



Geology Uprooted! Decolonising the Curriculum for Geologists.

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Abstract. Geology is colonial. It has a colonial past, and a colonial present. The majority of the knowledge we accept as the
10 modern discipline of geology was founded during the height of the early modern European Empires colonial expansion.
Knowledge is not neutral and its creation and use can be damaging to individuals and peoples. The concept of knowledge
being colonial or colonised has gathered attention recently, but this concept can be misunderstood or difficult to engage with
by individuals who are not familiar or trained to work with the literature on the issue. This paper aims to demystify
Decolonising the Curriculum, particularly with respect to geology. We explain what Decolonising the Curriculum is, and
15 outline frameworks and terminology often found in decolonising literature. We discuss how geology is based on colonised
knowledge and what effects this may have. We explore how we might decolonise the subject and most importantly, why it
matters. Together, through collaborative networks, we need to decolonise geology to ensure our discipline is inclusive,
accessible to all and relevant to the grand challenges facing our civilization.

1 Introduction

20 Decolonising the Curriculum is an initiative that has gained momentum around the globe in recent years (Charles, 2019). Its
origins are in Humanities and Social Sciences and therefore some of the language and rhetoric used, issues raised, and
supporting texts, experiences, theories and ideas may be impenetrable or unfamiliar to those from STEM backgrounds. As
academics there is good evidence that we most comfortably operate in ‘discipline silos’ of individuals who we feel share
common interests, values and skills (Becher and Trowler, 2001; Amara, 2008; Kreber, 2008 and Rogers and Cage, 2017). It
25 is understandable, therefore, that STEM groups may lack the expertise to unravel some of the scholarly work around
Decolonising the Curriculum. It is also true that many geoscience departments lack pedagogic experts (this is particularly
true in the UK). This piece aims to break down some of the barriers to accessing and understanding Decolonising the
Curriculum, and in this case is framed around the discipline of geology (however it should be of use to academics across
STEM disciplines). We have tried to avoid language that might be unfamiliar to geologists and have provided a glossary of
30 words and phrases that commonly appear in scholarly work on Decolonising the Curriculum and pedagogy. Examples of



colonial geological legacy are given, and we explore how and why this legacy may be problematic. We also suggest ways in which Decolonising the Curriculum can make our discipline more open, accessible, modern and inclusive. We openly acknowledge that this piece does not fully delve into every specific of the geology curricula or provide explicit ‘fixes’ – this is very much designed to explain what Decolonising the Curriculum is, particularly where geology is concerned, and some ideas of how to approach Decolonising the Curriculum are provided. This is an introduction to be built on. It is intended to demystify Decolonising the Curriculum and show its applicability to geology and geologists.

2 The foundations and dominance of colonial geological knowledge

As an academic discipline or branch of knowledge, geology is relatively young (the academic discipline of geology arose in Europe - and to an extent the United States of America - in the late 18th/early 19th century). There are references to geological knowledge in several ancient texts (including the creation/formation of certain rock formations and the links to ancient environments, ideas on plate tectonics, etc.), mostly attributed to polymaths from around the globe or by scholars of ‘other’ subjects and theologians (e.g., Theophrastus, BC 371-287, an Ancient Greek philosopher (Cuvier, 1830); Pliny the Elder, AD 23/4-79, an Ancient Greek philosopher (Pliny the Elder, 1855); Abu al-Rayān al Birun, AD 973-1048, an Iranian scholar (Asimov and Bedworth, 1998); and Shen Kuo or Shen Gua, courtesy name Cunzhong and pseudonym Mengqi/Mengxi Weng, AD 1031-1095, a Chinese polymath (Yao, 2003)). However, the study of the Earth and its changes through time has only really developed as a distinct academic pursuit since the late 18th century, arguably driven by a mixture of advanced mobility (the ability for individuals to cross vast distances recording rocks and relating them to one another), resource exploitation, and an increased interest in understanding ‘what’ Earth and its constituent systems are. The first two of these motivating factors have strong colonial roots; it was at the height of colonial Europe that many of the principles, theories, laws and practices that shape the discipline of geology were established. Prior to the late 18th century, the economically/resource-driven activities we might include under the broad umbrella of geology today (i.e. quarrying and mining) cannot be considered academic in nature (Sangwan, 1993).

The principles and practices established in the early formation of the discipline were made (and/or sponsored) by men who were privileged (mostly wealthy) enough to pursue academic interests, both in their native countries (nearly exclusively European) and increasingly across borders. Ultimately, the discipline of geology as we know it was born at the height of European Empires. But what does that mean for the subject- what difference does it make?

The Global North’s (Eurocentric) dominance of knowledge production has, as Winkler (2018) observed, led academic disciplines born of colonialism to “the tendency to systematically classify philosophical concepts for the purpose of organising knowledge into distinct properties [which] has become a hallmark of Western scientific reason.” (p592). The foundations of geology have been built on these pedagogical limitations.

