

Women in Geosciences: an overview

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Abstract

This article examines the evolving role of women geoscientists, highlighting both progress and persistent inequalities that continue to shape this discipline. Although women now account for approximately 40% of researchers worldwide, their representation in Geosciences remains uneven, particularly in senior academic, leadership and decision-making positions. Data from the United States, Europe and at country level consistently reveal a pronounced “leaky pipeline,” whereby female representation declines progressively beyond the PhD stage, often falling below 20% among full professors. In Italy, this trend is reflected in the well-known “scissors effect”, with women’s presence decreasing steadily across successive career levels. Despite growing evidence that women’s scientific productivity is comparable to, or in some cases exceeds, that of their male colleagues, disparities persist in authorship, citations, research visibility and access to leadership roles. Structural and cultural barriers, including bias, unequal recognition and limited access to decision-making roles, continue to shape women’s careers and hinder their advancement. Fieldwork, a fundamental component of Geosciences, presents additional challenges exposing women to a greater risk of harassment while also amplifying logistical constraints associated with caregiving responsibilities. These issues are often even more pronounced for individuals belonging to other underrepresented groups. A range of initiatives has been developed to address these disparities, including mentoring and training programs, safer fieldwork approaches, and institutional policies designed to foster diversity, equity, and inclusion. Equally important is the recognition of the often overlooked contributions of historical women geoscientists, whose achievements provide valuable role models for future generations. Although significant progress has been made in increasing women’s participation in Geosciences, gender inequality

remains deeply embedded within academic and professional structures. Achieving genuine equity requires more than numerical balance: it demands sustained structural reforms, cultural change, equitable recognition of scientific contributions, and inclusive working environments. Continued commitment from educational institutions, scientific organizations, funding agencies, and policymakers is essential to build a more diverse, equitable, and innovative geoscience community.

Keywords: Geosciences, Gender equality, Women in science, Glass ceiling, Career progression.



1. Introduction

The presence of women in the Geosciences has grown considerably over recent decades, still significant disparities remain, particularly in leadership, senior academic positions, and specific subdisciplines. Understanding the current situation requires both quantitative analysis of representation and a broader reflection on the structural and cultural barriers that continue to shape women's careers.

At the global level, women in Science as a whole account for around two-fifths of all active researchers (PTGERI, 2024). In the Geosciences, progress has been slower and uneven. In the United States, women hold less than a third of teaching posts in the Geosciences, with a marked decline at higher academic levels and less than 20% among full professors (Ranganathan et al., 2021). Existing models project a sobering timeline: even if a 1:1 hiring practice were sustained across the Geosciences, gender parity among full professors would not be achieved in the first half of this century.

In Europe, women geoscientists generally represent between 30% and 40% of the workforce, but their share in senior roles remains substantially lower (Akingbade, 2023). In Italy, a well-documented "scissors effect" shows female representation declining sharply after the PhD stage, barely reaching 20% of full professors (Agnini et al., 2020). In specific fields, such as Engineering Geology and Hydrogeology, bibliometric analyses reveal that women's scientific output is comparable to or exceeds that of their male colleagues; nevertheless, recognition, as reflected in authorship and H-index values, remains lower (Petrella et al., 2025). This finding is consistent

with broader evidence across the STEM (Science, Technology, Engineering and Mathematics) disciplines, showing that women receive less credit than men and are consistently less likely to be listed as authors on academic articles and patents (Ross et al., 2022).

A particularly acute but often underacknowledged issue concerns the safety and inclusivity of fieldwork environments (e.g., Kutz, 2023). Geosciences are distinctive because fieldwork plays a central role in both undergraduate training and research careers. Women postdocs with field-based research projects are more likely than men to be targets of sexual harassment and assault, while caregiving responsibilities make the logistics of fieldwork disproportionately burdensome for many women. Focus group studies have identified two primary drivers of gender-based harassment in the Geosciences: entrenched power dynamics and dominant stereotypes, combined with systematically ineffective institutional responses to reported incidents. The Geosciences are recognised as one of the least diverse STEM fields, and the remote nature of much fieldwork may create additional barriers for those who do not conform to the traditional image of the white, able-bodied, cisgender male geoscientist (Mattheis et al., 2022). These dynamics are further compounded for women of colour and LGBTQ+ scientists, who may face overlapping forms of exclusion.

