FINAL TECHNICAL REPORT

COMPILING SOILS AND GEOCHRONOLOGIC DATA TO IMPROVE LIQUEFACTION SUSCEPTIBILITY MAPPING, SAN FRANCISCO BAY AREA

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Program Element II
Keywords: age dating, liquefaction,Paleoseismology, surficial deposits

U. S. Geological Survey
National Earthquake Hazards Reduction Program
Award Number 02HQGR0074

June 6, 2003

Research supported by U.S. Geological Survey (USGS), Department of the Interior, under USGS award number 02HQGR0074. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government.

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Award #02HQGR0074

COMPILING SOILS AND GEOCHRONOLOGIC DATA TO IMPROVE LIQUEFACTION SUSCEPTIBILITY MAPPING, SAN FRANCISCO BAY AREA: YEAR 1

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ABSTRACT

To improve Quaternary geology and liquefaction susceptibility mapping of the San Francisco Bay Area, we are developing a database of existing geochronologic data, including isotopic and radiogenic data, soil-profile development data, paleontological records, and archeological records. Our emphasis is on late Pleistocene to Holocene ages that would help in documenting deposits most susceptible to liquefaction in the nine-county San Francisco Bay Area. In the first funded year of this project, we developed the database structure, assessed the availability and quality of existing geochronological data, and prepared a sample database of fifty records. We began by soliciting input from a panel of experts including geologists from the U. S. Geological Survey, the California Geological Survey, Lawrence Livermore Laboratory, private industry and an archeologist from Sonoma State University. Each panel member filled out a questionnaire and attended a workshop to discuss the project. Topics included: purposes for which the data are likely to be used; data fields to be included, strategies for representing variability in data quality; data access; sources of data; and issues of availability. We decided on an Excel spreadsheet having 48 columns for each record during an iterative process that involved entering data from varied sources and making changes to the database structure. Our goal is to provide sufficient information about each record so that the data are useful without making the compilation arduous. Publication of the data via the Internet will allow ready updating and easy access by a wide range of professionals. The Web presence will stimulate data submissions and improvements in geochronology and its documentation. We plan to add over 1000 ages to this database, import the data into ArcGIS, and develop an interactive GIS-based web site to make these data available to the professional community. The sample database currently resides at a private location on the Web (see appendix or visit http://soiltectonics.com/Downloads/Qdatabase.xls to see a read-only copy [click on “cancel” when asked for authorization to the read/write file]). This project lays the foundation for the next generation of Quaternary geology and liquefaction susceptibility maps in the San Francisco Bay Area.

1.0 INTRODUCTION

1.1 Background and Purpose

To improve existing Quaternary geology and liquefaction susceptibility mapping of the San Francisco Bay Area, we are developing a database of existing geochronologic data, including isotopic and radiogenic data, paleontological records, archeological records, soil-profile development data, and tephrochronology. Our emphasis is on data from late Pleistocene to Holocene age, the age of deposits most susceptible to liquefaction, for the entire nine-county San Francisco Bay Area.

Accurate age estimates are critically needed to improve the resolution of existing Quaternary geologic maps and the accuracy of the derivative liquefaction susceptibility maps in the San Francisco Bay Area. Past and ongoing NEHRP-funded projects to map Quaternary geology and liquefaction susceptibility have lacked ready access to geochronologic data that could be used to accurately assess deposit age. These studies (e.g., Knudsen and others, 2000) estimated age through an assessment of geomorphic position and age-dependent surface characteristics. A region-wide compilation of site-specific geochronologic data was not within the scope of these earlier efforts. As a result, the existing maps are often unable to resolve significant differences in age between similar deposits, as for example, between latest Pleistocene and Holocene deposits. This is unfortunate because there is a strong dependence of liquefaction susceptibility on deposit age, with the Pleistocene-Holocene transition providing a significant change in susceptibility. This new work will help to resolve these uncertainties, improve map accuracy, and improve the characterization of liquefaction susceptibility.

1.2 Approach

At the request of the NEHRP panel, our first-year effort focused on development of a database structure and an inventory of potential sources of geochronological data. We began by soliciting input from a panel of experts. The database is intended to be used by the professional community so input early in the project from potential users was deemed essential.

The database presented here is designed to provide sufficient information about each record so that the data are useful, without making the process of compiling and entering the data unnecessarily arduous. It is sure to be used by a wide variety of academic, government, and private researchers, and by other professionals as well as the general public. As such, it must be accessible, easy-to-use, and as accurate as possible. The final database structure is in Microsoft Excel format and contains 48 columns for data entry.

In the future we plan to add over 1000 ages to this database, import the data into ArcGIS, and develop an interactive GIS-based web site to make these data available to the professional community (Figure 1). Publication of the data via the Internet will allow ready updating and easy access by a wide range of professionals. The Web presence will stimulate data submissions and improvements in geochronology and its documentation

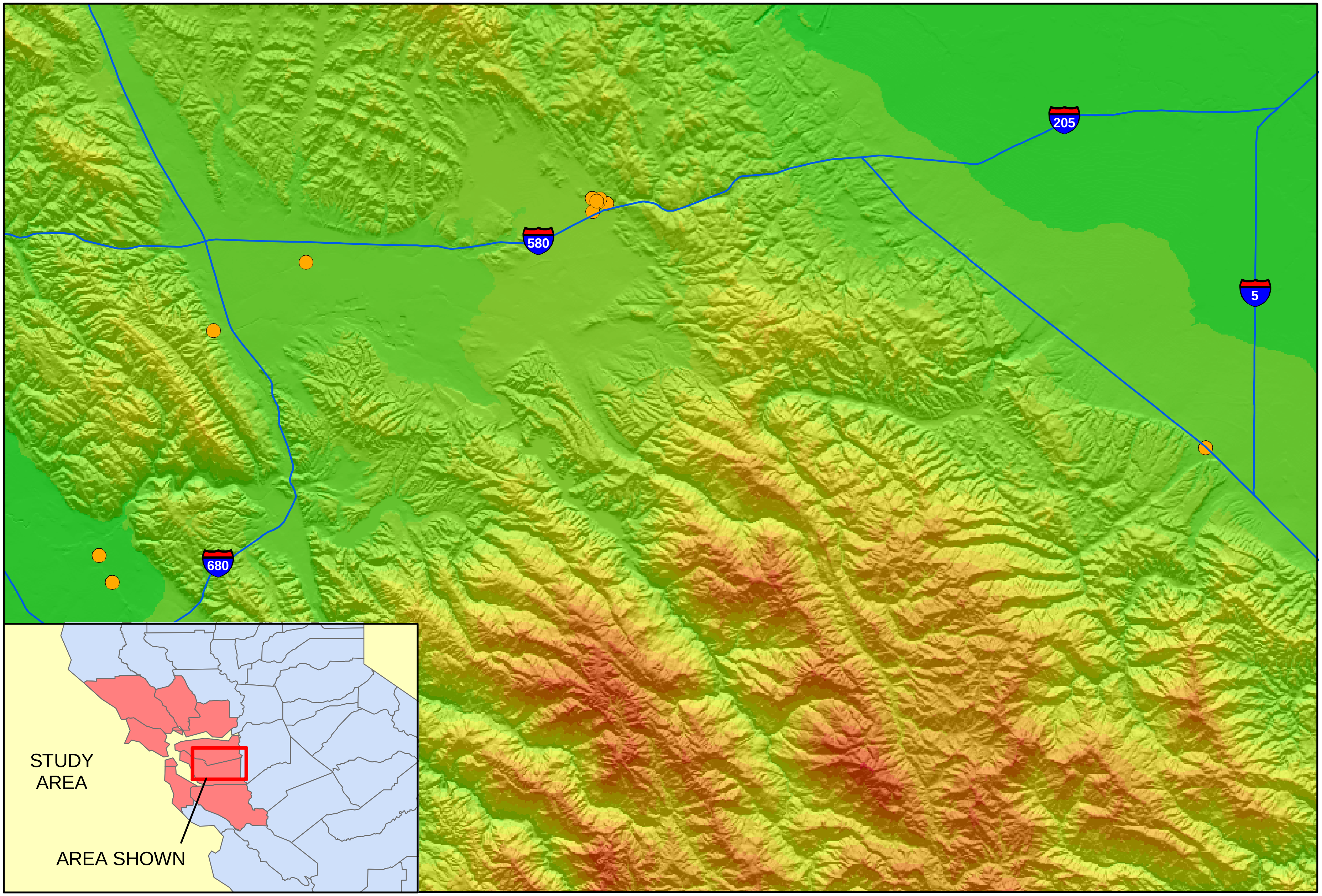

Figure 1. Geochronologic site locations (orange dots) are plotted in ArcGIS, and can be viewed on a variety of base maps, including shaded relief, USGS topographic maps, and Quaternary geologic maps. Inset shows nine-county study area.

1.3 Project Scoping

To gain guidance and perspective on the needs for and uses of such a database, we began by soliciting input from a panel of experts. Panel members included Carl Wentworth and Suzanne Hecker of the U. S. Geological Survey, Keith Knudsen of the California Geological Survey, Janet Sowers and Andrew Barron of William Lettis & Associates, Glenn Borchardt of Soil Tectonics, Gordon Seitz of the Lawrence Livermore Laboratory, and Jack Meyer of Sonoma State University. Archeologist Jack Meyer has already compiled, in Excel format, essential data for 1,030 radiocarbon dates from northern California, with most from the San Francisco Bay Area.

Each member of the panel filled out a questionnaire and attended a workshop to discuss the project. Topics covered included:

- Purposes for which the data are likely to be used
- Data fields to include for each record
- Strategies to properly represent variability in data quality
- Ways one should be able to access the database
- Sources of data in the San Francisco Bay Area
- Issues of data availability

Panel members envisioned a variety of purposes for which the database might be used. In addition to constraining ages of Quaternary units for the assessment of liquefaction susceptibility, the project could enable a new reconstruction of the paleoenvironment and late Quaternary history of the San Francisco Bay Area. This exciting project would have implications for the development of tectonic information such as uplift and subsidence rates, or rates of landform modification. Archeologists will use the data to understand the nature and timing of landscape evolution to improve predictions on where archeological materials are likely to be found. The database also will be used to help select sites where paleoseismic studies could be successfully conducted.

There was, of course, much discussion regarding which specific data fields to include in the database. However, panel members agreed to leave it to the principal investigators to create a first draft of the database. Technical panel members then were invited to provide additional input in the form of review comments. Revisions and improvements continued to be made until all issues and comments were addressed. The database presented here in is the result of this process.

Panel members were concerned about the future maintenance and publication of the database. Clearly, such activities would require ongoing funding. If the database were regularly updated, and published via the web, funding would need to cover the costs of adding new data to the database, providing quality control for the database as a whole, and maintaining the website. If a hardcopy publication were desirable, funding would be needed for that specifically. After the project is completed, the next step would be to identify some individual or institution committed to the project and work to obtain ongoing funding for them.

Another issue brought up by the panel was whether the database should include an evaluation of the reliability of the data. While it is true that some data are more reliable and complete than others, we felt that to assign reliability ranking was outside the mission of this project. It seemed a daunting task to come up with a fair scheme that reduced reliability to a single number. Reliability is a combination of several types of uncertainty. Instead we devoted several columns in the database to assessing sources of uncertainty. These include location uncertainty, laboratory analytical uncertainty, context uncertainty, sample quality, correction and calibration procedures, and significance of age. Another measure of reliability will be the completeness of the record; if important information is missing, the data may be seen as less reliable. With the information available in the database, individual users can assess reliability of the data by standards relevant to their specific projects.

2.0 DATABASE STRUCTURE AND PROCEDURES

2.1 Database Structure

The database is designed as a spreadsheet in Microsoft Excel. Each data field occupies a column and each record occupies a row. Data fields were designed to provide the essential information needed for the researcher to interpret the significance of the geochronological data. There is no requirement that every field be filled, however, the more data shown the more potentially useful the data. The 48 data fields are organized into six sections as described below (Table 1).