Carey et al. (2016) have pointed out that the modern (see ‘Baconian’ in the Glossary) view of knowledge creation (modern scientific method) “engendered a strong tendency in the environmental sciences to classify, measure, map, and, ideally,



dominate and control nonhuman nature as if it were a knowable and predictable machine, rather than dynamic, chaotic, unpredictable, and coupled natural-human systems” (p777). Rudolph et al. (2018) explain western universities’ dominance in
65 knowledge construction, production and legitimisation. They explain how ‘powerful knowledge’ is produced and refined in specialisations, predominantly in resource-rich universities, predominantly in the Global North. These institutions play by a set of internalised hierarchies and acknowledge internal rules, which go towards reinforcing colonial and racist power relations. Such ‘powerful knowledge’ continues to ignore, belittle and erase other systems of knowledge. What Peake and Kobayashi (2002) said of the discipline of Geography – that without explicit effort to address the often racist practices and
70 discourses which inform the foundations of the discipline’s knowledge as well as its structures, practices and processes, then the colonialist heritage will just continue to be embraced – is also true of geology and many STEM disciplines.

Colonisation of knowledge still takes place today and is not explicitly tied to historical colonial powers; it happens through imbalanced power relationships, internally within societies as well as externally (Popperl, 2018; Turner, 2018 and Calvert,
75 2001). The colonisation of knowledge is engineered by proclaimed experts, whose power typically originates from an elite (generally wealthy) societal group or standing. Colonisation of knowledge can happen where governments or corporations are involved, where organisations or institutions set the norms, but can also happen on a personal level, for example in the power balance between students and their tutors/supervisors.

3 What is Decolonising the Curriculum?

80 Although there is no single definition or understanding of what a curriculum is (Egan, 1978; Young, 2014), a curriculum can generally be summed up as the total sum of the knowledge, skills, social norms and experiences that a student undertakes, or is exposed to, within a designed educational process.

Decolonising the Curriculum is not an initiative looking to shame individuals for the content they teach, or for the work they make use of. It is not about cherry picking diverse content for the sake of diversity or deleting certain works, and is not an
85 outright ban on teaching the work of old, dead, white men (Pett, 2015). It is not about change for the sake of change, and it is not about the formerly colonised and the colonised switching places either. Decolonising the Curriculum recognises that a total or outright dismantling or destruction of all imperially created structures and processes is not likely to happen overnight, nor without resistance.

However, a restructuring would be helpful; a rebalancing of power to decrease the marginalization and othering (see
90 Glossary) of groups and knowledges could result in better pedagogy and greater understanding. It would also aid inclusivity through improved representation and diversity. Decolonising the Curriculum has also been highlighted as a method towards closing the awarding gap between white students and those from a Black, Asian or Minority Ethnic background (UUK and NUS, 2019). So, while Decolonising the Curriculum does not call for the abandonment of all Western theory, it does flag up that Western theory “does not in fact describe or map the entire planet, and that despite pretensions to universalism it suffers



95 from gaps and lacunae, and for this reason needs to be revised in the light of local empirical conditions” (Jackson, 2003, p73;
in Hönke and Müller, 2012, p390).

Decolonising the Curriculum is a philosophical and pedagogical initiative exploring the origin, development and use of
knowledge. It is a curriculum design process looking to recognise knowledge as power, as well as recognising the power that
enabled knowledge to be legitimised as such. It encourages us to question who created certain knowledges, why we use that
100 particular knowledge, and who has access to it and why. A decolonised curriculum acknowledges colonial debts to
knowledge creation, giving credit to those hidden and minoritised individuals who deserve it. Decolonising the Curriculum is
about exploring, examining, interrogating, and teaching the history of a discipline's knowledgebase. It involves inquiring
about the approach, method, framing, thought paradigms, theories, structures and concepts that underpin and form all content
within the discipline.

105 There are several definitions of Decolonising the Curriculum; here, as did Charles (2019), we support this definition taken
from part of Keele University's Decolonising the Curriculum Manifesto (Keele University, 2018):

“Decolonising the curriculum means creating spaces and resources for a dialogue among all members of the university on
how to imagine and envision all cultures and knowledge systems in the curriculum, and with respect to what is being taught
and how it frames the world.”

