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Commentary

Open Access in Geochemistry from Preprints to Data Sharing: Past, Present, and Future

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Abstract: In this short communication, we discuss the latest advances regarding Open Access in the earth sciences and geochemistry community from preprints to findable, accessible, interoperable, and reusable data following the 14f session held at Goldschmidt conference (4–9 July 2021) dedicated to "Open Access in Earth Sciences".

Keywords: open access; preprint; FAIR data; earth sciences

1. Introduction

Throughout history, the scholarly community has made numerous arguments for greater and easier public access to published research, which became known as Open Access (OA) in the early 2000s [1]. Over the last 20 years, scholarly publishing has seen a significant upheaval, with the move to OA signaling a significant shift in major publishers' revenue models [2]. Open-access publication is often conflated with the author-facing business model of Article Processing Charges (APCs), whereby authors (or their institutions) pay a pre-specified fee to cover the publication cost [3]. In 2020, 69% of fully OA journals do not levy APCs; although, perhaps counter-intuitively, 65% of articles published OA are published in journals with APCs [4]. In most cases, the APCs are covered by the government, which means public money [5]. Therefore, the public might pay researchers in four types of budget: a research budget, a journal-subscription budget, an APC budget, and the incentive for researchers for publishing in top-tier journals [6].

However, OA publication had been around for a long time before APCs became popular as OA publishing became more monetized. Importantly, most journals include self-archiving rules that allow authors to disseminate their peer-reviewed work in parallel and for free: the green OA. Many reliable, long-term platforms, including institutional repositories and collaborative services, are available to pursue green OA. Moreover, preprints, early versions of scholarly publications, made openly available prior to peer review, that enable faster dissemination of results, increase the attention given to a study and allow researchers to establish the primacy of their findings [7], and they are now more widely considered. Eventually, OA means accessible documents and accessible language [8] as well as the openness of all research outputs. Data, samples, and code must be handled in such a way that they are Findable, Accessible, Interoperable, and Reusable (FAIR) [9].

Geochemical research and protecting our global environment are inextricably linked, and we must ensure that future research is conducted and presented following FAIR principles in mind [10].

In this opinion, we discuss the latest advances regarding OA in the earth sciences and geochemistry community from preprints to data sharing (Figure 1).

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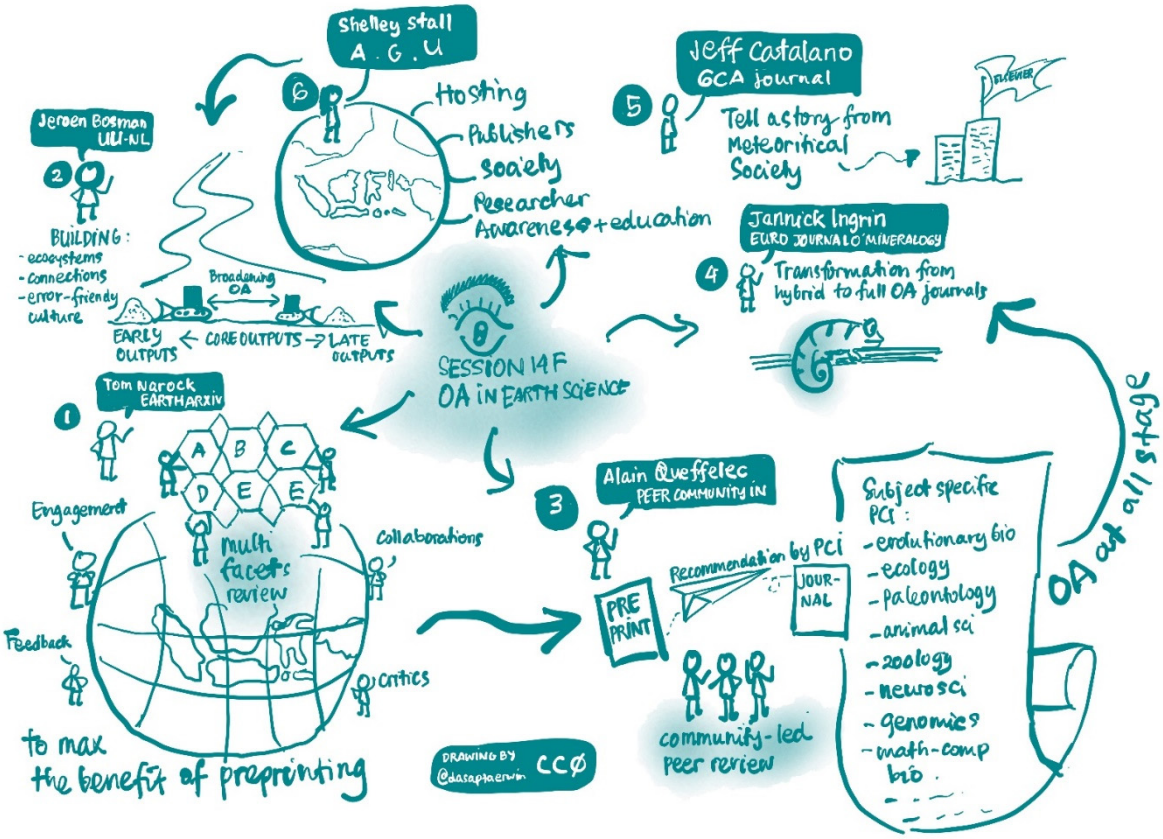

