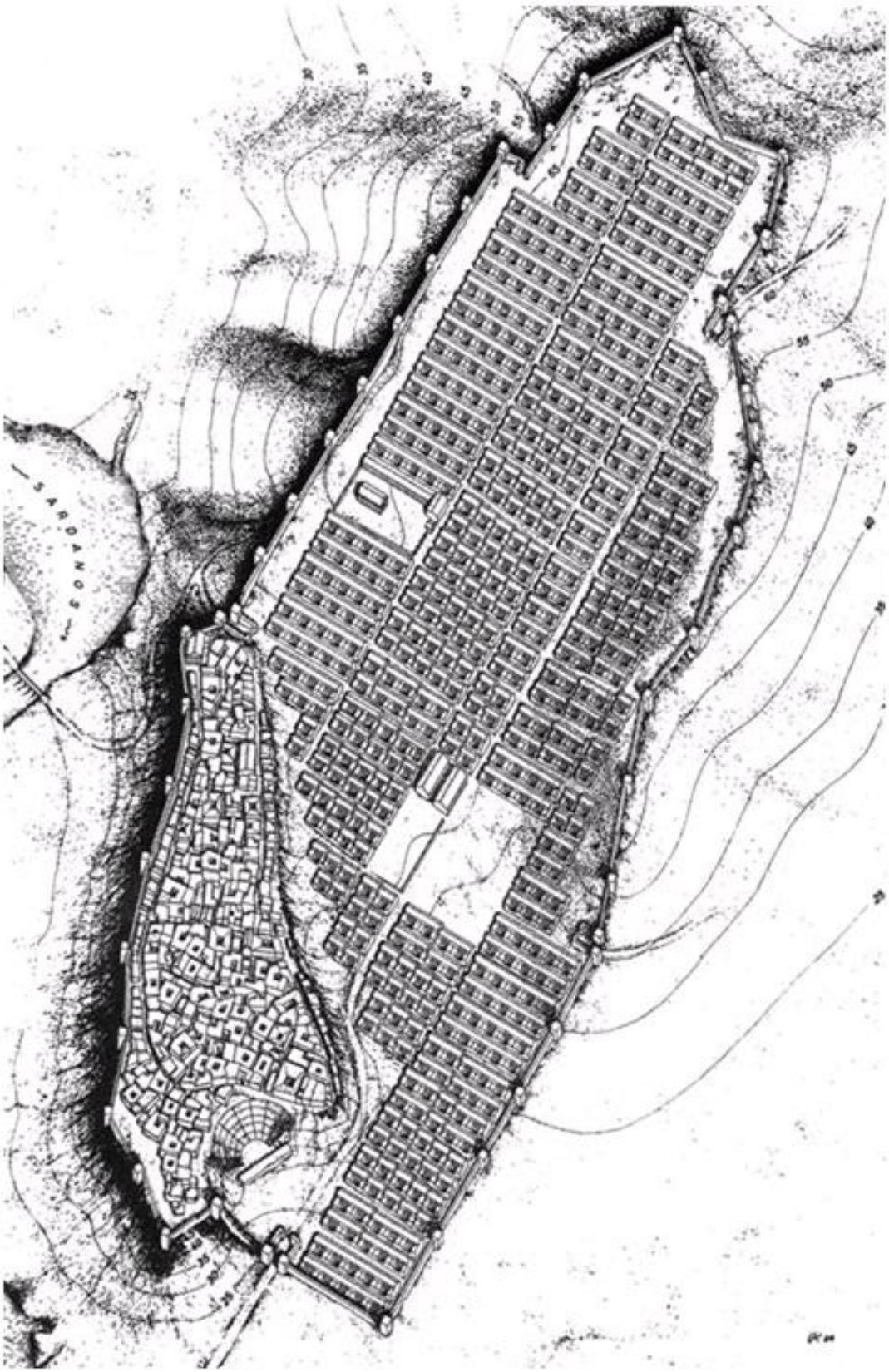
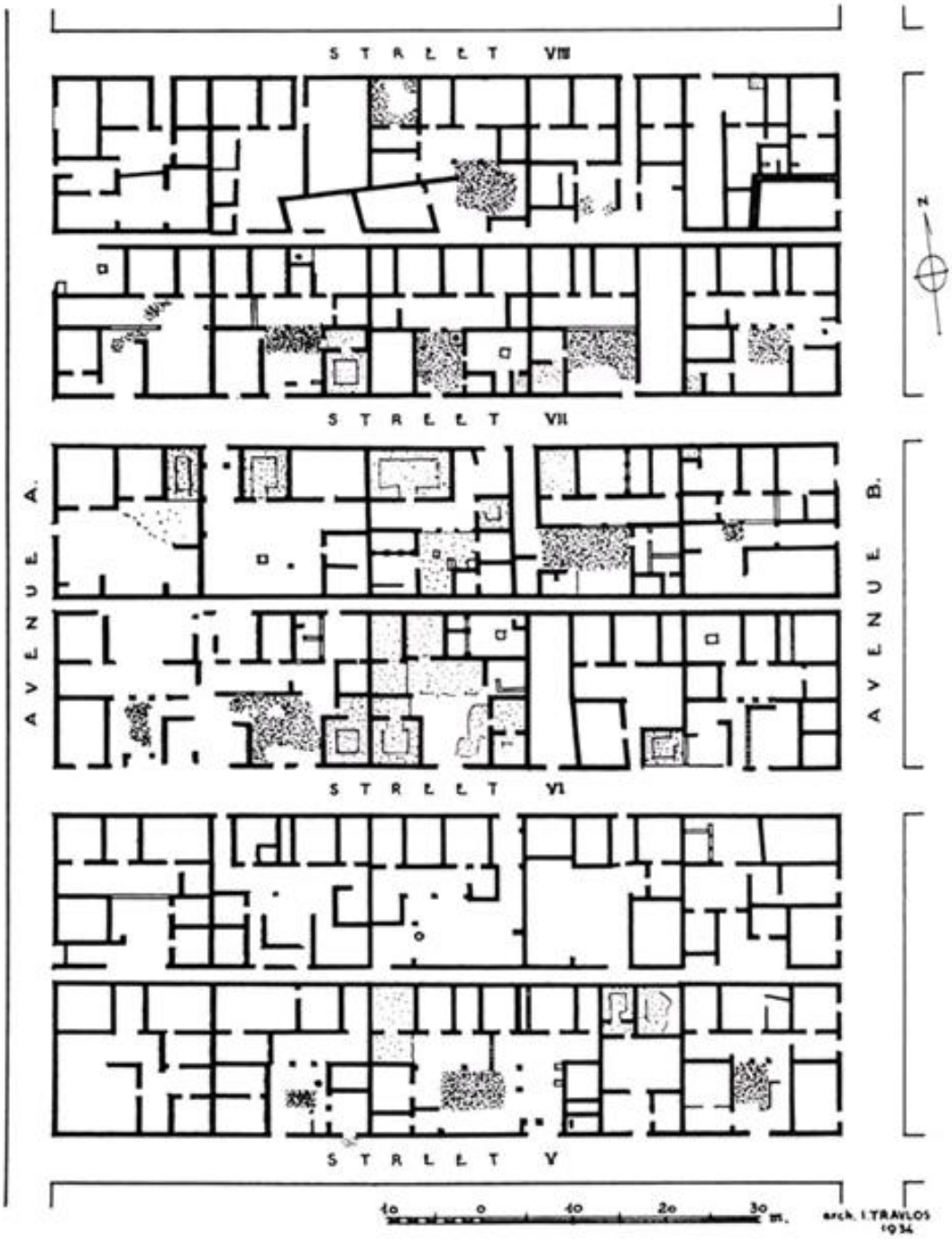
ECONOMIZING ENERGY
IN PROTECTED BUILDINGS

BIOCLIMATIC ARCHITECTURE IN GREECE IN THE COURSE OF TIME

ANCIENT ARCHITECTURE: THE FIRST ATTEMPTS OF AN ARCHITECTURE ADAPTED TO CLIMATE CONDITIONS



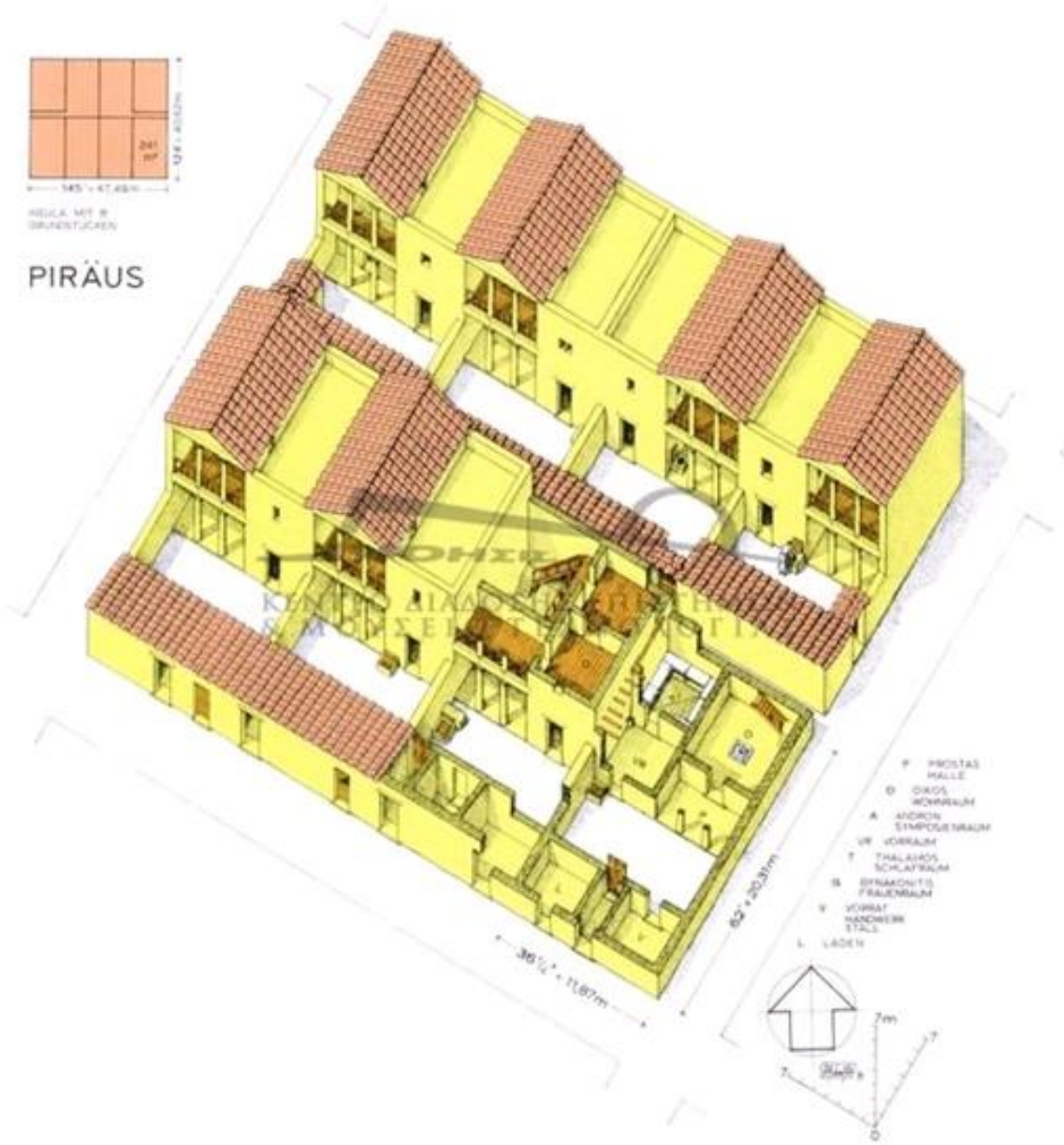
The city of Olynthos, in Macedonia, with its blocks designed so that every house would have the best orientation and profit by the sun's position



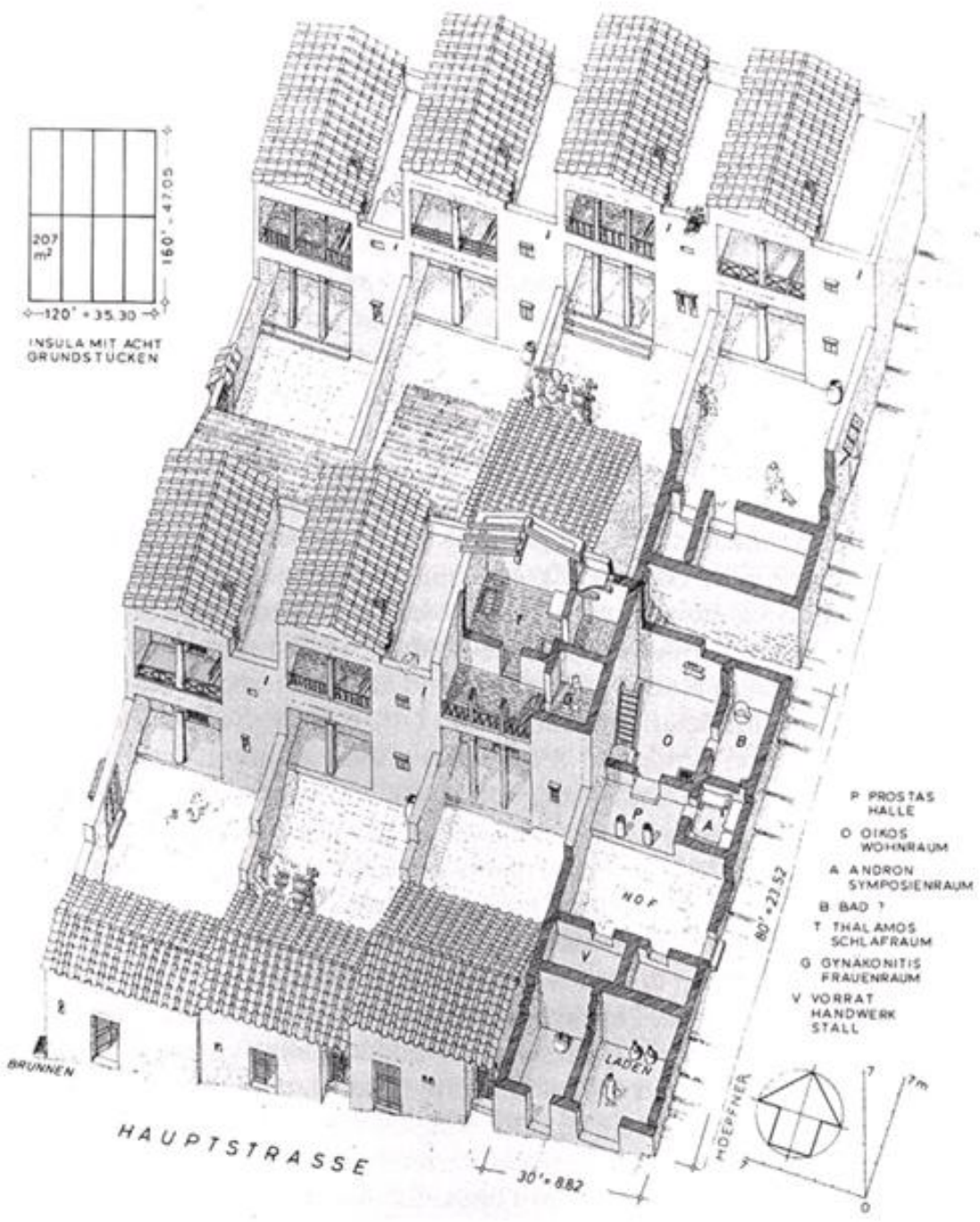
Three blocks of houses in the ancient city of Olynthos. Every house, independently of the entrance's orientation to the North or the South, is designed in such a way, that it has its court in the southern part of the plot and every main space of each house is oriented either towards the South or towards the East. In that way, all main spaces were exposed to the sun in winter and protected from it in summer.

