



# Women Underrepresentation in Editorial Boards of Geology Journals and the Utopia of Gender Equality

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The 5th goal of the 2030 Agenda for Sustainable Development aims at promoting gender equality and empowering all women and girls at all levels of decision making. This includes editorial decisions in the frame of the dissemination of scientific knowledge as a result of research and development activities. This work analyses the women representation in the editorial boards of 53 subscription or open access geology journals of all quartile rankings included in the Web of Science Core Collection™ in 2020 in order to assess how far female geoscientists are from the 2030 Agenda targets concerning gender equality. Among the analyzed journals, in 85% the position of editor(s)-in-chief is (are) occupied by a man or a group of men, and in the remaining 15% by women. Moreover, 80% of the people that make up the editorial board of the same journals are men and 20% are women. Only one journal indicates the editor(s)-in-chief gender and the number of members per gender that make up the editorial board. The strong gender gap detected in this study shows that the goal of gender equality in the editorial boards of geological journals still remains a long way off, and publishers should therefore increase gender diversity in editorial teams and referee pools.

**Keywords:** geology journals, editorial boards, women representation, gender equality, 2030 agenda

## INTRODUCTION

The UNESCO Priority Gender Equality Action Plan for 2014–2021 acknowledges the lack of women's leadership and the lack of women's voice and participation in decision-making processes (UNESCO, 2014a). And one of the goals of the 2030 Agenda for Sustainable Development focus on empowering all women and girls and ensuring women's full and effective participation and equal opportunity for leadership at all levels of decision-making in political, economic, and public life (UN, 2021a). According to the 2017 Report of the Secretary-General of the United Nations, in most of the 67 countries with data from 2009 to 2015, women accounted for less than one-third of senior and middle management positions (UN, 2021a).

A bibliometric study of gender inequality in research outcomes around the world, based on the scientific impact of all articles published between 2008 and 2012 and indexed in the Thomson Reuters Web of Science databases, shows that men dominate scientific production in nearly every country (Larivière et al., 2013). In certain areas of knowledge such as ecology, it was detected that articles written by women have lower acceptance rates and are less widely quoted than articles written by men (Fox and Peine, 2019). But a recent historic analysis of gender bias in science careers across countries and disciplines shows that men and women publish at a comparable yearly rate and have an equivalent career impact for the same volume of work (Huanga et al., 2020).

In higher education, women have made great gains, but are still underrepresented in managerial positions, namely in top academic leadership of different scientific fields, in performing key roles in public events (e.g., plenary speakers) and/or leadership positions in organizations and conferences (Hill et al., 2016; Piccoli and Guidobaldi, 2021) or in the activities of national science academies (Valentova et al., 2017; Ngila et al., 2021). However, very few men or women are prepared to accept that discrimination is a serious issue in the scientific world (Barres, 2006).

A study developed by Fox et al. (2016) about the peer review process for all papers submitted to *Functional Ecology* journal, from January 2004 to June 2014, revealed that editor gender, seniority and geographic location affect the kind of reviewers selected for the journal, as well as how invitees respond to review invitations.

Helmer et al. (2017), using public identity information for 9,000 editors and 43,000 reviewers of the *Frontiers* journal series demonstrate that women are underrepresented in the peer review process, that editors of both genders have a strong preference for the same gender, and the mechanisms of this homophily depend upon gender. Williams et al. (2018) conducted another study about the role of gender in publication in the *Journal of Pediatrics* during 2015–2016 which revealed that women were less likely to be peer reviewers and editorial authors than would be expected given their strong presence in pediatric faculties.

Also, a recent work regarding the women representation in sport sciences research, publications, and editorial leadership roles of 15 selected journals shows that women filled less than 1/5 of all editorial posts by September 2020, and none of the editors-in-chief were women (Martínez-Rosales et al., 2021).

