**Response to reviewers - "Probable surface ruptures along the San Juan fault in the recently-deglaciated northern Cascadia forearc"**

Dear Dr. Tobin,

Many thanks to you and the reviewers for taking the time to review our paper, we appreciate their suggestions and have made substantial revisions to the manuscript. We feel that the paper is much improved as a result.

Major improvements include full discussion of the fault kinematics and figures showing the surficial geology, both of which strongly motivate paleoseismic trenching, which lies beyond the scope and budget of this exploratory study but which we acknowledge will be an important future contribution. In addition to responding to the reviewers' comments, I have added some changes that were made to the manuscript in response to questions from my PhD defence (including from my external examiner, Nadine Reitmann at USGS). In particular, a new figure (Figure 9) was added to display apparent right-lateral offsets in river channels along the fault, with curved forms likely due to distributed deformation, a long elapsed time since the most recent earthquake, and/or the wet climate. Several lines of text and relevant references have been added to the discussion, speaking to this figure.

We have addressed the reviewers' suggestions and comments below, paraphrasing them or quoting them in bold, following with our response. Line numbers provided correspond with the updated "clean" manuscript document.

Regards,
Guy Salomon, on behalf of all co-authors

**Reviewer 1: Ashley Streig**

**To evaluate the Quaternary activity of the San Jan fault the authors conducted detailed lidar based mapping, and compile results of fault perpendicular profiles for many north-facing, and up hill facing scarps, however, no profiles demonstrating the features discussed in the paper are provided in the body of the article. I suggest adding a couple of annotated profiles demonstrating these important morphologic features the mapping interpretation relies so heavily upon – this will clearly demonstrate to the reader what these landforms look like. I would suggest adding one to two annotated profiles of the most discussed features in each map section to each of the Figures: 2ab, 3ab, 4ab, and 5a, and indicate the profile location in the appropriate map. The Results section 3.1 discussion of fault expression is a bit confusing, text here could be revised for clarity and written to directly speak to and reference the maps/figures.**

We thank Dr. Streig for her thoughtful and constructive review. Profiles of the fault have been added to several figures (Figures 4 & 5), where there was enough space to do so. The profiles have also been numbered and labelled more consistently throughout for easy comparison with all the profiles in the supplemental materials. The results section 3.1 has been reworked to read more clearly and directly reference the maps and figures. Please see details for this in our response to the line-by-line comments.

**Section 4.3 needs some revision, in seismic hazard models sources are modeled either as a fault source or an areal/background seismic source to capture poorly delineated faults that may produce an earthquake. The authors assert in this section that 'cryptic faults' like the SJF are excluded from seismic hazard models, however a fault rupture on a structure that either has a discontinuous surface trace, or has no clear Holocene or Quaternary offset can be captured by the assigned floating probability of a large earthquake on structures within a specific region (a bounding box for example in UCERF 3 or USGS NSHM). Faults that lack clear data like microseismicity and Quaternary displacements should not be categorized in the same way as a fault with established slip rates or paleoseismic/earthquake history sites, they could however be categorized as capable – see the New Zealand Seismic Hazard model and community fault model for these types of delineations. This is an interesting discussion, how do we handle these tricky, low-slip rate structures in seismic hazard characterization, but to have this conversation more background on what existing Canadian models include and exclude with specific examples (citations) are needed. Similarly, in two places the authors suggest the fault length, and scarp heights suggest > M7 earthquakes – without citing empirical scaling relationship papers that give us this kind of guidance. Assertions like these need to be supported with references to appropriate background literature.**

This section has been thoroughly revised, trying to incorporate your comments above. Added the following text ***in bold italics*** to section 4.3, with the intent to provide more information about how seismic hazard is calculated in the Canadian model and cited the empirical scaling relationship paper used to calculate our estimated largest event along the San Juan fault. Some of the text has been moved around to improve the flow of the section.

"***To approximate the maximum magnitude earthquake that the San Juan fault can accommodate, we use the full length of the mapped fault trace (80 km) and the following equation to calculate moment magnitude from Wesnousky (2008):***

$$Mw = A + B \cdot \log(Length(km)) \qquad (1)$$

***Where constant A = 5.56 and B = 0.87 for strike slip earthquakes. Substituting these values into the equation, the SJF could potentially produce an earthquake of Mw 7.2,*** which would have considerable impacts for the nearby population centres of Shawnigan Lake, Mill Bay, and Greater Victoria, and infrastructure including the Trans-Canada Highway." ***This motivates consideration of whether and how to include the SJF in seismic hazard models.***

***A challenge here is that despite the lines of evidence from lidar mapping, scarp analysis, rock strength tests, and ERT surveys, it is difficult*** to wholly and unequivocally prove that the SJF is an active fault. Similar to other shallow faults within the northern Cascadia fore-arc (e.g. Nelson et al., 2017; Morell et al., 2018; Harrichhausen et al., 2021, 2023), such evidence has been largely obscured by dense vegetation, high precipitation rates and recent glaciations, without narrow concentrations in instrumental seismicity or geodetic strain as independent evidence for activity. Including these structures in seismic hazard models is difficult since most such models require that the slip rate is well-constrained. ***The 6th Generation Seismic Hazard Model of Canada (CanadaSHM6) only a limited number of simple fault sources (and most of these are for plate boundary faults), and relies largely on areal sources based on recorded seismicity, assuming maximum magnitudes based on a truncated Gutenberg-Richter relationship (Kolaj et al., 2020, 2023). Importantly, the only Cascadia fore-arc crustal faults included in the CanadaSHM6 are the Leech River and Devil's Mountain faults (Kolaj et al., 2020, 2023). While overall, hazard is still dominated by the Cascadia megathrust and the intraslab seismic zone, incorporation of these two upper plate faults marginally increased seismic hazard for Victoria compared to earlier versions of the model, with the `excess' decreasing rapidly away from their surface traces (Halchuk et al., 2019; Kukovica et al., 2019; Goda et al., 2021). Mendoza et al. (2025) similarly found that source-to-site distances was an influential factor for hazard increases from upper crust faults near Vancouver, however, the authors noted that even small increases in hazard could be impactful for critical infrastructure such as airports, bridges, dams and energy infrastructure e.g. McCann and Addo, 2012).*** This brings into question the acceptable criteria for considering cryptic faults like the SJF in seismic hazard models: should they remain excluded until absolute evidence of rupture is found? ***In New Zealand, fault zones that have experienced considerable displacement in the recent geologic past (Neogene) but lack preserved evidence of late Quaternary movement are considered to be 'capable' fault zones, with the potential to generate earthquakes greater than Mw 6 in the present tectonic regime (Seebeck et al., 2024, 2022). Another potential approach could be to designate fault source polygons, similar to those found in the United States NSHM (Petersen et al., 2024), where fault zones capable of hosting multiple large magnitude events are identified and included in the hazard calculation, but specific fault sources remain unidentified.***

***Fault hazard assessments in environments such as Vancouver Island require a multi-faceted approach, combining seismological, geological and geophysical techniques. In our case, additional work is necessary to prove that the SJF is active, and constraining the ages of paleoseismic earthquakes will be vital in this respect. Follow-up research could aim to estimate the slip rate and other rupture constraints, to enable incorporation of the SJF into seismic hazard models, if warranted. In the absence of clear geomorphic offsets, the best option for this would be paleoseismic trenching. There are several potential trench sites, including the UPSCARP site discussed above or the drumlin cross-cut by the fault west of Shawnigan Lake (Figure 5). Alternatively, sediment cores could be taken from nearby lakes or from ponded sediment along the scarp at the GSS site (Figure 4), in the hopes of finding dateable earthquake related deposits."***

**Overall, the content is well laid out and figures are informative. I have suggestions included below to improve the flow of the article and to make the language more concise in places. Language used in this article occasionally slips into a conversational tone that needs to be reviewed and revised throughout. For example, line 100-102 could be revised and shortened, line 246 "making it normal slip sense", and line 267 "presents a vexing challenge because…", and line 329 "in spite of the lines of evidence", see suggested revisions in the In-Line comments below.**

Thank you, we appreciate the effort you have made to improve the manuscript. We have adjusted the language to read more concisely, and less conversationally where appropriate. Line 246 has been removed, as this would potentially be confusing and shouldn't necessarily be considered the overall fault kinematics.
Line 383 (previously 267) now reads "***A challenge here is that*** *despite the lines of evidence from lidar mapping, scarp analysis, rock strength tests, and ERT surveys,*" (i.e. we removed the parentheses and simplified).

