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**Title of article:** Co- and postseismic subaquatic evidence for prehistoric fault activity near Coyhaique, Aysén Region, Chile

**Name of Corresponding Author:** Morgan Vervoort

**Email Adress of the Corresponding Author:** Morgan.Vervoort@UGent.be

**RC2:** Pierre Sabatier

**RC2 review:** Indicated in blue

The paper of Morgan Vervoort et al. about « Co- and postseismic subaquatic evidence for prehistoric fault activity near Coyhaique, Aysén Region, Chile» investigate lake and fjord sediment records as a potential earthquake archive thanks to seismic stratigraphy and sediment cores with sedimentology and chronology data. The paper is well written and structured and result provided a new methodology to estimate earthquake location. However, I have to mains concerns 1/ some proxies used in Fjord Aysen (reflectance data) and some proxy interpretation (C/N) and 2/ the estimation of intensity threshold, how it was estimated and if it fluctuates through time with large implication on the medullisation part. Thus, I suggest major revision before to take into consideration for publication

Major comments:

1/Reflectance data: the author provide some proxy of TOC and mineralogical content derived from spectrophotometric data. The first one integrates the spectrum area with oxide contents and thus does not fully correspond to what was mentioned by the authors. This proxy could be an indicator of TOC but for that it needs to be calibrated by punctual analyses, and from Figure 3, it is obvious that this proxy does not fit with the TOC measurements. The use of this proxy is surprising, as many other proxies exist and are more robust for reconstructing TOC or at least chlorophyll content from this type of data. For the other proxy R590/R690 as a proxy of mineralogical content, yes it is use for like that by (Trachsel et al., 2010). I know that the USGS uses this proxy for mineralogical content but not for soft sediment with a high amount of organic matter, which is known to have a signal in this specific spectral range. As chlorophyll interacts with the spectrum at 670 nm, it is difficult to avoid integrating chlorophyll content into this proxy. L* is probably a better proxy for that, and a good comparison with R590/R690 is an argument. For well-established proxies, such as Chlorophyll, punctual analyses are not needed, but for others it is important, as they could be site dependent; thus, I strongly recommend that, as Trachsel said, “prior to interpreting the reflectance spectra, the general mineralogical composition and geochemistry of the sediment should be measured by established analytical methods (e.g., XRD)”. I can also recommend to the authors to have a look on a recent review publication on hyperspectral data (containing visible data) : (Jacq et al., 2022). The comparison between spectral proxy and TOC or LOI try to be done in Figure 4 and we can said that it is not good with a high dispersion of the data and if the author provide the correlation coefficient and the associated p value it will be for sure not validate, this is why I recommend to try other better define organic matter proxy. You understand that I have some doubt about the use of these proxies and Figure 4A confirm this doubt because if R590/R690 is a proxy of mineralogical content why the turbidite and light coloured layer has not similar values.

Since we measured the OM ($LOI_{550}$) and TOC content, the spectrophotometric data have been used as supplementary proxy to further illustrate and highlight our results. In this study, we do not focus on the mineralogy. But, by using these proxies we aimed to illustrate that the lighter-colored layer has a higher mineralogic content and thus suggesting a more clastic input.

The R and P values will be shown on Figure 4b, and since the R = 0.7 and P < 0.03 (LOI in function of TOC), together with the low number data points, these results are considered significant.

Furthermore, we did not expect that the lighter-colored layer and turbidite had similar values. As is confirmed by our results, illustrating a different origin between the turbidite in Aysén Fjord and the lighter-colored layer.

2/The interpretation of C/N ratio is very strange for me. The decomposition of organic matter is likely present (probably no so strong knowing this could environement), but it actually changes the C/N ratio, may be, but for a part of this organic matter will not expect this change. It is very strange that the C/N ratio decreased with increasing terrestrial inputs in the fjord record, especially when compared with that of turbidites, for which the C/N ratio increased. Did you consider potential GLOF deposits in this fjord record because a GLOF deposit will present lower TOC content (Piret et al., 2021), greater fine terrestrial input and potentially some organic matter previously deposited in aquatic environments, thus with low C/N ratio… Is it possible to have GLOF in the catchment, such as in other Patagonian Fjords (Vandekerkhove et al., 2021)

We do agree that the C/N values were rather anomalous. However, by the fact that it does decrease in this layer, we interpreted it as more decomposed organic matter being present. Together with the spectrophotometric results, indicating a more mineralogic/clastic input, this shows that the layer is different from the background sediment, and the turbidite, for which the higher LOI, TOC and C/N (and lower $\delta^{13}C$) values indicate more fresh organic matter.

We did not consider GLOF deposits, as this region has been deglaciated prior to the event: deglaciation started > 20 kyr BP (Van Daele et al., 2016) and the event is slightly older than the H2 tephra deposit (4.09-3.61 cal yr BP).

3/As few data about chromoly is presented in this paper (present in already published ones) it is important to specify if these lake system experience variations of sedimentation rate over time which could modify the sensitivity of lake to record earthquake event. If variation in the sedimentation rate occurred in the past, this could modify the availability of the sediment on the slope and thus the threshold to record earthquake with specific intensities will change also (Wilhelm et al., 2016; Rapuc et al., 2018).

The sedimentation rate has been very stable in both Lago Castor and Aysén Fjord throughout the Holocene. To illustrate this, the age models of both Lago Castor and Aysén Fjord will be added in the SI.

4/I have a main concern about the estimation of intensity threshold to record event deposit in this Fjord and lakes. If I well understand this estimation came from a comparison with a New Zeland sites and other worldwide? This threshold must be estimated from historical record and not record earthquakes on these sites, as there are already some papers published on these sediment sequences in which this intensity limit can be estimated to record or not earthquake… This threshold depends on many local parameters (faults, type of earthquakes, and lake parameters

such as sedimentation rate); thus, this threshold cannot be compared with what is already published worldwide. Without this precise estimation you cannot rule out the part about ground motion modelling. Maybe I do not understand something when I read the paper because I know that this team works well and made such estimation. Thus, if it is already estimated please add more clearly on the revised version. In addition, of course, this sensitivity could change over time in regard, for instance, to changes in the sedimentation rate, but additional information is needed; see the previous main comment.

Indeed, ideally, shaking threshold values are determined based on local calibration using negative evidence of historical earthquakes. However, especially for Lago Castor, no historical events are available to conduct such site-specific calibration. And therefore, average values based on the evaluation of global thresholds are used. This will be added in the manuscript, including in-line references to Vanneste et al. (2018) and Van Daele et al. (2020).

Minor comments:

All the minor comments were reviewed and changes were made in the manuscript.

L62: precise the type of Cretaceous rock

L66: Rio Simpson is not located on Figure 1

L179: how does you estimate the dip?

L210: for me on this figure it is just visible on the Eastern part

L214: CSB not presented, at least add it in supplementary

L220: I do not see the upper limit in Fig 2

L228: not in 5.4?

L242: Figure have to be presented in the right order, not 6 before previous ones.

L243: interpretation have to move after

Figure 5: may be add a contour plot it could be useful to identify grain size classes variations.

L331: which depth? What age?

L358: Provide the age of this H2 tephra

L367: why in the catchment

L379-381: no grain size data presented on this core.

Figure 8: please add the age distribution on this figure

L404: how was define this therehold?

Figure 9: from where these faults are coming? What are the main movement please add this information on the study site part. Please add the Fjord Aysen catchment on this figure to better estimate if it was affected or not. This figure is truly hard to read probability line in white are nit visible.

L457: what is the distance from this site?

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