Folding and faulting along the San Andreas fault, Palmdale,
Implications for simple shear mechanics and education of th

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Introduction

The hwy 14 road cut in Palmdale, California, is the location of shallow subsurface exposures of the San Andreas fault zone and its re along its entire 1000 km length. The fault zone is 1.6 km (1 mi.) wi (Barrows, 1987) and consists of a set of faults that parallels the Sa Approximately 3km to the east, the SAF zone, spans a width of 3.2 km 1987) and commonly spans a width of several kilometers along its exte

The Palmdale roadcut, about 27 m high and about 600 m long, exposes complexly folded and faulted, middle Pliocene, gypsiferous lacustrine rocks kn Formation (Wallace, 1949). The Mojave segment of the SAF, along whic recent rupture in 1857 occurred, crosses the highway at the southern The roadcut is aligned nearly perpendicular to the strike of the fau considered to be a large "trench." At the north end of the cut and pa the Little Rock fault which has had more than 20 km (Barrows 1987) o strike slip. The Little Rock fault is not exposed but located about 76m (250 ft) north o the northern end of the road cut (Smith, 1976). The "trench" allows a close lo shallow subsurface structure and deformation possibly related to the faults.

The San Andreas fault is one of the longest and best-known cont faults in the world, and this segment of the SAF has caused two of t earthquakes in California in historic time, one being the 1857 Fort As a geologist in California, I am compelled to contribute to the knowled this major active fault. My objective is to depict the structure of the roadcut a its development in terms of regional faulting and local ly strike-slip f

educate people on the processes of strike-slip faults and the dynamic

geology.

Experimental Methods and Procedure

The roadcut is difficult to approach in traffic so an encroachme permit is

required to examine the structures along the roadside. I was required to

an orange vest, and a hard hat at all times when on or in the vicinit Once

the permit was granted by the state (Palmdale office) I had to Caltrans my case

meet with an inspector at the site location to verify that I was prop

and cones, and was not obstructing traffic or doing anything illegal

test I was able to collect the geologic information I needed.

I examined the structures in the road cuts that are exposed on both side

“trench” and fit the structures in each wall together. I made a field

of the roadcut, closely examining the complexly folded and faulted st

major components of the structure and used a photo-mosaic to draw structural featu

that I was not be able to climb onto directly. The roadcut bisects a hill that I climb

on both sides for a complete view and optimal position to obtain the

Structural examination of both sides of the “trench” is necessary to determine

continuity of the structures from one side of the road to the other. I obtained measurements

of the fold axes, strike and dip of bedding, fault surfaces (where ex

(where accessible). I plotted the measurements on a stereonet to est

of the fold axis. To verify the continuity of the structures within t
mirror imaged one of the cross-sections with the other cross-section.

Project Challenges

The greatest challenge for the entire project was obtaining the along the roadcut. Obtaining a permit required persistence. Permits a night and should be carefully considered when planning a project that requires one. Permit applications should be submitted at least three months in adva problems. I was delayed for a month because of the lack of sufficient

A photo-mosaic requires a high quality camera with a lens that h distortion. I knew of the spherical distortion and thought that I had was mistaken.

The weather conditions must be considered when preparing a proje minor heat exhaustion one-day on the road cut even though I had prepared mys situation with plenty of water and proper clothing.

Observations

The roadcut contains numerous faults (Table 1 and figure 1) with di orientations in complexly folded sandstone and gypsiferous shale. After examining the sandstone beds closely in the road cut I found graded beds, sparse fi sequences in grain size and nonparallel trough cross-bedding. These sedimentary structures permitted me to determine stratigraphic tops of steep dipp rocks in the roadcut. The siltstone is interlaminated and interbedded with gypsum throughout the entire road cut. The faults differ in orientation and the f

appear to be refolded in places.

Fault	Strike	Orientation w/ respect to the SAF	Features	Conclusion
A	113°	0°, Parallel	Gauge zone	Subsidiary
B	113°	0°, Parallel		Subsidiary
C	115°	0°, Parallel	Folding on upper surface	Subsidiary
D	93°	20°-22°	Truncates synclinal s... beds	Riedel shear
E	105°	10°	Located within a fold	Accommodation fracture
F	115°	0°, Parallel	Cross-cuts a refolded fold	Subsidiary
G	110°	3°-5°, Parallel	Fault splay near surface	Subsidiary
H	95°	20°		Riedel shear
I	86°	30°	Drag folding on hangi	Thrust fault

Fault A strikes approximately 113° and has a gouge zone one meter wide. Fa also strikes 113° but lacks fault gouge. Faults A and B are parallel to the San Andreas fault.

Fault C strikes 115° and is also parallel to the SAF.

Fault D strikes 93° and is approximately oriented 20°-22° from the SAF. Laterally, it is planar to semi-planar in geometry. Fault D truncates synclinal sandstone b with an apparent vertical displacement of 1-2 m.

Fault E strikes 105° and is oriented approximately 10° from the SAF. Fault E is located within a synclinal fold and is discontinuous vertically.

Fault F strikes 115°, is approximately parallel to the SAF, and truncates a refolde fold.

