

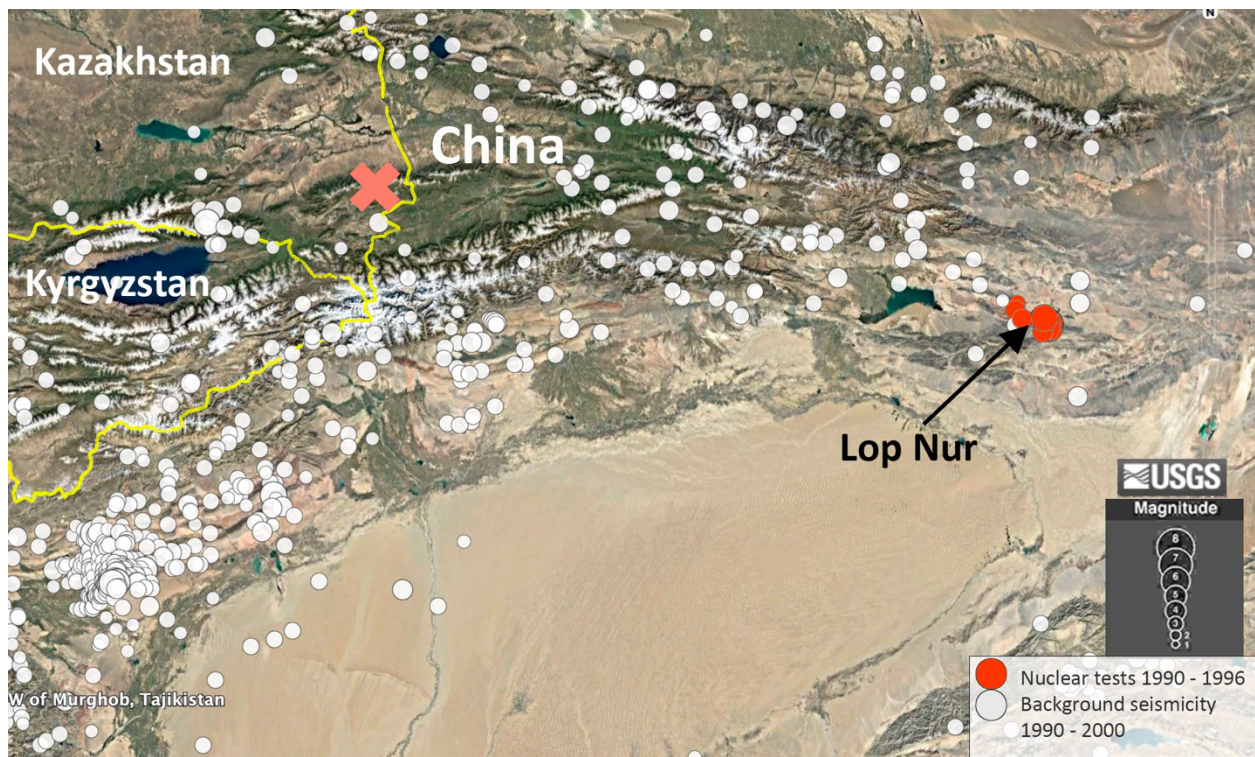
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Not My Fault: A Nuclear Test in China, Maybe

Lori Dengler for the Times-Standard

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This map shows the location of Lop Nur, China's primary nuclear test site near the Kyrgyzstan and Kazakhstan borders. Red dots are locations of the 10 documented Chinese nuclear tests conducted between 1990 and 1996 and white dots are earthquake epicenters recorded between 1990 and 2000. The pink X is the seismic station that recorded the June 2020 alleged nuclear test.

Last week, NPR and other news outlets aired a story about a possible nuclear test conducted in China. Assistant Secretary of State Christopher Yeaw alleged that China had conducted a clandestine nuclear test in June 2020. Yeaw, who has a PhD in nuclear engineering and is a former intelligence analyst, claimed the seismic signals were inconsistent with mining blasts or an earthquake. If true, the allegation puts China in violation of the yet unratified but still followed Comprehensive Nuclear Test Ban treaty (CTBT).

There are currently 187 nations that have signed the CTBT, but many including the U.S., Russia, and China have not ratified the agreement. Although not officially in effect, the signatories have agreed to follow the treaty. India, Pakistan, and North Korea are non-signatories with nuclear capabilities. The most recent acknowledged nuclear test was by North Korea in 2017 (see Not My Fault 9/6/2017).

The news stories about a 2020 test in China made me scratch my head. It was nearly six years ago, why was it news now? The Chinese government vehemently denied the allegation so what was it based on? There are many seismologists who specialize in the discrimination between nuclear tests, earthquakes, and other underground disturbances, what did they think?

I'm no nuclear expert but everyone from my generation has a visceral connection with atomic tests. I was in kindergarten when the first hydrogen bomb was tested, and I have clear memories of the elementary school drills. Dropping under our desks is now the norm for earthquakes but not too effective in a bomb attack. Nuclear tests and the fear of nuclear war was the backdrop of my youth and coming of age.

My nuclear test connections became more technical in college. In the early 1960s, the United States and the Soviet Union signed a treaty banning nuclear weapon tests in the atmosphere. When nukes went underground, seismology suddenly became very important. Several of my professors were funded by Defense Department grants and the underground atomic age drove the establishment of the first global seismic network.

