Mediterranean Archaeology and Archaeometry, Vol. 17, No 2, (2017), pp. 117-129

DOI: 10.5281/zenodo.800836

COMPOSITIONAL ANALYSIS OF SUNGAI MAS, KUALA SELINSING AND SANTUBONG GLASS BEADS

Zuliskandar Ramli[1], Nur Qahirah Abdul Rahman[2], Azimah Hussin[2], Sharifah Nur Izzati Sayed Hasan[1], Azharudin Mohamed Dali[3]

[1]Institute of the Malay World and Civilization, Universiti Kebangsaan Malaysia, Malaysia
[2]School of Environmental and Natural Resource Sciences, Faculty of Sciences, Universiti Kebangsaan Malaysia, Malaysia.
[3]Department of History, Faculty of Arts and Social Sciences, Universiti Malaya, Malaysia

Received: 29/03/2017
Accepted: 29/05/2017
Corresponding author: Zuliskandar Ramli (ziskandar@ukm.edu.my)

ABSTRACT

Sungai Mas, Kuala Selinsing or Pulau Kalumpang and Santubong are the name of the ports that existed since the early of the AD centuries where they played part as the port of accumulator and supplier and afterward, flourished to be a renowned entrepot port in the 5th or 6th A.D., especially Sungai Mas and Santubong. Sungai Mas and Santubong, for instance are not only the entrepot but also places where the socio-culture along with the science and technology evolved, shaped by the combination of the locals and foreign expertise. Amongst the expertise of the locals' Malay on the area is the skill to produce products such as earthenware in a massive quantity since the early of the century. Abundance of raw material around Bujang Valley and Santubong allows local communities to master in smelting activities and producing products from iron ore. The skill that initially belongs to the foreigners but later mastered by the locals in these three locations is the technology to produced and manufactured Indo-Pacific glass bead. Abundance of Indo-Pacific glass beads and its raw materials are discovered in Sungai Mas, Kuala Selinsing and Santubong. Based on the absolute dating conducted for these sites show that Kuala Selinsing has been manufacturing their Indo-Pacific glass beads since 2nd A.D. meanwhile Selinsing and Santubong started in 6th AD. This is justified by the discovery of the archeological finding in raw form which is glass lump used in producing the glass bead and the composition study which shows a different composition material with glass bead from India. The raw materials of glass suggested by Alastair Lamb in 1966 came from the Middle Eastern of Mediterranean in form of glass fragments. It can be concluded that the basic in the science and technology enable the locals' communities to master the foreign technology for their advantage on that time when the Indo-Pacific glass beads became an important commodity from 2nd A.D. to 11th A.D.

KEYWORDS: Sungai Mas, Kuala Selinsing, Santubong, Indo-Pacific glass beads, material composition, Mediterranean

1. INTRODUCTION

Sungai Mas, Kuala Selinsing or Pualau Kalumpang and Santubong is the name of the ports that exist since the early of century AD, started as the accumulator or feeder ports and evolved to be a Southeast Asia's well-known entrepot in the 5th or 6th A.D., when these ports received the arrivals of the merchants from all over the world. Sungai Mas and Santubong is the two ports that attained entrepot status meanwhile Pulau Kalumpang remained to be feeder ports which became the attraction of the merchants for food and fresh water supplies (Zuliskandar & Nik Hassan Shuhaimi 2012).

References from foreign written sources mentioned these two ports especially from China, which cited Kedah Tua as *Chieh Cha*, who allegedly sending an envoy to China on 638 A.D. Kedah Tua, also referred as *Kataha, Kadaram, Kidaram* in the India's sources and *Kalah* in Arab's (Wheatley 1964). Based on the source from China, especially records from Zhu Ying and Kang Tai written in the 3rd A.D., a location called *Po lu cong* was mentioned and believed to be a reference to Santubong. It is shown that both ports are chosen amongst the merchants and traders for their commodities and natural resources such as forest goods, precious metal, water and food, and facilitated ports.

Archaeological research at these sites has given important data in debating on local genius. Thousands of earthenware fragment was found at Sungai Mas and Pulau Kalumpang indicated that both sites produced their own pottery. Based on the chronometrical dating conducted, it is known that Pulau Kalumpang has been occupied since 200 B.C. (Nik Hassan Shuhaimi & Abdul Latip 1988) meanwhile Sungai Mas in 2nd A.D. (Zuliskandar et al. 2011). The ability of the community in producing the earthenware is the factor of why there are no discovery of *roulette ware*, an Indian type of earthenware. Thousands of earthenware were discovered in Lembah Santubong as well, notably in Bongkisam. In archaeology context, the fragment of the earthenware was found in the prehistoric layer namely between 5th to 13th A.D. The earthenware discovered mostly in Bongkisam and Bukit Maras (Cheng Te-k'un 1969).

Bujang Valley and Santubong Valley share several similarities in archaeological context. Both of sites are an advance entrepot ports since the 5th A.D., archeological findings consist of thousands of earthenware, traded potteries from China, mainly Tang Dynasty's ceramic (618-907 A.D.) and Sung's (969-1279 A.D.), monochrome glass beads, temple made of brick, and the existence of smelting industry or workshop and iron production (Harrison & O'Connor 1968). The iron smelting site is believed to appear since the end of prehistoric time which dated back to the early or before A.D. and not related to the immigrant from India. Smelting industry or workshop is one of the locals' skill that existed at both sites. In Malaysia, the tools and equipment has been found since the 3rd A.D. where it can be found individually or associated with the discovery of bronze items that related to the burial site of the Bronze age people (Zuliskandar & Nik Hassan Shuhaimi 2010).

Archeological study also found thousands of monochrome glass beads, known as Indo-Pacific glass beads in Sungai Mas, Pulau Kalumpang and Santubong. Other that these Indo-Pacific glass beads, various of beads made of semi-precious stone, wood, bones, terracotta, and metal are also discovered together with the polychrome glass beads. The shape and type of the beads discovered show that the earliest beads are from Rome, known as eye bead which was manufactured between 2nd to 4th A.D. These beads were found in Sungai Mas and Pulau Kalumpang. The findings of glass clump in Pulau Kalumpang and Sungai Mas indicated that monochrome glass beads were manufactured by the locals. This theory was first introduced by Evans through his research in Selinsing or Pulau Kalumpang, where he found damaged glass clump (Evans 1932). The same idea has been stated by Alastair Lamb based on the discovery of abundance of glass wastage and fragment in Pengkalan Bujang. He also believed that the glass fragment found in Pengkalan Bujang has been reused in making glass beads and probably originated from Middle Eastern of Mediterranean (Lamb 1966).

Peter Francis Jr (2002), who involved in various studies of beads in all over the world named Sungai Mas and Selinsing or Pulau Kalumpang as one of the Indo-Pacific glass bead's production center in South East Asia. This is based on the discovery of the Indo-Pacific glass beads in numerous amount and the remains of the raw material in both sites. However, Santubong was not included in the list of the production center in his studies. Based on the abundance of beads in Santubong especially Bongkisam and Bukit Maras, it is relevant to say that Santubong is eligible to be recognized as one of the production center of Indo-Pacific glass beads in South East Asia. Further research such as archeological excavation in Bongkisam and Bukit Maras is required to find stronger evidence especially raw materials used in manufacturing the glass bead and scientific study for the composition of the glass bead materials on this site. Scientific study on Indo-Pacific glass bead proved that Sungai Mas has manufacturing and producing their own glass beads and have different composition than Indo-Pacific glass bead found in Arikamedu, India.

