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Why Did the Russians Seal Up the Kola Superdeep Borehole?

By: [Jennifer Walker-Journey](#) | Jan 4, 2023



The small blue-and-white cap seen surrounded by rubble is all that seals the 40,230 feet (12,262 meters) Kola Superdeep Borehole in Russia. [WIKIMEDIA/CC BY-SA 4.0](#)

While the United States and the USSR were focusing on space exploration during the great [space race of the 1960s](#), the Americans and Soviets were also vying for supremacy of another kind: one to the center of Earth, or at least as close to it as possible.

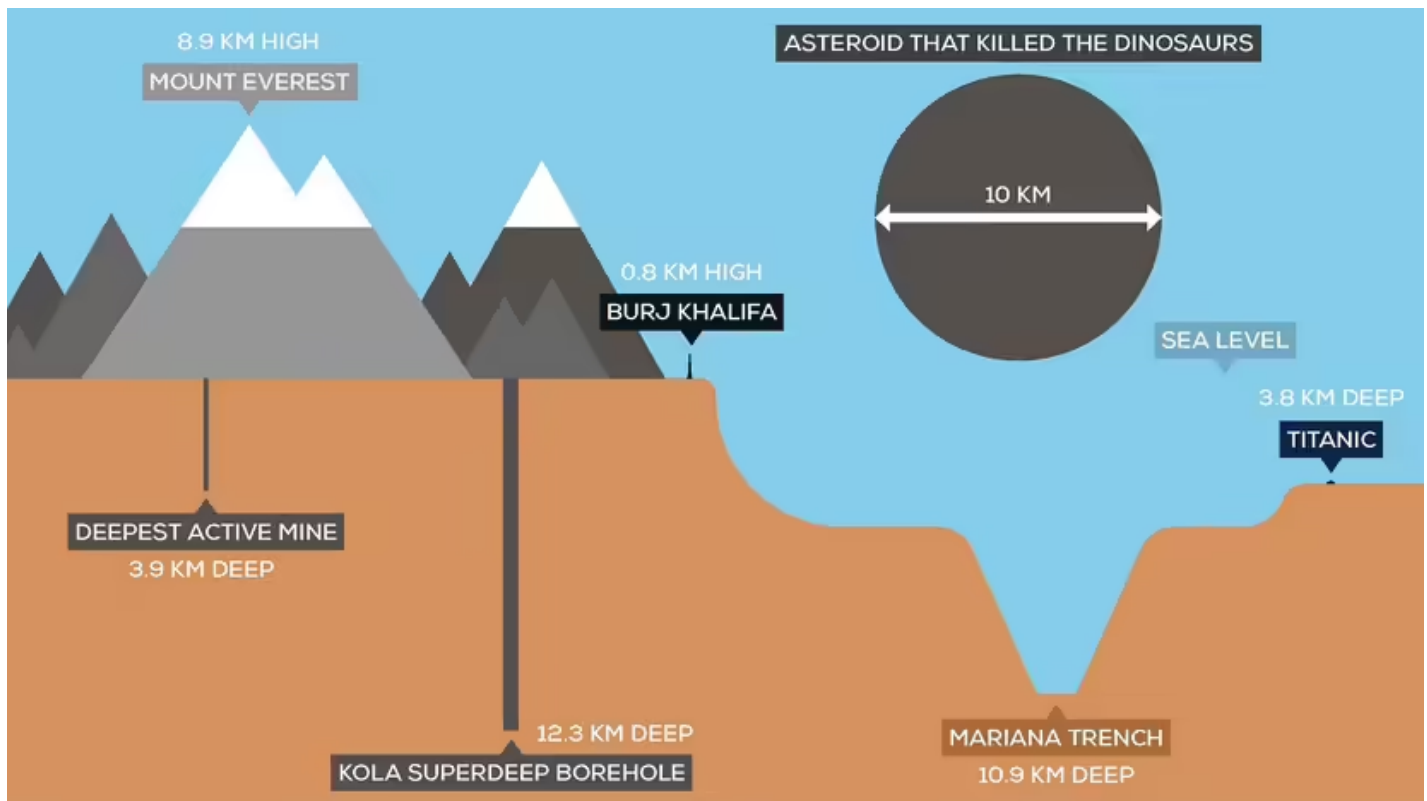
In 1958, Americans launched [Project Mohole](#), a plan to retrieve a sample from Earth's mantle by drilling to the bottom of the ocean off Guadalupe Island, Mexico. With funds from the National Science Foundation, they drilled 601 feet (183 meters) into the seabed before the project was pulled in 1966 by the U.S. House of Representatives.

