CORPUS PUBLISHERS

Journal of Mineral and Material Science (JMMS)

ISSN: 2833-3616

Volume 5 Issue 5, 2024

Article Information

Received date : November 25, 2024

Published date: December 18, 2024

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DOI: 10.54026/JMMS/1100

Short Communication

A Rock ! Is It Porous ? Does it Contain Oil or Water ? - A Tool for the Hiker

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Abstract

This mini-review discusses two instruments, for use both in the lab and the field, for studying porous rocks and the hydrocarbons or water that they may contain. One instrument is suitable for use by a hiker, the other is perhaps describable as "luggable".

Discussion

Here we see the ultra-compact MK4 Lab-Tools NMR T-D Spectrometer [1] - it is ideal for quantitative measurements of solid and liquid hydrocarbons (and water) in porous rocks in the lab and in the field. Only tiny (30mg to 100mg) samples are needed. Time-domain NMR Relaxation is an extremely useful quantitative technique for materials science and process measurement & control. This time-domain NMR spectrometer can be used to study solids such as polymers and porous materials (Figures 1 & 2). This gives data on sample component masses and molecular movement of the atoms and molecules, which lead to mobility qualities which are variously described as mobility, dynamics, stiffness, viscosity or rigidity.

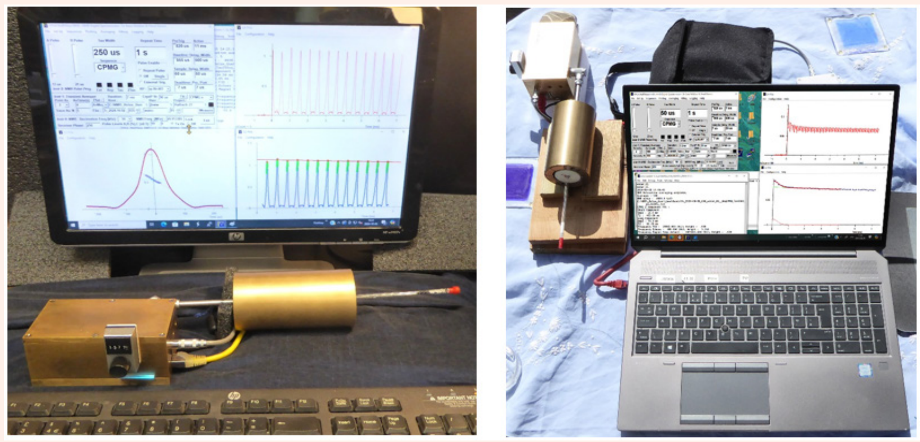

Figure 1: On the left : The T-D NMR Spectrometer being used in the lab to characterise liquids in pores. On the right : It is being used in the field : This NMR Spectrometer fits into a lap-top bag, complete with a regulated 8 hour battery supply, needing only a lap-top for control Graphical User Interface and data logging, so is extremely portable.

