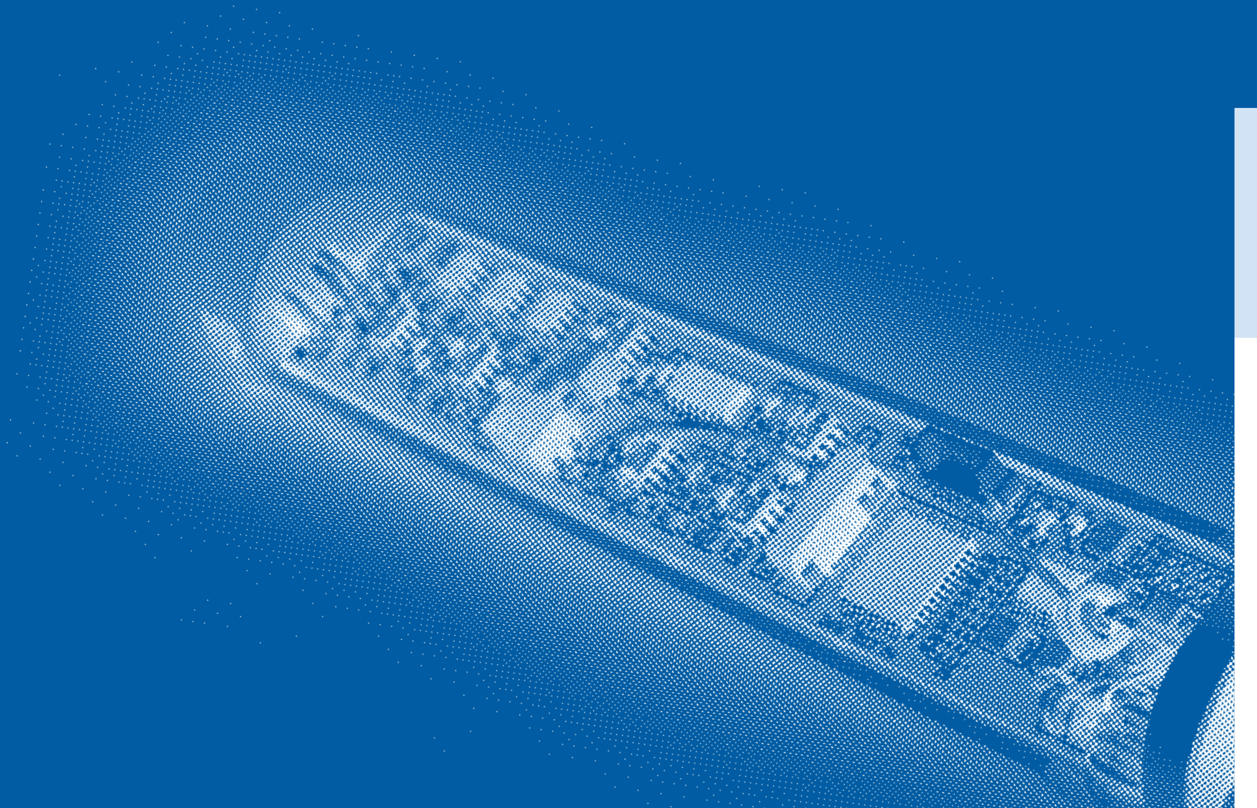
Full Tensor Magnetics

Energy Exploration and Engineering Benefits

EXPLORE THE DIFFERENCE

supracon®

SQUID and Microfabrication Technologies



New SQUID technology developed in Germany by IPHT-Supracon AG, has been adapted for use in airborne magnetic exploration and the development of energy resources including oil and gas, coal seam gas (CSG), coal and geothermal reservoirs. After many years of development, Supracon installed the system on a helicopter and successfully conducted several surveys in Africa for mineral exploration.

EXPLORATION BENEFITS

This ultra sensitive magnetic system measures the gradients and curvature of the magnetic field simultaneously at every measurement position, and provides detailed 3D information on the distribution of magnetic targets around the sensor.

A comparison of this sensor with a conventional unoriented measurement from a total magnetic field sensor shows that one can obtain a detailed 3D understanding of the magnetic property distribution beneath the ground surface with fewer measurements. This leads to improved decision on drill hole targeting of buried geological structures.