**In Line Comments:**
**87-88. Cool test, not differential weathering.**

Thanks!

**112. You use the Wolfe et al., 2020 toolkit to evaluate net slip and uncertainty. First good job fixing/updating the Python Code. Second, this is a paper based on the ground breaking approach developed by Thompson et al., 2002. As Wolfe et al., 2020 did, you need to cite the paper that establishes this method. Cite this paper "Thompson, S. T., Weldon, R. J., Rubin, C. M., Abdrakmatov, K., Molnar, P., and Berger, G. W.: Late Quaternary slip rates across the central Tien Shan, Kyrgyzstan, central Asia, J. Geophys. Res., 107, 2203, https://doi.org/10.1029/2001JB000596, 2002."**

Thank you, and thank you for pointing out this omission. I have added the following text to line 128 to include a reference to the Thompson paper: "*using the Monte Carlo Slip Statistics Toolkit (MCSST, Wolfe et al., 2020), which makes use of the Monte Carlo method for calculating dip slips developed by Thompson et al. (2002).*"

**146. add text "orienting the hammer at a perpendicular angle to the outcrop surface."**

Added "to the outcrop surface" to the end of the line.

**169. You cite Figure 2a, 2a shows 2 towns Port Renfrew and Mill bay but does not have fault traces. Add faults to this map so we can see the lineaments you are talking about relative to the cities you mention. If you want to keep an image without interpreted faults, perhaps this can be a 4 panel figure, as it is already nearly page size?**

Added "north of" before the mention of Port Renfrew. Updated text before Mill Bay to read "near' as there are actually strands north and south of the town. Triangles indicate location of the main fault trace on Figure 2a (now 3a). Updated the caption to reflect this change.

**172. "SJF trace first becoming clearly evident in the topography only east of Fairy Creek (Fig. 2c)" Describe here or in the caption exactly what you are referring to, use annotations in the figure to call the reader's attention to the specific features that are "clearly evident". Get the reader on the same page, building your body of evidence and arguments.**

The text has been updated to more fully describe our observations. *"The lidar data support this interpretation, with only sporadic, bedrock-associated lineaments. A more pronounced* *uphill-facing scarp emerges east of Fairy Creek, with an apparent offset of ~10 m (Figure 3c). Where it intersects the fault trace, Fairy Creek changes from a southward to westward flow direction, before turning southwards again 250 m past the mapped fault. In the context of similar deflections further east (described below), we interpret this as tectonic."*

**174. Add text "we map….with short discontinuous lineations and generally north-facing scarps (Figure 2c).**

Added the text in bold italics.
*"Between Fairy and Harris Creeks, we map a broad (<1 km) zone of deformation with short, discontinuous lineations and* ***generally north-facing scarps extending northwards from just above the valley floor (Figure 3c)."***

**175-176. "there are several large uphill-facing curvilinear fault scarps at an inflection point where the fault strike changes from ENE_WSW to E-W." Expand this for clarity. Write to the figure here.**

The direction of this inflection point has been updated and the following text has been added to improve clarity, ***"West of this inflection point mapped features generally trend ENE, while east of it they trend ESE before gradually curving back towards ENE east of Mercer Creek (Figure 4a, b)."***

**177-180. Hard to see what you are specifically referring to in the figure, also Figure 3a and b have no scale bar, N arrow, – making this more complicated. From the text "~250 m wide deformation zone" if it is important enough to discuss this annotate this feature on figure 3. "broadens to 500 m east of Fleet River" I see the Fleet river label on Figure 3, but cannot tell where exactly the broadening zone is. Difficult to figure out with no scale bar to measure distance.**

We do not feel that it is necessary to highlight the width of the deformation zone as suggested, especially, as this may clash with additional colored polygons that were added to the figure to describe the surficial cover along the fault. The figure has been updated to include a scale bar and north arrow, we have also added an annotation on the figure to help identify where the deformation zone broadens. We have updated the last section of this paragraph to write to the figure, ***"Surficial material in this area is mapped mainly as a thin veneer of colluvium, although the fault may pass through some fluvial sediments where it crosses Fleet River.*** Though this central SJF section crosses numerous secondary channels and interfluves at high angles, ***we do not observe any sharp, lateral offsets. However, several of these channels (e.g. Mercer Creek, Clydeside Creek, Fleet River) do change from southerly to more westerly flow directions close to where they cross the mapped fault trace, before switching back again shortly afterwards to create an overall arctangential deflection pattern consistent with right-lateral deformation. This will be discussed further in Section 4.2."***

**187-191. You mention that you have discarded the 6 westernmost profiles, but you have not shown why. Show the profiles that work, and the profiles that do not work, and use that to support your argument for the region where you terminate the**

**‘probable’ active trace of the SJ fault. It could be good for the reader to see the difference between the fault scarp and a non-fault scarp profile that is on-strike. Add profiles to your figures to demonstrate how sharp the fault scarp is and sense of motion (U & D).**

This statement was not entirely correct; we simply omitted the 6 westernmost profiles from the calculation of mean slip, but they are included in the figure and the plot. The text has been updated to more correctly provide this context. We have also added an example profile, as suggested. The lines now read ***“The main set of profiles (#7–#23) yielded a mean dip-slip of 3.6 m (up to the south) with a range of 0.1–7.7 m (Figure 4d); profiles #1–#6 across a tentative western scarp extension had large error bars and were excluded from this calculation.”***

**196-200. Scour & drumlins. How much relief from peak to trough on these features? How much uncertainty does that potentially add as you have scarp perpendicular topographic profiles across different-unmatched features? Is the range you give, 8-52 m a function of different glacial features/relief juxtaposed across the fault (if lateral component of slip?). If only a normal component of slip we would anticipate that with the north-side going down that this side would be buried, so surface profiles would be a minimum displacement. We have not seen a profile across the fault at these features and cannot compare the variability of relief. If the entire landscape was reset by the same glacial advance that scoured the landscape – then the range cannot be a function of age - where older features have experienced more earthquakes and are more offset than younger. Perhaps a couple more sentences on the uncertainty in these values (8-52 m) and some profiles would add clarity here.**

Added the following addressing the scale of the scours: *“**scours and drumlins with peak-to-trough relief of ~1–2 m** …”*
We have added a profile to Figure 4 to help the reader get a sense of scale for the scarp. Added the following text addressing concerns about uncertainties and range of values: ***“The wide range in apparent dip-slip reflects how slopes on either side of the fault are unlikely to be correlative, with undulating topography on the southern side of the fault making it hard to pick the scarp extents, particularly for profiles #33–#37.”***

**198. Add wording “A total of 14 fault perpendicular topographic profiles”**

Added “fault perpendicular” to the above line.

**201. Begin the sentence with “Moving west, the fault trace then descends…”**

Added “Moving east,” to the beginning of the sentence - as we were describing the fault expression moving eastwards from the west coast to the east.

**201. Koksilah River Valley – this is not labeled on Figure 3. Do you mean to cite Figure 2?**

Added an annotation for the Kosilah river to the figure in question.

**204. add figure citation to "… at the top of this escarpment (Figure 4).**

Added figure citation to this line.

