SCEC 2005 – 2006 Progress Report:

Development of the SCEC Community Vertical Motion Map

Dr. Mike Oskin, University of North Carolina at Chapel Hill
Dr. Thomas Rockwell, San Diego State University
Dr. Nathan Niemi, University of Michigan

Introduction

The vertical motion database project seeks to integrate disparate sources of geologic uplift and subsidence data into a single resource for investigations of permanent crustal deformation in southern California. Data gathering from the geology literature proceeds simultaneously with construction of customized data models that faithfully represent each data type. The database is available to the SCEC community via a web interface located at http://geomorph.geosci.unc.edu/vertical.

The SCEC Geologic Vertical Motion Map now contains over 2000 vertical deformation rate data points from locations of permanent vertical deformation in southern California. This year the map has successfully matured into a useful product for research of fault activity and elastic deformation of southern California. Three completed data sets are now present in the database: uplifted marine terraces, incised river terraces, and thermochronology, and efforts are underway to compile data on deformed stratigraphic surfaces from the literature and from other SCEC scientists. An innovative architecture and interface of the vertical motion map database exposes distinct data sets and reference frames, permitting user exploration of this complex data set and its underlying assumptions. New data exploration and download tools developed this year distribute processed vertical motion results as a GIS-compatible text file or through a map interface via the Google Maps web service. The database interface is exposed online at http://geommorph.geosci.unc.edu/vertical.

Vertical Motion Database and Map – 2005 Achievements

(1) We have completed compilation and entry of all but few *marine terrace data* points known to be available for southern California. These data record the relative position of sea level in the past at a site. Uplift can be calculated by subtracting these data from a known sea level reference frame. By compiling this data for all of southern California we have begun to recognize systematic trends in the uplift data that are probably a result of errors in the existing sea level reference frames. Efforts are now underway to refine the age dating and paleo-elevation for these terraces using the internal consistency of this combined data set.

(2) We have completed data gathering efforts for almost all significant, *dated river terrace chronosequences* in the coastal basins of southern California. These data record

the incision of rivers into growing topography. If the river level remains stationary with respect to sea level, the difference between terrace elevation and river elevation approximates a tectonic rock uplift rate. In most cases the assumption that rivers remain fixed with respect to present sea level is well-founded, provided that the river basin is large, the river channel descends at a low gradient, and care is taken to consider incision following exposure of the continental shelf edge during extreme sea-level lowstands. We initiated data gathering of river terraces with a pilot study of the Ventura River terrace sequence in late 2004. Based on this effort, a data model for reconstruction of base level was established in a collaborative meeting between the project PIs held at San Diego State University in March, 2005. In June, 2006, SDSU graduate student Danielle Verdugo visited the University of North Carolina to collaborate with Dr. Oskin to instituting a Geographic Information System (ESRI ArcGIS) for gathering of river terrace localities and adjacent river channel elevations. River terrace information were then culled from the literature over the remainder of the summer by this student. The river terrace data set significantly expands the vertical motion database inland to the periphery of the Los Angeles basin, the San Gabriel Mountains, and the Riverside area.

(3) We have completed development of a reference frame and data model for *thermochronology data*. Thermochronologic ages represent exhumation of rocks through a closure temperature, usually at 2 km depth or greater. Thus, in order to measure young ages at the surface requires 2 km or more of erosion! Typically this does not occur within a 10^5 year time frame, except in the exceptional case of Yucaipa Ridge in the San Gorgonio Pass. However, a significant amount of data exist that provide relevant exhumation rates at the 10^6 yr time frame. This data set is now compiled and available online. Reference frames present combinations of thermal models and age cutoff points.

(4) We have begun to develop a reference frame and data model for *stratigraphic data* of the coastal basins. Some preliminary data of this type presently resides in the database, including aquifer elevations for the southern Los Angeles basin and some key stratigraphic horizons from published oil well data. These comprise the first subsidence information incorporated into the vertical motion database. Reference frames for stratigraphic horizons are based on the facies, or depositional setting of the strata. Contacts have been made with the Harvard CFM research group and with researchers at the Institute for Crustal Studies at UC Santa Barbara to acquire additional stratigraphic information. Compilation of stratigraphic data from published sources will be a primary goal for 2006.

(5) We have developed new application layers for the web interface to the vertical motion database. This year the vertical motion database became interactive: a new, simple map-based tool has been implemented to explore vertical motion results. This tool uses the Google Maps web service to build an interactive map of the results. The user may explore vertical motion results on a street-map or satellite image background, and each point may be clicked to determine its unique identifier and calculated uplift rate. Scaleable symbols depict relative uplift rates between sites. Data may also now be downloaded as both an HTML table and as a GIS-compatible text file.

