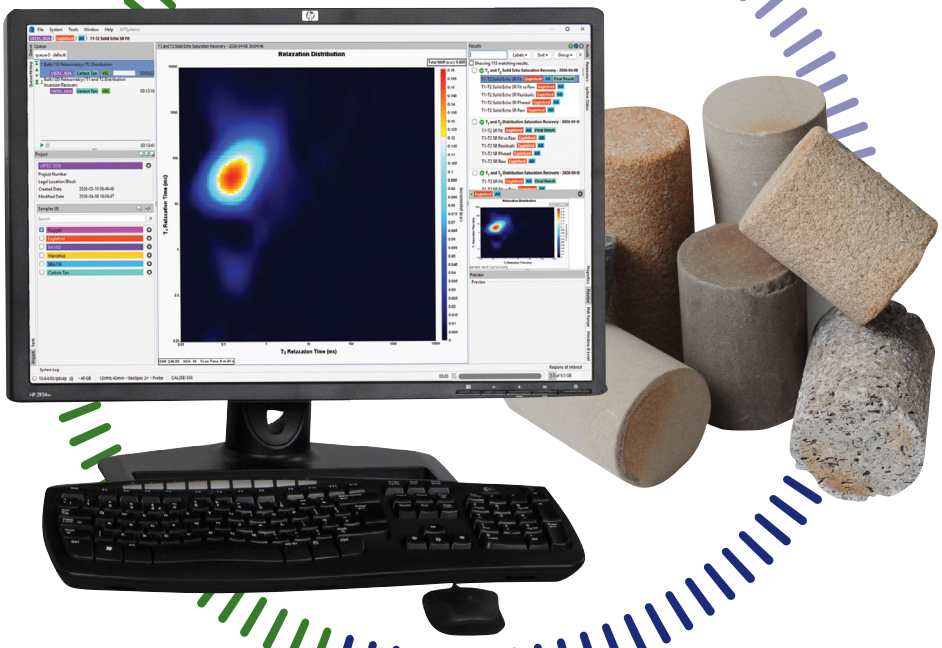
Green Imaging | OXFORD INSTRUMENTS

GeoSpec Software

NMR Software Solutions for the future



GeoSpec

NMR Software Solutions for the future

The world's cutting-edge rock core measurement techniques are all available in software solutions provided by Green Imaging and the **GeoSpec** line of NMR analysers developed by Oxford Instruments.

The **NMR ProLab** software line of products provides fast, accurate, non-destructive analysis of core plugs and is a proven asset in reservoir characterization. Reservoir properties such as capillary pressure, porosity, bound water, wettability, and relative permeability can all be measured or modeled from rapidly acquired NMR data. Green Imaging's software solutions solve current laboratory limitations and bring a new standard of simplicity, clarity, and usability.

The elegant user interface makes the acquisition, manipulation, and reporting of data exceptionally simple. We specialize in tight rocks, shales and other difficult regimes. From exploratory wildcats to increasingly difficult EOR regimes, Green Imaging's powerful techniques will help maximize core's data potential.

From Prediction to Production, Green Imaging's software solutions and laboratory measurement techniques lead the way.

Software that works for you

All **GeoSpec** rock core analysers come complete with **LithoMetrix** software, which acts as the user interface and performs all instrument management and basic core analysis functions. **LithoMetrix** can be upgraded to a version of **NMR ProLab** software for more advanced measurements. **NMR ProLab** packages include **NMR ProLab** Basic, **NMR ProLab** Advanced and **NMR ProLab** 3D Imaging. Each user can select the software package that includes the tests they want to perform on their **GeoSpec** instrument.

All software packages include:

- Intuitive user interface, designed in collaboration with professional rock core analysts.
- Diagnostic aids, easy calibration tools, and instrument performance database.
- Routine measurements pre-packaged with automatic calculations.
- Project and sample results database maintained automatically.
- "Scan cards" allowing multiple measurements to be set up in advance, to run unattended.
- Software used, tested and continually improved in our own commercial core laboratory.

