Automated NIKON photo-microscope supports world-leading rock analysis

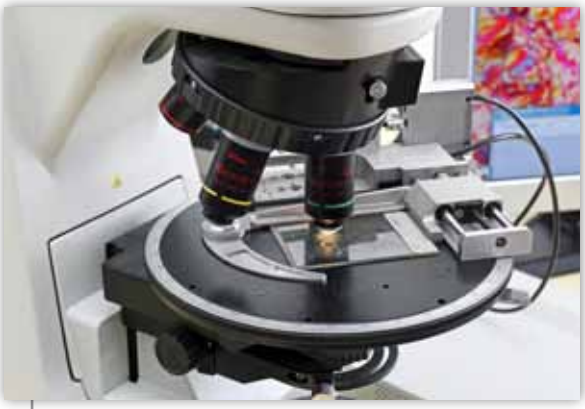
Computerised inspection system for the energy sector finds applications analysing safety-critical concrete

British companies have often been accused of inventing leading-edge technology and then allowing it to be developed commercially overseas. Conwy Valley Systems in North Wales is an exception. Founded in 1997 by Dr Barrie Wells and his partner, Mark Gorst, it has become a global leader in the supply of computerised photo-microscopy systems for inspection, statistical analysis and classification of rock samples to assist oil and gas exploration.

Known generically as a digital petrography tool and marketed under the trade name, PETROG, the latest system is powered by a Nikon Eclipse 50iPOL binocular microscope equipped with the Japanese firm's DS-series digital camera, all supplied through Nikon Metrology in Castle Donington, Derbyshire.

The advance in this branch of technology has been so profound that it has become almost essential for petrophysicists and remote sensing geophysicists to use it for calibrating and ground-truthing their otherwise largely relative, as opposed to absolute, measurements of rock structures. Companies in 44 countries use the system, the only significant markets yet to adopt it being China, Russia and Japan.

The automated point-counting system is a much faster and more accurate alternative to visual microscopy accompanied by manual tick-box recording of results. The user has a much better understanding of the rock sample, its constituent minerals, oil-bearing capacity and extraction potential. PETROG displays results almost immediately on the screen and has the added advantage of storing all photographic images for future re-analysis, if required.



The heart of a PETROG system is the low profile, motorised, rotating stepping stage, seen here fitted to the Nikon microscope.

The PETROG system comprises a Nikon Eclipse 50iPOL binocular microscope fitted with a Nikon Digital Sight DS-Fi2 5-megapixel camera which relays overlapping photographs of the rock sample to a computer for analysis via a Nikon FireWire control unit, DS-U3.

Another alternative way of testing rock is crushing analysis, which simply calculates the porosity of the sample and hence the amount of oil it could contain, but it gives no indication of how the holes were interconnected and thus how well oil would flow.

The uniqueness of PETROG derives from the invention of a stepping stage which allows the polarising microscope stage to rotate automatically. Unlike a conventional microscope on which the slide and stage are fixed, apparatus for looking at rock has to view light at different angles through a polarising filter. Only in this way it is possible to distinguish between different constituents such as feldspar, quartz and clay, hence the need to index the stage in known increments. The system is equally suited to studying samples illuminated episcopically (by reflected light) or diascopically (by transmitted light).

A further application in the energy sector is the analysis of coal samples to assess the quality of a seam. It enables a mine to determine how to blend its output and where it should be sold. For instance, a steel mill is able to use information on the coal's microstructure to calculate how long it will burn at blast furnace temperature, allowing the steelmaking process to be controlled and optimised.

The construction industry also benefits from PETROG, since a sample of man-made concrete can be analysed as easily as natural rock. It is an important new target market for Conwy Valley Systems. A recent success was the purchase by CEDEX, a Spanish government research agency in Madrid, of the digital petrography tool for monitoring the integrity of civil engineering structures in Spain's built environment, including critical structures such as dams, looking for early warning signs of failure in the concrete structure.