ENGINEERING BENEFITS

The high precision 3D measurements of the SQUID magnetometer makes it ideal for the detection of minute magnetic sources in oil field, coal mine and pipeline detection applications. One can detect buried pipelines, old well heads and underground obstructions that may have been lost over time. Precision survey techniques and improved geophysical interpretation methods provide new solutions for the mapping of lost assets.

NEW TECHNOLOGY FOR ENERGY EXPLORATION

New ultra-high sensitivity full tensor magnetometer technology developed for geophysical applications is now available commercially for hydro-carbon/ energy exploration throughout the world.

TÜV CERT
DIN EN ISO 9001:2008
Certificate 15 100 21403

All Supracon products are being fabricated under the German TÜV (German Association for Technical Inspection) controlled quality management system to ensure the highest standards.

ABOUT SUPRACON

Supracon is a high tech spin-off company from the world class Institute of Photonic Technologies (IPHT). Both institutions are based in Jena, Germany. The company develops and manufactures SQUIDs (Superconducting Quantum Interference Devices) the most sensitive existing sensors for accurately measuring magnetic fields. Since 2001, Supracon has, in its own right, grown from a trading company into a manufacturer of SQUID sensors and high precision measuring units.

SUPRACON HEAD OFFICE

Over the past few years, the focus of our activities has been to industrialise SQUID based measuring systems for geophysical survey applications. Supracon manufactures both Low Temperature (LTc) – and High Temperature (HTc) SQUID systems which are effectively used for ground Transient Electromagnetic surveys (TEM).

The most recent development, named JESSY STAR, is the world's first airborne SQUID system to record the complete gradient tensor of the Earth's magnetic field. It is deployed in routine surveys in cooperation with major exploration and mining companies.
SQUIDs are the sensors of choice whenever measuring tasks require ultimate sensitivity.

Supracon develops and manufactures customised SQUID systems; sub-systems and components. Special care is taken to allow a robust measuring setup operable in varying climatic and electro-magnetically disturbed environments.

GEOPHYSICS

In recent years SQUID based measuring systems have been successfully introduced into geophysical exploration communities. Both ground based EM receivers such as JESSY DEEP as well as airborne full tensor magnetic gradiometer systems have received increasing levels of attention fostered by the detection of major ore deposits with our SQUID sensors. Ultimate sensitivity and highest dynamic range are amongst the most prominent advantages over conventional sensors. It translates into greater depths of exploration, shorter data acquisition times and gathering of completely new types of information – the full tensor of magnetic field gradient.

The IPHT (Institute of Photonic Technology e.V.) and Supracon jointly develop geophysical measuring systems for the exploration of natural resources, archaeology, foundation studies and the evaluation of building sites. There are numerous other potential applications such as ore beneficiation, safety monitoring, to mention a few.

JESSY DEEP

EXPLORE WITH OPTIMAL RESULTS

ENERGY EXPLORATION

Courtesy of Anglo American & De Beers

ANGLO AMERICAN

JESSY STAR is a high-tech full tensor gradiometer which localises and quantises magnetic objects below ground surface and/or under water and is the most appropriate sensor when exploring for natural resources.

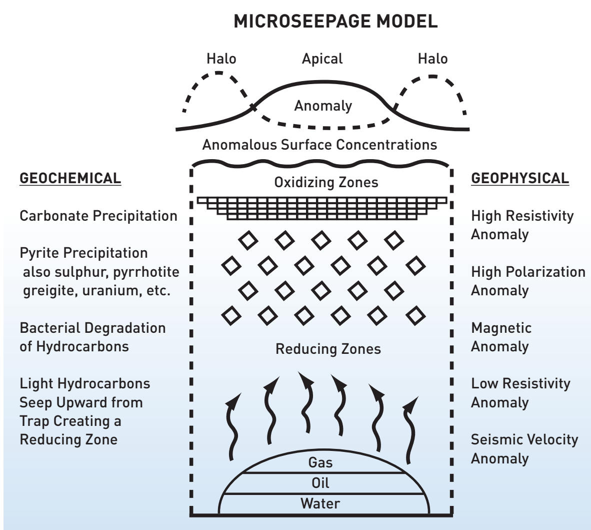
We develop specific SQUID gradiometer sensors which provide the exploration community with magnetic data of extraordinary sensitivity and tensor information never measured before. JESSY STAR operates in a helicopter mode, or alternatively in a fixed a wing aircraft configuration.

