The surprising way a volcanic eruption fueled a bloom of ocean algae

September 9 2019, by Kevin Krajick

Lava flows off the edge of Hawaii in June 2018, apparently triggering a massive algae bloom, left. Credit: U.S. Coast Guard

When Hawaii's Kilauea volcano erupted in 2018, it destroyed some 700 homes and sent hundreds of millions of tons of lava pouring into the ocean, creating billowing clouds and explosions along the coast. Soon, satellite imagery revealed something else happening: apparent huge blooms of marine phytoplankton popping up. That July, a team of scientists set out in a research vessel for several days to monitor the water and take samples around the clock, in an attempt to understand what was happening. Their working hypothesis: the surging lava was delivering mineral nutrients to the relatively nutrient-poor waters, sparking the bloom. But, as told in a study published in the journal *Science* this week, they were mistaken. A previously unsuspected mechanism was at work, one with wider implications for how marine biological processes work.

Phytoplankton are one-celled photosynthetic algae that form the basis of the marine food web. They also play a key role in regulating global climate, because they soak up vast amounts of carbon, some of which sinks to the bottom when the phytoplankton die. However, their growth is limited in many regions, because the water does not contain enough essential nutrients to go around. The field team, led by scientists at the University of Hawaii and the University of Southern California, initially assumed that the bloom was happening because volcanic dust and lava, rich in nutrients such as iron and phosphate, was feeding it.

Direct observations and later analyses showed this was not the case. For one, iron and phosphate were indeed entering the water, but not in forms available for the phytoplankton to use; they were clumping together into particles that the organisms could not take in. On the other hand, the water was suddenly loaded with nitrate–a nutrient not normally found near the surface around here, and which is practically nonexistent in lava. Where was the nitrate coming from, and were the phytoplankton using it?

Normally, scientists would expect to find the waters around Hawaii dominated by extremely small species called picoplankton, whose growth is limited by the abundance of iron and phosphate. But the composition of the organisms had shifted dramatically; the dominant species were now larger phytoplankton called diatoms. Samples of phytoplankton were sent to Sonya Dyhrman, a biological oceanographer at Columbia University's Lamont-Doherty Earth Observatory. She and Lamont associate research scientist Matthew Harke analyzed their metabolisms and found that the diatoms were responding vigorously to added nitrate.

"It's really exciting to see a rapid-response team of scientists work together to solve a mystery," said Dyhrman. "We were able to use our analysis to help confirm that nitrate was an important part of the story here, where we had thought it would be iron or phosphate."

The team now believes they have identified a fertilization mechanism that no one had thought of before. They say that lava pouring into the ocean stirred the pot, plunging as far as 1,000 feet below the surface. Down there in the cool depths, nitrate from dead organisms tends to collect, and mostly stay there. But the lava heated the water, causing it to rapidly well up. Once the welled-up water hit the zone where sunlight penetrates, nitrate-hungry diatoms took advantage and quickly multiplied. A confirmation of this idea: soon after the eruption stopped, the algae bloom subsided.

Volcanologist Terry Plank and biological oceanographer Hugh Ducklow, both also at Lamont-Doherty, wrote a commentary accompanying the study. In it, they say that no one had previously investigated whether eruptions might play such a role in marine ecosystems. Yet, the oceans are dotted with volcanic islands as well as submarine volcanoes including probably many that have not been discovered. Could these be influencing the ebb and flow of phytoplankton and the wider food web

in unsuspected ways? Among other things, they say, volcanic eruptions are known to contribute carbon dioxide to the atmosphere–but with the new discovery, it seems possible that they are balancing this out in part by fueling phytoplankton growth that takes back some of the carbon. Plank and Ducklow speculate that other transitory phenomena such as hurricanes might also play a similar role by stirring nutrient-rich waters from the deeps up toward the surface.

The eruption and the ability to study it in real time "provided a unique opportunity to see firsthand how a massive input of external nutrients alters marine ecosystems," said lead author Sam Wilson of the University of Hawaii.

More information: Samuel T. Wilson et al. Kīlauea lava fuels phytoplankton bloom in the North Pacific Ocean, *Science* (2019). DOI: 10.1126/science.aax4767

Provided by Columbia University