Paleoseismic Investigation of the Northern San Gregorio Fault at Pillar Point Marsh near Half Moon Bay, California

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INVESTIGATIONS UNDERTAKEN

The San Gregorio fault system is an active, northwest-trending right lateral strike slip fault zone located approximately 14-km west of the San Andreas fault in coastal San Mateo County, California (Figure 1). Despite geomorphic and paleoseismic evidence of Holocene activity (Simpson et al., 1997; Simpson and Knudsen, 2000), data on the timing and recurrence of past earthquakes along the northern San Gregorio fault (SGF) remain poorly constrained. Earthquake reccurrence data are essential for evaluating the seismic potential of the San Gregorio fault. This paleoseismic study will evaluate stratigraphic position of estuarine and sub-areal sediments to estimate the timing and recurrence of earthquakes along the SGF using coseismic land-level changes.

The northern on-land trace of the SGF extends from Pillar Point to Moss Beach and consists of three en echelon right-stepping fault traces (Figures 1 and 2). The western-most on-land fault trace extends across the headland of Pillar Point. The middle fault trace extends along the western edge of Pillar Point marsh. The eastern fault trace extends between the eastern edge of Pillar Point marsh and Moss Beach, and is geomorphically well-expressed as a northeast-facing escarpment over 30-meters high along the Seal Cove Bluff. Pillar Point marsh lies within an inferred pull-apart structure between the middle and eastern fault strands (Figure 2) and records evidence for submergence in the form of buried marsh soils that are abruptly overlain by tidal mud deposits (Simpson and Knudsen, 2000). Stratigraphic evidence for rapid submergence of tidal marsh soils may record coseismic land-level change within Pillar Point marsh caused by earthquakes on the SGF.

In October and November, 2002, we conducted a reconnaissance survey consisting of twelve 2.5-cm-diameter gouge cores along two transects oriented roughly east-west across Pillar Point marsh. The purpose of this initial survey was to characterize the subsurface stratigraphy and geometry of the marsh by collecting detailed lithologic data on the late Holocene estuarine deposits in the marsh. Based on the results of the initial survey we extracted seven additional 7.6-cm diameter vibra-cores at locations determined to have the greatest potential to record a sequence of buried marsh soils.

Analysis of cores is in progress. Five cores have been split, described, photographed, and sampled. We have collected 84 detrital macrofossil and bulk peat samples for radiocarbon analyses by accelerator mass spectrometry (AMS) and 82 sediment samples for diatom analyses. Additionally, four surface diatom samples were collected for comparison with subsurface micro-fossil samples. We will use the diatom analyses to evaluate the depositional environment above and below peat contacts suggestive of land level changes. Stratigraphic intervals that represent rapid changes of environment will be evaluated to identify potential co-seismic submergence events. These intervals will be dated in an attempt to develop an earthquake chronology for the northern SGF, at Pillar Point marsh.

PRELIMINARY RESULTS

The Half Moon Bay marine terrace comprises the coastal plain between the SGF and Pillar Point marsh on the west, and the coastal foothills to the east, and extends several kilometers north to the town of Montara. This marine terrace is correlated to the Stage 5a (83 ka) sea-level high stand based on a correlation of molluscan zoogeography and paleoclimatic events, as well as amino acid racemization analyses of bivalve shells (Kennedy et al., 1982a; 1982b). Sediments in a beach cliff exposure approximately 300 meters east of the marsh consist of a basal sandy clay unit overlain by 2-meters of clayey sand with gravel. The gravel consists of dominantly angular feldspar clasts derived from the granodioritic basement rock that forms the core of the Coast Range and Montara Mountain. The origin of the deposits is interpreted to be an alluvial fan from the mouth of Denniston Creek that prograded over the 83-ka marine terrace.

