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Late Quaternary Sedimentation on the Continental Shelf off the South-East Coast of Korea*

—A Further Evidence of Relict Sediments—

Yong Ahn Park
Department of Oceanography, Seoul National University, Seoul 151, Korea

韓半島 南東海域 大陸棚 海底에서의 第四期 後期의 堆積作用

朴 龍 安
서울大學校 海洋學科

Abstract: Two hundred suspended-matter samples were collected from the continental shelf off the southeast coast of Korea during September, 1981, March, 1982 and April 1983. Superficial bottom sediments on the shelf were also taken.

Based on the analyses of TSM distribution and concentration patterns, it is considered that fine-grained suspended matters are restricted to nearshore-inner shelf showing a band or zone paralleling with coastal morphology. This fact suggests a limitation of "modern" fine grained sediments to a nearshore and inner shelf band.

The sand deposits with the lower value of mud content (<5%) adjacent to the shelf break and on the outer shelf would probably be "relict" sediments (old beach sediments) deposited in response to a lower stand of sea level during the Pleistocene ice age.

The transgression did little to alter the distribution of sand on the outer shelf in this particular study area. The progress of shore line was so rapid that a given locality was in the beach zone and subject to rapid longshore drift and extensive reworking only for a few years. Probably the most pronounced effect of the transgression was sorting of the sand, and at least partial winnowing out of the finer fractions.

要約: 1981년 9월, 1982년 3월 및 1983년 4월에 한반도 남동해역 대륙붕에서 표층퇴적물과 부유물 표품을 채취하였다.

부유물 함량 분포에 의하면 세립한 부유물질은 연안의 내 대륙붕에 국한되어 연안에 평행하게 대상으로 분포하여 현생의 세립퇴적물이 내 대륙붕 지역에 국한되고 있음을 시사하고 있다. 그러나 외 대륙붕과 붕단에 분포하는 사질퇴적물은 니질 함량(<5%)이 매우 낮다. 이러한 조립질 퇴적물은 해수면이 낮았던(약 −152m±) 플라이스토세(Pleistocene) 빙기에 집적된 "잔류"퇴적물(고해빈퇴적물)로 사료된다.

현세 해수면 상승에 따른 해침현상이 일어나고 해안선의 전진이 빠르게 일어나게 되어 외 대륙붕의 사질물질이 재 분포 되는 경우가 대단히 약하였으며 일시적으로 강한 연안류 등에 의해 현지성(in situ) 재동작용을 받았을 것이다. 결과적으로 해침현상에 따른 가장 큰 영향은 사립물질의 분급작용이 가속된 것이고, 최소한 세립물질이 제거(winnowing out)되는 작용이 일어났을 것이다.

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Introduction

As one part of a cooperative research program and multi-disciplinary oceanographic investigation conducted by a team of faculty members of the Department of Oceanography, Seoul National University, a marine geologic research on the continental shelf area off the southeast coast of Korea has been carried out. The study area covers approximately 10,000km^2, where most of the area occupies continental shelf with 200m water depth of shelf break and its northeastern part includes continental slope and the Ulleung Basin exceeding 1,500m in water depth(Fig. 1 and 2). The waters of the area are characterized by three different water-mass components: (1) the Kuroshio Current which is passing towards the so-called Sea of Japan through the Korean Strait between the Korean Peninsula and Tsushima Island. (2) the North Korean cold water which is coming down towards the south along the eastern coast of the Korean Peninsula, and (3) the Japan Sea proper water which is a overlying deep water in the Japan Sea basin. In this particular area (Fig. 1), the purposes of this research are (1) to outline distribution pattern of particulate total suspended matter(TSM) in both surface and near-bottom water (1 m off bottom), (2) to determine percentage distribution of heavy minerals in relation to the distribution pattern of sedimentary textures(grain size parameters) of the superficial bottom sediments, and (3) to understand Holocene sedimentary processes in relation to the Holocene sca-level rise or Holocene transgression in the region. Results reported here are based on analyses of samples collected during three cruises (September 1981, April 1982, April 1983) aboard the Korea Maritime College T/V "Hanbada". The first part results of this study project, however, were already reported by Park in 1982. The author do appreciate the research fund(1982~1983, RIBS-ED-82-507) from the Ministry of Education. Also the author thank our ocean-going able graduate students of the department of oceano-

