

Uneven increases in racial diversity of US geoscience undergraduates

Rachel J. Beane¹✉, Eric M. D. Baer², Rowan Lockwood³,
R. Heather Macdonald³, John R. McDaris⁴, Vernon R. Morris⁵,
I. Joshua Villalobos⁶ & Lisa D. White⁷

Over the past 20 years, the proportion of US geoscience undergraduate degree recipients from marginalized racial groups has increased about threefold, more than for graduate degrees. Much of this progress currently is concentrated at relatively few universities.

National, departmental and individual efforts in geoscience departments across the United States have resulted in programs designed to broaden participation and support students from diverse racial and ethnic groups. Among these efforts, programs at Historically Black Colleges and Universities^{1,2}, Minority Serving Institutions^{3,4}, and community colleges⁵ have engaged many marginalized students. Faculty have investigated and adopted effective strategies for building inclusive learning environments^{6,7} and programs^{8,9}. Furthermore, research on broadening participation and supporting all students' success was identified as a grand challenge of geoscience education research¹⁰. Here we investigate how and where these numerous efforts have affected the racial and ethnic demographics of US geoscience students who receive undergraduate degrees, to complement earlier work on doctorates¹¹.

Trends in the race and ethnicity of students receiving geoscience Ph.D. degrees were found¹¹ to have made “No Progress in Diversity in 40 Years.” These findings powerfully signaled a need to work together as a community to transform how we do our science, teach and mentor students, and increase the diversity of students completing geoscience degrees. A report from the American Geoscience Institute (AGI) on “Diversity in the Geosciences” summarized national, workforce, and education trends by gender, race, and ethnicity. Using the Integrated Post-secondary Education Data System (IPEDS)¹² on degree completion, the report showed that from 2010 to 2019, Black/African Americans, Hispanic/Latinx, and Native American/Alaska Natives receiving bachelor's degrees increased from 9% to 16%, masters 7% to 10%, and doctorates 6% to 7%¹³.

We explore in more detail the race and ethnicity trends for students receiving geoscience bachelor's degrees in the US over the past 20 years. We acknowledge that such an accounting is only one measure of progress. Less readily quantifiable indicators such as belonging, individual experiences, and educational or occupational paths may further reflect progress or a lack thereof. Moreover, here we focus on racial and ethnic diversity; however, we acknowledge that the geosciences would benefit from further examining other aspects of diversity, including the intersectionality of identities¹⁴.

Twenty-year trends

The combined percentage of geoscience bachelor's degrees received by students-of-color and Hispanic/Latino students increased by about a factor-3 from 7%—of a total of 4239 degrees

¹Department of Earth and Oceanographic Science, Bowdoin College, Brunswick, ME, USA. ²Physical Sciences Department, Highline College, Des Moines, WA, USA. ³Department of Geology, William & Mary, Williamsburg, VA, USA. ⁴Science Education Resource Center, Carleton College, Northfield, MN, USA. ⁵School of Mathematical and Natural Sciences, Arizona State University, Phoenix, AZ, USA. ⁶El Paso Community College, El Paso, TX, USA. ⁷Museum of Paleontology, University of California, Berkeley, CA, USA. ✉email: rbeane@bowdoin.edu

