Ridgetop Splitting, Spreading, and Shattering Related to Earthquakes in Southern California

ANNUAL REPORT SUMMARY, FY 1999

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Program Element II.5: Identify active faults, define their geometry, and determine the characteristics and dates of past earthquakes.

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ABSTRACT

The San Gabriel and eastern Santa Susana Mountains contain anomalous ridgetop depressions that resemble depressions formed or reactivated during large earthquakes elsewhere in California and worldwide. We trenched 3 ridgetop troughs, 2 near the San Andreas fault in Pelona schist, and 1 NE of the San Fernando Valley in granitic gneiss. All 3 troughs were the surface expression of half-graben, with a master normal fault dipping 45-65 degrees under one flank, and a hinged zone cut by subvertical tension fissures under the opposite flank. The deformation of unconsolidated sediments deposited within each trough could be explained by as few as 2-3 displacement events at each site. Whether these displacement events correlate in time with known prehistoric earthquakes on nearby faults will be tested by radiocarbon samples to be submitted in the next few weeks.

INTRODUCTION

During FY 1999 we mapped ridgetop troughs and scarps on the mountains north of the Los Angeles Basin, to identify landforms and sediment traps likely formed by strong earthquake shaking and subsequent ridge collapse. So far in FY 2000 we have

excavated 3 trenches across linear troughs on ridgetops in the northern and western San Gabriel Mountains

INVESTIGATIONS

During October 1999 we spent 3.5 weeks excavating, logging, and sampling 3 trenches across ridgetop collapse landforms. The sites were: 1) summit of Blue Ridge directly south of Wrightwood, 2) summit of Upper Lytle Creek Ridge directly south of the Sharpless Ranch, and 3) summit of the ridge about 1 km east of Kagel Mountain, SE of Pacoima Reservoir.

RESULTS

1) Blue Ridge trench.

The Blue Ridge trench was located on the summit of Blue Ridge at 8400 ft elevation, about 2 km south of the town of Wrightwood and the trace of the San Andreas fault. The trench transected a 5 m-wide, 100 m-long ridgetop trough developed in Pelona Schist. The maximum scarp slope angle on the 0.8 m-high scarp was 35 degrees, suggesting relatively recent displacement. The trough was the surface expression of a south tilted half-graben, with a main normal fault dipping north about 45 degrees, and several subvertical open fissures on the hinged side of the graben. Unconsolidated Holocene (?) sediments were as thick as 1 m against the main fault zone (Fig. 1). Based on cross-cutting relationships and angular unconformities, 3 episodes of displacement created this trough.

2) Upper Lytle Creek Ridge trench

The Upper Lytle Creek Ridge trench was located on the summit of Upper Lytle Creek Ridge at 5600 ft elevation, about 2 km south of the Sharpless Ranch and the trace of the San Andreas fault. The trench transected a 20 m-wide, 150 m-long ridgetop trough developed in Pelona Schist (Fig. 2). The maximum scarp slope angle on the bounding scarps (1-2 m-high) were 15-20 degrees, suggesting relatively old displacement. The trough was the surface expression of a south tilted half-graben, with a main normal fault dipping north about 45 degrees, and several wide subvertical open fissures on the footwall. The north (hinged) side of the graben had a few insignificant subvertical tension fissures and down-to-the-south normal faults. Unconsolidated Holocene (?) sediments were as thick as 1 m against the main fault zone. Based on cross-cutting relationships and angular unconformities, 3 episodes of displacement created this trough.

3) Kagel Mountain trench

The Kagel Mountain trench was located on the summit of the ridge that extends east from Kagel Mountain about 2 km east of that summit. The trace of the San Fernando fault is about 5 km south of the site, and ground cracking was observed at Kagel Mountain during both the 1971 San Fernando and 1994 Northridge earthquakes. The trench transected a 10 m-wide, 100 m-long ridgetop trough developed in granitic gniess. The maximum scarp slope angle on the bounding scarps (1-2 m-high) were 15-20 degrees, suggesting relatively old displacement. The trough was the surface expression of a north tilted half-graben, with a main normal fault dipping south about 65 degrees (Fig. 3). The south (hinged) side of the graben had a few insignificant subvertical tension

fissures and down-to-the-north normal faults. Unconsolidated Holocene (?) sediments were as thick as 1.5 m against the main fault zone. Based on cross-cutting relationships and angular unconformities, 2-3 episodes of displacement created this trough.

4) Preliminary Conclusions

All 3 trenched ridgecrest troughs were the surface expressions of half-grabens with moderately dipping (45-65 degrees) normal faults. The higher and steeper scarp on the surface did not necessarily overlie the master fault. In fact, at all 3 sites the highest scarp was developed on the hinged side of the graben, whereas the scarp atop the master fault was smaller but steeper. The 1-1.5 m of unconsolidated Holocene (?) slopewash beneath each trough was relatively coarse-grained (sand and gravelly sand) and poorly stratified. Accordingly, the main contacts mapped in these deposits were soil horizon boundaries. In places it was difficult to distinguish whether changes in color and texture were parent material contacts or soil horizon contacts. Likewise, the lower boundary of slopewash was gradational with weathered bedrock. The bedrock beneath the trough was both extensively shattered and chemically weathered from infiltration of water beneath the closed depression, much more so than beneath the flanking scarps. We were looking for a "Pallett Creek on the mountaintop", but sedimentation in the troughs did not result in either well-stratified clastics or peats.

FUTURE WORK

In the remaining time of our contract we will digitize the trench logs, submit C-14 samples for dating, and perform computer retrodeformation of the trench logs.<P>

Reports Published: none to date.

Fig. 1. Photograph of the master normal fault zone in the Blue Ridge trench (red flags in wall in front of J.P. McCalpin). The buried free face extends upwards from the end of the tape measure and is outlined by green flags.

Fig. 2. Photograph of the site of the Upper Lytle Creek Ridge trench, looking east. The trench runs N-S (left to right) across the light-toned gassy meadow at left center. left of the dirt road (note vehicle on road, and faint yellow caution flagging outlining the trench). Mountain range in distance at upper right is the western end of the San Bernaidino Mountains.

Fig. 3. Photograph of the master normal fault zone in the Kagel Mountain trench (red flags in wall in front of J.P. McCalpin, near ladder). The fault juxtaposes fairly intact, foliated granite (light tones at far end of trench) against light brown scarp-derived colluvium (left center) and dark brown soil A horizons developed on sandy slopewash (center and right).