



# You Can't Climb a Broken Ladder: Examining Underrepresentation of Multiply-Disadvantaged Groups in Secure and Senior Roles in UK Geochemistry

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Geochemistry provides useful research tools related to fundamental processes in Earth, Environmental and Planetary Sciences. It has a distinct identity among the academic communities in these subjects, yet there is no specific data on workforce diversity among geochemists. We present the first demographic data of UK geochemists from a voluntary anonymous survey. We scrutinise the data with respect to protected characteristics (e.g., age, ethnicity, gender identity, sexual orientation and disability) and seniority of those within the community. We furthermore use this UK data to compare the career progression of geochemists who belong to multiply-privileged identities with those who belong to multiply-disadvantaged identities, to assess their representations with increased seniority on the academic career. This UK based case study on diversity and inclusion suggests that the career paths of geochemists belonging to multiple disadvantaged groups are restricted, including overrepresentation among those on fixed-term contracts or in service roles for laboratory support. Our data highlight that there is a decrease in diversity with an increase in seniority; specifically, UK geochemists from sexual and gender minorities, neurodiverse, and women from ethnic minority groups were not represented among the participants of our survey at the top of the academic ladder. There are many reasons for the loss of diversity in the UK geochemistry community with increased seniority. In order to address this and the underrepresentation of particular groups in senior leadership roles, our findings suggest that the career progression of geochemists requires an intersectional lens

to examine the complexity of identity data. Such an approach would enable a better understanding of the impact of multiple and compounded disadvantages, biases, negative experiences and discrimination faced by multiply-disadvantaged identities.

**Keywords:** geochemists, diversity, inclusion, multiply-privileged, multiply-disadvantaged, laboratory staff, intersectionality

## BACKGROUND

People working in a scientific discipline are the face of that discipline, serving as trainers and role models for subsequent generations. As a fundamental aspect of social justice, they need to represent a diversity of identities, to be relatable to all developing talent and to better serve society. The historical exclusion and continuing underrepresentation of certain groups is concerning because it could restrict ongoing and future recruitment of students and staff within a discipline. Such a context could be detrimental for recruiting and retaining diverse talent while also perpetuating the homogenisation of dominant groups. The phenomenon of so-called “groupthink” and its role in impeding scientific progress have been widely recognised (Allen and Howell, 2020). An imbalance in representation is damaging to scientific growth, and therefore to society, primarily through the lack of unique ideas and knowledge that individuals from diverse identities and backgrounds bring, compromising innovation (Hofstra et al., 2020), impact (AlShebli et al., 2018), and the productivity of underrepresented staff (RAE, 2018; Nelson et al., 2022). While things like increased innovation and productivity may appeal to some institutions, working towards building an inclusive geochemistry community should not require a business case. It is imperative that scientific disciplines work towards understanding and addressing underrepresentation within their communities. Disciplines in which underrepresentation of specific groups have persisted need to prioritise improving diversity and inclusion within their workforce, including supporting the career progression through to senior roles for individuals from historically excluded groups. With efforts to improve diversity and inclusion, we could make progress towards building a more equitable discipline that can contribute to a more just society.

In this article, we examine the diversity of the UK geochemistry academic community and specifically whether geochemists with multiply-disadvantaged identities are progressing to senior positions within academia compared to their peers with multiply-privileged identities. Within the existing literature, people whose identities include multiple disadvantaged groups, or individuals with more than one identity that is underrepresented or historically excluded, are also discussed as “multiply marginalised” (Hall et al., 2023), as having “intersecting minoritised identities” (Dancy and Hodari, 2023), and as facing “multiple and intersecting discriminations” (Equate Scotland, 2020). We provide the first report on the diversity of respondents across academic seniority in the UK geochemistry, a branch of science that utilises the concepts and tools of chemistry to understand

contemporary and ancient Earth and Planetary systems. Geochemistry is thus multidisciplinary and global in its reach. As a diverse branch of a scientific discipline, it should arguably host and support a diverse workforce.

A number of studies highlight lack of racial (Bernard and Cooperdock, 2018; Dowe et al., 2021) and gender (Stokes et al., 2015) diversity in geosciences. Studies have also shown that racially diverse geoscientists are disadvantaged compared to their white peers (Alderman et al., 2021). LGBTQIA+ (Lesbian, Gay, Bi, Trans, Queer/Questioning, Intersex, Asexual/Aromantic) academics and students leave STEM subjects at significantly higher rates compared to their heterosexual counterparts (Freeman, 2018; Hughes, 2018; RSC, 2020). Women and those who do not identify within the gender binary (geo)scientists also face disadvantages compared to their male peers (Dutt et al., 2016; RSE, 2018; Dyer, 2019; Downen and Olcott, 2023). For example, in the US although women received 40% of the doctoral degrees within geosciences in 2009, they held only 10% of full professorships within this field (Holmes et al., 2015). Positive action initiatives focused on a single disadvantaged identity group, such as the Athena SWAN (Scientific women's Academic Network) charter (2011) to promote (binary) gender equality, have achieved limited success. Although the burden of work involved in the Athena Swan application process has disproportionately been undertaken by marginalised groups, such as ethnic minority women and LGBTQIA + people (Tzanakou and Pearce, 2019), those same groups have not benefited from the limited progress made through Athena Swan as much as their more privileged (Heterosexual Cis White) peers (Bhopal and Henderson, 2021; Reggiani et al., 2023). While evidence of the underrepresentation of women academics in senior positions is widely reported annually (Advance HE, 2022), studies show that multiply-marginalised individuals face significant obstacles to reach senior positions in British academia, including racially/ethnically marginalised women (Bhopal and Pitkin, 2020), migrant women (Sang et al., 2013), and disabled women (Hansen, 2020). This evidence indicates the challenges faced by individuals with multiply-disadvantaged identities as they continue to be underrepresented not only within their disciplines but also among senior or leadership roles in academia.