Green Imaging's software solutions maximize the power of the **GeoSpec** NMR instrument by expanding the analysis that can be performed; accurately and repeatably.

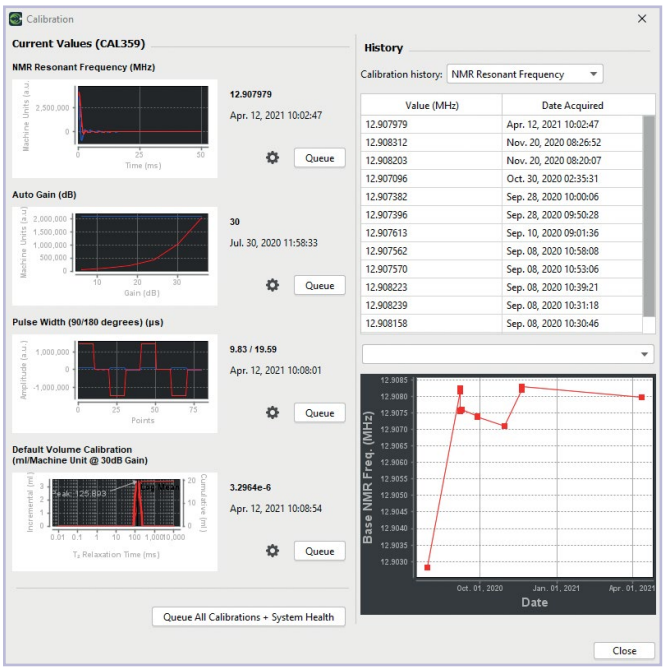
GeoSpec

LithoMetrix™

Our most basic software package, **LithoMetrix** acts as the operating system for the NMR instrument, simplifying calibration and maintenance of the system while providing a simple interface for users to perform the basic NMR analysis functions.

Process your data:

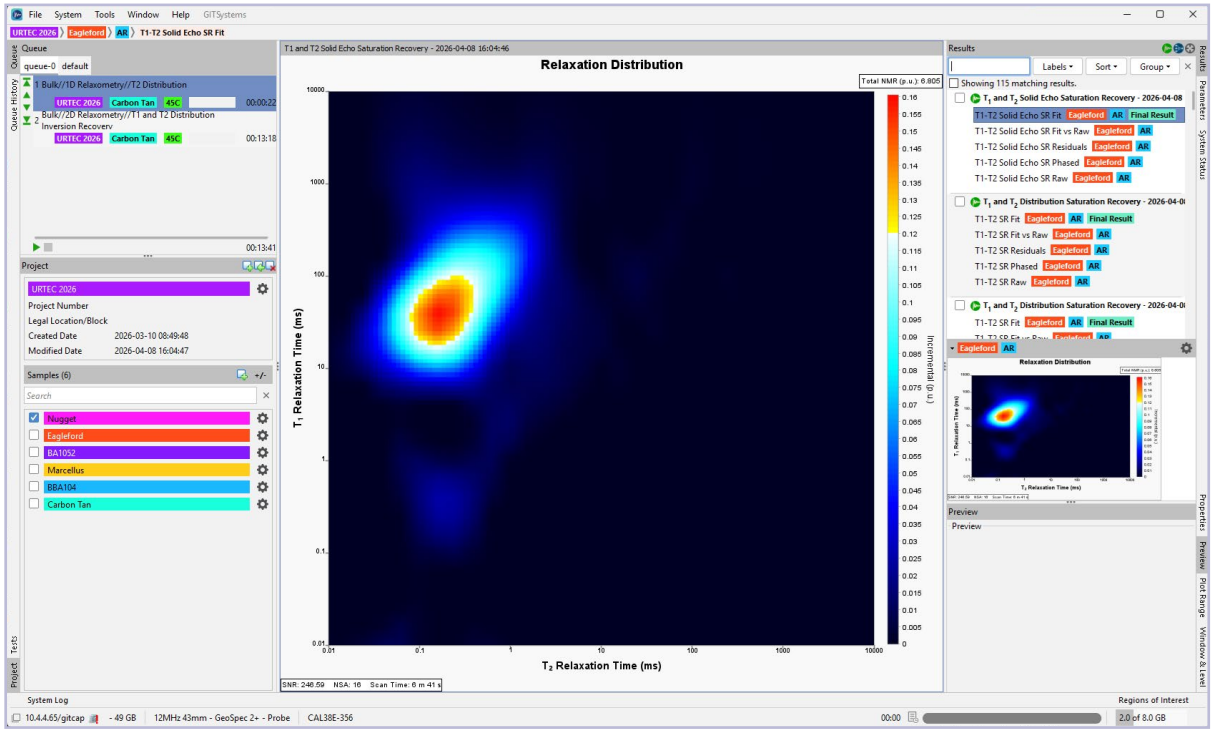
- Reprocessing of 1D Inversions
- Exponential fitting of data
- Standard permeability models (Coates & T_2 log mean)
- Compute model coefficients or permeability from standard values
- Multi-sample statistical analysis
- Background subtraction of data



