

Sa Huynh Culture as Approached from Geoarchaeology

Nguyen Quang Mien¹, Nguyen Quang Bac², Vu Anh Hung³

¹ Institute of Archaeology, Vietnam Academy of Social Sciences.

² VINASA Institute of Science and Technology.

³ Military Technical Academy, Ministry of Defence.

Email: nqmien1962@gmail.com

Received on 16 June 2019.

Revised on 24 July 2019.

Accepted on 16 August 2019.

Abstract: Sa Huynh cultural relics are widely distributed in Vietnam's Central region and its Central Highlands, with a dense concentration in coastal areas in the provinces from Quang Nam, Quang Ngai to Khanh Hoa and Ninh Thuan. This is an indigenous culture in Vietnam in the era of the Metal Age dating from the first millennium BC to the 1st-2nd century AD. Along with Dong Son culture in the northern, and Oc Eo culture in the southern part of the country, Sa Huynh culture has been considered among Vietnam's traditional cultures. Adapting to the sea environment has always been a prominent feature of the culture. Living in a dynamic and open environment, Sa Huynh culture residents had wide exchanging and trade relations with those in the mountainous areas of the Central Highlands, as well as in the southwestern delta and Southeast Asia, especially Southeast Asian islanders.

Keywords: Sa Huynh culture, geoarchaeology, Vietnam's marine culture.

Subject classification: Archaeology

1. Introduction

Sa Huynh Culture is one of the three major cultures of the Metal Age, the origin of traditional culture in Vietnam dating from the first millennium BC to the 1st-2nd century AD. With the typical feature of formation and development in the marine environment, since the very early stage, sea was an important part of the economic and cultural

activities of Sa Huynh residents. From the first years AD, Sa Huynh cultural residents had extensive trade relations throughout Southeast Asia, especially with Southeast Asian islanders, residents of Dong Son culture in the northern part, and residents of Oc Eo culture in the lower Mekong River delta in the southern part of the country. In the past as well as at present, this culture has always had a special impact on the economic-

cultural-social formation and development of Vietnam's central region. Geoarchaeology is an interdisciplinary methodology using geophysical and geological techniques to explain issues raised in archaeological research [17], [18]. Based on the geophysical, dating and archeological studies, the article presents some new materials and findings of Sa Huynh culture, of which marine environment adaptation has always been presented as the prominent feature of this culture.

2. Geological characteristics of coastal areas in Central Vietnam

2.1. Sea level fluctuation in the late Pleistocene-Holocene

With an average of 1km of coastline per ten km² of territory, Vietnam is a marine nation. Therefore, not only at present that Vietnamese people have to cope with sea level rise, but also in the past, they had to face with the ups and downs of sea level, which particularly in the case of is Sa Huynh residents in the central region. Evidence of the sea level fluctuation at the late Pleistocene can be found on the high-resolution seismic records in the project "Geological and solid mineral survey in nearshore East Vietnam Sea (0-30m water depth), scale 1:500,000" [1]. The map of seismic measurement lines is shown in Figure 1.

Since the global glacier, the last Wurm III (or Wumu - as called by Chinese geologists) occurred at the end of the late Pleistocene, the water-level in the oceans was lowered for a long period of time and in stages. According to the T3 seismic line section, we discovered that until the depth

of 110m, Quaternary sediments was found covering the Pliocene basalt layer, without any breaks. The next is the late Pleistocene sand layer being covered by the mud-clay of Holocene age. This is considered the traces of the first halt of the sea level in the marine regression period. The next includes the 2nd and 3rd beach sediments at the depth of about -130m and -140m respectively (Figure 2).

The consequence of this sea level drop is that the Southeast Asian mainland was expanded by hundreds of kilometres and almost all current islands were connected to the Asian continent (Figure 3). This period dates back to about 20,000 years ago [6, pp.87-97].

In the diagram in Figure 2, it shows clearly the 4th time beach sediment layer partially overlapped with the 3rd time beach sediment layer, that indicates there was a period of time when the sea level rose slightly and then fell back to the -140m depth. From this geophysical document it may be determined that the end of Pleistocene coastline in Central Vietnam lies at a depth of -140m compared to the current sea level.

After the maximum regression, the sea level started rising. The sea progressive-holding phases of this period left traces of ancient coastlines at different depths: -100m, -80m; -78m, -76m; -72m, -68m and -65m, -60m. Finally, the Flandrian sea progression might start from the current depth of -60m and gradually shift to the depths of -50m, -35m, -37m, -28m, -30m, -20m, -22m, -10m, -12m (Figure 4).

The traces of the intervals in this transgression time are also found in many different locations along the coastal line of

Vietnam. Through a comparative synthesis, most researchers agreed that, in the Flandrian transgression phase, in Vietnam, there were 5 points of timewhen when the sea level was paused at the depths of -60m, -50m, - 30m, -25 m, 0m, -2 m, +4 , +5 m and the present level [5, pp.36-38]. The traces of the period of the peak sea level during this time was also observed on the limestone cliffs in Ha Long Bay and Chua Hang area in Ha Tien and its model is shown in Figure 5.

2.2. *Creating components of Holocene sediments*

2.2.1. Early - middle Holocene sediments

- River sediment (aQ21-2). In this researched area, the sediment was formed before the time the sea level rose to the maximum. They are revealed in narrow strips along large river valleys and at the delta edge. In the northern provinces (Ha Tinh, Quang Binh, Quang Tri, Thua Thien Hue), this sediment normally has a height of 2-3m. In the southern part, in the plains of Da Nang, Hoi An, Quy Nhon, Tuy Hoa and Ham Tan, etc. such sediment is often in the form of narrow strips along the plain edge, with a width of about 50-300m.

- River-sea mixed sediment (amQ21-2). In the northern region, this sediment has a quite wide distribution area, but it is largely covered by later sediments and only a small part is exposed in the coastal areas of Quang Binh, Quang Tri and Thua Thien. Hue, with a height of 3-6m. From Hai Van Pass to Vung Tau, this sediment forms wider surfaces, depending on the rivers' basin like in Phu My or Quy Nhon.

- Wetland-sea mixed sediment (mbQ21-2). This sediment was also formed before the sea level rose, therefore, the exposed area is quite small and most of it is covered by later sediments.