The measurement system comprises six gradiometers and three oriented magnetic field sensors to compensate for sensor motion noise. High spatial resolution is achieved with a differential GPS system using SBAS and an inertial navigation unit (INU) which provides compensation data.

Direct Hydrocarbon Indicators Associated with Oil Seeps (DHIs)

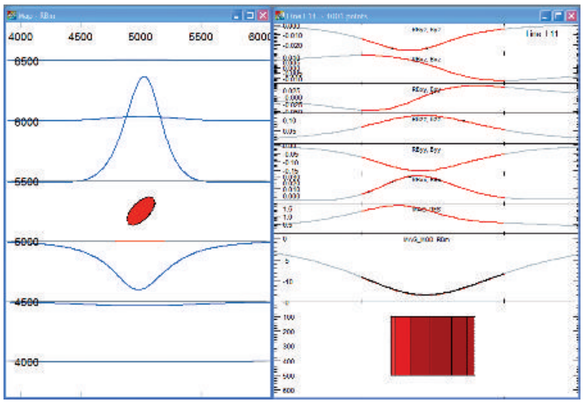
In the offshore areas of Western Australia and Malaysia low amplitude (1–5 nT), isolated magnetic anomalies have been detected along fault structures, identified by seismic surveys and which are inferred to be associated with hydrocarbon seeps. The magnetic source material develops in the upper 200 metres of the section in unconsolidated muds, where the hydrocarbons appear to interact with the sediments and oxygenated fluids to produce weakly magnetised materials.

One of the primary advantages of the SQUID full tensor system is its sensitivity to small targets that are offset from the flight lines. We expect occurrences which are only weakly detectable in current total field surveys to stand out more prominently in these SQUID surveys, and that previously undetected DHIs will become visible.



Small Pipes and Diatreme Intrusions between survey Lines

Undetected igneous intrusions can have a significant impact on seismic interpretation through diffractions of the signal and potential damage resulting in hydrocarbon loss to the reservoir zone below the shallow expression of such intrusions. The SQUID detector will provide a higher probability of detecting intrusions situated between survey lines, which would otherwise be missed by conventional surveys.



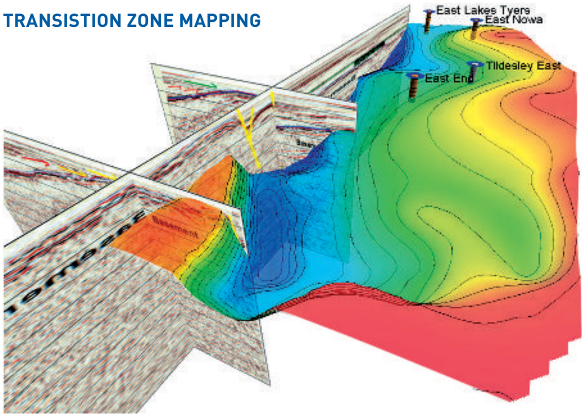
The offline location, depth and orientation of this pipe were interpreted directly from a fragment of data recorded on one line of SQUID magnetic data.

Transition Zone Mapping of Magnetic Lithologies and Structures

The transition zone covers an area up to 5 km offshore and possibly many kilometres onshore where coastal wetlands are either impenetrable or environmentally sensitive.

