Earth Surface Dynamics

Manuscript ID: egusphere-2023-929

Title: Palaeo-landslide dams controlled the formation of Late Quaternary terraces in Diexi, the upper Minjiang River, eastern Tibetan Plateau

Dear Editor and Reviewers,

I sincerely thank you for your review work on this manuscript. Your comments have greatly improved the quality of this manuscript and brought it closer to the requirements for publication in *Earth Surface Dynamics*.

The revised manuscript takes into consideration the comments and suggestions of the reviewing editor and anonymous reviewers, and has addressed the deficiencies they pointed out, while making some necessary quality enhancements, such as improving the language, revising the figures, and updating the description of OSL dating procedures. Additionally, we have included an additional author in the revised manuscript to better reflect the contributions and expertise involved in the research:

Author Name: Shugang Kang

Affiliation: State Key Laboratory of Loess and Quaternary Geology, Institute of Earth Environment, Chinese Academy of Sciences, Xi'an 710061, China

This author has made significant contributions to the OSL dating, and his involvement will better reflect the comprehensiveness and accuracy of the study. We believe this adjustment will enhance the quality and credibility of the manuscript. With his participation, we have updated the dating results. Out of the total samples, 8 samples remained unchanged regarding their ages. However, the ages of the remaining samples showed variations within approximately 7% of the ages reported in the original submission (with two samples showing variations of around 15%). As a result, there was a slight increase in the estimated dating errors for all samples. Based on this, we have revised the parts of the manuscript discussing the chronology and updated the supplementary materials. With the updated chronology, the revisions did not significantly impact the overall findings of the manuscript.

Herein, we provide a detailed point-by-point response to the issues and suggestions raised by the editor and reviewers, along with the corresponding modifications made in the manuscript, for the convenience of the subsequent review process. The revised manuscript, with the added author and all other revisions, is provided in track changes mode. The line numbers in this response correspond to those in track changes mode.

We appreciate the editor's and reviewers' valuable feedback, which has contributed significantly to improving the manuscript.

Best regards,

Xuanmei Fan on behalf of all co-authors

The Response to Comments from Anonymous Reviewer 1

General Comments
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. 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. The manuscript may be accepted after major revision, based on the following comments.
Response 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.
Specific comments
Comment 1 L15: the detail about the mud-phyllite in T3 is not of interest in the abstract.
Response 1 Thanks for your comment. We deleted this sentence in the abstract.
Comment 2 L21: You are rounding every age in this paragraph except for 9.35ka.
Response 2 We would like to thank you for pointing out this issue. Considering these ages obtained from the OSL method, we rounded the ages of all phases as: 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.
Comment 3 L39: Please mention the studies.
Response 3

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.