In this study, we focus on understanding how these broader issues of underrepresentation are present in UK geochemistry and we ask the question, are all UK geochemists progressing equitably through the academic ladder irrespective of their identities? To address this question, we collected and utilised community survey data of UK geochemists to report its composition and representation across the academic career

ladder (from postgraduate research or PhD students to professors, including laboratory technical support team members). We note for readers that our community study was required because intersectional demographic data for geochemists is currently absent among UK higher education institutions and funders. A wide variety of data was collected through our [E-DIAL, Evaluating Diversity and Inclusion across (geochemistry) Academic Ladder] project and here we scrutinise a small fraction to evidence progression of researchers and academics with diverse identities across the academic ladder. Based on the survey responses and selective quantitative data analyses, we show that across the UK Geochemistry academic ladder, geochemists:

- with multiple disadvantages progress to a lesser extent to senior leadership roles compared to those with multiple privileges.
- from minority groups such as sexual and gender minorities, neurodiverse and women from ethnic minorities are presently absent at the top of the academic ladder and, worse still, there are no Black and Middle Eastern women among the respondents.

We discuss possible reasons for lack of inclusion of certain groups within the geochemistry community and potential barriers for progression in achieving senior positions within academia. Based on these data, we make suggestions for reform of Equality, Diversity and Inclusion in UK higher education institutions. We argue that promoting and nurturing workforce diversity is critical to the future of the Environmental Science/Earth Science/Geoscience/Planetary Science, and wider STEM subjects in the United Kingdom.

## METHODOLOGY

Before launching a community survey, we received approval from the Open University Human Research Ethics Committee. The ethics process involved approval for data protection principles, secure storage and access of data and compliance with use of the information collected in the study for publication and communication. We also followed the guidelines from the Economic and Social Research Council's social science Ethics project and the OU's Ethics principle for research involving Human participants. We used Limesurvey to collect survey data which adheres with GDPR regulations and self-selected a unique identifier for each participant. The latter was to ensure that post survey additional information could be sent to the team by a form available at our website.

### Study Design and Participants

In this study we employed an anonymous voluntary survey design to investigate the diversity of the geochemistry community in the UK and to examine any changes of this diversity with increasing seniority. The survey was promoted through various channels, including social media platforms,

heads of departments and doctoral partnerships, professional societies such as the UK Geochemistry Group and the Mineralogical Society of Great Britain and Ireland, and geochemistry-focused list-servers. It should be noted that voluntary surveys tend to attract respondents with a vested interest in the topic of the survey (Sammut et al., 2021), and we thus anticipate that those identifying as belonging to a minority are likely overrepresented in our survey data compared to the overall geochemistry population. Although the responses may not be representative of the entire UK geochemistry community, the survey aimed to capture trends in diversity relative to seniority, which are expected to be representative of the UK geochemistry community as a whole.

### Survey Structure

The survey was divided into four sections. 1) Preliminary questions: this section introduced the survey, outlined the voluntary and anonymous nature of participation and provided the option to generate an anonymous code to link the participant's responses with potential future follow-on research. 2) Introduction questions: this section invited respondents to elaborate on the nature of their geochemistry research through a question about their research disciplines within geochemistry. 3) This section delved into foundational aspects of diversity, and focussed on questions related to age, gender identity, sexuality, ethnicity, disability, and economic privilege. 4) The final section explored the seniority of the participants of the survey, through three questions. Whether the participant is a PhD student, and if the participant is not a PhD student, the survey asked about their contract type (e.g., Fixed-Term vs. Permanent), and position (e.g., Research Associate, Research Fellow, Lecturer, Professor), and senior leadership role (e.g., Head of Department/Head of School). In all sections and respective questions, we allowed the participants to select multiple answers or choose none, and participants were also given the option to self-describe. Within the survey, participants had the option of including qualitative responses to most of the questions.

### Data Analysis and Grouping

The HESA (Higher Education Statistics Agency) guidelines for rounding and suppression of statistics to maintain anonymity were followed during data analysis, rounding and visualisation (HESA, 2020). Results for categories with one to four responses were suppressed and described as <5 or with a star in figures. Categories with five or more responses were rounded to the nearest multiple of 5. Categories with 0 responses are described as 0 and highlighted as empty columns without a star in the figures. Finally, to represent the proportions for data visualisation, the percentages of the categories with five or more responses are calculated based on unrounded numbers.

A total of 155 participants completed *Background* and *Methodology* sections, while *Results* and *Discussion* sections were completed by 135 participants. Thus, for the analyses on the research disciplines in the UK geochemistry community we

used the responses from 155 participants, and for the analyses of the diversity of the UK geochemistry community and the respective trend with increased seniority, we used the responses from 135 participants.

### Research Disciplines

For the research disciplines, categories with fewer than five responses (e.g., paleoclimatology, archaeological science, photogeochemistry, organic geochemistry, and analytical geochemistry) were grouped together as “other”. The categories labelled “economic geology with petroleum geochemistry” and “economic geology without petroleum geochemistry” were combined for analysis. Furthermore, we analysed the number of geochemistry disciplines that each participant selected. Here, all participants who selected six or more disciplines have been grouped.

### Seniority Characteristics

To analyse the changes in diversity with seniority, we used three different measures to describe the seniority of our participants. These are: a) the contract type, b) position (including PhD students as the most junior), and c) age of the participants. As there were fewer than 10 participants with an age over 60, to ensure an age seniority category with enough participants to provide meaningful insights into its diversity, we grouped the 60+ age category with the 50–59 age category and presented it as 50+ in our figures.