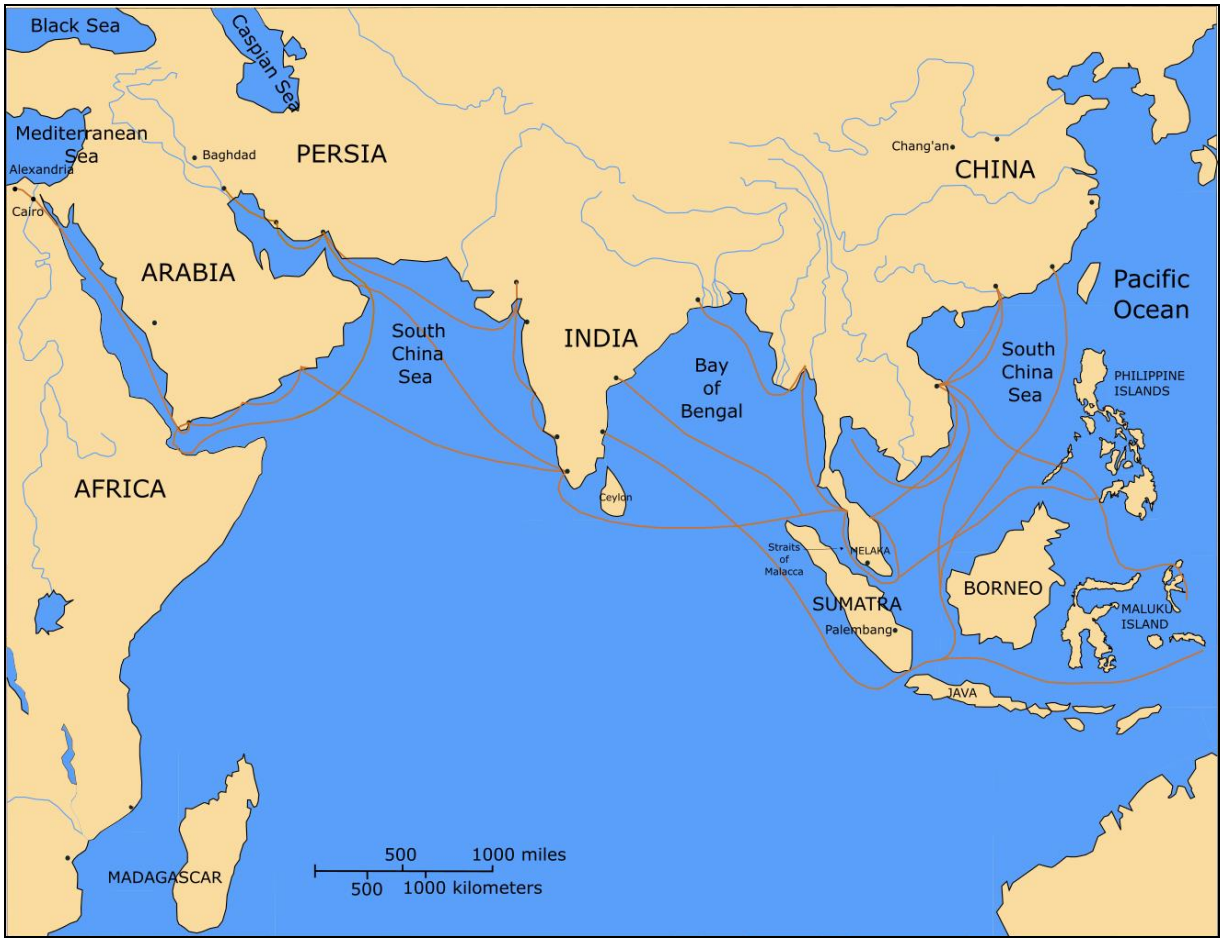

Figure 1. Trade route of the ancient trading from the west to the east.

2. METHODS & INSTRUMENTATION

The samples were gathered from the findings of each archeological site through conscientious excavation all around Asia. The samples were clean and let dry to remove impurities that may effected the result. It was then divided into group of color, shape and size and kept in the labelled container. The sample was name mostly according to colors and shape name was added for vast opportunity in differentiating colors and shape of the beads.

For the analysis, in order to determine the chemical composition of the potteries, each sample weighing 0.4g was refined and heated up for one hour at a temperature of 105°C and mixed until homogenous with the flux powder of a type of Spectroflux 110 (product of Johnson & Mathey). These mixtures were baked for one hour in a furnace with a temperature of 1100°C. The homogenous molten was moulded in a container and cooled gradually into pieces of fused glass with a thickness of 2mm and a diameter of 32mm. The samples were of 1:10 dilution. Press pallet samples were prepared by mixing 1.0g of samples together with 6.0g of boric acid powder and then pressure of 20 psi was applied by using hydraulic pressure equipment. The samples of fused pallets and pressed pallets were then analysed using a Philips PW 1480 equipment for analysis of major and trace elements. Representative bead samples were then selected for the geochemistry were determined by X-ray fluorescence (XRF), using a Bruker S8 Tiger x-ray fluorescence spectrometer. Sample weights were 1–1.5 kg before crushing and powdering. Major, minor, and trace element abundances were determined The elements include SiO2, TiO2, Al2O3, Fe2O3T, MnO, MgO, CaO, Na2O, K2O, P2O5, V, Cr, Co, Ni, Cu, Zn, Rb, Sr, Zr, Y, Nb and Ba.

3. INDO-PACIFIC GLASS BEADS PRODUCTION CENTER

Indo-Pacific glass beads are manufactured in several different locations all over Asia since the old time. Glass beads maker not require to make their own glass to make the glass beads since glass fragments are reusable. This lead to another issue regarding the origin of the glass used in the glass beads making. Some say that the glasses are originally imported from the western countries.

Studies conducted by Francis, where Indo-Pacific beads has been compared to the beads from western

shows that Indo-Pacific beads contained different element from western glass (Francis 1988-1989). Despite of Indo-Pacific glass beads (from analysis conducted in India and Southeast Asia) show few variation of chemical composition, the glass that has been used is basically have the same quality. Glass used in making the glass beads are categorized as Middle East or Roman-Hellenistic-Byzantine, where the glass contains low lead and no barium can be traces (Lamb 1965:36). Meanwhile high amount of lead found in China glasses.

However, the original places of the glass used for the Indo-Pacific was made is still an unanswered matter. The Indo-Pacific glass beads from various location such as Arikamedu, Karaikadu, Oc Eo, Kuala Selinsing, Sungai Mas, Khlong Thom and Takua Pa has been undergone through several scientific research. The result shows that there are differences in terms of element composition for each bead in their respective areas.

Indo-Pacific glass beads manufacturing industry started in Arikamedu (250 B.C. to 250 A.D.) India. This city is a renowned and advanced port city for almost five decades and identified as Ptolemy's Poduca Emporium. This city was left abandoned in 3rd A.D. after it has been attacked and annihilated by the people of Kalabras, which the Tamil Sangam literature considered as a barbarian attack. Before the city was abandoned, the makers and manufacturers of Indo-Pacific glass beads moved and open new production area in 2nd A.D. located in:

i. Mantai, Sri Lanka (1st or 2nd to 10th A.D.) – Port that functioned as a trading center port and the location of the exchange of goods from west and east. Identified based as Modutti Emporium.
ii. Klong Thom, south Thailand (2nd to 6th A.D.) – became the producer of beads for Southeast Asia's market. Identified as Ptolemy's Takkola Emporium
iii. Oc-eo or Go Oc Eo, Vietnam, Funan Province Port (2nd to 7th A.D.) – important stopover port between Malaya and China (Malleret, 1962), identified as Ptolemy's Kattigara Emporium. It's trading area covers East Asia's market.

