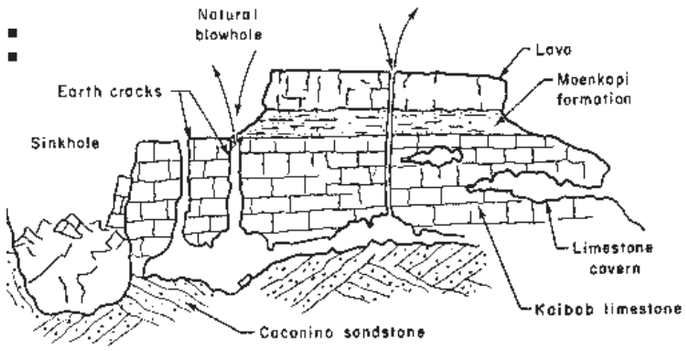
National Park Service
U.S. Department of the Interior

Wupatki National Monument

The Breathing Earth: Wupatki Blowholes



For a hole only a couple of inches across, the blowhole generates enormous interest. Perhaps it's the mysterious nature of the hole that stirs our imagination. No one knows for sure what is down there. Perhaps it's the uniqueness of the phenomenon that sparks our curiosity. We don't often encounter air naturally blowing in and out of the ground. What is it that interests **you** about this little hole in the ground, this place where the earth breathes?

What are they?

A blowhole is a small opening in the ground through which air will blow out or suck in—a kind of natural fan or vacuum. At Wupatki there are several known blowholes, one of which can be seen at the end of the Wupatki Pueblo interpretive trail. Research on blowholes in northern Arizona indicates that the openings connect with an extensive underground fracture system. Fractures open to the surface are locally known as "earth cracks," which are sometimes hundreds of feet deep.

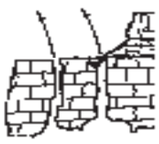
Before the masonry box was placed over the Wupatki blowhole in 1965, spelunkers descended 18 feet down the very small opening. The blowhole proved to be a small opening to a large underground fracture too constricted to explore.

The fractures are tectonic in origin, formed over millions of years as the Colorado Plateau region buckled and stretched in response to plate movements. Earth cracks form in limestone because, like salt, limestone dissolves when in contact with water, resulting in the enlargement of the existing fractures.

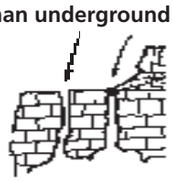
Some geologists argue that there are caverns beneath some of the blowholes. Most scientists, however, believe that the subsurface air space is confined to long, narrow and interconnected fractures. Regardless, there is substantial underground space in this area. Measuring the amount of air blowing in and out of the blowhole near Wupatki Pueblo, researchers estimated the underground air space to be seven billion cubic feet—equivalent to a tunnel 165 feet by 165 feet square and 50 miles long!

How do blowholes work?

Outside air warmer than underground air



Outside air colder than underground air

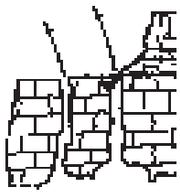


The operation of blowholes is tied to weather; air temperature and pressure are the elements that interact to drive this phenomenon.

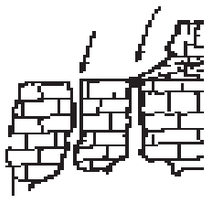
Temperature

Air travels from areas of higher to lower density. Therefore, the airflow cycle is tied in part to daily variations in temperature. When the air is cool at night and in early morning, it is relatively dense (heavy) compared to the air in the blowhole system. This difference causes air to rush in. As the outside air warms up, it may eventually become the same density as the air underground, causing air flow at the blowhole to stop. If the outside air continues to warm up and become less dense than the air underground, air will begin blowing out of the hole.

low pressure air mass



high pressure air mass



Pressure

In addition to changes caused by temperature, the blowhole is affected by changes in atmospheric pressure that occur as weather systems travel through the area. When a low pressure system moves in, the undergound air is relatively higher in pressure, which causes air to blow out. If high pressure moves in, the opposite occurs. (For an analogy, think of a fully inflated bike tire. If you push down on the tire valve, air rushes out due to the high pressure in the tire.)

Figuring it all out

If air is blowing out one blowhole, is it blowing in another?
The answer is no. All blowholes in the Wupatki region will usually be doing the same thing at the same time. This is because the weather will be similar throughout the region.

The complex interactions between air temperature and pressure make it difficult to predict what the blowhole may be doing at any specific time. The best way to determine what it's doing is to check it out in person. You won't be the first in history to contemplate this phenomenon and puzzle over how it works.

People and Blowholes

In 1962, a study was conducted to learn more about the blowholes in Wupatki and those in other places in Northern Arizona.

To test whether the blowholes are interconnected, a radioactive powder was injected into one of the openings. Air emitted from other blowholes, up to 44 miles away, was checked for traces of the powder. Unfortunately, due to contamination of the sites by one of the researchers, the positive results attained were discounted. Whether connections exist and whether other openings affect the airflow at the Wupatki blowhole is still unknown.

As another part of the study, an archeological team noted that many blowhole sites and earth cracks in the monument are associated with prehistoric habitation sites. The frequency of these associations is thought to be more than coincidental.

What significance might these blowholes and earth cracks have had for early people in the area? Air coming from blowholes is relatively cool in summer and warm in winter, prompting visitors today to suggest that they may have been used as air conditioners or heaters. Or maybe they served as weather predictors. When atmospheric pressure is low (and blowholes are blowing out) there is a greater chance of rain. In this arid land, blowholes may have been powerful and significant indicators of welcome change.

However, there are other possibilities to consider. Descendents of the Wupatki inhabitants still live in northern Arizona. They include the Hopi and Zuni, among others. In Hopi culture there is a story from the Second Mesa village of Shungopovi indicating that blowholes are connected to the supernatural, openings to the wind god, Yaponcha. Perhaps the people living in this area considered the blowholes to have spiritual significance and located some of their homes accordingly. Imagine what you would think of the blowholes if you were not bound by scientific thought.

Mysteries Continue

Like many other natural and cultural phenomena located within Wupatki National Monument, the blowholes are far from completely understood. Their full extent and makeup is uncertain. Research is sporadic, and the last study on blowholes was conducted in the 1970s. Perhaps these features will continue to hold on to some of their secrets. Perhaps... that's the way it should be.

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