Differences in the Texture of Chalk as observed by NMR

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Differences in the Texture of Chalk as observed by NMR

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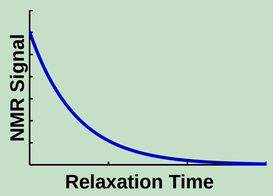
In this study, three cases under investigation illustrate how changes in the surface-to-volume ratio of chalk affect the low-field Nuclear Magnetic Resonance signal:

1. Outcrop chalk saturated with high salinity brine showed that saturation with **divalent ions** can cause major shifts in the T_2 curve.

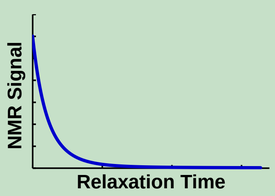
2. Fluid samples where **precipitation** reactions caused shifts in the T_2 curve due to the creation of crystals within the fluid.

3. Two types of chalk with **different surface-to-volume ratio**, saturated with the same brines produced different NMR signals.

➢ **NMR signal decay time (known as *relaxation)* is affected by the solid phase:**



Long distance from the pore walls means long decay times.



In **smaller distances**, NMR relaxation is affected by the solid.

➢ **Transverse relaxation rate, $1/T_2$:**

$$\frac{1}{T_2} = \rho \frac{S}{V}$$

ρ: surface relaxivity
S/V: surface-to-volume ratio

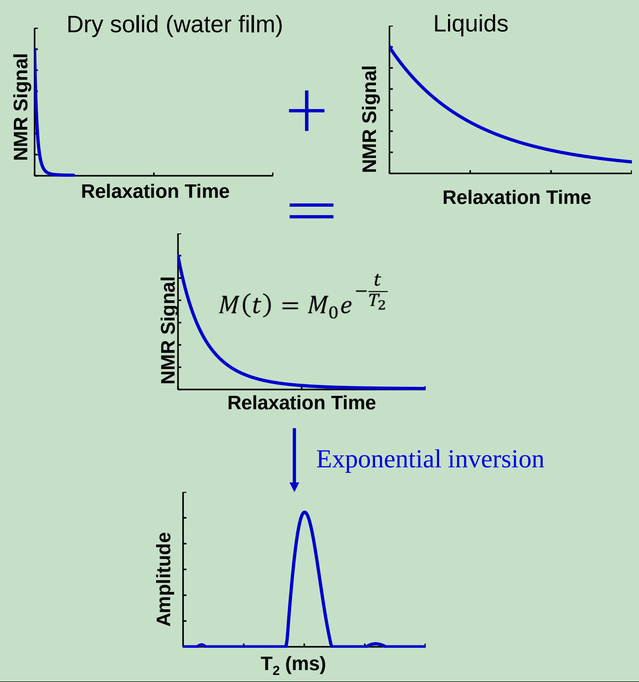
- ➢ Differences in the **rock texture**
- ➢ **Precipitants** within the pore space
- ➢ Variations in the **bound water thickness**

may affect the transverse relaxation time by altering the **surface relaxivity** or the **surface-to-volume ratio** in the following equation:

$$\frac{1}{T_2} = \rho \frac{S}{V}$$

as observed from the following results:

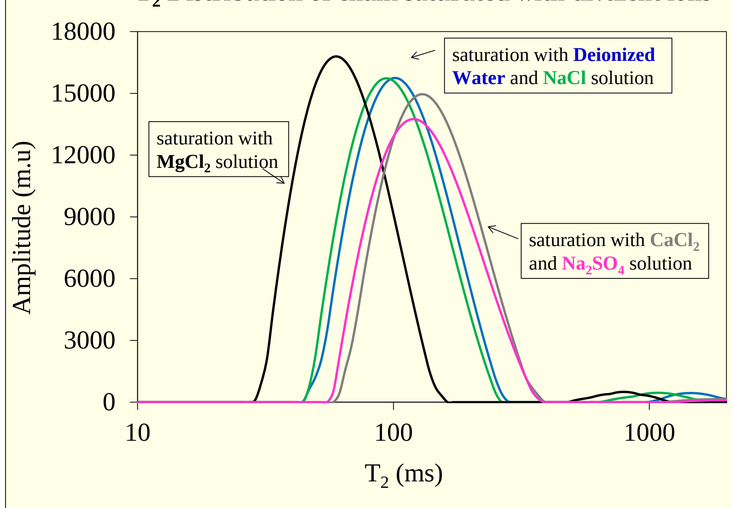
➢ **NMR Relaxation in the homogenous system of brine saturated chalk:**



