

<p>5 10.811</p> <p>E</p> <p>EVALUATION</p>	<p>23 50.942</p> <p>X</p> <p>X-RADIATION</p>		
<p>16 32.065</p> <p>P</p> <p>POSITION</p>	<p>5 10.811</p> <p>E</p> <p>EDUCATION</p>	<p>18 39.948</p> <p>R</p> <p>REALISATION</p>	<p>20 40.078</p> <p>T</p> <p>TRANSFORMATION</p>
<p>9 18.998</p> <p>I</p> <p>INNOVATION</p>	<p>19 39.098</p> <p>S</p> <p>SOLUTION</p>	<p>5 10.811</p> <p>E</p> <p>EXPLORATION</p>	

GEOSCIENCE SERVICES FROM SGS HORIZON

SUBSURFACE CONSULTANCY WITH AN INTEGRATED APPROACH FROM SGS HORIZON

HOW CAN YOU ENSURE EFFECTIVE RESERVOIR AND FIELD STUDIES FOR THE EVALUATION, DEVELOPMENT AND MANAGEMENT OF OIL AND GAS FIELDS?

Due to the challenging economics of the petroleum industry, there is an ever-increasing need to optimize field development and increase hydrocarbon recovery. With the growing complexity of hydrocarbon production, the need for extensive upfront evaluation and management of uncertainties is greater than ever. To ensure effective evaluation, development and management of oil and gas fields, accurate reservoir modelling and simulation is of paramount importance. That is why the need for a qualified and experienced partner you can trust to support your reservoir and field studies from start to end is essential.

BENEFIT FROM A FULLY INTEGRATED APPROACH FOR EVERY PHASE IN THE LIFECYCLE OF YOUR OIL AND GAS FIELDS

To help our clients make fully informed decisions, we offer a complete range of integrated reservoir and field studies for every phase of the lifecycle of oil and gas fields – from early exploration through to development planning and project execution.

Our know-how spans a wide range of disciplines, which includes seismic processing, exploration, geosciences, reservoir engineering and well and facility engineering. With this breadth of experience we are able to provide fit-for-purpose and targeted support, ranging from a single discipline service to fully integrated studies and field development plans.

Thanks to the strong international profile of our staff and comprehensive track record in just about every geological setting, and our in-depth knowledge and

experience of oil and gas fields globally, we can tailor our services to match virtually any specific situation or project you require.

We work closely with you, providing frequent technical meetings and reviews, always ensuring that deliverables are in line with your expectations. With tight integration of all disciplines, we offer you high quality customized services, delivered on time and budget.

UNDERTAKING NEW BUSINESS DEVELOPMENT IN NEW GEOGRAPHICAL AREAS OR UNKNOWN TERRITORIES

WE CAN HELP

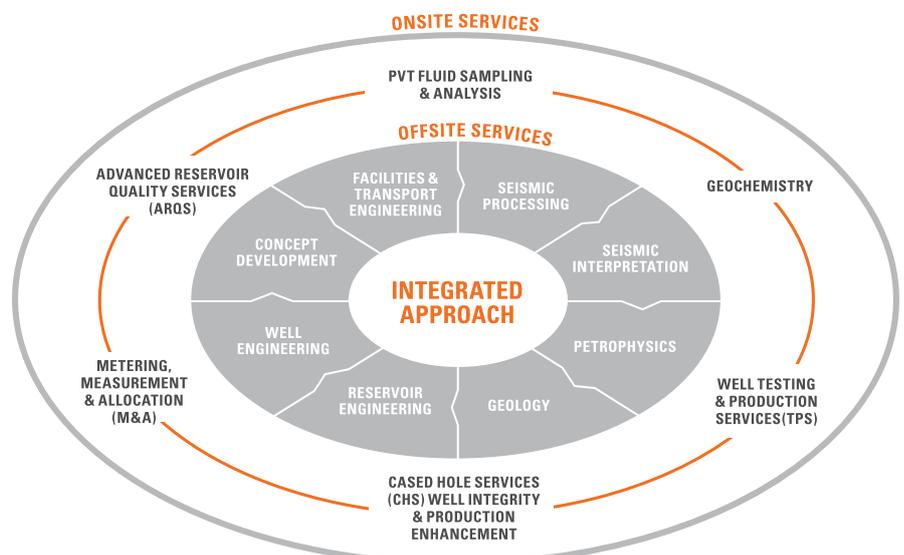
With our track record in most development areas in the world, and in both conventional and unconventional projects, we are the partner of choice for operators looking to develop new business in new territories. Our services include (regional) exploration reviews, reserves evaluation, data rooms, studies and full field development plans.

