

SHALE GAS ASSESSMENT METHODOLOGY CASE STUDY

Kuwait Oil Company - Makhul Shale
Onshore Kuwait

AWT DISCIPLINES

- Geology
- Geophysics
- Reservoir Engineering
- Petrophysics
- Project Management

PROJECT BACKGROUND

Kuwait Oil Company (KOC) invited AWT to present at a 2 day workshop in Kuwait, to demonstrate the methodology for conducting hydrocarbon in place (HIP) assessments of Kuwait's Shale Gas resources, including

- Identify a potential Shale Gas play (source rock)
- Establish the areal extent and thickness
- Define the prospective area (limits and cut-offs e.g. depth and thickness)
- Hydrocarbon charge magnitude and maturity (likely GOR)
- Reservoir characterisation and fractureability
- Estimate the Shale Gas-in-place (and liquids)
- Calculate the technically recoverable resource and the Prospective Resource
- Consideration of the Chance of Success (COS) commercial

Location:
Kuwait

For more information contact:
Tel: (+603) 2162 3127 or visit our
website at: www.awtinternational.com

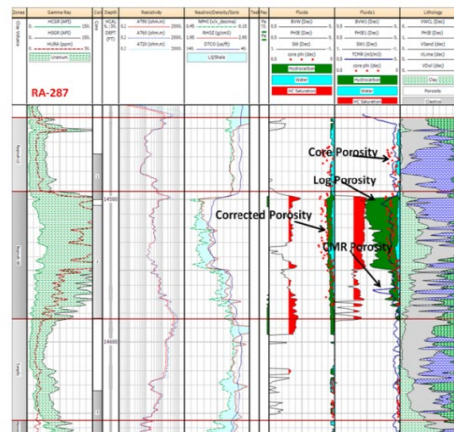


Figure 6. Najmah Shale member with log interpretation before and after kerogen effect porosity correction. It validated the corrected porosity to core porosity and CMR porosity.

AWT WORKSCOPE

Initial data gathering phase – the object of this stage was to produce a brief characterisation of the project, and to establish baseline criteria to evaluate the project.

Identification of Data Requirements, Availability, Accessibility and Gap Analysis.

Following discussions amongst the AWT team, a list of data requirements was prepared for the project. This covered the technical data as well as non-technical data.

Availability and accessibility were not expected to be issues in this case, given the types of data required.

Gap analysis was expected to be an ongoing issue. The team aimed to identify data gaps at the beginning of the process, so that steps could be taken to alleviate the situation. Recommendations to obtain new data e.g. by drilling and coring wells would also be made.

AWT ADDED VALUE

The following activities were conducted in providing a technical roadmap and data gap analysis to KOC:

- Reviewed existing data sets (remaining preserved core, core, SWC and cuttings).
- Reviewed upcoming well locations and potential to carry out additional sampling, such as core or pressurised core.
- Reviewed recent adsorption analysis by KOC and comment on the procedure and any improvements that can be made.
- Proposed additional experimentation on existing rock samples.
- Reviewed wireline log TOC calculations and correlation to core and cuttings measurements from pyrolysis.
- Using existing samples, suggested program for limited Tight Rock Analysis (TRA).
- Using existing samples, suggested program for limited Digital Rock Properties (DRP), and vRock.
- Sw was a poorly understood factor. AWT provided theoretical concepts and suggested measurement techniques beyond those already employed.

SHALE GAS ASSESSMENT METHODOLOGY CASE STUDY

Kuwait Oil Company - Makhul Shale

Onshore Kuwait

AWT DISCIPLINES

Geology
Geophysics
Reservoir Engineering
Petrophysics
Project Management

PROJECT BACKGROUND

Kuwait Oil Company (KOC) invited AWT to present at a 2 day workshop in Kuwait, to demonstrate the methodology for conducting hydrocarbon in place (HIP) assessments of Kuwait's Shale Gas resources, including

- Identify a potential Shale Gas play (source rock)
- Establish the areal extent and thickness
- Define the prospective area (limits and cut-offs e.g. depth and thickness)
- Hydrocarbon charge magnitude and maturity (likely GOR)
- Reservoir characterisation and fractureability
- Estimate the Shale Gas-in-place (and liquids)
- Calculate the technically recoverable resource and the Prospective Resource
- Consideration of the Chance of Success (COS) commercial

Location:
Kuwait

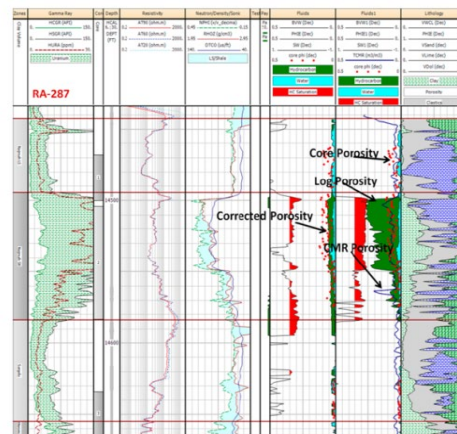


Figure 6. Najmah Shale member with log interpretation before and after kerogen effect porosity correction. It validated the corrected porosity to core porosity and CMR porosity.

AWT ADDED VALUE

- Reviewed Basin Modelling, number of points, recommend additional locations. Suggest hydrocarbon composition prediction method (complex as it should take into account previous expulsion episodes).
- Review FVF calculation and impact of overpressure and temperature on Z factor. Inclusion of Bo for oil component (depending on predicted shale rock hydrocarbon composition).
- Free Gas space porosity correction for adsorbed space. AWT suggested a method to determine/calculate.
- Recovery Factor (RF) and EUR's were poorly understood, very complex and probably best assessed using analogues. AWT reviewed US analogues to determine if parts of successful plays have a higher correlation to Kerogen than whole plays.
- Provided program/protocol for sampling cores (TRA, DRP, isotherms etc).
- Reviewed existing data sets (remaining preserved core, core, SWC and cuttings).
- Reviewed upcoming well locations and potential to carry out additional sampling, such as core or pressurised core.
- Reviewed recent adsorption analysis by KOC and comment on the procedure and any improvements that can be made.
- Proposed additional experimentation on existing rock samples.
- Reviewed wireline log TOC calculations and correlation to core and cuttings measurements from pyrolysis.
- Using existing samples, suggested program for limited Tight Rock Analysis (TRA).
- Using existing samples, suggested program for limited Digital Rock Properties (DRP), and vRock.