Paleoseismic History of the Rose Canyon Fault in San Diego &
Design of the Scenario Earthquake

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• Brief summary of what we know about the earthquake history of the Rose Canyon fault.

• Information on the slip rate, including new GPS campaign results

• Estimation of the likely rupture length for RCF earthquakes.

• Estimation of expected magnitude based on our knowledge of the faults past behavior, estimated displacement per event, and slip rate, and the general characteristics of the fault’s structure.
Plate boundary rate is about 50 mm/yr of strain accumulation, with about 10-15% coastal or offshore.
Rose Canyon Fault in San Diego

The RCF has a well defined onshore surface expression through San Diego.

RCF steps onshore from Descanso Fault dropping SD bay with help from La Nacion Fault zone.

There is also slip fed from the San Miguel – Vallecitos fault system in Baja California.

The slip is distributed on multiple strands through SD Bay, making estimation of displacement difficult.
San Miguel – Vallecitos fault, Salsipuedes, and Agua Blanca faults accommodate 6-7 mm/yr of dextral shear across the peninsula.
Paleoseismic studies conducted at:
Rose Creek (SDG&E Facility), Presidio Hills Golf Course, La Jolla, and
San Diego Airport (inferred from vertical offset of Holocene bay muds)

Rose Canyon paleoseismic team members include: Drake Singleton, Diane and Monte Murbach, Scott Lindvall, Scott Rugg, Jillian Maloney, Yuval Levy, Dave Schug, Mike Hatch, Tom Freeman, Marty Siem, Mike Hart, and many students

Offsets late Holocene alluvium, including the topsoil A horizon

Lindvall and Rockwell, 1995
Found secondary fault, but encountered a Mexican or Spanish era foundation wall and floor, which terminated trench T1.
Old Town Trench T2, SE side of Presidio Golf Course

Unfaulted Pleistocene and Holocene sections

Fault Zone

Unfaulted Holocene

Salisbury et al., 2018
Paleo-earthquakes resolved by upward fault terminations, filled fissures, structural grabens, and folding or tilting to determine where the ground surface was at the time of a surface rupture.

Six surface ruptures interpreted in the past 3300 years, 4 of which appear to have been large.

Salisbury et al., 2018
Event 2: faulting up to unit 100 truncated by historical alluvium

Event 3: Upward termination of faulting overlain by fine silt stringer and unit 110

Salisbury et al., 2018
43 radiocarbon dates are used to build the OxCal model to provide the chronology of the sediments and interpreted earthquakes.
The central fault strands ruptured the historical living surface and A horizon, which included glass, cow bone, and European ceramics. This can only be the May 27, 1862 earthquake, known as the Day of Terror in San Diego, with an estimated magnitude of M6.
Reported in the Los Angeles Star as San Diego’s **Day of Terror**

*From the 27th of May till June 14th, we been "favored" with a remarkable succession of "tremblores"……. The main shocks of May 27th —two in quick succession, at 12, M., lasting some ten seconds……. During the same afternoon, seven other shocks were counted. We may well term this a "day of terror," for the people rushed from their houses to the streets and public square, numbers remaining long in the attitude of prayer.*
Composite Holocene paleoseismic history of the Rose Canyon Fault

Average recurrence for large events ~ 700 years

Evidence for small events, such as 1862, is likely obliterated during the large events so recurrence interval for damaging earthquakes is <700 years!
First Slip Rate Site – Rose Creek

Tonal lineament
Country Club F.

Mt. Soledad F.
Scarp
Terrace riser
sag
>8.7 m in <8.1 ka yields a minimum Holocene slip rate of 1.1 mm/yr on one strand

Lindvall and Rockwell, 1995
The Rose Canyon fault in Rose Creek north of Mission Bay


Makes the $>1.1 \text{ mm/yr}$ rate even more of a minimum rate.
Channels incised into alluvium overlying the last interglacial marine terrace show deflections of 100-250 m, which suggests a minimum slip rate of 2 mm/yr (Rockwell, 2010)
Campaign GPS (Duncan Agnew’s local stations) combined with continuous GPS (Earthscope) suggests a strain rate of 2-3 mm/yr.
With a best-estimated slip rate of about 2-3 mm/yr and an average recurrence interval of about 700 years, this suggests average displacements of about 1.5-2 m per event. We use 2 m in the Planning Scenario.
We estimated displacement along the scenario rupture using Biasi et al. (2011) and using 2 m as displacement along the central part of the rupture.
New data suggests average recurrence interval of large earthquakes is about 700 years, although it is shorter when considering 1862-type smaller events.

At 2-3 mm/yr, this suggests events have displacements in the range of 1.5-2 m (6.6 feet) per earthquake.

Assuming complete rupture from Oceanside to the international border (~65 km) to a depth of 12 km yields a rupture area of about 780 square kilometers, and about 540 square km if the rupture terminates in San Diego Bay.

Using 2 m of maximum displacement and 1.5 m of average displacement yields a seismic moment of $2.5-3.3 \times 10^{26}$ dyne-cm ($M_o = \mu As$) which corresponds to a M6.9-M7 earthquake.

We choose M6.9 as the scenario earthquake.