METAL AGE AND ITS PROBLEMS IN SOUTH KALIMANTAN

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Abstrak. MASA LOGAM DAN PROBLEMATIKANYA DI KALIMANTAN SELATAN. Masa logam di Indonesia adalah suatu masa saat manusia telah mengenal teknologi pengolahan logam. Pada umumnya, peralatan logam dimanfaatkan, baik untuk keperluan sehari-hari maupun tujuan ritual. Namun, ada pula alat logam yang merupakan teknofak sekaligus ideofak. Hasil sejumlah penelitian arkeologis di wilayah Kalimantan Selatan menunjukkan bahwa data peralatan logam sangat sedikit. Oleh karena itu, penentuan mulai dikenalnya budaya logam dan varietas penggunaannya belum dapat dipahami secara komprehensif. Tulisan ini membahas sejumlah penelitian arkeologi di Kalimantan dalam upaya mengidentifikasi permasalahan yang berkaitan dengan budaya logam. Metode penelitian yang digunakan adalah deskriptif dengan penalaran induktif. Pengumpulan data dilakukan dengan studi laporan hasil penelitian Balai Arkeologi Banjarmasin, studi pustaka tentang budaya logam di Indonesia, serta studi referensi peralatan logam koleksi Museum Lambung Mangkurat. Hasil studi menunjukkan bahwa situs-situs masa logam di Kalimantan Selatan berupa bekas-bekas pemukiman dengan peninggalan budaya materialnya berupa fragmen alat besi ataupun terak besi. Namun, selain data tersebut, belum dapat diketahui lebih jauh, baik bentuk utuh alat maupun kronologinya.

Kata Kunci: masa logam, teknologi logam, budaya logam, situs masa logam, kronologi, *pyrotechnology*

***Abstract**. Metal age in Indonesia is the period when humans were familiar with metalworking. In general, metal tools were used for either everyday or ritual purposes. However, there are also metal tools which are used as ideofacts as well as technofacts. The results of a number of archaeological researches in South Kalimantan indicate that data of metal tools are very few. Therefore, the determination on the earliest use of metal tools and the varieties of its use has not been comprehensively understood. This paper discusses a number of archaeological researches in Kalimantan in the effort to identify problems related to metal culture. The research method used in this study was descriptive and inductive reasoning. Data were collected by studying research reports of the Centre for Archeology, Banjarmasin, literatures on metal culture in Indonesia as well as metal tools references of the collection of Lambung Mangkurat Museum. The results showed that metal age sites in South Kalimantan are settlements indicated by material cultures of fragments of iron tools or iron slag. Besides fragments of iron, neither the complete artefacts nor the chronology, have been identified yet.*

Keywords: metal age, metal technology, metal culture, metal age sites, chronology, pyrotechnology

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A. Introduction

The chronological framework of the prehistory of the Indonesian Archipelago was based on technological and cultural concepts. Pioneers were P.V. van Stein Callenfels, R. von Heine Geldern, A.N.J. Th A Th. van der Hoop, and H.R. van Heekeren. They built fundamental chronological periods which consecutively consists of Palaeolithic, Mesolithic, Neolithic, the Bronze and Iron Age (Soejono 1981, 12). However, this chronological framework appeared somewhat inadequate in every respect. Therefore, Soejono (1981, 14-16) refines, rearranges and modifies the old chronological model by adding a socio-economic aspect. Soejono's theory is developed from the concept of socio-economic development based on the levels of human's skill to fulfill one's daily necessities; he establishes a chronological model which is divided into four stages i.e. the simple hunting and gathering, the advanced hunting and gathering, the agricultural and the craftsmanship (or the Metal Age or perundagian or Undagi period)[1].

The simple hunting and gathering stage is characterized by massive tools and flakes. Such tools were found in various regions of Indonesia, particularly in caves. During the advanced hunting and gathering stage, artifacts were not found only in caves, but in coastal areas also. Tools which are identified to be dated from the advanced hunting and gathering stage comprise of flakes, bone and shell artifacts, and Sumatraliths[2]. During this phase, the prehistoric people began to live a more sedentary life, which enabled them to express their aesthetic and religious emotion (Soejono 2008, 180-181). The manifestation of their emotion was reflected by the creation of rock arts on the interior cave walls and the idea to bury their dead in caves.