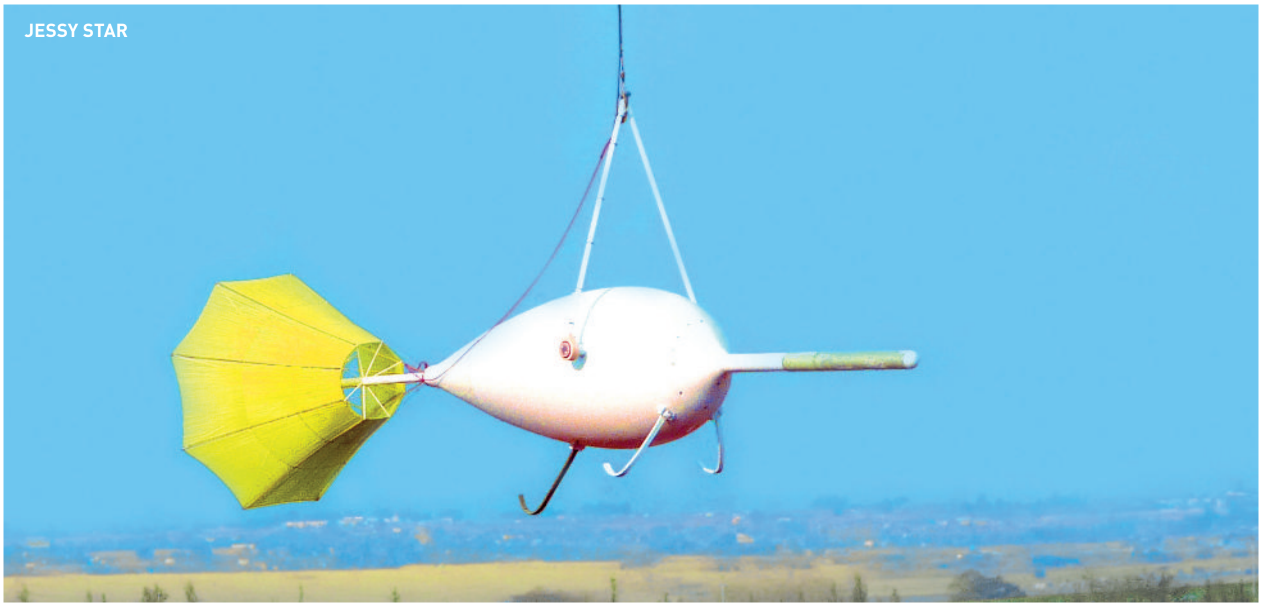
This zone leaves a gap in the data set, where it is difficult to correlate seismic horizons and structures between the offshore and onshore surveys. A high resolution SQUID system can be used to detect structures, intrusions and potentially map the subcrop of dipping formations where the formations are weakly magnetic.

TRANSISTION ZONE MAPPING



When combined with other geophysical methods such as airborne gravity, the SQUID magnetometer will assist in tying onshore seismic interpretations with valuable offshore seismic data.

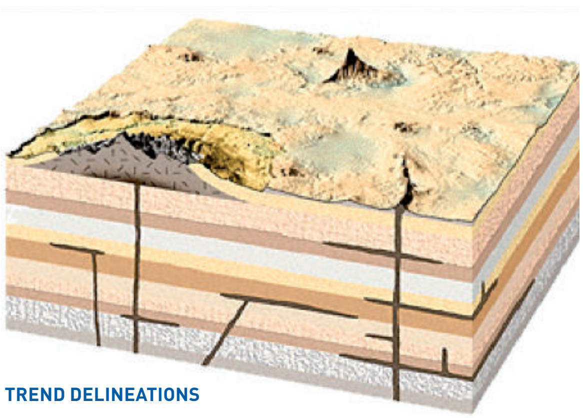
JESSY STAR



ENERGY EXPLORATION

Migration Path Modeling for Dyke intercalated Traps

The accurate and precise detection of dykes becomes important when they are suspected of having breached or altered oil and gas reservoirs or having altered the migration pathway for hydrocarbons. The SQUID sensor provides unprecedented precision for detection and mapping of such dykes.



