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We thank the Dr. Sam Wimpenny 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 the reviewer. We paraphrase the reviewer's comments in bold and follow with our responses and descriptions of relevant edits to a revised manuscript that will be resubmitted for review.

Review by Dr. Sam Wimpenny:

Consider emphasizing the poor constraints of the block model boundary from the GNSS velocities...I would recommend highlighting this to motivate the manuscript, as where shear strain is being accommodated is poorly known. ...– strain fields are almost always accommodated by multiple faults within continental lithosphere, particularly within mountain belts [McKenzie 1978].

Thank you for this suggestion. We agree that not only are the structures that accommodate deformation not well understood, that the actual boundary location itself is not well constrained. We have edited the following sentence in the introduction to emphasize this point: "However, the location of the northern edge of the Quito-Latacunga microblock and any structures that accommodate deformation predicted here have not been well constrained, especially at the scale of this study."

We also note the uncertainty in the boundary location due to the low density of GNSS stations in the study area in the Tectonic setting section.

Interpretation of distributed deformation in the InSAR data: I would recommend more clarity regarding what is meant by "distributed deformation" in Section 5.1. Some people use "distributed" to mean inelastic off-fault deformation [e.g. Milliner et al., 2025]. Here it is being used to mean any displacement around the fault that is not related to slip that reaches the surface.

We agree with the need to clarify what we mean by distributed deformation in this section and we have added the following sentence to do so:

"This 13 cm of total surface deformation includes any displacement along the fault that did not rupture the surface, and/or inelastic, off-fault, deformation in the area around the fault".

Additionally, we have checked all instances where we mention distributed deformation and ensured it is clear that we are referring to deformation across several fault zones.

Consider adding some reflection on how precise the radiocarbon dates are given they are based on bulk sampling: The authors should consider: (1) describing what organic material think they were dating within the bulk radiocarbon samples, and (2) reflecting on what the true uncertainties may be on these stratigraphic dates that are not captured by the formal lab-based uncertainties. Many studies assume a (conservative) ~1 kyr age uncertainty from bulk sampling because of the effects of bioturbation and root penetration meaning that organic matter does become mixed throughout the stratigraphy [e.g. Grutzner et al., 2016]...

We thank the reviewer for this constructive point and have added the following text in the Methods to discuss the uncertainty in our sampling strategy some more.

"The majority of our samples were collected from Páramo soils (Andisol), which have very high organic carbon content. Their low bulk density, high porosity, and humic/dark nature make them comparable to peat-like soils or organic-rich soils. Because of these properties, small-volume, focused sampling can retrieve sufficient organic carbon for radiocarbon dating, reducing the risk of time-averaging or mixing compared to bulk sampling in low-organic, mineral sediments. The high organic content and relative stability of organic matter in Andisol under cold, humid conditions at ~4000 m reduces decomposition and thus preserves carbon, making them good candidates for radiocarbon dating. These types of samples have been shown to provide reliable radiocarbon ages in previous paleoseismic studies in similar environments along the Pallatanga fault zone (Baize et al., 2015, 2020) and the Billecocha fault system (Jomard et al., 2021) An identical sampling strategy resulted in precise historical ages matching with the 1797 earthquake in Pallatanga area (Baize et al., 2015). Nevertheless, we acknowledge that post-depositional processes such as bioturbation and root penetration could introduce additional uncertainty that is not fully captured by the laboratory-reported analytical errors (e.g., Grützner, 2015). Additionally, our samples could be detrital giving ages that are older than the unit they are located within. This is especially the case for samples from colluvial wedges (e.g., DuRoss et al., 2022). Therefore, we assessed each sample and date and discounted dates that were likely to be affected by bioturbation and re-sedimentation.

Finally, we note that although our radiocarbon ages do not have an arbitrary uncertainty imposed on them as suggested, the units they are dating all have age ranges greater than 1000 years. Additionally, our earthquake event ages span ~800, 1500, and 1400 years. Thus, while we have kept the analytical uncertainty, we believe our method of interpretation has not overly constrained the unit or earthquakes ages.

Line-by-Line Comments

Line 28: Grammatical error "…whether deformation it is focused or…."

Edited.

Line 30: "Shear zones…" are particular structural geological structures in my eye – maybe consider rephrasing to "further characterise the distribution of faulting that accommodates deformation in the upper crust"?

We have made the suggested edit.

Line 46: No comma in "with the recent rupture, reveals…"

We have made the suggested edit.

Line 48: Comma missing from "…faults lie within the proposed epicentral area, and could be responsible for, the 1868 M 6.8 …"
We have removed all commas.

