

**AN APPROACH TO THE EVOLUTION OF EARTHEN BUILDING CULTURES  
IN ORIENT AND MEDITERRANEAN REGIONS  
—WHAT FUTURE FOR SUCH AN EXCEPTIONAL LEGACY? —**

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**Introduction and summary**

Among the immediately available building materials, earth was undoubtedly the elected material of mankind as soon as prehistoric ages. At that time, it was often associated with wood and plants. Its common use asserted itself during the protohistory in several regions of the world offering propitious conditions for the settlement of human communities. It played an essential part all along history, up today. All archaeological excavations which have been carried out since the XIX<sup>th</sup> century, on territories having given birth to ancient great civilisations, and the numerous studies covering the field of vernacular architectures existing worldwide, are proving this privileged use of the earth for building human settlements the size of which ranges from simple clusters of dwellings, as hamlets or villages, up to towns.

The use of earth in construction seems having been independently developed in the main well-known cradles of ancient civilizations: in both Tigris and Euphrates valleys, in Mesopotamia; in Egypt, along the banks of the Nile river, from Nubia to the delta; in actual Pakistan, on the tablelands of Baluchistan and then along the banks of Hakra and Indus valleys; in China, along the Huang-ho. But also on other continents: in Latin America, on the border desert lands of the Pacific Ocean which are drained by "*Rios*" (rivers) coming down from the Andes, and in Central America. Of course in Africa which gave birth to humankind in the Rift Valley. Simultaneously or successively, with most of times great gaps in history, the fertile regions which were propitious to the development of the Neolithic Agricultural Revolution, soon invited people to build their original settlements in earth. The alluvial soils, rich in sand, silt and clay, mixed with the straw of the farmed crops, have given birth to the first solid and durable building material: the earthen bricks dried under the sun or unbaked bricks now commonly called "adobes". Whatever the isolation of these different ancient civilisations was, whatever the relationships between them were, the art of building with earth rapidly flourished with the much more generalised use of the unbaked earth brick.

This article, in form of a synthesis, is based on a research carried out for presenting a 3<sup>rd</sup> cycle thesis in the "D.P.E.A.-Terre" driven by CRATerre-EAG, at the School of Architecture of Grenoble, France. It was prolonged by the presentation of a DEA equivalence, at the "Ecole Pratique des Hautes Etudes", Paris, IV<sup>th</sup> Section of "Sciences Historiques et Philologiques", under the direction of Professor Jean-Claude Margueron. In a first part, the article focuses on the evolutionary process of earthen building cultures in Near Orient and Mediterranean regions from ancient times and then points out the permanence of a large range of practices up to recent times as numerous living vernacular traditions are showing. In a second part, considering the importance of this building and architectural legacy, it is worth to question the major problem of the maintenance of a building techno-diversity for the future, according two directions: the architectural heritage conservation, and the relevant potential of the earthen building practices for a sustainable development.

As architect I am particularly indebted to all the community of scientists in archaeology of the

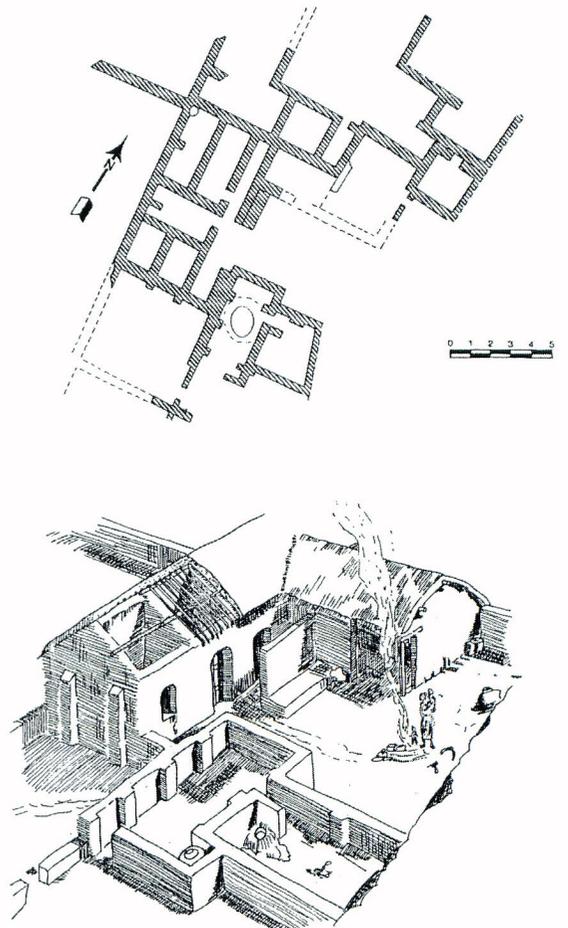
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world who has conducted patient works, passing on to humanity all the memory of the building cultures of humankind and this so exceptional and valuable scientific knowledge. Concerning the history of the vaulting construction in Orient, I want specifically thank Dr. Roland Besenval who has conducted his reference research on the “Technology of the vault in Ancient Orient” [Besenval 1984a: p. 74 and Besenval 1984b: Pls. 60 and 102].

### Main features of earthen building cultures in Ancient Orient “From the village to the town”

The organised production of what we now commonly call “adobe” has extended during the VII<sup>th</sup> millennium to be widely confirmed during the VI<sup>th</sup> millennium. In Anatolia, the site of Çatal Hüyük (Turkey), a Neolithic settlement which was inhabited between 6500 and 5700 B.C., shows an advanced degree of the adobe construction where the bricks, laid with mortar, fill up bearing structures made of wooden pillars and beams. The builders were already mastering the technology of lime plastering [Mellaart 1967: p. 232]. In Mesopotamia, the culture of the unbaked brick which was gifted with a great flexibility of use and of excellent structural performances characterising the masonry in small elements, would be progressively mastered during The Ages of Hassuna (mid-VI<sup>th</sup> millennium) and then during the Ages of Samara (from the V<sup>th</sup> millennium). These ages correspond to the coming out and progressive extension of bigger structures with thick walls strengthened by big pillars and buttresses (see Tell Hassuna Fig. 1). Some nice examples of such structures have been found at Chogha Mami, in the middle Tigris valley, or at Tell es Sawwan (Iraq). These massive farming constructions and other dwellings presenting some characters of ostentation are archaeologically



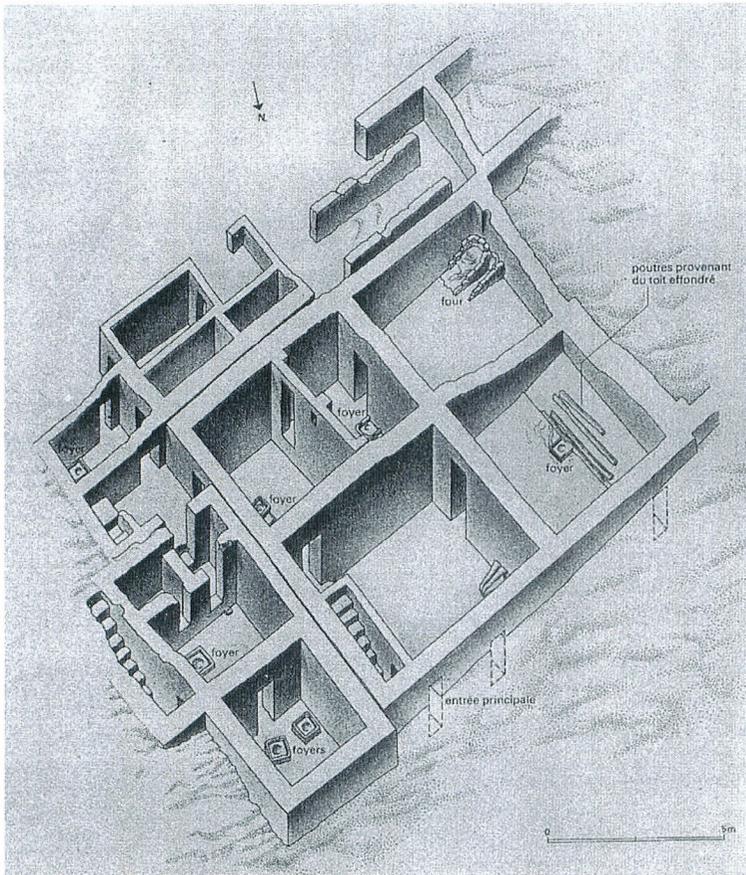
**Fig. 1** Adobe people’s housing of the 6<sup>th</sup> Millenium B.C. at Hassuna, IV<sup>th</sup> Level. Drawing from Nagel, see Gullini, Giorgio, 1970,71, in *Struttura e Spazio nell’Architettura Mesopotamica Arcaica, da Eridu alle soglie del Protodinastico*, Università di Torino, ed. Giappichelli, Torino, Italia, p. 187. Comments: we can already observe the structural consolidation of the earthen construction with outdoor and indoor buttresses. The roof should have been still thatched on a basic carpentry covering short spans with girders and rafters.

foreshadowing what Olivier Aurenche has defined as being the “*signs of the town*” [Aurenche 1985]. During the IV<sup>th</sup> millennium, the phenomenon of a town planning process was growing and extending with a transfer of patterns from regions to regions, channelled by a colonisation of new territories that are sometimes very far from the founding sites. This mobility of building, architectural and town-planning models follow people’s migrations moved by the searching of new settling sites, or pushed away by economical stakes or warlike events. On these considerations, Jean-Claude Margueron has made the hypothesis of such a transfer of cultural patterns from south Mesopotamia (Ur, Uruk) up to the North, in the territories of the Euphrates loop, with the founding of Mari [Margueron 1991].

### ***The coming out of a monumental architecture and vaulting structures***

The middle times of the IV<sup>th</sup> millennium seem to confirm a new step of evolution of people’s building ability with the coming out of the vault and cupolas. The first known examples show a corbelling building system. These vaults are not erected on top of bearing walls but directly on the ground. Some remains which have been excavated at Tell Arpachiyah, north of Iraq, conserved at a height of 80 to 85 cm, describe this building process of corbelling vaults and so is doing the famous Tholos 42 of Yarim Tepe in the same regions [Besenval *op. cit.*, see also Merpert *et al.* 1973]. By the beginning of the IV<sup>th</sup> millennium, with the Ubeidian period, a new type of monumental earthen architecture emerged defining its typological and spatial characters on the use of the symmetry where the rooms, similar in size and equal in number, were laid around a central rectangular or “T” shaped space. Several buildings present typical layouts organised in three parts. Chiefs of villager communities may have lived in the most elaborated of them, as they seem to have sheltered meeting or reception rooms. Such edifices have been excavated at Tell el’Oueili, near Larsa, at Eridu, southern Iraq, or at Tepe Gawra, northern Iraq. The birth of the Civilisation of Sumer and then of Elam, on the plateaux of Khuzestan, actual south-west of Iran, from the mid-IV<sup>th</sup> millennium, confirms the settling of the first religious centres which foreshadow the temples-towns. During the period of Uruk, the famous temples of Eanna and the White Temple of Uruk, the Temple of Enki, at Eridu, are built up on high earthen brick platforms. The aesthetic composition of their elevations affirms the principle of successive recessed and projected facings that would be dominant in the Mesopotamian architecture. By the entry in the III<sup>rd</sup> millennium, the VIII<sup>th</sup> level of Tepe Gawra [Speiser 1935] (room 846) testifies of the construction of the barrel vault with quite impressive structural performances (a span of 3,25 m and 8,50 m long). Roland Besenval quoted: “*It seems that it should be one of the first arched or barrel vault used for covering some important structure and presenting a radiating building process.*” At Yanik Tepe, structures erected on circular layouts have been found. They could be inherited from the Chalcolithic Transcaucasian building culture if we refer to the sites of Shulaveri and Shangavit. The external diameter of such structures could reach the impressive size of 6,20 meters. But the excavators prefer to hold the hypothesis of some wooden and thatched roofing system and not earthen bricks cupolas [Burney 1961].

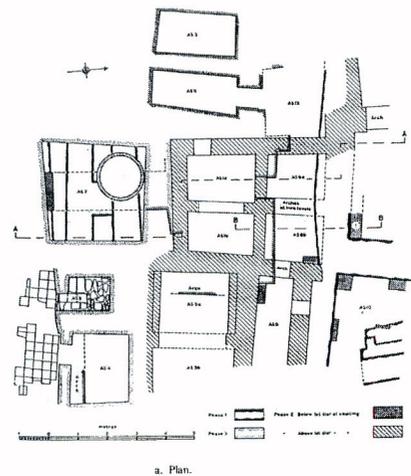
The proto-dynastic Ages (2700–2500 B.C.) generalised the development of religious towns around temples. At Khafajah, mid-valley of Tigris, the tombs settled around the famous Oval Temple are exhibiting earthen bricks vaulting systems. The bricks are plano-convex. These vaults are built up in successive inclined arches, placed side by side, with a generating broken section. The average dimension of the tombs is about 3,40 m × 1,20 m. These roofing solutions were also adopted for the dwellings as the site of Tell Asmar (Central Iraq), with its “arch houses”, shows [Delougaz 1967]. Wooley has made similar findings at Ur, on the Royal Tombs [Wooley 1934]. On the Iranian Plateau, at Shahr-i Sokhta, rural people’s houses of mid III<sup>rd</sup> Millennium (circa 2400 B.C.) developed a clustering design which confirms the evolution to an urban design (see Fig. 2). At Mari, east of Syria, the Presargonic period (2500 B.C.) shows an evidence of small houses which are organised around a



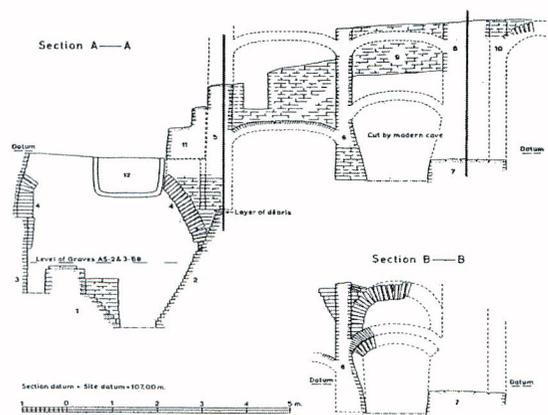
**Fig. 2** Adobe people's housing of the 3<sup>rd</sup> Millenium B.C. (around 2400) at Shahr-i Sokhta, Iranian Plateau. From Cleuziou, Serge, 1981, "Les villes du plateau iranien au III<sup>e</sup> millénaire", in *Le Grand Atlas de l'Architecture Mondiale*, ed. Universalis, Paris, 1981, p. 185. Comments: we can observe the clustering process of the people's housing of those ancient times clearly associating three housing units each of them having their own fire places. The presence of staircases confirms the previous existence of one storey or one accessible flat terrace. Entrance doors should have given on narrow streets.

raised central space as is showing the famous miniature of the "Red House". The great "cella" of the Ninni-Zaza and Ishtar Temples could have been covered by terraced wooden and earthen structures (see hypothesis of restitution by Jean-Claude Margueron and Olivier Callot [Margueron 1984a]). By the II<sup>nd</sup> millennium the Mesopotamian skyline was progressively marked out by prominent structures, the ziggurats, built up in successive platforms of unbaked bricks that would be then protected and adorned by burnt and glazed bricks facings. This architectural and religious tradition (these ziggurats were crowned by temples at their summits) which had been initiated on such sites as Ur, Eridu and Uruk, in southern Iraq, would extend and spread all over the Mesopotamian territories. Chogha Zanbil or «*Dur-Untash*», in Iran, south of Susa, exhibits one of the most famous examples of such tradition known today (see Pl. 1a). This site which was created by the Elamite King Untash Napirisa, around 1200 B.C., discovered by René de Mecquenem, and then excavated by Roman Ghirshman during the fifties to the sixties of the XX<sup>th</sup> century, shows an original building system the design of which is explained by the successive steps of construction of the structure. As the result of this construction history, the ziggurat is not commonly built in successive piled up platforms but in a way of encased levels, as a "Russian doll". This building principle is attested by a gallery that has been dug by the excavator from the north-west side up to the core of the ziggurat. The first and the second levels shelter in their thickness several chambers and temples (the Temple of the god Inshushinak, located at the first level, right site of the south-east elevation), which have been roofed with vaults. Located at the south-east part of this large site, beyond the second wall, the exceptional remains of the tombs of the Hypogeum Palace undoubtedly exhibit among the nicest barrel vault of those ancient times in the Mesopotamian space. All these structures are by now under a process of conservation and "mise en valeur", thanks to the ICHO-RCCCR-UNESCO-Japan Trust Fund and CRA Terre-EAG Chogha Zanbil Project carried out since 1998.

