2009 Annual SCEC Report

Late Quaternary slip rate of the northern San Jacinto fault

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During 2009 I conducted field mapping of three possible slip-rate targets on the northern San Jacinto fault between Moreno Valley and Redlands, California (Figure 1). This report focuses primarily on the Ebenezer landslide site, but also includes discussion of my work on the older, Quincy Ridge landslide and on offset channels at the Quincy site.

Figure 1: Location of slip rate sites along the San Jacinto fault discussed in this report.

Ebenezer landslide

A landslide offset by the San Jacinto fault is present within the headwaters of a canyon that drains into San Timoteo canyon. Much of this canyon, though not the landslide itself, is on the property of Rancho Ebenezer, hence the name for this site.

Field geologic mapping of the Ebenezer landslide is not quite complete, but preliminary results suggest the landslide is offset 270 ± 100 meters (Figure 2). The Ebenezer landslide (Qols2) is sourced from an older landslide deposit (Qols1) on the southwestern side of the fault. The Qols2 landslide deposit crosses the fault and is offset by it. The southeastern edge of the Qols2 landslide deposit is incised by a channel that is sharply offset by about 110 m. The Qols2 landslide deposit itself, however, appears to be offset greater than this amount. A minimum estimate of 170 meters for the landslide comes from restoring the southeastern edge of the Qols2 deposits northeast of the fault with the projection of the southeastern end of the headscarp to the fault (Figure 3). Any offset less than this restores the slide deposit against dioritic bedrock, which could not be a source for the tonalitic boulders in the slide deposit. A maximum offset of 370 m comes from restoring the poorly located northwestern edge of the Qols2 slide deposits northeast of the fault, with the intersection of the northwestern end of the headscarp with the fault. The misalignment of the southeastern edge of the landslide in this reconstruction can be explained by erosion of the southeastern edge of the slide deposit by the large channel along its margin. Similarly, the misalignment of the northwestern edge of the landslide with the northwestern headscarp in the 170-m reconstruction can be explained by erosion of the northwestern edge of the landslide on the northeast side of the fault.

