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Maxtrix and Fracture Characterization in Unconventional Reservoirs

Call for Proposals

December 2012

Aims

This is an open invitation to any organisation, from any sector, seeking partners and funding for innovative technologies in the oil and gas industry to submit high quality proposals for potential solutions for research, development and / or field trial of potential solutions related to Matrix and Fracture Characterization to optimise the economic development and effective management of Unconventional Reservoirs and to maximise reserves.

Specific Areas of Interest

- Interaction between hydraulic fractures and natural fractures
- Core based measurement and measurement standards
- Scaling issues
- Fluid interaction
- Monitoring and interpretation of fracturing
- Geomechanical characterization of fractures and matrix
- Seismic characterization of unconventional reservoirs
- Signature of drilling

Justification

ITF members from the major operating and service companies in the oil and gas sector identified unconventional reservoirs as a key technology challenge area. An Unconventional Reservoir Characterization Technology Road Map for research and development in this area was defined in March 2012 (Figure 1). Following this, the first workshop was held in Houston in October 2012 on Matrix and Fracture Characterization where information was gathered about the current technology gaps, member defined challenges and potential for innovative and game-changing research and technology development.

Who Should Respond

The invitation is open to all relevant industry sectors and all credible entities from small and medium sized enterprises, to academic and research institutions, to large industry players alike. ITF members would also like to receive proposals from a variety of industries outside of the oil and gas sector and this call provides the opportunity for a transfer of knowledge and technologies from other industries.

Qualifying Technologies

In order to qualify for potential sponsorship, technologies submitted in response to this Call for Proposals must:

- be applicable to the identified requirements
- be novel or innovative
- demonstrate a clear business case for support
- have a clear and demonstrable path to commercialisation and implementation

Note: Proposals submitted to any other ITF Call in the past nine months or any previously unsuccessful applications should not be resubmitted without first consulting ITF (contact information provided later in this document)

Benefits of Participation

- Funding: Up to 100% funding for any stage of the research, development and demonstration cycle.
- IP Protection: A proven confidential, collaborative and standard contractual process
- Exposure and validated applications for your scientific and technological expertise
- Access to the key global players in the oil and gas sector

How to Participate

Your contact points and outline method for submitting a proposal are provided in this document but you can immediately learn how to submit a proposal by going to our website: http://www.itfenergy.com/index/submit-a-proposal

Please send a notification of your interest in submitting a proposal as early as possible by sending an email to Pauline Otręba at p.otreba@itfenergy.com .

Keywords and Potential Technology Areas

Natural fractures, hydraulic fractures, matrix characterization, core based measurement, measurement standards, scaling, modelling, integration, fluid interaction, seismics, microseismics, monitoring and interpretation of fracturing, geomechanics, well logging.

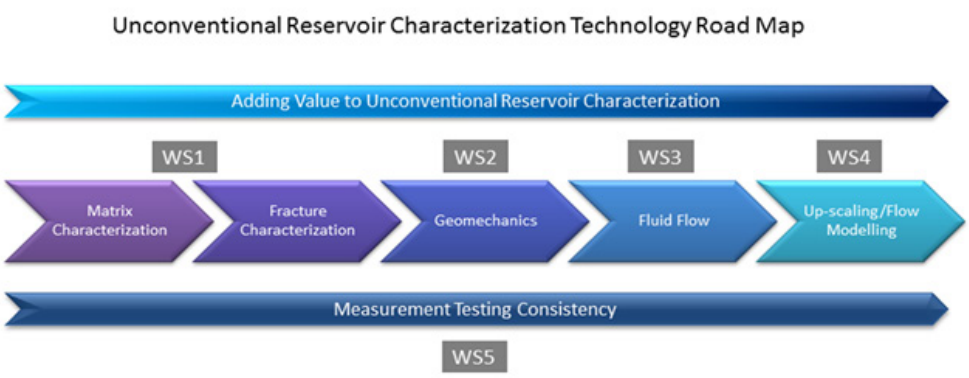

Figure 1

Matrix & Fracture Characterization in Unconventional Reservoirs

The prime areas of interest have been identified by ITF members as follows:

- Interaction between hydraulic fractures and natural fractures
- Core based measurement and measurement standards
- Scaling issues
- Fluid interaction
- Monitoring and interpretation of fracturing

Other challenges also identified by the ITF members include:

- Geomechanical characterization of fractures and matrix
- Seismic technology gaps
- Signature of drilling

These areas are further defined in the sections below, giving specific technology challenges under each theme and the potential for 'game-changing' solutions.

Interaction between hydraulic fractures and natural fractures

The aim is to better understand the interaction between the hydraulic and natural fractures and to be able to ground truth models by experiment to understand the physics of this interaction and other variables. The identified challenges and potential opportunities in this area are presented below and it is hoped that the scope of the investigation may be expanded to include contributions from other sectors such as materials science, mining, aerospace, and civil engineering. It is recognised that at present long-term monitoring and surveillance is limited and that the variability and heterogeneity of the shale plays present additional challenges. Ideas would be welcome from researchers in proposing experimental proof-of-concept studies about how to address these challenges.

