

Understanding the Stress Dependence of Velocity in Unconsolidated Sands

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Understanding the stress dependence of velocity is critical to the interpretation of time-lapse seismic studies. The stress dependence of rock properties must be understood so that their influence can be differentiated from the influence of saturation changes. In-situ stress values correlate with the stress dependence of velocity — as in-situ stress increases, the stress dependence decreases.

We establish a strong correlation between pore volume compressibility (C_p) and the velocity at in-situ stress. The value of C_p is dominated by the physics at grain contacts. This is demonstrated by a well-established relationship between C_p and contact length. Grain contacts also dominate the stress dependence of the velocity. As the stress dependence of velocity increases, the contact force between the grains decreases. In contrast sands with low compressibility and long contacts display lower velocity stress dependence.

The change in velocity with stress is also impacted by the presence of load-bearing ductile grains, which directly impacts the frame modulus, weakening it and causing a large stress dependence in velocity. Authigenic clays precipitated in primary pores influence in-situ velocity but not its stress dependence, because they are not typically in load bearing positions. This paper demonstrates these basic attributes of the stress dependence of velocity in unconsolidated sands.