Geology. — G. A. F. MOLENGRAAFF: "*On recent crustal movements in the island of Timor and their bearing on the geological history of the East-Indian archipelago.*"

The occurrence of elevated coralreefs on the islands of the eastern portion of the East-Indian archipelago, amongst others on the island of Timor, has attracted the attention of many scientists, because it proves that in a geological sense not long ago, these islands have been considerably raised above the level of the sea.

The Timor-expedition [1]) particularly studied these elevated reefs and their results may throw some light on the question of the character and correlations of the recent crustal movements in the East-Indian archipelago.

The following brief remarks, therefore, are intended as introduction to the history of these reefs.

The strata of the island of Timor were greatly folded at a time, which is known to be post-eocene and pre-pliocene, but which cannot at present be more precisely defined. Among these strata besides schists of unknown age various formations ranging from the Permian to the Eocene are represented, the whole of which will be here indicated by the name of the Perm-Eocene-series or simply as the older formations.

This period of folding and tilting was most probably followed by a period of prolonged and considerable denudation, because it is observed that a later-tertiary formation of neogene age is found resting unconformably on the much denuded (peneplainized) older formations. The oldest strata of these neogene deposits consist of pure Globigerina-limestone, a pelagic sediment devoid of the elements of terrigenous origin, which must have been formed in an open sea far distant from the land.[2])

From the time of deposition of the Globigerina-limestone important crustal movements had set in, which resulted in the forming of basins (graben), in which the soil was deposited slowly but continuously and thus filled up these true depressions [3]).

[1]) Messrs. H. A. BROUWER, F. A H. WECKHERLIN DE MAREZ OYENS and the author as leader, formed the Timor-expedition, during which geological explorations were made in the eastern half of the Netherlands-Timor in the years 1910—1912.

[2]) I am not inclined to regard this formation as a deep sea deposit, although it must have been formed in the open sea far from the land, but believe, that it may have deposited under similar conditions as the white chalk of Europe, to which this late-tertiary Globigerina deposit bears petrologically a remarkable resemblance.

[3]) Only the most important of those graben or depressions, which have been of such vital importance in the development of the later-tertiary deposits, are mentioned in this paper.

As the German terms "graben" and "horsten" are frequently used in this paper,

Beyond the "graben", in the adjoining "horsten", a slow upheaval of the land took place, in consequence of which the sea became shallower thus causing the growth of coralreefs upon the Globigerina-limestone. Foraminifera are found abundantly in these reefs whose preliminary determination points to a probable miocene age, although such an assumption must be confirmed by further palaeontological examination. Sometimes small pebbles are found in these reefs and in places they pass into littoral conglomerates. It appears that coral-reefs have been formed continuously during the long period of slow upheaval of these "horsten". So in proportion to their age so they occur at different levels, the oldest or first formed lying in the highest level, those which are younger gradually somewhat lower. These reefs therefore form together a slowly sloping more or less terraced covering or coating of coral-limestone. The entire thickness of this neogene formation from beyond the basins does not exceed 60 Meters.

Inside the "graben" where the neogene beds attain a much greater thickness, elements of terrigenous origin make their appearance in the upper portion of the Globigerina deposit and gradually it passes

