

New research proposal to Western National Parks Association (WNPA)

The information supplied should be limited to the space provided and submitted on these forms.

A proposal received in any other format will be returned. Additional attachments are not permitted.

Title of project: Climate and Vegetation Reconstructions Using Ice Cores in Lava Tubes at El Malpais NM	Park(s) in which research is to be conducted: El Malpais National Monument
Name, address, and phone number of principal investigator, (PI)(s): Bogdan Onac, Ph.D. School of Geosciences, University of South Florida 4202 E. Fowler Avenue, NES 107 Tampa, FL 33620 Phone: 813-974-1067; Fax: 813/974-4808	Payee information - individual name and address or Institution's name and address required: Kelley Schuler Research & Innovation, Sponsored Research, University of South Florida 3702 Spectrum Blvd., Suite 165 Tampa, FL 33612 Phone: (813) 974-2897; Fax: (813) 974-4962
Is this a multiyear project? NO Total amount requested: This year \$ <u>7,500.00</u> If multiyear project, estimated amount: 2nd year \$ _____ 3rd year \$ _____	Desired start date: November 1, 2017 Note: Not prior to October 1st
Project duration: 1 year Project final completion date: <u>September 30, 2018</u> (see research guidelines)	
Name(s) of research participant(s) who will acquire advanced degree(s) as a result of working on this project, if any:	Product(s) of research (articles, theses, maps, checklists, etc.) in addition to final report to WNPA (see research guidelines): Article/s and professional presentation/s.

Abstract to be provided by PI(s). Do not exceed the half-page space provided below.

The resources at ELMA are significant archives for understanding the paleoclimate of the region. Use of dendrochronology is the most established climate proxy at ELMA, providing a history back to 137 BC. Proxies can be derived from guano and perennial ice deposits accumulated in lava tubes. This funding will complement a CESU project established with Dr. Bogdan Onac from the University of South Florida through ELMA base funds (\$11,175) and support (\$15,000) from our Regional office. The scope of the original project was collecting data from both climate proxies. This proposal requests funds to help support collecting and analyzing additional ice cores; in particular, from the thicker ice deposits which we were not able to core due to equipment needs that we are now able to obtain through NPS. Results obtained from guano and ice can further help validate the paleoclimatic signal with existing dendrological studies. Perennial ice deposits in our lava tubes likely contain a record back to 3,000 years. Isotopic analysis of ice provides significant information relative to the source of moisture and air temperature. Bat guano in lava tubes can be precisely dated using the radiocarbon method and contains several environmental proxy indicators such as pollen grains, C and N stable isotopes, and charcoal, which can be analyzed and provide a timeline of vegetation and precipitation changes, nitrogen cycling in soil, as well as natural fires for hundreds to thousands of years. Recent observations indicate that the perennial ice at ELMA has diminished significantly, due to increases in temperature and drier conditions. One lava tube was observed to have lost over 3 meters of ice and others no longer contained perennial ice. The loss of this perennial ice and the paleoclimate record it contains is a significant concern.

(1) JUSTIFICATION (to be provided by submitting park): This section should specify the following: 1) Are NPS-appropriated funds available for the project (Yes/No)? 2) Where does this project rank in the submitting park's research priorities for all funding sources? 3) Was this proposal solicited by the park? If not, why is this project important to the park? 4) How will this research enrich visitors' understanding of the park? 5) What are the implications for resource management?

