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Quartz cementation mechanisms between adjacent sandstone and shale in Middle Cambrian, West Lithuania

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Quartz is an important cementing material in siliciclastic sandstones that can reduce porosity and permeability severely. For efficiently predicting and extrapolating petrophysical properties such as porosity and permeability, the controls on the occurrence and the degree of quartz cementation need to be better understood. Because it is generally difficult to identify specific sources for quartz cement, many models attempting to explain quartz cementation conclude that external sources of silica are needed to explain the observed quantity of quartz cement, such as the mass transfer between sandstone and shale.

Cambrian sandstones in Lithuania have abundant quartz cement which has significant effect on reservoir properties. The detrital quartz grains have been dissolved extensively along the shale-quartz contacts zones, making it a natural laboratory to study the influence of mass transfer between sandstone and shale to quartz cementation on petrophysical properties and reservoir quality.

Our Cambrian shale samples in west Lithuania are mainly silty shale or siltstone (sample locations vary from 330 to 2090 m of burial depth). They are composed of quartz, clay and traces of feldspars, sericite, calcite, and pyrite. The clay minerals are mainly illite, with variable content of kaolinite and traces of chlorite. In the sandstone lamina, authigenic illite occurs as pore-filling cement which was composed of fibrous illite; pore-filling kaolinite is generally well crystallized and occurs as hexagonal plates arranged in booklets; quartz overgrowth are obvious in these sandstone laminas, especially in the contact zones between sandstone and shale. Dolomite and pyrite cementation are also present in some sandstone laminas but with few quartz overgrowth. Depositional facies and architecture played an important role in the precipitation of silica.

Three different possible sources are distinguished for the quartz overgrowths in the intercalated sandstones: 1) Pressure dissolution (chemical compaction) of quartz within the shales, or internal supply through chemical compaction within sandstones or along sandstone/shale interfaces; 2) Dissolution of detrital silicate grains, such as feldspars or lithic grains may locally play a role; 3) Shale diagenesis process that required addition of K2O and $Al2O_3$, and resulted in loss of SiO_2. Thin shales could act as an open system and export silica towards the intercalated sandstones. The main mechanism to move these dissolved silica is supposed to be compaction that resulted in the elongated grains and etched margines in shales and sandstones. Dissolved silica that was produced during dissolution may have been transported by diffusion into inter-stylolite regions or porous area with less pressure where the aqueous silica precipitates as quartz cement on quartz grains.