Measure	To gain a better understanding of
T_1 and T_2 pore size distributions	Pore size distribution
T_1 and T_2 Analysis	Free fluid index, bound volume index, clay bound water, and effective porosity
Free Induction Decay (FID)	Rock matrix heterogeneity

Simplify your laboratory work:

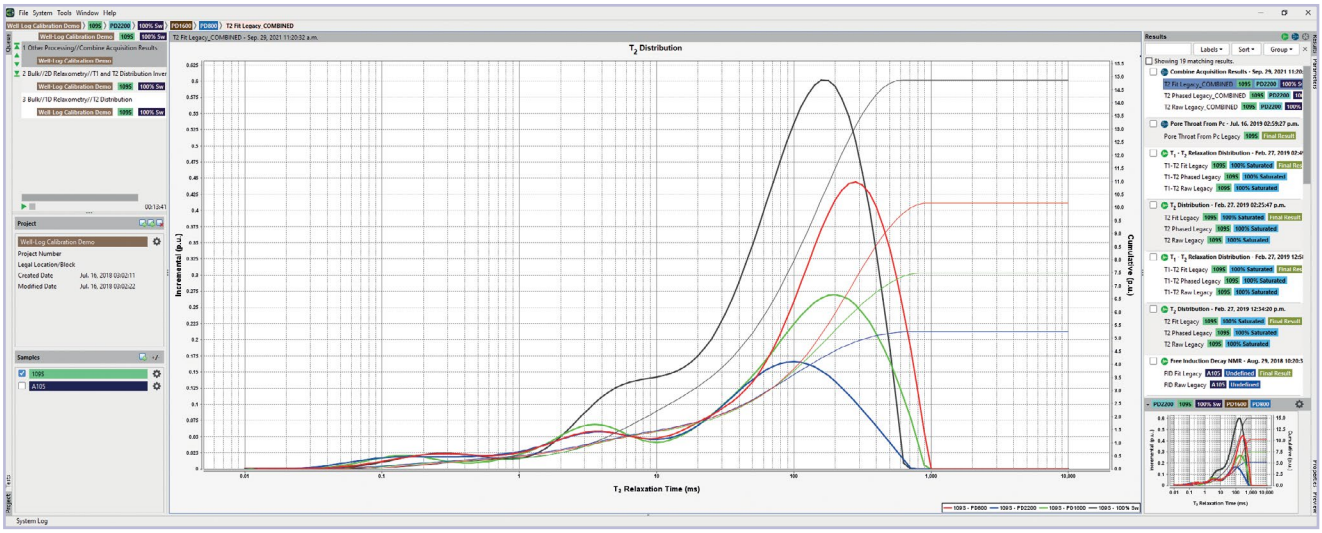
- Directly control NMR instrument
- Protect hardware and maintain calibrations
- Using a simple intuitive user interface
- Customizable reporting
- Remote database storage
- Multi-site configurable
- Scan Automation



NMR ProLab Basic

NMR ProLab Basic adds to the measurement capabilities within **NMR ProLab LithoMetrix**. We recommend that any **GeoSpec** analyser with gradients be equipped with **NMR ProLab** Basic software so the power of the gradients can be harnessed for more advanced measurements such as diffusion.

