CALIFORNIA DIVISION OF MINES AND GEOLOGY
FAULT EVALUATION REPORT FER-178

The San Gabriel Fault Near Castaic and Saugus Los Angeles County, California

by

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INTRODUCTION

Exploratory trenches, excavated across inferred traces of the San Gabriel fault, near the confluence of San Francisquito Canyon and the Santa Clara River, have revealed evidence for Holocene activity. One set of trenches was excavated in Rye Canyon. Another trench was excavated in the canyon between Rye Canyon and San Francisquito Canyon. Other trenches or road cuts were logged in the area but none revealed unambiguous evidence for Holocene activity. This new evidence requires reevaluation of this portion of the San Gabriel fault (see Figure 1) under the criteria of the Alquist-Priolo SSZ Act of 1972.

The segment of the fault between Castaic and Ruby Canyon, northwest of the area trenched, and the segment in the vicinity of Saugus, to the southeast, were investigated because of their proximity and the recognizability of the fault on air photos. The segment to the northwest is located on the Whitaker Peak and Val Verde 7 1/2 minute quadrangles (Figures 4, 5, and 6). The segment to the southeast and the area where the trenches were dug is located on the Newhall 7 1/2 minute quadrangle (Figures 7 and 8).

SUMMARY OF PREVIOUS WORK

A previous Fault Evaluation Report (Smith, 1978), done on the full length of the San Gabriel fault, summarized work completed prior to 1978. No unambiguous evidence of Holocene activity, sufficient to justify zoning, was recognized then. Late Pleistocene activity was considered probable but evidence for possible Holocene activity was judged to be very questionable. Zoning was not recommended.

Subsequently, continued work by Weber (1982, 1985a,b,c, 1986a,b,c,d) has affirmed late Pleistocene activity. He has not found unquestioned evidence for Holocene activity although he feels that some evidence

Note: This report includes 11 figures and 8 pages of text.

strongly suggests possible Holocene activity. Weber (1986b) has shown that lateral components of displacement (on rock units whose youngest portions are perhaps 1.0 million years old) are modest, less than a kilometer. Gross calculations from his data suggest a slip-rate whose right-lateral component may be less than 1 mm/yr.

Recent mapping by Yeats and others (1985) and/or Stitt (1986, figure 9), near the mouth of Violin Canyon, shows rocks of the Pico and Towsley Formations (common west of the San Gabriel fault) thrust eastward beyond the San Gabriel fault to rest upon rocks of the Violin Breccia and the Saugus Formation. A recent field trip to the San Gabriel fault (Ehlig, et al., 1986) describes the relationships in this area (Stop 8), see Figure 5. They say that "...the Santa Felicia fault places the Pico and Towsley formations across the trace of the San Gabriel fault in this area but it does not appear to be displaced by the San Gabriel fault". Stitt (1986, p. 68) says that "At this location, the field relationships show that the San Gabriel fault does not exhibit Quaternary activity."

Stitt (1980) earlier mapped a northeast trending fault, in Santa Felicia Canyon about 3 km to the west of the San Gabriel fault, which he called the Santa Felicia fault. Yeats and others (1985) and Stitt (1986) connect the thrust fault at the San Gabriel fault to the fault previously mapped by Stitt (1980) and they now call the whole extent the Santa Felicia fault. It is interesting to note that Stitt (1980), in his original mapping, showed no significant faulting in the area now traversed by the Santa Felicia fault. The most recent version of the Santa Felicia fault appears to be a nearly vertical fault transecting terrain of high relief until it reaches the San Gabriel fault where it suddenly turns into a thrust fault.

Weber (1986c; personal communications) disagrees with this latest interpretation on several grounds. He basically shows the San Gabriel fault as a slightly sinuous, through-going feature and shows no Towsley Formation over Violin Breccia or Saugus Formation. He maps rocks of the Castaic Formation where Yeats and others (1985) show Towsley. He also shows Pico Formation depositionally upon Violin Breccia east of the San Gabriel fault, not in fault contact. Furthermore, he says that the Santa Felicia fault is not exposed in recent roadcuts where Yeats and others (1985) show it west of the San Gabriel fault.

