Multisite Investigation of Sexist Experiences Encountered by Undergraduate Female Geology Students

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ABSTRACT

We examined the presence of sexist experiences encountered by female undergraduate students across six geology departments in the United States. Two departments graduated a high percentage of female students compared to the national average (high sites), two departments had a moderate percentage (medium sites), and two had a low percentage (low sites). Over 50% of all participants reported encountering sexism. Hostile sexism was the most frequently reported type of sexism, subtle stereotype sexism the second most frequently reported, and subtle benevolent sexism the least frequently reported. Low and medium sites had a higher percentage of participants reporting sexism than at high sites. Most of the hostile experiences were reported at low and medium sites, and nearly 50% of participants at those site types reported sexist experiences, suggesting that there may be a more pervasive hostile social climate in low and medium sites. These findings suggest that sexism may be common within the six geology departments and particularly at low and medium sites. We speculate that hostile sexism may serve as a barrier for recruitment and retention of women in low and medium sites.

KEYWORDS

gender; sexism; recruitment and retention; undergraduate students; department culture; geoscience

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INTRODUCTION

Barriers to women selecting and persisting in undergraduate science have been attributed to women encountering gender bias and hostile climates in university science programs (Hughes, 2012; Leaper & Starr, 2018; National Academies of Sciences, Engineering, & Medicine, 2016; National Academies of Sciences, Engineering, & Medicine, 2018). Researchers note that sexism disproportionately affects female students even in disciplines in which female students are the majority (Grunspan et al., 2016; Hughes, 2012). When female college students encounter sexism, they feel discouraged and less likely to select and persist in those science fields (Grunspan et al., 2016; Hazari, Sadler, & Sonnert, 2013). Much research examining the roles of gender bias and hostile climates as barriers for undergraduate female students has been conducted in biology, chemistry, physics, engineering, computer science, and astronomy (see Barthelemy, McCormick, & Henderson 2016; Moss-Racusin et al., 2012; Neumann et al., 2016; Riffle et al., 2013). Little research has examined sexism as a barrier for undergraduate female students in geology. We examined the presence of sexist experiences encountered by female students across six geology departments that varied in terms of success at graduating female students.

Sexism in Geoscience

The participation of women in geoscience in the United States (earth, atmospheric, and ocean sciences) increased steadily in the 1990s and the percentage of degrees conferred on undergraduate women reached 40% around 2000 (note: data are not reported for geology only). This percentage plateaued and has remained at about 40% for undergraduate majors and 23% for women in the geoscience workforce (National Science Foundation, National Center for Science and Engineering Statistics, 2017). There has been a nearly twenty-year stall in the percentage of women receiving undergraduate geoscience degrees. Little is known about the role sexism has on the recruitment and retention of women in undergraduate geology programs. St. John, Riggs, and Mogk (2016) call for increasing research on sexual harassment in geoscience as a matter of social responsibility towards change. The current study addresses this need.

Theoretical Framework and Research Questions

We used social cognitive career theory (SCCT) as an overarching framework to examine the impact sexist experiences have on students' academic and career trajectories. According to SCCT, the interplay of personal factors (e.g., personal interest and self-efficacy), behavioral (e.g., study habits), and contextual factors (e.g., role models and instructional experiences) explains one's academic and career decisions (Lent, Brown, & Hackett, 1994; Lent et al., 2018). An individual is more likely to pursue a science major if they have high self-efficacy, have interest in the science, and believe they would experience positive outcomes if they pursue the major (i.e., have positive high outcome expectations). However, contextual factors can hinder or support an individual's academic and career decision.

Contextual barriers can reduce an individual's self-efficacy, interest, and outcome expectations and ultimately deter a student from pursuing a particular academic and career path. Sexism is a contextual factor that has been examined as a barrier to individuals' academic and career decision (Byars-Winston & Fouad, 2008; Lent & Brown, 2001; Raque-Bogdan et al., 2013). SCCT serves as a useful framework for understanding the role that sexism encountered by geology majors has on a student's selection and persistence in a major.

Learning environments are considered SCCT contextual factors (Lent et al., 2011; Lent et al., 2013; Mills, 2009; Navarro et al., 2007). In addition to considering sexism as a contextual SCCT factor associated with female students' selection of and persistence in geology majors, we considered the department type as a contextual factor. We recruited geology departments that graduated a high percentage of female students compared to the national average (high sites), a moderate percentage (medium sites), and a low percentage (low sites).

Sexist experiences can take a variety of forms. In addition to more overt and hostile sexism, women also experience subtle expressions of sexism (e.g., Clancy et al., 2014; DeWelde & Laursen, 2011; King et al., 2012). Acknowledging that sexism can be overt or subtle, we used Glick and Fiske's (1996; 1997; 2001; 2007) ambivalent sexism theory as an additional framework to analyze the experiences of geology students. According to ambivalent sexism theory, hostile sexism describes behaviors and beliefs that "overtly and actively aim to harm the target toward whom [they are] directed" and is based on implicit or explicit ideas that women are inferior to men (Glick & Fiske, 2007, p. 163). Benevolent sexism is a subtle form of sexism that appears subjectively positive toward the target to whom they are directed, but are actually damaging to gender equality. These beliefs and behaviors come from paternalistic sociocultural stereotypes that women are nurturers and need men to protect and provide for them (Glick & Fiske, 1996; 1997; 2001; 2007). In classroom and workplace settings, instructors and supervisors who hold benevolent sexist beliefs may limit women's opportunities to engage in critical learning opportunities important to academic and career advancement (King et al., 2012).

