Influence of cementation factor on water saturation in carbonates of Main Dolomite in north-west Poland

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I. Introduction

Well logging data from the north-west part of Poland are used to show that diversity of cementation factor strongly influenced on water saturation and consequently calculated P-wave and S-wave velocity values. The purpose of this paper is to analyse alternative method of cementation factor selection in gas-bearing carbonates.

II. Workflow

First step was based on the calculation of an average cementation factor for each interval using Boraí formula (Eq.1) the result m=1.88 was obtained and after using Shell formula (Eq. 2) m=2.6. Laboratory analysis on core samples provided m=2. In the next step a water saturation interpretation was performed (Fig. 1) for the obtained cementation factors using GeoWiN Software (Jarzyna et al., 2002) to make borehole and environmental correction to resistivity. The next method of the reliability estimation of the Boraí and Shell formulas was the fluid substitution method. First, S-wave velocity was evaluated from wet Vp-Vs estimation using P-wave velocity and density curves and Brie’s equation GeoGraphix Discovery Software (Landmark AGH UST University Grant) for m=5 and Vp-Vs wet trend constants (Greenberg-Castagna equation) (Bala M., 2009). Having P-wave velocity (well log), S-wave velocity (wet Vp-Vs estimation, Brie’s equation for m=5) and diverse water saturation (Fig. 1) we examined changes in P-wave and S-wave velocities depending on gas saturation (Hampson-Russel Guide: crossplots).

Boraí formula (Eq. 1)

\[ m = \frac{-0.35 \Phi}{0.042 + \Phi} \]

Shell formula (Eq. 2)

\[ m = 1.87 + 0.049 \Phi \]

Symbols:
- m - cementation factor
- \( \Phi \) - porosity

III. Conclusions

Correct estimation of cementation factor is essential for proper porosity and water saturation determination in well log interpretation. Differences in Sw computed using different cementation factors: m=1.88, m=2, m=2.6 are significant.

- the highest gas saturation occurred for cementation factor m=1.88, and the lowest for m=2.6.
- Fluid substitution is the offer for P-wave and S-wave velocities calculations putting diverse water saturation,
- changes in P-wave velocities are likely seen than in S-wave,
- Vp/Vs ratio showed better discrepancy. Decreasing of the Vp/Vs ratio may be treated as a gas indicator in reservoir rocks.

There are known gas-bearing intervals: 2733-2763 m and 2775-2780 m. In those intervals P-wave velocity, S-wave velocity and also Vp/Vs ratio curves are parted for different water saturations (Fig. 1).

- interval occurred between two gas bearing layers showed small velocity discrepancy.

Crosplot 3D for Vp/Vs ratio shows significant differences in Sw computed using different cementation factors for m=1.88, m=2, m=2.6.

- for high porosity samples, low water saturation was observed and low Vp/Vs (Fig. 2). The higher gas saturation is, the lower Vp/Vs ratio occurs.

Figures:

Figure 1: Relation between P-wave and S-wave velocity and water saturation (Ca2- Main Dolomite top, A1G- Main Dolomite bottom).
*symbols are collected in table 1*

Table 1: Symbols for fig. 1

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Figure 2: Crosplot Vp vs Vs for m=2.6 and water saturation

Figure 3: Crosplot Vp/Vs ratio versus water saturation: for m=1.88 and porosity.

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References


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