RCL Vision Statement – Outcomes from the 2009 Charleston Workshop

Conveners and Participants of the RCL Synthesis Workshop

(www.nsf-margins.org/RCL/2009)

Introduction

Over the past decade, the Rupturing Continental Lithosphere (RCL) initiative of the MARGINS program has fostered a multidisciplinary research community examining rifting and rupture processes within the Gulf of California and Red Sea focus sites. A workshop of the RCL community was held on April 30–May 2, 2009 in Charleston, SC to discuss the major findings from the focus sites and complementary theoretical and laboratory studies, and to evaluate these results within the context of global studies. 83 students, post-docs, and scientists from a total of 9 countries participated in the workshop, including many from outside the traditional RCL community. A workshop report summarizing the results described in the oral and poster presentations was published in the Fall 2009 MARGINS Newsletter and can be found online at www.nsf-margins.org/Publications/Newsletters/Newsletter.html. The final day of the workshop was focused on outlining the key scientific questions that should motivate a successor MARGINS program.

Early career scientists led breakout groups to establish the future science objectives as well as to provide recommendations for designing a successor program to most effectively address these objectives (e.g., thematic vs. focus site approach). The breakout and plenary discussions were guided by the recommendations of the MARGINS Decadal Review Committee, who proposed that the RCL initiative be transformed into a *Rifts, Sediments, and Fluids* (RSF) initiative with a greater emphasis on integrating surface and sedimentary processes with the overall evolution of the margin. Presented below are the 5 major scientific questions derived from this workshop that could drive a future RSF initiative. We stress that these represent a consensus view of those present at the workshop, and thus are not meant to fully encompass all viewpoints. As the planning toward a MARGINS successor program continues, we encourage members of the community to expand upon these science objectives by submitting 2-page white papers for discussion at the MARGINS Successor Planning Workshop to be held in San Antonio, TX in February, 2010. Guidelines for submitting white papers can be found at

http://www.nsf-margins.org/SuccessorProgram/whitepapers.html .

Shaping the Future of RCL/RSF

Many new and fundamental scientific questions have arisen regarding the development and evolution of continental margins stemming from the advances

made during the last decade of MARGINS research. The systems-science approach required to answer these questions requires interdisciplinary science that "crosses-the-shoreline". The RCL initiative of the MARGINS program fostered such an interdisciplinary community as well as facilitating international collaborations that would otherwise be unlikely to crystallize. Early career scientists have been, and will continue to be integral to the success of a successor MARGINS program.

Articulating our emerging goal

At the Charleston workshop, breakout group and general discussions converged on the overarching goal of a successor program: *To understand the forces, responses, and feedbacks between continental rifting, mantle melting, and sedimentation* (Fig. 1). This requires studies that span the full range of time (seconds to millennia) and spatial (10^{-6} to 10^{8} m) scales. Below we identify 5 key scientific questions that were posed, which require integration of short-term and long-term observations, theory, and laboratory studies to fully understand processes acting at rifted continental margins:

1. What are the mechanisms and feedbacks that cause lithospheric thinning and weakening, which in turn lead to continental rifting? Specifically, what are the roles of magmatic and aqueous fluids in initial lithospheric strength reduction, and what are the feedbacks between sedimentation, climate and strain in space and time?

2. What are the mechanisms and feedbacks controlling the along-axis segmentation of continental rifts from initiation to breakup, with an

