

## The Response to Comments from Anonymous Reviewer

General Comments
<p>The manuscript has some linguistic deficiencies, particularly translation issues, which are discussed in more detail in the technical corrections. To improve the flow of reading, it is recommended to summarize some of the many short sentences. It is advisable to have a native speaker proofread the manuscript.</p> <p>The abstract provides a concise summary of the manuscript. The discussions are not well structured and difficult to follow, while the summary is more clear.</p> <p>The manuscript may be accepted after major revision, based on the following comments.</p>
<p><b>Response</b></p> <p>We appreciate you very much for your positive and constructive comments on our manuscript. We have fully revised our manuscript and have addressed all of your comments. All the revisions have been addressed in the revised manuscript shown in red. The manuscript has been revised by native English speaker to improve the grammar problems and readability, and clarify our ideas.</p>
Specific comments
<p><b>Comment 1</b></p> <p>L15: the detail about the mud-phyllite in T3 is not of interest in the abstract.</p>
<p><b>Response 1</b></p> <p>Thanks for your comment. We deleted this sentence in the abstract.</p>
<p><b>Comment 2</b></p> <p>L21: You are rounding every age in this paragraph except for 9.35ka.</p>
<p><b>Response 2</b></p> <p>We would like to thank you for pointing out this issue.</p> <p>Considering these ages obtained from the OSL method, we rounded the ages of all phases as:</p> <p>Phase I is 32 ka, Phase II is 27 ka, Phase III is 27~17 ka, Phase IV is 17 ka, Phase V is 10 ka, and Phase VI is 9 ka.</p>
<p><b>Comment 3</b></p> <p>L39: Please mention the studies.</p>
<p><b>Response 3</b></p>

Thanks for your comment. We have cited relevant studies on L41-43.

Currently, there are few studies on the influence of disaster events on the formation and evolution of terraces (*Chen et al., 2016; Hu et al., 2018; Montgomery et al., 2004; Xu et al., 2020; Yuan and Zeng, 2012; Zhu et al., 2013*), and further exploration is advisable.

#### **Comment 4**

L64-65: "might need to be further studied" and "should be considered" appears indecisive.

#### **Response 4**

Thanks for your comment.

We modified this sentence: "*Due to the lack of sedimentary sequence and chronological data, further study is needed on the evolution of palaeo-dam and the causes of terrace formation. The roles of tectonic activity, climate, river blockage and outburst events are crucial for discussing the formation of terrace staircases.*" on L67-70.

#### **Comment 5**

L95: Do you mean "alpine erosion landform" ?

#### **Response 5**

Thanks for your comment. Yes, we mean "alpine erosion landform", and we modified it on L101, as follows:

It has a typical *alpine erosion landform* with an 1868-4800 m elevation.