In response, the scientific community has gradually developed targeted initiatives. The NSF-funded ADVANCEGeo Partnership¹, for instance, provides bystander-intervention training for scientists at different career stages using discipline-specific scenarios, including fieldwork contexts, and offers workshops for designing effective codes of conduct for field research environments. Programmes such as Field SAFE (Clancy et al., 2014) have partnered with ADVANCEGeo to provide structured training, recognising that making fieldwork safer is one of the most direct ways to address the “leaky pipeline” through which women and other underrepresented groups leave academia.

Role models are another important tool for inspiring and supporting girls and women in Geosciences. Recovering the stories of pioneering women in the discipline is therefore essential (Kölbl-Ebert, 2026). From Martine de Bertereau (1590-1642?) in the 17th century to Mary Anning (1799-1847), whose fossil discoveries contributed to the foundations of evolutionary theory, to Zonia Baber (1862-1956), who proposed a holistic vision of Geosciences as a tool for humanitarian and environmental causes, these figures demonstrate long-standing contributions to the discipline despite systematic exclusion. Their histories, often overlooked or “obliterated” in official accounts, are now being reclaimed through rigorous archival research.

¹ <https://serc.carleton.edu/advancegeo/index.html> (accessed 15 September 2026).

Scientific literature has played an increasingly important role in consolidating and disseminating this knowledge. Special volumes and thematic collections have become key instruments for raising awareness and promoting cultural change (e.g., Thornbush, 2016; Kim et al., 2026; Kölbl-Ebert and Histon, 2027). Among these, the Special Issue “Women in Geosciences” of the Journal of Geoethics and Social Geosciences (Di Bucci et al., 2025) represents a timely and comprehensive contribution. Rooted in work presented at the 2024 Joint Congress of the Italian Geological Society and Italian Society of Mineralogy and Petrology, the volume brings together ten original studies spanning quantitative analyses of representation, accounts of pioneering women, assessments of training programmes, and institutional case studies. Together, these contributions provide a rigorous and multidimensional portrait of the challenges and opportunities facing women geoscientists today. They argue that genuine progress requires not only numerical targets, but also structural reform, inclusive field environments, equitable recognition of scientific contributions, and sustained cultural transformation at every level of the discipline.



Figure 1. Women's contributions to Geoscience span centuries, from 1600s naturalists studying minerals and fossils in the field, to modern researchers using satellites, drones, and new technologies. Despite historical barriers, women from diverse backgrounds have continuously advanced knowledge across the different disciplines of Geosciences. A golden thread connects them all, an unbroken legacy of female scientific inquiry through time (Rosati, February 2026, OpenAI, chatgpt.com).

Within this general framework, the present paper provides an overview of the current state of knowledge, briefly traces the evolutionary history of women's contributions to the Geosciences from the 17th century to the present day (Figure 1) and, drawing on a number of ongoing initiatives, projects and programmes, highlights future directions for achieving greater gender equity in this discipline.

2. Women in Geosciences

The analysis of the current status of women geoscientists is developed following three main lines of investigation. The first relies on quantitative data from the literature concerning the presence of women in Science and Geoscience at global, national and regional scale. The second line recovers stories of pioneering women, both to illustrate the challenges these scientists faced, and to highlight their achievements. These stories can also provide girls and women geoscientists with models to inspire their everyday efforts. Finally, the third line of investigation explores ongoing experiences of female geoscientists, allowing old critical issues and new advances to be recognised and analysed. A general discussion of these findings is developed in Section 3.

2.1. Collecting and analysing quantitative data

At the global level, only a limited number of quantitative studies are available on the representation of women in the scientific workforce. PTGERI (2024) shows that women's participation in research has increased in the last two decades, reaching the parity zone (40-60%) for the first time in 2022, with women accounting for 41% of all active researchers. This important result does not apply evenly to the STEM fields yet, where disparities persist, and women's participation remains much lower. At the EU level (European Commission, 2025), gender balance (where women and men each comprise between 40% and 60%) has been achieved among the overall pool of Doctoral graduates, with women accounting for 48%. Representation varies by field of study. Women remain underrepresented in Information and Communications Technology (ICT) and in Engineering, Manufacturing and Construction, where they account for less than 40%. Moreover, women's representation among Doctoral graduates has decreased in some STEM fields (Physical Sciences and Mathematics and Statistics), suggesting a shift away from gender balance in disciplines where women are already underrepresented. Women's presence in STEM professions and sectors remains limited. For example, women are less represented than men

as scientists and engineers (although the overall employed population is gender balanced with 41% women) and comprise only 25% of self-employed professionals in Science and Engineering, and ICT.

