



ИСТОРИЯ И РЕЛИГИЯ

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ARCHEOLOGY OF THE VOLCANIC CAVES IN KRONG NO: HISTORICAL - CULTURAL SIGNIFICANCE

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Abstract. This article introduces the results of excavation and research on the cultural remains of prehistoric people in the volcanic caves at Krong No, Dak Nong (Vietnam). The sediments in the caves have preserved a standard stratigraphy of the prehistoric culture of the ancient people who lived there, allowing an assessment of the tools, burial characteristics, and vestiges of animals and plants. The absolute dating system (¹⁴C) has revealed continuous human habitation in the caves from 7,000 to 4,000 BP. In addition, the archeological evidence from the volcanic caves at Krong No provides important information about the past environment, evolutionary history and diversity of nature, adaptation of people to changes in the environment, and their spiritual culture (from burial documents). Clear findings on the characteristics of the ancient fauna and flora are not commonly found in the archeological evidence of the Central Highlands volcanic region of Vietnam and Southeast Asia.

Keywords: archeological site, Central Highlands, Dak Nong, Krong No volcanic cave

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АРХЕОЛОГИЯ ВУЛКАНИЧЕСКИХ ПЕЩЕР КРОНГНО: ИСТОРИКО-КУЛЬТУРНОЕ ЗНАЧЕНИЕ

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Аннотация. В статье представлены результаты раскопок и исследований культурных останков доисторических людей в вулканических пещерах Кронгно, Дакнонг (Вьетнам). Отложения в пещерах сохранили стратиграфию доисторической культуры живших там древних людей, позволяющую оценить характеристики орудий труда, захоронений, остатки животных и растений. Система абсолютного датирования (¹⁴C) выявила постоянное проживание людей в пещерах от 7000 до 4000 лет назад. Археологические данные из вулканических пещер Кронгно дают важную информацию об окружающей среде в прошлом, истории эволюции и разнообразии природы, адаптации людей к изменениям окружающей среды и их духовной культуре (из погребальных документов). Четкие данные о характеристиках древней фауны и флоры обычно не встречаются в археологических свидетельствах вулканического региона Центрального нагорья Вьетнама и Юго-Восточной Азии.

Ключевые слова: археологический памятник, Центральное нагорье, Дакнонг, вулканическая пещера Кронгно

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Introduction

Prehistoric archeology research in Vietnam has more than 100 years of history, however, the type of volcanic cave vestige with pre-residence has only been discovered and excavated in recent years. In the first excavation of the archeological sites in the Krong No volcanic cave system, a 1.85 m thick and relatively intact stratigraphy was discovered, dating back to the middle Holocene, from 7,000 to 4,500 BP. The data acquired here have provided important information about habitation patterns, hunting and gathering activities, and cultural behavior regarding manufacturing activities and funeral rites. The geo-archeological evidence further elucidates the changes in the climate and environment of the volcanic fields, the changes in the local landscape, flora and fauna, and the human adaptation to the changes in nature at that time.

The article is the result of the investigation, survey, and excavation of volcanic caves C6.1 and C6' conducted by the authors at Dak Nong Geopark from 2017 to 2019. This study discusses the outstanding cultural and historical significance of the archeological sites in the volcanic caves and their contributions to the study of the prehistoric culture of Vietnam and Southeast Asia, as well as

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the responsibility of today's generations to conserve and promote the archeological sites in the volcanic caves of Dak Nong UNESCO Global Geopark to contribute to the sustainable socio-economic development of the Central Highlands.

Methodology

Investigation, exploration, and archeological excavation were the primary methods used in this research. Objects were selected for exploration and excavation based on the *typical selection method* for in-situ conservation, with the following specific criteria: (1) mixed heritage of outstanding significance; (2) heritage of outstanding significance in terms of science, education, aesthetics, the economy, and rarity; and (3) heritage of unique significance in danger of being harmed and in urgent need of protection and conservation [La The Phuc et al. 2022].

We collected analytical samples to assess the relics and artifacts of caves C6.1 and C6'. These include human remains, 185 magnetic samples, 22 pollen spore samples, 73 coal samples, 15 mineral and sediment samples (4 samples in 2017, 11 samples in 2019), and 93,542 samples of bones, teeth, and mollusk shells (bivalves and snails). The human and animal remain and the pollen spores were examined at the Vietnam Institute of Archeology. The mineral and sediment samples were analyzed at the Department of Geology, University of Science, Vietnam National University, Hanoi (Vietnam). The magnetic samples were analyzed at the Vietnam Institute of Geophysics and edited at a laboratory of the Department of Geology and Geophysics, Louisiana State University (USA). The coal samples were analyzed at the Laboratory of Radiocarbon Dating of the RAS Institute of Geography (Russian Federation) and edited at the University of Georgia (USA).

