Lithologically Controlled 'Split' Gas-Hydrate BSR at the Vøring Plateau and Below the Storegga Slide Deposits, Off-shore Norway

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ABSTRACT

Bottom-simulating reflector (BSR), presumably corresponding to the interface between partially hydrate-saturated sediments above and possibly gas-containing sediments below, have been previously reported at the southern edge of the Vøring Plateau (Bugge et al, 1987; Bugge et al, 1988; Mienert et al., 1998; Bouriak et al., 2000) and, at some locations, below the deposits of the adjacent parts of the Storegga Slide (Bouriak et al., 2000).

During the 10th expedition of UNESCO-IOC 'Training Through Research' (TTR) Programme with the RV *Professor Logachev* in August 2000, the area was re-visited with single-channel seismic system in order to continue mapping of the BSR spatial distribution that was started in 1998 within the programme of TTR-8 Cruise.

Within the area the BSR is expressed on the seismic records area either as a strong reflection of negative polarity, often crosscutting the stratigraphic layers, or as a sort of facies change between high-amplitude (enhanced) reflections below and normal amplitude reflections above it. This is supposed to be rather typical expression of a gas-hydrate BSR on medium to high resolution single channel seismic data (Vanneste et al., 2000). The analysis of seismic attributes of the collected records has shown distinct amplitude and frequency shadows below the BSR-locations and adjacent enhanced reflections. This is believed to be a strong evidence for increased intrinsic attenuation directly below the BSR and within the adjacent enhanced reflections, suggesting presence of free gas there, being trapped by hydrate-containing sediments at the base of gas hydrate stability field (GHSF).

For each of the seismic lines where the BSR was observed, the theoretical depths of the bottom of the local GHSF were calculated, basing on the local seafloor topography and the PT-conditions calculated by Bouriak et al (2000) from the depth of a single BSR-location within the area. The temperature gradient of 0.055°C/m used in this calculation was also supported by direct measurements (Vogt et al., 1999). For all of the lines, the resulting calculated

depths of the theoretical bottom of the GHSF fit nicely to those of the actually observed BSRs, which also confirms the gas-hydrate nature of the reflection.

The remarkable feature of the BSR appearance within the area is that at most of the seismic lines it is split into several isolated zones. More particularly, the reflection shows up only at several apparently stratigraphic layers, sandwiched between the strata where no BSR is observed. Four ‘BSR-demonstrating’ layers, showing a BSR when crossing the base of GHSF and continuing upslope (below the GHZF) as enhanced reflections, were identified, correlated between the lines, and traced through the area. The locations and width of the BSR occurrences on the seismic lines appeared to be a function of where and how each of these layers approaches the base of GHSF, both below the undisturbed sediments of the plateau and below the slide deposits. This suggests that the observation of the BSRs in the study area is lithologically controlled.

Apparently, the identified ‘BSR-demonstrating’ layers need to posses some physical or pethrographical property, that makes them most favorable for gas hydrate formation or/and accumulation of free gas. This could be increased, relatively to host sediments, permeability due to coarser grain-size, or/and increased water content. Being traced downslope (within the GHSF), some of these layers in several locations seem to terminate at the gliding plane of the slide. However, these locations are always deep inside the (both modern and pre-slide) GHSF that makes hydrate dissociation there hardly possible and, thus, argues against the hypothesis of possible link between gas hydrate dissociation and sediment failure in the area. On the other hand, the assumption of increased liquefaction of these layers, stimulating gas hydrate formation, apparently at the same time would be favorable for sediment failure. This assumption also fits well to the hypothesis of liquefied layers, acting as lubricants below the sliding sediments, suggested by Bugge et al (1987) as one of the most probable factors stimulating downslope transport of the material displaced by the Storegga Slide.

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