



CGI ANNUAL REPORT 2023 & 2024 BUDGET REQUEST

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1. Role of CGI

The Commission for the Management and Application of Geoscience Information (CGI) is a Commission of the International Union of Geological Sciences (IUGS).

- **Mission**

To foster the interoperability and exchange of geoscience information, by active community leadership, collaboration, education, and the development and promotion of geoscience information standards and best practice.

- **Vision**

- that geoscience information can be exchanged, understood, and used without limitation,
- that geoscience information can be readily integrated with standards-based information from other knowledge domains,
- that geoscience information is semantically rich and structured to enable seamless interaction in all environments,
- that global education about the management, modeling, exchange, and use of geoscience information enables its best possible application,
- that geoscience information is used for the benefit of all society.

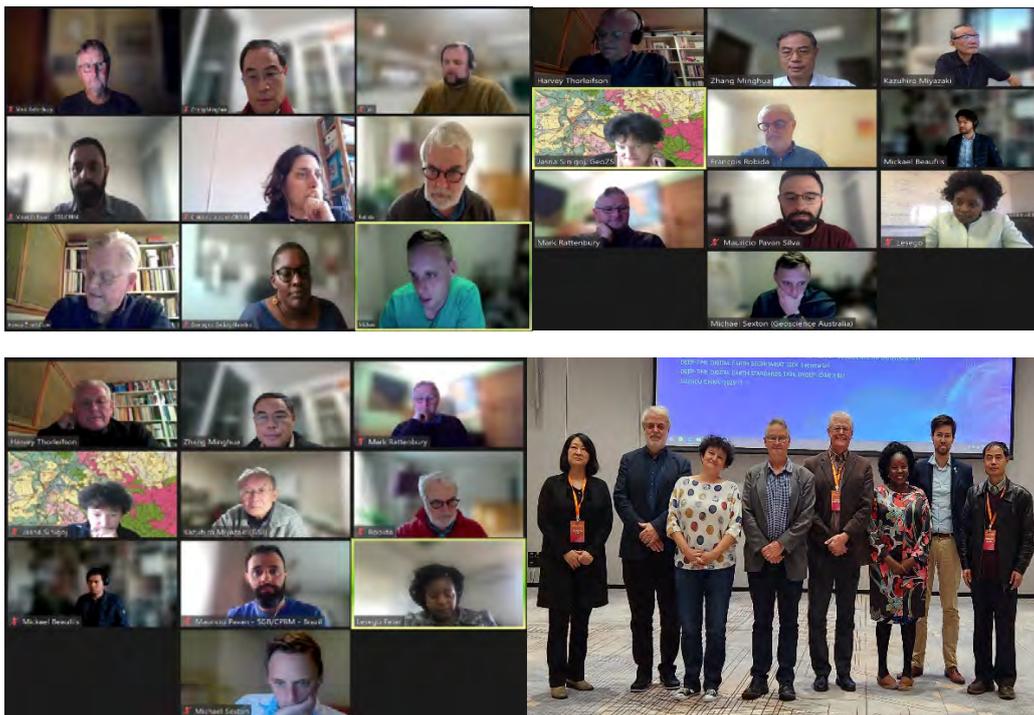
2. Role of CGI within IUGS science policy

CGI fulfills the role of the geoscience information body of the IUGS. It represents IUGS on geoscience information matters, provides the means for transferring knowledge on geoscience information and systems, assists international dissemination of best practice in geosciences information, stimulates and supports initiatives which are developing standards, and its Councilors hold leadership positions within the international information community.

3. Councilors, Officers, Meetings, Members

- **Councilors and Officers 2020-2024**

- Harvey Thorleifson (Chair) – USA
- Zhang Minghua (Secretary General) – China
- Mark Rattenbury (Treasurer) – New Zealand
- François Robida (Past Chair) – France
- Kazuhiro Miyazaki – Japan
- Christelle Loiselet – France
- Edward Lewis – UK
- Mauricio Pavan Silva – Brazil (2022-2024)
- Jasna Šinigoj – Slovenia (2023-2024)
- Lesego P. Peter – Botswana (2023-2024)
- Mickael Beaufils – France (2023-2024)
- Michael Sexton – Australia (2023-2024)
- Kombada Mhopjeni (Co-Secretary General) – Namibia (2020 - 2023)
- Éric Boisvert – Canada (2020-2022)



CGI online council meetings screen shots and the photo of CGI in-person council meeting on 10 Nov.

CGI co-hosted, with the DDE secretariat, the hybrid Future Geoscience Information Standards Forum and associated meetings on 7-10 November, 2023 at Suzhou, China with magnificent success. Some 40 experts on geoscience information and standards from Australia, Botswana, Denmark, France, Netherlands, New Zealand, Slovenia, USA, UK and China participated in broad and thorough discussions on next steps for international cooperation, focusing on standards for DDE, and the strategy for CGI and DDE to ensure a FAIR (findable, accessible, interoperable, reusable) geoscience knowledge and standards framework.



CGI-DDE Future Geoscience Information Standards Forum in-person participants, 7-10 Nov, Suzhou

Notably, the DDE geoscience information metadata standard (Edition 1.0-2023) was formally released at the meeting and on the CGI website for global use (<https://cgi-iugs.org/publication/dde-metadata-standard-v1>), marking a milestone in globally recognized DDE standards supporting FAIR data and knowledge resources.



Release of the DDE metadata standard by Zhang Minghua and Steve Richard at the Nov meetings in Suzhou

- **McHarg Medal award**

François Robida, CGI Past Chair, has won the 2024 EGU Ian MchHarg Medal! This medal was established by the Earth and Space Science Informatics Division in recognition of the scientific achievements of Ian MchHarg. It is awarded for distinguished research in information technology applied to Earth and space sciences. Congratulations, François!



Through these communications and collaborative meetings in 2023, CGI has become more visible and influential in global geoscience standards; in addition, a plan and agreements have been drafted for hosting standards issued outside or jointly with CGI, for instance, International Commission on Stratigraphy (ICS) and DDE standards.

The CGI secretariat office is located at the Development Research Center of China Geological Survey, Ministry of Natural Resources. The contact email is CGIsecretariat@mail.cgs.gov.cn. The CGI secretariat office helped a great deal in logistics of the November in-person in Suzhou this year, apart from daily services provided.

CGI working groups, networks, and collaboration projects and working groups include:

- DDE Standards Task Group (DDE-STG), in collaboration with CODATA – Harvey Thorleifson (USA), Zhang Minghua (China) and Alena Rybkina (Russia, up to September,2023)
- GeoSciML Standards Working Group (GeoSciML), in collaboration with the Open Geospatial Consortium (OGC) – Éric Boisvert (Canada)

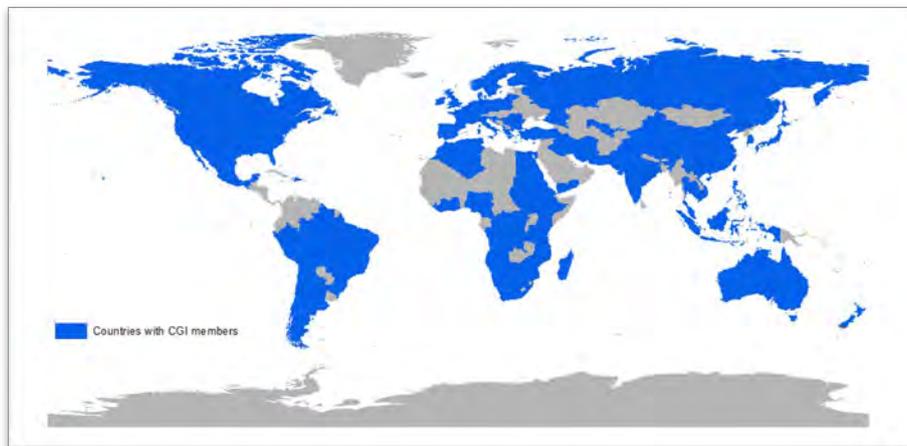
- EarthResourceML Working Group (ERML) – Michael Sexton (Australia)
- Geoscience Terminology Working Group (GTWG) – Mark Rattenbury (New Zealand)
- GeoScience Domain Working Group, in collaboration with the Open Geospatial Consortium (OGC) – Mickael Beaufils (France)
- Geoscience Information in Africa – Network (GIRAF) – Mesfin Wubeshet Gebremichael, Tanzania.

New working groups are planned to be set up in 2024 as follows,

- Geoscience knowledge graph
- AI applications in Geoscience

- **CGI Membership**

CGI now has 531 members in 82 countries across the world. There were 8 new CGI members in 2023, from Africa, Asia, Europe and North America, an increase that indicates the recovery of geoscience information activities from the pandemic.



Global distribution of CGI members (countries in blue)

CGI continued using a LinkedIn group (<http://www.linkedin.com/groups/6539642>) for some conferences and documents, particularly working groups communications.

4. CGI online presence and Newsletter

There have been no major updates or changes to the structure of CGI, ERML or GeoSciML websites in 2023, since the redirect done from the previous web address <https://www.cgi-iugs.org/> to <https://cgi-iugs.org/> last year.