The authors also used qualitative research methods such as synthesis and inheritance of materials and analyzed data from monographs, scientific journals, and scientific reports to compare and justify the perceptions, arguments, and conclusions of the article.

The archeological sites in the volcanic caves

Discovery and excavation

The volcanic caves, also known as lava tubes, in Krong No District, Dak Nong Province are of primary origin and were formed by volcanic eruptions during the Pleistocene. The caves were discovered by La The Phuc and his colleagues in 2007 and studied by the Geological Museum of Vietnam and the Japan Caving Association. Studies of the caves were later taken over by the Vietnam National Museum of Nature and the Japan Caving Association [La The Phuc et al. 2015]. So far, 45 volcanic caves have been discovered in this area, of which 20 have been measured and studied in detail regarding their origin, formation mechanism, and geological, biological, and archeological significance [Tachihara, Chikano 2018; La The Phuc 2020].

Traces of prehistoric humans have been found in 10 of the 45 caves: caves C1, C2, C3, C4, C4.1, and C6 in Dak Sor Commune; caves C6' and C6.1 in Nam Da Commune; and caves P1 and P2 in Buon Choa'h Commune. All archeological sites in the volcanic caves are located deep underground. Extrusive rocks with vertical grooves and twisted lineations representing the lava flow are exposed on two sides of the cave walls [La The Phuc et al. 2017; Le Xuan Hung et al. 2018].

Of the ten caves mentioned above, caves C6.1 and C6' were selected for exploration and excavation. In 2017, a 2 m² excavation pit was dug in Cave C6.1, which has a cultural layer of 0.8 m [Le Xuan Hung et al. 2018]. In 2018, according to Decision No. 52/QD-BVHTTDL dated January 9, 2018 and approved by the Minister of Culture, Sports and Tourism, the Department of Culture, Sports

and Tourism of Dak Nong Province and the Vietnam National Museum of Nature were allowed to coordinate in excavating caves C6.1 and C6'. Each cave is 20 m² in area [La The Phuc 2020]. The C6.1 cave was excavated in two years (2018 and 2019) with an area of 10.3 m². The excavation area of Cave C6' in 2018 was 13 m² [Nguyen Khac Su et al. 2018; 2019].

Excavation results of Krong No volcanic caves

Cave C6.1:

Cave C6.1 is located at 12°30'47.6" N and 107°54'06.2" E at an elevation of 346 m above sea level (fig. 1). The cave entrance is exposed because the weakest part of the arch has fallen, creating a skylight. Three cave entrances lead to the lava tube from different directions and are located at the bottom of the skylight. Cave C6.1 has two connecting entrances because the lava tube is curved in a C shape. Its total length is 293.7 m.

The prehistoric archeological sites are located at the mouths of the cave. The cave entrance is semi-annular, 15.0 m wide, and 3.2 m high. The cave floor slopes inward and is flat, wide, and airy. The structure of the cave arch is relatively stable and convenient for access. The cave is next to the Dray Sap waterfall near the Serepok River, with a good flow of water, raw materials for tool making, and a great source of aquatic animals to meet human needs.



Fig. 1. Cave C6.1, excavated in 2018 and 2019. *Photo:* Le Xuan Hung

The excavation at Cave C6.1 was conducted over an area of 10.3 m²; the 1.85 m stratigraphy indicates 13 ages, dating from 6,090±25 BP (the adjusted value is 6,954 BP) to 4,680±20 BP (the adjusted value is 5,391 BP). In the excavation pit, archeologists have found 14 stoves, 7 graves where the bodies were placed in the fetal position, and remnants of the meals of ancient people, including 76,425 pieces of animal bones and over 100,000 mollusk shell fragments. Other items found were 3,967 stone artifacts, 66 bone artifacts, 10 jewelry artifacts made out of sea snail shells, 1 bronze arrowhead, and 1,276 pieces of pottery. The evidence led us to conclude that Cave C6.1 was the residence, burial, and toolmaking site of prehistoric inhabitants in the Neolithic period and the latest known archeological site in the volcanic caves of Vietnam [Nguyen Khac Su et al. 2020].

Cave C6':

The cave has coordinates of 12°30'55.4" N and 107°54'04.4" E; it is 424 m above sea level and about 250 m southeast of Cave C6.1. Its shape resembles a tube 15 m wide and over 100 m long; the ceiling is 13 m from the cave floor. Cave sediments are soil and basalt clustered in three circular

piles, two of which were excavated in 2018. Cluster 1 (code 18.C6'.F1) has a base of 3 m × 3.5 m and a height of 0.6 m. Cluster 2 (code 18.C6'.F2) has a base area of 2.5–3 m² [Nguyen Khac Su et al. 2018] (fig. 2).



a. Cluster 18.C6'.F1



b. Cluster 18.C6'.F2

Fig. 2. Stoves F1 and F2 in Cave C6'. *Source:* [Nguyen et al. 2018]

The two excavation pits share the same stratigraphy from top to bottom, including the top layer – a basalt layer with rocks over 20 cm in diameter. The second layer is a dark brown soil layer containing fragments of animal bones. One layer below is a dark brown soil layer of pebbles less than 5 cm in diameter. Surrounding each cluster are stones of basalt arranged in an arc. The excavation pit dates to 4,160±20 BP, with an adjusted value of 4,707 BP, similar to the age of the latest layer in Cave C6.1. The excavators believe that the stone clusters are hearths made by hunters in which the teeth and bones of wild animals were discarded.