A detailed engineering geologic investigation (Cotton and Seward, 1984), done for the Newhall Land and Farming Company of Valencia, California, identified traces of the San Gabriel fault in several locations. One trench, Trench A, (Figure 2) revealed evidence for Holocene displacement on rocks dated between 7,700±60 and 8,140±60 years before the present (years b.p.). This trench was located by projection of the trace from known locations. No surface evidence was recognized here and the faulting seen in the trench reached only within about 4.7 m of the surface. Thick slope wash or alluvium masks any surface expression of the fault. Relative displacement is down on the east with possible modest right-separation.

Other trenches were dug by Cotton and Associates (Cotton, 1985) in Rye Canyon, which revealed a similar relationship to that in Trench A but exposed younger rocks which were faulted (see Figure 3) and dated at 3,500±250 years b.p. Also alluvium dated at 1,550±190 years b.p. was shown to be unfaulted establishing limits for the latest movement on this portion of the San Gabriel fault. Here again faulting could not be traced to the surface, being apparently buried by about 1.7 m of alluvium.

Numerous trenches were dug in the hilly terrane east of Saugus for a proposed development (Morley, 1984). None of the trench logs show evidence of Holocene activity; several show Saugus Formation against terrace gravels suggesting late Pleistocene activity. The trace near Bouquet Junction was called an old road on his map and was trenched (see Trench 39 and Trench 40 descriptions and Figure 8). The pertinent trench locations are shown on Figure 8. No evidence for Holocene activity is shown in any of the trench logs but selected descriptions, by the author, are included below, for convenience. Other trenches showed no faulting and are not described or shown on Figure 8.

Trench Log Descriptions

Trench 39 shows terrace deposits over conglomerate. Treiman (1986) maps these as Pacoima Formation and Saugus Formation respectively and maps the contact as a fault. (Conclusion) Because of the fault geomorphology present and rock contrast I believe this trench intersects a fault rather than a contact, as shown. No evidence of Holocene activity is present.

Trench 40 shows unbroken massive sandstone, presumably Saugus Formation, with "no attitudes possible" (Morley, 1984). I suspect this may be residual terrace deposits or colluvium. Unbedded Saugus is atypical. Faulting could be below depth of trench or could be obscure in such "porous, dry" material. The topographic expression here is not too well-defined but suggests an inferred fault extension between two well-defined portions.

Trench 41 intersects two faults. The southernmost juxtaposes terrace deposits (Pacoima Fm. per Treiman, 1986) to the south against Saugus Fm. to the north. The northernmost fault juxtaposes Saugus against Saugus. No evidence for Holocene activity on either fault is indicated on the trench log.

Trench 43 shows fault with the same sandstone unit on both sides, (presumably Saugus Fm. as mapped by Treiman). No evidence for Holocene activity is indicated.

Trench 46 shows Saugus Fm. against Saugus Fm. with nothing to indicate Holocene activity.

Trench 47 shows faulted conglomerate (presumably Saugus Fm.) overlain by unfaulted alluvium suggesting no Holocene activity.

Trench 48 shows faulted Saugus Fm. with on younger units indicated. No evidence of Holocene activity.

Trench 65 shows faulted terrace deposits, probably Pacoima Fm. and unfaulted soil. No evidence of Holocene activity.

Trench 67 shows Saugus Fm. to south faulted against terrace deposits to north and unfaulted soil. No evidence of Holocene activity.

Trench 68 shows Saugus Fm. faulted against Saugus Fm. overlain by unfaulted alluvium, soil and fill. No evidence of Holocene activity is indicated.

Mapping in the southeast quarter of the Newhall quadrangle (Treiman, 1986, in preparation) shows ponded alluvium, lithologic differences, and disrupted drainage channels along the fault trace. Other traces shown by Treiman do not appear to have as recent movement as the most easterly trace.

A recent GSA field trip (Ehlig, et al., 1986) highlighted the San Gabriel fault at Bouquet Junction (Stop 5). This location is shown on Figure 8 and has been mapped by Treiman (1986). No evidence of Holocene activity is present here.

FIELD AND AIR PHOTO INTERPRETATION

The segment of the fault between Castaic and Whitaker Peak was studied on several sets of aerial photographs and by limited field observations. The features and locations where evidence of late Pleistocene displacement may be present are shown on figures 4, 5, and 6. No unequivocal evidence for Holocene activity could be identified on the air photos. The area is severely eroded and the fault trace crosses numerous youthful gullies which are not offset. Apparently slope debris may be offset locally, suggesting late Pleistocene activity. One landslide seems to bury the fault and not be offset.

