

# **Diversity, Equity, and Inclusion: tackling gross under-representation and recognition among talents in Geochemistry and Cosmochemistry**

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## **Abstract**

Diversity, at every step along the scientific path, drives innovative research. Scientific societies, like the Geochemical Society (GS) and the European Association of Geochemistry (EAG), have a significant influence on which innovators are celebrated. Such choices have the consequence of shaping the future of research, and so are responsible for the evolution of our discipline and its relationship to the global community. These professional bodies are uniquely positioned to define and promote the success of all scientists, including those from under-represented groups, through proactive advocacy, inclusive mentorship, awards, and leadership. At present, the only data available to examine the distribution of under-represented groups between memberships, awardees leadership are those of gender. To assess gender diversity in the geochemistry and cosmochemistry community, we thus introspectively review available records of GS and EAG membership through Goldschmidt Conference attendees, awardees, leadership, and editorial boards. This work identifies areas for growth and begins a dialogue about how the society and its members can work together to better reflect and progress our community.

Our examination of the record spanning the last decade demonstrates that leadership positions, awards, and honors have continued to be disproportionately given to white men, to the exclusion of women. The GS and EAG have recently taken positive steps towards becoming more inclusive; however, much more work is needed. In order for both communities to become diverse, equitable and inclusive, where all scientists flourish, we offer suggestions for swift steps that the GS and EAG and their members can pursue. The suggested structural improvements will require ongoing analysis and reforms, which must be shared by all of us, to create a sustainable legacy that we can be proud of.

## **Keywords**

DEI, under-representation, awards, gender equity, professional societies

## 1. Introduction

Geochemistry and cosmochemistry provide quantitative means to address a diverse set of scientific questions about major concerns of our time as well as our habitable planet's operation, secular evolution, and origin. Geochemical concepts and / or principles underlie many Earth, planetary, and environmental processes that are part of global-scale biogeochemical cycles over geologic time. These processes concern present-day human interaction with our planet's surface, oceans, atmosphere and biosphere, as well as fundamental research into the chemistry and dynamical evolution of the Solar System and its constituent planets, moons, asteroids, comets / trans-Neptunian objects. Further, the origins of known and potentially yet to be recognized forms of life, and their co-evolution with planetary surface environments, are additional noteworthy areas to which our community contributes scientific knowledge.

The science that we do is also often considered via themes ranging from the impacts of climate change through paleoclimate reconstructions and understanding past Earth System processes, understanding mechanisms important to groundwater and contamination, resource exploitation, as well as their sometimes direct relationships to policy and to public health, the management of ocean ecologies, and the sustainability and strength of world economies (e.g., UN Sustainable Development Goals and the European Green Deal). Since the breadth of our research themes concern major global challenges of the present-day, with important societal implications, and can also inform humanity's aspirations and rapidly accelerating capabilities targeting extraterrestrial settings that require regulation via renewed international planetary protection legislation, it is crucial to ensure that access to- and cooperation among our communities and published outputs is widespread. The broad utility of geochemical and cosmochemical studies mean that it is natural to expect that our work involves representation of the wider public that it serves ([Cooperdock et al., 2020](#)). We believe that for Geochemistry and Cosmochemistry to prosper and reach their full potential, we must attract, develop and nurture a diverse community of talented people. The ultimate aim of publishing research is to disseminate information and describe advances in science

which benefit society, and should appeal to and be accessible to everyone, with all people and their diversity of thinking styles fairly represented and retained among us.

The Geochemical Society (GS) and the European Association of Geochemistry (EAG) have a long history of promoting diversity and inclusion, especially during their joint meeting, i.e. the annual Goldschmidt Conference (e.g., [Wood and Gunter, 2005](#)). Further examples of schemes that foster friendly relations with the purpose of increasing a sense of belonging among scientists from under-represented minoritized groups / nations are the joint EAG-GS Outreach Program, EAG's Distinguished Lecture Program, and GS's Capacity-building Grant Program. However, it was not until 2020 (following the murder of George Floyd and subsequent Black Lives Matter protests) that both GS and EAG took steps to constitute dedicated Diversity, Equity and Inclusion (DEI) committees. These committees comprise diverse groups of members to coordinate dialogue with the community so as to effectively address challenges to inclusion and to promote DEI (e.g., [Riches et al., 2021](#)), and to find solutions to problems such as the lack of equal opportunity for career development and international recognition.

