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Acoustic Technology for Monitoring Hydrate Phase-Changes

With the nation being revisited by high-energy prices, naturally occurring methane hydrates have caught the imagination of scientists and politicians alike as a possible solution to energy independence. With the advent of deep-water exploration, encounters with sea-bottom hydrates are generally avoided if at all possible due to possible hazardous drilling and/or operating conditions they may create. Before gas hydrates can be considered a producible source of energy, one of the technical challenges that must be dealt concerns the potential for hazards associated with hydrate phase changes induced by drilling and production operations. Compressional (P) wave and shear (S) wave experiments were performed using a ‘stoichiometrically-correct’ tetrahydrofuran (THF) mixture in unconsolidated sand. Unlike more conventional laboratory measurements that use acoustic transmission to measure rock properties, these experiments employed a coincident source and receiver to collect acoustic data in a reflection mode. The reflection geometry allows us to distinguish heterogeneities within the sample. By making simultaneous measurement of the temperature gradient as well as reflected compressional (P) and shear (S) wave velocities as a function of time and temperature, some rather interesting data resulted. These experiments illustrate that the THF hydrate crystals form in pore bodies and only affect the bulk properties of the sediment. As temperature is decreased, remaining fluid water in the pores freezes and welds the grains affecting the shear strength of the sediment. This kind of acoustic approach could be engineered for field deployment and used for monitoring in situ evolution of a multiphase system in real time.