

論文

## Paleolithic Cave use and the Landscape in South Sulawesi, Indonesia

IKARASHI, Ayumi

In a karstic area of Maros and Pangkep, South Sulawesi, Indonesia, many caves and rock shelters are seen at the foot or on the side of limestone cliffs. It is said that these caves and rock shelters were used by prehistoric humans. Previous studies have revealed that some of them were occupied during the Pleistocene to early Holocene. Moreover, not only stone tools and various food remains such as animal bones and shells have been reported, but also these caves are

known for cave paintings such as hand stencils and animal figures. Based on a field study on eleven cave sites and two open air sites, this paper describes the relationship between the cave users and micro and macro environment; for example location and accessibility of each cave, origin of the lithic material, and the change in food resources associated with climate and coastline change.

### I. Introduction

It is estimated that *Homo sapiens* reached Sahul via Eurasia 45,000 years ago or a little earlier with some Pleistocene sites showing evidence of human occupation (Allen and O'Connell 2008 : pp.31-32) (Fig.1). Conversely, there have been a number of prehistoric art sites reported from the geographically diverse area of Southeast Asia and Oceania (Tan 2014). Due to dating difficulties limited work has been undertaken on determining the age of associated art at some sites. This is despite the possibility that the first people who came to this area already possessed figurative art as a part of their culture



Fig.1 Location of Sulawesi and other islands (adapted from Allen and O'Connell 2008) (Map by A. Ikarashi)

(Aubert et al. 2014 pp.226).

This paper focuses on a concentration of cave sites in South Sulawesi, Indonesia. The cave sites are mainly located in Maros and Pangkep regencies hereinafter referred to as the Maros - Pangkep cave sites. Recent studies pointed out the possibility that people have used these caves since the late Pleistocene (Glover et al. 1981, Bulbeck et al. 2004). In addition, result of the U-Th dating of the cave art implies that occupation of the caves may have begun earlier than previously thought. However, few cave sites have been excavated, and, in particular, the occupation of these sites during 20,000 years ago to 10,000 years ago is unclear.

## II. Prehistory of the Islands of Southeast Asia and the Maros-Pangkep Cave Sites

It is believed that the movement of *Homo sapiens* into the islands of Southeast Asia and Australia occurred around 45,000 years ago (Allen and O'Connell 2008 : pp.31-32). Around 20,000 years ago, some evidence that indicates trade among the islands has been reported, for example, the importation of animals and obsidian. Potsherds and ground stone tools are present in the archaeological record in the islands of Southeast Asia around 3,500 years ago (Indo 2013, Ono 2013).

The prehistory of South Sulawesi shows evidence of similar changes in material culture. Reports from two Pleistocene cave sites, Leang Burung 2 and Leang Sakapao 1 (Glover 1978, 1981, Bulbeck et al. 2004) suggest the caves have been in use since around 30,000 years BP. Furthermore, the dating of cave paintings implies the earlier use of the caves (Aubert et al. 2014). Some sites that show later use of caves at around 10,000 years BP have been reported (Mulvaney and Soejono 1970, Heekeren 1972, Glover 1976, Bulbeck et al. 2000). Ulu Leang, located in Maros, has been utilized since around 8,000 years BP, and excavated artifacts represent a new assemblage of stone tools designated the Toalean assemblage (Bulbeck et al. 2000). The potsherds on the surface of the cave deposits indicate the arrival of the Neolithic culture.

## III. Present Environments around the Sites

### 1. Basic information on South Sulawesi

Sulawesi is one of the islands of Wallacea, located to the east of Borneo, and separated from Borneo by the Makassar Strait. Sulawesi is divided into six provinces. Cave sites are concentrated in the Maros and Pangkep regencies of South Sulawesi province (Fig. 2). More than 130 cave sites have been reported (Penyusun 2011, Permana 2014, Mulyadi 2016) (Fig. 4).

The latitude of the research area is around 5°12' to 4° 33', and the longitude is around 119° 28' to 119° 48'. This area is susceptible to monsoon (Glover 1981). Fig. 3 shows the change in temperature and the amount of precipitation in Makassar, located to the south of Maros between November 2014 and October 2016. The main precipitation occurs between November and March, and the dry season is between April and October. In 2015, the annual rainfall was 2070 mm, and average temperature was 27.6°C, and there is no annual fluctuation (22.9°C to 33.8°C).

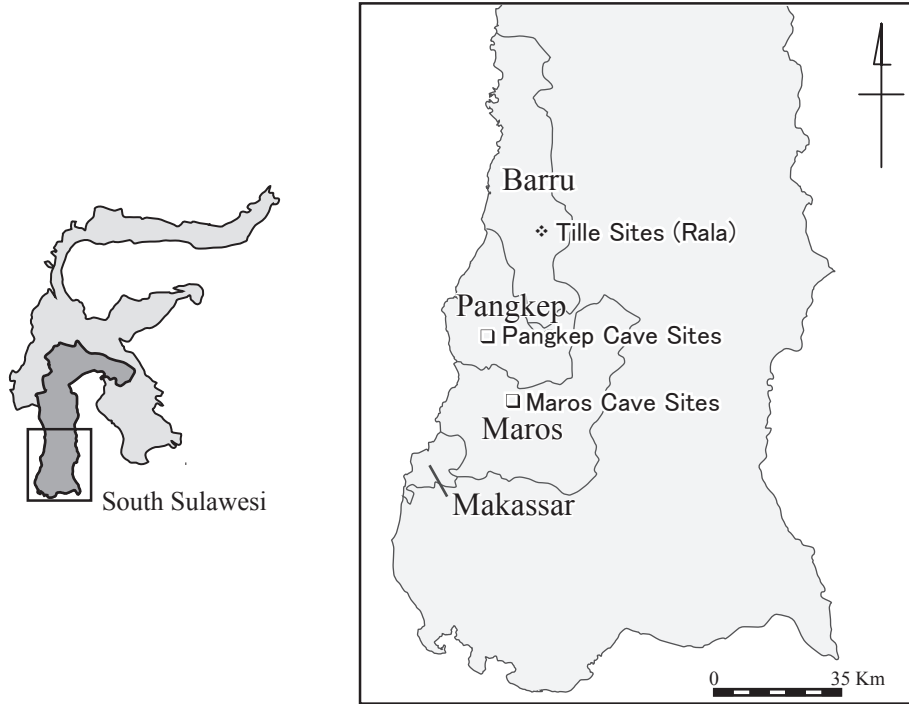


Fig.2 Map of the study area (Map by A. Ikarashi)

