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SUBMARINE PHYSIOGRAPHY AROUND TAIWAN AND ITS RELATION TO TECTONIC SETTING

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ABSTRACT

The island of Taiwan is among the volcanic islands that form an arc along the western Pacific. In addition to the visible complexity of the island's collision tectonics, the complex submarine topography around Taiwan is also remarkable. West and north of the island, the sea floor is generally shallower than 200 m and is underlain by the Eurasian continental crust. Off southeastern Taiwan, a major portion of the sea floor is submerged to a depth of up to 6,000 m. The offshore areas west and north of Taiwan are floored by continental shelves and slopes, mostly nearly featureless (relief smaller than tens of meters). In contrast, many prominent physiographic features with relieves greater than thousands of meters are present in two tectonically far more active offshore areas: the trench-arc system to the northeast of Taiwan and the collision complex in the south.

The surfaces of the shelves are smooth, marked only locally by low-relief features formed by the sea-level fluctuations during the late Pleistocene. Shelf width varies from about 400 km north of Taiwan to less than 2 km off the eastern coast. The slope off eastern Taiwan is a linear narrow zone of steep slope parallel with the suture zone exposed onshore eastern Taiwan. Off southwestern Taiwan, the continental slope is a broad deep water area that is marked by outward bowing of the isobaths contouring a huge mass of Pliocene-Quaternary sediments derived from the mountainous island.

The backarc basin, volcanic islands, forearc basin, trench slope break and trench form various major physiographic units of the continental margin off northeastern Taiwan. The sea floor off southeastern Taiwan is featured linearly with north-south trending ridges and troughs formed by the collision between the Philippine Sea plate and the Eurasian plate. The abyssal plain of the Gagua Basin is the major physiographic province off southeastern Taiwan. Since Early Pliocene the interaction between the Philippine Sea plate and the Eurasian plate has played an important role in making the submarine physiography around Taiwan.

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INTRODUCTION

The island of Taiwan is situated near the junction of the Ryukyu Arc and the Luzon Arc on the western margin of the Philippine Sea or tectonically on the boundary between the Eurasian plate to the west and the Philippine Sea plate to the east (Figure 1). The main island of Taiwan is surrounded by dozens of smaller islands and islets which include the Penghu Islands (Pescadores) , five volcanic islets and two prominent volcanic islands of Lutao and Lanhsu off its northeastern and southeastern coast respectively (Figure 2). There is a remarkable difference between the shallow and great depths of the sea floor on the two sides of the island of Taiwan, and the underlying crust is continental on one side but oceanic on the other. West of Taiwan, the sea is generally shallower than 200 m and is floored by the Eurasian continental crust. In contrast to this a major portion of the sea floor off eastern Taiwan is 3,000 to 5,000 m deep and is underlain by the oceanic Philippine Sea plate (Figure 2).

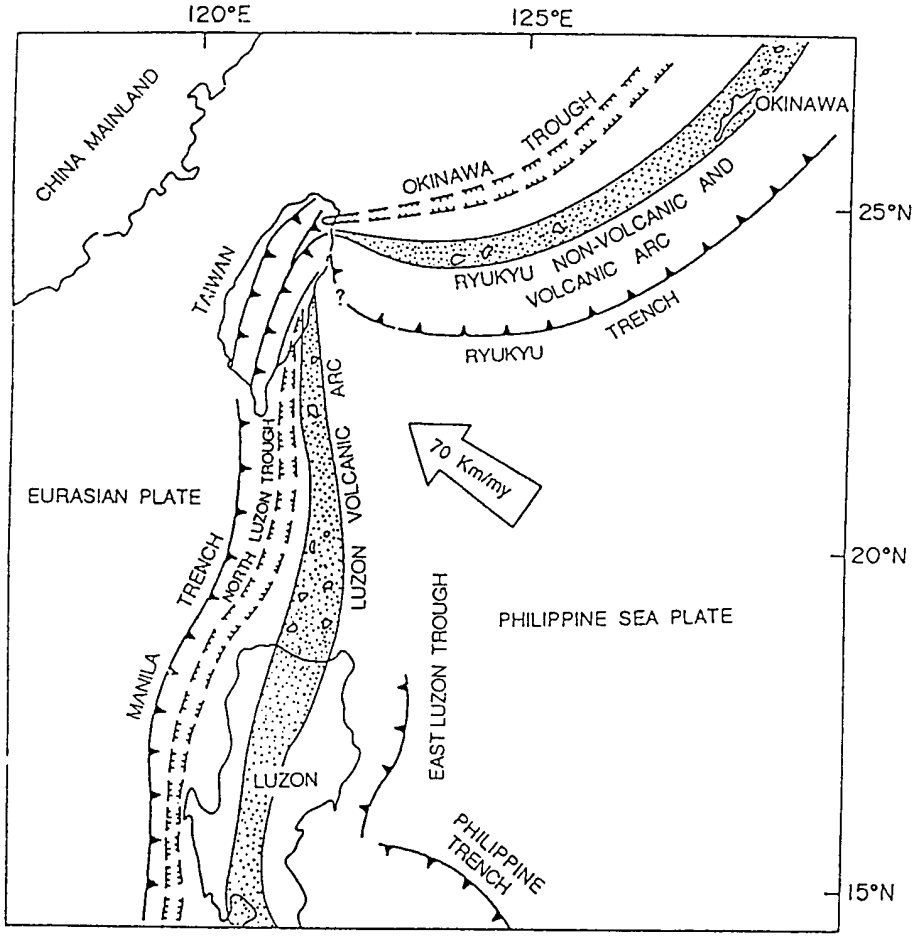

Figure 1. The plate tectonic setting of Taiwan showing the island of Taiwan near the junction of the Ryukyu Arc and the Luzon Arc along the western margin of the Philippine Sea plate (after Shyu and Chen, 1991).

