DISTRIBUTION OF SURFACE DEPOSITS OFF SHIMIZU COAST, SHIZUOKA PREFECTURE, JAPAN

Shuro YOSHIKAWA [1] and Kenji NEMOTO [2]

[1] Post Doctor, Tokai University
(3-20-1 Orido, Shimizu-ku, Shizuoka 424-8610, Japan)
E-mail: s08pd3@scc.u-tokai.ac.jp
[2] Professor, Department of Marine Mineral Resources, School of Marine Science and Technology, Tokai University
(3-20-1 Orido, Shimizu-ku, Shizuoka 424-8610, Japan)
E-mail: nemoto@scc.u-tokai.ac.jp

Coastal erosion has been one of the serious environmental problems in Japan. Numerous studies on sediment transport related to the coastal erosion for preservation of the coastal environment, have been performed on the basis of civil engineering research. To clarify sediment transportation related to the coastal erosion at the near shore zone, is very important for preservation of the coast at present and the future. In this study, we researched the surface deposits and sedimentary structures to discuss the process of sediment transportation off Shimizu coast, Shizuoka, Japan.

Key Words : *Coastal erosion, Surface deposit, Seismic profile, Sedimentary facies*

1. INTRODUCTION

Coastal erosion has been one of the serious environmental problems in Japan. In recent years, the influence that global warming exerts on the coastal environment has been extremely feared. The impacts of sea level rise induced by global warming on sandy beaches were assessed (Center for Global Environmental Research, 2000[1)]) . The eroded area in Japan reaches 56.6, 81.7, and 90.3 % of the total area of the existing beaches for the sea level rises of 30, 65, and 100 cm, respectively (Mimura and Kawaguchi, 1996[2)]) . The effects on sandy beaches are extremely large, because such erosion superimpose on the already existing erosion (Mimura and Kawaguchi, 1996[2)]) .

Numerous studies on sediment transport related to the coastal erosion for preservation of the coastal environment, have been performed on the basis of civil engineering research. For example, investigation on beach topography, wave observation, numerical simulation, analysis of bottom materials, observation air photos were reported (e.g. Uda, 2004[3)]; Itabashi and Uda, 1998[4)]). In addition, the study of the formative process of the beach last tens of years had been performed on the basis of analysis of boring cores (e.g. Sato et al., 2000[5)]). To clarify modern sediment transportation related to the coastal erosion at the near shore zone, is very important for preservation of the coast at present and the future.

Miho peninsula on the continental shelf off Shimizu coast, located at north-western Suruga Bay, in Shizuoka, Japan (Fig. 1A) had been formed of eroded sediments from Udo Hill and wash out sediments from Abe River which is located at the southwest of the peninsula (e.g. Hoshino, 1976[6)]). However, the peninsula does not received enough sediments from these sources in last 20 years. This decrease of sediment source was due to much extraction of sediments at bottom of Abe river (e.g. Sato, 1998[7)]). So that, Miho peninsula is now typical example site of the coastal erosion.

In this study, we researched the surface deposits and sedimentary structures to discuss the process of sediment transportation and formative process of the topography at the near shore zone, off Shimizu coast.

