IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	**Petrophysics and Rock physics modelling of carbonate reservoirs**	
Project Number	IMURA0957	
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Research Clusters:

Highlight which of the Academy's CLUSTERS this project will address? *(Please nominate JUST **one.** For more information, see www.iitbmonash.org)*	
1	*Material Science/Engineering (including Nano, Metallurgy)*
2	*Energy, Green Chem, Chemistry, Catalysis, Reaction Eng*
3	*Math, CFD, Modelling, Manufacturing*
4	*CSE, IT, Optimisation, Data, Sensors, Systems, Signal Processing, Control*
5	*Earth Sciences and Civil Engineering (Geo, Water, Climate)*
6	*Bio, Stem Cells, Bio Chem, Pharma, Food*
7	*Semi-Conductors, Optics, Photonics, Networks, Telecomm, Power Eng*
8	*HSS, Design, Management*

Research 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*
8	Design

The research problem

Rock physics providesa relationship between elastic parameters derived from rock properties obtained from laboratory experiments of core samples and well log data in a borehole. The models then are utilised in reservoir characterization. Intrinsic rock properties such as mineralogy, porosity and pore shapes, pore fluids, pore pressure, permeability, viscosity, stresses are either measured in the lab or are estimated. Rock physics models are able to reveal parameters that influence the elastic properties of rocks and types of pore spaces often filled with fluids. Thus, these models require calibration to a limited set of physical data (e.g compressional Primary &Secondary wave velocity data) under dry and saturated reservoir conditions. Many rock physics modelsare availablefor clastic reservoirs depending upon their sedimentation processes but development of such a model for carbonate reservoirsis challenging.This is due to the anisotropic and inhomogeneity of complex pore system modified bydiagenetic processes.With more and more data available for anaylsis, it would be interesting to include machine learning and other Artificial Intelligence based modelling toolfor extractinghidden structures and pore network from a 3D microCTimages. Such methods require substantial training with core and log measurements to warrant reliable and accurate estimations of complex pore system by mapping the core in 3D space using a suitable numerical modelling method. The project aims to develop a consistent Rock physics Model to fora carbonate reservoirthat would include porosity partitioning into various types - Primary, Secondary, isolated and connected pores through the use of experimental, field, modelling strategies likes effective medium theory and machine learning algorithms.Such models will have important applications and usage for oil and gas industry.

Project aims

The following objectives are to be addressed through this project:

1. Determine the mineralogy, elemental composition and pore structuralnetwrok and their connectivity through laboratory experimental studies and numerical simulation.
2. Determinethe petro-physical models of reservoir formations from well log data integrated with core data.
3. Develop rock physics model for a reservoir by utilising the elastic parametersmeasured at in-situ reservoir conditions of pore and confining pressure for carbonate reservoir sample integrated with well log data and a robust numerical methodology.

Expected outcomes

1. A Petro-physical model derived from measured logs, core samples and geology of the region.
2. A Rock physics model for a carbonate reservoir calibrated for in-situ reservoir conditions.
3. Algorithms forrock physics model on a platform supported by windows / Linux OS. The tools will be of immense use for oil and gas industries involved in carbonate reservoirs.

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

The present project will address the issues related to mineral volume computation, porosity partitioning for accounting secondary porosity and identification of isolated and connected secondary porosity. Permeability needs to be estimated both with the help of logs and core sample measurements. The Archie's constants can be derived from electrical logs through development of a suitable algorithm. However, the rock physics model parameters need to be understood from both consistent elastic parameters estimated from lab experiments and those estimated from numerical simulations using variables and lab-derived values. The derived rock physics model will allow petrophysicistand reservoir analyst to use models for better reservoir characterisation and exploitation.

Capabilities and Degrees Required

This research would likely be an extensive and exhaustive one and will require a candidate with two qualities. First, the project will involve numerical simulations using machine learning tools to understand the rock physics properties. Second, the development of petrophysics and rock physics model will require extensive laboratory investigations along with testing and validation of developed algorithms. This work requires scholarly support for which involvement of a student with the knowledge of geophysicspreferably M.Techwith a good background in petrophysics andadvanced computing knowledge like Python/Matlab, for development of algorithms will be beneficial to the project.

Potential Collaborators

Centre for Excellence - Oil, Gas and Energy, IIT Bombay