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STUDY OF CHANGES OF PALEO-COASTAL ENVIRONMENT OF FUJIAN (SOUTHEAST CHINA) CAUSED BY SEA-LEVEL VARIATIONS

- Fujian Paleo-Coastal Environment Reconstruction -

by

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STUDY OF CHANGES OF PALEO-COASTAL ENVIRONMENT OF FUJIAN (SOUTHEAST CHINA) CAUSED BY SEA-LEVEL VARIATIONS

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I. An Overview

The study of sea-level fluctuation has been considered as core to understanding of environmental changes and to inquire deeply into the problems of environmental make-up so as to shape environmental planning and management in order to appreciate a central theme of the interaction of man and environment.

The unprecedented explosion of public and academic interest in environmental problems ~~with~~ over the last few years, has stimulated the birth of a new discipline: ~~the~~ a ~~the~~ a environmental science. One of the most essential components of this new discipline is geoscience, the viewpoint of which is the study of sea level fluctuation is its viewpoint ---- its orientation to global problems, its conception of the earth as a set of interlocking, interacting systems and its interest in man as part of these systems.

Modern environment on the Earth Surface is the result of interaction among physical features. All facts indicate that since historic and geologic periods, the changes of geologic

structure, especially new-tectonic movement, climate of ice-age, rise or fall of sea-level, have left footprint on the physical environment. This is It's more real in Fujian.

Fujian (Southeast China) is situated on an active plate tectonic zone of the West Pacific Continental margin. During the past 50,000--100,000 years sea-level fluctuation and neo-tectonic movement have been great, especially in coastal region and nearby undersea zone, even now we can find active faults during the historic period. The study of paleo-climate, sea-level rise and fall, and new-tectonic movement has become the clue to the understanding of the development in paleo-physical environment in the area, and establish a general principle in order to reconstruct its paleo-coastal environment.

Since 1931, the author (Lin, David K. 1937) has made repeated investigations into Fujian Coast especially on the fluctuation of sea-level through field work, interviews with farmers and fishermen, and digging into coastal county annuals and other records to acquaint himself with the situation (Lin, David K. 1986). To prove that "skill comes from practice" or "Well acquainted with active situation will create ingenuity", thru this untiring practice, the author had discovered facts of three marine terraces, sub-surface valley, undersea canyon, high paleo-coastline, bays (Paleo-Huian, Fuzhou Bays together with modern bays), Dongshan Land Bridge and other geo-morphologic features. These are clear evidences for paleo-environmental

changes caused by sea-level fluctuation and tectonic movement along Fujian Coast (Lin, David K. 1959).

A fundamental fact is that northeast trend faults of new-Cathaysian tectonics control the framework of Fujian Coast (Ding, S.H. 1986). This fracture zone is cut by north-east, east-west, north-south trend faults. The amount of the uplift and subsidence which are by no means uniform in different parts of Fujian Shoreline running along or across these alternately up (northeast Fujian tectonic block) and down thrown (Fuzhou Fault block and Loyuang Bay fault) (Map of Louan Bay) fault blocks are respectively emergent and submergent. This Northeast Fujian coastal block reaches the coast with only a few modifications. To make this story short, the large scale uplifted Northeast Fujian coastal block was out of reach of mid-Pleistocene Sea. This explains the absence of Old Red-sand Bed in this area. In the meantime, the area has developed a geomorphologic history similar to that of upper Min River with three river valley pebble beds in broad valley basins without any connection with the sea. Holocene Sea invaded the area through two small outlets cut along the northwest trend fault line at Shacheng and Dongchong. Due to different amount of tectonic movement between Northeast Fujian and South Fujian Coast the development of bays is also different. Mid-Pleistocene Bay is well developed in Southern Fujian Coastal area such as Paleo Huian Bay but is absent in Northeast Fujian.

Coastal area. The above mentioned features all point to the facts that modern environment and paleo-environment are both the results of interaction of tectonic movement, sea-level fluctuation, climatic change, geomorphologic development and other features.