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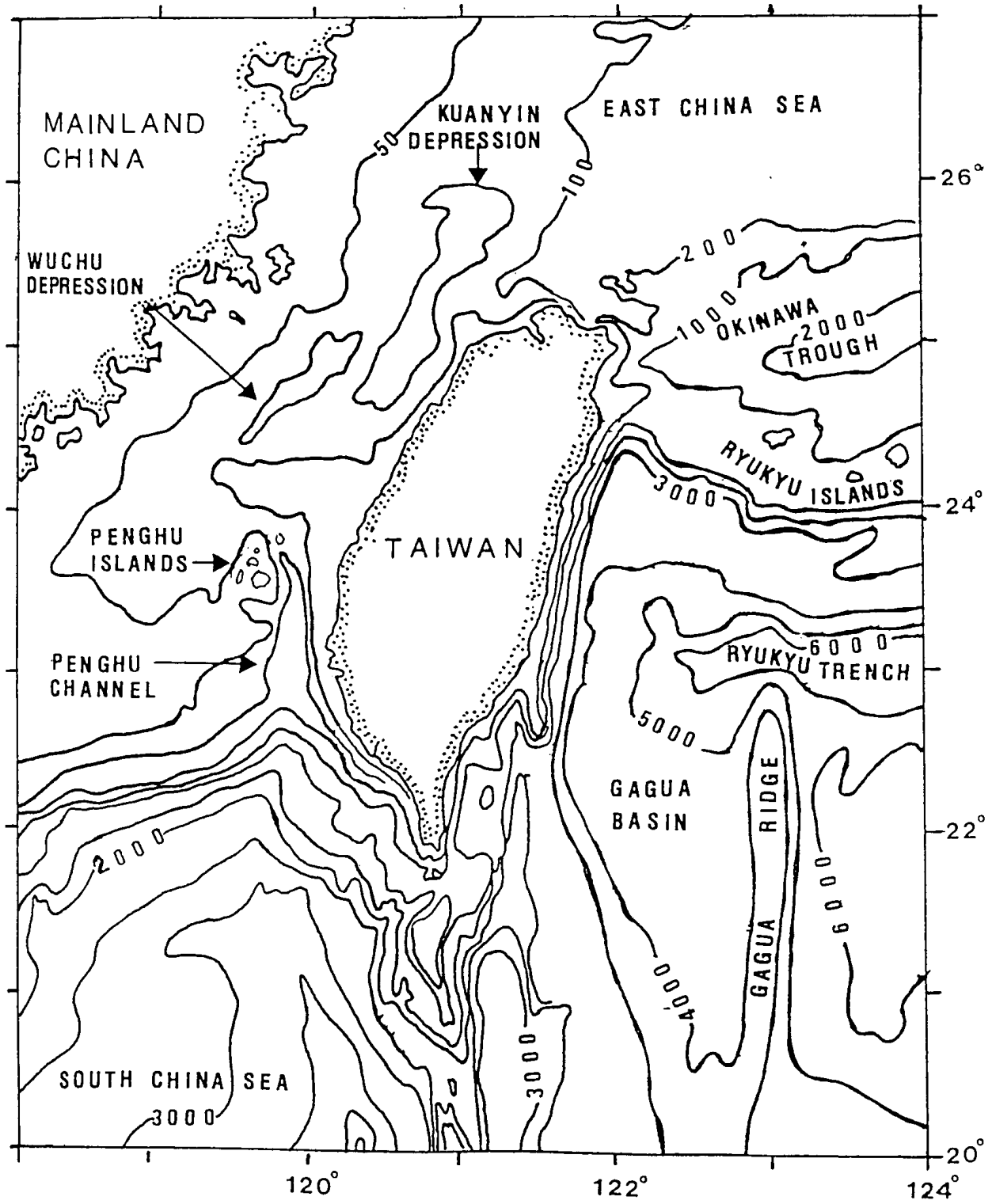

Figure 2. Bathymetric map of the sea floor around Taiwan compiled by the Institute of Oceanography, National Taiwan University (1990). Note that the contours are in meters.

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The sea floor around Taiwan is a region of complex topography resulting mainly from the relative movements between the Eurasian plate and the Philippine Sea plate. The dominating processes that determined the sea floor topography around Taiwan include the continental rifting in the areas west of Taiwan (Sun, 1985; Wang, 1987), back-arc rifting and spreading off northeastern Taiwan (Lee et al., 1980; Sibuet et al., 1987), arc-continent collision (Teng, 1990,Huang *et al.*, 1992) in the region off southern Taiwan. In addition, the eustatic sea-level changes in the late Pleistocene (Ma, 1963; Boggs *et al.*, 1979), orogenic sedimentation off southern Taiwan (Lundberg, 1988) and mass-wasting processes on the shelf-slope transition regions (Yu and Wen, 1992) also played significant roles in modifying the submarine topography around Taiwan.

Major elements for classifying the submarine physiography around Taiwan include bathymetry, topography, structure, tectonic setting and geography. Following the guidelines for naming undersea features recommended by such organizations as Intergovernmental Oceanographic Commission (IOC) and others, as rerwnded by Bouma (1990), this paper considers the bathymetry and topography as the primary criteria for naming the undersea features around Taiwan. The general descriptions of the submarine topography around Taiwan were given by Boggs *et al.* (1979). The physiographic and tectonic provinces of the Taiwan Strait were discussed by Nei and Peng (1989) and Chen (1991). The physiographic characteristics of the sea floor off Southwestern Taiwan were described by Yu and Wen (1992). The detailed discussions of the physiography and tectonics off southeastern Taiwan were given by Bowin *et al.* (1978), Chen and Juang (1986), Chen *et al.* (1988), Lundberg (1988), Lundberg et al. (1991), Chen *et al.* (1990), Huang and Yin (1990), Shyu and Chen (1991), Chen *et al.* (1992) and Huang *et al.* (1992). The bathymetric and physiographic characteristics off northeastern Taiwan were described by Yu and Hong (1992). However, these studies did not reach a concensus about the nature of the physiography around Taiwan, especially the relationships between the topography and tectonic evolution.

The purpose of this paper is to summarize the current knowledge of the bathymetry and physiography around Taiwan and to synthesize them into a physiographic framework in terms of plate setting for the offshore region around Taiwan. This physiographic framework is provisional and may be revised if better physiographic names are proposed.