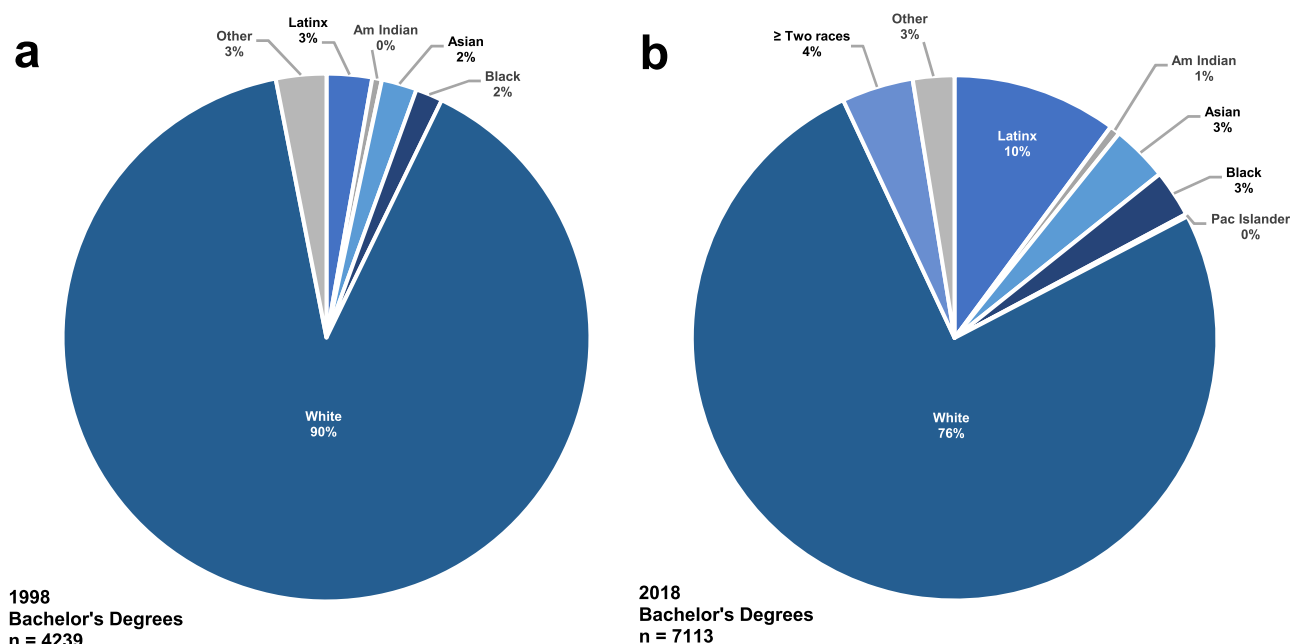


Fig. 1 Geoscience bachelor's degrees by race and ethnicity. Pie chart comparison of 1998 (a), and 2018 (b) geoscience bachelor's degrees by students' race and ethnicity. Latinx (Hispanic or Latino), Am Indian (American Indian or Alaska Native), Black (Black or African American), Pac Islander (Native Hawaiian or Other Pacific Islander), Other (Other or unknown).

awarded in 1998—to 21% of a total of 7113 bachelor degrees in 2018 (Fig. 1; Supplementary Table 1), according to degree completion data for bachelor's degrees in the US¹². Among these groups, the largest percentage increase was for Hispanic/Latino students which increased from 3% to 10%, with the most growth since 2007 (Fig. 2). This percentage increase was larger than that for physical science bachelor degrees combined (5% to 12%) and larger than that for all bachelor degrees (7% to 15%).

By contrast, for Black/African American and Asian American students, the percentage remained relatively steady, although absolute numbers increased in line with the increase in total bachelor degrees awarded. The percentage of bachelor's geoscience degrees conferred to Native Hawaiian/Other Pacific Islander and American Indian/Alaska Native students remains below 1%, with no clear trend. However, because Native Hawaiians and Pacific Islanders were included in the Asian group before 2008, and the option of reporting “two or more races” was only introduced in 2008, the trends of geoscience bachelor's degrees awarded in these categories are difficult to interpret. For example, students who pre-2008 might have selected Black/African American or Asian now have new options to select Native Hawaiian/Pacific Islander or “two or more races” and the number of bachelor degrees in these new categories has increased since 2008.

Associate degrees, 2-year programs with lower costs and time commitments than bachelor's programs, accounted for only a small fraction of geoscience degrees awarded overall—128 in 2018, compared to 7113 bachelors in the same year. Typically offered by community colleges, associate degrees showed higher diversity than bachelor degrees and a similar factor-3 increase for Hispanic/Latino students and students-of-color (11% in 1998 to 36% in 2018).

