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U-Pb dated Speleothem records of Plio-Pleistocen climate variability from South African hominin bearing caves

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We use stable isotopes of carbon and oxygen to investigate the potential palaeoclimate records from the caves near Johannesburg in South Africa. The sediments in these caves contain early human (hominin) fossils, as well as speleothem material, providing an ideal opportunity to investigate the palaeo-enviroments of our earliest ancestors. These sites are dated via uranium-lead to between 2.8 and 1.5 Ma and provide a window into changing climatic conditions, rare from both this period and region. We micro-drilled stalagmite and flowstone samples from Sterkfontein (2.8 -2.0 Ma), Swartkrans (2.4 -1.7 Ma) and Cooper's Cave (1.5 – 1.4 Ma) at 0.5mm spacing to provide a total of five high resolution records. Oxygen isotope values range from -6.5 to -3‰, clustering around -4.5‰. Carbon isotopes range from -8 to 2‰ and show more variation. Both a Hendy test and a C vs. O plot show that the deposits in question were deposited in equilibrium with their surroundings and the data can be used for environmental interpretations. Care was also taken to examine the petrography of all the speleothem material to access the mineralogy (calcite vs aragonite) and the extent of re-crystallisation. Oxygen isotope values are interpreted as the product of the amount and type of rainfall, with wetter periods represented by enriched excursions. The contribution of the dolomite aquifer above the cave may, however, obscure the 18O signal. The carbon isotopes reflect changes in the vegetational communities above the cave, with varying amounts of C3 and C4 plants. At present each speleothem piece has only one U-Pb date, the distribution of suitable uranium rich layers limits the spatial resolution of dates. The Cooper's Cave flowstone pieces display visible growth layers; should these be annual layers, then these two records represent as little as 60 years climate variability – specifically in the amount of rainfall. However, this would require very fast speleothem growth rates (0.5mm/year). The scale of variation observed in these records is within the same range as other speleothem records from southern Africa and these bands are more likely records of a longer term cycle of a few 1000 years. Still the records presented here do not document long-term climatic variations, but rather snap shot records of short term, detailed climate change. This is especially pertinent as the hominins (and other fauna) would have been more vulnerable to changes on these shorter, life-time time scales.