

Workshop Title: International Workshop on Investigating Continental Breakup and Sedimentary Basin Formation with the Integrated Ocean Drilling Program

Date of Workshop: September 16-19, 2006

Location of Workshop: Pontresina, Switzerland

Committed Cost Sharing for the Workshop:

1. The IODP has committed \$75,000 to fund the workshop. These funds will provide travel support for participants from IODP member countries in the ratio 7:7:3:1 (USA:Japan:ECORD:China).
2. The US MARGINS Office supports the goals of scientific synthesis and insight in understanding continental break-up and development of sedimentary basins that will result from this meeting, and will be underwriting travel for members of the US MARGINS Steering Committee who wish to participate. We anticipate that this will include 4-6 participants.

Anticipated number of Participants: ~35 funded by IODP, ~5 funded by US MARGINS, ~10 self funded, plus the 8 participants for which we request funding in this proposal. Total is about 58 participants.

Request to InterMARGINS:

We request that InterMARGINS provide transportation, hotel, and food support for 8 scientists from non-IODP member countries to attend the workshop. We estimate that the cost for this will average \$1,600 per person for a total request of \$12,800.

We have identified 6 such scientists who we believe have a great deal to contribute to the objectives and success of the workshop. We envision that other scientists (perhaps students or young investigators) from non-IODP countries will respond to the advertisement and we would like to be able to offer travel support to 2 or more of them.

Phil Symonds, Australia

Zvi Ben-Avraham, Israel

Webster Mohriak, Brazil

Tim Stern, New Zealand

Shyam Chand, India

German Leitchenkov, Russia

We believe that it is essential that the participation in this workshop be truly international. Without support from InterMARGINS, we will be unable to support the participation of scientists with valuable process knowledge, regional experience and global scope.

Proponents of this proposal and Co-Chairs of the Workshop Steering Committee:

Dale S. Sawyer (dale@rice.edu), Dept. of Earth Science, Rice University, 6100 Main St., Houston, TX 77005, USA

Mike Coffin (mcoffin@ori.u-tokyo.ac.jp), Ocean Research Institute, University of Tokyo, 1-15-1 Minamidai, Nakano-ku, Tokyo 164-8639, Japan

Other Members of the Workshop Steering Committee:

Neal Driscoll, Scripps Institution of Oceanography, La Jolla, CA, USA

Tim Reston, IFM-GEOMAR, Kiel, Germany

Shuichi Kodaira, JAMSTEC, Japan

Tony Doré, Statoil, UK

Gianreto Manatschal, Université Louis Pasteur, Strasbourg, France

Description of the Workshop

The workshop will take the first comprehensive look at the role of ocean drilling in the study of the processes by which continents rift to form new oceans since the work of the ODP North Atlantic Rifted Margins Detailed Planning Group (NARM DPG) in 1991. There have been spectacular advances in the understanding of continental rifting and the initiation of seafloor spreading since then, as well as advances in the drilling and site survey technologies that can be brought to bear on these problems. Unlike the NARM DPG, this workshop will adopt a global perspective.

As a result of 1) ODP drilling off Greenland, Norway, Iberia, Newfoundland, the Woodlark basin, and near mid-ocean ridges in the Atlantic and Indian oceans, 2) complementary geophysical and geological studies elsewhere in the world, and 3) advances in numerical modeling of the tectonics of the continental and oceanic lithosphere, we have radically changed the way we look at rifting processes. The first order observation is that two highly different end-members exist: magma starved rifted margins and volcanic rifted margins. At magma starved margins, we no longer talk of a line which is the Ocean/Continent boundary, but rather of a zone in which mechanical extension of the continental lithosphere yields gradually to magmatic processes necessary to produce new oceanic crust. At these margins we have learned that continental and oceanic upper mantle are commonly unroofed and exposed at the seafloor. This exposed mantle sometimes forms wide transitional lithosphere at magma starved margins and oceanic core complexes (megamullions) at slow spreading ridges. We know that serpentinization of the exposed mantle causes profound changes in mechanical properties that may facilitate low-angle detachment faulting during continental breakup and seafloor spreading. In studies of volcanic margins off Greenland and Norway, a close spatial and temporal relationship to the Iceland mantle plume has been demonstrated. Seaward dipping reflector sequences, which are commonly used as a diagnostic feature defining a volcanic margin, have been shown to be subaerially extruded flood basalts overlying thick igneous crust with unusually high seismic velocities in their lower part. Precise geochronology from ODP samples in the North Atlantic have shown that the igneous productivity is similar to that of vigorous mantle plumes, with most of the basalts being extruded in just a few million years. Significant amounts of active upwelling in addition to thermal anomalies within the mantle are indicated, providing important information on the mantle dynamics associated with this type of rifting and breakup. We now know that margins are fundamentally 3-dimensional, that they do not behave according to simple end-member models such as pure vs. simple shear, and that the nature of the rifting process changes spatially and temporally throughout a finite length rifting period. Planning for ocean drilling and complementary data acquisition must reflect this complexity. The workshop should synthesize the knowledge gained during the past decade in order that it might provide a base for planning future work.

