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Neogene stratigraphy in the Sibalom-Aganan Area of the Iloilo Basin, Panay Island, Philippines

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Abstract: This paper describes the litho- and biostratigraphy of the Neogene along the Sibalom and Aganan Rivers in the southwestern part of the Iloilo Basin, refferring to some related problems.

In the investigated area, the Neogene begins with volcanic rocks of andesitic to basaltic composition, through reef limestones, followed by a thick flysch-type sequence, and ends with conglomerate beds, attaining a total thickness of more than 5,600 m. It ranges in age from Miocene to Pliocene, and is divided into the A, B, C, D, E and F formations. Foraminiferal analysis indicates the following ages of the respective formations:

A formation	Zone N. 8 or older	Early Miocene
B formation	Zone N. 8	
C formation	Zones N. 9-15	Middle Miocene
D formation	Zones N. 16-17	Late Miocene
E formation	Zones N. 18-19/20	Pliocene
F formation	Zone N. 19/20	

1. Introduction

The Iloilo Basin occupying the central part of Panay Island is one of the representative Tertiary sedimentary basins in the Philippines. The Tertiary stratigraphy of the island was reported by SANTOS (1968) who advanced some refinements on the preliminary reconnaissance study by CORBY *et al.* (1951). GONZALES *et al.* (1963) described the Neogene sections in detail along the Tanian and Tarao rivers in the southwestern part of the Iloilo Basin, where the Neogene is typically exposed. GONZALES (1963) and TAKAYANAGI *et al.* (1977) made foraminiferal analysis on these sections. Molluscan fossils from the Tertiary of Panay Island were discussed by SHUTO (1969, 1971) and SAMANIEGO *et al.* (1970).

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In October and November 1981, the writers investigated the Neogene in the Sibalom-Aganan area northeasterly adjoining the Tanian-Tarao area as a part of the natural gas development project in the Iloilo Basin. As a result, the stratigraphic succession of the Neogene was established based on lithology and planktonic foraminifera, which is somewhat different from that of previous workers. So, this paper outlines the Neogene of the Sibalom-Aganan area with special emphasis on foraminiferal biostratigraphy, referring to related problems. Determination of microfossils was made by M. M. DE LEON. All samples used for this study are stored at the Philippine Bureau of Energy Development (BED) and the Geological Survey of Japan (GSJ).

The writers are grateful to Dr. H. NATORI of the GSJ, Mr. R. A. REYES of the BED and other members of the group of natural gas in-

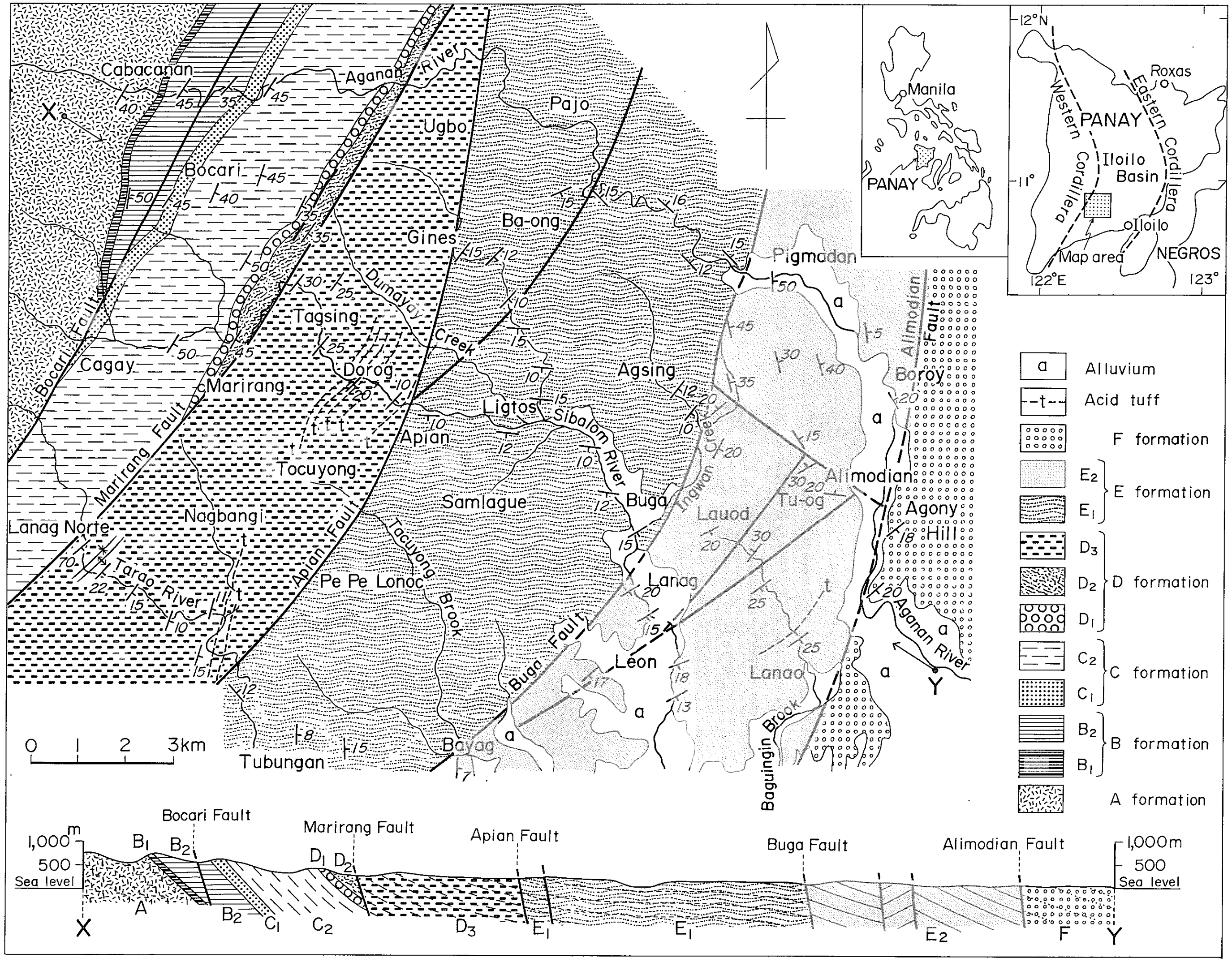

Fig. 1 Geological map of the Sibalom-Aganan area.

vestigation in Panay Island in 1981 for their kind advice and help during the course of this work. Thanks are also due to the Japan International Cooperation Agency and the BED which conducted the project in Panay Island.

