



INTEGRATED PVT SOLUTIONS

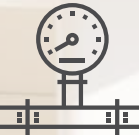
Optimise the end-to-end process
of reservoir management



ACCURATE FLUID PROPERTIES AND OPTIMISED EXTRACTION **ADDS UP**

SGS PHASE BEHAVIOUR (PVT) ANALYSIS

SGS



**ACCURATE FLUID
PROPERTIES AND
OPTIMISED EXTRACTION**

ADDS UP

SGS ADDS VALUE BY INCREASING EFFICIENCY, IMPROVING
QUALITY, REDUCING RISKS AND BUILDING TRUST

FLUID SAMPLING

SUBSURFACE SAMPLING

SURFACE SAMPLING

ANALYTICAL ANALYSIS

FIXED AND PORTABLE
LABORATORY CAPACITY

INTEGRATED PVT SERVICES

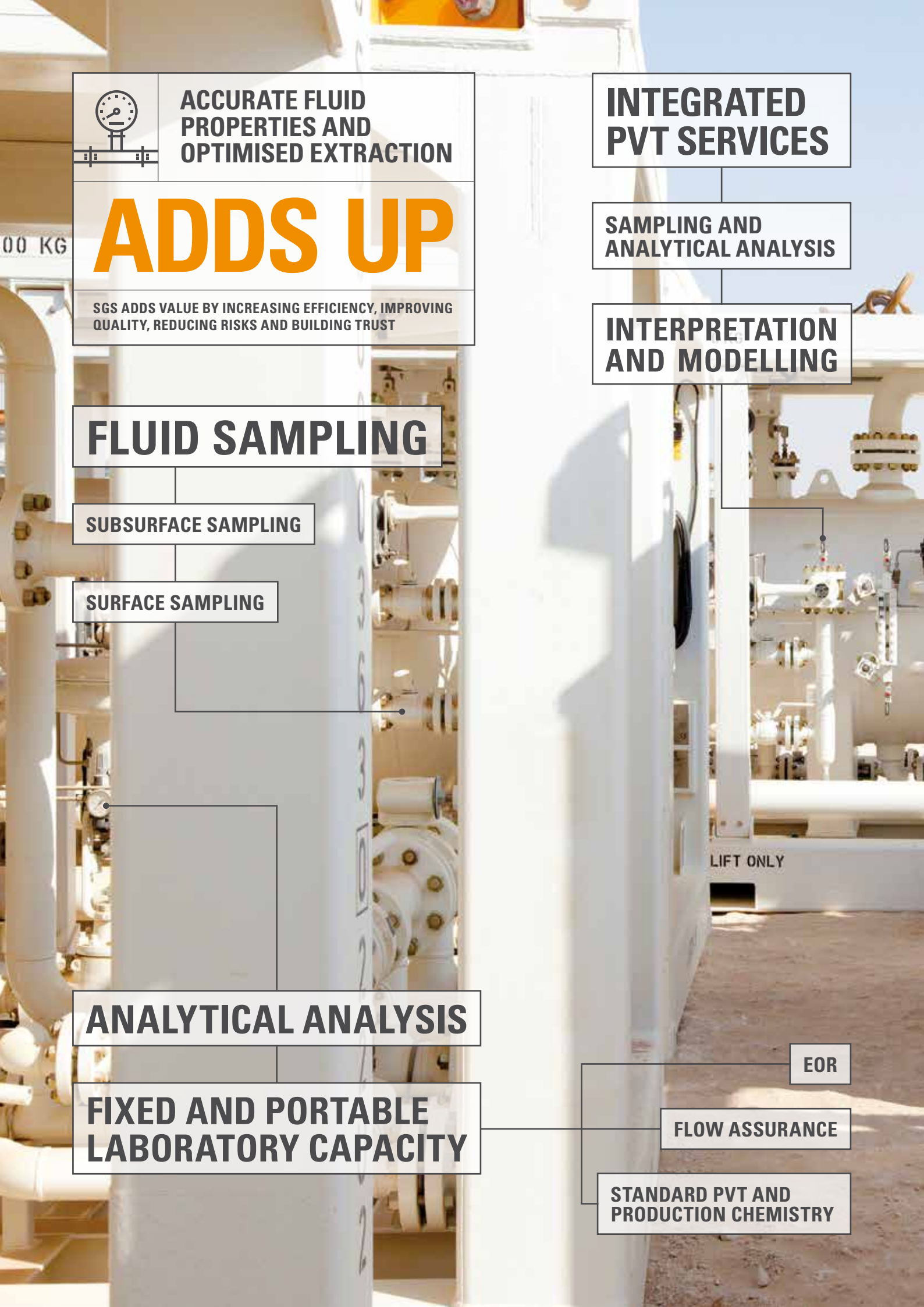
SAMPLING AND
ANALYTICAL ANALYSIS

INTERPRETATION
AND MODELLING

EOR

FLOW ASSURANCE

STANDARD PVT AND
PRODUCTION CHEMISTRY





WATER ANALYSES

**HYDROCARBON
FLUID ANALYSES**

**QUALITY CONTROL OF
ANALYTICAL RESULTS**

EQUATION-OF-STATE MODELLING

EOR AND COREFLOOD MODELLING

FLOW ASSURANCE STUDY

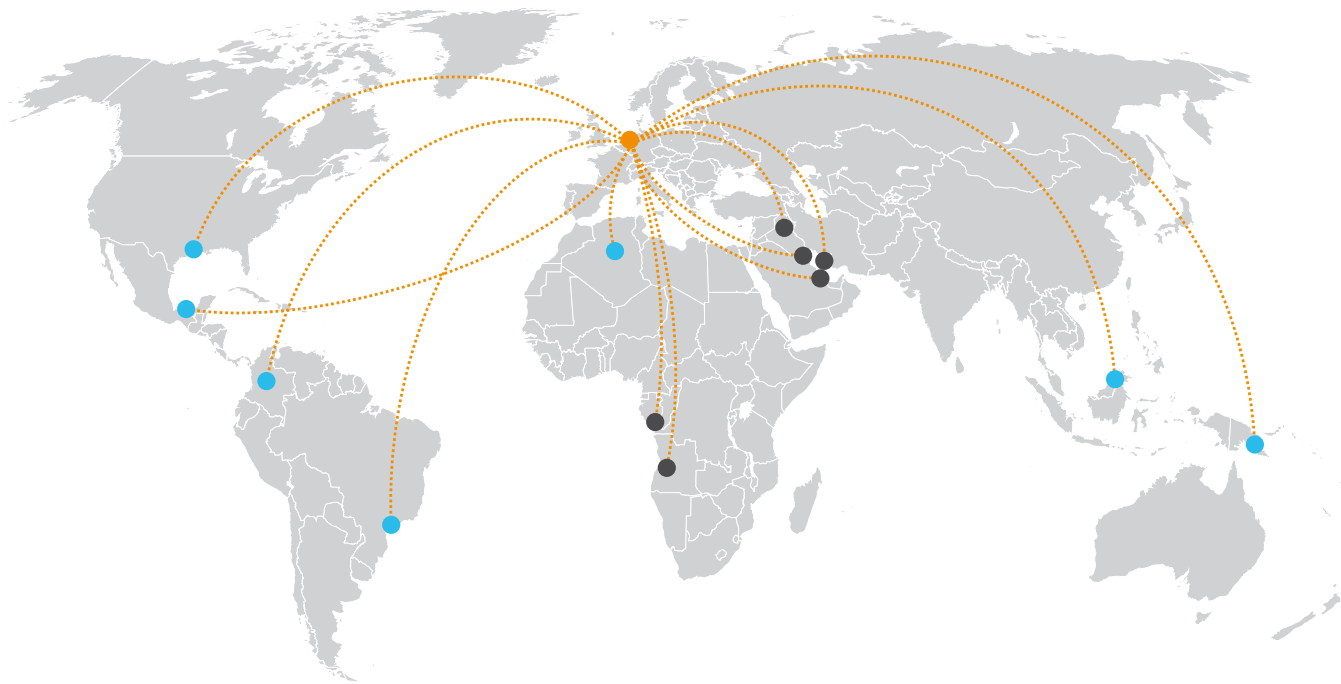
SCALE, HYDRATE, WAX AND ASPHALTENE

LABORATORY ANALYSIS

**MODELLING OF PRECIPITATION
AND INHIBITOR TREATMENTS**

A key challenge during oil field exploration and development is to understand the behaviour of reservoir fluids in order to optimise the end-to-end process of reservoir management. Today's industry demands innovative low cost technologies that not only evaluate fluid properties but also help solve any fluid-related issues encountered. SGS' global network provides integrated pressure-volume-temperature (PVT) analysis that encompasses the entire range of services needed for effective oil field exploration and development. We offer sampling to laboratory investigations, modelling to interpretation – and our PVT solutions can be used stand-alone or in combination with our comprehensive suite of upstream services. Integrated PVT solutions from SGS allow you to optimise production up to, but not limited to, tertiary recovery. We focus on providing you with reliable fluid analyses that solve your key production issues and enhance the productivity of your oil and gas field.

SGS PHASE BEHAVIOUR (PVT) SOLUTIONS



FLUID SAMPLING	LABORATORY INVESTIGATIONS	INTERPRETATION AND MODELLING
<p>SGS Oil, Gas and Chemicals</p> <ul style="list-style-type: none"> • Present in more than 130 countries • In-country logistics • Reservoir fluid sampling • Sample transfer 	<ul style="list-style-type: none"> ● SGS Fixed PVT Laboratories <ul style="list-style-type: none"> • Standard PVT analysis • EOR analysis • Flow assurance analysis • Crude oil, condensate and gas analysis • Water and production chemistry analysis • Geochemistry and isotope analysis ● SGS Portable PVT Laboratories <ul style="list-style-type: none"> • Standard PVT analysis • Flow assurance analysis • Water and production chemistry analysis • EOR analysis 	<ul style="list-style-type: none"> ● SGS Subsurface Consultancy <ul style="list-style-type: none"> • Reservoir rock and fluid characterisation • Static and dynamic modelling • EOR and flow assurance • Production optimisation and forecasting • Geochemical study • Integrated project coordination

INNOVATIVE TECHNOLOGIES AND INTEGRATED WORKFLOWS







We have developed innovative technologies and integrated workflows that bring together the disciplines and expertise of our staff into project-based teams. Our project-based team approach means you get the results you need as efficiently and cost-effectively as possible.

