San Andreas Fault study unearths new quake information

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View of the "Southeast" channel of the Bidart fan, Carrizo Plain, looking downstream. The channel is offset approximately 10 m by the San Andreas fault, at the bend in the middle ground of the photo, near the pump can. Trench 18, or "T18" (foreground) was excavated to exposure sediment in the channel for mapping and radiocarbon dating. Credit: Bidart Fan San Andreas fault research team, University of California Irvine / Arizona State University

Recent collaborative studies of stream channel offsets along the San Andreas Fault by researchers at Arizona State University and UC Irvine reveal new information about fault behavior - affecting how we understand the potential for damaging earthquakes.

The researchers' findings encompasses their work at the Carrizo Plain, which is located 100 miles north of Los Angeles and site of the original

"Big One" - the Fort Tejon quake of 1857. Applying a system science approach, the ASU-UCI team presents a pair of studies appearing Jan. 21 at *Science* Express that incorporates the most comprehensive analysis of this part of the San Andreas fault system to date.

In one of the studies, Ramon Arrowsmith, an associate professor in the School of Earth and Space Exploration in ASU's College of Liberal Arts and Sciences, and Dr. Olaf Zielke employed topographic measurements from LiDAR (Light Detection and Ranging), which provide a view of the earth's surface at a resolution at least 10 times higher than previously available, enabling the scientists to "see" and measure fault movement, or offset.

To study older earthquakes, researchers turn to offset landforms such as stream channels which cross the fault at a high angle. A once straight stream channel will have a sharp jog right along the fault and indicate that prior offset.

This highly detailed overhead view of Carrizo Plain stream channels measured the offset features linked to large earthquakes in this section of the southern San Andreas Fault.

"This virtual approach is not a substitute for going out and looking at the features on the ground," says Zielke, who earned his Ph.D. at ASU under Arrowsmith. "But it is a powerful and somewhat objective approach that is also repeatable by other scientists."

In the second Science Express study, a team led by UCI's Lisa Grant Ludwig with postdoctoral scholar Sinan Akciz and Ph.D. candidate Gabriela Noriega determined the age of offset in a few Carrizo Plain dry stream channels by studying how much the fault slipped during previous earthquakes. The distance that a fault 'slips', or moves, determines its offset.

By digging trenches across the fault, radiocarbon-dating sediment samples and studying historic and older weather data of these Carrizo Plain channels, and combining them with the LiDAR data, the researchers found something other than what scientists had thought. Instead of having the same slip repeat in characteristic ways, researchers found that slip varied from earthquake to earthquake.

"When we combine our offset measurements with estimates of the ages of the offset features determined by Lisa's team and the ages of prior earthquakes, we find that the earthquake offset from event to event in the Carrizo Plain is not constant, as is current thinking" Arrowsmith said.

"The idea of slips repeating in characteristic ways along the San Andreas Fault is very appealing, because if you can figure that out, you are on your way to forecasting earthquakes with some reasonable confidence," added Ludwig, an associate professor of public health. "But our results show that we don't understand the San Andreas Fault as well as we thought we did, and therefore we don't know the chances of earthquakes as well as we thought we knew them."

Before these studies, the M 7.8 Fort Tejon earthquake of 1857 (the most recent earthquake along the southern San Andreas Fault) was thought to have caused a 9 to 10 meter slip along the Carrizo Plain. But the data the teams acquired show that it was actually half as much, and that slip in some of the prior earthquakes may have been even less. The researchers also found that none of the past five large earthquakes in the Carrizo Plain dating back 500 years produced slip anywhere near nine meters. In fact, the maximum slip seen was about 5-6 meters, which includes the slip caused by the Fort Tejon quake.

This result changes how we think the San Andreas Fault behaves: it probably is not as segmented in its release of accumulated stress. This makes forecasting future earthquakes a bit harder because we cannot rely on the assumption of constant behavior for each section. It could mean that earthquakes are more common along the San Andreas, but some of those events are probably smaller than we had previously expected.

Since the 1857 quake, an approximate five meters of strain, or potential slip, has been building up on the San Andreas Fault in the Carrizo Plain, ready to be released in a future earthquake. In the last five earthquakes, the most slip that has been released was 5-6 meters in the big 1857 quake. This finding points to the potential of a large temblor along the southern San Andreas Fault.

"Our collaboration has produced important information about how the San Andreas Fault works. Like all science, it is pushed forward by hard work, good ideas, and new technology. I am optimistic that these results, which change how we think about how faults work, are moving us to a more subtle understanding of the complexity of the earthquake process," said Arrowsmith.

"The recent earthquake in Haiti is a reminder that a destructive earthquake can strike without warning. One thing that hasn't changed is the importance of preparedness and earthquake resistant infrastructure in seismically active areas around the globe," Ludwig added.

Provided by Arizona State University

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