We used ambivalent sexism as a lens to understand the types of sexism encountered by undergraduate female geology students. SCCT allowed us to consider how the types of sexism and types of departments, operating as contextual factors, may influence female students' selection and persistence in a geology major. Our research questions were:

1) Who reports experiencing or witnessing sexism encountered by female students in geology departments?
2) What types of sexism do female students encounter in geology departments?
3) How does sexism vary by site type (i.e., departments with high, medium, or low rates of female graduates compared to the national average)?

METHODS
We conducted a basic interpretive qualitative research design (Merriam & Tisdell, 2016) to investigate our research questions.

Setting and Participants
We used several criteria to purposefully sample six geology undergraduate departments at public universities in the United States. First, all departments were at doctoral universities with higher research or highest research activity (Carnegie Foundation for the Advancement of Teaching, 2011) and they were spread out across the United States to ensure geographic representation. Second, although the departments had multiple emphasis areas (e.g., one department had geology and environmental science), they had a primary focus on geology. Third, all of the departments graduated approximately 100 undergraduate students over a 6-year period. Fourth, to enable us to examine sexism across departments with different percentages of degrees conferred on female undergraduate students, we selected two sites in each of the following categories: graduated a low (less than 30% of graduates were women), medium (30%–40% were women), and high (greater than 40% were women) percentage of undergraduate female students compared to the United States national average (40% women) (Table 1). The specific categories definitions (e.g., categorizing a site as high if it graduated a higher percentage of women than the United States national average) were determined by the researchers; however, we followed a selection and category process described by Amelink and Creamer (2010).

Table 1. Mean percentage of degrees conferred on undergraduate female geology students at each site and range of percentage of degrees conferred over a 6-year period (from the 2008-2009 academic year through the 2013-2014 academic year). United States national average at the time of comparison was 40%.

Site Type	Specific Site	Degrees Conferred on Women (%)	Range of Percentage of Degrees Conferred on Women (%)
Low	Site 1	27	17% to 41%
	Site 2	28	13% to 50%
Medium	Site 3	33	22% to 49%
	Site 4	36	18% to 43%
High	Site 5	47	33% to 65%
	Site 6	47	35% to 63%

We recruited undergraduate students from introductory- to advanced- level geology courses to participate in in-person, gender-segregated 60-minute focus group interviews. Sexton and Bergstrom conducted all of the focus group interviews with Bergstrom serving as main interviewer in all cases. Sexton and Bergstrom are both White women. Thirty-six female students and 44 male students participated. The mean student age was 24 years, median age was 22. The ethnic breakdown of the student sample was 75.0% White, 8.8% Asian, 6.3% Latinx/Hispanic, 5.0% American Indian/Hawaiian, 3.8% Black, 1.3% other and multiple ethnicities. Table 2 summarizes the number and percentage of male and female student participants by site type.

Table 2. Sample size and gender for student and faculty participants by site type.

Site Type	Students			Faculty			All Participants n
	Female n (%)	Male n (%)	Total n	Female n (%)	Male n (%)	Total n	
Low	6 (31.6%)	13 (68.4%)	19	5 (41.7%)	7 (58.3%)	12	31
Medium	13 (50%)	13 (50%)	26	5 (45.5%)	6 (54.5%)	11	37
High	17 (48.6%)	18 (51.4%)	35	5 (41.7%)	7 (58.3%)	12	47
All Sites	36 (45%)	44 (55%)	80	15 (42.9%)	20 (57.1%)	35	115

We also recruited faculty members from each geology department to participate in 60-minute individual interviews (Table 2). The faculty members were selected because they had a high level of involvement in the undergraduate program (e.g., teaching core undergraduate courses, serving as undergraduate advisor) and experience working with undergraduates. Sexton conducted all faculty interviews. The ethnic breakdown of the faculty sample was 88.6% White, 2.9% Latinx/Hispanic, 2.9% Black, 5.7% other and multiple ethnicities.

Gender is reported with the binary categories to reflect the way in which the demographic data were collected. In line with recommendations from the American Psychological Association at the time of data collection, we used the term gender in our demographic data questionnaire and binary data (male and female) were sought from participants. However, since that time, considerable change has occurred in the terminology for gender identity and data collection occurring now would have more categories than we report here.

We hired a transcriber to transcribe the interviews verbatim for analysis. We compared all transcribed interviews to the audio recordings to ensure correctness.

DATA ANALYSIS
Research Question 1: Who reports sexism?
To examine who reported sexism, we calculated the number and percentage of participants reporting knowing about or encountering sexist experiences and beliefs. We separated out participants by gender (i.e., female, male), participant type (i.e., student, faculty) and site type (i.e., high, medium, low).

Research Question 2: What types of sexism do female students encounter in geology departments?
All data were double coded into 1) types of sexism (deductive categories described in the literature related to ambivalent sexism) and 2) how those types of sexism were manifested through behaviors, experiences, and beliefs (inductive categories connected to the data). We focused on the sexist experiences encountered by female students and sexist beliefs held about female students. Four researchers analyzed the data using a team coding process (Macqueen et al., 2008). There

were several rounds of independent coding, negotiations to reach consensus, independent coding, and peer review. Negotiations occurred until a final consensus was reached.

Research Question 3: How does sexism vary by site type?
To examine how the type of sexism varied by site type, we conducted descriptive content analysis (Neuendorf, 2017). We calculated the number and percentage of sexist experiences reported at each site type.

