Revisiting the archaeological stratigraphy of Hotu cave, Iran: preliminary report of the 2021 excavation

University of Tehran Prees

Journal of Archaeological Studies

Online ISSN: 2676-4288

https://jarcs.ut.ac.ir/

Revisiting the Archaeological Stratigraphy of Hotu Cave, Iran: Preliminary Report of the 2021 Excavation

Hassan Fazeli Nashli[1], **Mojtaba Safari**[2], **Roger Matthews**[3], **Judith Thomalsky**[4], **Jan Lentschke**[5], **Mina Madihi**[6]

1. Department of Archeology, Faculty of Literature and Human Sciences, University of Tehran, Tehran, Iran (Corresponding Author). ***Email:*** hfazelin@ut.ac.ir
2. Department of Archeology, Faculty of Cultural Heritage, Handicrafts and Tourism, University of Mazandaran, Babolsar, Iran (Corresponding Author). ***Email:*** m.safari@umz.ac.ir
3. University of Reading, UK. ***Email:*** r.j.matthews@reading.ac.uk
4. German Archaeological Institute, Tehran Branch (DAI). ***Email:*** Judith.Thomalsky@dainst.de
5. German Archaeological Institute, Tehran Branch (DAI). ***Email:*** Jan.lentschke@geo.hu-berlin.de
6. Department of Archeology, Faculty of Literature and Human Sciences, University of Tehran, Tehran, Iran. ***Email:*** minamadihi@ut.ac.ir

Article Ifo

Pp: 5-49

Article Type:
Research Article

Article History:

Received:
20 September 2024

Revised form:
16 October 2024

Accepted:
21 November 2024

Published onlin:
December 2024

Keywords:
Southeast Caspian Sea, Hotu Cave, Mesolithic, Neolithic, Caspian Sea Mesolithic, Caspian Sea Neolithic.

Abstract

The Mesolithic period and its transition to the Neolithic period in Western Asia is one of the most important stages of human cultural evolution during which. humans gradually changed their way of life and cultural behavior. After millennia of living as mobile hunter-gatherers, these changes in human lifestyle were so significant that some scientists consider them to have triggered the Anthropocene (Smith and Zeder, 2013). Therefore, the study of the Mesolithic hunter-gatherer way of life and its transformation into a Neolithic society is crucial for investigating the first steps and possible triggers of this fundamental change. A small number of important archaeological sites in the southeastern edge of the Caspian Sea coast provide rich sequences of hunter-gatherers dating from about 15,000 to 10,000 years ago with abundant cultural materials. One of those, Hotu Cave located nearby the modern Iranian city Behshahr, was firstly described by the American anthropologist Carlton Coon in 1949 and then excavated by him in 1951. Due to various reasons, a proper report on this cave was never presented. Our new activities at the site after 70 years aim to establish a secure chronology from the Mesolithic to the Parthian period and to link obvious gaps in the cave sequence to climatic and environmental changes during the Late Pleistocene and Holocene. The new excavation at Hotu Cave is not only useful to contextualize the data from the Coon excavations, but has also helped us to generate additional data to propose a regional chronology from the Mesolithic onwards. In this paper we present not only the current data on the chronology of the cave, but also all the chronological schemes attempted by scholars, which we have brought together. Our project not only includes activities in Hotu Cave, but also carried out excavations in 2022 and 2023 at the two other key sites of the relevant Mesolithic-Neolithic transitional horizon, Kamarband Cave and Komishani Tappe, which lies in front of Komishani Cave. The material culture from the recent excavations is very important in proposing a new model of the transition from the Mesolithic to the Neolithic for the Iranian highlands that goes beyond the Zagros region, which – until now – has been considered an independent core region of early domestication and Neolithization.

Cite this The Author(s): Fazeli Nashli, H., Safari, M., Matthews, R., Thomalsky, J., Lentschke, J. & Madihi, M., (2024). "Revisiting the Archaeological Stratigraphy of Hotu Cave, Iran: Preliminary Report of the 2021 Excavation". *Journal of Archaeological Studies,* 16(2): 5-49.
https://doi.org/10.22059/jarcs.2025.388982.143332

Homepage of this Article: https://jarcs.ut.ac.ir/article_100326.html?lang=fa

1. Introduction

The environmental and cultural importance of northeastern Iran lies in the connection of the Eurasian region with southwestern Asia. These factors may have played a key role in the movement of early farmers into South Asia and Central Asia during the Neolithic (Nishiaki et al, 2022; Taylor et al, 2021; Pollock et al, 2019; Matthews and Fazeli Nashli, 2022). The northern slopes of the Alborz Mountains and the southeastern coast of the Caspian Sea, with their high biological potential and ecotone, provided a rich habitat with abundant resources for the last hunter-gatherer communities due to their lush vegetation patterns.

It is important to mention that due to the dense vegetation in the southeastern region of the Caspian Sea, archaeological sites are much more difficult to find. However, the Mesolithic cultural features in the explored cave sites such as Al-Tepe (Ali Tepe), Hotu, Kamarband (or Coon's "Belt Cave") and Komishani have more remarkable data than other parts of Iran, such as the Zagros region (Coon, 1957; McBurney, 1968; Vahdati Nasab *et al.,* 2011; Jayez *et al.,* 2024). Some of these sites were excavated in the 1950s, others were identified and excavated through urban activities, and some of them were purposefully excavated (Jayez, 2011; Hashemi and Vahdati Nasab, 2014; Jayez and Vahdati Nasab, 2016). However, the reality is that excavations during these earliest times of "modern" archaeology cannot provide us further insights on economic subsistence, social and human-environmental dynamics or other aspects of life in the transitional phase between hunter-gatherer (Mesolithic) and food-producing communities (Neolithic).

During his excavation of Kamarband Cave in 1949, Carleton Coon also identified Hotu Cave and excavated it in 1951 with funding from the University of Pennsylvania (Coon, 1957). When Coon began excavating Hotu Cave, he was still in the early stages of his archaeological career. Despite his extensive efforts to record and describe the finds, he was unable to apply interdisciplinary sciences such as archaeobotany and geoarchaeology.

With the first re-examination of Coon's explorations, became clear that also his radiocarbon dating showed a significant difference of almost 2,000 years (McAuley, 2013). Actually, all those insufficient circumstances were realized by Carleton Coon himself. He consciously mentioned in his book "The Seven Caves" in 1957 that the final report of Hotu Cave had not yet been written and he is not sure whether it will ever be written in the future. He also remarked that although a sufficient number of layers from the Neolithic to the Iron Age had been excavated to provide good cultural remains for study by experts, the underlying layers were not adequately sampled for analysis. Coon explains, "someone should come back and dig up the rest of these deposits; for I have worked this part by trial and error and left the rest to others to analyse". (Coon, 1957: 201). Therefore, 70 years later in spring and summer 2021, Coon's excavations in Hotu Cave were resumed and carried out by an Iranian team led by Hassan Fazeli Nashli. The 10 m deep, rich archaeological layers of Hotu Cave cover the Mesolithic, the Early (or Non-Ceramic) Neolithic, the Late (or Ceramic) Neolithic, the Chalcolithic, the Iron Age and the Parthian era. Due to the wealth of information, this article is limited to the Mesolithic and Neolithic finds and focuses on a review of Coon's excavation and chronology, supported by our freshly obtained C14 dating results on samples from the 2021 re-excavation. We hope to cover other settlement culture strata in the cave in future articles.

2. Location of Hotu Cave

Hotu Cave (N 36041'17.88, E53029'47.63) is one of the most famous caves in the Iranian plateau and contains layers from the Mesolithic to the historical period. The cave has a protected interior area of about 142 square meters and is located about 8 km west of the city of Behshahr in a limestone formation 38.28 meters above sea level. The coast of the Caspian Sea is 13 km away (Figs. 1 & 2). Today the site is located within the boundaries of the village of Shahid Abad (formerly Trojen).The Jurassic limestone contains rich marine fossils of ammonites of the genus Periapices, dating back 150 and 65 million years. In the course of the Hotu excavations in 2021, a total of seven fossils were found in the Mesolithic layers (Fig. 3).

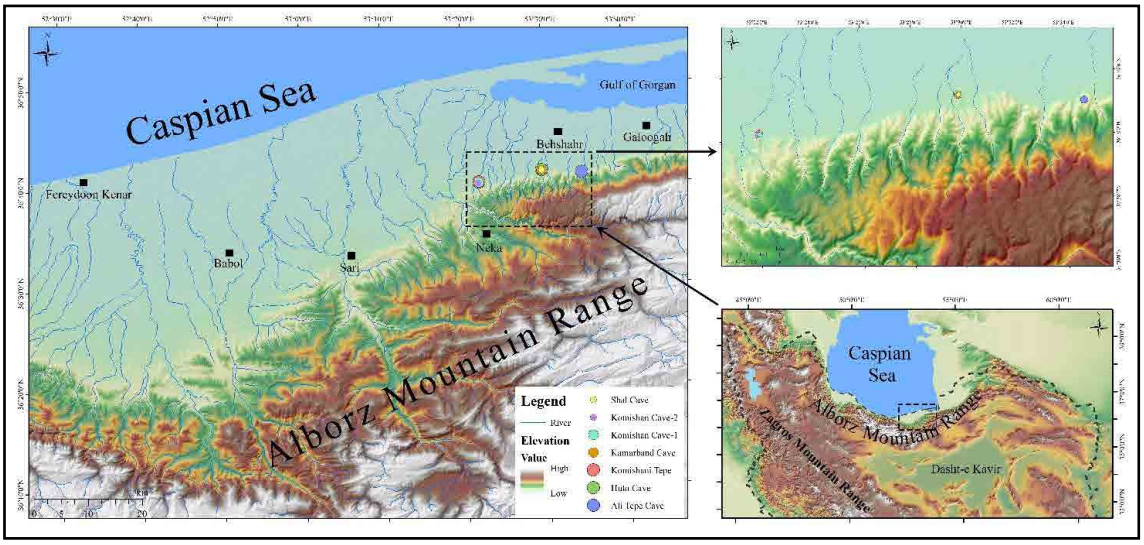


Fig. 1: The location of Hotu and Kamarband caves in the today's Iranian Mazandaran Province

Fig. 2 left: Hotu and Kamarband caves; right: entrance of the Hotu cave in 2021

3.Carleton Coon's Excavation in Hotu Cave

On October 21, 1949, during the ongoing excavation of Kamarband Cave, workers brought Carleton Coon to "Rustem Qala`a Cave", located behind a village of the same name. Although, the cave entrance had been destroyed by a dynamite explosion, Coon classified "Rostam Kolah Cave" as contemporary with Kamarband Cave on the basis of its surface finds (pottery and stone tools). However, he refrained from excavating this cave

Fig. 3: Fossils obtained from the re-excavation of Hotu Cave

as it was difficult to access. Coon writes in his book "The Seven Caves" about the Hotu Cave: that this cave was buried underground for a long time (Coon, 1957: 231). On his way back from "Kollareh Cave", two of his workers named Parviz and Morad informed him about the existence of "Hotu Cave" (Coon, 1957: 162). The entrance to the cave was completely buried by sediment deposits but blasting for stone extraction had created a hole in front of the cave. On his first visit inside the cave, he encountered a layer of bat guano, which made him realize that this space had been inactive for a long time. During his examination, he found the main entrance, which was filled with soil and gravel. The workers named this cave "Hotu" or "Otu", which means either flatiron because a stone in it looked like a flatiron (in Persian).

In February 1951, Coon returned to Behshahr for the second time. This season he was accompanied by Louis Dupree and his wife (Coon, 1957: 164). He began clearing the cave entrance, which had been blocked by mining operations, and excavated a large amount of soil from the backfilled entrance, which had been sedimented and filled for some time. By this time, excavations had been completed in two trenches, B and C, in the front part of Kamarband Cave (Coon, 1957: 231). From March 14 to April 21, the excavations in Hotu lasted five weeks. The first trench, Trench A, measuring 3 x 5 square meters and 12.50 meters deep, was excavated for stratigraphy (Fig. 4), with the first seven meters consisting of soft soil with sands underneath, which according to Coon resembled Pleistocene soil. The cave was probably abandoned for several thousand years. A thick layer of 20 to 30 centimeters of bat guano and mud covered the cave surface. Underneath was about 80 centimeters of clay mud with cultural finds such as animal bones and pottery from the Iron Age. A continuous series of ash, charcoal, and stones in various colors continued down to a depth of 1.60 meters, where the third significant soil change and a second set of silt deposits were found, consisting of darker and brighter layers in lower depths.

Coon describes the Mesolithic and Neolithic periods as follows: At a depth of 4.80 or 4.60 meters the fourth major soil change was found, beneath which a single layer of soil continued to the surface of stones laid on top of the sands deposited below. These large limestone slabs may have fallen from the ceiling due to wet weather or earthquakes. These slabs were laid on top of the sand. Below the slabs, Trench A was merged into the smaller excavation area Trench D. A number of painted pottery sherds and accurately chipped stone bladelets were found in this section, leading him to believe that he had reached the Neolithic layer. He writes that the Neolithic period of this site is different and comparable to the pottery found in the Turkmenistan region reported by Raphael Pumpelly, similar to that found in the Iranian plateau (Coon, 1957: 185).

Coon emphasized that no metal objects were found in these layers, while bone and stone objects were predominant. The bone findings suggest that domestic animals coexisted in Neolithic contexts, with rarer findings of cattle bones as the depth of the excavation increased, with only domesticated sheep and goat bones found in lower (= older) layers. Coon mentions a plausible idea at this point: When they left Hotu, some of them may have gone to the plateau, bearing their painted pottery to Sialk.

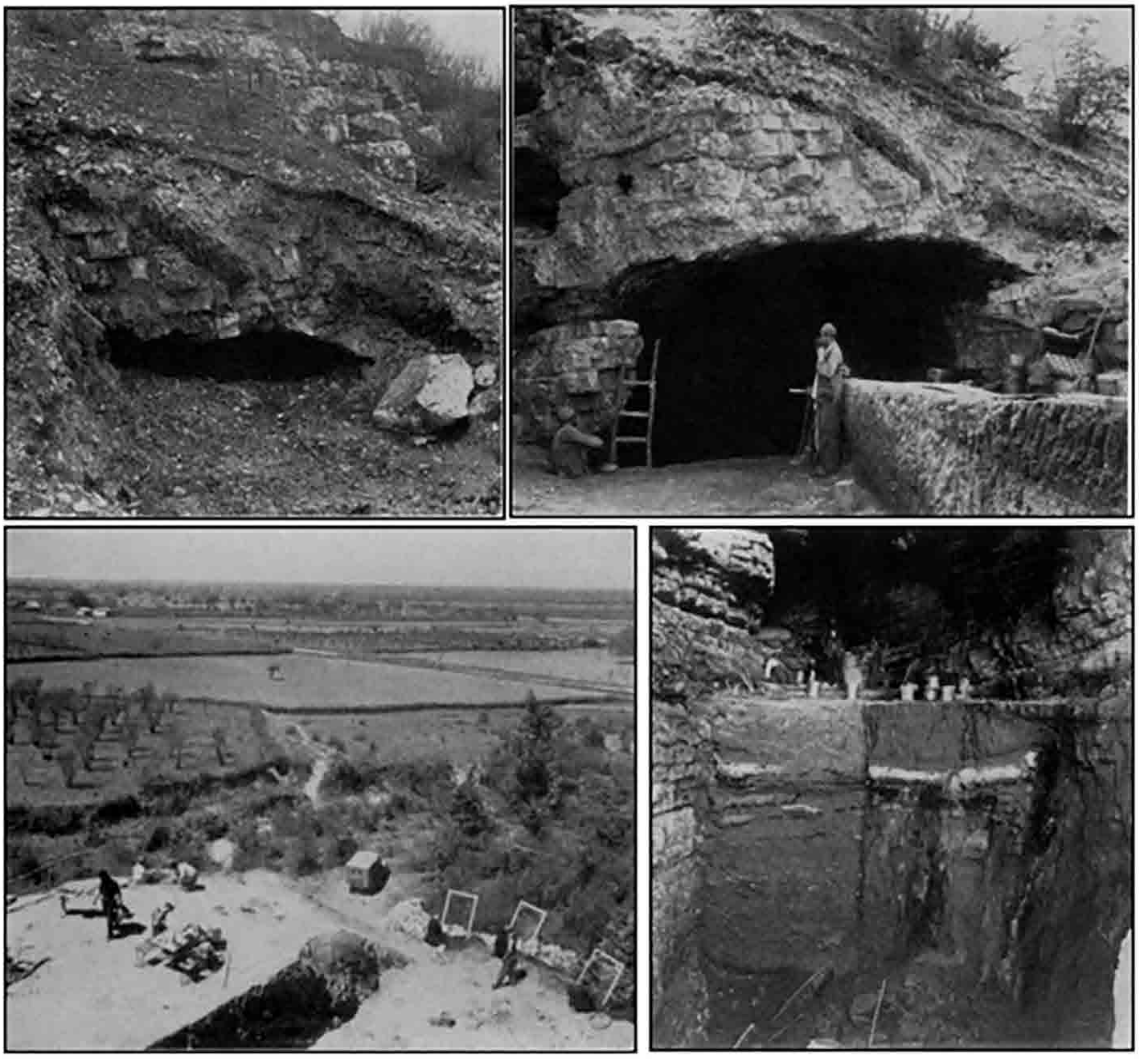


Fig. 5: Reopening of the cave mouth and excavation of Hotu Cave by Carlton Coon (Coon, 1952)

At a depth of 5 meters, the end of this horizon was reached. The sediments consisted of loose, high-clay content soil of brownish color, with finds of polished ground stones, chisels and flint blades with sickle sheen. The associated soft and unpainted pottery Coon compares to ceramic sherds found in Kamarband Cave. When reaching the very bottom of the Neolithic layers, a completely different type of sediment appeared, which was heavy, moist and loamy gray-colored. No pottery was found in this layer, but there were plenty of stone tools similar to the above-mentioned. Some flint flakes reached a depth of 50.8 centimeters (upper layer, Neolithic context). Very noteworthy are the finds of two human long bones and large stone slabs that spread throughout the entire space of Trench A. The latter are seen by Coon as most likely fallen from the ceiling and walls of the cave during the latest Neolithic occupation in Hotu (Coon, 1952: 242-243; Coon, 1957: 186), describing an ancient cataclysm, possibly an earthquake.

Beneath the stone slabs was a layer of sandy and very soft soil, which made it difficult to continue the excavation. Due to a lack of oxygen and light, the excavation was interrupted for a while and trench B was opened. This trench comprised from the edge of the ceiling to the beginning of Trench A with a length of seven meters. When the excavation of Trench B was finished, Coon started Trench C five meters further into the open space to facilitate the excavation and to get light into the cave (Coon, 1957: 188). When a depth of 7.15 m was reached, two flint cores were found that Coon originally identified as Paleolithic tools - actually a cleaver and the other a hand axe (Coon, 1957: 196), which encouraged him to excavate Trench D to a depth of 7.6 meters (Fig. 6).