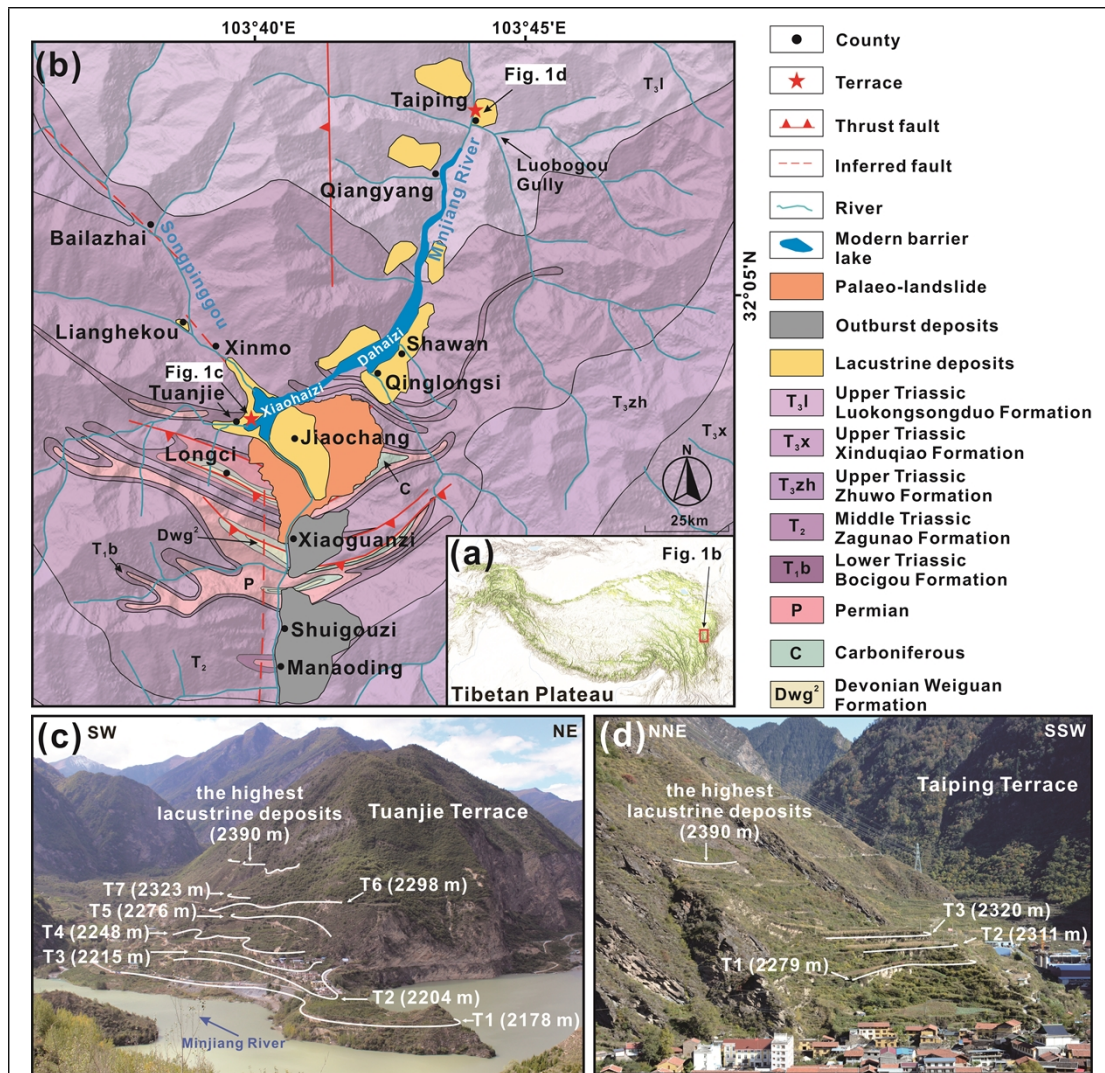
#### **Comment 6**

Fig 1: The symbols on the map for the study area and county are not clear. It is difficult to understand the geological formations from the map. The villages on the map c & d might not be at their correct locations, a directional arrow can help here.

#### **Response 6**

Thanks for your comment.

We bolded the lines in Figure 1b to clarify the boundaries between the strata. We changed the font color for Xiaohaizi and Dahaizi, and added arrows to indicate their locations. Additionally, we added three inferred faults, which we overlooked before. In Figures 1c and 1d, the term "village" is replaced with "Terrace" to better reflect the theme of this manuscript.



**Comment 7**

L122-123: This assumes that the terrace levels are increasingly younger the higher they are, which is not the case. I suggest not using the phrases "oldest" and "youngest".

**Response 7**

Thanks for your comment. We sincerely appreciate the significant suggestions. We deleted this description, and rewrote it on L127-128, as follows:

*These terraces are named in order of Terrace 1 (T1) to Terrace 7 (T7) from bottom to top.*

**Comment 8**

L139: Why did you take OSL samples from different units? In my opinion, this immediately introduces a problem of water content and dose rate. It is good as an age check next to another sample from the same terrace, but I find it a bit difficult this way. And what about T6?

**Response 8**

Thanks for your comment. We are sorry that this part was not clear in the original manuscript.

We collected dating samples from the top of lacustrine deposits, and gravel units, and the bottom of loess and paleosol units. The dating of lacustrine deposits confirms the damming process of the palaeo-landslide dam, the dating of gravel units corresponds to the outburst time, and the dating of loess and paleosol units used to determine the time of terrace geomorphic stability. Therefore, we believe it is necessary to conduct dating for each unit. We added a description on L137-140, in Sect 3.2, as follows:

*To clarify the damming and outburst processes of the palaeo-dam, and the stability time of terraces, we collected samples from the top of lacustrine and gravel units, and the bottom of loess and paleosol units.*

The ages of each phase (Phase I-VI) are determined based on the ages of lacustrine deposits. We did not compare the ages of different sedimentary units. Thus water content and dose rate do not affect our results.

The terrace T6 has experienced significant deformation, making it difficult to obtain suitable samples. Therefore, we did not collect samples from this terrace.

#### **Comment 9**

L156: Did you perform a density separation prior to etching to separate the quartz from the other material?