We have a responsibility as professional societies, and as key voices for the geochemical and cosmochemical community, to help encourage, inspire and support change. During recent years, both the GS and the EAG have changed their own governance, policies and activities to drive inclusion and diversity. Our work has been influenced not only by the values expressed by their memberships and elected Councils, but also by the policy and practice of other leading Geoscience societies and European governmental organizations (e.g., some among others are the American Geophysical Union: [White and Bell, 2019](#); Society for Sedimentary Geology: [Fernandes et al., 2020](#)).

Although successes in progressing DEI for the community have occurred over recent decades, many of the advances have been with respect to increasing the number of white women in the geosciences, while the number of scientist from historically excluded racial groups has remained consistently low for ~40 years (e.g., [Mukasa, 2009](#); [Bernard and Cooperdock, 2018](#)). Our ongoing efforts will make substantial strides in understanding the

present composition and condition of our community within the coming months, and will further advance kind and inclusive community cultures. Crucially, the EAG and GS DEI committees shall also spearhead initiatives intended to provide recommendations and frameworks for best practice and encourage the community members to share reports of their own successes. This approach will help everyone to deconstruct structural barriers and realize tangible and positive change in the processes pertaining to recruitment and retention of under-represented and marginalized groups in geochemistry and cosmochemistry.

## **2. Assessing Membership Trends through Goldschmidt Conference Delegations**

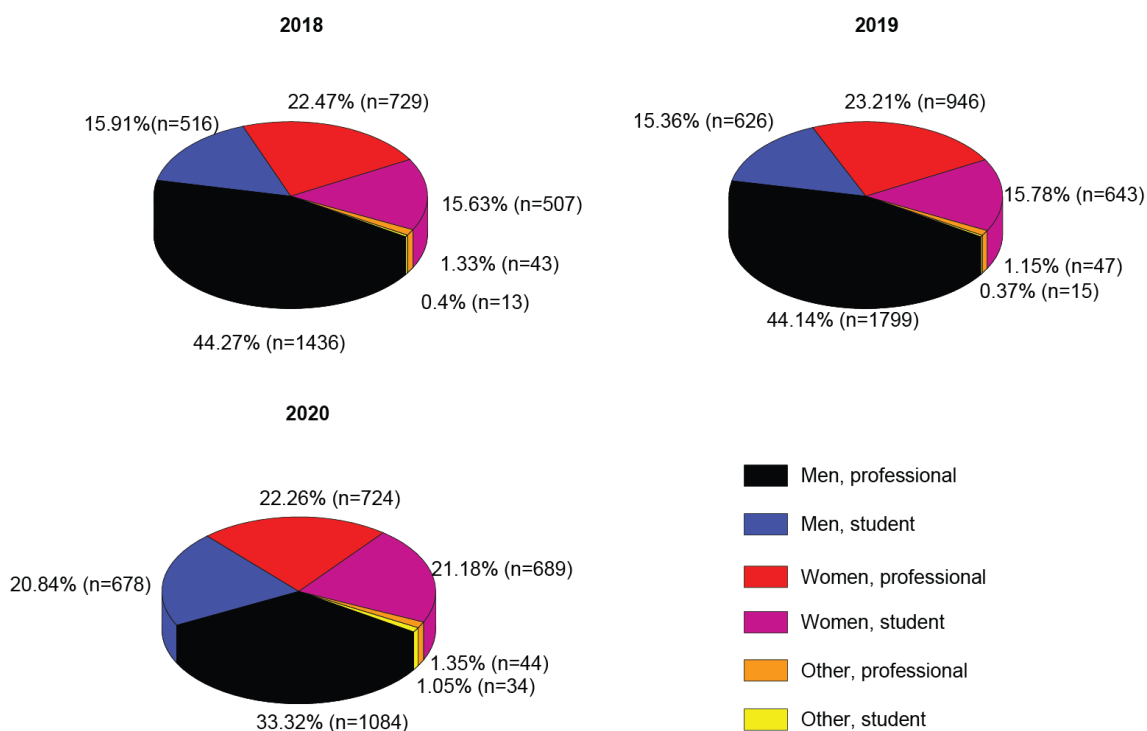
Membership data are currently scarce and limited to broadly defined status (job title, institution...), whereas data on gender, race, ethnicity, LGBTQ+ identity, and disability status (or differences in physical, learning, and mental health / neurodiversity needs, where societal and workplace constructs or prejudice can be the disabling factors) have never been collected. These missing data represent glaring omissions and barriers to our understanding of the community. Anonymous collection and transparent reporting of demographic information of the GS and EAG membership must be prioritized because such data are foundational to evaluating the present condition of our community and its culture. These data will also provide a basis for identifying target areas to make a concerted effort in promoting diversity and inclusion, hence shaping the ongoing development of the EAG DEI Strategic Plan. The number of scientists from under-represented minoritized groups who are joining, remaining with, or leaving GS and EAG are currently unconstrained. Career stages (early / junior vs senior) of professional members, not currently reported through society records, could provide much needed insights into membership trends and the composition of community leaders.