Editors act as gatekeepers in traditional journalism as they make important decisions that affect the process and its results (Resnik and Elmore, 2016). Journalists, like scientists, must have their content approved by their editors, albeit peer review procedures are more complicated than a simple one-step binary accept/reject approach (Wang et al., 2016). Personal background, experience, attitudes, and beliefs among other internal factors, strongly influence editors' decisions in both fields, as well as extrinsic factors, like the increasing competitive pressure of the media industry (Rusdi and Rusdi, 2020), a reality that can be also recognized in the academy. As assumed by Yoder (2021), who served as editor of *Sex Roles and Psychology of Women Quarterly* for 5 years, values and understandings guided her editorial decisions; she firmly believes that in editorial decisions the individual's social context matters.

## BACKGROUND AND OBJECTIVES

In the most mathematically intensive subjects, such as geosciences, women have historically been underrepresented, as is the case of professoriate, graduate school programs, and college majors (Ceci et al., 2014). As reported by Aladro Vico et al. (2014), based on analyses of science news articles published by five major general-interest paid-for Spanish newspapers over a

six-month period, the image of female scientists presented by the media also reveals a significant level of informative inequality in favor of male scientists, both in terms of the number of science news articles dedicated to them and in terms of treatment. Lukanda (2021) also claims that women are underrepresented as authors and sources of science stories in the media, based on a content analysis of 317 stories published in two Ugandan newspapers, and that the chances of females being published as authors and sources increase if they collaborate with a male. According to Mattox et al. (2008), who analyzed physical geology textbooks sold in the United States, books represent males as 3.5 times more likely to be geologists than females; this ratio far surpasses the current percentage of men and women joining this career (58 percent male and 42 percent female for B.S. degrees in Earth Science). Jhonson (2018) also looked at Hollywood depictions of women in geology, concluding that between 1986 and 2016, casting procedures did not match real-life demographics of women in geology, as just 31% of actors portraying geologists were female. Despite the recognition of images of female scientists and engineers in professional positions of high prestige, the study developed by Steinke (2005) about cultural representations of gender images of female scientists and engineers in popular films from 1991 to 2001, suggests that depictions of female scientists and engineers in these films often emphasized their appearance and focused on romance; they also report that among images of female scientists and engineers interacting with male colleagues overt and subtle forms of stereotyping were used to undermine and reinforce traditional social and cultural preconceptions about the role of women in science and technology.

Geosciences are among the least diverse STEM (Science, Technology, Engineering, Mathematics) disciplines regarding gender and underrepresented minorities (Bernard and Cooperdock, 2018; Eifert and Stewart, 2018; Popp et al., 2019; Piccoli and Guidobaldi, 2021; Zhang et al., 2022), despite their important contributions to geology's evolution and history through their diverse roles (Burek and Higgs, 2007). Systemic attitudes and behaviors are usually invoked as part of the problem (Steele et al., 2002; Settles et al., 2006; Rosen, 2017; De Kleijn et al., 2020).

Gender equality and empowerment of all women and girls at all levels of decision-making are one of the goals of the 2030 Agenda. This includes the access to opportunities as members of expert panels and advisory groups to editorial management responsibilities in the frame of the dissemination of scientific knowledge in specialized journals (UNESCO, 2014b). In fact, editorial and reviewing tasks can influence the success of scientists in disseminating their research, which in turn can affect their scientific careers (Fox et al., 2016). As pointed out by Loscalzo (2017), who served as editor-in-chief of *Circulation* for 12 years, editorship is a very unique and extraordinary professional experience and a critical component of a rewarding academic career. It remains to be seen to what extent a woman can achieve such professional satisfaction, namely in a male-dominated field like geology (Ward, 1992).

As so, the main purpose of this work is: to analyze the representation of female scientists in geology journals based

on the composition of the corresponding editorial boards in 2020; and to assess how publishers are contributing to the success of the 5th goal of the 2030 Agenda for Sustainable Development. The results will allow us to see the path that remains to be taken in the present decade.

## MATERIALS AND METHODS

The present work analyses the gender composition of the editorial boards of the world's most impactful journals classified within the category of "Geology" in 2020. The primary source of publication data for this study is the Clarivate Analytics' Web of Science Core Collection™ database.