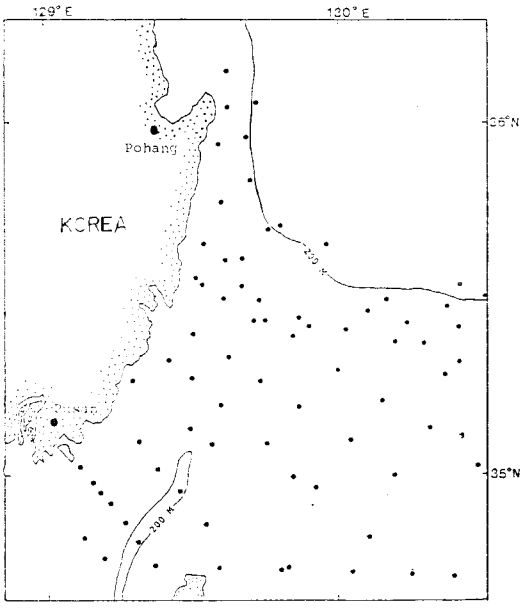

Fig. 1. Index map showing grab bottom sample stations: the 200 bathymetric contour is also shown.

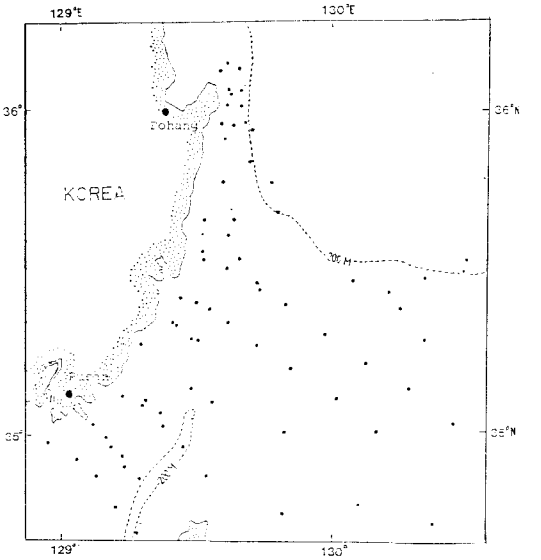

Fig. 2. Index map showing suspended matter sample stations: the 200 bathymetric contour is also shown.

graphy, Seoul National University for their great assistance and help both in the field and laboratory.

Methods and Materials

Figure 1 and 2 illustrate the index map and sample stations for bottom sediments and suspended materials in the water during a week in September, 1981, March, 1982 and April, 1983.

For suspended matter study 4 liter-Van Dorn water samplers were used. Grab samples were obtained using a shipeck heavy-duty and Van Veen grab sampler.

The grain-size analyses of the sand fraction (coarser than 63μm) were carried out using a dry sieving technique: the mud fraction(finer than 63μm) was analysed using pipette analysis.

Water samples for TSM(total suspend matter) were filtered by vaccum system through preweighed Nuclepore 47mm polycarbonate membrane filter paper(0.45μm).

Results

Grain-size Analysis

The distribution of sand (Fig. 3) shows the area of the highest amount of sand(>95%) close to the shelf break of the continental shelf. However, the lowest values(<5%) exist in the west and northwestern portion of the shelf, that is, along the south-eastern nearshore and inner shelf area. Additional other areas of higher sand content(80~95%) also exist along the shelf edge and saddle-like low area(named as Korea Strait ravine) between the Korean Peninsula and Tsushima Island, and to the south of the highest sand content area. The other rest areas have the values of sand content ranging from 40~50% to 10~40%. The mean particle-size distribution of the sand fraction of those samples with higher sand content shows that the coarser particles are deposited close to the shelf break

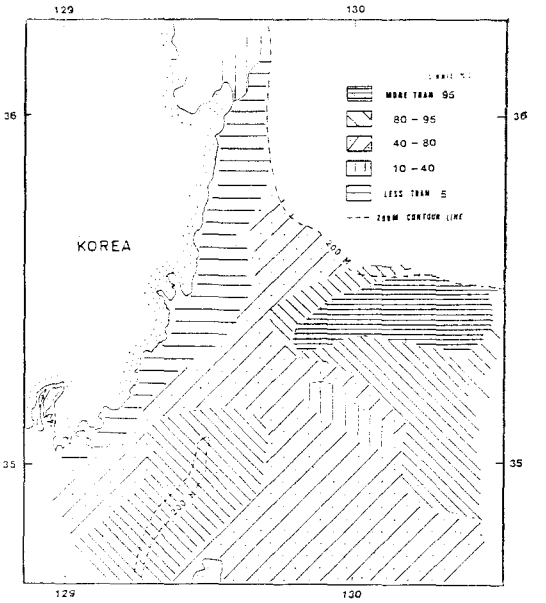

Fig. 3. Distibution of sand content (%) for surface sediment on the continental shelf of the southeastern sea of Korea.

areas: the finer fraction is concentrated along the nearshore and inner shelf area paralleling with southeastern coastline of the Korean Peninsula. The sorting of the sand fraction varies from moderately well sorted to very well sorted.