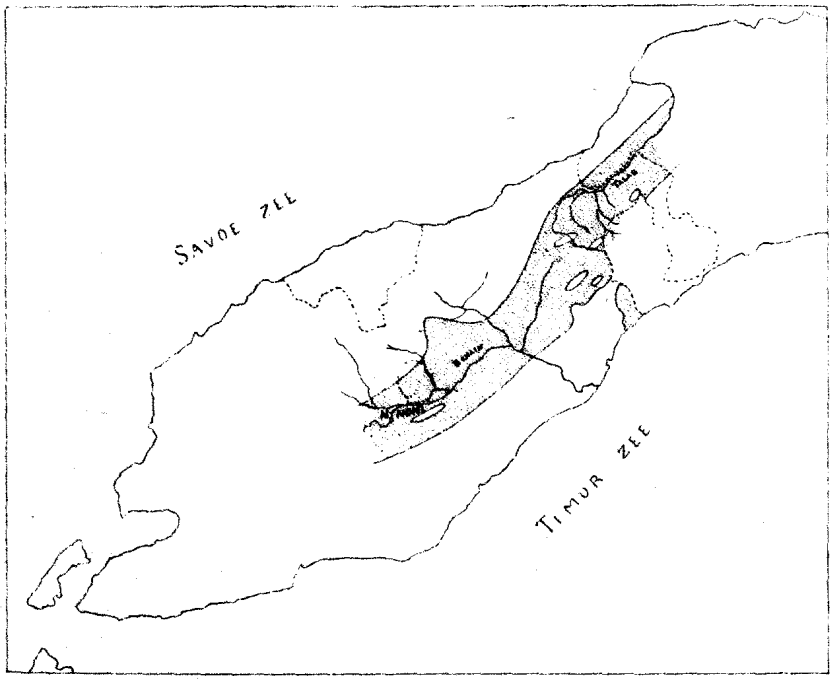

Fig. 1. Sketchmap showing the area covered by the later-tertiary deposits in Middle-Timor. Scale 1 : 2.560.000

it may be as well to explain that in case adjoining strips of land are affected by antagonistic movements and are separated one from the other by faults, the down-thrown strips or blocks are called "graben", whereas the upthrown strips or blocks are called "horsten".

into a sandy limestone, or even into a grit with calcareous cement. Thus the influence of land gradually increases and the higher strata consisting of marly claystones and marly sandstones are observed to contain numerous shells of the zone of shallow water which are regarded as of pliocene age [1])

The above-mentioned basins or "graben" trend in a direction approximately parallel to the longitudinal axis of the island of Timor (fig. 1). In a portion of Middle-Timor, as e. g. between Kapan and Niki-Niki, one single undivided "graben" exists which might be termed the median neogene basin, although generally, the structure of the "graben" is more complicated being subdivided by ridges ("horsten") or islands of older formations, which are elongated as well in the direction of the longitudinal axis of the island. Thus in the eastern portion of Middle-Timor the later-tertiary basin is divided by the Mandeo-mountains into two troughs, the Talau-Insana-basin and the Benain-basin [2]), while the latter more to the West again is subdivided by a narrow ridge of older formations into a northern Benain-Noilmoeti-basin and a southern Noil Lioe-basin. Faults of considerable character occur at the walls of the "graben", which by their influence have caused the younger tertiary strata in the basin to become suddenly curved and bent upwards near the edges. In many places a crush-breccia is found between the older formations and the tertiary strata thus indicating the position of these marginal or lateral faults.

During the formation of these "graben" by the slow subsidence of their deposits they remained always fairly well filled up with an accumulation of late tertiary sediments, from the character of which it may be gathered that the sea, although having occupied those basins, never attained a great depth.

These late-tertiary strata besides being tilted near the walls of the "graben", also show in places slight disturbances. The entire thickness of this formation in the "graben" is unknown although in my opinion in the Benain-basin it may safely be estimated at more than 500 metres.

True littoral formations such as conglomerates, oysterbanks, coral-reefs, etc. lie directly upon these pliocene deposits, and their thickness is at least 200 metres in the central axis of the larger or Benain-

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[1]) The pliocene age of these deposits is proved by MARTIN, who has examined the fauna of the marls of Fulumonu in the Talau-basin, which is identical with the fauna of the fossiliferous strata in the basin of the Benain. K. MARTIN. Tertiaer von Timor. Beiträge zur Geologie Ost-Asiens und Australiens. Serie I, Band III, p. 305. Leiden 1883—1887.

[2]) These two basins are united again West of the Mandeo-Mountains.

