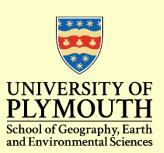
## 'Picking your path' towards accessible and inclusive geoscience field education

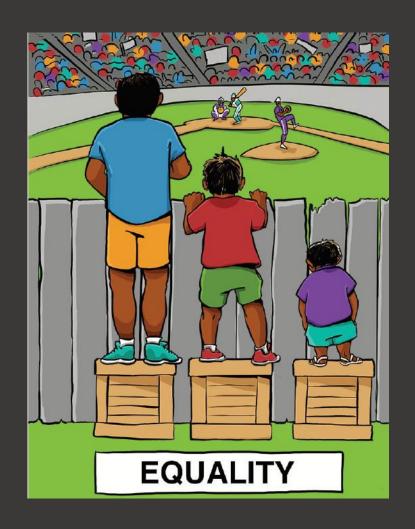


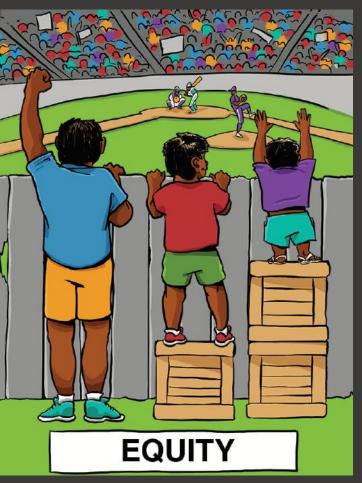


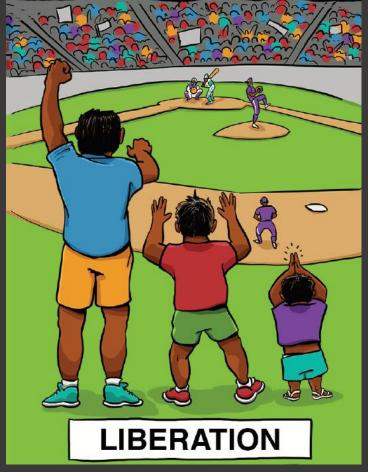
**Dr Alison Stokes** (she/her) Associate Professor in Earth and Environmental Science / Associate Head of School Education and Student Experience (alison.stokes@plymouth.ac.uk)

#### **ACCESS**

#### **INCLUSION**





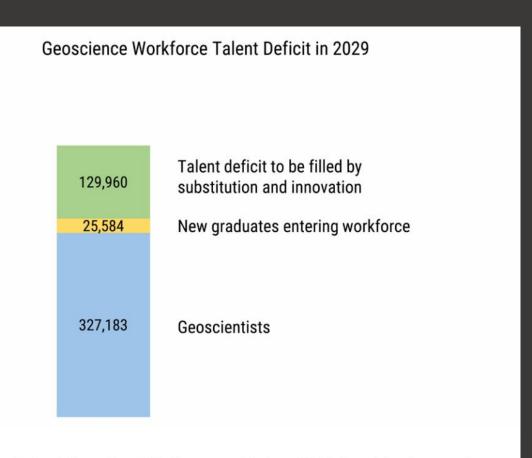


https://www.storybasedstrategy.org/the4thbox-resources

#### Big issue #1: there are not enough geoscientists

### American Geosciences Institute predict that by 2029:

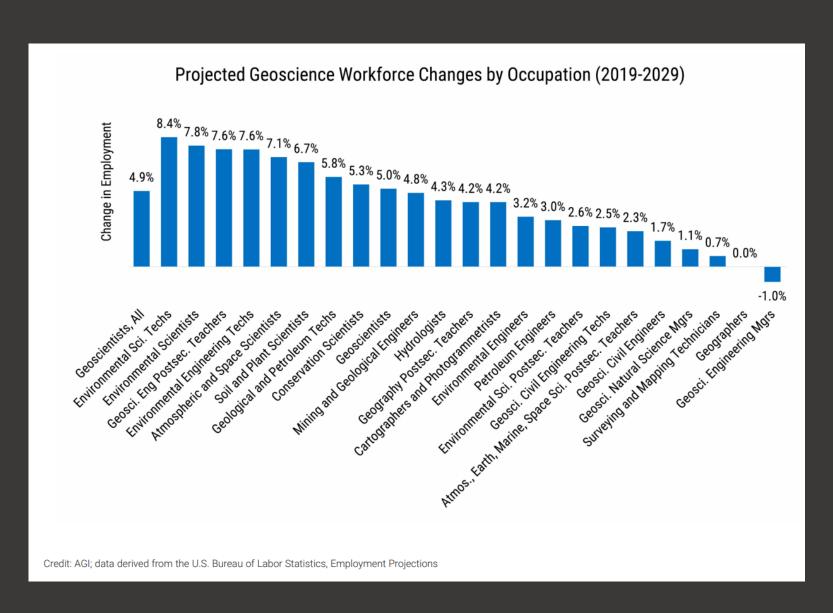
- Jobs in geoscience will increase by 4.9% to >480,000
- 27% of existing geoscience workforce will be retiring
- There will be a geoscience workforce talent deficit of ~130,000