Evidences from the early agricultural stage were found in Sumatera, Java, Bali, and the islands of Lesser Sunda. The tools made during this stage showed progress in quality, which was more elaborately worked and commonly polished. According to von Heine Geldern (1945, 138-139), the agricultural period in the Indonesian Archipelago began approximately 4,500 years ago. Tools produced during this stage were polished adzes, polished stone bracelets, arrowheads, bark-cloth beaters, flakes, beads, and pottery. The handmade earthenware occurred in simple forms with cord decoration, and is considered to be the first indication of the beginning of pottery manufacture in this region (Soejono 2008, 182). The expression of aesthetic and religious emotions became stronger during the agriculture stage, especially linked with ancestor worshipping (Soejono 1981, 16), which led to the erection of megaliths.

The Metal Age is characterized by sophisticated technology in metal and earthenware production. The constructing of megaliths became more intensified due to the development of religious concept, which was simultaneously accompanied by the increase of labor divisions to carry out various activities. Hence, a particular class of craftsmanship in the society, the undagi, was developed. The undagi is a group of people who are skilled to manufacture special types of objects to fulfill their economic needs in a community; for example building wooden houses, making

1 *Undagi* (Sanskrit): skill to make different things

2 massive monofacial oval stones

pottery, metal objects, jewelry, etc. However, many archaeological researches indicate that each region in Indonesia represents somewhat complicated stage which does not necessarily comply with the prehistoric chronological framework. In other words, the evidences show there were a number of prehistoric communities who used equipments predated their existence, therefore, suggest the use of technology in tool-making, either continuous or altered, differs between one cultural system and the others. An absolute dating of a site is obtainable, however, it is still difficult to determine its exact related-cultural-stage. Such cases occurred in Kalimantan, especially South Kalimantan, during the metal age or perundagian stage. This article discusses the problems in dealing with the hypothetically metal age sites in South Kalimantan based on the archaeological data examined by the Center for Archaeology, Banjarmasin.

B. Prehistoric Researches in Kalimantan

Kalimantan is the biggest island in the Indonesian Archipelago. Administratively, 78.97% of the total width is governed by the Republic of Indonesia, and the remainder is within the authority of Malaysia and Brunei Darussalam. Kalimantan is divided into five provinces i.e. the South[3], Central, West, East and North Kalimantan. Geographically, the five provinces have similar environment and sliced by many rivers, which a number of them are wide and long such as the Kapuas, Barito, Mahakam, and Kahayan. Ever since the prehistoric period, the people in Kalimantan usually live on riverbanks of both big and small rivers. The riverbank inhabitants share the same principal reason to choose the riverbank as their settlement spot, since it has been considered the most favorable area to live and move around by means of river, compared to the treacherous marshland and impenetrable tropical forest.

Many scientific researches have been conducted in Kalimantan, however, only a few and incomplete archaeological studies were carried out before 1994. Until today, countless archaeological researches have been carried out in the five provinces of Kalimantan; however, prehistoric sites have not been excavated thoroughly. The prehistoric sites which had been examined are Nanga Balang (Soejono 2008), Birang Complex (Arifin 2006)[4], Awang Bangkal (Soejono 2008; Fajari 2010), Gua Babi (Widianto and Retno Handini 2003), Candi Agung[5] (Kusmartono and Harry Widianto 1997/1998; Sunarningsih 2004), Jambu Hilir (Nasruddin 1996/1997; Anggraeni and Sunarningsih 2008), and Jambu Hulu (Sunarningsih 2008). Nanga Balang is administratively, located in West Kalimantan, Birang Complex is located in East Kalimantan, whereas the last 5 sites are located in South Kalimantan. Five of the sites are open-settlement-sites. While the Birang Complex and Gua Babi are rock shelters and cave dwellings. During 2010, a number of prehistoric researches was conducted such as the reconnaissance surveys of Müller Mountain, Meratus Mountain, and Riam Kanan River (Oktrivia 2010; Sugiyanto 2010; Fajari 2010)[6].