Between Castaic and Bouquet Junction no evidence of well-defined physiographic fault features can be seen either on air photos or on the ground to mark the trace of the fault. The fault has been exposed in trenches, hillside cuts, and enhanced roadcuts in this area and, where those are still accessible, the fault is visible. In the vicinity where the fault has been identified and dated in trenches and other excavations, no surficial features could be identified with confidence. This is not unexpected since the faulting identified in trenches does not reach the surface. Trench locations and other data are shown on figures 7 and 8.

Between Bouquet Junction and Oakdale Canyon, located about 3 km north-northwest of Newhall, the San Gabriel fault is well-defined by various geomorphic features, such as linear ridges, troughs or trenches, hillside benches, and ponded alluvium as shown on figure 9. These features may

indicate Holocene activity, perhaps earliest Holocene, or at least late Pleistocene. The fault trace is well-defined here for about 1.5 km along the zone. About 1 km northwest similar features occur along the zone for about 0.5 km. There is a temptation to project the fault between these two locations but the character of faulting expressed by differences in apparent attitude and geomorphic features suggest these two traces may be separate faults. Features interpreted as evidence for both lateral and vertical components of movement are present on both traces. The trace I have mapped near the railroad lies about 200 feet east of the fault shown as stop 5 (Ehlig, et al., 1986) on the GSA field trip. The trace I believe to be the most recent trace does not appear in a cut slope but the geomorphic expression is fairly clear on air photos, though not as well-defined as farther southeast (see Figure 8).

The vertical separation is consistently up on the northeast between Bouquet Junction and Oakdale Canyon and up on the southwest in the trenches suggesting significant lateral separation overall. The evidence for recent lateral separation is ambiguous, both left and right offsets occur locally, probably from erosional complication, but the general sense is right-lateral, based on hillslope displacement and linear ridge distribution.

CONCLUSIONS

The section of the fault northwest of Castaic along Paloma Canyon is well-defined on air photos but has limited evidence for recency of activity. There may have been Holocene activity along this stretch but the evidence is so weak that I question recent activity until further evidence has been found. The interpretations presented by Weber (1986c) and by Yeats and others (1985) and Stitt (1986) are basically in conflict with regard to Quaternary activity. Weber invokes late Pleistocene activity (from elsewhere on the fault) and the others preclude Quaternary activity. Neither suggest Holocene activity.

Detailed mapping for geomorphic evidence, not visible on air photos, may not be possible because of the poor accessibility of much of this terrane. From the evidence to date, I conclude that the fault is "well-defined" because of the severe erosion which has exposed it along most of the trace from Castaic to Ruby Canyon. Properly this stretch should be termed well-exposed rather than well-defined. It is not believed to be sufficiently active in this stretch to meet the A-P criteria.

Slip rates which may be less than 1 mm/yr, as mentioned earlier, could be the result of distributive regional strain and not a result of primary, earthquake producing movement on the San Gabriel fault. The amount of movement per event could be expected to be low also. Even if the offsets suggested by Crowell (1982) are accepted, the horizontal slip rate could be as low as 3 to 5 mm/yr, for Miocene rocks if activity has continued into the Holocene as suggested by recent trenching, instead of stopping 5 m.y. ago.

The stretch of the fault southeast of Bouquet Junction is well-defined and may be sufficiently active to meet the A-P criteria for zoning. Because of its proximity to the area where Holocene activity has been substantiated, to the northeast, this stretch of the fault is assumed to have been active in at least early Holocene time.

The stretch of fault where the trenches were dug by Cotton and Seward (1984) and by Cotton (1985) have established Holocene activity. The fault between the trenches is also assumed to be active and perhaps as far as can be comfortably projected. Beyond this immediate area the fault is not well-defined, in fact not physiographically defined at all, and cannot be zoned under A-P criteria. The amount of alluvium being deposited over the trace in this area has either obscured any possible surface expression or the rate of slip may be low enough to minimize the effect of surface rupture. Both processes could be a factor here. Cotton (1985) has inferred from these data that the fault will not be the locus of significant rupture in the future. This does not necessarily follow, but if the slip-rate is low the slip could be small. However, until the amount of slip per event can be more accurately estimated we should assume that damaging slip may occur.