### Identity Characteristics

To further ensure reliable analysis of the identity characteristics with increasing seniority, we grouped identity and background characteristics (Gender Identity, Sexuality, Ethnicity, Disability, and Economic Privilege) where possible, to ensure that each category of seniority had at least five responses for most diversity characteristics, allowing for trend evaluation. The final groupings used for the analysis of diversity with increasing seniority are for Gender Identity: Man, Woman and Other (includes gender queer, agender, gender non-confirming, non-binary), for Sexuality: Heterosexual and Other (includes Bisexual, Gay/Lesbian, Queer, Asexual, Questioning), for Ethnicity: White and Non-White (includes Asian; Black; Gypsy, Roma and Traveller; Middle Eastern; Mixed Ethnicity), for Disability: Non-Disabled and Disabled (Oliver, 2013), and for Economic Background/Privilege: Economically Privileged (includes respondents who identified as, for example, “lower middle class” and “well off”) and Economically Disadvantaged (includes, for example, respondents who identified as “upper lower class” and those who mentioned they were “struggling economically”). Previous research with university students indicated that participants’ “self-identified social class strongly correlates with students’ self-reported and institutionally reported family income and parental education, lending validity to students’ self-identification in a social class’ (Soria and Bultmann, 2014; Evans and Mellon, 2016; Dutt, 2020). Participants who selected “Prefer not to say” or provided no answer to a certain question were grouped together as “Prefer not to Say/No Answer.”

In addition, we also assessed diversity with increasing seniority by analysing the participants based on their responses to whether they are multiply-privileged or multiply-disadvantaged identities. First, respondents who did not answer and/or answered “Prefer not to say” to one or more questions included in the analyses of diversity with increasing seniority were grouped into the “Prefer not to Say/No Answer” category. Next, participants who selected one or zero disadvantaged identities from the identity characteristics included in the analyses were categorised as “multiply-privileged,” which includes, for example, a heterosexual Black non-disabled man from an economically privileged background. Finally, participants who selected two or more disadvantaged identities were categorised as “multiply-disadvantaged,” which includes, for example, a Lesbian White woman with Dyslexia from an economically privileged background.

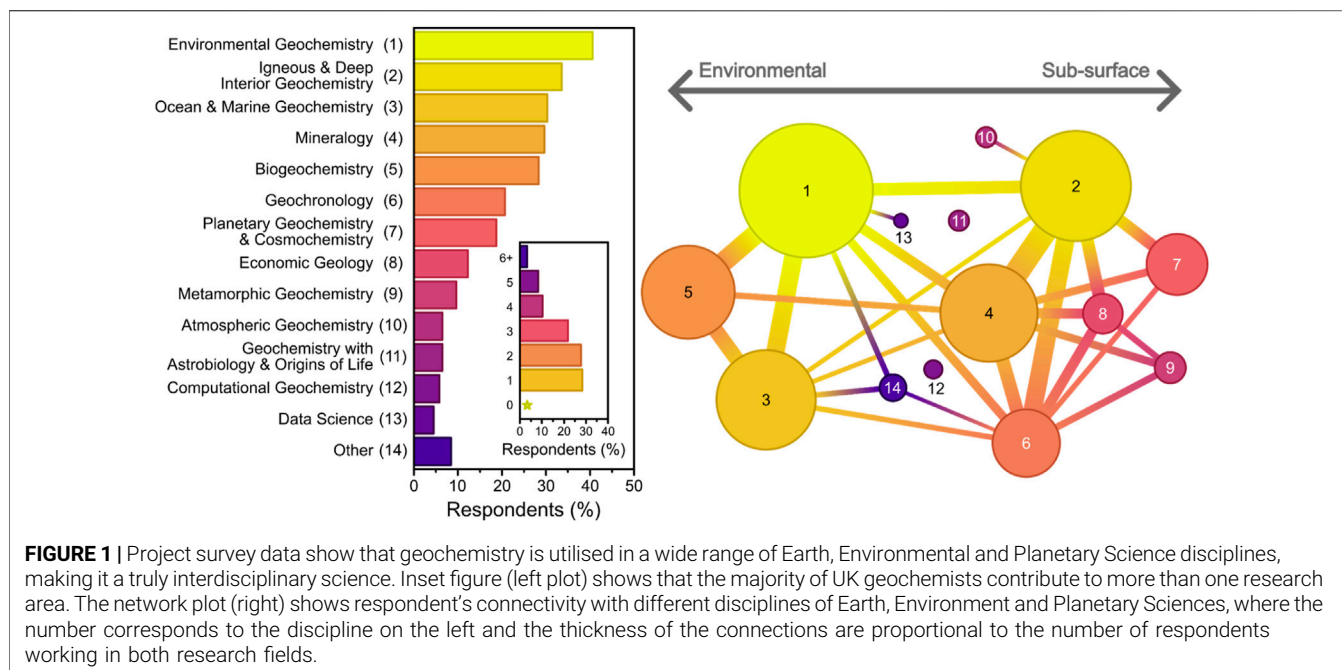
The theoretical framework this study employed is Intersectionality theory (Crenshaw, 1989), enabling an exploration of the complex ways that “interlocking systems of oppression” (Collins, 1986) impact on the working experiences and career progression of geochemists who are multiply-disadvantaged compared to those who belong to multiply-privileged identities. Intersectionality theory provides a lens through which to better understand and address systemic, persistent, and compounded inequalities, including the historical exclusion and underrepresentation of a number of groups across STEM disciplines (Leibnitz et al., 2022).