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3 in comparison to the other provinces, South Kalimantan is the smallest one, but has the most dense population

4 The Birang Complex comprise of Gua Kimanis, Liang Gobel and Lubang Payau.

5 Candi Agung site has two cultural layers with the chronology of 350 BCE (Before Common Era; prehistoric period) and 728 CE (Common Era; classic period; Kusmartono 2012, 163)

6 carried out by three teams from the Center for Archaeology, Banjarmasin

Soejono (2008) claims that Awang Bangkal is a palaeolithic site. Soejono's studies (2008) indicate that tools found in Awang Bangkal are catagorized as chopper-chopping-tool complex. Interestingly, the 2010 reconnaissance team (Fajari 2010) found a stone adze, a stone mortar, and a stone peg. The three artifacts represent the characteristic of Neolithic technology which was recognized during the agriculture stage. Unfortunately, Awang Bangkal was transformed into the Riam Kanan water reservoir in 1973.

Nanga Balang is known as a Neolithic workshop site which produced quadrangular adzes, pounding stones, stones anvils, grinding stones, pottery and beads. The absolute dating of this site is 2871 BP (Before Present; Lahagu et al, 1991; Simanjuntak 2002, 205). Although included in agriculture phase (Neolithic), this site also contains of a various sizes of flakes and microliths[7] and also a metal tool, a spear (Gihardani 1993, 49). Besides the latest finds, the team collected stone bark beaters from the contemporary villagers (Kusmartono 2006). A similar bark stone beater, which was found by the locals, was collected also from Muara Joloi I (Oktrivia 2010). In comparison to the typology of bark-cloth beater in Southeast Asia, the types from Nanga Balang and Muara Joloi I can be categorized as type VIII[8], stone choppers with grooved surface on its rounded base.

Nanga Balang is an open site which is situated in a riverbank similar to that of in South Kalimantan i.e. Candi Agung, Jambu Hulu, and Jambu Hilir. Based on the radiocarbon dating, the prehistoric cutural layer of Candi Agung is dated 350 BCE, whilst Jambu Hilir is 1000 BCE and Jambu Hulu 1000 CE. Most of the artifacts found from those sites are potshard which show similar color and decoration and suggest to have originated from similar shape as well. The subjects which mark the differences of sites characteristic are the ironslag and small terracotta crucible which were found only in Jambu Hilir and Jambu Hulu. Therefore, Jambu Hilir and Jambu Hulu are considered the only metal age sites in South Kalimantan so far. Heekeren (1958) claims the date of Indonesia's early metal age sites is approximately from 500 BCE until the early centuries of the Common Era. Interestingly, the indication of metal age of Jambu Hilir is older than 500 BCE, whereas Jambu Hulu existed a millenium after the turn of the century.

The materials used for metal tools during prehistoric periods were gold, silver, iron and bronze, while there were no tools made of copper[9] (Sofion 1993, 59). The material sources of metal artifacts have also been found in a number of islands in Indonesia. The metal resources found in Kalimantan are lead (Pb), zinc (Zn), Iron (Fe), and gold (Au; van Bemmelen 1994, 161-217; Gihardani 1993,

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7 based on archaeological excavation conducted by the Center for Archaeology, Banjarmasin, which involved the author as a team member

8 there are eight types of bark cloth beater in Southeast Asia (Cameron 2006, 66); she (2006, 65-72) divides the typology based on the different shapes of beater from the simple whitout carved to the shape with grooves craved on the one shape of surface. The beaters are made from stone and pottery. Many of those bark-cloth beaters are found in cemetery sites as burial gifts.

9 copper is used as an ingredient for producing bronze alloy (copper mixed with tin and lead)

51-52). The perundagian period was also marked by the arrival of bronze artifacts from Dong-son (Vietnam). The existence of Dong-son kettledrums[10] in Kalimantan informs a cultural interaction with the Dong-son culture. The Kalimantan kettledrums are found in West Kalimantan (Sambas), and Central Kalimantan (Kotawaringin Barat). A decorating element of kettledums was found in East Kalimantan as an anthropomorphic-twin-mask which was engraved on dolmens (Zahorka 2004). Zahorka (2004, 121-122) suggests the mask was used as part of a wax-stamp decoration in the process of making a kettledrum. Such opinion is still vague and needs to be examined further with other supporting data. Meanwhile, there is still no evidence of kettledrums in South Kalimantan.

