



CGI ANNUAL REPORT 2021 & 2022 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 within IUGS science policy

CGI fills 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 Council members hold significant positions within the international geosciences information community.

3. Organization, Council members and officers

- *Council Officers 2020-2024*

The CGI Council members are:

- Harvey Thorleifson (Chair) – USA
- Zhang Minghua (Co-Secretary General) – China
- Kombada Mhopjeni (Co-Secretary General) – Namibia
- Mark Rattenbury (Treasurer) – New Zealand
- Kazuhiro Miyazaki – Japan
- Éric Boisvert – Canada
- Christelle Loiselet – France
- Edward Lewis – UK
- Mauricio Pavan Silva – Brazil

- Ollie Raymond (Observer) – Australia
- David Percy (Observer) – USA
- François Robida (former Chair) – France

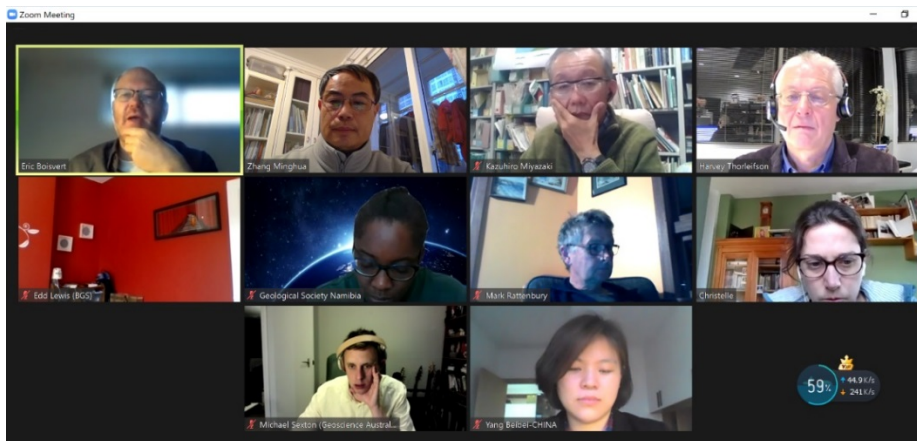
The Council was elected in 2020 for the term 2020-2024. One new member from Brazil geological survey as the representative of South America was recommended and accepted in 2021. CGI Council members are now widely distributed across all the continents. The list of contacts is given in the Appendix.

Under the leadership of Chair Harvey Thorleifson, CGI remained very active in 2021, utilizing the online means that have been dictated by the COVID-19 pandemic. Excellent council meetings were held on January 18th, April 14th, June 30th, and on September 16th, on various relevant important issues such as CGI standards implementation, geoscience knowledge and data science trends and cooperation between partners, and CGI strategy for the future.



AGENDA	
Location:	Online
Time:	11:00 – 12:30 UCT
1.	Welcome and confirmation of agenda HT
2.	Minutes of last Council Meeting KernM
3.	Chair HT
4.	Treasurer Finances CGI grants MR
5.	Co-Secretary General IGUS 2020 report Correspondence Membership Promotion (1/yr, etc) ZM
6.	Co-Secretary General Newsletter GSA KernM
7.	Working Groups geoskills EarthResourceM Deep Time Digital Earth Geoscience Terminology CGI/IGGC Geoscience Domain EB MS ZM, HT MR MB

CGI Council meetings online –January 18, 2021.



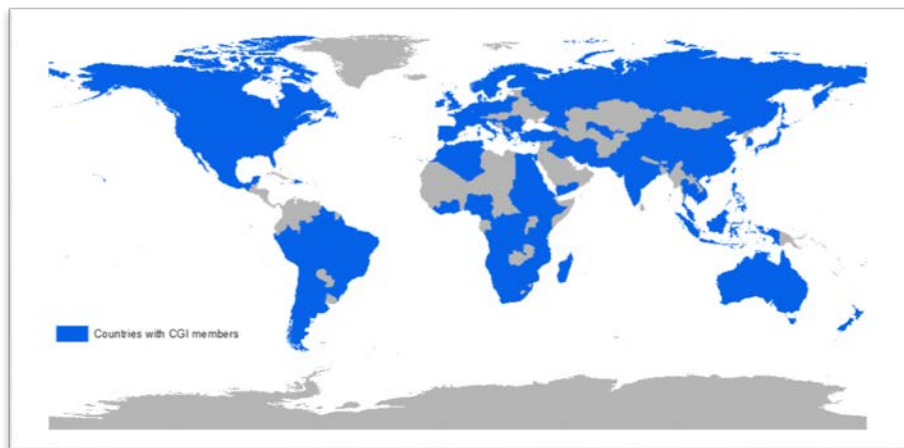
CGI Council meetings online on April 14, 2021.

CGI hosted a tremendously success webinar on June 23rd, and an equally successful Technical Seminar on September 9th. CGI leaders made major contributions to DDE Standards Training on October 26th-28th.

The CGI secretariat is located at the Development Research Center of China Geological Survey, Ministry of Land and Resources. The contact email is CGIsecretariat@mail.cgs.gov.cn.

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

- GeoSciML Standards Working Group (GeoSciML) – Éric Boisvert, Canada in collaboration with the Open Geospatial Consortium (OGC)
- EarthResourceML Working Group (ERML) – Michael Sexton, Australia
- Geoscience Terminology Working Group (GTWG) – Mark Rattenbury, New Zealand
- GeoScience Domain Working Group – Mickael Beaufils, France in collaboration with the Open Geospatial Consortium (OGC)
- Geoscience Information in Africa – Network (GIRAF) – Mesfin Wubeshet Gebremichael, Tanzania
- DDE geoscience standards project – Harvey Thorleifson (USA), Zhang Minghua(China) and Alena Rybkina(Russia)



Global distribution of CGI members (countries in blue).

- **Membership**

CGI now has 523 members in 82 countries across the world. Several new members from India, China and Canada have joined in 2021 during the pandemic which has affected activities of all geoscience organizations and CGI for 2 years.

CGI continued using the LinkedIn group (<http://www.linkedin.com/groups/6539642>) for some conferences and related documents.

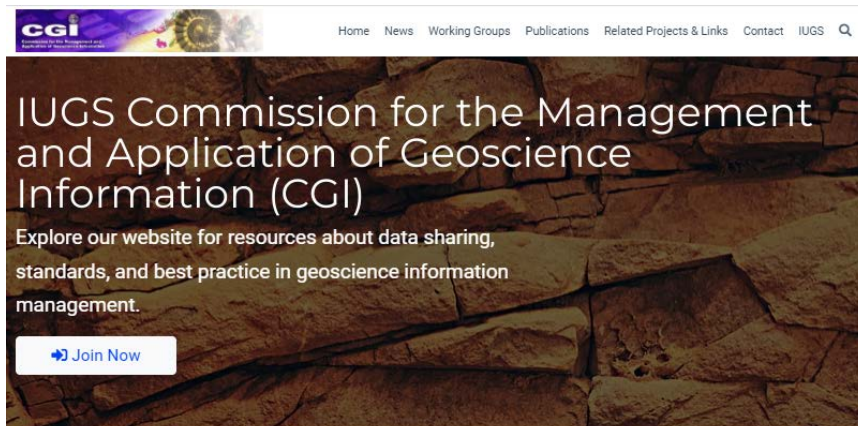
4. CGI online presence and Newsletters

- **CGI online updates 2021**

The new CGI website <https://cgi-iugs.org> is being continuously updated since being moved onto GitHub. Two excellent CGI Newsletters in May and August, and activity reports, were released on the website. CGI's activities were also reported and released on the IUGS E-Bulletins No.174, 176, 180 in 2021.

CGI updated its online flyers with updated coverage of its functionalities and collaboration partners in June, and put them also on IUGS website for view and download.

The cgi-iugs.org domain has been renewed for a further 9 years till Jan 2031.



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 Bolsvert



Geoscience Terminology Working Group (GTWG)

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

Mark Rettenbury

There also has been significant rationalisation on Github of repositories related to the functioning of geosciml.org, bringing them all under the <https://github.com/CGI-IUGS>.

Website: www.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/>

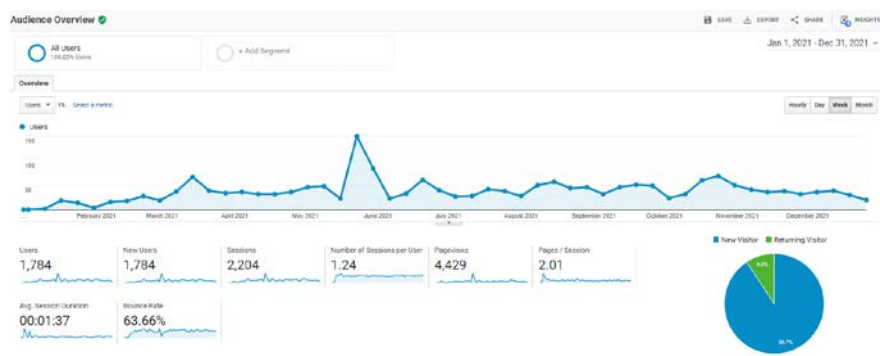
OGC-CGI Geoscience Domain WG: <https://cgi-iugs.github.io/project/geosciencedwg/>

The GitHub- hosted site went live in Q1 2021 at <https://cgi-iugs.org/>. Unfortunately the <https://www.cgi-iugs.org/> couldn't be redirected, however our analytics would indicate our users have continued to find the site and associated sites, <http://geosci.ml.org/> & <http://earthresources.ml.org/>.