The prize to the industry would be: to optimise field development; completions and well planning; to maximise profits; and to minimise environmental footprint.

The Challenges:

- Characterize the natural fracture system
- Detect hydraulic fractures and hydraulic connectivity
- Ability to quantify interaction mechanics
- Ability to quantify reservoir state / properties at the time of fracturing
- Calibrate / quality control the models
- Quantifying fracture cement strength
- Ability to quantify the conductivity of the hybrid system
- Mobilization / transport of proppant (embedment?)

Opportunities:

- Realistic experiments – lab – field – pilot areas / studies
- Sensitivity analysis of controlling parameters (control of hybrid system conductivity)
- Coupled reservoir/geomechanical simulations
- 4D natural fracture / hydraulic fracture characterization
- Quantify natural fracture behaviour under shear: generic and play-specific (physics based)
- New tools to model complex fluid through fracture network
- Develop novel, realistic experimental set-ups

Core based measurement: Measurement Standards and Petrophysical Modelling

The aims of core based measurement are addressed in two separate parts: A) measurement standards and B) petrophysical modelling with the overarching aims of addressing the current lack of data and need for robust geomodels (based on LWD data, core analysis etc.) while addressing the need to be able to identify the lateral heterogeneity for optimized development.

It is recognised that each specific company will have inherited methodologies and standards which were originally established for conventional reservoirs and there are the specific issues which need to be addressed in relation to unconventional reservoirs. It is proposed that this work will leverage existing methods and challenge them to benchmark. It is also proposed that established parameters and also those not studied yet should be identified, prioritised and addressed.

The prize to the industry would be: establishing the truth; a database of information; help with the construction of better;robust geomodels and/or reservoir models; and to be able to identify lateral heterogeneity for optimal reservoir development.

A) Measurement Standards Challenges

- Definition of standards and are they operator driven?
- What is to be measured - identify a list of parameters
- Under what conditions are measurements to be taken
- Sample size
- How to measure
- How different methods compare, especially between those currently used in the industry
- Identify possible damage to the core
- Improve accuracy of measurements
- Identify and address parameters related to flow mechanisms
- Coring / preservation issues

B) Petrophysical Modelling Challenges

- Petrophysical Modelling / Formation evaluation - lack of translator between the petrophysical measurements and log analysis
- Scale issues
- Limitations of log analysis
- Logging under special challenging situations such as deviated wells
- Limited number of wells being logged
- Limitations on which logs to run

Opportunities

There are many opportunities here for:

- Logging companies
- Research laboratories
- Service companies
- Academia

Scaling Issues

The aim is to address scaling issues in relation to unconventional reservoirs from a wide range of aspects such as working with models of different scales and with different types of data, addressing the fact that the pore scale in unconventional reservoirs may be may be 100 times smaller than that of conventional reservoirs, up-scaling of seismic data, up-scaling of log data and being able to integrate these different aspects. In the light of such investigations, it is hoped that appropriate models may be developed so that an accurate picture of the system may be developed over time.

The prize to be delivered to the industry includes: better reserves estimates; paring down to the essential measurements saving time and money; improved modelling and prediction for drilling and reservoir properties; and optimised completion and production.

The Challenges

- Measurement scales (property wise)
- Models (effective media) across scales both for matrix and fractures together and for matrix alone
- How do you go from a model at one scale to a model at another scale
- Match between geophysics and log scales
- Integrating the static and dynamic models
- Translation of vertical well rock properties to lateral scales
- Up-scaling of seismic data and up-scaling of log data and integrating the two
- Redefine effective media for unconventional reservoirs
- How do we measure: fracture networks; strength; density; elasticity; resistivity; permeability; time?

Opportunities

- Academic / research study
- Cross-discipline approach
- Redefine effective media scales for unconventional reservoirs:
    - Data mining on effective media players
    - Properties selection
    - Linking tools to reservoir properties to scales / matrix

Fluid Interaction

The aim is to develop a greater understanding of fluid interaction between natural fluids, stimulation fluids and the rock properties. It is recognised that there is a lack of documentation of existing information to explain the science for current practice. Cost is a factor which determines what is done and there is a desire for better measurement and analysis that could be achieved for example by cheaper logging tools and cheaper matrix analysis to enable more information to be gathered routinely.

The prize to the industry from the increased understanding that such investigations will provide will reduce risk; decrease uncertainty; and increase efficiency in finding and producing oil and gas from unconventional reservoirs.

