



# Acknowledging the Intersectionality of Geoscientists With Disabilities to Enhance Diversity, Equity, Inclusion, and Accessibility

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The geosciences have implemented a variety of efforts designed to strengthen diversity, equity, inclusion, and accessibility (DEIA) of underrepresented groups. While these efforts have had substantial financial investment, recruitment and retention for underrepresented individuals has yet to reflect this. To improve the resources available for underrepresented scholars, the geoscience community must expand its exploration of identity beyond a singular construct, and instead focus on how identities intersect. In this exploratory study, the framework of intersectionality will be highlighted to better understand the convergence of disability with other underrepresented identities in the geoscience disciplines. Major themes of social inclusion and belonging, power, safety, and opportunity are presented through the lived experiences of geoscientists, along with recommendations on expanding broadening participation efforts for underrepresented individuals in the geosciences.

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## INTRODUCTION

Over the last few decades, geoscientists and geoscience education researchers have attempted to emphasize the diversity, equity, inclusion, and accessibility (DEIA) of underrepresented identity groups across the geoscience disciplines. Such efforts to broaden participation include minimizing the barriers for students with disabilities (Carabajal et al., 2017), assessing the histories of racism and colonialism in specific geoscience disciplines (Monarrez et al., 2021), addressing the issues of racism (Dutt, 2021), and highlighting the lived experiences and challenges for all marginalized individuals in the geosciences (Marín-Spiotta et al., 2020; Núñez et al., 2020; Morris, 2021). While the financial investment to support such groups is substantial (NSF, 2023a), recruitment and retention data for historically underrepresented scholars are shown to not be proportionate to the efforts being implemented (Bernard and Cooperdock, 2018). Scholars and practitioners who have been historically underrepresented in the geosciences remain so, and the systemic issues preventing their inclusion persist.

When assessing the root-causes of underrepresentation, we must first consider the extent to which the various geoscience disciplines were founded upon, and/or continue to exhibit aspects of colonialism (Schär, 2015; Monarrez et al., 2021; Scarlett, 2022) sexism (Stafford, 1988; Simarski, 1992; St. John et al., 2016; Secord, 2018; Yusoff, 2018; Bocher et al., 2020; Sexton et al., 2020; Mattheis et al., 2022), ableism (Lawrence and Dowey, 2021), and racism (Berhe and

Ghezzehei, 2020; Dutt, 2020; Dutt, 2021; Monarrez et al., 2021; Morris, 2021) and continue to pervade and potentially oppress geoscience identity to this day (Wadman, 2017; Núñez et al., 2020; Cartier, 2021; Mervis, 2022; Prillaman, 2022). To improve resources for recruitment and retention of underrepresented scholars, the geosciences must further explore identity and its impacts within the discipline. More specifically, the effort must extend beyond the focus of identity as a singular construct. Broadening participation efforts tend to focus on singular identifiers such as race/ethnicity, disability, gender, sexual orientation, and other individual demographics (NAGT, 2022). This is evident in the number of identity-specific associations and non-profit organizations available for students, faculty, and professionals. These include, but are not limited to, the International Association for Geoscience Diversity, GeoLatinas, ADVANCEGeo, the National Association of Black Geoscientists, LGBT STEM, and the Geoscience Alliance. Additionally, financial resources designed to support students to attend conferences or finish undergraduate and graduate degrees, have been offered from programs such as the Geoscience Opportunities for Leadership in Diversity program (NSF, 2023b), Geological Society of America On to the Future travel grants for conference attendance (GSA, 2023), and the American Geosciences Institute Scholarship for Advancing Diversity in the Geoscience Profession (AGI, 2023). While these organizations support and provide many opportunities for geoscientists, they are limited in scope by their singular identity focus. The work to focus on broadening participation must account for the unique facets of identity in order to better understand the individual abilities, experiences, needs, and world views within a community. Through this understanding, the geosciences can embrace a more holistic and complex view towards addressing marginalization as it exists within the discipline. Most notably, consider the special attention that has been growing regarding geoscientists with disabilities, which represent the largest marginalized group with over one billion worldwide (Disability Funders Network, 2023; United Nations, 2023). Disability is unique from most identities in the sense that anyone can acquire a disability at any time, especially as they age. Thus disability can intersect with all other forms of identity (Forber-Pratt et al., 2017; Al-Mohamed, 2021). Understanding and raising awareness of the various ways that disability intersects with other underrepresented identities can therefore bring attention to the diverse needs of all geoscientists, and lay a foundation for the creation and evaluation of broadening participation available within the discipline.

