『東南アジア考古学』21 号: 146-159
Journal of Southeast Asian Archaeology 21: 146-159

THE PREHISTORY OF BUKIT TENGKORAK, SABAH, MALAYSIA

Stephen Chia
Pusat Penyelidikan Arkeologi Malaysia
Universiti Sains Malaysia 11800 Penang Malaysia
e-mail: stephen@usm.my

INTRODUCTION

In 1994-95, archaeological research was undertaken by a joint Centre for Archaeological Research Malaysia and Muzium Sabah team at Bukit Tengkorak, a prehistoric site in Semporna, Sabah (Figure 1). Two seasons of archaeological excavations, over a period of 5 weeks, were carried out at two volcanic outcrops near the summit of Bukit Tengkorak, approximately 600 feet above sea level[1]. Geologically, Bukit Tengkorak forms part of the rim of a 2 kilometre-wide volcanic crater, surrounded by numerous isolated hills and mountains, most of them representing sites of extinct volcanoes ranging from Pliocene to Quaternary in age (HD Tjia, personal communication; Kirk 1962; Lee 1970). A total of 6-one metre trenches, three in each outcrops, were excavated until the base of the undisturbed cultural deposits, about 150 cm in maximum depth (Figure 2). The top layer (0-20 cm) of trenches G17, G19, and J19 appeared to be disturbed but the subsequent layers contained undisturbed artefacts which were excavated in arbitrary controlled spits of 5 cm deep per spit. More than 6 cubic metres of soil was excavated and sieved through 1 mm and 0.2 mm meshes. A broad range of archaeological materials were recovered and they include large quantities of potsherds, chert, agate, and obsidian stone tools, polished stone adzes, a stone bark cloth beater as well as some shell and bone artefacts. There were also abundant food remains, mostly marine molluscs and fish bones, and some terrestrial animal bones.

Five radiocarbon dates place the site between 4300 BC and possibly 50 BC. All the radiocarbon dates are listed in Table 1. Out of the five samples, one (Beta-744447) is modern, confirming that the top layers (0-20cm) of trench G17 is disturbed. As such, the absolute date for the last use of the site is still unknown but given the absence of metal artefacts, stone wares, and porcelain at the top layers, the site is probably abandoned before 2000 BP or 50 BC[2].

Table 1: Radiocarbon dates from Bukit Tengkorak, Sabah

Lab #	Conventional Age (BP)	Calibrated Age (BC) *	Material	Notes
Beta-74447	101.0 ± 0.9%	---	charcoal	Trench G17, Layer 1 Spit 4, 15-20 cm

Beta-74448**	3190 ± 60	1190 to 860	*Anadara* Shell	Trench G17, layer 3 Spit 11, 50-55 cm
Beta-83783***	2940 ± 50	1285 to 990	charcoal	Trench G17, layer 4 Spit 15, 70-75 cm
Beta-83784	2650 ± 90	980 to 745	charcoal	Trench G17, layer 5 Spit 20, 95-100 cm
Beta-83785	5330 ± 80	4340 to 3975	charcoal	Trench G17, layer 8 Spit 26, 125-130 cm

* Cal BC dates (2 sigma, 95 % probability). Charcoal samples calibrated using Stuiver INT 93 Cal program

** This marine shell sample has been calibrated according to Stuiver & Braziunas (1993)

*** This sample was analysed using AMS (Lawrence Livermore)

CULTURAL PHASES

The archaeological evidence at Bukit Tengkorak revealed a pattern of cultural continuity where old traditions survived and new elements were incorporated. It is possible that the site was frequently used as there were no breaks in the occupational levels. Three cultural phases, namely: Early, Middle, and Late Phases were defined at Bukit Tengkorak on the basis of the soil stratigraphy, radiocarbon dates as well as the spatial and temporal distribution of artefacts.

The Early Phase (4340 –1285 BC)

This phase represents the earliest occupational phase where the site was used to manufacture pottery and stone tools. Pottery–making at the site provides strong evidence for a sedentary group of inhabitants. The early phase pottery is characterised by red-slipped and plain cooking pots, stoves, and large storage jars. The stone tools were mostly microliths in the form of small utilised and retouched flake tools. The majority of the microliths were made of agate and chert materials while only some were made of obsidian. The wide range of identifiable faunal remains suggested that the inhabitants relied heavily on fishing, catching turtles, and gathering edible molluscs from the sea. Some big mammals such as the Banteng was hunted as well.

The Middle Phase (1200-900 BC)

During this phase, there was increased contact with other communities, possibly in the form of trade or exchange. Archaeologically, this was manifested in the form of new pottery and stone tool types as well as a sharp increase

in imported obsidian (86%). The obsidian came from Talasea in Melanesia as well as other unknown sources. The new pottery types include a variety of impressed and incised pottery, some with lidded vessels. Red-slipped and plan pottery, however, increased substantially in production (19 times more than in the Early Phase). New stone tool types consisted of the borer and glossed flake tools made of agate and chert. The inhabitants also continued to make more flake tools, mostly retouched and utilised flakes. The inhabitants still depended heavily on fishing, catching turtles, and gathering shellfish from the sea. Hunting of animals, however, was not only limited to big mammals but also included other species such as wild boar, deer, kijang, monkey, and mouse-deer.