II.New Cathaysian and Neo-Tectonoic Along the Fujian Coast

Fujian Coast is a part of subduction zone of West Pacific Plate closely related to the nearby Island Arc. The area was covered by thick Yenshan volcanic rocks mostly rhyolite covering huge granite intrusion. Since Tertiary the coastal area has developed strong and numerous faulted block movements with a series of Northeast, Northnortheast and Northwest trend faults lining in a belt, with uplifted and subsided blocks alternately. In landscape, a larger and higher mountain blocks close to the sea with internal small subsided blocks. In the area north of the Min River there are many river mouth basins with marine deposits, coastal plains and hills close to the sea and more big islands than the north-east Fujian. A paleo-coastline follows roughly early Pleistocene faultscarpe at 400--500 meters about 20--40Km from present coastline in the South, 2-3 Km in the North. This together with the Northeast, Northnortheast trend faults later this fracture zone was later cut by northwest, east-west, north-south trend faults controlling the framework of the region with differential uplift and subsidence. Shore-line running along or across these alternately up and down-thrown fault

blocks are respectively emergent of Northeast Fujian Coastal block and submergent of Shacheng, Loyuang bays and Fuzhou basin.. The zigzag coast reflects the rugged tectonic line and shape, as this feature:river-mouth harbours cut by faults like Fuzhou Harbour at the mouth of Min River, and the Xiamen Harbour near the mouth of the Jiulong River. They are deeply cut by Northwest and east-west trend faulted trenches forming deep channels.

Since Quarternary differential tectonic movement has become more conspicuous, Taiwan Strait becomes strongly subsided and coastal area relatively uplifted especially Northeast Fujian Coast, and Fuzhou, Changzhou Basins relatively subsided. The faultscarpe bordering coastal hills and plains was abruptly uplifted with sea caves sticking with oystershells to a height of 400--500 meters forming a paleo-coastline (map of Paleo-Coastline)(Lin, David K. 1981). Furthermore, more differential neo-tectonic movements add up both uplift and subsidence of tectonic type. An example is seen in South Fujian where the first marine terrace of 5-6 meters (1000--2000 years BP) near Zhangzhou, while further south near Zhaoan at Daxi, this first terrace (looo--2000 years BP) has been elavated to 160-165 meters.

Apart from tectonic control of the framework of the Fujian Coast, the processes of denudation, particularly stream erosion, that is the streams developed along the northwest

trend fault line together with wave attack, have made Fujian Coast more irregular and rugged. The alternation between brief interglacials and longer glacials were paralleled by alternating morphogenetic regions fashioning the Fujian Coastal region. (Sealevel Curve)

To sum up, the above mentioned Fujian Coastal belt is an area of active faults, not so ~~much~~ discovered further west. The crustal movements have been great. The studies ~~about~~ on crustal movements themselves must be important ~~in order~~ to investigate of eustatic sea-level changes particularly to reconstruct development of paleo-environmental pictures and to thoroughly understand the modern environment.

III. Paleo-sealevel fluctuation

There are numerous indicators of sea-level fluctuations above and below present sea-level along Fujian Coast (Zhao,H.T. 1984). But it is difficult to distinguish glacioeustasy from hydro-isostatic movements and eustatic from tectonic. In general alluvial plains long the coastal regions of Fujian are considered to have developed ~~according to~~ in the following processes: during the last glacial stage when the sea-level was lowered, rivers dissected their valleys downard to that level. After then, in consequence of the post glacial rise of the sea-level these valleys were drowned and were filled up with Changle (Flandrain) deposits. The botton floors of such burried valleys are mostly found at 20-70meters below the present sea-

level. These bottom floors in many cases are covered with sediments of fine materials like clay, loam, fine sand, and peat, which deposited in the shallow sea during the last and post glacial transgression. The maximun accumulation of the ice during the last glacial stage should be enough to cause a lowering of the sea-level of about 30-80 meters below that of the present, or the lowest sea-level in Taiwan Strait (-100 meters) ~~examined the depth of these floors of burried valleys and deepest part of Taiwan Strait respectively~~. (Geologic Cross Section)

In theory, we have to relate that higher marine terraces were dislocated in active fault region as in Putien, Huian Area. Here the crustal movement themselves must be important for the investigation of eustatic sea-level changes.