2. Lithostratigraphy

Panay Island, one of the Visayan Islands, is physiographically divided into three belts trending in N–S direction; the Western Cor-

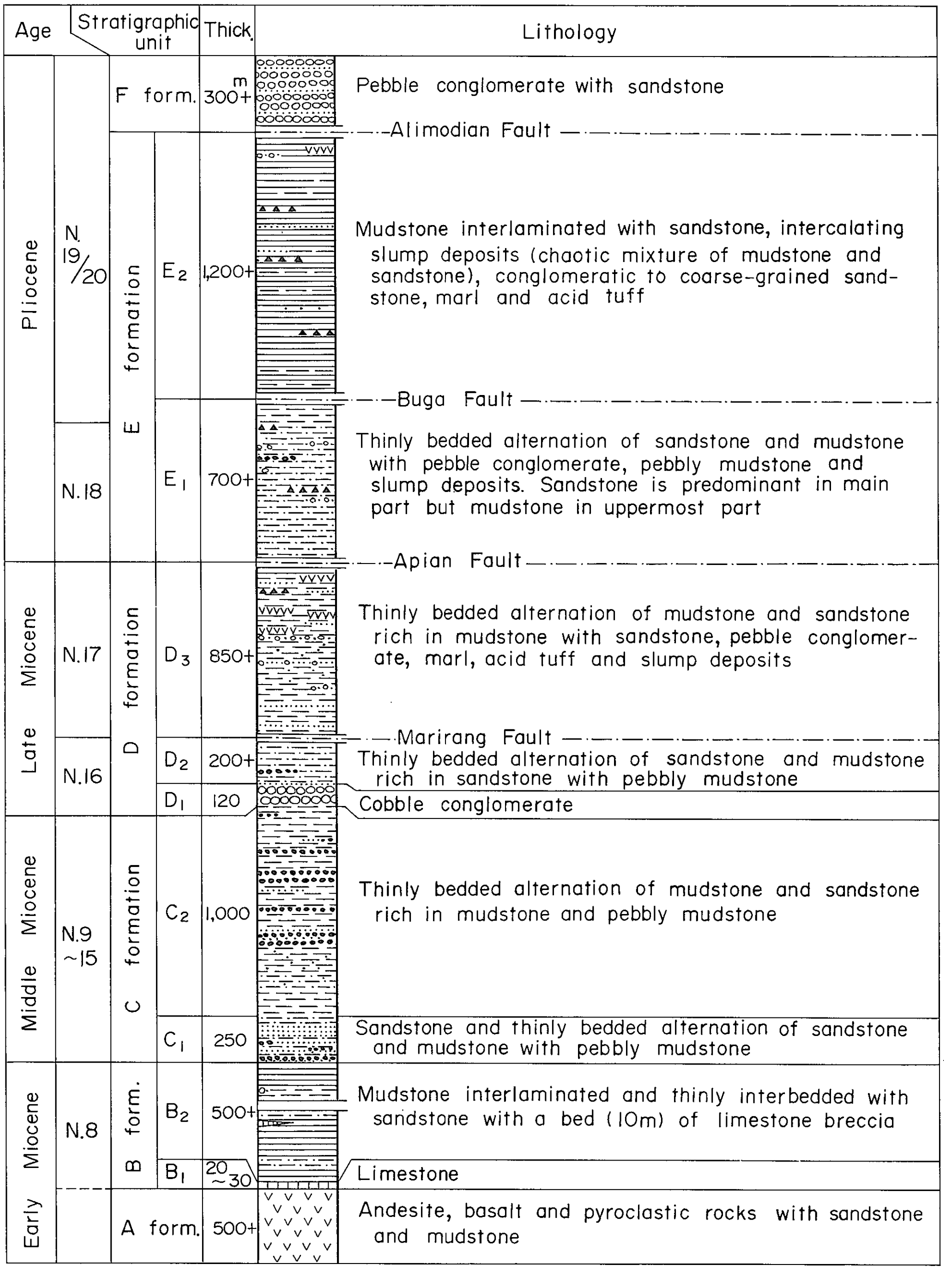

Fig. 2 Generalized stratigraphic colum of the Neogene in the Sibalom-Aganan area.

dillera, the Iloilo Basin and the Eastern Cordillera. Both the cordilleras are occupied mostly by Tertiary volcanic rocks associated with some intrusive rocks, while the Iloilo Basin is underlain by a thick sedimentary pile of Tertiary to Quaternary age. In the Western Cordillera are also known exposures of pre-Tertiary rocks such as crystalline schists, metavolcanic rocks, graywackes, quartzites, diorites and serpentinites.

The investigated area is situated in the southwestern part of the Iloilo Basin, where the Neogene is well exposed along the Sibalom and Aganan rivers, moderately to gently dipping east with a general trend of NNE-SSW. The dip of strata tends to become more gentle eastward. The Neogene of the area begins with a volcanic formation, through reef limestones, followed by marine clastic sediments attaining a maximum thickness of more than 5,000 meters, and is lithologically divided into six formations as shown in Figs. 1 and 2, though the complete succession is not observed due to faults.

The A formation corresponds to the uppermost part of a thick complex of greenish altered volcanic rocks widely exposed in the Western Cordillera. It consists chiefly of andesitic to basaltic lavas and pyroclastic rocks with a small amount of tuffaceous sandstones and mudstones. No fossils are obtained from this formation.

The strata of the B to E formations except the reef limestone beds of the B_1 member form

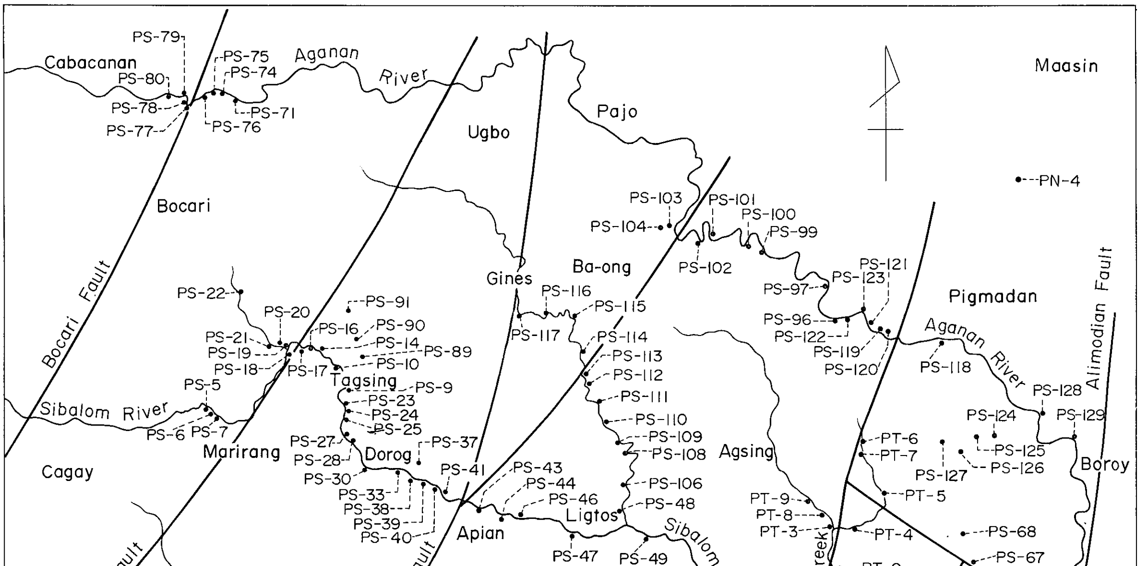

Fig. 3 Sample locality map of the Sibalom-Aganan area.