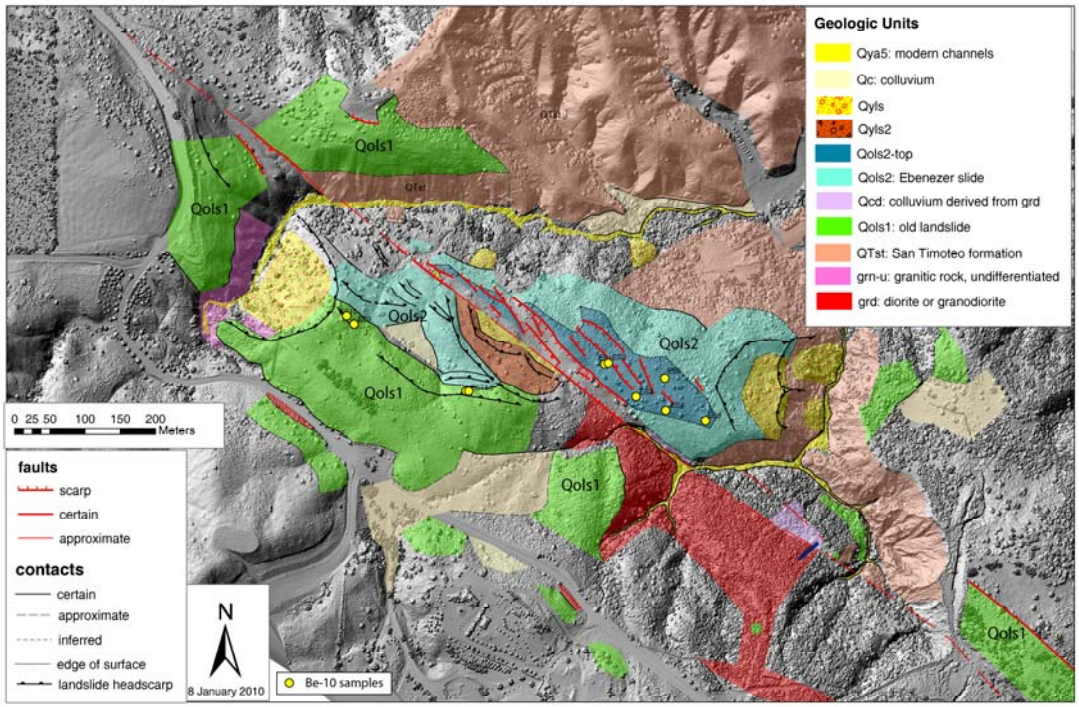

Figure 2: Preliminary geologic map (in progress) of the Ebenezer landslide. Yellow dots show locations of Be-10 samples from boulder tops.

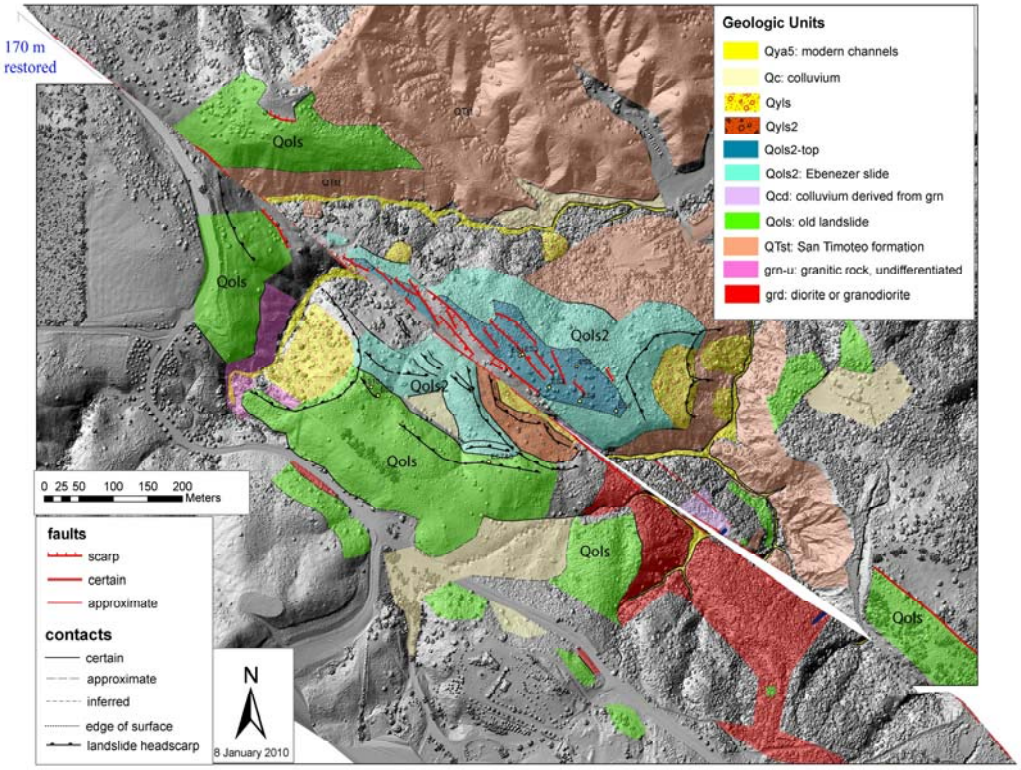

Figure 3: Minimum offset of 170 m restores the southeastern edge of the Ebenezer landslide (Qols2) with its headscarp.