In this paper, the author is merely to relate some facts of sea level fluctuation and their effect on the development of paleo-environmental make-up: ~~(1)~~ Up-lifted marine caves sticking with oyster shells: marine caves oyster shells are quite widely distributed along Fujian Coast discovered at an elevation of 400--500 meters, (Lin, David K. 1981) 130 meters, 10 meters. More such caves have been recorded in coastal county annuals and passed down as folklore and popular legend. In 1981 he published his paper on the High Fujian Paleo-Coastline involving 24 records of sea shells in the sea cave on the top of 400-500-meter mountain with embedded oyster shells (Lin, DavidK. 1986). He checked some of them in the field. This paleo-coastline

follows roughly early Pleistocene fault scarp at 400-500 meters about 20-40 Kilometers from the present coastline on the south and narrow to 2-3 Kilometers on the north due to larger and higher uplifted fault block there. This High Fujian Paleo-coasline must be the result of tectonic uplift of this fresh fault-scarpe, owing to the absence of marine cave at beach of the scarpe. These caves are distributed on the fault scarpe facing the sea but not at the back of it, evidently caves were formed before uplift. Under 400-500 meter elevation there is sea cave near LienJiang County at Guanling at a height of 130 meters (Lin, David K. 1981) possibly marked the upper limit of the last and brief interglacial sea-level. Beside the above mentioned levels, there are marine terraces with associated marine caves, pillars, notches at 30-40, 15-25, 5-10 meters above the present sealevel. These must be the result of the Quarternary and Holocene glacio-eustatic movement. In addition to these, are more conspicuous marine terraces and marine erosional features, one will see in the field some kind of deposits like boulder and pebble beds at the elevation 300-350 meters, and marine eroded caves and pillars at height between 200-80 meters with exception of 130-meter-cave with oyster shells sticking in the cave which as mentioned above was dated 125000 years BP late Pleistocene sea level limit (Hsia, T.T. 1984). At present time it is difficult to date 300-350 meter deposit and 200-80 meter marine erosional features. Like 400-500 meter cave they may be uplifted by neo-tectonic movement.

Mention must be made in connection with well known wave cut caves and pillars. "Rat Rock" near Suao, Pingtan, a rat-like head sticking out toward the sea with well developed notch underneath at an elevation of 30 meters. Down below this looking toward Pingtan Strait, there is big stone pillar called "Stone Tablet Wall", with a marked notch below the stone 1 meter from present sealevel. Near Nanpu (a small village) in Huian County a Chinese razor-like pillar called "Razor Stone" can be seen on a basin plain 30 meters above present sealevel surrounded by 40-50-meter pillars on the slopes of these hills. Under this plain at the depth of 4-6 meters there is clay-peat bed dated 40,000 years BP we named it Paleo-Huian Bay.

On the Northeast corner of Dongshan Island, there is a well known sea pillar "Wind Moving Stone" (picture of Wind Moving Stone), 20 meters above present sealevel, and under this two-meter-diameter-stone, a notch well developed underneath and around it, with only a small portion of the stone rest on the big rock below. There is a well developed erosional surface developed on weathered rocks between the regions of Min and Jiu-long Rivers. With occasional marine plain close by this kind of erosional surface is well developed south of Min River but absent in Northeast Fujian Coast. In the meantime time differential uplift of pillars, caves, erosional surfaces may be the result of small differential uplifts in different areas.

(2) Marine Deposit.

Marine deposits are widely distributed all over Fujian coast at the elevation of 30-40 meters, 15-25 meters and 5-10 meters above present sea-level. Generally speaking these marine sediments are widely spreaded on the back of modern bays including river-mouth bays and paleo-bays near the coast or quite far inland at the head of Fuzhou Bay. Composition of materials varies greatly from semi-consolidated pebble, sandy-clay, peat, shells beds above and below mean tide line. Higher elevated deposits include peat, Beach Rocks, Old Red Sand with peat in between. These deposits were dated 700 to 40,000 years BP. There are different elevations of these deposits probably due to differential uplift in active fault regions like Putien area.

