Differences in the Texture of Chalk as observed by NMR

Katika, Konstantina; Addassi, Mouadh; Alam, Mohammad Monzurul; Fabricius, Ida Lykke

Publication date: 2014

Citation (APA):
Differences in the Texture of Chalk as observed by NMR

Konstantina Katika, Mouadh Adassi, M. Monzurul Alam and Ida Lykke Fabricius

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 T2 curve.

2. Fluid samples where precipitation reactions caused shifts in the T2 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
  - 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:

- Outcrop chalk with low surface-to-volume ratio saturated with divalent ions:
  - Brines that contain precipitants after contact with chalk:
    - Batches with precipitants
    - Concentration (g/L)
    - Magnesium chloride solution 58.1
    - Calcium chloride solution 67.7

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

- 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.

\[ \text{Amplitude (m.u)} \]

\( S/V: \text{surface-to-volume ratio} \)

\( \rho: \text{surface relaxivity} \)

\( \mu \text{m/s} \)

\( \text{Parameter ST-Samples} \)

\( \text{Parameter MA-Samples} \)

\[ \text{T}_2 \text{ Distribution of chalk with high vs. low surface-to-volume ratio} \]

\[ \text{T}_2 \text{ Distribution of solutions that contain precipitants} \]

Acknowledgement
The financial support from DONG energy, Maersk oil, Danish energy agency and DTU is gratefully acknowledged.

\[ \text{Grain density (g/cm}^3) \approx 2.71 \]

\[ \text{Porosity (%)} \approx 42 \]

\[ \text{Permeability (mD)} \approx 6 \]

\[ \text{Specific surface (m}^2/g) \approx 1.7 \]

\[ \text{Carbonate content (%)} \approx 99 \]

\[ \text{Specific surface of the IR (m}^2/g) \approx 50 \]

\[ \text{Surface relaxivity (m/s)} \approx 0.9 \]

\[ \text{Brines with divalent ions} \]

\[ \text{Calcium Chloride solution} \]

\[ \text{Magnesium Chloride solution} \]

\[ \text{Deionized Water} \]

\[ \text{CaCl}_2 \]

\[ \text{MgCl}_2 \]

\[ \text{NaCl} \]

\[ \text{Na}_2\text{SO}_4 \]

\[ \text{T}_2 \text{ Relaxation in the homogenous system of brine saturated chalk:} \]

\[ \text{Dry solid (water film)} \]

\[ \text{Liquids} \]