facies E occurs adjoining to facies D. The delta front was formed by river floods without reworking by wave or tide. Based on the sedimentary structures of facies D, the Yahagi incised-valley system is interpreted to be calm and fluvial dominated system. The succession was interpreted as transgressive systems tract (the lower facies A and facies B) and highstand systems tract (facies C, facies D or facies E, and the upper facies A) formed under sea-level rise until ca. 7 cal kyBP and subsequent highstand. After the formation of the delta in ca. 7 cal kyBP, characteristic features of the delta front such as thickness, gradient, and grain-size distribution changed twice as delta prograded.

The first change occurred in 45 cal kyBP. In this change, the delta front became thicker and steeper. This change was induced by difference of water depth between middle incised-valley and outer incised-valley result from underlying clinoform architecture. This clinoform was formed in latest transgressive stage by difference of sedimentation rates between tide-influenced shallow area and deeper area when sea-level rising rate decreased to the same level as sedimentation rate in tide-influenced area.

The second change occurred in ca. 3 cal kyBP. In this change, grain-size distribution of the delta front became coarser and the sorting became poorer. Sediment discharge of the Yahagi River also increased abruptly. This change was induced by the increase of erosional capacity in the hinterland. Increasing human activities such as deforestation and poor soil conservation might induce this change.

These results imply that the delta system is strongly influenced not only by hydraulic- and geological-setting at the time but also by geologic history of the basin such as sea-level rising rate of former transgressive stage and topography of underlying estuary system or basement. In the piedmont and small incised-valley fill systems such as the Yahagi incised-valley fill system, these effects of underlying topography seem to be more important than other bigger systems.

Storm-influenced tiny delta

Toshiyuki KITAZAWA [1]*, Kiyoyuki SHIGENO [2], Shigekazu KOITABASHI [2], Seigo MIYASAKA [3], Tadafumi NIIZATO [1] & Koichi HOYANAGI [4]

[1]Horonobe Underground Research Center, Japan Atomic Energy Agency, 432-2 Hokushin, Horonobe, Hokkaido 098-3224, Japan
* E-mail: kitazawa.toshiyuki@jaea.go.jp
[2]Meiji Consultants Co. Ltd., 13, Minami 7, Nishi 1, Chuo-ku, Sapporo 064-0807, Japan
[3]Intelligent Partner for Geology Co. Ltd., Tonden 5-7-1-60, Kita-ku, Sapporo 002-0855, Japan
[4]Department of Geology, Shinshu University, 3-1-1 Asahi, Matsumoto 390-8621, Japan

To assess a long-term stability of the geological environments in a coastal zone, it is necessary to understand the depositional processes in the zone. At a river mouth during a high stand period, a delta is commonly developed. It is expected that the delta-forming processes are influenced by storm wave and flood during a storm event, however little is known about the characteristics of its facies. We investigated what kinds of facies are preserved in a storm-influenced tiny delta, in the case of the Lower Pleistocene Sarabetsu Formation in Horonobe area, northernmost Japan.

An upward-shallowing succession (exposed thickness: 34.4 m) formed as a results of progradation of a tiny delta adjacent to a strand plain is recognized at the studied pit. The depositional environments and the water depths (Dw) estimated from the thickness of overlying marine sediments are as follows in ascending order: 1) Delta front slope, Dw > 20 m; 2) Delta front platform, Dw = 20-15 m; 3) Lower shoreface, Dw = 15-10 m; 4) Upper shoreface, Dw = 10-2 m; 5) Foreshore, Dw < 2 m; 6) Backshore.

Storm event deposits are recognized in the succession and consist of 4 facies as follows:

Facies A) Fine sand with hummocky cross-stratification (HCS). It is in the deposits of the upper part of delta front platform and lower shoreface (Dw = 16.5-11.5 m). It erodes the underlying deposits and is overlain by facies B) or C). Facies A is interpreted as a storm-wave deposit at the beginning of a storm event.

Facies B) Sand and gravel with wave-dune ripple (wavelength < 80 cm). It is in the deposits of delta front platform and the lower part of lower shoreface (Dw = 20-13.5 m). It erodes the deposits beneath. Facies B is interpreted as a storm wave deposit, thus the storm-wave base was estimated deeper than 20 m.

Facies C) Sand and gravel with combined flow dune ripple (wavelength < 160 cm). It is in the deposits of lower shoreface and the lower part of upper shoreface (Dw = 13.5-7 m). It erodes the deposits beneath. Facies C is interpreted as a deposit formed by combined flow of storm wave and flood, thus it is estimated that the flood current have reached at least 13.5 m in the water depth.