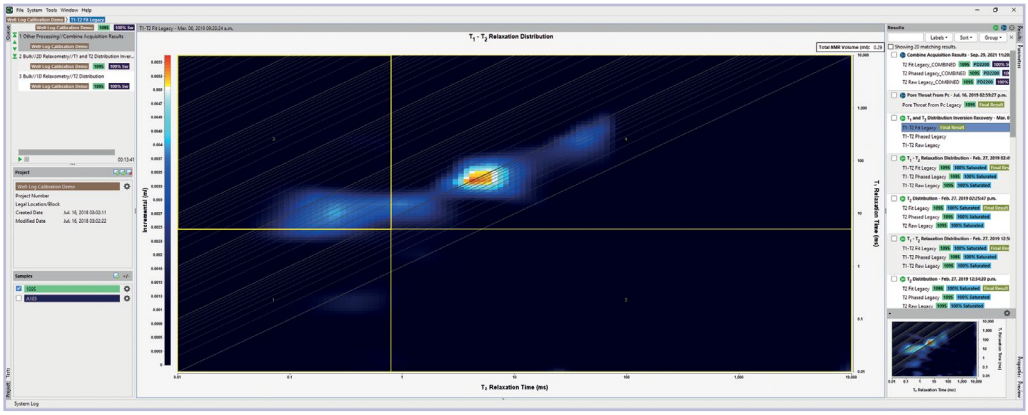
Quadrant	Represents	P.U
1	Bound water	1.9%
2	Heavy hydrocarbons	4.9%
3	Free fluids	3.6%
4	Water	2.3%



Analyze:

- Multi-sample permeability models optimization
- Air permeability vs. NMR permeability comparison
- Combine Acquisition results
- Gaussian fit distributions
- Permeability from T_1 or T_2
- Reprocessing of 2D Maps
- 2D Cut-off Analysis for T_1-T_2 Map (Fluid Typing)
- Artefact removal for 2D Maps
- Statistical Analysis

Measure	To better understand
Diffusion distributions	Fluid properties
2D Maps • Diffusions - T_2 • T_2/T_2 • T_1 / T_2	Fluid typing • Pore network connectivity • Shale fluid typing • Optional Saturation Recovery for quicker acquisitions.
Saturation Recovery T_1	Faster T_1 pore size
Slice Selective T_2	Longer sample support
Hydrogen Index determination	Fluid properties



