Advanced Reservoir Characterization Group, USA

Drilling and Technical Support for the Upstream Domestic and International Energy Industry

Advanced Reservoir Characterization Group (ARC GROUP), USA

Mature Oil and Gas Field Development and Exploration Services

Drilling and Technical Support for the Upstream Domestic and International Energy Industry

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Corporate Profile

• The ARC Group is an independent firm providing advisory services and technical project support to the upstream domestic and international energy industry.

• We specialize in integrated geoscientific and engineering analyses of exploratory and producing properties and projects.

• We provide full-service contracting and consulting, from seismic interpretation and visualization to simulation, by offering a wide range of integrated, multidisciplinary hydrocarbon discovery and recovery optimization services for both the domestic and international energy industry.

• The ARC Group is Austin, Texas-based but maintains professional associations with sister consulting firms in Houston and Dallas.
Reservoir Characterization Experience

• The ARC Group's experience in national and international basin analysis and advanced reservoir characterization has been developed over more than two decades of successful R&D in the United States, Argentina, Australia, Colombia, Mexico, Trinidad and Venezuela.

• We have also provided technology transfer workshops in basin analysis, reservoir characterization, marginal-field reactivation, and coalbed methane E&P in Austria, Brazil, China, Mexico, Peru, South Africa, and Trinidad.

• Our experienced, multidisciplinary core of staff members are fully time-dedicated.

• In-house expertise includes play analysis, sequence stratigraphy; basin analysis; reservoir architectural and attribute analysis; reservoir geophysics including high-resolution 2-D and 3-D seismic interpretation (supported by in-house 3-D visualization software); petrophysics; well completion and stimulation; and production engineering.

• Projects are undertaken using a synergistic approach and appropriately experienced staffers are assembled to address project-specific problems.
Advanced Reservoir Characterization Group, USA

Drilling and Technical Support for the Upstream Domestic and International Energy Industry

Reservoir Characterization Programs
Approaches to Advanced Reservoir Characterization

• Integrated characterization of heterogeneous reservoirs is proving to be a fertile source of new reserves in mature oil and gas provinces around the world.

• Field re-exploration strategies such as resource-targeted infill drilling and field extension wells, together with strategic recompletions and waterflood optimization strategies, the designs and locations of which are based on sophisticated reservoir characterization studies, are now the preferred approach to the revitalization of mature fields.

• These approaches have captured almost two thirds of the 40 billion barrels of oil that have been added to the US reserve base over the past 20 years.
**Technology Deployment:** Targeted infill drilling, horizontal and multilateral wells, recompletions, workovers, secondary recovery
Opportunity: Realizing Reserve Growth in Complex Reservoirs

• ARC’s approach to integrated characterization of heterogeneous reservoirs follows a three step process that (i) establishes the stratigraphic and structural framework of the component reservoirs of the field, (ii) establishes fluid character, location and flow characteristics, and (iii) identifies the residency, and quantifies the magnitude, of the remaining oil or gas.

• Steps one and two are iterative, and step three becomes the basis for designing a portfolio of advanced recovery opportunities in the field being characterized. This three-step path can be referred to as the static model.

• ARC Group also offers reservoir simulation based on the results of the static model to provide a dynamic-model analysis of production response to proposed recovery strategies.
Recent Company Project Collaboration and Reservoir Characterization Programs Include:

- PDVSA Gas (Venezuela)
- PEDVSA Intevep (Venezuela)
- Staatsolie (Suriname)
- PEMEX Exploracion and Produccion (Mexico)
- Petrobras and Ecopetrol (Colombia)
- PETROBRAS INTERNATIONAL BRASPETROL B.V.
- Hocol (Colombia)
- Petrotrin (Trinidad)
- Trinmar (Trinidad)
- Lease Operators (Trinidad)
- Neal and Massy (Trinidad)
- SCOTIA Group (Texas)
- SCHLUMBERGER (USA)
Recent Company Project Collaboration and Reservoir Characterization Programs (Continued):
Object Reservoir (Texas)
Compañía Pena Sanchez, S.A. de C.V. (Veracruz, Mexico)
Compañía Mexicana de Exploraciones, S.A. de C.V. (Mexico)
CGG/VERITAS (Mexico)
YPF-REPSOL (Argentina)
Reliance Industries (India)
Perenco (Colombia)
Nexen (Colombia)
Ecopetrol (Colombia)
Rosewood (USA)
IMP (Mexico)
Paradigm/NSA (Mexico)
Total Fina Elf (USA)
Nederland and Sewell
Mature Field Re-exploration and Rejuvenation

Production Reactivation in Mature Fields

• Deployment of advanced reserve growth strategies in mature fields is adding substantial volumes of oil to the US and world-wide reserve base. This reserve growth phenomenon is largely the product of field re-exploration with the concomitant deployment of advanced reservoir imaging and recovery strategies.

