Open Access publishing practice in Geochemistry: overview of current state and look to the future

Olivier Pourret[1*], Andrew Hursthouse[2], Dasapta Erwin Irawan[3], Karen Johannesson[4], Haiyan Liu[5], Marc Poujol[6] , Romain Tartèse[7], Eric D. van Hullebusch[8], Oliver Wiche[9]

[1]UniLaSalle, AGHYLE, Beauvais, France

[2]School of Computing, Engineering & Physical Sciences, University of the West of Scotland, Paisley PA1 2BE, UK

[3]Faculty of Earth Sciences and Technology, Institut Teknologi Bandung, Bandung, Indonesia

[4]School of the Environment, University of Massachusetts Boston, Boston, USA

[5]School of Water Resources and Environmental Engineering, East China University of Technology, Nanchang 330013, PR China

[6]Université de Rennes, CNRS, Géosciences Rennes - UMR 6118, Rennes, France

[7]Department of Earth and Environmental Sciences, The University of Manchester, Manchester M13 9PL, UK

[8]Université de Paris, Institut de physique du globe de Paris, CNRS, Paris, France

[9]Institute for Biosciences, Biology/Ecology Unit, TU Bergakademie Freiberg, Freiberg, Germany

*Corresponding author: olivier.pourret@unilasalle.fr

Abstract

Open Access (OA) describes the free, unrestricted access to and re-use of research articles. Recently, a new wave of interest, debate, and practice surrounding OA publishing has emerged. In this paper, we provide a simple overview of the trends in OA practice in the broad field of geochemistry. Characteristics of the approach such as whether or not an article processing charge (APC) exists, what embargo periods or restrictions on self-archiving' policies are in place, and whether or not the sharing of preprints is permitted are described. The majority of journals have self-archiving policies that allow authors to share their peer reviewed work via green OA without charge. There is no clear relationship between journal impact and APC. The journals with the highest APC are typically those of the major commercial publishers, rather than the geochemistry community themselves. The rise in OA publishing has potential impacts on the profiles of researchers and tends to devolve costs from organizations to individuals. Until the geochemistry community makes the decision to move away from journal-based evaluation criteria, it is likely that such high costs will continue to impose financial inequities upon research community. However, geochemists could more widely choose legal self-archiving as an equitable and sustainable way to disseminate their research.

1. Introduction

The majority of published scientific papers are behind paywall, rendering them inaccessible to the majority of the public (Tennant *et al.*, 2019). Since the end of the 1980s, members of the scholarly community have been making various cases for wider public accessibility to published research, referred to as Open Access (OA) (Suber, 2009). Scientific publishing is currently undergoing a

major transition (Lajtha, 2019; Watts *et al.*, 2020), with the change to OA representing a significant shift in the financial models of major publishers, opening up diversity in publishing routes and raising the issue of publishing ethics. It is critically important to ensure that scientists and their institutions do not have to pay more to read and publish papers than they do currently.

As with all other scientific disciplines, there is a strong imperative for the geochemistry community to ensure that the research it produces is widely accessible (Sparks, 2013; Chopin, 2018). Geochemistry as a discipline includes the study of the chemical composition of the Earth and other Solar System objects, and the geochemical processes that affect them (White, 2018; Holland and Turekian, 2013). Geochemical concepts and/or principles underlie many Earth and environmental processes, notably those relevant to human interaction with our planet from resource exploitation to public health. Since such themes have important societal implications, it is even more crucial to ensure widespread accessibility.