- Sea sediment (mQ21-2). This sediment was largely formed in the Flandrian transgression, therefore, it usually distributes in small coastal plains such as Phan Ri, Ham Tan and on islands ... In the coastal plains, this sediment often forms seabed with a height of 2-6m or sand sea-dikes with a height of 6-10m that is mainly composed of coarse-grained and medium-grain sand. In addition, there are a number of other components including sand, coral lime sand, sea shells and sea snails that were cohesive through the carbonisation process. The Radiocarbon dating of this series of sediments has been determined to be $4,500 \pm 250$ years ago [1].

2.2.2. Middle-late Holocene sediments

These sedimentary formations occurred after the maximum sea transgression time. In the researched area, they are classified by different types of origins, namely:

- River sediment (aQ22-3). This sediment spreads widely along large rivers and streams and mainly on mudflats and riverbed margins. In the areas of Quang Binh, Quang Tri and Thua Thien Hue, this sediment is distributed into narrow strips along Gianh, Hieu, Thach Han, and O Lau rivers, etc. in the form of alluvium of a height of 2-2.5m. In the coastal plains from Da Nang to Vung Tau, due to the short and steep flow, the river sediment here consists of coarse grains, mainly pebbles, grits, gravels, sand grits, etc. In Da Nang and Hoi

An, along Thu Bon and Chiem Son rivers, this sediment forms mudflats with a height of about 4-5m. In Tuy Hoa plain, the sediment of Da Rang river in the form of mudflats has a wide distribution area.

- River-sea mixed sediment (amQ21-2). In essence, this is the sediment at river mouth area being impacted by tides, with a common characteristic that is usually distributed between rocks, sand dunes or forming coastal plains, with a height of about 1.5-5.0m, a narrow width, in a small area, the sediment composition mainly consists of materials such as clay, powder, sand mixed with plant remains and shells.

- River-sea-wetland mixed sediment (ambQ22-3). In the researched area, this sediment has a very small exposed area, mainly found in low-lying areas between sand dunes such as Gio Hai, Gio Le (Quang Tri), Hoa Vang, Vinh Dien, and Tra Que, Tra Nhien (Quang Nam). In the coastal plains from Quy Nhon - Nha Trang - Vung Tau, this sediment is distributed along low-lying creeks, which are still impacted by the daily tide. The main components are sand, grit, clayey sand mixed with sea-animal remains and black plant debris.

- Wind-sea sediment (mvQ22-3). From Ha Tinh, Quang Binh to Thua Thien Hue, this sediment is distributed in the high-altitude terrain like mounts or dunes with uneven surface and a height of 8-33m. The main components mainly include gray or yellow small and medium grained sand. From Hai Van Pass to Vung Tau City, this formation has a typical shape in the form of sand dunes or a range of sand dunes connected with one side of a slope located in the west which is sheltered from the wind, and the other sloppier side located in

the east to which the wind can blow to, with a height of 5-30m, a width from several hundred metres to 2km and sometimes to 4-5km. The main sediment components are sand, sand grits, sometimes coral debris or marine mollusk shells.

- Sea sediment (mQ22-3). In Ha Tinh, Quang Binh, Quang Tri - Thua Thien Hue, this sediment is usually in the form of fairly flat sandbanks or low dunes close to the water edge, mainly composed of sand, sand mixed with shells and ilmenite minerals. In the area from Da Nang to Vung Tau, this sediment forms long narrow sandbars with quite homogeneous components of medium to fine-grained sand. In Son Hai and Ly Son islands, in addition to sand grits, this sediment also contains many small pieces of shells, corals, pebbles and gravels [10].

2.3. Topography and climatology

2.3.1. Topography

From north to south, the topography of the researched area is strongly separated by the rugged terrain of the marble mountain ranges spreading to the sea or rivers. According to the topography features, rivers in Central Vietnam tend to flow from west to east, with the common characteristics being short and steep, the volume of water in these rivers often varies in different months of a year. In particular, in the rainy season, the volume of water in these rivers often suddenly increases rapidly, creating floods that cause great harm to the lives and properties of the regional inhabitants. Many of these rivers, naturally, became the dividing lines of different residential areas

and, by the beginning of the AD, formed relatively independent emirates [19].

- Additionally, in the direction from the west to the east, the geomorphology of the area is also interrupted by natural sunken plots caused by the subsidence process. According to Tran Nghi [8], due to the geomorphological characteristics, in Vietnam's central delta, there often exist Neogen sinkholes, which are consequently shown on the surface of low-lying land such as swamps, lagoons, pools, etc. (Figure 6).

Therefore, the process of sedimentation and leveling to form the Central delta after the maximum rise of sea level during the Flandrian period usually started being developed from two sides: The west, which is the area edging the mountain foot and the east, which is sand dikes and sand dunes formed in the preceding Pleistocene.

2.3.2. Climatology

- The climate in the Central Vietnam also has a significant change over different sub-areas. In general, in a year the rainy and dry seasons in the north and south do not occur at the same time. In the northern part, from Ha Tinh to Hai Van Pass, in winter, the northeast monsoon brings vapour, so the whole area is affected by cold weather together with rain, the southwest monsoon of summer (also called foehn) causes hot and dry weather, there are even hot days with the temperature of over 40°C and very low humidity resulting in plants often withering all. In the southern part, from Da Nang to Vung Tau, due to not being under the impact of the northeast monsoon, the heat regime is relatively stable throughout

the year. In addition, the Quang Nam-Quang Ngai area has abundant rainfall, averaging 2,000mm-2,500mm annually, whereby trees remain green all year round, meanwhile, Binh Thuan - Ninh Thuan area carries the characteristics of semi-arid climate due to plenty of sunshine and wind but little rain [13].

3. Distribution of Sa Huynh culture relics

Preliminary statistics show that up to now there are approx.160 archaeological sites related to Sa Huynh culture. In particular, the farthest point to the north of the culture has been found in Ha Tinh province, with 3 relatively adjacent archaeological sites: Bai Phoi Phoi, Bai Coi and Bai Loi (Figure 7). To the south, the imprint of this culture has been observed in some jar burials in Phu Hoa and Hang Gon in the lowland hills of Dong Nai province. In addition, according to Professor Ha Van Tan, the imprint of Sa Huynh culture has also been found on Tho Chu islands, Phu Quoc or Nam Yet, Sinh Ton and Truong Sa islands, etc. [11, pp.5-10].

