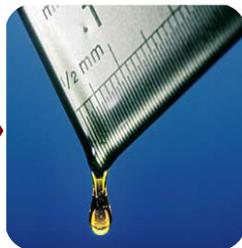


PREMIER COREX

CORE ANALYSIS
SERVICES BROCHURE

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INTRODUCTION

Acquiring core forms an important role in understanding and **modeling hydrocarbon reservoirs** as it allows direct measurements to be made on reservoir formation. PREMIER COREX works in partnership with operators to ensure that accurate and reliable data is obtained. This allows representative models to be built to **maximise the opportunity to recover hydrocarbons**.

PREMIER COREX HISTORY

Established in the mid 1970's, the last 40 years have seen PREMIER COREX build up a wealth of experience across the oil & gas industry. PREMIER COREX have analysed millions of samples and are recognised as one of the world's leading Independent Core Analysis providers.

COREX (UK) Ltd acquisition of the Core Analysis business and assets of Fugro Robertson Ltd in 2004 increased the experience, innovation and resources available to the company. The combined resources of the two businesses allowed the company to enhance our services, invest in new technologies and develop new markets.

In 2016, COREX (UK) Ltd was acquired by Premier Oilfield Group, LLC (Premier). Premier Oilfield Group was formed in May 2016 under the private equity sponsorship of CSL Capital Management. Over the next six quarters, the team acquired and integrated six businesses, focused on the generation and interpretation of rock and fluid data. Further acquisitions by Premier were formed, including the assets of the ConocoPhillips Subsurface Laboratory located in Bartlesville, Oklahoma, and NSI Technologies, LLC (NSI).



The acquisition of PREMIER COREX into the Premier Oilfield Group allows our group of companies to globalize our client base, expand in international territories, products and services and offer a more comprehensive solution worldwide.

The combined group of companies now has centers of excellence based in Aberdeen (UK), Cairo (Egypt) and Houston (USA) with front-line laboratories in Noida (India), Basra (Iraq) and recent growth in Abu-Dhabi (UAE) and Al Ahmadi (Kuwait).



QUALITY ASSURANCE AND PROJECT MANAGEMENT

PREMIER COREX are committed to ensuring that we meet both industry standards and the requirements of our clients. Both our main laboratories in the UK and Egypt are certified by The British Standards Institution (BSI) to Quality Management System ISO 9001:2008 standard. This gives assurance to the customer that the data we provide is measured on maintained and calibrated equipment, according to documented procedures by trained personnel. All other laboratories are working towards the same standard and are in the process of obtaining certification.

The principal focus of PREMIER COREX

- Establish standard operating procedures for laboratory testing processes in line with industry standards and best practice
- Ensure all instruments used in testing are regularly inspected maintained and calibrated
- Define administrative requirements, such as mandatory recordkeeping, data evaluation, and internal audits to monitor adherence to the required standard
- Identify training and continual professional development requirements to maintain high-quality employee performance

To help achieve this, PREMIER COREX have introduced Entropy Software Solution, BSI's management system software. Entropy has been developed to enhance the project management objectives of Quality Management System ISO 9001.

Entropy Software has five key workflows with capabilities that function independently, for targeted issues or together as an integrated system.

These workflows are:

- Audit & Compliance Management
- Incident Management
- Performance Management
- Risk Management
- Knowledge Management



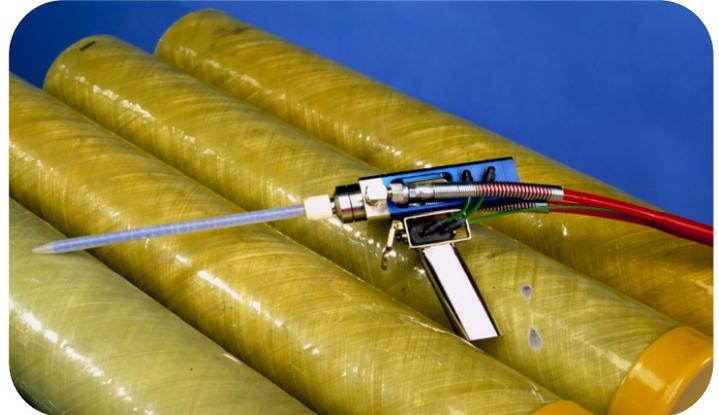
PREMIER COREX personnel will work with our clients to clearly establish key deliverables and timings on all projects.

PREMIER COREX staff undergo regular training to ensure that projects are properly planned, executed and delivered on time. All clients are provided with a Gantt chart and regular status reports during the project lifecycle. Post-project reviews are carried out to maximise learning opportunities for both PREMIER COREX and the client.

WELLSITE SERVICES - CORE HANDLING, SAMPLING, PRESERVATION AND STABILISATION

In order to achieve high quality core analysis, the handling of core at the wellsite is of the upmost importance. It is vital that personnel handling core at wellsites are fully trained and ensure careful attention is given to the orientation, marking and preservation of the core. PREMIER COREX recommend that experienced core analysts are available during core recovery to ensure best practice is followed and to maximise the value of data obtained during laboratory testing.