Open Access practices are increasing at a systemic level (Tennant *et al.*, 2019). The movement around Plan S (https://www.coalition-s.org), a funder-led initiative launched in September 2018, aims to accelerate the full transition towards OA. These initiatives have opened up discussions about journals' and research communities' aptitude to correctly and sustainably shift towards a dominantly OA model (Lajhta, 2019). Pourret et al. (2020) highlight that there are different ways of achieving OA which are identified as Gold, Bronze, Green or Diamond. Green and Diamond OA have no Article Processing Charge (i.e. publication fee; APC). Green OA corresponds to the self-archiving on a personal website, or on an archive of a near-final and peer-reviewed version, of their work. Use of trusted archive is usually preferable. Diamond OA denotes to the free supply of content on a journal website (i.e. without any APCs). Gold OA involves APCs to be paid for immediate publishing access. Geochemistry, like other scientific disciplines, now has a range of publishing options available to authors operated

by a range of universities, commercial publishers, and societies, forming a complex publishing landscape (Tennant *et al.*, 2019).

As part of this transition, it is even more an imperative that individual research communities obtain a better understanding of the academic publishing landscape, and the options available to researchers. Many of the professional societies active in this aspect are currently evaluating their publishing strategies and models, and some are considering an increased role for OA publication in their journals. Here we provide an overview and analysis of the current OA practices in "geochemistry" journals. This evaluation intends to support further debate, raise awareness and support decision making-processes for the future development of the geochemistry community (Chopin, 2018).

2. Methods

We constructed a list of 56 journals in which geochemistry research is regularly published based on the Scopus, Web of Science, SCImago Journal Rank and SHERPA/RoMEO databases. This list only includes discipline-specific journals (where the word 'geochemistry' appears in the aims and scope of the journal). *Science*, *Nature*, "mega-journals" (*i.e.* that have broad coverage of different subject areas like *PLOS ONE*, *Scientific Reports* or *Heliyon*), interdisciplinary environmental journals (i.e. that cover research in environmental science including geochemistry like *Environmental Science & Technology*, *Science of the Total Environment*) and regional journals (*e.g.*, *Special Publication of the Geological Society of London*, *Bulletin de la Société Géologique de France*) were excluded, acknowledging the publication of geochemically focused

studies in these journals. The full dataset is provided in Supplementary Information. These methods are an adaptation of Tennant and Lomax (2019). Data included:

Journal name;

Year of first publication;

Journal policy on:

- sharing of preprints (version of a research paper typically shared prior to peer review and publication in a journal);
- sharing of postprints (version of a research paper following peer review and, thus, acceptance, but before any type-setting or copy-editing by the publisher);
- presence or absence of an embargo period;
- sharing of the publisher version (known as VOR, Version of Record of scholarly research paper, after undergoing formatting by the publisher);
- option for gold OA exists (including hybrid OA);

Article processing charge for the gold OA option (zero denotes diamond OA) obtained from journal webpages;

Sherpa/RoMEO (http://www.sherpa.ac.uk/romeoinfo.html) colour status;

Journal impact factor in 2018 provided by Web of Science;

Name of publisher.

It should be noted that SHERPA/RoMEO colour status is not related to the OA type (*i.e.* gold, green…). For APC data, an average number of ten printed pages was considered for publishers that use a page-based fee. Prices were converted to US$ when necessary.

Bivariate correlation tests between APC and JIF were performed using OriginPro 8.5.1 and descriptive statistics using XLSTAT.

3. Results

Historically, geochemists have published much of their work in journals edited by geochemistry-related professional societies (Holland and Turekian, 2013). The first issue of *Geochimica et Cosmochimica Acta* appeared in 1950. The *Geochemical Society* (GS) was founded in 1955 and adopted *Geochimica et Cosmochimica Acta* as its official publication in 1957. The *International Association of Geochemistry and Cosmochemistry* (IAGC) was founded in 1966, and its journal, *Applied Geochemistry*, began publication in 1986. *Society for Environmental Geochemistry and Health* was established in 1971 and *Environmental Geochemistry and Health* became the official journal in 1981. *Chemical Geology* became the journal of the *European Association of Geochemistry* (EAG), which was founded in 1985. Geochemistry has become a major force in the *Geological Society of America* and in the *American Geophysical Union* (AGU) with titles like *Geochemistry, Geophysics, Geosystems* and *Journal of Geophysical Research-Solid Earth*. The titles listed above were originally owned by professional societies that used to work with small editing companies. Most of these small companies were then progressively acquired by major publishing companies (*e.g., Geochimica et Cosmochimica Acta* was historically published by Pergamon, but was purchased by Elsevier in 1991). In the meanwhile, the European Geosciences Union (EGU) use the OA business model with Copernicus Publication but none of these titles focused on geochemistry exclusively until 2019.