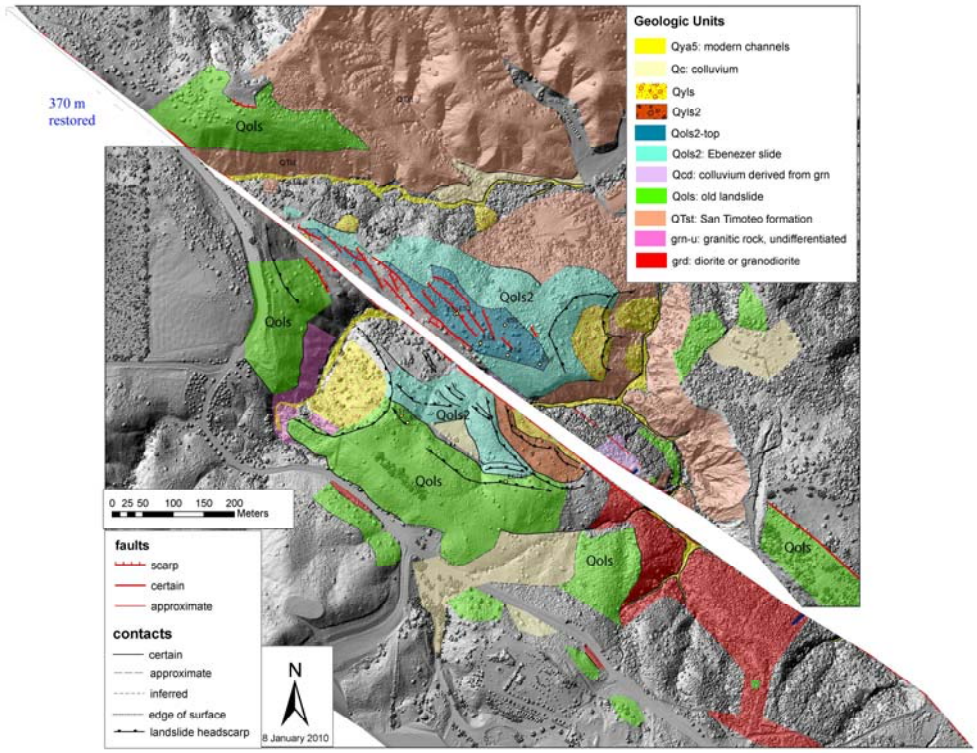

Figure 4: Maximum offset of 370 m restores the more poorly defined northwestern edge of the Ebenezer landslide (Qols2) with its headscarp.

Work is currently underway to date the Ebenezer landslide with Be-10 surface exposure dating. Samples were collected from 6 boulder tops on the portion of the slide deposit that is northeast of the fault and that is isolated from any current source of tonalitic boulders (Figure 5). Dates from these boulders may overestimate the age of the slide, if the boulders had a prior exposure history on top of the Qols1 slide, before it slumped to produce the Qols2 slide. Samples were also collected from 4 boulder tops in the headscarp of the Qols2 slide (Figure 5). These boulders were part of the older, Qols1 landslide that were suddenly exposed when the Qols2 headscarp formed. Dates from these boulders may underestimate the age of the Qols2 headscarp, because the headscarp may have undergone erosional retreat since its formation. Samples are currently being processed by Emiko Kent at University of Cincinnati.

Figure 5: (left) Boulder on the Qols2 deposit from which sample ES-1 was collected. (right) Boulder exposed in the Qols2 headscarp from which sample ES-8 was collected.

Quincy Ridge landslide

An older landslide deposit on top of Quincy Ridge (Figure 6) is similar to and appears to be offset from the Qols1 landslide that is the source for the Qols2 (Ebenezer) slide discussed above. This slide had not yet been fully mapped. At present, its geometry appears rather unusual—a long, thin strip parallel to and offset by the San Jacinto fault. Further mapping is needed to elucidate the origin of this landslide, but the foliated tonalitic boulders in the slide deposit appear to have come from bedrock highlands southwest of the Qols1 deposits on the southwestern side of the fault. The southeastern edge of this old landslide deposit appears to be offset about 1.0 km across the San Jacinto fault, and the complete offset is probably greater than this because scattered tonalitic boulders from this landslide deposit are present as float on top of the underlying San Timoteo formation as much as 1.6 km southeast of the southeasternmost outcrops of Qols1 on the southwestern side of the fault. Samples for Be-10 dating were collected from 6 boulder tops on the least-likely-to-be-disturbed portions of the surface of the Qols1 slide on Quincy Ridge (Figure 7). Soil pits will be dug and examined near some of these boulders in order to test whether or not the soil has been stripped in these locations, and to collect samples for a Be-10 depth profile.

