Wednesday PO Session

CC09 : WEpo01 : PO
Submarine Slope Failure Offshore Norway Causes Rapid Gas Hydrate Decomposition and Seafloor Collapse

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Offshore mid-Norway side-scan sonar and reflection seismic data indicate areas of seafloor collapse in close proximity to the northern head scarp of the Storegga Slide. The area involved in the seafloor collapse is 34 km^2 and the maximum observed collapse depth is 80 m. Reflection seismic data show evidence for laterally confined sediment mobilization and transport at 210 m beneath sea floor. Numerical modeling indicates that this was close to the depth of the base of the hydrate stability zone when the landslide occurred. We conclude that the seafloor collapse is a direct result of gas hydrate decomposition and subsequent gas and fluid escape. Readjustment of the steady-state geotherm deepened the base of the gas hydrate stability zone quickly after the landslide occurred. Thus, gas and fluid escape and associated sea floor collapse in this area are rapid processes.

CC09 : WEpo02 : PO
The Structural Control of the Methane Venting Area in the Southern Basin of Lake Baikal, Siberia

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Gas hydrates have been found in the near-bottom sediments within gas venting structures in the southern basin of Lake Baikal. The Baikal basin consists of three subbasins, separated by accommodation zones: the Academician Ridge between the north and central basins, the Selenga Delta Accommodation Zone between the central and south basins. The venting structures are located south of the Posolskiy Bank, which is a basement ridge with a thick sequence of sediments on top, trending NE, oblique to the main border fault. The Posolskiy Bank belongs to the Selenga Delta Accommodation Zone. It is delimited at its south-eastern side by the Posolskiy Fault with a displacement of more than 1000 metres. The venting structures are located close to an ENE trending fault, parallel to the Posolskiy Fault. Besides the fault which is delimiting the venting area at its northern side, and which has a vertical offset of its northern footwall of 25-30 metres, a fault with a vertical offset of its eastern footwall is not more than 5 metres. The venting area corresponds to a zone of local elevation of the lake floor, which is delimited at its northern side by the ENE trending fault and which is gently dipping towards SW in its southern part. It consequently appears as a zone of updoming probably related to a fluid and gas flow from depth, finally disrupted along its northern and eastern sides. The updoming is interpreted as the consequence of the disruption of the deep gas hydrate layer resulting from fluid overpressure. This interpretation is favoured by the regional pattern of the BSR, which shows strong variations in depth over this part of the south Baikal basin: it reaches minimum depths in the venting area and drops abruptly down to significantly larger depths north of the fault delimiting the venting area. The upward migration of the BSR is interpreted as a consequence of a regional fluid flow at depth, resulting in heat transport, consequent upward migration of the gas hydrates stability zone, updoming of the area and finally disruption along a fault zone. The origin of the fluid flow is discussed. Folding structures in the lake sediments along a NW-SE to WNW-ESE trend have been described in different parts of the central and southern basins. These folding structures are assumed to be related to left-lateral strike-slip movements along the eastern side of the basin. In this assumption, the NE trending fault associated with the venting structures and the spatial alignment of the structures themselves would correspond to the direction of extension associated with the left-lateral strike-slip, whereas the NW oriented direction of compression would correspond to the fluid flow.

CC09 : WEpo03 : PO
Multi-Frequency Acoustic Data (Deeptow, Surface Towed) on Hydrate Ridge: First Results

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During the SO150 expedition within the HYDGAS project framework on Hydrate Ridge, multi-frequency seismic profiles (sparker, watergun, GI-gun, airgun array, bolt gun) have been recorded with both deep-towed and surface-towed receivers in the immediate vicinity of ODP-site 892 (Leg 146) in order to characterise the acoustic signatures related to gas hydrate and free gas accumulations in the sediments. The data encompasses a total frequency bandwidth from 20 to 1500 Hz. The analogue signal detected by the deeptow streamer was transmitted via a 8000 m long cable before being digitised in the acquisition unit. The submersion depth was typically 500 m (offsets 850-900 m, vessel's speed about 3 kt). Despite the geometrical corrections inherent to the deep-tow system, advantages of such records over surface-towed data are the improvement of resolution (both lateral and vertical) and enhanced signal/noise ratio, as is evidenced by comparing the simultaneously recorded deeptowed rs. surface-towed acoustics sections. Next to that, data with larger offset can emphasise the presence of shallow gas accumulations (AVO-effect).