At country level, the situation is similar. In Italy, for example, a recent study focused on the National Commission for the Forecasting and Prevention of the Major Risks, which can be regarded as an indicator for the gender balance within the scientific community engaged on disaster risk for over 30 years (Di Bucci et al., 2025). The study shows that the percentage of women in the Major Risks Commission (20%) is broadly in line with the Academia in Italy. A general increase can be observed over time, but growth has remained limited. Among the reasons for this reduced female presence, two deserve particular attention. First, a non-negligible proportion of the Commission members are selected among Full Professors and Research Managers in STEM disciplines, where the number of women occupying such positions is limited. Second, especially in the early Major Risks Commissions (e.g., in the 1990s), several members were selected from higher hierarchical levels of State Technical Agencies. This criterion may appear neutral, but it is strongly biased because these positions were, and still are, largely occupied by men.

It is important to emphasise that the observed gender imbalance in STEM fields is a cultural and social construct of the adults' community. Children do not recognise any difference in the ability of boys and girls to approach STEM disciplines (Amelio et al., 2025).

Patterns observed across STEM fields are mirrored in the Geological Sciences. International quantitative studies and analyses on the presence of women geoscientists in the workforce vary greatly depending on the geographical area. The areas for which such analyses are available are mainly the United States and Europe, both at continental scale and in individual countries.

For instance, a comprehensive study by Ranganathan et al. (2021) analysed 2,531 Geoscience faculty from 62 United States universities and found that women comprise approximately 27% of Geoscience faculty positions. The data reveals significant attrition by rank: women make up 46% of assistant professors, 34% of associate professors, and only 19% of full professors. In addition, women in the United States receive about 40% of undergraduate Geoscience degrees, yet between 2010 and 2019 they accounted for only one third of geoscientists and environmental scientists in the workforce².

In Europe, studies conducted in the United Kingdom, Switzerland and Italy consistently show that women geoscientists account for around 30-40% of the total. In the UK, less than 40% of places on Geoscience courses are taken by women, and this

² <https://www.geosociety.org/GSA/gsa/positions/position26.aspx> (accessed 15 September 2026).

proportion drops by half when considering the UK STEM workforce (Akingbade, 2023). A comprehensive Swiss study analysing the Swiss Geoscience Meetings from 2003 to 2019 revealed prominent horizontal segregation among Geoscience disciplines and confirmed a significant dropout of women scientists after the PhD level (Piccoli and Guidobaldi, 2021).

In Italy, several studies have been carried out across both national and local contexts. At national scale, official data analysed by Agnini et al. (2020) for the 2001-2019 period showed a clear positive trend: the proportion of female full professors increased from 9.0% to 18.5%, while that of female associate professors increased from 23.6% to 28.9%. More recent official MUR data for *Area 04 – Earth Sciences* indicate that, in 2025, women accounted for approximately 18.7% of full professors and 31.9% of associate professors. These updated figures confirm an overall improvement in gender balance, although recent progress appears to have been modest, particularly at the full-professor level. The distribution of men and women across career stages still shows a typical scissor-shaped pattern: female and male MSc students in Geosciences account for approximately 35-40% and 60-65%, respectively. At PhD level, gender balance is reached (ca. 50%), but from that point onward, from researcher to full professor positions, the percentage of women declines to less than 20%.

Focusing on a specific branch of the Geosciences, namely Quaternary Science, Mazzini (2025) presents data from 1979 to 2025. The increase in women's representation from 6% to 39% (more than a 6-fold increase) provides clear evidence of the substantial progress achieved over this period. Nevertheless, this improvement in overall gender balance is not yet fully reflected in positions of visibility and authority, where women account for 22%. Thus, the Italian case illustrates both a marked improvement in women's participation and the persistence of a gender imbalance at leadership levels.