Uneven progress

Notably, only a few institutions have driven the increase in racial and ethnic diversity of geoscience bachelor's degree recipients: two-fifths of geoscience programs fail to graduate more than one student from a marginalized group per year. Students in these

programs will likely find that they are the only one of their racial or ethnic group in a class. Knowing the number of geoscience students from marginalized racial and ethnic groups who receive degrees at each institution is helpful because this context can contribute to limiting or fostering students' sense of belonging and their persistence in science programs¹⁵.

Looking at the race and ethnicity data individually the numbers are even more striking. From 2014 to 2018, only 32 institutions, <10% of the total number of programs, conferred an average of more than one geoscience bachelor's degree per year to Black/African American students, and only six averaged three or more per year (Table 1). Notably, many of these institutions are regionally located in the US southeast. For Hispanic/Latino students, a larger number—131 institutions—conferred more than one geoscience bachelor's degree on average per year, and eleven universities averaged more than ten Hispanic/Latino geoscience graduates per year (Table 1). These eleven universities, most in the southern US, awarded a quarter of geoscience degrees to Hispanic/Latino students and thus had a disproportionate effect on the total Hispanic/Latino geoscience bachelor's degrees in the US. Only at two universities, both in the western U.S., did American Indian/Alaska Native students receive more than one geoscience bachelor's degree on average per year between 2014 and 2018. The data suggest that both regional US demographics and institutional student demographics (Table 1) have had a significant influence on the diversity of those receiving geoscience degrees from individual programs.

Challenges ahead

We have shown that in terms of US undergraduate degrees, the geosciences have made progress in racial and ethnic diversity over the past 20 years, more so than for graduate degrees. This is encouraging. However, the percentages of geoscience bachelor degrees awarded to students from marginalized racial and ethnic groups are far lower than the percentages for these groups in the physical sciences or across all disciplines (Supplementary Table 1) and progress is not evenly distributed across institutions.

