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TIMS U-Th Dated Multiproxy Speleothem Records of Late Quaternary Climate and Environmental Change in England

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Cave speleothems offer the potential to provide an improved palaeoclimate and palaeo-environmental record, as unlike many other terrestrial records, their cave environment protects them from destruction by surface erosion, allowing long sequences to be preserved. Speleothems provide a climatic signal by the timing and rate of their growth and through the palaeo-environmental signals they contain, including, of particular interest in this study, pollen and organic acids trapped in the speleothem calcite. Conventional sources of such organic remains such as lake and bog sediments are constrained in that they can only be dated back to about 40 ka by ^{14}C dating. Beyond this limit the Middle Pleistocene terrestrial record in Britain has not been precisely dated, it is based on faunal and floral correlations.

In contrast to these organic deposits, speleothems are particularly well suited for dating through the application of U-series thermal ionisation mass spectrometry back to 350 ka (Li *et al.*, 1989), as they generally behave as closed systems since deposition. This makes them especially advantageous for palaeoclimate studies, as it enables an absolute timeframe to be determined for the many records they contain, allowing more secure correlations to be made, particularly with the oxygen isotope stages on which the stratigraphy of the Quaternary is based.

The method of speleothem pollen analysis was pioneered in Belgium by Bruno Bastin (Bastin (1978)). It has been demonstrated that well preserved pollen may be successfully extracted from speleothems in sufficient quantities to allow palaeo-environmental reconstruction, (Lauritzen et al., 1990) and that these pollen spectra are representative of contemporary surface vegetation (Burney and Burney, 1993). The fluorescence properties of organic acids in the speleothems are also being studied as a complementary record. If climatically induced variations in the rate of organic matter breakdown are reflected in changes in the composition of organic acids in the soil and their fluorescence properties, then a climatic signal may be preserved (McGarry and Baker, 2000). Figure 1 shows how the components of this study interact to produce an accurately constrained palaeo-environmental record.

TIMS U-Th dating of speleothems from Yorkshire and the Mendip Hills, England, in this study has shown growth to have taken place during interstadial and interglacial periods, ranging in age from 132 ka to 9 ka. Pollen has been successfully extracted from the samples in suitable concentrations, (from 1-5 grains per gram of calcite) showing little sign of degradation. For example, a flowstone from Yorkshire has been dated to have grown early in Last Interglacial, from 132 to 127 ka. This sample contains the pollen of such thermophilous species as *Quercus*, *Fraxinus*, *Alnus* and *Corylus*, which alone would be assumed to have been growing in the later more temperate stages of the interglacial, but the U-Th dates indicate these species were present at the beginning of this warm period, suggesting the climate had ameliorated sufficiently rapidly at this early part of the Eemian to allow such thermophilous species to migrate into the area. The organic acid record shows moist conditions and poorly humified soils.

This flowstone also grew during oxygen isotope stages 5c and 5a, as evidenced from the U-Th dates of 103 ka and 84.9 to 83 ka. Both of these levels yielded a range of herb pollen along with *Quercus*, *Fraxinus* and *Corylus*, species which, based on bio-stratigraphical correlation alone, might ordinarily have been assigned to sub-stages of the preceding interglacial, but the absolute ages obtained reveal the climate of these interstadials was in fact warm enough to allow growth of such thermophiles. Further, the dates allow direct comparison between speleothem pollen spectra and those obtained from long French pollen sequences (dated on the basis of the OIS stratigraphy), (Guiot et al., 1989) and a good agreement is seen The organic acids indicate soil humification had increased due to a decrease in soil moisture during these times.

The application of TIMS U-Th dating to pollen and organic acid records from cave speleothems is a significant new approach in palaeoclimate and palaeo-environmental research in Britain. In particular, this approach provides palaeo-environmental records for time periods for which few suitable sediments are available, specifically interstadials, and most importantly, it allows a geochronology to be put on records which would otherwise be less well constrained.

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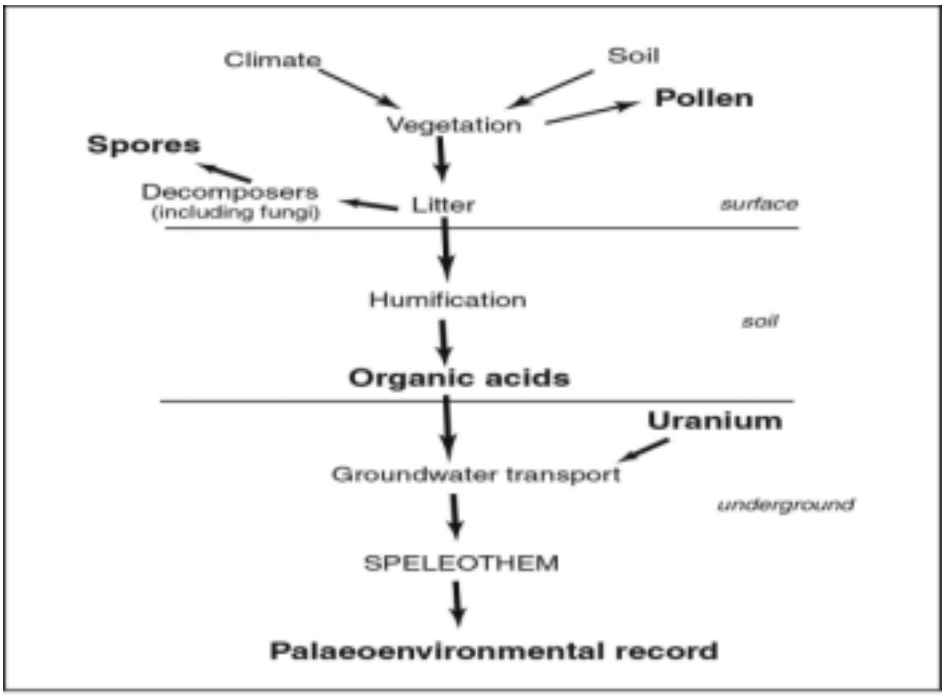

Figure 1: Flow diagram showing the interactions of all the components of this study.

Bastin, B, *Annales de la Societe Geologique de Belgique*, **101**, 13-19, (1978).

Burney DA & Burney L, *New Phytologist*, **124**, 523-535, (1993).

Guiot J, Pons A, Beaulieu JL de, & Reille M, *Nature*, **338**, 309-313, (1989).

Lauritzen SE, Løvlie R, Moe D & Østbye E, *Quaternary Research*, **34**, 306-316, (1990).

Li W-X., Lundberg J, Dickin AP, Ford DC, Schwarcz HP, McNutt R & Williams D, *Nature*, **339**, 534-536, (1989).

McGarry SF & Baker A, *Quaternary Science Reviews*, **19 (11)**, 1083-1097, (2000).