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.

- 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:

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

as observed from the following results:

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

- Magnesium chloride solution: Concentration (g/L) 58.1
- Calcium chloride solution: Concentration (g/L) 67.7

**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): ~1.6
  - Specific surface of the IR (m$^2$/g): ~0.9
  - Grain density (g/cm$^3$): ~2.70
  - Porosity (%): ~38

**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): ~0.9
  - Surface relaxivity (μm/s): ~1.5

**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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* Katika et al., Nuclear magnetic resonance and sound velocity measurements of chalk saturated with magnesium rich brine, Poromechanics V., Madshiu M. V. et al., Chemical Alterations Induced by Rock-Fluid Interactions When Injecting Brines in High Permeability Chalks, Trans Pennon Med, 87, 578-582, (2011).