In total, we considered the editorial boards of 53 journals, which have been characterized in terms of subscription (36) or open access journals (17) and quartile ranking (Q1 is occupied by the top 25% of journals in the list; Q2 is occupied by journals in the 25–50% group; Q3 is occupied by journals in the 50–75% group; and Q4 is occupied by journals in the 75–100% group). Among the 53 journals, 47 are included in Science Citation Index Expanded™ (SCIE) edition within the category of "Geology"; six are included in SCIE within other categories (Agriculture, Multidisciplinary and Geosciences, Multidisciplinary), but integrate the Emerging Sources Citation Index™ (ESCI) within "Geology" (Supplementary Table S1).

For each of the analyzed journals, the editor(s)-in-chief gender and the number of people per gender that make up the editorial board by quartile ranking were determined. Only one journal indicates the compositions by gender of the editorial committee on the respective website (Ore Geology Reviews). For each of the analyzed journals, the editor(s)-in-chief gender and the number of members per gender that make up the editorial board by quartile ranking were determined. The gender classification was determined by consulting different sources, besides personal knowledge. The gender was assigned to each member based on the name and photograph provided in the journal website, and using gender name finders available on the internet. To ensure the reliability of the gender assignment information collected from available curricula from personal and institutional websites, platforms such as ResearchGate™, ORCID™ and others, were also consulted for each person. Thus, it was possible to assign the male/female gender to all editors, although it is necessary to consider the possibility of some editors being included in one of two other categories ("non-binary or gender diverse" or "prefer not to disclose") usually recognized on Gender Diversity Distribution of the Editors among the journals that refer this issue.

To verify whether the preference for choosing men as editor(s)-in-chief and to compose the editorial board was casual or intentional, the results were analyzed using a  $\chi^2$  test. To this end, the total values by gender were determined for the composition of the editorial board and the editorial-in-chief, which correspond to the observed values. With reference to the gender equality goals inscribed in the 2030 Agenda (50% for each gender), the expected values were then determined.

It was chosen a significance level of 5% ( $\mu = 0.05$ ), and a degree of freedom (g.l) of 1, which corresponds to a tabulated  $\chi^2$  value of 3.841. Two hypotheses were defined:  $H_0$ : there are no significant differences between genders and the choice of male sex was casual;  $H_1$ : there is a relationship between the variables and the male gender is predominant for the composition of the editorial board of the journals.

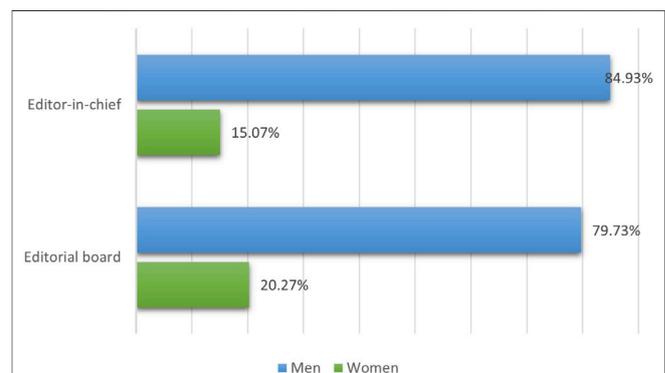
## RESULTS

A total of 1,431 individuals (1,141 men and 290 women) compose the analyzed editorial boards, where 73 individuals (62 men and 11 women) are editors-in-chief. Detailed data are included in Supplementary Table S1. In general terms, it can be said that the underrepresentation of women in geology extends to specific aspects of scientific activity such as editorial activities whether as members of editorial boards or as editors-in-chief, and regardless the typology of access and quartile ranking of the analyzed journals.