Trustworthiness
We used several strategies to ensure trustworthiness (Creswell, 2013; Merriam & Tisdell, 2016). To address credibility and dependability, we share our backgrounds and researcher's perspectives. Sexton and Riggs are geoscientists and educational researchers, Newman is a sociologist, and Bergstrom and Pugh are educational psychologists. Sexton and Bergstrom conducted all of the interviews and they along with Newman conducted the data analysis. Sexton, Bergstrom, and Newman are White, American women. Pugh and Riggs are White, American men. We hold social constructivist perspectives and believe that gender dynamics are influenced by historical, patriarchal social norms. We recognize that our identities and experiences influenced how research participants interacted with us and how we interpreted data. We believe having a team made up of diverse disciplinary perspectives enriched our data interpretations. To address credibility and dependability, we collected multiple sources of data (from students and faculty, from multiple site types, and from multiple sites within each site type) to confirm the emerging findings. We conducted investigator triangulation by having a team of investigators collect and analyze data. During analysis, the team members independently analyzed data and conducted peer reviews of each other's work to verify emerging themes (Macqueen et al., 2008). To address transferability, descriptions of the study context and interview examples are provided so that others who read about our study can determine the extent to which our findings are relevant to their own context (Merriam & Tisdell, 2016).

RESULTS AND DISCUSSION
Research Question 1: Who reports sexism?
We calculated the number and percentage of participants encountering sexist experiences and beliefs, separating out participants based on gender (i.e., female, male), participant type (i.e., student, faculty) and site type (i.e., high, medium, low). Across all participants at the three site types, 50% or more reported sexism. The highest percentage of participants reporting sexism was at low sites, the second highest percentage of participants reporting sexism was at medium sites, and the lowest percentage of participants reporting sexism was at high sites (Table 3).

We disaggregated the data by gender and participant type (faculty, student) and examined patterns (Table 3). There was no difference in the percentage of female faculty reporting sexism across the site types. Higher percentages of male faculty at low and medium sites reported sexism than at high site. A much higher percentage of female students at low sites reported sexism than female students at

medium and high sites. However, a higher percentage of female students at high sites reported sexism than at medium sites. A higher percentage of male students at low and medium sites reported sexism than at high sites.

We examined patterns across faculty and student reports of sexism (Table 3). A higher percentage of faculty than students reported sexism. One possible reason for this is that faculty may be more aware of sexism because they are in a department for a longer time than students and have experiences across multiple cohorts of students.

We examined patterns across students and gender (Table 3). At each site type, a higher percentage of female students reported sexism than did male students at the same site type (Table 3). At low and high sites, the percentage of female students who reported sexism was nearly two times higher than the percentage of male students at both site types. At medium sites, a higher percentage of female students reported than did male students, but the difference was smaller.

In summary, reports of sexism encountered by female students in the geology departments were not described by one gender or group (students versus faculty). Lower and medium sites had a higher percentage of participants reporting sexism; however, even at high sites 51% of participants recounted sexist behaviors or beliefs. With more than 50% of participants across all sites reporting sexism, these results may represent a widespread pattern of sexism within geology undergraduate programs.

Research Question 2: What types of sexism do female students encounter in geology departments?
We identified three types of sexism encountered by female students (Table 4). Two were connected to ambivalent sexism theory (Glick & Fiske, 2007): hostile sexism and benevolent sexism (which we called subtle benevolent). A type of sexism not described in ambivalent sexism theory also emerged through our analysis: subtle stereotypes. The three types of sexism manifested through four categories of behaviors, experiences, and beliefs: 1) female students being treated differently by faculty, 2) female students being treated differently by students, 3) promotion of a macho culture, and 4) perceptions of female students (Table 5). Table 6 summarizes the manifestation of these behaviors, experiences, and beliefs within the structure of the three types of sexism and the following subsections detail these relationships.

Table 3. *Number of participants interviewed overall and by gender, participant type, and site type (# I columns in table), number of participants who reported sexist experiences by gender, participant type, and site type (# RS columns in table), percentage of participants who reported sexism by gender, participant type, and site type (% RS columns in table).*

Site Type	All Participants			Female Faculty			Male Faculty			Female Student			Male Student		
	# I	# RS	% RS	# I	# RS	% RS	# I	# RS	% RS	# I	# RS	% RS	# I	# RS	% RS
Low	31	21	68	5	4	80	7	6	86	6	5	83	13	6	46
Medium	37	22	59	5	4	80	6	5	83	13	7	54	13	6	46
High	47	24	51	5	4	80	7	5	71	17	10	59	18	5	28
Total	**115**	**67**	**58**	**15**	**12**	**80**	**20**	**16**	**80**	**36**	**22**	**61**	**44**	**17**	**39**

Table 4. Types of sexism and definitions.

Type of Sexism		Definition
Hostile		Experiences that overtly aim to harm women including: 1) segregation, exclusion, demeaning comments, harassment, and attack; 2) stereotypes related to men having better abilities than women or describing women as not having agency; and 3) macho climate that is described as not welcoming toward women by participants.
Subtle Benevolent		Subjectively positive and paternalistic experiences and beliefs that women are wonderful but fragile and need men to protect them. Includes beliefs that women are nurturers and need to be cared for by men.
Subtle Stereotypes	Positive Stereotypes	Generalizations that describe admirable qualities of women that may be intended as compliments toward group members. Does not include subjectively positive, patriarchal beliefs; those are categorized in benevolent sexism.
	Preference Stereotypes	Generalizations about perceived preferences held by women. Neither subjectively positive or negative. Not generalizations about abilities, only preferences.

