Open access and open science progression

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SEG has taken important steps toward open access and open science during the past decade, and its strides likely will get longer in the years ahead.

Research funders are at the vanguard of a two-decades-plus march toward toll-free access to reports of supported work and the data that underlie them. An assembly of European governmental research funders and supporting organizations called cOAlition S quickened the pace in September 2018 with the announcement of Plan S (Science Europe, 2019).

The plan aims to flip the business models of all subscription journals — still the overwhelming majority in scholarly publishing — to open access. The coalition has stated that, beginning in January 2021, its members will pay author processing charges (APCs) for researchers they support only if the articles reporting on their work are published in fully open-access journals. The funders would pay no APCs on behalf of authors publishing in hybrid open-access journals such as *Interpretation*, GEOPHYSICS, *The Leading Edge*, and the *AAPG Bulletin*, although cOAlition S authors could publish in hybrid journals if they pay their own fees and contribute their articles to open-access repositories with no embargo (cOAlition, 2019).

SEG exposure to Plan S appears modest, as only about 2% of papers published in GEOPHYSICS from 2014 through 2018 reported on research funded by cOAlition S member agencies. However, the coalition is growing, with the Wellcome Trust and the Bill and Melinda Gates Foundation among other research funders that have signed on.

As the impact of funder open-access mandates has become greater, SEG has sought to provide publication opportunities to all affected authors working in the sciences it supports. How the Society can do this best, in support of its mission to advance applied geophysics, has been an essential and increasingly existential question facing the SEG Publications Committee, perhaps no more intensely than during the past year. Possible solutions discussed have ranged from benign neglect to launching a fully open-access journal to something in between such as teaming with other geoscience organizations to deliver a compliant open-access option.

With apologies to Johnny Mercer and a bevy of artists including Sammy Davis Jr. who latched onto his song, something's gotta give!

cOAlition S relaxed some of the most stringent requirements of Plan S when it released a fresh timeline and revised implementation guidelines on 30 May (Mudditt, 2019). The original implementation date was January 2020 but was pushed back a year in recognition that the earlier date could not reasonably be accommodated by publishers. Although works still must be published under an open license, CC BY-ND (Creative Commons license with an attribution requirement for reuse but no derivative works allowed) was added as an acceptable option alongside CC BY (only attribution required), and it was recognized that institutions as well as authors could hold copyright. An earlier-stated requirement that publishers open their books so that the coalition could assess the validity of author charges and set caps on APCs was eased to a more general call for fair pricing and transparency. Publishing in hybrid journals with funder support for APCs was stated as permissible for journals that have entered into transformative agreements — agreements to become fully open access over time. Clarity was provided that gold open access — the author-pays model — is not the only acceptable open-access business model under which a journal can operate and be regarded as Plan S compliant. The coalition stated its intent to foster evaluation research outputs on their intrinsic merits while de-emphasizing citation metrics, consistent with the Declaration on Research Assessments (DORA), a move that may chip at the dominance of the impact factor in journal assessment (DORA, 2019). It was restated that mirror journals — fully open-access journals that share an editorial board with a subscription journal — are not compliant.

Plan S poses a significant challenge to moderate-sized society publishers such as SEG, more so for similarly sized societies that publish much work that reports on research funded by cOAlition S agencies. Pressure to keep APCs low negatively impacts not-for-profit societies that rely on publications revenue to fund many other revenue-challenged but high-value activities that support society missions. To achieve sound financial performance under an open-access model, societies that rely on quality as a pillar of their brand may find themselves publishing at higher volume than is comfortable for them.

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The SEG brand always has stood for quality in applied geophysics technology transfer, first and foremost, even as the Society's output of scholarly works has grown. Although it has only three journals, SEG during the past five years has been by far the largest publisher of journal articles in GeoScienceWorld, the 46-journal aggregation in which it is a founding member. In addition, SEG's output of expanded abstracts each year is about twice the number of its journal articles. Workflow improvements have helped the Society increase speed and volume of output while maintaining a high level of quality and context.

It is a healthy sign for applied geophysics generally that publishing activity has remained high during a period of industry contraction. The combination of strong demand, robust production capacity, and quality focus appears to give SEG options at a time when publishing-industry contraction fueled in part by open-access uptake challenges society-publisher independence.

Yet the path forward will be illuminated most by what best meets the needs of researchers and practitioners in our geoscience community, as it always has.