GeoSpec

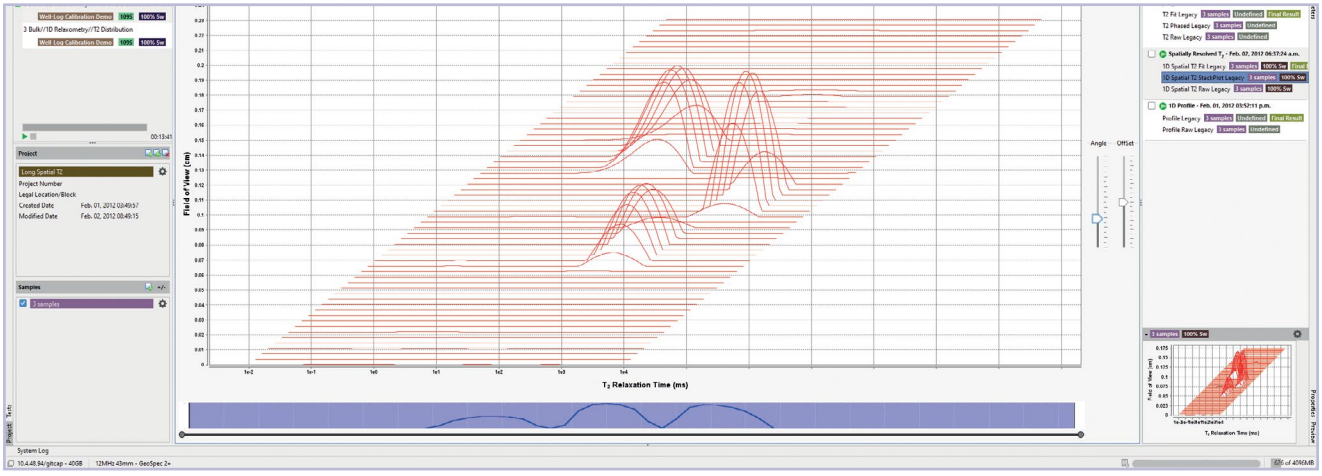
NMR ProLab Advanced

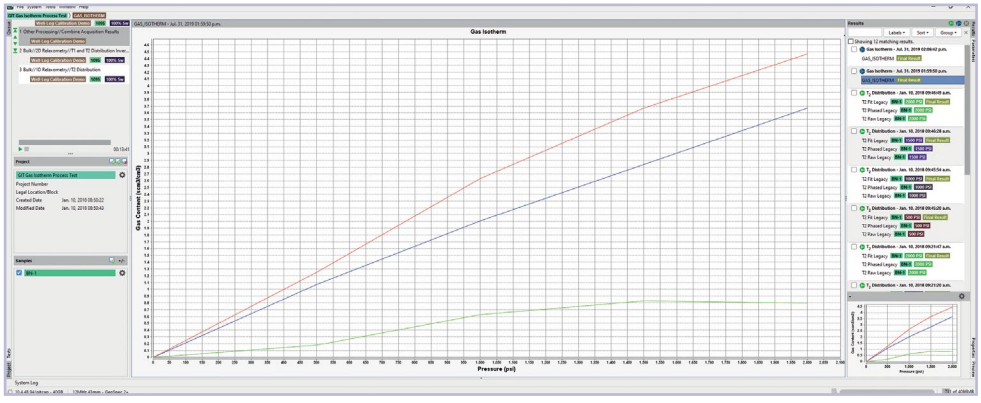
NMR ProLab Advanced provides access to the most advanced measurements for high end NMR systems for production and research environments. No longer are researchers and laboratory managers required to write their own pulse sequences to get the data they need. **NMR ProLab** Advanced provides access to Green Imaging's patent protected measurements and data processing tools to allow your research to advance to the next level.

Analyze:

- T_1/T_2 Relaxivity Determination
- Pore Throat Distribution from Pc
- Relative Permeability from Pc
- Pc from T_1/T_2
- Gas Isotherms
- Wettability from
  - T_1-T_2 Diffusion Maps
  - T_2 Distributions
  - T_1-T_2 Maps

Measure	To better understand
GIT-CAP capillary pressure measurement	Rock petrophysics
1D Saturation Profiles	Porosity distribution
Out of Volume Suppression for 1D Saturation Profiles	Support for long samples
1D Spatially Resolved • T1s • T_2s • T_1-T_2 Maps	Allows the ability to see spatial variations in these measurements
T_1-T_2 Diffusion Maps (3D relaxation maps)	Allows the ability to see individual maps for each fluid (fluid typing) and also can be used for wettability analysis
Wettability	Allows the ability to measure how the fluid in the sample interacts with the pore walls and monitor changes during flow studies.





NMR ProLab App Builder

For users who do want to write their own pulse sequences, **NMR ProLab App Builder** provides a complete development environment including sequence development and results visualization. Ask us for more information.

