An REU site at James Madison University: Understanding the Rift-to-Drift Transition in Eastern North America and the North Atlantic

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We propose a Research Experience for Undergraduates (REU) program in the Department of Geology and Environmental Science at James Madison University (JMU) based on the scientific objectives of the GeoPRISMS Implementation Plan for Eastern North America. We envision JMU as one of several collaborative REU sites forming a GeoPRISMS-wide REU network. Our department will encourage young students from local community colleges to participate in the REU program and to transfer into a four-year degree in the Geosciences. JMU is a public, primarily undergraduate institution (PUI) located in the central Shenandoah Valley of Virginia and has an enrollment of ~19,000 students. JMU is among the top ten PUIs in terms of number of students who go on to earn doctorate degrees in STEM fields (Table 1) and has NSF-funded REU programs in Materials Science, Chemistry, and Mathematics.

Table 1: Science and engineering doctorates earned by graduates of PUIs (2000-2009)

1	**Carleton College**	**503**
2	**Oberlin College**	**497**
3	**Wesleyan University**	**466**
4	**Cal Poly U- San Luis Obispo**	**455**
5	**Swarthmore College**	**445**
6	**Williams College**	**419**
7	**Reed College**	**371**
8	**Wellesley College**	**370**
9	**James Madison University**	**344**
10	**Harvey Mudd College**	**343**

Data taken from NSF survey of earned doctorates: http://webcaspar.nsf.gov/.

Geology faculty and students have participated in the JMU Materials Science REU in the past, and we would like to expand on these experiences to create an REU experience specifically for Geosciences.

The Department of Geology and Environmental Science at JMU has 15 full-time faculty members and ~125 majors in two degree programs: the BS in Geology and the BA in Earth Science. Students in both programs are required to complete an independent research project as part of their degree requirements. We have laboratory facilities and field equipment, including 4 dedicated field vehicles, to support research projects.

The REU program at JMU would promote the Outreach and Education goals of GeoPRISMS by:

1) Providing research experiences that encourage undergraduate students to attend graduate school and continue in careers in the GeoPRISMS disciplines;
2) Providing pre-service teachers (BA in Earth Science) with research experiences that will help expand GeoPRISMS science into the classroom;
3) Strengthening existing research collaborations between JMU and other institutions in the region including the USGS (Reston), the Virginia Department of Mines, Minerals, and Energy, the Consortium for Ocean Leadership and the Integrated Ocean Drilling

Program (IODP), the Smithsonian Institution, Virginia Tech, the University of Maryland, and the Ohio State University;

4) Creating new collaborations and sharing instrumentation and equipment resources with other universities.

Student research projects undertaken at JMU will be aligned with questions posed within the GeoPRISMS initiatives for Eastern North America by working with one of the faculty members listed below:

Anna Courtier is a structural seismologist who investigates deep Earth indicators of mantle flow and patterns of thermal and chemical variability in the mantle. Variations in mantle discontinuity and reflectivity structure are indicative of heterogeneous thermal and chemical structure within upper mantle rocks. In particular, studies examining the distribution of water in the mantle beneath Eastern North America may yield insight as to how continental collision and rifting are initiated. In addition to documenting current plate motion, upper mantle and lithospheric anisotropy records the deformation history associated with major tectonic events.

Anthony Hartshorn is a soils scientist who studies biogeochemical cycles (carbon, nitrogen, phosphorus, silica) and the genesis of soils and soil-landscapes. His research will address these GeoPRISMS questions for Eastern North America: 1) As mass is removed from the Atlantic seaboard, how are uplift rates, and therefore soil residence times, affected? and 2) How does a lithologic gradient in silica content affect weathering processes and therefore delivery rates of silica and other elements to the Chesapeake Bay?

John Haynes is a sedimentary petrologist with research interests focused on the Paleozoic of the central and southern Appalachians. He uses lithostratigraphic, chronostratigraphic, and petrographic methods in the field and lab to investigate the early Paleozoic history of the central and southern Appalachians, in particular the origin and significance of (1) altered volcanic ash beds (K-bentonites) and associated quartz arenites and conglomerates of Ordovician age from Virginia to Alabama, (2), chemical trends in mudrocks of the central Appalachians, (3) facies relations in Silurian and Lower Devonian strata of western Virginia, and (4) the connections between stratigraphy and karst development in the region.

Elizabeth Johnson is an igneous petrologist who uses geochemical and spectroscopic techniques to 1) investigate the source and mechanisms of magma generation which produced the Eocene (35-48 Ma) volcanic field of western Virginia, and 2) determine the composition, volatile content, and structure of the crust and mantle underneath the Shenandoah Valley and Allegheny Plateau from xenoliths entrained within the Eocene magmas. These data will be used to constrain and test models of the structure of the crust and mantle in Eastern North America.

Stephen Leslie is a paleontologist and stratigrapher whose interests include the integration of paleontology with stratigraphy, Most of his current focus is using conodont biostratigraphy and isotope stratigraphy to examine the greenhouse–icehouse transition at the end of the Ordovician. One of his projects would examine the petrology and potential fossil content of the Paleozoic sedimentary rocks preserved as xenoliths in the Eocene volcanic rocks.

Kristen St. John is a paleoceanographer and paleoclimatologist. Her project would address the GeoPrisms Tectonics-Climate-Surface Feedbacks Theme

(http://www.geoprisms.org/surface-feedbacks.html) by focusing on the ODP Site 908 post-rift marine depositional record on the Hovgaard Ridge, at the southern end of the Fram Strait. Opening of the strait and subsidence of this ridge allowed for water exchange between the Arctic and North Atlantic Oceans. Early low resolution investigations suggested no sea ice cover in the Oligocene sediments, however this is inconsistent with current understandings of regional (Greenland and Arctic) climate change. She will conduct a high resolution reinvestigation of the sea ice history of the Arctic gateway by examining the abundance, composition, and surface textures of the coarse sand fraction at Site 908.

Steven Whitmeyer is a structural geologist whose interests include 1) development of digital mapping techniques and 3D and 4D visualizations, and their incorporation into field geology curricula; 2) Bedrock mapping of the Blue Ridge - Valley and Ridge transition, including the semi-cryptic Blue Ridge thrust system; 3) Evolution of continental crust and basement development in orogenic zones, with recent focus on the mid-Atlantic region of the eastern United States.