PREMIER COREX have over 40 years experience in all aspects of wellsite core handling, sampling and preservation. PREMIER COREX staff work in close cooperation with coring companies and wellsite geologists to fulfil the clients requirements and successfully recover the maximum amount of core. PREMIER COREX technicians and engineers handle all types of core samples including conventional cores, sidewall cores, aluminium and fibreglass barrels as well as unconsolidated cores.



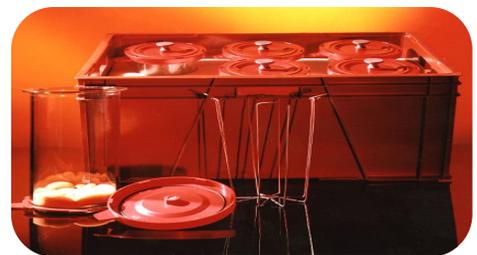
SAMPLING

The preservation methods provided by PREMIER COREX include:

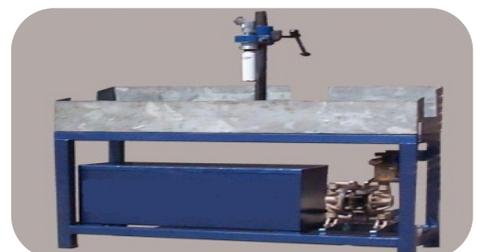
- Immersion of core in non reactive liquids using PREMIER COREX CPC jars
- Wrapping and dipping in heat strippable plastics / "wax"
- Foam stabilisation for unconsolidated or friable cores
- Use of laminates such as 'Proteccore'

Unconsolidated Core Stabilisation:

PREMIER COREX has *unparalleled experience* in the handling and analysis of unconsolidated and poorly consolidated sediments, both at the wellsite and in the laboratory. PREMIER COREX has developed and adopted a range of techniques to stabilise cores to prevent mechanical damage during transportation and processing. Each method has advantages and we recommend that PREMIER COREX representatives are involved in pre-spud discussions to allow the most appropriate technique to be selected for each coring program. Foam core stabilisation is the preferred method for nearly all core types.



PREMIER COREX Core Preservation Containers (CPC) for immersion of core in non reactive liquids



Wellsite plugging machine with self contained fluid recirculation unit.



Core stabilisation equipment



Example of foam stabilised core



Stabilised unconsolidated core showing sedimentary features still visible after core slabbing

The methods employed for core handling are based on American Petroleum Institute Recommended Practices 40 (API RP40), Recommended Practices for Core Analysis. Core handling methods are regularly reviewed and, where appropriate, improved by adopting industry best practices. PREMIER COREX also develop our own innovative equipment and techniques.

Services that PREMIER COREX offer include:

- Trained core analysts to perform on-site core handling services
- Equipment hire
- Specialised core stabilisation using either expanding foam, resin or gypsum techniques
- Sampling including taking preserved samples and cutting core plugs
- On-site core gamma
- Mini Permeametry
- Core photography
- Core packing prior to shipment

CONVENTIONAL CORE ANALYSIS SERVICES

Whilst conventional core analysis (CCA) programs tend to be relatively straight forward, the importance of selecting a skilled and dedicated team to manage this part of the reservoir study is vital to the overall success of the program.

PREMIER COREX technicians are experienced and highly trained. They work in close association with all relevant disciplines to maximise the value of information and data available from cores.

The following services are available from PREMIER COREX:

Core Gamma (both total and spectral):

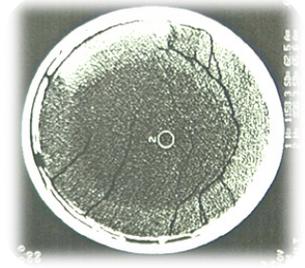
Following receipt of core and after initial quality control checks, spectral core gamma measurements are made prior to undertaking any core cutting operations.

PREMIER COREX Spectral Gamma instruments provide total and relative counts of Potassium, Thorium and Uranium. The surface core gamma log can be used to help identify lithology types in cores that are received in inner core barrels and to adjust drillers depths against the downhole gamma log.

Computed Tomography (CT) scanning:

PREMIER COREX offer a full range of CT scanning options including whole core CT scanning to establish whether any fractures are present in the cores prior to starting the analysis program. Micro CT scanning on smaller samples is also available.

This CT scan shows an example of core that has undergone damage during the coring process, in this case gas expansion is the likely cause.



SAMPLING / PLUGGING

PREMIER COREX offer a full range of core sampling and plugging services using an array of cutting fluids. Typically, PREMIER COREX will cut 1½ inch diameter core plugs but there are a variety of sizing options available. Specialised techniques for sampling unconsolidated samples are also available.