C. Metal Age Sites in South Kalimantan

Based on radiocarbon chronology, Jambu Hilir and Jambu Hulu is acknowledged as the potential metal age sites to date. Both settlement sites are located on the open area of the Amandit river basin. Detailed explanation of both settlement sites is as follows:

1. Jambu Hilir

Administratively, Jambu Hilir is located in Hulu Sungai Selatan District. Jambu Hilir lies on the bank of the dead Rangas-Tatau River[11], which is approximately 45 kilometer west of the Meratus Mountain and 23 meters above sea level (Anggraeni and Sunarningsih 2008, 120). Before archaeological researches were carried out in Jambu Hilir, the locals had unearthed many artifacts in 1980. Among the 1980 findings are undecorated and decorated potshard, teracotta crucible, fragments of iron, brass belt buckle, cupreous pendant, terracotta beads, stone and glass beads, and quadrangular stone adzes. The evidences were reported to the local office of Education and Culture of South Kalimantan, and some of them were housed in the Lambung Mangkurat Museum.

Based on the 1980 report, Jambu Hilir was excavated during 1996, 2007 and 2009. The 1996 research in Jambu Hilir was conducted by the Centre Archaeology of Banjarmasin lead by Nasruddin. The team dug five test pits (TP) which are TP I, TP II, TP III, TP IV and TP V. Most of the finds were potshard (decorated and undecorated). Other unearthed artifacts were stone anvils and grinding stones, fragments of adzes, flakes and pebbles, terracotta beads, and small chunk of charcoal (Nasruddin 1996/1997). The decoration was identified as red slip, incised, and impressed with geometrical pattern. Morphological analysis suggests the Jambu Hilir pottery was used as containers such as pots (with and without lid), bowl, crucible, plate, and (charcoal) stove. Striation was also found in some potshard indicating the use of low-speed wheel complimented by by paddle and anvil. Based on such artifacts, Nasruddin hypothetically, suggests Jambu Hilir was occupied from Neolithic to the early Metal Age.

After unattended for more than a decade, Jambu Hilir was excavated again in 2007 lead by Anggraeni from Gadjah Mada University (Anggraeni and Sunarningsih 2008). The 2007 excavation aimed to reassess the 1996

[10] There are many types of kettledrums and were found in some islands of Indonesia (Kempers 1988, 18-22)

[11] The contour of the riverbed suggests the river was about 50 -100 meters in width

investigation and to determine the chronology of site occupation by carrying out an absolute dating. Anggraeni also inquires about the types of activities performed by the inhabitants (Anggraeni and Sunarningsih 2008). The result of the 2007 dig on five excavation pits[12] indicated similar results to that of the former research. More ironslags and crucible (Plate 2) were found to support Nasruddins hypotheses. Chunks of charcoal were unearthed from two excavation pits, A1[13] (Layer 2[14]; Table 1; disturbed) and w16 (Table 2; undisturbed) and were sent to C14 laboratory in Waikato for radiocarbon dating analysis. The chronology of the charcoal samples from A1 is 33,730±315 bp (WK-22007) and 17,953±81 bp (WK-22008; Anggraeni and Sunarningsih 2007, 12-13). The charcoal samples from w16 were analyzed in Waikato twice. The first reading was 2922±45 bp (WK-22009), and the calibrated result was 3160 (68.2%) 2990 BP or 3220 (95.4%) 2920 BP (Ox Cal v.3.10). The second reading was 19,427±97 bp (WK-22010; Anggraeni and Sunarningsih 2008, 124). The first chronology is closer to the expected date than that of the second.

Other archaeological data which may help to determine relative dating are Chinese ceramics. Many foreign ceramics, including Chinawares were found scattered above ground in Jambu Hilir. Nasruddin's (1996/ 1997) ceramic analysis suggests the oldest Chinese ceramic dated from the Han Dynasty (206 BCE - 220 CE). Meanwhile, Chinese ceramics found during the 2007 research are of Tang Dynasty (7th - 9th century), Sung Dynasty (10th - 13th century), Yuan Dynasty (13th - 15th century) and Ming Dynasty (14th - 17th century; Anggraeni and Sunarningsih 2007, 9). Other wares are from Thailand, Vietnam and Europe. The existence of foreign ceramics may indicate that the inhabitants had high social standing, made trade contacts, and site was continuously inhabited until the Dutch occupation in Indonesia.