110 Decolonising the Curriculum is sure to mean different things to different people and will involve different actions for
different disciplines. This seems particularly true if we compare subjects from STEM, the Social Sciences and Humanities.
The process requires us to reflect on our backgrounds, experiences, ideologies and discipline-specific narratives. Drawing on
Tuck and Yang (2012)'s work calling for the non-domestication of decolonisation, Esson et al. (2017) eloquently argue that
“Decolonisation is a radical challenge to ‘unsettle’ the architecture of privilege” (p387). As academics who occupy positions
115 of privilege and are sometimes said to dwell in ivory towers, decolonising our curriculums has to be a deeply self-reflexive
process involving capturing the experiences of historically marginalized groups (decolonising aims to address and rebalance
injustices for all marginalised groups – it is not to be mistaken for a race/ethnicity issue). We need to acknowledge the biases
in our world views (including social and political) (Holmes, 2020), be aware of our relationship to curricula/research and
fully understand ourselves as educators and researchers, to address the context in which curricula design (both in terms of
120 content but also in terms of practice) (Rose, 1997) is taking place. To some extent, this is a complex manoeuvre where we
sometimes have to pull the rug out from under our own feet. And while decolonisation of anything, let alone curricula, is
clearly many pronged, multi-leveled, and complex, one thing it definitely will also be is discomfiting; those who undertake
to decolonise must be prepared to step outside of comfort zones and interrogate assumptions and privileges, and perhaps
even unlearn some of the latter (as Spivak advocates; Spivak, 1990 and Andreotti, 2007).

125 Decolonising the Curriculum should ideally be a reflective and honest process where we recognise the emergence and use of
the knowledge, or set(s) of knowledge, we choose to apply in any given circumstance. Under what circumstances was the
knowledge we use made, and why do we use this set of knowledge in particular? Several authors outline what decolonisation



might entail, and include themes such as recovering knowledge, reflecting on the exclusion of other knowledge, ethics, the use of language and the internationalisation of indigenous experience (e.g. Smith, 1999; Le Grange, 2020; Chilisa, 2021).

130 Whilst Decolonising the Curriculum is not a call for the vilification of past individuals this does not mean we cannot judge and be disappointed, embarrassed or angry at some of the unjust assumptions, beliefs and actions of figures in the past. It is a call to understand, reflect and call out the norms and actions of those who provided important advances to our knowledge. How might those behaviours have arisen, and how did they impact the formation of the knowledge we use? Were there others involved in the formation of that knowledge, who were forgotten or marginalised collaborators? How might that have

135 led to the continued exclusion of some groups in the present? The process acknowledges how certain knowledge was created, for example, by explaining where authors held views which are found repugnant today, or where data was gained at the expense of others. For example, Lam (2021) provides an informative piece outlining (amongst other colonial links to geosciences) the history of Henry De La Beche, a slave owner who advocated for slavery reforms rather than abolition (De La Beche, 1825) and who created the first geological map of Jamaica whilst visiting his slave plantation.

140 Teaching geology from a single perspective (often framed by the works of dead white men) leads to uneven power relations particularly in relation to race, class and gender (Begum and Saini, 2019). Where knowledge is ignored, or ownership of knowledge is denied as to originating or belonging to indigenous peoples, damage and hurt can be caused (Whitt, 2009). What we say and do matters. Decolonisation calls for us to consider the broader pool of knowledge available outside of our Eurocentric curricula (Hall and Tandon, 2017). Importantly, Decolonising the Curriculum seeks to highlight how injustice in

145 the past has led to some of the most fundamental aspects of modern thinking, discipline identities and continuing inequities (Harding, 2006) – and how by acknowledging and understanding this, we can be better and strive to make a just, fair, equitable and accessible modern system that provides a curriculum relevant to modern challenges.

Some of the conversations around Decolonising the Curriculum focus (in an unnecessarily constrained and limited way) solely on diversifying reading lists and case studies used across educational units. Diversity of representation in reading lists

150 is important; ensuring reading lists are not just from western male perspectives can enrich content and open the door to different frames of knowledge, experiences, and points of view. However, piecemeal developments like diversifying reading lists, whilst useful, do not fulfil the scope of Decolonising the Curriculum. Decolonising the Curriculum is a holistic process. It needs time, thought, collaboration and willingness, to not only take fragmentary steps but for a major overhaul. A common criticism of Decolonising the Curriculum is that it “removes” or conveniently effaces historical knowledge (by removing

155 certain case studies, authors or contexts, for example). Done properly, it should in fact broaden frames of reference, recognising other knowledge systems and ways of thinking, and opening global dialogue.

Vandeyar (2020, p5) provides a useful quote emphasising how we must go beyond the diversification of materials and ensure we challenge and interrogate the knowledge we use: “Decolonisation of the curriculum requires much more than just changing the curriculum. How things are taught and academics’ attitudes, perceptions and beliefs in this process are pivotal

160 to the decolonisation project. Decolonisation is more than just a ‘choice of materials’ (Wa Thiong’o, 1992). The attitude and disposition to materials used in the curriculum is critical.”