"graben". One of the coralreefs in the Benain-basin (fig. 2) is of great thickness (70 Meters) and of considerable extension, being consequently an element of importance in the configuration of the land-

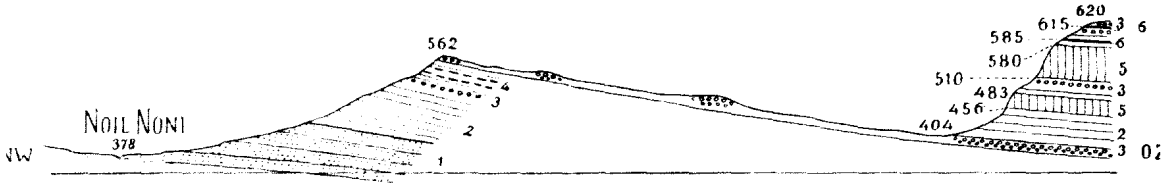

Fig. 2. Section across a portion of the Benain-basin in Middle-Timor.

1. Claystone and marl with shells, Pliocene.
2. Marls and sandy marls, containing in places marine organisms.
3. Conglomerate.
4. Sandy marl with Placunna.
5. Coralreefs, late-Pliocene or Pleistocene.
6. Oysterbanks.

Scale. 1 : 14.000. Altitudes in Metres above sealevel.

scape ; on these coralreefs is again deposited a succession of layers of sandstone, conglomerates, oysterbanks, etc., all significant of a littoral origin. From their considerable thickness we must infer that these deposits were formed during a period of slow subsidence, which must have occurred at the end of the pliocene or at the beginning of the pleistocene age.

These reefs and other littoral deposits although getting thinner towards the edges (walls) of the basins, are not always confined to the "graben", but in places they spread over a great area in Middle-Timor and overlap the older formations from which they are often separated by a well developed coarse basal conglomerate ; consequently they are also found resting unconformably upon the Globigerina-deposits where the latter are locally tilted at the edges of the "graben". It is obvious that these coralreefs of late-pliocene or early-pleistocene age have been formed outside the "graben" in close proximity, although generally at a somewhat lower level, to the above-mentioned older reefs of probable miocene and pliocene age. It was not proved possible to discriminate in the field between these reefs of different ages, with certainty, but probably a future examination of the Foraminifera contained in them may lead to more accurate results.

In the "graben" there is no break in the succession or unconformity visible between the pliocene strata and the overlying reefs and

littoral deposits; and there can be no doubt that the last mentioned reefs both inside and outside the "graben" all belong to one and the same continuous formation, the connection of which has only been interrupted by later erosion.

During and just after the formation of these coralreefs a great portion of Middle-Timor must have been covered by a sea full of coral-islands and reefs. The higher mountain-groups (Moetis, Lakaän, Mandeo etc.) emerged as islands from this sea, and the conglomerates, formed simultaneously with and posterior to the coralreefs, prove that the islands must have been steep and high and that the running water must have transported a considerable amount of debris from them towards the surrounding sea.

It may be accepted that the majority of the big coralreefs were thus formed in late pliocene or early pleistocene times as they overlie and clearly therefore indicate a younger age than the marls with pliocene shells.

Further, *as these reefs were already formed,* a general upheaval of the island of Timor took place which possibly still continues. This upheaval, however, was not equally strong everywhere, consequently the elevated coralreefs are no longer found in a horizontal position but feebly sloping.

It appears that the upheaval of the central portion of the island has been from the beginning somewhat stronger than that of the southern and northern coastal regions.

In fact the reefs of the Diroen-ridge south of the Lakaän near the central axis of the island occur now at an altitude of 1283 Meters, about 680 Meters higher than those on the hills of the north coast at Babilo. The big reef also of the Gempol-cliff in the central portion of the island not far from Kapan has an altitude of 1250 Meters above sealevel, whereas in the southern mountainranges near Niki-Niki the highest altitude at which coralreefs are found is only 750 Meters.

Moreover, the upheaval of the land has been stronger at the edges of the basins ("graben") than in the basins themselves. Consequently the coralreefs which rest on the pliocene strata in the "graben" are no longer found in their original horizontal plane of deposition, but assume a feebly basin- or trough-shaped position and are besides split up into blocks of slightly different altitudes. It may be that this latter circumstance is caused by compression and the squeezing out of the soft and more or less plastic pliocene strata underlying the heavy compact coral limestones, although it might just as well be suggested that it is caused by a feeble continuation of the crustal

movements which had been present to account for the formation of the pliocene "graben" and "horsten".[1])

During the prolonged period of recent upheaval the running waters were obliged to cut their courses with strong and increasing gradients. Narrow deep valleys, often true gullies (cañons) were formed which are characteristic of the topography of the greater part of the island. Numerous terraces are found along the courses of the rivers as well in connection with those rivers which have developed their systems within the late-tertiary basins, as also with those, where the systems lay entirely outside of the basins. This proves that the entire island of Timor took part in the recent upheaval, although not everywhere to the same extent.