The period of Isin-Larsa corresponds to the apogee of a very elaborated town planning, particularly in southern Iraq, around Larsa and Ur. At that time was confirmed the patterning of an earthen urban habitat organised around indoor open yards. The famous two-storied house of Ur shows this principle of an introverted layout with a patio distributing the rooms all around, by direct access at the ground floor, and by a staircase leading to a gallery at the second floor. The typical pattern of the earthen oriental house had already been totally accomplished and would stay without any major changes, from that time up to now. At Tell Al Rimah [Oates 1964, 65, 66, 67, 68, 71 and Besenval *op. cit.*] (Zone AS 1, a & b, see Fig. 3), north of Iraq, the beginning of this period of Isin-Larsa has passed on the mastery of the lowered brick vaults erected in inclined arches and defining two typical building patterns: either one progression from the four angles of the top walls of the rooms, or from the two short sides of the room. Both these patterns are now still used by contemporary Iranian builders. Beyond this time, there will be a generalisation of the radiating barrel vault and the civil as well as the monumental architecture will both build in unbaked and burnt bricks, these last ones being much more used. This is a typical feature of the building culture of the Medio-Assyrian period which will conclude by the unification of Sumer and Akkad Kingdoms by King Hammurabi, founder of the Babylonian Empire (1750 BC). Around 1200 B.C., in Syria, a period corresponding to a large extension of the Hittite Empire, new towns were settled around worshipping centres, still all built in earth bricks. Such is the city of Meskene-Emar, erected along the banks of middle Euphrates River, and its “Neighbourhood of the Soothsayer” with both temples of Baal and Astarte. All around, the people’s dwellings are erected in dense clustered structures, following the natural slopes of the

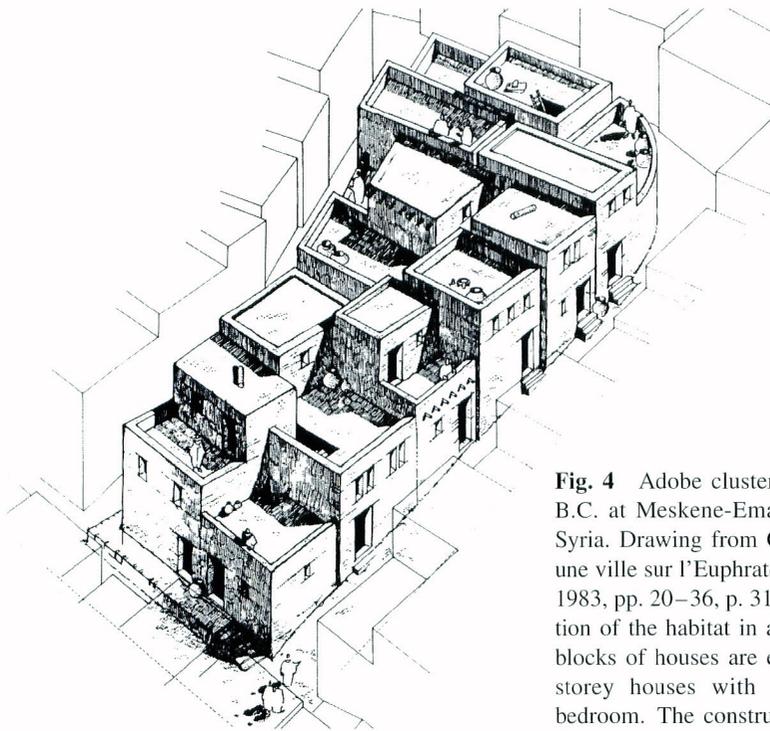


a. Plan.



b. Coupes.

**Fig. 3** The excavations of the AS Zone, at Tell Al Rimah (Period of Isin-Larsa, II<sup>nd</sup> Millenium B.C.), North of Iraq, have revealed the existence of vaulting systems covering narrowspanned spaces (1 to 1,5 m.). From Oates, D., “The Excavations at Tell Al Rimah”, 1970, *Iraq*, vol. XXXII, pp. 1–26, in Besenval, Roland, 1984, *Technologie de la voûte dans l’Orient Ancien 2*, éd. Recherche sur les Civilisations, Paris, 1984, Pl. 114. Comments: These vaults are flattened and should have been built without casing but directly on the ground or filling up materials after having erected the walls in adobe.



**Fig. 4** Adobe clustered people's housing of the XIII<sup>th</sup> Century B.C. at Meskene-Emar, block D (North-West part of the tell), Syria. Drawing from Callot, Olivier, in Margueron, Jean, "Emar une ville sur l'Euphrate", in magazine *Archaeologia*, n° 176, mars 1983, pp. 20–36, p. 31. Comments: we can observe the densification of the habitat in an urban planning design where successive blocks of houses are encircled by narrow streets. They are two-storey houses with upper terraces accessible from a high bedroom. The construction is following the slope of the natural ground and the terraces are enlightened by the sun all the day when the streets are more under shadowed. This architectural and urban design is totally actual in numerous traditional Syrian villages.

ground, and roofed with terraces (see Fig. 4). This town planning testifies of an accomplished urban earthen building culture that is fully adapted to the physical and climatic environment. The construction principle of vaulted roofs, in unbaked or baked bricks, will be permanently used up to the Neo-Assyrian periods (1000–600 B.C.). In between, during the Neo-Hittite Period (900 B.C.), some nice examples have been excavated at Tell Halaf, north of Syria in the sector of the Temple-Palace, with a wide variety of generating sections, from the lower, the barrel, to the raised up and broken design. During his reign, Sargon the II<sup>nd</sup> (729–705 B.C.) built Khorsabad, or "*Dur-Sharukkin*", which was fenced by a high quadrangular enclosure sheltering the citadel whose palaces and religious structures exhibited very nice examples of barrel vaults in unbaked bricks which also covered the main gates of the city. Then, under the reign of Sennacherib, the superb city of Niniveh, settled on the eastern banks of Tigris, would develop this system of fortifications with impressive entrance vaulted gates. There should have been 15 of such monumental gates. There are no very readable remains of the people's earthen habitat of that time but some dimensional graffitis, or reliefs, which have been found on the site, seem to evoke modest rural structures, roofed with over raised vaults. Their design can remind the conical corbelling cupolas that can be still observed, but more and more rare, in the region of Aleppo, in Syria.

#### ***A very clever earthen structural element for covering spaces***

During the dominating period of the Medes, appeared an original earthen building element that was used for covering spaces and being mainly used over the Iranian space. It is known as the "*strut*". It is a kind of precast element, made of earth and straw, reinforced by wooden pieces, shaped in portions of arches. Several of such elements are jointly laid, end to end, in order to configure a plain arch. This clever technology is replacing the use of bricks in the construction of arches and also for building vaults, resulting in an easier as faster building process, and saving of working labour and time. According the size of the spaces to be roofed, three to five or six struts are enough to achieve

the shaping of an arch. The site of Nush-I Jan Tepe, in Luristan (Iran), with its Central Temple, its West Temple, its Fort and its southern Street, releases this revolutionary technology for the first time in History [Stronach 1969 and Roaf & Stronach 1970]. Under the Neo-Babylonian epochs and under the reign of King Nebuchadnezzar, the new city of Babylon is flourishing. The unbaked brick will stay the main building material, but mainly used for popular structures, as the construction in baked bricks is going to be generalised for the palaces and monumental public buildings. These edifices are commonly faced with glazed bricks (Gate of Ishtar giving access to the sanctuary of Marduk). Much more trapezoidal bricks are used for building arches and vaults. The famous ziggurat Etemenanki, made of successive high terraces, still built in unbaked bricks, has testified of the reinforced masonry as the layers of building materials are embedding strong interlaced cables of twisted reeds [Koldewey 1918 and Reuther 1926]. Earthen builders have become structural engineers.

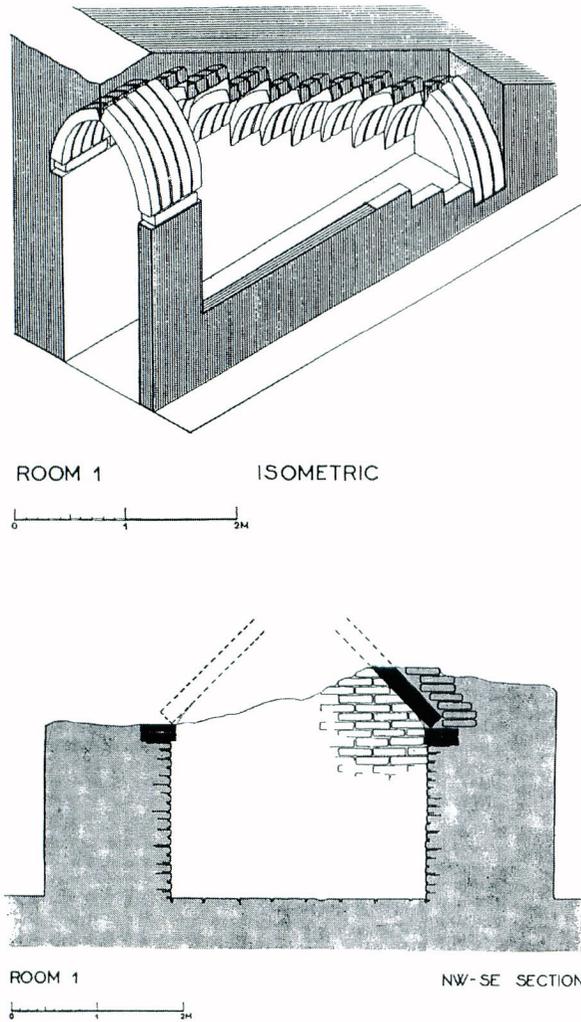
### *The blooming of the earthen vaulting technology*

With the conquests of Cyrus the II<sup>nd</sup> and the extension of the Achemenid Empire, with the assimilation of the Ionic influences, the use of stone extended but would not push out the ancient earthen building culture. The sites of the Fars valley (Pasargadae and then Persepolis), and then the Palace of King Darius at Susa, confirm the principle of the Apadana and the invention of the Hypostyle room, giving an ostentatious character to the palatial edifices. Nevertheless, the thickness of the outer bearing walls protected by a veneering of stones was still made of unbaked bricks. The use of the strut technology has been still attested at Persepolis for covering staircases and corridors embedded in the ramparts closing the access to the Apadana at the eastern side. At Susa we can also observe footing systems in rammed earth (“*pisé*”), or gravelled earth which is tampered in layers, between thick facings of burnt bricks. The use of “*pisé*”, and of the strut too, have been also testified by excavations made at Dahan-i Ghulaman (Iran, Seistan), on Building n° 3 [Scerrato 1966]. All these building systems and particularly the brick vaulting technology, were commonly adopted by the Persian vernacular architecture and spread all over Orient, up to the far eastern territories of the Achemenid Empire which was conquered by Alexander the Great. We can see such vaulted constructions in oriental Bactria, in Afghanistan (the mausoleum of Ai-Khanoum [Bernard 1972]), in Uzbekistan-Khorezm (mausoleum-fort of Koj Krylgan-Kala [Tolstov 1967]) where the vaults exhibit a parabolic generating section, either lowered or raised up, and with a high degree of mastery and sophistication at the site of Balandy II (400–200 B.C.) in Kazakhstan-Khorezm, where the vault adopts a toric shaping. Here too, the earthen brick masonry is erected on a basement made of rammed earth.

Then, during the Kushan period, in Afghanistan, the builders commonly developed the construction of vaults erected on square and rectangular layouts. This is the technology of lowered vaults and cupolas, built on squinches, also called “*balkhi*” vault, which is marvellously exhibited by the cistern (“*Sardoba*”) of Dilberjin Tepe [Kruglikova 1974], in Bactria. The Parthian Arsacids went on building vaults in struts as show the site of Shahr-I Qumis (Damghan) where several staircases and small rooms in short span (from 80 cm to 3 meters) have been excavated (Sites IV, VI, VII, see Fig. 5) [Hansmann and Stronach 1970]. Beyond these Parthian periods, the Sassanid reached the summits of the vaulting technology when they erected the first iwans, generalising the previous exceptional model of Ctesiphon (King Khosrau the I<sup>st</sup>, banks of mid-Euphrates, central Iraq, not far from the actual Baghdad). This is on such cultural footings having reached to a great mastery of the brick masonry and the vaulted technology that would flourish the building and architectural tradition of the Muslim Persia growing with the extension of Islam in this region.

### *The legacy of the earthen building culture in Iran* (see Pls .1b, 1c, 2a and 2b)

The first great mosques erected during the Caliphates, under the Ommiad dynasty, and then under the Great Abbasids, have chiselled the legacy of the Persian builders that would be raised at its highest level of brightening up by the beginning of the XVI<sup>th</sup> Century under the Dynasty of the



**Fig. 5** On the Site of Shahr-i Qumis, Iran, Damghan, Parthian Period, 1<sup>st</sup> – 2<sup>nd</sup> Century A.D., sites IV and VI. During those times, the Iranian earthen builders have invented a new way for covering the housing spaces, including the staircases: the “strut”. From Hansman, J. and Stronach, D., 1970, “Excavations at Shahr-i Qumis,” 1967, pp. 29–62, in Besenval, Roland, 1984, *Technologie de la voûte dans l’Orient Ancien 2*, éd. Recherche sur les Civilisations, Paris, 1984, Pl. 64. Comments: As we can observe on these isometric perspective on room IV and section on room VI, the technology of the strut has proposed different types of covering elements that have been adapted for vaulting or two-slopes roofing. On the same site of Shahr-i Qumis, Hansmann has also excavated larger rooms covered with three struts (site IV, room 3, site VII, room 5) as well as Stronach (1969) who has found such covering structures at Tepe Nush-i Jan with the vault on the room 2A. This roofing technology using light long elements made of earth and straw directly shaped and moulded on the building site have been used up to the Persian times as several corridors in the fortifications of Persepolis have shown. The abandon of this very clever building process is still a mystery.

