DESCRIPTIVE ANALYSIS OF PALAEOLITHIC STONE TOOLS FROM SULAWESI, COLLECTED BY THE INDONESIAN-DUTCH EXPEDITION IN 1970

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Abstrak. **Analisis Deskriptif Alat Batu Palaeolithik dari Sulawesi, Hasil Ekspedisi Indonesia-Belanda pada tahun 1970.** Studi ini menganalisis artefak temuan ekspedisi Indonesia-Belanda di tahun 1970 di Marale di hulu dan Beru di hilir Sungai Wallanae; termasuk menguji hipotesis bahwa penghalusan material kasar di hilir terjadi pada artefak kecil. Batu gamping, kersikan, dan rijang merupakan bahan yang dominan. Artefak umumnya mengalami abrasi dan pembundaran dari tingkat moderat hingga kuat. Hampir semua artefak terpatinasi. Teknik '*crushing*' merupakan tipe dominan dari persiapan bidang dorsal dekat dataran pukul. Dataran pukul umumnya datar dan ujung distal tipis. Himpunan serpih Marale yang umumnya lebih lebar dan panjang dibandingkan himpunan serpih Beru mendukung hipotesis tersebut. Kebanyakan alat serpih merupakan serut samping. Sebagai tambahan, berdasarkan klasifikasi morfologi yang baru diperkenalkan, umumnya batu inti (70%) memiliki platform tunggal, berbentuk *pyramidal* atau *polihedral*, walaupun ada yang *double platform*. Perkiraan pertanggalan van Heekeren dari 200 dan 100 ka agaknya tepat, sebagaimana publikasi van den Bergh yang mempertanggal artefak *in situ* dari ekskavasi di daerah yang sama di antara 194 dan 118 ka.

Kata Kunci: Sulawesi, Walanae, Palaeolithic, Alat-alat batu, Survei

***Abstract**. This study analysis lithic artefacts collected by the Indonesian-Dutch expedition to Sulawesi in 1970. In addition, the hypothesis was tested that downstream fining of coarse material results in smaller artefacts. The artefacts were collected by surveying in Marale (upstream) and Beru (downstream) along the Walanae River. Most artefacts were abraded and rounded. Almost all artefacts were patinated. Silificied limestone and chert were the predominant raw materials for making stone tools. Crushing was the predominant type of dorsal face preparation near the striking platform. The dominant platform type was plain and the dominant distal end feather. The width and the maximal length of the flakes of Marale were significantly larger than those of Beru, confirming the above hypothesis. Most flake tools were side scrapers. In addition to the functional standard classification also a new morphological classification was introduced. Most cores (70%) were single platformed, pyramidal or polyhedral, but also double platformed cores were present. Dating of the stone tools between 200 and 100 ka as earlier suggested by van Heekeren might be plausible based on a recently published study by van den Bergh (2016) who dated in situ artefacts excavated in the same region between 194 and 118 ka.*

***Keywords:** Sulawesi, Walanae, Palaeolithic, Stone tools, Surveying*

1. Introduction

1.1 General Introduction and Aim

In 1970 an Indonesian-Dutch expedition, headed by the Indonesian archaeologist Soejono, the Dutch archaeologist van Heekeren, and palaeontologist Hooyer, collected in a period of six weeks about 1100 lithic objects, predominantly by survey, in the Walanae

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depression in South Sulawesi. A treasure, kept at the National Research Centre of Archaeology in Indonesia (Pusat Penelitian Arkeologi Nasional) that was never studied in detail and reported so far. A recent publication of an excavation in the same area (van den Bergh et al. 2016), resulting in accurate dating of unearthed stone tools, highlights the importance of archaeological research in Sulawesi, and sheds a new light on the 'forgotten' assemblage of surface finds in 1970. This all strengthen the suggestion that Sulawesi may have played an important role in archaic island hopping of *Homo erectus* and the inhabitation of Flores that houses 1 Ma old stone artefacts (Brumm et al. 2010, 48).

The first Palaeolithic flakes in South Sulawesi were found by van Heekeren in August 1947 in Beru, in the beds of the river Walanae (Bartstra 1997, 31), together with vertebrate fossils. According to van Heekeren the flakes were identical to those from the Upper Pleistocene Notopuro layers in Sangiran, Java, and thus of Late Pleistocene age (Bartstra 1997, 33). Van Heekeren's surveys ended in 1949. In a posthumously published paper in 1975, van Heekeren stated that the stone implements from the surroundings of Beru, belonging to the so-called Palaeolithic Cabenge industry dated to the beginning of the Upper Pleistocene, somewhere between 200 and 100 ka. Van Heekeren associated the stone tools with those of *Homo soloensis*. Bartstra, who joined the Indonesian-Dutch expedition in 1970 as a student, showed in 1977 that the fossils and artefacts were not contemporaneous, as the above fauna in contrast to the artefacts occurred *in situ* in the top-sediment of the bedrock. In 1978 there was a new expedition, in cooperation with the Indonesian Archaeological Service, financed by WOTRO, where the non-contemporaneity of artefacts and fossils, the latter being of late Pliocene-early Pleistocene date, was confirmed. In 1980 there was an expedition by the University of Groningen. In the eighties the area of Beru was visited each year by Bartstra. From 1987 till 1992 also short expeditions to the central part of Sulawesi were made. More recently, from 2009 on, Morwood and his team restarted excavations in the Walanae close to Cabenge, Beru and Marale. The results of these excavations, up to 10 m down, have recently been published (van den Bergh et al. 2016). They found many stone artefacts *in situ*, which based on thermoluminescence dating of the sediments were estimated to be between 118,000 to 194,000 years old. Their data confirmed the earlier estimations of van Heekeren and von Koenigswald (Bartstra 1997, 44, van Heekeren 1957).

Palaeolithic archaeology and palaeoanthropology in Indonesia focus predominantly on the hominin fossils and dating of these fossils using chrono-, litho- and biostratigraphic methods, in order to learn about the distribution and evolution of *Homo erectus* and *Homo sapiens* in Indonesia and his environment. There is lesser focus on lithic material culture, in contrast to Europe where much is known about the technological systems of Palaeolithic. With studying the lithic artefacts of the 1970 survey in South Sulawesi the authors hope, in addition to extract the collection from oblivion, to contribute to a broader research question about what kind of lithic technological production systems were applied in Indonesia by early hominins, and what the variability might have been during the Palaeolithic of Indonesia, between 1.6 Ma and 50 ka. One marker of variability is size, which may depend on the size of raw material present. As the latter decreases if found in stream downwards, it is hypothesized that also artefacts at more downstream sites are smaller than at more upwards sites. This was shown by van Biggelaar et al. (2016) for a Dutch river system.

The aim of the study was to analyse the stone artefacts collected in South Sulawesi in 1970, morphometrically and technologically. The additional aim was to test the above hypothesis for artefacts found more stream upwards and downwards along the Walanae River.

