

# Oil & Natural Gas Technology

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## Quarterly Report

October 2008 to December 2008

### Heat Flow and Gas Hydrates on the Continental Margin of India: Building on Results from NGHP Expedition 01

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**EXECUTIVE SUMMARY:**

In October 2008, graduate student Peter Kannberg and professor Anne Trehu began working on the National Energy Technology Laboratory (NETL) funded project entitled *Heat flow and gas hydrates on the continental margin of India: Building on results from NGHP expedition 01*. This project is designed to complete analysis, interpretation and modeling of downhole temperature data that were acquired in spring 2006 at 21 sites drilled in gas hydrate-bearing sediments on the continental margin of India. In addition to finding several rich gas hydrate deposits, this expedition provided a number of important new insights into the geologic conditions leading to such deposits. One new insight is that buried channels and turbidite deposits are important for providing pore space in which hydrate crystals can nucleate. We hypothesize that these channels also have an influence on fluid flow and transport of methane into and through the gas hydrate stability zone (GHSZ). The objective of this project is to construct a map or regional heat flow by using the borehole data to calibrate heat flow estimates derived from observations of a bottom simulating reflection (BSR) in regional seismic data. Expedition NGHP 01 confirmed that the BSR near the boreholes reflected the base of the GHSZ on the eastern continental margin of India and in the Andaman Sea. We will then use these observation to model fluid flow and collaborate with sedimentologists working on the cores recovered from these boreholes to test this hypothesis. The project also supports development of human resources for hydrate studies by supporting tuition for Kannberg to take courses leading to a Masters degree in oceanography and geophysics.

The first quarter of this project was spent refining the Project Management Plan, Project Summary and Technology Status Assessment, processing multibeam bathymetric data, and evaluating the available seismic data provided by Fugro via Professor Michael Riedel (McGill University). These results were presented at NETL in the project kickoff meeting held in Morgantown WV during the first week of the second quarter (Jan. 6, 2009). In addition to starting this research project, Kannberg also took courses in Marine Chemistry, Physical Oceanography and Differential Equations, and a "reading and conference" course on gas hydrates to provide intellectual background for this project. Additional relevant courses are being taken during winter and spring, 2009. Kannberg also presented a paper at the fall meeting of the American Geophysical Union on temporal variations in gas venting at Hydrate Ridge on the continental margin of Oregon, which represented work done during summer, 2008 supported by a related project funded by the National Science Foundation.

**PROGRESS, RESULTS AND DISCUSSION:****Phase I - Task 1, Project Management Plan:**

During October 2008, the PI revised the Project Management Plan submitted as part of the original application package to incorporate comments from the review panel and the Project Officer.

### Phase I – Task 2, Develop Seismic Maps:

Seismic data from KG Basin and Andaman Islands have been received and loaded into Seismic-Microtechnology's Kingdom Software for seismic interpretation (Figure 1). Mahanadi Basin seismic maps have not yet been received and are expected in February 2009. The Mahanadi Basin represents a very small proportion of the entire data set. Seafloor horizons of in KG basin have been picked and gridded using Seismic-Microtechnology's Kingdom Software and GMT software packages. The seafloor grid obtained through seismic interpretation is being compared with KG Basin swath bathymetry. Seismic velocities from NGHP Expedition 01 are being used to convert two-way travel times to horizon depth and sediment thickness. BSR reflection horizons are in the process of being picked and gridded. Kingdom Software seafloor horizons are being output as XYZ ASCII files and map images.

