Origin of dissolved natural gas and interstitial fossil seawater in the Minami-Kanto gas field

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The Minami-Kanto gas field is the biggest natural gas deposit of dissolved-in- water type in Japan, that are reserved in middle to lower part of the Plio-Pleistcene Kazusa Group. It is distributed beneath mainly Chiba Prefecture and part of Tokyo, Kanagawa, Saitama and Ibaraki. Main constituent of the natural gas is microbial methane generated from CO_2, H_2 and H_2O. Methane is dissolved in fossil seawater, except around Mobara where gas phase exists in underground mudstone. The fossil seawater is depleted in sulfate ion, and rich in bicarbonate ion, iodide, humic substances, etc. Reserves of natural gas in the Minami-Kanto gas field is huge, but it lately attracted considerable attention as explosion accidents caused by hot spring development.

Two main origins of methane in nature are from microbial activity and thermal breakdown of organic matter in the deep of sedimentary basin. Microbial methane is distinguished by lighter carbon and hydrogen isotope ratios than those of the original bicarbonate and water. Methane from the Minami-Kanto gas field shows $d^{13}C$ = -67 to -65 per mil vs. PDB and dD = -190 to -170 per mil vs. SMOW, that means carbon isotope fractionation occurred in semi-closed system and four hydrogen atoms of methane were originated from fossil seawater, respectively (Kaneko *et al.*, 2002).

Iodine is a biophilic element and its concentration in seawater is 0.05ppm. It was preserved in sediments with organic matter, and removed to interstitial water in anaerobic condition beneath the seafloor. Brine from the the Minami-Kanto gas field includes iodine more than 100ppm, and provides 30% of world production.

There are two different ideas about relationship between the reservoir Kazusa Group and its interstitial water. One is those are cognate, that means seawater was incorporated with sedimentation of the Kazusa Group in forearc basin, and alternated and accumulated in methane and iodine. This idea is based on coincidence of potential of natural gas, iodine productions and the distribution of turbidite sandstone (Mita *et al.*, 2003). Another is interstitial water was incorporated at older age than the Kazusa Group. Muramatsu *et al.*(2001) reported radioactive ^{129}I ages of 50Ma for the brines. Their model is that seawater was incorporated into sediments and accumulated iodine above the Pacific Plate, and migrated by subduction. So that interstitial water, methane and iodine were originated from pelagic to trench-fill sediments. Whereas the author insists that interstitial water and methane/iodine had different origins, and the latter two have been accumulated through the time from incorporation of seawater to settlement into the reservoir. In other words, origin of the fossil water was seawater incorporated with trench-fill sediments, and the water existing at shallow depth beneath the seafloor had accumulated methane/iodine from co-existing trench-fill, slope and forearc basin sediments by accretion and compaction. Since interstitial water was tectonically decompressed after accretion, oversaturated methane migrated as gas phase or formed hydrate depending on P-T conditions.

Deposits are formed and destroyed through geologic time. The forearc Kazusa basin had been buried and became land, and meteoric water has begun to substitute the fossil brine. Gas deposits has been destroyed and salinity of the brine has decreased in north to west part of the gas field. But there remains high salinity brine dissolving methane in some area as deep-seated hot water. Whereas the deposits have been well preserved around Kujyukuri area in Chiba prefecture, where is situated at eastern part of the basin structure of the Kazusa Group, of that center is near Anegasaki in northern Tokyo Bay. As there is no high mountain area in Chiba, charge of meteoric water from the up-dip direction of the reservoir has less effect, but shallow parts were damaged caused by fall of sea level in past glacial age.