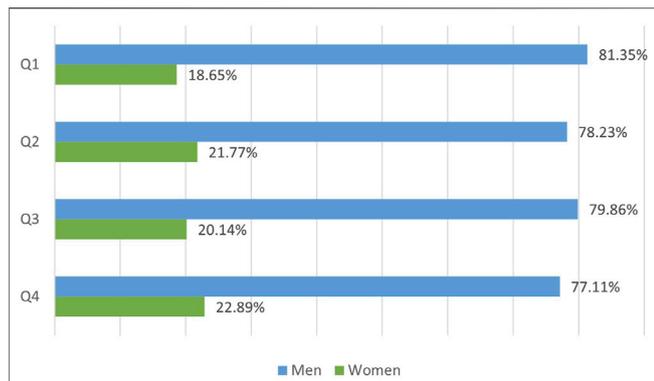
Results show that in 2020 among the 53 journals of "Geology", the number of members per gender that make up the editorial board of the analyzed journals, 80% are men and 20% are women. This gap is greater when considering the position of editor(s)-in-chief; 85% is (are) occupied by a man or a group of men, and 15% by women (Figure 1).

Considering the average gender composition of the editorial boards by quartile ranking of 47 journals, results show that the gender gap remains similar despite the journal ranking, but is greater among journals ranking Q1, where woman representation is around 18% (Figure 2). The gender composition of the editorial-in-chief by quartile ranking shows similar trend, and the gap is also greater among Q1 journals (Figure 3). This trend is even more pronounced when analyzing the same indicator for the 6 ESCI journals, where woman representation in Q1 journals is on average around 10% (Figure 4). No woman occupies the position of editor-in-chief of any journal (Figure 5).

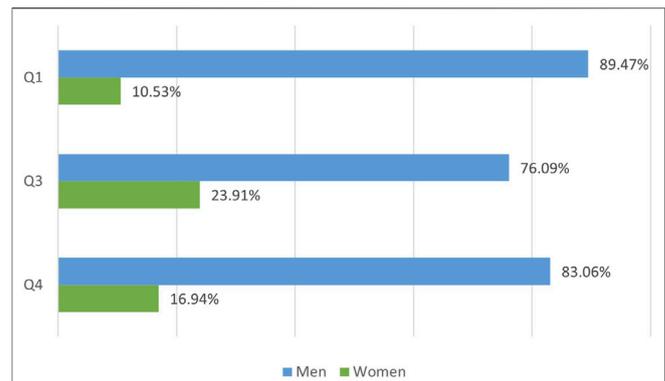
The results obtained from the application of the  $\chi^2$  test are based on data included in Table 1 and Table 2; Figure 6 represents the



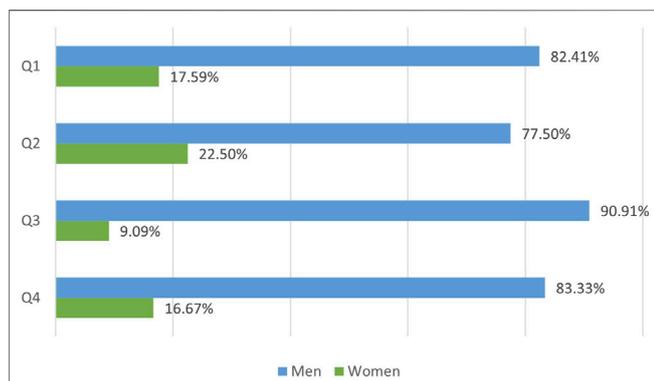
**FIGURE 1** | Gender representation in the position of editor(s)-in-chief and gender representation of the editorial board among the 53 journals classified within the category of "Geology" in 2020.



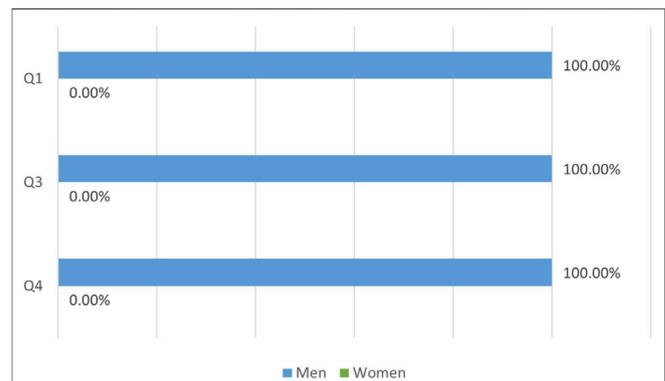
**FIGURE 2 |** Average gender composition of the editorial boards by quartile ranking of 47 journals classified within the category of “Geology” in 2020 and included in Science Citation Index Expanded™.



