Investigation of fresh and salt water distribution by resistivity method in Yellow River Delta

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Introduction:

Purposes of Yellow River Delta group are 1) to evaluate groundwater and river water discharges and their dissolved material transports into the Bo-Hai Sea, 2) to evaluate the effect of recent Yellow River cut-off due to changes in land utilization and water management on groundwater and Bo-Hai Sea, and 3) to evaluate the interactions between Yellow River, groundwater and Bo-Hai Sea in the delta. Therefore, we have to know the condition of present groundwater in the delta for our goal.

Yellow River Delta is expanding at a speed of about 500m/y by sedimentation. However, speed of groundwater flow is very slow in general. Therefore, it is assumed that there is a possibility which paleo-seawater remains under the delta. Moreover, it is also assumed that saltwater intrusion into the subsurface under the delta occurs, because Yellow River basin has some problems concern water environment such as the cut-off of river water and over-pumping of groundwater. Therefore, purpose of this study is to clarify of fresh and salt water distribution under the land.

Methods and location:

Study methods are resistivity measurement and conductivity measurement of groundwater. Resistivity method is the technique for understanding of subsurface construction by applying the electric current to the subsurface. Resistivity values and conductivity has negative correlation. Therefore, if we clarify the relationship between resistivity and conductivity in this delta, we can estimate the distributions of fresh and salt water in the area where there is no observation well.

Study area is located in Yellow River Delta (fig.1). Locations of resistivity measurement are 14 points. Measurements were done in September 2003, May 2004 and September 2004.

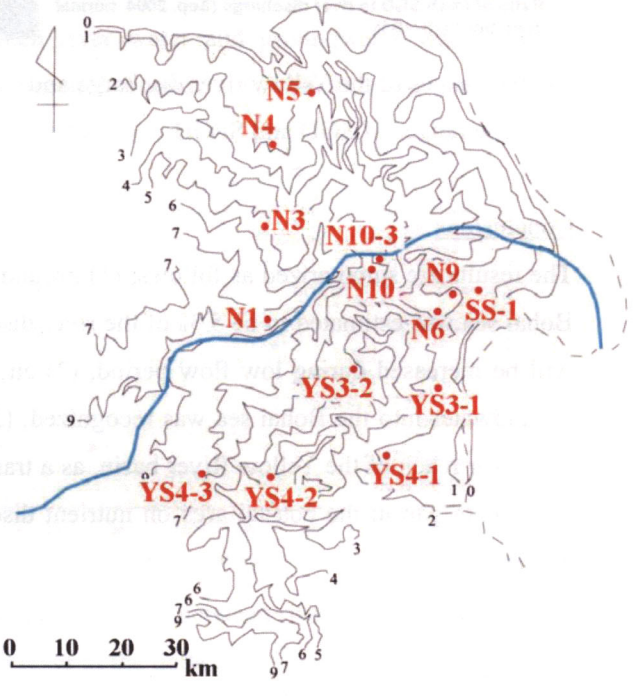

Fig. 1 Location map

Results and discussion:

Figure 2 shows all results of resistivity measurement. In these figures, warm color indicates high resistivity values, and cold color indicates low resistivity values. And, width and height of figure are 150m and 100m.

Comparisons of resistivity and conductivity have been done to confirm whether it has negative correlation in the delta also. Comparison was done by datasets of the point where both measurements were done. For example, if groundwater was corrected from 5 to 20m depths, resistivity datasets at the same depth were used for the comparison. Figure 3 is the result of comparison. Resistivity and conductivity have the negative correlation clearly. Therefore, it is thought that low resistivity indicates high conductivity and saltier water, and high resistivity indicates low conductivity and fresher water.