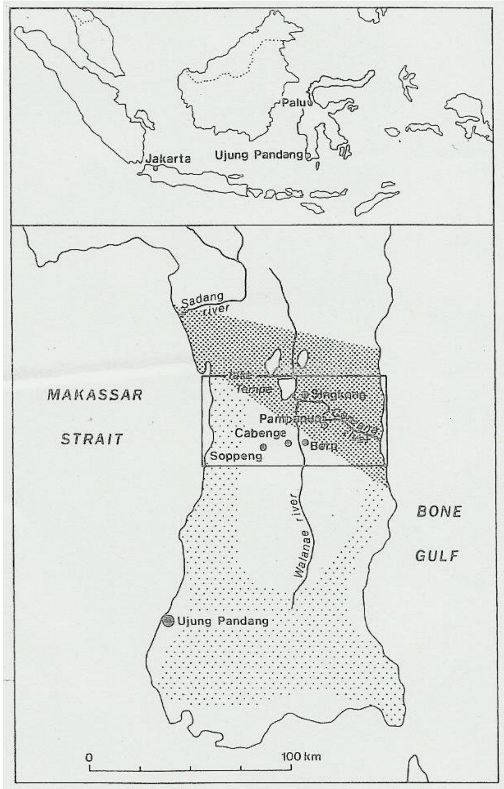
The specific research questions for this study were:

1. How many artefacts, incertofacts and geofacts are present in the collection?
2. What type of raw material was used for the artefacts?
3. What are the post-depositional, technical, metrical and typological characteristics of the artefacts?
4. Is there a difference between the artefacts of the sites Beru and Marale, with Beru located a bit stream downwards compared to Marale along the beds of the Walanae River in South Sulawesi?

1.2 The Palaeolithic of South Sulawesi

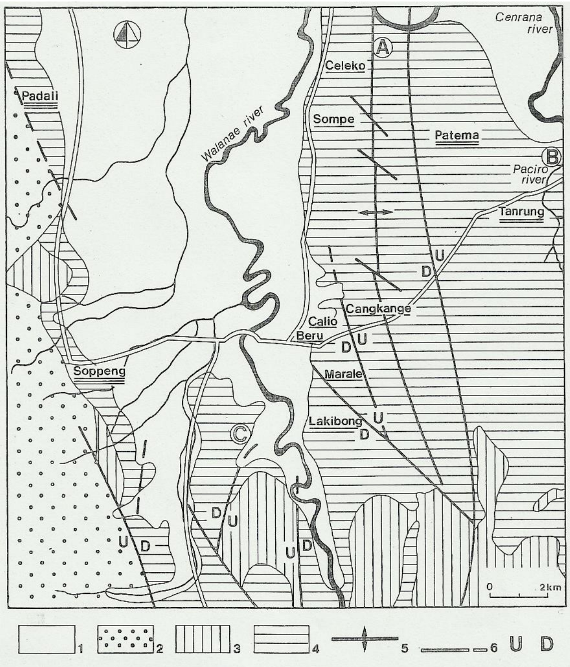
1.2.1 Geology

Geologically, Sulawesi Island is a complex region. The complexity is caused by three lithospheric plates: the northward-moving Australian plate, the westward-moving Pacific plate, and the south-southeast-moving Eurasia plate. Sulawesi is divided into three geological provinces: the Western Sulawesi Volcanic Arc, the Eastern Sulawesi Ophiolite Belt, and continental parts derived from the Australian continent. South Sulawesi, belonging to the first geological province, is structurally separated from the rest of the Western arc by a depression, the lake Tempe. The region of the various Palaeolithic finds lies directly south of this Tempe depression, extending from the mouth of the River Sadang to the mouth of the River Cenrana (Map 1). Till recently this depression was covered by sea. The drainage area of the River Walanae draining into the Lake Tempe is called Walanae depression (Bartstra et al. 1994). The area consists of river terraces, 4 or 5 levels. At the third and fourth levels, respectively 50 and 75 m above sea level, the artefacts described in this paper were found. Outcrops in the landscape, consisting of consolidated sandstones and conglomerates, form the bedrock of the region and have nothing to do with the terrace sediments. It is part of an anticlinal sandstone ridge, north south orientated, with marine fossils, a basin fill of Neogene age (Map 1 and 2).



Map 1. Southwestern Peninsula of Sulawesi. The shaded area is the Tempe depression, the dotted area is of Neogene age and the area within the rectangular is the main area of artefact and fossil finds (Source: Bartstra et al. 1994)

According to geologist Rutten (Bartstra et al. 1994, 6) the formation is at least 3000 m thick. The folding took place around the transition Pliocene to Pleistocene, after which denudation occurred. These filled basins are characteristic for many places, as a great part of the archipelago was under sea. During the Miocene the very south part of South Sulawesi was a U-shaped island, enclosing a sea, the present Walanae depression, where the sediments of the Walanae Formation developed. The silting up of the basin started in the south where fluvial deposits can be found, while in the surroundings of Beru still marine deposition



Map 2. The sites Beru and Marale. 1. Alluvial; 2. Volcanic rock; 3. Limestone; 4. Wallanae Formation; 5. Anticline; 6. Fault line; U. Up; D. Down. The volcanic rock, limestone and the greater part of the sediments of the Wallanae Formation are Tertiary in age. The alluvial deposits are mainly Holocene (Source: Bartstra et al. 1994)

took place. The area around Beru was the last area of the former sea to become dry. Therefore, non-marine (deltaic and fluvial), mixed marine/ non-marine and near shore marine deposits can be found there. The Walanae Formation includes all successive sequences of clastic sediments which is the bedrock in the Walanae depression. On the top of the Walanae Formation, Bartstra recognized a Beru member, estimated 300-500 m thick, characterized by its fossil vertebrate content (Bartstra et al. 1994). Although lithologically difficult to define it is clear that the Beru member reflects a rather restricted local depositional environment. At some locations the sediment layers of the Beru member were almost folded vertically during the Plio-Pleistocene. Sartono, on basis of foraminifera content, dates the vertebrate bearing sandstone to the Upper Pliocene, while Hooijer, on basis of the fossils, dates the layers to the Lower Pleistocene (Bartstra et al. 1994, 11). *The Archidiskodon-Celebochoerus* fauna (Fig. 2) has an endemic typical insular composition, characterized by both dwarfing and giantism. Since 1974 the name *Archidiskodon* has been replaced by the name *Elephas celebensis*. This is a pigmy species of maximally 1.5 m high. Another pigmy *Proboscid* was *Stegodon sompoensis*, almost 5 times smaller than the normal sized *Stegodan trigonocephalus*. The three-mentioned species lived simultaneously. According to Bartstra (1994, 14) these species have reached the North coast of Sulawesi swimming, because in case of a land bridge more vertebrate species should be found in the Beru member.