Safavids. Isfahan, capital town of Shah Abbas, is one of the most spectacular demonstrations also renewed in many other Iranian towns as Shiraz, Seojan, Tabriz, and Kerman. How more beautiful is this superb Meidan-é Imam Square, with its architectural composition opposing from one side the Great Mosque (oriented at 45°) to a central iwan giving access to the Bazaar on the opposite side, and from both long sides of the square, the facing of the smaller Sheikh Lotfallah Mosque and the Ali Kapu Palace? All around this wonderful square, so many examples of structures in arches and cupolas covering the Bazaar are still observed. In the city, the old houses made of earthen bricks seem to be much more rare, having been destroyed and replaced by steel structures filled up with burnt bricks or by concrete structures of our modern time. But visiting the periphery of Isfahan and leaving the city, many earthen vaulted caravanserais and villages are still existing. At Gavart, a small village located between the airport of Isfahan and the city, the surrounding landscape and the skyline is still marked out by the famous pigeon towers exhibiting one of the best examples of such exceptional rural building traditions in the world.

Undoubtedly, Iran is one of the Central Asian countries still testifying today of the greatest diversity of the earthen architectures. We can meet the tradition of wattle and daub on the piedmonts and in the bordering plain of the Caspian Sea, as well as on the arid slopes of the Elbourz Mountains. They are half-timbering houses filled up with daub (“*torchis*”) made of clayey soil mixed with rice blades (locally called “*kula*”) and chaff. But the tradition of the earthen brick is undoubtedly the predominating building culture in Iran where the popular architectural heritage is essentially built with it, as in

regions of plateaux (Baghestan), or in mountains (where it is associated to the stone and the wood) or in central desert (Yazd) and southern semi-desert regions. There is also a mixed building technology associating the earthen brick with the “cob” as we can observe around Isfahan and in Khuzestan. The traditional techniques of plastering are also calling for the use of earth mixed with straw. The white clay or “*gel-é sefid*” is used on the border of the Caspian Sea, when the yellow clay or “*gel-é zardî*” is used in the region of Elbourz, as well as the “*khâ-gel*”, also mixing a clayey soil with chops of straw, is the tradition of Khuzestan. The tradition of flat roofs predominates in most regions of piedmonts and valleys. Here, the wooden girders are covered with woven matting of straw or reed, then covered by small branches of local trees which are recovered by a layer of compacted earth, or “*gelenazok*”, then protected by a finishing layer of “*khâ-gel*”. On the other side, the vernacular tradition of Iranian roofs is more directly inherited from the ancient culture of arches, vaults and cupolas made of bricks. Most of the time, the arches are built up on forms made of gypsum reinforced by straw that are directly moulded on the ground. This technology is undoubtedly a survival of the ancient Parthian “strut”. Considering the actual typology of vaults, it appears to be very diverse. We can observe the simple barrel vault or “*taq-o-chechmeh*” which is declined in other types called “*bangui*” or “*chamchiri*” in mountain regions, the shuttle vault which is progressing simultaneously from both short sides of the rooms, probably inherited from the ancient vault “*balkhi*” of the ancient times and today called “*lili pouch*”. And there are also much more complex vaults as crossed vaults, edging vaults and vaults on squinches (“*lengeh pouch*”). Other mixed solutions associate arches erected in the spanning direction that then bears portions of vaults (oblong cupolas)). And surely the very common tradition of vaults on pendentives, or “*dorshin*”, when the most spectacular are the vaults built with a network of ribs then filled up with bricks creating different decorative patterns. This is the famous “*yazdi-bandi*” bonding tradition or that of the ribbed cupolas called “*torkine*”.

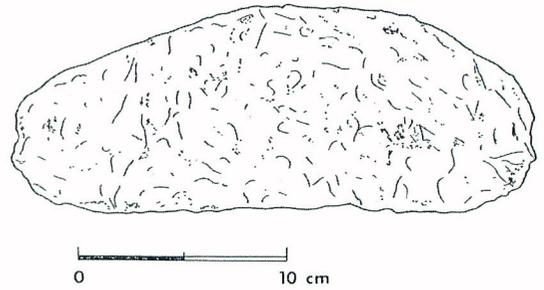
Beyond these exceptional earthen building know-how, the Iranian builders have also passed on other extraordinary traditions as this one of the wind tower, or “*badguîrs*”, that are a typical feature of the vernacular architecture in the bordering plains of southern Iran where the hot and humid climate imposes the air conditioning of spaces. The same clever device can be observed in the semi-desert or desert regions of Central Iran, in and around Yazd, where sometimes these wind towers are separated from the houses but bound to them by a tunnel conveying the fresh air. This tradition of the “*badguîrs*” was still used for conditioning the houses during the recent Khajar Period as we can see in the very nice and famous burgess houses of Kashan. What impressive lesson of architecture!

In most of other oriental countries (Sultanate of Oman, see Pls. 3a, 3b and 4a, or in Saudi Arabia, see Pls. 4b and 4c), as well as in Central Asian countries (Afghanistan, see Pl. 5a, or in Turkmenistan, see Pls. 5b and 6a), this wonderful vernacular tradition of the earthen architecture constitutes an exceptional legacy.

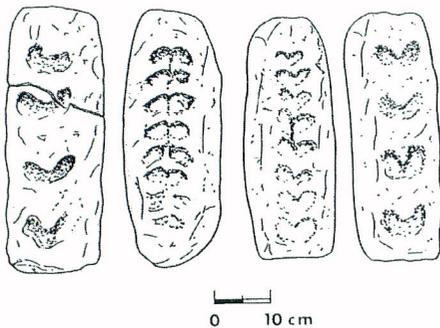
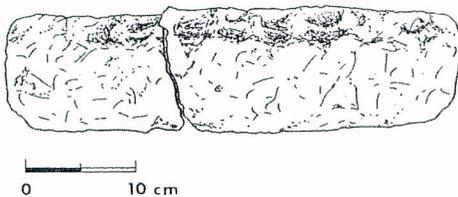
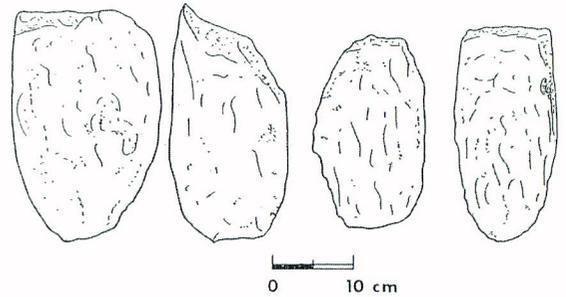
## **The Levant and the Mediterranean Region**

### ***The primitive periods***

The regions of the Mediterranean Levant and of the Taurus-Zagros Arch, today including Lebanon, Syria, Palestinian territories, Israel, Jordan, extended to the actual regions of Iran and Iraq, were the founding territories of the greatest ancient cultures and civilisations which have excelled in the earthen building art. The unbaked brick was the vector of a fantastic urban development during the IV<sup>th</sup> and III<sup>rd</sup> millennium B.C. despite this building culture has been emerging since the VIII<sup>th</sup> millennium as the famous site of Jericho has testified. At that time, the habitat is settled on hill slopes, both embedded in the thickness of the soil and partially aerial. It is basically oval and round shaped. The walls are erected with a kind of small hand-shaped earthen “breads” (see Figs. 6 and 7) which seem to have been built at their plastic state, without any mortar. This technique could be compared to what is called “cob” in England, or “bauge” in France, consisting in piling up plastic earth balls or packs, in order to

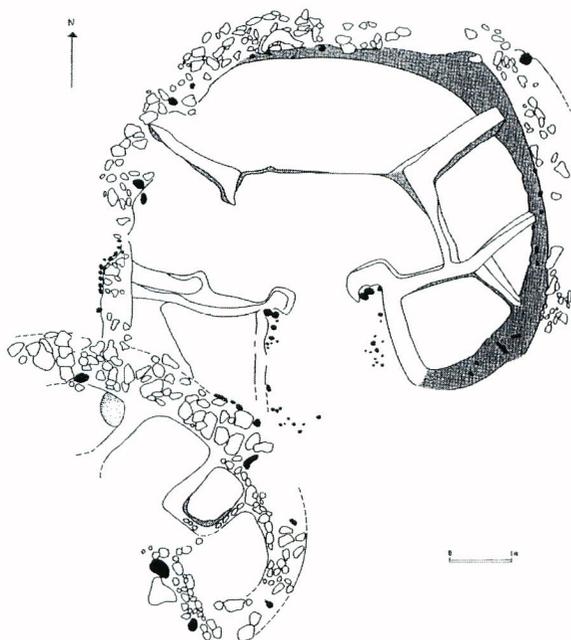


**Fig. 6** Moulded adobe bricks at Jericho PPNA. From Kenyon, K.M. and Holland, T.A., 1981, Pl. 152a (upper) and Pl. 44a (lower), in Aurenche, Olivier, 1993, “L’origine de la brique crue dans le Proche-Orient Ancien”, in *Between the rivers and over the mountains*, Rome, 1993, p. 73. Comments: these unbaked earthen bricks are shaped as small breads and should not have been very regular. We can suppose that they have been used at a plastic state (not dry) and built without mortar, just packed on together for erecting successive layers.



**Fig. 7** Moulded adobe bricks at Jericho PPNA. From Kenyon, K.M. and Holland, T.A., 1981, Pl. 138b (upper) and Pl. 138c in Aurenche, Olivier, 1993, “L’origine de la brique crue dans le Proche-Orient Ancien”, in *Between the rivers and over the mountains*, Rome, 1993, p. 77. Comments: these unbaked earthen bricks are much more regularly shaped and we can observe systematic marks made by the brick maker’s fingers. This might indicate that such bricks should have been possibly built at dry state with mortar, the marks facilitating the sticking between each brick.

realise successive layers of walling material. But compared to this technique, at Jericho, the walls are thinner and could be assimilated to a kind of direct shaping. This technology has been also observed on the site of Mureybet, Syria, where the common people’s houses of the VII<sup>th</sup> Millenium B.C. are round-shaped, partially embedded in the slopes of the tell, exhibiting small indoor spaces typically organised around a central space (see Fig. 8). This design is a permanent feature of numerous people’s houses across the following ages, with variations in the dimensions of the living spaces, but still common at the Early Bronze Age (*circa* 3200 B.C.) as we can observe on the tell of Bet She’an, in Israel (see Pl. 6b). Should it be a primitive design of what would become later the common patio of the oriental house? Later on, the influence of the earthen building know-how of Mesopotamia and also the influences coming from Egypt, in the art of using the common unbaked brick for building with arches extended in the territories of Near-Orient. Among representative examples of such evolution is



**Fig. 8** Round shaped houses with indoor partitions at Mureybet, Syria, by the VII<sup>th</sup> Millenium B.C. Drawing from Cauvin, J., in Huot, Jean-Louis, “Le Proche-Orient”, in *Le Grand Atlas de l’Architecture Mondiale*, ed. Universalis, 1981, p. 104. Comments: the structure of these people’s houses is partly embedded in the slope of the ground, back side and opened to the air at its front side with a small entrance door and space. The central room should have been the main living space with over small sleeping and storage rooms around. As we can see the structural design and position of the indoor partitions are playing a decisive play in the stability of the whole walling system and for bearing the wooden structure (probably made of jointed rafters) of a flat terraced roof. The central space seems to prefigure what will progressively evolve to the typical central patio or indoor yard of the further stage of the oriental houses. Such model from Mureybet will stay very common during the protohistory of Near Orient as well as the famous site of Mari, still in Syria, as revealed the same similar design of the famous “red house” (see Margueron, Jean, 1984).

the famous triple arched gate of the Canaanite city of Laish, at Tel Dan, northern Israel (see Pl. 6c) during the Middle Bronze Age (XVIII<sup>th</sup> Century B.C.). Apart from archaeological sites which are exhibiting remains of entrance gates covered with arches and barrel or inclined vaults built in unbaked bricks, the excavations carried out in the territories of Near-Orient have given few examples of the use of vaults or cupolas for the common roofing of vernacular people’s houses of ancient times. Some clues of the possible design of these people’s houses, during the Assyrian Times, have been given by graffitis which have been observed on the site of Niniveh. It seems that the conical-shaped vault, or corbelled cupola, might have been used and we could compare the morphology of this design to the shaping of vernacular houses in some Syrian villages, in the region of Aleppo (see Pl. 7a) which are today much more rare.

In Thessaly, Greece, primitive human settlements of the Mediterranean Europe are dated from the mid-VII<sup>th</sup> millennium (around 6500 B.C.), tracing back to the protoneolithic phase, so before the apparition of the ceramic. This primitive habitat settled on the border of the Aegean Sea, in the deep layers of Sesklo, shows huts presenting variable layouts, lightly buried in the soil. They are constructions made of wooden poles probably supporting walls in wattle and daub (“*torchis*”). The VI<sup>th</sup> millennium confirms the inputs of the Anatolian and Levantine building cultures up to Thessaly, Crete and Cyprus. Within its deep layers, the site of Nea Nicomedia (in Macedonia), exhibits a more advanced habitat but still made of wooden poles and wattle and daub. However, the houses have mainly one square room of a greater size (8 × 8 m). The soils are in compacted earth on top of an insulating layer of leaves and tree branches. In a post time of occupancy, we can observe the existence of an inside partition also made of wattle and daub. At the apogee of Sesklo [see Holtzmann 1985], during the mid-V<sup>th</sup> millennium (5500–4400 B.C.), the dwellings of the upper levels are both built in wattle and daub and unbaked bricks. They look much more structured and they adopt the rectangular layout. These houses should have been two slopes roofed and some of them should have been two-storied. Earthen walls are insulated from the humidity by stone basements, as the stone is also used for the defending walls and for some outdoor terraces of the site. However, these houses are still settled as independent farms and they are not really showing a social villager organisation. But, at that time, the basic layout of the habitat evolved to the “megaron” typology which would predominate

in the Ancient Greek architecture: one main room with a hearth slightly embedded in the soil, preceded by an open hall without frontage except a portico supported by one or two massive poles<sup>1</sup>). The same type of habitat has been found at Dimini (South of Sesklo) and would predominate during the Recent Neolithic Ages (4400–3000 B.C.), even if there is an evidence of a hierarchical society which is testified by the existence of some more important dwellings, settled on top of the hills of Sesklo and Dimini. These houses have also the typical opened entrance hall, but two rooms, the first one being larger and with the hearth. We have now a village structure protected by concentric surrounded walls, same devices which have been observed in the deep layers of Troy I (3000–2500 B.C.). Beyond these reference bordering sites of the Aegean Sea, in the inward and southern regions of Greece, the habitat looks much more precarious and invariably made of wattle and daub, a building tradition that might be connected with the Danubian building cultures (ribbioned ceramic) covering the Central Europe.