The Late Phase (900 BC to perhaps 50 BC)

The *in-situ* archaeological context of this phase is unclear because part of the soil layers (0-20 cm) representing this phase has been disturbed by treasure hunters. As such, no reliable radiocarbon dates can be obtained but the absence of metal and trade ceramics suggested that the terminal date for this phase is at least older than 2000 BP. Radiocarbon dates from the earlier phase, however, suggested that the beginning of this phase at or later than 900 BC. New stone tool types found in this phase include the stone bark-cloth beater, polished stone adzes, and a substantial increase in blade cores. The number of obsidian artefacts decreased drastically, suggesting that obsidian exchange or trade began to decrease or had virtually ceased during this phase (if the few pieces of obsidian found at this phase were from the earlier phases due to disturbances).

POTTERY PRODUCTION

The archaeological evidence for pottery-making comprised remnants of open pottery kilns, a clay heap, nearby clay sources, a strategic location, and a habitable environment. Open kiln remnants include a considerable quantity of pottery sherds (20,236 pieces) recovered during the excavations. A large portion of them (30%) were poor in quality and has ashes adhering to them. These sherds were mostly found in ashy and hearth contexts, 50 cm to 80 cm in thickness, suggesting that they were firing wastes and remnants of open kilns used for firing the pottery. A large heap of clay was also discovered during the excavations. X-ray diffraction analysis of the clay samples showed that it is high in kaolin and therefore suitable for making pottery. The soil profiles of seven cores around this clay heap indicates that it was contained within a boundary of volcanic rocks, arranged in a semi-circular pattern. The clay heap measures about 70 cm in thickness and was sandwiched between the upper loamy layer and the basal volcanic layer. Thin-section analysis of the clay samples revealed rounded to sub-rounded quart grains in the clay, pointing to a riverine origin of this clay heap. All these strongly suggest that the clay did not occur naturally at the site but was brought into the site for making pottery. In addition, basic anda essential raw materials for making pottery such as clays, water, and fuel (e.g. wood for firing) are readily and easily available in and around Bukt Tengkorak. The volcanic boulders at Bukit Tengkorak also formed a natural wind tunnel, with frequent breeze which is excellent for firing pottery. Moreover, the site is situated in a habitable environment where fresh water and food resources are accessible nearby.

The Bukit Tengkorak pottery tradition remained basically the same throughout the entire period of occupation, with some new pottery types of impressed and incised designs as well as the lidded pottery at around 3,000 BP. The majority of the pottery (87%) were red-slipped and plain in the form of simple utilitarian wares such as

cooking pots and stoves as well as large storage jars. A combinations of manufacturing techniques such as hand-moulding, the paddle-and-anvil, coiling, and the slow wheel were used to produce the pottery. All the pottery were low-fired, between 600°C and 700°C and most of them were sand-tempered (Chia 1998; Vandiver and Chia 1996). On the basis of both the archaeological and ethnographical evidence, the Bukti Tengkorak pottery tradition appears to have continued from about 4,000 BC until the ethnographic present.

STONE TOOL INDUSTRY

The stone tool industry at Bukit Tengkorak is basically a small flake and blade (microlith) industry. The presence of cores, tools, and waste flakes in close association with each other indicated stone tool- making at the site. A total of 4,135 pieces of stone artefacts were recovered during the excavations. The stone artefacts were made of agate (52%), chert (33%), obsidian (13%), slate (0.5%), and other lithic materials. The stone artefacts were analysed and classified on the basis of morphological, functional, and technological attributes into eight broad categories: cores (2.4%), core fragments (3.29%), utilised flakes (10.01%), retouched flakes (10.74%), polished adzes (0.22%), hammer stones (0.05%), bark-cloth beater (0.02%), and waste flakes (73.28%).

The flaking technology of chert and agate involved the use of cobbles or nodules to produce small flake and blade tools. Two stages of blade production were evident: the first involved the production of blade blanks and ridged flakes, some of which were retouched in the second stage to produce borers and scrapers. Most of the scrapers have low edge angles of between 30 and 40 degrees, indicating that they used mainly for scraping. A total of 12 pieces of the chert and agate tools have silica gloss on their edges and preliminary use wear analysis of these tools suggested that the silica gloss could have been caused by working on soft plant materials such as bamboo, palm leaves, or rattan. These materials are commonly used for manufacturing basketry and perhaps traps and tools, for example spear tips for hunting animals such as those used in New Guinea and Indonesia (Cranstone 1961:62; Heider 1970:280). The presence of stone bark-cloth beater also suggested the making of bark-cloth.

The flaking technology for obsidian, on the other hand, was aimed at producing very small flakes instead of blades. This is evident from the higher percentage of obsidian flake tools (32%) compared to blades (14%) . Obsidian cores are very small, weighing less than 5.6 grams. This is not surprising as only about 145 grams of obsidian was found and hence the desire to maximise the usage of this valuable material. Sourcing studies of the obsidian artefacts revealed that the obsidian originated from sources in Talasea, Melanesia (Chia 1998a). Chert and agate sources, on the other hand, are easily available in and around Bukit Tengkorak and Semporna. Thus it is very likely that the inhabitants of Bukit Tengkorak exploited these local sources of chert and agate to make their stone tools.