## THEORETICAL FOUNDATION AND DEFINING INTERSECTIONALITY

Understanding the multiple ways in which an individual's identity intersects is rooted in Black Feminist and Critical Race Theories (Crenshaw, 1989; Grillo, 1995; Solórzano, 1997; Wiggins, 2000; Gillborn, 2016; Mattheis et al., 2019).

From its inception, intersectionality is used to identify and address the issues of power that exist through the combination of underrepresented identities. This conceptual framework was established through the exploration of the experiences of Black women. In her description, Crenshaw (1989) suggests that "Black women can experience discrimination in ways that are both similar to and different from those experienced by white women and Black men . . . yet often they experience double-discrimination—the combined effects of practices which discriminate on the basis of race, and on the basis of sex" (p. 149). Through this statement, Crenshaw articulates the foundation of intersectionality. The compounding power imbalances experienced by individuals of underrepresented identities can manifest into unique forms of discrimination. From its origins of Black Feminist and Critical Race Theories, researchers have expanded intersectionality to bring emphasis towards additional combinations of identity. The exploration of disability-related intersectionality has been examined in several contexts, namely, disability and gender studies (Moodley and Graham, 2015), political activism and law (De Beco, 2020; Evans, 2022), education (Hernández-Saca et al., 2018), and in racial issues (Annamma et al., 2013; Lalvani et al., 2015; Kohli, 2016; Annamma et al., 2018). Theoretical frameworks have been created to assist in the design and implementation of disability-focused intersectional research. For example, Disability Critical Race Theory (DisCrit; Annamma et al., 2013; Annamma et al., 2018; Dávila, 2015; Liasidou, 2014) attempts to better understand how race and disability intersect. DisCrit bridges the ideas of Critical Race Theory and Disability Studies to explore issues of ableism and racism as they exist within the contexts of education and society (Campbell, 2008; Connor et al., 2008). Understanding how disability intersects with other identities includes the realization that individuals with disabilities are not always limited to a singular diagnosis. For example, an individual may have co-occurring physical disabilities and other health conditions requiring additional accommodation resources and support (Cooper et al., 2015; Dunn et al., 2018; Balboni et al., 2020).

Intersectional identities within the geosciences are perhaps best articulated through an analogy to the interdisciplinarity of the discipline. When we consider the Earth as a system that is composed of various interwoven sub-systems, such as the hydrosphere, geosphere, biosphere, cryosphere, and atmosphere, each component of the Earth system directly interacts with one another, and like dependent variables are sensitive to the changes that affect one or more of the components. This is not dissimilar to the impact of identity on individuals within the geoscience discipline. Like the components of the Earth system, identity acts as a system composed of various key traits, such as race/ethnicity, disability, socioeconomic status, gender, and sexual orientation. Each of the described traits interact with each other, forming a person's identity. Through this perspective, identity can be described as the system of characteristics that constantly interact with each other that defines who a person is.

The application of frameworks on intersectionality highlights the voices and lived experiences of those most marginalized by their identities. Amplifying the voices of those most underrepresented uncovers the academic and social injustices they have faced and how their personal experiences may differ from the current narratives of DEIA (Matsuda, 1987; Annamma et al., 2013; Todd et al., 2023). By listening to these often -silenced voices, the geosciences can benefit from the ways that diversify perspectives, participation, engagement, and belonging across the discipline (Núñez et al., 2020).

## Exploring Intersectionality

For the purposes of this paper, intersectionality will be used to further explore the themes discussed in the data analysis portion. When utilizing intersectionality and its related theories, there exists the risk of superficial adoption of its concepts and terminology that can negatively impact the discourse as a whole. Similar overgeneralization and metaphorization of social science frameworks have been noted in the research of decolonization and the failures to recognize the origins and struggles that are rooted in related frameworks (Tuck and Yang, 2012; Liboiron, 2021). As intersectionality continues to be explored in spaces such as the geosciences, the core values of frameworks such as DisCrit must be maintained. The core values, or tenets, of DisCrit include confronting power imbalances, the impact had by social constructs that are directly tied to identity, the historical and legal aspects of how identity labels have been used to deny rights to individuals, the support of activism and resistance against current power structures, and the privileging of voices from underrepresented individuals (Annamma et al., 2013; Mattheis et al., 2019). The tenets and core values of any theoretical framework must be maintained in order to ascertain the root purpose of broadening participation, both within the geosciences and the larger social contexts that surround it. Therefore, anyone advocating for or working in identity-based research must be held accountable to and consult the key literature on intersectionality and its related theories.