4 Colonised Geology

4.1 Origins and ‘firsts’

165 In the 17th century individuals such as Nicolas Steno began drawing up ideas about the deposition of sediments and the origin of fossils, questioning the accepted views of Earth science at the time (Adams, 1938; Gohau, 1990). The 18th century saw a realisation that minerals and ores (often inaccessible at the surface) could be found by studying certain natural phenomena. At this time two main schools of thought arose to explain the creation of Earth materials – Neptunism (also called Diluvianists) and Plutonism. Neptunism argued that geological materials precipitated from water (much of this thinking was linked to Christian Bible teaching, particularly the great flood) (Gohau, 1990). Plutonists believed that volcanism was mainly responsible for rock formation – and alluded to the age of the Earth being very old and not understandable from the limited span of teachings from the Bible (Gohau, 1990). It was in the 19th century where the foundations of the discipline we know today (from Global North education and industry) were founded. Uniformitarianism (and the opposing catastrophism) was proposed by Charles Lyell in his ‘Principles of Geology’ (Lyell, 1830-33). Ideas around stratigraphic principles and relative dating began to be developed at this time. In the 19th century geological investigation often included historical and ethnographic elements; geologists would investigate a wide variety of subjects including antiquities, ancestral and indigenous myths and past civilization/human activity and used texts and oral history to investigate local geology (Chakrabarti, 2021).

180 Geological expeditions/surveys (although not necessarily solely *geological* surveys, many aspects of botany and anthropology etc. were also included) were an instrumental tool of colonial expansion (e.g. Stafford, 1984 and 1988; Sangwan, 1993; Yusoff, 2018; Figueiredo, 2020; Zeller, 2000). Expeditions and surveys played an important role in the economic, technological and cultural development of colonial powers (Britain in particular), notably in the 1830s-70s (Teale, 1945; Chakrabarti, 2019; Stafford, 1984 and 1988). Many expeditions, surveys and ‘missions’ to countries and territories where colonies were later established included a geological element. Geological surveys were undertaken and estimates of natural resources were made, with the colonial party often being guided by locals. Many cases of colonial expansion and occupation were based on the findings of these ‘exploratory’ parties, particularly where natural resources were involved (Stafford, 1988). Other reasons for colonial expansion included strategic military/trade locations (including the slave trade), areas for European settlers to live and the desire to push colonial frontiers further into lands occupied by “savages” and “barbarians” (Webb, 2017). The importance of mineral wealth to the British Imperial effort was so commonly understood that military, naval and commercial (e.g. the East India Company) officers were offered training to better equip them to make scientific observations and enquiry, with mineral wealth from the colonies permanently held on display in London (Stafford, 1984). Official (British) Geological Surveys (i.e organisations, rather than the action of surveying/exploring) were established in nearly all UK colonial territories from 1918 (Colonial Geological Surveys, 1944). At a similar time to



195 European Colonial expansion a similar expansion of colonial settlers was occurring in the United States of America, where
geology surveys evaluated economic value of land and drove expansion into resource rich areas (Nyblade and McDonald,
2021).

Some of the leaders of exploratory parties are well known geologists today, with De La Beche and Murchinson key players
in the use of geological surveys for colonial expansion (Stafford, 1984). These surveys and the organisations responsible for
them were indirectly funded by the British Crown and Government, often directly through military organisations (e.g. the
200 Board of Ordinance) (Rose, 1996). Early geological activities had such strong military ties that for much of the 19th century,
certainly in the UK, geology was perceived as a military science (Rose et al., 2019). Colonial geologists are responsible for
the creation of most of the “first geological survey of ..[somewhere].” and are often associated with the first geological
interpretations of the areas they surveyed. In some cases, they are attributed with the “first discovery” of mineral wealth, or
of features they observed. This is, of course, absurd. Locals often provided valuable knowledge, guided and worked for
205 these parties without formal credit or recognition, and were clearly aware of many geological features prior to their reported
“discovery”. For example, Frank Dixey, the first Director of the Directorate of Colonial Geological Surveys talks about
“native information”, carriers and escorts in his personal memoirs on surveying Sierra Leone (Dunham, 1983). This
phenomenon is commonly known as ‘firsting’ (see Glossary). It was these types of activities that led to the establishment of
the geological discipline we know today.

210 Individuals such as De La Beche and Murchison were likely driven by the same excitement and inquisitiveness that many
geologists share about how the world works. The ‘exciting’ debates held by prominent geologists at the time concerning the
establishment of geological periods was a factor in influencing MPs, noblemen, military officers and colonial administrators
that geological knowledge and exploration could promote economic growth (Stafford, 1984). But many of these individuals
were in the privileged position to pursue an academic lifestyle due to injustices towards others, both domestically and
215 internationally (e.g. Hyde, 2020). Of course, there are individuals in the history of geology who were advocates for justice;
for example, William and Richard Phillips and William Allen, who were pivotal in the establishment of the Geological
Society of London, were abolitionists (Lam, 2021). These individuals, however, were still part of a group that encouraged
the removal of materials from colonial territories for “metropolitan analysis” (Stafford, 1984). Imperial resource extraction
may seem like an action of the distant past; however, geology as an essential tool for colonial expansion was celebrated as
220 recently as the 1940s and 50s (Teale, 1945), was a dominant economic process until relatively recently, and arguably still
continues via modern corporations. Reports of mineral extraction from colonial territories and scientific work resulting from
such activities were published in the “Bulletin of the Imperial Institute” and latterly in “the Quarterly Bulletin of the Colonial
Geological Surveys” up to at least 1957 (Beard, 1950).

