











# The Iron Civilization of Matano Lake, South Sulawesi: Paleometallic to Historical Periods

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**Abstract.** Artifacts of funnel axes, which characterize the paleometallic period, were found in Lake Matano. The discovery of several weapons in the form of kris, machetes, knives, daggers (*badik*) shows that the Matano area is a metal-producing area. In the Nagarakrtagama Manuscript, it is stated that the Majapahit Kingdom imported metal from Matano to make weapons. However, not much archaeological evidence has been found to know the pattern of development of ancient metal processing activities. This study aims to obtain information about the early development of iron age culture in the Lake Matano Region and innovations in the field of archeometallurgy that our ancestors once possessed. Through land and underwater explorations, it is known that there are traces of iron processing. The results of dating analysis show that metal processing in the Lake Matano area was carried out continuously from the 8th to the 18th centuries AD.

**Keywords:** paleometallic · archeometallurgy · Iron Age · Lake Matano

## 1 Introduction

One of the oldest iron artifacts in Indonesia was found in the Lake Matano area, East Luwu, South Sulawesi. Funnel ax artifacts that characterize the paleometallic period were found in Lake Matano. The metal material is non-corrosive. Other finds in the form of weapons, such as kris, machetes, knives, and daggers indicate that the Matano area was a metal producer.

In the Nagarakrtagama Manuscript it is stated that the Majapahit Kingdom imported metal from this area to be used as weapons. Even until today, the Lake Matano area

is still a national strategic area as a source of iron and nickel, which is currently being managed by Vale Indonesia Incorporated Company.

The findings in the form of funnel axes, kris, daggers (*badik*), and the like show the development of metal processing activities from the paleometallic period to the present in Matano. However, more archaeological evidences still need to be sought to determine patterns of development of metal processing activities in this region. Therefore, this study aims to obtain initial information on the development of iron age culture in the Lake Matano Region. The aim is to reconstruct the metal processing activities of the Lake Matano community in the past and increase knowledge about innovations in the field of metallurgy that our ancestors in Indonesia had.

This research was conducted by collecting data through archaeological excavations on the shores of the lake, underwater exploration, and ethnographic studies. During this research were found remains of iron artifacts, pottery, and charcoal which indicated the processing of iron.

Information that is important to know is the early knowledge about the emergence of iron in Matano as evidenced by findings of traces of metal processing. The data is needed to provide an overview of the beginnings of the iron civilization in the archipelago by revealing the availability of iron mineral natural resources, the ability to process iron ore for various purposes, and the social organization of metal processing which was arranged to reach an industrial scale.

Given the high demand for Matano metal in the past, it shows that Matano had a fairly advanced metal civilization. The Majapahit Kingdom in Java also imported iron and weapons equipment from this area. Negarakertagama books [1–3], write about this. It is not impossible that the Lake Matano area has supplied iron and nickel to the archipelago long before the existence of the Majapahit Empire.

The periodization of metals in the Archipelago began with the copper age, which was a mixture of bronze and brass. The copper used was originally a pure metal (native copper) which is available in nature. This type of metal is not so hard and the process of working was forging techniques to produce certain shapes. Metalworking like this is called a continuation of the stone age [4, 5] With the mastery of fire technology, rocks containing pure metals are heated to a certain temperature (over 1000 ° C). The metal melts and can be used to shape desired objects. Meanwhile, objects produced by casting technique are equipment for ceremonial or ceremonial purposes, such as ceremonial axes, bronze bells, statues, and so on.

There are not many metal smelting sites in the archipelago. The oldest metal smelting sites were found in China within a range from 475 BC to 1644 AD. Thus, the mastery of metal technology from the procurement of metal ore (mining) had started at that time [6].

Metal objects are also commonly found in burials during the Paleomatatic period as grave goods. Those metal objects were found, especially in the graves of certain people who were considered as community leaders, such as tribal chiefs or kings [7].

These metal objects are made of bronze or a metal alloy of several other metal materials through a casting or molding process.

There are presumptions that these metal objects were the result of recycling of several objects that arrived in the archipelago through the process of exchange or trade.