Line 48: Not sure this sentence makes sense to me: "By placing this study in context with …" – the study *is* the context as far as I can tell.
We have changed "this study" to "these results" to clarify the sentence and have cited the "parallel faults in Colombia" to emphasize that these are based on previous results.

Line 50: Would be worth stating quantitatively here what you consider "wide zone" to be? Is that 20 km or 200 km?
We have added "an ~70-km-wide zone"

Figure 1: Figure caption says "strain rates from Jarrin…" but you're showing slip rates across block boundaries and not strain rates.
We have changed "strain rates" to "slip rates"

Line 71: Grammatical error "…faults along strike to the north-east that transverse…"
Northeast is not hyphenated in American English, which we are using in this manuscript.

Line 78: Consider rephrasing to: "…show 0.7-1.6 mm/yr and 1.1-2.6 mm/yr of right-lateral reverse slip across the Buesaco and Aranda Faults, respectively."
We have made the suggested edit.

Line 81: Consider rephrasing to "A southward decrease in the eastward component of the GNSS velocities across the northern boundary …. consistent with right-lateral shear strain on ENE-WSW striking planes predicted …" – more precise about the velocity gradients and relation to inferred strain field.
We have made the suggested edit.

Line 88: Worth being explicit that you're saying that the GNSS velocities with ~20 km of Chiles may capture transient volcanic deformation rather than velocities that are representative of the long-term tectonic deformation. As written, it could sound like *all* GNSS velocities may reflect volcanic deformation.
We have made the suggested edit.

Line 92: Consider rephrasing "… Colombia provides higher spatial resolution measurements of deformation aross the norther …"Line 94-95: You would only expect sharp velocity gradients across faults creeping near the surface or where there had been recent earthquakes. A gradient in the velocity over ~20 km is entirely consistent with there being elastic strain accumulation around a single fault which is locked in the top ~15-20 km of the crust [e.g. Wright et al., 2001], so could well be representative of a block boundary.
Thank you for bringing this to our attention. The width over which the InSAR shows a reduction in velocities is over ~60 km, not 20 km, so we have corrected that.

Line 98: Should be "analysis" not "analyses" as it's singular.
We have made the suggested edit.

Line 105-107 and Figure 2: I would recommend providing the hypocentral locations of earthquakes alongside with the focal mechanisms of the larger events (Mw > 5) in Figure 2 if there are any. The focal mechanisms are key information as well for how the present-day strain field is being accommodated by faulting.
Good suggestion. We have added focal mechanisms for all EQs (Mw>4.5) since 1980 in the map area. Some have a non-double couple component indicating volcanic origins.

Line 115-119: Worth emphasising somehow that the earthquake was triggered, but that the total amount of strain generated by the episode of volcanic inflation was too small to account for the amplitude of fault slip. Therefore, there is probably tectonic strain accumulation in this area too, not just faulting entirely driven by magmatism. This means that the mechanism of the event should be related to the wider tectonic setting, rather than the local strain field caused by volcanic inflation/diking.
Thank you for this suggestion. We have added the following text to emphasize the potential tectonic origin of the stress: "InSAR and Coulomb stress modeling suggest that this earthquake could have been induced by inflation south of the volcano that could be attributed to volcanic inflation and a pore fluid pressure increase. However, its focal mechanism is consistent with tectonic stress and volcanism could potentially be just a trigger of the earthquake."

Section 3: Do you need this section? The information about Quaternary glaciation and landscape is important for understanding the sediments within which scarps are preserved, but could come in the Intro or section on fault-related geomorphology. The bedrock geology component seems overly detailed to me and the reader gets a little distracted here. I understand that later you compare the trends of the active faults with those within the bedrock geology, but that can simply be stated with citations later.
The relationships between active faulting, glacial geomorphology, volcanism, and inherited bedrock structures are discussed in detail in the Discussion of our manuscript. We feel that this information is essential to introduce and this section is the place to do so. The second reviewer suggested more detail in the bedrock geology section, but shortening of glacial and volcanic activity paragraphs, and we chose to follow their advice as it was one of their main comments.

Line 171: Cite the filtering approach – has someone else tested this carefully? If it's new here, then it needs explaining in more detail. What type of filter are you using?
This filtering approach has been described and tested in Marconato et al., 2024 (https://doi.org/10.1016/j.srs.2023.100113). We filter the interferogram with a standard sliding median, in order to smooth out part of the strong phase gradients resulting from earthquake displacements. Removing the gradient in the sliding window prior to filtering and reintroducing it after helps preserve the coseismic fringes.