a flysch-type sequence composed of interbedded sandstones and mudstones and laminated mudstones with intercalations of conglomerates, pebbly mudstones, chaotic mixtures of sandstone and mudstone, acid tuffs and marls (Figs. 4–7). The sandstones alternate with the mudstones in beds of less than 15 cm thick in general, and exhibit a distinct graded bedding and other sedimentary structures which are common in turbidites. Thicker beds of medium- to coarse- grained sandstones also occur associated with occasional granule to pebble conglomerates, and often include calcareous nodules and magafossils such as shallow marine shells and corals. The mudstones are abundant in foraminifera. Plant fragments and carbonaceous matters are also common in the mudstones. In the conglomerates of the D_1 member are found rounded cobbles and pebbles, partly boulders of gabbro, diorite, granophyre, basalt, andesite, amphibolite,

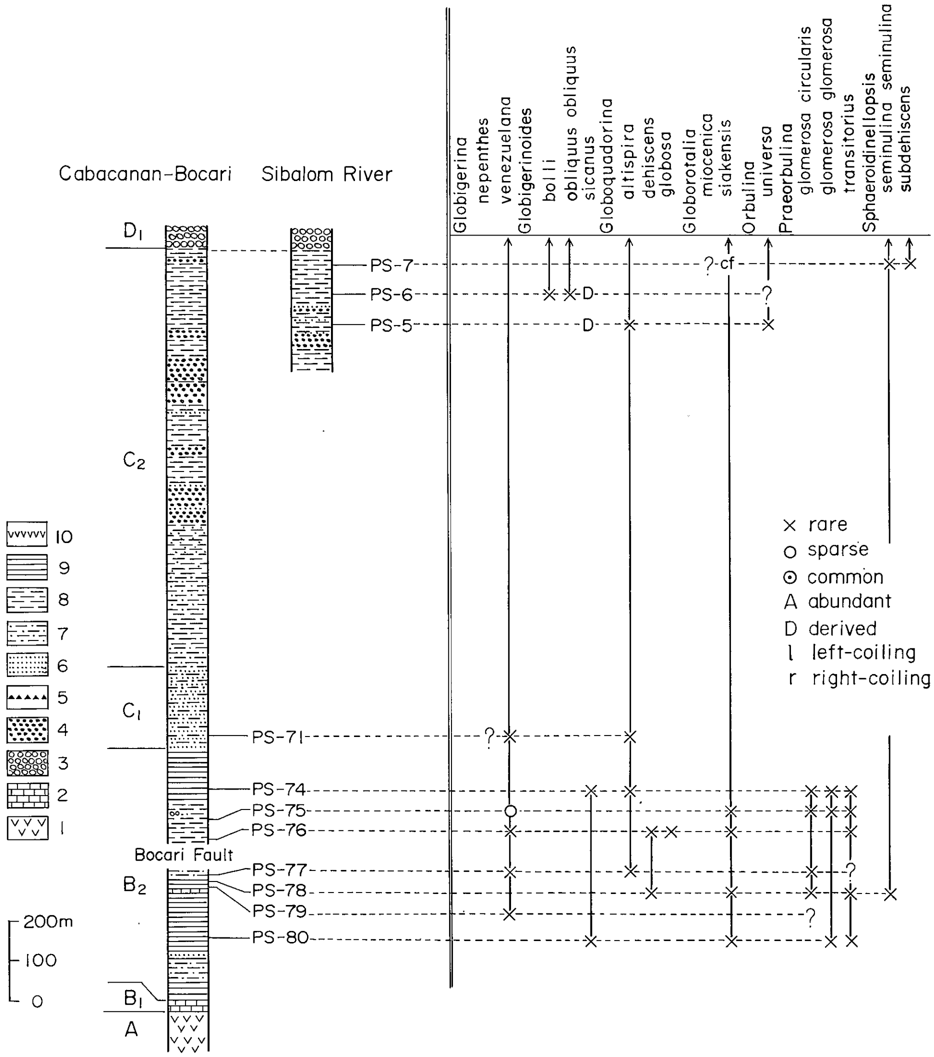

Fig. 4 Columnar sections and distribution chart of planktonic foraminifera of the B and C formations. 1. Andesitic to basaltic volcanic rocks, 2. Limestone, 3. Conglomerate, 4. Pebbly mudstone, 5. Chaotic mixtures of mudstone and sandstone due to slumping, 6. Sandstone, 7. Thinly bedded alternation of sandstone and mudstone predominant in sandstone, 8. Thinly bedded alternation of mudstone and sandstone predominant in mudstone, 9. Mudstone interlaminated with sandstone, 10. Acid tuff.

quartzite, chert, sandstone, slate, mudstone and limestone. The pebbly mudstones are intercalated at many horizons, especially within the D formation, and display slump structures. Their framework composition is similar to that of the conglomerates. The thickness of the pebbly mudstones ranges from 1 to 50 m. The chaotic mixtures of sandstone and mudstone, as well as the pebbly mudstones, are slump deposits including many fragments of rocks nearly contemporaneous with a muddy matrix, but are devoid of exotic clasts. The acid tuffs intercalated in the D_3 and E_2 members are of dacitic composition and include phenocrysts of biotite, plagioclase and quartz. The tuff layers are 1 to 3 m thick.

The uppermost part of the Neogene of the area is represented by the F formation composed mainly of conglomerates with fine-grained, laminated sandstones intercalating calcareous bands. The conglomerates are fairly well stratified and contain rounded to subangular pebbles, minor cobbles of the same kind of rocks as in the conglomerates of the D_1 member. This formation rarely yields foraminifera from thin interbeds of mudstone.

3. Biostratigraphy

Micropaleontological analysis was made on 137 samples collected mostly along the Sibalom and Aganan rivers. The localities of the samples are plotted in Fig. 3, and their stratigraphic levels are shown beside the columnar sections of each formation. Stratigraphic distribution of planktonic forami-