Discussion

Archeological sites in volcanic caves – a specific type of archeology in Vietnam's prehistory

The discovery of archeological sites in lava tube caves in 2017 at Krong No (Dak Nong Province) has added another type of prehistoric site to the archeological map of Vietnam. The archeological sites in volcanic caves are distinguished from those in karst caves by formation mechanism, stratigraphic characteristics, and geo-archeological significance. Karst caves form when flowing water erodes limestone. In contrast, volcanic caves are formed by volcanic eruptions that create lava tubes deep underground. Archeological sites in this type of cave formed after the structure of the lava tube stabilized and a portion of the lava tube fell, creating an entrance. Humans then started to reside inside and leave traces behind. No sediment clings to the cave walls and ceilings in contrast to karst caves.

Geologists from VNU (Vietnam), Hanoi University of Science analyzed the chemical composition stratigraphic sediments from Cave C6.1 in 2018 using a Shimadzu XRF-1800 fluorescence spectrometer and the mineral composition using a Siemens model D5005 X-ray diffractometer. By processing the mineral phases with BGMN Rietveld software, they found little fluctuation in the chemical composition of sediment layers at different depths. The main minerals were CaO, which had a high content (50.51–60.10%), and SiO₂ (8.70–13.03%). Minor components such as Al₂O₃, FeO*, P₂O₅, and MgO had contents of less than 5% and did not change much between layers. The mineral composition in this cave is mainly carbonate, in which calcite is the mineral phase with the highest content, followed by aragonite, calcium silicate, dolomite, witherite, and cerussite.

The high ratio of these minerals is a key factor in preserving human and animal bones as well as the shells of mollusks in volcanic caves [Ta Hoa Phuong et al. 2018].

In 2021, Nguyen Ngoc Truong found the calcium oxide (CaO) content of sediments in Cave C6.1 to be very high, ranging from 39.54% to 45.57%. As a result, organic matter is likely to be preserved in the cultural layer. Lime (CaO) is an anthropogenic mineral formed by human use of carbonate rocks (limestone), biochemical carbonate rocks, or mollusk shells heated to a temperature of 800°C [Nguyen Ngoc Truong et al. 2021]. We believe that the origin of CaO in Cave C6.1 can only be from mollusk shells collected by humans as food from nearby rivers and streams and brought into the cave, where the shells were burned and left. Statistics show that the ratio of CaO between the layers from 7,000 to 4,500 BP barely differs, indicating that the exploitation of terrestrial mollusks was a tradition of the local prehistoric inhabitants.

Cave C6.1 – A standard archeological stratigraphy of the volcanic caves in the Central Highlands

The stratigraphy of the excavation pit in Cave C6.1 is 1.85 m thick and includes eight successive layers of sediment from top to bottom. There are 13 ages in this stratigraphy, which was analyzed at the Laboratory of Radiocarbon Dating at the Institute of Geography RAS (Russia) and the Center for Applied Isotope Studies, University of Georgia (USA) (Table 1).

Table 1. Carbon-14 dates of charcoal from Cave C6.1 in Krong No (Dak Nong)

No.	Sample code	Sample depth (cm)	Material	Date (BP)	Date after adjustment (BP)
1	18.C6-1.C4.L1.2	16	Charcoal	4,680±20	5,391
2	17.C6-1.D3.L3	32	Charcoal	5,070±20	5,815
3	17.C6-1.D3.L.6	43	Charcoal	5,110±20	5,815
4	17.C6-1.D3.L.7	56	Charcoal	5,225±20	5,965
5	17.C6-1.D3.L.8	63	Charcoal	5,230±20	5,966
6	18.C6-1.C2.L4.3	58	Charcoal	5,760±25	6,560
7	18.C6-1.D4.L4.5	99	Charcoal	5,780±25	6,686
8	18.C6-1.D2.L4.7	125	Charcoal	6,030±25	6,876
9	18.C6-1.C2.L4.9	126	Charcoal	5,850±25	6,672
10	18.C6-1.D4.L4.10	138	Charcoal	5,945±25	6,768
11	18.C6-1.C4.L4.12	154	Charcoal	5,945±25	6,768
12	18.C6-1.D4.L4.13	175	Charcoal	5,970±25	6,800
13	18.C6-1.C3.L4.16	183	Charcoal	6,090±25	6,954