## RESULTS

Our results show that the survey captured views from people who use geochemistry as a tool to contribute to diverse research and teaching subject areas in Environmental, Earth and Planetary Sciences (Figure 1). Approximately two-thirds of the respondents contribute to more than one area of research (inset Figure 1). In addition to this, these results [e.g., researchers working in both Environmental Geochemistry (1) and Igneous & Deep Interior Geochemistry (2)] highlight the interconnected nature by which geochemistry is applied.

Using our survey responses, we summarise the diversity of the UK geochemistry community based on protected characteristics (Equality Act, 2010) (Figure 2). Our survey results show that the majority identify themselves as White ethnicity (74%), binary gender (96%; women—53% and men—43%), heterosexual (73%), able-bodied (65%), from an economically privileged background (60%), and with approximately half being <40 years old (Figure 3C).

We further analysed our data by contract type and by dividing the groups across the (geochemistry) academic ladder (from PhD to professor/senior roles). Our data show dominance of permanent (~49%) and a small proportion of fixed-term (~17%) contracts, and a modest size of PhD student (~31%) respondents (Figure 3A). We also include data for laboratory staff (but not across the ladder in the laboratory staff category), which represents an alternative career route in



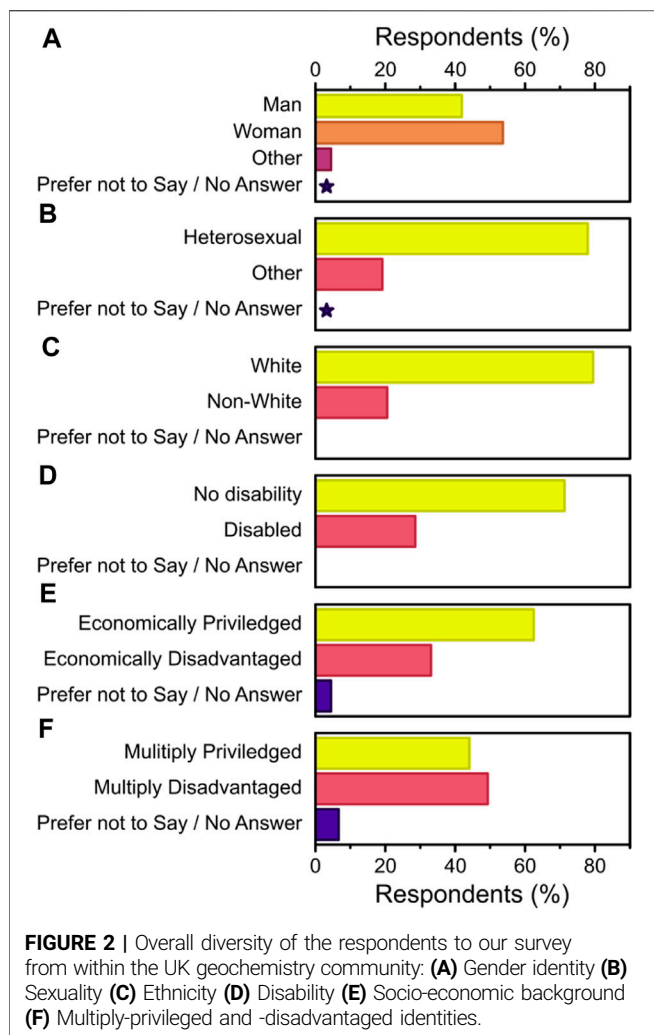
an academic environment. Our data captured all career stages of the academic ladder (**Figure 3B**): PhD students (~31%), Research Associate/Fellow (~24%), Laboratory staff (~14%), Non-professional academic staff including Lecturer, Senior Lecturer and Reader (~20%), and Professors including those in senior roles such as Head of Department/School, Dean and Pro Vice Chancellor (~23%).

Unfortunately, it was challenging to scrutinise data based on specific disadvantaged identities across the UK academic ladder because the number of responses for some identity categories was too low to present in this work. To better understand diversity across the UK academic ladder for geochemists, specifically with respect to multiply-disadvantaged identities, we grouped those that belong to multiply-privileged and multiply-disadvantaged identities (**Figure 2F**). Of our survey respondents, 50% identified as multiply-disadvantaged and 45% as multiply-privileged.

We would like to emphasise that the intention of this approach is not to suggest that individuals who are multiply-privileged or belong to one underrepresented or marginalised identity do not face barriers and disadvantages. For example, based on decades of existing literature, a White, heterosexual, non-disabled, woman from an economically privileged background may still face gender-based disadvantage or discrimination in her career (Blackburn, 2017). Similarly, an Asian, heterosexual, non-disabled man from an economically privileged background may still face race-based disadvantage or discrimination in his career (Eaton et al., 2020). However, our findings indicate that those who belong to multiply-disadvantaged identity groups are less represented in senior roles and may face more barriers to career progression than their peers from multiply-privileged identity groups.

We utilised three categories to ascertain seniority: contract type, academic ladder position, and age (**Figures 3, 4**) to account for shortcomings of any of these three seniority categories and for differences in, e.g., descriptions of job categories between different institutions. We note the following trends in our data analyses (**Figure 4**):

- Overall more women took part in the survey but relatively more men are present in senior leadership roles, including Professors, while at the 50+ age group both men and women respondents are similarly represented.
- There are no respondents who identify outside of binary genders (e.g., non-binary, agender, genderqueer) who are in permanent geochemistry positions nor in lecturer–senior leadership positions.
- There is a decrease in the proportion of respondents with non-heterosexual identities as careers progress (starkest decrease among the identities we have analysed) and a visible lack of representation from non-heterosexual geochemists across the academic ladder beyond research associate/fellow positions, and absence in senior leadership roles.
- The groups with the lowest reported disability are those in permanent contract, senior leadership, and 50+ age groups, whereas fixed-term contract, research associate/fellow (in their early/mid career) report highest occurrence of disability.
- The proportion of self-reported economic privilege is stable and dominates through the UK academic ladder across contract type, ladder positions and age groups.
- Technical and laboratory positions are predominantly held by women, economically-disadvantaged and multiply-disadvantaged identity groups.

