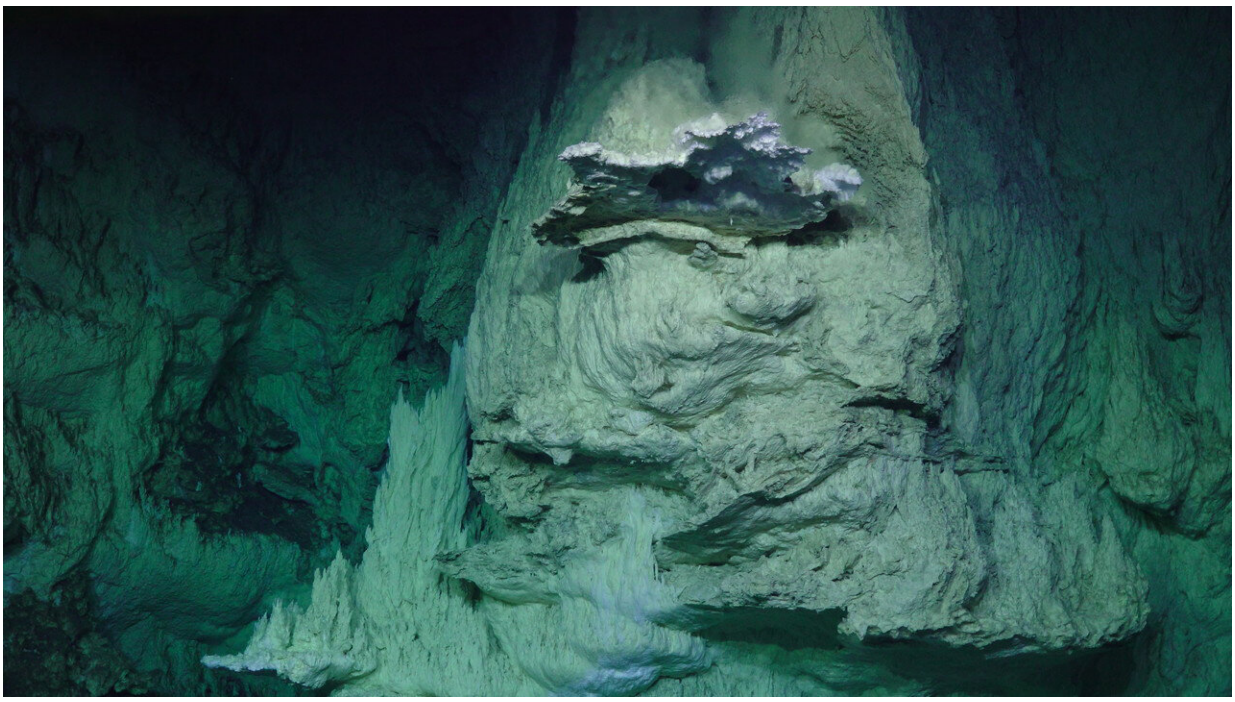
Deep below the Lost City, scientists uncovered superheated water that may fuel one of Earth's strangest ecosystems

July 15 2026, by Sayan Tribedi



This Lost City carbonate tower was imaged during the National Science Foundation-supported project Return to the Lost City 2018. Credit: Susan Lang, University of South Carolina/National Science Foundation/ROV Jason 2018 WHOI

Deep in the Atlantic Ocean, the Lost City hydrothermal field is known for eerie white chimney structures made of carbonate. Alkaline hot