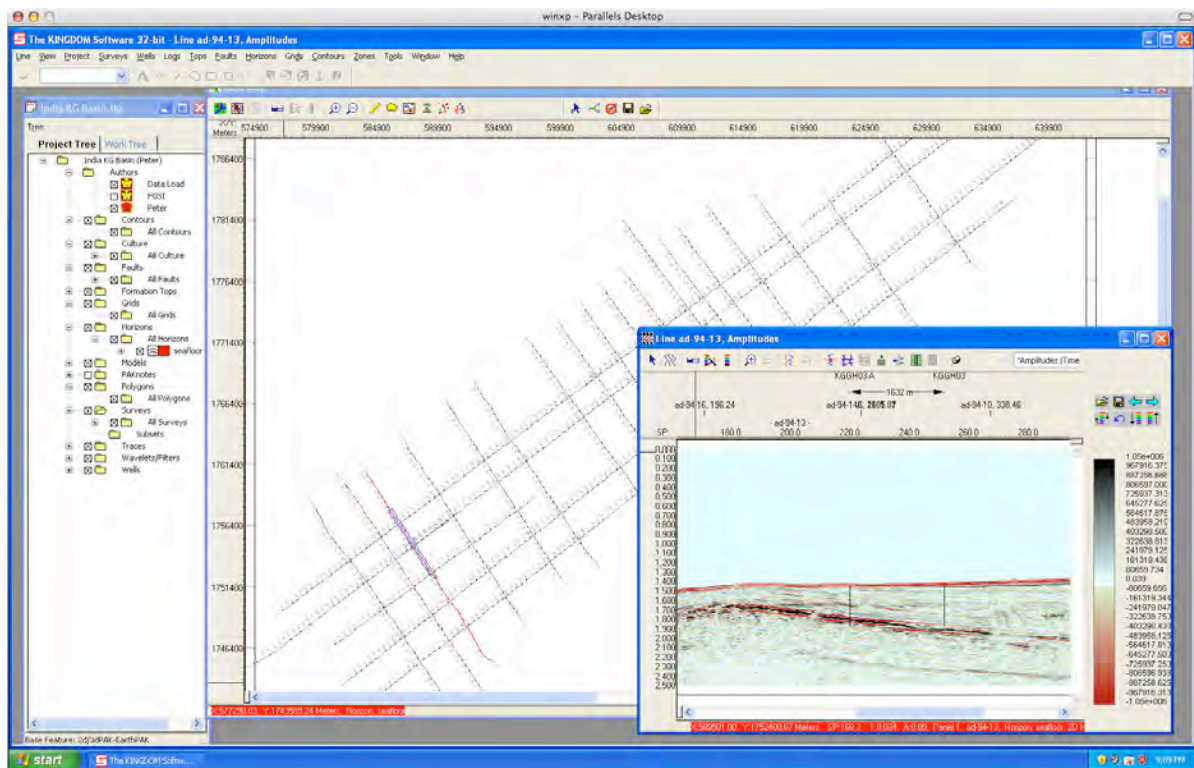


Figure 1. Screen shot of the seismic trackline map and a data image of a portion for one of these lines within the Kingdom Suite working environment. We have access to this software at no cost of DOE through a gift from SeismicMicroTechnology to Oregon State University.

Although we are able to proceed with the objectives of this project, we have recognized some problems with the seismic data, such as mismatches when lines cross (Figure 2) and loss of data due to seafloor mutes that cut off the seafloor reflection in a few places.

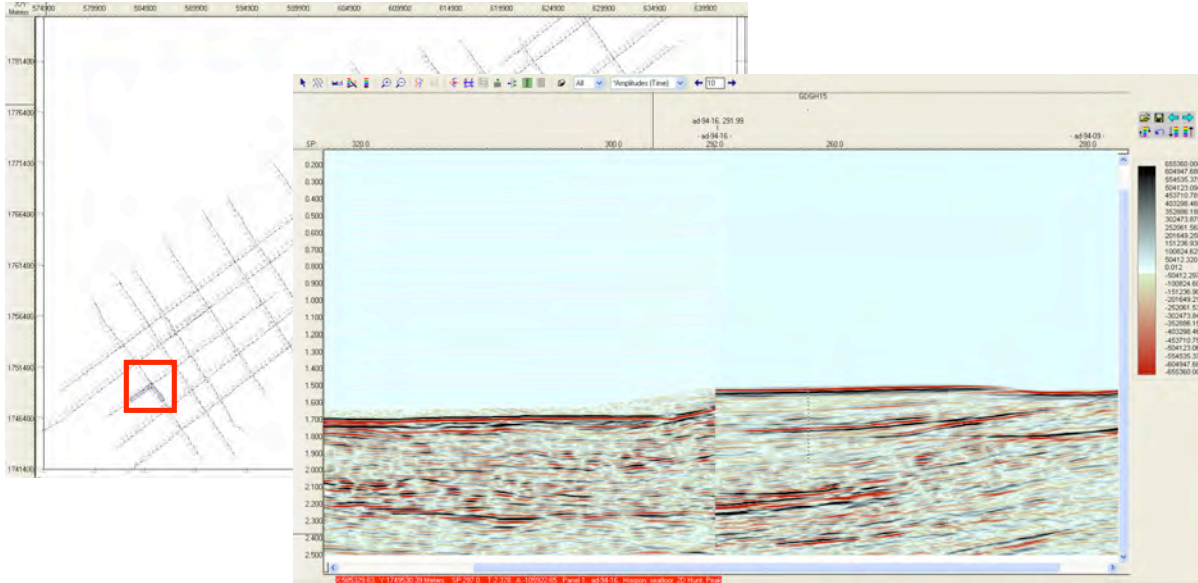
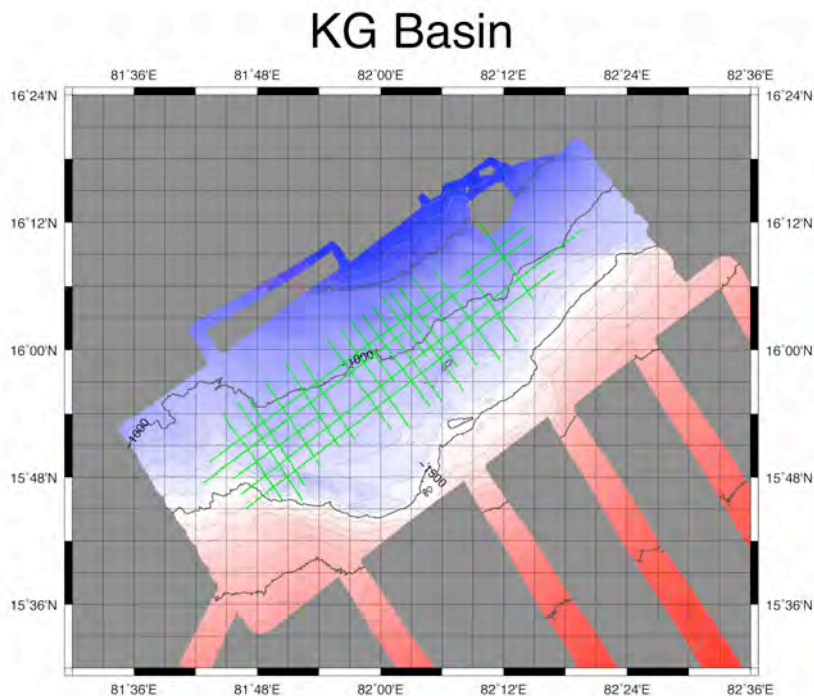