In south Thailand, Sating Pra (7th to 10th A.D.) became the producer of the Indo-Pacific beads. Associated with the empire of Oc-eo, and following in its footsteps, Sating Pra constructed canals in the city as water transport facilities and the canals connected to South China Sea and Andaman Sea.

Kuala Selinsing, Perak is also believed to be an Indo-Pacific glass beads production center. The beads that was manufactured here will be sent to Lembah Bujang which possessed more advance port. Early observation to Kuala Selinsing and Sungai Mas beads composition shows that there are differences in their chemical composition. However, this theory has not been proved scientifically. Braddlle (1980) emphasized on the fact that there was close relation between Kuala Selinsing and Trang (Klong Thom). There are possibilities that beads maker from Ec-eo settled in Sating Pra while the makers from Klong Thom moved to and settled in Kuala Selinsing. This theory however, is not match with the recent archaeological research of cultural layers and absolute dating of Kuala Selinsing site, where it shows that it has been a manufacturer of Indo-pacific glass beads since before 6th A.D. It can be suggested that Kuala Selinsing and Khlong Thom, Thailand has been a manufacturer of Indo-Pacific glass beads in the same time between 2nd to 6th A.D.

Takua Pa, south Thailand (9th to 10th A.D.) is a manufacturer of Indo-Pacific glass beads and there is possibility that the workers and the manufacturer came from Sating Pra (Francis 2002). Discovery of the trading ceramic here is just the same as found in Sungai Mas. It is possible that the entrepot in Takua Pa and Sungai Mas are thrived together. Simultaneously, they both became the production center of the Indo-Pacific glass beads in the archipelago.

Sungai Mas, Kedah is another production center of the beads in South East Asia. It played role as the entrepot ports since early of the A.D. A Malay's kingdom centralized in Sungai Mas appeared in 5th A.D. It is attested by the discovery of a votive tablet with the image of Buddha in Gupta era, Sungai Mas inscription and Cherok Tokkun inscription which indicates that it was made in 5th A.D. Francis (2002) believed that perhaps that the bead makers in Sungai Mas is originally for Kuala Selinsing. Development of Sungai Mas started after Kuala Selinsing was abandoned, possibly earlier than Takua Pa. Sungai Mas is believed to be a production center of the Indo-Pacific glass beads in 6th to 11th A.D in the golden age of Sriwijaya and the religion of Buddha Mahayana.

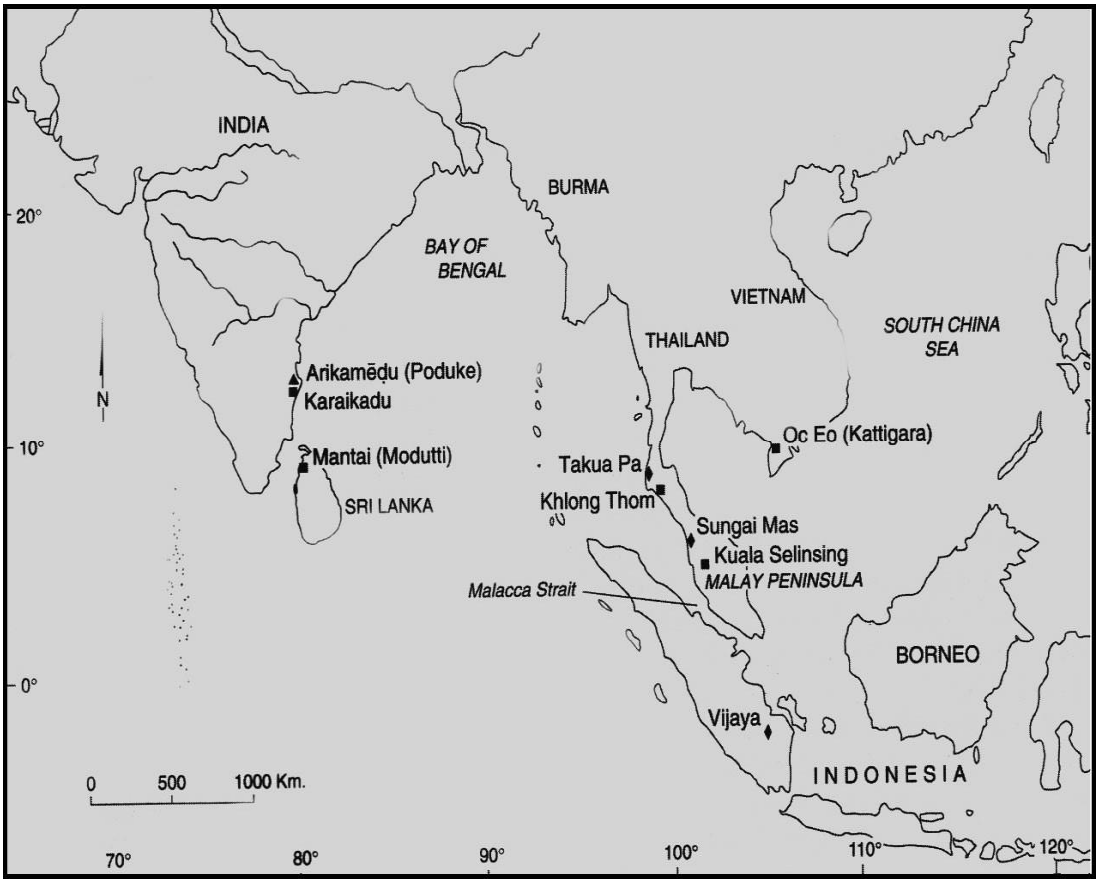

Figure 2. The location of Indo-Pacific beads manufacturer Peter Francis Jr (2002)

4. INDO-PACIFIC MONOCHROME BEAD PRODUCTION CENTER IN SUNGAI MAS, LEMBAH BUJANG

Research in Lembah Bujang that started since 1840s by Kolonel James Low has provide us with the remains of protohistoric civilization in the form of temple, construction materials, religious statue, inscription, and many other artifacts such as earthenware, trading ceramic, glass, metal materials and various type of beads. 160 years of study in Lembah Bujang resulted to the fact that Lembah Bujang evolved to be a distribution feeder port and entrepot since before century and 5th A.D. Old Kedah Malay Kindom was founded and centralized in Sungai Mas (Nik Hassan Shuhaimi & Othman 1992; Zuliskandar & Nik Hassan Shuhaimi 2012).

Additional to the role as an entrepot ports and center of early malay's kingdom, Lembah Bujang is also an archipelago's Indo-pacific glass beads production center. This is proven by the discovery of the raw materials to produce glass beads in archaeological sites and scientific analysis that has been conducted to the beads and its raw materials. Scientific analysis consists of chemical composition of the beads and its raw materials available in Kampung Sungai Mas, Kota Kuala Muda, Kedah. Sungai Mas bead composition analysis shows that it is different compare to the composition of the bead from Arikamedu in India, Khlong Thom in Thailand and Palembang in Indonesia (Zuliskandar 2008; Zuliskandar et al. 2011).