Traces of this culture have been seen widely distributed in Central Vietnam and formed in different natural sub-regions, accordingly that may be divided as follows:

3.1. Group of relics on coastal sand dunes

The number of Sa Huynh culture relics distributed on coastal sand dunes accounts for the largest proportion compared to other sub-regions, including typical relics such as Sa Huynh, Long Thanh, Con Rang, Phu Khuong, Go Ma Vuong, etc.

- Most of the relics here are grave sites with a large number of burial jars, there are places of up to several hundreds of them such as in Con Rang, Sa Huynh, Long Thanh, Hoa Diem, etc. The jar graves here are often large in size, with lids, and no human remains inside, containing objects buried along with the deceased, such as: pottery, jewelry of gold, glass or precious stones, etc. This proves that about 2,500 years ago, Sa Huynh people had a clear concept of life and death, the deceased were buried in a separate area, not too far from the residence of the community, and with their property and supplies so that they could continue using in the other world.

- On these sand dunes, some archaeological sites are also found to be residential places. Most of them are located at the edge of the sand dunes, near fresh water sources, that is both to avoid storms and wind, and to have freshwater for daily usage, as well as for easily going to other places for seafood. In Binh Chau relic, the excavations in 1977 found the residence being separated from the burial ground. The combination of working tools found in the relics shows that: The community of Sa Huynh culture in this place in the past lived mainly by sea fishing and exploiting the resources from the surrounding wetlands. Additionally, the Sa Huynh culture relics residing on sea sand dunes are also found in other locations, such as Tam My, Bau Tram, Long Thanh, Dong Cuu, Truong Xe, Hau Xa, My Tuong... In My Tuong site in Nhon Hai commune, Ninh Hai district, the excavation in 1979 identified the site as a

residential area with two cultural layers. In this upper cultural layer, two jar graves consisting of two attaching globular jars were found [12, pp.295-296].

3.2. Group of lowland hill relics on the plain edge

Following the findings of Sa Huynh culture relics distributed on coastal sand dunes, Vietnamese archaeologists found a series of relics of this culture distributed in low hills on the plain edge in the west with typical relics such as Dai Lanh, Tien Ha, Pa Xua, Sua Mountain, etc. Among which, in Dai Lanh relic, on a hill of about 2000m², around 500 jar graves were discovered [12, pp.301-302].

In 2011, in Quang Ngai province, archaeologists also found a series of Sa Huynh and Pre-Sa Huynh culture sites widely distributed in a valley along the Tang River in Tra Trung commune, Tay Tra district, which is now in the heart of the Nuoc Trong irrigation reservoir.

The excavation at the Nuoc Trong Lake site found chipping tools of the Paeolithic inhabitants about 10,000 years ago; shoulder-hoes, grinding-blade axes, types of stone axes used horizontally as hoes (Vietnamese: *bôn đá*) and pottery of the Late Neolithic inhabitants that date approx. 4,000 years ago. In particular, in the excavation hole, they also found Binh Chau style pottery of Pre-Sa Huynh culture and a group of pot-graves with buried items such as iron knives, typical double-animal-headed ear pendants of Sa Huynh culture [9]. The ceramic layer in the cultural level of the residential site was

relatively thick and continuously developed. This reflects the stable and long-term settlement of prehistoric inhabitants living on the alluvial terraces of both sides of Tang River.

3.3. Group of relics on riverbank alluvial grounds

The number of Sa Huynh culture relics distributed on riverbank alluvial grounds included the type of burial and residential sites. The number of jar-graves in each area is much less than that in coastal sand dunes. Burial items are richer, partly demonstrating the wealth of the owners. At Lai Nghi and some other sites, hundreds of agate beads were discovered, of which two objects are unique: an agate string Spatlys and another shaping a tiger. These are rare objects found in the relics of the Early Iron Age in Southeast Asia. There are also many valuable items such as double-animal-headed ear pendants, three-pointed earrings, crescent earrings and artifacts of a unique version such as the copper inlaid bowl, the axe made of both bronze and iron, ceramic containers with four legs.

In the residential sites, there found some working tools made of iron, such as knives, hoes, spades... showing that the inhabitants of Sa Huynh culture here had relatively high production skills and agriculture farming was their major living mode.

3.4. Group of relics on islands

One of the typical characteristics of Sa Huynh culture is that there are a considerable number of relics on islands, such as Bai Ong

relic on Cu Lao Cham (Quang Nam), Suoi Chinh relic on Ly Son island (Quang Ngai), those on Hon Tre island (Khanh Hoa), Phu Quy island (Binh Thuan), in Con Dao (Vung Tau), and on Tho Chu and Phu Quoc islands (Kien Giang).

The common feature of this group of relics is in the archaeological-cultural layers, in addition to the working tools commonly used in agriculture production in mainland such as hoes, knives, buffalo-teeth axes, thread-spinning plumb-lines, etc. there are also fishing tools such as: fishing nets, fish-stabbing javelins, hooks, etc. [2, pp.13-24].

In particular, in some relics, there found also a large number of jewelry such as necklaces, bracelets, ear pendants, etc. made from sea shells or sea turtle bones with sophisticated and unique techniques [4]. This shows that in Sa Huynh culture, the ocean is not only a place providing daily food but also a place offering materials to create beauty products for people.

In addition, in many sites, there found copper casting moulds and traces of metallurgy. It is noteworthy that ore mines and sites for getting mould-materials are often located on islands far apart. That proves that, in order to be able to produce metal objects in addition to the sophisticated skills of metallurgy, the ancient Sa Huynh people were very skillful in sea travelling. Also note that, in archaeological investigations in Spratly islands in 1994-1995 they found artifacts of Sa Huynh culture on Truong Sa, Nam Yet and Song Tu Tay islands. This provides us with important assertions about the presence of ancient Vietnamese on these offshore islands [12].

3.5. Group of relics in Central Highland mountainous area

One of the outstanding achievements of Vietnamese archaeologists in the final years of the 20th century was the discovery of a series of Sa Huynh culture sites in the Central Highlands of Vietnam. Typical relics in this area include: Lung Leng (Kon Tum); Tra Dom (Gia Lai), Buon Triet (Dak Lak), Dak Wer (Dak Nong), Phu My (Lam Dong)...

Lung Leng relics is located on the right bank of Po Co river, in the submerged area of the Yaly hydropower reservoir, in Sa Binh commune, Sa Thay district, Kon Tum province. In 2001, excavated was an area of about 11,500m², leading to the discovery of more than 120 burial tombs, including different types from jar-graves, attaching-pot graves, pottery-embarked graves, etc. bearing the Sa Huynh culture identities.