**FIGURE 4 |** Average gender composition of the editorial boards by quartile ranking of six journals classified in 2020 within the category of “Geology” in Emerging Sources Citation Index™, and included in Science Citation Index Expanded™ in other categories (Agriculture, Multidisciplinary and Geosciences, Multidisciplinary).



**FIGURE 3 |** Average gender composition of editor(s)-in-chief by quartile ranking of 47 journals classified within the category of “Geology” in 2020 and included in Science Citation Index Expanded™.



**FIGURE 5 |** Average gender composition of editor(s)-in-chief by quartile ranking of six journals classified in 2020 within the category of “Geology” in Emerging Sources Citation Index™, and included in Science Citation Index Expanded™ in other categories (Agriculture, Multidisciplinary and Geosciences, Multidisciplinary).

total observed and expected values by gender of the composition of the editorial board and editor(s)-in-chief, and **Figure 7** shows observed/expected values for each journal. Concerning the composition of the editorial board,  $\chi^2 = [(1,141-715.50)^2 + (290-715.50)^2]/715.50 = 506.08$ ; regarding the editor(s)-in-chief,  $\chi^2 = [(62-36.5)^2 + (11-36.5)^2]/36.50 = 35.63$ . Thus, both in the case of the composition of the editorial board and in the case of editors-in-chief, the values obtained (506.08 and 35.63, respectively), as they are higher than the tabulated value (3.841), allow considering the  $H_1$  hypothesis. So, there is a significant difference between females and males in the choice of editors, and that male gender is predominant.

## DISCUSSION

The geosciences’ historical lack of diversity poses an existential threat to the discipline’s long-term viability (Mogk, 2020). Despite the significant progress that women have achieved in school and the economy over the last few decades, there is still a significant disparity in women’s engagement in STEM disciplines

when compared to men, particularly at higher levels of employment (UNESCO, 2017). A research study conducted by Piccoli and Guidobaldi (2021) in Switzerland and the European Union in 2016 reveals that the proportion of women in academia diminishes as they advance in their careers. This “leaky pipeline” is an issue that impacts all research domains, with geosciences being the least varied of all STEM subjects (Bernard and Cooperdock, 2018).

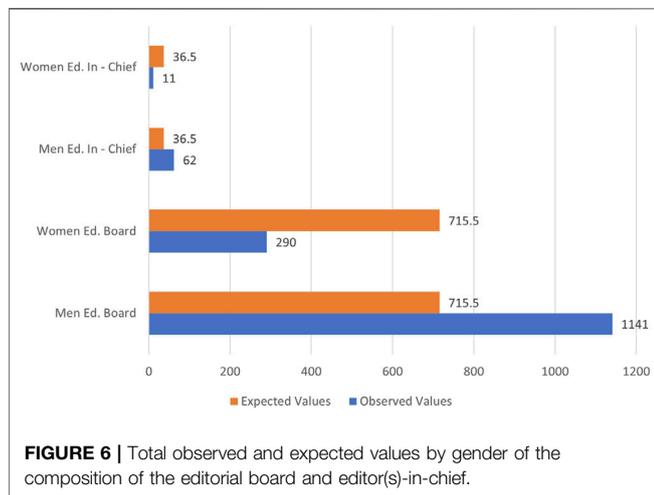
A recent Elsevier report highlights Portugal’s leadership in gender diversity and inclusion in the research workforce (Elsevier, 2021a). Portugal has the highest share of women among researchers, even in subjects where women are generally underrepresented like Earth and Planetary Sciences with 43% women, and in contrast to countries like Japan (Elsevier, 2017). According to Marín-Spiotta et al. (2020), the geosciences continue to have one of the least diverse workforces in the United States and other countries, and achieving gender parity in this sector will take at least 50 years. This requires,