With regard to other specific branches, such as Engineering Geology and Hydrogeology, Petrella et al. (2025) show that women account for 19.3% of full professors, 29.6% of associate professors, and 30.6% of researchers. In these fields, bibliometric analysis shows that women academics demonstrate scientific productivity that is comparable to, or even higher than, that of their male colleagues. Nevertheless, women were reported to have lower H-index values and fewer last author positions. H-index differences, however, should be interpreted cautiously, since this indicator is affected by career length, academic seniority and disciplinary citation patterns and cannot, by itself, be regarded as evidence of lower scientific recognition.

In addition, the results of an anonymous survey among female engineering geologists and hydrogeologists showed that about 60% of women have experienced workplace discrimination, while 38% of mothers felt their careers temporarily sidelined during maternity periods.

Taken together, these studies emphasise that addressing gender inequality in the Geosciences (as in other fields), requires not only quantitative assessments of representation but also a deeper examination of roles, recognition, and access to leadership opportunities, while taking into account the broader social context in which women operate.

2.2. Recovering the stories of pioneering women

Although the process leading toward gender equality began in the 19th century, thanks to the social and civic commitment of feminists, it reached its first major milestone only in the 20th century with the right to vote (1945-1946 in Italy) and with legislation guaranteeing, for example, access to education and, in theory, equal pay. However, full wage equality remains a goal that has not yet been achieved, due to persistent systemic gaps that still exist today. Women have encountered enormous difficulties and, in some countries, especially outside Europe, they still do, particularly in achieving leading roles. This also applies to academia, and particularly to STEM disciplines. Burek and Higgs (2007a), introducing their book (Burek and Higgs, Eds, 2007b) refer to a historic scientific conference organized by the Geological Society of London in 2005, during which the role played by women in the history and development of Geological Sciences was discussed exclusively for the first time. In this context, the Authors ask whether it is possible to analyse the situation of women working in the Geosciences today without knowing what happened in the past.

Indeed, there are numerous studies and research projects conducted in this regard. According to Kölbl-Ebert and Turner (2016), women have been pioneers in key Geoscience disciplines, despite facing systemic, social, and logistical barriers for centuries, gradually managing to break the “glass ceiling” and reaching top-level positions. Although women today sometimes even outnumber men in university Geoscience courses, they remain underrepresented at the highest professional levels, with significant geographical variations. It is possible that, over the course of this century, role models from the past will inspire women to achieve significant milestones and consolidate their careers across all geological disciplines (Kölbl-Ebert and Turner, 2016).

Vincent (2020) examines 210 women scientists active in the field of Earth Sciences between 1800 and 1929; all of them had to overcome gender discrimination and academic obstacles that often led to their work being attributed to male colleagues. In this context, the Author highlights patriarchal mechanisms of erasure (the “Matilda effect”, by Margaret Rossiter) and, to rescue these figures from oblivion, she advocates for a deeper examination of pre-1930 Earth Sciences literature,

alongside ongoing efforts to publicize these pioneering scholars within both the scientific community and the general public.

The Special Publication by Burek and Higgs (2021b) celebrates the centenary of a historic milestone: the 1919 election of the first women as Fellow of the Geological Society of London, an institution founded in 1807 that had initially restricted membership to men. The 18 contributions collected in this volume shed light on the stories, often previously unheard, of pioneering women geoscientists from all over the world. These women carved out paths in male-dominated academic and scientific circles, braved the harsh conditions of field exploration in Siberia, and met the strategic needs of the burgeoning American oil industry, establishing themselves as true pioneers in the field (the so-called “petroleum girls”).

Kölbl-Ebert (2026) describes the history of women’s presence in the Geosciences, tracing the transition from support roles in the 19th century to the struggle for professional recognition amidst increasing gender exclusion in the United Kingdom and globally. Early professional women were typically unmarried, working in niche or specialized fields, as gender barriers and limited university access persisted, with challenges regarding equal recognition remaining to this day.

Numerous examples can be cited of women who, with strength, determination and competence, overcame social barriers and managed to emerge in a world dominated by men. Many others remained “hidden” for a long time behind men (e.g., husbands, brothers and/or colleagues) who overshadowed them and, in some cases, took credit for their discoveries and research. Although these women lived in different times and places and belonged to profoundly different social strata, they shared a genuine passion for Geosciences. They also often faced the same struggles against a system that denied them access to scientific societies, academic publications, and formal education. Following a chronological thread, while also spanning different disciplines, it is worth mentioning some of these pioneers; these are certainly only some of the many women who have contributed to the development of the Geosciences.