- CGI Website: <https://cgi-iugs.org>
- Twitter: https://twitter.com/CGI_IUGS
- LinkedIn: <https://www.linkedin.com/groups/6539642/>

Working group / project links:

- DDE: <https://cgi-iugs.org/project/ddestandards/>
- ERML: <https://cgi-iugs.github.io/project/earthresourceml/>
- GeoSciML: <https://cgi-iugs.github.io/project/geosciml/>
- GTWG: <https://cgi-iugs.github.io/project/geoscienceterminology/>
- OGC-CGI Geoscience Domain WG: <https://cgi-iugs.github.io/project/geosciencedwg/>



Key Projects

DDE Standards Task Group

A collaborative task group implementing geoscience information standards for IUGS's flagship Deep-time Digital Earth Project

Dr Zhang Minghua



EarthResourceML

A CGI working group developing and publishing data standards for mineral resources and mining information

Michael Sexton



GeoSciML

A collaborative OGC-CGI working group for the GeoSciML geological data standard

Eric Boisvert



Geoscience Terminology Working Group (GTWG)

A CGI working group developing and publishing multi-lingual geoscience vocabularies

Mark Rattenbury

The main page of CGI website

Additional content has been added, including newsletters, DDE November workshop information, and both new and updated details of CGI Council Members. Site statistics for that past 12 months are as follows. Due to changes in the Google Analytics Platform, CGI only has data from 1st April onwards, however, new data are being collected as expected.

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Important CGI activities reported to IUGS as news paragraphs for the IUGS e-bulletin in 2023 were read widely within geoscience communities.

- https://www.iugs.org/files/ugd/f1fc07_706bdfd1beb64d2a98ce78128a4ac3e2.pdf?index=true

The 9th CGI newsletter, issued in Dec and focusing on the Suzhou meetings, has been distributed widely within and outside IUGS communities with the help of the DDE secretariat:

- <https://cgi-iugs.org/post/newsletter-issue-9/>
- https://cgi-iugs.org/docs/CGI_newsletter_2023_December.pdf
- https://www.iugs.org/files/ugd/f1fc07_438c8fef07d74655a9aac38b8988b6bc.pdf?index=true



IUGS-ebulletin no 201

https://www.iugs.org/files/ugd/f1fc07_706bdfd1beb64d2a98ce78128a4ac3e2.pdf?index=true

4. DDE-CGI November 2023 in-person meetings on geoscience standards were held with great success at Suzhou, China

Effective communication of information relies heavily on the adoption of global geoscience standards to ensure fairness of data resources. In order to optimize coordination and planning of geoscience standards, to support the success of DDE to enable acceleration of data driven deep time research and provision of benefits to support geoscience for the society, a workshop on the Geoscience Information Standards for DDE and a forum on Future Geoscience Information Standards co-hosted by Deep-time Digital Earth Secretariat and Commission for the Management and Application of Geoscience Information (CGI) of IUGS were held on 7-8 Nov and 9-10 Nov, respectively, at Suzhou, China and with great success. The workshop and forum were chaired by Prof. Harvey Thorleifson, Prof. Natarajan Ishwaran, Prof. Zhang Minghua, Dr Mark Rattenbury and François Robida. With the welcome address by IUGS President Prof. John Ludden, DDE



Photo: Suzhou participants, November 7th

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 2. Suzhou Meetings
 3. Invitation to CGI Membership
 4. New CGI Councillors
 5. IGC Korea abstract deadline

McHarg Medal to François Robida

François Robida, Past Chair of CGI, has won the 2024 EGU Ian McHarg Medal! This medal was established by the Earth and Space Science Informatics Division in recognition of the scientific achievements of Ian McHarg. It

(by Edward Lewis)

5. Extent of support from sources other than IUGS

Aside from the substantial in-kind contributions from agencies that fund the time of Councilors, CGI does not receive additional support. CGI activities are sometimes co-organized or supported by other organizations and programs/projects such as IUGS-DDE, UNESCO, University of Minnesota, China Geological Survey, GNS Science (New Zealand), Geological Survey of Slovenia, Geoscience Australia, United Nations Development program, the annual funding for the DDE Standards Task Group, and R&D project support from DDE.

6. Interaction with international organizations

• **CGI collaboration with OGC**

CGI, in collaboration with OGC, is continuing to maintain and update the geological data model standard GeoSciML, jointly working with the Geoscience Domain Working Group (GDWG) on interoperability standards for Geotechnical and Borehole data. OneGeology, OneGeology-Europe, and the European INSPIRE directive have used CGI products, including the GeoSciML and Earth Resource ML data models, and CGI vocabularies.



• **CGI and CODATA**

CGI and CODATA set up the DDE Standards Task Group (DDE-STG) in Oct 2019, and have carried out work plans since then, including a 3-year DDE-funded R&D project since 2021 on Geoscience Information Standards for DDE which was conducted with expected outcomes generated in 2023. CGI and DDE-STG joined a discussion with CODATA on 9th Sep 2023 on further cooperation, and submitted a project proposal in Nov 2023 on FAIR DDE geoscience disciplinary data based on CGI standards and the CODATA WorldFAIR framework.



- **CGI and DDE**

CGI was a founding member of the IUGS DDE program. CGI has been active in successfully leading the DDE-STG in collaboration with CODATA and other DDE WTGs. A total of 30 geoscientists, including 15 CGI member geoscientists and CGI councilors, are now working in DDE-STG and its R&D project. Apart from providing DDE geoscience knowledge system review procedures, CGI and DDE-STG made plans in 2023 to organize international reviews and to help setting up an international geoscience knowledge infrastructure for DDE.



- **CGI and OneGeology**

GeoSciML was adopted by OneGeology upon initiation of this international initiative in 2007. CGI's EarthResourceML data standard has also been implemented in OneGeology for mineral resource data.



7. Chief accomplishments and products

7.1 CGI News

- **CGI's leading role in the DDE Standards Group**

As one of the founding members of the IUGS DDE big science program, CGI set up the DDE Standards Task Group (DDE-STG) with CODATA and DDE in 2019. The first in-person meeting of DDE-STG was held in Jan 2020 in Beijing with great success. With support from CGI, CODATA, and DDE working groups, DDE-STG delivered the DDE Geoscience Knowledge System Review Procedure in Aug 2020 and updated it in May 2021 as the first product. The draft DDE metadata standard was circulated from 2021 through 2023, and the standard was released in Nov 2023. The DDE metadata App prototype has been in test use by DDE-WTGs and a formal App was deployed on the DDE platform for metadata population and harvest in early 2024. A draft data evaluation guide and geoscience data standards framework were also prepared. CGI and DDE co-hosted the hybrid Future Geoscience Information Standards Forum and associated meetings on 7-10 November, 2023 at Suzhou, China with magnificent success. The DDE-STG held many training meetings in 2023 for DDE-WTGs, including the DDE-China Assembly, and DDE-WTG workshops and standards related seminars with the DDE data group, knowledge group, and platform group, which guided and helped DDE WTGs in database and knowledge system developments, hydrogeology, geophysical and petroliferous basin evaluation knowledge system development for instance, and provided consultations to African geothermal map compilation, DDE-China data standards, DDE temporal ontology development, and other activities.



Zhang Minghua from CGI delivered a talk on CGI and DDE progress at the GIC meeting, 8-11 May 2023, Ljubljana, Slovenia.

- **CGI standards promotions**

CGI geoscience standards and vocabularies were introduced to scientists and officials from a variety of organizations and initiatives at seminars, workshops, and other events in 2023, including CGI-hosted and co-hosted workshops, DDE meetings, as well as regional sessions in Asia and elsewhere. For example, CGI presented at the 38th GIC meeting in Ljubljana, CAG29 in Windhoek, CODATA Global Open Science Cloud (GOSC) international training workshops, and a CGI/OGC standards talk at The Belt and Road Resource & Environment Scientific Data Sharing meetings held in Beijing by China Academy of Science, as well as the ASEAN-China workshop on geosciences and big data hosted by CGS.



CGI-OGC Standards for geoscience Open and FAIR report on 7 Sep 2023, International Training Workshop on Open Science and SDGs, Beijing.

For further cooperation with CODATA, CGI Secretary General prof Zhang Minghua visited Jianhui Li, vice president of CODATA in Feb 2023 at CNIC (CAS network and information center) and discussed potential cooperation with GOSC and DDE-China. Also, in September, meetings on cooperation among CGI, CODATA and DDE were held at CNIC, resulting in a joint proposal on FAIR principles implementation for DDE, along with other steps in future collaboration.



Two sessions at the 37th International Geological Congress (IGC) in Korea are now being planned by CGI officials, Geoscience Information in the 2020's by Harvey Thorleifson, and Geoscience Data Standards and Knowledge Graph by Zhang Minghua.



7.2 Working Group Reports



7.2.1 GeoSciML Standards Working Group

The OGC GeoSciML Standards Working Group (SWG) is jointly administered by the CGI. 2023 marked the 20th anniversary of the SWG.

The SWG again was largely inactive in 2023 due to the maturity of the GeoSciML standard.

- ***Membership and repository***

The GeoSciML SWG membership stands at 45 members and observers. The public GeoSciML mailing list has 97 registered members from Australia, Austria, Belgium, Brazil, Canada, China, Czech Republic, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, New Zealand, Poland, Portugal, Russia, Spain, Sweden, UK, and USA.

GeoSciML schemas on the OGC public schema site are at: <https://cgi-iugs.org/project/geosciml/> and <http://schemas.opengis.net/gsm/4.1/>. The OGC GeoSciML SWG's GitHub repository is at <https://github.com/opengeospatial/GeoSciML>. Sylvain Grellet (BRGM) and Éric Boisvert (GSC) have had management responsibilities.

- ***Meetings and activities***

There were no GeoSciML SWG meetings during 2023. A CGI Council grant to GeoSolutions for docker containerization of the ERML (an extension of GeoSciML standard), managed by Mark Rattenbury and Eric Boisvert, had been completed in late 2022. The goal of the project was to simplify the deployment of ERML, or any other standard supported by Geoserver, when the data provider has limited resources to deploy a simple static database. The contracted work involved the development and documentation of a process for publishing complex geology data features via docker image containerization and configure this in GeoServer.