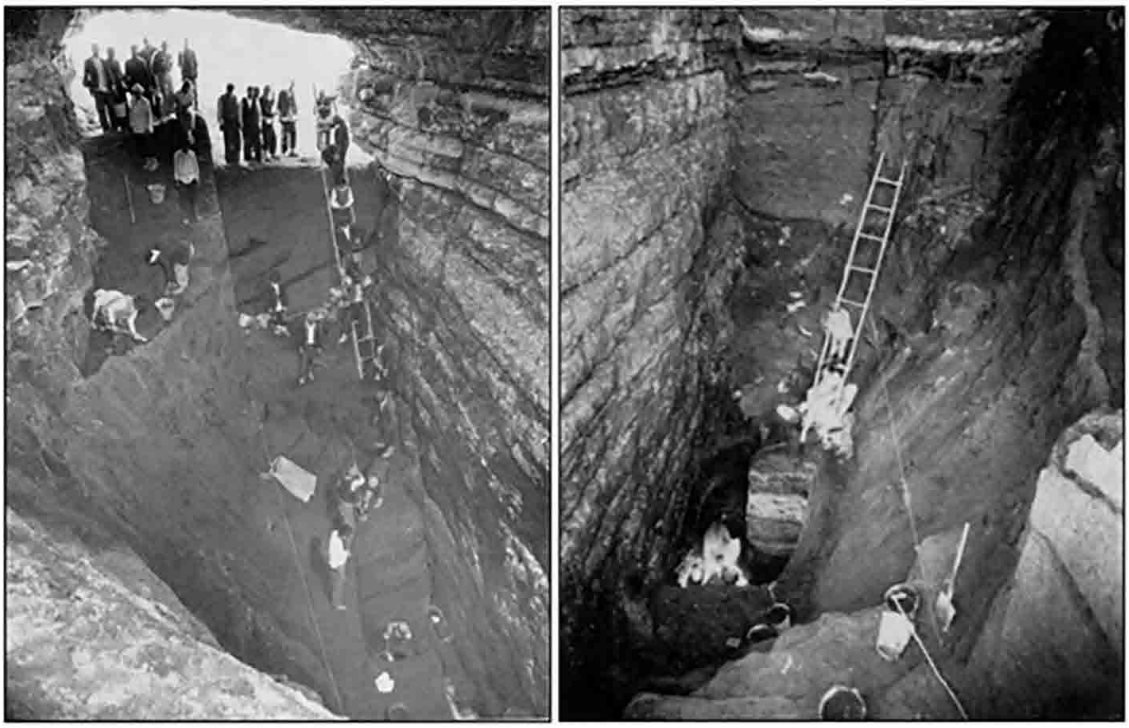


Fig. 6: View of Trench D in Hotu Cave (Coon, 1952; Coon, 1957)

4. Trench D

Major features and horizons excavated in Trench D can be summarized as follows: at a depth of 2.40 meters, four layers of black gravel and three layers of sandy soil (Layers 1-4 and 5-7). the uppermost layers can be assigned to younger activities in the cave, including

a first neolithic occupation (layer 3). Significantly, layer 4 consisted of collapsed rock bed splintered into stone slabs of different sizes that possibly have fallen from the cave ceiling similar to Trench A and thus separates the Neolithic from the earlier Mesolithic occupation. The stones scattered around one square foot and up to 20-30 cm height. Two of those stones appear to be responsible for the deaths of two individuals, identified by skeletons no. 2 and 3 (Coon, 1952: 232-233). Apart from these unfortunates, deliberately buried human remains were found on the sixteenth day of the excavation. The first burial, known as Hotu Skeleton 1, was discovered in the second gravel layer 4. Seven centimeters below this burial, two additional skeletons of possible females were found. All individuals did not have any objects with them, but the layer fill contained several lithic tools. As similar items were found in the upper zone of gravel layer 4, Coon became aware of the presence of Neanderthals in Hotu which actually was also the first identification of Neanderthals in Iran at that time (Coon, 1957: 201-206). Though, immediately after the results of the radiocarbon dating, which fall around 7240 cal BCE, he corrected this view. As Coon and his collaborators were about to uncover the burials in the upper half of Trench D, Louis Dupree, apparently due to the large amount of cultural deposits that exceeded their expectations combined with budget constraints and extreme excavator fatigue, quickly excavated Trench D to the virgin soil at a depth of 3.13 meters measured from the then modern floor of the cave. Consequently, Coon was unable to publish any finds from Trench D other than the human burials. Until now, little information was available from the Mesolithic and Neolithic periods of Hotu Cave (Coon, 1957: 202-205).

5. Animal bones and paleoenvironment

Coon divided the total of 1,000 animal bones found in Hotu Cave into three sections for research: He examined the bones of goats, sheep, deer, pigs, and seals himself. Fred Ulmer, a zoologist from Philadelphia, worked on the bones of wild cattle and herbivores, and Dr. Fraser from the British Museum studied the bones of rodents, bats, shrews, foxes, and other small mammals, of which 245 were published. With these findings, and based on ecological evidence, Coon attempted to reconstruct the climatic layers of various cultural and natural deposits in Trench D of Hotu and described them as follows. The gravel-infilled sequence below the sandy layers 1-2 indicate a rather non-forested environment, since no seals or rodents were found in this layer A drier climatic phase lay between two humid phases. He also interpreted the abundance of gazelle bones found in secondary layer of sand as a desert or steppe animal so as evidence for increasing drier climatic conditions. In contrast to this, the abundance of limestone chips in gravel layers 3 and 4 indicated relatively wet climatic conditions. The ox, red deer, and pig are forest animals. The sheep is a mountain animal.

Animal bones of gazelle and sheep were found in the succeeding red sand layers 2 and 3, but no evidence of ox, deer or pig. Three seal bones indicate that the Caspian Sea was not far from the cave during that period. In addition, a fauna adapted to cold and dry areas were also found in layer 3. This picture could indicate living conditions when the glaciers of the North Pole were melting, the waters of the Caspian Sea were rising, and the southern coast plain was experiencing an antiperiodic oscillation. Coon believes that the people living in Hotu focused more on gathering hunting animals and raiding bird nests than on hunting. The food sources suggest that these early inhabitants lived primarily on dry land, which enabled them to hunt a variety of prey. In contrast, the later occupants,

who resided in the cultural layers of sandstone above, were mountain and forest hunters. They concentrated on hunting wild oxen, red deer, and sheep.

6. Paleo-geography of the site

Hotu Cave is located at the foot of the northern slope of the Alborz Mountains, in the transitional zone between the forested hillsides and the coastal plain at the southeast of the Caspian Sea. It is one of seven caves in the so-called cave belt, which are only a few kilometers away from each other and where, due to geological conditions, karstification has created the caves that were used for settlement in prehistoric and historical times. The climate in the region is characterized as subtropical with dry summers. Due to the Alborz mountain range, which rises up to 5,609 m a.s.l., moist air masses are precipitated on the northern slopes of the Alborz Mountains, leading to numerous continuous surface runoff patterns, and the resulting lush vegetation reflects the climatic conditions. These natural conditions provided optimal conditions for agricultural use and settlement of the surrounding area in historical times, particularly in the Hotu Cave and the wider cave belt region.

The following section discusses various relevant environmental factors and their changes, as well as their potential immediate impacts on the region or on the catchment areas of rivers and settlement zones. Previous natural changes may have led to significant landscape transformations, which can offer insights into possible human-environment dynamics and interactions, as well as potential explanations for breaks in settlement chronology. Specifically, this can address the research hypothesis of whether natural environmental changes may have interrupted the process of Neolithization that was underway in this region around 8,500–8,300 cal. BC. Three relevant natural aspects, namely tectonic activity, sea-level fluctuations, and paleo-climatic conditions, will be highlighted.

First, tectonic activity is important, both in the present day and historically in the study area. As shown on the map, significant seismic and tectonic processes can be observed throughout the Alborz Mountains (Fig. 7). The uplift rates are approximately 4–6 mm per year. Evidence of this tectonically induced uplift is the Khazar Fault north of the Alborz, which exhibits land steps of 40 to 70 meters (Fig. 8).

These tectonic processes, both short-term and continuous, also changed the characteristics of the settlement area's catchment basin in historical times. Tectonic activities in the form of short-term processes, such as earthquakes, mass movements, or tsunamis, could cause not only the immediate destruction of settlements but also alter the morphology and morphological processes. Primarily, through continuous tectonic activity, the local erosion base and the erosion and accumulation processes of the river systems were altered. A lower sea level led to increased erosion in the inflow areas and the formation of terraces, while a higher sea level led to accumulation in these areas. These morphological processes, in turn, caused changes in the settlement areas, for example, an intensified deposition of fluvial or gravitational sediments, which could potentially cover settlements. Additionally, tectonic activities, especially displacements, also impact the river systems, as schematically depicted in Fig. 9. Such geodynamic processes can result in altered erosion and accumulation conditions, which over time could influence the discharge system of a river, causing rivers to lose their water-carrying properties or undergo complete restructuring. In this case as well, intensified erosion of material and

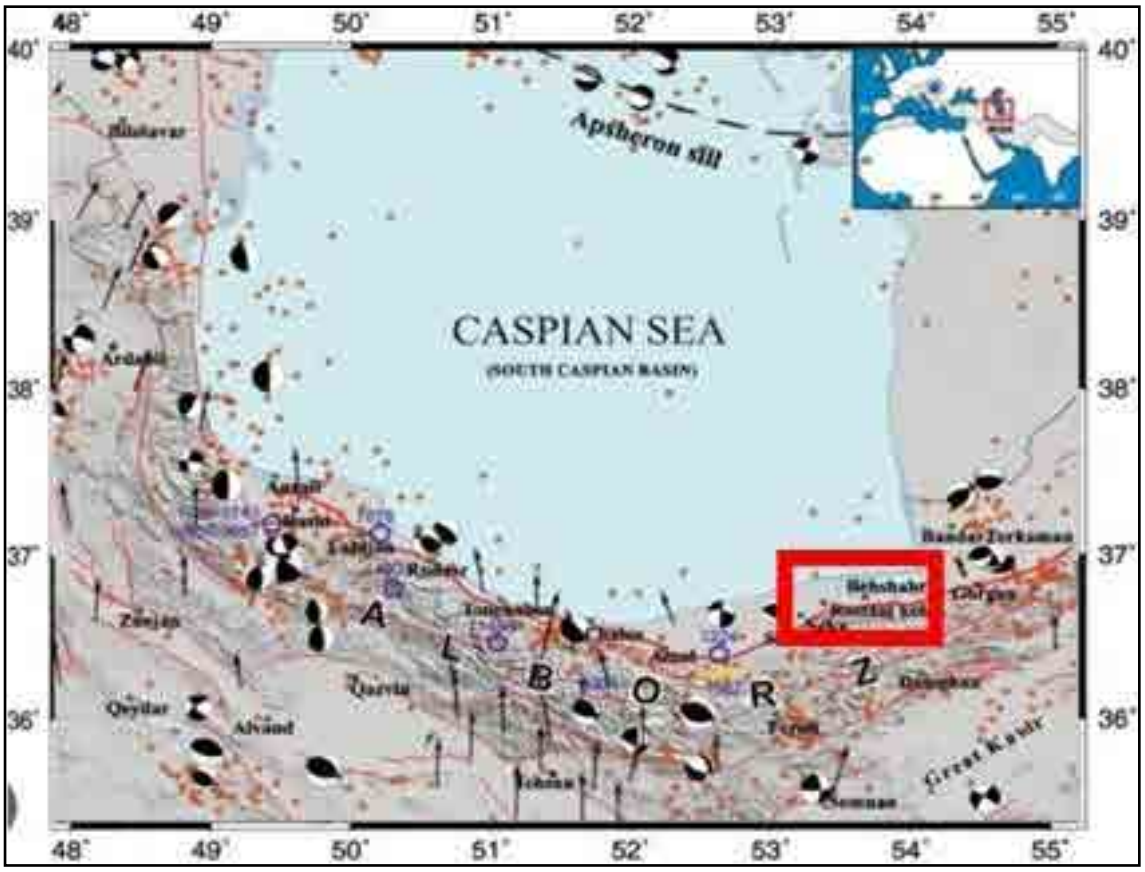


Fig. 7: Tectonic and seismic activity of the Alborz Mountains with the location of the study area (red rectangle) (Nazari *et al.,* 2021).

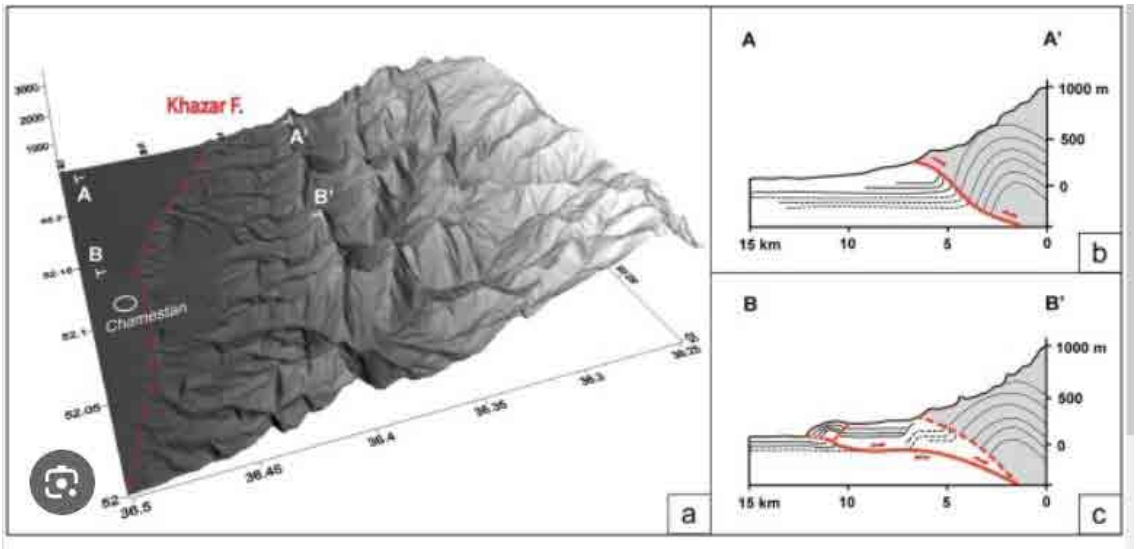


Fig. 8: Khazar Fold along the northern slope of the Alborz Mountains (a) with representation of the topographical step in profile sections (b and c) (Nazari *et al.,* 2021)

its transport could have led to deposition in settlement areas. Erosion, in turn, may have caused the gradual destruction of agriculturally used land.

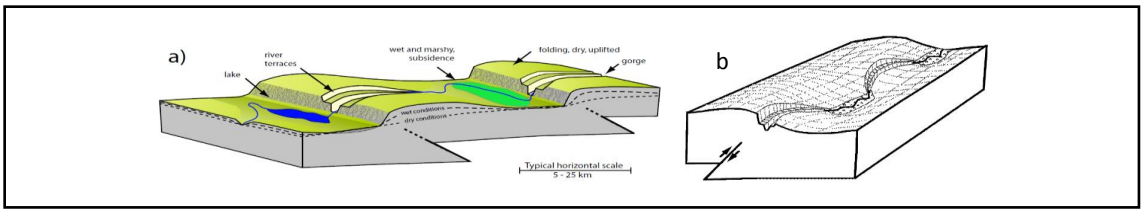


Fig. 9: Schematic illustration of the effects of tectonic activity; a) lifting across the river (Baileya *et al.*, 2011), b) along the river (Baileya/Geoffrey, 1994).

Hotu Cave is located in the southern Caspian lowland. This coastal region is only a few decimeters above the current sea level of the Caspian Sea (-28 m m.s.l.) (Figs. 10 & 11). Over the past 25,000 years, sea level fluctuations of the Caspian Sea can be reconstructed, showing variations ranging from -95 m to +35 m a.s.l. For our period of investigation, the historical sea-level fluctuations around 2400 BC and 9700 BC at -40 m a.s.l., or 4500 BC, 8000 BC, and 9000 BC at -20 m a.s.l., are particularly notable. As an example of the extent of high sea levels, the maximum transgression of the Caspian Sea at -20 m a.s.l. during the Holocene around 7 ka BP is sketched in Fig. 12. Large parts of the coastal plain are flooded and the coastline reaches up to 1500 m to Hotu Cave. These fluctuating sea levels had direct effects on the settlement areas at higher water levels, as the settlement area and its agricultural land were not only flooded and destroyed but also became salinized by the floodwaters, which could have made agricultural regrowth difficult or even impossible after the sea level receded. Along with the sea-level fluctuations, the local erosion base also changed, which, similar to the tectonically induced processes, led to changes in erosion and accumulation processes.

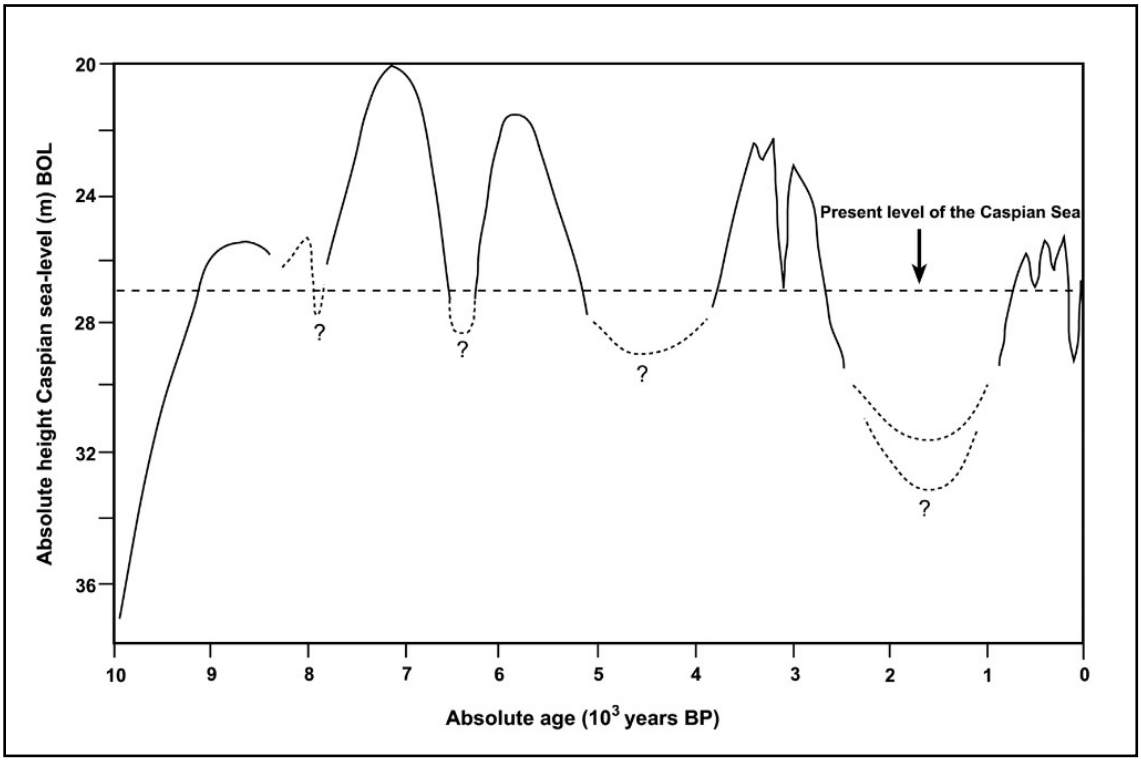


Fig. 10: Sea level changes during Holocene period (Kakroodi *et al.*, 2015)

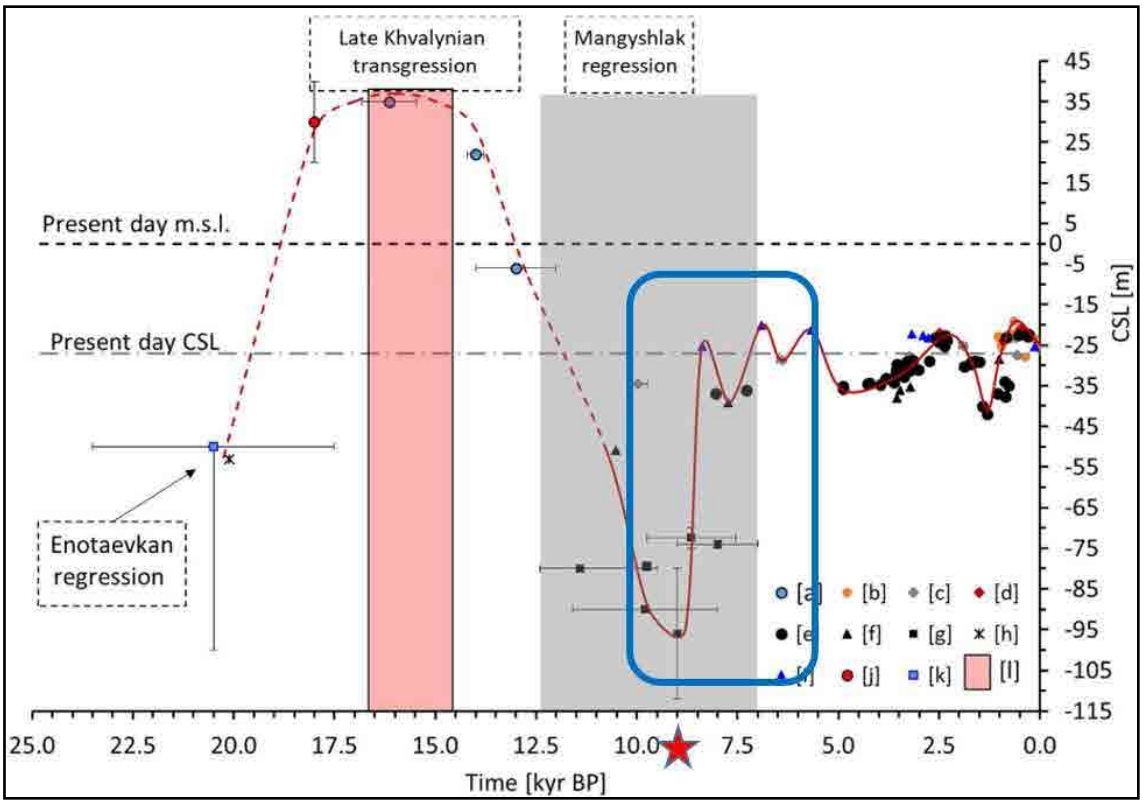


Fig. 11: Sea level changes of the Caspian Sea with the timeframe of the cave sequences (blue rectangle) and the 8.2 ka BP (6.2 ka BC) event (red star) (Koriche *et al.,* 2022)

Fig. 12: Illustration of the maximum transgression of the Caspian Sea during the Holocene around 7 ka BP (-20 m.a.s.l.) with flooded areas and location of the Hotu, Kamarband and Komishan caves.