#### **Response 9**

Thanks for your comment. We are sorry that this part was not clear. We rewrote this process on L154-166 in Section 3.2.1 OSL dating, which described how to separate the quartz from the other materials, as follows:

*Samples were processed and measured at the Institute of Earth Environment, Chinese Academy of Sciences. The quartz grains were extracted following the laboratory pre-treatment procedures (Kang et al., 2020; Kang et al., 2013). The sediments at the two ends of the tubes, which may be exposed to daylight during sampling, were removed. And, the unexposed samples were prepared for equivalent dose ( $D_e$ ) and environment dose rate determination. Approximately 50 g samples were treated with 30% HCl and 30%  $H_2O_2$  to remove carbonates and organic matter, respectively. Then, the samples were washed with distilled water until the pH value of the solution reached 7. For samples IEE5542 and IEE5550, the coarse fractions (90-150  $\mu m$ ) were sieved out and etched with 40% HF for 45 mins,*

*followed by washing using 10% HCl and distilled water. For the other 17 samples, the fine polymineral grains (4-11  $\mu\text{m}$ ) were separated according to the Stokes' law. These fine polymineral grains were immersed in 30%  $\text{H}_2\text{SiF}_6$  for 3-5 days in an ultrasonic bath to extract quartz. Finally, the purified fine (coarse) quartz was deposited (mouted) on stainless steel discs with a diameter of 9.7 mm for experimental use. The purity of quartz was verified by IRSL intensity and OSL IR depletion ratio (Figs. S1 and S2a; Duller, 2003).*

Because of adequate purity of quartz after HF etching of coarse polyminerals (Figs. S1 and S2), we did not perform a density separation after HF etching.

#### **Comment 10**

L162: What is the exact protocol you have been using?

#### **Response 10**

Thanks for your comment. The protocol illustrated on L171-172, as follows:

*The single-aliquot regenerative-dose (SAR) protocol (Table S1; Murray and Wintle, 2000; Wintle and Murray, 2006) was utilized to determine the Equivalent Dose ( $D_e$ ), as used in Kang et al. (2020).*

#### **Comment 11**

L166: How did you measure the environmental dose rate? Did you take appropriate samples in the field?

#### **Response 11**

Thanks for your comment. Sorry that this part was not clear. The samples of environmental dose rate are separated from the OSL samples, and they were not specifically collected in the field. And the environmental dose rate determination was presented on L156-158 and L181-L191, as follows:

*...The sediments at the two ends of the tubes, which may be exposed to daylight during sampling, were removed. And, the unexposed samples were prepared for equivalent dose ( $D_e$ ) and environment dose rate determination....*

*The environmental dose rate was estimated from the radioisotope concentrations (uranium, thorium, and potassium) and cosmic dose rates. U and Th concentrations were determined by inductively coupled plasma mass spectrometry (ICP-MS), while K concentration was measured by inductively coupled plasma optical emission spectrometry (ICP-OES). The cosmic dose rates were calculated using the equation proposed by Prescott and Hutton (1994). The  $\alpha$ -value of fine (4-11  $\mu\text{m}$ ) grained*

*quartz was assumed to be  $0.04\pm 0.002$  (Rees-Jones, 1995). Considering the current climate conditions, the sedimentary facies, and past climate changes since the sample deposition, the water content of the gravel and paleosol was assumed to be  $10\pm 5\%$ , while the water content of lacustrine deposits was estimated to be  $20\pm 5\%$ . Dose rate was calculated using the Dose Rate and Age Calculator (DRAC) (Durcan et al., 2015). Finally, the quartz OSL ages were obtained by dividing the measured  $D_e$  (Gy) by the environmental dose rate (Gy/ka).*

**Comment 12**

L170: Why did you sample there? In general, your choice of sampling location (also for OSL) is not entirely clear to me.

**Response 12**

Thanks for your comments. We added the description to explain why we collected these samples on L196-201 as follows:

*The AMS  $^{14}\text{C}$  sample collected from the top of the Taiping Terrace was used for comparison with the OSL sample (TP19-1), which was taken from the same position. The AMS  $^{14}\text{C}$  sample collected from the top of the Tuanjie Terrace was compared with the AMS  $^{14}\text{C}$  dating of the top of the Taiping Terrace. Utilizing the same dating method for age comparison enhances credibility. Field investigations showed that the loess unit of the Tuanjie T4 was the most complete and easier to collect, therefore, we collected the loess sample from T4.*

**Comment 13**

Fig 4.: This is a very nice and vivid illustration.

**Response 13**

Thanks for your comment.

**Comment 14**

L236: Is there an explanation for why T5 and T7 are missing the loess unit?

