GEOLOG

Surface Logging Services
Drilling Solutions
Lab Studies
Innovation Hub

40th ANNIVERSARY
1982 - 2022




Mission Statement

Our Mission

To help our clients make quantified, informed, substantial improvements in their drilling efficiency, hydrocarbon detection and reservoir characterization.

To constantly build a leading edge service company that attracts, develops and retains exceptional people.

To respect and improve the highest safety and environmental standards whilst actively participating in the development and know-how of the countries in which we operate.

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Company Overview

Geolog International (GEOLOG) is a world leader in oilfield services delivering solutions and expertise to National, International and Independent Oil, Gas and Geothermal operators globally. Since its founding in Milan, Italy, in 1982, GEOLOG has developed effective and cost-effective alternative solutions to complex and expensive downhole measurement tools. Through the optimisation of formation, fluid and reservoir analysis, well construction is improved, well delivery optimised and production delivery accelerated. By utilising these in or near realtime rigsite applications, operators are able to mitigate risk and reduce cost. As part of its strategy to become the global supplier of choice, GEOLOG has gained experience in over 70 countries worldwide, performing services and assisting operators onshore and offshore, during exploration, development and appraisal programs in shallow to ultra-deep water, HP/HT, unconventional oil and gas and geothermal wells.

GEOLOG maintains a committed focus on research and development, innovation and the implementation of proprietary technologies through continual investment in novel solutions to industry challenges. This robust commitment to continuous research and development has enabled GEOLOG to develop and deploy an extensive suite of wellsite Drilling and Formation Evaluation solutions. GEOLOG holds a significant number of patents, and targets the introduction of new patents annually. In parallel to delivering technical excellence, GEOLOG strongly prioritises its HS&E commitments, recently marking five years without a Lost Time Incident, while continuing to implement and refine its internationally recognized QHSE and CSR standards. In addition to being the global market leader in hydrocarbon evaluation at wellsite through its extraction, analysis and interpretation of gasses from drilling fluids, GEOLOG also provides a uniquely comprehensive, proven and market leading suite of drilling and formation evaluation solutions. Together, these technologies have the primary goal of reducing drilling time and costs, improving operational safety and greatly enhancing the understanding of formations and reservoirs during drilling. More recently, through its Milan-based Laboratory and R&D company GEOTech, GEOLOG has developed geochemical focused laboratory services for reservoir characterisation aimed at oil and gas production optimisation in both pre and post drilling phases, enabling a fully integrated approach to reservoir evaluation and understanding. Thanks to its independence and provision of surface solutions, GEOLOG has become a trusted advisor for operators looking at ways to reduce their expensive downhole measurements and optimise drilling programs.

Company History

Four decades of field experience

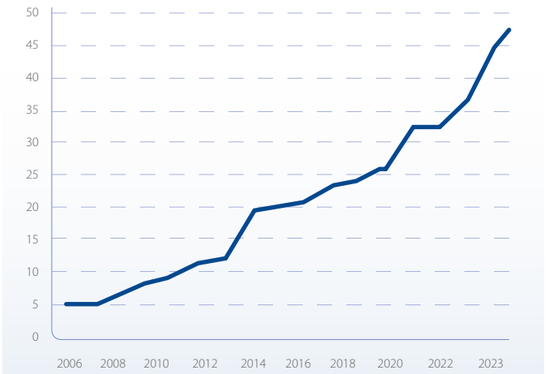
Milan office

GEOLOG was founded in Italy in 1982 to provide mud logging services to AGIP (ENI) on geothermal, oil and gas wells. From its early years, GEOLOG´s strong technological and R&D culture led to the development of a number of innovative solutions and highly technological patents. The Italian crisis of 1994, during which the company moved abroad, opening bases in Tunisia, Congo and Venezuela, servicing AGIP's international operations, acted as a catalyst for the company's international expansion.

Current management acquired the company in 2001 and has been able to develop its innovative solutions and technological patents into commercial products and services, thereby significantly growing the customer base across not only international oil companies but also across national oil companies worldwide. Whilst retaining R&D and production facilities in Milan, Italy, in 2016 the company reorganized its corporate structure under GEOLOG Surface Logging DMCC, based in Dubai, UAE.

Today, GEOLOG remains privately owned and has grown to become **the world's largest independent surface solutions provider to the oil, gas and geothermal industries**, offering a full spectrum of services including Surface Logging, Drilling Solutions, Laboratory Studies and R&D partnerships.

Cumulative Number Of Patents



Number of patents owned

Client References

GEOLOG's experience covers over 8,000 wells globally and includes national and international oil companies across multiple continents. Our services are in demand with traditional oil & gas operators and extend to small and large integrated service providers.

Our services have been performed both onshore and offshore for:

- Exploration Wells
- Development Wells
- Geothermal Wells
- Unconventional Reservoirs
- Extended Reach Drilling
- Narrow Mud Weight Windows
- Underbalanced-Managed Pressure Drilling

GEOLOG has logged over 900 wells in Deep and Ultra-Deep Water operations in:

- Angola
- Australia
- Brazil
- Colombia
- Congo
- Cyprus
- Equatorial Guinea
- Egypt
- Ghana
- Gulf of Mexico
- Guyana
- India
- Indonesia
- Italy
- Malaysia
- Mauritania
- Morocco
- Mozambique
- Namibia
- Senegal
- South Africa
- Spain
- Sri Lanka
- Tanzania
- Timor-Leste
- Togo
- Trinidad
- Tunisia
- Turkey
- UK
- USA
- Venezuela

HP/HT Well Experience includes:

- Algeria
- Angola
- Argentina
- Austria
- Bahrain
- Bolivia
- Brazil
- Cyprus
- China
- Equatorial Guinea
- Egypt
- Gabon
- Ghana
- Hungary
- India
- Iraq
- Italy
- Kuwait
- Mexico
- Mozambique
- Netherlands
- Norway
- Romania
- Saudi Arabia
- South Africa
- Sri Lanka
- Turkey
- UK
- Vietnam

Extreme Weather Environments:

North Africa **+55°C** Arctic **-50°C**

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International Oil Companies include:

ADDAX PETROLEUM, Anadarko, bhpbilliton, bp, CAIRN, CEPSA, Chevron, ConocoPhillips, dana PETROLEUM, devon, ecopetrol, equinor, eni, enel, ExxonMobil, HESS, LUKOIL, Marathon Oil Corporation, MURPHY OIL CORPORATION, Oil Search, OMV, Pan American ENERGY, PERENCO, pluspetrol, REPSOL, RWE DEA, Santos, Shell, SWN Southwestern Energy, Tecpetrol, TOTAL, TULLOW OIL plc, wintershall dea

National Oil Companies include:

ENAP, GAZFLOT, GAZPROM, INA, Kuwait Oil Company, ONGC, PEMEX, PERTAMINA, PDVSA, PETROBRAS, PETRONAS, PTTEP, Saudi Aramco, Sinopec, Sonangol, Sonatrach, TP

Integrated Service Providers include:

Baker Hughes, EXCEED, HALLIBURTON, Senergy, Marriott DRILLING GROUP, Petrofac, Schlumberger, Weatherford

Published Technical Papers

Innovation in Surface Logging & Drilling Services

Thanks to its strong commitment to innovation and constant improvement of its services, GEOLOG continuously conducts R&D projects in partnership with its clients. GEOLOG stands today as a leader in advanced surface logging technologies with unique solutions dedicated to drilling optimization and advanced rock and fluid characterization.

GEOLOG's R&D collaboration with its clients often starts at the early stage of conceptual design and follows through into the field deployment and solution validation. This is to ensure that the research work is entirely focused on meeting the client expectations and solving the challenges arising continuously in our oilfield industry.

The following is a list of some of the technical papers GEOLOG has written in collaboration with its clients over recent years:

Integrated Formation Evaluation Using Multiple Geochemical Solutions to Optimize Reservoir Description and Evaluate Production Potential from Multiple Targets in the Northern Delaware Basin. URTeC: 3723283 (URTeC, June 2022)

This paper reports an integrated formation evaluation workflow on a multi-well case study in the Northern Delaware Basin using surface logging and laboratory analyses only. We will present how this approach provided subsurface characterization for enabling key drilling and completion decisions and optimizing future well planning and target selections

Predict Geomechanical Parameters with Machine Learning Combining Drilling Data and Gamma Ray. SPE-204688-MS (SPE Middle East Oil & Gas Show, December 2021)

The paper shows the development of a reliable method for geomechanical parameters evaluation while drilling using surface logging data. It combines ML drilling data, XRF and well log data with machine learning techniques. The paper shows that a model trained with drilling parameters and GR coming from one well can predict the Young Modulus of different wells (same basin).

Holistic improvement in drilling efficiency using real-time quantitative cutting volume monitoring (IAPG, Buenos Aires, Argentina, November 2021)

Efficient cleaning of the drilled section will help to improve the rate of penetration (ROP) and effectively contribute to optimize rig performance, pipes run time, cementing, and fluid displacement. The opposite will lead to a detriment to drilling efficiency associated with problems such as: stuck pipe risks, drill cuttings accumulation, increase in torque and drag, etc.

Tecnologías de monitoreo en tiempo real para la evaluación de estabilidad y limpieza de pozos no convencionales (IAPG, Buenos Aires, Argentina, November 2021)

En este trabajo se muestran los resultados de la implementación de una herramienta que recoge y pesa en forma continua los sólidos recuperados en zaranda. A través de una serie de correcciones, calcula un volumen de material recuperado que, al ser comparado con el volumen teórico, permite detectar en tiempo real la ocurrencia de eventos de inestabilidad o mala limpieza del pozo.

In Situ Evaluation of Oil Biodegradation in Rock samples through the use of Thermal Extraction Gas Chromatography: a Case Study (OMC, Ravena, Italy, October 2021)

This paper concerns identification of biodegradation using cuttings extracts at rigsite via Thermal Extraction Gas Chromatography (G9+) in place of post-drilling laboratory fluid analysis. Biodegradation can lower API gravity, increase viscosity and impact economics of production, the method allows early recognition of biodegradation, improving completion decisions and development strategies.

Novel Approach to Reservoir Continuity Evaluation Through GC-MS Geochemical Fingerprinting (30th International Meeting on Organic Geochemistry, September 2021)

Reservoir continuity assessment via GC-fingerprinting is a recognised methodology, providing support to/replacing the conventional approach using pressure points. This paper extends the reservoir geochemistry approach using fluid samples to the use of cuttings extracts, illustrating the challenges, possible solutions and limitations of the technique; alongside a case history discussion.

Advanced Mud Gas Evaluation in a Complex Clastic Reservoir While Drilling in the Usano Field of PNG (Geosciences Conference and Exhibition, Papua New Guinea, February 2020)

This case study describes how the analysis of a range of hydrocarbon components enabled accurate reservoir zonation in an area of very complex geology. Specific proxies from the gas data were used to confirm fluid types and identify gas/oil/water contacts (GOC/OWC) in an environment where downhole tools failed to deliver definitive results.

Towards a Continuous Near-Real Time Reservoir Fluid Characterization by the Implementation of Advanced Mud Logging Technology (EAGE Reservoir Management in Carbonates, November 2019)

This paper shows how the use of the latest mud gas technologies, when combined with Geochemistry on cuttings is a valuable asset in oil and gas field development. The aim of the technology is to determine hydrocarbon fluid properties such as API gravity with reliable accuracy and with continuous measurement along the well bore.

Carbon Isotopes from Mud Gas: Lab IRMS or Wellsite Laser-Assisted Technologies? (International Meeting on Organic Geochemistry, September 2019)

The objective of the study is to screen differences in carbon isotopic analysis between laboratory GC-IRMS and one of the possible alternative solutions for wellsite deployment, Cavity Ring-Down Spectroscopy (CRDS). Comparison examined advantages and disadvantages of two approaches and technical performances in terms of LoD, precision and accuracy.

Quantification of Uncertainties of Fracture Permeability via Mud Loss Information and Inverse Stochastic Modeling (81st EAGE Annual Conference and Exhibition, London, UK, June 2019)

Fracture characterization of NFRs plays an important role in hydrocarbon production estimation. Uncertainty propagation from input parameters to model outputs is quantified through a Monte Carlo framework. Stochastic inverse modelling with field data is performed to evaluate posterior probability densities of fracture aperture and to simulate drilling fluid invasion in fractures in quasi-real time.

Identification of Bitumen In Najmah Source Rock, Utilizing Organic And Inorganic Analysis: A Case Study (SPWLA Annual Symposium, June 2019)

This study describes how geochemical data allowed the characterization of the organics present in the main reservoir, the control of the presence of bitumen and the estimation of its amount in key cored well samples, and the establishment of a methodology to tentatively extend the previous results to non-cored wells.

Integrated Reservoir and Source Rock Characterization: Refined Downhole Analyses through Advanced Surface Logging Technology. SPWLA-2019-PPP (SPWLA Annual Symposium, Woodlands, June 2019)

This study shows how the integration of several formation evaluation technologies from Advanced Surface Logging to Logging While Drilling and Wireline lead to the characterization of a complex reservoir system compartmentalized by an active structural setting. Among these applications, advanced mudlogging brings new opportunities to explore what barely is achievable with conventional logs.

Strongly Improving Hole Cleaning Management in Highly Deviated and Horizontal Well Using Surface Cuttings Rate Measurement Technology (EAGE Horizontal Wells, May 2019)

This paper covers the use of DrillClean to reduce potential NPT/ILT while drilling by identifying and mitigating issues arising from poor hole cleaning, improving ROP and optimizing hydraulics and fluid rheology, determining accurate hole volume for cementing, and monitoring shaker efficieincy and pill efficiency.

Real-Time Alkene Detection and XRF while drilling to monitor the efficiency of PDC Drill Bits in US Land Tight Rocks: A Case Study, AADE-NTCE-104 (AADE National Technical Conference & Exhibition, April 2019)

This paper demonstrates how alkenes detection is tracked in real time, in combination of XRF analysis on cuttings, to monitor pre-mature bit wear, in tight unconventional US Land drilling formation.

HSE & Quality

Health, safety, the environment and quality are fundamental to everything we do.

HSE & Quality

To respect and improve the highest safety and environmental standards whilst actively participating in the development and know-how of the countries in which we operate.

Health, safety, the environment and quality are fundamental to everything we do.

GEOLOG 7X7 Life Saving Rules

GEOLOG 7X7 Life Saving Rules are introduced as fundamental rules every employee has to follow. The aim of these HSE Golden rules are to enhance safety culture by providing basic guidance to carry out work in a safe manner and ensure that individuals are aware of these rules and act accordingly. Noncompliance to the rules may result into a serious injury or even death.

If you are representing GEOLOG, recognize your following responsibilities.

1. Be aware of GEOLOG 7X7 LSR
2. Always lead by an example
3. Discuss and disseminate these rules
4. Recognize at risk and positive behavior and intervene when there is an opportunity.

HSE Capabilities

Our vision at GEOLOG is to ensure we meet or exceed all health, safety and environmental ("HSE") expectations of our stakeholders and strive to improve our H, S & E performance on a continuous basis.

Since 2010 GEOLOG Management System (MS) has been certified by Det Norske Veritas (DNV) Currently GEOLOG Environment Management System (EMS) is certified to ISO 14001:2015 and Occupational Health and Safety Management System to ISO 45001:2018 both for office/base and rig site activities. This demonstrates that GEOLOG operations are managed safely and responsibly, providing reliable services to our clients free of risks associated with HSE matters.

Executive Management is fully committed to our H, S & E vision through constant personal involvement, including review meetings, audits and the provision/assignment of resources. QHSE policies are issued by CEO, Richard Calleri. The HSE function within GEOLOG has grown significantly to maintain pace with the increased expectations of customers and regulatory bodies globally as operations have expanded.

To comply with ISO standards, GEOLOG constantly monitors and evaluates its performance to ensure that requirements are being met. For this, the following items are monitored and reported to Management on a monthly basis: Man-hours worked, number of Lost Time Incidents [1] (LTI), LTI Frequency rate [2], LTI Gravity rate [3], and Environmental Spills. In 2019, GEOLOG achieved an outstanding HSE milestone of 10 Million LTI Free man-hours and glorious 5 consecutive LTI free year.

Quality Capabilities

The GEOLOG Quality Management system is certified ISO 9001:2015 by Det Norske Veritas (DNV). This allows GEOLOG to integrate with its certificates in ISO 14001:20015 and ISO 45001:2018. This integration between the three standards helps GEOLOG to have a fully operational QHSE Management system with the objective of achieving and demonstrating excellence in QHSE performance. To ensure the QHSE Management system is in place in the certified bases, GEOLOG has a team of internal auditors in the ISO standards in which GEOLOG is certified.

Our Integrated management system has all been reviewed against the API Q2 standard and a comprehensive GAP analysis performed to ensure compliance.
Apart from the ISO certificates, GEOLOG is also registered in both Achilles and the 1st Point databases (FPAL), helping reduce the risks in its supply chain and serving as further confirmation of GEOLOG's commitment and adherence to standards.

Additionally, GEOLOG has active subscription on several other supplier verification profiles like SEQual (UK) and MagentJQS (Norway).
Some of the major benefits of having an integrated certified system worldwide is:

- **To provide effective and consistent operational service to our clients.**
- **To provide efficient and consistent support to our rig site operations.**
- **To have standardized planning and procedures worldwide, enabling GEOLOG to work consistently at the highest standards.**
- **To encompass the participation of both office and rig site personnel.**
- **To have an active system for continuous improvement.**

[1] A Lost Time Incident (LTI) is a work-related incident, injury or illness to an employee in which a physician or licensed health care professional recommends day(s) away from work due to the incident.
[2] The Lost Time Incident Frequency rate (LTIFR) is measured as the number of Lost Time Incidents per million hours worked in the period analysed.
[3] The Lost Time Incident Gravity Rate (LTIGR) is the number of cumulative lost work days (resulting from a LTI) multiplied by 1 thousand divided by the cumulative man hours worked.

Satisfy customers with superior quality, value and services

Maintaining outstanding QHSE Performance that follows the ISO & OHSAS standards is a core expectation of GEOLOG. Our successful QHSE performance has been made possible through the teamwork and commitment of all employees. GEOLOG's QHSE Standards are based on the continual improvement of the QHSE Integrated Management system:

Corporate Responsibility

GEOLOG is committed to advancing its policies and systems to ensure it addresses all aspects of social responsibility that are relevant to its business. For these reasons GEOLOG is not only an Active member but also a Signatory Partner of United Nations Global Compact (UNGC) - a strategic policy initiative for businesses that are committed to aligning their operations and strategies with ten universally accepted principles in the areas of human rights, labour, environment and anti-corruption, as detailed here:

1. Businesses should support and respect the protection of internationally proclaimed human rights and make sure that they are not complicit in human rights abuses.

2. Businesses should uphold the freedom of association and the effective recognition of the right to collective bargaining, the elimination of all forms of forced and compulsory labour, the effective abolition of child labour, the elimination of discrimination in respect of employment and occupation.

3. Businesses should support a precautionary approach to environmental challenges, undertake initiatives to promote greater environmental responsibility and encourage the development and diffusion of environmentally friendly technologies.

4. Businesses should work against corruption in all its forms, including extortion and bribery.

GEOLOG publishes its annual COP (Communication on Progress) report in May of each year. The latest copy of which is available on GEOLOG´s website as well as the UNGC website.

GEOLOG supports local charitable initiatives and actively participate in projects that benefit communities around the world.

Industry Challenges

Integrated and proven surface solutions

GEOLOG's services help to reduce drilling costs through the innovative use of non-invasive and therefore low risk surface measurement of drilling parameters and formation/fluid analytics, thereby improving operational safety while optimising well construction and delivery. By monitoring and analysing fluid movements our KickAlarm and GeoFracture services respectively assist in the immediate and accurate identification of losses/influxes for safe drilling, and in real-time identification and characterisation of fractures for optimising testing and completions.

GEOLOG offers a range of services that drive improved drilling efficiency in real-time, including BitLife, our patented near real-time bit condition monitoring service, and DrillVibe for immediate stick-slip detection and mitigation, both of which provide very early warning of high-risk drilling issues, and so can help prevent low ROP and potential catastrophic bit/BHA failure. In addition, DrillBest is used in designing and monitoring operating metrics against key performance indicators (KPIs) for identification of invisible lost time and non-productive time in support of continuous improvement towards technical limits.

Our DrillClean service focuses on real-time volumetric measurement of solids removal to ensure adequate borehole cleaning and early warning of borehole instability to avoid potential pack-offs. Our GeoPressure services are used in areas where moderate to severe formation pressures require careful evaluation, and we also offer standard real-time and offline well engineering including torque-and-drag, hydraulics and vibration.

Our formation evaluation suite of services such as G5, G8, GeoIsotopes, G9+, GeoSource and GeoRox provide the most detailed analysis of all aspects of the formations drilled, and their contents.

Drilling Challenge	Essential	Value Added
Reducing Non-Productive Time and Costs	KickAlarm DrillBest BitLife	DrillClean GEOFracture
Measure, Monitor and Improve Drilling Efficiency/Drilling Optimization	DrillBest DrillVibe BitLife	DrillClean
Mitigating Fluid Influxes and Losses for Improved Safety	KickAlarm	GEOPressure GEOFracture
Minimizing Drilling Costs	DrillBest	DrillVibe BitLife
Optimizing Wireline and LWD Evaluation Programs	G5 DualFid™ G8 DualFidStar™ GEOROX	GEOIsotopes G9+
Real-Time Geological and Reservoir Answers	Wellcoms	GEOWITSML

GEOLOG

Deep and Ultra-deep Water

Drilling in deep and ultra-deep water poses many formation evaluation challenges for operators including increased costs, remote locations, complex formation pressures which in turn may lead to borehole instability and unplanned well-control situations and drilling muds cooled by long riser sections. Use of services such as KickAlarm help mitigate non-productive time by carefully identifying only true fluid influxes and losses. The DrillClean service provides accurate assessment of the volumes of returned cuttings, identifies borehole instability and monitors hole cleaning efficiency in real-time. Our GeoPressure services help identify, monitor and analyse the presence of formation overpressures and assist in the drilling of wells with narrow safe-drilling margins. Our G5, G8, G9+ and GeoIsotopes services provide the broadest range of data analyses available to analyse the hydrocarbon composition and origin in real-time at the wellsite. This allows the optimal use of other techniques such as wireline formation testing and sampling that require specific use of extended periods of rig-time. In addition to early-warning of inefficient drilling issues, both DrillVibe and BitLife can also provide realtime indication of effective weight transfer in high-friction wells.

Drilling Challenge	Essential	Value Added
Identifying and Quantifying Borehole Instability	DrillClean	GEOPressure
Drilling in Narrow Pore Pressure Margin Environment	GEOPressure	DrillClean
Early Reservoir Characterization	G5 DualFid™ G8 DualFidStar™ GEOIsotopes	G9+
Ensuring Efficient Drilling	DrillVibe BitLife	

High Pressure and/or High Temperature

By using only surface data analysis and interpretation techniques such as G5, G8, GeoIsotopes, G9+, GeoSource and GeoRox we are not constrained by down-hole temperature and pressure limitations of our tools and are able to evaluate data from any temperature or pressure regime. Our BitLife, DrillVibe, DrillClean and GeoPressure services are able to assist in the efficient drilling of wells in these complex environments.

Drilling Challenge	Essential	Value Added
Identifying and Quantifying Borehole Instability	DrillClean	GEOPressure
Drilling in Narrow Pore Pressure Margin Environment	GEOPressure	DrillClean
Minimizing Downtime from Downhole Tool Failures	GEOROX G5 DualFid™ G8 DualFidStar™ GEOIsotopes	DrillVibe BitLife
Accurate Reservoir Hydrocarbon Description	G5 DualFid™ G8 DualFidStar™ GEOIsotopes	G9+
Accurate Reservoir Hydrocarbon Description	DrillClean	

Unconventionals

Our range of services tailored to the drilling of unconventional gas and oil wells, such as GeoRox, G5 and G8 enable cost effective geosteering to allow accurate well-placement in extended horizontal and high angle wells and develop a better understanding of the geology through chemostratigraphic interpretation and correlation. Our GeoRox, GeoSource, G5, G8, G9+ and GeoFracture services identify "sweet spots" for stimulation and the composition of the hydrocarbon types present. The real time availability of these services at the wellsite means that lengthy delays waiting on laboratory turn-around are completely removed and timely decisions on how to complete wells can be made effectively and in a far more cost effective manner. By using GeoIsotopes and G9+ we are able to provide a laboratory quality service, at the well-site to identify hydrocarbon origin and maturity and help rapidly build up a more complete understanding of the results from the wells.

Challenges & Solutions	Essential	Value Added
Hydraulic Fracture Placement	GeoROX GeoSource	GeoSource GeoFracture
Finding Source Rock Sweet Spots	GeoROX GeoSource G5 DualFid™ G8 DualFidStar™	G9+ GeoFracture
Hydrocarbon Fluids Typing (Composition)	G5 DualFid™ G8 DualFidStar™	G9+
Stratigraphic Interpretation & Correlation	GeoROX	
Commercial and Production Potential	G8 DualFidStar™	G9+
Onsite Lab Results for Improved Turn-Around Time	GeoROX GeoSource GeoIsotopes	G9+
Hydrocarbon Origin and Maturity	GeoIsotopes	G9+

Exploration

Exploration drilling comprises a whole range of challenges, the primary of which is obtaining the maximum amount of information from the well in a cost effective and safe manner. By utilising our suite of formation evaluation services, G5, G8, G9+, GeoIsotopes, GeoSource and GeoROX, we are able to acquire the maximum amount of data possible, with no risk of loss, or later availability. These services cover the entire range of likely exploration scenarios from biogenic to thermogenic gas, condensate to heavy oil, clastic, carbonate or even granitic basement reservoirs. Our drilling related services, KickAlarm, DrillClean, DrillVibe, DrillBest and BitLife will help deliver a safe and economic well.

Challenges & Solutions	Essential	Value Added
Real-Time Geological & Reservoir Content Answers	G5 DualFid™ G8 DualFidStar™ GeoIsotopes	G9+
Minimizing Evaluation Risk	GeoROX GeoSource GeoIsotopes	GeoFracture
Onsite Lab results for improved turn-around time	GeoROX GeoSource GeoIsotopes	G9+
Commercial and Production Potential	G8 DualFidStar™ G9+	G9+
Hydrocarbon Origin and Maturity	GeoIsotopes	
Drilling in Narrow Pore Pressure Margin Environment	GeoPressure	DrillClean
Ensuring optimal well construction	DrillClean	DrillBest DrillVibe BitLife

Development

Development wells require the optimization of formation evaluation, improved drilling efficiency and the ability to identify all pay effectively. The combination of G5, G8, G9+ and GeoROX gives operators the opportunity to optimize their LWD and wireline evaluation programs effectively using surface data analyses and interpretations to help reduce costs across multiple wells and still acquire excellent formation and fluid characterization. The combination of G8 and GeoIsotopes enables hydrocarbon origin to be determined, and assist in evaluating complex reservoirs with multiple different geologic compartments. Complex structural and stratigraphic correlations are enabled by performing detailed chemostratigraphic analysis at the wellsite, ensuring that results and the geological model are understood. The DrillBest, DrillClean, DrillVibe, BitLife and KickAlarm services all enable optimal safe drilling practices.

Challenges & Solutions	Essential	Value Added
Unlocking Additional Reserves	G8 DualFidStar™ G9+ GeoIsotopes	
Stratigraphic Interpretation & Correlation	GeoROX	
Hydrocarbon Origin and Identification of Compartmentalization	G8 DualFidStar™ GeoIsotopes	GeoROX
Ensuring optimal well construction	DrillClean	DrillBest DrillVibe BitLife
Minimizing Costly Downhole Tool for Fluids Characterization	G8 DualFidStar™ G9+	

Horizontal and Extended Reach

Our experience in horizontal and extended reach drilling in both conventional and unconventional wells have enabled GEOLOG to be a leading provider of surface logging solutions in these wells. The G5, G8, G9+, GeoIsotopes and GeoROX services help determine hydrocarbon types and origins, stratigraphic position for effective well-placement and identify geologic sweet spots and potential barriers to production along the well-path. By using a combination of surface drilling data, we are able to optimize the use of more problematic LWD and Wireline services. Drillbest, BitLife and DrillClean all assist in improving drilling and hole cleaning efficiency. In addition to early-warning of inefficient drilling issues, both DrillVibe and BitLife can also provide realtime indication of effective weight transfer in high-friction wells.

Challenges & Solutions	Essential	Value Added
Finding Reservoir Sweet Spots	GeoROX GeoSource G5 DualFid™ G8 DualFidStar™	G9+ GeoFracture
Well Placement	GeoROX GeoSource	G5 DualFid™ G8 DualFidStar™ GeoIsotopes
Hydrocarbon Origin and Identification of Compartmentalization	G5 DualFid™ G8 DualFidStar™ GeoIsotopes	GeoROX
Maximizing Reservoir Exposure through Geosteering	GeoROX G5 DualFid™ G8 DualFidStar™	G9+
Stuck Pipe from Cuttings Accumulation	DrillClean	
Ensuring Efficient Drilling	DrillVibe BitLife	

Houston office

Geothermal

The drilling of geothermal wells introduces a different range of challenges but, by utilising GeoFracture and GeoROX we are able to identify natural fracture patterns and characterise complex mineralogy and make stratigraphic correlations. Our KickAlarm and DrillBest services enable the implementation of performance drilling, NPT reduction and the careful monitoring of losses and micro-losses for both safety and potential reservoir identification. The measurement of hazardous non-hydrocarbon gases are performed using specific technologies for a range of gases, which may include H2S or CO.

Challenges & Solutions	Essential	Value Added
Natural Fracture Identification	GeoFracture	GeoROX
Stratigraphic Interpretation & Correlation	GeoROX	DrillClean
Characterizing Mineral Alterations	GeoROX	DrillVibe

R&D and Laboratory Studies

GEOLOG's lab and innovation activities have been spun off into a dedicated company/brand, GEOLOG TECHNOLOGIES (GEOTech), which operates in partnership with clients and academia. GEOTech utilises a multidisciplinary group of very young and motivated professionals (under 35) with PhDs in various disciplines supervised by technical managers with long experience within Oil Companies.

The Approach

- Alliances with best in class technological providers to develop leading edge products. Research today demands very different skills and we continuously seek technological partners able to complete and integrate our competences. Academia, technological start-ups and Oil Companies are our preferred partners.
- Cross fertilization: to leverage technologies developed in other industrial sectors, adapting them to our needs
- Integration & multidisciplinary: magic technology doesn't exist; data integration is the only solution to reducing uncertainties and generate additional value from each technology.

Laboratory

GEOTech laboratory services are focused on helping clients to:

- Plan and optimize future wellsite activity, through preliminary tests
- Complete and integrate activity performed at wellsite, by using tools not yet available for field applications
- Test new experimental tools before moving them to wellsite

Innovation & Research

GEOTech recognises that ongoing advances in analytical techniques will have a fundamental impact upon the future of decision making within the oil, gas and geothermal industries: enabling multiple high-density data sets generated at the rigsite to replace the high-cost limited data sets previously utilised post-drilling. The availability of enhanced accuracy analysis of samples using technologies formerly restricted to laboratory environments will reinforce this trend, fusing geochemistry with mudlogging formation evaluation to produce new methods of understanding formations in real-time.

As such, GEOTech's innovation and research are focused to:

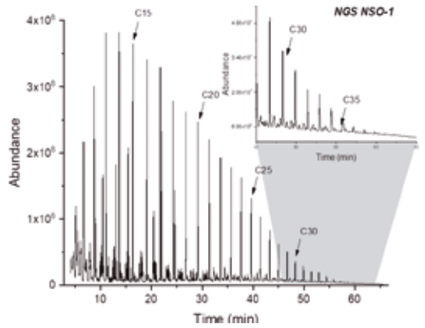
- Make available new analytical tools for field applications (towards the future full equipped upstream lab at wellsite)
- Squeeze maximum value from acquired data, to address and solve key industry issues

Oil - Oil and Oil - Source rock correlations

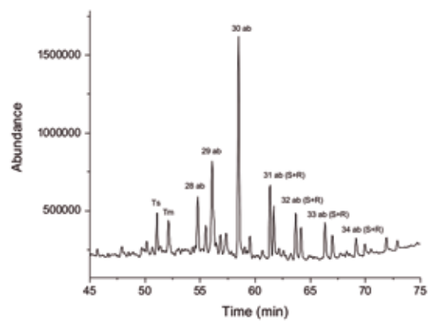
- Biomarker studies on oil and extracts
- Isotopic analyses (GC-IRMS)
- Samples may be whole oil or cuttings for solvent extraction or thermal desorption
- Production allocation studies based on alkylbenzenes fingerprinting

Source rock characterization and maturity assessment

- TOC
- Pyrolysis
- Organic facies identification and characterization
- Vitrinite reflectance
- AFTA
- Fluid inclusions



Example of whole oil GC-FID



GC-MS of oils Terpanes (m/z 91)

Gas characterization

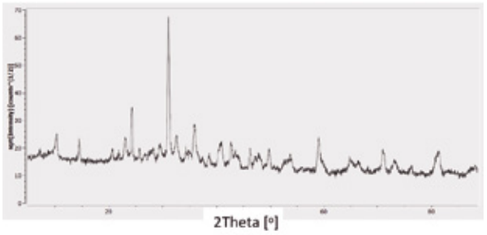
- Complete chemical analyses, including contaminant gases
- Carbon and deuterium isotopic analyses
- Gas – oil correlations
- Head Space analyses
- Residual gas (as still present in cuttings)

Head space: small samples, great information

Data Acquisition via GC-MS

Rock Analyses and characterization

- XRD diffraction for mineralogical analyses
- XRF chemical analyses for major, minor and trace elements



Examples of GEOTech solutions

Field Development: Reservoir Continuity

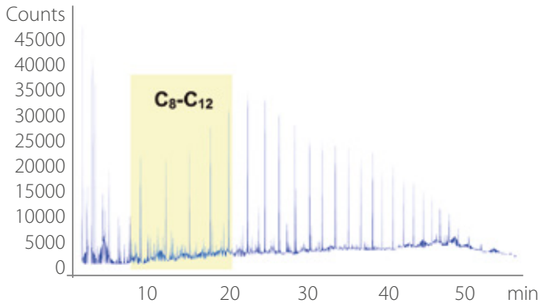
Reservoir continuity using produced oils is limited by the availability of expensive MDT or DST samples. GEOTech is able to offer a highly innovative and proprietary approach to establish reservoir continuity utilising cuttings.

Production Optimization: Fractured Reservoirs

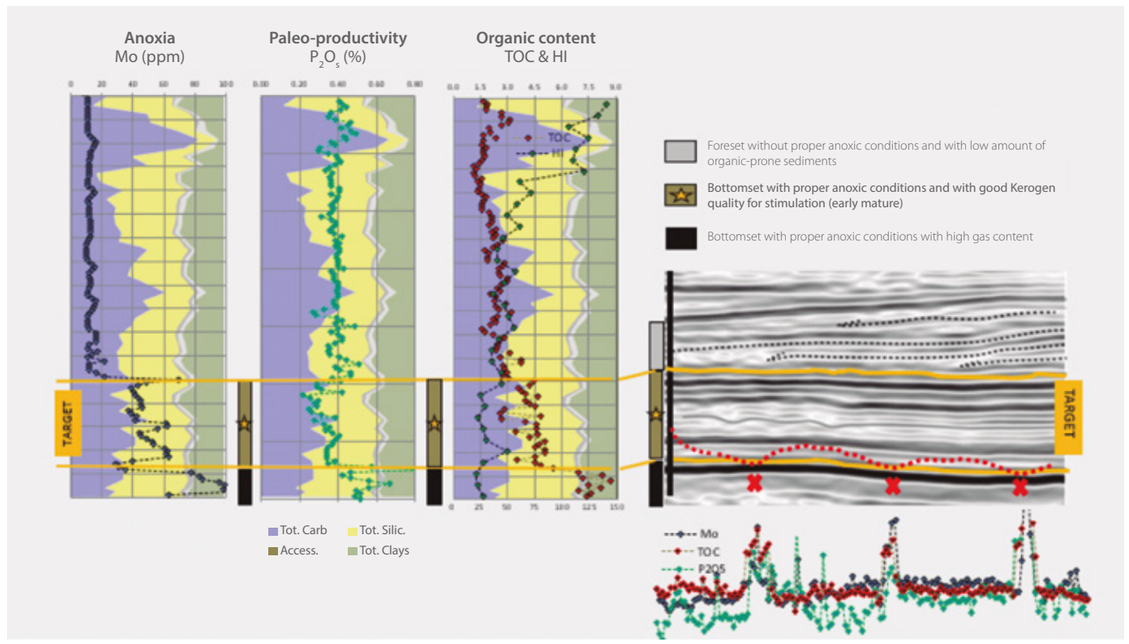
GEOTech, in addition to the package offered by GEOLOG at the rig site for fracture detection, is able to utilise proprietary and innovative software to evaluate fracture aperture using mud delta flow data collected at well site.

XRD and XRF integration

GEOTech's innovative software combines these two data sets to obtain more and more accurate data to allow better quantification of the different mineralogical phases.

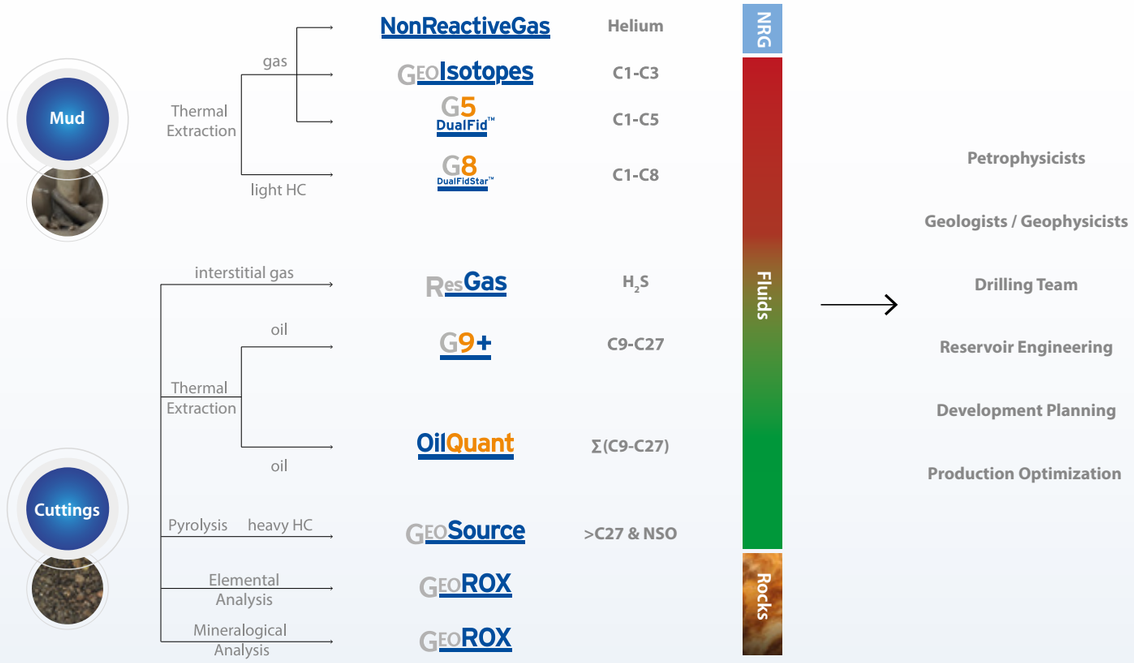


Focus on the light-middle Fraction of the oil



XRF, XRD and TOC data can give key information for reconstruction of source rock/unconventional reservoir deposition.