### *The Aegean World and the continental Greece*

In the Aegean world, the Ancient Bronze Ages (3000–2000 B.C.) which corresponds to the first civilisation of the Cyclades all over the islands, is marked by the development of the construction adopting the apsidal megaron type of layout, mainly built in stone and protected by thick defending walls including oval shaped towers (acropolis of Kalandriani, at Syros, sites of Paros and Melos). This protected habitat foreshadows the typical gathered town planning of the Cyclades that reaches up to our times. On Crete, during the Ancient Minoan (2700 B.C.), at Vasikili, the “house on the hill”, with its irregularly designed rooms, seems to announce the future palatial complexes. The earth might have been used, according the “cob” technology, piled up in casings at its plastic state [Sinos 1971]. The larger use of the unbaked brick seems to have colonised the Peloponnese just before the II<sup>nd</sup> millennium. In the deep layers of Lerne III, the “house with tiles” is erected within a fortified perimeter in the centre of which the American excavators have found this large building (25 × 12 m) showing a row of 4 rooms (among three of them present corridors). The starting of a stair confirms the existence of a second floor. All the thick walls of this house are erected in unbaked bricks and put up on a stone basement. These walls are plastered with stucco<sup>2</sup>).

During the Middle Bronze Age (2000-1500 B.C.), a very clear fracture can be observed between the continental Greece, which is submitted to Indo-European invasions and a cultural regression, and the Cyclades which seem to face a sudden rise of civilisation. In fact, in the Peloponnese, the Mycenaean fortifications increased. These fortified positions (Mycenae, Tyrinth, and Pylos) protected a rural habitat of shepherds, which was settled all around them. This habitat is not well known but seems to have been very precarious and maybe built in both wattle and daub (for inside partitions), and unbaked bricks (for main walling). The “house of the wine merchant”, and the “house of the oil merchant”, so called by the excavators, describe the characteristic megaron in three parts, inherited from the Thessalian Neolithic, with the “*prothyron*”, or portico with two columns *in antes*, the “*prodomos*”, or small anteroom, and the “*domos*”, or larger room organised around the hearth. But there is no many remains of such habitat, except some smaller villages that are conserving their fortifications built up in unbaked bricks<sup>3</sup>). After the brightening up inputs of the II<sup>nd</sup> millennium, some have spoken of a “coming back to the degree zero of the architecture”. At the same time, the insular context of the Crete favoured the harmonious development of the Minoan Civilisation. The superb “lighting palaces” of Knossos, Phaistos and Mallia, invested by the environmental nature, offered a very refined decoration. An omnipresent light comes in the rooms and cheers up the building materi-

1) See “*The beginnings of agriculture in Near-Orient and Europe*”, in Encyclopedia of Cambridge, 1981, pp. 110-111 with a drawing revealing the typical house in Sesklo.

2) According J. L. Caskey, quoted by Bernard Holtzmann, 1985, note 19.

3) According a description written by May Veber, Mycènes, creuset tumultueux de l’Hellade in *Les Grandes Civilisations Disparues*, 1980, pp. 70–79.

als: the tuff, the gypsum, the schist and the marble which are used for the main walls, the unbaked brick for the partitions or the wood used for the carpentry, the columns and their capitals, the porticos, the door and window frameworks. The wall facings are painted in dark red, deep blue, ochres, the sacred palette of the “*Minos*” residences, these kings-priests who are sharing the sovereignty of the Isle of Crete. Excavations that were made at Acrotiri de Thera (by 1967) have revealed what has been called the “Minoan Pompei”. The famous miniatures which are exhibited in the Museum of Herakleion, dated from the Mid-Minoan (1900–1600 B.C.) are representing the façades of typical houses and seem to confirm the post and beam building principle which might have been filled up with a blocking masonry of rubble-stones, as well as with unbaked bricks. But we know how this achieved scale of the civil Minoan town planning, and the splendour of the palatial architecture have been dramatically destroyed by a succession of violent seisms (Recent Minoan I a and b, around 1500 and 1470 B.C.) and the volcanic eruption of Santorin associated to a rain of ashes and petrified lava, and to a devastating tidal wave.

On the Greek peninsula, at the Mid-X<sup>th</sup> century, in Eubia, the city of Lefkandi seems to have played an important part since the II<sup>nd</sup> millennium. It has come to light an important structure of monumental character. This is a *Herôon*, an edifice that is consecrated to the cult of a Hero, which might foreshadow the first Greek temples. This apsidal-shaped building of 45 m long, the original walls of which are partially conserved at a height of 1,50 m for some parts, exhibits an unbaked bricks walling put up on a stone basement. The earth was used as bonding mortar. The inside facings were plastered with gypsum. The roof was supported by an axial bearing system of wooden columns in line erected on stone slabs and the pavement was in clay. This elaborated earthen architecture corresponds to a time that someone have called “the second starting of the Greek architecture” [Holtzmann *ibid*]. In fact the political context of that times (IX<sup>th</sup> and VIII<sup>th</sup> centuries), testifying of a reorganisation in regional states gifted with a relative stability, is favourable to such architectural fulfilment. At Smyrna, architectural restitutions which have been proposed by R.V. Nichols, shows a typology of habitat, also apsidal-shaped and protected by a thick fortification in unbaked bricks and stony material which is built up behind a cyclopean stone facing. The unbaked bricks are quite big (51 × 30 × 13 cm). Within this protected area of more or less 35000 m<sup>2</sup>, oval houses of about 3 × 5 m are settled without any specific order and also built with unbaked bricks of the same size, but not put up on a stone basement nor footings. Their outdoor facings are plastered. During the VIII<sup>th</sup> century, the apsidal megaron evolved to the rectangular shaping and Hellenic settlements extended up to Sicilia and South Italy (see Incoronato, near Metaponto). The walling building system in unbaked bricks, put up on a basement made of stone or big pebbles bonded with clay mortar, is widely used in the new Italic settlements (Sibari, Amendolara, Heraklea, Velia, Morgantina, Himere) and up to the Iberian peninsula as are testifying the Valencian sites of Vinnaragell and Pena Negra. It is undoubtedly from these coastline sites that the unbaked brick penetrated up to Catalonia and then to Aragon. At the same time, the Greek architecture started a petrifying process, particularly for its religious architecture and the unbaked brick would be more reserved for the megaron-type housing. The Greek domestic architecture developed later and stayed small, obscure and uncomfortable for a long time. This is only with the coming of Democracy (508–507 B.C., at Athens), that the civil and domestic architecture presented more elaborated principles as like the “*stoa*” (open portico with columns), the Hypostyle room, as the organisation of the rooms around an indoor peristyle. But during the blooming period of Pericles (453–429 B.C.), at the feet of the brightening up Acropolis of Phidias, the popular city was lying down in dense housing neighbourhoods mainly built in unbaked bricks or in post and beam structures filled up with such materials which were thatch-roofed and Athens looked like a great township. For the best living conditions, these houses are plastered with stucco or painted

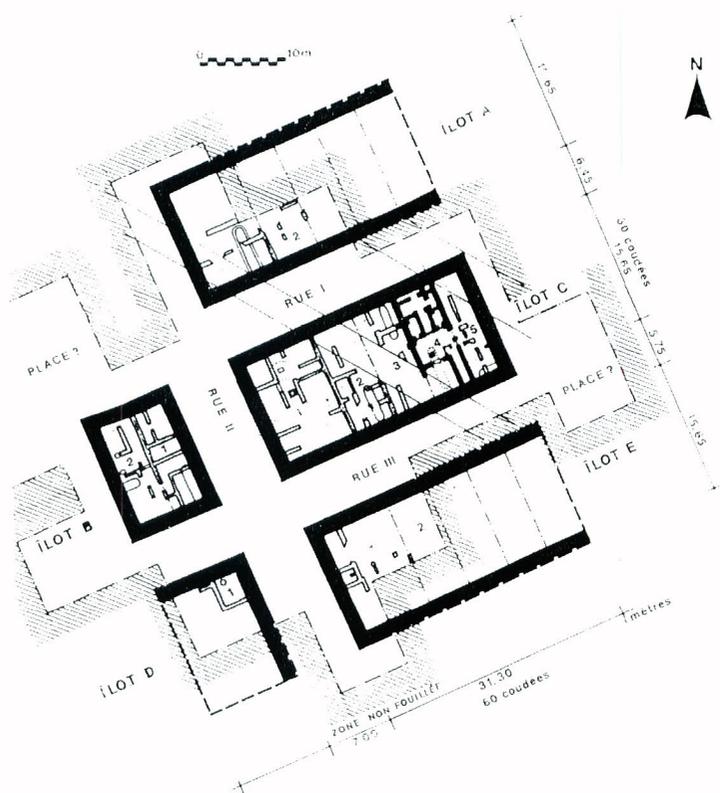
in bright colours<sup>4</sup>). Then the War of the Peloponnese (431–404 B.C.), between Sparta and Athens, and the subsequent instability for the villages and small townships of the rural areas, led to a regression in the use of the unbaked brick and a comeback to a temporary and precarious habitat built in wattle and daub and protected by defensive acropolis. However, all over the Greek world, the use of both “*Pentadoron*” and “*Tetradoron*” unbaked bricks has gone on until the 1<sup>st</sup> century A. D., as it was observed by Vitruvius during the Augustean Ages [Vitruvius 1674].

### *Phoenicians and Carthaginians*

With the apogee of the Phoenician stone construction in the urban context (Sidon, Tyr, Ugarit), the unbaked brick which has been a very common building material since ancient times in the Levant, was reserved for the construction of indoor building systems, as partitions of the rooms, and for the flat terraces where the material was compacted in several layers on top of a wooden ceiling. Out of the Phoenician cities, in rural areas, the unbaked brick still remains the main building material. Was the technology of rammed earth (“*pisé*”) that can be observed today in Lebanon and Syria developed during the Phoenician Ages? We have no conclusive findings on this subject. But, when the “People of the Sea”, pushed away by Assyrian attacks, had to transfer its civilisation to the littoral of North Africa, it has called for this technology of the compacted earth in wooden casings, associating it to the unbaked brick, for building the new Punic settlements. The birth of Carthage is taking place around 814–813 B.C. Its founding by Tyrians led by the Queen Elissa (or Didon according to Virgil) is a legendary history. The original settlement that was originally a modest colony called *Qart Hadashit* (*Karchedôn* for the Greek and *Karthago* for the Roman), or “new town”, became a powerful Mediterranean capital with an exceptional destiny. At its *acme*, by the II<sup>nd</sup> century B.C., its population should have reached about 700 000 inhabitants. During its first stage of development the original township was settled on the slopes of the Hill of Byrsa, configuring a modest acropolis. At its blooming stage, the city was covering about 2000 hectares, including several commercial and military harbours. This Great Carthage laying down in a perimeter of 32 kilometres was protected against threats that should come from the back inside land with an advanced line of fortifications. A twin rampart encircled the city itself. The French campaigns of excavations carried out on the Hill of Byrsa, by 1974–76, directed by Serge Lancel [Lancel 1979 and 1982], clearly show that Carthaginians have firstly used the slopes in order to establish a necropolis, the tombs of which being dated from the VIII<sup>th</sup> up to the VI<sup>th</sup> centuries. Then, this necropolis has been embanked to settle a neighbourhood of metalworkers with their forges and workshops. It is only by the beginning of the II<sup>nd</sup> century that this site has welcomed planned people’s housing units, the famous “Hannibal’s neighbourhood” and its housing blocks A, C and E (see Fig. 9) which can be visited today. These housing units exhibit a standard layout organising the rooms around a small indoor yard that is accessible by an entrance corridor. As confined spaces for the starting of staircases (probably in wood) are visible, these units might have been two or three-storied high. They have been settled according to an orthogonal urban design which looks typically Hellenistic; Serge Lancel and Jean-Paul Thuillier have compared it to the urban design of Olynthus, Priene and Solunte (V<sup>th</sup> to IV<sup>th</sup> centuries B.C.). According to Gilbert Charles-Picard [Charles-Picard 1980: p.14], the construction of this residential area should have been realised for some wealthy people, insofar as the housing units have been provided with a high level of comfort and luxury which could be allowed at that time. The cemented pavements were encrusted with marble, walls were faced with stucco, and very elegant thin columns summited with Ionic style capitals were ornamenting the façades. Bathrooms were satisfying exigencies of hygiene. Today, looking at the houses walling remains of the famous Blocks B and C, along Street II, one can clearly see the eclecticism of the Punic building culture where the use of the blocking stone masonry cohabits with unbaked brick and “*pisé*”

4) According to the historian, geographer and philosopher Dicaearque (347–285 BC), quoted by Lewis Mumford in his *La Cité à travers l’Histoire*, ed. le Seuil, Paris, 1964.

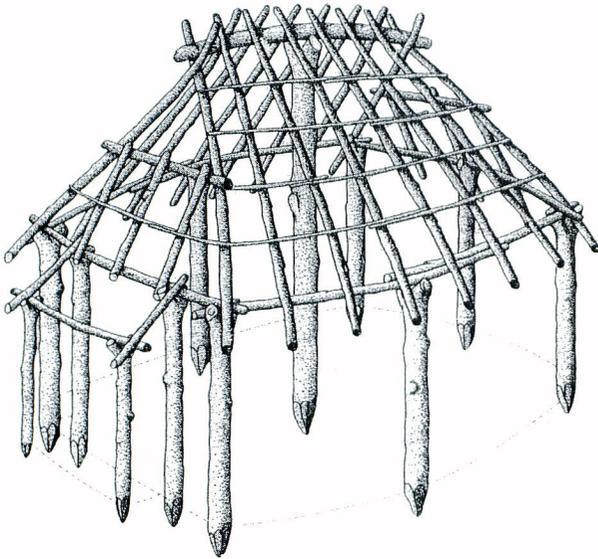
**Fig. 9** The famous Hannibal's neighbourhood which has been excavated on the hill of Byrsa testifying of the typical people's housing of Carthage during the 2<sup>nd</sup> Century B.C. some years before the last Punic War against the Roman. From Lancel, Serge, 1982, in "Byrsa II", Fig. 603, p. 369. These famous blocks A, C and E and particularly the block C located between Streets I and III, are showing the typical layout of the Punic houses or "flats" gathering five to six housing units in one urban block. Each unit is similarly designed with an entrance corridor giving to an indoor yard enlightening the back living rooms. Narrow staircases, probably built in wood, were giving access to a first and evenly to a second storey. The building culture of those times, in Carthage, was very eclectic associating the stone, the burnt brick and the unbaked earth used in adobe as well as "pisé" (or rammed earth). The bearing structure was made of stone pillars filled up with those eclectic building materials in between.



masonry, burn brick elements (see Pl. 7b). This is the typical "opus mixtum" or "opus africanum" (masonry within structural pillars in stone or burnt bricks) which has been related by the Roman. Only the main façades on the street were built with stones, put up in great bonding. These stones were coming from the Cap Bon, extracted in the quarries of El-Haouaria. The Hill of Byrsa, which had conserved its original topography all over the Punic periods of occupancy, was then totally embanked by the Roman. This was done late after the Victory of Scipion Emilian that has concluded with the total destruction of Carthage. This huge work was carried out to redesign and level the hill in order to settle the post Roman edifices, including the new Basilica and Forum. For that purpose, to warrant the stability of the new development ground and fond the edifices, the Roman have erected in compacted earth numerous thick footing columns some of them reaching a height of 9 m. These impressive footings in "pisé" are still visible (see Pl. 7c).