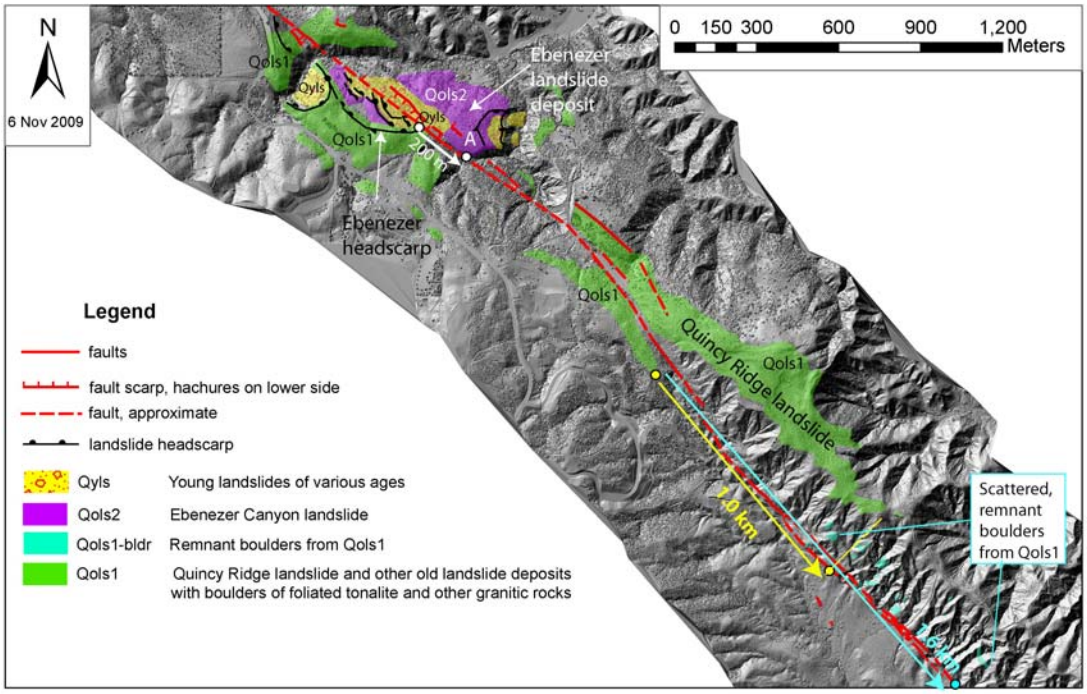

Figure 6: Simplified geologic map showing 1.0 to 1.6 km offset of the Quincy Ridge landslide across the San Jacinto fault.

Figure 7: Boulders on the top surface of Quincy Ridge landslide (Qols1) from which samples QR1 and QR2 were collected.

Quincy Site Offset Channels

Several incised channels at this site are offset 20-35 meters across the double-stranded San Jacinto fault zone (Figure 8). I mapped this site during January – March 2009 with a group of six students as part of an undergraduate mapping class. Nate Onderdonk and also mapped this site and he coordinated the excavation of trenches here (Figure 9). Trench 1 crossed a fault-parallel channel that has been truncated and abandoned as a result of the incision of a channel that is now offset about 20 meters. See Nate Onderdonk's 2009 annual SCEC report for logs of trench 1 and a slip rate estimate.