- ***Uptake***

Beyond implementation of web services, GeoSciML continues to attract attention from various standardization initiatives that seek to extend it to associated domains, such as GEOL_BIM (<https://www.espazium.ch/fr/actualites/mieux-protger-les-batiments-contre-les-glissemets-de-terrain-avec-le-bim>) and Geotechnic (<https://aecmag.com/opinion/ifc-for-infrastructure/>). GeoSciML and the extensive work made on GeoSciML vocabularies remains the starting point for the knowledge representation community, demonstrating its lasting influence. GeoSciML is integral to online training (e.g. <https://www.coursehero.com/study-guides/wmopen-geology/outcome-scientific-tools/>).

- ***Future work***

The popular GeoSciML-Lite standard previously identified as a quick win for JSON encoding is expected to progress with the awarding of a CGI-DDE contract to the British Geological Survey to develop a GeoJSON encoded version of the GeoSciML-Lite standard in 2024.

(by Mark Rattenbury)

7.2.2 Geoscience Terminology Working Group

- **Activities**

The 29 members of the Geoscience Terminology Working Group (GTWG) are from Australia, Brazil, China, Denmark, Finland, France, Germany, Great Britain, Italy, New Zealand, Poland, Russia, Slovenia, Spain, Sweden and USA. Membership is managed through a Google Group with membership rights administered by Mark Rattenbury (NZ, Chair since 2014) and Steve Richard (USA). Actual participation in vocabulary development and management involves only about half of the membership. A 2023 face-to-face meeting was not held. Resumption of vocabulary publication is awaiting implementation of a modified Excel->RDF-SKOS->VocPrez system at Geoscience Australia, where the CGI vocabularies are hosted. GTWG activities are described under the CGI website: <https://cgi-iugs.org/project/geoscienceterminology/> and from the GeoSciML website at <http://geosciml.org/>.

- **Achievements**

No new vocabularies were adopted in 2023. Significant time was directed at preparing for and running the Future Geoscience Information Standards meetings in Suzhou in November. Parts of these meetings discussed CGI vocabularies, their importance for standards implementation and their role in semantic ontology capability under the IUGS Deep-time Digital Earth Big Science Program (DDE). Under discussion is the release of incomplete vocabularies to enable their uptake and potentially trigger requests for additions and improvements.

- **Future Work and Issues**

There remain several outstanding GeoSciML data model vocabularies still to complete, including for GeoSciML and EarthResourceML data models. The DDE program includes a large component of semantic ontology development and this overlaps with GTWG vocabularies to some extent. The DDE Standards Task Group, co-led by CGI, is monitoring this. Working group activity is still unsatisfactorily low. The proposal to publish incomplete vocabularies without the burden of review cycles may generate more activity.

(by Mark Rattenbury, Chair, GTWG)

7.2.3 EarthResourceML (ERML) Standards Working Group

- **Activities**

The ERML SWG has 25 members, from Australia, Brazil, China, Canada, Denmark, Finland, Sweden, France, Great Britain, New Zealand, Poland and USA. Membership is defined and managed through a Google Group with membership rights administered by Michael Sexton (Australia, chair since 2021). No meetings were held for the ERML working group during the year. The ERML WG activities are described under links from the CGI website <https://cgi-iugs.org/project/earthresourceml/>. Vocabulary work for ERML and GeoSciML standards can be seen via GTWG website at <https://cgi-iugs.org/project/geoscienceterminology/>.

- **Data Model Development and Documentation**

ERML 2.0 was published in 2014: <http://www.earthresourceml.org/>. After small modifications in 2015 and 2016, ERML is now fully compatible with the requirements of the European Commission's INSPIRE data specification for Mineral Resources. ERML Lite 2.0.1 was published 2018, and it is implemented in Australia (AusGIN) and on the OneGeology Portal. Work on ERML 3.0 was paused due to the unavailability of working group members for large periods of the year. All the CGI SWG web pages have been harmonized, and the ERML web pages (<https://cgi-iugs.org/project/earthresourceml/>) have been updated. The data model documentation has been published in the ERML web pages.

- **Uptake of EarthResourceML**

The uptake of ERML continues, albeit at a reduced pace compared to previous years. However, the ERML data standard continues to be used for national and subnational geological surveys, for example in Australia and Europe, mainly through its adoption by data sharing communities such as OneGeology, AusGIN, INSPIRE/Minerals4EU and EGD. A major challenge is to engage USA and Canada as active participants to develop/implement the ERML standard. Recently, Chinese organizations and the British Columbia Geological Survey in Canada have been actively supporting the SWG.

- **Work planned**

Future development of ERML and ERML Lite will be undertaken by the ERML Working Group based on feedback from users, building on the current focus on critical minerals.

(by Michael Sexton)

7.2.4 The Joint CGI/OGC Geoscience Domain Working Group

- **Activities**

The GeoScience DWG met twice in 2023: first in Frascati (Italy) at the February OGC TC, then in Huntsville (USA) at the June OGC TC. The focus of the sessions was on the progress of the Geotech Interoperability Experiment (Geotech IE). The meeting in Huntsville was a joint session with the Observation, Measurement and Samples (OMS) SWG, highlighting the strong connection between the two working groups. Presentations of GeoScience DWG activities were also made at standardization organization events for Building Information Modeling (BIM) and tunneling in particular. This includes reports of Geotech IE progress during the buildingSmart International (bSI) Summit in Roma (Italy) in March and in the International Tunneling Association (ITA) WG22 in November. GeoScience DWG activities and a proposal for next steps were presented during the "Future Geoscience Information Standards Forum" workshop jointly organized by DDE and CGI-IUGS in Suzhou (China) in November.

- **Achievements**

The Geotech IE, the second Interoperability Experiment endorsed by the GeoScienceDWG came to an end and delivered its report in December 2023. The main result is a wiki that documents the production of the group: <https://github.com/opengeospatial/Geotech/wiki> In collaboration with representatives from the Association of Geotechnical and

Geoenvironmental Specialists (AGS), Data Interchange for Geotechnical and Geoenvironmental Specialists (DIGGS), and bSI communities, the GeotechIE discussed and proposed geotechnical data harmonization. Having defined concepts to describe geotechnics, mapping with standards showed equivalency and capacity to go from one format to another. To cover the perimeter of geotechnics with OGC and associated standards, the GeotechIE proposed the reuse and extension of multiple existing standards including:

- ISO: 19148 (Linear Referencing), 19156 (Observations, Measurements and Samples),
- OGC: GeoSciML, GroundWaterML2, LandInfra/InfraGML, SensorThingsAPI,
- INSPIRE: Natural Risk Zones Theme
- EPOS.

An additional major achievement was the provision of an API able to expose borehole data based on the data model developed by the IE. An extension of the SensorThingsAPI was designed for this and is being reused and completed by the WaterQuality IE to be then proposed as SensorThingsAPI v2.

The group examined how to expose geotechnical tests with that technology. This includes: borehole logs, Cone Penetration Test (CPT), Standard Penetration Test (SPT), Menard Pressure meter Test and Determination of Atterberg Limits. Real data issued from AGS and DIGGS were integrated in a demo server hosted by Fraunhofer. BRGM also set up an instance for its data.

- ***Future Work and Issues***

The Geotech IE strengthened links within the bSI, AGS and DIGGS communities. The work will be presented in Spring 2024 during a workshop of the International Society for Soil Mechanics and Geotechnical Engineering (ISSGMGE) TC222 dedicated to BIM and Digital Twins for Geotechnics. A paper is also planned.

The Geotech IE is not proposing a new standard, but rather building on an existing one. It is yet to be clarified whether updates to some OGC standards (e.g. update of GeoSciML to fit the new version of OMS) would be required to take advantage of the latest technologies and available solutions.

As for new activities, the GeoScience DWG has expressed interest in standardization for geophysics and 3D modelling. A poll will be sent in Spring 2024 to confirm this interest and identify potential participants for a possible third Interoperability Experiment.

(by Mickaël Beaufils, BRGM - GeoScienceDWG Chair)

7.3 CGI Regional Reports

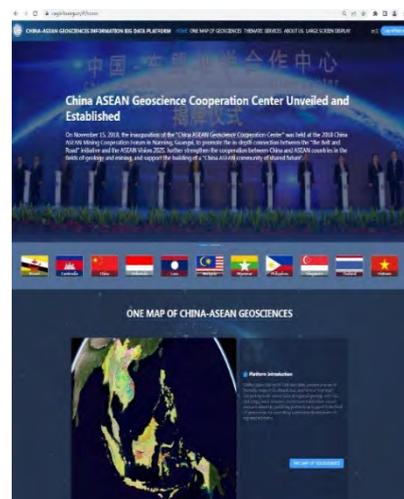
7.3.1 CGI in Asia

In Asia in 2023, progress on regional and international collaborations and in-person activities among national geological surveys and geoscience institutes increased with the passage of the pandemic. Cooperation on integrated geoscience data processing (IGDP) were led by China Geological Survey (CGS), with Geoinformation Sharing Infrastructure (GSi) led by Japan Geological Survey (GSJ), and Geoscience Data Repository (GDR) led by Korea Institute of Geoscience and Minerals (KIGAM).

The China Academy of Science started data release and cooperation with developing countries and organizations focused on UN SDG 13 in climate change, and a platform for east Asia natural disaster monitoring, mitigation and assessment was developed based on the Global Open Science Cloud and public data standards. Case studies and training with this platform were conducted in 2023.



