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DEEP SEA POLYMETALLIC NODULES: DIVERSIFICATION OF SUPPLY

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ABSTRACT

In the context of a growing demand of battery metals, GSR proposes a step-by-step, precautionary approach to exploration and exploitation of deep sea polymetallic nodules. The polymetallic nodules contain manganese, nickel, copper and cobalt (with a sum of the grades close to 30 %wt) and lie by a depth of 4500m on the seabed of the Clarion Clipperton Fracture Zone, which is located in the international waters of the Pacific Ocean, west of the Mexican coast.

The paper proposes a technically-focused update on the exploration and exploitation development of polymetallic nodules. It describes the conceptual nodule collection and processing chain and presents original test-work results related to the nodules comminution characteristics (results published in 2021). The paper also presents results related to a prospective life cycle assessment of the metal commodities obtained from the nodules, including a comparison with its land-based mining counterpart (paper published in 2021). A holistic environmental analysis is needed, in order to consider the entire value chain of the products obtained out of deep-sea exploitation. The system boundaries cover the value chain, from nodules collection to metallurgical processing. It considers as reference flow one tonne of (dry) nodules, using a cradle-to-gate approach up to the final metal commodities, analyzing the delivery to the market of 10.5 kg of copper, 12.8 kg of nickel, 2.3 kg of cobalt and 311.3 kg of ferromanganese.

Three environmental impact categories are analyzed, i.e., climate change, acidification and photochemical oxidant formation. Overall, onshore activities (e.g., hydrometallurgical processing) are the main hotspots for environmental impacts of metals sourced from the deep sea; offshore activities play a minor role in the value chain. The leveraged effect of the high grades and polymetallic nature of the nodules and the characteristics of the processing lead to potential reductions of 38% of the CO_{2e} emissions and 72% of acidification compared to land-based mining. The results of photochemical oxidation impacts are similar to those of land-based mining. The study shows the importance of the presence of renewables in the power mix used for processing chain, and the flexibility of the nodules processing regarding the choice of the processing location.

Keywords: polymetallic nodules, deep-sea, battery metals, mining, life cycle assessment, comminution, sustainable development, climate change, acidification, photochemical oxidation