Further work has been undertaken on the geosci.ml.org pages to remove orphaned and redundant pages.

- *Analytics – cgi-iugs.org*

Total users for the year was 1,784. In comparison, geosci.ml.org had 5,190 visitors and earthresources.ml.org had 878.



cgi-igs.org audience overview


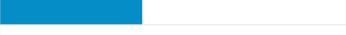
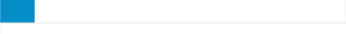

The CGI vocabularies register pages (<http://geosci.ml.org/resource/def/voc/> & <http://geosci.ml.org/resource/>) had over 3,500 page views.

The top 10 Country of origin for cgi-iugs.org is shown in the figure below. The breakdown was very similar for geosci.ml.org and earthresources.ml.org.

Country	Users	% Users
1. China	537	30.02%
2. United States	379	21.19%
3. Australia	94	5.25%
4. Canada	88	4.92%
5. Japan	68	3.80%
6. France	64	3.58%
7. United Kingdom	59	3.30%
8. Finland	49	2.74%
9. Germany	40	2.24%
10. India	38	2.12%

cgi-iugs.org user country of origin

Users most commonly get to cgi-iugs.org by accessing the URL directly, followed by access via Google and via links on other websites (possibly <https://geosci.ml.org/> or <https://www.iugs.org/>).

	Acquisition		
	Users	New Users	Sessions
	1,784	1,784	2,204
1 Direct	915		
2 Organic Search	734		
3 Referral	176		
4 Social	6		

cgi-iugs.org acquisition path

Social media appears to not offer many conversions of users to the website. Between both <https://cgi-iugs.org/> and <https://geosciml.org> in total 9 users came to the sites from Facebook, 2 from LinkedIn and 1 from Reddit.

(by Edward Lewis)

5. Extent of support from sources other than IUGS

Other than the substantial in-kind contribution by the geological organizations that pay the salaries and expenses of CGI Council and members, the CGI does not receive additional support. CGI workshops and activities are sometimes co-organized or supported by other organizations and projects such as UNESCO, Minnesota Geological Survey, Geological Survey of Canada, China Geological Survey, GNS Science (New Zealand), Geological Survey of Namibia, Australian Aid, and the United Nations Development program and the project of IUGS big science program Deep-time Digital Earth(DDE).

6. Interaction with other international organizations

- *CGI collaboration with OGC*

CGI, in collaboration with OGC, is continuing to develop the GeoSciML geology data model standard. Both the linked global OneGeology project and the past European EC project OneGeology-Europe are using GeoSciML to make geological data interoperable and accessible via their web portals. The EC Directive INSPIRE used CGI products for their Geology and Mineral Resources Implementing Rules: the GeosciML and Earth Resource ML (ERML) data model and CGI vocabularies. ERML was adopted by major EU funded projects as Mineral4EU or EURare.



- *CGI and CODATA*

CGI and CODATA jointly set up the Standards Task Group (DDE-STG) for the IUGS big science program DDE in 2019. In addition, a 3-year empowered project on Geoscience Information Standards for DDE was approved in 2021 by the DDE science committee and executive committee. Apart from helping DDE on the geoscience knowledge system review, the project will deliver geoinformation standards support to implement the DDE program in the coming 3 years.



- *CGI and DDE*

CGI is one of the founding members of the IUGS DDE program. CGI has been continuously active and successfully leading the DDE Standards Task Group (DDE-STG) in collaboration with CODATA and other DDE working groups and task groups. A total of 28 geoscientists, including 14 CGI member geoscientists and CGI councillors, are now working in DDE-STG.



- *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. The OneGeology mineral service based on ERML lite was prepared in 2021 and is ready for release in 2022.



7. Chief accomplishments and products

7.1 CGI News

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

As one of the founding members of the IUGS big science program DDE, CGI set up the DDE-STG together with CODATA and DDE in 2019, and the first formal face to face meeting of the DDE-STG was successfully held in early 2020 in Beijing. With the strong support of the CGI council and scientists, DDE-STG issued a knowledge system review guide and draft metadata standard for DDE in 2020 and 2021.

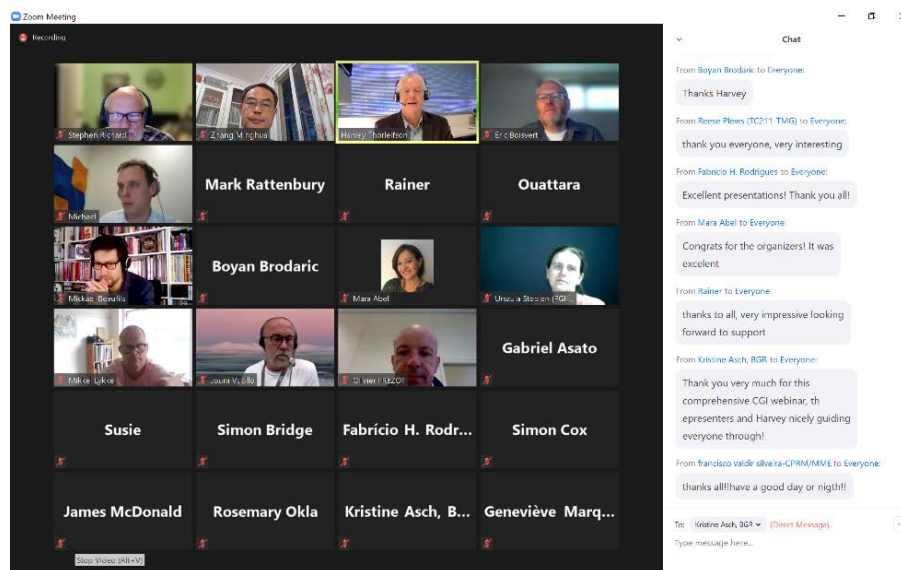
CGI hosted a successful Technical Seminar on September 9th, with DDE involvement, on knowledge graph and ontology. CGI leaders and scientists made major contributions to the comprehensive DDE Geoscience Standards Training on October 26th-28th.

- *CGI standards promotions*

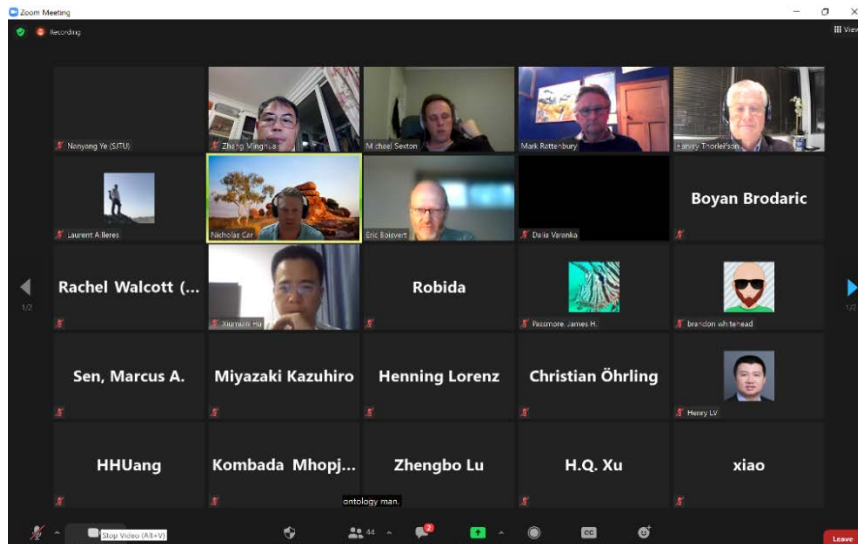
CGI standards were introduced to scientists, geologists and officials from a variety of organizations and initiatives at events and workshops in 2021, including CGI webinars, DDE meetings, as well as CCOP and ASEAN online sessions.

The webinar hosted by CGI on 23 June 2021, from 10 AM to Noon UTC, was attended

by 91 experts from around the world. **Harvey Thorleifson**, CGI Chair, indicated that the objective of the webinar was to share updates on the work that CGI is carrying out with partners, and to hear discussion. He thanked partners who were mentioned in the six presentations that followed. Discussion and feedback indicated that the webinar was a great success. Videos are available on [YouTube](#). **Mickael Beaufile** of BRGM spoke as Chair of the Open Geospatial Consortium (OGC) Geoscience Domain Working Group (DWG), that partners with CGI and many other organizations in making spatial information findable, accessible, interoperable, and reusable (FAIR). **Éric Boisvert** of the Geological Survey of Canada spoke on behalf of the OGC Standard Working Group (SWG) for GeoSciML (Geoscience Markup Language), an XML- and GML-based machine-readable format for geological maps that has been stable for almost two decades since emanating from work such as XMML, NADM, and G-XML. **Michael Sexton** of Geoscience Australia provided an overview of EarthResourceML (ERML), a markup language for the delivery of mineral occurrence, deposit, mining, and resource data that was initiated in 2006 as a collaboration between Australian state and federal agencies. **Mark Rattenbury** of GNS Science in New Zealand, spoke for the CGI Geoscience Terminology Working Group, which maintain lists of terms for earth features, properties, quantities, techniques, and processes that are collaboratively agreed upon and are widely accessible, including to machines. **Boyan Brodaric** of the Geological Survey of Canada, and Stephen Richard of the USGIN Foundation in USA, reported on GeoScience Ontology (GSO) research being conducted in association with Loop, an integrated and interoperable platform enabling 3D stochastic geological modeling. **Zhang Minghua** of the China Geological Survey, Co-Secretary General of CGI, described the work of the Deep-time Digital Earth Standards Task Group (DDE-STG) and existing CGI standards application in DDE and cooperation plan for supporting DDE.



