Annual Project Summary

Assessment of late Quaternary deformation, eastern Santa Clara Valley, San Francisco Bay region

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NON-TECHNICAL SUMMARY

This project characterizes faults present within eastern Santa Clara Valley, in the southern San Francisco Bay Area. These faults include the Piercy, Coyote Creek, Silver Creek, San Jose, Evergreen, Quimby, Berryessa, Crosley, and Warm Springs faults that underlie the communities of eastern Santa Clara Valley, including San Jose and Milpitas. These faults may pose a potentially significant surface fault rupture and ground motion hazards to these communities. We are examining the surface expression and activity of these faults and determining the subsurface extent of these faults to evaluate the earthquake hazard to the area.

BACKGROUND

A series of northwest-trending reverse faults are mapped within foothills along the eastern margin of Santa Clara Valley based on bedrock exposures, and beneath the valley floor, primarily on the basis of groundwater and borehole data. These faults include the Piercy, Coyote Creek, Silver Creek, San Jose, Evergreen, Quimby, Berryessa, Crosley, and Warm Springs faults. This series of faults (herein termed the "East Valley thrust system" after Fenton and Hitchcock, in press), traverses the communities of eastern Santa Clara Valley, including San Jose and Milpitas. Faults within the East Valley thrust system pose a potentially significant surface fault rupture and ground motion hazards to these communities. Currently, however, the basic seismic source characteristics of these faults are poorly constrained.

This study is aimed at characterizing the faults of the East Valley thrust system in order to assess the potential seismic hazard associated with them. We are focussing on two aspects of these faults: (1) the structural setting of the East Valley thrust system, including their relationship to, and interaction with, the Hayward and Calaveras faults; and (2) geomorphic features associated with the faults as indicators of late Quaternary activity.

As part of our investigation, we are constructing detailed retrodeformable geologic cross sections to evaluate the down-dip geometry and depth of interaction between the Hayward and Calaveras faults and the East Valley thrust system. These cross sections also will aid us in constraining the magnitude and rate of shortening on the East Valley thrust system. We are applying quantitative geomorphic techniques to assess the distribution and rates of late Quaternary deformation, supplemented by the use of standard structural geologic techniques to derive the locations and geometry of the reverse faults. In conducting this study, we are incorporating results of our two currently funded NEHRP studies to map the surface and subsurface geology of the southern San Francisco Bay area, respectively. This approach, combined with the application of numerical and correlative dating techniques, will provide data on the locations, styles, and rates of late Quaternary deformation within eastern Santa Clara Valley. In addition, integration of geomorphic and structural information from our study hopefully will contribute toward defining the style of strain transfer at the southern end of the Hayward fault.

The final products from our study will include: (1) a detailed map (scale 1:24,000) of fault-related geomorphic features showing the locations of Quaternary deformation (e.g., inferred faults and folds); (2) longitudinal profiles of selected drainages and geomorphic features showing the nature and amounts of Quaternary deformation; (3) a series of restorable cross sections that provide constraints on geometry and continuity (e.g., potential rupture dimensions) of seismogenic structures; (4) a structural/kinematic model of crustal shortening within the Santa Clara Valley between the Hayward, Calaveras, and San Andreas faults; and (5) a report characterizing the primary seismogenic sources in the Santa Clara Valley, with constraints provided on their nature and rates of deformation. This final report, to be summarized in a paper submitted to a peer-reviewed journal, will incorporate results of our previously published research along the western margin of the Santa Clara Valley (Hitchcock and Kelson, 1999) to provide a comprehensive overview of possible seismogenic sources in the Santa Clara Valley.

INVESTIGATIONS UNDERTAKEN

Using 1939 aerial photography, we have mapped potentially fault-related geomorphic features along much of the East Valley thrust system. Preliminary field mapping has confirmed the locations and nature of these features, where preserved. We have collected radiocarbon samples from terrace deposits along Evergreen Creek that are deformed, and faulted by, the Evergreen fault.

During our field mapping, we cleaned and logged a fresh exposure of the Silver Creek fault excavated during construction of a golf course along Silver Creek. The exposure enabled us to examine sediments covered by artificial fill and obscured by recent development. The excavation exposed bedrock faulted against scarp-derived colluvium and older alluvial gravels of unknown age (likely Pleistocene). The age of the faulted colluvium will be estimated based on radiocarbon analyses of two representative samples of charcoal collected from the colluvial deposits.

Currently, we are using two-foot topographic maps of major streams, surveyed prior to substantial stream channel modifications, to construct stream terrace and stream thalweg profiles. Combined with results of pending radiocarbon analyses of charcoal samples obtained from stream terraces, we believe that the terrace profiles will provide valuable information on late Quaternary uplift rates on major thrust faults within the East Valley thrust system.

RESULTS

Preliminary results of our field and office investigations provide better constraints on style of fault deformation and activity on several of the faults within the East Valley thrust system. Pending results of radiocarbon analyses, stream bank and man-made exposures provide information on the activity of the Evergreen and Silver Creek faults.

Retrodeformable geologic cross sections will provide constraints on the down-dip geometry and depth of interaction between faults of the East Valley thrust system and the Hayward and Calaveras fault systems. Based on the mapped geomorphic expression of the reverse faults along the base of a relatively linear, actively uplifting range front, it is possible that at least several of these faults are active, potentially seismogenic structures. Stream terrace profiling and geomorphic map features suggest that faults within the East Valley thrust system may experience repeated, minor offset and likely only rupture in secondary response to large earthquakes on the nearby Hayward and Calaveras faults and, thus, may not be fully independent seismic sources. Integration of geomorphic and structural information is helping to define the style of strain transfer at the southern end of the Hayward fault and to quantify the magnitude and rate of shortening on the East Valley thrust system.

TECHNICAL AND NON-TECHNICAL REPORTING

Results of our study will be useful for both deterministic and probabilistic regional and site earthquake hazard characterizations. Target audiences for data derived from this study include the planning and government agencies responsible for earthquake hazards reduction and risk mitigation in the San Francisco area. To ensure that the scientific community will have the opportunity to provide input into our research efforts, we will share our data directly with the U.S. Geological Survey, the California Division of Mines and Geology, and interested university researchers and private consultants.

We will present our preliminary results in poster format at the 2001 American Geophysical Union Fall Meeting in San Francisco on Friday, December 14th. Our AGU paper number is S52D-0671. The co-PIs will be available for questions and comments during the poster session.

Primary data collected for this study includes field mapping, field notes, radiocarbon samples, logs of natural and man-made exposures, and historic topographic maps. Data from our ongoing research include stream and terrace profiles, interpretive structural cross-sections, digital maps of geomorphic features and digital text and graphic files that will be incorporated in the final NEHRP technical report and peer-reviewed paper. Draft copies of these documents are available in hard copy format or Microsoft Word, ArcView 3.2, and Freehand digital format.

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