Supplementary information: Methodology and uncertainty of µXRF and IRMS measurements

µXRF mapping was done using the M4 Tornado’s Rh-anode X-Ray tube under maximum source energy settings (50kV, 600 µA) using two silicon drift detectors, a spatial pixel resolution of 50 µm and an integration time of 1 ms per pixel. µXRF line scans in growth direction on the hinges of shells M0, M4, M6 and M11 were measured on the M4 Tornado in point-by-point mode (**Figure 2;** see de Winter et al., 2017a) using maximum source energy settings (50kV, 600 µA), a spot size of 25 µm, a spatial sampling resolution of 50 µm and an integration time per point of 60 seconds (1085 measurements in total). This measurement strategy allowed XRF spectra to accumulate enough counts to reach the Time of Stable Reproducibility and Accuracy (de Winter et al., 2017b).

Analytical uncertainty of IRMS measurements was determined by repeated measurement (N = 110) of the in-house reference material MAR2 (Marbella marble, δ13C: 3.41 ± 0.05 ‰VPDB; δ18O: 0.13 ± 0.10 ‰VPDB; 1 standard deviation, SD) and the standard deviations of reproducibility were found to be 0.02‰ and 0.08‰ for δ13C and δ18O values (1 SD), respectively. This MAR2 reference material was previously calibrated using the international NBS-19 stable isotope standard (Friedman et al., 1982).

**References**

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