LETTER

Reply to Sun et al.: Confirming the evidence for Late Oligocene–Early Miocene birth of the Taklimakan Desert

In Zheng et al. (1), we applied radioisotopic methods to precisely date a volcanic tuff preserved in the Xiyu Formation, revised the magnetostratigraphy of the Cenozoic successions (2), and determined the initial desertification of the Taklimakan to be Late Oligocene to Early Miocene.

The key evidence (i.e., identification and dating of a volcanic tuff), as disputed by Sun et al. (3), was fully presented in supporting information for ref. 1. During a brief 2-h field trip to the Kekeya section (3), we presented the stratigraphy to all participants (Fig. 1*A*). Those with knowledge of volcanic geology and familiar with the regional geology agreed with our findings in the field. We here take this opportunity to clarify the issues raised.

Nature of the Volcanic Tuff/Lahar

The volcanic tuff/lahar (pyroclastic flow) is observed at four studied sections spreading over a distance of 80 km (from Aertashi to Kekeya); the stratigraphic position of the tuff is well-defined and spatially correlative. Variations in petrological composition, grain size, and sedimentary structures between different sites and layers are typical of such deposits.

Petrological Investigation

We show polarizing microscope images of four samples from Kekeya (Fig. 1) to demonstrate the petrological compositions. Vitric fragments, cracked crystal fragments, and sanidine, typical of volcanic origin, are present and locally abundant in all samples. We were surprised to learn that no volcanic ash components were found (3), which is possibly attributed to either the poor quality of their images or incorrect location of samples (taken from tuffaceous siltstone or underlying siltstone, Fig. 1*A*). Note that the grain sizes of crystals in the electron microprobe images of ref. 3 are mostly <65 μm, whereas our crystal fragments are mostly >100 μm.

Dating of the Volcanic Tuff/Lahar

Dating of different kinds of volcanic minerals (biotite and zircon) taken from different volcanic tuff/lahar layers and from different sites show remarkable consistency, which strongly suggests that the tuff and pyroclastic flow were deposited almost synchronous with the volcanic activity (1).

Finally, the accusation that "they selectively ignored mammalian fossil evidence" was not justified. The evidence that Sun et al. presented for constraining the Mazatagh section was obscure, and cannot be used for such a vital age control point (4). There have been, up to now, no descriptions of the fossil or its in situ lithostratigraphic position, or any photograph, all of which is common practice in paleontology. Its age diagnostic importance is impossible to judge without such details. We also note that the age of the Taklimakan was constrained by the fossil to be ~7 Ma (4) instead of ~5 Ma (3).

In conclusion, our finding concerning the birth of the Taklimakan Desert was based on thorough investigation of the Cenozoic sequences within and along the margin of the Tarim Basin, together with robust radiometric dating, and is supported by evidence of regional tectonism of Tibetan–Pamir Plateau and eolian input to the Chinese Loess Plateau (5) and northern Pacific.

ACKNOWLEDGMENTS. We thank all the participants who joined the field investigation on 7 August 2015. This work was supported by the Strategic Priority Research Program of the Chinese Academy of Sciences (Grant XDB03020300).

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2 Zheng HB, Powell CM, Butcher K, Cao JJ (2003) Late Neogene loess deposition in southern Tarim Basin: Tectonic and palaeoenvironmental implications. *Tectonophysics* 375(1-4):49–59.

3 Sun J, Alloway B, Fang X, Windley BF (2015) Refuting the evidence for an earlier birth of the Taklimakan Desert. *Proc Natl Acad Sci USA* 112:E5556–E5557.

4 Sun JM, Zhang ZQ, Zhang LY (2009) New evidence on the age of the Taklimakan Desert. *Geology* 37(2):159–162.

5 Guo ZT, et al. (2002) Onset of Asian desertification by 22 Myr ago inferred from loess deposits in China. *Nature* 416(6877):159–163.

Author contributions: H.Z. designed research; H.Z., X.W., R.T., P.D.C., B.W., F.J., P.W., and M.H. performed research; and H.Z. and X.W. wrote the paper.

The authors declare no conflict of interest.