SAMPLE CLEANING AND DRYING

After sampling CCA core, plugs usually undergo extraction of fluids and drying prior to routine core analysis.

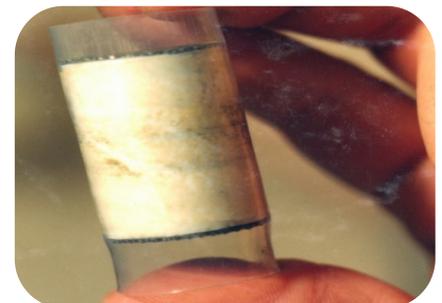
PREMIER COREX have a range of cleaning options available to suit the particular rock fluid system tested. Pre-screening to ensure compatibility of cleaning solvents is also available using PREMIER COREX's own state of the art in-house scanning electron microscope (SEM) facility. This allows us to see how the rock fabric may be impacted due to exposure to different solvents and/or temperatures.

The following plug cleaning capability is available:

- Constant Immersion
- Standard Soxhlet extraction (700 plugs)
- Cool Soxhlet extraction
- Individual Dean and Stark extraction sets (60 plugs)
- Miscible solvent displacement

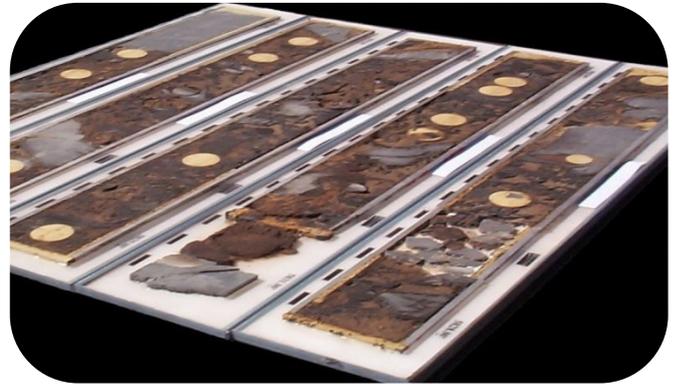
Following extraction, core drying can be achieved using a standard hot oven, vacuum oven or humidity oven.

Critical point drying is also available as an alternative.



SLABBING, PHOTOGRAPHY AND RESINATION

In order to understand the depositional environment and sedimentary context of cores, PREMIER COREX take great care to ensure that cores are maintained to the highest possible standards. Cores are slabbed using compatible fluids. Cores can be photographed at up to 20 million pixel resolution. Museum slabs can also be prepared to preserve a permanent record of the core features for future studies.



360 Degree photography:

PREMIER COREX offer automated high resolution 360 degree core photography. Photographs can be captured in white light and ultraviolet light and high, medium and low resolution options are available.

Porosity and Permeability:

At PREMIER COREX, porosity is determined using the helium expansion technique, combined with either measured bulk volume or direct pore volume measurements as described in API RP40. Pore volumes measured directly can be made at reservoir confining pressure. The laboratory has four porosimeters which can analyse sample sizes from sidewall to full whole core diameter. Porosity can also be determined by liquid saturation method. Gas and Klinkenberg Permeability is typically measured using a steady-state method at ambient temperature and applying appropriate confining stresses (up to 10,000psi) to the core plugs.

Probe Permeability:

PREMIER COREX offer several options for probe permeability measurements. As well as standard bench top machine measurements, PREMIER COREX also offer 'Tiny Perm' portable option for field work or difficult environments.

Probe permeability provides:

- Qualitative measurement laminate scale measurements
- Rapid measurements (300 points per day)
- Determination of average permeability over heterogeneous cores
- Use in fractured formations where plugging is not possible
- Portable



Whole Core Analysis:

Whole core analysis can be appropriate for fractured reservoirs, vuggy carbonates and conglomerates. Analysis can be carried out on classic rock or carbonate samples of up to 5 inch in diameter.

Fluid Saturation:

Fluid saturation determination is available by Dean Stark method through one of our 60 test sites capable of Dean Stark measurements. Saturation can also be determined by Retort method and Karl Fischer technique on request.



SPECIAL CORE ANALYSIS

Special core analysis plays an important role in the evaluation and decision making of hydrocarbon reservoirs. The results and interpretations from the SCAL program are used as inputs for reservoir modelling and engineering. The information can be used to calculate reserves in place, predict reservoir performance and production rates.

