U.S. Geological Survey
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FINAL TECHNICAL REPORT

Digital Database for the Concord and Green Valley faults

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ABSTRACT

This study presents a new digital map compilation of principal Quaternary and younger traces of the Concord and Green Valley faults in the eastern San Francisco Bay region. The work described is a part of a collaborative effort between private, government, and academic geologists and the U.S. Geological Survey to construct a Quaternary fault map and database for the San Francisco Bay area, with a target publication date of April 2006. This digital database includes a compilation of published and unpublished fault traces, line and point data delineating the geomorphic evidence of recent surface fault rupture, point data describing fault creep observations, and point data delineating trench sites documenting fault location, recency, and event chronology. Because these digital faults reside in a Geographic Information System database, geoscientists and other interested researchers can more efficiently locate and assess evidence for activity and locate those areas where further study could help answer questions regarding the rate of activity and past earthquake history on the Concord and Green Valley faults.

INTRODUCTION

The Northern California Quaternary Fault Map Database (NCQFMD) project is an attempt to integrate geologic, geomorphic, creep, trench investigation, and other data regarding Quaternary and younger faults into a single, consistent Geographic Information System and database. This integrated data will allow researchers and others to more easily determine which aspects of fault locations and activity levels are well determined by data and which have large uncertainties or are largely speculative. We prepared a digital fault map and associated database for Quaternary and younger traces of the Concord and Green Valley faults. The data compiled in this database are consistent with the nomenclature used in the National Quaternary Fault and Fold Database of the United States (Haller, et al, 1993).

RESULTS

Based on the reduction in the NEHRP grant for this project, we worked within the modified goals as described in an e-mail to compilers sent by R. Graymer on November 11, 2004. In order of priority, goals were to compile data for:

A. Fault traces in GIS, identifying names/numbers.
B. Fault strand rank.
C. Location certainty (text or numeric)
D. Geomorphic expression/creep expression data
E. Site specific point data OR offset unit data

Goals A and B were essential to the short term success of the NCQFMD project and goals C and D were desirable components for compilation. We completed goals A-D and, as funding allowed, partly completed the site specific point data delineated in E.

We prepared a detailed digital map and database incorporating geologic, geomorphic, creep, trench investigation and other data related to the Concord and Green Valley faults (Figures 1 and 2). Mapping of individual fault traces was digitized and attributed using the standardized data fields for the NCQFMD project (Tables 1-4, R. Graymer, written communication, 11/11/2004). Quaternary and younger traces of the Concord and Green Valley faults were digitized using the mapping of Bezore, et al (2002), Bryant (1982, 1992), Dames and Moore (1972), Dooley (1973), Earth System Associates (1977), Frizzell and Brown (1976), Graymer, et al (1999), Poland (1935), Rogers Pacific (1988), Rowley and Mc Rae (1985), Sharp (1973), Sims, et al (1973), and Wills and Hart (1992a and b) (Table 1). In addition, we digitized traces of the Atlas Peak-Foss Valley lineament zone mapped by Baldwin, et al (1998) just north of the Green Valley Fault (Figure 1). Based on our evaluation of the mapped traces and the traces encompassed by Earthquake Fault Zones under the Alquist-Priolo Earthquake Fault Zoning Act of 1972 (Hart and Bryant, 1997), we determined the primary and secondary Holocene active traces for the Green Valley and Concord faults, as well as identifying traces showing evidence of Historic fault creep. The strands.evirel table (Table 2), which associates geomorphic and creep evidence with specific fault strands, also was completed.

The sites.datarel and sites.pat tables (Tables 3 and 4) were compiled as much as possible with the reduced amount of funding available for this contract. The locations and source of 2 paleoseismic sites (slip rate data), 42 trench sites documenting location and fault recency, and 6 fault creep site locations are associated with specific traces of the Concord and Green Valley faults.

Data documenting Holocene and Historic activity along the Concord and Green Valley faults will allow geologists to evaluate the evidence for activity on the strands of the these faults and locate those areas where further study could help answer questions regarding the rate of activity on the fault or connections to the surrounding faults.

