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# Learning in the Wild: Fieldwork, Gender, and the Social Construction of Disciplinary Culture

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## ABSTRACT

This paper examines the creation and negotiation of disciplinary culture, through ethnographic fieldwork about socialization in a critical learning environment: scientific fieldwork. Field-based science has received scant research attention relative to its importance as a degree requirement, a professional rite of passage, and a site where sexual harassment and assault are disturbingly commonplace. We conducted a comparative ethnographic case study of two field-based geoscience courses, one each for undergraduate and graduate students. The data include 264 hours of participant-observation and 34 interviews with students and faculty. Three prominent qualities of the culture — eroding temporal and spatial boundaries, navigating challenging conditions, and normalizing alcohol — reflect and/or reinforce disciplinary norms of informality, togetherness, and toughness. We observed these qualities and norms could be leveraged for exclusion or inclusion; they are tools that, together, create a gendered disciplinary culture. Some women resisted the narrow definition of these norms, reframing toughness to include mental toughness, for example. Implications for course design and field leadership, as well as the possibilities and limits of disciplinary cultural change, are discussed.

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Scholars of higher education have long recognized the importance of learning environments as a central factor in a variety of outcomes. Applications of the classic Inputs-Environments-Outcomes model found that individual student characteristics combined with characteristics of environments like their courses and major, explain variation in outcomes such as retention, academic performance, and sense of belonging (Astin & Antonio, 2012; Mayhew et al., 2016). In more recent research, environments including the classroom, discipline, and campus have been positioned as influences on student and faculty outcomes (Hurtado et al., 2012; Neumann, 2009; Neumann & Pallas, 2019). This tradition of inquiry has expanded our understanding of how cultural practices in different higher education settings shape perceptions and experiences of climate, as well as how context is associated with racial, gender, and intersectional inequities.

In this paper, we flip higher education scholarship's typical emphasis on the impacts of learning environments on students. Instead, we position students and faculty as agents who purposefully navigate, negotiate, and may collectively try to redefine gendered norms within learning environments. Indeed, higher education's learning environments and their associated cultures may be inherited, but they are not fixed. Rather, they are historically and socially constructed — the product of daily, continually unfolding, activities and interactions. In daily work within disciplinary and other academic environments, students and faculty participate in constructing — sometimes by renegotiating — the very norms and practices that produce effects on them. We need to understand these processes of cultural negotiation that ultimately reproduce or resist the normative behavior that perpetuates gender, racial, and other inequities.

Examining how students learn to participate in disciplinary-based learning environments can provide insights about how the disciplines are formed, reinforced, and negotiated — and what these processes mean for inequities in higher education. We investigated these sociocultural dynamics through a case of geoscience, a STEM discipline with especially low representation of women and people of color. Fieldwork is a central learning environment and site of socialization in geoscience (Mogk & Goodwin, 2012) that has high rates of sexual harassment and assault (Clancy et al., 2017, 2014; Posselt, 2020). Geoscience fieldwork therefore served as an apt empirical context for this research. The central questions guiding this study were: What characterizes the culture of field-based learning environments? How do fieldwork's cultural qualities and norms relate to one another and affect the inclusion, exclusion, and/or experiences of women? How do women negotiate prevailing norms? Our comparative ethnographic case study of culture in two field-based geoscience courses, one for undergraduates and one for graduate students, is distinguished by extensive immersion in the field, including a total of 264 hours of participant-observation and 34 interviews with students and faculty.

This design is informed by two important intellectual developments: 1) consensus about the potential for case studies to elicit theoretical generalizations (Bastedo, 2012; Eisenhardt, 1989; Lamont & White, 2005) and 2) calls from higher education and science researchers alike for more discipline-based education research (e.g., National Research Council [NRC], 2012; Perez-Felkner, 2019). Comparative ethnographic case study yielded data about complex challenges to equity that would not have been possible with other methods. More specifically, we find core cultural qualities of the learning environment are a double edged sword, serving as both microfoundations of exclusion and creating grounds for powerful learning and connections. That core qualities of a culture are tools that can ultimately be used for and against equity may help higher education researchers seeking to understand how

faculty and students continually rationalize, reinforce, and renegotiate culture within the myriad contexts that constitute higher education learning environments.

## Literature review

In this section, we synthesize research about scientific fieldwork as a learning environment and discuss the construction of gender within educational and scientific environments. Conclusions of this review provide the grounds to shift from a framing of the discipline as an environment that operates as a social context or force *on* its members, to the discipline as a context being socially constructed — that is historically and presently unfolding.

### *Field science as a learning environment*

Within the geosciences, extended field-based science is a requirement for college degrees, a professional rite of passage, and critical for knowledge production. The field presents opportunities for conceptual, integrative learning (Hoisch & Bowie, 2010; Mogk & Goodwin, 2012; Nuñez et al., 2021; Stokes & Boyle, 2009; Whitmeyer et al., 2009) as students apply textbook knowledge to analyzing the structure and history of physical landscapes (Feig, 2010; Lock, 1998; Oleson, 2013). As in other disciplines, a transition toward independent scholarship often defines advanced learning in the field (Nuñez, et al., 2021; Posselt, 2018), with undergraduate students learning basic practices like mapping and measurement techniques in scaffolded groups and graduate students transitioning to solo, dyadic, or small group field projects (Feig, 2010; Mogk & Goodwin, 2012). The difference for field geoscientists is the expectation that students will come to lead research not in familiar, well-defined campus settings, but as this paper title notes, in the wild. As in social science field research, fieldwork is therefore distinguished by naturalistic, rather than experimental, inquiry. However, the field is as much a source of personal adventure and growth as a source of subject matter learning and data. Geoscientists relish chances to regale each other with stories of encounters with wild animals or foreign law enforcement, of finding oneself stuck in a heat wave or a storm that suddenly blew in, and of relationships born around a rock outcropping or campfire. Fieldwork is central to geosciences' disciplinary cultures and the identities of many within it (e.g., Feig, 2010; Fuller, 2006; Lock, 1998).

Although fieldwork can offer a transformative environment, people from historically underrepresented groups also regularly experience marginalization, threat, and violence. Students of color in the field usually lack role models and peers from their own backgrounds (O'Connell & Holmes, 2011). The shares of women doctorates and faculty in geosciences have increased over the

past 40 years, but the discipline continues to have a lower share of women bachelor's degree recipients (40%) than STEM disciplines as a whole (55%) (NSF, 2017). Among current geoscience graduate students, only 8% are Black, Latinx, or Native American (National Science Foundation [NSF], 2016), and at later stages, just one in five of tenure-line faculty in the top 106 geosciences programs in the U.S. are women (Glass, 2015).

Almost 80% of women in one recent survey reported experiencing sexual harassment in academic fieldwork settings. One in four reported that they had been victims of sexual assault while working in the field (Clancy et al., 2014). Another survey found that 66% of respondents experienced sexual harassment at a field site, with 38% reporting that harassment had “stymied their careers” or “caus[ed] them to question their abilities and their future in the discipline” (Meyers et al., 2014). Several high-profile sexual harassment and assault cases involving scientific field researchers (e.g., Wadman, 2019) have in fact prompted U.S. federal agencies to issue no-tolerance statements, policies to terminate funding for violators, and new accountability mechanisms to monitor the conduct of scientific investigators who receive federal funding (National Academies of Sciences, Engineering and Medicine, 2018). However, these policies have failed to address the engrained norms and values of the culture of field research, which over time have legitimated work styles that make gender more salient. This must be addressed because, as higher education research has documented, changes in demographic representation are rarely sufficient to create learning environments supportive of historically underrepresented students (Hurtado et al., 2012; Posselt, 2020).