At PREMIER COREX we provide a full range of SCAL services including:

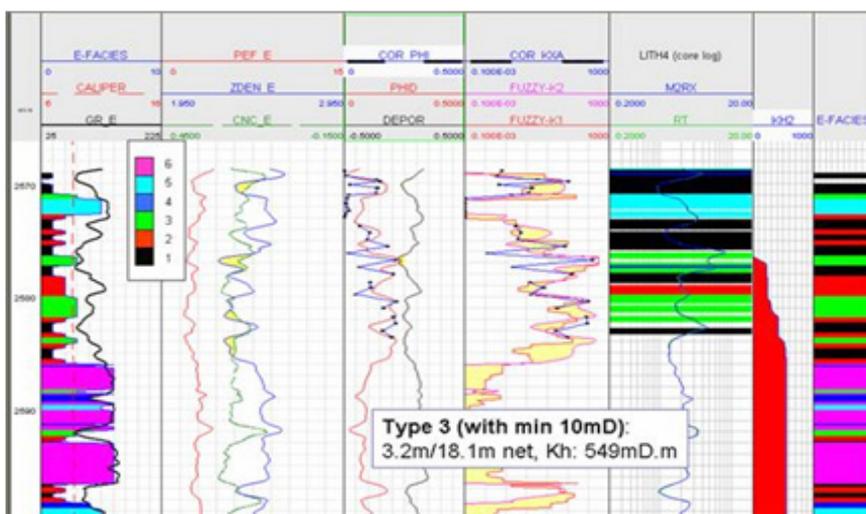
- Wettability
- Relative permeability (with in-situ saturation monitoring)
- Formation resistivity
- Capillary pressure
- Pore volume compressibility
- Permeability and porosity at overburden
- Nuclear magnetic resonance
- Consultancy and research projects
- Quality assurance & auditing of third parties

Our experienced team produce tailor-made programs, designed to meet our clients technical, budgetary and turnaround requirements.

Fully integrated studies are also available to encompass reservoir geology, pressure-volume-temperature and formation damage to provide a comprehensive description of all reservoir properties.

At PREMIER COREX we recognise that formation evaluation is integral to all exploration, development, and reservoir characterisation projects. Consequently, PREMIER COREX work closely with petrophysical experts and engineering colleagues to ensure that log-derived rock properties are appropriate for static and dynamic models.

Log interpretation using computerised techniques to derive rock properties from logging data, integration and modelling of core data to create benchmarks for validating results and reducing uncertainty are available through our extensive associations.



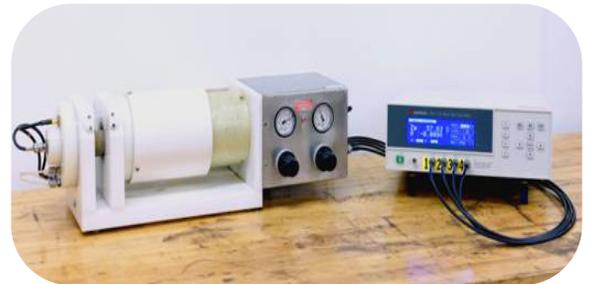
ELECTRICAL PROPERTIES

Laboratory measurements of reservoir core resistivities are used in the calibration and interpretation of downhole electrical logs. Core parameters (m), (n), (a) and (B_{qv}) are used as inputs into water saturation models such as Archie and Waxman-Smits. Core resistivities are influenced by the effects of pore geometry, lithology, brine salinity, formation stress and wettability.

PREMIER COREX have a variety of tests available including:

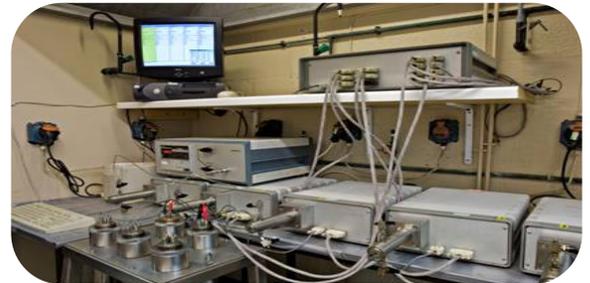
- **Formation Resistivity Factor:**

Measured on a brine saturated sample at ambient conditions and up to 10,000 psig overburden pressure. Cementation exponent (m) and tortuosity (a) as a function of porosity can be evaluated. Both 2-wire and 4-wire equipment configurations are also available.



- **Formation Resistivity Index:**

Frequently measured in conjunction with capillary pressure. Core resistivity increases as a function of decreasing brine saturation (S_w) to produce formation resistivity index (FRI) and saturation exponent (n) values.



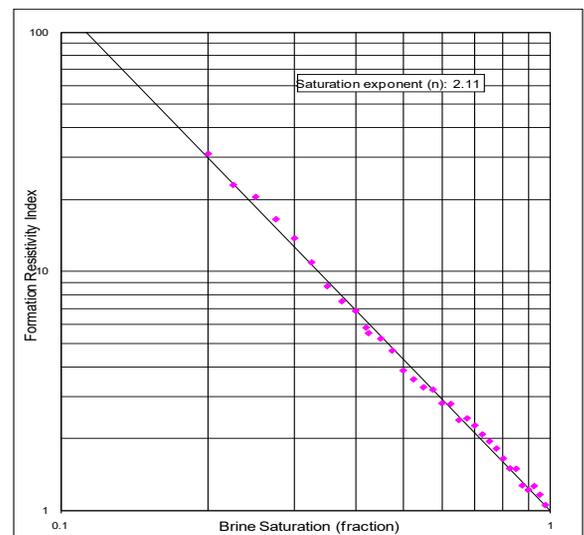
- **Saturation exponent:**

Is also available using the continuous injection technique. Sample de-saturation change is controlled very accurately by ultra-low rate pumps. This allows PREMIER COREX to make data available in a much shorter timeframe (2-3 weeks) compared to a capillary pressure test.