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BATHYMETRY

The bathymetry chart (Figure 2) used in this paper is compiled by the Institute of Oceanography, National Taiwan University. Other bathymetric maps around Taiwan include those by Marnmerickx *et al.* (1976), Boggs *et al.* (1979), Suppe (1984) and Marssett *et al.* (1987). Figure 2 covers the region from Long. 1180 to 1240 E and Lat. 200 to 270 N, the map area being about 500,000 sq km. Geographically, the sea floor around Taiwan is covered by the East China Sea to the north, the Taiwan Strait to the west, the South China Sea to the southwest, the Philippine Sea to the east and the southern Okinawa Trough to the northeast. The line connecting Fukueichiao at northernmost Taiwan and the Haitan Island off Fujian coast separates the East China Sea from the Taiwan Strait to the south. The southern boundary of the Taiwan Strait is the line drawn between the southern tip of Taiwan (Oluanpi) and the Tungshan Island off Fujian coast (Figure 3). One prominent bathymetric feature in the Taiwan Strait is the Penghu Channel marked in Figure 2, which is a narrow waterway between the Penghu Islands and southwest Taiwan. The shelf-slope transition around Taiwan can be placed approximately at 200 m (Figure 3). Bathymetrically, the sea floor around Taiwan can be divided by the shelf break (200 m) into two parts: the shallow water areas off the western and northern Taiwan coasts and the deep water region of the southwestern and eastern Taiwan. Clearly, the sea floor off the western Taiwan has water depths ranging from sea level to 200 m and that off the eastern Taiwan has water depths greater than 5,000 m. The bathymetric chart clearly illustrates the asymmetrical bathymetry of this region (Figure 3).

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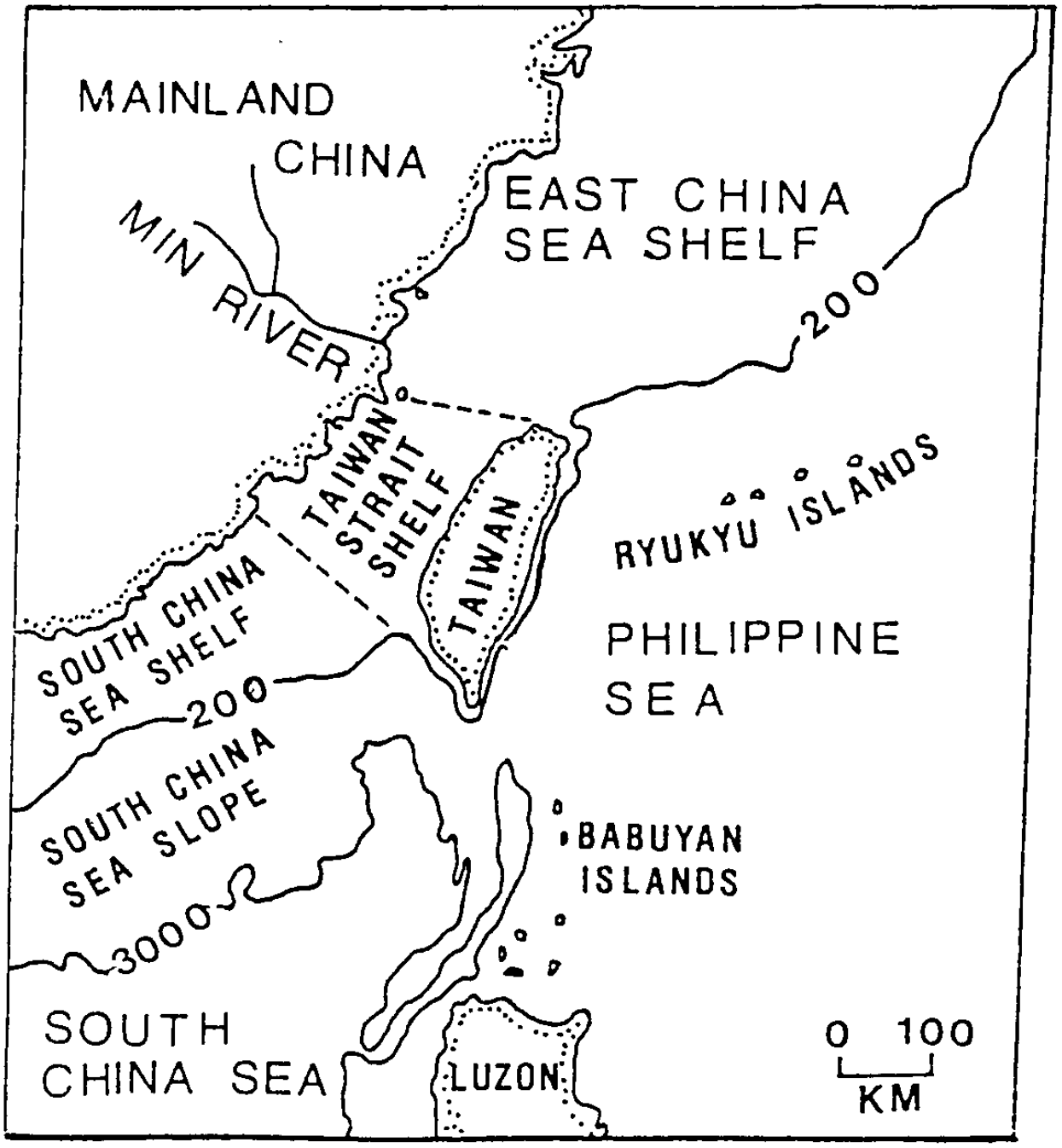

Figure 3. Map showing the asymmetry of bathymetry around Taiwan. The sea floor surrounding Taiwan can be divided by the shelf break (200 m isobath) into two parts: the shallow shelf to the west and deep-water basin floor to the east (After Yu and Wen, 1992).

The bathymetric map shows that, north of Taiwan, the sea floor is a part of the broad East China Sea shelf and is characterized by the water depths between 100 to 200 m. In general, the sea floor is rather smooth and flat but despite the existence of relieves such as ridges, charmers and canyons which are probably relict features resulting from the subaerial erosion during late Pleistocene time of glacially lowered sea level (Boggs *et al*., 1979). In addition, several bathymetrlic highs emerge from the sea to become small islands which are approximately 50 to 180 m above sea level and are composed mainly of andesites with tuff and agglomerates (Teng *et al*., 1992). Northeast of Taiwan, the sea floor extends from the shallow East China Sea shelf southeastward and, after passing the steep slope, reaches to the deep basin floor (about 2,200 m) of the Southern Okinawa Trough. The bathymetric chart also indicates the indentations of isobaths on the upper slope areas. These convex bending of the contours strongly suggests that the presence of submarine canyons as previously reported by Wang and Hilde (1973) and Boggs *et al.* (1979). West of Taiwan, the sea floor extends from the Taiwan coast westward to the China mainland, the coast to coast distance being 140 to 200 km. Taiwan Strait extends for about 375 km in a northeast/southwest direction. A major portion of the sea floor of this strait is less than 60 m deep. However, the bathymetric map reveals two major linear topographic depressions. One is the Kuanyin depression (Chen, 1989) located about 50 Ian off the Tanshui River, northwestern Taiwan. The other is the Wuchu depression off the Fujian coast (Nei and Peng, 1989). Off the Southwestern Taiwan coast, the sea floor passes a narrow shelf and descends to the depths of more than 3,000 m in the northern end of the abyssal plain of the South China Sea. It is noted that the sea floor topography off Southwestern Taiwan is represented mainly by a gentle sloping surface. However, the sea floor off southeastern Taiwan is characterized by its north-south trending linear bathymetric features with water depths of 1,000 to 3,000 m. East of Taiwan, the sea floor passes a very narrow shelf and extends eastward to the western end of the Ryukyu Trench and the Gagua Ridge where the depths reach 4000 to 6000 m. This ridge extends northward from the northeast comer of Luzon to the west end of the Ryuku Trench. Isobaths indicate that the shelf areas off the Ilan Plain, northeast of Taiwan are rather wide (10 km) and triangular as compared to the rest of the narrow (about 2 km) and linear shelves off the eastern coast of Taiwan to the south.

