Epilogue – The rhymes, musings and riddles of the International Community of Geological Surveys (ICOGS)

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Abstract: Building on the present volume, which provides a snapshot of Geological Survey organizations (GSOs) from around the world in 2020, this epilogue provides a retrospective on past efforts to form an international consortium of GSOs. These efforts have had the noble aim of bringing GSOs together to address problems of global scale, but have not fully succeeded in building a sustainable organization. The paper summarizes international discussions held over the past three decades, provides some analysis and makes some suggestions on how a world association of GSOs may become useful, credible and workable.

Supplementary material: Unpublished background documents such as attachments to past email exchanges and agenda of meetings between GSOs are available at: https://doi.org/10.6084/m9.figshare.c.5076287

‘History does not repeat itself, but it rhymes’ (Mark Twain)

When the authors undertook the editing of this volume as a legacy project to the 2018 Resource for Future Generations meeting in Vancouver, Canada, we knew little about past international meetings of Geological Survey organizations (GSO) with the exception of the proceedings volume from a 1992 meeting held in Ottawa (Bouchard et al. 1994). Neither did we then know about past initiatives to form an International Consortium of Geological Surveys. It seemed timely to bring together GSO leaders to discuss the potential for international collaboration as an echo to the 1992 meeting, and to close the 175th anniversary celebrations of the foundation of the Geological Survey of Canada. Many GSO leaders answered our invitation to meet with enthusiasm. We had a good meeting, the idea of a volume on the Changing Role of Geological Surveys was launched (this volume) and we thought that we would simply close the book and move on.

In Vancouver, we first heard from several participants of a so-called ‘International Consortium of Geological Surveys’ (ICOGS) that had been active in the past. Like us, most of the GSO heads who were present did not seem to know many details about it. After a search of the geoscience literature and consultation with some retired colleagues, we have discovered that a global association of GSOs has been a recurring idea over many decades. Although the record is scattered, there have been some serious attempts to develop the idea, but also long periods of inertia (Table 1). An initial period of enthusiasm occurred in the early 1990s, following the 1992 GSO heads meeting, and was marked by meetings in 1994 and 1996 and a proposed organizational scoping document (Findlay 1992). A few more infrequent ICOGS meetings occurred on the margins of subsequent International Geological Congresses (IGCs). At the Florence IGC in 2004, a group of GSO leaders decided that ICOGS warranted more investment in time and effort, but the momentum eventually faltered in 2008, when global efforts shifted toward the new OneGeology initiative (http://www.onegeology.org). The meeting of GSO heads in Vancouver in 2018 encouraged us to explore again the idea of an international alliance of GSOs and whether there would be interest in building such an alliance based on existing successes and relationships between GSOs. A follow-up meeting of GSOs was organized on 2 March 2020, at the Prospectors and Developers Association of Canada annual meeting in Toronto, as this book was reaching completion, with the explicit objective of exploring the founding of such an organization. Thirty participants assembled from all continents supported a re-initiation of efforts to create a global association