- **Excess conductivity:**

Certain formations containing hydrateable clays can exhibit excess conductivity which can affect the measured values of (m) and (n). This can be corrected by measuring core conductivity with varying brine salinities which then allows a direct measurement of excess conductivity (B_{qv}) to be obtained.

PREMIER COREX also offers an alternative method, the cation exchange capacity (CEC) technique, which involves titration of a solution containing a sample of crushed core and exchangeable ions.



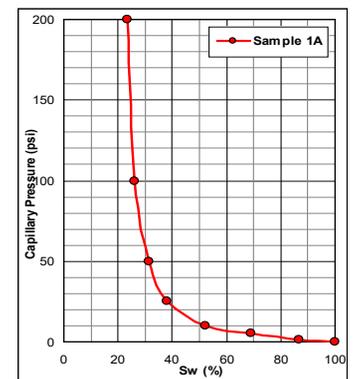
CAPILLARY PRESSURE

Capillary pressure has an important role in the distribution of reservoir fluids. Laboratory measured data is used to evaluate irreducible and residual saturations, location of fluid contacts and the creation of saturation height models.

Currently, PREMIER COREX offer porous plate, centrifugal and high pressure mercury injection methods to determine capillary pressure:

- **Porous Plate:**

Core plugs are desaturated at a series of individual pressures using either air or oil as the displacing phase. Typically, six to eight points are used to define the drainage capillary pressure curve. Measurements can be made at ambient or equivalent reservoir overburden up to 10,000 psig. PREMIER COREX has the capacity to measure up to 80 samples simultaneously in our multi-cell rigs. It is also possible for electrical properties to be measured in conjunction with this technique.



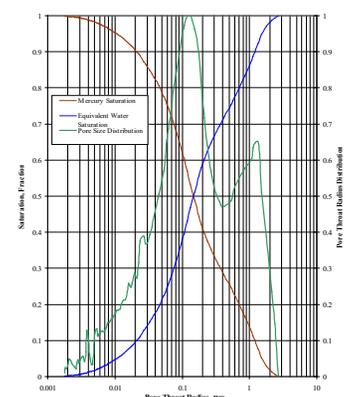
- **Ultra - Centrifuge:**

This method provides a quicker option in determining capillary pressure curves. Data is available approximately one week from the beginning of testing. Very high capillary pressures can be generated (up to approximately 1000 psig air/brine) meaning this method is better suited when analysing low permeability rock. "End face" corrected saturations are calculated using mathematical solutions including Forbes, Nordvedt and Ruth. PREMIER COREX are in the process of introducing an automated data capture system to our centrifuges. As well as further improving capillary pressure, curves definition of the measurement of displaced phase relative permeability will also be available.



- **High Pressure Mercury Injection:**

Capillary pressure and pore throat size distribution is available from a Micromeritics high pressure automated system. A maximum injection pressure of 60,000 psig allows the calculation of pore throat size distribution to 0.003 microns. Data is often used in rock typing, including identification of bi modal pore throat systems. Before injection testing commences, samples are cleaned and dried at set rates to provide the drainage curve. Imbibition data can then be collected from a reducing pressure sequence. Computerised control and sample data collection provides highly defined partition coefficient and power spectrum density calculations. Turnaround is rapid with up to 10 samples being completed over 24 hours. This technique is particularly effective when only a limited amount of core material is available, making the test suitable for sidewall and core trims.



WETTABILITY

Wettability has a significant influence on reservoir fluid saturations and distribution. It affects relative permeability, capillary pressure and core electrical properties. Therefore, it is important that the core wetting state is appropriate to the core measurement being made. Wettability is controlled by the formation mineralogy and the chemistry of the reservoir hydrocarbons and brine.



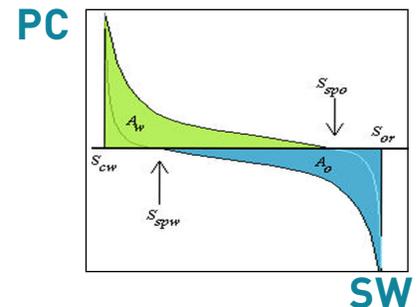
The wettability tests provided by PREMIER COREX include:

- **Amott Method:**

This uses static/forced imbibition and drainage of brine and oil to produce wettability indices respective to both fluids. The static stage uses Amott glassware, whereas the forced stage is usually measured with the core contained within a hydrostatic cell.