The journals analyzed here mostly have a gold OA policy (50/56; 89%). In the case of geochemistry, this generally translates to an "author pays" model (45/50; 90%) (Lajtha, 2019). Indeed, only five of the journals included in the database do not have APC. These journals comprise two community-led initiatives from within professional societies (EAG and EGU), a journal published by a university (Sapienza Università di Roma) and a journal published by Elsevier and funded by China University of Geosciences (Beijing) and Peking University.

3.1. Article Processing Charge and Journal Impact Factor

In the list of journals where OA is available, 45 apply an APC and five journals have a diamond OA option (i.e. no fee option). The APCs range from US$ 4,000 for journals such as *ACS Earth and Space Chemistry* or *Elements* (owned by the American Chemical Society and jointly published by 17 participating societies, including the *EAG* and the GS) to less than US$ 1,000 for EGU journals published by Copernicus (Fig. 1 and Table1). The mean APC value is US$ 2,214 whereas the median value is US$ 2,500 (Table 1). Amongst journals that charge APC, most of them charge between US$ 2,500 and US$ 4,000 per article (28/45, 62%; Fig. 1), dominated by major commercial publishers, (Elsevier, Springer Nature, and Wiley. Scholarly publishing industry's general state can be defined as an oligopoly, with a few major actors dominating the scene (Larivière *et al.*, 2015). Elsevier and Springer Nature publish the highest number of geochemistry journals (13 and 12, respectively), followed by Wiley (5). Together, this represents around 55% of the total number of geochemistry journals. The next major publishers of journals are the EAG (3 if *Elements* is included, which is jointly published by 17 societies) and Copernicus (4), followed

by Cambridge University Press (2), Schweizerbart (2), MDPI (2), Hindawi (2), and ten other publishers (1 each).