China Geological Survey launched the beta version of the ASEAN-China Geoinformation Bigdata Platform <https://www.caginfor.org.cn/#/home> in 2023 for ASEAN states to share geoscience data and information together with China for close cooperation in geological surveys and regional geoscience studies. In addition, the ASEAN-China Seminar on Geoscience information and big data was held on 26-27 Dec 2023 in hybrid meetings in Chengdu, China. Some 30 in-person participants and 30 online attendees joined this meeting. Topics included the progress of the ASEAN-China Geoinformation Bigdata Platform construction, China remote sensing data service network, ASEAN-China Kast data network and marine geological databases, etc. and an invited talk on open and FAIR geoscience standards was delivered by prof Zhang Minghua from CGI.



ASEAN-China Geoinformation and big data seminar on 26-27 Dec2023 in Chengdu, China.

CGI-OGC standards were promoted at several international workshops held in China in 2023, such as the September International Training Workshop on Open Science and SDGs in Beijing and International Training on Resource & Environment Scientific Data Sharing along the Belt and Road in November in Beijing, and a thematic standards workshop in March for DDE program. Talks were presented by prof Zhang Minghua, Wang Yongzhi, Yuhailong, et al.



CGI standards talks at the BRI workshop Nov 2023 in Beijing.

Geological Survey of Japan (GSJ) supported Coordinating Committee for Geoscience Programs in East and Southeast Asia (CCOP) members in the hosting of the WMSs of their geological maps for OneGeology portal registration. These WMSs include the geological maps of Indonesia, Malaysia, Vietnam, Mongolia, Myanmar, Philippines, and Papua New Guinea. The WMSs of Laos, Thailand and South Korea are hosted by these countries' servers. Furthermore, Japan registered 120 maps to OneGeology portal, including the 1:10M Geological Map of Asia, 1:200K Geological Maps of Japan, 1:200K Seamless Geological Map of Japan, 1:10M Earthquake Source Region, 1:10M Tephra Fall Distributions, 1:2M Volcanoes of Japan, 1:2K to 1:50K Geological Maps in volcanic areas in Japan. In Sep 2023, two GSJ researchers attended OneGeology Operational Strategic Steering Committee in the Netherlands.

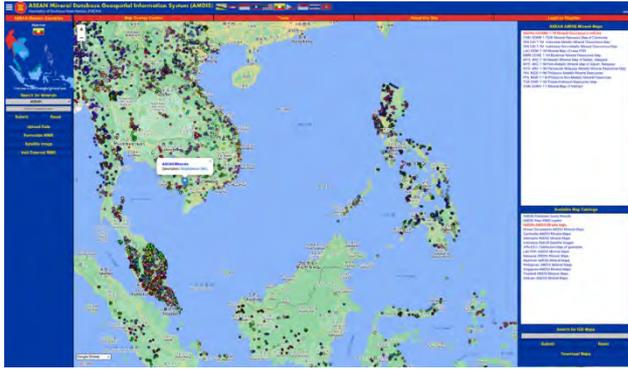
The Chinese translation of GeoSciML 4.1

(http://www.geosciml.org/doc/geosciml/4.1/documentation/ogc_spec_translations/16-008_OGC_Geoscience_Markup_Language_GSML4.1-CN2018.08.18.docx) was

revised and reviewed by CGS, following Chinese regulations for standards, in 2023 for release and wide implementation in China in 2024. The revised standard document named GeoSciML-CN has been implemented in the DDE-China node for some databases, particularly geological map data. EarthResourceML has also been tested for implementation in minerals data release in CGS.

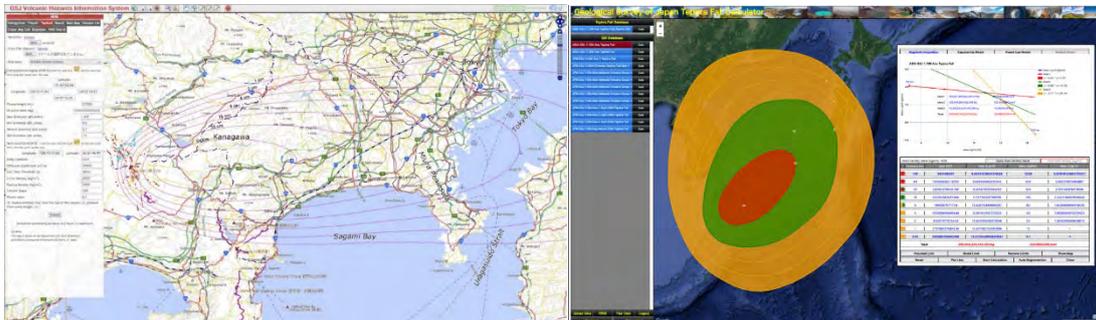
The Japan Geological Survey (GSJ) has implemented the CCOP Geoinformation Sharing Infrastructure (GSi) for East and Southeast Asia projects in cooperation with geological institutes in East Asia since 2016. More than 2,200 geological maps and related information are presently available on the GSi system. There are also more than 20 portal sites from CCOP countries that were setup using the GSi system, <https://ccop-gsi.org/main/>. GSJ also developed the ASEAN Mineral Database and Information System (AMDIS), <https://ccop-gsi.org/amdis/>.





GSI initiated "Development of High-Precision Digital Geological Information for Hazard Prevention and Mitigation" in 2022. This project includes the Volcanic Craters DB, High-resolution Active Faults, Slope Disaster Risk Assessment, Digital Marine Geology, and Geological Digital Transformation (DX) of various geological information.

The Integrated Geohazards Information System is also part of the Geological DX project. The project team is working on data distribution using API, data download service, web-based spatial information viewing platform, and the Integrated Geohazard Information System. The system will provide web-based data browse and search functions and download of GIS data, as well as an online simulation system for real-time hazard assessment and connection with other databases to activate the digitized geoinformation. The Volcanic Hazards Information System project (<https://volcano.g-ever1.org/>), a part of Integrated Hazard Information System, aims to develop (1) real-time hazard assessment using online numerical simulations, (2) eruption parameter analysis at various volcanoes, (3) digitization of tephra falls, pyroclastic flows, and debris avalanche distributions, (4) online tephra falls volume estimation, (5) display of volcanic crater distributions, and (6) integration of various volcano databases.



Tephra2 numerical simulation result(left) Tephra fall volume online calculation result(right)

GSI will hold a webinar on Practical Geological Survey Techniques - Application to Geological Disaster Mitigation - from Jan 22 to 24, 2024, organized for young geological researchers and engineers in the CCOP member countries. The webinar focuses on practical geological survey techniques because accurate geological mapping is fundamental for natural resources development, environmental conservation, and mitigation of geological disasters.

Korea Institute of Geoscience and Minerals (KIGAM) jointly held the 4th Working Group Meeting and Workshop of the Geoscience Data Repository (GDR) Project with Vietnam Geological Department (VGD) on 13-14 Sep 2023 in Hanoi Vietnam. The objective of this workshop was to update the progress of the GDR Project including the GDR system development and the countries' data population to the GDR Web System from <http://ccop-gdr.org/>. There were 27 participants from Member Countries – Brunei Darussalam, Cambodia, China, Japan, Republic of Korea, Lao PDR, Malaysia, Mongolia, Myanmar, Philippines, Thailand and Vietnam, as well from the CCOP Technical Secretariat attended this workshop.



Group photo of the Geoscience Data Repository project workshop in Sep 2023 in Hanoi, Vietnam.

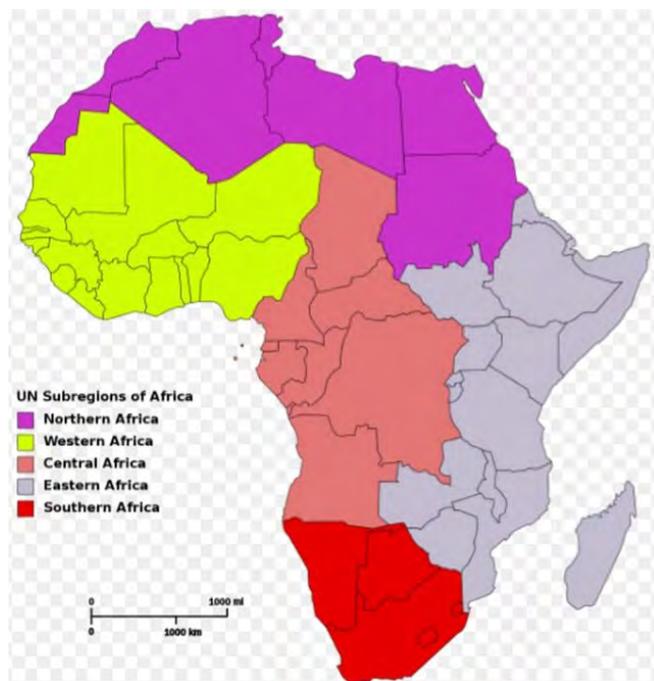
(by Zhang Minghua and Kazuhiro Miyazaki)

7.3.2 CGI in Africa

In 2023, African Geological Surveys continued to advance strategic initiatives to align geoscientific data with OGC and CGI data standards, as well as undertaking projects and training aiming at enhancing geological research.

- ***Collaborations Through Conferences and Activities***

The Africa Mining Summit was held on the 20 – 21 Sep 2023 in Gaborone, Botswana, to enable networking and exhibiting, with pre-scheduled match-making meetings using bespoke ‘meeting’ software. The programme focused on project presentations and panel discussions covering the energy transition and demand for strategic metals, diversifying Africa’s energy mix & its impacts, Africa’s coal exploitation and roadmap, Commodities outlook for 2023 and beyond, as well as Africa and the Global Markets.



The Organization of African, Caribbean and Pacific States (OACPS) Conference held in Zambia on the 20 – 22 Nov 2023 adopted a paper outlining options for an OACPS approach to the EU Regulation on Critical Raw Materials, targeted on allowing OACPS Experts to submit recommendations on issues of strategic interest to OACPS Members on Critical Raw Materials.