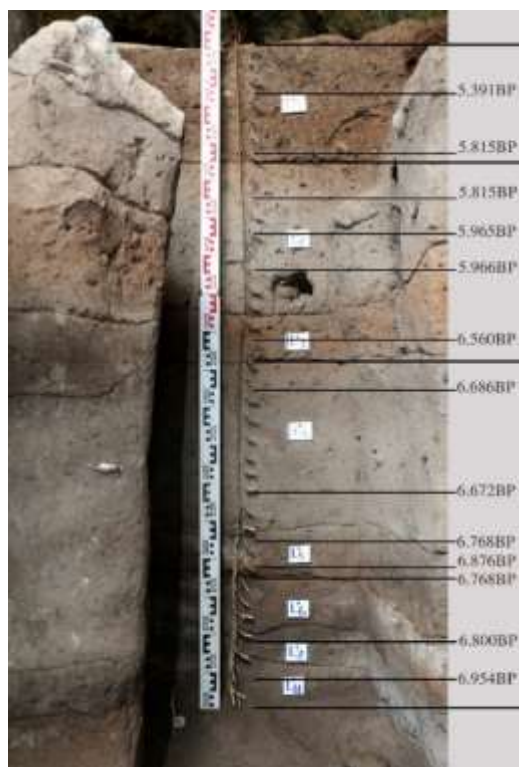


Fig. 3. Stratigraphy and ages of sediment layers in Cave C6.1. *Photo:* Le Xuan Hung

The stratigraphy of Cave C6.1 shows that humans had a continuous residence for nearly 3,000 years, from 7,000 to 4,500 BP. The first residence dates to 6,090±25 BP, with an adjusted value of 6,954 BP. The latest age dates to 4,680±20 BP, but it is not the most recent layer of the archeological site. Cave habitation is believed to have ended around 4,000 BP [Nguyen Khac Su et al. 2020] (fig. 3).

Cave C6.1 – a resource revealing the prehistoric culture of Krong No

Analysis of 19 pollen spore samples from the stratigraphy of Cave C6.1 shows that tropical plants played a dominant role, with little temperate and subtropical pollen in the climate, environment, and landscape of Krong No during the Holocene. The pollen of herbaceous plants accounts for 74%, fern spores for 12%, pollen from woody plants for 8%, and unspecified elements for 6% [Nguyen Khac Su et al. 2019]. The paleoclimate in this area changes from early to late stage according to the depth of the cultural layers. In the earliest layer, 156 to 185 cm (from 6,954 to 6,900 BP), fern spores, mainly *Polypodiaceae*, make up the majority (65%). Herbaceous plant pollen, including *Poaceae* and *Pilea* sp., accounts for 30%, and the pollen of woody plants (*Rubiaceae* only) accounts for 5%. At the beginning of the Middle Neolithic period of Cave C6.1, the climate was cool, slightly dry, warm, and humid. In the Middle Neolithic period, with the cultural layer depth ranging from 155 to 46 cm (5,900 to 5,300 BP), herbaceous plant pollen, including *Pilea* sp., *Poaceae*, and *Vilebrunea* sp. remains dominant at 60%. Fern spores make up 20%, and woody plant pollen makes up 20%. The latter include *Myrica* sp., *Carex* sp., and *Magnoliaceae*, which are typical of a warm and humid yet cool climate (with the *Sequoia* sp. pollen of temperate species). The latest layer, at a depth of 45 cm, includes the Late Neolithic habitation (from 5,200 BP to 4,300 BP). Herbaceous plants, such as *Pilea* sp., *Poaceae*, and *Vilebrunea* sp. account for 80%. Fern spores account for approximately 20%. These include *Polypodiaceae*, *Lygidium* sp., and *Cyathea* sp., with pollen of *Sequoia* sp. flowers, reflecting a cool, humid, and tropical climate.

From an analysis of magnetic susceptibility data of 185 ancient samples from the 1.85 m-thick stratigraphy at Cave C6.1, Luu Thi Phuong Lan has divided the stratigraphy into four cold periods (blue): C6.1-1, C6.1-3, C6.1-5, C6.1-7 and four warm periods (red): C6.1-2, C6.1-4, C6.1-6, C6.1-8. The C6.1-5 cold period is classified in more detail: there is a short warmer period (C6.1-5-2) between the two colder periods (C6.1-5-1 and C6.1-5-3). From 6,900 to 5,391 BP, there were two overlapping weather cycles in Cave C6.1: a cycle of 475 years and another of 317 years [Luu Thi Phuong Lan et al. 2021] (Fig. 4).