This unequal or differential upheaval of the land has caused the rivers which flow within the tertiary basins to generally transverse, somewhere in their course, one or more of the strong layers of reef-limestone, at those places where those are comparatively little elevated. Thus the Benain has, in the central portion of the Benain-basin near the native village Nèke, at an altitude of 296 M. cut a narrow deep gorge of more than two miles in length through a thick stratum of coral limestone. In one portion of this gorge the running water undermined a portion of the coral limestone, and thus formed over the current, which is very deep and strong a natural arch or bridge which is now a much frequented road of communication.

[1]) My conclusions differ slightly from those of VERBEEK (R. D. M. VERBEEK, Molukkenverslag. Geologische verkenningstochten in het oostelijk gedeelte van den Ned. O.-I. Archipel. Jaarb. van het Mijnwezen XXXVII. Batavia 1908). According to VERBEEK the coralreefs of the Talau-basin are of different age, and were all formed during the gradual upheaval of the land as fringing reefs, which are now found to be the older because of their higher level above the sea (l.c. p. 777).

The highest, those of the Diroen-ridge at an altitude of 1283 M. above sealevel, are regarded as of miocene age, those of Lahoeroes at an altitude of 569 M. of somewhat later date, and the lowermost, those of Fatoe Lamintoetoe at an altitude of 300 M. of pliocene age. These coralreefs diverge the older they are proportionally more from their original horizontal position; thus the oldest show a dip of 8°, those which are at a lower level of 5°40', whereas those which occur still further below dip only 3°50 (l. c. p. 357 and p. 778).

Although admitting that outside of the "graben", coralreefs of probably miocene age are found and that these ancient reefs occupy the highest levels now, I am of opinion that the majority of the elevated reefs i. e. the bulk of those which occur within the area of the "graben" including the Talau-basin, and also a part of those which are situated beyond the limits of the "graben", were formed before the commencement of the latest period of emergence (upheaval) of the island of Timor and consequently must be of the same late-pliocene or early-pleistocene age; and the above mentioned, feebly synclinal and somewhat disturbed and fractured position of the reefs, which spread continuously over large distances within the "graben", would be an explanation for the fact that these reefs are found at present in different altitudes, decreasing towards the central axes of the "graben".

In the same way the Talau-river just below its confluence with the Baukama at an altitude of 245 M. [1]) above sea-level, has cut a gorge which at present is 55 M. deep, across a high bank of coral limestone.

Theoretically one might expect, that during this prolonged period of upheaval, which possibly is still in progress, a series of fringing reefs had been formed all round the area of elevation. The current opinion is, of course, that the elevated coralreefs of Timor were formed in such a way from miocene times until now, during a continuous movement of upheaval of the land [2]). The fact is, however, that not a trace of elevated fringing reefs is found along the north western and southeastern coast, where the island of Timor adjoins the eastern continuation of the deep depression of the Savoe-sea and the equally deep depression of the Timor-sea. The western-most portion of the island, on the contrary, where it borders the shallow water which separates it from the island of Rotti, is covered with elevated fringing reefs.

If we look for an explanation of this remarkable fact, it is of importance to bear in mind that the island of Timor appears to be suddenly truncated and broken off by faults just along the north-western and southeastern coasts which border deep basins of the sea coming up close to the shore.