**204. "This morphology…" What are you referring to? Call this out on a figure/ annotate and update captions. More detail can be included in the captions.**

Changed morphology to "***section of several sub-parallel fault traces (Figure 5c)***"

**214. Delete "Just", begin sentence with "West…"**

Removed "Just".

**215. add figure citation, "northeastward towards Cobble Hill (Figure X)." If a place name is called out it must be on a map, reference it.**

Added figure citation as the end of the sentence.

**215. "There has been significant anthropogenic modification of the landscape…" Show area on Figure 4. I cannot see that at the sale of Figure 4 a & b.**

In order to allow those interested to view the hillshaded topography at whichever scale they would like, we have added the hillshades to the supplemental data on Zenodo. Added the following text, "***Hillshades at 1 m resolution along the entire fault length are included in the supplemental data repository."***

**225 "a change in slope" Figure 3c – Not clear what you are referring to here, the north or south trace in the figure? Greatest change in slope on the slopeshade is along the southernmost red lines, but no fault perpendicular profiles here. This would be useful.**

This was meant to refer to the b panel of Figure 4. This has been corrected in the text, and we have added an annotated cross section through the change in slope in question to highlight this point.

**229. Cite figure here (Figure 5).**

Added a citation to the relevant figure at the end of the sentence.

**232 – 240. Combine these two sentences with the paragraph below to remove redundancy. A table would concisely summarize & display the range and average rebound values for each geologic unit.**

These two sentences are not redundant, they provide the overall average value, grouped by lithology. The paragraph below splits these values by their location, north and south of the fault. Instead of creating a new table, the following text was added to reference the figure, which already contained the average values in the legend. ***"In relation to the SJF trace, the north side mostly comprises extrusive igneous rocks of Survey Mountain and the Bonanza Group, combining for an average R-value of 54 (Figure 6b). Rocks to the***

***south are mostly Leech River schist, with a few outcrops of Survey Mountain volcanics, together yielding an average R-value of 36, significantly lower than on the northern side. The lowest R-values of all belong to some of the rocks right along the fault trace."***

**234. Check for geologic unit name consistency with Table 1 and Figure 5. Here you have "Bonanza Volcanics" but Bonanza Group on Table 1. Island Plutonic Suite, but Group on Table 1. West Coast Crystalline complex is all caps in Table 1.**

Geologic units have been checked to ensure that their names and capitalizations are used consistently across the manuscript. Suite changed to Group in regards to the Island Plutonic group.

**240-242. This is interpretation, not a result. Careful not to mix a result (you observed) with what you interpret it to mean. Delete from this section.**

Removed this sentence, the last sentence of this section now reads "*We return to discuss the implications of this difference in rheological strength in Section 4.1*."

**244. Needs new introduction sentence. Introduce the overall findings of the ERT. For example "ERT revealed high and low resistivity slope-parallel layers along the length of the transect (Figure 6). High resistivity layers are shown as warm colors on Figure 6, and shows a north down sense of motion across a northward dipping lineament, which we map as the SJF (Figure 5b)." This is a good example of how to 'write to a figure'. The current sentence on line 244 is an interpretation, you say "confirm" the data must be interpreted to confirm a hypothesis, that is a discussion point. Delete. The results must describe the data, tell the reader what you see/what you want them to see, interpret it in the next section.**

Thank you for this suggestion and the clear example. To best accommodate this, we removed "The ERT profiles (Figure 6) confirm that the uphill facing scarp is not just a surface feature such as an old road bed." and added the following introduction sentence. "***ERT profiles across the uphill-facing scarp at the UPSCARP site show an apparent N-side-down offset in slope-parallel high- and low-resistivity units (Figure 7.)***"

**246. Revise sentence following above example, write to the figure. Note, on the figure you show an annotation of 78˚ in part a, and 77˚ in part b. Nowhere are there values of the range 73-82˚ on this figure. Explain how you arrive at this range – what is it from, other surveys, or uncertainty? If uncertainty perhaps on Figure 6 the values of 77 and 78˚ dips should include a ± value?**

Added a reference to the figure. This range should accommodate the uncertainty in fitting a line through the profile, and reading the dip of that line. The figure has been updated to include this.

**253. Revise to read "We paired the ERT profiles with a 0.5 m deep test pit…"**

The beginning of the paragraph has been changed to read as above.

**254. Show HR1 on location map. Show test pit on location map.**

HR1 refers to a high resistivity layer that is likely present near the surface along the entirety of the uphill facing feature, potentially representing the thickness of the colluvium at this site. Added the following text to better make this point within the text, ***“On the regional surficial geology map, this hillslope is described as a ~1 m veneer of colluvial material overlying bedrock (Senyk, 1979)”***. Test pit location has been added to Figure 8.

**262. Revise phrase “one that is more continuous” - this can be more concise, explain what you are thinking. Revise to read “The San Juan fault has strong geomorphic surface expression; north-facing fault scarps and lineaments are more continuous along strike than other neighboring faults to the south and east.”**

The line has been reworded to read, *“The San Juan fault displays a remarkably clear surface trace in the hillshaded DTM (Figures 2–4) with north-facing fault scarps and lineaments that are more continuous along strike than those along neighbouring active faults on southern or central Vancouver Island.”*

**267-268. Confusing. What do you mean by “it has no such age constraint.”? I think you are saying there are no good strain markers, no obvious piercing lines of a known age that reveal a Quaternary slip rate. Say this, be clear and explicit so the reader follows. I suggest you revise to read “The San Juan fault has a strong geomorphic expression in the landscape, however there are no post-glacial strain markers or piercing points to evaluate Quaternary slip on the fault.”**

Thank you for pointing this out, this was definitely confusing. The line has been changed to read: *“The SJF presents a greater challenge because, despite its clear geomorphic expression, there are no post-glacial strain markers or piercing points with which to quantify Quaternary or Holocene offsets.”*

**270. Revise to less conversational tone. Suggested revision “We consider several non-tectonic explanations for the prominent bedrock scarps we map across the glacially scoured landscape. First, we considered that the rheological strength on either side of the fault may differ;…”**

Changed to the suggested revision.

**278-280. Revise this sentence, reduce redundancy, the purpose of the sentence is given at the beginning of the paragraph. Revise to “Second, we considered the erosive powers of glacial plucking across differing lithologies and an existing bedrock fault and related fracture zone.”**

Changed the wording as suggested.

**268. You use the phrase crustal fault a lot, do you perhaps want to switch it up and also say ‘upper plate faults’? To be clear a crustal fault is any fault in the crust, so there are faults in the subducting oceanic crust and the overriding ‘upper plate’ crust.**

**You say crustal fault to distinguish that you are not talking about the plate interface. Tricky here in the PNW. I also use the phrase 'crustal fault'! Food for thought, I'm okay with this use.**

Thank you for this observation, we agree that this term has become somewhat ubiquitous, yet does not add much information about the context of the fault. In several places throughout the text, we have added "Forearc" in front of the term crustal fault, to refer to faults within the Cascadia forearc. In other places, the term has been replaced by "upper plate fault" as suggested.

**290. "such a slip rate would imply numerous M 6-7 earthquakes in the Holocene, each with several meters of slip." Add citation at the end of this sentence for appropriate empirical scaling relationship paper to support this assertion.**

Added a reference to Anderson et al. 1996, (Earthquake size as a function of fault slip rate)

**290 – 291. "…product of a much longer period of tectonic activity extending before the Holocene and that successive glacial cycles have not fully reset the landscape." This needs revision for clarity. You mean successive glacial cycles that occurred in the Quaternary - before the Holocene, but as written it reads as thought the glacial cycles are successive to the Holocene.**

Added the text in bold to reduce ambiguity, "*and that successive glacial cycles **within the Quaternary** have not fully reset the landscape*".

**295. first discussion of Cordilleran Ice Sheet. Add a sentence to Intro, around lines 42-47 and introduce this background information earlier. That will support you calling upon it here.**

The Cordilleran is mentioned in the Introduction, referred to as the Fraser glaciation, same as it is referred to in this paragraph.