A well-developed dark-gray brown, gravelly silty clay loam soil is developed in the deposits of the alluvial fan. Based on texture, color, and similar distributions of angular feldspar and granitic clasts, we correlate the alluvial fan soil with a gravelly clay loam observed at the base of all of the cores. Beneath Pillar Point marsh, the alluvial fan soil is buried by interbedded marsh, alluvial channel, and tidal mud deposits and represents the former landscape prior to the formation of the marsh. The alluvial fan soil crops out in tidal channel exposures on the northern and eastern margins of the marsh and gradually dips to the south and west where it is buried. At the western margin of the marsh, the alluvial fan soil lies approximately 4.5-meters below the marsh surface. Therefore, the alluvial fan surface defines a roughly triangular-shaped south-dipping basin approximately 245-meters-long by 150-meters-wide. The mechanism controlling formation of the basin is inferred to be tectonic subsidence between the middle and eastern strands of the on-land SGF. This interpretation is consistent with subsurface data northeast of the fault which indicate that the abrasion platform associated with the 83-ka marine terrace is warped downward beneath the Pillar Point marsh area (Simpson and Knudsen, 2000).

Stratigraphic sequences identified in the marsh consist of buried peat soils, alluvial channel deposits, intertidal mud, and beach deposits. The buried peat soils are interpreted to represent former marsh surfaces. Five buried peat soils are preserved in the marsh. Two well-developed peat soils occur within 2 meters of the marsh surface and are laterally continuous for over 110 meters. Three less-developed peat soils extend laterally over 67 meters and occur between 3.2 to 4.1 meters depth. All of the buried peat soils have sharp to gradual upper soil contacts and are overlain by inorganic mud to peaty mud. Based on the change from sub-areal to tidal environments, we infer that coseismic subsidence caused rapid relative sea-level rise that submerged and buried the peat soils. Multiple peat/mud couplets suggest that a record of several earthquakes may be preserved in the marsh stratigraphy.

In the coming weeks we plan to sample and describe the remaining two cores and construct detailed stratigraphic cross sections of the marsh stratigraphy. Additionally, we plan to complete a site survey with a Topcon total staion to document marsh geomorphic features and core locations. Based on the results of our lithostratigraphic and biostratigraphic analyses we will attempt to identify which land-level changes are related to co-seismic subsidence events. Radiocarbon analyses of plant macrofossils and bulk peat will provide age estimates to evaluate the history and recurrence of earthquakes on the SGF at Pillar Point marsh.

NON-TECHNICAL SUMMARY
Pillar Point marsh lies within a subsiding basin between two active traces of the on-land northern San Gregorio fault (SGF). Earthquakes on the SGF may produce abrupt land-level change that leads to submergence and burial of Pillar Point marsh. Therefore, dating buried marsh soils can be used to develop an earthquake history for the SGF. This research is designed to better understand the timing and recurrence of paleo-earthquakes on the northern SGF by investigating marsh stratigraphy sampled by vibracoring. Analyses of the cores identified five buried soils that may reflect marsh submergence due to earthquakes. Pending results of diatom analyses will be used to evaluate whether the buried soils are best explained by tectonic subsidence or other processes. Analyses of radiocarbon samples will be used to estimate the age of the most recent earthquake and possible older paleo-earthquakes on the SGF.

REPORTS PUBLISHED
None

DATA AVAILABILITY

Additional detailed information on the investigation is available from the Principal Investigators listed above. This information includes detailed stratigraphic descriptions of sediments contained in vibra-cores.