### ***The construction of gender in education and science***

To examine the social construction of learning environments that may perpetuate gendered exclusion, it is critical to examine how gender is constructed in organizations. Organizations construct gender at three levels — through structures, interactions, and cultural beliefs (Ridgeway, 2009). Structures include policies and established practices that allocate rewards and resources, and they bring order to work and learning. Federal agencies' focus on policy interventions is consistent with a structural focus in the literature on gender inequities in science. A structural emphasis assumes that policies and incentives affect wide scale stratification patterns, and can motivate individual choices, pathways, and organizational behavior (Riegle-Crumb et al., 2012; Xie & Shauman, 2003). The second level, interactions, includes patterns of communication and action that have mutual influence on the people involved. Within educational and scientific institutions, evidence points to the power of interactions, experiences, and perceptions of one's learning environment (i.e., organizational climate) as drivers of persistence and perceived belonging (Harding, 2015; Lee, 2002; Riegle-Crumb et al., 2006). The quality of faculty-

student interactions is one of the strongest predictors of student satisfaction and degree completion (Mayhew et al., 2016). A third, emerging paradigm for understanding the construction of gender focuses on cultural beliefs. It attends to norms, values, and assumptions within scientific learning environments and workplaces — and their consequences. Cultural analyses track widely held beliefs, routines, norms, and identities which develop over time and often favor the groups who developed them and predominate numerically within a given context.<sup>1</sup>

To summarize, gendered cultural beliefs pattern interactions, which are used to rationalize structural arrangements (Ridgeway, 2009). Shifts in macro-level stratification patterns cannot be sustained without negotiating the micro-level institutionalized beliefs, norms, and social interactions through which structures of scientific work are enacted. Beliefs, interactions, and structures alike are often laced with unexamined power gradients: the steeper these gradients, the more negative perceptions are of the climate among those who have been disempowered within it (Fox, 2006; Harding, 2015; Posselt, 2020). In this study, we focus on interactions and cultural beliefs in field-based learning environments, which have received substantially less attention in prior research, despite holding significant implications for the engagement of women, people of color, and individuals with disabilities in the discipline.

### Historical and theoretical perspectives

Theories of disciplinary cultures and social boundaries informed our research on the cultural dynamics of geoscience fieldwork that may perpetuate or challenge engrained norms in the discipline. Following Swidler (1986), we understand culture as a “tool kit of symbols, stories, rituals, and world-views, which people put to use in varying configurations to solve different kinds of problems” (p. 273). The toolkit includes both vehicles that transmit and practices that create culture, through which shared meanings are created, expressed, and reinforced. Today’s scientific cultures are situated within distinct, but overlapping disciplinary histories, which have legacies of inclusion and exclusion (Becher & Trowler, 2001; Lamont, 2009; Milem et al., 2005). These histories reveal roots of shared meanings and cultural practices that are evident and up for negotiation today. They also offer a starting point for understanding today’s inequities and the challenge of disciplinary cultural change (Posselt et al., 2019).

Geoscience is not alone as a discipline whose history includes social exclusion, economic exploitation, and natural resource extraction (Posselt, 2020; Yusoff, 2018). From the formation of the geosciences in early 19th century Britain into the 20th century, exclusion from professional associations blocked women from most geoscience networks and collaborations, limiting their engagement and undermining recognition (Winchester, 2001).

In the United States, geologists' mapping work facilitated westward expansion efforts including construction of the Pacific Railroad (Turner, 1994) and highway system. This infrastructure transformed the landscape and reduced transportation costs of future geoscience research, enabling geologists to examine even more deeply the West's mountains, basins, and ranges (McPhee, 1981). To this day, much geoscience fieldwork in the U.S. is carried out on Native American lands. During World War II, the U.S. Military Geology Unit provided intelligence for the Normandy invasion, and this unit was run through the US Geological Survey until 1975. Settler colonial and conquest mind-sets that underlie exploration and military activities are associated with hegemonic, toxic masculinities (Banet-Weiser & Miltner, 2016; O'Connell & Holmes, 2011). Their legacies may include beliefs, styles of interactions, and social structures (Ridgeway, 2009) in which geoscientists may be socialized to misrecognize as normal sexist norms and interactions that marginalize or mistreat women.

### ***Boundaries and socialization***

Given our aim to understand the field as a distinctive learning environment, we also employed theories of symbolic and social boundaries to frame our research. Temporal and spatial boundaries organize social life generally, and learning environments specifically. As these boundaries change, new ways of interacting become possible (Tilly, 2004). The fine distinctions people make between themselves and others, as well as those they make to organize time and space, are useful analytic tools in understanding culture; norms for individual behavior and community life derive from boundaries (Zerubavel, 1993). Norms serve a subtle controlling function, quite literally "disciplining" behavior of people on one side of a salient symbolic (i.e., conceptual) or social (i.e., group) boundary. As such, the ways people define themselves in relation to social boundaries can reproduce inequities by creating the grounds for excluding some from full membership and including others (Lamont, 1992). "At the causal level," write Lamont and Molnár (2002), "symbolic boundaries can be thought of as a necessary but insufficient condition for the existence of social boundaries" (p. 169). Boundaries can become engrained to embed inequities, but can also be erased, deactivated, transferred, translated, and/or relocated to encourage inclusion (Posselt, 2020; Rao et al., 2005; Tilly, 2004).

Students participate in a process of socialization as they learn the cultures of their disciplines and how to navigate the boundaries. We conceptualize socialization as progressive membership, developed by learning a community's values and norms, everyday practices, cultural knowledge, and appropriate roles (Van Maanen & Schein, 1977). Through educational exercises and other life activities in the field, aspiring geoscientists learn what constitutes "good



science,” appropriate behavior, and the prototype of who embodies them (Hogg & Reid, 2006; Hogg & Turner, 1985). Mogk and Goodwin (2012) describe how this experience plays out in field environments, and the power of temporal and spatial boundaries to shape it:

Through all of this interrogation of the landscape by using the tools of field geology, such as lenses, maps, and compasses, the students begin to gain an understanding of the transformations that occurred in deep time that produced the landscape through which they are now walking. Simultaneously, they find themselves transformed as individuals, on a scale of hours and days, from rank novices into developing geoscientists. (p. 133)

Over years, such learning shapes a sense of belonging (or lack thereof) and “professional vision” in the field (Goodwin, 1994), and thus, influences students’ emerging scientific identities (Austin, 2002; Bess, 1978).

Though usually cast as a flow of cultural influence from dominant groups to individuals, socialization may also involve reciprocal influence, particularly as a critical mass that has historically rarely participated in some group, such as women, enrolls and engages in greater numbers (Tierney & Bensimon, 1996). Engaging with the presence, knowledge, and behaviors of new members can catalyze reflection or dialogue on the part of established group members, creating the potential for reassessment of “the way we do things around here” and even catalyze innovations (Dobbin et al., 2011). Knowing how women and other members of marginalized communities negotiate disciplinary cultural norms is therefore critical to appreciating the future of a given discipline as anything other than smooth continuation along a trajectory inherited from historical tradition.

