Pandit Deendayal
Petroleum University

in association with

The University
of Oklahoma

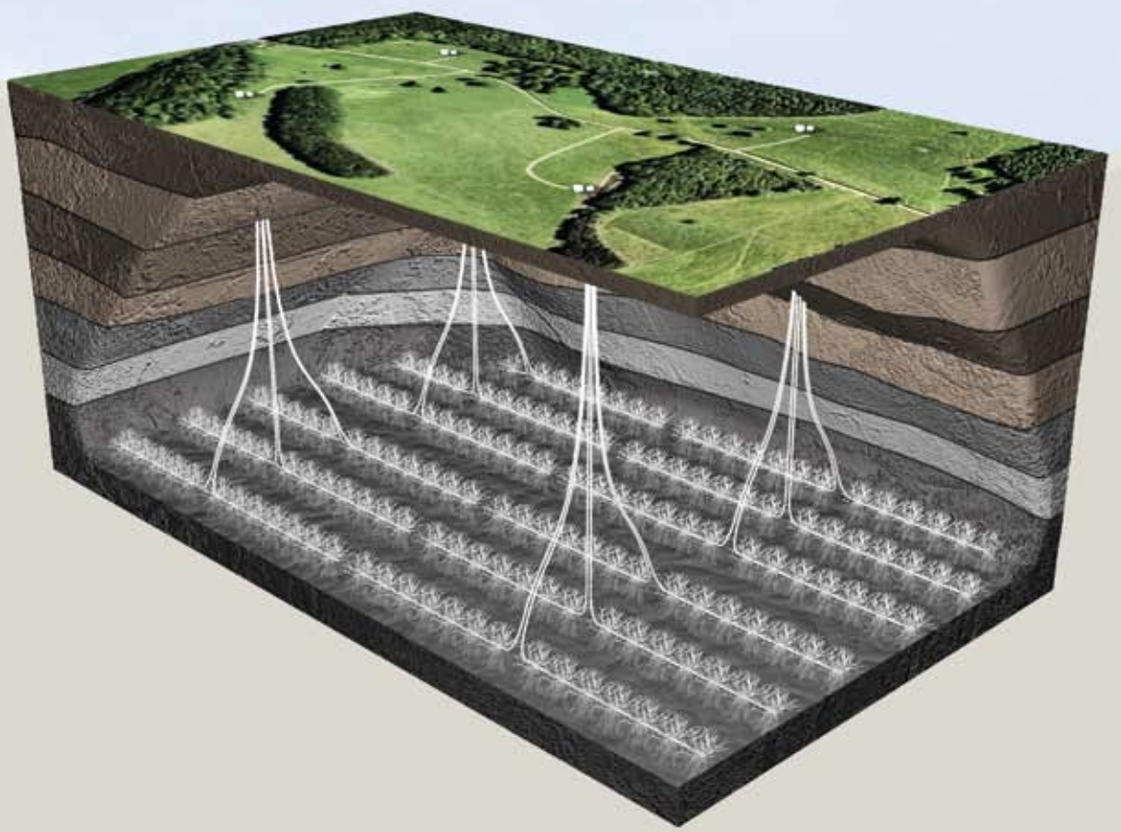
Mewbourne School of
Petroleum & Geological Engineering
The University of Oklahoma

An Orientation Workshop on

SHALE GAS
A Global Energy Alternative

Date: 6th - 7th January, 2011

Venue: PDPU Auditorium,
Gandhinagar, Gujarat, India



Workshop on Shale Gas

With the support of Mewbourne School of Petroleum & Geological Engineering, The University of Oklahoma, Norman, OK, USA, Pandit Deendayal Petroleum University, Gandhinagar, India is going to organise "An Orientation Workshop on Shale Gas". Senior policy makers, delegates from Indian Industry, faculty & researchers from PDPU, and delegates from The University of Oklahoma will discuss the challenges and prospects of the Shale Gas industry worldwide.

The interactive workshop is aimed to address the identification and production challenges confronting upstream, midstream and downstream development and marketing of Shale Gas resources. It will provide an invaluable insight into some of the economic and regulatory aspects of shale gas development in India and across the world.