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| Date            | Event                                                                                                                                                  | Location         | Participants                                                                 | Publication type  | Reference                  |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|-------------------------------------------------------------------------------|-------------------|---------------------------|
| April 12–14 1992 | World Organization of Geological Surveys initial proposal                                                                                               | Ottawa, Canada   | 175 from 18 countries                                                          | Notes (1) Notes (1) | Findlay (1994) Findlay (2010) Findlay (1992) |
| June 1992       | Publication in *Episodes:* ‘A world organization of geological surveys?’                                                                             | N/A              | N/A                                                                           | Article (1)       | Bouchard et al. (1994)    |
| 25 August 1992  | Business meeting at the 29th International Geological Congress                                                                                          | Kyoto, Japan     | 52 from 34 countries                                                           | Notes (1)         | Gaál (1994)               |
| 19–21 September 1994 | ICOGS Business meeting during the celebrations of the 125th anniversary of the Hungarian Geological Institute                                            | Budapest, Hungary | ?                                                                              | Volume (1)        | Gaál (1994)               |
| 19–21 September 1994 | ICOGS Business meeting during the celebrations of the 125th anniversary of the Hungarian Geological Institute                                            | Budapest, Hungary | ?                                                                              | Newsletter (1)    | Dudich (1995)             |
| August 1996     | ‘History of Geology’ symposia at the 30th IGC, co-sponsored by INHIGEO (International Commission on the History of Geological Sciences), IUGS and ICOGS | Beijing, China   | ?                                                                              | Proceeding (1)    | Hongzhen et al. (1997) Hase & Kodama (1997) |
| 1998–2005       | Asia-Pacific Newsletters                                                                                                                              | Tsukuba, Japan   | N/A                                                                           | Newsletter (7)    | ICOGS Asia-Pacific Newsletters (1998–2005) Gaál (2000) |
| August 2000     | ‘The application of geoscience mapping and related geoscientific products in the 21st century’ seminar at the 31st IGC                                                                                 | Rio de Janeiro, Brazil | 47 from 33 countries                                                          | Seminar abstracts (1) | Asch (2004)               |
| August 2004     | ‘Management and application of geoscience information’ symposia at the 32th IGC, co-sponsored by CGL IAMG and ICOGS                                                                                           | Florence, Italy  | ?                                                                              | Newsletter (1)    | Bjørlykke & Christmann (2007) |
| 26 August 2004  | Business meeting of GSOs                                                                                                                             | Florence, Italy  | ?                                                                              | Correspondence (1) | IGC (2008) Bjørlykke & Christmann (2007) |
| August 2008     | ‘International Consortium of Geological Surveys’ workshop and Business meeting at the 33rd IGC, reporting on 12 oral presentations and one poster     | Oslo, Norway     | ?                                                                              | Proceeding (1)    | Correspondence (1)        |
| August 2012     | ‘International Geo-surveys Forum’ Workshop at the 34th IGC reporting 14 oral presentations                                                                 | Brisbane, Australia | >12 from >11 countries                                                        | Agenda (1)        | IGC (2012)                |
| May 2012        | Launch of the SGMundo website                                                                                                                         | Belo Horizonte, Brazil | 172 countries                                                                 | Website (1)       |                             |
| June 2018       | ‘Changing Role of Geological Surveys’ symposium at the Resources for Future Generations 2018 meeting; 26 oral presentations and 2 panels,                                                        | Vancouver, Canada | 50 approx                                                                     | Conference session with abstracts (1) | Bohm et al. (2018) |
| March 2020      | Business meeting at the Prospectors and Developers Association of Canada convention  ‘Changing Role of Geological Surveys’                                                                             | Toronto, Canada  | 29 from 18 Countries                                                           | N/A               |                             |
| 2020            | Geological Society of London’s volume on the ‘Changing Role of Geological Surveys’                                                                   | N/A              | N/A                                                                           | Volume (1)        |                             |
| 2020            | Directory of Geoscience organizations of the World (Geological Survey of Japan)                                                                     | N/A              | N/A                                                                           | Website (1)       |                             |
or community of GSOs and their related regional associations.

In the course of our research on past musings about creating an international consortium or association among GSOs, we discovered much that echoed the 2018, 2020 and past discussions. The fact remains that, to date, no such global level international association or consortium of GSOs has proven to be sustainable.

As we close this volume, we would like to capture some of our findings about current and past musings on an international consortium, to collect this information in one place. As we move forward, understanding this history may help us. Here we summarize past views and provide some considerations and a proposal toward a useful, credible and workable world association of GSOs.

It is important to recognize that continental or regional GSO associations have been created over the last century (Table 2) and several of them are covered in papers in this volume: the American Association of State Geologists formed early at the invitation of the federal US Geological Survey (AASG, 1907), followed much later by the Coordinating Committee of Geosciences Programmes in East and Southeast Asia (CCOP, 1966). CCOP was founded under the auspices of the United Nations with the name ‘The Committee for Co-ordination of Joint Prospecting for Mineral Resources in Asian Offshore Areas’ and gradually evolved to include a broader spectrum of activities. The EuroGeoSurveys (EGS) is a formal not-for-profit association of GSOs of Europe that succeeded its predecessor the network of Western European Geological Surveys founded in 1971 and is now aspiring to form the first Geological Survey of Europe. The Geoscience, Energy and Maritime Division of the Pacific Community plays a role similar to an association and originates from the South Pacific Applied Geoscience Commission that was created in 1972 as part of a United Nations Development Programme Project arm. The more recent GSO associations are the Association of Geological and Mining Surveys of Iberoamerica (ASGMI, 1993), the National Geological Survey Committee of Canada (NGSC, 1996) and the Organisation of African Geological Surveys (OAGS, 2007). It is worth noting that the OneGeology (http://onegeology.org) digital mapping initiative is one of the rare global initiatives that has wide participation and support from most GSOs of the world. We discuss this element below since if a new, formal association of geoscientists is to be formed, to succeed and be beneficial, it will need to consider its inter-relationship with these associations and initiatives and build on their success in order to find its appropriate niche and usefulness in the international geoscience ‘ecosystem’.