Zambia International Mining and Energy Conference (ZIMEC) 2023 was held in Kitwe, Zambia, 3 Nov 2023. The conference, held under the theme ‘Investing in Zambia, mine to market, clean energy, and sustainable development of future minerals’, attracted over 500 attendees from 20 countries, consisting of 21 sponsors, and featured over 50 exhibition stands. The audience demonstrated the importance of the event and its impact on Zambian mining and energy.

The 29th Colloquium of African Geology (CAG), on “The earth sciences and Africa’s development: current realities, future projections” was held on 26-29 Sep 2023 in Windhoek, Namibia, a major biennial meeting organized by the Geological Society of Africa (GSAf).

The first CAG was convened by Professor W. Q. Kennedy, assisted by Dr. Tom Clifford, at the University of Leeds, England, in March 1964. There have been 28 events, 18 of which were held in Europe, and 10 in Africa, in South Africa, Ethiopia, Tanzania, Nigeria, Swaziland, Zimbabwe, Morocco (twice), Mozambique and Tunisia.

The 15th Organization of African Geological Surveys (OAGS) Annual General Assembly (AGM) was held in Luanda, Angola on 16 Nov 2023. The AGM was interpreted in English, French and Portuguese, the official languages of the OAGS. In attendance were by Heads of African Geological Surveys or their representatives from Algeria, Angola, Botswana, Burkina Faso, Chad, Comoros, Eswatini, Gambia, Ghana, Guinea Conakry, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mozambique, Namibia (Vice President), Niger, Nigeria, Senegal (President), Sierra Leone, South Africa (Permanent Secretariat), South Sudan, Togo and Uganda, Zimbabwe. The AGM noted apologies from Burundi, Cameroon, Congo Republic, Djibouti, Eritrea, Democratic Republic of Congo, Ethiopia.

The AGM welcomed and acknowledged participation of partners, including the representatives of the African Minerals Development Centre (AMDC), Comprehensive Test Ban Treaty Organization (CTBTO), European Geological Surveys (EGS), Geological Society of Africa (GSAf), Mineral African Development Institute (MADI) and the World Community of Geological Surveys (WCOGS).

- **Projects**

Geoscience projects continue to advance in Africa targeting on improving FAIR principles for geoscience data sharing and dissemination. Botswana Geoscience Institute (BGI) launched the Mining Cadaster live in Oct 2022, through which prospects can apply for prospecting and mining licenses online. The project was a success as it has increased more opportunities for Mining in Botswana. Republic of South Africa benchmarked on Botswana’s Mining Cadaster due to its effectiveness and benefits, seen after Botswana’s launch of the system.

- **Training**

Each African Country continues to advance training within the area of research and innovation towards advancing techniques and tools used in managing geoscience data.

(by Lesego P. Peter)

7.3.3 CGI in South/Latin America

The CGI councilor from South America joined CGI meetings throughout 2023. In addition, South American CGI members remotely joined several CGI meetings in 2023, including the Nov meeting of CGI-DDE meetings in Suzhou, China.

South American geological surveys are active in national geoscience information initiatives, and also in multinational coordination, including participation in CGI working groups.

For example, Brazil Geological Survey updated the mineral resources database of South America in 2023.

There has been an increased pace of digital transformation and database development after the waning of the pandemic in 2023, including a focus on knowledge graphs.

(by Mauricio Pavan Silva)

7.3.4 CGI in North America

In the US, Federal Geographic Data Committee (FGDC) reporting is governed by the Geospatial Data Act of 2018, and the 3D Nation study is the basis of lidar planning. In academia, EarthCube and Earth Science Information Partners are active.

National datasets are a focus, to support applications such as earthquake propagation modeling, water resource management, energy and minerals assessment, and infrastructure planning. The National Geological and Geophysical Data Preservation Program, and the National Cooperative Geologic Mapping Program, have been reauthorized by Congress, and funding increased. To support critical minerals planning, the Earth MRI program, largely focused on aeromagnetic surveys, has received major funding increases.

Similar progress is underway in Canada, on Canada3D and the related Canada 1 Water initiative, as well as national geoscience planning for example related to minerals. Post-pandemic, the annual Digital Mapping Techniques geological GIS conference has returned to in-person, and the Geological Mapping Forum that addresses mapping geology has remained a monthly online conference over the boreal winter. The next 3D geological mapping workshop will be held at GSA in California in September 2024.

(by Harvey Thorleifson)

7.3.5 CGI in Europe

In 2023, the European Geological Data Infrastructure (EGDI) continued as a geoinfo focus, along with development of the European Plate Observing System (EPOS) infrastructure.

- ***European Geological Data Infrastructure (EGDI)***

The EGDI (<https://www.europe-geology.eu/>) provides access to Pan-European and national geological datasets from the Geological Survey Organizations of Europe. EGDI is a central element of EuroGeoSurveys' ambition to establish a Geological Service for Europe. EGDI gives access to more than 800 map layers and uses CGI standards (GeoSciML and EarthResourceML) for geological and mineral resource data. In addition, scientific terms are documented in 15 project vocabularies (<https://www.europe-geology.eu/data-and-services/vocabularies/>).

- ***Geological Services for Europe (GSEU)***

A Geological Service for Europe (GSEU; <https://www.geologicalservice.eu/>) is being built by 48 partners from 35 countries. Under a 5-year agreement, the GSEU Project will develop a plan for a sustainable service as a permanent collaborative network of European geological surveys. An objective is to develop pan-European harmonized data on critical raw materials, geothermal energy resources, and subsurface storage capacities for sustainable energy carriers and CO₂ sequestration, groundwater dynamics and quality, coastal vulnerability, and baseline information. The European Centre of Excellence for Sustainable Resource Management will be established under the project to support the implementation of the United Nations Framework Classification of Resources (UNFC) and the United Nations Resource Management System (UNRMS). The geological data infrastructure will be developed based on the existing EGDI to enable continuous access to and dissemination of data and information services. The common European Geological Knowledge Base Platform will be provided as an open access portal to the results and the underlying national and regional data collections and infrastructures. CGI Councilors Edd Lewis, Christelle Loiselet, and Jasna Šinigoj are involved in the project. These European initiatives are using CGI standards for geological and mineral resource data, while contributing to the development of 3D practices.

- ***EPOS and Geolnquire Horizon Europe Project***

The European Plate Observing System (EPOS; <https://www.epos-eu.org/>) is a long-term plan to facilitate integrated use of data and facilities from distributed research infrastructures for solid Earth science in Europe. In this context, the Geo-INQUIRE (Geosphere INfrastructures for QUEStions into Integrated Research) project begins in 2022. Geo-INQUIRE is a Horizon Europe-INFRA project funded by the European Commission. Geo-INQUIRE consists of 51 partners from 13 countries across Europe and is led by GFZ Potsdam. The kick-off meeting took place at the beginning of October last year in Potsdam, Germany. The activities and objectives of the project are closely linked to several Research Infrastructures such as EPOS, EMSO, ECCSEL and contribute to a reinforcement at European level between the different Research Infrastructures. Within this project, geological data will be made available via "Thematic Core Services" based on CGI standards, providing access to millions of boreholes across Europe, for example. EPOS has also contributed to the CGI/OGC Borehole Interoperability Experiment.

- **Future Availability of Secondary Raw Materials (FutuRaM)**

The FutuRaM project will establish a methodology, reporting structure and guidance to improve the raw materials knowledge base up to 2050, and facilitate the exploitation of SRMs with a particular focus on CRMs. The project will integrate SRM and CRM data to model their current stocks and flows and consider economic, technological, geopolitical, regulatory, social and environmental factors to further develop, demonstrate and align SRM recovery projects with the United Nations Framework Classification of Resources (UNFC). This project will be carried out by a consortium of 28 partners from 11 countries across Europe. Universities and research institutes will combine their expertise with industry to implement FutuRaM. In close cooperation with the European Commission and other policy makers, the project will run for 4 years. The project cooperates with GSEU and EGDI and will use CGI standards for mine waste.

- **Mineral potential of the ESEE region (RESEERVE)**

The RESEERVE project (<https://reseerve.eu/>) was an EIT Raw Materials project mapping the mineral resources of the six ESEE countries: Albania, Bosnia and Herzegovina, Croatia, Serbia, Montenegro and North Macedonia, which were not previously included in the existing data platforms. The main result was the WEST BALKAN MINERAL REGISTER for primary and secondary raw materials as a starting point for integrating the region into the pan-European Mineral Intelligence Network and bringing it closer to the global mineral market. The project was finalised in 2021 and in 2023 the data was included in the Min4EU database and is available on EGDI using CGI standards.

- **INSPIRE Datasets**

In the INSPIRE Directive, the CGI standards - GeoSciML and EarthResourceML - were selected as the mandated European data transfer standards for geological and mineral resource information. The following table provides a summarised overview of the geological and mineral resources datasets on the EU INSPIRE portal.

(<https://inspire-geoportal.ec.europa.eu/srv/eng/catalog.search#/home>).

Theme	Metadata records	Downloadable Datasets	Viewable Datasets
Geology	976	164	202
Mineral resources	101	25	31

- **Geoscience Information Consortium (GIC) 38th Annual Conference**

CGI members are also active in the Geoscience Information Consortium (GIC) <http://www.g-i-c.org>, a global initiative for the exchange of information between GSOs on the use and management of geoscience information systems to support Earth science internationally. The members of the GIC are currently representatives of 36 GSOs from 34 countries in Europe, North America, South America, Asia, Africa and Australia. The 38th GIC Annual Conference was held in Ljubljana (Slovenia) from 8 to 11 May 2023. The conference was attended by 64 members from 25 countries (25 in-person and 39 virtual participants). Minghua Zhang gave an introduction to the standards group of the IUGS-DDE programme and the improvement of cooperation between GIC and CGI was also discussed.