1.2.2 Archaeology and Palaeontology

The fauna of Sulawesi is a mixed continental Asian and Australian fauna, so in ancient times the island must have been reached via land or by crossing the water. However, Sulawesi, as part of a volcanic arc, is separated at the west from the Sunda shelf and at the east from Sahul land. It is not clear whether a land bridge with continental Asia has existed during glacial periods. If so then the only possibility is a land bridge with the Philippines. From 1947 onward stone tools have been found in the region of Cabenge in South Sulawesi in the Walanae Valley (Map 1). Presently a small museum can be found in Calio which has a nice collection of these earlier and later stone artefacts (Fig. 1). The tools found at the higher terraces were of indeterminate Pleistocene age, ascribed to *Homo erectus* or even *Homo sapiens* (Belwood 2007, 66). At the lower terraces of the river Wallanae, Toalian-typed tools were found belonging to the Holocene. Anatomically modern humans may have populated the region as early as 50.000 BP. Bellwood (2007, 93) mentions three populations who reached Indonesia at different times: Barrineans (African source, 40 ka), Murrayians (Ainu source, 20 ka), and Carpentarians (from northern Australia, southern Indian source, 15 ka). South Sulawesi is well known because of

Figure 1. Prehistoric Museum in Calio with collection of local Palaeolithic stone tools (Source: Alink 2015)

the pre-ceramic sequences of late Pleistocene and Holocene tool working.

In the Maros region many cave sites have been excavated since 1902, producing assemblages consisting of backed flakes and microlites known as Toalian, dating 7000 years ago (Bellwood 2007, 193). Later in the Maros shelters of Leang Burung and Ulu Leang unretouched flakes and multiplatform cores have been found in levels dated between 29 and 17 ka ago (Bellwood 2007, 184). Some cave paintings in the Maros region have recently been dated at around 40.000 BP (Aubert et al. 2014).

The fossil material contained many remains of large pigs, *Celebochoerus heekereni*, with characteristic large canines (Fig. 2). In addition, a large land turtle, *Testudo margae*, was found.

At that time the fossils were associated with cemented conglomerated sandstone sediment dating to the Tertiairy. Now it is assumed that the vertebrate fossils from the Walanae valley originate from the upper part of the Walanae Formation, which is Late Pliocene, and possible Lower Pleistocene. But the discussions are still going on (van den Bergh et al. 2001). The fossils are from a rather complicated and eroded terrace system, consisting of three rivers and four sea terraces. Although Wallace suggested between Bali and Lombok the so-called Wallace line, splitting between Asiatic more advanced mammals and Australian more primitive vertebrates, like platypus and marsupials, the mixed Asiatic Australian fauna, with monkeys, buffaloes and pigs from Asiatic origin plead for a land bridge between the Asia mainland and Sulawesi. Also, the presence of a pigmy elephant is an argument for this. The only possibility is a land bridge between the Philippines and Sulawesi, due to the very deep Makassar Street between Borneo and Sulawesi. Also, the theory of overseas dispersal is considered as a possibility to explain the fossil *Archidiskodon-Celebochoerus* fauna of Sulawesi. Bartstra et al. (1994, 1) suggested that hominins might have sailed from Sundaland to the island Sulawesi. Concerning the artefacts found in the Walanae valley it was concluded that these artefacts had to be dated in the late Middle or early Upper Pleistocene. Van Heekeren was talking about

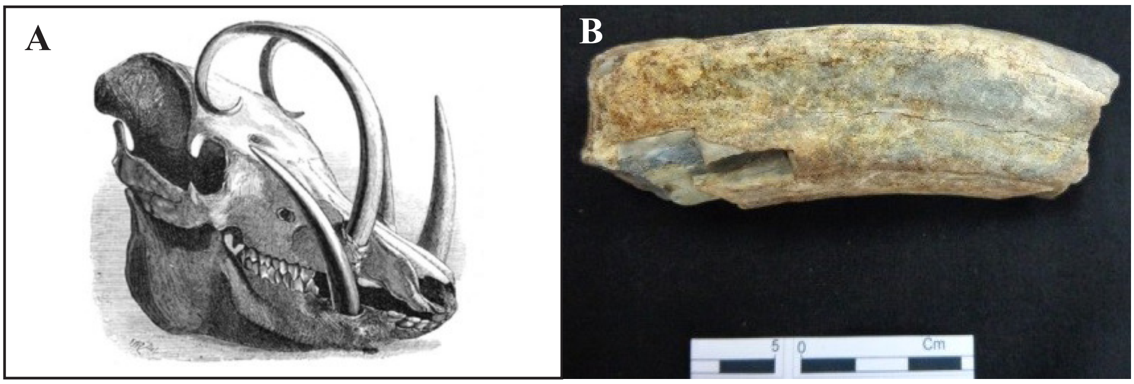


Figure 2. a) *Celebochoeres heekereni*, an extinct pig with large canines, looking like the present *Babyrousa celebensis* (http://darrennaish.blogspot.nl/2006/08/deer-pig-raksasa-only-living.html) b) part of *Celebochoeres canine* in the Beru-Marale collection of 1970 (Source: Alink 2015)

flakes in Clacton style with a large flaking angle and a non-faceted, plain striking platform. He mentioned these artefacts as belonging to the Cabenge industry, after a village where the first finds were done. According to Bartstra (1997) the sandstones mentioned by van Heekeren have nothing to do with the sediments, and are much older. The vertebrate fossils and artefacts come from loose terrace gravels. Van Heekeren could not produce evidence that the artefacts were coming from the sediments.

Van Heekeren and Hooijer hoped to find remains of Pleistocene humans in Sulawesi. Van Heekeren's surveys ended in 1949; in 1950 he left for Jakarta. He got a temporary job as curator of the Prehistoric Department of Museum Nasional. He went back to the Netherlands in 1956. In 1970 van Heekeren, Hooijer and Bartstra took part in the Joint Indonesian-Dutch Sulawesi Prehistoric Expedition (Fig. 3). Soejono, who was a previous student of van Heekeren, became head of the Prehistoric Department of the Archaeological Service after the return of van Heekeren to the Netherlands. Van Heekeren developed a working hypothesis that east of Cabenge fossils and artefacts are equally old and date from the Pleistocene. He thought that there was a good chance of finding *Homo erectus* in that area.

The above mentioned expedition lasted more than 6 weeks in June, July and August in 1970. All artefacts were labelled with site information; however, the provenance of the raw material is unknown. Unfortunately, there are no available documentation and no day or week reports left with information about the survey area or survey method. During the expedition no remains were found of *Homo erectus*, but a lot of fossils and artefacts. The many molars that were found appeared to be from suids (Artiodactyla) like *Celebochoerus heekerini*. Van Heekeren died in 1974. According to Bartstra van Heekeren was working on a monograph about the expedition, possibly prepared in the fall of 1970 for the WOTRO, but only a few notes and introductory pages have been realized. The contents page suggested that the monograph would have been substantial (Bartstra et al. 1994, 3).