**Response 14**

Thanks for your comment. We added the description on L269, in Sect 4.2.1, as follows:

*The absence of loess units in T5 and T7 may be caused by erosion and human activities.*

**Comment 15**

Fig 5.: The x-axis font is too small

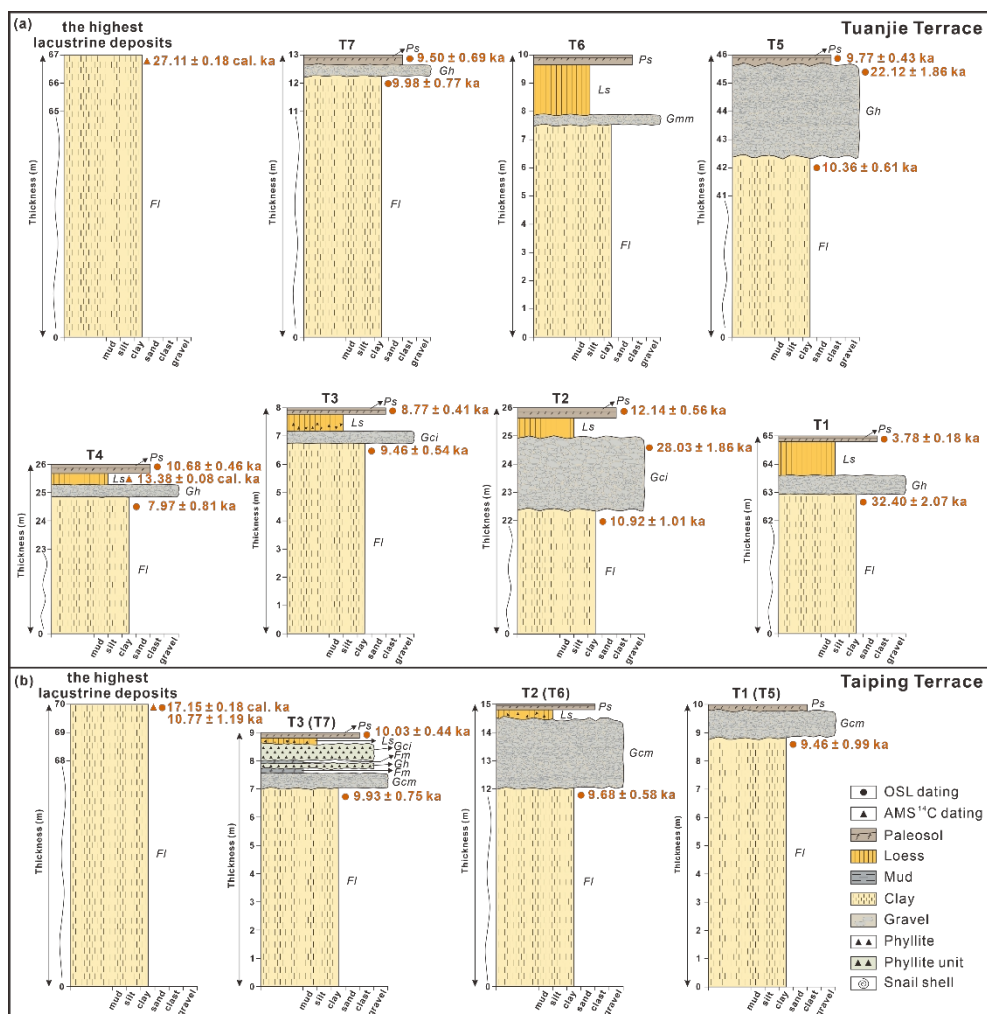


## Response 15

Thanks for your comment. We magnified the x-axis font of Figure 5 and corrected a mistake made during the drawing process. We modified the lithofacies code of the gravel layer of T3 from *Gh* to *Gci*. As it is an inverse grading, this correction was necessary.

The description of the lithostratigraphy of Tuanjie T3 has also been modified on *L258-261*, as follows:

*In Tuanjie T3 (Gci), the gravel units are poorly sorted and sub-circular to round gravels with a 3-25 cm diameter and exhibit inverse grading. These features suggest that the gravel units of T2 and T3 are clast-rich debris flows with high strength or pseudoplastic debris flows with low strength.*



## Comment 16

L272: It is not "Optional", but "Optically Stimulated Luminescence"

## Response 16

We are really sorry for our careless mistakes. Thank you for your reminder. Considering that the full term has been mentioned as "optically stimulated luminescence (OSL)" on *L73*, we used the

abbreviation "OSL" directly in this sentence. We modified it on L308, as follows:

*OSL* dating of lacustrine deposits in Tuanjie terraces yielded ages of 32.40±2.07 ka for the T1, 10.92±1.01 ka for the T2, 9.46±0.54 ka for the T3, 7.97±0.81 ka for the T4, 10.36±0.61 ka for the T5 and 9.98±0.77 ka for the T7.