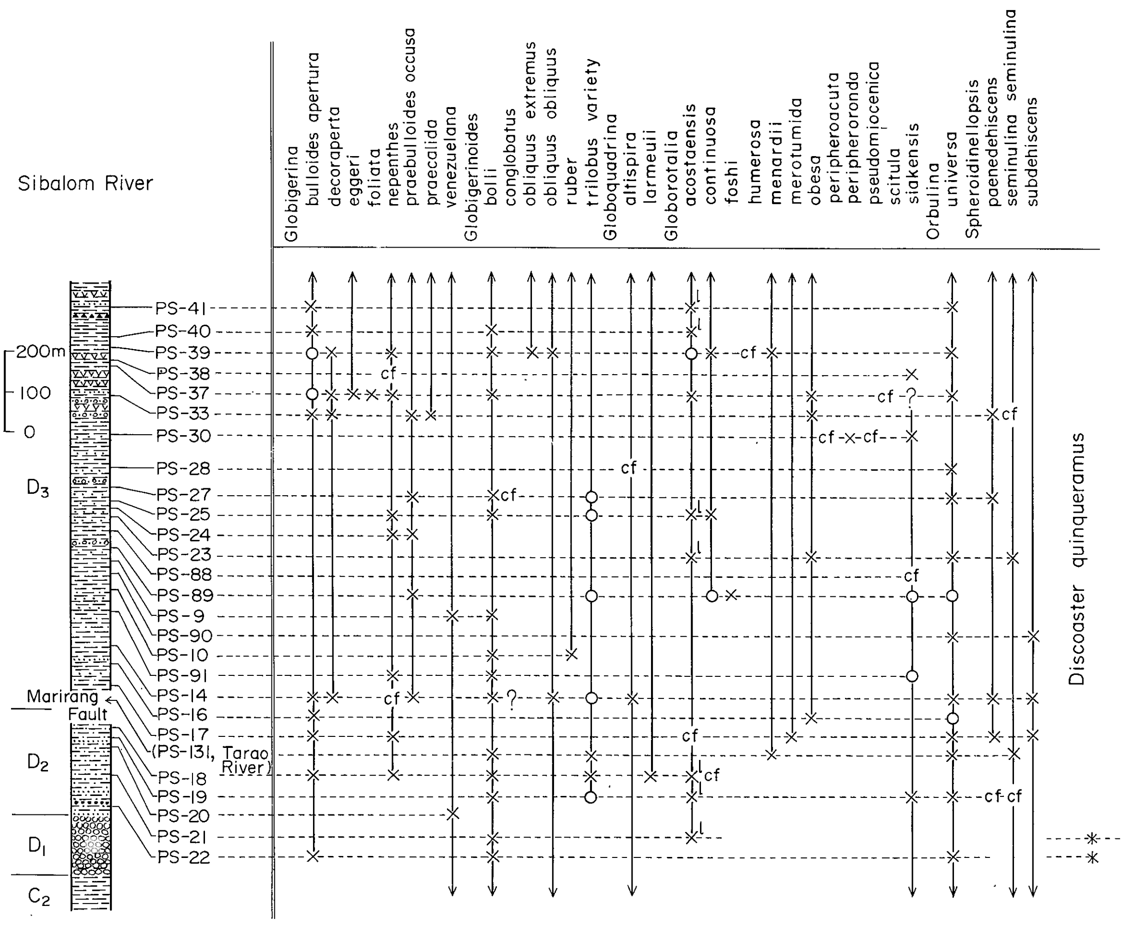

Fig. 5 Columnar section and distribution chart of planktonic foraminifera of the D formation.

nifera is given in Figs. 4 to 7, and a range chart of the selected species is shown in Fig. 8.

The samples collected were subjected to the standard laboratory method of processing. They were pulverized, soaked overnight in a hydrogen peroxide solution, washed, overdried and placed in uniform vials. The samples were picked of their faunal contents which were stored in cavity slides.

The age-determination of the Neogene sequence developed in the surveyed area was mainly based on planktonic foraminifera following the biostratigraphic zonation set by BLOW (1969) and the biostratigraphic work on the Japanese Neogene arranged by IKEBE and CHIJI (1981). To a very limited extent,

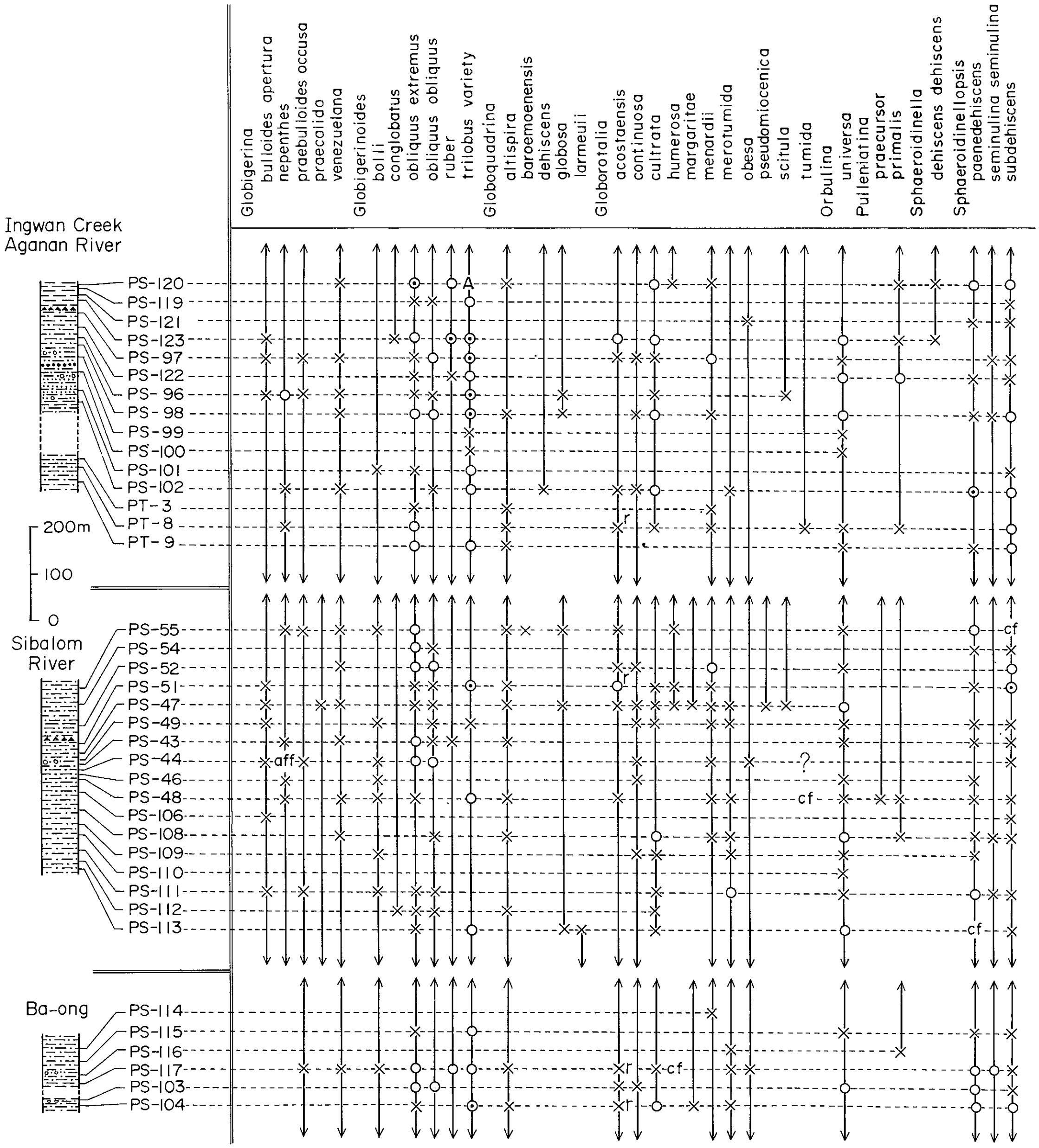

Fig. 6 Columnar sections and distribution chart of planktonic foraminifera of the lower part of the E formation.

