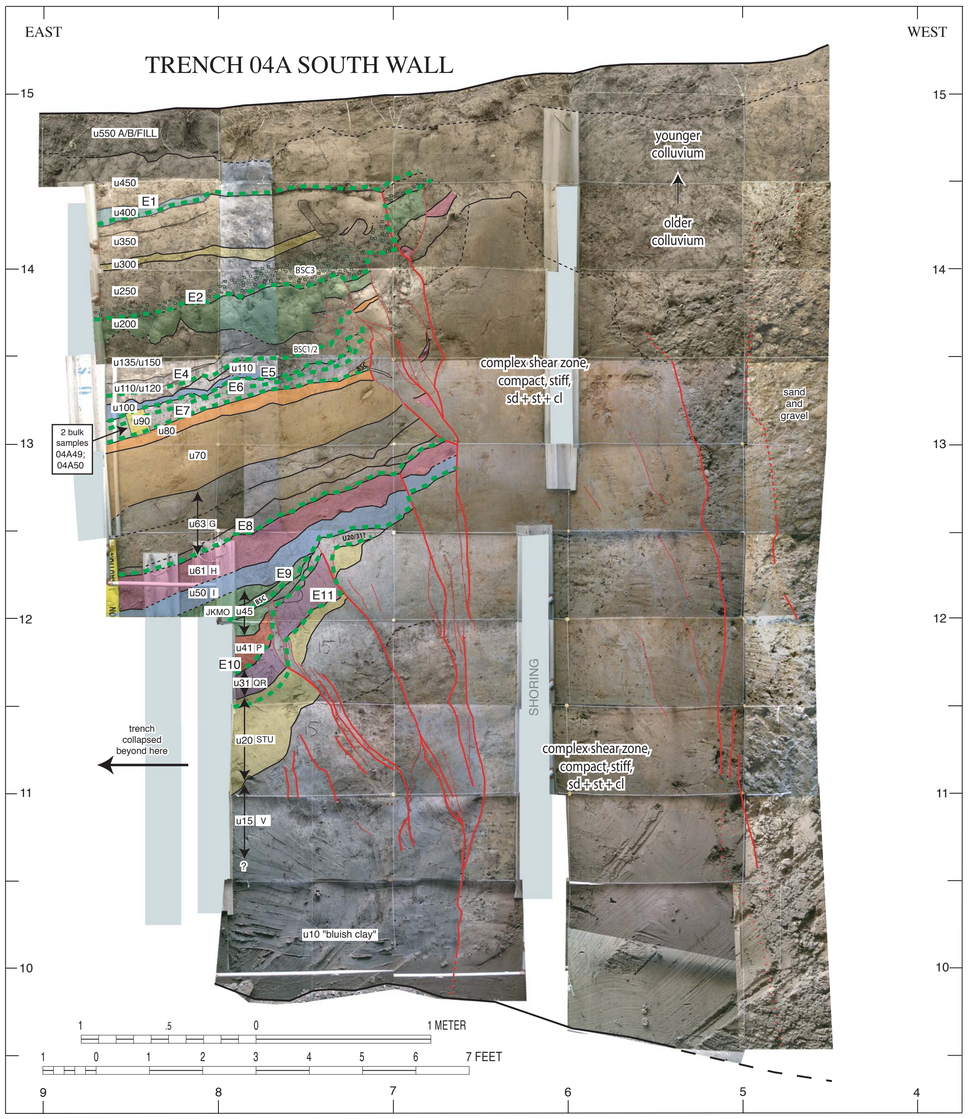
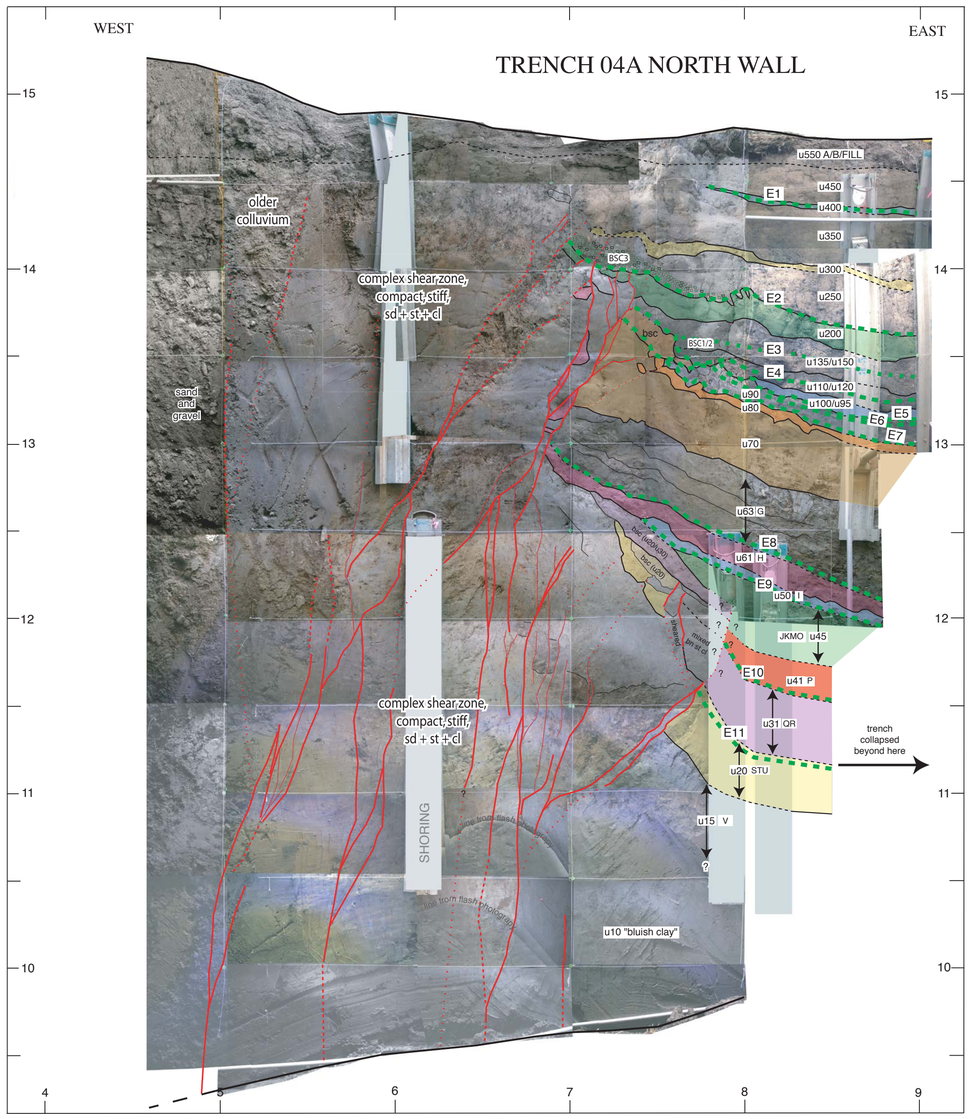
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