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The sea floor off northeastern Taiwan features with three major physiographic units which are the East China Sea continental shelf, the East China Sea continental slope and the southern Okinawa Trough and two less prominent topographic features of the Ilan shelf and the Ilan Ridge (Figure 4).

The wider East China Sea shelf is a smooth surface with low-relief features of ridges and troughs resulting from sea level fluctations during the late Pleistocene (Boggs *et al.*, 1979) and is dotted with several volcanic islands related to the back-arc rifting of the southern Okinawa Trough (Teng *et al.*, 1992).

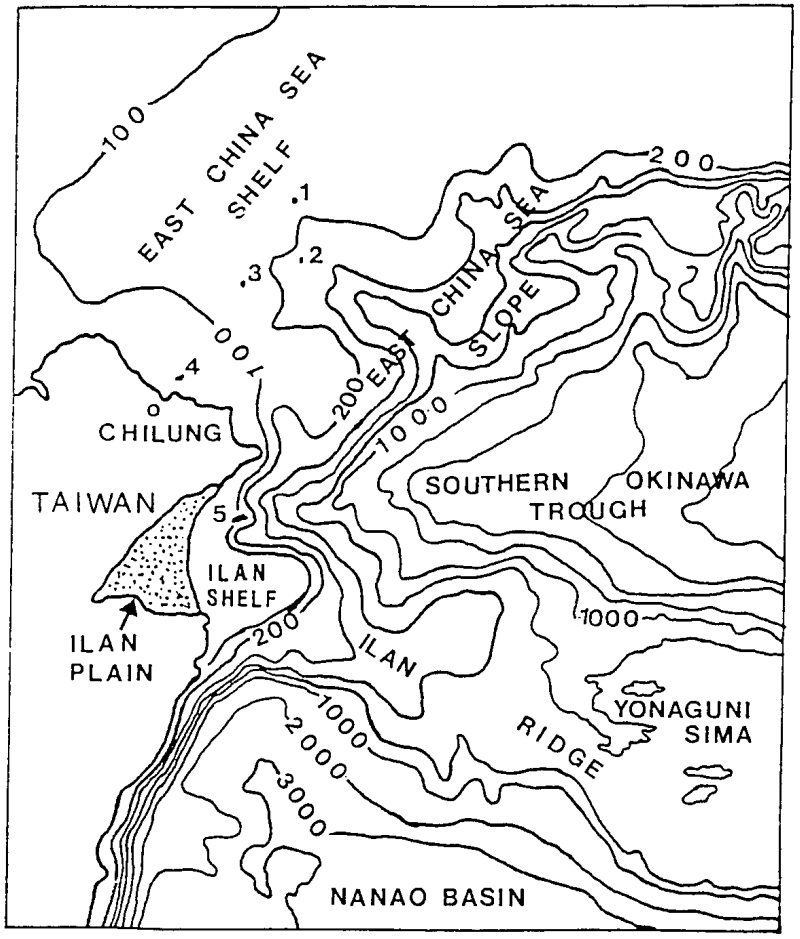

Figure 4. Map showing the physiographic units of the continental margin off northeastern Taiwan (After Yu and Hong, 1992). Small dots are volcanic islets. 1=Pengchiahsu, 2=Menhuahsu, 3=Huapinghsu, 4=Chilung Tao and 5=Kueishan Tao.

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The East China Sea slope varies greatly and laterally in terms of slope gradient and topography. The slope is marked by a variety of slumping or sliding scars, erosional gullies and debris flow deposits or turbidites. Other prominent topographic feature occurring on the slope are submarine canyons.

The western end of the southern Okinawa Trough is represented by the curvilinear isobaths at the greatest depths of about 2000 m. The trough is confined mainly by the East China Sea slope to the north and the slope off the Ryukyu volcanic islands.

The Ilan shelf is the seaward extension of the Ilan Plain on the northeastern Taiwan coast. The shelf is fan-shaped and the width varies from about 10 km off the Lan-Yang Hsi (river) mouth to about 2 km near the seaside towns of Toucheng and Suao.

The long and narrow Ilan Ridge extends seaward from the Ilan shelf and is between the Nanao basin to the south and the back-arc basin of the Okinawa Trough to the north. This ridge is confined by the Ryukyu volcanic islands to the east and is narrower than the island chain of the Ryukyus. It is considered to be a part of the Ryukyu Arc which is segmented and submerged near Taiwan.

Lying west of Taiwan, the Taiwan Strait shelf is a distinct submarine physiographic unit. The Taiwan Strait shelf may be considered to be a part of the eastern Eurasian plate margin. It extends continuously northeastward to the East China Sea sea shelf and southwestward to the South China sea shelf without being separated by apparent structural or tectonic demarcations. The continental shelf along the eastern Chinese margin is divided into the East China Sea shelf, the Taiwan Strait shelf and South China sea shelf mainly on the basis of geography rather than on geomorphic or structural characters.

Based on water depth, slope gradient and geography, the sea floor off southwestern Taiwan can be divided into the Kaoping shelf and Kaoping slope (Figure 5). The latter is subdivided further into an upper slope and a lower slope distinguishable in topography, morphology and sediment type (Yu and Wen, 1992). The Kaoping shelf is a narrow platform, generally less than 20 km wide. The shelf extends from the southern tip of the Hengchun Peninsula to the mouth of the Tsengwen River along the southwestern coast of Taiwan and has a length of about 150 km. The Kaoping shelf is the natural prolongation of the Coastal Plain and the southern Central Range of Taiwan. The surface of the shelf is smooth, though locally topographically irregular near the Hengchun Peninsula. Surface sediments on the shelf are composed mainly of fine-grained shelly terrigenous sands and muds (Boggs *et al.,* 1979).