Through what mechanisms might scholars negotiate or redefine typical norms? One possibility for field scientists is via the inherent risks, challenges, and unique possibilities of their work in a less constrained environment than the campus affords. As we learned by conducting ethnographic fieldwork on scientific fieldwork, the field presents physical and psychological risks, and with it, a strong affective experience: “Field studies provide the opportunity to study phenomena in open, unconstrained, dynamic, and complex systems” (Mogk & Goodwin, 2012, p. 135). Although geoscience field research does not have the formal reflexivity imperative of ethnographic fieldwork, some risks and challenges are widely acknowledged (e.g., Davies & Spencer, 2010; Monaghan, 2006). Alcohol, isolation, and physicality are widely acknowledged as potentially problematic. Women—especially women of color — may bring with them prior socialization that leads them to experience established risks and challenges in scientific learning environments differently than scientists who have been socialized to prevailing masculinities. To evolve disciplinary cultures, we must investigate how cultural norms are rationalized, reinforced, and renegotiated. Such investigation was the goal of our research.



## Settings and methods

Although ethnographic research in higher education is relatively rare (Jones et al., 2014), the extended immersion that it affords was required to examine how faculty and students form, reinforce, or negotiate disciplinary cultural norms. We employed methods of comparative ethnographic case study (Eisenhardt, 1989; Rhoads, 1995) as tools of cultural analysis, in this case to examine and compare norms of geoscience undergraduate and graduate learning environments. This research was part of a larger collaborative effort between two social scientists and an interdisciplinary team of geoscientists to develop professional opportunities for geoscience field instructors to develop more inclusive field courses (Posselt et al., 2019).

### *Site selection and data collection*

In Summer 2017, we each collected data in one field course: AuthorRedacted was a participant observer in an undergraduate geology-based course in the Rocky Mountains, primarily involving senior-level students, and AuthorRedacted was a participant observer in a graduate-level interdisciplinary geoscience course on the west coast. To identify suitable case study sites, we used purposive and criterion sampling to identify fieldwork courses that served different student populations. We aimed to select courses known for being typical for summer field-based learning experiences, seeking alignment with the “typicality” standard that Merriam (2009) suggests for case study selection. In terms of criteria for course selection, we selected courses that focused on earth science, because most field courses, especially capstone courses, focus on earth sciences (i.e., as opposed to atmospheric or marine science, which are also part of geosciences). We then decided to observe both an undergraduate course and a graduate course to gather insights about students’ field experiences at different stages of their education; the field as a site of progressive disciplinary membership has been part of this project from its conception. With the help of the geoscientists on the larger project, we obtained information about five possible fieldwork courses that fit the criteria we collectively identified, and identified two instructors of record for informational interviews, to further assess fit with the criteria and to explore possibilities for site access. These two instructors each agreed to participate in the study.

Each learning experience was “intrinsically bounded” in space and time (Merriam, 2009, p. 41), but have been offered every summer for many years in the same place where data collection occurred in Summer 2017. One researcher observed one of the courses and the other researcher observed the other course. All students, teaching assistants, and instructors participated in the study. The sample as a whole is summarized in Table 1. In this table, to

**Table 1.** Participant sample.

|               | Location                            | Instructors          | Students | Students of color | International students | Women students |
|---------------|-------------------------------------|----------------------|----------|-------------------|------------------------|----------------|
| Undergraduate | Rocky Mountains                     | 2 faculty;<br>4 TA's | 23       | 39.1%             | 17.4%                  | 34.5%          |
| Graduate      | Sierra Nevada; Island field station | 3 faculty;<br>5 TA's | 17       | 17.6%             | 47.1%                  | 47.1%          |

protect the anonymity of students of color in these relatively small courses, we classified all students who did not identify as white as students of color. Descriptions of data collection in each site are offered below.

The undergraduate course closely resembled the curriculum, pedagogy, assignment, and length of a typical undergraduate field course (Feig, 2010; Mogk & Goodwin, 2012; Oleson, 2013). At least 25 other undergraduate field courses, involving over 1,000 seniors from institutions all over the U.S., employed the same geographic location for their field courses that summer, which is a relatively large share of the undergraduate geoscience students nationally, considering that 7,283 seniors graduated in the U.S. in geoscience that same year (NSF, 2017). The field camp observed for this study was typical of the sort required of undergraduate geology students. It focused on developing basic geological skills (e.g., identification and measurement techniques) used for mapping the physical environment. Two five-day cycles of field activities were observed to allow for full exploration of the topic matter (Jahren, 2016). This totaled 112 hours of observation, which were complemented by 12 in-depth, semi-structured interviews with students and four interviews with instructors.

The five-week graduate course observed was typical of graduate coursework in the field, combining structured exercises and original research that were based on field-originated questions and data. It is a widely-respected well-funded opportunity in the geosciences that enjoys sponsorship from multiple universities and corporate donors. The course is multigenerational and international, led by four full-time faculty instructors, four TA's, and guest lecturers from a variety of universities. A central learning goal is providing exposure to emerging methods in geosciences. The course is therefore structured in three phases: a one-week field excursion to collect data and conduct field analyses; two weeks of lab rotations on an elite university campus to learn the latest technology for analyzing their field-collected data; then back into the field for 11 days at a second field site, a field research station with several laboratories. Throughout, evening seminars were part of the daily rhythm. Observations covered all activities of the first week's field trip; one day of lab rotations on campus; and the second 11-day cycle of fieldwork, lectures, and lab activities. Approximately 152 hours of participant observation took place, complemented by 13 semi-structured interviews with students and five interviews with instructors.

These two field courses were ideal for our research for a few reasons: Each included sufficiently prominent roles for women that we could expect gendered norms for field science not only to be present, but also salient and perhaps actively negotiated. Both courses had at least one woman instructor and a critical mass of women students. Having been carried out over decades, each course also had well-established schedules, routines, modes of interaction, and internal traditions that made them suitable for cultural analysis. Participants were fully immersed in the group over weeks, separated by hundreds or thousands of miles from campus. Intense engagement and physical distance from usual institutional accountability mechanisms may contribute to behaviors that compromise safety and inclusion; therefore, these courses' remote locations not only made them suitable as case studies, but suitable cases of environments where women are more likely to be at risk for mistreatment.

### **Observation**

As participant-observers, we resided in the same dormitories or apartment complexes where students and instructors stayed; completed day trips with them to field sites for mapping, data collection, and more; and attended meals, meetings, social events, and work sessions. We participated in one-on-one, small-group, and large-group activities, striving to understand routine interactions at different scales. At both sites, extensive field notes focused on group and dyadic interactions, how the physical environment affected student experiences, episodes in which moments where social identities became salient, and field instructors' behaviors in crafting and managing the learning environment (which we take to include their schedule and exercises for students as well as their practices for navigating the spatial/geographic environment).

### **Interviews**

During the courses, we also conducted 30–60 minute individual interviews with as many leaders and student participants as possible, totaling 34 interviews across the two fieldwork courses. We inquired about their experiences with field-based science and how those experiences related to their identities, perceptions of the climates for learning and diversity within the course, interactions in the field which they construed to be important, and meanings of activities that surrounded formal scientific activity. Each participant received a pseudonym to protect their confidentiality, and the interviews were transcribed verbatim.

