cookies, lunches, coach hire for excursion, wages of venue waitresses	3543.30
Participation of Alecos Demetriades (Chairperson of Sampling Committee & member of Steering Committee's Advisory Panel) at the 16th International Congress of the Geological Society of Greece (17-19 October 2022): Registration fee (US$82.44), daily allowance (US$249.824), hotel (US$251.823), return bus fare from Athens to Patras (US$37.773), taxi from hotel and to conference venue (US$42.74)	664.60
Annual Commission's website hosting fee and domain renewal (2022-2023)	277.38
Bank charges on the transfer of the Annual website hosting fee & domain renewal	1.22
Annual Zoom fee	191.43
Total 2022 expenses:	7.088.10

Balance at the end of 2021	US$ 7981.20
2022 IUGS Annual allocation	US$ 6000.00
Interest	US$ 0.46
Income tax on interest	US$ -0.07
Total available amount for 2022	US$13.981.59
2022 Expenses	US$ 7.088.10
Balance carried forward to 2023	**US$ 6.893.49**

For the organisation of the joint annual meeting in Athens, an additional amount of 800 Euros was used from the Royalties earned from the sale of two books of the work performed by the EuroGeoSurveys Geochemistry Expert Group, namely:

Johnson, C.C., Demetriades, A., Locutura, J. and Ottesen, R.T. (Editors), 2011. *Mapping the Chemical Environment of Urban Areas*. Wiley-Blackwell, John Wiley & Sons Ltd., Chichester, West Sussex, UK, 616 pp., http://eu.wiley.com/WileyCDA/WileyTitle/productCd-0470747242.html; https://doi.org/10.1002/9780470670071.

Reimann, C. and Birke, M. (Editors), 2010. *Geochemistry of European Bottled Water*. Borntraeger Science Publishers, Stuttgart, 268 pp., http://www.schweizerbart.de/publications/detail/artno/001201002#.

11. FUNDING REQUEST FROM IUGS FOR 2023-2024

11.1. PLANNED 2023 ACTIVITIES REQUIRING NO FUNDS

The main Commission activities in 2023 that require no funds are:

- Preparation of material for the promotion of the '*International Union of Geological Sciences Manual of Standard Methods for Establishing the Global Geochemical Reference Network*', and the two accompanying eBooks (a) *R-scripts for Generation of 5, 8 and 16 Random Sampling Points Within Predefined Rectangles, and* (b) *Program ROBCOOP4A for Estimation of Balanced Classical and Robust Analysis of Variance: Instructions for Use and Source Code*.
- Preparation of material for the scheduled two-day workshop on the standard methods for establishing the global geochemical reference network on the 1st and 2nd of July 2023 on the occasion of the SEGH 38th International Conference on Geochemistry and Health, which will be organised in Athens (Hellenic Republic).
- Organisation of webinars for the promotion of the '*International Union of Geological Sciences Manual of Standard Methods for Establishing the Global Geochemical Reference Network*', and other aspects of applied geochemistry.
- Conversion of statistical programs from MS-DOS Fortran 77/Power Station 4 to 32- and 64-bit Windows platform, and made freely available through the Commission's website (see Section §6.12.1.1).
- Preparation and printing of Periodic Table Element maps of the *FOREGS Geochemical Atlas of Europe* for stream water, stream sediment, subsoil and floodplain sediment for the printing of large-size posters for promotion of the Global Geochemical Reference Network project.
- Writing short articles about work performed to be published in the IUGS E-Bulletin.
- Updating the Commission's website.
- Writing a review paper about the Manual to be published in Geochemistry: Exploration, Environment, Analysis (GEEA).
- Organisation of the second Compositional Data Analysis workshop in the autumn.
- Looking for sponsors for the preparation of reference materials.
- Affiliation with other professional Geochemical associations.
- Providing assistance and information to requests from different geological surveys and individuals, especially participants in past workshops.
- Starting the compilation of a popular well-illustrated book for lobbying at the United Nations and UNESCO level for all 196 Member States to agree to carry out the Global project as will be detailed in the IUGS Manual of Standard Methods. This activity is in-line with the objective '*to increase the awareness of policy and decision makers of the need for harmonised geochemical data at the global scale*.' The promotion of the Global Geochemical Reference Network project is an activity that will be carried out beyond 2023. Although no funds are requested for the above work, it should be stressed that they are funded by Commission member Geological Surveys and Universities. Hence, it is considered important that a conservative estimate of person-months should be made. It is estimated that all colleagues from all over the world contributing to the above work is about 30 person-months parts [it will start after the completion of item (i)]
- Revision of the IGCP 259 Report, the 'Blue Book' (Darnley *et al.*, 1995) by removing all contradictory parts.

11.2. PLANNED 2023-2024 ACTIVITIES REQUIRING IUGS FUNDING

As unfortunately the World is still in uncharted waters with respect to the Covid-19 pandemic, and the waiting for the vaccination of 70% of the population to achieve immunity, we are still a little conservative with respect to any activities that need personal contact even in 2023.

The following planned activities in 2023, and first quarter of 2024, require IUGS funding:

- Organisation of workshops/webinars using Zoom in different continental- and time-blocks, starting from South America and ASGMI Geochemistry Group (it will be co-chaired by Gloria Prieto Rincón and Maria João Batista). We have the material to organise two- to three-day webinars. Organising webinars will be an important activity for the promotion of the techniques described in the '*International Union of Geological Sciences Manual of Standard Methods for Establishing the Global Geochemical Reference Network and Regional Geochemical Surveys*' (see Section §6.5). This activity requires the continued use of Zoom and add-on licences for virtual meetings and workshops (webinars), depending on the number of registered participants (the existing licence for 100 participants is until November 2023).
- Participation in the Goldschmidt 2023 conference, which will be held in Lyon between the 9th and 14th of July 2023. A session with the title '*The novel geochemical and mapping methods at global to local scales with applications in environmental sciences, food safety, ecology, archaeology and palaeontology*' was submitted in Theme 12 'Environmental geochemistry and human health'. The session was accepted in December 2022 and has been given the number 12g (https://conf.goldschmidt.info/goldschmidt/2023/meetingapp.cgi/Program/1110; https://conf.goldschmidt.info/goldschmidt/2023/meetingapp.cgi/Session/4833).
- Organisation of the first person-to-person two-day Workshop on the standard methods for establishing the global geochemical reference network scheduled as a two-day workshop on 1st and 2nd of July 2023 on the occasion of the SEGH 38th International Conference on Geochemistry and Health, which will be held in Athens (Hellenic Republic). The first day will be devoted to lectures, and the second demonstration of all sampling methods in the field.
- Organisation of the joint three-day autumn annual joint business meeting of the Commission in collaboration with the EuroGeoSurveys Geochemistry Expert Group and ASGMI Geochemistry Group, which is planned for October 2023 in Naples (Italy). The Commission will jointly host the meeting with the Dipartimento di Scienze della Terra, Università di Napoli Federico II.
- Participation in the 6th BASGES Workshop organised by the Shenyang Centre of China Geological Survey in the autumn-winter of 2023 on the condition that it is safe to travel.
- Printing of remaining posters on canvas of the Periodic Table of mapped elements of the Geochemical Atlas of Europe for stream water, stream sediment, subsoil and floodplain sediment for promotion of the Global Geochemical Reference Network project.
- Web-hosting annual fee and domain renewal (2023-2024) of the Commission's website.
- Renewal of the Zoom licence, and
- Participation in the 79th IUGS Executive Committee meeting in February 2024 at a place to be determined by the IUGS EC, subject to be safe for travel.

It should be mentioned that in the 2023 budget (Table 4), the cost of US$30,000 for the organisation of training workshops for CCOP countries recommended in the 2019 ARC report is not included, as this depends on the availability of funds from IUGS, and because of the sudden rise of the Covid-19 pandemic planning any physical workshops during 2023 in south-east Asia

may be difficult. Nevertheless, if such an amount is made available, it should not be restricted to CCOP countries, but it should include African and Latin American countries.

Table 4. Estimated expenses for 2023 and first quarter of 2023.

Event category	***Cost in US$***
Participation in the 78th IUGS Executive Committee meeting in February 2023 in Nairobi (Kenya)	3,000.00
Organisation of webinars for up to 300 participants using Zoom about the methods described in the '*International Union of Geological Sciences Manual of Standard Methods for Establishing the Global Geochemical Reference Network*'. Purchase of Zoom add-on licences, depending on the number of registered participants	500.00
Goldschmidt 2023 conference: Session 12g '*The novel geochemical and mapping methods at global to local scales with applications in environmental sciences, food safety, ecology, archaeology and palaeontology*' was submitted in Theme 12 'Environmental geochemistry and human health'.	2000.00
Organisation of the 1st person-to-person two-day Workshop on methods described in the '*International Union of Geological Sciences Manual of Standard Methods for Establishing the Global Geochemical Reference Network*', 1st and 2nd of July 2023 (Coach hire US$500; Coffee breaks US$400; Lunch US$1100; Travel expenses for 3 tutors US$1200; Hotel and sustenance expenses for 3 tutors US$1800; Memory sticks with workshop material and bibliography US$525) – Note: The estimates are based on 35 Workshop participants.	5,525.00
Printing and book-binding of new eBooks	500.00
Organisation of the three-day autumn annual joint business meeting of the Commission, the EuroGeoSurveys Geochemistry Expert Group and ASGMI Geochemistry Group in the autumn in Naples (Italy). The amount includes organisation expenses and providing financial support to members of the Steering Committee	5,000.00
Participation in the 6th BASGES Workshop organised by the Shenyang Centre of China Geological Survey in the autumn of 2023. Costs: Travel insurance, local travel to and from airport	250.00
Printing of remaining posters on canvas of the Periodic Table of mapped elements of the Geochemical Atlas of Europe for stream water, stream sediment, subsoil and floodplain sediment for promotion of the Global Geochemical Reference Network project	300.00
Annual Commission's website hosting fee and domain renewal (2023-2024) and additional space on server	600.00
Participation in the 79th IUGS Executive Committee meeting in January/February 2024 at a place to be decided by the IUGS Executive Committee	3,000.00
Total estimated expenses in US$ for 2023-24:	**20,675.00**
Outstanding balance (US$) in Commission's bank account at the end of 2022:	6,893.49

Taking into account the outstanding balance in the Commission's bank account of **US$6,893.49**, the estimated smallest amount required to cover 2023-24 expenses, as well as unforeseen expenses, is in the region of about **US$13,782**.

The Commission is, therefore, requesting financial support from IUGS in the order of **US$13,800** to cover planned expenses in 2023 and first quarter of 2024.

11.2.1. IUGS Annual allocation to cover first six months of following fiscal year

The Commission enjoyed a sort of freedom in the planning of its work and commitments until 2017, because it was able to accumulate slowly a reserve fund, which at the end of 2017 totalled about US$10,289. The insistence of an EC Councillor to use this reserve fund for RFG2018 resulted at the end of 2018 the outstanding balance to be at US$858.

Without any reserve funds, it is difficult to plan activities and make commitments for the following fiscal year, and especially the first six months, because the annual allocation is usually made available round about April or May of the calendar year. Therefore, it is proposed that the IUGS funding should cover the first six months of the following fiscal year.

11.2.2. Development of IUGS analytical reference materials

An important activity is the development of IUGS analytical reference materials. All IUGS Commissions are charged to set standards for their geoscientific discipline. Therefore, the Commission is mandated to set standards in geochemical mapping. The first such standard is the '*International Union of Geological Sciences Manual of Standard Geochemical Methods for the Global Black Soil Project*, which was approved by the IUGS EC and published in 2020, and is freely available from the Commission's website. The second and most significant standard work is the publication in 2022 of the '*International Union of Geological Sciences Manual of Standard Methods for the Global Geochemical Reference Network and Regional Geochemical Surveys*'.

However, the global project, as envisaged by Darnley *et al.* (1995) in the 'Blue Book', cannot start without the development of large reference materials of at least one tonne each for all the sampling types that will be collected, *i.e.*, stream sediment, overbank/floodplain sediment, residual soil, and rock. As IUGS is the global geoscientific body that sets standards in geosciences, it is appropriate to start the development of analytical reference materials. The Commission has the expertise and the laboratory that can make these reference materials, and we ask the IUGS EC to consider it.

12. LINK TO IUGS WEBSITE

The Commission's website has a link to the IUGS website through its logo, which is displayed on all web pages, and also in the Links web page at http://www.globalgeochemicalbaselines.eu/content/104/links-/.

13. DETAILS OF ANNUAL REPORT AUTHORS

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Darnley, A.G., Björklund, A., Bølviken, B., Gustavsson, N., Koval, P.V., Plant, J.A., Steenfelt, A., Tauchid, M., Xuejing, Xie., Garrett, R.G. & Hall, G.E.M., 1995. A Global Geochemical Database for Environmental and Resource Management. Recommendations for International Geochemical Mapping – Final Report of IGCP Project 259. Earth Science Report 19. UNESCO Publishing, Paris, 122 pp.; http://globalgeochemicalbaselines.eu.176-31-41-129.hs-servers.gr/datafiles/file/Blue_Book_GGD_IGCP259.pdf.

Davis, J.C., 1973. Statistics and Data Analysis in Geology. John Wiley & Sons, Inc., N.Y., 550 pp.

APPENDIX 1. IUGS-CGGB ANNUAL BUSINESS MEETING

Meropion Philanthropic Foundation, Athens, Hellenic Republic

Dionysiou Areopagitou 45, Acropolis, Athens 117 42

Group photo in front of the venue in Athens.

List of participants (in person):

Adánez Sanjuan, Paula, Spanish Geological Survey (IGME), Spain
Albanese, Stefano, University of Naples, Italy
Angiuli, Gabriella, University of Naples, Italy
Argyraki, Ariadne, University of Athens, Hellas
Dadashzadeh Ahari, Hooman, Geological Survey of Iran, Iran
Demetriades, Alecos, IUGS-CGGB, Hellas
De Vivo, Benedetto, University of Naples, Italy
Dong, Weng, Xi'an University of Technology, Shaanxi Province, China
Eleftherakis, Christina, Hellenic Survey of Geology and Mineral Exploration (H.S.G.M.E.), Hellas
Flem, Belinda, Geological Survey of Norway (NGU), Norway
Grammenos, Stephanos, P.S.G ENVIRONMENTAL GEO-EXPLORATION LTD (P.S.G.), Hellas
Guarino, Annalise, University of Naples, Italy
Hobiger, Gerhard, Geological Survey of Austria (GBA), Austria
Jakobsen, Rasmus, Geological Survey of Denmark (GEUS), Denmark
João Batista, Maria, Geological Survey of Portugal (LNEG), Portugal
Kanellopoulos, Christos, H.S.G.M.E., Hellas

Kontomichalou, Artemis, H.S.G.M.E., Hellas
Kourgia, Paraskevi-Maria, University of Athens, Hellas
Kuusma, Elina, Geological Survey of Estonia (EGT), Estonia
Kypritidou, Zacharenia, University of Athens, Hellas
Ladenberger, Anna, Geological Survey of Sweden (SGU), Sweden
Liakopoulos, Alexandros, H.S.G.M.E., Hellas
Lima, Annamaria, University of Naples, Italy
Martinková, Eva, Czech Geological Survey, Czech Republic
Poňavič, Michal, Czech Geological Survey, Czech Republic
Quijano Gaudes, Laura, EuroGeoSurveys (EGS), Belgium
Ratopoulou, Menelia, P.S.G., Hellas
Stouraiti, Christina, University of Athens, Hellas
Stavraki, Penelope, P.S.G., Hellas
Tarvainen, Timo, Geological Survey of Finland (GTK), Finland
Tassiou, Sophia, H.S.G.M.E., Hellas
Turco, Eugenio, University of Naples, Italy
Wysocka, Irena, Geological Survey of Poland (PGI-NRI), Poland
Zhang, Chaosheng, University of Galway, Ireland

Online:
Negrel, Philippe, French Geological Survey (BRGM), France
Anastasatou, Marianthi, H.S.G.M.E., Hellas

Recorded:
Ander, Louise, British Geological Survey, Keyworth, United Kingdom
Griffionen, Jasper, Geological Survey of The Netherlands (TNO), The Netherlands

NOTE: The numbers in front of discussion items refer to the PowerPoint presentations, which can be downloaded from the following pCloud hyperlink: https://u.pcloud.link/publink/show?code=kZ7rXnVZPCedXQJGfRfxFf6Rv15HwfEjocfV.

1st Day, Thursday, 13th October 2022, 09.30-17.00 (CET)

- **Opening of the meeting**

Alecos Demetriades (AD) apologises on behalf of the Director-General of H.S.G.M.E., Mr. Dionysios Gkoutis, for not being at the meeting due to an unexpected commitment, and conveyed his wishes for a successful meeting. The IUGS-CGGB 1st Co-chair and GEG Deputy Chair, Anna Ladenberger (AL), welcomed the participants. AD informed the participants that Philippe Négrel (PN) was unable to come to the meeting due to Covid and conveyed his wishes for a successful meeting. Maria João Batista (MJB), ASGMI-GG Chairperson and Ariadne Argyraki (AA), University of Athens, welcomed the attendees and Dr. Penelope Stavrakis (P.S.G., Hellas) welcomed the participants on behalf of the Meropion Philanthropic Foundation.

- **Round table self-introduction**

All the participants introduced themselves by presenting their background and research interests.

- **Organisation arrangements** by AD (IUGS-GEG local host), *e.g.*, coffee, lunch, visits, *etc.*

- **1. EGS-GEG activities 2021-2022**

Philippe Négrel presents virtually the main activities carried out during 2021 and 2022 by GEG. There are 58 official GEG members. Collaboration with EUSO (Soil observatory) - 4 working groups. Collaboration with IUGS-CGGB. Activities during 2021 and 2022. Publications. Key Performance Indicators (KPI) expert group. Are GEG members participating in GSEU?

Action 1: AL requests that all EGS-GEG experts to send her the tasks / activities in which the NGSOs are involved in the Geological Service of Europe (GSEU).

- **2. Activities of the ASGMI Geochemistry Group** (MJB)

MJB presents the main activities of the ASGMI Geochemistry Group, its mission, including member surveys, the expectations and opportunities for funding. The current situation of each of the ASGMI member countries, the main issue is the different national programmes. New mission: training sessions for capacity building, in person and online. *For example*, Guatemala is starting a geological Survey, El Salvador is starting to collect geochemical information. First task is to compile current situation in each Geological Survey. Future activities: Development of products (levelling or sampling), standard sampling procedures. Hence, the group is preparing a Manual for sampling and analyses in Spanish, adapted for South American conditions, and follows the newly published IUGS-CGGB manual, as a few South American colleagues are co-authors in most sampling chapters. ASGMI is interested in organising training programmes, where the newly published IUGS-CGGB Manual can be promoted and methods implemented. Gloria Prieto volunteered to lead the translation of the IUGS-CGGB Manual of Standard Methods into Spanish.

Action 2: Maria is in favour to have joint webinars with EGS expert group.

- **3. An update on EGS projects and activities** (Laura Quijano Gaudes, LQG)

LQG presents an overview of the activities of EGS members and EGS Secretariat in relation to projects, mandates, events, external relations and work programme for 2023. EGS has presently 36 member geological surveys.

Action 3: LQG invites the GEG experts to reply to the open consultation of the EC about the upcoming Soil Health Legislation.

- **4. EU Soil Strategy for 2030 and EU Soil Observatory (EUSO) Stakeholders Forum** (AL)

Information about the working groups: AL presents the main aims of the EU Soil Strategy and main activities of the EU Soil Observatory. GEG representatives are involved in the Working Groups. Belinda Flem remarks that there are no meetings of the Biodiversity Working Group (WG). AL stresses that there is a lack of dedicated EU legislation for soil protection. The Joint Research Centre's (JRC) LUCAS project is supposed to be the only soil monitoring programme that provides harmonised and systematic measurements on the chemistry and physical parameters. AD notes that the LUCAS data sets are not freely available. LQG contacted JRC about the release of the LUCAS data sets, and she was informed that these are confidential.

Action 4: LQG will contact the Chair of the WG to follow up the state of the Biodiversity group, and continue to explore the situation about the LUCAS data sets.

- 5. Goldschmidt2023 Lyon; SEGH 2023 Athens; EGU2023; Goldschmidt2023; 37th International Geological Congress (IGC), Busan, South Korea 2024; ISEH ICEPH & ISEG 2024, Galway, Ireland: session proposals (PN & AL)

AL presents the future events and encourages GEG experts to submit session proposals. Goldschmidt2023 will be held in Lyon in hybrid form and the GEG-CGGB members are involved in two session proposals. Ariadne Argyraki invites everybody to participate in the Athens SEGH conference in July 2023, where the Manual will be presented as a keynote presentation, and also a workshop will be organised. The Joint Conference of ISEH ICEPH & ISEG in Galway in August 2024 overlaps with the 37th IGC in Busan; Chaosheng is organising this joint meeting. The 37th IGC in Busan in 2024 is calling for sessions with the deadline 31st October 2022. CGGB will submit a session **Challenges and Opportunities of Global-Scale Geochemical Mapping (4th Arthur Darnley Symposium**), followed by a technical workshop about the methods described in the IUGS-CGGB Manual, and possibly a field training workshop.

Action 5: Submission of session proposals to all international conferences.

- **6. GEMAS - status of publications, GBA-GEMAS website, BGR-GEMAS Mapviewer** (AD & Manfred Birke, *et al.*)

AD presents the current status of the GEMAS publications. There are several papers under writing, some authors are not active.