## Broadening Participation Through Intersectionality

The recruitment and retention of students and geoscientists from historically underrepresented groups relies on the understanding of how geoscience disciplinary culture positively or negatively impacts the intersection of marginalized identities (Crenshaw, 1989; Gillborn, 2016; Mattheis et al., 2019; Núñez et al., 2020). Intersectional research in the discipline consists of, but is not limited to, the highlighting of the history of diversity across the geosciences (Mattheis et al., 2019), the creation of a geoscience-specific model of intersectionality (Núñez et al., 2020), the application of intersectional frameworks to address discrimination and harassment (Mattheis et al., 2022), and the push towards the creation of stronger, more inclusive and

accessible identity-based communities within the discipline (Ulrich, 2021). The goal of these efforts will help to understand how identity-related experiences impact student retention and the overall DEIA efforts in the geosciences. The outcomes of these studies also provide recommendations to improve the participation and engagement of geoscientists with disabilities. For example, Núñez et al. (2020) and Todd et al. (2023) established foundations for empowering the voices of those most underrepresented to collaborate in the designing of actionable approaches towards improved community support. Additionally, the application of social science research methods, such as participatory action research (PAR; Baum et al., 2006), can empower those who are historically underrepresented to collaboratively identify and address systemic barriers which prevent inclusion and participation in the geosciences. By fostering social science concepts such as intersectionality, the geoscience community can develop a more inclusive and accessible disciplinary culture that can better meet the broadening participation for all scholars.

The perspectives and experiences of underrepresented scholars is essential for strengthening the future STEM workforce (NSF, 2021). A recent U.S. National Science Foundation (NSF) report argues that the lack of diversity of perspectives in the STEM workforce are creating gaps in innovation, research, and advancement (NSF, 2021). To achieve a strong national STEM workforce, DEIA initiatives must call upon the experiences of the entire population to assist in addressing the current scientific questions and social concerns present in the STEM disciplines (Medin and Lee, 2012; Mogk, 2021; Freeman and Huang, 2014; Phillips, 2014; Page, 2017). Similarly, the Vision 2023 report (National Science Board, 2020), claims that the growth of the U. S. science and engineering workforce will require much higher enrollments of those currently underrepresented in all STEM disciplines in order to be representative of the overall population by 2030. Mentoring and training that purposefully integrate the intersectional identities of the individual will move the workforce towards a more inclusive disciplinary culture while also addressing broad social and scientific challenges (Griffin et al., 2010; Hayes and Bigler, 2013; Kendricks et al., 2013; Carroll and Barnes, 2015; Thomas et al., 2015; Hund et al., 2018; Corneille et al., 2019; Barabino et al., 2020; Stelter et al., 2020; Nkrumah and Scott, 2022).

In order to better understand the impact of intersectionality in addressing issues within the geosciences, this paper presents outcomes of a pilot study that explored the lived experiences of geoscientists who identify as having a disability and as belonging to an additional marginalized group. This pilot study sought to understand the following questions: 1) What are the lived experiences of individuals who identify as having a disability and belonging to an additional marginalized group? 2) Based on the experiences and perspectives of the participants, what are some actionable approaches/practices that can better support these individuals? and 3) How can intersectional frameworks such as DisCrit help further explore the impact of intersectional identities in the context of the

geosciences? The goal of these research questions is to not only better understand how the theoretical foundation of intersectionality adds to the discussions surrounding identity and marginalization in the geosciences, but also to incorporate the perspectives of the participants as the voices of those most negatively impacted to help guide action towards positive cultural change.

## PARTICIPANTS

For this pilot study, three cases are presented to highlight some of the personal experiences people with multiple marginalized identities have within geoscience culture. Specifically, each case provides a narrative for the ways that disability intersects with other underrepresented identities, such as ethnicity, gender identity, race, sexual orientation, and socioeconomic status (SES). The recruitment of participants was done through emails sent out to members of the International Association for Geoscience Diversity (IAGD). The three participants for this pilot study include Teri, who identifies as disabled and queer; James, who reports being a disabled male belonging to an underrepresented racial group, and coming from a low socioeconomic background; and Angela, a female with a disability. The names provided for the three cases are pseudonyms in order to protect the identities of the participants.