METADATA

The database was compiled in the MapInfo 8.0 Geographic Information System and exported in both MapInfo tab and ESRI shape file formats. The database consists of the fault map database, supporting metadata, and this report. The fault map database consists of 4 MapInfo GIS files (Tables 1-4) which were created and attributed according to the NCQFMD format for incorporation into the San Francisco Bay area Quaternary fault map database.

Map traces were compiled at the largest available scale from published sources (published maps ranged in scale from 1:62,500 to 1:24,000). Original source maps were scanned using a large-format scanner. The scanned maps were georeferenced using control points to link map edge tics and cultural features. The fault traces, supporting geomorphic features, fault creep localities, and trench sites were vectorized using heads-up digitization. Attribute tables were completed within GIS and follow the NCQFMD format.

Vectorized maps and the associated digital files were compiled from source maps at scales of 1:24,000 and 1:62,500 (preference given to the larger 1:24k scale). Although the digital format of the dataset permits viewing the data at a larger scale, the detail and accuracy of the line and point data is compromised at scales large than1:24,000. Viewing the data at a larger scale will not result in greater detail than that presented at the original source scale and should not be used for investigations requiring greater detail.

SUPPLEMENTAL DATA

Concord Fault

The Concord Fault is a Holocene active dextral strike-slip fault characterized by aseismic creep (rate 3.0 mm/yr to 3.5 mm/yr; Galehouse, 2000). Several site-specific studies in compliance with the Alquist-Priolo Act (Hart and Bryant, 1997) have documented the location and approximate age of most recent faulting (Wills and Hart, 1992a, b). Detailed studies at Galindo Creek yielded preliminary slip-rate of 3.7 ± 2.0 mm/yr (Borchardt, et al, 1998).

Geomorphic expression – The northern part of the Concord Fault extending from the south shore of Suisun Bay southeast to Buchanan airport generally is concealed by marshes near the mouth of Pacheco Creek. Fault locally is delineated by a linear west-facing escarpment near Tank Farm Hill and smaller scarps mapped by Sharp (1973). An eastern trace is delineated by a linear bench and associated broad scarp and tonal lineament (Wills and Hart, 1992a, b). From Buchanan airport southeast to westward flowing section of Pine Creek at the base of Lime Ridge the Concord Fault is delineated by geomorphic features indicative of Holocene dextral strike-slip displacement, including a closed depression (Keller Lake), scarps and linear tonal contrasts in alluvium, and

dextral offset of Galindo Creek (Sharp, 1973; Wills and Hart, 1992a, b; Borchardt, et al, 1998). Extending from Lime Ridge to the southern extent of the fault, the Concord Fault is delineated by a southwest-facing escarpment along the west side of Lime Ridge, a linear drainage, and a linear tonal contrast possibly due to ground water barrier.

Slip rate and recurrence – A dextral slip rate of 4.3 mm/yr to 17.4 mm/yr reported by Snyder, et al (1995) with preferred slip rate of 6.4 mm/yr. This rate was based on inferred dextral offset of Galindo Creek at two locations. Subsequent work at Galindo Creek by Borchardt, et al (1998) reported a slip rate of 1.7 mm/yr to 5.7 mm/yr with a preferred slip rate of 3.7 mm/yr. The revised slip rate is a result of a better-constrained dextral displacement of Galindo Creek (channel c). An inferred dextral deflection of Galindo Creek about 15 m farther east is not due to offset along the Concord Fault (Borchardt, et al, 1998), thus reducing the total dextral offset postulated by Snyder, et al (1995). Recurrence intervals have not been determined for the Concord Fault.

Timing of most recent paleoevent - Age of most recent paleoevent is not well-constrained. Borchardt, et al (1998) reported that the most recent displacement is < 2.6 ka.