At present, data are being analysed in GEOMAR and RCMG. First results indicate that the continuity and reflection amplitude of the BSR is observed to decrease with increasing source frequency, a feature explained in terms of vertical and horizontal resolution. GI-gun data give the best quality records with continuous high-amplitude BSR features in the entire area. On the very-high-frequency sparker profiles, the commonly-expected BSR is often replaced by a series of enhanced reflections, thought to be caused by gas saturation. This suggests that (1) gas migration and accumulation is stratigraphically and lithologically controlled and (2) the BSR as evidenced on lower-frequency data originates at the top of the free gas layer rather than at the base of the hydrate stability zone.

CC09 : WEpo04 : PO
Measured and BSR-Derived Heat Flow in an Area of Gas Venting in Lake Baikal

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Recently gas venting sites associated with hydrate occurrences and destabilization, have been discovered on the bottom of Lake Baikal. The mapping of local BSR and heat flow variations in that area offered the opportunity to study the measured versus BSR-derived heat flow in detail and in relation with processes of hydrate destabilization. A large-scale BSR-derived heat flow map for the southern and central Baikal (Golmshtok et al., 1997) shows an overall good agreement with the existing probe data, but at individual stations deviations up to 50% occur in both senses. Near the venting sites in the southern Baikal basin strong fluctuations in the BSR depth and heat flow are known to exist. We present new shallow heat flow and BSR data from a small study area including the venting sites. We used the 2 m long GEOS-T thermoprobe for the in-situ measurement of thermal gradients and conductivities. The BSR derived heat flow values have been calculated assuming a thermal conductivity/depth relationship as described by Golmshtok et al. (1997). The following geothermal features have been recognized: (1) Measured heat flow in the study area averages to 75 mW/m^2, which is slightly higher compared to the common background heat flow values for Baikal (50-70 mW/m^2). At the venting site heat flow increases to a maximum of 110-160 mW/m^2. The shape of the anomaly is typical for the focused upflow of warm fluids, but the intensity suggests a relatively cold seepage. (2) In general there is a good correlation between the heat flow and changes in BSR depth. However, everywhere along the profiles the measured data is higher compared to the BSR derived heat flow values. (3) Along the venting site the correlation is very good. Measured values vary between 55 to 90 mW/m^2, and difference with BSR heat flow is only about 5%. (4) Southeast of the venting sites the measured thermal gradient variations correlate better with BSR depth changes than the heat flow. Here, measured heat flow (60-80 mW/m^2) is up to 40% larger than estimates from BSR depth. In fact, the BSR-derived heat flow shows a regional low in this area and is most anomalous. The geothermal observations suggest that in the vicinity of the venting sites the thermal conditions in the sediments are disturbed, both near the surface and near the gas hydrate stability zone. The differences outlined between the shallow and BSR derived heat flow are believed to be the result of processes of heat and fluid flow destabilizing the hydrates, and offer a useful tool to constrain the mechanism of these processes.

Golmshtok AYa, Duchkov AD, Hutchinson DR, Khanukaev SB & Elnikov AI, *Russian Geology and Geophysics*, **38**, 1714-1727, (1997).

CC09 : WEpo05 : PO
Effect of Mud Volcano Activity and Gas Hydrate Formation on Sub-bottom Temperature Field

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Gas hydrate accumulations associated with submarine mud volcanoes are known in many areas of the ocean. Gas hydrate accumulation in submarine mud volcano Haakon Mosby is the most extensively studied including geothermal measurements. This accumulation has an axial-symmetric structure and is controlled by shape and size of the mud volcano. The formation of the accumulation is conditioned by ascending fluid flow that is the main source of hydrate-forming gas and water (Ginsburg at al, 1999). The central part of the mud volcano is also characterized by significant value of sub-bottom geothermal gradient more then 30ºC/m. It can be explained by steady-state filtration of mud fluid. In this case the rate of fluid rise can account for 2.5 m/year. Based on this assumption the steady-state model of the temperature field and gas hydrate stability zone was calculated.

There is in addition a non steady-state discharge of warm mud that spread over the seafloor, eventually flowing down-slope from mud volcano center. This is evident from temperature data measured in the cores from the central part of the mud volcano. The similar sheet-flows of mud has been observed in Gulf of Mexico (MacDonald et al., 2000). Our investigation shows that time of cooling of warm mud layer with thickness of 4 m can reach 30 days for an assumed temperature of 20 deg C of warm mud. In this case the influence of this transient heat pulse on the underlying depth can be close to 10 m. By this is meant that the boundary of gas hydrate stability zone will be changed. Our results suggest that time-dependence of mud discharging should be consider when geothermaled modelling of mud volcanoes are used.

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MacDonald IR, Buthaman DB, Sager WW, Peccini MB, Guinasso NL, *6th International Conference on Gas in Marine Sediments, Abstracts Book*, 86-88, (2000).