TABLE 1. DATABASE OUTLINE

Section	**Description**
Section I: Location Coordinates	Location coordinates in one of four formats - UTM, Latitude-longitude, Street address, or BLM system, used to plot site location in GIS.
Section 2: Site Information	Additional information about the site location, including location uncertainty, sample depth, county, and quad sheet.
Section 3: Geologic Setting	Description of the geologic setting and the nature of the sample.
Section 4: Age	Age data in conventional and calibrated format, with analytical uncertainty.
Section 5: Interpretation	Information such as context uncertainty, sample quality, calibration procedures, and significance to help users interpret the age.
Section 6: Documentation	References and other data that give access to further information on that age result.

Section 1 contains the sample location coordinates. To speed data entry, the user has a choice of four different formats for location information. Only one format is required for each sample. The format choices are: UTM coordinates, latitude and longitude, street address, or BLM township range and section. The preferred formats are UTM coordinates and latitude and longitude. However, such information may not be readily available. Regardless of format, the data in Section 1 must be sufficient for the sample to be plotted on a map in GIS.

Section 2 contains additional location information, such as location uncertainty, elevation, county, name of USGS 7.5' map, and further location details. These data are optional, though useful.

Section 3 contains geological information about the site and sample that help with understanding and interpreting the data. Included in this section are geologic context, stratigraphic unit, field sample number, material sampled, and depth.

The fourth section presents the age results for the sample. Data fields include method of analysis, time range or period, numerical age, conventional C-14 age, laboratory uncertainty, calibrated C-14 age, calibrated range, sigma, and carbon-13/12 delta ratio. This section is flexible enough to allow entry of age data for any method. For example, a fossil bone might have the method of analysis in column AC listed as "paleontology," and state an age of "Irvingtonian" in column AD. A U-series age would state "U-series" in column AC, give a numerical age in column AE, a lab uncertainty in column AG, and report sigma in column AK. Or, a modern radiocarbon age may have detailed data entered in columns AF through AL.

Section 5 provides an opportunity to assess the quality of the data by describing important factors that affect the interpretation of the results. These include context error or how the age of the sample relates to the age of the deposit, sample quality, a listing of any calibration or correction procedures used, and a discussion of the significance of the age result.

In Section 6 documentation and reference information is given. This information enables the user to locate additional information about the sample if desired. Data include laboratory name, sample number, reference document, institution responsible, date of data entry, and the name of person who entered the data.

The data entry form is a standard Excel spreadsheet with the data fields listed across the top as column headings (Table 2). The text explaining each data field or column heading pops up in a small box to the side when the pointer is moved into the column heading cell. This text is provided in Table 3.

2.2 Data Entry Methods and Standards

To test the utility of the database we have entered 50 records, including radiocarbon, uranium series, paleontologic, and soils data (see appendix or visit http://soiltectonics.com/Downloads/Qdatabase.xls to see a read-only copy [click on "cancel" when asked for authorization to the read/write file]). Some data were taken from our own projects, others from the literature. We found the database structure to be flexible and able to

TABLE 2. BLANK DATA ENTRY FORM

Record number	SECTION 1: LOCATION COORDINATES (Choose one method)														SECTION 2: SITE INFORMATION						SECTION 3: GEOLOGIC SETTING OF SAMPLE						
	UTM		Latitude			Longitude				BLM system																	
	North (m)	East (m)	degrees	min	sec	degrees	min	sec	Street address	Twp	Rng	Sec	1/4 Sec.	1/4 of 1/4 Sec	Location uncertainty (radius in m)	Elev (ft)	Elev (m)	County	7.5'quad	Location details	Geologic context	Strat. unit	Field sample no.	Material sampled	Min. Depth	Max. Depth	Depth units
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB
1																											
2																											
3																											
4																											
5																											
6																											
7																											
8																											
9																											
10																											
11																											
12																											

Record number	SECTION 4: AGE										SECTION 5: INTERPRETATION			
	Age data					**C-14 Calibration**								
	Method of analysis	**Time period or Range**	**Numerical age** (not C-14)	**Conventional C-14 age** RCY B. P.	**Lab uncertainty** + or -	**Calibrated C-14 age** cal B. P.	**Calibrated maximum age** cal B. P.	**Calibrated minimum age** cal B. P.	**Sigma (1 or 2)**	**$\delta^{13}C$**	**Temporal and contextual uncertainty**	**Sample quality**	**Calibration, correction procedures**	**Significance of age**
A	**AC**	**AD**	**AE**	**AF**	**AG**	**AH**	**AI**	**AJ**	**AK**	**AL**	**AM**	**AN**	**AO**	**AP**
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														

Record number	SECTION 6: DOCUMENTATION					
	Lab sample no	Lab name	Reference	Institution	Date Entry Last Revised	Entered by
A	AQ	AR	AS	AT	AU	AV
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

TABLE 3. EXPLANTATION OF DATA FIELDS

Column #	Column Heading	Explanation
A	Record number	A sequential number assigned by order of data entry and linked to GIS
SECTION 1. LOCATION COORDINATES*		
	UTM:	Universal Transverse Mercator coordinates
B	North (m)	Meters north of the origin, NAD 27, Zone 10 north, e.g. 4164500
C	East (m)	Meters east of the origin, NAD 27, Zone 10 north, e.g. 644000 Assumes sector 10
	Latitude:	NAD27
D	Degrees	Enter whole degrees here (e.g. 38), then enter minutes and seconds in the next two columns. Alternatively, enter degrees with decimal equivalents here, and nothing in the next two columns (e.g. 38.25)
E	Minutes	Minutes north latitude, 0 to 59. Decimal minutes okay, e.g. 15.25
F	Seconds	Seconds north latitude, 0 to 59
	Longitude:	NAD27
G	Degrees	Enter whole degrees here (e.g. 121), then enter minutes and seconds in the next two columns. Alternatively, enter degrees with decimal equivalents here, and nothing in the next two columns (e.g. 121.56)
H	Minutes	Minutes longitude, 0 to 59. Decimal minutes okay, e.g. 15.25
I	Seconds	Seconds longitude, 0 to 59
J	**Street Address**	Give number, street, city, state, and zip code
	BLM system:	Bureau of Land Management's Township-Section system
K	Twp	Township, e.g. T1N
L	Rng	Range, e.g. R5E
M	Section	Section, e.g. 16
N	1/4 Sec	Quarter section, e.g. NE
O	1/4 of 1/4 Sec	Quarter of quarter section, e.g. NW1/4 of NE1/4

Column #	Column Heading	Explanation
SECTION 2. SITE INFORMATION		
P	Location error	Radius of circle, in meters, that includes the site. Circle is centered on the location (UTM, Lat-Long point, BLM location, or street address) given above. If an archeological site, enter UTM coordinates rounded down to nearest 1,000 m UTM block in columns B and C, and enter here "SW corner of 1,000 m UTM block."
Q	Elev (ft)	Elevation of the ground surface, in feet AMSL (above mean sea level). Use surveyed site elevation or interpolate between contours on a USGS 7.5, map. Leave blank if entering elevation in meters in the next column.
R	Elev (m)	Elevation of the ground surface, in meters AMSL (above mean sea level). Use surveyed site elevation or interpolate between contours on available metric maps. Leave blank if entering elevation in feet in the previous column.
S	County	Name of county in California
T	7.5' quad	Name of U. S. Geological Survey 7.5-minute quadrangle map, scale = 1:24,000, on which the site is located.
U	Location details	Give additional available location details such as trench or pit number, distance from intersections or other geographic features.
SECTION 3. GEOLOGIC SETTING		
V	Geologic context	Nature and origin of deposit that hosts sample, geomorphic setting, or landform.
W	Strat. unit	Stratigraphic unit from which the sample was taken, as described in the reference publication or report (column AP).
X	Field sample #	Number given to sample in the field.
Y	Material sampled	Describe material sampled, for example, detrital charcoal, peat, bone, disseminated organic matter, soil carbonate, shell, mammoth tooth, charred wood, etc. Be specific.
Z	Min. Depth	Minimum depth below ground surface from which sample was taken. Designate units in column AB.
AA	Max. Depth	Maximum depth below ground surface from which sample was taken. Designate units in column AB.
AB	Depth units	Units used to measure depth in the previous two columns, for example cm, ft, or m.

Column #	Column Heading	Explanation
SECTION 4. AGE		
AC	Method of analysis	Methods may include conventional radiocarbon, AMS radiocarbon, U-Th, Pb-210, obsidian hydration, paleontology, TL, OSL, Amino Acid Racemization, and others. Be specific.
AD	Time period or range	Time period or range determined by non-numerical methods. Examples include biostratigraphic age, archeological time period, oxygen isotope stage, glacial stage, geologic period or epoch, Quaternary unit, or a numerical range based on a correlated or calibrated methods such as paleontology, archeology, or soils.
AE	Numerical age (not C-14)	Numerical ages, in "years ago", from numerical methods other than radiocarbon (C-14) such as U-Th, Pb-210, obsidian hydration, TL, OSL, Amino Acid Racemization.
AF	Conventional C-14 age (RCY B.P.)	Uncalibrated radiocarbon age, in radiocarbon years before present (RCY B.P.).
AG	Lab uncertainty (+/-)	Laboratory uncertainty in uncalibrated radiocarbon age or other numerical age, in years plus or minus. If +/- values are different, list both, e.g. +240,-300.
AH	Calibrated C-14 age (cal B.P.)	Calibrated intercept, as computed by author. Calibration method should be listed in column AG.
AI	Maximum age (cal B. P.)	Calibrated maximum age (cal B. P.)
AJ	Minimum age (cal B. P.)	Calibrated minimum age (cal B. P.)
AK	Sigma (s) (1 or 2)	Statistical basis for calculation of calibrated age range. Put "1" if one sigma, "2" if 2 sigma(s).
AL	$\delta^{13}C$	$\delta^{13}C$ per mil relative to PDB standard.
SECTION 5. INTERPRETATION		
AM	Context error	Note temporal relationship between the sample and the deposit. I s the sample expected to be older than, younger than, or contemporaneous with the deposit? Does sample age provide a minimum constraint on the age of the deposit (for example: soil carbonate)? Or a maximum constraint (for example, charcoal reworked from an older deposit)?
AN	Sample quality	Describe sample features (e.g. color, structure, purity) that affect its suitability for dating. How well does the sample meet the requirements of the method?

Column #	Column Heading	Explanation
AO	Calibration, correction, procedures	List specific calibration and correction procedures used, including name and version of any computer programs. List references for procedures used.
AP	Significance of age	What scientific issue(s) does this age result address?
SECTION 6. DOCUMENTATION		
AQ	Lab sample no.	Number given to the sample by the laboratory.
AR	Lab name	Full name of laboratory including address.
AS	Reference	List the complete reference for the original publication or report in which these age data appear. If none, give names of principal investigators and date of work. List URL's of any websites that give additional information on this age.
AT	Institution	List the institution of the principal investigator at the time of the study, or the institution responsible for the study from which additional information can be obtained. Please give name and address.
AU	Date entry last revised	Month, day, and year
AV	Entered by	Name or initials of person entering data.

Notes: *Only one of the four location methods is required: (1) UTM, (2) Lat-long, (3) street address, or (4) BLM system.

Abbreviations and Definitions:

1 sigma	One standard deviation. Two-thirds of repeated measurements will yield ages within one standard deviation of the mean.
2 sigma	Two standard deviations. 95% of repeated measurements will yield ages within two standard deviations of the mean.
AMS	Accelerator mass spectroscopy
GIS	Geographic Information System
ka	Kilo anno, thousands of calendar years before present (1950 A.D.)
NAD27	Coordinate system used on most topographic maps in California
NAD83	Alternate coordinate system used on some maps
NA	Not applicable
ND	Not determined
NR	Not reported in reference documents
no	Number
OSL	Optically stimulated luminescence
TL	Thermoluminescence dating

accommodate a variety of data from different methods and geologic contexts. Some data records are brief, and may simply contain a location, a material sampled, method used, an age, and a reference. Other data have more associated context information, documentation, and analytical data. The more complete data will, of course, be more useful and can be more readily interpreted by other researchers.

Some data were so poor or incomplete that they were not suitable for inclusion in the database. These data were missing important information, or reported an age result, location, or context that was clearly in error. To be included in the database each record had to contain information for the following fields:

1. Sample location (known to within a 1000-meter-square block)
2. Material sampled
3. Method of analysis
4. Age result
5. Reference

If the data seemed useful regardless of dubious quality, they were included if accompanied by explanations and comments regarding potential uncertainty in the appropriate columns.