Table 5. Categories of behaviors, experiences, and beliefs within the structure of the three types of sexism. Definitions of the categories and example quotes from participants provided. Interview examples modified for clarity and confidentiality.

Categories	Definitions	Interview Examples
Female students poorly treated by faculty	Male or female faculty members in the department treat female students negatively.	• "One faculty member singles out female students, he ridicules women in class, he picks on women" (Female Faculty)
Female students poorly treated by students	Male or female students in the department treat female students negatively.	• "A male student was extremely rude to female students; condescending, mean, sexist" (Male faculty)
Macho culture promoted	The social climate in the department, classroom, or field is labeled by participants as "macho" and may be described as a competitive environment and unwelcoming to women.	• "In the field courses, the students are split up into groups. And I have seen cases where there has been exclusion of women. You know they've been kind of left on the edge…it comes back to this macho thing. A group of male students, didn't want a woman there cuz they thought that she would hold them back physically as well as intellectually. They thought she wouldn't be able to run around the mountains as fast as they did and therefore they didn't want her in the group." (Male faculty)
Perceptions of female students	Beliefs or values about female students.	• "Women tend to be more organized, realistic, and reasonable. I prefer students who are organized for my research program and it tends to be women." (Male Faculty)

Hostile Sexism Encountered by Students

Hostile sexism, based on the definition of prejudice described by Allport (1954/1979) and the more recent definition described by Glick and Fiske (1996), describes behaviors and beliefs that overtly discriminate and harm women (Table 4). Hostile sexism is manifested through all four categories of behaviors, experiences, and beliefs (Table 6).

Hostile sexism occurred in geology departments when faculty and students treated female students in demeaning and discriminatory ways. For example, a female faculty member noted that a male faculty member "singles out female students, he

ridicules women in class, he picks on women" (female faculty). A female student shared the following experience of hostile sexism from her peers.

> *"I've been told a couple of times by other students 'You're brown and you're a woman so you're fine. You can get an F in this class and you're fine.' I know that's not true. But I feel like there's this attitude of 'You can get the scholarship with a .5 GPA because you're a woman and you're brown.'" (female student)*

This example illustrates how issues of gender can intersect with issues of ethnicity. We saw such intersectionality in a few other cases. However, we did not target or probe for intersectionality as this was not an original purpose of our research.

Table 6. A "yes" is shown in a cell if the type of sexism is manifested in the category of behaviors, experiences, or beliefs. A "no" is shown if the type of sexism was not manifested in the category of behaviors, experiences, or beliefs.

		Categories of Behaviors, Experiences, and Beliefs			
		Female students poorly treated by faculty	**Female students poorly treated by students**	**Macho culture promoted**	**Perceptions of female students**
Type of Sexism	**Hostile**	Yes	Yes	Yes	Yes
	Subtle Benevolent	Yes	Yes	No	Yes
	Subtle Stereotypes	No	No	No	Yes

There were also examples in which the promotion of a macho culture served as hostile sexist experiences. Below a female faculty member describes how the macho culture promoted in field environments is unwelcoming to women and other minority groups.

> *"I think the field aspect of geology is not good for women or minorities. I know that everyone says it's the field that's gonna make students love our classes. No! It's gonna make a lot of women, people in poor health, and minorities want to leave. I know that a lot of it in the field is 'how macho can you be, how much can you drink.' And I think that that's a very bad thing if you want to keep women in the geosciences. People seem to really make a big deal that in order to be a good geologist that you have to be macho." (female faculty)*

Finally, there were also hostile sexist perceptions of female students. For example, some geology faculty and students believed that men and women have different brains and that difference explains why there are fewer women in science.

> *"A male faculty member told me that it's been scientifically proven that women's brains didn't develop in the same way as men's brains*

> *because women were gatherers and men were hunters. He said that*
> *although we have to have female students in our program, they're*
> *never going to be scientists [because they have different brains]."*
> *(female faculty)*

> *"I mean it's been pretty well documented that males think more*
> *logically, more mathematically, more scientifically. Where women think*
> *more socially." (male student)*

The common thread for all hostile sexism examples is negative and exclusionary treatment and beliefs about women. Sexism and hostile climates in science classrooms can serve as a barrier to women's academic success and to their persistence in science in academic and nonacademic settings (Grunspan et al., 2016; Hazari et al., 2013; Riffle et al., 2013; Settles, Cortina, Malley, & Stewart, 2006). As a SCCT contextual factor, hostile sexism can affect SCCT personal factors. For example, exposure to hostile sexism can negatively impact women's self-efficacy and beliefs about themselves (Vescio, Gervais, Synder, & Hoover, 2005), increase feelings of sadness (Schneider, Tomaka, & Palacios, 2001), and amplify a sense of self-consciousness (Pinel, 1999). When female students interact with a sexist instructor or mentor, they may experience social identity or stereotype threat, which can undermine their performance in science and engineering (Hughes, 2012).

Subtle Benevolent Sexism Encountered by Students
Glick and Fiske (1996) describe benevolent sexism as paternalistic and stereotypical beliefs and behaviors toward women that may go unrecognized as sexism or even appear subjectively positive (Table 4). These paternalistic beliefs and behaviors reinforce sociocultural norms of women as nurturers and caregivers and as needing protection from men. Because this form of sexism may go unrecognized, we labeled it subtle benevolent sexism. It was manifest in geology departments in three of the four categories of behaviors, experiences, and beliefs (Table 6).

Female students were treated differently by faculty and other students. In the first two examples below, faculty and other students were protective of female students in field environments and female students were not expected to engage in the manual labor aspects of field work at the same level as were male students. In the third example, female students received attention for their work because of their appearance.

