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## Sustainable geoscience

To the editor – Humankind is using more natural resources than ever before. The way we are using these materials has already started to affect our ecosystem irreversibly. Overuse of the Earth's natural wealth has the potential to impact our ability to sustain the economy, protect national security and preserve the natural environment. Geoscientists are well placed to make critical contributions to contemporary sustainability issues. Yet, most geologists have little or no direct involvement in the growing societal shift towards sustainable development.

Humans are now a dominant geological force on the planet. The cumulative impacts of anthropogenic changes are sufficiently significant to earn our own bespoke epoch: the Anthropocene. In this burgeoning human age the applied aspects of economic geology, petroleum geology, engineering geology, hydrogeology, and geohazards assume even greater importance, alongside climate science, land management and disaster risk reduction. It is surprising then that today we, geologists find ourselves woefully underrepresented in relation to other disciplines in current discourses on Earth's health and well-being (Mora 2013).

Geologists possess a valuable synoptic and temporal conceptual framework for evaluating Earth's sustained viability for life. We are trained in a range of practical skillsets and flexible mindsets that are well suited to those developing more sustainable environmental practices (Mora 2013). As a community, we must get more involved in the sustainable development arena by broadening our experiences and explicitly integrating sustainability into geoscience education and training.

It is clear that geoscientists need to work with engineers and planners, but we must be more ambitious than this. We must collaborate with allied Earth science disciplines such as biology, zoology, ecology, agronomy and environmental science. More significantly, to fully appreciate the complexity of contemporary human-environment relations, we must also draw from the social sciences.

The key role of social science disciplines is arguably most critical in enhancing our ability to communicate our geoscientific know-how to those lay audiences that we feel most need it, whether policy makers, civic authorities, business leaders, the media or the public at large. Those areas of geoscience that are at the frontline of societal engagement – most acutely in the fields of climate change and natural hazards – appreciate all too readily that simply explaining the technical science rarely effects meaningful mitigative actions among those at risk (Liverman 2008). Indeed, an important paradox of geoscience communication is that the more effectively a potential threat is made public by the scientist, the more readily the scientific message becomes normalised into the complex and chaotic discourses of daily life. Scientific concerns become subsumed and lost within wider social, economic, political concerns (Cormick 2014).

For decades, social scientists have recognised this dilemma and have developed methodologies and strategies for deconvolving public attitudes, motivations and perceptions about scientific problems. If geoscientists are going to contribute effectively to sustainability issues then we will need to quickly grasp practical ways to overcome such formidable societal asperities. There are signs that some geologists are trying to do just that, especially in the societal frontline of natural hazards. In the UK, for example, the Natural Environment Research Council is currently funding innovative interdisciplinary research projects on Strengthening Resilience in Volcanic Areas (<http://streva.ac.uk/>) and Earthquakes Without Frontiers (<http://ewf.nerc.ac.uk/>) in which geoscientists work alongside social scientists to identify and address generic issues in disaster risk.

Away from its immediate public interface, however, geology remains a realm that ordinary people pay little attention to and show little interest in (Stewart & Nield 2013). Few have anything but a

vague and often misconceived sense of the subsurface, an alien environment that lies hidden and out of bounds. Moreover, most struggle to grasp the cumulative impact of slow, gradual changes over periods that exceed human timespans, or appreciate the feedbacks lurking within complex natural systems. That unfamiliarity with geoscience is understandable given that most countries lack a direct exposure to geology within the school curriculum (Stewart & Nield 2013). Until recently, there was little incentive among academics and industry professionals to help bridge that divide and translate our science for non-technical audiences. In the last few years, however, this long-standing science-public disconnect is being countered as national governments, funding agencies and institutions demand more public accountability for research through increased outreach activity. With geoscientists are now expected to justify what we are doing and why we are doing it, the impetus to convey geological relevance to sustainable development will only increase.

Sustainable geoscience – and how to communicate it – must become integrated into geological education and professional development (Gosselin et al. 2013). Teaching geology students to work with other scientists, business people, and politicians to develop viable solutions to environmental and resource challenges is likely to significantly increase their employability. Moreover, stronger academic engagement with local environmental issues will bring community-based stakeholders, including employers, into the classroom. In the classroom, students who think that geology is ‘just rocks’ will appreciate that it is really about how the Earth works and what that means for those living on it. And it always has been about that. In 1788, James Hutton’s seminal ‘Theory of the Earth’ opened with the remark that “‘this globe of the earth is a habitable world, and on its fitness for this purpose, our sense of wisdom in its formation must depend’”. Almost two hundred and fifty years on, geologists are still struggling to put that vision into practice.

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