Tonga volcano eruption stimulates life: Rapid, massive bloom of ocean phytoplankton

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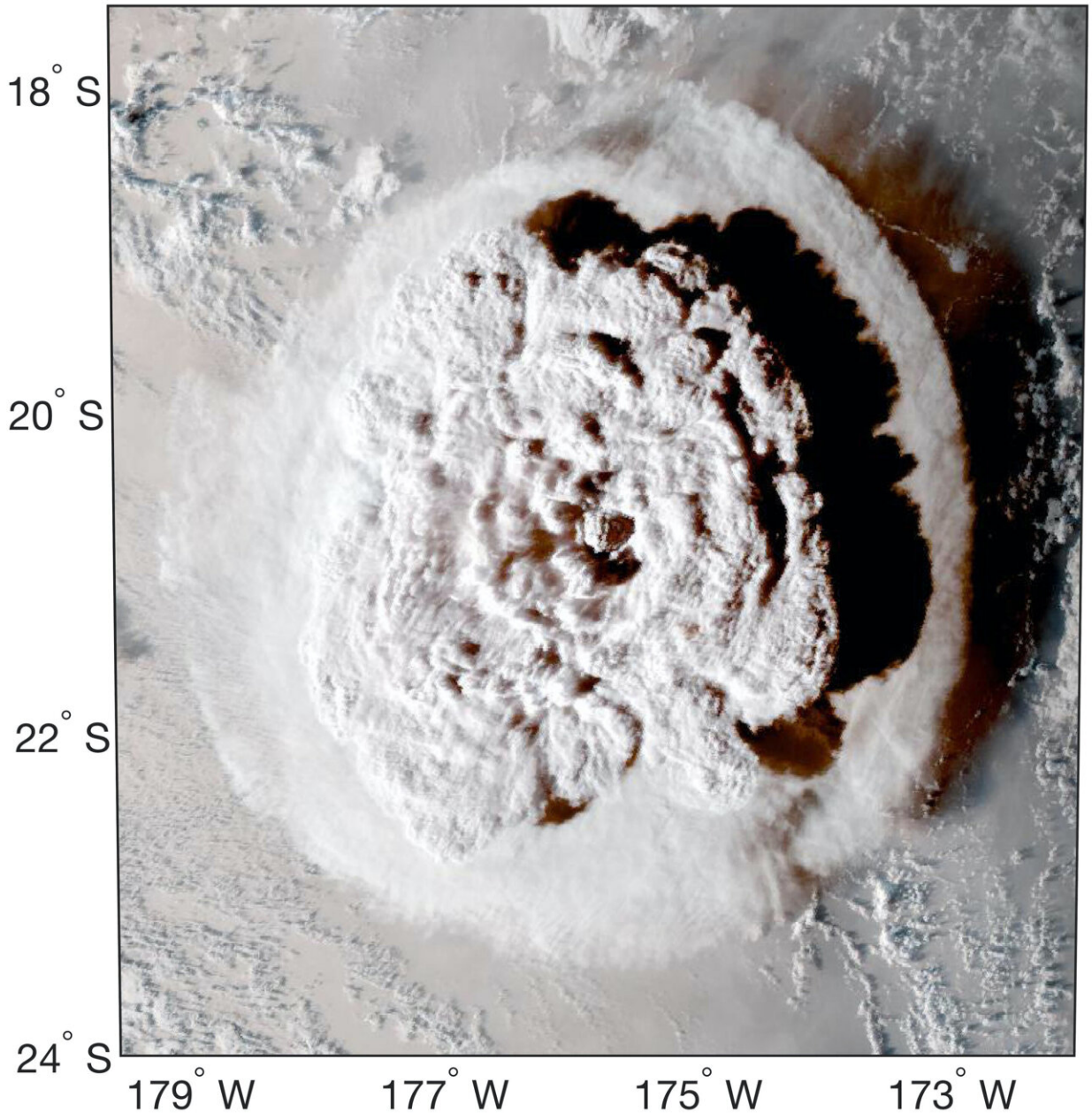


Hunga Tonga-Hunga Ha‘apai eruption as seen from the GOES satellite. Credit: NASA/ NOAA

In January 2022, the largest submarine volcanic eruption of this century led to a dramatic phytoplankton bloom north of the island of Tongatapu,

in the Kingdom of Tonga. A team of scientists from the University of Hawai'i (UH) at Mānoa and Oregon State University revealed in a recently published study that the bloom of microscopic marine life covered an area nearly 40 times the size of the island of O'ahu, Hawai'i within just 48 hours after the eruption.