### *Italy and southern Gaul*

The site of Rome was already occupied during the Bronze Age as the findings of the *Forum Boarium*, dated from 1500–1400 B.C., are testifying. Later, at the beginning of the Iron Age (VIII<sup>th</sup> century B.C.), several of the famous seven hills were inhabited as are confirming two Villanovian hamlets which have been excavated on the Palatine. These hamlets seem to have been unified around a kind of common civic centre settled on the actual Forum area. At that time, the habitat was still very primitive. It gathers huts or wooden shanties, rectangular or oval shaped, supported by a central wooden pole and perimetric smaller poles. It is slightly embedded in the soil. The roof might have been in thatch and walls in wattle and daub. In that way, Rome, at the beginning of the VI<sup>th</sup> century, was just an agricultural township when it was influenced by Hellenic inputs which had been previously introduced by Greek colonists settling in Campania by 750 B.C., and then transmitted by the Etruscan domination. By that time Central Italy knows a real metamorphosis. The wooden huts, plastered with earth and thatch-roofed of the primitive Rome (see Fig. 10), were gradually giving place



**Fig. 10** The primitive house of the earlier republican times of Rome, during the Villanovian Culture, VIII<sup>th</sup> Century B.C. From Davico, A., in Holtzmann, Bernard, 1981, "Rome primitive et l'architecture étrusque", in *Le Grand Atlas de l'Architecture Mondiale*, ed. Universalis, Paris, 1981, p. 156. During those times, the roman construction is still very primitive and houses are wooden huts made of large posts bearing a thatched roof on heavy rafters. The shape of such huts is rather oval than rectangular but we can note the specific design of a sheltered entrance door. Such huts have disappeared during the VII<sup>th</sup> Century.

to rectangular houses built in unbaked bricks. Similarly to the first Etrurian temples, the first sacred and public monuments of the Republic (IV<sup>th</sup> and III<sup>rd</sup> centuries) should have been erected with unbaked bricks and tile roofings gradually replaced the thatched roofs. An orthogonal town planning took the place of the previous modest and disordered settlement. Great rectangular housing blocks, sometimes fortified by an embankment of earth, the "*agger*", preceded by a large ditch, were erected (see Marzabotto, near Bologna). By the V<sup>th</sup> century, Rome extended its domination from the Latium all over the Italian peninsula. New colonies were settled on the base of the fortified camps of the military legions, adopting a regular town planning (*Decumanus* and *Cardo*). In Rome of the IV<sup>th</sup> century, high blocks of flats (*insulae*) edge the streets where an important rural exodus, attracted by the commercial activity of the city, crowded. At this epoch of great change, the unbaked brick that had been previously the main building material was much more used for the construction of modest people's housing, for indoor partitions and most of the time for filled up post and beam structures. This popular technique of wood and earth construction was used up to the period of Nero (37–68 A.D.) and a lot of housing units were destroyed during the dramatic fire of the year 64. The same building process had been commonly employed for the construction of numerous new settlements of the Roman colonists when the Empire extended in actual Europe, particularly in Gaul. So many remains of such building practices have been found on French Gallo-Roman sites, in Lyon, Vienne or Vaison-la-Romaine, in Nîmes, Lattes or Arles. The recent works of the French archaeology carried out on the Mediterranean regions are confirming a large use on the unbaked brick, but also of the "*pisé*" during these periods (III<sup>th</sup> to II<sup>nd</sup> centuries B.C.)<sup>5)</sup>. The dimensions of the unbaked bricks have been very varied, some of them being very large (45 × 15/18 × 10 cm, in Arles) and other reminding the module described by Vitruvius (30/32 × 15/16 × 12/14 cm, in Vaison-la-Romaine). The unbaked brick seems to have been also frequently used for putting up indoor pavements (in Lattes).

On the Celto-Gallic territories, the Iron Age had develops a habitat settled in *oppida* gathering small wattle and daub or cob houses. In southern Gaul, on actual territories of Provence, from Languedoc to Roussillon, Hellenic influences were introduced with the creation of the first Greek trad-

5) See Desbat, Armand, "La région de Lyon et de Vienne", in DAF (Documentation of the French Archaeology) n° 2: *Architectures de terre et de bois*, 1985. This document concerns the excavations made at Lyon, Rue des Farges and at the Verbe incarné (Hill of Fourvière); but also at Saint-Romain-en-Gal (facing Vienne). See also De Chazelles, Claire-Anne, and Poupet, Pierre, in "L'emploi de la terre en milieu urbain: Nîmes," in *Revue Archéologique de Narbonnaise*, Tome XVII, 1984, ed CNRS, Paris, 1985. Concerns the excavations carried out on the site of "*Propriété Solignac*".

ing settlements, as *Phocea* (Marseille), *Antipolis* (Antibes), *Agathe* (Agde), *Nikaia* (Nice), and also on the Iberian territories with *Emporion* (Ampurias). This took place between the VI<sup>th</sup> and the V<sup>th</sup> centuries B.C. By that time, the “civilisation of *oppida*” of the southern Gaul<sup>6)</sup> rapidly adopted the Hellenic inputs and particularly the use of the unbaked brick which would substitute for the wattle and daub construction all over the indigenous settlements of the Gulf of Lion coastline. The evidence of such a change in the building practices is visible on sites as Ruscino, Enserune, La Lagaste or Entremont. Simultaneously, there is a gap between the coastline and inland settlements where the wattle and daub and cob building technology are still predominating. Then a slipping between the earth and stone construction gradually extended in numerous *oppida* during the IV<sup>th</sup> and III<sup>rd</sup> centuries [Fiches 1979].

During the Final Iron Age, the open rivalry between Rome and Carthage leads to the first Punic War (264–241 B.C.) which gives the support of *Emporion* to the Roman and allows the conquest of Sicilia. In southern Gaul, the legacy of successive Greek influences maintains the predominating use of the unbaked brick in construction. In his “*De Agricultura*” (14,4), Caton gives advises for building a farm, either in raw stones and lime mortar or in unbaked bricks put up on stone footings (*parietes ex lateres*). During the Second Punic War, inhabitants of Massalia (Marseille) give their support to Rome. Hannibal’s troops pass through the Alps and reach Italy. This period of great brightening up of Carthage might have contributed to a wider dissemination of the building technology in *opus mixtum* and blocking masonry of rubble-stones, “*pisé*” and unbaked bricks walling put up in between stone or burnt brick toothings, particularly on the Iberian peninsula, but also up to Sardinia (see the site of Tharros) and Sicilia. The ancestor of the Sardinian “*ladriri*” (in southern “*Campidani*”) might be searched into these old cumulated influences of Greece and Carthage.

When Caesar began the conquest of Gaul (59–51 B.C.), he observed a local construction where the use of rudimentary building materials was very common. The “*vici*” (rural townships) and the “*aedificia*” that he describes in his “*De Bello Gallico*” might have been undoubtedly built in wattle and daub or cob, evenly in unbaked bricks. In his “*De Bello Civili*”, Cesar gives an other description of the “*muris gallicis*” which is made of earth, stone and wood. At the end of the I<sup>st</sup> century, and up to the imperial Ages (in 31 B.C., after the victory of Actium), Rome was in its major part built in unbaked bricks or in post and beam structures filled up with this material. In his “*Roman History*” (XXXIX, 61), Dion Cassius evokes a rising of the river Tiber that over flooded all low neighbourhoods of Rome and notes that “the houses made of bricks took water from everywhere and collapsed”. Nevertheless, the “*lidio*”, “*crudi lateres*” or “*latericus paries*” still remained the building material for the popular housing, beyond the Augustean Ages. As previously observed, Vitruvius [Vitruvius, op. cit.] was taking the unbaked brick into great consideration, recognising “its greatest utility so long as it does not load the walls too much”. He willingly calls for its use “so long as someone building with it should take the necessary care for putting it up correctly”. He precises that to build with several floors, the unbaked brick construction should be twin layers bonded (“*paries biplinthus*”) or even three layers bonded (“*paries triplinthus*”). However, after this dramatic flooding of the river Tiber, the use of the unbaked brick was pushed away from the city as soon as building rules were promulgated which prohibited the construction of thick walls, obliging to respect a maximum thickness of one foot and a half (44,3 cm) for all party walls. By that time, for erecting high buildings, the Roman civil builders prefer to use post and beam structures filled up with a blocking masonry of mixed rubble stones and fragments of tiles, reinforced by stone bond beams. By the same time, in his “*Res Rusticae*” (I, 14,4), Varron evokes the “*pisé*” construction as regards as rural fencing walls (“*maceria*”) protecting an agricultural farm located on the Sabine territory. He describes the

6) 277 units of *oppida* have been identified in the Var, more than 300 in the Alps of High Provence and more than 200 in the Gard, all actual territories of Southern France.

technique as “a mixing of earth and gravel which is agglomerated in casings”. He also observes the common use of the unbaked brick (“*lateribus crudis*”) for the construction of such rural fencing walls (“*pars agraria*”). During the 1<sup>st</sup> century, in his “*De Re Rustica*” (X, 1,2 and XI, 3,2), on the subject of a hunting reserve construction, Columelle quotes that “if the cost of the stone and manpower allows it, the park could be fenced by a wall put up with raw stones and lime mortar, if not it should be erected with unbaked bricks”.

With the coming of the Julio-Claudian Dynasty (Tiberius, Caligula, Claudius and Nero), the tuff, baked bricks and blocking stone rubble-masonry with bonded cut stones or bunt bricks facings, became the main Roman public construction techniques. By 120 A.D., in his “*Augustus*”, evoking the Emperor Augustus, Suetone writes that he has embellished Rome and preserved it from the flooding and firing danger. He writes that Augustus praised himself to have received a town made of unbaked bricks and having left it in marble (“*marmoream se relinquere, quam latericiam accepisset*”). But the popular urban and the rural architecture, as the construction in numerous far-west provinces of the Roman Empire, went on using the unbaked bricks. In Gaul, the “*pax romana*” favoured an urbanisation pressure around the “*vici*” and other rural townships as well as the construction of numerous “*villae*”. As Strabon observed in his “*Geographia*” (IV, 4,3, and XII, 1, 67), “*Gallics are building large round houses with wooden planks and wattle walling that they are covering with thick thatched roofs*”. So, Tacitus in “*Germania*” (XVI, 3), on the subject of the German housing was noting that “*they do not make use of stones nor tiles; for every building purpose they use raw materials (“materia informi”) without taking care to any beauty or attractiveness; some parts are more carefully plastered with a so pure and so brightening earth that it imitates the painting and colouring strikes*”. Numerous settling sites of the Gallo-Romans “*villae*”, as far as over the actual northern territories of France, in Picardy, that have been identified by the famous aerial archaeology works carried out by Roger Agache and Bruno Bréart [Agache and Bréart 1983/84], are confirming the existence of basements put up in blocking stone rubble-masonry (“*caementicius paries*”) that should have been heightened with earthen building materials, unbaked bricks, or wood and earth walling whose falling in debris are clearly visible thanks to the colouring variety of the soils showing darken spots attesting of the ancient presence of buildings. The more elaborated “*villae*” have often made a distinction between the use of the earthen building technique, mainly reserved for the “*pars agraria*” (agricultural outbuildings), and stone or burnt brickwork technique for the residential building or “*pars urbana*”. Roger Agache and Bruno Bréart are precisizing that “*for the numerous large “villae” the quasi totality of employed materials are collected nearby the constructions: here as on the whole Gaul. But of course, earth is the most local easily available material for lacking of other building materials. (...) From plane, we can observe, nearby the constructions, one or several ancient quarries that have been transformed in ponds*”. Such characters of the Roman “*villae*” mainly built in unbaked bricks with a typical association of the burnt brick during the late Roman Times used as well as for structural reasons (consolidation) and aesthetic purposes are common in European countries where numerous sites have been excavated. The south-west of France (region of Aquitaine) and the northern territories of Spain (Castilla) are testifying of the blooming of this building art as, among several examples, that one of the Roman villa of La Olmedia, in Pedrosa de la Vega, a great residence of the IV<sup>th</sup> century A.D. is still showing (see Pl. 8a)

### ***In North African countries, or “Maghreb”***

The collect of the raw earth nearby the working site has been commonly used since ancient times and has been still adopted by vernacular earthen builders up to the recent times as we can still observe it in many countries where the earthen construction is still alive. This is actually the case in South Morocco, in the Drâa and Dades valleys (beyond Ouarzazate), when the “*m,alems*” (master masons) are still building houses and fencing walls in “*leuh*” (*pisé*). Effectively, earthen building traditions that

are still actual over northern African territories, in Libya, Tunisia, Algeria and Morocco, are originated from these ancient Carthaginian, Greek and then Roman successive influences that have been perpetuated, improved by further civilisations, up to the coming of the Arabic domination, and much further with the vernacular building practices which have passed on this ancient legacy by the channel of generations and generations of anonymous builders. This is really this “architecture without architects”<sup>7)</sup>, or this “spectacular architecture”<sup>8)</sup>, mainly built with earth, that goes up to us now and offers to see so diverse applications of elaborated building cultures tracing back to millenniums. The Hellenic and then Roman influences all over northern African territories are evident on numerous grounds of excavations. In Tunisia, from the beginning of the I<sup>st</sup> century to the III<sup>rd</sup> century A.D., the unbaked brick or “*pisé*” construction was very common in the Province of Byzacena as are testifying excavated dwellings in Acholla, the famous “*House with red columns*”, “*Asinius Rufinus’ House*” or “*Neptune’s House*”, which are dated from the reign of Marc-Aurele, or by 170–180 A.D. In “*Neptune’s House*”, the “*pisé*” is used for buttressing the pressure of a cistern located in the “*viridarium*”. In Uzitta, near Souss, several houses have been excavated showing a common use of earthen structures put up on top of stone basements. It might have been the same in the near Province of Tripolitania. The city of Thysdrus has passed on among the best-conserved testimonies of the public and domestic architecture of those times. In the “*Lucius Verus’ House*” and in the “*House with frescos*”, a great number of unbaked brick (50 × 35 × 9 cm) walling, put up on of stone basements built according the “*opus Africanum*” type have been observed. These remains of earthen walls are plastered with a 2 cm thick lime mortar. Again in Thysdrus, the “*House of the death masks*”, which is of Punic type, is built in “*pisé*” with 50 cm thick walls erected on top of a 70 cm high basement made of blocking stony masonry. During the period of Roman occupancy, in Tingitania (Morocco), the construction in earth has been attested on the site of Volubilis, particularly in the “*House with the cistern*” located nearby the North of the triumphal arch. This large dwelling, dated from the II<sup>nd</sup> century A.D., covered a private bath of about 150 m<sup>2</sup> from the I<sup>st</sup> century where “all walls present a stone basement at a variable height, when the elevation was in “*pisé*” or unbaked bricks” [Slim 1985]. The southern neighbourhood of Volubilis, called in other words the “craftsmen’s neighbourhood”, or “indigenous neighbourhood”, has revealed numerous findings of fit in together houses, gathered in a very dense cluster, all built in unbaked bricks laid on with a clayey mortar on top of 80 cm high basements in stone blocking. The size of the common bricks is 44 × 28 × 8 cm.

