Characterising and U-series dating (TIMS) of travertine from Hungary

M. SIERRALTA[1], F. MELCHER[2] AND M. FRECHEN[1]

[1]Leibniz Institute for Applied Geosciences (GGA), Stilleweg 2, 30655 Hannover, Germany (m.sierralta@gga-hannover.de)
[2]Federal Institute for Geosciences and Natural Resources, Stilleweg 2, 30655 Hannover, Germany

Introduction

Terrestrial carbonate formations, such as travertine, speleotherm and lake sediments, are important archives of terrestrial climate forcing. At the sections at Süttö in Hungary, a complex sequence of travertine is covered by loess and palaeosols indicating at least an OIS 7 age for the travertine. The Süttö travertine is a high resolution continental archive of interglacial palaeoenvironmental change.

Analytics

As the growth of travertine is a very complex mechanism and pore cements may cause serious problems for precise dating (e.g. Mallick and Frank 2002), we utilized microscopic, mineralogical and geochemical methods to determine the abundance of primary calcite phases. The state of alteration of primary spar and micrite was characterized by cathodoluminescence and microprobe analyses. Absolute ages were determined by TIMS ^{230}Th/U.

Results and Discussion

In contrast to travertines from Weimar-Ehringsdorf, Germany, travertines from Süttö showed homogeneous phases of primary calcite, minor micropores and rare pore cements. For U-series dating the samples were prepared from areas with mainly micrite and spar, avoiding pores. We determined ^{230}Th/U isochron ages with an isochron approach using the leachate/leachate method (Kaufman 1992). Travertines from Süttö show Mid Pleistocene ages which are supported by results from luminescence dating of the overlying loess sequence.

Conclusions

The absolute age determination of travertines at Süttö, Hungary yields a more reliable chronological frame to reconstruct both climate and environmental change for the time period of the Mid Pleistocene more precisely.

References

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On the ^{40}Ar/^{39}Ar age of biotite in Green River Formation ash: The advantages of incrementally heating single crystals with a laser

M. E. SMITH, B. S. SINGER AND A. R. CARROLL

Department of Geology and Geophysics, University of Wisconsin-Madison (msmith@geology.wisc.edu)

Some distal ash fall tuffs in the Eocene Green River Formation either lack sanidine, or the small proportion of sanidine crystals yield heterogeneous ages unsuitable for precise ^{40}Ar/^{39}Ar-based age stratigraphy. Thus, we have on occasion turned to biotite, mindful that it is far more prone to alteration, argon loss, and $^{39}Ar_K$ recoil. For example, we determined the age of biotite in the 6th tuff using a CO_2 laser to fuse 26 small aliquots, each comprising three ~500 μm diameter crystals, to be 49.70 ± 0.17 Ma [1] based on 22 of the measurements [2]. A second laser fusion study[3] of biotite from the same tuff measured smaller (>354 μm) and fewer (1-2) crystals per aliquot, with the result that only 11 of 31 apparent ages were considered concordant and gave a mean age of 49.12 ± 0.39 Ma [1], ~580 kyr younger than our fusion age [3].

To resolve this age discrepancy, and investigate the problems presented by biotite, we incrementally heated large (~1000 μm), hand-screened, euhedral crystals, or groups of three such crystals together with a laser. Twenty-three of twenty-six such experiments yield reproducible, concordant plateau ages that give a grand weighted mean age of 49.62 ± 0.17 Ma [1] (MSWD = 1.02). The three excluded experiments exhibit discordant spectra with young initial steps, plateau ages ~500 kyr older than the mean age, and integrated ages both older and younger than the mean. This pattern suggests that microscopic alteration along crystal edges and internal cleavage planes promoted subtle ^{40}Ar*-loss and $^{39}Ar_K$ recoil from these domains in ~10% of studied grains. Such open-system behavior may explain much of the variance attributed to xenocrystic contamination in previous fusion-based studies, particularly given the smaller crystals used [2,3]. Our new age fits well into the sanidine-based ^{40}Ar/^{39}Ar accumulation rate profile for the Green River Formation [2]. Should biotite be the only available chronometer for a distal ash, incremental heating of large crystals is recommended.

References

[1] ages relative to 28.34 Ma TCs standard; ±2σ intercalibration uncertainty.

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