**TABLE 1 |** Total observed and expected values by gender of the composition of the editorial board.

Editorial Board Gender	Male	Female	Total
Observed values	1141	290	1431
Expected values	715.5	715.5	1431

**TABLE 2 |** Total observed and expected values by gender of editor(s)-in-chief.

Editor In Chief Gender	Male	Female	Total
Observed values	62	11	73
Expected values	36.5	36.5	73



**FIGURE 6 |** Total observed and expected values by gender of the composition of the editorial board and editor(s)-in-chief.

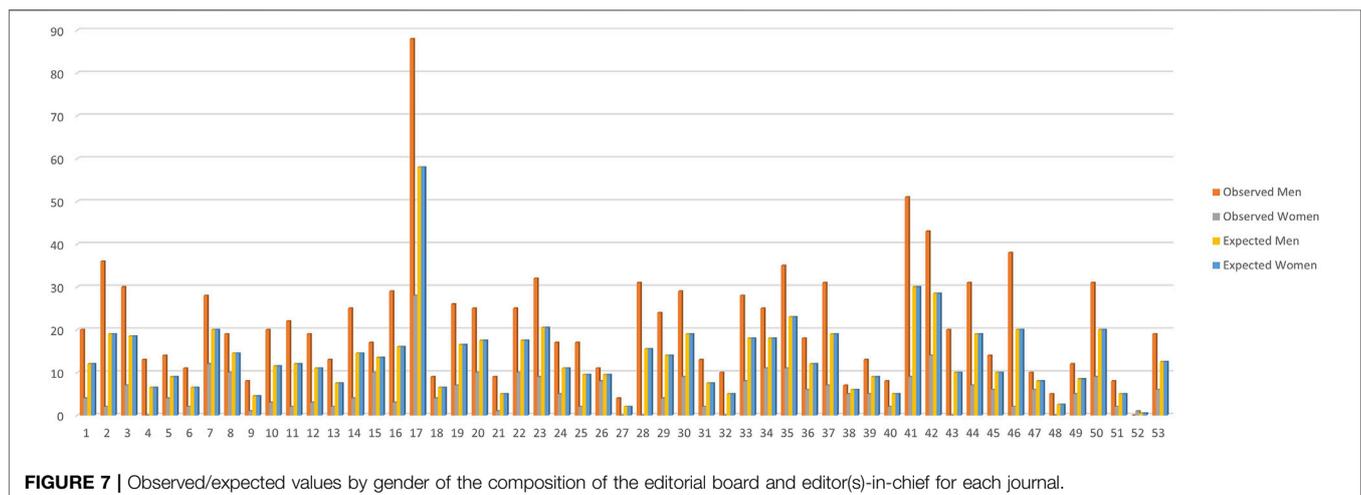
among other things, increasing the quality and quantity of women’s participation in geosciences, as well as introducing girls and young women to geoscience careers (Schneider et al., 2018; AWG, 2021).

The detailed study conducted by Elsevier (2021a) focusses on four indicators regarding gender differences: in author

distribution, in research output, in citations and in pay and working conditions. Suggestions concerning opportunities of reducing the gender gap in decision making positions are limited to the need of increasing the number of women in senior positions in higher education; the representation of women researchers in editorial boards of scientific journals was not assessed.

