OIST OKINAWA INSTITUTE OF SCIENCE AND TECHNOLOGY GRADUATE UNIVERSITY

Science and Technology Group

Annual Report FY2014: Mirona Chirienco

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1 Introduction

My primary research concerns studying the past climate (paleoclimate) and past environmental (paleoenvironmental) changes in continental regions, such as Midwestern USA, from cave deposits or speleothems, such as stalagmites. Studying continental paleoclimate is particularly challenging due to the scarcity of terrestrial data---speleothems provide one of the most reliable resources for such data. Caves in Midwestern USA carry records of glacial and inter-glacial periods, and thus have a notable importance in paleoclimate studies. Focusing on a cave located near the foot of the past glaciers, I am pursing two projects. In one project, I am analyzing speleothems as indicators of abrupt climate changes during the period from 60,000 to 49,000 years, a period that corresponds to the Marine Isotope Stage 3 (MIS 3). The high-resolution isotope data from this analyses may allow for a unique insight into the past climate of this region, with possible connection to abrupt global climate events.

In another project, I am studying stalagmite growth dynamics and correlating their growth and ages with past earthquake activity along the regional seismic zones.

I am also interested in petrographic studies. In collaboration with another STG member, I study thin sections of Okinawan ceramic artifacts (from 17^{th}-18^{th} century) under microscope to determine their provenance, manufacturing techniques, and evolution of style.

2 Activities and findings

1) The key element for successfully resolving the climate signal in any proxy is a high-resolution age model. In FY2014 I visited the Xi'an Jiaotong University (China) where I prepared and analyzed sub-samples of stalagmites in order to determine their growth dynamics, identify periods of growth cessation (hiatuses) and establish a reliable age model. Additionally, I have obtained microscopic thin sections along the entire lengths of one of the key samples, which enable direct microscopic observation of possible hiatuses and any changes in the micro fabric of the growth layers, and thus, allow for a better sampling strategy for various analytical methods.

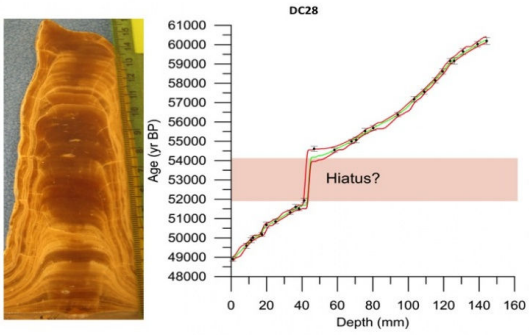

Figure 1. Sample DC 28 (halved and cut along the growth axis), and its age model based on precise U-Th absolute dates. Note: plotted ages are in reverse order

2) Some of the stalagmites that I have collected from Donnehue's Cave in Midwestern USA show abrupt and marked changes in their growth axes, which may be linked with large earthquakes. I have performed isotope analysis of the locations marking the changes, and my preliminary results suggest that the changes in growth axes correlate well with historical earthquakes. (I performed the isotope analyzes at the University of Illinois at Urbana-Champaign, USA.) Encouraged by these results, I plan to undertake a detailed analysis of the stalagmites and construct a paleoseismic record spanning the past 300,000 years. In the long term, I would like to better constrain the role of stalagmites as paleoseismic record-keepers.

3) In ideal cases, ceramic petrography can provide information about forming processes, firing temperatures, firing atmosphere and firing regime of ceramic artifacts.

Under a petrographic microscope, using both plane-polarized and cross-polarized light, I first characterize each artifact's composition (i.e., raw material type, mineral components, types of inclusions/temper used, porosity and types of voids), and then classify them according to composition. This enables me to assess whether the artifact was produced locally or was a result of trading/ exchange (i.e., interpretation of provenance).

My preliminary results, based on analysis of artifacts from Chibana and Kina kiln sites of Okinawa, suggest that these artifacts were obtained from local raw material and that the two kiln sites employed very similar in technology (firing regime and material used). I plan to perform further analysis using artifacts from various kiln sites in Okinawa and Ishigaki.

3 Collaborations

3.1. Project: Paleoclimate of the MIS 3 from cave formations in Donnehue's Indiana, USA. Collaborators:

- Professor Hai Cheng, Xi'an Jiaotong University (China)
- Samuel Panno, Senior Geochemist, Illinois State Geological Survey (USA)
- Professor Craig Lundstrom, University of Illinois at Urbana-Champaign (USA)

4 Publications and other output

4.1 Book chapters

1. Chirienco, M. (2014) "Karst" in *Encyclopedia of Planetary Landforms*, Springer, 1-6, doi: 10.1007/978-1-4614-9213-9506-1
2. Chirienco, M. (2014) "Karst-like landforms" in *Encyclopedia of Planetary Landforms*, Springer, 1-6, doi: 10.1007/978-1-4614-9213-9630-1

3. Chirienco, M., Persoiu, A. (2014) “Cave” in *Encyclopedia of Planetary Landforms*, Springer, 1-6, doi:10.1007/978-1-4614-9213-932-1

4.2 Poster presentation

Chirienco MC, Panno SV, Lundstrom CCL , Hackley K, Hong W: *Paleoclimate and speleogenesis: a conceptual model from Donnehue’s Cave, Midwestern USA.* Climate Change: The Karst Records VII, Melbourne, Australia (2014)

4.3 Meetings and events

Guest seminar title (OIST): Natural Climate Variability Recorded in Ancient Geological Weather Stations. Prof. Silvia Frisia (Earth Sciences Department, The University of Newcastle, Australia.)