CGI's June 23 Webinar attended by 91 registered scientists.



CGI-DDE-LOOP seminar on knowledge graph and ontology on 9 Sep. 2021.

On 9 September 2021, CGI held an informal technical seminar on geoscience ontology and knowledge graph, that was attended by a great members of scientists and friends of relevant working groups of CGI, LOOP 3D and knowledge group of DDE, and the partner organizations. Videos of this seminar are also put on [YouTube](#).

7.2 Working Group Reports

7.2.1 GeoSciML Standards Working Group



- *Membership and repository*

The official OGC GeoSciML Standards Working Group (SWG) membership stands at 49 members and observers. The public GeoSciML mailing list has more than 100 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 GeoSciML: [https://cgi-iugs.github.io /project/geosciml/](https://cgi-iugs.github.io/project/geosciml/) and <http://schemas.opengis.net/gsml/4.1/>. The GeoSciML SWG's GitHub repository provided by OGC is located at <https://github.com/opengeospatial/GeoSciML>. Sylvain Grellet (BRGM) and Éric Boisvert (GSC) have management responsibilities.

- *Meetings and activities*

There were few official GeoSciML activities during 2021 due to the pandemic, apart from activity jointly conducted with CGI's other working groups, attending CGI hosted webinars, and the DDE standards training workshop in Oct 2021, at which, Eric Boisvert and Ollie Raymond delivered talks on GeoSciML and relevant standards, and the next steps towards FAIR and machine based applications.

Other activities do not affect the model itself, but reflect a shift regarding how data are used, by machine learning and artificial intelligence. The emergence, and fast growth, of these technologies is pressuring geoscience information providers to feed data-hungry algorithms with data and knowledge. Loop3D (<https://loop3d.org/>) in partnership with OneGeology, is concluding the current phase of development of the Knowledge Management Work Package, a knowledge encoding (OWL/RDF) of GeoSciML. The ontology community is leveraging the GeoSciML model and vocabulary in an attempt to encode geoscience knowledge.

- *Uptake*

There is an increasing amount of GeoSciML-based web services, mostly because of OneGeology and INSPIRE and spinoff projects and large initiatives such as GeoEra, etc. GeoSciML lite is by far the most popular version because of its simplicity. This sends a strong message that simple models are a key to driving uptake.

IDBE Geotech is including GeoSciML in their standardization and has planned creation of a Geotechnical Extension of GeoSciML. This work is came to fruition in late 2021.

The emerging focus is to build knowledge representations (such as OWL) while several projects are looking into encoding vocabularies to enable machine reasoning and linked data applications. GeoSciML, and especially the work of the Geoscience Terminology Working Group, is attracting much interest from the knowledge representation community.

- *Future work*

At the latest OGC GeoScience DWG, it was agreed that progress be made on GeoSciML encoding issues that have been lingering. The uptake of the new OGC API – while not imposing any specific encoding – brings some expectation from developers that services provide formats from the JSON family.

Because of its simplicity, and popularity, GeoSciML-Lite has been identified as a quick win for *JSON encoding. RDF encoding is already being undertaken by Loop3D, under the OneGeology umbrella. This effort follows early contributions from BRGM, addressing a different modelling and encoding perspective.

(by Éric Boisvert)

7.2.2 Geoscience Terminology Working Group

- *Activities*

The membership of the group numbers 27. Members come from Australia, Brazil, China, Denmark, Finland, France, Germany, Great Britain, Italy, New Zealand, Poland, Russia, Slovenia, Spain, Sweden and USA. Membership is defined and 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 2021 face-to-face meeting was not held due to ongoing travel restrictions imposed because of the Covid-19 pandemic.

The GTWG activities are described under link from CGI's website, simplified and updated in late 2016, http://www.cgi-iugs.org/tech_collaboration/geoscience_terminology_working_group.html and from the GeoSciML website at <http://www.geosci.ml.org/>

- *Achievements*

No new vocabularies have been adopted. Progress has been slowed in part because of not having a face-to-face meeting to accelerate vocabulary publication and because the vocabulary publication process through Github has not been streamlined.

The vocabulary host service, a cloud-based VocPrez instance managed by Geoscience Australia, is working well for published vocabularies and these are findable in the Australian National Data Service (ANDS) Research Vocabularies Australia (RVA) [Portal](#).

Mark Rattenbury was invited and presented to the online-only SciDataCon 2021 meeting in October on the importance of governance for vocabularies, presented on GTWG work at the CGI webinar event in June, presented on vocabularies to the CGI technical seminar in September, and presented a session on geoscience terminology to the DDE-STG training workshop in October.

- *Future Work and Issues*

There remain a number of outstanding GeoSciML data model vocabularies still to complete, although as a priority the GeoSciML Basic module and EarthResourceML requirements have been prioritised. A possible candidate for the problematic mineralDepositType vocabulary has been published by the USGS but not formally discussed within GTWG.

The CGI Council grant awarded to the British Geological Survey to advance and deliver three vocabulary-related items has made limited progress in 2021. The project is to deliver 1) Functioning VocPrez service on Github architecture, 2) Updated SKOS-RDF files for all vocabularies with translated MTG terms and links added to all related INSPIRE vocabularies, and 3) Published SKOS-RDF files for all vocabularies with translated MTG terms and links where available.

The pace of working group activity is still unsatisfactorily low, and the lack of a face-to-face meeting this year due to Covid-19-imposed restrictions has exacerbated this

issue.

(by Mark Rattenbury)

7.2.3 EarthResourceML (ERML) Standards Working Group

- *Activities*

This ERML SWG-report covers the period from January 2021 to December 2021.

The ERML WG 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 (AUS, chair since 2021).

The 2021 face-to-face meeting was not held, nor was an online meeting held in its place. Continued travel restrictions and lockdowns made the organising of an online meeting difficult. An online meeting will be held in early 2022.

The ERML WG participated in many promotional activities, including CGI webinar (23 June 2021) CGI Technical Seminar (9 September 2021) and DDE Standards Training Webinar (26-28 October 2021). Successful adoption of ERML is needed to keep up momentum. It is critical for CGI to maintain and renew the expertise as core people retire.

The ERML WG activities are described under links from the CGI website http://www.cgi-iugs.org/tech_collaboration/earthResourceML.html. Vocabulary work for ERML and GeoSciML standards can be seen via GTWG website at http://www.cgi-iugs.org/tech_collaboration/geoscience_terminology_working_group.html.

- *Data Model Development and Documentation*

The ERML data model

Version 2.0 of the CGI data standard for mineral occurrences and mines 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.

Cooperative work between geoscientists at GA, USGS, and GSC working on critical minerals resulted in a formal mineralDepositType vocabulary, which will be submitted to GTWG.

There were few official ERML activities during 2021, and new full version of ERML is in progress, in relation to mining waste, processing plants and collections of mineral resources and ore reserves.

Documentation

All the CGI SWG web pages have been harmonized, and the ERML web pages (http://www.cgi-iugs.org/tech_collaboration/earthResourceML.html) 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. In the medium term, the major challenge is to get USGS/USA and GSC/Canada to join 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 use of ERML v2.0 such as Minerals4EU and ProSum projects. Further work on the data model was done in 2021, and the next versions of ERML v.3.0 will be published in 2022.

(by Michael Sexton)

7.2.4 The Joint CGI/OGC Geoscience Domain Working Group

A report on the Borehole Interoperability Experiment was delivered in May 2019. At the Dublin OGC meetings, plans had been made to start a working group on 3D standards, and the leadership position is still open.

Some peripheral work has been done in EPOS on description and access to 3D models. There are OGC and CGI efforts on geotechnical data. Several discussions were held with other OGC groups especially with the IDBE (Integrated Digital Built Environment), a joint working group between OGC and building Smart International (bSI) on BIM standards, and on developing standard models for describing the city subsurface.

The recent MUDDI (Model for Underground Data Definition and. Integration) SWG is also targeting a conceptual model to describe the urban subsurface.

With the spread of BIM and the Digital Twin concept, more and more cities are asking for or even experimenting the definition of Urban Digital Twins, including their subsoil.

This context emphasizes the demand for standardized APIs and vocabularies for subsurface description. CGI has great potential for a more significant role in OGC, so more coordination is needed.