Figure 3. From left to right: Hooijer, van Heekeren and Bartstra (Source: Alink 2015, Calio Museum)

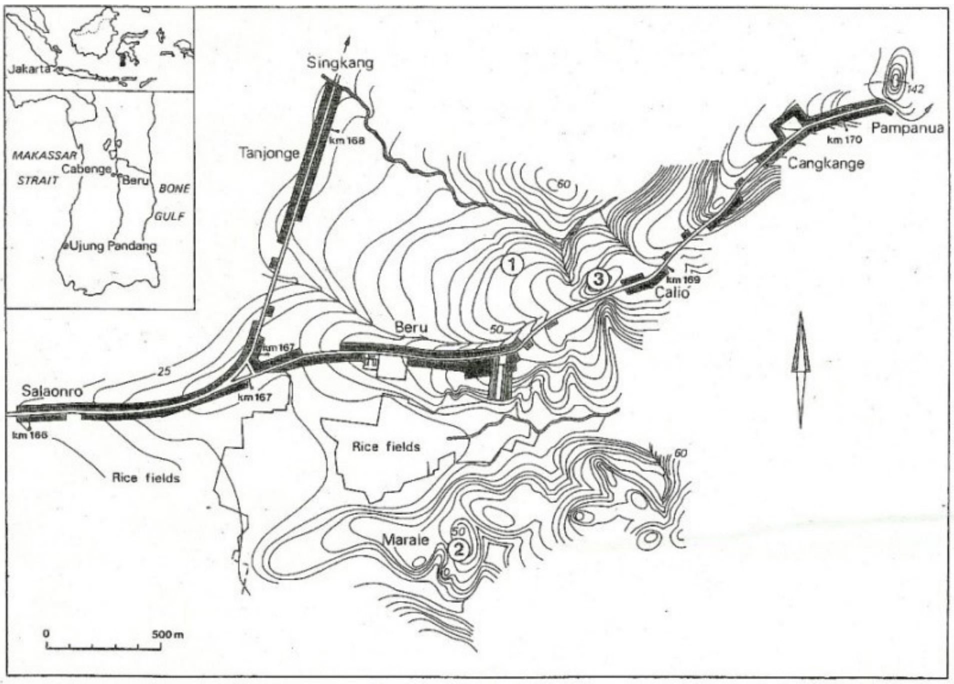
Bartstra associated the Cabenge industry with early *Homo sapiens* (Bartstra et al. 1994). Van Heekeren believed (also in his book of 1972) that the stone artefacts and the remains of the *Archidiskodon-Celebochoerus* fauna were of the same age. Bartstra showed that the fossils and artefacts were not contemporaneous as the Palaeolithic artefacts of the Cabenge industry could only be associated with the terrace gravels and not with bedrock. According to Sjahroel, geologist during the expedition, there were Pliocene-Pleistocene beach gravels in coarse clastics that were thought to be Upper Pleistocene by Bartstra.

From a later expedition Keates and Bartstra (1994) described 28 artefacts of the sites Beru and Marale. They were found at the terraces at 50 and 75 m above river level. The artefacts were very rolled and patinated, flake as well as core artefacts. Very few artefacts with no traces of abrasion were found in the proximity of the Walanae River. According to Keates and Bartstra (1994) the geomorphology of the terraces indicated a Late Pleistocene age. Based on flake and core tool technology three groups were recognized, two Late Pleistocene ones, one very abraded on higher terraces and one less abraded on the lower terraces. The third group, with small flakes and cores, and found at the higher terraces, was of Holocene and comparable with those in cave sites. Keates and Bartstra (1994) suggested an evolution towards a smaller size of the artefacts in northern Wallace depression comparable with what they saw in the Maros cave. Van Heekeren saw a parallel between the Cabenge and the Sangiran industry especially for the keeled flake blades. However, a technological parallel does not indicate necessarily a cultural or temporal relationship. According to Keates and Bartstra the Walanae technology is characterized by hard hammer percussion and preferential selection of fine-textured raw materials. Faceted striking platforms indicate rough core preparation but not *Levallois*. Keates mentioned uni and bifacial pebble and cobble artefacts, picks and pointed unifaces and bifaces (proto-handaxes and handaxes). However, these handaxes are different from the Acheulean handaxes in Europe and Africa. Flakes, especially the notched ones, might have been used for woodworking processes. An important role of non-lithic technology could explain the conservative and generally amorphous character of local lithic industries. The distribution of bamboo might have coincided with the distribution of choppers and chopping tools (Pope 1989; Keates and Bartstra 1994). According to them, modelling of hominid behaviour in the Far East solely by lithic technology disregards the consideration of the palaeo-environmental context. They state that some of the Walanae artefacts may be representative for the earliest phase of hominid occupation in Sulawesi.

2. Methods

2.1 Plan of Investigation

As a manner to study the artefacts it was planned to measure a number of variables according to the system used by De Loecker (De Loecker and Schlanger 2004), previously



Map 3. Detailed map of the sites Beru and Marale in South Sulawesi. The numbers 1, 2 and 3 refer to site locations with small excavations (Source: Keates and Bartstra 1994)

applied by the author on Middle Palaeolithic lithic complexes from the centre of the Netherlands (Alink 2013). Using this system would also make possible to compare the toolkit of *Homo erectus* with toolkits of early hominins in Europe, such as Neanderthals, and to learn about variability and possible evolution of the technical systems applied.

After selection of the artefacts out of all collected stone implements, flake blanks were described and analysed on the type of raw material, and on post-depositional, technological and metrical markers (see chapter 2.3). In addition, based on technological features the flake blanks were grouped into 8 different types as described under results (Table 12). Flake tools were described and analysed according to existing functional nomenclature (De Loecker and Schlanger 2004). Cores were also analysed based on existing typology, but in addition grouped into 4 different types according to technological markers (Table 14). A comparative study was made between artefacts from Beru and Marale to test the hypothesis that downstream fining of coarse material would result in smaller artefacts.

2.2 Sample Selection

The artefacts studied were from Beru or Marale. A detailed map of the location of the sites and the terraces is given in Map 3. A total of 1096 stone implements, collected during July 1970 on sites in Beru and Marale, were studied. First the collection was divided into artefacts, incertofacts or pseudoartefacts and geofacts. For artefacts most of the following marks needed to be present: percussion bulbus, striking platform, dorsal negatives (scars) and not too severely abraded. Incertofacts had just a few of these characteristics, while geofacts had none of these. Two sites were compared: Beru and Marale. Beru consisted out of 571 lithic objects, of which 433 were considered to be artefacts, 53 were incertofacts and 85 geofacts. Marale consisted of 525 objects, of which 431 were artefacts, 48 incertofacts and 46 geofacts.

2.3 Variables

The following variables were described and analysed: the type of raw material, post-depositional markers of abrasion or rounding, patina and fragmentation; the technological markers platform type, dorsal face preparation, dorsal pattern and distal end; and the metrical variables length, width and thickness. In addition, the artefacts were grouped into different typologies (see Results and discussion chapter). Table 1 gives an overview of the main variables and how they were measured.

Table 1. Overview of variables that were measured in flakes of Beru and Marale

Variable	Category
Patina	different colours
Rounding	absent-light, moderate, strong
Percentage cortex	0, 1-25, 26-50, 51-75 % on dorsal surface
Fragmentation	complete, proximal, medial, distal
Length, width, thickness	in mm
Platform Type	missing, outer surface, plain, faceted, retouched dihedral, polyhedral, punctiform, undetermined
Dorsal Face Preparation (near butt):	crushed, faceted/retouched, combination of both, no dorsal face preparation
Distal end	feather, stepped, overstruck, missing
Dorsal Surface Pattern	outer surface, natural fissure, plain, simple, convergent, radial, side, opposed, simple opposed,simple + side, undetermined

3. Results and Discussion

The total number of artefacts studied was 864. From the Beru site 433 artefacts were studied of which 236 (54.5%) were flake/flake tools, 131 (30.3%) core/core tools, and 66 (15.2%) flaked implements. From the Marale site 431 artefacts were studied of which 273 (63.3%) were flake/flake tools, 122 (28.3%) were core/core tools, and 36 (8.4%) flaked implements. A flaked implement was defined as an artefact that was clearly flaked but could not be placed in a flake or core category.