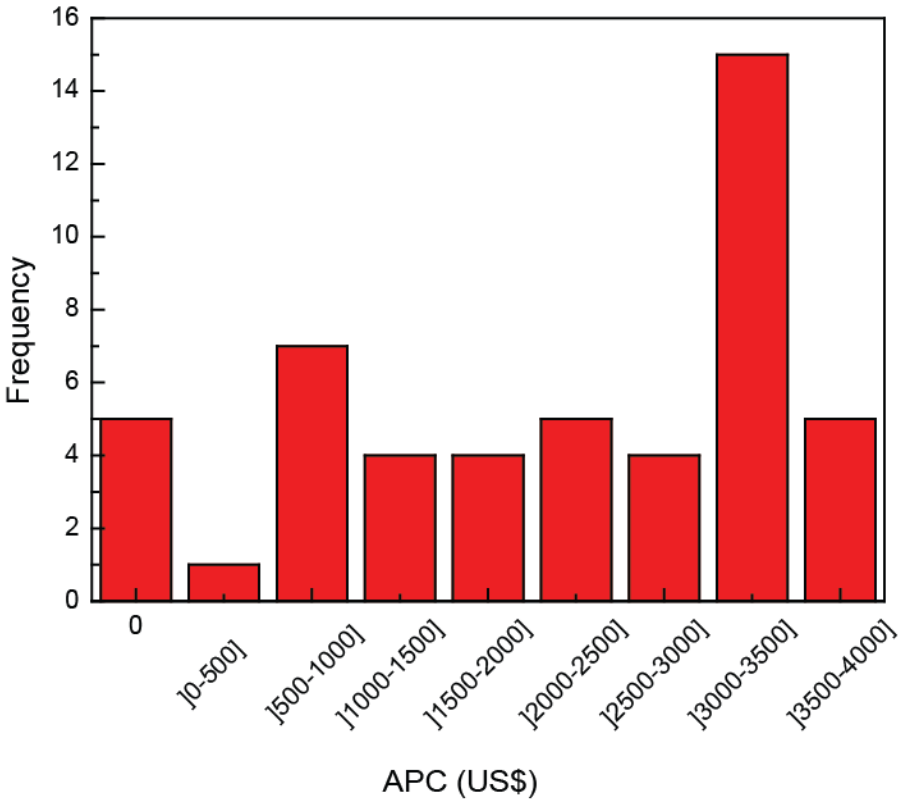

Figure 1 APC range distribution for all journals that have a gold OA option.

Table 1 Descriptive statistics

	Mean	Median	Minimum	Maximum
APC (US$)	2,214	2,500	0	4,000
JIF	3.06	3.25	0.84	8.75

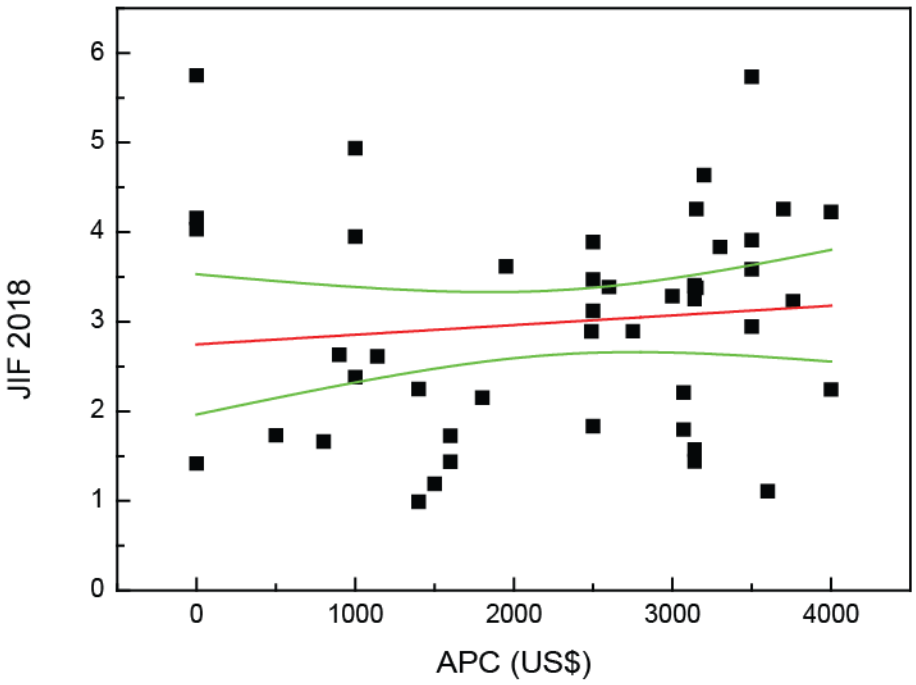

Figure 2 JIF as a function of APC (Pearson's r=0.1079; red line corresponds to the linear fit, whereas green lines correspond to the 95% intervals. It must be noted that the journals that do not have JIF were not considered (*e.g.* journals created in 2019 *Results in Geochemistry* and *Geochronology*).

Geochemistry journals have a journal impact factor (JIF) ranging from 0.84 to 8.75 with a mean value of 3.06 and a median value of 3.25 (Table 1). Half of them are in the range between two and four (26/51; 51%). Journals with highest JIF include monographs (*Geochemical Perspectives*), book series (*Reviews in Mineralogy & Geochemistry*), as well as review journals (*Elements*), which tend to receive more citations and are often considered to be of higher impact. The relationship between JIF and APCs does not show any evident correlation (Fig. 2). Three journals with a JIF above four do not charge an APC, *Geochemical Perspective, Geochemical Perspective Letters*, and *Geosciences Frontiers*.

