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 ratios, 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**, $1/T_2$:
    \[
    \frac{1}{T_2} = \rho \frac{S}{V}
    \]
    where $\rho$: surface relaxivity, $S$: surface-to-volume ratio

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

- Brines that contain precipitants after contact with chalk:
  - Calcium chloride solution
  - Magnesium chloride solution
  - Brines with precipitants Concentration (g/L)
    - Calcium chloride solution 67.7
    - Magnesium chloride solution 58.1

- Outcrop chalk with high surface-to-volume ratio saturated with divalent ions:
  - $T_2$ Distribution of solutions that contain precipitants
    - Delineated water
    - Magnesium chloride solution
    - Calcium chloride solution

- Outcrop chalk with low surface-to-volume ratio saturated with divalent ions:
  - $T_2$ Distribution of chalk saturated with divalent ions
    - Deionized water
    - MgCl$_2$ solution
    - CaCl$_2$ solution

- NMR Relaxation in the homogenous system of brine saturated chalk:
  - Dry solid (water film)
  - Liquids

- **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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