We close this paper by presenting key questions to be addressed if GSOs are to form a new global community alliance, and present some possible answers and a proposal towards an association with a possible useful niche, organization models and general principles.

### International congresses, IUGG, IUGS and key initiatives

Geoscientists have been meeting internationally to discuss and critique all the disciplines in the field of Earth Sciences for over two centuries (Fig. 1). The earliest geoscientists were quick to realize the value of visiting other countries and colleagues abroad to compare geological data, observations and methodologies. Vai (2002) documented the

| GSO association name       | Region or country               | Founding year | Number of GSOs | Web site                        |
|----------------------------|---------------------------------|---------------|----------------|--------------------------------|
| AASG                       | USA                             | 1907          | 50             | https://www.stategeologists.org|
| CCOP                       | Southeast Asia                  | 1966          | 15             | http://www.ccop.or.th          |
| EuroGeoSurveys             | Europe                          | 1971          | 37             | https://www.eurogeosurveys.org |
| Pacific Community – Geoscience, Energy and Maritime Division | Pacific | 1972 | 26 | https://gem.spc.int |
| ASGMI                      | Central and South America, Spain and Portugal | 1993 | 22 | http://asgmi.org/en/ |
| National Geological Survey Committee (Coordinating committee) | Canada | 1996 | 12 | http://ngsc-cptgs.com |
| OAGS                       | Africa                          | 2007          | 54             | https://www.oagasafrica.org    |
interrelationships between a small group of early geoscientists from Canada, USA, France, Italy, UK and Sweden that visited each other in the mid nineteenth century and took advantage of the 1878 International Exhibition of Paris to host the first IGC. James Hall was the President of this first congress, and Sterry Hunt the Secretary General. Both men and the organizing committee were closely associated with the early GSO leaders. The congresses were held as a means of elucidating correlation issues between countries and continents that are instrumental in geological map development, a key function of GSOs. Indeed, the mandate of the first congress was: ‘for the purpose of getting together comparative collections, maps and sections, and for the settling of many obscure points relating to geological classification and nomenclature’ (Vai 2002).

From this point on, geoscientists from around the world continued to meet at the IGC every c. 4 years. Through these meetings, considerable efforts in creating international scientific commissions and initiatives to unravel the more complex scientific challenges have been made. Many of these commissions and initiatives have become multi-decadal efforts and are on-going, (e.g. such as the Commission on the Geological Map of the World (https://ccgm.org/en) created in 1972 at the 24th IGC in Montreal).

The International Union of Geodesy and Geophysics (IUGG) just celebrated its 100th anniversary having formed in 1919 (http://www.iugg.org). It presently comprises 73 countries (Members and Associate Members) and eight affiliated, semi-autonomous thematic associations. The closely related International Union of Geological Sciences (IUGS; http://www.iugs.org) was created in 1961 (Harrison 1978), and later became the oversight body for the IGC. It presently comprises 121 countries and 54 affiliated associations. Cheng (2020) describes its latest ambition and calls on the GSOs of the world to support the advancement of the new IUGS ‘Digital Deep Earth’ initiative.

To address the need for international standardization and classification, the International Commission on Stratigraphy (ICS; http://www.stratigraphy.org) was created. It is the largest and oldest constituent scientific body in the IUGS and was formed nearly simultaneously with its parent organization in the 1960s (Vai 2001). The ICS is the largest grouping of geoscientists in the IUGS and GSO scientists are active participants in its subcommissions. The primary objective of the ICS is to precisely define
global units (systems, series and stages) of the International Chronostratigraphic Chart that, in turn, are the basis for the units (periods, epochs, and age) of the International Geologic Time Scale, thus setting global standards for the fundamental time scale for the history of the Earth.

At the 24th IGC in Montreal, Canada in 1972, the International Geological Correlation Program (Lopes 2020) was created. The Geoparks initiative was started by UNESCO in 1997 and it was later merged with the International Geological Correlation Program to become the International Geoscience and Geoparks Program (http://www.unesco.org/new/en/natural-sciences/environment/earth-sciences/international-geoscience-programme). Barr (2005) summarizes the origins and main functions of these global initiatives, in the context of Canada’s role in initiating and supporting them.