Following its official creation in September 2017 (Southampton TC), several sessions of the GeoScience DWG were held in 2018 (Orleans TC, Stuttgart TC), 2019 (Toulouse TC) and 2020 (Virtual TC). Several use cases have been identified and are addressed. Currently the group is chaired by Mickaël Beaufiles (BRGM). Since the departure of the second co-chair Carina Kemp (Geoscience Australia) no substitute was proposed yet.

About GeoScienceDWG: <https://www.ogc.org/projects/groups/geosciencedwg>

Resources: https://external.ogc.org/twiki_public/GeoScienceDWG/WebHome

- *The Borehole Interoperability Experiment (Borehole IE)*

The Borehole IE is defining a domain neutral semantic for a general concept for boreholes and associated data. This activity resulted with the production of a public OGC engineering report (<https://portal.ogc.org/files/19-075r1>) that summarize the overall cross-domain (including Oil&Gas, with Energistics), inter-standard findings and recommendations for a best practice implementation that should follow.

About Borehole IE: <https://github.com/opengeospatial/boreholeie>

Resources: <https://github.com/opengeospatial/boreholeie/>

<http://www.opengeospatial.org/projects/initiatives/boreholeie>

Final report: <https://portal.ogc.org/files/19-075r1>

The CGI/OGC Geoscience Domain Working Group was deeply involved in pushing forward geotechnical data standardization in an harmonized way with OGC-CGI standards in 2021. This was pushed in a project in France called MINnD, then in the activities of the buildingSmartInternational Tunnel project.

The project is now reaching a new step with the launch of an Interoperability Experiment: <https://www.ogc.org/projects/initiatives/geotechie> that aims at bridging (or tunneling) with what is proposed with bSI. The KickOff is expected at the end of February 2022. A White Paper for this activity is being circulated in geotechnical and geoscience communities.

(by Mickaël Beaufiles and François Robida)

7.3 CGI Regional Group Reports

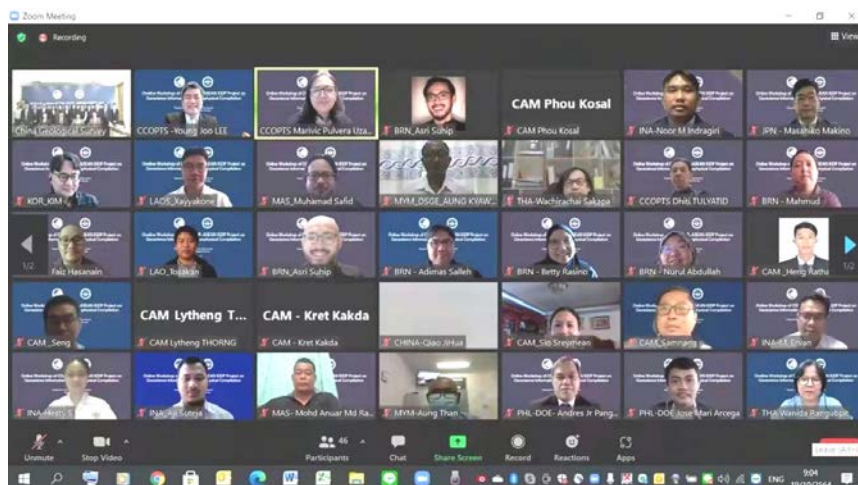
7.3.1 CGI in Asia

Meetings, activities and projects were greatly affected by the COVID-19 pandemic in

2021. However, several important activities in promotion and implementation of CGI-IUGS standards have been conducted, and achievements were made with efforts of the local group.

The Geological Survey of Japan (GSJ) supported the Coordinating Committee for Geoscience Programs in East and Southeast Asia (CCOP) countries in the formulation and server hosting of the WMSs of their geological maps for OneGeology portal registration. These spatial information 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 the OneGeology portal. These maps include 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

An online geoscience information technology training workshop co-hosted by China Geological Survey (CGS) and CCOP TS(technical secretariat office) under the CCOP-ASEAN-CGS Integrated Geoscience Data Processing project (IGDP) Project, funded by the CGS was successfully held on 19-21 October 2021. There were 46 participants from Brunei, Cambodia, China, Indonesia, Japan, Korea, Laos, Malaysia, Mongolia, Myanmar, Philippines, Thailand, Vietnam and CCOPTS attend this event. Several African professionals from Tanzania and Namibia also joined this training workshop. Prof Zhang Minghua, co-secretary general of CGI, acting as the project leader, chaired this event together with Ms Marivic form CCOP TS. CGI/OGC standards were introduced and promoted at the training workshop and activities of DDE Standards Task Group and Southeast Asia task group were also briefed during the training. The IGDP project, aiming to facilitate implementation of CCOP 2021-2025 Strategy Plan and Action Plan, has planned to promote CGI and DDE standards for geoscience data sharing and geological compilation in this region.



Online CCOP-ASEAN-CGS training workshop on Geoinformation on 19-21 Oct, 2021

attracted 46 participants form Asia and Africa

EarthResourceML and other CGI standards were introduced at the ASOMM + 3 (China, Korea, Japan) online conference to ASEAN senior officers in minerals sector for effective data sharing platform development in July 2021 to implement AMCAP 2021-2025.



CGS online training courses on geoscience information sharing technology.

CGS has delivered online training courses in geoinformation technology in 2021 for some 450 officials and technicians from 25 countries, including Geocloud of CGS, geoscience big data apps, Big data storage for geological surveys, etc. and geophysical, geochemical data and high resolution satellite images in mineral exploration, and mineral resource assessment based on big data and AI.

(by Zhang Minghua and Kazuhiro Miyazaki)

7.3.2 CGI in Africa

There were few activities in Africa in 2021 due to COVID-19 pandemic.

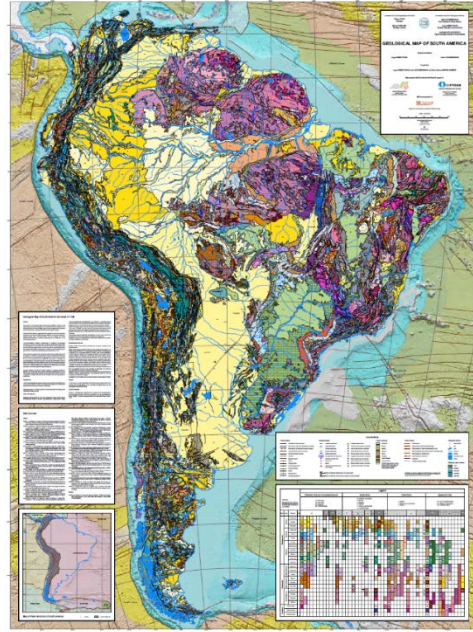
To revive Geoscience Information in Africa (GIRAF) activities and improve engagement with members, the Geological Society of Africa and GIRAF Secretariat held discussions in an online meeting. But the GIRAF workshop did not happen as the 28th Colloquium of African Geology (28CAG) in Morocco was postponed again.

Some discussions on a possible webinar on geoinformation in 2022 in Africa were made.

(by Kombada Mhopjeni)

7.3.3 CGI in South/Latin America

On 30th March 2021, the OneGeology Strategic Steering Committee (OSSC) held via teleconference the 3rd meeting of the committee with the presence of representatives of 10 countries. During the event, the Director-President of CPRM, Ms Esteve Pedro Colnago, gave a presentation on the Tectonic Map of South America, 1:5 M, that had been uploaded to the OneGeology portal. The Director of Data Services & Infrastructure (Dr Matt Harrison - GGRM), thanked him for the presentation and acknowledged the amount and scale of the work that had gone into producing this map, particularly the time it must have taken to collate all the data. He said it was an amazing example of the linking together of so many large scale initiatives and the hard work involved in geological surveys working together to make it possible.



In the up coming meeting of the Association of Ibero-American Geological Surveys (ASGMI) in February 2022, more CGI activities and relevant standards will be presented and surely more activities in national geological surveys in South America will be conducted in 2022.

7.3.4 CGI in North America

In the US, new Federal Geographic Data Committee (FGDC) reporting is being implemented under the Geospatial Data Act 2018. EarthCube and Earth Science Information Partners (ESIP) are active. There is much effort and expenditure on national datasets such as elevation and hydrography, and on applications such as the National Water Model. A major focus in government geoscience is on major new funding. The USGS geological mapping budget has been doubled, with focus on seamless, evergreen national compilations, and funding to drillhole data and related info has increased over 8-fold. In late 2021, Congress allocated US\$64M/year for a multiple-year program focused on aeromagnetic surveys and related activity. Progress in Canada continues on Canada3D, and the related Canada 1 Water initiative, as well as national geoscience planning for example related to minerals. This builds on efforts to migrate GIN to a new platform based on linked data. In-person meetings have shifted to virtual, including Digital Mapping Techniques and the Geological Mapping Forum, although an in-person 3D Workshop will be attempted in autumn 2022.

(by Harvey Thorleifson and Éric Boisvert)

7.3.5 CGI in Europe

In 2021, there has been much activity on the EGDI and development of EPOS infrastructure, a platform for EU researchers.