3.2. Open Access policy

The majority (84%) of journals in our database allow authors to share preprints of their articles (47/56). Only four journals do not allow sharing article preprints (8%), all of which being professional society-based journals. Five journals do not have an explicit preprint policy (6%). For postprints, the situation is broadly similar. Forty-seven journals allow authors to share postprints (84%), and only four explicitly prohibit postprint sharing (8%). Five journals do not have a clear postprint sharing policy (8%). The four journals that prohibit sharing of postprints are the same that prohibit sharing of preprints. Journals from the large commercial publishers (Elsevier, Springer Nature, Wiley) and from most professional societies allow sharing of postprints. Earth scientists, including geochemists, are in the top group to pursue green road to OA (between 25% and 30%; Bjork et *al.*, 2004). MDPI, which is a purely OA publisher, publishes a few journals in Earth Sciences but does not have any dedicated geochemical titles, although *Geosciences* has a Geochemistry section. Hindawi, another purely OA publisher, manages *Geofluids* and a geochemistry section in *Journal of Chemistry* (after withdrawing the *Journal of Geochemistry*). The AGU publishes several newly-established journals in OA and promotes the green road to OA in the geochemistry field via a number of well-established journals (*e.g.*, *Geochemistry, Geophysics, Geosystems*, *Journal of Geophysical Research-Solid Earth*). Authors in AGU subscription-based journals are granted permission to deposit the final published citable VOR of the article six months after official publication (Van der Hilst and Hanson, 2013). Springer's portfolio of OA journals, Springer Open, also includes a number of geochemistry titles (including

Aquatic Geochemistry, *Biogeochemistry* and *Environmental Geochemistry and Health*). The first transitions from subscription-based to full-OA journals have already taken place. In the 2000s, *Geochemical Transactions* moved toward full OA (Schoonen et *al.*, 2006). In 2012, the EAG released its new title *Geochemical Perspectives*, which was followed in 2015 by *Geochemical Perspectives Letters*. Finally, Elsevier launched its title *Results in Geochemistry* in the autumn of 2019.

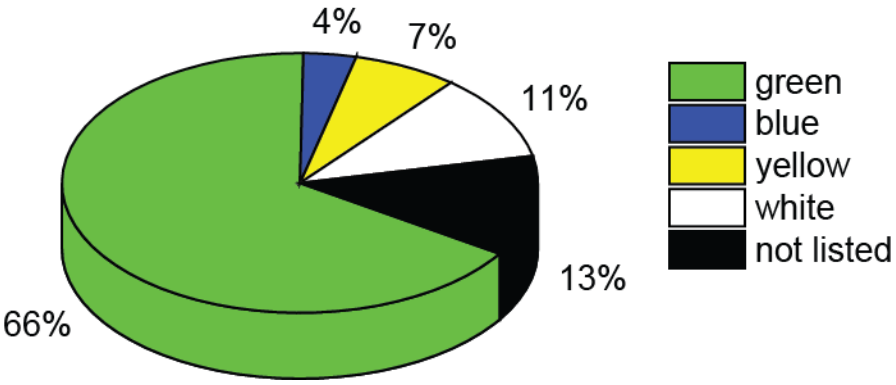

Figure 3 SHERPA/RoMEO colours. Green indicates that preprints and postprints can be archived, blue that postprints can be archived, yellow that preprints can be archived, and white that archiving is not formally supported.

Overall, 49/56 journals (88%) have an entry in SHERPA/RoMEO, among which 37 are "green", 2 "blue", 4 "yellow", 6 "white" (Fig. 3).