To assess gender diversity in the geochemistry community, we have examined Goldschmidt attendee data over the period 2018-2020 (Figure 1), the only period for which gender data are available. Unfortunately, several demographic categories are absent from

this dataset, including a break-down of gender identity and / or LGBTQ+ status. Considering the available three-year dataset, 58% of attendees are men (70% professional, 30% students), 40% women (57% professional, 43% students) and 2% others; 65% of attendees are professionals (63% men, 35% women and 2% other) and 35% students (49% men, 49% women and 2% others). It is notable that while there is gender parity amongst student members, the data tilt heavily towards men in the professional category, suggesting inherent discrimination within organizations against the balanced progression / retention and participation of women. Interestingly, 2020 saw a higher attendance of students (both male and female) compared to professional, and women compared to men. This could illustrate the particular circumstances under which the 2020 Goldschmidt conference took place: it was held exclusively online, as a result of the COVID-19 pandemic, while in previous years, attendance was in person at a conference venue (Boston, MA, USA in 2018; Barcelona, Spain in 2019). These data could hint at the more equitable nature of online conferences ([Niner et al., 2020](#)): because they represent a much smaller financial burden, they are more accessible to students, researchers from developing nations and women (on average in earlier career stages than men; e.g., [Sonnert and Holton, 1996](#)).

The findings arising from our assessment of the Goldschmidt Conference delegates echo a wealth of documented evidence for Science, Technology, Engineering, Mathematics (STEM), where the proportion of women in academia progressively decreases with advancing career stages. For example, the Royal Society of Chemistry finds that women chemical scientists tend to leave academia at early-career stages — and that those who remain do not ascend to senior grades in the same proportion as their male counterparts ([Gewin, 2019](#)). Women comprise just 9% of UK chemistry professors, and 18 % of Natural Sciences and Mathematics in the European Union ([Picoli and Guidobaldi, 2021](#)) meaning that after undergraduate level, the relative proportion of female natural scientists drops by 32 percentage points. This phenomenon, known as the “*leaky pipeline*” ([Alper, 1993](#)), affects all research fields and all minorities (including LGBTQ+: [Hughes, 2018](#); racial: [Krämer, 2020](#)) but is particularly accentuated in geosciences ([Bernard and Cooperdock, 2018](#)). These stark

and deeply concerning failures with respect to diversity are a problem for the entire community as this stifles scientific excellence and innovation.



