

IUGS Review of the Deep-Time Digital Earth (DDE) Large Science Project

The review committee comprised the following members

John Ludden, IUGS President and will be on IUGS executive committee as Past President for the next 4 years, used to be the head of BGS and French Research Council for Earth Sciences, and currently his main interests are mainly in geothermal energy in Iceland.

Shuwen Dong, who is a research fellow of Chinese Academy of Geological Sciences and the leading scientist of the Deep Earth Exploration Programme in China and was the Treasurer of IUGS from 2012 to 2016.

Sharon Tahirkheli, who is the former director of GeoReF, which is the abstracting and indexing bibliographic system run by the American Geosciences Institute (AGI) and has also been the manager of the Glossary of Geology and performed as the interim executive director of AGI.

Matt Harrison, who is the former director of Informatics at BGS, currently is the head of Environmental Data Service for the Natural Environmental Research Council, has been involved in many European programs, and has also been the Chair of One Geology for 10 years. Recently moved to a new role in Amazon Web Services.

Ludwig Stroink, who is the head of the Department of International Affairs and Third-Party Funding at Helmholtz-Center Potsdam-German Research Center Geosciences (GFZ) and was IUGS councilor (2020-2024) and currently is the Secretary General of IUGS.

Marko Komac, who is the Vice President of IUGS, Treasurer of INTRA and working on their projects related to raw materials, was involved in OneGeology and served as the Vice President of IUGS (2012-2016), has been mainly managing projects in the past 10 years.

The committee met on the 25th September 2024 and discussed the process of review and exchanged general comments concerning the Statutes document (Annex 1), the internal review from 2023 and the SWOT (given below) that the DDE had provided.

The committee met for a second time on the 15th November 2024, and met virtually with a number of DDE representatives and followed the agenda given in Annex 2.

General statement

In the first instance the DDE project team must be congratulated on bringing the project to its current state, and this in particularly challenging situation involving a global pandemic and significant geopolitical instability. The committee agrees with the successes identified in the DDE SWOT analysis (annex 1) and it underlines and supports the growing recognition of DDE globally.

The committee thanks the sponsors of DDE, notably the China's Ministry of Natural Resources for funding the secretariat and the Kunshan City government support. Furthermore, the research and development platform, including software, algorithms, data, knowledge graph, standards, etc., developed by Chinese scientists through project funding from many sources in China including the National Natural Science Foundation of China, the China Geological Survey and the Chinese Ministry of Science and Technology.

The committee underlines the **need for continuity in funding** in an initiative of the scale of DDE. IUGS will continue to provide funding of at least \$20,000, which although a token in the entire budget, does recognise the IUGS strong support of DDE. IUGS will also accompany DDE in requests for additional funding in China and internationally.

Nonetheless, the review committee identified **problems in the structural integrity** of the overall governance of DDE and these are outlined below. IUGS will work with DDE to help address these.

The DDE Statutes document was reviewed and commented on by the Committee. The DDE executive is asked to take these suggestions into account and to revise the DDE statutes accordingly. The final document should be validated by the IUGS executive.

As the governance of DDE and GeoGPT involve separate entities direct questions on the future governance for GeoGPT were not included. Nonetheless the fact that GeoGPT was inspired by DDE and shares some technology, **a close working relationship with GeoGPT and DDE** needs to be developed.

DDE needs to be a legal entity if it is going to develop digital tools. As such an entity, DDE can license valuable data, if necessary, to improve the quality of the tools. Much of the most valuable data is not freely available. If there is a way to actively pursue this status, it should be developed.

DDE Review Panel Recommendations

Governance

Currently there are **inefficient connections between advice, governance & implementation** of advice. One example might be after review of the Working and Task groups by the Science committee, how will recommendations be implemented and what will be the overall management of the outcomes? In short, clearly defined roles and responsibilities of different DDE bodies is required.

The Governing Council is too large to be effective or efficient. Current requirements that each WTG have a representative on the Governing Council means that meetings are unwieldy and that many representatives are not actively involved. One suggestion is to create an independent advisory committee reporting to the GC.