RECOMMENDATIONS

Zoning is not recommended for the San Gabriel fault northwest of Castaic because of lack of evidence for Holocene activity in that area.

The stretch between Castaic and Bouquet Junction should be zoned in the vicinity of the trenches and along the projection of the fault as shown on figure 10. This zone should not be connected across the Santa Clara River with the zone at Bouquet Junction. I feel that this area represents a left-stepping migration of the San Gabriel fault.

The stretch southeast of Bouquet Junction should be zoned where the fault is well-defined, as shown on figure 11. The zoning could be considerably narrower here. I would agree to a 300 foot setback since the fault is reasonably straight and well-defined.

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July 1, 1986

I have reviewed the data and air photos and concur with the recommendations. The zone proposed on fig. 11 and possibly fig. 10, should be drawn a little narrower than shown.

Earl W. Hart
7/7/86

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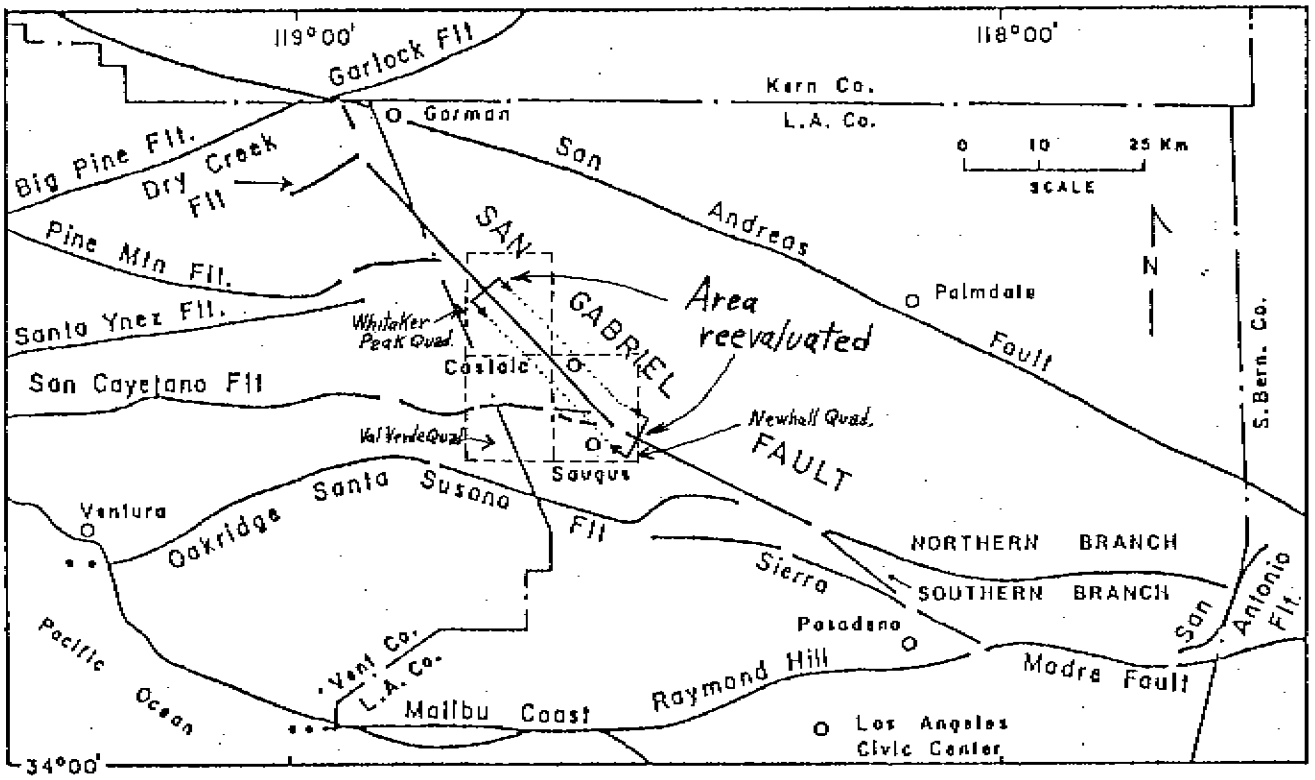

Figure 1 (FER-178). Index map showing major faults of southern California and the segment of the San Gabriel fault reevaluated. Base from Weber (1986b).

