Shale gas is becoming an important source of natural gas in many countries. According to recent assessments, Australia has around 437 trillion cubic feet (Tcf) of technically recoverable shale gas resources. Western Australia (WA) alone is roughly estimated to be holding the fifth largest reserves of shale gas in the world.

In line with the government’s effort to make sure that the nation’s growing future energy needs are met, a research group was established in 2010 by an industry consortium to investigate shale gas prospectivity in Western Australia. The focus of the research activities of the Curtin Unconventional Gas Research Consortium has been on the evaluation of potential gas shale formations within the Perth and Canning Basins of Western Australia but the focus has now switched to studies of the other onshore Australian basins.

The major objective of the previous consortium was to map sweet spots in the Perth and Canning basins. Geological, geophysical, geochemical and petrophysical parameters are still under evaluation to achieve this target.

The objectives of the project

The main goal of this project is to identify, assess and map potential shale gas formations and to define areas having the greatest gas potential. To achieve this objective it is required to characterize the potential shale formations in terms of geological, geochemical, and petrophysical properties:

- **Integrated reservoir characterization of shale gas formations:**
  - We have made a complete database for more than 500 boreholes in the Perth and Canning basins. This database can be utilized to characterize the major shale intervals for any location in Perth and Canning basins. We are expanding our database to other Australian onshore basins.

- **Petrophysical evaluation of shale gas reservoirs:**
  - Porosity and permeability measurements,
  - Capillary pressure analysis,
  - High pressure volumetric analysis (HPVA) to measure adsorbed gas content,
  - Access to different pore structure evaluation techniques including low pressure nitrogen adsorption, mercury intrusion and NMR laboratory for measuring pore size, pore shape and surface area of the shale samples,
  - Compositional analysis of shale samples using XRD, FTIR and SEM/EDS.

High pressure adsorption instrument (HPVA) can measure the adsorbed gas capacity of the shale samples. The adsorption isotherm can be used to calculate Langmuir volume and Langmuir pressure which are required to measure gas adsorption potential for shale samples.
The objectives of the project, continued

- **Shale gas geochemical evaluation:** A well-established database has been collected for geochemical parameters of shales, besides that we can also measure the following organic geochemical parameters which are so important for sweet spot mapping:
  - Quantity of organic matter in the shale samples by measuring Total Organic Carbon (TOC) content,
  - Thermal maturity of the shale samples by measuring Tmax,
  - Type of organic matter by measuring Hydrogen and Oxygen indices.

Rock pyrolysis equipment for determining the geochemical parameters of shale samples. Using this instrument we can measure total organic carbon, thermal maturity and type of organic matter. Figures above show how geochemical analysis can be used to evaluate and rank different shale samples.

- **Well log analysis to estimate the following shale parameters:**
  - Porosity, Gas saturation, TOC contact, Rock mechanical properties, Pore pressure, Net thickness identification and Volumetric calculations of gas reserves
UGRG facilities available to sponsors

Sponsors will benefit from the strengths of Petroleum Engineering Department of Curtin University including:

- High pressure volumetric adsorption (HPVA) instrument for measuring adsorbed gas of gas shale samples,
- Rock pyrolysis system for determining geochemical parameters of gas shales,
- Unique true tri-axial cell for hydraulic fracturing studies,
- Helium porosimeter/permeameter,
- High pressure-high temperature density measurement tool,
- Ultra Rock Centrifuge for rapid determination of capillary pressure curves,
- Dean-Stark cleaning and extraction apparatus,
- Porous plate capillary pressure measurement tool,
- Core sample preparation tools including coring and cutting tools,
- Highly motivated young researchers in different aspects of gas shale evaluation which could continue their collaboration with sponsored companies.

Automated helium porosimeter/permeameter, Low pressure nitrogen adsorption instrument.

Our petrographic analysis will help to characterize shale samples in terms of composition and texture. Scanning Electron microscopy (SEM) image of a shale sample showing packs of clays and frambooidal pyrite, Redback#2, Perth Basin.

We use a wide range of facilities to understand fluid flow mechanism in shale reservoirs.
We apply rock physics and seismic forward modelling to predict shale characteristics.

We generate contour maps that show different characteristics of the shale formations and highlights shale gas sweet spots within each onshore basin.

UGRG Team

This work will be performed by a team of petrophysicists and geology Masters/PhD students under the supervision of Professor Reza Rezaee. Our research group is expanding and currently there are 9 PhD and several Masters students working on the following projects:

- Shale gas prospectivity mapping in Perth Basin
- Shale Gas potential evaluation of Goldwyer and Laurel Formations, Canning Basin, WA
- Petrophysical evaluation of shale gas reservoirs in the Perth and Canning Basins
- An investigation on the pore pressure for the potential shale gas intervals in the Perth and Canning Basins
- Quantitative Analysis of Seismic Response to TOC Content and Maturity of Shale Gas Formations in Perth and Canning Basins
- Seismic inversion applications and laboratory measurements to identify high TOC shale
- Pore network modelling of shale gas to investigate flow mechanisms
- Microwave heating effects on formation damage in tight gas sands
- Shale Gas Reservoir Simulation

For further information please contact:
Prof. Reza Rezaee,
Department of Petroleum Engineering,
Curtin University, Western Australia.
Telephone: +61 8 9266 7980
Email: r.rezaee@curtin.edu.au