New Scripps Study Reveals San Andreas Fault Set for the 'Big One' Clearest picture yet of fault movement shows massive earthquake threatening; lesser known San Jacinto Fault also poses risk of dangerous large event

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Mario Aguilera

A researcher investigating several facets of the San Andreas Fault has produced a new depiction of the earthquake potential of the fault's southern, highly populated section. The new study shows that the fault has been stressed to a level sufficient for the next "big one"-an earthquake of magnitude seven or greater-and the risk of a large earthquake in this region may be increasing faster than researchers had believed, according to Yuri Fialko of Scripps Institution of Oceanography at UCSD.

Historical records show that the San Andreas Fault experienced massive earthquakes in 1857 at its central section and in 1906 at its northern segment (the San Francisco earthquake). The southern section of the fault, however, has not seen a similar rupture in at least 300 years.

Although seismologists have not been able to predict when a great earthquake will occur on the southern San Andreas, most believe such an event is inevitable. Fialko has produced the clearest evidence to date of the strain buildup that will ultimately result in a large earthquake along the southern San Andreas Fault, a 100-mile segment that cuts through Palm Springs, San Bernardino and Riverside. Such an event would be felt in the major populated areas of Los Angeles and San Diego.

"For the public the most important result of this study is that these data show definitively that the fault is a significant seismic hazard and is primed for another big earthquake," said Fialko, an associate professor at the Cecil H. and Ida M. Green Institute of Geophysics and Planetary Physics at Scripps. Fialko's study, which appears in the June 22 edition of the journal *Nature,* involves an analysis of several data sources that help depict the movements of the San Andreas Fault. One result of the study shows that the southern section of the fault is overdue in its "interseismic period," or cycle of earthquake activity. "All these data suggest that the fault is ready for the next big earthquake but exactly when the triggering will happen and when the earthquake will occur we cannot tell. It could be tomorrow or it could be 10 years or more from now," said Fialko.

Earth's surface is divided into several large tectonic plates separated by fault zones. The San Andreas Fault, which spans nearly 800 miles through western California from near the Salton Sea north to near Cape Mendocino, divides the slow but steady movement of the North American plate, which moves southeasterly relative to the neighboring Pacific plate. When plates slide past each other, which seismologists call "creep," strain accumulates less than when plates "lock" and stress loads continue to escalate, increasing the prospects of an eventual fault rupture and earthquake.

In order to develop a detailed representation of the behavior of the San Andreas and study how the fault has been moving, bending and deforming, and to get a clearer idea of its stress points, or "interseismic loading," Fialko analyzed high-quality images taken by European Space Agency satellites. He also coalesced data from ancient geological records, Global Positioning System readings and seismic instruments.

Fialko found evidence that the southern San Andreas is mostly locked and continues to accumulate significant amounts of strain. He calculated the rate at which the fault is moving and estimated the "fault slip rate," the pace of the plate movement at the fault, to be about an inch per year. According to Fialko, this means that during the last 300 dormant years the fault has accumulated approximately six to eight meters of slip "deficit," which will be released in the future big earthquakes. If all inferred deficit is released in a single event, it would result in a magnitude eight earthquake, roughly the size of the 1906 San Francisco earthquake.

"In the earthquake business, the past is a key to understanding the present and by comparing ancient observations of the fault with what we have measured over the last 10 years, we can say with some certainty that the fault is approaching the end of its loading period," said Fialko.

One unusual result that emerged from Fialko's study is that the two sides of the fault are behaving vastly differently, with the North American plate showing flexibility in its movement patterns and the Pacific plate demonstrating more rigid characteristics, akin to a giant unbending block. Fialko says this new insight on fault structure may help seismologists further understand fault activity at the San Andreas and other faults. Future studies by Fialko and others will address these marked differences and their implications for earthquake risk.

Another surprising result concerned the San Jacinto Fault, a lesser known Southern California fault yet one of the most significant branches of the San Andreas system. Fialko's analysis of the San Jacinto Fault, which winds through populated areas in San Bernardino, Riverside and Borrego Springs, found that it is moving at roughly twice the speed of previous estimates and thereby its propensity for earthquakes is greatly enhanced. While the San Andreas is at risk for an earthquake of magnitude eight or higher, the San Jacinto Fault has an even greater risk for a slightly smaller earthquake of magnitude seven, which still falls into the category of a major earthquake.

The new results also shed light on the large faults off Southern California's coast. Fialko found that the San Andreas and San Jacinto faults account for so much of the North American and Pacific plate motions that the offshore faults must carry much less seismic risk than previously estimated. He says these offshore faults, including the Oceanside, Rose Canyon and Elsinore Faults, are moving much more slowly than anticipated, reducing the earthquake threats from these faults for cities such as San Diego.

Even with the highly precise data used in Fialko's study and the new understandings that resulted, he noted that there is a great deal left to explore in regards to the complex dynamics of tectonic loading and the tipping points for faults and earthquake events.

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Contacts: Mario Aguilera or Cindy Clark, (858) 534-3624

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