Refining Cascadia Earthquake Chronologies that Bracket a Candidate Segment Boundary, Southern Oregon:
Collaborative Research with Humboldt State University and
William Lettis & Associates, Inc.

Award # 02HQGR0056

Harvey M. Kelsey [1] and Robert C. Witter [2]

[1] Department of Geology
Humboldt State University
Arcata, CA 95521
707-826-3991
hmk1@axe.humboldt.edu

[2]William Lettis & Associates, Inc.
1777 Botelho Dr., Ste. 262
Walnut Creek, CA 94596
925-256-6070, -6076 (FAX)
witter@lettis.com

Program Elements I and II

Keywords: Fault Segmentation, Recurrence interval, Age Dating, Regional Seismic Hazards

Investigations Undertaken

This research tests the hypothesis that the Cascadia subduction zone always ruptures the entire length (>900 km) of the plate interface. If this hypothesis is true, then stratigraphic records of coseismic subsidence along the length of the margin should reflect the same earthquake chronologies. We will compare the earthquake chronologies at two proposed study sites in southern Oregon to one another, and to the documented earthquake chronology in southwestern Washington (Atwater and Hemphill-Haley, 1997). The two study sites, which bracket a potential Cascadia subduction zone segment boundary, are the Sixes River and the Coquille estuaries in south coastal Oregon. Comparison among sites will evaluate segmentation models and temporal patterns of earthquake recurrence. The results of our research will provide revised earthquake chronologies for the south-central Cascadia subduction zone, improve estimates on the range of earthquake recurrence intervals for plate-boundary earthquakes, evaluate whether earthquake chronologies reflect temporal clustering, and possibly resolve whether prehistoric great earthquakes have ruptured discrete segments of the plate boundary.

Our research will produce new radiocarbon ages for coseismically buried soils to supplement our existing data set for southern Oregon. These radiocarbon ages will provide a better means for interpreting the synchroneity or non-synchroneity of events along the Cascadia subduction zone that ruptured the plate boundary between Willapa Bay and Cape Blanco. Ultimately, these data will allow better evaluations of probabilistic seismic hazard models for the PNW and may lead to reduced loss of life and infrastructure in future earthquakes on the Cascadia subduction zone.

Results

In August 2002 we recovered five additional vibracores at the locations of cores J and V of our previous study in the lower Sixes River valley (Kelsey et al., 2002). Cores J and V provided the most complete and well-preserved stratigraphy of the 28 original cores sampled at the Sixes River. Cores J and V were split open at the Humboldt State University sedimentology laboratory in late January 2003. The cores were photographed and logged, noting the lithological characteristics of stratigraphic units, abruptness of unit boundaries, and depths to the top of buried soils. We sampled eleven buried soils for detrital plant macrofossils, which will provide optimal material for ^{14}C dating. The Sixes samples are being processed and prioritized as described below, and will be submitted for dating in May, 2003.

Accurate estimation of the time of soil submergence requires evaluation of the stratigraphic context of the fossil specimen submitted for ^{14}C analysis. Therefore, following selection and identification of detrital plant macrofossils preserved near upper buried soil contacts, we will document the stratigraphic context and likely provenance of each fossil specimen in order to rank the samples and optimize the likelihood that the sample ages will closely estimate the time of soil burial. Criteria considered when ranking include relative degree of decay, sample weight, macrofossil type, evidence for reworking, and stratigraphic context. Sample material from soils that will more directly test the research hypothesis will also receive a higher weight. Once the specimens are selected by rank, they will be submitted for AMS radiocarbon analysis and combined and calibrated using CALIB 4.3 (Stuiver and Reimer, 1993; Stuiver et al., 1998). The new ^{14}C age estimates generated by this study will be used to improve plate-interface earthquake chronologies for southern Oregon.

Due to inclement weather and scheduling conflicts, we were unable to revisit the Coquille estuary during the summer of 2002. In June of 2003, we plan to relocate representative stratigraphic successions of buried tidal marsh soils in tributary valleys of the Coquille estuary. We will focus on the location of core I, in the Sevenmile Creek valley and an additional site near Fahys Creek. Core I contained the most complete stratigraphic record of 10 coseismic subsidence events recognized during previous investigations at the Coquille study site (Witter, 1999). Using a vibracore, we will collect 2 to 3 sediment cores (7.6-cm diameter) that are more than 7.5 m in length. We recovered >7-m-long vibracores at the core I site during the previous investigation and do not anticipate encountering logistical difficulties. Similar to cores from the Sixes river valley, the sediment cores will be split at the Humboldt State University sedimentology laboratory, photographed, and logged in detail. We will not sample the buried soil that records the AD 1700 earthquake because precise estimates for the age of this event at the Coquille estuary were reported in earlier studies.

Non-technical Summary

Geological and geophysical evidence shows that the most recent Cascadia earthquake broke over 900 km during a magnitude 9 event. However, earthquake records from estuaries in southwestern Oregon suggest that not all events are of that size. This research focuses on two previously studied sites, Cape Blanco and Coquille estuary, that chronicle earthquake histories over the past 6,000 to 7,000 years. Further investigations will provide new data to improve earthquake records. Comparisons between these records and records from southwestern Washington will improve our understanding of the size of Cascadia earthquakes, how often they occur, and whether events cluster in time.

Reports Published

None to date.

References

Atwater, B. F., and Hemphill-Haley, E., 1997, Recurrence intervals for great earthquakes of the past 3500 years at northeastern Willapa Bay, Washington, United States Geological Survey Professional Paper 1576, 108 p.

Kelsey, H.M., R.C. Witter, and E. Hemphill-Haley, 2002, Plate-boundary earthquakes and tsunamis of the past 5500 yr, Sixes River estuary, southern Oregon, Geological Society of America Bulletin, 114, 3, 298-314.

Stuiver, M., and Reimer, P.J., 1993. Extended ^{14}C data base and revised Calib 3.0 ^{14}C age calibration program, Radiocarbon, 35, 215-230.

Stuiver, M., Reimer, P.J., Bard, E., Beck, J.W., Burr, G.S., Hughen, K.A., Kromer, B., McCormac, F.G., v. d. Plicht, J., and Spurk, M., 1998. INTCAL98 Radiocarbon age calibration 24,000 - 0 cal BP, Radiocarbon, 40,1041-1083.

Witter, R. C., 1999, Late Holocene paleoseismicity, tsunamis and relative sea-level changes along the south-central Cascadia subduction zone, southern Oregon, U.S.A.: Ph.D. dissertation, Eugene, University of Oregon, 178 p.