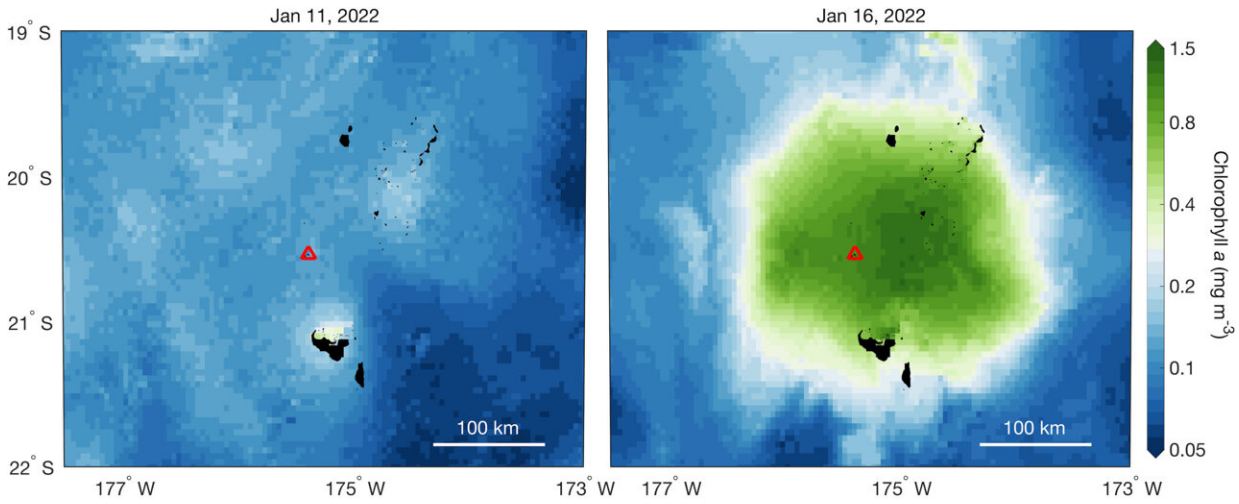
The UH Mānoa School of Ocean and Earth Science and Technology (SOEST)-led team, analyzed satellite images of various kinds—true color, emission of red and infrared radiation, and light reflection at the sea surface—and determined that the deposition of volcanic ash was likely the most important source of nutrients responsible for phytoplankton growth.

Phytoplankton are the tiny photosynthetic organisms that produce oxygen and serve as the base of the marine food web. The growth of these microbes is often limited by the low concentrations of nutrients dissolved in the surface ocean, but phytoplankton can increase rapidly when nutrients become available.

"Even though the Hunga Tonga-Hunga Ha‘apai eruption was submarine, a large plume of ash reached a height of tens of kilometers into the atmosphere," said Benedetto Barone, lead author of the study and research oceanographer at the Center for Microbial Oceanography: Research and Education (C-MORE) in SOEST. "The ash fallout supplied nutrients that stimulated the growth of phytoplankton, which reached concentrations well beyond the typical values observed in the region."

"We were impressed to observe the large region with high chlorophyll concentrations within such a short time after the eruption," said Dave Karl, study co-author and director of C-MORE. "This shows how quickly the ecosystem can respond to nutrient fertilization."

"A casual observer might see seemingly very different parts of the environment—in this case, a volcano producing a large eruption and a major shift in the ecology of the oceans nearby," said Ken Rubin, study co-author and volcanologist in the SOEST Department of Earth Sciences. "However, our observations illustrate the broad interconnectedness and interdependence of different aspects of the environment, perhaps even indicating an under-appreciated link between volcanism and shallow marine ecosystems globally."



Maps of ocean chlorophyll from before (left) and after (right) the eruption. Credit: Barone, et al. (2022)

Applying lessons from Kilauea

Three of the study authors had previously assessed and sampled a smaller phytoplankton bloom that was linked with the Kilauea eruption of 2018, which highlighted the potential impacts of volcanic eruptions on ocean ecosystems.

"When I heard of the Tonga eruption, it was fairly straightforward to modify the computer code that I had written to analyze the satellite measurements around Hawai'i to determine the impact of the Tonga eruption on the nearby ocean ecosystem," said Barone. "From the first moment of seeing the results of the analysis, it was clear that there had been a fast phytoplankton response in a large region."

Understanding ocean fertilization

Phytoplankton pull from the atmosphere the carbon dioxide that is responsible for warming most regions of our planet. The eruption was a natural fertilization event that revealed the capacity of these microscopic powerhouses to respond fast, when the right conditions arise.

"The dynamics of this event can help us predict the behavior of pelagic environments, when nutrients are added to nutrient-impoverished regions of the ocean," said Barone. "This knowledge can prove useful in the discussion about the impacts of carbon dioxide removal technologies based on ocean fertilization."

More information: B. Barone et al, Satellite Detection of a Massive Phytoplankton Bloom Following the 2022 Submarine Eruption of the Hunga Tonga-Hunga Ha'apai Volcano, *Geophysical Research Letters* (2022). DOI: 10.1029/2022GL099293

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