Walanae Formation and Walanae Terraces in the Stratigraphy of South Sulawesi (Celebes, Indonesia)

by Gert-Jan Bartstra, Groningen

The river Walanae flows through the south-western arm of the island of Sulawesi (Celebes, Indonesia; see fig. 1). The terraces of this river have acquired a certain fame, both for the remains of fossil Pleistocene vertebrates (the *Archidiskodon-Celebochoerus* fauna; first publications: Hooijer, 1948a, b and c), and for stone artefacts (the Tjabengè industry*); first announcements: Van Heekeren, 1949a, b and c).

It is always maintained in the literature that fauna and industry are probably contemporaneous (e. g. Van Heekeren, 1972, p. 69 and 1975, p. 48; Hooijer, 1973, p. 12; Soejono, 1975, p. 95). However, I very much doubt whether fossils and artefacts are originally from the same deposit. I first had these doubts when taking part in a joint Dutch-Indonesian expedition to South Sulawesi in 1970 (financed by the Netherlands Foundation for the Advancement of Tropical Research: WOTRO). Apart from the description of some specimens from the newly-found fossil material (Hooijer, 1972), the results of the expedition have not yet been published. But the leaders of the team in Sulawesi, Dr. H. R. van Heekeren and Dr. R. P. Soejono, have as far as I know, never basically changed their ideas about the contemporaneity of artefacts and fossils.

I will give here the reasons for my doubts and will do this in the form of a survey of the stratigraphy of South Sulawesi. Thanks are due to Dr. D. A. Hooijer and Dr. H. J. Veenstra for their critical reading of the manuscript. Mr. Jac. Klein did the drawing work.

Older deposits

In this article I mean by South Sulawesi the southern part of the southwestern arm, i. e. the region below Lake Tempe. The latest data on the geological structure of that region are to be found on the "Reconnaissance Geological Map of the Ujung Pandang Area, South, Sulawesi, scale 1:250,000". This map was made in the beginning of the seventies by the Geological Survey of Indonesia, Ministry of Mines. From now on this map will be referred to as: GMSS.

Summarised information on the geology of South Sulawesi is to be found in the writings of Van Bemmelen (1949), although his findings are based mainly on the articles by Rutten (1927). The latter in turn bases his findings for the most part on the results of the two-year-long fieldwork by 't Hoen and Ziegler (1913–1914), which were first published in 1915 (1917). Before 1913, however, many geological observations had already been made. In fact, towards the end of the last century the geology of South Sulawesi was already roughly known (Wichmann, 1893).

A cross-section of South Sulawesi, from the Strait of Makasar in the West to the Bone Gulf in the East, reveals first a flat coastal plain, followed by a western range with a peak of ± 1650 M.; the plain of the

* The Tjabengè industry owes its name to a small town in the vicinity of the main sites. The present spelling of the name of the town in Indonesian is: Cabengè. Here, however, the traditional spelling has been maintained for archaeological use, while the new spelling is used only for the purely geographical indication of the name.