- **USBM:**

This method uses the ultra centrifuge to measure forced imbibitions and drainage of brine and oil. The core plugs are spun at increasing rates of rotation to produce imbibition and drainage curves of average brine saturation (S_w) versus capillary pressure. By evaluating the area under the curves, the single USBM wettability index can be calculated. The static imbibition stage of the Amott method can also be included to produce both Amott and USBM indices.



RELATIVE PERMEABILITY

Data from these relative permeability measurements is a key input into many reservoir engineering calculations. Measurements can help define the displacement characteristics of hydrocarbon by water and gas. This has significant contributions in reservoir economics including, producible reserves, recovery rates and water cuts.

PREMIER COREX offer the following Relative Permeability tests:

- **Unsteady state:**

Single phase displacement is carried out by water, gas or oil, either by constant flow rate or constant pressure i.e. only one variable is changed thus, pressure drop and production volumes are recorded versus time. Data analysis is conducted using Johnson-Bossler-Naumann (JBN) and Jones-Rozelle methods. Testing is also available at reservoir overburden.

- **Steady State:**

Fixed ratios of brine and oil are flowed simultaneously until saturation equilibration is achieved (as indicated from injected and produced fraction flows being equal) and a constant pressure drop over the core sample. Saturations are determined from acoustic separation and permeabilities from application of Darcy's law.

For both measurement techniques to determine relative permeability, rig design (including the core holder headers, end pieces and loading configuration) is highly flexible to ensure each particular combination of measurement parameters can be satisfied as per the client's requirements.

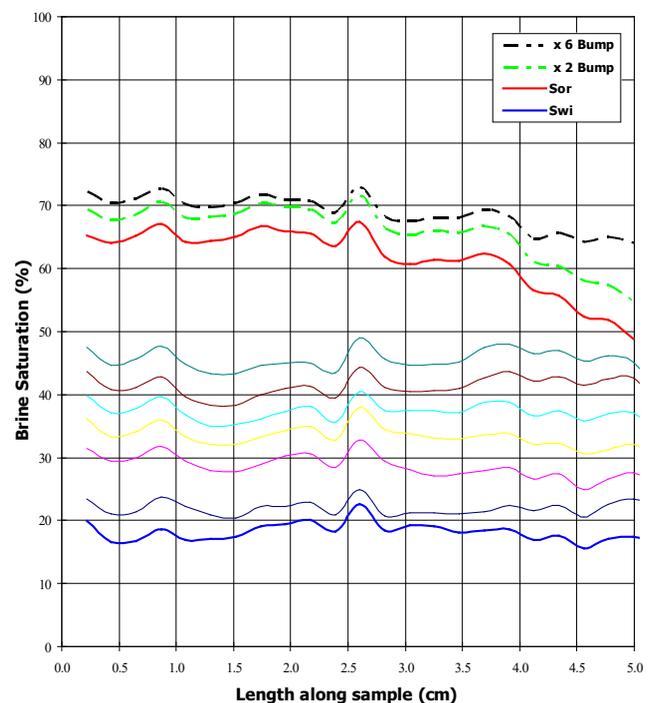
INSITU SATURATION MONITORING (ISSM)

At PREMIER COREX, In-Situ Saturation Monitoring (ISSM) using X-rays is used to provide data on fluid saturations within core plugs during flow tests. This system provides the ability to scan and log data from either set points on the core or complete core scans, allowing the recording of saturation profiles.

ISSM offers a number of advantages for relative permeability testing including real time measurement of fluid saturation, flood fronts and end effects. The use of ISSM allows the magnitude of capillary end effects to be assessed and accounted for in the calculation of residual oil saturation (S_{or}). This allows a more accurate value of S_{or} to be calculated in comparison to conventional relative permeability methods. Once measurements are recorded (in the form of X-ray counts) they are converted to fluid saturations on calibration of the system. The computer and operating software allows the input of scanning criteria such as slice size, number of slices and scanning time per slice.

The system also provides automatic data logging enabling increased data accuracy and experiment control. Pressure measurements are achieved by using two precision transducers, accurate to 0.05% full scale. Together with an arrangement of two differential pressure transducers, accurate to 0.5% full scale, accuracy can be maintained at low differential pressures. The pressure transducers and thermocouples are linked to the system computer, enabling the software to log data and monitor the rig conditions at all times. X-ray scanning times can be varied to suit the test type and range from 10mm per minute. The optimal scanning rate in terms of accuracy is 2mm per 15 seconds.

Both unsteady state and steady state methods are available using a single plug or stacked plugs up to 12 inches long. Overburden pressure up to 10,000 psig and temperature up to 150°C are also available.



PORE VOLUME COMPRESSIBILITY

The compressibility of a hydrocarbon reservoir influences the evaluation of reserve forecasts and field development strategies. Laboratory measurements are therefore an important input into mass balance calculations during reservoir depletion.