### **Data analysis**

Data analysis was iterative and comparative, utilizing the constant comparative method's open, axial, and selective coding processes (Glaser, 1965). We began by reviewing our field notes several times to generate open codes based

on frequency and/or salience to participants, and which were relevant in both courses. Because existing literature informed the development of the interview and observation protocols, we also drew on sensitizing concepts (Bowen, 2006) based on that literature to guide our early interpretations of observation and interview data. At the same time, we identified patterns that were not anticipated in our initial protocols. For example, the protocols did not include questions directly about alcohol, but because drinking alcohol was a common activity at both sites, we created additional initial codes (Saldaña, 2015) about the role of alcohol in field courses. We then proceeded to focused analysis of the field notes and interview transcripts using this set of common codes, meeting regularly to discuss convergence and divergence in the prevalence and examples within each course.

Through axial coding, we generated themes that cut across both cases (Emerson et al., 2011), contextualizing them for each course according to their 1) different student populations, 2) students' differing prior exposure to fieldwork, and 3) different course structure and staffing. Finally, we conducted a cross-case comparison to identify broader patterns of divergence and convergence in the two cases. For example, as we note later in the findings, we found that subgroups of women in both courses created ways to navigate the field that were different from those of the whole group. However, we also note that women in the graduate course were more likely to emphasize the physical strength they had, while undergraduate women were more likely to support one another in handling limited physical strength. In another example, the graduate course's facilitators purchased alcohol for students and brought it to the field, whereas the undergraduate class members had to go out and purchase alcohol, either at a bar or at a liquor store. Therefore, although we found both sites legitimized alcohol as part of the norm of togetherness, we also noted variation in the prevalence of and social dynamics associated with alcohol between the courses. In this paper, we foreground gender, given our sample. However, additional findings with respect to social identity (e.g., religion and race/ethnicity in the undergraduate course, national origin in the graduate course) would have come through clearly if we were conducting only single-case studies of each class, rather than seeking patterns across them.

### ***Positionality***

As social scientists, our goal has been to understand dynamics of inclusion and exclusion in field courses. Neither of us had participated in geoscience fieldwork prior to the study, so we were newcomers to the culture of this type of fieldwork. We both identify as women and are sensitive to gender dynamics in groups. Each of us was physically fit and able-bodied enough to fully participate in and observe the physically challenging field conditions that involved several miles of hiking a day, often at high altitudes, in hot weather and on

rocky terrain. One of us is a white woman from the U.S. and the other is Latinx. Given the span of our research interests and backgrounds, we brought multiple personal and professional perspectives to bear on the framing and interpretation of the results.

### **Trustworthiness**

We independently coded transcripts and field notes from the different sites, before comparing memos and refining themes with one another, to enhance trustworthiness of the study (Saldaña, 2015). Immersion in the field, collection of data from multiple sites, and collection of multiple sources of data also augmented the trustworthiness of the results. In addition, we conducted three rounds of expert checking of the early findings with different groups of geoscientists. In total, about 130 geoscientists offered feedback. In their reviews of preliminary results, they expressed that our findings resonated with their own experiences. Other than indicating that the results could vary according to the specific subdiscipline of geoscience, they did not suggest any changes to the interpretations.

### **Limitations**

The potential to investigate dynamics of inclusion and exclusion in the field according to social identity was limited by the racial/ethnic composition of the courses that we observed. Although the representation of undergraduate students of color in the field course was slightly higher than the representation of undergraduate students of color across the nation in geoscience (NSF, 2019), the graduate class had a very low share of students of color. These conditions limited our capacity to explore the social construction of race/ethnicity in the field. This precluded the possibility of an intersectional analysis of how multiple social identities are experienced in the field. Through a separate analysis of just the undergraduate course data (Núñez, Rivera, & Hallmark, 2020), and a comprehensive literature review on diversity in geoscience (Mattheis, Murphy, & Marin-Spiotta, 2019), intersectionality has been found to be a salient lens in understanding inclusion and exclusion in fieldwork.

Furthermore, both courses examined in this study focused on just one subfield of geosciences, earth science, when geoscience encompasses also other fields like atmospheric science, marine science, and ecology. Cultural practices and even gendered norms in learning environments for other subfields may be different from those in the type of field course that we observed. Growing concern about sexual harassment and assault in subfields such as polar science (Wadman, 2017) and oceanography (Voss, 2017) suggest that additional, context-specific research is warranted.

## Findings

Our analyses across two courses indicate that fieldwork culture is marked by distinctive qualities that render it a double-edged sword for inclusion. Three core qualities — eroding temporal and spatial boundaries, navigating challenging conditions, and normalizing alcohol consumption—characterize the distinctiveness of fieldwork, and its associated learning environment and community. However, these qualities of the culture could also become the basis for exclusion or marginalization, particularly depending upon one's gender, physical ability, and/or past experience with the outdoors.

Three norms took hold in this mode of life together — informality, toughness, and togetherness. Eroded boundaries supported informality and allowed time for ample mentoring that women did not always receive on their home campuses. Challenging conditions upheld toughness as normative, and alcohol was legitimated as a reward for fieldwork participants' toughness and a tool for encouraging togetherness. Women navigated these norms not only by adhering to them, but also in some cases by 1) taking advantage of them for one another's advancement, and 2) resisting the narrow definitions constructed by these norms to protect their own belonging. The findings are structured according to these themes, with insights about the roles of community norms and their renegotiation woven into the narrative.

### *Erosion of boundaries*

In the field, typical spatial and temporal boundaries defining the learning environment were eroded, not unlike the landscapes geologists studied. This erosion modified relational boundaries that define interactions. The field's distance and difference from everyday campus life necessitated and enabled new ways of interacting. We observed that eroded boundaries created the potential for negative (e.g., unprofessional, gendered) and positive (e.g., peer mentoring) interactions, and that eroded boundaries encouraged norms of informality and togetherness.

### *Temporal boundaries*

On a daily basis at both sites, field activities lasted 4–9 hours in duration instead of the typical 1–3 hour periods for lecture or lab. All time in the field courses was effectively class time. Instructors, teaching assistants, and students slept in the same dorms or apartment complexes; ate around the same fires, tables, or dining hall; and socialized in the same places. For example, on a typical day in the graduate course, students would be up by about 6:00am, with organized daily activities extending to 9:00pm each evening, and informal activities extending often late into the night. The class would gather near vans

at 6:30am or 7:00am, travel for 30–60 minutes, then hike and conduct experiments and exercises in the field for 5–7 hours, before returning to their lodging for group work, dinner, and a 7:30pm evening seminar. After this, many would linger for continued conversation, research, and drinks. Conversations about science, work, and life thus became possible at literally any hour of the day. The undergraduate course followed a similar rhythm, with longer daily periods of hiking (eight hours) and fewer formal evening meetings, but more time designated in the evenings to complete assignments or socialize.

Erosion of temporal boundaries happened quickly, and we noticed firsthand that separation from campus and its schedule made it easy to lose track of what day and time it was. People experienced a shift to what several called “field mode.” On the first day of driving to a field research site, vans in the graduate course drove past a small church that served as a landmark in noting where to turn. A passenger said, “Hey it’s Sunday morning. We could go to church.” The driver commented that it was actually Monday, eliciting a good laugh. “We must be in field mode. There goes time and space,” the first person said. “Poof!” another replied. They were clearly amused that it had only taken one day for them to lose track of time. Expectations of constant togetherness and of all-day-every-day science meant both that they could be more informal about tracking time, and that those with specific time needs (e.g., diabetics’ need for insulin, practicing Muslims’ need for prayer) found themselves nearer the margins than the core of community life.