Credit: AGI; data derived from the U.S. Bureau of Labor Statistics, Employment Projections and Current Population Survey, and from AGI's Directory of Geoscience Departments

### Big issue #2: lack of diversity in geoscience

- Geoscience is one of the least diverse disciplinary fields (Gewin, 2023)
- People with disabilities are the largest minority group in the US (e.g. Carabajal et al., 2017)



## Where does fieldwork fit into this?

Geoscience pipeline model (Levine *et al.,* 2007)

- Prevalence / importance of fieldwork distinguishes geosciences from other STEM
- Positive fieldwork experiences associated with recruitment and retention

#### MIDDLE/HIGH SCHOOL INDICATORS Course selection Peer pressure Science instruction Geoscience awareness Extracurricular activities College preparation activities Personal characteristics Effective instruction Familial factors Engaging geoscience courses Parental support (material, Role models behavioral, emotional) for Economy geoscience activities Encounters with racism Outdoor experiences JUNIOR COLLEGE INDICATORS FOUR-YEAR COLLEGE INDICATORS Course selection Course selection Required STEM courses Required STEM courses Introductory Geoscience Introductory Geoscience Major selection Major selection Extracurricular activities Obtaining information about Personal characteristics geoscience major Extracurricular activities Ethnic cultural values and socialization Personal characteristics Familial factors iscal abilities Ethnic cultural values and socialization Familial factors Outdoor experiences Fiscal abilities Peer pressure Geoscience awareness Outdoor experiences Four-year college preparation activities Peer pressure Geoscience awareness Career development activities Geoscience internships Graduate school preparation activities Career development activities Effective instruction Geoscience internships Engaging geoscience courses Knowledge of geoscience careers Role models Salary Encounters with racism Outdoors work Travel Mentors Facilitate graduate school GRADUATE SCHOOL INDICATORS application Familial factors Effective instruction Fiscal abilities Engaging geoscience courses Outdoor experiences Field trips Career development activities Role models Professional socialization Geoscience culture Mentors Economy Role models Geoscience job market Geoscience culture Encounters with racism Geoscience job market Encounters with racism CAREER IN THE GEOSCIENCES

**NOVICES IN** ELINE EOSCIENCE

**EXPERTS OUT** 

NOTE: Bolded text represents verification of the pipeline category from the critical incident study. Italicized text represents additional categories and subcategories added as a result of the critical incident study

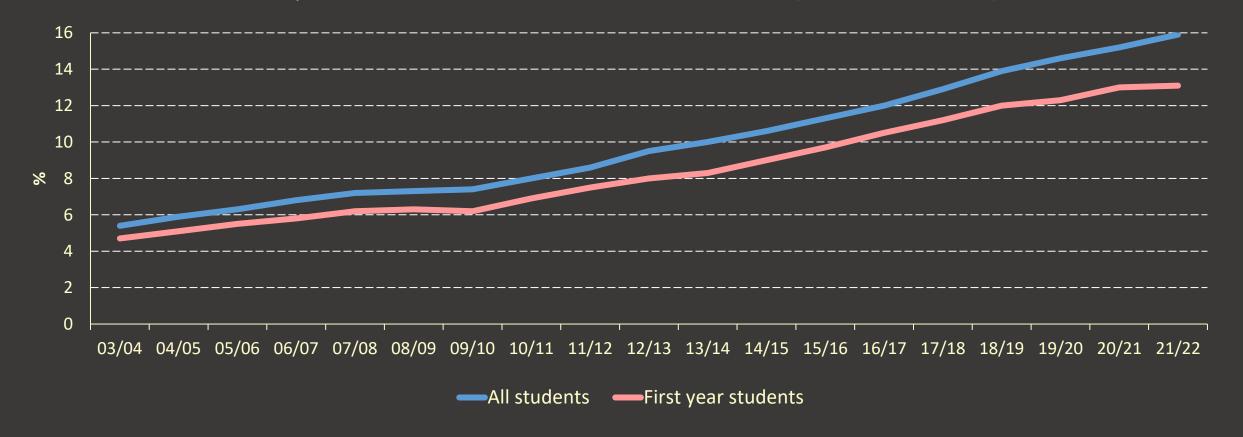


"If field experiences are integral to professional preparation, then they must be made equitable for all students" (Marshall & Thatcher, 2019)