Research and discovery of beads in Lembah Bujang has been reported by Qiaritch- Wales about the finding of glass bead in Merbok in 1940s and Alastair Lamb in Pengkalan Bujang in 1960s. Alastair Lamb is the first researcher who took the initiative to perform the chemical analysis on the beads from Lembah Bujang. This study encouraged Lamb to connect the bead in Peninsular Malaysia with other locations in Southeast Asia, such as Sumatera, Java, Thailand, Laos, Vietnam, Sarawak and Philippine (Lamb 1961:48, 1964, 1965a:36, 1965b:39-40, 1965c:108). Based on the result of the research and observation done by Lamb around the area of Site 18 Pengkalan Bujang in 1961, he stated that 5000 pieces of glass bead (discovered together with other artifact, ceramic and fragmented glass) are the remains of an important entrepot trading. The existence of the bead and glass shows that glass from Middle East plays important part in the Southeast Asia trade (Lamb 1961:48). This is proven by the finding of the beads and glasses in Kuala Selinsing and Takuapa which show similar physical features and chemical

properties with the glass from Lembah Bujang (Mohd Kamaruzzaman Abdul Rahman 1989). West Asia's glass that discovered plentifully in Pengkalan Bujang and other location in Southeast Asia, clearly shows that the residual from glass manufacturing factory are important as it was used as raw materials in bead manufacturing (Lamb 1961:48, 1965a:36, 1965b:39-40, 1965c:108).

Most of the bead found in Lembah Bujang can be classified as monochrome glass bead or Indo-Pacific bead and the area with the highest number found was Sungai Mas. Other bead found was polychrome glass bead, semi-precious stone bead, metal and terracotta bead, wooden bead and bones bead. These beads are originally from India, Middle East, Southeast Asia and locals made.

4.1 Bujang Valley Glass Bead composition analysis

Bujang Valley glass bead composition analysis started by Alastair Lamb in 1961 where at that time he also carried out the chemical analysis on the beads from Takuapa and Pengkalan Bujang. Chemical analysis conducted by Lamb to the few beads found in Ko Kho Island, Takuapa and Pengkalan Bujang shows that the two beads in dark red and orange-red from Pengkalan Bujang and the bead from Takuapa are consists of similar high percentage amount for copper and iron. High copper content in faint red glass bead are similar to the bead from South India, Africa and Kuala Selinsing (Lamb 1961). Analysis run by Alastair Lamb (1965) on the glass bead and fragmented glass found in Pengkalan Bujang show that glass bead contains high silica which is between 56.2% to 61.5%. Aluminum content is high as well with the amount around 14.8% to 16.3%. Sodium amounted between 14.0% to 16.8%, meanwhile potassium 1.3% to 2.6%. Based on the silica, aluminum and potassium content clearly indicated that the glass bead from Pengkalan Bujang are not originated from India or China and it shows that this glass beads were made in Bujang Valley (Zuliskandar et al. 2011:12). The fragmented glass was undergone the same analysis by Alastair Lamb, where the result show that the glass contains 72.3% to 73.1% silica while aluminum result was 7.1% to 8.2%, lower than the previous glass bead. Sodium shows the same result which is 13%. High silica content (50% to 70%) and high sodium and non-existence of lead was characterization related to the glass made in Mediterranean or Middle East area. Lamb suggested that the chemical properties stated were the raw materials used in producing mutisalah bead, materials to the fragmented glass of Ahichchhatra and scrap glass found in Pengkalan Bujang (Lamb 1965). Referring to this data, Lamb proposed that the beads in Pengkalan Bujang were made locally using scrap from Middle East (Lamb 1961:48, 1965a:36, 1965b:39-40, 1965c:108).

The outcome from the main composition analysis run on the beads and materials in Kampung Sungai Mas show that all the sample studied used alkali sodium substance as flux in reducing the glass's melting point. Silica content for these samples are between 58.46% to 68.81% while sodium content was between 14.06% to 18.53%. Aluminum contents show the percentage amounted 7.97% to 13.52%. The analysis shows that monochrome glass bead in Sungai Mas used the same materials and based on this fact, it is clearly indicating that these beads was local product (Zuliskandar 2008, Zuliskandar et al. 2011b). The content of the main element in the monochrome glass bead in Sungai Mas can be referred to Table 1.

Copper, lead, iron and possibilities of Zr, Sr, and Ce has been made to tint the spectrum of colors for Sungai Mas beads. Green beads or glass used both elements copper and lead where the lead content is usually higher than copper. Blue beads or glass used copper as coloring agents while yellow beads or glass used lead as coloring agent. Beads or glass in red in color used copper and iron as coloring agent, meanwhile brown or chocolate beads and glass contains high amount of copper, usually more than 10% as well as iron.

Black glass material or beads contained high Ce as well as Zr and Sr. The discovery of the glass material in light yellow shows that this material contains low copper, lead and iron while consists of high Zr and Sr. This data, indicated the probabilities of Zr and Sr was used as coloring agents. Further study is required to determine if these two elements are used as coloring properties in bead manufacturing. Element content used as colors can be seen in Table 2.

Comparisons of beads from Arikamedu with beads and its material from Sungai Mas shows that both of sites used different materials as flux that was used to reduce silica melting point where, Arikamedu beads used potassium while Sungai Mas beads used sodium. It is proven that there are differences between beads from Arikamedu and Sungai Mas in term of composition and manufacturer when they use different material to decrease the melting point of the glass. Obviously, makers and manufacturers of Asia and Southeast Asia's bead used their own combination of substance in their production.

Table 1. Content of major elements (percentage of total) in Sungai Mas Indo-pacific beads

Bead colour	SiO_2	Na_2O	K_2O	CaO	Fe_2O_3	Al2O3	TiO_2	MnO	MgO
Yellow	67.37	14.56	1.86	2.16	1.85	8.87	0.53	0.08	0.45
Green	63.09	15.4	1.93	3.27	2	9.46	0.56	0.08	1.05
Black	66.22	17.04	1.91	2.31	2.39	9.11	0.44	0.05	1.25
Translucent blue	65.36	17.34	1.99	2.65	1.38	7.79	0.49	0.06	0.64
Orange	60.36	14.84	1.98	2.47	3.04	12.04	0.61	0.06	1.47
Translucent blue	66.35	15.9	2.01	2.69	1.8	8.29	0.53	0.07	0.87
Translucent blue	62.88	18.48	1.94	2.83	1.79	9.94	0.53	0.08	1.16
Light green	63.9	16.36	1.76	2.54	1.96	9.83	0.52	0.08	1.15
Translucent Blue	66.25	18.17	1.5	3.07	1.63	8.21	0.3	0.05	0.82
Red (opaque)	64.5	15.77	1.75	2.88	2.74	10.29	0.5	0.06	0.96
Light yellow*	64.37	14.08	1.98	2.27	1.72	9.59	0.59	0.07	0.73
Yellow	64.82	16.87	1.97	2.08	1.7	9.84	0.52	0.07	0.92
Blue	68.81	16.64	1.72	2.09	1.67	8.08	0.49	0.06	0.95
Green	65.64	16.51	2.14	2.25	1.7	9.88	0.53	0.06	0.9
Light yellow*	65.6	15.4	2.02	2.43	1.91	9.14	0.59	0.07	0.46
Red (opaque)	62.16	17.7	2.12	2.86	2.03	11.05	0.53	0.07	0.85
Translucent blue	62.66	17.78	1.87	2.73	1.87	9.95	0.52	0.07	1.25
Black	65.3	18.53	2.06	2.17	1.43	11.2	0.56	0.07	0.88
Green	67.6	16.33	1.9	3.13	2.06	9.7	0.54	0.07	0.92
Light yellow*	58.46	18.31	1.54	3.1	1.38	11.99	0.6	0.05	0.82
Translucent blue	64.21	17.72	1.85	3.03	1.36	9.2	0.45	0.05	0.67
Brown	61.48	14.64	1.96	3.12	3.83	13.52	0.6	0.08	1.69