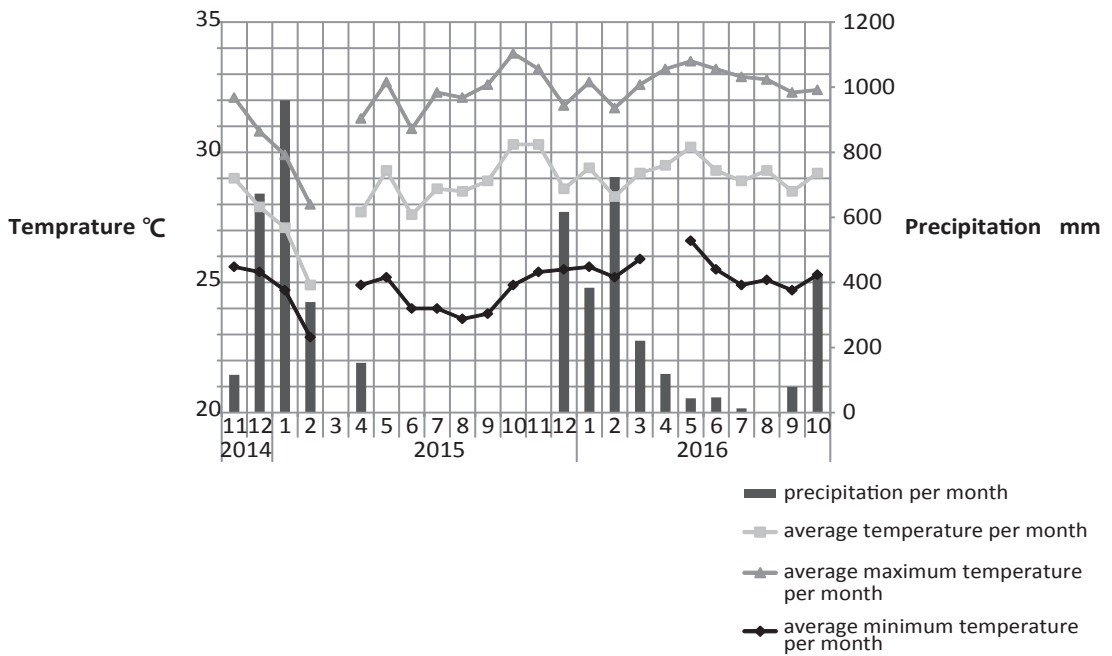


Fig.3 Temperature and precipitation of Makassar between 2014 and 2016. (Source: Japan Meteorological Agency)



Fig.4 Distribution of cave sites in Maros and Pangkep (Map by A. Ikarashi)

## 2. Present landscape around the cave sites

The caves of the Tonasa Formation consist of carbonates deposited from the early Eocene to Middle Miocene. Volcanic rocks deposited during the middle to late Miocene cover the east side of Tonasa Formation (Fig. 5).

Alluvial plains extend to the west of the limestone karstic area of Maros and Pangkep. According to McDonald, the karstic limestone area consists of some plateau-like karstic limestone hills. The average altitude of alluvial plains is 5 to 15m, and is mainly utilized as rice fields or residential areas (McDonald 1976 : pp.80-82) (Fig. 6). Conversely, the altitude of valley floors among the hill reaches greater than 120m. The caves are mainly distributed on the margin of the karstic hills. Tributaries of the rivers running at the foot of the karstic towers formed a number of cliff foot caves. McDonald explained that these foot caves formed at the lower level of the alluvial plain due to the action of subterranean rivers. Therefore, caves located at the same or higher level of the alluvial plain, would have formed by the same process (McDonald 1976 : pp.80-82, Glover 1981 : pp.6-7).

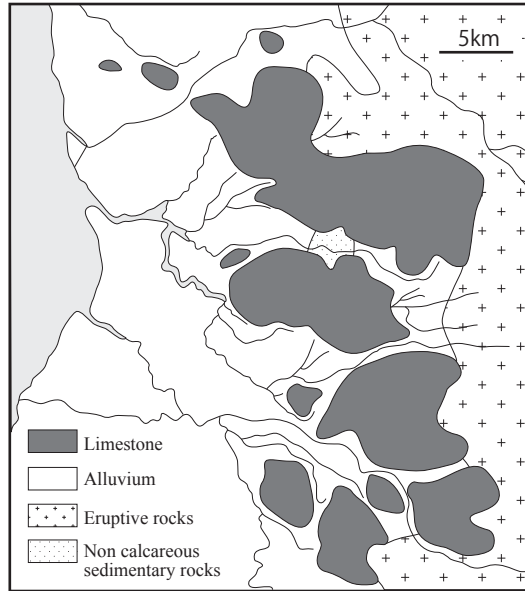


Fig.5 Simplified geological map of Maros and Pangkep (adapted from McDonald 1976)



Fig.6 Landscape from the alluvial plain to karst mountains (Photograph by A. Ikarashi)

#### IV. Field Study

With the cooperation of Dr.R.Cecep Eka Permana, Center of Archaeology, University of Indonesia, Balai Arkeologi Makassar, and Balai Pelestarian Cagar Budaya the team visited Sulawesi from 16 - 19, September 2016, and studied the cave sites of the Maros and Pangkep regencies. Eleven caves were visited: Leang Burung 1, 2, Leang Timpuseng, Leang Sampeang, Leang Pattae, Leang Peta Kere, Leang Jarie, Leang Sakapao 1, 2, 3, and Leang Lompoa (Fig. 7, 8).

The following description shows the results of the field survey of each cave. The GPS data was taken during the site visits. The data on the size of the cave mouth is taken from previous studies (Permana 2014).

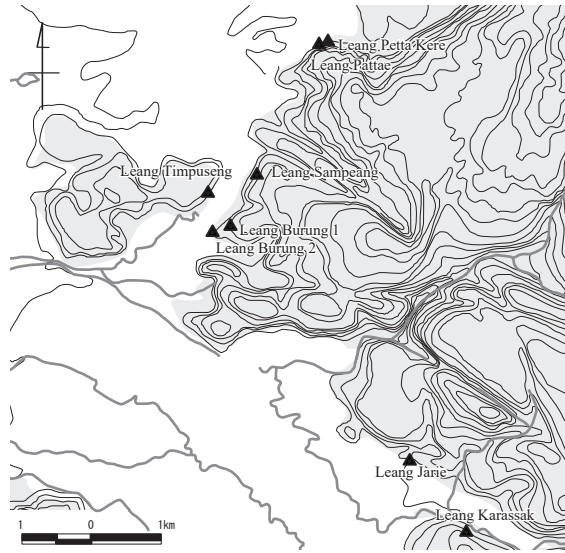


Fig.7 Location of the Studied Cave Sites in Maros (Map by A. Ikarashi)

