Application for a 2015 Research Grant

Name:
Sharon McMullen

SSN:

GSA Member No:

Street Address:

Daytime Phone No:

E-Mail Address:

University:
University of Wisconsin-Madiso

Department:
Geoscience

Masters Degree?:
YES

Current Degree Program:
Ph.D.

Yrs. in Graduate School (Masters):
2nd Year

Yrs. in Graduate School (Ph.D):
3rd Year

Minority Status:
White/Caucasian

Citizenship:
USA

Gender:
Female

Are you a member of a GSA Division?:

Are you a member of a GSA Section?:

Did you attend the Grant Writing Workshop?:

Amount requested from GSA:
2500

General field of this research project:
Stratigraphy/Sedimentology

Geographic focus, if any:
Rocky Mountain U.S.

Project Title:
Controls on the stratigraphic distribution of non-marine fossils: a case study in the Late Jurassic Morrison Formation, western USA

Project Supervisor(s):

Specialized Award(s):

The problem to be addressed or the hypothesis to be tested:

An awareness of preservational biases in the fossil record linked to sedimentation and stratigraphic architecture has lead to the development of the field of stratigraphic paleobiology (Patzkowsky and Holland 2012). Within the field of stratigraphic paleobiology, the extent to which stratigraphic architecture influences distribution and preservation of fossils in non-marine settings remains unknown. Here I propose to combine stratigraphic analyses of a large fossil alluvial system with paleontological and taphonomic data to test the hypothesis that fossil preservation is predictably linked to stratigraphic architecture in non-marine settings. The non-marine Late Jurassic Morrison Formation in the western United States is renowned for well-preserved and abundant vertebrates (Foster 2006), making this unit ideal as a template for assessing the relative importance of rate of accommodation formation, sediment supply, and fluvial geomorphology in governing fossil preservation.

Discuss the previous work on your problem(s) that (1) places the project in a disciplinary and, if appropriate, regional context and (2) documents the importance of your project:

Stratigraphic paleobiology utilizes modern stratigraphic concepts to interpret the fossil record, recognizing that fossil distribution is governed not only by biological and ecological factors but also by sedimentation and stratigraphic processes (Patzkowsky and Holland 2012). Many studies have shown a strong influence of sequence stratigraphic architecture on marine invertebrate preservation (eg., Brett 1995; Holland 1995; Holland 2000) and several studies have explored this relationship for marine vertebrates (eg., Peters et al. 2009; McMullen et al., 2014). Considerably less attention has been devoted to the stratigraphic occurrences of terrestrial fossils because without the influence of sea level, many principles of sequence stratigraphy do not apply, and the corresponding predictions about fossil preservation break down. Despite the scarcity of studies on fossil preservation in fluvial settings, much of the terrestrial vertebrate fossil record is found in fluvial environments, making it an important system to understand to interpret the history of life (Behrensmeyer 1988). This research has applied utility in that it is likely to help characterize alluvial stratigraphy generally and prioritize regions for fossil prospecting by providing a predictive stratigraphic framework (Patzkowsky and Holland 2012). Initial data for this study collected during the summer of 2013 and supplemented from data from the Paleobiology Database suggest that areas of apparently high accommodation in the Morrison Formation result in higher rates of preservation of fossil material and greater diversity (fig.1). This preliminary research was recognized at the North American Paleontological Convention in 2014 for its merit as an Honorable Mention for Best Graduate Presentation. Insight from this project will allow biological studies on Morrison fauna to be conducted within a stratigraphic framework to avoid issues such as time-averaging. In addition to this stratigraphic paleobiological research, I am using 40Ar/39Ar on sanidine and single-crystal zircon U-Pb to constrain depositional ages in northern Wyoming and southern Montana for the Morrison. This will allow for comparison of the evolution of stratigraphic architecture on the previously dated Colorado Plateau to sites in Wyoming and Montana. Further fieldwork is necessary to assess fossil distribution in the Morrison and to characterize the stratigraphic framework of the Morrison in light of this new information.