Our expertise includes services for:

- Advanced fluid sampling techniques at wellhead, bottomhole or separator outlets
- Onsite fluid analyses
- Laboratory investigations including enhanced oil recovery (EOR), flow assurance and general crude assay
- Interpretation and modelling

With extensive experience, a global network of offices and laboratories, and dedicated project-based teams, we aim to create competitive advantage and maximise extraction value for the oil and gas industry.

SGS FLUID SERVICES PORTFOLIO

 SAMPLING SERVICES <ul style="list-style-type: none"> • Openhole sample transfers and quality checks • Bottomhole sampling • Wellhead and separator sampling • SGS Portable PVT services: <ul style="list-style-type: none"> ■ FluidPro PAL™ ■ RDK™ ■ GC-GOR™ • Water sampling • Sample preservation 	 ADVANCED SAMPLING AND ONSITE ANALYSES <ul style="list-style-type: none"> • Multi-phase PVT sampling • Wellsite chemistry services • Wet gas metering • Real-time compositional trending • Direct leak metering • Pressurised pH monitoring • Seawater and ROV sampling 	 BASIC LABORATORY INVESTIGATIONS <ul style="list-style-type: none"> • Standard PVT analyses • EOR and IOR analyses • Flow assurance analyses • Fluid contamination study • Scale deposition, emulsion separation, etc. • Advice on laboratory designs, commissioning, evaluation of lab workflows and risk management • Isotope sampling and analysis
 HYDROCARBON FLUID ANALYSES <ul style="list-style-type: none"> • Crude oil assay • Determination of physical properties • Fractional distillation • Analysis of heavy components • Screening studies for special fluids: H₂S, sulphur, ash content, calorific value, etc • Trace sulfur speciation • Radon and mercury in gas • Biomarkers and high-resolution C60+ chromatography • Full range of ASTM testing 	 WATER ANALYSES <ul style="list-style-type: none"> • Salinity, pH, density, TDS • Ion analysis • Souring studies • Dissolved gas in water including isotope analysis • Sulfur-reducing bacteria analysis • Water preservation 	 INTERPRETATION AND MODELLING <ul style="list-style-type: none"> • QA/QC of analytical results • Black oil and EOS models • Fluid typing • Dynamic simulation to calibrate laboratory results • Geochemical analyses • Fluid characterisation at different conditions • Analysis and modelling of scale, wax, hydrate and asphaltene deposition

SAMPLING SOLUTIONS AND ONSITE SERVICES

SAMPLING

A true representation of the reservoir fluid starts with gathering your sample from the wellsite. At SGS, we make sure only trained and experienced professionals extract fluid samples according to industry standards and procedures. An excellent sample can become useless in untrained hands. SGS can advise on well conditioning prior to sampling, to ensure representative samples are obtained.

Depending on your requirements, the hydrocarbon sample can be collected at any well depth under reservoir pressure and temperature conditions; at single phase bottomhole conditions (if required) at any stage during the life of the well/reservoir; or a fluid sample can be taken at wellhead or separator conditions. The option to collect samples from subsurface to surface allows you to understand fluid behaviour in different

conditions and optimise fluid typing and recovery process.

