IUGS Commission on Geoscience Information (CGI)
Summary Report 2016-2020

Introduction

As the Commission for Geoscience Information of IUGS, CGI has continuously made significant progress and achievements in the past four years in successful completing its mission(to foster the interoperability and exchange of geoscience information by active community leadership, collaboration and education, and the development and promotion of geoscience information standards, and best practice), especially in providing means for transferring geoscience knowledge, assisting international dissemination of best practice in geosciences information, and in stimulating and supporting initiatives in developing standards.

By brings together the best experts in the field of geoinformatics and IT from around the world in the past 4 years, CGI is now leading 4 active excellent geoscience data standard working groups, GeoSciML Working Group (GeoSciML) , EarthResourceML Standard Working Group (ERML), Geoscience Terminology Working Group (GTWG) and GeoScienceDWG Working Group, and 1 regional geoscience information network in Africa(GIRAF). The CGI working groups meet once a year in face-to-face meeting and many times via teleconferences on standard related and common issues.

CGI's 5 regional groups are also very active in Asia, Africa, Europe, North America, South America and Oceania in promotion and help the implementation of CGI standards in national geological surveys, regional geoscience organizations and international initiatives and programs.

CGI now has 10 councils and 516 members form 78 countries. There has been a big increase of 105 CGI members and 16 new countries since 2016 which is mostly form Asia and Africa. And CGI council members hold several significant positions within the international geoscience information community.

CGI maintains several websites, online newsletters, a LinkedIn group, and online file repositories for its Working Groups. In addition, CGI redeveloped its website in 2019 mainly to focus on CGI activities and major events and news of globe geological science information and news from IUGS.

Great success is made in the past several years in world-wide implementation of GeoSciML and ERML standards. And extensive progress is also made in developing

Geoscience Vocabularies and multi-lingual Thesaurus that help to establish global consistency in geological terminology, which is now adopt by the IUGS Big Science Program Deep-time Digital Earth (DDE) for knowledge system development.

In addition, in 2019 the CGI underwent a successful Ad Hoc review (ARC review) of the IUGS which pointed out that CGI has not only stimulated interest in the need for geoinformation standards, but led the actual structuring and development of the GeoSciML and ERML standards, and standard Vocabularies, and that CGI has been extremely successful in meeting its original intent and goals.

CGI's main achievements and activities can be summarized as the following six parts.

I. International collaboration and partnership

1. CGI-IUGS and OneGeology

OneGeology was recognized as an in innovative initiative largely due to the extensive use of CGI standards. It has been awarded in international conferences as demonstrating efficient interoperability based on international standards. Through OneGeology and other projects, the geological surveys around the world have broadly adapted GeoSciML and ERML, which is now implemented on a large scale in Europe and Oceania.

From the early days of CGI, the support of the geological surveys has been very effective, and the OneGeology project initiated in 2007 became a flagship project to test, demonstrate and disseminate the use of GeoSciML through the continents. OneGeology and other national or continental projects and initiatives have also supported a large awareness, training and dissemination activity. The cookbooks developed by OneGeology were in particular very useful to facilitate the implementation of the standards.

2. CGI-IUGS and DDE

CGI-IUGS is one of the founding members of the IUGS DDE program, recognizing the importance of standards in the building of this large international initiative which has been kicked off in February 2019 and will last for 10 years. CGI is actively and successfully leading the setting up of the DDE Standards Task Group (STG) in 2019 in collaboration with CODATA and DDE, with CGI and CODATA co-chairs the group. Some 28 geoscientists including 14 CGI member geoscientists and CGI councillors now working in this group.

- CGI Geoscience Terminology vocabulary was fully adopt as supporting geoscience nodes and terms by DDE Knowledge Group since 2019 to develop the DDE knowledge system.

- GeoSciML and EarthResourceML are being planned as the main geoscience data reference standards for DDE big data group on distributed open geoscience

databases development. And the standards implementing training course is planned for DDE cross-disciplinary scientists in 2020.

- The DDE-STG first face to face meeting has been held in success in January 2020 in Beijing with fruitful results of STG organization structure, work mechanism, 10-year research work proposal/plan, short-term workplan2020, DDE knowledge system review, existing standards implementation and newly data standards demands from DDE, and activity plan at 36th IGC, etc. And DDE-STG has been chosen as one of the several advanced/mature groups of the DDE program to empower to conducted annual work plan in 2020.

3.CGI-IUGS and OGC

One of the most important results of the most recent 4 years has been the development of a mutually-beneficial partnership between CGI-IUGS and the Open Geospatial Consortium (OGC). CGI participates in OGC has helped to Official creation of a CGI/OGC Geoscience Domain Working Group (GeoScienceDWG) within the OGC structure in 2017 and co-chaired with CGI, leading to the adoption of GeoSciML v4.1 as a formal OGC standard, and also focusing towards OGC Hydrology Domain Working Group, with the aim of coordinating the development of GroundWaterML. The first targets are standards for boreholes and for 3D geological models. And the GeoScienceDWG conducted a Borehole Interoperability Experiment project since 2019 and has already yield a public OGC engineering report.

