**1. Mark your confusion.**
**2. Show evidence of a close reading.**
**3. Write a 1+ page reflection.**

## Why Scientists Are Starting to Worry about the Moon Shrinking

*Some seismic activity is near the lunar south pole, where NASA wants to send humans*

Source: Kasha Patel, *Washington Post*, February 4, 2024

For hundreds of millions of years, our moon has been shriveling like a raisin. Now, scientists say that decrease in circumference is leading to shallow moonquakes — including near NASA's potential sites for human visits.

"A concept that I think that many people have is that the moon is this geologically dead body, that something on the moon never changes," said lunar geologist Tom Watters. But "the moon is a seismically active body."

Studies of moonquakes date back to the Apollo era. More than 50 years ago, astronauts placed seismometers around the near side of the moon's surface to record trembles. The most powerful shallow quake was located near the south pole, which is near landing spots for NASA's Artemis III mission to send people back to the moon, potentially in 2027. The lunar south pole region is enticing because it contains permanently shadowed regions that some speculate could have water-based ice.

In a new study, Watters and his colleagues state that this powerful quake is tied to a group of currently seismically active faults, which were created as the moon has shrunk. Quakes in the area could trigger landslides from loose rocks and dust from surrounding craters, according to models.

Other researchers say we still don't have enough information to determine hazardous places to land on the moon.

**How a shrinking moon could lead to quakes**

The moon's shrinking has been measurable, but small. It has contracted about 150 feet in diameter over the last few hundred million years. Much of the shrinking is driven by natural cooling of our moon's molten core. As the core cools, the moon's surface contracts and adjusts to the change in volume. As it shrank, portions of the crust pushed together to form ridges known as thrust faults.

Earth's gravitational pull on the moon also applies force to the lunar surface and adds stress, helping form these thrust faults on the moon.

Earth doesn't experience this same type of shrinking. Our molten core is also cooling, but Earth's crust is made of a jigsaw of tectonic plates, unlike the moon that has a single plate. Energy from Earth's core moves those plates or is released through volcanic eruptions, Watters said.

The shrinking of our moon has negligible effects for Earth. The change in size won't alter the occurrence of eclipses, for example. Its mass also isn't changing, so Earth's tides are not affected differently.

There's no reason Earthlings would need to be concerned with a shrinking moon — unless we move there.

"The idea is not to discourage anyone from exploring the south pole of the moon," said Watters, a senior scientist emeritus in the National Air and Space Museum's Center for Earth and Planetary Studies. "But just to make sure that it's understood that it's not a benign environment."

Like on Earth, these faults are often associated with seismic activity. The thrust faults can appear like a wall tens of meters high — detectable but certainly no mountain. Thousands of small thrust faults have now been discovered across the moon, thanks to high-resolution imagery from NASA's Lunar Reconnaissance Orbiter. The fact they remain on the surface, instead of being eroded to nonexistence, means they must be young and probably active, Watters said.

When they located the thrust faults in images, team members reanalyzed data from the Apollo seismometers. Using an algorithm, they were able to narrow down the thrust faults that likely triggered the

moonquakes. They found the largest earthquake — a magnitude of 5 on the Richter scale near the south pole — was linked with a cluster of likely still active faults.

"There's no reason to believe that they're not currently active because we know the moon is still hot and its interior is still cooling off," Watters said.

To determine potential damage, the team modeled surface slopes in the south polar region to see if any areas were more susceptible to landslides from seismic shaking. It found some slopes in permanently shadowed areas, like the Shackleton Crater that is one of the potential landing sites for the NASA's Artemis III mission, was very prone to landslides from seismic activity. Even a light amount of shaking triggered landslides along its steep walls.

"It's not like a huge mass of material, but it's still significant enough that you wouldn't want to be anywhere near it," Watters said.

Moonquakes are different from earthquakes in a few key ways. They can last much longer on the moon, sometimes for hours. Because of the moon's weaker gravity, a quake will also feel much stronger than on Earth. Even a moderate amount of shaking could take you off your feet, Watters said.

The study brings "more evidence that there are moonquakes and some of them may be relatively large," said geophysicist Allen Husker, who was not involved in the research. The combination of the moon's shrinking and pull from Earth "combine to make these moonquakes larger than we would have guessed beforehand."

**How the quakes could affect future human visits**

Even if the quakes are big, they don't occur too often. Husker's research estimated that shallow moonquakes occur about once every 100 days on average across the entire lunar surface. It would be very coincidental if a quake hit right where the astronauts land for a few days.

The hazard, he said, would be important to protect against if and when people build an outpost for visiting or even living on the moon — much like a strengthening a building in earthquake-prone areas in California.

"Future moon bases should be installed far from seismic sources to avoid damage or built to withstand seismic shaking," said Husker, also a researcher professor at California Institute of Technology. "If we can map those as we have done on the Earth, then we can avoid them."

Not everyone is convinced of this potential hazard, though. One separate study published in 2022 concluded that shallow moonquakes from these thrust faults would be weaker than what this new research describes. It also wouldn't affect many areas on the moon, including the majority of Artemis III landing site candidates.

Senthil Kumar, an author of the 2022 study, said his "stand remains the same" despite the new research. In fact, the new study presents "one of the rarest possibilities."

"It is too early to argue for such hazard scenarios to Artemis sites, [which] might devastate the lunar base," said Kumar, a researcher at the National Geophysical Research Institute in Hyderabad, India.
To make an accurate hazard assessment, he said the scientific community needs a better understanding of the local site conditions, properties of potential moonquake sources and the conditions that would propagate the seismic ground motion.

The best way to get some of those details is probably to go to the moon.

**Possible Response Questions**

- What are your thoughts about the prospects of humans living on the moon? Explain.
- Did something in the article surprise you? Discuss.
- Pick a word/line/passage from the article and respond to it.
- Discuss a "move" made by the writer in this piece that you think is good/interesting. Explain.