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Time Series delta^{26}Mg Analysis in Speleothem Calcite: kinetic versus equilibrium Fractionation, Comparison with other Proxies and Implications for palaeoclimate Research

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Magnesium-isotope time series MC-ICP-MS analyses from a Pleistocene speleothem - collected in a limestone cave in NW Africa (Morocco) - are reported and discussed in a process-oriented context. In addition, high-resolution C, O and Sr-isotope data, and Mg and Sr element abundances were compiled from the same stalagmite. Subsamples were collected along the stalagmite growth axis and a second data set was drilled perpendicularly within one growth interval (Hendy test). The analytical results show clearly co-variant, systematic and cyclical fluctuations for all proxies collected along the growth axis and - with respect to the analytical error - invariant data within one growth increment. Magnesium-isotope ratios (delta^{26}Mg) fluctuate between minus 4.39 permil plus/minus 0.02 2 sigma and minus 4.17 permil plus/minus 0.05 2 sigma and are within the range of published results of speleothem calcite from limestone caves. The difference of 0.22 permil is significantly beyond the error of the external reproducibility of plus/minus 0.03 permil 2 sigma for delta^{26}Mg. Considering the analytical error, neither a purely kinetic nor an equilibrium fractionation process explains the observed isotope pattern. It is suggested that two external factors drive the speleothem Mg-isotope cyclicity: (1) climate-driven (arid versus humid) variances in the precipitation rate of a carbonate phase from meteoric water within the karstic system prior to entering the cave system; and (2) changing rates of silicate

(aeolian material) versus carbonate weathering. Both of these processes fractionate the Mg-isotopic composition of runoff/seepage water. There is clear evidence that the magnesium-isotope system, applied to speleothem archives, bears significant information concerning continental climatic variability and deserves further research.