

PAPER • OPEN ACCESS

Broken painting in the prehistoric cave and chemical content of paint used in Maros Regency, South Sulawesi

To cite this article: A Thosibo *et al* 2019 *J. Phys.: Conf. Ser.* **1341** 032047

View the [article online](#) for updates and enhancements.



IOP | ebooks™

Bringing you innovative digital publishing with leading voices to create your essential collection of books in STEM research.

Start exploring the [collection](#) - download the first chapter of every title for free.

Broken painting in the prehistoric cave and chemical content of paint used in Maros Regency, South Sulawesi

A Thosibo¹, N H Soekamto², A Duli¹ and Y Mulyadi¹

¹Archeologi Department, Faculty of Humanities, Jl. Perintis Kemerdekaan, Km 10, Tamalanrea, Makassar 90245, Indonesia

²Department of Chemistry, Hasanuddin University, Jl. Perintis Kemerdekaan, Km 10, Tamalanrea, Makassar 90245, Indonesia

E-mail: anwar_thosibo@yahoo.com

Abstract . An examination have been done of the cause of damage to the prehistoric paintings in Maros South Sulawesi. The cause of the damage is besides human factors, natural factors are the main cause. A total of 4 prehistoric caves as samples where four painting colors (red, black, brown and white) were taken. After being observed, it can be seen that the form of damage consists of peeling painting paint, weathering the rock where the painting is, and erosion. The method used is by gouging out damaged paintings as samples and analyzing these samples using X-Ray Fluorescence (XRF) and X-Ray Diffraction (XRD) instruments. Based on XRF and XRD data analysis, these colors contain compounds CaO, SO₃, Cl, P₂O₅, V₂O₅, Nb₂O₅, MoO₃, SiO₃, Fe₂O₃, TiO₂, Nb₂O₅, dan Sb₂O₃.

The results of the analysis show that in general the main content of all paint paintings from different locations is CaO and SO₃ . This indicates that the measured paint contains a lot of lime. Other chemical components contained are reddish brown Fe₂O₃. This compound contributes to the color of red, brown and one black painting.

Based on the results of elution absorption and color reactions, paints of red and black are not derived from human or animal blood. The results of this study provide useful information about the composition of the compounds used to produce prehistoric painting paints, which can later be reproduced and utilized in the context of conservation and restoration of damaged paintings.

1. Introduction

The Republic of Indonesia is rich in natural resources and cultural resources that can be used to advance science and improve people's welfare. One area that contains a lot of cultural resources in South Sulawesi Province is the limestone mountain range Maros [1]. In this region there are approximately one hundred caves which in prehistoric times were inhabited by humans.

For the first time, the existence of caves in Maros revealed by two Swiss nationals are natural explorers Paul and Fritz Sarasin in his book "Reisen in Celebes" in 1905. Forty -five years later (1950), van Heeren Palm Heekeren and find paintings of pigs deer and red palms paintings in the cave. Elsewhere, a similar painting was also found by the Frobenius expedition team who were looking for prehistoric paintings on stone walls along the west coast of Papua led by Josep Roder in 1938. The stone wall where the painting was later named "Ancient Culture Walls" [2].

In all places in the world where paintings are found [3], the pattern of painting arrangement is not broken and looks like a burning frenzy of all time. All of them are separate words and shouts that are expressed without a relationship that can be seen [4] .



There is an amazing thought that prehistoric humans of cave dwellers were basically the same kind of creature, even though all were in different times and spaces but experienced the same desires and reacted life with the same spirit. To determine the time of making the painting, Van Heekeren tried to connect the prehistoric paintings on the stone from Indonesia with the Middle Stone Period (Mesolithic Age), but Roder suspected that some might only be three or four centuries old, while the oldest might be up to 1000 years [5].

The prehistoric humans of cave dwellers in Maros and Papua are basically the same kind of creature, even though both are within a different time and space but experience the same desire and react to life with the same spirit. Because the pattern of arrangement of paintings made does not experience regularity, then all such separate words are expressed without relationships that can be seen.

To determine the time of making the painting, Van Heekeren tried to connect the prehistoric paintings on the stone from Indonesia with the Middle Stone Period (Mesolithic Age). If Roder suspects that the oldest prehistoric paintings might be 1000 years old (Claire Holt, 2000: 3). then Aubert (2014) based on the results of research with an absolute dating tool produced a minimum age of paintings at Maros 39,900 years ago.