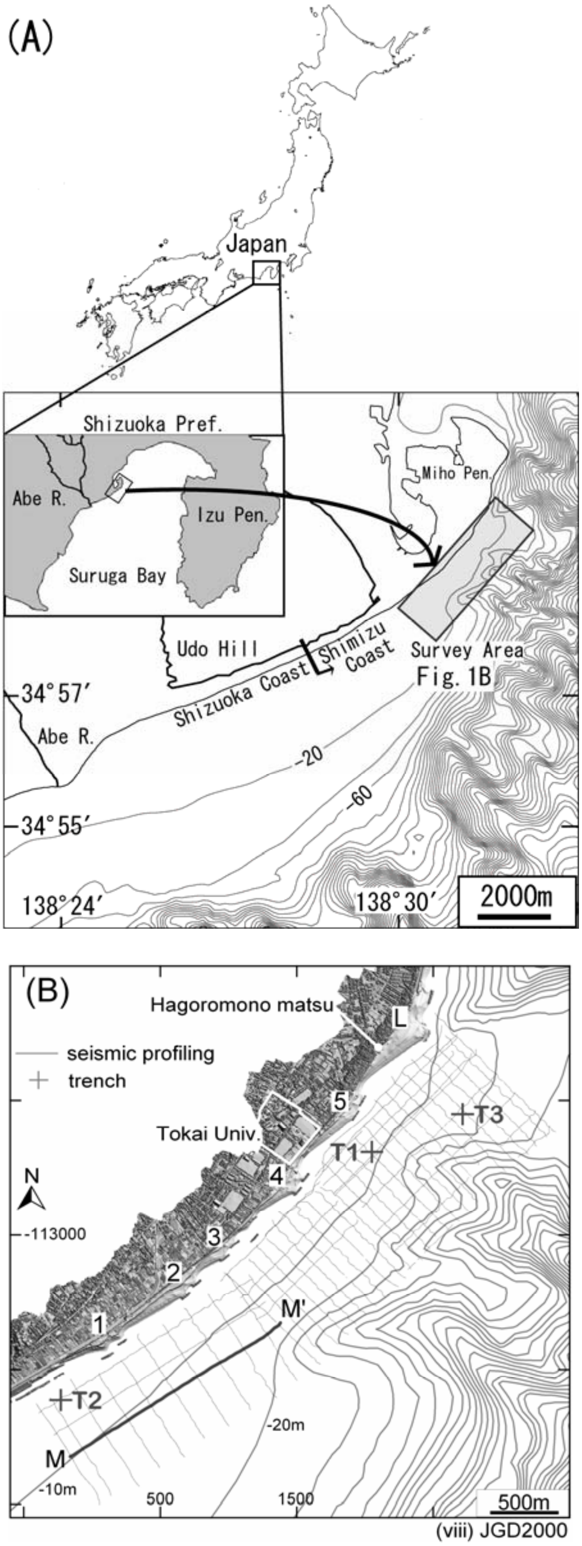

Fig.1 (A) location of the survey area. (B) seismic survey lines and trench points. 1 ~ 5 and L in the figure are headlands (coastal structures).

2. SURVEY METHOD

(1) Seismic profile

The survey had been conducted by seismic profiling, using the parametric seismic reflection profile echo sounder (SES-2000 compact: made by Innomar Tech. in Germany) off Shimizu coast in April 2007 (Fig. 1B). D-GPS (MX421: made by Leica Geosystems Inc. in America) was used for the positioning of the sensor, and dynamic motion sensor (DMS-05: made by TSS Inter. Ltd. in Britain) was used for correction of roll, pitch, and heave of the ship. The tidal data in Shimizu port was applied for the tidal correction of depth values.

36 track lines in the direction of northwest to southeast with 100 to 200 m line interval are prepared for seismic works. In addition, 16 track lines in the direction of northeast to southwest with 200 m line interval are added (Fig. 1B). This seismic system has sound wave of 100 KHz in the sound primary source, and sound wave of 5 to 15 KHz in the sound secondary source. The transmission power is 12kW. The main two characteristics of this system are that, 1: angle of the sound wave of secondary is plus or minus 1.8 degrees, which is very narrow, 2: the depth resolution is 5 cm, showing very high resolution.

(2) Trench

Sedimentary facies on the study area had been observed by trench in the seafloor in June and November in 2007 (Fig. 1B). The observation shows nature of seismic reflectors and lithology of each seismic facies.

The procedure of the trench work by scuba diving is as follows. 1: takes pictures and sediment samplings on the sea floor at the trench points. 2: surface sediment on the seafloor is pulled out by the air lift. 3: After the digging depth reached the reflector, the sampling and taking pictures of deposits executed again. Maximum depth on the every trench point is that T1 is about 1.3 m below the seafloor, T2 about 1.5 m, and T3 about 1 m.

In addition, the radiocarbon (^{14}C) ages of the twigs in the sediments below the seafloor were measured by AMS (Accelerator Mass Spectrometry). This analysis consigned to the Pareo Lab Ltd.. Other samples calculated content the rate of gravel, sand, and mud in each sample by grain size analysis.