**Comment 17**

L281/282: Your terraces do not become younger with increasing elevation. T5 & T7 are older, but higher than T3 & T4 for example. Generally, this section is very difficult to follow (L272-286).

**Response 17**

Thanks for your comment. We deleted this sentence, and summarised on L312-314, as follows:

*The chronological results of lacustrine deposits are chaotic. Tuanjie T1-T4 becomes younger with increasing elevation. Tuanjie T5 and T7 have a similar age, but are older than T3 and T4. The highest lacustrine deposits are only about 5 ka younger than T1.*

**Comment 18**

L307: Have you done a bleaching test to correct the residuals?

**Response 18**

We rewrote the bleaching extent on L335-337, as follows:

*Considering the fine silt dominated nature, the relatively stable depositional environment, and the normal distribution of  $D_e$  particularly for the two coarse samples, we assume that all the OSL samples were well bleached before deposition.*

**Comment 19**

L336: Round the numbers as they suggest a level of accuracy that you don't have. It is unclear what you are referring to with Table S1. You must mention the source for these ages.

**Response 19**

Thanks for your professional suggestions. We rounded these numbers as "830 ka", "1 ka", "40 ka", "6 ka" on L372, as follows:

In summary, the terrace ages along the upper Minjiang River span from 830 to 1 ka, with the majority formed between 40 and 6 ka. The Diexi area shows a higher concentration of terraces than the upstream and downstream regions, with these terraces primarily formed from 30 to 0 ka.

We mention the source of these ages on L364-369, as follows:



The ages of the upstream terraces indicate that the formation and evolution of terraces in the upper Minjiang River began around 830 ka (the early Pleistocene, *Zhao et al., 1994*), and primarily formed between 47-2 ka (Fig. 6). The terraces in the Diexi area have ages that are distributed between 550 and 50 ka (*Duan et al., 2002; Guo, 2018; Kirby et al., 2000; Wang et al., 2020; Wang et al., 2007; Wang, 2009; Yang et al., 2003; Zhong, 2017; Gao and Li, 2006; Jiang et al., 2014; Luo et al., 2019; Mao, 2011; Zhang, 2019*), with the majority formed between 32-2 ka (Fig. 6). Downstream terraces were deposited between 400 and 50 ka (*Yang et al., 2003; Yang, 2005; Zhao et al., 1994; Zhu, 2014*), with a significant portion formed between 40 to 20 ka (Fig. 6).

#### **Comment 20**

L427-433: You have large ranges for incision rates here and you claim that there are significant differences. However, the differences are mainly in one area only, rather than compared to all of them.

#### **Response 20**

Thanks for your comment. Sorry for the misunderstanding. This part is not clear, "Diexi area" on L433 (previous version) means "Taiping-Tuanjie".

We rewrote this part on L458-470, as follows:

*Considering the short distance of only 12 km between Tuanjie and Taiping, we regard them as in the same tectonic uplifting background. In Section 5.2, we divided the upper Minjiang River into three parts: the Zhangla to Gonggaling area (upstream of the Diexi area), the Diexi area (Taiping-Tuanjie), and the Maoxian-Wenchuan area (downstream of the Diexi area). During the damming period of the Diexi palaeo-dammed lake (32-10 ka), the incision rates in these three sections ranged from 8.3-85.3 mm/yr, 13.6-198 mm/yr, and 58 mm/yr, respectively, from upstream to downstream (Table. S2). And the Minshan Block, which includes the Minjiang River, has experienced an average uplift rate of 1.5 mm/yr since the Quaternary (Zhou et al., 2000). It can be observed that the incision rates of the upper reaches of the Minjiang River during the period of 32-10 ka are significantly higher than the uplift rate of the Minshan Block, indicating that tectonic activity has little influence on the formation of regional terraces. In particular, the Taiping-Tuanjie region has a higher incision rate than the upstream and downstream areas, highlighting its unique characteristics. That is, tectonic activity is not a critical factor in the evolution of Tuanjie and Taiping terraces.*

#### **Comment 21**

L510: The results now indicate the exact opposite of the previous findings (see L122 & L281)

### Response 21

Thanks for your comment. We deleted and rewrote this sentence on L541-542, as follows:

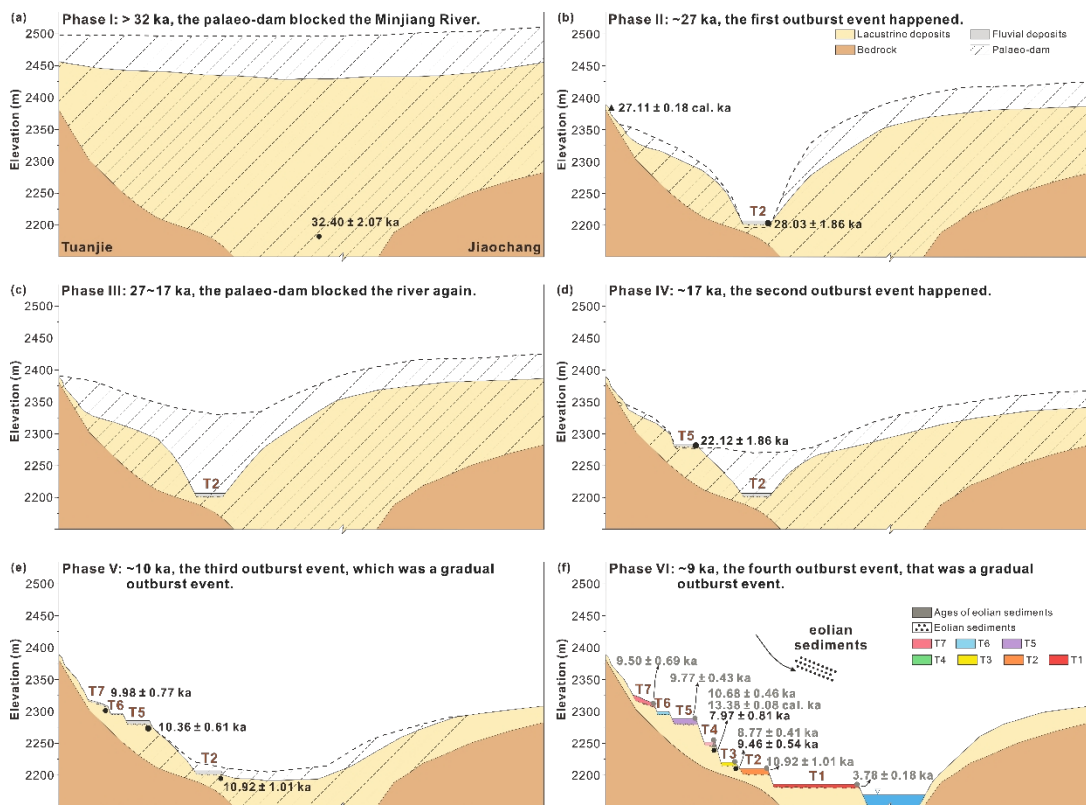
*Most lacustrine deposits in the Tuanjie and Taiping Terraces were deposited from  $32.40 \pm 2.07$  ka to  $7.97 \pm 0.81$  ka.*

### Comment 22

Fig. 10: Really nice presentation of the process and absolutely necessary.

### Response 22

Thanks for your comment. We round the phase ages in this figure:



### Technical corrections

### Comment 1

L27: Word repetition "evolution".

### Response 1

Thanks for your comment. We modified this sentence as "*Terraces, as a natural archive of the process of valley evolution, are used to explore the controlling mechanisms of river landscapes*" on L29-30.

### Comment 2

L46: "The upper Minjiang River is located in the eastern Tibetan Plateau, and it is characterised by a wide distribution of three-tiered terraced."

**Response 2**

We modified it on L49-50, as follows:

*The upper Minjiang River is located in the eastern Tibetan Plateau, and a wide distribution of three-tiered terraces characterizes it.*

**Comment 3**

L56-58: Word repetition "sedimentary system". It can be summarized as "fluvial, lacustrine, alluvial fan [...] sedimentary system".

**Response 3**

Thanks for your comment. We rewrote this sentence: "*The analysis of lithofacies and sedimentary systems determined that the Diexi area is mainly composed of fluvial, lacustrine, alluvial fan and eolian sedimentary systems*" on L58-59.

**Comment 4**

L61: "This indicates that" instead of "This is".

**Response 4**

We modified it on L63, as follows:

*This indicates that* the Diexi palaeo-dammed lake has experienced at least one outburst flood event

**Comment 5**

L74: Colloquial. "The Diexi area is located in the upper reaches of the Minjiang River". And please connect the first two sentences.

**Response 5**

We rewrote the first sentence on L79-81, as follows:

*The Diexi area is located in the upper reaches of the Minjiang River, which belongs to the northeast margin of the Tethys Himalayan domain and the Barkam formation zone, on the eastern margin of the Bayan Har Block (Fig. 1a).*

**Comment 6**

L78: "..and the steep slopes on both sides of the river valley have a gradient of 30-35°."

**Response 6**

We modified it on L83, as follows:

...and *the steep slopes* on both sides of the river valley have a gradient of 30-35°.