- *GeoERA* <http://geoera.eu/>

A group of 45 national and regional geological survey organisations (GSOs) from 32 European countries have joined forces to develop an ERA-NET Co-Fund Action programme titled “Establishing the European Geological Surveys Research Area to deliver a Geological Service for Europe (GeoERA)”.

The main objective of GeoERA is to contribute to the optimal use and management of the subsurface. GeoERA funded 15 research projects that will support 1) more integrated and efficient management and 2) more responsible and publicly accepted exploitation and use of the subsurface. The projects covered the applied geosciences, addressing the following four themes: geo-energy, groundwater, raw materials, and information platform. The information platform supported the requirements of the three other themes, and in particular for data dissemination. It is built on the top of the EGDI (European Geological Data Infrastructure).

Edd Lewis and Christelle Loiselet of CGI Council is involved in those parts of the project. GeoERA uses CGI standards for the geological and mineral resources data, and contributes to the evolution of 3D practices.

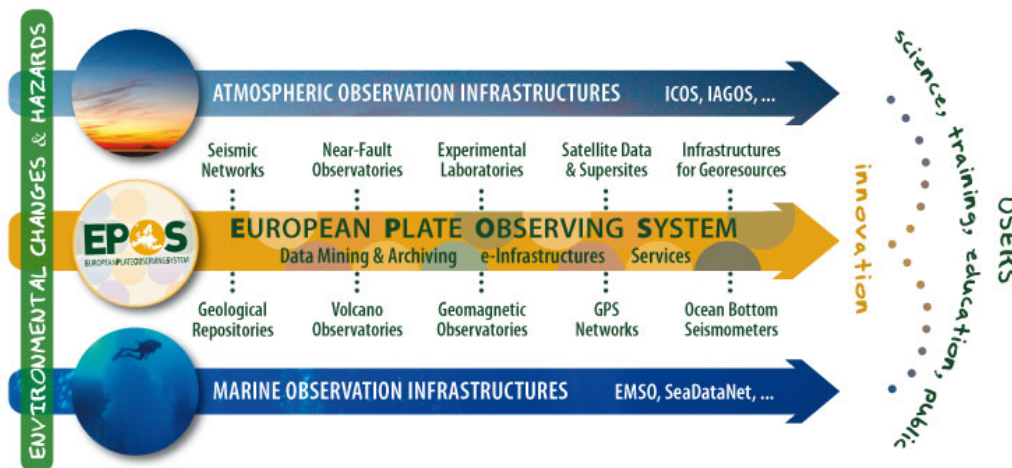
- *EGDI* <https://www.europe-geology.eu/>

In 2021, the EGDI Consortium has continued ensuring the stable operations of the EGDI system thereby sustaining the results of the 14 geoscientific research projects of GeoERA and using CGI standards. EGDI will also be service provider for EPOS for several data sets and the adoption of the services for these has been a big issue.

- *EPOS* <https://www.epos-ip.org>

EPOS, the European Plate Observing System, is a long-term plan to facilitate integrated use of data, data products, and facilities from distributed research infrastructures for solid Earth science in Europe.

EPOS brings together Earth scientists, national research infrastructures, ICT (Information & Communication Technology) experts, decision makers, and public to develop new concepts and tools for accurate, durable, and sustainable answers to societal questions concerning geo-hazards and those geodynamic phenomena (including geo-resources) relevant to the environment and human welfare.



The EPOS vision is that the integration of the existing national and trans-national research infrastructures will increase access and use of the multidisciplinary data recorded by the solid Earth monitoring networks, acquired in laboratory experiments and/or produced by computational simulations. The establishment of EPOS will foster worldwide interoperability in the Earth sciences and services to a broad community of users.

The EPOS mission is to integrate the diverse and advanced European Research Infrastructures for solid Earth science, and build on new e-science opportunities to monitor and understand the dynamic and complex solid-Earth System.

EPOS has been initiated through H2020 co-funded projects, and became a legal body in October 2018. The main H2020 project was finished in September 2019. The geological data are served through “Thematic Core Services” based on CGI standards, delivering for instance access to millions of boreholes across Europe. EPOS also contributed to the CGI/OGC Borehole Interoperability Experiment. Christelle Loiselet of CGI Council and her BRGM Team lead the TCS GIM. TCS GIM focusses particularly on sharing European geological data using the Linked Data approach. It ensures the best semantic description and also enrich with complex description and contents.

(by Christelle, François Robida and Edd Lewis)

CGI in Oceania

The Australia/New Zealand Government Geoscience Information Committee (GGIC) met three times in 2021, all virtual meetings due to ongoing pandemic travel restrictions. The following projects have been completed or have made substantial progress:

Data Science use, uptake and future plans

Nine geological survey organisations responded to a survey around their application of data science with artificial intelligence methods, machine learning and advanced

statistics. The survey also asked for information on current resources and future intentions.

- All have indicated some level of data science application in their business and their intentions to embed more.
- Spatial applications currently predominate, including predictive mapping, as well as text processing and analysis.
- Minerals applications of data science are widespread and those undertaking geophysical data acquisition processing and modelling are also committed to applying AI methods.
- Those geological survey organisations with a substantial data-driven and research focus, Geoscience Australia, Geological Survey of Queensland and GNS Science in particular, have invested more heavily in data science, including for processing time series data streams, and this is also expressed in their commitment to strategic goals towards using data science and their recruitment of data science specialists.

3D geoscience data sets

The member geological survey organisations are responding to a survey requesting information on their 3D geoscience datasets, including geological, geophysical, geochemical and groundwater. Emerging so far are:

- A large number of products are available.
- A range of software, formats and web delivery mechanisms are being used.
- Metadata availability and quality are variable.

Geoscience Vocabularies

Following on from the lead of the Geological Survey of Queensland (GSQ) in 2020 and 2021, Geoscience Australia (GA) plan to publish a wide range of its geoscience vocabularies in 2022 to support its geological web services. The vocabulary service will use the same open source VocPrez application that is also used by GA to host the IUGS CGI vocabulary service.

Petroleum Data Working Group

PetroleumTenementML v1.0 schema and supporting vocabularies are now available online:

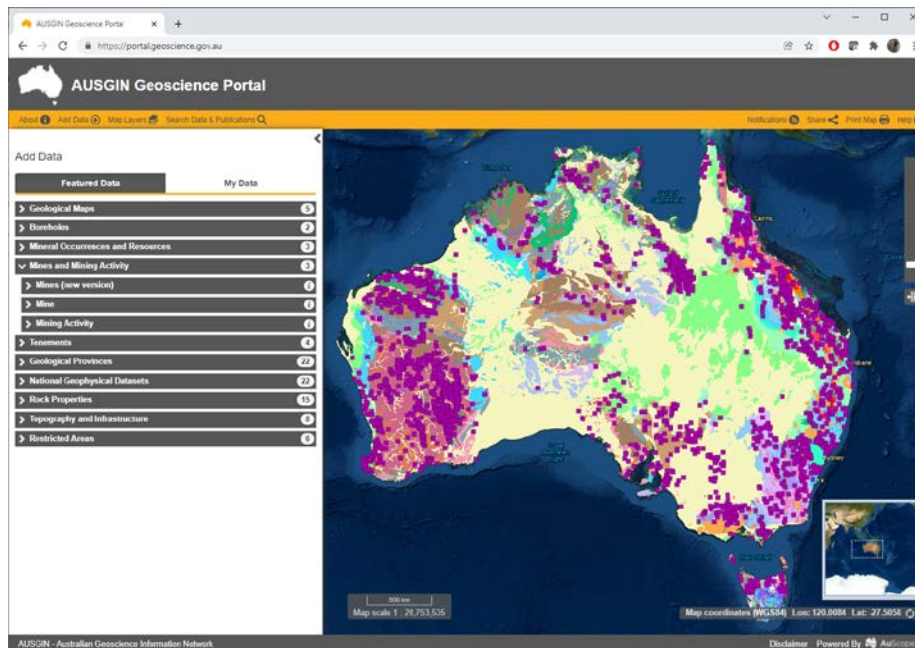
- schema and explanatory spreadsheet - <https://schemas.geoscience.gov.au/?prefix=PetroleumTenementML/1.0/>
- vocabularies for petroleum tenement STATUS and TYPE - <http://www.geoscience.gov.au/data-standards/ggic-vocab-register>

AusGIN

Australian Geoscience Information Network (AusGIN) is a flagship project of GGIC to deliver geoscience information from Australian geological survey organisations. This

involves:

- ongoing developments of AusGIN Portal functions to deliver and analyse interoperable data services
- ongoing collaboration between Australasian GSO's to improve the quality of interoperable web services and improve the web services skills bases of State and Territory GSO's working with limited budgets



AusGIN Geoscience Portal, showing web map services of underlying geology and mines as clustered points

New Data Releases

In Australia, the northern half of the continent is now covered in a new seamless 1:1,000,000 scale 'solid geology' GIS dataset and web service comprised of time slice geological map layers outlining the Cenozoic, Mesozoic, Paleozoic, Neoproterozoic, and pre-Neoproterozoic geology.