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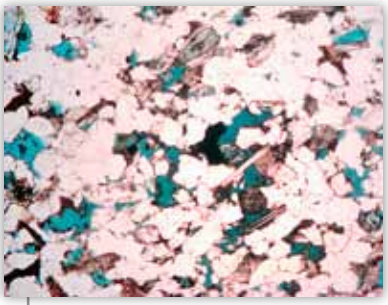
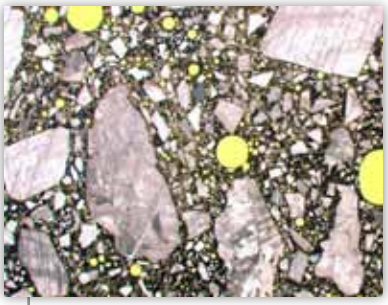


A photo-micrograph of sandstone from one of Total's oilfields, with the pores highlighted by the addition of blue dye. It was taken with a Nikon-equipped PETROG system. Conwy Valley Systems has a patented process (patent number GB2480065) to make use of the information obtained from this staining.



A photo-micrograph of a concrete sample taken by CEDEX, Spain. The pores appear yellow because the concrete is impregnated with epoxy and a fluorescent dye has been added. The porosity in this sample is quite moderate. The aggregate is limestone, which can be granitic, while the brownish matrix is cement paste. Picture height is 13.6 mm.

A polished thin section of rock sample from the Chicxulub meteorite impact site in Mexico, which is suspected of having caused the dinosaurs to die out 65 million years ago. The rock shows the effects of high stress and high temperature alteration. The photomicrograph was taken by Conwy Valley Systems using plain transmitted light on a Nikon-equipped PETROG system.

The first application in this sector dates back to 2004, when a PETROG system was installed in Cornwall, UK, to support mortgage providers by checking for a specific impurity in locally made concrete that can potentially cause cracking. The so-called mundic tests are needed because, before 1950, houses in the South West of England were often built with concrete block containing aggregate consisting of copper or lead mine waste which in turn contains sulphides that can oxidise and accelerate degradation. The PETROG installation, at Petrolab in Redruth, was an early example of a system fitted with a digital camera (model DXM1200) from Nikon Metrology. Other manufacturers' digital cameras and microscopes can be similarly utilised, according to customer preference.

Conwy Valley Systems, which won The Queen's Awards for Enterprise in the Innovation category in 2011, offers its petrography system with or without a microscope, according to whether one exists at a user's premises. It is assumed that a computer is available, although one can be provided. Key to the company's service are the supply and fitting of the stepping stage to the microscope, the digital camera and PETROG software. The latter is available in various versions to interface with different digital cameras' low-level control software so that images can be captured remotely and embedded for petrographical analysis. Eight man-weeks of programming by Conwy Valley Systems are typically required to achieve this level of integration.

The Nikon Eclipse 50iPOL polarising microscope is a compact desktop model with up to five centerable objectives ranging from 4x to100x mounted to the nosepiece. The bright, 30 Watt halogen light source consumes little power and so generates minimal heat, reducing the chance of temperature-induced focus drift.

More details are available at:
http://www.nikonmetrology.com/en_EU/Products/Microscope-Systems/Upright-Microscopes/Eclipse-50i-POL

The company's Digital Sight DS-Fi2 camera used in this microscopy application has a configurable head, a high-definition 5-megapixel sensor and a newly developed CCD control circuit offering a fast frame rate of 21 per second. A digital video camera is recommended for use with PETROG, rather than a still camera, as the faster response reduces waiting time for the image to catch up when refocussing, rotating the stage or changing filters.
Further details are at:
http://www.nikonmetrology.com/en_EU/Products/Microscope-Systems/Cameras/Digital-Cameras/DS-Fi2

The PC-to-camera control unit, DS-U3, uses a high-speed IEEE1394b (FireWire 800) serial bus interface, enabling rapid capture, management, processing and analysis of images.
Further details are at:
http://www.nikonmetrology.com/en_EU/Products/Microscope-Systems/Cameras/Controllers/DS-U3-Controller

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