From higher elevation to mean tide line, include: "Old Red Sand" bed, made up of red fine sand well sorted clay locally mixed with small broken shells, and the color turns to brown yellow downward. At Sunghsia (Changle County) the bed rests on pebble bed (half a meter thick) covered by the slope deposit on weathered and wave eroded rhyolite. It indicates a paleo-beach deposit. At Qinfeng (Pingtan Island) there is peat bed in between the "Old Red Sand" 30 meters above present sealevel ~~was~~ dated 35000 years BP. It was a bay deposit with peat on brown yellow bed overlain by Old Red Sand. At Koleng (South Quangzhou County) the bed is 40-45 meters above the present sealevel thin out toward east. The landscape of this narrow belt of the Old Red Sand bordered by hills on both sides is evidently a small

strait. On Nanri (South Sun) Island, there is storm type deposits containing ... foraminifera and Ostracode (Wang, S.H. 1982) of Q3 or Q2 period. Closeby Old Red Sand bed there is black clayey loam bed of bay channel deposit. At the base of the bed--- while grey medium-fine sand, in middle of the bed is peaty black clayey-loam over lain brown yellow clay the C14 date is 16415 to 41670 years BP with foraminiferal and pollen fossil indicate warm environment. Elevation is similar to that of Old Red sand dated 30,000 years BP reflecting an environment of warm sub-inter glacial when high level reach 40 meters above the present sealevel.

Holocene Sediments are more widespread than older marine deposits. This includes sandy beds, beach rock, including shell bed, peat. One could find sand bed from north east Fujian Coast to Dongshan Island on southern coastal village of Hsiashu (Hsiapu County) and nearby village at Yuyang a gravel bed 1 kilometer wide overlies a marine sand bed with wind blown sand on the top. At Guanling (Lienjian County) a loose shell bed deposited near river-mouth bay. Near Jiangtien Village (Changle County) formally a bay is now filled with marine sand bed (yellowish sand on the top, underneath is peaty bed dated 700-1500 years BP half meter in thickness, overlying graysand bed, all 5-10 meters above the present sealevel. The sand bed along the shoreline is covered by sand dunes 10-15 meters from the present sealevel. On this tan- kilometer long sandy coast zone

there one kilometer long gravel bed (This may be a river mouth gravel bed carried down by a river running accross the Jiangtien Bay from west of the Bay from Sanchi Village near head of this Paleo-Bay of Jiangtien. A similar sequence of sandy bed is found at Yuyang (Hsiapu County to the Northeast of Fujian Coast). Toward south at Luao Peninsula pockets of sandy beds are covered by sand dune. Both on Pingtan and Dongshan Islands, they are drilling Quartz sand. The drill had to go through sand bed 50 meters thick sand bed. There special geologic history in connection with sand mine on west of Pingtang County Seat now facing Pingtan Strait-Bay. Present plain is sloping toward the strait, but 5-10 meters under the present plain, the former plain was aloping east from strait area (Columar diagrams) formerly a part of mainland, later sub-sided under the Strait).

Older bed discovered in the western portion of Fuzhou Basin (formerly Fuzhou Bay)) there the shell midden of clam (gali) bed a kind of shell could only survive in sand bed at river mouth (the area where fresh and salt water meet). These shells are dated 4000 years BP. People of new stone age living around Tanshishan fished these shells for food from nearby Bay area, (must be a half clay walking distance, otherwise the shell fish will be rotten over the afternoon.

~~Peat and Beach rock including shellbed~~

Holocene peat is widely distributed along Fujian Coast particularly in Bay area to be found in front of filling up