**Comment 7**

L85-86: Word repetition "about".

**Response 7**

We modified on L90-92, as follows:

*The highest elevation of the palaeo-landslide is 3390 m, and the main slide direction is SW18°. The length and width of the palaeo-landslide are respectively about 3500 m and 3000 m, with a volume of the accumulation reaching 1.4 to 2.0×10<sup>9</sup> m<sup>3</sup> (Zhong et al., 2021).*

**Comment 8**

L97-98: "The climate of the entire region is monsoonal, being influenced by the Plateau Monsoon, the Westerlies, and the East Asian Monsoon."

**Response 8**

We modified it on L103-104, as follows:

*The climate of the entire region is monsoonal, being influenced by the Plateau Monsoon, the Westerlies, and the East Asian Monsoon.*

**Comment 9**

L194: The heading repeats. You should either write introductory words to the following chapters under chapter 4.1. or simply omit the top chapter. Same for chapters 5.2 and 5.2.1

**Response 9**

Thanks for your comment. We omitted the "4.1 Terraces distribution and sequence", and modified *Section 4.1.1* to *Section 4.1*, *Section 4.1.2* to *Section 4.2*. We rewrote "Tuanjie Terrace" as "4.2.1 Tuanjie Terrace", and "Taiping Terrace" as "4.2.2 Taiping Terrace".

We deleted "5.2 Evolution of terraces in the upper Minjiang River", and modified *Section 5.2.1* to *Section 5.2* and *Section 5.2* to *Section 5.3*.

We also renamed *Section 5.5* as "*The formation and evolution mechanisms of terraces*".

**Comment 10**

L199: Word repetition "extension/extends"

**Response 10**

We rewrite this sentence as "*Terrace T1 has the most significant extension towards the center of the Diexi Lake.*" on L227-228.

**Comment 11**

L200: "On a high mountain" is colloquial.

**Response 11**

Thanks for your comment. We used "on the hillside" instead of "on a high mountain" on L228, as follows:

Taiping terraces developed *on the hillside* with a slope of 40°-60°, influenced by landslides and croplands. The horizontal extensions of T1, T2, and T3 are equal to 520 m, 380 m, and 190 m, respectively.

**Comment 12**

L231: "Angular phyllites occur in T3."

**Response 12**

We modified it on L263, as follows:

*Angular phyllites occur in T3.*

**Comment 13**

L332: Just write 830 ka

**Response 13**

We modified it on L365, as follows:

The ages of the upstream terraces indicate that the formation and evolution of terraces in the upper Minjiang River began around *830 ka (the early Pleistocene, Zhao et al., 1994)*, and primarily formed between 47-2 ka (Fig. 6).

**Comment 14**

L334: "The terraces in the Diexi area have ages that are distributed between 550-50 ka (Table S1), with the majority observed between 32-2 ka."

**Response 14**

Thanks for your comment. We modified it on L366-369, as follows:

The terraces in the Diexi area have ages that are distributed between *550 and 50 ka* (Duan et al., 2002; Guo, 2018; Kirby et al., 2000; Wang et al., 2020; Wang et al., 2007; Wang, 2009; Yang et al., 2003;

Zhong, 2017; Gao and Li, 2006; Jiang et al., 2014; Luo et al., 2019; Mao, 2011; Zhang, 2019), with the majority observed between 32-2 ka (Fig. 6).

**Comment 15**

L345: "It can be seen that the terrace formation mechanism downstream is different from that upstream."

**Response 15**

Thanks for your comment. We modified it to "*These results indicate that the terrace formation mechanism downstream differs from that upstream.*" on L381-382.

**Comment 16**

L346: I would suggest not to write "publish".

**Response 16**

Thanks for your comment. We rewrote this sentence: "*However, sufficient evidence has not been presented to support this perspective. In the following sections, we will present additional evidence to explore this phenomenon further.*" on L382-383.

**Comment 17**

Fig 6: You have the same sentence here with the age 46.40 ka to 2.81 ka.

**Response 17**

Thanks for your comment. For clearly, we modified the figure name as "*Frequency distribution histogram of terrace ages since 50 ka in the upper reaches of the Minjiang River*" on L380-381.

**Comment 18**

L370-373: Rewirte the sentences. Not "Tx are...".

