

## **Testing and Conservation Actions in the Hittite Mud Bricks Fortification of Porsuk – Zeyve Höyük (Southern Cappadocia, Türkiye)**



**Claire BARAT (LARSH, UPHF, IFÉA)**, Chamsia SADOZAI  
(CRATERRE), Jean-François PICHONNEAU (French Ministry  
of Culture, IFÉA)  
Université Polytechnique Hauts-de-France,  
LARSH, Campus des Tertiales, rue des Cent-têtes  
59 313 Valenciennes Cedex 9, FRANCE  
[Claire.Barat@uphf.fr](mailto:Claire.Barat@uphf.fr), [clairebarat33@yahoo.fr](mailto:clairebarat33@yahoo.fr)

### **ABSTRACT**

This paper will present the testings and actions of conservations lead in the archaeological excavation of Porsuk – Zeyve Höyük in Southern Cappadocia (Türkiye). The site of Porsuk – Zeyve Höyük is mainly characterized by its Hittite mud bricks fortification built in 1600 BC and repaired and rearranged after 1280 and in 837 BC, after wars and fires. It is the unique example of 8 meters of original mud bricks walls from the Hittite period in Türkiye. The first objective of the study is to understand the history of the fortification that means construction, destructions, reconfigurations and restorations of the mud bricks fortifications of Porsuk – Zeyve Höyük during Antiquity. The second objective is the realisation of a mud bricks workshop, using the knowledge and know-how of Porsuk region local inhabitants (the mud bricks architecture is still used in this mountainous region of Türkiye). The third objective is to test techniques of encapsulation to protect original Hittite mud bricks structures. The fourth objective is a reflection about the valorisation of the conservation and preservation of the mud bricks Hittite fortification. The methods employed are research-action methods: archaeological excavations, mud bricks production, testing of the preservation and conservation actions of encapsulations.

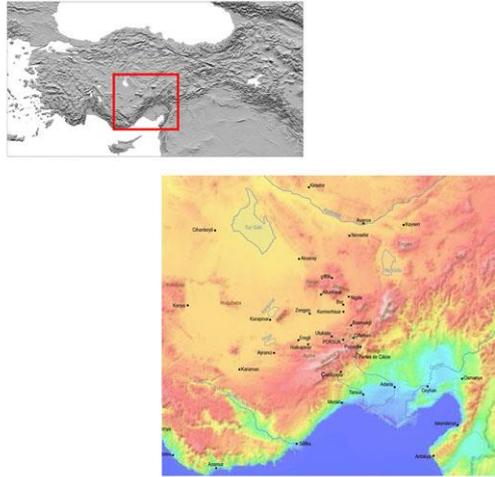
The conclusions are the creation of a management plan for the conservation and valorisation of the mud bricks architectures of Porsuk – Zeyve Höyük, in relation with a project of mud bricks centre of interpretation from Antiquity to nowadays in the village of Porsuk (Niğde province), linked to sustainable tourism and development in the region.

### **Keywords:**

**Mud bricks – Hittite fortification – Porsuk-Zeyve Höyük – Conservation**

### **1 INTRODUCTION**

The archaeological site of Porsuk – Zeyve Höyük is situated in Southern Cappadocia, in the region of Niğde, near to the sub prefecture of Ulukışla, at the bottom of the Taurus Mountains (Bolkar Dağları) [1] [2], 40 km on the North of the Cilician Gates (Gülek Boğazı) [3], famous circulation pass between Anatolian Plateau and Cilicia from Antiquity, 'Fig. 1'.



**Fig. 1:** Map of localisation of Porsuk in its Anatolian environment  
(© Porsuk – Zeyve Höyük archaeological mission)

The site is a tabular höyük, 400 x 180 m in size, situated at an average elevation of 1300 m, with an area of 4 ha [1] [2], ‘Fig. 2’.



