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A method for U-series dating of $CaCO_3$ crusts on Paleolithic lithic artifacts and bones and its application to Pleistocene archaeology of the Iranian Plateau

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Precise chronological determinations of Paleolithic archaeological samples are essential for interpreting the cultural development, occupation, and movement of Paleolithic human groups. However, dating of Lower and Middle Paleolithic remains is beyond the scope of radiocarbon while the radiocarbon dates of the Late Middle- and early Upper-Paleolithic are mostly underestimating the true age. However, U-series dating of calcite crusts/growths overlying some of these archaeological samples can potentially provide a minimum age (*terminus ante quem*) for the underlying artifacts or human/animal bone. Despite this opportunity, more limited sample size (lower U and Th concentrations) and contribution of detrital ^{232}Th will affect the final U-Th age results. In this study, we collected several samples from selected cave and rock-shelter sites in Western Zagros (Iran) and dated overlaying calcite crust and coral growth. We collected two calcite crust overlaying lithic artifacts from the Middle Paleolithic site (Darai Rock-shelter), one calcite crust overlaying an occipital fragment of a human cranium from multiple period Paleolithic site (Kulian Cave), and one coralloid formation over a cave bear's femur (Zilou cave).

Furthermore, we reconstruct $\delta^{18}O$ record for the coralloid formation and for a flowstone collected from Darband Cave in North Iran to test our dating method with global and regional climate records. The U-Th dates from Darai Rock-shelter, put the occupation in early MIS 4 and early MIS 3., which provided a minimum age for the selected samples and correspond well with the archaeological sequence of this shelter. Calcite crust overlaying a human cranium from Kulian Cave put the sample in the final part of the MIS 2. Dating the uppermost and basal part of coralloid formation from Zilou cave reveals a time frame from MIS 5e to early MIS 3. Applying this age model to $\delta^{18}O$ data shows that the reconstructed climate record is strongly correlated with the regional stalagmite records as well as with the global records of marine $\delta^{2}H$. Additional evidence is coming from $\delta^{18}O$ record of a 20-mm thick flowstone from Darband Cave which strongly correlated with the MIS 5a-c climate variability in the regional and global records.