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We thank the reviewer for their thoughtful comments and suggestions for our manuscript " Distributed right-lateral strain at the northern boundary of the Quito-Latacunga microblock" that we submitted for publication in *Solid Earth.* This letter contains our responses to the comments and suggestions by Reviewer 2. We paraphrase their comments in bold and follow with our responses and descriptions of relevant edits to a revised manuscript that will be resubmitted for review.

Introduction: this section is well-structured. The only thing missing is more detail in the second paragraph (the state of the art). Please include more about the Neotectonics work done in Southern Colombia/Northern Ecuador over the last 20 years. (You already mention these papers later in the Tectonic Setting and the Discussion sections).
Thank you for your suggestion. We have changed the sentence in the second paragraph indicating that while active faults have been confirmed in southern Colombia, they are not aligned with or that close to the predicted block model boundary.

Tectonic Setting: My suggestion here is to make the material more accessible and easier to digest for the reader that is not familiar with the study area by using subsections to clearly delineate the topics covered (tectonic framework, GNSS, InSAR, instrumental and historical seismicity). For example, the recurring mention of historical seismicity in several paragraphs is redundant and should be streamlined.
We have added subtitles to the sections in the Tectonic Setting section. We are not sure as to what the reviewer is referring to by "recurring mention of historical seismicity" as it is only mentioned in the last two paragraphs (both of which discuss seismicity).

Geologic Setting: The last two paragraphs discussing volcanic and glacial activity are too long and should be simplified and made more concise. Importantly, the manuscript omits discussion of the Romeral Shear Zone (RSZ) (or Romeral Fault System). This system is considered a reactivated suture zone with an origin distinct from the Cayambe-Afiladores-Sibundoy fault system. Since the RSZ is active in the study area through structures like the Buesaco and Aranda Faults. The authors should be clearer about this system and its neotectonics implications throughout the paper.
Thank you for pointing out the Romeral fault zone, we have now included text clarifying its significance as a reactivated structure in the region.

We have also shortened the volcanic and glacial activity section by removing some of the details. The glacial geomorphology section is essential as we are using glacial geomorphologic markers to constrain our slip rates, thus we hesitate to shorten these sections too much.

Methods: As with the Tectonic Setting section, I would recommend the authors split this section into subsections given the numerous techniques they used. Also, more details about cosmogenic dating should be provided (See comments below).
We have added subtitles. See reply to the comments on cosmogenic dating below.

Results: The structure of this section is generally good, but the following points require revision:

I have difficulty identifying the claimed offset moraines or channels based on the DTM and external imagery. Please provide more detailed information on the topography analysis to validate these estimates.
See reply on the offset moraine identification comments below.

To reflect the dating of multiple structures, move the Dating subsection outside of the Reservoir Fault section.
The dating subsection in the Reservoir fault section only discusses dating of the Reservoir fault. Dating of the Polylepis fault is within that section. We have clarified this by adding a "Dating" subsection to the Polylepis fault results.

Include additional details on the Polylepis Fault and the surrounding lineaments, as these features are important for future structural interpretations and neotectonic works.
We have added the new lineament suggested by the reviewer to Figure 8 and have described it in the Polylepis fault section. See reply to comments on the Polylepis fault below for more details.

Discussion: This section lacks an analysis of all the different fault systems present in northern Ecuador and southern Colombia. For example, some of the conclusions about the role of the reactivated suture zones (like the Romeral Fault System) are simplified by citing a paper that describe the tectonics of southern Ecuador, far from the study area.
We agree that more introductory material and discussion is needed on the Romeral fault zone in southern Colombia and have added text that places it in context with our study. The cited paper discussed faulting in Central Ecuador along the eastern boundary of the Quito-Latacunga microblock, which is specifically mentioned as a comparison to our study area. We have edited the text to clarify where this study took place.

The authors propose volcanic inflation as a potential conditioning factor (or triggering mechanism) for the occurrence of the July 2022 earthquake. Nevertheless, no further explanation is provided. A schematic figure would be of great help to strengthen your hypothesis.
This is a good suggestion, however upon imagining a schematic figure we feel that the regional InSAR figure (Figure 3a) is a great reference for our proposed earthquake triggering. We have therefore explained our mechanism further with the following text referring to Figure 3a and have added arrows showing the inflation direction to Figure 3a. These arrows should assist the reader in visualizing our proposed earthquake mechanism.