(<http://pid.geoscience.gov.au/dataset/ga/135277>)

In New Zealand, there has been limited data release including the 3rd (2020) edition of the 1:250 000 seamless GIS-based Geological Map of Zealand incorporating alignment to new and more accurate topography, enhanced data structures including greater use of GeoSciML and CGI vocabulary standards and limited geological revision. A more localized GIS dataset, the Hyde-Macraes-Waihemo fault zones area in northeast Otago, including the major Macraes gold mine, has been completed.

(by Mark Rattenbury and Ollie Raymond)

7.4 IUGS Deep-time Digital Earth (DDE)

With the strong support of CGI, CODATA and the DDE secretariat office, the DDE

Standards Task Group(DDE-STG) has made major contributions to the DDE program in 2021 and relevant achievements were made in the geoscience standards guide and training for DDE WTGs, DDE knowledge system architecture and review, and metadata standards for DDE data and resources.

DDE-STG fully conducted the four major planned activities in 2021 and relevant achievements were made, including DDE knowledge system review procedure upgrading, geosciences standards training, DDE metadata standard draft version and helping international release of DDE products. The DDE Geoscience Information Standards Training workshop and DDE Metadata Standard draft version and App can be regarded as milestones in 2021.

- *DDE Geoscience Standards Training Workshop*

In order to meet the demands of the DDE program for understanding relevant existing world-wide implemented geoscience data standards, technologies, particularly CGI/OGC standards GeoSciML, EarthResourceML, Geoscience Terminology and the FAIR data principles, DDE-STG planned and organized an online training course for DDE Working Groups and Task Groups(WTGs) and geoscience organizations with great success on 26th -28th October 2021, together with DDE secretariat office.

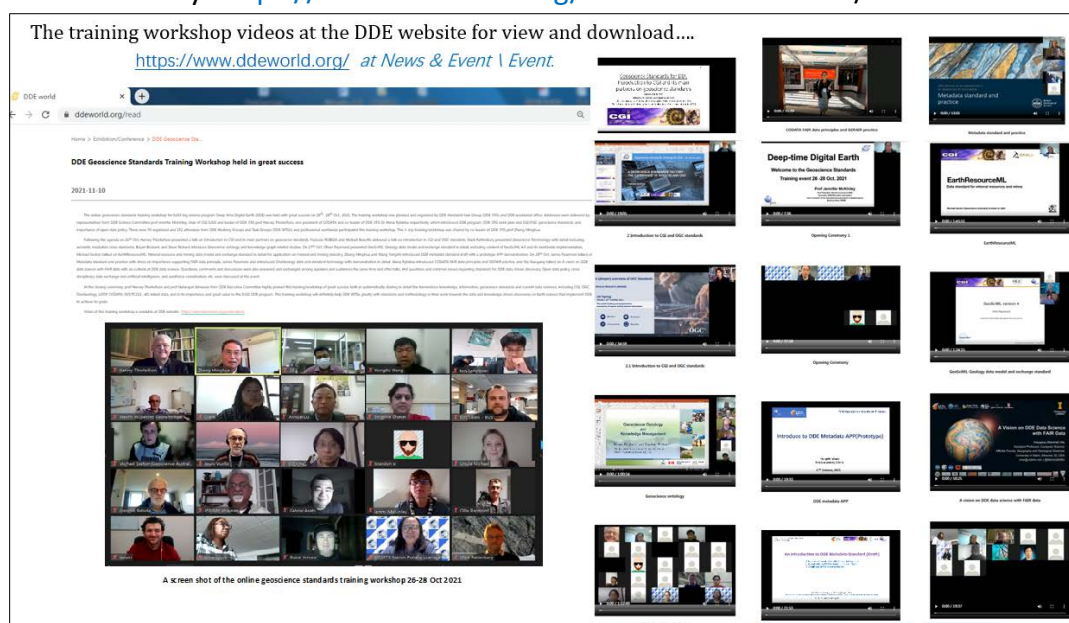
Addresses were delivered by representatives from the DDE Science Committee(SC) prof Jennifer McKinley, chair of CGI and leader of DDE-STG prof Harvey Thorleifson, vice president of CODATA and co-leader of DDE-STG Dr Alena Rybkina respectively, which introduced the DDE program, DDE-STG work plan and CGI/OGC geoscience standards, and importance of Open Science Policy. A total of 93 registered and total 152 attendees from DDE -WTGs and professional organizations worldwide participated this training workshop. This 3-day training/workshop was chaired by the co-leader of DDE-STG prof Zhang Minghua.

On 26th Oct, Harvey Thorleifson presented a talk on Introduction to CGI and its main partners on geoscience standards, Francois ROBIDA and Mickael Beauflis delivered a talk on Introduction to CGI and OGC standards, Mark Rattenbury presented Geoscience Terminology with details including semantic resolution cross standards, Boyan Brodaric and Steve Richard introduced Geoscience ontology and knowledge graph related studies. On 27th, Oliver Raymond presented GeoSciML- Geological Data Model and Exchange Standard in detail, including content of GeoSciML 4.1 and its worldwide implementation, Michael Sexton talked on EarthResourceML- Mineral Resource and Mining Data Model and Exchange Standard in detail for application on mineral and mining industry, Zhang Minghua and Wang Yongzhi introduced DDE metadata standard draft version with a prototype APP demonstration. On 28th Oct, James Passmore talked on Metadata Standard and Practice with stress on importance of supporting FAIR data principle, James also introduced OneGeology data and standard technology with demonstration in detail. Alena Rybkina introduced CODATA FAIR data principles and GOFAIR practice, and Ma Xiaogang presented A vision on DDE

data science with FAIR data. Questions, comments and discussions were also answered and exchanged among speakers and audiences the same time and after talks, in which the common issues were standards for DDE data-driven discovery, data exchange, artificial intelligence and workforce coordination.

At the closing ceremony, prof Natarajan Ishwaran from the DDE Executive Committee(EC) highly praised this training/workshop of a great success both in systematically sharing in detail the tremendous knowledge, information, geoscience standards and current data sciences, including CGI, OGC, OneGeology, LOOP, CODATA, ISO/TC211 , 4D, Linked Data, and in its importance and great value to the IUGS DDE program.

Videos of this training workshop are uploaded to the DDE website for view and download freely: <https://www.ddeworld.org/> under News & Event/Event.



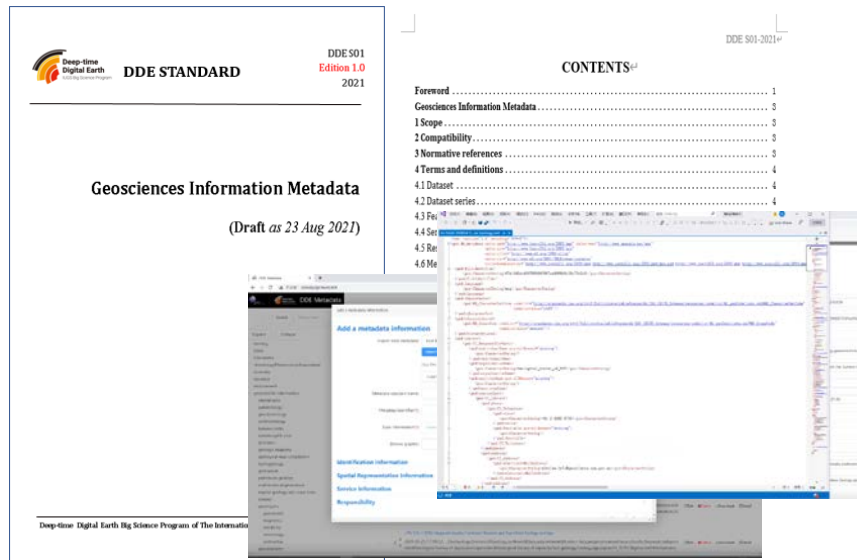
DDE geoscience standards training workshop and the videos for download at the DDE website

- ***DDE metadata standard draft version and APP for practice.***

DDE-STG issued the draft version of a DDE metadata standard in August 2021, based on existing world-wide implemented metadata standards and web application technologies, including ISO19115:2014(E) and OGC, to respond to demands from DDE WTGs on data resources, data services and information discovery and sharing. The first draft version was circulated within DDE WTGs leaders and the big data group in particular for comments in September. The formal draft version was introduced at this training workshop together with the prototype APP for existing metadata Reuse online. Improvements are also being made following feedback from DDE WTGs in late 2021.

Compatible with OneGeology, INSPIRE, Dublin Core and CCOP metadata standards, this draft DDE metadata standard is richer in content and topic categories for DDE. The topicCategory is extended to 28 secondary conceptual names and codes from only one

geoscientificInformation in ISO ISO19115-1:2014(E). Data resource code, data source acquisitionCode and geologicTime scale are defined with Annexes. The standards now consists of 5 entities/classes (Metadata information, Dataset Identification information, Spatial representation information, Responsible party information and Service information), 39 elements (in which 15 are mandatory) , 11 code lists and 1 example.

