Digital Analysis of Reservoir Compaction Processes

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Reservoir compaction is of significant concern to the oil and gas industry. Compaction leads to issues of reservoir productivity. It might aid in production by squeezing oil from the rock, but can also reduce permeability and thus production. Compaction may also effect ultimate recovery. Understanding the interplay of these effects for various production scenarios is essential.

We have previously demonstrated an ability to image sedimentary rock in 3-D at the pore/grain scale. We have also demonstrated an ability to directly measure rock fabric and texture from 3-D digital images of core material and developed robust techniques for partitioning the pore space of a porous material. In this paper we describe studies of the progression and contribution of various compaction processes in 3-D using micro-CT imaging and 3-D grain analysis. Studies of compaction are undertaken on an idealized monodisperse grain pack, unconsolidated quartz sands and on consolidated quartz sands. During the experiment individual grains are tracked allowing one to observe and quantify the grain displacement processes. These results can lead to a better understanding of the role of various compaction processes (e.g. grain rotation, deformation, slippage) on reservoir compressibility. Analysis of the pore space of the image allows one to quantify the degree the pore space is squeezed. Direct simulation of permeability on samples under different compaction conditions is undertaken and permeability reduction is correlated to the mode of compaction. Changes in the pore morphology/topology and their effect on relative permeability and ultimate recovery is also considered.