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Seismic Velocities in Fractured Rocks

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Good agreement is found between laboratory measurements and theoretical computations of velocities in porous competent rocks subject to hydrostatic and nonhydrostatic stresses and fluid pore pressure at room temperatures. Nonhydrostatic stress induces velocity anisotropy in rocks with acoustic double refraction. In these rocks the measured static moduli are systematically smaller than the dynamic moduli. This difference, usually of the order of 10 percent, increases to a factor of 50 for uncompetent rock powder subject to large confining pressure. Furthermore, unlike the case of competent rocks, there is no relation at all between density and velocity in extensively broken rocks, in which the same velocity is obtained in material with 55 percent and 20 percent porosity. Available mechanical models have so far failed to explain these observations. Experiments show that elevated temperatures cause a host of mechanical effects due to temperature dependent compressibility and density of water vapor. Velocities are also affected by chemical effects of sintering and solution of silica in pore water. The results of these studies suggest useful applications to seismic detection of geothermal and gas pockets, and provide a powerful tool for the prediction of earthquakes in areas which undergo dilatancy.