The Governing Council has expressed a desire to meet more frequently and seems to have been constrained by the difficulty of coordinating so many members. As the group providing direction and vision to the Executive, it is imperative that the Governing Council be fully engaged, informed and in touch with the activities. The Executive expressed a desire that the Governing Council meet more frequently and be more active.

The GC should include a member of the IUGS executive, or a person nominated by the IUGS as its representative.

The Governing Council needs to be more visible – both to the Executive and to the international geoscience community. This could improve the real need for increased internationalization while also ensuring that the Executive is working toward the same goals as the Council.

The EC needs to include financial, communication and Legal and intellectual Property experts

Chairs of each of the standing Committees (GC, SC, Digital committee – see comment - and FC, should report to the Executive Committee (EC).

Digital innovation and science innovation

It is difficult to interrogate DDE about its digital developments and it is unclear where the strategic digital developments are decided upon and implemented by DDE.

A **Digital Committee** is needed to provide strategic oversight and guidance on the technical development of DDE platform and a technical user perspective in the tools developed. It is needed to oversee the development and implementation of a Data Policy and to engage in a meaningful way with global data and digital initiatives such as CoData in practical terms beyond just the use of high-level agreements.

An efficient interconnection between the **DC and Science Committee must be guaranteed (or create a single S&T committee – see below)**. Chair of SC should become a member of DC (without voting rights) and vice versa. CTO/CIO should become a member of both commissions as well.

These suggestions for a committee or strengthened expertise could provide governance and advice for a Chief Technology Officer or Chief Information Officer role in DDE. This role would act as a focal point for technology and data developments and requirements and responsibilities.

This committee might have oversight of a Geoscience Academic Knowledge Graph (GAKG) which needs to be managed in an open and transparent way and links to GeoGPT clearly stated.

Such a structure would have reduced the controversy and focussed the technical response to events surrounding the GeoGPT development, it could also provide credibility in the global digital geoscience community and lead to enhanced engagement.

The **Scientific Committee** does not view itself as making strategic decisions in digital or science innovation; they view themselves as a committee for research evaluation only. As such the SC is not performing a strategic function and does not have the responsibility for science and technology strategy and advocacy.

The Scientific Committee and the Governing Council both expressed concerns over inactive WTGs. The Governing Council meetings are impacted by the lack of participation from the WTGs and the Scientific Committee echoed a concern over silent WTGs.

To cement the WGs into the Governance of DDE there could be a requirement that each WG has a sponsor from the Science Committee or Digital Committee- see below. That sponsor attends the meetings and maintains the link from each WG to the overall DDE Governance.

An alternative that would not result in an additional committee, would be to create a single Science and Technology (S&T) committee with strong digital expertise and an ad-hoc committee when needed to evaluate science proposals. **In all cases digital expertise based roles (25% minimum) should be included in all the existing governance committees.**

Communication and engagement

Prioritise **website and Online resources**, e.g. the GeoOpenKnowledge Graph KG isn't currently available, and this is a resource that has been advertised since 2022. Such a resource and other of the building-block tools that underpin the DDE platform could underpin many initiatives beyond just DDE and GeoGPT and be part of the role of DDE in Open Science and the IUGS open science responsibilities.

Undertake a **full review of website** as it is difficult and slow to navigate.

Leverage cooperation with other organizations/partners outreach activities to enhance DDE visibility

We propose a memorandum of Understanding with IUGS that will govern future cooperation. This should be updated as needed.

Who are the Users of DDE? The project needs a user strategy, user reviews, user feedback, features requested by users. Prioritisation of user requirements including user stories available on the website and videos and slide-decks to be available for conferences.

Finance

DDE must emphasize a not-for-profit approach, a non-aligned geopolitical status, and unbiased, objective geo-data provider.

A proactive approach to seeking alternative funds beyond a single country is needed if DDE is to be successful and survives beyond its first five years, **fundraising needs to be re-invigorated at an international level** – whether through projects in kind or actual funds.

DDE needs to seek a legal solution that would address the international nature of the entity and ensure the appliance with international legislation

An exercise to quantify in-kind resources from outside a single country will demonstrate the level of global engagement – an example might be the inclusion of digital models funded by third parties (National funding agencies, Geological Surveys etc.) and used by DDE.

