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Effects of confinement on rock velocity relations for different rock types

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Rock velocity measurements are carried out on the cores obtained from the desired depth of target formation in laboratorial environment. In reality subsurface rocks are encountered with confining pressure of neighboring rocks. On the other hand, presented formulas to predict shear wave velocity from compressional wave velocity are usually based on laboratorial tests and under no confinement. These formulas are employed in continuous velocity calculations in oil and gas fields or medium depth constructional projects where rock samples restrained by nearby formations. Some discrepancies between real and predicted values may originate from such difference in circumstances. The effect of confinements on a series of published data gathered from different locations with various rock types was studied. The samples included main categorizations of the rocks: igneous, metamorphic and sedimentary rocks with different depths of coring. All the samples have been tested in the lab while definite confining pressures were applied to the cores. The common trends of these rocks showed that increasing the confining pressure could lead to increase of R-square between shear and compressional velocities and better estimation of Vs from Vp for clean sandstone. But the trend showed a cyclic behavior for metamorphic and igneous rocks like basalt, granite, serpentine and gneiss. In these samples, R-square value decreased and then increased while confining pressure was ascending. The trend was reverse for other sedimentary rocks, especially when impurities were present in the framework. Chert and shale samples in this study showed a trend of increase and then decrease in R-square values. In all, rock types showed different trends for R-square changes. For better estimation and conclusion, each data point velocity values was plotted vs. confining pressure and the same trend was observed. In addition, Vp/Vs ratio was also plotted as a function of confining pressure and the results conveyed similar conclusions. This may be suggested as a method for rock type definition when rock velocities are the only available data. It can be mentioned that shear wave velocity estimation only by compressional velocity could not be enough, because of changes in R-square value with various confinements. It seems that another parameter should be considered which makes prediction independent of regional pressures.