The lives of some pioneering women ended tragically. Martine de Bertereau (1590-1642?), regarded as the first female mining engineer and mineralogist (Fregola et al., 2025, and references therein), travelled across Europe investigating mineral deposits and publishing pioneering works on mining. Her scientific activities and unconventional lifestyle, however, led to accusations of witchcraft, and she ultimately died in prison alongside her husband.

Some of these pioneers have been recognized as true icons in their field. Mary Anning represents a particularly notable case: despite having no formal training in Paleontology, apart from that acquired through extraordinary passion, she made a significant contribution to our understanding of animal life in the distant past and influenced the development of Charles Darwin’s theory of evolution. Her

life has inspired two movies and has been extensively studied by many Science Historians (Burek and Higgs, 2007b; Davis, 2012; Cofano and De Ceglie, 2025a, and references therein; Fregola et al., 2025). At the same historical moment, Mary Elizabeth Horner Lyell (1808-1873)'s scientific contribution was "obliterated", and only careful examination of archival material, travel accounts, and correspondence can do justice to what this pioneer achieved as a geologist, conchologist, field assistant, translator, and correspondent within international scientific networks (Cofano and De Ceglie, 2025b). The first woman to receive the degrees of Doctor of Science in 1893 from the University of London, and Doctor of Philosophy in 1900 from the University of Munich, was the Scottish scientist Maia Matilda Ogilvie Gordon (1864-1939); above all, she overcame the prejudice that women were incapable of climbing and surveying, by studying the Dolomites in depth and creating detailed geological maps (Burek, 2005; Wachtler and Burek, 2007; Argentieri, 2020; Fregola et al., 2025).

Another significant example is the American educator in geology and geography Zonia Baber (1862-1956), who not only pioneered innovative approaches to teaching the Geosciences, but also fought strenuously to defend human rights and protect the environment. For her, Geosciences required, first and foremost, laboratory and field experiences. Her holistic vision considered Geosciences as a tool not only for the advancement of knowledge, but also for the achievement of humanitarian causes and the protection of geological heritage (Rosati et al., 2025, and references therein). Maria Vasilyevna Klenova (1898-1976) should also be remembered (Fregola et al., 2025). In 1929, she became the first woman in the world to lead a scientific expedition at sea and develop a new methodology for making nautical charts, thereby mapping the seabed of the Barents Sea, which she also named in honour of the Dutch navigator Willem Barents (1550-1597).

As we approach the present day, we can remember Oplinia Hieke Merlin (1915-2006); she was a pioneering Italian scientist who made fundamental contributions to petrography and volcanology (Fregola et al., 2025). Bridging Chemistry and Geology, she taught at the Universities of Padua, Bari, and Venice, while also leaving a lasting cultural legacy as a patron of the arts. Finally, Maria Bianca Cita (1924-2024), an "all-rounded" geologist and the first woman President of the Italian Geological Society (1989-1990) and of the Italian Association for Quaternary Research (AIQUA; Mazzini, 2025), opened new avenues for the study of the ocean floor and the history of the Mediterranean, becoming an international model for generations of researchers, both women and men. A documentary dedicated to her is entitled: *Maria Bianca Cita – Why not?*³.

³ <https://www.lucamariani.me/mariabiancacita> (accessed 15 September 2026).

The pioneers commemorated here represent only a small fraction of all the women who have left their mark on the Geosciences and, as Burek and Higgs (2021a) wrote, *"We are grateful for those first trailblazers and celebrate them. There is still a long way to go, but without them the path would be longer"*.