I logged trench 2, which crossed the fault zone where a young, fault-parallel channel segment has been offset or deflected around a buried shutter ridge of Plio-Pleistocene San Timoteo formation. The most recent fault ruptures have occurred

between the 7-9 meter marks in trench 2 (Figure 10). Within this zone, two and possibly three paleo-earthquakes are probably recorded. In the northwestern wall of trench 2, unit b (colored blue) appears to post-date faults D and E1 (event 2), yet unit b is offset by faults E2-E4 (and by fault F on the southeast wall) (event 1). Relationships in the southeastern wall of the trench are consistent with this interpretation, though they do not require two events. A third, even older event, may be suggested in the southeastern wall of trench 2. Fault A appears to terminate upward at the base of unit d, whereas faults B-D offset unit d. Given the poor stratigraphy, however, the interpretation of this as a separate event is speculative.

A few dozen detrital charcoal samples were collected from this trench and six of these have been dated. Because the samples are detrital, we ignore dates that are older than other dates from the same layer or from underlying layers, as long as the younger dates do not appear to have been bioturbated. This interpretive choice suggests that at least event 1 and probably event 2 have occurred since 190 ± 15 radiocarbon years BP (sample 2-25, near meter 9). Dendrochronologic calibration yields allowable (2-sigma) date ranges for this sample between AD 1663 and AD 1951. If two events have indeed occurred at this site since AD 1663, then this would indicate an event at this location that is not recorded at the Hog Lake site, near Anza, about 58 kilometers to the southeast. The most recent event at Hog Lake is thought to be a few decades prior to AD 1800 and the penultimate event occurred around AD 1570 (Rockwell and others, 2006). The stratigraphy within Trench 2 at the Quincy site is poor, however, and it cannot be determined with certainty that either the 190 ± 15 BP sample or a nearby 230 ± 20 BP sample (sample 2-4, near meter 7) predate event 2, though it seems most likely that they do.

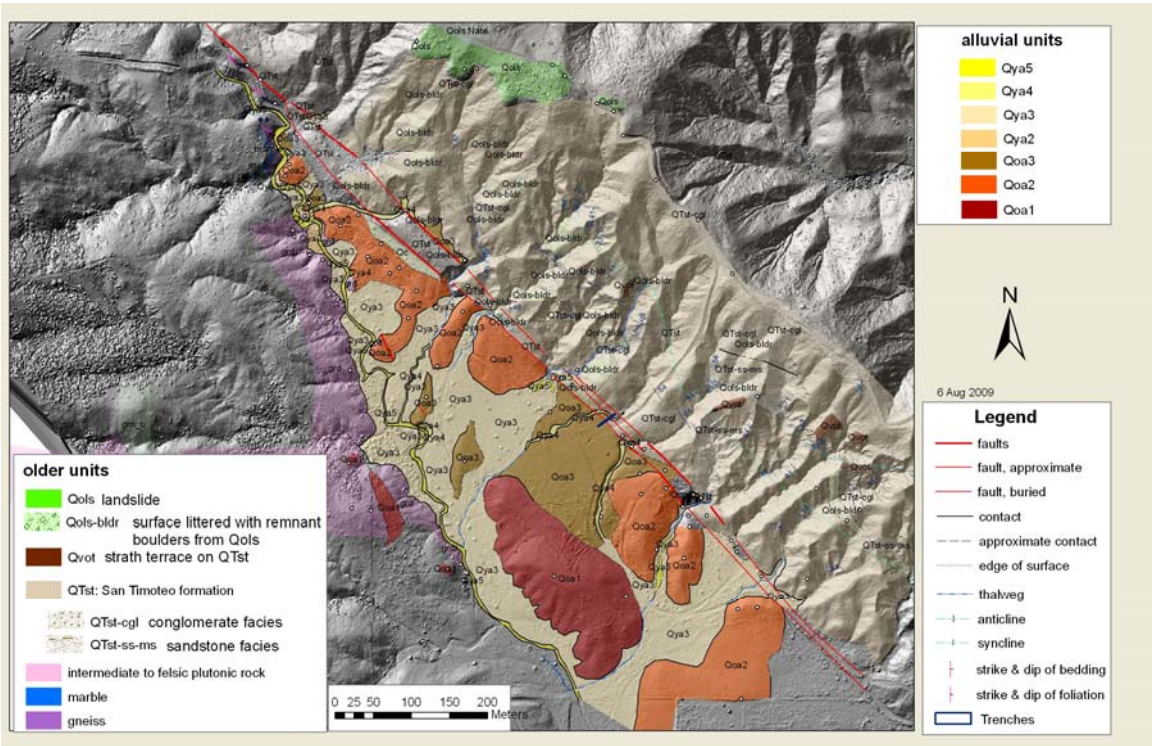

Figure 8: Geologic map of the Quincy site.