Objectives of the Workshop

The two-day workshop will project how in an era of depleting conventional oil and gas resources, Shale Gas can play asignificant role in meeting global energy demand. It will also provide attendees with a fundamental understanding of identifying shale gas reservoirs. Attendees will learn the following:

- Shale Gas and its importance
- Appropriate Technology to produce Shale Gas
- Uncover the real impact of Shale Gas on the global gas industry
- Sharing of knowledge and experiences
- Raising the profile in this game-changing gas industry

Topics to be addressed in the Workshop

- Overview of US shale gas plays
- Shale Gas petrophysics
- Shale Gas microstructure
- Pore scale modeling and volumetric calculations
- Rock typing in Shale Gas
- Completion & fracturing stimulation considerations
- Log analysis in Shale Gas

Shale Gas - An Overview

Shale Gas is essentially natural gas contained within a sequence of predominantly fine grained rocks, dominated by shale. Natural gas contained within the shales is primarily biogenic methane stored in both the free and adsorbed state. Most shales have low matrix permeabilities and require the presence of extensive natural fracture systems to sustain commercial gas production rates. The low permeability of Shale Gas reservoirs results in recovery rates of only 20% of original gas in place compared to 75% for conventional reservoirs. Overall declining production from conventional gas reservoirs makes it even more necessary to develop Shale Gas resources. Conventional gas reservoirs have permeabilities in millidarcies; tight gas reservoirs have permeabilities in microdarcies whereas shales have their permeabilities in nanodarcies. Due to the long life nature of Shale Gas reservoirs, substantial advances in technology in recent years and today's high commodity price environment, the economics of shale gas have never been better. High gas prices and better completion techniques are unlocking the potential.

There is a positive correlation between Total Gas Content and Total Organic Carbon (TOC) content of the shales and between the amounts of gas stored by adsorption and both total organic carbon content and pressure. Therefore, it is likely that a significant proportion of gas within the shales is stored by adsorption. Sandstone/ siltstone interbeds within the shales tend to have lower TOC values. These intervals are more likely to contain a higher proportion of free gas, as opposed to adsorbed gas, as the primary gas storage mechanism. They have either natural permeability conduits (sandstone/siltstone interbeds or fractures), or the mechanical properties are such that the shales can be successfully fractured through induced processes. These units should contain minimal amounts of swelling and/or migrating clays. Shale Gas prospects should also have low water saturation and high gas content. The ideal reservoir is over pressured and gas saturated; a significant proportion of the gas remains in the reservoir and has not been expelled or migrated from the shales.

Shale Gas - Energy Innovation of the Decade

World's energy demand is increasing day by day and the conventional resources of fossil fuel are almost stagnant. The need to explore unconventional energy resources are getting more important. Besides, natural gas price has steadily increased over the past few years and has spurred interest in the development of "unconventional" gas resources, such as Shale Gas, Gas Hydrates and Coalbed Methane. Shale Gas resources represent a vast, long-term, global source of natural gas which have not been appraised systematically. Shale Gas is locked in organic-rich sedimentary rocks, which is found below the surface between two rock formations. Shale acts as source rock, cap rock as well as reservoir rock for natural gas. Geologists have known the presence of natural gas in shales for years together, but until recently could not be cost-effectively extracted. However developments of horizontal directional drilling and hydraulic fracturing have paved the way for improving the production of natural gas from shales.

PRIMARILY THREE FACTORS HAVE EMERGED IN THE RECENT PAST TO MAKE SHALE GAS MORE ATTRACTIVE:

1. **Advancements in Horizontal Drilling Technology**
2. **Advancements in Hydraulic Fracturing Technology**
3. **A surge in natural gas prices over the past few years as a result of significant demand pressures.**

Together, these factors have transformed shale formations from marginal sources of natural gas to substantial contributors to the natural gas supply portfolio, ushering in a robust resurgence in domestic natural gas production. Today, it can be seen as a potential source of cheap and eco-friendly natural gas and could bring about a revolution in the global energy sector.

Key Challenges Facing Increased Use of Natural Gas

Classification of all unconventional gas resources

Unconventional gas resources come in various forms such as tight gas, coal bed methane and Shale Gas. All these unconventional resources require similar infrastructure for development. A single classification may help lowering cost of production by providing economy of scale for the operations.

Criterion for selection of the developer

Shale Gas geology is in its infancy in India and one cannot be sure if the Shale Gas economics are beneficial until a few wells are drilled. The financial criteria may consider a strong balance sheet and sufficient cash reserves. Technical criterion could consider a technological alliance with an overseas entity or availability of technical experts or understanding of technical knowhow.

De-regulation framework

Gas price freedom/deregulation in the US has been mentioned as one of the turning point for Shale Gas success. Complete freedom to price and sell Shale Gas within India will be of key interest to established players.

Acreage size and terms of lease

A block below the threshold area may lead to slapdash approach in resource exploitation and prevent it from becoming a pure capital market play. The right size of the Shale Gas blocks will invite interest from established entities. The terms of the lease should give adequate period for the complete exploration of the awarded blocks. Though Shale Gas extraction seems more controllable than producing gas from a conventional hydrocarbon reservoir, but the term of the lease should be adequate for completion of commercial exploitation without much slack.

