

Extended range of U-series dating by combining $^{230}\text{Th}/\text{U}$ disequilibrium and ^{234}U excess dating

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Since the early work on U-series disequilibrium by α spectrometry during the 1960s and '70s, the development of spectrometric (TIMS and MC-ICP-MS) determinations of U and Th isotopes, which are more precise and accurate, have opened new applications for U-series. This analytical progress, allowing the use of smaller samples, increases the dating limit from 350-400 ka by α spectrometry to ~600 ka by MC-ICP-MS. Here we present U-series data, obtained by the analytical methods mentioned above, from pure CaCO_3 hydrothermal travertine deposits from southeast Morocco. The results from outcrop sections and a 12 m core show that calculated $^{230}\text{Th}/^{234}\text{U}/^{238}\text{U}$ for all outcrop sections, as well samples from the upper 5.5 m of the core, yield $^{230}\text{Th}/\text{U}$ ages between 10 to 500 ka, depending on their stratigraphic positions. In addition, the calculated initial $(^{234}\text{U}/^{238}\text{U})_0$ activity ratio for all these samples indicate a relatively high (~5) and constant initial excess of ^{234}U . Below 5.5 m all samples show $^{230}\text{Th}/\text{U}$ at radioactive equilibrium, when taking into account the analytical errors, while $^{234}\text{U}/^{238}\text{U}$ indicates disequilibrium and thus the ^{234}U excess decay method can be applied. For these samples, an age based on the decay of ^{234}U excess can be calculated assuming that the initial $(^{234}\text{U}/^{238}\text{U})_0$ activity ratio prevailed for the period older than 500 ka. Using this approach we calculate ages up to 1000 ka in the lower part of the core. A paleomagnetic inclinations record of the core can be used to validate these calculated ages. The results show a transitional change from about -50° at 8m depth to $+50^\circ$ at 10 m depth. This change to a reverse polarity was attributed to the B/M transition. Ages of samples at these depths varies from 724 ± 48 to 784 ± 48 ka, this is in good agreement with the age of the B/M transition. In conclusion, the combination of $^{230}\text{Th}/\text{U}$ dating with the decay of initial ^{234}U excess allow, in our case, to extend the range of applicability of U-series dating.