IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	**Petro-Rock physics modelling and inversion of carbonate reservoirs**	
Project Number	**IMURA0789**	
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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 addresses the relationship between measurement of elastic parameters made from surface, borehole, laboratory experiments and intrinsic rock properties such as mineralogy, porosity and pore shapes, pore fluids, pore pressure, permeability, viscosity, stresses and overall architectural features like lamination and fractures. Rock physics provides the understanding necessary to optimize imaging and characterization solution based on elastic data. Rock physics models capture one or select few factors that influence the elastic properties of rocks. In addition, these models typically are calibrated to a limited set of physical data (e.g compressional P&S wave velocity data). Various rock physics model have been formulated in clastic rock depending upon their sedimentation process but in carbonates development of rock physics model becomes extremely difficult because of its complex pore system due to digenetic process.Artificial neural networks, fuzzy logic and neuro-fuzzy models have been used to diagnose and quantify lithofacies. Such methods require substantial training with core and log measurements to warrant reliable and accurate estimations of complex lithology and thinly-bedded rock sequences. The project will aim to produce a consistent Rock physics Model to generate Density, Vp and Vs for carbonate reservoir at variable porosity, pore type fractions e.g. Primary, Secondary, isolated and connected pores through the use of various machine learning tools and effective medium theory.

Project aims

The following objectives are to be addressed through this project:

1. Determine the mineralogy, elemental composition and pore structural type and their connectivity through geological laboratory studies and numerical simulation studies.

2. Determine the petro-physical properties of reservoir formations on core samples through the integration of log and core data and machine learning algorithm.

3. Estimate the rock elastic properties (Vp, Vs) at in-situ reservoir conditions of temperature, pressure (pore & confining pressure) for carbonate rock types retrieved from the well and effective medium theory.

Expected outcomes

- A robust Petro-physical Model from measured logs, core samples & geological information.

- A consistent Rock physics Model to generate Density, Vp and Vs for various Carbonate reservoir conditions at variable porosity, pore type fractions e.g. Primary, Secondary, isolated and connected.

- Machine learning algorithms for Rock physics modeling on a platform supported by windows / Linux OS. The tools will be of immense use for carbonate reservoir modelling.

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 estimation from lab experiments and numerical simulations from assumed variables and lab-derived values. The designed analytical rock physics model can allow Geophysicists to convert geophysical log measurements to desired engineering and geological rock properties.

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 using machine learning tools 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 good background in petrophysics and advanced computing capabilities using Python/Matlab, C-Sharp for development of algorithms on linux platform.

Potential Collaborators

None

Select up to **(4)** keywords from the Academy's approved keyword list **(available at http://www.iitbmonash.org/becoming-a-research-supervisor/)** relating to this project to make it easier for the students to apply.

Carbonates, petrophysics, rock physics models, effective medium theory