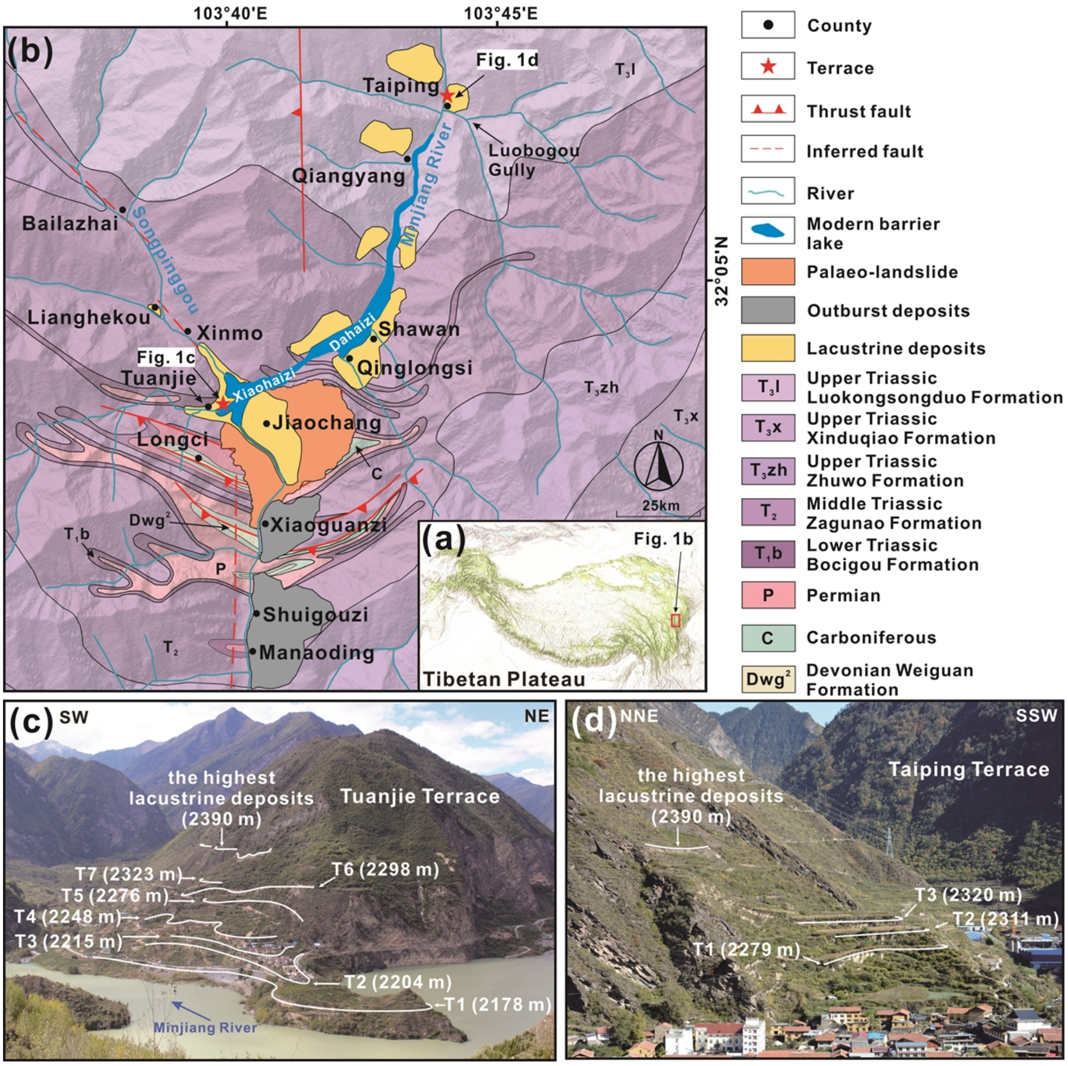
Comment 6

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 μm) 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 μm) were separated according to the Stokes' law. These fine polymineral grains were immersed in 30% H_2SiF_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 (De) 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 α-value of fine (4-11 μm) grained *quartz was assumed to be 0.04±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±5%, while the water content of lacustrine deposits was estimated to be 20±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}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}C sample collected from the top of the Tuanjie Terrace was compared with the AMS ^{14}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