**Fig. 2:** General view of the höyük of Zeyve  
(© Porsuk – Zeyve Höyük archaeological mission)

The English Geographer W.-M. Ramsay noticed the site in 1899, during his survey in the Cilician Gates region [4] [1] [5], but he proposed to identify it with the *Colonia Faustianiana* created in 176 AD by Roman Emperor Marcus Aurelius after the death of his wife Faustina. In 1926, the Swiss Assyriologist and pioneering Hittitologist E.-O. Forrer identified on the site the remains of a vaulted underground passage, dated, thanks to the ceramics, to the Hittite period. In 1937, in an article published in *Klio*, he proposed to identify the site to the Hittite Dunna, the Assyrian Tunna and the Ptolemee’s Tynna, in the neighbourhood of the site of Faustinopolis, founded by Roman Emperor Marcus Aurelius [6].

No more archaeological survey was lead, and the site was really discovered after road works in 1960, for the construction of a track to access to the neighbouring gypsum quarry. A bulldozer cut off the western extremity of the höyük and considerably cut the top off it [1] [2]. A Neo-Hittite hieroglyphic inscription of the 8<sup>th</sup> Century BC was discovered in this occasion. It mentioned the General Parahwaras [7] [8] and was immediately transferred to the regional museum of Niğde. In 1961, the French Hittitologist Emmanuel Laroche saw this inscription in Niğde and went to see the site of Porsuk – Zeyve Höyük. He took steps to obtain excavation permission for the Turkish authorities, and, in 1968, a survey permission was given to Emmanuel Laroche, at this time director the French Institute of Archaeology of Istanbul [1] [2] [9]. In 1969, the archaeological excavations began, under the direction of Prof. Olivier Pelon (Lyon University), then under the direction of Prof. Dominique Beyer (Strasbourg University) between 2003 and 2015, and, since 2016, under the direction of Assoc. Prof. Claire Barat (Hauts-de-France Polytechnic University, Valenciennes) [10] [11]. Different excavation areas (called “Chantiers”) were open on the höyük,

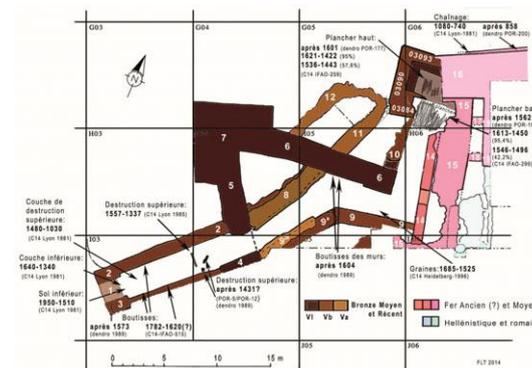
but the more important to understand and to study the mud bricks Hittite constructive systems was in Chantier 2, where a defensive system were brought to light, with fortification walls and entrance system, known as the “Hittite postern”.

The originality of the Porsuk – Zeyve Höyük archaeological remains in Chantier 2 is the original Hittite mud bricks conserved with an elevation going until 8 m in some parts of the fortification.

The aim of this paper is to study the ancient mud bricks constructive systems in Porsuk – Zeyve Höyük and to describe the mud bricks workshop started in 2018 in order to lead conservative actions on the original archaeological remains. This paper will also present encapsulation techniques tests used to protect the archaeological remains and to allow future visitors to see the Hittite fortification walls. Finally, a reflection will be lead about the valorisation of the conservation and preservation of the mud bricks Hittite fortification.

## 2 HISTORY OF THE ANCIENT CONSTRUCTIVE SYSTEMS IN PORSUK – ZEYVE HÖYÜK

The excavations of the fortification system of Porsuk – Zeyve Höyük began in the Chantier 2 zone (1969-1970), then in Chantier 4 zone (1971-1972 and 1976-1977), and in parallel in both Chantier between 2005 and 2015 [9]. During these excavation campaigns, C14 analysis and dendrochronological analysis were lead in order to date the constructive systems in Porsuk- Zeyve Höyük [9] [12], ‘Fig. 3’.



