

Depth of gas hydrate stability zone and its implications for the heat flow in the Ulleung Basin, East Sea (Sea of Japan)

YOUNG-GYUN KIM^{1*}, SANG-MOOK LEE¹, HIDEKI HAMAMOTO², OSAMU MATSUBAYASHI³, MAKOTO YAMANO²

¹*School of Earth and Environmental Sciences, Seoul National University*

²*Earthquake Research Institute, University of Tokyo*

³*Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology*

* *Contact number: +82-2-885-6756; E-mail address: kky1@snu.ac.kr*

The Ulleung Basin, which occupies the southern part of the sea and is considered to have formed by back-arc extension during the late Oligocene to middle Miocene, is one of three major basins in the East Sea (Sea of Japan). According to existing measurements, the heat flow in the Ulleung Basin varies from 51-157 mW/m² with no apparent correlation with major features of the basin, which raises the important question as whether the data collected over several decades really represent to the background heat flow of the basin or merely indicate measurement errors of different types of instrument deployed in the surveys. In June 2007, gas hydrate containing 99.9% methane was recovered for the first time in the Ulleung Basin several meters below the seafloor (mbsf). In the following month, new heat flow measurements were conducted at 10 probable sites of gas hydrate (HF01-10) using recently-built Ewing-type heat probe. According to our measurement, the geothermal gradient ranges from 103-137 mK/m and in-situ thermal conductivity 0.82-0.95 W/m-K. The corresponding heat flow (84-130 mW/m²) increases towards the center of the basin. Using a simple empirical relationship which assumes equilibrium of a ternary system (water+CH₄+NaCl 3.5 wt.%), we estimated the lower boundary of gas hydrate stability zone (GHSZ). The estimated depth to the base of GHSZ (153-181 mbsf) is slightly shallower, but is quite consistent with the BSR depths obtained from seismic experiment and drilling. In addition, the existing heat flow data were compared with two-way travel time (twt) values of bottom simulation reflector (BSR) which were obtained from high-resolution seismic reflection investigations of the region. The

comparison was made because BSR depth can be an independent or perhaps is a more reliable constraint on the background heat flow than the actual seafloor heat flow measurements which are prone to various uncertainties stemming from measurement and conditions of the seafloor. Unlike the heat flow data, the BSR depth of the basin is quite constant at 160-192 mbsf (200-240 ms in twt). The lack of correlation suggests that the map of heat flow distribution is unreliable and thus one should not take it as a true representation of the background heat flow. Based on the depth of BSR, the background heat flow of the Ulleung Basin is approximately 120 mW/m² at 2500 m (basin center) and 80 mW/m² at 1000 m (basin flank).