Our integrated, innovative approach creates value for your company when dealing with exploration projects, green fields, mature fields, and complex oil and gas reservoirs, such as tight gas, heavy oil, shale oil and gas or coal bed methane (CBM). From prospect evaluation to characterization of CBM reservoirs, chemical enhanced oil recovery (EOR) in heavy oil fields and unconventional reservoir studies, we offer a variety of services for the upstream sector.

DISTINCTIVE EXPERIENCE IN SPECIALIZED AREAS

Besides our reservoir studies we also offer experience in specialized areas like:

- Seismic Processing and Imaging
- Unitization and Redetermination support
- Unconventional studies
- Reserves Evaluation
- Acquisition & Divestment
- Governmental and Regulatory support



THE SERVICE

SGS Horizon (SGSH) is a project based subsurface consulting organisation that assembles fully integrated multi disciplinary teams. To address the ever increasing demand to optimise the seismic data, SGSH now offers seismic processing and inversion (quantitative interpretation / QI) as part of their integrated activities, both 'stand alone' and as part of their integrated subsurface studies.

PROCESSING PORTFOLIO

The geophysical processing portfolio of SGSH and its geophysical associates Moser Geophysical Services (MGS) and Z-Terra Inc. covers a wide range and is applied in a large variety of projects. The attention to detail is a key aspect of every part of the process.

SEISMIC IMAGING

- Time processing: Pre-Stack and Post-Stack Migration, 2D & 3D studies, 3D multiple and noise elimination, Land Marine and transitional zone environments
- Pre-stack Depth Migration – 2D/3D, true-amplitude preservation, anisotropic and isotropic, irregular acquisition
- Tomography (isotropic/anisotropic) and complex velocity model building
- Full 3D diffraction imaging
- Ray tracing – illumination studies/ acquisition planning

RESERVOIR CHARACTERIZATION

Seismic (Acoustic & Elastic) inversion:

- Pre-stack and post-stack seismic inversion, Time-lapse inversion, and PP-PS (converted wave) inversion
- AVO/AVA analysis and DHI extraction
- Reservoir property estimation and derivation based on Joint Seismic inversion and AVO/AVA analysis
- Rock-physics analysis of the reservoir and bounding rock properties and Fluid Substitution Modelling

SOFTWARE

State of the art imaging algorithms:

- Kirchhoff, Fast Beam and Wave Equation Migration
- Anisotropic velocity analysis (Tomography)
- Multi-dimensional, multi-volume data analyses and visualization
- Ray tracing (3D, two-point, anisotropic inhomogeneous layered media)
- 3D PSDM of irregular data
- Model-based 3D Diffraction Imaging
- Multidimensional grid and scattered data interpolation
- AVO, Strata and Emerge from the Hampson-Russell Software Suite

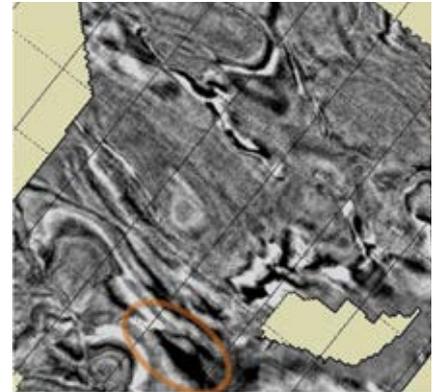
TRACK RECORD

The SGSH Geophysics Team has successfully participated in many projects, ranging from exploration studies, reserves certifications, asset evaluations and data room reviews to redeterminations and integrated field development planning around the entire globe, including Europe, Africa, the Middle East, Asia-Pacific, the Former Soviet-Union and South America.

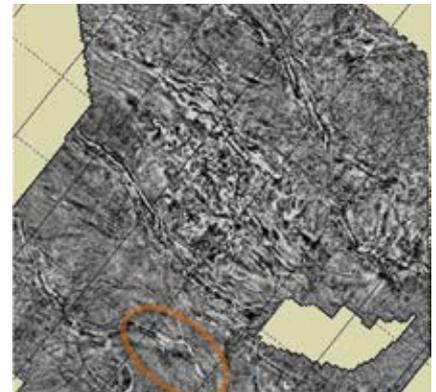
In many of these projects our geophysical processing portfolio has been used successfully and has resulted in significant added value to our clients.