4.2 Colonised forms of geological knowledge

225 Geology is a discipline created by colonial forces/parties at a time of active (explicit) colonial expansion (Yusoff, 2018;
Figueiredo, 2020; Zeller, 2000). Because of its global relevance and common use of international case studies, it might be



230 felt by some that geology is no longer colonial, or that the colonial roots of geology no longer influence the subject's arena. However, the discipline born during Imperial expansion is still very much the discipline taught across Western institutions today (albeit with adaptations as technologies/methods/nomenclatures/schemas have developed). It is important to recognise that this colonial version of geology, known to most geologists as the accepted global norm (and adopted by many non-western countries likely as a result of colonial legacy), is not the only form of geological knowledge practiced today or in the past.

235 Many indigenous peoples have described and used their local geology for thousands of years (Nyblade and McDonald, 2021 and references therein). Reano and Ridgway (2015) highlight some of the geological workings of the Acoma People (west-central New Mexico), who rather than use the stratigraphic framework and classifications familiar to institutional geology (education, academia, industry) use a cultural framework that is passed down generation to generation. This framework groups lithologies by their cultural or resource significance (e.g. farmland, building materials, pottery materials, water resources). These 'alternative' cultural frameworks can be linked and compared to 'standard' frameworks to better welcome minority groups into geology (Reano and Ridgway, 2015). For wider cohorts, cultural frameworks also encourage better understanding of world views and the relationship between indigenous populations and their lands, and highlight how cultural tensions can arise from modern colonisation (resource exploitation on indigenous lands, for example).

240 Internal colonisation can also be a barrier. Most UK/Eurocentric/Western geologists probably do not think that cultural frameworks of knowledge even exist locally – often regarding the local as lesser, 'less developed' (a colonial attitude!) - but that is far from the truth. Within the Global North, some parts which were themselves formerly colonial powers as well as internally colonised, have (or had) a wealth of unacknowledged local cultural geological knowledge, some of which persists. For example, in South Shropshire (England) many locals refer to "dhustone" for a hard, black igneous rock quarried from a place called Clee Hill. If asked about dhustone, many locals would likely be able to tell you where this rock can be found, and why it is quarried. If, however, you were to ask locals if they knew where you could find micro-gabbro in the area, they would likely not know. This sort of geological knowledge, which exists across the globe, is often downplayed or explained as 'not proper' geology – why? The knowledge serves a purpose and is successfully disseminated. Many of the terms used culturally for rock types with decorative aspects (such as Cotham marble, Purbeck marble, Sussex marble, and Puddingstone in the UK) are often dismissed as 'incorrect' by geologists. This narrow acceptance of what is 'correct' geological knowledge potentially damages the image of the geological discipline, with individuals being made to feel inferior and therefore unwilling to engage further. Learning about and working with local cultural knowledge is not an onerous task and could lead to a more engaged and responsive reaction to geological activities (e.g. Palmer et al., 2009).

255 The connection between the geoscience industry and active harm to sites of cultural significance is a tangible result of the erasure and belittlement (or wilful misunderstanding and ignoring) of local, cultural knowledge. The destruction of a 46,000-year-old First Nations heritage site of rock shelters in Western Australia to access higher volumes of high-grade ore is a recent example (Wahlquist and Allam, 2020a). The responses to these inexcusable actions have been positive; all mining companies in Australia are recommended to review all agreements with traditional land owners, and Rio Tinto have several



recommendations including remediation work, restitution packages and a commitment to halt actions on 1,700 First Nation heritage sites it has permission to destroy (Wahlquist and Allam, 2020b). Geoscience researchers have been responsible for similarly destructive activities, with several well documented cases of rock core/samples being taken from sites of cultural significance (e.g. Sahagún, 2021) and from areas of natural beauty (MacFadyen, 2010), in spite of code of conducts existing to mitigate against this (e.g. Scottish National Heritage & the Geologists' Association, 2011).

Perhaps the most important aspect of acknowledging geology's colonial past, and its debts to marginalised peoples and damage to environments, is to ensure that in the present and future we work towards a more collaborative discipline in which co-production of knowledge with all involved parties is normalised (Adame, 2021; Adams et al., 2014, Wilkinson et al., 2020; Sheffield et al., 2021). The geosciences are often overlooked (or misunderstood) in policy (Stow and Laming, 1991; Gill and Smith, 2021), process and considerations for sustainable development, and this is undoubtedly linked to past geological activities being associated with extractive and damaging processes.

