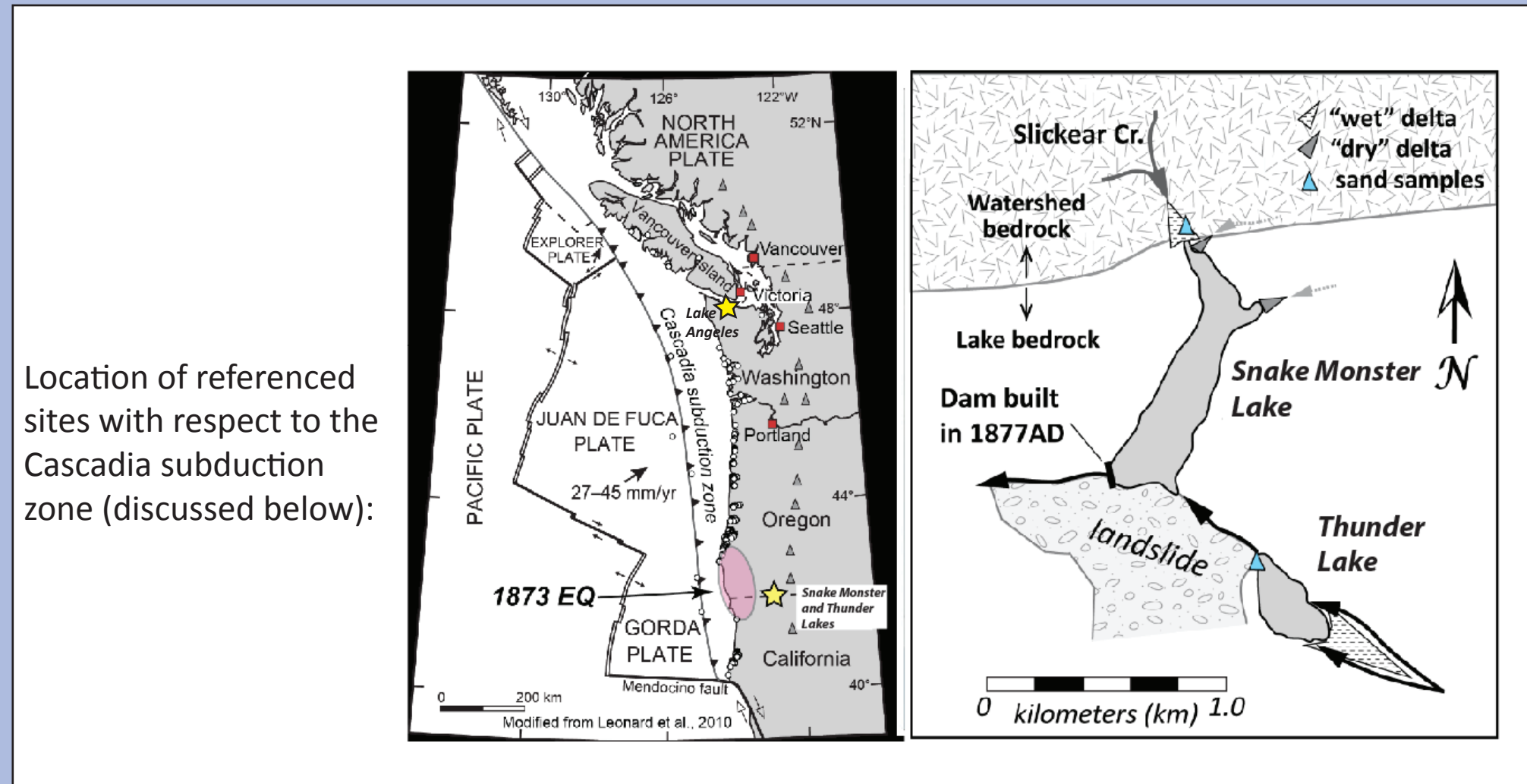


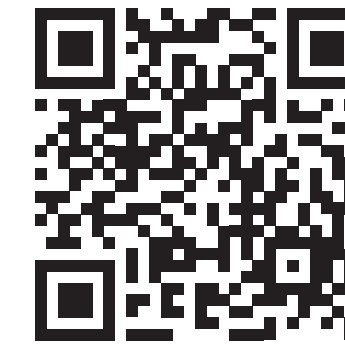
Can we determine the timing of past Cascadia Earthquakes to the year?