The emergence of continental associations of GSOs

The AASG now comprises 50 geological survey organizations in the USA. As outlined above, this is one of many country- or continental-level associations that have emerged since (Table 2). Taken together all of these organizations have a membership of some 216 GSOs across the world and together all of these organizations have a membership of some 216 GSOs across the world and their activities have been the cornerstone of international, cross-organization and cross-association collaboration over the last several decades. Examples abound:

- The joint AASG/US Geological Survey/GSC National Geologic Map Database (https://ngmdb.usgs.gov/Info) is an initiative to develop technical standards and guidelines for the creation of geological maps.
- The EGS–OAGS PanAfGeo Partnership (2016–19) was the first intercontinental Geoscience cooperation programme, supporting geoscientific staff from African Geological Surveys through the development of an innovative training programme (https://www.eurogeosurveys.org/projects/current-projects/panafgeo/). A sequel PanAfGeo2 programme has been proposed (EGS & OAGS 2019).
- The CCOP (http://www.ccop.or.th/) has been active in Southeast Asia for over 50 years and actively engages a group of affiliate GSO members from around the world. It organizes many collaborative activities such as the series of workshops on Transboundary Aquifer Monitoring and Management in the Mekong Basin. In association with CCOP, the Korea Institute of Geoscience and Mineral Resources (KIGAM) organized a major conference with heads of surveys from around the world in Busan, 2018, that celebrated the 100th year of KIGAM (KIGAM 2018).
- The ASGMI (http://asgmi.org/en/) holds regular meetings and workshops across Latin America. A recent example was the 2019 International Workshop of Hydrogeology and Hydrogeological Cartography in Río de Janeiro, Brazil, organized by the Geological Survey of Brazil (http://asgmi.org/wp-content/uploads/2019/09/Acta-de-Acuerdos-Taller-Hidrogeolog%C3%ADa-R%C3%ADo-de-Janeiro.pdf) and attended by participants from all over Latin America. ASGMI collaborates with EGS through the INTERMIN project (https://interminproject.org/meet-the-team/) that aims to create a self-sustainable long-term lasting international network of training centres for professionals.
- The Pacific Community’s Geoscience, Energy and Maritime Division’s largest programme is the Disaster and Community Resilience Programme (https://gem.spc.int/key-work/DCRP), one among several key technical pillars. It develops, implements and supports coordination of innovative applied science and technical action to respond and adapt to some of the greatest challenges facing Pacific Island countries and territories related to climate and direct and indirect anthropogenic change (e.g. sea-level rise, coastal erosion and protection of water sources such as coastal aquifers). It also helps to drive critical partnerships for action using science to better inform decision making.
- The NGSC of Canada reports to Ministers of Mines of Canada under the Intergovernmental Geoscience Accord since 1996. The NGSC provides advice to ministers on matters of public geoscience and coordinates the development of federal, provincial and territorial geoscience collaborative projects. In 2019, it was mandated to develop a Pan-Canadian Geoscience Strategy under the new Canadian Minerals and Metals Plan (https://www.minescanada.ca/en/content/action-plan-2020-introducing-pan-canadian-initiatives-march-2020).

The musings and efforts to create an international association of GSOs

International Conference of Geological Surveys, 1992

Table 1 summarizes the key events related to the creation of a global organization of Geological Surveys. The starting point appears to have been a special International Conference of Geological Surveys that was convened in Ottawa in 1992 (Bouchard et al. 1994). Beyond the exchanges that occurred regarding each organization’s mandate and challenges, time was set aside for the specific purpose
of evaluating a proposal by Chris Findlay of the Geological Survey of Canada (Findlay 1992, 1994, 2010) to form a ‘World Geological Organization’. He observed that the roots of many of the issues facing geological surveys were global in nature, such as the finite reserves of mineral resources, although their immediate impacts may be local or regional. He also observed that in 1992 two dominant views emerged: (1) all Geological Surveys will have to respond quickly to the priorities of the environmental agenda; and (2) in order to contribute effectively toward solutions to environmental problems, Geological Surveys will have to develop better methods of communication, particularly communication upward to their policy-making and political levels.

There was a substantial discussion of the possibility of a World Geoscience Organization that weighed the pros and cons of such an organization between the heads of GSOs (a dialogue broadly reported by Findlay 1994, pp. 175–177). Three possible governance options were presented: (1) a commission of the IUGS; (2) an informal ‘club’ of GSO heads that would meet from time to time to exchange views and develop new initiatives; and (3) a formal World Geoscience Organization (WGO) with statutes and membership fees.

Option 3 was favoured by Findlay (1992) and he proceeded to present a potential charter for a WGO, reproduced here as Table 3, but the organization failed to launch and proceeded informally until the present, more or less as option 2.