- 1) No, not currently. Funds were provided through base funding and support from regional office for this project in 2017; however, these funds were primarily used as a feasibility study and to assess viability of ice for paleoclimate reconstruction. We are now collecting cores that were unobtainable at the time due to equipment constraints at the time. ELMA will provide in-kind contributions through staff assistance with fieldwork while Dr. Onac and his graduate student are collecting the cores. Additionally, staff will collect water samples and monitor temperature and relative humidity as needed. Equipment such as I-button data loggers will be available. Compliance will be conducted on the research project.**
- 2) The park rated the project as the number 1 priority for project funding for 2017.**
- 3) This project was solicited by the park and is critically important due to the rapid ice loss in the caves at El Malpais NM.**
- 4) Results from this project can be used to provide to the public a better sense of how scientists come to conclusions about climate change. Often there is little understanding of where scientist's claims about climate change come from and this aspect creates doubt. Due to the extent of time that his project is attempting to reconstruct, it can be used to address the principles behind climate change without having to deal directly over controversial questions as to whether current climatic events are man-induced. This project can be expanded to explain the scientific process and help to explain similar issues at El Malpais, such as the ever-changing dates of the lava flows. The results on climate change impacts from this project should be relayed during all new ELMA employee training where the information can be relayed through public presentations to high schools, colleges, and citizen groups. In collaboration with interpretive staff at El Malpais NM a dedicated cave ice-based climate change booth can be developed and incorporated at "Earth Day" and "National Public Lands Day" events. The project will be important to legislators, as many are not aware on how climate change science is collected and have many doubts about its validity. This project is informative to scientists since the use of ice (from caves) and guano cores are not commonly used to extract climate proxies. It would be expected that Dr. Onac and/or his graduate student would present this information in a manuscript and/or professional presentations.**
- 5) Reconstructing past climate change, particularly the timing, extent, and the role of temperature in past droughts in the Southwest U.S. is a challenge of societal importance. This project will have benefits by further contributing crucial information to the climatic record in the Southwest US that then can be used to test various space- and time-dependent Holocene climatic models. Results from such investigations can help resource managers in their efforts to encourage and guide practices to support environmental resiliency. As our climate continues to warm and drought/fire conditions increase in frequency, we can expect significant changes in vegetation and wildlife habitat at the monument. Lack of precipitation and continual warming has rapidly reduced the extent of the ice and there is concern that this important resource and the irreplaceable data it contains will be lost in the near future.**

(2) **CONCISE STATEMENT OF RESEARCH OBJECTIVES, DESIGN, AND METHODOLOGY.** This section should include the facilities and sites to be used. Note: Limit this section to the two pages provided.

Engaging University of South Florida (USF), a top research academic institution in the US, this project will benefit from gaining access to state-of-the-art analytical facilities and highly qualified scientific personnel. This project will use funds to investigate the hypothesis that decadal-to-century-scale climate variability was a persistent feature over the past millennia in SW US, and that the Little Ice Age and Medieval Warm Period were part of this pattern of decadal-to-centennial variability. The researchers will fill this science gap by obtaining an annual-to-subdecadal record from a layered-ice deposit from within two lava tubes. A particular strength of these ice deposits is that their oxygen isotopes can be used in reconstructing the source of moisture and temperature in the region, whereas the seasonal layering in the ice should provide an extremely high-resolution and well-dated record of changing climatic conditions (wet/dry). The quality, high-resolution nature of the proposed record (ice) will allow us to potentially answer a number of important questions:

1) How do moisture source and temperature anomalies combine to produce the droughts and pluvials in the SW US?

Although warm droughts and cool pluvials are typical, we will also explore the opposite climate context, i.e., cool droughts and warm pluvials. We will examine the degree to which droughts are accompanied by warmth in the late Holocene ice paleorecord and the degree to which temperature influences the timing, duration, and amplitude of wet and especially dry extremes.

2) What are the relative contributions of winter versus summer monsoon variations to SW megadrought and pluvial periods?

With a highly resolved ice record from El Malpais National Monument (NM) lava tubes, we can assess whether the monsoon is prone to significant periods of failure, which may not be captured in other shorter records (e.g., tree-ring).

3) How can our refined understanding of drought and its drivers improve estimates of future drought risk?

We aim to understand relative roles of internal variations, external forcing, local feedbacks and background climate, and use that insight to improve estimates of future drought risk. We hope to identify long/short-term and recurrent processes of climatic change and fluctuations, temporal correlation of these events with major changes in the North Atlantic region (driving force behind most major climate events in the Northern Hemisphere).

Objectives:

- 1) Establish a present-day calibration program to better understand how the climatic signal is transferred from surface into the cave.
- 2) Recover ice cores from ELMA caves for analysis.
- 3) Prepare pollen samples and diagrams for ice.

Methods:

Objective 1

- Continuously log temperature and relative humidity outside and inside the ice cave during the project.

- Collect water samples (precipitations and cave drip water) every week through the year to capture the seasonal isotopic signal.

- $\delta^2\text{H}$ and $\delta^{18}\text{O}$ will be measured in all collected water samples in order to understand the relationship between isotopic composition of precipitation and drip water, rainfall amount, and if the drip water $\delta^{18}\text{O}$ time-series display sub-seasonal, seasonal, or annual cycles.

Objective 2:

- Ice cores will be photographed and visually examined and described in detail inside the cave, then stored in a freezing unit.

- Ice samples for isotopic analyses and pollen investigations (1-cm interval along each core) will be collected inside the freezing unit.

