Change of Gas Hydrate Stability Zone in the Northeastern Continental Slope of Sakhalin Island, Sea of Okhotsk and Its Implications for Slope Failure

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Abstract

The sudden dissociation of gas hydrate within sediments at continental margin due to ocean warming and/or sea level drop has been suggested as a possible cause of global climate change as well as a negative slope failure. In the northeastern continental slope of the Sakhalin Island (Sea of Okhotsk), numerous gas hydrate-related manifestations in addition to gas hydrates have been reported, which include significant hydroacoustic anomaly through the water column, pockmarks and mounds on the seafloor, seepage structure and bottom-simulating reflectors (BSRs) in the sediments. These manifestations are known as gas hydrate seepage and have been observed in the area of study.

1. Marine Surveys in the Sakhalin Continental Slope

In this study, we used survey results obtained from SSGH09.

2. Interesting Phenomena Related to Gas Hydrate in the Study Area

(a) The study area, presented as a box, is located in the northeastern continental slope of Sakhalin Island. The Grey Basin lies to the west. The thick lines indicate major faults in this region. Lavrentyev Fault Zone in the southern part of the Okhotsk plate is illustrated by a dotted line. (b) The dotted and shaded lines represent the area of high side-scan sonar images. The boxes represent the location of the study area (c) and (d), respectively.

3. Estimated and Measured Heat Flow

The horizontal lines indicate the top of gas hydrate stability zone (TGHSZ) on the Sea of Okhotsk. BSR depths matches well with the base of gas hydrate stability zone (BGHSZ) estimated under the presence of the non-hydrous gradient. The temperature gradient observed at the active venting has ceased, the convective heat flow would rise up quickly to the surface (Case 3). Once the active venting has ceased, the convective fluid would rise up quickly to the surface (Case 3).

4. Possibility of Past and Future Slope Failure Due to Change of Gas Hydrate Stability Zone

The extent of the slope failure occurs up to much shallower depth than the intersection depth of BGHSZ with the seafloor at 20 ka, possibly indicating complexity of natural landslides. Furthermore, this region has witnessed a rapid sea water temperature increase in the last 50 years. If such a trend continues, additional slope failure can be expected in the near future, considering that the region is not far from a transform plate boundary where shallow seismicity occurs.

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