Quality control procedures for data entry were also established. To insure the highest accuracy and quality of the information, each chronometric date was entered into the database using the publications, reports, records, and maps in which the information originally appeared. The relevant information that was available for each date was entered into the appropriate columns across a single row of the database in accordance with the standards outlined in column 3 of the database structure (Table 2). A unique sequential record number was assigned to each row of data. This record number was displayed on the GIS map and can be used to retrieve the complete Excel data for that record.

The entry of data focused on dates with consistent and complete documentation, and those most useful to liquefaction studies. Data was rejected if, for example, location was not known within a 1000-meter block, the original reference was not available, or no geologic context or sample material information was provided. The entries were reviewed regularly for accuracy and consistency in an effort to find and correct potential data entry errors.

All data fields need not be filled in with data. However, all blank data fields were filled in with a code that explains the lack of data. The code "NA" means "Not Applicable" and refers to data fields that logically should not apply to a particular record. For example, when a thermoluminescence age was reported in column AE the columns for radiocarbon results, columns AF, AH, AI, AJ, AK, and AL, were each filled with "NA." The code "ND" means "Not Determined" and was placed in the column if a particular piece of relevant data was not determined; for example if sample depths were not measured or sample quality was not recorded. Note that "ND" was used only when it was clear that the data were not determined by the study and there was little chance that further research would lead to retrieval. The code “NR” means "Not Reported" and refers to data that may have been determined but were not included in the reference. For example, laboratory names and lab sample numbers often are not reported. If it is unclear whether the data were not determined or simply not reported, the default code is "NR."

The exception to the rule in the above paragraph is in Section 1. Only one location coordinate method was filled out for each record, and other columns in Section 1 were left blank.

3.0 SOURCE DATA INVENTORY

Also in this first year, we identified the institutions, agencies, consultants, individuals, and publications from which late Quaternary soils and geochronological data for the San Francisco Bay Area can be obtained. We have made a preliminary evaluation of the amount and quality of the different types of data available.

TABLE 4. SOURCES OF GEOCHRONOLOGIC DATA

SOURCE	COMMENTS
Published compilations: For example, Wright (1971), Frizzell and others (1972), Price (1982), Wigginton and Carey (1982), Breschini and others (1996)	These early compilations are very valuable, although the complete supporting data are not always provided. Original references can be obtained in most cases. Data from Breschini and others (1996) are voluminous, but are from archeological sites and do not provide site locations.
Alquist-Priolo fault investigations: Available from CGS, cities, and counties	A-P reports contain minor amounts of geochronologic data, depending on the scope of the investigation. The reports are currently being put on compact disc so that they can be easily searched for relevant data.
USGS NEHRP reports and publications: USGS Menlo Park library, journals	NEHRP-funded paleoseismic reports often contain high quality age data directly relevant to Quaternary studies. Some reports are available electronically.
University of California Museum of Paleontology records, and records from other Bay Area museums	Most of these data will relate to paleontologic or archeologic sites.
Archeological site records: Northwest Information Center, Rohnert Park, CA	Abundant data exists, primarily for the middle to late Holocene. However, protection of archeological site location information must be addressed. See text.

SOURCE	COMMENTS
Consultants’ reports: available from local geological consultants including William Lettis & Associates, Geomatrix, URS, Soil Tectonics, Cotton, Shires and Associates, Kleinfelder, Connelly, Lowney, ENGEO, Brunsing Associates	Data are fair to excellent quality and often directly relevant to Quaternary studies. Some data may be proprietary and others are public. Good cooperation and participation are expected.
Field trip guidebooks	Some unpublished geochronologic data can be found in the "gray" literature, including field trip guidebooks.
Private files of local geologists, including USGS scientists, consultants, and university professors, for unpublished data	A potential treasure trove of data. Availability will depend on the interest and participation of the geologists.
Radiocarbon laboratory records	Large volumes of data exist. Permission of the researcher for each project must be obtained before inclusion in the database.

The inclusion of geochronologic data associated with archeological sites presents a special challenge. The National Historic Preservation Act prohibits any undertaking that has the potential to cause negative effects to historic properties. The Archeological Resource Protection Act protects site location information and exempts archeological site information from the Freedom of Information Act.

To include the wealth of age information associated with the many archeological sites in the Bay Area, we took preliminary steps to ensure that exact locations were not provided in the database nor shown on the GIS map. To that purpose, the location coordinates of archaeological sites were rounded to the nearest 1000-meter UTM interval (both easting and northing) so the exact location did NOT appear in the database. By using the rounded interval, an arbitrary 1000-meter UTM-block was generated for purposes of depicting the location of these samples on the GIS-map without disclosing the exact location of the site. Only the rounded-down UTM coordinates were included in the database; no further location information was given.

We have arranged for these safeguards to be reviewed by a qualified USGS official, and to determine whether this project is an "undertaking" as defined in section 301(7) of the National Historic Preservation Act (16 USC 470f), and if so, determine the obligations of the USGS under 36 CFR Part 800 (as amended). At the writing of this report, cultural resources specialists at the U. S. Geological Survey have been contacted with information about the project and the proposed method of protecting site information. After their review is complete, we will implement the USGS recommendations.

Another challenge in assembling this database is the large volume of age data that is not published. Especially in recent years, it has become common to run multiple radiocarbon samples in the same unit so that a confident statistical average can be determined. The individual age results then are not published, only the resulting averages. Two options seem feasible for dealing with these data. We may choose in some cases to enter the average results into the database, then make comments to that effect and provide references or access information for the complete data. In other cases it may be more desirable to request the complete data from the researcher and publish them in their entirety in the database. The degree of cooperation and interest on the part of the researcher will likely be a major factor in choosing the appropriate method for a specific data set. Permission would be obtained from the researcher before entering any unpublished data in the database.

4.0 CONCLUSIONS

This pilot database containing 50 sample data records, along with this report are herein submitted as the final technical report for this year. Additional funding will be needed to add more data to the database, import the data into GIS, and develop a website for publication of the database. A second year of funding has been requested for FY 2004.

This project will lay the foundation for the next generation of Quaternary geology and liquefaction susceptibility maps in the San Francisco Bay Area. The geochronologic database will enable the needed improvements to age estimates for many map units, critical to accurate liquefaction susceptibility assessments. In addition, the database will be available to other studies of Bay Area Quaternary geology including earthquake fault history. Publication of the data via the Internet will allow instant updating and easy access by a wide range of professionals. The Web presence should stimulate data submissions and improvements in geochronology and its documentation.

5.0 REFERENCES

Breschini, Gary S., Trudy Haversat, and Jon Erlandson, 1996, California Radiocarbon Dates, Eighth Edition.

Frizzell, Virgil A., ed., 1972, Progress report on the USGS Quaternary studies in the San Francisco Bay Area, an informal collection of preliminary papers: Guidebook for the Friends of the Pleistocene, October 6-8, 1972. Dates for Mountain View dump, sag pond near La Honda, others.

Price, Carol A., 1982, Maps showing locations of radiocarbon-dated samples from Central and Northern California: U. S. Geological Survey MF-1321.

Wigginton, W. B., and Carey, Debra, 1982, Age dating of Holocene deposits within the Livermore and San Ramon Valleys, in Hart, E. W., Hirschfeld, S. E., and Schulz, S. S., eds., Proceedings of the Conference on Earthquake Hazards in the Eastern San Francisco Bay Area, California Division of Mines and Geology Special Publication 62, p. 207-216.

Wright, Robert H., 1971, Map showing locations of samples dated by radiocarbon methods in the San Francisco Bay region: U. S. Geological Survey, Miscellaneous Field Studies Map, MF-317, BDC 33, scale = 1:500,000.

Non-technical Summary:

This project is to compile existing age data on young (<50,000 years) deposits, to support Quaternary geology and liquefaction susceptibility mapping the San Francisco Bay Area. An Excel database structure has been developed and 50 sample records entered. The database provides details such as site location, geologic context, material sampled, method of analysis, numerical age, uncertainty, data quality, laboratory, and reference. In the future sample locations will be shown on a GIS map and the data will be accessible on a website. Input was solicited from technical experts to guide creation of the database and the acquisition of the data.

Reports published

None

APPENDIX A. SAMPLE DATA

Appendix A contains tabulated records for fifty sample geochronologic data from the San Francisco Bay Area. These tables are printed from a Microsoft Excel file. Due to the cell-size limits established for printing, some text may be truncated. Complete text can be viewed in Excel at the following private URL address.

http://soiltectonics.com/Downloads/Qdatabase.xls

Key to abbreviations

NA	Not Applicable
ND	Not Determined
NR	Not Reported in reference documents

Record number	SECTION 1: LOCATION COORDINATES (Choose one method)														SECTION 2: SITE INFORMATION						SECTION 3: GEOLOGIC SETTING OF SAMPLE						
	UTM		Latitude			Longitude				BLM system																	
	North (m)	East (m)	degrees	min	sec	degrees	min	sec	Street address	Twp	Rng	Sec	1/4 Sec.	1/4 of 1/4 Sec	Location uncertainty (radius in m)	Elev (ft)	Elev (m)	County	7.5'quad	Location details	Geologic context	Strat. unit	Field sample no.	Material sampled	Min. Depth	Max. Depth	Depth units
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB
1	4,157,584	590,391													4	52		Alameda	Niles	Trench M2, ~150m N of Tule Pond	Fluvial and lacustrine sediments	Unit 32	ND	ND	2.8	3.2	m
2	4,157,584	590,391													4	52		Alameda	Niles	Trench M2, ~150m N of Tule Pond	Fluvial and lacustrine sediments	Unit 17	ND	ND	1.5	2.5	m
3	4,157,584	590,391													4	52		Alameda	Niles	Trench M2, ~150m N of Tule Pond	Fluvial and lacustrine sediments	Unit 60	ND	ND	1.8	2.2	m
4	4,157,584	590,391													4	52		Alameda	Niles	Trench M2, ~150m N of Tule Pond	Fluvial and lacustrine sediments	Unit 18	ND	ND	1.8	2.2	m
5	4,157,584	590,391													4	52		Alameda	Niles	Trench M2, ~150m N of Tule Pond	Fluvial and lacustrine sediments	Unit 11	ND	ND	2.5	3	m
6			37	32.98		121	58.11								20		17.8	Alameda	Niles	SW wall of trench DMG-3 at station 8.8 m NE of the west branch of	Gravel to overbank transition	In coarse sand immediately beneath offset	86B077	Desseminated Charcoal	195	205	cm
7			37	32.98		121	58.11								20		17.8	Alameda	Niles	SW side of fault in the NE wall of trench DMG-2 at station 26.8 m SW of the	Gravel to overbank transition	15 cm Below Top of Channel Gravel (2C soil horizon)	86B095	1-cm Chunk of Charcoal	180	180	cm
8			37	32.98		121	58.1								20		17.3	Alameda	Niles, CA	Lowest point in middle of downwarp on NE side of the west branch of	Soil carbon in upper 130 cm of Soil Profile No. 4	MRT of poorly drained A soil horizon on NE side of	86B086	Bulk soil sample in groove 4 cm wide, 4 cm deep, and 130 cm long at	0	130	cm
9			37	32.98		121	58.1								20		17.3	Alameda	Niles, CA	Lowest point in middle of downwarp on NE side of the west branch of	Pedogenic carbonate in upper portion of the Bk horizon of Soil Profile No. 4	Bk soil horizon (upper portion)	86B087	Bulk soil representative of the pedogenic carbonate in the	54	84	cm
10			37	32.96		121	58.1								20		19.2	Alameda	Niles, CA	Edge of the downwarp on the NE side of the west branch of Hayward fault	Pedogenic carbonate in entire Bk horizon	Bk soil horizon (entire horizon)	86B055	Bulk soil representative of the pedogenic carbonate in the	87	207	cm
11			37	39.712		121	54.97								3	499		Alameda	Dublin	About 143' SSE of former residence on the west side of the Calaveras	Paleosol at toe of landslide	2Bbkt horizon of Soil Profile No. 1 at station	99B084	Bulk sample representative of all pedogenic carbonate in this profile	304	368	cm
12			37	39.711		121	54.971								3	500		Alameda	Dublin	About 145' SSE of former residence on the west side of the Calaveras	Landslide plane	2Bbkt horizon of Soil Profile No. 1 at station	99B086	Bulk sample representative of pedogenic carlcite formed only within the	316	326	cm
13			37	43.238		121	42.04								5	592		Alameda	Altamont	Between stations 303' and 550' in Trench No. 4	Alluvial plain	Between the base of a sandy channel deposit and	Project 85087-A	Sediment organic matter	7	8	ft
14			37	43.272		121	42.318								5	568		Alameda	Altamont	At station -53' in the north wall of Trench No. 6	Alluvial plain	Between the base of a sandy channel deposit and	NR	Fossil Harlan's ground sloth femur	7.7	7.9	ft
15			37	43.024		121	42.505								5	564		Alameda	Altamont	Test pit TP-4	Alluvial plain	Soil Profile No. 1	85B075-82	Soil	0	320	cm