The late-tertiary or early-quaternary reefs and littoral deposits which form the uppermost portion of the neogene series of the Talau-basin, on the mountain-ridge of the northcoast for instance near Babilo, abruptly terminate with their full thickness in a steep cliff, facing the sea at an altitude of about 610 Meters. Evidently the strata once extended much further towards the North, but afterwards became detached. Between this point and the actual coast no trace of elevated coralreefs is found, whereas at the beach in the surf small reefs of living corals are abundant. This circumstance as well as the fact that along the north coast the hills rise with an uncommonly steep slope from the sea, tends to prove that the island of Timor is broken off towards the North. More convincing evidence still, is afforded by the south coast, where in the district of Amanatan the parallel ridges of the Amanoeban-mountainchain, which is mainly composed of Jurassic strata striking 010N-W10S (a direction differing about 12° from the general trend of the coast line), follow each other abruptly abutting against the coast and terminating in high cliffs.

[1]) VERBEEK, in his description of the tertiary basin of the Talau-river, also mentions this gorge l. c. p. 348.

[2]) R. D. M. VERBEEK, l. c. p. 777.

The sea deepens suddenly all along this coast and no trace of islands or shoals are found which might be regarded as the submarine continuation of those ridges. All observations made along this coast give support to the opinion that the island terminates here against a fault facing the Timor-sea.

I think it quite possible that the faults which thus terminate the island of Timor both towards the North and the South have been the cause of the absence of elevated reefs along those coasts of upheaval.

If we accept the existence of these breaks, the question arises: What has been detached towards the North and the South? Clearly it must be the sunken blocks of land which are found in the deep basins of the Timor-sea and the Savoe-sea.

To the North of the island of Timor the eastern continuation of the Savoe-sea has a depth of 3255 M. near the island of Kambing; to the South the depth of the Timor-sea is 3109 M. and this considerable depth is found much nearer to the coast of Timor than to the Sahul-bank which forms part of the continent of Australia.

Not only Timor, however, is thus bordered at both sides by deep sea-basins, but it is a coincidence which holds good for the majority, if not for all of the islands of the eastern portion of the archipelago, consequently, the origin of the deep sea-basins and the elevation of the islands in the eastern portion of the archipelago may be regarded as a simultaneous process between which a genetic connection must have existed.

The genesis of adjoining sunken and tilted blocks must be the result of one and the same crustal movement, which in my opinion would be the cause of a process of folding at great depths.

If the question were raised as to what might be seen at the earth's surface if an area were folded by crustal movement at a certain depth, I should be inclined to reply that its appearance would be similar to what obtains at present in the eastern portion of the Indian archipelago [1]). It is a well known fact that the folding of rock-strata is only possible under high pressure; it may therefore be inferred that folding can only originate at certain depths below the earth's surface. At the surface, in the zone of fracture, where the rocks cannot be plicated, the phenomena of deeply seated thrust and folding would be indicated by the presence of "graben" and "horsten", the former corresponding to the troughs, the latter to the saddles of the deeply seated folds. Generally speaking every range of tilted

[1]) ABENDANON has arrived at a somewhat similar conclusion, in his analysis of the topography of the island of Celebes. E. C. ABENDANON, Celebes en Halmaheira, Tijds. K. Ned. Aardr. Genootsch. 2, XXVII. p. 1149, Leiden 1910.

blocks, or islands in our case, as well as every range of sunken blocks, or deep sea basins in our case, must indicate the position and the trend of the major folds, which are in mode of formation at a certain depth; thus the character of the deeply seated folds would be found reflected in the surface topography.

But then one has to take into account also, the submarine topography [1]) and fortunately the excellent deep sea chart of the Siboga-expedition enables us to do this [2]).

The most salient feature on this map is the striking difference which exists between the western portion (the Java-sea and its surroundings), and the eastern portion (the Molucca-sea). The latter exhibits a complicated topography and great variations both in the depth of the sea and in the heights of the numerous islands, which generally emerge boldly from the sea; whereas the western area shows a slight and very uniform depth of the sea and smooth outlines of land which rises with a very gentle slope from the coast [3]).