For example, in one of our recent processing projects in the Dutch sector (land, marine and transitional zone), reprocessed legacy data provided a well tied 3D PSDM volume which was subsequently processed through 3D Diffraction Imaging to enhance interpretability of the final volumes. The results have been presented in a conference paper at the EAGE Amsterdam 2014: Diffraction Imaging in the North Sea, case study over the Dutch Q16 fields.

In another example, one of our recent studies in the Dutch offshore, inversion proved to be a powerful tool to map the properties of the heavily faulted Rotliegend reservoir situated below the deep Zechstein salt.



Standard migration



Diffraction migration

The advanced imaging technology enables better focussing of geological structures and improves reservoir characterization in deep water areas and complex sub-salt areas. Our depth imaging portfolio provides a comprehensive suite of migration algorithms and model building technologies designed to solve the most challenging problems.

In many of the redetermination related studies depth conversion sensitivity plays a key role in assessing the relevant parameters that influence the final Tract Participations and Unit Interests.

Both QC and execution of Pre-Stack Depth Migration and Inversion of seismic data have been undertaken in a variety of settings, and in these projects de-/remigration, ray tracing and illumination analyses regularly play an important role.

The SGSH team of experienced processing specialists has supervised many large scale pre-processing and PSDM/PSTM projects on behalf of their clients.

THE SERVICE

SGS Horizon (SGSH) is a project based subsurface consulting organisation that assembles fully integrated multi disciplinary teams. One of the integrated aspects of our activities concerns Quantitative Interpretation.

ADVANCED RESERVOIR CHARACTERIZATION

Our highly skilled Quantitative Interpretation (QI) team can offer a full range of specialist geophysical techniques that allow full reservoir characterization:

- **Seismic inversion:**
 - Acoustic impedance inversion (pre – and post-stack)
 - Full and extended elastic impedance inversion
 - Time-lapse impedance inversion
 - Converted wave (PP-PS) inversion
 - Well-seismic data matching QC, Seismic-to-Well tie, Pre – and poststack wavelet extraction
- **AVO analysis:**
 - DHI extraction
 - 3D AVO modelling
 - AVO interpretation
- **Rock physics diagnostics:**
 - Fluid substitution (replacement) modelling
 - Well logs data cross-plot and cluster analysis

AVO ANALYSIS

Before stacking, the amplitude of a seismic trace describes the variation of the wave propagation effect within the underlying geologic medium. In the unstacked gathers the amplitude varies with different offset or angle (AVO/AVA).

As a result of wave propagation, the AVO/AVA variation indicates the properties of the rock and its pore fluids. By carefully extracting the AVO/AVA anomalies, the presence of hydrocarbons can be identified, classified and quantified.

SEISMIC INVERSION

Integration of the data into a single model through a process of Seismic Inversion is a technique that has been proven to reveal details that greatly enhance the understanding of the reservoir. Insight into the reservoir is obtained through the combination of inversion results with rock physics, geological and petrophysical models.

COMBINING INVERSION WITH AVO

Seismic data respond to both the Acoustic (P) Impedance and the Shear (S) Impedance of the rocks. This additional information within the seismic data can be exploited using the variation in seismic reflection amplitude with angle or offset. Standard AVO analysis has been used for many years to improve the understanding of the subsurface and reduce risk.

Simultaneous Inversion integrates the best of inversion whilst exploiting the full information within the seismic data. The result is three volumes of absolute rock properties tightly calibrated to the well log data: P-Impedance, S-Impedance and Density. Having these extra datasets opens up a new world of possibilities. This includes analyzing the V_p/V_s ratio and determining the elastic rock properties. It has been shown that V_p/V_s has the capability to identify reservoirs that were “invisible” to conventional seismic and acoustic impedance displays. These properties can provide a wealth of additional knowledge about the subsurface.

RESERVOIR CHARACTERISATION

Successful reservoir characterisation requires the close cooperation of petrophysicists and geoscientists to be able to fully integrate the fine details of the well logs with the coarser seismic data. SGSH has a strong background in reservoir modelling and reservoir engineering and is able to utilise this expertise to build reservoir models constrained by the 3D seismic attributes gained from the inversion results, thus predicting porosity distribution and other reservoir rock properties. All this information can be integrated into a static and dynamic model reducing the uncertainty in facies and/or porosity distribution as well as HC distribution and location.