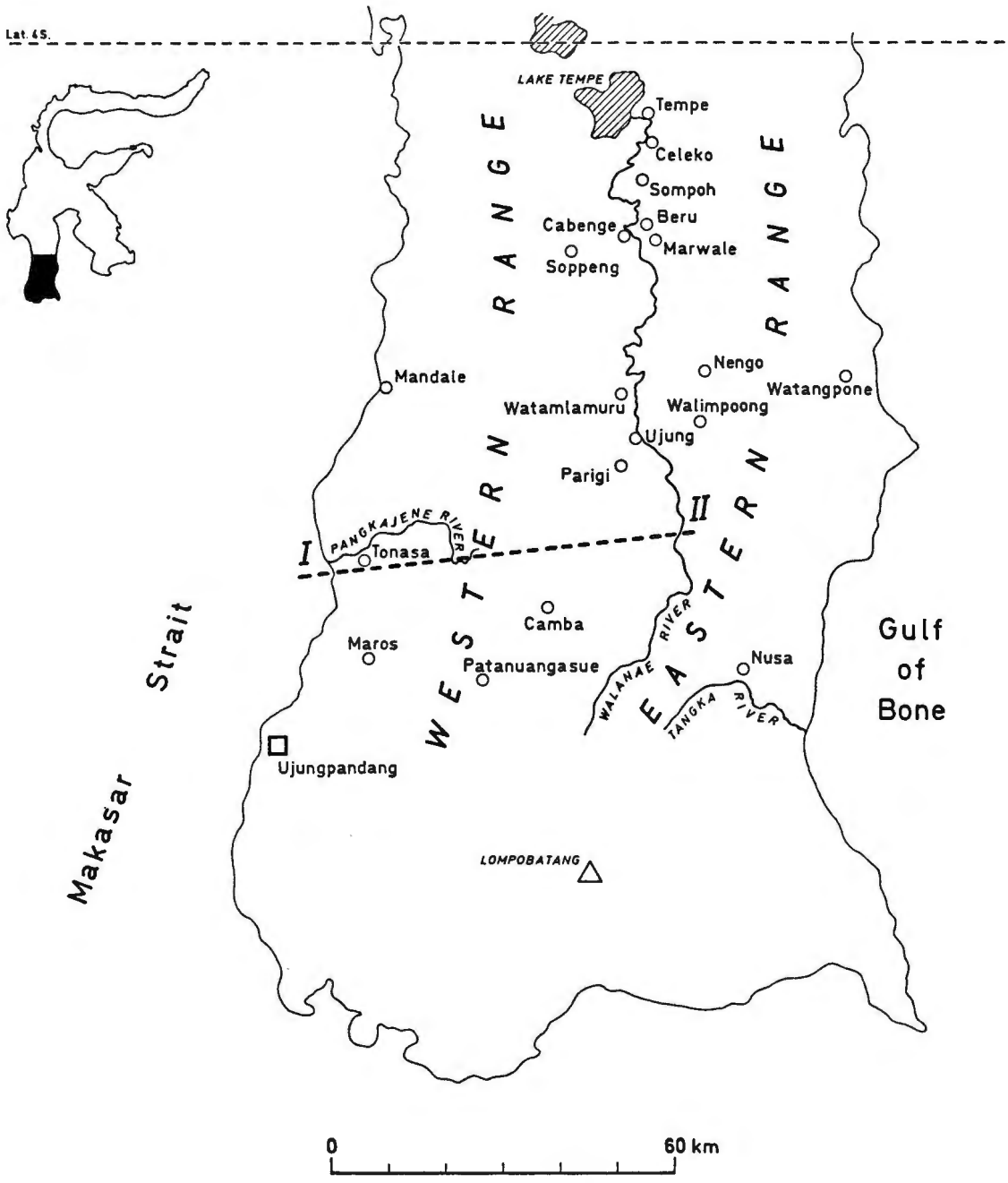


Fig. 1. Map of South Sulawesi. The dotted line I–II refers to the cross-section of fig. 2.

Walanae river; an eastern range (the Bone mountains) with the highest point at ± 800 M.; and then another coastal plain. The total width of this section is ± 100 KM. (see fig. 2).

The eastern and western mountain ranges merge in the south into a mountain region, from which as its peak the now extinct volcano of Lompobatang (± 3000 M.). In those mountains the river Walanae has its origin; from there it flows northwards towards Lake Tempe.

The width of the western coastal plain is varied. Near Mandale off-shoots of the western range reach down to the sea. But near Ujungpandang (Makasar), there is a very wide plain. A characteristic description is given by the well-known Wallace (1869): "The coast . . . is low and flat, lined with trees and villages so as to conceal the interior, except at occasional openings, which show a wide extent of bare and marshy ricefields" (p. 211).

South Sulawesi is rich in volcanic deposits. Some traces of this are found already in the western coastal plain, in the form of marine leucite-tephrite tuffs, known as "kuri-stone", and first described by Wichmann (1890).

More to the north, in the river Pangkajene, one of the numerous rivers running down from the western range, Wichmann also found boulders of leucite-basalt, so that he was the first to show the dispersion of alkaline rocks on South Sulawesi. Later, Schmidt (1901), who was processing rock samples of the Sarasins, reported from the vicinity of the Lompobatang, trachydolerite, phonolite and shonkinite. Brouwer (1924) also describes shonkinites from the vicinity of Patanuangasue. In the western range, however, alkaline rocks are in the minority.

Besides leucite-basalt Wichmann also describes other kinds of pebbles found in the Pangkajene river, namely crystalline schists. It appears that on the upper reaches of the river, on the west side of the western range, various schists have been exposed. This has become clear in particular from the investigations by 't Hoen and Ziegler, although Bücking (1902) should be mentioned, who found the solid rock of the schists formation along the Pangkajene river, where Wichmann only mentions the river pebbles. 't Hoen and Ziegler consider the crystalline schists to be the oldest formation in the stratigraphy of South Sulawesi.

A (see fig. 2 and 3) consists of strongly-folded quartz-, mica-, glaucophane- and chlorite schists, together with gneisses and serpentine. These schists are followed by siliceous shales and quartzites: B. And on top of these lies formation C, consisting of shale, graywacke, and arkose. This formation is synorogenic, consisting of erosion remnants from the oldest mountain range.

D, also exposed in the upper reaches of the Pangkajene river, is separated by an unconformity from the underlying clastic sediments. Formation D had the special interest of 't Hoen and Ziegler, as it promised to be of economic interest, due to the occurrence of coal. For actually 't Hoen and Ziegler were in South Sulawesi to do mine-prospecting. The layer of coal, however, proved not to be very thick.