### ***Spatial boundaries***

Field culture also relaxed divisions between spaces and their associated purposes. Participants roomed with one another; packed themselves and their gear more tightly into vans than any setting on campus would require; and conducted their science without walls, chairs, tables, or much of the usual equipment. Exercises in field sites might also require small group members to spread out over a mountainside shouting their measurements and observations. Space unbounded required continual practices of creativity, resourcefulness, and flexibility. Every instructor in the graduate course quipped the line “Roll with it” at least once, and modeled strategies for sharing, improvisation, and informality in the absence of usual resources. Lacking a particular tool one day in the field in the graduate course, for example, a TA repurposed for scientific use a plastic spoon brought for his lunch — until water from a hot spring melted it, which led the small group to improvise all over again.

Most of the students in the undergraduate course were conducting outdoor fieldwork for the first time, and instructors used informal language to encourage the class to move closer to the rock outcrops so that, in the words of one instructor, they could learn how to “see far, and also see up close.” When



students appeared hesitant to step forward, instructors urged them with phrases like “Get your nose in it!” to look closely and share observations. Women were less likely to move forward first to look at the rocks even then, but did so more freely in small groups composed of all women and as time went on in the course.

Boundaries on acceptable uses of the learning environment also relaxed, and it was not hard to see how norms of acceptable interactions might blur along with this. Instructors unofficially condoned a group of male graduate students running extracurricular experiments from their kitchen table. Among the several apartments in use, the kitchen and living area of the course coordinators’ apartment was repurposed as the “food condo” for the entire group. Students and instructors would trickle into it early to get a bite for breakfast, a cup of coffee, and to prepare lunches for the day in the field. Then, they would return late afternoons after field exercises for drinks and dinner. Another instructor’s apartment — the site for evening lectures and leisure — was designated the “lecture condo,” and a third whose counters and kitchen table held microscopes was designated the “lab condo.” Everyone knew whis-key was also in the lab condo.

In the undergraduate course, common space in the dormitories simultaneously served as space to work and socialize. Further, because field courses from other universities also used the dormitories, the common space was not always available for the participants’ use, so participants would work in their bedrooms. Undergraduates sometimes socialized later at night in local bars, eroding the social boundaries between course participants and town residents. These combinations represent the broader pattern that we observed: that though spaces are still needed for specific activities of work and life, being in the field does not permit their typical forms or the privacy that people enjoy.<sup>2</sup> It is not hard to see how in this type of setting, boundaries on personal space became difficult to protect. We turn now to discuss the positive and negative gender implications that come with eroded boundaries for interactions in this learning environment.

### ***Interactional boundaries, togetherness, and informal mentoring***

With interactions no longer limited to certain hours in certain spaces with certain resources, togetherness became normative and science was truly collective—either carried out in small group or whole class activities. Faculty and students learned to engage in a continuous, informal stream of (mostly) science-centered life together. Some loved it. As one woman graduate student put it, “the longer the field season the better as far as I’m concerned because . . . your brain gets in that mode.” For others, the loss of familiar structure to time and space, and the loss of privacy and of autonomy over one’s time, lent a sense of disorientation which took time to settle into and adapt to as a new

normal. It is our judgment that this is due to a loss of personal control over one's engagement in the learning environment that comes with eroded boundaries. A culture in which the *modus operandi* is "Roll with it," in a learning environment with eroded boundaries, may privilege collectivism; however, it appears to be at the cost of empowering students to engage on terms that feel safe to them. It is not hard to see how the field is cast as a rite of passage, nor how in such an environment, consent might also be threatened.

No longer constrained by the usual work day or week, nor by expectations of campus life or commuting to individual homes, informal mentoring conversations became commonplace, especially among women students. These conversations provided encouragement, information, and strategies for finding opportunities; they surfaced possibilities of different professional choices than those to which they had previously been exposed. In our interviews, both undergraduate and graduate students spoke of the power of getting to know their instructors "as people" who had career trajectories of their own. For example, between measurements of rock outcrops, one undergraduate woman asked another, "Have you gotten involved in research yet?" The other student said, "No, but I'm hoping to, on this trip. I am interested in volcanic rocks, and so I want to ask Dr. Stokes (a pseudonym) if I can work with her when she is leading camp." "That's great," the first student said, adding, "it's good that you can get to know the professor." Similar conversations took place in meal lines, drives to and from field sites, and while relaxing together in the evenings.

Similar mentoring in the graduate field course covered everything from the faculty job market and negotiating offers, to managing sexism, to counter-normative career paths. As in the undergraduate field course, these discussions could take place at any time or place. On the first full day, a group of four women ate lunch in a patch of shade in the grass and discussed their career decision-making processes, their hopes for the long term, the internships and fellowships they had pursued, and constraints on doing what they wanted. Informally, they provided each other advice and perspective. One commented authoritatively, "There are lots of ways to be a scientist." She then discussed how this viewpoint emerged through a summer fellowship for women in science. A third woman expressed interest in the same fellowship, and later, they exchanged details about application. Although the vast majority of informal mentoring that we observed was among women, a cross-gender network opening occurred when a male instructor in the undergraduate course asked a woman student of color about her post-college plans. When she mentioned going to graduate school, he said, "Good, I'll put you in touch with my colleague who does research in that area." Such conversations rarely occur among geoscientists on campus, we learned from participants, making fieldwork a means of both learning the field and managing the opportunity structure.

### ***Challenging conditions and the norm of toughness***

The challenging conditions of fieldwork are a second core quality of this learning environment, and reinforced toughness as a cultural norm. As with eroded boundaries, the challenging conditions for scientific learning and work presented a double-edged sword for inclusion. We observed that, on the one hand, most participants viewed challenge as inherent to the value and distinctiveness of field science. The immersive nature of the work—becoming part of the physical system you study—facilitated a learning experience that simply could not occur on campus. As one graduate student of structural geology described it:

Learning in the field is the only kind of learning. I think the physicality of it, of being able to touch something, of walking over something to realize how far it is or how long it is. Say, ‘Well, did that feel like a short walk? No. You just walked over 700 meters of carbonate.’ There’s nothing like thinking around it in that way. Like – you get to be inside it, so you get to look along a ridge & see how far it goes. You are in the layers! You can be at the point where when it’s deposited, as if that stuff above it hasn’t arrived yet.

Though the physicality of the work could be difficult, it enabled immersion “in the layers” rather than “thinking around it.” Social benefits came with fieldwork’s physicality, according to most students. It developed their work ethic, enabled them to work efficiently, think independently, make decisions, build confidence, and communicate with others more effectively. We present the evidence for these learning outcomes in another paper from this project (Núñez, et al., 2021).

Others talked about taking in the fresh air, Vitamin D, and majestic landscapes. Together, these experiences created a unique sense of doing science. Participants described the essence of fieldwork as more than scientific knowledge. Students in the undergraduate course emphasized that fieldwork “brought to life” what they had learned in their past coursework, and those in the graduate course framed fieldwork as a site for “knowledge plus inspiration.”

On the other hand, the intense physical demands of hiking 5–10 miles a day at high elevations, often at high temperatures without access to shade, reinforced conventional norms of physical toughness that privileged men and the most able-bodied people in the course. Certain days and moments in the courses epitomized this trend. The group photo for the undergraduate course was taken at the top of a mountain that not all of the students were able to climb. The graduate field course happened to coincide with a major heat wave, making the high desert settings for field excursions all the more intense. It was telling that even the most fit women in that course experienced dizziness on the hottest days. It was equally telling that these same students had so internalized the disciplinary expectations of toughness that they confessed they never would admit their dizziness to their instructors, so concerned were they that it would elicit negative judgments of them.