In 1970, the Soviets launched their attempt, drilling into Earth in Murmansk, Russia, just outside the Norwegian border near the Barents Sea. It's known as the **Kola Superdeep Borehole** and it was more successful, penetrating much deeper into Earth and collecting samples that still wow scientists today.

Why dig so deep into the Earth? "To address key scientific questions" that could give answers to some of science's biggest mysteries about our planet, says [Dr. Ulrich Harms](#). Harms is the director of the German Scientific Earth Probing Consortium at the German Research Centre for Geosciences in Potsdam, Germany. He's visited the Kola Borehole, browsed the repository of core samples and even laid hands on the now-defunct wellhead.

And while the Kola Superdeep Borehole never reached beyond [Earth's crust](#), it remains the deepest man-made hole in the world.

The Kola Borehole Is Deep



The Kola Superdeep Borehole in [Russia](#) is the deepest hole in the world. It's deeper than the Mariana Trench and deeper than Mt. Everest is tall. SIMON KUESTENMACHER

Hidden in an abandoned drill site among rotting wood and sheets of scrap metal — remains of the derrick and housing that once stood in Russia — sits a small, unassuming, heavy duty maintenance hole cover secured into place with a dozen large, rusting bolts. Underneath — and virtually unseeable from ground level — at just 9 inches (23 centimeters) in diameter, is the world's deepest borehole.

The Kola Superdeep Borehole runs about 40,230 feet (12,262 meters) or 7.6 miles (12.2 kilometers) into Earth's surface. For perspective, the hole's depth is the height of Mount Everest and Mount Fuji placed on top of one another. It's also deeper than the deepest point of the ocean, the [Mariana Trench](#), which lays at a depth of 11,034 meters (36,201 feet) below sea level.

For perspective, [Earth's outermost layer](#) — the ground we stand on — called the continental crust, is about 25 miles (40 kilometers) thick.

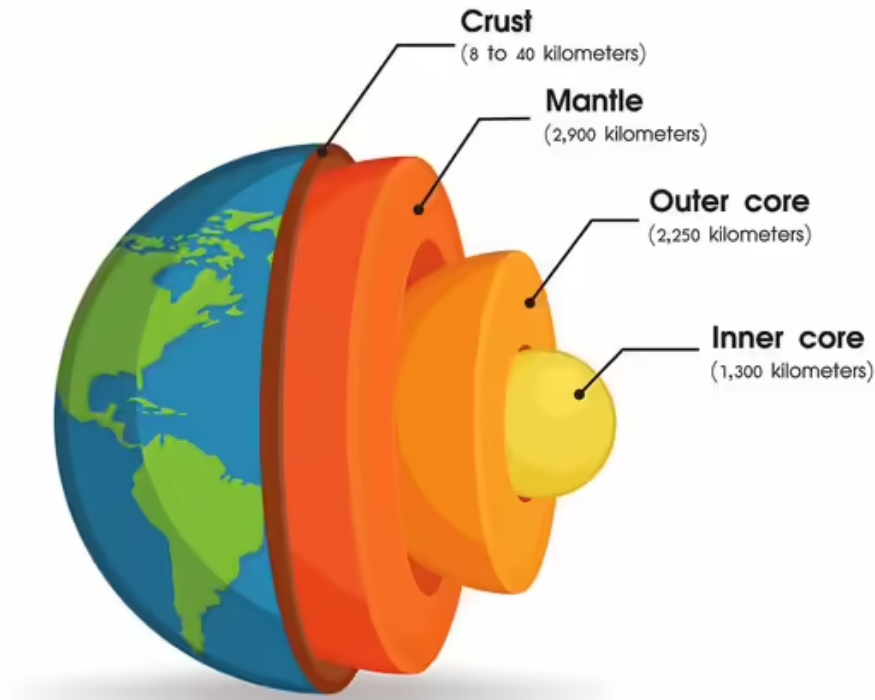
The next layer, the mantle, continues for another 1,800 miles (2,896 kilometers). The outer core extends about 1,400 miles (2,250 kilometers) before reaching Earth's inner core, a hot, dense, mostly iron ball with a radius of about 758 miles (1,220 kilometers). From where you are standing, [Earth's core](#) is about 1,802 miles (2,900 kilometers) below your feet.