Record number	SECTION 4: AGE										SECTION 5: INTERPRETATION			
	Age data					C-14 Calibration								
	Method of analysis	Time period or Range	Numerical age (not C-14)	Conventional C-14 age RCY B. P.	Lab uncertainty + or -	Calibrated C-14 age cal B. P.	Calibrated maximum age cal B. P.	Calibrated minimum age cal B. P.	Sigma (1 or 2)	$\delta^{13}C$	Temporal and contextual uncertainty	Sample quality	Calibration, correction procedures	Significance of age
A	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP
1	C-14	NA	NA	NR	NR	1,200	1,315	1,085	1.6	NR	Detrital charcoal is older than the sediment in which it is found.	NR	Calibration applied using time series of Stuiver and Pearson (1986). Standard deveiation includes an inter-laboratory error multiplier = 1.60.	Helps constrain timing of ruptures on Hayward fault.
2	C-14	NA	NA	NR	NR	240	480	0	1.6	NR	Detrital charcoal is older than the sediment in which it is found.	NR	Calibration applied using time series of Stuiver and Pearson (1986). Standard deveiation includes an inter-laboratory error multiplier = 1.60.	Helps constrain timing of ruptures on Hayward fault.
3	C-14	NA	NA	NR	NR	1,880	2,040	1,720	1.6	NR	Detrital charcoal is older than the sediment in which it is found.	NR	Calibration applied using time series of Stuiver and Pearson (1986). Standard deveiation includes an inter-laboratory error multiplier = 1.60.	Helps constrain timing of ruptures on Hayward fault.
4	C-14	NA	NA	NR	NR	1,030	1,280	780	1.6	NR	Detrital charcoal is always older than the sediment in which it is found.	NR	Calibration applied using time series of Stuiver and Pearson (1986). Standard deveiation includes an inter-laboratory error multiplier = 1.60.	Helps constrain timing of ruptures on Hayward fault.
5	C-14	NA	NA	NR	NR	2,090	2,300	1,880	1.6	NR	Detrital charcoal is older than the sediment in which it is found.	NR	Calibration applied using time series of Stuiver and Pearson (1986). Standard deveiation includes an inter-laboratory error multiplier = 1.60.	Helps constrain timing of ruptures on Hayward fault.
6	AMS	NA	NA	7,990	160	8,814	9,030	8,597	ND	NR	Detrital charcoal is older than the sediment in which it is found.	NR	Calibrated by Glenn Borchardt on 6/1/03 by using the University of Washington, Quaternary Isotope Lab Radiocarbon Calibration Program Rev. 4.3	Dates 44.5 m of offset along the western trace of the Hayward fault, yielding a horizontal slip rate of 44.5m/8.81 ky = 5.05 mm/yr. Also dates coarse-to-fine
7	AMS	NA	NA	8,260	190	9,230	9,435	9,024	1	NR	Detrital charcoal is older than the sediment in which it is found.	NR	Calibrated by Glenn Borchardt on 6/1/03 by using the University of Washington, Quaternary Isotope Lab Radiocarbon Calibration Program Rev. 4.3	Dates 44.5 m of offset along the western trace of the Hayward fault, yielding a horizontal slip rate of 44.5m/9.23 ky = 4.82 mm/yr. Also dates coarse-to-fine
8	C-14	NA	NA	2,020	140	1,986	2,151	1,820	1	ND	Because this is from soil carbon formed under less than saturated conditions, the actual time of deposition of the material at the base of the unit sampled	Excellent. Soil horizon appears undisturbed.	Calibrated by Glenn Borchardt on 6/1/03 by using the University of Washington, Quaternary Isotope Lab Radiocarbon Calibration Program Rev. 4.3	Based on the MRT of 2020 yr B.P., the upper 130 cm of this soil was considered to have begun soil development and overbank accumulation about
9	C-14	NA	NA	810	90	727	792	662	1	ND	The actual duration of development within this soil horizon is more than twice this MRT (mean residence time).	Excellent. Soil horizon appears undisturbed.	Calibrated by Glenn Borchardt on 6/1/03 by using the University of Washington, Quaternary Isotope Lab Radiocarbon Calibration Program Rev. 4.3	This MRT date implies that pedogenic carbonate began to form in this horizon about 1600 yrs ago. The A horizon above it, likewise, began to form at that
10	AMS	NA	NA	3,030	170	3,179	3,386	2,972	1	ND	Due to the coarse, gravelly nature of the material beneath the Bk horizon sampled, some leakage of pedogenic carbonate occurred. The actual duration of	Fair. Soil horizon appears undisturbed, but leakage of calcite is obvious.	Calibrated by Glenn Borchardt on 6/1/03 by using the University of Washington, Quaternary Isotope Lab Radiocarbon Calibration Program Rev. 4.3	This minimum MRT date implies that pedogenic carbonate began to form in soil considerably more than 6358 (3179 X 2) yrs ago.
11	AMS	NA	NA	6,980	60	7,795	7,850	7,725	1	-10.8	Depth measurements include 156 cm of artificial fill	Excellent	Calibrated by Glenn Borchardt on 6/1/03 by using the University of Washington, Quaternary Isotope Lab Radiocarbon Calibration Program Rev. 4.3	Dates the MRT of pedogenic calcite formed in this soil. The 13C/12C ratio indicates the calcite formed from atmospheric CO2 and not from dissolution of
12	AMS	NA	NA	6,880	60	7,560	7,580	7,465	1	-10.7	Depth measurements include 156 cm of artificial fill	Excellent	Calibrated by Glenn Borchardt on 6/1/03 by using the University of Washington, Quaternary Isotope Lab Radiocarbon Calibration Program Rev. 4.3	Dates the MRT of pedogenic calcite formed only along the slide plane, which showed no evidence for movement since the last calcite was deposited.
13	C-14	NA	NA	17,140	800	20,403	21,373	19,432	1	-24.0	Depth to the organic layer varies over its lateral extent of 247'	"Discontinuous organic-rich layer near base of trench." "Faint parallel laminations" in surrounding silty clay material having "lenses of clayey sand	Calibrated by Glenn Borchardt on 6/1/03 by using the University of Washington, Quaternary Isotope Lab Radiocarbon Calibration Program Rev. 4.3	Provides a minimum age for the upper 2.3 m of alluvial plain SW of the Greenville fault and 84 m north of Altamont Creek. The eroded surface beneath the
14	Paleontology	Pleistocene, 10,000-1,500,000	NA	NA	NA	NA	NA	NA	NA	NA	In silty clay to clay sand unit having strong brown (7.5YR4/4) color, clay films, and secondary caliche.	Excellent	Identification by Howard Hutchinson, Research Paleontologist	Provides a minimum age for the upper 2.4 m of an alluvial channel fill 123' south of Altamont Creek. The base of the channel fill was 0.6 m beneath
15	Pedochronology	Early Wisconsin, 40,000 to 80,000	NA	NA	NA	NA	NA	NA	NA	NA	Excellent representative of soil development on this alluvial plain.	Excellent exposure	Age derives from comparison to similarly developed soils in the area described by Herd (1977) [Herd, D. G., 1977, Geologic map of the Las Positas,	Provides a relative age for the alluvial plain at a considerable distance (1600') from the modern stream channel

Record number	SECTION 6: DOCUMENTATION					
	Lab sample no	Lab name	Reference	Institution	Date Entry Last Revised	Entered by
A	AQ	AR	AS	AT	AU	AV
1	ND	CAMS	Williams, Patrick L., 1992, Geologic record of southern Hayward fault earthquakes, *in* Borchardt, Glenn, and others, eds., Proceedings of the second conference on earthquake hazards in the eastern San Francisco Bay area: California Department of Conservationk Division of Mines and Geology Special Publication 113, p. 171-179.	Lawrence Berkeley Laboratory	6/2/2003	J.M. Sowers/ Glenn Borchardt
2	ND	CAMS	Williams, Patrick L., 1992, Geologic record of southern Hayward fault earthquakes, *in* Borchardt, Glenn, and others, eds., Proceedings of the second conference on earthquake hazards in the eastern San Francisco Bay area: California Department of Conservationk Division of Mines and Geology Special Publication 113, p. 171-179.	Lawrence Berkeley Laboratory	6/2/2003	J.M. Sowers/ Glenn Borchardt
3	ND	CAMS	Williams, Patrick L., 1992, Geologic record of southern Hayward fault earthquakes, *in* Borchardt, Glenn, and others, eds., Proceedings of the second conference on earthquake hazards in the eastern San Francisco Bay area: California Department of Conservationk Division of Mines and Geology Special Publication 113, p. 171-179.	Lawrence Berkeley Laboratory	6/2/2003	J.M. Sowers/ Glenn Borchardt
4	ND	CAMS	Williams, Patrick L., 1992, Geologic record of southern Hayward fault earthquakes, *in* Borchardt, Glenn, and others, eds., Proceedings of the second conference on earthquake hazards in the eastern San Francisco Bay area: California Department of Conservationk Division of Mines and Geology Special Publication 113, p. 171-179.	Lawrence Berkeley Laboratory	6/2/2003	J.M. Sowers/ Glenn Borchardt
5	ND	CAMS	Williams, Patrick L., 1992, Geologic record of southern Hayward fault earthquakes, *in* Borchardt, Glenn, and others, eds., Proceedings of the second conference on earthquake hazards in the eastern San Francisco Bay area: California Department of Conservationk Division of Mines and Geology Special Publication 113, p. 171-179.	Lawrence Berkeley Laboratory	6/2/2003	J.M. Sowers/ Glenn Borchardt
6	A-2215	University of Arizona	Borchardt, Glenn, Lienkaemper, J. J., and Budding, K. E., 1992, Holocene slip rate of the Hayward fault at Fremont, in Borchardt, Glenn, Hirschfeld, S. E., Lienkaemper, J. J., McClellan, Patrick, Williams, P. L., and Wong, I. G., eds., Proceedings of the Second Conference on Earthquake Hazards in the Eastern San Francisco Bay Area: Program and Abstracts, California Department of Conservation, Division of Mines and Geology Special Publication 113, p. 181-188. http://nisee.berkeley.edu/cgi-bin/texhtml?form=eea.all&controln=238368 [abs.]; Borchardt, Glenn, ed., 1988, Soil development and displacement along the Hayward fault (Volume I): Fremont, California, California Division of Mines and Geology Open-File Report	California Geological Survey	6/2/2003	Glenn Borchardt
7	A-2216	University of Arizona	Borchardt, Glenn, Lienkaemper, J. J., and Budding, K. E., 1992, Holocene slip rate of the Hayward fault at Fremont, in Borchardt, Glenn, Hirschfeld, S. E., Lienkaemper, J. J., McClellan, Patrick, Williams, P. L., and Wong, I. G., eds., Proceedings of the Second Conference on Earthquake Hazards in the Eastern San Francisco Bay Area: Program and Abstracts, California Department of Conservation, Division of Mines and Geology Special Publication 113, p. 181-188. http://nisee.berkeley.edu/cgi-bin/texhtml?form=eea.all&controln=238368 [abs.]; Borchardt, Glenn, ed., 1988, Soil development and displacement along the Hayward fault (Volume I): Fremont, California, California Division of Mines and Geology Open-File Report	U.S. Geological Survey	6/2/2003	Glenn Borchardt
8	I-14,695	Teledyne Isotopes	Borchardt, Glenn, ed., 1988, Soil development and displacement along the Hayward fault (Volume I): Fremont, California, California Division of Mines and Geology Open-File Report DMG OFR 88-12, 124 p.	California Geological Survey	6/2/2003	Glenn Borchardt
9	I-14,696	Teledyne Isotopes	Borchardt, Glenn, ed., 1988, Soil development and displacement along the Hayward fault (Volume I): Fremont, California, California Division of Mines and Geology Open-File Report DMG OFR 88-12, 124 p.	California Geological Survey	6/2/2003	Glenn Borchardt
10	I-15,021	Teledyne Isotopes	Borchardt, Glenn, ed., 1988, Soil development and displacement along the Hayward fault (Volume I): Fremont, California, California Division of Mines and Geology Open-File Report DMG OFR 88-12, 124 p.	California Geological Survey	6/2/2003	Glenn Borchardt
11	Beta-131838	Beta Analytic	Borchardt, Glenn, 2000, Pedochronological report for the Jara property, Foothill Boulevard, Alameda County, California, in Connelly, S.F., ed., Fault and landslide investigation: Proposed subdivision, Jara property, Foothill Road, Alameda County, California: Unpublished consulting report prepared for Miguel Jara, San Jose, California, Project No. 9920: Cupertino, CA, Steven F. Connelly, C.E.G., Consulting in Engineering Geology, p. A-1 to A-22.	Soil Tectonics	6/2/2003	Glenn Borchardt
12	Beta-131839	Beta Analytic	Borchardt, Glenn, 2000, Pedochronological report for the Jara property, Foothill Boulevard, Alameda County, California, in Connelly, S.F., ed., Fault and landslide investigation: Proposed subdivision, Jara property, Foothill Road, Alameda County, California: Unpublished consulting report prepared for Miguel Jara, San Jose, California, Project No. 9920: Cupertino, CA, Steven F. Connelly, C.E.G., Consulting in Engineering Geology, p. A-1 to A-22.	Soil Tectonics	6/2/2003	Glenn Borchardt
13	GX-11278	Geochron Laboratories	Seeley, M. W., 1985, Evaluation of active faulting and other potential geologic hazards: 145 acre parcel at Northfront and Laughlin Roads near Livermore, California: Unpublished consulting report prepared for Jerry Bibler, Campbell, California, Project No. 85087-A (CDMG Consulting Report AP-1833): Pleasanton, CA, Merrill Seeley Mullen Sandefur Inc., 26 p.	Merrill, Seeley, Mullen, Sandefur, Inc.	6/2/2003	Glenn Borchardt
14	NR	U.C. Berkeley	Seeley, M. W., 1985, Evaluation of active faulting and other potential geologic hazards: 145 acre parcel at Northfront and Laughlin Roads near Livermore, California: Unpublished consulting report prepared for Jerry Bibler, Campbell, California, Project No. 85087-A (CDMG Consulting Report AP-1833): Pleasanton, CA, Merrill Seeley Mullen Sandefur Inc., 26 p.	Merrill, Seeley, Mullen, Sandefur, Inc.	6/2/2003	Glenn Borchardt
15	NA	NA	Borchardt, Glenn, 1985, Quaternary stratigraphy of soils in the Greenville fault zone, Livermore, California, in Seeley, M.W., ed., Evaluation of active faulting and other potential geologic hazards: 145 acre parcel at Northfront and Laughlin Roads near Livermore, California: Unpublished consulting report prepared for Jerry Bibler, Campbell, California (Project No. 85087-A [CDMG Consulting Report AP-1833]): Pleasanton, CA, Merrill, Seeley, Mullen, Sandefur Inc., p. D1-D34.	Soil Tectonics	6/2/2003	Glenn Borchardt