up bay along the present beach of former bay, close to high tide line up to 10 meters near the surface of the plain. Peat discovered along modern beach like that in Jiangtien is dated 700-1500 years BP. Bed 15 meters in the east of Fuzhou Basin dated 8000 years BP. Peat bed at Northeast Fujian Coast is found a little above or below mean tide line. In Southern part of Fujian Coast, peat bed is found at higher elevation (5-10 meters above the present sealevel). Older peat bed found in Old Red Sand bed or under high plain (or floor of paleo-bay, or 50 meters under Fuzhou Basin (formerly Bay) dated 35,000 years BP. The formation of peat bed, new or old all indicate more stable sealevel in these periods. Scattered beach rock and its associated shell bed has been found in Fujian Coast south of the Min River but ~~it~~ they are like Old Red Sand ~~as beach rock~~ is absent in Northeast Fujian Coast. Near Kuaotou (Putien County) the beach rock is dated 3400 years BP at 4 meters and also 16 meters elevation, the highest reach 38 meters at Lung-hushan (Dragon-Tiger Mountain, Putien County)probably due to local uplift from the highest of 4 meters. At Liuao Peninsula (Changpu County), there are two kinds of beach rock which local people used as building stone. It is situated 4 meters above the present sealevel and dated 3200 years BP. Covering ~~on~~ the top the beach rock there ~~is~~ are loose shells brought by storm. These shells are dated 1400 years BP. In northeast Fujian shell beds are found in the Bay area above or below mean tide

line. Holocene uplift in northeast Fujian Coast is much smaller than that ~~of~~ in southern area.

(3) Marine Plain and Paleo-Bay

The distribution of marine plains is closely related to the location of bays. There is no one big plain east of fault scarp mountain on the North but plains are larger on the southern end of the fault scarp. The width of the plain area varies from 20-40 Kilometers from sea coast in the South but only 2-3 Kilometer toward northeast coast. The Southern area consists of many smaller uplifted and subsided blocks forming basins within the hilly regions, and bays during ~~rise~~ rose and of sealevel. First series of bays formed when sea level rise between 25-40 meters. These bays were not deep, horizontal erosion is much greater than vertical one. Red Table like land on weathered rock was well developed with small basins of sedimentation made in low area only as deep as 3-5 meters ~~with~~ of clay and peaty clay. In small indentations in form of small bays or channels, there the Old Red Sand bed was developed. Paleo-Huian Bay and Paleo-Quanzhou Bay, are more conspicuous paleo-bays, the peaty sediments in Old Red Sand bed was dated between 30,000-40,000 years BP. evidently of Pleistocene Age.

After the disappearing of paleo-bays, there is another series of bays deeper in south (like Quanzhou Bay 70-80 meters) and Fuzhou Bay (the Min River Basin) with a depth of 20-70 meters. Toward the northeast, the thickness of bay deposit is

around 20-40 meters. The range of subsidence is greater in the South, decreasing toward northeast coast area. Generally speaking, thickness of sediment is greater on Longchi Island, amounting to 180 meters, 10 meters greater than that of the Fuzhou Basin. According to the cores from Fuzhou Basin these two marine deposits, the first -1--30 meters of Holocene sediment of Marine clay was dated 4000-9000 years BP, second, the depth of -55 to -60 meters of ZH core was dated 30000-22000 years BP. Below this deposit at this Min River valley floor, there are fluvial deposit gravel, sand and clay. Marine plain closer to the sea have different type of deposits like Jiantien sandy plain overlies a thin peat bed, further down a series of beds of Quastz sand to the depth of 50 meters. This evidently is former Jiantien Bay dated 700 to 2000 years BP.

Modern bays are developed in faulted area or extension in ~~of~~ paleo-bays. Such as Shachen Bay, Sansha Bay, Loyuan Bay all of faulted type. (Map of Loyuan Bay) Meizhou Bay, Quanzhou Bay are extensions ofPaleo-Huian Bay, Paleo-Quanzhou Bay respectively.

(4) Submarine landform (Lin,David K. 1982)

From the vertical distribution of indicator of sealevel fluctuation along Fujian Coastal area from Holocene to Pleistocene sediments like beach rock, peat and Old Red Sand respectively are the results of sea level variations. In the meantime, 130 meter sea cave oyster shell, is the result of last and brief interglacial level.

The fluctuation of sealevel is also extended down below sealevel as deep as -100 meters in Taiwan Strait cutting submarine canyon to the depth of -80 meters (the extension of Min River under Taiwan Strait with a delta developed at the mouth of the submarine canyon.