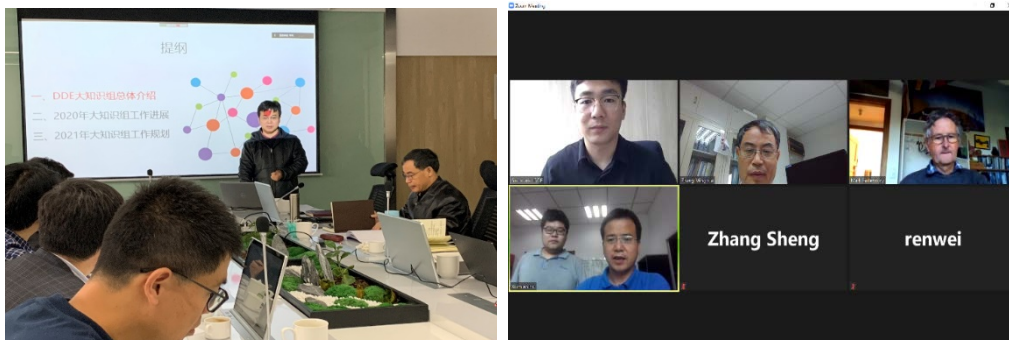


The cover of DDE metadata standard draft version and typical pages of the online App.

- *DDE-STG support for the DDE knowledge system review and products release*

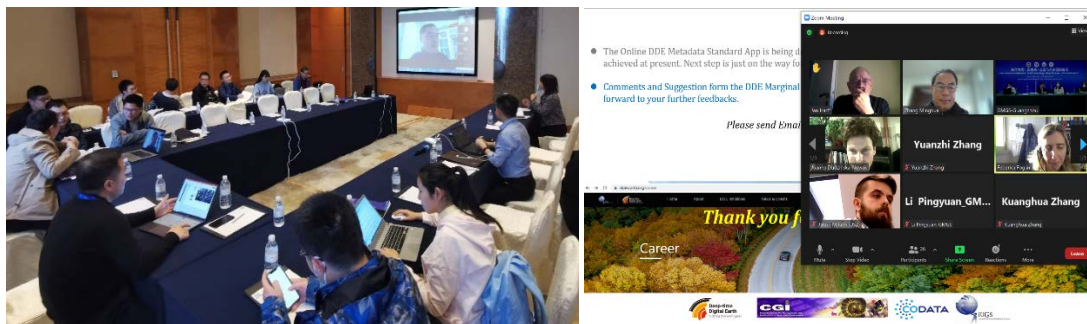
DDE-STG continued to collect demands and requests from DDE WTGs on geoscience standards by either hosting or attending meetings from March to December 2021, and all these comments for the work of DDE-STG were well put into consideration in standards issuing and training workshops.

DDE-STG helped the DDE knowledge system review in 2021 and upgraded the existing August 2020 version of the DDE knowledge review procedure to the new version of May 2021. The STG guided several DDE WGs on ways of building geoscience ontology and geoscience disciplinary knowledge graphs through relevant meetings online and face to face, including STG organized meetings.



DDE-STG activities in supporting the DDE knowledge system review (Left: DDE-STG attended DDE knowledge system group meeting on 21 Mar.2021. Right: Discussion on classification rules for science contents of knowledge system)

DDE-STG co-organized a seminar on geoscience knowledge graph and ontology on 9 Sep.2021, see 7.1, and invited Prof Hu xiumian of the DDE knowledge group for an introduction to the progress of the DDE knowledge system. Boyan Brodaric and Steve Richard introduced current studies on geoscience ontology technology. CGI workgroup chairs introduced CGI standards development in supporting ontology. A short discussion focused on geoscience knowledge graphs and the standardization was then made.



DDE-STG activities in standards support to DDE (Left: DDE-STG meeting for standards demands collection on 23 March 2020. Right: DDE-STG attended the conference of DDE Marginal Sea project on 16-18 Dec.2021.)

Apart from the online APP for implementation of the DDE metadata standard, DDE-STG has provided an Excel format template of the DDE metadata standard for Chinese users and tools for converting metadata from Excel to XML were also developed on demand.

The DDE funds of USD 5000.00 for DDE Standards Task Group annual activities was allocated in 2021 and also well spent on all these activities. The three-year R&D project proposal of Geoscience Standards for DDE with a budget of \$150,000 USD was approved by DDE SC and EC in 2021. The project funding allocation agreement was signed in late December.

The DDE-STG work plan for 2022 and the R&D project plan 2022 is now under discussion and will be issued shortly.

(by Zhang Minghua, Harvey Thorleifson and Alena Rybkina)

8. Main problems encountered

As in 2020, the COVID-19 pandemic strongly affected CGI activities in 2021, particularly face to face meetings of the working groups and the council, and face-to face training

courses as well, which were planned during the January DDE-STG meeting in Beijing in early 2020 and more recently at other online meetings.

Global economic uncertainty has had strong impact on monetary support for regional activities of the CGI in 2021.

Also, some working group chairs and key members are nearing retirement. To find young geoscientists capable and willing to work on CGI standards is still a big issue, particularly facing the fast changing world of big data and AI today.

Limited funding for completion of standards to support demand for comprehensive geoscience information issues is always a big challenge.

The difficulties in cross-border communication and limited budgets for meeting organization is another challenge to maintain group cohesion and to stay informed on the issues that each of the CGI member countries are struggling with.

The CGI Council acknowledges the financial plight of many representatives, and that travel expectations of council members should not be applied as strictly to them. While every effort should be made by all council members to attend annual meetings in person, if this is not possible, Council members are expected to participate in online meetings.

Also, other outreach activities are often being organized synergistically, based on any opportunities given, rather than on medium term planning.

Careful arrangements have been established for opening IUGS-CGI bank accounts, to achieve robust expenditure approval and transparency, and to achieve efficiency in financial operations.

9. Annual Financial Report

- **CGI Council Grants**

In late 2020, two grants were approved by CGI Council to further advance geoscience information interoperability. One project has centred around containerisation of GeoSciML and EarthResource data model standards that addresses challenges around their deployment into different operating environments and their maintainance across version changes. This work is being undertaken by GeoSolutions, an Italian geospatial open source software company, and is supervised by the GeoSciML Working Group chair Eric Boisvert. The technical aspects of the project have been completed and remaining work is focused on documentation. The agreed value of the work is \$11,680 USD with \$8,176 yet to be invoiced.

The second project is advancing multi-lingual terminology publication and rationalizing CGI vocabulary publication. This work is being undertaken by the British Geological Survey, supervised by CGI Council member Edd Lewis. Much of the work has been completed and is awaiting ratification by Geoscience Australia who host the vocabulary server. The agreed value of the work is \$10,000 USD and this is yet to be invoiced.

• 2021 Income and Expenditure Summary

There were relatively few transactions in 2021 owing to no face-to-face meetings of the CGI Council or its working groups, and general curtailment of travel due to the ongoing Covid-19 pandemic. CGI Council grants awarded to GeoSolutions and the British Geological Survey for interoperability projects have only been invoiced in part to date.

Significant income:

- IUGS's Deep-time Digital Earth Executive Committee awarded a grant of USD 5,000 to CGI to enable DDE-Standards Task Group activities.
- IUGS awarded CGI an annual grant of USD 10,000.

Significant expenditure:

- A part payment of USD 3504.18 was for the CGI Council grant awarded to GeoSolutions (Italy) for the interoperability containerization project.
- Payments to GNS Science of USD 2000.00 and Geoscience Australia of AUD 1500.00 were made for contributor presentations to the DDE-STG training workshop in October.

Summary transactions:

	Transaction description	Debit	Credit	Balance
1 January 2020	Opening balance (New Zealand account NZD)			\$28,067.00
11 February	DDE allocation to CGI		\$6,777.56	
16 March	IUGS annual grant		\$13,605.27	
2 November	Bank charges	\$37.41		
2 November	CGI Grant part payment to GeoSolutions	\$4,961.04		
2 December	DDE-STG workshop contributor payment to GNS Science	\$3,377.00		
2 December	DDE-STG workshop contributor payment to Geoscience Australia	\$1,592.42		
31 December 2021	Closing balance (New Zealand account NZD)			\$38,482.45

10. Work plan for next year

- Actively participate and play important roles in the IUGS DDE program, through a leading role in the DDE Standard Task Group, to both support DDE and to implement CGI standards.
- Actively participate in the IUGS 60 year celebration, to prepare and promote CGI achievements in geoscience information standards and related activities.
- Consider the strategy of CGI in the data and information revolution, and play the leading role in geoscience information for IUGS.
- Complete a draft 4-year future action plan of CGI.
- Continue to push forward the joint CGI/OGC Geoscience DWG work, especially a work plan for CGI within the DWG.
- Continue to push forward the implementation of GeosciML after becoming an OGC Standard.
- Continue the development and implementation promotion of EarthResourceML, especially ERML-lite for OneGeology.
- Consider how GeoSciML and ERML function with the new OGC API suite of standards.
- Continue to develop and publish new geoscience vocabularies, improve existing vocabularies including the addition of multilingual terms.
- Actively connect UNECE for the possible cooperation for a general resource classification code and standard framework.
- Continue to push forward promotion of CGI products and to draft a marketing plan.
- Update and enrich the CGI website.
- Continue to publish the CGI newsletter regularly and to contribute to IUGS E-Bulletin.
- Take measures to publish more publications of CGI related issues within IUGS “Episodes”.
- Organize a GIRAF workshop and a meeting at the 28th Colloquium of African Geology (28CAG) in 2022.
- Represent the IUGS in Geoscience information matters
 - Effective collaboration with CODATA in DDE Standards Task group, and more.
 - Enhanced relations with RDA
 - More activities on geoscience information relevant to IUGS involved

events towards UN Goals 2030 and ISU

- Hold the next CGI annual meeting in association with the IGC, or with GIC in June 2022, if this is feasible.