TREND DELINEATIONS

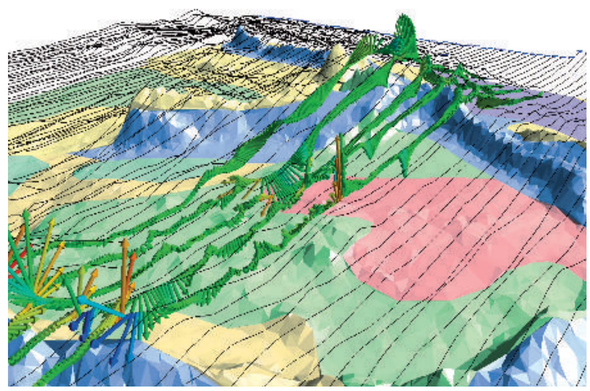
Remanent Magnetization for characterising Igneous Intrusions of different ages

Remanent magnetic studies can be used to detect and estimate relative differences in the ages of intrusions that may affect the emplacement of hydrocarbons. Dykes that predate hydrocarbon migration could alter the pathway and trap mechanism.

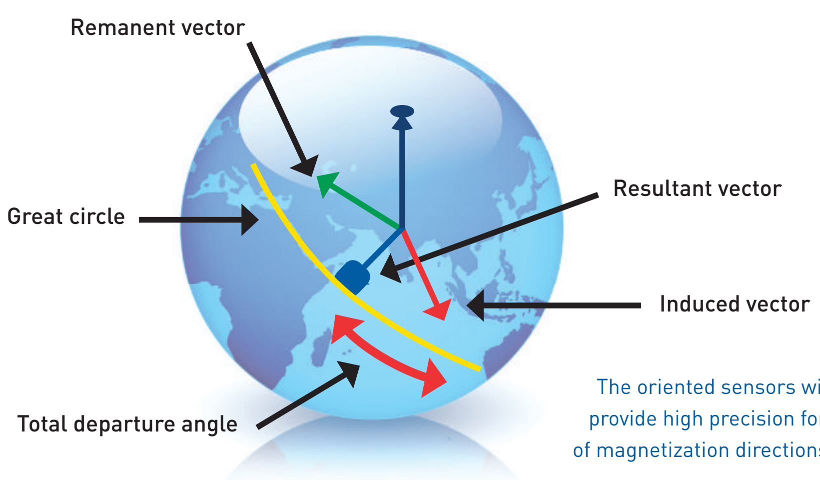
Trend Delineation between Widely Spaced Lines

The trend directions of linear magnetic geological units such as steeply dipping bedding, volcanic members and dykes that intersect the flight lines at an acute angle can be determined from the magnetic tensor as the cross-line components are very sensitive to the strike direction.