According to the compilation by Kehl *et al.,* (2023), there is limited data available for paleoclimatic reconstructions for all of Iran, with only data from two sites available for our study area. Paleoclimatic proxy data allow for a good reconstruction of natural changes in historical times, which can, in turn, provide insights into settlement dynamics. Further research is underway to obtain additional data for reconstructing the paleoclimate and sea-level fluctuations in the Gorgan Plain in the southeastern Caspian Sea region, as well as to identify other potential sites for future data collection and investigations. Currently, a database has been compiled from 64 datasets, encompassing results from various methods and which will be further analyzed in relation to specific research questions. Presently, samples from the Komishani (Trench 6) and Gorji Mahale areas are being examined in the laboratory, using various methods such as ICP, 14C dating, grain size analysis, and micromorphology. Future plans include conducting additional sampling in wetlands near archaeological sites.

In addition to the sedimentological analyses of boreholes and existing datasets, GIS and remote sensing methods are being applied to assess landscape changes and land use in historical times. Aerial photographs from the years 1962 and 1970 are available, which will be used to identify additional potential sites for sedimentological investigations. Furthermore, the catchment areas of the rivers that are relevant in the context of settlement areas will be studied along the entire northern slope of the Alborz Mountains. The comparison of different time points (recent, 1970, and 1962) will enable the identification of historical erosion events that may be applicable to the current study period. Morphometric analyses, as well as the detection of terraces and alluvial fans, will provide clues to erosion and accumulation processes at the archaeological sites. Finally, remote sensing analysis of the two main rivers and their tributaries will be conducted to gain further insights into environmental processes and their impacts on settlement areas.

7. New archaeological investigations at Hotu Cave, 2021: "Trench E"

New activities in Hotu Cave took place 70 years after the first explorations of Carlton Coon. These recent investigations aim to establish a secure regional chronology from the Mesolithic to the Parthian period and to link obvious gaps in the cave sequence to climatic and environmental changes during the Late Pleistocene and Holocene. Our excavation of Hotu Cave began in March 2021 and lasted for 70 days. Following Coon's four trenches named A, B, C, and D, we opened a new trench, Trench E (4×2 m), located in the south-west of the cave. The excavation revealed several cultural periods, along with evidence of environmental and climatic changes data that occurred over the millennia. The cultural layers identified in the cave extend from the surface soil down to a depth of 9 meters. In total, eight cultural periods were identified in the sequence of Hotu Cave, spanning from the Mesolithic to the Iron Age and including the Parthian period (Table. 2).

Extensive cultural findings and in total 124 contexts were identified in Trench E, including fireplaces, settlement floors, human burial remains, animal and plant artifacts, stone and pottery sherds, and other small finds. The lowest layer of the cave was located at a depth of 9 meters. Further investigation revealed a sedimentary layer consisting of brownish clay loam, which did not contain any cultural artifacts (see: Figs. 13 & 14). For this area, we can identify a transitional horizon between the Mesolithic layers (121 to 104) and the earliest Neolithic occupation (103 to 77). This transition is significant and can be differentiated by various characteristics. The Neolithic period is further divided

Fig. 13: View of Trench E on the left; The upper layers and on the right side the lower layers in Hotu Cave.

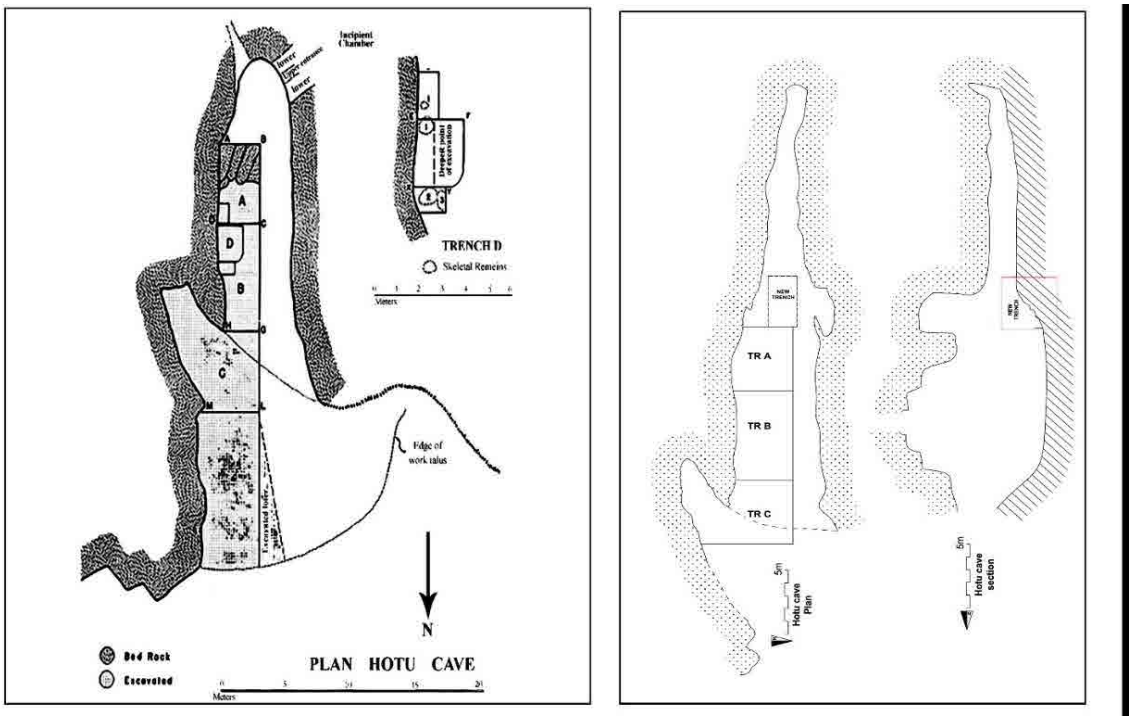


Fig. 14: a) The plan drawn by Coon and the location of the trenches in Hotu Cave. b) The plan of the cave in 2021, with its newly documented southern extension and excavated trench E in 2021

into a non-ceramic and ceramic stage, with the first clay vessel appearing in the relevant context. Contexts from 103 to 58 represent the subsequent Early (non-ceramic) Neolithic period, while contexts 76 and 75 reveal significant gaps of the cultural sequence with infills of sediments without any trace of human occupation These gaps mark distinctive interruptions in the cultural development of the region.

Additionally, for the first time, we can identify a transformation from the Neolithic to the Chalcolithic period, which includes both a "Formative" and a "Transitional Chalcolithic" phase. The material from these horizons provides important archaeological links between the Behshahr region and the cultural developments of the Northern Iranian Plateau..

8. The Mesolithic occupation in Hotu Cave

The Mesolithic period is a cultural phase that follows the Upper Paleolithic period, beginning later around the Caspian Sea. The complete understanding of human occupation in the Caspian Sea region between 21000 and 15000 years ago is still not fully documented. Current data suggests that during the Bølling-Allerød interstadial (ca. 15,000-13,000 years ago), groups of hunter-gatherers with regional identities developed in this area of Iran. These groups were likely not isolated populations; rather, they probably formed a regional identity within a larger social context.

During this period, we observe the use of advanced stone tool technology (Jayez *et al.,* 2024), seasonal and temporary utilization of caves, and potentially year-round movements or increasing sedentism. Additionally, there is evidence of complex ritual systems and social memory, which are reflected in burial practices and craft art.

The deepest layer of the cave, found at a depth of 9 meters, was examined further to confirm its pristine condition. This sedimentary layer, composed of brown clay loam and devoid of any cultural artifacts, may have been deposited in the cave through wind or water activity (see: Fig. 15).

This period marks the first evidence of settlement in Hotu Cave (Fig. 16), which developed on undisturbed soil. It encompasses contexts 104 to 121, spanning from 900 to 670 centimeters within the cave, around 252 centimeters of the cultural layers dating to the Mesolithic period. This layer is approximately 230 centimeters thick and represents one of the longest episodes of settlement in the cave. It includes the remains of two human burials, fireplaces, animal bones, and plant remains. Absolute dating from context 121 indicates 11,945-11,800 BCE, while context 111 shows a date range of 8,130-7,960 BCE, reflecting a period of approximately 2,000 years of continuous occupation. This indicates that before the Younger Dryas, hunter-gatherers inhabited Hotu Cave. The animal remains found in Hotu Cave from the Mesolithic period reveal the exploitation of various species, including Caspian seals, deer, oxen, pigs, canids, equids (horses), gazelles, goats, and sheep. The presence of seal bones, aurochs, and deer suggests that the area had rich environmental resources, as stated by Groene *et al.,* (2023a).

Other significant findings include a large collection of stone and bone tools (Fig. 18). Mesolithic people of Hotu had a chipped stone industry in which both flakes and blades were produced and used in hunting and processing various food sources available in the ecotone. Pointed backed tools in the Mesolithic industry were probably used as projectile armatures and scrapers and notched-denticulated tools were probably used for processing prey carcasses as well as local plant and aquatic food (Jayez *et al.,* 2024).

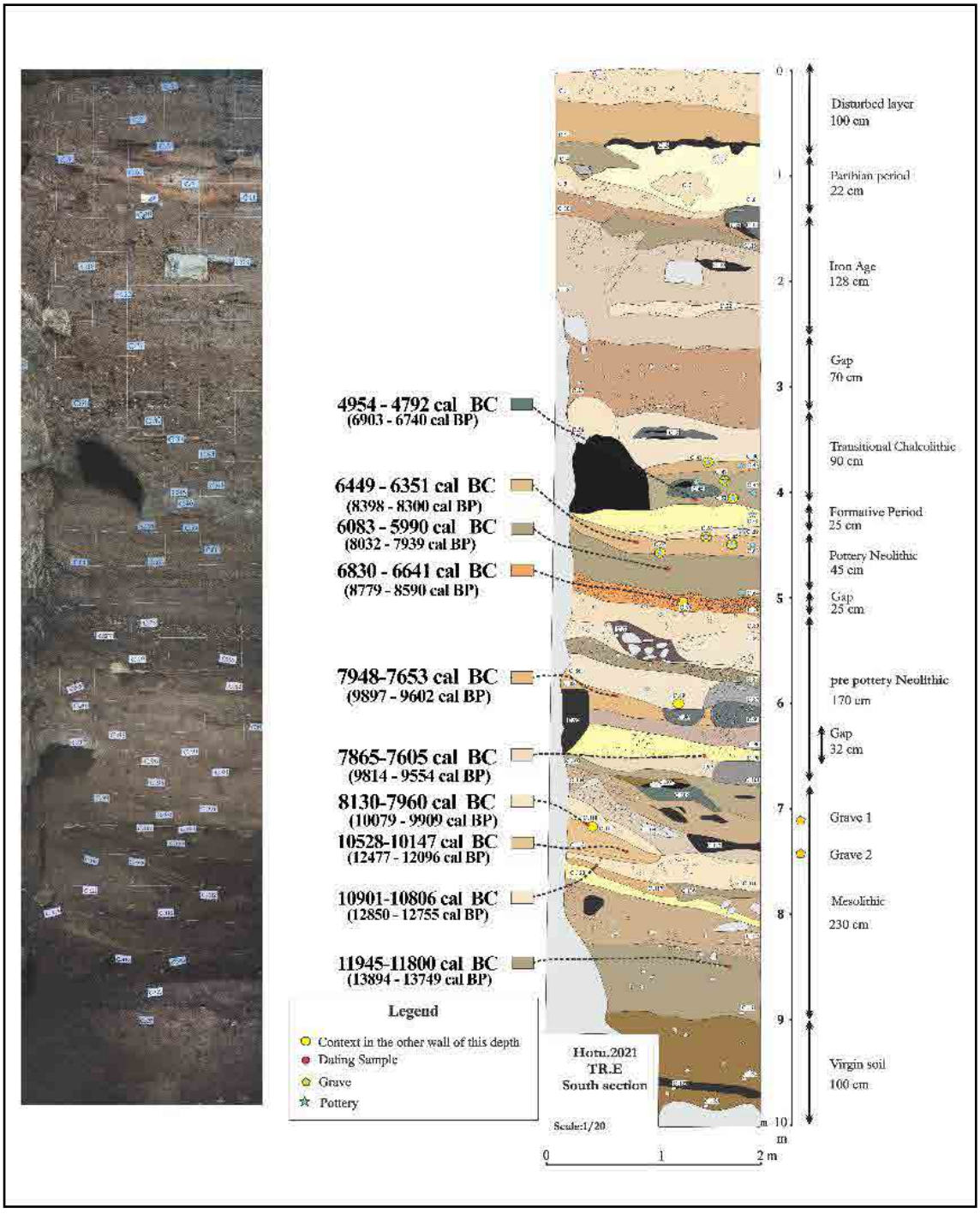


Fig. 15: Profile of Trench E, from virgin soil to the Iron/recent layers with C14 dating.

The presence of medium to large plant remains, which are suitable for human consumption, indicates that hunter-gatherers recognized the importance of plant resources for food during the pre-farming era. Additionally, several fireplaces were discovered, primarily simple in structure and lacking stones, identified as ash and charcoal lenses within the cultural deposits of this period (see: Fig. 19).

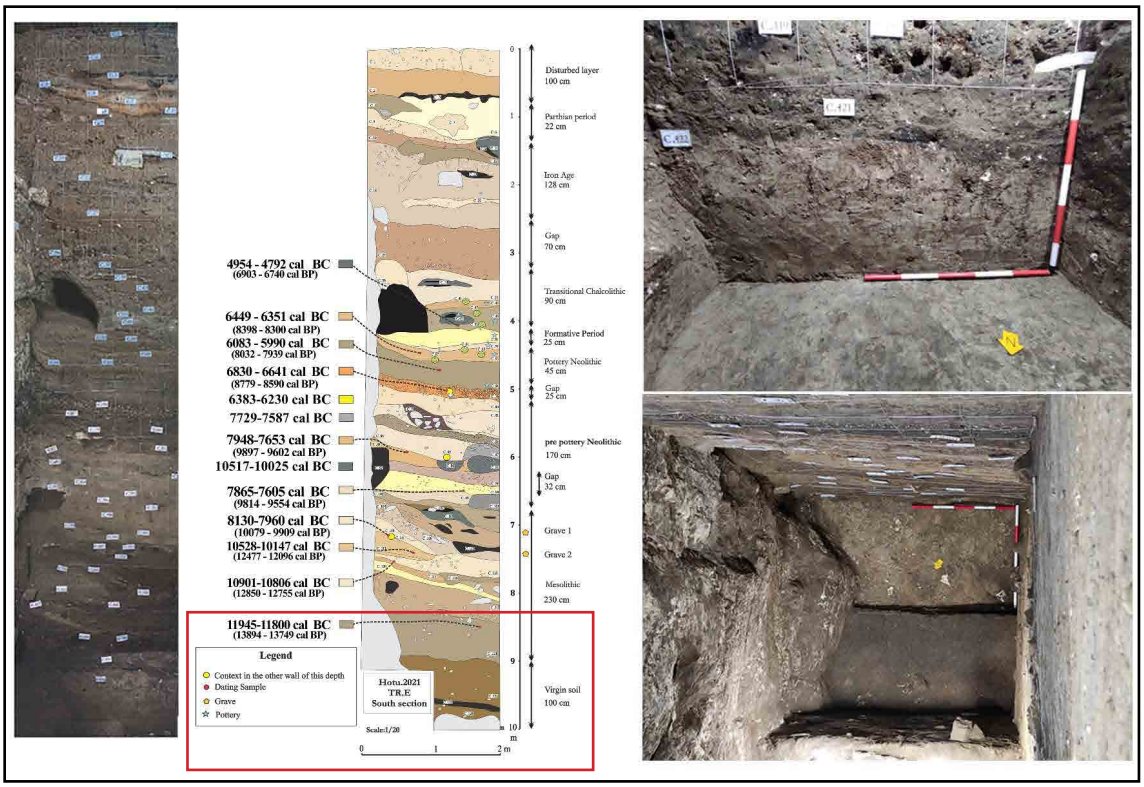


Fig. 16: Virgin soil at a depth of 9 meters from the fixed measurement point, respect. the bedrock of the cave.

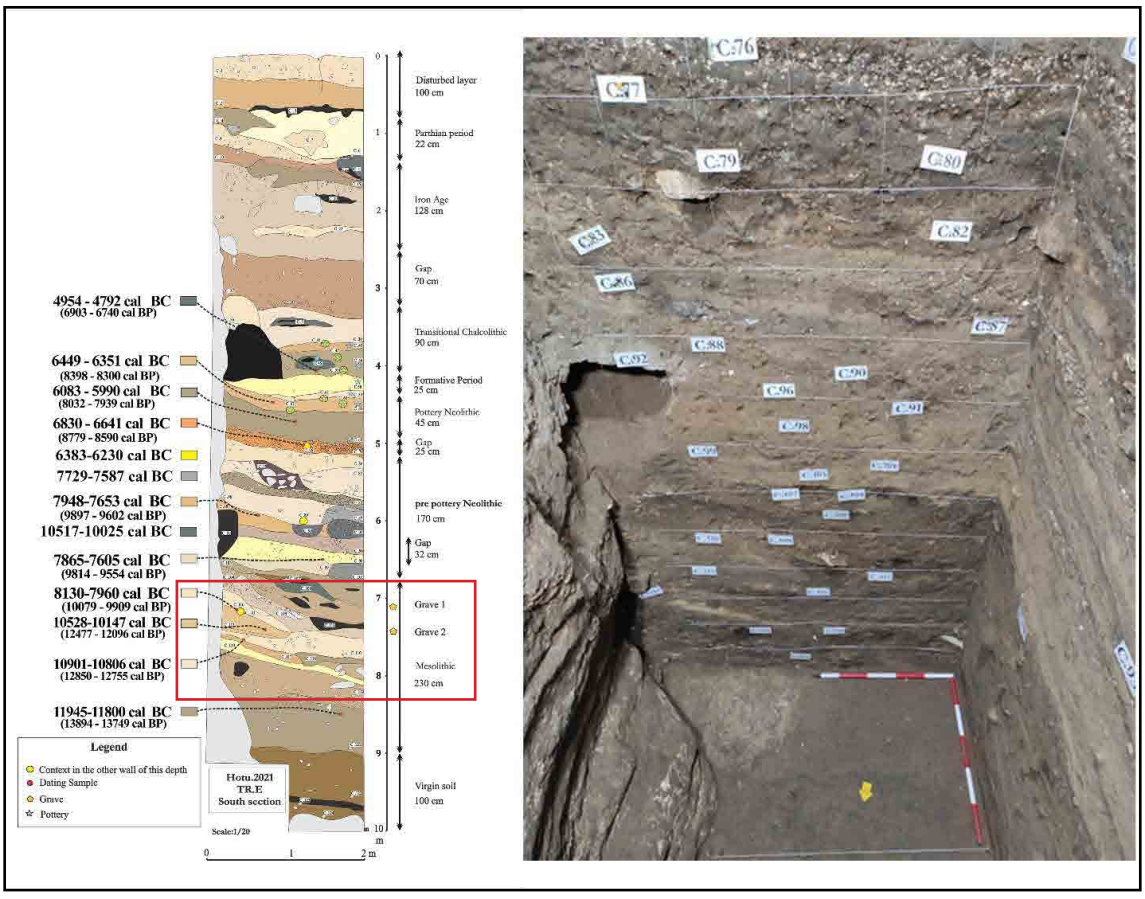


Fig. 17: The Mesolithic period in the stratigraphy section of Hotu cave.

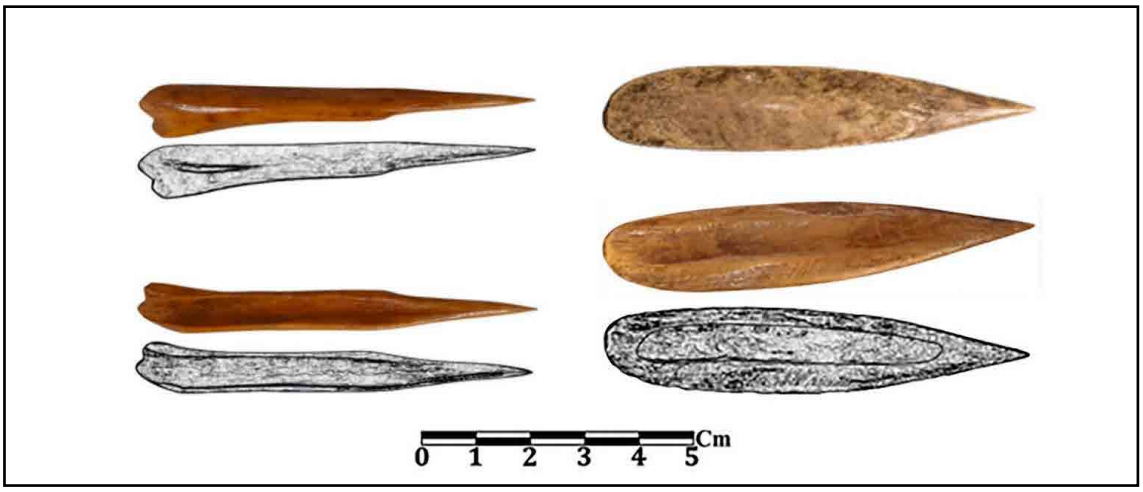


Fig. 18: Mesolithic worked bone tools from Hotu Cave (drawn by Hedayat Kalvari).

