Towards Development of a Vertical Motion Database for Southern California
A SCEC Undergraduate Research Experience Project

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ABSTRACT
Towards the development and population of a database on long-term vertical velocity, we began compilation of information on the ages and elevations of marine and fluvial terraces in coastal Southern California, and rock uplift information derived from low-temperature thermochronometry. Surface uplift rates are calculated as the difference between a terrace’s current elevation and the elevation at which it formed, relative to today, divided by the terrace age. We identify those primary sources of uncertainty: terrace age, elevation of the marker feature (e.g., paleo-shoreline), and elevation of the reference frame (paleo-sea level at crustal channel level). For terrace age, we compiled all available information including radiometric age, U-Th or other age data, including all isotopic ratios, amino-stratigraphic information, fault assemblage geologic data including references from southern and northern external source areas, and other age data (carbonate, OSL, TL dates). Elevation data are compiled from primary sources and include both surficial and topographic elevation information on the shelf platform, paleo-shoreline or terrace trend. Elevation of paleo-sea level is potentially the most problematic, as California observations appear somewhat at odds to estimates from Barbados and New Guinea. We have developed three alternative sea level models that we test against the terrace observations, all of which agree at the 0.1 myr level.

All terrace information has been entered into a Geographic Information System database (Arc/Info), and geo-referenced into a common coordinate system. We have included available data on modern vertical uplift rates, including continuous Global Positioning System data from the Southern California Integrated GPS Network, Electromagnetic Distance Measurements (EDM) from the USGS, and tide gauge data from NOAA. An experimental web site has been developed to distribute the vertical uplift information to the SCEC community via a map-driven interface utilizing Arc Map Interface Server. Currently, all data can be viewed, printed, and queried through the web interface. Advanced modeling objects, allowing SCEC community members to align tide gauge, GPS, and benchmarks, and calculate vertical uplift rates for specific terraces using user-specified sea level curves, or demarcation points with specific temporal models, and to compare long-term and recent uplift rates from multiple data sets are under development.

Marine Terraces
Marine terrace elevations were gathered as pilot data for developing the geologic vertical motion database. Reported terrace elevation data were obtained directly from survey measurements of different shoreline features and indirectly through extrapolation and topographic sources, such as maps, allow for terrace elevation data whose direct field measurement is not possible, and the shoreline angle can be calculated from a platform elevation point at a known distance from the sea cliff and an average platform angle elevation. In cases where shoreline angle elevations of surfaces are not reported, they are approximated and entered into the database by averaging elevations of other reported shoreline features, including sea cliffs and bedrock abrasion platforms. The terrace elevations are geographically represented in the database by arcs, which have been referenced to an online topographic database (TopoView) and given latitudes and longitudes coordinates for each individual entry. The resolution of terrace elevation data is within the average differences of daily mean sea level and the geographical coordinates given to the data are within 500 meters (most within 50 meters) of the actual reported point.

Data Model

Example Marine Terrace Locality Data

Example Oxygen Isotope Stage Data

Example Amino Acid Ratiation Data

Example U-Th Disequilibrium Age Data

Data Access

Selected data are queried from vertical motion data base. Data of each unique type are counted and the result is returned to the user for inclusion or exclusion in the vertical motion output. Available reference frames for each data type are also returned.

Server

ARC Internet Mapping Server

Data Processing

Processing

PostgreSQL PL/SQL

PostGIsR Web Services receive a request for map data from a client Arc Explorer (applet (free download)) or ArcGIS.

120.1422

120.1423

117.4476

117.448

Latitude (dec deg)

Longitude (dec deg)

Marine Terrace No: 117-448

Point Conception 1st H

Point Conception 2nd A

Arroyo Honda 1st

Arroyo Honda 2nd

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Researchers browse interface and interactively selects data.

User marks data for inclusion in the vertical motion output and selects a reference frame for each data type.

PL / SQL stored procedures within an Oracle database populated in PostgreSQL, an open-source object-relational database. Custom PostgreSQL functions were programmed in PLSQL to query complex geometric data and calculate uplift rates. A web-based user interface was created integrating ArcIMS, a Java-based commercial map server, dynamic HTML, and custom PHP scripts.

Vertical Motion Data

Server

PostGIS Vertical Motion Database

Data and data processing information returned to the user.

Examples of marine terrace location data include:

Example Amino Acid Ratiation Data

Example U-Th Disequilibrium Age Data

Latitude (dec deg)

Longitude (dec deg)

Marine Terrace No: 117-448

Point Conception 1st H

Point Conception 2nd A

Arroyo Honda 1st

Arroyo Honda 2nd

Example Oxygen Isotope Stage Data

Example Amino Acid Ratiation Data

Example U-Th Disequilibrium Age Data

Because sea level has not been constant over time, the paleo-sea level (where sea level curves intersect the shelf) is essential in estimating paleo-sea level along the coastline. In order to model the effects of volumetric changes in eustatic sea level on the coastline, we need several models of rates of change in sea level. The sea level curve is essential in estimating paleo-sea level along the coastline. Models that we test against the terrace observations, all of which agree at the 0.1 myr level.

Thus several models of rates of change in sea level are needed to estimate the curves. The sea level curve is essential in estimating paleo-sea level along the models that we test against the terrace observations, all of which agree at the 0.1 myr level.

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