SOFTWARE

- AVO, Strata and Emerge from the HAMPSON-RUSSELL Software suite
- State of the art seismic processing and imaging software and algorithms through our alliance with Z-Terra Inc. Houston and Moser Geophysical Services (MGS). This includes Kirchhoff, Fast Beam and Wave Equation Migration, Anisotropic velocity analysis (Tomography) and Model-based 3D Diffraction Imaging
- EarthPAK, SynPAK, AVOPAK, VelPAK from the KINGDOM suite

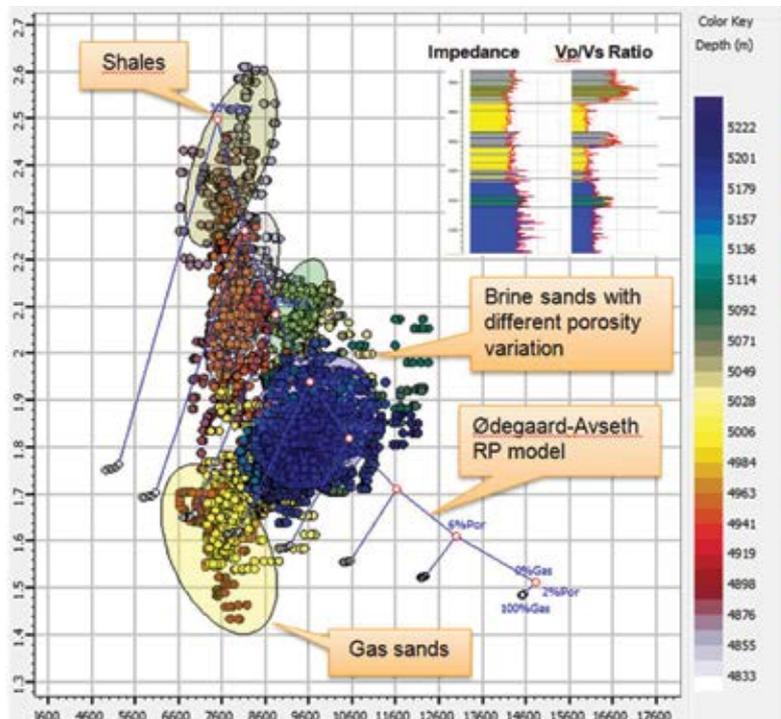
TRACK RECORD

The SGSH Geophysics Team has successfully participated in many projects, ranging from exploration studies, reserves certifications, asset evaluations and data room reviews to redeterminations and integrated field development planning around the entire globe, including Europe, Africa, the Middle East, Asia-Pacific, the Former Soviet-Union and South America.

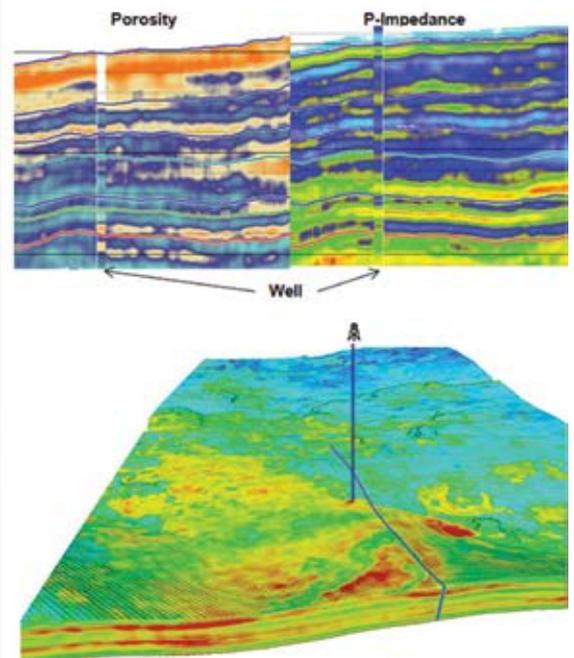
In many of these projects our portfolio for reservoir architecture assessment spanning seismic processing, imaging, inversion and interpretation has been

used successfully and has resulted in significant added value to our clients.