So, while Kola is an impressively deep borehole, it is surprisingly shallow compared to Earth's depth. In total, Kola only penetrates about a third of Earth's crust and 0.2 percent of the entire distance to the [center of Earth](#).

It also took a while. Years in fact. Drilling at Kola began May 24, 1970. The goal was to go as far as possible, which [scientists](#) at the time expected to be about 9.3 miles (15 kilometers). By 1979, the project had [broken all world records](#) for man-made holes when it surpassed about 6 miles (9.5 kilometers).

In 1989, drilling reached a depth of 40,230 feet (12,262 meters) vertically below Earth's surface. It is the deepest point ever reached. That's when temperatures in the well increased from the expected 212 degrees Fahrenheit (100 degrees Celsius) to 356 degrees Fahrenheit (180 degrees Celsius). (More on this in a minute.)

STRUCTURE OF THE EARTH



Despite drilling to a depth of more than 40,000 feet (12,192 meters), researchers barely scratched the surface of Earth's crust.

CRSTOCKER/SHUTTERSTOCK

Why Drill So Deep into Earth?

Massive holes are drilled for various reasons, most notably for extracting resources like fossil fuels and metals. Some other deep examples include the 100-year-old [Bingham Canyon copper mine](#) in the mountains near Salt Lake City, the site of a pit that extends three-quarters of a mile (1.2 kilometers) deep and spans 2.5 miles (4 kilometers) across, and the [Kimberley Diamond Mine](#), aka The Big Hole, in South Africa, one of the largest holes in the world dug by human hands and no machinery.

Holes are also dug in the name of science, Harms says, to better understand things like:

- Geohazards such as earthquakes and volcanic eruptions
- Geo-resources such as geothermal heat and energy
- Evolution of Earth and life on it
- Environmental changes in the past to better project into the future

"One example in detail is that observations very close to an earthquake zone allow [researchers] to monitor the initiation and propagation of even the tiniest earthquake in response to stress and strain," Harms says. "We want to recover these near-field physical, chemical, and mechanical data to fundamentally understand these processes that cannot be simplified in lab experiments or computer models."

It's Difficult to Dig So Deep



The Kola Superdeep Borehole was abandoned in 1992 after the fall of the Soviet Union. Today it is in complete shambles. [WIKIMEDIA/\(CC BY-SA 4.0\)](#)

In 1977, NASA launched Voyager 1 into space and beyond the solar system into interstellar space. As of [August 2022](#), the satellite has traveled 14.6 billion miles (23.5 billion kilometers) into space. So why, in 20 years' time, have engineers only been able to dig a few miles into Earth?

It turns out that the voyage to the center of the Earth is a bit trickier than researchers expected. When drilling began at the Kola Superdeep Borehole site in the 1970s, for example, the drill plowed through the [granite rock](#) rather effortlessly. But when drillers

reached about 4.3 miles (6.9 kilometers) deep, the layers became more dense and more difficult to bore into.

As a result, drill bits broke and the team had to change the direction of the drilling several times. "As a consequence, several drill paths were drilled until a pretty vertical [path] was finally achieved," Harms says. The resulting drill pattern resembles a Christmas tree of sorts.

Engineers plowed on, but the deeper the drill went, the hotter Earth became. The temperature gradient conformed to what scientists had **predicted** down to about 100,000 feet (30,408 meters). But beyond that point, as they drilled deeper, the heat intensified until it reached temperatures of 356 degrees Fahrenheit (180 degrees Celsius) at about 7.5 miles (12 kilometers) down. That was a drastic difference from the 212 degrees Fahrenheit (100 degrees Celsius) they were expecting.