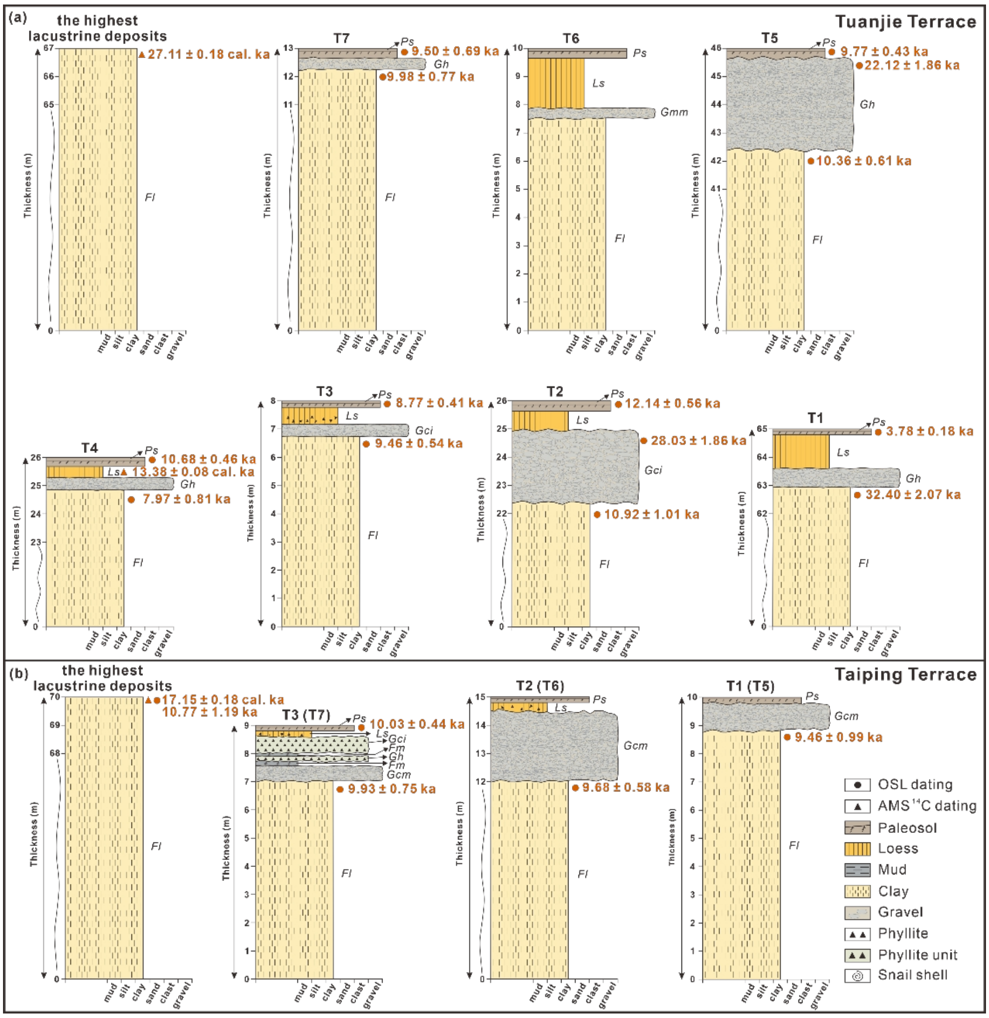
Fig 5.: The x-axis font is too small

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

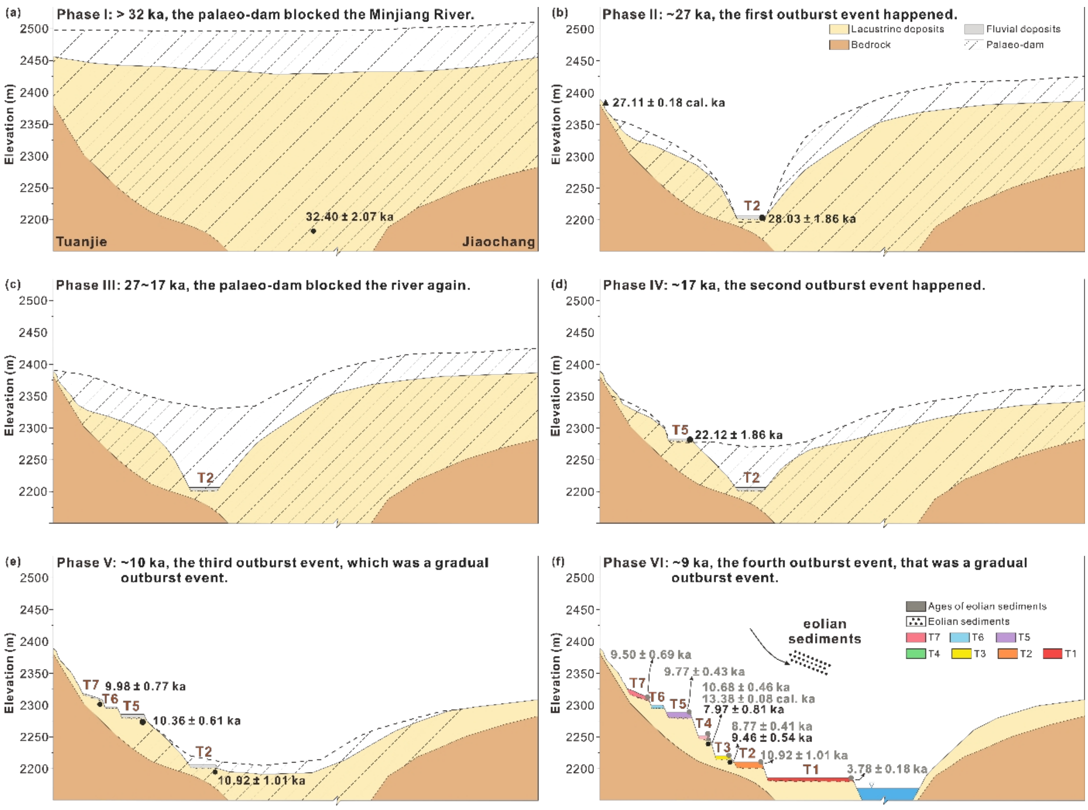
Thanks for your comment. Sorry for the misunderstanding. This part is not clear, "Diexi area" on *L433* (previous version) means "Taiping-Tuanjie".