SUBSISTENCE AND DIET

The archaeological evidence at Bukit Tengkorak indicated a broad spectrum economy, focused on marine and forest environments. A wide range of fish, molluscs, reptile, and crustacean from the seas as well as animals from the forest were exploited by the inhabitants using various fishing, hunting, and gathering methods. The identifiable faunal remains include mostly marine fishes such as Scaridae (parrot fishes) and Sparidae (breams),

sharks, sting ray, sea turtle *Chelonisde spp.*, crabs, wild boar *Sus scrofa* and *Sus barbatus*, Sambar *Cervus unicolor*, deer, macaques *Macaca spp.*, langur *Presbytis sp.*, large mouse-deer *Tragulus napu*, kijang, and Banteng *Bos javanicus* as well as a wide variety of edible marine and riverine molluscs.

The quantities of identifiable faunal remains suggested a predominantly maritime-based diet which include a wide range of marine fishes, molluscs, and some turtles. Other dietary items include large mammals such as the Banteng in the early Phase and wild boar, deer, kijang, monkey, mouse-deer, and crab in the Middle and Late Phases. A range of fishing, hunting, and gathering methods were employed. Nets, spears, and boats were probably used to catch coral fishes, turtles, and sharks. Sea turtles can also easily caught when they come ashore to nest on the sandy beaches. Edible marine and riverine molluscs can be gathered from nearby beaches and rivers. The blowpipe and/ or the bow and arrow might have been employed to capture arboreal animals like the monkeys. Big games such as the Banteng, Sambar deer, and wild boar were probably speared or trapped using snares by small groups of people.

PREHISTORIC CONTACT, TRADE AND EXCHANGE

Archaeological sites which have similar assemblages to that of Bukit Tengkorak have found in numerous areas in island Southeast Asia. For instance, similar red-slipped and plain pottery in the form of large jars and small bowls, dating back as early as 4000 BC have been found in the Balobok rockshelter in the Sulu Archipelago (Spoehr 1973; Ronquillo *et al.* 1993). There are also some check-impressed and lime-filled circular impressions, similar to those of Bukit Tengkorak. Elsewhere, red-slipped and plain pottery, dating 2,500 BC, were also discovered in Leang Tuwo Mane'e in the Talaud Islands (Bellwood 1976), Ulu Leang in Sulawesi and Eastern Timor (Glover 1976) as well as sites in Madai and Baturong in Sabah (Bellwood 1988). The small flake and blade industry in Bukit Tengkorak, on the other hand, is closely similar to those in a number of sites such as Duyong and Guri caves in Palawan (Fox 1970), Timor (Glover 1986), Buad island in central Philippines (Scheans *et al.* 1970), the Toalean region in southwestern Sulawesi (Mulvaney and Soejono 1970; Heekeran 1972; Glover 1976), and Paso in Minahasa, Indonesia (Bellwood 1976). Our sourcing study of 30 obsidian samples from Bukit Tengkorak indicated four different sources of obsidian were utilised (Chia 1998; Tykot and Chia 1996). The majority (57%) of the samples, dated about 1200-900 BC have been chemically traced to the well-known Kutau/Bao source in Talasea, Melanesia which is located about 3,500 km away from Bukit Tengkorak. This connection, represents perhaps the longest traded/exchanged obsidian in the world for this time period. Just how they obtained the obsidian is an open question. Down-the-line trade and/or exchange maybe the most likely explanation at the moment. The rest of the obsidian samples have yet to be traced to any geological source.

CONCLUSIONS

The archaeological research at Bukit Tengkorak has uncovered and identified three phases of occupation: the Early Phase (4340-1285 BC), the Middle Phase (1200-900 BC), and the Late Phase (900-50 BC). Bukit Tengkorak was used as a pottery making site where the potters used local clays, very likely from the large clay sources available at the foot of Bukit Tengkorak, to manufacture the pottery. Other activities carried out at Bukit

Tengkorak include stone tool-making as well as the daily subsistence activities. Red-slipped and plain pottery in the form of cooking pots, stoves, and large storage jars occurred throughout the three phases but during the Middle and Late phases, a wide variety of new incised and impressed pottery, some with lids as well as stone borers and obsidian flake tools from Talasea began to appear, suggesting that there was increased contact with other prehistoric communities, probably in the from of trade and exchange. The inhabitants of Bukit Tengkorak had a predominantly maritime-based subsistence and diet throughout the three phases which included fishing and gathering of a wide variety of fish, turtle, crustacean, and molluscs from the sea. This was supplemented by the hunting of big mammals such as the Banteng in the Early phase and other species such as the wild boar, deer, kijang, monkey, and mouse-deer in the Middle and Late phases. On the basis of the close similarities in material culture, in particular pottery and stone tool types, this research has revealed that from about 1,200 BC or earlier to perhaps 50 BC, there was considerable and widespread contact between the inhabitants of Bukit Tengkorak and other prehistoric communities living the regions along the coast of southeastern Sabah, the Sulu Archipelago, Palawan island, southern Mindanao, Minahassa, Talaud, Sulawesi, and the chain of islands between Papua New Guinea and into Melanesia.

