# A seismologist present at the discovery of plate tectonics

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Lynn Sykes with an old-fashioned rotating-drum seismograph at Lamont-Doherty Earth Observatory, ca. 2015. Credit: Columbia University

As a young seismologist in the 1960s, Lynn Sykes made crucial observations of earthquakes under the ocean floors that helped solidify the theory of plate tectonics—the foundation of modern geology. Later, hoping to apply his discoveries to saving lives, he helped identify zones prone to great earthquakes, particularly along coastlines. He also went on to assess the risks that earthquakes pose to nuclear power plants, and to advance the use of seismology to detect nuclear-bomb tests.

In his 2017 book *Silencing the Bomb*, Sykes described his lifelong quest to turn back the clock on nuclear proliferation. In a new memoir, *Plate Tectonics and Great Earthquakes: 50 Years of Earth-Shaking Events*, Sykes takes readers on a scientific and personal journey through the rest of his work, carried out over more than five decades at Columbia University's Lamont-Doherty Earth Observatory.

We spoke with Sykes about what influenced his career, what he encountered along the way, and unanswered questions that researchers today face.

## Why did you become a seismologist?

As an undergraduate in the late 1950s, I was very interested in geophysics, the application of physics and geology to the study of the earth. I narrowed my field to earthquakes when I applied to graduate school. I visited Lamont, where seismologist Jack Oliver spent a lot of time with me on a Saturday morning. I decided to work with him.

## Plate tectonics is basically the unifying theory about how the Earth works. In 100 words or fewer, what is it?

The outer 100 miles of the earth is composed of about 15 plates of strong, rigid rock that move with respect to one another, much like cakes of ice on a river. They are underlain by rock called the asthenosphere, which is close to the melting point, the gliding layer of plate tectonics. Most earth deformation, earthquakes and volcanoes occur at the boundaries of plates, where they either move apart from one another as along the Mid-Atlantic Ridge, converge as along island arcs and deep sea trenches like Japan, or slide by one another as along California's San Andreas fault.

## In the book, you say you were once a plate-tectonics skeptic. What changed your mind?

Wrong question–I was never a plate-tectonics skeptic, but I was a continental drift skeptic. As an undergraduate I was told that bright young scientists should not work on vague, incorrect ideas like continental drift. That theory was proposed by Alfred Wegener more than 100 years ago. From 1920 to the 1960s, most earth scientists in North America, including me, believed drift did not occur. I became a convert to continental drift and sea-floor spreading one day in late spring 1966, when I obtained my first mechanism solutions of earthquakes along the Mid-Atlantic Ridge. They agreed with Tuzo Wilson's hypothesis of transform faulting along huge fracture zones that displace segments of ridges. My finding showed that the Mid-Atlantic Ridge was growing along its ridge crests and that continents on the two sides of the Atlantic were moving apart. I went on in 1968 with colleagues Jack Oliver and Bryan Isacks to show how plate motion was occurring where one plate plunges beneath another at subduction zones like the Aleutians, Japan and Tonga.

## What percentage of plate tectonics do we truly understand? Are we now down to just cleaning up details, or are there still big remaining mysteries?

Most present-day motions of the earth's plates are well understood. We have known since the 1960s that plate motion is very concentrated in the oceans, but more diffuse [elsewhere], especially in Asia. We still don't understand that diffuse motion very well. When in the earth's history plate tectonics started is still widely debated.

## In part due to your work, we can now pinpoint places where big earthquakes are likely to happen. But we still can't predict when, or how big. Why not?

I have worked for several decades on long-term earthquake prediction on a time scale of 10 to 20 years. Great earthquakes cannot occur at the same place in a short amount of time. The pressures or stresses released suddenly in a great shock must be slowly built back up by plate motion. Using rates of plate motion and time intervals between past great shocks helps estimate better the times of occurrence of future great earthquakes.

## You've explored the risks posed by nuclear power plants in seismic zones, from Japan's Fukushima to New York's Indian Point, right near your house. What have you learned?

Fukushima was largely a human-induced disaster, in that officials in Japan did not believe it could happen, and did not take steps to lessen or reduce the damage that followed the 2011 giant earthquake and tsunami. Similarly, officials of the Nuclear Regulatory Authority in the U.S. have learned few lessons from the Fukushima disaster. They continue to insist that U.S. reactors are safe, and do not respond to reasonable critics.

## What are you working on now?

Understanding the occurrence, or lack thereof, of great earthquakes at a large number of subduction zones around the world. On a different topic, I continue to work on ways to lessen the chances of nuclear war.

Provided by Columbia University

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