3.3. *Geochimica et Cosmochimica Acta* and *Chemical Geology* examples

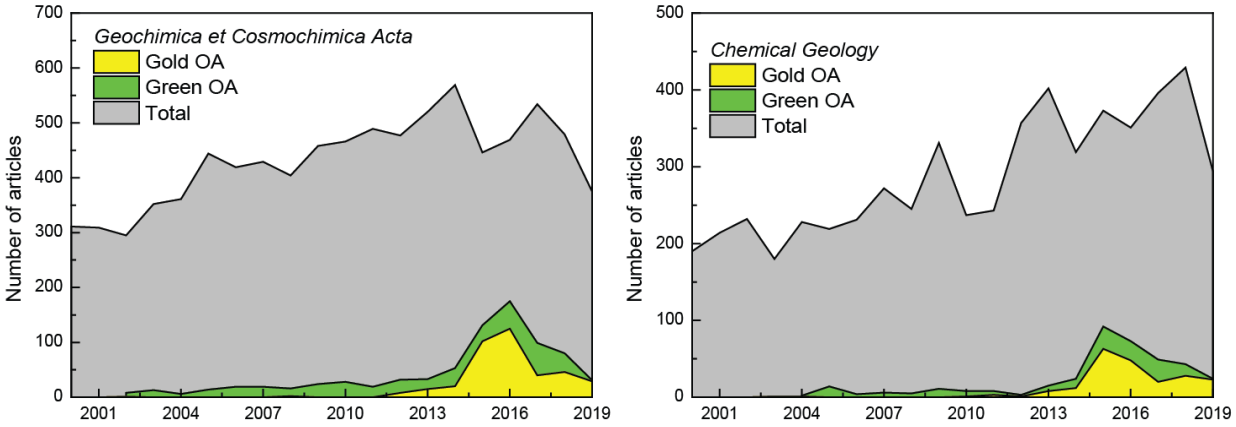

Figure 4 Evolution of OA distribution for articles published between 2000 and 2019* in (a) *Geochimica et Cosmochimica Acta* and (b) *Chemical Geology* (data accessed July 2019 from Scopus for gold OA and total, and @unpaywall for green OA). *year 2019 is incomplete.

To illustrate OA evolution in geochemistry, we have chosen the two historical and most prolific journals, *Geochimica et Cosmochimica Acta* and *Chemical Geology* (Fig. 4). Both are hybrid journals distributed by Elsevier, are green in the SHERPA/RoMEO classification and charge APC of US$ 3150 and US$ 1950, respectively. In 2018, only 9% of *Chemical Geology* and 14% of *Geochimica et Cosmochimica Acta* papers, respectively, were available as gold OA. The distribution of articles published in *Geochimica et Cosmochimica Acta* show that their country of origin (i.e. data obtained from authors' affiliation in Scopus; in some cases when authors are from multiple countries, the article can be attributed several times) are 56% from the USA, 11% from Germany, 10% from France, and 10% from the UK. Gold OA articles originate 66% from the USA, 37% from the UK, and 16% from France. In comparison, 33% of the articles published in *Chemical Geology* originate from the USA, 16% from France, and 14% from Germany. For gold OA articles published in *Chemical Geology*, 57% originate from the USA, 27% from the UK, and

20% from Germany. Green OA is mostly available on dedicated repositories such as *HAL* (*i.e.* French repository https://hal.archives-ouvertes.fr) where 42% of green OA articles for *Geochimica et Cosmochimica Acta* and 23% of green OA articles for *Chemical Geology* are archived. Gold OA publishing peaked in 2015 and 2016 for *Geochimica et Cosmochimica Acta* (23% and 27%, respectively) and for *Chemical Geology* (17% and 14%, respectively). Similarly, green OA publishing peaked between 2015 and 2017 in *Geochimica and Cosmochimica Acta* (7%, 11%, and 11%, respectively) and *Chemical Geology* (8%, 7%, and 7%, respectively) (Fig. 4).