OPEN-FILE REPORT 2005-1350
SHEET 1 OF 2





EXPLANATION

u400	**Organic clayey silt**
u300	**Organic clayey silt**
u200	**Organic clayey silt**
u100	**Organic clayey silt**
u80	**Orange silty clay***
u70	**Banded brown clays & silts**
u63(G)	**Organic clayey silt**
u61	**Charcoal-rich sand**
u50(I)	**Organic clayey silt**
u45	**Upper shelly silt**
u41	**Lower shelly silt**
u31	**Gray clayey silt***
u20	**Yellow sandy silt***

*lighter shades indicate blocks of material in shear zone or scarp colluvium

Contact—Dashed, approximate; dotted, inferred
Fault—Dashed, approximate; dotted, inferred
Minor shear
Fissure or crack—Open or filled voids without distinguishable slip, possibly tectonic in origin
E3 **Event horizon**
u80 **Unit number**
bulk 00A21 **Radiocarbon sample location**—rectangle indicates bulk samples
(k) **Krotovina**—infilled burrow

ABBREVIATIONS

bsc	blocky scarp colluvium
cl	clay
gc	gray clay
gv	gravel
m	medium
sd	sand
st	silt
rk	rock

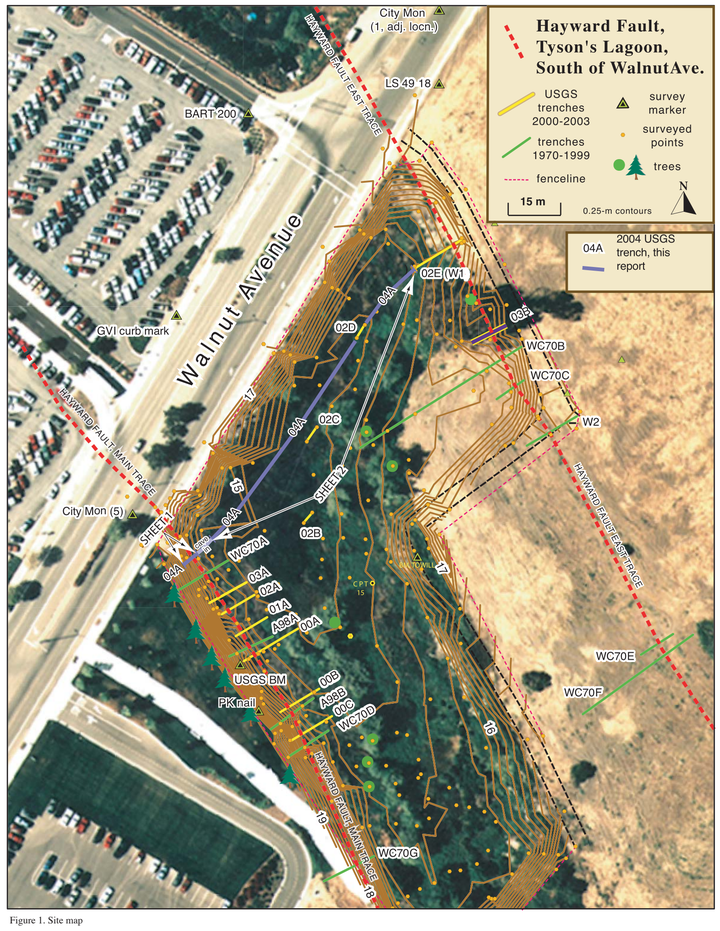


Figure 1. Site map

INTRODUCTION

This publication makes available a detailed trench log (sheets 1 and 2) of a 110-m trench we excavated in 2004 across a tectonic sag pond in the Hayward fault zone. Also included are revised stratigraphic unit descriptions from this fifth field season of subsurface investigation of the Hayward fault at Tyson's Lagoon (Tule Pond). Preliminary findings based on fieldwork done in 2000 have been published (Lienkaemper and others: data archive, 2002a; report, 2002b), as were the logs and data for 2001-2003 (Lienkaemper and others, 2003, *L03*). A continuous exposure of the geologic section across the entire pond made in 2004 (Fig. 1, 04A) has revealed some critical miscorrelations of units made in the original on-line version of *L03*, hence users of these earlier trench data should only use the 2005 revised version 2.0 of *L03* for correlation purposes. Lienkaemper, Williams, and Sickler interpreted the geology and logged the trenches. Fumal did most of the trench photography.

The Hayward fault is recognized to be among the most hazardous in the United States (Working Group on California Earthquake Probabilities, 2003). Establishing a chronology of prehistoric or paleoearthquakes is of immediate use in resolving the likelihood of future large earthquakes Hayward fault. This document makes available geologic evidence for historical and prehistoric surface-rupturing earthquakes preserved at the site. A second, formal report on our conclusions based on these data is in preparation.

Much previous trenching work was done at Tyson's Lagoon (fig. 1 on sheet 1; and *L03*). Lienkaemper (1992) references the location of most of the early trenches. This earlier trenching was generally for the evaluation of local fault-rupture hazard, except for the study of Williams (1993), which was a paleoearthquake investigation. An unpublished study by J.N. Alt in 1998 (fig.1, 98A and 98B) also sought evidence of paleoearthquakes. Alt's study and one by Woodward-Clyde and Associates (1970; trenches 70A to 70G, fig. 1) were located south of Walnut Avenue in one of the few areas that remained undisturbed and were, thus, useful in planning our work in 2000. Unpublished field investigations at this site by P. L. Williams in 1992 (trenches W1 and W2) are incorporated in *L03*. William's 1992 trench W1 was re-excavated by us in 2002 and is shown as trench 02E in *L03*.