The presumption is strengthened by the fact that no metal smelting sites have been found and there are no or not yet known metal ore producing areas in the archipelago.

Thus, it is necessary to conduct research on areas containing metal ores in the archipelago. These areas will prove a metal civilization that was once existed, bearing in mind the many findings of weapons, daily tools, and slag or iron slag in several areas in the archipelago.

The discovery of metal and iron objects in Matano [8] and the remains of a smelting furnace in Kalimantan [9], trigger a number of questions. Some of the research questions that arise related to the issue of Matano iron culture that need to be disclosed are: What cultural remains in the Matano Lake Area that are related to the beginning of iron culture? Viewed from the aspect of time, when did the Lake Matano iron culture begin based on archaeological remains? Another question is how was the continuation of the culture of blacksmiths in the Matano area and its surroundings?

The research objectives to be achieved are to obtain information through archaeological data about the chronology in the Lake Matano Region, how were the relationships of the Matano civilization, the blacksmith community in Matano Lake with surrounding civilizations and the Majapahit Kingdom (Java) in the maritime context, as well as ways to preserve underwater archaeological potential in Matano Lake.

It is hoped that this study can find out how iron was managed in the Matano community in the past. This information can be used as a reference for the shape and character of the iron civilization in the region, especially in the management of natural resources and the organization of the iron industry at that time.

The discovery of iron or metal shows that there were groups of people who know metal. Metal objects as tools were used by people in the past to carry out various forms of work, including constructing buildings, such as temples. An example is the Borobudur Temple which is one of the wonders of the world [10].

However, we do not know exactly where the iron tools came from, due to the lack of studies on metal tools in Indonesia. However, the many findings of iron tools indicate the existence of an industry that were carried out by skilled hands or blacksmiths from Lake Matano [8, 10, 11].

## 2 Rationale of the Study

The paleometallic period is often referred to as the *perundagian* or carpentry period with the skillful making of things from certain materials. In the classical period, this skilled person or *pande* was mentioned in inscriptions, such as *pande tamwaga* to refer to a coppersmith, *pande gangsa* to refer to someone skilled and skilled in processing bronze, and *pande wesi* or ironsmith [12].

The details of the distribution of skills in metal processing show that there is specialization within the community organization, especially with the mastery of fire technology and knowledge of the composition of the materials to be processed. This shows that metal processing refers to a complexity and is reasonable if it is declared as a civilization.

In a community group with a regular organization, the activities of *pande* are very intensive, so leaders and supervisors are needed so that these activities can run smoothly

from processing to marketing. On the basis of mastery of the manufacture of this metal, the community can be called a group that controls a fairly high civilization.

This research was conducted to obtain a complete and comprehensive picture of the cultural civilization of Lake Matano in the past, as well as its relation to the early development of iron production in the archipelago. The problem is that the civilization of Lake Matano seems to have sunk and is no longer visible, even though stories about the intelligence of the Matano people in producing iron in the past are often heard.

Instructions regarding iron production activities in Matano are written in the *Negaraker-tagama* manuscript, which tells that the Majapahit Kingdom imported iron from an area called Luwu. Archaeological research results show that the *Negaraker-tagama* text is inaccurate, because the source of iron in question is not in Luwu, but in the Lake Matano Region. This is evidenced by the many findings of iron smelting remains and iron artifacts produced in Matano Lake.

The Lake Matano Civilization can be said to be one of the earliest iron industrial areas in the archipelago or perhaps in Southeast Asia. In fact, until now Lake Matano is still an industrial area for iron and nickel mining which supplies the whole world. Therefore, we want to get a complete picture of the iron civilization in Lake Matano through a comprehensive and empirical archaeological study of the social, political and economic life of the people in the past.