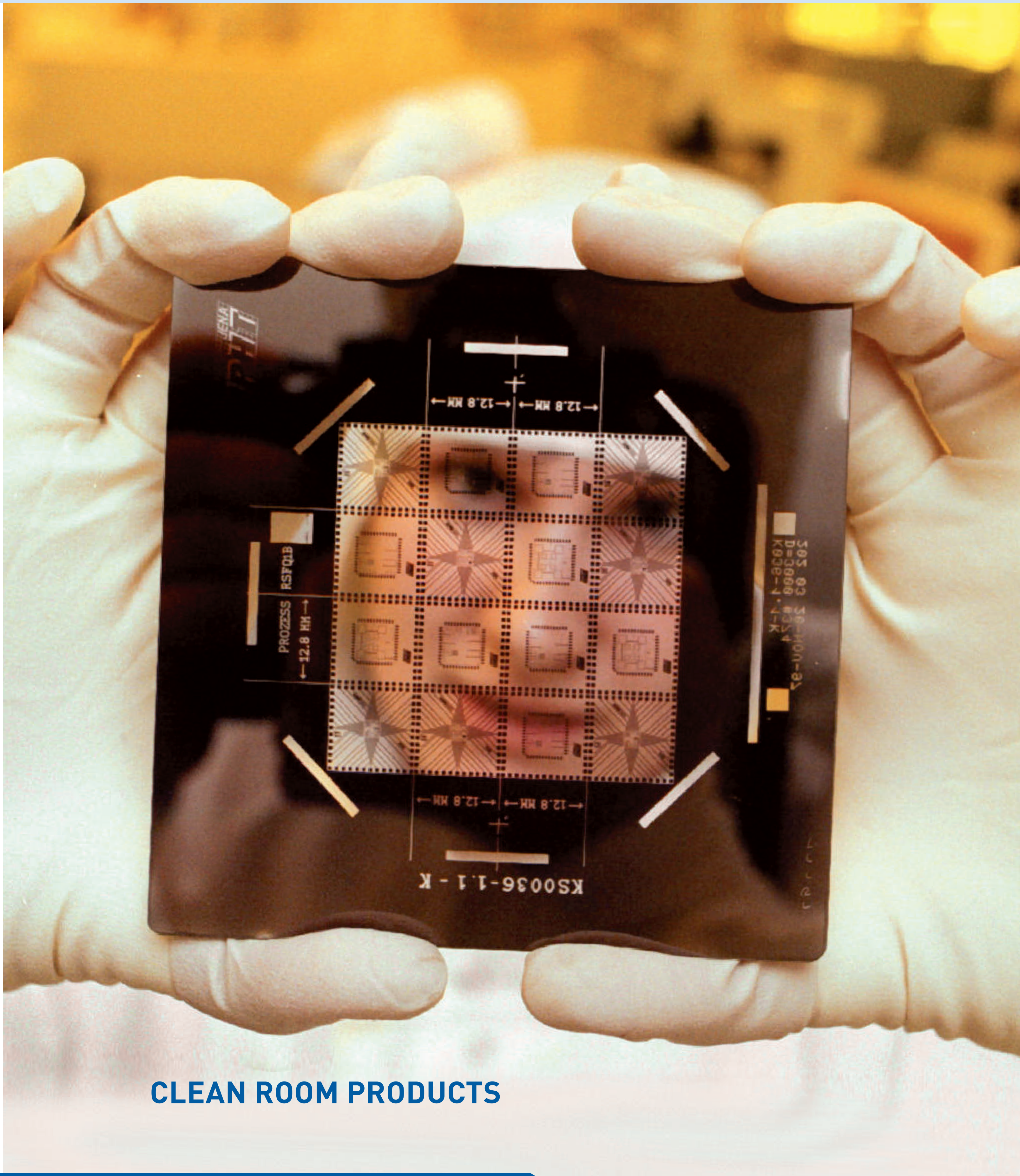
DYKE INTERCALATED TRAPS



This capability allows interpreters to predict geological trends from a single line and relate it more effectively to the geological features interpreted from seismic data usually recorded on widely spaced seismic survey lines. In turn, this trend information can be used to reduce any ambiguity inherent in a 2D seismic interpretation of prevailing structures.



The oriented sensors within the SQUID detector provide high precision for estimation and detection of magnetization directions of igneous intrusions.



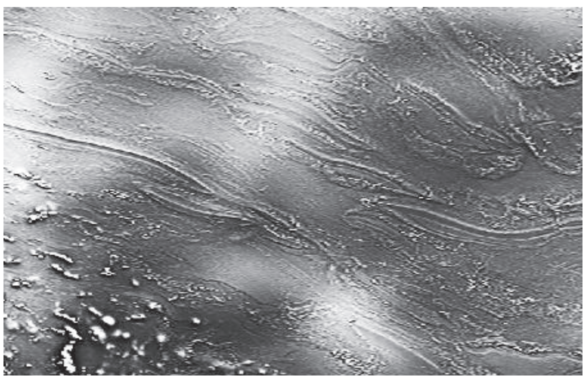
CLEAN ROOM PRODUCTS

ENERGY EXPLORATION

Precision Mapping of Weakly Magnetized Dipping Sediments

Weakly magnetized sedimentary formations, located at an unconformity surface, where the formation boundary can only be linked to sparse seismic data, can now be mapped accurately so that a 3D geological model can be constructed. There are many examples of this in Australian basins such as the Pedirka, Amadeus, Canning and Darling.