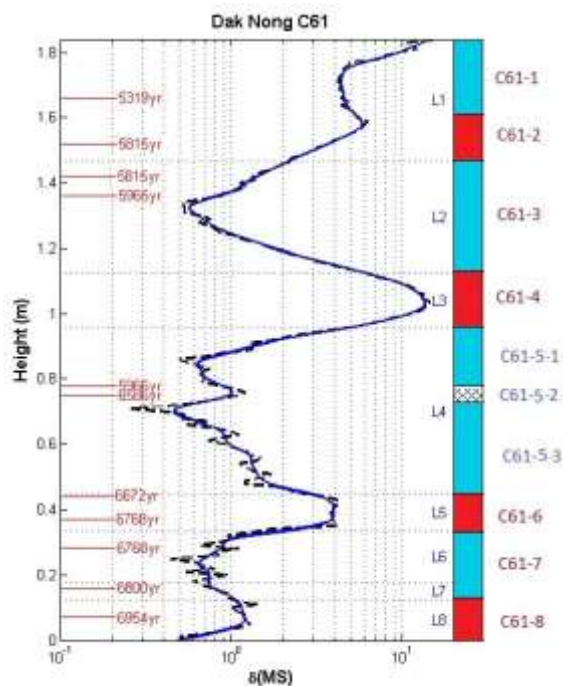


Fig. 4. Magnetic domains. Source: [Luu et al. 2021]

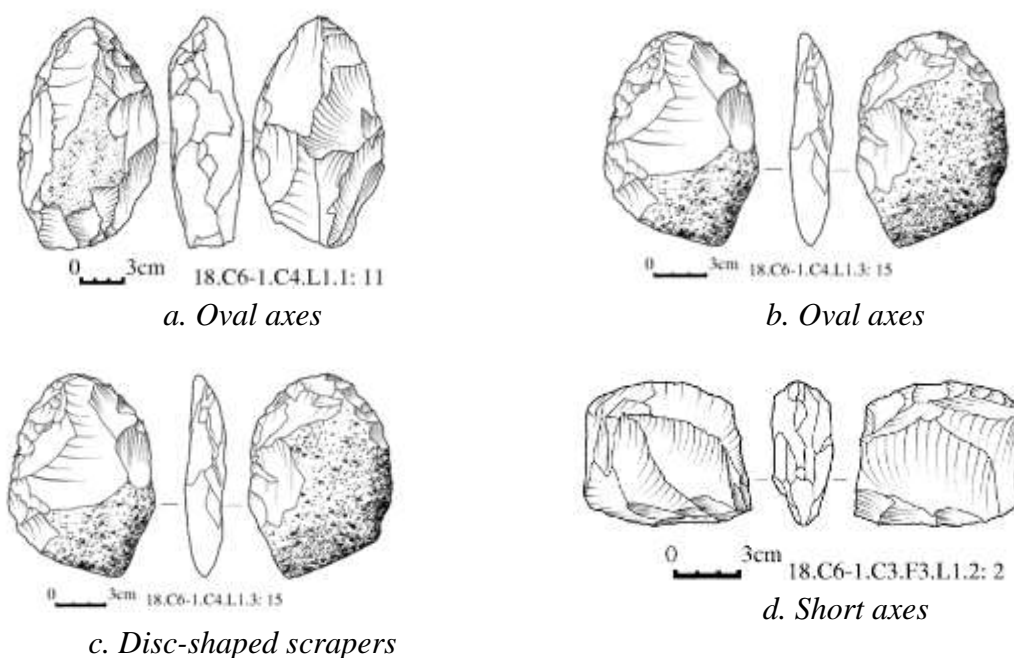


Fig. 5. Typical stone tools from Cave C6.1. Source: [Nguyen Khac Su et al. 2018]

A key feature of the volcanic cave residents is their exploitation of local materials such as basalt, chert, and stream pebbles to make tools with shapes similar to those of the Hoa Binh culture, such as oval axes, short axes, disc-shaped scrapers, and iron-shaped tools. The difference is that the tools in this area are smaller, primarily double-sided, and finely adjusted (fig. 5). This feature indicates the preservation of the toolmaking tradition of the prehistoric inhabitants of the Central Highlands [Nguyen Khac Su 2021a].

The other artifacts obtained from the cave are 66 bone tools with sharp awl-like tips formed by a polishing technique to function as sewing needles or fishing spears, and 10 shells of sea snails (*Cypraea* sp.) with pierced backs and threaded to make jewelry. The ancient people in the cave used pottery after $5,225 \pm 20$ BP; 1,276 pieces of pots, bowls, and plates with decorative patterns of twisted rope marks and dashed, dot-dash, and dotted lines were found. All were made from fine-grained sand, clay, and fine-grained ceramics (fig. 6).