- Ag, Au, PGEs, Tl (AD): under preparation
- Zr (Dee Flight & Clemens Reimann), PN interested to take over, need to contact Dee & Clemens
- FOREGS (Perchlorate) not active at the moment (Manfred Birke, MB)
- I, Br (MB): under preparation
- Mo (Domenico Cicchella): status unknown (Stefano Albanese (SA) will be contacting Domenico)
- XRF/AR (Enrico Dinelli): status unknown (SA will be contacting Enrico)
- 4th QC Report – (AD) Data from Fabian − still waiting (to contact Clemens)
- Zn (Italian colleagues): status unknown (SA undertaken
- Grain Size, no progress
- Colour: status unknown (Karl Fabian) – AD to contact Clemens
- Element deficiency (Koen Oorts): status unknown – AD to contact Koen
- Medical Geochemistry (AL, PO, AG): no progress
- Spatial analysis of Cr (GJ): written paper 80% − status unknown – Stefano to contact GJ
- Spatial analysis of Hg (GJ): under preparation – Stefano to contact GJ
- Sn and W (MJB): no progress – MJB will proceed
- GEMAS in house standard – we should have an article, no leader right now
- XRD Mapping (Jasper G.): whole Ap? Make a budget, USGS? Check labs and prices?

AL informed participants about the authorship procedure used in the GEMAS publications, and encouraged anybody that is interested to participate in the writing of the papers to contact the leading author.

BGR GEMAS website: GEMAS maps are currently available from the BGR website via their Product Centre (https://produktcenter.bgr.de/terraCatalog/Start.do). There are plans for translation of the descriptions into English. The English version should be ready by April 2023.

GEMAS website hosted by the Geological Survey of Austria needs to be moved. An open discussion about the data hosting and the future of the data was carried out.

- **7. The latest GEMAS scientific publications** (PN)

PN presents the latest GEMAS publication, and those under preparation:

- Négrel, Ph., Ladenberger, A., Reimann, C., Demetriades, A., Birke, M., Sadeghi, M. & GEMAS Project Team GEMAS, 2022. GEMAS: adaptation of weathering indices for European agricultural soil derived from carbonate parent materials. Geochemistry: Exploration, Environment, Analysis, 22, 1-12; https://doi.org/10.1144/geochem2021-059.
- Négrel, Ph., Ladenberger, A., Reimann, C., Demetriades, A., Birke, M., Sadeghi, M. & GEMAS Project Team. GEMAS: Major element geochemistry of European agricultural soil: weathering processes of silicate parent materials. To be submitted soon to Chemical Geology.
- Négrel, Ph., Ladenberger, A., Reimann, C., Demetriades, A., Birke, M., Sadeghi, M. & GEMAS Project Team. GEMAS: Boron geochemistry of European agricultural soil. In preparation for submission to either Applied Geochemistry or STOTEN.
- Négrel, Ph., Ladenberger, A., Reimann, C., Demetriades, A., Birke, M., Sadeghi, M. & GEMAS Project Team. GEMAS: Phosphorus geochemistry of European agricultural soil. In preparation for submission to STOTEN or Applied Geochemistry.

Note: All GEMAS publications are available from pCloud by using the following hyperlink: https://u.pcloud.link/publink/show?code=kZ4JfDZURdEoTF0F0fzFyqWGxGDRbApshv7.

Action 6: EGS Secretariat (LQG) will explore the possibility to host GEMAS website on its server. LQG to organise an online meeting about the migration of the website. AD explained the procedure used for updating the GEMAS website (http://gemas.geolba.ac.at/), and this procedure must be kept, *i.e.*, AD sends the new information to Paolo Valera, who writes the necessary scripts, and he sends them in turn to Sebastian Pfleiderer, who copies them to the GBA server.

Action 7: AD requests to send to him all the publications published, and the pending publications when published in order to be distributed to all members through pCloud.

Action 8: The GEMAS raw data should be available online. We need to decide what data and on which website.

- **8. IUGS-CGGB activities report** (AD, AL): This is included in item 10.

- **9. 25th Anniversary of the FOREGS Geochemical Atlas of Europe** (the kick-off meeting was in January 1997, http://weppi.gtk.fi/publ/foregsatlas/) (AD & Timo Tarvainen).

AD presents a summary of the history of the FOREGS Geochemical Atlas of Europe that was, and still is, the first multinational and harmonised continental-scale geochemical survey carried out in 26 countries according to "*Blue Book*" specifications. The history of the FOREGS project is presently being written by Reijo Salminen with the help of co-workers and it will be published as a review paper.

- **10. 25th Anniversary of the IUGS-CGGB** (AD, AL) https://www.globalgeochemicalbaselines.eu/

AD presents a summary history of the Commission, beginning in the 1980's to 2016 and all the activities in recent years, leading to the publication of the Manual of Standard Methods. The

Commission was established in 2016 after many years of work as a Task Group (1997-2016). The CGGB produces manuals and standards as well as provides expert advice. The work is reported every year at the annual IUGS Executive Committee meeting and every four years at the IUGS Council meeting on the occasion of the International Geological Congress. The activities of CGGB are reported in its annual reports, which are available from its website (http://www.globalgeochemicalbaselines.eu/content/90/annual-reports-/).

In 2022, the CGGB has published the Manual of Standard Methods:

Demetriades, A., Johnson, C.C., Smith, D.B., Ladenberger, A., Adánez Sanjuan, P., Argyraki, A., Stouraiti, C., Caritat, P. de, Knights, K.V., Prieto Rincón, G. & Simubali, G.N. (Editors), 2022. *International Union of Geological Sciences Manual of Standard Methods for Establishing the Global Geochemical Reference Network*. IUGS Commission on Global Geochemical Baselines, Athens, Hellenic Republic, Special Publication, 2, xliv, 515 pages, 375 figures, 35 Tables, 5 Annexes and 1 Appendix, ISBN: 978-618-85049-1-2 (http://www.globalgeochemicalbaselines.eu/content/174/iugs-manual-of-standard-methods-for-establishing-the-global-geochemical-reference-network-/).

AD informed that Gloria Prieto Rincón proposed its translation into Spanish.

- **11. Presentation of the IUGS-CGGB manual and plans for implementation and advertising – Other IUGS-CGGB publications** (AD)

The Manual of Standard Methods for Establishing the GGRN was briefly presented, and all the available Supplementary material, Word and PowerPoint files with embedded figures, and original figures.

The IUGS-CGGB published two technical supporting publications:

He, J. & Geng, X., 2022. *R-scripts for Generation of 5, 8 and 16 Random Sampling Points Within Predefined Rectangles*. IUGS Commission on Global Geochemical Baselines, Athens, Hellenic Republic, Special Publication, 3, vi, 14 pp., 5 Figures, 3 Appendices, Supplementary material, ISBN: 978-618-85049-2-9 (https://www.globalgeochemicalbaselines.eu/content/185/ebook-r-scripts-for-generation-of-5,-8-and-16-random-sampling-points-/).

Vassiliades, E., 2002. *Program ROBCOOP4A for Estimation of Balanced Classical and Robust Analysis of Variance: Instructions for Use and Source Code*. IUGS Commission on Global Geochemical Baselines, Athens, Hellenic Republic, Special Publication, 4, vi, 42 pp., 12 Figures, 4 Tables, 2 Appendices, Supplementary material, ISBN: 978-618-85049-3-6 (https://www.globalgeochemicalbaselines.eu/content/191/ebook-program-robcoop4a-for-estimation-of-classicalrobust-anova/).

Its translation to Spanish was discussed, and Paula Adánez Sanjuan has undertaken this work.

Action 9: The promotion of the Manual will become the main activity for the Commission in the coming year.

The first day meeting closed at 16:30.

2nd day, Friday, 14th October 2022, 09.30-17.00

Organisation arrangements by AD (guided visit to the Acropolis Museum in the afternoon, evening meal, and excursion to the Lavreotiki peninsula on Saturday).

The following 15-minute presentations were delivered by EGS-GEG experts and invited guests:

12. *Soil geochemical baselines in Finland – From soil samples to web server* – Timo Tarvainen (physical attendance) & Jaana Jarva
13. *Monitoring of soil and air of Campania region, Italy* – Benedetto De Vivo
14. *Current geochemical issues in Denmark at GEUS* − Rasmus Jakobsen
15. *Estimation of diffuse contamination of topsoil by comparing the statistical distribution of element concentrations in soil horizons* – Belinda Flem
16. *Identification of soil contamination hotspots based on regional and national geochemical databases* − Chaosheng Zhang
17. *Sampling mining waste in Sweden* – Anna Ladenberger
18. *Comparing the outcomes of different methods to define background/baseline in soil of Napoli metropolitan area* - Annalise Guarino
19. *Radon concentrations in the regional tap water of Campania: distribution patterns and risk assessment* – Stefano Albanese
20. *Current exploration and geochemical mapping projects of IGME-CSIC (Spain)* - Iván Martín & Paula Adánez Sanjuan
21. *LNEG recent projects and international cooperation* - Maria João Batista
22. *Recent geochemical projects realised at the Polish Geological Institute (PGI)* - Irena Wysocka
23. *On the origin of PFAS contamination in Dutch soils* (prerecorded) - Jasper Griffionen
24. *Sample archive and Digital Database of the Regional Geochemical Atlas of Hellas* – Stephanos Grammenos, Menelia Ratopoulou & Christina Eleftherakis
25. *Ongoing work for the Soil Geochemical Atlas of Hellas* – Artemis Kontomichalou
26. *Ongoing geochemical exploration in northern Hellas: The cases of Kimmeria, Xanthi and Kirki, Evros* - Marianthi Anastasatou
27. *Do humans take good care of their offspring as animals do…! The Lavreotiki and Lavrion 'sagas', Hellenic Republic* - Zacharenia Kypritidou, Paraskevi-Maria Kourgia, Ariadne Argyraki & Alecos Demetriades (This talk is a sort of introduction to the excursion in the Lavreotiki peninsula)
28. *An update on regional geochemical research and innovation at BGS* – Louise Anders (prerecorded)

Free discussion:

After the presentations, an open discussion about data analysis and statistics was carried out.

It is considered that the IUGS Manual should be included in the knowledge exchange programme of PanAfGeo2 (https://panafgeo.eurogeosurveys.org/) and EUSO during its trainings.

Action 10: EGS Secretariat will communicate to PanAfGeo2 PC the request to share the IUGS Manual for training purposes.

Action 11: AL proposes an extra short GEG meeting in a digital form in addition to annual meeting. The annual meeting should be in a hybrid form if possible. The group discussed Pan-European project proposals and initiatives:

- Urban Geochemistry of Europe (II)
- Water Geochemistry of Europe (WAGE)
- Ore deposits geochemistry database
- Modern isotope systems (GEMAS samples)
- Mineralogical Determination on GEMAS samples
- Harmonised and coherent lithogeochemistry of Europe (problem is that there are countries that have no rocks; however, the low sampling density survey can use material from drill-cores)
- Low sampling density geochemistry of European shelf
- Forest soil Geochemistry
- Biogeochemistry
- Geochemistry of the North Atlantic Basin (collab. With Marine Geology EG)
- Use of GEMAS data as ground proofing data set for remote sensing (discussion with ESA)

Timo proposed that open presentations should be organised for geological survey people.

Alecos proposed that an additional day is needed, *i.e*., a three-day meeting in order to have time for discussion.

Action 12: The group proposed the following events next year:

- Review article about the Manual (to be published in the Journal of Geochemical Exploration as Stefano Albanese is Editor-in-Chief)
- Summary paper about the Manual (AD – This will most likely be published in GEEA)
- Manual should be updated every 10 years (proposed by AL). AD stressed that the sampling sample preparation, and quality control methods cannot be changed as these must be standard and consistently applied in order to establish the Global Terrestrial Network, and to produce a harmonised global-geochemical database for multipurpose use. Most likely a Manual of Standard Geoanalytical methods will be needed.
- Promotion of the Manual at conferences, webinars and technical workshops.
- A proposal of a webinar about the production of geochemical maps, spatial analyses and data treatment.
- Next meeting in 2024: location to be discussed. There are invitations from Naples, Prague and Ljubljana.

The meeting closed at 17:00 (Athens time)

3rd Day, Saturday, 15th October 2022 (08:30-19:00)

EXCURSION TO LAVREOTIKI PENINSULA (All day)

A visit to the unique ancient mining district of Lavreotiki peninsula (6th to 4th century BC installations), and a trip round Lavrion showing the great area extend of the ore-beneficiation wastes and slag, generated during the nineteenth and twentieth century industrial activities.

Alecos Demetriades guides the group at the 5th century BC ore washing-beneficiation plants, Souriza valley, Aghios Constantinos, Lavreotiki peninsula.

Group photograph at the ancient amphitheatre at Thorikon, Lavrion (6th century BC).

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APPENDIX 2: EVALUATION REPORT OF THE UNESCO-ICGG

APPENDIX 2

EVALUATION REPORT

of the

UNESCO
INTERNATIONAL CENTRE ON GLOBAL-SCALE GEOCHEMISTRY

by

Alecos Demetriades

Representative of the IUGS Commission on Global Geochemical Baselines
to the Centre's Governing Council and Scientific Committee

January 2023

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1. INTRODUCTION

According to UNESCO rules, centres under its auspices must be subjected to an independent periodic evaluation by international experts, especially at the end of the agreement period. The Covid-19 pandemic and travel restrictions to and from China make a professional international evaluation difficult, if not impossible. Because of this problem UNESCO extended for one-year the agreement with China Geological Survey for the operation of the International Centre on Global-Scale Geochemistry (ICGG) until May 2023. Unfortunately, the pandemic is still with us, and UNESCO decided to carry out the required evaluation by selecting a local geoscientist, whose profession is not related to the work of the ICGG. This decision has many obvious flaws even to the non-expert. However, these flaws will not be discussed further here out of respect to the local geoscientist, who accepted the challenge with the knowledge that he is completely out of his waters.

One may ask, did UNESCO have other alternatives? The answer is, of course, yes, and was to use the international councillors, who are applied geochemistry professionals with many years of experience and from different continents, namely Africa, North America, South America, Australia and Europe. As the local evaluator had a very difficult task to perform he resorted in the use of an obvious alternative by interviewing a number of international councillors, and asking them to complete a questionnaire. As I do not know how he used this material and his final recommendation to UNESCO, the submitted questionnaires from the international Councillors are included in Annex 2.1, and should be carefully studied and digested before proceeding in the reading of this evaluation. However, it is important to be informed about the reaction of the international Councillors when the ICGG Secretariat Director got in touch with them and asked them to review the Centre's 2021 Report. These electronic messages are in Annex 2.2.

Please note that I consider it an obligation towards the international applied geochemistry community to submit this evaluation report, and to recommend strongly that UNESCO acts for the interest of the global community and not for the interests of an individual nation or institution, and in this case, I mean China and China Geological Survey, respectively.

2. IMPORTANT BACKGROUND INFORMATION

Before reading my evaluation and recommendation, please study first the following sections in the Commission's Annual Reports, and also herein Annexes 2.1 and 2.2, because it is important to have all the available information to understand the evaluation. The Sections that should be studied are in the following Commision Annual Reports:

- 2017 Annual Report:- *Section §7.2.6* (pages 35−42): *2017 Workshop on Geochemical Mapping for "Belt and Road" Countries, 23-30 September 2017, UNESCO International Centre on Global-Scale Geochemistry, Langfang, China*, and especially the "*Comments on the Chinese floodplain sediment sampling technique*" (pages 40−42).
- 2018 Annual Report:- *Section §6.5* (pages 19−23): *Participation in the second meeting of UNESCO ICGG* and especially sub-sections:
  - §6.5.1. *Comments on the Chinese floodplain sediment sampling method* (pages 20-23). Reference is also made to the following paper that should be studied: Demetriades, A., Smith, D.B., Wang, X., 2018. *General concepts of geochemical mapping at global, regional, and local scales for mineral exploration and environmental purposes*. In: Licht, O.A.B. (Guest Editor), Geochemical Mapping. Special Issue, Geochimica Brasiliensis, 32(2), 136−179; http://doi.org/10.21715/GB2358-2812.2018322136.
  - §6.5.2 (pages 23-26): *Comments on the Agreements signed with other countries*
- 2019 Annual Report:- *Section §5.1* (pages 8−9): *UNESCO International Centre on Global-Scale Geochemistry*.

- 2020 Annual Report:- *Section §5.1* (pages 10−12): *UNESCO International Centre on Global-Scale Geochemistry*. And most importantly *Sub-section §6.11.1* (pages 26−28) *Evaluation of questionable sampling and recommendation*.
- 2021 Annual Report:- *Section §5.1* (pages 8−9): *UNESCO International Centre on Global-Scale Geochemistry*. And most importantly Appendix 2 (pages 29−35) *Comments on Third Session of UNESCO ICGG*.

3. EVALUATION CRITERIA

The Organization for Economic Cooperation and Development (OECD) has defined six evaluation criteria, namely relevance, coherence, effectiveness, efficiency, impact and sustainability – and two principles for their use (OECD, 2021).

The six evaluation criteria are explained in Table 2.1, and the two Principles in Table 2.2.

Table 2.1. Explanation of the six evaluation criteria developed by the OECD (2021).

Evaluation criterion	***Question to be answered***	***Concise explanations***
1. RELEVANCE	Is the intervention doing the right things? Are the objectives of the ICGG adequately defined, realistic and feasible, and are the results verifiable and aligned with current international standards for development interventions?	The extent to which the intervention objectives and design respond to beneficiaries, global, country, and partner/institution needs, policies, and priorities, and continue to do so if circumstances change.
2. COHERENCE	How well does the intervention fit?	The compatibility of the intervention with other interventions in a country, sector or institution.
3. EFFECTIVENESS	Is the intervention achieving its objectives?	The extent to which the intervention achieved, or is expected to achieve, its objectives, and its results, including any differential results across groups.
4. EFFICIENCY	How well are resources being used?	The extent to which the intervention delivers, or is likely to deliver, results in an economic and timely way.
5. IMPACT	What differences does the intervention make?	The extent to which the intervention has generated or is expected to generate significant positive or negative, intended or unintended, higher-level effects.
6. SUSTAINABILITY	Will the benefits last?	The extent to which the net benefits of the intervention continue, or are likely to continue.

Table 2.2. Explanation of the two evaluation principles developed by the OECD (2021).

Principle	***Use of criteria***	***Concise explanations***
Principle One	The criteria should be applied thoughtfully to support high quality, useful evaluation.	They should be contextualised – understood in the context of the individual evaluation, the intervention being evaluated, and the stakeholders involved. The evaluation questions (what you are trying to find out) and what you intend to do with the answers, should inform how the criteria are specifically interpreted and analysed.
Principle Two	The use of the criteria depends on the purpose of the evaluation. The criteria should not be applied mechanistically.	Instead, they should be covered according to the needs of the relevant stakeholders and the context of the evaluation. More or less time and resources may be devoted to the evaluative analysis for each criterion depending on the evaluation purpose. Data availability, resource constraints, timing, and methodological considerations may also influence how (and whether) a particular criterion is covered.

Based on the six-year experience of monitoring the work of the UNESCO-ICGG, and the continuous assessment of its work as Governing Board Councillor and Scientific Committee member, I have all the necessary information to make a professional evaluation (refer to the Commission's Annual Reports as detailed above). Further, the opinions of other international Councillors and Scientific Committee members, given in Annexes 2.1 and 2.2, are supporting this evaluation of the UNESCO-ICGG.

In Table 2.3 the answers to the six OECD (2021) evaluation criteria are given, and in Table 2.4 answers are presented for a few practical questions.

The rating of each criterion is from 0 (very poor) to 10 (excellent).

Table 2.3. Answers to the six OECD (2021) evaluation criteria and their rating.

Evaluation criteria and questions to be answered	***Answers to questions (refer to Table 2.1)***	***Rating***
1. RELEVANCE: *Are the objectives of the ICGG adequately defined, realistic and feasible, and are the results verifiable and aligned with current international standards for development interventions?*	The objectives of the ICGG are clearly defined in its Statutes, and are realistic and feasible. However, these were not realised because they are not in the interest of China Geological Survey. As analytical and quality control methodologies have never been discussed with the ICGG Scientific Committee, it can be stated that they are not aligned with current international standards. The following paragraph from page 8 of the draft version of the 2021 annual report explains the Chinese attitude and the reasons that the International Councillors were never consulted during its six year operation: "*Since the establishment of ICGG in 2016, it has successfully held 36 international training courses in and out of China and*	3

Evaluation criteria and questions to be answered	*Answers to questions (refer to Table 2.1)*	*Rating*
	attracted 856 participants from 52 countries, which has effectively enhanced the international influence of China geochemical technologies." The Chinese standard of the international training courses is very low, as the lectures are at the level of conference presentations and, essentially, a show of how China is great. There are no hands-on training courses. The participants, however, coming from mostly third-world countries are happy with the hospitality and of touring China. The objective of China Geological Survey is through these courses to have local agents that can influence national decisions for the benefit of China.	
2. COHERENCE: (a) *To what extent is the Global Geochemical Baselines project designed to use existing international systems and structures for the its activities and to what extent are these used?* (b) *Is division of labour with other international partners used when implementing the project, and if so to what extent?* (c) *To what extent are common systems used for monitoring, learning and accountability?*	As there is no cooperation between the UNESCO-ICGG with the international Governing Board Councillors and Scientific Committee members, it is impossible to provide a satisfactory answer to these three questions about coherence of its activities. I can certainly answer that the existing accepted international sampling methodology with respect to floodplain sediment, the sampling medium used by the ICGG, was not applied before the first biennial meeting in October 2018 (refer to Chapter 3.5 'Overbank and Floodplain Sediment Sampling' (pages 257−305 in the IUGS-Manual of Standard Methods – Demetriades *et al.*, 2022). At this meeting there was an agreement about the sampling of floodplain sediment (see Commission's 2020 Annual Report and Annex 1.1.1. '*Agreement on Catchment Basin Sediment Sampling*' (page 43). However, I cannot verify if this agreement was honoured as no information was made available. As there was a request for confidential assistance by a country, which had a contract with China Geological Survey, it appears that the agreed sampling protocol was not used (refer to Section §6.11.1 '*Evaluation of questionable sampling and recommendation*' in the 2020 Annual Report (pages 26−28).	3
3. EFFECTIVENESS: (a) *Is the Global Geochemical Baselines project achieving its objectives?* (b) *Are the results verifiable, reliable and aligned with current international standards?*	The UNESCO-ICGG will reply positively to both questions. However, from the evaluator point of view the ICGG is providing a false picture of its achievements by mixing results of geochemical baseline projects in Europe, USA and Australia, which have been carried out years ago, and its own international work. As the results have not been made available to the ICGG Scientific Committee, I cannot say that the results are verifiable, reliable and aligned with current international standards.	3
4. EFFICIENCY: (a) *How well are resources being used and justified by its results?* (b) *Were the activities cost- and time-effective?*	In my opinion the resources made available by the Chinese taxpayer are not being used efficiently. This is something that I have pointed out since September 2017 as tutor at the Workshop for "Belt and Road Countries". The majority of the workshop participants are not applied geochemists or chemists; they are economic geologists, geophysists and even office personnel, personnel that will never use applied geochemical methods. Although this wasteful procedure was discussed directly with the ICGG Management this wasteful scheme is still being used.	2

Evaluation criteria and questions to be answered	*Answers to questions (refer to Table 2.1)*	*Rating*
5. IMPACT: (a) *What differences does the Global Geochemical Baselines project make?* (b) *To what extent has the Global Geochemical Baselines project generated positive or negative, intended or unintended effects?*	(a) The Global Geochemical Baselines project as carried out by the UNESCO-ICGG with the sampling of only floodplain sediment, a sampling medium that is not used systematically by all countries, will not make any difference in the short and long term. (b) As the Global Geochemical Baselines project is carried out in a piecemeal fashion, and to my knowledge the ICGG has no proven experience in the levelling of geochemical results, analysed at different times, the produced disparate results will be incompatible.	3
6. SUSTAINABILITY: *To which extent the net benefits of the Global Geochemical Baselines project will continue or are likely to continue?*	The way that the Global Geochemical Baselines project is being handled by China Geological Survey, which is dictating the UNESCO-ICGG's programme, will most likely not continue when the cooperation programmes between countries that has interests ends.	1

Table 2.4. Answers to additional evaluation criteria and their rating.