Green Valley Fault

The Green Valley Fault is a Holocene active dextral strike-slip fault. This fault, which is the easternmost strike-slip fault of the San Andreas Fault system in the San Francisco Bay area, is characterized by aseismic creep and has been monitored by Galehouse (2000) since 1984. Detailed reconnaissance level mapping exits for most of fault, based on geologic and geomorphic data (Weaver, 1949), Dooley (1973), Sims, and others (1973), Frizzell and Brown (1976), and Bryant (1982, 1992). Several site-specific studies in compliance with the Alquist-Priolo Act (Hart and Bryant, 1997) have documented location and approximate age of most recent faulting. Preliminary data from the Lopes Ranch paleoseismic site indicates Green Valley Fault has produced multiple surface-rupturing events in the past 2.7 ka and has a minimum late Holocene dextral slip rate of 3.8 mm/yr to 4.8 mm/yr (Baldwin and Lienkaemper, 1999).

Geomorphic expression – The Green Valley Fault is delineated by geomorphic features indicative of Holocene dextral offset, including closed depressions, ponded alluvium, dextrally offset drainages, linear troughs, sidehill benches, and scarps in young alluvium (Dooley, 1973; Frizzell and Brown, 1976; Bryant, 1982, 1992). Extensive, massive landslides locally conceal fault traces along the northern extent of the fault in Wooden Valley, and locally obscure fault traces between Suisun Bay and Highway 80.

Slip Rate and Recurrence - Bryant (1982, 1991) estimated long term Quaternary slip rate of 3 mm/yr, based on unconstrained dextral separation of Pliocene Sonoma Volcanics mapped by Sims, et al (1973). Wesnousky (1986) reported a slip rate of 4 mm/yr for the Green Valley Fault. This rate is actually the creep rate for the Concord Fault reported by Harsh and Savage (1982). Baldwin and Lienkaemper (1999) reported a minimum late Holocene dextral slip rate of 3.8 - 4.8 mm/yr, based on 1.2 – 1.5 m

dextral offset (minimum) of a 310 yr old paleochannel. This value is a minimum because: 1) the measurement of the offset channel is uncertain and may represent a minimum value, and 2) additional fault traces to the east have not been accounted for in the displacement value. The Green Valley Fault is characterized by aseismic creep, which is highly episodic. Galehouse (2000) reported average dextral creep rate of 4 mm/yr to 5 mm/yr for the past 14 years along the Green Valley Fault. Recurrence intervals have not been determined for the Green Valley Fault.

Timing of most recent paleoevent – The age of most recent paleoevent has not been determined, but is probably late Holocene based on trench data reported by Baldwin and Lienkaemper (1999). Cole and Pratt (1990) interpreted offset soil horizon with weak Stage I pedogenic carbonate development to be 5 ka to 9 ka. Baldwin and Lienkaemper (1999) identified multiple surface-rupturing events in the past 2.7 ka.

NON-TECHNICAL SUMMARY

We completed a digital map of Quaternary traces of the Concord and Green Valley faults, located in the eastern San Francisco Bay region. These faults will be used in conjunction with other digital faults to assemble a map of Quaternary faults in the San Francisco Bay region. Because these digital faults reside in a Geographic Information System database, geoscientists and other interested researchers can more efficiently locate and assess evidence for activity and locate those areas where further study could help answer questions regarding the rate of activity and past earthquake history on the Concord and Green Valley faults.

REPORTS PUBLISHED

Data compiled for the Concord and Green Valley faults were integrated into U.S. Geological Survey Scientific Investigations Map 2919, Map of Quaternary-active Faults in the San Francisco Bay Region (Graymer, et al, 2006).

