

Final Technical Report for USGS-NEHRP grant 01HQGR0010 (University of Oregon grant number 238831) entitled:

Assemble and Evaluate Turn of the Century Uplift Data in Pacific Northwest.

PI Weldon, 541-346-4584, ray@uoregon.edu

Department of Geological Sciences, University of Oregon, Eugene, OR 97403

Summary:

We collected and began to analyze all of the historical leveling and sea level records for the coastal region of the Pacific Northwest. Additional analysis continues in the context of our current USGS-NEHRP grant 05HQGR0053, entitled “Quantifying Cascadia’s locked and transition zones in Central Oregon.” Preliminary analysis of the data demonstrates that it is possible to extract uplift data of sufficient quality to characterize the seismic hazard associated with the Cascadia subduction zone. These results have been presented in several abstracts (listed below) and are currently being written into formal publications by the PI and graduate student Reed Burgette, who is conducting this research as his PhD Thesis.

The funding was used to support graduate student Reed Burgette, who will complete his thesis late in 2007, and to support efforts to assemble and digitize the data (most of the records were paper and needed to be scanned or typed). Most of the sea level records existed as tidal data in NOAA archive at Silver Springs, MD; the PI, Weldon visited NOAA five times (usually in conjunction with an NSF panel meeting, to save money) and copied all of the available tidal and benchmark data. Subsequently most of this data was moved to the National Archive which will make it much more difficult and expensive to access in the future. Most of the 1st and 2nd order leveling data was obtained electronically from NGS, and relevant 3rd order data was ordered from the USGS archive in Colorado (after one trip to learn how the data are archived and copy their index, which permits locating and ordering the data). Minor additional data was collected from the Army Corps, and several State and Federal highway administrations. All of the data has been organized and filed at the University of Oregon and some of the most important data has been typed into scanned into files that can be shared with other investigators.

The “seed money” provided by this grant grew into a more complete proposal to analyze the data to assess the seismic hazard associated with the Cascadia subduction zone, that is still ongoing. Critical results from the “seed money” grant and overlapping into the first year of our current analysis include:

Regional sea level and leveling uplift rate analysis

- * Updated records of all six outer coastal Oregon and northern California continuously-operated tide gauges.
- * Extended the records of four of these tide gauges by digitizing archived hourly records and used historical leveling records to tie these data into the same reference frame as the modern observations.
- * Collected and digitized all archived hourly records for 24 other historic tide gauge sites in southern Cascadia.

- * Analyzed the stability of the benchmarks that provide the reference frame for water levels at the continuous tide gauges, and made corrections for instability.
- * Obtained more precise estimates of uplift rates at the six southern Cascadia tide gauges by using a least-squares adjustment to incorporate the constraints of differences of sea level time series.
- * Re-analyzed the historical leveling data for western Oregon to identify and correct errors present in previous analyses. Identified unstable benchmarks and excluded them from further analysis.
- * Increased the number of benchmarks with precise leveling uplift rates by making secondary ties between survey epochs with local tide gauge surveys and other NGS data.
- * Made the leveling relative uplift rates absolute by attaching them to the rates at the tide gauges with a least-squares adjustment that accounts for the errors in both the leveling and sea level rates.
- * Produced a vertical velocity field with uplift rates and uncertainties for 308 stable benchmarks in western Oregon and northern California.

Local geodetic data collection

- * Relevelled line from Charleston tide gauge to Cape Arago Lighthouse, extending leveling uplift rates 3 km toward the trench in the Coos Bay area.
- * Reconnaissance, planning, and releveling of 26 km east-west line between Reedsport and Scottsburg to obtain uplift rates from NGS leveling in 1930 and 1941.
- * Completed 29 km east-west releveling traverse from North Jetty tide gauge site at Florence to Mapleton.
- * Reconnaissance of benchmarks on three potential east-west leveling lines in southern Oregon- surveying planned for Summer, 2007.
- * Reoccupied five tide gauge sites along Siuslaw estuary to obtain modern sea level measurements and refine tide gauge technology.
- * Developed techniques for removing tides and shared environmental noise from short tidal records to get uplift rates from our modern tidal observations coupled with historical hourly data at the five Siuslaw sites.
- * Reconnaissance of future tide gauge installations at key sites in southern Cascadia.
- * GPS campaign survey of key benchmarks at the ends of historical leveling lines.

Numerical modeling of uplift rates

- * Updated the 3-D elastic dislocation model geometry to the recent McCrory (2003) compilation.
- * Modeled the results of our regional uplift rate data, showing that there are significant differences in locking on the subduction zone along strike in southern Cascadia.

Presentations:

Weldon, R. J., Burgette, R. J., Schmidt, D. A., 2006, Along-strike variation in locking on the Cascadia subduction zone, Oregon and northern California, Eos Trans. AGU, 87(52), Fall Meet. Suppl., Abstract T41A-1556.

Burgette, R.J., Weldon, R. J., Livelybrooks, D., Schmidt, D. A., Alba, S. K., and Weldon, L. M., 2006, New data and insights into the geodetic uplift of the Oregon Coast, PANGA annual meeting.

Burgette, R.J., Weldon, R. J., Livelybrooks, D., Schmidt, D. A., Alba, S. K., and Wisely, B. A., 2005, Constraints on the extent of subduction zone locking along the central Oregon coast from leveling and sea level observations, Eos Trans. AGU, 86(52), Fall Meet. Suppl., Abstract S51C-1017.