Seasonal Variation of Temperature Profile in Tidal Flat of the Ariake Sea, Japan

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1. Introduction

The Ariake Sea, having a unique feature is famous for its various types of fisheries products and sea weed cultivation. However, a dramatic decrease of catch of shells is observed both in the tidal flat mud and inside the deep sea mud in the Ariake Sea for the last 3 decades. The cause for this declination of the fishery products is the unfavorable geoenvironmental condition of the Ariake Sea created by acid treatment practice for the sea weed cultivation (Hayashi and Du, 2005). As the tidal flat sea bed is directly exposed to the sun light and heat, the thermal properties of the tidal flat mud is influenced by the solar heat (Moqsud et al. 2006). So to study of the thermal environment as a part of regular monitoring of the geoenvironmental condition is very important in the tidal flat mud. However, not much study has been carried out before to evaluate the temperature profile in the tidal flat mud in the shallow seas. The objective of this study is to evaluate the seasonal variation of temperature profile in the tidal flat of the Ariake Sea.

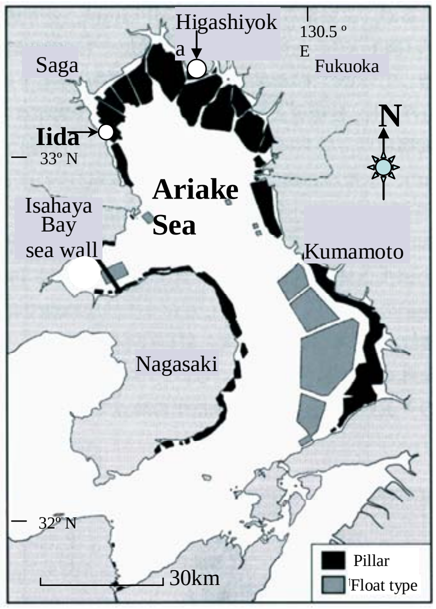

Fig.1: Map of Ariake Sea

2. Study Areas

The Ariake Sea is situated in the north-western part of the Kyushu Island, Japan. It has a vast tidal flat which is exposed to the sunlight during the ebb tide. In our study, two tidal flat areas, Iida and Higashiyoka were selected as the study areas. In this paper temperature profile of Higashiyoka tidal flat area is discussed due to the lack of space and also the two study areas profile is not so significant. Figure 1 shows the locations of the two study areas along with the two types (pillar type and float type) of *Porphyra sp.* cultivation areas.

Table 1: Basic physicochemical properties of tidal mud of the Ariake sea

Physicochemical parameters	Iida tidal mud	Higashiyoka tidal mud
Density (g/cm^3)	2.69	2.71
Water content (%)	235	168
Liquid limit W_L (%)	150	130
Plasticity Index Ip	87	73
Ignition Loss (%)	13.3	11.9
pH	7.92	8.03
ORP (mV)	-95.4	-40.7
AVS (mg/g-dry mud)	0.42	0.16
Salinity (mg/L)	16	17
Grain size analysis (%)		
Sand	7	9
Silt	30	36
Clay	63	55

3. Materials and Methods

For seasonal temperature variation measurement, every month in the last week, the data were collected from Higashiyoka tidal flat, 20 m away from the shore line during the ebb tide. By inserting the thermocouple (3 m long and 0.96 cm diameter) vertically into the tidal flat upto 3.0 m depth and at each 0.10 m interval the data was measured. The thermocouple was connected with a battery and a digital display. The temperature data was displayed directly in degree celcius. Field investigation for collecting data was carried out from January 2007 to December 2007 to observe the seasonal variation of temperature in the tidal mud.

4. Results and Discussion

Fig. 2 shows that the seasonal variation of temperature at different depths at Higashiyoka tidal mud. During the spring and summer the surface temperature shows a higher value than the subsequent depths. Tidal mud expands at that time due to high temperature. The sulphate reducing bacteria also become active at that time and produce acid volatile sulphide in a large quantity and the tidal mud becomes more unfavorable for the living condition of the benthos. In winter when the sea laver cultivation started and use the sea laver treatment medicine much then the tidal mud shrink due to low temperature.

During summer time, heat was absorbed by the tidal mud and heat was transferred from the surface to the deeper part of the tidal mud and heat was transferred from the surface to the deeper part of the tidal mud.