SGS sample management and distribution services ensure all samples reach the laboratory in the optimal condition for analysis.



WELLSITE SERVICES

Our advanced sampling services and solutions for complex applications and processes include:

- High quality PVT samples from multi-phase stream
- Seawater sampling for water compatibility studies
- Remotely operated vehicle (ROV) sampling tool used for ground seepage sampling

In addition, our onsite analytical services ensure that real-time results are provided so you can make vital decisions at the right time, with the right data.

For example, contaminants in gas such as mercury, sulphur and radioactive components will absorb in sampling cylinders so it is recommended these analyses are performed at the wellsite. Onsite services are deployed in oil and gas fields with complex reservoir properties, continuous monitoring support, formation damage and repetitive operational issues.

Our onsite analytical services include but are not limited to:

- Wellsite chemistry services
- Wet gas metering

- Real-time compositional trending
- Measurement of sand production
- Real-time monitoring of pH, TSS, PSD
- Acoustic wellbore surveillance to determine fluid levels, leakages, pressures and more
- Monitoring annular leaks

Our reputation for independence, excellence and innovation has established us as the market leader in providing wellsite services that improve efficiency, reduce risk and deliver competitive advantage.

MOBILE AND FIXED LABORATORY SERVICES

SGS is a world leader in mobile and fixed laboratory services for the oil and gas industry. We provide a wide range of fluid analytical services to customers all over the world covering various applications and standard laboratory tests including fluid characterisation (PVT studies and specific test for each specific EOR technique), core floods, production chemistry, and fluid sampling.













In addition to standard testing, our expertise in sampling and technological innovation enables us to create bespoke test protocols specific to customer requirements. Specialised fluid characterisation and core floods (at reservoir conditions), using in-situ fluids with high amount of H₂S and a range of injectants, are performed to tailor production mechanism and chemical reactions for a specific reservoir.

Our laboratories are equipped with standard PVT analysis tools used for fluid characterisation, and we also provide advanced PVT analysis for different chemical EOR methods.

Oil and gas companies continue to optimise production strategies along the life of the field – with flow assurance being one of today's most challenging issues. You can trust in our flow assurance experts to guide you in the right direction and help find solutions for issues such as scale, wax and asphaltene deposition.



SOLUTIONS

	STATE OF THE ART PVT EQUIPMENT		ALLOCATION TARGETED ANALYSES
	ALL MERCURY-FREE PVT CELLS		FULL 'DOWNSTREAM' LABORATORY ONSITE
	EXTENSIVE FLOW ASSURANCE CAPABILITIES		SUBSURFACE AND SURFACE SAMPLING
	EXTENSIVE EOR/IOR CAPABILITIES		RESTORATION AND TRANSFER OF SAMPLES
	ROUTINE GAS COMPOSITION		INNOVATIVE PVT CELL AND TECHNOLOGY
	ROUTINE LIQUID COMPOSITION TO C36+		FLUID CHARACTERISATION OF HEAVY OIL

PORTABLE SERVICES

How do you cut costs and turnaround times for shipping, cylinder rental and fluid testing? Simple: take the laboratory to the field. Oil and gas fields that require immediate fluid analyses in order to manage on-field issues and save vital time benefit the most from portable analytical laboratories.

We offer the SGS FluidPro PAL™ and the SGS Rapid Deployment Kit™ (RDK™), our unique portable analytical

fluid properties laboratories often deployed in oil fields; and the SGS GC-GOR™ unit for characterisation of gas properties using chromatography and gas-oil ratio measurement, deployed in oil and gas fields. Our FluidPro PAL™ laboratories can be operated on platform either for testing while drilling, at a centralised shore base or as a stand-alone laboratory in remote locations. The RDK™ provides live sample composition

(i.e. water, gas and oil), trace contaminant, base oil contamination, and physical properties measurement of the samples right at the wellsite.

Building on our expertise in laboratory analysis, and using industry-standard methods and our own SGS-patented technologies, we offer you a wide range of testing options from formation brine samples to pipeline gas samples – wherever and whenever you need results.



SGS FLUIDPRO PAL™

Reservoir Fluid (PVT) Studies

- Constant Composition Expansions
- Differential Liberations
- Constant Volume Depletions
- Reservoir Fluid Viscosities
- Separator Tests and Optimisations
- Oil-Based Mud (OBM) Contamination
- HP/HT Sample Restoration/Transfer
- Sub-Ambient, Pressurised Testing
- Flow Assurance Testing
 - Screening for Asphaltene Onset Pressure (AOP) and Wax Appearance Point (WAP)

Compositional Analyses

- GOR and GWR Measurements
- Live Sample Composition and Density
- Inert and Acid Gas Content (CO₂, H₂S...)
- Shrinkage Tests
- Extended Gas Compositions by GC
- Oil Compositions to C36+ by GC

Water Geo-chemistry

- BS&W by Heated Centrifuge
- Brine Preservation Kit
- Karl Fisher Water Content
- Molecular Weight by Precision Cryette
- Multi-Temperature Viscosities/Densities
- Brine Properties (pH, Conductivity, TDS)
- Geochemical Brine Chemistry by Titration
- Chandler Dewscope Gas Dewpoints
- Stain Tube Measurements
- Radon and Mercury Measurements

SGS RDK™

Sampling

- Conventional Subsurface Sampling
- Separator Sampling

Compositional Analyses

- GOR and GWR Measurements
- Live Sample Composition and Density
- Inert and Acid Gas Content (CO₂, H₂S, etc.)
- Shrinkage Tests
- Extended Gas Compositions by GC
- Oil Compositions to C36+ by GC

Production Chemistry

- S&W by ASTM Centrifuge Method
- Karl Fisher Water Content in Oil or Gas
- Oil Molecular Weight by Precision Cryette
- Density, Viscosity and Rheology
- Crude Salinity
- Brine Basic Properties (pH, Conductivity, TDS)
- Brine Composition by IC/Titration
- Brine Preservation Kit
- Sulfate Reducing Bacteria in Water
- Dewscope Gas Dewpoints
- Stain Tube Measurements

- Mercaptans and Trace Sulfurs by GC-FPD
- Mercury in Gases or Liquids
- Sand Content in Produced Fluids
- H₂S in Gas, Oil and/or Brine
- Radon in Gas

FIXED LABORATORY CAPABILITIES

Our portable units take minimum space and are designed to thrive in offshore as well as onshore conditions. We ensure all HSE guidelines are followed, and each portable unit can operate 24/7 without any delays. Equipment and instrumentation in our mobile laboratories offers comparable capabilities to those of fixed laboratories; with staffing by PVT chemists which are third-party certified (including a requirement to pass a rigorous internal training programme before being deployed as an SGS field chemist). For your piece of mind, our mobile laboratory is also remotely monitored by highly experienced SGS QA/QC teams via satellite phone and the internet.