### What do the data (from the UK) tell us?

#### 1. The number of students in HE declaring a disability is increasing

Proportion of students with disabilities 2003-2022 (Advance HE, 2023)



### 2. The majority of disabilities declared on geoscience programs are 'unseen' conditions

Students enrolled on GEES programmes and impairment type 2021-22 (Advance HE, 2023)

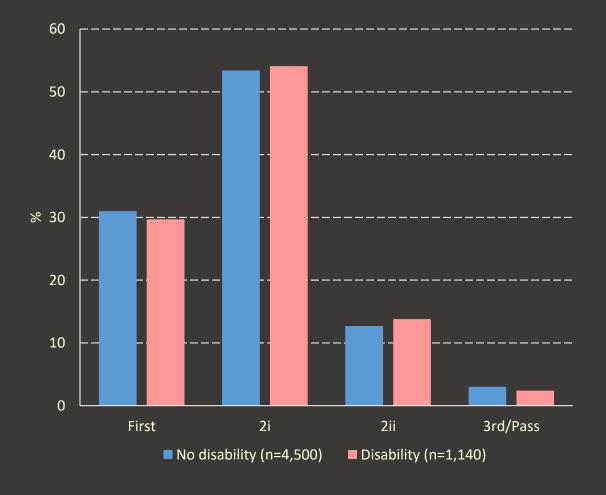


#### 3. Students with disabilities are just as likely to succeed academically

Non-continuation rate among UK undergraduate students (OfS, 2021)

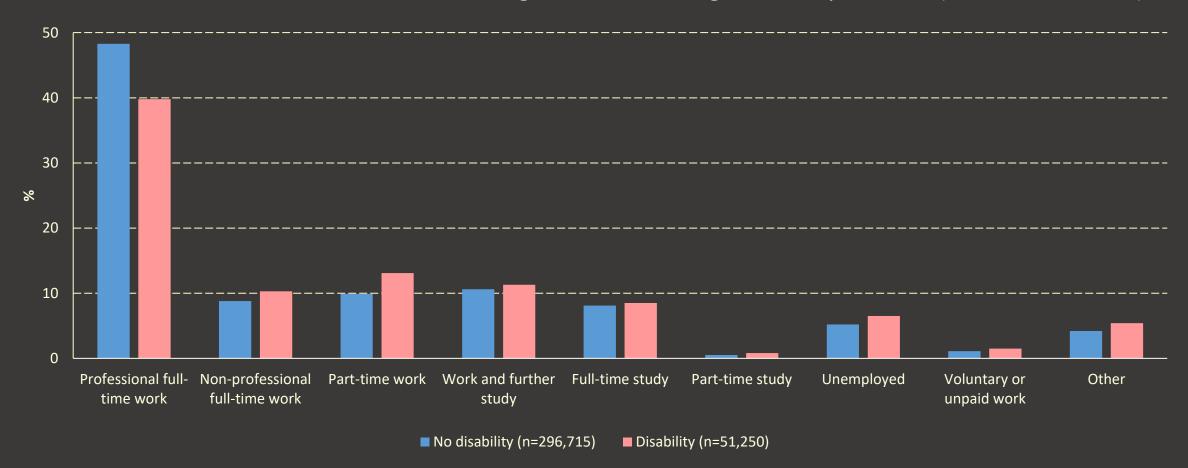


Attainment gap between GEES students declaring and not declaring a disability 2021-22 (Advance HE, 2023)



### 4. Students with disabilities are less likely to gain professional employment

Graduate outcomes: students declaring and not declaring a disability 2021-22 (Advance HE, 2023)



## What are the main barriers to fieldwork?

#### Physical access and logistical barriers

- Mobility / negotiation of terrain
- Removal from familiar environments
- Adjustments to / support with activities

#### **Social inclusion**

- Engaging in social interaction and building relationships
- Developing identity and sense of belonging





#### Key research activities





Type of fieldwork

Single-day field excursion (Vancouver)

Week-long residential field course (Wales)

Fieldwork design

Workshop-style: students and faculty working collaboratively. Pre-existing fieldwork adapted to be accessible for students with diverse needs.