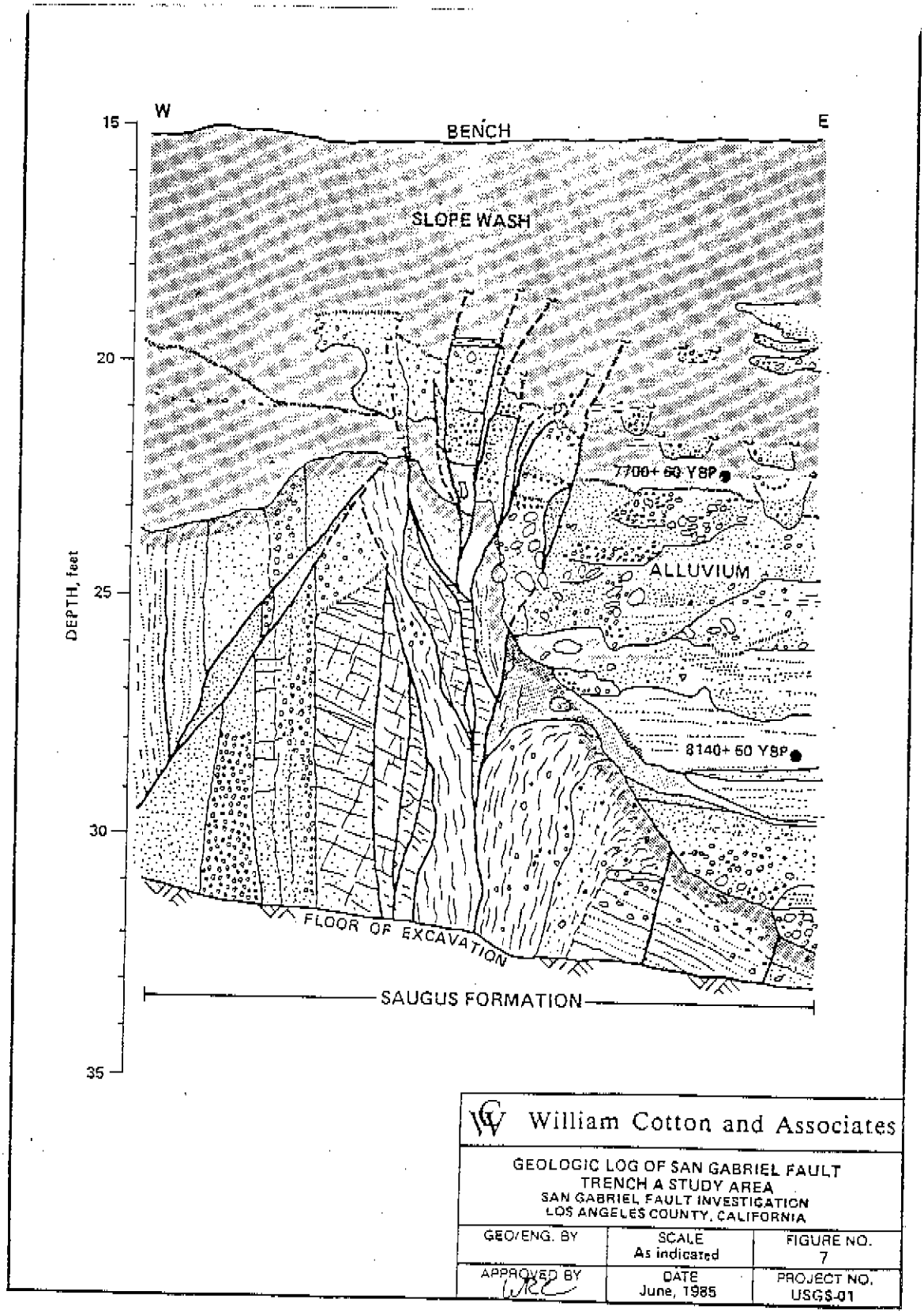

Figure 2 (FER-178). Portion of trench log (Trench A) across the San Gabriel fault. From Cotton (1985).