Since its publications first appeared on the Web, the Society has embraced among the most liberal green open-access policies in scholarly publishing, akin to those of other physics and mathematics societies. Authors are permitted to post final published versions of their papers on their own Web sites or the Web sites of the institutions with which they are affiliated, with no embargo period, provided that the electronic version published in the SEG Library is recognized as the version of record and there are linked citations to it.

In 2011, SEG began offering authors a gold open-access publishing option. With payment of an APC of US$2,500 and all mandatory page charges, GEOPHYSICS, *Interpretation*, and *The Leading Edge* authors may retain copyright and publish under one of four specified Creative Commons open licenses (SEG, 2011). Most choose the CC BY license, which requires attribution for reuse of any material. Papers published on this basis are offered free to all SEG Library and GeoScienceWorld visitors. AAPG adopted a similar policy for its journals (AAPG, 2013).

In 2012, both SEG and AAPG launched wikis in which most material is published under an open license — Creative Commons Attribution-Share Alike 3.0 (CC BY-SA) — that also is used by Wikipedia. Both organizations seeded their wikis with books they had published. For SEG, these were the *Encyclopedic Dictionary of Applied Geophysics*, Fourth Edition, by Robert E. Sheriff, and *Seismic Data Analysis: Processing, Inversion, and Interpretation of Seismic Data*, by Oz Yilmaz. A third SEG book is being added: *Problems in Exploration Seismology and their Solutions*, by Lloyd Geldart and Sheriff. The *Encyclopedic Dictionary* has been translated into Spanish by a large and dedicated group of volunteers, and translations of it are under way in Chinese and Arabic. The SEG Wiki has been tremendously successful, with more than 131,000 edits applied since its inception, a growing portfolio of content infusions, and strong readership.

Also in 2012, preparations were under way for the launch the following year of *Interpretation*. Before AAPG joined the initiative, SEG leaders were presented a choice of whether to sustain the journal through subscriptions or whether to rely solely on author fees, i.e., gold open access. They chose the subscription model, concerned about the effect APCs might have on submissions to the new publication.

In 2014, SEG decided to join CHORUS, a system under which governmental agency funders and publishers team in a distributed network environment to provide public access to articles reporting on funded research (CHORUS, 2019). The Society has been a member for several years but for technical reasons has not implemented a solution in the SEG Library; it intends to do so by late this year.

In 2018, SEG made two important strides forward in open science. One was the Reproducibility Zoo at the Annual Meeting in Anaheim, California. Participants in the event, conducted on the exhibition floor, used data cited in SEG publications to test and reproduce results reported in the paper (SEG, 2018).

The second advance was the institution of a data policy for SEG publications (SEG, 2019). Under the policy, SEG encourages authors, when feasible, to make available data necessary to understand, evaluate, replicate, and build upon their reported research. Authors are encouraged but not required to make data underlying their research available in open repositories. Authors are required to include a Data and Materials Availability statement in their papers.

Per-capita response has been greater for *Interpretation* authors than for GEOPHYSICS authors thus far. Of 112 *Interpretation* papers exported from the peer-review system for processing this year through 15 July, 13 include links to data, 54 indicate data can be obtained from corresponding authors, three include custom statements (e.g., that there are no data associated with the paper or that only some of the data are available), and 42 contain indication the data are confidential and cannot be shared.

Of 357 GEOPHYSICS papers sent into production during the same time frame, 17 include links to data, 197 indicate data can be obtained from corresponding authors, 40 include custom statements, and 103 contain indication the data are confidential and cannot be shared.

More work is needed to connect authors able to share their research data with mechanisms through which they can do it.

Under open access, usage tends to be greater than under the 400-year-old subscription business model for publications (Wang et al., 2015). However, author access to publications channels can be more limited under the gold, author-pays model if fees collected do not cover the expenses of publishing the work of those unable to pay APCs. Under the subscription model, SEG Members can publish up to 10 pages in GEOPHYSICS without incurring mandatory page charges, and anyone regardless of

membership affiliation can publish up to 12 pages in *Interpretation* without such fees.

A few well-funded journals offer platinum open access under which they make content freely available without charging fees to authors. *Annual Reviews* recently experimented with a model it calls Subscribe to Open under which content is made freely available to any journal site visitor if those institutions that traditionally have subscribed to it or should subscribe to it pay their subscription fees (Annual Reviews, 2019). This intriguing model may find traction and viability in certain publishing programs.

As SEG assesses the landscape of opportunities in open access and open science in the years ahead, it will choose paths that best maximize opportunities for researchers and advance science.

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