How you plan to address your problem or test your hypothesis:

The Morrison Formation represents a distributive fluvial system which is the presumed most common type of fluvial setting preserved in the geologic record, suggesting that the Morrison is a suitable system to begin developing models for non-marine fossil preservation (Weissmann et al., 2010). Fluvial architecture in distributive fluvial systems is closely tied to the rate of change in accommodation space; specifically, periods of high accommodation create single-story fluvial channels and stages of low accommodation produce multi-story stacking of architectural elements (fig. 1a; Bridge and Leeder 1979; Shanley and McCabe 1994; Davidson et al. 2011). To understand how non-marine fossil preservation is influence by the relationship of accommodation and sedimentation rates this study

will target areas of the Morrison Formation where vertebrates have been found and areas that have been prospected but no or few vertebrate fossils were discovered. Specifically, the study areas focus on different fluvial architectures that may explain the range in quality and abundance in fossil preservation. Fieldwork for the summer of 2015 will involve measuring and describing stratigraphic columns in Colorado, Utah, Wyoming, and Montana at known fossil localities. These sites have not yet been well described in a stratigraphic context. Fieldwork conducted during the summer of 2013 consisted of measuring and describing seven stratigraphic sections: four on the Colorado Plateau and three sections in northern Wyoming (fig. 1b). I will record lithology, sedimentary structures, vertebrate fossils, invertebrate fossils, and ichnofossils for each bed (sensu Allulee and Holland 2005). Paleocurrent directions will be recorded where available. To characterize lithology, approximately thirty hand samples will be collected for petrographic analysis. Sections will be interpreted and correlated to form a regional stratigraphic cross-section. These data will be then used along with additional stratigraphic columns from previously published research on the Morrison Formation to compile a high-resolution stratigraphic model for the Morrison. Fossil data from the Paleobiology Database (pbdb.org) that have stratigraphic context will be used in addition to the in-field record. The integration of well-documented fossil data from the Morrison combined with the high-resolution stratigraphic model should reveal any trends in non-marine fossil preservation related to fluvial architecture.

Duration of investigation (dates):
June 2015 - August 2015

Budget: **LIST IN ORDER OF PRIORITY**, justification for funding of chemical and isotopic analysis, equipment, technicians and expendable laboratory supplies is necessary for consideration. Grants are made for one year only.

	Title of Category	Total Amount Budgeted	Amount Requested from GSA
1.	Transportation (gasoline)	$1575	$1000
2.	Lodging (campsites)	$600	$600
3.	General field supplies	$150	$150
4.	Shipping	$360	$300
5.	Thin sections	$450	$450
6.		$	$
7.		$	$
8.		$	$
	TOTAL:	$3135	$2500

Budget justification:

Round-trip estimate combined with travel between sites is approximately 9,000 miles. The vehicle to be used averages 20 mpg, and projected cost of gas is $3.50 per gallon (www.eia.gov), giving a total of $1575 needed to cover gas. I am asking GSA for $1000 toward transportation. Thirty nights of paid camping will be needed during travel to sites and when visiting sites where BLM camping is not available. Camping on BLM land, at no cost, will be done when possible. A campsite will cost approximately $20 a night. I am asking GSA to provide $600 for lodging. General field supplies will be needed for collection and field notes at an expense of approximately $150. I am asking GSA for $150 toward field supplies. Samples will need to be shipped to UW-Madison via USPS large-sized Priority Mail Flat Rate Boxes, costing $18 per box. Estimated total number of boxes shipped is 20, based on previous fieldwork. I am asking GSA for $300 toward shipping expenses. Thirty thin sections, at a cost of $15 per slide, will be sufficient to characterize lithology of facies and variability, based on the estimated number of facies. I am asking GSA to cover the cost, $450.

Amount and nature of other available funds, facilities, materials, etc.:

No other funding for this project is available at this time. Student grant proposals are also being submitted to the SEPM Student Grants, Paleontological Society Student Grants, the American Museum of Natural History Theodore Roosevelt Grant, the Evolving Earth Foundation, the American Association of Petroleum Geologists, the Jurassic Foundation, and Sigma Xi. Research facilities available at the University of Wisconsin-Madison include a laboratory with microscopes examine thin sections. The radiometric dating project on the Morrison Formation mentioned in this proposal has been funded fully by AAPG and ConocoPhillips.