ACKNOWLEDGEMENTS

The archaeological research at Bukit Tengkorak was funded by grants from the Intensification of Research in Primary Areas, Muzium Negara, and the Toyota Foundation. I would like to thank Dato' Professor Ishak, the Vice Chancellor of Universiti Sains Malaysia and Dato' Professor Zuraina Majid, my supervisor and the director of the Centre for Archaeological Research Malaysia as well as Tuan Haji Zulkifli, the former director of Muzium Negara, Datuk Jamdin Buyong and Ms Particia Regis, former directors of Muzium Sabah. I am very grateful to the following for their assistance in the field: Peter Koon, Peter Molijol, Osman Nassib, Affendi Rahmat, Jamain Musi, Johari Sibuli, Anthony Sintau, Uling Lakim, and Jeffrey Ating of Muzium Sabah, Junaidi Rashid and Sanim Ahmad of Muzium Negara as well as my colleagues Dr. Mohktar Saidin, Ang Bee Huat, Jaffrei Ignatius, and Zolkurnian Hasan, and all my friends in Semporna. I owe special thanks to Dr. Tjia Hon Djin of PETRONAS Research and Scientific Services Sdn Bhd, Associate Professor Siti Zauyah Darus of Universiti Putra Malaysia, Dr. Geoffery Davison of World Wide Fund for Nature Malaysia, Kuala Lumpur and Daneilla Bar Yosef of Harvard University who helped in the geological, soil, and faunal studies respectively.

NOTES

1: Test excavations were done at Bukit Tengkorak over a period of 8 days in 1987 by Bellwood (1989) & Bellwood and Koon (1989).

2: Despite the lack of a well-established date for the first use of metal in island Southeast Asia, a date of about 2,000 BP is generally accepted for the arrival of bronze and iron artifacts, particularly in Java, Bali, the Talaud islands, and Sabah (Soejono 1979; Bronson and Glover 1984; Bellwood 1985).

REFERENCES

Bellwood, P.S.

1976 Archaeological research in Minahasa and the Talaud Islands, northeastern Indonesia. *Asian Perspectives* 19: 240-288

1985 *Prehistory of Indo-Malaysian archipelago.* New York: Academic Press

1988 Archaeological research in southeastern Sabah. *Sabah Museum Monograph* 2. Sabah Museum, Kota Kinabalu

1989 Archaeological investigations at Bukit Tengkorak and Segarong, Southeastern Sabah. *Bulletin of the Indo-Pacific Prehistory Association* 9: 122-162

Bellwood, P.S. & Koon, P.

1990 ' Lapita colonists leave boats unburned'. The question of the Lapita links with island Southeast Asia. *Antiquity* 63: 613-622

Bronson, B. & Glover, I.C.

1984 Archaeological radiocarbon dates from Indonesia: a first list. *Indonesia Circle.* 34: 37-44

Chia, Stephen

1998 Prehistoric pottery production and technology at Bukit Tengkorak, Sabah, Malaysia. Paper presented at the Singapore Symposium on Premodern Southeast Asian Earthenware. July 9-12.

1988a The obsidian Industry at Bukit Tengkorak, Sabah, Malaysia. Paper presented at the 16th Congress of the Indo-Pacific Prehistory Association, Melaka, Malaysia. July 1-8.

Cranstone, B.A.L.

1961 *Melanesia: a short ethnography.* London: British Museum

Fox, Robert

1970 The Tabon Cave. *National Museum Monograph* 1. Manila, Philippines

Glover, I.C.

1976 Ulu Leang Cave, Maros: a preliminary sequence of post-Pleistocene cultural development in south Sulawesi. *Archipel* 11: 113-154

1985 *Archaeology in Eastern Timor 1966-7.* Canberra: The Australian National University, Department of Prehistory, Terra Australia no. 11

Heekeren, H.R. van

1971 *The Stone Age of Indonesia,* 2nd edition, Nijhoff: The Hague

Heider, K.G.

1970 *The Dugum Dani.* Chicago: Aldine Publishing Company

Kirk, H.J.C.

1962 *The geology and mineral resources of the Semporna Peninsula, North Borneo,* Geological Survey Department of British Territories in Borneo, Memoir 14, Kuching

Lee, T.C.

1970 Semporna area, eastern Sabah", progress reports: East Malaysia, *Malaysia Geological Survey Annual Report,* Kementerian Pertanian dan Tanah, Jabatan Penyiasatan Kajibumi, Malaysia, 180-183

Mulvaney, D.J. and Soejono, R.P.

1970 The Australian-Indonesian archaeological expedition to Sulawesi. *Asian Perspectives* 13: 163-177

Ronquillo, W.P., Santiago, R.A., Asato, S and Tanaka, K.

1993 The 1992 archaeological reexcavation of the Balobok rockshelter, Sanga Sanga, Tawi Tawi Province, Philippines: a preliminary report. Reprint from the *Journal of Historiographical Institute,* Okinawa, Japan: Okinawa Prefectural Library, No. 18

Scheans, D.J., Hutterer, K.L. and Cherry, R.L.