- Each ice core will be sampled for organic material (leaves, branches, bones, etc.).

- Oxygen and hydrogen stable isotope determinations on ice samples (and standards).

Objective 3:

- Generate pollen slides and counting under microscope up to 500 pollen grains/slide(sample).

- Construct pollen diagram and interpret past vegetation assemblages.

Project Timeline:

1. Collection of meteorological data (we have already deployed data loggers for temperature, relative humidity, and rain and drip water gauges);

2. Recover and sample ice cores in the first month of the project

3. O, H, C, and N isotope analyses on water and ice.

4. Results are used to prepare public and scientific presentations, and peer-reviewed publications E. Weaver is an experienced cave specialist working for ELMA. He is responsible for setting up the weather station and data loggers and weekly collecting water samples (surface and cave); he will also periodically check the data loggers and participate in all field-related activities. Dr. B.P. Onac is a Professor of Karst Geology and Paleoclimatology at USF. He will supervise the coring activities, sampling and ice, and the interpretation of all results. A graduate student (USF) will take part in all field activities and will be responsible with sampling, preparation, and performing the isotope and pollen analyses and writing the scientific reports.

(2) CONCISE STATEMENT OF HOW YOUR RESEARCH CAN ENHANCE THE INTERPRETIVE MISSION OF THE PARK. Also include one paragraph describing the plan for an interpretation-related product of the research. Use this page only.

This project has the potential for a strong interpretive component as it increases climate change literacy of land managers and community at multiple levels. To promote climate science literacy, including the proposed research results, members of the team will continue to 1) serve as a resource for state legislators sponsoring climate adaptation bills, 2) give several public lectures throughout the life of the project to high schools, colleges, and citizen groups, 3) incorporate the results on climate change impacts resulted from this project to all new ELMA employee training, and 4) develop a dedicated cave ice-based climate change booth to be included at “Earth Day” and “National Public Lands Day” events. The multidisciplinary approach developed at ELMA can be applied to Holocene ice and/or guano deposits from other caves in the park or elsewhere in TX, AZ, and CA, to assess the role of temperature in drought mechanisms. Reconstructions of temperature and precipitation seasonality, derived from ELMA cave ice and guano, for periods prior to the instrumented record will be of use for climate scientists, park managers, policy makers, and water resource managers, especially given recent projections of unprecedented drought risk for the SW US. Results of this study are expected to impact paleoclimate research approaches, as the methodology we will advance to monitor modern systems and assess ice and guano proxies can be adopted by others. The methodology may be applied to similar lava tubes or ice caves in other geographic regions. We will ensure that the project results are disseminated both to the scientific community (published in peer-review journals and presentations at national and international meetings) and to the broader public through popular science articles and educational products (flyers, brochure, posters, lectures, etc.) to show the risk of global warming.

(3) QUALIFICATIONS OF THE PI(S) CONDUCTING THE RESEARCH. Use this page only. List only those qualifications directly related to this grant request. Include a list of other WNPA-funded research conducted by this PI.

Bogdan P. Onac, PhD

I am a Professor of Karst Geology and Paleoclimatology in the School of Geosciences at the University of South Florida (Tampa). My research focuses on understanding the controls on Earth's climate on time scales ranging from seasonal to 100s of thousands years. I am particularly focus on exploring high-resolution records of past climate change that are preserved in the geochemistry of cave deposits (speleothems, guano, and ice). Ultimately, these records help calibrating our understanding of: 1) seasonal climate patterns in the past, and 2) atmospheric and oceanic circulation during rapid climate change events. I use a combination of techniques that includes radiogenic dating (U/Th and U/Pb), stable isotope measurements, and other mineralogical and geochemical methods.

Below are listed 5 most relevant publications to current proposal:

