Velocity Structure from Borehole Seismic in a Methane Hydrate Bearing interval in the Nankai Trough

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In early 2004, the MH21 Research Consortium undertook a methane hydrate research drilling campaign in the Nankai trough.

In order to reveal the seismic velocity structure, at one of these wells, a Zero Offset Vertical Seismic Profile (ZVSP) survey was conducted with the Versatile Seismic Imager tool (VSI∗), the latest generation wireline borehole seismic array tool. The seismic sensors were deployed over an interval that included both the hydrate bearing sediments and the Bottom Simulating Reflector (BSR), situated a few hundred meters below the seabed.

In addition, an offset VSP survey was performed in the same well to acquire clear converted shear waves at formation boundaries. The offset vertical seismic profile (OVSP) survey used two offset airgun sources that were placed approximately one kilometer from the well. One source was located to the southwest and the other to the southeast.

In this paper the compressional and shear wave velocities (vp and vs) were computed from both the break times and travel time inversion with both the ZVSP and OVSP data. The computed interval velocities of both the borehole seismic and borehole sonic log were compared. The results show that the seismic vp and vs velocities increase within the hydrate zone, and then decrease at the BSR. Within the hydrate bearing interval the seismic and sonic velocities showed reasonable agreement. Throughout the BSR zone, located immediately below the hydrate, the shear velocities were in agreement but the compressional velocities were dramatically different. The paper reviews the source of this discrepancy through an in-depth understanding of the fundamental physics of both the borehole seismic and sonic measurements

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