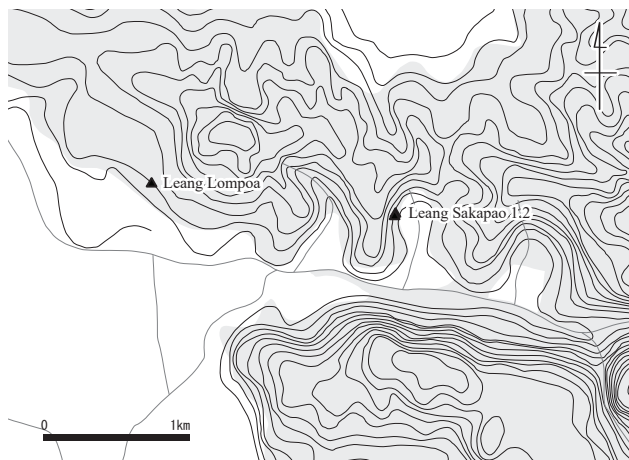


Fig.8 Location of the studied cave sites in Pangkep (Map by A. Ikarashi)

### 1. Cave sites in Maros

#### (1) Leang Burung 1.2

Two adjacent caves located in Maros, S 05° 00' 07.2"—E 119° 39' 43.2" and S 05° 00' 09.9"—E 119° 39' 41.8". The cave mouth of Leang Burug 1 is 2.5m in height and 2.5m in width. The interior of Burung 1 is 5m long, 2.5m wide and 4m high (Permena 2014). The cave floor of these caves is not smooth, and the inside of both caves is dark, however the light penetrates the area around the cave mouth (Fig. 9). Both caves have sufficient height to allow standing and walking inside. The shell deposits appear in places on the walls and are referred to as cemented deposits in preceding studies (Glover 1981). Spiral shells and a small number of stone flakes were scattered in front of the cave mouths. The cave floor is dry and sandy. Both caves have one main chamber, although there are



Fig.9 Landscape forms inside Burung 1 (Photograph by A. Ikarashi)

crevices, which are smaller than the main caves, forming part of the overall integrated structure.

The front space of the caves is flat, and there are few plants. There is a small wood between the flat space and a paved road thus, visibility from the cave mouth is limited. There is little vegetation inside the caves, however, the vegetation around the caves is rich, and various plants are present on the karst cliff.

These caves have hand stencils on the ceilings and walls. The hand stencils are surrounded by red pigment. One of the stencils is painted on the ceiling near the cave mouth, approximately 13m higher than the cave floor.

## (2) Leang Timpuseng

This cave is on an isolated hill and is opposite Leang Burung 1, 2. Its location is S 04° 59' 52.9" — E 119° 39' 39.8". The size of the entrance and inside space is reported to be 32m in width, 6m in height and 9m long, 30m width and 6m in height (Permana 2014).

The alluvial plain between the two hills is mainly utilized for rice fields (Fig.10a). The area surrounding this cave is flat, and the plants are sparse. The rice fields are visible from the cave mouth. The back of the cave is approximately 1m higher than the flat area in the front of the cave, and small stairs are present leading up to the space (Fig.10c). This smaller space appeared creating another chamber. The inside of the chamber is not spacious and a limestone mass extends out like a ledge. The floor above the limestone block is flat, so it is possible to climb on top of it (Fig.10b, c).

Stone tools and shells were discovered around the cave mouth. On the left side of the cave, there is a small scale crack in the limestone wall with a small river or spring inside. The cave is dotted with some cave paintings, such as hand stencils and an animal like a wild pig. Like Leang Burung, these paintings were painted in red pigment. The size of the hand stencils is not uniform, and the presence of a small hand stencil suggests that it was made by a child. A deer painting is on the wall about 3.5 m above the floor level. These paintings survived due to their presence inside the small chamber rather than the lighter space near the dripline.



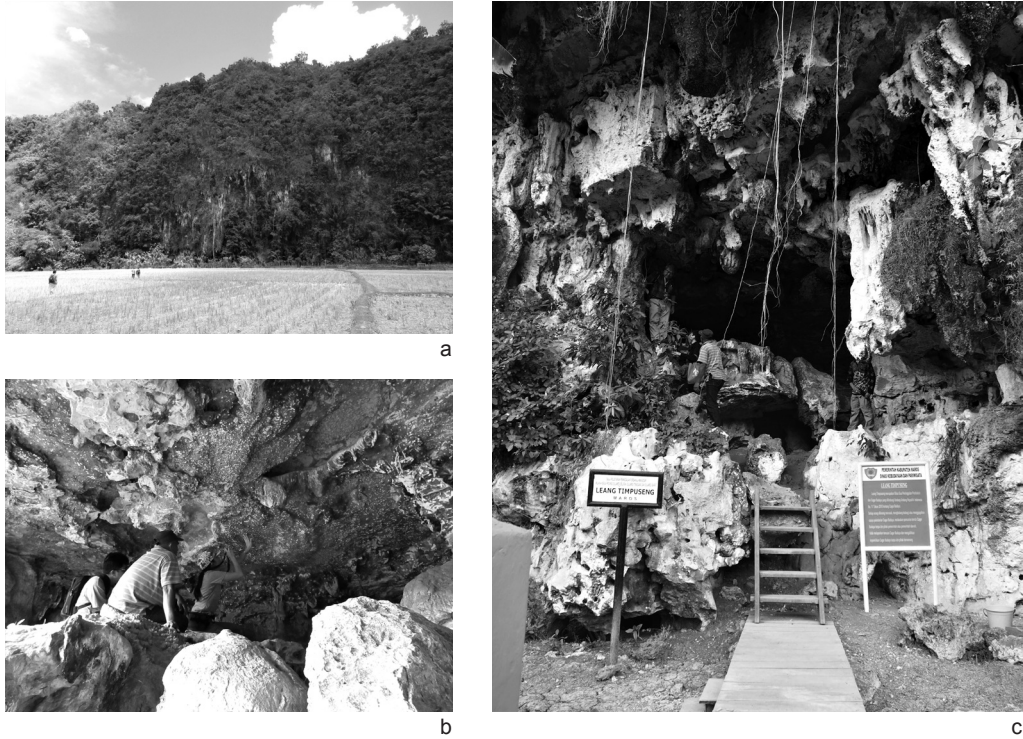


Fig.10 a: The cliff and rice fields. Leang Timpuseng is located at the bottom of the cliff. (Photograph by A. Ikarashi)  
 b: The interior of Timpuseng. There were some hand stencils. (Photograph by K. Hisada)  
 c: Cave entrance of Leang Timpuseng. (Photograph by A. Ikarashi)

