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Data treatment and systematic analysis of MC-ICP-MS $^{230}Th/^{238}U$-dating of secondary carbonates

Inga Kristina Kerber, Fabian Kontor, René Eichstädter, Andrea Schröder-Ritzrau, Sophie Warken, and Norbert Frank
Institute for Environmental Physics, Physics of Environmental Archives, Heidelberg, Germany

Carbonate based archives, such as speleothems and cold-water corals, yield valuable information on past states of the climate system. The key chronometer to access the deposition times of these archives is $^{230}Th/U$ dating, typically measured using multi-collector inductively coupled plasma mass spectrometers (MC-ICP-MS). Here, we present our Python-based data treatment, correction and age calculation algorithm equipped with a graphical user interface (GUI) which ensures reproducibility and allows for customized calculation constants. We outline the relevance of proper data outlier treatment and review hardware settings such as fade-out times of Faraday cups (FC). Furthermore, we systematically analyse the effect of variation in different MC-ICP-MS raw data corrections as tailing and process blank on the accuracy of the atomic ratios $^{230}Th/^{238}U$ and $^{234}U/^{238}U$ and the ages. To do so, three speleothem samples of different isotopic concentrations and ages were employed. We find that already a variation in tailing of 10 % causes a deviation on the permille level from the actual age for older samples (~150 ka), whilst younger samples are hardly affected. Process blank (instrumental background) measurements in turn affect the youngest samples strongest, as we found that an unnoticed increase of 50 % of the process blank results in a deviation on the percent level for the youngest sample (few hundred years). On contrary, hydride correction is minor for all samples, thus all time scales. In conclusion, the methods presented here permit routine precision levels of isotope analysis in the order of 5 ε units (1 ε-unit = 10^{-4}).