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Estimation of Gas-hydrate Saturation at the Hydrate Ridge, Offshore Oregon

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Multicomponent seismic data were acquired in summer 2002, offshore Oregon, on the Hydrate Ridge of the Cascadia convergent margin. The primary goal of the experiment was to map the gas hydrates and free gas (methane) and understand the mechanism of fluid migration. Our analysis estimated the compressional- (P-wave) and shear-wave (S-wave) interval velocities with the final goal of relating these velocities to the presence and quantification of gas hydrate and free gas. We performed interval velocity analysis in the tau-p (intercept time - ray parameters) domain following three main steps: 1) P-wave velocity analysis, 2) P- to S-wave (converted S-wave) event correlation, and 3) S-wave velocity analysis. We correlated P- to S-wave event for a reflector using synthetic seismograms (generated with reflectivity method) and traveltime tables. A traveltime table contains the arrival times of different wavetypes for a reflector and is calculated using the sonic logs or modeled velocities. Seismic velocities are correlated to gas hydrate saturation using a Modified Wood equation. We found that maximum saturation of gas hydrate is 7% of rock. The P-wave velocity is lower down to 50m below the sea floor at the south summit, probably because of the presence of free gas within the gas hydrate stability zone (GHSZ). Gas probably migrated from below GHSZ up to sea floor through near-vertical fractures. We identified hydrate-bearing- and free-gas-bearing sediments with anomalous increase and decrease of P-wave velocity, respectively (with a reference velocity calculated in water saturated sediments). However, S-wave velocity does not show anomalous increase in the hydrate-bearing sediments. Thus, we interpret that hydrate does not cement sediment grains enough to affect shear properties. It is more likely that hydrates form within pore spaces.