**Fig. 3:** Map of Chantier 2 with principal dendrochronological and C14 measures (D. Beyer [13])

The foundation of the Hittite fortification seems to occur in the 17<sup>th</sup> Century BC. Mud bricks walls were constructed and a primitive gate allowed entering into the fortification. In the 13<sup>th</sup> Century BC, the fortification was attacked and fired, and the fortress was reconstructed with new mud bricks (another module, smaller). An advanced corridor was added, forward the primitive gate, forming the “Hittite postern” and this entrance became a secondary entrance. Under the reign of Salmanazar III, during his 22<sup>nd</sup> campaign (837 BC), the curved corridor in the “Hittite postern” system was obdurate by a mud bricks wall. Above this Middle and Late Bronze Age System, an Early Iron Age system of fortification was built [5] [9] [13] [14].

So the use of mud bricks appeared in Porsuk – Zeyve Höyük since the 17<sup>th</sup> Century, in the first state of the fortification. It seems that the first module for the first state of the fortification was slightly bigger (0,49 m x 0,44 m x 0,12 m) than the following one, discovered in the fire levels (0,49 m x 0,34 m x 0,14 m and 0,49 m x 0,42 m x 0,11 m), but, nevertheless, the length remained constant. The mud bricks were used not only for the edification of the fortifications but also for private and public housing. In the implementation of the rampart, the apparatus is associating mud bricks in stretchers and bondstones. The whole of the structures constructed in mud bricks was covered with a layer of earth witch composition is identical of mud bricks ones, and on the earth mortar, a whitewash was applied.

The excavations and resumption of previous surveys allowed highlighting the remains of the Middle Iron Age rampart. It is composed internally by a mud bricks massif and in frontage by a facing of gypsum blocks tied by an earth mortar. This defensive ensemble was not fired. Manifestly, the construction of this rampart required in a first time a levelling of the Late Bronze Age cooked mud bricks ruined structures of the rampart, and the definitive obstruction of the corridor.

In order to prepare conservation actions on the Hittite fortifications of Porsuk – Zeyve Höyük, a mud bricks workshop was initiated in 2018 under the direction of Claire Barat.

### **3 MUD BRICKS WORKSHOP IN PORSUK – ZEYVE HÖYÜK**

During the 2014 campaign, testing mud bricks small walls were built, with four different compositions [15]. In 2018, it was possible to identify which combination was the more resistant to wind, rain and snow, and this combination was reproduced in the mud bricks workshop, 'Fig. 4'. The composition of the mud bricks was the following one: earth, 20 % straw and water [10] [11].



**Fig. 4:** Production line of 2019 the mud bricks of Zeyve Höyük  
(© Porsuk – Zeyve Höyük archaeological mission)

The archaeological mission of Porsuk – Zeyve Höyük could benefit from the knowledge and know how of the workers, all from Porsuk village. In fact, in the region of Porsuk, at the bottom of the Taurus Mountains, there is a still alive mud bricks construction culture. The old village of Porsuk (Eski Porsuk) abandoned in the beginning of the 1990s for the summer village, New Porsuk (Yeni Porsuk), show good examples of the use of mud bricks in vernacular constructions, 'Fig. 5'.



**Fig. 5:** Houses and constructive details of Eski Porsuk village  
(© CRAterre\_C. Sadozai)

The earthen material for the preparation of the mixture came from the rubble of the previous excavations. The straw came from old bale and was chopped in small pieces. The mix was then trampled underfoot by workers during one hour, and stayed rotting during twelve hours. The putty was moulded in wooden moulds on the next day. The mud bricks stayed outside to dry one week. Listening to the traditional knowledge, the normal drying time before using is forty days.

The module chosen for the new mud bricks was 0,40 m x 0,18 m x 0,12-0,13 m, corresponding to the second state of the Hittite constructions.

#### **4 CONSERVATION AND SITE PRESENTATION**

During 2021 campaign, CRAterre undertook an assessment of the conservation methods in Zeyve Höyük, thanks to a grant from the French Ministry of Foreign Affairs promoting conservation of earthen architecture on all French archaeological missions abroad. Preliminary results are presented here.

The history of the conservation actions at Zeyve Höyük, as is often the case on archaeological sites, has been dependent on the will of its director. They were only thought for the Chantier 2, the Hittite postern, and to be presented to the public. D. Beyer initiated wall tests in 2014, he started works to have a trail for visitors, protected areas with a plastic roof and installed few boards. He left the project to C. Barat who took over from him.