Figure 1. Live sketchnote from the 14fa session at Goldschmidt 2021 by Dasapta Erwin Irawan (7 July 2021).

2. What Is the Future of Preprints in Geochemistry?

The quantity of scientific articles has exploded in recent years and is expected to continue to do so in the coming years. The existing system, which is run by a few for-profit publishers, has grown prohibitively expensive for our universities [11]. On the other side, preprints deposited in open archives can be distributed quickly; however, the quality of these preprints must be guaranteed [12]. With the extensive use of social media, research is being disseminated at a rapid pace, the traditional practice of publishing in for-profit journals is being questioned more and more. In recent years, scholars have increased their calls for the system to be reappropriated [13,14].

Many tools and systems, based on agreed standards and long-term models, facilitate self-archiving or preprinting behaviors [15]. The main preprint services for the earth sciences are EarthArXiv [16] and ESSOar [17], which are web-based systems that allow open-access publishing of non-peer-reviewed scientific publications before they are published in a peer-reviewed journal [18]. While the use or preprints is expanding in general, but rates and completeness (data and code) of submissions differ by discipline. Self-archiving policy from publishers (big or small) allows not only preprint, but also postprint version (some might call it version of record), to be posted to public repositories or preprint servers. Therefore preprint-to-postprint ratio trend for each subject also reveals how the various earth-sciences communities are using the service.

Another initiative, the Peer Community In (PCI) [19], was designed to allow communities of researchers to review the quality of work stored in open archives and therefore assure a wider distribution of high-quality knowledge [20]. PCI provides an innovative means of disseminating our scientific findings: it is open, online, and peer-reviewed, and it is free for authors and users. PCI also promotes Open Science and scientific reproducibility by

requiring the deposit of all required datasets prior to the recommendation of any preprint and allowing pre-registration of publications.

While OA to publicly published products is critical, it allows a significant amount of room for early reuse, feedback, and collaboration. Proposals, data, procedures, protocols, code, posters, and presentations, as well as preprints, are all examples of early outputs that can be shared as part of open science. Early output sharing has become standard practice in many scientific domains, including earth sciences and geochemistry. However, there is insufficient but growing evidence of the increased value of sharing early outputs, both at the researcher and system level. Preprints can allow early feedback that could be considered as peer-review if a concept like PiePlate (multi-faceted open peer-review) became widely used [21]. There are also still serious barriers holding researchers back, like proposals to Australian Research Council funding being rejected because they have cited preprints [22]. To sum up, advocates of open science should have responsibilities (i) to promote practices such as preprint publication and (ii) to prevent such open practices from doing harm.

3. Moving from Paywall to Fully Open Access

Subscription journals have long been a primary publisher of geochemistry research and face substantial impacts from the ongoing transition to open-access publishing [23,24]. In 2020, according to the Directory of Open Access Journals [25], 70% of fully OA journals in earth sciences do not levy APCs; although, 62% of articles published OA are published in journals with APCs [4]. Indeed, supra-national initiatives such as Plan S are seemingly showing a strong financial preference towards APC-driven gold models while simultaneously appearing to neglect more equitable and financially sustainable green (self-archived OA) and diamond (gold, but no-APC) routes [24].

The *European Journal of Mineralogy* (EJM) is owned by four European learned societies. EJM, published under a commercial publisher, used the open-access hybrid model and decided in early 2018 to switch to full open access. Two years later, Copernicus now publishes EJM as gold open access, with moderate APCs. The journal's quality and appeal have significantly increased, with greater distribution, a shorter processing time for publishing, and a cost-of-production decrease of more than 50%. Even though the number of submissions reduced from prior years, they are now returning to their previous submission rate. It suggests that the introduction of APCs, which was new to many writers, has had only a minor impact on the journal's attractivity. Nevertheless, in order to help authors adjust, APC rates are currently below the real cost of production [26]. APC waiver programs have also been established to assist authors who are unable to pay full charges.

