ERRATUM

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Expanded glaciers during a dry and cold Last Glacial Maximum in equatorial East Africa | Meredith A. Kelly, James M. Russell, Margaret B. Baber, Jennifer A. Howley, Shannon E. Loomis, Susan Zimmerman, Bob Nakileza, and Joshua Lukaye

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There was an error in the beryllium carrier concentration reported in this paper. The carrier concentration has been corrected and the ^{10}Be concentrations and ages recalculated. Please see the corrected Figure 1, and Table DR1 in the GSA Data Repository (http://www.geosociety.org/datarepository/2014/2014184.pdf). The ^{10}Be ages and mean moraine ages are corrected below in the Abstract and Results sections. The overall interpretations of the paper remain unchanged.

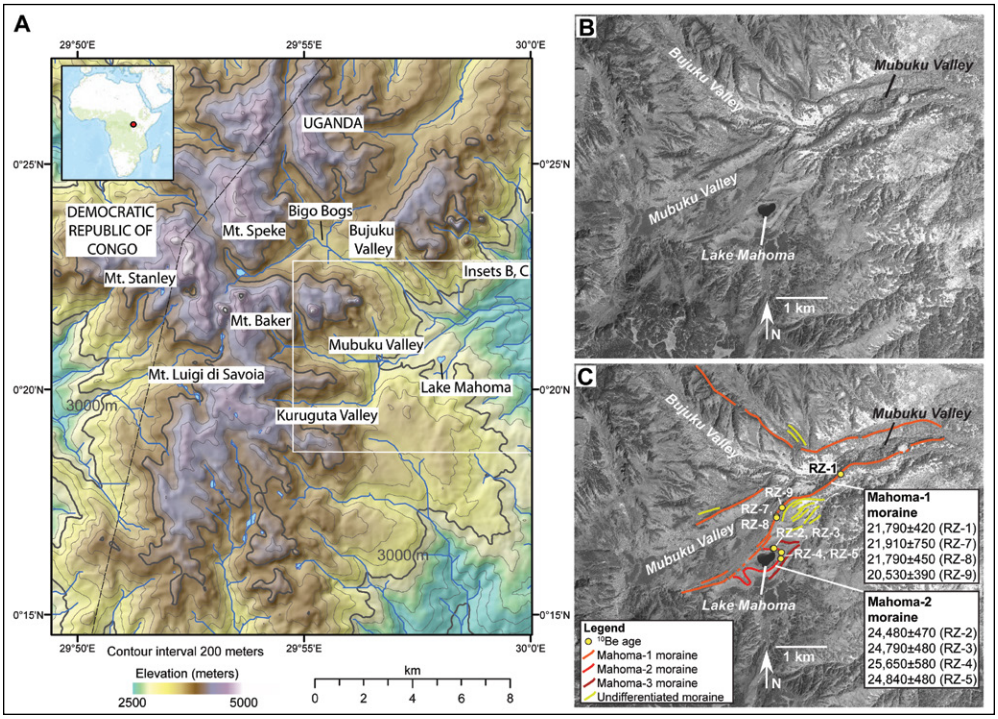
ABSTRACT

Glaciers on the world's highest tropical mountains are among the most sensitive components of the cryosphere, yet the climatic controls that influence their fluctuations are not fully understood. Here, we present the first ^{10}Be ages of glacial moraines in Africa and use these to assess the climatic conditions that influenced past tropical glacial extents. We applied ^{10}Be surface exposure dating to determine the ages of quartz-rich boulders atop moraines in the Rwenzori Mountains (~1°N, 30°E), located on the border of Uganda and the Democratic Republic of Congo. The ^{10}Be ages document expanded glaciers at ca. 24.9 and 21.5 ka, indicating that glaciers in equatorial East Africa advanced during the global Last Glacial Maximum (LGM; ca. 26–19.5 ka). A comparison of these moraine ages with regional paleoclimate records indicates that Rwenzori glaciers expanded contemporaneously with dry and cold conditions. Recession from the moraines occurred subsequent to ca. 21.5 ka, similar in timing to a rise in air temperature documented in East African lake records. Our results suggest that, on millennial time scales, past fluctuations of Rwenzori glaciers were strongly influenced by air temperature.

RESULTS

We measured eight high-precision ^{10}Be surface exposure ages of boulders on the Lake Mahoma Stage moraines (Fig. 1; also see Table DR1). Four ^{10}Be ages from the Mahoma-2 moraine range from 24,480 ± 470 to 25,650 ± 580 yr ago (^{10}Be ages ± 1σ measurement uncertainties) with a mean age of 24,940 ± 500 yr ago (arithmetic mean ± 1σ). Four ^{10}Be ages from the right-lateral Mahoma-1 moraine range from 20,530 ± 390 to 21,910 ± 750 yr ago (^{10}Be ages ± 1σ measurement uncertainties), with a mean age of 21,500 ± 650 yr ago (arithmetic mean ± 1σ).

In general, uncertainties in ^{10}Be dating arise from ^{10}Be production rate and measurement uncertainties as well as geological uncertainties such as boulder surface erosion, cover by sediment, snow or vegetation, and post-depositional boulder movement. The ^{10}Be ages presented here are calculated using a ^{10}Be production rate determined at a similarly low-latitude, high-altitude location (Kelly et al., 2013) with an estimated uncertainty of ~6% (http://cosmognosis.wordpress.com/). Measurement uncertainties are <3.5% (Table DR1). The ^{10}Be ages show excellent internal consistency on individual moraines and suggest that the geological uncertainties are small. For example, two boulders from <10 m apart on the Mahoma-2 moraine (RZ-2, RZ-3) yield nearly identical ages of ~24,480 ± 470 and 24,790 ± 480 yr ago (Figs. 1 and 2). Moreover, the ^{10}Be ages are consistent with the crosscutting relationship of the moraines showing that the Mahoma-1 moraine is younger than the Mahoma-2 moraine. Our ^{10}Be moraine chronology is also consistent with a radiocarbon age on organic material in a sediment core from Lake Mahoma (uncalibrated age is 14,750 ± 290 ^{14}C yr B.P.; Livingstone, 1962) This material (comprising ~20 cm of organic-rich sediment located 60 cm above gravelly till at the base of the core) provides a minimum-limiting age on glacial retreat of 17.2–18.6 kyr B.P. (2σ calibrated age range based on IntCal13; Reimer et al., 2013).



Corrected Figure 1. Location map of Rwenzori Mountains and ^{10}Be ages of Lake Mahoma Stage moraines in the Mubuku and Bujuku Valleys. A: Topographic map of the Rwenzori Mountains on the border of Uganda and the Democratic Republic of Congo showing locations discussed in text, including the Kuruguta, Mubuku, and Bujuku Valleys, Lake Mahoma, and the Bigo Bogs. White rectangle shows locations of B and C. B: Worldview2 (www.satimagingcorp.com/gallery-worldview-2.html) 0.5-m-resolution satellite image taken in January 2012 showing the Mubuku and Bujuku Valleys located in the eastern part of Rwenzori Mountains. C: Same satellite image showing Lake Mahoma Stage moraines, ^{10}Be sample locations, and ^{10}Be ages corresponding to sample locations. We have mapped undifferentiated moraines based only on satellite imagery and currently have no chronological data to constrain their ages. ^{10}Be ages shown are in years ago (i.e., prior to date of sample collection in A.D. 2012) with 1σ measurement uncertainties.