### 3 Materials and Methods

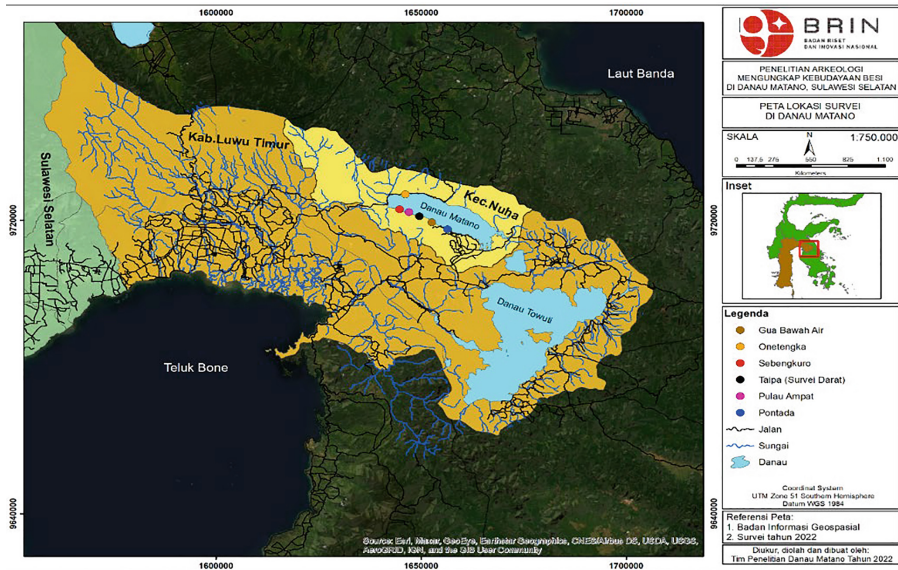
An underwater exploration of Lake Matano by the Lake Matano diving community and the University of Indonesia Mapala team managed to find many archaeological remains scattered at the bottom of Lake Matano. Several artifacts from the bottom of the lake have been secured and stored at the diving community's basecamp.

Based on information from the Matano Lake diving community, the National Research Centre of Archaeology took the initiative to examine archaeological findings at the bottom of the lake in situ. The method used is systematic underwater archaeological recording so that the context of the artifact findings can be identified and studied. In addition, land surveys and excavations were carried out in the area around the lake.

The underwater sites under study are the Pulo Ampat Site, Pontada Site, Sukooyo Site, Taipa Site, Underwater Cave Site, Sebengkuro Site, Ide Beach Site, and Onetengka Site, while the terrestrial area sites include the Rahampu'u Site, Matano Site, Sukooyo Site, and the Pontanoa Bangka Site which are located on the west coast of Lake Matano.

Data collection techniques were carried out underwater and terrestrial including excavations and surveys. The underwater technique applies the principles of underwater archeology by creating a grid in the underwater area that has been selected as an exploration area. The technique used is diving and underwater exploration, which requires special skills and is licensed (Fig. 1)

Meanwhile, in terrestrial areas, excavations are carried out with the size of the box according to needs. The area has been determined during the survey by taking into account the existing surface features and landscape forms. Excavation is carried out using a spit system (every 10 cm) combined with soil layers and using a total station to determine datum points for accurate and systematic measurements.



**Fig. 1.** Research location in Lake Matano Area (source: Matano Reseach Team 2022)

This research also involves other disciplines, such as geology to find out the geology and geography of the Matano area. During the search, a trench was also opened to find out the layers of soil.

Sampling of charcoal in underwater, terrestrial and other areas is carried out to determine the dating of the site and the past environment of the area based on the findings, for example animal remains or human remains if any. Some dating samples are carried out in a designated laboratory. Meanwhile, several other findings, such as pottery and iron slag were identified and included in the context of the findings and units of analysis for interpretation purposes.

#### 4 Data and Discussion/Interpretation

The focus of this research activity is trying to reveal the iron culture in the Matano Lake area. This research has entered its 4<sup>th</sup> phase in 2022. Previously, researches were carried out in 2016 and 2018, then in 2019, 2021, and 2022. The novelty of these researches is from 2019, 2021, to 2022 by not only focusing on archeology, but developing towards chronological information about metal civilization in the archipelago.

Such advanced civilization was obviously managed by an advanced social system with a government or kingdom called the Matano Kingdom. The king is called Mokole. Research on the cultural history of Matano needs to be continued to prove this, bearing in mind the active Matano fault, past and future earthquake activities that have to be researched (fault studies) to anticipate and mitigate disasters.