There are many open questions regarding continental rifting. We do not yet understand the driving forces of rift initiation and continuation, nor the controls on the loci of rifting. We do not know the scale of deformation of the lower continental crust during rifting and the early period of seafloor spreading. We do not understand the role of fluids and volatiles during rifting, nor the mechanisms by which huge volumes of magma are generated very quickly and over wide areas at some rifted margins. We do not know the heat budget associated with rifting and the initiation

of the normal generation of oceanic lithosphere. Only a comprehensive, multi-disciplinary approach including ocean drilling can hope to move us toward increased understanding. The workshop can serve to identify the key questions and show how ocean drilling can help address them.

The US MARGINS program emerged after the work of NARM DPG and identified a number of advantages to studying active rifts. Based on that strategy, they selected the Gulf of California and the Red Sea as focus sites for their “Rupturing Continental Lithosphere” program. Although each of these focus sites has experienced some data acquisition difficulties, it is likely that the large effort devoted to one or more of these areas may lead to future IODP drilling proposals. Likewise, other national margins-focused programs and the international InterMARGINS program are identifying high priority sites for the study of continental rifting and the initiation of seafloor spreading. Each of these potential study areas, and the underlying strategy of studying active vs inactive rifting, deserves discussion and consideration at the workshop.

The tremendous potential, but accompanying limitations, of using the riser equipped drill ship *DV Chikyu* to study rifted margins are not thoroughly understood and have not been widely discussed within this scientific community. The potential comes from the ability to use a riser and drilling mud to stabilize a hole when penetrating deep fractured and/or unstable formations. These are problems that have and will continue to plague drilling deeply on rifted margins. However, the limitation that is most important is the length of riser (2.5 km) that can be deployed. Most holes that have been drilled and are being considered for future drilling on continental margins are in water deeper than 2.5 km and the *DV Chikyu* riser cannot be used. The community needs to consider whether this limitation should guide us toward studying rifting processes in areas where useful drilling can be done in water depths less than 2.5 km, or whether we should continue working in areas where important problems can be addressed without the use of a riser. On the positive side, the IODP riser vessel has greater derrick weight bearing capacity than the non-riser vessel and that will allow her to deploy a longer drill string and run longer and larger casing strings. These capabilities create opportunities for drilling deep targets and stabilizing holes (even without using a riser) beyond that which was possible in the past. The workshop will provide a forum for educating the community about new drilling capabilities and foster discussion of the best ways and areas to deploy them for the advancement of our science.

Workshop participants will: synthesize the base level of knowledge on continental breakup and sedimentary basin formation, define key scientific objectives for studying these processes; identify global, long-term drilling strategies; and specify technological requirements for addressing these objectives. We will consider the full spectrum of rifted continental environments, including magma-dominated and tectonic-dominated rifting, and older and younger rifting. Participants will include scientists with expertise in magmatic, tectonic, and sedimentary processes, and whose methods range from field observation to geodynamic simulation. Drilling engineers will participate and provide information about soon-to-be-enhanced drilling, logging, and long-term borehole monitoring capabilities of the IODP.

Based in Pontresina, near St. Moritz, the workshop will include a one-day field trip, led by Gianreto Manatschal from the Université Louis Pasteur Strasbourg, to spectacular exposures of rifted continental crust and exhumed upper mantle in the Swiss Alps.