Several meetings of GSOs occurred every two to four years between 1992 and 2008. At the Kyoto 29th IGC 1992 (Bouchard et al. 1994, addendum) a ‘World Geological Survey Committee’ was formed, with an objective of meeting every four years at the IGC. In 1994, the ICOGS met in Budapest on the occasion of the 125th anniversary meeting of the Hungarian GSO, and a series of presentations were made by the heads of GSOs (Gaál 1994; Dudich 1995). Some limited activity appears to have occurred at the 30th IGC in Beijing, 1996 (Hongzhen et al. 1997; Hase & Kodama 1997). From 1998 to 2005, the Geological Survey of Japan started to publish a regional newsletter, highlighting regional GSO activities, and announcing an eventual ICOGS session at the IGCs. At the 31st IGC in Rio de Janeiro, 2000, ICOGS held a session on geological mapping, with emphasis on emerging digital products (Gaál 2000). In Florence, 2004 an ICOGS business meeting was held where a commitment was made to form a small committee, to propose a formal structure for ICOGS at the next IGC (Bjørlykke & Christmann 2007, Annex 1). At the 33rd IGC in Oslo, an ICOGS workshop was held (IGC 2008), and a business meeting was held to follow up on the 2004 commitment (see below). Meanwhile a competing, albeit complementary, international initiative was rising that required the attention of GSO heads. This initiative, OneGeology, was very much undertaken in the spirit of the ICOGS collaborative objectives, but focused on the fast rising tidal wave of data and the need for standards for sharing it across the internet.

**Table 3. Potential Charter for a World Geoscience Organization (Findlay 1992)**

- To provide collective leadership in guiding the application of governmental geoscientific knowledge and expertise in order to address the major social and environmental problems affecting the human condition.
- To provide a mechanism for fostering communication and collaboration among major international non governmental scientific organizations, such as the IUGS, ICSU and IUGG, and social, economic and development organizations, such as UNESCO, United Nations Environment Programme and United Nations Development Programme.
- To provide a global network for consultation, development of consensus views on major issues, and timely exchange of advice and opinions at senior levels within the world’s geological survey organizations.
- To facilitate and promote the development of major trans-national projects that would require the support of a number of government agencies in order to be feasible.
- To facilitate the development of multilateral memorandums of understanding or other instruments that could serve as enabling mechanisms for regional and international cooperation in geoscience projects, as above.
- To serve as a clearinghouse for information (Secretariat function); to facilitate the exchange of data, information and staff amongst participating countries and agencies; and to develop and promote training and technology transfer programmes.

**OneGeology**

In 2007, following a workshop in Brighton, UK, the OneGeology global digital geological map initiative was founded, largely through a group of GSO professionals and leaders, to take advantage of digital technologies and the internet. It ramped up very quickly, thanks to the dynamism of several individuals, such as Ian Jackson (British Geological Survey), John Broome (Geological Survey of Canada) and François Robida (BRGM, France), as well as, critically, with the support of their GSOs.

The signature in March 2007 of the OneGeology Brighton Accord marked a major milestone in the cooperative movement of GSOs towards a world association (http://www.onegeology.org/).
OneGeology was officially launched at the 33rd IGC, in Oslo Norway in 2008. In order to start OneGeology, a small group of GSOs took leadership and funded the secretariat and technical support from the onset. This formula has continued to this day with an expanding number of contributing members. Since the onset, it has been a well-organized initiative that includes technical advisory committees, the development of data standards and ‘cookbooks’ to help GSOs bring their data online, as well as mechanisms to help GSOs learn from each other about geoscience data management and web access according to international standards.

In 2016, at the 35th IGC in Capetown, South Africa, the OneGeology Steering Committee approved the advancement of a new ‘Loop3D’ Project proposed by Australia, the first of a series of new cooperative research initiatives. The most recent initiative is the concept of ‘Digital Twins’, including the structure and processes of entire sedimentary basins, suggested at the 2019 OneGeology Steering Committee in Uppsala, Sweden.

The International Association of Geological Surveys proposal, Oslo 2008

Another business meeting of GSOs was held at the 32nd IGC in Florence, Italy, in 2004. A steering committee consisting of GSO leaders from all of the broad regions of the world was formed. This committee deliberated and consulted widely in December 2007

Table 4. IAGS proposed objectives and activities (Bjørlykke & Christmann 2007)

| Objective | Description |
|-----------|-------------|
| Article 3: Objectives | IAGS pursues the following objectives: |
| • To jointly address international issues of common interest | |
| • To promote the contribution of geosciences to UN organizations and their action programmes | |
| • To assist UN organization to obtain technical advice from the members of the Association | |
| • To provide a permanent network between the Geological Surveys and a common, but not unique, gateway to each of the Surveys and their national networks | |
| • To represent geological surveys in international organizations. | |