Evaluation criterion	*Comments*	*Rating*
Communication with Governing Board Councillors and Scientific Committee Members	Only before the biennial meetings (October 2018 & December 2021) and in August 2022 for the review of the 2021 Annual Report (this concerns the international members)	2
Collaboration with Governing Board Councillors and Scientific Committee Members	Essentially no collaboration during the whole six-year period (this concerns the international members)	0
Dissemination activities: (a) Reporting; (b) Website; (c) Newsletter; (d) Webinars	(a) Reports are made available before the biennial meetings (October 2018 & December 2021) and in August 2022. (b) The website (http://www.globalgeochemistry.com/en) is down most of the time. (c) Only one Newsletter was published during the six-year period. (d) No webinars organised.	2
Workshop: (a) Tutors; (b) Material	(a) The tutors are Chinese, except in one case (the "Belt and Road" workshop in September 2017, where I was invited to teach at the workshop). So, there is a valid question: *Is the UNESCO-ICGG an International Centre or a Chinese Centre?* (b) The material taught at the Workshop has not been approved by the Scientific Committee.	1
Field training	The tutors are Chinese, except in one case (the "Belt and Road" workshop in September 2017, where I was invited to teach at the workshop). So, again there is a valid question: *Is the UNESCO-ICGG an International Centre or a Chinese Centre?*	1
Analytical methods used for the analysis of the Global Geochemical Baselines samples	No details have been provided to the Scientific Committee Members	0
Quality control methods	No details have been provided to the Scientific Committee Members	0

A final question is: *Why the ICGG Secretariat Director asked the Governing Board Councillors and Scientific Committee members to review the 2021 Annual Report?* The answer is very simple: It is because of the UNESCO evaluation, the ICGG wanted to have a good evaluation, and indirectly was asking us to support the renewal of the agreement for another six-year period. When the ICGG was mostly likely informed about the answers given by the International Councillors to the questionnaire sent by the UNESCO Evaluator, it has not sent us the revised version of the 2021 report. The last communication was on the 27th of October 2022. Therefore, the ICGG is back to its old self ignoring completely the existence of the Councillors, and especially the international ones, as I do not know the relationship with the Chinese Councillors.

4. CONCLUSION AND RECOMMENDATION

Because of this very poor performance in all evaluation criteria, the recommendation is that UNESCO must not renew the agreement with China Geological Survey for the operation of the so-called International Centre on Global-Scale Geochemistry under its auspices. The Centre can continue to work as a Chinese Centre, under the auspices of China Geological Survey as it has done since 2016.

The International Union of Geological Sciences should also distance itself from the ICGG as recommended by Roland Oberhänsli (IUGS representative in the ICGG Governing Board & Interim Chair of the Scientific Committee (2018-), and past IUGS President (2012-2016)) in his submitted report (13th January 2022) on the results of the 3rd Biennial meeting on the 10th of December 2021.

REFERENCES

OECD, 2021. Applying Evaluation Criteria Thoughtfully. OECD Publishing, Paris, 82 pp. https://doi.org/10.1787/543e84ed-en.

Annex 2.1. Answers to the questionnaire sent by the UNESCO Evaluator

David B. Smith	Abstention
Patrice de Caritat	Rejection
Belinda Flem	Rejection
Alecos Demetriades	Rejection
Gloria Prieto	Abstention

Gloria Namwi Simubali and Davies Theophillus did not return the questionnaire, because of personal problems. Gloria Namwi Simubali at the virtual biennial meeting of the 10th of December 2021 voted Rejection. Davies Theophillus did not take part in the meeting.

Name	**David B. Smith**
Occupation	Applied Geochemist
Affiliation	IUGS Commission on Global Geochemical Baselines
Position in the ICGG	Governing Board Councillor & Scientific Committee member
Term of Office	2016 - present
Representative Organization	IUGS Commission on Global Geochemical Baselines
Country	USA

General comments on the 6-year ICGG management, operation and achievements

In my opinion, ICGG management has made a sincere effort since 2016 to develop an efficiently functioning organization. However, they have faced some difficult problems. From my understanding, the China Geological Survey (CGS) is actually running the UNESCO Centre. Again, it is my understanding that the agreements with other countries are not between the country and the UNESCO Centre, but rather between the country and the CGS. Global-scale geochemistry, the mission of the UNESCO Centre, seems to be an afterthought with the goals of the CGS taking priority. If this continues, it will be difficult for ICGG management to obtain their goal of producing a global geochemical database using floodplain sediments as the sampling medium. It is my opinion that the UNESCO Centre is not functioning in the true UNESCO spirit, but rather is just a subunit of the CGS. Perhaps because CGS is providing all the funding for the UNESCO Centre, this model of operation is to be expected. However, I do not believe such a model is in the best interests of UNESCO.

The annual report provided by the UNESCO Center does not provide sufficiently detailed information to judge the achievements. The report should provide much more detailed information about the work in other countries. Such information as the number of samples collected, the number analyzed, information on quality control, and the status of sampling and chemical analysis should be described in detail. This will allow the Scientific Committee to see how the sampling and analysis is proceeding in each country. In those countries where agreements have been signed but no sampling has begun, there should be information about the planned number of samples, the proposed schedule for field work and chemical analysis. A draft annual report should be provided to each member of the Scientific Committee in order to allow each member to thoroughly review and comment on the report. Then the report can be revised and re-distributed.

A major problem exists with the way in which the UNESCO Centre uses the Scientific Committee. There is virtually no communication between the Centre and the Committee except for a brief flurry of emails shortly before the meeting with the Committee, which should take place every two years. I think the Centre's management really has no idea of how the Scientific Committee could benefit the Centre. At the moment, the Centre management

seems to feel the only use of the Committee is to lend an air of legitimacy to the UNESCO Centre. This was obvious in 2016 at the first meeting of the Committee in Langfang. The Committee was provided with the draft statutes for the Committee which stated that its purpose was to approve all the activities of the UNESCO Centre. Some Committee members quickly pointed out that the purpose of the Committee was to review and provide constructive feedback on the operation of the Centre. That might involve honest disagreements at times and, at times, the Committee might not approve some activity of the Centre. That is how these oversight committees are supposed to work. To date, ICGG management has given no concrete indication that their attitude has changed. Communication with the Scientific Committee must improve, or the Committee should be dissolved because it serves no useful purpose.

Another issue that must be recognized it the relationship between ICGG and the IUGS Commission on Global Geochemical Baselines (CGGB). The statutes of the ICGG state the ICGG will do the following: "Apply the standardised global-scale geochemical methods developed by the IUGS Commission on Global Geochemical Baselines, so as to document the concentration and spatial distribution of chemical elements in the various environmental compartments of the Earth's surface, and to establish global geochemical baselines for monitoring future geochemical changes" Now that the CGGB has published the "International Union of Geological Sciences Manual of Standard Methods for Establishing the Global Geochemical Reference Network", the two groups need to hold discussions, including trips to the field to demonstrate and compare sampling techniques, to make sure the sampling methodology detailed in the IUGS publication are being followed by ICGG. There are many opportunities for collaboration between the two groups and these should be thoroughly explored and discussed. There is also a risk of competition and duplication of effort between ICGG and CGGB. Great care must be given to avoid such appearances.

Major recommendations for the ICGG

My major recommendations are:

1. ICGG management must be much more open in their communication with the Scientific Committee. There is a lot of expertise on the Committee and the members can provide very useful feedback and recommendations to the UNESCO Centre. Such communication can improve the effectiveness of the UNESCO Centre and can improve its standing in the international scientific community. The annual reports must be improved to provide more detailed information about the activities and achievements of the Centre. As currently written, the annual reports simply do not provide much useful information. For example, in the most recent (2021) report, there is a section titled "ICGG Fully Supported CGS In the International Bidding for Geochemical Survey in the Arabian Shields." This section briefly discusses the Saudi Arabia Geological Survey's awarding to CGS a contract to conduct a "high-resolution geochemical survey of the Arabian Shield, through stream sediment and heavy mineral concentrate samples." Global-scale geochemistry is not mentioned at all in this section. Will global-scale sampling using floodplain sediments also be conducted in conjunction with the high-resolution stream-sediment sampling? What is the role of ICGG in this project other than to "fully support" CGS? If this project in Saudi Arabia does not involve global-scale sampling, then why even mention it in the annual report of ICGG? This is just one example where communication through the annual report needs to be improved. There are many others.

2. ICGG and CGGB need to have face-to-face meetings in order to discuss how the two organizations will cooperate and collaborate in the future. These meetings should include visits to floodplain sampling sites where both the ICGG sampling methodology and the

methodology published in the International Union of Geological Sciences Manual of Standard Methods for Establishing the Global Geochemical Reference Network can be demonstrated and standardized.	
Position for the renewal of the ICGG	Abstention
Signature	David B. Smith
Contact, phone/email	dbsmith13@gmail.com
Date	15 September 2022

Name	**Patrice de Caritat**
Occupation	Research Scientist
Affiliation	Geoscience Australia, Canberra, Australia
Position in the ICGG	Governing Board Councillor & Scientific Committee member
Term of Office	2016 - 2021
Representative Organization	Geoscience Australia
Country	Australia

General comments on the 6-year ICGG management, operation and achievements

In my view, the International Centre for Global-Scale Geochemistry (ICGG) has been run with as little consultation with its constituent Governing Board and Scientific Committee as possible. We have had three meetings in the last six years, including the inauguration meeting in May 2016. It took until October 2018 to finalise the Statutes, which are the building blocks of the organization. There was no or very little communication with the members of either constituent groups over those six years, thus the ICGG missed the opportunity to leverage the vast experience and expertise they represent. There was one Newsletter produced in that timespan, and I believe two Annual/Biennial Reports. Yet, the ICGG appears to have been very active, carrying out surveys, analyzing samples, training people and hosting visitors from around the world. So this whole situation begs the question of why have a Governing Board and Scientific Committee if no advise is sought, no information is shared, and no true collaboration is fostered

Major recommendations for the ICGG

At the December 2021 virtual meeting (Third Session), I voted against renewal of the Centre because I believed it had been run in an opaque, inwardly directed way, not in a truly collaborative, world-focused program one would expect the UNESCO to sponsor. I understand where the funding is coming from and why having an apparent international 'endorsement' is important, but ultimately I had to view this as a citizen of the world asking what good to humanity is coming from this program.

If renewal proceeds, however, I would recommend more transparency, accountability, and genuine collegial cooperation starting at the upper echelon of the ICGG. As it has proven unworkable to let the Centre manage itself internally, a number of incremental reporting and approval steps/gateways are the only way, unfortunately, that transparency, accountability, and cooperation can be reported, measured, and rated against realistic and quantifiable performance metrics

Position for the renewal of the ICGG	Rejection
Signature	Patrice de Caritat
Contact, phone/email	Patrice.deCaritat@ga.gov.au
Date	19/9/2022

Name	**Belinda Flem**
Occupation	Norway
Affiliation	Geological Survey of Norway
Position in the ICGG	Councillor & Scientific Committee member
Term of Office	2016 - present
Representative Organization	Europe: EuroGeoSurveys Geochemistry Expert Group (EGS-GEG)
Country	

General comments on the 6-year ICGG management, operation and achievements

At the beginning of 2016 Dr. Clemens Reimann, the then Chairperson of the EuroGeoSurveys Geochemistry Expert Group (EGS-GEG), was informed that he would be the European representative to the Governing Board and Scientific Committee of the UNESCO International Centre on Global-Scale Geochemistry. Dr. Reimann declined the positions, because he was in the process of stepping down from the chair of EGS-GEG and proposed me (Dr. Belinda Flem). I was selected after consultation with the other members of EGS-GEG. However, I was not invited to the Centre, nor was I mentioned in the published first newsletter of the UNESCO International Centre. Not until Dr. Slavko Solar, former EuroGeoSurveys Secretary General, made contact and pointed this out. In 2018, I was invited to the Centre by Prof. Yao Wensheng (at that time Director of ICGG Secretariat Office). The impression during this process was that the Centre tried to dictate who the European representative should be. During the 6 years of operation, and also after the time when the Centre accepted me as the European representative, very little information on the Centre's activity has reached me. There have been no meetings for discussing sampling and analytical strategies, nor strategies on publication of the global scale data set. As the Centre does not clearly distinguish between the global scale mapping data and the data/samples collected for the Geological Survey of China, it is difficult to actually quantify the achievements of the Centre.

Major recommendations for the ICGG

I think Gloria Prieto Rincón summarized the major recommendations very well in her response to the last Annual Report and Biennial Evaluation Report of ICGG.

She states the following:
1. I agree that in any report it is essential to be faithful to the source of information, strictly referring to the methodologies, data, maps, authors, and scope of the projects.
2. I agree with Belinda about "lack of cooperation and information on scientific strategies".
3. I think that it is very important and fundamental to maintain the meetings established in the Governing Board and in the Scientific Committee of the UNESCO center in Langfang, even virtual meetings that are very useful.
4. It is also essential to include all the members belonging to the committees in the decisions and maintain permanent information among the members.
5. Additionally, the Center's reports must be shared prior to delivery with the members of the center's governing and committees to obtain their input and approval.

Position for the renewal of the ICGG	rejection
Signature	Belinda Flem
Contact, phone/email	+47 73904011 (switch board) +47 95830071(mobile) e-mail: Belinda.Flem@ngu.no
Date	16/9/2022

Name	**Alecos Demetriades**
Occupation	Applied Geochemist
Affiliation	Member of Advisory Panel of the Steering Committee of the IUGS Commission on Global Geochemical Baselines and Chairperson of Sampling Committee of the IUGS Commission on Global Geochemical Baselines
Position in the ICGG	Governing Board Councillor & Scientific Committee member
Term of Office	12 May 2016 to 12 May 2023
Representative Organization	IUGS Commission on Global Geochemical Baselines
Country	Hellenic Republic (Greece)

General comments on the 6-year ICGG management, operation and achievements

The following comments are being made from the International Councillor point of view.

Management and Operation: Director of ICGG was also the Director of the Institute of Geophysics and Geochemistry (IGGE), and he was Dr. Peng Xuanmin, who did not speak English. Deputy Director of IGGE & ICGG was Dr. Hao Guojie, who does speak English. Prof. Wang Xueqiu, Executive Director of ICGG, who does speak English, and Secretariat Office Director was Dr. Yao Wensheng, who has been replaced by Dr. Bimin Zhang (and both speak English). At some stage between 2108 and 2021 the IGGE/ICGG Director and Deputy Director and Secretariat Office Director were replaced, and the international Councillors were not informed in advance about these changes according to Article 40 of the ICGG statutes "The Director of the Centre shall be appointed by the Chairperson of the Governing Board in consultation with the Director-General of UNESCO. The legal representative of the Centre shall be the Director. The Director shall appoint the Executive Director and the Deputy Director, and inform the Governing Board. The Executive Director and Deputy Director shall assist the Director with the daily work of the Centre". From the 12th of May 2016 to the present time the international Governing Board Councillors and Scientific Committee members, and most likely the Chinese too, were never consulted on any issue concerning the ICGG. The only time that the international Councillors had any information about the activities of the ICGG was approximately a month before a planned biennial meeting, *e.g.*, October 2018 and December 2021. At the October 2018 meeting the UNESCO representative, Mr. Philippe Pypaert (if I remember correctly his name), asked Dr. Peng for the reasons that the international Councillors were never been informed about the activities of the Centre. Dr. Peng, avoided to provide a reasonable answer, and just stated that "now we have the approved Statutes we will be informing them". Of course, the ICGG Management never did operate according to the approved statutes. Hence, the conclusion from the international point of view is that the ICGG is being mismanaged, as no transparent procedures are followed. It is quite apparent that ICGG does not care to operate according to its own approved statutes, and to use the expertise of the international councillors, and just wants them as show cases, and nothing more.

ICGG Website: Most of the times is not working. I had many complaints from colleagues from all over the World, and used to inform Yao Wensheng (former Director of the ICGG Secretariat Office). As this was a continuous problem, I given up. I tried the ICGG website hyperlink (http://www.globalgeochemistry.com) on Wednesday, 14th September 2022 at 20:12, and on Saturday, 17th September 2022 at 15:28 Athens time and is not working. The continuous non-working of the ICGG Website shows how much the Management cares about the dissemination of information. The international Councillors were never asked to review the contents of the website in order to correct the mistakes.

ICGG Newsletter: During my forty-day stay at the ICGG in October-November 2016, I have compiled and edited the first Newsletter of the ICGG, and trained Yao Wensheng to use the Microsoft Publisher in order to design the second and subsequent Newsletters. To my knowledge no other Newsletter was published by the ICGG, which again shows that the Management does not care about the dissemination of information.

Laboratory analysis: This is one of the greatest problems. The ICGG has not provided any information about the analytical methods used in the IGGE laboratory. I pointed this problem to Yao Wensheng (former Director of the ICGG Secretariat Office), who made an attempt to collect all the required information. He sent me the first version of the IGGE analytical methods on the 14th of February 2019. I reviewed the text and sent him my comments and questions. The 6th and last version was sent to me on the 9th of December 2019. As there were still questions, I given up, because this activity was taking too much of my time. The ICGG should contact, however, Yao Wensheng for a copy of the "IGGE Analytical methods", as I am aware that corrections have been made, and after a thorough review by the international External Advisory Committee in collaboration with the IUGS Commission on Global Geochemical Baselines, make it available through the ICGG Website.

External Quality Control: The ICGG relies on the quality control procedure that is set up by the laboratory. This is one of the problems I stressed many times that the ICGG Executive Director must not rely on the results of the laboratory quality control and must set up its own external quality control scheme. I have explained how this is done many times and with examples and provided access to the three quality control reports of the European GEMAS project, where the procedure is explained, and even data of non-acceptable quality are reported: (1) https://www.ngu.no/upload/Publikasjoner/Rapporter/2009/2009_049.pdf; (2) https://www.ngu.no/upload/Publikasjoner/Rapporter/2011/2011_043.pdf, and (3) https://www.ngu.no/upload/Publikasjoner/Rapporter/2012/2012_051.pdf. I stressed that each analytical data set generated according to the agreement made with other countries must be accompanied by a detailed quality control report, otherwise the analytical data must not be accepted by the collaborating country. Unfortunately, no interest was shown by the ICGG Management to produce such quality controlled geochemical data sets. Hence, I have my doubts about the quality of the generated analytical data.

Contracts with other countries: The contracts with other countries are signed by China Geological Survey the interests of which are quite different from those of the ICGG. Refer to Section "*6.5.2. Comments on the Agreements signed with other countries*" (p.23 to 26) in the 2018 annual report of the IUGS Commission on Global Geochemical Baselines (https://www.globalgeochemicalbaselines.eu/datafiles/file/IUGS-CGGB_2018_Annual_Report_final.pdf) where the Agreement Conditions are described, and comments made on the ICGG work performed.

Floodplain sediment sampling: The composite floodplain sediment sampling carried out by ICGG before the October 2018 meeting was depth related and without any consideration if two or more floodplain sediment layers were sampled. This is unacceptable method. Refer to Section "6.5.1. Comments on the Chinese floodplain sediment sampling method" (p.20-23) in the 2018 annual report of the IUGS Commission on Global Geochemical Baselines (https://www.globalgeochemicalbaselines.eu/datafiles/file/IUGS-CGGB_2018_Annual_Report_final.pdf) where comments and recommendations are made. At the October 2018 meeting the main principles of the floodplain sediment layer-based sampling were agreed and were signed by those present on the 17th of October 2018. I signed "with reservations", because I had my doubts if the ICGG colleagues will follow the procedure.

Complaints by different countries: As I am the Chairperson of the Sampling Committee of the IUGS Commission on Global Geochemical Baselines, I have been contacted by colleagues from many parts of the world with complaints about the training provided by ICGG, IGGE or China Geological Survey: (1) Chinese trainers do not speak good English; (2) Chinese trainers do not speak English and they have Chinese translators, who do not have a good command of technical terms; (3) Worse of all unacceptable training in sampling. One national Geological Survey has sent me a mixture of photographs of samples collected by the Chinese trainers and their trainees. More details will be found in the 2020 Annual Report of the IUGS Commission on Global Geochemical Baselines (pages 26 to 28): https://www.globalgeochemicalbaselines.eu/datafiles/file/IUGS-CGGB_2020_Annual_Report_Final.pdf, namely Section "6.11.1. *Evaluation of questionable sampling and recommendation*".