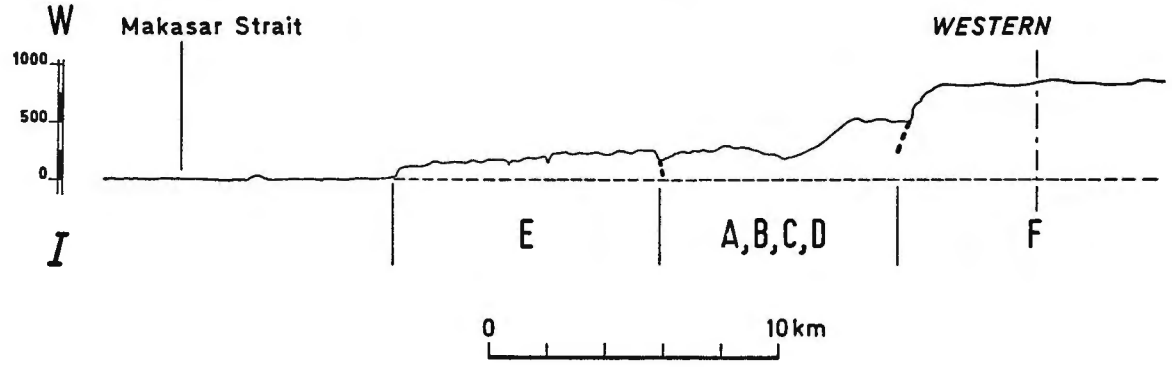
At the base of D we find conglomerates, there on yellow sandstones and shales with intercalations of coal. The entire formation is slightly folded. 't Hoen and Ziegler give no definite data on the thickness of D, but in some places it goes beyond 1000 M. Important in D is the first occurrence of tuff-layers, indicating the beginning of the enormous volcanic activity evidenced by the main body of the western range.

E is a very marked Palaeogene deposit in the western range: a very compact, massive limestone formation of a marine facies, mostly without distinct stratification. East of Maros, for instance, these limestones rise suddenly with very steep walls out of the surrounding countryside. They rest conformably on D.

Already in the middle of the last century the occurrence of *Nummulites* in these limestones was pointed out (van Dijk, 1858). These fossils account for the name "Nummulinidenkalksteen", which 't Hoen and Ziegler gave to E.

From the most recent limestone deposits remnants of fish and a terrestrial flora were found, which Brouwer (1924; also: Brouwer and de Beaufort, 1923) collected near Patanuangasue. The fossils were found in lighter-coloured layers, which are embedded in the "Nummulinidenkalksteen" and which, in contrast to the latter, do not contain Foraminifera. It is assumed that these lighter-coloured limestones are the result of erstwhile sedimentation in lagoons of overgrown coral islands.

In E tuff lenses occur locally, from which it can be deduced that the volcanic activity begun in D was continuing.



However, the volcanism reached its climax in the Lower Neogene, as is evidenced by the more than 1000 M. thick eruptive series F (Tnv on the GMSS). As stated previously, the main body of the western range was formed at this time. The alkaline rocks mentioned above are for the most part of a more recent date: thus the phonolite of the Peak of Maros goes through the tuff-breccias of F.

On the GMSS some KAr-dates are mentioned of igneous rocks of the western range, which dates are given by the Indonesian Gulf Oil Company; e. g. a basalt from Tonasa yielded a date of 17.7 million years, and an augite-basalt from Camba a date of 7.5 million years.

The main body of the eastern range also dates from the Lower Neogene. In these mountains A, B and D are not exposed: they lie buried everywhere under the thick volcanic series. On the west side of the mountains near Walimpoong, however, formation C is exposed (graywacke), while southward a kilometer-wide strip of "Nummulinidenkalksteen" (E) extends (see fig. 1 and 2).

Walanae Formation

G (Tms on the GMSS; "Celebesmolasse" to the Sarasins, 1901 and 1905) is a formation of clayey, sandy, gravelly and partly tuffaceous material, named Walanae or Bone Formation by 't Hoen and Ziegler. This formation is folded everywhere. East of Lake Tempe, and then southward to beyond Marwale, there is a distinct anticline (already described by Wichmann in 1890).

During the sedimentation of the Walanae Formation the main bodies of the western and eastern range had already been formed, and G therefore first of all is the filling-up of the basin between the two land ridges. G has a predominantly marine character; only in the youngest deposits does a terrestrial facies occur.

Exposures of G should be sought in the present valley of the Walanae river. 't Hoen and Ziegler point first of all to the east side of the western range, where there are blue calcareous clays in several places, which belong to G. Sometimes conglomerates of igneous rock are embedded in these clays, which become scarcer as one gets further away from the mountains, as is to be expected if the Walanae Formation consits of the detritus of older land ridges. The blue clays are rich in marine gastropods.