OGC is an international industry consortium of over 538 companies, government agencies and universities, which is driven to make geospatial information and services findable, accessible, interoperable and reusable.

4.CGI-IUGS and CODATA

CGI-IUGS is identified as a pioneer by ICS/CODATA on interdisciplinary integration for developing new science (stated by Geoffrey Boulton, former President of CODATA in 2018). CGI standards presented at CODATA workshop in June 2017 on "*21st Century Scientific and technical data developing a roadmap for data integration*" and at CODATA Beijing2019 conferences with the title of *Geoscience standards factory: Successful Experience of CGI-IUGS and OGC.*

CGI EC members discussed cooperation with CODATA leaders in Beijing Oct 2019 and reached the cooperation in geoscience standards on the joint DDE Standards Task Group(DDE STG) focus on DDE demands for standards by CGI and CODATA co-chairs the group.

5. CGI-IUGS and YES

CGI and the Young Earth Scientists (YES) Network has cooperated successfully in 2019 on held a Competition Award on CGI-IUGS Standards for Geoscience Data for passionate young geoinformatics

professional to present their application of CGI standards at the upcoming 36th IGC by sharing the payment of the successful applicant's travel, accommodation and registration cost. The final winner out of 8 applicants has been selected by the CGI EC members.

II. World-wide CGI standards adoption and implementation

1.GeoSciML adopt by OGC in 2017
The GeoSciML v4.1 data standard was ratified and published by Open Geospatial Consortium (OGC) in March 2017, shortly after the acceptance of GeoSciML version 4.0 data transfer standard by a unanimous vote of the Technical Committee of OGC in November 2016.This significant milestone cements GeoSciML's place as an international geological data transfer standard.

2. CGI standards implementation in global programs and large research infrastructure initiatives.
The important implementations of CGI-IUGS standards are One Geology initiative, EC Directive INSPIRE and Minerasl4EU or EURare for the Geology and Mineral Resources, EMODnet(European Marine Observation and Data Network), EPOS (European Research Infrastructure on Solid Earth), AuScope (Australian research infrastructure for geoscience),and EarthCube (US Geoscience cyberinfrastructure). The USGS identified GeoSciML in its spatial data infrastructure roadmap. CGS (China Geological Survey) has also adopted GeoSciML 4.1 for spatial geoscience data release recently.

All the European Surveys (and other organizations holding public geological data) are serving the geological maps, the mineral resources maps using GeoSciML profiles and CGI vocabularies.

All Australian and New Zealand (GNS) geological survey agencies are now delivering geological map, borehole, mineral occurrence, and mines data as web services using CGI data standards. All the Australian services are all available through the AusGIN Geoscience Portal,which links to all CGI data standards.

3. CGI standards adopt for international geoscience knowledges system development.
CGI Geoscience Terminology vocabulary has been adopted by many geological surveys, especially in Europe and Oceania for geoinformation infrastructure and semantic webservices in data release. The vocabulary is now being fully studied and adopted as supporting key nodes and terms by DDE for geoscience knowledge system development. And GroundwaterML, which is an extension of GeoSciML, is now in consideration as a WMO (World meteorological Organisation) standard.

4. Cooperation for standards implementation

CGI experts invested significant efforts to work with software developers such QGIS, ESRI, and Dassault systems to implement their standards.

Because of this successful record of contributions to the development of digital spatial standards, CGI is identified as a geoscience information pioneer by the Commission on Data of the International Council for Science (ICS).

5. CGI-IUGS standards and workforce support OGC standards
Over the past 4 years, CGI has focused attention to extending its successful geoscience data standards to other geoscience domains, such as borehole data and 3D geological models. To assist the global community in understanding the use of geoinformation standards, i.e., to "train the trainers", CGI has prepared tools and guides for the implementation of the standards, and the membership has organised training classes for geoscientists.

6. CGI standards adoption by software developers
CGI standards implementation cookbooks help users to implement the standards for serving GeoSciML and ERML. In order to guarantee that those services are consumed by client software, CGI experts invested many efforts in the past 4 years to make sure that the software developers were going to implement CGI standards.

- QGIS - For QGIS (open source GIS), a specific ad-on has been developed with funding coming from external organizations to support reading of GeoSciML complex schema.

- ESRI - With ESRI, many exchanges have taken place, with the invitation of CGI experts to Redlands (ESRI headquarters), however the support of GeoSciML and ERML still needs to be improved.