Fig. 19: Fireplaces in the Mesolithic period.

Two human burials were discovered in the Mesolithic context (contexts 111 and 114). Burial 1 (see: Fig. 20) contained the remains of an infant buried at a depth of 700 centimeters, making it one of the most unique burials in the southeastern Caspian Sea region. Radiocarbon dating of a bone fragment from this burial indicates a date range of 8,130-7,960 cal BCE. Notable artifacts found in this burial include several black and white beads, animal teeth (from a jackal and possibly a hedgehog), and a bone plaque that was fashioned into a necklace and wrapped around the child's neck. This type of decorated necklace, comprising beads and animal teeth, appears to have been a cultural practice among regional hunter-gatherers. Similar practices have also been observed in Kamarband Cave, Ali Tepe Cave, and Komishani (Fig. 21). The child was buried near a fireplace, and it seems the necklace belonged to an adult, likely one of the parents.

Burial 2 (Fig. 22), located at a depth of 750 centimeters in context 114, contained the remains of a child estimated to be between 4 and 5.5 years old. The child was buried in a fetal position, covered with red ochre clay, with the upper body laid supine, the right hand resting on the stomach, and the lower body bent to the left. No burial objects were found nearby the remains, but only various-sized stone pieces and numerous stone artifacts scattered around. Absolute dating of the skeleton is 10,901-10,806 cal BCE.

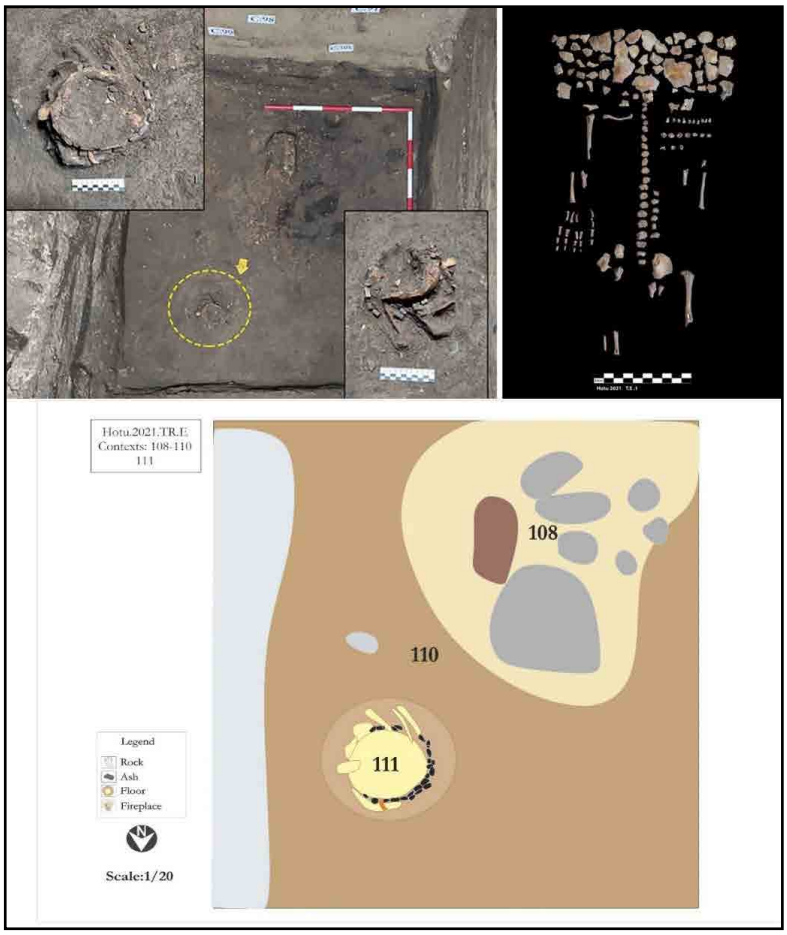


Fig. 20: Burial No 1 is a 3–4-month-old baby with bone remains and a necklace.

Fig. 21: Necklace made of stone beads and animal teeth recovered from human burial No 1 dating into the Mesolithic

Fig. 22: Burial No 2 is a 4-5-year-old child with bone remains.

One noteworthy shell ornament measuring 3.5×4.03 centimeters was found in the lowest Mesolithic contexts 110 and 118 (Fig. 23). Its method of mounting suggests that it could have functioned as an ornamental pendant, similar to those discovered at the Komishani site (Fazeli Nashli, 2023). This finding indicates a regional cultural tradition that persisted from the Mesolithic into later periods.

Based on the teeth of jackals and hedgehogs, as well as the ornaments and burial types from Hotu, Komishani, and Kamarband caves, we can infer that the Mesolithic period in the southeastern region of the Caspian Sea was quite advanced in bead-making and domestic tools. This advancement is similar to evidence from the Levant, the Zagros, and the Alborz mountains, particularly regarding the relationships between humans and animals (Asouti *et al.,* 2020; Maher *et al.,* 2011; Garrard *et al.,* 2018).

Fig. 23: Decorative shell in the Mesolithic period, context 118, of Hotu Cave.

9. The Early (non-ceramic) Neolithic Horizon

One of the main objectives of the re-excavation of Hotu Cave was to investigate the transition from the Mesolithic to the Neolithic period and to evaluate the changes caused by internal or external stimuli. The Early Neolithic period, observed in the Central Zagros and the Levant after the Younger Dryas climatic event, is estimated to have occurred from around 9,800 to 7,000 BCE (Fazeli Nashli and Thomalsky, 2024; Darabi, 2022). Initially, settlements during this period were mostly seasonal and temporary, as seen at sites like Sheikhi Abad, Chogha Golan, and Eastern Chia Sabz (Darabi, 2022; Zeidi and Conard, 2023; Matthews and Fazeli Nashli, 2022). Over time, these communities reduced their mobility, and by the end of the 9th millennium BCE, permanent settlements began to emerge (Richter and Darabi, 2023; Richter *et al.,* 2021; Zeder, 2024; Groene *et al.,* 2023b). Characteristics of this period include the management of domesticated crops such as wheat, barley, chickpeas, and lentils, as well as efforts toward the domestication of animals like goats. Other findings from this period include the widespread use of blades and microblades, the presence of clay objects such as tokens, the construction of animal and human figurines, the production of stone vessels, and the emergence of milling equipment, including mortars, pestles, and hand mills (Conard and Zeidi, 2013; Weide *et al.,* 2017).

The cultural zone of the Caspian Neolithic once encompassed a vast area that included the northern and southern Caucasus, the eastern Black Sea, the Caspian Sea, the Kuban River basin, the Atrak River basin, Dagestan, Georgia, Azerbaijan, and Armenia. Today, each region is assessed based on the unique characteristics of its Neolithic lifestyle.

In Hotu Cave, the Early Neolithic period spans contexts 103 to 68, with a depth ranging from 670 to 450 centimeters and an approximate thickness of 220 centimeters. Unfortunately, due to limited excavations around the southeastern Caspian Sea, we currently lack comparative information for this period. Additionally, the cultural deposits of the Neolithic period in the Komishan Cave have unfortunately been lost.

The excavation of Hotu Cave reveals a significant hiatus of nearly 1,800 years, from a burial dating back to 10,806-10,901 cal BCE (Burial 2) to another burial dated between 8,130 and 7,960 BCE (Burial 1). Initially, it was assumed that Burial 1, which contained the remains of an infant, belonged to the Neolithic, coinciding with the domestication of goats in Ganj-Dareh, while Burial 2 was thought to be of Mesolithic in date. However, due to the difference of approx. 50 centimeters in depth between these two contexts and the distinct characteristics of the layer textures, it now appears to us that both burials were dug from overlying layers and are actually both related to the Mesolithic period.

The stratigraphy of the Early Neolithic period within the layer sequence features a light brownish texture. Additionally, there is a gap layer (context 98) with an approximate thickness of 32 centimeters present during this period. Three radiocarbon dating samples taken from charcoal in contexts 99 (7865-7605 BCE), context 88 (7948-7653 BCE), and context 77 (6830-6641 BCE) indicate that the cave was occupied during this time (Fig. 24).

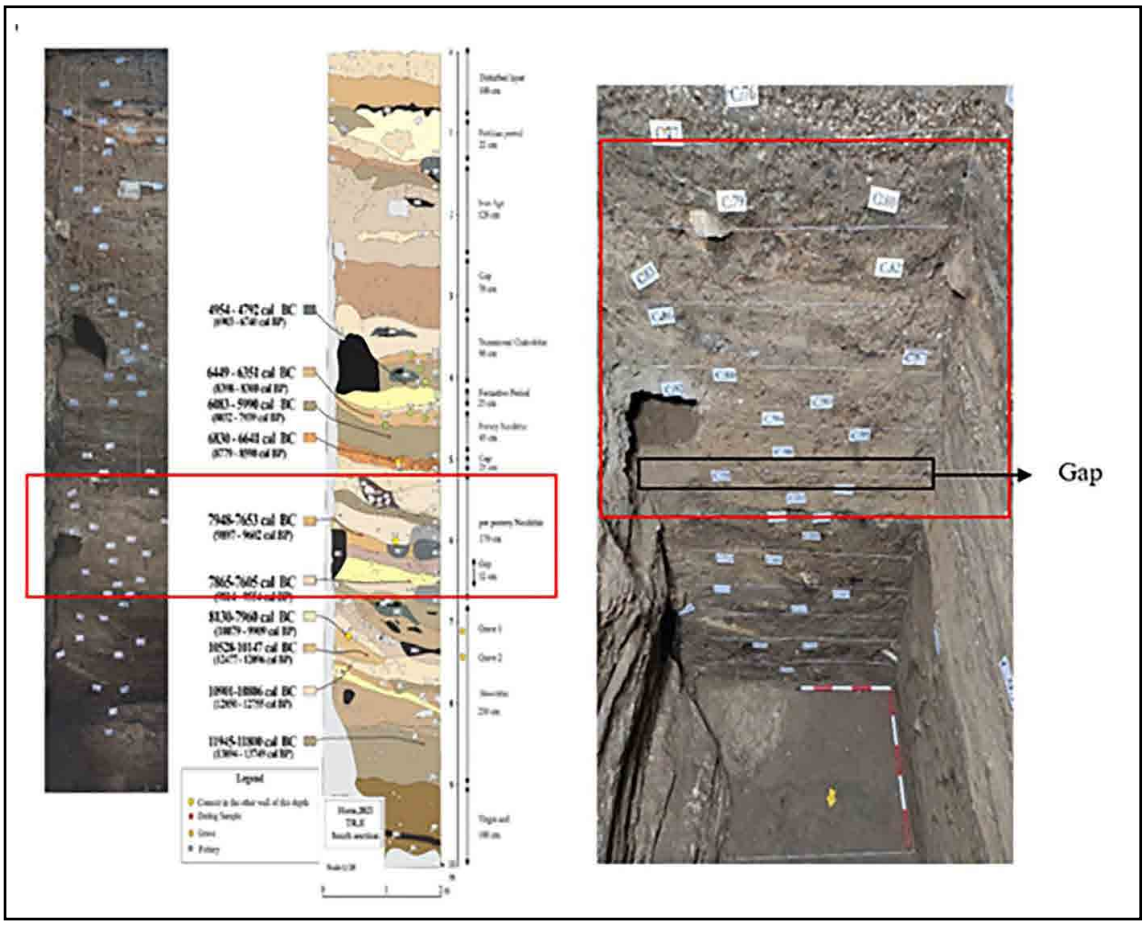


Fig. 24: The Early Neolithic period in the stratigraphy section in Hotu cave.

During the Neolithic period, a total of 24 fireplaces were discovered. Many of these were deliberately structured and constructed, indicating a significant increase in fireplace construction compared to earlier periods (see: Fig. 25). The fireplaces were typically built in pits with average dimensions of 40×50 centimeters and a depth of approximately 15 to 20 centimeters. Various limestone slabs or riverbed stones were used in their construction, and these fireplaces saw extensive use. Some of them were filled with stone chips on top of the ash that accumulated over time.

Loess soil was used for some of the fire installation spaces, resulting in areas with a mix of materials. Environmental deposits tinged these installations in shades from red-brown to orange due to the heat, while the constant high temperatures transformed the soil into baked and solid clays. Additionally, the excavation team uncovered some fired clay, which may indicate the early stages of local pottery production in the region, either accidentally or otherwise (Figs. 26 & 27).

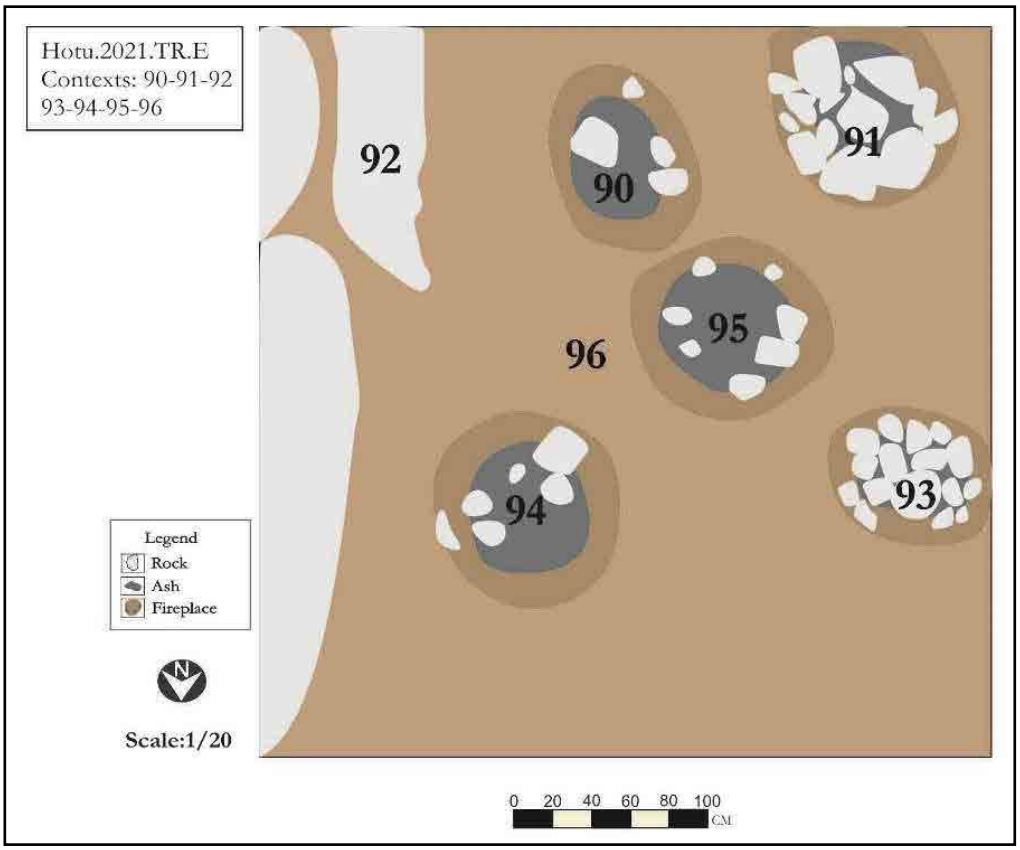


Fig. 25: Several fireplaces in the Early Neolithic period of Hotu Cave.

Fig. 26: Fireplace installations, of heated mud.

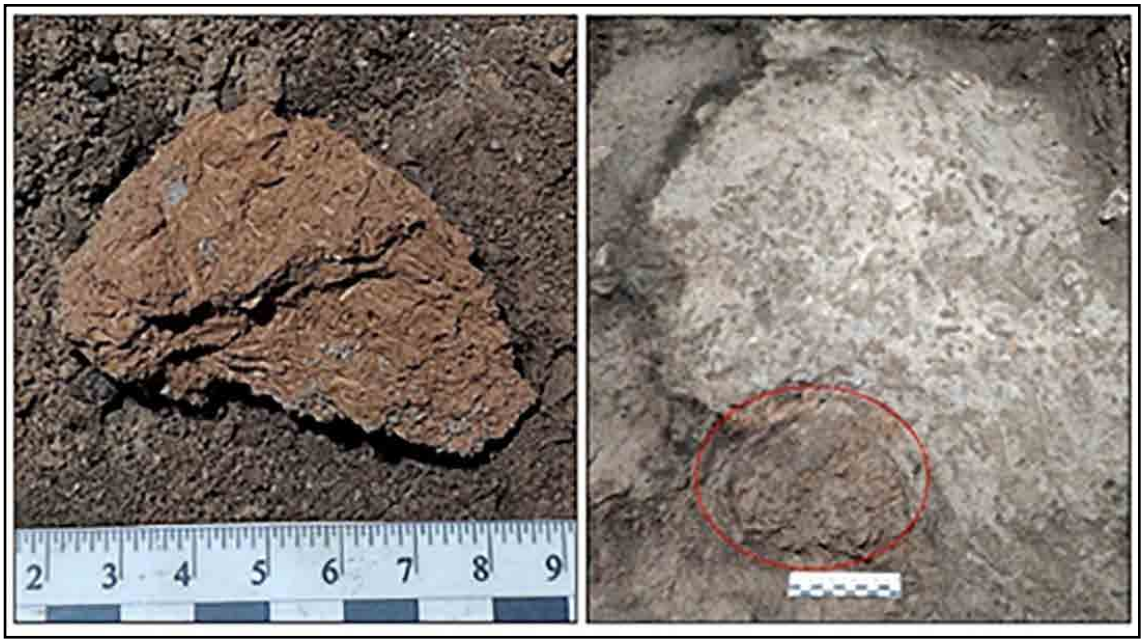


Fig. 27: An example of heated mud for the construction of fireplaces, with visible addition of plant (straw?).

Stone artifacts were commonly discovered from this period. Technologically, from Mesolithic to Neolithic, the chipped stone manifest two major changes which are introduction of the pressure technique for the removal of blades in an advanced stage of technology and the emergence of sickle tools, esp. trapezoids inserted obliquely in hafts. However, the Mesolithic and the PPN assemblage of Hotu also share some characteristics. Besides the continuation of the total dependence on local Behshahr chert, the two assemblages show a similar technological composition, higher percentage of flake tools versus blade tools, and the use of similar tools such as notched-denticulated, various scrapers and backed tools (see: Jayez *et al.,* 2024).

One ground stone artifact from context 88 (without illustration here) measures 14.29×4.06 centimeters, a chisel or polisher made from basalt stone measures 8.3×3.21 centimeters from context 89, a rim fragment of a larger stone vessel measuring 29.65×15.08 centimeters was found in context 95, along with a fragment of a mortar made from granite that measures 15×12.78 centimeters from context 103 (Fig. 28). Other discoveries from this period include baked clay that appears to have been created while using the fireplaces.

