Massive underwater plateau near Solomon Islands is younger and its eruption was more protracted than previously thought

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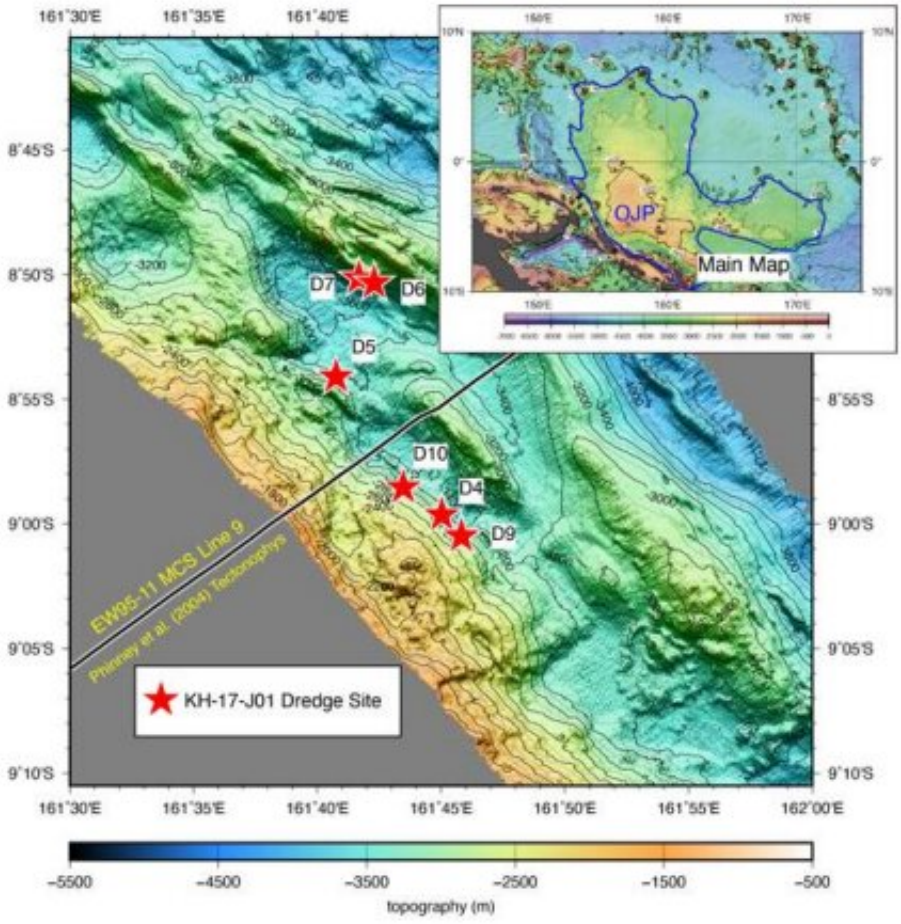

Location of dredge samples selected for $^{40}Ar/^{39}Ar$ analyses, other dredge locations not shown. The large map shows multibeam seafloor bathymetry off the northern coast of Malaita Island. Credit: *Science* (2023). DOI: 10.1126/science.ade8666

The Ontong Java Plateau, a volcanically-formed underwater plateau located in the Pacific Ocean north of the Solomon Islands, is younger and its eruption was more protracted than previously thought, suggests new research led by Oregon State University.

The findings, just published in *Science*, also cast doubt on long-held assumptions that the formation of the plateau, which is roughly the size of Alaska, was the cause of a global deposit of black shale throughout the world's oceans.

"This type of shale is formed when there is very limited oxygen in the ocean. This layer was formed about 120 million years ago and can be found preserved everywhere around the world in geological formations," said Anthony Koppers, a professor of marine geology in OSU's College of Earth, Ocean, and Atmospheric Sciences and a co-author of the study.

"A massive volcanic eruption like the one that formed Ontong Java Plateau could deplete the ocean of oxygen, and it was believed that this massive volcanic activity and the shale deposits were connected. But our findings suggest that is not the case," continued Koppers.

Ontong Java Plateau covers roughly 1% of Earth's surface. The plateau is a fragment of the Ontong Java Nui, a superplateau that broke apart shortly after its formation, creating Ontong Java, Manihiki Plateau and Hikurangi Plateau.