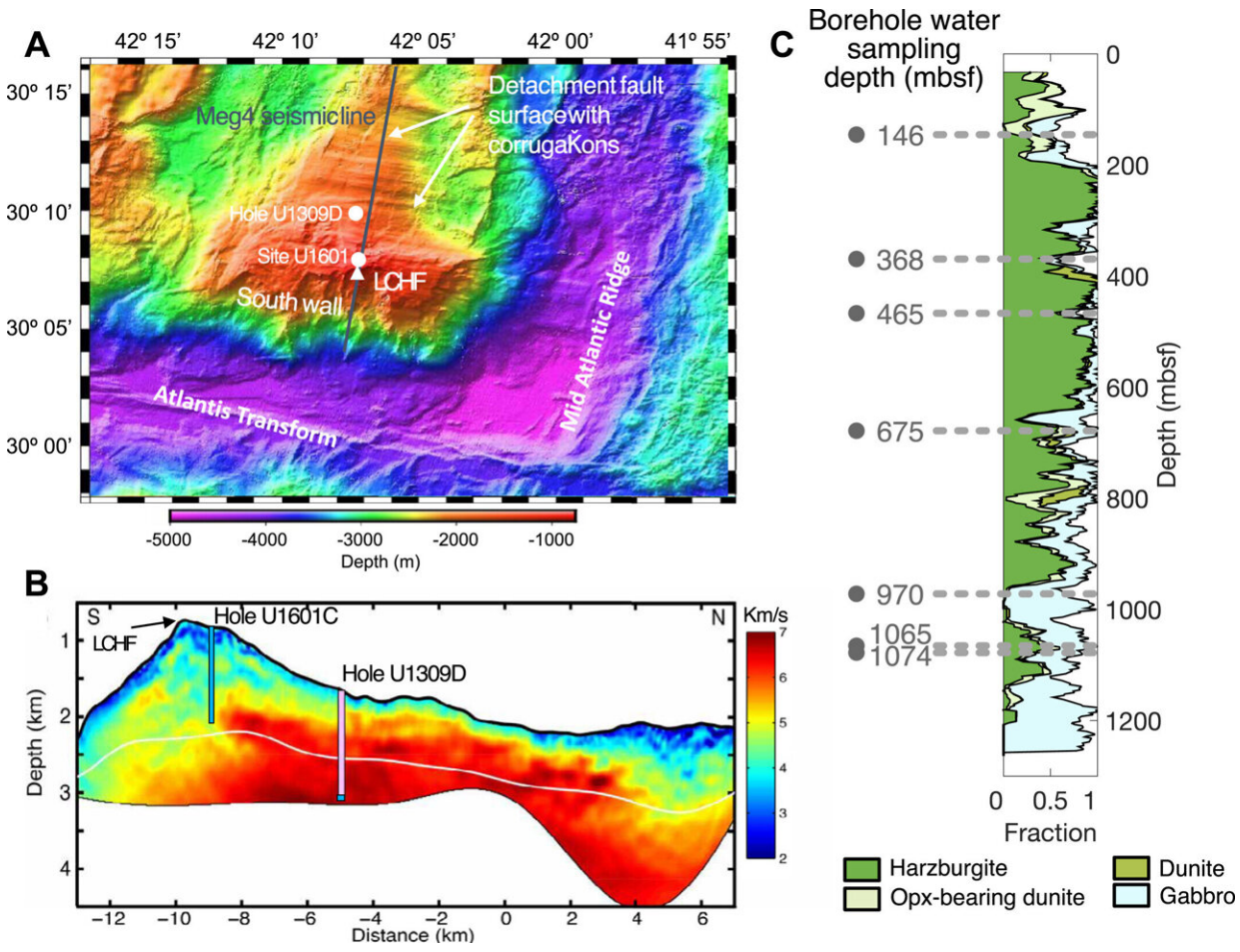
springs, loaded with hydrogen and methane, emerge from the seafloor there. Rather than depending on sunlight for survival, living organisms thrive on energy produced by the reaction of water with rocks underground. However, one question remained: Where does the energy-rich fluid that feeds this strange ecosystem actually come from?

In an experiment, researchers drilled to a depth of almost 1.3 kilometers (0.8 miles) within the Atlantis Massif, where they found water emerging from beneath the ocean floor. Chemical tests confirmed that the water contained chemicals formed by reactions occurring at temperatures of at least 300°C (572°F). Even more astonishing, the water's chemical composition was almost identical to that of water emerging from the Lost City vents. The results show that the system's fuel came from a superheated underground water source.

The results of this experiment were published in the journal *Geochemistry, Geophysics, Geosystems*.

Drilling into the Atlantic crust

In early 2023 (IODP Expedition 399), scientists aboard the JOIDES Resolution drilled Hole U1601C to 1,268 meters (4,160 feet) below the seafloor (mbsf) in the Atlantis Massif, just about 800 m (2,600 feet) north of Lost City. This unusually deep borehole penetrated mostly mantle peridotites, along with layers of gabbro. After drilling stopped, researchers pumped borehole water to the surface from various depths.



