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Significance of pressure solution structures analysis for fluid flow studies – examples from Struga-1 well (Zechstein Main Dolomite; W Poland): first results

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The internal structure and composition of pressure solution structures are factors that may influence petroleum generation and migration (Hofmann & Leythaeuser 1995). Pressure solution structures (PSS) i.e. stylolites and solution seams occur frequently in Zechstein carbonates of Poland (Kłapciński 1972). They are common in rocks of the Zechstein Main Dolomite. These rocks are both the source and reservoir rocks (Kotarba et al. 2000). Therefore, defining the role of pressure solution structures in migration of hydrocarbons is a key element of reservoir characterization.

The main aim of this study is to determine the role of pressure solution structures in fluid flow in dolomites from the Polish part of the Zechstein Main Dolomite (Ca2). Sixteen samples were collected from the core of the Struga-1 well for mineralogical, microstructural and petrophysical studies. The inflow of oil was obtained from the interval within the range of 2042.5–2058.5 meters (Kotarba et al. 2000). This interval was sampled and it corresponds to an occurrence of carbonates of the Zechstein Main Dolomite.

Lithology of the sampled cored interval was described based on macroscopic studies. Standard thin sections were studied using polarization microscopy for identification of mineral composition and microstructures. These studies were supplemented by observations in UV light for identification of organic matter and hydrocarbon inclusions. Chemical staining method was used in identification of carbonate minerals in 6 thin sections by solution of alizarin red and potassium ferricyanide. All thin sections were observed under the cathodoluminescence (CL). PSS were studied in details using the scanning electron microscopy (SEM) with X-ray microanalysis (EDS). Frequency of their occurrence in the core was described by macroscopic and microscopic studies as number of PSS per 1 m and per 1 cm respectively.

Nuclear magnetic resonance (NMR) was used to define the value of porosity. These measurements were performed on eight water-saturated samples using the 2MHz Magritek Rock Core and 24MHz Tomography system. The pore size distribution (PSD) of the rock sample was precisely determined by T2CMPG experiments.

According to the paleogeographic interpretation of Ca2 basin Struga-1 well is located in a platform depression (flat) (comp. Kotarba et al. 2000). This was a low-energy zone dominated by mudstones, wackestones with numerous bioclasts, e.g. gastropodes, foraminifers and bivalves. Intraclasts were delivered from adjacent high-energy zones (Czekański at al. 2010). In a new interpretation by Kosakowski & Krajewski (2013) the well intersects facies association of the carbonate platform lower slope.

The studied rocks are fine crystalline dolomites. Coarser crystals occur only at the lowest part of the studied core. In most of thin sections primary textures are not recognized. In some

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samples bioclasts replaced by dolomite as well as anhydrite and gypsum are visible. Under the CL the dolomite mosaics show dark orange to brown luminescence. Relicts of calcite are absent or very rare. Anhydrite is observed as patches filling pore spaces.

Moldic and intercrystalline porosity is present. Moldic porosity is probably related to dissolution of bioclasts and halite crystals. A few vertical microfractures were noted. Some of them are filled by dolomite, blocky anhydrite, and gypsum and fluorite crystals. However, some microfractures are still open and filled in part by drusy anhydrite and/or gypsum crystals. The effective porosity of dolomite samples varies from 1.59% to 2.69%.

Solution seams are horizontally oriented. Their thickness is up to 0.1 mm. Some of the seams form clusters up to 1 mm thick. In thin sections number of solution seams varies from 0/cm to 8/cm. Dark thicker seams are also visible on the core. They are most frequent in the middle part of the core profile (up to 200/m).

Two groups of stylolites are noted: vertically and horizontally oriented. Microscopic studies concerned only horizontal, diagenetic structures. Amplitude of them is diverse reaching 1.2 cm. They occur mostly in the lowest part of the core profile where solution seams are rare.

Fluorescence microscopy of polished sections revealed a presence of organic matter. Dark brown to black organic laminae and orange oil inclusions are present inside PSS. Framboidal pyrite was recognized both in dolomite and solution seams. Clay minerals are common in solution seams. Based on SEM-EDS analyses fluorite was recognized along stylolites.

Thin wavy microfractures are associated with PSS. These microfractures are short (i.e. up to 1 mm), less than 0.01 mm thick. They are oriented parallel to PSS. Relationship between porosity values and quantity of PSS is unclear. Maybe observed microfractures reflect stress anisotropy in the clay seam and stylolite.

Summing up, PSS have recorded migration of oil as well as migration of other fluids, which were responsible for fluorite mineralization. Organic matter accumulation in stylolites and solution seams of carbonate rocks was documented among others by Leythaeuser (1995). In the studied rocks, this accumulation is marked by an occurrence of dark laminae probably overmature organic matter. The presented results show that PSS hosted in dolomites from Struga-1 well impacted redistribution of organic matter and migration of fluids.

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