The results of zooarchaeological studies in this cave during the specified time period reveal a notable shift in the diet of its inhabitants. In contrast to the Mesolithic period, where only 4% of the animal remains consisted of bone fragments from goats and sheep, the Neolithic period shows a significant increase, with these two species accounting for 98% of total animal remains (excluding microfauna). This indicates the growing importance of goats and sheep compared to the previous period. However, earlier evidence from Coon's investigations suggests that hunting and the selective slaughter of these animals were practiced as well, continuing into the Neolithic. The presence of animal domestication over a prolonged period indicates that when humans initially settled in the region during the Mesolithic, they were already familiar with hunting wild goats and sheep (Groene *et al.,* 2023b). After a significant gap between the layers pre pottery neolithic and pottery neolithic, these populations recognized the importance of these species in their diet and eventually transitioned to a system of selective and purposeful slaughter. Despite

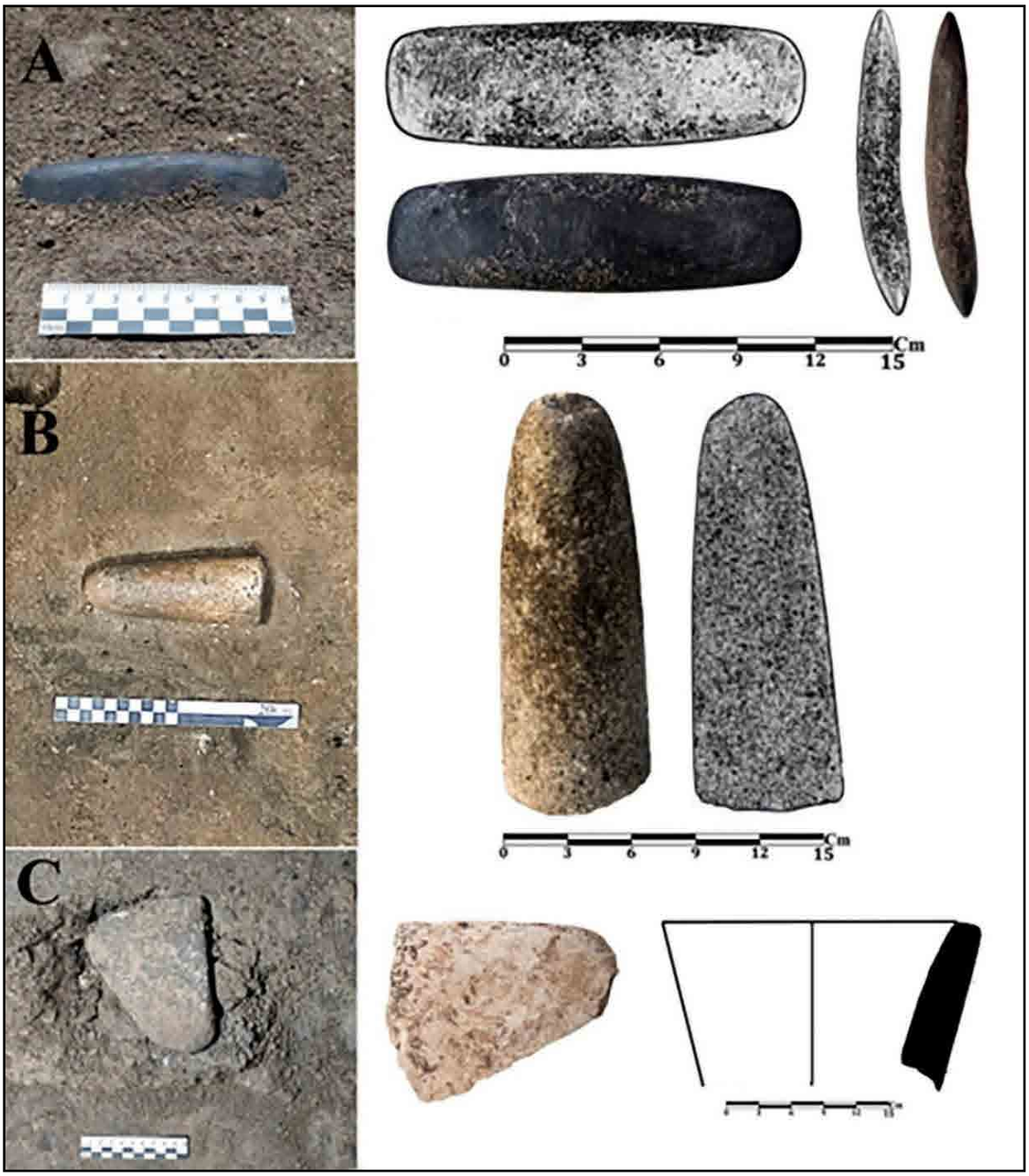


Fig. 28: Stone artifacts obtained from the Early Neolithic context: A) chisel/polisher; b) mortar fragment; c) rim of a stone vessel (drawings by Hedayat Kalvari)

limited excavation space and the scarcity of animal remains, further archaeological work is needed to accurately identify morphological changes in the domesticated species. Nonetheless, evidence of animal domestication persists within local structures, suggesting the possibility that domestication may have originated from another region nearby.

Since this study is focused on the transition between the Mesolithic and Neolithic, we will compare only the findings from Trench D, which are contemporary with this timeframe. While Coon was occupied with the excavation of the human burials, his colleague, Louis Dupree completed the excavation of Trench D within two days. There is only one stratigraphic layer plan for this trench, which Coon used to give initial descriptions of soil types and natural findings.

The plan drawn in 1951 indicates that some cultural layers from Coon's excavations overlap with layers of our new trench E opened in 2021. Particularly comparable are the numerous scattered stones on the cave floor and in the upper part of Trench D that we also observed in Trench E. The contexts identified include Context 76 with a layer of gravel 2, Context 77 with a layer of sand 2, Context 83 with a layer of gravel 3, and Context 92 with stone rubble inside gravel 4, all of which are part of the same horizon (Fig. 29).

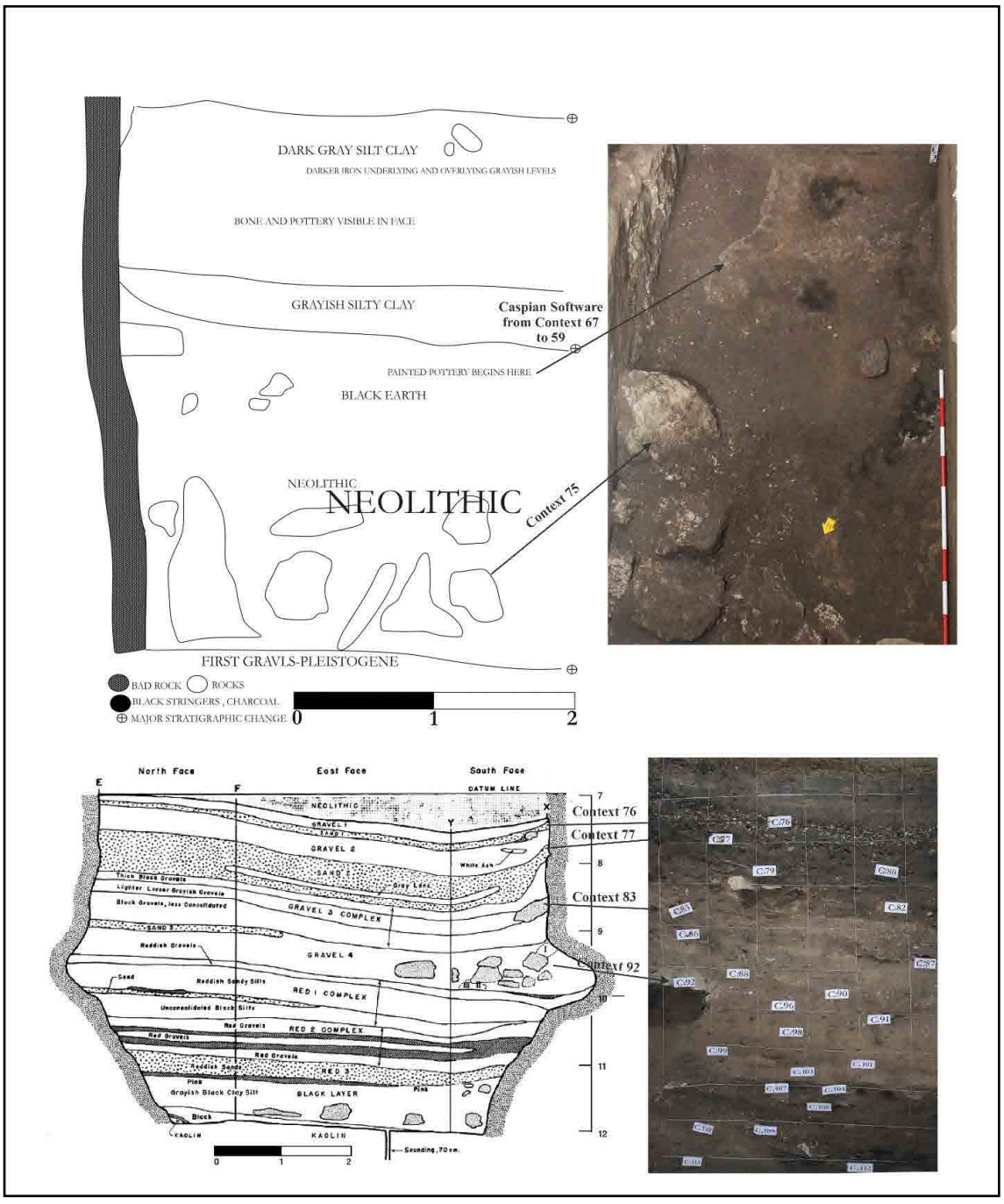


Fig. 29: Stratigraphy of Trench D (Top: left) in comparison of the profile of Trench E (right).

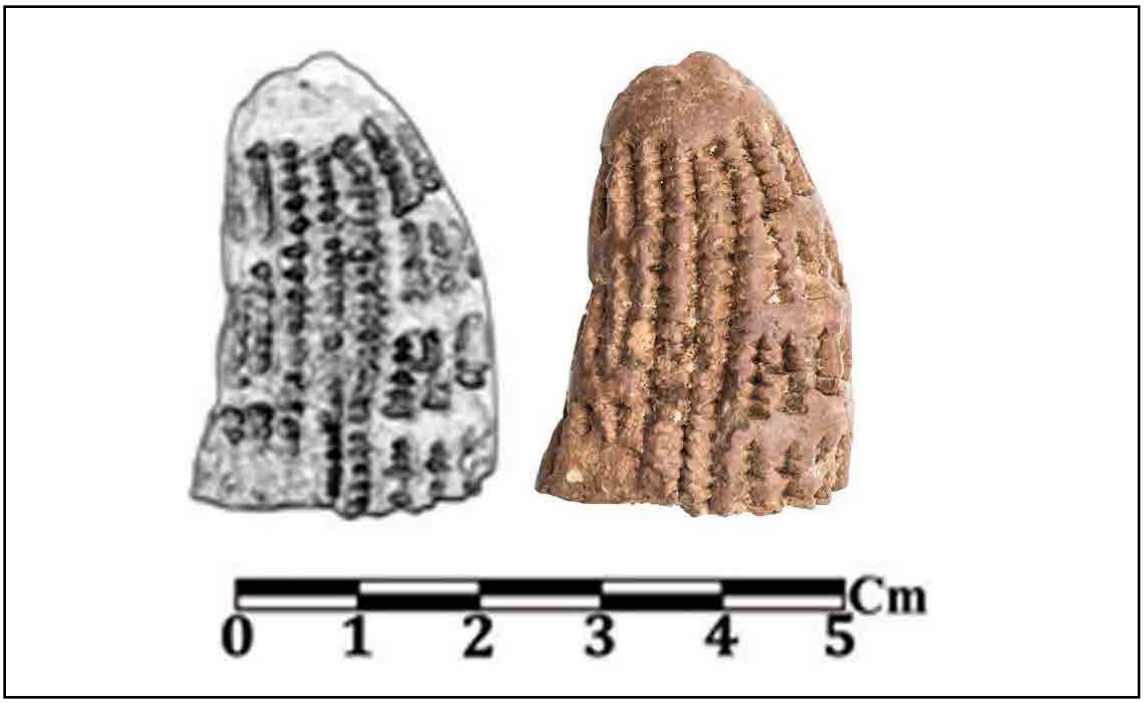


Fig. 30: Clay object obtained from the Early Neolithic period, Context 110, Hotu Cave (designed by Hedayat Kalvari)

An unidentified clay object, a unique finding from the Neolithic period, has been discovered in Hotu Cave. This heated clay object, adorned with linear and incised or impressed designs created using a very specific plant stipe (?) or a shell rim. The object measures 4.5×2 centimeters and was retrieved from context 110 (Fig. 30). Its age dates to approximately the 9th millennium BCE, which is noteworthy. Despite its surprising age, the object is elaborately decorated and likely did not serve any practical purpose, indicating that it may have been used for a possibly ritual function. A similar piece was discovered in layer I of Hotu Cave and in the disturbed sections of Komishan Cave, highlighting the importance of this object (Vahdati Nasab *et al.,* 2011: 115). The existence of two comparable and potentially purposeful objects in different contexts underscores their significance. It is noteworthy that there is no published information about the Neolithic layer in Komishan Cave, which dates back to approximately the 9th millennium BCE. If similar findings were made during the same period, it may suggest the presence of an earliest Neolithic layer in Komishan cave that overlies the Mesolithic period.

10. Occupational gaps

At the end of this period, and just before the beginning of the Pottery Neolithic, it seems that natural events, possibly a series of earthquakes, led to significant changes in the area. The presence of numerous ammonite fossils in the limestone debris supports the hypothesis that parts of the limestone ceiling and cave structure collapsed due to seismic activity. Consequently, the entire surface area of the trench was covered with large stone slabs. Additionally, Carleton Coon noted a substantial number of these stone slabs beneath the Pottery Neolithic layers, suggesting that a layer of the cave ceiling may have collapsed over much of the cave's interior (Fig. 31). It appears that after the cave roof collapsed, rainwater accumulated between the slabs.

Based on the C14 dating, we have observed a significant gap of approximately 400 years between the Early non-ceramic Neolithic and the Pottery-containing Neolithic periods. Determining whether such a cultural gap has regional characteristics is a significant question. Japanese excavations at Sang-e Chakhmaq indicate a cultural gap of approximately 400 years between the west and east mounds. The West Mound of Tappeh Sang-e Chakhmaq was occupied from 7,000 cal BCE until 6,700 cal BCE. In contrast, the East Mound was first inhabited around 6,200 – 6,100 cal BCE and continued to be occupied until approximately 5,300 cal BCE (Pichon *et al.,* 2023; Roustaei *et al.,* 2015; Nakamura, 2014). As previously mentioned, the latest non-ceramic Neolithic layers of Hotu can be assigned between 6,830 and 6,641 cal BCE, while the East Mound of Sang-e Chakhmaq was abandoned around 6,700 cal BCE, coinciding with the end of its occupation.

Fig. 31: View of Context 75, stone slabs, and collapse between the Early Neolithic and Late (ceramic / pottery) Neolithic in Hotu Cave.

11. The Late (ceramic) Neolithic horizon

The Early Neolithic period of the Iranian Highland, and here in particularly the Zagros fringes, is characterized by the appearance of bladelets and their bullet-shaped cores, which are actually the exhausted remnants of the characteristic pyramidal single-platform bladelet cores. This characteristic technology is firstly recognized in caves in Fars Province around 9,500 cal BCE, and seems to be common until ca. 6,500 BCE (Thomalsky, 2016). Similar technologies are known from Central and East Asia, apparently earlier in time, and might have spread from there to Eastern Iran as well (Jayez *et al.,* 2024). In the succeeding Late Neolithic Period, larger blade technology was established altogether

with clay vessel production and gradually replaced the bladelet industry, most possibly in favor of the usage for sickle implements. This can be demonstrated also for the Djeitun lithic industry around 6,000 BCE.

In terms of subsistence and economy, evidence from the site of Tappeh Sang-e Chakhmaq indicates that wheat, barley, peas, and lentils were cultivated during this time (De Pichon *et al.,* 2023). Additionally, permanent villages were established throughout northeastern Iran, supported by a farming economy and the use of simple irrigation systems (Pollock *et al.,* 2019; Fazeli Nashli *et al.,* 2024). Also, the inhabitants of Hotu expanded their diet to include pig meat, alongside other resources such as cattle, large deer, and foxes, during the Pottery Neolithic period. Goats were present in both Early Neolithic and Late Neolithic levels, with a ratio of nearly 2:1 compared to sheep. Pigs, likely domesticated, appeared in our animal assemblages from the Pottery Neolithic for the first time. Due to fragmentation, the assemblage contains a significant number of prenatal remains, though not all of these could be identified (de Groene *et al.,* 2023a).

Coon refers to the discovery of a baked clay sculpture and several pieces of baked clay in the Early Neolithic layers of Hotu Cave (Dupree, 1952: 253, 257; Gregg and Thornton, 2012). He notes that, unlike a baked conical clay piece found in layer 10, the conical clay pieces in layers 11 and 12 are unbaked. Over time, the inhabitants of the Mesolithic gradually developed pottery, which was then utilized during the pottery Neolithic period (Coon, 1951: 78). He furthermore briefly mentions these ceramics in a one-page report on Hotu and Kamarband Caves. Matson discusses four pieces of pottery and associates three of them with the early pottery horizon (Matson, 1951).

Robert Dyson was the first archaeologist who wanted to study the pottery collection from the Hotu and Kamarband Caves in detail, which are now stored at the University of Pennsylvania Museum. However, due to concurrent projects he supervised in Hasanlu, his evaluation was published a decade later (Dyson,1991). Dyson identified three pottery horizons in northeast Iran based on the collections from these caves as well as other Neolithic sites in the region. The oldest of these horizons, known as the "Caspian Soft Wares," dates back to 6610 cal BCE (Thornton, 2013: 243). He described the features of these pottery pieces as lightly fired, handmade, chaff-tempered, thick, and crumbly, with the most common form being a deep bowl resembling a beaker, characterized by slightly concave sides and rounded rims. Pottery of the so-called Djeitun style is found on top of this horizon and has a more recent dating of 6100 BCE (Harris, 2010: 120). Djeitun pottery is characterized by poorly-fired, chaff-tempered ceramics with thin pink to buff slips, decorated with painted linear designs. Dyson identified the final pottery layer before its dating by the presence of Cheshmeh Ali ceramics from the Sialk II period, which dates around 5300-4400 BCE. He also noted a similar pottery sequence at the site of Djeitun itself. Following this, Michael Gregg and Christopher Thornton studied the pottery of both sites to trace the Neolithic pottery tradition from north-central Iran to southern Turkmenistan. They stated that no single piece of Djeitun pottery were present in the collections from Hotu and Kamarband Caves.

12. The (Southeast) Caspian Soft Ware

The emergence of pottery in northern Iran remains a topic of debate. Tsuneki proposed that the Hotu ceramics were created by the settlers of Hotu (Tsuneki, 2017). Conversely, Gregg and Thornton calibrated dates from Kamarband Cave, identifying the oldest pottery

from the Early Neolithic period dating back to 7,140 cal BCE (Gregg and Thornton, 2012). This suggests that the Caspian Ceramic Wares in Eastern Mazandaran region appear earlier than in neighboring areas of Central Asia and the Iranian Plateau, although slightly later than in the Central Zagros region.

Gregg and Thornton describe Caspian pottery ware as having a thick cross-section and reddish-brown color, often featuring a thin red stripe on the inner edge (Fig. 32). This pottery includes unique forms such as deep bowls or cups with protruding edges, which are not found anywhere else in northern Iran. Despite this, there are several pieces of Caspian pottery with a thick reddish-brown slip and a low-baked appearance in the Caspian Soft Wares collection within the ancient Neolithic layer of Hotu Cave. These resemble early container styles found in locations like Tappeh Sang-e Chakhmaq. Additionally, this collection includes a cup with a handle, extending beyond the typical deep bowls and cups (Gregg and Thornton, 2012).

Fig. 32: Pottery Neolithic ceramic sherds recovered from Hotu Cave by Carlton Coon (today stored in the Pennsylvania Museum Archives)

In relation to the re-excavation in 2021, it is important to note that illicit excavations have disturbed portions of the cultural context of the Pottery Neolithic, making it difficult to achieve a clear interpretation. Looters horizontally dug into the cave, and past environmental activities have caused water to wash away soils and cultural artifacts from the upper layers (Neolithic layers) down into the lower layers of the Pottery Neolithic contexts.

In Hotu Cave, pottery from the Neolithic period was found above debris between contexts 74 and 60, with an estimated thickness of 70 cm. Additionally, two samples were analyzed: charcoal from context 63 (dated to 6499-6351 cal BCE) and one bone

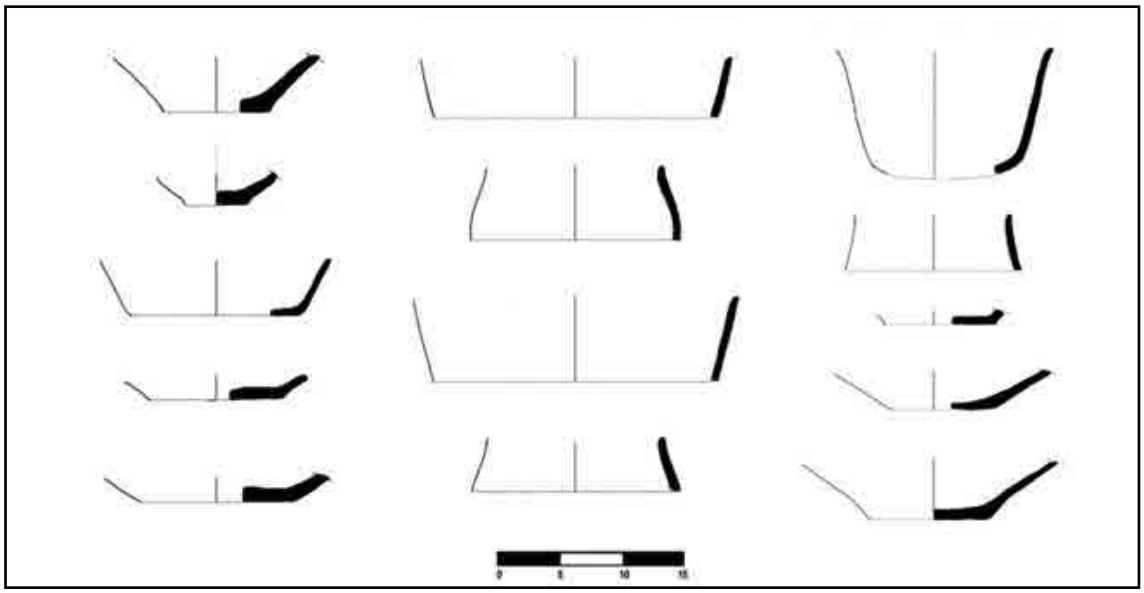


Fig. 33: Bowls, shallow dishes, deep bowls, and shallow flat-bottomed bowls found by Carlton Coon in Hotu Cave (Gregg and Thornton, 2012)

from context 64 (dated to 6083-5990 cal BCE). These results indicate an occupation of approximately 400 years during the Pottery Neolithic. It is significant to mention that the C14 dating from context 64, which originated from the upper layers, where samples have moved and become diffused in the lower layers of Hotu Cave. A total of 24 pottery pieces were discovered in contexts 67, 65, 64, 63, 61, and 59 (see: Fig.s 34, 35 & 36). Carbon-14 dating indicates that context 63 dates back to 6400 BCE. Among the earliest pottery from Neolithic contexts, we found reddish-brown pieces with a thin glazed coating. Earlier, Coon had attributed these to Kamarband Soft Wares, a local pottery tradition that was extensively used in Hotu, known as the "Caspian Soft Wares." It is important to note that pottery from context 67, which was found at a lower depth, has not been dated. Therefore, we suggest that the beginning of the Pottery Neolithic in Hotu Cave should be placed around 6600 to 6500 BCE. The pottery from this period is relatively well-baked and features a reddish-brown edge adorned with a colorful striped design. Unfortunately, only one sample of this type was found, and given its antiquity, further discussion is necessary. However, the stratigraphy appears clear, and only a few pottery pieces from the Pottery Neolithic period were retrieved from Hotu Cave.