Achievements: The ICGG presents its so called 'achievements' in the reports just before the bi-annual meetings, and during the meetings in a PowerPoint presentation. Hence, the Councillors (International and Local) cannot really assess objectively if they are achievements of any real and lasting value.

Workshops: As I have been involved as a tutor in at least one Workshop organised by the ICGG, namely the "Workshop on Geochemical Mapping for "Belt and Road" Countries", September 23-30, 2017, Langfang, my comments are included in Section "7.2.6. 2017 Workshop on Geochemical Mapping for "Belt and Road" Countries, 23-30 September 2017, UNESCO International Centre on Global-Scale Geochemistry, Langfang, China" of the 2017 Annual Report of the IUGS Commission on Global Geochemical Baselines (pages 35 to 42): https://www.globalgeochemicalbaselines.eu/datafiles/file/IUGS_CGGB_Annual_Report_2017_Final_Web.pdf. The ICGG content of this particular workshop was just PowerPoint presentations presented in conferences. There is no real hands-on training, which will be of real value to the trainees. As I have participated in two workshops organised by IGGE before the establishment of the ICGG, the content was similar. Regarding the field training, it is just a demonstration of the ICGG methodology. Similar comments are included in the following paper: Demetriades, A., Smith, D.B., Wang, X., 2018. *General concepts of geochemical mapping at global, regional, and local scales for mineral exploration and environmental purposes*. In: Licht, O.B. (Guest Editor), Geochemical Mapping. Special Issue, Geochimica Brasiliensis, 32(2), 136-179; http://doi.org/10.21715/GB2358-2812.2018322136 from page 165 in Section "**10. PITFALLS TO AVOID**". Please note that Professor Xueqiu Wang is co-author, which means he agrees with the contents of the paper.

Reports from people attending the workshops, especially applied geochemists, is that the material is not really useful, and was a waste of their time. I had the same feedback from a few people that participated in the September 2017 workshop that I was tutor. However, the ICGG hospitality is excellent. Finally, these short workshops with no real hands-on training are not satisfactory to train effectively the participants, especially geologists, that would like to use effectively applied geochemical methods in their country.

Workshop participants: Something that I have commented is the vocation of the workshop participants. There is a mixture from office personnel to geologists and chemists, and usually only few applied geochemists. For example, in Sections (a) "3.1.1 2018 International Training on Geochemical Mapping", which is reported in the "EN-ICGG2018-2020Work Report" (p.20-22), out of the 26 participants there is only one geochemist; (b) "3.1.2 2018 Training Course on Geochemical Mapping Technologies and Environmental Geochemical Survey in Developing Countries" (p.22-24) out of the 32 participants there is again only one geochemist (consultant); (c) "3.1.4 2019 International Geochemical Mapping Technology Training Course" (p.25-26) out

of the 17 participants there is again only 1 geochemist and 2 chemists (there are 8 with undefined vocation), (d) "3.1.5 2019 Training Course on Geochemical Mapping and Environmental Geochemical Survey Techniques for Developing Countries" (p.26-28) out of the 18 participants there is no geochemist and only 1 chemist. The irony is that the workshop participants in (d) are referred to as "officials and technicians in the field of geochemistry and geology". In my opinion, the ICGG is wasting Chinese taxpayers' money in its "training courses in geochemical mapping" that will never use the knowledge gained. The ICGG argument is that in most developing countries the geoscientific disciplines are not well-defined, and that the 'geochemical knowledge' obtained from the workshops helped the different countries to carry out their geochemical mapping. This is indeed a very worrying attitude, because in my opinion these people do not have the expertise and experience to carry out an efficient and effective geochemical mapping programme.

Hierarchy: The greatest problem is the operation of the ICGG is the Chinese bureaucratic hierarchy. Procedures have been set up by Professors, who most of them may be now Academicians, and these procedures are followed strictly by the younger generations, and nobody lower in the hierarchy dares to change them or challenge them. If this attitude does not change, the ICGG will continue to work inefficiently.

Major recommendations for the ICGG

1. Although I do not think is worth making any recommendations for the ICGG, as the Management during its six-year operation did not even respect its own Statutes. However, I will make a few recommendations.
2. **Governing Council Councillors and Scientific Committee members:** All Chinese Councillors must speak and understand English, as direct communication with the international councillors/members is important, and to be able to use the modern technology for communication, namely electronic messaging.
3. **ICGG Management and staff:** The Management and staff of a UNESCO international centre must definitely have a good command of the English language.
4. Governance: The Management of ICGG to operate according to its own statutes and professional international etiquette.
5. **Secretariat office:** The following proposal was submitted by an E-mail message on the 13th of November 2017 to the then ICGG/IGGE Director Dr. Peng Xuanming: All Secretariat Office staff must have a good command of the English language. The work involved needs at least five people: One translator; One person to manage the Centre's website; Two persons with a scientific background and with a good command of English, and One person with international experience. Under the supervision of the Secretariat Director, these people will be responsible for updating the website contents, the typesetting of the Newsletter, and monitoring the daily routine work of the Centre. Essentially the Secretariat Office will be the backbone of the Centre.
6. **Operation:** The ICGG must operate as a UNESCO international centre, and not as a Chinese centre, and it must follow to the letter its approved Statutes.
7. **Newsletter:** At least one annual electronic newsletter in English must be published and made available through the ICGG website. Of course, the contents of the Newsletter must be approved by the members of the Scientific Committee.
8. **Preparation of Reference materials for external quality control:** As ICGG is using floodplain sediment for the Global Geochemical Baseline mapping in other countries, and this work will mostly likely last for many years, it is important to prepare at least five floodplain sediment samples with different chemical composition. Until the preparation of these reference samples, which will be used for the external quality control, all sampling in other countries must stop. The reasons for this recommendation will be found in

Chapter 8 of the International Union of Geological Sciences Manual of Standard Methods for Establishing the Global Geochemical Reference Network (https://www.globalgeochemicalbaselines.eu/content/174/iugs-manual-of-standard-methods-for-establishing-the-global-geochemical-reference-network-/): Johnson, C.C. & Lister, T.R., 2022. *Data Conditioning Methods: Generating Time Independent Geochemical Data*. Chapter 8 In: Demetriades, A., Johnson, C.C., Smith, D.B., Ladenberger, A., Adánez Sanjuan, P., Argyraki, A., Stouraiti, C., Caritat, P. de, Knights, K.V., Prieto Rincón, G. & Simubali, G.N. (Editors), International Union of Geological Sciences Manual of Standard Methods for Establishing the Global Geochemical Reference Network. IUGS Commission on Global Geochemical Baselines, Athens, Hellas, Special Publication, 2, 429−456.

9. **According to Article 7 of the ICGG statutes:** The functions of the Centre shall be to: "7.1. Apply the standardised global-scale geochemical methods developed by the IUGS Commission on Global Geochemical Baselines, so as to document the concentration and spatial distribution of chemical elements in the various environmental compartments of the Earth's surface, and to establish global geochemical baselines for monitoring future geochemical changes", which means that ICGG will have to apply the methods that are described in Chapter 3.5 "*Overbank and Floodplain Sediment Sampling*" (p.257−305) the "International Union of Geological Sciences Manual of Standard Methods for Establishing the Global Geochemical Reference Network" (https://www.globalgeochemicalbaselines.eu/content/174/iugs-manual-of-standard-methods-for-establishing-the-global-geochemical-reference-network-/). Hence, it is expected that there should be closer cooperation between ICGG and the IUGS Commission on Global Geochemical Baselines.

Position for the renewal of the ICGG	Rejection*
Signature	Alecos Demetriades
Contact, phone/email	alecos.demetriades@gmail.com
Date	17 September 2022

* My vote was and still is that UNESCO should NOT RENEW the agreement with China for the following reasons (a) the ICGG management had the chance after the 2018 October meeting to correct all the wrong doings of the past two-and-half years, and to abide by the clauses of the approved ICGG Statutes; (b) the ICGG continued to work as a Chinese and not as an International UNESCO centre; (c) the ICGG did not inform the international Councillors that UNESCO approved an extension until the 12th May 2023; (d) the ICGG did not try to correct the wrong doings directly after the 10th of December 2021 meeting, and (e) the ICGG waited until August 2022 to send to all Councillors for comments the 2021 Annual Report. So, after six-and-a-half years of operation, the ICGG Management never used the expertise of the international Councillors. So, can we trust that the ICGG management will change its attitude after the renewal of the agreement with UNESCO for another six-year period. In my opinion, we will be very naïve to believe so.

It does not meet the condition set by (1) Darnley *et al*. (1995, p.87) with respect to the global project's requirement: a "*single permanent agency to accept formal responsibility for securing funds, managing and coordinating these activities according to scientific guidelines determined by an external advisory committee*", this condition is included in Article 7, Section 7.2: "*Foster the implementation of global geochemical baseline programmes by securing funds, managing and coordinating these activities according to the scientific guidelines, determined by an External Advisory Committee cooperating with the IUGS Commission on Global Geochemical Baselines*;" the "External Advisory Committee" was never activated.

Of course, I know that UNESCO will go ahead and renew the agreement for another six-year period as the issue is political, and does not care if the ICGG worked efficiently according to its own approved statutes. My recommendation is that in the new agreement there should be binding clauses for the ICGG to work as an International Centre, and to abide by Article 7 for the close collaboration with the IUGS Commission on Global Geochemical Baselines and to set up directly the External Advisory Committee in collaboration with the Commission. There should be biennial evaluations, and if it failed to pass two successive biennial evaluations the agreement to be forfeited directly.

Finally, I truly state that my wish was and still is for the ICGG to work efficiently and professionally according to internationally accepted procedures.

Name	**Gloria Prieto**
Occupation	Director of Mineral Resources
Affiliation	Columbian Geological Survey
Position in the ICGG	Councillor & Scientific Committee Member
Term of Office	
Representative Organization	Colombian Geological Survey
Country	Colombia

General comments on the 6-year ICGG management, operation and achievements

There are many aspects that must be considered for evaluating the ICCG.

First it is important to say that the Center is a very good opportunity to develop the geochemistry knowledge of the world.

As I mentioned in a previous e-mail, I cannot comment about specific details on the reference of some projects as other participants can do it, because I do not have the details of these projects. Alecos, Patrice and Dave as leaders of the Global Geochemical Baseline group in previous years, were involved in those projects and have sufficient information for giving better opinions.

However, it is pertinent to mention some general topics that are easy to apply to improve the performance of the activities of the UNESCO Center.

1. I agree that in any report it is essential to be faithful to the source of information, strictly referring to the methodologies, data, maps, authors, and scope of the projects.

2. I agree with Belinda about "lack of cooperation and information on scientific strategies".

3. I think that it is very important and fundamental to maintain the meetings established in the Governing Board and in the Scientific Committee of the UNESCO center in Langfang, even virtual meetings that are very useful.

4. It is also essential to include all the members belonging to the committees in the decisions and maintain permanent information among the members.

5. Additionally, the Center's reports must be shared prior to delivery with the members of the center's governing and committees to obtain their input and approval.

There are aspects to corrected and improved related to management, operation and achievements of the Center, such as:

1. Taking decisions with all the members of the scientific and government boards, taking in account all the opinions

2. Carry out regular meetings (in person or virtual) to maintain information and take on decisions

3. Carry out Periodic revisions of the methodologies and of training course to update procedures and projects

Major recommendations for the ICGG

My recommendation is to improve management and operation issues of the Center. The ICGG is necessary because there are few Centers dedicated to geochemistry topics, and this

discipline is very important for knowing each territory to plan development of each country and to contribute with information to big problems of the humanity: energy, industry, alimentary security, infrastructure, and so on.

The Center also bring opportunity to many geoscientists and general young people to learn about geochemistry and to incentive projects in geochemistry and its applications.

Thank you for your attention,

Position for the renewal of the ICGG	Abstention
Signature	Gloria Prieto R
Contact, phone/email	gprieto@sgc.gov.co; g.prietor@outlook.com
Date	27/9/2022

Annex 2.2. Electronic messages with the UNESCO-ICGG Secretariat Director

INTRODUCTION

After a very long silence from the UNESCO-ICGG, the following message was received from the Secretariat Director, Dr. Zhang Bimin (see below 1. UNESCO-ICGG message). As is customary, the UNESCO-ICGG remembers the existence of the Governing Board and Scientific Committee just before a meeting or in this case the UNESCO periodic evaluation, which is crucial for the renewal of the agreement.

Below are given the first message sent by the UNESCO-ICGG Secretariat Director Dr. Zhang Bimin, and the replies by the Governing Board Councillors and Scientific Committee members, which are of interest with respect to this evaluation.

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1. UNESCO-ICGG Secretariat Director's message, 13 August 2022

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Fra: office@unesco-icgg.org <office@unesco-icgg.org>
Sendt: lørdag 13. august 2022 11:53
Til: Patrice.deCaritat <patrice.decaritat@ga.gov.au>; alecos.demetriades <alecos.demetriades@gmail.com>; gprieto <gprieto@sgc.gov.co>; dbsmith13 <dbsmith13@gmail.com>; Belinda Flem <Belinda.Flem@NGU.NO>; theo.clavellpr3 <theo.clavellpr3@gmail.com>; djun <djun@cugb.edu.cn>; dongshuwencags <dongshuwencags@hotmail.com>; huruizhong <huruizhong@vip.gyig.ac.cn>; nsj <nsj@cdut.edu.cn>; qiuming.cheng <qiuming.cheng@iugs.org>; roland.oberhaensli <roland.oberhaensli@geo.uni-potsdam.de>; wufengchang <wufengchang@vip.skleg.cn>; Simubali <namwig@gmail.com>; yx.wang <yx.wang@cug.edu.cn>; imgre <imgre@imgre.ru>

Emne: Annual Report and Biennial Evaluation Report of ICGG

Dear Governing Board Councilors and Scientific Committee Members,

Sincerely hope that you are all in good health, as well as your families.

The main purpose of the letter firstly is to send the 2021 Annual Report on ICGG Activities for your review, secondly is to briefly report on the work of ICGG in the first half of 2022 and the work plan.

For China's strict policy to prevent the spread of Covid-19, ICGG is still not allowed to go abroad to carry out geochemical mapping cooperation. In the first half of the year, the following work has been done:

- the sample analysis, data processing and map generation of global geochemical baselines samples in Turkey, Colombia, and Peru.
- compilation of the Atlas of Global Geochemical Baselines for Turkey.
- compilation of the 2021 Annual Report.
- the upgrade of "Chemical Earth" big data platform, including data sharing modules and methods.
- renewal of agreements with Colombia and Peru.
- establishment of cooperation on global geochemical baselines mapping with Cuba and Argentina, and drafted the agreements.

- negotiating data sharing matters with some countries which have finished the global geochemical baselines mapping.

In the second half of the year, ICGG will focus on the following work：

- accepting the 6-year periodic evaluation from UNESCO.
- carrying out global geochemical baselines cooperation with countries such as Colombia and Peru based on the signed cooperation agreements, and providing training to Cuba and Argentina.
- organizing the 2022 ICGG Training on Geochemical Mapping.
- further negotiating with countries that have completed Global Geochemical Baselines work to share more geochemical data and maps on the “Chemical Earth”platform.
- applying for GEO or IGCP projects to get more developing countries involved in the ”Chemical Earth” Big Science Programme.

ICGG expects valuable comments and suggestions from you on our work. We will also continue to enhance communication and exchange with you to promote our work.

Best wishes,

Zhang Bimin Ph.D
Secretariat Director of UNESCO International Center on Global-Scale Geochemistry
Director of Geochemical Exploration Division
Institute of Geophysical and Geochemical Exploration, CAGS, CGS
84 Jinguang Rd., Langfang, Hebei 065000,P. R. China
Mobile:+86 13831600950
Tel: +86 (316) 2267 721
Fax: +86 (316) 2212 744
Email: zhangbimin@unesco-icgg.org, zbimin@mail.cgs.gov.cn

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2. Alecos Demetriades’ reply on 2021 Annual Report, 17 August 2022

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From: Alecos Demetriades
Date: 2022-08-17 20:41
To: office@unesco-icgg.org
CC: Wu Zhenham; Belinda.Flem; David Smith; Davies Theophilus Clavell; Gloria Prieto; Gloria Namwi Simubali; Igor Spiridonov; Patrice de Caritat; Qiuming Cheng; Deng Jun; Dong Shuwen; Hu Ruizhong; Jiang Shaoyong; Liu Congqiang; Ni Shijun; Roland Oberhansli; Xueqiu Wang; Wang Yanxin; Wu Fengchang
Subject: Re: Annual Report and Biennial Evaluation Report of ICGG

Dear Bimin,

Today I devoted some of my time to studying the 2021 Annual Report. I am indeed happy that finally, the ICGG Management is asking all Governing Board Councillors and Scientific Committee members for comments on an annual report. The English saying "better late than never" is very appropriate because after 6 years of the Centre's operation this is the first time that we are asked to be somehow involved.

With respect to the presentation, the report is attractive and congratulations are in order for the people that worked for its production. However, as I am more interested in science and not in how

attractive a report is, I am afraid that the report does not meet the high standards that are expected from a UNESCO international centre.

Firstly, the English language of the report is poor. So, my advice is before sending such a professional report to the international Governing Board Councillors and Scientific Committee members, the language needs to be corrected and edited by a person with a good command of the English language.

Secondly, the report includes maps that are not correct. I have pointed this out in the attached pdf file, namely:

Map on page 1: The legend should be in English, and Never show a map without a caption.

Fig. 1 on page 2. The map is wrong because it includes countries that have not followed the specifications of the "Blue Book"
- https://www.globalgeochemicalbaselines.eu/datafiles/file/Blue_Book_GGD_IGCP259.pdf (i.e., collecting samples according to the random sampling scheme within the 160x160 km Global Terrestrial Network grid cells
- https://www.globalgeochemicalbaselines.eu/content/111/sampling-design-/). These countries are the United States of America, Mexico and Australia. So, these countries must not be shown on a map claiming to be showing the progress of the "Global Geochemical Baselines project" with respect to "floodplain sediment" (if, of course, this is the sampling medium used). Also, what is missing is the sample medium. *Does the map show the sample sites of floodplain sediment samples collected from large third-order catchment basins according to the Blue-book classification?* I recommend that a table is compiled to show the countries, number of GTN grid cells covered in each country, sample type, and number of samples collected.

The second map on page 2 has no number. As I have pointed out many times this map is completely wrong because it combines geochemical data derived from different sample types, which are prepared and analysed by different methods. A UNESCO scientific centre must be extra careful about what is producing and presenting not only for the scientific community but also for the public.

The map on page 3 shows the distribution of Cr in Turkey. The Figure caption should include the sample type, grain-size and analytical method. Regarding map presentation, this is something that we have discussed extensively during the FOREGS Geochemical Mapping of Europe project for the presentation of the geochemical maps. Colour-surface maps are, of course, attractive but as an interpolation method is used to interpolate element concentration values in unsampled space, they do not show the true spatial distribution. Hence, we have decided that the true element concentration must be shown at each sampling site by variable-size dots, which are superimposed on the colour-surface map. So, the non-expert (politicians, laypersons) will look at the colours, and the professional applied geochemist will look at the dots. I have included the map of aqua regia chromium distribution in floodplain sediments.

Pages 10 to 12 show the list of people that have attended the workshops. Since, the first workshop/seminar I was involved in way back in 2012, i.e., the CCOP Geochemical Mapping Seminar held in Nanjing, I found out to my surprise that most of the people attending the seminar were not applied geochemists. Worse of all was the fact that in this particular workshop most of the attendees did not understand English.

It appears that this is normal practice, because it was repeated in another two workshops I was a tutor, i.e., in 2013 (CGS-CCOP-ASEAN-IUGS workshop) in Nanning, and also during the operation of the Centre in 2017 (Belt and Road countries) in Langfang.

Out of the 51 participants in the workshops (pages 10-12), there were 5 geochemists and 2 chemists. My comment this is a waste of Chinese taxpayers' money, as you have paid all the expenses for 44 people that are not applied geochemists. My recommendation is that this waste of Chinese taxpayers' money should stop. Only Applied Geochemists and Chemists should be attending the seminars/workshops.

Recommendation: The English language of the 2021 Annual Report should be corrected, Figure 1 corrected and Pb distribution map deleted, and the report to be sent to all of us for a second review.

In case, something is not clear, please get in touch with me.

Warmest wishes,
Alecos

P.S. Dear Bimin, it will be good if you can find the missing E-mail addresses of the following Governing Board Councillors:
Dr. Peng Qiming
Dr. Du Yue
Dr. Jiang Jianjun
Dr. Li Jinfa
Prof. Wang Xiaolie
Dr. Wu Zhenhan

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3. David Smith's reply on 2021 Annual Report, 20 August 2022

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From: David Smith
Date: 2022-08-20 05:12
To: office@unesco-icgg.org
CC: Patrice.deCaritat; alecos.demetriades; gprieto; Belinda.Flem; theo.clavellpr3; djun; dongshu wencags; huruizhong; nsj; qiuming.cheng; roland.oberhaensli; wufengchang; Simubali; yx.wang; i mgre; wangxueqiu

Subject: Re: Annual Report and Biennial Evaluation Report of ICGG

Dear Bimin,

I hope all is well in Langfang and that everyone is staying safe and healthy. Thank you for sending the 2021 Annual Report for the UNESCO International Center on Global-Scale Geochemistry. I found it to be informative and well organized. I have identified a few issues for your consideration as discussed below:

1. Regarding the map on page 1, I agree with Alecos' comments that a map should never be shown without a caption. This is obviously the same map as shown in Fig. 1. I would suggest replacing this map with a photo of a field crew conducting sampling.

