

Peer Review Report

Review Report on Metal sourcing for a sustainable future

Review, Earth Sci. Syst. Soc.

Reviewer: Nick Arndt

Submitted on: 25 Aug 2021

Article DOI: 10.3389/esss.2022.10049

EVALUATION

Q 1 Please summarize the main theme of the review.

The manuscript describes how metals will be needed for the energy transition and to meet some UN sustainability goals, then points out that mineral exploration and mining will need to change to satisfy other UN goals and to meet current societal and environmental norms. It makes a series of recommendations about how this might be done, notably calling on transparent and inclusive stakeholder participation and harmonisation of political instruments and investment policies.

Q 2 Please highlight the limitations and strengths.

The major limitation is the writing, which is too complicated, too full of jargon, with too many references to ideas and subjects that will not be familiar to many readers and are not explained in the manuscript. I have uploaded my attempt to rewrite the abstract to make it more comprehensible for me, and eventually, other readers.

The strength of the manuscript is that it does summarise many pertinent and recent ideas related to the need to make mining more sustainable.

Q 3 Does the review include a balanced, comprehensive and critical view of the research area?

I found that the manuscript is neither well balanced nor comprehensive. In opinion there is too much emphasis on political and social aspects and too little discussion of geological and economical factors. I note that the reference list is almost entirely restricted to publications in journals focussing on sustainability, environment, policy and societal issues, with almost no papers related to the geosciences or mineral economics. I list below just a few papers that the authors may wish to refer to:

Graedel, T. E., Harper, E. M., Nassar, N. T., Nuss, P. & Reck, B. K. Criticality of metals and metalloids. *Proc. Natl Acad. Sci.* 112, 4257-4262 (2015).

Jowitt, S., Mudd, G. M., Thompson, J. F. (2020). Future Availability of Non-renewable Metal Resources and the Influence of Environmental, Social, and Governance Conflicts on Metal Production. *Communications Earth & Environment* 1-8. *Nature*. <http://dx.doi.org/10.1038/s43247-020-0011-0>

Herrington R (2013) Road map to mineral supply. *Nature Geoscience*, 6, 892-894 doi:10.1038/ngeo1947

Herrington, R. Mining our green future. *Nat Rev Mater* 6, 456-458 (2021).

<https://doi.org/10.1038/s41578-021-00325-9>

Meinert, L. D., Robinson, G. R., & Nassar, N. T. Mineral resources: reserves, peak production and the future. *Resources* <https://doi.org/10.3390/resources5010014> (2016).

Arndt, N. T. et al. Future global mineral resources. *Geochem. Perspect* 6, 1-171 (2017).

Mudd, G. M. & Jowitt, S. M. 2018. Growing global copper resources, reserves and production: Discovery is not the only control on supply. *Econ. Geol.* 113, 1235-1267 (2018).

Vidal O, Goffé B, Arndt N (2013) Metals for a low-carbon society. *Nature Geoscience* 6: 894-896

Q 4 Check List

Is the English language of sufficient quality?

No.

Is the quality of the figures and/or tables satisfactory?

No.

Does this manuscript refer predominantly to published research? (unpublished or original research is non-standard for a review article, and should be properly contextualised by the author)

Yes.

Does the manuscript cover the topic in an objective and analytical manner

Yes.

Does the reference list cover the relevant literature adequately and in an unbiased manner?

Yes.

Does the manuscript include recent developments?

Yes.

Does the review add new insights to the scholarly literature with respect to previously published reviews?

Yes.

Q 5 Please provide your detailed review report to the editor and authors (including any comments on the Q4 Check List):

I will say at the start that I had great trouble reading this manuscript (and confess that I was never able to read it through carefully from start to finish). I suspect that this in large part due to my lack of familiarity with the type of writing and vocabulary used by social scientists, and for this I apologise. However, I suspect that this will also be the case for many readers of *Earth Science, Systems and Society*, a journal that aims to publish “research of high importance across the breadth of the geosciences”. Another problem is the style and complexity of the writing – far too many phrases are overly long and convoluted, while being at the same time rather vague. I give some examples at the end of my review.