The relative percentage of the sand, silt and clay of 9 station samples across the shelf(nearshore area to the shelf break) is significantly changing as shown in Figure 4. The highest values of silt and clay content occur in the nearshore and inner shelf area(some 25km width from the shore line): the lower values occur both on the outer shelf and at the shelf break area. Also, relatively high values of silt and clay content occur in the continental slope environment. In contrast with the silt and clay content variations of the sediments across the shelf(Fig. 4), the highest percentage values of sands occur in the outer shelf area: contents are especially high in the shelf break areas.

Heavy Mineral Content

The distribution of total heavy mineral con-

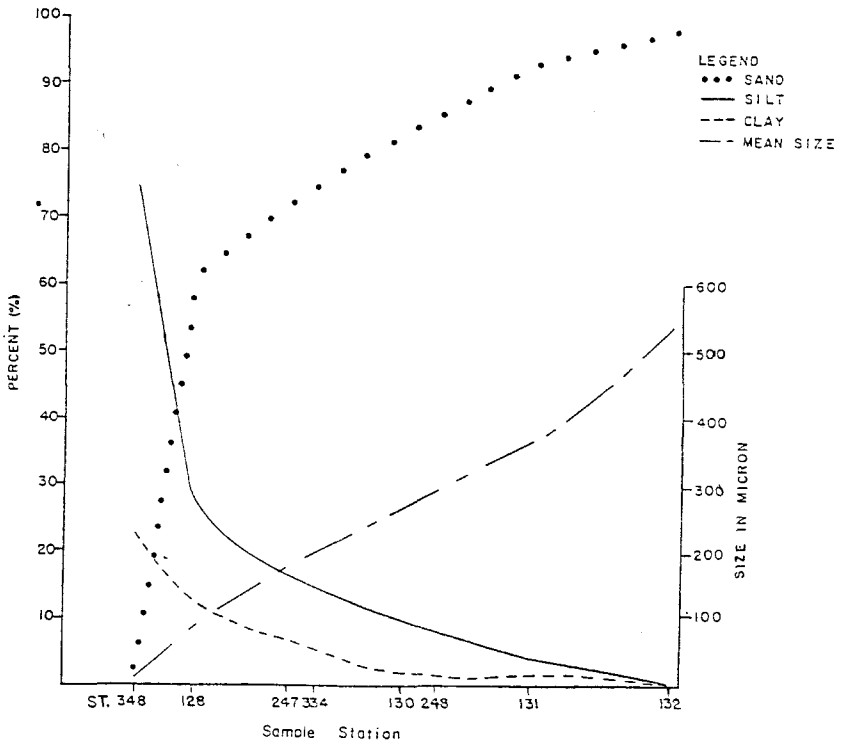

Fig. 4. Variation in relative content(%) of sand, silt and clay for surface sediment across the continental shelf (nearshore to shelf break) and change in mean particle size of surface sediment across the shelf. Distance from nearshore (St. 348) to shelf break (St. 132) is about 150km.

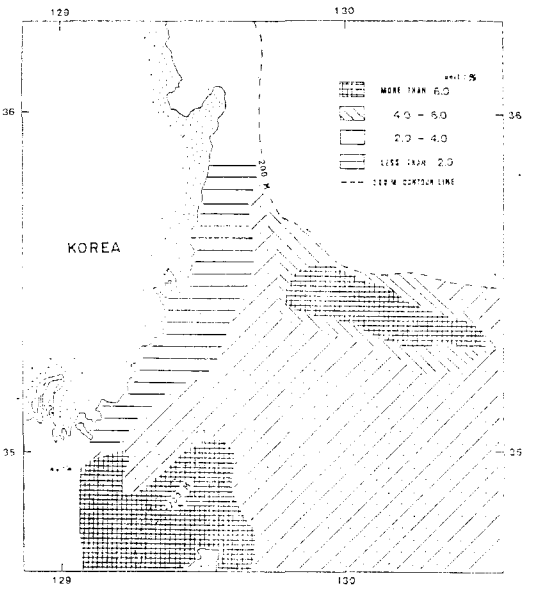

Fig. 5. Distribution of weight percent of total heavy minerals in bulk samples of surface sediment.