### (3) Leang Sampeang

Leang Sampeang is located on the same limestone hill as the Leang Burung caves. The cave is located at S 4°59'44.8"—E 119°40'01.3". The level of the entrance is estimated to be 5m higher than the surrounding flat area, requiring the placement of a bamboo ladder to facilitate access (Fig. 11a). There are woods and bush surrounding the cave, and the rice fields beyond the woods cannot be seen from the cave mouth. Inside of the chamber was dark, and it narrowed toward the interior. The back of the room is less than 1m in height, so people could not reach the deepest wall of the cave. Some hand stencils are painted on the cave wall and ceiling in the deep and narrow part of the cave where the light does not penetrate (Fig.11b). Moreover, a drawing that appears to be of a human being is on the ceiling near the hand stencils (Fig.11c). It is depicted in black pigment. According to Dr.R.Cecep Eka Permana, University of Indonesia, this black line drawing is newer than the hand stencils and wild pigs painted in red pigments. The height from the floor to the ceiling is too low to stand and walk, and it is necessary to lie down to see the paintings and drawings (Fig.11b).

A small river runs near the cave, and shell scatters that seem to comprise the same species as found in the river are present around the cave mouth (Fig.11d).





Fig.11 a: The front of the Leang Sampeang. (Photograph by A. Ikarashi)  
b: Interior of Leang Sampeang. Looking at hand stencils. (Photograph by K. Hisada)  
c: Human figure on the ceiling of Leang Sampeang. (Photograph by A. Ikarashi)  
d: Spiral shell from a small stream near Leang Sampeang. (Photograph by A. Ikarashi)

#### (4) Leang Peta Kere

This cave is located at S 04° 58' 44.0"—E 119° 40' 34.0", in Tourism Park Leang Leang (Taman Wisata Leang Leang). The park is dotted with some caves, and stairs and signboards have been constructed. The level of the cave mouth is reported to be about 20m from the surrounding flat space (Permena 2014). The size of the cave mouth was reported to be 3m in width and 5m in height (Permena 2014). Visitors can climb the stairs and reach the cave entrance (Fig. 12a). There are two depressions,

but the smaller one does not have any paintings. The other has well preserved paintings of wild pigs with a pattern of fur which are covered by a great many hand stencils (Fig.12b). Owing to land forms around the cave mouth, it was difficult to get close to the paintings and the inside of the cave.

While the view from near the cave mouth was very good, accessibility to this place is difficult however the preserved forest of the national park can be seen from the cave entrance (Fig.12c).



Fig.12 a: General image of Leang Peta Kere (Photograph by A. Ikarashi)

b: The paintings and hand stencils of Leang Peta Kere. The hand stencils and animal figures were painted on the wall more than 10m above the bottom of the stairs. (Photograph by A. Ikarashi)

c: Landscape from the top of the stairs. Visitors can see the preserved forest in this tourism Park. (Photograph by A. Ikarashi)

#### (5) Leang Pattae

This cave is also in the Tourism Park Leang Leang, S 04°58' 43.6" —E 119°40' 34.2". There are small trees or other plants around the cave entrance. The slope in front of the cave is gentle. The first and second chambers are separated by a comparatively small passage and the light does not penetrate inside the second chamber (Fig.13). Therefore, hand stencils inside the cave were not visible without any light source.



(6) Leang Jarie

A small wood surrounds the cave. The cave is located on a hillside, more than 10m higher than the foot of the hill at S 04° 58' 41.7"—E 119° 40' 27.5". Yet, accessibility is not difficult because the hill slope is not steep. The size of the cave mouth was reported as 16m in width and 10m in height (Permena 2014). There are some stone pillars and boulders inside the cave, so the cave floor is not flat (Fig.14). Stone flakes and spiral shells were recovered, and the presence of hand stencils is confirmed. A relatively big river ran near the cave.

**2. Cave sites in Pangkep**

(1) Leang Sakapao 1

The cave is located in Pangkep at S 04' 50' 03.6" E 119° 36' 09.5". The flat area which is used for rice fields is surrounded by karst hills (Fig.15a). Leang Sakapao 1 is about 70m up from the west cliff foot (Bulbeck et al. 2004: p.113). From the path leading to the cave mouth, it is possible to see the rice fields and hills opposite.

The size of cave mouth has been reported as 8m in width, 4m in height (Permena 2014). A ladder was placed in front of the cave because the flat space of the cave was higher than the pass (Fig.15b). Cave art was painted on the wall of the northeast side and comprises stencils and pig like animals (Fig.15c). This cave has been excavated (Bulbeck et al. 2004), thus there was a fence around the excavated area (Fig.15d). The light



Fig.13 Cave mouth of Leang Pattae (Photograph by A. Ikarashi)

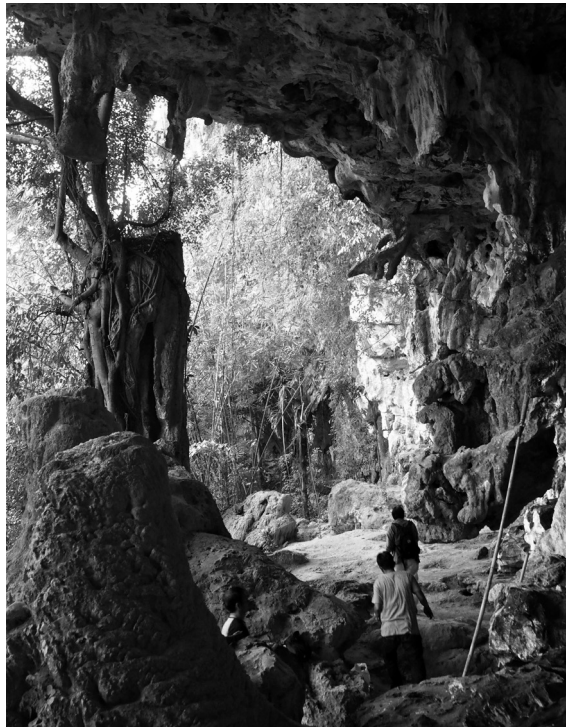


Fig.14 General image of Leang Jarie taken from inside the cave (Photograph by A. Ikarashi)

penetrated almost to the middle of the chamber, however, it was completely dark at the back of the cave. The stone tools and shells seemed fewer than in the other foot cave sites, and these artifacts were found near the ladder. The inside space of Leang Sakapao 1 has been reported as 27.5m long, 9.5m wide and 3m in height (Permena 2014).

Leang Sakapao 2 and 3 were seen a short distance from Sakapao 1. These caves were smaller than Sakapao 1, and were used by local people as a straw warehouse. Neither of them had any cave paintings.