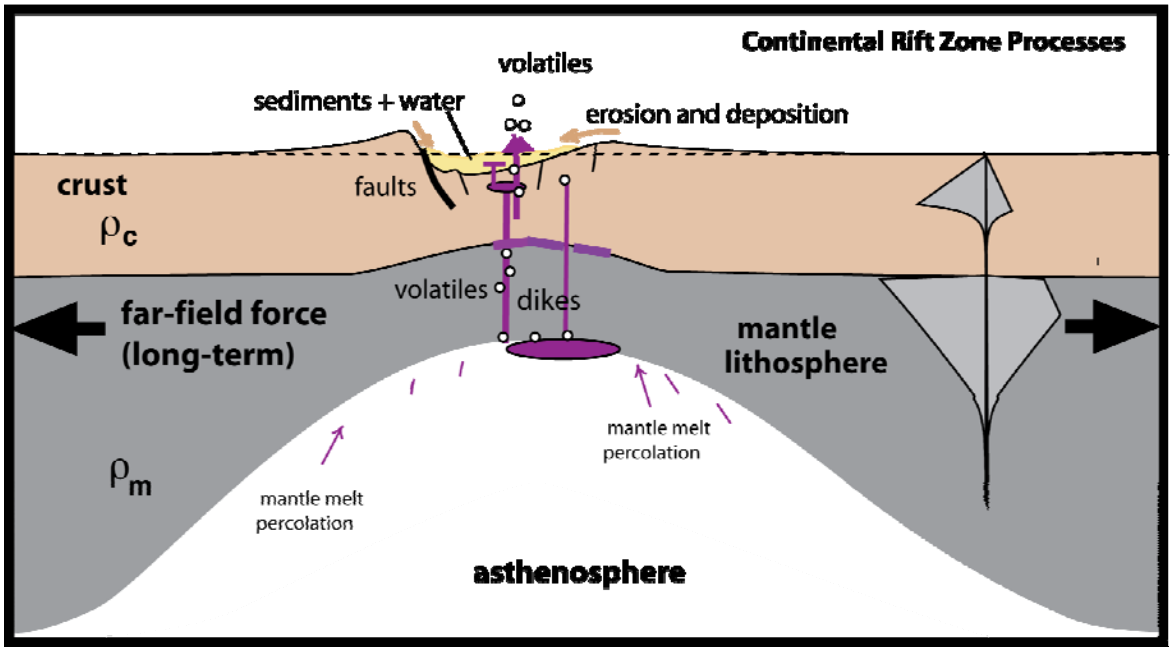

Figure 1: *Schematic diagram illustrating feedbacks between key processes influencing the evolution of rifted continental margins.*

emphasis on understanding the generation and focusing of magmas, and determining the timescales and rates associated with these processes?

3. What are the implications of these processes for societally-relevant issues such as earthquake and volcanic hazards, and the storage and release of hydrocarbons and greenhouse gases?

4. What are the rates, processes and timescales of delta transport across shelves into deep basins? How do these processes vary with climatic and tectonic forcing in continental rifts, and how are the signals of these variations expressed in the stratigraphic record?

5. What are the dynamic feedbacks between crustal deformation, erosion, climate, and sedimentation in and adjacent to continental rifts?

What infrastructure and approaches are needed to achieve goals?

Sequestered funds within a MARGINS successor program allow the development and use of large-scale infrastructure investments to study scientific problems that are unlikely to arise from a core NSF program. Such a program will catalyze the development of large interdisciplinary projects and international collaborations that benefit from this infrastructure. The current MARGINS program promotes informed collaboration rather than competition, and thus leverages infrastructure to benefit scientific advancement. For example, the active involvement of scientists in different disciplines who communicate and address fundamental questions synergistically would be impossible without an umbrella program like MARGINS. Regular thematic meetings and theoretical institutes build a community of 'Rifting' researchers, and they maximize scientific productivity and synergy. These meetings are particularly beneficial for students, post-docs, and early career researchers. Further, the short time-scales of many of the processes occurring at continental margins can require a rapid response that is best orchestrated through a program such as MARGINS. Examples include the recent boninite eruption at the Tonga trench, funded through a partnership between MARGINS and RIDGE 2000 (www.nsf-margins.org/SF/Lau/Lau2009.html).

As with the current MARGINS program, a successor program seeks to "cross-the-shoreline" with joint observations based on marine seismic (and other geophysical datasets), sampling, drilling (onland and offshore), terrestrial field observations, satellite based studies, geochemical analyses, new geochronologic methods, experimental approaches, and numerical models. A MARGINS successor program is well positioned to take advantage of new technologies (SAR satellite data or other space-based technologies that can see through vegetation; quantify displacements, deformation, or fluxes) as well as advances in established techniques. The rapid growth and success of the Computational Infrastructure for Geodynamics (CIG), for example, facilitates the general use of coupled numerical models and computational abilities for rheological, mechanical, and coupled surface evolution problems (deformation, fluid flow, etc.) relevant to continental margins problems. A successor program should aim

to leverage existing computational infrastructure developed by NSF funding for geodynamics and landscape evolution, as well as take advantage of geoinformatics and encourage open-access databases for new data collected under the MARGINS program. An outcome of the current and successor program is fully developed proposals to IODP; OOI; Earthscope; and evolving partnerships with industry to provide a substantial element of subsurface characterization.

Structure of a Successor Program

The MARGINS Decadal Review stressed that a successor program could not continue with a "business as usual" approach and must move beyond the current focus sites. Meeting participants debated the pros and cons of focus sites, thematic programs, and hybrid theme and focus site options. Answers to the fundamental rifting questions presented above necessarily require new observations from, and new models of, multiple locations globally spanning the evolution of rifts from inception to breakup. There was a clear consensus that 1) a future *Rifting, Sedimentation, and Fluids* initiative should include studies at active margins where processes can be examined as they are happening, as well as successfully rifted margins with experiments that span the continent-ocean divide, and 2) that focus sites should enable characterization of 4D strain processes. The merit of a coupled active-ancient program stems from new technologies to probe ancient margins in 3D, and to develop strong IODP proposals and links with industry. The final choice of future focus sites should build on existing major experiments and infrastructure, allowing us to apply RCL experience to future sites. Exploitation of well-sampled sites (e.g., drill sites) using new technologies and analytical techniques will enhance the cost-to-benefit ratio, and integrate with newly collected data.

Concluding Remarks

The Charleston RCL meeting achieved consensus on core themes for the MARGINS successor program. These scientific aims, and programs to achieve these aims will be honed and structured at the MARGINS Successor Planning Workshop in San Antonio, TX in February, 2010 (http://www.nsf-margins.org/SuccessorProgram/index.html). We encourage members of the community to attend this workshop and/or to submit white papers expanding on the scientific objectives discussed at the Charleston workshop.