Quarterly Report: November 2007

Methane Recovery from Hydrate-bearing Sediments

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INTRODUCTION - PROJECT SUMMARY - STATUS

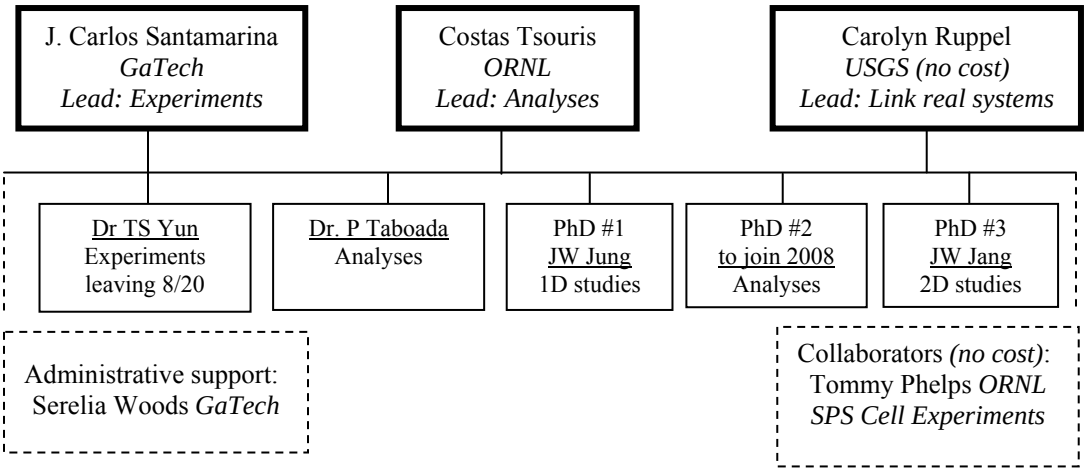
Goals: Understanding and modeling of processes taking place during methane hydrate production

Approach: observation and interpretation of phenomena at multiple scales, ranging from pore-contact scale to the macro-reservoir scale, taking into consideration various possible driving forces (e.g., depressurization, thermal stimulation)

To this end, we intend to: (1) gain a thorough physical understanding of underlying phenomena associated with methane hydrate production through unique multi-scale experimentation and associated analyses; and (2) develop one or more mathematical models that account for the observed phenomenon and provide a better understanding that may optimize methane hydrate production methods.

This four year project is organized into seven tasks with a "check point" before task 7. Tasks and team organization follow.

Task 1	Research Management Plan	Done	*(brief summary here)*
Task 2	Technology Status Assessment	Done	*(submitted report)*
Task 3	Continuous Literature	In Progress	*(submitted report)*
Task 4	1-D Single Mineral Surface Studies	In progress	*(brief summary here)*
Task 5	2-D Porous Network Studies	In progress	*(brief summary here)*
Task 6	3D Sediment: Experiments using uσ' Cell	Developments under parallel projects	
---------- check point ----------			
Task 7	3D Sediment: Experiments in SPS Cell	Developments under parallel projects	



DEVELOPMENTS DURING PRESENT QUARTER

The main developments in this quarter, with emphasis on events following the meeting in Colorado, are listed next:

Task 4: 1-D Single Mineral Surface Studies

Completed:

- Detailed review/analysis of data on freezing point depression (molecular analyses to experimental data).
- 1D studies associated to hydrate contact bonding and strength (calcite and quartz substrates; CH_4, CO_2, and THF hydrates, and ice – following recommendations at Golden CO)
- Application of the new intrinsic kinetic model to explore different experimental scenarios and 1D experimental data.

Current:

- Review of kinematics of dissociation, including the reanalysis-reinterpretation of work by Kim et al.
- 1D experimental studies of time-dependent hydrate formation and dissociation in capillaries (wetting and non-wetting surfaces - following recommendations at Golden CO)
- 1D experimental study of contact level dissociation under different driving forces
- Development of a new model to include an experimentally-based pressure history curve as input and chamber boundaries. The properties of the gas are calculated via the Peng-Robinson equation of state. Due to the additional mathematical complexity, the solution algorithm is modified to include a numerical integration method (Cardano-Tartaglia and the Gauss-Jordan methods).

Task 5: 2-D Porous Network Studies

Completed:

- Development of analytical model to allow close form estimation of P-T evolution during dissociation. Takes into consideration capillary effects and skeletal compressibility (in collaboration with KAIST)\
- Enhanced test control for hydrate formation in 2D radial configuration by successive injections of predefined volume fractions.

Current:

- 2D experimental studies of hydrate formation and dissociation in porous network. Both, wetting and non-wetting surfaces are being studied (following recommendations at Golden CO)

- Application of the intrinsic kinetic rate expression to the dissociation of hydrates in sediments. Correction of the driving force to account for the effects of small porous.
- Consideration of nanothermodynamics and evaluation of surface effects in hydrate equilibrium.

Task 6: 3D Studies

Current:

- We have started the development of a comprehensive numerical simulator based on the robust Code_Bright platform. This platform will allow us to solve simultaneously all transport, mass balance and energy balance equations taking into consideration the behavior of the sediment using the most robust numerical model ever developed (Cam-clay adapted to hydrate bearing sediments). This development is taking place in collaboration with Dr. Sanchez from Strathclyde University, UK. The completed analytical model listed above will be used for testing the numerical model.

Related Activities

October 8-11 – Dr W. Waite from USGS (at Georgia Tech). (1) Active interaction on the properties of hydrate bearing sediments. (2) Planning of Spring event (on the properties of hydrate bearing sediments).

November 4-10 - Dr. Sanchez from Strathclyde University (at Georgia Tech): (1) Short course on Code_Bright. (2) Development of governing equations for hydrate bearing sediments.