Table 1. Artifact distribution in A1

Layer	Depth	Artefact
1	0-40 cm	-
2	40-70 cm	- potshard: decorated body, carination, rim; - small crucible; - charcoal 1 (WK-22007); - charcoal 2 (WK-22008)
3	70-130 cm	-

On the other hand, the existence of crucible (kowi or musa) and ironslags[15] in Jambu Hilir suggest the people who inhabited the banks of Rangas River in 1000 BCE had mastered the skill of metalworking. Whereas,

12 name of the pits are KX, FXII, A1, w16 and BV

13 the excavation was carried out during the construction of irrigation canals; the first layer of A1 was destroyed by a bulldozer

14 40cm below ground surface, right under the top (humic) layer that was scraped off by a bulldozer

15 the ironslags were found in the 5 excavation pits along with fragments of iron artefact. However, the fragments are very small, the shape is not recognizable, whether originated from a weapon or common daily utensil

the variation of stone tools such as stone with round and oval shape found in association with hematite and potshard suggests the people of Rangas River had also made pottery. The potshard indicated variation of shapes, colours, and decorations.

Table 2. Artifact distribution in w16

Layer	Depth	Artefact
1	0-20 cm	Potshard: body
2	20-40 cm	-
3	40-60 cm	- potshard: decorated body, carination, rim decorated, footring, handle; - small crucible; - ochre; - ironslag; - clay pellet - concentred charcoal (WK-22009) ; - unconcentrated charcoal (WK-220010)
4	60-90 cm	- potshard: body, rim, foot; - ochre

2. Jambu Hulu

During 2008, another excavation was carried out approximately 500 meter to the south of Jambu Hilir, the Jambu Hulu, which lies on the bank of Amandit River (Figure 1). The objective of the 2008 research was to investigate whether the inhabitants of Amandit River occupy both sides of the river bank or not. Three excavation pits were dug on both banks, but apparently, abundant data were discovered only on the northern riverbank, leaving the south blank. On the surface of the riverbank, there were found abundant fragments of Chinese ceramic of various motif, colour and hypothetically, shape. The fragments of Chinese ceramic were identified as Song, Yuan, Ming and Qing wares. Other ceramic fragments were from Thailand and Europe. The excavation unearthed[16] decorated and undecorated potshard which consists of open and close containers in association with baked-clay beads, small crucible, fragments

Table 3. Artifact distribution in TP2

Layer	Depth	Artefact
1	0-20 cm (disturbed layer)	Potshard (body), ceramic, nail, iron wire
2	20-80 cm	-
3	80-110 cm	- potshard: decorated body, carination, rim, footring, handle; - a very small bowl; - ochre; - metal tool fragment; - burnt clay; - terracotta beads; - concentred charcoal (sent to Bandung); - resin