After thousands of years left behind, now cave paintings in the limestone mountains of Maros have been damaged. Damage can be identified by visible cracks found in the painting. In addition to cracks, the color of the painting is no longer clear even some have faded same as in France [6]. The most worrying condition is the emergence of chemical weathering which causes the peeling of the rock surface skin. As a result, there were several parts of the painting that were released and disappeared and even the shape of the drawing was not recognized.

Therefore, knowledge about the chemical content contained in the basic color of the painting is needed for conservation and preservation purposes. Various benefits can be taken if the question about the chemical content used in coloring the painting can be revealed. These benefits, among others, can be used as a reference in restoring paintings that peel or disappear if needed. For this reason, cooperation with other scientific disciplines is needed, especially in the field of natural chemical.

2. Materials and Methods

2.1 Observation and Sampling.

A minimum of 4 (four) caves were selected for sampling from the Maros karst area of South Sulawesi. The sampling site is a large cave, somewhat hidden and far from the crowds because it is alleged that I have more paintings.

Data regarding cave samples such as location, altitude and direction are recorded and documented. Cave samples that have been selected are then cleaned and marked or labeled. The paintings on the cave wall that were damaged were ready to be identified as the damage.

During observation and selection of cave samples, the researcher recorded data in the form of notes, pictures, maps, forms, photos and videos both on the site and on the state of the surrounding environment.

2.2. Initial Search for Causes of Painting Damage.

The condition of the walls of the cave in the study area is overgrown by creeping plants, fungi and as a nest for various limestone mountain animals. There are also a number of markers, color paint and sharp objects scratched due to vandalism of humans who visit many caves, and there are many other causes of damage [7] . This situation has led to the need to trace the damaged paintings and what caused the damage.

2.3 Determination of the chemical components of the color of the Painting

Determination of chemical components in the color of the painting was measured using XRF and XRD instruments. In addition to analyzing the chemical components of the color of the painting,

analysis was also carried out in the form of absorption and color reactions to find out whether the color came from blood or not.

3. Discussion

3.1 Prehistoric Cave in Maros Regency.

3.1.1 Gua Jing

Gua Jing is located 04O 59 '27.2 "LS and 119O 38' 58.3" BT with a height of 48 meters above sea level. Located \pm 12 m east of Balang Cave. Indeed, this cave is on a vertical cliff wall with a height of \pm 8 m above the foot of the hill, so to reach it must climb perpendicular. There are two doors on both ends of the hall which are approximately 30 meters long, each measuring 3 meters wide. The cave, which has two doors facing south, is actually only a cavity from a main cave in the east which is then called Gua Barugaya. The two caves are connected by other cavities, so if you enter through the cave Jing can go out in Barugaya cave or vice versa. Gua Jing's cavity is quite dark, the air temperature ranges from 24-27°C with humidity ranging from 70-80%



Figure 1 Jing Cave

The accumulation of archaeological remains observed at this site consisted only of cave paintings mounted on a fairly black cave wall, while other remains such as stone tools and kitchen waste were not obtained. Convincing wall paintings as bird images, human images and palm stamp images all of which use red. Bird images and human images are worked out in a way outlined, while for the palm of the hand is done by splashing colorful liquid on the back of the hand which is first arranged above the surface of the stone wall. The results of observations made, 45 images of the palm of the hand were displayed. Laying paintings on cavity walls has a long pattern that impresses like a diorama.

3.1.2 Barugaya Cave

Gua Barugaya consists of two caves, both of which are only 40 meters away, which in the site inventory list are named Gua Barugaya I and Gua Barugaya II. The two caves are to the east of Leang Jing within \pm 250 meters which are connected by a cavity, so that the two caves can be accessed without having to go down to the passing yard at the foot of the hill. Leang Barugaya facing north is in the position of astronomic 04⁰ 59 '42.0 "LS and 119⁰ 39' 24.0" BT, with an altitude of 45 m above sea level.

Barugaya Cave is included in the category of burly cave type which is marked by the number of interconnected cavities, the emergence of pillars around the cave door, the travertine process that covers the cave floor and gives rise to some flow stones so that my floor seems to be very moving. The cave door is quite wide \pm 30 meters resulting in air temperature in the cave fresher ranges from 26-29 degrees. The humidity of the cave cavity ranges from 65-75%, while the moisture of the cave walls ranges from 20-26%.

The accumulation of archaeological data observed at this site consists of cave frescoes, microlite stone tools, kitchen waste dumps, cave wall paintings identified as red palm stamp images. The image of the palm of the hand is generally placed on the ceiling and wall of the cave that is done by splashing red liquid on the back of the palm of the hand which is first placed on the surface of the stone skin.