Detailed comments line by line

Line 15. The right name is Chiles-Cerro Negro volcanic system (there is two volcanoes in this system: Chiles and Cerro Negro). Please revise the manuscript to ensure consistent usage of Chiles-Cerro Negro

Volcanic System (or CCN-VS if you prefer) throughout. For example, in line 153 you refer to it as the Cerro Negro-Chiles Volcano while in line 157 is called the Chiles-Cerro Negro volcanic complex.
Thank you for pointing out this inconsistency, we have edited the term throughout the manuscript.

Line 28. Remove "it" after "...whether deformation..." Line 34. Can you be more specific on these boundaries?
We have removed "it". We are unclear one what you mean by more specific. The locations and the faults that define the boundaries are described and shown in Figure 1.

Line 40. Please make sure the epicenter of the July 25, 2022, earthquake is added to Figure 1. This location is crucial as it highlights part of the motivation for the study and represents the source area for the InSAR analysis you present.
We have added the July 22 EQ epicenter to Figure 1.

Line 60 ("These studies highlight...") feels out of place or disconnected from the preceding text. You attempt to emphasize your motivation, but you should use a better transition or connector at the start of the sentence to improve the logical flow of the paragraph.
We respectfully disagree as the studies in the previous sentence are precisely what we are referring to in this sentence.

Lines 62-63 Please rephrase to be more concise.
We believe this sentence cannot be made more concise without losing its meaning.

Lines 79-80 The area between Ibarra (Ecuador) and Pasto (Colombia) has experienced several historic earthquakes. Please consult the historic seismicity project led by the Colombian Geological Survey (https://sish.sgc.gov.co/visor/). It would be useful to add these additional historic events to Figure 2.
The earthquakes we believe the reviewer is referring to are mentioned in the paragraph on instrumental and historical seismicity.

Line 93. Why is it important or not to identify a sharp gradient in velocities? What would be the implications for the seismic hazard?
A sharper gradient in velocities would suggest more localized crustal deformation. More strain localization could suggest a single throughgoing fault where all the slip is concentrated. Having a single fault versus several faults would affect how seismic hazard is modeled. We have edited the text to explain this point more clearly.

Line 121. Make sure Inter-Andean Valley is consistent throughout the paper (you used Interandean valley in line 6 or Inter Andean Valley in line 129)
Thank you for catching this. We have made edits to be consistent throughout the manuscript.

Lines 128-132. You mentioned three oceanic plateaus but only two terranes: San Juan and Guaranda. Is there a terrane missing? Were not all of them accreted?
There were three terranes accreted but only two are exposed in our study area. We only provided the names of those two terranes.

Lines 137-138. This tectonic interpretation may be valid for Ecuador, but the situation in southern Colombia is complicated by the active suture zones. These zones display extensive evidence (geomorphological, historical, and instrumental) of recent activity, resulting in complex interaction with

the NE-SW structures. The Romeral Shear Zone (or Romeral Fault) is the best illustration of this complexity (see Ego et al., 1995; Paris et al., 2000; Vinasco, 2019; Garcia-Delgado et al., 2022). The Buesaco and Aranda faults that are mentioned in lines 77-78 for the first time are part of the Romeral system and represent reactivated segments of the sutures zones between oceanic and continental blocks (see Paris et al., 2000; Tibaldi and Romero, 2000).
See response to comments above on the Romeral fault system.

Line 144. Remove the extra parenthesis when calling Fig 2. Line 176. Please Correct Colmbia.
We have made the suggested edits.

Line 177. The provided URL leads to the webpage of the Colombian Geological Survey, not the specific data repository for the DTM. Please provide a direct link to the data service or repository so that the metadata can be properly verified.
We have now provided the DTM in the supplemental data repository linked to this manuscript.

Lines 196-199. Was this issue related to the way the Pleiades DTM is modeled? Were the moraines too small?
This issue is unrelated to the DTM, as it is a function of the large width, subtle crests, and undulating topography of the lateral moraines (as mentioned at the end of the paragraph).

