

Not My Fault: The 2018 US seismic wrap, part II: Hawaii's hot spot system

Lori Dengler/For the Times-Standard

Posted: January 23, 2019

Alaska had the most, the biggest and the costliest earthquakes of 2018, but there were seismic stories elsewhere in the US. After four years of leading the felt earthquake count outside of Alaska, Oklahoma slipped to third place and we had another quiet year on the North Coast.

M 3 or larger is a useful proxy for earthquakes likely to be felt. Alaska led more than 5,200, but Hawaii was the surprising runner-up with nearly 3,000. Hawaii is a seismically active place and typically experiences between 50 and 80 M 3 or larger tremors most years. In 2018, that number soared to 2,954. Not only was the number a bit astounding, almost all occurred in the three-month window between May 4 and August 4.

Hawaii's earthquakes were associated with the latest eruptive episode at Kilauea. Kilauea is the most active volcano in the United States. It has been in nearly continuous eruption since January 1983. This most recent eruptive episode began in early May. Its onset coincided with magnitude 5.7 and 6.9 earthquakes near the Leilani Estates subdivision on Kilauea's south flank.

Hawaii earthquakes can have multiple sources that are, in one way or another, related to volcanic activity. These earthquakes are unrelated to tectonic plate boundaries. The Hawaiian Islands are in the middle of the Pacific Plate, more than 2300 miles from the nearest plate boundary. The islands owe their existence and their seismic threat to a hot spot, a plume of hot rock that originates deep within the earth's mantle. This plume creates small amounts of molten rock (magma) that migrates slowly upwards, feeding volcanic vents that reach the surface. The Hawaiian hot spot system is at least 70 million years old and has left the scars of its history as a 3800-mile long string of islands as the Pacific plate slowly passes over.

Hot spots produce voluminous amounts of lava and other volcanic products. As magma moves upwards, it exerts pressure producing small earthquakes as the surrounding rock yields to the stress. The great weight of lava on the surface deforms the crust beneath and near the islands

producing regional stresses that can also cause quakes. And the pile of lava flows can become gravitationally unstable as they build up unevenly, producing yet another source of earthquakes.

Hawaii is a carefully balanced but inherently unstable edifice. Magma rises and moves in complex patterns, causing the surface to inflate and deflate. In early May, volcanologists detected lateral movement of magma draining the Kilauea summit area and flowing to the east. The M 5.7 and 6.9 earthquakes on May 4 were thrust earthquakes and appear to be centered on the Hilina slump, a large failure surface that encompasses much of the southeast part of the island as the forceful injection of magma forces the island to expand. The release of seismic energy helped to activate new vent systems and over the next three months, nearly 14 square miles of land was covered by new lava flows, swallowing up 700 homes, causing 24 injuries and \$800 million in property losses and closing Volcanoes National Park.

Magma continued to flow from the Kilauea summit area feeding the new eruptive vents for nearly three months. As the magma drained, an interesting feedback loop was established with collapse blasts equivalent in size to magnitude 5.2 to 5.4 earthquakes occurring almost every day and felt over much of the island. And then, almost as suddenly as it had started, the spigot turned off. The lava flows stopped. From a daily average of 500 to 700 small quakes, the number plummeted to less than ten by mid August. The USGS continued to monitor earthquake activity, gas emissions and surface deformation and for the first time in more than 35 years, all was quiet. On December 5, they officially declared Hawaii's longest historic eruption to be over.

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