**Figure 1** Gender breakdown from Goldschmidt Conference attendees between 2018 and 2020.

### 3. Rethinking Society Awards

In order to better inform strategies in DEI, we ought to be guided by robust evidence and data so that we can lift the veil and rectify flawed or discriminatory approaches to enable everyone to achieve their full potential. A particular area of interest is the process of nominations and attributions of awards and honors of the GS and EAG; potentially powerful tools to spur wider progressive change. It is vital that we monitor and respond to any bias or barriers to award nomination and attribution. Outstanding researchers with varied forms of contributions, or who have battled adversity, should be rightly included in recognition bestowed by our societies and then gain from the career (and quiet confidence) benefits that can follow. This work is important not only because it should significantly elevate trust to



enlarge and broaden nominee pools, but also revise and improve community perceptions of excellence. In the latter case, this will be achieved by ensuring evaluation criteria and panel assessment procedures can be reformed to better align with diversity, equity, and inclusion ideals. These endeavors are critical to the health, appeal, reputation and competitiveness of our discipline because awardees serve as prominent and inspiring role models as well as ambassadors for our subject / discipline. Thus, we need to ensure that these role models reflect the global societies that we serve and are relatable for all kinds of talented people whose aspirations may rise in consequence. Equally, we need to better understand how we have historically named award after and also bestowed recognition on those who are privileged in terms of access, socioeconomic setting, circumstances, and our conditioned unconscious cognitive bias. Furthermore, we have a responsibility to instill in our award systems, and thereby infuse the community, the value and necessity of excellent teams; ensuring that our own processes and procedures recognize but in no way contribute to the perpetuation of hostile or toxic academic environments. Of concern is that evidence shows that academic bullying as well as acts and systems that marginalize people disproportionately impact minority groups ([Fernandes et al., 2020](#); [Kernen et al., 2021](#)).

These individuals include potentially vulnerable people with immigrant status and / or work-visa reliance. Such people could be unaware or averse to confronting problems through their employer's hiring resource or support networks. These individuals may also not have or wish to access trade union protections, or might feel that they cannot easily otherwise access confidential and independent help or advice. With these considerations in mind, and the difference our actions could make for deserving people as well as community morale, we here focus on assessing and improving DEI among award names / types and awardees. This approach aims to account for the lack of equal opportunity in scientific careers, as presented above (e.g., between genders – women career's progression being notoriously more challenging than that of men; [Perez, 2019](#); and cultural origin and location – the access to research facilities being for instance more challenging in Africa than in North America). This will ensure that many more excellent scientists are nominated under fairer conditions of

assessment, while these changes also transform positively the image of our discipline, thereby helping to accelerate progress for all future generations.

In this context, we identify themes around age, gender identity or expression, sexual orientation, nationality, ethnicity, disability, career path, and religion (or lack thereof) where we need to do better in terms of both representation and true integration and belonging. However, our knowledge and understanding of community demographics and barriers specific to the geochemical sciences has been and continues to be limited. This is an area of development through the activities of DEI committees supported by the GS and EAG during and beyond 2021. The approach taken here has mined data from past awards. In doing so we recognize that our data set is useful to benchmarking the status of aspects related to awards so as to inform recommendations for improvements. We acknowledge that more complete and voluntary data was not collected prior to 2021. Such complete data collection would be beneficial for a more equitable nomination and attribution process of awards. In building such knowledge we will be better able to address equal opportunities in science by promoting diversity, equity and inclusion while tackling misconduct and academic bullying. We, therefore, strongly recommend that such information is collected as a matter of standard practice from this point forward (the precise nature of the data to be collected in relation to awards in future is a matter presently under discussion).

