Dating deep-sea sediments with ^{230}Th-excess

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We present a dating method for deep-sea sediments that is independent from the presence of microfossils, carbonates or ash layers. In analogy to the constant-rate-of-supply (CRS) model for excess ^{210}Pb, we use the natural radionuclide ^{230}Th (half-life 75,380 years) as an absolute age marker. Using a sediment core from the Western Indian Sector of the Southern Ocean (PS63/146-2), we evaluate how a set of values of ^{230}Th, ^{232}Th and U isotopes concentrations can be used to derive age information for the last ~450,000 years for a continuously deposited sediment if the precision, resolution and depth/age coverage of the analytical data is sufficient.

We also assess the age uncertainties resulting from analytical errors using a Monte-Carlo approach as well as an analytical solution for error propagation. These methods show good agreement. In addition, we evaluate deviations due to a violation of model assumptions, e.g. by variable focusing of deep-sea sediments, using a simulated core. The results show that the sensitivity of dates to these effects is quantifiable, and smallest in the central part of the record. The obtained ages also allow calculating ^{230}Th-normalized preserved vertical rain rates of various sedimentary compounds.

Our example for a ^{230}Th CRS dated record of lithogenic fluxes in the Southern Ocean agrees exceptionally well with the timing of the completely independent global oxygen isotope record of foraminifera in marine sediments. $^{230}Th_{ex}$-CRS-dating therefore adds an important tool for dating marine records irrespective of their composition, and for quantifying elemental fluxes in a broad range of deep-sea sediments.