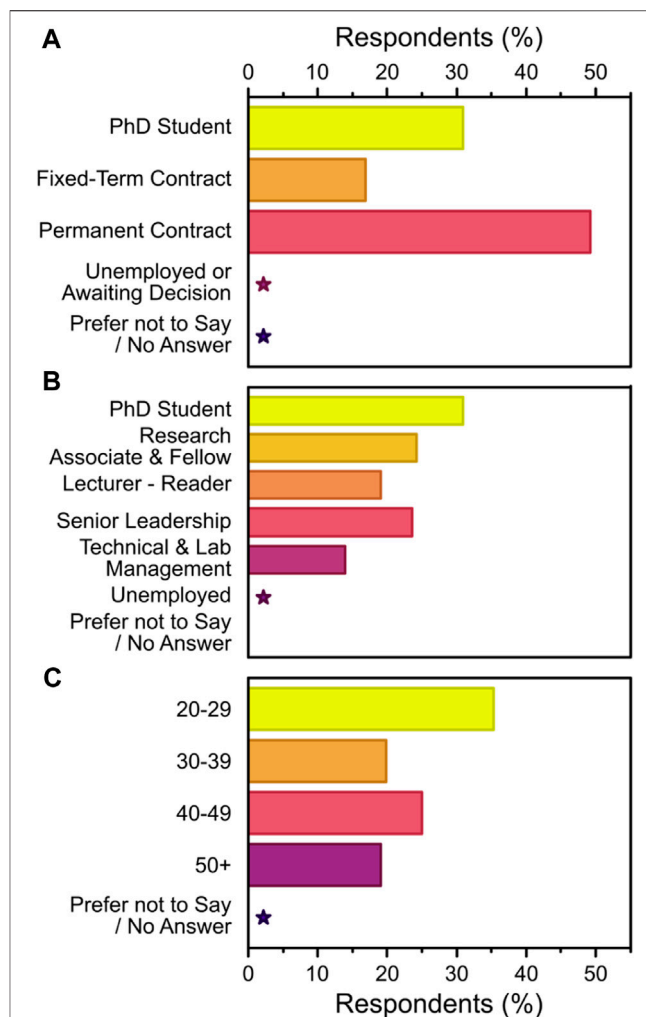


- While the proportion of multiply-disadvantaged identity respondents is relatively stable along the age category and only decreases from 40–50 to 50+, the proportion of multiply-privileged identities group increases systematically from PhD student through to academics in permanent contracts and senior leadership roles. Multiply-disadvantaged identities are lacking at the top of the academic ladder.

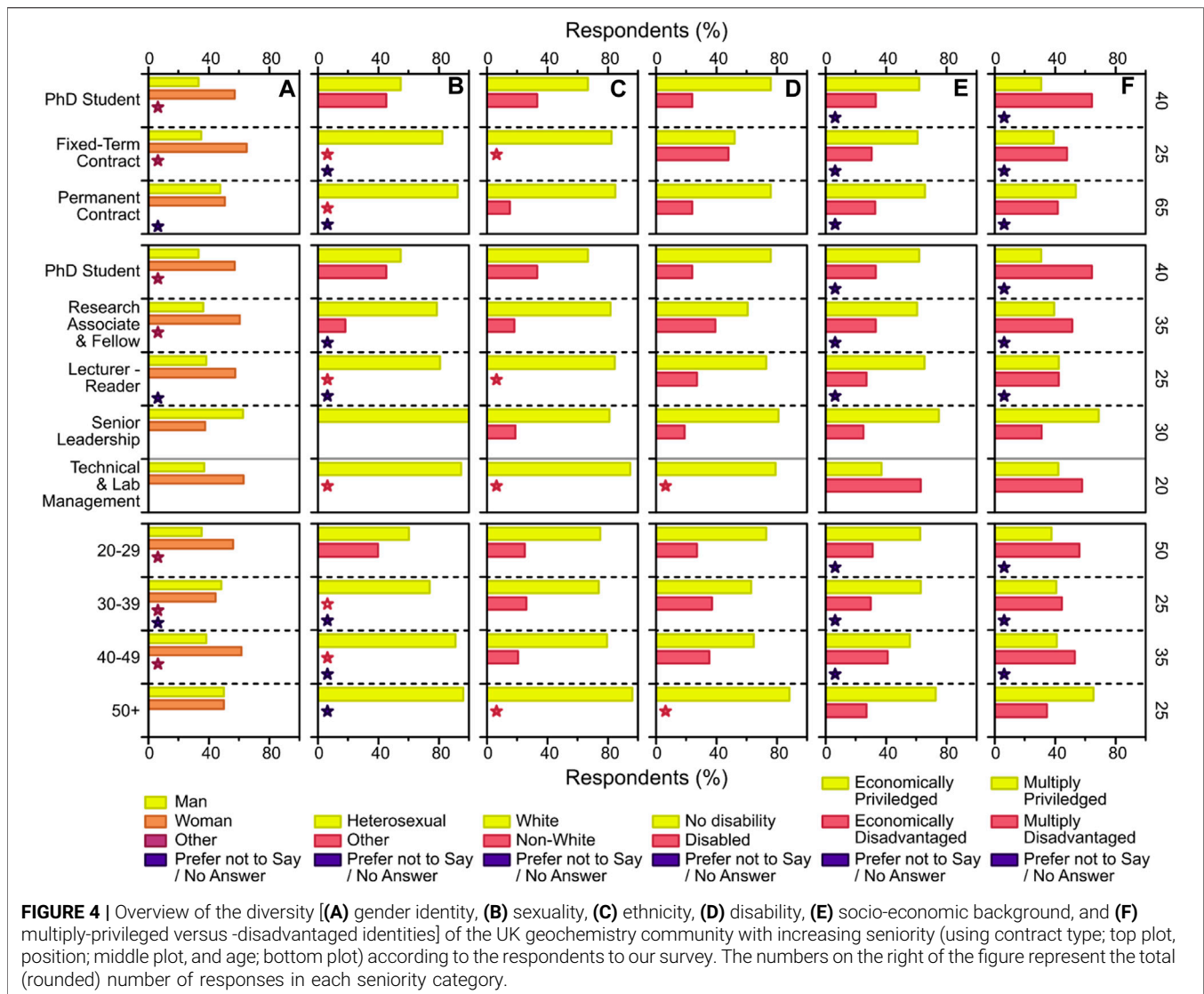
To enhance the discussion of our quantitative findings, we include representative examples from the themes within our qualitative data. However, it should be noted that this is not a fully mixed-methods paper. A full analysis of the qualitative data collected for the study will be explored in a future publication.

