

Title

Magnetic Resonance Free Induction Decay of Geological Porous Materials in the Single-Exponential and Non-Exponential Regimes

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Keywords used to describe the data topic:

Magnetic Resonance; Free Induction Decay (FID); Chalk; Berea Sandstone; Rocks; Exponential Decay; Diffusion; Porous Materials; Bloch-Torrey Equation; Internal Magnetic Field Gradients

Data description

This dataset contains ^1H magnetic resonance free induction decay (FID) data of three rock samples:

- Sample A – Berea sandstone, acquired from Kocurek Industries (Caldwell, TX, USA),
- Sample B – Danian chalk, retrieved from the Kraka oilfield in the Danish North Sea, and
- Sample C – Danian chalk, retrieved from the Dan field in the Danish North Sea,

vacuum-saturated with 2 wt% NaCl solutions. Berea sandstone is an Upper Devonian sandstone from the Kipton formation with a porosity of 0.20 and the average pore size of 26 μm from microscopy. It is grain supported with a composition of 89% quartz, 6% feldspar, and 5% micaceous clay minerals. Samples B and C had porosities of 0.32 and 0.37, respectively, and are both dominated by calcium carbonate with minor pyrite impurities and pore sizes smaller than a few micrometers.

Solvent flushing by ethanol and toluene completely removed crude oil, formation water, and any possible drilling fluids from the reservoir core plugs. The Berea sandstone core plug was saturated as received. All samples were in approximately cylindrical shape, 38-mm in diameter, and were dried at 70°C before saturation.

Two instruments recorded free induction decay data:

1. Oxford Instruments Maran DRX-HF vertical bore permanent magnet with the magnetic field of 0.20 T corresponding to ^1H frequency of 8.5 MHz. The 90° pulse length was 11 μs and the probe dead time was 67 μs .
2. Nalorac 2.4 T horizontal bore superconducting magnet with a Tecmag console and the magnetic field of 2.32 T corresponding to ^1H frequency of 98.8 MHz. The 90° pulse length was 11.5 μs and the probe dead time was 8 μs .

Both systems were shimmed by a water phantom with 3-axis imaging gradients prior to free induction decay measurements.

Parameter-estimation simulations with a matrix solution of the Bloch-Torrey equation in a planar pore geometry with the first-order approximation of linear gradients matched the free induction decay measurements. The details of the simulation study are reported in “Magnetic resonance free induction decay in geological porous materials” in *The European Physical Journal E*, <https://doi.org/10.1140/epje/s10189-021-00110-0>.

Data Files

A tabulated file is uploaded for each free induction decay measurement or simulation, each consisting of two columns of t and I ; where t is the time after the 90° pulse and I is the absolute signal intensity. Twelve comma-delimited text files contain the information as described in Table 1.

Table 1 – The list of comma-delimited text files containing free induction decay measurements and simulations.

File Name	Sample	Magnetic Field, T	¹ H Frequency, MHz	Data Type	Number of Points
A988M.txt	A	2.32	98.8	Measurement	1016
A988S.txt	A	2.32	98.8	Simulation	500
A085M.txt	A	0.20	8.5	Measurement	1024
A085S.txt	A	0.20	8.5	Simulation	400
B988M.txt	B	2.32	98.8	Measurement	2040
B988S.txt	B	2.32	98.8	Simulation	500
B085M.txt	B	0.20	8.5	Measurement	4096
B085S.txt	B	0.20	8.5	Simulation	400
C988M.txt	C	2.32	98.8	Measurement	2040
C988S.txt	C	2.32	98.8	Simulation	500
C085M.txt	C	0.20	8.5	Measurement	4096
C085S.txt	C	0.20	8.5	Simulation	400

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