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Name: Jody Wycech	**SSN:**	**GSA Member No:**
Street Address:	**E-Mail Address:**	
University: University of WisconsinMadison	**Department:** Geoscience	**Masters Degree?:** NO
Current Degree Program: Ph.D.	**Yrs. in Graduate School (Masters):** 0	**Yrs. in Graduate School (Ph.D):** 3rd Year
Minority Status: White/Caucasian	**Citizenship:** USA	**Gender:** Female
Are you a member of a GSA Division?: None of the Above	**Are you a member of a GSA Section?:** North-Central	**Did you attend the Grant Writing Workshop?:** No
Amount requested from GSA: $ 2500	**General field of this research project:** Paleoclimatology/Paleoceanography	**Geographic focus, if any:** Other

Project Title:
Ground-truthing in situ δ18O and Mg/Ca ratios measured in planktic foraminiferal shells to reconstruct sea surface conditions

Project Supervisor:

Specialized Award(s):

This section should present the problem, hypotheses, and the overall objectives of the project. (1,000 character limit, including spaces).:
Past sea surface temperatures (SSTs) and salinities are typically reconstructed by measuring Mg/Ca ratios and oxygen isotope (δ18O) compositions of planktic foraminiferal shells preserved in deep-sea sediments. Unfortunately, these shells are aggregate mixtures of various carbonate phases that formed under different physiological and environmental conditions. One approach to minimizing this problem is to use secondary ion mass spectrometry (SIMS) and electron probe microanalysis (EPMA) to perform in situ δ18O and Mg/Ca analyses, respectively, within individual foraminiferal shells. I propose to ground truth this hypothesis by using these analytical techniques to perform high resolution (3-10 µm), in situ δ18O and Mg/Ca ratio analyses within individual Holocene foraminiferal shells from five globally distributed sites. The calculated SSTs and surface oxygen isotope composition of seawater (δ18Osw) values derived from these data will be compared to the observed values for each site.

This section should discuss the scientific and societal significance; what is the importance of this project? (2,500 character limit, including spaces):
The calcite shells of planktic foraminifera are commonly preserved as microfossils in deep-sea sediments, and their shell chemistries are assumed to record the water conditions in which they calcified. Unfortunately, an individual shell is a mixture of three different carbonate phases–primary biogenic, reproductive gametogenic, and secondary diagenetic calcites–that formed under very different environmental and physiological conditions. Prior to death, many planktic species undergo a reproductive stage called gametogenesis, a process that can add up to 28% to the shell mass in approximately 16 hours for the species Globigerinoides sacculifer (Bé, 1980). This calcite, although formed biologically, is deposited rapidly in deeper, often colder water that does not reflect surface conditions. Additionally, diagenetic calcite is precipitated inorganically onto the shells after burial, reflecting deep water δ18Osw and temperature (Pearson et al., 2001). Previous publications demonstrate that in situ techniques can be used to identify and avoid domains within individual shells that have undergone post-depositional alteration (Kozdon et al., 2013). If the proposed in situ measurements from primary biogenic calcite reflect modern sea surface conditions, then I plan to use the same techniques, foraminiferal species, and sites to reconstruct Pliocene SSTs and surface δ18Osw. The Pliocene qualifies as an ancient analogue for future climate change because the physiographic configuration of the

continents had a modern-like condition, and atmospheric pCO2 (300-425 ppm) was comparable to today (Kürschner et al., 1996; Raymo et al., 1996). The selected sites aim to evaluate changes in sea surface conditions due to the controversial permanent El Niño state, closure of the Central American Seaway (~4.6 Ma), and the reduced latitudinal temperature gradient (Dowsett et al., 2013; Haug and Tiedmann, 1998; Wara et al., 2005). Reconstruction of accurate surface δ18Osw and SST from in situ techniques will better constrain the Pliocene hydrologic cycle and latitudinal heat transport. The proposed research will assess the accuracy of in situ measurements and ensure in situ-derived paleoclimate records truly reflect paleoceanographic conditions. The enhanced fidelity of such records will provide tighter constraints on model predictions of past and future climate change that, in turn, are used by governmental agencies to legislate and regulate societal practices(Stocker et al., 2013).