Aerial view of blocks of houses in the ancient city of Olynthos

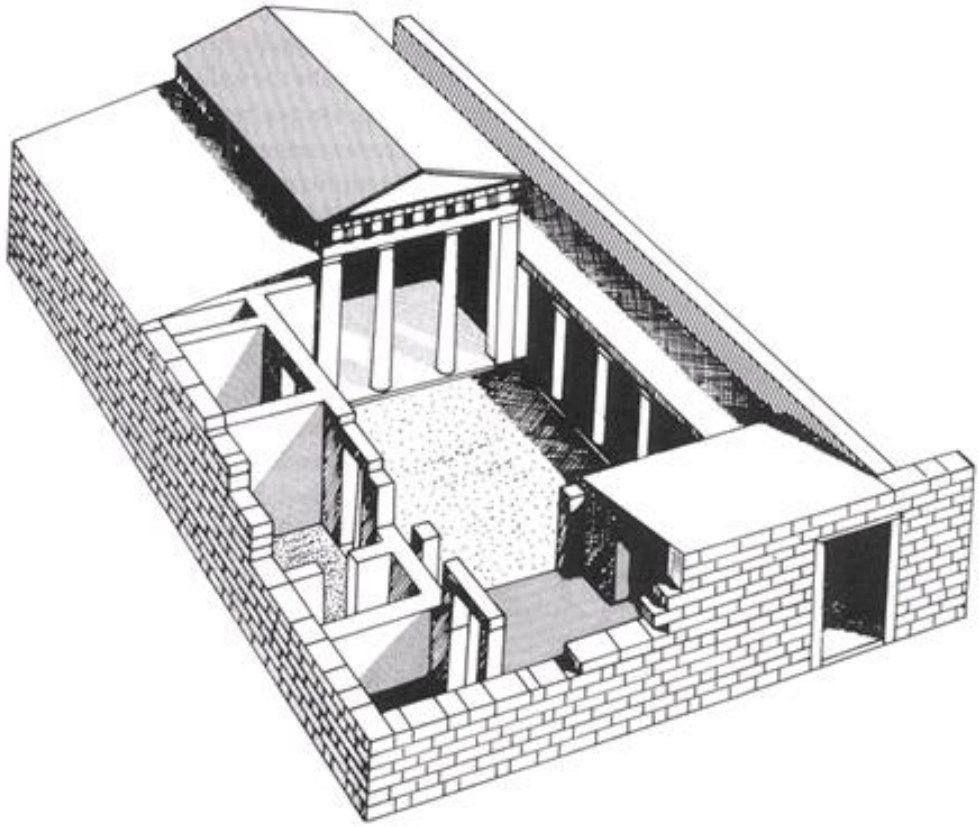
Reconstruction of a block of houses in the ancient city of Olynthos



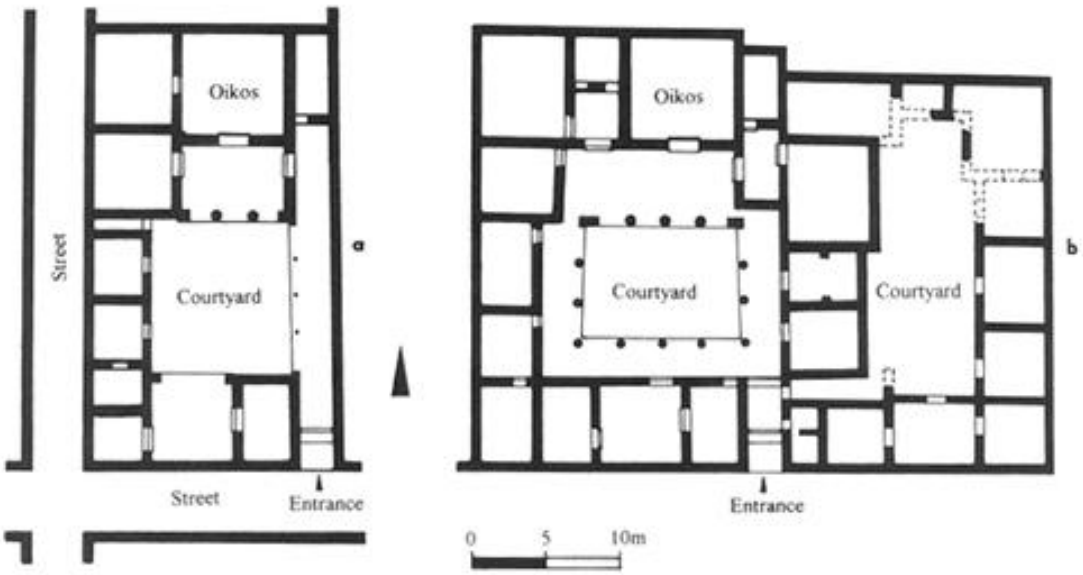
Reconstruction of a block of houses in ancient Piraeus, the port of Athens. Every house has its main spaces open to the South through loggias in both floors. The loggias permit the use of a semi-open space in days with rain or too much sun, but mild temperatures.



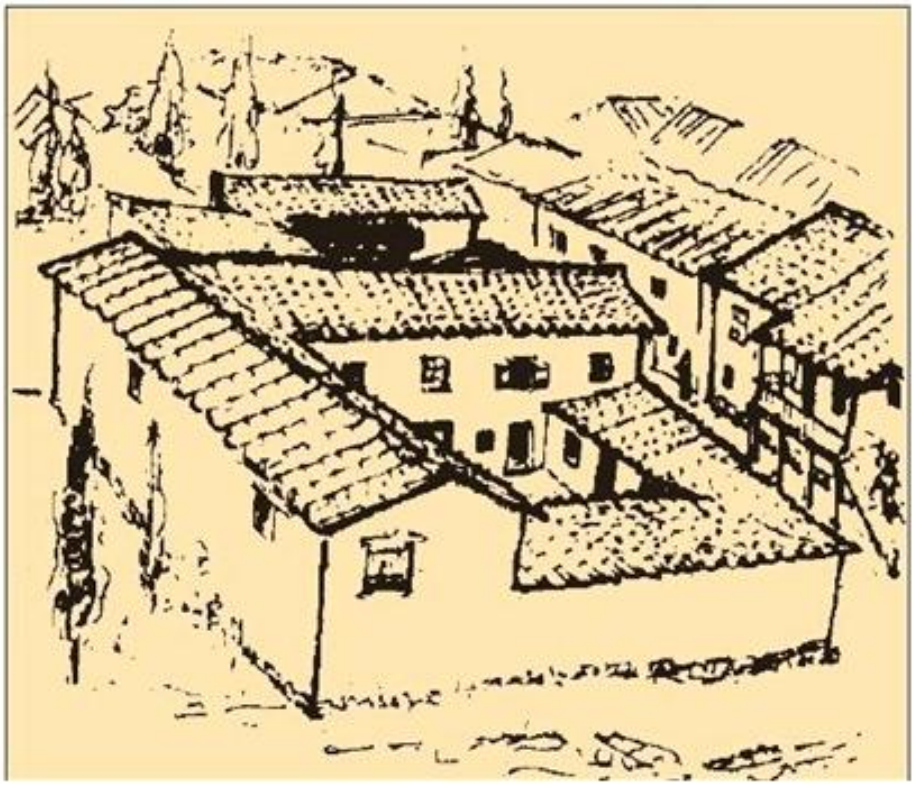
Reconstruction of a block of houses in ancient Priene, in Asia Minor. Every house has its main spaces open to the South through loggias in both floors. The loggias permit the use of a semi-open space in days with rain or too much sun, but mild temperatures.



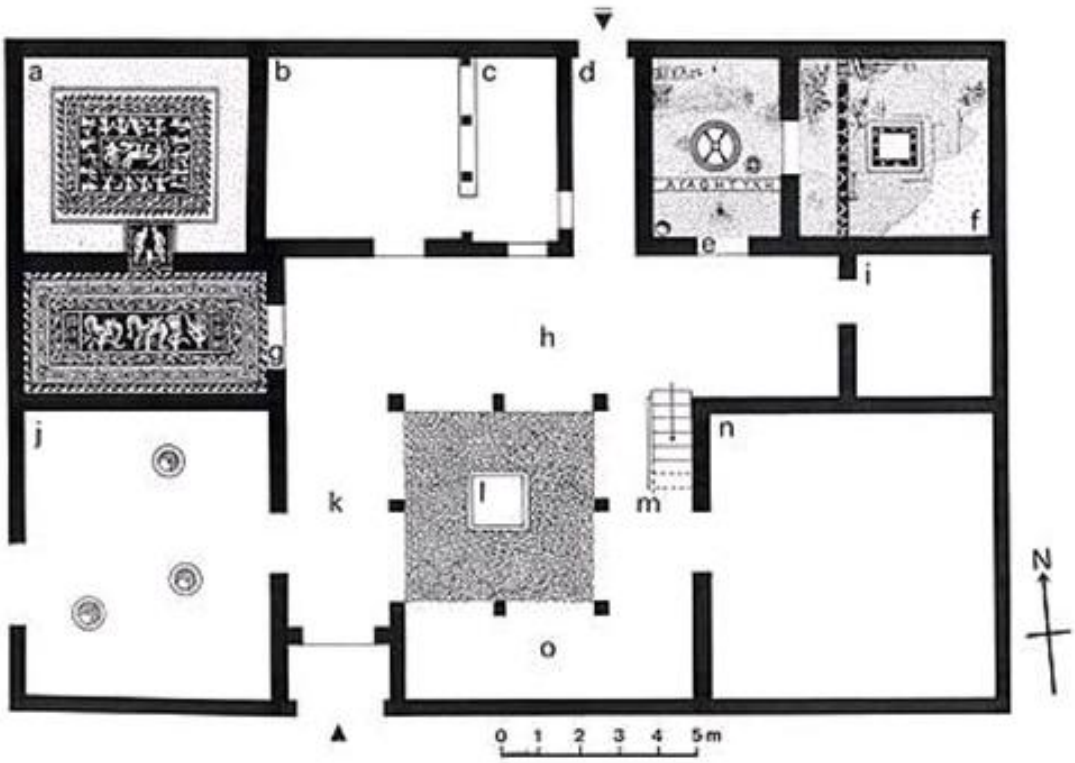
Reconstruction of a house in ancient Priene, in Asia Minor. The main spaces are open to the South and the East. A portico open to the West permits the use of a semi-open space in days with rain or too much sun, but mild temperatures.



Plan of two types of house in ancient Priene. The first one corresponds to the reconstruction immediately above.



A house in ancient Athens. The main spaces are exposed to the South and to the East.

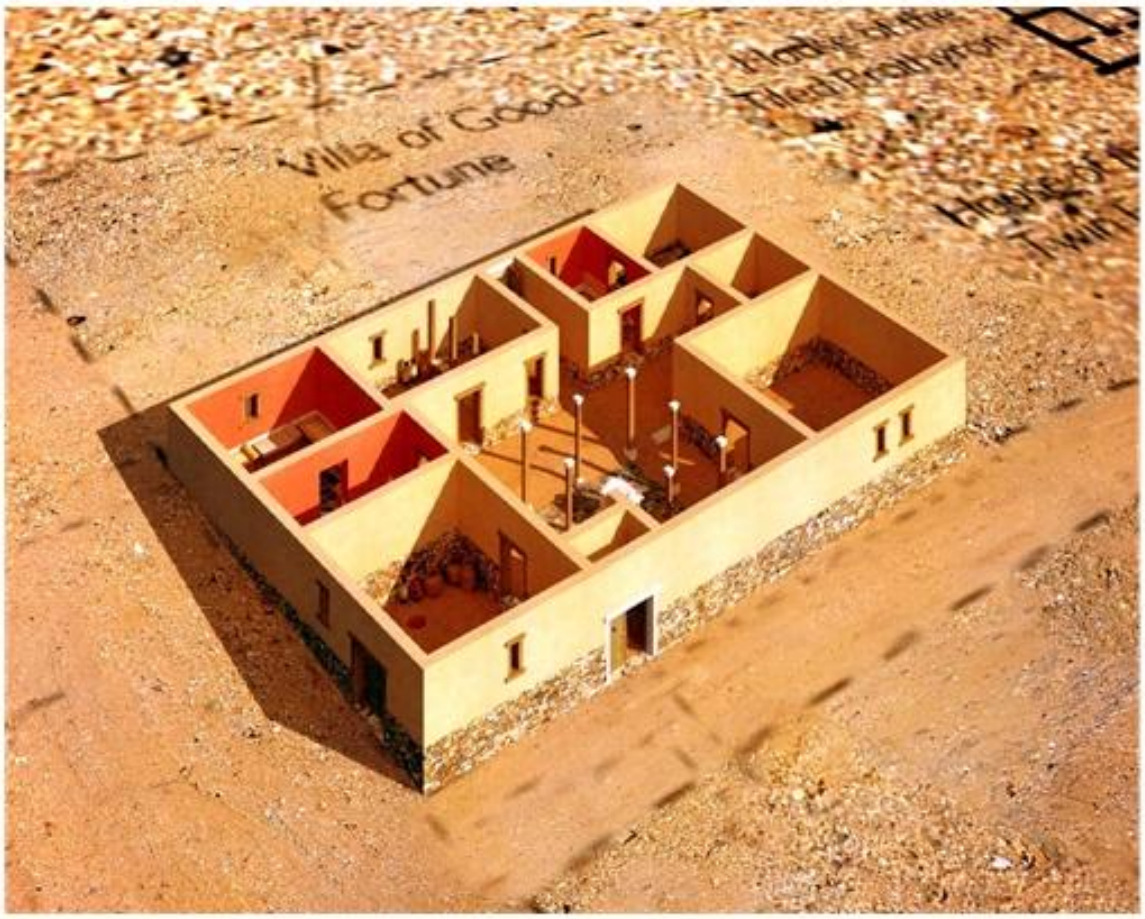


Plan of the Villa of Good Fortune in ancient Olynthos

Villa of Good Fortune in ancient Olynthos. Reconstruction on a picture of the ruins.