I did PhD my research at Lawrence Livermore Laboratory in the 1970s while nuclear testing was still in its heyday. Not only were weapons tests conducted at the Nevada Test Site, but so-called peaceful uses of nuclear explosions were also being explored. I worked on samples retrieved from a nuclear gas stimulation experiment in Colorado and every day walked through the nuclear device assembly area to get to my lab. I had nothing to do with the tests themselves, and the gas experiments turned out to be failures. My project was in understanding why. But it did give me a somewhat uncomfortable connection to what actually happens when a nuke explodes underground.

Seismology is the primary tool for determining the source characteristics of earthquakes. Within minutes of an earthquake, it is now possible to estimate not only the location and size, but the characteristics of faulting. This has made it fairly routine to distinguish between earthquakes and non-tectonic sources such as landslides, mining explosions, and large underground nuclear tests. Explosions, even very big ones like a hydrogen bomb, are fundamentally different than earthquakes.

First is location. Nuclear tests are located on land at relatively shallow depths and in test site facilities that are recognizable from space. It costs money to drill deep holes, so you don't want to drill any deeper than you have to. Most tests have been between 5000 and 9000 feet – the intent, not always achieved, to avoid venting of radioactive materials into the atmosphere. If the depth of a suspect seismic event is tens of miles beneath the surface, it can be ruled out.

Earthquakes release energy by rupturing the fault and displacing the rock on either side. They produce three types of seismic waves: the initial compressional or P-wave with up and down movement, the stronger transverse secondary S-wave that moves from side-to-side and causes the most damage, and the longer period but larger amplitude surface waves that some people have observed as the ground rolling like the ocean.

Explosions are a point source pushing outward in all directions. The result is a very strong initial P-wave, and hardly any S-waves or surface waves. By comparing the relative amount of P-wave

and S-wave or surface wave energy, it is pretty easy to nail the explosion. When I taught the introductory earthquake class at Humboldt, I included two seismograms on the final exam, and most students had no problem telling which one was the explosion.

Discrimination becomes more difficult with smaller events. The Threshold Test Ban Treaty signed by the U.S. and the Soviet Union in 1974 limited the yield of underground test to 150 kilotons, about ten times the size of the Hiroshima bomb and roughly equivalent in energy release to a magnitude 5.5 earthquake. The current global seismic network can detect events of this size and compare the P-wave and surface wave signature fairly easily.

There is a caveat. It is possible to dampen the energy of an explosion by putting it in a larger hole. This is called decoupling. If there is air between the detonation and the surrounding rock, the initial explosive energy goes into increasing gas pressure and heating the air in the cavity rather than directly transmitting it into the surrounding rock. It's far more expensive to drill a larger hole but the effect can reduce the seismic signal nearly 100-fold.

Enter artificial intelligence. Machine learning algorithms have greatly increased the accuracy of distinguishing explosions and earthquakes. It's not just the amount of energy that goes into the different types of seismic waves, but the details of the waves themselves that show source differences. My guess is that AI is one of the reasons the June 2020 event in China has now re-emerged as a possible nuclear test.

Here's what I've been able to glean about the China event. On June 22, 2020, a seismic station in Kazakhstan detected a small event, equivalent to a magnitude 2.75 earthquake. The seismic station is part of the network established for monitoring the CTBT and is centered over 450 miles away from Lop Nur, the primary Chinese nuclear testing facility. Ten documented nuclear tests were conducted at Lop Nur between 1990 and 1996 with equivalent magnitudes between 4.9 and 6.5. Yeaw alleges that more recent analysis of the M2.75 event shows the signature of the nuclear explosion and that the Chinese were using decoupling to evade detection.

The Chinese government vehemently denies that it has conducted any nuclear tests since 1996 although the U.S. State Department notes several suspicious events at Lop Nur in 2019. The Comprehensive Test Ban Treaty Organization that monitors compliance with the CTBT has stated that information is inconclusive to confirm Yeaw's allegations. This is a region of high background earthquake activity caused by tectonic sources and the small magnitude and lack of multiple station recordings makes it too difficult to prove.

The U.S. allegations come at a time when international tensions are high, and the status of nuclear test ban treaties is uncertain. The Partial Test Ban Treaty signed in 1963 that bans tests in the atmosphere, underwater, and in outer space remains in place. The New START treaty that limited the size of the U.S. and Russian nuclear arsenals expired on February 5th and while negotiations for a new agreement are ongoing, there are currently no limitations.

The current administration has expressed some interest in renewing nuclear testing and has been pressuring China to join the U.S. and Russia in a three-way nuclear arsenal limitations agreement. Beijing has rejected the offer on the grounds that they currently have a far smaller store of nuclear weapons. The jury remains out on whether the June 2020 event was a

nuclear test or not. What is certain is that we are in a time of nuclear uncertainty and it will continue for some time.

Lori Dengler is an emeritus professor of geology at Cal Poly Humboldt, and an expert in tsunami and earthquake hazards. The opinions expressed are hers and not the Times--Standard's. All Not My Fault columns are archived online at <https://kamome.humboldt.edu/taxonomy/term/5> and may be reused for educational purposes. Leave a message at (707) 826-6019 or email Kamome@humboldt.edu for questions and comments about this column or to request copies of the preparedness magazine "Living on Shaky Ground."