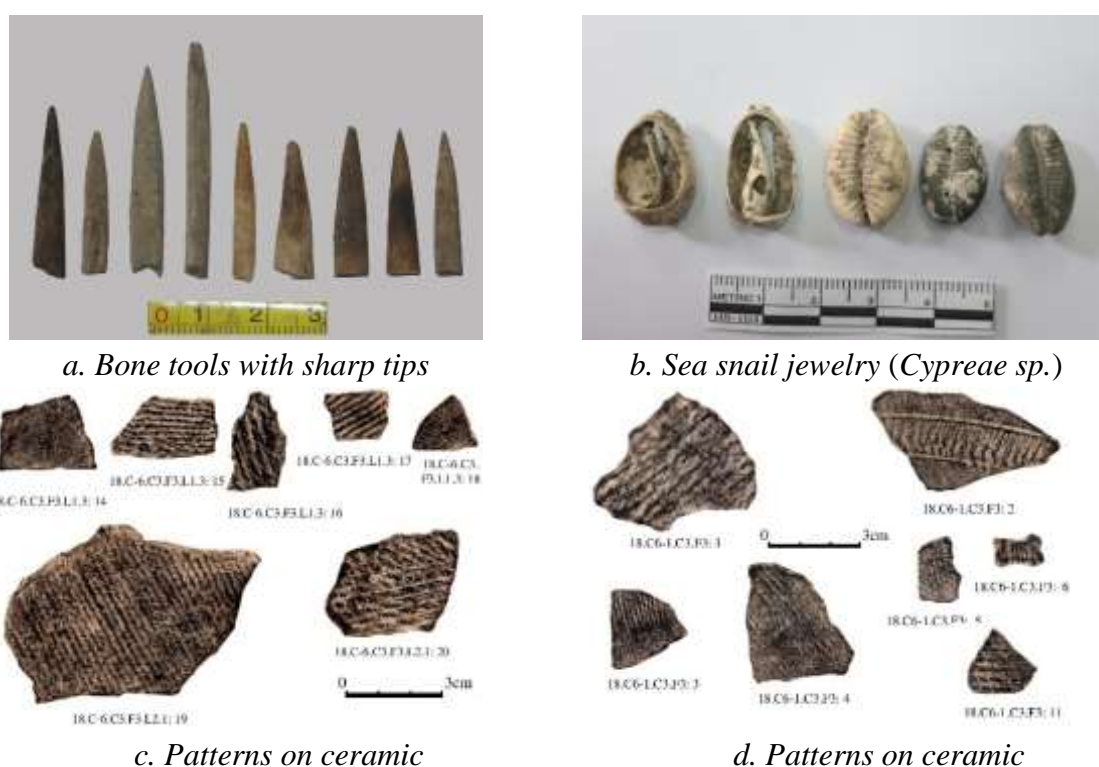


Fig. 6. Bone tools, mollusks, and ceramic patterns from Cave C6.1. *Source:* [Nguyen Khac Su et al. 2018]

Hunting-gathering was the main activity of the prehistoric inhabitants of Cave C6.1. Among the 76,425 animal bones found, there is no evidence of domesticated animals. Hunting and gathering activities increased from the earliest to the latest stage, as demonstrated by the increase in animal bones and mollusk shells from bottom to top. Fig. 7 shows animal remains collected in Cave C6.1.



a. Snail shells



b. Animal bones

Fig. 7. Animal remains from Cave C6.1 (Krong No, Dak Nong). Photo: Le Xuan Hung 2019

Of the animal bones identified, turtles are the most numerous, accounting for 27.1%, followed by fish with 24.6%, bats with 17.1%, deer with 7.71%, and monkeys with 5.14%. These species groups are in all layers, while other mammals are in smaller numbers. Some animals hunted by C6.1 cave dwellers are monkeys (*Macaca* sp.), orangutans (*Pongo* sp), sambar (*Rusa unicolor*), Indian hog deer (*Axis porcinus*), wild boars (*Sus scrofa*), wild buffaloes/bison, tigers (*Panthera tigris*), hog badgers (*Artonyx collaris*), Asian small-clawed otters (*Aonyx cinerea*), bears (*Ursidae*), civets (*Viverridae*), jackals (*Canidae*), and rhinoceroses (*Rhinoceros* sp.). Hard shell and softshell turtles account for a large number and are considered a common source of food of the ancient people.

Mollusk shells are a frequent object collected by humans, increasing over time from the earliest to the latest stage [Nguyen Khac Su et al. 2018; 2019]. The majority is a species of freshwater snail with a gill and an operculum (*Sinotaia aeruginosa*) (85.4%). It also reflects the tradition of eating snails in caves by the inhabitants of the Hoa Binh culture in Southeast Asia prehistory (fig. 8).

In spiritual life, the ancient people of the C6.1 cave knew how to beautify themselves with jewelry. The jewelry was made from the shells of sea snails (*Cypreae* sp.) having an oval body, a long narrow mouth, and a profoundly concave smooth white shell. The shells were pierced on the back to make a chain worn as a necklace. Some of these shells were dyed with ocher and buried with the dead. The use of sea snail shells as jewelry and burial items was widespread in the Hoa Binh culture in northern Vietnam thousands of years ago [Nguyen Khac Su 2021a].