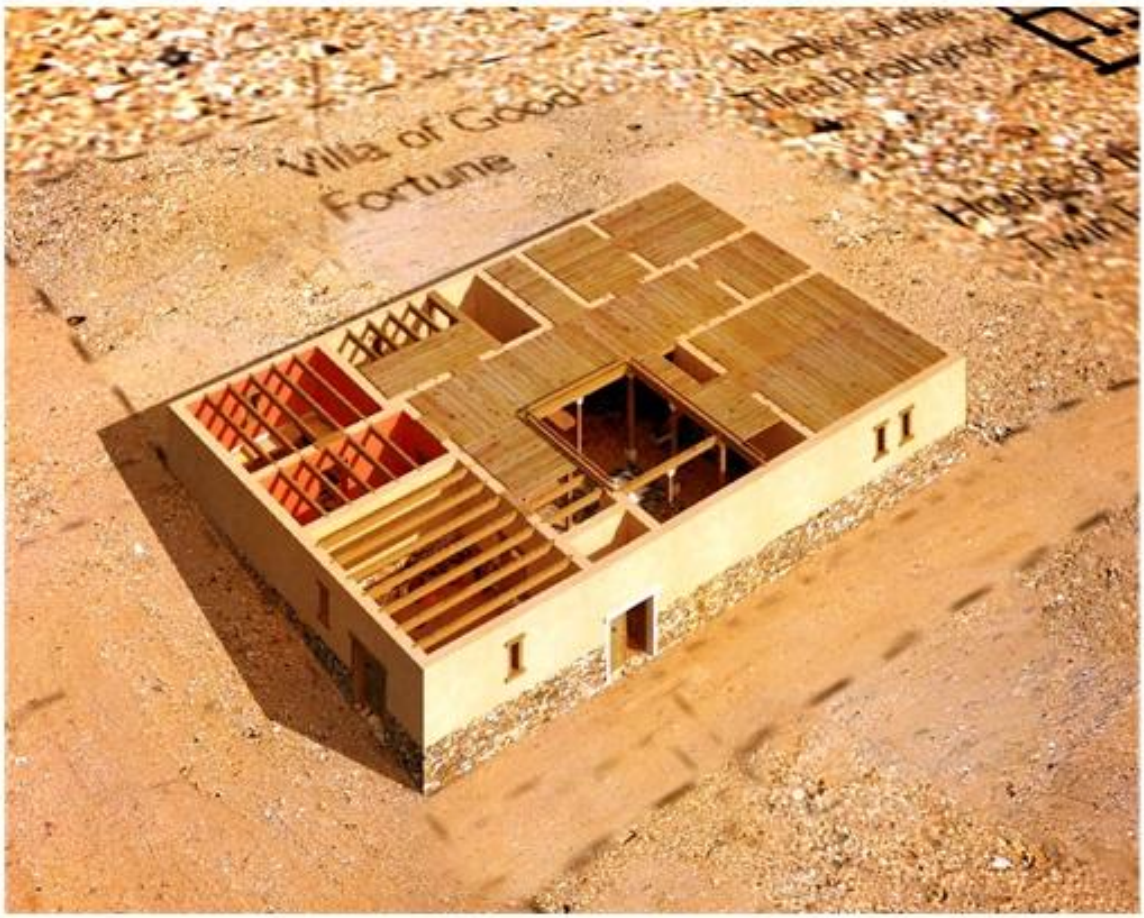
Villa of Good Fortune in ancient Olynthos. The internal court. The existence of many intermediate spaces between the interior and the exterior, adapted to the Mediterranean climate, is obvious.

Villa of Good Fortune in ancient Olynthos. The lower parts of the walls were of stone, in order to protect from humidity the upper parts, made of raw earth, a perfect bioclimatic material.



Villa of Good Fortune in ancient Olynthos. The upper part of the walls, made of raw earth. Raw earth was covered with a lime coating, in order to protect it from the rain.

Villa of Good Fortune in ancient Olynthos. The wooden beams supporting the first floor. Wood, together with raw earth, was the most bioclimatic among the main construction materials available in ancient times.



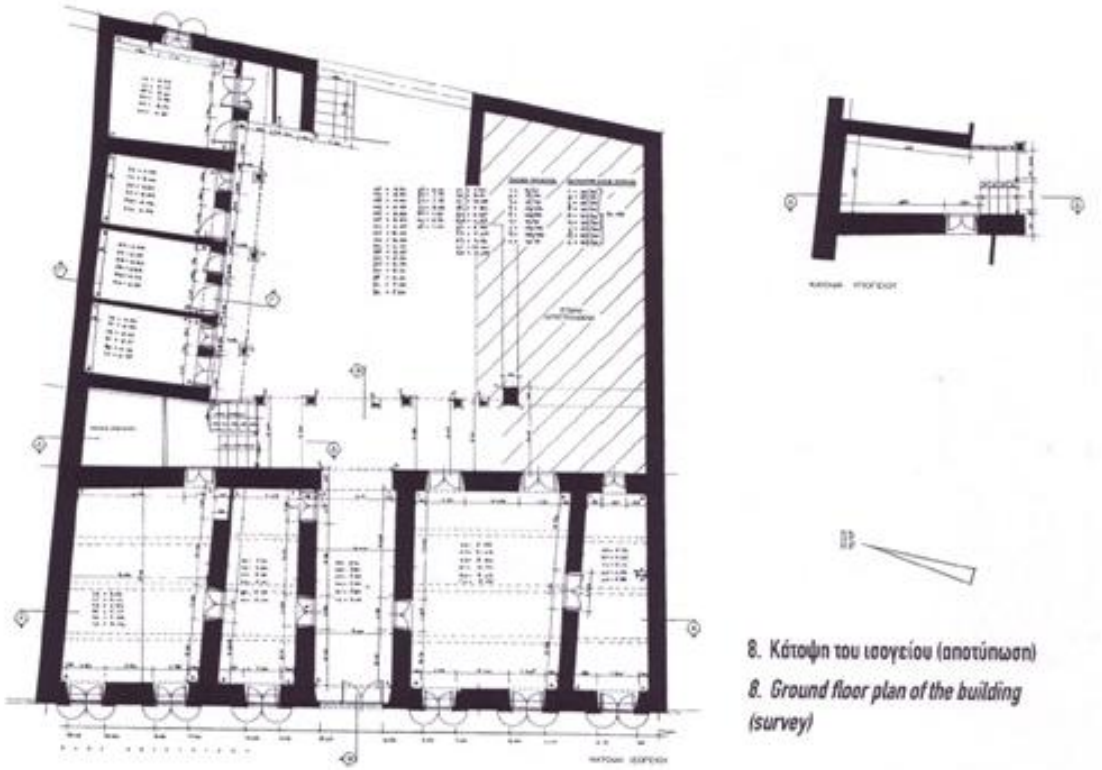
Villa of Good Fortune in ancient Olynthos. The wooden ground of the first floor.

Villa of Good Fortune in ancient Olynthos. The walls of the first floor were entirely made of raw earth. The columns supporting the portico surrounding the court and its roof were made of wood.

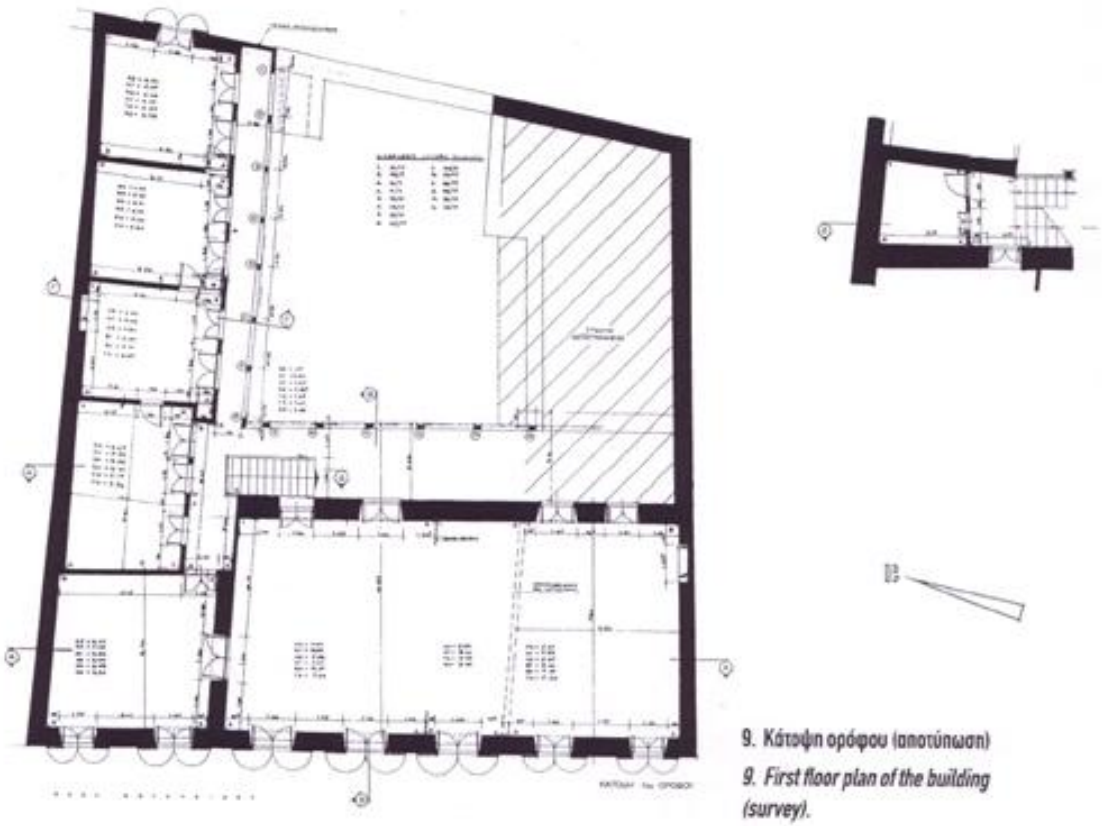
Villa of Good Fortune in ancient Olynthos. The roofs of the upper floor were made of wood and had tiles of clay.

TRADITIONAL ARCHITECTURE IN GREECE SINCE THE MIDDLE AGES: CONTINUING A TRADITION OF MILLENIA

THE CONTINUATION AND EVOLUTION OF BIOCLIMATIC LAYOUT



8. Κάτοψη του ισογείου (αποτύπωση)
8. Ground floor plan of the building (survey)

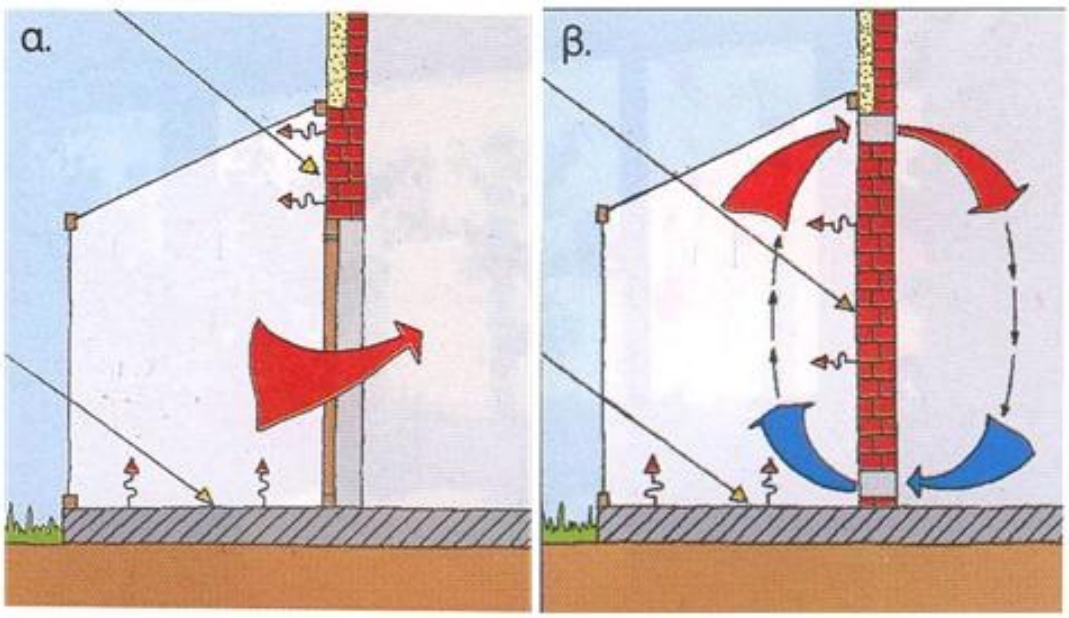


9. Κάτοψη ορόφου (αποτύπωση)
9. First floor plan of the building (survey).

An 18th century traditional house of Athens, repeating, after thousands of years, the disposition of ancient houses, around a court, with the main spaces facing the South and the East.