Discoveries of the group of Sa Huynh culture relics in the Central Highlands not only expanded the Sa Huynh culture space but also contributed to clarifying the origin and the indigenous nature of the culture.

4. Chronology and development stages

4.1. Analytical results for dating

Currently, in Central Vietnam, there are nearly 200 archaeological sites being discovered and researched, in which many sites have been analysed by radiocarbon dating and tree-ring dating. The research samples were collected by various research teams, at different times and analysed by many different laboratories (Table 1). That demonstrates the objectivity and reliability of these chronological data.

Accordingly, on the basis of comparative analysis of types of relics, artifacts and tree-ring dating results, primarily, Sa Huynh culture in the Central Vietnam may be divided into period of: Pre-Sa Huynh, Sa Huynh and Late Sa Huynh.

4.2. The Pre-Sa Huynh period

The relics of the Brass period and Pre-Sa Huynh period are widely distributed in the Central and Central Highlands provinces, and there are about 50 relics with typical ones such as Xom Con, Bai Ong, Long Thanh, Bau Tram, Binh Chau, Truong Xe, My Tuong, Hon Do, etc. [1].

In particular, Xom Con and 7 nearby relics on coastal sand dunes and islands of Phu Yen and Khanh Hoa provinces have been established as a separate period named Xom Con culture with ¹⁴C dating from 4180±80 years BP to 2,935±65 years BP that is exchanged to tree-ring age of from about 2,000BC-1,000BC (Table 1).

The Long Thanh - Binh Chau period, having a large number of relics and mainly distributed in the provinces of Quang Nam, Quang Ngai, Binh Dinh and Central Highlands, with typical relics such as Long Thanh, Binh Chau, Bau Tram, Go Mieu, Tra Xuan, Truong Xe, Nui Sua, Lung Leng, etc.

On the basis of the results of ¹⁴C dating and the tree-ring dating in the relics of Long Thanh, Bai Ong, Lung Leng, Con Rang, Hoa Diem and Go Ma Voi, etc. it may be possible to evaluate the dating frame of this period at about 1,300BC- 400BC (Table 1).

4.3. The period of development of Sa Huynh

The relics of this period are widely distributed from Ha Tinh, Quang Binh to

Binh Thuan, Dong Nai and remote islands. However, on the map of relics distribution, it shows that Sa Huynh relics are concentrated mainly in the coastal plain in the provinces of Quang Nam, Quang Ngai and Binh Dinh, demonstrating the core areas of this culture.

According to the results of the ^{14}C dating and the tree-ring dating in the relics of An Bang, Go Cam, Dong Cuu, Lai Nghi, Suoi Kinh, etc., we may determine the dating frame of this period at about 500BC-100AD (Table 1).

4.4. The Late Sa Huynh to Champa period

This period is considered as a period of transition (or development) from Sa Huynh culture to Champa culture, which is also the period of formation and development of Champa Kingdom in Central Vietnam.

The dating frame of this period was estimated from the end of the first century AD until Sri Mara, also known as Khu Lien, established Champa Kingdom in 192 AD.

5. Conclusion

Sa Huynh culture relics are widely distributed in Vietnam's central coastal areas from Ha Tinh, Quang Binh, Quang Tri to Phu Yen, Khanh Hoa, Ninh Thuan, and in the Central Highlands provinces. However, it is clear that the core (centre) of this culture is in the areas of Quang Nam, Quang Ngai and Binh Dinh provinces today. Sa Huynh culture existed during the first millennium BC until the 1st to 2nd century AD, at the same time with Dong Son culture in northern Vietnam and has its own outstanding features shown in the relics and artifacts.

Adapting to the marine environment is also a fundamental feature of Sa Huynh culture. Although living in many sub-regions of different natural environmental conditions, Sa Huynh residents always had appropriate adaptation solutions. For example, when it required to settle on coastal sand dunes, they often chose to build houses at the foot of sand dunes and near freshwater swamps, and that can both avoid storms and strong winds, and be convenient to go for sea-food exploitation. The burial site was near or right in the residential area. The residential area of Sa Huynh inhabitants was often located along estuaries near the sea, coastal freshwater lagoons, mostly on large sand dunes. Sa Huynh people had a developed pottery career. It may be because the residential areas were often located on sand dunes, where there was often a risk of lacking fresh water, especially in the dry season, that Sa Huynh inhabitants made large-sized jars to store fresh water. The large jars became items closely associated with the people, who used them to contain water when alive, and when they die, the jars became the shelter for their souls. Until today, images of large jars containing water are still commonly seen in the areas. Following the fluctuations of the sea level, Sa Huynh people had to move to another residential area to suit new living conditions. That is, after the highest rise, the sea level lowered gradually giving way to new lands - the delta plains gradually being formed by the rivers. That is where having more favourable natural conditions, so a part of the population moved to live there. On these new lands, they cultivated and produced handicrafts to exchange with other resident communities.

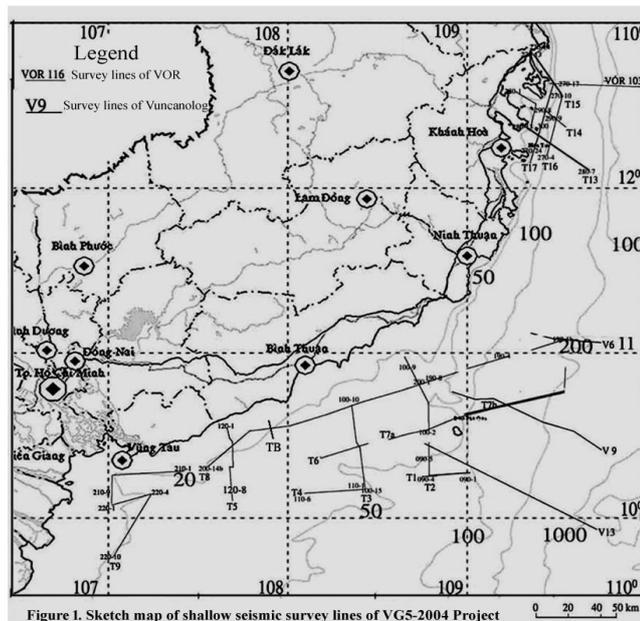
Being active and open is a characteristic of Sa Huynh culture people, they are not