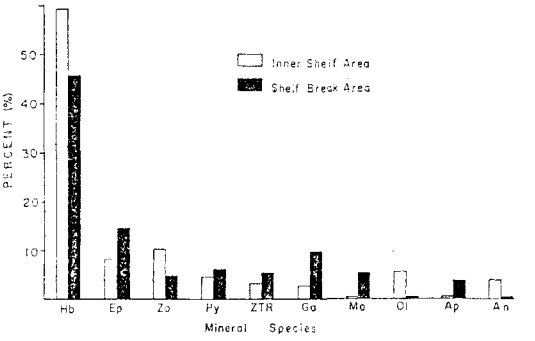

Fig. 6. Relative abundance of heave minerals (63-125 μm size fraction) from inner shelf and shelf break area.

tent in the surficial sediments in the area ranges from less than 2% to more than 6.0%. The lower values(2.0%) along the inner shelf and nearshore area are shown in Figure 5. High values(in excess of 6.0% and 4.0~6.0%) occur in the outer shelf and shelf break areas. The

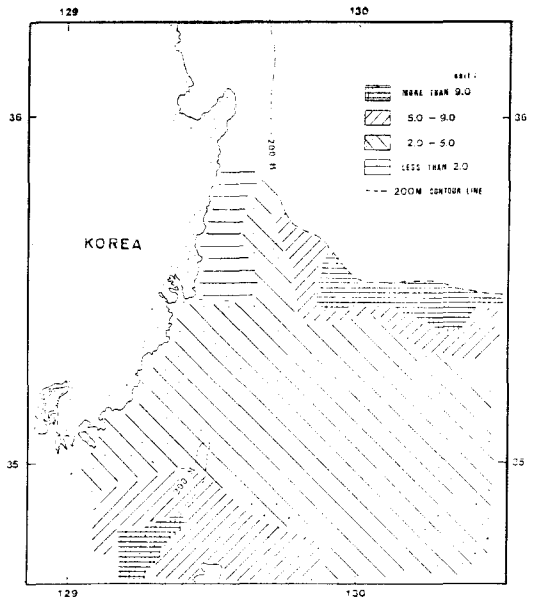

Fig. 7. Distribution of ZTR index for surface sediment on the continental shelf.

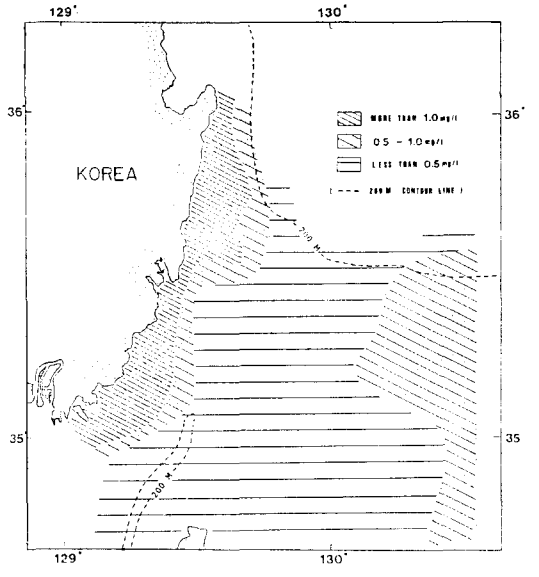

Fig. 8. Distribution of total suspended matter in the surface water (April, 1983).

main heavy mineral species are garnet, hornblend, tourmaline, rutile and zircon(Fig. 6). Figure 7 shows the distribution of ZTR index in the area. The highest values(9.0) are in the sand rich area along the shelf break.

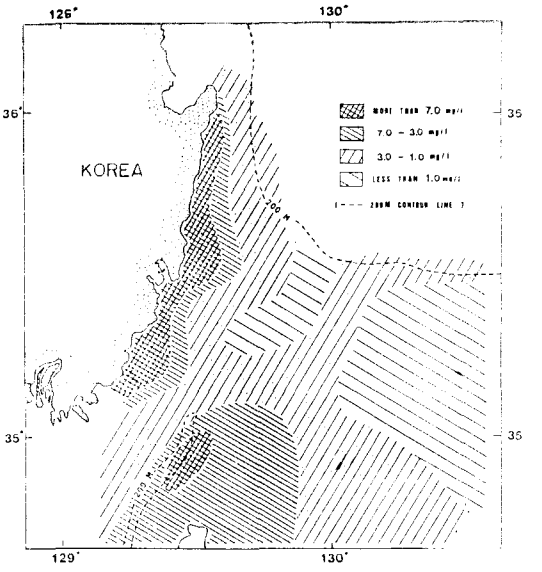

Fig. 9. Distribution of total suspended matter in the near bottom water (April, 1983).