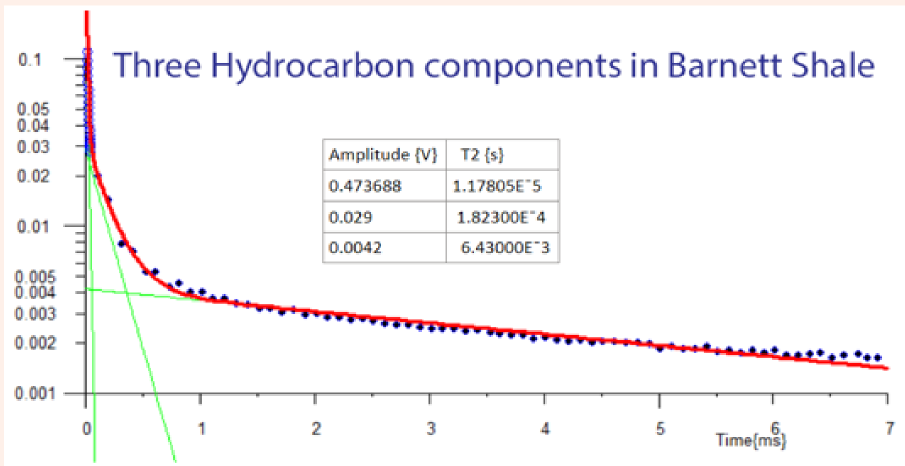

Figure 2: Three resolved hydrocarbon components in a Barnett Shale. For hydrocarbons in porous rocks, the MK4 NMR TD Spectrometer can quantify and discriminate between the tar-like components, the more mobile oils, as well as the light oils, and then report on their mobility properties in real-time in the field.

Pore-Size-Distributions in Porous Rocks

The CryoPx Lab-Tools NMR Cryoporometers can be used for measuring nano- to micro- pore size distributions in porous rocks in the lab and in the field. The components are modular, including a MK4 NMR T-D Spectrometer, needing only say a car boot to transport the larger (but carriable) component. Like the standard Gas adsorption technique, NMR Cryoporometry uses a thermodynamic technique to measure pore-size (Figures 3 & 4). From the Gibbs Equations. The constant temperature version gives rise to the Kelvin Equation, and hence the technique Gas Adsorption. The constant pressure version gives rise to the Gibbs-Thomson Equation, and hence the technique Cryoporometry [2]. The use of T-D NMR makes the system highly quantitative.

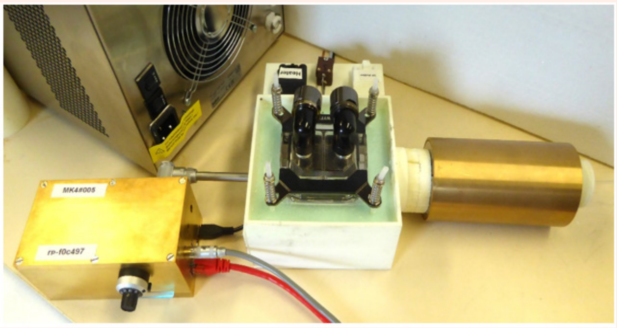

Figure 3: Components of a portable NMR Cryoporometer for measuring pore-size distributions in porous rocks : On the left, a MK4 T-D NMR Spectrometer, centre, a Pelter thermo-electric cooled variable-temperature NMR probe, right, a 0.5T 40mm ID bore Halbach NMR Magnet. At the rear, there is a portable thermo-electric chiller for removing waste heat.

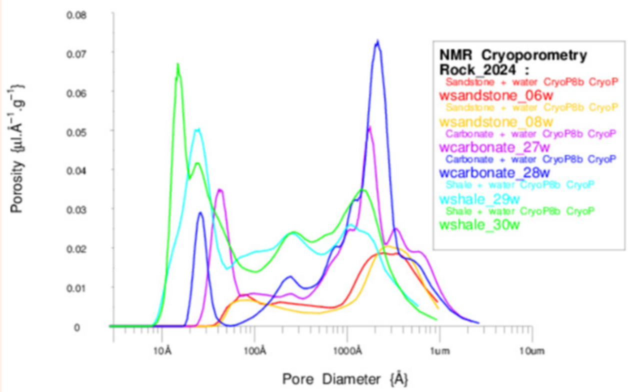

Figure 4: The pore size distributions of three porous rocks here are all measured twice using NMR Cryoporometry; Red & Yellow: Sandstone; Mauve & Blue: Carbonate (chalk); Cyan & Green: Barnett Shale.

References

1. Webber JBW (2024) Updates on an even more compact precision NMR spectrometer and a wider range V-T Probe, for general purpose NMR and for NMR cryoporometric nano- to micro-pore measurements. Micro 4: 509-529.
2. Mitchell J, Webber JBW, Strange JH (2008) Nuclear magnetic resonance cryoporometry. Physics Reports 461: 1-36.