2. I suggest a revision to Fig. 1. The current title implies that all the sampling shown on the map was conducted under an overarching effort called the Global Geochemical Baselines Project. In reality, most of the sampling was conducted as national-scale geochemical surveys (conducted at a scale that can be classified as "global") by individual countries with no real affiliation with the Global Baselines project. As Alecos pointed out in his email, none of these samples, with the exception of the FOREGS project in Europe, were collected according to Blue Book specifications (i.e., multiple sample media, *etc.*). I suggest showing two maps here as follows:

Fig. 1a. Map showing sampling locations for global-scale geochemical mapping studies unrelated to the UNESCO International Centre on Global-Scale Geochemistry. *(this map would show the studies conducted prior to 2016 (Australia, Europe, Mexico, US, China, others?) The map should have different colored dots to indicate the different sample media collected in each study. Europe's dot would be defined as multiple sample media. The dates of sampling should also be indicated (e.g., in the US, the dates would be 2007-2010.)*

Fig. 1b. Map showing (1) global-scale floodplain sampling sites collected, as of 31 December 2021, under collaborative agreements between the UNESCO Centre and the individual country (blue dots) and (2) global-scale floodplain sampling sites planned for collection under collaborative agreements between the UNESCO Centre and the individual country during 2022-2023 (red dots). (This map would show where the UNESCO Centre has collaborated with other countries to collect floodplain sediments with those sites already sampled being shown in red and those sites planned for collection under already established agreements during 2023-2024 (or perhaps a longer time period as defined by the agreements) shown in blue.)

I think having these two maps will more clearly distinguish between sampling sites where samples were collected according to protocols established for a national study and those sites where the samples were collected according to the protocols established for the global-scale sampling under the supervision of the UNESCO Centre. I also think this revision may take care of Alecos' concerns,

1. In section 1.1, the following statement is made: "*Up to now, the Global Geochemical Baselines Network,involving more than 40 countries, has covered a total of 36 million square kilometers, taking up 32.7% of the global land area.*" I am assuming that these 36 million km^2 include Australia, US, Mexico, Europe, *etc.* It should be pointed out that, while geochemical surveys were conducted at a "global scale" in all these countries shown in Fig. 1, the samples shown on the map were not collected by standardized protocols and the samples were not analyzed by standardized protocols. So, in reality, there is not as much of the global land area covered by the "Global Geochemical Baselines Network" as this statement and Fig. 1 would make it appear. Revising Fig. 1 as suggested above and revising the sentence shown above should clarify this issue.

2. Regarding the "Global geochemical map of Pb", note Alecos' comments, which are exactly correct. This map mixes sample types, collection protocols, and analytical methods. If you choose to show this map for Pb or for another element, this must be explained fully. These same comments also apply to the map with the caption "Global Geochemical Baselines Atlas" on page

3. The map of Cr in Turkey should provide information about the sample type, analytical method, sample density (is this map based on global-scale sampling or national-scale sampling?).

4. In Section 1.3, it is stated that a high-resolution geochemical survey will be conducted on the Arabian Shield, but no mention is made of global-scale sampling there. Will this be conducted in conjunction with the high-resolution survey?

5. On the Financial Statement, the units used for "Source of ICGG Fund" seem to be different than the units used for "Use of ICGG Fund." I think maybe the units for the Source table are actually thousands of yuan. Please check; the units should be consistent.

Best regards,
Dave
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4. Patrice de Caritat's reply on the 2021 Annual Report, 23 August 2022

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Patrice de Caritat 23 Aug 2022, 03:26 (12 days ago)

to office@unesco-icgg.org, dbsmith13, me, gprieto, Belinda.Flem, theo.clavellpr3, djun, dongshuwencags, huruizhong, nsj, qiuming.cheng, roland.oberhaensli, wufengchang, Simubali, yx.wang, imgre, wangxueqiu, swdong, shyjiang, wuzhenhan, liucongqiang

Dear Bimin

Thank you for sending through the ICGG Annual Report. Apologies for the slight delay in replying; I was out of the office for a few days. I hope you and family and colleagues are all well.

Having had a peruse of the report, I concur with earlier feedback, mainly that it is very nicely presented but is flawed in its substance. There are issues with mixing sampling media and analytical methods that preclude combining the data in seamless maps. There are issues about integrating pre-ICGG datasets, such as the USA and Australia making them appear as achievements by the Centre, when they predate and are independent from ICGG work. Such material must be clearly identified as such and references to the original atlas given (for Australia http://dx.doi.org/10.11636/Record.2011.020). Captions/Legends in mandarin only are not acceptable for an international document.

Finally, I am surprised (and disappointed) to read about some activities of the Centre, such as international exchanges and collaborations. Yes we heard about them at the meeting in December 2021, but, as a sitting member of the Scientific Committee and Governing Board, I expect to have been at least *informed* of such activities before they took place. Ideally, such important decisions should be *taken* collegially. In my view the ICGG has really missed an opportunity by running a 'closed' show rather than opening up for true international cooperation.

I look forward to hearing back from you and send you my regards

Patrice de Caritat, PhD | Minerals, Energy and Groundwater Division | GEOSCIENCE AUSTRALIA
p +61 (0)2 6249 9378 **m** +61 (0)418 219 478 **w** www.ga.gov.au https://orcid.org/0000-0002-4185-9124

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5. Belinda Flem's reply on the 2021 Annual Report, 25 August 2022

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From: Belinda Flem
Date: 2022-08-25 14:28
To: office@unesco-icgg.org
CC: dbsmith13; alecos.demetriades; gprieto; Belinda Flem; theo.clavellpr3; djun; dongshuwencags; huruizhong; nsj; qiuming.cheng; roland.oberhaensli; wufengchang; Simubali; yx.wang; imgre; wangxueqiu; swdong; shyjiang; wuzhenhan; liucongqiang

Subject: SV: Annual Report and Biennial Evaluation Report of ICGG

Dear Bimin,

I hope all is well in Langfang and that everyone is staying safe and healthy. Thank you for sending the 2021 Annual Report for the UNESCO International Center on Global-Scale Geochemistry. I apologise for my late respond, but I have needed time to go through it thoroughly and in depth. In

the meantime, I see that Dave, Patrice and Alecos have reacted to the report and sent their comments. These comments also cover my concerns and requests for corrections. My main concern is the lack of cooperation and information on scientific strategies. This was also discussed in the December meeting, and it was stated that also the UNESCO International Center on Global-Scale Geochemistry wanted and intended to improve the cooperation. However, I have not seen any outlined strategy for this yet.

I look forward to hearing back from you and send you my regards

Best wishes

Belinda

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6. Gloria Prieto's reply on the 2021 Annual Report, 31 August 2022

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From: Gloria Prieto Rincón
Date: 2022-08-31 05:20
To: office
CC: Patrice.deCaritat; alecos.demetriades; dbsmith13; Belinda.Flem; theo.clavellpr3; djun; dongshuwencags; huruizhong; nsj; qiuming.cheng; roland.oberhaensli; wufengchang; Simubali; yx.wang; imgre
Subject: Re: Annual Report and Biennial Evaluation Report of ICGG

Dear Bimin

Thank you for the report.

At this time I delayed my comments because just now we have changes in governmental authorities in Colombia, and we have many activities on this topic. I am sorry for my late reply.

I have reviewed the report and I feel that I cannot comment about specific details on the reference of some projects as other participants can do it, because I do not have the details of these projects. Alecos, Patrice and Dave as leaders of the Global Geochemical Baseline group in previous years, were involved in those projects and have sufficient information for giving better opinions.

However, it is pertinent to mention some general topics that are easy to apply to improve the performance of the activities of the UNESCO center.

I agree that in any report it is essential to be faithful to the source of information, strictly referring to the methodologies, data, maps, authors, and scope of the projects.

I agree with Belinda about "lack of cooperation and information on scientific strategies".

I think that it is very important and fundamental to maintain the meetings established in the Governing Board and in the Scientific Committee of the UNESCO center in Langfang, even virtual meetings that are very useful.

It is also essential to include all the members belonging to the committees in the decisions and maintain permanent information among the members.

Additionally, the Center's reports must be shared prior to delivery with the members of the center's governing and committees to obtain their input and approval.

Thank you for your attention,

Warm regards

The best wishes

Gloria Prieto R.
Dirección de Recursos Minerales
Servicio Geológico Colombiano

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7. Forwarding of Davies Theophilus reply on the 2021 Annual Report, 4 September 2022

==========

Alecos Demetriades <alecos.demetriades@gmail.com> 2022-09-04
to office, Patrice.deCaritat, djun, dongshuwencags, huruizhong, nsj, qiuming.cheng, roland.oberhaensli, wufengchang, yx.wang, imgre, wangxueqiu, swdong, shyjiang, wuzhenhan, liucongqiang, zhangbimin, dbsmith13, me, Belinda.Flem, theo.clavellpr3, Simubali, Gloria

Dear Bimin,

The following message by Davies Theophilus should have been sent to you and all the Councillors. Theo makes a good recommendation that should be considered.
==========

---------- Forwarded message ---------
From: **Davies Theophilus** <theo.clavellpr3@gmail.com>
Date: Fri, 26 Aug 2022 at 09:45
Subject: Re: Annual Report and Biennial Evaluation Report of ICGG [SEC=OFFICIAL]
To: Alecos Demetriades <alecos.demetriades@gmail.com>
Cc: Patrice de Caritat <Patrice.deCaritat@ga.gov.au>, dbsmith13 <dbsmith13@gmail.com>, gprieto <gprieto@sgc.gov.co>, Belinda.Flem <belinda.flem@ngu.no>, Simubali <namwig@gmail.com>, <daviestheophilus2025@yahoo.com>

Dear All,

Please receive warm greetings from Durban. Hope all of you and families are keeping well and safe.

Please accept my apology for the rather tardy response.

I did go through the "Annual Report" with a critical eye, and have to concur with the comments of Aleccos, Dave, Patrice and Belinda

Thankfully, Birmin, in his response to the critiques, agreed that " ... *The Centre will seriously consider the issues mentioned in your letter. After careful study and discussion, we will give the response and revise the annual report.*" [sic.].

My suggestion is that in future reports, a draft should first be circulated to each and every councillor, and their inputs implemented before even considering final preparation for submission, approval and publication.

Please accept my very best wishes.

With warm regards,

Theo

T.C. Davies, PhD, CGeol, FGS, FAAG
Research Professor (Medical Geology)
Mangosuthu University of Technology
511 Mangosuthu Highway
KwaZulu Natal Province
Republic of South Africa
theo.clavellpr3@gmail.com; daviestheophilus2025@yahoo.com
Tel.: +27 78 491 63 62
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APPENDIX 3. REGIONAL REPORTS

A3.1. AFRICA

Report by Theophilus C. Davies (Mangosuthu University f Technology, Mangosuthu Highway, KwaZuluNatal Province, 4031 South Africa; theo.clavellpr3@gmail.com)

During 2022, several applied geochemistry studies were undertaken in Africa, involving data collected at various scales (sampling, data analyses and interpretation); but very few of these studies bore direct relevance to the Africa Geochemical Database (AGD) programme. African governments and their geological surveys; as well as university management have never been ardent in formulating specific policies for advancing the AGD programme. Examples of studies published in 2022 that were pertinent to the AGD effort include the following:

I. Main publications

(i) Demetriades, A., Johnson, C.C., Smith, D.B., Ladenberger, A., Adánez Sanjuan, P., Argyraki, A., Stouraiti, C., Caritat, P. de, Knights, K.V., Prieto Rincón, G. & Simubali, G.N. (Editors), 2022. International Union of Geological Sciences Manual of Standard Methods for Establishing the Global Geochemical Reference Network. IUGS Commission on Global Geochemical Baselines, Athens, Hellenic Republic, Special Publication, 2, xliv, 515 pages, 375 figures, 35 Tables, 5 Annexes and 1 Appendix, ISBN: 978-618-85049-1-2; https://doi.org/10.5281/zenodo.7307696 (accessed 21.12.2022). Further information about this Manual is available in the Publications/Publications IUGS Manual of Standard Methods for Establishing the Global Geochemical Reference Network web page.

(ii) Balaram, V. and Satyanarayanan, M., 2022. Data Quality in geochemical elemental and isotopic analysis. Minerals 2022, 12, 999. https://doi.org/10.3390/min12080999 (accessed 21.12.2022).

II. Conferences

A few major conferences having geochemical mapping sub-themes pertinent to the AGD programme were held in Africa during 2022. The proceedings of two of these conferences could largely be described as '*Application of geochemical data to environmental health problems and their mitigation*':

1. The 2nd International Students Conference on Medical Geology and Environmental Health (ISCMGEH)-Africa Edition https://segh.net/iscmgeh-africa-1 (accessed 21.12.2022) was held from 29 November to 1 December 2022. The Book of Abstracts https://segh.net/iscmgeh-africa-1 (accessed 21.12.2022) summarises several contributions on geochemical sampling, analyses and data interpretation that can be applied in the study of environmental disease distribution, monitoring and prevention.
2. The 37th International Conference on Geochemistry and Health [https://uoeld.ac.ke/37th-international-conference-geochemistry-and-health (accessed 21.12.2022)] held from 10 to 14 October, 2022 at the University of Eldoret, Kenya was organised by the Society for Environmental Geochemistry (SEGH), University of Eldoret (UoE) and British Geological Survey (BGS). This Conference represented an international virtual platform for students (undergraduates and postgraduates) from Africa and elsewhere to showcase their research findings in Environmental Geochemistry and Health and Medical Geology. A wide range of the presentations, summarised in the 'Book of Abstracts' [Request from Scientific Committee at: https://fns.uniba.sk/fileadmin/prif/envi/kge/LifeWater/PDF/abstract_Rapant_et_al_37SEGH_Kenya_2022.pdf (accessed 22.12.2022)] involved several papers on sample collection, analyses and data interpretation techniques pertinent to the AGD programme; and how

these can be applied to studying the distribution, monitoring and prevention of various environmental diseases in Africa.

III. Geochemical exploration: Newmont tests Deep Sensing Geochemistry in Namibia

In October 2022, Osino Resources announced that Newmont Corporation has completed a geochemical orientation programme to test their proprietary Deep Sensing Geochemistry (DSG) technique over known covered mineralisation at Osino's Twin Hills gold project [(https://www.miningreview.com/gold/newmont-tests-deep-sensing-geochemistry-in-namibia/ (accessed 21.12.2022)].

"Newmont has completed a series of DSG soil sampling traverses across the Twin Hills deposit to collect surface sand and sheet wash covering the calcrete. Newmont's in-house laboratory is currently processing and analysing these samples to measure ultra-low concentrations of gold and associated metals, with a view to determining its effectiveness in the Namibian covered terranes. Results are expected in Q1, 2023." [Sic.]

A3.1.1. PanAfGeo-2 project in Africa

Report by Maria João Batista (LNEG)

Maria João Batista is in charge of coordination of Work Package-B (WPB)– Mineral Resources Assessment of PanAfGeo-2. Training was already conducted in Lubango-Angola including among other subjects exploration geochemistry methods and experience of the different Portuguese Speaking countries, including Nigeria and Namibia (Co-leaders countries of WPB-Mineral Resources). The taught techniques were based in the guidelines of *International Union of Geological Sciences Manual of Standard Methods for the Establishment of the Global Geochemical Reference Network*. Mineral resources reconnaissance in the field together with reporting and presentation of results were also included in the training programme. Emphasis was given to the Kunene Anorthosite Complex and ornamental stones exploitation. In 2023, training will occur in Morocco, Mozambique, Angola and probably Zambia.

A3.1.2. Angola PLANAGEO Project

Report by Maria João Batista (LNEG)

During the first half of 2022, Maria João Batista (LNEG) was responsible for the finalisation of the Metallic Mineral Resources maps at 1:50.000 scale in the southern part of Angola as the final task of PLANAGEO project, conducted by the UTE Consortium, which includes IGME Spain (Ivan Martín) and LNEG Portugal-IMPULSO. This task started in the second trimester of 2021 in the southern part of Angola. In this region of Angola 39 maps at the scale of 1:50.00 were sampled for rocks, soils and sediments for mineral resources recognition. Three clusters of geochemical anomalies were defined based on the mineral resource's potential of the regions, namely: (i) Au-Fe in the Cassinga region; (ii) REE elements in alkaline complexes and carbonatitic rocks of Catanda, Tchivita-Bonga and Serra da Neve regions, and (iii) base and rare metals in pegmatitic rocks and magmatic Arc of Namibe rocks and Chibia-Hamutenha, Cacimbas, Lola e Quilengues ultramafic rocks. Analysis of rocks, soils and sediments were conducted at ALS – South Africa and the portable XRF determinations were compared with the results of the ALS laboratory. These results were presented on 1:50.000 scale maps. Single and multi-elemental maps were also plotted, based on multivariate statistics. Geochemistry, geophysics and geology were combined for plotting predictive potential mineral resources area maps.

A3.2. AMERICA, NORTH

A3.2.1. Mexico

In 2022, baseline and geochemical anomaly studies were performed using the geochemical database of element concentrations in soil of the Mexican landscape.

The field protocols of the Proyecto geoquímica de suelos y paisajes de Norteamérica (North American Soil Geochemical Landscapes Project) were designed for sampling 4 soil horizons: 0-5, A, B and C, spaced in a grid of 10x10 km, quality control of the field and analytical information, processing and interpretation of the geochemical data. The objective of the project was to identify geochemical anomalies for prospecting and exploration of lithium minerals, radioactive elements, critical minerals and rare earth element concentrations in Northern Mexico. The results are under processing. It is expected that the geochemical results will supplement the geological evaluation of sites and localities at which it is inferred that there are some background data on the occurrence of some sort of mineral deposits related to lithium, radioactive, critical minerals and rare earth elements.

A3.3. AMERICA, SOUTH

A3.3.1. ASGMI Geochemistry Group

Report by Maria João Batista (LNEG)

During 2022 the Geochemistry Group of ASGMI finalised the provisional version of *The Geochemical Handbook for the Geological Surveys of Ibero-America*, which was presented in Medellin, Colombia in September of 2022 (https://asgmi.org/pt/grupo-de-expertos-en-geoquimica/).

A3.3.2. Brazil

2022 Report – Division of Geochemistry (João Henrique Larizzatti)

In 2022, prospective regional geochemical surveys were carried out by Manaus (AM), Goiânia (MT) and Salvador (BA) teams at Rondônia-Juruena Belt (Mato Grosso), Gavião Block and Jacobina region (São Francisco Craton, BA). In addition, one special exploration project was developed searching for graphite (Igatu region, CE). Geochemical mapping covered an area of approximately 45,000 km^2 (Figure A3.1).

In the Tectonic and Metalogenetic Evolution of the Gavião Block Project, the geochemical survey was conducted on the eight map sheets of the Jacobina region. In this survey, 1200 stream sediment samples and panned concentrates samples were collected.

At Roosevelt Belt (MT), geochemical mapping was carried out within Geology and Mineral Potential Rondônia-Juruena Project. One hundred and fifty one sites were visited and in total 453 stream sediment, pan concentrate and water samples were collected. From the areas of Peixoto Azevedo and Paranaíta, in total 234 stream sediment and panned concentrate samples were collected.

At Ceará state (CE), Igatu sheet, 137 sites were visited and in total 234 stream sediment and pan concentrate samples were collected.

During this year, due to Covid-19 pandemic, most of the data treatment and interpretation work were performed in the office by the Geochemistry Division researchers. The team supports projects all around the country.

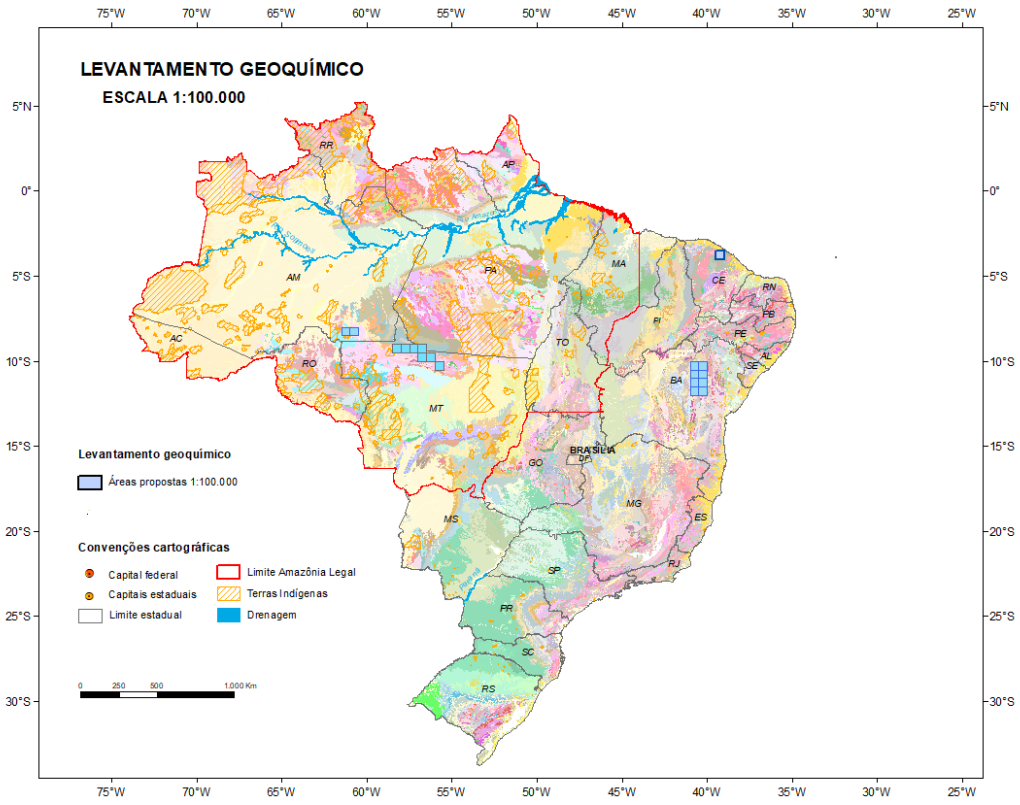


Figure A3.1. Geochemical mapping in Brazil during 2022.

