

Research Spending & Results

Award Detail

Awardee: MONTCLAIR STATE UNIVERSITY

Doing Business As Name: Montclair State University

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Award Title or Description: The Stratigraphic Expression of the Onset of Glaciation in Eocene-Oligocene Successions on the Antarctic Continental Margin

Federal Award ID Number: 1245283

DUNS ID: 053506184

Program: ANTARCTIC EARTH SCIENCES

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Awardee Location

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County: Montclair

Country: US

Awardee Cong. District: 11

Primary Place of Performance

Organization Name: Montclair State University

Street:
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Country: US
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Abstract at Time of Award

Intellectual Merit:

This project will investigate glacial advance and retreat of the East Antarctic Ice Sheet through the Eocene-Oligocene transition, a major episode of ice growth. In Prydz Bay, East Antarctica, a 130-170 m thick Eocene-Oligocene transition interval of glaciomarine sediments was cored in drillholes of the Ocean Drilling Program at Sites 739, 742 and 1166. Correlations between the Prydz Bay drillholes have recently been made through well-log and multichannel seismic interpretations. Recent drilling on the Wilkes Land margin of East Antarctica recovered earliest Oligocene sediments overlying a major regional unconformity in two drillholes. The PI will study the lithostratigraphy and weathering history of cores in the five drillholes, to establish a unique Eocene-Oligocene transition record within Antarctic continental margin sediments of glacial advance and retreat cycles, the onset of physical weathering, and glacio-isostasy and self-gravitation processes with implications for the margin architecture, sediment routing, and off-shore sediment dispersal. Cores from the five drillholes will be re-examined through detailed core description using an updated classification scheme, so that lithofacies can be compared between drillholes. Samples will be collected for detailed laser particle size and bulk major element geochemistry via ICP-AES to determine the degree of chemical alteration of the sediments. Phases of major ice growth will be recognized as marker beds of physically eroded sediment and will be correlated to isotopic records documenting Antarctic ice growth offshore in the Southern Ocean.

Broader impacts:

This project will benefit a large minority undergraduate student population through the availability of up to two paid laboratory internships, a classroom exercise, and the availability of research equipment supported by this award. The project also allows support and training of a graduate student.

Publications Produced as a Result of this Research

Note: When clicking on a Digital Object Identifier (DOI) number, you will be taken to an external site maintained by the publisher. Some full text articles may not yet be available without a charge during the embargo (administrative interval).

Some links on this page may take you to non-federal websites. Their policies may differ from this site.

Passchier, S., Ciarletta, D., Miriagos, T., Bijl, P., Bohaty, S., "An Antarctic stratigraphic record of stepwise ice growth through the Eocene-Oligocene transition" *GEOLOGICAL SOCIETY OF AMERICA BULLETIN*, v.129, 2017, p.318. doi:10.1130/B31482.1

Sandra Passchier, Daniel J. Ciarletta, Victor Henao, Vicky Sekkas "Sedimentary processes and facies on a high-latitude passive continental margin, Wilkes Land, East Antarctica" *GEOLOGICAL SOCIETY OF LONDON SPECIAL PUBLICATION*, v.475, 2018, p.. doi:10.1144/SP475.3

Houben, A.J.P., Bijl, P.K., Pross, J., Bohaty, S.M., Passchier, S., Stickley, C.E., Röhl, U., Sugisaki, S., Tauxe, T., van de Fliert, T., Olney, M., Sangiorgi, F., Sluijs, A., Escutia, C., Brinkhuis, H., and the Expedition 318 Scientists "Reorganization of Southern Ocean plankton ecosystem at the onset of Antarctic glaciation." *SCIENCE*, v.340, 2013, p.341. doi:10.1126/science.1223646

Stocchi, P., Escutia, C., Houben, A.J.P., Vermeersen, B.L.A., Bijl, P.K., Brinkhuis, H., DeConto, R.M., Galeotti, S., Passchier, S., Pollard, D., and IODP Expedition 318 scientists "Relative sea level rise around East Antarctica during Oligocene glaciation." *NATURE GEOSCIENCE*, v., 2013, p.. doi:10.1038/ngeo1783