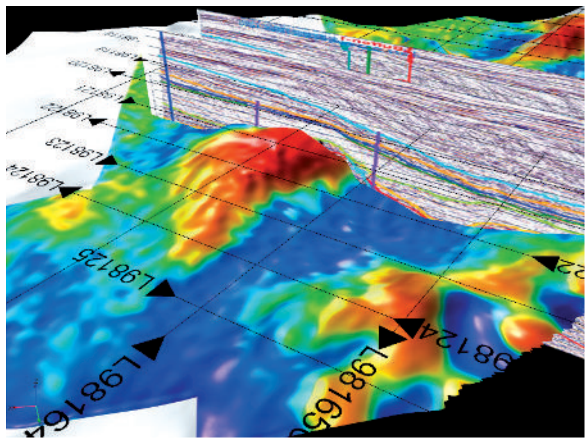
The figure below shows the first vertical derivative of the total magnetic field from a segment of the Amadeus Basin in Central Australia.



The high precision of the SQUID sensor will improve detection limits and mapping of geological boundaries between lines. Subtle offsets that can be attributed to faulting will contribute to the development of an improved structural framework by combining seismic structures with geological detail that exists between the seismic lines.

Precision Mapping of Reservoir Seals

There are many localities where volcanic horizons provide effective hydrocarbon seals during subsequent structural evolution. The SQUID system has the potential to improve on the accuracy of the final map product when the magnetic data is combined with sparse seismic data.



When combined with detailed seismic and drilling data, magnetic survey interpretations provide additional geological constraints for seismic interpretations and assist with the correlation of features between widely spaced seismic lines.

More interpretable Magnetic Field Inclinations

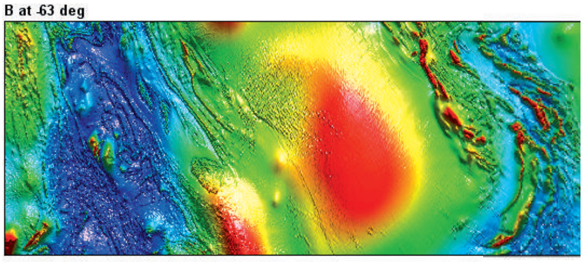
Total field magnetic surveys recorded in regions of low magnetic field inclinations are difficult to interpret as a direct analogue of a geological map. The vertical gradient of the vertical component of the magnetic field is much easier to interpret and thus produces more reliable geological interpretations.

The set of images overleaf shows the results of transforming a total magnetic intensity image at an inclination of -63 degrees (top) to a low field inclination image at -10 degrees (middle). The low field inclination is much more difficult to interpret as the high amplitude features are displaced from their true spatial location.

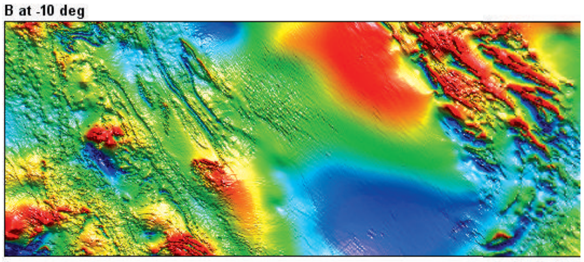
THE BEST QUALITY IN SQUID AND MICROFABRICATION TECHNOLOGIES

A further transformation of the middle image to the vertical gradient of the vertical component is shown in the lower image. This image simulates the vertical gradient component of the SQUID gradiometer and provides insights into the type of geological information that will be recorded directly by the gradiometer in areas of low magnetic field inclination. In this image the geological features are expressed clearly in their true spatial location.

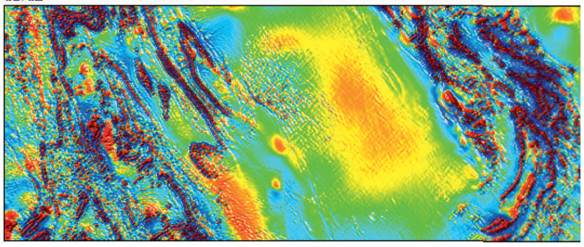
B at -63 deg



B at -10 deg



dB/dZ



Oil producing regions in northern Africa, the Middle East, India, south Asia and northern South America are adversely affected by the low magnetic inclination problem if surveyed with a conventional total field magnetometer.

