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Effect of Diagenetic Cements on Seismic and Transport Properties in Sandstones: Data and Theory

Diagenetic cements may appear at the grain contacts in well-sorted high-porosity sands in the form of amorphous quartz, clay, or carbonate. Small amounts of such cements only weakly affect the total porosity. However, their effect on the P-and S-wave elastic properties is dramatic. In a porosity range between 25 and 35%, sands with contact cement have a seismic-wave velocity several hundred m/s higher than uncemented sands of similar mineralogical content. This difference has to be taken into account during seismic exploration and reservoir characterization because the seismic signatures of high-porosity contact-cemented sands filled with light hydrocarbons may be very similar to those of uncemented sands filled with brine. This dramatic difference due to diagenesis can be explained and quantified by rock physics effective-medium models that relate the rock seismic properties to porosity, mineralogy, and texture. By analyzing well log data, we find that reservoir sands from different basins around the world, including the North Sea, the Gulf Coast, and West Africa, follow the same velocity-porosity trend, which is also predicted by the theoretical contact cement model. This universality of the seismic expression of diagenesis enhances the predictive power of seismic attributes in hydrocarbon exploration. Contact cement has a significant effect on the strength and permeability of reservoir rock. Usually, contact-cemented sands are stronger and less prone to wellbore damage and sanding during production than are uncemented sands of the same porosity. Also, the permeability of contact-cemented sands is higher than that of uncemented sands.