> *"Whenever you're in the field doing field work that requires a lot of*
> *hiking, moving, carrying samples etcetera, some of the professors*
> *expect more from the males based on the idea that males are meant*
> *to be outdoors. And the professors are more lenient on girls." (male*
> *student)*

> *"There are situations in which it is hard not to treat students differently. If we're in the field, across all of our faculty, we don't want women to go in the field alone, right? But we wouldn't say the same thing to males." (male faculty)*

> *"You see a positive bias with networking and with some professors in the classroom. Sometimes people are complaining 'Oh it's easy to get people to look at your undergraduate poster if you're little and cute or if you're wearing a short dress,' but as silly as that might seem, I've noticed it seems like it's easier to network if you're an attractive young female." (female student)*

Benevolent sexism was also manifest as perceptions when faculty and students described women as more nurturing and caring, as in the following example:

> *"[In geoscience] you can get dirty doing lab work or field research and that might not be an interest to some ladies out there. They'd rather do nursing and help people. Or do veterinary science, which is also a very challenging science background, but they really like helping animals." (male student)*

Benevolent sexism is generally not recognized as sexism partly because it appears subjectively positive and because it reflects broader sociocultural norms that women are "pure creatures who ought to be protected, supported, and adored and whose love is necessary to make a man complete" (Glick & Fiske, 2001, p. 109). However, benevolent sexism represents underlying paternalistic beliefs that women are weak and need protection and has negative impacts on women (Glick & Fiske, 2011). For example, female college students exposed to benevolent sexism were less likely to consider themselves skilled at a task and more likely to delegate leadership roles to male students (Barreto, Ellemers, Piebinga, & Moya, 2010).

In the workplace, male managers with high levels of benevolent beliefs provided female employees with less challenging work experiences that would have developed new skills and provided the foundation for work promotions (King et al., 2012). By not getting access to these experiences, women may be excluded from developing critical skills that enable advancement and contribute to the underrepresentation of women in higher-level work positions. Dardenne, Dumont, and Bollier (2007) found that benevolent sexism had a worse impact on women's cognitive performance than did hostile sexism. The impact of benevolent sexism may also be understood by considering what these experiences are likely to communicate to the individuals involved. Ramos, Barreto, Ellemers, Moya, and Ferreira (2016) demonstrated that benevolent sexist beliefs conveyed the message that men were assumed to be competent while women were assumed to be warm rather than competent. Ramos and colleagues (2016) also found that benevolent sexism communicated that women should be less competent than men and that male and female participants equally held this belief.

Subtle Stereotypes Encountered by Students
We identified a type of sexism that fit the general definition of subtle sexism but did not fit within the definition of benevolent sexism or within ambivalent sexism more broadly. We labeled this type of sexism subtle stereotypes. It was manifest in geology departments as perceptions (Table 6). We identified two forms of subtle stereotypes—Positive Stereotypes and Preference Stereotypes.

We defined positive stereotypes as generalizations that describe subjectively complimentary attributes about women (Table 4). Positive stereotypes have been defined and described in the literature (Czopp, Kay, & Cheryan, 2015) and differ from benevolent sexism in that they do not describe women in patriarchal ways and do not suggest women need care and protection. We shared examples of our data with Peter Glick, one of the foundational researchers of ambivalent and benevolent sexism, and he confirmed that our examples described stereotypes, but did not belong in the benevolent sexism category. In geology departments, participants expressed positive stereotypes when they described women as being more organized, better communicators, and the best students in the program as in the following examples.

> *"On average, our female students are better than our male students. When you end up with a female student in a group with several guys, often it's the female that does a lot of the organizational work and makes sure things get done and they're doing things well and so forth." (male faculty)*

> *"We [female students] didn't really grow up with the whole gender bias, it was quite the opposite. Generally, the girls are the smart ones and the boys are, you know, not as smart" (female student)*

These stereotypes appear positive on the surface-level. However, like all stereotypes, they generalize and extend beliefs to entire group of people on the basis of a single identity characteristic. Such beliefs can incorrectly be applied to individual interactions, affecting the expectations one may hold for individuals with that trait.

Preference stereotypes are generalizations about perceived preferences held by women related to aspects of geology work (e.g., female students do not prefer field work) or aspects of interactions that occur in academic settings (e.g., female students prefer to work with other female students). Descriptive and prescriptive stereotypes were the closest forms of sexism we found in the literature to our preference stereotypes. Descriptive stereotypes are beliefs about <u>how women are</u> (e.g., women are more soft-spoken) and prescriptive stereotypes are beliefs about <u>how women should be</u> (e.g., women should be more soft-spoken) (Burgess & Borgida, 1999). Descriptive and prescriptive stereotypes overlap: the perceived characteristics of how women are, are also the perceived characteristics of how women should be (Heilman, 2012). Often people who hold descriptive or prescriptive stereotype beliefs are not intentionally trying to discriminate; however, those beliefs can have negative impacts (Burgess & Borgida, 1999).