We have a history of undertaking and successfully executing large-scale, complex international projects. With a presence in every single region around the globe, our people speak the language and understand the culture of the local market and operate globally in a consistent, reliable and effective manner.

FLEXIBLE, REAL-TIME AND EFFICIENT

HIGH QUALITY DATA EQUIVALENT TO FIXED LABS

NO BACKLOG AND SHIPPING DELAYS

TRAINED AND CERTIFIED CHEMISTS

SURVIVES IN HARSH CONDITIONS

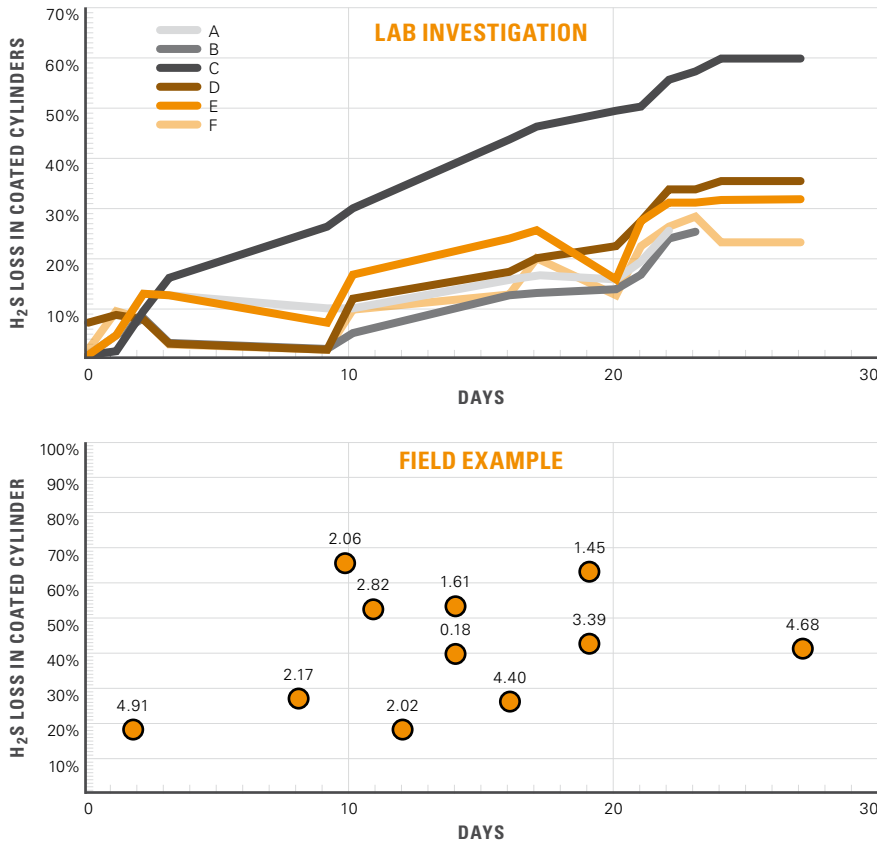
LIVE SAMPLE ANALYSES WITH RDK™

EXPERT ADVICE FROM SGS ONSITE CHEMISTS

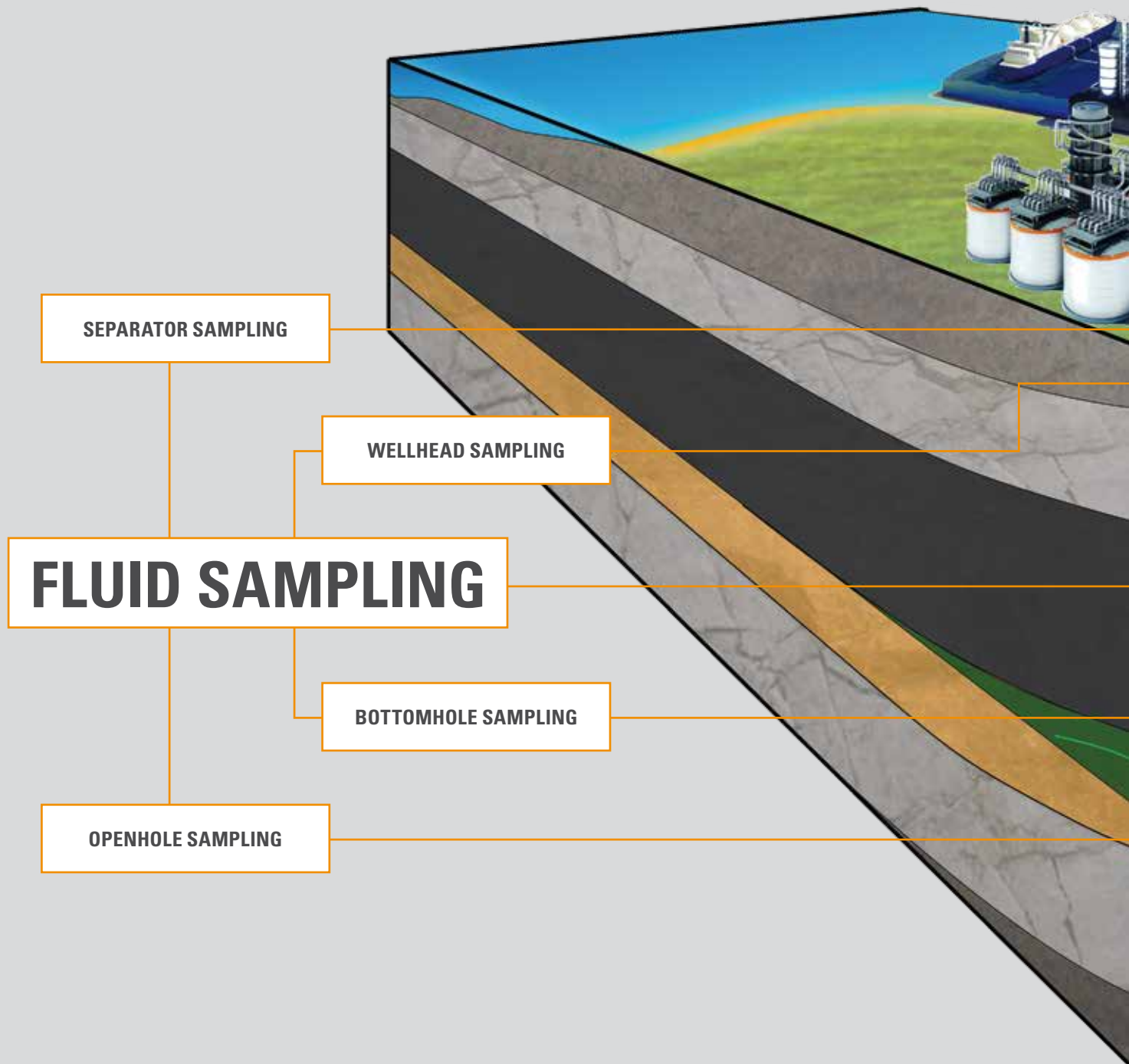
CAN BE INSTALLED ON WELLSITE OR FIELD BASE

ONSITE ANALYSIS: H₂S

Current industry methods for analysis of hydrocarbon containing H₂S requires onsite sampling into an appropriately inert coated cylinder and transportation of the sample to a fixed laboratory for analysis. Our laboratory investigation and field experience show that transportation time between sampling and analysis is a key factor in accurate H₂S measurements of hydrocarbon samples in coated cylinders. To overcome this, we perform H₂S measurements onsite, right after sampling via our portable laboratory units.