In many of our recent studies in the Dutch, West Africa, and Middle East offshore, inversion proved to be a valuable additional tool to map the reservoir properties on top of the conventional interpretation using seismic amplitude only.



P-Impedance vs Vp/Vs_Ratio



SGSH Rock Physics Analysis of Reservoir Rocks

THE SERVICE

SGS Horizon (SGSH) is a project based subsurface consulting organisation that assembles fully integrated multi disciplinary teams. One of the integrated aspects of our activities concerns the interpretation of seismic data both in exploration and development/production studies.

SKILLS

The skills of the SGSH geophysics staff cover a wide range of capabilities which are applied in a large variety of projects.

In detail, SGSH offers:

- Seismic QC and interpretation 2D / 3D / 4D
- Depth conversion
- Attribute analysis
- Quantitative Interpretation
- Seismic modelling
- Seismic processing supervision
- AVO modelling and analysis

SGSH works with associates to address specific specialist areas such as seismic processing and inversion. These subjects have featured in several integrated projects during the last couple of years. For example, in one of the studies in the Dutch offshore, inversion proved to be a powerful tool to

map the properties of the heavily faulted Rotliegend reservoir situated below the deep Zechstein salt.

TRACK RECORD

The SGSH geophysics team has successfully participated in many projects, ranging from exploration studies, reserves certifications, asset evaluations and data room reviews to redeterminations and integrated field development planning around the entire globe, including Europe, Africa, the Middle East, Asia-Pacific, the Former Soviet-Union and South America.

Project Description Deep-Water Nigeria

On behalf of our client SGSH evaluated the exploration potential of the deep-water acreage of Nigeria with the objective to identify promising blocks that could merit a licence application. The initial scope of the project was 16 man months and included participation of one of the client's representatives. The study was mainly seismically driven, but the project was executed in a fully integrated mode with geological and petrophysical disciplines.

First a basin-wide screening, based on 2D seismic data, was carried out which involved a workflow that included evaluation and interpretation of relevant well data and of a regional seismic grid, followed by construction of structural

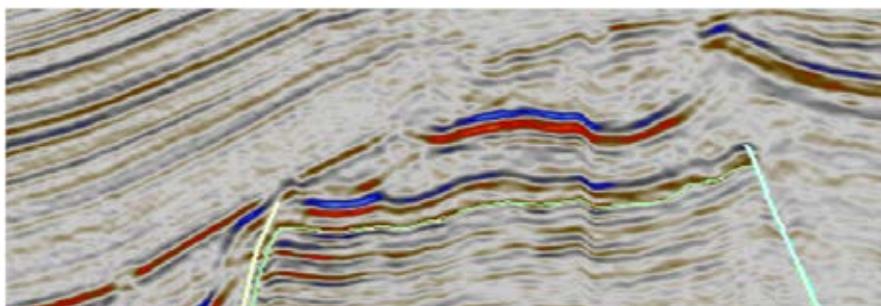
maps and of play fairway maps. This allowed definition of focus areas for further review. This included detailed mapping of channel and basin floor fan facies and construction of reservoir distribution maps, based on seismic attributes.

Analysis of AVO and review of other DHIs aided in assessing the possible presence of hydrocarbons. After definition of source and kitchen areas and construction of maps displaying migration routes, ranking and volumetric assessment of prospects allowed focus on four target blocks.

The subsequent licence application was successful and based on the initial recommendations a 3D seismic survey totalling 7000 sq km was purchased for detailed interpretation. SGSH has also been involved in the evaluation of these data.

Project Description – NW Europe

SGSH assisted several international majors with the preparation of their technical submission for equity redeterminations. The projects had initial focus on full understanding of applicable rules and regulations under the Unit Operating Agreement and included detailed volumetric sensitivity studies to ensure that the full Hydrocarbon in-place effect of the various technical evaluation scenarios was understood. Subsequently the results allowed selecting a beneficial and robust case for submission to 'Expert' and defence against adversary cases presented by others. Geophysical studies played an important role in these fully integrated projects and included seismic interpretation, depth conversion, attribute analyses and review of seismic processing.