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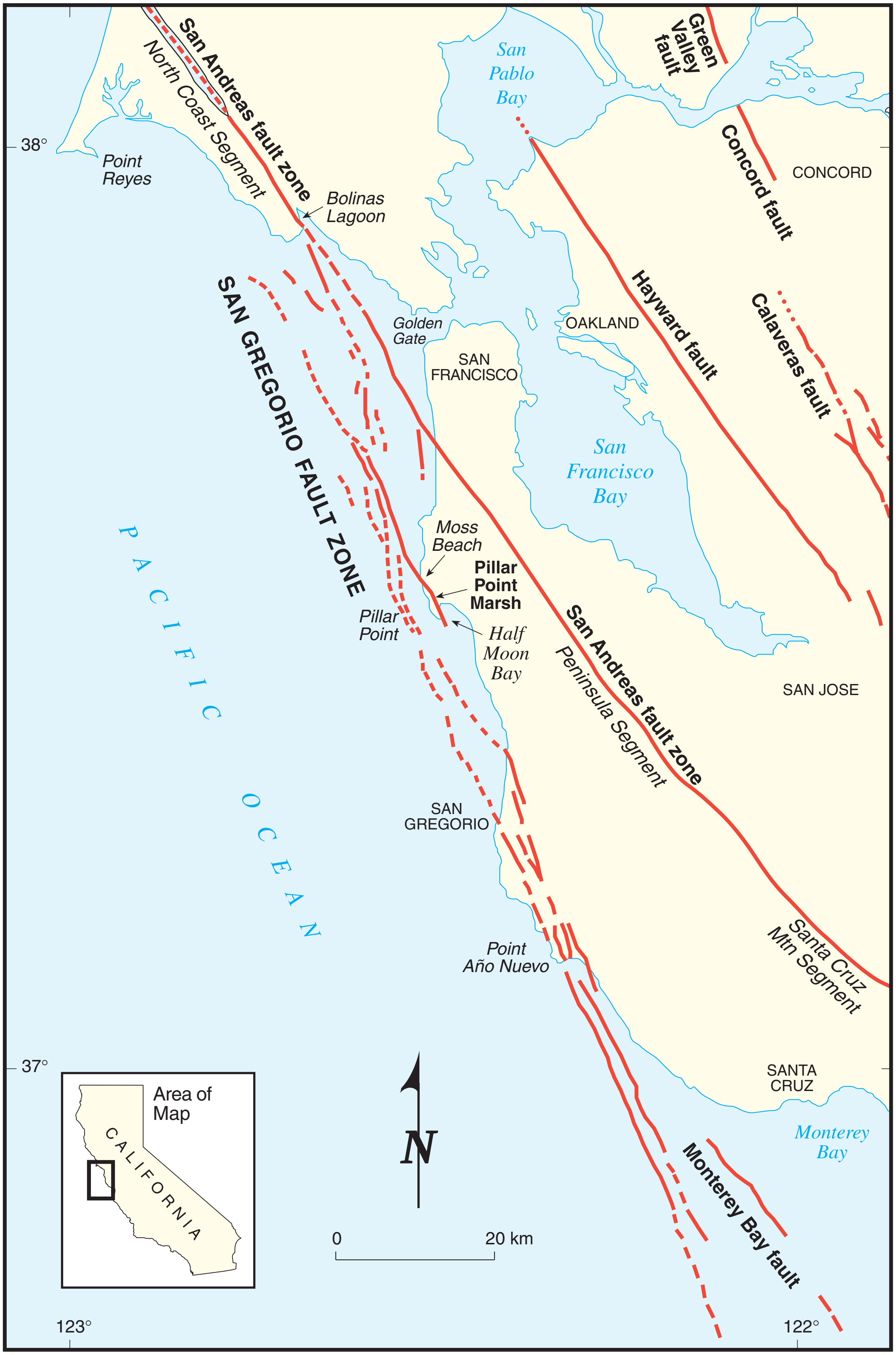

Figure 1. Map showing the San Gregorio fault zone and other principal Holocene faults in the San Francisco Bay area. Modified from Jennings (1994).

Explanation

(heavy red dashed line)	Northern San Gregorio Fault
(fine red dashed line)	Previously mapped trace of San Gregorio fault
(solid/dashed line)	Geologic contact; dashed where approximate
(landslide symbol)	Landslide

Explanation of geologic units

Qha	Holocene Alluvium
Qmt_2	Marine terrace, 83,000 yrs. old
Qmt_1	Marine terrace, 125,000 years old
Tpp	Purisima formation

Figure 2. Site location map.