Diagenesis of the Lower Jurassic sandstones in Central Poland

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Sandstones from boreholes located in the zone Toruń – Radom have been petrographically and petrophysically studied. The Lower Jurassic sediments in the area of research occur at depths ranging from 800 to 2100 m. The following research methods were used in sandstone observations: polarizing microscope (PL), cathodoluminescence studies (CL), scanning electron microscope (SEM) investigations and energy dispersive spectrometer studies (EDS ISIS), X-ray diffraction analyses (XRD) and petrophysic laboratory studies.

Sandstones are represented mostly by quartz arenites and wackes, from very fine to medium grained. The main component of grain framework is quartz, which in average is about 70 volume % of rocks. However, feldspars (representing mainly potassium feldspar) and lithoclasts most often occur approximately in 1 volume % of rocks. Plate micas (mainly muscovite, less biotite) and chlorite occur in sandstones in varying quantities. Organic matter and heavy minerals constitute a small percentage.

The main type of cement is matrix which is a mixture of detrital clay minerals, quartz dust, iron hydroxides and organic matter. In addition, there is a cement in sandstones, which is built by diagenetic minerals. Quartz, carbonates, clay minerals, and locally pyrite were distinguished among them.

Quartz cement is the most important in the Lower Jurassic sandstones ranging in content from 0 to 23.7 volume %. It creates syntaxial rims developed on quartz grains and partly fills the sandstone pore space. Authigenic quartz overgrowths are very well visible in the CL image. They are characterized by dark brown luminescence, differentiating itself from the quartz grains which show blue-violet or brown luminescence.

Carbonate cements are represented mainly by siderite (and another minerals of siderite-magnesite series) and Fe-dolomite/ankerite. Their content ranges from 0 to 31.7 volume % of rocks. Siderite represented by siderite and sideroplesite often creates very fine-crystalline grains. They fill the pore space in the rock and are found in clay laminae enriched in organic matter. Locally, coarse-crystalline siderite is also present, sometimes in the form of rhombohedrons. It is represented by sideroplesite, sporadically by pistomesite. In comparison to the fine-crystalline siderite, the corse-crystalline one is characterized by higher content of MgCO3. Ankerite creates spar cement, often in the form of isolated euhedral, rhombohedral crystals. Because of the large content of Fe^{+2}, ankerite in CL studies does not show luminescence.

Authigenic clay minerals are represented mainly by vermiform kaolinite, reaching up to 14.0 volume % of rocks. Most commonly kaolinite occurs in the form of platy aggregate, which in the scanning electron microscope can be seen as pseudohexagonal crystals forming characteristic booklets forms. In the CL image kaolinite is characterized by a dark blue color. The occurrence of authigenic illite was found locally by SEM examination. Illite crystallites usually take the form of filaments, which grow over the pore spaces of sandstone.

The Jurassic sandstones are characterized by very good and good filtration properties. Their porosity often exceeds 20% and permeability ranges from 0.001 to 1930.756 mD. The porous space parameters measured in porosimeter show the following trend: factor of dynamic porosity 6.28-29.94%, average amount of pores > 1 mm 8-99%, threshold diameter 0.2-90.0 mm and hysteresis 6-76%.