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.	2015	Paleontoogical Society Student Grants	$800	$	$
2.	2015	SEPM Student Grants	$500	$	$
3.	2015	American Museum of Natural History Theodore Roosevelt Memorial Grant	$2900	$	$
4.	2015	Sigma Xi	$1000	$	$
5.	2015	Jurassic Foundation	$500	$	$

Have you ever received a GSA national grant?
YES

Related to this project?
NO

Year(s) applied: 2011, 2013, 2014
Year(s) granted: 2011

Progress Report:

GSA Research Grant Progress Report Form Name: Sharon McMullen Year Granted: 2011 GSA Member No: 9143516 Award amount: $1645 Please list any special awards or recognition that accompanied your grant: n/a Please list any contact information changes below: n/a Project Title: The occurrence of vertebrate and invertebrate fossils in a sequence stratigraphic context: the Jurassic Sundance Formation, Bighorn Basin, Wyoming, U.S.A Project Abstract, if prepared for a journal article or poster (if you are not finished with your research please leave blank): Previous studies of the sequence stratigraphic distribution of fossils have focused on the record of relatively abundant marine invertebrates. Only a handful of studies have examined how sequence stratigraphic architecture influences the occurrence of vertebrates, particularly large and rare tetrapods. The Jurassic Sundance Formation of the Bighorn Basin, Wyoming, USA, contains a rich suite of invertebrate and vertebrate fossils, including large and rare marine reptiles, and this allows the sequence stratigraphic controls on the distribution of these groups to be compared. The Sundance Formation consists of four depositional sequences, with the lower two being carbonate dominated and the upper two siliciclastic dominated. Two incised valley fills are also present. The presence of multiple depositional sequences and strongly erosional sequence boundaries is the likely cause of the complicated lithostratigraphic nomenclature of the Sundance. Invertebrates (mollusks and echinoderms) in the Sundance conform to well-established patterns of occurrences, including strong facies control and fossil concentrations at maximum flooding surfaces, in the upper portion of parasequences, and within lags overlying sequence boundaries. As expected from their rarity, marine reptiles (ichthyosaurs, plesiosaurs, and pliosaurs) show a weaker connection to sequence stratigraphic architecture. Nonetheless, they do display facies control and are found primarily in offshore mudstone, rather than shoreface and estuarine sandstone. They are also more common at hiatal surfaces, including a zone of concretions at the maximum flooding surface and in lag deposits overlying sequence boundaries. These associations suggest that sequence stratigraphic architecture may be a useful approach for discovery of marine vertebrates and that sequence stratigraphic context should be considered when making paleobiological interpretations of marine vertebrates as well as invertebrates. Itemized budget at this point in time: Gas: $700 Camping: $150 General Field Supplies: $100 Shipping: $320 Thin Sections: $375 Total: $1645 Publications supported by this grant: McMullen, S. K., Holland, S. M., and O'Keefe, F. R., 2014, The occurrence of vertebrate and invertebrate fossils in a sequence stratigraphic context: The Jurassic Sundance Formation, Bighorn Basin, Wyoming, USA: Palaios, v. 29, p. 277-294.

Abbreviated Resume:

Education: Ph.D. Candidate, 2012-current, The University of Wisconsin-Madison, Dept. of Geoscience, Advisor: Dr. Shanan Peters, Thesis: "Stratigraphic paleobiology in non-marine settings"; M.S., 2012, University of Georgia, Dept. of Geology, Advisor: Dr. Steve Holland, Thesis: "The occurrence of vertebrate and invertebrate fossils in a sequence stratigraphic context: the Jurassic Sundance Formation, Bighorn Basin, WY, USA." B.S., 2009, College of Charleston, Major: Geology, Minor: Biology, Honors Thesis. Awards: Honorable Mention for Best Graduate Student Poster, North American Paleontological Convention-2014; Robert & Lynn Maby Memorial Grant, AAPG Grants-in-Aid-2014; Paleontological Society Harrel S. Strimple Award-2013 & Ellis L. Yochelson Award-2011; Weeks Hall Research Grant-2013; GSA Research Grant-2011; Miriam-Watts Wheeler Fund Research Grant-2011; Royal Hartenberger for Field Studies-2007. Positions: RA for the Paleobiology & Macrostratigraphy Databases 2012-15: ConocoPhillips Geoscience Intern 2014; Graduate fieldwork in the Morrison Fm. 2013; Session Chair for Recent Advances in Stratigraphy at the National GSA Convention 2012; Paleontology GeoCorps internship with BLM Gunnison Gorge NCA surveying for fossils in the Morrison 2011; Graduate fieldwork in the Sundance Fm. 2011; Cincinnati Museum Center, Field Crew, Morrison Fm., Montana 2010-11. Related: Wilderness Medicine Institute of NOLS Wilderness First Aid certification, spring 2015 Teaching: Paleontological Society TA: Stratigraphic Paleobiology Field Course, Summer 2014; UW-Madison, Senior TA: Sedimentation & Stratigraphy Fall 2014; Undergraduate Spring Break Field Trip, Spring 2013; UGA, TA Sedimentary Geology, Spring 2012, 2011: Paleontology, Fall 2011, 2010. College of Charleston, TA: Intro. to Geology, Fall 2008. Selected Publications: McMullen, S. K., Holland, S. M., and O'Keefe, F. R., 2014, The occurrence of vertebrate and invertebrate fossils in a sequence stratigraphic context: The Jurassic Sundance Formation, Bighorn Basin, Wyoming, USA: Palaios, v. 29, p. 277-294; McMullen, S.K., 2014, Controls on the stratigraphic distribution of non-marine fossils: A case study in the Upper Jurassic Morrison Formation, Western, USA. The Paleontological Society Special Publications, 13; McMullen, S.K. and Hadden, G., 2012, Paleontological survey of Upper Jurassic and Lower Cretaceous deposits in Gunnison Gorge Conservation Area, CO, USA for a GeoCorps America internship. GSA Abstracts, 44.