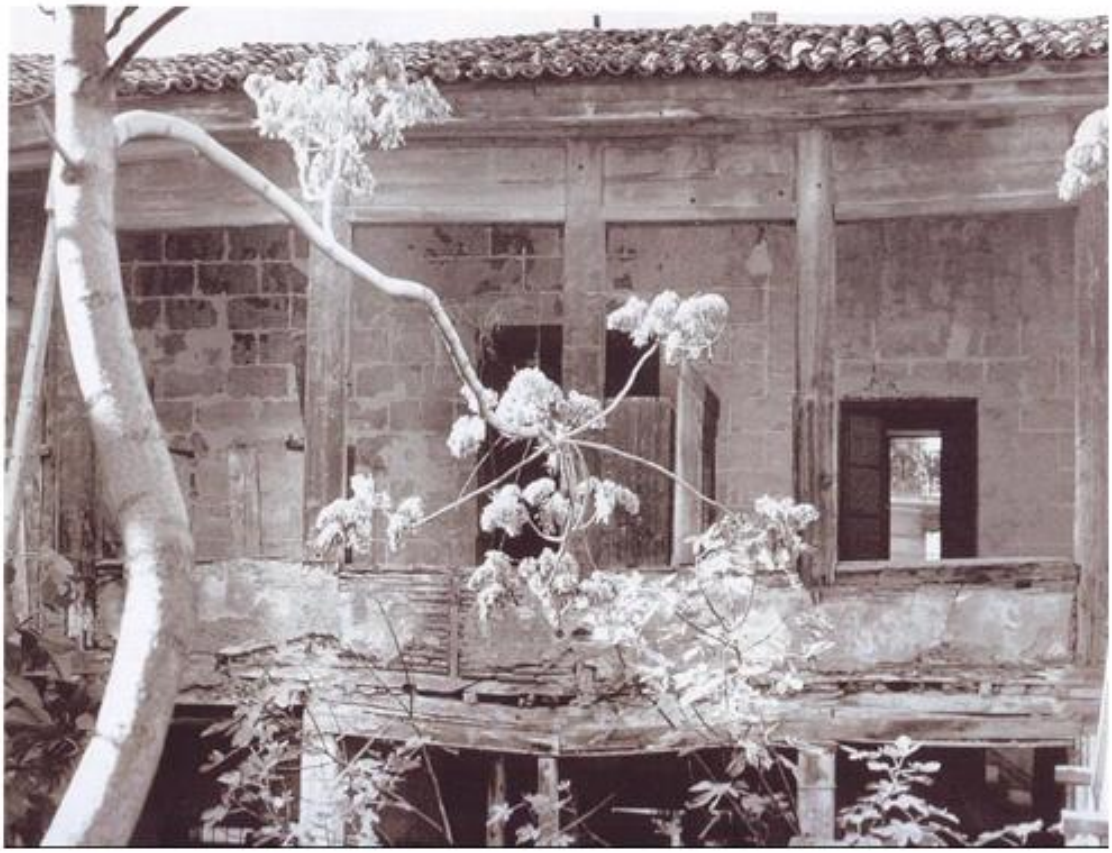
The house's court. The only difference with ancient houses is the addition of the glass panes, since that was not possible in ancient times. That addition transforms the balcony in a sort of a greenhouse.

The same court from above. The coexistence of spaces covered with shelters and others closed with glass panes, together with the internal rooms, creates three types of spaces, appropriate for as many different climate conditions in the course of the year. The very limited and flexible furniture permitted the easy change in the use of each space, according to the time of the year.



The way these balconies closed with glass panes work: A southern orientation is needed. The air behind the glass panes is heated by the sun and, in its turn, heats the interior, not directly exposed. The method can be applied even if the wall is blind. In that case, a hole in the lower part permits the cold air to get heated by the sun, become lighter and re-enter the house by an upper hole. The phenomenon is continuous.

Photos of the same house before restoration. This is the usual state of such houses before intervention. It is obvious that their condition (especially the destruction of their initial coatings) gives the opportunity to add any modern material which will increase their bioclimatic qualities (additional insulation for example, or the use of double glass panes).

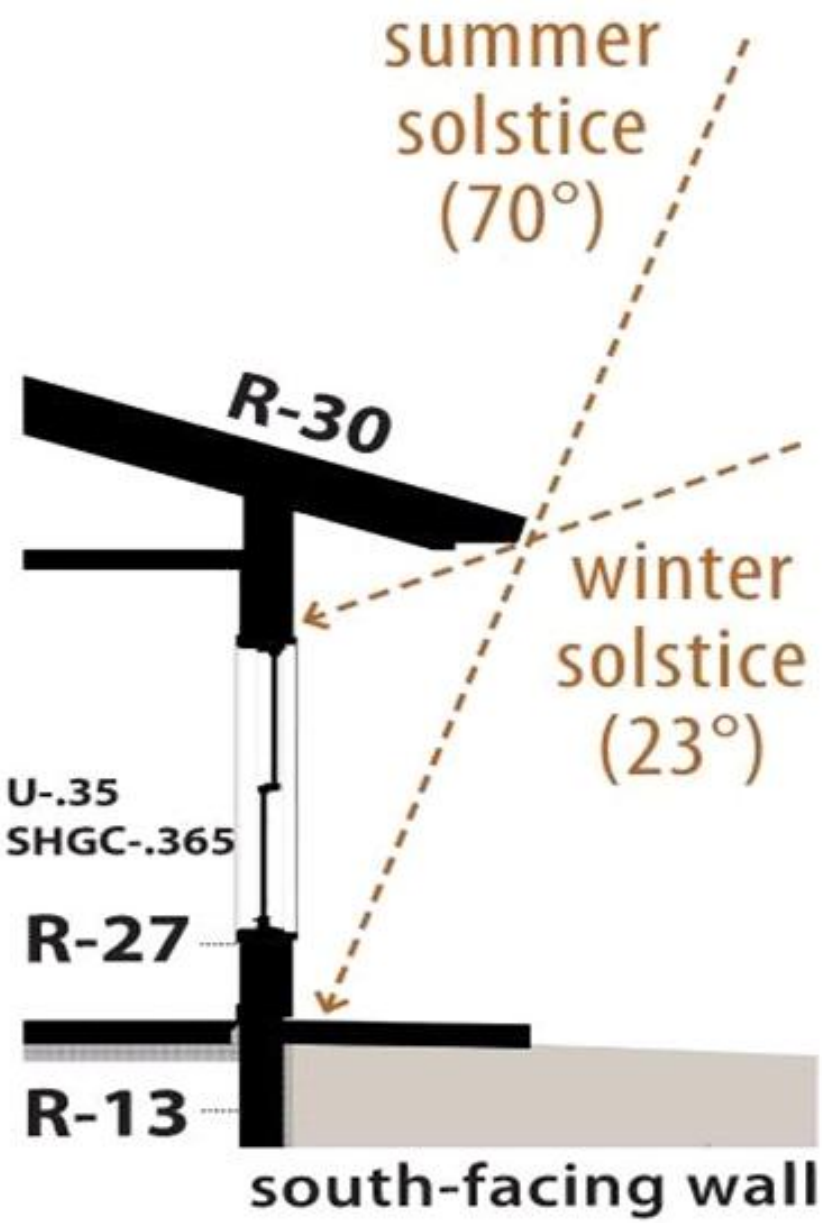


Two photos of the oldest house of Athens (17th century), where the same observations apply as in the previous one.

EVOLUTION OF BIOCLIMATIC LAYOUT OF THE ANTIQUITY: THE INVENTION OF FLEXIBLE FORMS

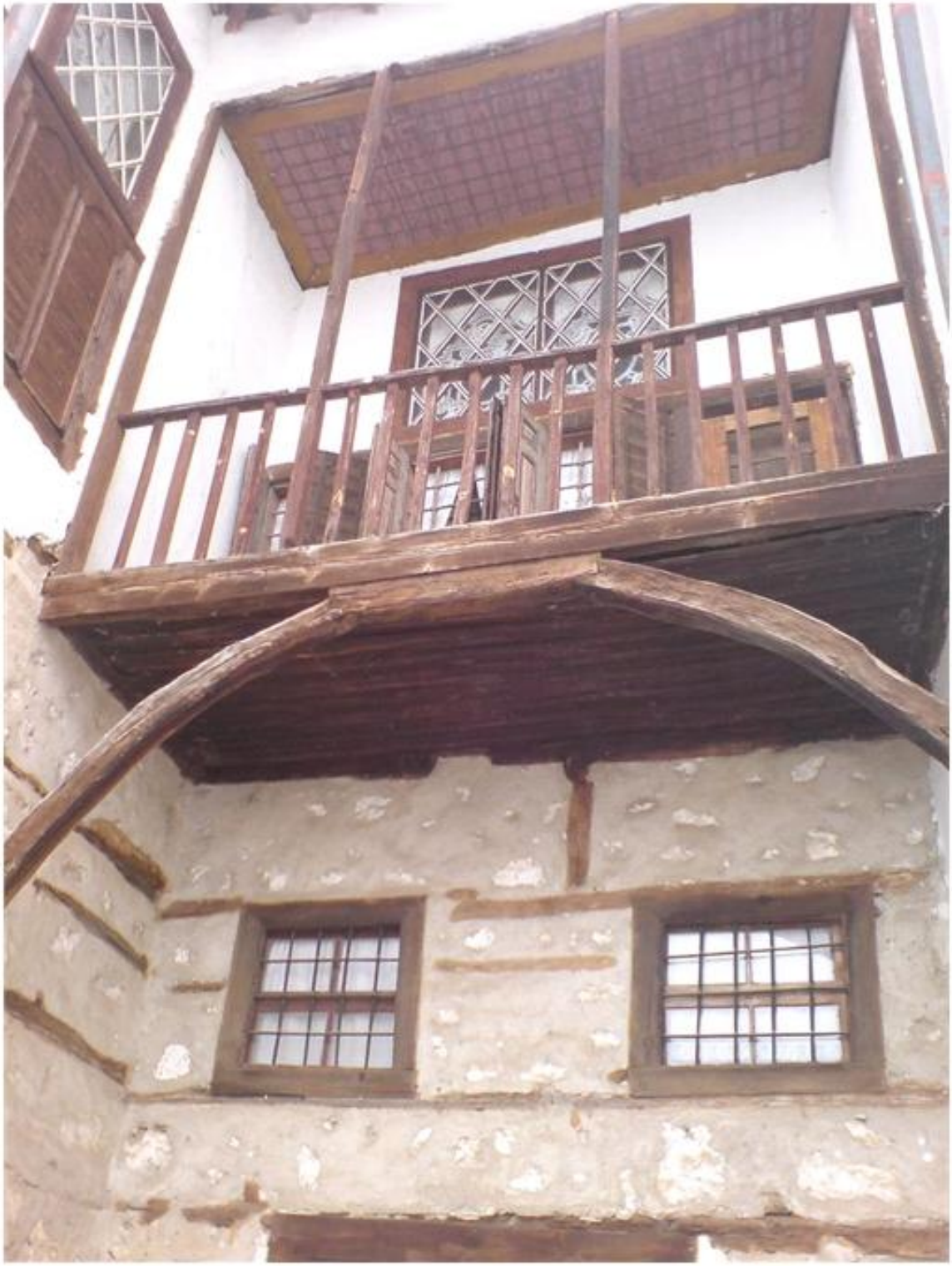
A street in the island of Samos. Social conditions leading to more extrovert houses than those of the antiquity, permitted the appearance of the balconies closed with glass even in the house's exterior.

A house in Kastoria, Macedonia. When the external space permitted it, the house's main rooms in the upper floors had a different orientation than the ground floor, in order to be turned towards the South or the East and have the best conditions possible. The upper windows, protected by the roof, didn't need any shutters, since the sun was high in summer and low only in winter, when it was welcome to enter the house.



Explanation of the principle mentioned in the previous pictures. The shelter protects the southern wall against summer sun, but permits the sun to enter in winter.

Examples of traditional architecture exploiting the climate conditions (Northern Greece: Macedonia, Thrace, Thessaly)



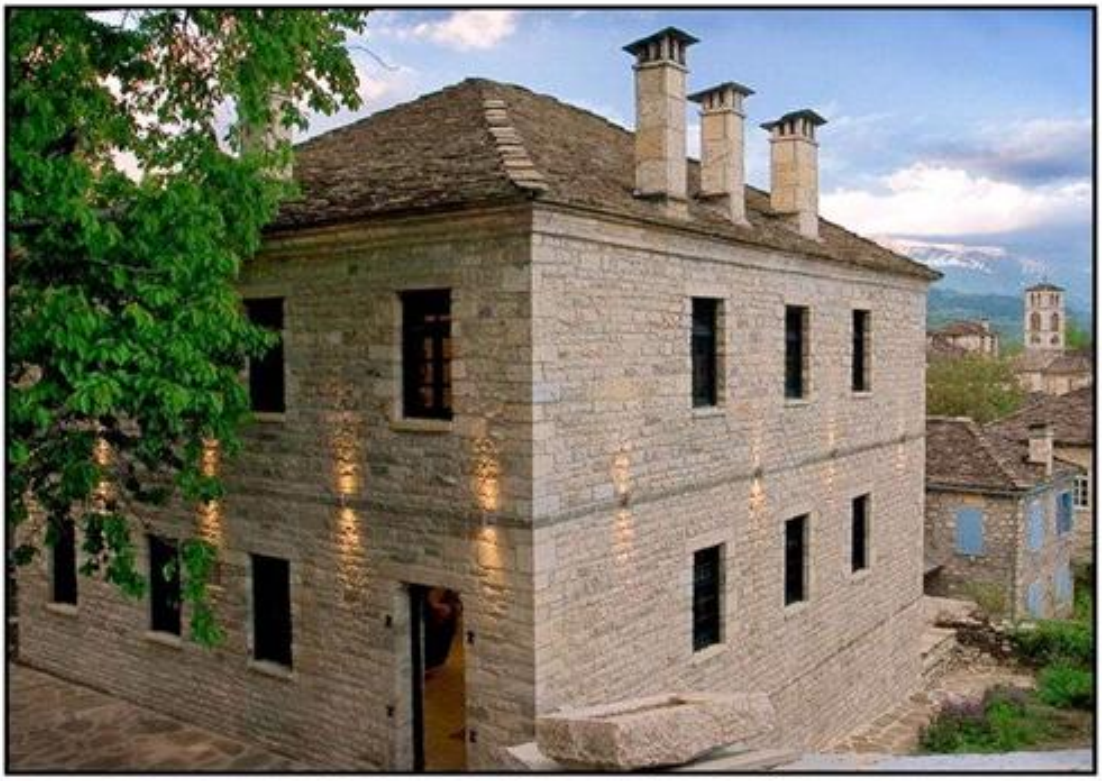
The internal spaces of the above buildings. The spaces created with the above principles are luminous and well aerated. For every time of the year there is a part of the house presenting the appropriate conditions.