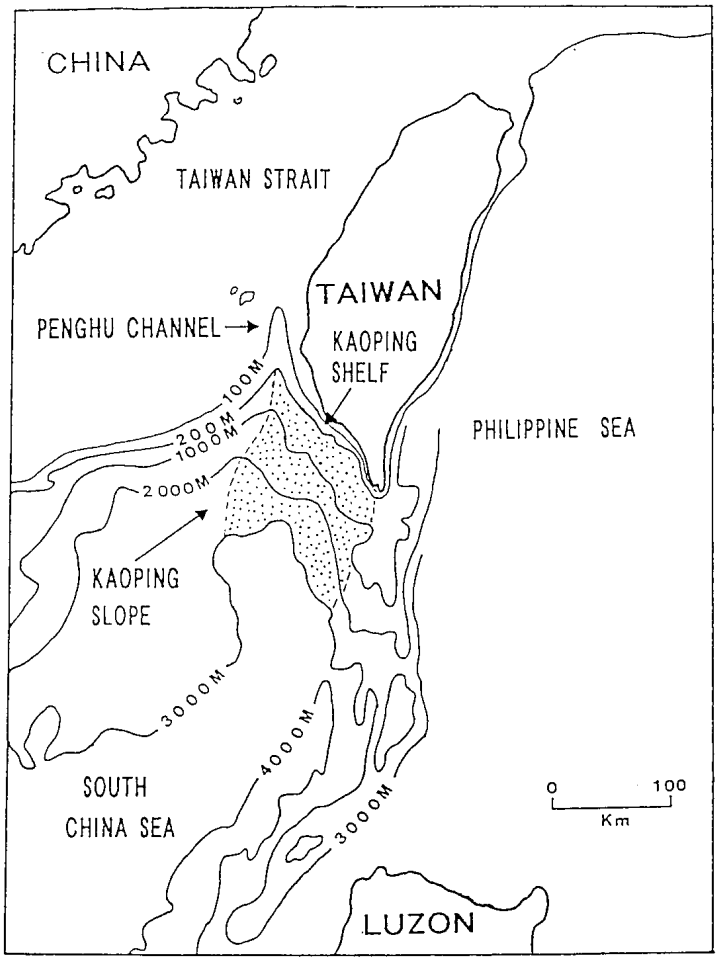

Figure 5. The sea floor off southwestern Taiwan is characterized by the narrow Kaoping shelf and the relatively broad Kaoping slope (After Yu and Wen, 1992).

The Kaoping slope is a broad deep water area of more than 16,000 sq km. The slope is further divided into two parts: an upper slope and a lower slope separated by the 1,000 m isobath. Four major submarine canyons and several channels occur mainly on the upper slope. The Kaoping slope floor is covered largely with silts and clays (Boggs et al., 1979, Chen, 1983).

The sea floor off southeastern Taiwan is featured with north-south trending submarine ridges and troughs. These physiographic highs and lows are named from west to east as follows: (1) Hengchun Ridge, (2) Southern Longitudinal Trough, (3) Huatung Ridge, (4) Taitung Trough and (5) Lutao-Lanhsu Ridge (Figure 6). An E-W trending seismic profile illustrates these features (Figure 7).

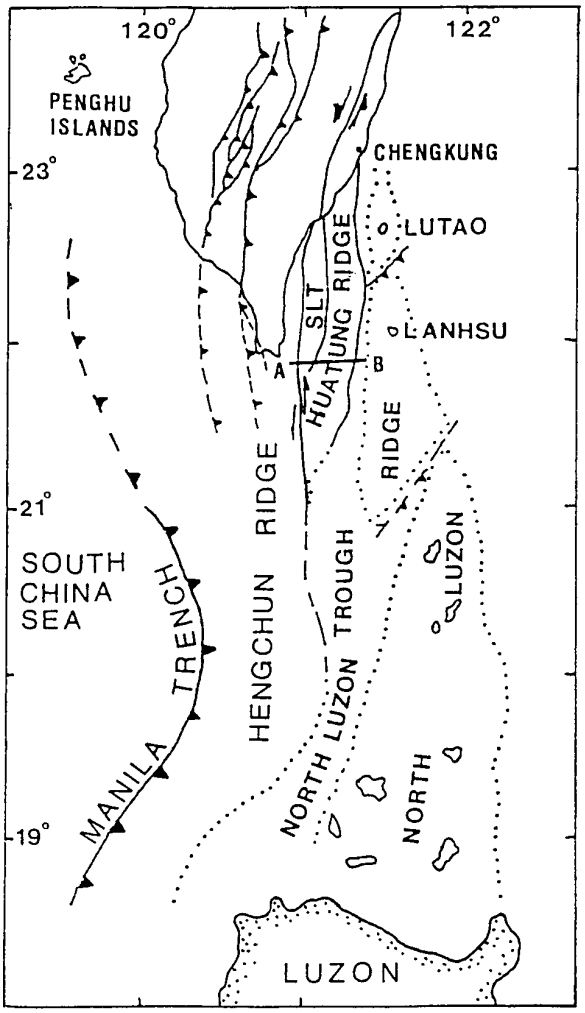

Figure 6. Map showing the major submarine physiographic features in the waterways between southern Taiwan and northern Luzon. Note that the occurrence of the N-S trending bathymetric ridges and troughs (After Shyu and Chen, 1991). SLT=Southern Longitudinal Trough.