*raw material
Source: Zuliskandar et al. 2011a

Table 2. Contents of trace elements (ppm) in Sungai Mas Indo-Pacific beads

Bead colour	Cu (ppm)	Pb (ppm)	Zr (ppm)	Sr (ppm)	Ba (ppm)	La (ppm)	U (ppm)	Ni (ppm)	Cr (ppm)
Yellow	<10	5386	387	284	247	79	33	<10	64
Green	2529	6634	519	381	271	67	11	<10	85
Black	45	154	314	426	132	96	15	<10	111
Translucent blue	5254	95	558	429	241	92	14	<10	53
Orange	13938	<10	348	446	327	96	11	48	79
Translucent blue	4049	69	616	415	254	57	<10	19	60
Translucent blue	3789	244	638	504	267	70	<10	<10	58
Light green	2668	6454	527	404	267	80	12	<10	62
Translucent blue	5295	104	522	611	152	77	<10	<10	88
Red (opaque)	2661	<10	708	248	673	51	15	<10	85
Light yellow*	17	<10	490	458	390	70	18	<10	86
Yellow	171	6533	490	467	303	74	29	<10	98
Blue	3976	111	584	398	240	70	18	<10	64
Green	2196	6424	510	360	283	64	30	<10	53
Light yellow*	<10	<10	758	976	277	62	25	<10	84

Red (opaque)	2240	<10	578	795	398	68	<10	<10	86
Translucent blue	3264	64	649	481	275	82	11	<10	69
Black	<10	746	701	764	341	34	24	<10	65
Green	2368	4078	499	422	251	60	27	<10	64
Light yellow*	<10	<10	779	1029	296	67	<10	<10	59
Translucent blue	6187	18	343	361	247	80	12	<10	40
Brown	14587	268	337	240	318	75	20	50	92

*raw material
Source: Zuliskandar et al. 2011a

5. INDO-PACIFIC MONOCHROME BEAD PRODUCTION CENTER IN PULAU KALUMPANG

Based on the discovery of deep sea fish bones in Pulau Kalumpang, it is believed that the civilization of Pulau Kalumpang were a group of proficient navigators. Other than that, the community of Pulau Kalumpang is believed to be traders who involved regionally, proven by the existence of beads and foreign ceramic. Among the ceramic found was Persian ceramic and glasses likelihood to be from Middle East (Nik Hassan Shuhaimi & Abdul Latif 1988) and stone pottery made in Yueh Dynasty (Evans 1932). The capabilities of local society in seamanship allowed Pulau Kalumpang to obtain the status of supplies port and supported Bujang Valley as entrepots. It is believed that there is influence from Kedah Tua which can be seen from the findings of the similar artifact and the ability of the locals in earthenware and monochrome bead made.

Apart from producing earthenware in numerous quantity, the discovery of this sites also found beads made of various type such as fish bones, glass and semi-precious stone. The most found beads were made of glass. Blue and dark blue glass beads together with its raw materials which is found in the shape of clump and yet to be finished in Pulau Kalumpang is an indication of there were glass beads maker existed in Pulau Kalumpang and this opinion was first proposed by Evans in his research on Pulau Kalumpang glass beads (Evans 1932). The glass beads were discovered in various colors, both in opaque and transparent form. Among the semi-precious stone beads found were carnelian, agate, amethyst, quartz and many others. Evans assumed that these semi-precious stone was imported from India, meanwhile glass beads, agate and terracotta was made in Pulau Kalumpang and to be exported to Sungai Mas or Pengkalan Bujang (Evans 1932).

This opinion regarding precious stone beads was shared by Quaritch-Wales who thought that these beads was originated from ports in South India and mostly found in 7th A.D. protohistoric sites. Alastair Lamb (1964) also had the same statement where it was stated that there are beads that has been brought in from India and West Asia, and also Java. Meanwhile Paul Wheatley (1996) believed that these beads were originated from several places such as Philippine, Borneo, Zanzibar and Zimbabwe.

Evans (2002) considered Pulau Kalumpang as one of the production center of the Indo-Pacific glass beads in Southeast Asia. He stated that the glass bead from Pulau Kalumpang or Kuala Selinsing was produced between 7th to 10th A.D. These beads then brought to Bujang Valley to be traded, under the conclusion that Pulau Kalumpang was not a suitable port as a trader stop center. Francis also attempted to make a connection between Pulau Kalumpang and Klong Thom by saying that the beads maker in Pulau Kalumpang was originally from Klong Thom (Francis 2002).

Based on the archeological excavation conducted at Pulau Kalumpang in 2008, it was found that the Indo-Pacific glass beads were discovered in the lowest culture strata. Absolute dating that was run to the finding of the organic materials in the same strata resulted to the fact that the glass beads in Pulau Kalumpang existed since 2nd A.D. (Zuliskandar & Nik Hassan Shuhaimi 2009; Ramli et al. 2012). As a matter of a fact, Indo-Pacific glass beads has been produced in Pulau Kalumpang or Kuala Selinsing since 2nd A.D. shows that it played similar role to the Mantai in Sri Lanka, Klong Thom in South Thailand and Oc-eo in South Vietnam (Ramli et al. 2012). Pulau Kalumpang accommodated high demand from Peninsular Malaysia, Sumatra, Java and Borneo.

Before Indo-Pacific glass beads were introduced in Pulau Kalumpang, local civilization has mastered the technique of making the beads from fish bones, wood and seashells. At start, the expertise of glass bead making was obtained from beads manufacturer from South India who are skilled in producing this type of bead since 250 B.C. proven by the dating resulted from a research in Arikamedu, an ancient port. The beads makers from India came to the Southeast Asia after Arikamedu was annihilated in barbaric attack. This technology than mastered by

the locals and spread to Sungai Mas, Takuapa and Santubong. The usage of glass beads is considered important in protohistoric period owing to the fact that there were lots of discovery of production center and the beads are also used in end of protohistoric sites whether in rural or coast area, as example tomb items in Lembah Bernam, the same site where metal material was found both iron and bronze, Gua Angin, Gua Gelanggi in Pahang and Gua Chawas in Hulu Kelantan.

