Evaluation of Rock Properties Using Ultrasonic Pulse Technique and Correlating Static to Dynamic Elastic Constants

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Formation elastic parameters including Young's modulus, Poisson's ratio and shear modulus are the input parameters for wellbore instability and sanding prediction analysis. These parameters are customarily estimated from laboratory experiments on core samples and called static elastic properties. This is an expensive and time consuming approach, as intensive care required for sample preparation and handling. An alternative laboratory approach is to measure the dynamic moduli on a core sample through Acoustic Travel Time (ATT) method. This method is advantageous in being non-destructive and fast; however, the static moduli are required to be obtained for any geomechanics related studies.

As a result, a correlation between static to dynamic moduli needs to be developed. In general, static moduli are smaller than that of dynamic moduli due to higher level of strain applied to the rock. Several correlations have been proposed in the literature for this purpose, although each has been developed in a specific formation and hence not appropriate to be used in other areas.

In this paper, a large number of ATT tests were conducted on a variety of rock types in conjunction with measurement of other rock physical and mechanical properties including density, porosity, water absorption, uniaxial compressive strength and indirect tensile strength.

Statistical analysis of the results enabled developing some good correlations between velocity of elastic waves and physical/mechanical properties of rock. Also dynamic elastic moduli measured using ATT and static moduli calculated through UCS tests, were analyzed and used to develop a correlation between static to dynamic moduli. Using these equations, physical and mechanical properties of rock and static elastic constants can be estimated by peforming non-destructive ATT test.