Monkey jaw



Orangutan tooth



Deer jaw



Wild boar jaw



Jackal jaw



Turtle jaw

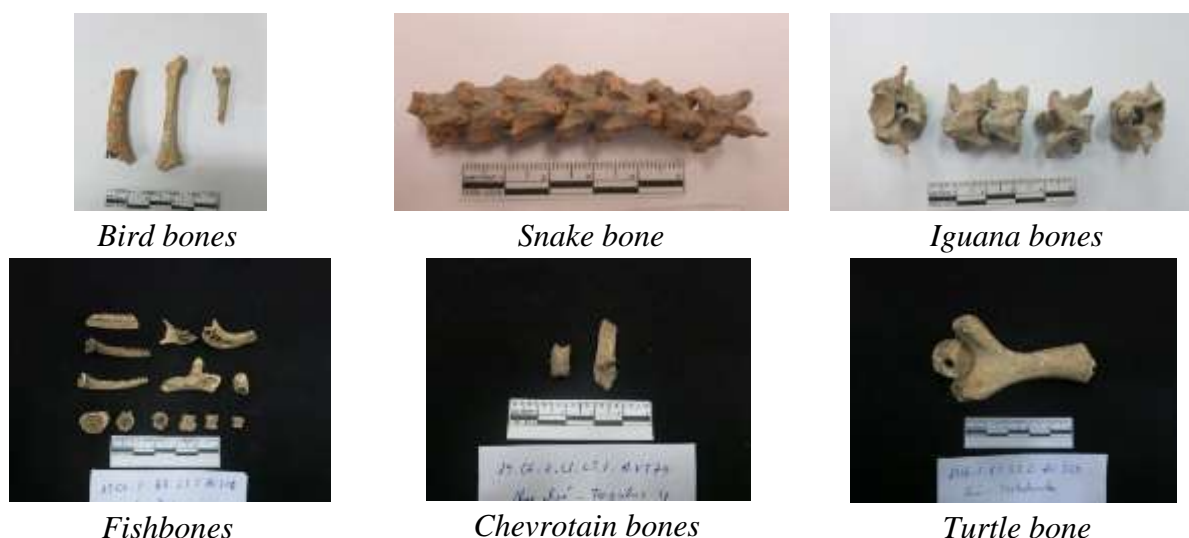
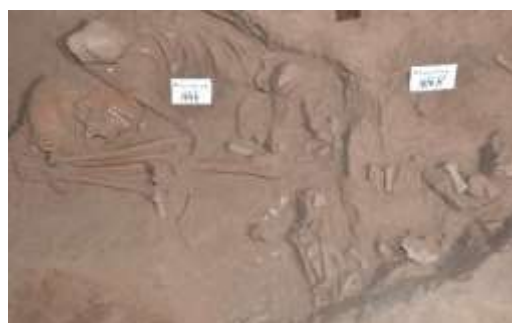


Fig. 8. Animal remains from Cave C6.1. *Source:* [Nguyen, Tran 2020]

Culture of handling death: The inhabitants of the volcanic caves buried their dead in the fetal position at their residence, next to the fire. Seven graves were discovered in the excavation pit. Human remains in these graves have been preserved relatively intact. Grave 1 is in a layer dating to 5,780 BP (the adjusted value is 6,686 BP); the dead body is that of a man about 25 to 35 years old. Based on the length of the limb bones, this person is believed to have been about 1.84 to 1.85 m tall. In terms of the composition of anthropology, the skull is similar to Melanesian and Indonesian skulls, which was common in Hoa Binh culture (fig. 9: 1a, 1b, 1c). Grave 2 is at a depth of 68 cm and dates to 5,230±20 BP. The body is an infant about four years old buried in a sitting position with legs flexed closely to the chest. The skull bone is thin and broken into more than 100 pieces. These pieces were reassembled to form a skull, but its ethnicity is unknown. The infant's skull has a wide nasal cavity, a low-slanted eye socket, and large teeth, commonly seen in the black race (fig. 9: 2a, 2b, 2c) [Nguyen Lan Cuong 2019]. In addition, fragments of human bones and teeth are scattered in the cultural layers of the excavation pit. The burial process and anthropological composition indicate that the inhabitants in this area are related to the people of the Hoa Binh culture in northern Vietnam in the Neolithic period after Hoa Binh [Nguyen Khac Su et al. 2019].



1a. Grave 1. The body was placed in the fetal position.



1b. Lateral view MI



1c. Frontal view MI



Fig. 9. Graves 1 and 2, and skulls from Cave C6.1. *Source:* [Nguyen Lan Cuong 2019]

Stoves and community structures: In the excavation pit of Cave C6.1, 14 stoves were discovered at different depths and coded from F1 to F14. A stove was usually formed by piling up black or dark black soil. The soil pile is round or oval, with a thick layer of ash coal placed in the middle and a thin outer layer. A large stove has a diameter of 0.6 m, and smaller stoves have a diameter of 0.4 m. The stoves are surrounded by stones of basalt and contain ash coals, animal bones, burnt mollusk shells, and a few scraps and pieces of pottery [Nguyen Khac Su et al. 2018; 2019]. Most stoves in Cave C6.1 are small and possibly owned by households with two generations: a husband and wife and their children (fig. 10).