4.3 'Parachute' science

Parachute knowledge creation is a phenomenon not restricted to geology or STEM disciplines. It is the act of researchers (typically from the Global North) traveling to conduct fieldwork in a 'Majority World' region (typically the Global South) and either not collaborating with, or not recognising the participation of, local researchers, landowners, or guides (e.g. Greshko, 2020; North et al. 2020). Spivak argues that field data collection (which she refers to as "information retrieval") is another form of imperialism, which centres the Western academy (Andreotti, 2007; Nordling, 2021).

Parachute knowledge creation may involve the removal of samples or specimens from countries to be held or exhibited elsewhere (without full collaboration or agreement from the country/area/people of origin), to extractivism. It may lead to the creation of academic outputs (e.g. articles published in academic journals) where the authorship team is exclusively from the Global North, and collaborators from the study area are not included or acknowledged. This process leads to the perception of the need for external experts to local issues; it doesn't meet or help local research efforts and can even hinder these local efforts (Stefanoudis et al., 2021). The practice of hindering local efforts has been recently highlighted by local geologists working on Nyiragongo volcano, Democratic Republic of Congo (Nordling, 2021).

Parachute/colonial science often leads to the phenomenon of firsting (see Glossary). A recent example of this practice has been reasonably visible and involves a unique Brazilian fossil that ended up in a German museum and was subsequently published on by a group with no Brazilian collaborators (Vogel, 2020). The example of the Brazilian fossil also raised questions on the ethical (and legal) practices of obtaining materials; Brazilian law forbids the exportation of fossils, other than for loans (Vogel, 2020). It is important to recognise that these behaviors can cause hurt to those being othered, and result in the breakdown of engagement, trust and willingness to help from these parties.

Yozwiak et al. (2016) highlight that international collaboration is fundamental to tackling major global health emergencies. This is also true for tackling geoscience-related challenges such as climate change, critical material extraction, disaster risk reduction, and water extraction. Equitable collaborations between global experts, including those with invaluable local



295 knowledge, are essential to avoid the damage caused by colonial science. Building research collaborations with support,
training and educational opportunities for local communities helps engage key stakeholders and creates more equitable
partnerships (Whiteford and Vindrola-Padros, 2015). These collaborative actions may seem daunting to those without the
experience, time, resources, or incentives to carry them out (Roldan-Hernandez et al., 2020), but they should be normalized
and built into ethical planning and research grant submissions.

5 Towards a Decolonised Geology Curriculum.

300 In decolonising the geology curriculum, we need to acknowledge the colonial legacy of the knowledge we teach and
understand that the knowledge we use is not ‘better’ than other types of knowledge. We must recognise the damage and
harm which that knowledge creation was, and is still, part of; that some knowledge has been suppressed, erased, and that
some has been created unethically. Geology is not apolitical nor is it unconnected to the sustainable future of our civilization.
We need to understand that all knowledge used has power.

305 To create a discipline that is equitable, progressive, and compassionate, curriculum development teams need to start
considering decolonisation of their curricula now. The process will take time, effort, and willing. Sharing effective practice,
collaboration, co-creation, and listening to individuals from colonised territories, or those whose knowledge has been
colonised, is vital. There will be a wide range of actions specific to different curricula, dependent on what and how it is
taught - each journey will be unique. Here we outline some suggestions on how we can begin to Decolonise the Geology
310 Curriculum:

1. **Explain and explore what Decolonising the Curriculum is.** Invite students to participate. Create or share
resources that help explain what decolonising means. Emphasise the focus on knowledge production and use, and of
power in the process of knowledge generation and suppression. Outline that it is not ‘good vs bad’ and not about
removing bodies of work based on individual beliefs and behaviours, but about exploring how this has influenced
315 both the knowledge itself, and how individuals were oppressed or disadvantaged during the knowledge creation
process. Explore why we should learn from this history, rather than repeat it.
2. **Teach the history of geology.** No geology is neutral (Yusoff, 2018). Teaching this discipline needs to include
pointing to its framing. Exploring the origins of the knowledge we use, and acknowledging that people were
damaged in the creation of that knowledge, allows us to understand why some groups might feel they do not
320 ‘belong’ in geology and how some groups have been excluded. It may help explain why diversity in geology
cohorts is worryingly low (Dowey et al., 2021). It allows us and our students to understand the consequences of past
actions and hopefully reduce/remove these actions in the present and future.
3. **Set the Context of the Discipline of Geology.** Instead of presenting the syllabi or curriculum as the definitive,
universal version of ‘Geology’, contextualise to make clear that the geology taught in our degree programs is one
325 version of many possible knowledges, from particular perspectives, and that it is selective and exclusive in various
ways, as all curricula must be (GeoContext, 2021). Make clear to students how even the best selected syllabi cannot
claim to speak for the entire discipline nor be completely representative, let alone comprehensive or exhaustive. To
this end, the conceptual framework could introduce methods and approaches which emphasise contextualised and
situated knowledges, recognising that knowledge is place and time specific. Knowledge is underpinned by powers
330 which have legitimised it as knowledge, often at the expense of other/alternative knowledges.



