

**Studies of historic earthquakes in Washington and Oregon: Collaborative research with University of Washington, Washington and Oregon state emergency management agencies, and the USGS**

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**Non-technical Summary**

This proposal funded a study of historic records of earthquakes prior to 1928 in Washington and Oregon. The main objectives are to estimate magnitudes and locations for historic earthquakes, search for aftershock sequences, and make information on early historic earthquakes in Washington and Oregon accessible via the web.

**Investigations undertaken**

An event's magnitude and location can be estimated if the strength of shaking is known at a number of different places. Large earthquakes are felt over wide areas and shaking generally falls off with distance from the earthquake. Shaking strength is described by the Modified Mercalli intensity (MMI) scale, which assigns values from 0 to 12 depending on severity of shaking. Older earthquakes that took place before seismometers were installed were often reported felt at many communities, and the geographic distribution of intensities estimates the distribution of ground acceleration.

To determine the location and magnitude of older earthquakes, we first use earthquakes with known locations and magnitudes to estimate how shaking weakens with distance. That "attenuation relation" is then used in a large number of trials with various location/magnitude combinations. Using a trial location and magnitude, each observed intensity is compared to an intensity calculated from the trial location/magnitude. By testing many possibilities, the location/magnitude combination that best fits the observed data is determined.

Other aspects of this study include conducting a systematic search for accounts of aftershocks for some of the larger earthquakes, and reformatting multiple catalogs and hundreds of newspaper articles (collected under previous funding and augmented under this study) for convenient viewing via internet.

**Results**

Using a previously compiled database of newspaper clippings and records of weather observers, we estimated about 1,000 intensities and matched them to geographic coordinates. For selected events with enough intensity values for location/magnitude estimation, we searched for additional newspaper accounts to expand the geographic range of the intensity estimates. Trial locations were attempted for larger events, but

more work is needed to reconcile reports of intensities varying over short distances. This is likely the result of difficulty differentiating among the effects of MMI II-V reports, possibly also reflecting site conditions at reporting locales. In studying the information available for making intensity assignments, we note that very few events had reports consistent with intensities over MM V. Only six reports for Modified Mercalli intensity VII were found, and only 30 for intensity VI. This indicates that no other earthquakes in Washington or Oregon approached the magnitudes of the 1872 and 1949 earthquakes (not included in this study).

The consultant completed a search for foreshocks and aftershocks of the larger Puget Sound earthquakes, and located about 100 new accounts. The main new finding was that the 1909 northwestern Washington earthquake, previously considered to be a Benioff zone earthquake in the subducting slab, appears to have had a significant number of felt aftershocks. Felt aftershocks are uncommon in Benioff zone earthquakes.

A method for exporting the full data-base to web-compatible format was developed and a draft version of the data base is available at [http://www.pnsn.org/HIST\\_CAT/CASCAT/](http://www.pnsn.org/HIST_CAT/CASCAT/). The final report and finalized data-base will be available by the end of Feb. 2005 (work on this project has been delayed due to the large number of additional accounts provided by the consultant, and to the eruption of Mount St. Helens).

An additional task, developing outreach materials based on Native American earthquake and tsunami stories, was proposed as part of this study in cooperation with emergency managers in Washington and Oregon but not funded. A small part of this work has gone forward under other support, and three publications are in press, review, or preparation.

## Publications

### · *Reports and Articles*

Ludwin, R.S., R. Dennis, D. Carver, A.D. McMillan, R. Losey, J. Clague, C. Jonientz-Trisler, J. Bovechop, J. Wray, K. James, 2005 (in press), **Dating the 1700 Cascadia earthquake; Great coastal earthquakes in Native stories**, Seismological Research Letters, March/April 2005.

Ludwin, R.S., G.J.Smits, D. Carver, K. James, C. Jonientz-Trisler, A.D. McMillan, R. Losey, R. Dennis, J. Rasmussen, A. De Los Angeles, D. Buerge, C. P. Thrush, J. Clague, J. Bovechop, J. Wray, (in review, 2005), **Folklore and Earthquakes, Native American oral traditions from Cascadia compared with written traditions from Japan**, IN Geomythology, L. Piccardi and W. B. Massey, eds., Geological Society of London

Ludwin, R.S., C. P. Thrush, K. James, D. Buerge, C. Jonientz-Trisler, J. Rasmussen, K. Troost, A. De Los Angeles, 2005 (in preparation), **Serpent spirit-power stories from Puget Sound Natives may refer to the A.D. 900 Seattle earthquake**, for submission to Seismological Research Letters.