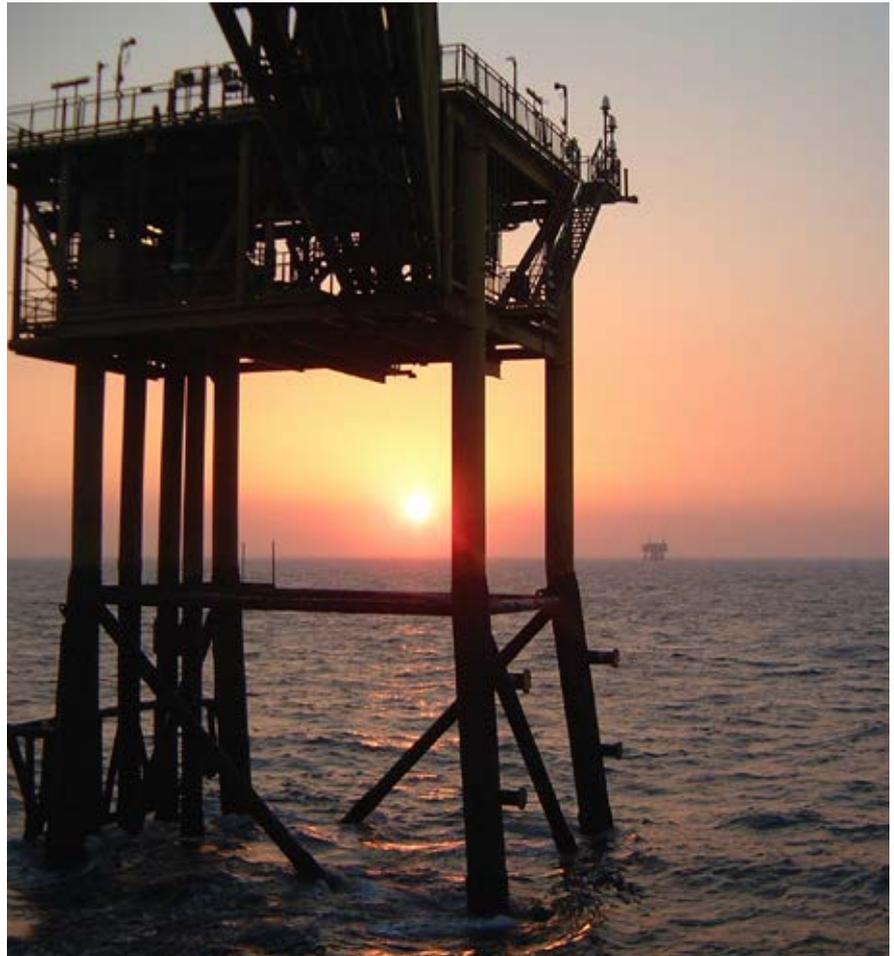


Project Description – South-East Asia

A customer in Asia requested SGSH to conduct a resources certification project. Objective of the study was to provide an estimation of contingent and prospective resources for a series of discoveries.

For this the volumes were estimated according to the PRMS resources classification system.

The project was an integrated study of petrophysics, geophysics and reservoir engineering but was mainly seismic driven making use of recently acquired long-streamer 3D seismic data that were PSDM processed and inverted. The seismic anomalies were calibrated to the wells and the combined extent of the various anomalies then provided a measure for the extent of the discovery. Before the mapping exercise was performed, criteria for anomaly definition were established in order to be as objective as possible. This way the difference between contingent and prospective resources was clear, as well as the 1C, 2C and 3C classes. The customer was very satisfied with the established workflow and results.



WHY SGS?

Founded in 2001, SGS Horizon became part of the SGS Group in 2008. As part of SGS's Oil, Gas & Chemicals business, SGS Horizon provides integrated solutions throughout the field lifecycle, covering all subsurface, well and engineering aspects from exploration through development and production to abandonment. These solutions help the oil and gas industry add value to their assets.

Our in-depth knowledge and experience of a wide range of oil and gas regions, settings and environments, enables us to tailor our services to almost any specific situation or project.

SGS is the world's leading inspection, verification, testing and certification

company. Our global network of offices and laboratories and our dedicated team allow 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.

A WORLDWIDE COMPANY WITH GLOBAL SOLUTIONS

Recognised as the global benchmark for quality and integrity, we employ over 80 000 people and operate a network of more than 1 650 offices and laboratories around the world.

We provide innovative services and solutions for every part of the

oil, gas and chemicals industry and environmental services, when and where they are needed. 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 more information about subsurface consultancy or any other upstream service, contact nl.horizon.sales@sgs.com or visit www.sgs.com/subsurface

WWW.SGS.COM

WHEN YOU NEED TO BE SURE

