Review: A 2700-yr record of Cascadia megathrust and crustal/ slab earthquakes from Upper and Lower Squaw Lakes, Oregon

By Ann Morey and Chris Goldfinger

The manuscript presents important paleoseimic data from a lacustrine archive at the southern end of the Cascadia subduction zone, where records have been scarce compared to the northern part. It also contributes knowledge to the characterization of so-called (disturbance) event deposits in organic-rich lake sediments where the identification of events can be difficult due to the homogeneous nature of such deposits as well as other factors such as low sedimentation rates etc. The amount of data presented is sufficient to support the main messages of the paper.

Despite the clear scientific merit, the concept used to identify earthquake-induced deposits and how these are generated remains somewhat unclear. There are also weaknesses in the background information and the structure of the paper. I believe these can be addressed but require some revision. Here are my major concerns:

1) It looks like that there is a companion paper to this paper characterizing the 1700 deposit in greater detail. Even if references are made, I believe that in order for this paper to stand alone, it must include more background information. I am wondering if the authors have considered to merge both papers?

2) The seismicity of the southern Cascadia subduction zone has to be mentioned. For example, it is important to know the estimated groundshaking at the lake site for the historic earthquake in 1873 as well as the 1700 earthquake (or other large megathrust earthquakes).

3) More importantly, the geologic setting of the lake must be better characterized to understand the concept that is used to distinguish between large megathrust and smaller earthquakes. This includes the geology and geomorphology in the watershed of the lake as well as lake basin geometry and any delta or landslide deposits within the lake that could be destabilized during ground-shaking. This information is crucial to understand the source of the sediments found in type 1 deposits in contrast to the source of mineralogies found in type II deposits.

4) While the two types of deposits are relatively well characterized, I think that the processes that lead to the formation of these two types of event deposits remain somewhat uncertain. For example, I am having difficulties understanding what is meant by the watershed sourced turbidites. Do these turbidites incorporate sediment that comes from steep slopes in the surrounding watershed destabilized during ground shaking and subsequently transported into the lake (similar to NZ lakes in Howarth et al. 2014)? Is the other type of turbidite generated from slope failures within the lake? Is the difference of the two types just an effect of the amount of groundshaking at the site? I think I am not clear how you can distinguish between the different earthquake sources.

5) I think that it is not necessary to correlate physical proxies of other lake studies as shown in figure 9 and 10. I would merge these records with figure 8 or include a similar figure that just shows the correlation of the ages for those sites. I think this will also streamline the discussion section.

Minor comments:

Abstract:

I would avoid specific deposit names such as deposit J, turbidite T1, T2 etc. in the abstract and the introduction since they have not been introduced, yet. Consider some rephrasing and add a sentence on the methods used.

Introduction:

Maybe include short review on how earthquake induced event deposits look like and what other lake studies have found in the area. I am wondering about overlap with the referenced paper Morey et al. 2023. Can the two papers be merged?

Setting:

The first paragraph under "Methods" seems to be geologic setting. As mentioned above, this has to be expanded significantly regarding seismicity of the area and geologic setting of the lake.

Methods:

The title of the manuscript implies that there is also a record from Upper Squaw Lake. However, the methods only describe cores taken from Lower Squaw Lake. Has data from Upper Squaw Lake already been published?

Mention also XRD measurements that are mentioned later in the text.

I believe the last three paragraphs of the methods section can be shortened and possibly restructured.

Inferred characteristics for earthquake types

See my major comment 4. It is not clear what is meant by "Sediment sourced from watershed" and "Turbidite sourced from lake margin bedrock".

Yes, the structures at the base look like load structures. The question is, if these formed due to rapid sedimentation at the time of turbidite deposition or subsequent seismic loading. Maybe you can disucss later?

For both types I am missing a short statement about the lateral, lake basin wide distribution.

The list of characteristics at the end of this section seems to be a repetition.

Results

3.1: I would avoid the term “schist layers”

It seems as if the last two paragraphs that talk about correlation to Upper Squaw Lake should be under 3.2. I think the results section in general could be restructured a bit.

Discussion

The process of earthquake disturbance layers has to be described in more detail.

“Physical property peaks” is a little too vague.

I think the post-fire and flood-related erosional events can be shortened especially since fires are already excluded as a trigger in Upper Squaw Lake sediments.

I would leave section 4.2.2 and Figure 9 out. It is tricky to correlate selected physical proxies from two very different environments.

4.3: There are some references and terms in this section that don’t seem related to the paper.

Section 4.4. is based on figure 9 and 10 which I would leave out and just add the age distributions to figure 8. See my comment 5.

From the manuscript it is not clear how the summary of ideal lake characteristics was established. Under Summary and Conclusions there is another paragraph that talks about the suitability of regional lakes. Consider merging/ rephrasing.

References not checked – sorry!

Figures: I am not sure if I have access to the highest resolution possible for these figures. Some seem fuzzy and are hard to read.

Figure 1: Could it be cut above northernmost location mentioned in text (I believe above ~45 deg N). Could you add a smaller overview figure showing the entire Cascadia subduction zone/ northwest Pacific and mark extent of southern Cascadia?

Figure 2: I have a hard time reading the core names but it looks like this study is mostly based on cores from the lake side and not from the deep basin? It is important to explain why those were chosen since deep basin cores would probably show a more complete record.

Figure 3: What is meant by calcium minerals? If $CaCO_3$ data exits from LOI it might be useful to plot here especially if it correlates with a specific source area for the turbidites. I think the figure can be simplified. Not all smear slide pictures and detailed descriptions are necessary.

Figure 4: very hard to see details. I suggest plotting only selected cores at a larger scale.

Figure 6: I don’t think D is necessary. Maybe merge information with A, B and C and enlarge.

Figure 8: Is it possible to add ages of events from Figure 9 and 10 here? Also, can you indicate what archive each site represents (marsh record, lake, offshore, etc.)