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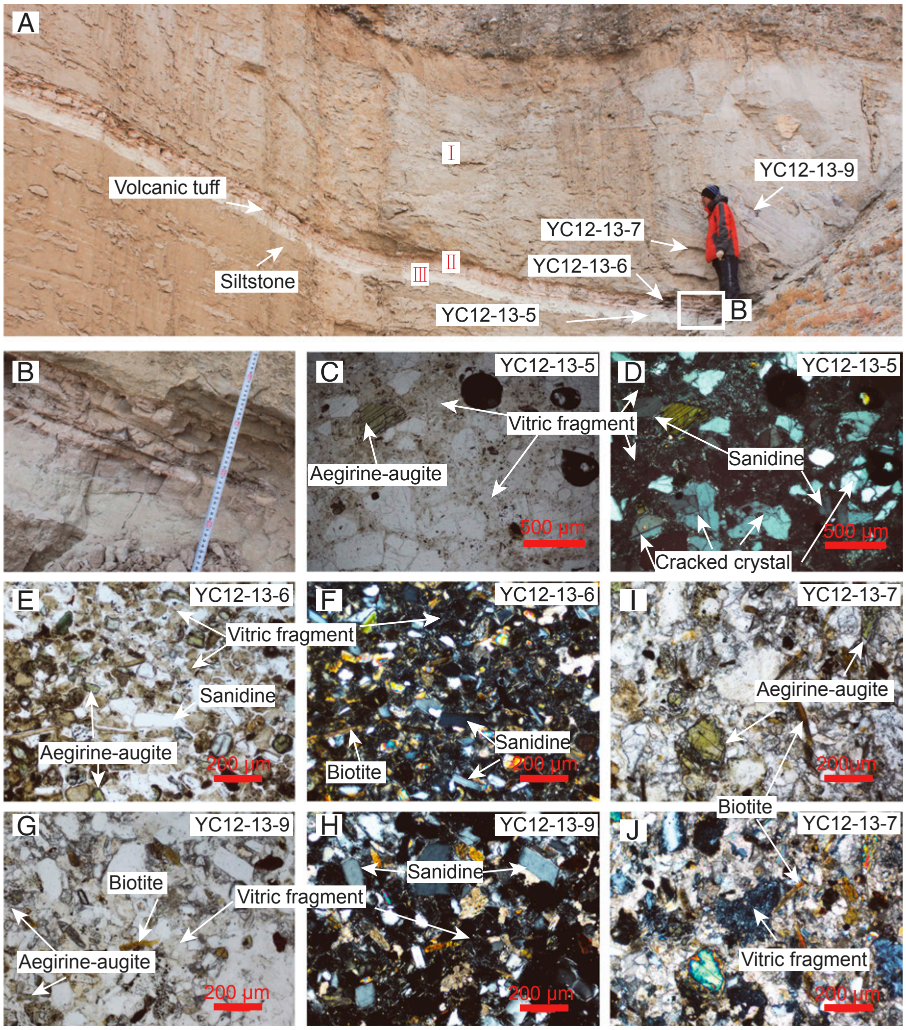

Fig. 1. Photos and thin section images in Plane Polarized Light (PPL) and Crossed Polars (XPL) of samples from the volcanic deposit layer at Kekeya section. To better compare our evidence with that of ref. 3, we follow their layer division. (*A*) Photo showing outcrop of volcanic tuff/lahar and sample locations. (*B*) Photo of tuff layer II and layer III showing cracks (but no cross-bedding, as claimed by ref. 3). (*C* and *D*) Thin section images in PPL (*C*) and XPL (*D*) of sample YC12-13-5, showing abundant vitric fragments and cracked crystal fragments, typical of volcanic origin. (*E* and *F*) Thin section images in PPL (*E*) and XPL (*F*) of sample YC12-13-6, showing vitric fragments, sanidine, and contorted biotite, typical of volcanic origin. (*G* and *H*) Thin section images in PPL (*G*) and XPL (*H*) of sample YC12-13-9, showing vitric fragments, sanidine, and contorted biotite, typical of volcanic origin. (*I* and *J*) Thin section images in PPL (*I*) and XPL (*J*) of sample YC12-13-7, showing minor (but still present) vitric fragments and abundant carbonate cements, likely indicating more-terrigenous clastic compositions. However, aegirine–augite, a characteristic mineral in the above three samples, and contorted biotite can also be found in YC12-13-7, which suggests the presence of volcanic components in this sample.