Shear-wave logging in natural gas hydrates

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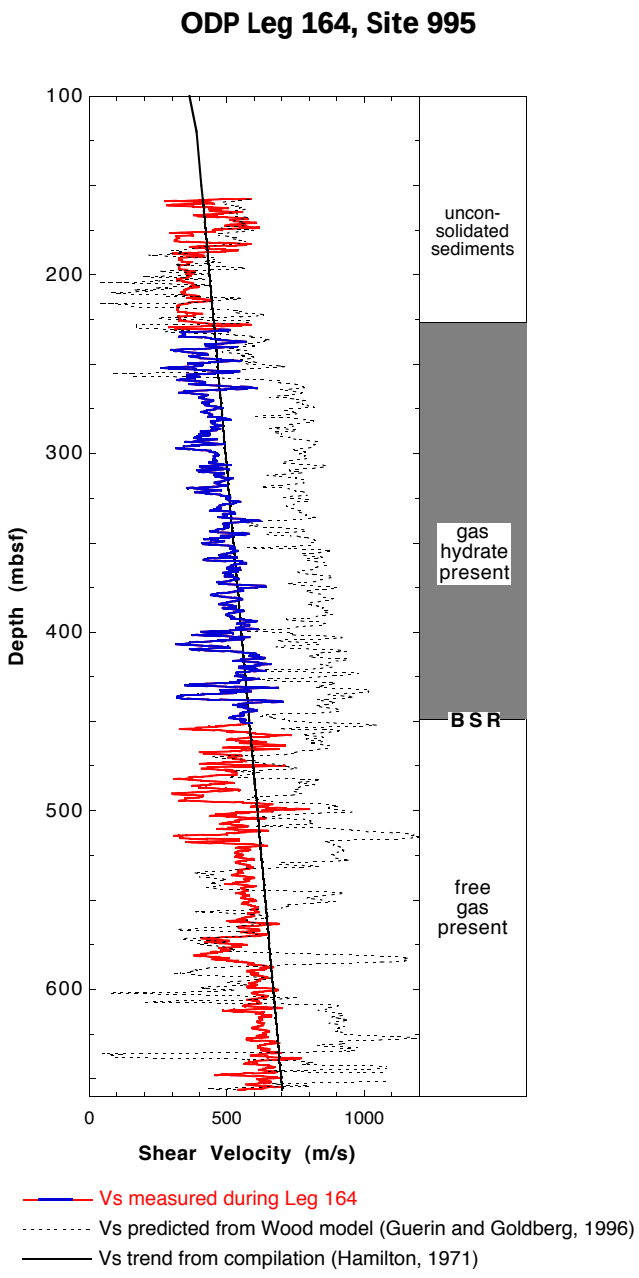
The occurrence, distribution, properties, and hydrocarbon reservoir potential of natural gas hydrates in marine sediments continue to be enigmatic questions in marine geoscience. Gas hydrates are unstable under ambient atmospheric conditions, formed when the thermodynamic conditions of methane in buried sediments reach appropriately cold temperatures and high pressures. *In situ* detection methods, therefore, play a crucial role in measuring their unusual properties. To address these problems, ODP Leg 164 on the Blake Outer Ridge conducted extensive logging experiments at three sites, including the first ODP deployments of a shear sonic tool in hydrates and gas-saturated sediments. In each hole, this tool enabled *Vp* and *Vs* to be recorded during a single deployment in the low-velocity, high-porosity calcareous clays that were encountered. The results show that *Vs* increases from 430 and 700 m/s through the hydrate stability zone to 450 m depth, where a bottom-simulating seismic reflection (BSR) is associated with the top of free gas. In the hydrates, the log agrees with elastic wave propagation models and with a global compilation of *Vs* data for consolidated marine sediments. Above 250 m depth, *Vs* can be predicted from porosity, *Vp,* and r_b using a model for unconsolidated sediments [*Guerin and Goldberg,* 1996], but this model significantly mismatches the log data measured in the hydrates. Consequently, the presence of gas hydrate increases sediment rigidity above that expected for unconsolidated clays, acting like an intergranular cement. The resulting porosity reduction is also more rapid than predicted by simple compaction which may be a key to predicting hydrate concentration from seismic velocities in similar environments.



Reference

Guerin, G., and D. Goldberg, Acoustic and elastic properties of calcareous sediments across a siliceous diagenetic front on the eastern U.S. continental slope, *Geophys. Res. Lett.*, *23*, 2697-2700, 1996.