SGS INTEGRATED PVT SOLUTIONS



INTERPRETATION AND MODELLING

QC OF ANALYTICAL RESULTS

EQUATION-OF-STATE MODELLING

GEOCHEMICAL STUDY

FLOW ASSURANCE STUDY

FORMATION AND INJECTION WATER

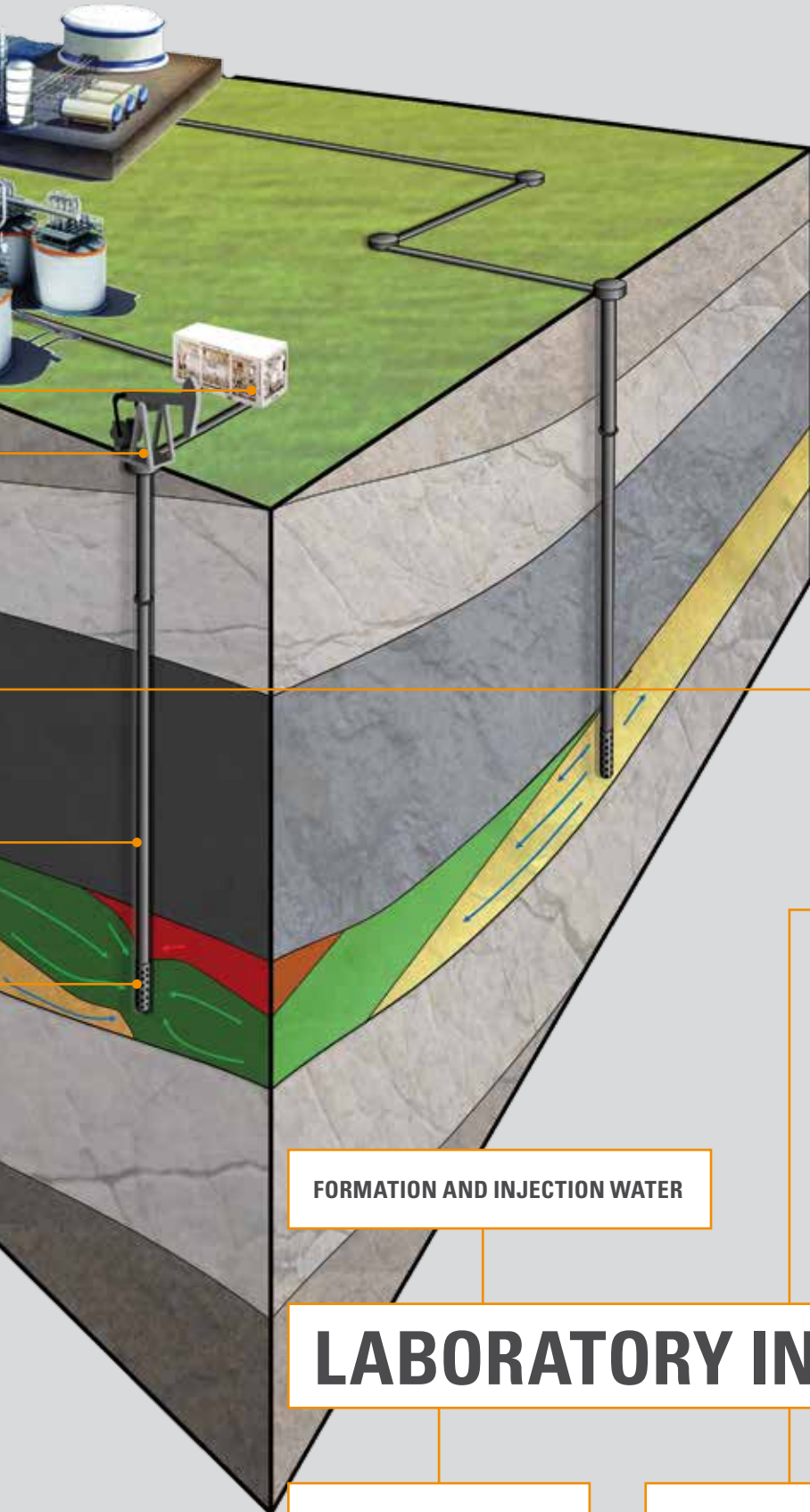
CRUDE OIL, CONDENSATE AND GAS

LABORATORY INVESTIGATIONS

FLOW ASSURANCE

EOR

STANDARD PVT



SGS INNOVATIVE SOLUTIONS

We are continually advancing technologies to provide solutions for our customers. At the SGS Applied Technology and Innovation Center (ATIC), our experts have developed numerous instruments utilising the latest technologies available for detection and measurement. Our focus is on creating new sampling and testing solutions that redefine what is possible, while always maintaining or wherever possible improving on the quality and reliability of traditional systems.



SGS MINI-PVT™ SYSTEM



An example of our commitment to innovation is the SGS Mini-PVT™ system. Our proprietary PVT system is like no other on the market today, and is rated to 20,000 psi (137.9 MPa) and 350°F (177°C). As the name implies, our system is a compact unit that is small enough to be used in our mobile laboratories but still performs all of the same functions with improved accuracy using the same, or smaller, sample volumes as conventional PVT systems.

The Mini-PVT™ consists of a PVT cell, NIR cell, viscometer, flash system, and recombination cell all in one semi-automated unit. Equipped with the highest accuracy pressure/temperature gauges commercially available, the system features a unique mixing procedure that makes the Mini-PVT™ a stand out for analysing heavy oils with viscosities in excess of 200,000 cP or retrograde gases with viscosities as low as 0.020 cP traceable to NIST

standards within +/- 2% relative error. It can be used for EOR and flow assurance measurements including swelling studies, multi-contact studies, shear-based rheology measurements, asphaltene onset studies, wax appearance temperatures, and oil compatibility studies, in addition to conventional black oil, volatile oil and retrograde gas condensate PVT studies.