Facies D) Mud layer thinner than 9 cm. It is in the deposits of delta front platform, lower shoreface, and the lower part of upper shoreface (Dw = 20-7.5 m). It covers facies A), B), and C). Facies D is interpreted as fine materials suspended by flood and storm wave, and deposited at the end of the storm event.

Four types of storm-event sequence are recognized in the deltaic succession; B-D (Dw = 20-13.5 m), A-B-D (Dw = 16.5-13.5 m), A-C-D (Dw = 13.5-11.5 m), and C-D (Dw = 13.5-7 m). The variation is inferred to have been caused by the scale of the storm events and water depths. These types could be applied to estimate the scale of flood and storm wave in the other ancient and modern deltas of the world.

Coastal accretion and erosion in Red River Delta and influence of monsoon

Tran Duc THANH [1], Yoshiki SAITO [2], Vu Van VINH [1], Nguyen Huu CU [1]

[1] Institute of Marine Environment and Resources, VAST, Vietnam
[2] Geological Survey of Japan, AIST, Japan

During last thousand years, the mean rate of seaward expansion with the time has increased in the southwest part and has decreased in northeast part of Red River Delta (RRD). In the present time, RRD expands seaward at the mean rate of 25-30m/year, maximum 120m/year and prolonges southwest ward. This is a result of combination of Coriolis force and prevenlling Northeast monsoon, and is reflected by morphology of streams and displacement of river mouths which are moved alternately northeast ward or southwest wad by periods of 30 50 years for large ones and 7 11 years for small ones.

There has been an irregularly accretion between high tidal flats and low tidal flats. High tidal flats have accreted faster 1.7 times than low tidal flats. In the same transversal section, the high tidal flats accrete rapidly, the low tidal flats accrete slowly, and contrarily, generally. The vertical rate of deposition has changed with elevation of tidal flats, from1-4 cm/year when elevation below mean sea level (MSL); 5-20 cm/year from MSL to high neap tidal level; then smaller than 3 cm/year when elevation over the last level.

Based on the relationship between erosion - accretion, the coastal zone of RRD is divided into three parts. In Yen Lap Do Son part (North) located in the Bach Dang estuary, erosion has a longtime tendency, but not large in rate. In Do Son Ba Lat part (Middle), erosion was very strong, but has been weak recently. In Ba Lat Lach Truong part (South), erosion has been very strong and increased after time. Erosion and accretion relation can be divided into five main kinds: 1) Accretion has continued since the end of the last century; 2) Erosion is on-going from long time; 3) Accretion and erosion phases are alternately occurred; 4) Erosion was strong during longtime ago, but it has changed into accretion recently; and 5) Accretion was dominant, but it was suddenly changed into erosion recently. The mean rate of coastal accretion of RRD throught periods 1930 1965, 1965 1990 and 1990 present was culculated as 28.7/year, 29.1 m/year and 44 m/year respectively. The sediment supply significantly depend on flood time falling in Southeast monsoon or dry time falling in Northeast monsoon, and the periods of great discharge from 8 13 years or the periods of small discharge from 10 28 years. Some extreme discharges of suspended sediments were recorded as 52.5 ton in 1963 (min.) and 202 mil.ton in 1971 (max.).

RRD has eroded in the total coastline length of 22.75 km with a mean rate of 11.5 m/year and maximum 20.5 m/year. Particularly, the Hai Hau (Van Ly) coast has eroded in the length of 17.2 km and at a mean rate of 14.5 m/year. The relationship between coastal direction and prevelling monsoon direction impacts greatly to coastalerosion. For almost eroded sites of RRD with NE-SW coastal direction of, the strongest erosion happen in the beginning of northeast monsoon (September December). The southwestwards longshore drift by wave and seawards transversal drift created by great fluctuation of tidal range and combination of ebb tidal current and wind current in Northeast monsoon is cause of sedimentary lack in Hau Hau eroded coast. In RDD, the Cat Hai eroded site with latitudinal direction is a special case where the cosatl erosion time is in the Southwest monsoon.

The effects of the use of DELTA zones for various industries and development projects in Sri Lanka

U.de S. JAYAWARDENA

Department of Civil Engineering, Faculty of Engineering, University of Peradeniya, Peradeniya, Sri Lanka
E-mail: udsj@pdn.ac.lk.

The country Sri Lanka is a small Island and it is being considered as a developing country in the Asian region. The available resources in the Island and imported raw materials are used for