In the Walanae plain 't Hoen and Ziegler mention the following exposures (p. 260, etc.):

Near Watamlamuru, north of Ujung, one can see in a small tributary of the Walanae river calcareous strata and tuffaceous layers of a sandy-calcareous composition, as well as blue clay.

Near Parigi, south of Ujung, soft, dun-coloured breccia-like tuffs are exposed, which show a slight eastward dip and rest on a tuffaceous sandstone.

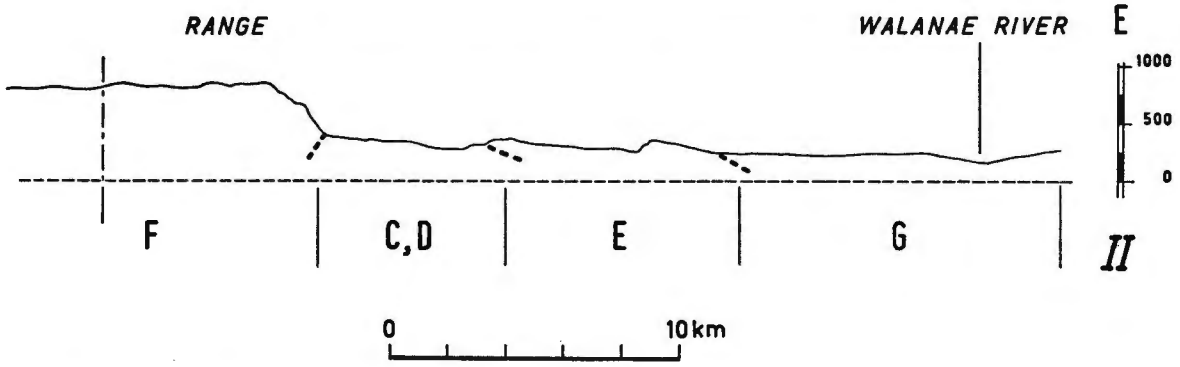


Fig. 2. Cross-section of the western part of South Sulawesi. Partly after 't Hoen and Ziegler (1915 [1917]).

In the southern part of the Walanae valley near Nusa, G is characterised by a terrestrial facies. According to 't Hoen and Ziegler fine, white quartzcontaining tuffs are exposed at the surface, with a distinct stratification and with petrified wood. Underneath we find a ten meters' thick sediment of grey shales, with here and there lignite lenses. In the shales one can find many leaf-prints. Underneath the shales, finally, there are once more the blue calcareous clays with marine gastropods, with in some places conglomerates of igneous rock.

These same deposits can be found in the bed of the Tangka river, situated south of Nusa.

In the northern part of the Walanae valley (north of Watamlamuru) the Walanae Formation is characterised, according to 't Hoen and Ziegler, by sandy clays and sandstones, from which in some places a less eroded, sandy conglomerate emerges (p. 277). The deposits are held to be less tuffaceous than in the south.

A look at the geological map of South Sulawesi drawn by 't Hoen and Ziegler and added to the report of their field work, shows that the area surrounding the lower reaches of the Walanae river has hardly been explored by the two mining engineers. Compared with their detailed description of the south, their information on the northern part of the Walanae plain is only superficial. But it is precisely in that area that Van Heekeren towards the end of the forties made his striking discoveries of remains of an extinct vertebrate fauna, together with primitive-looking stone artefacts.

The first official report on the discoveries on Sulawesi was written by Hooijer (1948a). He had from the first occupied himself with the new fossils, and he begins his series of articles on the Pleistocene vertebrates from Sulawesi with a description of a huge suid, named *Celebochoerus heekereni,* thus honouring Van Heekeren, the first hunter of this fossil pig.

Announcements by Van Heekeren himself appeared one year later. In these Van Heekeren says (1949a) that some kilometers east of the town of Cabengè at the lower reaches of the Walanae river, Pleistocene strata have come to the surface through erosion and movements of the earth, from which fossil bones and molars as well as artefacts are washed out. The exposed strata could be followed as far as the town of Sompoh, some ten kilometers north of Cabengè (p. 109). In later publications Van Heekeren mentions two other localities: the small village of Beru, situated directly east of Cabengè, and Celeko, eight kilometers north of Sompoh.