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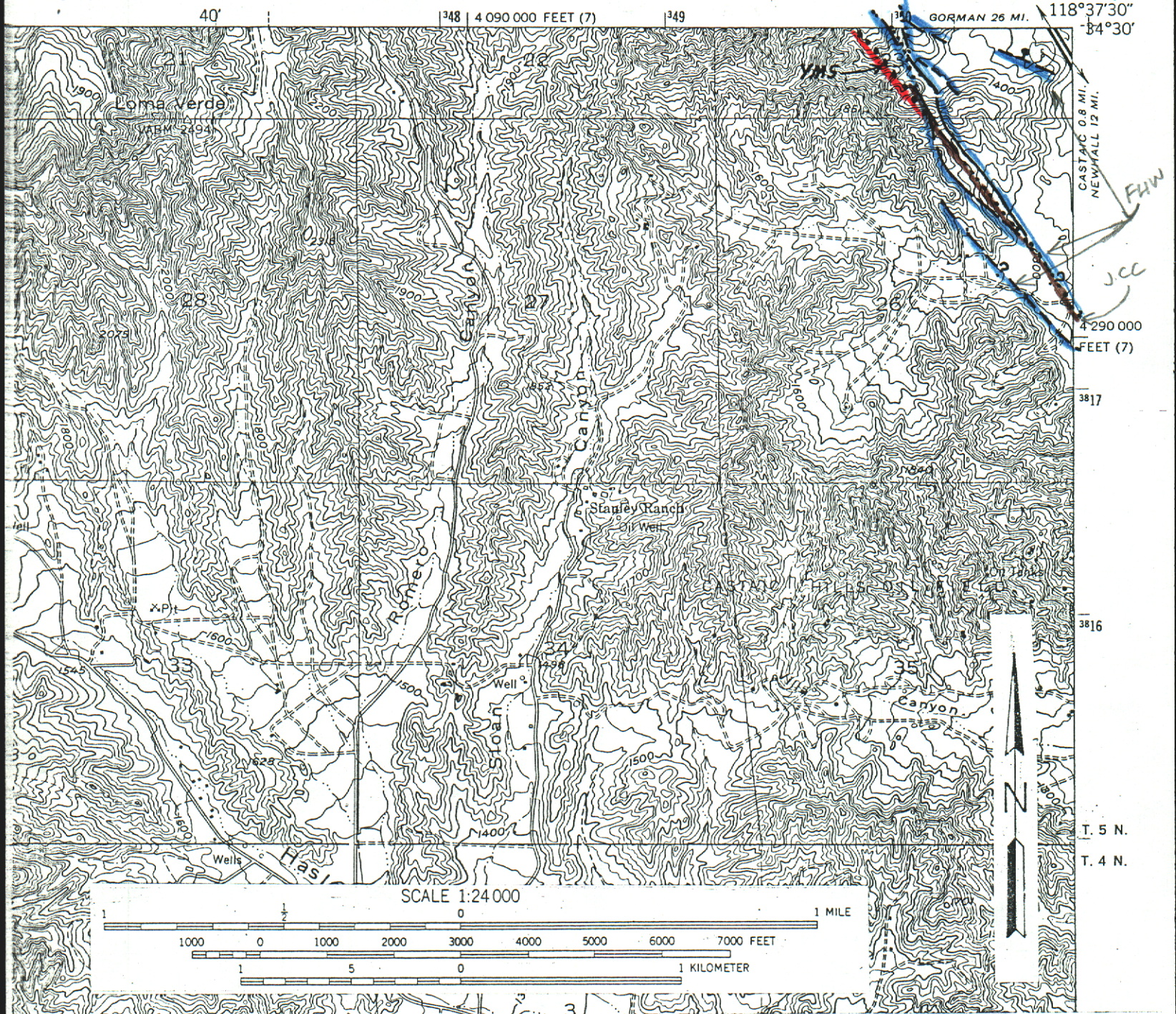

FIGURE 6 , FER-178. Map showing fault evaluated, and selected observations in the VAL VERDE QUADRANGLE

EXPLANATION

Source of information; color adjacent to trace.

- Blue or FHW – Weber (1982).
- Brown or JCC – Crowell (1982).
- Red or YMS – Yeats, et al. (1985).