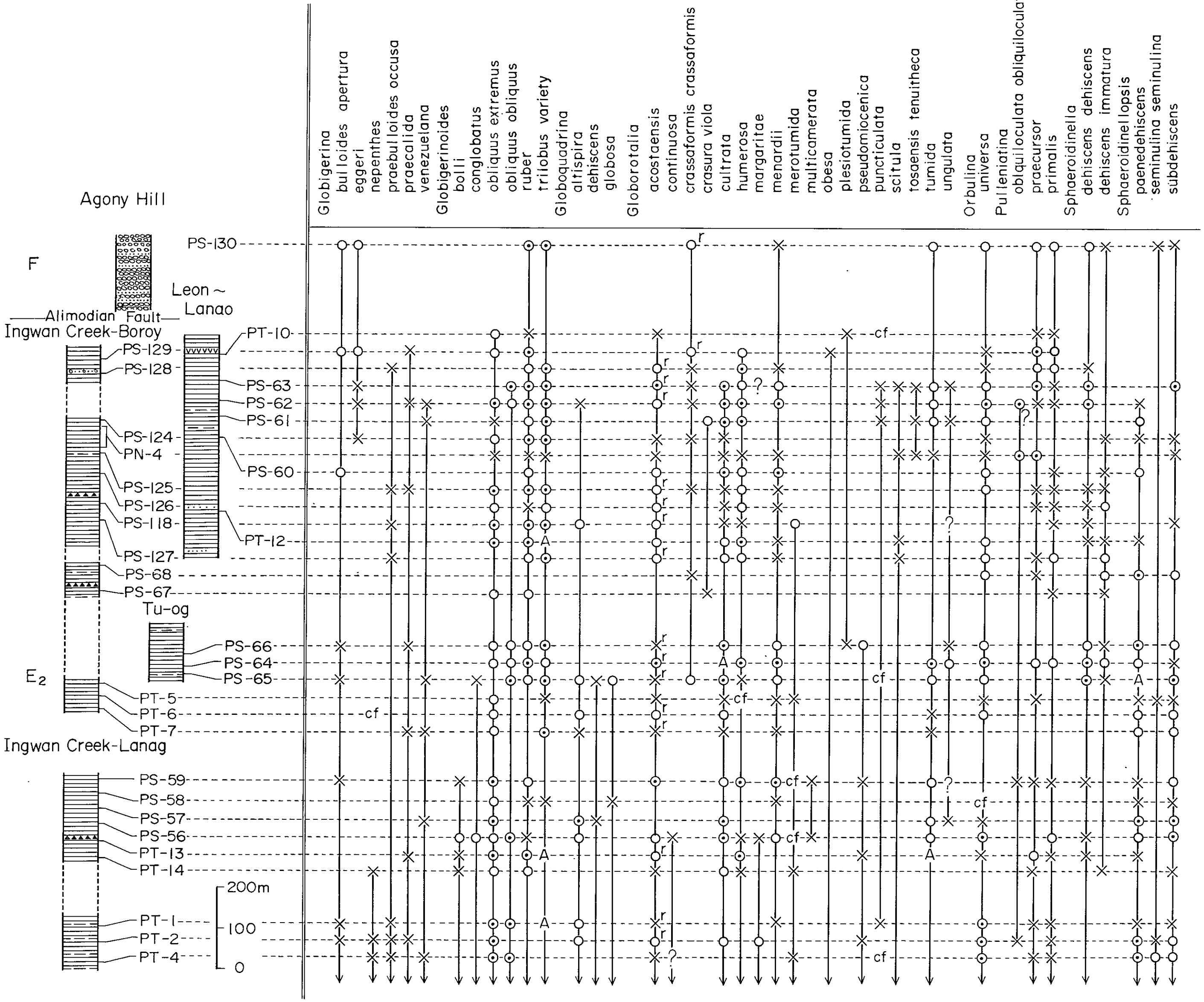

Fig. 7 Columnar sections and distribution chart of planktonic foraminifera of the upper part of the E formation and the F formation.

however, calcareous nannoplankton was used to check doubtful age based on foraminifera.

A formation: No fossil is found in this formation.

B formation: The foraminiferal fauna of this formation is characterized by *Globigerinoides sicanus, Praeorbulina glomerosa circularis, P. glomerosa glomerosa* and *P. transitorius*, lacking Middle Miocene markers such as *Orbulina*. This fauna indicates that the B formation is correlated with Zone N. 8 of latest Early Miocene age.

C formation: Fossils from the C formation in the surveyed area do not give a definite age. In the Tanian-Tarao area, however, some foraminifera available for age-determination were reported from the Sewaragan Complex and the Igtalongon Shale (GONZALES, 1963; TAKAYANAGI *et al.*, 1977), which correspond mostly to the southwestern

