



SWALLOWED

Sinkholes are engulfing buildings, roads, and even people. Can scientists learn how to predict them?

First, the hotel guests heard cracking noises. Then the windows in their rooms began to shatter. It was just after 11 p.m. this past August 11 at the Summer Bay Resort in Clermont, Florida—not far from Walt Disney World—when the commotion woke up Maggie Ghamry, who was on vacation with a friend.

“We heard some shaking [and] glass breaking, and we thought maybe it was just kids running up and down the hall,” Ghamry told the local news. “Next thing I know, people are yelling, ‘Get out of the building! Get out of the building!’”

Security guards quickly evacuated all the rooms. It wasn't until they got outside that the guests realized what was happening: A *sinkhole* 30 meters (100 feet) wide had opened in the ground beneath the resort, and the building was collapsing into it. Forty minutes later, all three stories had been completely destroyed. Luckily, everyone escaped unharmed.



Sinkholes form when the ground caves in after rock beneath the surface dissolves away. They can swallow up buildings, roads, and cars, injuring people and causing millions of dollars in damage. Though sinkhole formation is largely unpredictable, scientists are working on new ways to figure out where

the holes may appear—and ways to keep people and things from falling into them.

HOLES IN THE GROUND

Because of its geological makeup, Florida is one of the most sinkhole-prone places in the country, says Jon Arthur, director of the Florida

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COLLAPSE!

A building falls into a sinkhole at the Summer Bay Resort in Clermont, Florida, this past August. Luckily, no one was injured.

Geological Survey (see *Sinkhole Hot Spots*, p. 10). Other highly susceptible areas include Missouri, Pennsylvania, Kentucky, and Tennessee. But nearly every state in the U.S. has at least some spots where sinkholes can form.

What makes these places vulnerable to sinkholes is the composition

of their *bedrock*, the layer of solid rock that sits underneath the soil. Sinkholes form in areas where the bedrock is made of minerals that can dissolve in water.

In Florida and Missouri, most of the bedrock is limestone, which is *soluble* in acidic water. Rain is naturally slightly acidic, so when it filters

through the soil and runs down through cracks in the bedrock, it dissolves some of the *sediment* that makes up the limestone. Even a very small trickle of water can gradually erode the rock.

"With not much water, you can carry lots of little particles away," says Doug Gouzie, a geologist at

Missouri State University who studies sinkholes. "Over time, that can open up a big hole."

Millions of years of this erosion have carved out numerous underground cavities in the bedrock. Geologists call this swiss-cheese landscape *karst terrain*. Many of the holes in the karst can't be seen from the surface—until something causes the ground above them to collapse.

SINKING FEELING

Usually, as an underground cavity grows, soil slowly flows down through cracks in the bedrock to fill it. This creates a *subsidence sinkhole*, where the ground sinks so gradually that it may be years before anybody notices.

What swallowed the Clermont resort, however, was a more dramatic *collapse sinkhole* (see *How a Sinkhole Forms*, p. 11). To understand how this type of sinkhole starts, imagine pouring candy pieces out of a bag. "If you cut a corner off an M&M bag and start to pour them out, they'll usually pour pretty well," says Gouzie. "But every now and then, two or three of them will position themselves just right so that they'll jam up."



HUGE HOLE!

This sinkhole opened suddenly in a town in Germany in 2010. It swallowed a parked car and forced 25 people to evacuate their homes.

The same thing can happen to soil falling into an underground cavity, says Gouzie. If particles catch against each other in the right way, they stop flowing down and instead form a bridge over the growing hole.

But the soil bridge is precarious, and the right forces can trigger it to collapse. If a drought dries out the trapped particles, for example, they may shrink and separate from