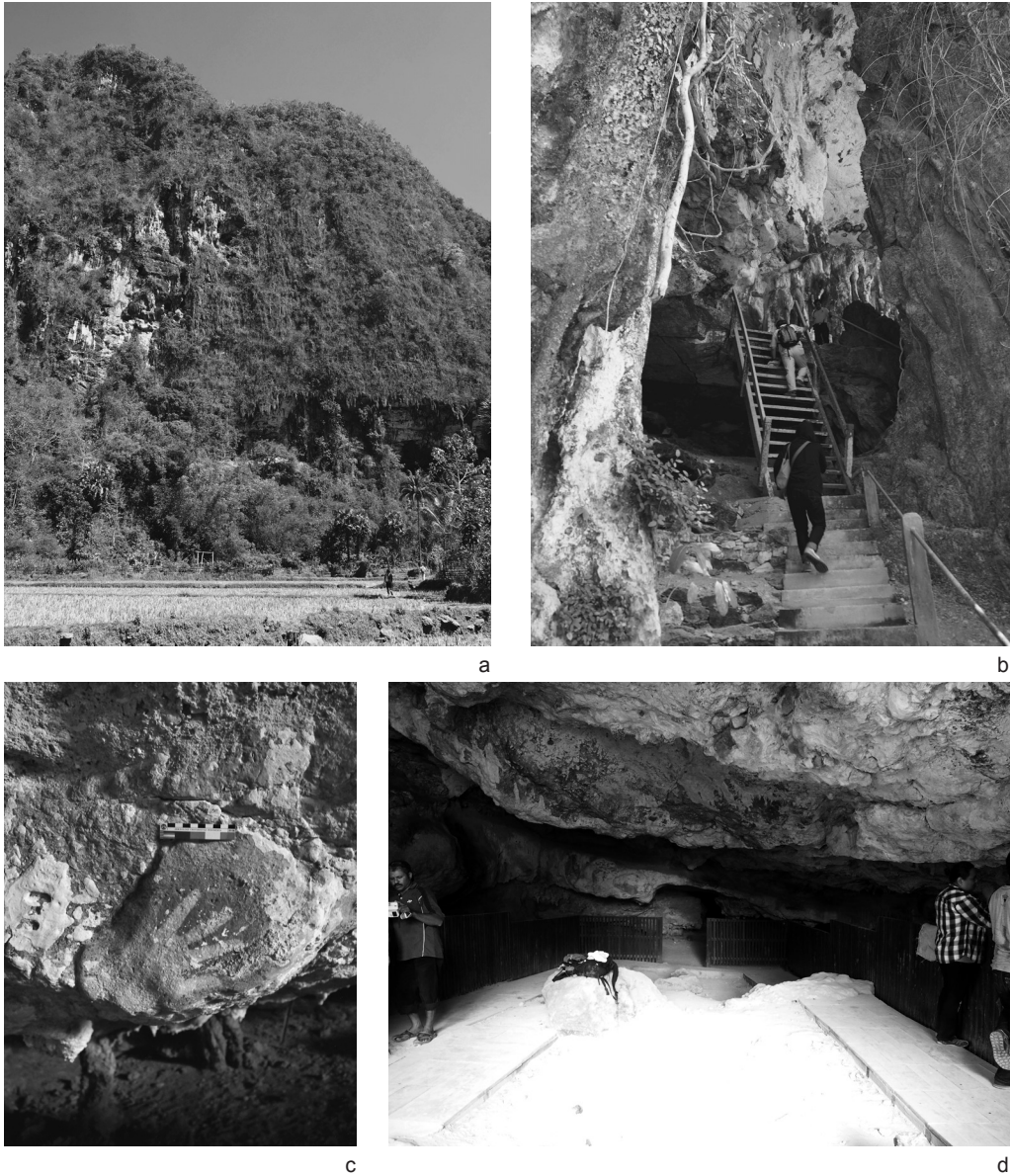


Fig. 15 a: The cliff and rice fields. Leang Sakapao 1 is located on half way up this limestone hill. (Photograph by A. Ikarashi)  
 b: Entrance of Leang Sakapao 1 (Photograph by A. Ikarashi)  
 c: A hand stencil in Leang Sakapao 1 (Photograph by A. Ikarashi)  
 d: Inside of Sakapao 1 (Photograph by A. Ikarashi)



There was a space where the ground rose slightly in the flatland among the hills. This small mound included some stone flakes and unprocessed stones which appeared the same type as stone tools. Therefore, this open site is considered to have been a knapping site for stone tools. A small river runs across the flat land, and the spiral shells also inhabited the stream. The northeast side of the limestone outcrop near the river included some siliceous nodules (Fig.19a).

## (2) Leang Lompoa

Leang Lompoa is located on the same hill as Leang Sakapao. The location is S 04° 50' 02.6" E 119° 35' 16.3". There was a small river near the cave, and its eroded limestone wall. The front of the cave mouth was a gentle slope some meters higher than the alluvial plain. The presence of woods between the paved road and the cave meant nothing was visible except for a grove from the cave entrance. Shells and stone flakes were deposited on the gentle slope in the front of the cave. The cave can be divided into three chambers (Permena 2014). The first chamber has a large mouth (20m width, 15m height (Permena 2014)) and is illuminated by sunlight; however, the entrance of the second chamber was relatively small. Therefore, the middle part of the cave is fairly dark without a flashlight. Hand stencils were present on the wall of the darker space. There was a large hollow in the ground created by local people who take the bat droppings as fertilizer.

Another cave mouth opened into the depth of the cave. There were plants in front of the mouth, so the environment beyond the cave mouth is not clear (Fig.16). There were a lot of rocks, and the flat space is not large.



Fig.16 Landscape as seen from the deeper mouth of Leang Lompoa. (Photograph by A. Ikarashi)

## 3. Artifacts

There were shells and stone flakes on the surface of most of the cave sites. During this field trip, some shells and stone artifacts were collected from target caves except for Leang Burung 2 and Leang Pattae by obtaining permission from Balai Arkeologi Makassar. Table 1 shows all the samples collected during this research.

Many of the stone artifacts are flakes and fragments. According to Emeritus Professor Katsuhiko

Onuma, Kokushikan University, there are a few retouched stone artifacts. However, one stone artifact from a workshop site near Leang Sakapao appears to be a retouched notch (Fig.17a); however there is still the possibility that it was created by natural erosion. A retouched side scraper was collected from Leang Jarie (Fig.17b). In addition, two heat-altered flakes retrieved from this site imply the use of fire and existence of hearths. Not only stone tools but also potteries were collected from some of the cave surface. In Leang Lompoa, potsherds and polished stone tools were present.