Current nickel production in the area is based on renewable energy. This production turns natural resources into prosperity for society with sustainable development through

innovation. Sustainable production also provides support for the preservation of local archaeological and cultural sites.

#### 4.1 Iron and Nickel of Matano

Archaeological and historical evidence shows that the iron civilization in Matano produced quality materials, so that it became a commodity that was widely spread throughout the country. The evidence also shows that since ancient times the Indonesian people have been able to process metal from ore in the traditional way.

In addition, ancient mining organizations can be revealed by the existence of a spiritual leader in the form of the '*tamoa*' symbol hanging on the stove. In addition, there are regional rulers (Kingdom/Kedatuan) who control raw materials. The organizational system and skills of the *pande* formed a Matano iron industry known throughout the archipelago. This industry has even continued to this day with modern managed nickel production on a world scale.

It is certain that Lake Matano Civilization is one of the earliest sites of the mass of metals, especially iron and nickel, in Indonesia and in Southeast Asia. Research results up to 2022 show that the Matano Lake Area had an iron and nickel processing industry since at least the 8th century AD and continued until the 18th century AD.

New facts also show that *pamoro Luwu* originates from Matano. This is evidenced by geological surveys and XRF analysis of raw materials, all of which are found in the Lake Matano area. From the results of our observations and research, we have an interpretation that the people of Lake Matano in the past were able to process and produce iron and nickel tools in a fairly advanced way. The proof is the processing of iron and nickel which is quite complicated, because the technique of mixing the two materials has been carried out since at least the 10th century AD (Fig. 2).

Some of the iron tools found in Matano include kris, funnel axes, daggers, iron anvils, machetes of various sizes, clamps, and agricultural tools. There are also various pottery motifs and shapes [13]. This shows that the people of Lake Matano in the past had high creativity and good taste in art. These clay objects have also been used quite massively by the people of Lake Matano. It is assumed that the pottery was used as daily objects and to support the production of metal tools (iron and nickel) in Lake Matano (Fig. 3)

An interesting thing found in the process of producing iron and nickel tools at Lake Matano is the use of chert. The manufacture of metal materials in Matano can be stated purely relying on materials from the natural environment around Lake Matano which is rich in iron minerals. It was this skill to extract rocks containing iron ore into metal raw materials that became human innovation in the past in processing nature into an industry according to the spatial scale at that time. This evidence is reinforced by the results of the XRF analysis which reveal that cluster analysis, indicator values, and principal



Fig. 2. Some metal (iron) objects from Matano. Source: Matano Research Team 2022



**Fig. 3.** Some decorative motifs on pottery from Matano. (Source: Matano Research Team, 2022)



**Fig. 4.** some appliances that were used in pottery-making and metal industry: *anvil*, *paddle*, and *crucible*. (Source: Matano Research Team, 2019-2021)

component analysis are very helpful in identifying the raw materials of an artifact. The identifications are as follows: (Fig. 4)

- The raw materials for artifacts from Lake Matano can be grouped according to type, namely stone tools, pottery, and metal weapons. The grouping was carried out by comparing the elemental concentrations of these artifacts with rock/sediment samples taken from the field.

- The raw material for stone tool artifacts is chert which is composed of silica elements which are scattered in the southern part of Matano Village, which is part of the Matano Formation.

- The raw materials for pottery artefacts, especially pottery that came from excavations in Matano Village, are a mixture of weathered clay, limestone of the Matano Formation which is spread to the southeast of Matano Village, and weathered laterite soil of ultramafic rocks in Matano Village. The elements that compose it include silica, magnesium, iron, aluminum, and calcium.

- The main candidate for metal weapons' raw materials are iron concretions present as iron capped layers of the limonite zone part of weathered ultramafic rocks. This material is scattered in the northern part of Matano Village. Besides that, other possible raw materials are laterite, iron sand, and serpentinite, which are in the north and northeast of Matano Village. This group is characterized by the element of iron as its main character. There are several other elements, such as silica, magnesium, aluminum, chromium, including nickel and vanadium, which are two very specific elements and are found in good quality steels such as Damascus steel, Syria [8].