The GS and EAG award several distinct honors annually. Among them, the V.M. Goldschmidt, F.W. Clarke, C.C. Patterson, H.C. Urey and F.G. Houtermans medals (see award descriptors below) are all named after white, male scientists. Of 173 awards, 154 (89%) awards were attributed to men and 19 (11%) to women (Figure 2 a and c). Gender ratios of awards in the last decade (2011-2020) improved slightly (Figure 2 b and d); of 50 awards, 37 (74%) went to men and 13 (26%) went to women. Two third of all awards to women were attributed in the last ten years (68%). The F.G. Houtermans award is the only one with equal gender representation in the last decade, perhaps because it targets early career researchers, before the “leaky pipeline” takes effect in earnest. The presently

available data are such that we are not able to provide a meaningful appraisal of under-representation among ethnic, LGBTQ+, and groups of varying career paths, physical / mental health ableness and neurodiversity. Yet, we hope to reform procedures so as to address these aspects in future. Nevertheless we conclude that the awards bestowed by society are presently woefully imbalanced, as emphasized by our statistics relating to gender. Hence, current award criteria and assessment procedures should be evaluated and revised.

**Award Descriptors up to 2021:**

**V.M. Goldschmidt Award**, The GS's highest honor, presented annually for major achievements in geochemistry or cosmochemistry, consisting of either a single outstanding contribution, or a series of publications that have had great influence on the field.

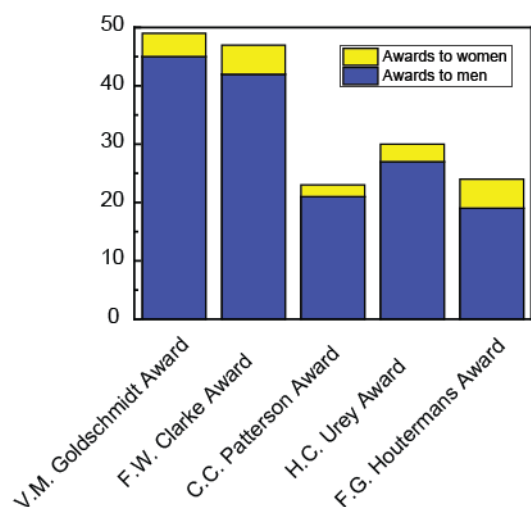
**F.W. Clarke Award**, Presented annually by GS to an early-career scientist for a single outstanding contribution to geochemistry or cosmochemistry, published either as a single paper or a series of papers on a single topic.

**C.C. Patterson Award**, Awarded annually by GS for a recent innovative breakthrough in environmental geochemistry of fundamental significance, published in a peer-reviewed journal.

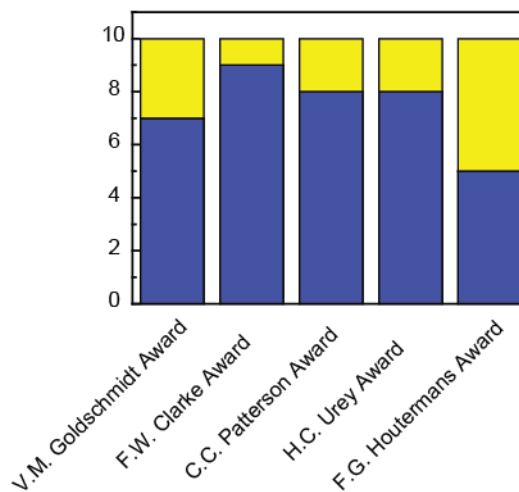
**H.C. Urey Award**, the EAG's highest honor, recognizing outstanding contributions advancing geochemistry over a career.

**F.G. Houtermans Award**, recognizing exceptional contributions to geochemistry made by scientists within 12 years from the start of PhD by EAG.

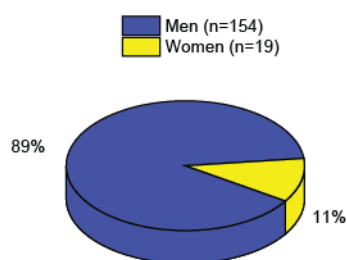
(a) All-time awards



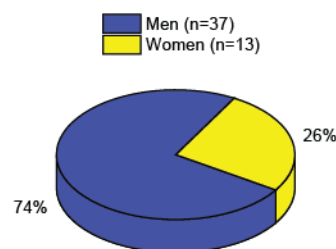
(b) Recent awards (2011-2020)