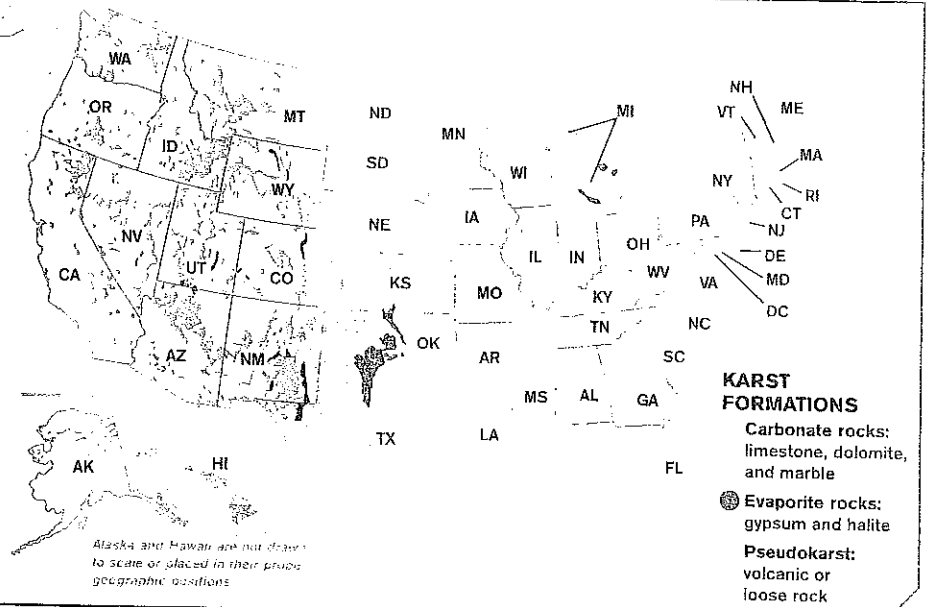
each other, then fall suddenly the next time a heavy rain weighs them down. That's what scientists think happened in June 2012, when Tropical Storm Debby hit Florida after a dry spell, leaving behind hundreds of sinkholes.

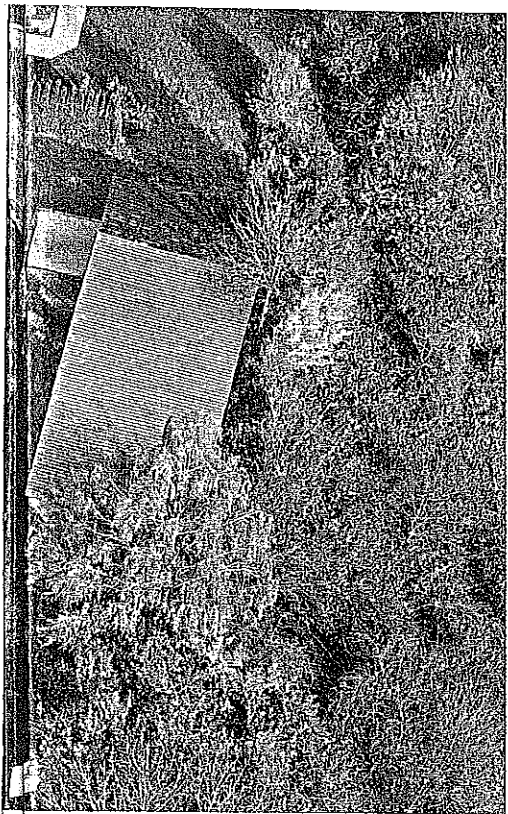
Human activity can also trigger a collapse. If someone unknowingly constructs a building above a cavity, the weight may overwhelm the soil

SINKHOLE HOT SPOTS

About 20 percent of the U.S. sits on karst terrain, where water has carved holes in the bedrock beneath the soil. That makes these areas susceptible to sinkholes.

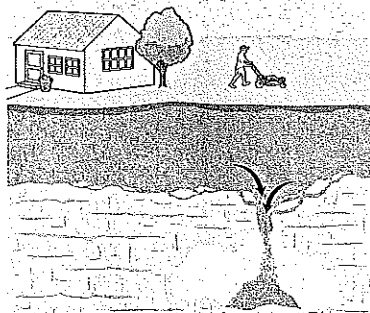
Karst forms in *carbonate* rocks, like limestone, and *evaporite* rocks, like gypsum. Other rock types, such as lava that hardens with air pockets inside, are called *pseudokarst* and can also form sinkholes.