There are two submarine terraces on the both sides of Taiwan Strait at -18 meters and -36 meters. At southern portion of the Strait there is a bank at -40 meters. It connects Dongzhan and West Taiwan forming Dongzhan Land Bridge. The mainland people of new stone age moved to Taiwan through the Bridge and left on the Bridge the tools they carried. New Stone Age tools discovered in Taiwan are of Fujian type. Mainland animals like elephant, deer also travelled through the Bridge to Taiwan. Penghu Canyon with a depth of 400 meters is the result of faulting. Study of temporal, areal and altitudinal changes of seakevek. We have discusses at length the time since Yenshan movement Fujian Coastal foundation has been laid. As a solid block of volcanic rocks, it has been cut by northeast, northnortheast and northwest trend faults ready for tectonic activities, to uplift or to subside. Then the area has gone through ice ages to cause sea level to rise or fall. The Northeast Fujian Coastal area the larger block uplift, while mid-south area differential uplift and subsidence of smaller blocks. This explains the absence of Old Red Sand in the Northeast Fujian Coastal area. Beach rocks prevails in southern areas and absent

over the Northeast. Altitudinally the range of sea-level variations is between 500 meters and -100 meters (but -160 under continental shelf under the East China Sea and South China Sea). Main activities of sealevel fluctuation was between 40 and -70 meters. Thus the foundation of environmental changes was laid, and main impact on environmental development are evident. The areal distribution is broader in mid-Fujian, 70 Kilometers of Fuzhou Basin and 20-40 Kilometers in the south and narrow to 2-3 Kilometers up toward northeast from the shoreline.

Due to differential neo-tectonic uplift and subsidence from faultscarp to the coast complicate the vertical sealevel changes. The vertical uplift on land over-shadow the subsidence under the sea increasing elevation of the two . Vertical height of the Paleo-Coastline becomes greater.

Since early Late Pleistocene (12,5000 years BP) the height of sealevel was 6 meters, but during the late Pleistocene, the tectonic movement was very active in form of fault block, especially under Taiwan Strait and along the coastal regions. Some sealevel indicators subsided under sealevel such as on Longchi Island indicators of late Pleistocene sealevel was subsided to a depth of -50 meters, in the meantime the similar indicator subsided to a depth of -55 meters, all of 30000 years BP But on eroded red platform the sealevel of the same period was uplifted to the elevation of 20 to -3 meters. During 15000 years BP, the low sealevel was at -100~~-120~~, but not continental shelf

under East China Sea the low sealevel was at -155 meters. Holocene high sealevel was at 10-20 meters near, Fuzhou Basin was flood to form Fuzhou Bay. Sealevel fluctuation and environmental changes are closely related whole Fujian Coast is an area where both Quarternary Sealevel fluctuation and neo-tectonic movements are active. Here sealevel frequently rises and falls, and causes shoreline to deposit and to erode continuously. The subtropical humid climate quickens the processes of weathering in the area. As time moves on erosion led the way and then followed by increasing deposition. Continued erosion cut hills and valleys and increased differential elevations.

In the meantime differential crustal movement caused different paleo-environmental changes. In the area north of the Min River the land block uplift has been greater than in the South, during the time of deposition of Old Red Sand, and was left out in the area. Steep cliffs are close to the sea coast.

But on the south of the Min River, the area has been cut into smaller pieces with ups and downs. Weathering is more widespread and deeper. Red earth platform is better developed between Futsing and Tungon area with large scale deposition. In this area two Paleo-Bays of Huian and Quanzhou have been developed during high sealevel. (Geologic Cross Section)

The investigation of drilling crores of the sedimention (Geologic Cross Section) along the coastal region since Q3

indicates that sealevel variations fluctuates between 130 meters above the present sealevel to below -100 (-155 under East China continental margin). During the period of high sea level, people originally lived close to the sea East of Jian g-tien, carried with them sea farming habit to inland as far as Tangshishan 60 Kilometers from Jiantien. During low sealevel people on Dongshan Island moved along the Dongshanland Bridge toward east to Taiwan. New Stone Age culture in Taiwan, had its origin in Fujian. Both human beings and animals left their foot print on the bridge as they went East. Exchange of species, culture, went on between Fujian and Taiwan. As sea-level rises and falls modification of paleo-environment went on. Man left their impact on this new environment. People living around the coastal area followed the rhythm of sealevel rise or fall and adjusted their life pattern to sea-environment. Seaside people have left their impact on their environment. The way of life is so different from that of the people living inland. Their outlook is so different that sea-farming outlook encouraged them to seek life oversea. People living in coastal counties worship Sea God but inland people worship Taoist God.