Several other journals have made similar announcements like *Geochemistry, Geophysics, Geosystems* (AGU/Wiley), and the *Geochemical Journal* (Geochemical Society of Japan) and will be relaunched fully OA in 2022.

Geochimica et Cosmochimica Acta (GCA) is another society-sponsored journal that is owned and published by Elsevier in a hybrid format. Only 10% of publications issued in GCA are gold OA, with no increase since 2016, most likely due to the high APCs [27]. Subscription contracts between Elsevier and Projekt DEAL, the University of California system, and other organizations are being terminated; it has had a significant impact on GCA because of the migration to OA. Many authors, reviewers, and associate editors in these groups have decided to leave GCA. Despite these obstacles, total submissions to GCA have climbed by 23% in the last five years, owing mostly to an increase manuscripts from Chinese researchers [27]. These and other effects on GCA from the move to open-access publishing are beyond the journal's control, but they raise legitimate concerns about its long-term viability. Even though many other geochemistry journals have similar APCs, most researchers cannot afford to pay more than USD 3000 (see a list of 58 journals in Pourret et al. [23]). Elsevier's attempts to develop mirror, completely gold OA journals only avoid the main issue: the cost of author-supported OA is prohibitively expensive. Geochemists have no interest in or ability to pay APCs, but they also are not inclined to put

their work behind a paywall with ever-restricted access. Diamond OA journals are still too few in geochemistry [28], and a new journal (what about *Geokimica*) based on the model of *Volcanica* or *Tektonika* should be part of the solution.

Pourret et al. [23] assessed whether APCs and Journal Impact Factors (JIFs) appear to influence publication. In 2018–2019, more than 40% of publications in geochemistry were published OA, with nearly 70% of those in fully OA journals and a mean APC of USD 900 [24]. The others were published in hybrid journals with a mean APC of more than USD 1800. The number of OA studies published in hybrid journals in geochemistry and their JIF have a moderate and positive relationship, whereas the number of OA articles published in fully OA journals and the APC have a stronger positive correlation. It appears that the proportion of OA articles published in hybrid journals in geochemistry with a higher JIF tends to rise.

However, geochemists could more widely choose legal self-archiving as an equitable and sustainable method to disseminate their research and a form of rights retention. Negotiation of contracts between institutions and publishers that include blanket OA remuneration for authors at covered organizations is one conceivable future outcome. However, unless a new access paradigm emerges, the geochemical community may be forced to forsake foundational journals in favor of alternative, low-cost, or diamond OA venues (like *Geochemical Perspectives Letters* and *Volcanica*) [28].

4. Research Data and Software Need to Be Open

Open access encourages the openness of all research outputs, including data, software, and samples, in addition to peer-reviewed research articles [29]. To establish trust in science and to accelerate the discovery and creation of new knowledge, OA to data, tools, and samples is critical. Well-documented data and software should be found independently of the publication and stored in a FAIR-aligned repository aids in the evaluation and replication of research [30]. To enable for automated attribution and credit as its own research output, data and necessary software should be acknowledged in articles' reference or data availability section. When permanent identifiers are used, these citations enable linking to the work. In recent years, the increased adoption of open data rules by funding organizations and publishers has facilitated data sharing in geochemistry. Many earth sciences journals have adopted the FAIR principles and no longer accept data as supplemental files, instead requesting that data-supporting publications be uploaded to trustworthy repositories and linked to relevant studies using permanent identifiers. Funders place similar demands on their recipients.

Data contributions to geochemical data repositories like the EarthChem Library [31] have increased significantly. GeoROC [32], a leading source of geochemical and isotopic datasets affiliated with the Interdisciplinary Earth Data Alliance [33], has facilitated thousands of peer-reviewed articles and new geochemical research areas. The goal of GEOROC 2.0′s new Digital Geochemical Data Infrastructure (DIGIS) [34] concept is to continue and enhance existing data collection by creating a connected platform that meets future challenges of digital data-based research and provides an advanced community service. Eventually, over 500 international stakeholders and signatories are involved in the Enabling FAIR Data [35], which aims to put in place the practices needed to ensure that all research data is discoverable and well-documented in accordance with the FAIR principles. Overall, as a goal, open and FAIR data and software necessitates participation from everyone in the research community.