The finds made in the forties are all from the surface; but Van Heekeren was convinced from the very beginning that fossils and artefacts had their origin in the Pleistocene strata. The first indications concerning the nature of these strata are to be found in Hooijer (1948b and c; 1949a and b). A right scapula of the giant land tortoise *Testudo margae* (now: *Geochelone atlas,* Hooijer, 1971, p. 505), which came from

QUATERNARY	H	Riverterraces. Formation of marine deposits in the Tempe depression. Growth of coral reefs (?). Probable formation of a part of the alkaline rocks and of the kuri-stone (leucite-tephrite tuff near Ujungpandang).
		Unconformity
upper TERTIARY	G	Folding and denudation. Deposition of terrestric sediments during the younger phase, and marine sediments in the older phase.
	F	Formation of eruptive breccias, tuffs and lava flows. Thickness of the volcanic formation is at least 1000 m.
lower TERTIARY	E	Formation of paleogene limestones. Continuation of the volcanic activity.
	D	Formation of the coal-sandstone series, beginning of volcanic activity. Basal conglomerates.
		Unconformity
pre- TERTIARY	C	Folding and denudation. Formation of soft shales, graywackes, and arkose.
	B	Deposition of quartzites and Radiolaria-bearing siliceous shales.
	A	Deposition of sediments, which have been altered into regional metamorphic crystalline schists (gneisses, quartz-mica-glaucophane-chlorite-hornblende schists, serpentine).

Fig. 3. Stratigraphy of South Sulawesi. Partly after Van Bemmelen (1949).

Beru, was embedded in a matrix "consisting chiefly of calcite grains of irregular form and containing grains of quartz and also some alkaline felspar" (1948b, p. 1169). Exactly the same matrix was found on four teeth of the pygmy buffalo *Anoa depressicornis* from Sompoh (1948c, p. 1323), though with more felspar and less quartz (1949b, p. 149). But a right upper molar of the dwarf *Archidiskodon celebensis* (now: *Elephas celebensis*, e. g. Hooijer, 1975, p. 40) from Sompoh was found in a different matrix of "detrital grains of lateritic sandstone, the interstices partly filled with amorphous limonitic silica and opaque components. There are some pieces ouf quartz and veins of rhombohedral calcite. The volcanic components consist for the greater part of diopside and a few crystals of alkaline felspar" (1949a, p. 205).

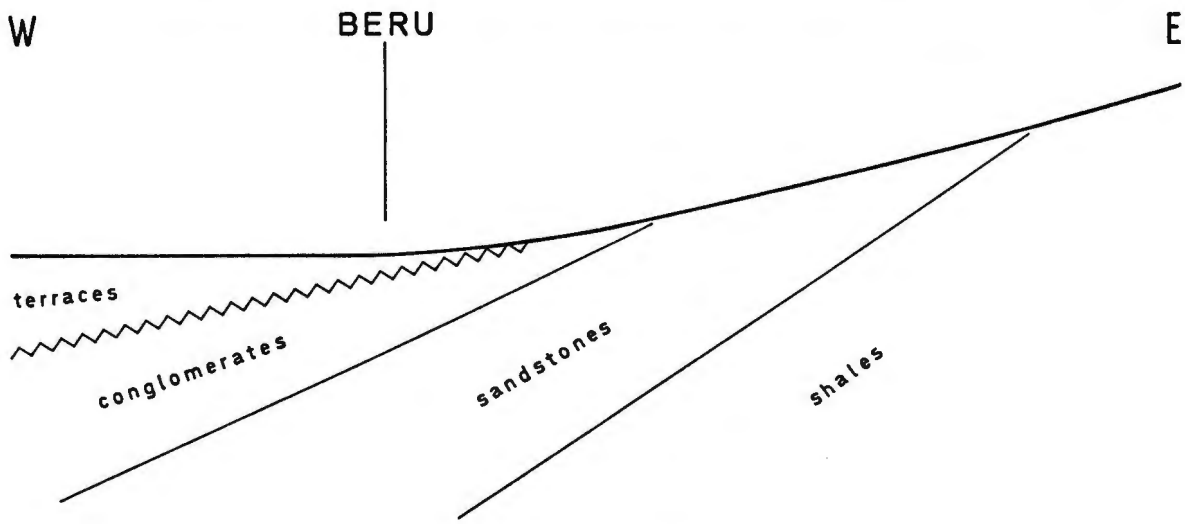


Fig. 4. Profile near Beru.

When in 1950 Van Heekeren's fieldwork had to be stopped because of political unrest, it had therefore been demonstrated that the fossil vertebrates from Sulawesi collected from the surface had their origin in river-laid sediments; the matrix analysis further showed that in those sediments there are at least two bonebearing beds.

If one takes the road running eastward from Cabengè to Watangpone, one can find after the village of Beru on both sides of the road outcrops of cemented conglomerates and sandstones. These sediments belong to the Walanae Formation, as described by 't Hoen and Ziegler (G in fig. 3). A closer investigation reveals that in general the clastics become finer as one goes further up the western flank of the aforementioned anticline, which can be observed from Lake Tempe to beyond Marwale (fig. 4). The fact that these clastics become finer, is due to the change of facies within the Walanae Formation, which forms the sedimentation in a gradually filled-up basin. From the oldest to the most recent sediments we see a variation from bathyal to neritic, to terrestrial facies, with a corresponding stratigraphy of shales underlying sandstones and sandstones underlying conglomerates.