Spatial Distribution of Suspended Matter

The concentration and distribution pattern of total suspended matter(TSM) in surface and near-bottom waters in the area varies characteristically as shown in Figure 8 and 9.

The TSM concentration pattern in the surface water(Fig. 8) reflects that the nearshore and inner shelf area shows relatively higher TSM concentration.

As shown in Figure 9, the TSM concentration in the near-bottom waters decreases seaward away from the shore area and the distribution patterns are relatively paralleling along the coastal zones. And the area of the highest concentration of TSM($>7mg/l$) is also located along the shelf break to the northwest of Tsushima Island showing northeast-southwest trending lobe shape.

DISCUSSION

On the basis of another detailed textural data of the superficial sediments and the distribution patterns of TSM on the continental shelf in this particular study area, it is further suggested that the presence of nearshore and inner shelf

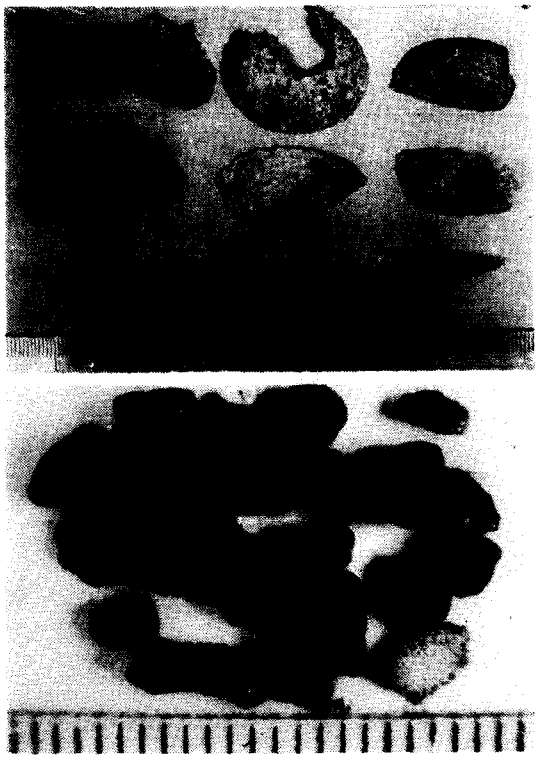

Fig. 10. Deeply weathered relict shells (oyster and pelecypods) and rounded gravels taken from sample stations along the shelf edge and outer shelf.

band of fine-grained bottom sediments could be considered to represent some extent of modern sedimentation on the shelf and on the other hand, the offshore sand bottom sediments (>95% of sand fraction) adjacent to the shelf break would be considered as "relict" sediments: that is, sediments deposited in response to a lower stand of sea level during the Pleistocene ice age. Figure 10 shows the abraded shallow marine shells (oyster and pelecypods) collected along the shelf edge and also the SEM photography of the quartz surface texture does indicate a beach high-energy environment under which the shelf edge sand sediments were deposited in response to a lower stand of sea level (Fig. 11). Such fact of lower stand of sea level in Korean Peninsular during the late Pleistocene has been studied and confirmed by Park (1969 and 1983)

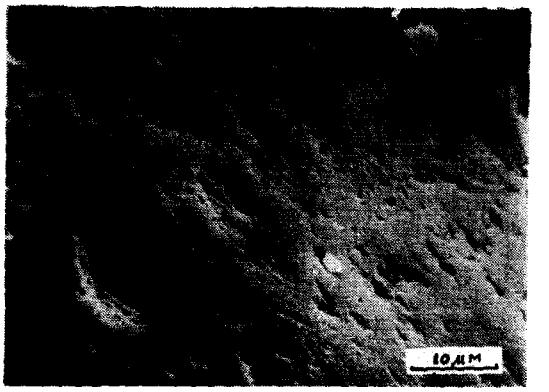

Fig. 11. SEM photograph showing the surface texture of a high-energy beach environment. Note V-shaped percussion marks and scratching on the quartz grain surface. The quartz particles were collected along the shelf edge in the study area.

and Park et al. (1985). Emery (1969) also described that most of coarse grained sediments (at least 75% of them) along the outer shelf and break areas in the world might be firstly suggested to be relict.