The following services are available from PREMIER COREX:

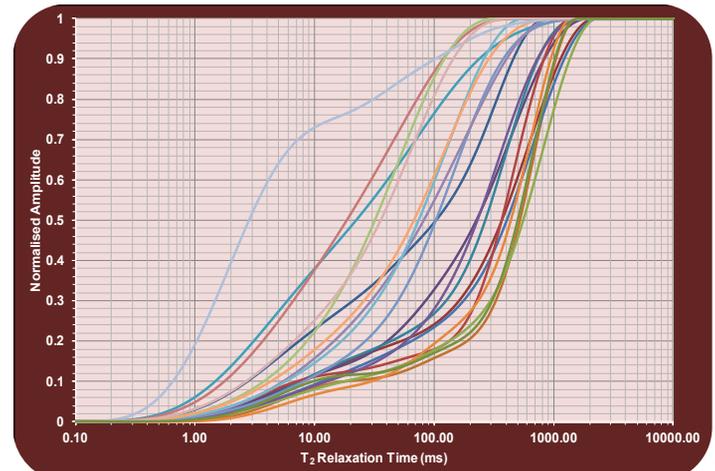
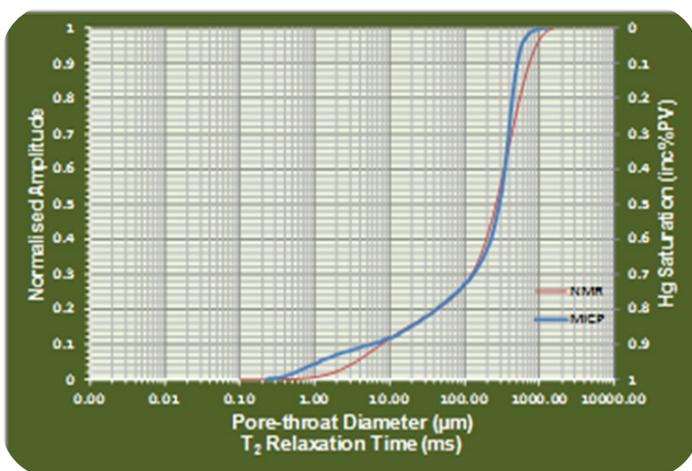
- Compressibility:**
 Calculated from the fractional change in pore volume with respect to the unit change in increasing overburden pressure.
- Automated PVC System:**
 Pore volume compressibility can be determined under isostatic loading. Measurements can be made using cyclic loading and constant-rate loading application systems. Application of load is achieved using a computer controlled dual pump system. The system is capable of applying overburden pressure up to 10,000 psi over a pre-determined period of time. Pore volume reduction is measured using electronic micro-burette.



NMR CORE ANALYSIS

At PREMIER COREX we can provide the best in NMR core analysis. Our highly experienced personnel have worked with all main logging contractors, to design and execute NMR core and log acquisition programs. PREMIER COREX are world renowned for our experience in the industry to offer expert advice. Our well established protocols and unique data acquisition procedures allows both NMR core and logs to be analysed with precision and accuracy.

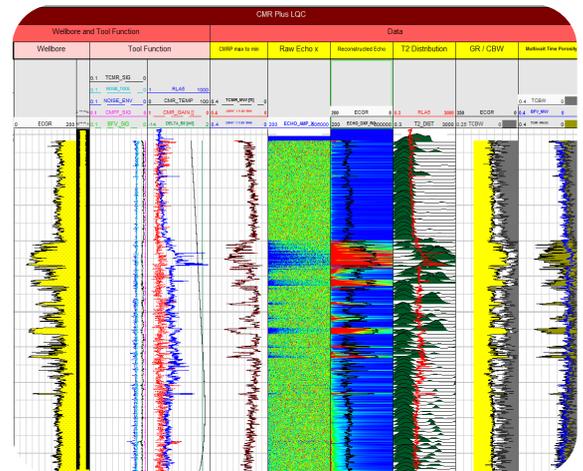
Our analysis includes full use of the NMR core for log calibration, fluid characterization, Hydrogen Index determination, evaluation of NMR properties of oil and unique Rock Typing technology. In addition it can also be integrated with sedimentological studies and



Between NMR and MICP we can assess the relationship between pore throat and pore body.

PREMIER COREX range of NMR services include:

- NMR pore (rock) types determined by NMR
- NMR Log Interpretation
- Advisory services, training, mentoring
- Independent advisor for NMR logging projects
- Reside between client and logging contractor
- Assure acquisition parameters fit data requirement
- Receive data and perform QA/QC
- Individual well or field studies
- Interpret NMR log
- Integrate with conventional data and well tests
- Integrate with Sedimentological data
- Build robust permeability models
- Integrate with geological model



CONSULTANCY

Core analysis data, whether conventional or SCAL, contains a wealth of relationships, trends and indicators, which may be used in problem solving. When allied to petrophysical characteristics, the potential to address seeming anomalies and to investigate a reservoir’s potential is enhanced.