Figure 2 Barugayya Cave

3.1.3 Uluwae Cave

Uluwae Cave is at position $04^{\circ} 59' 04.0''$ LS and $119^{\circ} 40' 23.1''$ BT with a height of 65 meters above sea level. While the height of the ground in front is only around 2 meters. The cave facing southwest has a door size that is high and 10 meters wide and 20 meters wide. The distribution of land in front of the cave is traced as a sloping courtyard with a width of ± 3 m and on top of it are many in situ stones. This court is right at the door of the cave. Then the narrow land is limited by a basin that functions as a watershed. The outermost part of the distribution of land in front of the cave is a stretch of rice fields that produce only when the rainy season lasts [8].



Figure 3 Uluwae Cave

Uluwae Cave is included in the category of burly caves which is characterized by the travertine process that occurs inside it. Therefore quite a lot of stalagmite and stalactic are seen in the cave cavity. The average air temperature in the cave cavity ranges from $\pm 28^{\circ}\text{C}$ with an average humidity of 70%, while the average humidity of the cave walls ranges from 12-20%. The painting found in Uluwae is in the form of 14 pieces of palms. The pictures of the palms were originally red but because they had undergone fading so that some of them were memorable as if they were white and those with a black impression.

3.1.4 Lambatorang Cave

Lambatorang Cave is located in Bulu Lambatorang cluster. In fact, there are 2 caves in Lambatorang and one of them is located in the belly of a cliff that reaches 40 meters high which is very difficult to reach. Therefore the data used here is only to the cave which is at the foot of the hill.

Administratively Lambatorang Cave is located in Borongpao Village, Bungaeja Village, Bantimurung District. Located to the north of the Leang Leang Prehistoric Park with a distance of ± 1.3 km. Affordability of the location is easily reached by using a two-wheeled vehicle via a road that passes in front of Leang Leang Prehistoric Park and turns east into the path towards the Lambatorang Elementary School building. Behind this school building Lambatorang hill stood.



Figure 4 Lambatorang Cave

Lambatorang Cave is at $04^{\circ} 58' 16''$ LS and $119^{\circ} 39' 58''$ BT with a height of 60 m above sea level. The cave facing the northwest has a door that is 6 meters high and 12 meters wide and is 6 meters above the ground in front of it. The distribution of land in front of the cave can be traced to a courtyard located right in front of the cave. In this part of the courtyard there are many insitu stones and some trees that grow on the outer side. Lambatorang Cave is included in the category of burly cave type which is characterized by vertical fractures and the occurrence of the travertine process in the ceiling of the cave. As a burly cave, the air temperature in it ranges from $26-28^{\circ}\text{C}$ with cavity humidity ranging from 75-85%.

The accumulation of archaeological data observed at this site consists of cave paintings, microlite stone tools and the remains of seashells as kitchen waste. The wall painting I identified was in the form of 4 red palm prints.

3.2. Factors Causing Painting Damage

The description in this section refers to the results of observations during observations which are then presented in the form of general descriptions, related to the damage and potential threats that occur in this region. The measurement data is related to the temperature and humidity level as well as the flora and fauna of each cave displayed in the form of a table in the appendix to this report. Damage factors are divided into two categories, namely natural factors and human factors.

3.2.1. Natural Factors

Paintings on prehistoric cave walls generally suffer the same damage, namely peeling and sedimentation. Besides that in some places the color of the painting fades, especially the paintings that are located on the front wall of the mouth of the cave.

Damage to cave paintings is caused by a large temperature change in a day. Temperatures rise high during the day and drop sharply at night. When rocks are exposed to heat and expand during the day, then cool and contract at night, pressure is often experienced by the outer layer. Pressure causes the outer layer of rock to peel off and become a thin layer. Although this damage is caused mainly by changes in temperature, this process is also exacerbated by the presence of high humidity. This allegation is reinforced by the fact that the paintings in the mouth of the cave (open) have a higher level of damage than those on the inside of the cave. But it cannot be denied that almost all the

paintings in front of cave suffered severe damage, both of which were still in good vegetation. This is caused by increasingly uncertain weather changes and of course global warming factors.

In the rainy season the mouth of the cave that is unprotected will be exposed to rain continuously. Water that reacts with carbon dioxide can form carbonic acid, flows through the rock surface that has a painting, causing damage to the painting. In addition, the surface of the rock exposed to rainwater will grow moss / algae / fungi (higher plants). The growth of moss / algae / fungus is accelerated by sun exposure. With the help of sunlight the photosynthesis process can take place quickly which spurs the development of green plants. Some plants can create chemical weathering through the release of acidic compounds, namely moss on the roots.