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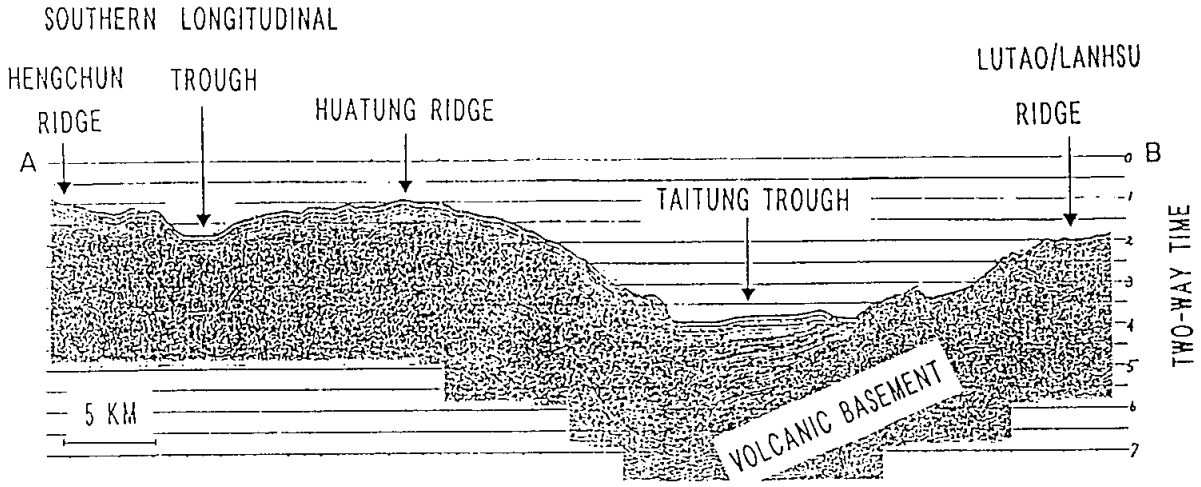

Figure 7. The seismic section showing the five major physiographic units off southeastern Taiwan (After Lee et al., 1992). Location of profile A-B in Figure 6.

Morphologically, the Hengchun Ridge is the seaward extension of the southern Central Range of Taiwan. The ridge deepens gradually toward the south and ends near Lat. 19°30" N. This ridge is bounded by the Kaoping slope to the west. Structurally, the Hengchun Ridge is confined to the west by the N-S trending fault zone extending from the Laonung fault on Taiwan (Chen and Juang, 1986, Huang and Yin, 1990). Tectonically, the ridge may be considered to be an accretionary wedge east of the Manila trench (Suppe, 1988, Huang and Yin, 1990, Huang *et al.*, 1992).

The Southern Longitudinal Trough is located to the east of the Hengchun Ridge. This submarine trough can be traced northward to the Longitudinal Valley on eastern Taiwan. Structurally, this trough has been regarded as a collision basin lying along the suture zone between the Eurasian plate and the Philippine Sea plate (Huang and Yin, 1990). We consider the Southern Longitudinal Trough to be a part of the northern extension of the North Luzon Trough which, tectonically, is a forearc basin in front of the Luzon Arc (Figure 6).

The Huatung Ridge is located to the east of the Southern Longitudinal Trough and can be recognized as the seaward extension of the Lichi Melange belt on eastern Taiwan (Huang et al., 1992). However, Chen et al. (1992) considered that the Huatung Ridge may better be correlated with the Kenting Melange in the vicinity of the Hengchun Ridge. We suggest that the Huatung Ridge is a compressed bathymetric high resulting from the convergence between the Eurasian plate and the Philippine Sea plate. This ridge disappears when it extends southward into the North Luzon Trough which is still fore-arc basin.

The Taitung Trough can be regarded as a part of the northern extension of the North Luzon Trough. It narrows at about Lat. 22°31" N and gradually merges into the North Luzon Trough where the subduction process is dominant. Nevertheless, Chen and Juang (1986) suggested that the Taitung Trough can be regarded as an interarc basin between the Luzon Arc and the former arc of the Coastal Range. Lee *et al.* (1992) suggested that the basement of the Taitung Trough consists of volcanic rocks equivalent to those of the Luzon Arc. We believe that this V-shaped trough could be simply a structural low between the Huatung Ridge and the Lutao-Lanhsu Ridge.

In a regional scope, the North Luzon Trough, Southern Longitudinal Trough, Huatung Ridge, Taitung Trough and the Longitudianl Valley off eastern Taiwan are partly a subductionrelated convergence zone between the Hengchun Ridge and Luzon Arc to the south and partly a collision-related suture zone between the Central Range and the Coastal Range to the north. The North Luzon Trough can be traced into the onshore Longitudinal Valle in eastern Taiwan.

The Lutao-Lanhsu Ridge between Lat. 21° and 23° N, east of the Taitung Trough is named after the volcanic islands of Lutao and Lanhsu perched upon this ridge. It is noted that there exists a deep depression of about 3,000 m deep between these two volcanic islands (Huang and Yin, 1990, Shyu and Chen, 1991). We suggest that a left lateral strike-slip fault trending northeastward separates Lanhsu from Lutao.

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The prominent deep submarine Gagua Ridge is located east of the Lutao-Lanhsu Ridge and between the northeast extremity of Luzon and the Ryukyu Trench. The Gagua Ridge was called Palaui Ridge which extends southward to the Palaui Island at the northeast comer of Luzon (Karig, 1973). On the other hand, Bowin *et al.* (1978) restricted the northern segment of the Palaui Ridge north of Lat. 21° N to the name of Gagua Ridge. It has been interpreted as an inactive subduction zone (Karig and Wagemen, 1975), an extinct spreading center (Bowin et al., 1978) or an old fracture zone (Mrozowski et al., 1982). Recently, Lewis (1992) considered the Gagua Ridge to be a remnant arc which resulted from the breakup of the Luzon Arc. The Gagua Basin is surrounded by the Ryukyu Trench to the north, the Lutao and Lanhsu Ridge to the west and the Gagua Ridge to the east. The floor of the basin is deep and relatively flat.

North of the Ryukyu Trench lies the Yaemaya Ridge which is a submarine ridge running parallel with the Ryukyu Trench (Figure 8). Karig and Sharman (1975) considered the Yaemaya Ridge to be a forearc associated with an accretionary prism. The oceanic basin between the Ryukyu Islands and the Yaemaya Ridge represents the forearc basin and is named the Nanao Basin (Blanchet *et al.*, 1988).