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 ±2.07 ka to 7.97±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 2.0×10^9 m^3 (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:

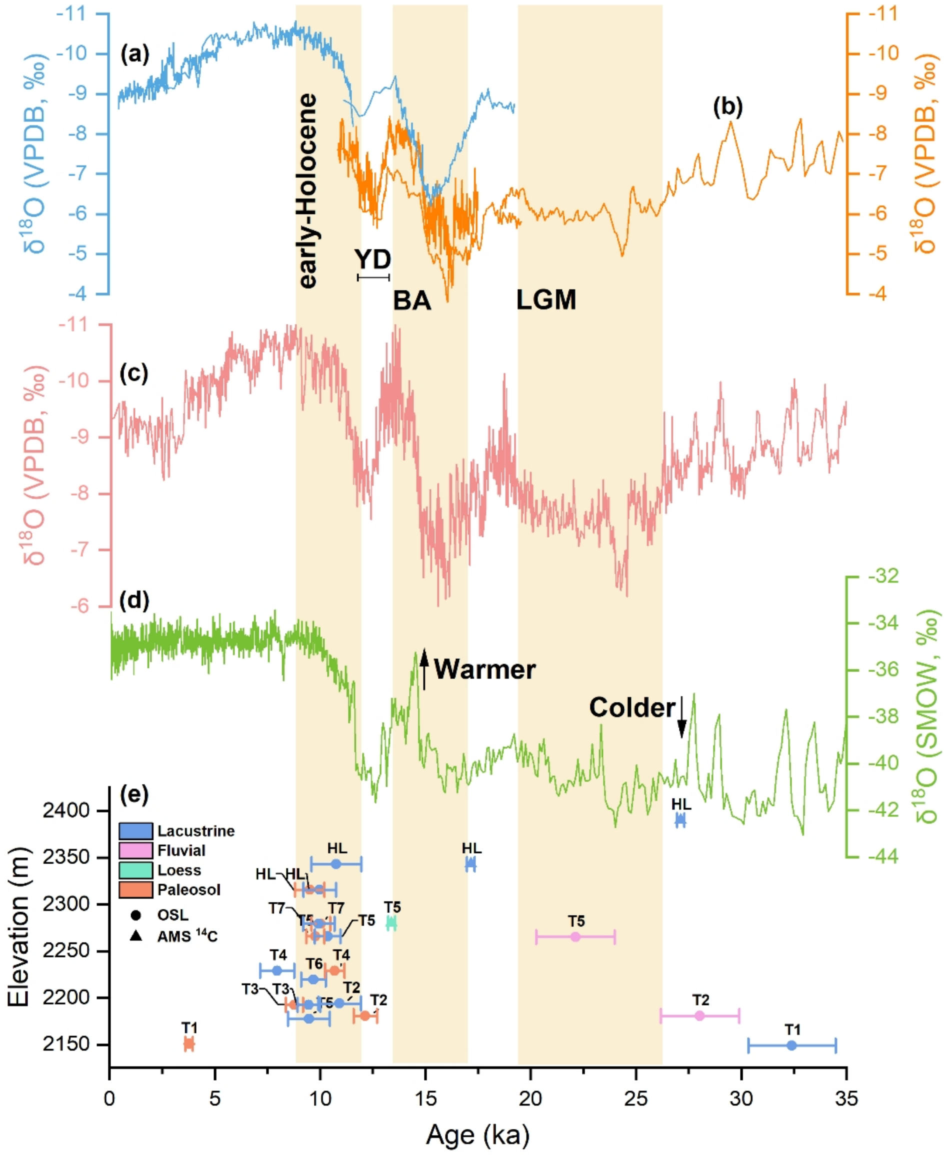
Ages of the lacustrine deposits of Taiping T1 (9.46±0.99 ka) and Tuanjie T5 (10.36±0.61 ka), as well as Taiping T3 (9.93±0.75 ka) and Tuanjie T7 (9.98±0.77 ka) (Table. 3), are similar, which confirms from a chronological perspective that the two terraces correspond to each other (Fig. 5).