**299-303. The intro sentence of this paragraph introduces looking for smaller, 1-2 m scarps in the landscape for evidence of 'post-glacial Holocene rupture', then jumps into a discussion of sackungen. Revise the intro to introduce looking for micro-offsets/separations, that may have a handful of different sources. Importantly, make the point here that sackungen/landsliding creates very short escarpments, often related to a landslide deposit, whereas a fault creates a linear feature that is continuous across several km.**

Added the text in bold. *"Although the prominent, continuous scarp is suggestive of pan-Quaternary fault activity, we must look to smaller, more subtle scarps for evidence of more recent, post-glacial Holocene rupture. **As these features are shorter-lived than the bedrock scarps, they preserve smaller scale offsets, but as with the bedrock scarps, we must also consider other potential origins. For example, on slopes overlooking the San Juan River west of Clydeside Creek,** swarms of short, ridge-parallel, uphill-facing scarps are likely sackungen, the result of gravitational slumping within thick accumulations of till in response to San Juan River incision (e.g. Figure 8a, d). **This interpretation is***

***supported by landslide scars at the slope base, a potential cause of formation of the sakungen directly up-slope."***

**305. "is not a sackung, since it is isolated..". What do you mean by isolated? Do you mean it is not adjacent or within a larger translating body or along the margin of a landslide deposit?**

It is a single uphill facing scarp, with only a small landslide feature below it. The text added to the previous paragraph should help differentiate from sackungen which often form in groups.

**309. "The uphill facing scarp may provide evidence for a post-glacial Holocene earthquake along the SJF, as it offsets channels running across it, indicating that this offset is relatively recent and has not been removed by erosion" Here end the sentence with the phrase "by stream erosion". Indicate these offset channels on a figure, describe in a caption (channels offset of X m across the SJF, if you suspect lateral component of slip you could use the Lateral Displacement Calculator by Olaf Zilke). If the channels are over-steepened you should provide the channel elevation profile to demonstrate this knickpoint, and annotate it in the figure. This statement is important, and unfortunately it does not reference an existing figure/s – the reader cannot easily find these offset channels to look at them for themselves. This is a great place to use an extracted profile paired with a map to make your point. You could show a hillslope fault perpendicular topo profile, a channel thalweg elevation profile, and your mapping.**

Changed the wording as suggested. These features are very small scale and quite difficult to show off in a figure, we have tried our very best to do so in Figure 8 - we have added an in text reference to this figure. We did attempt to use LaDiCaoz to measure lateral slip, although had very little success here, even with our higher than normal DTMs.

**310. Great point.**

Thank you!

**326-327 – revise sentence structure for improved clarity.**

This sentence has been revised to read "As such, a slip rate of 1~mm/yr could be the upper bound for the SJF, ***however, other factors may be at play, such as the different underlying geology (Siletz terrane basalts in the case of the Sadie Creek fault, Nelson et al., (2017), Schermer et al., (2021)).***"

**329 "in spite of the lines of evidence" This is too conversational. Please revise. Consider instead outlining the evidence and saying that even combined the lidar mapping, scarp analysis, rock strength tests, and a fault perpendicular electrical resistivity tomographic surveys of the SJF demonstrate a bedrock fault, but do not unequivocally demonstrate Holocene or even Quaternary fault movement.**

Changed to *"**Despite the lines of evidence from lidar mapping, scarp analysis, rock strength tests, and ERT surveys, it is difficult to wholly and unequivocally prove that the SJF is an active fault.**"*

**333-334. "Including these structures in seismic hazard models is difficult since most models require that the slip rate is well-constrained." Cite some examples of regional seismic hazard studies that do not include faults without a slip rate to support this assertion. In seismic hazard models sources are modeled either as a fault source or an areal/background seismic source to capture the poorly delineated faults that may produce an earthquake. I would cautiously note here that in many hazard models there is floating probability for earthquakes in a region that are not assigned to a specific fault – many models include a floating earthquake for a region that is considered capable of generating an earthquake but the fault traces are discontinuous or the faults have little evidence of Holocene displacements. For example, in the US you could refer to UCERF 3, or the NSHM. A good example of capturing these rupture possibilities is the 2014 Napa earthquake in California. Are you certain that Seismic Hazard models for Canada do not include areal seismic sources to cover this exact type of fault rupture scenario? This needs to be addressed, appropriate models should be cited, and your argument carefully laid out - if you are to keep these statements in this manuscript.**

We have made some changes to the paragraph, addressing your concerns and adding details about how the Canadian Seismic Hazard model includes areal sources based on recorded seismicity and a truncated Gutenberg-Richter relationship (see reply to your main comments/concerns).

**335-336 – You have not demonstrated that rupture on this fault is not captured by a floating earthquake. If this has not been considered in existing regional seismic hazard models you need to state that and cite the most current**

This has been added.

**342-343. "… and provide dates of previous earthquakes for slip rate estimation…" It is important to note that earthquake timing sites are not fault slip rate sites. Earthquake timing developed by paleoseismic techniques yields a feel for recurrence interval, a slip rate needs to be established from piercing points that have experienced many, many earthquake cycles – 10 or more is good, so the open interval (waiting for the next earthquake) has little impact on the slip rate. A slip rate established from a 2 or 3 earthquake history common in most paleoseismic trenches will have huge uncertainties, as another earthquake tomorrow would dramatically change the slip rate. The greater the number of earthquake cycles a feature has experienced the less important the open interval (to tomorrows earthquake is). For more background on this please read to Hatem et al., 2025, How Does the Onset of Offset Influence Geologic Slip Rates?, https://pubs.usgs.gov/publication/70261766**
**I suggest you revise these couple of sentences.**

These sentences have been revised and now read as follows ***"In our case, additional work is necessary to prove that the SJF is active, and constraining the ages of***

***paleoseismic earthquakes will be vital in this respect. Follow-up research could aim to estimate the slip rate and other rupture constraints, to enable incorporation of the SJF into seismic hazard models. In the absence of clear geomorphic offsets, the best option for this would be paleoseismic trenching."***

**Table 1. Revise table title to "Geologic units and lithologic descriptions sampled while collecting Schmidt hammer rebound measurements."**
**Use more space in this table, ensure Descriptions for each Unit are clearly separated. Separate out each map unit on Figure 5. Check Unit names here and on Figure 5 and in text for consistency. For example, in Table 1 Island Plutonic Group, in Figure 5 labeled "Island Plutonic Suite". On Table 1 Bonanza Group, on Figure 5 labeled "Bonanza volcanics". Can you add color to Table 1 to match the colors used in this figure?**

Changed table title as requested. Added blank lines to better separate the units, colored the unit name cells with the same colors as used in the figure. Checked and made unit names consistent across the text, table and figure.

**Figures:**
**Use of U and D on opposing sides of faults in Figures with red fault traces would be helpful to the reader to visualize the relative sense of up and down across the fault. Other motion indicators like left lateral arrow or normal sense of motion ball & stick symbols are omitted from detailed lidar mapping figures (2, 3, 4, 5…)**

Nearly all of the features described are south side up, and we think that the hillshaded imagery and revised description show this clearly without needing to add more to the figures.

**Figure 1. part b, consider adding a legend for the star and earthquake ages. The caption doesn't quite capture what you have done here, the paleoseimic earthquake timing is really interesting to compare along strike of these structures and across the region.**
**In part b – the upper right-hand corner of the figure – faults BBF and SPF have stars that are floating just north of the fault, should those overlie the black line that is shown as a fault?**

Added the star and ages to the legend. In part b, those are the correct locations of the lines and stars.

**Figure 1. part c, can you add a rectangle for "Area of Figure 2" to the geologic map?**

Added bounding box for Figure 3 to the geologic map on Figure 2.
**Figure 2 – revise caption and add annotations to support the discussion of fault features in section 3.1. Call the reader's attention to specific features.**

Updated caption.