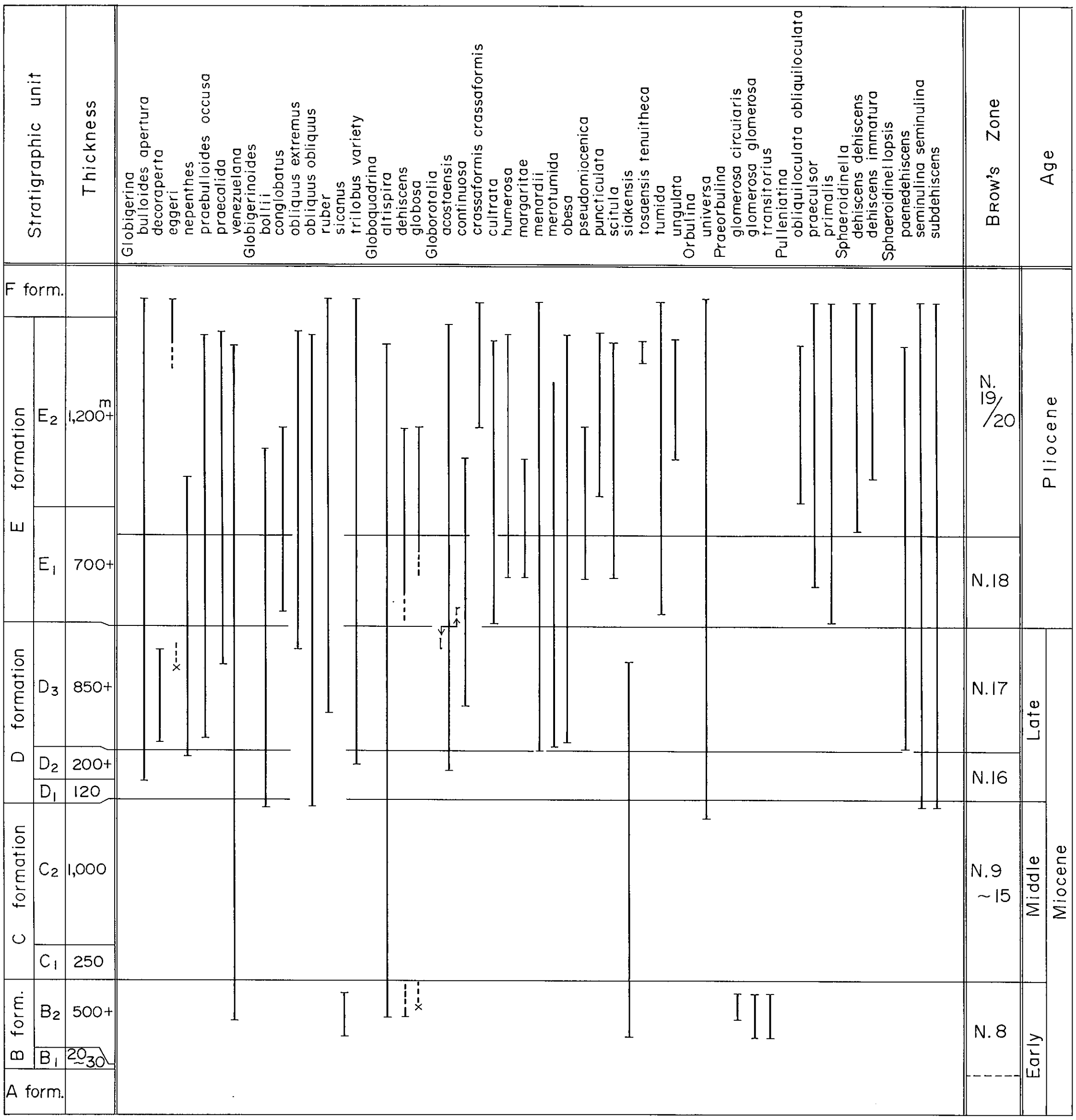

Fig. 8 Range chart of selected planktonic foraminifera of the Neogene in the Sibalom-Aganan area.

extention of the C formation. The Sewaragan Complex includes Zone N. 9 as will be discussed later, and according to TAKAYANAGI *et al.* (1977), the Igtalongon Shale ranges at least from Zone N. 14 to Zone N. 15. Because of this and the age of the underlying and overlying units, the C formation is considered to be the Middle Miocene.

D formation: The lowest occurrence of *Globigerina bulloides apertura* and *Globorotalia acostaensis* from the D_2 member indicates that the lower part of the D formation is correlative with Zone N.16. On the other hand, the D_3 member yields *Sphaeroidinellopsis paenedehiscens* indicative of N. 17 or younger. Consequently, the D formation is the Upper Miocene.

E formation: Based on the lowest occurrence of *Globigerinoides conglobatus* and *Globorotalia tumida* from the lower part of the E_1 member, the lower limit of Zone N. 18 can be placed at the base of the E formation. It is notable that coiling direction of *Globorotalia acostaensis* changes sharply from sinistral to dextral at the boundary between the D and E formations. The lower limit of Zone N. 19/20 is placed within the E_1 member because of the lowest occurrence of *Sphaeroidinella dehiscens* from its upper part. Though the occurrence of *Globorotalia tosaensis tenuitheca* is recorded from the upper part of the E_2 member, this part is regarded as Zone N. 19/20 from the coexistence of *Globigerina venezuelana, Sphaeroidinella dehiscens immatura* and three species of *Sphaeroidinellopsis*. The E formation is of Early Pliocene age, ranging from Zone N. 18 to N. 19/20.

F formation: The lower part of the formation is regarded as Zone N. 19/20 because its foraminiferal fauna is almost same as that of the upper part of the E_2 member. The upper part of the formation remains unknown in age.

SANTOS (1968) and GONZALES *et al.* (1978) set the following stratigraphic succession in the southwestern part of the Iloilo Basin.

Cabatuan Formation
Ulian Formation
Iday Formation
Tarao Formation
  Guimbal Mudstone Member
  Tubungan Siltstone Member
Singit Formation
  Barasan Sandstone Member
  Igtalongon Shale Member
  Tanian Limestone Member
  Sewaragan Complex Member
Basement Complex

The Basement Complex is the oldest rock unit mapped by CORBY *et al.* (1951) and GONZALES *et al.* (1963), and consists of various kinds of igneous, metamorphic and sedimentary rocks, being predominant in volcanic rocks of andesitic to basaltic composition. The A formation dominated by volcanic rocks occupies the upper part of the Basement Complex mentioned above.

The Singit and Tarao Formations are typically exposed in the Tanian-Tarao area. They are characterized by turbidite facies as well as the strata of the B_2 member to E formation in the Sibalom-Aganan area. The correlation of these strata is carried out on the basis of lithology and microfossils given by GONZALES (1963), TAKAYANAGI *et al.* (1977) and the present writers.

The Sewaragan Complex, the lowest member of the Singit Formation, was regarded as being of Early to early Middle Miocene age by GONZALES *et al.* (1963). Recently, GONZALES *et al.* (1978) considered the Singit Formation to range in age from Late Oligocene to Miocene. However, *Orbulina suturalis, O. universa* and *Praeorbulina glomerosa circularis* are common in the basal part of the Sewaragan Complex along the Tanian River (GONZALES, 1963). These fossils indicate that the complex is correlative with Zone N. 9, and is younger than the B formation (Zone N. 8). The complex corresponds to the lower half of the C formation. The B formation is the oldest unit dated by fossils in the Tertiary exposed at the surface in the Iloilo Basin. BANDY (1963) mentioned that his Antalon Complex, marine beds older than the Singit Formation, spans an interval of Chattian to Bur-

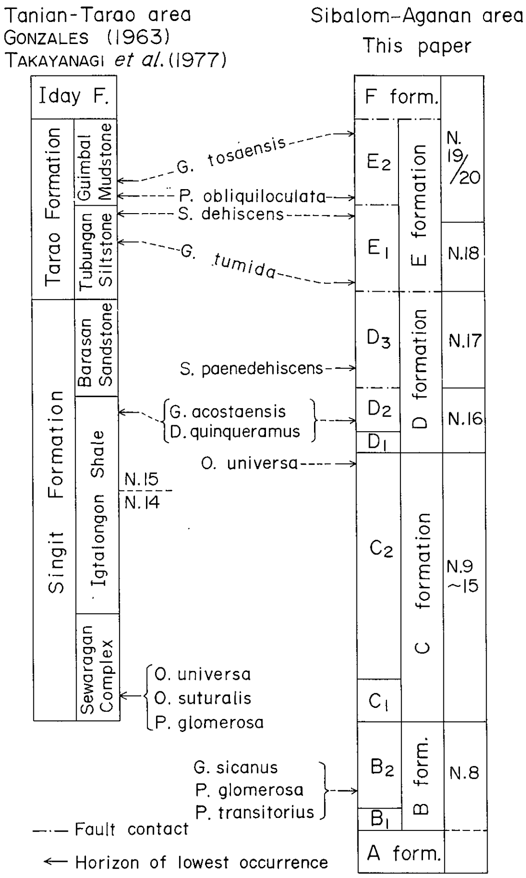

Fig. 9 Occurrence of some representative planktonic foraminifera in the Neogene of the southwestern part of the Iloilo Basin.

digarian, but he did not show any paleontological evidence in the southwestern part of the basin.

