This study presents the crust and upper mantle velocity structure extending from the North Qilian to the Beishan block and discusses the tectonic significance of the observed crustal deformation. The newly acquired dataset, a 460-km-long seismic wide-angle and refraction profile, appears to have been carefully collected and processed, and provides valuable insights into the deep lithospheric structure of the region. The manuscript would benefit from careful English editing to improve clarity and readability. In particular, some expressions are overly colloquial and should be revised to meet the conventions of scientific writing. I hope these comments are helpful and contribute to improving the overall quality of the manuscript.

Response to Reviewer Comments

We thank the reviewer for the thorough review and constructive comments, which have significantly helped improve the quality of our manuscript. We have carefully considered all points raised. Our point-by-point responses and the planned revisions are detailed below.

We acknowledge the comment regarding the need for careful English editing. We thoroughly revised the entire manuscript to improve clarity, readability, and adherence to the conventions of scientific writing. This includes correcting colloquial expressions, improving grammatical accuracy, and ensuring a formal tone throughout.

Q1: In lines 58–66 of the introduction, the text appears to summarize the main conclusions of the study. It may be more appropriate to move this content to the conclusion section.

Response: Agreed. We reorganized the "Introduction" section (lines 48-95), and deleted the summary of the main conclusions from the introduction (lines 95-143). The introduction was revised to maintain its focus on presenting the research problem, context, and objectives.

Q2: The manuscript states that the crustal-upper mantle structure remains ambiguous due to limited resolution. Could the authors clarify the actual resolution of the present data and indicate whether it is higher than in previous studies? Additionally, please specify which aspects remain unresolved and how this study's findings differ from prior work.

Response: Our data provides higher resolution of velocity structure in the same study area. Compared to the "Golmud-Ejin" wide-angle reflection and refraction profile acquired in 1992, we used dense shot interval and station spacing, and higher yield explosive. The geophones we used are much more sensitive to the seismic waves than the ones before (the detailed parameters are shown as follows).

The sentences "Nevertheless, the crustal-upper mantle velocity structure remains ambiguous because of the wide shot and receiver spacing and the relatively weak

explosive sources inherited from the earlier, lower-resolution acquisition design (Cui et al., 1995).” Explained the reasion (lines 85-88)

Seismic profile	Shot interval	Station spacing	TNT	Record medium
Golmud-Ejin	80-200 km	4 km	1.5 T	Tape
This study	40-60 km	2-3 km	1.5-3 T	Digital

Q3: Please note that in scientific writing, en dashes (-) rather than hyphens (-) should be used to indicate numerical ranges (e.g., 0.3–1.0 km/s). Please pay attention to the use of definite articles (e.g., ‘the’) to improve grammatical accuracy. Additionally, check the capitalization of all proper nouns, including geographic names, tectonic units, and geological terms, and maintain consistency throughout the manuscript.
Response: We performed a thorough check and correction of the entire manuscript to: 1) replace all hyphens with en dashes in numerical ranges, 2) carefully review and correct the use of definite articles ('the') for grammatical accuracy, and 3) standardize the capitalization of all proper nouns and ensure consistency throughout the text. (line 406)

Q4: In the “Crustal Velocity Structure Implications” parts, how does this velocity value inform the structure implications? Providing explicit links between the velocity data and geological implications would strengthen this section.

Response: We considered that placing the “Crustal Velocity Structure Implications” between the “Velocity Structure” and “Discussion” sections was somewhat structurally unconventional. To improve the logical flow of the manuscript, this subsection has been integrated into the “Introduction” section. (line 393-397)

Q5: “The crustal velocity structure proposes an unusual scenario where the deepest Moho is found in the central Jiuquan basin, rather than the North Qilian Shan with the highest elevation. Could you explain it in the manuscript?

Response: Yes, we have carefully considered this observation. We propose that the North Qilian Shan and the Jiuquan Basin share a common basement, which explains their comparable Moho depths. Although the Moho beneath the Jiuquan Basin is slightly deeper, the North Qilian Shan exhibits a higher surface elevation, indicating a significantly thicker crust overall when topographic compensation is taken into account.