## DISCUSSION

Inclusion requires societal representation not only in academia but at all career levels on the academic ladder. The geochemistry community needs to examine persistent gaps in recruitment,



retention, and progression of diverse talent. Within our data, there are a number of groups underrepresented in senior or leadership roles in geochemistry, including women, racial/ethnic minorities, disabled people, and those from economically disadvantaged backgrounds. Our findings show that respondents with a single minority identity are either absent (e.g., LGBTQ+, **Figure 4**) or their numbers decline significantly at the senior positions (e.g., Women, **Figure 4**). This contrasts the trend observed for men, where their numbers are comparatively lower at the start of the career and increase progressively towards the top of the ladder amongst our respondents (**Figure 4A**). This trend is interesting as we find that the number of both men and women respondents in the age-based seniority category becomes similar as it reaches 50+ level despite differences at the earlier stages. This trend is similar to



previous reports on a lack of women in senior positions compared to men in STEM academia (RSE, 2018; García-González et al., 2019) and in Geosciences (Marin-Spiotta et al., 2020). Furthermore, a US based study has suggested that it may take another 50 years to achieve gender parity in Geosciences despite significant improvement in recruiting women doctorate students in the US (Bernard and Cooperdock, 2018).

Although the impact of the “leaky pipeline” on the career advancement of underrepresented researchers, including the loss along the career pathway towards senior roles by gender, has been explored in geochemistry (Pourret et al., 2021), there is more research and intervention to be done. The leaky pipeline is a common though imperfect metaphor for the loss of diversity, including multiply-disadvantaged researchers, at crucial career points. However, we also agree with the criticism of the metaphor as a leaky pipeline suggests the loss of talent is a passive process. Other more active metaphors such as obstacle course (European Association of Geochemistry (EAG), Diversity,

Equity and Inclusion Committee et al., 2021), chutes and ladders (Windsor et al., 2021) and hostile climate (Marin-Spiotta et al., 2020) acknowledges the existence of systemic and structural inequalities that must be dismantled. Irrespective of the metaphor to be used, it is undeniable that addressing the disadvantages and discriminations that multiply-disadvantaged researchers face can and should be the active responsibility of organisations and funders. While impact of active or passive forms of loss of diversity cannot be ruled out in our data, and academic adjacent careers and/or contemporary career paths can be enabling and rewarding (Batchelor et al., 2021), it is often that minority groups take a disproportionate burden of administrative work for gaining diversity awards such as for the Athena SWAN and for other university committees. A recent study recognised such disproportionate workload burden and highlighted structural inequalities whereby marginalised women were found to have less prominent roles while White women were overrepresented

within Athena SWAN self assessment teams and as champions for institutional/departmental submissions (Munir et al., 2013).

In the UK, positive targeted action initiatives such as the Athena SWAN charter (since 2005) for women, Stonewall for LGBT+ (2012) and Race Equality for Black and Minority Ethnic (2014) have supported higher education institutions and departments to advance careers of specific disadvantage identities (e.g., Athena SWAN charter, 2011). So far, these initiatives have been targeted on supporting one aspect of disadvantaged identity, for the disciplinary communities including within geochemistry, with limited success (Bhopal and Henderson, 2021; Campion and Clark, 2021). We need interventions designed with intersectional approaches, where the impact of multiple disadvantages is better understood and the careers of a broader spectrum of geochemists and academic community are supported. Though it is worth noting that progress is being made in revising Athena SWAN charter principles through inclusion of broader gender (including non-binary and transgender) understanding and addressing intersectional inequalities (Athena SWAN Charter, 2022). In promoting inequalities for specific disadvantaged groups, it is important not to ignore other disadvantaged identities (such as sexuality, disability and socioeconomic disadvantages). While the focus of research and positive actions have been on the binary gender, LGBTQ+ and race based inequalities and career progression in academia, similar focus for funded research and positive action initiatives for multiply-disadvantaged identities are needed.

Inclusion also requires job security to build a thriving career. Within our data, a number of groups are underrepresented amongst those who have permanent contracts in geochemistry, including racial/ethnic minorities, disabled people, and those from economically disadvantaged backgrounds. On fixed-term contracts, women and disabled geochemists are overrepresented compared to their man and able-bodied peers. Studies have shown that fixed-term positions such as postdoctoral research posts, while allowing freedom for mobility of early career researchers (ECRs), are also precarious and detrimental to improving diversity (Vitae-UKRI Partnership, 2020; Woolston, 2020; Gladstone et al., 2023). Lack of financial security in these fixed-term contracts further negatively impacts those who have young families or are from economically disadvantaged backgrounds. The challenges of dealing with fixed-term contracts have been suggested to be one of the factors that pushes women scientists out of academia in Chemical Sciences (Royal Society of Chemistry report, 2018).