Record number	SECTION 1: LOCATION COORDINATES (Choose one method)														SECTION 2: SITE INFORMATION						SECTION 3: GEOLOGIC SETTING OF SAMPLE						
	UTM		Latitude			Longitude				BLM system																	
	North (m)	East (m)	degrees	min	sec	degrees	min	sec	Street address	Twp	Rng	Sec	1/4 Sec.	1/4 of 1/4 Sec	Location uncertainty (radius in m)	Elev (ft)	Elev (m)	County	7.5'quad	Location details	Geologic context	Strat. unit	Field sample no.	Material sampled	Min. Depth	Max. Depth	Depth units
16			37	43.358		121	42.263								5	567		Alameda	Altamont	Test pit TP-3	Recent flood plain alluvium	Soil Profile No. 2	85B069-74	Soil	0	270	cm
17			37	43.368		121	42.521								5	568		Alameda	Altamont	Southeast wall at station 30.5' in Trench T-1 1.5 m east of the contact	Alluvial plain adjacent to Tertiary Cierbo (?) fm	Soil Profile No. 3	85B052-58	Soil	0	265	cm
18			37	43.367		121	42.522								5	568		Alameda	Altamont	Southeast wall at station 21.5' in Trench T-1 1.5 m west of the contact	Tertiary Cierbo (?) fm adjacent to the alluvial plain	Soil Profile No. 4	85B059-64	Soil	0	277	cm
19			37	43.298		121	42.372								5	567		Alameda	Altamont	South wall in Test Pit TP-2 80' north of Altamont Creek.	Alluvial plain	Soil Profile No. 5	85B065-68	Soil	0	300	cm
20			37	59.7		122	21.68								5		5.3	Contra Costa	Richmond	SW-facing bay cliff on the SW side of the Hayward fault, at km 0.837	Colluvium/Older bay mud	From the 4Btkcb2 soil horizon in Paleosol P2	85B051	Calcite nodule	333	355	cm
21			37	59.7		122	21.68								5		5.3	Contra Costa	Richmond	SW-facing bay cliff on the SW side of the Hayward fault, at km 0.837	Colluvium/Older bay mud	From the 4Btkcb2 soil horizon in Paleosol P3	85B051	Calcite nodule	333	355	cm
22			37	59.577		122	21.527								5		1	Contra Costa	Richmond	From a core taken at station 12 m in Core Trasect CT-3 at km 1.333	Tidal marsh	From the 2Ab1 soil horizon at Estuarine Study Site	85B102	Peat	36	46	cm
23			37	33.342		121	58.451								3	50		Alameda	Niles	W trace of the Hayward fault on the W side of Tyson's Lagoon (Tule Pond),	Colluvium and pond sediments	Youngest unit dated (S4, u450) (S wall)	00A9	Charcoal	43	47	cm
24			37	33.342		121	58.451								3	50		Alameda	Niles	W trace of the Hayward fault on the W side of Tyson's Lagoon (Tule Pond),	Colluvium and pond sediments	Oldest unit dated (u30) (N wall)	00A3	Charcoal	390	400	cm
25			37	33.334		121	58.446								50	51.5		Alameda	Niles	W trace of the Hayward fault on the W side of Tyson's Lagoon (Tule Pond),	Colluvium and pond sediments	Base of NE-dipping organic silt layer E of W trace of the	NR	Carbonized wood	286	305	cm
26			37	33.334		121	58.446								50	51.5		Alameda	Niles	W trace of the Hayward fault on the W side of Tyson's Lagoon (Tule Pond),	Colluvium and pond sediments	Base of NE-dipping dark gray silty clay layer stratigraphica	NR	Black silt with carbonized wood and snail shells	286	305	cm
27			37	33.141		121	58.299								20	60		Alameda	Niles	W trace of the Hayward fault on the W side of Tyson's Lagoon (Tule Pond),	Colluvium and pond sediments	NE-dipping sheared, silt layer E of W trace of the Hayward	NR	Carbonaceous sediment	8.5	8.5	ft
28			37	33.141		121	58.299								20	60		Alameda	Niles	W trace of the Hayward fault on the W side of Tyson's Lagoon (Tule Pond),	Colluvium and pond sediments	NE-dipping layer E of W trace of the Hayward fault	NR	Carbonaceous sediment	7	7	ft
29			37	35.801		122	0.392								20	47.2		Alameda	Newark	Test Trench 9, SE wall at station 27 SW of the Hayward fault	Alluvial fan of Masonic Creek	Stratified silt bed	NR	Fossil skull and tusks of *Mammuthus columi* (mammoth)	16.5	16.5	ft
30			37	35.793		122	0.367								20	101		Alameda	Newark	1989 Trench east wall, station 26.7 m/6.1 m SW of the Hayward fault	Alluvial fan of Masonic Creek	Top of channel fill in Fan Apex Unit CU	89B341	Charcoal	0.5	0.6	m

Record number	SECTION 4: AGE										SECTION 5: INTERPRETATION			
	Age data					C-14 Calibration								
	Method of analysis	**Time period or Range**	**Numerical age** (not C-14)	**Conventional C-14 age** RCY B. P.	**Lab uncertainty** + or -	**Calibrated C-14 age** cal B. P.	**Calibrated maximum age** cal B. P.	**Calibrated minimum age** cal B. P.	**Sigma (1 or 2)**	**$\delta^{13}C$**	**Temporal and contextual uncertainty**	**Sample quality**	**Calibration, correction procedures**	**Significance of age**
16	Pedochronology	Upper 37 cm estimated at 9,000 to 10,000 and the lower portion	NA	NA	NA	NA	NA	NA	NA	NA	Excellent representative of soil development recent flood deposition on this alluvial plain.	Excellent exposure	Age derives from comparison to similarly developed soils elsewhere in the Bay Area.	Provides a relative age for the flood plain deposition upon the alluvial plain near the modern stream channel
17	Pedochronology	Estimated at 40,000 to 80,000	NA	NA	NA	NA	NA	NA	NA	NA	Excellent representative of soil development on this alluvial plain.	Excellent exposure	Age derives from comparison to similarly developed soils in the area described by Herd (1977) [Herd, D. G., 1977, Geologic map of the Las Positas,	Provides a relative age for the alluvial plain apparently not influenced by the modern stream channel
18	Pedochronology	Estimated at 40,000 to 80,000 with the 3K horizon at the base of the	NA	NA	NA	NA	NA	NA	NA	NA	Excellent representative of soil development on this alluvial plain.	Excellent exposure	Age derives from comparison to similarly developed soils in the area described by Herd (1977) [Herd, D. G., 1977, Geologic map of the Las Positas,	Provides a relative age for the alluvial plain apparently not influenced by the modern stream channel
19	Pedochronology	Estimated at 40,000 to 80,000	NA	NA	NA	NA	NA	NA	NA	NA	Excellent representative of soil development on this alluvial plain.	Excellent exposure	Age derives from comparison to similarly developed soils in the area described by Herd (1977) [Herd, D. G., 1977, Geologic map of the Las Positas,	Provides a relative age for the alluvial plain only slightly eroded by the modern stream channel
20	U-series	NA	26,500	See sample 21 below	2,000	See sample 21 below	See sample 21 below	See sample 21 below	1	See sample 21 below	Time of burial of paleosol containg these nodules is unknown. Estimate based on pedochronology is 64 ka (Borchardt, Seelig, and Wagner,	5-cm diameter nodules with clean centers	Details of analytical method given in: Szabo, B. J., McHugh, W. P., Schaber, G. G., Haynes, C. V., Jr., and Breed, C. S., 1989,	MRT of period of calcite pedogenesis since 114 ka
21	C-14	NA	NA	21,590	470	26,000	27,000	25,000	1	NR	Time of burial of paleosol containg these nodules is unknown. Estimate based on pedochronology is 64 ka (Borchardt, Seelig, and Wagner,	Two 5-cm diameter nodules with clean centers	Calibrated by using data of Bard, Edouard, Hamelin, Bruno, Fairbanks, R. G., and Zindler, Alan, 1990, Calibration of the 14C timescale over the past	MRT of period of calcite pedogenesis between 114 ka and 50 ka
22	C-14	NA	NA	1,360	80	1,281	1,335	1,227	1	NR	Peat layer varies slightly in thickness and depth, but is clearly identifiable throughout the marsh (Borchardt, 1988).	Excellent, widespread marker	Calibrated by Glenn Borchardt on 6/1/03 by using the University of Washington, Quaternary Isotope Lab Radiocarbon Calibration Program Rev. 4.3	Dates sedimentation rate/sea level rise
23	AMS	NA	NA	NR	NR	210	250	170	1	-25	This unit contains *Erodium cicutarium* pollen from a weed introduced after 1776 AD. This charcoal sample was slightly older than the 1868 M6.9	ND	Ages corrected for C-13 by using the method of Stuiver and Pollach (1977).	Youngest charcoal dated in material deposited since the 1868 M6.9 earthquake (event horizon at about 72 cm). This site had 51 AMS dates
24	AMS	NA	NA	NR	NR	3,670	3,760	3,580	1	-25	All other dated samples are stratigraphically above this one. An older sample at the 100-cm depth is discordant.	ND	Ages corrected for C-13 by using the method of Stuiver and Pollach (1977).	Oldest charcoal dated at this paleoseismic site. It was stratigraphically beneath the other dated units, near the base of the trench.
25	C-14	NA	NA	2,160	100	2,176	2,307	2,044	ND	ND	Max. depth is beneath the 50.5' elevation on fill slope.	Good	Calibrated by Glenn Borchardt on 6/1/03 by using the University of Washington, Quaternary Isotope Lab Radiocarbon Calibration Program Rev. 4.3	Oldest date close to the western trace of the Hayward fault. Sedimentary unit containing the carbonized wood dips NE, showing the effect of vertical
26	C-14	NA	NA	700	95	633	709	556	ND	ND	Max. depth is beneath the 49.3' elevation on fill slope. Probably too young because the sample was a mixture.	Fair to poor. It is complicated by being a mixture of humic acid, fulvic acid, charcoal, wood, and snail shells.	Calibrated by Glenn Borchardt on 6/1/03 by using the University of Washington, Quaternary Isotope Lab Radiocarbon Calibration Program Rev. 4.3	Youngest date close to the western trace of the Hayward fault. Slight NE dip indicates the effect of vertical drag.
27	C-14	NA	NA	2,415	100	2,527	2,706	2,348	ND	ND	Sample was at an elevation of 41.5'. Sheared portion of carbonaceous layer in record 28 below.	Fair	Calibrated by Glenn Borchardt on 6/1/03 by using the University of Washington, Quaternary Isotope Lab Radiocarbon Calibration Program Rev. 4.3	Oldest charcoal dated at this seismic trenching site. It was stratigraphically beneath the other dated units, near the base of the trench. The uncalibrated
28	C-14	NA	NA	1,995	95	1,959	2,062	1,855	ND	ND	Sample was at an elevation of 43'. Unsheared portion of carbonaceous layer in record 27 above.	Fair	Calibrated by Glenn Borchardt on 6/1/03 by using the University of Washington, Quaternary Isotope Lab Radiocarbon Calibration Program Rev. 4.3	Being younger, this date is probably better representative of the minimum age of Tule Pond than record 27 above.
29	Paleontology	50 ka to 1.5 Ma	NA	7,400	165	8,232	8,357	8,107	1	NR	Silty material surrounding the sample indicates that it was deposited in an overbank deposit. The 17.1-ka charcoal later discovered by Borchardt	The C-14 age of this material is "very uncertain, collagen badly degraded." J. Buckley of Isotopes, Inc.	Calibrated by Glenn Borchardt on 6/1/03 by using the University of Washington, Quaternary Isotope Lab Radiocarbon Calibration Program Rev. 4.3	Dates alluvium on the SW side of the Hayward fault.
30	C-14	NA	NA	415	60	490	560	420	1	NR	Detrital charcoal is always older than the sediment in which it is found.	Excellent	Calibrated to the year 1990 after using the program CalibETH 1.5b (ETH Zurich, 1991) and ATM20.C14B calibration file (Linick and others, 1986).	Youngest charcoal dated in alluvium deposited across the Hayward fault. Analysis of 34 AMS dates and one conventional C-14 date was