3.1 Raw Material

Most stones collected consisted of rounded cobbles of locally available silicified limestone, chert or flint (80 % in Beru, 84% in Marale). Among the artefacts it was even more (88% in Beru, 90% in Marale). This is in agreement with stone artefacts found elsewhere in the Indonesian Archipelago (Bartstra 1976). Other raw materials of which artefacts were made were andesite, jasper, basalt, chalcedony, limestone, sandstone and granite. The site Beru appeared to have a greater variety in raw materials than Marale, resulting in a slightly higher percentage of artefacts made of other material than silicified limestone, chert or flint. However, a number of raw materials collected in Beru, like quartz, quartzite and breccia turned out not or less to be used for artefacts production (Table 2). Another difference between Beru and Marale was that in Beru most artefacts were made of silicified limestone (40.2%) while in Marale chert was the predominant raw material (41.3%).

3.2 Post-Depositional Markers

The post-depositional markers studied were abrasion, patination and fragmentation.

3.2.1 Abrasion

Most artefacts were moderate (42-46%) to strongly (37-41%) abraded in Beru as well as in Marale. The number of strongly abraded artefacts was slightly higher in Beru (40.6%) than in Marale (36.8%) (Table 3). In both Beru and Marale 83% of the artefacts showed moderate till strong abrasion and rounding, probably due to river transport, as most of the artefacts were surface finds at the river terraces. The slightly higher abrasion in Beru than in Marale (36.8%) may indicate a longer river transport. Keates and Bartstra (1994) mentioned earlier the fluvial wear of artefacts found in the terrace gravel in the surroundings of Beru. This is a general phenomenon for lithic artefacts

Table 2. Raw material of all stones (including artefacts) and artefacts collected in Beru and Marale

	All stones				Artefacts			
	Beru		Marale		Beru		Marale	
	N	%	N	%	N	%	N	%
Slicified limestone	203	35.6	203	38.6	174	40.2	174	40.4
Chert	193	33.8	201	38.2	159	36.7	178	41.3
Flint	58	10.2	38	7.2	50	11.5	33	7.7
Andesite	21	3.7	11	2.1	11	2.5	6	1.4
Jasper	20	3.5	13	2.5	13	3	8	1.9
Basalt(ic)	13	2.3	11	2.1	9	2.1	11	2.6
Chalcedony	8	1.4	5	1	3	0.7	3	0.7
Limestone	12	2.1	17	3.2	4	0.9	11	2.6
Sandstone	4	0.7	4	0.8	1	0.2	1	0.2
Breccia	12	2.1	4	0.8	4	0.9	0	0
Granite	4	0.7	1	0.2	3	0.7	0	0
Lava	2	0.4	2	0.4	0	0	0	0
Quarzite	6	1.1	2	0.4	1	0.2	1	0.2
Quartz	10	1.8	5	1	1	0.2	1	0.2
Obsidian	0	0	3	0.6	0	0	2	0.5
Tuff	1	0.2	4	0.8	0	0	2	0.5
Fossil wood	2	0.4	0	0	0	0	0	0
Undetermined	2	0.4	2	0.4	0	0	0	0
	571	**100.4**	**526**	**100.3**	**433**	**99.8**	**431**	**100.2**

Table 3. Abrasion of stone artefacts from Beru and Marale

Abrasion	Beru		Marale	
	N	%	N	%
Absent-mild	67	16.5	65	17
Moderate	174	42.9	177	46.2
Strong	165	40.6	141	36.8
	406	**100**	**383**	**100**

found in river sediments, as was also shown for Palaeolithic artefacts found in river deposits in the Netherlands (Biggelaar et al. 2016).

3.2.2 Patination

Almost all artefacts were patinated. Also, Keates and Bartstra (1994) describe their artefacts as being all patinated. Most of the artefacts from Beru and Marale had a brown or yellow-brown patina, 70.7% and 79.3% respectively. In Beru, maybe due to the slightly greater variation in raw materials, more reddish patination was observed than in Marale (Table 4).

3.2.3 Fragmentation

About 80 % of the flakes, blanks and tools, were complete, in Beru as well in Marale (Table 5). Of the flakes from Beru in 5.8% only the proximal part was present, in 3.6% the medial and in 9.4% the distal part. For the flakes from Marale these figures were 7.1, 2.6 and 8.6% respectively. All fractures were old based on their patina. It is not known whether fragmentation occurred during manufacture or use of the flakes or post-depositional.

Table 5. Fragmentation of flake blanks and tools from Beru and Marale

Fragmentation	Beru		Marale	
	N	%	N	%
Complete	180	80.4	215	80.2
Proximal	13	5.8	19	7.1
Medial	8	3.6	7	2.6
Distal	21	9.4	23	8.6
Lateral	2	0.9	4	1.5
	224	**100.1**	**268**	**100**

3.3 Technological Markers

The technological markers studied were percentage of cortex, dorsal face preparation, striking platform type, distal end type and dorsal pattern of flake blanks and tools from Beru and Marale. The percentage of cortex was also studied in unretouched flaked implements. The frequency distribution of the percentage of cortex on the dorsal side of the flakes shows that about 53% (Beru) till 56% (Marale) of the flakes had cortex. In Beru as well as in Marale about 30% of the flakes had more than 25% of the dorsal surface covered with cortex (Table 6). Also, Keates and Bartstra (1994) mention the high percentage of cortex on artefacts from the Walanae depression.

If we look at the dorsal face preparation near striking platform then about 30% of the flakes in Beru and Marale showed no dorsal face preparation at all. At both sites crushing

Table 4. Different types of patina on all stones and stone artefacts of Beru and Marale

Patina	All stones				Artefacts			
	Beru		Marale		Beru		Marale	
	N	%	N	%	N	%	N	%
Brown	312	54.6	275	52.3	254	58.8	239	55.5
Yellow-brown	92	16.1	142	27	80	18.5	119	27.6
Black-grey	35	6.1	18	3.4	19	4.4	13	3
Yellow	37	6.5	21	4	28	6.5	16	3.7
White	31	5.4	32	6.1	8	1.9	21	4.9
Reddish	26	4.6	15	2.9	18	4.2	8	1.9
Yellow-white	13	2.3	10	1.9	10	2.3	7	1.6
Grey-white	13	2.3	12	2.3	11	2.5	7	1.6
Green	3	0.5	0	0	0	0	0	0
Purple	4	0.7	1	0.2	3	0.7	1	0.2
Translucent	1	0.2	0	0	1	0.2	0	0
No patina	4	0.7	0	0	0	0	0	0
	571	**100**	**526**	**100.1**	**432**	**100**	**431**	**100**

Table 6. Percentage of cortex on flake blanks/tools, core/core tools and flaked implements from Beru and Marale

Cortex	Flake blanks/tools				Core/core tools				Flaked implements			
	Beru		Marale		Beru		Marale		Beru		Marale	
	N	%	N	%	N	%	N	%	N	%	N	%
0	109	47.4	119	43.9	26	28.3	18	21.2	11	28.9	1	4.8
1-25%	55	23.9	74	27.3	42	45.7	30	35.3	9	23.7	8	38.1
26-50%	34	14.8	48	17.7	15	16.3	26	30.6	12	31.6	7	33.3
51-75%	14	6.1	18	6.6	9	9.8	10	11.8	3	7.9	4	19.0
76-100%	18	7.8	12	4.4	0	0	1	1.2	3	7.9	1	4.8
	230	**100**	**271**	**99.9**	**92**	**100.1**	**85**	**100.1**	**38**	**100**	**21**	**100**

was the predominant type of dorsal face preparation (22.5 and 24.4% respectively), followed by faceted/retouched (12.9 and 12.4% respectively) (Table 7).