GeoSpec

Measure	NMR ProLab LithoMetrix	NMR ProLab Basic	NMR ProLab Advanced	NMR ProLab 3D Imaging
T_1-T_2 Pore size distributions	✓	✓	✓	✓
Free Induction Decay (FID)	✓	✓	✓	✓
T_1-T_2 Analysis	✓	✓	✓	✓
FFI, BVI, CBW Effective Porosity, T_2 Cut-Off	✓	✓	✓	✓
NMR Permeability Estimation from T_1 & T_2	✓	✓	✓	✓
Multi-Sample Analysis	✓	✓	✓	✓
Reprocessing of 1D Inversions	✓	✓	✓	✓
Background Substraction of Data	✓	✓	✓	✓
App Builder		✓	✓	✓
Multi-Sample Permeability Models		✓	✓	✓
Air Permeability vs NMR Permeability Comparison		✓	✓	✓
Diffusion Distribution		✓	✓	✓
2D Maps (T_1-T_2, Diffusion/T_2, T_2/T_2)		✓	✓	✓
Saturation Recovery T_1		✓	✓	✓
Slice Selective T_2		✓	✓	✓
Combine Acquisition Results		✓	✓	✓
Hydrogen Index Determination		✓	✓	✓
Gaussian Fit of Distributions		✓	✓	✓
Statistical Analysis		✓	✓	✓
Permeability from T_1 or T_2		✓	✓	✓
2D Cut-Off Analysis for T_1-T_2 Map (Fluid Typing)		✓	✓	✓
Artefact removal for 2D Map		✓	✓	✓
Reprocessing of 2D Maps		✓	✓	✓
GIT-CAP™ Capillary pressure measurement			✓	✓
Relative Permeability from Pc			✓	✓
Pore Throat Distribution from Pc			✓	✓
T_1-T_2 Relaxivity Determination			✓	✓
1D Saturation Profile			✓	✓
Out of Volume Suppression for 1D Saturation Profiles			✓	✓
Pc from T_1-T_2			✓	✓
1D Spatially resolved T_1			✓	✓
1D Spatially resolved T_2			✓	✓
1D Spatially resolved T_1-T_2 maps			✓	✓
T_1-T_2 Diffusion Maps (3D relaxation maps)			✓	✓
Gas Isotherms			✓	✓
Wettability from T_1-T_2 Diffusion Maps			✓	✓
Wettability from T_2 Distributions			✓	✓
Wettability from T_1-T_2 Maps			✓	✓
2D Spatially Resolved T_2				✓
3D Image Viewing				✓
2D Spiral SE-SPI, 3D conical SE-SPI				✓
2D spiral SPRITE, 3D conical SPRITE				✓
FSE 2D Centric and 3D FSE Spiral				✓
Variable Tau CPMG	✓	✓	✓	✓
3D T_1-T_2-Diffusion Maps				✓

NMR ProLab 3D Imaging

For NMR and MRI instruments with full 3D imaging capabilities, NMR ProLab 3D Imaging provides access to the latest 3D imaging pulse sequences (acquisitions) and tools for viewing and analyzing 3D imagery of rock cores. Flow studies can be viewed in real time in 3D allowing users to see the flow front interacting with the entire pore network.

The 3D Imaging software provides access to NMR applications such as fluid mobility, saturation, porosity, wettability studies, shale analysis, and capillary pressure. It also adds a full suite of 3D acquisitions, processing and viewing capabilities.

