W7 PETROACOUSTIC CHARACTERIZATION OF RESERVOIR ROCKS FOR SEISMIC MONITORING STUDIES

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Abstract

The production of oil and gas reservoirs, always has direct repercussions on the fluid content and pore pressure, and hence on the seismic properties of reservoir rocks. The poster describes the laboratory methods used to measure the effect of variations in differential pressure and saturating fluid on elastic waves propagation velocities in reservoir rocks.

The pressure effect is easy to measure in the laboratory, via the Hertz coefficient, exponent of the power function linking the velocity to the differential pressure. It is difficult to estimate the representativity of core samples that have undergone the sudden stress relaxation caused by coring. A statistical comparison of the measurement results on surface samples and core samples confirms the reality of this damage. The values measured in the laboratory are often values from above. They are very useful for setting the upper bounds of the anticipated effect of differential pressure. This effect is often negligible in many limestone reservoirs. lt may be high or overpressurized in shallow sandstone reservoirs (underground storage facilities).

The effect of the saturating fluid is quantified by the Gassmann formula, the value of which is usually confirmed by experiment. The use of this formula requires the knowledge of certain elastic properties of the rock. These moduli can be determined at the laboratory. We propose an original method that is also simple in principle, based on the experimental measurement of the quasi linear relation predicted by the Biot-Gassmann theory, between the bulk modulus K_{sat} of the saturated rock and the bulk modulus K_{fl} of the saturating fluid.

ln sandstones, during substitution experiments, the liquids used must not disturb the clay minerals (and weathered feldspars). Apart from the case of perfectly clean sandstones, it is therefore highly preferable to preserve an irreducible saturation of brine (S_{wi}) and hence to work with two-phase saturation (brine/hydrocarbons).

ln limestones, which usually contain no clay, fluid substitution experiments are facilitated by the possibility of single-phase flushing by liquids with highly varied bulk modulus. The advantage procured by this experimental expedient is unfortunately diminished by the difficulty of signal processing caused by the "path dispersion" mechanism corresponding to the scattering on heterogeneities of nonnegligible size compared with wavelength. These heterogeneities (obviously associated with the complex diagenesis of limestones) are omnipresent but not always detectable by a conventional petrographic study. The use of phase velocities in processing transmitted signals is the safest means to help solve this difficulty. ln the case of rocks of simple mineralogical composition (limestone, clean sandstone), the knowledge of the bulk modulus of the solid matrix K_{grain} offers an excellent means to check the results, thereby substantially facilitating interpretation.