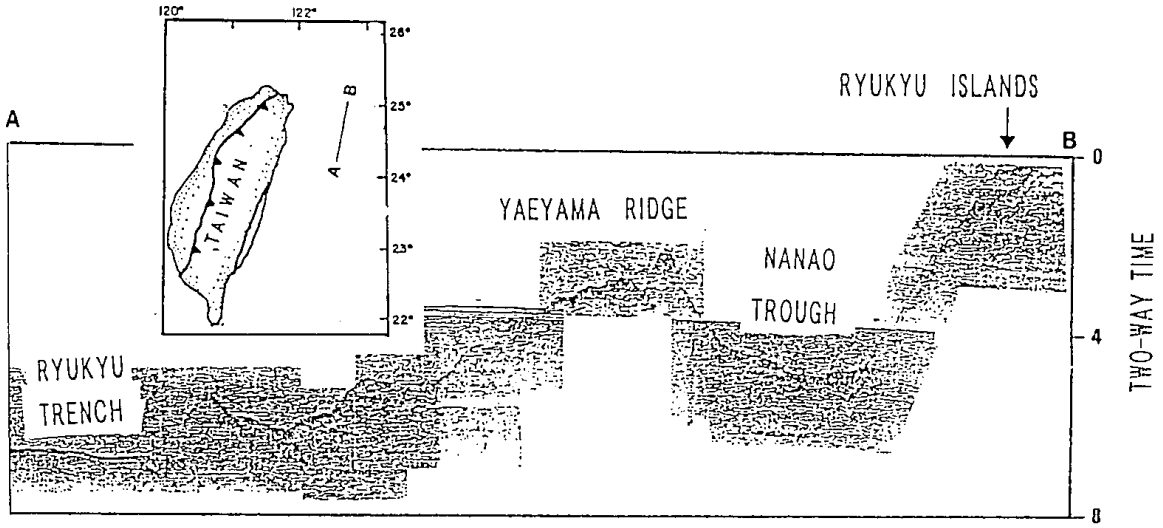

Figure 8. The seismic section from TAIJUNT of 1975 cruise of the R/V Chiu Lien showing the typical island arc system off northeastern Taiwan which includes the Ryukyu trench, Yaemaya ridge, Nanao trough and the Ryukyu islands, progressing towards the Asian continent.

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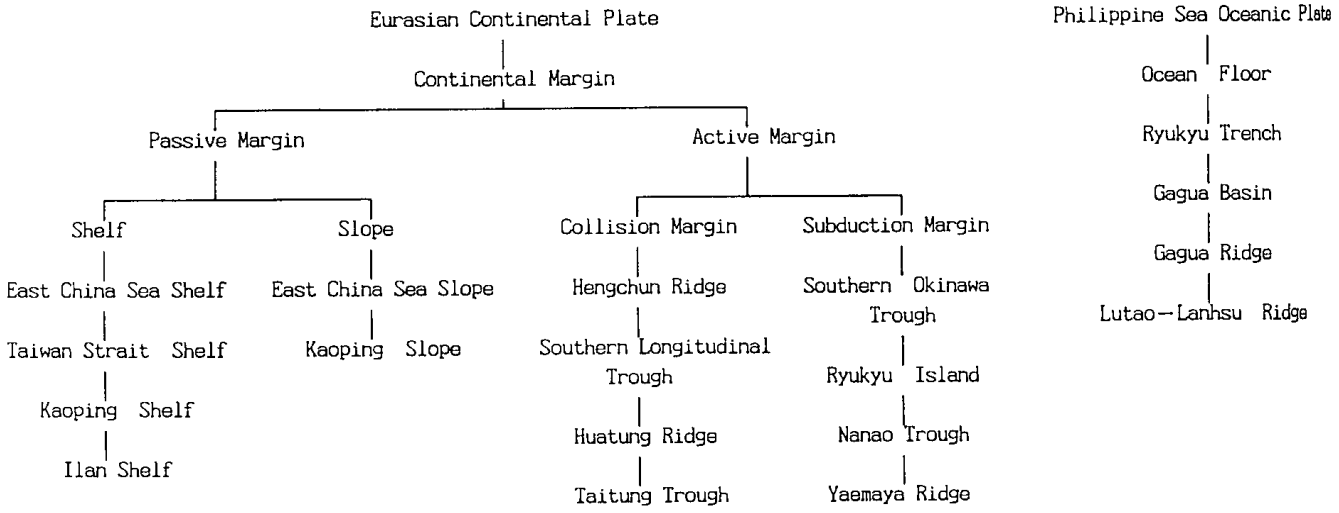
Table 1. A summary of submarine physiography around Taiwan



TECTONIC SETTING

Relating the submarine physiography to the tectonic settings, we propose a tentative classification of the various sea floor features around Taiwan (Table 1). A schematic block diagram displays the plate setting of Taiwan and the associated major submarine physiographic features (Figure 9). The nature of the crust on which the physiographic units rest is the first-order criterion for the classification. The sea floor around Taiwan is underlain in the areas west of the Southern Longitudinal Trough by the Eurasian continental crust and in the areas east of this trough by the Philippine Sea oceanic crust. The plate tectonic setting around Taiwan is two-fold, clearly distinguishable into an Eurasian continental margin domain and a Philippine Sea ocean margin domain. The continental margins around Taiwan can then be further divided into the passive and active margins. The morphology and structures are the second-order criteria to classify the physiographic features on the continental margins and the ocean floor.

These physiographic units like the East China Sea shelf are considered to be first-order morphotectonic features. Other geomorphologic features such as the submarine canyons on the shelf-slope transitions (Yu and Liu, 1992) are regarded as second-order features which will be presented in greater detail elsewhere.

However, this classification is not good enough for putting each physiographic unit into an appropriate pigeon-hole. For instance, the Pliocene-Quaternary andesitic volcanics in northern Taiwan and neighboring offshore areas were grouped as Northern Taiwan andesites and interpreted as parts of the Ryukyu Volcanic Arc (Teng et al., 1992). They cautioned that parts of the Ryukyu Islands including Iriomete Jima and Yonaguni Jima between the southern Okinawa Trough and the Nanao Trough are not volcanic islands, hence, the southern Okinawa Trough between the Northern Taiwan andesites and the Ryukyu Arc (non-volcanic) can no longer be considered to be a backarc (volcanic arc) basin in terms of an idealized island arc tectonic setting (Karig and Sharman, 1975, Schweller, 1987). In other words, the subduction of the Ryukyu Trench beneath the Eurasian margin has not yet produced a typical island arc system which should be a succession of trench, accretionary prism, forearc basin, volcanic islands, and backarc basin (or interarc basin). However, the volcanic or nonvolcanic nature of the Ryukyu Arc in the vicinity of Taiwan is still debatable. We prefer to consider the southern Okinawa Trough a backarc basin.