Tectonic setting and site location have been described in Lienkaemper and others (2002b). Methodology was described in the previous data archives (*e.g., L03)* and will not be repeated here. Sheet 1 shows a detailed log (1:20 scale) of the western (main) fault trace of the Hayward fault in trench 04A on a photographic base. Sheet 2 shows a less detailed log (1:30 scale), also on a photographic base, of the unfaulted central part of the pond. Because of a cave-in during excavation a gap in logging exists between meters 9 and 15. The northeast end of trench 04A overlaps the end of a previous trench, 02E that crosses the eastern fault trace (*L03*). Locations of radiocarbon samples are shown on the logs, but no laboratory ages are available at this time. Many previous radiocarbon ages have already been reported (Lienkaemper and others, 2002a&b, *L03)* and pending analyses will be published in the final report on this investigation.

We assigned unit numbers to the stratigraphic units, from u05 (east trace, *L03*) and u15 (west trace) at the lowest level exposed in the trenches to u550, the most recent artificial fill. These unit numbers are used to compare the relative stratigraphic position of the radiocarbon samples between trench walls. In 1992 Williams assigned letter codes to each unit in trench W1 (02E). Because most of these units continue westward, while gradually coalescing into the fewer distinguishable thicker, numbered units, we use these letter codes to subdivide the numbered units where possible. Color is used to highlight some key stratigraphic units on the logs, which are described in Appendix 1. The pond deposits are generally fine-grained with varying amounts of silt and clay, and some sand, particularly near the main fault trace. Sandy alluvium is more abundant on the east side of the pond, and the abundance of clay and silt generally increases westward. The main (western) fault trace is located between meters 5-8 (sheet 1). West of the main fault trace are older sand and gravel alluvial deposits of the Niles alluvial cone (California Department of Water Resources, 1967) that predate the inception of subsidence at Tyson's Lagoon. We have dated pond deposits near the base of these trenches as about 2000 years BP, but do not yet know the age of inception of the pond.

Earthquakes cause a disruption of the ground surface along the trace of the causative fault. The original ground surface prior to deformation can be shown on a trench log as a *paleoearthquake horizon*. Paleoearthquake (event) horizons are shown as green dashed lines labeled E1 through E10. The five most recent events (E1-E5) correspond to events E1, E2, E3, E4 and EY respectively as shown in Lienkaemper and others (2002a).

Acknowledgments

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Appendix 1. Stratigraphic Unit Descriptions

Unit u10, a bluish gray to blue clay is the lowest pond deposit observed in our trenches. It may actually comprise different units that have been subjected to continuous saturation. Near the main fault trace blue clay (u10) underlies u15, but in the pond it may be derived by the reduction of younger units. Blue crystals of unknown origin and mineralogy can be seen by 20X hand lens in the freshly exposed blue clay. Unit u15 (V), is light brown organic silty clay, darker near the east trace, which becomes progressively more altered with depth to shades of light gray. It develops a mottled appearance, suggesting that some chemical process may remove the organics, and at greater depth begins a transition toward blue clay.

Unit u20 (STU) is very fine yellowish sandy silt, relatively low in organics except for a nearly continuous charcoal-rich burn layer in the upper 10-20 cm. Unit u31 (QR) is brown clay silt, more organic rich near the top; in the east unit Q is composed of distinct bands of clay and silt (*L03*). A key marker unit, u41 (P), the lower shelly layer, is observed in all trenches at the site. Near the east side of the pond it is a cross-bedded fine sand, but has westward (into the pond) increasing amounts of organics, silt, gastropod shells, and bioturbation.

Unit u45 (JKLMNO) is gray brown clayey silt with shells, but has many fewer gastropods than u41 and also has shells of freshwater clams. The shells in u45 diminish and disappear close to the main fault on the west. On the east side of the pond u45 is composed of sandier units (J, L, N) and clayier units (K, M, N, O), which gradually merge westward. Layer N pinches out within a meter of the east end of trench 04A. Layer L rapidly looses its sandy character going into the pond, the layer. U45 is also described as JKMO after the more persistent subunits.