Main spaces

Secondary spaces

MODERN EXAMPLES OF BUILDINGS INSPIRED BY TRADITION: BIOCLIMATIC LAYOUT AND MATERIALS

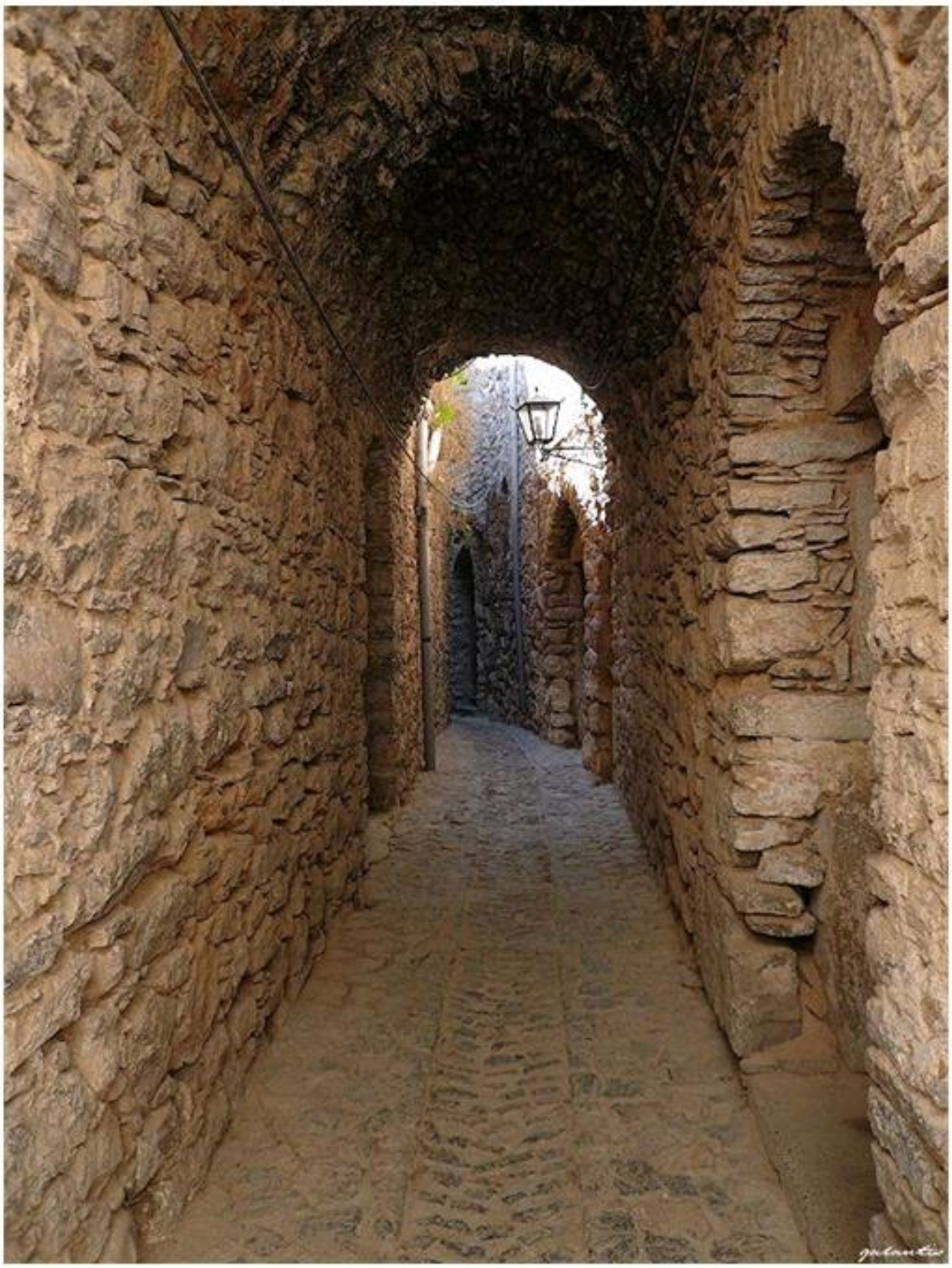
Hostels in Epirus

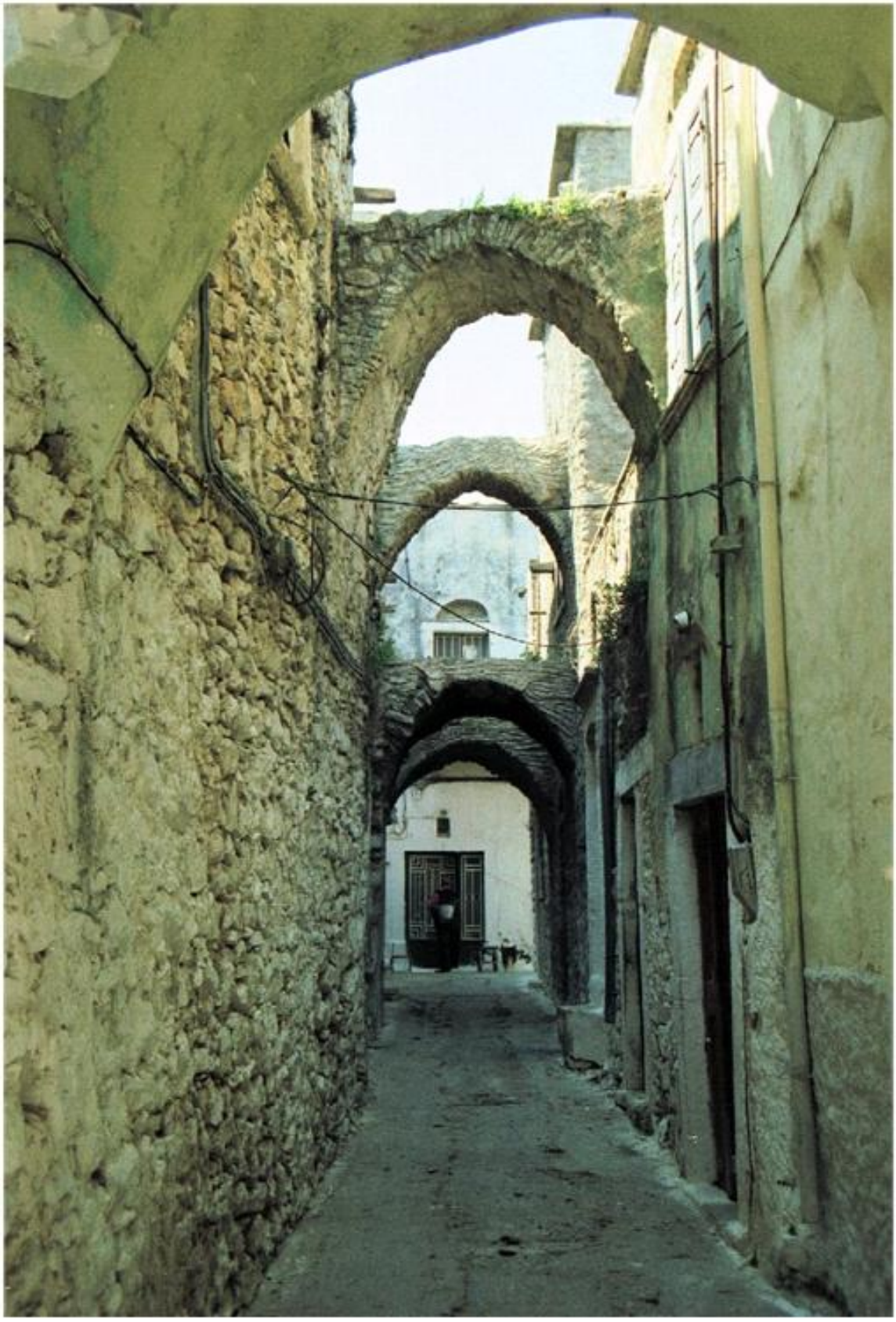


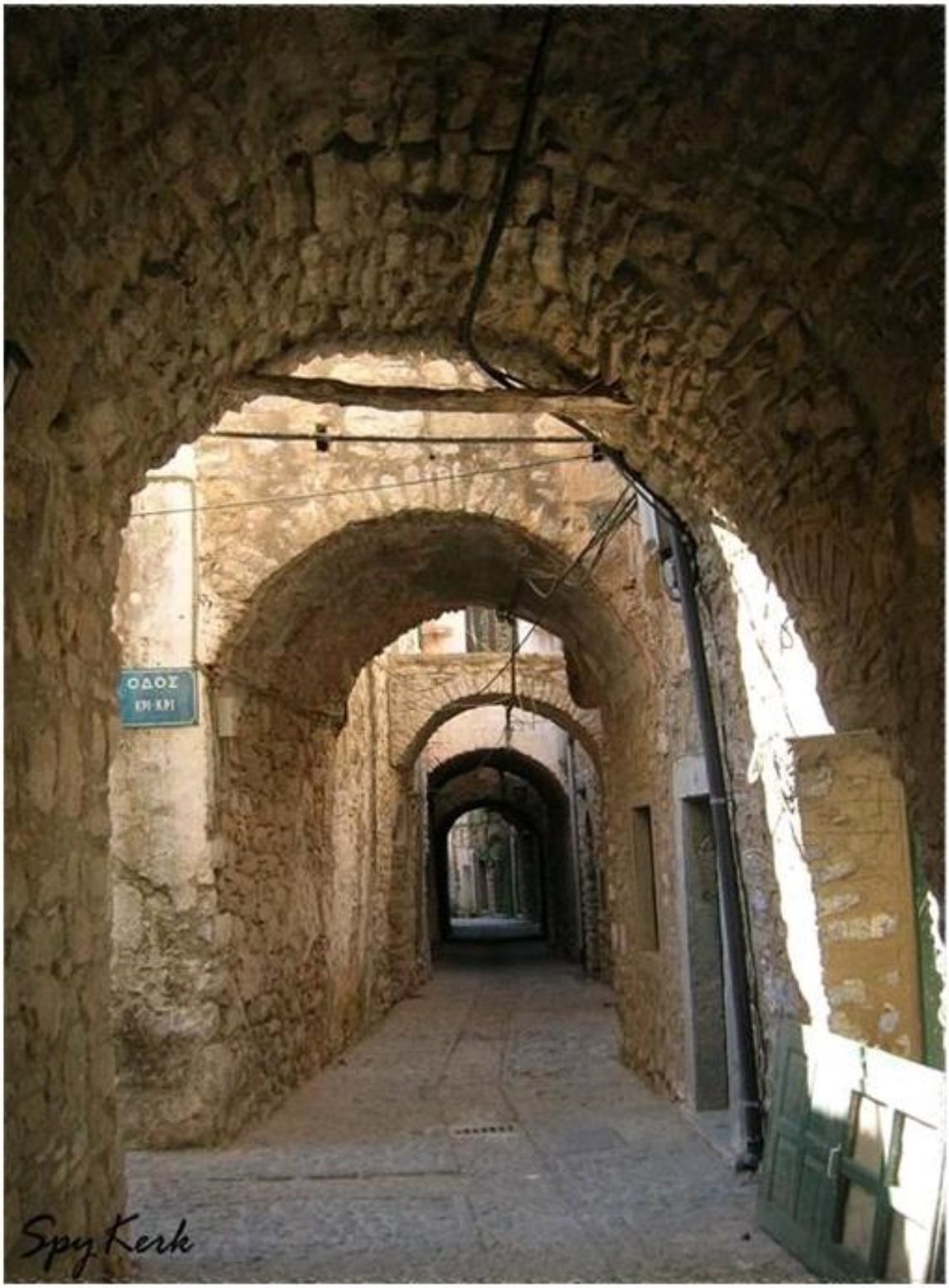
A modern house in Athens, applying the traditional method of turning the main spaces to the appropriate orientation, but with the use of modern materials.

SETTLEMENTS WITH BIOCLIMATIC CHARACTERISTICS IN AREAS WITH VERY HOT SUMMERS

Island of Chios, village of Mesta, a 14th century settlement. The stone vaults give more space to the houses of the narrow settlement, surrounded by walls, while at the same time protecting from the sunshine in summer. The wind circulating in those streets aerates the settlement in the difficult months of the summer. The main reason of that layout was the protection against pirates, but today its main advantage is functional.



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BIOCLIMATIC LAYOUT IN AREAS WITH VERY INTENSE SUNSHINE: SMALL WINDOWS AND WHITEWASHED WALLS IN THE ISLANDS OF THE SOUTHERN AEGEAN

The house's small windows limit the sun's access. The whitewashed walls reflect the sunrays and limit the amount of heat entering the house. The settlement's layout is similar to that of the previous one in the island of Chios, for the same reasons.

Island of Astypalaia

Island of Astypalaia

Island of Milos

INTERMEDIATE SPACES BETWEEN EXTERIOR AND INTERIOR IN AREAS WITH VERY INTENSE SUNSHINE AND MILD WINTERS(SOUTHERN AEGEAN)

Contrary to the use of glass panes in the examples of northern areas, in hotter areas architecture adopts vaulted loggias and shelters, often made of canes (both options due to the rarity of wood here).

Island of Milos. A modern house adopting traditional forms (due to legislation imposing it). Vaulted loggia and cane shelter.

Island of Milos. Another modern house adopting traditional forms

Island of Milos

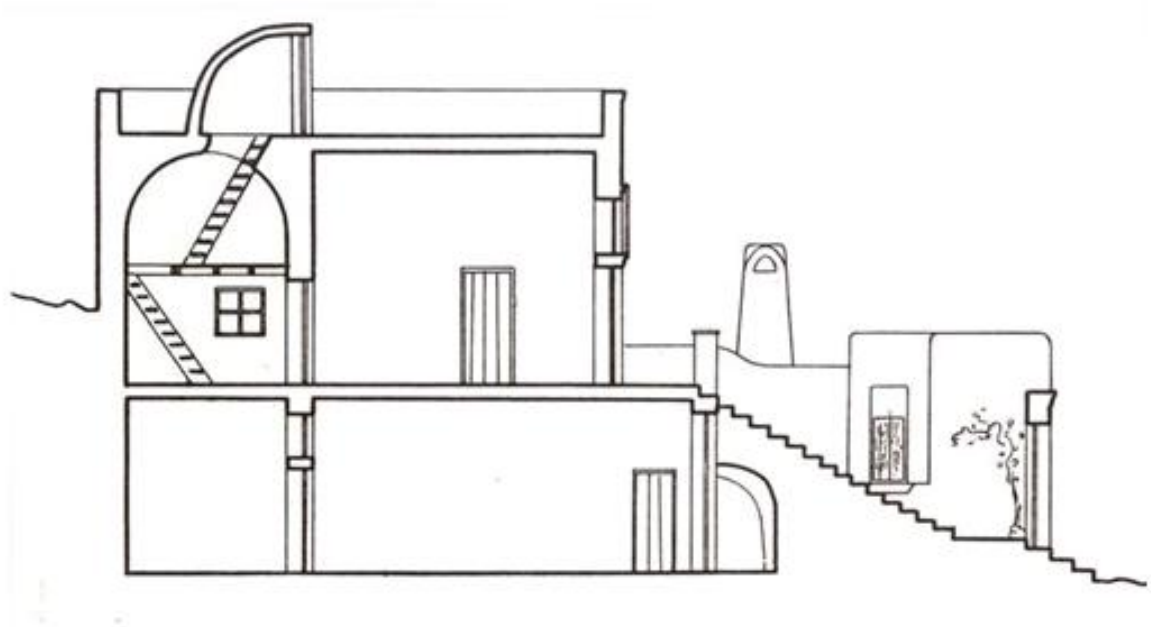
Island of Paros. Cane shelter.