## DATA COLLECTION AND ANALYSIS

Each participant individually took part in a semi-structured interview focused on their personal experiences in the geosciences. Throughout the interviews, participants were asked to describe personal experiences with their own intersecting identities in the geosciences. This involved discussions around both opportunities and barriers they've experienced, instances of inclusion and exclusion throughout their education and/or careers, and discussion of ways in which they had worked to overcome challenges when they occurred. Each of the interviews were analyzed and thematically coded based on similar responses across the three cases. Themes were identified as social inclusion and belonging, power, opportunity, and safety. Excerpts and quotes from the interviews provide evidence for each theme, along with suggestions to address the barriers, challenges, or instances of exclusion. The goal of the analysis is to identify and describe the impact of the marginalization experienced by these individuals based on their intersectional identities and to propose suggestions from the participants as to how to address them. This study was approved by the Institutional Review Board (IRB). The following discussion is inclusive of the voices of the interview participants and is aligned to relevant broadening participation literature where available.

### Social Inclusion and Belonging

The most prominent theme that emerged from the three interviews was social inclusion and belonging. Social

inclusion is the process of improving participation in society, particularly for those who are disadvantaged, through enhancing opportunities, access to resources, voice, and respect for rights (United Nations, 2016). Within the geosciences, social inclusion can be related more to the affective sense of belonging in the discipline (Callahan et al., 2015; Atchison et al., 2019; Belanger et al., 2020; Todd et al., 2023). James describes his personal experience in the geosciences with "I didn't find a lot of people like me within the field." James's experience underscores the need to have more role models of underrepresented identities in academia and other geoscience careers (Noonan et al., 2004; Foor et al., 2007; Zeldin et al., 2008; Dunn et al., 2012). Angela also described a situation where she believes she was purposefully excluded from a departmental visit to a new field site. While she expressed interest in attending when the trip was introduced, the trip took place without Angela being aware. "They brought it up as 'that thing we're doing later' in later discussions but did not mention anything to me about joining in," Angela recalls. Based on her lived experience, Angela strongly believes that she was excluded from the event. Not only that, but Angela believes that her exclusion was not caused by issues such as poor planning or a lack of communication, but rather a purposeful effort to not include her in the field site visitation. Social exclusion can be both deliberate and passive. The exclusion described by Angela is an unfortunately common experience for individuals with disabilities in the geosciences (Davis et al., 2015; Berhe et al., 2022). Unfortunately, as a woman with a disability, the exclusion in this case could be tied to both aspects of Angela's identity (Berhe et al., 2022). Similar discriminatory experiences and microaggressions have been noted for women of color in the geosciences (Davis et al., 2015; Marín-Spiotta et al., 2020; Berhe et al., 2022). In this context, DisCrit highlights the ways that multiple identity traits can intersect in often neutralized and non-apparent ways that perpetuate the *status quo* and a sense of normalcy (Annamma et al., 2013). While identities such as race and ability are socially constructed, the impacts faced by individuals with such labels fuel social exclusion as they are set outside of western norms (Matsuda, 1987; Annamma et al., 2013). In the examples presented by the participants, the social exclusion they experienced ties directly to their identities and can stem from not only the individual identities they embody, but also how they intersect to form unique and compounding barriers. Understanding the impact of identity on an intersectional level allows for a further examination of marginalization in the geosciences and can help guide the designing and implementation of efforts to address it.

To strive towards social inclusion, focus must be placed on proper communication and building trust (Callahan et al., 2015). In the context of this paper, proper communication focuses on an open interaction and sharing of ideas and experiences between parties. For example, Teri explains the struggle of requesting and securing accommodations to participate in an event. "Communication shouldn't [always] be me asking for an accommodation, but rather the event or

activity saying that if you need an accommodation, here is how to go about getting it.” Teri’s example shows that communicating accommodations should be proactive rather than reactive. Geoscience faculty can easily address this by listing offered accommodations through course syllabi, hiring/recruitment documentation, and through departmental web pages with opportunities for additional accommodations and approaches as needed (Stokes et al., 2019; Carabajal and Atchison, 2020; Mogk, 2021; Mangan, 2023). Through such communication, faculty and students may begin to build a relationship where they can work to each other’s talents. This, in turn, builds trust. Establishing trust requires open, transparent communication, purposeful collaboration, and the commitment to amplify the voices of those who are underrepresented in the decision-making process to develop socially inclusive and physically accessible geoscience spaces. For underrepresented individuals, trust is essential for building a sense of belonging and feeling included in a space.