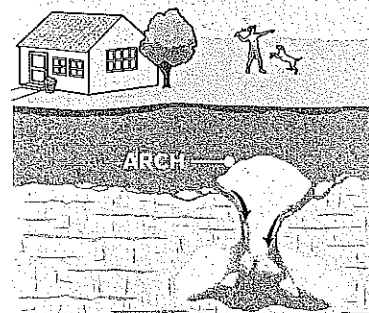


HOW A SINKHOLE FORMS

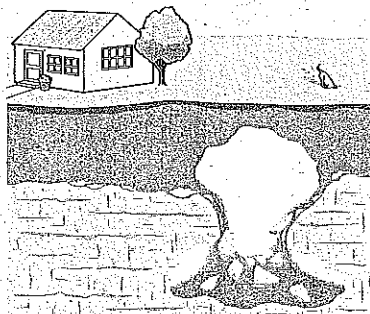
Most sinkholes form gradually. But occasionally, the right conditions lead to a sudden and dramatic collapse, like the one at a Florida resort last year.



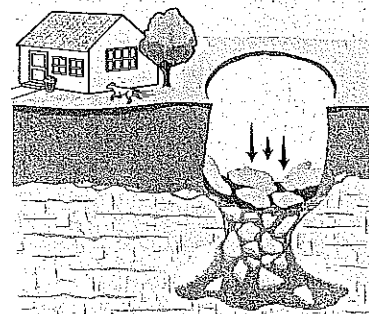
1 Erosion carves out cavities in the bedrock beneath the soil. Sediment flows down into a cavity through cracks in the bedrock.



2 Sediment keeps flowing into the cavity, but some of the soil particles catch against each other and form an arch over the hole.



3 The cavity grows larger over time, but remains undetectable from the surface.



4 Eventually, the roof over the cavity collapses, creating a sudden and dramatic sinkhole.

bridge and cause the ground—and the building on top of it—to fall in.

Collapse sinkholes are much rarer than subsidence sinkholes, but they can be far more dangerous. In Seffner, Florida, about an hour from Clermont, a man was killed last year when a collapse sinkhole formed under his bedroom, pulling him in.

SCIENCE TO THE RESCUE

Sinkhole deaths like the one in Seffner are extremely rare. Even in Florida, where sinkholes are relatively common, officials know of only four people who have ever been killed by them. But sinkholes are dangerous enough that scientists and engineers are looking for better ways to predict them and prevent any harm.

Before building in a sinkhole-prone area, geotechnical engineers can look for cavities beneath the surface using *ground-penetrating radar*—energy waves that map

out what's underground. If they find a cavity, they can sometimes inject it with material to stabilize the ground above. Those technologies are very expensive, says Arthur, "but if I knew I was building in [an area with] a high probability of sinkholes, it might be worth the investment."

Scientists like Arthur and Gouzie are trying to improve their understanding of where exactly those high-probability areas are. They'll never be able to predict precisely when and where a new

sinkhole will appear. But they can study existing sinkholes and the bedrock around them and look for patterns, which can help them figure out where new holes are most likely to form. That will help homeowners and city planners decide where to build and what precautions to take.

Worried you'll fall into a sinkhole? Don't be, says Gouzie. Most sinkholes form gradually, so people have plenty of time to get out. Only a tiny fraction collapse suddenly.

"What are the odds that I'm standing on top of one of those when it happens?" he says. "The chances are very, very small." ❄

—Mara Grunbaum

CORE QUESTION

What makes some areas more susceptible to sinkholes than others?

"Swallowed Up"
Science Article Assignment
Due Friday, January 9, 2015

Name: _____ Period: _____

Vocabulary:

Bedrock – a layer of solid rock that sits underneath the soil

Soluble – the ability to dissolve

Sediment – soil such as rock and sand that has been put down

Precarious -- dangerously insecure

Answer the following questions on clean, white paper.

- I. Paraphrase paragraphs 6 and 7. Your paraphrase should be of both the paragraphs together. Starting with "What makes these places" Ending with "Even a small trickle of water" 20pts.

- II. Answer the following questions in complete sentences. Each question is worth 10pts.
 1. What states are highly susceptible to sinkholes?
 2. Explain how sinkholes form?
 3. How can human activity trigger a sinkhole?
 4. Explain the difference between a subsidence sinkhole and a collapse sinkhole?
 5. What is karst terrain? How much of the US sits on karst terrain and why are these areas susceptible to sinkholes? **THIS IS A THREE PART QUESTION.**
 6. How do geotechnical engineers look for cavities beneath the surface and what can they do if they find a cavity?

This article is worth 80 points.

I am available for extra help in the morning and during lunch. If you need help, you need to see me.