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1 Diversity Crisis in UK Geoscience Research Training

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10 **Geoscientists have a key role to play in the great challenges of the 21st Century, but**
11 **solving these problems requires diverse collaborations and engagement with**
12 **stakeholders from all backgrounds, both in the fundamental science and its**
13 **implementation. How can we break down the barriers that have made Geoscience**
14 **amongst the worst for racial minority representation and make our discipline equitable?**

15

16 The great social, environmental and economic challenges of the 21st Century, as exemplified by
17 the United Nations Sustainable Development Goals, require the work of Geoscientists¹. We
18 must collectively address the increasing vulnerability to geological hazards presented by rapid
19 population growth, meet the demand for rare minerals and renewable energy, and sustainably
20 manage resources (such as water) as our climate changes. Ironically this ‘fourth industrial
21 revolution’ of technological, economic and societal change is occurring at a time when UK
22 STEM businesses have warned of a growing skills shortage as they struggle to recruit suitably
23 qualified workers².

24

25 For us to tackle these challenges, Geoscience needs to attract more researchers than ever,
26 from a variety of backgrounds and experiences. To work sustainably across communities and
27 face global problems that impact people from all walks of life, we must remove the biases and
28 barriers that have led to inequity in our subject. We need to develop diverse collaborations for
29 more innovative problem solving³ and new ways of thinking⁴. However, postgraduate
30 Geoscience research is facing an ongoing diversity crisis. In the USA, Geoscience is “the least
31 diverse of all STEM fields”, with just 6% of doctorate degrees awarded to students from
32 underrepresented minorities (defined as American Indian or Alaska Native, Black or African
33 American, and Hispanic or Latino groups), despite comprising 31% of the population^{5,6}. Here we
34 present data from the Higher Education Statistics Authority (HESA)⁷ that paints a similarly
35 dismal picture in the UK.

36 **The data**

37 In the UK, 18.5% of 18-24 year olds identify as BAME^{8†} (defined by 'Black', 'Asian', 'Mixed' and
38 'Other' in UK Census and HESA ethnicity data). While the absolute number of UK-domiciled
39 students who identify as BAME in UK Higher Education (HE) has grown by >150,000 since
40 2003, there remain pronounced disparities between white and BAME students in their
41 continuation into postgraduate research⁹. These disparities vary between disciplines, and
42 between ethnic groups within the BAME identifier.

43

44 In the 2018/19 academic year, the proportion of UK-domiciled BAME students enrolled in UK
45 HE overall was 24.8% at undergraduate level⁷, dropping to 18.1% in postgraduate research.
46 Physical Sciences[‡] has a particularly poor record of BAME representation. The subject group
47 had 16.8% BAME student undergraduate enrolment in 2018/19 (third lowest of the nine
48 Science, Engineering, and Technology subject groups assessed; only Veterinary and
49 Agricultural Sciences were lower). This number drops to just 12.1% at research postgraduate
50 level⁷. Geoscience disciplines perform worse than the average: Geology and Physical
51 Geography were amongst the three Physical Sciences subjects with the poorest BAME
52 representation in 2018/19. BAME enrolment in undergraduate Geology was just 10.1%, and in
53 postgraduate Geology research just 10.4%. Physical Geography was the worst of all the
54 Physical Sciences, with 8.5% BAME representation on undergraduate courses, dropping to just
55 5.2% in postgraduate research⁷ (see Figure for five year averages).