[16] in a cultural layer 80-110 centimeters below ground surface

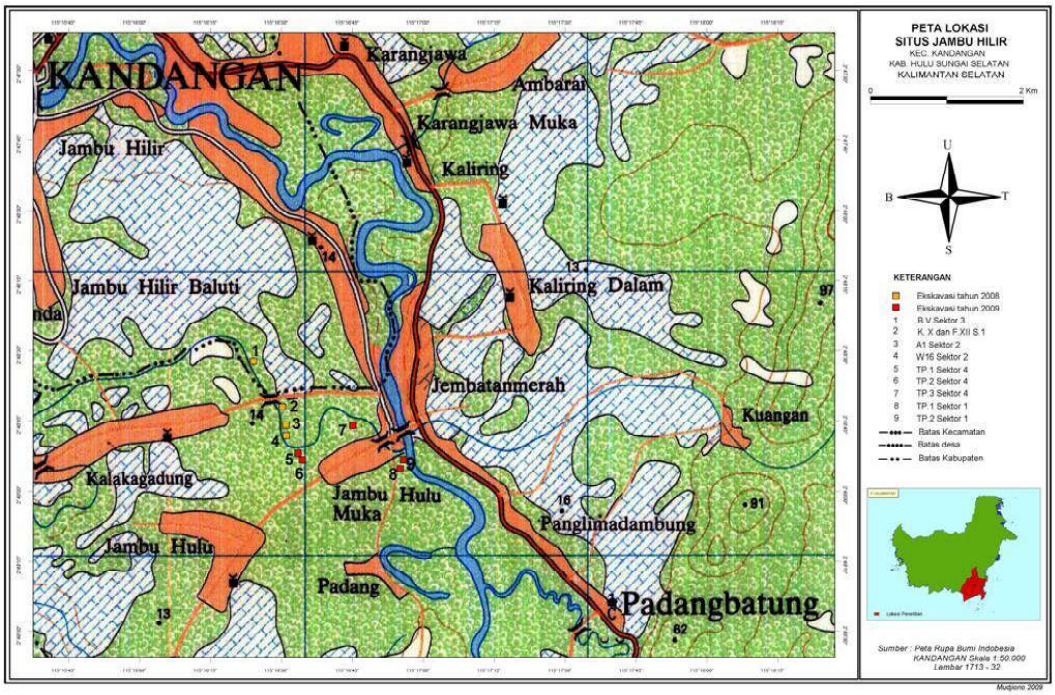

Figure 1. Map of Jambu Hilir and Jambu Hulu

of iron tool, hematite, charcoal, and stone tool with various shapes (oval and circle). The charcoal sample was sent for radiocarbon dating at the Research Centre for Geology and Marine in Bandung and resulted a chronology of 940±110 BP (1000 CE). Table 3 is the artifact distribution in TP2.

The excavation team also obtained a number of artifacts from the people of Jambu Hulu who found them surround the site; the artifacs were two types of coins which has different decoration on each side and a kind of music instrument with oval shape and dragon decoration (Plate 1). The decoration on the coins is a figure of semar, rooster and Javanese letters. These artefacts were dated from a much later period, especially, the coins.The variety of evidences indicates Jambu Hulu has

Plate 1. Two different coins and one oval music instrument (courtesy: Balai Arkeologi Banjarmasin)

also been occupied from the Metal Age until the Dutch occupation. Such evidence is similar to that of Jambu Hilir. Since metal artifacts from both sites are very limited; the metal age

stage was recognized mainly from the existence of fragments of iron and ironslags. Even though crucible can be considered as evidence of metalworking in the past, the shape of metal artifacts remains unidentifiable.

D. Metal Artifact Collection of Lambung Mangkurat Museum

The Lambung Mangkurat Museum is a state museum located in Banjarbaru, South Kalimantan. The museum houses a wide range of colletion of weapons of iron. There are 9 types of traditional weapons, which each of them consists of a number of subtypes. The 9 types of traditional weapons are (Kaderi 1988/ 1989, 34-49):

1. *lading balati* or knife (consists of *bini*/ female and *laki*/male);
2. *pisau* or knife (consists of *bini*/female and *laki*/male);
3. badik or dagger (consists of *belitung*, *raja tumpang, asu, sadup, sakin, kawali, santik hundang, sating, santagi, kuku bima, jambia, cukmar, abu gagang bini, abu gagang laki, ilat patung*);
4. *keris* or kris (kris without *lok* and kris with *lok*);
5. *parang* or machete (consists of *mandau, ambang, kemudi singkir, parang lubuk, pajang kajang rungkup, parang bungkul, parang kayu tangi, parang baduk, parang sundrik, parang lais, parang wawalutan, parang pacat gantung*);
6. *tombak* or spear (consists of *tombak kuningan lok dapak, tombak kalang patalu, tombak biji waluh, tombak sapit abun, tombak sangkuh, tombak blankas, tombak biring, tombak lumpus, tombak cikil laki, tombak duha, tombak belimbing, tombak sanggah* or *trisula*);
7. *cabang*;
8. *rutikalung*;
9. *camati.*

Amongst the 9 types of traditional weapons, 7 are not used anymore today. The ones that are still used by people for their daily chores are the knive and machete. A subtype of machete, the mandau, a weapon used by the Dayak people, still exist today.

The existence of traditional iron weapons suggests that people in South Kalimantan have been familiar with the use of a various forms of iron weapons since approximately 2000 years ago. The introduction or innovation of such equipment could probably have undergone a long process, which involved evolutions in terms of technology, form and function. For instance, a dagger or kris was familiar in South Kalimantan as a result of Javanese influence which occurred during the interaction between the Islamic kingdom of Demak and pre-Islamic kingdom in southern Kalimantan.