S Passchier, DJ Ciarletta, TE Miriagos, PK Bijl, SM Bohaty "An Antarctic stratigraphic record of stepwise ice growth through the Eocene-Oligocene transition" *GEOLOGICAL SOCIETY OF AMERICA BULLETIN*, v.129, 2017, p.318. doi:10.1130/B31482.1

Project Outcomes Report

Disclaimer

This Project Outcomes Report for the General Public is displayed verbatim as submitted by the Principal Investigator (PI) for this award. Any opinions, findings, and conclusions or recommendations expressed in this Report are those of the PI and do not necessarily reflect the views of the National Science Foundation; NSF has not approved or endorsed its content.

The behavior of polar ice sheets in a warming climate is one of the critical uncertainties in estimating future sea level rise. The East Antarctic Ice Sheet is the largest ice sheet in the world with a total volume equivalent to a sea level rise of more than 50 m (150 ft). The stability of the East Antarctic Ice Sheet under current conditions of rising greenhouse gas concentrations in the atmosphere is highly uncertain. The mechanisms and timing of ice growth and decay are poorly known because 1) many processes operate on timescales that extend beyond the instrument record of recent observations, and 2) the current period of greenhouse gas emissions to the atmosphere is an anomaly in our time series of direct observations. With this NSF funded project we investigated a geological archive embedded in Antarctica's continental margin to address the conditions and timing of Antarctic ice growth and decay during a greenhouse period in Earth's distant past.

We used legacy deep-sea drillcores acquired by the International Ocean Discovery Program (IODP) from East Antarctica's continental margin to extract the ice sheet and climate history from the geological archives. A drillcore, a rock column extracted by rotating a pipe vertically into the layers beneath the seafloor, provides a cross-section of the layers of mud and sand that accumulated over time at each site. We visually re-examined and sampled the cores at the IODP Gulf Coast Repository in College Station, TX. Analytical work on ca. 400 samples from five drillcores was carried out at Montclair State University.

Sedimentological results show that the East Antarctic Ice Sheet expanded earlier than previously thought onto the Antarctic margin under conditions of higher than present, but decreasing greenhouse gas concentrations. The high temporal resolution of our data and improved age models provide context to analyses that require targeted sampling of drillholes, such as published and ongoing thermo-chronological and organic geochemical approaches adopted by others. Our analytical results show evidence for rapid changes in the surface weathering climate between wet/warm and dry/cold conditions on the continent of Antarctica that time. Furthermore, in its early stages the East Antarctic Ice Sheet expanded in a step-wise pattern and was more dynamic under these conditions of elevated greenhouse warming than in its present state. We conclude that atmospheric processes played a role in driving the dynamics of the nascent ice sheet. Our results demonstrate the potential for an increasing role of the East Antarctic ice sheet in future sea level fluctuations, as greenhouse gas concentration continue to rise and reach values not previously encountered in human history.

The project contributed to the growth of laboratory facilities and basic research opportunities at Montclair State University. During the award period Montclair State University became a Doctoral Research University in the Carnegie Classification, and was recognized as such by the State of New Jersey. A Lab Manager was hired in support of the geochemical lab facilities that are used by multiple research groups and the department, plus the sedimentology and geochemical labs used in this project, were moved into a new state-of-the-art facility. The award contributed to the replacement of an outdated water purification system.

The project results were shared with broader non-science audiences, for example, through ad-hoc lectures and activities in collaboration with the American Museum of Natural History, the K-12 Visiting Scientists Program of Montclair State University, and the IODP Distinguished Lecture Series. The project directly supported the thesis work of two graduate students. In addition, three undergraduate/1st year graduate students received analytical training and research mentoring through laboratory technician positions and participated in lab group meetings. Two Earth Science teachers (grades 6-12) participated in aspects of the project and incorporated their experiences with the scientific process in classroom activities. An upper undergraduate/graduate level geology and climate lesson was also created and published online at the Science Education Resource Center at Carleton College.

Last Modified: 06/08/2018
Modified by: Sandra Passchier

For specific questions or comments about this information including the NSF Project Outcomes Report, contact us.

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