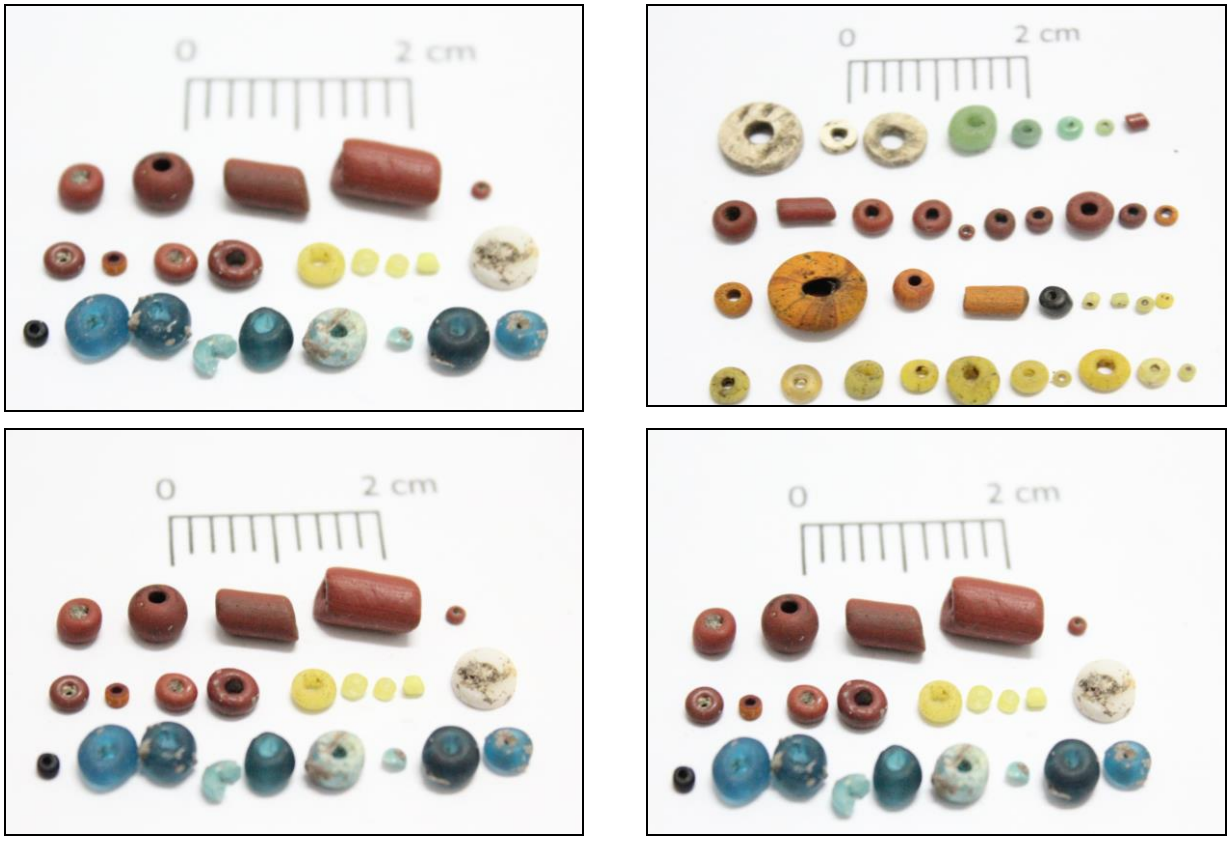

Photo 1. Discovery of artifacts and ecofacts in Pulau Kalumpang, Matang Perak

5.1 Pulau Kalumpang Indo-Pacific Glass Bead composition analysis

First composition analysis for Info-Pacific glass beads in Pulau Kalumpang or Kuala Selinsing was conducted by Tom Harrison and published in 1964 (see Table 1) based on the data obtained, it shows that potassium is more than sodium for sample in the color dark red, orange, dark blue, light blue and dark green. Meanwhile, for light green and yellow beads, sodium content is higher than potassium. Generally, high potassium content indicate that the bead is from South India while if it is the opposite, the bead is made in Southeast Asia, where it will also consist of high aluminum content which is more than 8%. Harrison's analysis for the glass bead exhibit high calcium content, more than 4% and light green contains 9% calcium.

Table 1. Content of major elements in Indo-Pacific beads in Pulau Kalumpang

Sample	SiO_2	Na_2O	K_2O	CaO	Fe_2O_3	Al_2O_3	CuO	MnO	PbO	MgO
Red (Opaque)	67	2	6	4.7	2.7	5.7	1.1	Trace	1.2	Trace
Orange	76	1.3	3.4	4.7	2.9	4.2	5.7	0.01	0.05	1.3
Dark blue	69.1	1.8	5.2	6.5	2.6	11	0.6	Trace	0.36	0.4
Light Blue	69.5	2.9	3.2	6.3	1.5	11.5	1.6	0.04	Trace	Trace
Dark Green	67	2.4	6	8.3	1.3	12	1.2	Trace	0.46	Trace
Light Green	71	5	1.4	9	1.3	6	0.6	0.46	0.46	Trace
Yellow	64	5	Trace	7.3	3	10	0.2	Trace	2.7	0.6

Source: Harrison 1964

Pulau Kalumpang glass bead element analysis content has been done using NAA technique (Neutron activation Analysis) shows most of Pulau Kalumpang sample contains high sodium compare to potassium (see Table 2). High sodium content which is more than 9% to 15% compare to potassium value between 0.01% to 2%. Calcium content in glass bead shows percentage around 0.01% to 4.67%. Five beads sample in light green, dark green, light blue and dark blue contain 0.01% calcium. Aluminum content shows between 3.88% to 8.89%, whereas other non-oxide reading relevant to glass bead made in Southeast Asia. Iron reading is between 0.1% and 2.1% and use as one of the substance to determine the color of that glass bead. Titanium and magnesium both respectively show reading between 0.33% to 0.96% and 0.27% to 1.59%. Comparison of the Pulau Kalumpang Indo-Pacific glass beads with Sungai Mas glass beads (Rahman et al.; Ramli et al.) shows that there are differences between the both site's glass bead in term of composition and it is proven that these beads were made in Pulau Kalumpang and supported by the discovery of the raw material used in beads manufacturing.

Table 2. Content of major elements in Indo-Pacific beads in Pulau Kalumpang

Sample	Na	K	Ca	Fe	Al	Ti	Cl	Mg
Opaque Red	13.95	1.9	2.97	2.1	5.39	0.52	0.71	0.59
Opaque Red	14.8	2.09	2.49	1.26	5.57	0.54	0.71	1.04
Orange	9.83	1.88	2.23	1.5	3.88	0.51	0.58	0.78
Orange	10.12	1.88	4.67	1.79	8.89	0.42	0.61	1.57
Light Blue	13.71	2.41	0.01	0.77	5.71	0.33	0.67	0.6
Dark Blue	10.95	0.01	2.38	1.16	5.25	0.47	0.61	0.79
Dark Green	12.04	1.33	2.06	1.21	4.77	0.63	0.74	1.32
Light Green	12.52	1.87	0.01	1.03	5.32	0.43	0.54	0.75
Yellow	13.52	1.93	2.31	1.22	4.02	0.49	0.64	0.27
Light Blue	12.35	1.97	0.01	1.11	4.8	0.25	0.54	0.47
Dark Blue	11.16	2.01	0.01	0.1	5.49	0.42	0.58	0.29
Dark Green	13.42	1.6	0.01	1.09	4.6	0.36	0.58	0.82
Light Green	14.29	0.01	1.42	1	4.86	0.6	0.68	1.19
Yellow	15.69	1.26	3.61	0.91	5.81	0.37	1.1	0.6
Dark Blue	9.13	2.09	2.7	1.27	5.32	0.46	0.61	1.12
Light Blue	13.9	2	3.38	1.09	5.94	0.64	0.72	1.59
Opaque Red	13.38	1.9	2.04	1.27	5.08	0.96	0.66	1.04

6. SANTUBONG VALLEY AS INDO-PACIFIC MONOCHROME BEAD PRODUCTION CENTER

Santubong is a protohistoric archaeological site full of archeological artifacts, with ancient ports and iron melting site discovery, bricks structure believed as stupa associated with China's ceramic from the Tang, Song and Yuan Dynasty and as well as mysterious carving on large stone. Based on the inscription by Zhu Ying and Kang Tai written in 3rd A.D., Santubong was called *Pu lo Chong* where one of the main trading goods are camphor and other forest materials (Munoz 2006). It can be seen that the role played by Santubong port is similar to Kedah Tua at that time. Both ports manufactured iron as one of commodities in expanding their economy and in the meantime produced earthenware, sea and forest product. Santubong and Kedah Tua is one of the monochrome glass beads known as Indo-Pacific glass beads from 6th to 11th A.D. This is proven by the discovery of abundance on the beads and its raw material when archaeological excavation was carried out.