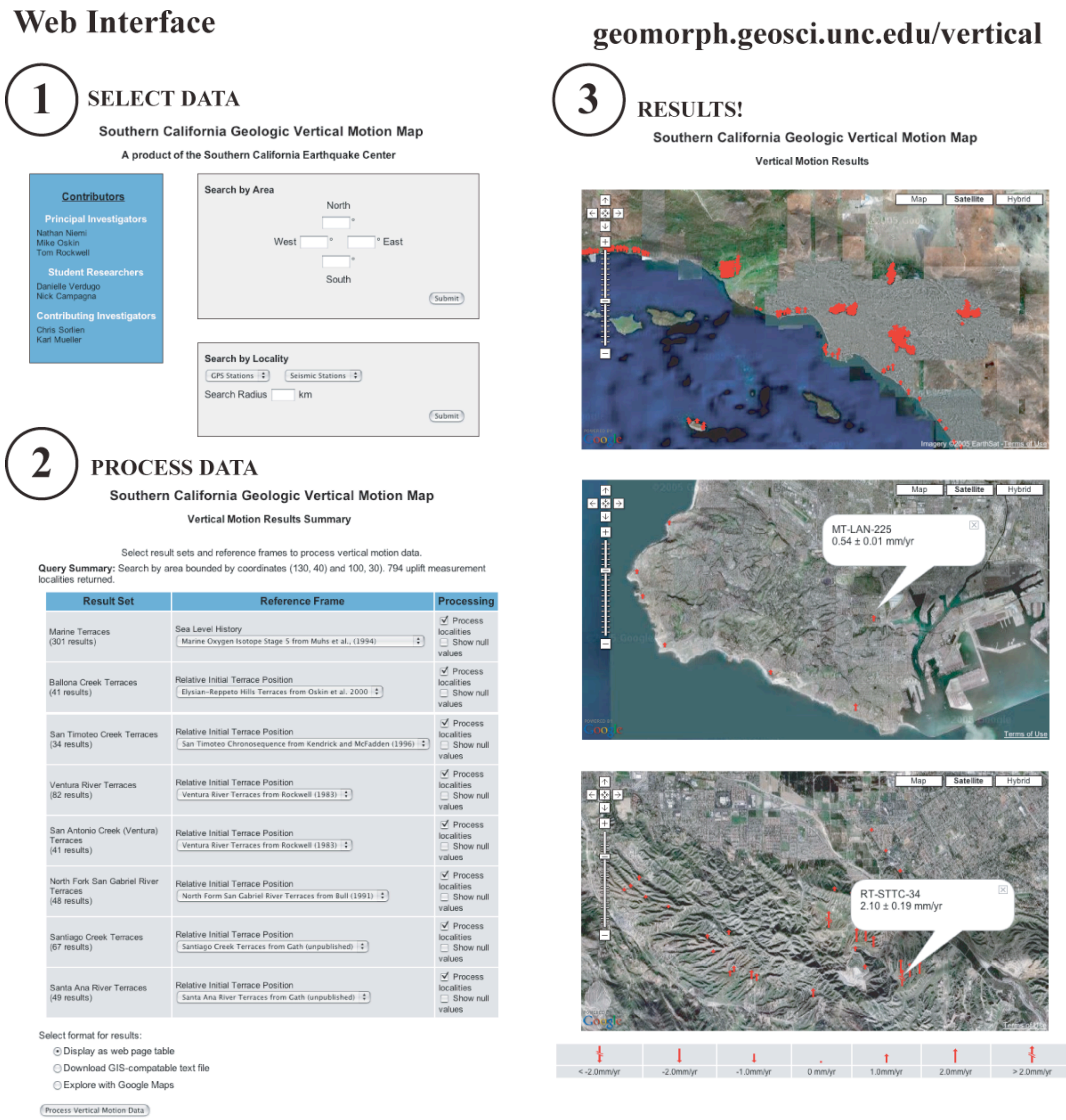

Figure 1. Web interface of the vertical motion database for southern California. (1) Selection screen provides two complimentary selection criteria for finding vertical motion data: Either define an area with latitude or longitude or search within a specific distance of a known seismic or GPS station. An option to select all of the data will be added to the interface in the future. (2) Processing data involves the user in two ways. First, the user must choose whether or not each data type should be included in the results. Secondly, the user must choose an appropriate reference frame for each data type. Default values are provided for selections, as shown, so that a user can easily acquire a 'standard model' based on these defaults (3) A new web-based map interface, based on the Google Maps web service, permits users to explore the distribution of data and drill down on individual sites. Boxes listing data identifier and calculated vertical motion rate, with uncertainty, appear when a locality arrow is clicked by the user.