only fishermen familiar with exploiting aquatic resources in the far away fishing area, but also traders with very long journeys. The rivers in the region (Thu Bon, Tra Bong, Ba, etc.), were the trade links between Sa Huynh residents and mountaineers. The imprint of Sa Huynh culture has also been found on remote islands such as Phu Quy, Con Dao, Tho Chu, Truong Sa, etc., proving that Sa Huynh culture residents had a habit and level of sea-travelling at a high standard. Following the sea routes, the traces of Sa Huynh culture are found in many neighbouring cultural areas such as the Dong Son culture in northern, Oc Eo culture

in southern Vietnam and especially even going up to Kananay in the Philippines. In addition, Sa Huynh culture relics have also found a significant amount of artifacts from distant lands such as: Double-animal-headed ear pendants made of Nephrit stone jade, Western Chinese copper mirrors, Indian hydrographic seals and agate beads of the Mediterranean region ... This, once again affirmed, the ancient Sa Huynh people had extensive trade relations throughout the Southeast Asia and beyond. It is such economic exchange that was an important driving force for promoting Sa Huynh culture to develop with brilliant and splendid achievements.

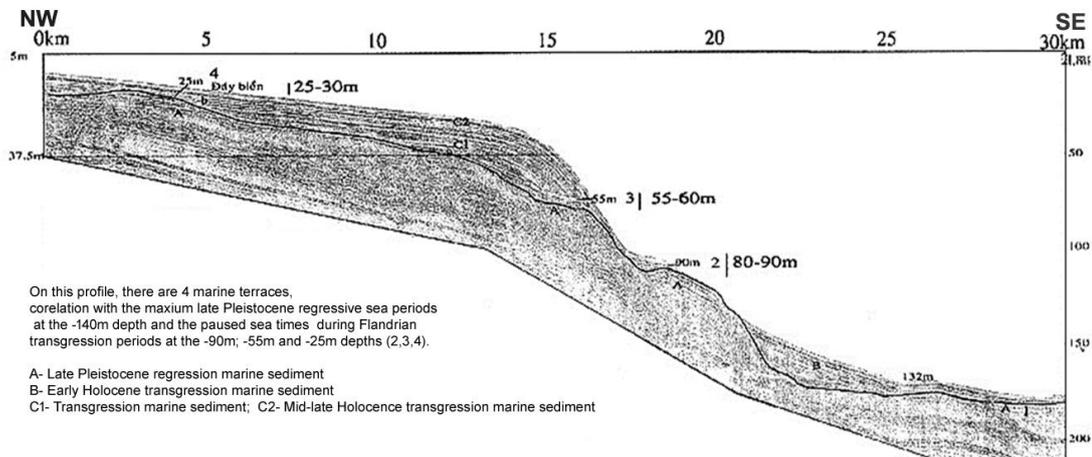
SOME ILLUSTRATION PICTURES

Figure 1: Diagram of Seismic Measurement Lines VG5-2004 Project



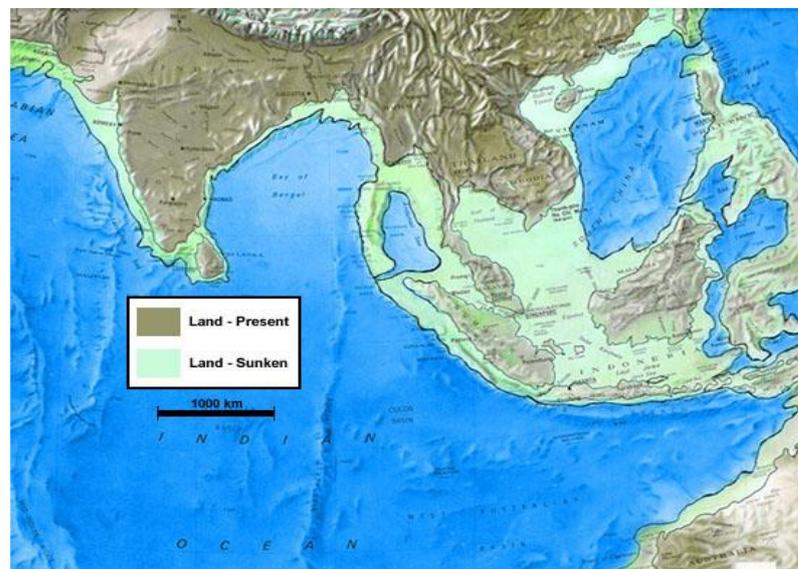
Source: Mai Thanh Tan (2003), *East Sea, Vol. 3: Geology -Geophysics*, Hanoi National University Press, Hanoi.

Figure 2: Traces of Beaches at a Depth from -110m to -140m, Formed during Sea Regression at Late Pleistocene That Was Confirmed by Results on T3 Line Seismic Records of VG05-2004 Project



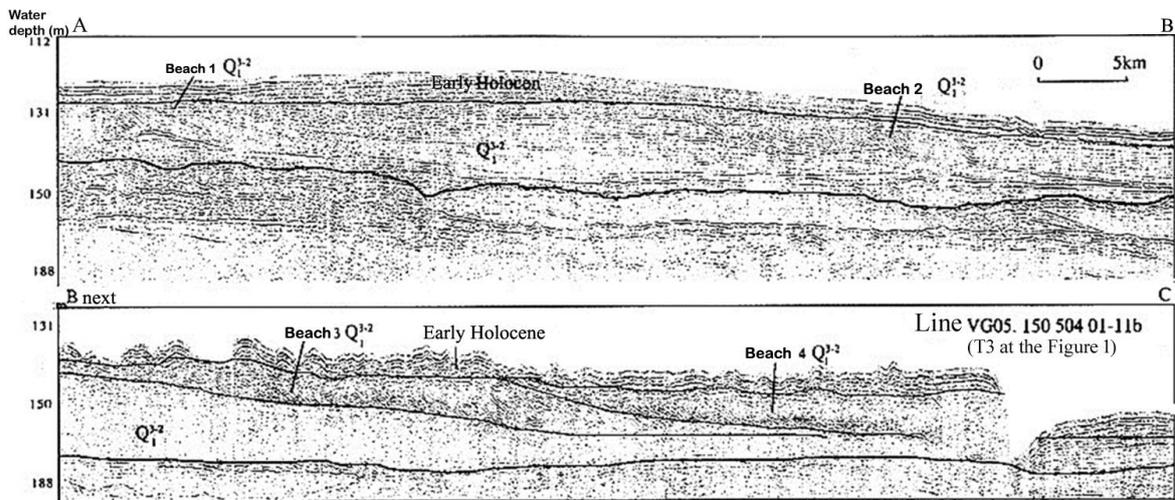
Source: Nguyen Bieu (2001), *Results of Geological and Mineral Investigation in Vietnam's Nearshore Shallow Sea (0-30m Water Depth), Scale 1:500,000 (1991-2001)*, General Department of Geology and Minerals of Vietnam.