We did not have sufficient information in our study to determine if the data we categorized into preference stereotypes aligned more with descriptive or with prescriptive stereotypes; therefore, we did not place them into either category but gave them our own unique name of preference stereotypes. Preference stereotypes do not describe women as deficient or lacking, rather they describe women as having different preferences than men. Preference stereotypes are neither subjectively positive or negative attributes about women, rather these generalizations may appear subjectively neutral (Table 4). For example, the following participants describe stereotypes that women do not prefer doing fieldwork, have preferences about particular geology subdisciplines and other sciences, and prefer working with other women:

> "There are more women interested in studying environmental science-y things and paleo biology; whereas, typically the hard rock petrology side is more sort of male-dominated." (male faculty)

> "From a girl's perspective, there's only a quarter of most females who are willing to go get dirty and not bathe for a few days and do some field work. It's one of those careers that doesn't appeal to a lot of women because of the name and stigma to it." (female student)

> "I might feel more comfortable being like 'hey (to one of my female classmates), do you know these answers?' before I'm gonna be like hey (to a male classmate). A woman feels more comfortable talking with women sometimes." (female student)

Stereotypes are often described in the context of negative and prejudiced judgements about a group. In our Subtle Stereotype category which includes Positive and Preference stereotypes, we identified stereotypes that come across as subjectively positive or neutral. There are mixed impacts of subjectively positive stereotypes (for a review see Czopp et al., 2015). For example, individuals performed better on performance tests when they heard a positive stereotype related to their identity (e.g., women are better communicators) prior to taking a test (e.g., Shih, Pittinsky, & Ambady, 1999; Shih, Pittinsky, & Trahan, 2006). However, individuals can experience emotional distress (e.g., anger and desire to attack the speaker) when they are recipients of positive stereotypes (Garcia, Miller, Smith, & Mackie, 2006) or perceive the person holding the positive stereotype to actually hold negative stereotypes (Siy & Cheryan, 2016). It seems counterintuitive that a positive stereotype (e.g., female students are better students) can have a negative impact. One explanation for the negative impacts of positive stereotypes is that targets of positive stereotypes feel their identity is depersonalized and that judgements about them are made based on generalizations about a group rather than of them as an individual (Siy & Cheryan, 2016). The feeling of depersonalization may be an unintended consequence of positive stereotypes and may produce significant negative outcomes.

The Preference stereotypes we identified in our study are related to beliefs about women in academic and work contexts—women prefer some geology subdisciplines

over others, do not prefer field work, and prefer to work with other women. These stereotypes may align with descriptive or prescriptive stereotypes which can have negative impacts. Descriptive stereotypes become problematic when there is a perceived misalignment between a woman's perceived characteristics (e.g., does not like to get dirty and do field work) and the characteristics thought to be necessary for success in a particular activity or occupation (e.g., it is necessary to enjoy getting dirty to be successful at field work) (Heilman, 2012). The results of this perceived misalignment include the belief that women are not suitable for a particular activity or occupation; a lower likelihood women are selected for a particular activity or occupation; if a woman is selected for a particular activity or occupation then there are differences in the job assignments than there are for men; and reduced possibilities for promotion (Heilman, 2012). There are also negative impacts for women who violate prescriptive stereotypes (Heilman, 2012; Heilman, Wallen, Fuchs, & Tamkins, 2004). For example, when women exhibit success in a male-dominated occupation or activity, they violate prescribed stereotypes and are viewed as less likeable and less worthy for pay increases and promotions (Heilman et al., 2004).

Research Question 3: How does sexism vary by site type?
We found several patterns when we examined sexism by site type.

Hostile Sexism Frequently Reported, Especially at Low and Medium Sites
Within each site type, hostile sexism was the most frequently reported type of sexism, subtle stereotype sexism was the second most frequently reported, and subtle benevolent sexism was the least frequently reported (Table 7). That hostile sexism was the most frequently reported form of sexism is interesting considering that at a societal level, more overt and hostile types of sexism have decreased over time and more subtle forms of sexism are generally reported (Glick & Fiske, 2011; Robnett, 2016; Rudman, 2005). There may be several reasons that hostile sexism was more frequently reported. Perhaps hostile sexism has endured more persistently in geology departments than at the societal level. Alternatively, because hostile sexism is more overt, it might be more easily recognized than subtle forms of sexism.

Of the 84 hostile sexist experiences reported across all site types, about 75% of those experiences were reported at low and medium sites (Table 8). Hostile sexism was reported 2.1 times more frequently at low sites, 1.8 times more frequently at medium sites, and 1.1 times more frequently at high sites than the next most frequently reported form of sexism (subtle stereotypes) (Table 7). That most of the hostile experiences were reported at low and medium sites, sites which are less successful at recruiting and retaining undergraduate female students, and nearly 50% of participants at those sites reported sexist experiences, may suggest that there is a more pervasive hostile social climate in low and medium sites. Although this was not a causal study, we speculate that hostile sexism may serve as a barrier for recruitment and retention of women in low and medium sites.

Table 7. Number of sexist experiences reported overall in each site type.

Site Type	Total number of incidents within site types	Hostile		Subtle Benevolent		Subtle Stereotypes	
		number of incidents	percentage of incidents	number of incidents	percentage of incidents	number of incidents	percentage of incidents
Low	52	32	62%	5	10%	15	29%
Medium	63	32	51%	13	21%	18	29%
High	41	20	49%	3	7%	18	44%

Out of the total number of experiences reported within each site type, Table 7 shows what number and percentage of the experiences were Hostile, Subtle Benevolent, and Subtle Benevolent. The Subtle Stereotypes included both positive and preference stereotypes. The data in Table 7 are the same as in Table 8 and presented by site type.

Table 8. Number of each type of sexism that were reported overall.