A careful examination of the cemented coarser clastics east of the village of Beru, however, shows these sediments to be fossiliferous. The top layers of the Walanae Formation contain the fossil remains of a vertebrate fauna, which at one time must have populated the continent around the ever-shrinking inland sea which formerly existed in South Sulawesi. In any case these top layers form one of the bonebearing beds whose existence was demonstrated in Hooijers's announcements on matrix analysis.

As to the precise age of these top layers, very little can be said. The Walanae Formation as a whole is considered by 't Hoen and Ziegler to be Neogene (Upper Miocene and Pliocene; p. 268). That age is also given on the GMSS, on the basis of the occurrence of *Globigerinoides obliquus* and *Globigerinoides extremus*. However, these Foraminifera occur in the marine facies of the Walanae Formation, that is to say in the lower part. And actually we have every reason to assume that the top part of the Walanae Formation is Upper Pliocene or Lower Pleistocene. In this connection it should be pointed out that the sediments of the Walanae Formation can be divided into further rock units (shale-, sandstone-, conglomerate unit), which, however, have no significance as time-stratigraphic units. When one keeps in mind the idea of the filling-up of a basin and realises that the present village of Beru is situated in a place

which was more or less in the middle of the former inland sea, one must come to the conclusion that the coarse clastics near Beru have to be younger than the coarse clastics found more southward.

A major aim of a future expedition to South Sulawesi must be to obtain suitable samples for the calibration of the different lithological units of the Walanae Formation by radiometric methods. The possibilities exist, due to the prolonged Tertiary and Quaternary volcanism in South Sulawesi. The aforementioned exposures of the Walanae Formation mentioned by 't Hoen and Ziegler may serve as starting-places in the search for sampling-localities.

Younger deposits

All deposits which from a stratigraphical point of view are younger than the Walanae Formation should be considered as belonging to H (Qual on the GMSS). These include first of all the marine clays along the lower reaches of the Walanae river and around Lake Tempe. The clays point to a marine transgression which must have taken place after the regression of which the Walanae Formation is the evidence. Wichmann (1893) already describes the clays and mentions a deposit of "Tausenden von Austernschalen", and remains of *Spondylus* and *Cidaris* north-east of the village of Tempe, "am Westabhang des Sandsteinrückens" (p. 282). Furthermore, Wichmann mentions molluscs and corals along the lower reaches of the Walanae river (exact localities are not given) with, e. g., *Ostrea, Arca* and *Cypraea*. These two last genera of Lamellibranchiata are also mentioned by 't Hoen and Ziegler from the clays around Lake Tempe (p. 266).

H may also include the young coral limestones found in the region north of the volcanic main body of the eastern range, and which 't Hoen and Ziegler describe as the large limestone complex of Bone (p. 277; not to be confused with the aforementioned occurrence of "Nummulidenkalksteen" [E] at the west side of the eastern range).

Near Nengo these limestone have been shaped into round conical hills (conekarst; partly bioherms?). Rutten (1927) assumes that these limestones lie unconformably on the deposits of the Walanae Formation (p. 545). Van Bemmelen (1949) supports him in this view (p. 435). 't Hoen and Ziegler, however, are not absolutely convinced that there is an unconformity here and suggest that these coral reefs still partly belong to G (p. 263). On the GMSS this Bone limestone is also indicated as a reef limestone facies of the Walanae Formation (Tms).

In any case H includes the river terrace deposits which can be observed along the Walanae, such as east of Cabengè. In his earlier publications Van Heekeren places near Beru seven terraces (e. g. 1957, p. 51; 1958 [1960], p. 77). Later, partly as the result of a revisit to the Beru area in 1968, he reduces that number to five (1972, p. 66). But even this number is open to discussion. It is quite possible that the actual number of terraces near Beru is no more than three or four. The terraces are heavily dissected, and accidental steps in the road from Beru eastward do not necessarily correspond with distinct scarps and flat treads in the fields on either side of the road. Generally speaking, the tracing of a system of terraces on the basis of surface heights, as done by Van Heekeren, is of little signicance. With such a procedure, the chances are that one creates a variety of levels which in no way reflects the actual number of terraces. Due to erosion, the original terrace surface will only rarely be visible. The highest terrace deposits around Beru are really only recognisable in hills covered with coarse gravel. The maximum height of these hills is around forty meters above the mean water-level of the Walanae river.

Not all gravels in the fields around Beru are terrace deposits, however. There are also gravels which form the residue of consolidated top layers of the Wananae Formation which have been eroded away. To this difference between the gravels, so important with regard to their origin, no attention has as yet been paid. Nevertheless, the distinction is highly important: it is the key to determining the relative ages of fossil vertebrates and artefacts.