- Dassault Systems / GEOVIA – GEOVIA, the Dassault System is the provider of the most widely used commercial software solution for the mining industry

7. CGI standards promotion activities
CGI standards were introduced to scientists, geologists and officials of science and geoscience organizations at many international events and regional training courses in the past 4 years. such as CODATA, ICS, DDE program, CCOP annual session, Africa Geological Surveys, GIC meeting, etc. follows are 2 examples.

- CGI standards were introduced in Chinese training courses on geoscience information for more than 60 Asian, African and Arabian countries.

- CGI attend the first United Nations World Geospatial Information Congress (UNWGIC-Who aim to advance the potential and usefulness of geospatial information for sustainable development and to tackle global challenges) in Nov.2018 with the flyer on CGI-IUGS and pamphlets of CGI-IUGS and CGI/OGC

standards, which attracted by many professionals and officials for regional administration and urban planning, and they realized by the time that geological standards are critical for the sustainable development of a smart society.

• IUGS DDE Program is planning to adopt, and using CGI/OGC standards Geoscience Terminology, GeoSciML and EarthResourceML as basic standards for the development of DDE data standards (*from DDE working meetings in Suzhou and Beijing, China, 2019*).

• CGI standards EarthResourceML, GeoSciML and Geoscience Terminology were introduced/promoted on 23 September 2020 at the UNFC/PRMS Session of the IFEDC2020: Sustainable Resources Management, Technology and Best Practice for a wider resources sector.

III. CGI Scientists Dedication Awards

1.Dr Stephen Richard, the former CGI working group chair, was awarded the 2016 IUGS Science Excellence Award in Geoscience Information at the 35th International Geological Congress.

2. Oliver Raymond received a 2017 achievement award from Geoscience Australia for his leadership in the production of the GeoSciML data standard over the last 10 years.

IV. CGI Big Events and Business

1. CGI Council Meeting in South Africa during 35th Congress in August 2016 in Cape Town, South Africa. Election of CGI Board (EC members), discussion of Common issues concerned, workplan and near future actions were key topics of the meeting.

2. At the 35th IGC in 2016 in Cape Town, CGI organized large symposia on international geoinformatics in association with GIC, IAMG and OneGeology, which consisting of 6 major themes on data and information management, interoperability, data delivery, multi-dimensional modelling and visualization, informatics standardization, international geoscience maps and geoscience Information in Africa

3. A successful CGI-IUGS/OneGeology/INSPIRE geoscience data symposium/workshop "Working with Interoperable Geoscience Data" was held at the 35th IGC. Over 20 presentations and a practice on Building Geoscience Web Service were given on a wide range of digital geological data management, data analysis, and data delivery topics.

4. The Australia-New Zealand Government Geoscience Information Committee (GGIC) ran the first of a planned series of technical workshops on building geological web services using CGI data standards (GeoSciML and EarthResourceML) in May 2016.

5. CGI GeoSciML v4.0 was adopted by OGC in November 2016 and GeoSciML v4.1 was released as a formal OGC standard in March 2017.

6. OGC-CGI partnership was extended by the officially co-creation of the CGI-OGC Geoscience Domain Working Group(GeoScienceDWG) for commonly addressed geospatial data and services findable, accessible, interoperable and reusable, aiming at extending the scope of standards to be developed, through the expertise of CGI.

7. At the 26th Colloquium of African Geology (CAG) in Ibadan, Nigeria, the coordination of the GIRAF network was successfully handed over from BGR and CGI to a new Executive Committee with Secretariat offices in at the African Minerals and Geoscience Center (AMGC) in Dar es Salaam (lead by the Southern and Eastern Africa Mineral CentreSEAMIC). AGIRAF meeting was held as a session at the 27th Colloquium of African Geology (27th CAG) and 17th Conference of the Geological Society of Africa in July 2018 in Aveiro, Portugal, for the CAG27.

GIRAF has served as a platform since its inception in 2009 for African geo-information experts to share information and experiences, and to facilitate the inclusion of African geoscience information experts into international initiatives and projects. GIRAF has more than 400 members from more than 30 African Countries and 12 non-African ones.

8. CGI had organized a successful session at RFG2018 in Vancouver numbered RS17 with the title of Geoinformation for the Next Generation, which had 22 presentations and had become the second largest session under the theme "The Role of Geological Surveys".

9. CGI joined 3D geological mapping workshops in Vancouver 2018, which successfully illustrated the transition of 3D from pilots two decades ago, to methods development a decade ago, to the current emergence of national strategies such as Canada-3D and US EarthMAP.

10. CGI has successfully organized a symposium numbered 45.10 under the theme of IUGS with the title of Advances in Geoscience Data Sharing and Processing in collaboration with IAMG, OneGeology and CCOP for the planned 36th IGC in 2019. 29 abstracts were received and 24 accepted and 18 for oral presentation after review. The symposium is focusing on application of CGI/OGC standards in global and regional data sharing and analysis, advances in and application of the OneGeology initiative, new research and achievements in mathematical geoscience, AI and other new data technology in geoscience.