Type of Sexism	Total number of incidents in each	Low Site Type		Medium Site Type		High Site Type	
		number of incidents	percentage of incidents	number of incidents	percentage of incidents	number of incidents	percentage of incidents
Hostile	84	32	38%	32	38%	20	24%
Subtle Benevolent	21	5	24%	13	62%	3	14%
Subtle Stereotypes	51	15	29%	18	35%	18	35%

Out of the total number of experiences reported within each type of sexism, Table 8 shows what number and percentage of the types of sexism were reported at Low, Medium, and High Site Types. The Subtle Stereotypes included both positive and preference stereotypes. The data in Table 8 are the same as in Table 7 presented by types of sexism.

Table 9. Number and percentage of participants at each site type who reported each type of sexism.

Site Type	Total number of participants	Hostile		Subtle Benevolent		Subtle Stereotypes	
		number of participants	percentage of participants	number of participants	percentage of participants	number of participants	percentage of participants
Low	31	14	45%	5	16%	12	39%
Medium	37	17	46%	8	22%	12	32%
High	47	17	36%	3	6%	12	26%

Subtle Stereotypes included both positive and preference stereotypes. The percentages for each site type do not sum to 100 because not all participants reported a sexist experience and some participants reported more than one sexist experience

Subtle Stereotypes Second Most Frequent Form of Sexism, Unclear Site Type Pattern

Subtle stereotypes were the second most frequently reported form of sexism within each site type (Table 7). There were 51 examples of subtle stereotypes reported and they were more frequently reported at medium and high sites (35% of examples at medium sites and 35% of examples at high sites) than at low sites (Table 8). Although a lower percentage of examples were reported at low sites, there was a higher percentage of participants reporting those examples at low sites than the percentage of participants reporting examples at medium and high sites (Table 9). This may suggest that subtle stereotypes, although reported less frequently at low sites, were more pervasive at low sites since a higher percentage of participants reported them. Although the negative impacts of hostile and benevolent sexism have been well-documented (Barreto et al., 2010; Dardenne et al., 2007; Dumont, Sarlet, & Dardenne, 2010; Moya, Glick, Exposito, de Lemus, & Hart, 2007; Ramos et al., 2016), it is uncertain what impact the forms of subtle stereotypes we found in this study have on the recruitment and retention of women in geology.
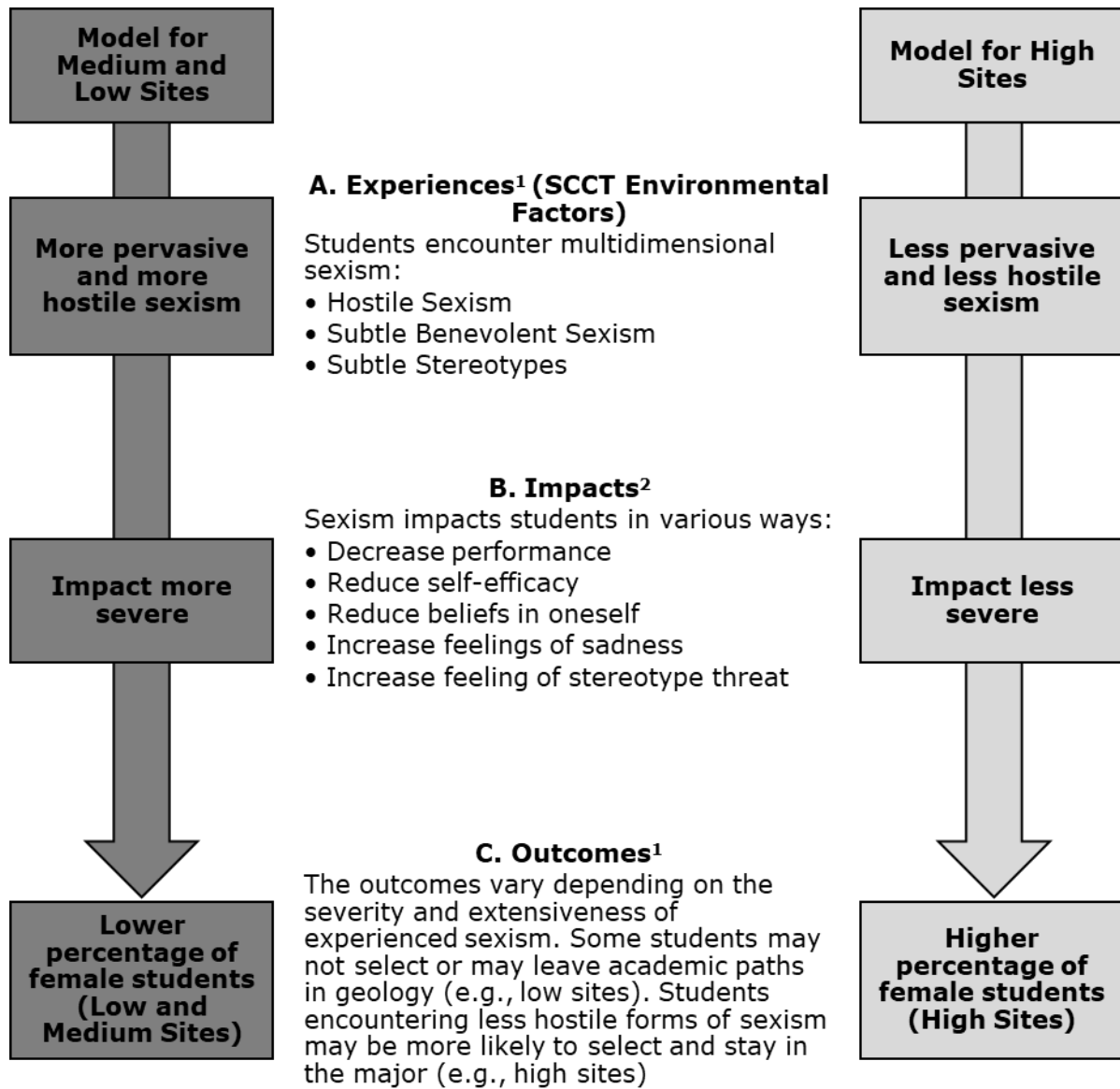
IMPLICATIONS, LIMITATIONS, AND FUTURE DIRECTIONS
This study used SCCT and ambivalent sexism theory to understand the pervasiveness and type of sexist experiences that female students encountered in geology programs. Given that sexism has been documented as a barrier to female students persisting in science (National Academies of Sciences, Engineering, and Medicine, 2018), this project examined sexist encounters as a contextual factor that likely impacts the recruitment and retention of women in geology. We used ambivalent sexism theory to better understand the kinds of sexism that students were encountering in their departments.