Van Heekeren has always situated the bone-bearing beds indicated by Hooijer within the terrace system of the Walanae river. Even when, after a revisit to the Beru area in 1972, he states that not all fossils are surface finds, but that some of them have their origin in conglomerates and sandstones, he still means by these clastics: terrace deposits (pers. comm.; cf. 1972, p. 66).

Fossil vertebrates are indeed found in the highest terrace fills along the Walanae river. But these terrace deposits should be clearly distinguished from the toplayers of the Walanae Formation, which, as we mentioned before, are also bone-bearing. The difficulty in the Beru area lies in the fact that all these fossiliferous deposits may occur in the form of exposed gravels, which at first sight can hardly be differentiated. In places where the coarse clastics of the Walanae Formation are still consolidated, the difference from the loose terrace fill is, of course, much more distinct.

The vertebrate remains from the upper part of the Walanae Formation are indicated here by: G-fossils; the remains from the terraces by: H-fossils; G- and H-fossils together form the well-known *Archidiskodon-Celebochoerus* fauna.

Another aim of a future expedition should be to find out whether the H-fossils are autochthonous, or partly or wholly allochthonous, i. e. whether they form in fact derived and redeposited G-fossils. The very rolled condition of the rear end of an upper molar of *Stegodon trigonocephalus,* found during a terrace excavation near Beru in 1970 (Hooijer, 1972, p. 10), may be an indication that the true parent-layer of this *Stegodon* should be sought in the upper part of the Walanae Formation. In any case, the *Archidiskodon (Elephas) celebensis* occurs in situ: in 1970 a complete skull was recovered from the Upper Walanae Formation east of Beru (Hooijer, 1972, p. 2; later wrongly indicated as a terrace find: 1975, p. 40).

Besides remains of fossil vertebrates, one also finds stone artefacts in the vicinity of Beru. Because Van Heekeren had never before found fossils and artefacts together in situ, he suggests with regard to an association only a careful "presumably of the same age" (1972, p. 69). But in fact there has never been any doubt in Van Heekeren's mind about the contemporaneity of fossils and artefacts (pers. comm.), as is also obvious from some of his publications (e. g. 1958 [1960], p. 79). Others have accepted this view of a contemporaneity (e. g. Soejono, 1975, p. 95; Hooijer, 1973, p. 12; Von Koenigswald and Ghosh, 1973, p. 30), while it is also found in the textbooks (e. g. Oakley, 1969, p. 253). The question arises whether fossils and artefacts are indeed contemporaneous and with wich bone-bearing beds the artefacts should be associated.

The expedition of 1970 has not yielded any evidence that the top layers of the Walanae Formation are implementiferous. Therefore, an association of the artefacts of the Tjabengè industry and the G-fossils cannot be considered. There is no reason to view the G-fossil *Archidiskodon (Elephas) celebensis* as younger than Lower Pleistocene, because this would be required by supposedly Upper Pleistocene artefacts (cf. Hooijer, 1949b, p. 148).

However, patinated flakes and cores are found around Beru in gravels belonging to the terrace deposits of the Walanae Formation, which, as mentioned above, do contain H-fossils. But it has not become clear during the excavations carried out in the highest terraces near Beru, whether these artefacts occur in the entire terrace fill, or whether they are only dispersed over the surfaces of the highest terraces. Among the expedition members there was considerable discussion about the question whether the flakes coming from the lower part of the excavation pits were artificial or not. When the artefacts occur only on the terraces and not in them, an association with the H-fossils is doubtful.

In conclusion we may say that the hypothesis posed in the literature concerning a contemporaneity of artefacts of the Tjabengè industry and fossils of the *Archidiskodon-Celebochoerus* fauna has not been verified. A reverse hypothesis is at this stage of research even more likely.

References

Bemmelen, R. W. van, 1949. The geology of Indonesia. The Hague. (2nd ed., The Hague 1970).

Brouwer, H. A., 1924. Geologische beschrijving der omgeving van de Tertiaire fossielrijke lagen nabij Patanoeang Asoe E in Z. Celebes. Jaarb. v. h. Mijnw. in Ned. Oost-Indië 1923, Verh., pp. 153–166.

Brouwer, H. A. & L. F. de Beaufort, 1923. Tertiaire mariene afzettingen met fossiele visschen van Zuid-Celebes. Versl. Kon. Akad. v. Wet. (Amsterdam) 32, pp. 33–40.

Bücking, H., 1902. Beiträge zur Geologie von Celebes. Samml. Geol. Reichsmus. Leiden 7, pp. 29–207.

Dijk, P. van, 1858. Over de waarde van eenige Nederlandsch Indische kolenterreinen. Nat. Tijdschr. Ned. Indië 15, pp. 149 ff.