Fault, solid line where accurately located, long dash where approximately located, short dash where inferred, dotted where concealed. Bar and ball on downthrown side of scarp. Query (?) indicates additional uncertainty.

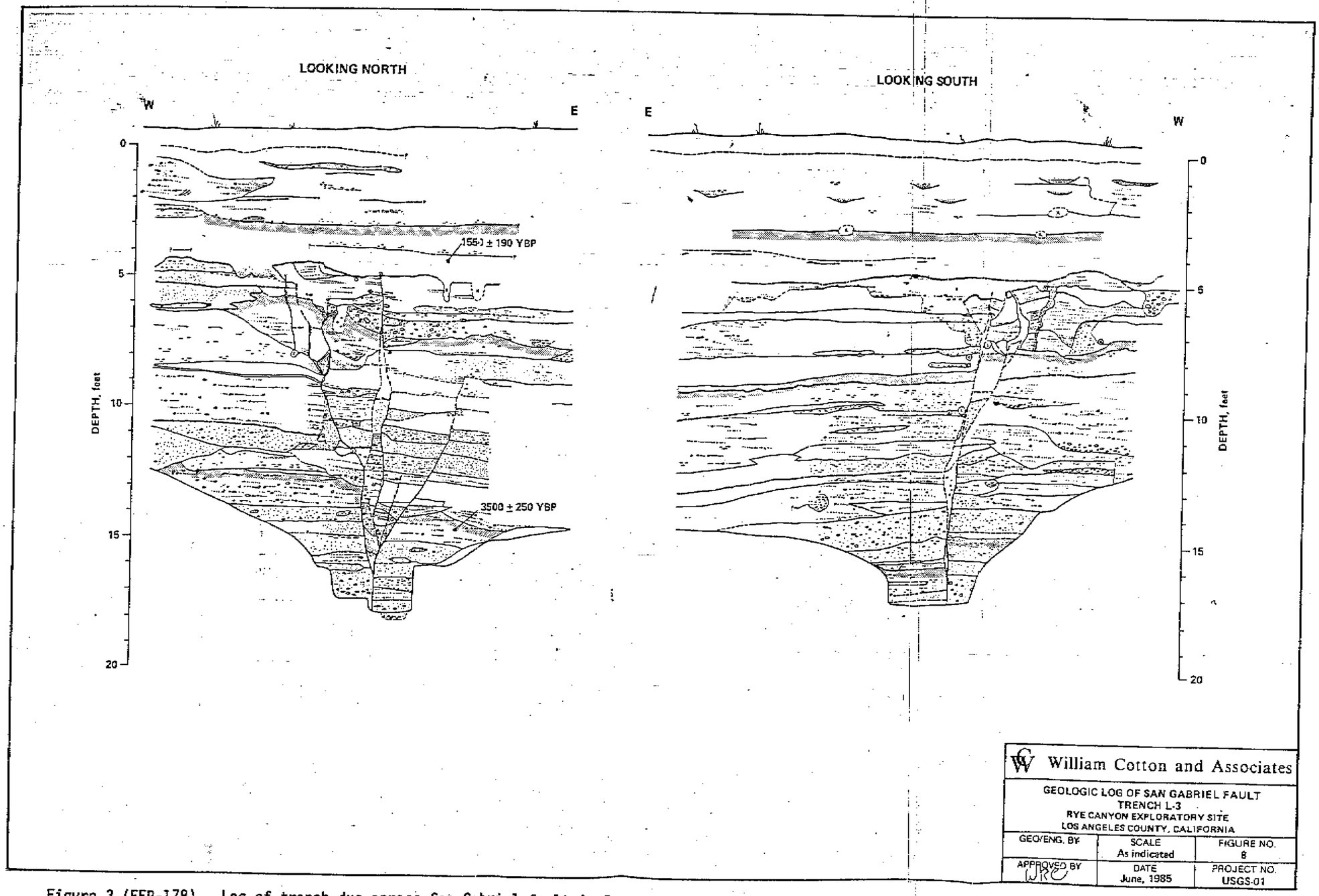

Figure 3 (FER-178). Log of trench dug across San Gabriel fault in Rye Canyon. From Cotton (1985).

