4D back-projection method reveals seismicity that initiated in the lower mantle in 2015

August 20 2021, by Jack Lee

By using a 4D back-projection method, researchers traced the behavior of a 2015 earthquake beneath Japan's Ogasawara (Bonin) Islands, pictured here. Credit: Anagounagi, CC BY-SA 4.0

On 30 May 2015, a magnitude 7.9 earthquake took place beneath Japan's remote Ogasawara (Bonin) Islands, located about 1,000 kilometers south of Tokyo. The seismic activity occurred over 660 kilometers below Earth's surface, near the transition between the upper and lower mantle. The mechanism of deep-focus earthquakes, like the 2015 quake, has long been mysterious—the extremely high pressure and temperature at these depths should result in rocks deforming, rather than fracturing as in shallower earthquakes.

By using a 4D back-projection method, Kiser et al. traced the path of the 2015 earthquake and identified, for the first time, seismic activity that initiated in the lower mantle. They relied on measurements by the High Sensitivity Seismograph Network, or Hi-net, a network of seismic stations distributed across Japan. The data captured by these instruments are analogous to ripples in a pond produced by a dropped pebble: By calculating how seismic waves spread, the researchers were able to pinpoint the path of the deep-focus quake.

The team found that the main shock initiated at a depth of 660 kilometers, then propagated to the west-northwest for at least eight seconds while decreasing in depth. Analyses of the two hours following the main shock identified aftershocks between depths of 624 and 751 kilometers. A common model for deep-focus earthquakes is transformational faulting; in other words, instability causes the transition of olivine in a subducting slab into a denser form, spinel. The aftershocks below 700 kilometers, however, occurred outside the zone where this transition occurs. The authors propose that the deep seismicity may have resulted from stress changes caused by settling of a segment of subducting slab in response to the main shock, although the hypothesis requires future investigation.

More information: Eric Kiser et al, Lower Mantle Seismicity Following the 2015 Mw 7.9 Bonin Islands Deep-Focus Earthquake,

Geophysical Research Letters (2021). DOI: 10.1029/2021GL093111

This story is republished courtesy of Eos, hosted by the American Geophysical Union. Read the original story here.