Figure 3: Southeast Asia Mainland during Sea Regression Period, Approx. 20,000 Years Ago



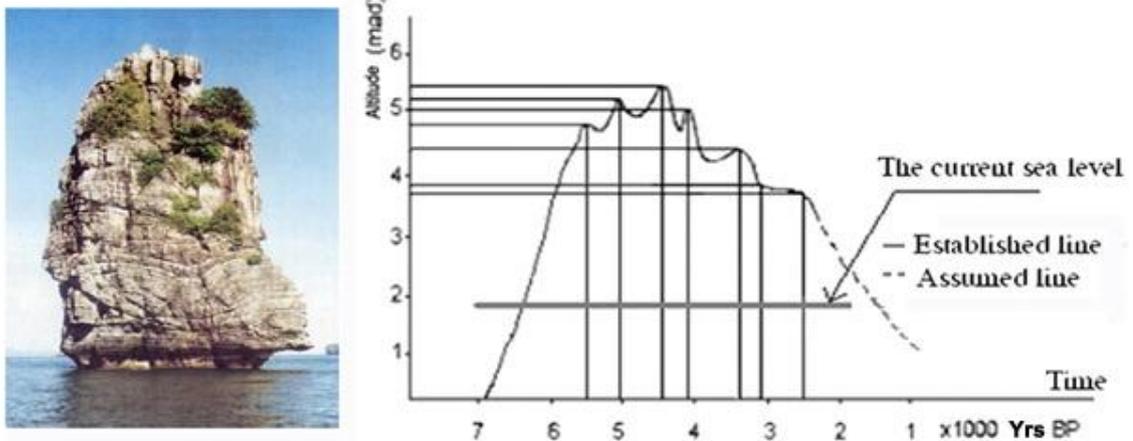
Source: <https://atlantisjavasea.files.wordpress.com>

Figure 4: Traces of Sea Terraces in the Flandrian Transgression



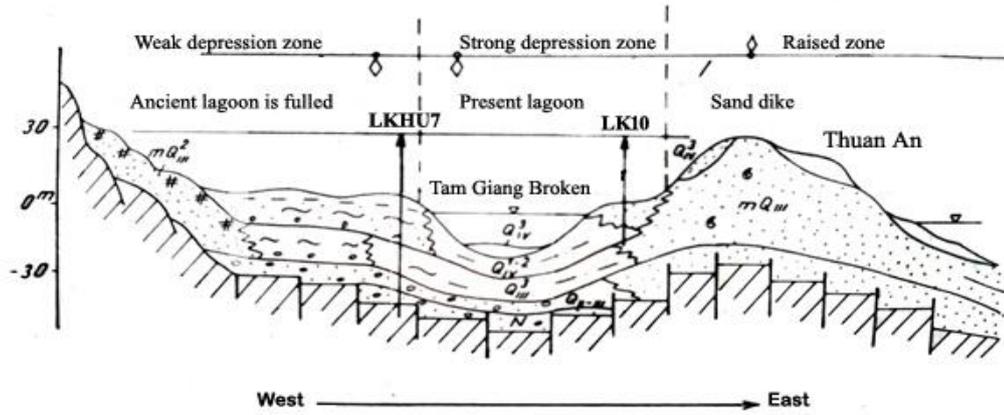
Source: Nguyen Bieu (2001), *Results of Geological and Mineral Investigation in Vietnam's Nearshore Shallow Sea (0-30m Water Depth), Scale 1:500,000 (1991-2001)*, General Department of Geology and Minerals of Vietnam.

Figure 5: Oscillating Model and Sea Level Imprint on Limestone Cliff



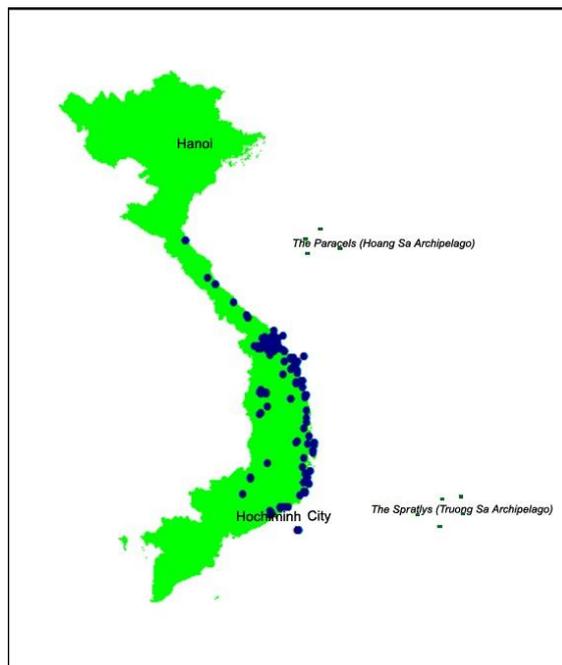
Source: Nguyen Quang Mien (2010b), "Geological Environment of East Sea and Geoarchaeological Data in Region", *Journal of Archaeology*, No. 5, pp. 80-90.

Figure 6: Model of Subsidence Creation in Vietnam's Central Delta



Source: Tran Nghi (1996), "Evolution to Coastal Sand Formation in Central Region in Interaction with Sea Level Fluctuations in Quaternary", *Marine Geological and Geophysics Studies*, Vol. 2, Institute of Oceanography, National Centre for Natural Science and Technology, Hanoi, pp.130-138.

