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Re-arranging the family tree: the new role of U-Pb dating flowstones

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The value of speleothems as archives of palaeoclimate information is greatly enhanced by their inherent suitability to U-series dating. U-Pb dating goes beyond the 500 000 year cut off of U-Th and with the recent, major advances in this technique the possibilities are both numerous and exciting. While much U-series work has focused on dating stalagmites, in many archaeological and palaeontological settings, flowstones are useful targets as they can provide age constraints for the material associated with them. This is especially pertinent in South Africa, where the dolomite caves of the 'Cradle of Humankind' contain early human (hominin) fossils embedded in calcified cave sediments. Knowing how old these fossils are is critical to placing them in our human family tree, especially when new species are identified, such as Australopithecus sediba discovered in 2009.
However, the whole dating process is subject to numerous pitfalls. Firstly, careful and thorough fieldwork is needed to identify flowstone associated with the fossils and in the best cases find flowstone layers 'sandwiching' in the fossil layers. Secondly, in many cases bulk U concentrations in flowstones are typically too low (< 0.05 μg/g) to provide useful ages and some form of pre-screening using, for example, laser ablation ICPMS traverses, is needed in order to select potentially datable layers with U concentrations ≥ 1 μg/g. Thirdly, in samples as young as 2 Ma, very small amounts of radiogenic Pb has accumulated and a dominance of common Pb, even in Pb poor material, further complicates dating. Finally, current age estimate errors are at best around 1% but can be as high as 10%.
A suite of new U-Pb dates for flowstones from four early hominin caves in South Africa reveal a number of intriguing results. Flowstones from caves several kilometres apart have U-Pb ages within error of each other, suggesting some large scale cyclicity behind the alternating deposition of flowstone and cave sediment. The sites are now placed in chronological order and discrete fossil bearing horizons of the same age compared with each other, as well as with similarly aged deposits in East Africa. Ages can be assigned to the early hominin species and, in the case of Au. sediba, by combining the U-Pb ages with the palaeomegnetic signals preserved in the sediments and flowstone remarkably precise estimates can be achieved.