Both the Governing Council and Scientific Committee indicated that fundraising was not part of their activity, but there was no clear indication of where that responsibility resided. We note that the **Finance Committee (FC)** mentioned in the DDE Statutes has not been created and we recommend creation of such a committee as an ad-hoc committee reporting to the GC and chaired by a person from the GC.

The FC will look for funding opportunities and ensure accountability of the DDE.

Conclusion

The DDE is a bold initiative that has had significant successes. It requires stability in its governance structure and additional finance and legal support in its executive structure. It needs a mechanism to undertake strategic decisions in Science and Technology that are then

understood and shared across the organisation. DDE needs to ensure strong partnership including one with the GeOGPT initiative of the Zhejiang lab, China.

The DDE ad-hoc review committee (ARC) of IUGS
December 2024

Annex 1

The SWOT analysis on DDE prepared by the DDE group is presented as follows:

Strengths:

- Platform, GeoGPT, RCEs
- Geological standards, knowledge graphs, other technical expertise
- Explicit alignment with Open Science and FAIR
- Large number and geological range of WTGs
- Growing recognition in Africa and around world
- Growing visibility through int'l events and funded projects, e.g. 1:5 M World Digital Geological Map
- Some strategic MOUs e.g. CODATA
- Some strategic members ICDP, IGEO
- Lots of published papers
- Increased funding in China in 2024
- Not for profit and non-aligned geopolitically

Weaknesses:

- Funding is not diverse
- Perceived China dominance
- Website improvements needed
- Weak public relations and outreach
- Slow reaction to adverse publicity
- Academic focus (not enough applied geology track record)
- Slow Platform response to user needs
- Low levels of users from the Global South
- Inadequate inter/multi disciplinarity
- Weak/unengaged business/industry data & knowledge
- Perceived weak governance and lack of transparency
- Weak connections between WTGs

Opportunities:

- Education, virtual fieldwork, research through DDE Outcrop 3D
- Applied geology CCS, engineering geology, hydrogeology, net zero/energy transition
- New uses of geoscience discipline-specific LLMs
- Work with SDGs and UNESCO
- Work with business/industry in resources e.g. critical minerals
- Work with business/industry in information systems
- Market DDE Platform as an enabler for geodata in the Global South

Threats:

- Changing IUGS leadership; clarity on IUGS attitude to DDE
- Reductions in funding
- Adverse publicity
- Geopolitics

Annex 2

Agenda for the review committee meeting on the 15th November 2024

1) Review committee discussion on main points to ask in interviews (30 minutes)

Participants: DDE Review Committee members only

2) Interviews with Qiuming Chen and Roland Oberhaensli (45 minutes)

Interviewees: Roland Oberhaensli (Potsdam, Germany, start around 12:30 at noon)
Cheng Qiuming (Beijing, China, start around 19:30)

3) Discussion Review Committee (15 minutes)

Participants: DDE Review Committee members only

4) Interviews with the DDE Executive Chair plus (2-3 people) (45 minutes)

Interviewees: Wang Chengshang, Natarajan Ishwaran, Cai Min (Beijing, China, start around 20:30)

5) Discussion Review Committee (15 minutes)

Participants: DDE Review Committee members only

6) Interview with the DDE BoG chair (30 minutes)

Interviewees: Harvey Thorleifson (Saint Paul, Minnesota, USA, start around 7:30 am)
Manuel Pubellier (Paris, France, start around 14:30)
Mike Stephenson (London, UK, start around 13:30)
Chris Shen (Secretary for this section, Beijing, China start around 21:30)

7) Discussion Review Committee (15 minutes)

Participants: DDE Review Committee members only

8) Interview with the DDE Scientific Committee chair and chairs of subcommittees (45 minutes)

Interviewees: Hans Thybo (Copenhagen, Denmark, start around 15:15/Beijing, China, start around 22:15)
William Cavazza (Rome, Italy, start around 15:15)
Mónica Chamussa Juvane (Maputo, Mozambique, start around 16:15)
Li Chao (Secretary for this section, Beijing, China, start around 22:15)

9) Wrap up and next steps (30 minutes)

Participants: DDE Review Committee members only