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 ^{14}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*.

The Response to Comments from Anonymous Reviewer 2

General Comments
Based on geomorphology, sedimentology, and chronology, the manuscript reconstructing two damming and four outburst events occurred in the minjiang river during the late Pleistocene, which suggests that the blockage and collapse of the palaeo-dam have been a major factor in the formation of tectonically active mountainous river terraces, and tectonic movement and climatic fluctuations, on the other end, play a minor role. I think the topic of the paper is interesting. However, this manuscript mainly focuses on sediment dating and geomorphological interpretation. The content association with dynamics is much weak, thus I am wondering whether it is suitable for this journal or not. Considering that this manuscript still has a plenty of problems, we suggest a major revision.
Response We are very grateful for your professional suggestions on our manuscript. We have considered the comments carefully and tried our best to revise the manuscript accordingly. Our responses are given in a point-by-point manner below. All the revisions have been addressed in the revised manuscript shown in red We have asked native English speakers to improve the language, and clarify our ideas.
Specific Comments
Comment 1 Language should be improved by a native English speaker, please avoid all kinds of grammar errors and please use scientific language to write the paper.
Response 1 We are sorry for the grammatical problems and have corrected them based on your suggestions. We have asked native English speakers to polish and modify the manuscript.
Comment 2 The evolution of Diexi landslide-dammed lake in eastern Tibetan Plateau has gotten special attention of a plenty of scientist. The author should introduce the details of Diexi landslide dammed lake, including the history of repeated landslide damming.
Response 2 Thanks for your comments. We added the description on *L64-67*, as follows: *Moreover, the sedimentological analysis also suggests that the Diexi palaeo-dammed lake*

experienced at least two periods of blocking and outburst events (Yang, 2005; Yang et al., 2008), and four periods of fluvial progradation (Xu et al., 2020).

The concept of repeated blockage is introduced in this manuscript, as previous studies have only mentioned multiple instances of progressive breaching. As mentioned in *L61-64*:

Currently, Tuanjie Terrace is thought to have resulted from the outburst of a palaeo-dammed lake 15000 years ago, and each terrace corresponds to different stages of outburst (Duan et al., 2002; Wang et al., 2005; Wang, 2009; Zhu, 2014).

Comment 3

Ordinarily, uncertainties in estimating water content during burial are one of the largest sources of uncertainty in luminescence dating methods. Please give out the process of the determination of water content.