Table.1 Stone Artifacts from the caves

Leang Timpuseng	Micro Flake	3	Open air workshop site near Sakapao 1	Flake	2
	Fragment	1		Cortical Flake	5
Leang Pattae	Micro Flake	2		Retouched Notch	1
	Elongated Flakes	1		Single Platform Flake Core	1
	Fragment	1		Fragment	1
	Micro Blade Fragment	1	Leang Lompoa	Flake	4
Leang Jarie	Flake	4		Cortical Flake	1
	Retouch Flake	4		Flagment	1
	Micro Flake	1	Tille Site (Rala)	Flake	4
	Cortical Flake	3		Naturally Backed Flake	1
	Heat-Altered Flakes	2		Flake	2
	Fragment	1		Blade	1
	Side Skraper	1		End-Scrapers On Blade	1
Micro Blade	1	Pseudo-Levallois Point		1	
		Unclassifiable Cores		1	
Leang Sakapao 1	Flake	1		Fragment	1
	Fragment	3			

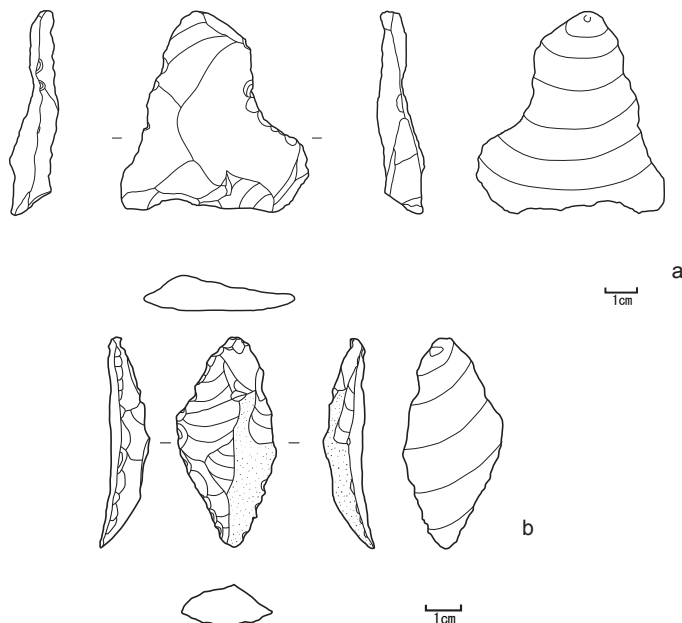


Fig.17 a: Stone tool from open air site near Leang Sakapao 1 (retouched notch(?))  
 b: Stone tool from Leang Jarie (retouched side scraper)  
 (Illustration by A. Ikarashi)

## V. Characteristics of Caves and the Purpose of Cave Use

### 1. Inside the cave

The topography of the cave floor is different in each cave and part of each cave. Leang Burung 1, 2 have relatively flat surface inside and surrounding these caves, and there is not a big difference in height between inside the cave and under the drip line.

Leang Lompoa and Leang Pattae appear to have similar landform characteristics. Their second rooms are dark and separated from the lighter under- roof space by a small entrance. In addition, landform in front of the drip line is gently tilting towards the outside. Therefore, the first chamber is light but not flat while the second chamber is dark but relatively flat.

Conversely, the front of Leang Timpuseng and Sampeang is relatively flat and there is no big gap in height between the cave foot and surrounding rice fields despite their complicated topography in the depth of the caves (see Fig.10b and 11a).

Whilst there is variation in form, almost all the caves have sufficient height and width to stand and walk in their entrance at least. In addition, the caves that do not have a large space and a flat floor in the depth also have a level area near the cave entrance or under the drip line. For instance, the topography of depth of Leang Timpuseng is relatively complicated and seems unsuitable for habitation compared with Leang Burung 1, 2 or Leang Sakapao 1, however, it is flat under the drip line.

The brightness inside the caves is divided by caves or by the sections in the caves. Generally, it seems that if caves have a bigger mouth, the light penetrates deeper into the cave, however, if the cave consists of some chambers and the passage to each is small, naturally inside the rooms is completely dark. As a whole, there were no caves lit by natural light that penetrated to the deepest wall. Most of the shells and stone tools were scattered around the comparatively bright place near the drip line.

It is supposed that the inhabitants cave usage focused on the front space of the cave that was flat, bright, and protected from wind and rain. This is supported by the fact that they have flat, bright, large areas around the entrance in common to some degree, although the eleven caves have a varied topography that is difficult to classify.

### 2. Accessibility and cave use

Most of the caves are not difficult to access because if they are not located at the same altitude as the surrounding alluvial area, their entrance and alluvial flat plain connects with a relatively gentle slope like Leang Jarie (Fig.18). McDonald (1976: pp.85-89) shows the types of slopes, which appear in karstic area in this region.

On the other hand, there are caves located high on the cliff-side. Leang Sakapao 1 is reported as 70m further up from the base of the limestone cliff (Bulbeck et al. 2004 : pp.113). There is no gentle slope between the cave and hill base (Fig.15a), In

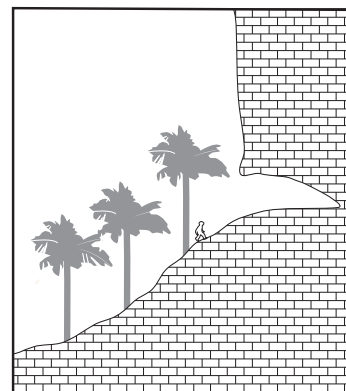


Fig.18 Landform in front of Leang Jarie (Illustration by A. Ikarashi)



addition there are big gaps between its floor level and the pass in front of the cave (Fig.15b) therefore, accessibility is worse than other hill base caves. However, this higher cave has a good view compared with other caves.

Chazine (2005) reported about twenty-seven caves and rock shelters in Sarawak cave sites along the Merang River, East Kalimantan. He focused on the altitude of the caves, and insisted that the caves were divided into three categories according to their altitude and archaeological characteristics. According to his report, painted sites were located in higher places, funerary sites are in the middle and the domestic sites are in the lower regions. In this case, a domestic site is defined a caves which contains food refuse, stone flakes, charcoal and potsherds.

In case of the eleven caves in Maros and Pangkep, Mulyadi (2016) has reported many caves have both cave paintings on their walls or ceilings and stone tools and shells around the cave mouth though the altitudes of the caves are different (Mulyadi 2016). Therefore, it seems difficult to classify the eleven sites by their archaeological characteristics and the caves altitudes differ from the East Kalimantan sites.

Chazine (2005) indicated that the domestic sites are large rock shelters located at the foot of the cliffs, and they have a dried, flat surface. Yet, the eleven caves in South Sulawesi appear to show slightly different characteristics particularly in terms of altitude and complicated topography in the deep areas of the cave.

