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One of the principal aims of the 2014 fieldwork was a sampling programme to collect dateable material to build a chronology of the human activity using Uranium–Thorium and Carbon-14 dating techniques. Small samples of flowstone which had formed over anthropogenic modification such as finger fluting, and on top of archaeological floors were collected for application of Uranium-Thorium dating. Where possible, samples of organic materials for radiocarbon dating, such as archaeological charcoal and shell, were collected from the same contexts to allow comparison of dating methods. This paper presents the fieldwork aims, preliminary results and describes the sampling programme.

Millennial scale control of European climate by the North Atlantic Oscillation from 12,500 BP: The Asiul speleothem record

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Contemporary climate in Europe is strongly influenced by the North Atlantic Oscillation (NAO), the atmospheric pressure dipole between Iceland and the Azores[1]. Under positive NAO conditions winter storm tracks associated with the Atlantic Westerly Jet (AWJ) migrate northwards, leading to wetter and warmer winter conditions in north-western Europe and dry conditions in southern Europe; including the Iberian Peninsula. Under the negative NAO phase, storm tracks weaken and shift southwards reversing the pattern[1]. Existing proxy records of the NAO suggest that this atmospheric process only began to dominate European climate at approximately 8000 years BP, related to the final breakup of the Laurentide ice shelf[2]. However, here we present evidence of precipitation changes from a high-resolution speleothem $\delta^{18}O$ record from northern Iberia, which indicates NAO-like forcing extending throughout the Holocene and into the Younger Dryas (YD) at 12,500 years BP. These variations in precipitation delivery relate to an underlying millennial scale cycle in NAO dynamics. The speleothem $\delta^{18}O$ is strongly correlated to existing records of North Atlantic Ocean ice rafted debris (IRD)[3], indicating an NAO-like connection with oceanic circulation during the Holocene[2]. These large-scale atmospheric processes have dramatically influenced the delivery of precipitation to northern Iberia and may have played a decisive role in environmental and human development in the region, throughout the Holocene.

[1] Hurrell *et al.*, 2001. *Science,* Vol.291, 603–605.
[2] Giraudeau *et al.*, 2010 *Quaternary Science Reviews,* Vol.29, 1276–1287.
[3] Bond *et al.*, 1997. *Science,* Vol.278, 1257–1266.

Multiple U-Th-Pb techniques applied to speleothems: climate and landscape evolution applications

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Speleothems are widely recognised as valuable archives of palaeoenvironmental change capable of delivering accurate and precise chronologies for materials up to ~ 500 ka old using the U-Th decay scheme (Richards and Dorale, 2003). For materials at or approaching secular equilibrium the development of U-(Th-)Pb dating techniques has created new opportunities in speleothem research, leading to fresh insights into climate change, landscape development, tectonics, and human and faunal evolution and migration, see review by Woodhead and Pickering (2012). However, widespread adoption of the U-Pb decay scheme for speleothem dating has been hampered by the need to accurately and precisely predict the initial state of U-series disequilibrium (i.e. $(^{234}U/^{238}U)_{(initial)}$) for materials at or analytically indistinguishable from secular equilibrium, in addition to difficulties associated with identifying samples with a sufficient range of U/Pb ratios to provide high precision isochron age determinations. These challenges are further compounded by the labour intensive nature of current U-Pb dating methods, which employ isotope dilution (ID) and either TIMS or MC-ICP-MS analysis.

Here, we present results demonstrating the potential of U-Pb dating by laser ablation (LA) MC-ICP-MS for a suite of speleothems from Canada, Australia and UK, spanning the Late Pliocene to the Late Pleistocene, exhibiting variable U (1-100μg g^{-1}) and low non-radiogenic Pb (<50ng g^{-1}). To resolve issues of initial disequilibrium, we have adopted a combined U-Th-Pb dating strategy to take full advantage of the sensitivity and spatial resolution of all of the following techniques for individual growth layers: (1) in-situ U-Pb LA MC-ICP-MS (193nm ArF excimer laser) techniques, which enables fast throughput, high spatial resolution and a wide range in U/Pb for individual spots; (2) conventional U-Pb ID TIMS and MC-ICP-MS, for high-precision three-dimensional isochrons at lower spatial lower resolution; (3) U-Th MC-ICP-MS static Faraday methods, to obtain high-precision estimates of initial $^{234}U/^{238}U$ for material $\gg$500 ka. We discuss the compromises that have to be made between spatial resolution and age precision for speleothems with different growth rates and ages when using the various methods above. In addition, we also highlight a number of challenges specific to U-Pb dating by LA MC-ICP-MS, including U/Pb down-hole fractionation in carbonates.