4. Discussion

As scientific publishing continues to transition from the traditional pay-walled model to OA, it is likely that individual researchers will face increasingly difficulties addressing the APC system, regardless of any potential waiver or discount systems in place. Thus, the APC-driven elements of OA generally constrains journal choice available for those individuals who want to, or have to, publish OA articles, but have restricted funding. In many cases, one of the only options is to publish their research in a high impact journal without paying the APC and place their paper behind a paywall. In the UK, publicly-funded research has to be made available OA. UK research councils provide universities with a tranche of money dedicated to cover costs of gold OA publishing. These universities then use that pot of money how they see fit: some cover gold OA costs for publications by their staff on a first come, first served basis, while others favor publications they believe will have a higher impact. Any publication not selected for gold OA (be it because it was not deemed impactful enough, or because the pot of money has run out) has to be deposited green OA.

Overall, the APC-dominated philosophy has created a complex system around OA. This scheme seems to broadly divide the research community into two groups, namely those that can afford to publish in OA journals, and especially in those that charge high APC, and those that do not benefit from such financial funding and are imposed to publish behind a paywall. The fact that APC is becoming more mainstream and tends to increase the profit-making capacity of commercial publishers and disadvantages authors with lesser financial privileges (Hedding, 2020; Pourret; 2020). It would be interesting for future research to investigate the impact that APC-related constraints have had on publication ranges, and the potential impact this can have on the visibility and re-use of geochemical research.

Eventually, there is a clear role for self-archiving of peer reviewed accepted manuscripts (postprint), the green way, in parallel to traditional journal publication. Indeed, in some countries, the policy of making research available to the wider public (the tax payer, ultimately funding the research) has essentially forced institutions to establish archives to do this. The Green OA approach is cost-free for authors and to pursue green OA, numerous platforms are available such as institutional repositories and collaborative tools (*e.g.,* EarthArXiv https://eartharxiv.org/; Earth and Space Sciences Open Archive, https://essoar.org/) for preprints. The preprint model is unfortunately still confidential in geochemistry. Another area of concern is that the current APC model has an additional restriction on research from developing countries, where the fees for OA are beyond reach, driving many researchers to lower cost options or, worse still, "predatory journals" (Beall, 2012). The proliferation in opportunities to publish scientific research as OA articles in these journals where lack of academic mentorship for early career academics (Hedding, 2019) or support from scientific societies and un-validated review processes and "for profit"

approach with little apparent consideration of what is published. This questions the long-term future of peer review and the ethics of publishing. We acknowledge that there is a good level of debate on this topic between professional and learned societies and academic publishers. We encourage the geochemical community to be active and engage in the debate and actions, prioritizing clear, transparent and robust peer review and visibility of our work.

5. Concluding remarks

The hurried evolution of scientific publishing models let us draw attention to the situation of hybrid journals. Indeed, the majority of traditional historical journals in geochemistry are hybrid journals. Plan S recommends supporting fully OA and, excludes hybrid journals. It strictly discourages from having to pay APCs in a subscription-based journal and asks us not to provision a model that leads to "double-dipping". It is indeed conceivable to publish in a hybrid journal without paying APC and to distribute a manuscript in open archives on a repository. On the journal's website, the article will be available only to subscribers, and it will be available to all on the open archive.

Acknowledgments

The authors would like to thank Heather Piwowar for providing Green Open Access data available via @unpaywall, Jonathan P. Tennant, David W. Hedding and Marie-Aude Hulshoff for useful comments on the preprint version of this contribution.