Figure 7: Map of Distribution of Sites of Sa Huynh Culture in Central Vietnam



Source: The Authors

Table 1: Analysis and Dating Results of Some Relics of Pre- Sa Huynh, Sa Huynh, and Late Sa Huynh Periods

No.	Location	No. of samples sent for analysis	Depth (Layer/cm)	Material	Number at Laboratory	$\delta^{13}\text{C}$ Figure	Year (BP)	Date of tree-rings	
								1 sigma	2 sigma
1	An Bang			Coal		-25	2260 \pm 90*	400BC-200BC	750BC-50BC
2	Bai Ong	OOBVOH1.L9 δ_{c_2, b_2}	110	Coal	HNK-37	-25	3010 \pm 60	1380BC-1130BC	1420BC-1050BC
3	Bai Dong	07.TC.M1		Vso	HNK-526	0,0	2020 \pm 50	90BC-60AD	170BC-80AD
4	Bich Dam				HCMV.11/94	--	2935 \pm 65	1260BC-1040BC	1380BC-940BC
5	Con Mieu Ba	07.CMB.M1		Vso	HNK-527	-25	2280 \pm 65	410BC-200BC	520BC-170BC
6		02CR.01	Grave	Coal	HNK-169/1	-25	2490 \pm 70	770BC-520BC	790BC-410BC
7	Con Rang	02CR.02	Grave	Coal	HNK-169/2	-25	2630 \pm 60		
8		02CR.03	Grave	Coal	HNK-169/3	-25	2770 \pm 65		
9		02CR.04	Grave	Coal	HNK-169/4	-25	3310 \pm 55	1670BC-1510BC	1740BC-1450BC
10	Con Dai		Grave	Coal	---	--	2320 \pm 65*		
11			Grave	Coal	---	--	2260 \pm 75*	400BC-200BC	520BC-100BC
12		03.DgC.H1 (M1)	38	Coal	HNK-192/1	-25	2100 \pm 55		
13	Cuom Cave	03.DgC.H1 (M2)	Grave	Coal	HNK-192/2	-25	1980 \pm 55		
14		03.DgC.H1 (M4)	31	Coal	HNK-192/4	-25	1810 \pm 55	120AD-320AD	70AD-350AD
15		03.DgC.H1 (M5)	80	Coal	HNK-192/5	-25	2250 \pm 60	390BC-200BC	410BC-160BC

No.	Location	No. of samples sent for analysis	Depth (Layer/cm)	Material	Number at Laboratory	$\delta^{13}\text{C}$ Figure	Year (BP)	Date of tree-rings	
								1 sigma	2 sigma
16		GC2000.H1.L4.c ₂₋₃		Coal	Bêta.43499	--	2140 ± 60		
17		GC2000.H1.L3.C3		Coal	Bêta.43500	--	2330 ± 60		
18	Go Cam	01GC.H2F5.Tr6:M1		Coal	HNK-130	-25	2230 ± 50	520BC-230BC	750BC-20BC
19		01GC.H2B4.Tr1:M2		Coal	HNK-131	-25	2080 ± 50		
20		2001.M1 {H2a5}	40-60	Coal	SNU 03-598	-24,1	2000 ± 40		
21		2001.M1 {H3L3a2}	100	Coal	SNU 03-599	-24,1	4760 ± 80		
22		H2F5(GC01H2Tr2/1)		Coal	SNU 03 -618	--	2060 ± 40		
23		H2F5Pole6		Coal	SNU 03 - 619	--	1960 ± 30	AD-75AD	40BC-130AD
24		Go Mai Voi				Hd – 21258	--	2342 ± 45	510BC-370BC
25	Go Que			Coal	---	--	2040 ± 50*	150BC-30AD	180BC-70AD
26	Hoa Diem	02HDH1	Layer 3-4	V.s.o	HNK – 167	0.0	2240 ± 60	390BC-200BC	410BC-160BC
27		02HDH1L3	Layer 3	Coal	HNK – 168	-25	2050 ± 60	170BC-20AD	210BC-80AD
28				Coal	---	--	2129 ± 61*		
29				Coal	---	--	2133 ± 50*		
30	Lai Nghi			Coal	---	--	2086 ± 50*		
31			Grave	Coal	SNU 03-612	--	2070 ± 60	180BC-AD	350BC-70AD
32				107	Coal	SNU 03-613	--	2150 ± 60	360BC-90BC
33			198	Coal	SNU 03-614	--	2150 ± 60		

No.	Location	No. of samples sent for analysis	Depth (Layer/cm)	Material	Number at Laboratory	$\delta^{13}\text{C}$ Figure	Year (BP)	Date of tree-rings	
								1 sigma	2 sigma
34	Long Thanh	78.LT.H2-0,6m	60	Coal	Bln.2054	--	2875 ± 60	1160BC-930BC	1260BC-900BC
35		77.GMV.TS	160	Coal	---	--	3370 ± 40	1740BC-1610BC	1750BC-1530BC
36	Lung Leng	01.LL.HC2.L6.M4	Layer 6	Coal	HNH-203	-25	3220 ± 105	1630BC-1390BC	1750BC-1200BC
37		01.LL.HC2.L6.M5	Layer 6	Coal	HNH-204	-25	3110 ± 80	1490BC-1260BC	1540BC-1120BC
38	Chinh Stream			Vso	AA 75511	--	1994 ± 35		
39				Vso	AA 75512	--	1875 ± 34	70AD-210AD	60AD-240AD
40		05SchH1LII6-a5	160	Vso	HNK-332	0.0	2110 ± 50		
41		05SchH1LII3-a2	95	Vso	HNK-335	0.0	2150 ± 50	360BC-100BC	370BC-50BC
42	Con Hamlet				HCMV/10/94	--	4140 ± 80	2880BC-2620BC	2900BC-2490BC
43	Oc Hamlet	97XO.H1.L4.Od2	80	Vso	ANU-10878	--	1900 ± 60	20AD-220AD	40BC-250AD
44		97XO.H1.L5.Oa1	109	Vso	ANU-10879	---	1910 ± 60		
45		97XO.H1	60-80	Vso	SNU 03-597	-26.3	2090 ± 60	200BC-40BC	360BC-60AD

Source: The Authors

Note

^{1, 2, 3} This paper was translated by Van Thi Thanh Binh. Edited by Mahler Etienne.