Response 3

Thanks for your comment. We were in an emergency situation in the field at that time and did not have enough time to excavate water content samples that could accurately reflect the true conditions. However, considering factors such as modern climate, depositional facies, and climate change history since deposition, we assumed the water content data.

We rewrote the water content on *L186-189*, as follows:

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±5%, while the water content of lacustrine deposits was estimated to be 20±5%.

Comment 4

For OSL dating, the results of recycling ratios and recuperations should be presented, and aliquots with recycling ratios out of 0.9-1.1 and recuperations higher than 5% should be rejected.

Response 4

Thanks for your constructive comments. We added the result on *L177-180*, and presented the recycling ratios and recuperation ratios on the supplementary, as follows:

Conventional tests in SAR protocol, including recuperation ratio, recycling ratio, quartz OSL brightness and fast-component dominated nature, growth curve shape, and D_e distribution (Figs. S2 and S3), indicate that the protocol can be robustly used to date the samples in this study.

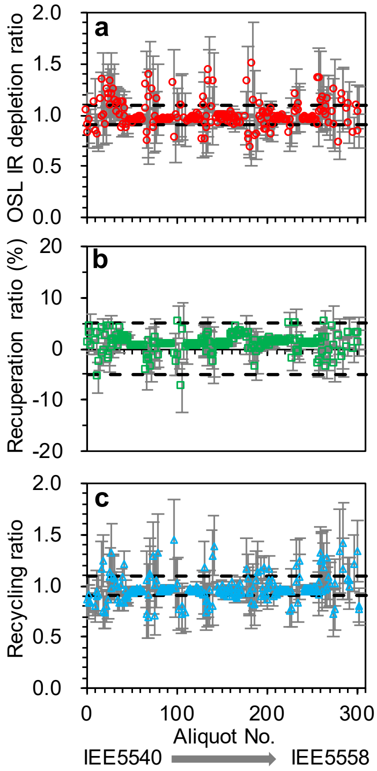


*Fig. S2. Quartz OSL IR depletion ratio (with IR/without IR **a**), recuperation ratio (recuperated/natural, **b**), and recycling ratio (repeated/regenerated, **c**) for all the 222 aliquots (used for D_e determination) of the 19 luminescence samples.*

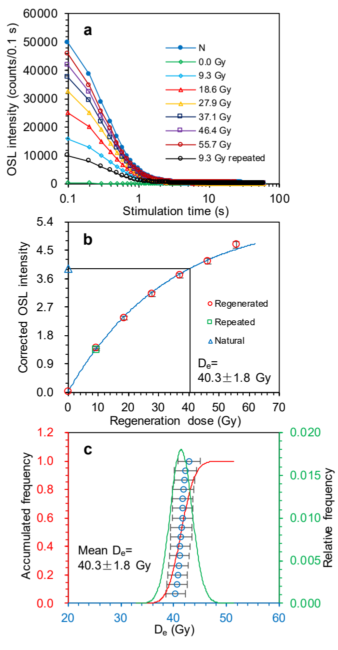


*Fig. S3. Quartz OSL D_e determination for sample IEE5543. (**a**) Natural and regenerative-dose OSL decay curves from one of the 15 aliquots used for D_e determination. (**b**) Dose-response curve and D_e determination for the aliquot in (**a**). (c) Probability density distribution of D_e and mean D_e.*

Comment 5

The authors should select appropriate preheat and cutheat temperatures based on a preheat plateau test (Murray and Wintle, 2000) or following some case studies, and add some references.

Response 5

Thanks for your comment. We rewrote this progress on *L173-174,* as follows:

Quartz grains were preheated at 260°C for 10 s for natural and regenerative-dose, and a cut-heat at 220°C for 10 s was applied for test dose.

We rewrote and added some references in *Section 3.2.1* to clarify the OSL procedures.

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 μm) 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 μm）were separated according to the Stokes' law. These fine polymineral grains were immersed in 30% H_2SiF_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).