'Typical' residential field course with faculty-led and student-led activities. Designed to be inclusive for students with diverse needs.

**Participants** 

14/15 students and 3/14 faculty self-identified as having a physical, neurodiverse or mental health condition

4/12 students declared a neurodiverse and/or mental health condition, and 2/12 declared a mobility impairment

**Key references** 

Feig et al. (2019), Stokes et al. (2019)

Houghton et al. (2020)

### Suggested design principles for inclusive fieldwork

Multiple means of access

Identify locations that offer multiple options for accessing the geology

Multisensory engagement

Make learning materials available in formats that are accessible to different senses, e.g. visual, audio etc.

Pace and timing

Ensure that the time available for the learning activity and pacing of delivery is sufficient

**Collaborative learning activities** 

Encourage interaction between students and their peers, and with faculty, during all fieldwork tasks, including downtime

Academic as opposed to physical rigor

Design activities / choose locations to accommodate different levels of physical ability

**Promoting self-advocacy** 

Invite students to make their needs known prior to and during field activity

# Find out about students' needs and previous fieldwork experiences

- Fieldwork is daunting
- Perceived by others as lazy and a burden
- Feeling alone, misunderstood and unsupported
- "The last guy back to the bus"



#### Day 2: Tuesday Cemlyn Bay 4<sup>th</sup> September, 2018 Lligwy Bay **Anglesey** Rhosneigr 100 Cretaceous 150 Jurassic **Red Wharf Bay** 200 Cliff and foreshore outcrops of Carboniferous Triassic limestone, sandstone and shales and a 250 Miocene(?) aged beach deposit. Permian LlanfairPG 300 Carboniferous In the woods, beneath the Marquess of 350 Anglesey's statue, are a series of Neoproterozoic blueschist outcrops. Devonian 9am: Depart (40 minute drive) Silurian 10.15am: At Red Wharf Bay 2pm: Depart for LlanfairPG (15 minute drive) 500 2.30pm: At LlanfairPG Cambrian 3.30pm: Leave for hostel 4.00pm: Back at hostel Veoproterozoic 600

## Consider planning, schedules, pace and timing

- Information delivered beforehand helps to reduce anxiety
- Provide a clear schedule of activities including break times, but be prepared for 'uncertainties'!
- Prioritise spending more time at fewer locations

### Offer different means of accessing learning

"...people, you know, they split up, they did their own thing, they explored the way that they would—and then, again, reconvening and sharing all of their experiences with each other at the end. That I think made it more accessible, because you picked your path, but there were so many options and your experience and observations were just as valuable as everyone else's" (Greta, S2SH)



### Recognise that field learning is multisensory

Sight is not the only sense – there is more to geology than what we observe!

Also consider learning resources such as handouts

### Fieldwork is also a social process

Design tasks and activities to encourage collaboration and knowledge-sharing...





...but social interaction may be extremely challenging for some students

#### Communication is key!

Diversity of students = diverse range of communication requirements!

- Tour guide system
- Walkie talkies
- Live feed system
- Skype/FaceTime

\*See Atchison *et al.* (2019) for further case studies involving technology-enabled accessible fieldwork







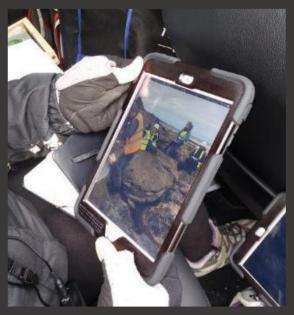


"The tour guide system's been really good...cos, now I don't miss anything, because I can't deal with being in a crowd or...getting too close, or having to sort of, back off and go somewhere to the side on my own. I can now do all those things, but I don't miss anything" (Frank, AA)