It is unclear with present limited information as to why the caves located higher up the cliff were used in spite of accessibility difficulties, for example, Leang Sakapao 1. This cave was excavated and was possibly occupied about 31,000 years ago to 25,000 years ago (Bulbeck et al. 2004). Stone tools and shells were reported from the excavation (Bulbeck et al. 2004). Cave paintings were also seen on the walls and ceilings.

In the case of this cave site, it seems that the cave occupants put comfort before accessibility concerns because this cave has a flat, extensive interior, and light penetrates deeper into the cave from its large cave mouth. In addition, another reason for occupation is the presence of a river and siliceous rock outcrops in the valley and surrounding hills where the cave is located. According to previous research (Penyusun 2011, Permena 2014, Mulyadi 2016), there are no other caves in this valley except Sakapao 1, 2, 3 (Fig.8), and it is assumed that Sakapao 1 was the most suitable cave near this valley in spite of its height.

Futhermore, as explained above, the presence of cave paintings also characterizes these archaeological sites. In contrast to the Kalimantan sites, these paintings co-occur with other artifacts and food refuges (Mulyadi 2016). The hand stencils appeared in rather dark and not easily accessible places in each cave. For instance, they are painted on small crevasses near the main chamber of Leang Burung 2, and on the low ceiling in a small and dark chamber of Leang Sampeang. Particularly, paintings of Leang Peta Kere seemed to be painted on the most difficult place (Fig.11b). It is about 20m higher from the surrounding flat space.

Of course, the influence of weathering should be taken into account however, these characteristics

related to painting place might be intentional. If so, the cave users in this region might have defined space categories in caves into, 'painting space' or 'living space' according to the darkness and micro-landforms of each caves in contrast to the example of Chazine (2005).

## VI. Landscape and Natural Resources

### 1. Acquisition of stone resources

The stone artifacts are made of siliceous rock, which is contained in limestone as a block or a plat because it shows light and shade concentrically. The source of these siliceous rocks has been mentioned in previous studies; a small stream bed in front of Karassak cave (Glover 1981) (Fig. 7) and bed of the Patunuang Asue River (Leang burung 2). However, in this field study, limestone containing siliceous rocks was not found near the cave sites in Maros. On the other hand, there was a small outcrop that showed siliceous nodules near Leang Sakapao, Pangkep (Fig. 19a). However, the nodules are mainly black, while the stone tools collected from the open air site near the outcrop are cream or orange in color. Therefore, it is not definite if there is a connection between the outcrop and stone tools. Overall, the cave concentration area does not appear to be stone source concentration area.

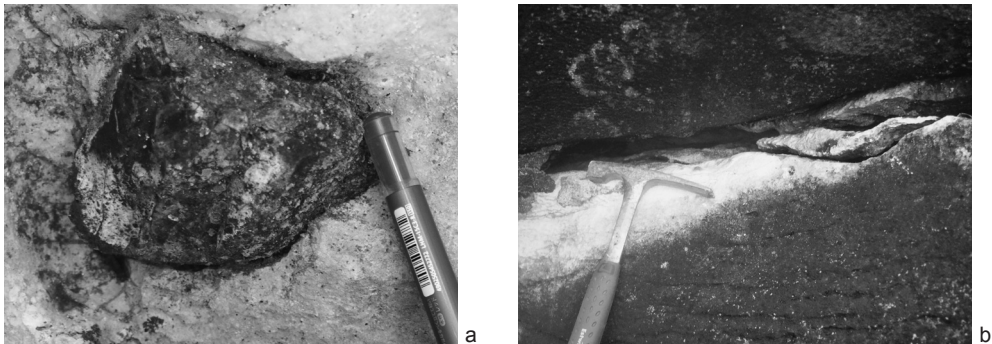


Fig. 19a: Outcrop of bedded limestone including siliceous nodules near Leang Sakapao. (Photograph by A. Ikarashi)  
b: Siliceous nodules from the Tille site. (Photograph by A. Ikarashi)



Fig. 20: General image of an open air site called Tille site on Rala. Rala is the village name. (Photograph by A. Ikarashi)

According to researchers from Balai Arkeologi Makassar, the source concentration area is located in the Barru Regency, north of Maros and Pangkep (Fig.2). One open air site (siliceous rock containing outcrop and a stone tool workshop) is near a village called Rala. The location is S 04° 50' 03.6" E 119° 36' 09.5". The name of this site is unclear, but sites around this area are generally called the Tille sites. The site is on a limestone hill. Altitude is about 250m to 300m. A lot of stone flakes and cores are scattered on the gentle slope over approximately more than a hundred square meters (Fig.20). Bedded limestone outcrops on the north side of the slope. Siliceous nodules appear along particular beds, and the size is bigger than the bed near Leng Sakapao (Fig.19b). Fig.21a, b shows the stone artifacts retrieved from this site. Fig.21a is a core from this site. The other flakes retrieved from the same site indicate that they are core-preparation flakes exfoliated from the core like Fig.20a. Owing to the weathering condition of the surface, it is suggested that all samples from this site were created during the same period. Fig.21b shows one of the flakes, which was classified as a pseudo-levallois point (Classified by Emeritus Professor Katsuhiko Onuma, Kokushikan University).

The relationship between cave sites and the Tille sites is unclear. Therefore, further study is needed to reveal the source of the stone tools present at the cave sites.

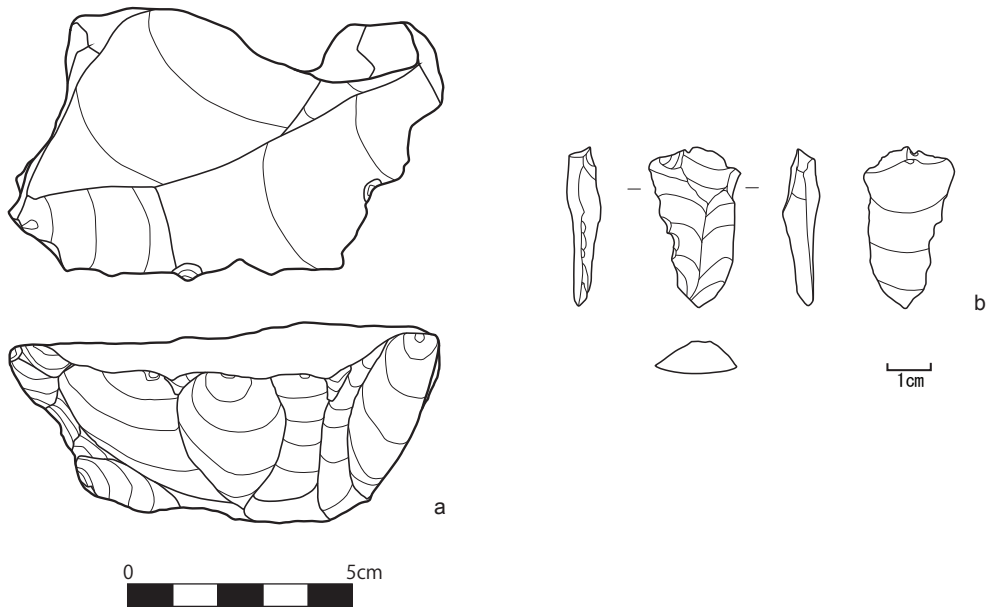


Fig.21 Stone artifacts of Tille site near Rala a: core b: pseudo-levallois point (Illustration by A. Ikarashi)