1970 A newly discovered blade tool industry from the Central Philippines. *Asian Perspectives* 13: 179-181

Soejono, R.P.

1979 The significance of the excavations at Gilimanuk (Bali). Smith, R.B. and Watson W. (eds). Early South-East Asia. Essays in archaeology, history, and historical geography, Oxford: Oxford University Press, 185-198.

Spoehr, A

1972 Zamboanga and Sulu: an archaeological approach to ethnic diversity. *Ethnology Monograph No. 1.* Department of Anthropology. Pittsburg; University of Pittsburgh

Vandiver, P and Chia, S

1996 The Pottery Technology from Bukit Tengkorak, a 3,000-5,000 year old site in Borneo, Malaysia. Paper presented at the Materials Research Society Meeting at Massachusetts Institute of Technology in Boston, December.

Figure 1: Map Of Bukit Tengkorak In Semporna, Sabah

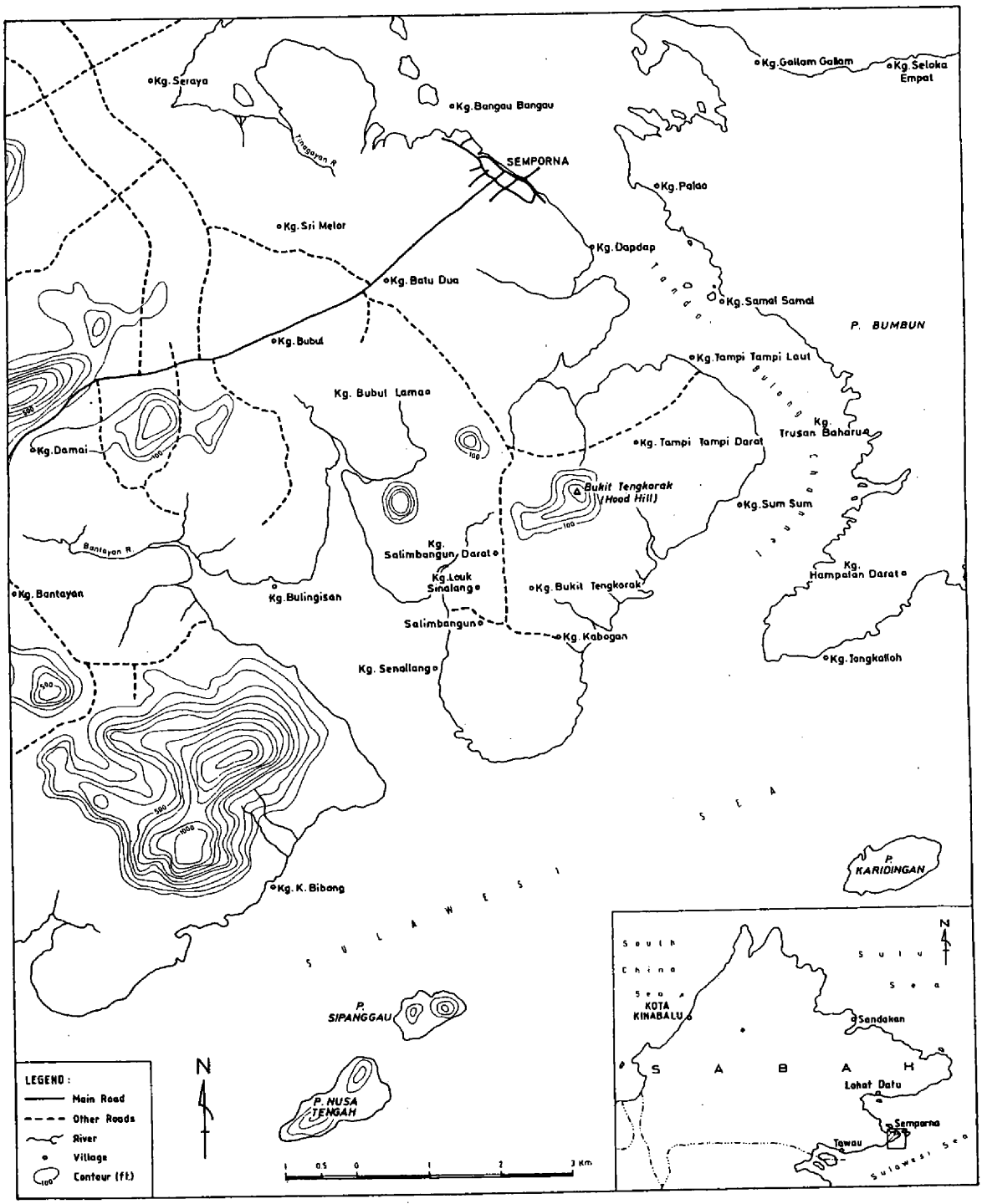
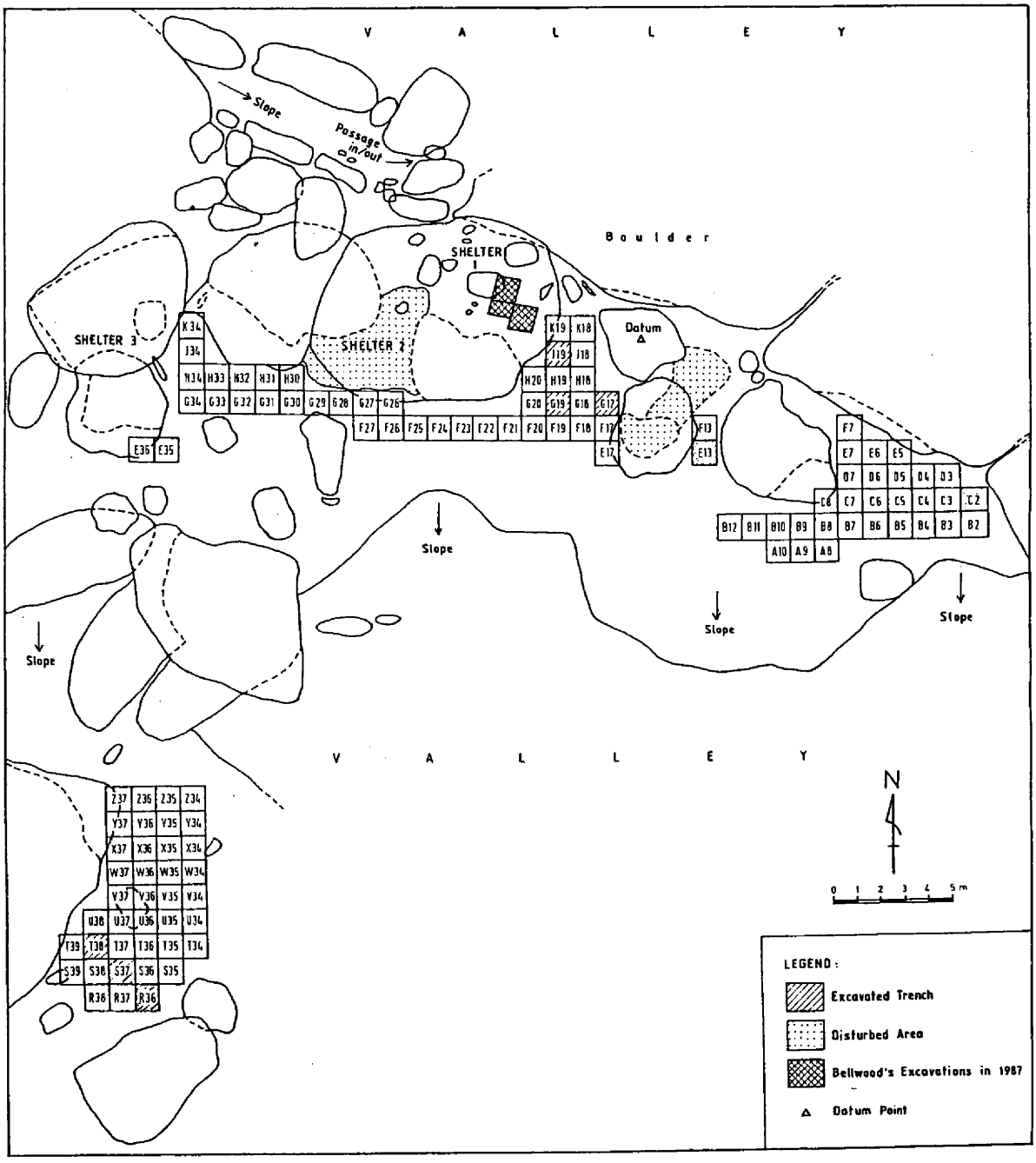


