U-Pb in fossil tortoise shell: a potential geochronometer for sedimentation

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This study analyzes U-Pb isotopes in fossil material associated with early hominid (*homo erectus*) artifacts from Wonderwerk Cave, Northern Cape Province, South Africa using LA-ICP-MS and ID-TIMS techniques in order to constrain ages of deposition. Vertebrate fossils incorporate uranium and lead following diagenetic processess, which involves bacteria-driven degradation of organic matter and often results in U enrichment. Assuming that the fossil did not lose or gain U or Pb after reaching equilibrium, the U-Pb age may closely approximate the age of deposition. Uranium-lead age determinations of vertebrate fossils have been applied in different studies, however most samples contain low U/Pb making the U-Pb technique inapplicable. Preliminary LA-ICP-MS analysis on fossil tortoises show that tortoise shells might be more suitable for U-Pb geochronology than the rest of the bones. The fossil samples analysed here contain average U concentrations of 40 ppm up to >400 ppm. $^{238}U/^{206}Pb$ ratios average 60 and range above 200. The samples are ca. 1 Ma old, so the U enrichment process may not substantially post-date burial. The age estimates from the fossil tortoises are compared to U-Pb dating of speleothem layers, which generally showed low U (<1 ppm) but very low initial Pb, resulting in $^{238}U/^{206}Pb$ ratios up to 400 or greater. LA-ICPMS data do not give useful age precision (0 +/- 1 Ma) but allow selection of the most radiogenic samples for ID-TIMS, which will be reported on later.

Accurate ages of fossilization will allow us to better establish the time-scale of diagenesis, which if on the order of a few Ka or less, would allow absolute stratigraphic age control of hominid settlements in Wonderwerk Cave and other archeological sites. Furthermore, since turtles/tortoises (Testudinata) are abundant from Mesozoic to Pleistocene deposits, their U-Pb dating could be used as geochronometer to constrain the stratigraphic record.