Science and Technology Group
Annual Report FY2016

Chirienco Mirona
Science and Technology Associate

1 Introduction

In FY2016, I continued to work on the paleoclimate evolution of Donnehue's cave region in the Midwestern USA, with the focus on the Marine Isotope Stage 3 (MIS3) time period. To that end, I conducted analyses of high-resolution trace element records from MIS3 stalagmites I have collected previously (DC20 and DC28). Interpreting the trace element records from stalagmites can be quite challenging as the composition of the feeding drip water varies with seasons and also over long periods of time. Further, over the same period of time, there can be substantial spatial variation, i.e., different drip sites can have different water composition over the same length of time. Despite the numerous challenges, when coupled with the stable isotope data I obtained during the previous fiscal year, my preliminary results suggest that the trace element records can furnish a valuable tool for distinguishing between the various processes that influence the stalagmites composition.

In order to better understand the way that the paleoclimate signal is incorporated in stalagmites at this cave site, I selected another pair of stalagmites that grew during quite different conditions, namely during an interglacial period. Well-constrained deglaciation chronologies are absent from this region, and that is exactly the time when the most significant climate changes occur. By obtaining precisely dated paleoclimate records from stalagmites that grew during both glacial and interglacial conditions, I aim to gain new insights on this site's sensitivity to climate forcing and rates of climate changes over time.

2 Activities and Findings

1) I analyzed the trace element records for two stalagmites, DC20 and DC28. The data includes the standard full suite of trace and minor elements, and the full interpretation is work in progress. Amongst the trace elements analyzed, one of the most relevant for this study is Mg, which, in certain settings, can be used as a paleohydrological proxy. A preliminary interpretation for the Mg concentration variation indicates a possible aridity event and/or prior calcite precipitation. Prior calcite precipitation (PCP) occurs under dry conditions due to degassing of carbon dioxide before reaching the cave chamber. An increase in Mg concentration may indicate an increase in PCP and a decrease in effective rainfall (defined as meteoric precipitation minus evapo-transpiration by Fairchild & Treble, 2009). This hypothesis is supported by the fact that the Mg concentration increase occurs in both stalagmites during the same time interval (ca. 54,000 yrs BP, Figure 1), thus confirming that the observed increase is not an artifact of the drip site, but rather an indication of the rainfall availability or the lack thereof.
2) I obtained preliminary U-Th dates for two stalagmites from different parts of Donnehue's Cave, and their new chronology indicated that they grew during both glacial (MIS 6) and interglacial (MIS 7) conditions. Marine Isotope Stage 7 (MIS7), also known as the Penultimate Interglacial, was punctuated by very pronounced warm intervals (MIS7e and MIS7 a-c), separated by a much cooler interval (MIS7d).

Chirienco Mirona
Science and Technology Associate

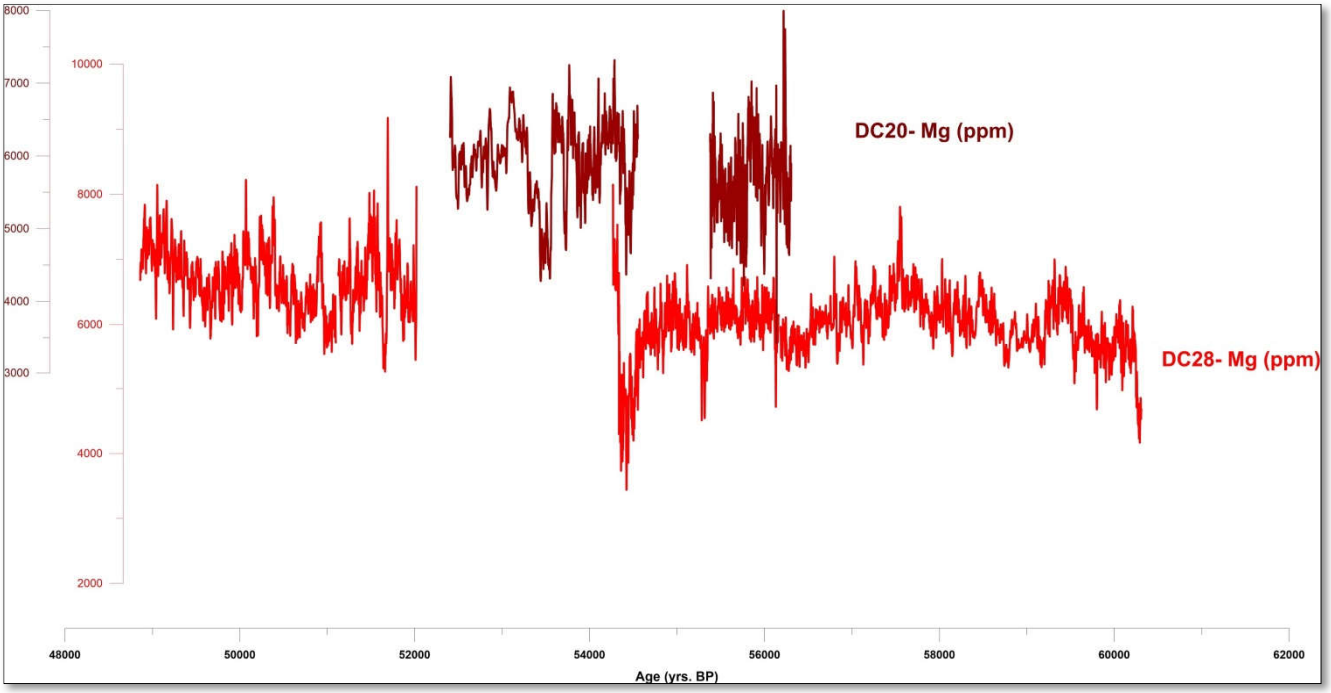

Figure 1. Stalagmites DC20 and DC28 Mg concentration data vs time

3 Collaborations

Prof. Hai Cheng, Xi'an Jiaotong University, China.
Dr. Klaus Peter Jochum, Max Planck Institute for Chemistry, Germany
Prof. Christoph Spötl, University of Innsbruck, Austria
Mr. Samuel Panno, Illinois State Geological Survey, USA.

4 Publications and other output

Chirienco M.I., Li X., Spötl C., Cheng H., Panno S.V., Lundstrom C.C.L Climate variability during the MIS3 recorded in speleothems from Midwestern USA. Seminar, International Research Center on Karst (IRCK) in Guilin, China (2016)

References

Fairchild, I.J., Treble P.C (2009).: *Trace elements in speleothems as recorders of environmental change*. Treble P. Quat. Sci. Rev. 28, p. 449-468