Engineers also discovered, as they plowed past the first 14,800 feet (4,511 meters) that the rock had much more porosity and permeability. That, paired with the extremely high temperatures, made the rock behave more like a plastic than a solid, rendering drilling virtually impossible.

These temperatures were beyond the capabilities of their drilling equipment, but the Soviets pressed on until 1992, but never got any deeper than the depth reached in 1989. Drillers had no choice but to discontinue the effort, falling short of their 9.3 miles (15 kilometers) goal. The drill site was officially **shut down** and the hole sealed in 2005.

Other attempts have been made through the years by other countries including Germany, Austria and Sweden. None of those holes are deeper than the Kola Superdeep Borehole, though some were longer, having veered off their vertical courses.

What'd They Find in the Kola Superdeep Borehole?



(Clockwise from left) Workers in the drill room; a piece of core extracted from the Kola well; a piece of metabasalt rock from 6,238.25 meters (20,465 feet) deep in Earth's crust. PECHENGA

Scientists discovered a lot from the Kola Superdeep Borehole. For starters, they realized they needed to update the temperature map for the Earth's interior, since they encountered temperatures much higher than expected.

They were also blown away that there was no transition from granite to basalt, a boundary geologists call "[Conrad discontinuity](#)," that was reasoned to exist based on results of seismic-reflection surveys.

Another discovery was liquid water far deeper than they had previously thought could exist. "One of the unexpected results was certainly the occurrence of open saline water-filled cracks documenting that the crust is not dense but that pathways exist allowing fluids to flow," Harms says. Researchers suspected that the water may have been squeezed out of rock crystals by the incredibly high pressure within Earth.

Even more exciting was the discovery of biological activity in the rocks. At 4.4 miles (7 kilometers) deep, researchers [found dozens of fossils](#) from single-celled marine

organisms dating back 2 billion years. The clearest evidence were microscopic fossils encased in organic compounds that were surprisingly intact despite the extreme pressures and temperatures of the surrounding rock.

Can We Dig Deeper?

Yes, eventually. But, Harms says, "digging deeper than 12 kilometers (7.45 miles) depends on two critical factors: temperature and borehole stability, the latter being dependent on stress, strain, and drilling fluid composition and weight." That'll take some pretty technologically advanced equipment, considering temperatures there are predicted to be as high as 500 degrees Fahrenheit (250 degrees Celsius).

The real pie in the sky — or rather, in Earth — would be reaching Earth's mantle, the layer that begins just past Earth's crust, about 25 miles (40 kilometers) below our feet.

"We can learn a lot about the mantle if we get access through drilling," Harms says.

"Earth scientists want access to the real in situ mantle to understand the nature of this boundary that is still debated and from which we have no fresh samples that contain information on how the crust and mantle interact, how fluids and magma droplets escape from the mantle into the crust and ultimately into our hydrosphere, and how they feed the biosphere — or how matter escapes back into the mantle.

"These grand circles of how our planet evolves remain enigmatic along this boundary and the Moho Discontinuity [the boundary between Earth's crust and the mantle] is therefore a prime objective of scientific."

Now That's Interesting

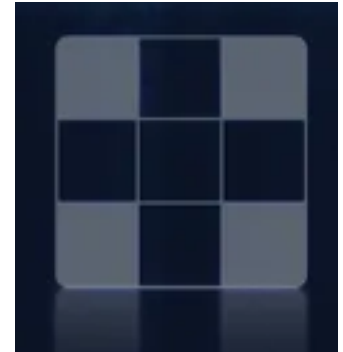
One effort to drill to Earth's mantle is being conducted by a group of international researchers working with Japan's Agency for Marine-Earth Science and Technology. The agency's drilling ship Chikyu, currently located off the coast

of East Asia, is equipped to drill through 2.5 miles (4 kilometers) of ocean water and 3.7 miles (6 kilometers) of crust to reach the mantle. The project is expected to cost upward of \$500 million.

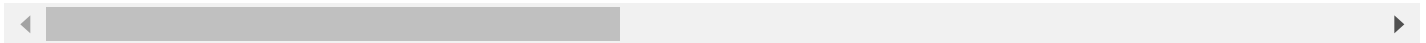
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