This section should concisely state your research plan and how it will test your hypothesis stated above. (2,500 character limit, including spaces):
I plan to reconstruct SST and surface ocean δ18Osw using core-top samples at five sites (Figure). The reconstructions will be completed using in situ Mg/Ca and δ18O measurements from pre-gametogenic calcite of the mixed-layer dwelling foraminifer, Gs. sacculifer, for the western equatorial Pacific (WEP), eastern equatorial Pacific (EEP), Caribbean, and subtropical Atlantic, and G. bulloides for the North Atlantic. δ18O and Mg/Ca ratios will be measured from 10 shells per sample. The WEP samples are from Ocean Drilling Program (ODP) Site 806 collected at a water depth of 2,520 m from atop the Ontong Java Plateau (0°19.11'N, 159°21.69 E). The EEP samples are from ODP Site 847 located 380 km west of the Galapagos Islands and 20 km from the equator (0°11.5851'N, 95°19.189'W) placing it directly beneath modern equatorial divergence at a water depth of 3,334 m. The Caribbean samples are from ODP Site 999 atop the Kogi Rise, a bathymetric high offshore of Panama (12°44.639'N, 78°44.360'W) at a water depth of 2,828 m. The subtropical Atlantic samples are from ODP Site 997 recovered from the Blake Ridge (31º50.588'N, 75º28.118'W) offshore of South Carolina at a water depth of 2,770 m. The North Atlantic samples are from ODP Site 609 at a water depth of 3,902 m on the eastern flank of the Mid-Atlantic Ridge (49°52.667'N; 24°14.287'W). All samples are in-house and have been disaggregated using a pH-buffered solution consisting of 3% aqueous sodium hexametaphosphate, rinsed over a 63-µm sieve, oven-dried overnight at 30°C, and dry sieved (>150 µm) to concentrate the foraminiferal shells. The shells will be handpicked, mounted in epoxy, and ground to cross-section (Figure). The scanning electron microscope (SEM) at UW-Madison will be used to image the shell cross-sections before and after analysis. The δ18O measurements will be completed using a CAMECA IMS-1280 large radius multicollector ion microprobe (WiscSIMS Laboratory) by targeting minute (3-10 µm diameter) domains within an individual foraminiferal shell. Analytical precision for δ18O is ±0.3-0.8 permil (2SD). The Mg/Ca ratios from 5-µm domains in foraminiferal shells will be collected with a CAMECA SXFive electron probe microanalyzer (EPMA). The in situ Mg/Ca ratios and δ18O values obtained from pre-gametogenic calcite in the same individual foraminiferal shells will be paired to yield the most accurate SST and δ18Osw reconstruction.

Duration of investigation (dates):
5/2015-5/2016

This section should have an itemized budget and detailed justification for each item listed. MAXIMUM of $2,500 to be requested from GSA. List in order of priority and be sure to total up each column of budgeted item costs.

	Title of Category	Total Amount Budgeted	Amount Requested from GSA	Amount Requested from Other Sources
1.	Mount Preparation	$20	$20	$0
2.	SEM	$325	$300	$0
3.	SIMS	$2880	$1920	$0
4.	EPMA	$400	$260	$0
5.		$	$	$
6.		$	$	$
7.		$	$	$
8.		$	$	$
	TOTAL:	$3625	$2500	$0

Budget justification:
A total of 50 shells, 10 shells per site for 5 sites, will be measured with in situ techniques. Each shell will be mounted in epoxy, ground to cross-section, and polished by University of Wisconsin-Madison's thin section laboratory ($20). SEM images will be collected for each shell before mounting to observe surface textures, in mounted cross-section to identify low-porosity domains, and after analysis to

evaluate analysis pits in targeted domains. Based on prior experience, the described SEM imaging will require ~13 hours for ~700 images ($25/hour). To account for intra-shell variability, four in situ Mg/Ca measurements will be obtained from each shell, requiring 8 hours on the EPMA ($50/hour). Three in situ δ18O measurements will be obtained from each shell, requiring 24 hours on the SIMS ($1440 per 12 hour session).

Amount and nature of other available funds, facilities, materials, etc.:
There are no other funds currently available or pending. All materials (samples) are already in-house and cleaned. The only funds needed are for analysis preparation and instrument time.