A3.3.3. Chile

Report by Juan Pablo Lacassie Reyes (Chief Geologist – Geochemistry Unit, Geological and Mining Survey of Chile (SERNAGEOMIN); juan.lacassie@sernageomin.cl)

A3.3.3.1. General Information

The Geochemical Map of Chile is a Government programme, which has been carried out since 2011 by the Geochemistry Unit of SERNAGEOMIN. The objective is to promote the sustainable growth of Chile by the definition of geochemical baselines and the identification of mineral resources.

A3.3.3.2. Geochemistry Unit

Currently, the Geochemistry Unit has 4 geologists with different specialties and responsibilities (Fig. A3.2). It has a publication rate of 2 products per year, with every project having a 3.5-year cycle. The current projects include 1:250,000 scale geochemical atlases, maps and databases, along with technical reports associated with geochemical studies of fluvial basins.

In respect to the 1:250,000 scale projects, the goal is to cover northern Chile by 2029. For this reason, it has been considered in reinforcing the geochemical sampling through external tenders (Fig. A3.3). This type of external support was successfully tested in 2021, during the sampling of the Aguas Blancas Sheet. For this, a key factor was the use of an application designed to perform geochemical sampling using smartphones (Fig. A3.4). Among other advances, this application allowed: (i) to have a standardised list to collect the field data, including uploading representative photographs; (ii) remotely control the daily progress of sampling, including the location of the sampling points, and (iii) populate the database in real time.

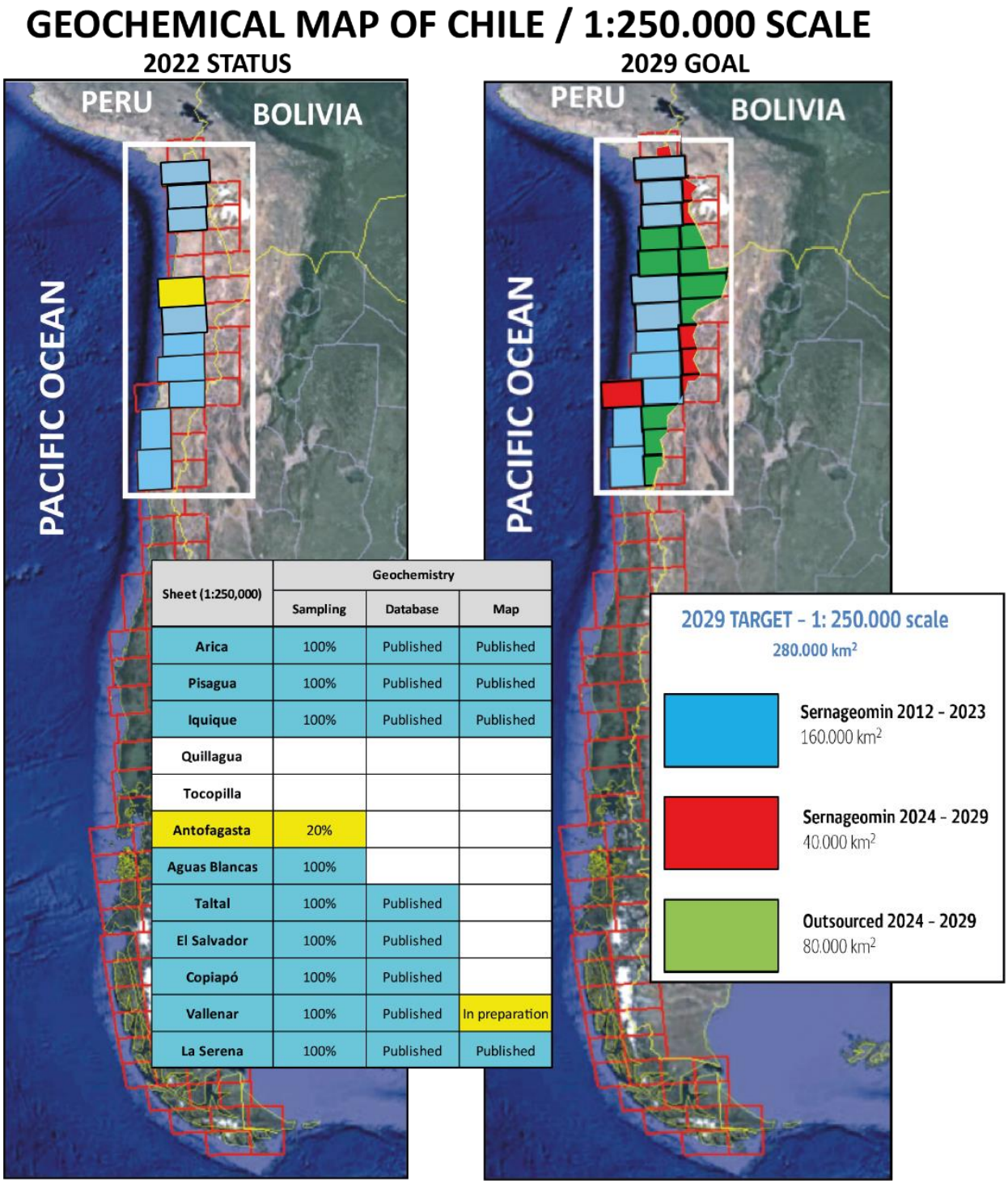
Along the same line of progress, another technical achievement is the implementation of a new geochemical map format (Fig. A3.5). This new format corresponds to a web map application,

visible from any internet browser, including smartphones, by scanning a QR-code (Fig. A3.5) or using the following hyperlink: https://arcg.is/1y0qDb0.

Other advantages of this format are that it allows: (i) *in situ* visualisation of the geochemical information; (ii) the interactive combination of different layers of information, and (iii) the permanent updating of the map, including new functions for the interactive analysis of geochemical information.

Up to date, 10 river basins have been studied, including those associated with the Lluta and Azapa rivers (Fig. A3.6, zone 1); Salado, Copiapó and Huasco (zone 2); Elquí and Limarí (zone 3); Rapel (zone 4), Aysén (zone 5) and Valdivia (zone 6; *in publication*). The study of the Mataquito river basin (zone 7) is in progress, while the sampling of Tierra del Fuego (zone 8) and the Bueno River basin (zone 9) will begin in 2024.

Figure A3.2. Professionals of the SERNAGEOMIN Geochemistry Unit during fieldwork in the Atacama Desert (March 2021). From left to right: Rafael Mardones, Felipe Astudillo and Pablo Oliva. Photograph by J.P. Lacassie.



Sheet (1:250,000)	Geochemistry		
	Sampling	Database	Map
Arica	100%	Published	Published
Pisagua	100%	Published	Published
Iquique	100%	Published	Published
Quillagua			
Tocopilla			
Antofagasta	20%		
Aguas Blancas	100%		
Taltal	100%	Published	
El Salvador	100%	Published	
Copiapó	100%	Published	
Vallenar	100%	Published	In preparation
La Serena	100%	Published	Published

Figure A3.3. Geochemical Map index of Chile, 1:250.000 scale: Progress status for the year 2022 and goals until 2029. The limits of the 1:250,000 scale map sheets (red boxes) are for reference only. The work areas correspond only to those included in the Chilean territory.

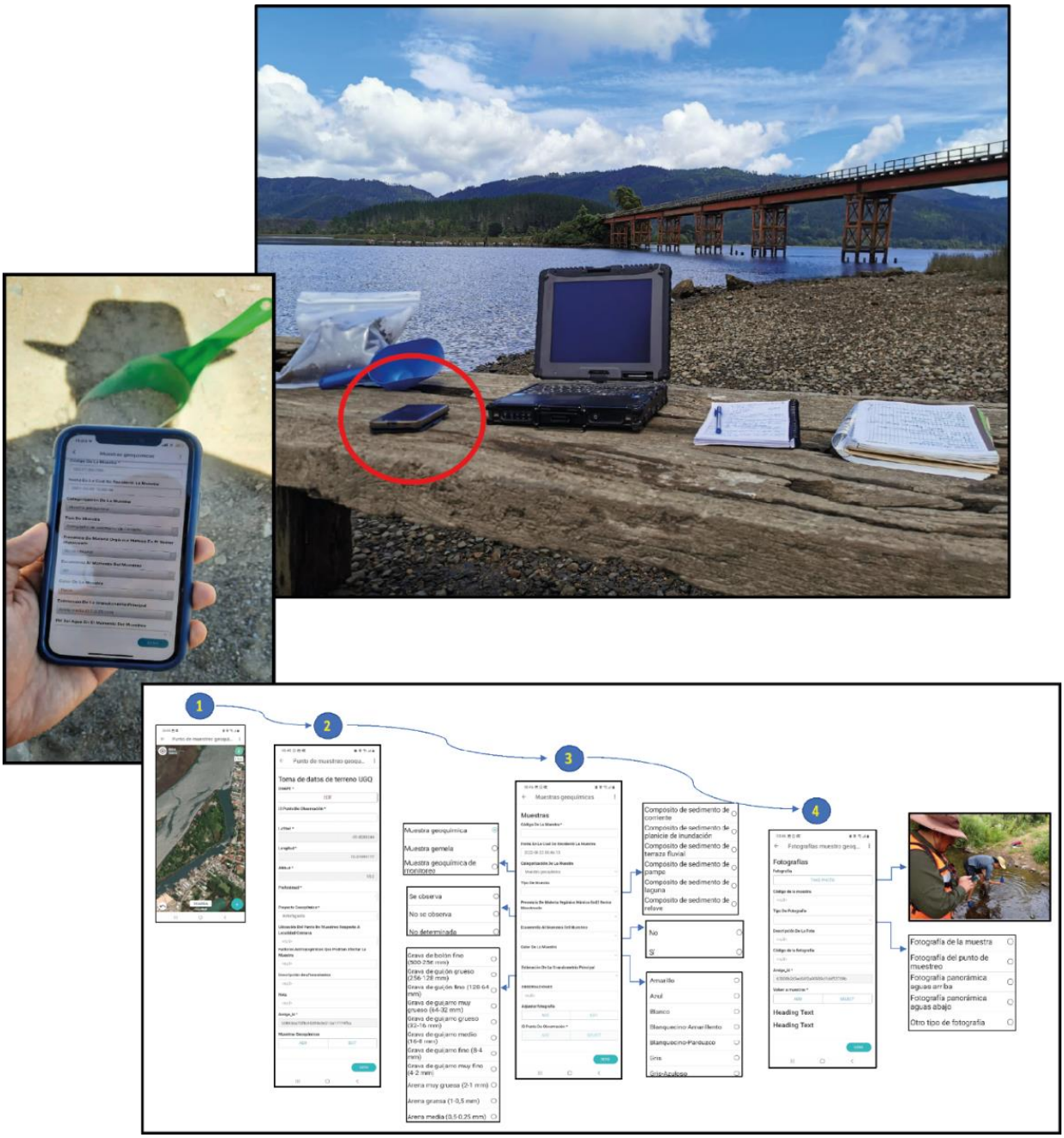


Figure A3.4. As a result of a constant innovation process, the Geochemistry Unit of SERNAGEOMIN has implemented the capture of geological terrain data through mobile phones (smartphones). This technological leap corresponds to an evolution from the classic paper notebook, through the robust field notebook and leading to the versatility of the smartphone. The application allows having a standardised form for the capture of terrain information. Field photographs by Pablo Oliva, Braulio Águila and J.P. Lacassie.

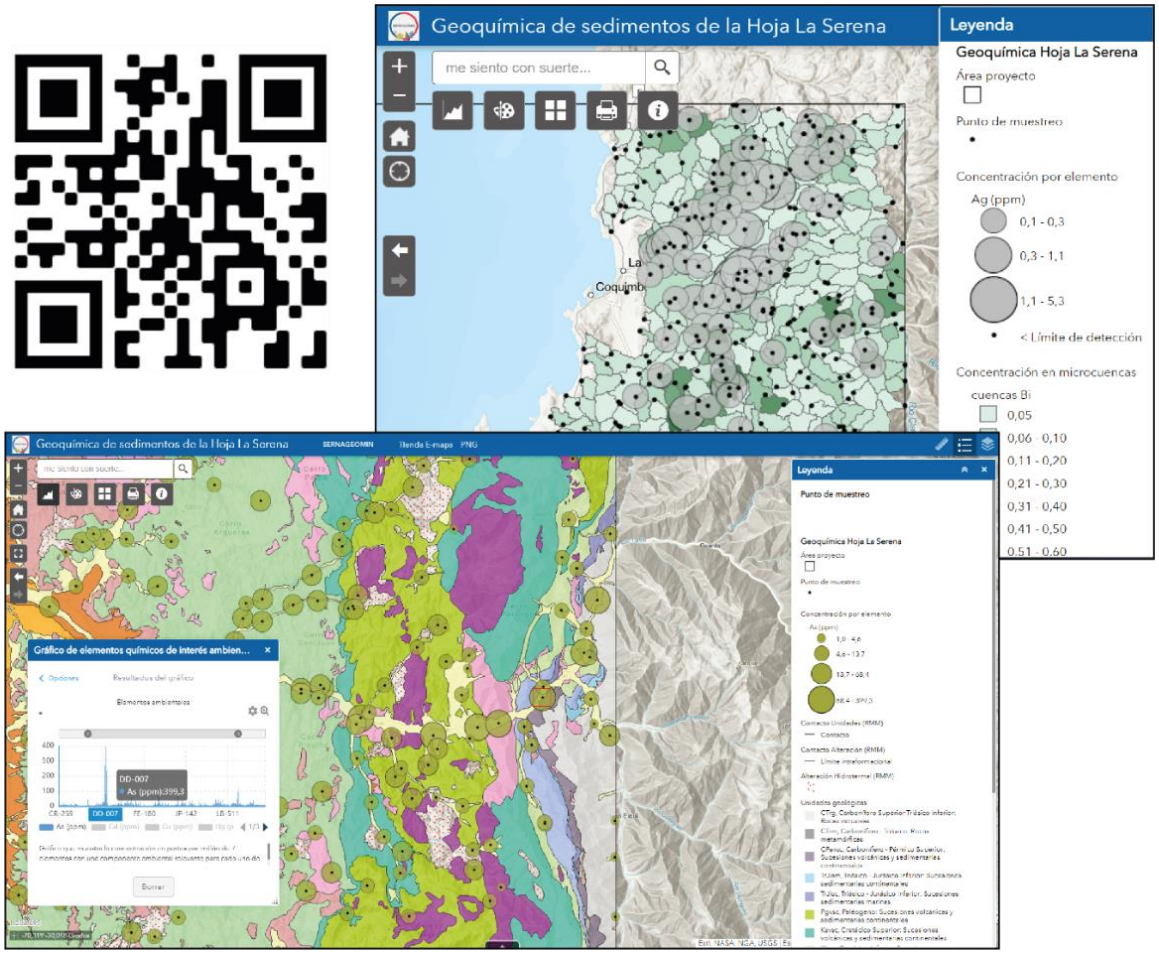


Figure A3.5. Different ways of visualising the geochemical map sheet of La Serena at a scale of 1:250,000 in web map format. Top right: combination of sampling points (black dots), Ag concentrations (grey circles) and Bi concentrations in sub-basins (green coloured scale). Bottom: Arsenic (As) concentrations superimposed on the geological map. The interactive viewer allows the user to automatically locate the position of the point with the highest As concentration (sample point DD-007 with 399.3 ppm As). The map can be accessed directly, from a smartphone, by scanning the QR code in the top left corner of the figure.

The associated technical reports include cases of environmental concern (Fig. A3.6), such as the following:

1. *Limarí River basin:* In the NE portion of this basin, the sediments of the Hurtado River have Cu-As-Cd-Zn concentrations that are higher than their respective environmental PEC threshold values (MacDonald *et al.*, 2000; coloured circles in Fig. A3.6). This is a natural feature associated with the source areas with hydrothermal alteration or mineralisation and related natural acid drainage (red coloured sediments).
2. *Rapel River basin:* In this basin, the sediments of the Cachapoal River are characterised with extremely high Cu-Mo concentrations associated with the mining activities of the El Teniente Cu-Mo mine (Lacassie and Ruiz-Del-Solar, 2021). In particular, the Cu values are higher than those reported in the sediments of the Fly River, after decades of contamination with mining derived materials from the Ok Tedi Cu-Au mine (pink area in Cu diagram of Figure A3.6; Baker and Harris, 1991).
3. *Aysén River basin:* In the NE portion of this basin, the sediments of the Toqui River present Cu-As-Cd-Zn-Pb-Hg concentrations are higher than their respective environmental threshold values (PEC values; MacDonald *et al.*, 2000). This is associated with mining derived materials from the Confluencia mine tailing of the El Toqui Au mine.

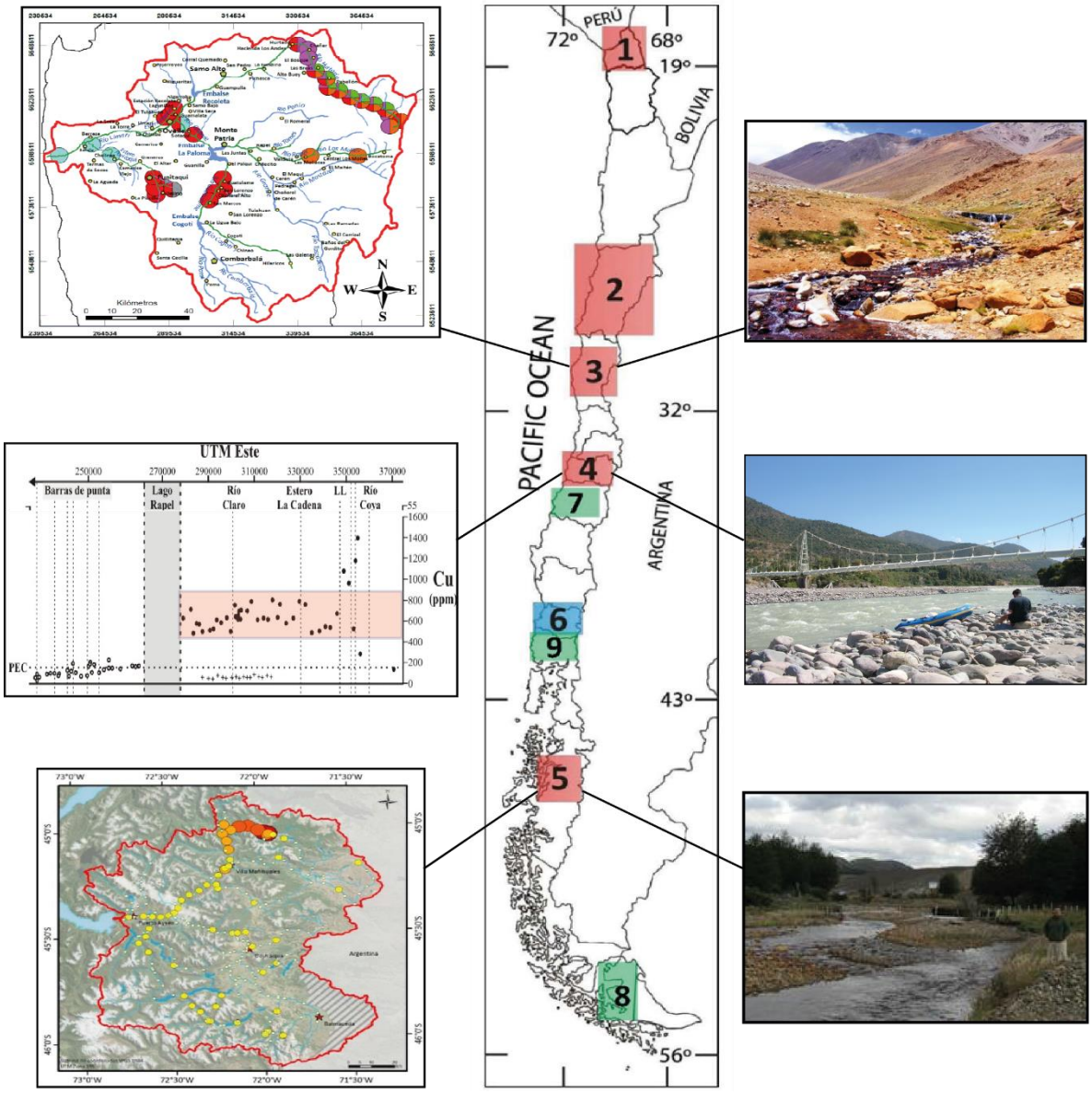


Figure A3.6. Geographical location of (a) the studied river basins (pink), (b) currently under study (blue) and (c) those that will be studied (green) in the near future. 1: Lluta and Azapa-Vitor River basins; 2: Copiapó, Salado and Huasco River basins; 3: Elqui and Limarí River basin; 4: Rapel River basin; 5: Aysén River basin; 6: Valdivia River basin; 7: Mataquito River basin; 8: Tierra del Fuego basin; 9: Bueno River basin. The geochemical data revealed different cases of environmental concern, including: 1) the Limarí River basin, with concentrations of Cu-As-Cd-Zn that are higher than their respective environmental PEC threshold values (coloured circles; MacDonald et al., 2000). This signature is particularly strong in the upper reaches of the Hurtado River, in coincidence with an alteration-mineralisation area, with evidence of acid drainage of natural origin; 2) the Cachapoal River of the Rapel River basin, with extremely high Cu-Mo concentrations associated with the mining activities of the El Teniente Cu-Mo mine (Lacassie and Ruiz-Del-Solar, 2021), and 3) the Toqui River in the Aysén River basin with Cu-As-Cd-Zn-Pb-Hg concentrations that are higher than their respective PEC threshold values, associated with inputs of mine derived material from the Confluencia tailing.

