This Yellowstone hot spring’s rhythmic thump makes it a geo-thermometer

reader comments

21 with

Share this story

The vibrating water surface of Doublet Pool in Yellowstone National Park. Credit: Jamie Farrell/University of Utah
The vibrating water surface of Doublet Pool in Yellowstone National Park. Credit: Jamie Farrell/University of Utah
Yellowstone National Park is most famous for Old Faithful, a geyser with fairly predictable periodic eruptions that delight visiting tourists. But it’s also home to many other geothermal features like Doublet Pool, a pair of hot springs connected by a small neck with the geothermic equivalent of a pulse. The pool “thumps” every 20-30 minutes, causing the water to vibrate and the ground to shake. Researchers at the University of Utah have measured those thumping cycles with seismometers to learn more about how they change over time. Among other findings, they discovered that the intervals of silence between thumps correlate with how much heat is flowing into the pool, according to a new paper published in the journal Geophysical Research Letters.

“We knew Doublet Pool thumps every 20-30 minutes,” said co-author Fan-Chi Lin, a geophysicist at the University of Utah. “But there was not much previous knowledge on what controls the variation. In fact, I don’t think many people actually realize the thumping interval varies. People pay more attention to geysers.”

Yellowstone’s elaborate hydrothermal system is the result of shallow groundwater interacting with heat from a hot magma chamber. The system boasts some 10,000 geothermal features, including steam vents (fumaroles), mud pots, and travertine terraces (chalky white rock), as well as geysers and hot springs.

In the case of geysers, high pressures keep the deep water from boiling over. But as the hot water rises, the pressure decreases and bubbles of steam form, expanding until they are too big to pass through the geyser’s narrow conduit near the surface. Eventually the bubbles reach a critical threshold and the geyser starts to overflow. The pressure drops sharply and the water boils, producing large amounts of steam that force a jet of hot water out of the vent in one of those crowd-pleasing eruptions. And then the cycle starts all over again.

By contrast, most hot springs maintain a fairly stable hydrodynamic balance. Superheated water cools as it reaches the surface, sinks, and is replaced by hotter water from below, so the water never reaches the required temperature needed to set off an eruption. However, some hot springs, like Doublet Pool and Iodine Pool in New Zealand, have those mysterious periodic thumps that resemble a geyser’s periodic eruption pattern: when bubbles of heated water vapor reach the cool upper parts of the conduit, they collapse suddenly with a thump.

Advertisement



Enlarge / Doublet Pool in the Upper Geyser Basin in Yellowstone National Park.

By studying Doublet Pool, Lin and his co-authors hoped to learn more about the dynamic hydrothermal processes of Yellowstone. They specifically wanted to explore what controls the variations that occur during geyser eruption or hot spring thumping cycles, so they decided to focus on measuring the intervals of silence between thumps. From the fall of 2015 through November 2021, they ran several sampling experiments with geophones set up near Doublet Pool. They also collected temperature data in November 2021 and pressure data to monitor changes in water levels for four days in April 2022.

Lin *et al*. found that the silence intervals varied not just year by year but hour by hour or day by day. For instance, the interval was around 30 minutes in November 2016 but just 13 minutes in September 2018, increasing to about 20 minutes by November 2021. It just so happens that on September 15, 2018, nearby Ear Spring erupted for the first time since 1957, and afterward, Doublet Pool's water boiled. All that heat and pressure had decreased by 2021, per the authors, so Doublet

Pool’s interval of silence started to return to its normal 30-minute span.

As for the daily and hourly variations, the authors suggest there could be a correlation with wind speed. Higher wind speeds seem to correlate with longer silence intervals, which means the wind is somehow removing heat energy from the water, much like blowing on a hot cup of coffee. “Right now, we are treating the pool as one whole system, which means energy taken away from the surface makes it harder for the system to accumulate enough energy to thump,” said Lin. “One possibility is that the pool is actively convecting so the cooling near the surface can affect the bottom of the pool in a relatively short time scale.”

The authors were also able to calculate the heating rate and amount of heat needed to trigger thumping at Doublet Pool: about 3 to 7 megawatts of energy, the equivalent of the energy output of 100 household furnaces. This, in turn, enables them to use the silence interval as a thermometer, measuring how much heat is coming into the pool. (More heat equals shorter intervals.)

DOI: Geophysical Research Letters, 2023. 10.1029/2022GL101175 (About DOIs).

Listing image by WikiBunny11/CC BY-SA 4.0

https://arstechnica.com/?p=1923136