11. IGS (http://www.igsint.com/) created RDF ontologies from GeoSciML vocabularies. They showed interest into any progress the SWG can make into RDF encoding. Their approach showed an interesting way to merge model and vocabularies.

12. The first steps to "Global Mineral Resource" service will be OneGeology portal and the thematic layer of Mineral Resources in early 2019. and the next versions of ERML v.3.0 will be published in 2020.

13. CGI supports of the new IUGS topic "Geoscientific Mapping of the Ocean Realm (GeoMore) starting as scoping study at the IUGS meeting in Busan, January 2020.

V. CGI Noteworthy Products

1. GeoSciML schemas on OGC public schema site http://schemas.opengis.net/gsml/4.1/.

2. GeoSciML repository provided by OGC at https://github.com/opengeospatial/GeoSciML.

3. The CGI-IUGS multi-lingual (18 languages) vocabularies published for general discovery in the Australian National Data Service (ANDS)'s Research Vocabularies Australia (RVA) Portal:
https://vocabs.ands.org.au/search/#!/?p=1&publisher=CGI%20Geoscience%20Terminology%20Working%20Group&q=

4. Harmonized CGI SWG web pages and updated ERML data model and documents at http://www.cgi-iugs.org/tech_collaboration/earthResourceML.html.

5. The Borehole Interoperability Experiment has published OGC engineering report (OGC 19-075r1) https://portal.ogc.org/files/19-075r1
Summarizing the overall cross-domain, inter-standard findings and recommendations for a best practice implementation that should follow.

6. Chinese translation version of GeoSciML 4.1 at OGC website since 2018:
http://www.geosciml.org/doc/geosciml/4.1/documentation/ogc_spec_translations/16-008_OGC_Geoscience_Markup_Language_GSML4.1-CN2018.08.18.docx

VI. CGI Future Plan 2020-2024
- Actively participate and take responsibility in the IUGS DDE Program by playing a leading role in DDE Standards Task Group to provide standards, tools and methodologies to support harmonized cross-disciplinary deep time data in a convenient form to science, public and industry.

- Play a more visible role in coordination of regional initiatives, e.g. by organizing workshop and training courses on geoscience information management, standards and language.
- Continue to push forward GeoScienceDWG in developing interoperability of 3D - 4D geosciences data models.
- Catalyse productive alliances between geo-information bodies, including OGC, CODATA, RDA, and W3C, Digital Twins, LOOPS;
- Stimulate progress in development and application of standard geoscience concepts and their representation in multiple languages.
- Promote international use of data exchange standards (especially broad adoption of GeoSciML, ERML and Geoscience Terminology) in regions, commissions, countries, and organizations in collaboration; Facilitate outreach, knowledge transfer and take-up of best practice in geo-information.
- Continue encourage software developers to facilitate their implementation of CGI standards;
- Enhance collaboration with other IUGS commissions, e.g. ICS.
- Prepare a CGI geoscience information symposium at IGC 2021 in India and IUGS DDE related activities, e.g. DDE knowledge system demonstration.
- To maintain and renew the expertise available in the CGI by reinforcing relevant standards working groups, outreach collaborations (e.g. DDE, OneGeology, EPOS, AuScope) and necessary skills in new geoscience industry data and new technologies.
- To support the new IUGS Scoping Study "Geoscientific Mapping of the Ocean Realm (GeoMore)

Conclusion

As the Report of the Ad-hoc Review of the Commission for Geoscience Information, CGI, October 2019 states, CGI has been extremely successful in meeting its original intent and goals in the past several years. In the past years 2016-2020, CGI's principal achievements are the development of leading data model and data transfer standards for geoscience information captured in geological maps, studies, boreholes, databases, etc. in particular, the development of a mutually-beneficial partnership between CGI and the Open Geospatial Consortium (OGC). CGI's flagship standards: GeoSciML and EarthResourcesML, Geoscience Terminology have been successfully tested and broadly adopted by the geological informatics community, including geological surveys around the world, and by IUGS DDE big science program recently. The work of the Commission remains extremely timely and, indeed, CGI appears to be on the cusp of even more significant recognition of their hard work.

With fully aware of the primary importance of maintaining and renew the expertise available in the CGI by reinforcing the necessary skills in new data and technologies, especially as the leading body of DDE Standards Task Group, CGI has issued in advance a future work plan to fulfil the demands of geoscience communities and the current world-wide transformation of geological surveys.

CGI is looking forward to better completing its mission as the Commission for Geoscience Information of IUGS and a continuous productive cooperation in 2020-2024.