The first mudbricks were molded in 2018, and implemented the next year. The technical choice to keep the earthen remains safe and understandable for the public has been the encapsulation, 'Fig. 6'. The original volume of wall is covered by a layer of new mudbricks, on the sides and on the top, leaving a void of 5 cm fulfilled by dry soil from the rubble. On the top, mudbricks are laid without mortar and covered by a layer of earthen plaster, 'Fig. 7'.



**Fig. 6:** Encapsulation of the original Hittite mud bricks  
(© Porsuk – Zeyve Höyük archaeological mission)



**Fig. 7:** Conservation action of tower North-West, chantier 2, Porsuk – Zeyve Höyük  
(© Porsuk – Zeyve Höyük archaeological mission & © CRAterre\_C. Sadozaï)

The mission being cancelled in 2020 because of the Covid-19 pandemic, only two campaigns of encapsulation were undertaken, in parallel with the excavations. Other technics of preventive conservation have been implemented such as stone wall consolidation (with earthen mortar), a cover of geotextile membrane and targeted paralloid consolidation for plasters, 'Fig. 8'.



**Fig. 8:** Localisation of conservation action in Chantier 2, Porsuk – Zeyve Höyük  
(© Porsuk – Zeyve Höyük archaeological mission & © CRAterre\_C. Sadozaï)

The assessment showed that the site is in a good state of conservation, even after fifty years of research and exposure. The dry climatic conditions and the fact that most of the walls were fired allowed the remains to stay stable. Shelters of red corrugated plastic are efficient to slow down the decay process initiated by wind and rain, if they remain for the short-term.

The brick production is well mastered by the inhabitants of the region, but needs some improvements. Indeed, after two years the 2019 brick stock was partially broken and unusable. The inner quality of the materials has been identified as a possible weakness (grain size distribution and clay quality), as well as a lack of rotting time of the mix.

The choice of the encapsulation has also been questioned. This technic is hiding the original fabric to the public and is enlarging the original width of the walls. Angles are sharp and surfaces are new, the authenticity of the archaeological site could be affected.

Recommendations have been made for the next campaign. Technical adjustments will be tested, with new recipes of mix for mudbricks and more rotting time of the straw. Samples of other preventive measures will be implemented, such as sacrificial renders and targeted repairs. The scientific collaboration between archaeologists and conservators will continue with the elaboration of an action plan taking into account the objectives of both fields: the forthcoming excavations will be defined according to the needs of the site presentation, and to make the remains more understandable for the public. More widely, a discussion will be initiated to define a vision and the heritage values to be enhanced on Zeyve Höyük and a tentative management plan will be drafted in accordance with local authorities. They have shown a strong interest with the traditional building techniques of Zeyve Höyük and Eski Porsuk and want to enhance this know-how to the young generation, using the means of the Hittite fortress to build a Visitor centre made of mudbricks.

## 5 ACKNOWLEDGMENTS

If included, acknowledgments should appear before the list of references. Grants, other financial aid and assistance may appear under the heading Acknowledgements, which has to be placed before the list of references.

The authors wish to extend their gratitude to the General Direction of Antiquities and Museums of the Turkish Ministry of Culture and Tourism, to the Niğde Regional Directorate of Culture, to the Museum of Niğde, for enabling the excavations at Porsuk-Zeyve Höyük. In particular, this work would not have been possible without the support of the Consultative Commission of the

Archaeological Research of the French Ministry of Foreign Affairs, the French Institute of Anatolian Studies in Istanbul, the Maison Européenne des Sciences de l'Homme et de la Société (Lille), Hauts-de-France Région, the Sub prefecture of Ulukışla, and the municipality of Porsuk. We are indebted to the years of previous research carried out at Porsuk-Zeyve Höyük by E. Laroche, O. Pelon and D. Beyer. This paper could not be completed without the collaboration of CRAterre expertise, the International Center of Earthen construction and the team of researchers of the Grenoble National School of Architecture, Unité de recherche Architecture, Environnement et Culture Constructive (AE&CC).

