

Discovery of Dark Oxygen Production in Areas of the Deep-Sea with Polymetallic Nodules

A Communication by the KDM Marine Mineral Resource Strategy Group

Sweetman et al. (2024) published an article in *Nature Geoscience* on 22 July 2024, presenting observations that polymetallic nodules on the seafloor may produce oxygen through electrolysis, a process referred to as "dark oxygen production (DOP)." Sweetman et al. (2024) suggest that the nodules possess a voltage potential sufficient to explain DOP, at least partially, through the electrolysis of seawater. This hypothesis is based on measurements of dissolved oxygen in benthic chambers over 48 hours in nodule fields of the Clarion-Clipperton Zone (CCZ) in the NE Pacific, as well as in controlled laboratory experiments. The measurements showed an increase in dissolved oxygen up to a factor of 5 in the enclosed water volume of the benthic chambers compared to ambient near-bottom seawater.

To rule out biological sources of oxygen production, the nodules were treated with various substances in laboratory experiments to inhibit microbial activity. Despite this treatment, the oxygen levels above the nodules continued to increase, which led to the hypothesis of seawater electrolysis to explain the abiotic oxygen production.

This publication has sparked significant discussion within the scientific community and the public. If confirmed, these findings would represent a fundamental shift in our understanding of the planet's oxygen production, which has traditionally been attributed solely to photosynthesis driven by sunlight. "Dark oxygen production" would introduce a previously unrecognized source of oxygen that operates independently of sunlight. However, it also raises concerns that manganese nodule extraction could negatively affect local oxygen levels in near-bottom seawater or porewater, adding further complexity to the discussion on the environmental impact of deep-sea mining.

It should be noted, however, that Sweetman et al.'s (2024) findings contradict some previous studies measuring oxygen levels without finding an increase in dissolved oxygen in benthic chambers above manganese nodules (e.g., Khripounoff et al., 2006; Vonnahme et al., 2020; An et al., 2024). There is ongoing debate about the role of microbial activity in manganese nodules and the plausibility of electrolysis as the source of dark oxygen production on the seafloor (see rebuttals by Tengberg et al., 2024; Denny et al., 2024; and Nakamura, 2024). Moreover, an increase of dissolved oxygen in the near-bottom seawater outside the benthic chambers could not be detected so far which may indicate an overall low contribution of DOP to the total oxygen budget of the near-bottom seawater.

In conclusion, while the "dark oxygen production" hypothesis is intriguing, there are still many methodological and scientific uncertainties. These issues require further investigation, and any conclusions should be based on robust scientific evidence and not be influenced by public opinions or political agendas.

Further Information:

<https://www.deutsche-meeresforschung.de/en/strategy/strategy-groups/mineral-resources>