(c) All-time awards



(d) Recent awards (2011-2020)



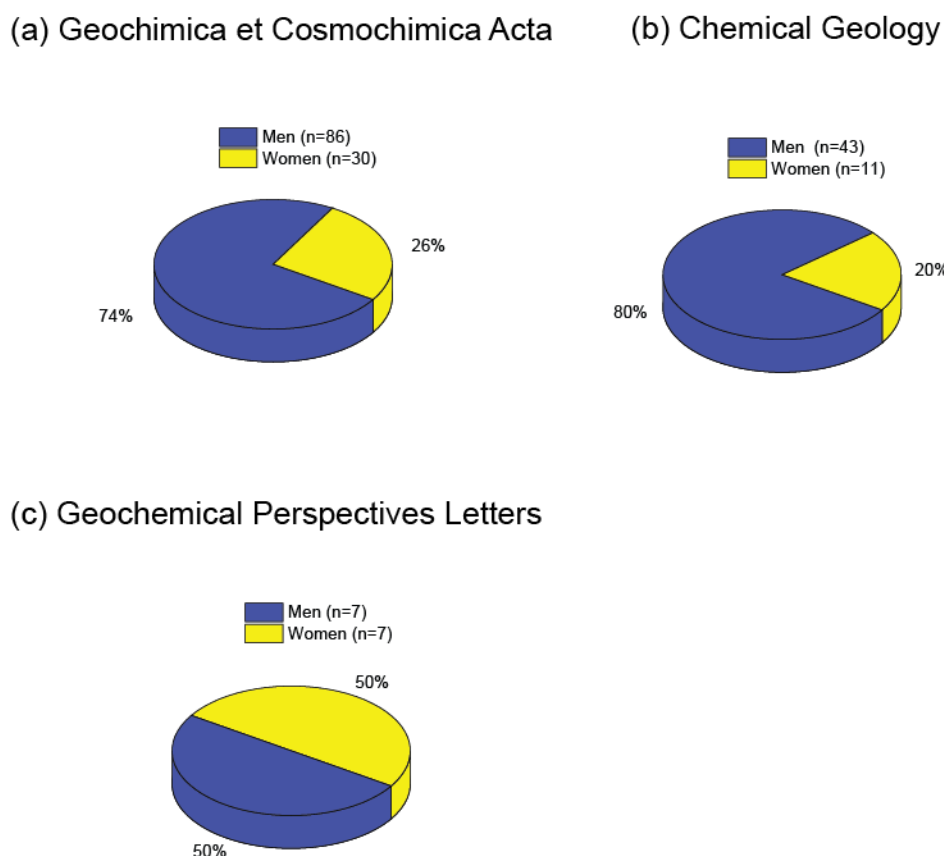
**Figure 2** Gender breakdown in some selected awards recipients, including (a) all-time award categories, (b) award categories from the last ten years, (c) all-time awards, and (d) awards for the past ten years (data accessed on 10/10/2020).

While individual recognitions are important, rarely if ever are scientific discoveries achieved by an individual. This has been marked by awards such as the Nobel Prize (itself known to be a historically imperfect system with respect to DEI) where a team of researchers are marked out for their effort for scientific discovery. Collaborative working is the foundation of geochemical and cosmochemical research and this approach has led to numerous discoveries (e.g., clumped isotope interlaboratory calibration, [Petersen et al., 2019](#)) or scientific advances underpinned by sample collection by an international and diverse group of researchers (e.g., International Ocean Discovery Program, space missions such as

Stardust and Hayabusa2). Yet, these collaborative efforts are currently overlooked by our award system in geochemistry and cosmochemistry; in parallel among some funding systems too. In addition, by prizing team efforts and cooperative research cultures, divisive issues arising from over-pressured competition within the community, potential for institutional pressures or gaming, and exploitation / bullying of early career and / or under-represented groups among both established and junior academics can be potentially reduced.

