MULTI-FREQUENCY SEISMIC STUDY OF THE GAS HYDRATE ACCUMULATIONS IN LAKE BAIKAL, SIBERIA

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Recently, the presence of methane hydrates has been evidenced in Lake Baikal, Siberia, by means of seismic profiling, deep drilling and shallow coring. This is -up to now- the only reported occurrence of gas hydrates in a confined fresh-water basin. In this presentation, we discuss the frequency-dependent acoustic characteristics of the hydrate-bearing sediments, using 5 different types of reflection seismic data encompassing frequencies from 10 to 1000 Hz. On low-frequency airgun-array data, the base of the hydrate stability zone (HSZ) is observed as a single, high-amplitude, inverse-polarity reflection that often crosscuts the local stratigraphy. Amplitude and continuity of the BSR decrease or even disappear on higher-frequency data. On medium- to high-frequency data (e.g. watergun) the base of the HSZ is no longer expressed as a single reflector, but rather as a facies change between enhanced reflections below and blanked reflections above. The increasing reflection amplitude of the BSR with increasing offset (AVO-analysis), the high reflection coefficient of the BSR (-40 % of lake floor reflection) and the presence of enhanced reflections beneath the BSR suggest the presence of free gas below the HSZ. The observation of some enhanced reflections extending into the HSZ could even indicate that free gas may co-exist with hydrates within the HSZ. Blanking of the reflection amplitudes above the BSR is variable. Instantaneous frequency analyses reveal a low-frequency shadow beneath the BSR. We also collected lake-bottom reflection/refraction data, using GEOMAR's "Ocean-Bottom Hydrophones". Several profiles were recorded with a medium-resolution single airgun with sufficient energy to penetrate below the HSZ. The velocity information obtained from these measurements shows a distinct low-velocity layer below the base of the HSZ. Above, several higher-velocity layers are recognised. Modelling of interval velocities in this zone indicate hydrate presence of 5 to 8 % of pore volume. We also acquired new medium-frequency, single-channel airgun data at the BDP-1997 site (Baikal Drilling Project), providing the first acoustic images from this location. Hydrates (10 % pore volume) were retrieved from 121 and 160 m sub-bottom depth, but still about 200 m above the base of the local hydrate stability field. Remarkably, the seismic data at the drilling site show no indications for the presence of hydrates at the hydrate-recovery depths (no acoustic blanking, no BSR). These results were used to roughly estimate the amount of carbon stored in the Lake Baikal hydrate reservoirs, showing that most probably they do not form a future energy resource.