**Figure 3a & b have no scale bar, north arrow, etc.**

**Move the text "extent of c" closer/ along the edge of the polygon.**
**Make EAST, UPSCARP, GSS, SLIDE white boxes a heavier line weight. Difficult to see.**
**Figure 3c. How can you better demonstrate the landslides in this figure? Hard to see at this scale. Can you map the polygon for the landslide deposit and the headscarp? It is hard to see the landslide features for the western landslide. I think I see the shading of a SE failing small landslide on the east.**
**Figure 3 caption – be consistent and use the same acronyms in that caption that is in in the text and on the figures. Revise by adding acronym "d) Dip slip measurements for the uphill facing scarp in UPSCARP.." for e) add GSS to the caption here.**

Added scale bar and arrow. Added polygons for the landslide. Edited caption.

**Figure 4 – From lines 203 & 204 add label text 'north facing escarpments' and 'bedrock scarp' on part c.**
**Figure 4 caption – Add text "d)Dip slip measurements for all profiles shown in b and c, with…"**

Edited caption, added annotations to c.

**Figure 5. Caption reads "coloured by sampled lithology" or do you mean coloured by Geologic units? Units are labeled on Figure 5, while the actual lithologies within each Geologic unit are described in Table 1.**

Adjusted caption.

**Reviewer 2: Brian Sherrod**

**I found the manuscript to be reasonably well written with a few caveats, well organized, and generally the figures were well drafted.**

**The authors investigate a long linear fault trace on in southern Vancouver Island (the San Juan fault, or SJF), located near other faults that are known to be active, which they say supports the hypothesis that the SJF is active. To test this idea, they collected airborne and drone lidar data and identify a feature on lidar images that corresponds to the mapped fault trace and infer from the correspondence of the lidar features that they represent fault scarps along the SJF.**

**The biggest shortcomings of the manuscript are:**
**1) the lack of a map(s) showing the relationship of the scarps to Quaternary deposits. The only surficial geology map I could find online by Clague and others 1982 suggests that the scarps disappear just west of Sannich Inlet when the fault trace enters an area of mapped Q. The authors must address this – if they are arguing that the fault is potentially active, then show the reader it's expression across some Quaternary deposits and landforms. Also, does the scarp show up in Q deposits east of Port Renfrow in the San Juan valley? If the preponderance of evidence suggests it is not present on Quaternary surfaces, you need to rethink your hypothesis that this is an active fault.**

Thank you for pointing out this shortcoming; to address your concern we have added surficial geology from some recently digitized maps (Alley, 1975a, 1975b; Senyk, 1975), the best currently available for southern Vancouver Island. We acknowledge that these maps may be somewhat lacking, given the maps were made in 1975, but think that they do provide a general understanding of the surface materials found along the fault. One of our goals was indeed to map any locations where we saw fault scarps within Quaternary landforms (see figures 4 and 5 in particular). Additionally, our paper addresses one of the big challenges of mapping active faults in glacially scoured terrain: that there is often very limited preservation of Quaternary deposits. Our novel application of a Schmidt hammer attempts to address this issue, as it offers a test for Quaternary activity in the absence of clear cross-cutting of Quaternary deposits.

**2) Place the study in the modern tectonic regime – your need to summarize and show GPS and block model interpretations of the region to put your study in the proper context (see references below).**

Thank you for this feedback. As a result of this comment we have added a new figure 1, displaying the raw GPS velocities, and the residual GPS velocities after a modelled Cascadia megathrust locking signal has been removed. We have also included the following paragraph and added an inset cartoon to Figure 2, to set out the problem and regional context.

*"Active upper plate faults across northern Cascadia share common ~E-W and ~SE-NW trends and strike-slip to oblique-transpressional kinematics, but how they accommodate deformation of the forearc remains an open question. The Juan de Fuca plate subducts northeastwards at ~5 cm/yr beneath North America (Mccaffrey et al., 2007), with the northern Cascadia forearc experiencing elastic interseismic strain induced by partial coupling of the subduction zone interface (e.g., Dragert et al., 1995; Miller et al., 2001; Savage & Lisowski, 1991) and permanent strain from subduction zone coupling and far-field tectonic forces (e.g., Delano et al., 2017; Finley et al., 2019; Nelson et al., 2017). Removing the modelled strain from the Cascadia megathrust shows that southern Vancouver Island and northern Washington are undergoing margin-parallel shortening (Figure 1b), but there are too few GNSS stations and the associated uncertainties are too large to resolve strain rates across individual faults (Mazzotti et al., 2011; Mccaffrey et al., 2013). The limited available focal mechanisms for small to moderate earthquakes across southern Vancouver Island predominantly have right-lateral, right-lateral oblique, and reverse nodal planes along W--E to NW-SE trends (Brocher et al., 2017), consistent with NW-SE- to N-S-oriented maximum horizontal compressive stresses (Fig. 2a; Balfour et al., 2011). Figure 2b shows a conceptual model for how margin-parallel shortening could be accommodated by such structures via vertical axis block rotations, consistent with paleomagnetic, geologic, and geodetic data that show counterclockwise rotation of the Cascadia forearc north of the strait of Juan de Fuca Finley et al, 2019; Mccaffrey et al., 2007 Miller et al., 2001; Prothero et al., 2008; Wells & McCaffrey, 2013). Regional active faults that fit this model include the Leech River fault (Harrichhausen et al., 2021; Morel et al, 2018) and the North Olympic fault zone (Nelson et al., 2017; Schermer et al., 2021). However, there are other active faults along similar trends with different kinematics, including the left-lateral Utsalady Point fault (Johnson et al., 2004), the Southern Whidbey Island reverse fault (Johnson et al., 1996), and a network of steeply-dipping structures beneath the Salish Sea are tentatively interpreted as left-lateral*

*based on offset bathymetry (Greene & Barrie, 2022). These apparent contradictions strongly motivate the identification and characterization of other active faults in the forearc as a means to understand regional neotectonics."*

**3) References – I found the manuscript lacking references in a few critical areas – mainly tectonic block models (e.g., Wells, etc., 1998), GPS velocities (Mazzottii etc, 2002, 2003), and strain rates (Hyndman et al, 2003). If the San Juan fault does not fit into any of these models, it is even more important for you to explain this and why.**

We have added references to the papers above…

**Final thoughts: Does this warrant publication? As written, probably not. With some thoughtful additions, you can make this a much better manuscript that warrants publication. My recommendation is for a major revision – anything short of that should warrant a reject/resubmit.**

**Specific comments: (also, see my scribbles in the attached scanned hard copy)**
**Title**
**"Probable surface ruptures" – based on your findings, is it really probable these are surface ruptures? I'd say no. Maybe possible but nothing stronger than that. Would your findings elevate this to an active fault that should be used in a seismic hazards analysis? "In Canada, an active fault is generally defined as one that has demonstrated movement within the last 10,000 years, specifically within the Holocene epoch, and is considered likely to move again in the future." Do your findings elevate the fault to this level?**

We have chosen to keep the title as is. We stand by our interpretations of the ERT surveys, and hope that the additional figures, including surficial mapping, and the improved regional context provided in the revised manuscript will help convince you that the San Juan fault has been active in the late Quaternary. While we cannot conclusively define the SJF as an active fault, our objective in conducting this research is to improve our knowledge of active faults within the region, and hope that this work will help fuel further research along the SJF, which may or may not elevate it to an active fault.