We have added the Marconato et al., 2024 reference to our manuscript.

Line 172: Explain what unwrapping method you used? Did you not bother unwrapping the Sentinel-1 interferograms (why not)?
We used a region growing algorithm (we have added this text to the manuscript).

We unwrapped the Sentinel-1 interferogram as well but the unwrapped ALOS-2 is cleaner. We have now included two unwrapped Sentinel-1 interferograms in the data supplement.

Line 185: Missing bracket closure around link.
Added bracket.

Line 193-194: Were you specifically projecting the lateral moraine crests?
Yes we were specifically projecting the moraine crests, which were mapped based on hillshades, slope maps, and topographic contours. We now provide some more detail on this methodology in the methods section.

He-3 Cosmogenic Dating: Is sample erosion a factor in influencing the exposure age (this is not mentioned)? Do the authors account for this in the uncertainties on the estimated dates, or do they assume negligible erosion? Is there field evidence that supports this assumption?
The cold climate and unaltered appearance of the basalt boulders suggest little chemical weathering allowing us to assume that sample erosion is negligible. We now state this in the manuscript.

Line 266: How many kilometres wide?
Thank you for catching the typo. It should read ~15 km-wide**.**

Line 273-274: Strikes should be quoted in 3 figures (060-070) as they're azimuths.
We have made the suggested edit.

Line 292: Spelling error "…and then displaces the stream along …"
Good catch!

Line 297: Correct grammar of this sentence: "Additionally, the undulating terrain relatively minor vertical …"
Edited.

Section 5.3: Looking at the terrain topography, have you tried creating structure contours for the fault to constrain its dip? It looks like it should be near vertical by the way it cross-cuts the topography in Figure 5b, but it is a simple exercise and would add evidence to support the inference that the faults are likely mostly strike-slip.
Yes, we did attempt to construct contours at locations where the fault crosses the glacial valleys. The individual fault segments here are subvertical, or dip steeply north suggesting strike-slip structures.

Figure 6 & 7 order: Figure 6 is only briefly mentioned before an extensive discussion of the observations in Figure 7 – consider switching the order in which these appear in the text so the reader doesn't jump backwards and forwards between figures.
This is a good suggestion but we believe that Figure 6 is the best place to fit in the scarp photo, and it should be presented before the outcrops.We have switched the order of the outcrop descriptions so the outcrop in Figure 6 is described first and therefore is closer to the figure in the paper.

Line 309: Should be "WSW-ENE-striking fault zone" based on Figure 5.
Thank you for catching that typo.

Line 311: Spelling "…narrows to a single strand…"
Edited.

Line 338: Avoid starting sentence with "~" – just use the word "Approximately".
Edited.

Line 348: Grammar "… the the…"
Edited.

Line 366: "Assume it is recycled" – more specifically you assume that the colluvial wedge contains sources of organic matter that are recycled and have been transported into a fracture. Could make this clearer in the text.
Thank you for your suggestion. We have changed the sentence to read: "Because of this age discrepancy and the observation that #39 is part of a colluvial wedge (CW2), we assume that this sample has been recycled and has been transported into a fracture."

Section 6.2: It is unclear to me whether volcanic deformation would cause accelerated strike-slip faulting over the long term (i.e. ~10 kyrs) because it would require the strain from volcanic deformation be translated predominantly into permanent right-lateral strain on ENE-WSW trending planes. Volcanic deformation related to magma intrusions (dykes, sills, spherical magma reservoirs) induces dominantly vertical displacements [Okada et al., 1985; Yang et al., 1998], and therefore dominantly dip- slip faulting [Rubin 1998]. Consider reflecting on whether this mechanism is mechanically feasible and consistent with the (absence of) evidence of dip-slip faulting.
Thank you for making this point. We agree that it likely wouldn't increase long-term slip rates, but volcanic unrest may increase the short-term slip rate due to an increased number of earthquakes during volcanic activity.

Given the shallow inflation (as evidenced by shallow seismicity) and the clear westward and eastward crustal motion away from an area immediately south of Chiles, we feel that strike-slip rupture would be mechanically feasible. Volcanic inflation has been shown to induce strike-slip earthquakes at the Makushkin volcano in Alaska (Chang and Grapethin, 2024). It is beyond the scope of this manuscript to test our suggested trigger with a rigorous coulomb stress model, but this would be a great follow up study. We have added text to section 6.2 to explain this and have referenced Chang and Grapethin (2024).

Line 470: Change "don't" to "do not".
Edited

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

Nicolas Harrichhausen et al.