E. Efforts to Clarify the Existence of Blacksmith in South Kalimantan

Based on the discovery of metal artefacts from Jambu Hilir and Jambu Hulu, it is suggested that metalworking had occurred during 3000-1000 BP. Such chronology corresponds to the Metal Age stage in Indonesian archaeology. Nevertheless, there are 3 matters which will be discussed futher in regard to the discovery metal artefacts:

1. Limited Discovery of Metal Artifacts

Geographically, about three quarters of the South Kalimantan Province are flat and

lower than 100 meters (above sea level), while about 8,000 km² are swampland. Dividing the province into two regions is the Meratus Mountain which streches from the northeast to the southwest. The annual rainfall intensity is high between 2,000 and 3,700 mm. The biggest river is Barito which is used as transportation passage to the northern part of the province and to the Province of Central Kalimantan. Some small rivers in Hulu Sungai Selatan District are the tributaries of Barito River including Amandit River.

Settlement sites are found on the riverbanks tend to be wet and even flooded during rainy season. The most interesting questions in regard to artifact findings in South Kalimantan is: "why metal artifacts are scarcely found in this province?". Such condition leads to hypothetical inference on the durability of metal tools and preservation process by the environment. Huisman (2010)[17] suggests there are some artifacts will undergo degradation process including iron object, which is intensified by soil condition where they are embedded. The environment which destroy metal easily is: a) aerated condition; b) anoxic with sulfhate-rich conditions (e.g. under seafloor); and c) anoxic with sulphate-poor conditions. In aerated condition, the iron transformed into oxides, the shape is preserved, but hollow and loses the use-wear, trace elements, etc. Moreover, in rich sulphate environment the metal object will completely disintegrate, whereas in poor sulphate condition it is either partly preserved or transforms entirely to carbonates.

Since the soil in the wetland is acid and easily destroy any artifacts except pottery, it is understandable that finding metal artifacts is similar to searching a needle in a hay stack. Therefore, the soil condition is one of the factors why iron artifact is rarely found in South Kalimantan. Another possibility is that it may occur that during Metal Age in South Kalimantan the people did not use metal artifacts as extensive as pottery. Did they prefer using wooden tools to metal tools? A more elaborate research has to be undertaken to answer such question.

2. Limited Research on Metal Sites

The first effort to expand the research area is done by intensive survey, especially in the District of Hulu Sungai Selatan. Up untill now, archaeological surveys conducted by the Center for Archaeology, Banjarmasin, were performed along with the excavation. There has not been specific surveys on settlement site in open areas and the investigations were based on information fom the locals. Therefore, the surveys were equipped only with Global Positioning System (GPS) and some notification of surface findings, whereas the discovery of metalworking remains such as hearth is very important for a more elaborate and comprehensive explanation.

According to Nishimura (2001), there are a number of survey methods to search for artifacts and features buried below ground without destroying the matrix. The methods among others are Magnetometer Survey (MS), Ground Penetrating Radar (GPR) and Electromagnetic Prospection (EM). Every method uses specific equipments and purposes. In order to recognize metalworking sites, MS is most suitable. Nishimura (2001,

[17] Based on the power point of "Degradation of Archaeological Remains "in Archaeometry class (2010) by Huisman at Faculty of Archaeology, Leiden University

546) suggests the MS is a powerful method for prospection of kiln and hearth, since it has unique characteristics. However, the MS also has flaws due to passive measurement of the earth's magnetic field. Other objects consist of iron such as railroads, motor vehicles or houses which produce greater magnetic than archaeological features near the site will disturb any magnetic survey work.