Table 7. Dorsal face preparation near platform of flake blanks and tools from Beru and Marale

Dorsal face preparation	Beru		Marale	
	N	%	N	%
None	61	29.2	84	33.6
Crushed	47	22.5	61	24.4
Faceted/ Retouched	27	12.9	31	12.4
Crushed+Fac/Ret	9	4.3	14	5.6
Undetermined	65	31.1	60	24
	209	**100**	**250**	**100**

The dominant platform type in flake blanks and tools from Beru and Marale was plain (49 and 56.4% respectively). In addition, polyhedral, dihedral (8%), punctiform and outer surface were observed, the latter slightly higher in Marale. No major differences were observed between Beru and Marale (Table 8). The high percentage of plain striking platforms is in agreement with what was observed by Keates and Bartstra (1994).

Table 8. Striking platform type of flake blanks and tools from Beru and Marale

Platform type	Beru		Marale	
	N	%	N	%
Plain	103	49	141	56.4
Dihedral	17	8.1	20	8
Polyhedral	16	7.6	19	7.6
Punctiform	6	2.9	14	5.6
Faceted/retouched	5	2.4	7	2.8
Outer surface	15	7.1	11	4.4
Undetermined	45	21.4	38	15.2
None	3	1.4	0	0
	210	**99.9**	**250**	**100**

Flakes from Beru as well as from Marale had feather as the dominant distal end, 67.8 and 74.3% respectively. In much lower numbers step and overstruck (plunge) were observed as distal end (Table 9).

Table 9. Distal end of flake blanks and tools from Beru and Marale

Distal end	Beru		Marale	
	N	%	N	%
Feather	139	67.8	176	74.3
Overstruck	10	4.9	6	2.5
Step	41	20	43	18.1
Undetermined	15	7.3	12	5.1
	205	**100**	**237**	**100**

The dorsal pattern, consisting of scars from previous flakes, was very diverse. The dominant patrons were simple + side (22.1 and 24.6% in respectively Beru and Marale), side (17.8 and 18.5% respectively) and simple (14.9 and 12.7% respectively). A marked difference

Table 10. Dorsal patron of flake blanks and tools from Beru and Marale

Dorsal patron	Beru		Marale	
	N	%	N	%
Cortex	10	4.8	15	5.8
Plain	23	11.1	23	8.8
Simple	31	14.9	33	12.7
Simple + side	46	22.1	64	24.6
Simple + opposed	3	1.4	7	2.7
Side	37	17.8	48	18.5
Side + opposed	7	3.4	9	3.5
Radial	14	6.7	8	3.1
Convergent	5	2.4	21	8.1
Opposed	1	0.5	3	1.2
Ridge	2	1	2	0.8
Natural fissure	0	0	1	0.4
Undetermined	29	13.9	26	10
	208	**100**	**260**	**100.2**

between Marale and Beru was the high number of flakes with a convergent dorsal patron in Marale (8.1% compared to 2.4% in Beru). For main dorsal patterns there were no differences between Beru and Marale (Table 10).

3.4 Metrical Markers

The metrical markers of flake blanks and tools were length, width, thickness and maximal dimension. Chart 1 shows the frequency distributions of the length, width, thickness and

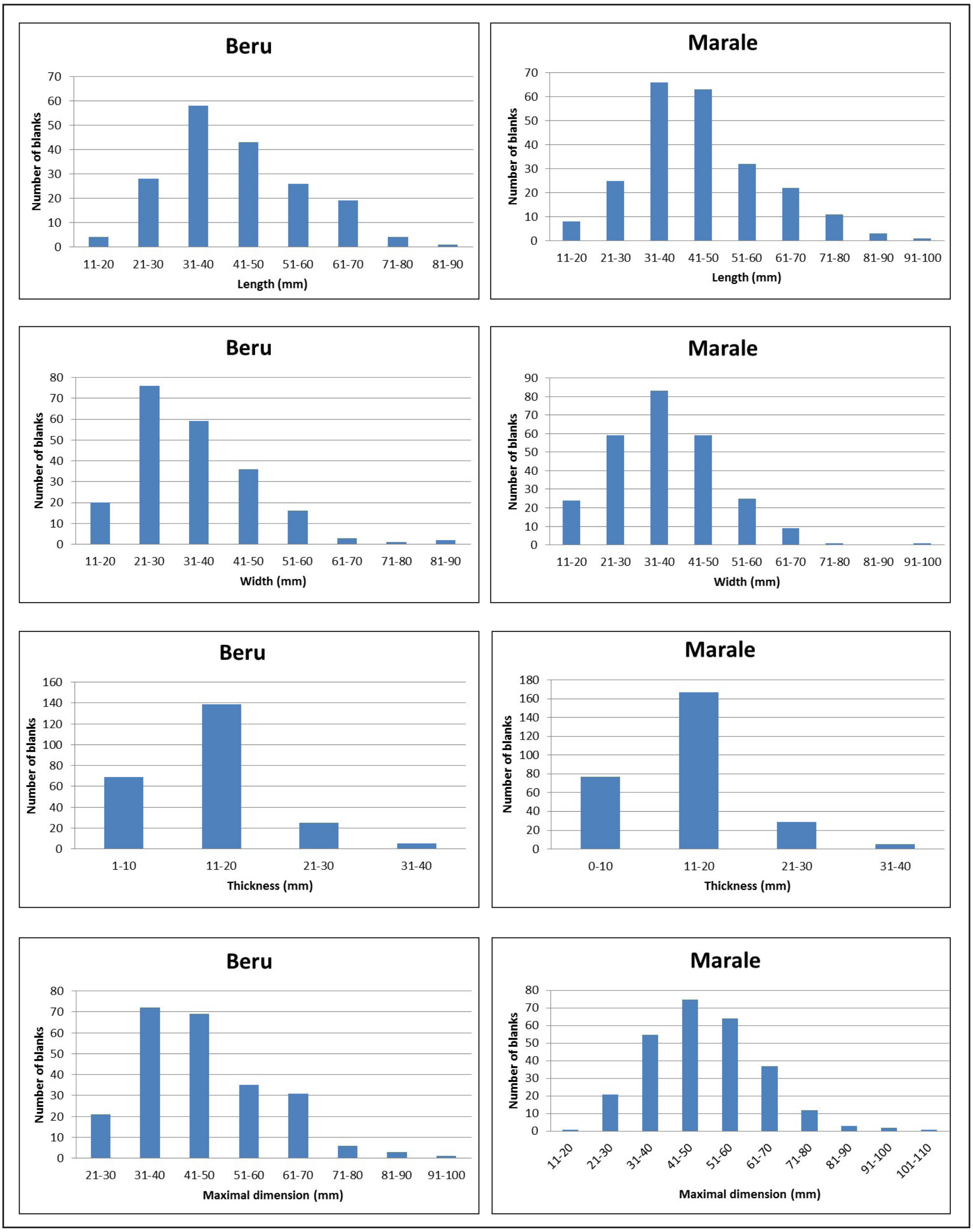


Chart 1. Frequency distribution of length, width, thickness and maximal dimension classes of flake blanks and tools from Beru and Marale

maximal length of the flake blanks and tools from Beru and Marale.