High levels of plant growth also occur in caves located near rice fields / water. This is due to evaporation of the surrounding water, causing the cave environment to become moist and accelerate the growth of high-level plants (moss / algae).

In the rainy season, the rock surface will experience biological weathering accompanied by the formation of moss layers. In the dry season the surface will be exposed to sunlight continuously resulting in evaporation of water and plants on the rock surface will die. This dead plant will leave a blackish green layer on the rock surface. The decay of dead plants in rock layers can form organic acids which, if dissolved in water during the next rainy season, cause chemical weathering. The release of chelate compounds can easily affect the rocks around it and can cause leaching of great rock layers resulting in peeling of the surface layer.

3.2.2. Human Factors

The degradation of ecosystems in the karst mountains in Maros occurs due to the felling of trees around the karst environment which can disrupt the balance of the karst mountain environment which causes great changes. In the beginning, environmental changes were still in nature's ability to recover naturally, but more and more it caused a lot of environmental changes. Environmental changes that occur often can still be tolerated, but the greater the changes eventually lead to clear and meaningful losses. Cutting down trees around the karst environment can be one of the factors causing damage to paintings in the cave such as soil degradation and erosion, sedimentation in caves, and decreasing water quality.

The cave is an inseparable part of the environment outside the cave causing changes that occur outside the cave to be very influential on the cave environment. Changes in the outer environment of the cave will affect the availability of feed sources in the cave. The occurrence of land changes such as illegal logging or deforestation greatly influences the availability of guano produced by bats and influences the availability of water in caves through fracture cracking systems which causes changes in microclimate conditions in caves that affect the decomposition and development of important microorganisms as energy sources main in the cave. In relation to preservation of prehistoric caves, logging trees around caves for plantations and the close of houses around the cave can cause changes in the microclimate (temperature, humidity) and seepage water quality that enters and flows on the walls of the cave. This is related to the increasing content of carbon dioxide in the air. The higher the content of carbon dioxide in the air the karstification process (dissolution of lime) will also increase.

In some prehistoric caves in this region, there has been a change in the environment around the cave, which caused the cave environment to be open and unprotected by vegetation. This makes it easy for sunlight to enter the cave without any obstructions and about painting directly. Paintings that are exposed to sunlight continuously and for a long time can be one of the factors that accelerates weathering on the walls of the cave. Besides that, with the opening of the environment it also makes it easier for the wind to enter the cave directly regarding the painting. This factor accelerates the exfoliation of the outermost layer of the cave wall which contains paintings that have undergone weathering. From field data shows that the condition of painting damage that is quite severe mainly occurs in paintings located on the mouth of the cave and not protected by stalactites, trees and so forth. Cave wall damage is thought to be caused by contact with a significantly different atmosphere in the wet and dry seasons. Damage to cave wall paintings that occur among them is the peeling of the walls

of the cave in the painting. The growth of moss / algae covering the paintings and paintings was erased by the flow of rain water passing through the painting.

There are large temperature fluctuations in a day both in the dry season and the rainy season, where temperatures rise high during the day and drop sharply at night. When rocks are exposed to heat and expand during the day, then cool and contract at night, stress (stress) is often experienced by the outer layer. The pressure causes the outer layer of rock to peel off into a thin layer. Although this thermal expansion is caused mainly by changes in temperature, this process is also exacerbated by the presence of high moisture (highly moisture) . This allegation is reinforced by the fact that the painting in the mouth of the cave (open) has a higher level of damage than the one inside the cave.

In the rainy season the mouth of the cave that is unprotected will be exposed to rain continuously. Rainwater can be acidic because atmospheric carbon dioxide dissolves in rainwater to produce carbonic acid. In an unpolluted environment, the pH of rainwater is around 5.6. This oxide in rain water produces strong acids and decreases pH to 4.5 or 3.0. This sulfur dioxide can come from polluted environments due to exhaust gases from motorized vehicles. Acidic rainwater can cause weathering in the outer layer / surface of rocks exposed to rainwater. This is made worse by the condition of the courtyard and access to several caves that are flooded during the rainy season, so that the humidity level increases.

3.3. Determination of the chemical components of the color of the Painting

Analysis of measurement data with XRF and XRD instruments containing compounds CaO, SO₃, Cl, P₂O₅, V₂O₅, Nb₂O₅, MoO₃, SiO₃, Fe₂O₃, TiO₂, Nb₂O₅, Sb₂O₃. In each color from different locations in general the largest content is CaO and SO₃. This identifies that the measured color sample contains a lot of lime from the wall where the painting is located.

Another chemical component contained in the color of the painting is Fe₂O₃ which is reddish brown. These compounds contribute to the colors of red, brown and one black painting.