The sentence “These characteristics indicate that the NQS and the Jiuquan basin share a consistent basement structure, which aligns with the findings from residual gravity anomaly analyses (Yang et al. 2024).” explained the reason. (lines 330-333)

Q6: The conclusion section currently shows formatting inconsistencies and incorrect numbering. A careful revision is recommended. Furthermore, restructuring the conclusions to more clearly highlight the key scientific findings would enhance the clarity and impact of this section.

Response: We carefully reformatted the conclusion section to correct numbering and formatting. We also restructured it to concisely and clearly list the key scientific findings first, followed by their broader implications, thereby enhancing the section's clarity and impact. (lines 667-680)

Q7: It is suggested that the formatting of both in-text citations and the reference list be revised and standardized to ensure consistency with the journal's guidelines.
Response: We meticulously revised the formatting of all in-text citations and the reference list to ensure they are complete and fully consistent with the specific guidelines of the target journal. (Line 706)

Detailed Comments and Corrections:

- **Line 21: "five strata" → "five layers"**

  "five strata" was changed to **"five layers"**. (Line 25)

- **Line 35: Before using the simplified CAOB, it's better to add it in Line 35 after the "Central Asian Orogenic Belt".**

  The simplified acronym **CAOB** was added in parentheses after its first full mention: **"Central Asian Orogenic Belt (CAOB)"**. (line 55)

- **Line 42: Figure 1b → Fig. 1b**

  "Figure 1b" was changed to **"Fig. 1b"** (and consistency for all figure citations was checked). (Line 160)

- **Line 61: Removing the excess space before "Notably".**

  We reorganized the introduction; the sentence was deleted. (line 116)

- **Line 69: "In Cenozoic" → In the Cenozoic or during the Cenozoic.**

  "In Cenozoic" was changed to **"In the Cenozoic"**. (Line 155, line 453)

- **Line 73: "of NE Tibet" → "of the NE Tibet"; please check and correct similar expressions throughout the manuscript.**

  "of NE Tibet" was changed to **"of the NE Tibetan Plateau"** (and similar expressions throughout the manuscript were corrected). (Line 65, line 71, line 74, line 449)

- Line 78: Removing the excess space.

  We reorganized the introduction, the sentence was deleted. (lines 133-143)

- **Line 80: HUANG et al. 2014 → Huang et al. 2014**

  "HUANG et al. 2014" was changed to **"Huang et al., 2014"** (and citation formatting was standardized). (Line 84)

- **Line 82: a N-S-trending → an N-S-treading**

  "a N-S-trending" was changed to **"SW-NE-trending"**. (line 88)

- **Line 96: Delete "respectively".**

  The word **"respectively"** was deleted as suggested (line 177).

- **Line 99: Please clarify the meaning of "the final sealing position."**

The term **"the final sealing position"** was changed to "**amalgamation position**" to express the eaxt meaning. (line 116)

- **Line100：North Beishan block → North Beishan Block; in middle-late Ordovician>> in the Middle to Late Ordovician.**

  "North Beishan block" was capitalized to **"North BOC"**. (line 181)

  "in middle-late Ordovician" was changed to **"in the middle to Late Ordovician"** (line 182).

- **Line 131 What's the meaning of "TNT"?**

  The meaning of the acronym **"TNT"** was refered to "**Trinitrotoluene**", which was upon its first use in the manuscript in line 217.