Unit u50 (I) is charcoal-rich, organic-rich clayey silt, which thins westward and was not recognized from meter 15-34, but reappears near the west fault trace. Unit u61 (H) is charcoal-rich alluvial sand with stones at its base. Unit u63 (G) is a thick layer of sandy silt, apparently mostly a single flood deposit. U63 is capped by u70, a series of brown clayey silts that in some exposures appear as distinct bands of varying shades of brown and elsewhere seem more massive.

Unit u80, the orange silty clay is a burn layer, which in most locations is conspicuous, but in some places is indistinguishable from a minor band near the top of u70, lying within 5 cm of its top. Overlying the orange silty clay are gray silty clays, units u90 and u95, identical except that u95 contains several fine charcoal stringers, the lowest of which forms the base of the unit. Strata above this are described in Lienkaemper and others (2002b).

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REFERENCES CITED

California Department of Water Resources, 1967, Evaluation of groundwater resources: South Bay (Appendix A: Geology), California Department of Water Resources Bulletin, p. 153.

Lienkaemper, J.J., 1992, Map of recently active traces of the Hayward fault, Alameda and Contra Costa counties, California: U.S. Geological Survey Miscellaneous Field Studies Map MF–2196, 13 p. (1 sheet). [http://quake.wr.usgs.gov/research/geology/docs/mf2196_HF_map/]

Lienkaemper, J.J., Dawson, T.E., Personius, S.F., Seitz, G.G., Reidy, L.M., and Schwartz, D.P., 2002a, Logs and data from trenches across the Hayward fault at Tyson's Lagoon (Tule Pond), Fremont, Alameda County, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-2386, 12 p. (3 sheets). [http://geopubs.wr.usgs.gov/map-mf/mf2386/]

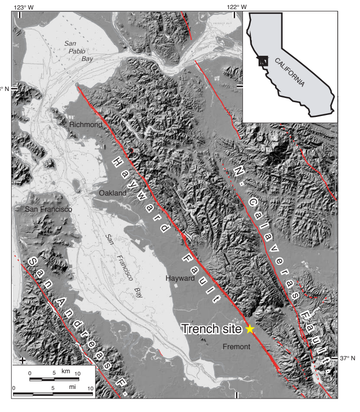
Lienkaemper, J.J., Dawson, T.E., Personius, S.F., Seitz, G.G., Reidy, L.M., and Schwartz, D.P., 2002b, A record of large earthquakes on the southern Hayward fault: Seismological Society of America Bulletin, v. 92, no. 7, p. 2637-2658.

Lienkaemper, J., Williams, P., Dawson, T., Personius, S., Seitz, G., Heller, S., and Schwartz, D. 2003, Logs and data from trenches across the Hayward fault at Tyson's Lagoon (Tule Pond), Fremont, Alameda County, California: U.S. Geological Survey Open-File Report 03-488, version 2.0, 6 p., 8 plates. [http://pubs.usgs.gov/of/2003/of03-488/]

Williams, P.L., 1993, Geologic record of southern Hayward fault earthquakes: California Division of Mines and Geology Special Publication, v. 113, p. 171-179.

Woodward-Clyde and Associates, 1970, Fremont Meadows active fault investigation and evaluation, Fremont, California [on file at California Division of Mines and Geology, San Francisco, California; file no. AP-744].

Working Group on California Earthquake Probabilities, 2003, Earthquake probabilities in the San Francisco Bay Region: 2000-2030: U.S. Geological Survey Open-File Report 03-214, 235 p. [http://geopubs.wr.usgs.gov/open-file/of03-214/]



LOG OF TRENCH 04A ACROSS THE HAYWARD FAULT AT TYSON'S LAGOON (TULE POND), FREMONT, ALAMEDA COUNTY, CALIFORNIA

By

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2005

This map was printed on an electronic plotter directly from digital files. Dimensional calibration may vary between electronic plotters and between X and Y directions on the same plotter, and paper may change size due to atmospheric conditions; therefore, scale and proportions may not be true on plots of this map.

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