2.3. Current experiences of women geoscientists

Despite all the difficulties mentioned so far, it must be acknowledged that, in recent years, women have gained an increasingly significant presence in the field of Geosciences. This trend suggests that a cultural change is underway, although its pace remains slow, and its effects are still uneven across career stages, institutions and professional contexts. Such change is reflected both in structural transformations within academic, scientific and public institutions, and in the gradual erosion of traditional gender stereotypes and barriers. Positive experiences and notable achievements increasingly show how women are contributing to reshaping the discipline. The expansion of public education in the 20th and 21st centuries has also made geoscientific training more accessible to women, leading to a significant increase in the number of qualified female professionals. This is evident, for instance, in academia, where the proportion of female associate and full professors in Geosciences has almost doubled over the past 20 years, indicating a positive, albeit still slow trend in women's career advancement (Agnini et al., 2020). In disciplines such as Engineering, Geology, and Hydrogeology, we have seen that female academics demonstrate a level of scientific productivity that is comparable to, if not actually higher than, that of their male counterparts, with similar or higher publication counts in certain contexts. Many Geosciences disciplines require considerable fieldwork, which can disproportionately affect women, especially those with caregiving responsibilities. Recent research has highlighted how the logistics of fieldwork, combined with traditional expectations about family roles, can hinder the participation and retention of women geoscientists (Bernstein, 2024). In some countries (e.g., Argentina), the local cultural norms and historical practices continue to influence women's experiences in Geological Sciences, from exclusionary field policies to persistent stereotypes about physical suitability for field roles (Lutri, 2024). Further insights are provided by recent data published by Radeff et al. (2025), who investigate gender distribution across different roles and positions within the Department for the Geological Survey of Italy in comparison with those from other European Geological Surveys, covering a period of approximately 14 years (2010-2024). The results show that, at the European level, although the available data are limited, the percentage of female staff did not change significantly between 2017 and 2022,

ranging from a minimum of 38.6% in 2019 to a maximum of 40.9% in 2017. A slightly lower value (37.2%) was reported by Pichezzi et al. (2013) for 2010, based on a smaller sample of 12 out of 33 European Geological Surveys. The study also highlights that, by 2024, there was a disparity between the percentage of female graduates and the overall number of geologists in Italy: women accounted for 37.7% of BSc graduates and 38.5% for MSc degrees, but only 19.7% of geologists. In the Geological Survey of Italy, female staff with a geological background accounted for 35.4% in 2024, whereas female staff with scientific training – that was not strictly geological – accounted for 38.1%. These figures are partly comparable with those of other research institutes such as INGV (Istituto Nazionale di Geofisica e Vulcanologia, National Institute of Geophysics and Volcanology) and OGS (Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, National Institute of Oceanography and Applied Geophysics). The Geological Survey of Italy has implemented various strategies (e.g., flexible working, support before, during and after maternity leave, inclusivity, where possible, in daily and field activities) to facilitate the participation of women in both office and field work, helping women during delicate phases such as motherhood.

Looking at the future, new branches of Geosciences, such as geospatial technologies, including remote sensing, GIS, drones, machine learning, InSAR, offer important opportunities. A study by Qadir et al. (2025) explores women's contributions in these fields and evaluates how directed training programs can strengthen their role in environmental decision-making processes. The Authors combined three methodological approaches based on i) review of scientific literature, ii) analysis of capacity-building programs (WoGIT-Women in Geospatial Information Technology) and iii) quantitative pre- and post-training assessment. Their results highlight that, although women represent approximately 30% of researchers globally, they play a significant role in advancing Geospatial Sciences. From 2018 to 2021, the WoGIT training program (in person and online), involving women from Afghanistan, Bangladesh, Bhutan, Nepal, and Pakistan, demonstrated significant improvements in participants' scientific competence. Furthermore, the participation of women coming primarily from countries where fieldwork is prohibited (such as Afghanistan) or where cultural barriers, family pressures, and safety concerns in remote areas persist (for example, Pakistan, Bangladesh, and Nepal) is particularly significant. Of course, attention has to be paid, as digital collaboration may reproduce well known problems, such as online harassment and professional discrediting targeting female researchers (Popp et al., 2019; McCullough et al., 2021; Mattheis et al., 2022).

3. Discussion

The status of women geoscientists, both internationally and nationally, has changed profoundly compared to the distant past, evolving from a pioneering and often marginalized presence to increasingly active and numerous participations. However, although recent studies indicate a gradual increase in women's representation and some narrowing of the gender gap, progress remains slow and uneven, particularly at senior academic, managerial and leadership levels. A cultural shift has certainly taken place, particularly in recent times, as many women geoscientists are now engaged in fieldwork research, whereas previously most of them conducted almost exclusively laboratory-based research. Nevertheless, despite the overall increase in women's participation in Geosciences, their representation still declines markedly at higher career levels, indicating that the leaky pipeline and the glass ceiling remain significant barriers to full gender equality.

