High resolution trace element and oxygen isotope analyses of a modern speleothem

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Annual resolution of speleothem proxy climate records is an attractive goal in Quaternary palaeoclimate studies. This is now attainable following advances in LA-ICP-MS and SIMS technology. We present 5 micron spatial resolution LA-ICP-MS trace element data alongside 40 micron resolution SIMS $\delta^{18}O$ data for a modern stalagmite from the Margaret River region of southwest Western Australia. The trace element data show clear cycles of positively correlated Sr and Ba concentrations that are negatively correlated with Mg concentrations. These cycles are known to be annual since the age of the stalagmite is well-constrained by the date of placement of the cave tourist boardwalk on which it grew (1911-1992). These findings support earlier studies using lower resolution SIMS data (Roberts *et al.*, 1998; Finch *et al.*, 2001; Huang *et al.*, 2001).

Unique to this study, the relatively fast growth rate, (approx. 350 microns per year) has enabled SIMS $\delta^{18}O$ analyses to be performed alongside a portion of the trace element data. These $\delta^{18}O$ data show an annual cycle of approximately one per mil, in sympathy with the magnesium concentration variations.

The superior age control provided by the cave tourist boardwalk together with the excellent annual growth rate control provided by the trace element data, make this sample ideal for conducting a rigorous examination of the trace element and $\delta^{18}O$ cycles with the instrumental climate data. This should bring us closer to decoupling the cave temperature and precipitation signal in speleothem records, and thus verification and validation of these climatic proxies.

References

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Primordial noble gases in the Earth: remnants of accreted planetesimals or a solar protoatmosphere ?

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Elemental abundances in the terrestrial atmosphere are fractionated relative to solar composition, similar to carbonaceous chondrites. This led to the concept of “planetary” noble gases, ascribing Earth´s inventory to degassing of precursor planetesimals (Ozima and Podosek, 2002). However, the discovery of solar He and Ne in Earth´s mantle was regarded to support an alternative scenario: This considers fast, almost complete accretion of the Earth *before* dissipation of the solar nebula, gravitational attraction of a dense solar-type protoatmosphere, dissolution of solar noble gases into an underlying magma ocean, and fractionation during protoatmosphere loss (Mizuno et al., 1980). However, recent high precision analyses of mantle rocks (Trieloff et al. 2000) demonstrated that solar neon in Earth´s mantle is indistinguishable from solar wind implanted neon as found in meteorites (“Ne-B”). Such an irradiation requires a much earlier dissipation of the solar nebula when the Earth´s precursor planetesimals were relatively small (0.1-1 km), and precludes later gravitational capture of a dense primary protoatmophere.

An early irradiation has been previously suggested for carbonaceous chondrites. While solar wind implanted neon increases in the sequence CI-CM-CV-Earth´s mantle, other non gaseous volatiles decrease, probably indicating a link between early T-Tauri activity of our sun and volatile depletion in the early solar system.

Both CV chondrites and Earth´s mantle have a similar hybrid of solar He and Ne-B, and planetary Ar, with indistinguishable Ne/Ar ratios. Therefore, also Ar could be inherited from accretion, but similar conclusions for Kr and Xe are more problematic. I will consider subcomponents that possibly match terrestrial Ar, Kr, Xe abundances and fractionated Xe. Pros and cons of protoatmosphere models will also be discussed.

References

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