Heekeren, H. R. van, 1949a. Voorlopige mededeling over Palaeolithische vondsten in Zuid-Celebes. Oudheidkundig Verslag (v. d. Oudheidk. Dienst in Indonesië) 1941–1947, pp. 109–110.

– 1949b. Early man and fossil vertebrates on the island of Celebes. Nature 163 (4143), p. 492.

– 1949c. Preliminary note on Palaeolithic finds on the island of Celebes. Chron. Naturae 105, pp. 145–148.

– 1957; 1972. The stone age of Indonesia. The Hague 1957; 2nd rev. ed. 1972 (= Verh. Kon. Inst. voor Taal-, Land- en Volkenkunde 21, resp. 61).

– 1958 (1960). The Tjabengè flake industry from South Celebes. Asian Persp. 2, 77–81.

– 1975. Chronology of the Indonesian prehistory. In: G. J. Bartstra & W. A. Casparie (eds.), Modern Quaternary Research in S. E. Asia. Rotterdam 1975, pp. 47–51.

't Hoen, C. W. A. P. & K. G. J. Ziegler, 1915 (1917). Verslag over de resultaten van geologisch-mijnbouwkundige verkenningen en opsporingen in Zuidwest-Celebes. Jaarb. v. h. Mijnw. in Ned. Oost-Indië 44, Verh. II, pp. 235–363.

Hooijer, D. A., 1948a. Pleistocene vertebrates from Celebes, I: Celebochoerus heekereni nov. gen. nov. spec. Proc. Kon. Ned. Akad. Wet. (Amsterdam) 51, pp. 1024–1032.

– 1948b. Pleistocene vertebrates from Celebes, II: Testudo margae nov. spec. Proc. Kon. Ned. Akad. Wet. (Amsterdam) 51, pp. 1169–1182.

– 1948c. Pleistocene vertebrates from Celebes, III: Anoa depressicornis (Smith) subsp., and Babyrousa babyrussa beruensis nov. subsp. Proc. Kon. Ned. Akad. Wet. (Amsterdam) 51, pp. 1322–1330.

– 1949a. Pleistocene vertebrates from Celebes, IV: Archidiskodon celebensis nov. spec. Zoöl. Meded. (Leiden) 30, pp. 205–226.

– 1949b. The Pleistocene vertebrates of Southern Celebes. Chron Naturae 105, pp. 148–150.

– 1971. A giant land tortoise, Geochelone atlas (Falconer & Cautley), from the Pleistocene of Timor, I. Proc. Kon. Ned. Akad. v. Wet. (Amsterdam), ser. B, 74, pp. 504–524.

– 1972. Pleistocene vertebrates from Celebes, XIV: Additions to the Archidiskodon-Celebochoerus fauna. Zoöl. Meded. (Leiden) 46, pp. 1–16.

– 1973. Reuzenschildpadden en dwergolifanten. Museologia I–X, pp. 9–14.

– 1975. Quaternary mammals west and east of Wallace's line. In: G. J. Bartstra & W. A. Casparie (eds.), Modern Quaternary Research in S. E. Asia. Rotterdam 1975, pp. 37–46.

Koenigswald, G. H. R. von & A. K. Ghosh, 1973. Stone implements from the Trinil beds of Sangiran, Central Java, I and II. Proc. Kon. Ned. Akad. v. Wet. (Amsterdam), Ser. B, 76, pp. 1–34.

Oakley, K. P., 1969. Frameworks for dating fossil man. 3rd. ed., London.

Rutten, L. M. R., 1927. Voordrachten over de geologie van Nederlandsch Oost-Indië. Groningen.

Sarasin, P. & F., 1901. Materialien zur Naturgeschichte der Insel Celebes, 4. Band: Entwurf eine geografisch-geologischen Beschreibung der Insel Celebes. Wiesbaden.

– 1905. Reisen in Celebes. 2 vols. Wiesbaden.

Schmid, C. 1901. Untersuchung einiger Gesteinssuiten, gesammelt in Celebes von P. und F. Sarasin. In: P. & F. Sarasin, Materialien zur Naturgeschichte der Insel Celebes, 4. Band: Entwurf einer geografisch-geologischen Beschreibung der Insel Celebes. Wiesbaden.

Soejono, R. P., (1975). Jaman Prasejarah di Indonesia, C. Teknologi. (= Sejarah Nasional Indonesia 1 (in print).

Wallace, A. R., 1869. The Malay Archipelago. 2 vols. 2nd ed. New York.

Wichmann, A., 1890. Bericht über eine im Jahre 1888–1889 ausgeführte Reise nach dem Ind. Archipel. Tijdschr. Kon. Ned. Aardr. Gen., pp. 921–994.

– 1893. Die Binnenseen von Celebes. Petermann's Mitteilungen 39, pp. 225–231, 253–259 & 277–282.