[1]) In my opinion it is imperative to study the submarine topography, because the part of the surface of the earth hidden beneath the sea in this archipelago is so much greater than that of the islands. This itself is a favourable circumstance, because it tends to prove, that the basins until now were comparatively little filled up by products of erosion brought from the land, and consequently the surface topography originated by the recent crustal movements has been fairly well preserved at the bottom of the sea. The upraised islands of course are smaller and less high now than they would have been, were it not that the erosion had from the start counteracted the results of the upheaval. In or near large continents the chances for the preservation of a salient topography are much smaller, because the original features would have been much sooner obliterated by the effects of erosion and sedimentation. Thus in a portion of Northern Germany and the Netherlands, geologically not long since, crustal movements formed a surface topography, certainly not less complicated than that of the East-Indian archipelago, in which the levelling processes have been so powerful, that its original topographical details has become obliterated, with the result that at present only a trace of them can be seen at the surface; indeed we have to imagine the quaternary and a portion of the tertiary deposits removed to be able to realize the complexity of this topography.

[2]) G. A. F. TYDEMAN. Hydrographic results of the Siboga-expedition. Chart 1. Part III of M. WEBER. Siboga-Expeditie. Leiden 1903.

Soundings which have been made in the archipelago since the results of the Siboga-expedition were published, have proved, that the submarine topography is still more complicated than that shown on the chart. Very probably, the most important result of the researches of the Siboga-expedition i. e. the existence of a strikingly complicated submarine topography in the eastern parts of the East-Indian archipelago, will be more accentuated by future researches.

[3]) VERBEEK has already drawn attention to this striking difference between the western and the eastern portion of the archipelago and he pleads a causal origination for the presence of the deep sea-basins and the islands with elevated

This western portion with the tranquil topography both of the land and the sea-bottom, has not taken part in the more recent crustal movements; since the upheaval which raised the miocene sandstone formation in Central-Borneo to a level of more than 1000 M. above the sea, no movements of the soil have been recorded there, probably with the exception of the area immediately bordering the Street of Macassar. In the eastern portion of the archipelago, where a complicated topography of the land and the sea bottom prevails, deep sea-basins have been formed by subsidence; and, during the same time, ranges of islands have been elevated above the sea, caused by antagonistic movements which are probably still in course of progress. *It thus appears that in the latest geological period the crustal movements, in the geosynclinal or movable area between the Australian and the Asiatic continent, have been confined to the portion, immediately adjoining the Australian continent, i. e. between Borneo and Australia.*

In tropical regions generally, a coating of coral-limestone is formed along an elevated coast, as long as there are no causes to counteract or annihilate the results of the growth of successive fringing reefs during the period of upheaval.

This easily recognisable coating of coral-limestone (series of fringing reefs in different levels one above the other) in tropical regions, affords an excellent criterion from which may be judged whether a coast has been elevated in proportion to the level of the sea.

Now in the entire western portion of the archipelago with its undisturbed topography i. e. the land surrounding the Java-sea where, according to my opinion, no movements of the land in relation to the level of the sea have taken place in the latest geological time, raised coralreefs have not been recorded [1]).

In the eastern portion of the archipelago with its complicated topography, where crustal movements have occurred, elevated coralreefs are found on the great majority of the islands.

I believe, that generally speaking it may be accepted, that where

coralreefs (l.c. p. 817). VERBEEK, however, believes in an indirect cause for such a phenomenon. In his opinion the upheaval of the islands took place only after the deep sea-basins had already been formed, by the subsidence of landmasses; pressure exercised by the sunken blocks caused later folding at a great depth, as well as the upheaval of the islands (l.c. p. 816). In my opinion, however, the causal origin was of a direct nature; the subsidence of the deep sea-basins and the elevation of the islands took place at the same time, and both antagonistic movements were the results of one and the same phenomenon of thrust and folding at a certain depth.

[1]) Java, especially the southern coast, would have been subjected again to the crustal movements, which had occurred at the border between the Indian Ocean and the East-Indian archipelago.

a deep sea chart shows a complicated topography the adjoining coasts must show signs of upheaval (in tropical regions, as a rule, elevated coralreefs), and where this is not the case one must expect no evidence of importance in favour of the upheaval of the adjoining coasts.