3. RESULT AND DISCUSSION

Three basic stratigraphic units are recognized on the high resolution seismic records. These are Layer S1, S2, and S3 in descending order (Fig. 2). Two reflectors, Ra and Rb, are found between almost each layer. Reflector Ra between Layer S1 and S2 is mostly flat, parallel to the seafloor. On the other hand, Reflector Rb between Layer S2 and S3 shows irregular surface (Fig. 2). Layer S1 characterized by

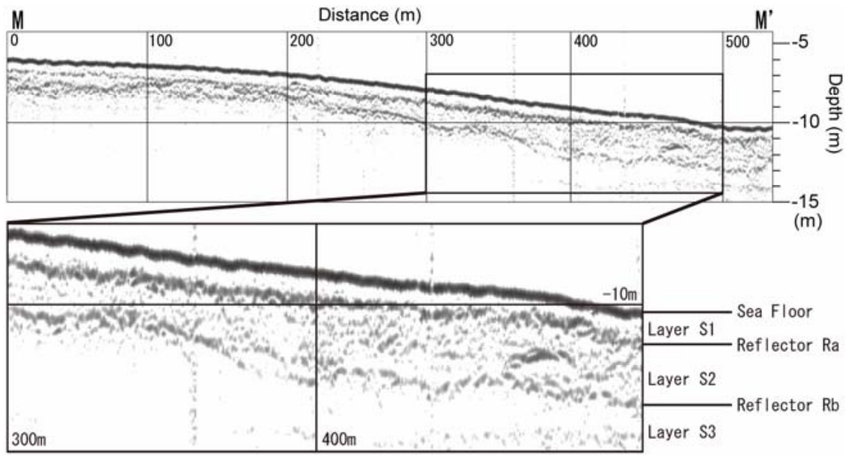

Fig.2 Seismic profile and its interpretation. Location of the profile is shown in Fig. 1B. Acoustic stratigraphy is shown in the figure. Three basic sediment units, Layer S1, Layer S2, and Layer S3 are clearly recognizable. X: Distance (m) from starting point, Y: Depth (m).

internal transparency on the seismic records has thickness between 0 m and 4.2 m, averaging about 0.6 m. Layer S2 characterized by many internal reflectors on the seismic records has thickness between 0 m and 4.2 m, averaging about 0.8 m. Layer S3 is characterized by that clear consecutive reflector such as Reflector Ra and Rb was almost never recognized in this layer.

Sedimentary facies (Fig. 3) observed by the trench are correlated with seismic layers. Layer S1 is correlated with facies A which is well sorted sandy

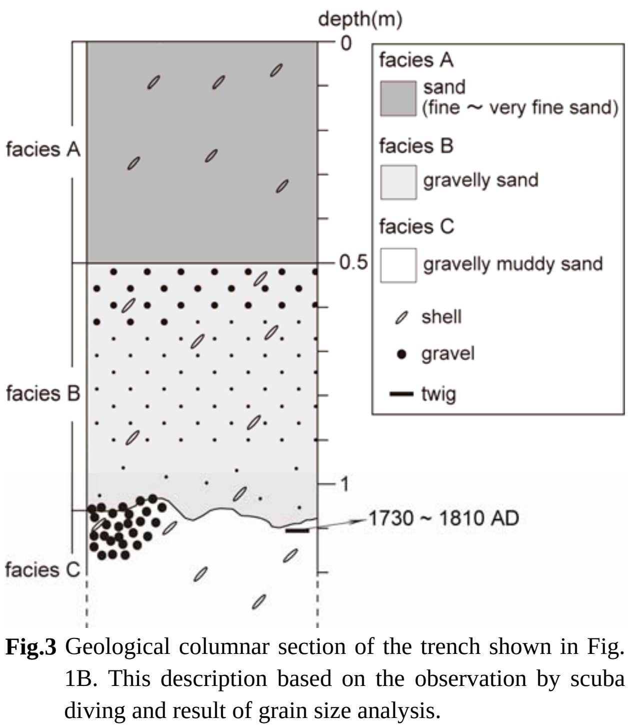

Fig.3 Geological columnar section of the trench shown in Fig. 1B. This description based on the observation by scuba diving and result of grain size analysis.

deposits. Layer S2 is correlated with facies B which is sandy gravelly deposits. And Layer S3 is correlated with facies C which is sandy gravelly deposits including muddy deposits.

Layer S1 had been appear to be formed during 20 years. This interpretation is supported by following reasons. 1) Distribution of Layer S1 can not be found on the seafloor where sediment transportation from beach to submarine canyon is currently active. 2) Layer S1 has accumulated very thick around the submarine dune which was formed after 1985 (e.g. Yoda et al., 1997[8)]). 3) Layer S1 is correlated with easily movable well sorted sandy deposits. 4) Sand ridges are formed by Layer S1. These ridges are thought to be formed by result of sediment transportation from beach at storms (Yoshikawa et al., 2006[9)]).