Article 4: Activities
The International Association of Geological Surveys will undertake only those activities that lie clearly in the domain of public interest or of public management and that will benefit most from the combined and coordinated expertise of its members in the direct interest of the UN at large or other global institutions/companies by circulating results of surveys and draft proposals for the statutes of a new consortium of geological surveys (Arne Bjørlykke, pers. comm., 2020; Table 1). The initial widely circulated proposal had a large number of possible priorities, many of them similar to Findlay’s (1992) ‘charter’. However, the discussions in advance of Oslo appear to have sharpened the mandate of a newly termed ‘International Association of Geological Surveys’ (IAGS) (Table 4). The IAGS statutes largely mimicked the EuroGeoSurveys Statutes, proposing that only one national GSO per country could be a member, and suggesting a membership fee for each member.

Neither the statutes nor the launch of the new organization was approved. It appears that the energy and funds invested in the launch of OneGeology may have contributed to an unwillingness to commit to a new association of world GSOs. It was suggested at the origin that OneGeology could be a programme under an ICOGS (A. Bjørlykke, pers. communication, 2020). The formalization of ICOGS was put aside, and the model of a meeting of GSOs at the IGC was resumed with a session at the 34th IGC in Brisbane (IGC 2012).

Directories of GSOs

- There are two active directories of GSOs. In 2008–12 the Brazil Geological Survey compiled an inventory of the mandates and organizational priorities of GSOs of the world and published it in 2012 through their web site (https://www.cprm.gov.br/sgmundo/form_consulta_ext_eng.php).
- The Geological Survey of Japan maintains a full list of contacts of GSOs and other organizations, many not affiliated directly to the above-mentioned national or continental associations (https://www.gsj.jp/en/gsj-link/directory/dir-gse.html).

March 2020 workshop on ICOGS

Model – a federation of ‘continental’ organizations; a community

On 2 March 2020, the GSC and IUGS held a business meeting at the Prospectors & Developers Association of Canada 2020 convention in Toronto, Canada, to decide whether to re-launch the ICOGS. Over 250 email contacts were made with GSOs around the world to invite them to a discussion on this topic. The invitation yielded an assembly of some 30 individuals from some 20 countries. Three of the regional associations had representatives: the EuroGeoSurveys, OAGS and ASGMI. This demonstrated a serious willingness to discuss, given the tight timeframe to hold the meeting in Toronto, following the cancellation of the earlier proposed...
meeting at the 36th IGC in Delhi, India, owing to COVID-19 concerns (some 50 people had confirmed interest for the earlier Delhi meeting). Presentations were made by various participants to support the discussion, and efforts were made by the organisers to present excerpts of analyses and proposal documents received from individuals who could not attend the meeting (e.g. B. Ashi, personal communication). The participants agreed notionally, if volunteers could be found to develop it, to move forward with the revival of a plan to be presented at the 36th IGC, expected to be held in November 2020 in Delhi, India.

While views on the level of formality for the new association vary somewhat, the majority felt that having a formalized association would carry weight in order to be able to make progress, as generally found in other GSO associations: a strategic intent, objectives, terms of membership, with a simple organizational structure with a steering committee, so that discussions can be organized, and plans and decisions made. Participants also discussed the importance of having geographic representation, developing standard methodologies and agreements to ease cooperation and sharing data to support decision-making. To put the community on a sustainable footing, IUGS offered the support of the IUGS secretariat. Further discussions are required to define the objectives and path forward. The next step is to form a committee of volunteers with contingent representation to develop and coordinate the preparation of a plan for the structure and operations.

Depending on the ambition and level of resourceing that GSOs may wish to provide it with, the participants suggested that the revival of ICOGS could be an opportunity to discuss how we can leverage the expertise and network of the GSOs to accelerate the resolution of complex horizontal global problems through international cooperation. Participants were presented with the views that GSOs play a key domestic role in addressing a broad range of national issues critical to a nation’s well-being, including climate change, environmentally responsible natural resource exploration and development, disaster risk reduction, the digital economy, sustainable cities, water and sanitation, geo-heritage, biodiversity preservation, education and geo-health. Many of these issues cross international boundaries and there is great value in international collaboration to broaden perspectives, exchanging knowledge and developing and adopting common standards and practices. It is also important to note that geoscience has become ever more multidisciplinary in nature and the future community should therefore be open to other disciplines and sectors, even beyond the natural sciences. Bridging science and policy would appear to be a particularly interesting opportunity for growth.