Figure 2. Example of a crossing line problem in the seismic data revealed by extracting the data from two lines where they intersect. While most line crossings do not have this type of problem, a few do.

**Phase 1 – Task 3, Develop Apparent Heat Flow Maps:**

Swath bathymetry grids have been received and maps have been generated using Generic Mapping Tool (GMT) software package (Figure 3). Swath bathymetry data is available as map images and grid files. This, along with the development of maps from the seismic data, represents the first step in completing this task.

Figure 3. Swath bathymetry with seismic track line overlain in green.



**Phase 1 – Task 4, Evaluate Effects of Bathymetry on Apparent Heat Flow:**

This task is scheduled for the third and fourth quarters of Phase 1 of this project.

**Phase 2 – Task 5, Develop Numerical Model:**

This task is scheduled for the second year of the project provided the project goes forward after a go/no go decision based on preliminary results from Task 4.

**Phase 2 – Task 6, Interpret Modeling Results:**

This task is scheduled for the second year of the project provided the project goes forward after a go/no go decision based on preliminary results from Task 4.

**COST STATUS:**

*Table 1. Project costing profile for Budget Period 1. (Table does not include OSU cost share of \$1,544/month for Trehu salary and fringe benefits and overhead).*

	Oct (planned)	Oct (actual)	Nov (planned)	Nov (actual)	Dec (planned)	Dec (actual)
PI salary & fringe benefits	547	528	547	528	547	528
GRA salary & fringe benefits	2,271	2,419	2,271	2,119	2,271	2,119
Computer subscription	250	250	250	250	250	250
Travel	0	0	0	0	1,600	1,153*
Tuition	3,132	3,132	0	0	0	0
Indirect Costs	1,417	1,481	1,417	1,417	2,157	1,871
	7,617	7,810	4,485	4,314	6,825	5,921

\* Planned travel to the Project Kickoff meeting at NETL in Morgantown WV was delayed from December, 2008 to the first week in January, 2009 because of scheduling difficulties. Airline tickets were purchased in Dec. for \$1,153, but an additional ~\$500 for this trip will appear in the January or February expenditures as reimbursements for travel expenses on Jan. 5-6, 2009.

**PUBLICATIONS, CONFERENCE PRESENTATIONS AND OTHER PRODUCTS:**

- Revised project management plan was completed.
- Short description of the project was posted on the NETL web site.
- A related project was presented at the fall 2008 meeting of the American Geophysical Union, which provided an opportunity for Kannberg to make contacts useful for the interpretation phase of this project.
- A presentation was made at the Project Kickoff Meeting during the first week of the second quarter.
- A bathymetric map of the KG Basin has been prepared.

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