Global bedrocks ($^{234}U/^{238}U$) disequilibrium and its implications on U-series disequilibrium dating

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The “comminution age” dating requires an assumption on bedrocks ($^{234}U/^{238}U$) activity ratios, typically assumes to be 1. However, the global bedrocks ($^{234}U/^{238}U$) activity ratios published in the past half-century ranges from 0.70 to 1.28 with an average of 0.98±0.07 (*N*=161), suggesting that visibly-unweathered/unfractured rocks worldwide could have activity ratios less than or beyond 1. We also measured the ($^{234}U/^{238}U$) activity ratio of unweathered bedrocks sampled from the Zhuoshui River catchment in central Taiwan Island, in which the value lowered following chemical leaching procedures attributed to the removal of non-detrital matter. These findings demonstrate that most of the global parent rocks are not in secular equilibrium and generally depleted in ^{234}U. This contradicts the knowledge that bedrocks are always in a “closed system,” and with age greatly exceeding ~6 times the half-life of ^{234}U (~1 Myrs), ^{234}U and ^{238}U are at secular equilibrium with their activity ratio ($^{234}U/^{238}U$) equal to 1. The widely observed ^{234}U deficiency ($^{234}U/^{238}U<1$) can not result only from the direct α-recoil into the porewater but may be caused by a preferential ^{234}U release or removal model from the inter-, intra-granular pores, micro-fissures created during crystallization in igneous and metamorphic rocks or diagenesis of sedimentary rocks, especially in the near-surface region where bedrocks can interact with porewater. In addition, the activity ratios of source rocks also depend on the local lithology, and mineral crystal sizes, and especially, with the presence of specific mineral (e.g., biotite) increases porosity and microfractures during incipient weathering. Henceforth, assuming ($^{234}U/^{238}U$) = 1 in the bedrocks seems to be impetuous, and the initial comminution process could commence in the parent rocks with ($^{234}U/^{238}U$) activity ratios <1, which may bias the U-series disequilibrium dating result, deserves more investigations globally.