Calibrated radiocarbon isotopic age dating from upper part of the Layer S3 (which corresponds to facies C) ranges from 1730 to 1810AD (Fig. 3). If this age assumed the period when the wooden piece (Fig. 3) was deposited in the facies C, depositional age of layer S2 is from after 1730 to 1810 to about 20 years ago.

The sedimentation rates and volumes of Layer S1 and S2 in the survey area were estimated from these considerations described above. Layer S1 had been accumulated about 2,300,000 m^3 during 20 years, and layer S2 had been accumulated about 3,100,000 m^3 during 180 to 260 years. Amount of annual sedimentation average for layer S1 is about 115,000 m^3, and layer S2 ranges from about 12,000 to 17,000 m^3. The difference in these sedimentation rates were appear to be triggered by sudden influx of a huge amount of sediment from beach to the shelf. These migrated sediments are as follows. 1) Sediment which migrated to the survey area by long shore transport. This volume of the sediment had been decreased during about 20 years, because of controlled the long shore transport by headlands were built. The volume was 130,000 m^3/yr before headlands were built, and the volume was 70,000

m^3/yr after headlands were built (Uda et al., 2006[10]). 2) Nourishment (35,000 m^3/yr) in the survey area during about 20 years.

4. Conclusion

Three basic sediment units, Layer S1, Layer S2, and Layer S3 are recognized on the seismic records. We discussed the depositional process and sediment transportation off Shimizu Coast last 260 years on the basis of the disdribution and character of these sediment layers. Natures of these layers are observed by trench, and the depositonal age of the facies was determined by radiocarbon (^{14}C) age.

In the future, sedimentary facies analysis from the result of boring cores and the study on the migration of the surface sediment layer at storm, are scheduled. These studies may clarify the origin of the reflectors and the layers, and the depositional process at the near shore zone more clearly.

ACKNOWLEDGMENT: We wish to thank students and graduate students of school of Marine Science and Technology, Tokai University for assistance of field investigation and data analysis, and the Tetsugumi Underwater Operation Co. Ltd. for trench works.

REFERENCES

1) Center for Global Environmental Research : Data book of sea level rise 2000, National Institute for Environmental Studies, Japan, 128pp, 2004.
2) Mimura, N. and Kawaguchi, E. : Responses of coastal topography to sea-level rise, Proc. of 25th ICCE, pp. 1349-1360, 1996.
3) Uda, T. : The realities and solutions of coastal erosion, Sankaido, 304pp., (in Japanese) 2004.
4) Itabashi, N. and Uda, T. : Field observation of erosion and accretion waves on Shizuoka and Shimizu coasts in Suruga bay in Japan, Proc.of 27th ICCE: pp. 3178-3191, 1998.
5) Satoh, S., Maeda, R., Isobe, M., Sekimoto, K., Kasai, M., Torii, K., Yamamoto, K. : Field investigation on coastal morphological processes of the south Kashimanada coast, J. Jpn. Soc. Civil Eng., No.663/II-53, pp. 89-99 (in Japanese with English abst.), 2000.
6) Hoshino, M. : Mystery of Suruga bay, Shizuoka Shinbun Co., 253pp (in Japanese) 1976.
7) Satoh, T. : Beach erosion of Orido coast, Shimizu, Japan -On the transportation of the gravels and coarse materials-, Bull. Mar. Sci. Tech, Tokai Univ., 46, pp.107-117 (in Japanese with English abst.), 1998.
8) Yoda, M., Ishii, R., Takino, Y., Ohta, M., Hukuoka, K. and Nemoto, K. : Distribution of sea bottom sediments off Mihonomatsubara in western Suruga bay, central Japan, Bull. Mar. Sci. Tech, Tokai Univ., 43, pp.157-170 (in Japanese with English abst.), 1997.
9) Yoshikawa, S., Nemoto, K., Yokoyama, S., Kitoh, T. and Kimura, K. : Migration and sedimentation of clastic sediments from beach to inner shelf off Miho Peninsula, J. Jpn. Soc. Mar. Surv. Tech., 18(1), pp.3-15 (in Japanese with English abst.), 2006.
10) Uda, T., Ishii, T., Sugiyama, K., Nishitani, M., Ogiwara, S., Serizawa, M. and Ishikawa, T. : Evoluation of controlling effect by detached breakwaters built on dynamically stable beach on sand transport, Annu. J. JSCE, 53(1), pp. 661-665 (in Japanese), 2006.