We found hostile, subtle benevolent, and subtle stereotype sexism were reported by participants in all six departments. Over 50 percent of participants at all sites reported encountering or being aware of sexism or holding sexist beliefs and hostile sexist was the most frequently reported. These findings suggest that both overt, hostile sexism and subtle forms of sexism may be common in geology departments.

Our findings across the research questions are conceptualized in Figure 1. Female students encounter multidimensional forms of sexism (Area A), which can impact them in various ways (Area B), leading to a range of possible outcomes (Area C). In low and medium sites (the model on the left side of Figure 1), there was more pervasive (reported by more participants than at high sites) and hostile sexism than at high sites. These more pervasive and hostile forms of sexism can have a range of impacts on female students such as potentially contributing to a lower percentage of female students selecting and staying in the major. In high sites (the model on the left side of Figure 1), there was less pervasive (reported by fewer participants than at low and medium sites) and hostile sexism than at low and medium sites. In those departments, the impacts of sexism on students may be less severe, potentially contributing to a higher percentage of female students selecting or staying in the major.

Figure 1. Model showing connection of sexist experiences to impacts and outcomes.

Model for Medium and Low Sites		Model for High Sites
More pervasive and more hostile sexism	**A. Experiences[1] (SCCT Environmental Factors)** Students encounter multidimensional sexism: • Hostile Sexism • Subtle Benevolent Sexism • Subtle Stereotypes	**Less pervasive and less hostile sexism**
Impact more severe	**B. Impacts[2]** Sexism impacts students in various ways: • Decrease performance • Reduce self-efficacy • Reduce beliefs in oneself • Increase feelings of sadness • Increase feeling of stereotype threat	**Impact less severe**
Lower percentage of female students (Low and Medium Sites)	**C. Outcomes[1]** The outcomes vary depending on the severity and extensiveness of experienced sexism. Some students may not select or may leave academic paths in geology (e.g., low sites). Students encountering less hostile forms of sexism may be more likely to select and stay in the major (e.g., high sites)	**Higher percentage of female students (High Sites)**

Students encounter various forms of sexism (Area A), which impacts them in various ways (Area B), leading to a range of possible outcomes (Area C). [1] Experiences and Outcomes are based on data from our study. [2] Impacts are based on research literature describing the impacts of experiencing sexism.

We speculate that more inclusive department practices are related to a more inclusive social climate, which in turn is related to lower reports of hostile and benevolent sexism, which in turn may lead to better recruitment and retention of women. However, our study was descriptive, not causal or predictive and we had a lower number of female student participants at low sites compared to the other sites. Caution should be used in concluding that the type and frequency of sexist experiences caused some departments to be more or less successful in recruiting

and retaining female students. Other factors may have also contributed to why departments are more or less successful in recruiting and retaining female students.

We highlight additional limitations in our study and suggest corresponding future research directions. We think that sexism was underreported in our study for a number of reasons. First, some participants may have felt uncomfortable discussing sexism and this discomfort may have led participants to withhold information. For example, we conducted focus group interviews with the students and they may have felt uncomfortable discussing sexism with their peers present. Second, we did not provide participants with definitions of sexism or gendered experiences. Rather, we asked participants to describe instances in which they were treated differently based on gender. Students and faculty in geology do not typically learn how to recognize sexism in the content of undergraduate and graduate curricula; therefore, they may be unaware that some of their experiences and beliefs are sexist and hostile. Additionally, they may not know how to communicate about those experiences. Third, because only a sample of faculty and students were involved in the study from each site, some sexist experiences may have been missed. Fourth, there were low sample sizes for some of the comparisons; therefore, some patterns may be related to the sample size.

This is one of the first studies to examine sexism encountered by female undergraduate students in geology departments and there are several future research directions based on the findings. First, we identified differences in the frequency and forms of sexism reported by site type. Additional research is needed to triangulate our findings with larger sample sizes and more sites. Second, the site type patterns need further investigation to examine the impacts of sexism encountered by female students and how the forms of sexism may be associated with the success of departments to recruit and retain female students. Third, we identified a category of sexism we labeled subtle preference stereotype. Future research should examine the presence and impact of preference stereotypes on undergraduate female students. Fourth, the prevalence and type of sexist experiences across intersectional identities was not a focus of this study, but future research should explore how sexism is experienced across intersectional identities (e.g., across gender and ethnic identities). For example, researchers could explore what types of sexism are experienced by White women and Black women. Finally, future work should investigate what department characteristics (e.g., department culture and climate, disciplinary culture, institutional structures, and the like) enable and reduce sexism directed toward geology female students. We are currently conducting a study to address this final aspect with the aim to provide departments with practical actions that they can take to reduce sexism and provide a more inclusive climate.

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