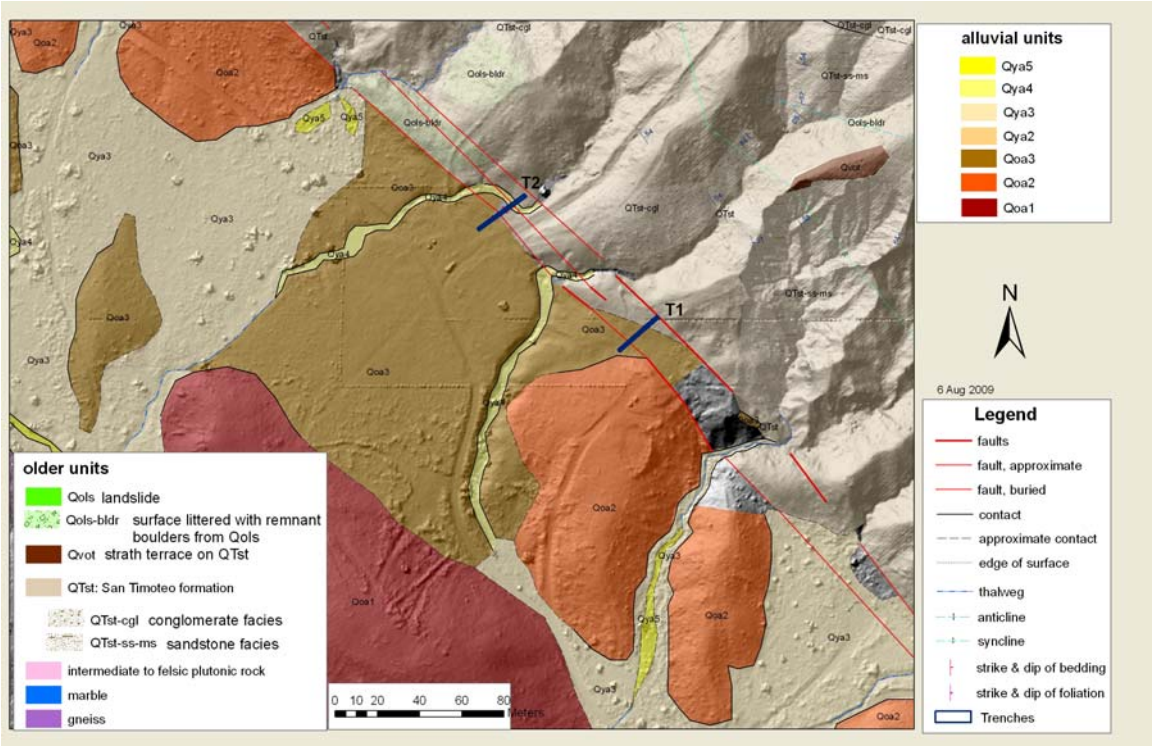

Figure 9: Enlargement of figure 8 showing locations of trenches 1 and 2 at the Quincy site. Trench 1 is located only approximately in this figure.