Lines 203-206 The description of the exposure dating techniques is insufficient, especially considering their importance in supporting the manuscript's interpretations. Please expand this section to provide details, including the fundamental assumptions underlying the exposure dating method (e.g., nuclide production rates (spallogenic and muonic), shielding, erosion history). Specifically, the authors must clearly outline the assumptions, the mathematical formulations, and the sources and magnitude of uncertainties behind the reported ages.
The cited papers in the methods section provide the requested details about the dating technique and we believe that rewriting these methods would be redundant.

Lines 205-206. Did you consider complex burial/re-exposure history? What field evidence do you have to reject this scenario?
This is a good point. The selected samples were fresh with little to no alteration therefore we made the assumption that there was little to no exposure before weathering and erosion. We now state this assumption in the methods section. However, a complex burial/re-exposure history is still very much possible, and may explain the very old age of the boulder on the moraine near the Polylepis fault, which we state in the Polylepis dating section.

Lines 219-220. Please provide more details about this assumption. What corrections are needed if all measured He4 is magmatic in origin?
This assumption is based on the young ages of the samples not allowing for significant build-up of radiogenic and nucleogenic He.

As we assumed the He^4 we used a $^3He/^4He$ ratio of 5 Ra (Ra = 1.384±10-6 being the atmospheric ratio) to correct the measured ^3He concentrations (Line 242 of the original manuscript and Blard et al (2013) *EPSL* for more information).

Lines 284-294. The offset moraines and channels mentioned are not visually apparent in Figure 5 or verifiable using independent satellite imagery (like Google Earth Pro). Please provide more detailed information on the methodology used to project the moraine ridges onto Figure 5c so that these features can be verified.
We believe that we show a good example of an offset moraine in Figure 5c. The projections were estimated using a best fit to the break in slope at the moraine crest as indicated by contour lines extracted from the Pleiades DTM. We have edited the methods section to explain this in more detail. The offsets are not clearly visible in Google Earth due to its lower resolution, which is why we obtained the Pleiades dataset. We have now made the Pleiades DTM and our selected moraine projections (shapefile) available in the supplemental data repository associated with this manuscript so it is available for an independent interpretation (see Data Availability section for link).

Figure 5. Can you color the slope maps in panels C and D?
Thank you for the suggestion. We tried changing the slope map to a colour scale, but this change makes it more difficult to see the other layers of the map.

Figure 7. This is a really nice Figure!
Thank you!

Line 375 Grammar "...of the of the fault exposures..."
Good catch, we have made the suggested edit.

Section 5.4 After carefully inspecting Google Earth, one can notice that the area of the Polylepis Fault is made by more than one structure that would be worth including in your Figure 8. The new imagery provides a better contrast to aim in the identification of the fault traces.
Thank you for pointing this out, this is a great observation. We have now included this new fault segment in our Figure 8 and describe it in Section 5.4. We have kept the old imagery as it shows the main structure.

Line 399. Remove "...more..." to avoid redundancy
Removed "more".

Line 400. Why are these structures considered fault systems? Also, uou mention three fault systems but only two faults: Polylepis and Reservoir.
We have edited the text to say "faults" instead of fault systems. We now explicitly mention the July 25 fault as well.

Line 403. Shouldn't the two faults be one fault system if that's the case?
See above response.

Line 404. How did you define the width of the fault zone?
We are just defining the width of the three parallel faults here. The perpendicular distance between the two furthest apart faults.

Line 405. What do you mean by right-lateral strain?
We are referring to the 3 mm/yr of strain modeled in the geodetic block model. We have edited this sentence to make this clearer.

Lines 406-407. As mentioned above, please consider my comments on the offset features and the uncertainty around the interpretation of recent displacements along the Reservoir Fault.
We believe by placing a very large uncertainty on our offset measurements, and using a wide range of ages for lateral moraines, we are adequately constraining the uncertainty in our slip rate estimations.

Line 416. This is the first time you mention the July 25 fault in the main body of the manuscript. Please ensure the fault is named and described consistently upon its first relevant mention. Furthermore, I suggest replacing this name with a geographically significant name to facilitate referencing.
Thank you for your suggestions. The fault in this case was delineated using the InSAR surface rupture. We agree that this was not clear in this section previously and we now explicitly mention its name here. We have kept the name "July 25 fault".

