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U-Th, U-Pb and U-U dating of the Corchia Cave speleothems: a continuous 1 Ma chronology

J. Hellstrom (1); J. Woodhead (1); R. Drysdale (2); I. Couchoud(2); G. Zanchetta(3)

(1) School of Earth Sciences, The University of Melbourne, Victoria 3010, Australia; (2) Environmental and Climate Change Research Group, The University of Newcastle, Callaghan NSW 2308, Australia; (3) Department of Earth Sciences, University of Pisa, via Santa Maria 53, Pisa 56100, Italy

Speleothems from Corchia Cave, Italy provide long and detailed records of North Atlantic paleoclimate with clear correlations to polar ice core data. U-Th, U-Pb and U-U dating reveals overlapping growth periods from the Holocene to over 1 Ma. Mass spectrometric U-Th dating works well for Corchia speleothems younger than about 400 ka, giving uncertainties of ˜1 ka for MIS 5, ˜3 ka for MIS 7 and ˜10 ka for MIS 9. Corchia stalagmites are particularly suitable for U-Pb dating, allowing its routine use on samples younger than normally possible. Isochrons with age uncertainties of as little as 2 ka have been obtained for samples of ˜1 Ma, although this currently increases to ˜20 ka after accounting for initial disequilibrium. A third technique, 238U-234U, is used to increase the dating density, possible because the seepage water at Corchia has undergone an unusually stable and uniform 234U/238U evolution, characterised using many U-Th and U-Pb dates. This allows an age to be determined for any Corchia speleothem on the basis of its 234U/238U measurement, to an uncertainty of ˜40 ka.

A unique feature of using these three dating methods together on the same suite of samples is that they improve each other through constraint of 234/238U evolution and absolute spike calibration. This will have a particularly strong effect on the precision obtainable using U-U and is expected to lead to a composite age uncertainty of at most ca. 10 ka at any time over the last 1 Ma once many more U-Pb and U-U analyses have been undertaken. LA-ICP-MS elemental imaging of Corchia speleothems allows unambiguous cross-matching between them, meaning that effort expended dat-

ing one speleothem can be transferred to others already known to be of similar age. Ultimately it is expected that all available age determinations shall be synthesised into a single unified timescale for the Corchia proxy records covering the last 1 Ma. As already demonstrated for MIS 5 and 6, there is enormous potential for transfer of such radiometric Corchia timescales to marine and ice core records.