**Introduction**
**Hypothesis: SJF is active based on its proximity to known faults, that those nearby active faults reactivate preexisting faults, and its sharp linear trace.**
**The authors could lay out a more appropriate multiple working hypothesis?**
**1) It's an active fault**
**2) fault line scarp or erosional feature;**
**3) alignment of topographic features;**
**4) glacial/erosional features (terrace edge, moraine, raised shoreline, etc)**
**Hypothesis test(s): Use airborne and drone lidar imagery (is this really an appropriate test of an active fault?)**
**Other hypothesis tests: trenching, outcrop mapping of Q units along/across fault, ponded sediments, ground penetrating radar, seismic reflection, marine geophysics in**

**Port San Juan, coastal deformation (Port Sand Juan), lake paleo (Fairy Lake?). Every scarp deserves a trench. In my opinion, the gold standard test of a possible fault scarp is to dig a trench. It doesn't have to be a huge trench excavated by a gigantic track hoe – a surgical strike with a small hand-dug trench works just fine. The goal is to show a structure beneath the scarp intersecting and deforming Q materials – these can be soils in the shallow subsurface so it doesn't have to be a huge trench. But the lack of elevation profiles across the scarp makes it difficult to access good places to put a small trench. In most of the hand dug trenches I've done, we excavated through the soil/Q veneer and into bedrock so these area cheap and easy way to trench in the most rugged terrain.**

We agree that paleoseismic trenching will be necessary to unequivocally provide evidence of late Quaternary earthquakes and their timing, but it was beyond the scope and budget of the current study. We have added reference to this clear need in the abstract (line 24), introduction (105), discussion (393-396) and conclusion (408).

Our ERT profiles across the UPSCARP site (Fig 7) do show clear offset of shallow subsurface sediments that are interpreted as late Quaternary in age. The subsurface offset is consistent with the surface offset demonstrated in the elevation profiles of Fig. 4c-d. The UPSCARP site is one of several locations proposed in the paper for future trenching.

**Lay out the problem better – use residual GPS plots from Mazzotti and Hyndman 2002, 2003 to help set it up, Tom James' work for GIA setting. Lay out multiple working hypothesis and then go though each, one by one, and show how that particular explanation works or doesn't work. Your fault has vertical deformation and crosses the Port San Juan shoreline at Elliotsville. The San Juan River is pushed all the way across the valley and hugs the south valley wall for most of its length – is this because the fault tilted the valley or GIA? My point is that the river and shorelines are going to react to an active fault at the mapped location of the SJF and might help explain if it's active or not. I doubt the GIA tilt is strong enough to do that but I'm just guessing.**

Please see our response to your main comment #2. However, we were not too sure how to incorporate the comments about valley tilt and GIA.

**Your figures strongly suggest you think this is a RL strike slip fault. Why? What are the alternatives? How does the fault sit relative to the modern strain field(s)?**

In response to the kinematics of the fault, we do believe that it is oblique right lateral, and have included several reasons for this in the revised Introduction "*Correcting the GNSS velocities for modelled elastic strain due to megathrust locking shows that southern Vancouver Island and northern Washington are undergoing margin-parallel shortening (Figure 1b), but there are too few GNSS stations and the associated uncertainties are too large to resolve strain rates across individual faults (Mazzotti et al., 2011; McCaffrey et al., 2013). The limited available focal mechanisms for small to moderate earthquakes across southern Vancouver Island predominantly have right-lateral, right-lateral oblique, and reverse nodal planes along W--E to NW--SE trends (Brocher et al., 2017), consistent with NW--SE- to N-S oriented maximum horizontal compressive stresses (Figure 2a; Balfour et al., 2011).*

*Figure 2b shows a conceptual model for how margin-parallel shortening could be accommodated by such structures via vertical axis block rotations, consistent with paleomagnetic, geologic, and geodetic data that show counterclockwise rotation of the Cascadia forearc north of the strait of Juan de Fuca (Miller et al., 2001; McCaffrey et al., 2007; Prothero et al., 2008; Wells and McCaffrey, 2013; Finley et al., 2019)."*

As well as in the description of the fault expression (Section 3.1) - "*Though this central SJF section crosses numerous secondary channels and interfluves at high angles, we do not observe any sharp, lateral offsets. However, several of these channels (e.g. Mercer Creek, Clydeside Creek, Fleet River) do change from southerly to more westerly flow directions close to where they cross the mapped fault trace, before switching back again shortly afterwards to create an overall arctangential deflection pattern consistent with right-lateral deformation. This will be discussed further in Section 4.2*"

As well as a significant rework of the Discussion section 4.2 (quoted further down in this response document).

Additionally, we have included a new figure to enhance this discussion (Figure 9).

**Methods**

**Fault scarp morphology**

**This section IS NOT about fault scarp morphology. Rather, it's about using a software tool to infer slip estimates from fault scarps (of know origin I presume). This section/paragraph should be moved to the discussion/interpretations section. Any slip estimates you have right now are highly suspect because you've not demonstrated that this is an active fault.**

We have changed the title of this subsection to "*Fault scarp measurements*". Our quantitative measurements of fault scarp vertical separation and causative dip-slip are an important outcome of our work, and so it makes sense to follow the usual separation of methods, results, and discussion. To improve clarity, we have categorized these measurements based on whether we interpret surfaces on either side of the scarp to be geomorphically equivalent (yellow profiles, measurements of dip slip, e.g. at the UPSCARP site) or not (blue profiles, measurements of apparent dip slip, e.g. at the GSS site). We acknowledge that the latter measurements would usually be discarded, since they do not record a robust tectonic offset of a distinct geomorphic surface. However, in the context that rocks on the raised, S side of the fault scarp are softer not harder than those on the lowered, N side, these measurements are still significant, because the obvious interpretation is that they record Quaternary tectonic offset rather than differential erosion.

We have added the following to text to the methods section explaining this classification "*The fault scarp measurements were categorized according to the geomorphic equivalence of the surfaces on either side of the scarp. If the surfaces were interpreted to be equivalent, the dip-slip was measured. In cases where they were not equivalent, apparent dip-slip was measured. To allow for easy identification, we have coloured dip slip profiles yellow, and apparent dip slip profiles blue.* "

We have also updated the captions of Figures 4 and 5 to explain this classification better, see example from Figure 5, "*Points are coloured based on the geomorphic equivalence of the surfaces on either side of the fault. Yellow points are for profiles where the surface on either side of the fault is interpreted to be the same, blue are for profiles where this is not the case. Green was used for measurements of bedrock outcrops.*"

Additionally, the following text was added to the fault scarp morphology section (now called Fault scarp measurements) - "*The wide range in apparent dip-slip reflects how slopes on either side of the fault are unlikely to be correlative, with undulating topography on the southern side of the fault making it hard to pick the scarp extents, particularly for profiles #33-#37.* "

**Results**
**Lidar morphology/fault expression: show lidar profiles across the scarp (show lots of them). In flatter areas, a strike slip fault probably would not show any vertical. If your profiles show one side higher than the other, It's either an oblique fault or dip slip. I'm not telling you anything you don't already know but you should demonstrate your knowledge of this to the audience. The lidar images suggest there is a significant vertical elevation change across the scarp but your reader cannot tell which side is up or down on your images. Describe the scarps succinctly in one section so the reader knows what the scarp looks like along its mapped extent – they do this but in a more haphazard way in several direct sections. Put it in one section with some profiles and some good maps.**

Reviewer #1 made a similar suggestion. We have added some lidar profiles from along the scarp to Figures 4 and 5. The expression and scarps are described in Section 3.1, which has been considerably reworked to improve clarity and speak to the figures which it references. See our response to Reviewer #1 for details.

**Show scarp relative to Quaternary surficial geology. Add surficial geologic map of region and study areas – see Clague, J. J., Fulton, R. J. & Ryder, J. M. (1982). Surficial geology, Vancouver island and adjacent mainland, British Columbia, map. Geological Survey of Canada, Open File, 837. https://doi.org/10.4095/129736**

Thank you for this suggestion, we think that this is a very good one and have added the most recent geological mapping that was available - Surficial geology maps from 1975, (Alley, 1975a, 1975b; Senyk, 1975).