Trust can be difficult to build when working across identity groups, even for those who are DEIA advocates and allies. The importance of building trust while working towards positive change was especially noted by Teri, who stated, “You can’t just label a space as safe, because you can’t make someone feel safe with you.” In recent years, efforts such as the UK Science Council Declaration on Diversity, Equality and Inclusion (Science Council, 2023), Unlearning Racism in Geoscience (URGE; Duran et al., 2021), the European Geosciences Union’s Champion(s) for Equality, Diversity, and Inclusion Award (European Geosciences Union, 2023), and the American Geophysical Union’s Strategic Plan (American Geophysical Union, 2023) have been established to help strengthen social inclusion. These efforts have also helped establish numerous DEIA committees and boards across professional societies in the geosciences. However, belonging to or working towards such efforts does not guarantee access, inclusion, and/or safety to those who are most negatively impacted by geoscience culture. Geoscience faculty and industry professionals are encouraged to actively collaborate with and learn from known identity-focused advocates, allies, and support organizations, such as the National Association for Black Geoscientists (NABG), GeoLatinas, the International Association for Geoscience Diversity (IAGD), and Asian Americans and Pacific Islanders in Geosciences (AAPiG). Working directly with these communities is an excellent start in codesigning more equitable, inclusive, and accessible curricula, events, and workspaces.

For all levels of participation in the geosciences, listening to and collaborating with the voices of underrepresented students, faculty, and other geoscience professionals is essential. Intersectionality, emphasizes the importance of amplifying underrepresented voices. When planning or designing accessible opportunities for social inclusion, decisions should not be made without the voices of the individuals or groups most impacted by the decision and therefore must be included in the decision-making process.

For example, people with disabilities are the experts of their own needs and abilities, and their perspectives must be valued as such. The mantra, “Nothing about us, without us” (Charlton (2000), p. 3), is central to DisCrit and other forms of intersectional frameworks as it charges researchers and community members to amplify voices of those most directly affected by decisions being made on their behalf. To implement these ideas, geoscience community members should invite members of underrepresented groups to collaborate in efforts designed to bolster social inclusion, whether at the department or institutional levels, or even in larger scale efforts undertaken by professional workplaces. Furthermore, these individuals and their experiences should be valued as main drivers for designing change as they represent the individuals most directly affected by it. Through such action, the geoscience community can learn how and begin to respond to issues existing within the discipline through the guidance of those most directly affected to ensure their needs are not ignored (Matsuda, 1987; Annamma et al., 2013).

## Power

Power is a dynamic interaction in which one individual or group can exert control or influence over the structure or environment of a community, affecting members of that community. Differences in power can manifest in many different ways. Perhaps most commonly, power can be found through cultural assimilation, where marginalized individuals are expected to assume the behaviors, values, rituals, and beliefs held by the broader social community (Holohan, 2012; Dutt, 2020). Power facilitates the oppression of others, often in non-apparent ways, with the effort of maintaining *status quo* (Freire, 1990). Power can influence any social situation, including the norms that make up the culture of the geosciences. Distinct imbalances of power commonly persist in academia and disciplines with limited population diversity (Marín-Spiotta et al., 2020). In the context of this pilot study, power refers to the ability of an individual, group, or institution to assert control or influence the behavior of others. Power imbalances often impact those with disabilities as society often generalizes disability types against a sense of normalized ability (Davis, 1995; Frederick and Shifrer, 2019).

Generalization increases the prevalence of bias and stereotypes of what accommodations an individual may need to engage and/or actively participate in an activity (Lindstrom, 2007; Gregg, 2011). Overgeneralization and stereotype can lead to normalizing an individual’s abilities and can also strip their power to self-advocate for what is needed in pursuit of their own success. It must be known that no two disabilities are the same. Even those with similar disability types will have vastly different personal experiences with entirely different accommodation needs (Lindstrom, 2007; Gregg, 2011).

Often predicated through social bias and stereotypes, social labeling most often causes individuals with disabilities, especially those with non-apparent disabilities, to become hesitant to disclose personal information and request accommodations in the future (Gallagher, 2010; Hallberg

et al., 2010; Kulkarni, 2022). Teri, who recalls “the moment I [disclosed] disability, [the person] decided what I needed. People don’t always believe you are a reliable narrator for your own experience.” Intersectionality allows us to explore the impact that socially constructed labels can have, which vary based on the complexity of additional identity types (Annamma et al., 2013). Labeling has the potential to limit power and agency for individuals and thus cause underrepresented voices to be devalued and even ignored (Erevelles and Mutua, 2005; Matsuda, 1987).