Discussion

‘You can never direct a living system. You can only disturb it’ (Maturano & Varela 1992)

As the history described previously suggests, there is a perception among GSOs that there would be considerable benefits in establishing an association or federation of GSOs. Several global drivers such as climate change and the UN Sustainable Development Goals appear to make this more important than ever. Yet the enterprise is fraught with challenges: the need for widespread buy-in, developing the right governance model and finding funding for even a small secretariat to support the organization. GSOs all operate with finite human and financial resources, so such an enterprise is always subject to competition for resources within each GSO. The COVID-19 crisis may represent an important opportunity to increase the dialogue between GSOs. The worldwide social confinement implemented by most governments has led to a widespread adoption of web-based videoconferencing and virtualization of many scientific conferences (e.g. the announcement of a free Europe Geoscience Union virtual conference, as we write these lines). This change has been particularly evident in some government departments, which are often slow to introduce new digital technologies. Most digital events can be held at little cost, with little advance notice, and require a level of organization that only increases with the ambition of the event (webinar vs a formal conference).

The idea that emerged from the March 2020 meeting was for a sort of federation of GSOs, where each of the regional associations together with some individual, unaffiliated GSOs would be represented and form the core of the federation. This intercontinental community or federation of Geological Surveys would connect chiefly through these associations to individual GSOs. It would be crucial for the new federation to connect with other global organizations, both formal organizations such as IUGS and IUGG, but also less formal groups such as the Earth Science Information Partnership https://www.esipfed.org- (an organic international association of Earth science organizations). Connecting to the experience held by these groups would avoid duplication, maximize success and optimize the benefits both to the world and to the GSOs themselves.

Sustaining this effort will require new thinking about the nature of the organization and several further key questions will need to be addressed to solicit and obtain broad endorsement and create a viable new alliance. Legitimate questions that we have heard and asked ourselves include:

- There are already several regional GSO associations and related initiatives. What would be the definition and critical function of a geological
survey consortium, community, or federation of associations?
- The international OneGeology initiative is broadly supported through an alliance of GSOs, and has been a success. Why create a new one if it could be transformed to play a broader function for GSOs?
- Who is meant to benefit? Should the new association be a simple assembly for Directors of geological surveys to discuss challenges or an international body with global objectives to serve the world as a whole, a dilemma that has been recognized since 1992 (Findlay 1994)?
- Would the association be a social platform for creating relationships or more focused on organizing and supporting projects and activities? Or both?
- Would it supplement or replace traditional bilateral and existing multilateral relationships?
- What would be the clear value for a new proposed association at the global level when most GSOs operate at the national level for a largely domestic policy purpose?
- Are the domestic mandates of the different GSOs fundamental obstacles to an international association?
- Do present-day global issues, players and interests provide any better opportunity than in the past to sustain such an organization?
- Does the existence of other associations and their related initiatives fill most of the previously imagined (or yet to be imagined) purpose, so that there is no viable niche for such an international association of GSOs?

Although we do not have answers to all these questions, we present here a few suggestions. Having taken stock of the success of each of the continental and national Geological Survey organizations, we contend that there exists a need for a global, world community of Geological Surveys, an opportunity to build on the existing relationships, the learnings and the assets of the continental/regional GSO associations and the global OneGeology. These successes show that some inherent obstacles, such as the largely domestic rather than international mandates of GSOs, can be overcome.

As the papers in this volume show, GSOs are interested in dialogue about their particular unique nature in the science ecosystem. They also occupy a particular niche in government policy, principally to pursue domestic objectives. It is therefore clear that each GSO and its government should first see value in their participation in a global organization if it helps them better achieve national objectives or contribute to international objectives to which they are bound. Increasingly, international commitments such as the Sustainable Development Goals filter down and get domesticated into law and national objectives (Raustiala 1995), many of which find their way into GSO mandates.

Finally a new association should increase synergies and help and support GSOs rather than complicate the navigation and sustenance of the existing crowded series of national and international associations, projects, initiatives and networks.

As is witnessed through several of the GSO associations, direct benefits can flow to GSOs if such an association can connect GSOs leaders and help them to become: (1) more agile to respond to evolving national government needs about emerging issues in other continents and nations; (2) more efficient by using common geological survey standards, sharing equipment and technologies; (3) more effective in uncovering new stakeholder geoscience needs; (4) more attractive of talent by being at the forefront of science and technology; and (5) less vulnerable to funding cutbacks and power loss in the context of competing policy and client priorities.

