Supplement of The Cryosphere, 12, 163–168, 2018
https://doi.org/10.5194/tc-12-163-2018-supplement

The Cryosphere
Open Access

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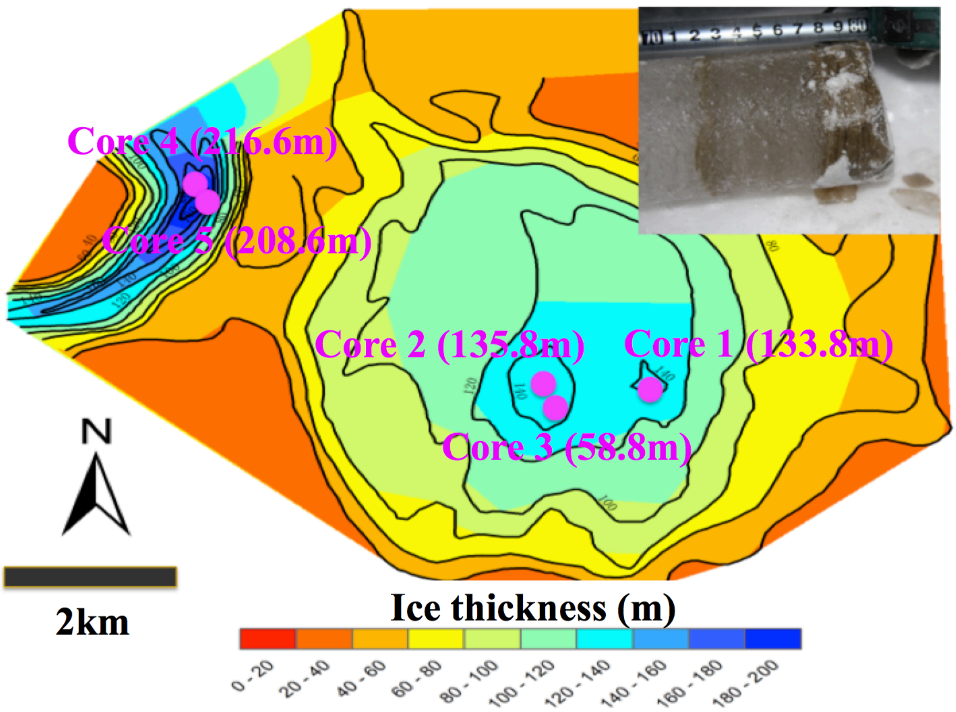


Figure S1: Map showing part of the Chongce ice cap where our ice cores were recovered. Core 1 (133.8 m) and Core 2 (135.8 m) to bedrock and Core 3 (58.8 m) were drilled at an altitude of 6010 m a.s.l. in 2012. Core 4 (216.6 m) and Core 5 (208.6 m) to bedrock were drilled at an altitude of 6100 m a.s.l. in 2013. The sediment samples that we measured for luminescence dating was collected from the very bottom section of Core 4, which is similar to the bottom several centimeters section as shown by the inset photo of Core 2.