Power imbalances can occur when the process of requesting basic accommodations (e.g., wheelchair access to a laboratory, captioning during a lecture, microphones for both the presenter and the audience during a conference presentation) becomes the sole responsibility of the individual who needs these supports to be included in the activity. Power imbalances can even appear in the basic need for access. As Teri highlighted previously, communication concerning accommodations should not be driven solely by the person in need, but must instead be proactively considered in the planning and designing of the activity. Likewise, Angela described attending a conference that was hosted in a physically inaccessible building. The conference hosts were described as stating “we can’t fix the building, but we will work with you and accommodate you to make sure you’re involved with the conference.” Reactively offering accommodations places the burden on the individual to adjust to an inaccessible situation, and places the responsibility of belonging squarely onto those who are already marginalized from the community. Being open to making changes is good, but not planning and preparing for potential inaccessible situations is inexcusable. Additionally, Angela was asked by the conference hosts “can you make any suggestions on accessibility?” While the intention here is to help improve accessibility moving forward, it is inappropriate to place responsibility on a single individual in the moment of an event or activity. No one should be expected to justify all accommodations or speak on behalf of everyone who may need them, and doing so can further burden those seeking to belong and participate within an event, such as a conference (Dowse, 2001; Bruce et al., 2020). The awareness, research, and preparation to proactively and collaboratively offer accessible and inclusively-designed options must fall upon us all to sustain a diverse academic and professional workplace.

To address the inherent culture of exclusion perpetuated across a community, the first step must be to not only acknowledge that power imbalances exist (Cooperdock et al., 2020; Marín-Spiotta et al., 2020; Ali et al., 2021), but also how intersectional identities are affected by such power imbalances (Ahmed, 2006; Chapman, 2010). For example, instead of reactively offering accommodations in the moment, conferences and similar events must proactively communicate, offer resources, and provide options for attendees to make needs requests in advance. Classroom instructors and workplace colleagues should also be aware of exclusionary practices. While maintaining open communication and offering specific

resources may not fully meet the needs of every individual, doing so shows a commitment to accessibility and inclusion within community spaces, such as classrooms, lab groups, departments, and even conference venues. This practice allows for those who are most underrepresented in a community, particularly those with disabilities, to actively plan their schedules and levels of engagement, while preemptively requesting additional support, as needed, just as any student, employee, or conference attendee would. Such an approach to accommodations also goes beyond physical accommodations focused on disability. Proactive accommodations also helps build trust, sense of belonging, and safety. Common conference accommodations could include, but are not limited to, access to childcare, lactation rooms, designated quiet spaces, gender-inclusive restrooms, and conference ID badges with pronouns or personal interaction preferences. Instructors and lab managers can include lists of commonly provided accommodations in syllabi, safety briefings, and student job postings, as well as provide links and contact information to additional accessibility and/or inclusion support services that can further enhance the participation of those most underserved by traditional practices.

Power must be shared. Addressing identity-based power imbalances can be seen in the work by Kingsbury et al. (2020), where they describe options for improved inclusion involving autistic geoscientists. The authors emphasized effective communication, presumed competence in autistic geoscientists for planning their own accommodations, and expectation management strategies. These guidelines demonstrate a basic commitment of not only listening to, but also hearing the voices of those who are most often marginalized in geoscience learning and research settings, and collaboratively working with them to address issues that cause exclusionary practices. Validation of voice and a commitment for collaborative decision-making has the potential to disrupt current power imbalances present across the discipline and facilitate a growing culture of access, equity, and inclusion. By addressing the imbalances of power commonly present in most academic settings, the geosciences can not only positively impact the diverse community population, but also work to provide a safe environment for everyone to engage with the broader discipline.

## Safety

Each of the participants considered very different aspects of safety. In the context of DEIA, safety focuses primarily on protection from discrimination and potential harm based on one’s identities. James discussed safety primarily from the perspective of race. Teri focused on gender identity, and Angela related safety to physical access. Both Teri and James tied their need to feelings of safety, specifically related to working in the field. Teri focused on her health complications and how her pre-existing conditions can be impacted by the environmental effects of working in the field. People with chronic illnesses or comorbidities are susceptible to the rapidly changing environmental conditions and thus can be limited in the amount of field activity they can engage in. “I have to be careful how far I walk, how long I am in the field, and I often need a place to sit while working,” Teri elaborated. Teri also

emphasized the issue of safety regarding working in various regions of the country. As a queer geoscientist, Teri has to be aware of her access to healthcare and increased potential of harm if working in areas which are known to be unwelcome to members of the LGBTQ+ communities (Mogk, 2021; Zebracki and Greatrick, 2022; Downen and Olcott, 2023; Kamran and Jennings, 2023). James added to this point through his personal experience of safety related to working in various regions of the country, "I would never go out into the field alone. It's not just for the hazards that are present in field work, but for the societal dangers too." Angela described the need for safe access to the field.