SGS GC-GOR™ SYSTEM



The SGS GC-GOR™ system is another example of innovation from ATIC. Every PVT laboratory uses a flash system of some sort and our laboratories are no different. However, we have designed a unique '0-flash system' that requires less sample volume, integrating the flash and compositional analyses into one unit. Unlike conventional systems where the flashed gas and oil are collected in separate vessels then

transported to another laboratory for compositional analysis, our GC-GOR™ system combines all of these functions into one, seamless, temperature-controlled process. Not only does this improve the compositional analyses, our unique GC-GOR™ provides accurate measurements of gas-to-oil ratio (GOR), oil formation volume factor (FVF), and other essential fluid properties.

We are committed to providing innovative solutions for our customers by building advanced equipment, reducing costs and improving turnaround times associated with traditional PVT measurements.

INTERPRETATION AND MODELLING

Understanding PVT properties plays a crucial role in effective, efficient and optimised field development. Information gathered during the sampling and laboratory investigation phase is generally followed by the interpretation and simulation studies that guide the future potential of a well or a field.

SUBSURFACE CONSULTANCY

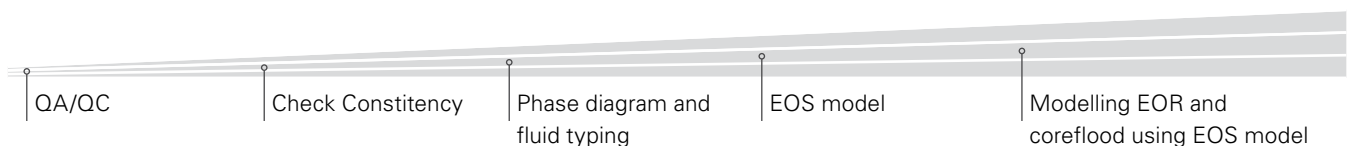
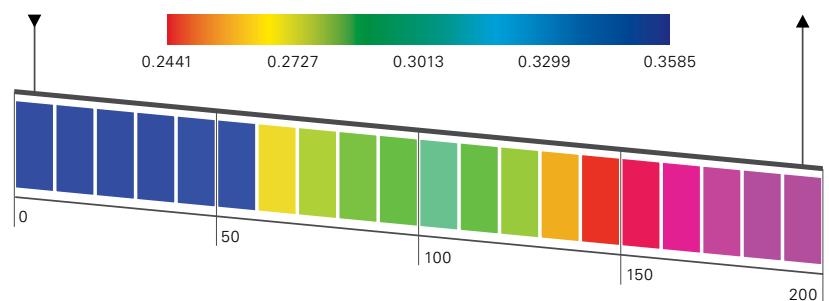
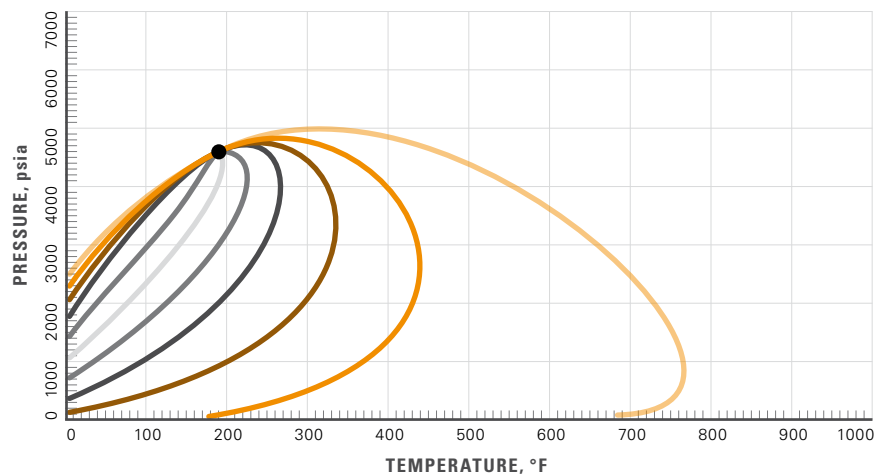
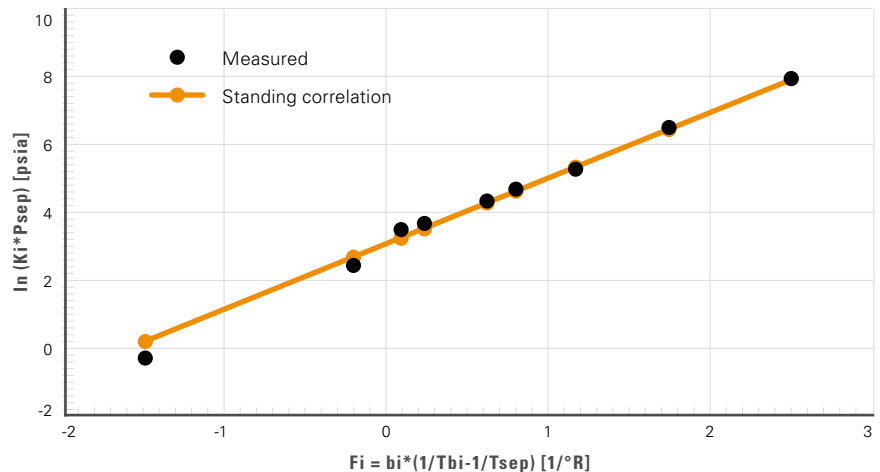
Interpretation and modelling of PVT data is performed by our SubSurface Consultancy team located in the Netherlands. Laboratory reports, along with raw sampling data, are provided to our consultancy team comprising highly skilled geoscientists and reservoir, drilling and well engineers.