In 1931 when the author started his sealevel research in Pingtan Island through collecting huge amount of folklore and popular legend redated to sea life and sea level variations. (Lin, David K. 1937, Lin, David K. 1986)

In 1982 he published his paper on "Fujian Paleo-Coastline"

involving 24 records of sea shells on the top of 400-500-meter mountains with embedded oyster shells (Map of Paleo Coastline). By 1981 he had established the standard of "Chinese Geographi- cal-Historical method in sealevel shoreline research through digging into ancient Chinese geographical records and of interviewing farmers and fishermen to find scientific facts (Lin, David K. 1986) passed down as floklore and popular legend. Human impact on environment and in turn environment shape the life and culture of the coastal region. They are interchangable.

Furthermore
~~Beside~~/the investigation of physical features is to reveal the development of sea level fluctuations and its effects on paleo-environment. But thru geographical-historical study of human activities will also give us evidences for paleo-coastline variations. A large number of mountains in Fujian Coastal Area are named after sea animals such as Stone Oyster Mountain in Changzhou, Big Clam Mountain in Putien, Sea Snail Mountain in Tungan. These names fit well with Coastal County Records and folklores in connection with sea-level fluctuations.

A stone tablet on Liu-ao Peninsula carved with words of "floating (uplifting) of Fujian and sinking (subsiding) of Dongjing (Eastern land)" and "this road will lead you to Dongjing (now sinking into the sea." about 30 kilometers away.

A shell midden (dated 4000 years B.P.) at Tanshihshan, 30 kilometers west of Fuzhou City is a source for additional information on Holocence shoreline and sea-level reconstuction. The

site election was decided primary by near occurrence of the shell fish in sufficient quantity at a half-day walking distance (30 Kilometers) up river Min River flowing into the Fuzhou Bay where the broad sandy coast is located. The people living near the site could have the shellfish brought down river to Transhihshan in four hours for their noon meal. After the noon time the geli will get rotten.

IV. Looking into the Future

From the above discussions we could easily see the problems involved in sea-level rise or fall ~~and~~ which caused changes ~~with~~ in coastal environment and also affected its make-up. It is going to be so in the future. The World is expecting a future rise of sea-level. A future coastline must be drawn. World scientists are watching closely any slight rise or fall which will cause a change in coastal environment. A young scientist living near Meizhou Bay was told by a fisherman that a rock near his sea village was slightly (20CM) above sealevel, and is now being submerged by sealevel rise in recent years. Such increasing rise would gradually innundate iow-lying area, erode beaches, and raise salinity levels in estuaries. What we are going to do with the situation? Sealevel scientists must work through case study to figure magnitude of future sealevel rise, its effects, and valuation of policies that prepare for the consequences of a small or large rise. We should ~~put our~~ make efforts to study effects of sealevel rise on coastal erosion, on modification

of coastal landscape, on development of new erosional surface, new sea cliff, new sedimentation. In the meantime, it is necessary to study the measures for controlling erosion, innundation and salt water intrusion. Such a rise would also substantially upset important wetland ocosystems. Sensitivity of climate has been keenly felt in the geologic past and will ~~also~~ be so in the future. The selevel fluctuation and change of geologic structure together will cause enviromental changes. A storm surge in 1920 near the mouth of the Min River destryed a coastal village and brought a layer of sand and pebble bed one meter thick up five meters above the present sealevel.

Furthermore, we have to think ~~of~~ that a rise of sealevel will have its economic impact, implication for coastal zone planning and management. The last, but not the least, a rise of sealevel will cause a change of environment which will greatly affects the lives of people living along the coastal areas.

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