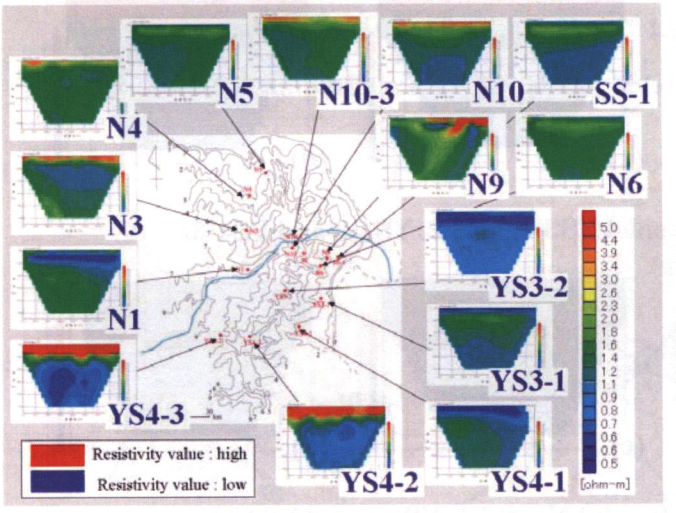

Fig. 2 Results of resistivity measurement

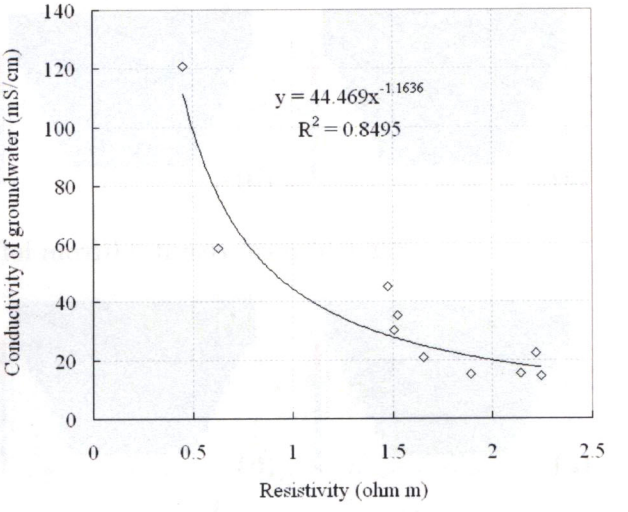

Fig. 3 Negative correlation between resistivity and conductivity

We introduce some typical results of resistivity measurement about fig.2. First one is the result which high resistivity region seems to go underground (N9, fig.4). It is thought that it means surface water recharge because there is a pond which is fresher than salt water on the ground. Second one is the result which there is low resistivity region in spite of the land (N1, fig.5). It is thought that there is the paleo-seawater remains in this region because conductivity of groundwater is also high. Third one is the comparison of results in the ridge part and results in the valley part (YS3-1, YS3-2, YS4-2 and YS 4-3, fig.6). In shallow underground, there is the low resistivity region at the ridge part. However, there is the high resistivity region at the valley part. It is thought that the paleo-seawater remains at the valley part. And, last one is the results about near the coast (N5, SS-1, YS3-1 and YS4-1, fig.7). Results near the coast has low resistivity region in the shallow depth. There are many aquaculture ponds near the coast. Therefore, it is thought that there is salt water from these ponds in this region.

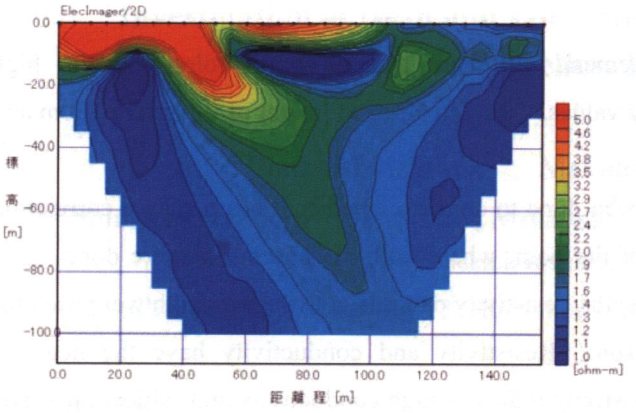

Fig. 4 Typical result 1 (N9)

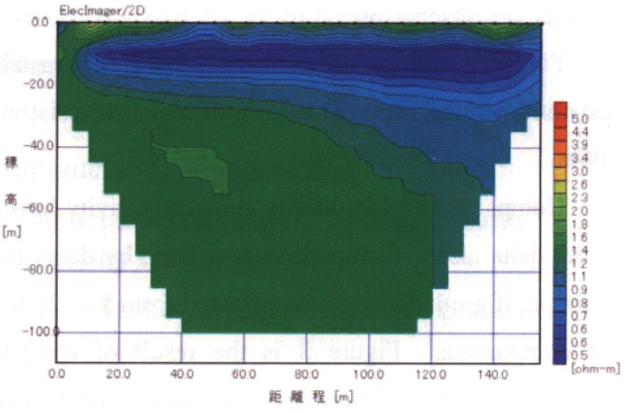

Fig. 5 Typical result 2 (N1)