The limitation of "high amount" of recent suspended matters to nearshore band (Fig. 8 and 9) in this thirdly repeated sampling period suggests that transport of fine grained suspended matters is limited to the zone of nearshore-inner shelf area by a certain current flow pattern. Naturally, such current circulation or flow pattern in the shelf area will be very significant. However, it is still in question as to whether some of the fine-grained sediments are being transported in suspension seaward of the zone to the outer shelf and deep waters. Such a case process in the similar shelf condition was also considered by Curray (1960) and McCave (1979).

Based on this study results it is further considered that the transgression did little to alter the distribution of sand on the outer shelf in this particular study area. The progress of shore line was so rapid that a given locality was in the beach zone and subject to rapid longshore drift and extensive reworking only for a few

years. Probably the most pronounced effect of the transgression was sorting of the sand, and at least partial winnowing out of the finer fractions. These are consistent with the case processes described by Creager and Sternberg (1972), Kraft(1971) and Swift et al.(1972).

CONCLUSIONS

The distribution patterns and concentration of TSM both in surface and near-bottom waters on the continental shelf area and sedimentologic study of the superficial bottom sediments on the shelf have also been carried out in terms of sedimentary processes within the region.

On the basis of TSM dispersal patterns, it has been found that fine-grained suspended matters are restricted to a so-called "nearshore-inner shelf band". However, it is further in question as to whether some of fine grained suspended matters delivered by the rivers are being transported seaward of the band to outer shelf and deep waters. In fact, it is apparent that the deposition of fine-grained sediments in suspension is limited to the zone of the nearshore-inner shelf in the study area in relation to the concept of "modern" sedimentation.

The sand deposit with the mud content of less than 5 percent adjacent to the shelf break and on the outer shelf would probably be "relict" sediments deposited in response to a lower stand of sea level during the Pleistocene ice age. Furthermore, the rest of sandy coarse-grained sediments on this outer shelf area is also considered to be relict origin, because modern fine-grained sediment contributed by major rivers and estuaries along the southeast coasts is limited in its distribution on the continental shelf to a narrow nearshore-inner shelf band.

REFFRENCES

Creager, J.S. and R.W. Sternberg, 1972. Some specific problems in understanding bottom sediment distribution and dispersal on the continental shelf. *in* Shelf sediment transport: process and pattern, Swift, D.J.P., D.B. Duane & O.H. Pilkey (eds.), 333-346, Stroudsburg, Pa: Dowden, Hutchinson & Ross.

Curray, J.R., 1960. Sediments and history of the Holocene transgression, continental shelf, Gulf of Mexico. *in* Recent sediments, NW Gulf of Mexico, Shepard, F.P., F.B. Phleger & T.H. van Andel (eds.), 221-266. Tula, Okla.: AAPG.

Curray, 1965. Late Quaternary history, continental shelves of the United States. *in* The Quaternary of the United States, Wright H.E. & D.G. Fry (eds.), 723-735. Princeton, NJ: Princeton Univ. Press.

Emery, K.O., 1969. The continental shelves. Scient. Am., 221:106-122.

Kraft, J.C., 1971. Sedimentary facies patterns and geologic history of a Holocene marine transgression. Bull. Geol. Soc. Am., 82:2131-2158.

Park, Y.A., 1969. Submergence of the Yellow Sea Coast of Korea: Jour. Geol. Soc. Korea, 5:57-66.

Park, Y.A., 1983. The nature of Holocene sedimentation and sedimentary facies on the continental shelves of Korea. Proceeding, 1983. Summer conference for domestic and foreign scholars of science and technology: KOFST, 72-80.

Park, Y.A. and Bloom, A.L., 1985. Holocene sea-level history and tectonic movements, Republic of Korea, The Quaternary Research(Japan), 24 (2):77-84.

McCave, I.N., 1979. Tidal currents at the North Hinder lightship, southern North Sea: flow directions and turbulence in relation to maintenance of sand bars. Mar. Geol., 31:101-114.

Pierce, J.W., 1976. Suspended sediment transport at the shelf break and over the outer margin. *in* Marine sediment transport and environmental managemental management, D.J. Stanely and D.J.P. Swift (eds.), (1976), 437-458.

Swift, D.J.P., D.B. Duane and O.H. Pilkey (eds.), 1972, Shelf sediment transport: process and pattern, p. 151-164, Stroudsburg, Pa: Dowden, Hutchinson & Ross.

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