The Challenges

- How to identify what is producing the matrix, the natural fractures, and hydraulic fractures and how to differentiate
- Hydrogeology of shale gas matrix: - imbibition - pore systems - stresses in ultralow permeability – water / rock interactions
- How do molecules move through the pores and natural and/or induced fractures
- Water as proppant
- Stress along well bore
- How to identify a regional 'sweet spot'
- How to determine where on the lateral you should hydraulically fracture/stimulate
- How to determine the landing zone from stratigraphy
- The chemical interaction between rock matrix, proppant fluid and natural fracture fill
- The organic network versus the inorganic matrix
- The role of surface chemistry in gas storage and migration
- Fluid type and kerogen maturity effects on productivity and connectivity
- Permeability and porosity creation and preservation
- Wettability and capillary pressure issues
- A better understanding of flow mechanisms
- Swelling clays and are they good, bad or indifferent
- Where is produced gas stored in rock matrix

Opportunities

- Multidiscipline study of fluid transport
- Multifunction device 'tricorder' used for on pad analysis of laterals
- Cheaper matrix analysis (TOC, minerals, defects)
- Electromagnetic imaging around / between the well bore to characterize flowing volume
- Monitor pressure, temperature, flow phases over life of well
- Rate of loading effects

An interdisciplinary approach for the following type of studies would also be desirable:

- Literature review
- Web-based information resource
- Fluid/rock interaction
- Hydrogeology in shales
- Examination of hydrocarbon presence in shale - spectral analysis
- Stress states and probability productivity
- Advanced multispectral analysis of organic matter in matrix of unconventional reservoirs
- Web-based knowledge resource of natural fluids and industry stimulation fluids
- Calibration beyond Ro

Monitoring and interpretation of fracturing

The aim of monitoring and interpreting fracturing is to enable there to be a clear understanding of what is being produced, from where and at what time.
It is hoped that a high level of integration in the framing of research activities will be achieved and support will be given for such joint cross-industry efforts. It recognised that this will require broader skillsets and that the current business model/culture 'mindset' and supply chain model will need adaptation as this should require more money to be spent in the pilot phase with the gain being that fewer wells will then need to be drilled.

The prize to the industry will be a more sustainable more optimised development philosophy for unconventional reservoirs and as a result of this, greater public acceptance and licence to operate.

The Challenges

- Microseismic interpretation
- Big data challenges
- Understanding pore rock physics in the context of microseismic events (earth model)
- Classical production logging is impractical on a large scale
- Assessment of and forecasting productivity and drainage patterns
- Early integration of dynamic data
- HSSE and integrity assurance
- Water availability

Opportunities

- Well-to-well seismic
- 4D seismic
- Passive seismic
- Mud gas and drilling mechanics data
- DTS/DAS/Tracers
- Hydraulic fracture data analyses and flow back
- Understand coupling between microseismic and geomechanical simulations
- Integrated/coupled geologic-geomechanics-fluidflow model
- Linkage between the model and performance and measurements
- Data-mining

Other challenges also identified by the ITF members include:

- Geomechanical characterization of fractures and matrix such as how do we characterize brittle versus ductile behaviour in shale for hydraulic fractures and a definition of a 'fracability index' – beyond elasticity
- Seismic technology gaps such as seismic attribute analysis, natural fracture imaging ahead of the bit (orientation and density), how to use shear converted waves anisotropy at seismic scales in relation to stress and fractures
- Signature of drilling such as how to relate drilling information to the reservoir model, can we use mud logging for natural fracture detection and/or proxy production logging and the gap between routinely obtained drilling parameters and natural fractures

Technology Challenge Timeline

Technology Challenges follow a staged timeline from the identification of the challenge through to the launch of successful projects. The following list of tasks describes the key milestones and their associated dates.

Call for Proposals Issued	12 Dec 2012
Deadline for Expression of Interest Form	8 March 2013
Publish to members for review	March 2013
Member review & voting	March/April 2013
Technical Clarification Meeting(s)	April 2013
Developers to submit full proposal (if sufficient member interest)	May 2013
Members to finalise commitment to sponsor	May 2013 onwards

Process for Submitting a Proposal

1. **Download & Complete the 'Expression of Interest Form'**
   This form is available via the ITF website: 'ITF Downloads'/'Proposal Submission.'

2. **Complete the 'Project Presentation Template'**
   This template is available via the ITF Website: 'ITF Downloads' / 'Proposal Submission' section of the ITF Website.

3. **Email the Completed 'Expression of Interest Form' and 'Project Presentation Template' to ITF**
   Email the completed form in Microsoft Word format (not PDF) and the 'Project Presentation Template' in Microsoft PowerPoint format (not PDF) to Pauline Otręba at p.otreba@itfenergy.com by no later than 18 February 2013.
   Proposals received after this date may not be processed

ITF's Role & Approach

The **Industry Technology Facilitator (ITF**) is a not for profit organisation owned by major oil and gas operators and service companies. Our key objectives are to identify technology needs, foster innovation and facilitate the development and implementation of new technologies. To date, ITF has been responsible in launching more than 180 new collaborative and revolutionary joint industry projects (JIPs).

- ITF's is an internationally recognised champion for facilitating research, development and deployment of technology innovation within the upstream oil and gas and related energy industries.
- ITF uses a proven process, working in collaborative participation with both its members and industry to identify technology needs and potential solutions.
- ITF has contractual confidentiality arrangements with all its members and will enter into a parallel agreement with all developers submitting proposal applications.
- Proposals submitted under this Theme will be reviewed for financial sponsorship by all ITF members therefore this is an excellent opportunity to gain a global audience in seeking support for your technology.

For details of ITF's full Portfolio of Members, please visit our website – www.itfenergy.com

Contact Information

If you would like to discuss any matters related to this call or any other issue related to ITF, please contact any of the following people:

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