ABSTRACT

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Project Title: Surface Faulting and Slip Distribution for the 1954 Rainbow Mountain-Stillwater Earthquake Sequence, Central Nevada

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The Rainbow Mountain area was the site of three moderate to large earthquakes on July 6 and August 24, 1954. Recent field investigations of the surface rupture zone have revealed new information regarding the distribution and style of surface offsets. With the aid of aerial photos, we have delineated new areas of surface ruptures including a 17km-long, 8km-wide zone of ruptures in Carson Sink. This area consists mainly of northeast-striking breaks subparallel to and along-strike with ruptures on the Rainbow Mountain fault to the south (Tocher, 1956). We have also identified historic breaks with small vertical offsets (15cm) along a several-km section of a previously unmapped fault in Four

Mile Flat. This fault is parallel to and forms a 10km left-step to the southeast of the Rainbow Mountain fault. Doser's (1986) relocations for events of sequence, along with anecdotal information for the events suggest the Four Mile Flat ruptures probably formed during a second 6 July earthquake (event **b** (M6.4)) which occurred ~1.1hrs after and was likely triggered by the initial 6 July event (event **a** (M6.6)). The newly discovered breaks in Carson Sink and Four Mile Flat extend the zone of ruptures by more than 25km to a total length of 70km. In contrast to Tocher's original studies, we find evidence for a strong right-lateral component of slip along portions of the rupture zone including offset stream channels (0.5-1.0m), left-stepping echelon scarps, and a well-preserved, 100m-long mole track on the playa surface in Carson Sink. The strong right-slip component is consistent with focal plane solutions for the events (Doser, 1986) and recent geodetic models (Hodgkinson et al., 1996). Recognition of relatively large lateral offsets and an increase in length for the rupture zone help to explain a significant discrepancy between seismologically determined moments and those determined geologically from the lesser measurements of (vertical) offset and length reported by Tocher (1956). The northeast-striking surface ruptures differ from the north-northwest-striking nodal planes for the sequence and suggest that fault ruptures may rotate and fan upward from focal depths in the fashion of Riedel shears. Finally, examination of both man-made and natural exposures has revealed evidence for both the timing and style of paleoseismic activity along the 1954 rupture zone. The Rainbow Mountain fault has experienced at least one prehistoric surface rupturing event since 29ka. Previous movement on this fault is characterized by right-normal-oblique slip, consistent with the style of 1954 slip. The Four Mile Flat fault has experienced at least two prehistoric surface rupturing events since 25ka, the most recent of which appears to have occurred since ~1.2 ka.

NON-TECHNICAL ABSTRACT

This study investigated the characteristics of surface faulting associated with the 6 July/24 August 1954 Rainbow Mountain-Stillwater earthquake sequence in central Nevada. Investigations included traversing the entire zone of surface ruptures in the field while making frequent measurements of fault offsets, mapping details of the rupture zone on large scale (1:12,000) low-sun-angle aerial photographs, exploring natural and man-made exposures of geologic deposits which are disrupted by faults, and dating of volcanic ash deposits in order to constrain the timing of prehistoric earthquake activity along the 1954 rupture zone.

The results of the study show that the zone of ruptures is about 25 km longer than originally mapped in the late 1950's, and that the style of fault offset is characterized by a strong right-lateral component of slip, at least locally along the rupture zone, which is also in contrast to the original studies. Finally, evidence for the timing of previous earthquakes shows that the 1954 rupture zone has experienced at least two prehistoric earthquakes during the past 25,000 years. The most recent prehistoric earthquake probably occurred during the past 1100 years.

FINAL REPORT SUMMARY

The primary objectives of this project were to investigate contemporary ground motion associated with the Wasatch fault, Utah (traversing most of the densely populated Wasatch Front, Utah) using continuous GPS monitoring. An ancillary study evaluated fault stress interaction on the Wasatch fault incorporating Holocene slip rates, contemporary seismicity and GPS-determined deformation rates as well an analysis of fault displacement probability of the Wasatch fault. The project was conducted within the framework of the USGS National Earthquake Hazards Reduction Program for FY 97 and FY 98.

During the period of the award, efforts were devoted to investigations outlined and described in the report summaries that are attached, as well as in published papers and in thesis partially supported by this grant. The summaries are updated and expanded versions of those submitted for inclusion in the National Earthquake Hazards Reduction Program Summaries of Technical Reports.

As directed by the USGS National/International review panel, funding for the project was reduced from that requested and our efforts were focussed primarily on the task of measuring deformation of the Wasatch fault from CGPS (Continuous Global Positioning System) measurements (Attachment A). Secondary tasks include analysis of fault-stress interactions of the Wasatch fault and their effect on probabilistic estimates of seismic hazards as well as incorporating the CGPS results (reported here) that provides critical information on the earthquake hazard evaluation of the Wasatch fault (Attachment B). Initiation of related study of the probabilistic fault displacement hazard of the Wasatch fault supported by other grants. An M.S. thesis describing the study of earthquake hazards on the Wasatch fault from tectonic induced flooding and stress triggering of earthquakes is appended (Attachment C).

University of Utah CGPS Data Availability -- We note that the USGS review panel specifically addressed the need to incorporate data from regional CGPS stations of the Harvard-Smithsonian/CalTech Basin-Range GPS network with our data. We addressed this task in conjunction with assistance of computer engineers from UNAVCO and in cooperation with scientists, Paul Davis (Harvard-Smithsonian Institution and Brian Wernicke (Cal Tech). The sharing of data amongst both research groups was achieved and provides an example of how various CGPS networks can jointly share data for mutual areas of interest.

As a result of this collaborative effort, all Wasatch Front and surrounding area continuous GPS data are archived (in Rinex format) at the UNAVCO data management center, Boulder, Colorado and are accessible to anyone via the Internet at: unavco.ucar.edu/data.

Also, hourly data from the University of Utah RBUT station are provided to the local surveying community via the National Geodetic Survey and the CORS on-line network which are accessible by ftp at: ftp://cors.ngs.noaa.gov/coord