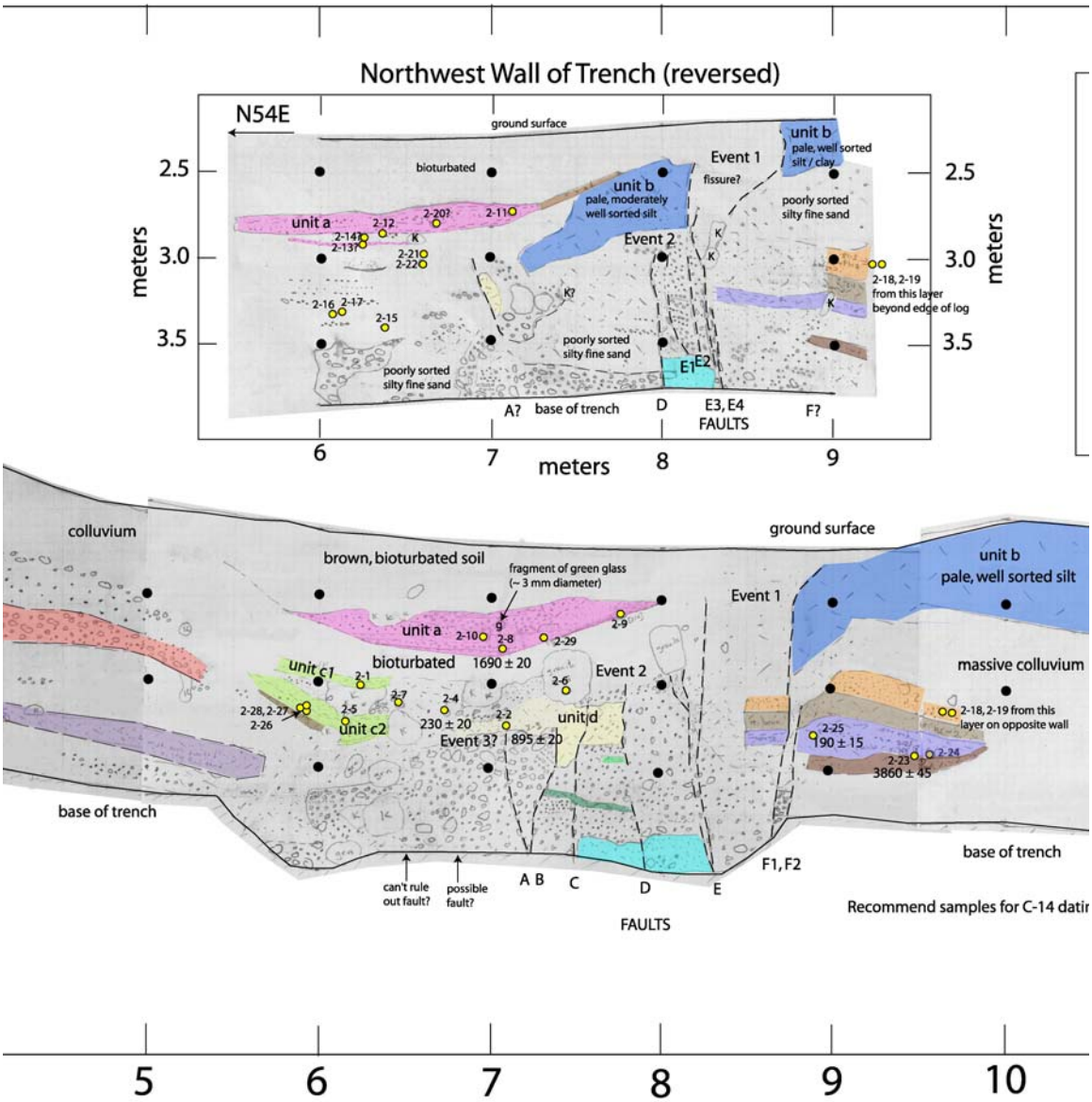

Figure 10: Log of a portion of Trench 2 at the Quincy site, showing detail within the fault zone. Dates are uncalibrated radiocarbon dates in years BP.

References

Rockwell, T, Seitz, G., Dawson, T., and Young, J, 2006, (abstract) The long record of San Jacinto fault paleoearthquakes at Hog Lake: Implications for regional patterns of strain release in the southern San Andreas fault system: Seismological Research Letters, v 77, p. 270.