The Geological Society of America notes that women remain underrepresented in Geoscience careers, particularly at higher academic and professional levels, and identifies structural barriers such as bias, harassment, precarious employment, limited mentoring, and unequal access to recognition as major obstacles to career advancement (GSA, 2023). UNESCO's recent international data show that women still make up only around one third of researchers worldwide and just one in ten STEM leaders. In the Geosciences, this imbalance becomes especially visible in academic careers, where women's representation decreases as rank and decision-making power increase (UNESCO, 2024).

At national level, some good attempts deserve to be mentioned. In Italy, for instance, Almalaurea data shows that in 2024, a total of 316 men and 154 women graduated in Geological Sciences. Based on this gender gap, also found in STEM degree programs in general (Almalaurea, 2026), the Italian academic "Scientific Degrees Project" (PLS⁴) has dedicated part of its activities to encouraging girls' enrolment in STEM degree programs, seeking to overcome the prejudice that Science is "men's stuff!".

Despite the significant progress achieved in women's emancipation, such biases remain unshakeable. Often, the belief that women are unsuited to scientific disciplines originates within the family. But this is a widespread preconception even at a political level. One stark example is the public speech by a former Italian senator against the Rector of the University of Bari, who had introduced a 30% discount on tuition-fees for girls enrolled in STEM courses. According to the senator, men were naturally

⁴ https://www.istruzione.it/dg_studente/piano_nazionale_lauree_scientifiche.shtml (in Italian, accessed 15 September 2026).

more inclined towards technical subjects such as Engineering, whereas females were more inclined toward care-related professions such as obstetrics⁵.

Nonetheless, awareness of the need for gender policies is constantly growing in our society. In Italy, for example, for over ten years “Equal Opportunity Commissions” have been established in various institutions (at the national, regional, provincial, municipal levels, in professional associations, universities, etc.) to promote effective equality among citizens, eliminate discrimination, give value to gender differences, and encourage female participation in political, social, and economic life.

From a mentoring perspective, it is also necessary to take a ‘bottom up’ approach, introducing young women to role models in Geosciences who have played a pioneering role and can serve as examples; furthermore, and perhaps above all, women geoscientists can in turn support and guide younger generations through mentoring. Responsibility for cultural change should not fall solely on women or other underrepresented groups. Rather, it should be shared among universities and research institutions, scientific societies, public administrations, professional organizations, funding agencies and policymakers. Institutional and public policy measures are essential for modifying the structures within which careers develop, while grassroots initiatives, including mentoring, role models and community engagement, can help to change everyday practices and professional cultures. These two levels of intervention should therefore be regarded as complementary. To facilitate a stronger female presence, at least equal to that of men, in panels of geological workshops, conferences, or in the candidatures for the leadership roles, for example, in the universities (e.g., Rector, Department Head, Degree Course Coordinator), both individual empowerment actions and concrete interventions of inclusive institutional policies are necessary. Such policies may include transparent selection and nomination procedures, active efforts to ensure gender balanced candidate pools and panels, and systematic monitoring of gender representation in appointments and leadership positions. Gender quotas may be one possible way of beginning to increase women’s participation, but numerical targets alone are unlikely to remove the structural and cultural barriers underlying unequal career progression.

The experiences reviewed here suggest that gender equality initiatives are more likely to produce lasting effects when they become embedded in ordinary institutional practices, rather than remaining isolated awareness-raising activities. Measures addressing recruitment and promotion procedures, access to leadership and decision-making positions, mentoring, fieldwork safety, caregiving responsibilities

⁵ https://www.repubblica.it/politica/2021/05/26/news/omofobia_lega_simone_pillon_post_sessista_donne_universita_di_bari-302849981/ (in Italian, accessed 15 September 2026).

and working conditions are more likely to influence organizational routines, workplace climate and career outcomes. At the same time, the available evidence summarized in this overview does not allow for the ranking of individual initiatives according to their long-term effectiveness, which highlights the need for a systematic and longitudinal evaluation.

Progress towards gender equality cannot be evaluated solely through publication output or through the overall proportion of women in a discipline. Scientific productivity is only one dimension, and comparable results in terms of work output do not necessarily lead to comparable recognition or career progression. A multidimensional assessment should therefore consider representation across career stages, recruitment, retention and promotion rates, participation in leadership and decision-making roles, authorship and scientific recognition, workplace climate, experiences of discrimination or harassment, access to mentoring and training, work-life balance and fieldwork inclusiveness. Whenever possible, longitudinal analyses and pre- and post-intervention assessments should complement simple head counts or bibliometric indicators.