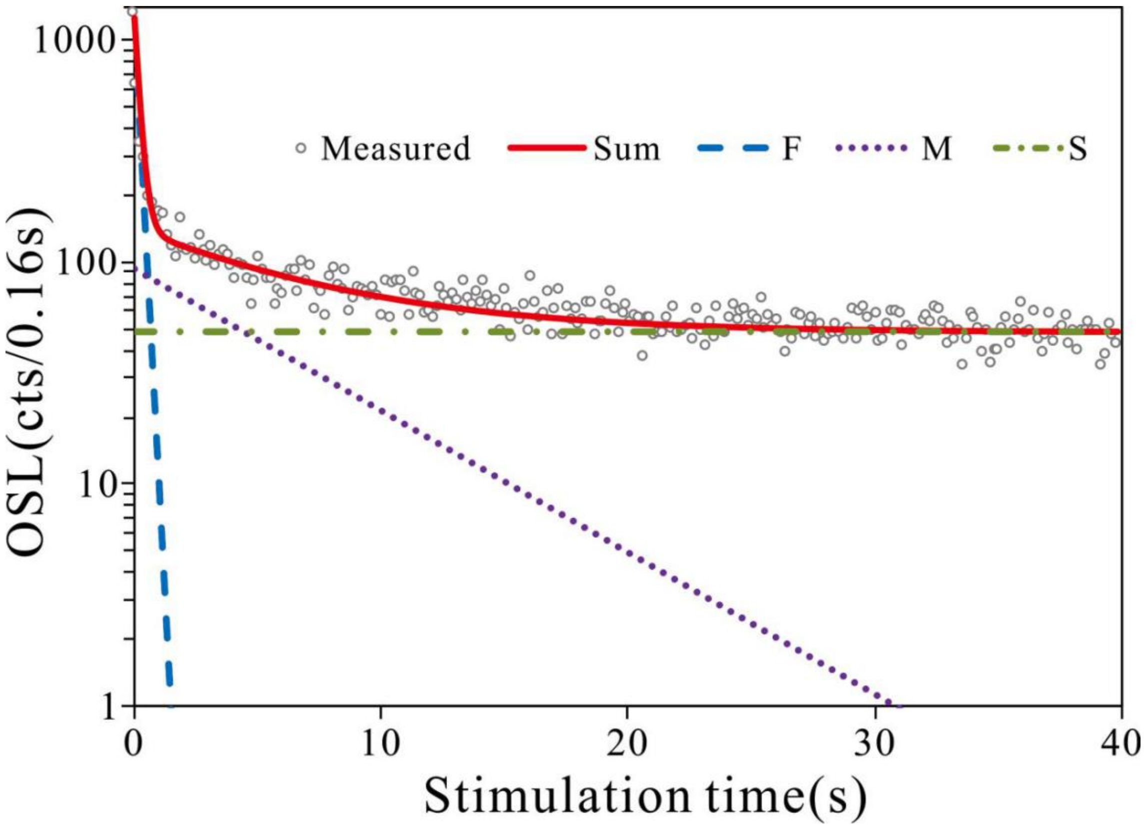
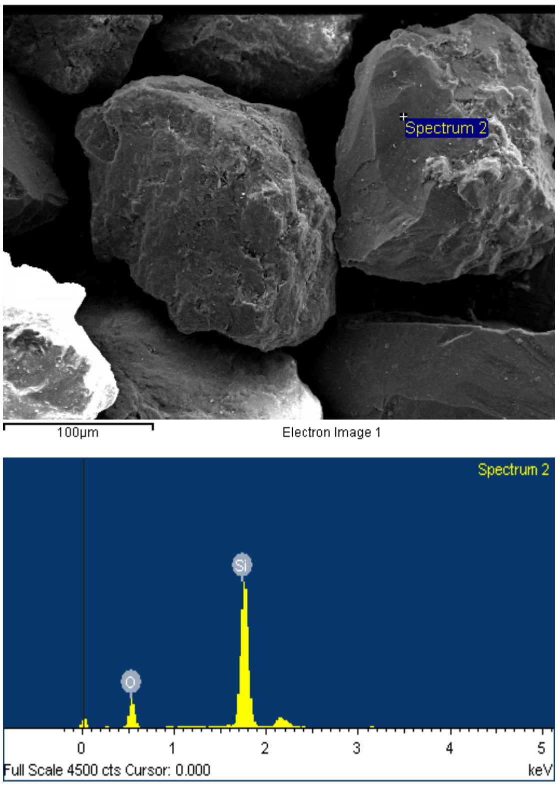


Figure S2: Natural OSL decay curves and their relative components for the fine grain quartz aliquots. Sum, F, M and S represent natural OSL signal, fast, medium and slow components, respectively. Fitting curve is matched with “Luminescence Analyst” program.



Spectrum processing:

Peaks possibly omitted: 0.260, 2.144, 9.690 keV

Processing option: Oxygen by stoichiometry (Normalized)

Number of iterations = 2

Standard:

Si SiO2 1-Jun-1999 12:00 AM

Element	Weight %	Atomic %	Formula
Si K	46.74	33.33	SiO2
O	53.26	66.67	
Totals	100.00		

Figure S3: Example photograph of Scanning Electron Microscope coupled with an energy dispersive X-ray microanalyzer.