## 2. Sea level change and transition of food resources

The influences of late Pleistocene to early Holocene climate change on prehistoric cultures have been discussed through sites in Southeast Asia. Lipuun Point cave sites in the Philippines, for instance, show a change in excavated shellfish from freshwater species to brackish and saltwater species relating to the transgressive event in the early Holocene. Moreover, some caves show the beginning and end of cave occupancy associated with the timing of climate change (Imamura 2001). Another study carried out in Khao Toh rock shelter, Peninsular Thailand, by Marwick et al. (2017) reports that the peaks of excavated *Neoradina prasongi*, freshwater shellfish, occurred around 9,000 years ago and 3,000 years ago, and suggest that these peaks probably related to the low sea level of the early Holocene and around 3,000 years ago.

In the South Sulawesi cave sites, the influence of climate change is implied by previous studies. Bulbeck et al. (2004) supposed that the abandonment of Leang Sakapao 1 and Leang Burung 2 before the Last Glacial Maximum reflects the regressive phase of the late Pleistocene, and resulted in the karstic area becoming an unattractive region for people. Further, he considers that the transgressive phase of early Holocene influenced the reutilization of the karstic region and the change in regional economic system. In his discussion, he introduces water depth around South Sulawesi as evidence of this idea (Bulbeck et al. 2004) (Fig.21).

The flat topography of eastern part of South Sulawesi and a stretch of shallow water indicates easy landscape modification due to sea level change.

While Bulbeck suggested the cave use reflected the environment change around the Patunuang Asue River, analysis of excavated shells also implies landscape and economy change as a result of climate change. Glover suggested that a few shellfish from Leang Burung 2 were related to the long distance between coast and the cave sites (Glover 1981: p.50). On the other hand, some saline species were reported from Ulu Leang 1 in Maros (Glover 1981, Clason 1989). According to Glover (1981), the increase in marine and saline shells after the early Holocene would be interpreted as a result of sea level change. Further, some shells collected through this field study appear to represent marine or saline species (Table.2). If they were formally identified as belonging to a marine species, their occurrence on the cave surface would support the idea that people began to use marine resources following improvement in accessibility to the shoreline. However, the fact that the excavated shells from Leang Sakapao 1, Leang Burung 2, and Ulu Leang 1 belonged to fresh water species and the large quantity of *Brotia perfecta* sediments indicates that shellfish resources were mainly collected from inland fresh water rather than the shore line.

The presence of detailed information about sea level change around cave sites, could suggest that more detailed fluctuation would be shown in marine shell occurrence.

Table.2 Shells collected from the caves

Species	Habitat	Site (N)
<i>Tylomelania</i> sp.	freshwater	Burung 1,2 (4), Sakapao 1(5)
Neritidae	saline and freshwater	Burung 1,2 (2)
Naticidae	saline and brakish water	Sakapao 1 (2)
Mactridae	saline water	Burung 1,2 (4)
Archidae <i>Anadara</i> sp.	brakish water	Lompoa (2)
Anomiidae	saline water	Lompoa (1)
Anomiidae <i>Placuna ehipivium</i>	brakish water	Lompoa (1)

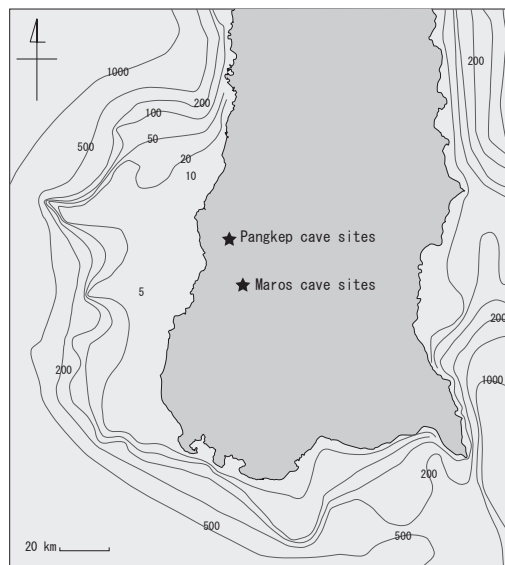


Fig.22 Sea depth around South Sulawesi (Source: the Naviconics Webapp) (Illustration by A. Ikarashi)

## VII. Conclusion

South Sulawesi Cave sites were mainly located at the foot of accessible cliffs, but also on cliff faces. The occurrence of shells and stone flakes indicates that they were used as occupation sites. Despite inconvenient locations or limited suitability for daily life inside the cave chambers, all cave sites appeared to have flat and bright areas around the cave mouths. Overall, prehistoric cave users might prefer such caves, and might use not-accessible caves under certain circumstances if the caves satisfy other conditions. As the above suggests when considering cave use, light and flatness would be important factors as well as accessibility. The dark or uneven interior of the caves, however, also suggests specific utilization because of the occurrences of hand stencils and paintings of wild pig-like animals on space, which is dark or difficult to reach.

A lot of stone flakes and shells were found in front of the caves. The lithic material used for stone artifacts are siliceous nodules concentrated in limestone. It is also important to determine the origin of stone resources; however, these details have not been determined in previous studies. This paper, reports a workshop site in the Barru Regency, but further research is required in order to determine the location of these stone resources and their relationship to human mobility or trading. From the present information, cave users would have used cave sites for gathering food resources as animals or plants ranged in forest areas rather than for sourcing stone raw materials, as the density of limestone with the siliceous nodules appears low.

The presence of marine shells from the cave surface and deposits after 8,000 years could be related to the transgressive marine event and food resource change. Cave users basically depended on inland, fresh water resources; however, they might have utilized the marine shells following the improvement in accessibility to the shoreline or brackish water.

Further research on the restoration of the coastline and vegetation along with the excavation of caves and dating of cave paintings could reveal more detailed changes in the landscape and human subsistence patterns.

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