Marine biology

‘Dark’ oxygen found in the deep

Sea-floor nodules full of valuable metals seem to raise oxygen levels in the ocean depths, suggesting they may have a valuable role in ecosystems, finds **Madeleine Cuff**

METALLIC nodules scattered across the seabed are a source of oxygen for nearby marine life – a finding that could upend our understanding of the deep ocean and affect plans to mine there.

Abyssal plains in some regions are scattered with potato-sized mineral lumps packed with cobalt, manganese and nickel, which are targets for industrial extraction.

Andrew Sweetman at the Scottish Association for Marine Science in Oban first noticed something strange about these areas in 2013, when he was doing research in the Clarion-Clipperton Zone, a nodule-rich part of the Pacific Ocean.

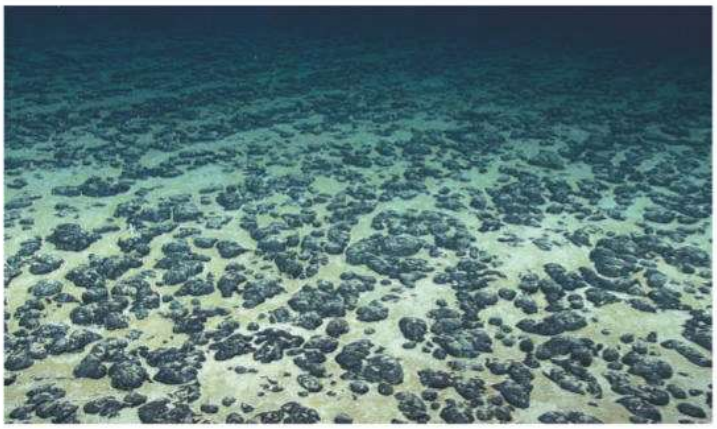
Sweetman and his colleagues were sending machines down to the ocean floor to seal off a patch of seabed and measure its oxygen flux. Instead of oxygen content decreasing in monitored sections, the data suggested it was rising.

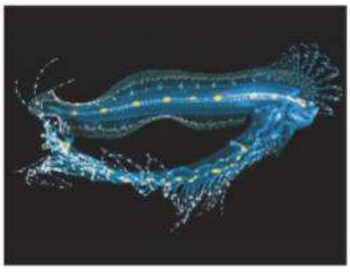
Without any noticeable plant life, that didn’t make sense, says Sweetman. “I’ve been taught from a very young age that oxygenated ecosystems are only possible through photosynthesis,” he says. His conclusion was that the equipment was faulty. “I literally ignored the data,” he says.

Then, in 2021, Sweetman was on another research cruise in the Pacific and machines returned the same finding – increasing oxygen levels on the seabed. Using a different measurement approach yielded the same result.

“We were seeing the same oxygen production in these two different datasets,” says Sweetman. “Suddenly I realised that for the last eight or nine years I had been ignoring this hugely groundbreaking process.”

He and his colleagues deduced that the metallic nodules must be playing a role in raising oxygen levels in the deep sea after lab testing ruled out the presence of oxygen-producing microbes.





CLOCKWISE FROM TOP: NOAA; BLUE PLANET/ALAMY; C. BRIDGEWATER (2024)

Clockwise from top: manganese nodules on the sea floor off the south-eastern US; a sample from the Pacific being tested in a lab; oxygen generated by nodules may help organisms like cusk eels survive in deep water

Instead, Sweetman says the materials in the nodules are acting as a “geobattery”, generating an electric current that splits seawater into hydrogen and oxygen. “These nodules are being mined because there’s everything there that you need to make an electric car battery,” he says. “What if they are acting as natural geobatteries, by themselves?”

Each nodule can produce up to 1 volt of electric potential, the team found by probing them. If the rocks were clustered together, there would be enough voltage to split seawater into hydrogen and oxygen via electrolysis, explaining the elevated oxygen levels (*Nature Geoscience*, doi.org/m9b6).

“Potentially, we have discovered a new natural source of oxygen,” says Sweetman.

There are many outstanding questions. For example, the source of energy generating the electric current is still a mystery. It is also unclear under what conditions the reaction happens and the contribution this “dark” oxygen makes in sustaining surrounding ecosystems. “We don’t have all of the information yet, but we know it’s happening,” says Sweetman.

Emergence of life

In deep-sea environments devoid of sunlight and plants, some life forms get their energy from chemicals that erupt from the sea floor at hydrothermal vents. Some scientists think life on Earth first appeared at these vents, but early organisms would have needed a source of oxygen to make food from inorganic compounds. The findings raise the possibility that nodules were the source of oxygen to help life get started, says Sweetman.

That interpretation might be a stretch, says Donald Canfield at the University of Southern Denmark. Oxygen is needed to produce the manganese oxide in the nodules, he points out. “Oxygenic photosynthesis is a prerequisite for their production,” he says. “For this reason, oxygen production by the nodules does not represent an alternative type of oxygen production to be equated with oxygenic photosynthesis. It is very unlikely that they have played a role in the oxygenation of the planet.”

However, Ruth Blake at Yale University says the idea of oxygen production in the deep ocean is exciting and warrants research into its potential impact on deep-ocean ecosystems.

Sweetman’s study was part-funded by The Metals Company (TMC), a deep-sea mining firm that is looking to harvest metallic nodules in the Clarion Clipperton Zone. In response to the study, Patrick Downes at TMC said he has “serious reservations” about the findings, adding that TMC’s own analysis suggests Sweetman’s results are due to oxygen contamination. “We will be writing a rebuttal article,” Downes said in a statement to *New Scientist*.

However, the findings are likely to strengthen calls for a ban on deep-sea mining. Paul Dando at the UK’s Marine Biological Association says the paper reinforces the view of deep-sea scientists “that no mining should take place until we understand the ecology of these nodule fields”. ▮