➢ **Outcrop chalk with low surface-to-volume ratio saturated with divalent ions:**

Parameter	ST-Samples
Porosity (%)	~42
Grain density (g/cm^3)	~2.71
Permeability (mD)	~6
Carbonate content (%)	~99
Specific surface (m^2/g)	~1.7
Specific surface of the IR (m^2/g)	~50
Surface relaxivity (μm/s)	~0.9

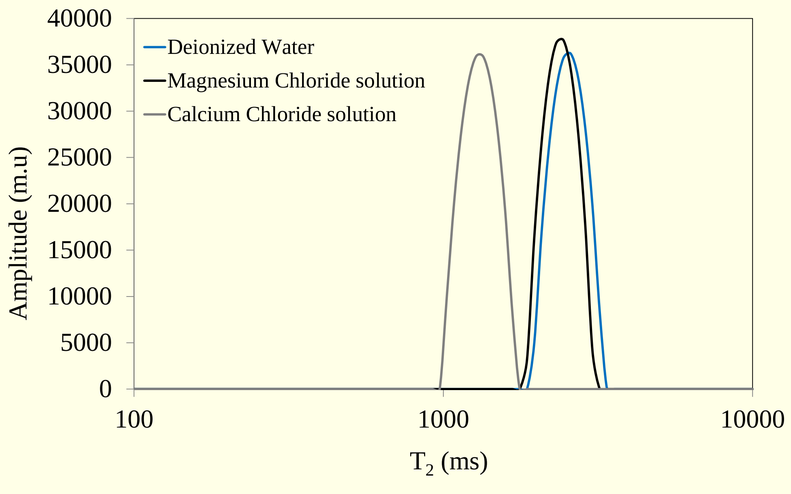
T_2 Distribution of chalk saturated with divalent ions



➢ **Brines that contain precipitants after contact with chalk:**

Brines with precipitants	Concentration (g/L)
Magnesium chloride solution	58.1
Calcium chloride solution	67.7

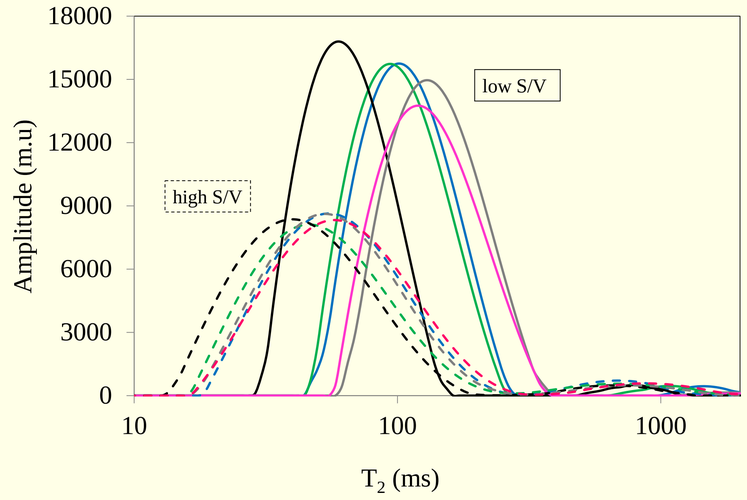
T_2 Distribution of solutions that contain precipitants



➢ **Outcrop chalk with high surface-to-volume ratio saturated with divalent ions:**

Parameter	MA-Samples
Porosity (%)	~38
Grain density (g/cm^3)	~2.70
Permeability (mD)	~5
Carbonate content (%)	~99
Specific surface (m^2/g)	~1.6
Specific surface of the IR (m^2/g)	~70
Surface relaxivity (μm/s)	~1.5

T_2 Distribution of chalk with high vs. low surface-to-volume ratio



➢ Low field NMR was successfully used to identify **changes in the surface-to-volume ratio**.

➢ Samples with **high surface-to-volume ratio result in smaller relaxation times**. Samples saturated with Mg-rich brines, brines containing precipitants, and chalk with different texture illustrate this.

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