Record number	SECTION 6: DOCUMENTATION					
	Lab sample no	Lab name	Reference	Institution	Date Entry Last Revised	Entered by
16	NA	NA	Borchardt, Glenn, 1985, Quaternary stratigraphy of soils in the Greenville fault zone, Livermore, California, in Seeley, M.W., ed., Evaluation of active faulting and other potential geologic hazards: 145 acre parcel at Northfront and Laughlin Roads near Livermore, California: Unpublished consulting report prepared for Jerry Bibler, Campbell, California (Project No. 85087-A [CDMG Consulting Report AP-1833]): Pleasanton, CA, Merrill, Seeley, Mullen, Sandefur Inc., p. D1-D34.	Soil Tectonics	6/2/2003	Glenn Borchardt
17	NA	NA	Borchardt, Glenn, 1985, Quaternary stratigraphy of soils in the Greenville fault zone, Livermore, California, in Seeley, M.W., ed., Evaluation of active faulting and other potential geologic hazards: 145 acre parcel at Northfront and Laughlin Roads near Livermore, California: Unpublished consulting report prepared for Jerry Bibler, Campbell, California (Project No. 85087-A [CDMG Consulting Report AP-1833]): Pleasanton, CA, Merrill, Seeley, Mullen, Sandefur Inc., p. D1-D34.	Soil Tectonics	6/2/2003	Glenn Borchardt
18	NA	NA	Borchardt, Glenn, 1985, Quaternary stratigraphy of soils in the Greenville fault zone, Livermore, California, in Seeley, M.W., ed., Evaluation of active faulting and other potential geologic hazards: 145 acre parcel at Northfront and Laughlin Roads near Livermore, California: Unpublished consulting report prepared for Jerry Bibler, Campbell, California (Project No. 85087-A [CDMG Consulting Report AP-1833]): Pleasanton, CA, Merrill, Seeley, Mullen, Sandefur Inc., p. D1-D34.	Soil Tectonics	6/2/2003	Glenn Borchardt
19	NA	NA	Borchardt, Glenn, 1985, Quaternary stratigraphy of soils in the Greenville fault zone, Livermore, California, in Seeley, M.W., ed., Evaluation of active faulting and other potential geologic hazards: 145 acre parcel at Northfront and Laughlin Roads near Livermore, California: Unpublished consulting report prepared for Jerry Bibler, Campbell, California (Project No. 85087-A [CDMG Consulting Report AP-1833]): Pleasanton, CA, Merrill, Seeley, Mullen, Sandefur Inc., p. D1-D34.	Soil Tectonics	6/2/2003	Glenn Borchardt
20	1 and 2	Daniel R. Muhs, USGS, Denver, CO	Borchardt, Glenn, and Seelig, K. A., 1991, Soils, paleosols, and Quaternary sediments offset along the Hayward fault at Point Pinole Regional Shoreline, Richmond, California, in Sloan, Doris, and Wagner, D. L., eds., Geologic excursions in northern California: San Francisco to the Sierra Nevada, California Department of Conservation, Division of Mines and Geology Special Publication 109, p. 75-83.	California Geological Survey	6/2/2003	Glenn Borchardt
21	I-16,113	Teledyne Isotopes	Borchardt, Glenn, and Seelig, K. A., 1991, Soils, paleosols, and Quaternary sediments offset along the Hayward fault at Point Pinole Regional Shoreline, Richmond, California, in Sloan, Doris, and Wagner, D. L., eds., Geologic excursions in northern California: San Francisco to the Sierra Nevada, California Department of Conservation, Division of Mines and Geology Special Publication 109, p. 75-83.	California Geological Survey	6/2/2003	Glenn Borchardt
22	I-14,631	Teledyne Isotopes	Borchardt, Glenn, and Seelig, K. A., 1991, Soils, paleosols, and Quaternary sediments offset along the Hayward fault at Point Pinole Regional Shoreline, Richmond, California, in Sloan, Doris, and Wagner, D. L., eds., Geologic excursions in northern California: San Francisco to the Sierra Nevada, California Department of Conservation, Division of Mines and Geology Special Publication 109, p. 75-83.	California Geological Survey	6/2/2003	Glenn Borchardt
23	69167	CAMS	Lienkaemper, James J., Dawson, Timothy E., Personius, Stephen F., Seitz, Gordon G., Reidy, Liam M., and Schwartz, David P., 2002, A Record of Large Earthquakes on the Southern Hayward Fault for the Past 500 Years: Bulletin of the Seismological Society of America, v. 92, no. 7, p. 2637-2658. http://www.seismosoc.org/publications/BSSA_html/bssa_92-7/00611.html Lienkaemper, James J., Dawson, Timothy E., Personius, Stephen F., Seitz, Gordon G., Reidy, Liam M., and Schwartz, David P., 2002, 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, 11 p.	U.S. Geological Survey	6/2/2003	Glenn Borchardt
24	68697	CAMS	Lienkaemper, James J., Dawson, Timothy E., Personius, Stephen F., Seitz, Gordon G., Reidy, Liam M., and Schwartz, David P., 2002, A Record of Large Earthquakes on the Southern Hayward Fault for the Past 500 Years: Bulletin of the Seismological Society of America, v. 92, no. 7, p. 2637-2658. http://www.seismosoc.org/publications/BSSA_html/bssa_92-7/00611.html Lienkaemper, James J., Dawson, Timothy E., Personius, Stephen F., Seitz, Gordon G., Reidy, Liam M., and Schwartz, David P., 2002, 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, 11 p.	U.S. Geological Survey	6/2/2003	Glenn Borchardt
25	NR	NR	Cluff, L. S., Hansen, W. R., and Taylor, C. L., 1970, Fremont Meadows active fault investigation and evaluation, Fremont, California: Unpublished consulting report prepared for F. B. Burns and Associates, Project No. G-10396 (CDMG File No. AP-744): Oakland, CA, Woodward-Clyde and Associates, 62 p. (Figure 12)	Woodward-Clyde & Associates, Oakland, CA	6/3/2003	Glenn Borchardt
26	NR	NR	Cluff, L. S., Hansen, W. R., and Taylor, C. L., 1970, Fremont Meadows active fault investigation and evaluation, Fremont, California: Unpublished consulting report prepared for F. B. Burns and Associates, Project No. G-10396 (CDMG File No. AP-744): Oakland, CA, Woodward-Clyde and Associates, 62 p. (Figure 12)	Woodward-Clyde & Associates, Oakland, CA	6/3/2003	Glenn Borchardt
27	NR	NR	Cluff, L. S., Hansen, W. R., and Taylor, C. L., 1970, Fremont Meadows active fault investigation and evaluation, Fremont, California: Unpublished consulting report prepared for F. B. Burns and Associates, Project No. G-10396 (CDMG File No. AP-744): Oakland, CA, Woodward-Clyde and Associates, 62 p. (Figure 15)	Woodward-Clyde & Associates, Oakland, CA	6/3/2003	Glenn Borchardt
28	NR	NR	Cluff, L. S., Hansen, W. R., and Taylor, C. L., 1970, Fremont Meadows active fault investigation and evaluation, Fremont, California: Unpublished consulting report prepared for F. B. Burns and Associates, Project No. G-10396 (CDMG File No. AP-744): Oakland, CA, Woodward-Clyde and Associates, 62 p. (Figure 15)	Woodward-Clyde & Associates, Oakland, CA	6/3/2003	Glenn Borchardt
29	I-6983	California Academy of Sciences and Isotopes, Inc.	Woodward Lundgren Associates, 1972, Geologic and seismic site evaluation, Masonic Home of California, Union City, California: Unpublished consulting report prepared for Masonic Homes of California, Project G-12547 (CDMG File No. C-20): Oakland, CA, Woodward Lundgren Associates, 33 p. (Figure 10 and p. 21)	Woodward Lundgren Associates, Oakland, CA	6/3/2003	Glenn Borchardt
30	AA-4657	NSF-Arizona AMS Facility, Univ. of Arizona, Tucson	Lienkaemper, J. J., and Borchardt, Glenn, 1996, Holocene slip rate of the Hayward fault at Union City, California: Journal of Geophysical Research, v. 101, no. B3, p. 6099-6108. http://nisee.berkeley.edu/cgi-in/texhtml?form=eea.all&controln=267937 [abs.]	USGS & Soil Tectonics	6/3/2003	Glenn Borchardt