Biography of references cited in proposal:

Allulee, J.L. and Holland, S.M., 2005, The sequence stratigraphic and environmental context of primitive vertebrates: Harding Sandstone, Upper Ordovician, Colorado, USA: Palaios, v. 20, p. 518-533. Behrensmeyer, A.K., 1988, Vertebrate preservation in fluvial channels: Palaeogeography, Palaeoclimatology, Palaeoecology, v. 63, p. 183–199. Brett, C., 1995, Sequence stratigraphy, biostratigraphy, and taphonomy in shallow marine environments: Palaios, v. 10, p. 597-616. Bridge, J.S. and Leeder, M.R., 1979, A simulation model of alluvial stratigraphy: Sedimentology, v. 26, p. 617-644. Davidson, S.K., Leleu, S., and North, C.P., eds., 2011, From River to Rock Record: the preservation of fluvial sediments and their subsequent interpretation: Society of Sedimentary Geology, Special Publications, v. 97, 447 p. Foster, J.R. and Lucas, S.G., 2006, Paleontology and Geology of the Upper Jurassic Morrison Formation: New Mexico Museum of Natural History, bul. 36, p. 1-249. Holland, S.M., 1995, The stratigraphic distribution of fossils: Paleobiology, v. 21, p. 92-109. Holland, S.M., 2000, The quality of the fossil record: a sequence stratigraphic perspective: Palaios, v. 26, p. 148-168. McMullen, S.K., Holland, S.M., and O'Keefe, F.R., 2014, The occurrence of vertebrate and invertebrate fossils in a sequence stratigraphic context: The Jurassic Sundance Formation, Bighorn Basin, Wyoming, USA: Palaios, v. 29, p. 277-294. Patzkowsky, M.E. and Holland, S.M., 2012, Stratigraphic Paleobiology: Understanding the Distribution of Fossil Taxa in Time and Space, University of Chicago Press, Chicago, 259 p. Peters, S., Sameh, M., Zalmout, I., Gingerich, P., 2009, Sequence stratigraphic control on preservation of late Eocene whales and other vertebrates at Wadi Al-Hitan, Egypt: Palaios, v. 24, p. 290-302. Shanley, K.W., and P.J. McCabe, 1994, Perspectives on the Sequence Stratigraphy of Continental Strata: American Association of Petroleum Geologists Bulletin, v. 78, p. 544–568. Weissmann, G.S., A.J. Hartley, G.J. Nichols, L.A. Scuderi, M. Olson, H. Buehler, and R. Banteah, 2010, Fluvial form in modern continental sedimentary basins: Distributive fluvial systems: Geology, v. 38, p. 39–42. Weissmann, G.S., A.J. Hartley, L.A. Scuderi, G.J. Nichols, S.K. Davidson, S.C. Atchley, O.V. Hurd, P. Bhattacharyya, T. Chakraborty, P. Ghosh, L.C. Nordt, L. Michel, and N.J. Tabor. 2013: Prograding distributive fluvial systems—geomorphic models and ancient examples. SEPM Special Pub.109:131–109:14.

Images On File:
Yes