All OSL measurements were performed on a Lesxyg Research measurement system, with blue light at (458±10) nm, and infrared light at (850±3) nm for stimulation and a $^{90}S/^{90}Y$ beta source (~0.05 Gy/s) for irradiation. Luminescence signals were detected by an ET 9235QB photomultiplier tube (PMT) through a combination of U340 and HC340/26 glass filters.

The single-aliquot regenerative-dose (SAR) protocol (Table S2; Murray and Wintle, 2000; Wintle and Murray, 2006) was utilized to determine the Equivalent Dose (D_e), as used in Kang et al. (2020). Quartz grains were preheated at 260°C for 10 s for natural and regenerative-dose, and a cut-heat at

220°C for 10 s was applied for test dose. The quartz was stimulated for 60 s at 125°C with blue LEDs. The OSL signal was calculated as the integrated value of the first 0.5 s of the decay curve minus the integrated value of the last 0.5 s as the background. For D_e determination, approximately 10 aliquots were measured for each sample. And, the mean D_e value of all aliquots was used as the final D_e value. Conventional tests in SAR protocol, including recuperation ratio, recycling ratio, quartz OSL brightness and fast-component dominated nature, growth curve shape, and D_e distribution (Figs. S2 and S3), indicate that the protocol can be robustly used to date the samples in this study.

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 α-value of fine (4-11 μm) grained quartz was assumed to be 0.04±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±5%, while the water content of lacustrine deposits was estimated to be 20±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 6

How did the authors obtain the final De? Please illustrate.

Response 6

Thanks for your comment. We illustrated on *L171-172* and *L176-180*, 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). …
For D_e determination, approximately 10 aliquots were measured for each sample. And, the mean D_e value of all aliquots was used as the final D_e value. Conventional tests in SAR protocol, including recuperation ratio, recycling ratio, quartz OSL brightness and fast-component dominated nature, growth curve shape, and D_e distribution (Figs. S2 and S3), indicate that the protocol can be robustly used to date the samples in this study.

Comment 7 Line 281: "T1 has the youngest paleosol unit with an age of 3.78±15 ka. Terraces grow younger amid the increase in elevation." Obviously, this is paradoxical. Please find a better way to present the chronological results, to avoid the reader's misunderstanding.
Response 7 Thanks for your comments. We deleted and rewrote this sentence 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 8 For the lacustrine terraces, the dates can only implied that the filling up ages of the dammed lake rather formation time of terrace. Because of this misunderstanding, the comparison between climate date and terrace "formation" ages is also problematic.
Response 8 Thanks for your comments. We apologize for this misunderstanding caused by the ambiguities expressed in this text. The Diexi palaeo-landslide dammed lake in the past 30,000 years was not a stable and continuous water storage process, as evident from our chronological data. The age of the lacustrine deposits is chaotic (Figure 5). Therefore, these ages not only represent the time when the palaeo-dam blocked the river, but also indicate the time of its failure. Specifically, at 27.11±0.18 ka, the water level of the palaeo-dammed lake reached its highest point (2900 m), but at 17.15±0.18 ka, the water surface of the palaeo-dammed lake only reached 2342.95 m (Table 4). Therefore, the dam must have failed around 27 ka in order to have another "water storage period" at a lower elevation. In other words, the palaeo-dam blocked the river between 27 and 17 ka. During the repeated blocking and failure processes of the palaeo-dam, especially the catastrophic failure event (~27 ka, Ma et al., 2022), the banks of the river were eroded, eventually forming terrace staircases. The comparison between climatic chronology and terrace ages in the manuscript illustrates that climatic changes have little impact on the lacustrine units, that is, they have little influence on the

process of damming and failure of the palaeo-dam. Additionally, other depositional units of the terrace did not occur under significant climatic change conditions, thus excluding the significant influence of climatic changes on the process of damming and outburst of the palaeo-dam.