(a) Bathymetric map of the Atlantis Massif indicating the location of Site U1601, Hole U1309D, and the Lost City hydrothermal field (LCHF) (b) Seismic line Meg 4 with locations of the newly drilled Hole U1601C and Hole U1309D. The high velocity gabbroic rock penetrated by Hole U1309D (red) contrasts with the mostly serpentinized peridotite at Hole U1601C. (c) Downhole lithology of recovered material from Hole U1601C highlights the depths from which water samples were collected within the borehole. Credit: *Geochemistry, Geophysics, Geosystems* (2026). DOI: 10.1029/2026gc012967

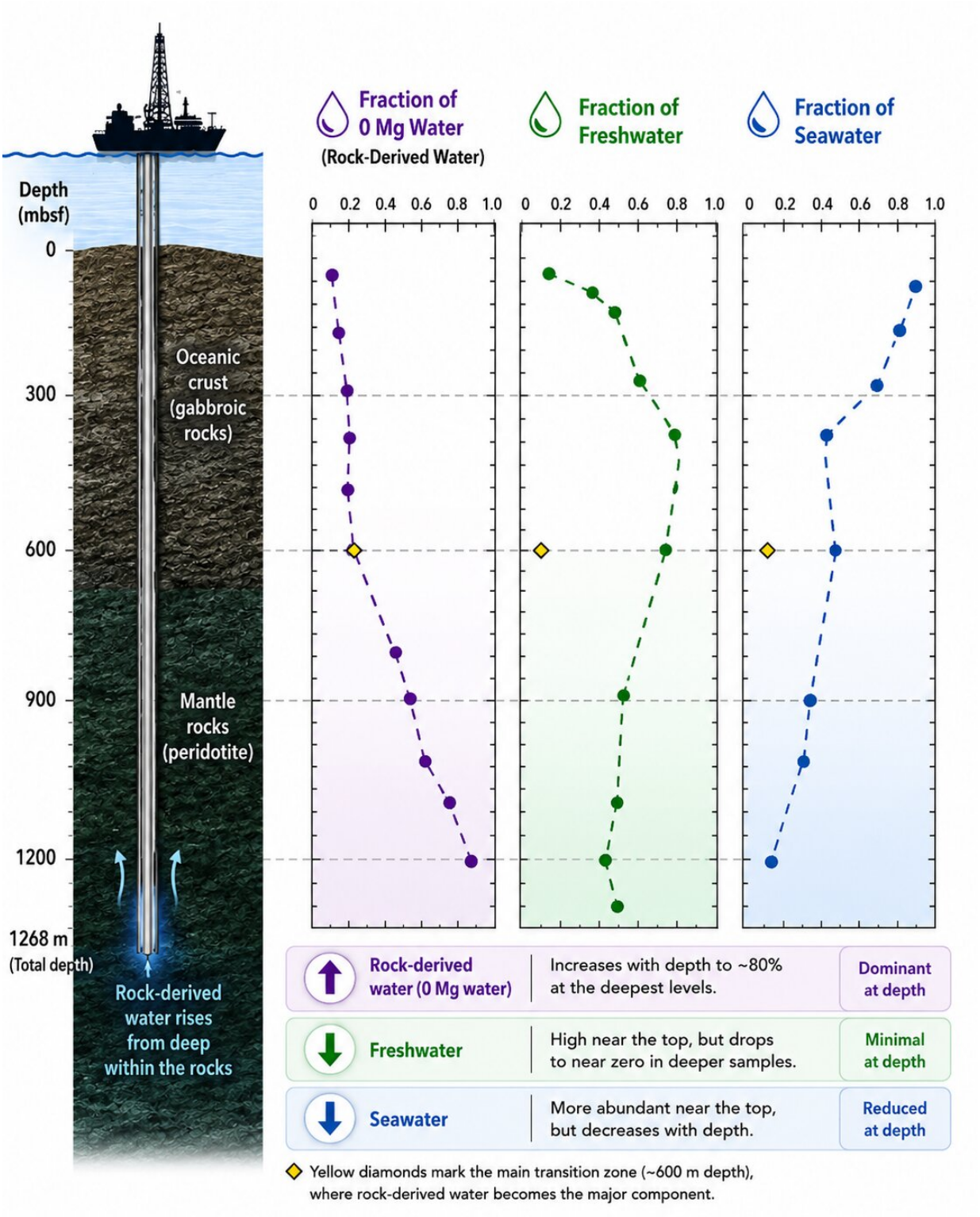
The upper about 465 m (1,530 feet) of fluid was dominated by injected seawater and freshwater used during drilling. Crucially, deeper samples contained an increasing share of natural "formation water" flowing up

