

# **Proposal for an InterMARGINS Workshop on Climate-Tectonic Studies in the Red River Drainage**

June 5–7<sup>th</sup> 2006, Kochi, Japan

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**Introduction.** Interactions between the solid earth and the global climate system are a frontier area for ocean and Earth science research. Of all the possible links between these earth systems the proposed associations between the elevation of the Tibetan Plateau and the strength of the Asian monsoon are some of the most dramatic and controversial. Testing and quantifying these proposed links requires independent records of the evolving climatic, tectonic and erosional histories that can be correlated, or not, in order to determine how these systems are linked over long periods of geologic time. The most complete sedimentary records necessarily lie offshore on the continental margins where sediments preserve the evolving erosional flux since the start of India-Asia collision, likely around 50 million years ago. Although Integrated Ocean Drilling Program (IODP) operations have been proposed for the Bengal Fan and are already approved for the Indus Fan, these bodies are dominated by erosion from the Himalaya and are not appropriate for examining the erosional flux from Tibet, which lies at the heart of the monsoon climate-tectonic coupling debate. Instead the erosion of eastern Tibet is recorded in the sediments preserved in the East Asian marginal seas. Deep drilling of the Red River offshore sedimentary deposits has been proposed to IODP. However, the science of understanding the evolving drainage and erosion patterns requires a broader approach, with drilling being combined with marine geophysics and onshore studies of the sediment source regions, as well as with the tectonic history of the Red River Fault. Only by working both on and offshore can the sediment transport be understood. We here request the endorsement of InterMARGINS for a workshop to develop a broad based, multi-disciplinary research program for the Red River, integrating marine and terrestrial geoscientists. As well as advancing our understanding of erosion and tectonics in eastern Tibet, the study of the Yinggehai-Song Hong Basin, lying along the trend of the Red River Fault Zone has implications for the importance of this structure in accommodating strain in eastern Tibet and for its role in driving the opening of the South China Sea. The work will also be an important test for the extrusion tectonic hypothesis.

**Why the Red River?** The fundamental questions to be answered through work in the Red River offshore are as follows:

- 1) What is the uplift history of the Tibetan Plateau?
- 2) What is the climatic effect of Tibetan Plateau uplift?
- 3) What is the erosional response to the evolving tectonic and climatic conditions?
- 4) How does motion on the Red River Fault relate to basin evolution in the Yinggehai-Song Hong Basin, and to seafloor spreading in the main South China Sea basin?

Scientific operations that exploit the new deep riser drilling facilities of IODP, coupled with terrestrial field programs can contribute substantially to these goals through reconstructing evolving continental erosion using the marine sedimentary record. The Red River is highlighted as a system of special interest because it flows directly from Tibet without crossing wide flood plains, thus allowing it to communicate erosional pulses straight from source to sink. Because

the offshore sink is well defined mass balancing eroded and deposited volumes is more accurate than in most large drainage system. Furthermore, the Red River appears to have been involved in a series of drainage capture events that are believed to have been driven by Tibetan Plateau surface uplift. The Red River has been proposed as the ancestral river of East Asia, having lost headwater drainage into the adjacent drainage systems as Tibet grew and the eastern Namche Barwe syntaxis of the Himalaya propagated towards the northeast. There is far more sediment offshore in the Song Hong-Yinggehai Basin than can be accounted for within the modern drainage system, and initial provenance studies are unable to find all sources within the present source region consistent with large-scale drainage capture. If the evolving clastic flux into the Red River delta and fan can be quantified then the history of erosion and drainage capture may be reconstructed, thus constraining plateau uplift and permitting correlation with climate change.

**Existing Research Plans.** Testing the river capture hypothesis and dating Tibetan uplift using the Red River sediment record has already been proposed to IODP. While this plan represents an important contribution to understanding the erosional response to Tibetan uplift and monsoon intensification it is equally clear that this program alone is insufficient to convincingly resolve the nature of climate-tectonic interactions in East Asia, or to understand the tectonics of the Red River Fault and Yinggehai-Song Hong Basin. The IODP plans are also in need for additional intellectual input beyond the traditional marine geology community if this multidisciplinary project is to be a success. In this workshop we will determine what additional efforts are required to answer our primary scientific questions and we shall formulate an action plan to put these ideas into effect, writing this up as a white paper that can be used to seed proposals. This report will be made available via the meeting web pages and will be submitted to IODP and InterMARGINS.

