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Shear wave speed increases with depth to the one-sixth power in sandy/silty marine sediments

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Gravity holds the sediment's particles in loose contact; the strength varies with depth. The distribution in shapes, sizes, and orientations is presumed independent of depth. Each particle is subject to several contact forces, and also to a buoyancy force exerted by the surrounding water. An externally imposed shear stress results in distortions in the individual grains, the nature and magnitudes of which depend on the contact areas between the grains, which in turn depend on depth. A derivation making use of fundamdental mechanics, the theory of elasticity, and Hertz's theory of contact yields shear modulus G as a dimensionless quantity times $g^{1/3}(\rho_S\text{-}\rho_W)^{1/3}E^{2/3}d^{1/3}$, where d is depth into the sediment and E is the elastic modulus of the solid material in the grains. The dimensionless quantity depends on Poisson's ratio and porosity. The shear speed $(G/\rho_{\mathrm{av}})^{1/2}$ consequently varies with depth as $d^{1/6}$. The prediction is consistent with data reported in the past by Stoll, Yamamoto, and Hamilton; the discrepancy of the theoretical prediction of 0.167 with experimentally derived exponents of the order of 0.25, although not viewed as significant, is discussed, and it is suggested that such may be caused by the variation of porosity with depth.