Geochemists are reliant on access to a functioning laboratory. Therefore, they are naturally invested in managing and maintaining related laboratories. They also have a significant role in providing specific specialised training and support to PhD students and postdoctoral researchers with added workload, which invariably goes unrecognised in career progression. This additional work is particularly important when laboratories are unsupported with expert technical support staff. When baseline

laboratory support staff are present, they are either on a fixed-term contract or, if employed on a permanent contract, on a fixed salary scale without a ladder to progress up (Lee, 2016). Lack of job security and/or progression opportunity for technical staff in geochemistry within UK institutions affects their morale and motivation, overall compromising support for other researchers within the team and wider research innovation. Our data show that women and economically disadvantaged (when combined in our analyses they are considered as multiply-disadvantaged) identities dominate research support positions in geochemistry. In the UK, there is an initiative to enable organisations to commit to supporting technical staff through career development opportunities, visibility, recognition and sustainability (Technician Commitment, 2023). However, there is still a gap to address in terms of salary scale progression (a ladder equivalent to academic progression) for supporting their economic progression. A reform that can support technical staff progression through a career ladder (both their job title as well as economic progression) equivalent to academic progression would be needed to fully realise the technical route as a viable career prospect in geochemistry.

Inclusion requires an intersectional understanding of the impact of multiple and compounded disadvantages, adverse experiences, and discrimination. Our data show that the respondents who belong to multiply-disadvantaged groups are more likely to be on fixed-term contracts as well as in technical and laboratory management roles, and less likely to be in senior or leadership roles. This echoes similar findings from national UK higher education data published annually by Advance HE (2022) which suggests that certain underrepresented groups are overrepresented in fixed term contracts and/or part time roles. Our data and the national data both suggest that, for some multiply-disadvantaged geochemists, career choices are made with more limitations and higher risks of precarious contracts, part time work, and/or possible periods of unemployment when compared with their privileged peers. Therefore, contractual positions/roles with fewer opportunities for career advancement are detrimental to supporting a respectful research culture where everyone is valued, thereby undermining potential for a thriving research environment.

A number of underrepresented groups are not amongst our respondents, including Black or Middle Eastern women. Additionally, a number of groups are not represented in permanent or senior roles within our data. For example, there are no respondents who identify outside of binary genders who are in permanent positions; no Asian women in senior leadership roles, no respondents who identify as LGBTQIA+ in senior leadership roles, and no neurodiverse (incl. autism, dyslexia, ADHD) respondents in senior leadership roles. Some groups are not sufficiently represented throughout the geochemistry career ladder within our data, such as Black and Asian men. Though our respondents include a few Black and Asian men at senior levels, their numbers are still not reflective of equitable representation. Our data echoes some of the underrepresentation



evident in the recent Global Geochemistry Community Survey report EAG (2023). Although the absence of specific groups in our data may be attributed, in part, to the timing of this specific survey, it is important to note that the absence of some disadvantaged identities, especially within senior or leadership roles, is reflective of a national, sector-wide issue of significant underrepresentation and historical exclusion of particular groups in STEM in the United Kingdom. For example, Black scholars make up just 1.6% of all academic staff in science and engineering disciplines (Advance HE, 2022) compared to 4.2% of the overall population of England and Wales, census (2021). Although some historically excluded identities are not represented within our data (suggesting a lack of those identities in the UK geochemistry community), our respondents do include representation of Black men and Asian men who are professors. Black and Middle Eastern women were also not represented amongst the survey respondents data published by the Royal Society of Chemistry (2020).

Whilst our findings show inequalities in representation amongst underrepresented and historically excluded groups, particularly amongst those who belong to more than one disadvantaged identity group, we know that these statistical findings alone do not reveal the causes of persistent patterns of exclusion and underrepresentation. The qualitative responses collected through our survey suggest some possible causes, as exemplified by these responses:

“Limited progression opportunities for technical staff; post-doctoral research too unstable for family life.” (multiply-disadvantaged participant)

“In my field, permanent positions are rare. ... The department trumpets its diversity credentials. ... [However], the money and permanent positions inevitably go to privileged white men who are friends with powerful men.” (multiply-disadvantaged participant)

Previous research on the barriers facing those with disadvantaged identities in STEM have identified and are also highlighted by exemplar qualitative responses (in this study):

- (1) hostile work environments (sexist, racist, ableist, homophobic) (Williams et al., 2014; Dyer, 2019; RSC, 2020; Arredondo et al., 2022; Berhe et al., 2022).

“I have experienced bias, marginalisation, homophobic comments, and bullying from senior academics in the department” (multiply-disadvantaged participant)

- (2) lack of fair adjustment (e.g., for disabled or religious staff and students) (Careers Research Advisory, 2020),

“Disability and reasonable adjustments were entirely ignored by at least one employer and with no obvious additional steps or procedures taken to engage with disability expertise.” (multiply-disadvantaged participant)

- (3) biases during recruitment and promotion processes (Beattie and Johnson, 2012)

“Considered leaving the academic sector due to toxic promotion process and working environment” (multiply-disadvantaged participant)

- (4) lack of visible role models within academia (Bothwell, 2019)

“Have more diverse people in key roles, such as heads of department, senior researchers, key note speakers at conferences etc. - visibility is everything.” (multiply-disadvantaged participant)

- (5) lack of funding awarded to underrepresented researchers in STEM (UKRI, 2023)

“There is clearly not enough funding to go around and a lot of it is concentrated in a few institutions and a few well-established researchers. There has to be a better way of distributing funding more equitably.” (multiply-privileged participant)

In addition to underrepresentation of particular groups in STEM, previous studies have explored a number of potential reasons why those within the STEM workforce from multiply-disadvantaged identities face additional or structural barriers to linear progression within academia. Some possible reasons include experiencing a “cumulative effect” originating from embedded, historical dimensions of prejudice and discrimination in the workplace environment (Faulkner, 2009). Furthermore, these barriers and the degree of difficulty that people of underrepresented identities face navigating or overcoming them is often complex, including the impact of discrimination and underrepresentation on, for example, mental health (Estrada et al., 2018).