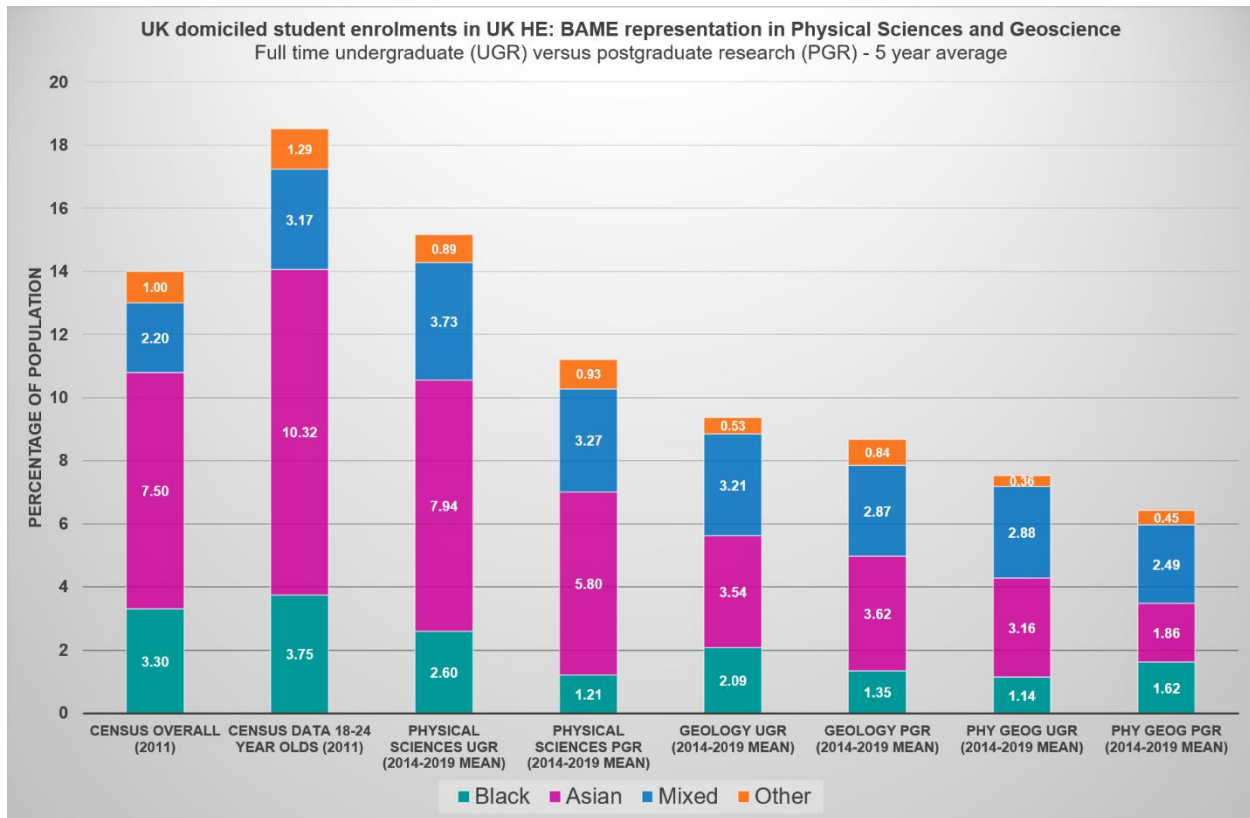
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57 In addition to underrepresentation at undergraduate level, the decrease at the transition to
58 postgraduate research in Geology is particularly significant for Black students (i.e. the 'B' of
59 BAME). Since 2015, the proportion of Black students in postgraduate Geology research has
60 been consistently lower than the proportion taking up undergraduate study. On average, over
61 the past 5 years, just 1.35% of postgraduate Geology research students were Black (10 Black
62 students in 2018/19)⁷, even though 3.75% of the UK 18-24 population is Black⁸.

63

† We use the term 'BAME' in this piece for consistency with HESA public data and terminology. However, we recognise the problems with using this identifier as it artificially homogenises many different backgrounds and identities³³. It also obscures discrimination that is overwhelmingly felt by one race or ethnicity. In some places we refer to data from a distinct ethnic group (e.g. Black) to highlight particularly wide disparities in the data.

‡ Physical Sciences includes Chemistry, Materials Science, Astronomy, Physics, Geology and Physical Geography



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Representation of BAME (Black, Asian, Mixed and Other ethnic minorities) in Physical Sciences and Geosciences from Higher Education Statistics Agency data⁷, alongside ethnicity data from the 2011 UK Government Census⁸. HESA data is based on full-time “all undergraduate” (UGR) and full-time “postgraduate research” (PGR) categories and is a five-year mean average of data from 2014/15 to 2018/19.