Despite of lack of the written reference to say that Santubong used to be trading ports that manufactured iron products, it is supported by archaeological evidence that Santubong was once a protohistoric port that produced iron. An archaeological finding in the form of iron slag, associated with fragmented ceramic from Tang Dynasty (618 to 906 A.D.) in Sungai Jaong, a site located about 2 kilometers from Kampung Santubong. In addition to that, it was discovered on this site ten sandstones with anthropomorphic and geometry carving. With the amount of iron slag and fragmented ceramic from Tang Song Dynasty, shown that this site was one of the iron melting center and entrepot ports believed to be occupied around 6th A.D.

Excavation in Bongkisam also discovered similar archaeological remains which is iron slag and ceramic from China. The most important finding is a stone platform believed to be a Buddha stupa, and a reliquary. More Buddha's artifacts were found in Bukit Maras in the downhill of Gunung Santubong, facing Bongkisam.

Sungai Buah site, across the river from Santubong, a discovery of remains such as iron casting residual and fraction of Song Dynasty's ceramic. Other sites located in Santubong area including Tanjung Kubur and Tanjung Tegok, numerous artifacts of Song's ceramic found in both sites. Derived from the archaeological evidence, Santubong might participated in international trading that connected India, Middle East, Southeast Asia and China. Buddha and Hindu's relics found in Santubong is an indication of this area Tanjung Pura, has established an international commerce with India merchant and the earliest empires in Southeast Asia. This is related to the fact that Kalimantan's southwest province were part of the Srivijaya centered in Palembang ruled from 7th to 13th A.D., and part of Majapahit from 14th to 15th A.D.

6.1 Lembah Santubong Indo-Pacific Glass Bead composition analysis

Based on the data acquired from material composition analysis run by Harrison show that silica content in monochrome glass bead in Bukit Maras is high, around 71.5% and 76.5%. While aluminum content shows the reading between 9.8% to 12.8% and sodium which is used as flux show higher reading that potassium mainly around 7.2% to 12.8% (Harrison 1964). High silica and aluminum proved that this beads are not from Arikamedu, India and it is suggested that this monochrome glass beads were made in Santubong Valley. Major element and trace element contained in Bukit Maras monochrome glass bead can be seen in Table 3.

Harrison conducted a composition analysis on few glass bead obtained from the Kelabits. The result show that the beads from Kelabits contain 60.3% to 62.9% silica. While aluminum is 4.7% to 9.0%. It is interesting to say that these beads also show high lead reading between 12.8% to 16.9%. Alkali element show that potassium reading is higher than sodium and it shown that potassium is used as flux to decrease silica melting point. Calcium's reading show high reading as much as 7.9% to 8.4%. Based on lead, potassium and calcium content, it is clear that these beads are not originated from Southeast Asia. China might as well as out of option based on the fact that the beads from China are usually high in lead content with percentage around 40% to 60%. Glasses with medium lead content, 10% to 20% is almost similar to the crystal glass introduced from Europe around 17th A.D. From typology study of polychrome beads worn by Kelabit people, it is for certain that the beads were made in Venice which became popular trading goods and imported by European merchant to archipelago since the 16th A.D.

Table 3. Series B Bead, Bukit Maras, Santubong

Sample	SiO_2	Na_2O	K_2O	CaO	Fe*	AI2O3	Cu*	Mn*	PbO	Mg*
Standard red, long cylindrical	72	9.8	1.3	3.6	0.32	12.2	0.14	0.02	0.28	0.12
Standard red, oblate spheroidal	71.5	10.4	1.3	3.2	0.25	12.8	0.11	0.02	0.23	0.07
Green opaque, small	73.4	8.9	2.1	5.1	0.12	9.9	0.06	0.01	Nil	0.15
Green opaque, very small	74	7.9	2.4	4.9	0.19	10.1	0.05	0.01	Nil	0.11
Standard yellow, small	74.8	7.4	1.5	3.9	0.21	11.7	0.03	0.03	Nil	0.18
Standard dark blue	73.6	8.5	1.9	4.2	0.21	10.9	0.17	0.1	0.19	0.17
Standard black	72.5	8.7	1.9	4.3	0.23	11.4	0.19	0.12	0.17	0.19
Orange with black striœ, long cylinder	75.7	7.8	1.5	3.8	0.05	9.8	0.03	0.03	0.75	0.14
Orange with black striœ, small	76.5	7.2	1.3	3.9	0.04	9.8	0.03	0.03	0.61	0.15

* Analysis is for element alone, not oxide (as in A and C); this slighty reduces the figure
Source: Harrison 1964

Table 3. Series C beads, Kelabit uplands, necklace (T.Harrison, collection)

Sample	SiO_2	Na_2O	K_2O	CaO	Fe_2O_3	AI2O3	CuO	MnO	PbO	MgO
Spherical, light blue	61.7	0.9	4.6	8.4	0.3	4.7	0.4	0.07	12..8	Trace
Barrel, light blue	62.9	0.6	3.6	7.9	0.4	8	0.8	0.04	13.6	Trace
Cylindrical, dark blue	60.3	0.9	3.4	8.5	0.3	9	0.2	0.3	16.9	Trace
Flat cylindrical, dark blue	61.1	0.8	3.2	8.4	0.3	8.7	0.2	0.3	16	Trace

Source: Harrison 1964

7. PULAU KALUMPANG, SUNGAI MAS AND SANTUBONG AS INDO-PACIFIC BEADS PRODUCTION CENTER IN SOUTHEAST ASIA

Studies that has been conducted on these three sites especially the one with archaeological study has proven the role played by all three sites as a supplies ports as well as entrepot ports. In the context of the beads discovery and the materials, archaeological excavation has found tens or even hundreds of thousands of beads where most of it are monochrome glass beads or Indo-Pacific glass beads. Discovery of the raw materials and monochrome glass bead in significant amount has encouraged scholars such as Evans, to proposed that the beads in Pulau Kalumpang was made by the locals lived in the area while the study in Lembah Bujang area by Lamb also encouraged him to expressed his opinion that the beads in Pengkalan Bujang (site 18) is a local product and raw material used is the fragments of glass imported from Middle East (Evans 1932; Lamb 1964:48, 1965a:36, 1965b:39-40, 1965c:108). As well as Santubong, it is reported that abundance quantity of beads has been found mainly in Bongkisam and Bukit Maras (Harrison 1950, 1964). So far, there are no reports on the findings of the bead's raw material in this area but intensive excavation can be done therefore, more solid evidence will be obtained.

