Research Advances

Cosmogenic $^{26}Al/^{10}Be$ Burial Dating of the Uplift Rate of Southern Qinling Mountains since the Middle Pleistocene

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Objective

The Qinling Mountains (QM) in Central China is a natural barrier that corresponds to the boundary between the southern and northern climate and environment (Gong Hujun et al., 2017). Northern QM is relatively steep, and southern QM is in contrast relatively low and gentle. Investigations have shown that the average uplift rate of northern QM since 17.8 Ma is approximately 0.19 mm/a (Yin Gongming et al., 2001), whereas that of central QM since 0.36 Ma is approximately 0.32 mm/a (Wang Fei et al., 2004). To date, however, few investigations have yet been conducted on the uplift rate of southern QM. Accordingly, we aim to obtain the uplift rate of southern QM by using the cosmogenic $^{26}Al/^{10}Be$ burial dating method to determine the age of the highest river terrace on the southern slope of QM.

Method

When a geological body is uplifted, the rivers in the area will erode and will be cut down until the heights of the riverbed and the water table are the same. The height difference between the highest river terrace and the modern riverbed is the depth of the river that was cut down, which can basically represent the uplifting height of a mountain on both sides of a river. Therefore, if we determine the time of the highest terrace, we can then obtain the cut-down rate of a river and the uplift rate of a mountain. The $^{26}Al/^{10}Be$ burial dating technique is an important method for dating quartzose deposits buried in the past 0.3–5.0 Ma. It has been successfully used in dating river fluvial deposits. Three quartzose gravel specimens (6–10 cm in diameter) from the highest Jinshui River terrace (i.e., the seventh terrace: T7), which is 210 m higher than the current Jinshui River bank, were collected for $^{26}Al/^{10}Be$ burial dating. The three samples were pretreated in Nanjing University in China and then sent to the PRIME Lab of Purdue University in the USA for chemical analysis and accelerator mass spectrometry (AMS).

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Results

The AMS result of the samples exhibited relatively good precision. Appendix 1 presents the nuclide concentrations and their corresponding simple burial ages, namely, JS-1: 0.741±0.124 Ma, JS-2: 0.357±0.124 Ma and JS-3: 0.473±0.134 Ma. For the samples that were buried smaller than 10 m, the dating results could have been underestimated to a certain degree because of non-negligible nuclides that were produced post-burial. Hence, we suggest using the older period (0.741±0.124 Ma) to represent the age of the seventh terrace. Accordingly, the cutting depth of the Jinshui River since 0.741 Ma is 210 m, and the erosion rate is 0.283 mm/year. We then obtain the uplift rate of the southern slope of QM.

Conclusion

We determin that the uplift rate of the southern QM is approximately 0.283 mm/a, based on the simple $^{26}Al/^{10}Be$ burial dating method. We found that the uplift rate of southern QM was faster than that of northern QM since the Middle Pleistocene.

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Fig. 1. The Jinshui River terrace system from T1 to T7 in the southern slope of QM.

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Appendix 1 Cosmogenic nuclide concentrations and simple burial ages of vein quartz gravel from the seventh terrace of the Jinshui River

Sample	Description	Burial depth (m)	^{10}Be concentration ($\times10^6$ at g^{-1})	^{26}Al concentration ($\times10^6$ at g^{-1})	^{26}Al/^{10}Be	Burial age (Ma)
JS-1	T7	8.0	0.0630±0.0024	0.2946±0.0144	4.675±0.289	0.741±0.124
JS-2	T7	8.0	0.0506±0.0020	0.2853±0.0137	5.642±0.348	0.357±0.124
JS-3	T7	8.0	0.0556±0.0023	0.2962±0.0156	5.331±0.355	0.473±0.134

Minimum ages are obtained by assuming that the samples are completely shielded from cosmic rays after burial without considering the nuclides produced during and after the depositional process, which is caused by insufficient shielding against cosmic rays.