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A High-Resolution, Multi-Proxy Palaeoclimate Study of the Central Northern Mediterranean

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Two stalagmites, SLO-1 and SLO-2, collected from Postojna cave, Slovenia show very high growth rates ($\sim$0.28mmyr^{-1}), and grew to impressive lengths – SLO-1 measures 2.2m (2200mm) and SLO-2 measures 1.38m (1380mm). This record is constrained by U-Th and α-mass spectrometry dates collected on both stalagmites, indicating growth between 16 and 0.6ka BP. Together, these samples provide a potentially exceptionally complete and high-resolution record of climate in the central northern Mediterranean for the Holocene. Moreover, within these stalagmites, there is an overlapping period between $\sim$4.5 and $\sim$9.1ka which allows cross-validation of two records.

Stable isotope data collected to date form a continuous, 1-mm resolved record for the upper 554mm of SLO-2, resulting in a record covering $\sim$1.5ka, from $\sim$0.6ka BP to $\sim$2.1ka BP and a series of "Hendy tests", which indicate that kinetic fractionation has been small. The stable isotope data spans the Medieval Warm Period and Dark Ages Cool Period and shows a marked cyclic variability probably reflecting the balance of winter and summer precipitation. Regionally cooler periods show typically isotopically negative (winter-like) $\delta^{18}O_{calcite}$ values, whereas regionally warm periods show relatively positive (summer-like) values. High temperature fluctuations between summer and winter in Slovenia result in large ($\sim$6‰) variations in $\delta^{18}O_{precipitation}$. Such a dramatic shift between winter and summer precipitation makes changes in winter/summer balance more noticeable in these samples than in other areas. Shorter scale variability is also prevalent, especially when longer term variations have been removed by detrending. This is in spite of the aquifer feeding the stalagmites being well-mixed, which would ordinarily hinder finer resolution records. This may be due to an influence of cave ventilation affecting the fractionation of isotopes once the drip has entered the cave.

The climate record is in good agreement with known climate fluctuations, including the periods mentioned above, as well as the very beginning of the Little Ice Age, with the potential for the record to be extended much further back in time.

In addition to the stable isotope record, trace element analysis has also been performed using two methods, inductively coupled plasma optical emission spectrometry (ICP-OES) and X-ray fluorescence (Itrax). Included in this study is the first direct calibration of the two techniques for a stalagmite in an attempt to discern the efficacy of the two techniques. Itrax poses many advantages over the more conventional ICP methods, perhaps the most important being the ability to perform non-destructive analysis on the stalagmite surface. A successful calibration would validate the use of the faster, cheaper Itrax method as an alternative to ICP.