Record number	SECTION 1: LOCATION COORDINATES (Choose one method)														SECTION 2: SITE INFORMATION						SECTION 3: GEOLOGIC SETTING OF SAMPLE						
	UTM		Latitude			Longitude				BLM system																	
	North (m)	East (m)	degrees	min	sec	degrees	min	sec	Street address	Twp	Rng	Sec	1/4 Sec.	1/4 of 1/4 Sec	Location uncertainty (radius in m)	Elev (ft)	Elev (m)	County	7.5'quad	Location details	Geologic context	Strat. unit	Field sample no.	Material sampled	Min. Depth	Max. Depth	Depth units
31			37	35.793		122	0.367								20	101		Alameda	Newark	1990 Trench west wall, station 16.2m/1.7m SW of the Hayward	Alluvial fan of Masonic Creek	First material deposited after Fan Apex Unit E was	90B314	Charcoal	3.7	3.8	m
32			37	35.793		122	0.367								20	101		Alameda	Newark	1989 Trench west wall, station 74.0m/3.3m SW of the Hayward	Alluvial fan of Masonic Creek	First material deposited after Fan Apex Unit G was	89B031	Charcoal	2.8	3	m
33			37	35.793		122	0.367								20	101		Alameda	Newark	1989 Trench West wall, station 121.5m/2.5m SW of the	Alluvial fan of Masonic Creek	Paleosol P5	89L021	Charcoal	2.65	2.75	m
34			37	36.793		122	0.367								20	101		Alameda	Newark	1990 Trench West wall, station 80.2m/3.9m SW of the Hayward	Alluvial fan of Masonic Creek	Contact between noncalcareo us paleosol P2 and	90B262	Charcoal	1.41	1.43	m
35			37	36.793		122	0.367								20	101		Alameda	Newark	1990 Trench West wall, station 64.9m/2.2m SW of the Hayward	Alluvial fan of Masonic Creek	Contact between calcareous paleosol P4 and	90B214	Charcoal	3.7	3.72	m
36			37	36.793		122	0.367								20	101		Alameda	Newark	1989 Trench East wall, station 81.3 SW of the Hayward fault	Alluvial fan of Masonic Creek	Bk horizon of paleosol P3 (8.3 ka - 7.1 ka)	89B351	Pedogenic calcite	1.5	2.1	m
37			37	36.793		122	0.367								20	101		Alameda	Newark	1989 Trench East wall, station 81.3 SW of the Hayward fault	Alluvial fan of Masonic Creek	Bk horizon of paleosol P4 (10.2 ka -8.3 ka)	89B352	Pedogenic calcite	2.1	3.15	m
38			37	36.793		122	0.367								20	101		Alameda	Newark	1989 Trench West wall, station 94.0m/1.47m SW of the	Alluvial fan of Masonic Creek	Contact between noncalcareo us paleosol P5 and	89B118	Fossil teeth and bone, camel and horse	4.85	4.89	m
39			37	33.738		122	4.535								100	13		Alameda	Newark	Coyote Archaeologic Site (UCAS Alameda-13) (also Ala-13)	Bay Mud	Buried hearth	NR	Burned limb	55	55	ft
40			37	33.48		122	4.918								100	13		Alameda	Newark	Patterson Archaeologic Site (UCAS Alameda-328) (also known as	Bay Mud?	Shellmound (?) on bay mud	NR	Charcoal	11	11	ft
41			37	33.48		122	4.918								100	13		Alameda	Newark	Patterson Archaeologic Site (UCAS Alameda-328) (also known as	Bay Mud?	Shellmound (?) on bay mud	NR	Charcoal	11	11	ft
42			37	21		121	55								500			Santa Clara	San Jose West		Alluvium, Guadalupe River		Guad#1	Organic sediment	5.3	5.3	m
43			37	21		121	55								500			Santa Clara	San Jose West		Alluvium, Guadalupe River	NR	Guad #2	Charred material	6.5	6.5	m
44	4,164,500	644,000													300		100	San Joaquin	Solyo	Trench 1, ~3/4 km NW of Lone Tree Creek/ I-580 crossing	Gravelly alluvial fan sediments	Terrace 7	106	Soil carbonate, inner rind layer on clasts	1.8	3	m
45	4,164,500	644,000													300		100	San Joaquin	Solyo	Trench 1, ~3/4 km NW of Lone Tree Creek/ I-580 crossing	Gravelly alluvial fan sediments	Terrace 7	106	Soil carbonate, inner rind layer on clasts	1.8	3	m

Record number	SECTION 4: AGE										SECTION 5: INTERPRETATION			
	Age data					C-14 Calibration								
	Method of analysis	Time period or Range	Numerical age (not C-14)	Conventional C-14 age RCY B. P.	Lab uncertainty + or -	Calibrated C-14 age cal B. P.	Calibrated maximum age cal B. P.	Calibrated minimum age cal B. P.	Sigma (1 or 2)	δ13C	Temporal and contextual uncertainty	Sample quality	Calibration, correction procedures	Significance of age
31	C-14	NA	NA	4,000	70	4,560	4,690	4,430	1	NR	Detrital charcoal is always older than the sediment in which it is found.	Excellent	Calibrated to the year 1990 after using the program CalibETH 1.5b (ETH Zurich, 1991) and ATM20.C14B calibration file (Linick and others, 1986).	Charcoal representing the age when fan apex E was abandoned and subsequently offset 42±6 m by the Hayward fault.
32	C-14	NA	NA	7,435	60	8,270	8,350	8,190	1	NR	Detrital charcoal is always older than the sediment in which it is found.	Excellent	Calibrated to the year 1990 after using the program CalibETH 1.5b (ETH Zurich, 1991) and ATM20.C14B calibration file (Linick and others, 1986).	Charcoal representing the age when fan apex G was abandoned and subsequently offset 66±6 m by the Hayward fault.
33	C-14	NA	NA	14,200	160	17,080	17,270	16,890	1	NR	Detrital charcoal is always older than the sediment in which it is found.	Excellent	Calibrated to the year 1990 after using the program CalibETH 1.5b (ETH Zurich, 1991) and ATM20.C14B calibration file (Linick and others, 1986).	Oldest charcoal dated in the alluvial fan of Masonic Creek. It was found in the fifth paleosol. A still older paleosol, estimated to have begun forming at about 24
34	C-14	NA	NA	6,110	60	7,060	7,150	6,970	1	NR	Detrital charcoal is always older than the sediment in which it is found.	Excellent	Calibrated to the year 1990 after using the program CalibETH 1.5b (ETH Zurich, 1991) and ATM20.C14B calibration file (Linick and others, 1986).	Dates the end of the early Holocene dry period in the Bay Area, as measured by the cessation of pedogenic calcite formation at this site in Union
35	C-14	NA	NA	9,260	70	10,240	10,320	10,160	1	NR	Detrital charcoal is always older than the sediment in which it is found.	Excellent	Calibrated by using file Stuiver3.C14B (Stuiver et al., 1991).	Dates the beginning of the early Holocene dry period in the Bay Area, as measured by the initiatio of pedogenic calcite formation at this site in Union
36	C-14	NA	NA	3,880	70	4,300	4,425	4,175	1	-12.5	Based on 0.19 g of calcite in soil containing 0.14 g/100 g calcite.	Excellent. Soil horizon is undisturbed. Calcite appears as thin filaments and fine nodules. 13C/12C ratio indicates atmospheric, rather than marine	Calculated by Beta Analytic from Vogel et al. (1993); Talma and Vogel (1993); Stuiver et al. (1993).	Mean residence time (MRT) of pedogenic calcite in paleosol P4 (10.2 ka -8.3 ka) at this site in Union City.
37	C-14	NA	NA	6,720	100	7,600	7,675	7,520	1	-12.3	Based on 0.32 g of calcite in soil containing 0.15 g/100 g calcite.	Excellent. Soil horizon is undisturbed. Calcite appears as fine nodules and thin filaments. 13C/12C ratio indicates atmospheric, rather than marine	Calculated by Beta Analytic from Vogel et al. (1993); Talma and Vogel (1993); Stuiver et al. (1993).	Mean residence time (MRT) of pedogenic calcite in paleosol P3 (8.3 ka - 7.1 ka) at this site in Union City.
38	Paleontology	Late Wisconsin	NA	NA	NA	NA	NA	NA	NA	NA	Fossils found at the top of paleosol P6, which was buried before 17.1 ka.	Fair. Adequate for identification.	NA	Confirms Pleistocene age of paleosol P5, which had charcoal with a C-14 date of 17.1 ka and paleosol P6, which was estimated to have begun forming
39	C-14	NA	NA	1,685	85	1,612	1,709	1,514	1	NR	55' depth seems too much (uncovered during excavation for Alameda Creek drainage?)	NR	Calibrated by Glenn Borchardt on 6/1/03 by using the University of Washington, Quaternary Isotope Lab Radiocarbon Calibration Program Rev. 4.3	Dates hominid occupation of distil portion of Niles alluvial cone.
40	C-14	NA	NA	2,588	200	2,639	2,850	2,427	1	NR	Location plotted from small scale map implying that it is on bay mud.	NR	Calibrated by Glenn Borchardt on 6/1/03 by using the University of Washington, Quaternary Isotope Lab Radiocarbon Calibration Program Rev. 4.3	Dates base of the cultural deposits on the distil portion of Niles alluvial cone.
41	C-14	NA	NA	2,090	220	2,082	2,338	1,825	1	NR	Averaged with Chicago-690 to get 2339+-150 yr B.P. for the base of the cultural deposit.	NR	Calibrated by Glenn Borchardt on 6/1/03 by using the University of Washington, Quaternary Isotope Lab Radiocarbon Calibration Program Rev. 4.3	Dates base of the cultural deposits on the distil portion of Niles alluvial cone.
42	C-14, standard	NA	NA	NR	NR	6,320	6,390	6,250	ND	NR	NR	NR	NR	NR
43	C-14, AMS	NA	NA	NR	NR	6,700	6,740	6,660	ND	NR	NR	NR	NR	NR
44	U-series	NA	61,000	NA	7,000	NA	NA	NA	1	NA	Date is a minimum age on terrace deposits because of time required to form and isolate rind. Inner rind closest to deposit age.	Dense, crystalline carbonate rinds, 0.5 to 2.0 mm thick	Ages are detritus corrected	Helps constrain timing of movement on the San Joaquin fault
45	U-series	NA	65,000	NA	6,000	NA	NA	NA	1	NA	Date is a minimum age on terrace deposits because of time required to form and isolate rind.Inner rind closest to deposit age.	Dense, crystalline carbonate rinds, 0.5 to 2.0 mm thick	Ages are detritus corrected	Helps constrain timing of movement on the San Joaquin fault