The results of the XRF analysis show that Matano's iron artifacts have a high element of nickel which makes the weapon lighter, less rusty, and easier to forge. This is what may have caused the demand for Matano's iron weapons to be high.

The XRF method in this study can distinguish the elemental composition contained between swords that have an archaeological context made during the early iron civilization and blade fragments that have no archaeological context made today. In the context

of research on Lake Matano, this shows the need to make a determination on the characteristics of metal artefacts, including swords originating from Matano based on their concentrated elemental content.

By determining the characteristics of these metal tools, especially metal weapons, the most important thing to do next is to find out the causes of these differences in characteristics, such as whether there have been changes in the processing methods of the iron industry from time to time or whether there have been changes in the selection of raw materials used, and others. In addition, the presence of nickel and vanadium elements such as those found in Damascus steel, which was originally developed in India and Syria, raises the question of whether there is an influence from the method of processing iron from these areas to the country.

Almost similar to metal weapons, PCA analysis results show differences in the characteristics of the elemental composition between the pottery shards from the excavations at Matano Village and those from the Pontada underwater site. The results of analysis of the raw materials for pottery artifacts available in Matano are more closely related to pottery originating from Lake Matano excavations. This fact raises the question whether or not Pontada's pottery originates from outside Matano. Another possibility is that there were changes in the manufacturing methods and raw materials used in the making of Matano pottery over time.

These questions prompted the need for an elemental analysis of the pottery from each Matano site to see the characteristics of the composition, which provoked the need to carry out an elemental analysis of pottery originating from Matano. The results of this elemental analysis can be used as a consideration to study any relationships that have occurred between the Matano area and areas outside Matano.

## 4.2 Metal Workshop Village

Excavations in the Rahampuú sector prove that the metal workshop is located near the lake (beach) where the materials are sourced from the surrounding area. This metal village is surrounded by earthen ramparts that all lead to the lake. Some of the sites are among others Rahampu'u (10–14 AD); Sukoiyo, Pontanoa Bangka (16–18 AD), Fort Matano, Pontada (13–15 AD), Pulo Ampat (8 AD); as well as Sebengkuro, Onetengka, and Underwater Caves.

Pottery from Matano has different characteristics from pottery from outside Matano, including pottery from other parts of Sulawesi. The iron and nickel content of the Matano pottery is relatively higher (10 times) and the silica content is lower than pottery from outside Matano. Metal artifacts contain an average of 9% iron and 0.1 to 0.2% nickel.

The evidence of metal processing can be seen from the furnace, which is irregular in shape and composed of hardened clay besides the stone. For the process of smelting metal ores and metal-containing rocks, chert is used, which is widely available around it. Chert is made or flaked in such a way as to be used as flint. The large number of chert found in the furnace and its surroundings is strongly suspected as a material that can release the silica needed in the smelting process to increase nickel levels, so that the resulting metal is better. This of course has high economic value, because the nickel element in iron can make iron stronger and more expensive.



The nickel element can make iron stronger, resist corrosion, and add a beautiful white glow to metal objects. The specialty of Matano iron is the presence of nickel in its basic ingredients.

Likewise, the findings of pots containing iron slag mixed with charcoal and shells are strongly suspected as containers for metal ore to be marketed or exported outside the region. The technology of mixing nickel and iron was a high technology that was already mastered by the Matano people at that time, and the pottery at Matano Lake had very distinctive decorative motifs.

The results of the excavation also proved that the metal furnace was equipped with a pottery pipe which had a lot of molten metal at the end. There is also a thick, black body of pottery shards associated with the process of making metal using pottery vessels.

Analyses of the decorative motifs and the techniques of making decorative motifs shows that geometric patterns typical of prehistoric times were combined with each other to form certain patterns. The motifs are also placed at certain parts that can characterize Matano pottery. For example, decorative patterns are placed on the edges, the neck at the bottom end, and the edges with cut up technique, so that the object or container has jagged edges. Likewise with the manufacturing technique, most of which do not use a rotary wheel (potter's wheel), but instead use a hand rotation technique with paddle and anvil.

