Field work in the 2003-2004 season consisted of continuing and initiating student theses, and making progress on a number of fronts in the Salton Trough project. We also continued our interactions and exchange of ideas with other colleagues working on related projects in the area. Five graduate students are currently involved in this project: Amy Fluette (Western Washington University), Mary Kairouz (UCLA), Stefan Kirby (Utah State), Andy Lutz (UO), and Alex Steely (Utah State). A few highlights of this work are summarized below.

1. The late Miocene to early Pleistocene west Salton detachment fault system (WSDF) (Fig. 1) has been tested and verified, basically as proposed by Axen and Fletcher (1998), with three main exceptions: (1) we have refined the location and kinematics of the WSDF, and in some areas see significant departures from prior interpretations; (2) the detachment fault zone reveals a wide range of kinematics, including slip to the east and SE, indicating a significant component of dextral slip; and (3) the detachment fault contains growth folds in its hanging wall and footwall (Steely et al., 2004). This suggests that dextral strain was not perfectly partitioned onto the San Andreas fault (Steely et al., 2004), as proposed in earlier studies.

2. Late Cenozoic upper-plate transport toward the E, NE and SE was coeval with dextral slip on the San Andreas fault (Fig. 2). Combined slip on these faults created two large sedimentary basins in the western Salton Trough: the well studied Fish Creek–Vallecito Basin in the south and the less well known San Felipe Basin in the north. The distal portions of these basins shared a similar early history of widespread marine incursion (Imperial Formation) followed by progradation of the Colorado River delta (Palm Spring Formation). Local variations in stratal succession record synbasinal fault growth (Steely et al., 2004). Basin interconnectedness ended at ~3.0Ma when new faults with as-yet uncertain origin and kinematics segmented the upper plate into smaller sub-basins.

3. Structural analysis shows that the WSDF was once a continuous structure from Palm Springs to the Tierra Blanca Mountains (~120km) and has since been cut and deformed by younger strike slip faults of the San Jacinto and Elsinore fault zones. The cross-cutting relationships are complicated, however, because there is evidence for significant reactivation of portions of the strike slip faults during transition between the original and present configuration, and in some areas strike-slip faults continue to activate portions of the detachment fault (e.g., Steely, et al., 2004; Axen and Kairouz, in progress).

4. A well exposed fault on the northeast margin of the Tierra Blanca Mts. That formerly was considered to be a strand of the Elsinore fault is now recognized as a large normal fault that makes up part of the break-away zone of the detachment fault system (Dorsey and Janecke, 2002). Geomorphic evidence shows that the frontal fault of the Tierra Blanca Mts. Has been active in late Quaternary time and represents either continued slip or reactivation of the detachment fault in the present strike-slip regime.
5. Axen’s group has dated six pseudotachylyte/ultracataclasite samples from three localities along the detachment at Yaqui Ridge, five of which give weighted mean total gas ages of ~20-25Ma and one of which gives such an age of ~6Ma. SEM mapping of splits from the same samples indicates that mafic minerals are absent and that the only identifiable K-bearing phases are K-spar and plagioclase. All six samples have hump-shaped Ar release spectra, which is characteristic of K-spar that has been crushed or recrystallized, with grain-size reduction as opposed to growth (Kairouz et al., 2003). Additional dating is in progress, including Ar dating of three more pseudotachylyte/ultracataclasite samples and (U-Th)/He thermochronology of three samples from the footwall of the detachment system.

6. New paleocurrent data from the Palm Spring Formation indicate that the mouth of the Colorado River (Yuma, AZ) was located northeast of the northern San Felipe basin during deposition; this requires ~130km of slip on the San Andreas fault since the end of Palm Spring time. The age of the top of the Palm Spring Formation is tentatively estimated at ~3.0Ma based on lithologic similarity to the Fish Creek section (Johnson et al., 1983; Winker and Kidwell, 1986), but its age is not well known in the San Felipe basin. Magnetostratigraphic analysis by Housen will provide new age data for the Palm Spring and overlying Borrego Formations, and a constraint on the slip rate for the San Andreas fault since Pliocene time.

7. We have new evidence for reorganization of early strike slip faults in the San Felipe Hills. A widespread unconformity in the southern San Felipe Hills records broad uplift, erosion, and gentle tilting prior to deposition of the laterally equivalent Ocotillo and Brawley Formations (Kirby et al., 2004). Most tight folds and faults associated with the modern San Jacinto fault zone deform and post-date the Ocotillo and Brawley Formations, indicating that the active system of strike-slip-related transpressional deformation is very young, post-1.0Ma (Janecke et al., 2003). The Ocotillo Formation records voluminous influx of coarse clastic detritus that prograged into a pre-existing lacustrine depocenter (Borrego Fm.) beginning at about 1Ma, immediately following broad uplift and erosion. This represents a major reorganization of the basin that was probably fault-controlled, and is related to either initiation or reorganization of the San Jacinto fault zone (Kirby et al., 2004). Paleomagnetic data show that the base of the Ocotillo/Brawley formation is the same age in widely separated locations and thus represents a chronostratigraphic marker of a major tectonic event.

8. Stratigraphic analysis in the Borrego Badlands (Lutz and Dorsey, 2003) confirms the presence of two conformable members in the Ocotillo Formation, as originally recognized by Jarg Pettinga (unpubl. map data). Coarse-grained facies represent distal alluvial fans and ephemeral streams that prograded from the fault-bounded northeast and southwest margins of the basin, passing laterally into lacustrine siltstone and claystone in the central Borrego Badlands. Rapid progradation of coarse detritus (upper mbr.) into a former lacustrine depocenter (lower mbr.) records reorganization of the SJFZ at about 600 ka; this change coincides in time with initiation of the NW strand of the Coyote Creek fault (Dorsey, 2002) and probably records initiation of the Santa Rosa fault on the NE margin of the basin.
Figure 1: Faults and topography of the northern Gulf of California and Salton Trough region. Decorated thicker blue lines are detachment faults, tick marks on upper plate; red lines are high-angle normal and strike-slip faults. ABF, Agua Blanca fault; BSZ, Brawley Spreading zone; CDD, Canada David detachment; CPF, Cerro Prieto fault; E, Ensenada; IF, Imperial fault; SAFZ, San Andreas fault zone; SD, San Diego; SGP, San Gorgonio Pass; SF, San Felipe; SJFZ, San Jacinto fault zone; SSPMF, Sierra San Pedro Martir fault; T, Tijuana; WB, Wagner basin. Shaded-relief map base courtesy of H. Magistrale.
Figure 2: Conceptual model for Plio-Pleistocene regional strain partitioning of the southern San Andreas Fault (SAF) and west Salton detachment fault system (WSDF; Axen and Fletcher, 1998; Axen, 2000). Crustal accretion takes place in the Brawley seismic zone where continental crust has been completely attenuated by oblique rifting (Fuis et al., 1984). Space created by lithospheric rupture is filled with upper-mantle basaltic intrusions from below and voluminous sediment accumulation from above. This diagram depicts ‘ideal’ regional strain partitioning into San Andreas fault strike-slip and west Salton detachment fault dip-slip extension. Ongoing work by Axen, Janecke, Dorsey, and Housen suggests a more complicated strain field, in which a significant share of strike-slip occurred on the detachment fault system, possibly in the later stages of fault slip and related basin evolution.

References (* indicates student author)


Dorsey, R.J., 2002, Stratigraphic record of Pleistocene initiation and slip on the Coyote