In Beru most flake lengths were in the class 31-40 mm with much less in class 41-50 mm and a considerable number in the 21-30 mm class. In Marale there were almost as many flakes in length class 41-50 cm than in class 31-40 cm. So, the flakes in Marale (length 45.1 ± 1.0 mm, mean ± SEM) tended to be slightly, but not significantly (p=0.16) longer than in Beru. The flakes of Marale were significantly (p=0.035) wider than those of Beru (37.0 ± 0.8 compared to 34.5 ± 0.9 mm), with most flakes in the width class 31-40 mm, while in Beru most flakes could be found in the 21-30 mm class. No difference (p=0.3) was seen in the thickness of the flakes between Beru and Marale, for both sites most flakes were in the class of 11-20 mm. This means that the flakes from Beru are more massive than those of Marale, having somewhat shorter lengths and widths but the same thickness. That the flakes of Marale are made out of slightly bigger cobbles than those of Beru is confirmed by comparing the maximal length. The flakes of Marale (max. length 49.6 ± 0.9 mm, mean ± SEM) were significantly (p=0.007) longer than those of Beru (46.2 ± 0.9 mm). The flakes of Marale had a peak in the 41-50 mm class, and a high number in the 51-60 class, and ranged up to 101-110 mm, while the flakes of Beru had a peak in the 31-40 mm class and a maximal range up to the 91-100 mm class. It is suggested that the differences in size of the artefacts is caused by differences in size of available pebbles at both locations. Also in the study of van den Biggelaar (Biggelaar 2016; Alink 2013) it was found for middle Palaeolithic artefacts that assemblages found upstream have a larger size than those downstream. Although it cannot completely be excluded that for the sites Beru and Marale artefact dimensions were biased by preferential surface collection of the artefacts, this is not very likely due to the large number of artefacts and the collection of artefacts at both sites by the same team. Keates and Bartstra (1994) described 11 flakes (7 from Marale area) and found most flakes in the length class 71-80 mm, the width classes 41-60 mm and the thickness classes 11-30 mm. Their flakes were larger than the ones described in this study, but as stated above this also might be due to bias caused by the selection of the finds or by the much smaller number in their study.

3.5 Typology of Flake Blanks and Tools, and of Cores

3.5.1 Flake Blanks and Tools

Flake tools have been described according to their morphological classification. In Table 11 totally 114 tools from Beru and 131 from Marale are described. At both sites most of the flake tools were scrapers, side or end scrapers or combined tools having side and end scraper properties, the in this study called composite tools. Also, a high number of denticulates were found at both sites (16.7 % in Beru, 12.2 % in Marale). Furthermore borer, points and notches were identified. In Marale more scrapers were present than in Beru, while in Beru the number of denticulates was slightly higher.

Table 11. Flake tool types from Beru and Marale

Flake tools	Beru		Marale	
	N	%	N	%
Scaper	71	62.3	99	75.6
Denticulate + notch	28	24.6	23	17.6
Borer	5	4.4	4	3.1
Point	7	6.1	5	3.8
Chopper/chopper tool	2	1.8	0	0
Pseudo handax	1	0.9	0	0
	114	**100.1**	**131**	**100.1**

In addition to the tool type classification, flake blanks and tools were also classified according to a classification based on morphological criteria. In this system 8 different types were recognized (Fig. 4). For the description of the types see Table 12. 54% of the flake blanks and tools of Beru and 56% of

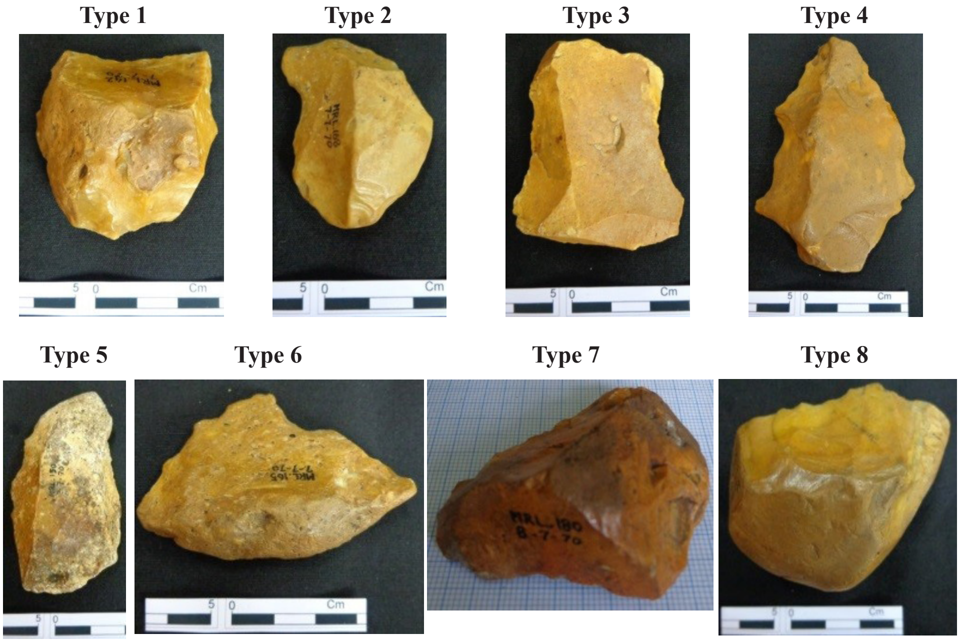


Figure 4. Different types of flakes from Beru and Marale (Source: Alink)

Table 12. Description of different types of flakes from Beru and Marale (see also Figure 5)

Flake type	Description
1	Short thick flakes, length and widht about equal, distal slanting side ending in shard edge
2	Flake slightly bended on distal side to left or right, ridge on dorsal side, parallel to lenght axis, on one side of ridge often three scars, on the other side plain
3	Oblong rectangular flake, on dorsal side a parallel flake scar on each side of straight ridge, triangular cross section
4	Like type 3, not rectangular but pointed on distal side
5	Instead of central ridge as in type 3 and 4, horizontal scar parallel to ventral side, resulting in dorsal side with three parallel scars; trapezium cross section
6	Characteristic rounded triangular flat flake tool (piece of cake), ventral side plain, dorsally one coarse edge consist of cortex, the other sharp edge is denticulated
7	Oval or rectangular relative thin flake, both side plain, one side often cortex
8	Rectangular or rounded massive flake, dorsal side consist of cortex with some parallel scars on either proximal, distal or lateral side

Table 13. Classification of flake blanks and tools based on morphological criteria

Flake types	Beru		Marale	
	N	%	N	%
Type 1	13	10.3	17	11
Type 2	22	17.3	37	24
Type 3	21	16.5	23	14.9
Type 4	21	16.5	22	14.3
Type 5	21	16.5	20	13
Type 6	10	7.9	9	5.8
Type 7	19	15	22	14.3
Type 8	0	0	4	2.6
	127	**100**	**154**	**99.9**

those of Marale could be attributed to one of the described types. Table 13 shows that there were no major differences between Beru and Marale. Concerning the number of flakes belonging to type 2, the percentage in Marale was higher than in Beru, respectively 17.3 % in Beru, and 24% in Marale.