### 4.3 Dating Analysis

C14 dating analysis of the charcoal shows there is a 200 year time gap between underwater and land sites. This shows that the sites under water are older than terrestrial sites, and it is estimated that these sites are a continuation of sites that have sunk. This can also indicate that the underwater site is most likely a site that sank for a long time, which is strongly suspected as a result of tectonic processes. This phenomenon is also distinguished by the sinking of several villages as a result of the construction of three dams, namely: Laron, Balambano, and Karebbe by Vale Indonesia Incorporated Company, which began operating around 1978.

The C14 dating analysis, which shows the numbers from the 8th to 18th centuries, shows that the Matano iron village was used continuously. Production is expected to continue until outside investors arrive with PT Vale producing nickel and meeting most of the world's nickel needs. On that basis, perhaps apart from the tectonic process (shifting of the Matano Fault) that submerged the blacksmith villages, there was also an international mining company.

Currently, several areas of material sources are mining areas. In this way, the life of the people changed, namely they became miners. This has caused the potential to make iron tools obsolete and lost.

Back again to the Matano paleometallic period, there are two opinions regarding this period. First, the Neolithic period continued and was mixed with historical periods, making it difficult to identify the initial and subsequent boundaries, because they were continuous. Second, there was a rather strict boundary between the 8th and 15th centuries AD, when it was known that the production of kris as weapons and heirlooms was not used en masse, but was almost owned by all the kings in the archipelago.

There are other products, such as clamps or a kind of dowel used in the construction of temples in Cambodia. This still needs further research, including metallurgical analysis of these objects to find out their elements and composition as evidence that these objects were from Matano.

Techniques for smelting iron ore in the Matano area are still not known with certainty, although tuyere findings with molten metal at the ends are often found, both as a result of excavations in terrestrial and underwater areas. Likewise with the findings of slag and pottery shards in the vicinity.

Another excavation result is a furnace made of stone mixed with molten metal that has hardened, and the arrangement is irregular. Remains of forged furnaces can still be seen in Matano village as evidenced by an iron anvil that is 10 to 15 cm thick and measures approximately 25 x 35 cm.

Experiments carried out by the local community in Matano Village by making metal workshops (forges) commonly called *tondoho*, show recycling techniques that produce agricultural tools, while the skills of making daggers and kris weapons require special skills by ex [14]. According to the results of the latest archaeological research by the National Research Center of Archaeology, which is now the National Research and Innovation Agency (Badan Riset dan Inovasi Nasional or BRIN), the iron tools known as Pamor Luwu are strongly suspected of originating from the Lake Matano Region.

In the development of paleometallic research at various sites in Indonesia, there are also similar sites that produce iron from their ore, which are local natural resources, such as the smelting site along the Montalat river course, South Kalimantan [9]. The invention of the smelter provides a comparison of similarities and differences between smelting sites in lake and river landscapes. Regarding the different social organizations related to their natural environment, it still needs to be proven.

According to Sofyan, who also examined metal remains in the Montalat watershed based on the remains of the furnaces found, the knowledge of metal smelting was obtained from outsiders who came and interacted with local people. They shared knowledge about metal smelting, which local people naturally adapted to local natural conditions and their abilities. Based on an analysis of the forms of ancient stoves and data from archaeological research regarding archeometallurgy in Indonesia, at least the Indonesian people have been familiar with the iron metal smelting process since the 8th century AD in the Sulawesi region and in Kalimantan from the 14th century to the 19th century AD, using forging furnace technology (bloomery iron) [15].

*Bloomery iron* his also requires a bellow (*ububan*) to circulate air to increase the temperature of the fire in the iron that is being processed.

Based on the development of metallurgical research at several sites in Indonesia, at least it has shown that there are sources of materials that are owned and capable of being managed to a more complex level. However, the time period needs to be investigated further whether it is included in the beginning or several years BC, such as the findings of ancient metal sites in China. In Matano's context, this information can fill in the gaps in the chronology of the paleometallic period, which according to Heekeren has been going on since 300–200 BC [16].