• Synthesis of geological, petrophysical, engineering and geophysical data into an integrated, and quantified, reservoir model forms the basis for the development of multi-faceted, production-optimization portfolios that guide the extended development of the candidate fields.

• Successful field rejuvenation projects based on ARC Group's redevelopment portfolios have seen production-decline reversals of five- to ten-fold daily production and recovery of upfront costs expended on reservoir characterization studies in days of incremental production.
Production response to the reactivation of a mature field reactivation project, Salinas Basin, Mexico based on the production-optimization recommendations provided by our staff.
Other ARC Group Oil and Gas Field Reactivation Successes

**BUDARE FIELD OIL PRODUCTION (1989-1997)**

**RESULTS**

- 20 wells drilled
- 95% success rate
- Two wells with "average" prod.
- 17 excellent wells
- Multiple wells recompleted

PDVSA
INTEVEP
Field Rejuvenation – Early Results

- Drilled 10 horizontal wells
  - Account for 59 percent of production
- 23 new locations identified
- Identified 75 recompletion opportunities
  - None of the new wells were unsuccessful and all met or exceeded performance predictions
- Initial reactivation resulted in incremental production of almost 1,000,000 bbl oil in year 1
EQUIPOS DE TRABAJO INTERDISCIPLINARIOS, PERMITEN TOMAR GRANDES DECISIONES

–Ejemplo: Estudio Integrado Campo Yaguará

William Barbosa & Noel Tyler
Petrobras International B.V
The ARC Group LLC
SUCCESSFUL FIELD REACTIVATION STUDIES IN MEXICO

Major Burgos Basin Fields, Mexico

Basin Reactivation Results
Field Reactivation Studies Targeting New Well Locations Have Been Undertaken In Parrylands/Guapo, Moruga West, and Fyzabad Onshore Fields, and Main Soldado Offshore Field, Trinidad
2.8 million barrels of oil waiting to be drilled.

Petrotrin multi-disciplinary team impresses

Wilfred Harper said that he had heard and read about the benefits of Reservoir Characterization and the type of studies done elsewhere. As a result, a decision was taken to "take the plunge" because of the increased oil production to be derived. Additionally, he pointed out that new oil was the only way to maintain and increase production in the EsPSBU. The Cartographic department came in for high praise for their use of new techniques to assist the study team. This, Mr. Harper said, was one of the reasons why Petrotrin was now in the first quartile with respect to technology, as opposed to being in the fourth quartile some time ago. Such was the level of technological expertise, that persons who normally use 3D seismic technology are now using the processes employed by Petrotrin.

He praised the team for completing the project on time, adding that the work would be tested in the coming weeks and months. Further, the team would have the opportunity to present its findings to wider audiences in the near future.

Dr. Noel Tyler, President of the Advanced Research Characterization and Exploration Services Group (The ARC Group, Austin, Texas, USA); Kasie Singh and Wayne Sumadh (Study Team Leaders); geologists Tricia Andrews, Hasely Vincent, Dave Mayers, Mano Carrera and Satra Ragbir; petroleum engineer Wendy Chadde and support personnel from Technical Services, Information Technology, Laboratory Services, Exploration and Joint Ventures, Geological Draughting Services and Field Units.

Eight months after the start of the Reservoir Characterization Study, Petrotrin stands to benefit from 2.8 million barrels of oil at reserve growth in the Parrylands area only. The study incorporated different processes/concepts to identify oil reserves on land.

The study was approached from two angles - a Structural and Stratigraphic approach and a Petro-physical and Reservoir Engineering analysis approach. The team comprised the following members: Dr. Noel Tyler - President of the Advanced Research Characterization and Exploration Services Group (The ARC Group, Austin, Texas, USA); Kasie Singh and Wayne Sumadh (Study Team Leaders); geologists Tricia Andrews, Hasely Vincent, Dave Mayers, Mano Carrera and Satra Ragbir; petroleum engineer Wendy Chadde and support personnel from Technical Services, Information Technology, Laboratory Services, Exploration and Joint Ventures, Geological Draughting Services and Field Units.