On the other hand, during the winter and autumn the surface temperature was lower than the subsequent depths. During this time heat is released to the surface. During April, the variation was not so prominent. It showed almost straight line. The temperature profiles in different seasons, which result primarily from the molecular diffusion of heat through the sediment, resemble those typical of field soils and their form is similarly dependent on the thermal properties of the sediment medium and ambient meteorological conditions. This type of trend is due to the effects of the heat transfer direction. During day time the heat is absorbed in the surface and then transfers to the deeper depths. Again, during night heat is released from the surface of the tidal flat. So there is one layer where during the heat transfer phenomenon is occurred, the heat transfer direction is changed due to temperature difference in the subsequent layers in the day and night.

Figure 3 illustrates that the monthly temperature variation at surface, 10 cm,50 cm,100 cm , 200 cm and 290 cm depth. It is found that at surface and near surface region the temperature variation is more significant than in the deeper regions. At 200 cm and 290 cm the temperature variation in not so prominent however there is a slightly variation of temperature.

Figure 4 shows that the schematic model of temperature profile at different depths as it varies in different seasons in the tidal flat in the Ariake Sea, Japan. During summer, when solar heating of the mud was greatest, temperature gradients in the upper layer are observed which is different from winter.

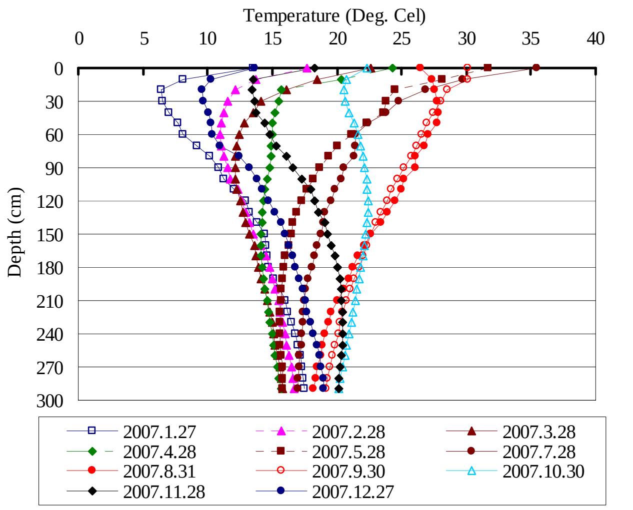

Fig 2: Seasonal variation of temperature with depth in the Higashiyoka tidal flat in 2007

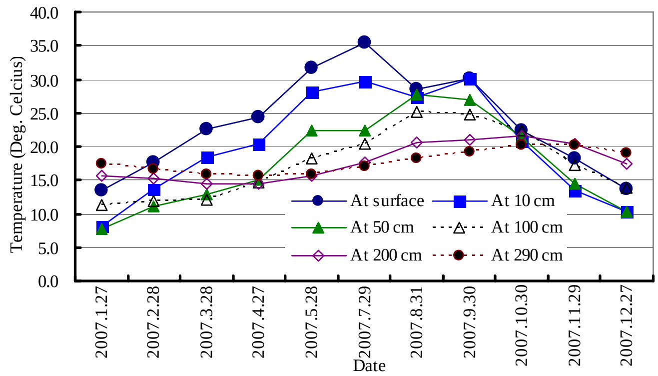

Fig 3: Monthly variation of temperature in the Higashiyoka tidal flat

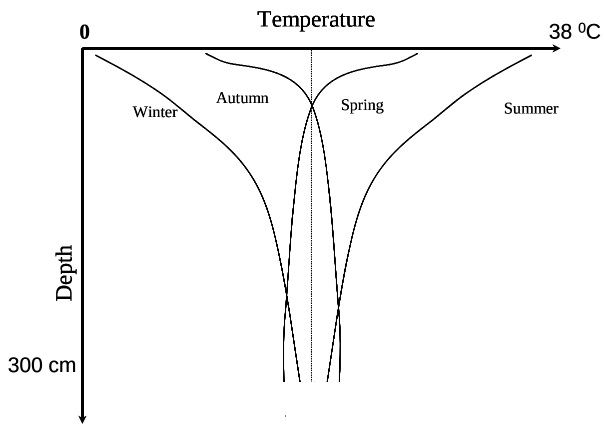

Fig 4 : Schematic profile of seasonal variation of temperature in the Higashiyoka tidal flat

5. Conclusions

The temperature profiles, which result primarily from the molecular diffusion of heat through the sediment, resemble those typical of field soils and their form is similarly dependent on the thermal properties of the mud and the ambient meteorological conditions. From the seasonal variation of temperature, it is seen that during late summer, the surface and subsurface temperature is always higher than the deeper depth of the mud while in the winter the opposite phenomenon occurs. However, in the deeper region, the variation of temperature is not so significant.

References

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