### ***Resisting a narrow conception of toughness***

When what counted as valued, normal behavior left them vulnerable to exclusion, some women in each class did not passively sit back and follow this behavior. In addition to reframing professional norms about career trajectories through peer mentoring, women in both courses negotiated with one another the hypermasculine norm about toughness. Here, however, findings from the undergraduate and graduate student data diverged: some women graduate students enlisted each other in solidarity to broaden the meaning of toughness, whereas some women undergraduate students provided each other with mutual support.<sup>3</sup>

### ***Graduate students: Performing strength with ease***

Women graduate students, who had more exposure and socialization to disciplinary norms and practices than did the women undergraduate students, knew the social premium placed on togetherness and keeping up with the group through difficult conditions, and on performing that they could hold up well in these conditions. For example, two women disclosed in informal conversations while hiking that they had learned to “hide their struggles” or to “pretend I’m feeling strong” in the field to fit in; although the data do not indicate whether or the extent to which other women felt similarly. A group of 4–6 students and instructors — all white women — worked together to perform a new version of toughness to fit in, which we call strength with ease. Congruent with a disciplinary emphasis on toughness, they enacted strength with ease through lifestyles centered on physical fitness. However, they challenged a more narrow conception of toughness by adding an emphasizing the importance of mental toughness—not just physical toughness — to succeed in the field. Specifically, they regularly exercised together in the early mornings (e.g., meeting for 3–6 mile runs at 5:00am) or late afternoons, before or after field activities.

During participant-observations of three such workouts, these women reflected together on how their own success to date had required as much “mental toughness” and “mental determination” as the “grinding” and “soldier-like” approach to toughness that characterized men at the front of the pack in the field. With the larger group, we observed that these incredibly fit women not only had field stories to share with their peers, but also stories of long-distance trail races at altitude; climbing a 14,000 foot mountain “to see what my body could handle”; and swims in the open ocean for fun, research, and competition. We interpret their expression and amplification for each other and for the larger group the value of physical fitness and personal determination as efforts to communicate and broaden the group’s conception of toughness. However, this new prototype clearly depended upon having privileges of able-bodiedness, psychological well-being, and extreme physical fitness.

***Women undergraduates: Mutual support***

Women undergraduates also felt vulnerable under the toughness norm and worked hard to either keep up with the group or care for members who were struggling. While hiking to sites, it was not unusual to see all of the men ahead of all of the women. Women also tended to mirror one another, making measurements side by side and staying close to one another for group work. Men working in the same group, on the other hand, could be as physically far apart as 500 feet. As one woman undergraduate explained, “So guys and girls generally just, it seems like with being outdoors, they just naturally kind of separate . . . also, it’s about pace, too. Guys typically walk faster, and the girls just kind of take it a little slower and maybe take time for more detail.” Her comments highlight that approaching fieldwork more slowly covers less terrain, but holds the potential advantage of increased attention to detail. Indeed, when the instructor returned their first assignments, the only assignment held up as a model for including sufficient detail was one of the women’s.<sup>4</sup>

When confronting situations in the field requiring physical performance and toughness, women in the undergraduate course continued this pattern of support. The most difficult hike of field camp was up a steep mountain covered in scree and cactus. “I don’t think I’m going to be able to make it up,” one woman student said before the hike. “Don’t worry, we’ll take it slow,” another told her. Later, as students were winding up the mountain, the woman who had been concerned yelled, “I can’t hike because I can’t breathe!” The students looked up to see if any instructor or TA would respond, but the instructors were all out of sight and hearing distance. For about 5 minutes, two women students stood with the struggling student, breathing deeply, stooped slightly, their hands on their thighs. Then the three stood up, adjusted their backpacks, and continued to climb. In stopping for their classmate when the instructors could not hear or see her, going “slow,” and offering to wait for one another, women broke from the instructors’ example. Unlike women in the graduate course performing strength with ease, women undergraduates’ pace and support were strategies for navigating expectations.

***Legitimizing alcohol consumption***

A final theme concerns the role of alcohol in the learning environment, and here the gender implications are both direct and indirect. As with eroding boundaries and challenging conditions, alcohol clearly is a double-edged sword for inclusion. Our respondents spoke easily in interviews about the affordances of alcohol for their community, legitimating its prominent place in the culture. Yet as discourse around campus sexual assault has brought into focus, alcohol consumption in unbounded environments raises the likelihood that sexual boundaries will be crossed or social dynamics contaminated.

The geosciences has a reputation for beer drinking in particular, and it surfaced as important in our data as well, although more prevalent in the graduate course. As one graduate student commented of geologists, “If you like flannels and hiking boots, that’s great and it feels lovely.” But more than that, she said, “We are all proud of our beer drinking.” Alcohol was a fixture of the graduate course, with instructors providing a variety of options — along with snack and meal options—to students and instructors while staying in the field apartments. The course coordinator, Bonnie, judged this group to be “quite moderate” in its drinking relative to the course historically, but the ethnographic field notes for the graduate course were replete with observations of beer (See Table 2). Beer bottles were as commonplace an artifact of the culture as bottles of sunscreen, hats, rock hammers, and backpacks.

So prominent was alcohol in day-to-day routines that we added a question to our interview protocol to understand its role, and we probed for in-course or past field experiences where alcohol had been problematic in students’ views. Two logics for its legitimation dominated responses: Alcohol was understood as a *means of bonding* and a *reward for the hard work* of field science. Three-fourths of instructors across both courses spoke to bonding, describing how social drinking fostered connections, community, and the informal culture for which geology is known. A woman instructor connected this logic to scientists’ social awkwardness:

Maybe it’s that a lot of geologists deep down are like a little bit socially awkward, sometimes a lot, and that they’ve noticed that having like one beer or two beers like suddenly you feel like way more comfortable talking about your newest crazy idea . . . I realize that like there are people who don’t drink or people who have like, you know, have alcoholic issues. I realize there are problems with that because it’s not totally inclusive, but I think the idea, the point being to break down those social barriers so that you feel more comfortable talking to people is a good one.

A male instructor, on the other hand, connected beer to collegiality in the discipline:

Most geology groups and programs tend to be a little bit more collegial. Certainly, like chemists or molecular biologists or – um, they don’t tend to do that [i.e., drink as much]. And – and so that – well, for one, it makes it a more pleasant working environment, but it

**Table 2.** Patterns of alcohol consumption observed in the graduate field course.

| Dimension | Patterns Observed                                                                                                                                                        |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| What      | Beer (afternoon and evening, especially US students); Wine (evening and with dinner, especially international students); Hard liquor (evening, especially after seminar) |
| When      | As soon as possible after returning from the field, then through dinner and into the evening seminars and the night                                                      |
| Where     | In the designated food condo, but also in evening seminars, at the microscope or laptop in the evening, at a beach excursion, in the parking lot between apartments      |
| How much  | Variable by person and day, with TA’s who were men appearing to consume more than typical in the group.                                                                  |

does lead to a different style of sort of interacting and learning, and you're collaborating . . . It's part of the tradition. To the students, maybe it feels like it's less formal, or less rigid, or something.

