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Application of computer data processing and image analysis in studies of pore space in the Pennsylvanian sandstones from Western Pomerania

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The petrological investigations focused on sandstones from the following five boreholes: Gorzysław 10, Petrykozy 6, Sarbinowo 1, Trzebusz 1 and Wrzosowo 8. The thickness of the Pennsylvanian sediments ranges from 144.0 m to 633.0 m. These deposits reflect transitional conditions from marine environments of a tidal flat to continental fluvial and lacustrine settings. The following research methods were used: observations in polarizing microscope, computer image analysis, cathodoluminescence analysis and investigations in scanning electron microscope.

The Pennsylvanian sandstones examined are represented by quartz arenites and quartz wackes, predominantly fine- and medium grained [1]. The quartz with the predominance of monocrystalline quartz grains over polycrystalline ones, is the main component of the grain fabric, while the content of feldspars and lithoclasts is subordinate. Moreover, there are mica flakes in varying amounts and accessory minerals. The sandstone cement is composed mainly of quartz, clay minerals and haematite. Quartz cement occurs as syntaxial overgrowths of authigenic quartz on quartz grains. Clay minerals are represented mainly by kaolinite, dickite and illite, locally by mixed-layered illite-smectite minerals. Haematite and iron hydroxides often fill intergranular spaces and impregnate the clay and dolomite cements. Carbonates, represented by Mn-calcite and dolomite, which mostly form the pore or basic type cements, are in smaller amounts. Sulphates: anhydrite and barite are subordinate cements.

The sandstones examined have a porosity in the range from 0 to 18.5% vol. measured in thin sections impregnated with blue resin using point-counting analysis. The porosity in the same samples measured using the image analysis is from 1.31 to 14.21% vol. Research conducted by computer image analysis provided information about the size, shape, and distribution of the analyzed pore space [2]. In the sandstone samples with lowest porosities of about 2% vol., pores having a length in the range of 0.001-0.01 mm and nearly 100% of similar width represent 90%. Furthermore, in these sandstones the pores having a length larger than 0.1 mm account only to about 1%. On the other hand, in the sandstone samples which have a porosity of about 10%, the pore length of 0.001-0.1 mm account to about 83% and the pore of length larger than 0.1 mm to about 3%. For most of the analyzed samples data characterizing the pore space of the sandstones are comparable. Only the sandstone samples having a porosity of approximately 2% vol., the lowest as compared to the other analyzed rocks, show lower values of equivalent diameter, volume equivalent sphere and cylinder, length and the maximum and minimum Feret's. The pore space of studied sandstone samples is fairly uniformly created. The macropores (>0.001 mm) prevail in the pore space quantitatively, and in comparison with micropores (<0.001 mm) they enlarge the total porosity of the rock.

The primary and secondary porosities have been distinguished in the sandstones. The secondary porosity, which is the effect of the dissolution of lithoclast and potassium feldspar grains and locally micas, anhydrite and quartz cements, constitutes a small percentage of the whole sandstone porosity.

In the Carboniferous sandstones analyzed, effects of the following diagenetic processes may be observed: compaction, cementation, dissolution, replacement and alteration. Compaction and cementation of the above listed processes, had the greatest impact on reducing the sandstone porosity. On average, cementation resulted in primary porosity reduction by 52%, compaction by approximately 37% [1].

References:

[1] Kozłowska A (2008) Biuletyn PIG 430: 1-28

[2] Kozłowska A and Kuberska M (2006) Prz Geol 54:671-673