The scarcity of archaeological finds at a smelting site can indicate that this site is worn out, because it is often mined, so that its original shape changed or even lost. In

the context of Matano's metal, this is thought to be due to the process of searching for metal objects that has been going on and has unknowingly changed its original shape. The second estimate is that the natural resource area containing iron ore has become a mining area that is managed in a modern way. The third estimate is that because it is located at the end of the active Matano Fault, and if this fault moves, it will have an impact on the site; it might disappear or sink into the lake.

How did the Matano people's ancestors extracted metal from its ore is also a big question for the current generation who love heirlooms (*Pompessi*) or metal objects from the heyday of Matano iron, such as daggers (*badik*), kris, machetes, and their various variants. The Pompessi organization is supported by Datu Luwu who realizes the potential of this Matano iron and is still undergoing the ritual of cleaning the heirlooms.

The interesting thing is that metal workshops are found in areas that are very far from the Matano area as a source, for example in Babang, near Palopo. To reach this area it takes four hours to drive four wheels. This reinforces the assumption that it is difficult to find the remains of the smelting workshop. Apart from being damaged and missing, there is also population displacement due to various causes other than natural disasters.

These sites must be sought in a somewhat remote area, bearing in mind that local folklore is very thick with the mastery of iron technology. Examples of folklore, such as the story of the three blacksmiths, were adapted by Mardiani Pandego, a teacher in Matano [17].

## 5 Conclusion

Research on Iron Age Civilization and Earthquake Disaster Mitigation in Matano Lake, East Luwu Regency, South Sulawesi Province, is a combination of underwater and terrestrial explorations. This research has added to the evidence that there was a Nusantara metal civilization once belonged to the Indonesian nation. The metal civilization in question utilized the natural resources around the lake. This utilization starts from metal ore processing, smelting, processing (forging), to producing a product of a tool/object.

This civilization is in accordance with what was previously mentioned by previous researchers van Heekeren (1958) [18] and Bellwood (2000) [19] that the Mori tribe who once lived in the Matano Lake Region had been processing iron since 300 BC. They were familiar with iron smelting for export. Reports about metal processing by the Mori people have only been written down and are not heard anymore, so it is not yet known what form of metal processing they had.

The story about the metal processing of Mori seemed to be lost in the history of the archipelago, which led to the emergence of the story that the metal in the archipelago (Indonesia) came from outside Indonesia, because they did not have sufficient sources of material. Meanwhile, metal objects found in the archipelago are either recycled or imported from outside. The Matano iron civilization was able to invalidate this opinion and prove that the ancient Indonesian people were able to make metal.

The metal industry in the archipelago has grown since at least the 8th century AD and has become a major industry until now with the existence of Vale Indonesia Tbk Incorporated Company. Based on the analysis of dates, it is known that metal processing in the Lake Matano area was carried out continuously from the 8th century to the 18th century AD.

## 6 Recommendations

Local knowledge of making metal using chert stones needs to be studied again as an effort to reconstruct past culture to compile the history of the Matano iron culture. Metal research in the metallurgical context to determine the metal technology of the Matano civilization has not been widely carried out, so it needs to be continued so that Matano iron as a civilization can be understood more broadly.

Efforts are needed to foster a collective memory of the iron culture that was mastered in the past in Matano. The efforts are to continue research to create a model for preserving underwater cultural remains, in addition to saving underwater archaeological remains from being depleted by visitors (divers). Another effort is to make a museum on land and in the water, so that the location of objects in it is not easily shifted or lost. This is one of the efforts to strengthen the identity (local genius) of the Indonesian nation in iron culture.