This type of ceramic is contemporary with Tappeh Sang-e Chakhmaq, yet it differs from both the Sang-e Chakhmaq and Djeitun cultures. These ceramics feature a reddish slip adorned with geometric designs arranged in horizontal bands, showcasing a new cultural style. The ceramic pieces have a flat base and a carinated body.

13. The Transitional Chalcolithic period

During the Transitional Chalcolithic period, the societies of the north-central plateau of Iran established connections with those in northeastern Iran through the exchange of cultural materials and stylistic influences (Fazeli Nashli *et al.,* 2024; Thornton, 2013; Dyson and Thornton, 2009).

The pottery from this period evolved into a style known as Cheshmeh Ali/Sialk II, which was discovered in the cave at a depth of -415 cm, specifically in context 58.

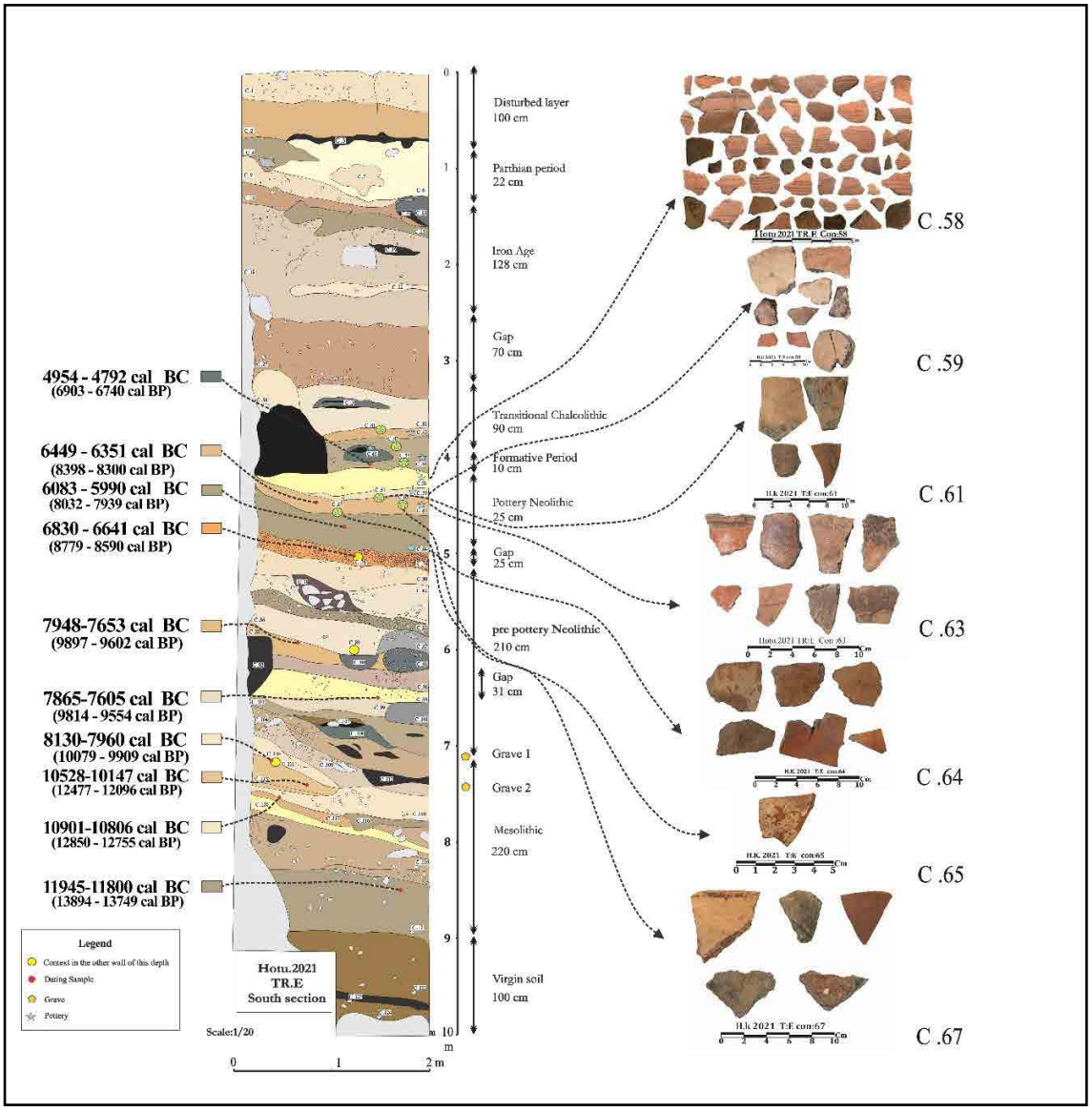


Fig. 34: pottery Neolithic and Formative period find from Hotu Cave in the re-excavation (drawn by Mina Madihi).

However, a carbon dating sample from this pottery indicates a date range of 4,954-4,791 cal BCE at a depth of -370 cm, in context 45. Given that the Cheshmeh Ali pottery type appeared at a depth of -415 cm, which was not dated, it is reasonable to infer that the introduction of red ceramic in the Hotu cave likely occurred much earlier. The origin and spread of the Cheshmeh Ali ceramic ware in northeastern Iran still pose challenges for researchers. This pottery may resemble that of Sang-e Chakhmaq; however, it is actually a few hundred years older than the earliest pieces found in Tappeh Sang-e Chakhmaq (Fig. 37).

The Cheshmeh Ali/Sialk II ceramic type appeared in northeastern Iran around 5500-5300 BCE at sites such as Tepe Pahlavan and Ghaf Khaneh (Akbari Zarrin Qabaei *et al.,* 2024; Roustaei, 2018). Notably, during the same period, the Transitional Chalcolithic began in the north-central plateau around 5250 BCE. Morteza Hessari proposed a time range for this development of 5,321–5,051 BCE based on findings from Tappeh

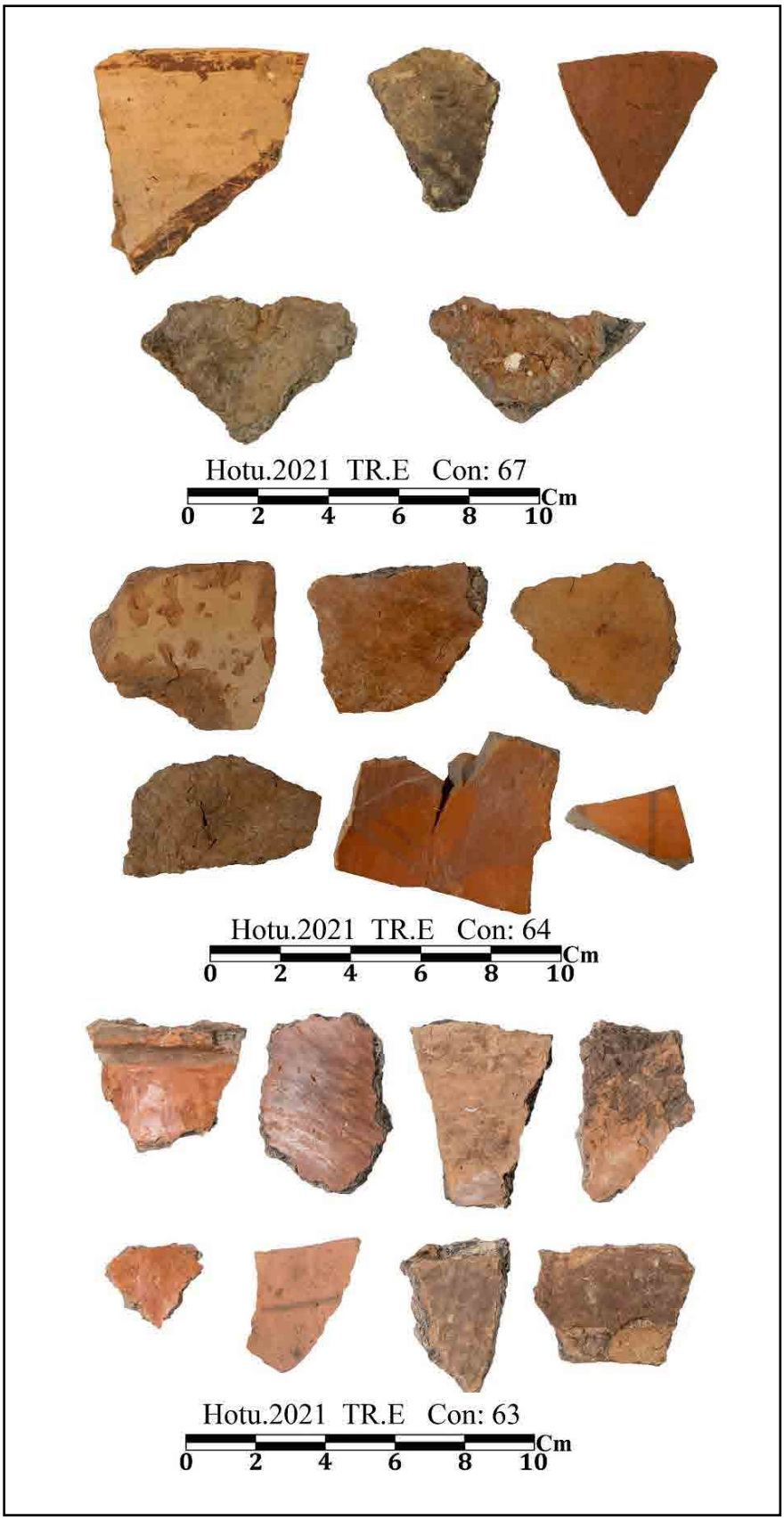


Fig. 35: Pottery Neolithic period obtained from Hotu Cave, Neolithic (Kamarband Software).

Moeinabad (Hessari *et al.,* 2024). The ceramics from the north-central plateau are much finer than those of the Caspian Sea Transitional Chalcolithic type, suggesting that they were likely introduced independently.Dyson has suggested that the Cheshmeh Ali ware appeared in northeastern Iran around 5300-4400 BCE. We believe that the maximum time gap between the emergence of Cheshmeh Ali pottery in northeastern Iran and the northern Central Plateau is approximately less thsn 100 years. Based on the current data, we can propose that the beginning of Cheshmeh Ali ceramics was an independent innovation in northeastern Iran, rather than a result of demographic diffusion from the northern Central Plateau. Numerous C14 dates from Transitional Chalcolithic sites, such as Qaleh Khan, indicate a timeframe of 4,954 – 4,791 cal BCE (Garazhian *et al.,* 2024).

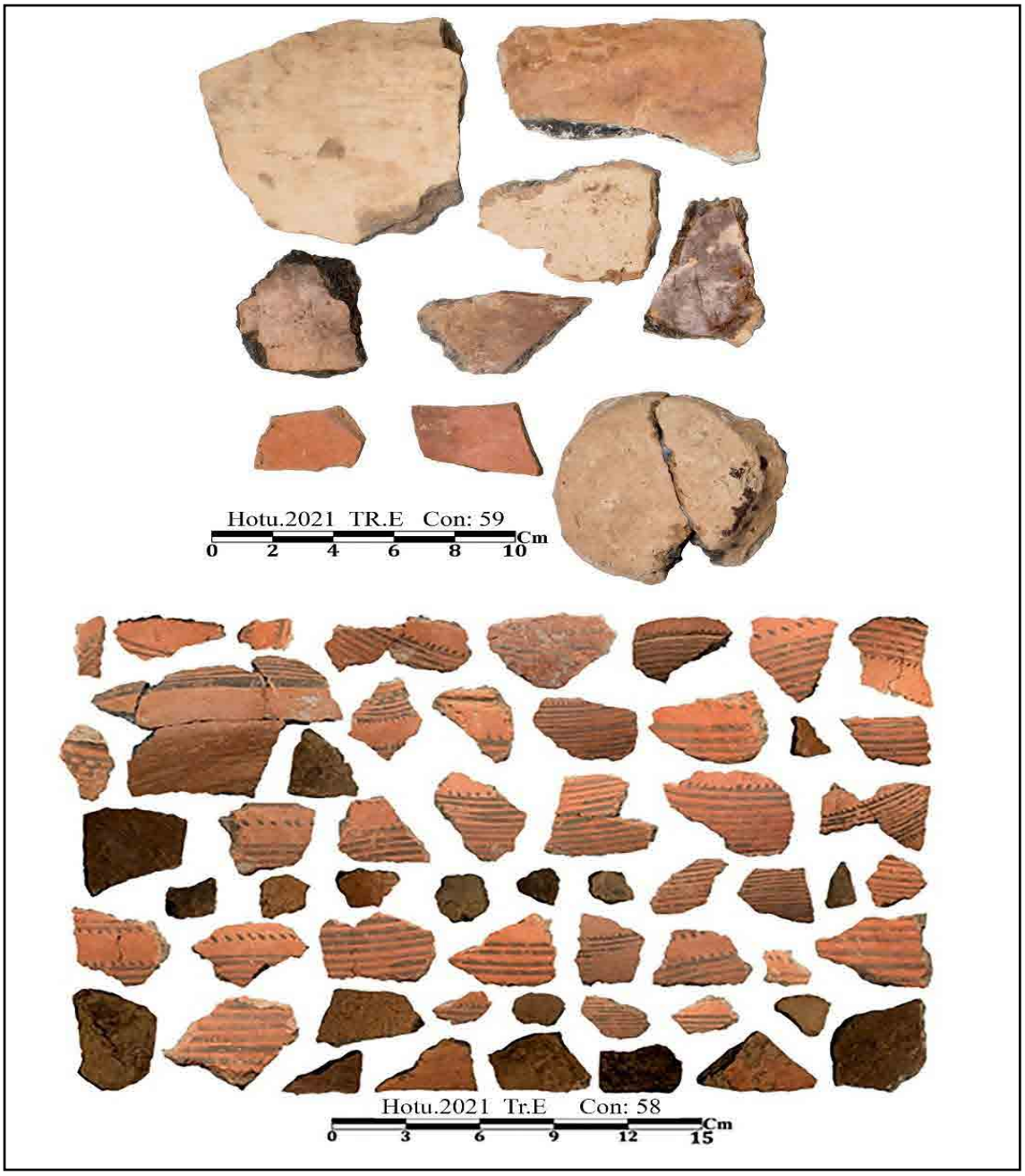


Fig. 36: Selected pottery sherds from Hotu Cave, Formative Period.

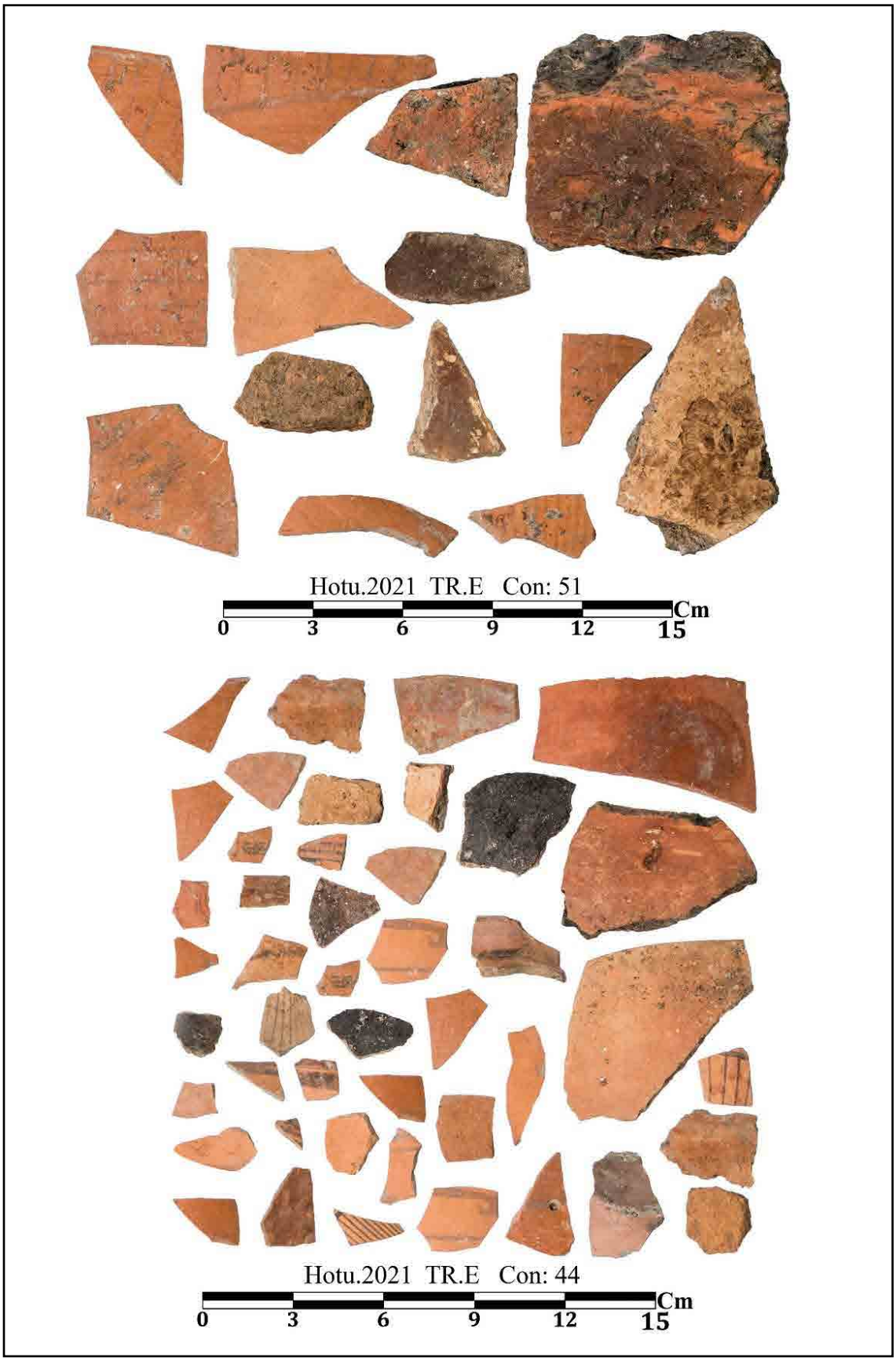


Fig. 37: Typical pottery wares and decorations from Hotu Cave, Transitional Chalcolithic period.

14. Absolute dating results based on the re-excavation of Hotu Cave

Hotu Cave is one of the oldest Mesolithic caves in Iran. It has been dated multiple times (Gregg and Thornton, 2012; Coon 1950, 1951), but several errors necessitated a re-excavation of the cave in 2021. Radiocarbon samples from Coon were analyzed by renowned radiocarbon expert Elizabeth Ralph, who tested 22 samples from 17 layers of Hotu Cave. Coon's materials were sent to two laboratories for verification, yielding dates of 9190 ± 590 years by Ralph and 9480 ± 250 years by Dr. J. Laurence Kulp from Columbia University (Coon, 1957: 207; Ralph, 1955: 150-151).

In 2013, Jennifer McAuley dated the skeleton found in Hotu Cave using AMS dating based on a single tooth. She believed that most samples were contaminated with plastic, urethane, wire, and glue, making them unsuitable for dating. Her results indicated dates of 10985 ± 15, 10720 ± 70, 10610 ± 10, and 11045 ± 15 years ago (McAuley, 2013).

Coon proposed four cultural periods based on data from Trench D. The Neolithic period began around 6120 ± 500 BCE. This was followed by the Vole Mesolithic period, which includes three human burials dating back to 7240 ± 590 BCE. The Vole Mesolithic period itself dates back to 7270 ± 570 BCE. Lastly, the Mesolithic (Seal Hunters) period dates back to 9910 ± 810 BCE. Furthermore, Coon notes that these dates align perfectly with those from Kamarband Cave, suggesting that both caves were inhabited around 10,000 BCE (Coon, 1957: 209).