Figure 2: Map Of Bukit Tengkorak And The Excavated Trenches



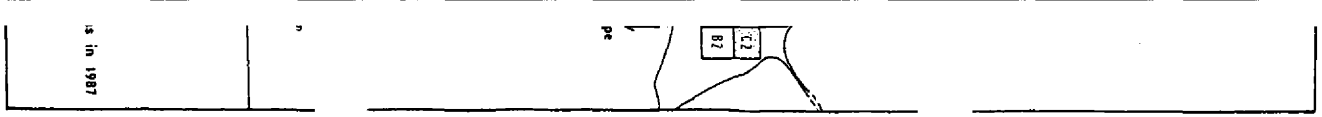


Table 2: Vertical Distribution Of Decoration Types In Trenches G17, G19 And J19

Spit (cm)	Decoration Types							Total	%
	Plain	Red-slip	Impressed (Imp)	Incised (Inc)	Imp + Inc	Imp/Inc+Perforated	Perforated		
1(0-5)		799	10	1	1		1	812	5.09
2(5-10)		919	22	15	4			960	6.02
3(10-15)		691	7		5			703	4.41
4(15-20)	3	204	9	3				219	1.37
5(20-25)	19	1167	39	8	7			1240	7.78
6(25-30)	75	2041	35	7	3			2161	13.56
7(30-35)	37	421	19	21	13		8	519	3.26
8(35-40)	87	1860	48	11	3	2		2011	12.62
9(40-45)	88	630	42	17	7	1	1	786	4.93
10(45-50)	5	114	64	24	12		4	223	1.40
11(50-55)	155	1647	38	29	3			1876	11.77
12(55-60)	46	335	31	13	4		1	430	2.70
13(60-65)	141	644	89	23	6	1	1	905	5.68
14(65-70)			48	12	2	4	1	67	0.42
15(70-75)	92	331	23	45	5	1		497	3.12
16(75-80)	85	341	16	24	4		1	471	2.96
17(80-85)	136	685	18	23				1064	6.68
18(85-90)	19	211	5	10	1		1	247	1.55
19(90-95)	19	350	8	7				384	2.41
20(95-100)			3	3				6	0.04
21(100-105)			3	7				10	0.06
22(105-110)		33	7	2	1			43	0.27
23(110-115)		29			1			30	0.19
24(115-120)			2	8	1			11	0.07
25(120-125)	1	77	1	7				86	0.54
26(125-130)	6	53	1	1				61	0.38
27(130-135)								0	0.00
28(135-140)	8	108						116	0.73
29(140-145)								0	0.00
Total	1028	13890	588	321	83	9	19	15938	100
%	6.45	87.15	3.69	2.01	0.52	0.06	0.12	100	

10 100 5 2

Table 3: Vertical Distribution Of Decoration Types In Trenches R36, S37 And T38

Spit (cm)	Decoration types						Total	%
	Plain	Red-slip	Impressed (Imp)	Incised (Inc)	Imp+Inc+Perforated	Perforated		
1(0-5)		66	9				75	1.66
2(5-10)			29		4	3	36	0.80
3(10-15)						1	1	0.02
4(15-20)		93	2		7		102	2.26
5(20-25)			9	1	1		11	0.24
6(25-30)		38	9		2		49	1.09
7(30-35)		97	21		3	2	123	2.73
8(35-40)	1	327	26	3	2		359	7.96
9(40-45)		402	25	1	6	1	435	9.64
10(45-50)	2	294	31	2	11		340	7.54
11(50-55)	1	244	21	3	4		2732	6.05
12(55-60)	1	431	13	3	1	1	450	9.97
13(60-65)		783	45	7	5		840	18.62
14(65-70)	4	370	9	2	5		390	8.64
15(70-75)	1	458	11	3	3		476	10.55
16(75-80)	1	316	3	4	2		326	7.23
17(80-85)		101	8	18	1		128	2.84
18(85-90)		56	9	5			70	1.55
19(90-95)			6	6			12	0.27
20(95-100)			3				3	0.07
21(100-105)			1			1	2	0.04
22(105-110)				5			5	0.11
23(110-115)							0	0.00
24(115-120)				2	2		4	0.09
25(120-125)			1				1	0.02
26(125-130)							0	0.00
27(130-135)							0	0.00
28(135-140)							0	0.00
29(140-145)			1				1	0.02
Total	11	4076	292	65	59	9	4512	100
%	0.24	90.34	6.47	1.44	1.31	0.20	100	

50 2

Table 4: Vertical Distribution Of Fish, Reptile And Crustacean Remains (By Weight In Grams) Represented At Bukit Tengkorak

Spit (cm)	Fish							Reptile	Crustacean	Total	%
	Sparidae	Scaridae	Shark	Stingray	Cart Fish	Bony Fish	Fish	Sea Turtle	Crab		
1(0-5)		18				2	8	8		36	0.37
2(5-10)	0.5	125			8	51	16.5	134	1	336	3.44
3(10-15)	0.50	21			25	75	19.5	192		333	3.41
4(15-20)	0.50	20			2	29	17.5	34		103	1.05
5(20-25)	21	143	5		15	148	60	245		637	6.52
6(25-30)	31.50	307			2	311	113.50	560		1330	13.62
7(30-35)	14	49			2	59	30	130		284	2.91
8(35-40)	67	263			8	323	131	336		1128	11.55
9(40-45)	6	126	6		4	101	34	348		625	6.40
10(45-50)	0.2	138	6		8	186	41.8	525		905	9.27
11(50-55)	16.5	155		1	11	224	91.5	312		811	8.31
12(55-60)	7	99			3	78	31	94	14	326	3.34
13(60-65)	91	195			7	129	51	418		891	9.13
14(65-70)	4	59			2	37	18	80		200	2.05
15(70-75)		89			5	73	36	154		357	3.66
16(75-80)	5	116	18		15	38	20	136		348	3.56
17(80-85)	1	41			0.50	20	17	174		254	2.60
18(85-90)	6	16				4	11	202		239	2.45
19(90-95)		14			0.50	30	7	96		148	1.51
20(95-100)		33	8			9	3	29		82	0.84
21(100-105)	3	15			1	59	22	130	6	236	2.42
22(105-110)		13				8	3	18		42	0.43
23(110-115)						6	4			10	0.10
24(115-120)	8					5	26	32		71	0.73
25(120-125)	0.50	26				1	6.50			34	0.35
26(125-130)		10					0.50			11	0.11
Total	283	2091	37	1	119	2006	819	4387	21	9764	100
%	2.90	21.40	0.38	0.01	1.22	20.54	8.39	44.95	0.21	100	
	5 gms	10 gms	2 gms		2 gms	20 gms	10 gms	50 gms	2 gms		