#### Live feed methods







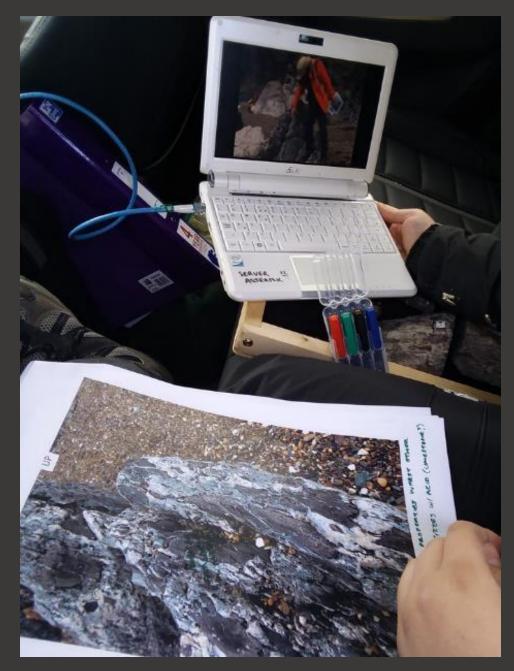
- Technology such as a simple LAN or Skype/FaceTime can provide live feed for remotely located students
- The most important thing is to keep all students connected!

#### Parallel field activities





"...when we were sitting in the car and we have the video, and the pictures, and the hand samples and everything, and...I quite enjoyed that, just 'cos it felt like I was there, and I was doing something and like, part of the team..." (Abi, AA)



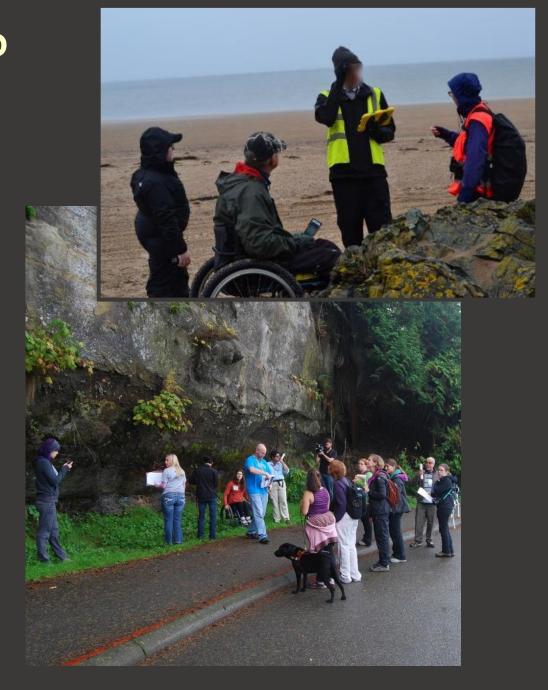


## What is the impact on student experience?

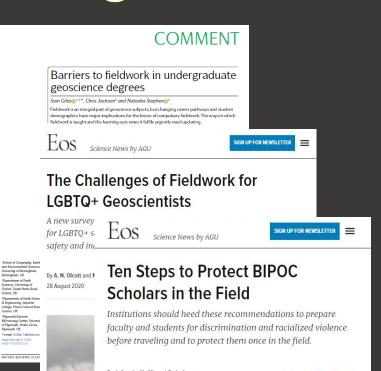
- "Pressure off" and feeling fully included
- Social interaction facilitated,
   although still challenging for some
- Pace allowed opportunity for exploration and discovery
- Willingness to advocate

#### What have we learned so far?

- Good pedagogic practice is key to making fieldwork inclusive and accessible
- Technology and alternative activities are important for enhancing access, but should not hinder inclusion
- Traditional fieldwork 'cultures' can exclude students academically and socially
- When students feel included, they feel empowered to advocate for themselves and for others



### Things ARE changing...





Mammoth Hot Springs at Yellowstone National Park. Credit: Hendratta Ali

https://doi.org/10.5194/adgeo-53-53-2020

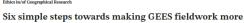
Author(s) 2020. This work is distributed under the Creative Commons Attribution 4.0 License



AREA . WILEY

#### An investigation of accessible and inclusive instructional field practices in US geoscience departments

Received: 2 March 2021 Revised: 21 June 2021 Accepted: 22 July 2021



accessible and inclusive Anya Lawrence<sup>1</sup> | Natasha Dowey<sup>2</sup>

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Earth and Environment

INTRO

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"Nothing about us without us:" The perspectives of autistic geoscientists on inclusive instructional practices in geoscience education