Island of Naxos. Vaulted loggias in medieval and modern houses

Island of Hydra. Vaulted loggias in an 18th century house

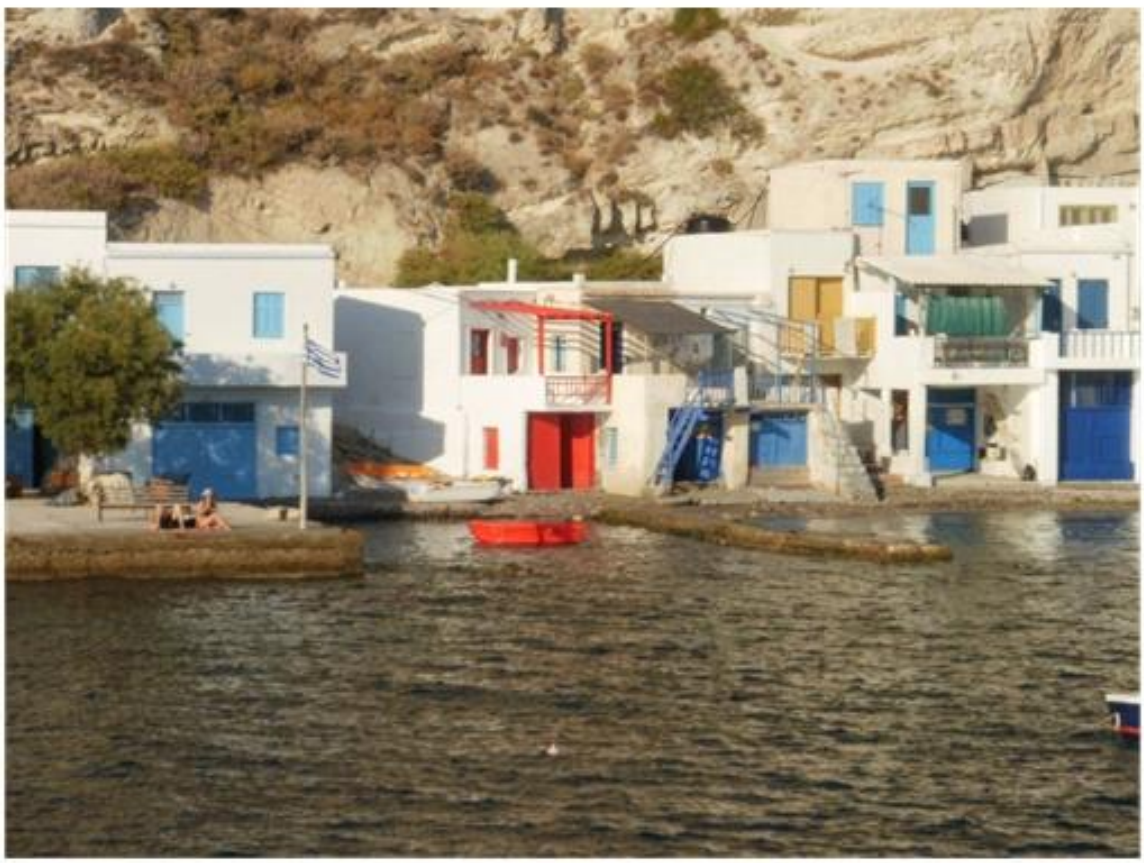
Chania, island of Crete. Vaulted loggia in a 15th century Venitian arsenal. Its today use as a cultural centre led to the addition of glass panes.

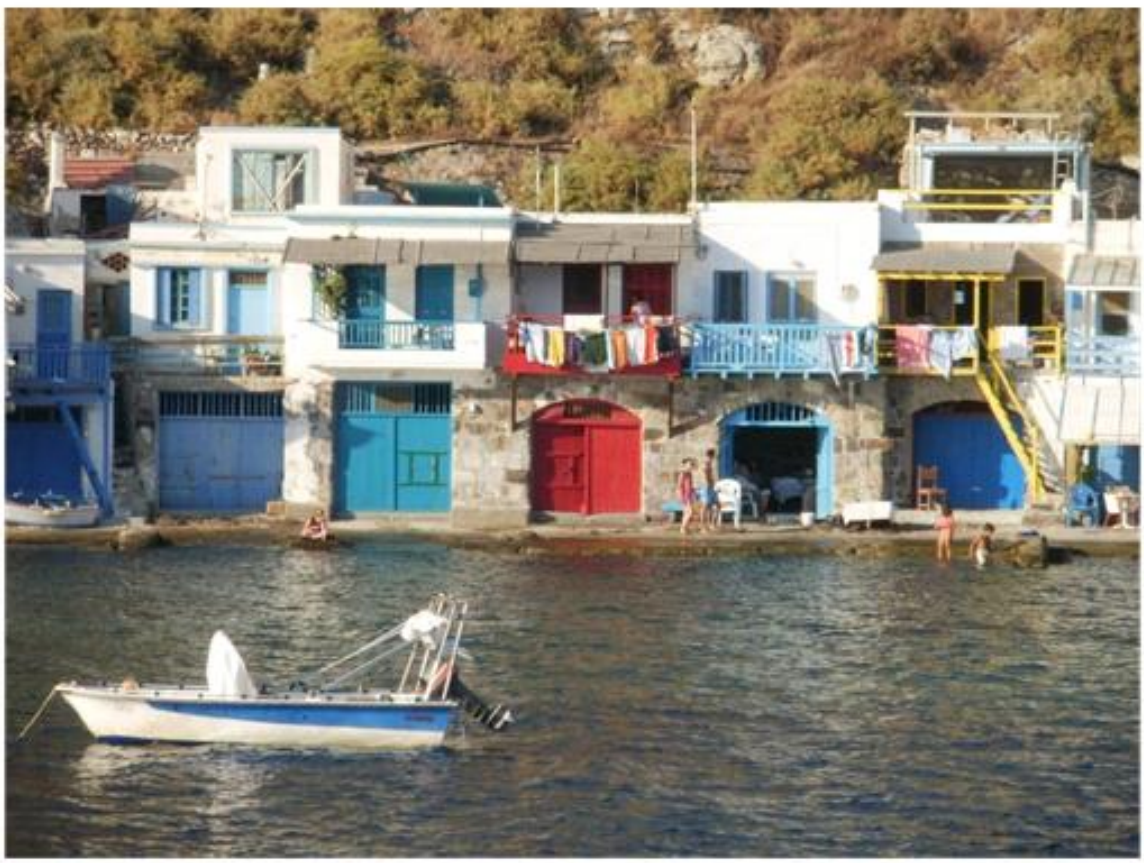
BIOCLIMATIC QUALITIES OF HOUSES
HALF-DUG IN THE GROUND

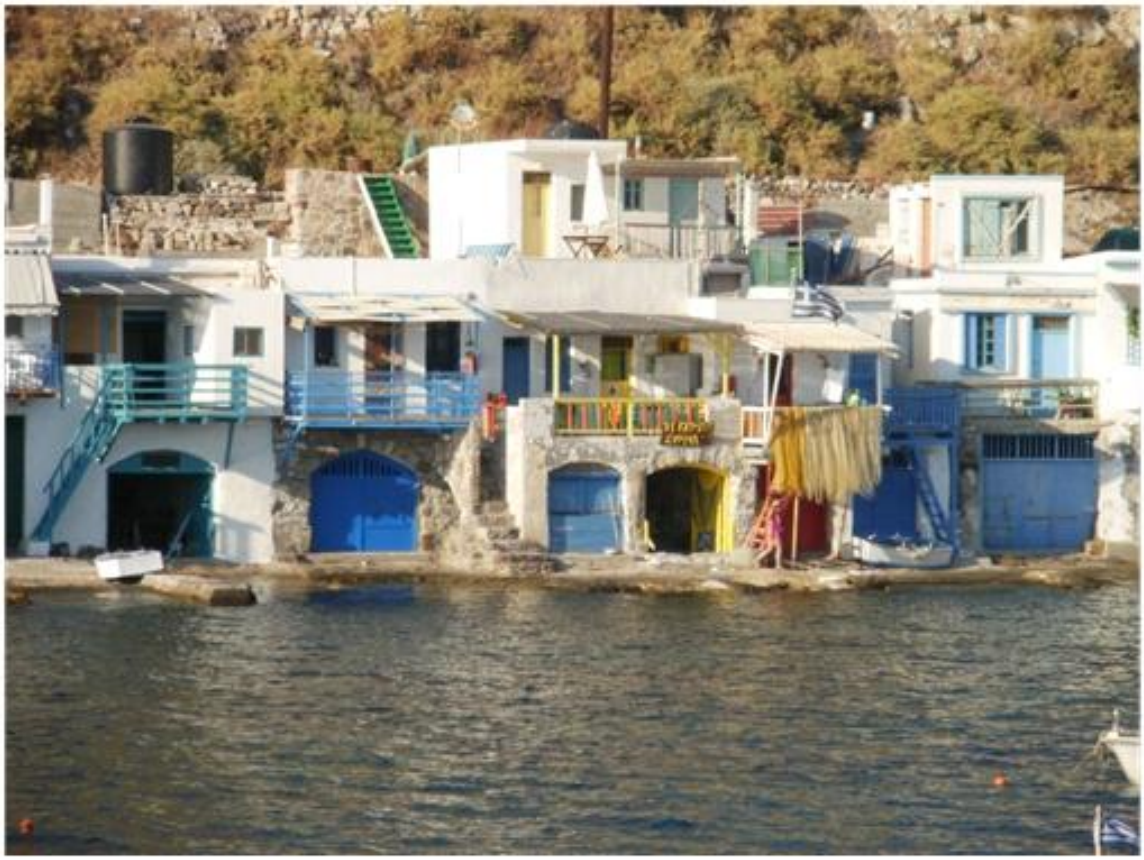


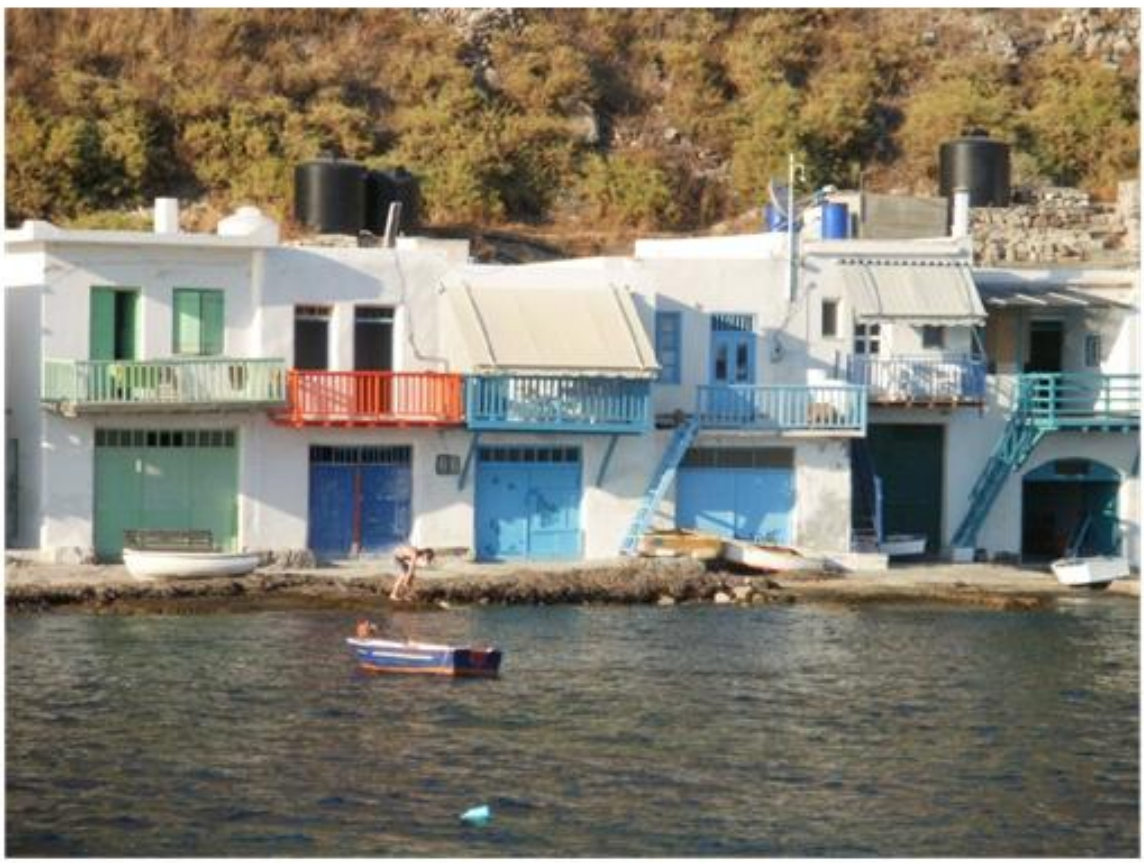
Section of a typical house of the Southern Aegean half-dug in the ground. In summer, the ground has a temperature much lower than that of the environment. Its contact to the house's walls helps to eliminate the heat from the building. In winter, the building's contact to the ground limits the heat losses towards the cold environment. The lack of humidity in the ground of these areas doesn't permit the appearance of a humidity problem in the building's interior.