Students also discussed alcohol in relation to geologists' interactions. One woman student referenced drinking as a way to develop connections with one's advisor:

Field work is really great because you get all this bonding experience with your advisor and with your coworkers and I think that that really helps form connections. You have these late-night moments where you talk about all of these different things and you're all sitting around, drinking beer together and I think that's really constructive.

Their comments highlight how alcohol is ultimately a cultural tool, one that changes the boundaries on interactions and reinforces two of the three cultural norms we found throughout our research: informality and togetherness.

A second logic, frequently cited by graduate students, is related to the norm of toughness. Some constructed drinking as a reward for the hard work that the field demands. Numerous participants used the phrase "at the end of a long day" to legitimate drinking after returning from the field, even if they started drinking mid-afternoon, before group work, dinner, and an evening seminar were to occur. A male student said, "If you go to the field, the day is kind of harsh and tough, so having your beer at the end of the day is always nice. I really have no answer for this. It's just like yeah, it's true that we drink a lot." A woman instructor said, "everyone is out in the field working together, it's hot or it's cold or it's like whatever reason, you all get back and you like have a beer and relax and like have really good conversation." In connecting beer drinking to the demands of the field, they legitimated beer as a reward for the difficulty of their work.

About one-third of the undergraduate class did not drink regularly, despite being of legal drinking age. We attribute this difference to several factors: The undergraduate class did not have alcohol delivered or provided, so students had to purchase their own at a local store or bar. Some students did not ever drink, including a group of Muslim students who abstained and another group who called themselves "homebodies." Finally, some opted not to drink to prioritize their academic work and prevent dehydration in the hot, dry terrain. As with undergraduate women deviating from the norm of toughness, it is unclear from our data whether the undergraduates purposefully resisted alcohol in the field or had yet to be fully socialized to its role.

### ***Women questioning the institutionalized status of alcohol***

Across both courses, though, not every respondent was comfortable with the institutionalized status of drinking. Those who spoke about it with us frequently connected their discomfort to gender dynamics. A woman graduate



student described alcohol in the field as, “a male thing. You bring your beers [to the field] just like you’d bring your beers camping or to a game or something.” One undergraduate ventured that some of her peers felt pressure to drink out of fear of not fitting into a mostly male class — a clear issue of belonging and social closure.

Several students and instructors—the majority women — articulated their discomfort in relation to the risks for harassment and assault. Some shared personal stories. For example, an undergraduate student expressed how, in a remote paleontology internship the prior summer, where she lived with other interns, “The most stressful part was actually the social interaction, not the work.” She described how a fellow male intern, “would say really awkward comments to the women, like sexual, and it was not comfortable.” She explained that the women in the group always made sure that they were together around him, to protect each other. Although she and other interns reported his behavior and poor job performance to their supervisors, the supervisors “. . . still didn’t do anything” to challenge or mitigate his discomfiting behavior, which was amplified by group drinking.

A woman student in the graduate course described how her relationships with two professors (both men) became strained following an incident just three days into her first field campaign:

On that Death Valley trip, three days in, our professors had a huge blowout [fight]. They’ve had a few beers, maybe a few too many beers, and the undergrads were like freaked out. I stayed up with one just talking about symmetry rocks to calm him down. Afterwards, the older professor apologized to me, right? He said, ‘I’m sorry.’

She accepted his apology, she said, and continued her reflection in our interview:

I felt grateful that he let me in on the course so I told myself like, ‘That’s Max. Max says inappropriate things.’ Like the time he told my friend, ‘Well, at least your boobs can get you a job even if geology doesn’t.’

Here, we see a woman directly connecting a professor’s “inappropriate” comments and misogynistic views to his behavior when under the influence of alcohol. We are also privy to the complex sensemaking that may be required to persist in environments where professors behave badly. She accepts his apology for assaulting a colleague while inebriated, in part based on her gratitude for a learning opportunity and in part based on her read of Max’s tendency toward “inappropriate” behavior. Whether or not women are directly harmed as a result of alcohol consumption, normalizing consumption raises risks and may create toxic social dynamics. In a learning environment where boundaries are already eroded (and where informality and togetherness are normative behavior), relying upon alcohol to encourage informal

interactions or as a reward for toughness may unwittingly normalize reduced inhibitions for behavior that everyone can identify as “inappropriate.” Such behavior may therefore go unchallenged and be perpetuated.

## Discussion

Through a comparative ethnographic case study of two geoscience fieldwork courses, we examined the social construction of gendered learning environments and their implications for equitable participation. In both the undergraduate and graduate courses, we found three cultural qualities of field-based learning environments — eroded boundaries, challenging conditions, and legitimizing alcohol — that provide a window into gender-based marginalization and inequity in the discipline. In this section, we summarize the findings, then situate them within extant literature and theory, before discussing implications.

## Summary

First, field culture breaks down typical spatial, temporal, and interpersonal boundaries that define campus learning environments. Eroded boundaries facilitated norms of togetherness and informality, on the one hand, which enabled informal mentoring through which women came to see new career trajectories for themselves in science. On the other hand, eroded boundaries expanded the space of risks that women felt that they encountered, and made the conditions of work more challenging.

That eroded boundaries could make the work more interpersonally challenging is especially important because a second core cultural quality of the field is the challenging conditions of fieldwork. Physical challenge gives rise to a uniquely powerful experience of learning, albeit one that reinforces conventional norms of toughness that privilege men and able-bodiedness. Some women resisted the narrow construction of toughness they encountered, by either elevating the value of mental toughness required in the field and performing “strength with ease,” or by actively supporting one another in going at their own pace. We found that a culture whose tagline was to “Roll with it,” within a learning environment whose boundaries were eroded privileged collectivism; however, what the class was expected to “roll with” was obviously more supportive of traditional masculinity. And women graduate students’ redefinitions of strength appeared in some cases to reify ableism. What they called “strength with ease” and “mental strength” could become new forms of privilege and embodied cultural capital.

Finally, a third cultural quality of the field was legitimating the prominent role of alcohol, even while acknowledging that it could be problematic. Participants across gender rationalized its potential to encourage connections and collegiality that make the geosciences distinct, and they constructed it as a reward for the

challenging nature of fieldwork and toughness it demands. Yet they also recognized consumption as a norm that marginalizes those who abstain, reduces inhibitions in an environment with already eroded boundaries, and indirectly raises risks for safety. Decades of research with college students and other young adults has found that alcohol use raises risk of the occurrence of sexual and physical assaults (Campbell et al., 2021), as well as the degree of victimization experienced by women who are sexually assaulted (Ullman et al., 1999). And, highlighting the importance of attending to indirect effects of alcohol on the culture of fieldwork, excessive alcohol use has also been found to inhibit bystander intervention in high-risk sexual situations among individuals who have high intent to help (Leone & Parrott, 2019).

In short, core qualities of the culture in field-based learning environments—eroded boundaries, challenging conditions, and legitimizing alcohol—are double-edged swords that can be used as tools for engagement or marginalization. This dual quality explains why some are ambivalent about redefining cultural standards in the name of inclusion: they see good reason to retain community-defining aspects of the culture, even as they recognize concomitant risks. However, this ambivalence—their willingness to stand up for and rationalize aspects of the culture that have the effect of exclusion—enables the reproduction of the disciplinary culture as a gendered context for learning and science.