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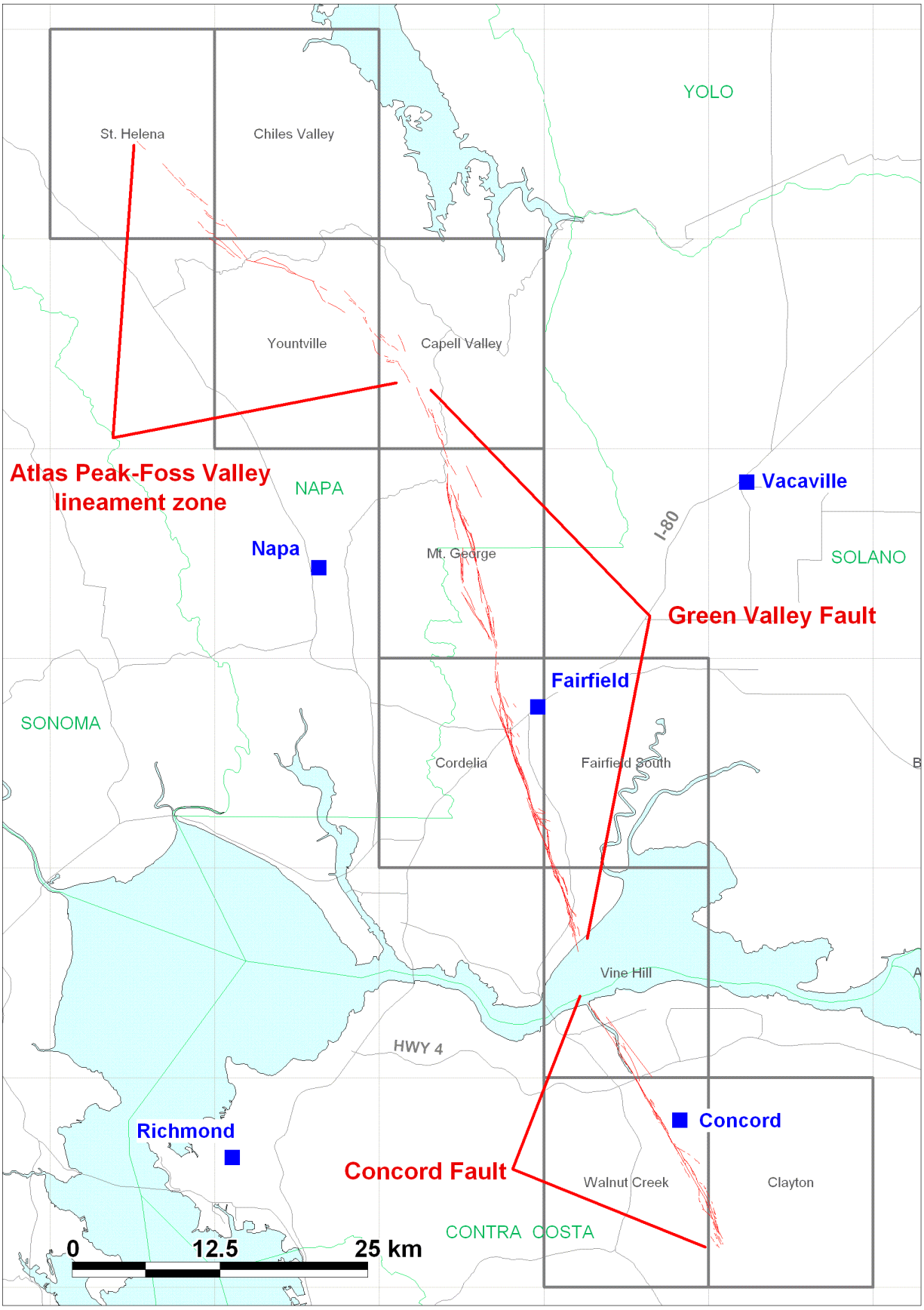

Figure 1. Digitized traces of Concord and Green Valley faults, including Atlas Peak-Foss Valley lineament zone, located in eastern San Francisco Bay region.