- **the travetime of ZB1→ The travetime of ZB1**

  We reorganized this sentence, which now is "**The travetimes recorded at shotpoint ZB1**…" ((line 244-245)

- **Line 159: Delete repeated parentheses.**

  The repeated parentheses were deleted (Lines 259-260)

- **Lines 168–172: P1–P4 are not shown in Fig. 5; please clarify or adjust the text accordingly.**

  P1-P4 are actually C1-C4, we corrected this mistake. The revised sentences are "The typical continental crust is stratified into three principal layers: the upper crust, comprising sedimentary cover overlying crystalline basement characterized by an average P-wave velocity of 6.0–6.3 km s^{-1}; the mid-crust, composed of interleaved silicic and basic lithologies, with velocities of 6.3–6.5 km s^{-1}; and the lower crust, dominated by more mafic assemblages, exhibiting velocities of 6.6–6.9 km s^{-1} (Christensen, 1995; Jia et al., 2019). Based on our velocity structure result, the crust can be divided into upper crust (from the surface to C2), middle crust (from C2 to C3), and lower crust (from C3 to the Moho). The upper crust can be separated into two layers by intracrustal interface C1 determined by seismic phase P2. The lower crust can also be subdivided into two layers by intracrustal interface C4 indicated by seismic phase P4." (line 282-286)

- **Lines 239–244: Specify which figure corresponds to this phase.**

  We put the figure 5 behind the sentence, which is as "The upper mantle velocity structure exhibits distinct lateral variations across the study area (Fig. 5). (line 382)

- **Line 254: Text formatting is inconsistent; please revise.**

  The sentence was revised as "To improve the visibility of the velocity heterogeneity of the crustal-upper mantle structure the mean layer velocities are subtracted to produce a velocity anomaly structure of the crustal-upper mantle (Fig. 6). "(lines 399-403)

- **Line 258: -1.1–-0.15 km/s → -1.1 – -0.15 km/s or "ranges from -1.1 to -0.15 km/s"**

  Line 258: "-1.1—0.15 km/s" was corrected to **"-1.1– -0.15 km s^{-1}"**. (line 406)

- **Line 281: The text formatting is not standard.**

  The sentence was revised as "The BOC is characterized by a strong positive velocity anomaly (0.02–0.12 km s^{-1}) and exhibits a northward-increasing trend (Fig. 6)." (line 428-429)

- **Line 310: Consider deleting the semicolon (";") and revising lines 310–313 for clarity and grammar.**

  The sentences were revised as "Although previous geophysical investigations have covered the Qilian Shan (Xiao et al. 2016; Guo et al. 2019; Shen et al. 2020; Li et al. 2021), focus has largely been on the neotectonics rather than the Paleozoic evolution. In this study, we observed north-dipping velocity contour from interface C2 to the uppermost mantle beneath the Qilian Shan, coupled with a lower-crust–upper-mantle low velocity anomaly beneath the Hexi Corridor (Fig. 6). These features most plausibly record early Paleozoic north-dipping subduction of the Qilian Ocean, which aligns with the surface geology; later collisional or bidirectional shortening may have locally overprinted the original polarity (Davis and Darby, 2010)." (line 484-491)

- **Line 345: The abbreviation "Mts." is informal; use "Mountains" instead. Line 347: The comma should be deleted.**

  The informal abbreviation **"Mts."** was replaced with the full word **"mountain belt"**. (line 476)

- Line 347: The comma should be deleted.

  We have thoroughly reviewed the manuscript and made corrections to all punctuation errors throughout.

- **Line 371: How is the decoupled crust inferred from the seismic profile in this study? Or is this based on previous studies? Please clarify.**

  The **decoupled crust** was interpreted based on our seismic profile, the base of interface C1 is acting as the decollement as shown in the Fig. 5. ("correlate to

the north-vergent thrusting that decouples from a co-thickened middle-lower crust (25–50 km, 6.5–6.8 km s^{-1}), which is consistent with the reflection structure (Xiong et al., 2025).” (lines 518-520)

- Figure 5 & 6: Letters (a) and (b) are not shown on the figures. It is suggested to mark the north (N) and south (S) directions for clarity.

  Given that Figures 5a and 6a are not referenced in the main text, we have omitted the subplot labels (a) and (b) from Figures 5 and 6. Accordingly, all citations of these figures in the manuscript have been updated from “Fig. 5b” to “Fig. 5” and from “Fig. 6b” to “Fig. 6” to ensure consistency. **Northeast (NE) and Southwest (SW) directional indicators** was clearly marked on the figures for orientation. (line 1103, line 1107)