(by Loiselet Christelle and Jasna Šinigoj)

7.3.6 CGI in Oceania

Most multi-agency geoscience information standards coordination in Oceania occurs through the Australia/New Zealand Government Geoscience Information Committee (GGIC), which comprises information managers from state and national surveys, and that met twice online in 2023. The following GGIC projects have been completed or have made substantial progress:

- ***Geoscience vocabularies***

Vocabulary development has been a strong activity in Oceania with state geological surveys in South Australia, Queensland and Western Australia continuing to develop and improve their own services as is Geoscience Australia nationally. These vocabulary services adopt CGI vocabularies where appropriate for their needs and augment them with vocabularies that are more specific to individual state requirements or Australia in general (for example mineral tenement type and status). The vocabulary production process is continuing to utilize the data systems implementation company KurrawongAI and utilizing the GitHub web-based coding repository. The process involved vocabulary construction within a structured Excel template that can be converted into a SKOS-RTF (TTL) file format that can be published via the VocPrez web delivery system code. The technical nature of the process is being made easier through new coding applications under development. The Australian geological surveys are intending to share and reuse vocabularies wherever possible and this is being governed through GGIC's recently restarted Controlled Vocabulary Working Group.

- ***Data Transfer Standards***

The Borehole Harmonization Working Group, which reports to the GGIC Petroleum Reporting Working Group, is developing a Borehole Status Vocabulary and Borehole Purpose Vocabulary for jurisdictional harmonization of borehole terminology. The vocabularies are in draft status, and currently are under review by participating state and federal agencies.

- ***FAIR compliance***

Geoscience Australia (GA) has a number of systems that exemplify FAIR compliance, including:

- **Persistent Identifiers (PIDs)** – Digital Objects Identifier (DOIs) are minted for products delivered by Geoscience Australia that resolve to the metadata landing pages. This process has now been standardized using the DataCite international DOI registry.
- **Catalogue** – eCat is GA's metadata catalogue that provides a single point for all science products that can be accessed through the Discovery Portal or using the OGC standard catalogue service.
- **Metadata** – eCat uses the ISO 19115-1 standard for geographical metadata, and GA's dedicated metadata profile ensures comprehensive information is available to describe and provide context to our science products.
- **Delivery protocols and web services** – GA makes data available through web services, including OGC standards WMS, WFS, WCS, and WMTS.
- **Vocabularies** – GA maintains vocabulary services that host vocabularies on behalf of GA, CGI and Government Geoscience Information Committee (GGIC). GA vocabularies are also discoverable through the ARDC Research Vocabularies portal.

State and territorial geological surveys in Australia have implemented similar systems, with Geological Survey of Queensland (GSQ) and Geological Survey of South Australia (GSSA) implementing CKAN for their data catalogue, and VocPrez being used for regional level vocabularies by GSQ, GSSA and Geological Survey of Western Australia (GSWA). GSWA will be implementing CatPrez for their main catalogues.

- **AGSON**

The Australian Geological Survey Organizations Network (AGSON) portal is the government geoscience data and services access point <https://www.geoscience.gov.au/> for Australia. All Australian geological surveys contribute web services to the portal. A new underlying architecture is being considered for the portal hosted at Geoscience Australia.

- **New Data Releases**

A new version of the seamless 1:250 000 Geological Map of New Zealand was released in mid-2023. This digital-only dataset is downloadable as GIS data and via WMS and WFS services. The new version includes additional compliance to GeoSciML Lite model and CGI vocabulary standards.

(by Mark Rattenbury and Michael Sexton)

7.4 DDE Standards Task Group and R&D Project

The goal of the DDE-STG is to support implementation of DDE geosciences data standards to meet the need of DDE-WTGs for fast and harmonized data resources growth and toward FAIR. With the strong support of CGI, CODATA and DDE program, the DDE Standards Task Group (DDE-STG) has made significant achievements in 2023 in geoscience standards for DDE, particularly for data and knowledge resources development and FAIR.

There are 30 scientists of CGI, CODATA, DDE and some other organizations from China, USA, France, New Zealand, UK, Italy, Australia, Canada, Denmark, Netherlands, Slovenia, Russia, Brazil, Argentina, Namibia, Botswana, Costa Rica, Brunei, India, Korea, etc. continuously contributed to the DDE standards group and the R&D project in 2023. There are 34% females, 43% young scientists in the DDE-STG and 64% are from developing countries.

DDE-STG leaders, prof. Harvey Thorleifson, Prof. Zhang Minghua keep regularly online meeting to deal with the group affairs with lots supports from Mark Rattenbury and Francois Robida at joint leadership meetings of CGI. Zhang actively in charge of the R&D project management with help of Harvey and group scientists. The secretariat (ddestgsecretariat@ddeworld.org), Ms Kathy (Yu Rui) looks after logistics and meeting arrangement and relevant issues.

DDE-STG host its website at both CGI website (<https://cgi-iugs.org/project/ddestandards>) and DDE website (<https://www.ddeworld.org>). DDE-STG has put its products on Feishu system and CGI website, and the test version of DDE metadata App on the DDE website. DDE-STG will deploy the formal DDE metadata App on the DDE platform for global use start from early 2024, and will help DDE Catalogue system construction at the DDE platform as well in 2024.

DDE-STG has continuously contributed activities news, standards documents and workshop achievement and videos to DDE website since 2021.

- **Major achievements and important meetings**

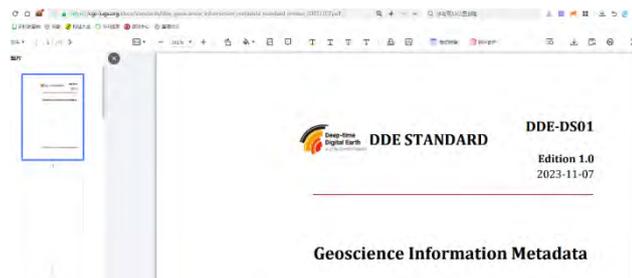
(1) DDE geoscience information metadata standard supports DDE resources Findable

The DDE standards task group (DDE-STG) continuously revised and circulated the DDE metadata standard draft documents within and outside DDE-STG and DDE WTGs in 2023 for a mature geoscience metadata specification to make machine-readable DDE resources Findable. Document finalization was made thru August and October 2023 and welcomed by DDE WTGs and the global geoscience communities.

This standard met the demand from DDE program of simplicity, efficiency, whole coverage of geoscience and related topics and geological historical times. It consists of 13 entities (MD_Metadata, MD_Identification, SV_Service identification, MD_Imagery, MD_SpatialRepresentation, MD_Distribution, CI_Date, EX_GeographicExtent, MD_Identifier, CI_OnlineResource, CI_Responsibility, EX_TemporalExtent, MD_Constraint) and 88 elements (22 Mandatory), 14 code lists and the XSD file. It extends one topicCategory code for geoscience in ISO standard to 41 secondary topicCategories and one more first category dataScience, and ordinary Date and Time to cover geological time by International Commission of Stratigraphy.

The DDE geoscience information metadata standard (Edition1.0-2023) was officially released at the Suzhou international geoscience standards meetings on 7-10 November 2023. It is now on the CGI website for global use (<https://cgi-iugs.org/publication/dde-metadata-standard-v1>). This release marks a milestone in globally recognized DDE standards supporting DDE data and knowledge resources going FAIR.

An interoperability App based on GeoNetwork for population and implementation of this metadata standard in compatibility with ISO19115 standard metadata is being developed and hopefully will be deployed on the DDE platform shortly.



(2) DDE knowledge system review procedure updates and consultations helps the fast development of DDE geoscience knowledge system.

Recommendations and consultations on the DDE knowledge system review and development has been continuously provided by the DDE-STG throughout 2022-2023 to the DDE knowledge group and relevant Working groups and task groups (DDE-WTGs), on using the Formal DDE Knowledge System Review Procedure document (<https://www.ddeworld.org/product>) which is submit by DDE-STG to DDE knowledge group in Aug 2020 and updated in May 2021for DDE disciplinary geoscience knowledge system development, particularly the Geophysics, Hydrogeology, Sedimentology, and Petroleum Geology groups in 2023 on ontology and

knowledge graphs.

(3) General guide for DDE accessible data assessment pushes DDE data quality and Open

Regarding recommendations for the stakeholder review and larger geoscience community data requirements, particularly DDE data resource development globally, the DDE-STG scientists updated the General Guide for DDE Accessible Data Assessment through 2022-2023 for DDE Data Group, as well as consultations on data standards to the group and other DDE WTGs on request. This general guide for data resource evaluation is of cutting-edge importance of the state-of-arts in FAIR and Open Science today, which is based on ISO 19157:2013, FAIR Data Principles, OneGeology Web Services Accreditation Scheme, and current methods for open data resource assessment with data authority, quality, volume, openness, service capacity, and user scale is also taken into consideration.

(4) DDE-CGI Global Geoscience Standards Workshop and Forum outlined a strategy plan for CGI and DDE geoscience knowledge and standards framework towards FAIR.

An international in-person workshop and forum on Status and the Future of Global Geoinformation Standards and DDE Progress were held on 7-10 November, 2023 at Suzhou through collaboration by CGI and DDE, with magnificent success. A wide and deep outlook after tremendous thoughtful discussions for next step international geoscience information science cooperation particularly focusing on DDE has been formed, that will contribute greatly to the development of DDE.