References

- [1] Nguyễn Biểu (Chủ biên) (2001), *Kết quả điều tra địa chất và khoáng sản biển nông ven bờ 0-30 m nước Việt Nam, tỷ lệ 1/500,000 (1991-2001)*, Tư liệu Cục Địa chất và Khoáng sản Việt Nam. [Nguyen Bieu (chief author) (2001), *Results of Geological and Mineral Investigation in Vietnam's Nearshore Shallow Sea (0-30m Water Depth), Scale 1:500,000 (1991-2001)*, General Department of Geology and Minerals of Vietnam].
- [2] Nguyễn Trung Chiến (2010), "Thời tiền - sơ sử trên các hải đảo ven vùng biển Kiên Giang qua phát hiện khảo cổ học năm 2008", Tạp chí *Khảo cổ học*, Số 2. [Nguyen Trung Chien (2010), "Pre- and Early History Time on Islands along Kien Giang Coast through Archeological Findings in 2008", *Journal of Archaeology*, No. 2].
- [3] Nguyễn Chiêu (2005), *Báo cáo khai quật Gò Dừa*, Tư liệu Viện Khảo cổ học. [Nguyen Chieu (2005), *Report of Excavation at Go Dua*, Document at Institute of Archaeology].
- [4] Lâm Thị Mỹ Dung (2009), "Văn hóa Sa Huỳnh: nhận thức từ những phát hiện mới", *Bài trình bày ở Hội nghị quốc tế 100 năm nghiên cứu phát hiện Văn hóa Sa Huỳnh*, Quảng Ngãi. [Lam Thi My Dzung (2009), "Sa Huynh Culture: Understanding from New Findings", *Presentation at International Conference on 100 years of Studying and Discovering Sa Huynh Culture*, Quang Ngai].
- [5] Nguyễn Địch Dỹ (1979), "Ranh giới giữa Pleistocen và Holocen", *Những phát hiện mới về khảo cổ học năm 1978*, Nxb Khoa học xã hội, Hà Nội. [Nguyen Dich Dy (1979), "Boundary between Pleistocene and Holocene", *New Archeological Discoveries in 1978*, Social Sciences Publishing House, Hanoi].
- [6] Nguyễn Quang Miên (2010a), "Các đới bờ ven biển và một số dẫn liệu về địa môi trường khu vực Nam Trung Bộ Việt Nam", Tạp chí *Khảo cổ học*, số 2. [Nguyen Quang Mien (2010a), "Coastal Zones and Data on Geo-environment of South Central Vietnam", *Journal of Archaeology*, No. 2].
- [7] Nguyễn Quang Miên (2010b), "Môi trường địa chất Biển Đông và một số dẫn liệu về địa khảo cổ học trong vùng", Tạp chí *Khảo cổ học*, số 5. [Nguyen Quang Mien (2010b), "Geological Environment of East Sea and Geoarchaeological Data in Region", *Journal of Archaeology*, No. 5].
- [8] Trần Nghi (1996), "Tiến hoá thành hệ cát ven biển miền Trung trong mối tương tác với sự dao động mực nước biển trong Đệ tứ", *Các công trình nghiên cứu địa chất và địa vật lý biển*, tập 2, Viện Hải Dương học, Trung tâm Khoa học tự nhiên và công nghệ Quốc gia, Hà Nội, tr.130-138. [Tran Nghi (1996), "Evolution to Coastal Sand Formation in Central Region in Interaction with Sea Level Fluctuations in Quaternary", *Marine Geological and Geophysics Studies*, Vol. 2, Institute of Oceanography, National Centre for Natural Science and Technology, Hanoi, pp.130-138].
- [9] Hoàng Thúy Quỳnh (2016), *Kỹ thuật chế tác gốm trong văn hóa Sa Huỳnh*, Luận án tiến sĩ, Tư liệu Viện Khảo cổ học. [Hoang Thuy Quynh (2016), *Pottery Making Techniques in*

- Sa Huynh Culture*, Ph.D thesis, Document of Institute of Archaeology].
- [10] Mai Thanh Tân (chủ biên) (2003), *Biển Đông, Tập 3: Địa chất - Địa vật lý*, Nxb Đại học Quốc gia Hà Nội, Hà Nội. [Mai Thanh Tan (chief author) (2003), *East Sea, Vol. 3: Geology - Geophysics*, Hanoi National University Press, Hanoi].
- [11] Hà Văn Tấn (1996), "Nhận xét về kết quả các chương trình khảo cổ học Trường Sa, Tây Nguyên và Nam Bộ", Tạp chí *Khảo cổ học*, số 4. [Ha Van Tan (1996), "Comments on Results of Archaeological Programmes in the Spratlys, Central Highlands and Southern Vietnam", *Journal of Archaeology*, No. 4].
- [12] Hà Văn Tấn (chủ biên) (2002), *Khảo cổ học Việt Nam*, tập 2, Nxb Khoa học xã hội, Hà Nội. [Ha Van Tan (chief author) (2002), *Vietnam Archaeology*, Vol. 2, Social Sciences Publishing House, Hanoi].
- [13] Lê Bá Thảo (1990), "Các đặc điểm địa lý của vùng khô hạn Thuận Hải", Tạp chí *Thông tin khoa học địa chất*, số 1-2. [Le Ba Thao (1990), "Geographical Characteristics of Dry Areas of Thuan Hai", *Geological Science Information*, No. 1-2].
- [14] Andreas Reinecke, Nguyễn Chiểu, Lâm Thị Mỹ Dung (2002), *Neue Entdeckungen zur Sa Huynh Kultur: das Gräberfeld Gò Mả Vôi und das kulturelle Umfeld in Mittelvietnam - Những phát hiện mới về văn hóa Sa Huỳnh: khu mộ táng Gò Mả Vôi và vị thế văn hóa của nó ở miền Trung Việt Nam*, song ngữ Đức-Việt với tóm tắt tiếng Anh, ISBN 929290-27-8, Lindensoft Press, Koln, 233 trang. [Andreas Reinecke, Nguyen Chieu, Lam Thi My Dzung (2002), *New Discoveries of the Sa Huynh Culture: The Burial Site Go Ma Voi in Quang Nam Province and its Cultural Position in Central Vietnam*, bilingual in German, Vietnamese with English summary, ISBN 929290-27-8, Lindensoft Press, Koln, 233 pages].
- [15] <https://atlantisjavasea.files.wordpress.com>, retrieved on 15 May 2019.
- [16] <https://vietbao.vn>, retrieved on 10 May 2019.
- [17] <https://en.wikipedia.org/wiki/Geoarchaeology>, retrieved on 18 May 2019.
- [18] <https://journals.openedition.org/sapiens/422>, retrieved on 18 May 2019.
- [19] <https://lysonsahuynhgeopark.com/vi/news/di-san-dia-chat/>, retrieved on 16 May 2019.