A proposal: the World Community of Geological Surveys

We are inspired by the long-held motto of the environmental movement, ‘Think globally, act locally’, and the basic tenets of ‘living systems’-based approaches in proposing here a possible scope for a new alliance of GSOs. This new ‘World Community of Geological Surveys’ (WCOGS) would be a modernized version of ICOGS and would have as its principal characteristics:

- It would be defined as a digitally based community focused on the needs of GSOs, developing common standards, supporting the development of their capacity to deliver their mandate, sharing best practices, discussing issues and developing projects of common and critical interests, including the application of fast evolving new technologies such as artificial intelligence, and the integration of GSO science, expertise and data into policy.
- It would take advantage and accelerate the benefits of the enormous progress, cultural change, reductions in costs and other efficiencies of video-conferencing, web-based conferences, document sharing and related innovations that have emerged in the scientific community and that appear to be spreading widely to other communities and organizations as a consequence of the COVID-19 pandemic crisis.
- It would ensure engagement from the start through a small steering committee of ‘champions’ representative of all continents, who are willing to invest effort, resources and influence to set the direction and governance of the organization so that buy-in exists.
• It would examine, complement, support and build on the broad successes of current GSO Associations (e.g. EGS, ASGMI, OAGS, CCOP, AASG, NGSC), which should be deemed core constituents of the WCOGS. It would capitalize on their existing communication channels to create events, generate more buy-in and create unique and useful WCOGS niche events. Such practice will also provide opportunities for face-to-face meetings between GSO leaders from all continents. An example is the annual ‘Director workshop’ of EGS and ASGMI that seem to be very good at generating strong discussions and building relationships.

• It would have frequent events that connect beyond the heads of the GSOs but engage their leadership teams. It would create convergence points such as ‘geoscience for policy’ events, issue-oriented projects and capacity building workshop and exchanges to support GSOs’ growing influence on their own government and with stakeholders, as public service organizations.

• It would capitalize on OneGeology and other GSO initiatives rather than overtake them through WCOGS. The WCOGS could facilitate the mapping of functions supporting GSOs rather than seeking to rule over them.

• It would aim for a simple, frugal organization, adjusting its resource level to be commensurate to its success and the desires of its membership, yet starting with a level sufficient to reduce the risk of failure from the start. As has been demonstrated by the success of OneGeology, a crucial factor of success will be the enthusiasm of a handful of GSO leaders willing to give it time, care and nurture to grow and bear fruit.

We are also inspired by the systems thinking that underlies the Living Systems Theory pioneered by Capra (1996, 2002). As articulated by Barlow & Stone (2011) in a completely different context, living systems, including human networks, have different properties from mechanical systems and favour strategies that would be applicable to WCOGS:

• *Nurture community and cultivate networks* – ‘Sustainability is not an individual property, but the property of an entire network’ (Capra 2005). Building connections between GSOs will be a key activity.

• *Work at multiple levels of scale* – the reality is that GSOs are embedded in a hierarchy of administrative and political structures within their own countries, as well as in regional organizations. Each GSO will need to be allowed to find its way through these structures in order to participate. ‘One size fits all’ will never work.

• *Recognize openings for the breakthrough of novelty* – living systems require and necessarily find states of stability that can impede change, but certain events, often crises, can lead to the breakdown of old structures and the opportunity to reconfigure in a way that works better. As we implied in the introduction to this volume, the world is never short of disruptive technology and events and GSOs are often on the forefront of such changes.

• *Cultivate systems’ capacity for self-organization* – living systems are inherently self-organizing, so that attempts to force conformity will not work. Common standards may be useful within certain parts of the system, but moving forward the federation will need to welcome variety in approaches.

• *Facilitate, don’t expect to direct* – despite our best efforts to control our world, change tends to occur spontaneously. In a complex federation of GSOs, change cannot be directed. ‘Facilitating the emergence of change calls for a different kind of leadership that supports a system’s capacity for generating creative solutions by nurturing its networks of connection and communication, by creating climates of trust and mutual support, and by encouraging questioning and rewarding innovation’ (Barlow & Stone 2011).

• *Plan on change taking time* – the evidence in front of us is that it has taken nearly 30 years to arrive at this point and this point is still just the starting point. The federation will need to temper its expectations about what progress means. The old trope that ‘it is the journey that counts not the destination’ is truly apt. Yet change theory teaches that there is a need to generate urgency and buy-in if change is to happen.

• *Be prepared to be surprised* – as the federation of GSOs develops and evolves, unpredictable ‘emergent properties’ are likely to emerge. It should embrace them because such properties are where local actions can become influential on a larger scale.

Time will tell if a new WCOGS will take hold and become sustainable. It could embrace the characteristics described above to maximize success, grapple with whether formal terms of reference are required to ensure understanding of vision, role and mission, and whether a simple and frugal secretariat will be effective. Perhaps the key element will be for it to ‘rhyme with the times’.

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