Cole G. Kingsbury\*\* @, Elizabeth C. Siberth. @, Zachary Killingback\*\* @, and Christopher L. Atchison\* @ \*Department of Geology, University of Pretoria, Hatfield, 0028 Pretoria, Republic of South Africa; \*Department of Earth and Planetary Sciences, Harvard University, Cambridge, Massachusetts 0.2138, "Sockey of Fellows, Harvard University, Cambridge, Massachusetts 0.2138, "Department of Earth Science, Dunham University, Dunham DH1 SLE, United Kingdom, "School of Education and Department of Geology, University of Cindmati, Cindmati, Ohio 45221

ARTIMET
In resultingly more students with disabilities including actatic or otherwise neutralivers students, are studying for dispose in STM fleid subjects. In occurt year, there has been an increased effort from the specificiens education community to make being more as existly and inclusives to form the specificiens education community to make studing more as existly and inclusives the three practices are to a wro. This, combined with the medical, drift bloads understanding of autient spicially prevented in the Internation, has resulted in the perpetuation of Hemital description, along with recommendations that may not actually are as best practice. Here we present a mort as accosed and belocks explanation of what advers makely is asking or their deportment and most accordance of the properties of which adversarially is allow got bent deportment and manufactures goocking studies, with a focus on fleid-based learning. This framework includes these pillars (a) develop defect communication parkneys with actitic students, (b) pressures competence and include autistic students in the planning of their own accommoditions, opportunits the seminory processing a secret of adultine spectrum conditions as assigned tradepole for ogrizing the sensory processing aspects of autism spectrum conditions and suggest strategies for minimizing these difficulties in a field environment. By certaining autistic voices in the discussion of how to support autistic geoscience students, we hope to change the narrative of indusion for this dwere, but significant population.

Although increasing attention has been paid in the scientific literature to improving access and inclusion of students and

to recognize challenges and support of mental health in the field (e.g. John & Khan, 2018; Tacker & Horton, 2019).

practitioners with disabilities in Science, Technology, inclusive planning and design across our discipline and along practitioners with canonicies in societies, examining inclusive paraming and unuqui across our temperature. Engineering and Mathematics of STEM) education and pulsays to generate our carries (e.g. Hartman, 2019), the generateness have had the other carries (e.g. Hartman, 2019), the descriptions have been described or a chair-ship regarding augment for auditic indicate within lowest participation rates of individuals with disabilities the geometric education community appears to be lacking the when compared to its STEM peers, (Locke, 2005; NSF voice of the students and the population that they are trying when Comparia is no 0.1 km point, toness, we voice of the students with to zerve. Likely due to the omission of audistic voices, there disabilities in gookiences have focused on physical (Cilley). et al., 2015), sensory (Hendécke et al., 2017), and other way: they are grounded in harmful stereotypes about autism, non-appaint disabilities (De Paor et al., 2017, John & and give suggestions for 'apporting' autistic students which Khan, 2018, 'Tucker & Horton, 2019,' there has been have the potential to harm more than help.

increasing effort in secent years to help geosciences attract. At some point in their career, all geoscience faculty mem and retain neumdiverse participants - students diagnosed bes will flud themselves teaching autistic students whether with, for example ADHD, Autism, dyslexia, dyspraxia, and or not the students explicitly direlose such diagnoses. Recent those with mental health challenges. These include initiatives studies suggest that as much as 1.9% of the student popula such as improving field mapping and geoscience education tion of a large public university in the United States could accessibility for students with Austian Spectrum Conditions be austistic (White et al., 2011). If we consider this to be rep-(ASCs) as reported in Lang and Persico (2019), and Billing resentative, a typical introductory geoscience class of 150

CONTACT Cale C. Ring bury (2) The CORng 317 (kgrad corn (2) Department of Geology, University of Privates, Private Big XXII, Helinki, Private 0028, Republic of Smith Mice. authors contributed equally to this work

Supplemental data for this article can be accessed at https://doi.org/10.1080/1089995.2020.1768017 C 2020 National Association of Georgiesise Teacher

#### Effective Use of Personal Assistants for Students With Disabilities: Lessons Learned From the 2014 Accessible Geoscience Field Trip

Julie E. Hendricks, 1 Christopher L. Atchison, 1,2,4 and Anthony D. Feig3

n 2014, the Geological Society of America sponsored an Accessible Field Trip, designed to demonstrate best practices in analyzed through self-reflective case study. The lived experiences of the participants and the assistant are interpreted to

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INTRODUCTIO

Toilet stops in the field: An educational primer and recommended best practices for field-based teaching

Sarah Greene, Kate Ashley, Emma Dunne, Kirsty Edgar, Sam Giles, Emma Hanson, University of

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USA
Department of Geol
18221, USA
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Michigan 48858, USA
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christopher atchison@

Accessibility and Fieldwork in the

Fieldwork in the geosciences is increasingly relying on groundwork laid by accessibility advocates.