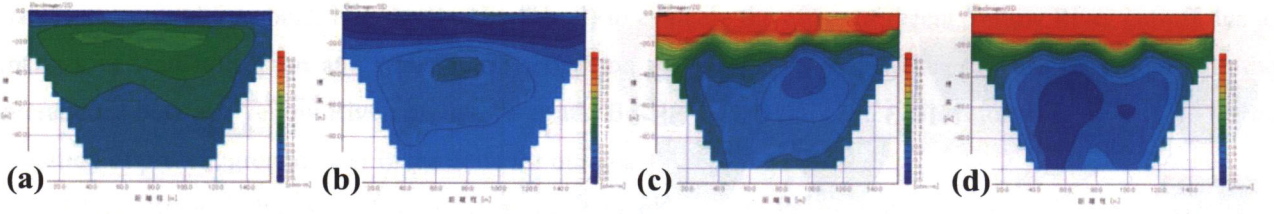

Fig. 6 Typical result 3 ((from left side) YS3-1, YS3-2, YS4-2 and YS4-3)

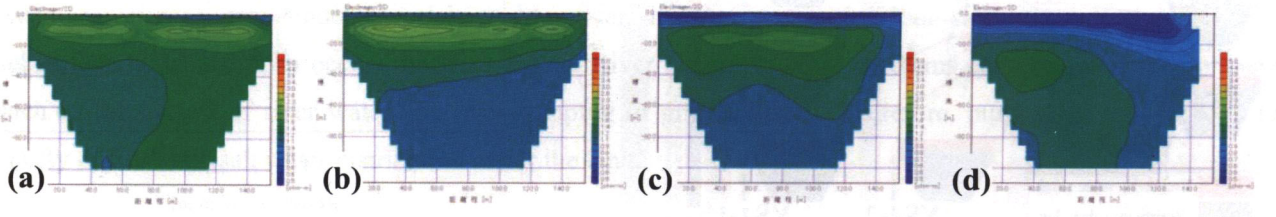

Fig. 7 Typical result 4 ((from left side) N5, SS-1, YS3-1 and YS4-1)

Figure 8 shows spatial variations of conductivity and resistivity. Spatial variations of both sides indicate negative trend because resistivity and conductivity have negative correlation.

And figrure 9 shows spatial variations of conductivity which are estimated by regression line between resistivity and conductivity (fig.3) every 10m. Figure 9-a shows region of fresher and saltier water. However, there are almost saltier region in deeper part from 20m depth.9-b shows region of saltier water in this region.

Conclusion:

1) Negative correlation between conductivity of groundwater and resistivity under the land in Yellow River Delta was confirmed by comparison of conductivity and resistivity.

2) Existence of paleo-seawater, differences between valley and ridge part, and recharge of surface water to the subsurface were clarified by resistivity measurements in every points.

3) Distributions of fresh and salt water were assumed by resistivity measurements.

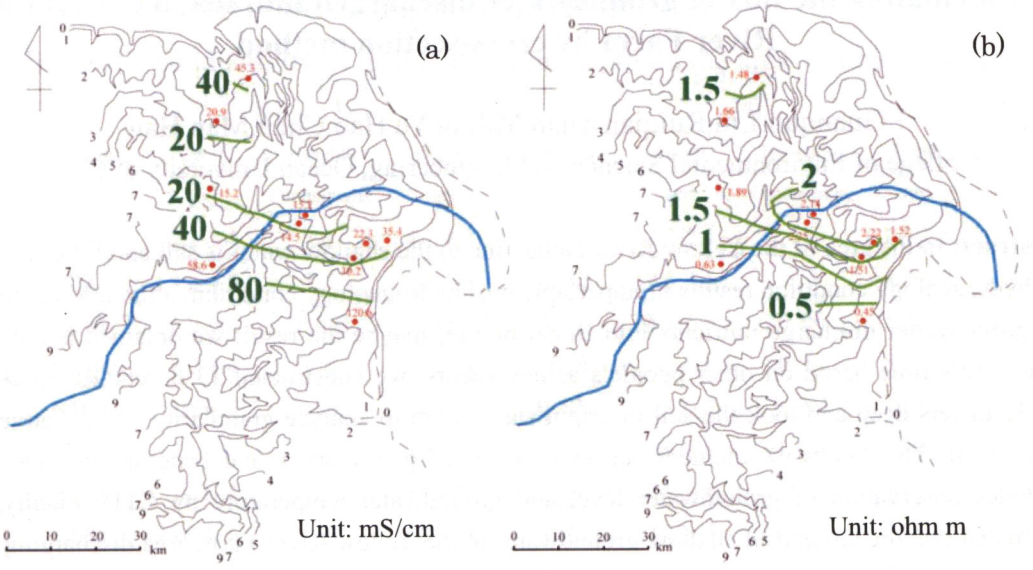

Figure. 8 Comparison of groundwater conductivity (a) and resistivity (b) variation