### ***The common ancient earthen building cultures legacy in the Mediterranean region***

The coming of the Antonine Dynasty (Nerva, Trajan, Hadrian, Antonin the Pious, Marc-Aurele, Comode), by the II<sup>nd</sup> century A.D., extended the “*pax romana*” over the far-east dimensions of a Roman Empire reaching its apogee at the end of this century. On purpose of the building culture, this brightening up of the Empire corresponds to the development of a burnt brick civil construction, particularly for the blocks of flats (“*insulae*”) which increased in number in most of the Roman cities (the “*insulae*” of Ostia are among the best examples of such a urban domestic architecture). But the construction in earth, in unbaked bricks or “*pisé*”, still predominated in most regions for the popular and rural architecture. Beyond the Fall of the Roman Empire, these buildings practices quasi definitively marked the rural and a great part of the urban people’s housing construction, particularly over the Mediterranean regions, up to the modern times. This cultural legacy has resisted to the coming back to the dark times of the High Middle Ages (from the V<sup>th</sup> to the X<sup>th</sup> centuries) that have known a regression to more common and simple building practices. In Italy, where various rural traditions can be still observed; that one of the “*casoni*”, in the “*Friouli*”, or that of the “*pinciaie*” of Abruzzi. But

7) Expression borrowed from Bernard Rudovsky, *Architecture Without Architects*, 1987.

8) Referring to Jean-Louis Bourgeois and Carrolle Pelos, *Spectacular vernacular*, 1989.

also the “*ladriri*” of the Sardinian “*Campidani*” (from Cagliari to Oristano) which could be certainly connected to the ancient Carthaginian influences (see Pl. 8b). Equally for the Iberian Peninsula. In Spain, region of Catalonia (around Barcelona), where people was still building in “adobe” and in “*pisé*” (“*tapia*”), only just twenty years ago (see Pl. 8c). Also in “*Tierra de Campos*” (Castilla and Leon, North of Valladolid and Palencia), where a very nice tradition of pigeon towers can be still observed (Pls. 9a and 9b); In Portugal with the similar building culture of “*taipa*”, in the region of Algarve where, closely to the border of Spain, can be still observed the legacy of the typical “*Al Andalus*” earthen building process which is inherited from the period of occupancy of the Moors: the thick walling built up in “*tapial*” are faced with a raw stonework masonry put up with a lime mortar (see Pls. 10a and 10b). In France, the vernacular earthen architectures are a typical feature of the rural landscape in almost all regions of the country. The northern territories are typically concerned by the tradition of the construction in posts and beams (“*colombage*”) filled up with wattle and daub or “*torchis*” as we can observe in Champagne, around the city of Reims (see Pl. 11a) where a local tradition of the unbaked brick was also developed along the Marne River valley (see Pl. 11b). In the south, the Mediterranean legacy of Ancient Greece and Rome, the Carthaginian inputs and more recently the Arabic influences, are particularly evident: “adobe” (unbaked brick) all over the southern territories, from Aquitania (see Pl. 11c) to Provence, “*pisé*”, all along the Rhone and Saone River valleys up to the Forez (Auvergne, Central Massif), and in Dauphiné (North of Isere); (see Pls. 12a, 12b and 12c).

Everyone travelling in Morocco can observe the “*ma, lems*” (traditional master masons) still building houses, or fencing walls, in “*leuh*” (“*pisé*”), nearby the townships settled in the Dra, and Dades river valleys, from Ourzazate to Zagora (border of Mauritania), or to Boulmane. Effectively, in South Morocco, as in the Atlas mountains, the tradition of the “*Kasbah*” and “*Ksour*” (fortified farms and rural villages), is undoubtedly one of the most brightening up “*pisé*” building culture in the world. Was this tradition influenced by the Ancient Mediterranean earthen building cultures (Carthaginian and then Roman), or by cultural inputs coming from much far away (Arabic peninsula), with the penetration of Islam across central Africa (the Art of the Mosques in the “*Sahil*”, Delta of Niger in Mali that has been occupied by Moroccans several centuries ago)? Both hypotheses are still under discussion. Recent projects have been launched, during the eighties of the last century that have contributed to a fashionable revival of the “*pisé*” construction in Morocco. In the generation of new architects, Elie Mouyal and Charles Boccara were — and still are — the developer of such a post-modern “*pisé*” and “adobe” architecture which is reinterpreting the legacy of an historical tradition tracing back to ancient times and promoting a local syncretism between the Greek, Roman and Islamic styles. And who can ignore the importance of the work done by the great Hassan Fathy, in Egypt, who has reactualized the adobe architecture in vaults and cupolas taking roots in the vernacular Nubian tradition (beyond Aswan)?

### ***The earthen architecture is existing! Toward a revival***

If, in so-called industrialised countries, the earthen construction has been regressing since the Second World War, it is still existing in most developing countries. On the one hand, the industrialisation of the construction was pushing out traditional building cultures that were considered as obsolete and not adapted to a general euphoric aspiration to the technical progress. A new set of modern building technologies (reinforced concrete, steel, glass, plastic and polymers), imposing much more professional specialisation and division of labour, was rejecting ancient practices founded on the mutual aid of the communities. On the other hand, in developing regions, the lacking of industrialised building materials, very costly in imported currencies and energy, the brutalist transfer of the occidental technologies, by now much more culturally, socially and economically contested, are inviting to consider again the relevance of the local resources and cultural know-how. In the “North”, we observe a much more

shared caring taken to the heritages (their preservation, conservation and rehabilitation), the coming out of a qualitative questioning reacting against the making of architectural landscapes a commonplace and exhibiting an international style, a world-wide “transculturation”. The threats faced by our natural environment are mobilising larger sections of our developed societies. In this context, a new cultural, social and economical attention given to the earthen architectures can emerge. In the “South”, the earthen building cultures are still living practices, as well as in urban contexts (peripheries), as in rural areas. Most of the time, the earth is still the main accessible (financially) material for the major part of people who has no other choice to use it for sheltering with dignity. Here, the coming back to the earthen construction is not only circumstantial. It is also voluntary and bears a “vision” of what could be a self-centred development that could be founded on different and local political, social and economical strategies that are closely connecting “culture & development”.

“A material is not so interesting in itself but for what it can do for society” as was saying the architect John F.C. Turner, thirty years ago. Since these seventies, dramatically affected by the so-called “Energy Crisis”, industrialised countries are searching for alternatives to the building industry practices which are accounting in an overexploitation of not renewable resources (wood, sand, river-side aggregates,...), in a continuous increase of the energetic bill (oil, nuclear energy) for the production of the building materials, their use in construction and for the comfort management (heating and air conditioning). On the other hand, the injuries which are generated by the construction industry — esthetical and visual (open air quarries), health damages (materials with secondary pathogen effects as asbestos) — the growing of urban violences much more associated to what we call now the “dictatorship of the concrete”, are more and more publicly criticised. This socio-cultural critic is raised and carried up by an environmentalist tendency that is becoming an anti-internationalisation movement the width of which is now reaching, with similar commitments, the developing countries (India as spearhead<sup>9)</sup>). The global approach is now clearly opposed to the local one, and a new concept is raising: this of “*glocal*”. Some are declaring that is it the time now “to dismantle the development for remaking the world<sup>10)</sup>”? Based of such considerations, the earthen construction, as numerous other traditional techniques, might be one of the answers for a “post-development”.

### ***Just a glance at the mobilisations in Mediterranean countries***

All over the occidental Mediterranean countries, the earthen architecture rebirthing movement is in progress. After having welcomed the “7<sup>th</sup> International Conference on the Conservation and Restoration of Earthen Architecture”, “Terra 93”, in Silves, Algarve, the “Direcção Geral de Edifícios y Monumentos Nacionais” (DGEMN, Ministry of Housing) of Portugal has created the “Escola Nacional de Artes e Ofícios Tradicionais”, institutionalising a “Programa Pedagógico, Curso de Construção Civil Tradicional Construção de Terra”<sup>11)</sup>. In this school that is training future craftsbuilders and contractors, located in Serpa (Southeast of the country), young people can learn the adobe and “*taipa*” (“*pisé*”) building techniques to use them for the restoration of the national earthen architectural heritage, or for developing a contemporary architecture. Spain begins to worried about the conservation, maintenance and revival of its so nice “*tapial*” heritage located in “*Tierra de Campos*” now exposed to great threats of destruction because of an endemic exodus of the local population to big towns, pushed away by the searching of employment and better living conditions (the agricultural regulations of the European Community have contributed to a radical change of the structure of the local rural economy). Italy has created its ICOMOS Sub-Committee for Earthen Architecture

9) Considering the position of leaders of such commitments in India, as Dr. Vandana Shiva (See Biopiracy, *The Plunder of Nature and Knowledge*, ed. South End Press, Boston, Mass. USA), or Arundhati Roy (see her struggle against nuclear weapons and also against the construction of giant weirs in the Narmada Valley).

10) As the recent issue of the magazine, *The Ecologist*, was suggesting.

11) National School of Arts and Traditional Craft including a Pedagogical Programme; Traditional Civil Construction Course on Earthen Construction.

(AICAT), has multiplied venues and conferences on this subject in order to promote a national network of specialists. This country counts now on 9 studying groups with university settings, which are dedicated to the research and education covering the field of earthen architecture<sup>12)</sup>. In Sardinia, an important programme for the conservation of the traditional architecture of the “*Campidani*”, built in “*ladriri*” (“adobe”), has been launched some 10 years ago, which is supported by the regional authorities. France has already invested in this movement since the last 25 years contributing to activate co-operation programmes with African countries, in order to mobilise, update and modernise vernacular earthen building traditions for answering to a fantastic demand of low-cost social housing where the majority of people can not access to wealthy modern materials. The UNESCO Chair “Earthen Architecture, building cultures and sustainable development” which has been set in the School of Architecture of Grenoble, in the year 1998, has already contributed to develop specialised teaching programmes in the official curricula of several African universities: in Uganda, Nigeria, South Africa. In France several regional groups gathering professionals (architects, building contractors, scientists), now attempting to federate their efforts in a national network called “*Ecobâtir*” (Ecological construction), are developing studies and projects aiming at promoting the conservation of our national earthen architectural heritage and the new construction in earth. Recently, a “Global Contract for Development”, supported by the main regional and local territorial communities of the Rhone-Alps Region (Southeast of France), has included in its economical and cultural objectives of development an action entitled “valorisation of the *pisé*”. This programme that concerns 46 communes of North Isere has been launched last year and will run up to the year 2005. This movement for a revival of the earthen architectures that took place in the previous quoted countries is now enlarging its impacts and inputs to many other parts of Europe. So were recently created in England (Devon) the “*Out of Earth*” movement, and in Germany (in the “*Die Grünen*” motion), the “*Lehmbau*” network, which are already both very active. Who will stay more out of concern of such an international Renaissance of the Earthen Architecture?

### **The recent international mobilisation for the safeguarding of the earthen architectural heritage.**

During the year 1987, the “*5<sup>th</sup> International experts meeting on the Conservation of Earthen Architecture*”<sup>13)</sup> that has been held in Rome, jointly organised by ICCROM and CRATerre, was finally recommended to push on the development of a specific set of institutional activities in this field. These activities should mainly focus on a specialised education and should support the setting up of specialised teaching programmes in academic institutions. The educational dimension of this project was justified by an evident statement shared by several international organisations: the dramatic lack of professional competencies that should be necessary for conserving a world-wide earthen architectural heritage (archaeological sites and historical buildings) threatened of destruction. In 1989, following this recommendation, a specific project is inaugurated, jointly defined by CRATerre and ICCROM, the “*Project Gaia*”, adopting as main objectives: i) the development of professional training courses; ii) scientific investigations; iii) co-operation projects and, iv) the dissemination of the knowledge. From this time, four international courses on “The Preservation of the Earthen Architectural Heritage” (“PAT” Courses) were successively organised in the School of Architecture of Grenoble (France), in 1989, 1990, 1992 and 1994. Supported by a reflection on the didactics, the pedagogy and the teaching methodologies, this initiative is growing and leads in 1994 to the creation of the “*Project TERRA*” that enlarges the initial partnership of ICCROM and CRATerre to the Getty

12) These groups are set in the universities of Torino, Milano, Genova, Udine, Venecia, Firenze, Macerata, Pescara and Cagliari.

13) This meeting was following previous scientific events covering the topic: in November 1972, Yazd, Iran, “*First International Conference on the Conservation of Monuments built in Unbaked bricks*”; in March 1976, still in Yazd, “*Second International Symposium on the Conservation of Monuments built in Unbaked bricks*”; in October 1977, Santa Fe, USA, “*Working Session on the Adobe Preservation*”; in September-October 1980, Ankara, Turkey, “*Third International Symposium on the Earthen brick (adobe) Preservation*”.

Conservation Institute (GCI, Los Angeles, USA). Considering the importance of the strengthening of specialised regional centres, this remodelled project has already organised two “*Pan-American Courses on the Conservation and the Management of Earthen Archaeological and Historical Earthen Architecture*” that have taken place in Peru, in 1996 and 1999. They have been organised in partnership with the “*Instituto Nacional de la Cultura*” and its regional office “*La Libertad*”, located in Trujillo. These courses have directly gained from the facilities of the site museum of Chan Chan, from the archaeological site itself (Chimú period, 9<sup>th</sup>–11<sup>th</sup> centuries A.D.), and from other sites of the Moche and Chicama Valleys, “*Huaca de la Luna*” y “*Huaca del Sol*”, “*El Brujo*”. These two courses have strongly contributed to the setting up of a regional specialised centre, based in the site museum of Chan Chan, and to the definition and editing of the “Chan Chan Management Plan”. They have also given an impulse to the exchanges of experiences among a larger international network of professionals (historians, archaeologists, architectural conservators, architects, cultural site managers) that has been initiated since 1989 with the previous “PAT” Courses organised in France. Since that time, this international network has had several opportunities to be gathered, thanks to successive international conferences that have been held in USA (“*Adobe’90*”, in Las Cruces), in Portugal (“*Terra’93*”, in Silves) and in England (“*Terra 2000*”, in Torquay). Simultaneously, over the past few years, the “*Project TERRA*”, has given its support to the organisation of several other national conferences or events: in England, Italy, Germany, Czech Republic, favouring the creation of several ICOMOS “*Sub-Committees on the Study and Conservation of the Earthen Architecture*”. The “*Project TERRA*” has also launched and supported several scientific research activities. Among them can be raised up the publication of a first specialised bibliography covering the field, a “*Research Index*”, a “*Literature Review*”, a preliminary reflection aiming at “structuring the discipline of the earthen architecture conservation”, and more recently, a fundamental scientific research on the cohesion and the loss of cohesion of the earth material<sup>14</sup>).