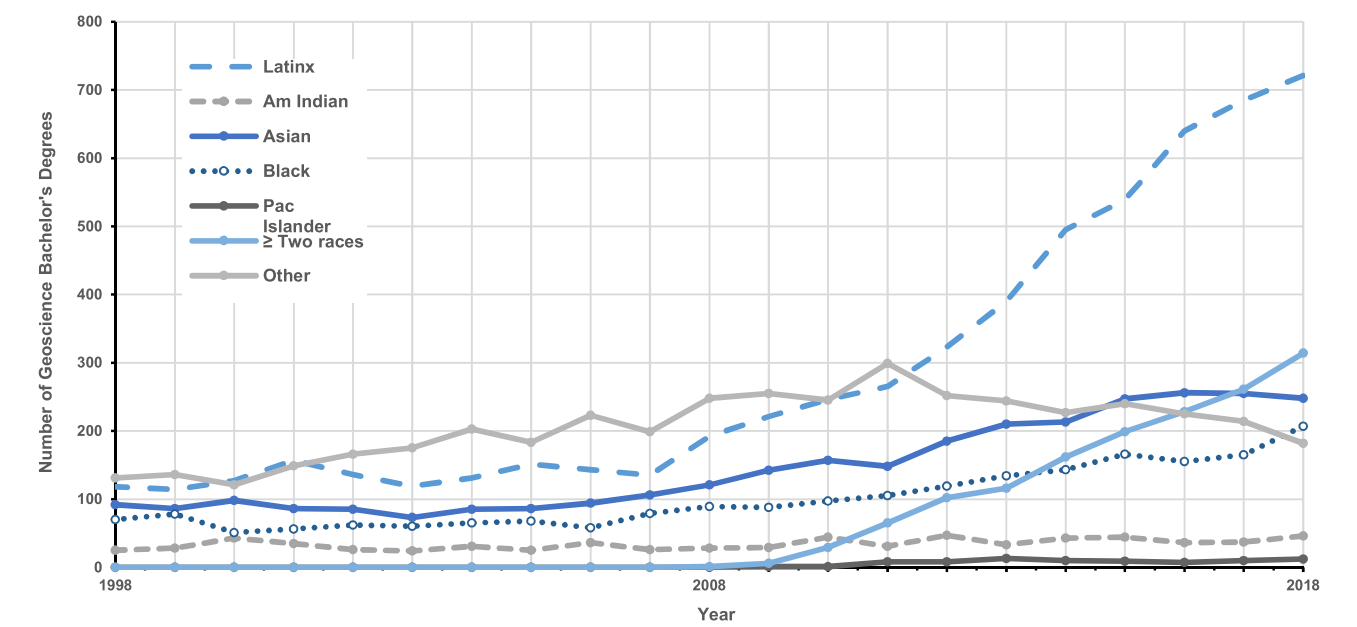


Fig. 2 Bachelor's degrees by race and ethnicity 1998–2018. Line chart of geoscience bachelor's degrees by students' race and ethnicity from 1998 through 2018. Latinx (Hispanic or Latino), Am Indian (American Indian or Alaska Native), Black (Black or African American), Pac Islander (Native Hawaiian or Other Pacific Islander), Other (Other or unknown).

Table 1 Sum of bachelor degrees awarded from 2014 to 2018 for Am Indian (American Indian or Alaska Native), Black (Black or African American), and Latinx (Hispanic or Latino) students for given institutions.				
US Institutions	Designation	Am Indian	Black	Latinx
California State University at Fullerton	HSI			59
Florida International University	HSI			57
Fort Lewis College	NANTI	12		
Georgia State University	PBI		21	
Mississippi State University			26	
Oklahoma State University		10		
Pennsylvania State University			31	54
Savannah State University	HBCU		15	
Texas A&M—College Station				96
United States Naval Academy			17	
University of California-Irvine	HSI			56
University of California-Santa Cruz	HSI			52
University of Houston	HSI		18	106
University of Puerto Rico	HSI			84
University of Texas at Austin				54
University of Texas at El Paso	HSI			69
University of Texas at San Antonio	HSI			51

Numbers are only shown for the institutions granting the highest number of degrees to students for each of these groups as detailed in the text. HSI determined as having >25% Hispanic undergraduate students in 2018.
HBCU Historically Black Colleges and Universities, HSI Hispanic Serving Institution, MSI Minority Serving Institution, NANTI Native American Serving Non-tribal, PBI Predominately Black Institution.

Databases such as IPEDS offer opportunities to delve into geoscience demographic trends and identify with more nuance the problems and successes. The community approach to grand challenges¹⁰ is powerful; we encourage future research on geoscience degree attainment to examine the intersection of gender and gender identity with race and ethnicity, the influence of instructional practices, the differences between geoscience disciplines, and what contributes to geoscience programs successfully attracting, mentoring, and graduating diverse geoscience students. We also caution that as long as databases continue to treat ethnocultural groups as part of larger monoliths, the experiences of many identities will be lost.

We have work to do to make our field more accessible, inclusive, and equitable everywhere. We must acknowledge the

varied pathways and entry points students take in a geoscience course of study and encourage mentoring that is flexible and adaptable at all career stages¹⁶. We will need to attract an inclusive student body, diversify the faculty, create accessible and inclusive learning environments, and ensure that all students feel they belong and are prepared for academic and career success in the geosciences. Justice, equity, diversity, and inclusion are grand challenges for the geosciences that depend upon our collective efforts and contributions.

Data availability

We used data from the Integrated Postsecondary Education Data System (IPEDS)¹². Numerical undergraduate degree data by race and ethnicity with calculated percentages for Geosciences (Classification of Public Instruction—CIP—codes 40.04 and 40.06),

Physical sciences (CIP 40), and all disciplines (including sciences, social sciences, and humanities) for 1998 and 2018 are available in Supplementary Table 1. IPEDS data are publicly available for download from <https://nces.ed.gov/ipeds/use-the-data> and through an interactive tool https://ncesdata.nsf.gov/builder/ipeds_c.