Plate 2. A crucible from Jambu Hilir (courtesy: Balai Arkeologi Banjarmasin)

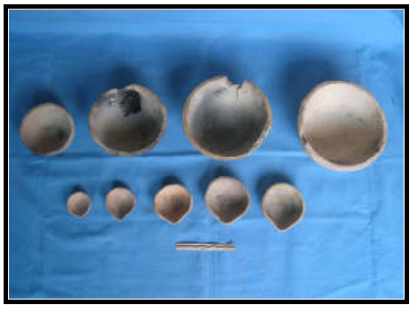

Plate 3. Crucibles from Nagara for melting gold, which are still used nowadays (courtesy: Balai Arkeologi Banjarmasin)

On the other hand the ethno-archaeological research surround the site may reveal ones who still have occupation as blacksmiths. Ethnography can be a reliable comparative data for understanding the social aspects behind metalworking processes. Beside that, it is advisable also to compare excavation data with

Plate 4. A villager is making large crucibles (kowi) for melting brass and other recycled metals (courtesy: Balai Arkeologi Banjarmasin)

research on languages in regard to the existence of iron. Such investigation was carried out by Blust (2005) who studied Borneo and iron by comparing language groups which mention besi or iron. Therefore, if the suggestion that the archaeological data of Jambu Hulu and Jambu Hilir have any relation with metalworking activities is accepted, hypothetically, the source of iron which may be found not far from the site cannot be denied. Bronson (1992, 66) reports that in South East Asia, extensive beds of nodular iron concretions occur in river deltas and wide tracts of sedimentary soils covered with laterite. Both concretion and laterite have been used as iron ore by traditional smelters. Therefore, in order to know further about the iron source, it is necessary to conduct an appropriate survey surround the site and to understand futher whether the river along the site contains iron ore or the crucibles found in the site were associated with the iron fragments as well as ironslag.

The size of the crucible (*kowi*) is small (Plate 2) and it is suggested to be used more suitable for gold smelting than iron. Such inference is based on my observation on the making of gold jewelry and other metal tools in the Nagara; the small *kowi* is commonly used

by crafters of gold jewelry (Plate 3), while for smelting other metals such as brass, crafters use larger *kowi*. Large *kowi* (Plate 4) is not only made out of pure clay, but it is also mixed with sand that contains iron ore; therefore, it will be resistant during the high-tempertured heating process.

3. Non-artifacts Analysis for Pyrotechnological Process

Iron slags which were found in Jambu Hilir and Jambu Hulu have become crucial evidences to explain metalworking activities during the Metal Age in Indonesia. There are two reasons why slags are considered important evidences for prehistoric smelting technology: First, slags are metal waste which was usually left at smelting sites and preserved in its chemical position and mineral assemblage, so the temperature and the furnace atmosphere can also be recognized from it (Killick 2001, 488). Second, slags and residue can be associated with pyrotechnological process which enables the confirmation of the existing of such process. Therefore studying pyrotechnological process is needed to depict what had occurred during metalworking process. According to McDonnell (2001, 493), the terminology of pyrotechnology has evolved to signify the deliberate processes utilizing the control and manipulation of fire. McDonnell (2001, 494-495) claims there are three components of chemical reactions needed for pyrotechnology which are fuel, temperature and atmosphere. In order to control those three parameters depends on the nature of the technological process itself, and the technological development can be viewed as evidence for increasing control of these parameters.

McDonnell (2001, 502) also divided slags and residue in two broad groups i.e. the diagnostic and non-diagnostic. In regard to the diagnostic group, slags are related to particular industrial processes which comprise of ironworking such as smelting or smithing and non-ferrous residues such as crucible or lime burning. Whereas, non-diagnostic group of residue cannot be directly associated with pyrotechnological process except by identifying diagnostic residue of clay furnace lining that can be related to metal smelting. Unfortunately, iron slags and crucibles found in metal sites in South Kalimantan have not been elaborately analyzed yet. Therefore, it is crucial to carry out chemical analysis on the metal artifacts of Jambu Hilir and Jambu Hulu to support the assumption of the existence of metalworking process in both sites.

F. Conclusion

The main purpose of an archaeologist's job is to complete the puzzles of the past by answering what had happened during the ancient people inhabited Jambu Hilir and Jambu Hulu. Up until today, there are still many problems to be dealt by archaeologist to answer such question. The immediate problems concern with little metal artifact assemblage have been found, small scale investigation have been carried out and the lack of developed methodology and technology used in archaeological research during survey, excavation and post-excavation analysis. Nevertheless, it can be inferred that Jambu Hilir and Jambu Hulu presents significant on metalworking in South Kalimantan during 3200-1000 BP, and a continuous land use until approximately the 18th century.

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