Science and Technology Group
Annual Report FY2022

Name
Science and Technology
Associate

1 Introduction

The period from 250,000 to 200,000 years ago was characterized by dynamic climatic shifts between glacial and interglacial conditions, significant changes in ice sheet extent, and corresponding impacts on sea levels, vegetation, and animal populations in the Northern Hemisphere.

Marine Isotope Stages (MIS)

- **MIS 8 (~300,000 to 243,000 years BP)**: This stage represents a glacial period characterized by colder temperatures, extensive ice sheets, and lower sea levels. Large ice sheets, such as the Laurentide in North America and the Scandinavian in Europe, dominated the landscape.
- **MIS 7 (~243,000 to 191,000 years BP)**: An interglacial period marked by multiple warm phases (sub-stages 7a, 7c, 7e) interrupted by colder intervals. During these warmer phases, temperatures increased, ice sheets retreated, and sea levels rose, creating more temperate conditions.

We analyzed the trace elements of a stalagmite (DC48) that grew in Donnehue's Cave (USA) over the span of the transition from MIS 8 to MIS 7 all the way to sub stage 7c.

2 Activities and Findings

Trace Element Analysis:

Yttrium (Y): Concentrations of yttrium in the stalagmite provide insights into soil productivity, detrital input and chemical weathering processes. Variations in Y suggest periods of increased erosion and changes in the environment and vegetation above the cave.

Magnesium (Mg): The Mg/Ca ratio is sensitive to hydrological changes and prior calcite precipitation (PCP). Variations in Mg indicate shifts in temperature and precipitation patterns, aiding in the reconstruction of past climate conditions.

Strontium (Sr): Changes in strontium levels reflect alterations in the source of drip water, influenced by weathering processes of the different rocks and sediments above the cave and by changes in the water infiltration pathways. In our cave setting, high Sr levels possibly indicate a till cover above the cave.

Uranium (U): Uranium concentrations offer information on redox conditions and cave hydrology, influenced by external environmental factors, and may also reflect the composition of different erratics (e.g. granites, slate) carried by the ice sheets in the proximity of the cave.

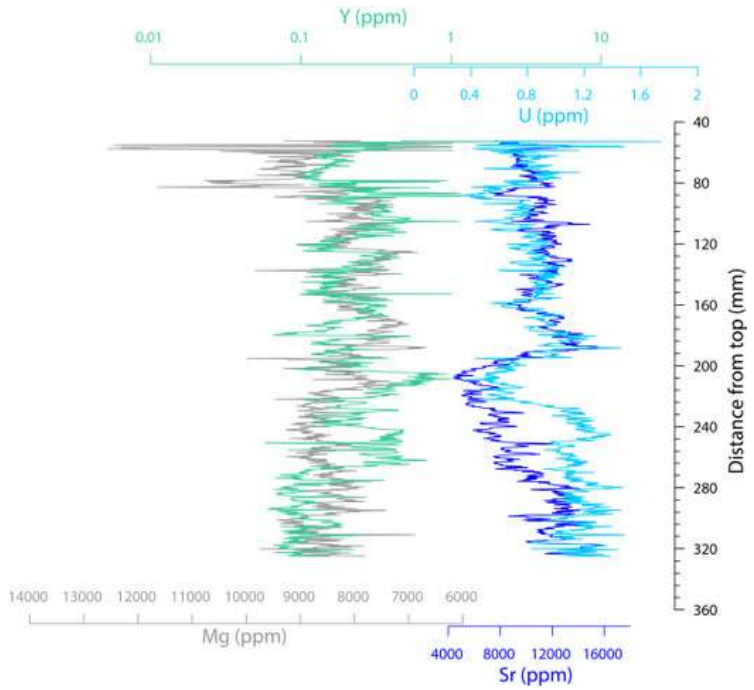

Figure 1. Trace elements for DC48: Mg (gray), Y (green), Sr (dark blue), U (light blue). Data has been binned into 250 micrometer intervals. Y was plotted on a logarithmic scale

Preliminary interpretation of the trace element data:

- **Decreasing Mg and Sr Levels**: Indicate a shift to wetter climate conditions with increased rainfall, resulting in faster drip rates and reduced PCP. This interval corresponds with the beginning of MIS 7, an interglacial period that saw rising temperatures and retreating ice sheets.
- **Fluctuating Y Levels**: Reflect variable weathering intensity and changing detrital inputs as well as changes in the vegetation cover above the cave.
- **Stable U Levels**: Suggest relatively constant redox conditions within the cave.
- **High Mg**: Indicate a return to drier conditions with reduced rainfall and increased PCP. These peaks likely corresponds to warm periods within MIS 7
- **High Sr Levels:** These peaks likely indicate the presence of till or other Sr-rich deposits weathering above the cave and/or the changing hydrological pathways through the different deposits in the cave area.
- **Stable to Decreasing Y Levels**: Suggest reduced detrital input due to stabilization of vegetation and soil cover.
- **Variable U Levels**: possibly reflect continued changes in redox conditions within the cave; may also be an indicator of changing water pathways through different types of rocks and sediments.

3 Collaborations

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

Brigitte Stoll, Max Planck Institute for Chemistry, Germany
Ulrike Weis, Max Planck Institute for Chemistry, Germany
Dr. Jasper Wassenburg, IBS Center for Climate Physics, South Korea

4 Publications and other output

Chirienco M.*, Panno S.V., Cheng H. , Lundstrom C.C.: *Signatures of past glacial episodes on speleogenesis of Donnehue's Cave (Midwestern USA)"*, AGU Fall Meeting 2023, Online Poster Session for Paleoceanography and Paleoclimatology IV (2024)
*presenting author

Outreach activities:
Science Challenge 2024 - Seminar on Science Communication, February 20th 2024
Science Challenge 2024- Seminar on proposal presentation, February 21st 2024