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Influences of litho-static pressure on deep sandstones: insight from single-factor simulation

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Nowadays, deep oil and gas exploration has become an important domain in petroleum industry. The deep system is special because of the great burial depth, high temperature and high pressure, resulting in complex evolution of reservoir rocks. There are several key factors that affect the reservoir quality, among which the litho-static pressure is an important one. Previous works proved that litho-static pressure caused great decrease of primary porosity in the shallower strata, while few works mentioned the influence of litho-static pressure on the diagenesis of deep/ultra-deep strata.
This study simulated the effect of litho-static pressure on the evolution of deep sandstones. Two kinds of man-made silica sands, 70-100 mesh and 30-40 mesh were used. The litho-static pressures are 55MPa, 82.5MPa, 110MPa, 137.5MPa, and 165MPa respectively. The shaped samples were extracted and made into thin sections.

The preliminary results include that:

(1) At the shallower burial depth, the compaction effect on fine-grained sediments was more obvious than that of the medium-grained sediments; at great burial depth, the grains went through compressional deformation when the closest packing of the grains was destroyed. The coarser the grains are, the easier to generate cracks.

(2) The inferred interpretation model was established: with the increase of litho-static pressure, the packing of the grains becomes closer. When the grains were deep buried, the closest packing mode was destroyed. The fine-grained sediments showed stronger compaction resistance and they were laterally compressed firstly. Medium-/coarse-grained sediments showed relatively poor compaction resistance and the grains deformed and cracked, which improved the physical property of the reservoirs. In the sandstones with more brittle & coarser grains, it is much easier to generate new fractures. In the Kuche Foreland Basin in China, abundant fractures are observed in the tight deep sandstones that are medium-grained, quartz & feldspar dominated.

This study is helpful to understand the effect of litho-static pressure on evolution of deep reservoirs, which can provide reference to the prediction of the favourable deep reservoirs, especially the ultra-deep reservoirs.