### ***Contextualizing the findings***

Naming these dynamics through empirical research is the first step to opening a conversation about how a community can (re)construct cultural norms and how new members are already negotiating them. Through our deep look into educational experiences of one disciplinary culture, we hope to open a path for higher education scholars to seriously analyze and compare other disciplinary, campus, and course-based cultures (Trowler, 2001). It is in otherwise implicit socialization to these cultures that intersectional inequities in participation are reproduced, limiting the diversity of epistemological and ontological perspectives that enrich knowledge creation (Harding, 2015).

Becoming a field scientist in geoscience involves learning the subject matter and techniques of field science, as well as socialization to the role of field scientist and to the STEM community (Kim & Sinatra, 2018; Szelényi, 2013). Juxtaposing women's undergraduate and graduate field experiences in our research revealed a process of professional socialization unfolding over years, in which women did not simply absorb values as they gained exposure and experience. Rather, women students and TA's acted as "newcomer[s] [who] bring experiences, values, and ideas into the organization" (Austin, 2002, p. 97). In attuning to one another's physical struggles and adapting their pace to one another, women undergraduates demonstrated physical and social support as values. Compared to undergraduates, graduate students have had more exposure to field activity,

and thus more socialization to field culture. The ways that women in the graduate course strove to support each other in going at their own pace and to emphasize mental strength in the field were two ways that they worked to broaden—and strip hypermasculine gender norms from—the prototype of a good scientist. Finally, women’s informal mentoring shows how the culture of fieldwork can also facilitate access to social and cultural capital (Bourdieu, 1986) and reduce informational and social network barriers historically experienced by members of underrepresented groups in geosciences.

### ***Implications for designing learning environments***

Creating more inclusive learning environments requires those with responsibility for design and leadership of learning experiences to name, interrogate, and consider changing everyday practices that insiders take for granted as normal, but which alienate or present barriers for newcomers (Santamaría & Santamaría, 2013). By documenting what interactions unfold in a specific learning environment, how women experience them, and how newcomers negotiate the cultural dynamics, our findings can inform professional development for leaders who want to make their field courses more inclusive to women. These findings may enable geoscience insiders to see field culture as if from the outside. Such a perspective opens the possibility of more critical discussion of tacit, cultural norms like toughness. Field leaders are survivors of a system that first formally—and now informally — have excluded women and other populations. Therefore, leaders will benefit from reflection, perspective-taking, and dialogue to look beyond their own socialization and experiences (Boland & Tenkasi, 1995; Posselt, 2020). Professional development is critical to 1) raising field leaders’ awareness of how the current field culture privileges some students and marginalizes others, 2) envisioning combinations of more inclusive practices, and 3) harnessing resources to implement them.

The project from which this study emerged, Fieldwork Inspiring Expanded Leadership and Diversity (FIELD), convened 30 geoscientists leading field experiences across the United States for a three-day institute aimed at developing knowledge and skills necessary to address underlying cultural problems with current field experiences (Posselt et al., 2019). As scientists have begun to count inclusiveness among the norms for what counts as a good learning experience, design and implementation of more inclusive policies and experiences has followed. Some field camps and courses have adopted no-intoxicant policies, for example, recognizing that alcohol increases the risk of crossing interactional and sexual boundaries that need to be protected. Others have made a principled case against no-intoxicant policies, believing it healthier to keep alcohol out in the open rather than behind closed doors. To be sure, what steps should be taken to create safe, supportive learning environments for students from historically marginalized or excluded groups is an evolving conversation.

### ***Implications for theory and research***

In her discussion of scholarly identity formation, Neumann (2009) contends, “To understand what goes on in classrooms, researchers need to sit, watch, listen, and think with the teachers and students in them” (p. 230). Ethnography enables immersion with faculty and students in learning environments that inform their socialization, providing insights into how norms and behaviors are reproduced, reinforced, or challenged from moment to moment, in ways that have implications for equity in who participates in the discipline. Accordingly, we see implications of this study for theorizing and research on how learning environments in higher education are maintained, evolve, and can be reimagined to engage more diverse learners. We focused on the construction of a gendered culture, but there is great need also for understanding the racialization of learning environments (Ray, 2019; Rodgers, 2020).

For scholars of organizational culture in higher education, our focus on the construction of a gendered culture highlighted how prevailing norms could have dual — even contradictory — meanings and consequences for equity. For example, we found that eroded boundaries primed members for informal interactions. Informality became a critical aspect of the learning environment by enabling peer mentoring and integrative learning interactions, but also perpetuated interactions in which women’s concerns were overlooked, ignored entirely, or possibly even violated. Future research should examine patterns of interactions more directly, and consider how they dis-incline women to speak up about other compromises to equity and inclusion, such as threats to their safety and policies that undermine their advancement.

We also found that the manipulation of usual spatial, temporal, and social identity boundaries in the field created opportunities for students to notice, discuss, and think differently about their discipline and their developing place within it. In this cultural space, sub-groups of women both coped with and resisted the narrow definition of toughness, broadening its meaning in the graduate course and actively supporting each other in the undergraduate course, even at the cost of breaking the norm of staying together with the larger group. Our findings suggest the importance of considering how students and faculty are not just socialized by higher education institutions, but can contribute to shaping them (Austin, 2002; Tierney & Bensimon, 1996). Further research by scholars about how faculty *and* students co-create disciplinary and departmental learning environments is needed.

We focused on gender because of the demographic composition of these classes and field-wide concerns about women’s safety and participation, but there is an urgent need to design studies of educational and scientific cultures with an explicitly intersectional analytic framework. Given persistent inequities in the professoriate and leadership of many disciplines, higher education as a field should privilege research that examines how multiple identities and

systems of power — including race, class, and disabilities—work together to influence learning, experiences, and professional opportunities (Núñez, 2014). Ethnography is well-suited to this task. We learned how gender and ability were often wrapped up with one another not only by hearing women's reflections in interviews, but also in observing their daily engagement in tasks that challenged their physical and emotional wellbeing. It will require intentionality to design research that addresses multiple systems of power and identities, to expand the application of ethnographic methods in higher education research, and to tend carefully to human subjects considerations in disciplines where certain groups (particularly women of color) are so underrepresented as to be potentially identifiable.

Finally, research that examines how interlocking systems of power affect educational and professional opportunities elevates the potential of research-practice partnerships through which higher education scholars not only study practitioners, but work with them to co-create knowledge and practice. Already widespread in K-12 education, research-practice partnerships earn community members' trust and allow us to design for reciprocal benefits to scholars and practitioners alike (Coburn & Penuel, 2016; Posselt, 2020). A major lesson of this research for us has been that scientists' own viewpoints about their culture complements the perspectives we hold as higher education scholars. By learning to collaborate across social identity and disciplinary differences, we can collectively improve learning environments wherein structure, interactions, and culture work together to shape equity.

## Notes

1. This is distinct from organizational climate analysis, which focuses on perceptions and experiences.
2. This fact even affected our research process, in that we both found it difficult to identify places for private interviews with participants, ultimately opting to conduct interviews in our rooms, where we knew other students and instructors would not enter.
3. We thank an anonymous reviewer for this insight.
4. Women also demonstrated collaboration at the dormitories and apartments when completing their final group assignments. All but one of the women often spoke with one another to compare and contrast interpretations and depictions of the terrain. Meanwhile, the men, even those who were members of the same group, did not tend to talk with one another at all. The most extreme example of this was when one all-male group completed their assignments side by side, while wearing headphones and not speaking with or looking at one another.

## Disclosure statement

No potential conflict of interest was reported by the author(s).

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