Between 1973 and 2000, researchers drilled cores into the sediment and underlying basalt basement—among the thickest and oldest rock that forms the Pacific oceanic crust—from several sites in the region and collected samples to study. The cores were collected using the scientific ocean drilling vessels Glomar Challenger and JOIDES Resolution during

the Deep Sea Drilling Project and Ocean Drilling Program.

Past research using these cores suggested that Ontong Java was formed in a single, relatively short volcanic event about 120 million years ago, around the time of the shale deposit. But there have been concerns about the accuracy of the data used to make that determination, said Koppers, an international expert in large-scale geodynamic processes. who also serves as associate vice president for research advancement and strategy in OSU's research office.

"Understanding the timing of these volcanic eruptions is essential to establishing a link between the eruptions themselves and the formation of the black shales," Koppers said. "Establishing this causality is important to understanding large changes in ocean chemistry, similar to what is happening today through climate change due to human activity."

Koppers and the study's lead author, Peter Davidson, who worked on the project as a doctoral student and has recently completed his degree at Oregon State, replicated the original 1993 dating studies to see if they could achieve the same results while also taking advantage of major improvements in scientific techniques and in mass spectrometry equipment used in chemical analysis.

Using several of the same core samples from the original drilling projects, Davidson ran 40 experiments to try to replicate the earlier findings. Of the 40, a surprisingly large number—38—failed when applying modern-day data quality standards.

"The new results showed that the original samples were greatly affected by an unwanted process during the irradiation of the samples, which causes the ages to appear to be too old," Davidson said. "This irradiation issue, called recoil, is a problem that could not easily be seen with the older equipment used decades ago, but our new, highly sensitive

instrumentation can easily identify this problem."

Davidson then ran another set of dating experiments, applying the same analysis on another mineral phase of the original samples—a type of feldspar, or rock-forming mineral, called plagioclase.

"The data from the plagioclase is much higher-resolution than past data, and more importantly, it is entirely devoid of the recoil issue that skewed the original ages for the Ontong Java Plateau that were based on the basalt," Koppers said.

The new tests showed that Ontong Java was up to 10 million years younger than expected and likely formed over several million years.

"All of the tests showed a high level of internal consistency in the ages measured and a remarkable reproducibility between multiple samples from the same volcanic eruptive units, providing us with a tremendous degree of confidence," Davidson said. "These results mean we can't connect Ontong Java anymore to the anoxic event that led to the shale deposits. The dates no longer line up."

The data also suggests that Manihiki Plateau is several million years older than Ontong Java, raising questions about theories that the two were once connected and broke apart. Instead, the findings suggest that volcanic activity may have started under the Manihiki Plateau and migrated hundreds of kilometers across the Pacific over time.

The finding is likely to cause some head-scratching among scientists, Koppers noted, because there is no longer an explanation for the large oxygen-depletion event that left shale deposits around the world.

There is also a possibility that lower portions of Ontong Java are older, he said. The available samples from Ontong Java were drilled only into

the top couple hundred meters of the plateau, whereas the plateau is a geologic megastructure up to 35 kilometers thick, with the top 8 to 9 kilometers considered the eruptive portion.

"In that sense, we have only scratched the surface of Ontong Java," Koppers said.

Davidson hopes to continue the research by hunting down samples of older portions of the plateau and running new analyses using these modern techniques. There are some areas in the Solomon Islands where up to four kilometers of the top of the plateau are exposed and could potentially be accessible.

"We hope that by targeting further samples from deeper in the volcanic stratigraphy, we can uncover potentially even older portions of the Ontong Java Plateau," Davidson said. "It might be possible that these older portions of the plateau did cause the black shale deposition, but they might not."

"These future studies should further help us understand Ontong Java, which is the largest volcanic feature on Earth's surface, and how volcanic eruptions of this magnitude can potentially cause global environmental disruptions."

Additional co-authors are Takashi Sano of the National Museum of Nature and Science in Tsukuba, Japan; and Takeshi Hanyu of the Japan Agency for Marine-Earth Science and Technology in Yokosuka, Japan.

More information: Peter C. Davidson et al, A younger and protracted emplacement of the Ontong Java Plateau, *Science* (2023). DOI: 10.1126/science.ade8666

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