- 335 4. **Teach responsible resource extraction.** Emphasis should be placed on ethical, sustainable extraction and exploration. Cultural considerations should be embedded into our curricula (e.g. land ownership works in very different ways around the globe). Curricula should encourage students to explore where the majority of material extraction occurs vs. the abundance of the material globally. Explore what local environmental and human rights look like and compare the price of commodities and where those materials are being consumed. Case studies of local and indigenous knowledge systems can be used to explore equitable partnerships with local communities. Examples of where indigenous land, knowledge and culture has been destroyed can be used to frame these discussions.
- 340 5. **Explain the unethical practice of “parachute science” and unethical specimen extraction, to avoid the pitfall of extractivism.** Teach case studies and acknowledge how these events have negatively affected locals whilst benefiting the individuals/groups responsible. Explore how collaboration and co-creation with local groups would have led to benefits to all involved. Cultural ethical considerations should be embedded in research project design materials, from dissertation level to grant applications. Those with responsibilities of writing grant applications or leading field courses should be encouraged to account for working with local groups. True partnerships should be encouraged rather than Global North (senior) partners setting the research agenda and designing the project, and then inviting Global South partners on board. Ensure results are disseminated within the local community and in a form which can be assessed easily and is useful.
- 345 6. **Explore the bias of Global North research (abundance, ‘impact’ and perception).** There is a bias in both the number of papers produced by teams from the Global North - even where this research is focusing on topics from the Global South (North et al., 2020), and in the ‘impact’ and perception of the quality of work produced by researchers from the Global North vs. South (Collyer, 2016). Commit to including works from a broader range of authors. Embed decolonised actions into research procedures – work with local researchers and people. Consider inviting researchers from the Global South for reviews and to provide virtual research seminars to students.
- 350 7. **Participate in creating a more diverse population of geologists.** Research has shown that projects run by diverse groups are more impactful than those with non-diverse project teams (AlShebli et al., 2018). This is also true of curricula, particularly those co-created with student bodies. Alternative knowledge can be offered and integrated within the curricula to appeal to a wider audience and resonate with a greater number of non-geologists. Work towards dismantling hierarchies and structures that create barriers and exclude groups. Diverse representation likely creates more inclusive communities of practice (Sheffield, et al., 2021). A diverse body of geologists is needed to tackle the grand challenges of the twenty-first century (Dowey et. al., 2021)
- 355 8. **Teach climate change as a social justice and colonial issue.** Geological knowledge of climate change is essential to understanding the dangers of the anthropogenically enhanced Climate Crisis. Teach students that climate change is not apolitical; it is an example of modern colonialism, with largest anthropogenic contribution to pollution from the Global North whilst the largest impacts are felt in the Global South (e.g. Weizman and Sheikh, 2015; Mahony and Enfield, 2018). Policy and process must be created with researchers and populations from the Global South to ensure equity of proposals and partnerships.
- 360 9. **Co-create and collaborate.** Traditional curricula tend to focus on the individual – whether that is in highlighting ‘lone geniuses’ or in emphasising individual academic achievement. Our curricula should emphasise the benefit of group and teamwork (Gregory and Thorly, 2013; Johnson and Johnson, 2009 and Springer et al., 1999) – including working with those with indigenous and local knowledge bases. Students should be encouraged to create content or design parts of the curriculum (a choice in assessment style, for example). The exploration of knowledge and its creation should be encouraged and individuals should be steered towards processes that benefit them and those around them. Industry partners should be sought to help create authentic assessments based on complex issues and problems, and the human element of geological activities should be embedded alongside the physical and process-based narrative.
- 365 10. **Educate for sustainability.** Sustainability themes, issues and challenges are excellently curated into the United Nations Sustainable Development Goals (SDGs). Embedding exercises based around the SDGs is a useful way of



380 examining how vital geology is to a sustainable future (e.g. Stewart and Gill, 2017; Gill and Smith, 2021; Geology for Global Development, 2021), and how crucial it is to acknowledge colonial damage caused by geological activities. The SDGs can be tracked to activities across the geology curriculum (Rogers et al., 2018).

These actions are by no means exhaustive but aim to provide a starting point for geology academic teams beginning to think about Decolonising the Curriculum.

385 Sundberg (2014) highlights the importance of taking steps – moving, engaging, reflecting – in enacting decolonising practice, “understanding that decolonisation is something to be aspired to and enacted rather than a state of being that may be claimed”. Sundberg encourages those undertaking decolonisation to progress by recognising and encompassing other forms of knowledge (‘multiplicity’). They argue that we each create our own truth or knowledge, because we are all subject to different conditions; our experience of the world is not inevitable (‘historical contingency’). This goes some way to explain why we find different knowledge in different societies and places; our lived experiences differ and so therefore does the way we build knowledge around these experiences. Historical contingency should not be a concept unfamiliar to geologists. The
390 idea that historic (geological) events are not inevitable, but that each event relies on a number of complex conditions, is one that anyone reconstructing past Earth events will understand.