Nine samples for carbon-14 dating were collected during the 2021 excavation activities in Hotu Cave (Fig. 38) comprising both charcoal and bone samples, to determine the absolute ages of the Mesolithic and Neolithic periods, and in particular the transition between the Early Neolithic and Late Neolithic. To prevent contamination, each sample was carefully placed in aluminum foil using tweezers and assigned with precise coordinates placed onto the sample tissue. These samples were analyzed using radiocarbon measurement techniques with Accelerator Mass Spectrometry (AMS) at the Beta Analytic Testing Laboratory in the United States. The results, presented with a 2-sigma error, were then processed using OxCal software version 3.2 (Figs. 38 & 39).

The dating results from four samples collected from the Mesolithic period at Hotu Cave include one charcoal sample and three bone samples. The earliest date identified is 11,945-11,800 cal BCE from context 121, located at a depth of 845 cm. The second sample, taken from context 115 at a depth of 750 cm (Burial 2), dated to 10,901-10,806 cal BCE. The third sample, found at a depth of 740 cm in context 113, yielded a date of 10,528-10,147 cal BCE. Additionally, the end of this period is dated to between 8,130 and 7,960 cal BCE in context 111 (Burial 1), situated at a depth of 720 cm.

These two burials are approximately 1800 years apart, yet only about 30 cm of sediment separates their layers. Given the close proximity of the two burials, it is likely that pit digging from above may have caused disturbance to the lower layers. Consequently, the dating of this period remains uncertain until further samples from the fire provision and adjacent plant layers in these burials can be analyzed to clarify this ambiguity. Three radiocarbon dates from the Early non-ceramic Neolithic period were obtained. The beginning of this period is represented in context 99, where a sample taken from a depth of 632 cm dates to between 7,865 and 7,605 cal BCE. There is a noted hiatus in context 98, which has an approximate thickness of 32 cm. Another sample from context 88, extracted at a depth of 590 cm, dates to between 7,948 and 7,653 cal BCE. The final test sample comes from context 77, which is recognized as the last settlement layer before the

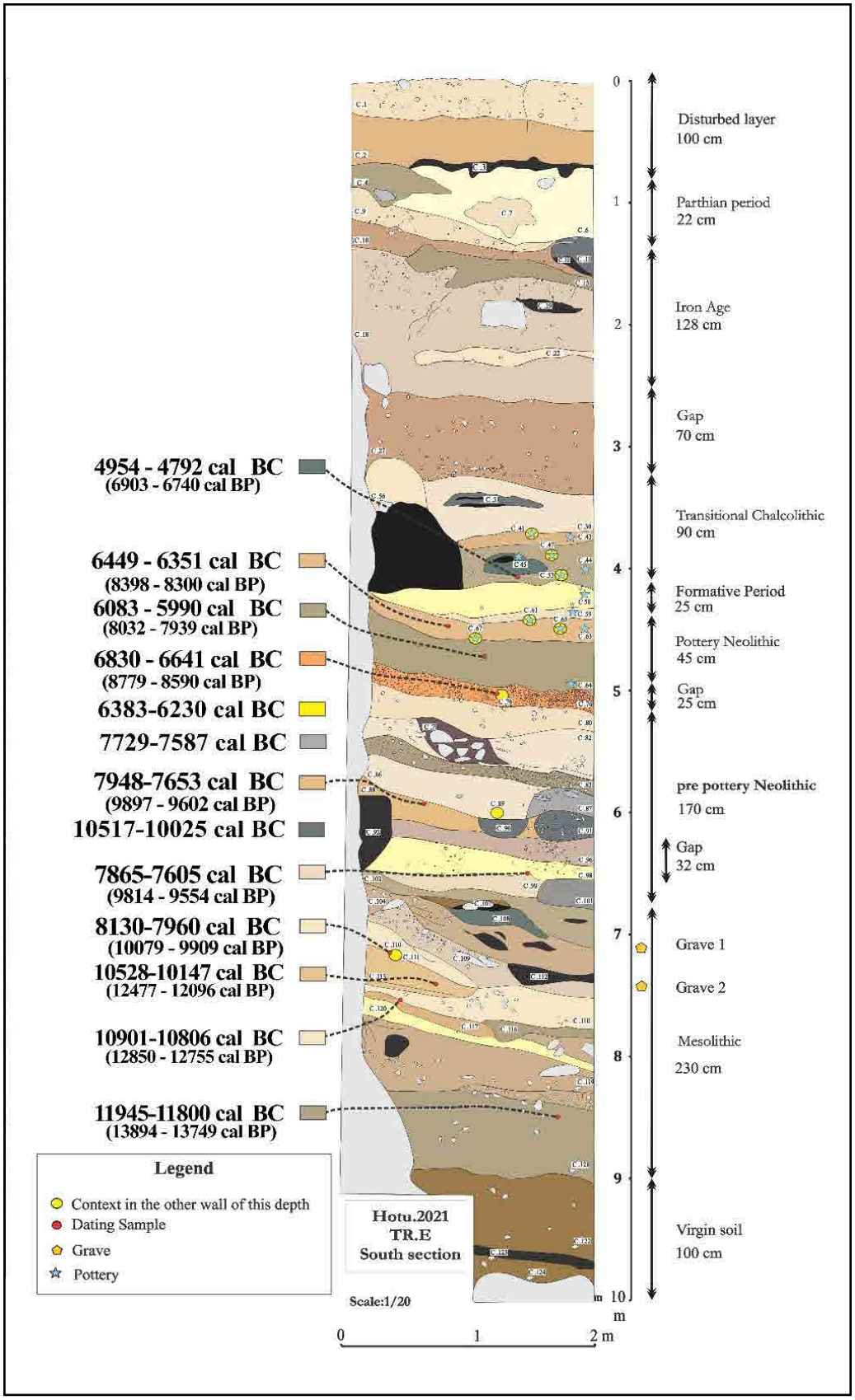


Fig. 38: The stratigraphy section of Trench E and the absolute dating in the Mesolithic and Neolithic period of Hotu Cave, (designed by Mina Madihi)

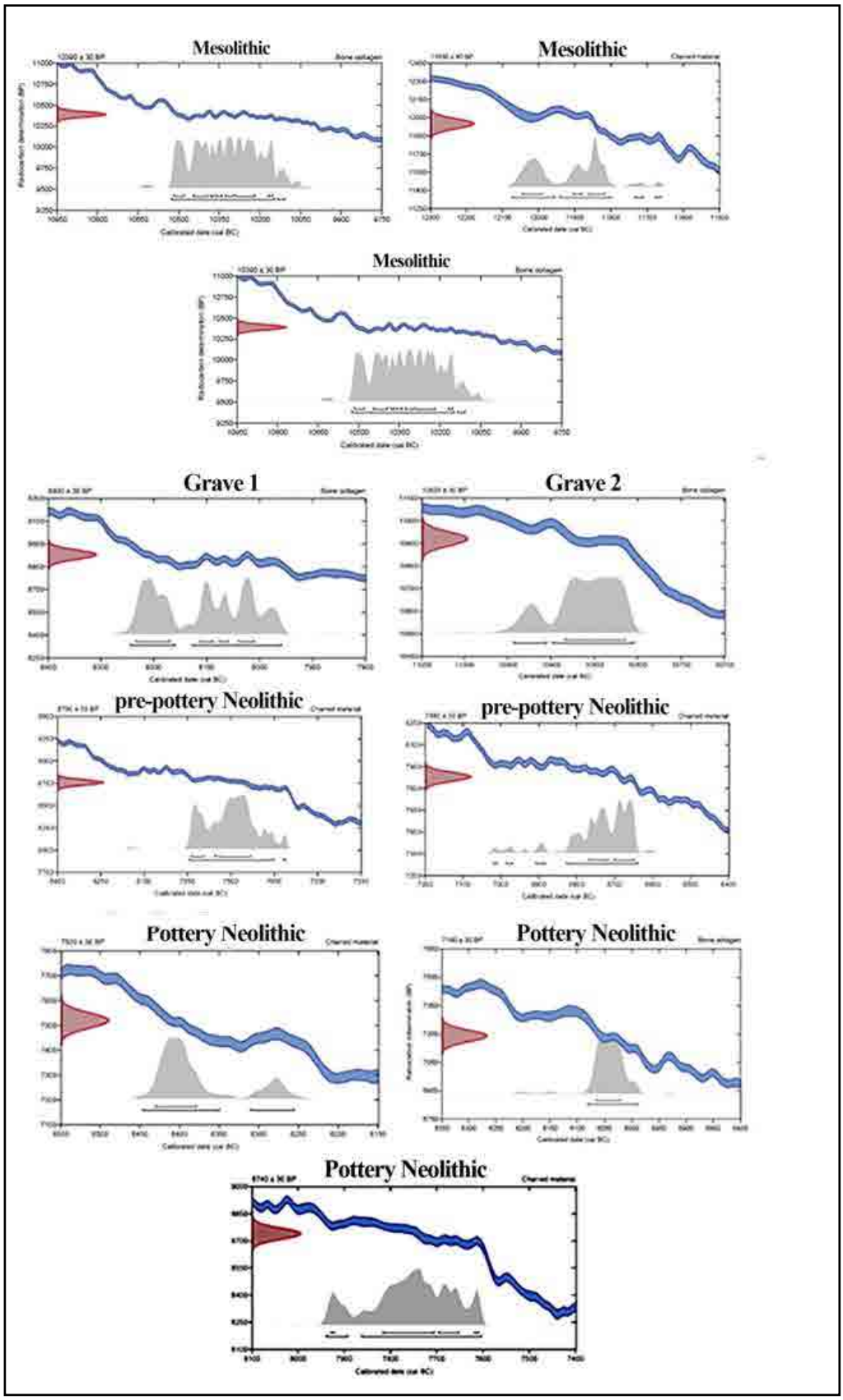
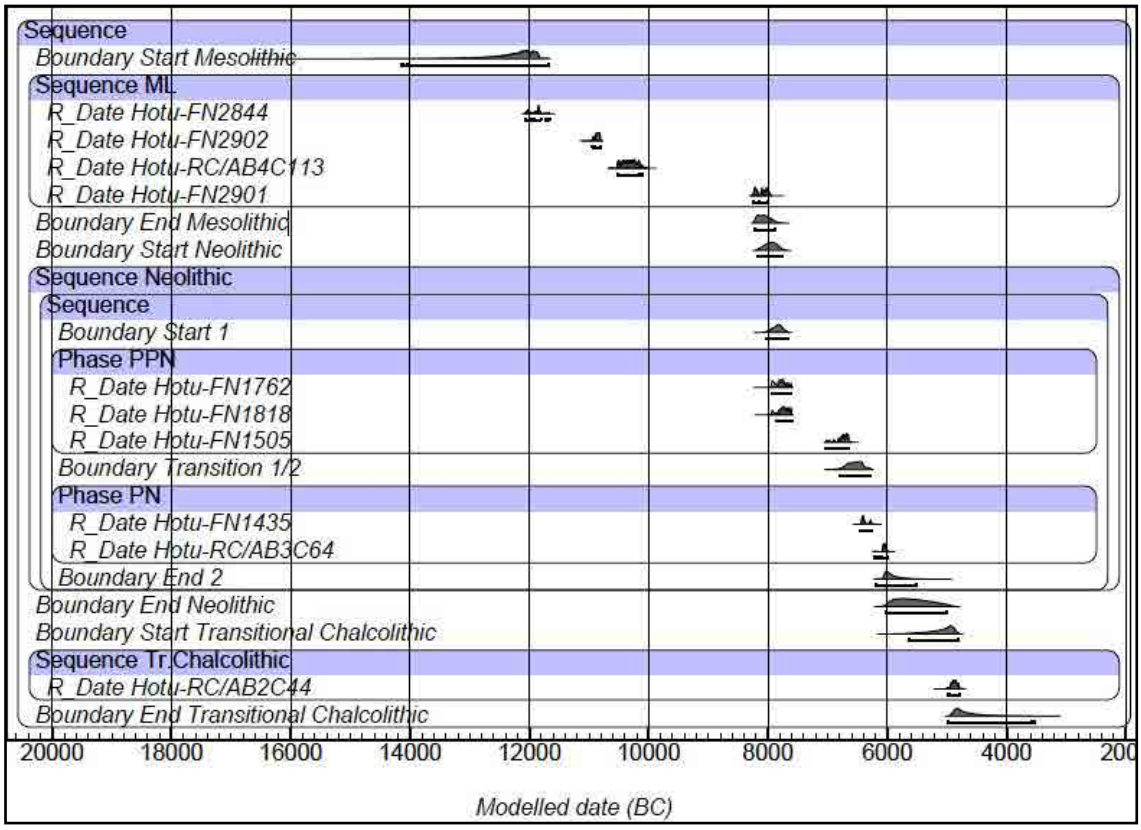


Fig. 39: Calibrated and modeled the absolute chronology diagram of the Mesolithic and Neolithic periods of Hotu Cave

Table 1: Ox Cal model of absolute chronology of Hotu Cave samples



earthquake that affected context 75, marking a significant hiatus in the cave's occupation. This sample, taken from a depth of 504 cm, dates to between 6,830 and 6,641 cal BCE.

The Late (ceramic) Neolithic period begins in context 67; however, due to the lack of charcoal samples for radiocarbon testing, we selected samples from context 64 (one bone sample) and context 63 (one coal sample). The sample from context 64 dates between 6,083 and 5,990 cal BCE, while the sample from context 63, taken from a depth of 442 cm, falls between 6,449 and 6,351 cal BCE. These results demonstrate that the cave was inhabited from 11,945-11,800 cal BCE to between 6,449 and 6,351 cal BCE (spanning the Mesolithic to the Pottery Neolithic periods), though this settlement was not continuous. One key distinction between the recalibrated dates presented by Gregg and Thornton and the absolute dating from the re-excavation survey is a difference of 1,000 to 2,000 years in the calibrated dates provided by Gregg and Thornton. In contrast, the time difference in the recalibrated dating is only about 300 to 100 years. Therefore, we have achieved more accurate dating.

15. Conclusion

The re-excavation project at Hotu Cave in 2021 aimed to identify the stratigraphy of the cave and examine its occupation periods. Over the course of 70 days, the team excavated 10 meters and uncovered evidence of seven cultural periods: the Mesolithic, Neolithic (both Early /or non-ceramic and Late/ceramic phases), Transitional Chalcolithic, Iron Age, and the Parthian period.

The findings from the new excavation revealed several gaps in the archaeological record, prompting a revision of Carleton Coon's previously established occupation history

Table 2: Comparative Chronology proposed by Carleton Coon 1957 and Ralph 1955, Gregg and Thornton 2012 and the excavation of 2021.

Period	Radiocarbon dating by Coon, 1957 and Ralph, 1955	Calibrated by Gregg and Thornton, 2012	Revision excavation by Fazeli Nashli, 2021	
			Absolute data	context
Islamic	1220± 230 BP = 730 AD	565-1020 cal AD	324 - 418 cal AD	8 to 1
Parthian?	2200± 280 BP = 250 BC	760-40 cal BC		9
Early Iron Age	2685± 210 BP = 735 - 1000 BC 2950± 230 B.P = 735 – 1000 BC			27 to 10
Painted Pottery/Transitional Chalcolithic **(Cheshmeh-Ali Ware)**	4830± 480 B.P = 2880 B.C	4345-3105 Cal BC	4954 - 4791 cal BC	57 to 30 59 to 58
Neolithic Software	6385± 425 B.P = 4435 B.C	5975-5050 Cal BC	6083 - 5990 cal BC 6449 - 6351 cal BC	67 to 60
Sub-Neolithic **(non-ceramic)** **Early Neolithic**	8070± 500 BP = 6120 BC (TR. D)	7940-6650 cal BC	6830 - 6641 cal BC 7865 - 7605 cal BC	103 to 77
Mesolithic	9190± 590 BP = 7240 BC (TR. D)	9800-7975 cal BC	8130 - 7960 cal BC 10901-10806 BC 10528 - 10147 cal BC 11945-11800 B.C	121 to 104
	9220± 570 BP = 7270 BC (TR. D)	9875-8000 cal BC		
	11860± 840 BP = 9910 BC (TR. D)	13920-11350 cal BC		

of Hotu Cave. During his excavations, Coon reached a depth of 12.5 meters in Trench D and documented five human burials, animal bones, pottery, and various special finds.

In contrast, our 2021 excavation in Trench E's lower layers uncovered two human burials, several fireplaces, stone artifacts, and both plant and animal remains. These discoveries indicate that Hotu Cave was inhabited by the last hunters and gatherers from 11945 BCE during the Mesolithic period, transitioning to practices of agriculture and animal husbandry in the Neolithic. The excavation conducted in 2021 reveals that there were significant periods of inactivity during the Holocene period. Some of these hiatuses may have been local, while others could represent a regional phenomenon. The inhabitants of the cave adapted their way of life according to environmental factors and adjusted to changing conditions. For instance, during periods of high fluctuation in the Caspian Sea, when the distance between the coast and the cave was minimal, the hunters primarily relied on hunting Caspian seals. However, as the water level dropped and plains gradually emerged along the southern shores of the Caspian Sea, increasing the distance between their settlement and the shore, the hunter-gatherer communities shifted their focus to hunting herbivorous mammals like deer.

In recent years, significant archaeological researches have been carried out on both sides of the Alborz Mountains. From the recent archaeological research programs, we not only revised the chronology both sides of Alborz Mountain but also scrutinize the patterns of human community movement and human-environment interactions during the Holocene period. Some of these paleo-environmental changes significantly impacted human societies, leading to the abandonment of agricultural lands, and forcing people to abandon their homeland until nature returned to its natural state after a few centuries, allowing agricultural life to flourish again. For example, at Hotu Cave, Kamarband and Komishani, some of these phenomena can be observed which is related to climate events such as 10.2 ka, 8.2 ka, and 7.2 ka. In this paper we also address some evidence of the 7.2 ka climate event is significantly associated with the Caspian Sea regression which obviously caused major changes in the human occupation pattern. These changes can be observed not only in the archaeological sites of the northern part of the Alborz Mountains but also clearly in the northern part of the Central Iranian Plateau. Ancient sites such as Sialk, Zagheh, Ebrahim Abad and Moein Abad clearly show the effects of climate change and systematic cultural collapse after 5000 BCE. In northeastern Iran, from Tappeh Sang-e Chakhmaq, Tepe Pahlavan to Hotu cave, we have witnessed such phenomena. In conclusion, recent research highlights the need for a review of the overall climatic changes during the Holocene period, and therefore, in the future, there should be interdisciplinary research programs between archaeologists and paleo-climatologists to reconstruct the depth and extent of climate changes and their impacts on human societies.

16. Acknowledgments

First and foremost, we would like to express our deepest gratitude to all members of the Hotu Cave excavation team: Hedayat Kalvari, Hassan Afshari, Hamed Tahmasebi-Far, Morteza Khalighi, Ghasem Moradi, Narjes Khan Fini, Sana Ghasemi, Zahra Aghajan Nasab, and Neda Zare. Their hard work, meticulous report preparation, data recording, and professionalism throughout the fieldwork were invaluable.

We would also like to thank Dr. Behrouz Omrani and Dr. Shirazi, the former heads of the Cultural Heritage Research Institute and the Cultural Heritage, Handicrafts, and Tourism Organization of Mazandaran. Their cooperation in obtaining excavation permits and expediting administrative and financial matters was greatly appreciated.

Additionally, we are grateful to Mr. Farzaneh, Mr. Izadi, and Dr. Saman Sortichi, the research managers of the Cultural Heritage Organization of Mazandaran province, for their ongoing support. Special thanks to Mr. Farhad Majidzadeh and Mr. Jamshid Mohammadi, the provincial manager of properties in Mazandaran, as well as Mr. Abazar Baqeri, who oversees the Cultural Heritage Protection Unit of Behshahr, and all the staff of this unit for their assistance during the excavation.

Finally, we would like to thank Mr. Baqer Nabavi and Elias Parichehreh from the Sabzegostar Hotu Complex for their generous support in facilitating the excavation. We also appreciate Christopher Thornton for providing pottery photographs and designs from the Pennsylvania Museum archive and sharing his writings and articles with the authors. The authors express their gratitude to Chris Thornton and Mozhgan Jayez for their valuable comments and suggestions, which have significantly contributed to enhancing the quality and impact of this study.

References

- Akbari Zarrin Qabaei, A. & Azizi Kharanaghi, M. H., (2024). "The Description, Classification, and Typology of Late Neolithic and Transitional Chalcolithic Periods (Cheshmeh Ali) Pottery at Tepe Pahlavan, Northeastern of The Iranian Plateau". *Parseh Journal of Archaeological Studies,* 8(27): 7-36. Doi: https://dx.doi.org/10.22034/PJAS.8.27.

- Asouti, E., Baird, D., Kabukcu, C., Swinson, K., Martin, L. & García-Suárez, A., (2020). "The Zagros Epipalaeolithic revisited: New excavations and 14C dates from Palegawra cave in Iraqi Kurdistan". *PLoS ONE,* 15(9): e0239564. https://doi.org/10.1371/journal.pone.0239564.

