The Geological Society

Earth Science, Systems and Society

EDITORIAL
published: 12 January 2024
doi: 10.3389/esss.2024.10103

Editorial: Sustainability in the Extractive Industries

Bénédicte Cenki[1]*, Hannah Hughes[2] and Patrick Asamoah Sakyi[3]

[1]Géosciences Montpellier, UMR5243 Université de Montpellier, CNRS, Montpellier, France, [2]Camborne School of Mines, College of Engineering, Mathematics and Physical Sciences, University of Exeter, Exeter, United Kingdom, [3]Department of Earth Science, University of Ghana, Accra, Ghana

Keywords: sustainability, education, critical raw materials, extractive industry, ESG criteria

Editorial on the Special Issue

Sustainability in the Extractive Industries

As the world shifts away from fossil fuels, we will need to produce materials for vast arrays of wind turbines, solar panels, electric vehicles, batteries, fuel cells, hydrogen and more. Demand for the raw materials, from aggregates to metals, needed to build these and other components of the infrastructure required for decarbonisation will skyrocket (Hund et al., 2020). Securing access to these raw materials is essential for building a sustainable low-carbon economy, but how can this be carried out responsibly and fairly? Improving the sustainability of all aspects of the extractive industries is vital, otherwise the looming supply shortage in the coming decades will lead to a range of geopolitical, economic, and environmental issues (Lee et al., 2020).

This Special Issue on "*Sustainability in the Extractive Industries*" puts a spotlight on the important and varied role that Earth Science plays in the raw materials economy. The published papers within this special issue tackle the issues related to the sustainability of the extractive industry to ensure economic growth as well as social and environmental protection:

Renn et al. shed some light on the conundrum between society's need for exploring and extracting the metals and the unsustainable perception of mining. This article reviews how the sustainability criteria can be applied to the extractive sector. This encompasses environmental, economic, and social sustainability aspects whose policies need to be homogenized worldwide. They highlight three key aspects to ensure sustainability in political instruments and investment policies in order to achieve the desired results. The article emphasizes the need for transparent and inclusive stakeholder participation as well as a holistic understanding of the impact of extractives activities. The authors propose that investors providing capital for companies operating in the extractive industries should place sustainability indicators into their decision-making with the aim of improving governance of the extractive industry for increased economic prosperity and environmental protection.

Lawley et al. show that integrating biodiversity variables in prospectivity models is essential to ensure a responsible supply of battery metals. This article suggests that a quantitative approach bringing together machine learning tools and models with geological and ecological databases is efficient in tackling the conundrum our society faces, helping to balance areas that can be exploited and those needing to be preserved. The authors recommended the application of artificial intelligence aimed at lowering the ecological and environmental risks of the natural resources sector.

Troll and Arndt focus on the European case which is characterized by an almost complete dependency on importation for critical raw materials, thus delocalizing the negative environmental impact of the extractive industry. The authors highlight that Europe has a moral responsibility to change that paradigm and regain sovereignty by initiating a

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Edited by:
Kathryn Goodenough,
British Geological Survey-The Lyell Centre, United Kingdom

***Correspondence**
Bénédicte Cenki,
benedicte.cenki@umontpellier.fr

Received: 10 December 2023
Accepted: 04 January 2024
Published: 12 January 2024

Citation:
Cenki B, Hughes H and Sakyi PA (2024) Editorial: Sustainability in the Extractive Industries. *Earth Sci. Syst. Soc.* 4:10103. doi: 10.3389/esss.2024.10103

sustainable extractive industry on the continent, yet demonstrate that there is Continuing opposition to the exploitation of Europe's proven and potential ore reserves, primarily due to concern over the environmental impact of mining. The paper observes that Europe's almost total dependence on foreign suppliers of many metals impacts negatively on the continent's balance of trade, opening the region to potentially damaging supply problems and enabling foreign actors to place political demands on European leaders and economies. Furthermore, this practice has a considerable negative environmental impact in many parts of the world.

Sides and Allington further emphasize the key importance of harmonizing, at the international level, evaluation criteria for environmental, social and governance (ESG) aspects of mineral projects in order to better inform decision makers and potential investors. The authors report and discuss international guidelines and reporting standards that have been developed The Committee for Mineral Reserves International Reporting Standards (CRIRSCO) and the Pan-European Reserves and Resources Reporting Committee (PERC).

Finally Katz points to the critical role of educating geoscientists to train the future generation for the mining industry in a truly trans-disciplinary manner to make the critical raw material supply chain resilient and the extractive industry sustainable, while respecting both people and the planet. He emphasizes the need to develop and to introduce social responsibility content into the undergraduate geoscience syllabus in order to diversify student's skills–the author suggests that this could particularly form part of fieldwork, where there are opportunities for community engagement. This article belongs to the few pioneer articles [together with Jansson et al. (2020) for example] that address the change of paradigm in teaching geosciences that is a direct consequence of the energy and digital transition.

We hope that this special issue contributes to raising awareness about the challenges and pitfalls of creating a critical raw materials resilient supply chain and sustainable extractive industry. The path to a true circular economy for critical raw materials is still a long way ahead, but engaging in these conversations and raising awareness is a positive step forward. Transdisciplinary approaches modelling the fate of mining territories and their past, present and future trajectories are emerging (Rossi et al., 2021). If the energy and digital transition is not planned in the long term, the finite resource that has fueled humanity in past centuries (i.e. fossil fuels) will simply be replaced by another finite resource (i.e. metals and minerals) (Vidal et al., 2013). It is our responsibility as scientists to inform the public and policy makers to make our "green future" sustainable for the people and the planet.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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