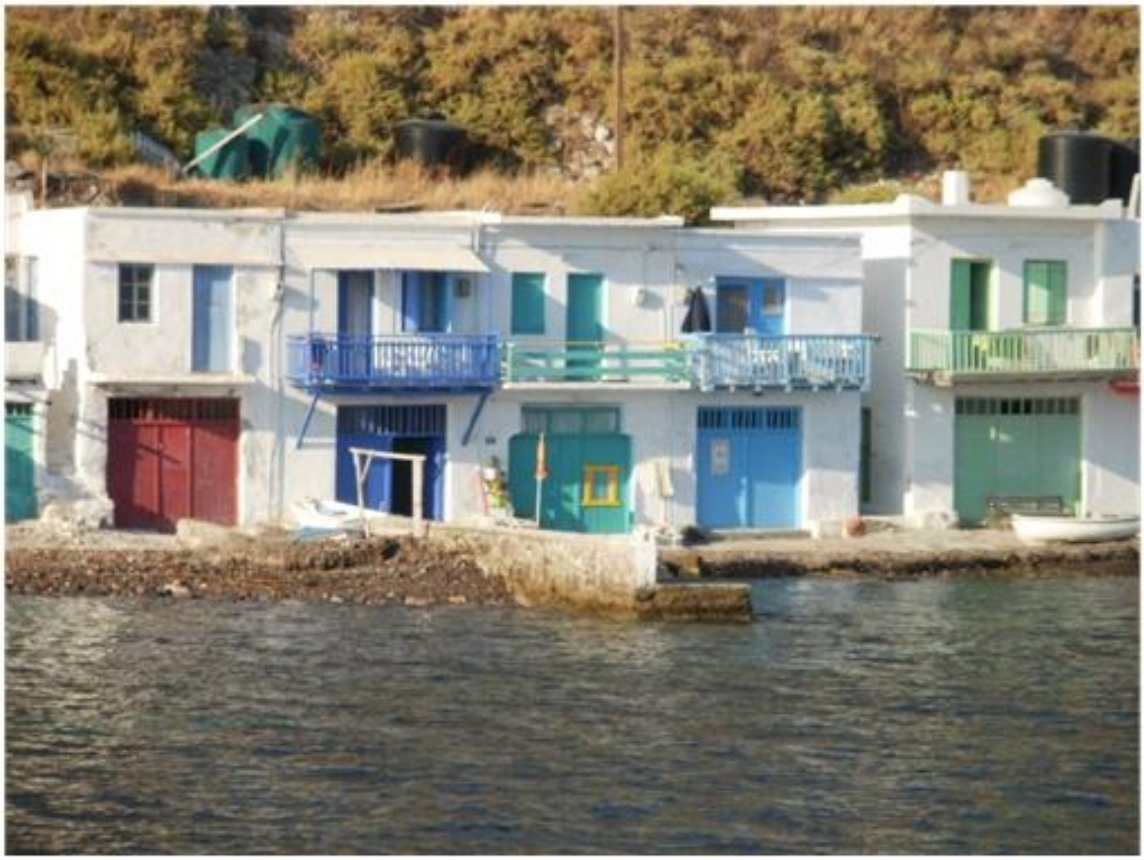
Examples from the island of Milos. Traditional fishermen houses half-dug in the rock are repeated by modern rented rooms mixed with the old buildings. Bioclimatic qualities are accentuated by the addition of shelters above the balconies.

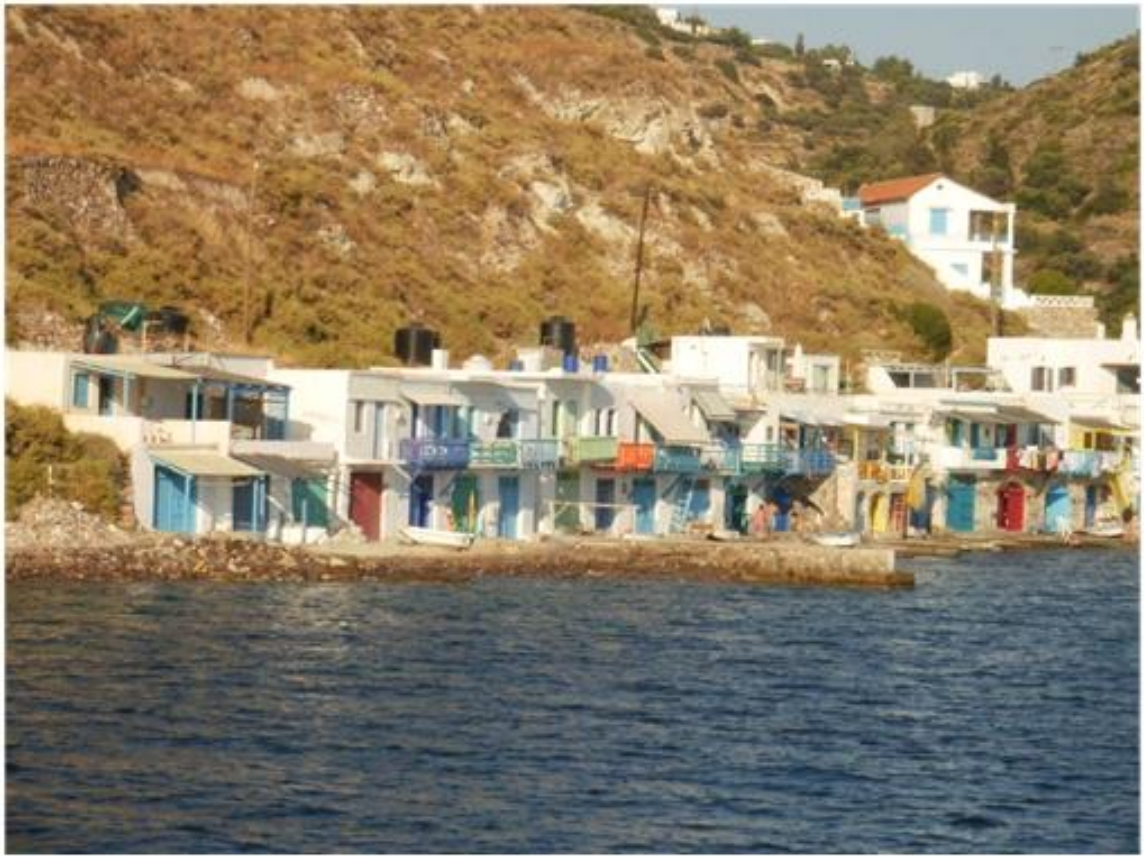












BIOCLIMATIC MATERIALS

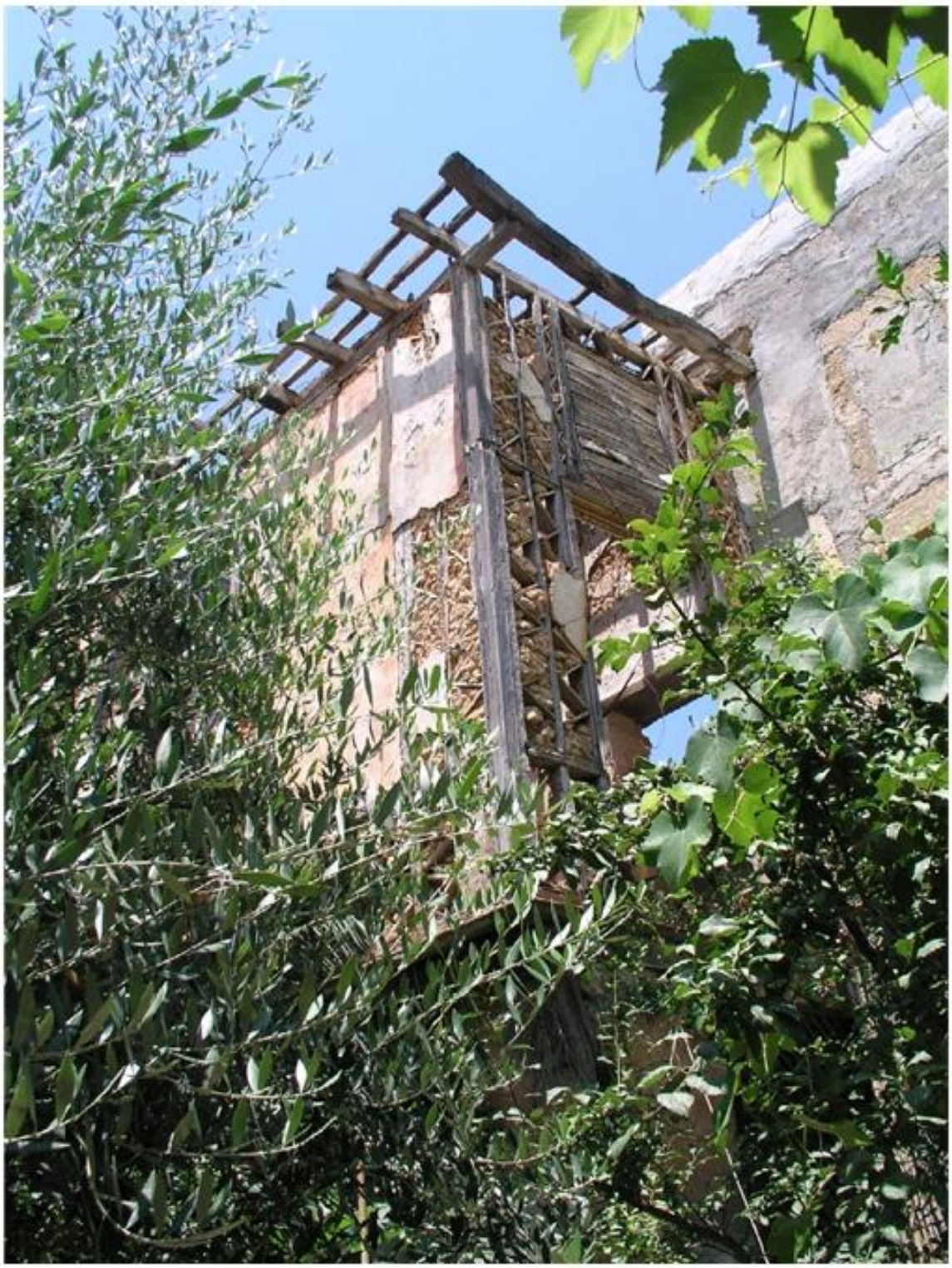
TRADITIONAL WALLS OF EARTH: THE CONTINUATION OF THE ANCIENT TRADITION

Walls of raw earth in Amfissa, Central Greece, with exceptional bioclimatic qualities. Raw earth is still, after thousands of years, the perfect material for walls in Southern Greece, where the limited humidity permits its use, provided they are covered with a coating, contrary to countries of the Middle East, where its use is still very often, without any coating.

TRADITIONAL WALLS, ROOFS AND FLOORS FILLED WITH EARTH, BROKEN TILES AND CANES

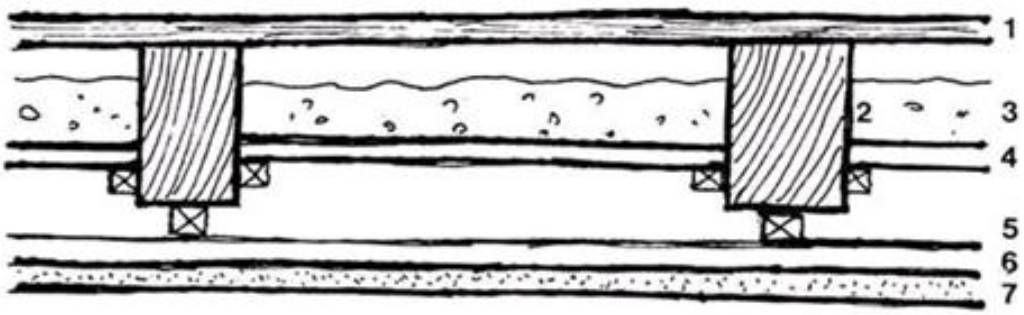
In more humid areas, the traditional wall is of a wooden frame, filled with earth, broken tiles and canes and covered with a lime coating. That type of wall too has exceptional bioclimatic qualities. It was used in the upper floors, permitting more space than the thick stone walls of the ground floor. The latter were necessary, though, in order to protect the upper wooden frames from humidity coming from the ground, but also for safety reasons. That system is the common one in Northern Europe too, with the difference that the walls' interior is usually filled with baked bricks. Baked bricks were rare in Greek traditional architecture, because of the lack of the appropriate infrastructures to produce them. Moreover, the areas where this architecture dominates are mostly mountainous, which means abundance of stones and wood, but not of clay.

Island of Samos

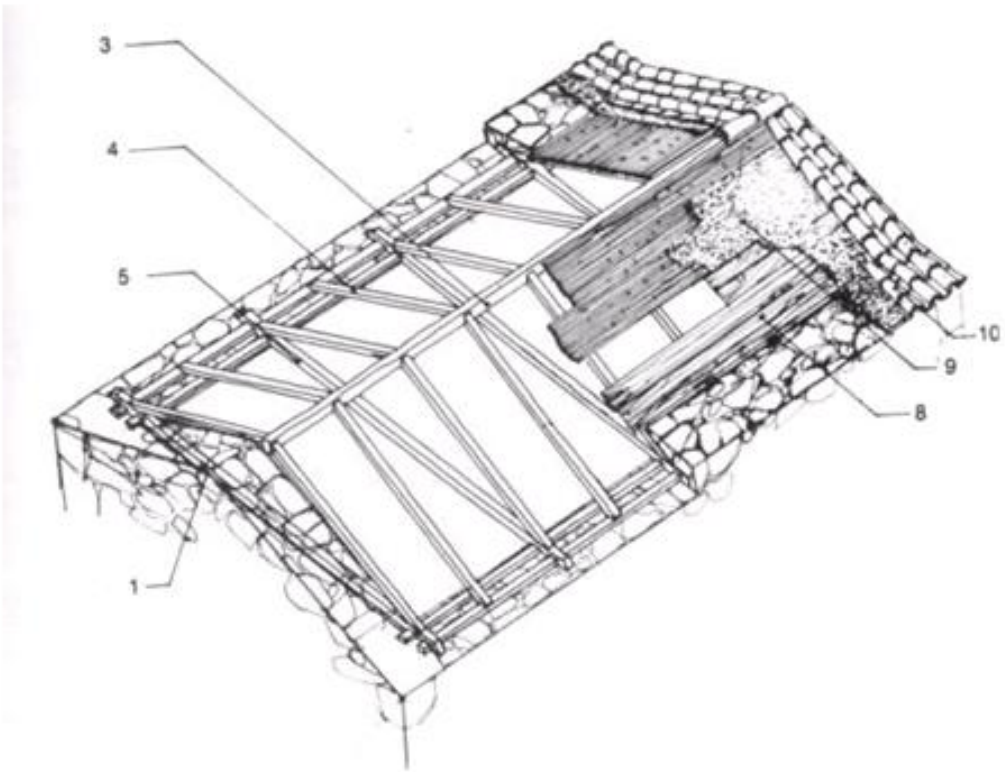


Chania, island of Crete

Chalkidiki, Macedonia



Sections of a traditional floor and a traditional roof in continental Greece and the islands of the Northern Aegean. In both cases earth in the structure's interior works as insulation. Floor: 1. Upper surface 2. Beams 3. Earth 4. Boards supporting the earth 5. Little beams 6-7 different layers of lime mortar