Figure 3

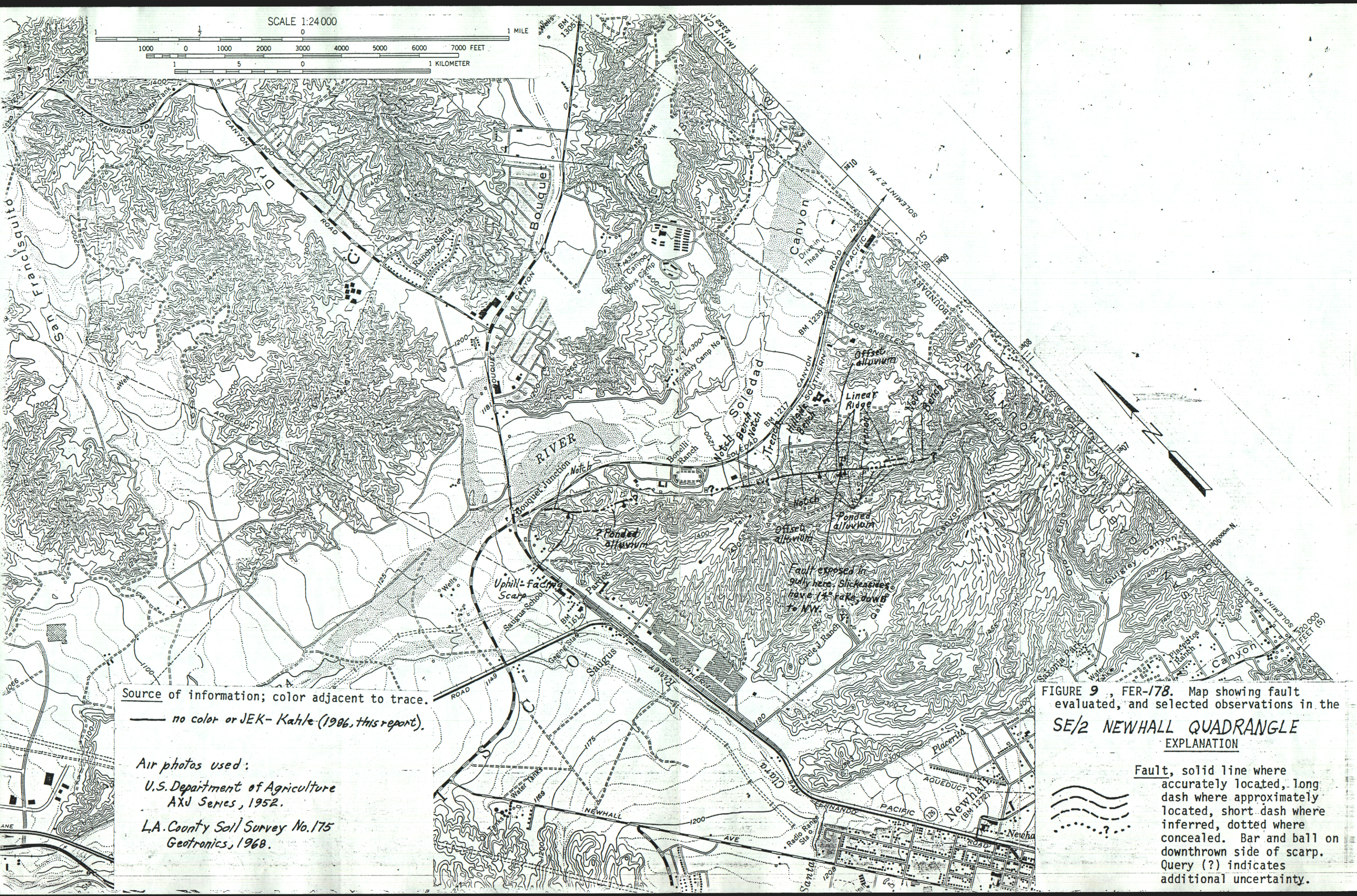

FIGURE 9, FER-178. Map showing fault evaluated, and selected observations in the SE/2 NEWHALL QUADRANGLE

EXPLANATION

Fault, solid line where accurately located, long dash where approximately located, short dash where inferred, dotted where concealed. Bar and ball on downthrown side of scarp. Query (?) indicates additional uncertainty.