9) Effect of submarine groundwater discharge on Nutrient characteristics in the sediment

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1. Introduction

Submarine groundwater discharge (SGD) is an important source of new nutrients, trace elements, and contaminants discharge to the coastal ocean in many parts of the world. Several studies showing that SGD makes a significant contribution to the nutrient budget of coastal waters. As the importance of SGD, it has led to growing research interest in this phenomenon. While the nutrient interaction process and the signals of sediment in this discharge process as well as the long term effect of nutrient discharge through SGD is unknown.

The Seto Inland Sea is the largest semi-enclosed coastal sea area in Japan. The eutrophication incidents occurred in this area with most serious scale from the 1960s to 1970s. The contribution of nutrient discharge through SGD in some part of Seto Inland Sea area is focused by other researchers. In order to determine the sediment nutrient characteristics in this area, we compared the vertical variance of Nutrient in the sediment and sediment pore water from a costal bay area (Kojima Bay) and a semi-enclosed bay (Hiuchi-Nada) in Seto-Inland Sea, Japan.

2. Method

Sediment Core samples were taken by piston sampler and by diving in the field trip in 2009 and 2010 (Fig.1). The sediment samples were analyzed for the pore water nutrient and sediment phosphorus nitrogen, carbon content. The dating data of the sediment core was also determined by ^{137}Cs and ^{210}Pb analysis. The sediment pore water was extracted by centrifugation for 30 min at 3500 rpm. The nutrient content in pore water samples were measured by spectrophotometry. The sediment phosphorus content in the sediment was determined by using the methods of Aspila et al. (1976). Sediment carbon and sediment nitrogen content were analyzed by CHN analyzer.

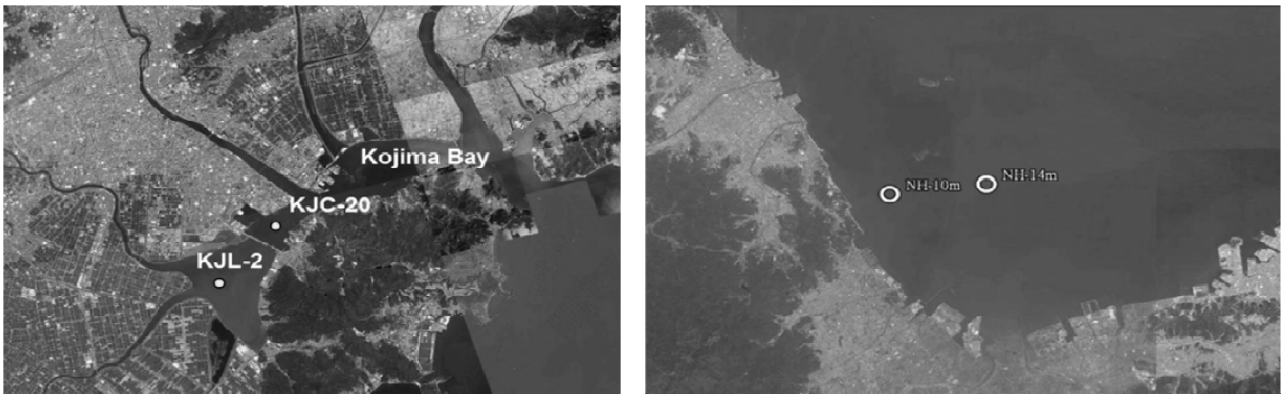

Fig.1 the research location, Kojima Bay (left) and Hiuchi-Nada (right)

3. Results and Discussion

1) SGD effect on sediment pore water

The pore water shows significant difference trend between the two locations. The results show that both the PO_4-P and total phosphorus concentrations in sediment pore water (Fig.2) are comparable higher in Hiuchi-Nada sediment samples than the pore water samples in Kojima Bay area. As the SGD is an important way of discharging the nutrient into the coastal area. Also in Seto-Inland sea area, Onodera et al. (2007) reported that the coastal groundwater around the Seto Inland Sea is characterized by high phosphorus concentration. The pore water TN shows that the Hiuchi-Nada area has lower TN concentrations compare to the Kojima bay core samples. The relationship between N and P in the pore water (Fig 3) shows significant difference trend between the two locations. Kojima bay area has high N:P ratios (average 322:1) and the values has been in increasing trend down core while Hiuchi-Nada area has a decreasing trend down core with relatively lower value (average 26:1). This may indicate nutrient of the pore water affected by different terrestrial resources between two locations rather than the different sediment accumulation process. The semi-enclosed bay sediment nutrient structure may have connection with submarine ground water discharge process reported by Saito et al. (2011) that provides a nutrient supply and water discharge affection.

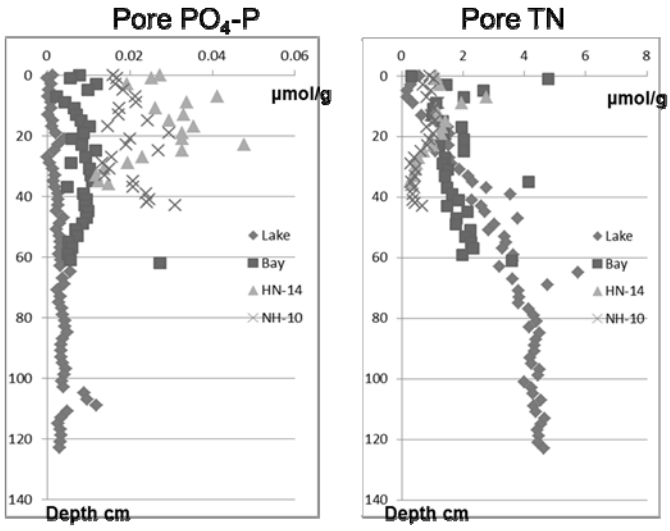

Fig.2 the pore water phosphorus and nitrogen concentrations in sediment pore water samples

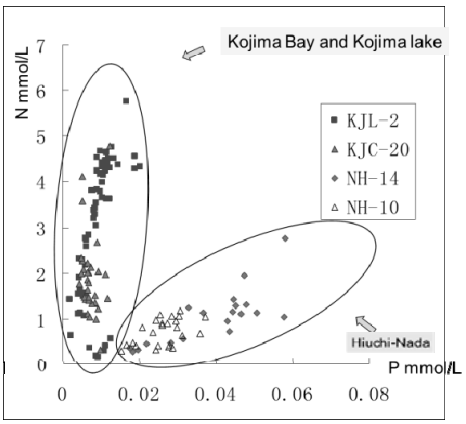

Fig.3 relationship between pore water nitrogen and phosphorus

2) Sediment phosphorus and nitrogen content

The results show that Kojima Lake (an artificial lake by enclosed inner part of the Kojima bay) has captured higher phosphorus in sediment (0.37-1.19 μg/g) than nearby Bay area (0.42-0.62 μg/g) and Hiuchi-Nada area (0.45-0.63 μg/g)in Seto Inland Sea. On the other hand phosphorus did not show the significant variations with depth in the sediments in Kojima bay and Hiuchi-Nada area. Sediment nitrogen content shows higher level in Kojima bay rather than the lake and Hiuchi-Nada area, High correlative relationship between the carbon and nitrogen content in sediment(R^2=0.64, n=89) may indicates nitrogen deposition was affected by the organic matter transportation by river discharge

Different from the affection by river discharge, SGD did not result in big variations in sediment N and P properties. Nutrient discharge through SGD may more obviously affect the pore water nutrient content which is considered an important pathway of SGD nutrient discharge.