In this favourable context that has enlarged the awareness for the conservation of earthen architectures, that has allowed the emerging recognition of a specialised disciplinary field, other several important projects are now carried out. They are confirming the commitment of much more international and national organisations in charge of the cultural heritage conservation. In this direction, such organisations as the World Heritage Centre and the Division of the Cultural Heritage of UNESCO, the Japan Trust Fund, the Getty Grant Programme, the World Monument Watch, numerous national institutions, and much more specialised experts as well as professionals, all over the world, are playing an essential part. This is resulting, among other important facts, in the entering of precious earthen archaeological sites and historical buildings on national lists of monuments, or on the prestigious World Heritage List. This dynamic process is notably worth reading in Africa, with the commitment of numerous African Cultural Ministries, museums and professionals participating to the development of the Programme “*Africa 2009*”<sup>15</sup>). Other exemplary projects have been launched. Among them it is

14) See : “*projet Gaia project*”, *Bibliography on the Preservation Restoration and Rehabilitation of Earthen Architecture*, ed. CRATerre-EAG-ICCROM, Rome, Italy, 1993, 136 p. (900 documentary references). The « *Research Index* » has been published by the “*Project TERRA*”. Based on a wide survey carried out close to architectural conservation professionals, it precises the main scientific research directions for the next years, according to the professionals’ needs and expectations. The “*Literature Review*”, prepared and drafted by CRATerre-EAG (Arch. H. Guillaud), and then revised by a corpus of North American and European scientists covering various fields of research, will be published by the GCI late 2002. The research on the cohesion and loss of cohesion of the earth material is driven by CRATerre-EAG (Eng. Hugo Houben), in partnership with GCI and ICCROM Research Units and several other Research laboratories and Units of French universities-UMR-CNRS.

15) The Programme “*Africa 2009*” has been launched in 1998. It is carried out by African cultural institutions, in partnership with the World Heritage Centre of UNESCO, ICCROM and CRATerre-EAG. It has already contributed to : i) the realisation of three “*Regional Courses on the Conservation and Management of the African Earthen Architectural Heritage*” in Nairobi, Kenya (1999 and 2001) and in Porto Novo, Benin (2000), for professionals working in Sub-Saharan countries ; ii) the realisation of seminars gathering the directors of African museums ; iii) the launching of research activities resulting in publications ; iv) the raising up of an African professional network editing now its own Newsletter ; v) the carrying out of much more experts’ missions resulting in the classification

worth to raise up the “Chogha Zanbil Conservation Project”, which has been launched in 1998, carried out by the Iranian Cultural Heritage Organisation (ICHO) and the Research Centre for the Conservation of Cultural Relics (RCCCR), in partnership with UNESCO and Japan Trust Fund<sup>16</sup>. But, so many other examples could be quoted here that are very encouraging for the future of the earthen architecture conservation and “mise en valeur”.

## CONCLUSION

### *Preserve the techno-diversity: an essential option for tomorrow*

For warranting this so-called “sustainable development” — or maybe “post-development” —, the new paradigm of the III<sup>rd</sup> millennium founded on a global alliance aiming at protecting the biodiversity, haven’t we the obligation to preserve and pass on the cultural memory which conveys intangible sense and values that are so indispensable to every living society? Is not there any alternative for conserving our architectural heritages expressing shared universal values? On such a point of view, the earthen architectures — existing over all continents — should not be essential to this protection and passing on of our inherited cultural, bio and techno-diversity? Might not they offer an alternative to this homogenising building and architectural transculturation that could be devastating? In this way, it should be upon the indissociable triptych “conservation — sustainable development — modernity” that could raise a “vision” for a recreated future of the earthen architectures useful for the coming out of more viable societies generating new specific as diverse equilibriums between “men”, their environments and their cultures.

Effectively, today, there are great threats for evacuating the techno-diversity, for imposing more, and much more, uniformity. Conserving the earthen architectures and the memory of the building cultures, might be a way to found concrete hopes for the transmission of the techno-diversity to present and future generations. To safeguard an evolutionary balance between nature and culture, between “*oikos*” and “*tecné*”. Without any nostalgic feeling, is not there an evidence of harmony between natural (physical) and cultural (fitted-on) landscapes? An evidence of alliance between biodiversity and techno-diversity which is so often characterised by the world-wide vernacular architectures? Is not there an evident fantastic creativity of numerous traditional builders in this clever use of local cultures, know-how and resources, and a so exact respectful attitude of the environment? In too sacrificing to the modernism, Promethean attitude, is not Man committed on the path to a scheduled tragedy? That of a break-up between nature and culture? The maintenance of the techno-diversity might not bring answers to a wide set of crisis now faced by humankind? Energy crisis (exhaustion of fossil energies<sup>17</sup>); crisis in the production of manufactured materials (more and more costly and inaccessible for a great part of the world population); development and employment crisis (how to create more jobs when the technological progress is suppressing them every day for more and more people?); crisis of cultural identity (architectural and landscaping transculturation); housing crisis (according

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of remarkable African sites on national lists of monuments and on the List of the World Heritage, with the definition of correlated management plans.

- 16) The first phase of this project (1998–2002), has already given valuable outputs : i) the carrying out of a preventive conservation programme on the main architectural structures of the site, the prestigious Ziggurat, the Hypogeum Palace, the Water-Tank ; ii) the development of a spectacular experimental and scientific research programme on the local building materials (geology, unbaked brick, earthen and traditional “*kh,-gel*” mortars, baked bricks), the reactivating of archaeological researches on the site of Chogha Zanbil and at Haft Tappeh ; iii) the setting up of a specialised centre at Haft Tappeh around a team of young architectural conservators and scientists coming from three Iranian universities preparing their diploma in architectural conservation and Ph. D. thesis ; iv) the holding, in February 2000 of a “*First national course on the conservation and management of earthen structures*” for Iranian professionals and students in architectural conservation, the holding, in February-March 2002, of a “*First Regional Course on the Conservation of Earthen Structures*” that have been opened to professional coming from Central Asian countries. Project ICHO-RCCCR, Cultural Division of UNESCO, Japan Trust Fund and CRATerre-EAG.
- 17) In some countries, the reserve of oil will be exhausted during the next 50 years. We already see the development of such a war for oil conducted by consuming countries !

# PROJECT TERRA

## *The Project TERRA guiding principles*

**CONSERVATION OF THE EARTHEN ARCHITECTURAL HERITAGE**  
 Institutional involvement

EDUCATION	RESEARCH	APPLICATION	AWARENESS
University Embedment	Systematic Assemblage	Integrated Methodologies	Value Driven

**INFORMATION**  
 Knowledge management

## *The Project TERRA aims*

**CONSERVATION OF THE EARTHEN ARCHITECTURAL HERITAGE**  
 Establish a recognized discipline

EDUCATION	RESEARCH	APPLICATION	AWARENESS
Build a field Study	Elaborate a specific science	Promote A professional practice	Stimulate A social endeavor

**INFORMATION**  
 Initiate a structured knowledge basis

UNO, about 50% of the world population is badly housed or without shelter); housing production crisis (the formal production systems are only answering to the solvable demand of the middle and upper classes; self-construction and informal forces attempt to alleviate the deficiencies of the formal system); environmental crisis (in several regions, it is now impossible to build with wood: African Sahelian regions, Niger, Burkina Faso, Mali, North Nigeria); industrial pollutions (how many industries are classified in the range of the “Seveso risk?”); physical discomfort (much more people yearn for living in healthier dwellings and leaves the towns for buying private houses in new fashionable compounds, or prefer to restore traditional houses; and this is a luxury for developed regions !); crisis of History (the cultural values of the architectural heritage are cared with unprecedented attention; we classify, conserve, enhance, we “manage” the heritages that contribute to maintain a presence and a sense of History and identity).

The erosion of the techno-diversity comes under a cultural amnesia, the consequences of which could be dramatic for the worldwide socio-economical system. The preservation and the revival of this techno-diversity are becoming a factor of vitality for the future of the planet. But, considering the challenge for the coming out of a sustainable development, we have to produce a huge effort for taking stoke of our techno-diversity, for a better knowledge and more understanding of this “building intelligence” (see Jean Prouvé<sup>18</sup>), and go on updating, enriching our cultural legacy by a more appropriate use of the potential of our technologies<sup>19</sup>. But, there is another danger: to be frozen in an “illusion of the permanence”, that is also an untenable “reactionary” attitude. Based on such considerations, the conservation of the earthen architectural heritages, the sustainable development of a scientific research and specialised education in this field, today, are undoubtedly a decisive contribution for tomorrow; this is part of a shared effort — to be developed at the world scale — aiming at reconcile Man and History, and with its cultural diversity that we have now to consider as a paramount option and vector for a “local” development to be balanced with a “global” development. This is a possibility for opening new paths to a “post-development” which could not be only based on the omnipotence of money (profit) and macro-techniques which are generating much more cultural, social and material impoverishment, too much more unacceptable human poverty.

This article is integrating contributions of other researchers of CRATerre-EAG, particularly for the last part dealing with the presentation of the « *Project TERRA* » and other considerations on the sustainable conservation and development issues. We particularly raise up here, as main contributors : Eng. Hugo HOUBEN and Arch. Eng. Marina TRAPPENIERS. But also from Arch. Alejandro ALVA, co-director of the “*Project-TERRA*” at ICCROM, Rome, Italia.

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18) Jean Prouvé is a French engineer who specialised in steel construction and who defined this concept of “building intelligence” when he was searching for the best appropriate use of building materials.

19) See for instance the stabilisation of earthen building materials that has given birth to the actual roadway technology or to the stabilised compressed earth block. See also the researches and experimentations which have been developed in chemical consolidation

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Pl. 4c: Arch. Patrice DOAT

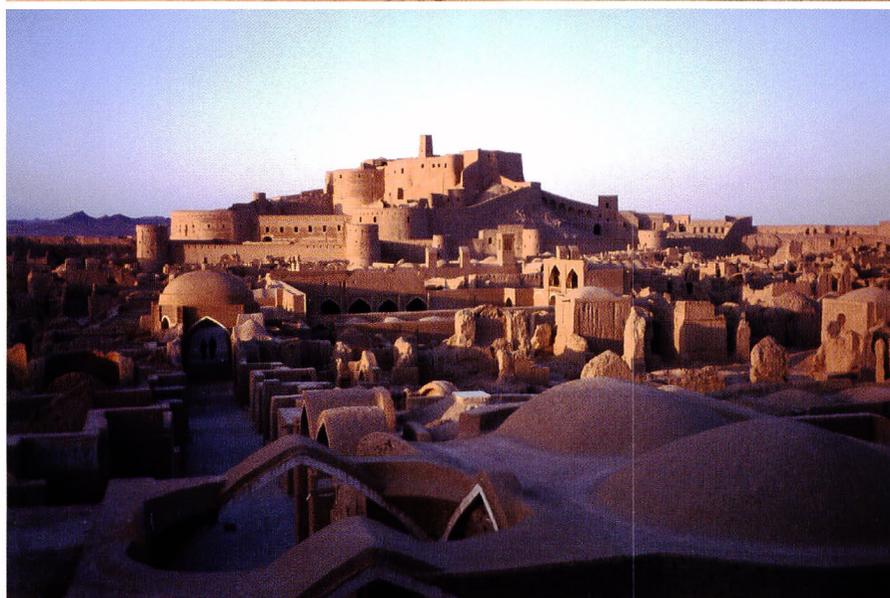
Pl. 7a: Arch. Mohmoud BENDAKIR

Pl. 10a: Arch. Mariana CORREIA

Pl. 12a: CRATerre-EAG's archives.



**a:** The Ziggurat of Chogha Zanbil, Khuzestan, Iran, Elamite site of the XII<sup>th</sup> Century B.C. On this site, the unbaked earthen brick or “*Khesht*” in Persian, still has been the main building material for the construction of the core of the structures, not only for the Ziggurat itself but also for other main significant structures as the temples located in the *Temenos* area or the Hypogeum palace and other royal palaces and massive gates. But on the Ziggurat, the structural components have been protected with burnt bricks while all plastering devices for the outside protection have been made in “*khâ-gel*” or clayey mortar amended with chops of straw.



**b:** One of the most famous earthen architectural site of Iran, Arg-é Bam, located south-east of the country, after Kerman and not too far from the border of Afghanistan, while totally abandoned today and suffering of impressive decays, still testifies of the excellence of the Persian earthen building cultures. The origins of the fortress should trace back to the Sassanian times but the major part of the city as expended during the Mongol invasions. Despite an appearance of important destruction, Arg-é Bam still testifies of the excellence of the Persian earthen construction, particularly for numerous examples of roofing systems in vaults and cupolas, and also for the technology of the “*pisé*”. An important work of conservation and restoration is now carried out which has already contributed to the restoration of the fortress, caravanserais and Koranic schools..



**c:** Still impressive is the famous tradition of the pigeons towers built in adobe and burnt bricks on the plateau of Isfahan, Iran. Here, by a locality called Gavart (between Isfahan and the airport), and all around, most of the traditional villages are mainly built in “*khest*” (unbaked brick), plastered in “*khâ-gel*” and exhibit the blooming of the Persian traditional know-how that have produced an earthen architecture in vaults and cupolas.



**a:** Typical feature of the traditional people's housing in earth valorising the technology of the "cob" (thick walls in stacked packs of mud) on the Plateau of Khuzestan. Here, the roofs are terraced and particularly adapted to a dry climate.



**b:** The climatic adaptation of the earthen architecture in Iran has produced the famous tradition of the wind towers or "badguirs" which can be still observed in the desertic region of Yazd (Central Iran) and in numerous other regions suffering of a very hot climate in summer. Here, such bioclimatic devices are observed on the roofs of the "Brugerdaha house", located in Kashan, one of the jewels of the Kajar architecture (end of the XIX<sup>th</sup> Century and beginning of the XX<sup>th</sup> Century).



**a:** The Sultanate of Oman testifies of a very nice earthen architecture built in unbaked earthen bricks which have been traditionally conical-shaped and recently evolving to the common rectangular shape. This traditional earthen architecture of the Sultanate covers numerous examples of Forts with massive outer defensive walls and towers, or “*borjs*”, and a nice tradition of outdoor and indoor plastering in “*sarooj*” (natural lime) or “*juss*” (gypsum) as well as earth and straw. Here the Fort of Bid Bid, on the road from Muscat to Nizwa. The Fort of Bid Bid has been restored during the 80’s of the last XX<sup>th</sup> Century by the Ministry of National Heritage of Culture which has recently conducted new restoration works valorising the aesthetic of the traditional renderings.



**b:** Still in the Sultanate of Oman, the Fort of Bahla, located at 25 km after Nizwa, with its “*Qela’a*” (the whole fortress) and “*Qasabah*” (the Fort itself), as well as the full dimension of the oasis including pure examples of the Omani people’s housing, numerous mosques and a precinct wall of about 12 km long, with massive entrance gates, has been entered on the List of the World Heritage of UNESCO, in 1987. An important project of conservation, including interventions of restoration and revitalisation has been initiated in 1995 and still now running on where the traditional Omani earthen traditional building know-how is fully valorised. A Management Plan is actually defined.