Finally, during the last 2 years, great emphasis has been placed on the publication of the products of SERNAGEOMIN, including those of the Geochemistry Unit. After a joint work with specialists in animation, 2 videos have been generated, which show in a simple way the scope and uses of geochemical maps (Fig. A3.7). These videos can be viewed at the following links:

- https://www.youtube.com/watch?v=P1ypIN3R0rI
- https://www.youtube.com/watch?v=ZB6941qlV30

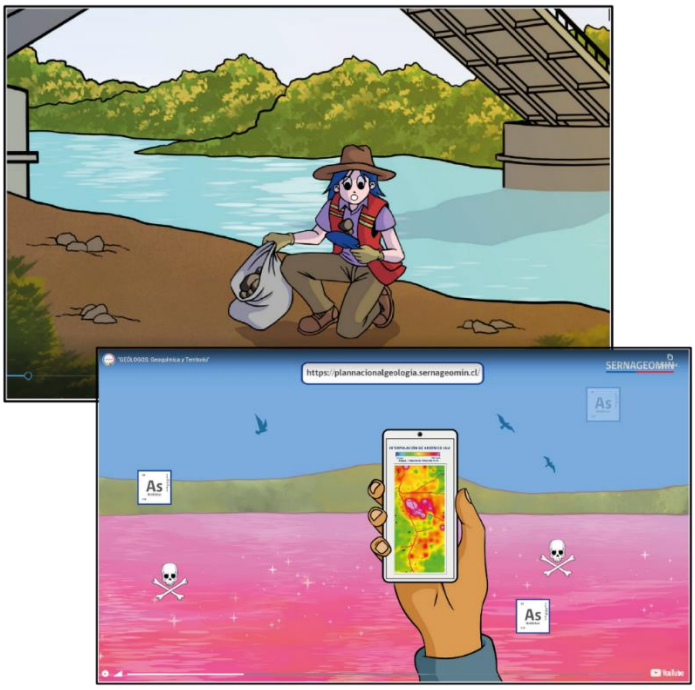


Figure A3.7. Screenshots of the 2 videos that explain to the public the scope and uses of the geochemical maps generated by SERNAGEOMIN. Above: Agatha, the avatar of the Geochemistry Unit, commenting on how the sampling and preparation of the samples is carried out. Below: Mamiña, a local tour guide, explaining what the geochemical composition is and how it is important for life.

A3.3.3.3. References

Baker, E. & Harris, P., 1991. Copper, lead, and zinc distribution in the sediments of the Fly River Delta and Torres Strait. Marine Pollution Bulletin, 22(12), 614−618; https://doi.org/10.1016/0025-326X(91)90250-V

Lacassie, J.P. & Ruiz-Del-Solar, J., 2021. Integrated mineralogical and geochemical study of the Rapel fluvial system, central Chile: An application of multidimensional analysis to river sedimentation. Journal of South American Earth Sciences, 109: 103289; https://doi.org/10.1016/j.jsames.2021.103289.

MacDonald, D.D., Ingersoll, C.G. & Berger, T.A., 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Archives of Environmental. Contamination and Toxicology, 39, 20−21; https://doi.org/10.1007/s002440010075.

A3.3.4. Colombia

Report of the Advances of the Geochemistry Programme in Colombia – 2022 by *Gloria Prieto* - prigloria@gmail.com; g.prietor@outlook.com

During 2022, the multipurpose geochemical mapping programmes in the Colombian territory were led by the Colombian Geological Survey (SGC in Spanish). Progress was made in ultra-low-density sampling, collecting samples of floodplain and overbank, following the standards of the mapping programme of the Global Geochemical Baselines project that the Colombian Geological Survey (SGC) began in 2016. Samples of stream sediments, soils and waters were collected following medium density sampling protocols for the Geochemical Atlas of Colombia. Rocks, sediments, soils, and waters samples, according to high-density sampling methodologies, were collected for mineral prospecting and exploration programmes and for other applications such as mineral fingerprinting, metallogenic studies, and environmental geochemistry as well as geomedicine research.

During 2022, sample analyses were carried out, data and information were verified, data were processed and interpreted, maps were produced, research documents were prepared, and geochemical information was disseminated in congresses, fora, and virtual seminars, as well as in specialised scientific publications.

A3.3.4.1. Geochemical Mapping of Ultra Low Density in Colombia - Geochemical Baselines Project

The ultra-low-density sampling (low density) that started in 2016 covered 90% the country, leaving those areas where access was impossible. Within the framework of the cooperation agreement between the Colombian Geological Survey (SGC) and the China Geological Survey, the collected samples were sent to the laboratories of the Institute of Geophysical and Geochemical Exploration (IGGE) in China. Analytical data were received, results were validated, and QA/QC parameters were verified both from the sampling and from the chemical analyses performed (Figs. A3.8 to A3.10).

(a)

(b)

Figure A.3.8. Low-density Geochemical Mapping Project in Colombia. Sampling of floodplain sediment vertical sections in (a) Pavasa River, department of Chocó (N5° 22' 43.56", W77° 22' 9.54"; N1086546, E 967658), and (b) Valle River, department of Chocó (N6° 6' 48.9", W 77° 23' 23.94"; N1167809, E965411). Photographs from the SGC archive.

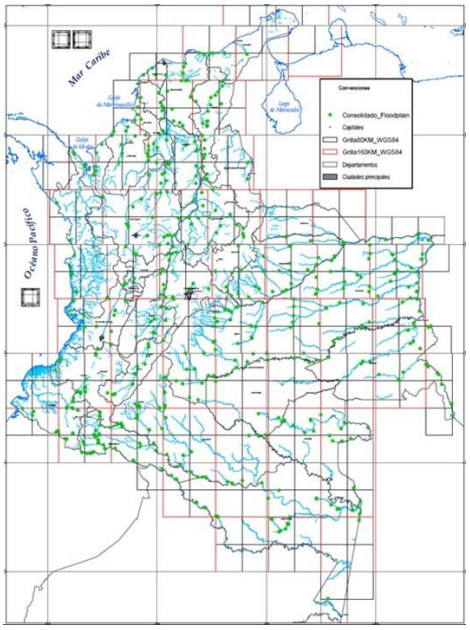


Figure A3.9. Floodplain sampling, Low Density Geochemical Mapping Project in Colombia. Map from the SGC archive.

A3.3.4.2. Multipurpose Geochemical Mapping of Medium Density - Geochemical Atlas of Colombia 2022 version

In the medium-density geochemical cartography and mapping programme of the SGC, progress was made in the sampling of 5,200 km^2 by collecting stream sediments, waters, and soils in the departments of Cundinamarca, Tolima, and Santander (Fig. A3.10). The 2022 version of the Geochemical Atlas of Colombia (AGC) was completed, which includes data from new samples of stream sediments for 58 chemical elements.

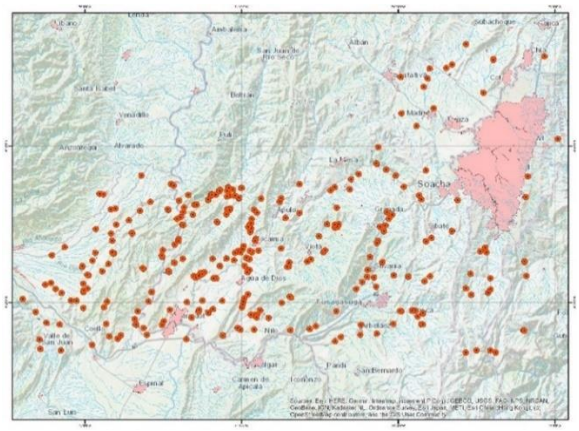


Figure A3.10. Medium density geochemical sampling in 5,200 km^2 in 2022. Collection of samples of stream sediments, waters and soils in Cundinamarca and Tolima Departments, Colombia.

A3.3.4.3. High-Density Multipurpose Geochemical Mapping

- Identification of geochemical anomalies for application in evaluation of mineral potential in Colombia:-

During 2022, samples of sediments (stream sediments and dry bed sediments), rocks, pan concentrates, soils, and waters were collected from 8 metallogenic districts, with a density of one sample every 1 to 3 km^2 in basins of first and second order. Information was verified, geochemical analyses were performed, data were processed and interpreted, and geochemical anomalies were identified for prospecting and mineral exploration for energy transition, food security, and infrastructure for society in the Colombian territory (Fig. A3.11).

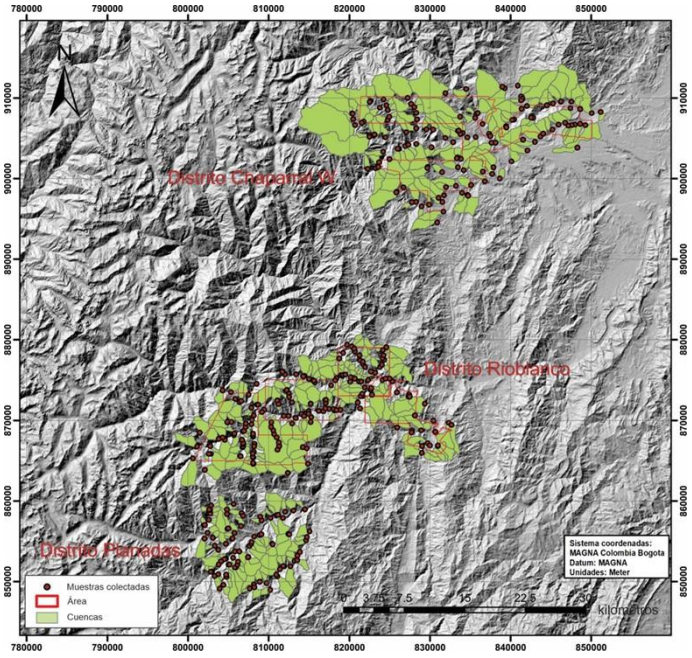
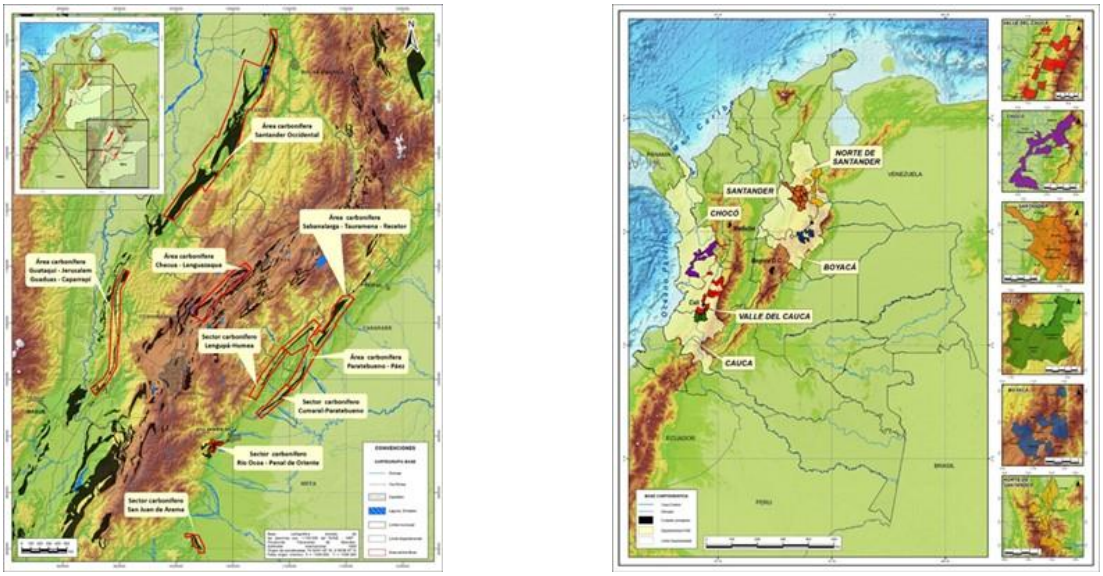


Figure A3.11. Collection of samples of current active sediment in the department of Tolima. SGC archive map.

- Research in Environmental Geochemistry and Geomedicine:-

In the SGC's medical and environmental geochemistry programme, sampling, verification and validation of data and information continued. Processing and interpretation were carried out and maps were produced on specific topics: mercury (Hg) baseline in Colombian coals (Fig. A3.12a), cadmium (Cd) in agricultural soils, selenium in livestock soils (Se) and arsenic (As) in waters (surface and groundwater) in areas with volcanic influence. In addition, areas were selected for geochemical research on mining environmental liabilities (PAM in Spanish) (Fig. A3.12b).



(a) (b)

Figure A3.12. (a) Coal areas under investigation for Hg Geochemical Baseline in Coal, Colombia; (b) Areas for geochemical characterisation of mining environmental liabilities (PAM in Spanish) in Colombia. Figures from SGC archive.

- Research in Fingerprint of Minerals (Mineral Geochemistry):-

In the multipurpose geochemistry programme applied to the identification of the "fingerprinting of minerals" with an emphasis on gold, progress was made in information processing and identification of the fingerprint of minerals in deposits of 2 new gold districts in Colombia until completing the 10 potential (Fig. A3.13).

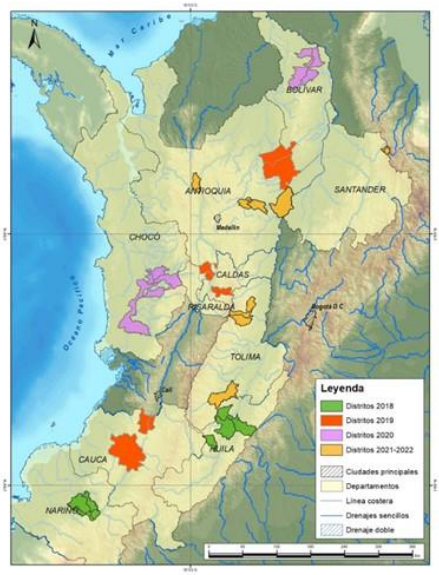


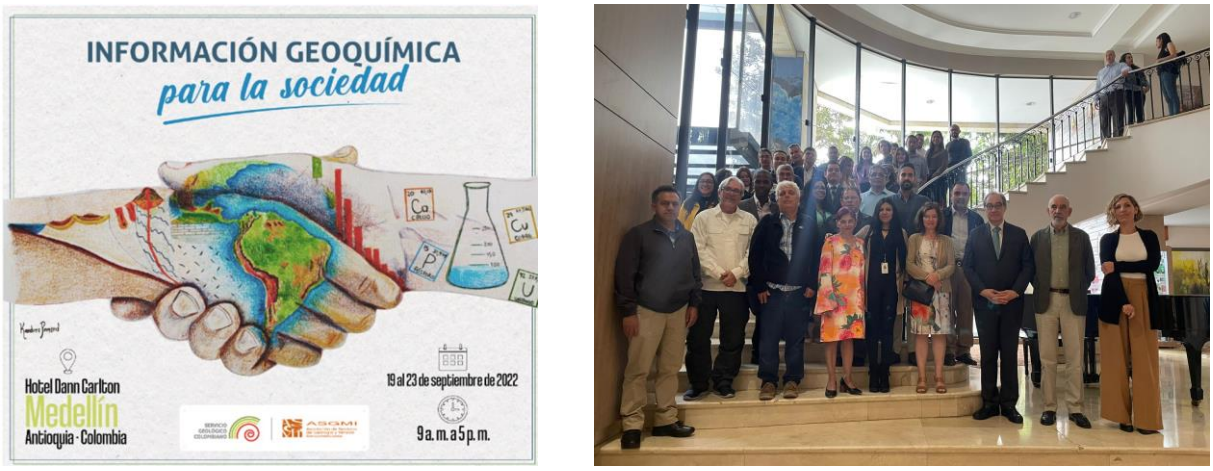
Figure A3.13. Investigated gold districts for Fingerprinting of Gold in Colombia. Image, SGC archive.

A3.3.4.4. Social Appropriation of Geochemical Knowledge

Advancing in the social appropriation of geochemical knowledge, the products of the investigations and geochemical cartography of Colombia were disseminated in face-to-face, virtual and hybrid events.

In execution of activities of the Group of Experts in Geochemistry (GEGEOQ) of the Ibero-American Association of Geology and Mining Services (ASGMI), Colombia participated in the preparation of *the Geochemical Handbook for the Geological Surveys of Ibero-America*: *Geochemical Information for the Society*, 2022.

As part of the dissemination of geochemical methodologies and projects of the member countries of ASGMI, between the 19th and 23rd of September 2022, the SGC carried out a Geochemical Information Workshop for Society (Fig. A3.14) in Medellín, Colombia. The Workshop was attended by colleagues interested in geochemical information from different continents and with the participation of the Ibero-American Geological Surveys (Argentina, Brazil, Chile, Colombia, Cuba, Ecuador, Spain, Catalonia, Guatemala, Honduras, Mexico, Peru, Portugal, Uruguay, Salvador, Dominican Republic), and experts from the geochemistry groups from Canada (Dr. Duane Petts), EuroGeoSurveys (EGS) and the International Union of Geosciences (IUGS) (Dr. Anna Ladenberger) and UNESCO Earth Science Division (Dr. Özlem Adiyaman).



(a) (b)

Figure A3.14. (a) Image of the Geochemical Information for Society event, held by ASGMI, from the 19th to the 23rd of November, 2022, Medellín, Colombia (image designed by geologist Karina Portilla for ASGMI); (b) Participants in the Geochemical Information for Society Workshop (hybrid).

A3.4. ASIA

A3.4.1. China

Report by Xueqiu Wang

In 2022, the UNESCO International Centre on Global-scale Geochemistry continued to implement the International Big Science Program of “Chemical Earth” on Global Geochemical Baselines and China Geochemical Observation. China had shared data with 16 countries and compiled the global geochemical baseline atlas of Turkey. In addition, in 2022, the ICGG organised three international geochemical mapping workshops.

A3.4.1.1. Updating and sharing geochemical data

The ‘Chemical Earth’ big data platform provides basic services of equal access to global scale geochemical data and knowledge sharing, builds a bridge between the scientific community, decision makers and the general public. ICGG has further promoted the ‘Chemical Earth’ big data platform (Fig. A3.15), which obtained two software copyrights in 2022, with the following improvements made: higher speed and better user experience; structural adjustment of the WEB system of the ‘Chemical Earth’; completion of the parallel structure of two-dimension and three-dimension, and the shift from one to the other; adjustment of the PC interface design and improvement of statistical module.

Figure A3.15. The ‘Chemical Earth’ big data platform.

The geochemical data of 40 elements from the China Geochemical Baseline project can be downloaded from the ICGG website. The website also provides links to other important data sharing websites, such as links to the US Geological Survey, the Australian Geoscience and the European FOREGS project, *etc.*

Up to now, the ICGG has bilaterally shared the data with Laos, Mongolia, Turkey, Russia, Colombia, Peru, Ethiopia, Cambodia, Papua New Guinea, Indonesia, Uzbekistan, Pakistan, Kyrgyzstan, Tajikistan, Mexico and Madagascar (Table A3.1). The ICGG will gradually publish the project data and maps. According to the geochemical mapping, cooperation agreements signed between the ICGG and the cooperation countries, the global-scale geochemical data and maps will be shared bilaterally during the project implementation, and released to the public after the required time stipulated in the agreement for intellectual property rights sharing and protection.

Table A3.1. Data sharing between the ICGG and the cooperation countries.

No.	*Country*	*Data Amount (units)*	*No.*	*Country*	*Data Amount (units)*
1	Colombia	51,680	8	Ethiopia	146,694
2	Peru	21,280	9	Cambodia	129,859
3	Turkey	11,502	10	Papua New Guinea	104,605
4	Laos	146,503	11	Uzbekistan	74,834
5	Mongolia	661,340	12	Indonesia	214,866
6	Pakistan	295,113	13	Tajikistan	91,287
7	Kyrgyzstan	123,165	14	Madagascar	396,405

A3.4.1.2. International Cooperation on Global Geochemical Baselines Project

Since 2016, the ICGG has provided technical and financial support for 13 countries to carry out the global geochemical baselines, covering a total area of 9.28 million square kilometers (Table A3.2). In 2022, the ICGG has cooperated with Turkey to complete sampling of 1,010 catchment

sediment samples (505 sites), and analysis of 76 chemical elements covering 783,600 square kilometres. A global-scale geochemical baseline atlas covering the entire territory of Turkey has been produced for the first time (Fig. A3.16).

Table A3.2. Statistical table of cooperation on geochemical mapping.

No.	*Country*	*Coverage area*	*No.*	*Country*	*Coverage area*
1	Laos	0.22 million km^2	8	Indonesia	0.10 million km^2
2	Colombia	1.00 million km^2	9	Papua New Guinea	0.05 million km^2
3	Mongolia	0.90 million km^2	10	Eritrea	0.10 million km^2
4	Peru	0.90 million km^2	11	Russia	0.50 million km^2
5	Tanzania	0.95 million km^2	12	Mexico	1.96 million km^2
6	Turkey	0.78 million km^2	13	Iran	1.64 million km^2
7	Cambodia	0.18 million km^2			

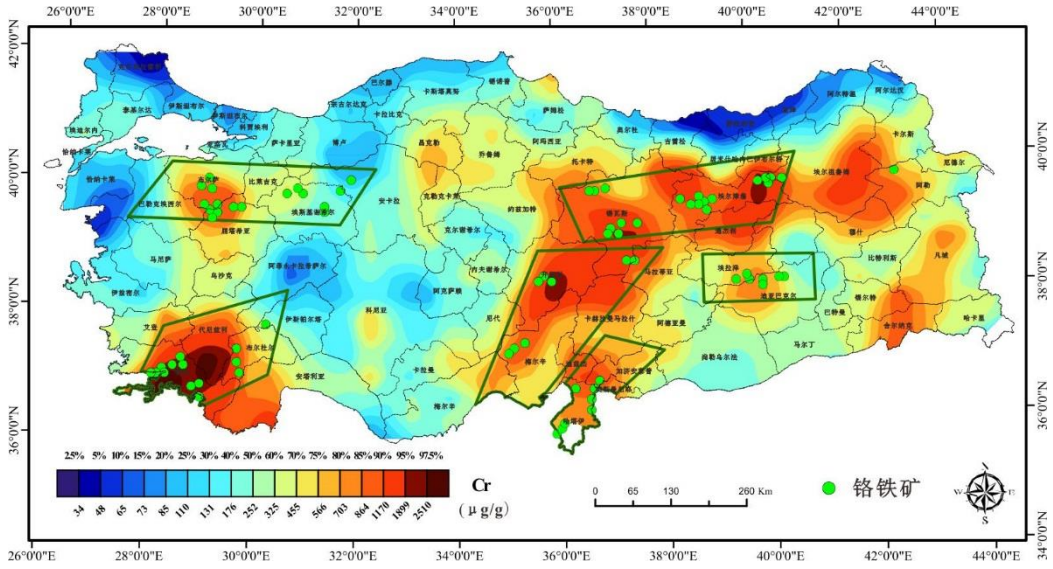


Figure A3.16. Geochemical map of chromium in Turkey.