The inclusion of an experienced core analyst, with a geological background and an understanding of reservoir engineering logs, can assist the Asset team in achieving their objectives. This specialist knowledge can be provided on a consultancy basis, in a format tailored to the client’s particular needs.

PREMIER COREX’s consultancy portfolio of services can be extended into areas that may best be described as applied technology research, where experience and knowledge are combined with an independent and innovative perspective. Recent examples of PREMIER COREX’s involvement with particularly progressive projects include, enhanced oil recovery, improved gas production, water production control and unconventional gas development.

PREMIER COREX also offers personnel training in core analysis preparation and analytical techniques, integrated with data quality control and assessment as an additional element of our consultancy services.

Premier Oilfield Group operate out of global laboratories based in Houston, Oklahoma City, Denver, Midland, Aberdeen, Cairo, Basrah, Kuwait, Abu Dhabi, and Delhi (Noida).

Please contact us for more information regarding COREX and Premier Oilfield Group international operations, capabilities and service portfolios.

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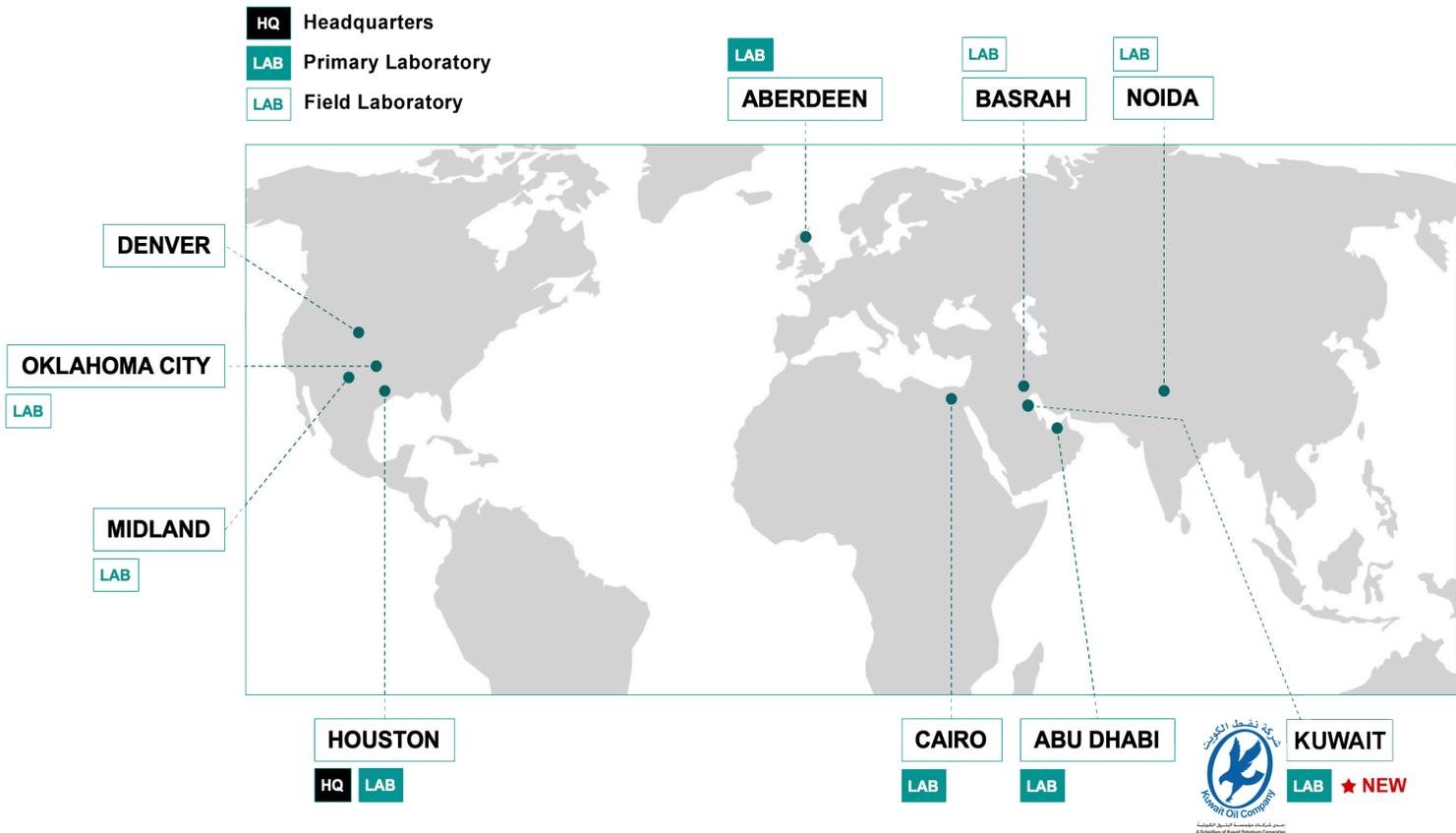
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Further information is also available on our website:
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