However, the lack of consistent protocols and vocabularies for formatting and documenting geochemical data so that it can be trusted, reused with confidence, and easily combined with analogous datasets for advanced data analysis remains the fundamental difficulty today [36]. Journal editors require community-endorsed rules for data reporting in articles, which authors must follow. Data repositories, likewise, require community-endorsed criteria to ensure that the data they manage is not just discoverable and accessible online but also reusable and compatible with data from other repositories. Standards are

also required to create an ecosystem of interoperable technologies that will assist researchers and labs in managing geochemical data from collection to preservation.

International initiatives such as OneGeochemistry [37] to take on the development and promotion of data standards for geochemistry. Further work should be planned to strengthen the conversation between geochemical societies, geochemical data's repositories, editors and publishers, and funders.

5. Towards Some Inequities

The rise of OA publication may have an impact on researcher profiles and tends to shift costs from institutions to individuals [38]. It is likely that such high expenses will continue to impose financial disparities on the research community until the geochemical community makes the decision to transition away from journal-based evaluation criteria. Although OA publishing aims to make scientific achievements more accessible to readers, there is a current tendency that some researchers prefer hybrid journals to OA ones when submitting earth sciences articles [39]. In China, the world's larger producer of scientific articles [40], a historical national incentive encouraging researchers to publish articles in top journals (i.e., high JIF and first quartile from Scimago) categorized by the Chinese Academy of Sciences is one of the important causes for this trend in China. The same requirement has been used as the basis of incentive for researchers in other regions, such as in South East Asia (e.g., Indonesia). The lack of a need to pay APC for publishing research in a "high impact" predominantly English hybrid journal makes a contribution to the trend as well as highlighted by the distribution in GCA articles (19% of articles in 2021 but only 5% OA) [27]. However, the trend may change in response to a newly launched national-level policy in China in early 2020: to ban the use of journal-based metrics as assessment criteria for academic promotion and recruitment [41]. Further, publishing in Chinese journals is being proposed as part of the prerequisites for application of top national awards. The policy will give priority to considering the innovation of one's research work and significance of representative achievements in solving practical problems. A move away from high JIF journals [42] like many organizations worldwide (see signatories of DORA [43]) to Chinese journals could be a real game changer as Chinese researchers produce the bulk of articles, the majority of which have page charges and are fully OA by default. Specifically, the new policy tackles perverse incentives that drive the "publish or perish" culture, which might be encouraging questionable research.

Science comes from anyone and is made for all. However, with the current research situation, we need to redefine it [44]. Irawan and Susanto [45] use volcanology and disaster themes, which can be found in scientific databases (commercial and non-profit) to determine the extent of the collaboration of geoscience researchers in the world and how they build knowledge from prior knowledge. Some of their earliest indications are that: (i) international collaboration has occurred with most of the research funding flowing from the Northern Hemisphere. This will (automatically) determine who is the first author, what language is used (not a local language), the journal that published it (not a local journal), (ii) language has the potential to distance science from the main stakeholders (local communities), and (iii) minimal references to articles written in local language. Based on these indicators, it is past time for us to adapt the method we communicate scientifically, particularly if the subject of our research is located in a nation where English is not the primary language. A good example is the special issue of *Volcanica* [46] with articles from each of the volcano-monitoring agencies of Latin America, all published dual-language, in English and in Spanish.

6. Concluding Remark

Open access means both accessible documents and accessible language [8]. It is unfortunate that preprints are infrequently used by the geochemical community relative to the scale of the total research outputs produced, and its sustainability remains uncertain. A PCI geochemistry would reinforce this trend. Indeed, the current APC model imposed by

many journals can have deleterious effects on researchers who have no funding, especially from lower-income countries. APC must not be the next wall to face after the paywall. Therefore, it is almost mandatory for researchers coming from countries where English is not the first language, who are fortunate enough to publish their work in the "high impact journals," to also provide the translated version of their study to be disseminated to their national community. Creative audio-visual work could be used for this purpose.

Scientific publications need to be returned to their main function as tools for dissemination, rather than self-promotion. Researchers should not only rely on science writers/journalists to do the outreach, but instead they should also first-handedly participate in the dissemination. We need to go a step further than the science communication we are doing today [44,47]. Eventually, we encourage you to start or continue your journey towards making open and FAIR data, software, and science outreach/science communications as an important part of our research culture. Eventually, in-person meetings have always been seen as the best method to communicate with each other, but virtual conferences have shown undeniable advantages (including accessibility), and we are convinced that the future of events will be hybrid.

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