Finally, the low female presence at various levels in geological disciplines intersects with a broader crisis affecting the discipline itself. In this regard, a qualitative analysis of UK public perception reveals that Geology is often stereotyped as boring, outdated and male-dominated, contributing to declining university enrolment (Rogers et al., 2024). At the same time, the growing relevance of environmental and sustainable related Geoscience topics seems to stimulate and involve the new generation, and more women, thanks to a greater sensitivity towards sustainability issues ("Eco Gender Gap").

4. Conclusion

Keeping in mind Goal 5 of the UN 2030 Agenda for Sustainable Development⁶, which established the elimination of discrimination and gender-based violence and the promotion of women's participation in decision-making as a global priority, the European Commission (2025) also emphasizes the need to increase women's representation and reduce gender inequalities in the workplace. Furthermore, it considers it necessary to implement targeted actions to fight gender bias in education, the workplace and society, whilst tackling new threats such as online violence. Its gender equality strategy also focuses on increasing women's presence in different

⁶ <https://docs.un.org/en/A/RES/70/1> (accessed 15 September 2026).

contexts, including the gender pay gap reduction, and implementing targeted actions to combat gender bias in education, work, and society⁷.

Specifically, to narrow the gender gap in Geosciences, there are international associations such as the Association for Women Geoscientists (AWG⁸), which promotes professional development and funds specific scholarships (e.g., the Chrysalis Scholarship for struggling female researchers), or the Earth Science Women's Network (ESWN⁹), which offers career support, collaborations, and mentoring.

European and global projects include initiatives such as ENGIE¹⁰, which works to introduce girls to the Geosciences from school age, while organizations such as UNESCO¹¹ and IUGS (International Union for Geological Sciences)¹² support inclusion and gender equality through dedicated action groups. In addition, the Women in Geoscience & Engineering (WGE) community at EAGE (European Association of Geoscientists and Engineers)¹³ focuses on supporting equity, offering advice and addressing issues such as work-life balance.

Last but not least, there are global events and celebrations, such as the International Day of Women and Girls in Science, established by the United Nations and actively implemented by UNESCO, which is celebrated every year on February 11; this day honours women's contributions to Science and promotes gender equality. Only sustained and coordinated action across education, research, professional practice, and policy can make the Geoscience discipline genuinely inclusive and capable of responding to the complex environmental and social challenges of the future.

In this perspective, we would like to conclude with an ongoing experience we are promoting in Italy, a good practice shared by all, men and women of the Geosciences community. Since 2022, the Italian Geological Society has introduced a new Division, called EDI-PanGEA (with two of us serving as coordinator in these years), which includes scientists, public officers and professionals. Since then, every year the Division organizes a meeting in the occasion of the UNESCO International Day. Since 2024, this meeting has been organised as a side event of the Annual Conference of the National Group of Solid Earth Geophysics. In this way, the theme of gender balance in the Geosciences is regularly brought to the attention of the geological and geophysical communities, promoting experience sharing and discussion. Only through sustained and coordinated action, driven by educational institutions, research

⁷ https://commission.europa.eu/strategy-and-policy/policies/justice-and-fundamental-rights/gender-equality/gender-equality-strategy_en (accessed 15 September 2026).

⁸ <https://www.awg.org/> (accessed 15 September 2026).

⁹ <https://eswnonline.org/> (accessed 15 September 2026).

¹⁰ <https://www.engieproject.eu/> (accessed 15 September 2026).

¹¹ <https://www.unesco.org/en> (accessed 15 September 2026).

¹² <https://www.iugs.org/> (accessed 15 September 2026).

¹³ <https://eage.org/communities/women-in-geoscience-and-engineering/> (accessed 15 September 2026).

bodies, industry leaders and policymakers, can this cultural shift be fostered, making the Geosciences a truly inclusive discipline capable of addressing the complex environmental and social challenges of the future.

Finally, in order to assess and measure the impact of all initiatives aimed at bridging the gender gap, we believe a holistic approach is necessary, combining quantitative indicators and qualitative evidence, with a view to monitoring cultural and systemic change.



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