Availability of water & environmental issues

Shale Gas operations would require large quantities of water for hydraulic fracturing process. Unavailability of water sources for the awarded blocks could pose logistical issues and mean additional cost. Guidelines to prevent the contamination of aquifers and limits on well pads and well density in populated areas will minimize the environmental impact.

Shale Gas and Carbon Credits

Natural gas, being the clean source of energy compared to coal or crude oil, has the potential to mitigate environmental degradation. Countries all over the globe are reducing their carbon footprint as mandated/agreed upon at the Copenhagen Summit. The world is aware that maximum percentage of the global carbon footprint will be of the emerging nations, primarily China and India.

It is therefore very important that the developed countries bring the necessary funding and technology into these emerging nations to rapidly grow the Shale Gas industry. Natural gas can offset the CO_2 emissions of crude oil and coal, and pave the way to a cleaner and greener world.

Key Speakers

Chandra S. Rai

Director /Eberly Chair - Mewbourne School of Petroleum & Geological Engineering

B.S., Applied Geophysics, Indian School of Mines, Dhanbad, India, 1970
M.S., Applied Geophysics, Indian School of Mines, Dhanbad, India, 1971
Ph.D., Geology and Geophysics, University of Hawaii, Honolulu, Hawaii, 1977

Research Interests : Rock and Mineral Physics, Reservoir Characterization, Petrophysics

Yucel Akkutlu

Assistant Professor & Graduate Liaison - Mewbourne School of Petroleum & Geological Engineering

B.S., Chemical Engineering, Hacettepe University, 1992

M.S., Petroleum Engineering, University of Southern California, 1995

Ph.D., Petroleum Engineering, University of Southern California, 2002

Research Interests : Fluid Flow, Transport & Reaction in Porous Media, Unconventional Oil & Gas Recovery

Subhash Shah

Stephenson Chair Professor - Mewbourne School of Petroleum & Geological Engineering

B.S., Chemical Engineering, M.S.University of Baroda, India, 1968

M.S., Chemical Engineering, University of New Mexico, Albuquerque, 1971

Ph.D., Chemical Engineering, University of New Mexico, Albuquerque, 1974

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Carl Sondergeld

Associate Dean/Curtis - Mewbourne School of Petroleum & Geological Engineering

B.A., Geology, Queens College, CUNY of New York, 1969

M.A., Geology, Queens College, CUNY of New York, 1973

Ph.D., Geophysics, Cornell University, Ithaca, 1977

Research Interests : Rock Mechanics, Acoustic Emissions, Rock Physics

Pandit Deendayal Petroleum University

Pandit Deendayal Petroleum University, established in 2007 is a research-led university based in the vibrant city of Gandhinagar in Gujarat. Spread over a campus extending over 100 acres in the Educational Zone, PDPU is promoted by Gujarat State Petroleum Corporation (GSPC) and established by an Act of Gujarat State Legislature. The University is recognized by the University Grants Commission (UGC) and its flagship programmes are approved by the AICTE. Today, PDPU is widely recognized as a centre of excellence in energy education, quality research and for its strong industry interface. The university has over 1200 students on campus.

The objective is to create a world class university in energy education and research with special focus on the oil and gas sector. The University addresses the need for trained and specialized human resources for the Energy and Infrastructure industry worldwide. It intends to expand the opportunities for students and professionals to develop intellectual knowledge with leadership skills and offers well-planned undergraduate, post graduate, doctoral programmes and intensive research initiatives. PDPU also aims to function as a leading resource centre for knowledge management and entrepreneurship development in the areas of science, technology, management and humanities.

Mewbourne School of Petroleum and Geological Engineering, The University of Oklahoma

The University of Oklahoma is a co-educational public research university located in Norman, Oklahoma. Founded in 1890, it existed in Oklahoma near the Indian Territory for 17 years before the two became the State of Oklahoma. As of 2007, the university had 29,931 students enrolled, most located at its main campus in Norman. Employing nearly 3,000 faculty members, the school offers 152 Baccalaureate programmes,160 Master's programmes, 75 Doctorate programmes, and 20 majors at the first professional level.

Mewbourne School of Petroleum and Geological Engineering of the University of Oklahoma, provides undergraduate and graduate students with educational experiences that allow them the opportunities to develop technical competence and the intellectual perspective to function effectively in and continue professional growth during their careers. These educational experiences occur primarily through innovative classroom instruction, laboratory experiences, student mentoring and individual research at the graduate level.

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