We illustrate the combination of both LA-MC-ICP-MS and ID-TIMS U-Pb dating alongside U-Th MC-ICP-MS analysis for a specific example of landscape evolution for the 70km-long Ogof Draenen cave system in South Wales, UK, where the timing and extent of Late Quaternary glaciations has influenced local topography and cave development through sediment choking, resulting in repeated changes/switching of underground drainage, creating a hydrological see-saw (Farrant and Simms, 2011).

Farrant, A R and Simms, M J, 2011. Ogof Draenen: speleogenesis of a hydrological see-saw from the karst of South Wales. *Cave and Karst Science,* Vol.38(1) 31–52.

Richards, D A and Dorale, J A, 2003. Uranium-series Chronology and Environmental Applications of Speleothems. *Reviews in Mineralogy and Geochemistry,* Vol.52, 407–460.

Woodhead, J and Pickering, R, 2012. Beyond 500 ka: Progress and prospects in the UPb chronology of speleothems, and their application to studies in palaeoclimate, human evolution, biodiversity and tectonics. *Chemical Geology,* Vol.322–323, 290–299.

The lost limestone mines of Dudley ***ORAL and DISPLAY***

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The Dudley Limestone Mines history goes back to the first half of the eighteenth century. An example of the way in which the limestone extraction increased from this time can be seen from mine records. In 1724, Richard Bolton, the bailiff for Lord Ward of Dudley, estimated the value of the whole limestone works at £250 per annum free of tax. However, by 1796, they were let for guaranteed royalties of at least £6000 per annum. Some of the local limestone had also been used much earlier, for the building of the Priory in the twelfth century and Dudley Castle in the thirteenth century. Two bands of limestone were mined. These were known as the upper and lower limestone beds, but were more commonly referred to as the Thin and Thick Seams. The Thin Seam was 25 feet thick while the lower Thick Seam was some 30 feet thick. The two seams were separated by 120 feet or so of Nodular Beds. A unique feature in these mines is that the limestone was removed from the Wren's Nest Hill and Castle Hill Mine galleries by means of an underground canal system. The mines under Castle Hill were abandoned around 1850, while the Seven Sisters mine under the Wren's Nest Hill still had five men working underground until September 1924. Following a fatal injury to one of them, mining operations ceased.

In 1961, an entrance into the North end of the Seven Sisters, known as the "Devils Mouth", was collapsed by blowing out five of the supporting roof pillars along the gallery below, using half a ton of explosives. While sealing off this entrance, it created serious problems on the hillside above, resulting in the whole hilltop being fenced off, as it still is today. Next, in 1964, there was a serious Crown-in to the surface of one of the mine galleries located beneath the local football ground. Being next to the Dudley Guest Hospital, this saw the start of major infilling operations by the local authority. By 1970, following a stability survey of the mines on the Wren's Nest Hill, this work accelerated, initially being focused on Wrens Nest and later on Castle Hill, Mon's Hill and sections under Sedgley. The last phase of this infilling programme took place in 2009, when the "East Mines" galleries under the Wren's Nest Hill were infilled. To give an idea of the scale of this infilling, when it began on the Wren's Nest Hill, in the 1970's, one section of the mine received some seventy lorries a day, each carrying twenty tons of sand. By working seven days a week, it took about two years to infill this part of the mine.

Today, it is possible to visit only one of these underground mine galleries, this being on the Castle Hill site. It enters the "Singing Cavern" in the Thin Seam, using the canal system, which is run and operated by the Dudley Canal Trust. Regarding the Wren's Nest Hill and the well-known Seven Sisters mine (formerly known as the Daylight Caverns), all the lower levels have been infilled. The upper daylight gallery has been temporally sealed, but not infilled. Hopefully, it will be opened for visitor access before too long, but this is subject to significant grant aid being available.