**How does this fault fit into the modern strain field? I presume the arrows in Fig 1 show interseismic strain from CSZ. What do the residuals look like once interseismic effects are removed (ala Mazotti 2002; Hyndman et al)**

As mentioned in addressing your main concerns, Figure 1b now shows residual GPS velocities. The arrows in what is now Figure 2a are maximum horizontal compressional stress directions. We have added a cartoon block model as Figure 2b to show the conceptual kinematic model for northern Cascadia forearc deformation. We have added text and relevant references to the introduction to better explain how the SJF fits into this stress regime and what kinematics we expect from it:

*“Removing the modelled strain from the Cascadia megathrust shows that southern Vancouver Island and northern Washington are undergoing margin-parallel shortening (Figure 1b), but there are too few GNSS stations and the associated uncertainties are too large to resolve strain rates across individual faults (Mazzotti et al., 2011; McCaffrey et al., 2013). The limited available focal mechanisms for small to moderate earthquakes across southern Vancouver Island predominantly have right-lateral, right-lateral oblique, and reverse nodal planes along W–E to NW–SE trends (Brocher et al., 2017), consistent with NW–SE- to N–S-oriented maximum horizontal compressive stresses ((Figure 2a; Balfour et al., 2011). Figure 2b shows a conceptual model for how margin-parallel shortening could be accommodated by such structures via vertical axis block rotations, consistent with paleomagnetic, geologic, and geodetic data that show counterclockwise rotation of the Cascadia forearc north of the strait of Juan de Fuca (Miller et al., 2001; McCaffrey et al., 2007; Prothero et al., 2008; Wells and McCaffrey, 2013; Finley et al., 2019). Regional active faults that fit this model include the Leech River fault (Harrichhausen et al., 2021; Morell et al., 2018) and the North Olympic fault zone (Nelson et al., 2017; Schermer et al., 2021). However, there are other active faults along similar trends with different kinematics, including the left-lateral Utsalady Point fault (Johnson et al., 2004), the Southern Whidbey Island reverse fault (Johnson et al., 1996), and a network of steeply-dipping structures beneath the Salish Sea tentatively interpreted as left-lateral based on offset bathymetry (Greene and Barrie, 2022). These apparent contradictions strongly motivate the identification and characterization of other active faults in the forearc as a means to understand regional neotectonics.”*

We have added a whole new discussion section (4.2) and figure (Fig. 9) on our interpretation of fault kinematics, referring back to the Introduction above.
*“If the SJF is Quaternary active, then what are its likely kinematics? Firstly, we consider its tectonic context. The fault is generally interpreted to record predominantly left-lateral motion in its earlier history (Johnson, 1984; Rusmore and Cowan, 1985; England and Calon, 1991; Harrichhausen et al., 2022), which implies that the modern fault should have inherited a relatively steep dip angle. This is consistent with its highly linear surface trace across rugged relief. Purely strike-slip faults can exhibit vertical offset, but the ubiquity of the S-side up sense of vertical separation across the SJF does also imply a component of dip-slip. The modern day stress field has maximum horizontal compressive crustal stresses orientated ~N–S on central Vancouver Island, close to fault-normal, but ~NW–SE on southern Vancouver Island, more consistent with right-lateral kinematics (Balfour et al., 2011, Fig. 2a). All of this points to the modern SJF having a dextral-reverse sense of slip, similar to its closest neighbour to the south, the sub-parallel Leech River fault (Morell et al., 2017, 2018; Harrichhausen et al., 2021). This also fits with the conceptual model in which northern Cascadia upper plate faults accommodate margin-parallel shortening of the fore-arc via right-lateral slip and counter-clockwise vertical-axis block rotation (Finley et al., 2019, Fig. 2b).*

*However, despite several channels and glacial flutes crossing the fault at high angles, we found no unequivocal geomorphic evidence for right-lateral offset across the SJF. Several factors can hinder interpretation of offset markers including the superimposed nature of tectonic landscapes, transient variations in fault slip, and climate variability (Reitman et al., 2019). However, along the central SJF we did observe curved drainages (including Fairy Creek, Mercer Creek, Clydeside Creek, and Fleet River) with consistently right-lateral senses of deflection (Figure 9). This subtle expression of right-lateral slip might suggest* *distributed deformation (Duvall and Tucker, 2015; Gray et al., 2017), a long elapsed time since the latest earthquake (Reitman et al., 2019), or simply poor preservation of lateral offsets in the high precipitation climate (Reitman et al., 2022). For comparison, the Sadie Creek fault on the nearby Olympic peninsula (a branch fault of the NOFZ, Figure 2b) has sharper channel offsets and a slip rate of around 1–2 mm/yr (Nelson et al., 2017) on very similar hillslopes to those found along the San Juan valley. As such, a slip rate of 1 mm/yr could be the upper bound for the SJF, although there are other factors to consider as the underlying geology is different, being Siletz terrane basalts in the case of the Sadie Creek fault."*

**Slip estimates derived from scarp measurements. I would avoid these as much as possible at this stage of the game. Show your audience that you understand the kinematics of the fault and the ruptures that created the scarp (if any…), then provide estimates of slip.**

We feel that the estimates of slip help to provide a sense of scale for the features that we were mapping. Many of the surfaces showed significant offsets, much larger than would be expected with a single surface rupturing earthquake, and so we thought it would be worthwhile to gather these slip measurements to try see how large these features were, if they showed similar amounts of slip along their entire length, and if different surfaces showed significantly different amounts of slip. The description of the categorization of these measurements has been reworked when responding to your comment about fault scarp methodology.

**References missing? Mazzotti et al, 2002, Hyndman et al, 2003, James GIA**

We have added these.

**Writing: Something most of us suffer with - lots of passive voice and tense issues within paragraphs. Please do a thorough edit on your final draft and fix these.**

We have fixed these.

**Figures:**
**Fig 1: make stars bigger in B. Put stars on C. Use velocities with subduction zone interseismic effects removed (Mazotti et al?). Should terrace bounding faults be shown, even if they are not known to be active – it's kind of weird to show terranes but not have bounding faults shown. Your maps show the SJF as RL but you say its LL in the text. Clarify on your maps and in the text.**

Made stars for the location of paleoseismic studies bigger.

Included a new figure 1, which shows GPS velocities, and residual velocities after removing the modelled subduction zone interseismic effects.

Terrane bounding faults, and other non-active geologic faults are included in the Figure.

The text is now consistent with the figure regarding kinematics of the SJF.

**Utsalady Pt fault – demonstrably a left lateral fault– where its labeled DDMFZ needs to be shown as left lateral, even if it doesn't fit your conceptual model because that's what we found in the field.**

Sorry about that, the typo has been corrected in the text  and the symbol in the figure has been corrected to be left-lateral.

**I suggest adding a panel that shows Q deposits.**

Surficial coverage has been added to select panels on Figures 3, 4 and 5.

**Fig 2: Lidar coverage boundaries are difficult to see in places – add line around them? The scale of panels B and C is such that it is hard to see the lidar features you highlight – I'd almost rather see more panels with better enlargements of the lidar.**

Updated the lidar coverage, since the initial submission almost the entire area now is covered with publicly accessible lidar data on the LidarBC portal. Any areas not hillshaded do not have lidar coverage, this should be more obvious now. We have included full resolution hillshaded tifs in the supplemental data for readers who want to look at the data in more detail.

**Fig 3: This is better in terms of being able to see lidar features. There are glacial landforms in some areas and these need to be described more fully in the text. Do the scarps cut these features? There are a set of NW-trending features that are entirely missing from the text and lidar mapping - what are these features? Is it bedding or underlying bedrock structural grain? They cross the fault trace so might be useful for getting at lateral offset. Please show some elevation profiles, somewhere.**

NW trending features you mention are likely bedrock structural grain (Leech River Schists), which may not be much use as the geology across the fault is different. The following text has been added to the caption "*Note: NW trending lineaments visible in the hillshade south of SLIDE are likely the bedrock structural grain of the Leech River Schists.*"

Elevation profiles have been added to b and c.