Our quantitative findings highlight the stark inequalities multiply-disadvantaged scholars face in geochemistry. The following quotes illuminate the themes within the qualitative data that are focused on participants’ suggestions for change:

- “Hire more diverse people as these serve as role models. Do more outreach. More unconscious bias training in a more diverse set of areas to include ableism.” (multiply-disadvantaged participant)
- “Work to retain the best diverse talent at all stages of the academic ladder. Also increase monetary investment in research careers, make it a job that even those from poorer backgrounds can afford to undertake.” (multiply-privileged participant)
- “Better recognition for the work of technical research staff including promotion opportunities. Also, longer post-doctoral contracts and less expectation to move institutions for those who don’t want to. ... The current system excludes people who want a conventional family life in their late 20s and 30s” (multiply-disadvantaged participant)

To repair the geochemistry career ladder, based on our findings, we recommend with urgency that the government, funding bodies, learned societies, and institutions prioritise:

- Collecting and publishing more robust data, including examining inequalities through an intersectional lens to enable targeted initiatives to address inequalities and barriers to career progression faced by multiply-disadvantaged researchers.
- Implementing positive action around research funding, with an aim to increase the number of underrepresented geochemists serving as PIs and Co-Is (UK Government guidance, 2023).
- Providing more funding for supportive initiatives/programmes focused on career development and progression for geochemists, with a focus on improving the number of underrepresented and/or multiply-disadvantaged geochemists in secure and/or senior roles. This should include a particular focus on the career progression for laboratory technicians and staff.
- Reviewing and improving recruitment and retention policies and procedures, including engaging in an Equality Impact Assessment (EIA) (Advance HE, 2020), to address attrition of diverse talent from the geochemistry career ladder.

More funding and dedicated research is needed to explore the details of why underrepresentation persists for many groups, including multiply-disadvantaged researchers, in geochemistry. Such work should also assess the importance of previously identified barriers, especially with respect to representation at the top of the academic career ladder. Importantly, that work should explore what interventions and initiatives will effectively address these patterns of persisting inequalities without placing the burden on those from disadvantaged identities, which creates a minority tax (Faucette et al., 2022). Any implementation of or changes to funding, policies, strategies, initiatives, or interventions should be robustly evaluated to ensure accountability for effective and transformational change. We call on the government, funding bodies, learned societies, and institutions to jointly take a sustainable, “whole sector approach” (Wellcome Trust, 2021) to creating inclusive research cultures, to foster a geochemistry community where everyone can climb the career ladder and thrive.

## CONCLUDING REMARKS

This study shows that there are several disadvantaged identities that are progressively less represented with increasing seniority on the academic ladder. Specifically, there is a marked lack of gender minorities, non-heterosexual, and disabled representation in senior

leadership roles. We discuss possible reasons for this underrepresentation from historical dimensions of prejudice and discrimination, which puts disproportionate burden on individuals possibly leading to disenchantment with academia or departure from academia.

Our work highlights that women and economically disadvantaged groups dominate the technical and laboratory support staff community. Their career progression and aspirations need to be addressed through a reform (of economic increment and role progression) that would be vital for supporting a thriving research and innovation environment within the United Kingdom.

This study also investigates representation and progression across the geochemistry academic ladder through a lens of multiply-privileged and multiply-disadvantaged identities groups. In comparing those who belonged to multiply-privileged with those who are multiply-disadvantaged identities, we find that multiply-disadvantaged identities groups lack career progression. Our findings do not suggest that those who are part of one historically excluded group do not face barriers and/or discrimination, but that the people more likely to reach senior roles in their geochemistry career are those who are multiply-privileged, including, for example, white, able-bodied, heterosexual women from economically advantaged backgrounds.

Our data suggest the need for further research and initiatives in many areas related to recruitment, retention, and progression of diverse talent in geochemistry, with a priority for future research to identify the barriers faced by researchers and academics from disadvantaged identities and explore how such barriers can be circumvented. Finally, if we are to work towards building an inclusive academic community and/or workplace (School/Faculty/Institution), the requirements of those with multiply-disadvantaged identities (some disadvantages are invisible) will need to be taken into account, ideally with their involvement but without putting disproportionate burden on those who are already marginalised.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusion of this article will be made available by the authors, without undue reservation.

## ETHICS STATEMENT

Before launching a community survey, we received approval from the Open University Human Research Ethics Committee. The ethics process involved approval for data protection principles, secure storage and access of data and compliance with use of the information collected in the study for publication and communication. We also followed the guidelines from the Economic and Social Research Council's

social science Ethics project and the OU's Ethics principle for research involving Human participants. We used Limesurvey to collect survey data which adheres with GDPR regulations and self-selected a unique identifier for each participant. The latter was to ensure that post survey additional information could be sent to the team by a form available at our website.

## AUTHOR CONTRIBUTIONS

PA led the project with contribution from all team members. PB, FA, and PA carried out data analysis following discussion with JG and SB. PA, PB, and JG led the drafting and editing of manuscript with contributions from all authors. All authors contributed to the article and approved the submitted version.

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## CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.escubed.org/articles/10.3389/esss.2024.10098/full#supplementary-material>

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