Received: 13 April 2021; Accepted: 24 May 2021;

Published online: 15 June 2021

References

- Morris, V., Joseph, E., Smith, S. & Yu, T. The Howard University Program in Atmospheric Sciences (HUPAS): A program exemplifying diversity and opportunity. *J. Geosci. Educ.* **60**, 45–53 (2012).
- White, L. D., Reddy, R. S., Liu, H., Williams, Q. & Shoemaker, J. Thirty years of meteorological education at a Historically Black University. *J. Geosci. Educ.* **61**, 20–27 (2013).
- McDaris, J. R., Manduca, C. A., Iverson, E. R. & Orr, C. H. Looking in the right places: Minority-Serving Institutions as sources of diverse earth science learners. *J. Geosci. Educ.* **65**, 407–415 (2017).
- Robinson, L., Rousseau, J., Mapp, D., Morris, V. & Laster, M. An educational partnership program with Minority Serving Institutions: a framework for producing minority scientists in NOAA-related disciplines. *J. Geosci. Educ.* **55**, 486–492 (2007).
- Villalobos, J. STEM education in community colleges. *Phys. Today* <https://physicstoday.scitation.org/doi/10.1063/PT.4.0510/full/> (2013).
- Beane, R., McNeal, K. S. & Macdonald, R. H. Probing the National Geoscience Faculty Survey for reported use of practices that support inclusive learning environments in undergraduate courses. *J. Geosci. Educ.* **67**, 427–445 (2019).
- Macdonald, R. H. et al. Accelerating change: The power of faculty change agents to promote diversity and inclusive teaching practices. *J. Geosci. Educ.* **67**, 330–339 (2019).
- Callahan, C. N. et al. Theoretical perspectives on increasing recruitment and retention of underrepresented students in the geosciences. *J. Geosci. Educ.* **65**, 563–576 (2017).
- Wolfe, B. A. & Riggs, E. M. Macrosystem analysis of programs and strategies to increase underrepresented populations in the geosciences. *J. Geosci. Educ.* **65**, 577–593 (2017).
- St. John, K. A Community Framework for Geoscience Education Research. (ed. St. John, K.) https://doi.org/10.25885/ger_framework/15 (National Association of Geoscience Teachers, 2018).
- Bernard, R. E. & Cooperdock, E. H. G. No progress on diversity in 40 years. *Nat. Geosci.* **11**, 292–295 <https://www.nature.com/articles/s41561-018-0116-6> (2018).
- IPEDS: Integrated Postsecondary Education Data System. <https://nces.ed.gov/ipeds/> (National Center for Education Statistics, accessed 2020).

- Gonzales, L. & Keane, C. Diversity in the Geosciences. *American Geosciences Institute Data Brief* 2020-023. <https://www.americangeosciences.org/geoscience-currents/diversity-geosciences> (2020).
- Núñez, A., Rivera, J. & Hallmark, T. Applying an intersectionality lens to expand equity in the geosciences. *J. Geosci. Educ.* **68**, 97–114 (2020).
- Johnson, D. R. et al. Examining sense of belonging among first-year undergraduates from different racial/ethnic groups. *J. Coll. Student Dev.* **48**, 525–542 (2007).
- Batchelor, R. L. et al. Reimagining STEM workforce development as a braided river. *Eos* **102**. <https://doi.org/10.1029/2021EO157277> (2021).

Author contributions

R.H.M. initiated discussions among all authors (R.B., E.B., R.L., J.M., V.M., I.J.V., and L.W.). Based on these discussions, R.B. led the writing of the commentary. E.B., R.B., and R.L. analyzed and plotted the data. E.B. and R.B. wrote the supplement. All authors provided input and edits throughout the process.

Competing interests

The authors declare no competing interests.

Additional information

Supplementary information The online version contains supplementary material available at <https://doi.org/10.1038/s43247-021-00196-6>.

Correspondence and requests for materials should be addressed to R.J.B.

Reprints and permission information is available at <http://www.nature.com/reprints>

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this license, visit <http://creativecommons.org/licenses/by/4.0/>.

© The Author(s) 2021