Other grants that (a) have supported this project, (b) are currently supporting this project, and (c) are being applied for. This list should include funds available to or applied for by the thesis supervisor, if these can support the proposed work:

	Year Applied	Agency Title Applied to	Amount Requested	Amount Granted or Date Decision Expected	Amt. remaining as of March 30 this year (projected)
1.			$	$	$
2.			$	$	$
3.			$	$	$
4.			$	$	$
5.			$	$	$

Have you ever received a GSA graduate student research grant?	Related to this project?	Year(s) applied: 2013
YES	NO	Year(s) granted: 2013

Progress Report:
Name: Jody Wycech Year Granted: 2013 GSA Member No: 9139678 Award amount: $2,125 Please list any special awards or recognition that accompanied your grant: N/A Please list any contact information changes below: N/A Project Title: Effects of Seafloor Diagenesis on Planktic Foraminiferal Radiocarbon Ages Project Abstract, if prepared for a journal article or poster: Radiocarbon (14C) analysis of planktic foraminiferal calcite is widely used to study ocean-climate change over the past ~40 ka of Earth history. However, it is well known that planktic shell calcite typically yields 14C ages ~400 years older than those of bulk carbonate from the same sample. Such age discrepancies are problematic, and have been attributed to size-selective sediment mixing and/or differential dissolution of planktic shells within the sedimentary bioturbated zone. Another likely cause of such temporal offsets is the addition of secondary calcite to planktic shells via post-depositional diagenesis, but quantifying the deleterious effects of diagenesis on foraminiferal 14C ages has proven difficult owing to a paucity of suitable study materials. We address this problem by comparing 14C ages and δ13C values of planktic shells exhibiting a state of preservation (frosty) traditionally deemed acceptable for paleoceanographic studies to those of extremely well preserved (glassy) shells. Aliquots of frosty and glassy shells (>150 µm) of mixed-layer species (Globigerinoides ruber, Gs. sacculifer, Orbulina universa) were picked separately from a stratigraphic series of clay-rich samples recovered in a piston core taken atop Blake Ridge (northwestern Atlantic Ocean). Sample selection was guided by a foraminiferal δ18O record, which constrained the Last Glacial Maximum to ~100 cm core depth. Results support a diagenetic mechanism as glassy shells yield 14C ages that average ~2,000 ± 100 years younger than frosty shells from the same samples. Further, average δ13C of glassy shells is 0.6 ± 0.1‰ lower than that of frosty shells. Our findings indicate that 14C ages are artificially elevated by the dissolution of previously deposited (“old”) carbonate and its subsequent reprecipitation as secondary carbonate on younger foraminiferal shells at, and beneath, the seafloor – a phenomenon that has not been quantified prior to this study. Itemized budget at this point in time: All analyses have been completed. GSA funds were utilized for: Radiocarbon Analyses (6 dates)……….$1,782 Trace Element Analyses……………….$343 Publications supported by this grant: Wycech, J.; Kelly, D.C.; Marcott, S. Effects of Seafloor Diagenesis on Planktic Foraminiferal Radiocarbon Ages: Science, in prep. Wycech, J.; Kelly, D.C. Effects of Seafloor Diagenesis on Planktic Foraminiferal Radiocarbon Ages: AGU Fall Meeting, San Francisco, CA, 2014.

Abbreviated Resume:
EDUCATION: Ph.D., Geoscience, Environmental Engineering Minor, August 2016, University of Wisconsin-Madison, GPA 4.00, "Effects of diagenesis on planktic foraminiferal calcite", PI: Clay Kelly. B.S. Environmental Chemistry, Geology and Business Minors, April 2012, Grand Valley State University, GPA 3.97. RELATED EXPERIENCE: Membership: Geological Society of America (GSA), American Association of Petroleum Geologists (AAPG), Graduate Women in Science and Phi Kappa Phi honor societies. Short Courses: Weatherford Well-log Interpretation, 2014; WiscSIMS Workshop, 2013; University of Utah Isocamp, 2013; BP Sequence Stratigraphy, 2013. EXPERIENCE: Work: Independent instrument operation: SIMS (96 hours), EPMA (49 hours), SEM (80 hours). SEM Technician, University of Wisconsin-Madison, Geoscience Department, Summer 2014. Analytical chemistry intern, Michigan State University Bioeconomy Institute, Summer 2012. Instrument technician, Chemistry Department, Grand Valley State, 2011-2012. Leadership: Geoscience Graduate Student Association Vice President, UW-Madison, 4/13-4/14. Chemistry Club President, Grand Valley State, 9/10-4/12. Outreach: Bonding Undergraduate and Graduate Students mentor, 9/14-Present. Madison Science Symposium Student Mentor, 11/12-5/13. Habitat for Humanity, 10/08-3/12. Teaching: Oceanography (GEO 105), Teaching Assistant, Spring 2014. Deciphering the Past (Integrated Liberal Studies 252), Teaching Assistant, Fall 2013. Past Research: NSF paleoclimate REU, University of Texas at Austin, Summer 2011. NSF aeolian geomorphology geochronology REU, UW-Platteville, Summer 2010. Environmental Chemistry Research Assistant, Grand Valley State, 8/08-12/11. HONORS: Verville Award for Paleontology Research, University of Wisconsin-Madison, 2014. NSF Marine Geology and Geophysics Grant, Research Assistantship, 2014-2016. Weeks Fellowship, University of Wisconsin-Madison, Geoscience, 2012-2014. GSA Graduate Student Grant, 2012. Outstanding Senior Chemist of the Year, Grand Valley, 2012. PRESENTATIONS: Wycech, J. and Kelly, D.C., 2014, Effects of Seafloor Diagenesis on Planktic Foraminiferal Radiocarbon Ages. AGU Abstracts, PP41D-1431. Wycech, J.; Kelly, D.C.; Kozdon, R.; Fournelle, J.; Valley, J.W., 2013, Warm tropical sea surface temperatures during the Pliocene: a new record from Mg/Ca and δ18O in situ techniques. AGU Abstracts, PP53C-2016.