70 **Factors involved in BAME inequity in research training across UK HE**

71 Location of study, awarding gaps, unconscious and structural bias, and an application system
72 that fails to account for these biases all contribute to the drop in BAME representation between
73 undergraduate study and postgraduate research.

74

75 Rates of BAME students entering undergraduate study in the UK have grown considerably in
76 recent years⁹. However, BAME students applying to high tariff universities (e.g. Russell Group
77 and Oxbridge) are less likely to be offered places than white students with comparable A-level
78 qualifications¹⁰. For example, BAME applicants to Mathematical, Physical and Life Sciences
79 subjects at Oxford are 5.8% less likely to receive an offer than their white counterparts¹¹. In
80 2018/19, Black students made up just 3.9% of students at ‘high-tariff’ universities, compared to
81 12.2% at low-tariff universities⁷.

82

83 Once at university, the well-documented awarding (also known as attainment) gap means that
84 BAME students are less likely to gain a first or 2:1 degree classification than their white
85 counterparts¹². BAME students are also particularly vulnerable to exiting their undergraduate
86 degree before completion¹³. Leading Routes, a UK initiative to prepare and support the next
87 generation of Black students, report that although a range of factors have been proposed to
88 explain this attainment gap, an “unexplained gap” still exists; it is likely that unconscious bias
89 and inequitable frameworks within higher education systematically disadvantage Black and
90 minority ethnic students¹⁴. A lack of BAME representation at faculty level likely contributes to
91 this hostile environment and has been linked to BAME students not continuing to PhD level¹⁵.
92 Across the UK 10.8% of professors are BAME; just 0.74% are Black¹⁶.

93
94 Aspects of the PhD application process that negatively affect marginalised and
95 underrepresented students, such as emphasis on prior attainment, preference for graduates
96 from research-intensive universities, and fixed notions of academic excellence, have recently
97 been raised in an open letter to UK Research and Innovation (UKRI), the UK national funding
98 agency¹⁷. Although these factors affect students from a broad range of underrepresented
99 groups, many of them are particularly relevant to BAME applicants. The letter outlines nine
100 short-term actions to be taken, including the publication of candidate demographic data at
101 application, interview, offer and acceptance stages, which would provide a clearer picture of
102 postgraduate recruitment diversity. UKRI have recently published a diversity report¹⁸ that
103 reveals just 9% of UKRI studentships were awarded to ethnic minorities (the Office for National
104 Statistics uses ‘ethnic minority’ rather than BAME) in 2018/2019; a dismal statistic considering
105 that 19.4% of 18-34 year olds (the demographic to which the majority of studentships were
106 awarded) are BAME⁸. For the Natural Environment Research Council (NERC), the national
107 funder of environmental sciences, these numbers are even lower, with just 6% of studentships
108 going to ethnic minorities¹⁸. However, in 19% of cases ethnicity was “unknown” or “not
109 disclosed”, highlighting the need for improved reporting and transparency.

110

111 **Factors involved in BAME inequity in UK Geoscience**

112 Geoscience programmes involve a melting pot of subject-specific barriers to BAME
113 accessibility.

114

115 In a recent unpublished Geological Society survey of undergraduate students, 60% of
116 respondents mentioned a lifelong interest in the natural environment. Rural environments may

117 be less accessible to children who grow up in urban settings, which are more ethnically diverse
118 than rural settings¹⁹, or to children from low-income households, who in the UK are
119 disproportionately more likely to be Pakistani, Bangladeshi, Chinese or Black than white²⁰.

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121 A lack of diverse role models, the perpetual stereotype of a geoscientist as a white man²¹, and
122 the link between Geoscience and both past and contemporary imperialist or colonialist
123 attitudes²² are perception issues that may be particularly off-putting to those from minority ethnic
124 backgrounds. Furthermore, a career pathway in Geoscience, particularly in postgraduate
125 Geoscience research, may not be seen to offer the financial security of other professions such
126 as Law or Medicine²³ by some minority or low-income communities.

127

128 In addition to the academia-wide issues outlined by Leading Routes¹², once in Geoscience there
129 are 'hostile climates'²⁴ that can deter BAME students from continuing in postgraduate research.
130 Fieldwork requirements create barriers to racial and ethnic minorities, for reasons including cost,
131 inclusivity and racial harassment²⁵. The 'alcohol culture' in many Geoscience departments and
132 at conferences²⁶ presents barriers to inclusivity for students who do not drink, who are more
133 likely to be from BAME backgrounds²³. Representation and presence of role models is likely an
134 issue; there is a pronounced lack of BAME faculty members in Geoscience (<10% in both 'Earth
135 Science' and Physical Geography in 2015/16²⁷) and BAME geoscientists are invited to give
136 fewer talks at conferences²⁴.

137

138 Although all these factors are found in Geoscience, some overlap with those encountered in
139 other Physical Sciences. If we can work towards acknowledging and resolving these issues in
140 Geoscience, and increase the diversity of our particularly white subject, we can develop
141 strategies transferable to other UK HE subjects. Furthermore, a framework of intersectionality,
142 identifying the multiple individual, cultural, and structural dimensions that shape the way
143 individuals navigate the discipline of Geoscience, is key for broadening participation to a range
144 of minority groups²⁸.

145

146 **What can we do about it?**

147 A number of suggestions have been made in recent years to improve BAME diversity in
148 Geoscience^{5,24,25,29,30}. These include making application processes more transparent, adapting
149 fieldwork requirements and experiences so they are more inclusive, broadening participation
150 through summer schools and paid internships, ringfencing funding or fellowships for

151 underrepresented groups, increasing diversity in faculty staff, and acknowledging the 'colonial
152 and exclusionary' foundations of our institutions to address hostile environments.

153

154 In the UK, we must push our professional bodies, such as the Geological Society, for the
155 accreditation reform that may help improve inclusivity. We can also continue to pressure funding
156 organisations to be more transparent in their recruitment practices and encourage our own
157 Centres for Doctoral Training (CDTs) and Doctoral Training Partnerships (DTPs) to break down
158 competitive barriers and share ideas for broadening participation. We need to modernise our
159 curriculum and improve perceptions, by exploring links between Geoscience and colonialism³¹
160 with our students, embedding sustainable development into our teaching, and considering the
161 importance of Geoscience in urban landscapes and the 'fourth industrial revolution'. We should
162 develop stronger links with industry, both to encourage more paid (ringfenced) internships, and
163 also to change career perceptions of our subject. We need to change how we talk about and
164 market Geoscience, developing more diverse promotional materials and ambassador schemes -
165 without disproportionately placing the burden of such work on BAME members of our community³².
166 We need to put forward progressive funding bids for evidence-driven action research that works
167 to address datagaps, advocates for real change, and develops effective strategies to broaden
168 participation. We can be more multidisciplinary, and work with other subjects and bodies facing
169 similar challenges, sharing transferable solutions across the HE sector.

170

171 Crucially, we need to acknowledge the hostile environments that deter BAME students from
172 applying to, and continuing with, our discipline. We must address personal and structural
173 biases, and go beyond this to be actively anti-racist. The less diverse a field is, the more
174 prevalent implicit biases become⁶. We must act now, and have those difficult conversations, to
175 create a modern Geoscience research culture that reflects the diverse nature of the planet we
176 study.

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181 comments on this piece.