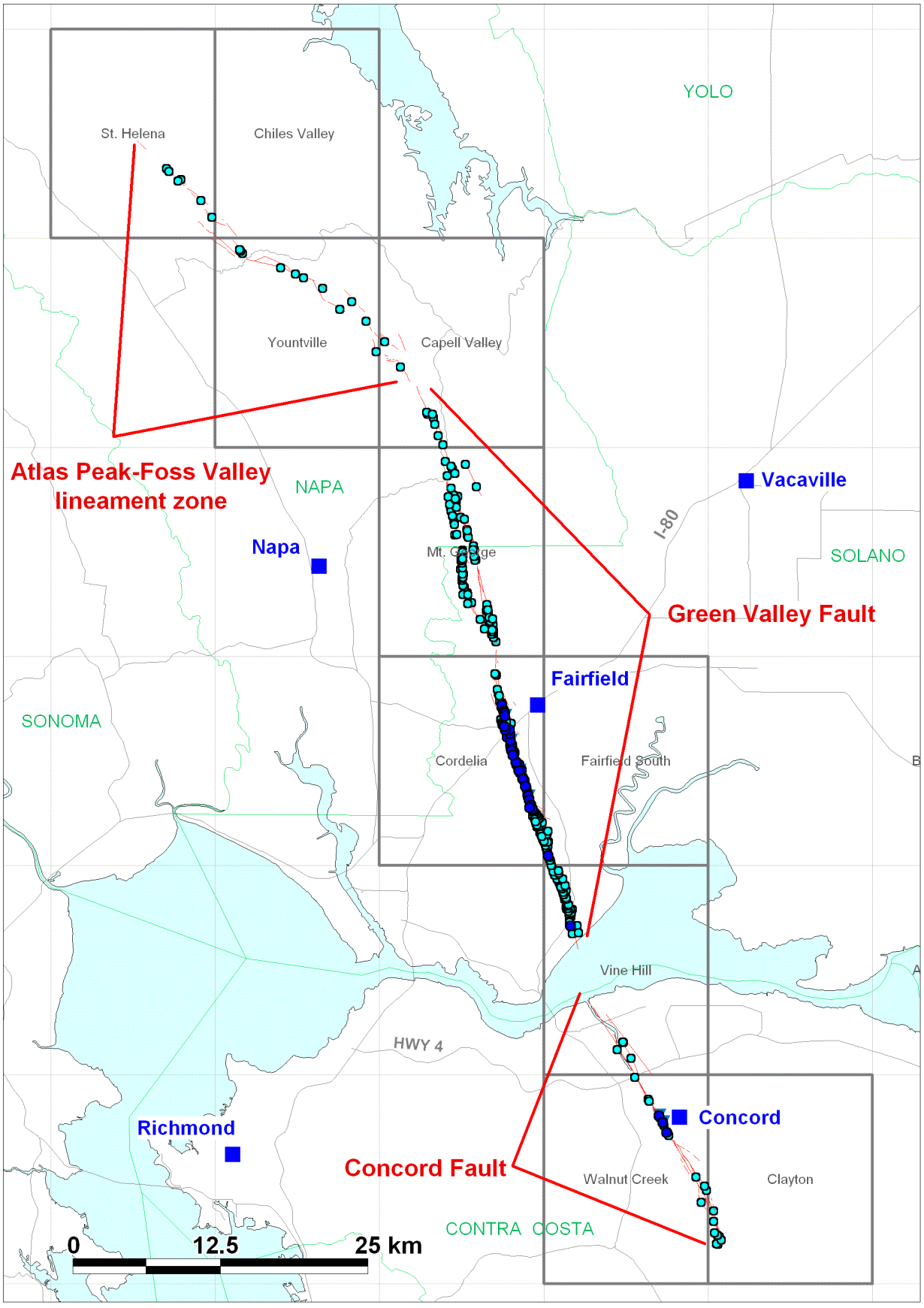

Figure 2. Digitized traces of Concord and Green Valley faults, showing locations of geomorphic features (light blue circles) and trench sites and fault creep localities (dark blue circles).