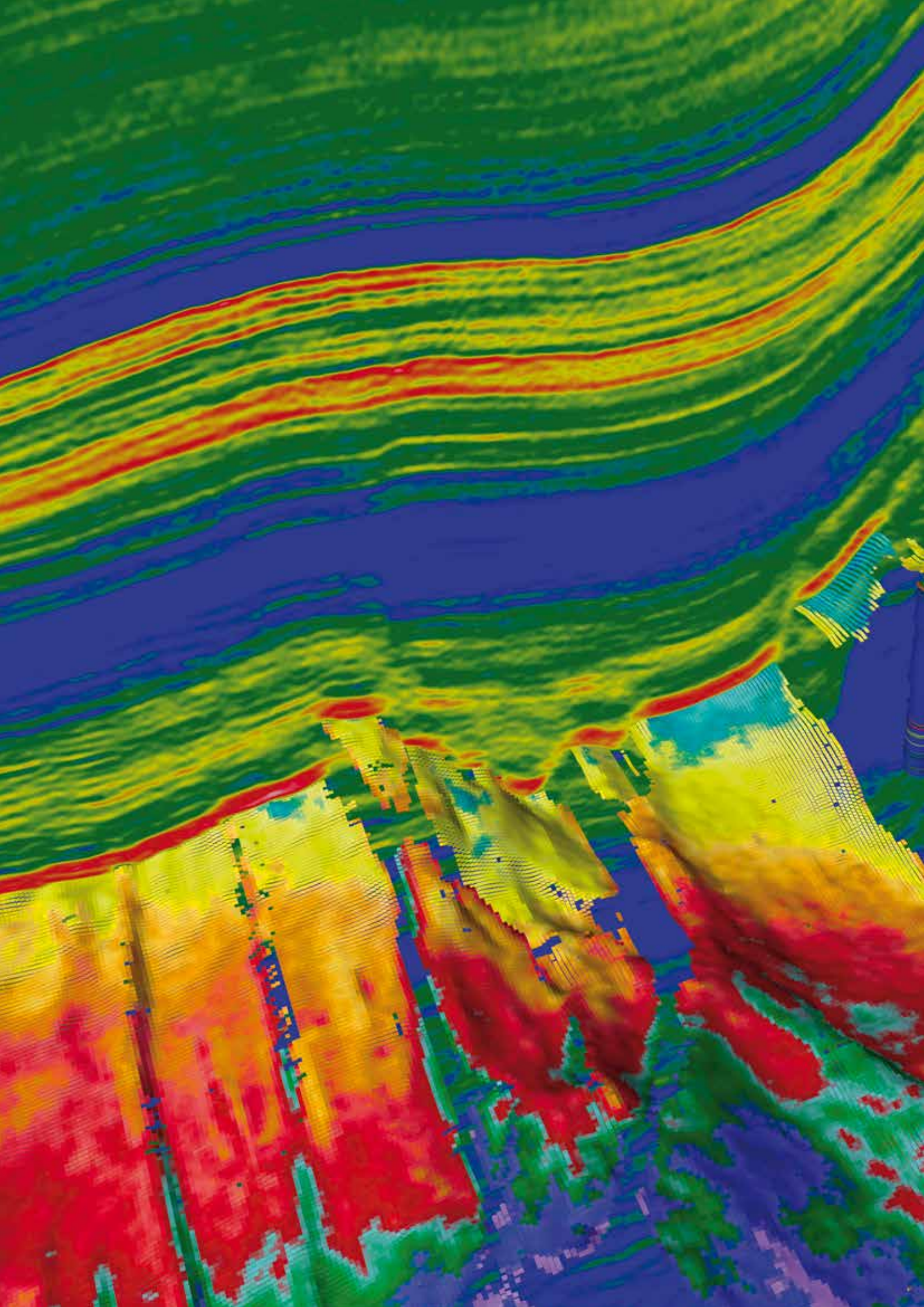
We provide fully integrated technical services to a diverse customer group including the oil and gas majors as well as independent and national oil and gas companies. Our experience includes thousands of completed projects in PVT services, ranging from short single evaluations to integrated field studies.

Due to our broad experience, you can trust in SGS to evaluate projects from subsurface through to surface.

Our subsurface experts ensure that investigative samples represent the wellstream quality. Once this is established, it is followed by quality control (QC) for individual experimental data. Post-QC, our experts develop equation of state (EOS) models, calibrated to reliable laboratory results. EOR and coreflood experiments are also numerically modelled and calibrated against experimental results, to better understand relevant mechanisms for sensitivity analysis and integration into a sector or a full-field reservoir model.

Innovative practices and an extensive portfolio in PVT interpretation and modelling means our experts can offer you competitive advantage and the ability to deliver your final product at the best quality possible.

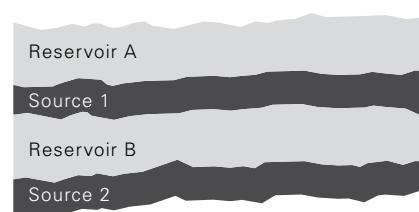




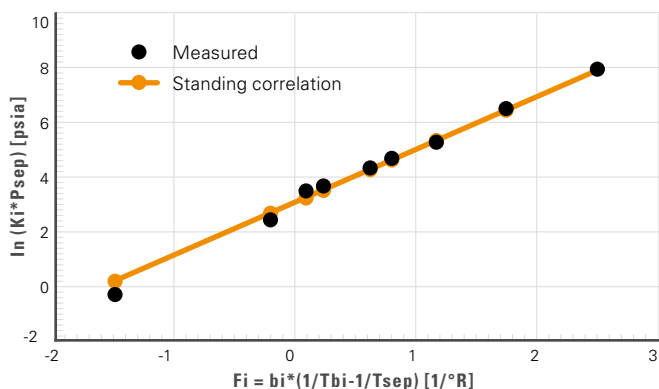
GEOCHEMICAL ANALYSIS OF A HYDROCARBON BASIN

Compositional PVT data can also be used for geochemical analysis of a hydrocarbon basin. In one of our recent studies, we calculated geochemical indexes from wellstream fluid compositional for each hydrocarbon type to determine source rock-reservoir correlation and migration path in a hydrocarbon basin. With this data we can better understand and predict hydrocarbon type pattern and compositional variation in a basin to guide and help our customers to optimise drilling activities. Following our investigation, we incorporated the findings and concept into a follow-up basin modelling study for further analysis.