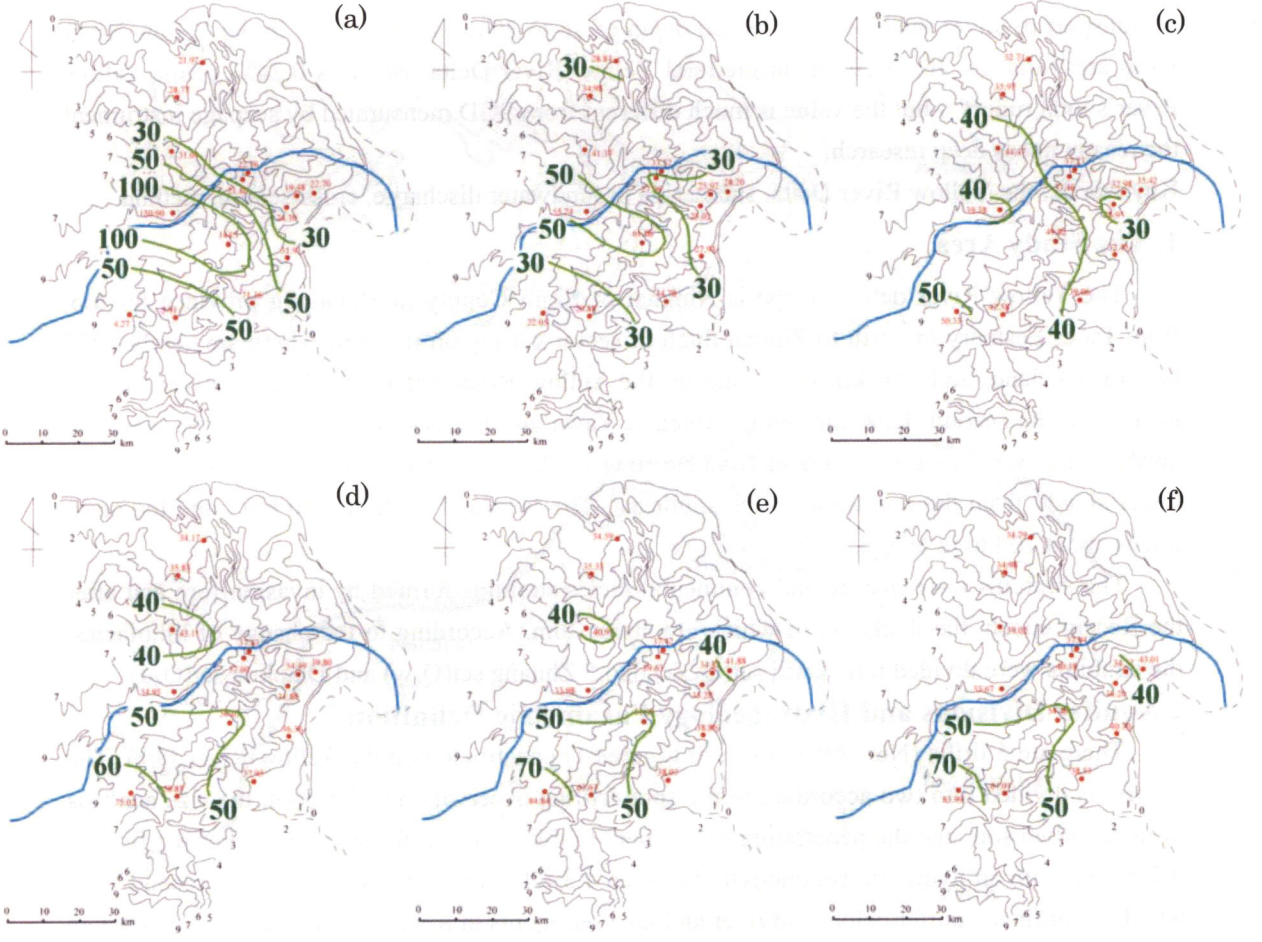

Figure. 9 Distributions of conductivity estimated from resistivity under the land

(a):10m depth, (b):20m depth, (c):30m depth, (d):40m depth, (e):50m depth, (f): 60m depth (Unit: mS/cm)