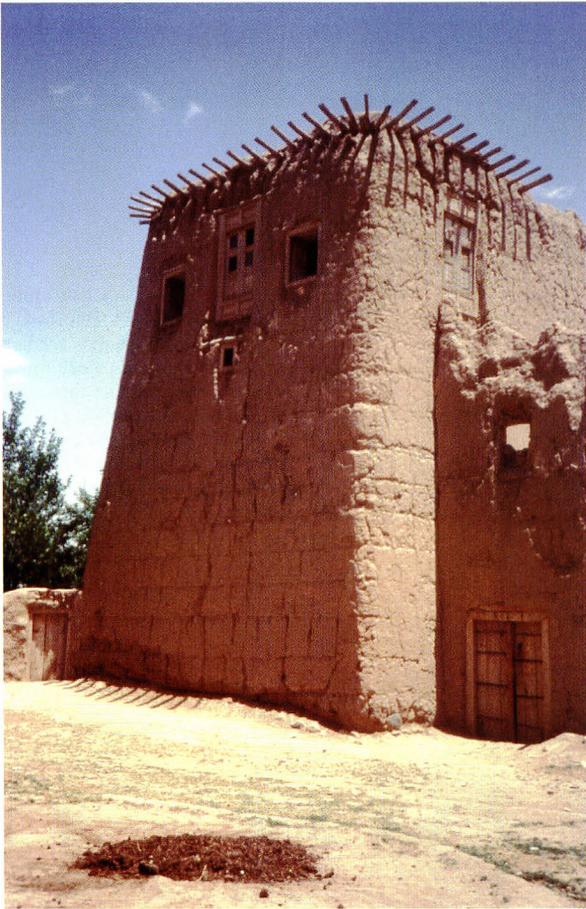
**a:** An aspect of a recent intervention of restoration which has been recently conducted on the Fort of Bahla, Sultanate of Oman, under the site guidance of Arch. Enrico d'Errico within the project carried out by the Ministry of National Heritage and Culture and the expertise of UNESCO. Here we can observe the partial restoration and reconstruction of the “*Borj ar-Rih*”, or “Wind tower”, according the architectural evidence given by a documentation coming from photographs taken at the end of the XIX<sup>th</sup> Century by a British explorer, Colonel Miles. All outer plasters have been made in traditional “*sarooj*” and earth and straw.



**b:** Typical earthen people’s housing in the South of Saudi Arabia, region of Najran. These constructions are made of successive “*cob*” layers (stacked packs of plastic earth). The desert climate of this region authorizes a basic protection of the more exposed parts of the structures, the top of the walls and the outer reveals of the bays that are generally plastered with natural white lime which are regularly maintained.



**c:** An other typical and nice tradition of earthen architecture in Saudi Arabia, here built in unbaked bricks. In this region the climate is not only dry but also humid with some hard and very devastating rains and flooding. To protect their houses, traditional builders have included in the façades of the houses layers of salient stones which are pushing out the rain water. On the other side, during the hot season, these stones are also maintaining a projected shadow which contributes to the cooling of the walls and the bioclimatic conditioning of the houses.



**a:** In Afghanistan, close to the border of Pakistan, an example of local typical fortified rural houses, or farms, built in “cob”. This building culture, in numerous regions of Afghanistan, is much more present than the adobe construction and locally called “*parsha*”.



**b:** In Turkmenistan, the famous medieval site of Ancient Merv which has been entered on the List of the World Heritage of UNESCO in 1998. The original architectural design of the outer walls of the “*Great Kyz Kala*”, built in unbaked bricks during the XI<sup>th</sup> and the XII<sup>th</sup> Centuries A.D. is today known as a “*corrugated*” structure the shape of which having been compared with other structures of a similar type existing in Iraq.



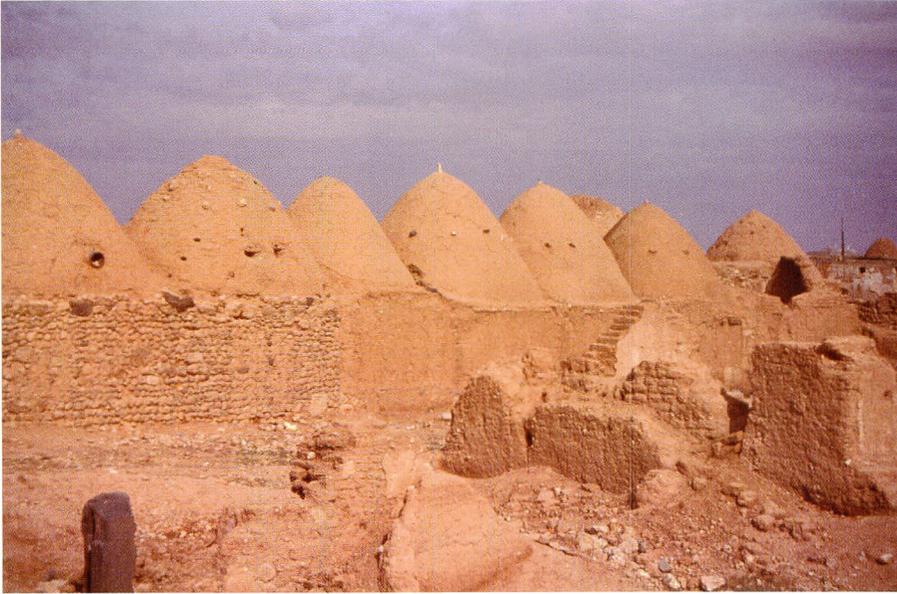
**a:** On the same site of Ancient Merv, visitors can observe an impressive structure built in unbaked earthen bricks, a ice house. This tradition of such big structures used for storing the snow, the ice and the cold water in big tanks deeply embedded in the ground is one of the permanent feature of the vernacular architecture of the Central Asian region.



**b:** On the slopes of the Tell of Bet She'an, Northern Israel. A particularly well preserved and wonderful example of a people's housing in unbaked earthen bricks tracing back to the Bronze Age (circa 3200 B.C.) which has been excavated by Professor, archaeologist, Amihai Mazar. We can clearly observe the typical structure of this house organised around a central circular space.



**c:** View of the eastern façade of XVIII<sup>th</sup> Century B.C. (Middle Bronze Age) gate of the Canaanite city of Laish at Tel Dan, northern Israel. This famous triple arched gate in unbaked bricks of Tel Dan (built in three radial courses) the span of which is about 2.30 m, has been excavated by Professor, archaeologist, Avraham Biran. It is part of a defence system which consisted of sloping ramparts and glacis. Stone constructions have been found, built against and close to the mud structures whose successive layers are made with brown and grey coloured bricks.



**a:** A traditional village in the region of Aleppo, Syria. Here, the earthen building culture testifies of a traditional roofing system in corbelled conical cupolas. Such structures are now very rare but this know how is tracing back to very old times as it has been confirmed by some graffitis which have been found in Niniveh (Assyrian times) evocating the rural people's of this period.



**b:** On the hill of Byrsa, Tunis, North Africa, the remains of the famous Hannibal's neighbourhood of the 2<sup>nd</sup> Century B.C. which has been excavated by the French mission under the Direction of Serge Lancel. The housing blocks A, C and E which have been surveyed by G. Robine, exhibit the typical Punic building culture, very eclectic in the use of the materials including stone, burnt and unbaked earthen bricks as well as "pise". On the outer walls of these houses (in fact urban flats) which were sheltering metallurgist's families and their workshops, lime plasters can be still observed.



**c:** Detailed view of the columns in "pise" erected by the Roman, when, some years after the destruction of Carthage, they have refilled the slopes of the hill of Byrsa for levelling a new platform which will bear the new Forum and Basilica of the Roman Carthage (1<sup>st</sup> Century A.D.). This structural performance consisting in building earthen columns for realising new footings is in fact common in the Roman engineering practices. Other similar traditions are existing in the history as this can be observed at Susa, Khuzistan, on the Darius' Palace.



**a:** North of Spain, Province of Palencia, in Pedrosa de la Vega. The Roman Villa of La Olmedia, one of the greatest residences (33 rooms) dated from the IV<sup>th</sup> Century A.D. (late Roman Period) which have been found in Spain. The remains are exhibiting base-ments of walls made of unbaked earthen bricks and of stacked earth (“cob”). This view is also showing the remains of the heating system or hypocaust.



**b:** Typical house in unbaked earthen bricks, “ladriri” or “mattoni”, in southern Sardinia, region of the “Campidani”, village of Riola Sardo. In this region, numerous villages are built in earth and a programme for their conservation, restoration, rehabilitation and maintenance, associated to a revival of the earthen building technology has been recently launched under the guidance of the University of Cagliari in close collaboration with the municipalities. This tradition of the unbaked earthen brick traces back to Greek, then Punic (site of Tharros) and Roman times.



**c:** Eastern Mediterranean seaside of Spain, inland region of Catalonia, around Barcelona. Numerous villages are built in rammed earth or “tapial” which is no more a living building culture.



**a:** North of Spain, Province of Palencia, in a land called “Tierra de Campos”. The village of Medina de Rio Seco is part of a very nice vernacular earthen architectural heritage gathering numerous other villages where Christian churches are also built in “*pisé*”.



**b:** The presence of numerous pigeon towers, or “palomares” is one of the typical feature of the traditional rural landscape of the region of “Tierra de Campos”, Northern Spain. This tradition of round-shaped pigeon towers in “*pisé*” (“*tapial*”) is one of the most achieved in Europe where some other nice examples can be still observed in France, in the Saone River Valley (North of Lyon) or in the region of Aquitaine (South-West of France), where these “*pigeonniers*” are built in adobe.



**a:** The remains of the Castle of Silves, Province of Algarve, South of Portugal. The tradition of fortified castles tracing back to the period of “*Al-Andalus*” (Moore times) testifying of the construction in “*pisé*” (“*taipa*”) is quite common in this region of Portugal where several projects of conservation have been launched.



**b:** The construction in “*pisé*” (“*taipa*”) is a permanent feature of the history of architecture in Portugal. Here the palace of the ducal City of Villa Viçosa.



a: France is gifted with a very important, rich and diverse earthen architectural heritage covering circa 15% of its full rural and urban heritage in almost all regions of the territory. Here, a typical village in Champagne, Outines, classified on the list of the National Heritage, where houses in “colombages” (posts and beams structures) filled up with wattle and daub (“*torchis*”), and a nice Christian church have been restored.

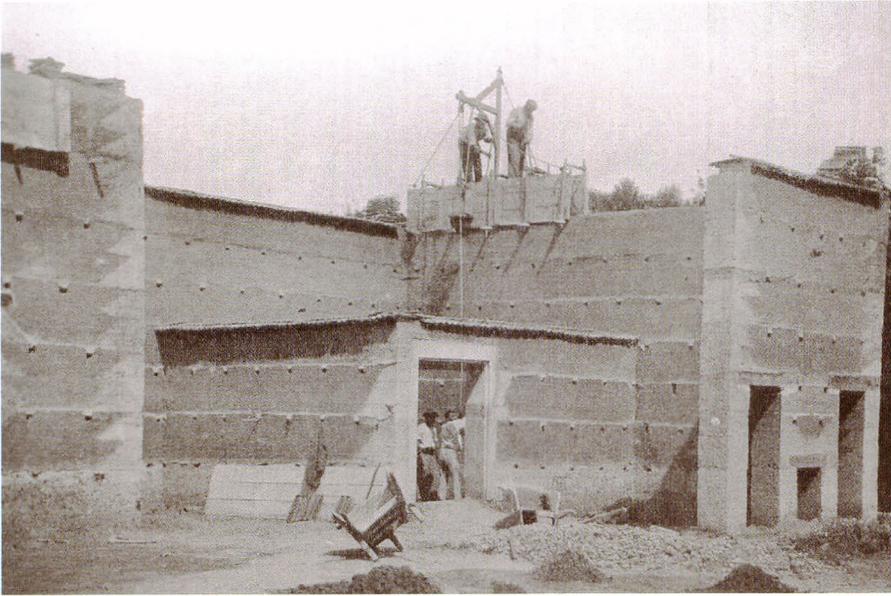


b: Still in Champagne, near the cities of Ay and Epernay, well known for their excellent vineyards, numerous villages and rural houses are built in unbaked earthen blocks locally called “*carreaux de terre*”. This tradition is notably visible in villages located along the Marne River Valley but is not still living.



c: In the Region of Aquitaine, South-West of France, where exists a very nice tradition of vernacular adobe architecture. Here, the building culture, inherited from ancient Gallo-Roman times, prolonged under the Moore influences coming from the Iberian peninsula during the Middle Ages and then coming up to recent times, is associating the use of the adobe to the burnt brick which is commonly used for strengthening the reveals of the bays, the angle chains of the buildings and for the design of very nice elements of architectonic outlining.

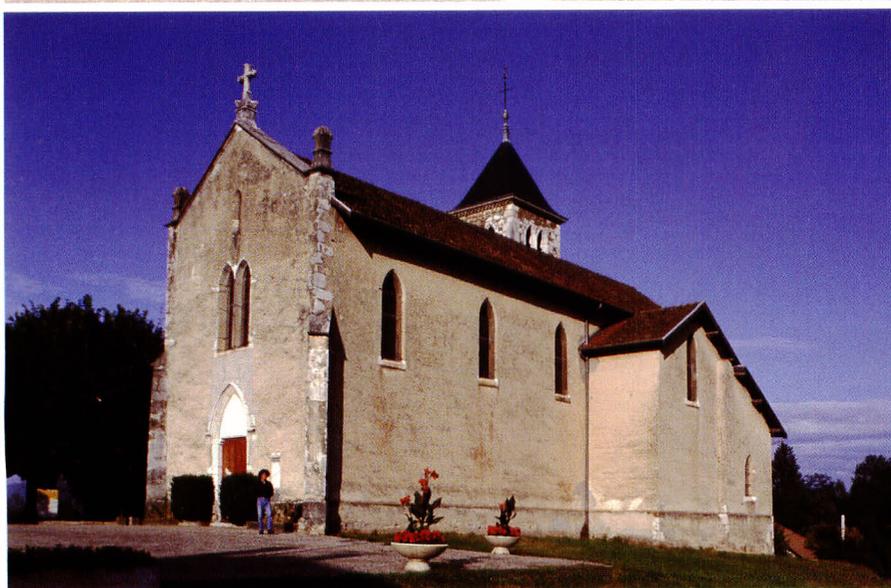
Mediterranean Region



**a:** This photograph taken at the beginning of the XX<sup>th</sup> Century, circa 1914-20, is showing the common practice of the “*pisé*” construction (rammed earth) in the Province of Dauphiné, region of Isere, northern of Grenoble (South-East of France). At that time, a typical evolution was introduced in the practice of “*pisé*” with the use of the concrete, replacing the traditional corner-stone, the quoins in burnt brick-work or in lime mortar, or for consolidating the reveals of the bays.



**b:** A typical village house in “*pisé*”, built at the beginning of the XX<sup>th</sup> Century, with reveals in concrete, located in the northern part of Dauphiné, region of Isere, South-East of France. Most of these houses are not plastered though the local climate is very rainy in Spring and Autumn. The main front façades of wealthier houses are sometimes decorated with layers of burnt bricks and river pebbles.



**c:** A rare and nice example of a Christian church built in “*pisé*”, plastered with a thin lime distemper, in Isere, village of Charancieu located around 30 km north Grenoble. This church has been built at the middle of the XIX<sup>th</sup> Century. All walls, excepted those of the bell tower are in “*pisé*”.