Table 5: Vertical Distribution Of Mammal Bones (By Weight In Grams) Represented At Bukit Tengkorak

Spit (cm)	S. scrofa	S.barbatus	Sambar	Deer	Monkey	Macaca	Presbytis	Napu	Kijang	Banteng	Big mammals	Small ma	Total	%
1(0-5)													67	2.50
2(5-10)	10								6		28	16	60	2.20
3(10-15)	6												6	0.20
4(15-20)	16												16	0.60
5(20-25)	10		6										16	0.60
6(25-30)	28	34		16			1				12		92	3.40
7(30-35)	42								8				50	1.90
8(35-40)	83				1			0.5			2		86.5	3.20
9(40-45)	12			16							6		34	1.30
10(45-50)	90	8									202	57	357	13.20
11(50-55)	135				0.2	0.5						50	185.7	6.90
12(55-60)	94				0.5			2			8	2	106.5	3.80
13(60-65)	148			13	0.5						198	4	363.5	13.40
14(65-70)	17										16	6	39	1.40
15(70-75)	58		50	4	6								118	4.40
16(75-80)	6		58								4	26	94	3.50
17(80-85)	2		60								57		119	4.40
18(85-90)	24		13										37	1.40
19(90-95)	79		6										85	3.10
20(95-100)											40		40	1.50
21(100-105)	77									70			147	5.40
22(105-110)	152												152	5.60
23(110-115)													0	0.00
24(115-120)												1	1	0.10
25(120-125)													0	0.00
26(125-130)													0	0.00
27(130-135)													0	0.00
28(135-140)											434		434	16.00
Total	1089	42	193	49	8.2	0.5	1	2.5	14	70	1007	162	2638	100
%	41.3	1.6	7.3	1.9	0.3	0.02	0.04	0.09	0.5	2.7	38.2	6.1	100	
	10 gms	5 gms	5 gms	2 gms	1 gms	0.1 gms		0.5 gms	1 gms	10 gms	20 gms	5 gms		

Table 6: Mollusc Species Represented at Bukit Tengkorak

	Class	Family	Genus species	Environment/Habitat
1	Gastropoda	Turbidae	*Turbo argyrostomus (Linn, 1758)*	Marine/reefs, intertidal to 3 m
2	Gastropoda	Turbidae	*Turbo sp.*	Marine
3	Gastropoda	Trochidae	*Tectus cf. Pyramis (Born, 1778)*	Marine/shallow reefs
4	Gastropoda	Neritidae	*Theodoxus sp.*	Marine
5	Gastropoda	Neritidae	*Nerita undata (Linn, 1758)*	Marine/intertidal rocks
6	Gastropoda	Neritidae	*Nerita turrita (Gmelin, 1791)*	Estuarine & marine/intertidal, near mangroves
7	Gastropoda	Littorinidae	*Littorina sp.*	Marine
8	Gastropoda	Ranellidae	*Cymatium sp.*	Marine
9	Gastropoda	Cypraeidae	*Cypraea annulus (Linn, 1758)*	Marine/subtidal, rocks
10	Gastropoda	Turridae	*sp.*	Marine
11	Gastropoda	Strombidae	*Lambis lambis (Linn, 1758)*	Marine/shallow waters
12	Gastropoda	Strombidae	*Strombus cf. urceus (Linn, 1758)*	Marine/sand & mud to 20 fms
13	Gastropoda	Strombidae	*Strombus cf. canarium (Linn, 1958)*	Marine/shallow water
14	Gastropoda	Strombidae	*Strombus sp.*	Marine
15	Gastropoda	Strombidae	*Strombus sp.*	Marine
16	Gastropoda		*Pleuroploca trapezium (Linn, 1758)*	Marine/shallow waters
17	Gastropoda		*sp.*	Marine
18	Gastropoda		*sp.*	Marine
19	Gastropoda		*sp.*	Marine
20	Gastropoda		*Conus sp.*	Marine
21	Gastropoda		*Chircoreus cf. ramosus (Linn, 1758)*	Marine/shallow waters
22	Gastropoda		*Melania sp.*	Freshwater
23	Gastropoda		*Telescopium telescopium (Linn, 1758)*	Estuarine/mangroves
24	Bivalvia		*Anadara cf. antiquata (Linn,1758)*	Marine/shallow waters
25	Bivalvia		*Trachycardium cf. flavum (Linn, 1758)*	Marine/shallow waters
26	Bivalvia		*Sp.*	Marine
27	Bivalvia		*Comptopallium radula (Linn, 1758)*	Marien/shallow waters
28	Bivalvia		*Sp.*	Marine
29	Bivalvia		*Hippopus sp.*	Marine
30	Bivalvia		*Tridacna sp.*	Marine/coral reefs
31	Bivalvia		*Eamesiella corrugata(Deshayes 184?)*	Marine/intertidal to 10m
32	Bivalvia		*Gafrarium sp.*	Marine
33	Bivalvia		*Trachycardium cf. flavum (Linn, 1758)*	Marine/shallow waters