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Physical properties and rock physics models of sediment containing natural and laboratory-formed methane gas hydrate

William J. Winters,[1,*] Ingo A. Pecher,[2] William F. Waite,[1] and David H. Mason[1]

[1]U.S. Geological Survey, 384 Woods Hole Road, Woods Hole, Massachusetts 02543, U.S.A.
[2]Institute of Geological and Nuclear Science, 69 Gracefield Road, Lower Hutt, New Zealand

Abstract

This paper presents results of shear strength and acoustic velocity (p-wave) measurements performed on: (1) samples containing natural gas hydrate from the Mallik 2L-38 well, Mackenzie Delta, Northwest Territories; (2) reconstituted Ottawa sand samples containing methane gas hydrate formed in the laboratory; and (3) ice-bearing sands. These measurements show that hydrate increases shear strength and p-wave velocity in natural and reconstituted samples. The proportion of this increase depends on (1) the amount and distribution of hydrate present, (2) differences in sediment properties, and (3) differences in test conditions. Stress-strain curves from the Mallik samples suggest that natural gas hydrate does not cement sediment grains. However, stress-strain curves from the Ottawa sand (containing laboratory-formed gas hydrate) do imply cementation is present. Acoustically, rock physics modeling shows that gas hydrate does not cement grains of natural Mackenzie Delta sediment. Natural gas hydrates are best modeled as part of the sediment frame. This finding is in contrast with direct observations and results of Ottawa sand containing laboratory-formed hydrate, which was found to cement grains (Waite et al. 2004). It therefore appears that the microscopic distribution of gas hydrates in sediment, and hence the effect of gas hydrate on sediment physical properties, differs between natural deposits and laboratory-formed samples. This difference may possibly be caused by the location of water molecules that are available to form hydrate. Models that use laboratory-derived properties to predict behavior of natural gas hydrate must account for these differences.