1. Persoiu, A., **Onac, B.P.**, Wynn, J.G. Blaauw, M., Ionita, M., Hansson, M. 2017: Holocene winter climate variability in Central and Eastern Europe. *Scientific Reports*, **7**: 1196 DOI:10.1038/s41598-017-01397-w
2. Teehera, K.B., Jungbluth, S.P., **Onac, B.P.**, Acosta-Maeda, T.E., Hellebrand, E., Misra, A.K., Pflitsch, A., Rappé, M.S., Smith, S.M., Telus, M., Schorghofer, N. 2017: Cryogenic minerals in Hawaiian lava tubes: A geochemical and microbiological exploration. *Geomicrobiology Journal* (in press).
3. Cleary, D.M., Wynn, J.G., Ionita, M., Forray, F.L., **Onac, B.P.** 2017: Evidence of long-term NAO influence on East-Central Europe winter precipitation from a guano-derived $\delta^{15}\text{N}$ record. *Scientific Reports* (in review).
4. Cleary, D.M., **Onac, B.P.**, Forray, F.L., Wynn, J.G. 2016: Controls on $\delta^{15}\text{N}$ values of cave bat guano: an assessment for reconstructing paleoclimate and environmental changes. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **461**: 87-97.
5. **Onac, B.P.**, Hutchison, S.M., Geanta, A., Forray, F.L., Wynn, J.G., Giurgiu, A.C., Coroiu, I. 2015: A 2500-year Late Holocene multi-proxy record of vegetation and hydrologic changes from a cave guano-clay sequence in SW Romania. *Quaternary Research*, **83**: 437-448.

Budget for New Research Proposal

Project title and submitting park **Climate and Vegetation Reconstructions Using Ice Cores in Lava Tubes, El Malpais National Monument**

Personnel

PRINCIPAL INVESTIGATOR(S)	Funds requested from WNPA	Cash or in-kind contribution (Please specify which type and source.)
1 Dr. Bogdan Onac	\$0.00	
2		
3		

OTHER PERSONNEL (Specify number in brackets. Specify duties to be performed to earn funds on next page.)	Funds requested from WNPA	Cash or in-kind contribution (Please specify which type and source.)
1 Dylan Parmenter-Graduate Student{1}	\$0.00	
2		
3		
4		
5		

TOTAL PERSONNEL COSTS \$0.00

EQUIPMENT COSTS (List item and dollar amounts for those items costing more than \$100 each on next page.) \$600.00

TRAVEL AND SUBSISTENCE (Itemize on next page.) \$1,904.00 NPS lodging (\$1,274.00)

OTHER COSTS

1 Supplies and material	\$4,996.00	
2 Consulting services		
3 Computer services		
4 Subcontracts (Itemize on next page.)		

TOTAL PERSONNEL COSTS \$7,500.00 \$1,274.00

TOTAL PERSONNEL COSTS \$7,500.00 \$1,274.00
 If multiyear project, summarize estimated subsequent year(s) budget(s) on next page.

COSTS (Cont'd). Note: Be sure to explain here the duties that will be performed by any funded individual.

Travel total: \$1,904.00

Travel for Dr. Onac and his graduate assistant includes their flight from Florida (est. \$400*2=\$800); rental car (est. \$50 per day for 7 days=\$50*7=\$350); M&IE for 7 days (\$51*2=102; 102*7= \$714); Gas \$40.00. Dr. Onac and his graduate student will collect and prepare samples for analysis and will run all measurements, except the radiocarbon datings.

Equipment total: \$600.00

Large HDPE bottles for melting ice samples, reagents for preparation of pollen samples \$600.00

Analysis total (Placed under supplies and Materials on previous page): \$4,996.00

- Radiocarbon ages \$1,980.00
- Oxygen and hydrogen isotopic measurements \$800.00
- Carbon and nitrogen isotopic measurements \$600.00
- Water isotope analyses \$800.00
- C and N isotope analyses \$600.00
- Reagents (pollen analyses) \$190.00
- Pollen slides \$26.00

Total: \$7,500.00

A special note for researchers and the park superintendent:

WNPA is the funder of this grant on behalf of NPS, and WNPA monitors progress, administers the payment schedule, and determines successful completion or default.

All other decisions regarding the conduct of this research grant (e.g., park access, laws, safety, protocols, etc.) and uses of the research, data, and its products (e.g., release of information, publication, intellectual property, etc.) rest in the hands of NPS and are the responsibility of NPS. Researchers and NPS should clarify any questions or assumptions before accepting the grant.

Due to several factors, ALL WNPA grants are for ONE YEAR ONLY (1 year only); however, we welcome and will carefully consider applications for second or third years following a successful first year.

Best wishes and hopes for a successful project. Thank you from WNPA.

I have read and agree to abide by the research guidelines in effect at the time of this application.



Signature of Principal Investigator(s)

August 31, 2017
Date



Signature of Park Superintendent

8/31/17
Date



Signature of Chief of Interpretation

8/31/2017
Date

For WNPA Use Only

WNPA Research Committee Review: Action and Date:

Amount Granted: