Environmental Analysis of Modern Speleothems from Sterkfontein Caves and its' Implications for Reconstructing Palaeoenvironments

MSc Thesis

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A thesis submitted to the Faculty of Science, University of the Witwatersrand, Johannesburg, in fulfilment of the requirements for the degree of Master of Science.

Johannesburg, 2017

Abstract

During the Plio-Pleistocene, the Earth experienced a period of gradual cooling, leading to a decrease in atmospheric temperature and increased seasonality. This resulted in the aridification of large parts of Africa, and this is believed to have encouraged human evolution and innovation. Palaeoenvironmental analyses using sediment deposits as palaeoclimate proxies in the Cradle of Humankind have been used to understand the timing and intensity of this aridification by determining how changes in environmental conditions and seasonal cycles affected the South African landscape. These changes are recorded within the carbon and oxygen isotopic signatures of speleothems, which have precipitated within the Sterkfontein Caves system. The aim of this study is to understand the degree to which modern speleothems represent the modern climate and environment, and thereby deduce the reliability of speleothem deposits in the Sterkfontein Caves system as palaeoclimate proxies. Samples of modern speleothems were collected from different chambers of the Sterkfontein Caves, along with the collection of modern drip water samples bi-weekly over a period of 14 months. Oxygen and carbon stable light isotope analyses of these modern speleothem and drip water samples were used to obtain modern temperature, precipitation and vegetation data. These data were then compared to modern climatic and environmental records for atmospheric temperatures and precipitation from weather stations around the Sterkfontein Caves area. The $\delta^{13}C$ trends produced from the modern speleothem samples reflected the current vegetation distribution in terms of C_4 and C_3 vegetation very well, while the temperatures calculated from the $\delta^{18}O$ values of the modern speleothem and drip water samples displayed variations related to kinetic fractionation effects, rendering these data less useful in reflecting the current atmospheric temperatures. The $\delta^{18}O$ values of the drip water samples, along with the measured drip rate reflected current precipitation seasonality, taking into account groundwater residence time and recharge rate. The conditions within the cave conducive to formation of the speleothems was well reflected by the pH and electro-conductivity values produced from the drip water samples. These values also provided further insight into the exterior climatic conditions.

Overall, the carbon and oxygen stable light isotope data revealed patterns present in the modern speleothem and drip water samples, which could be further related to changes in local climate during the precipitation of these modern speleothems from drip water sources. This, to a certain degree, provides evidence of the reliability of speleothems in the Sterkfontein Caves system as suitable palaeoclimate proxies with regards to vegetation and precipitation

interpretations, over a longer term scale and at higher sampling resolution.