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Recent Advances:



This poster presents concepts proposed for a Fellowship (not yet awarded). The goal of presenting this proposed research at this workshop is to maximize the benefit to other projects, should the agency fund it. Because the cost of this project is high (each pollen radiocarbon sample will cost ~\$2,000), it is hoped that the results be broadly and quickly shared with others as deemed acceptable by the funding agency. To express your interest in collaborating or to share ideas for consideration, please follow the following link to a form:



Where does this get us? We can determine if past Cascadia earthquakes were all full margin ruptures (~M9) or some were partial (~M8) ruptures:

Comparing the timing of southern and northern Cascadia ruptures attributed to the 1700 CE earthquake. FIELD WORK, Winter 2023: Lake Angeles, WA.

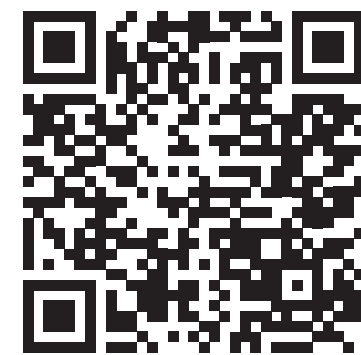


Does the lake contain a deposit that can be attributed to the 1700 CE earthquake? Do the same methods work to differentiate between deposit types in this lake as compared to the example from southern Cascadia? The lake sediments should be varved, therefore we should be able to determine the exact time of deposition by counting them.

Did the deposit attributed to the 1700 CE Cascadia earthquake occur the same year as the southern Cascadia earthquake deposit?

Is it possible to differentiate between subduction earthquake deposits in lake sediments from other types of disturbances (floods, other types of earthquakes)? Yes, at Snake Monster (Squaw) Lake, Oregon.

Preprint:

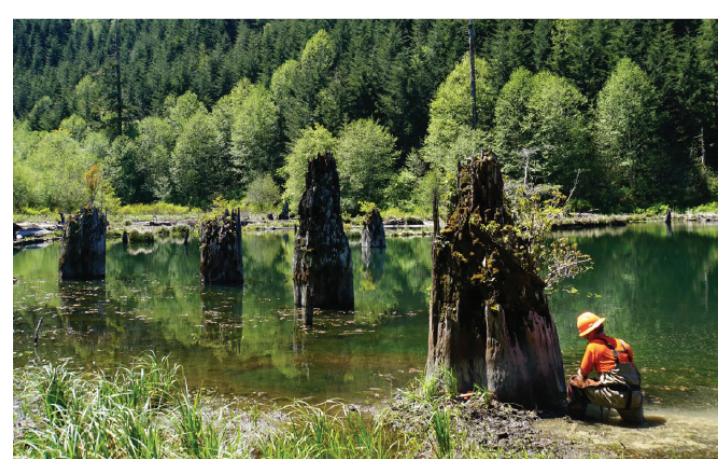


Do the deposits in the downcore record at Snake Monster Lake, Oregon, determined likely to be the result of CSZ EQs, occur at about the same time and frequency compared to the offshore record of Goldfinger et al., 2012? Yes!

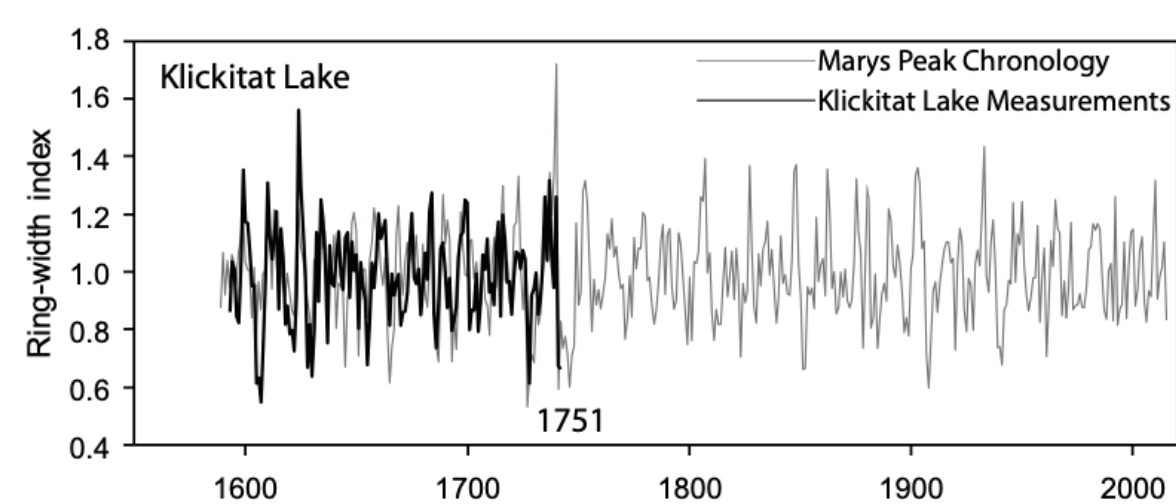
Preprint:



Dendrochronology example - dating the time of creation of landslide-dammed lakes in Cascadia; work by Struble et al., 2020.