- Conard, N. & Zeidi, M., (2013). "The ground stone tools from the aceramic Neolithic site of Chogha Golan, Ilam province, western Iran, Stone Tools in Transition: From Hunter-Gatherers to Farming Societies in the Near East / Ferran Borrell". Juan José Ibáñez, Miquel Molist (eds.) — Bellaterra (Barcelona): Universitat Autònoma de Barcelona. Servei de Publications: 365-375.

- Coon, C. S., (1951). "Cave Explorations in Iran 1949". University of Pennsylvania Museum, Philadelphia.

- Coon, C.S. (1952). "Excavations at Hotu Cave, Iran, A Preliminary Report," Proceedings of the American Philosophical Society, 96/3: 231-249.

- Coon, C. S., (1957). *The Seven Caves.* Alfred A. Knopf, New York.

- Darabi, H., (2022). "The Creative Millennia: Highlighting the Transitional Neolithic (ca. 9800-8000 BCE) in the Central Zagros, Iran". *Journal of Archaeological Studies*, 14(2): 37-58. Doi: 10.22059/jarcs.2022.343781.143122.

- Dupree, L., (1952). "The Pleistocene Artifacts of Hotu Cave, Iran". *Proceedings of the American Philosophical Society,* 96 (3): 249-257.

- Dyson, R. H. & Thornton, C. R., (2009). "Shir-i Shian and the Fifth-Millennium Sequence of Northern Iran". *IRAN*, 47(1): 1–22. https://doi.org/10.1080/05786967.2009.11864756.

- Fazeli Nashli, H., (2022). "The Report of the Stratigraphic Excavation of the Kamarband Cave, Behshahr City, Mazandaran Province". document center of cultural heritage organization [In Persian].

- Fazeli Nashli, H., (2021). "Excavation Report to Determine the Site and Privacy of Huto and Kamarband Caves and Excavation of the Stratification of Hotu cave, Behshahr City, Mazandaran Province". document center of cultural heritage organization [In Persian].

- Fazeli Nashli, H., (2023). "Report of the Second Season of Stratigraphic Excavation of Komishani Tappe, Neka City". Mazandaran Province, document center of cultural heritage organization [In Persian].

- Fazeli Nashli, H., Young, R., Gręzak, A., Afshari, H. & Nazari, H., (2024). "The first farmers and herders of the North Central Plateau and Northeastern Iran: an irrigation society". in: *From Sedentarisation to Complex Society: Settlement, Economy, Environment, cult, proceedings of the workshops in Lisbon, Tehran and lima.* eds by Judith Thomalsky, Hassan Fazeli Nashli, Markus Reindel, Peter Kaulicke, Michael Kunst, Ana Catarina Sousa, Reihe, Band/Series, Volume: Menschen - Kulturen - Traditionen, 21, Reichert Verlag, Wiesbaden: 265-274.

- Fazeli Nashli, H. & Thomalsky, J., (2024). "Research on the Neolithic in Iran

(9600–5200 BC): state of the art and perspectives". in: Thomalsky *et al.,* (eds.), *From Sedentarisation to the Complex Society. Settlement, Economy, Environment, Cult. Proceedings of the Workshops in Lisb on, Tehran, and Lima (2016 − 2019).* Menschen – Kulturen – Traditionen 21, Wiesbaden: Reichert Verlag: 235-264.

- Garazhian, O., Yazdi, L. P. & Ghaemi, H. F. E., (2014). "Qaleh Khan a Site in Northern Khorassan and the Neolithic of Northeastern Iranian Plateau". *Archaologische Mitteilungen Aus Iran Und Turan*, 46: 21–50. https://www.researchgate.

- Garrard, A., Edwards, Y., Stock, J. & Yazbeck, C., (2018). "Epipalaeolithic and pre-Pottery Neolithic burials from the north Lebanese highlands in their regional context". *Levant*, 50(1): 1–13.

- Gregg, M. & Thornton, C., (2012). "A preliminary analysis of prehistoric pottery from Carleton Coon's excavations of Hotu and Kamarband Caves in Northern Iran," *implications for future research into the emergence of village life in Western Central Asia*. Intl. J. Humanities, 19 (3): 56-94.

- Groene, D., Bendrey, R., Müldner, G., Coogana, A. & Matthews, R. E., (2023b). "Sheep and goat management in the Early Neolithic in the Zagros region (8000–5000 BC): New zooarchaeological and isotopic evidence from Ganj Dareh". *Bestansur and Jarmo, Journal of Archaeological Science: Reports*, https://doi.org/10.1016/j.jasrep.2023.103936.

- Groene, D., Fazeli Nashli, H. & Matthews, R., (2023a). "The Epipalaeolithic–Neolithic Transition in North-Eastern Iran: Zooarchaeological Evidence from the Southern Shores of the Caspian Sea". *Antiquity,* 97(393): 541-556. https://doi.org/10.15184/aqy.2023.37.

- Harris, D.R. 2010. "Origins of Agriculture in Western Central Asia, an Environmental-Archaeological Study." University of Pennsylvania Press, Philadelphia.

- Hashemi, S. M. & Vahdati Nasab, H., (2014). "Study of Reduction Intensity on the Side-scrapers of Komishan Cave, Mazandaran". *Archaeological Research of Iran,* 4 (6): 27-46 [In Persian].

- Hessari, M., Bernbeck, R., Rol, R. Pollock, S. & Wolff-Heger, L., (2024). "Tappeh Moeinabad. A Late Neolithic Site in the Varamin Plain, Iran". *Journal of Neolithic Archaeology*: 1-29.

- Jayez, M., (2012). "Techno-typological Analysis of Komishan Lithic Industries and its Compatibility with the Epipaleolithic Industries from Zagros Region". Unpublished Ph.D. dissertation, Tarbiat Modares University (TMU), [In Persian].

- Jayez, M., Safari, M. & Ghasemi, S., (2024). "Typo-technological Classification of the Chipped Stone Assemblages of Hotu Cave from the Mesolithic to the Transitional Chalcolithic: Reflections on Local Raw Material Procurement in the Caspian Sea Littoral Ecozone". *Journal of Archaeological Studies,* 16(1): 53-86. https://doi.org/10.22059/jarcs.2023.357605.143194.

- Jayez, M. & Vahdati Nasab, H., (2016). "A Separation: Caspian Mesolithic vs. Triacetin Lithic industry. Research on the Excavated site of Komishan, Southeast of the Caspian Sea, Iran". *Paleodiet,* 42/1: 75-94. https://doi.org/10.3406/paleo.2016.5694.

- Kehl, M., Rafiei-Alavi, B., Alizadeh Ketek Lahijani, H., (2023). "Holocene Paleoenvironmental Change and Phases of Drought in the Iranian Highlands". A Review. Reinhard Bernbeck, Gisela Eberhardt and Susan Pollock (eds) *Coming to terms with the future, Concepts of Resilience for the Study of Early Iranian Societies*: 21-38.

- Koriche, S. A., Singarayer, J. S., Cloke, H. L., Valdes, P. J., Wesselingh, F. P.,

Kroonenberg, S. B., Wickert, A.D. & Yanina, T. A., (2022). "What are the drivers of Caspian Sea level variation during the late Quaternary?". *Quaternary Science Reviews,* 283: 107457. https://doi.org/10.1016/j.quascirev.2022.107457.

- Maher, L. A., Stock, J. T., Finney, S., Heywood, J. J. N., Miracle, P. T. & Banning, E. B., (2011). "A unique human-fox burial from a pre-Natufian cemetery in the Levant (Jordan)". *PLoS ONE,* 6 (1): e15815. https://doi.org/ 10.1371/journal.pone.0015815 PMID: 21298094.

- Manca, L., Mashkour, M., Shidrang, S. & Biglari, F., (2018). "Bone, Shell Tools and Ornaments from the Epipalaeolithic Site of Ali Tappeh, East of Alborz Range, Iran". *Archaeological. Sci. Rep.,* 21: 137-157.

- Matson, F. R., (1951). "Notes on the composition and manufacture of sherds from Belt Cave, Appendix III, Cave Explorations in Iran 1949". University of Pennsylvania Museum, Philadelphia:93- 95.

- Matthews, R. J. & Fazeli Nashli, H., (2022. *The Archaeology of Iran from the Paleolithic to the Achaemenid Empire.* Routledge.

- McAuley, J., (2013). "Skeletal Study of the Hominins from Hotu and Belt Caves, Iran. An Example". of Conservation Gone Wrong. MA thesis.

- McBurney, C. B., (1968). "The Cave of Ali Tappeh and the Epi-Paleolithic in N. E. Iran". *Proceedings of the Prehistoric Society,* 12: 385-413.

- Nakamura, T., (2014). "Radiocarbon dating of charcoal remains excavated from Tappeh Sang-e Chakhmaq. In: Tsuneki A, editor. The first farming village in northeast Iran and Turan: Tappeh Sang-e Chakhmaq and beyond". February 10–11, 2014 (Programe and Abstracts). Tsukuba: University of Tsukuba: 9–12.

- Nazari, H., Ritz, J. F., Burg, J. P., Shokri, M., Haghipour, N., Mohammadi Vizheh, M., Avagyan, A., Fazeli Nashli, H. & Ensani, M., (2021). "Active tectonics along the Khazar fault (Alborz, Iran)". *Journal of Asian Earth Sciences*, 219: 104893. https://doi.org/10.1016/j.jseaes.2021.104893

- Nishiaki, Y., Otabek, A., Arai, S., Akashi, C., Nakata, H., Sayfullayev, B., Ergashev, O. & Suleimanov, R., (2022). "Neolithization during the 6th millennium BCE in western Central Asia: New evidence from Kaynar Kamar Rockshelter, Hissar Mountains, Southeast Uzbekistan". *Archaeological Research in Asia,* 30, ISSN: 2352-2267, https://doi.org/10.1016/j.ara.2022.100352.

- Pichon, F., Ibañez Estevez, J. J., Anderson, P. C. & Tsuneki, A., (2023). "Harvesting cereals at Tappeh Sang-e Chakhmaq and the introduction of farming in Northeastern Iran during the Neolithic". *PLoS ONE,* 18(8): e0290537. https://doi.org/10.1371/ journal.one.0290537.

- Pollock, S., Bernbeck, R. & Ogüt, B., (2019). "Looking Closely: Excavations at Monjukli Depe, Turkmenistan"., 2010–2014, Vol. 1. Sidestone Press, Leiden.

- Ralph, E.K. 1955. "The University of Pennsylvania Radiocarbon Dates I". *Science,* 121/3136: 149-151.

- Richter, T., Darabi, H., Alibaigi, S., Arranz-Otaegui, A., Bansgaard, P., Khosravi, S., Maher, L., Mortensen, P., Pedersen, P., Yeomans, L., (in press). "The formation of Early Neolithic Communities in the Central Zagros: an 11, 500-year-old communal structure at Asiab". *Oxford Journal of Archaeology,* 40(1): 2-22.

- Roustaei, K., (2018). "Beyond the Mounds: Insights into a late sixth millennium BCE

sherd scatter site in the Shahroud plain, northeast Iran". *Ancient Near Eastern Studies,* 55: 143–182.https://doi.org/10.2143/ANES.55.0.3284689.

- Roustaei, K., Mashkour, M. & Tengberg, M., (2015). "Tappeh Sang-e Chakhmaq and the beginning of the Neolithic in north-east Iran". *Antiquity*, 573–595. https://doi.org/10.15184/aqy.2015.26.

- Smith, B. & Zeder, M. A., (2010). "The onset of the Anthropocene". *Anthropocene,* 4: 8-13.

- Taylor, W. T. T., Pruvost, M., Posth, C., Rendu, W., Krajcarz, M.T., Abdykanova, A., Brancaleoni, G., Spengler, R., Hermes, T., Schiavinato, S., Hodgins, G., Stahl, R., Min, J., Alisher Kyzy, S., Fedorowicz, S., Orlando, L., Douka, K., Krivoshapkin, A., Jeong, C., Wariner, C. & Shnaider, S., (2021). "Evidence for early dispersal of domestic sheep into Central Asia". *National Human Behaver,* 5(9):1169-1179. https://doi.org/*10.1038/s41562-021-01083-y.* Pub 2021 Apr 8. PMID: 33833423.

- Thomalsky, J., (2016). "The development of lithic industries in Iran in the light of the processes of Neolithization". in: K. Roustaei and M. Mashkour (eds) *The Neolithic of the Iranian Plateau: Recent Research. Studies in Early Near Eastern Production, Subsistence, and Environment* 18. Berlin: ex oriente: 169–188.

- Thornton, C. P., (2010). "Sang-e Chakhmaq. Encyclopedia Iranica". http, //www.iranicaonline.org.

- Thornton, C. P., (2013). "Tappeh Sang-e Chakhmaq, a new look. in R. Matthews and H. Fazeli Nashli (eds.), the Neolithization of Iran. The formation of new societies". 241256, Oxford, Oxbow Books.

- Tsuneki, A., (2017). "The emergence of pottery in northeast Iran: the case study of Tappeh Sang-e Chakhmaq". in: A. Tsuneki, O. Nieuwenhuyse, S. Campbell (eds.), *The emergence of pottery in West Asia,* Oxford: 119–132.

- Vahdati Nasab, H., Nikzad, M., Jayez, M., Hashamei, M., Knapp, Z., Sykes, N., Khalili, M.Z., Moghassam, H.H., Bakhtiari Nasab, F. & Olszewski, D. I., (2020). "Komishan Cave: A Mesolithic and Later Settlement of the Southeastern Shore of the Caspian Sea, Iran". *ANES,* 56: 97-125.

- Vahdati Nasab, H. & Vahidi, M., (2011). "Re-evaluation of Scrapers Reduction Model Using Kuhn's Geometric Index of Reduction, Mr-Tarik Middle Pa neolithic Assemblages". *Iranian Journal of Archaeological Studies,* 1: 26 34.

- Weide, A., Riehl, S., Zeidi, M., Conard, N. J., (2017). "Reconstructing subsistence practices: techonomic constraints and the interpretation of wild plant remains at aceramic Neolithic Chogha Golan, Iran". *Vegetation History and Archaeobotanical,* 26 (5): 487-504.

- Zeder, M., (2011). "The origins of agriculture in the Near East". *Current Anthropology,* 52 (S4): 221-235.

- Zeder, M., (2024). "Out of the Shadows: Reestablishing the Eastern Fertile Crescent as a Center of Agricultural Origins: Part 2". *Journal of Archaeological Research*, https://doi.org/10.1007/s10814-024-09195-5.

- Zeidi, M. & Conard, N. J., (2023). "The Earliest Neolithic Lithic Traditions Evidence from Chogha Golan in the Western Foothills of the Zagros Mountains, Iran". in: *The Epipalaeolithic and Neolithic in the Eastern Fertile Crescent*, eds by (Richter and Darabi) Routledge: 171-198.

Journal of Archaeological Studies

Online ISSN: 2676-4288

https://jarcs.ut.ac.ir/

University of Tehran Prees

بازنگری لایه‌های باستان‌شناسی غار هوتو، ایران: گزارش مقدماتی کاوش‌های باستان‌شناسی سال ۱۴۰۰

حسن فاضلی‌نشلی[۱]، مجتبی صفری[۲]، راجر متیوس[۳]، جودیت تومالسکی[۴]، یان لنتشکه[۵]، مینا مدیحی[۶]

۱. گروه باستان‌شناسی، دانشکدهٔ ادبیات و علوم انسانی، دانشگاه تهران، تهران، ایران (نویسندهٔ مسئول)، **رایانامه:** hfazelin@ut.ac.ir
۲. گروه باستان‌شناسی، دانشکده میراث فرهنگی، صنایع دستی و گردشگری، دانشگاه مازندران، بابلسر، ایران (نویسندهٔ مسئول).
رایانامه: m.safari@umz.ac.ir
۳.دانشگاه ریدینگ، انگلستان، **رایانامه:** r.j.matthews@reading.ac.uk
۴. مؤسسه باستان‌شناسی آلمان، شعبه تهران، ایران، **رایانامه:** Judith.Thomalsky@dainst.de
۵. مؤسسه باستان‌شناسی آلمان، شعبه تهران، ایران، **رایانامه:** Jan.lentschke@geo.hu-berlin.de
۶. گروه باستان‌شناسی، دانشکدهٔ ادبیات و علوم انسانی، دانشگاه تهران، تهران، ایران، **رایانامه:** minamadihi@ut.ac.ir

چکیده

دورهٔ میان‌سنگی و گذار آن به دورهٔ نوسنگی در جنوب‌غرب آسیا، یکی از مهم‌ترین مراحل تحول فرهنگی انسان است که در آن جوامع انسانی به تدریج شیوهٔ زندگی و رفتار فرهنگی خود را تغییر داده و وارد عصر جدید شدند. انسان پس از هزاره‌ها سبک زندگی به‌عنوان شکارچیان و خوراک‌جویان سیار وارد دوره‌ای شدند که برخی از دانشمندان آن را عامل شروع دورهٔ آنتروپوسن (دورهٔ انسانی) می‌دانند؛ بنابراین، مطالعه و شناخت شیوهٔ زندگی شکارچی-گردآورنده‌های دورهٔ میان‌سنگی و ورود آن به عصر نوسنگی بسیار ضروری می‌باشد. درحال حاضر، چندین استقرارگاه‌های باستان‌شناسی مهم در محدودهٔ نوار جنوب‌شرقی سواحل دریای خزر مورد پژوهش قرار گرفت که دارای توالی‌های غنی از شکارچیان و گردآورندگان خوراک از حدود ۱۵,۰۰۰ تا ۱۰,۰۰۰ سال پیش را نشان می‌دهد. این غارها ازلحاظ موادفرهنگی این دوره بسیار چشمگیر است و قابل‌مقایسه با هیچ جای ایران نیست. یکی از این مکان‌ها، غار هوتو است که در نزدیکی شهر امروزی بهشهر واقع‌شده و نخستین‌بار در سال ۱۹۴۹ و ۱۹۵۱م. توسط انسان‌شناس آمریکایی کارلتون کوون کاوش شد؛ اما متأسفانه به‌دلایل مختلفی گزارش مناسبی از این غار هرگز ارائه نشد. فعالیت‌های جدید ما در این غار پس از ۷۰ سال به‌دنبال تحقق یک تقویم گاهنگاری درست و مطمئن از دورهٔ میان‌سنگی تا دورهٔ اشکانی و پیوند دادن خلأهای واضح در توالی غار و تغییرات اقلیمی و محیطی در سال ۱۴۰۰هـ.ش. بوده است. کاوش جدید در غار هوتو، نه‌تنها برای جانمایی داده‌های حاصل از کاوش‌های کوون مفید است، بلکه به ما کمک کرد تا بتوانیم توالی جدیدی را برای این غار پیشنهاد نماییم. در این پژوهش، ما نه‌تنها داده‌های کاوش سال ۱۴۰۰ را شرح داده‌ایم، بلکه تمام پیشنهادهای دوره‌بندی که توسط کارلتون کوون، مایکل گرگ و کریستوفر تورنتون را نیز جمع‌بندی و با داده‌های جدید ترکیب کرده‌ایم. پروژه ما نه‌تنها شامل داده‌های غار هوتو می‌باشد، بلکه کاوش‌های اخیر در دو محوطهٔ مهم و کلیدی دیگر، یعنی غار کمربند و تپه کمیشانی را با هم مقایسه کرده‌ایم. براساس کاوش‌های اخیر در منطقه می‌توان مدلی جدید از گذار به دورهٔ میان‌سنگی به نوسنگی جنوب‌شرق دریای کاسپی پیشنهاد نمود. همچنین داده‌های اخیر نشان می‌دهد که شاید این منطقه، یکی از کانون‌های اولیهٔ اهلی‌سازی حیوانات و گیاهان درنظر گرفته شود که برای تدوین این مهم باید منتظر نتایج دیگر داده‌ها باشیم.

تاریخچه مقاله

صص: ۴۹-۵

نوع مقاله: پژوهشی

تاریخ دریافت:
۱۴۰۳/۰۶/۳۰

تاریخ بازنگری:
۱۴۰۳/۰۷/۲۵

تاریخ پذیرش:
۱۴۰۳/۰۸/۰۱

تاریخ انتشار:
۱۴۰۳/۰۹/۳۰

کلیدواژگان:
جنوب‌شرقی دریای خزر، غار هوتو، میان‌سنگی، نوسنگی، میان‌سنگی دریای خزر، نوسنگی دریای خزر.

ارجاع به مقاله: فاضلی‌نشلی، حسن؛ صفری، مجتبی؛ متیوس، راجرز؛ تومالسکی، جودیت؛ لنتشکه، یان؛ و مدیحی، مینا. (۱۴۰۳). «بازنگری لایه‌های باستان‌شناسی غار هوتو، ایران: گزارش مقدماتی کاوش‌های باستان‌شناسی سال ۱۴۰۰». مطالعات باستان شناسی، ۱۶(۲): ۵-۴۹.
https://doi.org/10.22059/jarcs.2025.388982.143332

صفحهٔ اصلی مقاله در سامانهٔ نشریه: https://jarcs.ut.ac.ir/article_100326.html?lang=fa