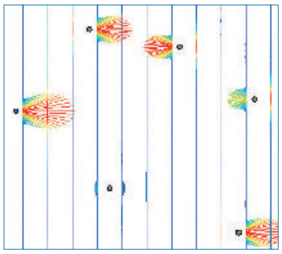
ENGINEERING & PRODUCTION

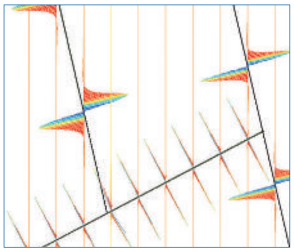
Buried infrastructure such as well collars and well casings can be detected by the SQUID gradiometer even if it does not pass directly over the location of the lost asset. The high sensitivity and directional sensitivity of the SQUID gradiometer enables it to detect objects that are buried and situated away from the sensor and between lines of flight.

Problems in locating infrastructure such as pipelines, drains and electrical cables are experienced in many old oil fields in the USA, Canada and Europe. The high sensitivity and directional sensitivity of the SQUID gradiometer can assist in mapping and the recovery of the lost infrastructure. In the simulated example shown opposite, the surface projection of the well heads are shown as black dots surrounded by vector plots of the Bxz, Byz, Bzz tensor components, colour coded by Bzz. The vectors point towards the casing, and geophysical inversion allows for accurate positioning of the holes even though they are offset from the flight lines.

It is often impractical to fly conventional magnetometers in this situation as it can be difficult to distinguish objects located on, or above, the surface from those which are situated or buried one to two metres beneath the surface. Helicopter mounted systems are ideally suited for capturing data in regions with significant infrastructure where a conventional fixed wing survey aircraft may be prohibited from flying. The example below shows a vector display from a model simulation over buried pipelines.

SIMULATED EXAMPLE OF SURFACE PROJECTION





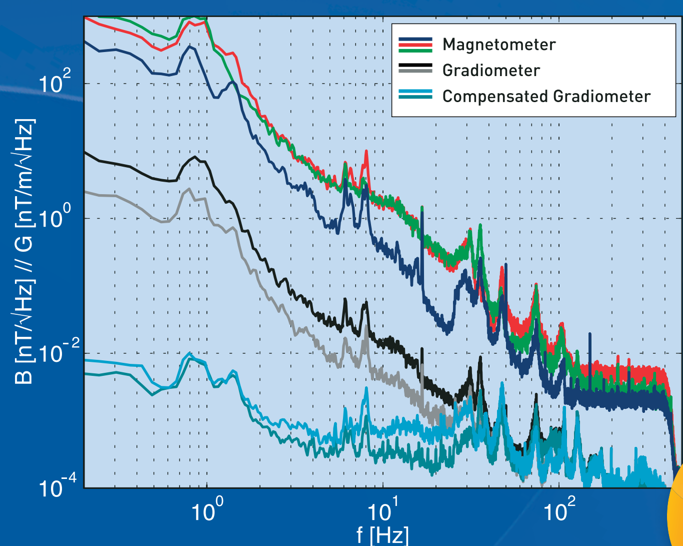
High Resolution Microstructures in the Near Surface

When interpreting onshore surveys, micro-magnetic anomalies associated with shallow structures are often used as a way of mapping structural trends, with both jointing and faulting. The orientation, persistence and frequency can be related to the current tectonic framework and help in the re-assessment of structures at depth.

The SQUID sensor will increase the level of detection and the ability to determine azimuth and correlation from line to line.

HARDWARE SPECIFICATIONS

Component	Description
SQUID gradiometer	specially developed SQUID sensors can extraordinarily well suppress homogeneous fields and reveal hidden structures
Cryostat	non-magnetic, low noise Dewar for liquid helium, refilling interval of 2-3 days
Magnetometer SQUID	used for noise compensation and for extra data analysis
SQUID electronics	electronics for the ampflification of sensor signal and control of the SQUIDs
24 Bit data acquisition system	Analogue to digital conversion and data transmission via WLAN to the computer
Inertial unit	sensors, and differential GPS for the determination of position and motion of the platform and the SQUID sensor
Power Supply	power supply for the measuring system, independent from on-board systems



unsurpassed sensitivity

EFRE
EUROPA FÜR THÜRINGEN
EUROPÄISCHER FONDS FÜR REGIONALE ENTWICKLUNG

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LAYOUT & GRAPHIC DESIGN: timespin

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