When conducting field work, Angela discussed the importance of having the resources and support to not only conduct, but also to revisit field activities safely. In her case, Angela discussed the integration and usability of tools and strategies such as 3D scans of outcrops (Bistacchi et al., 2022; Walter et al., 2022), virtual field courses (Whitmeyer and Dordevic, 2020; Pugsley et al., 2022; Horota et al., 2023), and cross-collaboration with field partners (Atchison et al., 2019; Gilley et al., 2015; Hendricks et al., 2017). Considering resources to assist with field-based accessibility allows for collaborative data collection, multiple representation of content materials and resources, and virtual engagement with the field sites which can be helpful in broadening participation for individuals that may not be able to physically access a field site (Gilley et al., 2015; Hendricks et al., 2017; Atchison et al., 2019; Mead et al., 2019; Stokes et al., 2019; Carabajal and Atchison, 2020; Houghton et al., 2020; Whitmeyer and Dordevic, 2020; Peace et al., 2021). Many accessible field approaches have been expanded upon since the beginning of the COVID-19 pandemic and continue to help support underrepresented individuals in the discipline (Barton, 2020; Whitmeyer and Dordevic, 2020; Bond and Cawood, 2021; Peace et al., 2021; Tavani et al., 2022). Such resources allow Angela to work in the field in a safe, accessible way, even when physical field access is limited. To support geoscientists with disabilities, the broader geoscience community must be aware of the barriers they face, potential accommodations, and proactively working with them to understand their individual needs (Feig et al., 2019; Stokes et al., 2019).

Each of the interview participants suggested that issues of safety in the geosciences can and should be addressed institutionally. Field instructors must acknowledge and be prepared to provide resources and guidance that will ensure those who are underrepresented in their programs are safe to study and work in the field, regardless of the location (Gilley et al., 2015). Resources and guidance on safety must also address issues of discrimination and harassment directed towards those who are underrepresented. Examples of this can be seen within the National Science Foundation Geosciences (GEO) Directorate handbook<sup>1</sup> regarding research experiences for undergraduates (Sloan and Haacker, 2020). The handbook offers recommendations that can be utilized by teaching staff and industry professionals for

safety through the use of inclusive practices, the prevention of sexual and racial discrimination, laboratory safety, and safe living quarters for students conducting field work (Sloan and Haacker, 2020). Importance should be placed on recognizing non-apparent barriers, such as discriminatory behaviors, inherent biases, and risks associated in geoscience workplaces (Jackson, 2021). Additionally, guidance has been provided to include mandatory racial risk assessments, active engagement, allyship training, communication with local authorities before conducting field work, documentation of hostile experiences, and immediately addressing discrimination when it occurs (Ali et al., 2021; Jackson, 2021; Marshall et al., 2021; Morales and Reano, 2023; Oliveri and Bohacs, 2005). Safety should not only be an issue related to fieldwork. Providing safety for all geoscientists involves addressing hostility and microaggressions that can be found in all academic and professional workplaces (Sue, 2010; Marín-Spiotta et al., 2020) such as ableism, racism, sexism, and other forms of identity biases, harassment, and discrimination (Cortina, 2008; Olsen et al., 2020; Lawrence, 2021; Núñez et al., 2021). Addressing issues of safety in the geosciences highlights a commitment to protect the members of an instructional or research community and work to remove barriers that currently restrict opportunities to participate and contribute (Marín-Spiotta et al., 2020; Jackson, 2021).

## Opportunity

Each of the three cases described accessible or inclusive opportunities for training and employment, as well as seeking more general opportunities to be involved in the broader geoscience community. James discussed the struggle in finding opportunities to engage in the geosciences that align to his racial and disability identities, as well as his financial means. After being discouraged from pursuing a traditional post-secondary education in a geoscience program, James struggled to find other opportunities to continue within the discipline. Eventually, James was able to join informal geoscience interest and educational groups and work directly with local and regional non-profit organizations to participate in research and outreach opportunities within the discipline.