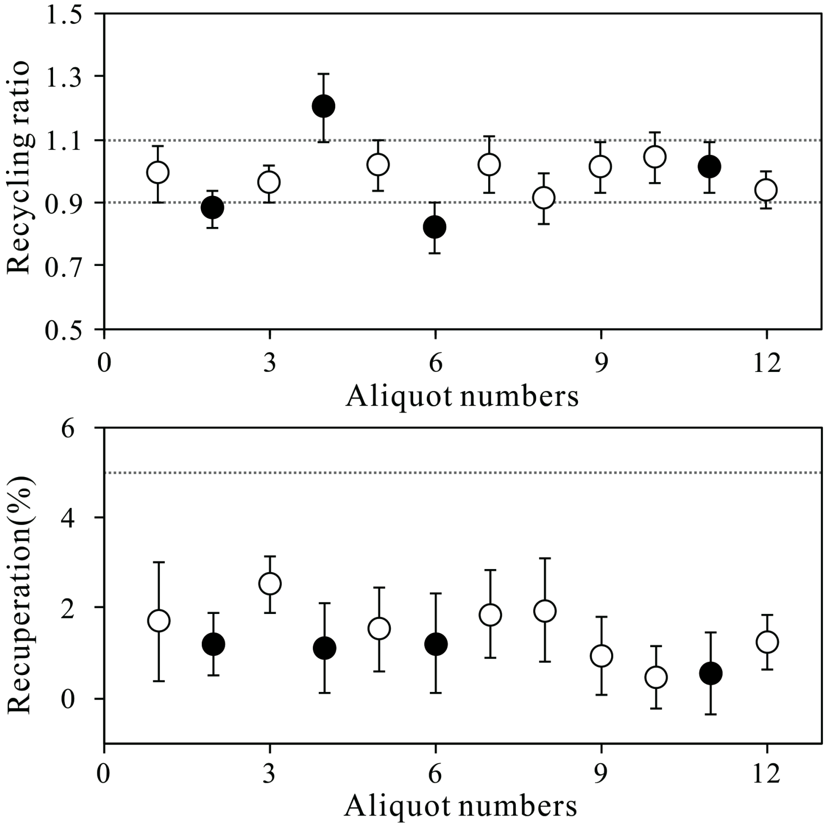


Figure S4: Recycling ratio and recuperation for fine grain quartz of the sample. Dose recuperation is expressed as the zero-dose corrected OSL in percent. The filled symbol represents the aliquots that were excluded in the final age calculation.

Table S1. Summary of dosimetric determined by gamma spectrometry analysis.

Sample	^{238}U(Bq kg^{-1})	^{226}Ra(Bq kg^{-1})	^{210}Pb(Bq kg^{-1})	^{232}Th(Bq kg^{-1})	^{40}K(Bq kg^{-1})
CCICE*	53 ± 11	45.5 ± 1.8	64 ± 13	45.5 ± 1.7	1096 ± 32

* CCICE stands for Chongce Ice

Table S2. Information on all the aliquots of the coarse (90-150 μm) and fine (4-11 μm) quartz grains

Grain size	Disc#	De (Gy)	Recycling ratio	Recuperation (%, corrected natural OSL intensity)
90-150 μm	1	171	0.94	2.68
	3	325	1.12	2.36
	5	175	1.13	2.51
	7	215	1.2	5.11
	9	442	0.99	2.48
	11	101	0.93	2.3
4-11 μm	1	162	1.02	1.52
	3	126*	0.82	1.21
	5	205	1.02	1.86
	7	149	0.91	1.95
	9	217	1.01	0.94
	11	239*	1.04	0.46
	13	180	1.01	0.54
	15	196	0.94	1.25
	17	165	0.99	1.71
	19	172*	0.88	1.19
	21	151	0.96	2.53
	23	194*	1.2	1.1

* stands for the aliquots that were not used for final De calculation.

Table S3. Results of the coarse quartz grains with their corresponding OSL ages.

Sample	U (ppm)		Th (ppm)		K (%)		D_e	Water content	Dose rate	Age
	Gamma	NAA	Gamma	NAA	Gamma	NAA	(Gy)	(%)	(Gy/ka)	(ka)
CCICE*	3.66 ± 0.15	3.45 ± 0.12	11.21 ± 0.42	11.40 ± 0.32	3.52 ± 0.10	3.48 ± 0.08	238 ± 51	0	5.25 ± 0.45	45 ± 11
								30 ± 15	3.85 ± 0.24	62 ± 14

* CCICE stands for Chongce Ice.

The Guliya ice core and the Kesang stalagmite core

In 1992, a 308.6 m ice core to bedrock was recovered from the Guliya ice cap located at 35°17'N, 81°29'E on the northwest Tibetan Plateau (Figure 1). The drilling site is at an elevation of 6200 m a.s.l. Top 266 m of the core was dated to a period spanning 110 ka, and ice below 290 m depth was suggested to be more than 500 ka old due to ^{36}Cl-dead in the ice (Thompson et al., 1997). Three Guliya interstadials (Stages 3, 5a, and 5c) are marked by increases in $\delta^{18}O$ values similar to that of the Holocene and Eemian (~124 ka ago) (Thompson et al., 1997).

The Kesang Cave is located in the Tekesi County, western China (42°52′ N, 81°45′ E, elevation ~2000 m a.s.l.) (Fig. 1). Eight samples from the Kesang Cave were collected to establish the Kesang $\delta^{18}O$ record with three covering the Holocene and five covering the rest of the Pleistocene portion. Cheng et al. (2012) obtained precise ages (~150 dates), all in stratigraphic order within errors, using a ^{230}Th dating technique in the University of Minnesota. The stalagmite $\delta^{18}O$ variations largely reflect changes in the $\delta^{18}O$ of meteoric precipitation (Cheng et al., 2012).

To reconcile the difference in the $\delta^{18}O$ variations between the Guliya and the Kesang records, Cheng et al. (2012) suggested that the Guliya record needs to be younger about a factor of two.