SECTION 6: DOCUMENTATION

Record number	Lab sample no	Lab name	Reference	Institution	Date Entry Last Revised	Entered by
31	AA-6824	NSF-Arizona AMS Facility, Univ. of Arizona, Tucson	Lienkaemper, J. J., and Borchardt, Glenn, 1996, Holocene slip rate of the Hayward fault at Union City, California: Journal of Geophysical Research, v. 101, no. B3, p. 6099-6108. http://nisee.berkeley.edu/cgi-in/texhtml?form=eea.all&controln=267937 [abs.]	USGS & Soil Tectonics	6/3/2003	Glenn Borchardt
32	AA-4259	NSF-Arizona AMS Facility, Univ. of Arizona, Tucson	Lienkaemper, J. J., and Borchardt, Glenn, 1996, Holocene slip rate of the Hayward fault at Union City, California: Journal of Geophysical Research, v. 101, no. B3, p. 6099-6108. http://nisee.berkeley.edu/cgi-in/texhtml?form=eea.all&controln=267937 [abs.]	USGS & Soil Tectonics	6/3/2003	Glenn Borchardt
33	AA-4662	NSF-Arizona AMS Facility, Univ. of Arizona, Tucson	Borchardt, Glenn, and Lienkaemper, J. J., 1999, Pedogenic calcite as evidence for an early Holocene dry period in the San Francisco Bay area, California: Geological Society of America Bulletin, v. 111, no. 6, p. 906-918. http://www.gsajournals.org/gsaonline/?request=get-abstract&issn=0016-7606&volume=111&issue=06&page=0906 [abs.] http://www.soiltectonics.com/	USGS & Soil Tectonics	6/3/2003	Glenn Borchardt
34	AA-6820	NSF-Arizona AMS Facility, Univ. of Arizona, Tucson	Borchardt, Glenn, and Lienkaemper, J. J., 1999, Pedogenic calcite as evidence for an early Holocene dry period in the San Francisco Bay area, California: Geological Society of America Bulletin, v. 111, no. 6, p. 906-918. http://www.gsajournals.org/gsaonline/?request=get-abstract&issn=0016-7606&volume=111&issue=06&page=0906 [abs.] http://www.soiltectonics.com/	USGS & Soil Tectonics	6/3/2003	Glenn Borchardt
35	AA-6819	NSF-Arizona AMS Facility, Univ. of Arizona, Tucson	Borchardt, Glenn, and Lienkaemper, J. J., 1999, Pedogenic calcite as evidence for an early Holocene dry period in the San Francisco Bay area, California: Geological Society of America Bulletin, v. 111, no. 6, p. 906-918. http://www.gsajournals.org/gsaonline/?request=get-abstract&issn=0016-7606&volume=111&issue=06&page=0906 [abs.] http://www.soiltectonics.com/	USGS & Soil Tectonics	6/3/2003	Glenn Borchardt
36	Beta-113914	Beta Analytic	Borchardt, Glenn, and Lienkaemper, J. J., 1999, Pedogenic calcite as evidence for an early Holocene dry period in the San Francisco Bay area, California: Geological Society of America Bulletin, v. 111, no. 6, p. 906-918. http://www.gsajournals.org/gsaonline/?request=get-abstract&issn=0016-7606&volume=111&issue=06&page=0906 [abs.] http://www.soiltectonics.com/	USGS & Soil Tectonics	6/3/2003	Glenn Borchardt
37	Beta-113915	Beta Analytic	Borchardt, Glenn, and Lienkaemper, J. J., 1999, Pedogenic calcite as evidence for an early Holocene dry period in the San Francisco Bay area, California: Geological Society of America Bulletin, v. 111, no. 6, p. 906-918. http://www.gsajournals.org/gsaonline/?request=get-abstract&issn=0016-7606&volume=111&issue=06&page=0906 [abs.] http://www.soiltectonics.com/	USGS & Soil Tectonics	6/3/2003	Glenn Borchardt
38	NA	Identified by Glenn Borchardt and James J. Lienkaemper	Borchardt, Glenn, and Lienkaemper, J. J., 1999, Pedogenic calcite as evidence for an early Holocene dry period in the San Francisco Bay area, California: Geological Society of America Bulletin, v. 111, no. 6, p. 906-918. http://www.gsajournals.org/gsaonline/?request=get-abstract&issn=0016-7606&volume=111&issue=06&page=0906 [abs.] http://www.soiltectonics.com/	USGS & Soil Tectonics	6/3/2003	Glenn Borchardt
39	Geochron GX1049	NR	Wright, R.H., 1971, Catalog of samples dated by carbon-14 in the San Francisco Bay region, California: U.S. Geological Survey San Francisco Bay Region Environment and Resources Planning Study Basic Data Contribution 33 (Carbon site 38). Rackerby, Frank, 1967, The archeological salvage of two San Francisco Bay shellmounds: Department of Antropology, San Francisco State College, Occasional Papers in Anthropology, v. 3, p. 49.	San Francisco State University and USGS	6/3/2003	Glenn Borchardt
40	Chicago-690	NR	Wright, R.H., 1971, Catalog of samples dated by carbon-14 in the San Francisco Bay region, California: U.S. Geological Survey San Francisco Bay Region Environment and Resources Planning Study Basic Data Contribution 33 (Carbon site 39). Libby, W.F., 1954, Chicago radiocarbon dates IV: Science, v. 119, no. 3083, p. 138.	U.S. Geological Survey	6/3/2003	Glenn Borchardt
41	NR	NR	Wright, R.H., 1971, Catalog of samples dated by carbon-14 in the San Francisco Bay region, California: U.S. Geological Survey San Francisco Bay Region Environment and Resources Planning Study Basic Data Contribution 33 (Carbon site 39). Libby, W.F., 1954, Chicago radiocarbon dates IV: Science, v. 119, no. 3083, p. 138.	U.S. Geological Survey	6/3/2003	Glenn Borchardt
42	130741	NR	Meyer, Jack, West, G. J., and Gassner, B., 2000, A geoarcheological study of the Guadalupe Parkway corridor, State Route 87, San Jose, Santa Clara County, California: unpublished report prepared for the California Department of Transportation, Oakland, CA	Sonoma State University	10/14/2002	J.M. Sowers
43	130742	NR	Meyer, Jack, West, G. J., and Gassner, B., 2000, A geoarcheological study of the Guadalupe Parkway corridor, State Route 87, San Jose, Santa Clara County, California: unpublished report prepared for the California Department of Transportation, Oakland, CA	Sonoma State University	10/14/2002	J.M. Sowers
44	106-1	Berkeley Geochronology Center	Sowers, J. M., Sharp, W. D., Southard, R. J., and Ludwig, K. R., 2000, Geochronology of deformed terrace soils on the east front of the Diablo Range near Tracy, California, Final Technical Report, U. S. Geological Survey National Earthquake Hazards Reduction Program, # 99-HQ-GR-0101	Wm. Lettis & Associates, Inc., Walnut Creek, CA	10/14/2002	J.M. Sowers
45	106-3	Berkeley Geochronology Center	Sowers, J. M., Sharp, W. D., Southard, R. J., and Ludwig, K. R., 2000, Geochronology of deformed terrace soils on the east front of the Diablo Range near Tracy, California, Final Technical Report, U. S. Geological Survey National Earthquake Hazards Reduction Program, # 99-HQ-GR-0101	Wm. Lettis & Associates, Inc., Walnut Creek, CA	10/14/2002	J.M. Sowers

Record number	SECTION 1: LOCATION COORDINATES (Choose one method)														SECTION 2: SITE INFORMATION						SECTION 3: GEOLOGIC SETTING OF SAMPLE						
	UTM		Latitude			Longitude				BLM system																	
	North (m)	East (m)	degrees	min	sec	degrees	min	sec	Street address	Twp	Rng	Sec	1/4 Sec.	1/4 of 1/4 Sec	Location uncertainty (radius in m)	Elev (ft)	Elev (m)	County	7.5'quad	Location details	Geologic context	Strat. unit	Field sample no.	Material sampled	Min. Depth	Max. Depth	Depth units
46	4,164,500	644,000													300		100	San Joaquin	Solyo	Trench 1, ~3/4 km NW of Lone Tree Creek/ I-580 crossing	Gravelly alluvial fan sediments	Terrace 7	124	Soil carbonate, inner rind layer on clasts	1.8	3	m
47	4,164,500	644,000													300		100	San Joaquin	Solyo	Trench 1, ~3/4 km NW of Lone Tree Creek/ I-580 crossing	Gravelly alluvial fan sediments	Terrace 7	125	Soil carbonate, inner rind layer on clasts	1.8	3	m
48	4,164,500	644,000													300		100	San Joaquin	Solyo	Trench 1, ~3/4 km NW of Lone Tree Creek/ I-580 crossing	Gravelly alluvial fan sediments	Terrace 7	130	Soil carbonate, inner rind layer on clasts	1.8	3	m
49	4,164,500	644,000													300		100	San Joaquin	Solyo	Trench 1, ~3/4 km NW of Lone Tree Creek/ I-580 crossing	Gravelly alluvial fan sediments	Terrace 7	130	Soil carbonate, inner rind layer on clasts	1.8	3	m
50	4,164,500	644,000													300		100	San Joaquin	Solyo	Trench 1, ~3/4 km NW of Lone Tree Creek/ I-580 crossing	Gravelly alluvial fan sediments	Terrace 7	106	Soil carbonate, outer rind layer on clasts	1.8	3	m

Record number	SECTION 4: AGE										SECTION 5: INTERPRETATION			
	Age data					C-14 Calibration								
	Method of analysis	**Time period or Range**	**Numerical age** (not C-14)	**Conventional C-14 age** RCY B. P.	**Lab uncertainty** + or -	**Calibrated C-14 age** cal B. P.	**Calibrated maximum age** cal B. P.	**Calibrated minimum age** cal B. P.	**Sigma (1 or 2)**	**$\delta^{13}C$**	**Temporal and contextual uncertainty**	**Sample quality**	**Calibration, correction procedures**	**Significance of age**
46	U-series	NA	64,000	NA	8,000	NA	NA	NA	1	NA	Date is a minimum age on terrace deposits because of time required to form and isolate rind. Inner rind closest to deposit age.	Dense, crystalline carbonate rinds, 0.5 to 2.0 mm thick	Ages are detritus corrected	Helps constrain timing of movement on the San Joaquin fault
47	U-series	NA	57,000	NA	19,000	NA	NA	NA	1	NA	Date is a minimum age on terrace deposits because of time required to form and isolate rind. Inner rind closest to deposit age.	Dense, crystalline carbonate rinds, 0.5 to 2.0 mm thick	Ages are detritus corrected	Helps constrain timing of movement on the San Joaquin fault
48	U-series	NA	61,000	NA	4,000	NA	NA	NA	1	NA	Date is a minimum age on terrace deposits because of time required to form and isolate rind. Inner rind closest to deposit age.	Dense, crystalline carbonate rinds, 0.5 to 2.0 mm thick	Ages are detritus corrected	Helps constrain timing of movement on the San Joaquin fault
49	U-series	NA	56,000	NA	7,000	NA	NA	NA	1	NA	Date is a minimum age on terrace deposits because of time required to form and isolate rind. Inner rind closest to deposit age.	Dense, crystalline carbonate rinds, 0.5 to 2.0 mm thick	Ages are detritus corrected	Helps constrain timing of movement on the San Joaquin fault
50	U-series	NA	33,000		1,000				1		Date is a minimum age on terrace deposits because of time required to form and isolate rind. Outer rind much younger.	Dense, crystalline carbonate rinds, 0.5 to 2.0 mm thick	Ages are detritus corrected	Helps constrain timing of movement on the San Joaquin fault

Record number	SECTION 6: DOCUMENTATION					
	Lab sample no	Lab name	Reference	Institution	Date Entry Last Revised	Entered by
46	124-1	Berkeley Geochronology Center	Sowers, J. M., Sharp, W. D., Southard, R. J., and Ludwig, K. R., 2000, Geochronology of deformed terrace soils on the east front of the Diablo Range near Tracy, California, Final Technical Report, U. S. Geological Survey National Earthquake Hazards Reduction Program, # 99-HQ-GR-0101	Wm. Lettis & Associates, Inc., Walnut Creek, CA	10/14/2002	J.M. Sowers
47	125A-1	Berkeley Geochronology Center	Sowers, J. M., Sharp, W. D., Southard, R. J., and Ludwig, K. R., 2000, Geochronology of deformed terrace soils on the east front of the Diablo Range near Tracy, California, Final Technical Report, U. S. Geological Survey National Earthquake Hazards Reduction Program, # 99-HQ-GR-0101	Wm. Lettis & Associates, Inc., Walnut Creek, CA	10/14/2002	J.M. Sowers
48	130A-1	Berkeley Geochronology Center	Sowers, J. M., Sharp, W. D., Southard, R. J., and Ludwig, K. R., 2000, Geochronology of deformed terrace soils on the east front of the Diablo Range near Tracy, California, Final Technical Report, U. S. Geological Survey National Earthquake Hazards Reduction Program, # 99-HQ-GR-0101	Wm. Lettis & Associates, Inc., Walnut Creek, CA	10/14/2002	J.M. Sowers
49	130B-1	Berkeley Geochronology Center	Sowers, J. M., Sharp, W. D., Southard, R. J., and Ludwig, K. R., 2000, Geochronology of deformed terrace soils on the east front of the Diablo Range near Tracy, California, Final Technical Report, U. S. Geological Survey National Earthquake Hazards Reduction Program, # 99-HQ-GR-0101	Wm. Lettis & Associates, Inc., Walnut Creek, CA	10/14/2002	J.M. Sowers
50	106-2	Berkeley Geochronology Center	Sowers, J. M., Sharp, W. D., Southard, R. J., and Ludwig, K. R., 2000, Geochronology of deformed terrace soils on the east front of the Diablo Range near Tracy, California, Final Technical Report, U. S. Geological Survey National Earthquake Hazards Reduction Program, # 99-HQ-GR-0101	Wm. Lettis & Associates, Inc., Walnut Creek, CA	10/14/2002	J.M. Sowers