from the rock. In the deepest samples (around 675–800 mbsf, or 2,215–2,625 feet), up to about 80% of the fluid was this native water.

The chemical composition of the deep water revealed that it had reacted extensively with rock minerals: Almost all its magnesium content was stripped away, while it gained large amounts of calcium and other minerals. Such a reaction requires prolonged interaction with hot rocks. Indeed, the formation water appears to have been in equilibrium at a temperature of 300°C (572°F) or higher, despite the hole being much cooler during sampling.

The chemistry tells the tale

The composition of the formation water offers compelling clues. Its zero-magnesium, high-calcium signature is a textbook indicator of extensive water–rock reaction in gabbroic and ultramafic rock. In addition to calcium, the fluid picked up abundant lithium, rubidium, cesium and strontium from the rock. Such a signature closely matches models of the deep endmember of Lost City's vent fluids. This deep-water chemistry closely resembles the "fuel" that emerges at Lost City.



The deeper the borehole, the greater the share of rock-derived water. The graphic illustrates how seawater becomes less dominant with depth, while water

that has reacted with hot rocks increasingly takes over, reaching about 80% of the deepest samples. Credit: Generated using AI tools with the image adapted from *Geochemistry, Geophysics, Geosystems* (2026). DOI: 10.1029/2026gc012967

The researchers emphasize the importance of this result. As they write, "Our results provide the first direct evidence for deep, high-temperature fluid circulation through gabbroic and ultramafic lithologies beneath the Atlantis Massif." They have found the elusive deep source of the vents' fluid.

The water's journey—plunging, heating up and then rising—demonstrates a hidden plumbing system. "These findings demonstrate how seawater circulates deep into oceanic plates and transports chemical energy to shallower environments, potentially supporting microbial life," the team notes. Rocks deep in the crust are now shown to be generating and channeling the hydrogen-rich fluid that fuels Lost City's ecosystem.

Looking to other worlds and the future

This finding has far-reaching implications. It indicates that hydrogen-enriched natural water can form through reactions involving deep crustal rocks, an important area of research for understanding Earth's energy cycles and searching for extraterrestrial life. Lost City is considered one of the sites analogous to habitable environments on ice-covered ocean worlds.

However, the authors stress the limitations of the current findings because the samples are heavily mixed. In particular, the borehole fluid samples were taken a few days after drilling and were mixed with

seawater, freshwater and drilling fluid. The exact proportions contributed by gabbro versus ultramafic rock remain uncertain, and the study does not yet prove a direct pipe between this borehole and the Lost City chimneys.

In the future, the researchers will return to the hole once it has stabilized and use gas-tight samplers to capture purer formation water (including dissolved hydrogen). Improved samples will help refine how and where the deep fluid reacts with rock and how much chemical energy it delivers.

For now, scientists have peered into one of Earth's last great frontiers: the deep, fractured ocean crust. Their findings suggest that far below the Lost City vents, scalding, hydrogen-rich fluids circulate through the basement rock. This ancient, hidden reservoir of energy may prove central not just to our own planet's mysteries, but to understanding where life could thrive in sunless seas beyond Earth.

More information: C. Geoffrey Wheat et al, Borehole Waters From Hole U1601C (Atlantis Massif) Provide Constraints for a Deep-Sourced Formation Water That (Could) Feed the Lost City Hydrothermal Field, *Geochemistry, Geophysics, Geosystems* (2026). DOI: 10.1029/2026gc012967

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