By Richard I Sima using su tampon want pr













### What still needs to change?



"I think anybody that gets into geoscience, regardless of their age or limitations, should have the opportunity to be able to learn and not be judged..." (Amanda, S2SH)



**EXPERTS OUT** 

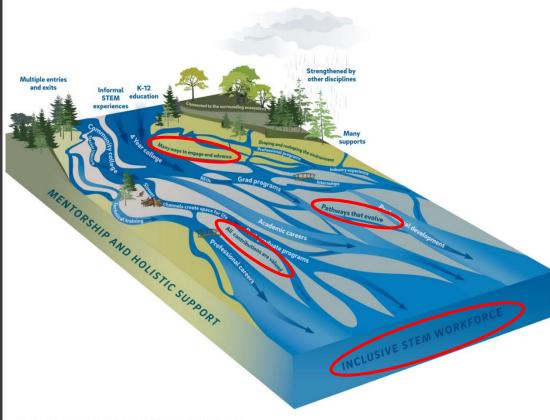
Reimagining the geoscience pipeline?

#### Eos

#### Reimagining STEM Workforce Development as a Braided River

A contemporary approach to today's science careers looks less like a structured pipeline and more like a collection of paths that change and adapt to the needs of the individual.

By R. L. Batchelor, H. Ali, K. G. Gardner-Vandy, A. U. Gold, J. A. MacKinnon, and P. M. Asher 19 April 2021



A braided river in New Zealand. Credit: Findley Watt, stock.adobe.com

## THANK YOU!





## Questions ?

#### References and further resources

- Advance HE (2021) Equality + higher education: Students statistical report 2021. Advance HE/HESA. <a href="https://www.advance-he.ac.uk/knowledge-hub/equality-higher-education-statistical-report-2021">https://www.advance-he.ac.uk/knowledge-hub/equality-higher-education-statistical-report-2021</a>
- American Geosciences Institute (2020) AGI Currents: Geoscience Workforce Projections 2019-2029. https://www.americangeosciences.org/geoscience-currents
- Anadu, J., Ali, H. & Jackson, C. (2020) Ten steps to protect BIPOC scholars in the field. *Eos*, 101, 30–31. doi: 10.1029/2020E 0150525.
- Atchison, C.L., Marshall, A.M. & Collins, T.D. (2019) A multiple case study of inclusive learning communities enabling active participation in geoscience field courses for students with physical disabilities. *Journal of Geoscience Education*, 67 (4), 472-486. doi: 10.1080/10899995.2019.1600962
- Batchelor, R. L., Ali, H., Gardner-Vandy, K.G., Gold, A.U., MacKinnon, J.A. & Asher, P.M. (2021) Reimagining STEM workforce development as a braided river, *Eos*, 102, doi: 10.1029/2021E0157277.
- Carabajal, I. G., Marshall, A.M. & Atchison, C. L. (2017) A synthesis of instructional strategies in geoscience education literature that address barriers to inclusion for students with disabilities. *Journal of Geoscience Education*. 65, 531-541, doi: 10.5408/16-211.1.
- Carabajal, I. G. & Atchison, C. L. (2020) An investigation of accessible and inclusive instructional field practices in US geoscience departments. *Advances in Geosciences*, 53, 53–63, doi. 10.5194/adgeo-53-53-2020.
- Cooke, M.L., Anderson, K.S., and Forrest, S.E. (1997) Creating accessible introductory geology field trips. *Journal of Geoscience Education*, 45, 4-9, doi: 10.5408/1089-9995-45.1.4.
- Feig, A.D., Atchison, C.L., Stokes, A. and Gilley, B. (2019) Achieving inclusive field-based education: results and recommendations from an accessible geoscience field trip. *Journal of the Scholarship of Teaching and Learning*, 19 (2), 66-87, doi: 10.14434/josotl.v19i1.23455.
- Fuller, I.C. (2006) What is the value of fieldwork? Answers from New Zealand using two contrasting undergraduate physical geography fieldtrips. *New Zealand Geographer*, 62, 215-220, doi: 10.1111/j.1745-7939.2006.00072.x.
- Giles, S., Jackson, C. & Stephen, N. (2020) Barriers to fieldwork in undergraduate geoscience degrees. *Nature Reviews Earth & Environment*, 1, 77–78. doi: 10.1038/s4301 7-020-0022-5
- Greene, S., Ashley, K., Dunne, E., Edgar, K., Giles, S. & Hanson, E. (2020) Toilet stops in the field: An educational primer and recommended best practices for field-based teaching. OSF Preprints. doi: 10.31219/osf.io/gnhj2
- Hall, T. & Healey, M. (2004) The experience of learning at university by disabled students in geography, Earth and environmental sciences and related disciplines: Report on the Inclusive Curriculum Project (ICP) Student Survey, <a href="http://gdn.glos.ac.uk/icp/student%20survey.pdf">http://gdn.glos.ac.uk/icp/student%20survey.pdf</a>

- Hall, T. & Healey, M. (2005) Disabled students' experiences of fieldwork. Area, 37 (4), 446-449, doi: 0.1111/j.1475-4762.2005.00649.x.
- Hall, T., Healey, M., & Harrison, M. (2004) Fieldwork and disabled students: discourses of exclusion and inclusion. *Journal of Geography in Higher Education*, 28 (2), 255-280, doi: 10.1080/0309826042000242495.
- Hendricks, J.E., Atchison, C.L. & Feig, A.D. (2017) Effective use of personal assistants for students with disabilities: Lessons learned from the 2014 accessible geoscience field trip. *Journal of Geoscience Education*, 65 (1), 72–80. doi: 10.5408/16-185.1
- Houghton, J.J., Morgan, D.J., Gordon, C.E., Stokes, A., Atchison, C.L., Collins, T.D., Craven, B. & Willis, K. (2020) Access Anglesey 2018: Lessons from an inclusive field course. Advances in Geosciences, 53, 183-194. doi: 10.5194/adgeo-53-183-2020.
- Kingsbury, C.G., Sibert, E.C., Killingback, Z. & Atchison, C.L. (2020) "Nothing about us without us:" The perspectives of autistic geoscientists on inclusive instructional practices in geoscience education. *Journal of Geoscience Education*, 68 (4), 302–310. doi: 10.1080/10899 995.2020.1768017
- Lawrence, A. & Dowey, N. (2022) Six simple steps towards making GEES fieldwork more accessible and inclusive. Area, 54, 52-59. doi: 10.1111/area.12747
- Levine, R., González, R., Cole, S., Fuhrman, M. & Carlson Le Floch, K. (2007) The Geoscience Pipeline: A Conceptual Framework. Journal of Geoscience Education, 55 (6), 458-468, doi: 10.5408/1089-9995-55.6.458
- Marshall, A.M. & Thatcher, S. (2019) Creating spaces for geoscientists with disabilities to thrive. Eos, 100. https://doi.org/10.1029/2019E0136434
- Office for Students (2021) Equality, diversity and student characteristic data. <a href="https://www.advance-he.ac.uk/knowledge-hub/equality-higher-education-statistical-report-2021">https://www.advance-he.ac.uk/knowledge-hub/equality-higher-education-statistical-report-2021</a>
- Olcott, A.N. & Downen, M.R. (2020) The challenges of fieldwork for LGBTQ+ geoscientists. *Eos*, 101, 22–24. doi:10.1029/2020E O148200
- Stokes, A. & Boyle, A.P. (2009) The undergraduate geoscience fieldwork experience: Influencing factors and implications for learning, in Whitmeyer, S.J., Mogk, D.W., and Pyle, E.J., eds., *Field Geology Education: Historical Perspectives and Modern Approaches*: Geological Society of America Special Paper 461, 291–311, doi: 10.1130/2009.2461(24).
- Stokes, A., Feig, A.D., Atchison, C.L. & Gilley, B. (2019) Making geoscience fieldwork inclusive and accessible for students with disabilities. *Geosphere*, 15 (6), 1809-1825. doi:10.1130/GES02006.1.
- Struele, M.J. & Craig, L.E. (2016) Social learning theories an important design consideration for geoscience fieldwork. *Journal of Geoscience Education*, 64 (2), 101-107, doi: 10.5408/15-119
- Whitmeyer, S.J., Atchison, C. & Collins, T.D. (2020) Using mobile technologies to enhance accessibility and inclusion in field-based learning. *GSA Today*, 30, doi: 10.1130/GSATG462A.1