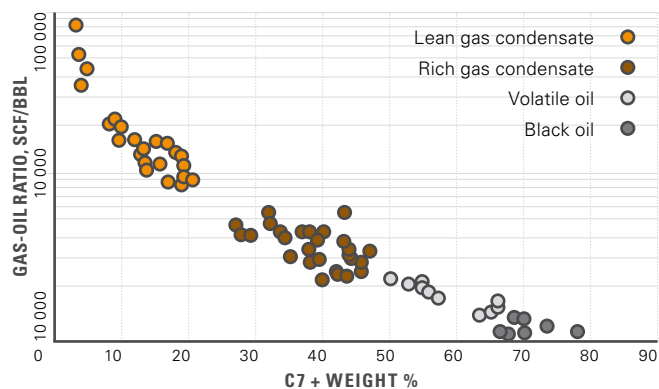
GEOLOGICAL SETTING OF THE BASIN



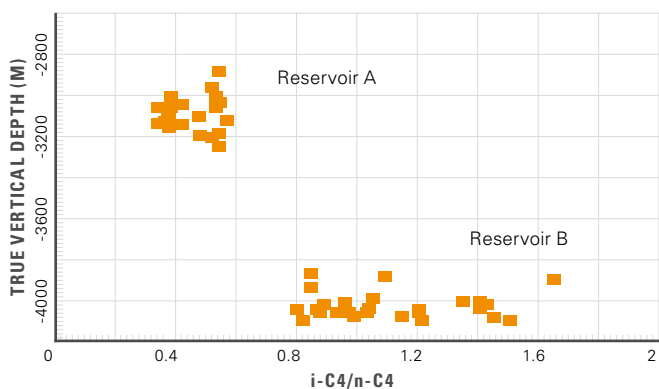
1 QC OF PVT DATA



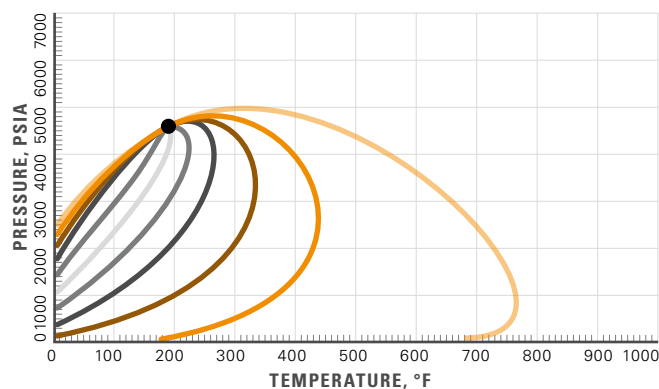
2 HYDROCARBON CLASSIFICATION



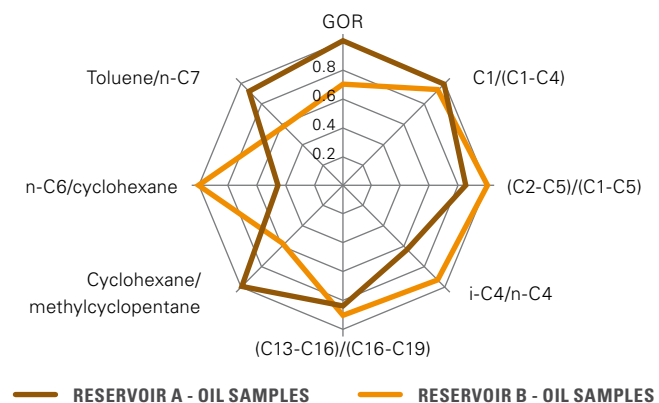
4 GEOCHEMICAL ANALYSIS



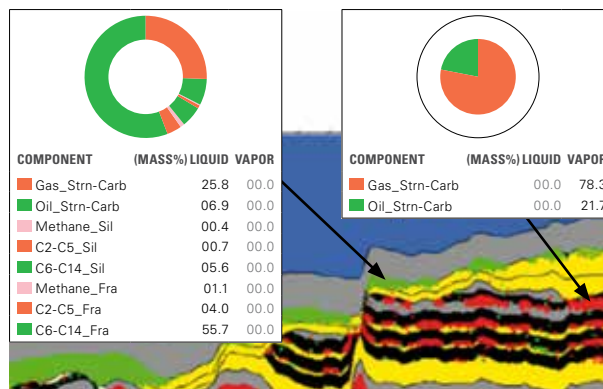
3 EOS MODELLING



5 GEOCHEMICAL INTERPRETATION



6 INCORPORATING INTO BASIN MODELLING



PRODUCTION CHEMISTRY AND FLOW ASSURANCE APPLICATIONS

We offer a full suite of testing for optimising your well performance and minimising the operating expenditure. You can outsource to our experienced staff and trust in their expertise and our state-of-the-art fixed laboratories for all your analyses. Our testing programme allows you to understand and minimise the impact of scale, corrosion, acidisation, wax, asphaltene deposition and rock-fluid compatibility on the productivity of your reservoir. We also offer onsite mobile laboratories that we custom-configure through our FluidPro PAL™ program or, for smaller projects, our RDK™ rapid deployment kit.

BRINE GEOCHEMISTRY

- Multi-temperature density/viscosity measurements
- pH measurement for brine/water acidity
- Conductivity and total dissolved solids (TDS)
- Ionic concentrations by programmed digital (ISE) titration
- Automated methods for high quality analyses



GAS PROPERTIES

- Moisture content by hygrometer
- Stain tube measurements to client specifications
- Radon content
- Mercury content
- Sulphur components (H₂S, Mercaptans and Carbonyl Sulphide)



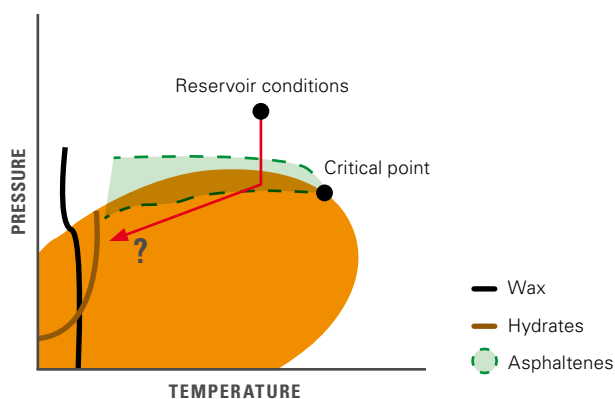
OIL AND CONDENSATE PROPERTIES

- BS&W and Karl Fisher water content (conforms to ASTM, IP, API, BS and ISO methods)
- Molecular weight by freezing point depression
- Oil pH and TAN by digital titration



FLOW ASSURANCE CAPABILITIES

- Wax appearance temperature by cold filter plugging and spectrophotometer methods
- Asphaltene onset by spectrophotometer
- Rheology measurement with capillary viscometer with and without gas in solution





BENEFITS

SGS **ADDS UP**

SGS is the world's leading inspection, verification, testing and certification company. Recognised as the global benchmark for quality and integrity, we employ over 90 000 people and operate a network of more than 2 000 offices and laboratories around the world. We are constantly looking beyond customers' and society's expectations in order to deliver market leading services wherever they are needed.

We have a history of undertaking and successfully executing large-scale, complex international projects. With a presence in every single region around the globe, our people speak the language and understand the culture of the local market and operate globally in a consistent, reliable and effective manner.

We provide innovative services and solutions for every part of the oil, gas and chemicals industry. Our global network of offices and laboratories, alongside our dedicated team, allows us to respond to your needs, when and where they occur. Our reputation for independence, excellence and innovation has established us as the market leader in providing services that improve efficiency, reduce risk and deliver competitive advantage for you.



**OPTIMISE
PRODUCTION**



**INNOVATIVE
TECHNOLOGIES**



**INTEGRATED
WORKFLOWS**



**ONSITE
EXPERTISE**

**FOR MORE INFORMATION ON SGS
OIL, GAS AND CHEMICALS SERVICES
CONTACT OGC@SGS.COM OR VISIT
WWW.SGS.COM/OGC**



WWW.SGS.COM

WHEN YOU NEED TO BE SURE