The physiographic features off southern Taiwan are a very narrow shelf and a large southwest facing continental slope to the southwest and several north-south trending ridges and troughs to the southeast. These were collectively called an accretionary prism or wedge resulting from the convergence of the Philippine Sea plate and the Eurasian continental margin in the region off southern Taiwan as shown in Figure 6 (Bowin *et al.*, 1978, Covey, 1984, Letouzey and Sage, 1988, Lundberg *et al.*, 1991). Although some uncertainties of the classification exist, these physiographic units off eastern and southern Taiwan are more or less related to plate boundary activities in the region.

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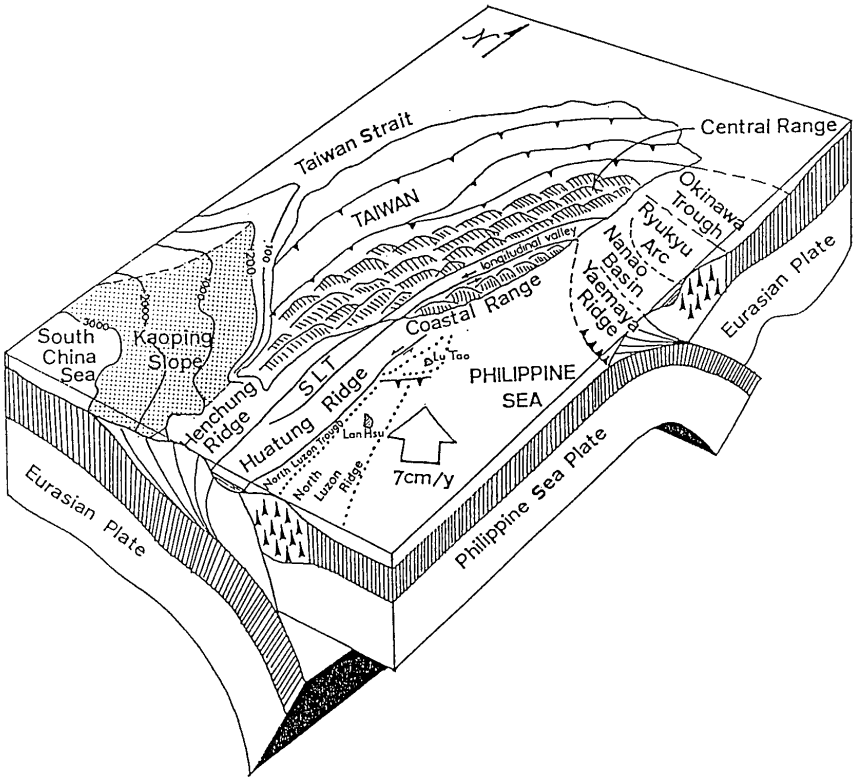

Figure 9. Schematic block diagram showing the plate setting of Taiwan and the associated major submarine physiographic features.

The East China Sea shelf, Taiwan Strait shelf and the South China Sea shelf and slope to the north, west and southwest of Taiwan are parts of the Eurasian continental margin and may be included in a passive type margin (Figure 3). As a part of a passive margin the Taiwan Strait is situated near the eastern edge of the Eurasian plate which has obliquely collided with the Luzon Arc on the Philippine Sea plate since the Pliocene-Pleistocene. The subsiding strait floor has been a recipient of a mass of Pliocene-Quatemary sediments 1 to 2 km thick derived from mainland China and Taiwan. These sediments formed an elastic wedge thickening eastward with little structural deformation.

It is not surprising that the "passive" continental shelves are almost featureless (relieves smaller than tens of meters) except some relieves resulting from the subacrial erosion due to the late Pleistocene lowstands of sea level or modem hydrodynamic conditions (Boggs *et al.*, 1979, Luo and Yang, 1991). In contrast, many prominent physiographic features (relief greater than thousands of meters) are present in "active" tectonic boundaries. Hence, since the Early Pliocene the plate tectonics between the Philippine Sea plate and the Eurasian plate has played a major role in forming the submarine physiography around Taiwan.

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SUMMARY AND CONCLUSIONS

The bathymetry chart around Taiwan clearly shows the smooth topography of the shallower parts of the sea floor to the north and west of Taiwan but high-relief features on the deep sea floor off the southern and southeastern coasts of the island. Physiographically, the East China Sea and Taiwan Strait shelves are recognized as the major physiographic units on the Eurasian plate, and the Gagua Basin together with the Gagua Ridge, stands alone as another major physiographic unit in the deep Philippine. Sea. The morphotectonic features such as the Ryukyu Islands and the Ryukyu Trench extend westward toward Taiwan and gradually lose their identities as distinct bathymetric features. The linear bathymetric features off southern Taiwan resulted mainly from the deformation of the northern extension of the Manila trench-slope ccimplex as a consequence of the transition from subduction to collision between the Philippine Sea plate and the Eurasian plate near southern Taiwan. Since the early Pliocene the subduction and collision in the Taiwan-Luzon region have shaped the sea floor around Taiwan into its present-day complex topography.

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臺灣周圍之海底地形與地體構造架構之關係

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摘　　要

臺灣屬於西太平洋火山島弧之一，除了陸上可見複雜的碰撞地體構造，台灣島四周複雜的海底地形也相當可觀。臺灣西部及北部外海的海底一般淺於二百公尺，其下為歐亞大陸地殼；臺灣東南海域大部分屬於深海區，其深度可達六千公尺。臺灣西部及北部的海床展現成大陸棚及大陸斜坡，海床表面的起伏很小，一般小於一百公尺；反之，有許多顯著的地形，其起伏落差大於數千公尺，位於兩個地體活動較強的海域：東北海域的海溝一島弧系統及南部海域的碰撞體系。

大陸棚的表面平坦，僅有少數小起伏的地貌，其為晚更新世海水面變動的產物。大陸棚的寬度變化很大，北方陸棚寬約四百公里，而東部陸棚狹於二公里。臺灣東部海域的斜坡呈線狀，平行於陸上的碰撞縫合帶；西南海域的大陸坡呈一弓狀，頂點朝北、範圍寬廣，主要由源自臺灣的上新世一第四紀沉積物堆積而成。

弧後盆地、火山島嶼、弧前盆地及海溝組成臺灣東北海域主要的地形單元。臺灣東南外海地形以南北走向狹長的海脊與海槽為特徵，其為菲律賓海板塊與歐亞大陸板塊聚合的結果；加瓜海盆的深海平原也是臺灣東南海域的一個主要地形單元。自早上新世以來，歐亞大陸板塊與菲律賓海板塊相互間的運動扮演著主要角色來形成臺灣外海的海底地形。