If my suggestion is correct that folding at a certain depth is the cause of the simultaneous origin of both deep sea-basins and the elevation of the islands, the following phenomena would result:

1. The elevated islands would be grouped in rows, for they are nothing but the elevated though fractured strips of land on top of the saddles of the deeply seated folds. The trend of the rows of islands would indicate the line of strike of such folds, examples of which may be seen in the rows at Soemba-Timor-Timorlaut-Kei-Ceram-Buru; as also at Soembawa-Flores-Wetter etc.

2. The deep sea-basins would be elongated in one direction more or less exactly parallel to the adjoining rows of islands, because they are formed on top of the troughs of the deeply seated folds. For example I may quote the case of the Savoe-sea, the depth near the island Kambing, the Timor-sea, the Weber-depth, etc.

3. Near the surface, in the zone of fracture, one would also expect to find faults, which had broken the connection in the sides of the folds. Such faults would exist between the deep sea-basins and the elevated islands; and where the faults had repeatedly cut away the land at the coast, the development of elevated fringing coralreefs would have heen hampered. This has taken place both at the north and the south coast of the island of Timor, and also at the islands of Moa and Leti.

4. All the islands of one row would be elevated, but the upheaval would have been very unequal, as can be observed if the islands are compared one with the other, or if an examination be made of different portions of one island. This is indeed the case in all the elevated islands, as can be principally deduced from the desriptions in VERBEEK's Molukken-verslag.

5. There is no reason why faults should occur between adjoining islands belonging to one and the same elevated range (saddle of a deeply seated fold), which would hamper the development of elevated coralreefs. It is possible that this circumstance might explain why, at the western extremity of Timor, elevated fringing coralreefs appear to be so well developed.

6. Where the deeply seated fold, shows sudden bends or curves,

or where two systems of folds interfere[1]) exceptions to the above mentioned rules and complicated cases may be expected. The deep sea chart of the Siboga shows good examples of this fact.

Zoology. — *"On the Freshwater Fishes of Timor and Babber."* By MAX WEBER and L. F. DE BEAUFORT.

The Timor Expedition, under leadership of Prof. G. A. F. MOLENGRAAFF, returned to Holland with extraordinarily rich mineralogical, palaeontological and geological collections and its leader has already communicated some important preliminary results, which are of great importance, not only to our knowledge of Timor, but also to the geological history of the whole indo australian archipelago. As they throw new light on the youngest phases in the development of the archipelago, they are of special importance to the zoogeographer too.

Therefore it is a memorable fact, that Prof. MOLENGRAAFF consented to our request to make a collection of freshwater fishes, when time and circumstances permitted, as thus important light is thrown on at any rate the younger phases of the evolution of the indo-australian archipelago.

We are glad to seize this opportunity to thank him as well as his collaborator Mr. F. A. H. WECKHERLIN DE MAREZ OYENS for the collection of well preserved specimens of fish, brought together by the lastnamed in different rivers of Timor and the island of Babber.

As far as we know, Babber was — ichthyologically — a terra incognita. The following fishes were collected by Mr. WECKHERLIN DE MAREZ OYENS in the rivers (Jer), which are mentioned next to the name of the fishes.

Anguilla mauritiana BENN. Jer Lawi, 7 Km. above mouth. Jer Toilila near Tepa, 500 M. above mouth.

Caranx carangus BL. Jer Lawi, 7 Km. above mouth.

Gymnapistus niger C. V. Jer Lawi, 7 Km. above mouth.

Eleotris gyrinoides BLKR. Jer Toilila near Tepa, 500 M. above mouth. Jer Lawi, 7 Km. above mouth.

[1]) The East-Indian archipelago is situated in the area of junction of two systems of folding of the earth's crust, the alpine and circumpacific system, vide E. HAUG. Les géosynclinaux et les aires continentales. Bull. de la Soc. Géol. de France. 1900. 3. Sér. Vol. 28 p. 635. Whereas E. HAUG refers in this area to an "embranchement" of the two systems, SARASIN goes further and speaks of an actual conflict: "Ich habe noch immer den Eindruck, dasz es sich im malayischen Archipel um einen Konflikt zwischen den Kettensystemen der Tethys und denen der pazifischen Umrahmung handle". P. SARASIN. Zur Tektonik von Celebes. Monatsberichte der deutschen Geol. Ges. 1912. p. 215.