A3.4.1.3. China Geochemical Observation Networks for Environmental Changes

In 2022, ICGG launched China Geochemical Observation Networks for 200 monitoring sites, covering mining districts, cities and cultivated land across the whole country. The results showed that soil heavy metals exceeding the risk limit decreased in mining districts, increased in metropolitan areas and showed slight changes in major crop producing land, compared with the data of the China Geochemical Baselines project (2008-2012). Soil contamination from mining activities was effectively controlled after 2010. The soil environment in major crop producing areas was clean, and contamination risks remained in some urbanised areas.

A3.4.1.4. Workshop on geochemical mapping

In 2022, the ICGG has hosted or co-organised three international workshops on geochemical mapping. The teachers and students had good communication and exchange on the technical issues of geochemical mapping. After the training, the training video was uploaded to the ICGG website for students to consolidate learning. Many students sent emails to express their gratitude for the training, believing that the training was well prepared and practical, and it was very useful for them to carry out their own country's geochemical investigation.

Since the establishment of ICGG in 2016, it has successfully held international training courses in and out of China for 830 participants from 48 countries, which has built a good learning and communication platform, promoted global sharing of geochemical knowledge and technology,

enhanced the international influence of China geochemical technologies, and served the UN 2030 Agenda for Sustainable Development.

A3.4.1.5. Published Papers

In 2022, a total of 15 papers related to global geochemistry of geochemical mapping were published:-

1. Concentrations and spatial distribution of chlorine in the pedosphere in China: Based on the China Geochemical Baselines Project, Journal of Geochemical Exploration.
2. National-Scale Geochemical Baseline of 69 Elements in Laos Stream Sediments, Minerals.
3. Extensional Setting of Hainan Island in Mesoproterozoic: Evidence from Granitic Intrusions in the Baoban Group, Acta Geologica Sinica (English Edition).
4. Geodetector based identification of influencing factors on spatial distribution patterns of heavy metals in soil: A case in the upper reaches of the Yangtze River, China, Applied Geochemistry.
5. Nation-wide concentration and spatial distribution of manganese with links to manganese mineralization in China, Journal of Geochemical Exploration.
6. Regional Geochemical Distribution and Controlling Factors of Lithium in the Sino-Mongolia Border Areas, Earth Science (in Chinese with English abstract).
7. Geochemical Background Values of 69 Elements in Surface Sediment of the Laos, Earth Science (in Chinese with English abstract).
8. Regional Geochemical Distribution of Uranium in Fine-Grained Soil and Prediction of Prospecting in Erlian Basin, Earth Science (in Chinese with English abstract).
9. Coastal change detection along the fire island, us under the impact of hurricane sandy, ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences.
10. Temporal and spatial distribution characteristics of lithium geochemistry and prospecting prediction in the key resource prospecting new area of Yunnan, Guizhou, and Guizhou in southwest China, Acta Geologica Sinica (in Chinese with English abstract).
11. Distribution of Copper in Stream Sediments and Rocks and Genesis of Copper Geochemical Provinces in the Middle and Lower Reaches of the Yangtze River and its Adjacent Areas,China, Geotectonica et Metallogenia (in Chinese with English abstract).
12. Assessment of Selenium Bioavailability in Natural Selenium-Rich Soil Based on Diffusive Gradients in Thin Films, Rock and Mineral Analysis (in Chinese with English abstract).
13. Representative of Different Soil Genesis in Hilly Area Multi-Purpose Regional Geochemical Survey: A Case Study of Shaoxing District, Zhejiang Province, Geological Bulletin of China (in Chinese with English abstract).
14. Geochemical Anomalies Spatial Distribution of deep samples Manganese in China and Implications for Potential Prospects, Geological Bulletin of China (in Chinese with English abstract).
15. Geochemical Characteristics of Selenium in Surface Soil of Central Townships in Zhaojue County, Sichuan Province, Rock and Mineral Analysis (in Chinese with English abstract).

A3.4.2. Japan

Report by Atsuyuki Ohta, Geological Survey of Japan, AIST, Tsukuba

Japan Geochemical Mapping project using soil substances

New geochemical map of Japan has been plotted by using 3,222 soil substances. Soil samples were collected from a depth of 0 to 20 cm (A layer) at each site. We consider that the existing geochemical map using a stream sediment corresponds to that using soil collected from the deep layer (C layer), which is more strongly influenced by bedrock. Fifty-three elements, including As, Cd, and Hg have been analysed using ICP-AES, ICP-MS, and AAS to reveal the abundance and

spatial distribution of elements in soils over the whole of Japan. Chemical composition of soil is considered to differ from those of stream sediments because it reflects the result of complex interactions among various factors such as the origin of soil, depositional environment, climate system, and diagenetic and weathering effects. Nevertheless, spatial distribution patterns of elements in soil resemble those in stream sediments, which are basically controlled by the underlying geology and mineralisation. *For example*, the high concentration area of K in soil is concentrated in the area underlined by granitic rock, rhyolitic-dacitic rock, mudstone and mélange with muddy matrices in accretionary complexes. The ultramafic rock outcrop is limited to a small area in Japan, but it elevates Cr and Ni concentrations both in soil and in stream sediment samples. Metalliferous deposits have a coherent relation to potentially hazardous element concentrations such as Cd, Pb and Hg in both soil and stream sediment samples. Comparing mean elemental concentrations of soil and stream sediment, soil samples are systematically depleted in Na, Mg, Al, K, Ca, Rb, Sr, and Ba due to their dissolution during chemical weathering process; highly concentrated in P, Cu, Cd, Sb, Hg, Pb, and Bi due to anthropogenic activities. However, we find differences between chemical composition of andosols and lowland soil in the Kanto region, which are caused by different chemical composition in their origin and different weathering process in both soil types. We are aiming to publish soil geochemical maps in 2023.

A3.2. AUSTRALASIA

A3.2.1. Australia

Report by Philip T. Main and Patrice de Caritat (Geoscience Australia; philip.main@ga.gov.au)

A review of the continental-scale National Geochemical Survey of Australia (NGSA) was published this year (Caritat, 2022). The paper not only reviews the technical aspects of the project, but also evaluates the impact of NGSA in terms of publications/citations (academic impact) and reports on an independent assessment of return on investment of two subsequent large projects the NGSA contributed to (economic impact). Such independent economic impact review has seldom been undertaken for continental surveys. The paper concludes that the NGSA was a low-cost, high-benefit project that delivered scientific excellence, promoted stakeholder engagement, demonstrated national leadership, and contributed to enhanced national resource wealth. The NGSA sample archive has also provided ongoing benefit through new projects such as the Heavy Mineral Map of Australia (https://ecat.ga.gov.au/geonetwork/srv/eng/catalog.search#/metadata/146747) making use of the archive material.

As part of the Geoscience Australia National Geochemical Framework project (https://www.eftf.ga.gov.au/australias-resources-framework) a large number of samples from across Australia, originally collected in the 1970s – 1990s, have been reanalysed for a fuller suite of elements using state-of-the-art methods and instrumentation. These samples are planned to be levelled with more recent surveys, such as the NGSA, to create an increased coverage of the surface geochemistry of Australia in a single, internally consistent data set.

A regional-scale data compilation focusing on the Curnamona province in South Australia and New South Wales has been released (Taylor *et al.*, 2022). This data set is a compilation of more than 600,000 curated legacy geochemical data from the Geological Survey of New South Wales, Geological Survey of South Australia, Geoscience Australia and the Commonwealth Scientific and Industrial Research Organisation (CSIRO). The complied data include various media (*i.e.*, rock, soil, stream sediment, and groundwater) and a range of digestion techniques. The data have been through a cleaning process and restructured into the same format to allow ease of use.

A3.2.1.1. Articles, papers, atlases and books

Caritat, P. de, 2022. The National Geochemical Survey of Australia: review and impact. Geochemistry: Exploration, Environment, Analysis, geochem2022-032; https://doi.org/10.1144/geochem2022-032

Taylor, H., Schroder, I.F., Main, P.T., Champion, D.C. & Evans, T., 2022. Curnamona Geochemistry Compilation. RECORD 2022/039. Geoscience Australia, Canberra. http://dx.doi.org/10.11636/Record.2022.039. Report by Patrice de Caritat (Geoscience Australia; Patrice.deCaritat@ga.gov.au)

A3.2.2. New Zealand

Report by Adam P. Martin (GNS Science; a.martin@gns.cri.nz)

A national geochemical soil baseline data set for New Zealand has been generated (see Fig. A.3-20) and this is in the process of being written up for publication. Additionally, an urban geochemical soil baseline survey (Fig. A3.17) was completed for New Zealand's most populous city, Auckland, and published in Applied Geochemistry (Martin *et al.*, 2022). The study shows duration of urbanisation is a driving factor in soil contamination, and where the period of urbanisation is similar, then factors such as housing age and housing quality become important.

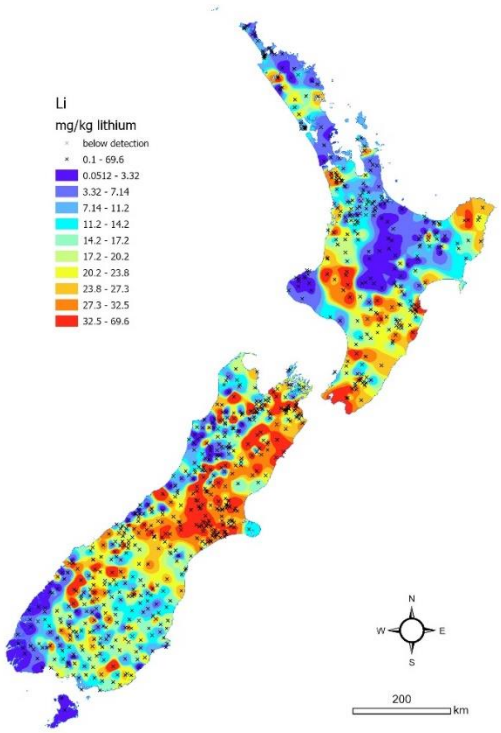


Figure A3.17. Map showing the interpolation of lithium (Li) in near-surface soil across New Zealand. This is an initial interpolation that will be updated as the project progresses and is one of 65 elements analysed for the project.

Samples that form part of the national geochemical baseline survey were subsampled and contributed to a national strontium isoscape map for New Zealand (Kramer *et al.*, 2022) being used for product provenance and archaeology. Additionally, regional studies were completed looking at carbon and nitrogen stable isotopes and metals in soils of New Zealand viticultural regions (Rogers *et al.*, 2022); landscape evolution studies (Raab *et al.*, 2022); the use of spectroscopy to determine metal concentrations in soil (Shrestha *et al.*, 2022); and a new hierarchical spatial factor model was developed to capture inter-depth dependency, handle below

detection limit data and exploit sparse approximations to Gaussian processes to deliver inference (Davies *et al.*, 2022).

A national New Zealand community science project has now been running for 2 years looking at soil metal concentration in domestic gardens (Fig. A3.18). It is called SoilSafe: Aotearoa (https://soilsafe.auckland.ac.nz/) and is a partnership between GNS Science, The University of Auckland and Macquarie University. Nearly 800 homes and more than 3500 samples have been analysed and this work is complementing the New Zealand geochemical baseline endeavours. Adjacent to this work are community science projects promoting education and outreach about soil for younger people (SoilSafe Kids: https://soilsafe.auckland.ac.nz/home/soilsafe-kids/); and a community science project looking at metals and other contaminants in dust inside people's homes (DustSafe: Aotearoa; https://www.dustsafe.auckland.ac.nz/; Isley *et al.*, 2022). A second MSc thesis has also been completed looking at the uptake of soil contaminants by edible plants important to New Zealand and the potential risk to human health (Strawbridge, 2022: https://researchspace.auckland.ac.nz/handle/2292/61372).

Figure A3.18. Collecting soil samples from 3 depths during the urban geochemical soil baseline survey, Auckland, New Zealand.

A3.2.2.1. Articles, papers, atlases and books

Davies, T.M., Banergee, S., Martin, A.P. & Turnbull, R.E., 2022. A nearest-neighbour Gaussian process spatial factor model for censored, multi-depth geochemical data. Journal of the Royal Statistical Society. Series C, Applied Statistics, 71(4), 1014−1043; https://doi.org/10.1111/rssc.12565.

Isley, C.F., Fry, K.L., Liu, X., Filippelli, G.M., Entwistle, J.A., Martin, A.P., Kah, M., Meza-Figueroa, D., Shukle, J.T., Jabeen, K., Famuyiwa, A.O., Wu, L., Sharifi-Soltani, N., Doyi, I.N.Y., Argyraki, A., Ho, K.F., Dong, C., Gunkel-Grillon, P., Aelion, C.M. & Taylor, M.P., 2022 International analysis of sources and human health risk associated with trace metal contaminants in residential indoor dust. Environmental science & technology, 56(2), 1053−1068; https://doi.org/10.1021/acs.est.1c04494.

Kramer, R.T., Kinaston, R.L., Holder, P.W., Armstrong, K.F., King, C.L., Sipple, W.D.K., Martin, A.P., Pradel, G., Turnbull, R.E., Rogers, K.M., Reid, M., Barr, D., Wijenayake, K.G., Buckley, H.R., Stirling, C.H. & Bataille, C.P., 2022 A bioavailable strontium (87Sr/86Sr) isoscape for Aotearoa New Zealand: implications for food forensics and biosecurity. PLoS one, 17(3): e0264458; https://doi.org/10.1371/journal.pone.0264458.

Martin, A.P., Lim, C., Kah, M., Rattenbury, M.S., Rogers, K.M., Sharp, E.L. & Turnbull, R.E., 2022. Soil pollution driven by duration of urbanisation and dwelling quality in urban areas : an example from Auckland, New Zealand. Applied Geochemistry, 148: article 105518; https://doi.org/10.1016/j.apgeochem.2022.105518.

Martin, A. P. Lim, C., Kah, M., Rattenbury, M.S., Rogers, K.M., Sharp, E. & Turnbull, R.E., 2022. Auckland soil geochemical baseline. Mendeley Data, 1, https://data.mendeley.com/datasets/gmhpnr7tjh.

Raab, G., Egli, M., Norton, K.P., Martin, A.P., Ketterer, M.E., Tikhomirov, D., Wanner, R. & Scarciglia, F., 2022. Soil weathering dynamics and erosion in a dry oceanic area of the southern hemisphere (Otago, New Zealand). Scientific Reports, 12: article 19803; https://doi.org/10.1038/s41598-022-23731-7.

Rogers, K.M., Martin, A.P., Pradel, G.J., Yuwei, Y., Zhang, Y. & Turnbull, R.E., 2022. Elemental and isotopic compositions of New Zealand regional soils identify human and climate-induced effects. Applied Geochemistry, 143: article 105356; https://doi.org/10.1016/j.apgeochem.2022.105356.

Shrestha, G., Calvelo-Pereira, P., Roudier, P., Martin, A.P., Turnbull, R.E., Kereszturi, G., Jeyakumar, P. & Anderson, C.W.N., 2022. Quantification of multiple soil trace elements by combining portable X-ray fluorescence and reflectance spectroscopy. Geoderma, 409: article 115649; https://doi.org/10.1016/j.geoderma.2021.115649.

A3.3. EUROPE

Annual Report 2021 was compiled by Philippe Négrel (Chair, BRGM), Anna Ladenberger (Deputy Chair, SGU), Jasper Griffioen (Deputy Chair, TNO).

A3.3.1. EuroGeoSurveys Geochemistry Expert Group (EGS-GEG) activities

The joint annual meeting from the 13th to 15th October 2022 was organised in Athens by the Geochemistry Expert Group of EuroGeoSurveys, the IUGS Commission on Global Geochemical Baselines (CGGB) and the Geochemistry Group of ASGMI (Ibero-American Association of Geological and Mining Surveys). The three-day physical meeting was hosted by the local IUGS-CGGB, the Hellenic Survey of Geology and Mineral Exploration and the Faculty of Geology and Geoenvironment of the University of Athens. A total of 33 participants from Europe, China and Iran attended in person.

The first day was focused on the activities carried out by the participating groups and future joint collaborations (publications, session proposals to congresses and meetings in 2023). Various anniversaries were celebrated with praising presentations, namely the 60thAnniversary of IUGS, the 25th Anniversary of the Commission under the auspices of IUGS, and the 25th Anniversary of the FOREGS Geochemical Atlas of Europe (http://weppi.gtk.fi/publ/foregsatlas/).

The second day was devoted to presentations of geochemical studies carried out by the geological surveys (Denmark, Finland, France, Hellenic Republic, Ireland, Norway, Italy, Poland, Portugal, Spain, Sweden, The Netherlands and United Kingdom) and associated partners from the universities in the Hellenic Republic, Ireland and Italy.

On the third day, an excursion to the Lavreotiki peninsula was organised, with a visit to the ancient lead, zinc and silver mines, 6th to 4th century BC ore beneficiation plants, the 19th to 20th century smelter, and the ore beneficiation and smelter wastes within the town of Lavrion.

GEG's deputy-chair Anna Ladenberger (and 1st Co-chair of the CGGB-IUGS) was one of the invited speakers at the IUGS Earth Science Festival, where geochemistry had a special webinar ''*A planetary health check on Global Geochemical Baselines. Assessing the geochemistry of life's most vital resources*'', which was held on the 10th of October 2022. The first part of the event comprised two invited talks given by Prof. Hassina Mouri about the impact of water quality on human health, and Prof. Mark Macklin giving an overview of the impacts of metal mining on river systems using floodplain sediments. In the second part, speakers from the GEG and IUGS Commission on Global Geochemical Baselines presented the concept of the Global Geochemical

Baseline studies and the recently published *Manual of Standard Methods for Establishing the Global Geochemical Reference Network,* as well as examples of applications.

During the second half of 2022 the GEG work continued on establishing collaboration with EUSO (EU Soil Observatory), which is a direct response to the recently released EU Soil Strategy. The Second EUSO Stakeholder Forum was held 24-26 October 2022 and GEG members took active part in this workshop. GEG members are also involved in consultation panel discussions regarding the new EU Soil Strategy.

With the involvement of the Slovak State Secretary, several Commission services, and almost 1000 registrations, the Second EUSO Stakeholder Forum showed the high level of interest in efforts by the EU and Member States to develop policies to protect soils while enhancing the ecosystem services that they provide. The EUSO is an excellent example of how the JRC is providing technical support and scientific knowledge to efforts that go towards meeting the objectives of the Green Deal. In the Stakeholders Forum, they had the opportunity to update the audience on various themes including: the latest developments in EU soil policy, the state of soil science, new and ongoing soil research projects as well as methods to assess soil health in the EU and beyond. Agenda, recordings and presentations are available HERE. Second EUSO Stakeholders Forum - ESDAC - European Commission (europa.eu)

Several GEG members are active in various work packages of the Geological Service for Europe project (GSEU), which started on the 1st September 2022 and will run for five years. Examples of other EU-funded projects in which GEG members are active are PANAFGEO2, SCRREEN2, EURAD, European Partnership, LIFE IP restart, EU-WaterRes and FUTURAM.

In October-November 2022, several GEG members have been involved in the preparation of a session proposal for the Goldschmidt2023, which will be held in Lyon (France) in July 2023. The Goldschmidt is organised by the European Association of Geochemistry and the Geochemical Society. The session was accepted in mid-December under the Theme 12 *"Environmental geochemistry and human health*" of the Science Programme under the title: '*The novel geochemical and mapping methods at global to local scales with applications in environmental sciences, food safety, ecology, archaeology and palaeontology*'. GEG's deputy-chair is one of the conveners of this session. The abstract submission deadline for Goldschmidt2023 is the 1st of March 2023.

In November-December 2022, the GEMAS website was moved from the GBA (http://gemas.geolba.ac.at/) to the EGS server and from now on it will be maintained there. The website received a new hyperlink: https://gemas.eurogeosurveys.org/.

A3.3.1.1. Publications

In collaboration with the IUGS Commission on Global Geochemical Baselines, several GEG members have been involved in the publication of the "*IUGS Manual of Standard Methods for the Establishment of the Global Geochemical Reference Network*" which was published online in June 2022:

Demetriades, A., Johnson, C.C., Smith, D.B., Ladenberger, A., Adánez Sanjuan, P.A., Argyraki, A., Stouraiti, C., Caritat, P. de, Knights, K.V., Prieto Rincón, G. & Simubali, G.N. (Editors), 2022. ***International Union of Geological Sciences Manual of Standard Methods for Establishing the Global Geochemical Reference Network*.** IUGS Commission on Global Geochemical Baselines, Athens, Hellenic Republic, Special Publication, 2, 515 pages, 375 figures, 35 Tables, 5 Annexes and 1 Appendix, ISBN: 978-618-85049-1-2; https://doi.org/10.5281/zenodo.7307696**.**

Other publications by GEG members that are related to past and ongoing GEG work are:

Tarvainen, T., Salminen, R., Demetriades, A., Hatakka, T., Ladenberger, A. & the FOREGS Project Team, 2022. The FOREGS Geochemical Baselines Project – 25 years of European-wide geochemical mapping. *In:* Bergman Weihed, J., Johansson, Å. & Rehnström, E. (Eds.): Geological Society of Sweden, 150-year anniversary meeting, Uppsala, August 17–19 2022, Abstract volume. Geologiska Föreningen Specialpublikation 1, 228–229.

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