Some 20 experts in geodata and standards from Australia, Denmark, France, Netherlands, New Zealand, Slovenia, Botswana, UK, USA and China joined in-person and some more others joined online discussed geoinformation standards used in a number of databases currently accessible on the DDE Platform (www.deep-time.org), and recommendations for future improvements were also made. Keynote presentations, panels, and discussion groups that followed in the subsequent days of the workshop generated many ideas and suggestions for international collaboration on data standards for geoscience information that could facilitate and advance data-driven research.



DDE-CGI Nov 2023 Suzhou meetings on geoscience standards.

DDE-STG international scientists and experts from worldwide visited the Suzhou center during the Nov DDE-CGI Meetings. This was the first time for the DDE center to be shown to this group of international geoscientists, thus greatly promoting DDE to global geoscience communities.



DDE-STG and geoinformation scientists visited Suzhou center in Nov 2023

(5) Close cooperation with CODATA on DDE resource going FAIR

The DDE-STG actively and deeply participated in the cooperation with CODATA in 2023, including the MOU between DDE and CODATA in September, and a new R&D project proposal on FAIR Principles Implementation for DDE has also submit in November 2023 by collaboration drafting of DDE-STG, CODATA, CGI and relevant organizations.



(6) Progress in the DDE Standards Group presented at the 29th Colloquium of African Geology, 25 September 2023, Windhoek, Namibia.



DDE standards progress report at the 29CAG on 25 Sep2023 in Windhoek, Namibia.

(7) The planned session on DDE geoscience standards and knowledge graph will be held at

the 37IGC 2024 at Busan, Korea. And lots work on the preparation has been done, including 2 keynotes speakers and titles are fixed and some paper abstracts from colleagues are ready.

- ***Geoscience Standards Promotion and Training workshops***

There were dozens of meetings in China, in-person and online in 2023 for training and capacity building for DDE-WTGs and DDE-STG itself as well, including DDE Chinese Assembly and DDE-WTGs workshops on knowledge system development, database constructions, China-node promotions, etc., for example at SINOPEC in Beijing on petroliferous basin evaluation knowledge system and knowledge graph standards, in Wuhan on hydrogeology knowledge system and African geothermal map compilation standards, in Beijing for geophysical knowledge system construction and database standards, and so on.

And several seminars on DDE metadata standard revision and training in June, July, Aug2023 within DDE-STG and relevant DDE data group, knowledge group and platform group which contributed to the metadata standard. Three times training discussion on implementation of the DDE metadata standard for DDE data group and relevant groups were also conducted in Nov 2023 already. And also consultations on temporal ontology development were provided by DDE-STG scientists to the DDE knowledge group in middle November, 2023.

Activities and deliverables of the DDE-STG have made significant contributions to making DDE widely visible to the international geoscience communities and industries. Several promotion events including conference papers and presentations, panel discussions at important international meetings, such as GIC38 in May in Ljubljana, CAG29 in Sep 2023 in Windhoek, training workshops of CODATA-GOSC in September 2023, BRI-environment and information technology in November 2023, and especially the November Suzhou international geoscience standards workshop and forum.

- (1) DDE Chinese Assembly and DDE geoscience standards training workshop, 21-25 March 2023, Hangzhou.



DDE-STG joined DDE China Assembly in Nar2023 and held standards training workshops

- (2) DDE geoscience standards progress report at the GIC meeting, 8-11 May 2023, Ljubljana Slovenia, which led to the negotiation for GSEU to join DDE.
- (3) CGI-OGC Standards for Open and FAIR Data progress report, 7 September 2023, International Training Workshop on Open Science and SDGs, Beijing.

(4) Geoscience standards supporting DDE Open and FAIR data, International Training on Resource & Environment Scientific Data Sharing along the Belt and Road, 13 November 2023, Beijing.

- ***Contributions and support to DDE Medium Term Plan objectives***

For the 6 objectives of DDE MTP, DDE-STG contributions and supports are focusing on the 1st of Cyberinfrastructure serving geosciences communities based on existing knowledge base and data standards and the 4th and 5th of Prioritized integrated/metadatabase development. The specific deliverables of DDE -STG are and would be,

- (1) DDE Knowledge System review procedure document and consultations provided to DDE-WTGs on science contents and functionality have helped DDE to achieve a high-quality knowledge system/graphs to serve geosciences communities.
- (2) DDE metadata standard (Edition1.0-2023) on DDE data, knowledge and service resources Findable and Accessible throughout the internet and DDE Cyberinfrastructure with geoscience and deep time characteristics, and wider coverage of geoscience domains and category topics (Extend the only one code “GeoscientificInformation” in ISO standard to 41 secondary categories of geoscience), capable and accuracy expression of geological time, and geoscience data acquisition methods, etc. And it’s compatible with existing international initiatives (OneGeology, INSPIRE for instance), ISO19115-3 and OGC CSW in machine readable, as well. This will help greatly to global metadatabases harvest and integration.
- (3) DDE geoscience data standards formwork to be established based on existing well implemented CGI/OGC standards like GeoSciML, EarthResourceML, Geoscience Terminology/Vocabularies and GroundWaterML will guide the 10-year DDE program, particularly DDE-WTGs for disciplinary databases and knowledge graphs development with Interoperable and Reusable that benefit global geoscientists on data driven research and discovery with distributed DDE data and knowledge resources.

Given that the existing norms and standards prescribed under ISO and other organizations are not sufficient for facilitating the creation of new and integrated metadatabases and databases as foreseen under MTP Objective 4 and 5, the work of DDE -STG are particularly important and critical. And some significant results has obtained in 2023 with the hard work of DDE-STG.

Other deliverables of DDE-STG may include free software packages like App for conveniently implement these DDE metadata standard and other relevant API for data exchange standards, GeoSciML for instance, to be easily implemented to save time of DDE-WTGs scientists, and also the guide for geoscience data resource FAIR evaluation which will help the development of DDE program fast and with high quality.

- ***Work Plan 2024***

Along with the DDE R&D project on DDE geoscience standards, which particularly focus on accurate handling DDE-WTGs demands and comprehensive studies on DDE geoscience standards framework and also development of software tools for DDE distribute data resource exchange and harmonization, and to interface DDE portal/platform with DDE metadatabase

and Catalogue system, and with global existing platforms and systems, the DDE -STG will help to conduct the following four activities and obtain relevant expected results in 2024.

- (1) Population of the DDE metadata standard (Edition 1.0-2023), within DDE-WTGs and global geoscience communities with open source App development and improvement together with the DDE R&D projects for a metadata standard with App with deep-time characteristics and FAIR data principle, to develop a shared understanding of current practice, cross-domain interoperability and machine-actionability of data and metadata.
- (2) Conduction of the jointly proposed R&D project with CODATA on DDE data resource FAIR if approved in 2024. Focus on WorldFAIR methodology training workshops on geoscience data FAIR profiles and DDE geoscience data resource FAIR demonstration preparation, to examine the technical documents and experiences for FAIR with/on existing geoscience database (dataset), typically with geological survey organization data like DDE-China node geological map data, and academy research data like Igneous Rock database (OnePetrology), and other community databases, such as Mindat, OneGeochemistry, or, OneSedimentology, OneStratigraphy, in collaboration with relevant WTGS and relevant communities.
- (3) DDE Knowledge System review, release and FAIR evaluation, by undertaking a review organization conducting physically review by relevant top experts and an evaluation of the DDE Knowledge System in relation to “FAIRness”, in collaboration with CGI and the relevant WTGs like DDE knowledge group, etc. and communities like OneGeochemistry, OnePetrology and other geosciences communities using the DDE-Knowledge System.
- (4) Promotion of DDE resources FAIR and supporting standards, with support from international standards including DDE/CGI/OGC/ISO, etc. methodologies and expertise, with collaboration with global organizations and communities, particularly CGI, CODATA, IUGS, IUGG, ISC. Activities includes sessions, townhall meetings and symposiums at big international events like IGC2024, and EGU, AGU, etc.

- **Relevant information**

DDE-STG thanks DDE secretariat, Suzhou center for support in the past years on conferences organization and other helps, 2023 Suzhou meetings in particular.

DDE-STG Thanks to all the group member scientists and their organizations for support and contributions to DDE geoscience standards work. Thanks also go to DDE-WTGs for cooperation and support.

(by Zhang Minghua)

8. Main problems encountered

CGI activities have evolved to the post-pandemic paradigm of mixed online and in-person meetings. CGI has succeeded in recruiting new leaders, although major challenges remain in funding international travel, and finding capable people who are able and willing to dedicate significant time to needed technical work.

9. Annual Financial Report

- **CGI Council Grants**

CGI Council Grants were anticipated for 2023 but none reached contracting stage. The British Geological Survey work relating to CGI-DDE vocabulary and a GeoJSON version of GeoSciML is still wanted but the host agency has not yet been able to supply a contract agreement.

- **2023 Income and Expenditure Summary**

Transactions in 2023 continued to be light owing to limited travel. The face-to-face meeting of the CGI Council in Suzhou in Nov required payment for meeting rooms.

Invoices and financial statements are stored in Finance folders in the CGI Council's Google Drive document repository.

- **Significant income**

IUGS awarded an annual grant of USD 15,000 for CGI operational activities.

- **Significant expenditure**

Payment of USD 10,000 for the Suzhou meeting room hire (Xin Place) for CGI-led meetings on future geoscience information standards.

Payment of USD 2497.50 for reimbursement of flight and hotel expenses for the CGI Chair Harvey Thorleifson to attend the upcoming IUGS Executive meeting in Nairobi, Kenya.