#### **4. Representation**

Gender equity remains a significant problem for geochemistry and cosmochemistry (Mukasa, 2009). It is evident from our results that there persists a lack of success in cultivating and maintaining women in geochemical science leadership roles. Specific challenges resulting in this differential attrition among genders include: women's progression and retention, the pipeline of women in higher education, gender pay / promotion / strategic influence / infrastructure allocation inequalities, and lower publication rates, especially as first author (Pico et al., 2020). Though we note here that publication rates can be lower among gendered groups and some institutions may currently emphasize such measures, we are mindful that this does not take account of differences in access or career path, contributions of excellent edited volumes or books, training and mentoring of superb personnel, curation of major collections, instrument and / or laboratory development and construction. Plus, leadership of complex international initiatives or space missions, important new advances in curricula, engagement of the public and policy makers, and wider contributions to build capacity and advance the field are undervalued when metrics are over-emphasized. Similarly, publication rate alone is not a measure of the novelty, difficulty, innovation and / or scientific impact of the published works that should be considered as primary markers of excellence.



**Figure 3** Gender breakdown in 2020 editorial boards of (a) *Geochimica et Cosmochimica Acta*, (b) *Chemical Geology* and (c) *Geochemical Perspectives Letters* (data accessed on 10/10/2020).

Inclusion and diversity will continue to need strong and visible leadership by the GS and EAG. Indeed, it is worth mentioning that the GS board of directors has ten women and seven men; and EAG council has also ten women and six men. In 2010, there were only four women on the GS board. This change filters down to various committees, too. Many GS and EAG committees have gender parity now and Editorial Boards from the journals' societies (i.e. *Geochimica et Cosmochimica Acta*, *Chemical Geology* and *Geochemical Perspectives Letters*) tend to have gender parity too, or at least have tried to improve (Figure 3). There is a conscious effort to populate GS and EAG leadership positions with diversity in mind: the last five GS Presidents have been women (only one for EAG). Here we emphasize gender,

but geographic diversity has also been kept in mind, as well as trying to cover the topical spectrum of geochemistry and cosmochemistry. Other categories like ethnicity, sexual orientation, and physical ability have not been addressed to the same extent, primarily because there is a lack of data collection to explore disparity and improve awareness and recognition. To recognize and value DEI service among academic communities, a more inclusive approach is required. For example one that more fairly distributes community and DEI service among all members of the community, and encourages institutions to evaluate and value DEI activities favorably with respect to promotion and tenure. In turn, longer-term systemic change can be generated by consistently more diverse presence(s) at the leadership level ([Mukasa, 2009](#)).

## 5. Recommendations

The results of the findings of our preliminary investigation of demographics among chosen areas of emphasis (i.e. gender) lead us to make a range of recommendations to improve practices and commitments to drive positive change in diversity and inclusion. To guarantee that geochemistry and cosmochemistry is for all, we propose six main calls for improvement in community culture and practices:

- (i) Strong and visible diverse leadership free of (accusations of) academic misconduct and / or bullying;
- (ii) Improved two-way dialogue through which marginalized and minoritized groups can share their views as we support the philosophy of “not about us without us”. These exchanges must not only be through friendly and critical discussion at conferences and during online Town Halls, via email contact points, but also through social media and publications in journals, in Elements, and in the EAG blog;
- (iii) Anonymous data collection should include age, ethnicity, nationality, gender identity or expression, sexual orientation, career path, and differing physical / learning / mental health needs (‘disability’) for membership, conference attendance, publications and awards;

- (iv) More targeted research and analysis to understand the workforce in geochemistry and cosmochemistry globally;
- (v) Revisions to award descriptions and procedures to enlarge and diversify nomination pools. Reforms will guarantee that there is less emphasis on matters such as citation metrics or journal impact factors and more recognition of contributions to broaden impact and engagement so as to increase (e.g., geographic) diversity;
- (vi) Elevating recognition of effective working partnerships and valuing of collaborative research teams (e.g., All-Aboard Geo Project <https://mlp.ideo.columbia.edu/all-aboard-geo-project/>; and inclusive of technical staff / laboratory managers). This approach has the intended consequence of reducing potential fuel for “toxic academic environments” or over-pressured internal competition.