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## References

1. S. Mulyana, *Nagarakretagama dan Tafsir Sejarahnya*. Jakarta: Bharata karya Aksara, 1979.
2. S. Robson, *Desa Warnana (Nagarakrtagama)* by Mpu Prapanca, Terjemahan. Leiden: KITLV Press, 1995.
3. F. Ali and I. Sumantri, *Keadatuan Luwu*. Makassar: Lembaga Penerbitan Universitas Hasanuddin dan Institut Eynografi Indonesia, 2000.
4. T. Haryono, *Logam dan peradapan manusia (The development of prehistoric metal-work in the Javanese civilization)*. Yogyakarta: Philosophy Press, 2001.
5. H. Hodges, *An introduction to early materials and technology*. New Jersey: Humanities Press, 1995.
6. W. Qian and X. Huang, "Invention of cast iron smelting in early China: Archaeological survey and numerical simulation," *Advances in Archaeomaterials*, vol. 2, no. 1, pp. 4–14, Jun. 2021, <https://doi.org/10.1016/j.aia.2021.04.001>.
7. R. P. Soejono, *Sejarah Nasional Indonesia I (Zaman Prasejarah di Indonesia)*. Jakarta: Departemen Pendidikan dan Kebudayaan. P.N. Balai Pustaka, 2008.
8. R. Triwujani, et al., "Mengungkap Peradaban Zaman Besi dan Mitigasi Bencana Gempa di Danau Matano, Sulawesi Selatan Melalui Kajian Arkeologi," Jakarta, 2019.
9. Hartatik, H. O. Soffian, Sunarningsih, N. N. Susanto, and R. B. Sulistiyo, "The sustainability of the iron industry based on local wisdom in the Barito watershed," *IOP Conf Ser Mater Sci Eng*, vol. 980, no. 1, p. 012046, Dec. 2020, <https://doi.org/10.1088/1757-899X/980/1/012046>.
10. S. Adhityatama et al., "Pulau Ampat site: A submerged 8th century iron production village in Matano Lake, South Sulawesi, Indonesia," *Archaeological Research in Asia*, vol. 29, p. 100335, Mar. 2022, <https://doi.org/10.1016/j.ara.2021.100335>.
11. R. Triwujani and S. Adhityatama, "Mengungkap Peradaban Danau Matano, Sorowako, Masa Paelometalik Hingga Masa Sejarah, di Kabupaten Luwu, Sulawesi Selatan," Jakarta, 2018.

12. T. Haryono, “Keris dalam Sistem Budaya Masyarakat Jawa Tradisional ditinjau dari Pendekatan Arekologi dalam Keris Dalam Perspektif Keilmuan,” in *Keris Dalam perspeektif keilmuan*, Jakarta: Pusat Penelitian dan Pengembangan Kebudayaan Badan Pengembangan Sumber Daya Kebudayaan dan Pariwisata, 2008.
13. T. Wurjani, “Ragam Hias Tembikar Matano Korelasinya Dengan Tradisi Tembikar Sahuyn-Kalanay,” *PURBAWIDYA: Jurnal Penelitian dan Pengembangan Arkeologi*, vol. 7, no. 1, p. 1, Aug. 2018, <https://doi.org/10.24164/pw.v7i1.261>.
14. E. Sedyawati, “Keris Pada Masa Jawa Kuno,” in *Keris Dalam perspeektif keilmuan*, Jakarta: Kementerian Kebudayaan dan Pariwisata. Badan Pengembangan Sumber Daya Kebudayaan dan Pariwisata. Pusat Penelitian dan Pengembangan Kebudayaan, 2011.
15. H. O. Sofian, “Development of Technology Ferrous Metal Melting Furnace Ancient Times in Indonesia,” *KALPATARU*, vol. 30, no. 2, pp. 141–152, Nov. 2021, <https://doi.org/10.24832/kpt.v30i2.863>.
16. H. R. van Heekeren, *The bronze-iron age of Indonesia*. Verhandelingen, Matijnuss Nijhoff, KITLV, 1958.
17. M. Pandego, Putri Loeha dan payung saktinya, *Kumpulan Cerita Rakyat dari sekitar Danau Matano*. PT. Inco Tbk dan KPG (Kepustakaan Populer Gramedia), 2008.
18. H. R. van Heekeren, *The Bronze-Iron Age of Indonesia*. Matijnuss Nijhoff, KITLV, 1958. [https://doi.org/10.26530/OAPEN\\_613360](https://doi.org/10.26530/OAPEN_613360).
19. P. Bellwood, *Prasejarah Kepulauan Indo-Malaysia*. Jakarta: Gramedia Oustaka Utama, 2000.

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