References cited in proposal:
Bé, A.W., 1980, Gametogenic calcification in a spinose planktonic foraminifer, Globigerinoides sacculifer (Brady): Marine Micropaleotology, v. 5, p. 283–310. Dowsett, H.J., Foley, K.M., Stoll, D.K., Chandler, M.A., Sohl, L.E., Bentsen, M., Otto-Bliesner,

B.L., Bragg, F.J., Chan, W.-L., Contoux, C., Dolan, A.M., Haywood, A.M., Jonas, J.A., Jost, A., et al., 2013, Sea Surface Temperature of the mid-Piacenzian Ocean: A Data-Model Comparison: Scientific Reports, v. 3. Haug, G.H., and Tiedmann, R., 1998, Effect of the formation of the Isthmus of Panama on Atlantic Ocean thermohaline circulation: Nature, v. 393, p. 673–676. Kozdon, R., Kelly, D.C., Kitajima, K., Strickland, A., Fournelle, J.H., and Valley, J.W., 2013, In situ δ18O and Mg/Ca analyses of diagenetic and planktic foraminiferal calcite preserved in a deep-sea record of the Paleocene-Eocene thermal maximum: Paleoceanography, v. 28, p. 517–528. Kürschner, W.M., van der Burgh, J., Visscher, H., and Dilcher, D.L., 1996, Oak leaves as biosensors of late Neogene and early Pleistocene paleoatmospheric CO2 concentrations: Marine Micropaleontology, v. 27, p. 299–312. Mulitza, S., Donner, B., Fischer, G., Paul, A., Pätzold, J., Rühlemann, C., and Segl, M., 2003, The South Atlantic Oxygen Isotope Record of Planktic Foraminifera, in Wefer, G., Mulitza, S., and Ratmeyer, V. eds., The South Atlantic in the Late Quaternary: Recontruction of Material Budgets and Current Systems, Springer-Verlag Berlin Heidelberg, New York Tokyo, p. 121–142. Pearson, P.N., Ditcheld, P.W., Singano, J., Harcourt-Brown, K.G., Nicholas, C.J., Shackleton, N.J., and Hall, M.A., 2001, Warm tropical sea surface temperatures in the Late Cretaceous and Eocene epochs : Nature, v. 415, p. 481–487. Raymo, M., Grant, B., Horowitz, M., and Rau, G., 1996, Mid-Pliocene warmth: stronger greenhouse and stronger conveyor : Marine Micropaleontology, v. 27, p. 313–326. Stocker, T.F., Qin, D., Plattner, G.-K., Tignor, M., Allen, S.K., Boschung, J., Nauels, A., Xia, Y., Bex, V., and Midgley, P.M. (Eds.), 2013, Climate Change 2013: Cambridge University Press, p. 1–1552. Wara, M.W., Ravelo, A.C., and Delaney, M.G.L., 2005, Permanent El Niño-Like Conditions During the Pliocene Warm Period: Science, v. 309, p. 758–761.

Images On File:

Yes