PALEOSEISMOLOGY OF THE MERCUR FAULT AND SEGMENTATION OF THE OQUIRRH-EAST GREAT SALT LAKE FAULT ZONE, UTAH

AWARD NO. 98HQGR1036

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TECHNICAL ABSTRACT

A series of *en echelon* down-to-the west normal faults bound the western flank of the southern Oquirrh Mountains and comprise the South Oquirrh Mountains fault (SOMF). These include the Mercur, West Eagle Hill, Soldier Canyon and Lakes of Kilarney faults, extending a total length of 25 km. Although these faults pose an earthquake threat to Salt Lake City, Provo, and the nation's chemical weapon cryofracture plant and storage facility at the Deseret Chemical Depot, very little is known about their paleoseismicity, and what is known remains controversial. Therefore, to better understand the Quaternary behavior and earthquake potential of the SOMF, we conducted a detailed paleoseismic trench investigation of the Mercur fault, the longest fault with the best geomorphic expression.

Our mapping, scarp profiling, trenching and geochronology (radiocarbon and luminescence ages) of the SOMF provide insights into late Quaternary paleoseismicity, indicating a basinward migration of faulting and possible coseismic rupture with the Oquirrh fault to the north. Both the SOMF and the Oquirrh fault are part of the Oquirrh-East Great Salt Lake fault zone, a north-striking, west-dipping, range-bounding, 205-km-long normal fault that lies 22 to 55 km west of the Wasatch fault in the eastern Basin and Range. Trenches across three traces of the Mercur fault reveal paleoseismic evidence for 5 to 7 surface-faulting earthquakes that occurred since 92 ± 14 ka (2-sigma errors), offsetting an alluvial fan with 9.25 to 11.1 m of net vertical tectonic displacement. Four of these events occurred on the westernmost (basinward) trace since 75 ± 10 ka, including the youngest event that occurred shortly after 4110 ± 60 ^{14}C yr BP and before 1510 ± 60 ^{14}C yr BP. This is much younger than previous published estimates for the

Mercur fault, but is consistent with recent mid-Holocene cosmogenic ages for a northern bedrock scarp of the Lakes of Kilarney fault along the northern part of the SOMF. The average recurrence interval between the past 5 to 7 events is 12,000 to 25,000 years, but some intervals vary from less than a few thousand years to over tens of thousands of years. Vertical displacements per event average 1.3 to 2.2 m, much larger than expected for a 25-km long rupture (total SOMF length). Slip rate estimates for individual seismic cycles vary between 0.03 to 1.9 mm/yr due to large uncertainties. However, the average vertical slip rate for the past 4 to 6 complete seismic cycles is 0.09 to 0.14 mm/yr across the entire Mercur fault, which is similar to slip rates for the Oquirrh fault to the north. Overall, the overlapping ages for the youngest event, the large displacements per event for both faults, the similar late Quaternary slip rates, and along-strike displacement patterns for the SOMF all suggest coseismic rupture of the SOMF and Oquirrh fault. Paleomagnitude estimates for such a 52-km long rupture range from M_w 7.1 to 7.3, much larger than previous estimates of M_w 6.5 that were based on the Mercur fault length alone. Larger magnitude events have important implications for seismic hazards in nearby Salt Lake City and the Deseret Chemical Depot where chemical weapons are stored and destroyed. These results are already being used in a microzonation study of Salt Lake Valley (NEHRP Award No. 98HQGR1038) and several other seismic hazard evaluations of dams and pipelines throughout the Wasatch Front.

Non-technical Project Summary

The Mecur fault poses an earthquake threat to nearby Salt Lake City, Provo, and the nation's chemaical weapons cryofracture plant at Desert Chemical Depot. We excavated trenches across the Mercur fault to better understand how big and how often large earthquake have occurred in the past. We found evidence for younger and larger eathquakes than expected, suggestion that the Mecur fault may rupture with faults to the north, yeilding bigger events that occur on average every 12,000 to 25,000 years. These results are already being used in several hazard evaluations of dams and pipelines throughtout the Wastach Front.