Table 1 - Strands.att attribute table

ITEM NAME	WIDTH	TYPE	Field Comments
STRAND#	6	I	Unique strand id number
FNAME	50	C	Natl Q. Fault DB fault name
FNAME_COMM	320	C	Comment on fault name
FSEC_NAME	50	C	Natl Q. Fault DB section name
FSEC_COMM	320	C	Comment on section name
QFAULTID	8	C	Natl Q. Fault DB fault/section id
LOC_CER_TXT	50	C	Text description of location certainty
LOC_CER_NUM	6	I	Numerical estimate of loc cert (m)
LOC_CER_COMM	320	C	Comment on loc cert
OFFSET	100	C	Text description of offset type
OFFSET_COMM	320	C	Comment on offset type
FRANK	50	C	Fault strand rank
FRANK_COMM	320	C	Comment on fault strand rank
DIP	2	I	Dip (degrees, 0-90)
DIPDIR	1	C	Dip direction, N,S,E,W
DIP_COMM	320	C	Comment on dip
DATE_UPDATED	8	D	Date of last data entry (yyyymmdd)

Table 2 – Strands.envirel attribute table

ITEM NAME	WIDTH	TYPE	Field Comments
STRAND#	6	I	Unique strand id#, same as in AAT
FTR_MAPPED	320	C	Geomorphic/creep expression
FTR_MAPPED_BY	100	C	Reference to previous work
FTR_MAPPED_HOW	100	C	Type of mapping used
G_WAT_EFFECT	100	C	Ground water effect
G_WAT_COMM	320	C	Comments on grd. water effect

Table 3 – Sites.datrel attribute table

ITEM NAME	WDTH	TYP	Field Comments
SITE#	6	I	Site id number, same as in PAT
DATA_TBL#	6	I	Unique id #
DATA_TYPE	50	C	Creep rate, long term rate, event sequence, AP, etc.
DATA_COMM	320	C	Comments on data
DATA_REF	100	C	Published data reference
AGE_TXT	50	C	Text age of event/offset unit
AGE_MEAN	12	I	Numeric mean age
AGE_MAX	12	I	Numeric max age
AGE_MIN	12	I	Numeric min age
AGE_PDF	320	C	PDF of age
AGE_COMM	320	C	Comments on age
DISPL_TXT	100	C	Text amount of measured offset
DISPL_MEAN	12	I	Numeric mean offset
DISPL_MAX	12	I	Numeric max offset
DISPL_MIN	12	I	Numeric min offset
DISPL_PDF	320	C	PDF of offset
DISPL_DIR	100	C	Direction of offset
DISPL_TYPE	50	C	One-event, shared, long-term
DISPL_COMM	320	C	Comments on displacement
DISPL_SHARE_EV	70	C	List of data_tbl# for events shared in displacement
EV_EXIST	4	F	Probability (0-1) that recorded event is actual
CREEP_DAT_LIST	320	C	List of offset/date pairs for creep measurements
CREEP_TXT	50	C	Text creep rate
CREEP_MEAN	12	I	Numeric mean creep rate
CREEP_MAX	12	I	Numeric max
CREEP_MIN	12	I	Numeric min
CREEP_PDF	320	C	PDF for creep rate
CREEP_COMM	320	C	Comments on creep
DATA_EVAL_BY	100	C	Name of scientist providing evaluation
DATA_UP_BY	100	C	Name of data contributor
DATE_UPDATED	8	D	Date of last data entry (yyyymmdd)

Table 4 – Sites.pat attribute table

ITEM NAME	WDTH	TYP	Field Comments
SITE#	6	I	Unique site id number
SITE_NAME	50	C	
QFAULTID	8	C	Natl Q. Fault DB fault/section id
STRAND#	6	I	Strand id number from Strand DB
SITE_ALT_LOC	50	C	Alternate location info (GPS, etc.)
SITE_TYPE	50	C	Trench, multi-trench, geomorphic, etc
SITE_COMM	320	C	Comment on site
DATA_TBL_LIST	140	C	List of related entries in sites.datrel
EV_SEQ_LIST	35	C	List of related entries in sites.seqrel
EV_SEQ_WEIGHT	70	C	Relative weight of alternate event sequences
EV_SEQ_COMM	320	C	Comments on event sequences
EV_SEQ_EVAL_BY	100	C	Event sequences evaluated by
UPDATE_BY	100	C	Name of data contributor
DATE_UPDATED	8	D	Date of last data entry (yyyymmdd)