



$^{230}\text{Th}/\text{U}$ and $^{234}\text{U}/^{238}\text{U}$ dating of cold-water corals: Approaching the disequilibrium theory

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U-series disequilibrium dating or more specifically $^{230}\text{Th}/\text{U}$ - dating of cold-water corals is a major absolute chronological toolbox to study the evolution of coral reefs through time and to determine absolute time scales for climate proxies. Advances in multi-collector inductively coupled ion source mass spectrometry (MC-ICPMS) have continuously improved precision of Th and U isotopic measurements over the past decades thanks the development of new high ohmic resistors for Faraday cups. Consequently, isotopic measurements and absolute precision levels are in epsilon ranges for $^{234}\text{U}/^{238}\text{U}$ ratios and in the case of materials older than a few tens of thousands of years also for $^{230}\text{Th}/^{238}\text{U}$ ratios. To obtain accurate ages the corals isotope ratios need to evolve as a U series closed system and must be free of initial ^{230}Th and non-carbonate materials. The latter being often traced using the natural most abundant ^{232}Th isotope. Coral diagenesis, bio-erosion, residual ferromanganese coatings, recrystallization, and recoil displacement of U isotopes are known sources of age disturbances and U series open system behavior. Here, I want to advocate, however, that such cold-water corals can be ideal dating objects opening far reaching perspectives of marine climate science and for past ecosystem studies. Based on approx. 1200 coral ages and isotope ratios of reef-forming cold-water corals, which correspond to strict quality criteria, a perfect agreement with theoretical predictions of a closed U series system can be found. The resulting oceanic initial ($^{234}\text{U}/^{238}\text{U}$) activity ratio for the past 510 ka varies by at most 6.7 ‰ (2s) surrounding the mean of modern seawater and of all reconstructed values of 146.5 ‰ (HU1 reference material is assumed here to be in secular radioactive equilibrium). Consequently, the $^{234}\text{U}/^{238}\text{U}$ ratios may be used for dating of old cold-water corals to expand the dating range to more than 1.2 million years. Moreover, any significant deviation between closed system $^{234}\text{U}/^{238}\text{U}$ ages and $^{230}\text{Th}/^{238}\text{U}$ ages may be used to detect U series open - system behavior. Based on the combined age determination, more consistent chronologies can be derived for cold-water coral reefs beyond 350 ka and theoretically the quality of this archive has opened a path for absolutely dated marine climate proxy records since the Mid Pleistocene Transition.

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