**Response 18**

Thanks for your comment. We rewrote these sentences on L404-406, as follows:

*Ages of the lacustrine deposits of Taiping T1 (9.46±0.99 ka) and Tuanjie T5 (10.36±0.61 ka), as well as Taiping T3 (9.93±0.75 ka) and Tuanjie T7 (9.98±0.77 ka) (Table. 3), are similar, which confirms from a chronological perspective that the two terraces correspond to each other (Fig. 5).*

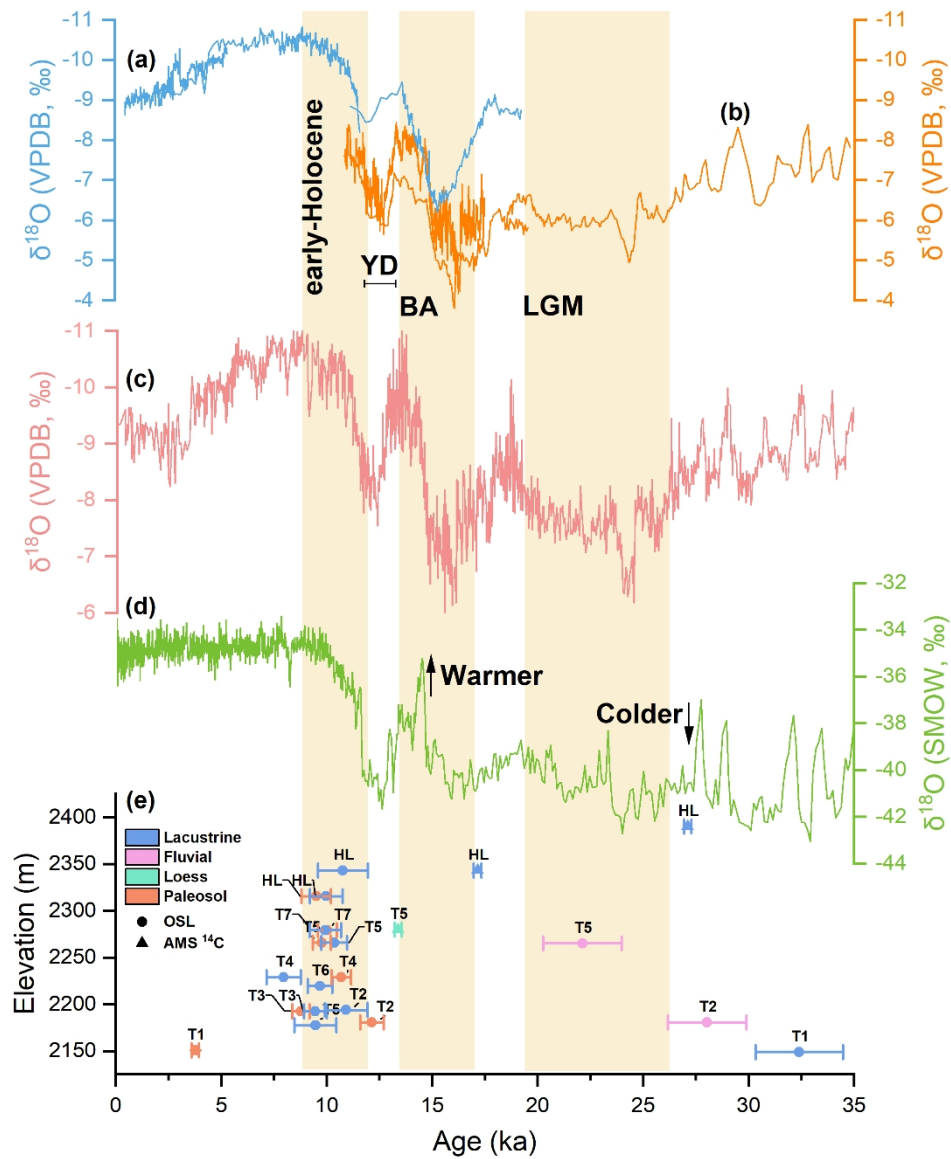
**Comment 19**

Fig. 7: Use different colors with each symbol.

**Response 19**



We are very grateful for your careful reading. We modified the symbol colors, and added the "circle" and "triangle" symbols to represent the OSL dating and AMS <sup>14</sup>C dating methods, respectively.



**Comment 20**

L487-489: "The upstream and downstream effects of the blockage are a rapid rise in water level followed by potential upstream flooding."

**Response 20**

Thanks for your comment. We modified it on L521-522, as follows:

*The upstream and downstream effects of the blockage are a rapid rise in water level followed by potential upstream flooding.*

**Comment 21**

L492: "Gravity and density caused the material to be deposited in the palaeo-dammed Diexi Lake and formed a channel."

#### **Response 21**

Thanks for your comment. We modified it: "*Gravity and density cause the material to be deposited in the Diexi palaeo-dammed lake, forming a channel.*" on L525-526.

#### **Reference**

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