In general, it can be said that hard hammer percussion was predominant and that probably only for retouched flakes (scraper tools) soft hammer technique was used. Van Heekeren (1957) saw a parallel between the Cabenge industry, as he called the industry to which the Beru and Marale artefacts belong, and the Sangiran industry based on the 'keeled flake blades'. These blades correspond with the type 3 flakes described in this study. Also, Keates and Bartstra (1994) described a 'keeled flake'. Von Koeningswald also saw a parallel with late Pleistocene artefacts from the Notopuro beds of Sangiran (van Heekeren 1957). A short comparison with Sangiran artefacts (by first author, not further described) showed only a similarity for type 1 flakes.

3.5.2 Cores

The cores of Beru and Marale were classified according to four different types as described in Table 14 and shown in Figure 5. About 80% of all cores could be attributed to one of the categories. Most cores, 69-73%, belonged to type 1, which were described as single platformed, pyramidal (a) or dipyramidal, conical or polyhedral (b). Eleven (Beru) till 16 % (Marale) of the cores were double platformed (type 2). In type 2 the platforms were parallel and in some cases the sides were alternately flaked. These cores showed a Levallois like appearance. Type 3 was less well classified and was described as a pebble or core tool with three flaked sides and with at least one sharp edge. Type 4 can be described as thin, flat core (piece of cake) with one of the sides retouched. This core was quite different from the other types (Table 14). Although there were slightly more type 2 cores in Marale than in Beru no marked differences were observed between the cores of Beru and Marale (Table 15). Keates and Bartstra (1994) found also double platform cores, possibly corresponding with type 2 as described in this study. The similarity between patrons of cores from Beru and Marale and core patrons found in western Europe might suggest a multi-regional development of equal technologies for core reduction. Real choppers and chopping tools as described for Pacitanian industry (Bakara 2007; Bartstra 1976; van Heekeren 1957) have not been observed in the collection studied. However, following strictly, the definition used by Movius, as choppers being pebbles flaked on one (unifacial) and chopping tools flaked on both sides (bifacial), a few of these core types were present. Although according to the Movius typology (Bartstra 1976, 81) these artefacts fall under the definition of chopper and chopping tool, Keates and Bartstra (1994) prefer not to

Type 1a **Type 1b** **Type 2** **Type 3** **Type 4**

Figure 5. Different types of cores from Beru and Marale (Source: Alink)

Table 14. Description of different types of cores from Beru and Marale

Core type	Description
1	Singled platformed, pyramidal (a) or dipyramidal, dipolar, conical or polyhedral (b)
2	Double parallel platformed, discoid or disc. In some cases the sides were alternately flaked. Cores show a levallois like appearance
3	Pebble or core tool with three flaked sides and with at least one sharp edge
4	Thin, flat, 'piece of cake' like core with one of the sides retouched. This core was quite different from the other types

Table 15. Classification of cores according to four different types

Core types	Beru		Marale	
	N	%	N	%
Type 1	76	74.5	68	68.7
Type 2	11	10.8	16	16.2
Type 3	10	9.8	12	12.1
Type 4	5	4.9	3	3
	102	**100**	**99**	**100**

use this functional term but prefer the terms unifacial and bifacial pebbles or cobbles. Bifacial pebbles in the sense of handaxes of the Acheulean type, although existing in indonesia according to Simanjuntak et al. (2010), have neither been observed in the studied collection.

4. Conclusion

Although the flakes of Beru and Marale looked much the same, accurate description and analysis showed some small differences in raw material, dorsal pattern, size and typology. Most strikingly was the slightly but significant smaller size of the flakes of Beru compared to Marale. It is supposed that these differences are due to downstream fining, the deposition of smaller cobbles and gravel in Beru, as this site is located north of Marale, thus downstream the Walanae river. It is less logical that small differences between two very nearby sites such as Beru and Marale in the Walanae depression reflect real cultural, local adaptive or temporal differences, or is the reflexion of collection bias based on the relative high number of artefacts studied. According to Bartstra, who participated in the expedition, selective collecting is not probable as the same teams operated at both locations, Beru and Marale (personal communication, 2014). South of Marale, thus upstream, in Kecce, Paroto and Bunane, even bigger artefacts have been found, of the size of the Pacetan cobbles, and looking similar to those that belong to the Pacetan culture. Also, Biggelaar observed in Central Netherlands a strong relation between size of artefacts and size of gravel and cobbles at upstream or downstream locations.

Based on morphological criteria eight flake types and four core types were recognized. Keates and Bartstra recognized among artefacts from the Walanae depression three different groups, two late Pleistocene, one very abraded on higher terraces and one less abraded on the lower terraces and a third group, with small flakes and cores, found at the higher terraces belonging to the Holocene. Some smaller non-abraded artefacts in our study showed similarity with the third group of Keates and Bartstra and might belong to the Upper Palaeolithic.

The artefacts of Beru and Marale, belonging to the so called Cabenge industry, were dated by van Heekeren to the late Middle or early Late Pleistocene, between 200 and 100 ka. Bartstra dated the Cabenge industry later in the Late Pleistocene, and even suggested that the artefacts could have been made by early *Homo sapiens*. However, based on the described characteristics in this paper most artefacts of Beru and Marale have similarities with early Middle Palaeolithic artefacts of Europe. Although comparison with Palaeolithic periods in Europe is not possible for Southeast Asian Palaeolithic, based on the technology of the studied artefacts a roughly dating between

200 and 100 ka might be plausible. Recently van den Bergh showed that artefacts unearthed in situ in Talepu in the Walanae Basin close to Marale and Beru might indeed be of an age of 200 ka or even older.

Morphological and technological studies on the artefacts in the Walanae Basin might reveal whether local differences do exist. Comparison with other collections in the Indonesian archipelago may indicate whether the Cabenge industry can be defined based on descriptive variables that differ from other known industries. Accurate dating of the stone artefact complexes is needed. Only differences in artefact features between well dated artefact collections may give insight in whether or not there were evolutionary processes in lithic technologies during the Palaeolithic period of Indonesia.

Still not much is known about the Palaeolithic of Sulawesi and the first hominins. As the recently described lithic artefacts of the island Flores belong to the oldest in Indonesia and a possible human migration could have come from the North, from Sulawesi, studying Palaeolithic stone tool collections from Sulawesi is relevant for our knowledge of human migration in Southeast Asia.

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