Their responsibility was to fulfill the mandate of developing a portfolio of reserve growth potential. Study Team Leader Wayne Sumadh explained that the results of the study was the culmination of eight (8) months of very detailed and intense work which had significant benefits for Petrotrin in the short, medium and long term.

66% of the reserves in the last twenty (20) years has come from the rejuvenation of mature fields. In some cases, the reserves had increased to original rates. The process has also been tested in Venezuela with similar results.

The study was two-fold. Firstly, to increase production; secondly, to find out whether the processes and concepts that were applied elsewhere would work in Trinidad & Tobago. Dr. Tyler was quick to point out that his Company, ARC, did not do the work - the Petrotrin team did the work. They simply provided guidance during the study.

Why Parrylands?

Initially, seven (7) areas were selected and the data compiled and evaluated - Parrylands, Barrackpore, Forest Reserve, Moruga East, Oropouche, Cachil and Trinidental. Eventually, a group of four was chosen and a decision was made based on both the favourable and unfavourable characteristics of the fields. The potential uncovered in Parrylands alone can be extended to an enormous area of South Trinidad.

In Parrylands, of the 430 wells, 287 reach the Cruse formation, with only 65 presently producing. Original oil production was just over 27.6 million barrels, with current reserves of 1.34 million barrels that can be tapped immediately. 2.8 million additional barrels of oil reserves have been identified by the study team. This figure does not include any reserve growth from secondary or EOR opportunities, for which there is potential.

The success of Reservoir Characterization in general is dependent on the establishment of a stratigraphic framework, and it was no different for Parrylands. The unfavourable characteristics discovered were not enough to outweigh the favourable aspects.

In the course of its deliberations, the team has unearthed 46 new locations along with 7 follow-up locations, the latter figure being quite conservative. In addition, there is a total of 20 recompletion opportunities (4 available immediately). Overall, the increment from targeted recompletions is 500,000 barrels.

The participants along with the co-presenters were extremely excited about these new developments. Even though they admitted to some highly complex formations in the Parrylands area, they were confident that with the talented personnel in the EsPSBU tapping into oil reserves both in this area and other areas in the South, would not be a problem. This study was only the tip of the iceberg and already there are wells in place to test the concepts employed during the study.
Coalbed Gas Resource Assessment and Play Analysis of the Guasare Subbasin, Zulia State, Western Venezuela

Dr. Noel Tyler and Mr. Roger Tyler
The ARC Group
Ms. Vania Savian and Mr. Ulneiver Canonico
Mr. Rafael Tocco, Project Manager
PDVSA-INTEVEP
December, 2002

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<th>Area (Square Miles)</th>
<th>Average Coal Thickness (ft)</th>
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<th>Coal Resources (Billion Short Tons)</th>
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Modelo Geológico, Caracterización Dinámica e Ingeniería de Yacimientos del Campo Soledad, Porción Sur: 
Modelo Geológico de Simulación: 
*Phase 4 Report*
Actualización Modelo Geológico Campo Soledad, Porción Sur.

Prepared for
*Compañía Mexicana de Exploraciones, S.A. de C.V.*
EMPRESA PARAESTATAL
AV. DIAGONAL DE PATRIOTISMO Nº 1 PISOS 2º, 3º Y 6º
COL. HIPODROMO CONDESA
DELEGACION CUAUHTEMOC
C.P. 06179 MEXICO, D.F.

**Dr. Noel Tyler**
The ARC Group, Leander, Texas
October 2003
Depositional Systems Analysis, Structural Attributes, Reservoir Characterization, and the Potential for Infield and Field Extension Opportunities, Moruga West Field, Southern Trinidad

Final Presentation
By
Noel Tyler and Roger Tyler
ARC Group
And
Clyde Ramkhalawan
NMERL
Prepared for
Neal and Massy
Energy Resources Ltd
And
Petrotrin
Trinidad and Tobago
October, 2003
The ARC Group
Austin, Texas, United States of America
Reactivation of a Mature Field in South Mexico and Rate of Return

Project Impact

Incremental Production 2100 bopd

Return of project cost – 10 days production (and shrinking)

$110k/day@$50/bbl

ARC Project
To Contact the ARC Group, call, write or email at the following:

<table>
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<tr>
<th>ARC GROUP, LLC.</th>
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<tbody>
<tr>
<td>Direct email</td>
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<td>Roger Tyler, Vice-President</td>
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