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185 **References**

- 186 1. Gill, J. C. Geology and the Sustainable Development Goals. *Episodes* **40**, 70–76 (2017).
- 187 2. Skills shortage costing STEM sector £1.5bn. *STEM Learning* (2018).
- 188 3. Hong, L. & Page, S. E. Groups of diverse problem solvers can outperform groups of high-
- 189 ability problem solvers. *Proc. Natl. Acad. Sci. U. S. A.* **101**, 16385–16389 (2004).
- 190 4. Phillips, K. W. *How Diversity Makes Us Smarter*. *Greater Good Magazine* (UC Berkeley,
- 191 2017).
- 192 5. Bernard, R. E. & Cooperdock, E. H. G. No progress on diversity in 40 years. *Nat. Geosci.*
- 193 **11**, 292–295 (2018).
- 194 6. Dutt, K. Race and racism in the geosciences. *Nat. Geosci.* **13**, 2–3 (2020).
- 195 7. Higher Education Statistics Authority. Higher Education Student Data. (2019).
- 196 8. GOV.UK. Population of England and Wales. (2018).
- 197 9. Advance HE. *Equality in higher education: statistical report 2019*. (2019).
- 198 10. Boliver, V. Why are British ethnic minorities less likely to be offered places at highly
- 199 selective universities? in *Aiming Higher: Race, Inequity and Diversity in the Academy*.
- 200 15–18 (Runnymede, 2015).
- 201 11. Inge, S. Scale of Oxford’s ‘white bias’ laid bare by internal report. *Research Professional*
- 202 *News* (2020).
- 203 12. National Union of Students & Universities UK. *Black, Asian and Minority Ethnic Student*
- 204 *Attainment at Universities*. (2019).
- 205 13. Woodfield, R. *Undergraduate retention and attainment across the disciplines*. (The Higher
- 206 Education Academy, 2014).
- 207 14. Williams, P., Bath, S., Arday, J. & Lewis, C. *The Broken Pipeline*. (2019).
- 208 15. Fazackerley, A. ‘Look at how white the academy is’: why BAME students aren’t doing
- 209 PhDs. *The Guardian* (2019).
- 210 16. Higher Education Statistics Authority. Higher Education Staff Data. (2019).
- 211 17. Giles, S. *et al.* Open letter concerning CDT and DTP student recruitment across the UK.
- 212 (2020).
- 213 18. UK Research and Innovation. *Diversity Results for UKRI funding data 2014/15 to 2018-*
- 214 *19*. (2020).
- 215 19. GOV.UK. *Rural Population and Migration*. (2018).
- 216 20. Office for National Statistics. Child poverty and education outcomes by ethnicity. (2020).
- 217 21. Goldberg, E. Earth Science Has a Whiteness Problem - The New York Times. *The New*
- 218 *York Times* (2019).

- 219 22. Roy, R. Science Still Bears the Fingerprints of Colonialism. *Smithsonian Magazine*
220 (2018).
- 221 23. Fernando, B. & Antell, G. *Recommendations for improving racial equality, diversity, and*
222 *inclusion in the Department of Earth Sciences, University of Oxford.* (2020).
- 223 24. Marín-Spiotta, E. *et al.* Hostile climates are barriers to diversifying the geosciences. *Adv.*
224 *Geosci.* **53**, 117–127 (2020).
- 225 25. Giles, S., Jackson, C. & Stephen, N. Barriers to fieldwork in undergraduate geoscience
226 degrees. *Nat. Rev. Earth Environ.* **1**, 77–78 (2020).
- 227 26. Guertin, L. Want to be more inclusive? Stop making geology conferences about the beer.
228 *GeoEd Trek- AGU Blogosphere* (2019).
- 229 27. REF.ac.uk. HE Staff Equalities Tables by Ethnicity. (2016).
- 230 28. Núñez, A. M., Rivera, J. & Hallmark, T. Applying an intersectionality lens to expand equity
231 in the geosciences. *J. Geosci. Educ.* **68**, 97–114 (2020).
- 232 29. Thomas, D., Ashworth, P., Nield, J. & Souch, C. *International Benchmarking Review of*
233 *UK Physical Geography.* (2017).
- 234 30. Dutt, K. Promoting Racial Diversity Through Transparency. *Eos (Washington. DC).* **100**,
235 (2019).
- 236 31. Stafford, R. A. Geological Surveys, Mineral Discoveries, and British Expansion, 1835–71.
237 *J. Imp. Commonw. Hist.* **12**, 5–32 (1984).
- 238 32. Gewin, V. The time tax put on scientists of colour. *Nature* (2020).
- 239 33. Stevenson, J., O'Mahony, J., Khan, O., Ghaffar, F. & Stiell, B. *Understanding and*
240 *overcoming the challenges of targeting students from under-represented and*
241 *disadvantaged ethnic backgrounds.* (2019).
- 242