11. Critical milestones

- The webinar hosted by CGI on 23 June 2021 attracted 91 experts from around the world, with tremendous success in promoting CGI and its standards. Similarly, the DDE geoscience information standards training workshop on 26-28 October allowed CGI to become much more visible in supporting FAIR data principles and Open Science.
- The 3-year DDE R&D project proposal on Geoscience Information Standards for DDE with a budget of \$150,000 USD was approved by DDE SC and EC in 2021. The project will be conducted by CGI officials and scientists as the main resource in collaboration with CODATA, DDE WTGs, and other relevant organizations on facilitating DDE with well implemented standards like CGI/OGC standards.

12. Budget request for 2022 and potential funding sources

CGI Council would request a similar budget to that provided by IUGS in 2021 - \$10,000 USD to enable the full delivery of interoperability projects supported by two CGI Council grants and to complete planned work in 2022 to support CGI activities as the commission for geoscience information of IUGS, such as coordination with partners, standards upgrades, to motivate efforts and for development of a new strategy for CGI-IUGS.

Also, CGI would appreciate being able to have extra funding for contribution to the celebration of IUGS 60 years.

The DDE R&D project funding will support the DDE Standards Task Group through involvement of CGI members in the project work.

CGI will continue to search for other financial support to the critical activities related to standards upgrade, extension and implementation, and face-to-face meetings if the pandemic allows.

13. Objectives and work plan for the next 5 years

A new CGI Council is in the process of updating the 5-year workplan. Some of the objectives include:

- Actively participate in and support the IUGS DDE program by playing a leading role in the DDE Standard Task Group, particularly in the three year R&D project of Geoscience Information Standards for DDE which was approved and funded in late 2021.
- Support the celebration of the IUGS 60th anniversary in 2022, by highlighting CGI achievements and contributions, and by preparing a report to IUGS on the conduct of DDE-STG and the R&D projects following the DDE Medium Term Plan in 2024, together with relevant organizations.
- Complete CGI grant-funded projects with the Geological Survey of Canada on developing digital docker containers for geoscience data model installations and with the British Geological Survey for multilingual implementation and github hosting of CGI vocabulary services which is anticipated to be complete by March 2022.
- Play a more visible role in coordination of regional initiatives, e.g. by organizing workshop and training courses on geoscience information management and application, standards and language.
- Motivate and recruit capable people, especially younger scientists from both 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 productive alliances between geoinformation bodies, including OGC, CODATA, RDA, and Linked Data.
- Promote international use of data exchange standards (especially broad adoption of GeoSciML, EarthResourceML and CGI geoscience vocabularies) in regions, commissions, countries, and organizations in collaboration; 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.
- Reorganize the IGC CGI/IAMG/OneGeology geoscience information symposium, and organize a symposium at 37 IGC in Busan on geoscience information.

14. Suggestions for improvement of IUGS activities

It would be helpful if IUGS Council can continue to approve 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 (eg, IGC).

15. Conclusion

CGI was active, productive and more visible in 2021, utilizing the online means that have been dictated by the pandemic. Excellent CGI Council meetings were held on January 18th, April 14th, June 23th, and on September 16th. Grants were awarded to important projects needed to advance CGI goals. The superb new web site is up to date, and excellent CGI Newsletters were produced in May and August. Updated CGI flyers released at IUGS website and CGI Activities reported and released at the IUGS E-Bulletins No.174, 176, 180 in 2021.

CGI hosted a tremendously success webinar on June 23rd, and an equally successful Technical Seminar on September 9th. CGI leaders made major contributions to DDE Standards Training on October 26th-28th. CGI coordinates closely with partners such as OGC, CODATA, CGMW, Loop, and OneGeology.

The CGI-led DDE R&D project on Geoscience Information for DDE was approved by the DDE SC and EC in 2021, marking a new stage for CGI/OGC standards implementation in the IUGS big science program, and stronger collaborations with CODATA and relevant organizations both international and regional for data-driven and knowledge-driven geosciences.

The ambition of the CGI is to pursue its approach of developing standards for geoscience data resources, by taking into account current technological developments and new needs for the future, such as semantic web, linked data, big data, artificial intelligence, digital twins, ontology and knowledge graph, and more.

To do this it seems important to maintain and strengthen links:

- with **scientific communities**, in the field of geosciences, with the support of geological organizations, through presence in major international or continental projects (DDE, OneGeology, EPOS, AuScope, ...), and also with other disciplines through CODATA and the RDA for example,
- with the **geoscience industry**, a major producer of data, to promote their adoption of CGI standards,
- with the **IT and data science sectors**, the powerful and efficient tools and supports to the data-driven and knowledge-driven geosciences,
- with the other actors of standardization in the digital domain such as OGC or

- W3C (semantic web),
- with software developers to encourage and facilitate their implementation of CGI standards,
- with the communities of geoscientists around the world to push the deployment of these standards.

To achieve these ambitions, it is of primary importance to maintain and renew the expertise available to CGI by reinforcing necessary skills in new technologies.

Finally, CGI would like to express its thanks to all members of the CGI and its regional and the 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 2022, marking the IUGS 60 years, hopefully during a waning pandemic.

CGI Council, 31 January, 2022

Appendix Contact – CGI Council members 2020-2024

Harvey Thorleifson (Chair)

Minnesota Geological Survey
Department of Earth Sciences
College of Science and Engineering
University of Minnesota
2609 West Territorial Road
St Paul MN 55114-1009, USA
Telephone: +1 612-626-2150
Email: thorleif@umn.edu

Zhang Minghua (Co-Secretary General)

Development Research Center
China Geological survey
45 Fuwai St., Beijing, 100037, China
Telephone: +86-10-58584305
Fax: +86-10-58584359
Email: zminghua@mail.cgs.gov.cn

Kombada Mhopjeni (Co-Secretary General)

Geological Survey of Namibia
Ministry of Mines and Energy
P.O.Box 3984, Windhoek, Namibia
Telephone: +264-812 317919
Email: Kombada.Mhopjeni@mme.gov.na

Mark Rattenbury (Treasurer)

Geologist & Program Leader
GNS Science,
1 Fairway Drive, Avalon 5010,
PO Box 30368, Lower Hutt 5040,
New Zealand
Telephone: +64 04 570 4697
Email: m.rattenbury@gns.cri.nz

Kazuhiro Miyazaki

Geological Survey of Japan/AIST
The Institute of Geology and Geoinformation
Tsukuba Central 7
1-1-1 Higashi
Tsukuba, Ibaraki, 305-8567, Japan
Telephone: +81-29-861-2390
Fax: +81-29-861-3742
Email: kazu-miyazaki@aist.go.jp

Eric Boisvert

Groundwater Geoscience Program Manager
Geological Survey of Canada
Natural Resources Canada
490 de la Couronne, Québec, Canada
G1K 9A9
Tel. (418) 654-3705
Fax (418) 654 2615
Email: eric.boisvert2@canada.ca

Christelle Loiselet

Geologist modeler, Head of Unit
IT Division
BRGM
3 Avenue C Guillemin - BP 36009
4506 Orleans cedex 02, France
Telephone : +33 7 860 358 50
Email: c.loiselet@brgm.fr

Edward Lewis

Standards Lead
British Geological Survey
Nicker Hill, Key worth,
Nottinghamshire, NG12 5GG, UK
Telephone : +44 07487559371
Email: edlew@bgs.ac.uk

Mauricio Pavan Silva

International Affairs Consultant
Directory of Geology and Mineral Resources
Geological Survey of Brasil(CPRM)
Rua Costa, 55, 01304-010
São Paulo, SP, Brazil
Telephone: +55 11 37755108
Fax: +55 11 3775-5165/3256-8430
Email: mauricio.pavan@cprm.gov.br

Oliver Raymond(observer)

Team Lead – Information Services
Minerals, Energy and Groundwater Division
GEOSCIENCE AUSTRALIA
Cnr Jerrabomberra Avenue and Hindmarsh Drive
Symonston ACT, GPO Box 378
Canberra ACT 2601, Australia
Telephone: +61 2 6249 9575
Fax: +61 2 6249 9971
Email: Oliver.Raymond@ga.gov.au

David Percy (observer)

Portland State University
1721 SW Broadway Rm 17x
Portland, OR 97201, USA
Telephone: +1 503 725 3373
Email: percyd@pdx.edu

François Robida (former Chair)

28 allée de Limère
41506, ARDON - France
Telephone: +33 6 21 05 21 10
Email: f.robida@outlook.fr