The gender imbalance in editorial boards of scientific journals may not affect the peer review process or the editors’ ultimate decisions about manuscript publication. Nevertheless, Wing et al. (2010) identified many gender-based disparities in parts of the peer-review process, including submission triage, turnaround time, and editor’s grades assigned; furthermore, men with longer tenure on the editorial board rejected more papers than women with shorter tenure. A previous study conducted by Gilbert et al. (1994) also revealed that male reviewers took longer than female reviewers to return papers. However, Fox et al. (2016) observed no differences on outcomes between male and female reviewers or male and female editors of the peer review process of the Functional Ecology journal from January 2004 to June 2014. But Witze (2016) analyzed manuscripts sent to American Geophysical Union journals between 2012 and 2015 and concluded that women published less than men, but have a higher acceptance rate; moreover, invitations to participate as peer reviewers are declined at a higher proportion by women than by males. As so, there seems to be no objective reason to keep the women underrepresentation in editorial boards of scientific journals, which configures a situation that clearly prevents men and women from achieving full equality of rights and opportunities.

The geological establishment’s easy acceptance of women as assistants rather than leaders, by both men and women, has not entirely gone away, and similar barriers for women in other fields, like as chemistry, engineering, medicine, and law, have existed throughout history (Burek and Higgs, 2021). According to Rosen (2017), women suffer subtle prejudices and structural impediments to success in the geosciences, from the peer-review process to our basic understanding of what it means to be brilliant. The study reported by Popp et al. (2019) about



**FIGURE 7 |** Observed/expected values by gender of the composition of the editorial board and editor(s)-in-chief for each journal.

perceptions and impacts of gender inequality in the Earth and Space Sciences show that the impact of gender disparity on women worsens as they advance in their careers. The authors also conclude that male, who dominate in senior career levels and are in position to tackle the problem, are the ones who are less affected by the harmful effects of gender inequality.

Among the analyzed journals in this work, women occupy around 15% of the editor-in-chief position only among journals included in Science Citation Index Expanded™; they are absent in journals included in Emerging Sources Citation Index™. The editor-in-chief is the highest-ranking member of the editorial team at a publication. He or she is ultimately responsible for the content of the journal, and he or she must guarantee that the journal's goals, scope, and content adjust to any shifts in the field of study in order to include new research (Elsevier, 2021b). Moreover, editors of scientific journals have obligations to the authors who contribute to the journals, the peer reviewers who comment on manuscripts' appropriateness for publishing, the journal readers and the scientific community, the journal owners/publishers, and the general public (Cox, 2018; EPC, 2021). A previous report by Dan Lovegrove, a geology publisher for Amsterdam-based publishing group Elsevier, states that despite the fact that women contribute 30% of articles to Elsevier's Earth and Planetary Sciences publications, just 13% of journal editors are female (Witze, 2016). The present study also shows that concerning the number of members per gender that make up the editorial board of "Geology" journals, only 20% are women.

Peer review processes are mainly managed by senior editors and editorial boards of male senior scientists who can write fluently in English; moreover, editors tend to invite reviewers that are like themselves, therefore contributing to enlarge the gender gap among the people involved in peer review processes (Fox et al., 2016). Editorial tasks require specific skills, namely a deep understanding of science and typically a background as a scientist (IET, 2021). In collaboration with his or her publishing contact, the editor-in-chief also chooses the Editorial Board (Elsevier, 2021a), usually by inviting reputable scientists in the journal's field of expertise.

Yet, it seems that female geologists do not enter this equation, despite the evidences reported by Huang et al. (2020), who show that active female and male scientists had nearly identical annual performance and receive a similar amount of citations for the same size body of work. So, the recruitment to join an editorial team of a scientific journal seems to be in line with differences in the selection of candidates for other jobs. A recent research conducted by Moscatelli et al. (2020) reveals that women and men job candidates are examined on different dimensions, and women are tested against multiple criteria, therefore they may be expected to meet more standards to be picked and create a career than males.

Progress has been made, but women remain vastly outnumbered in many STEM fields (Hill et al., 2010). Bendels et al. (2018) documented a well-advanced integration of female scientist in Earth and Planetary Sciences, but a recent study conducted by De Kleijn et al. (2020) shows that between 2014 and 2018, the global ratio of women to males as active authors in

this field was generally 0.3 to 0.4; Argentina (0.83), Portugal (0.68) and Poland (0.63) present the best scores. The ratio women to men according to year of first publication presents a similar trend.