To create dates in calendar years, the variability from each time series was averaged within the site, producing a floating mean chronology that was then compared to the high-frequency variability from the Marys Peak chronology (living trees, Black et al., 2015). The exact year of tree death (= time of lake formation) could then be determined if the wood immediately under the bark was well-preserved.



Struble et al., 2020:



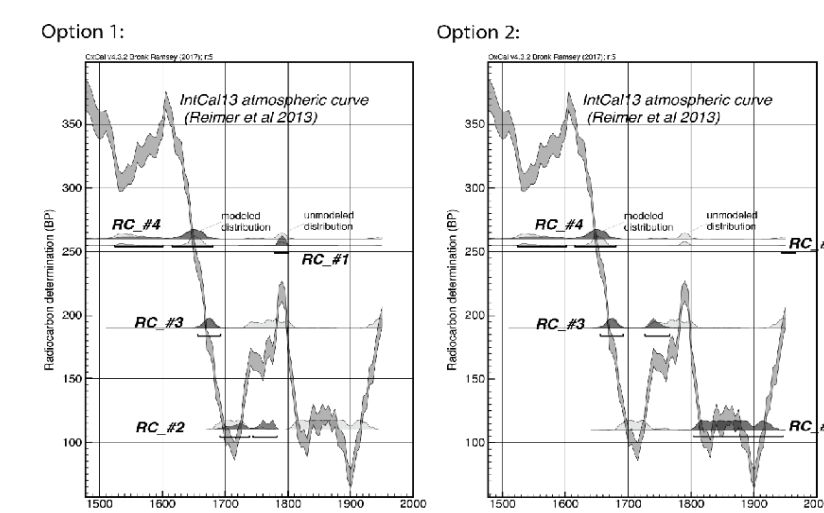
Estimating past earthquake timing . . . to the year?

1. Acquire radiocarbon determinations from annual layers sampled from a 500-yr old oak that was cut down from the margin of Snake Monster Lake.
2. Acquire radiocarbon determinations using pollen from the pseudo-annual layers from the lake sediments and pollen from the organic-rich tail of the deposit interpreted to have resulted from the 1700 CE Cascadia earthquake.
3. "Wiggle match" the pollen radiocarbon determination time series to the oak tree radiocarbon determination time series to determine the "year" in which the earthquake occurred.

The 1700 CE earthquake - is a deposit present in Snake Monster Lake?

We can't be certain that the deposit attributed to the 1700 CE Cascadia earthquake was actually deposited in 1700 CE using the data we have. Could there have been more than one rupture along the margin, one in 1700 CE and one shortly after or before?

1. Radiocarbon alone
2. nearby sed rates:
3. paired lake comparison:



Sedimentation rates from a nearby lake (Bolan L., OR; Briles et al., 2008) vary between 1-3 cm/10 yrs, making the age estimate for deposit J 1240-1710 CE. Correlation to the upper lake (Thunder Lake) provides an age estimate of 1718-1758 CE for deposit J. Upper lake age/depth model source: Colombaroli et al., 2018.

Using "wiggle-matching" we can match radiocarbon time series using the variations in radiocarbon production, without the errors inherent in the IntCal compilation (shown above).

Pollen separation method:

Yamada, K., Omori, T., Kitaba, I., Hori, T. and Nakagawa, T., 2021. Extraction method for fossil pollen grains using a cell sorter suitable for routine 14C dating. Quaternary Science Reviews, 272, p.107236.

Was the 1700 CE CSZ EQ part of an event sequence?

Melgar, D., 2021. Was the January 26th, 1700 Cascadia earthquake part of an event sequence? Preprint of a manuscript submitted to the Journal of Geophysical Research - Solid Earth. <https://eartharxiv.org/repository/object/2029/download/4231/>

If this project can determine the relative timing between these two deposits (synchronously triggered or closely spaced in time) with low uncertainty, it opens up the opportunity to look for lake sites near possible segment boundaries:

Do we find two or more subduction zone earthquake deposits stacked one on top of the other, one of which is dated to 1700 CE exactly, and the other(s) confidently dated as older or younger by some amount of years?

In addition, we can use information about the other processes reflected in lake deposits to bracket earthquake ground motions in Cascadia:

- **Local (not subduction-related) earthquakes produced deposits resulting from lake-wide slope failures without evidence of liquefaction.**

- **A deposit suspected to be the result of the 1906 San Andreas earthquake is a thin layer with evidence of liquefaction.**

- **The landslide dam failed during a non-subduction earthquake, allowing for failure analysis.**