The B_1 member composed of reef limestones seems to be correlated with the upslope facies of the Tanian Limestone of SANTOS (1968) because of the similarity of their lithology and stratigraphic relation to the underlying volcanic formation.

As for the Igtalongon Shale of the Tanian section, TAKAYANAGI *et al.* (1977) settled the zonal boundary between N. 14 and N. 15 within its upper part. Moreover, the lowest occurrence of *Globorotalia acostaensis* and *Discoaster quinqueramus* (calcaleous nannoplankton) were recorded by them from the uppermost part of the member. The coexistence of these species is found also in the D_2 member of Zone N. 16 along the Sibalom River. Therefore, it is clear that the upper limit of the Igtalongon Shale ranges up in age to Late Miocene.

Globorotalia tumida, Sphaeroidinella dehiscens, Pulleniatina obliquiloculata and *Globorotalia tosaensis* are known to successively appear in ascending order in the Tarao Formation as well as in the E formation, and thus the two formations are of same age. Lithologically, the Tubungan Siltstone and the Guimbal Mudstone are correlative with the E_1 member and the E_2 member, respectively.

The F formation in the mapped area corresponds to a part of the Iday Formation.

4. Some problems on the Tertiary stratigraphy of Panay

The previous descriptions suggest the following geologic history of the western half of the Iloilo Basin. During Early Miocene time, the basin was a site of intense volcanism represented by the A formation, followed by regional subsidence. Weak volcanic activity took place later. The Neogene marine transgression started at the close of Early Miocene age. The basin was covered at the early stage by a shallow sea where the B_1 limestone deposited, and then become rapidly deeper to accumulate a thick flysh-type sequence of the B_2 member to the E formation. It reached the greatest depth in the Late Miocene, followed by a gradual shallowing. In the Pliocene, conglomerates and sandstones increased conspicuously. The Neogene history mentioned above is very similar to that of the Japan Sea side of the Japanese Islands in time of volcanism and marine transgression.

In the eastern half of the Iloilo Basin, the latest Oligocene and Early Miocene clastic rocks are known to rest on basic volcanic rocks in several wells drilled for oil exploration. Compared with the Tertiary sediments of the western half of the Iloilo Basin, those of

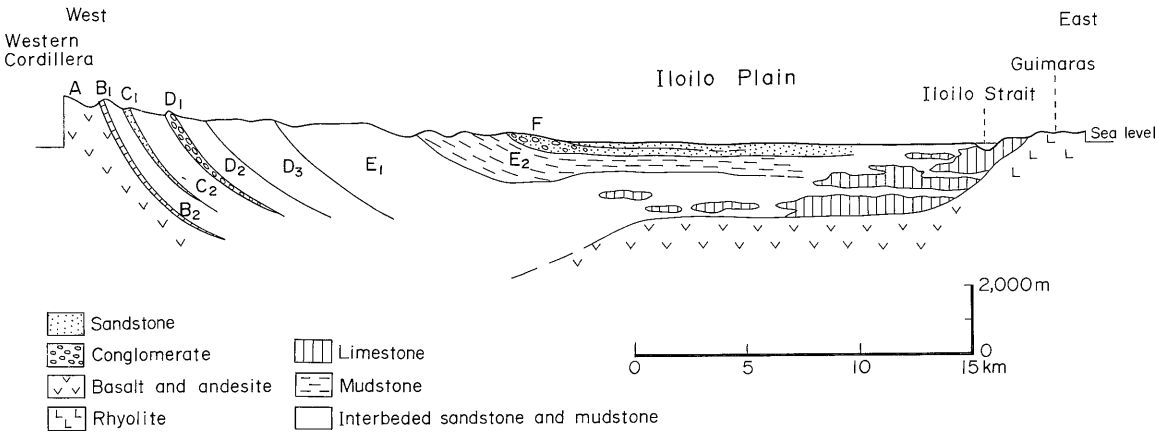

Fig. 10 Schematic profile of the southern part of the Iloilo Basin.

the eastern half are thin and fine grained in general, and are rich in reef limestones which occur at many horizons from the Oligocene to the Pliocene. Such regional differences are shown schematically in Fig. 10.

SMITH (1924) reported the occurrence of "a presumable *Vicarya callosa*" from a sandstone bed in the upper reaches of the Tigum River to the north of the surveyed area. KANNO *et al.* (1980) correlated the *Vicarya* bed with a part of the Upper Miocene Barasan Sandstone of the Tanian-Tarao area, and considered it to be younger than the *Vicarya* beds of other areas in the Philippines. Such a opinion was supported by HASHIMOTO (1981). The present survey, however, reveals that the *Vicarya* bed of Panay is included in the northern extention of the C formation, being older than the Barasan Sandstone and of Middle Miocene age.

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フィリピン，パナイ島，イロイロ盆地南西部の新第三系層序

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要　旨

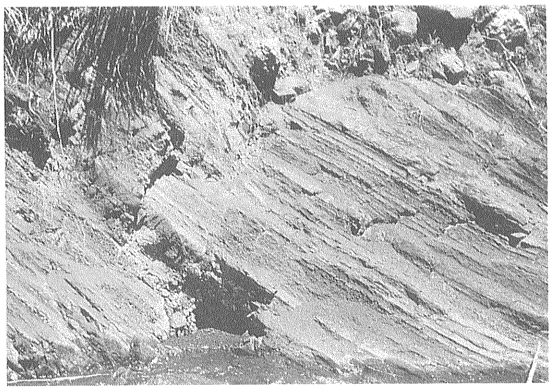
パナイ島のイロイロ堆積盆地南西部は，フィリピンにおける新第三系の標式的な発達地の一つとして古くから注目され，とくにタニアン—タラオ川沿岸では，層序・古生物の詳しい研究が進められてきた．1981年秋，筆者らは，タニアン—タラオ川のすぐ北に接するシバロム川・アガナン川地域の新第三系について地質調査を行った．

この地域の新第三系は，全層厚5,600 m 以上に達する厚層で，岩相的には安山岩質ないし玄武岩質の火山岩層に始まり，礁性石灰岩をへて，厚いフリッシュ型互層が引き続き，礫岩層をもって終っている．これをA-Fと仮称した6つの累層に区分した．大局的構造は，北北東-南南西の走向で，東へ20-50°傾く単斜構造を示し，走行方向にほぼ平行ないくつかの断層で切られている．浮遊性有孔虫にもとずく各層の年代は，次のようである．