None of those writers' original languages are English, which is an extra handicap for those researchers because English is widely regarded as the worldwide language of science, particularly in the natural sciences (Testa, 2012; Ramirez-Castañeda, 2020; Valenzuela-Toro and Viglino, 2021). Gay-Antaki and Liverman (2018) also highlight how a good command of spoken and written English represent an important barrier to women's participation in the Intergovernmental Panel on Climate Change reports, one of the most major international climate science gatherings. This means that knowledge developed in Earth Sciences, for example, in Portuguese, remains outside of relevant bodies like the Thomson Reuters Company (2012), despite the fact that Portuguese is the world's fifth most spoken language, the third most spoken in the Western Hemisphere, and the most extensively spoken in the Earth's Southern Hemisphere, totaling approximately 300 million speakers (Henriques et al., 2013). In other language communities the same will eventually happen, which accentuates gender diversity in editorial teams, age and geographic diversity of their editorial boards detected by Fox et al. (2016).

## CONCLUSION

Diversity in any discipline boosts working groups' creativity and problem-solving ability, which is crucial for its long-term health (Mogk, 2020). Women have historically been underrepresented in Earth and Planetary Sciences as active authors, and such gender gap can be also recognized in decision making positions like the membership and leadership of editorial boards of scientific journals. The female underrepresentation on editorial boards can affect women's scientific careers, as well as influence journal management and peer review outcomes (Fox et al., 2016).

This work analyses men and women representation as editor(s)-in-chief and as members of editorial boards among 53 subscription or open access journals of all quartile rankings classified within the category of "Geology" in 2020 in the Clarivate Analytics' Web of Science Core Collection™ database.

Results show that among the analyzed journals, in 85% the position of editor(s)-in-chief is (are) occupied by a man or a group of men, and in the remaining 15% by women. Moreover, 80% of members that make up the editorial board of the same journals are men and 20% are women. This women underrepresentation in editorial boards of geology journals is coeval with the ratio of women to men as active authors, and it is in line with the historically underrepresentation of women in geosciences.

Only one journal includes in its website the ratio of women to men as editor(s)-in-chief or as members of the editorials boards. Such concern can be interpreted as a sign of some awareness about the need to achieve gender parity in editorial leadership positions within geosciences. As pointed in a Nature Editorial (2018), the lack of diversity in science is a problem that affects

everyone, and everyone has a responsibility to look around them, recognize the situation for what it is, and take the appropriate actions to make publication process to be more inclusive.

The role of academic journal editors is crucial in helping to move the overall scientific enterprise forward, and women still have a lot of input in which research topics are important and should be published. Available leadership opportunities at all levels of decision-making is a 2030 Agenda target that has yet to be realized in relevant activities such as scientific journal editorial management. Publishers should therefore increase gender diversity in editorial teams, age and geographic diversity of their editorial boards and referee pools (Squazzoni et al., 2021). This glaring underrepresentation of female scientists might generate disparities in editorial and peer review throughout the entire peer review process that contribute to gender and geographic disparities in scholarly publishing (Fox et al., 2016). The responsibility to address this goal rests with all sectors and industries, including the sectors in which geologists operate (Gill, 2017). This is the case of Elsevier, that began a pilot project to increase gender equity in editorial board recruitment, and the Geological Society of America, which strives to maintain a larger number of female editors and associate editors in its four journals (Witze, 2016). Language barriers are easily overcome if non-English-speaking editors can rely on advisory support to do so, and age diversity requires greater efforts to recruit and retain female students to Earth Sciences.

According to Mogk (2020), the geosciences have an ethical obligation to broaden their diversity. Gender equality is not only a basic human right, but it is also necessary for promoting peaceful societies, and empowering women boosts productivity and economic progress (UN, 2021b). In fact, gender inequality is a huge waste of the world's human potential (GGSD, 2021), and no country can afford to ignore half of its population's intellectual contributions (Larivière et al., 2013).

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## DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author.

## AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/feart.2022.803900/full#supplementary-material>

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