- **Summary of transactions**

Transaction Date	Transaction description	Debit	Credit	Balance
01 Jan 2023	Opening balance (New Zealand account NZD)			\$37,244.06
16 Mar 2023	IUGS annual grant		\$23,877.37	
16 Mar 2023	Bank Charge	\$15.00		
29 Nov 2023	CGI Suzhou meeting room hire	\$16615.71		
29 Nov 2023	Bank Charge	\$33.86		
11 Dec 2023	IUGS Executive travel for CGI Chair	\$4,175.79		
31 Dec 2023	Closing balance (New Zealand account NZD)			\$40,281.07

Closing balance is equivalent to USD 25,477.92 (as of 1 January 2024 NZD-USD exchange rate).

- **2024 Budget**

Balance 1 January 2024 (USD)

\$25,477.92 Carried over from 2023

Income for 2024 (USD)

\$10,000 DDE grant for 2023 for DDE-STG activities

\$10,000 Requested 2024 funds from IUGS

Expenditure for 2024 (USD)

\$18,000 DDE-specific metadata and GeoNetwork parts of the BGS contract (to be confirmed)

\$12,000 BGS contract for vocabulary and GeoJSON development (DDE-STG, to be confirmed)

\$3,000 Meeting room hire (face-to-face CGI Council and WG meetings in Korea)

\$10,000 CGI Grant funds for commissioned projects - proposal(s) to be sought

\$2,000 Travel to IGC Korea for Chair final payment – likely less than this

Balance 31 December 2024 (USD)

~ \$- 1522.08 (estimated in Jan 2024)

(by Mark Rattenbury)

10. Work plan for 2024

- Complete a 2024-2028 Action Plan to ensure that CGI addresses the most pressing needs for geosciences standards, through collaboration with DDE, Codata, OGC, ISO and other partners, in particular through the CGI/OGC Geoscience DWG and collaboration with GIC.
- Organize geoscience information sessions of **IGC37** 2024 in Busan Korea and promote CGI and DDE-STG achievements and standards for Open and FAIR geoscience.
- Support DDE, through a leading role in the DDE-STG and an R&D project on FAIR Principles for DDE, to both support DDE and implement CGI standards in cooperation with CODATA.
- Set up working groups for themes such as AI and knowledge graphs in geoscience, so as to play a leading role in geoscience information communities within IUGS.
- Continue to push forward the implementation of CGI standards. With GeoSciML now being an OGC Standard, start a CGI-funded project for its GeoJSON encoding, and to test digital docker containers for geoscience data model installations. For EarthResourceML, complete the next version with emphasis on critical materials. Also, consider how these standards function within the new OGC API suite.
- Continue to develop geoscience vocabularies, and improve existing vocabularies, including expanded multilingual terms; start setting up authored services on geoscience vocabularies and knowledge graphs for global users, based on multilingual implementation and GitHub hosting of CGI vocabulary services completed by CGS.

- Start hosting geoscience standards co-issued by CGI and issued by other organizations and initiatives with agreements to make CGI-IUGS an authorized organization for global geoscience standards management and maintenance.
- Update and enrich the CGI website.
- Continue to publish the CGI newsletter regularly, regularly contribute to IUGS E-Bulletins, and ideally submit papers to IUGS “Episodes”.
- Represent the IUGS in Geoscience information matters
 - Effective collaboration with CODATA in DDE-STG, DDE R&D projects, and more.
 - Enhanced relations with RDA, OGC and ISO.
 - More activities on geoinfo relevant to UN SDG’s.
- Increase support to regional initiatives, e.g. by organizing workshops and training courses on geoscience information management and application, standards and language.
- Recruit capable people, especially younger scientists from both geoscience and IT backgrounds to work with CGI working groups and to undertake collaboration projects.
- Election of the new 2024-2028 council.
- Hold the next CGI annual meeting in association with the 37 IGC in Aug 2024.

11. Critical milestones

The in-person Suzhou meetings co-hosted by CGI and DDE on 7-10 November 2023 were a tremendous success in guiding the development of CGI plans for 2024-2028. The formal release of the DDE Geoscience information metadata standard marked a milestone in globally recognized geoscience information metadata specifications, with richly detailed machine-actionable geoscience characteristics that are convertible with ISO19115-3, to ensure that DDE data and knowledge will be FAIR. This metadata standard has now been issued by CGI/CODATA/DDE-WTGs scientists worldwide.

12. Budget request for 2024 and potential funding sources

➤ In 2024, CGI Council requests 10,000 USD from IUGS.

These funds will support meeting expenses at 37IGC in Korea, and to support 2024 projects such as GeoJSON encoding for GeoSciML, updated EarthResourceML for critical minerals, an implementation test of the digital docker containers for GeoSciML multilingual vocabularies services installation, and authorized services on geoscience vocabularies and knowledge graphs. As the commission for geoscience information of IUGS, in 2024 CGI will enhance coordination with partners, upgrade standards, and complete a new multiyear plan. Anticipated DDE R&D project funding will support the DDE Standards Task Group with involvement by CGI members.

13. Objectives and work plan for the next 5 years

CGI Council met 4 times in 2023, plus a session to start a new 5-year plan. Objectives include:

- Support the IUGS DDE program by leading the DDE Standards Task Group, through R&D projects that ensure that DDE data and knowledge will be FAIR, including cooperation with CODATA, and implementation of the DDE geoscience information metadata standard.
- Play a role within IUGS to prepare for current AI applications, and update geoscience knowledge infrastructures by setting up working groups in 2024 that benefit stakeholders.
- Select and fund projects with British Geological Survey on GeoSciML in GeoJSON to widen use, and put into application the grant-funded project results by Geological Survey of Canada in digital docker containers for geoscience data model installations and by BGS for multilingual implementation and GitHub hosting of CGI vocabulary services.
- Act on CGI holding geoscience standards co-issued by CGI and issued by other organizations with agreements that make CGI-IUGS an authorized organization for global geoscience standards management and maintenance, to meet demands from all sides, including setup of authorized services on geoscience vocabularies and knowledge graphs.
- Play a role in coordination of regional initiatives, e.g. by organizing workshops and training on geoscience information management and applications, standards and language.
- Recruit capable people, especially younger scientists from geoscience and IT backgrounds to work with CGI standards working groups and to undertake collaboration projects.
- Review the scope and intent of the CGI working groups as data standards mature and new opportunities arise, for example, developing interoperability of 3D - 4D geosciences data models and geoscience ontologies, as well as geoscience knowledge graphs.
- Catalyze alliances between geoinfo bodies, including OGC, CODATA, RDA, & Linked Data.
- Provide support to UNESCO Open Science and ISC FAIR data principles by promoting international use of data exchange standards (especially adoption of GeoSciML, EarthResourceML and CGI geoscience vocabularies) in regions, commissions, countries, and organizations; facilitate outreach, knowledge transfer and take-up of best practice in geo-information (e.g. with the South America initiative, the Asia initiative, and the GIRAF).
- Enhance collaboration with other IUGS commissions, e.g. ICS.
- Reconcile CGI activity with DDE, CGMW, and OneGeology geoscience events, and organize relevant sessions at 37th IGC in Busan on geoscience information.

14. Suggestions for improvement of IUGS activities

It will be helpful if the IUGS Executive can continue to approve of CGI's management and carryover of annual IUGS allocations over multiple years. This enables CGI to meet intermittent, larger expenditure items such as contracts for specific standards development work, website maintenance, and a CGI presence at major conferences.

15. Conclusion

CGI was active, productive, and influential in 2023, in the field of geoscience information standards, utilizing both online and in-person meetings and activities, with fruitful outcomes. By far the most important highlight of the year was the international in-person Workshop and Forum on the Status and Future of Global Geoinformation Standards in November 2023 at Suzhou, China. These highly successful meetings attracted 40 expert scientists from around the world, including colleagues from many partner agencies.

Throughout the year, CGI Council meetings were held, in Jan, June, Aug, and Nov, plus a Council planning session in Dec. A new 5-year CGI strategic plan to be developed through 2024 will outline achievable goals that will meet needs both urgent and long-term from the global geoscience community and relevant stakeholders. CGI has active and productive topical working groups, and regional alliances. The CGI website is up to date. Timely CGI News items were produced for release as the CGI Newsletter, on the DDE web site, and in IUGS E-Bulletins. The CGI-led DDE R&D project on Geoscience Information Standards was completed and the DDE metadata standard for geoscience information was released, with FAIR resources.

The ambition of CGI is to accelerate our response to global geoscience community needs for standards and procedures for FAIR information, by considering current technological developments and new needs for the future, such as semantic web, linked data, big data, artificial intelligence, digital twins, ontology, knowledge graph, and more.

To do this it will be important to maintain and strengthen relationships:

- with **geoscience professional communities**, with the support of their organizations, through a presence in international conferences and projects such as DDE, OneGeology, EPOS, and AuScope, and also with other disciplines through CODATA and the RDA,
- with the **geoscience industry**, a major producer of data, to promote their adoption of CGI standards, and to learn about needs,
- with **IT and data science sectors**, whose powerful and efficient tools facilitate data-driven and knowledge-driven geosciences,
- with other **standards** organizations such as OGC or W3C,
- with software **developers** to encourage and facilitate their implementation of CGI standards, and
- with **geoscientists** around the world to facilitate the deployment of these standards.

To achieve these ambitions, it will be important to maintain and renew the expertise available to CGI through recruitment of capable people and establishment of effective working groups. Finally, CGI Councilors would like to express their thanks to all members of the CGI and its regional and working groups, and also to the members of the IUGS Executive Committee for their help and encouragement. We are very much looking forward to continuous and productive cooperation in 2024, with the highlight being the 37th IGC in Korea.

CGI Council, 12 January 2024

➤ Appendix – CGI Council members 2020-2024

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