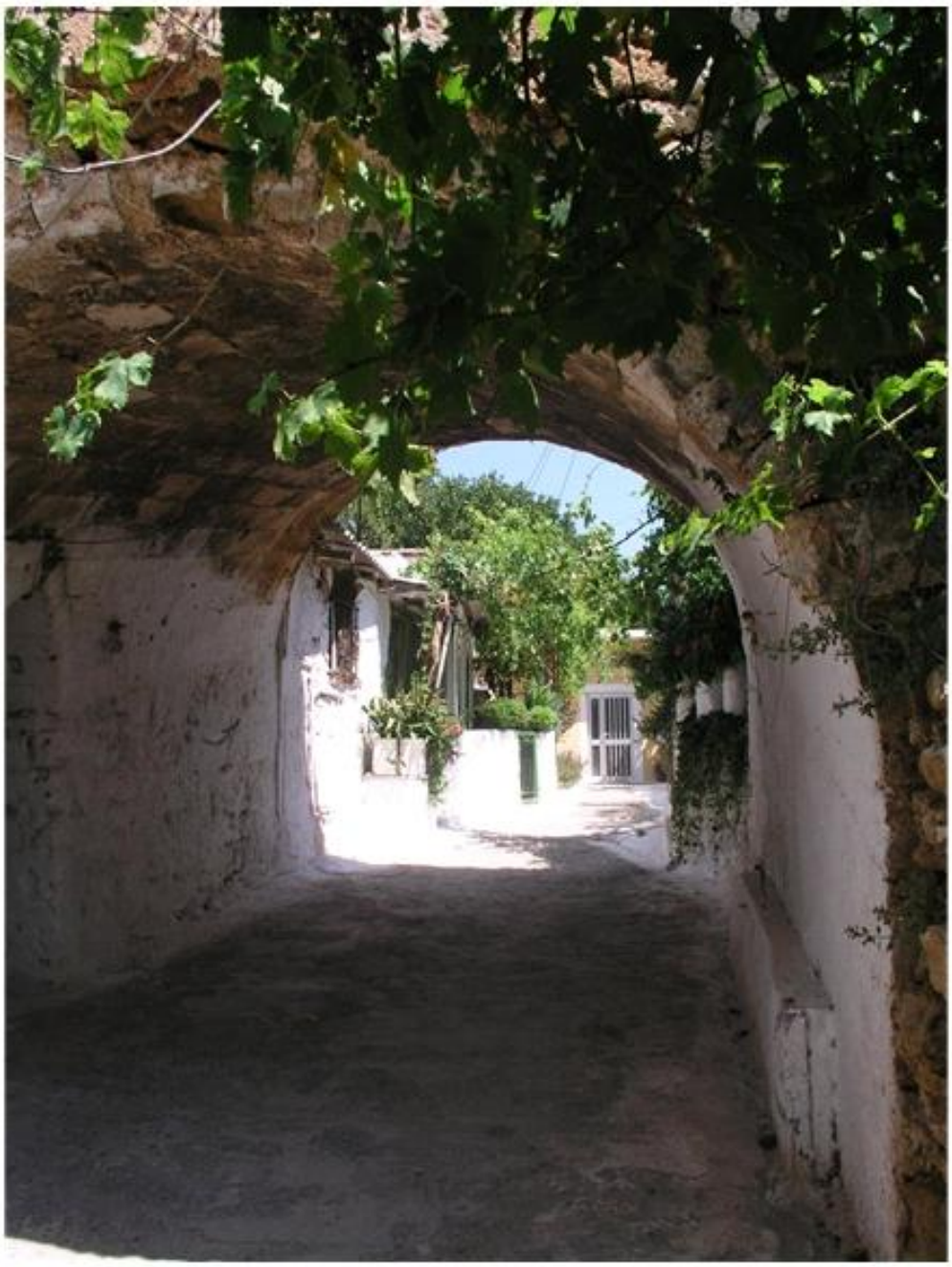
Islands of Santorini (above) and Patmos (below). The roofs have insulation made of earth and seaweeds and they are flat, in order to collect the rain water.

THE USE OF PLANTS TO AFFECT CLIMATIC CONDITIONS

Plants are a great tool to affect the climate conditions in buildings and out of them. If they are deciduous, they protect against the sun during summer, but they let the sun pass during winter.

Chania, island of Crete

Chania, island of Crete



Chania, island of Crete

Island of Syros. Combination of cane shelter and plants.

Island of Syros. Combination of cane shelter and plants.

Island of Skopelos

Island of Skopelos

Athens

NEOCLASSICAL ARCHITECTURE: THE FIRST RUPTURE WITH NATURE SINCE ANCIENT GREECE

With the introduction of neoclassicism in Greece after 1830, for the first time in the country's history architecture was imitating formal models of strict symmetry, not adapted to the climate and the specific conditions of each place. However, there is a clear distinction between the houses of the high bourgeoisie, completely following European formal models and abandoning the lessons of traditional architecture, and the houses of the lower classes. Those have usually a neoclassical façade, hiding a layout continuing the well tested typological traditions of so many centuries.

Athens

Athens

Athens

Athens

Athens

Athens. The strict formality of such an architecture would never permit a bioclimatic layout.

Athens. A house hiding a traditional layout behind the symmetrical and inflexible neoclassical façade.

Athens. Another example of a house hiding a traditional layout behind the symmetrical and inflexible neoclassical façade.

Athens. An example of a house hiding completely its traditional and highly bioclimatic layout behind its symmetrical and rigid façade. It is the house with the balcony closed with glass panes presented previously.

Athens. An example of a traditional house, renovated in the era of neoclassicism. The traditional layout coexists with neoclassical decorative elements.

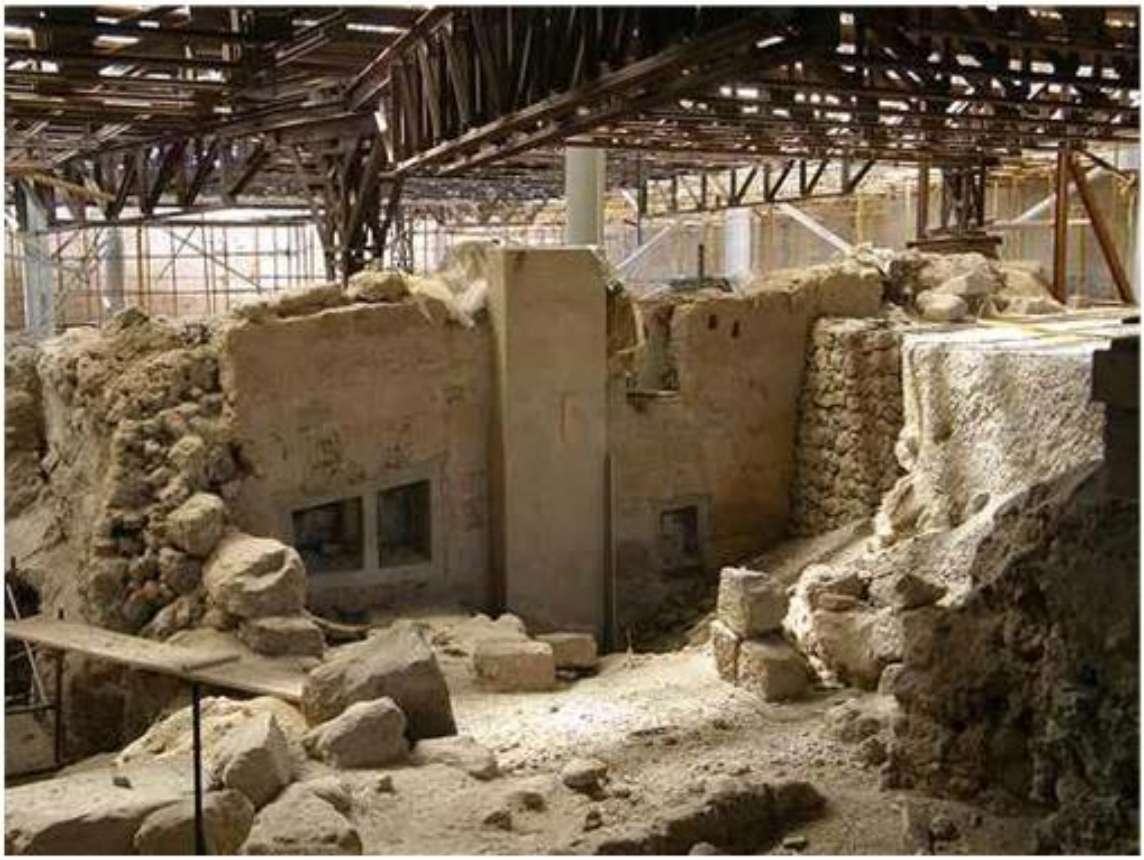
Athens. The previous house’s court.

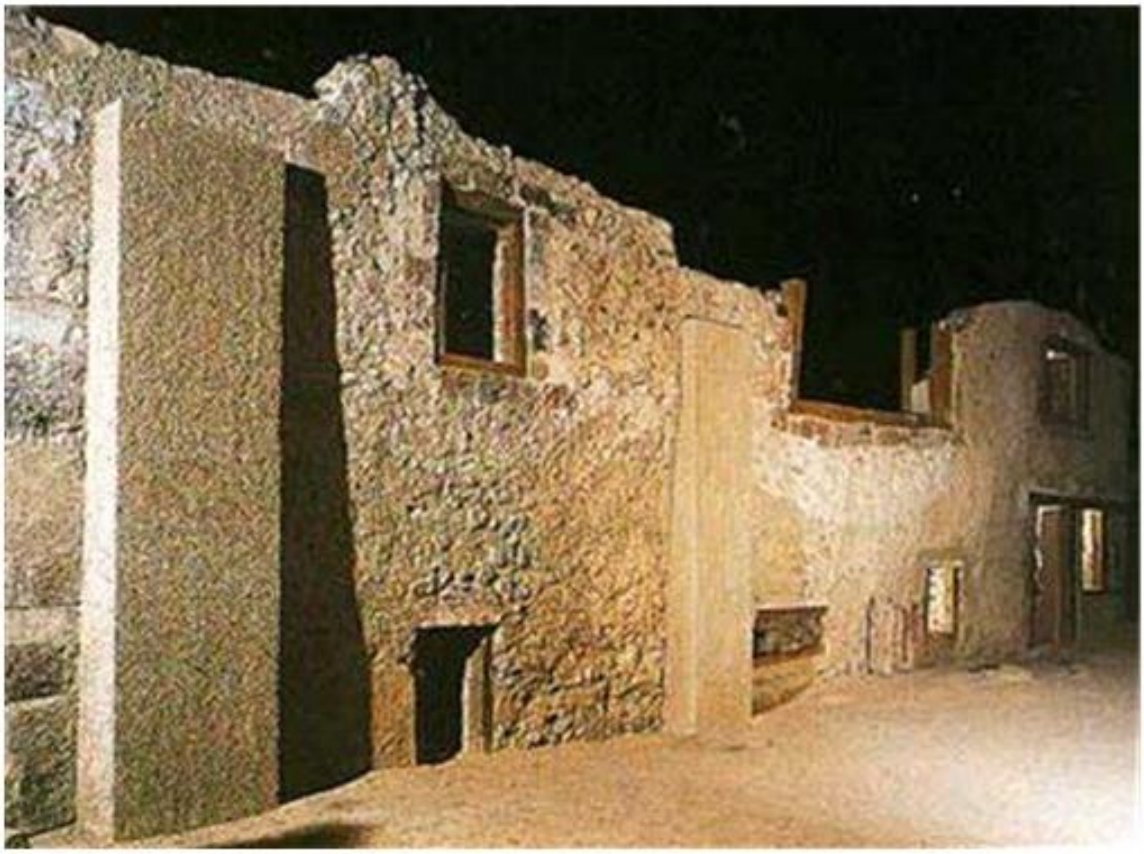
THE RESISTANCE TO THE RUPTURE WITH NATURE: POPULAR ARCHITECTURE IN THE ERA OF NEOCLASSICISM

At the same time neoclassicism was sweeping Greece and transforming architecture, ignoring for the first time the climate factor, the lower layers of the population, with no financial means to build neoclassical houses with their expensive decoration and also very hostile to that imported habits, stuck to their traditions and insisted building in traditional ways. That was not only a decision, but also a need, traditional architecture being more economic and in, the case of Athens, more appropriate for those who had to build with no permission in the town's periphery. A good example surviving until today is the settlement of the builders who came from the island of Anafi to build… neoclassical houses in Athens. For their own houses, built during the night on the slope of the Acropolis, they remained faithful to their island's traditions: whitewashed walls, flat roofs, small windows, cane shelters, plants giving shadow. These houses are until today perfect examples of bioclimatic architecture.

THE MOST FAMOUS COMBINATION OF MODERN AND TRADITIONAL BIOCLIMATIC TECHNOLOGY IN GREECE: THE SHELTER OF THE PREHISTORIC MINOAN SETTLEMENT IN AKROTIRI, SANTORINI

The shelter of the archaeological site of Akrotiri in Santorini has attracted international attention and has entered many important lists of bioclimatic architecture. It may be the biggest archaeological shelter in the world, covering 16 acres. The archaeological site is of a unique importance at an international level, being a settlement of the Minoan civilization of Crete, dating from the 15th century BC and conserving houses instead of palaces, as it is the case in Crete. The shelter lets light and air pass, but in a specific way and from specific directions, in order to ensure the space's lighting and aeration, but also its air-conditioning. In the hottest hours of the day, the sheltered archaeological site has about 7 - 8 degrees Celsius below the external environment. The shelter is covered with the special earth of Santorini, coming from the volcano and being the main covering material of the island's roofs. It is considered to be one of the most perfect bioclimatic materials in the world. The shelter, with a life expectancy of 300 years, is thus the best example of combination of modern and traditional bioclimatic technology in Greece, showing the possibilities of combining tradition with modern technology to have the best results.





THE WAY TO SPREAD THE KNOWLEDGE OF TRADITIONAL AND MODERN BIOCLIMATIC ARCHITECTURE AND THEIR COMBINATION: EDUCATING YOUNG SPECIALISTS

SEMINARY ENTITLED "RESTORATION, CONSERVATION AND THERAPY OF BIOCLIMATIC ELEMENTS IN TRADITIONAL HOUSES"

It is organized since 2009 by the association of Greek architects and takes place in the Mount Pelion in Thessaly, very rich in traditional architecture. Participants play an active role in the restoration project.

THANK YOU
FOR YOUR ATTENTION