References

Beall, J. (2012) Predatory publishers are corrupting open access. *Nature* 489, 179. doi: 10.1038/489179a

Björk, B.-C., Laakso, M., Welling, P., Paetau, P., 2014. Anatomy of green open access. *Journal of the Association for Information Science and Technology* 65, 237-250. doi:10.1002/asi.22963

Chopin, C. (2018) The credibility of scientific writing: An appeal for responsibility. *Elements*14, 79. doi:10.2138/gselements.14.2.79

Hedding, D.W. (2019) Payouts push professors towards predatory journals. *Nature* 565, 267. doi : 10.1038/d41586-019-00120-1

Hedding, D.W. (2020) Comments on "Factors affecting global flow of scientific knowledge in environmental sciences" by Sonne et al. (2020). *Science of the Total Environment*, 135933. doi: 10.1016/j.scitotenv.2019.135933

Holland, H.D., Turekian, K.K. (2013) Executive Editor's Foreword to the Second Edition. *Treatise on Geochemistry: Second Edition* xvii-xix. doi:10.1016/B978-0-08-095975-7.09816-8

Lajtha, K. (2019) Publishing scientific research in open access, hybrid, or paywall journals: what model serves all authors and all readers? *Biogeochemistry* 144, 229-231. doi:10.1007/s10533-019-00592-3

Larivière, V., Haustein, S., Mongeon, P. (2015) The Oligopoly of Academic Publishers in the Digital Era. *PLOS ONE* 10, e0127502. doi: 10.1371/journal.pone.0127502

Pourret, O. (2020) Global Flow of Scholarly Publishing and Open Access. *Elements* 16, 12-13.

Pourret, O., Irawan, D.E., Tennant, J.P., Wien, C., Dorch, B.F. (2020) Comments on "Factors affecting global flow of scientific knowledge in environmental sciences" by Sonne et al. (2020). *Science of the Total Environment*, 136454. doi: 10.1016/j.scitotenv.2019.136454

Schoonen, M.A.A., Anderson, K.B., Wood, S.A. (2006) Moving Geochemical Transactions forward as an open access journal. *Geochemical Transactions* 7, 1. doi:10.1186/1467-4866-7-1

Sparks, R.S.J. (2013) Opportunities for Innovative Publishing in the Electronic Age? *Eos, Transactions American Geophysical Union* 94, 116. doi:10.1002/2013eo120010

Suber, P. (2009) Open access? *Nature Geoscience* 2, 155. doi:10.1038/ngeo450

Tennant, J.P., Lomax, D.R. (2019) An overview of open access publishing in palaeontology. *Palaeontologia Electronica* 22, 1-10. doi: 10.26879/968

Tennant, J.P., Crane, H., Crick, T., Davila, J., Enkhbayar, A., Havemann, J., Kramer, B., Martin, R., Masuzzo, P., Nobes, A., Rice, C., Rivera-López, B., Ross-Hellauer, T., Sattler, S., Thacker,

P.D., Vanholsbeeck, M. (2019) Ten Hot Topics around Scholarly Publishing. *Publications* 7, 34. doi:10.3390/publications7020034

Van Der Hilst, R., Hanson, B. (2013) Update on AGU Publishing: A Focus on Open Access. *Eos, Transactions American Geophysical Union* 94, 345-345. doi:10.1002/2013eo390006

Watts, M.J., An, T., Argyraki, A., Arhin, E., Brown, A., Button, M., Entwistle, J.A., Finkelman, R., Gibson, G., Humphrey, O.S., Huo, X., Hursthouse, A.S., Marinho-Reis, A.P., Maseka, K., Middleton, D.R.S., Morton-Bermea, O., Nazarpour, A., Olatunji, A.S., Osano, O., Potgieter-Vermaak, S., Saini, S., Stewart, A., Tarek, M., Torrance, K., Wong, M.H., Yamaguchi, K.E., Zhang, C., Zia, M. (2020) The Society for Environmental Geochemistry and Health (SEGH): building for the future. *Environmental Geochemistry and Health* 42, 343–347. doi: 10.1007/s10653-019-00381-9.

White, W.M. (2018) Geochemistry, Encyclopedia of Earth Sciences Series, pp. 561-570. doi:10.1007/978-3-319-39193-9_294-1.