A major problem comes right at the start. The words “sustainable development” and “sustainability” are used innumerable times throughout the manuscript, but their meaning is never made totally clear. To many readers, the phrase “sustainable mining” requires more explanation than simply repeating the Bruntland definition: “Sustainability and sustainable development (WCED 1987) allow us to meet the needs of the present without compromising the ability of future generations to meet their own needs”. What is the difference between “sustainability” and “sustainable development”? How, exactly, can mining be sustainable given that once a mineral deposit is mined out, it can no longer be regrown or regenerated? Readers familiar to the subject will have the answers – they will know that exhausted deposits will be replaced by newly discovered deposits. However, this will not be evident to readers without specialist knowledge, and this should be clearly explained in the manuscript.

Many references are made to the UN Sustainable Development Goals but commonly in a way that will be understood only by readers familiar with these goals. For example, we are told that “Mining operations spur economic growth and lower the unemployment rate (SDG 8) and, when properly governed, can contribute to mitigate inequalities and discrimination (SDG 1, 5, 10)”. From this we must infer the content of SDG 1,5,8 and 10. It would be very useful to list, in a table or figure, the UN Sustainable Development Goals, if not all of them, then at least those relevant to mining. There are only two figures in the manuscript and many more should be added to help pass the relevant information to the reader. The two figures already in the manuscript are not very informative and incorrect in some ways. In Figure 1 we read “Environmental” but in the text, the term “ecological” is used in the text.

Very often we read sentences like the one copied below in which numerous jargon-filled phrases are followed by references. Perhaps if the reader had the time and energy to read each cited reference, the meaning would be clear, but I doubt that many readers will do so: “Life cycle assessments (Pelletier et al., 2019),

environmental management accounting studies (Latan et al., 2018), and eco-efficiency assessments of circular economy (Liu et al., 2019) demonstrated that the biggest opportunity for impact reduction of mining operations lies in the design phase, rather than in operation or postclosure (McLellan et al., 2009). With the Industry 4.0 paradigm, new technologies will transform the mining industry and the underlying economics (Kagermann et al., 2013).” Even more familiar phrases like “green bonds” and “weak and strong sustainability” are used without the minimal explanation that I believe would be required if most readers are to understand what is being said.

What then do I recommend? On the first page, 22(!) authors are listed and although many of these have economics or social science backgrounds, others come from geology departments, mining schools or mineral exploration companies. I strongly urge these authors to go carefully through the manuscript and help rewrite the entire text so that it will be understandable to all readers, especially those with earth science backgrounds. Once this is done, I will be happy to review once again the manuscript and offer more substantial criticism of its content. At present I am unfortunately unable to do this.

Some examples of phrases that I found impossible to understand

“There is the necessity to link the utility value, the availability as well as the natural resources with assessment approaches to material efficiency, resource intensity, supply risks, criticality, resource efficiency, resource consumption, and sustainability in a material–economical system to ensure a reliable input for resource policy.”

“By decomposing complex interrelations of sustainability, economic concepts of accounting, assessing and balancing benefits and risks may serve as suitable tools to analyze investments and operationalize impacts to the natural and social environment.”

This sentence has no subject: what is it that “... may serve as suitable tools”? Do the authors mean “Decomposition of complex interactions ... may serve as suitable tools?”

What is meant by “tools ... to operationalize impacts”? I do not understand the meaning of “operationalize”

Nicholas Arndt
Grenoble, August 2021

QUALITY ASSESSMENT

Q 6	Quality of generalization and summary	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q 7	Significance to the field	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Q 8	Interest to a general audience	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Q 9	Quality of the writing	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

REVISION LEVEL

Q 10 What is the level of revision required based on your comments:

Substantial revisions.