Abstract

$^{10}$Be $(t_{1/2}=1.39 \text{ Ma})$ concentrations in sediments of lakes with large catchment areas depend not only on the production rate but also on climate related transport and erosion processes. In this study we evaluated the potential use of the annually laminated and accurately dated (by U-Th) lacustrine sediments of the Lisan Formation (deposited from Lake Lisan, the late Pleistocene precursor of the Dead Sea; Fig 1) as a high resolution production rate archive of atmospheric $^{10}$Be. Lisan sediments comprise of annual pairs of primary aragonite and silty detritus material (Fig 2) that originated from desert dust blown to the lake’s vicinity and washed with desert floods (Fig 3). $^{10}$Be is mainly contained within the detritus laminae, while the aragonite laminae store information on the geochemical limnological history of the lake. The relative contributions of production and climate to the overall $^{10}$Be signal were evaluated by measuring the $^{10}$Be and chemical compositions of modern dust and the detritus laminae in intervals representing lake level changes and intervals representing rapid change in the $^{10}$Be production (i.e., the Laschamp excursion).

Our results demonstrate that during periods in which the $^{10}$Be production rate varies moderately the recycled $^{10}$Be component is significant. During these periods the $^{10}$Be concentration correlates with the combined Al and Fe content ($R^2$ = 0.88; Fig 4) and lake level variations (Fig 5). Yet, during the Laschamp excursion interval (~ 41–40 ka BP), $^{10}$Be concentrations show a ~two fold increase (2.98±0.12 – 5.30±0.12 x$^{10^6}$ atoms·gr$^{-1}$) that cannot be attributed to the mentioned correlations and possibly reflect the enhanced atmospheric production.

Radiocarbon measurements in primary aragonite laminae of the Lisan formation showed a significant 14C anomaly (up to ~900‰) across the Laschamp interval. We will combine $^{10}$Be and radiocarbon data to deduce the non production fraction of the radiocarbon anomaly.

Figure 3: Location map showing the Dead Sea, its drainage basin, the maximum extent of the late Pleistocene Lake Lisan.

Results and discussion

![Image](https://example.com/image)

**Figure 4:** $^{10}$Be vs. silicate (A) and carbonate (B) mineral proxies. $^{10}$Be shows a good linear correlation with siliate mineral proxies. The samples that lie out of the correlation (marked in red) correlate in age with geomagnetic excursions (Fig 5).

![Image](https://example.com/image)

**Figure 5:** $^{10}$Be vs. elevation (B) and age (C). The lithology of the sampled section MS1 (A) and Lake Lisan lake level curve (D; modified after Bartov et al 2003) are shown for comparison. The overall $^{10}$Be concentration correlates with lake level. However, during periods of rapid change in the $^{10}$Be production rate (i.e. geomagnetic excursions) the $^{10}$Be concentration shows a ~two fold increase (2.98±0.12 – 5.30±0.12 x$^{10^6}$ atoms·gr$^{-1}$)

Summary

This study evaluated whether $^{10}$Be variations in the laminated detritus sediments of the last glacial Lake Lisan reflect production or climate. The main findings of this study are:

1. During periods of moderate $^{10}$Be production rate variations (i.e. no paleomagnetic excursion) the $^{10}$Be content in Lake Lisan detrital sediments is determined by the amount of $^{10}$Be adsorbed from flood waters. Therefore, the Lisan formation can not be used to trace small fluctuations in the $^{10}$Be production rate.

2. $^{10}$Be production rate variations induced by large geomagnetic excursions are detectable in Lake Lisan sediments. This implies that $^{10}$Be can potentially be used as a paleomagnetic isochron of continental archives.

3. $^{10}$Be and radiocarbon data will be combined to deduce the non production fraction of the radiocarbon anomaly found in the Lisan formation during the Laschamp excursion.