IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	Study of Gas hydrates using effective medium theory and rock physics modeling	
Project Number	**IMURA0673 (5)**	
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Research Academy Themes:

Highlight which of the Academy's Theme(s) this project will address?
(*Feel free to nominate more than one. For more information, see www.iitbmonash.org)*

1. **Advanced computational engineering, simulation and manufacture**
2. Infrastructure Engineering
3. Clean Energy
4. Water
5. Nanotechnology
6. Biotechnology and Stem Cell Research
7. Humanities and Social Sciences

The research problem

The evaluation of natural gas hydrates is essential to further our understanding about their resource potential and possible impacts on environment. Although the gas hydrate reserve worldwide is speculative but since the trapped methane below the hydrate-bearing sediments is nearly twice the amount of fossil fuels, it seems attractive to work on understanding the geomechanical properties of gas hydrates. In near offshore regions, the gas hydrates influences the seismic velocities by increasing its magnitude while the

underlying methane has the tendency to reduce its velocity value. The compressional wave primarily gets affected, with nearly no change in shear waves in the underlying strata. Thus, numerical estimation of gas hydrate bearing strata and the underlying methane stored as free gas needs assessment based on rock physics modelling. This information can help both exploration and production activity of the areas bearing natural gas hydrates. Thus, estimation of elastic velocity estimated in the laboratory or in-situ measurements or from processing of surface seismic data can be integrated with rock physics models to estimate gas hydrates and their properties as a function of depth. Here, the differential effective medium theory combined with self-consistent approximation can be utilised for the study of micromechanics of gas hydrate bearing strata.

Project aims

A continuum physics model for gas hydrates was introduced by Helgerud (1999) which estimates the elastic moduli of sediments (dry) using critical porosity. The elastic moduli for dry sediments depend on the effective pressure. The effective elastic for various minerals in the solid phase are calculated from the Hill's average formula. The rock physics modelling along with laboratory experiments will be applied to the gas hydrates sediments to achieve the following aims of the proposed project:

1. Derive gas hydrate saturation models for dry and marine environments
2. Determination of the effective elastic moduli for rock matrix resembling gas hydrate bearing sediments from laboratory experiments
3. Role of water and gas hydrates in load-bearing and non-load bearing gas hydrate models
4. Estimate the elastic moduli of gas hydrate models from effective medium theory combined with self-consistent approximation

Expected outcomes

1. Elastic properties of gas hydrate models
2. Gas hydrate saturation models with changing matrix values
3. Suitable rock physics model applicable to gas hydrate saturations with depth

How will the project address the Goals of the above Themes?

The key to development of oil and gas field in an area is to have ample information on the in-situ conditions where the gas hydrate bearing sediments occur naturally. The challenge is to understand its geomechanical characteristics, saturation conditions and mineralogy to evaluate their resource potential and its potential impact on the environment. Methane gas trapped below these natural gas hydrates are released when these hydrates dissociate. This looses the strength of the soil causing slope failure and instability at the sea floor. However, gas hydrates are a numerous source of energy which needs to be harnessed, but it requires rigours rock physics modelling at dry and saturated conditions. This becomes more critical if the field is to be developed in deep water. Thus to maximise the productivity of a gas hydrate, this research will not only benefit the industry for better preparedness in exploitation of the resources but also will help to explore other oil fields. This project directly meets the objectives of the Advanced computational engineering, simulation and manufacture to address energy security issues for India and technology up gradation to accelerate domestic exploration and production of energy resources.

Capabilities and Degrees Required

This research would likely be an extensive and exhaustive one that would involve two aspects. First, the project will involve numerical simulations to understand the rock physics properties. Second, for performing experimental investigations in the lab along with testing and development of algorithms. Each of these aspects would require extensive scholarly support for which involvement of a student with the knowledge of geophysics with a knowledge of basic seismic data processing with geotechnical understanding and application will be required.

Potential Collaborators

Please visit the IITB website www.iitb.ac.in OR Monash Website www.monash.edu to highlight some potential collaborators that would be best suited for the area of research you are intending to float.

None

Please provide a few key words relating to this project to make it easier for the students to apply.

Gas hydrate saturation, elastic moduli, rock physics models, effective medium theory