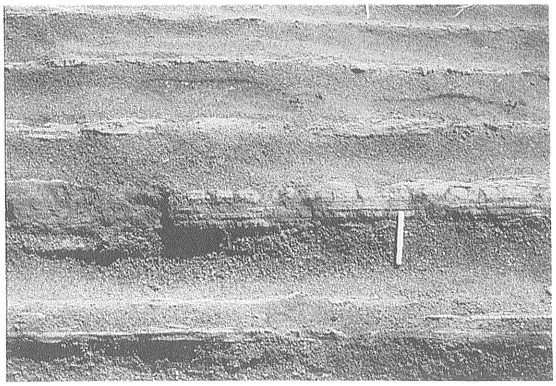
A 累層：N.8 またはそれより古い		中新世初期
B 累層：N.8		中新世初期
C 累層：N.9-N.15		中新世中期
D累層	D_1・D_2 部層：N.16	中新世後期
D累層	D_3 部層：N.17	中新世後期
E 累層	E_1 部層下・中部：N.18	鮮新世
E 累層	E_2 部層上部—E_2 部層：N.19/20	鮮新世
F 累層：N.19/20		鮮新世

この他，上記の層序区分と従来の層序区分との比較，イロイロ堆積盆地の地史に関する2・3の考察，今までフィリピンで最も若いとされていたパナイ島の“Vicarya”産出層準の検討などを行った．

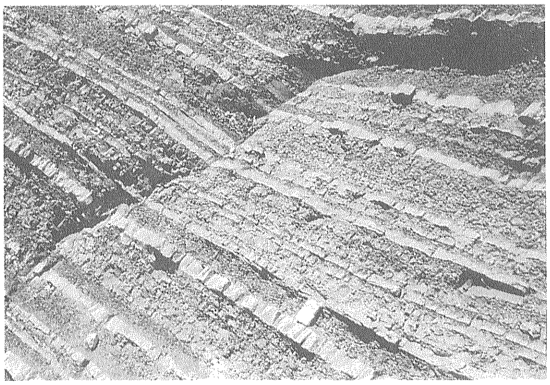
（受付：1985年５月22日；受理：1985年７月16日）



1) Mudstone interlaminated with sandstone, B_2 member, Aganan River, north of Tarug.



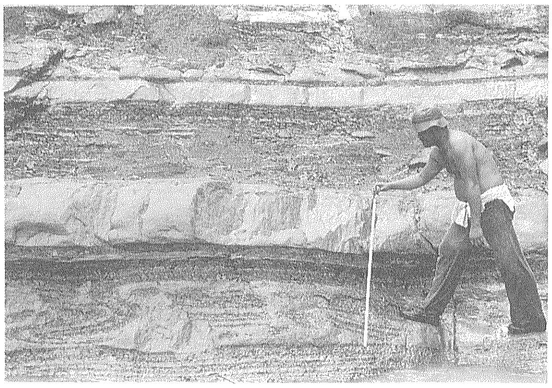
2) Close-up of the outcrop shown in Fig. 1, Scale bar 8 cm.



3) Interbedded mudstone and sandstone predominant in mudstone, C_2 member, 3 km east of Bucari.

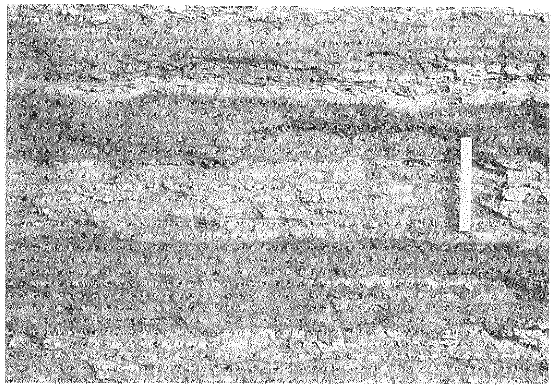
4) Pebbly mudstone containing exotic boulders, B_2 member, 2 km west of Tagsing.

5) Alternating mudstone and sandstone, D_1 member, Sibalom River, east of Tagsing.

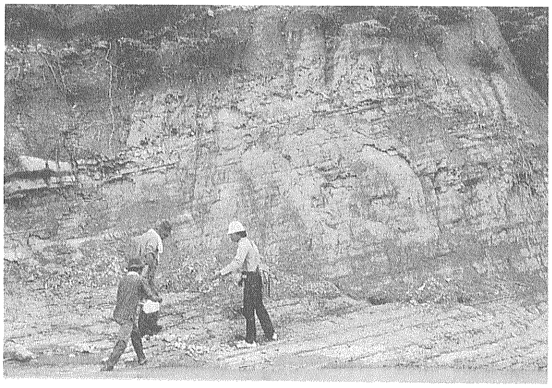


6) Slump fold of alternating mudstone and sandstone at the outcrop shown in Fig. 5.

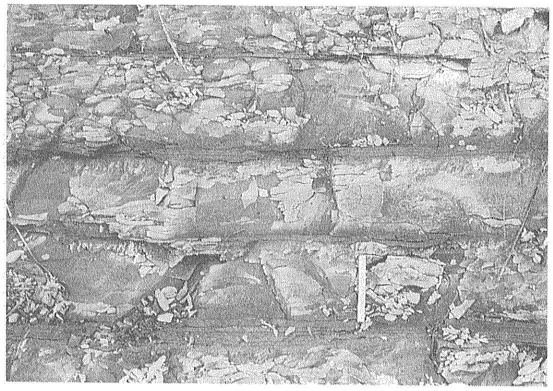
1) Interbedded sandstone and mudstone predominant in sandstone, E_1 member, Ligtos.



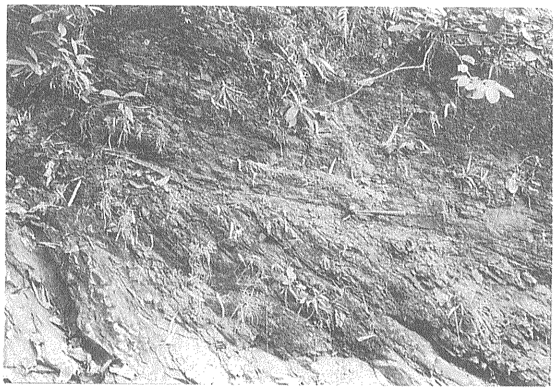
2) Close-up of the outcrop shown in Fig. 1. Scale bar 8 cm.



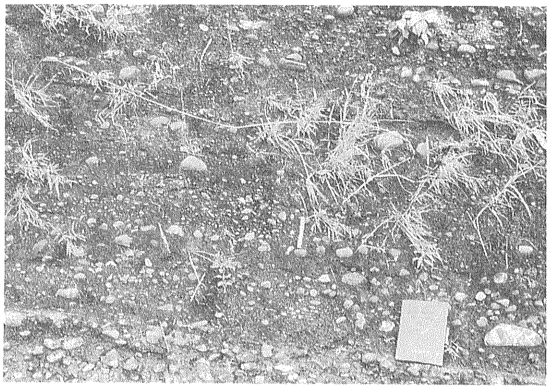
3) Mudstone interlaminated with sandstone, E_2 member, Sibalom River, east of Leon.



4) Close-up of the outcrop shown in Fig. 3. Scale bar 8 cm.



5) Discordance of mudstone beds due to slumping, E_2 member, 2 km southeast of Alimodian.



6) Pebble conglomerate, F formation, Aganan River, east of Alimodian.