The workshop will involve a wide research community in deciding how the existing plans for scientific drilling might be augmented by additional IODP drilling, by marine geophysical experiments, or by other programs such as International Continental Drilling Program (ICDP) onshore. Opportunities for land-based field geology in the headwaters of the Red River will be key if we are to quantify and date continental erosion in this classic region for tectonic and monsoon studies. Erosion studies of the onshore drainage are crucial to interpreting the offshore because we need to mass balance the erosion that can be measured through thermochronology in the sources and the sedimentary volume offshore if capture events are to be reconstructed. Dating the incision of gorges provides an important control to our ability to interpret pulses of sediment delivery, i.e., are these generated by regional surface uplift and gorge incision events, by drainage capture, or due to enhanced erosional yield driven by climate change? Testing whether clastic flux to the Red River delta is being driven by tectonics, drainage capture or climate change clearly requires an understanding of both the solid Earth tectonics and the climate. Although dating of the fault activity along the Red River Fault Zone has been done in the past the tectonics of the strike-slip zone continue to be debated and are already the focus of ongoing studies by groups in the USA, France and UK. Understanding the tectonics of the fault zone is important to interpreting the offshore stratigraphy, because this structure controls the basin formation, and causes sediment source regions to be uplifted and exhumed.

**Workshop Plan.** We are running a workshop for 30-40 scientists at the Corestore and Laboratory facility of IODP, newly opened at Kochi, Japan. We have already invited an initial set of participants from all IODP member countries, as well as academic and industrial scientists

from the South China Sea region, and those working onshore. The meeting is open to interested parties and further advertisements will be made for participants via e-mail, as well as at major meetings to be held in the meantime. The meeting will take place on June 5–7<sup>th</sup> 2006 and will have the following objectives:

- 1) Review what is presently known about the marine geology of the Yinggehai-Song Hong Basin, the tectonics of the Red River Fault Zone and the uplift of eastern Tibet. The climatic history of the region will also be summarized and current climate models linking the two will be assessed.
- 2) We shall assess the major scientific goals and the data sets that will be required to answer outstanding questions. We shall discuss where such data sets can best be generated.
- 3) There will be a presentation of existing research proposals for work on the continental margins of SE Asia, especially with links to climate-tectonic coupling. We shall discuss whether the proposed locations are optimally located to address the science goals. Additional offshore and onshore drilling targets will be proposed and discussed. The meeting will assess the need for a Complex Drilling Proposal (CDP) to be submitted to IODP for the Gulf of Tonkin and formulate a science plan that extends the work already proposed.
- 4) Additional scientific programs that are needed to complete the project will be determined. These may include cooperation with IGCP projects, and possible ICDP drilling of the Hanoi Basin or through the Red River Fault. Work on the tectonics and geomorphology of eastern Tibet will be important for understanding the offshore record. Characterizing the geochemistry and thermochronology of the potential source regions, as well as the modern river fluxes are important to developing the provenance tools needed to test the capture hypothesis using marine sediment.
- 5) We shall review the status of marine geophysical data, especially seismic reflection data from the offshore. This will require involvement of the hydrocarbon industry whose representatives have been invited to the workshop. A regional seismic stratigraphy, tied to existing well data will allow the age of basin formation and inversion to be determined.

### **Budget**

The costs of attending the meeting will be born by the participants themselves, although we expect many of them to be supported by national IODP offices. A proposal to support US scientist involvement has been submitted to JOI-USSAC, allowing ten scientists from that community to attend. A budget for Japanese participants is proposed to J-DESC. The meeting venue itself and basic meeting costs and support is being provided by JAMSTEC and the Japanese IODP. We request support from InterMARGINS to help scientists who cannot find funds from their IODP organizations, and from developing countries in the region, who might otherwise not be able to attend. If possible we would like to involve students or postdocs, as well as recognized experts in the field.

## Appendix

### Expected expenditure and income

#### **Expenditure**

Rental fee of meeting hall - \$3,000  
Salary for support staff - \$2,000 - (3 persons)  
Printing abstract volume - \$500  
Geological field trip - \$1,500  
Travel fund for unsupported scientists - \$17,200  
Total - \$24,200-

#### **Income**

Registration fee - \$3,200- (\$80 x 40 persons)  
InterMARGINS - \$12,000  
JAMSTEC - \$10,000  
Total - \$24,200