The need for more flexible engagement with career options and accommodations was also mentioned in the three interviews. Active mentoring is critical to support students in finding the career path that best aligns to their interests and talents (Wilson et al., 2010; Blake et al., 2013; Wilson et al., 2013). James argued that there should be more opportunities for those who are most underrepresented in the geosciences to work with local, state, and federal geoscience organizations, attend and give research presentations, and have access to additional career training beyond academia. He strongly believes that purposely promoting the representation of underrepresented individuals helps alter the perception of who a geoscientist is, how they look, and what they can do, encouraging the inclusion of a more diverse workforce. Similar findings have been found describing how perceptions within the geosciences potentially fuel the low diversity of student

<sup>1</sup><https://edec.ucar.edu/university-partnerships/geo-reu/geo-reu-resource-center/geo-reu-handbook>

enrollment (Mol and Atchison, 2019; Sexton et al., 2018), thus diminishing the awareness and understanding of the needs of those with underrepresented identities. Low participation rates of underrepresented geoscientists have the potential to perpetuate bias, stereotypes, and overall misunderstandings of who can be a geoscientist (Atchison and Libarkin, 2016). To address the current perceptions regarding geoscientists with disabilities and other intersecting identities, extra emphasis can be placed on flexible careers that do not require extensive fieldwork (Gilley et al., 2015; Stokes et al., 2019; Carabajal and Atchison, 2020), identifying and dismantling microaggressions and harassment as they occur (Marín-Spiotta et al., 2020; Morris, 2021; Mattheis et al., 2022), and promoting universally-designed instruction to improve accessibility and inclusion (Carabajal et al., 2017; Fairfax and Brown, 2019; Higgins and Maxwell, 2021). Such efforts to challenge current perceptions also call back to DisCrit and its emphasis on activism and resistance against the *status quo* (Annamma et al., 2013). Intersectional frameworks, such as DisCrit, explicitly challenges the notions of deficit-based perspectives regarding underrepresented groups and call for direct action along with said groups to work towards positive change (Annamma et al., 2013).

## LIMITATIONS, REFLECTIONS, AND FUTURE WORK

Learning from the lived experiences of geoscientists who identify with multiple intersecting, marginalized identities has not only provided insights into how the complexities of identity impact members of the broader geoscience community, but it also has the potential to set the groundwork for further studies to examine the nuances of identity within the traditional design of the geoscience disciplines. The issues involving identity in the geosciences and how they intersect requires further study. The outcomes of this pilot study are limited due to the small sample size and the different identity intersections of each of the participants. Thus, finding commonalities and differences within the personal descriptions of the participants is simply not possible to represent the larger community. For future research, the methods used in this pilot study will be greatly expanded to not only get a larger pool of participants, but also to focus the study more on specific intersections of identity such as the intersections of race and disability.

## CONCLUSION

As DEIA efforts to broaden participation in the geosciences continue to work towards advancing awareness and representation, the strategies currently being used to support those most underrepresented must evolve to consider the intersectionality of identity and how disability and other underrepresented identities in the geosciences are directly impacted by the variables of social inclusion, power,

opportunity, and safety. Social inclusion and belonging primarily present themselves through the current lack of role models and sources of exclusion that exist in the discipline. Power imbalances present themselves through the overgeneralization of the abilities of those who are disabled and thus not addressing needs on an individual level, the negative impact around identity-based labels and how they can limit agency of the individuals who have them, and the lack of emphasis towards proactive accommodations. Safety issues are alleviated when underrepresented individuals are protected from sources of harassment, discrimination, and other potential risks of harm within geoscience research and educational settings. Opportunity is created from more flexible geoscience education and career options. Mitigating these barriers requires more effective communication, the building of trust between individuals, being proactive in determining how power imbalances exist within the discipline, and providing inclusive mentorship, resources, and institutional protections for safely conducting geoscience training and research. Such efforts cannot happen without direct collaboration with those directly impacted by the undercurrents of exclusionary practices in the geosciences. Amplifying the voices and experiences of students and professionals from underrepresented groups is key to identifying and understanding the barriers present in the discipline, and collaboratively constructing and implementing new resources to improve equity, inclusion, and accessibility.

The broader academic, research, and industry communities will benefit from integrating the core values and tenets of intersectional frameworks, such as DisCrit, to focus on the needs of the individual more thoroughly. Through such frameworks, the culture of the geosciences may become more equitable, inclusive, and accessible in the design and implementation of resources which support all individuals within the discipline. Intersectional frameworks exist to highlight the voices of the underrepresented because, "Those who have experienced discrimination speak with a special voice to which we should listen" (Matsuda, 1987, p. 63).

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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 authors.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Carla Wilson, IRB coordinator for the University of Cincinnati Institutional Review Board. The participants



provided written informed consent to participate in this study. Written informed consent was obtained from the individuals for the publication of any potentially identifiable data included in this article.

## AUTHOR CONTRIBUTIONS

IC and CA designed the study; IC conducted the interviews and lead the data analysis. Both IC and CA contributed to the final version of the manuscript. CA supervised the project. All authors contributed to the article and approved the submitted version.

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## AUTHOR DISCLAIMER

Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not

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necessarily reflect the views of the National Science Foundation.

## 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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