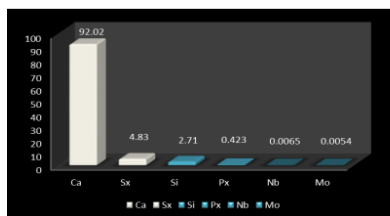


Figure 5 (a)

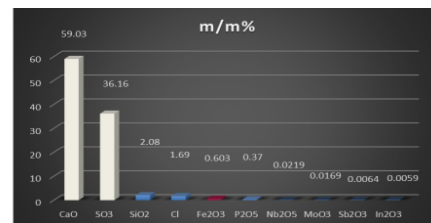


Figure 5 (b)

(a) The black color of the Lambatorang Maros Cave painting

(b) Red color of Uluwae Maros Cave paintings

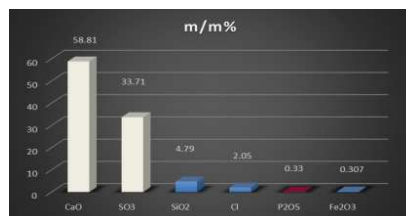


Figure 6 (a)

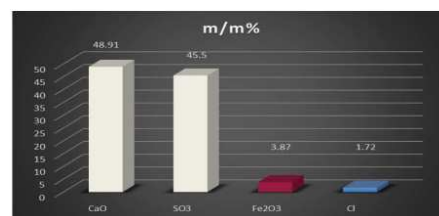


Figure 6 (b)

(a) The red color is Gua Barugayya B1 Maros painting

(b) The red color is Gua Barugayya B2 Maros painting

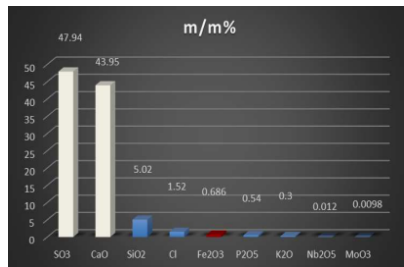


Figure 7 (a)

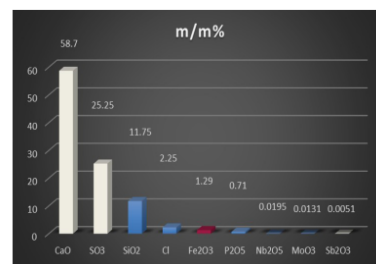


Figure 7 (b)

(a) The brown color of the Jing Jing Maros painting

(b) The black color of the Uluwae Cave painting in Maros

Figure 7(b) which is black contains Fe₂O₃ as well as in red. This is probably due to the presence of other compounds such as MoO₃.

The above description is reinforced by data from absorption analysis and color reactions that do not indicate that the color comes from blood.

4. Conclusion

1. About 60% of prehistoric cave paintings that were sampled in the Maros karst area were damaged
2. Based on the chemical components contained in the color of the painting can be known compounds that contribute to the existing colors and not from the color of blood and hematid.
3. Archaeological conservation needs to be done to restore the integrity and authenticity of damaged paintings.

Acknowledgments

We thank the University of Hasanuddin for the financial support.

References

- [1] O'Connor S, Bulbeck D and Meyer J 2018 *The Archaeology of Sulawesi: Current Research on the Pleistocene to the Historic Period* (ANU Press)
- [2] Heekeren V H R The Stone Age of Indonesia | Ian Glover | Request PDF
- [3] Taçon P S C, Tan N H, O'Connor S, Xueping J, Gang L, Curnoe D, Bulbeck D, Hakim B, Sumantri I, Than H, Sokrihy I, Chia S, Khun-Neay K and Kong S 2014 The global implications of the early surviving rock art of greater Southeast Asia *Antiquity* **88** 1050–64
- [4] Permana R C E 2014 *Gambar tangan gua-gua prasejarah: Maros-Pangkep, Sulawesi Selatan* (Jakarta, Jakarta Selatan: Wedatama Widya Sastra)
- [5] Holt Claire S R M Melacak Jejak Perkembangan Seni di Indonesia /Claire Holt, R.M. Soedarsono
- [6] Parker S 2018 *Painting the Prehistoric Body in Late Nineteenth-Century France* (Rowman & Littlefield)

- [7] Said A M 2013 *Refleksi 100 Tahun Lembaga Purbakala Makassar 1913-2013: Pengelolaan Pelestarian Cagar Budaya* (Direktorat Jenderal Kebudayaan)
- [8] Glover I 1986 *Archaeology in Eastern Timor, 1966-67* (Dept. of Prehistory, Research School of Pacific Studies, Australian National University)