Fault G strikes 110° and is oriented approximately parallel to the SAF. A fault splay originates near its surface with an oblique sense of displacement.

Fault H is planar, strikes 95°, and is oriented approximately 20° from the SAF.

Fault I strikes 86° and is oriented 30° from the SAF. It is a bedding plane surface thrust fault and displays drag folding on the “hanging wall” segment. North of fault I is complexly folded and convoluted siltstone and gypsiferous shale.

The orientations of strata in the fold limbs were plotted as poles to stereonet without separation into segments of the refolded fold. The pole to the girdle of poi so plotted yields an east-west fold axis. The mean orientation of the estimated by placing the poles on a great circle that offers the best estimate. The mean orientation was estimated to be 110° ± 5°. A few degrees of axial rotation of the folds be cause a range of orientations of the fold axis between 100° and 115°.

Interpretations

Simple shear structures typically form en echelon arrangements a faults in relatively narrow zones. Numerous simple shear clay model e produced en echelon shear and extension fractures approximately 10–30° from the axis of shortening and folds at 45° to the axis of shortening, but the folds can be folded, truncated, and refolded to complex geometries and possibly rotated. Five sets fractures form from simple shear model experiments as illustrated in 1) Riedel

shear fractures. 2) Folds. 3) Extension fractures. 4) Thrust faults.
structures.

The fault zone at Palmdale may be interpreted as a strike-slip entire roadcut is sandwiched between two strike slip faults (figure cumulative displacement of over 100 km and the Little Rock fault with of displacement. Subsidiary planar faults are oriented approximately ~30 to the SAF and are Riedel shear fractures or thrust faults. The folds are oriented to the strike of the SAF and are simple shear fold structures.

Faults A, B, C, F, and G, are subsidiaries of the SAF zone. The an area that encompasses the entire road cut and includes the Little faults, including the Little Rock fault are roughly parallel to the

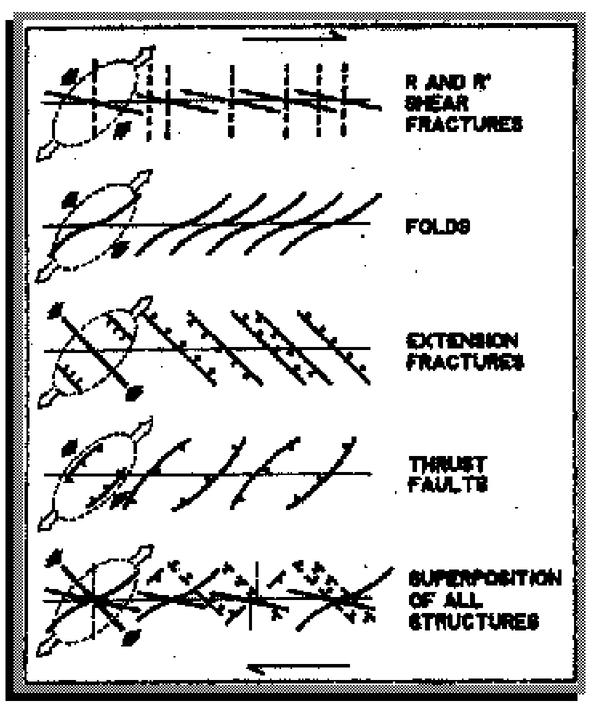

Figure 2: 1) Riedel shear fractures 2) Folds 3) Extension fractures 4) Thrust f
Superposition of all structures. (Sylvester, 1988)

Faults D and H are Riedel shears oriented 20°-22° to the strike of the SAF. Fault I is a thrust fault, oriented 30° to the SAF, and contains drag folds on t hanging wall segment.

Fault E is an accommodation fold fracture because it is disconti parallel with the fold axis, and its displacement may have been conte folding. It is also dissimilar to the SAF subsidiaries and Riedel she

In conclusion, the fault zone is predominately composed of subsi strands from the SAF, scarce Riedel shears or thrust faults, and fold locally can be inferred to have had predominately right lateral strik minor component of simple shear. It is unclear whether the SAF couple Rock fault or the SAF alone were the source for the simple shear.

Log of Events

Week by week log of steps and procedures for Palmdale project by Lowell Kess

- July 28, 1998, a permit to encroach the shoulder of highway 14 was submit California Department of Transportation.
- Week of August 2-8, reconnaissance of the road cut with my mentor.
- Week of August 9-14, preliminary cross-sectional drafts, structural analy for the photo-mosaic.
- Week of August 15-22, Intern Colloquium at USC, JPL, CalTech, and reading Sieh and Yehuda Ben-Zion.
- Week of August 23-29, Field mapping and sketching of western segment of t road cut.
- Week of August 30-September 5, partial sketch of eastern segment of road outside temperature and heat exhaustion. Spent half the week recuperating.
- Week of September 6-12, received permit to encroach on shoulder of highwa persistence. Set up cones and a sign and took measurements of strikes and dips along entire roadcut on eastern and western segment where possible.
- Week of September13-19, completion of structures mapping and sketching of eastern segmen of road cut.
- Week of September 20-26, compilation of data and research of strike slip report and preparation of poster for annual conference on October 17, 199
- Week of September 27-October 5, completion of report, abstract, and poste

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