5.1 The Power of Decolonisation

Decolonising the Curriculum may initially feel inaccessible to scientists, with its own set of terminology/jargon and its basis in historical context. However, it is vital to a more equitable future for geology and many other disciplines, with value to
395 both academics and students. It also serves as a reminder that the work we conduct is not apolitical, neutral, nor divorced from society – people, places, knowledge, power and the environment are interwoven with our science.

Decolonising any curriculum involves not just the contents of the syllabi, but the pedagogical structures underpinning the curriculum, from delivery right through to assessment methods. Decolonising the Curriculum is a set of processes, a pedagogical approach as well as an ideology, which seeks to enhance knowledge and learning, to make disciplines richer and
400 more enthralling. It seeks to include more, to dig deeper, to encompass more viewpoints and representations and voices, to welcome diversity rather than stay narrow and limited. Decolonising is a democratic and collaborative process, breaking down hierarchies to heighten productivity and effectiveness. It talks truth to power, exposing power structures that have shored up practices and processes unseen and uncalled out for most of their existence. Decolonising curricula, if done well, should be a liberating process and an education enhancer for both staff and students.

405 6 Decolonising the Curriculum Glossary and Recommended Reading

In this resource we have tried to steer clear of language that may be unfamiliar, impenetrable or off-putting to many geologists (and probably individuals from other STEM subjects); or else, if we have used such terms, we have tried to



explain them along the way. In this section, we highlight some key terms typically found in Decolonising the Curriculum literature in an attempt at de-mystifying them for those unfamiliar:

410

Baconian knowledge: Modern scientific method as developed by Sir Francis Bacon; a method of knowledge creation based on systematic observation resulting in empirical data.

Colonial/colonialism: the act, practice or policy of control of a people by a power or other people. Often associated with the establishment of colonies.

415 *Epistemicide*: the systematic destruction of existing (usually of an indigenous) knowledge base (Bennett, 2007)

Epistemology: How knowledge was produced.

Epistemological violence: where empirical data is interpreted in a way that implies the Other is inferior (Teo, 2010)

Extractivism: The process of extracting natural resources for export for economic gain (often associated with poor environmental process and policy).

420 *Imperial/Imperialism*: relating to an empire and/or activities of an empire

Firsting: Knowledge (of a discovery, a finding etc.) framed from a European perspective for phenomenon that was made by Others previously. This framework of knowledge promotes (mostly white, male) Europeans as creators of global knowledge often to the detriment of those who are not accepted as “firsters” (Beck, 2017).

425 *Neoliberalism*: a movement with commitments to individual liberties, belief in shifts in policy and ideology against government intervention and a conviction that market forces should be self-regulating (Olssen *et al.*, 2004)

Neocolonial: the process and/or practice of using economic and cultural influence and globalisation to influence or control a country, society or people, rather than through direct occupation and colonial governmental control

Ontology: What knowledge actually is as knowledge.

430 *Others, Othering, the Other*: individuals or groups who are presented as not fitting with the social norms of a social group. A process which influences how people view and treat the others and leads to in- and out-groups (Held, 2020).

Privilege: how a person’s identity can afford them (often unacknowledged) advantages as a function of the group to which they identify. For example, social class, age, nationality, disability, ethnic or racial category, gender, neurodiversity, sexual orientation, and religion.

435 We recommend the following texts/resources for those who wish to explore the theme of Decolonising the Curriculum further:

Decolonising Curricula and Pedagogy in Higher Education: Bringing Decolonial Theory into Contact with Teaching Practice (ThirdWorlds) by Shannon Morreira, Kathy Luckett, et al.

Towards Decolonising the University: A Kaleidoscope for Empowered Action by Dave S.P. Thomas and Jivraj Suhraiya

440 **Decolonising Intercultural Education: Colonial differences, the geopolitics of knowledge, and inter-epistemic dialogue** (Routledge Research in International and Comparative Education) by Robert Aman



Dismantling Race in Higher Education: Racism, Whiteness and Decolonising the Academy by Jason Arday and Heidi Safia Mirza

Re-imagining Curriculum: Spaces for disruption by Lynn Quinn

445 **Decolonising the University: The Challenge of Deep Cognitive Justice** by Boaventura de Sousa Santos

Recognising Geology's Colonial History for Better Policy Today by Maddy Nyblade and Jenn McDonald (see references)

Decolonising the Curriculum by Amrita Narang, York University (<https://edta.info.yorku.ca/decolonizing-the-curriculum/>)

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