Francis (2002) in his observation on the Indo-Pacific beads distribution named two locations in the Peninsular of Malaysia as the production center of this bead, Sungai Mas and Pulau Kalumpang, also referred as Kuala Selinsing. Santubong was excluded and it became question mark if he overlooked Bukit Maras and Bongkisam sites in Santubong. Since the archaeological data used by him is, the sites discovered massive number of bead. Francis (2002) based on the data, proposed that Sungai Mas has become the Indo-Pacific beads production center in 8th A.D. while Pulau Kalumpang in 6th A.D. On a different note, it is more likely that Sungai Mas was an Indo-Pacific glass beads production center since the 6th A.D and continuously to do so until 11th A.D. This is supported by the fact that the beads were found in the cultural layers and the association to that cultural layers dating. Meanwhile in Pulau Kalumpang, the production of the bead has started from the 2nd A.D and end in 8th A.D.

Other than the discovery of the raw materials, composition analysis is also used in proving that the beads from Sungai Mas, Pulau Kalumpang and Santubong are local's product, and not imported, especially from India. One of the clue that distinguish those beads from Sungai Mas, Pulau Kalumpang and Santubong locals' beads is the differences of flux content which is potassium and sodium, calcium content as stabilizer and aluminum content. Analysis on the Sungai Mas, Pulau Kalumpang and Santubong glass bead show high content of aluminum and low calcium compared to glass bead from India. Meanwhile flux used is sodium compared to potassium for India's bead (Zuliskandar et al. 2011).

Monochrome glass bead or Indo-Pacific beads manufacturing technology is a foreign technology or skill brought into Southeast Asia in 2nd A.D. This technology was originally from port city of Arikamedu, India and per its history, was attacked by the barbarian in 3rd A.D. lead to the annihilation but not before the beads maker moved or migrated to others port to expand this industry. Through time, this foreign skill was mastered by the locals who attracted to this industry. Bead is believed to possess high value in world market since 1st A.D. where there is a discovery of this type of bead in Africa. Monochrome glass beads have been found in every temple excavated in Lembah Bujang, Kedah. This implied that other than used as currency, jewelries, marriage, and status symbol, beads are also used in religious ceremony. This type of bead was found in bronze age sites and stone slab grave, as burial or grave goods for the dead and it is believed that the dead was in possess of higher status amongst society.

These Indo-Pacific or monochrome glass bead centers are likely to underwent deterioration when most of the ports subjected to Srivijaya was attacked by King Chola in 1025 A.D. Does the industry has been rebuild by the bead maker or vanished? Between 12th to 13th A.D. most of beads from China was discovered in several main ports including Singapore or Fort Canning. Most probably Indo-Pacific glass bead industry are able to survived until the 12th A.D. and after that period the Southeast Asia market was seized by China's monochrome glass bead industry. In 15th A.D., Europe beads industry especially in Venice, emerged and appearance of this beads are mostly found in Sarawak and Sabah highland, occupied by the Kelabits and others. It seems that Sarawak's native still appreciates this bead which considered possess extra ordinary power to the wearer other than used as status symbol.

8. CONCLUSION

Archeological study and scientific analysis approach successfully proved that Sungai Mas, Pulau Kalumpang and Santubong produced monochrome glass bead known as Indo-Pacific glass bead. However further research is essential for Santubong glass beads and it should involve both archeological and scientifically. Depend to the point of locals' skill,

commodity and products available in all three sites, indicated that these sites have strong relation and trading network and there are possibilities that the citizens are related to each other.

ACKNOWLEDGEMENTS

This study was conducted by using funding from the research projects of the DPP-2015-068 and FRGS/2/2014/ STWN05/UKM/02/1.

REFERENCES

Braddel, Rolland. (1980). Most Ancient Kedah. In. Chandran and J. Baharuddin (eds.) Lembah Bujang: The Bujang Valley, pp. 35-54, Kuala Lumpur, Persatuan Sejarah Malaysia.

Cheng Te-k'un. (1969). Archeology in Sarawak. Cambridge, W. Heffer and Sons.

Evans, I.H.N. (1932). Excavations at Tanjong Rawa, Kulal Selinsing, Perak. Journal of Federated Malay States Museum Vol 15, No 3. pp. 79-133.

Harrison, T. (1950). Kelabit Land Dayak and related glass beads. Sarawak Museum Journal Vol 5, No. 2, pp. 201-220.

Harrison, T. (1964). Monochrome glass beads from Malaysia and elsewhere. MAN Vol. 64, pp. 37-41.

Francis, P. Jr. (2002). Asia maritime, bead trade 300 B.C to the present. Honolulu, University of Hawai'I Press.

Lamb, Alastair. (1961). Some glass beads from Kakao Island, Takupa, South Thailand. Federated Museums Journal Vol. 6 (New Series): 48-55

Lamb, Alastair. (1964). Notes on Beads from Johor Lama and Kota Tinggi. Journal of The Malayan Branch Royal Asiatic Society (JMBRAS) Vol. 37, No. 1, pp. 88-98

Lamb, A. (1965a). Some glass beads from the Malay Peninsula. MAN Vol. 65, pp. 36-38

Lamb, A. (1965b). A note on glass fragments from Pengkalan Bujang, Malaya. Journal of Glass Studies Vol. 7, pp. 35-40

Lamb, A. (1965c). Some observations on stone and glass beads in early Southeast Asia. JMBRAS Vol. 38, No.2, pp. 87-124

Nik Hassan Shuhaimi Nik Abdul Rahman dan Abdul Latib Ariffin. (1988). Penyelidikan Arkeologi di Pulau Buluh (Pulau Kalumpang), Kuala Selinsing, Perak. Jurnal Arkeologi Malaysia Vol. 1, pp. 36-49

Munoz, P.Y. (2006). Early kingdoms of the Indonesian Archipelago and the Malay Peninsula. Singapore: Edition Didier Miller.

Rahman, S.A., Hamsah M.S., Wood, A.K, Elias & Zakaria, K. (2008). INAA of ancient glass beads from Sungai Mas archaeological sites, Bujang Valley, Malaysia. Journal of Radioanalytical and Nuclear Chemistry,Vol 278, No. 2, pp. 271-276.

Ramasamy, A. (1987). History of Pondicherry. New Delhi. Sterling Publishers.

Zuliskandar Ramli. (2008). Sumbangan sains dalam penyelidikan arkeologi.: khusus kepada kajian komposisi bahan. Tesis Sarjana Persuratan, Intitut Alam dan Tamadun Melayu, Universiti Kebangsaan Malaysia.

Zuliskandar Ramli & Nik Hassan Shuhaimi Nik Abdul Rahman. (2010). Petempatan masyarakat zaman logam di Selangor. International Journal of the Malays World and Civilisation, Vol 28, No. 1, pp. 41-55

Zuliskandar Ramli & Nik Hassan Shuhaimi Nik Abdul Rahman. (2012). Zaman proto sejarah di Malaysia: Satu pengenalan. Bangi: Institut Alam dan Tamadun melayu, Universiti Kebangsaan Malaysia.

Zuliskandar Ramli, Nik Hassan Shuhaimi Nik Abdul Rahman & Abdul Latif Samian. (2011). X-ray fluorescent analysis on Indo-Pacificglass beads from Sungai Mas archaeological sites, Kedah, Malaysia. Journal of Radioanalytical and Nuclear Chemistry Vol. 287, No. 3, pp. 741-747. DOI 10.1007s10967-010-0920-y