

Oroville Dam earthquakes in February 2017 related to spillway discharge

December 18 2018



Credit: CC0 Public Domain

A closer look at small earthquakes that took place at the Oroville Dam in California's Sierra Nevada foothills in February 2017—near the time when the dam's spillway failed—suggest that the seismic activity was related to reservoir discharge that opened and closed fractures in the rock below the spillway.

It seems likely that fluid leaking through cracks in the main spillway altered the pressure on the underlying rock fractures, causing them to slowly open and then slam shut, over and over, according to the report in the *Bulletin of the Seismological Society of America*.

Researchers at the U.S. Geological Survey were able to detect more than 19,000 very small [seismic events](#) that occurred over the past 25 years, apparently as the result of these fractures opening and closing underneath the spillway.

The seismic events did not cause the failure of the dam's main spillway in mid-February 2017, said USGS seismologist Robert Skoumal, who led the research team.

"These seismic events were not directly associated with the spillway failure. Although experts determined that water leaking through spillway cracks led to the failure, we think this leaking water also caused the seismic events," explained Skoumal. "These seismic events occurred for decades prior to failure, and continued to occur after the failure itself."

Skoumal and his colleagues took a closer look at seismic signals located

near the dam after two [small earthquakes](#) of magnitude 0.8 and 1.0 occurred on 14 February 2017. After unusually [heavy rainfall](#) in the area and record-breaking water levels in the Oroville reservoir, parts of the Oroville Dam main spillway crumbled between 7 and 12 February, prompting the evacuation of nearly 188,000 people in the Oroville, California area.

Using a technique called template matching to search for events similar to the February 2017 magnitude 1.0 earthquake, the researchers detected more than 19,000 tiny seismic events at the dam that occurred between May 1993 and April 2018.

The February 2017 earthquakes were intriguing to Skoumal and his colleagues in light of a 1975 magnitude 5.7 earthquake sequence that was previously linked to the filling of the Oroville reservoir. "We wanted to know if these recent earthquakes could also be related to rapid changes in reservoir level and determine if these events might be precursors to larger magnitude earthquakes," Skoumal said.

The day after the magnitude 0.8 and 1.0 earthquakes, which were too small to be felt by humans, the researchers completed a preliminary analysis, "and very quickly we saw that there were tons of these kinds of earthquakes, located close to the spillway, and they did not look like natural events," Skoumal added.

Earthquakes as small as the Oroville events are often not detected by usual seismic monitoring, so the researchers turned to a technique called template matching to search for other seismic signals from the reservoir area. "With this approach, we treat the waveform from a successfully identified earthquake like a 'fingerprint,'" explained Skoumal. "We take that 'fingerprint' and scan through decades of data looking for signals that look similar, just with smaller amplitude."

The technique works well with earthquake swarms—a lot of earthquakes that occur over a short time period. Swarms can occur naturally, near volcanoes or within tectonic subduction zones, but they are also common in cases of seismicity induced by human activity, said Skoumal.

"We were seeing thousands of small events, which abruptly turned-on and turned-off, so we knew there was some kind of trigger that was causing these events," he said. "But it was a puzzle at that point. If it was induced, we thought it would be related to the reservoir itself, because there are many examples of reservoirs inducing earthquakes."

However, when the scientists compared the seismic data to the water levels in the reservoir, there was only a weak correlation between the tiny earthquakes and high [water levels](#). Instead, data on Oroville spillway usage from the California Department of Water Resources turned out to fit the seismic data perfectly. The small earthquakes occurred during times of outflow from the [reservoir](#) over the spillway, and they were not related to the processes responsible for the 1975 [earthquake](#) sequence.

Spillway discharge leaking through cracks in the spillway likely created rapid changes in fluid pressure along fractures in the weathered rock underlying the spillway. The researchers concluded this process could have caused the fractures to repeatedly open and close and generate the seismic swarms.

"Will the seismic events return when they resume usage of the spillway, which has since been repaired, or are they gone for good? Depending on the amount of rainfall we get, we might be finding this out in the next year or two," he said.

More information: "Microseismic events associated with the Oroville Dam spillway," [DOI: 10.1785/0120180255](https://doi.org/10.1785/0120180255)

Provided by Seismological Society of America

Citation: Oroville Dam earthquakes in February 2017 related to spillway discharge (2018, December 18) retrieved 13 March 2024 from <https://phys.org/news/2018-12-oroville-earthquakes-february-spillway-discharge.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.