## 6 REFERENCES

- [1] Dupré, S., *Porsuk I. La céramique de l'Âge du Bronze et de l'Âge du Fer*, Éditions Recherche sur les Civilisations, Paris, 1983.
- [2] Pelon, O. & Dupré, S., 'Une fouille française au pied du Taurus', *Archéologia*, 221, 14-25, 1987.
- [3] Lebreton, S., 'Les Portes de Cilicie', in *Lieux de mémoire en Orient grec à l'époque impériale*, ed. A. Gangloff, Peter Lang, Bern-Berlin-Brussels, pp. 305-331, 2013.
- [4] Ramsay, W.M., 'Cilicia, Tarsus and the great Taurus pass', *Geographical Journal*, 22 (4), 357-410, 1903.
- [5] Pelon, O., 'Le höyük de Porsuk, une forteresse hittite en Cappadoce méridionale', in *La Cappadoce méridionale de la préhistoire à la période byzantine*, eds. D. Beyer, O. Henry & A. Tibet, Institut Français d'Études Anatoliennes Georges Dumézil – CNRS USR 3131, pp. 91-100, 2015.
- [6] Forrer, E.O., 'Kilikien zur Zeit des Hatti-Reiches', *Klio*, 30, 135-186, 1937.
- [7] Laroche, E., 'Le dieu anatolien Sarruma', *Syria*, 40, 227-302, 1963.
- [8] Hawkins, J.D., 'A Hieroglyphic Hittite inscription from Porsuk', *Anatolian Studies*, 19, 99-109, 1969.
- [9] Beyer, D. & Laroche-Traunecker, F., 'Le site de Zeyve Höyük – Porsuk aux époques hittite et néo-hittite. Remarques sur la succession des systèmes défensifs', in *L'hittitologie aujourd'hui : Études sur l'Anatolie Hittite et néo-hittite à l'occasion du centenaire de la naissance d'Emmanuel Laroche*, ed. A. Mouton, Institut Français d'Études Anatoliennes Georges Dumézil – CNRS USR 3131, pp. 229-244, 2017.
- [10] Barat, C., Köker Gökçe, E., Pichonneau, J.-F., Mathé, V., Bruniaux, G. & Storaï, R., 'Porsuk – Zeyve Höyük : Rapport préliminaire des campagnes 2018 et 2019', *Anatolia Antiqua*, 28, 145-172, 2020.
- [11] Barat, C., Köker Gökçe, E., Pichonneau, J.-F., Mathé, V. & Bruniaux, G., 'Recent works (2018-2019) at Porsuk – Zeyve Höyük in Southern Cappadocia' in *The Archaeology of Anatolia. Volume IV. Recent Discoveries (2018-2019)*, eds. S. Steadman & G. MacMahon, Cambridge Scholars Publishing, Cambridge, pp. 132-145, 2021.
- [12] Kuniholm, P.I., Tarter, S.L., Newton, M.W. & Griggs, C.B., 'Dendrochronological investigations at Porsuk/Ulukışla. Preliminary report, 1978-1989', *Syria*, 69, 379-389, 1992.
- [13] Beyer, D., 'Quelques nouvelles données sur la chronologie des phases anciennes de Porsuk, du Bronze Moyen à la reoccupation du Fer', in *La Cappadoce méridionale de la préhistoire à la période byzantine*, eds. D. Beyer, O. Henry & A. Tibet, Institut Français d'Études Anatoliennes Georges Dumézil – CNRS USR 3131, pp. 101-110, 2015.
- [14] Tibet, A. & Laroche-Traunecker, F., 'Les fortifications occidentales de Porsuk, restitutions et modélisation des états les plus anciens', in *La Cappadoce méridionale de la préhistoire à la période byzantine*, eds. D. Beyer, O. Henry & A. Tibet, Institut Français d'Études Anatoliennes Georges Dumézil – CNRS USR 3131, pp. 111-130, 2015.
- [15] Beyer, D., Karavul, C., Laroche-Traunecker, F. & Tibet, A., 'Rapport préliminaire sur les travaux de la mission archéologique de Zeyve Höyük – Porsuk 2014', *Anatolia Antiqua*, 23, 275-290, 2015.