Example of data integration in reservoir characterisation



Locations

Based at the Universita Di Milano's research incubator facility, GEOTech is ideally situated to leverage exposure to multiple fields of advanced technology research to enable the development of novel solutions to the challenges of the oil, gas and geothermal industries.

In addition to the Milan Research Laboratory, GEOTech also has satellite operational laboratories in Houston, USA, Neuquén, Argentina and Doha, Qatar.

Partners

GEOTech actively seeks to collaborate with the industry and leading academic institutions on new projects to drive forward the state of the art in geochemical and physical techniques. Recent projects include the following partners:

www.geologtech.com

In-house Manufacturing

Reliability, performance and quality delivered through our unique production line

GEOLOG prides itself on manufacturing all of its oilfield services Equipment and mobile laboratories at its production facility in Milan. By taking ownership of the entire manufacturing process in-house, GEOLOG is the only global surface logging supplier to provide the complete surface logging process to its clients from design of equipment through to interpreting the results of service provision. From design to physical assembly, full control and accountability is maintained for the quality and the highest standards being implemented for all cabins, computing hardware, gas acquisition and detection equipment, advanced geochemical analytical tools and specialist drilling technologies. By providing hardware of the highest possible standard, our field engineers and crews are able to focus on providing an exemplary service, acquiring, analysing and interpreting data, communicating results and delivering as much value from the wellsite as possible. Component selection is based upon technical features as well as customer and internal user feedback, ensuring that lessons learned in the field are incorporated into future production and operational technical support processes.

Complete control over the entire manufacturing process sets GEOLOG equipment apart, in terms of quality of material, performance, reliability and traceability. Designs are modular, with acquisition and analytical components being suitable for all mobile laboratories. Through this process, GEOLOG is able to offer standard and optional extended warranties for its equipment, supported by a global 24/7 network of technical support from its production and operations teams. GEOLOG has in place a dedicated network of operational support bases with qualified, competent resources to provide local technical assistance. It is through this network and with assistance from our Milan Manufacturing Centre that we are also able to provide thorough installation and commissioning of all of our products and services and guarantee the availability of spare parts and upgrades to avoid obsolescence. Frequent and regular refurbishment and upgrading occurs to ensure continued reliability in the field and for our crews to be able to maintain their focus on performing their services. Comprehensive training is also provided for local technical support personnel to ensure that assistance is available in as timely a manner as possible.

Our manufacturing and design teams are able to provide detailed drawings, plans and certification to a variety of standards, addressing all customer concerns about the specifications of our units. Our mobile laboratories can be built according to various international standards, and in a variety of configurations, summarized in the following table:

Available Unit Lengths	20 ft, 25 ft, 30 ft and 40 ft. Custom length on request
Offshore Container Certification	DNV 2.7-1 (Det Norske Veritas)
Offshore Electrical Certification	DNV 2.7-2 (Det Norske Veritas)
Thermal Protection Certification	SOLAS A0 (0 min) and A60 (60 mins) for Zone 1 - (Safety of Life at Sea)
Helicopter Transportation Certification	NATO-STANAG 3542
Norwegian Petroleum Industry Certification	NORSOK Z-015 (Norsk Sokkels Konkurranseposisjon)
Winterized Unit	A0 and A60 down to – 20 °C (– 4 °F)
Winterized Alaska Model Unit	A0 down to – 50 °C (– 58 °F)
Combo Unit	A0 and A60 for Zone 1 (LWD, MWD)

As a global oilfield services provider, we have extensive experience in developing, building and using equipment in harsh high temperature and extremely low temperature environments. We offer "winterized" components and systems proven to operate consistently in temperatures below -20 degrees C. In hot climates we provide dual air-conditioning units to ensure redundancy. Our full range of equipment and services have been tried and tested in temperatures up to 50 degrees C. We are also able to provide a range of specialty service cabins, including "Advanced Service" cabins designed to be used alongside other surface logging companies providing only standard services (deployed for example in Brazil for Petrobras, in Senegal for Cairn Energy and in Tanzania for Statoil) and "Combination Service" cabins (designed to accommodate GEOLOG's services and third-party services such as Logging While Drilling (LWD), or Measurement While Drilling (MWD) services in one cabin). For certain land operations, GEOLOG has trailer mounted units, capable of being towed easily between locations.

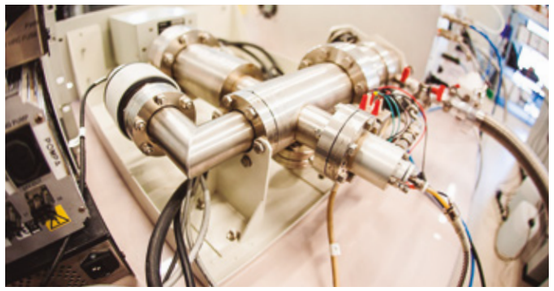
In addition to our various service provision cabins, GEOLOG also provides suitable certified small toolbox/support containers, commonly used in more remote environments to house additional spares, tools and consumables to ensure continued, uninterrupted service no matter where operations may be occurring.

GEOLOG Surface Logging Equipment Characteristics:

- All equipment manufactured in our Milan facility
- Fully certified equipment by Det Norske Veritas (DNV)
- Customized equipment according to customer/project needs
- Equipment quality independent of 3rd party suppliers
- Fully modular and upgradeable Surface Logging Unit & Equipment
- Efficient and fast implementation of upgrades

With our equipment GEOLOG:

- Guarantees the availability of spare parts
- Offers Global Support 24/7
- Provides commissioning and start-up
- Provides a wide network of locations with support personnel and equipment
- Provides manuals, drawings, certification and other critical production information



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