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

- Transverse relaxation rate, $1/T_2$:
  \[
  \frac{1}{T_2} = \frac{S}{\rho V}
  \]
  $\rho$: surface relaxivity
  $S$: surface-to-volume ratio

- Outcrop chalk with low surface-to-volume ratio saturated with divalent ions:
  - Brines that contain precipitants after contact with chalk:
    | Parameter                  | ST-Samples | MA-Samples |
    |---------------------------|------------|------------|
    | Porosity (%)              | 42         | 38         |
    | Grain density (g/cm³)     | 2.71       | 3.24       |
    | Permeability (mD)         | 6          | 3          |
    | Carbonate content (%)     | 99         | 99         |
    | Specific surface (m²/g)   | 1.7        | 1.6        |
    | Specific surface of the IR (m²/g) | 50    | 50         |

- Outcrop chalk with high surface-to-volume ratio saturated with divalent ions:
  - Brines with precipitants Concentration (g/L)
    - Magnesium chloride solution: 58.1 g/L
    - Calcium chloride solution: 67.7 g/L

- NMR Relaxation in the homogenous system of brine saturated chalk:

- 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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