Solutions can be tricky to implement. Discussions of race, ethnicity, and other cultural minorities' perspectives can be nuanced and painful because they contribute to the identification of crucial systemic problems that remain unequal in a global society. Experiences shared by under-represented and minority groups of scientists' stories are personal and true, might be traumatizing to those affected to repeat, and frequently produce observations that relate to the precarious nature of relationships between races and other sensitivities as well as the need to navigate the world differently (Cooperdock et al., 2020). Moreover, we must take more genuine action to build, promote and retain a diverse student population, work on curricula and fieldwork requirements that are inclusive and provide opportunities for disadvantaged groups to promote equity (e.g., Anadu et al., 2020; Chiarella and Vurro, 2020; Kingsbury et al., 2020). Such efforts will enable us to build an increasingly diverse and excellent research community in which more people feel that they belong thereby supporting scholars through student journey to early career to mid- and senior scientist stages.

To increase the speed of transition, we propose new commitments aimed at reforming our policies and practices:



- (i) Launching a new research flagship initiative to combat gender and ethnic inequity, and to recognize the obstacles and enablers to the retention and advancement of women and other or intersectional under-represented minority groups into leadership positions. Collecting data will help better understand trends amongst under-represented and marginalized groups;
- (ii) Examining how we collaborate and value teams within our community, both those within and those that cross traditional subject matter, geographic, and institutional boundaries;
- (iii) Encouraging community engagement with publications of this type and also with GS's and EAG's forthcoming strategic plans to advance diversity, equity, and inclusion;
- (iv) Making data, observations, and expertise available wherever possible to inform centralized initiatives that seek to progressively transform scientific workplaces and ecosystems for the better of all (e.g., via government / funder focused studies and programs).
- (v) Further, we recognize that our intended reports and publications could help beyond the scope of improving inclusivity and equity in EAG and GS award procedures. Our published and openly accessible works could inform and influence the protocols of other international bodies while also encouraging the community in cooperative efforts to improve the representation of our geochemistry and cosmochemistry among other international award provisions. For example, [Nature](#), [Association for Women Geoscientists](#), [Royal Society Africa / Rising Star prizes](#), [Blavatnik Awards](#), [L'Oreal-UNESCO Women in Science](#), [National Geographic Society](#), [MacArthur Fellowships](#), among our [partner societies](#), [affiliates](#), as well as other comparable bodies, and while acknowledging the collective benefits of national / international [Young Academies](#) such as that for [Europe](#) and national groups.

We cannot do this alone. We also advise that the entire community should help to build momentum and inspire more reform. We need to lift the bar in higher education, and among private and non-profit employers, for diversity and inclusion. Institutions should better recognize the inherent value and the full range of contributions made to their organization by

colleagues among diverse workforces, and must make greater commitments to developing the best environments and policies for change. The geochemical and cosmochemical community needs to overcome institutional disadvantages and encourage as many individuals to contribute to scientific discovery and innovation as possible ([Bierman and Corbett, 2020](#)). We must accelerate the pace of change and broaden the discussion beyond gender.

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## **Conflict of interest**

OP is a member of the Editorial Board of Chemical Geology and the DEI Committees of both EAG and GS. PA, SA, PB, ZL, ECM and JMC are members of the DEI Committee of EAG. AD is a member of the Editorial Board of Chemical Geology and the DEI Committee of GS. JM is a member of the DEI Committee of GS. BN is a member of the Editorial Board of Chemical Geology and the DEI Committee of EAG. AR is Co-Chair of the DEI Committee of EAG and has previously served as Guest Managing Editor in leading a Special Issue of *Geochimica et Cosmochimica Acta*.

## **Credit authorship contribution statement**

OP: Conceptualization, Data Curation, Formal Analysis, Visualization, Writing Original draft, Writing - review & editing. All other authors are listed in alphabetical not order of intellectual contribution: Writing Original draft, Writing - review & editing.

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