Two large stoves of overnight hunters were found in Cave C6', dating back to the latest stage of the cave. It is more likely that the owners of these hunting campfires were residents of Cave C6.1 nearby.



Fig. 10. Stoves discovered in Cave C6.1. *Photo:* Le Xuan Hung

Conclusion

(1) For the first time, Vietnamese archeologists have learned about a type of archeological site in volcanic caves and have added such sites to the map of prehistoric archeological sites in Vietnam. Volcanic caves have preserved a relatively intact stratigraphy, reflecting the historical process from 7,000 to 4,000 BP and clarifying the stages from the earliest to the latest based on cultural layers [Nguyen Khac Su et al. 2020].

The early stage, consisting of the 3rd to 8th cultural layers (7,000 to 5,500 BP), experienced a humid tropical climate alternating with cooler periods. Humans resided, made tools, and buried their dead in caves. The inhabitants quarried local stream pebbles of quartz, quartzite, schist-silica, chert, and basalt. The raw materials were then hewn and slightly modified to create oval axes,

sharpening axes, disc-shaped graters, short axes with chopped handles, and thin flakes similar to those of the Hoa Binh culture. In addition, ancient people made and used small, sharp bone tools that smoothed the whole body. During this time, people hunted animals, including rhinos, tigers, buffaloes, bison, deer, wild boars, iguanas etc, and mollusks, such as snails and freshwater mussels; there is no evidence of domesticated animals. The early inhabitants maintained the tradition of burying their dead in caves with the bodies placed in the fetal position, resembling the Melanesian and Indonesian ethnic characteristics of the Hoa Binh people.

In the late stage, from 5,500 to 4,000 BP, people resided in caves, but some chose to live outdoors around Dray Sap waterfall, where cultural relics have been found. The cave dwellers perfected tools for hedging and sharpening, and the shape was more stable. A few opal tools and crude pottery were found, which indicate that the inhabitants of this period had contact with groups of Late Neolithic people in the area where stone ax and opal quadrilateral manufacturing was practiced.

(2) Geo-archeological documents indicate the adaptation of humans to changes in the environment of the volcanically active area of Krong No. Such compatibility is reflected in the exploitation of toolmaking materials, bifacial and blade sharpening techniques, and the preservation of tool shapes of the Hoa Binh culture. In the tropical environment of the red soil highlands, the inhabitants retained the tradition of living in caves, collecting mollusks, and hunting various species. The inhabitants of the Krong No volcanic caves followed the tradition of burying the dead in their residences with the dead bodies in a flexed position with the legs bent or in a sitting position with the legs flexed closely to the chest. Their graves were sprinkled with ocher and their bodies were buried with stone tools and sea snail shells of *Cypreae* sp, practices that resemble the Hoa Binh culture. In terms of ethnic composition, people of this period belonged to the Indonesian ethnic group, originating from the Hoa Binh culture of northern Vietnam.

(3) The archeological documentation of Cave C6.1 is reliable in terms of the prehistory of the Central Highlands from the Middle to Late Neolithic. The typical cultural relics of the Middle Neolithic in the Central Highlands are those of the Krong No volcanic caves, the relics of Lang Ga (Gia Lai) and Buon Kieu (Dak Lak), Thon Tam (Dak Nong) etc [Le 2020]. These relics are in the same line as other Neolithic cultures in Vietnam, such as the Cai Beo culture (Quang Ninh and Hai Phong), the Da But culture (Thanh Hoa and Ninh Binh), the Quynh Van culture (Nghe An and Ha Tinh) (6,000–3,500 BP) and the Bau Du archeological site (Quang Nam) [Nguyen Khac Su 2021b].

After the Hoa Binh culture in the Neolithic period of Vietnam, most of the habitations developed in the delta-coastal area, while some developed on the red soil plateau mentioned above. Typical habitations that developed in the Central Highlands during the Late Neolithic period include the Lung Leng culture (Kon Tum), the Bien Ho culture (Gia Lai), and groups of residents of Hamlet Bon (Lam Dong), Chu K'tur (Dak Lak) etc [Le Xuan Hung 2020].

(4) The presence of archeological sites in the volcanic caves of Krong No clearly indicates an intact chronicle with outstanding environmental changes and human adaptation in the past. It is a typical example of the tradition of living in caves and using natural resources, representing the process of interaction between humans and the environment under the influence of changes in nature and society in the Central Highlands. Prominent findings on the characteristics of fauna and flora are not common from the archeological evidence of the Central Highlands volcanic region in Vietnam and Southeast Asia.

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