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Some sections of the San Andreas Fault system in San Francisco Bay Area are locked, overdue

SAN FRANCISCO – Four urban sections of the San Andreas Fault system in Northern California have stored enough energy to produce major earthquakes, according to a new study that measures fault creep. Three fault sections – Hayward, Rodgers Creek and Green Valley – are nearing or past their average recurrence interval, according to the study published in the *Bulletin of the Seismological Society of America* (*BSSA*).

The earthquake cycle reflects the accumulation of strain on a fault, its release as slip, and its re-accumulation and re-release. Fault creep is the slip and slow release of strain in the uppermost part of the Earth's crust that occurs on some faults between large earthquakes, when much greater stress is released in only seconds. Where no fault creep occurs, a fault is considered locked and stress will build until it is released by an earthquake.

This study estimates how much creep occurs on each section of the San Andreas Fault system in Northern California. Enough creep on a fault can diminish the potential size of its next earthquake rupture.

"The extent of fault creep, and therefore locking, controls the size and timing of large earthquakes on the Northern San Andreas fault system," said James Lienkaemper, a co-author of the study and research geophysicist at U.S. Geological Survey (USGS). "The extent of creep on some fault sections is not yet well determined, making our first priority to study the urban sections of the San Andreas Fault system, which is directly beneath millions of Bay Area residents."

Understanding the amount and extent of fault creep directly impacts seismic hazard assessments for the region. The San Andreas Fault system in Northern California consists of five major branches that combine for a total length of approximately 1250 miles. Sixty percent of the fault system releases energy through fault creep, ranging from 0.1 to 25.1 mm (.004 to 1 inch) per year, and about 28 percent remains locked at depth, according to the authors.

The monitoring of creep on Bay Area faults has expanded in recent years. Alignment

array measurements made by the San Francisco State University Creep Project and recently expanded GPS station networks provide the primary data on surface creep, which the authors used to estimate the average depth of creep for each fault segment. Where available, details of past ruptures of individual faults, unearthed in previous paleoseismic studies, allowed the authors to calculate recurrence rates and the probable timing and size of future earthquakes.

According to the study, four faults have accumulated sufficient strain to produce a major earthquake. Three creeping faults have large locked areas (less than 1 mm or .04 inches of creep per year) that have not ruptured in a major earthquake of at least magnitude 6.7 since the reporting of earthquakes by local inhabitants: Rodgers Creek, northern Calaveras and southern Green Valley. The southern Hayward fault, which produced a magnitude 6.8 earthquake in 1868, is now approaching its mean recurrence time based on paleoseismic studies.

The authors also estimate three faults appear to be nearing or have exceeded their mean recurrence time and have accumulated sufficient strain to produce large earthquakes: the Hayward (M 6.8), Rodgers Creek (M 7.1) and Green Valley (M 7.1).

“The San Andreas Fault and its two other large branches, the Hayward and Northern Calaveras, have been quiet for decades. This study offers a good reminder to prepare today for the next major earthquake,” said Lienkaemper.

The BSSA paper, “Using Surface Creep Rate to Infer Fraction Locked for Sections of the San Andreas Fault System in Northern California from Alignment Array and GPS Data,” is co-authored by Lienkaemper and Robert W. Simpson of USGS and Forrest S. McFarland and S. John Caskey of San Francisco State University.

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For a copy of the paper, please write press@seismosoc.org

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