Comment 9

"The third and fourth gradual collapse events respectively occurred at ~10 ka and ~9.35 ka." How to divide the period of dammed lake? Is it just according to the age? How can we be sure that such a small difference in results is not due to a dating error? For the optical dating of the paper, both of the method and the internal checks of the results were not sufficiently presented. The reliability of the OSL data awaits further examination and more work is needed. My biggest concern about the OSL data comes from the bleaching extent of the OSL signals before deposition. However, the problem of bleaching extent has not been mentioned and explained in this paper, not yet anyway.

Response 9

Thanks for your comments.

The Tuanjie terrace, as the closest terrace to the palaeo-dam, is used as a criterion for delineating the palaeo-lake period based on the chronology of lacustrine deposits and gravel units. Due to the better exposure of gravel layers in only T2 and T5 terraces, we obtained the ages of these two gravel layers. Therefore, the division of periods for the damming and failure events of the palaeo-dam is primarily based on the ages of the lacustrine deposits, combined with previous dating results. As mentioned in the text, such as *L407-425*, we listed regional paleo-disaster events during Phase I to Phase IV to support our conclusions.

In the revised manuscript, we rounded the ages to ensure data consistency:

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.

For Phase V (10 ka) and Phase VI (9 ka), we initially divided them based on the ages of the lacustrine deposits. We believe that dating errors do not cause them. Firstly, our operating procedures were also standardizeds. Furthermore, climate changes during the Holocene were frequent, and the current records from archives, such as lakes and stalagmites have achieved high precision at scales of 100 years (Yuan et al., 2004; Cheng et al., 2016; etc.). Therefore, we believe that these two dam failure events should be distinguished.

We mentioned 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 10

Tectonic uplift and climate changes are the two critical factors controlling the evolution of river landscapes and the formation of terraces. However, rock uplift rate is calculated from bedrock terraces, rather than lacustrine terraces.

Response 10

Thanks for your valuable comments.

The primary purpose of calculating the incision rate based on lacustrine deposits is to distinguish the influence of tectonic activity from the effects of damming and failure events. The main applications of uplift rate and incision rate in this study are demonstrated as follows:

The Tuanjie and Taiping terraces are located in a tectonically active area, where several thrust and inferred faults are developed within the region (Fig. 1b). To determine whether the formation of terrace staircases is related to the strong tectonic activities in the Quaternary, we compared the incision rate of the Diexi area with that of the upstream and downstream, and the average uplift rate of the Minshan Block. The results indicate that the incision rate in the upstream reaches of the Minjiang River is significantly higher than that of the Minshan Block, suggesting that the formation of terrace staircases in the region is less influenced by tectonic activity. Particularly in the Taiping-Tuanjie area, the incision rate is much higher than in the upstream and downstream areas, indicating its unique characteristics. As mentioned in *L465-470:*

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.

In addition, we compared the downcutting rate of the Tuanjie terraces (T7 to T5) with the river incision rate at 10 ka in the study area. The downcutting rate of the terrace staircases was found to be significantly higher than the river incision rate. This rapid incision not only suggests that regional tectonic activity has little influence on the formation of terrace staircases, but also supports the viewpoint that the damming and breaching of palaeo-dam played a crucial role in forming the Diexi terraces. We described this in *L543-549*:

Most lacustrine deposits in the Tuanjie and Taiping Terraces were deposited from 32.40 ±2.07 ka to 7.97±0.81 ka. *Initially, the palaeo-dam had a large blocking scale, resulting in a high lake level, and corresponding lacustrine deposits at higher positions with older age. Since the palaeo-dam gradually broke, the height of the palaeo-dam body decreased, leading to a drop in the lake surface and the formation of lower staircases with younger ages, such as the age of the highest lacustrine deposits older than Tuanjie T2-T7. Besides, the downcutting rate of Tuanjie T7 to Tuanjie T5 (1652.33 mm/a) is higher than the maximum channel incision rate (198.00 mm/a) of the study area around 10 ka ago (Duan et al., 2002).* This rapid downcutting supports that the damming and dam-breaking of the palaeo-dam are critical factors in the formation and evolution of the Diexi terraces.

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