**Fig 4: Again – showing your scarps relative to mapped Q units in the area would be very helpful. It looks like the fault may cross into Q and/or glaciomarine deposits west of Sannich Inlet and the scarps seem to stop right at the marine limit/edge of thick Q deposits. Only way to see this is with a figure of Q deposits with your scarps plotted on it. If this indeed is the case that the scarps stop when the enter an area of thick Q deposits, that suggests the probability of Q activity on the SJF is low.**

Surficial cover has been added to this figure. The area covered by glacial deposits has also undergone significant anthropogenic change, and as a result it may be difficult to find any tectonic morphology which may have cut through it. For the benefit of those interested in taking a look themselves, we have included hillshaded images at 1m resolution in the supplemental data.

Dear Harold,

Thank you very much for your careful review of our revised manuscript. We have addressed your concerns below. Our responses are given in italics. Line numbers provided correspond with the updated “clean” manuscript document.

Regards,
Guy Salomon, on behalf of all co-authors

**General Comments:**
1. In the manuscript figures, especially Fig. 3c and 5b&c, there are some red lines (your “SJF lidar” designation) crossing fluvial, presumably Holocene age, and glacial surficial deposits. You study the bedrock scarps nearby, but don’t address the places where you have mapped a fault trace, but no lidar evidence is discussed. Examples are near the left side of 3c, a bit above the letters “SJF,” also in the same figure, short traces just west of Lens Creek in the fluvial; and in Figure 5C under the arrow that marks “north facing scarp.” Are these traces intended, and what is the basis for them? There are also a few spots in Figure 3b&c where I was left wondering why a fault trace was <u>not</u> mapped, like along the north edge of the mapped fluvial in the main SJ river valley between Harris Creek and Fairy Creek, but maybe I’m being fooled by something glacial or anthropogenic.

*These traces are intended as potential segments or lineaments associated with the San Juan fault, and they may highlight areas which would be worth further detailed investigation. However, they may also highlight areas where the surficial mapping could be improved. In the instance of Figure 3C, I believe that the surficial material is incorrectly mapped as fluvial where the fault traces are also mapped. This assessment is based on texture in the hillshade that is much closer to other areas that are mapped as bedrock or very thin colluvium. It would have been great to reach this area for some in-field observations, however, that proved to be impractical during our field trips. As for the lineament between Harris Creek and Fairy Creek, it is hard to distinguish at the resolution in the figure, but I believe that to be a glacial streamline, rather than a tectonic lineament. The figure has been updated to reflect this.*

*In the case of Figure 5, those traces are certainly intended, and were mapped in the same manner that all the SJF lidar fault traces were mapped, using a combination of hillshades, slope maps and TPI to identify lineaments, which there then assessed to be either tectonic, glacial, bedrock, or anthropogenic. In fact, some of these eastern lineaments have been targets for subsequent research (an Honours student’s project). The only reason why I didn’t explore these further is because the lidar data for Figure 5 only became available at the time that this paper was initially submitted. As we had already written the paper, I just added the new lidar coverage, and a few figures to apply our general mapping across the full extent of the fault/*

2. I think you’ve done a great job being measured about the non-definitiveness of evidence for late-Q displacements. Nonetheless, by using words like “prove” or “disprove” you come on a little strong in places. See comments below.

*Thank you, we have made the changes suggested in the comments below. I have also done a thorough read-through to try to identify other places where our language ought to be toned down. In doing so, I changed lines 414-415 to read “In our case, additional work is necessary to demonstrate conclusively that the SJF is active …”*

3. The “BCGS” faults from Cui et al. 2017 appear in multiple figures and are often very different from what you’ve interpreted – I think I understand why, but I also think it would be useful to discuss them. As far as I can tell, this reference only shows up in figure captions, and there’s not any mention nor discussion of them in the main text. Please add some information about what they are and why they’re shown on the figures.

*Thanks for catching this, the following text has been added to the end of paragraph 1 in Section 2.1 (lines 116-121).*

*“In addition to our mapped lineaments, we also plot faults (black dashed lines on Figures 2--5) from the British Columbia Geological Survey's (BCGS) Digital Geology dataset (Cui et al., 2017). This province-wide integrated geological dataset is useful for identifying major structures and lithological changes at coarse, kilometer-scale resolution. As this dataset was compiled from a range of mapping scales (1:50,000 to 1:250,000), structures and geological units can be misplaced at the scale of local field sites. We include these data to highlight general structures and highlight where refinements could be made to the existing map.”*

4. I would encourage you to consider changing the word "Probable" to "Potential" or "Possible" (or similar) in the title. I'm not requiring such a change, but leave it up to you as the authors, how strong a statement you wish to make on this key point.

*Thank you for not requiring this change. While we have changed the language throughout the manuscript to be less strong, we would like to keep the title as is. The title isn’t overly sensational, nor is it unreasonable given the suite of observations that the paper details.*

**Specific editorial comments:**

(Abstract) Line 18: “disprove” is a strong term to use; I’d recommend something like “we demonstrate that this hypothesis is unlikely” or similar.

*The sentence now reads “ We argue against this hypothesis using Schmidt hammer measurements, …”*

Line 89: again change “proof” to “no convincing evidence of such reactivation” has yet been found.

*The wording has been changed as suggested. The last half of the sentence now reads “but no convincing evidence of such reactivation has been found.”*

Line 384: In the same vein, I would say “…difficult to demonstrate that the SJF is an active fault.” You come across as being a little too much in favor of the idea that this is true but the evidence is just wanting, as opposed to more neutral.

*Thank you for the clarification, “prove” has been changed to “demonstrate” as suggested.*

Figures:

Figure 1 – plate motion vector. ITRF does indeed give 19 mm/yr JdF-NA (I checked), but MORVEL is 39 mm/yr. Almost all other studies use the larger value, and I don't think 19 mm/yr is compatible with coastal GNSS data. I don't know what's up with the ITRF model, but I suggest changing this. This is also inconsistent with what the manuscript says at line 42.

*Thanks for checking, this was certainly puzzling when I initially put the plot together. We agree that most studies use the MORVEL value and so have changed the plate motion vector in Figure 1 to the MORVEL 2010 output for the specified point. This is much closer to the 39 mm/yr values that most other studies use. Also updated the value and citation on Line 42 to improve consistency.*

Figure 2. Identify dash-dot line as the international boundary in either caption or key.

*Added an entry in the key for the international boundary.*

Figure 3. To my eye, the red and pink lines in C are a bit too fine and hard to see. Since you have the uninterpreted panel, I think you could bump up the line weight a little.

*I have increased the weight of the red and pink lines as suggested.*

Figure 4. It's not very clear that the words "extent of c" refer to the box around the UPSCARP site (if that's correct); maybe leave these words off and just identify the box as c. The small inset profile in "c" needs scale units for both axes.

*That is correct. The label for the c panel has been updated as suggested. Axes labels have been added to the inset profile.*

Figure 5. Ditto as with Fig 4 on the axes of the inset in C. In C, there is a mapped trace crossing the valley filling fluvial sediments – is there any evidence of activity in these younger seds? In lines 295-296, you state "there are no post-glacial strain markers or piercing points with which to quantify Quaternary or Holocene offsets" – is this an example of positive evidence of no strain of such deposits, or just that the existence of a trace there is unclear?

*Added axes to inset figures in Figure 5.*

*There may be evidence for Quaternary activity in the eastern portion of the SJF, however, as mentioned before, this lidar data was only released as we were preparing to submit the manuscript. Nevertheless, the mapped traces in fluvial deposits are not easy to quantify, and will likely need further work, like geophysics and paleoseismic trenching to determine if quantifiable offsets can be measured across them. This is something we'd like to do in the future.*