Line 418. You didn't calculate strain rate but slip rates. Please review the article to avoid mixing concepts such as slip rate and strain rate, which are not the same.
Thank you for pointing this out. We have changed "geologic strain rate" to "geologic slip rate"

Lines 420-423. An examination of the mapped structures and your interpretation (Fig. 2) suggests a plausible southern extension of the Romeral Shear Zone (Buesaco and Aranda faults). Specifically, lineaments southwest of the Galeras volcano (potentially belonging to the Cauca-Patía system?) appear to show a southward prolongation, possibly merging with the Reservoir and Polylepis Faults. Given that both the Cauca-Patía and Romeral structures are right-lateral faults, their regional kinematics align well with the mapped structures in the study area. If this is true, it poses a significant tectonic implications: this extended zone may delineate either a separate, unmapped microblock or represent the northern boundary/extension of the QL microblock.
Great point. We do consider that these structures may be the northern boundary of the microblock in Figure 9 of the discussion. We have added the fact that they are likely reactivating basement structures in a new paragraph in the Discussion section.

Lines 428-430. This interpretation is out of place because it hasn't been developed before. Only in section 6.2 you discuss the potential influence of the CCN-VC.
We have added "see section below for further discussion" to point the reader to where they can be introduced in detail to our interpretation. We also cite two papers as examples.

Lines 437-443. The role of volcanic inflation should be more elaborated since it's a key conditioning factor for the triggering of the July earthquake. It'd be helpful to see that on a map or a new schematic figure.
See reply to comment on volcanic inflation below.

Lines 441-442. I'd recommend to remove this interpretation about the 1868 earthquake since its speculative.
We have edited the sentence in question to say "We **speculate** that the larger M 6.6 1868 earthquake also been related to volcanism at Chiles-Cerro Negro as volcanic activity was reported around that time".

Line 456-458. The presence of thick volcaniclastic deposits inherently presents significant difficulty in observing recent faulting. Consequently, the lack of clear surface expression through the sedimentary cover does not preclude the underlying structure from being active. For example, you didn't observe a rupture for the July 25 earthquake. So the same reasoning should be valid for the N-NE suture zones.

We agree that there are probably active structures that we cannot observe given the thick volcanic deposits. However, we can only discuss the results that we observe, and we did not make observations of major reactivated N-NE suture zones in our study.

Line 458. Please refer to my recommendation and include in your analysis the Romeral and Cauca-Patia fault systems which in southern Colombia are considered tectonically active. The Buesaco and Aranda faults are part of the Romeral fault system (or shear zone depending on the authors).
See response above to comments on the Romeral fault system.

Lines 462-465. Please rewrite this section as the current discussion is unclear. Furthermore, to support the proposed earthquake conditioning factors, please add a figure showing the modeled horizontal stress field from the CCN-Vc and its orientation relative to your mapped fault structures.
We have modified our interpretations and rewritten the section on how volcanic activity may affect earthquakes on the studied fault. We still interpret that eastward directed motion of the crust away from the Chiles-Cerro Negro volcano would induce northwest--southeast shortening near the July 25 fault, thus promote right-lateral earthquake. However, given the different locations and orientations of the Reservoir and Polylepis fault, we suggest that inflation or deflation may play a different role in earthquake triggering, potentially through an increase in pore fluid pressure (e.g. Ebmeier et al., 2014).

Line 470 Avoid contractions (don't)
Edited.

Lines 488-494. I'd recommend to keep only the radiocarbon-based paleoearthquake estimates for the Reservoir Fault. The moraine and cosmogenic 3He estimates are too vague; their 2σ uncertainty (2 kyr) is too large to constrain the recurrence interval defined by the radiocarbon dating.
We only use radiocarbon dates to define earthquake ages and recurrence intervals in this study. We use the cosmogenic ages to confirm that the mapped moraines were most likely from the LGM and we then use them combined with the published range of ages for the LGM in this region in our slip rate calculations. We believe that this appropriately constrains the uncertainty in moraine age for these calculations.

We thank the reviewer for their comments and suggestions, we believe they have greatly strengthened the manuscript.

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