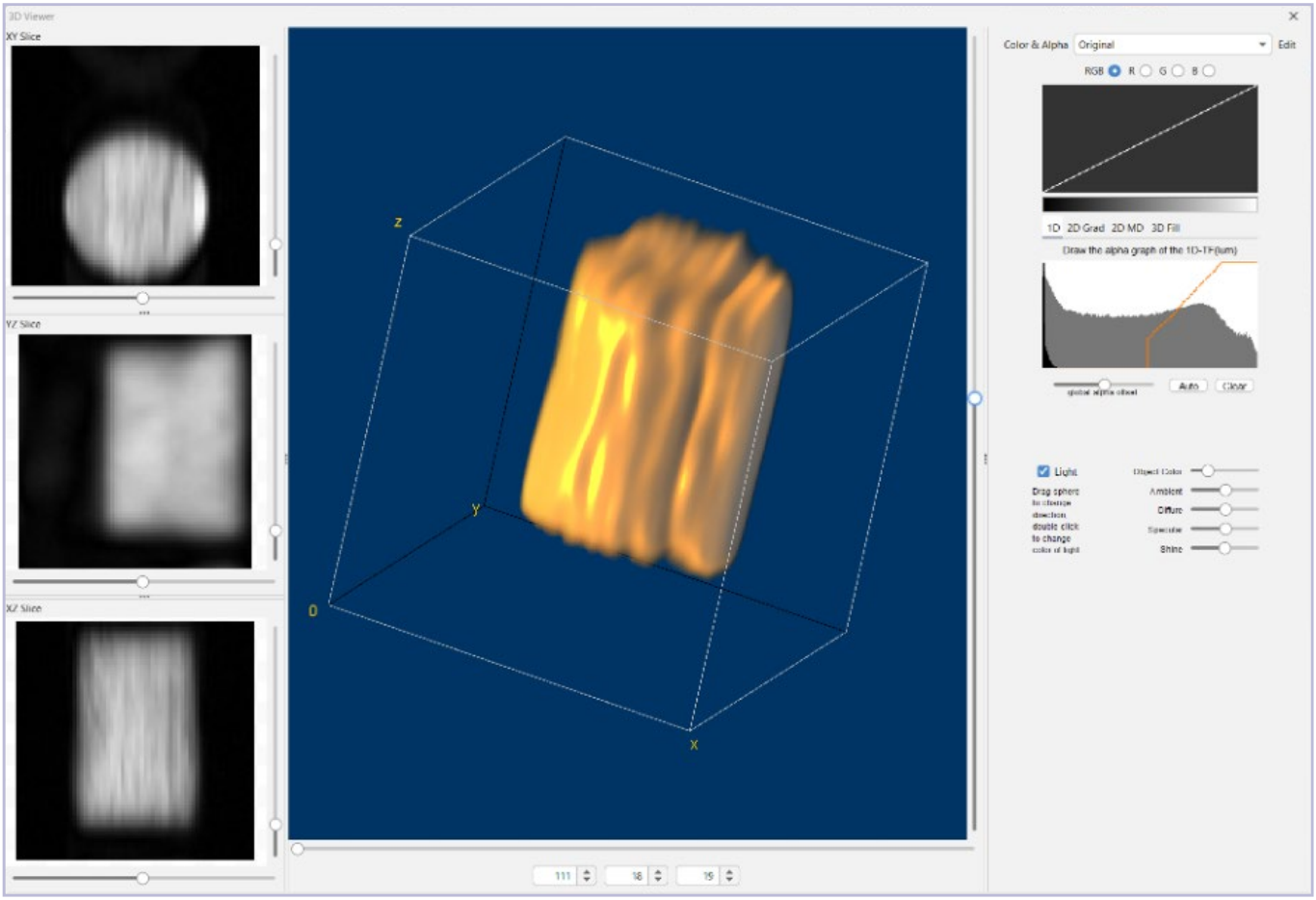
Analyze:

- 3D image processing
- 3D viewer tool
- Ability to use custom k-space trajectories for all imaging acquisitions

Measure	To better understand
2D spatially resolved T_2	Fluid distribution with added information about what type of pore it is in (size of pore)
2D spiral SE-SPI, 3D conical SE-SPI	Pulse sequences specifically designed to perform measurements on medium porosity rocks
Saturation Recovery T_1	Pulse sequences specifically designed to perform measurements on tight rocks
Slice Selective T_2	Pulse sequences specifically designed to perform measurements on conventional rocks

A perfect solution to monitor:

- Flooding experiments
- EOR research
- Sweep efficiency



Global Support

The Oxford Instruments – Green Imaging Technologies partnership has experience of supplying systems all over the world, with instruments installed on 6 continents. Our hardware and software is developed, built and tested in-house.

We have our own core analysis laboratory, providing a service specialising in difficult rocks, which can be used to validate your own results or act as a backup to your own production lab. We have support bases in the UK, the USA, Canada, and China, as well as a network of partners and resellers with global reach. No matter where you are located, our global support network can provide prompt, personal service.

For more information visit: **nmr.oxinst.com/geospec**

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