Chapter 2
The Abric Romaní Site and the Capellades Region

Josep Vallverdú-Poch, Bruno Gómez de Soler, Manuel Vaquero and James L. Bischoff

Abstract The main goal of this chapter is to provide a general presentation of the Abric Romaní site, paying special attention to archeological level J. First, we will present the basic information concerning the geological and geomorphological characteristics of the Capellades region, which are fundamental to understand site formation. We will summarize the history of the archeological excavations carried out at the Abric Romaní, since the discovery of the site in 1909 to the current works. This history shows the different theoretical and methodological paradigms that dominated European Prehistory in the course of the twentieth century. Within this context, the excavation of level J will be exposed in detail. Finally, we will present the stratigraphy of the site and the chronological framework, which is largely based on U/Th dating of tufas.

Keywords Abric Romaní • Geology • Capellades • Research history • Stratigraphy • Chronology

In this chapter, we will provide a general presentation of the Abric Romaní site in general and archeological level J in particular. First, we describe the main geological and geographical characteristics of the Capellades area, in which the Abric Romaní is located. Second, we summarize the long history of archeological research at the site through the various different excavations carried out at the rockshelter since its discovery in 1909. We then describe the the history of the excavation of level J in detail. Finally, we present chronostratigraphical data related to the site, again with special attention to level J.

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The Geology and Geography of the Capellades Region (NE Iberian Peninsula)

The Abric Romaní is a wide rockshelter (Abric) in a travertine cliff called *Cinglera del Capelló*, located in a karstic landscape near Capellades (Barcelona, Spain) on the west bank of the Anoia River, 50 km west of Barcelona. The Abric Romaní has an elevation of 265 m above sea level. The cliff escarpment is orientated NW–SE with the entrance on the NE side of the wall, facing the Capellades Gorge. Its coordinates are 1°41′30″ longitude E and 41°32′ latitude N. At this point, the Anoia valley forms a narrow gorge, which in historic and prehistoric times was one of the main natural passages between the inner regions of Catalonia and the coastal areas. This cliff harbors several rockshelters with evidence of prehistoric occupation.

The Capellades area in which the Abric Romaní lies opens towards the Conca d'Òdena (Ódena basin), an erosional marginal basin in the Eastern Ebro Basin created by the Anoia River in its course towards the Mediterranean Sea as a tributary of the Llobregat River. The Anoia shaped the Capellades Gorge that connects the Penedès Depression and the Ebro Basin (Fig. 2.1). The Vallès-Penedès normal fault marks the subsidence of the Penedès Depression and the uplift of the Prelitoral Range and Ebro Basin. This morphostructural frame allowed for a new hydrological network that was incised capturing the Ebro Basin, thereby reversing the direction of pre-existing Pleistocene drainage (Gallart 1981).

There are three structural units in the Capellades region (Fig. 2.1):

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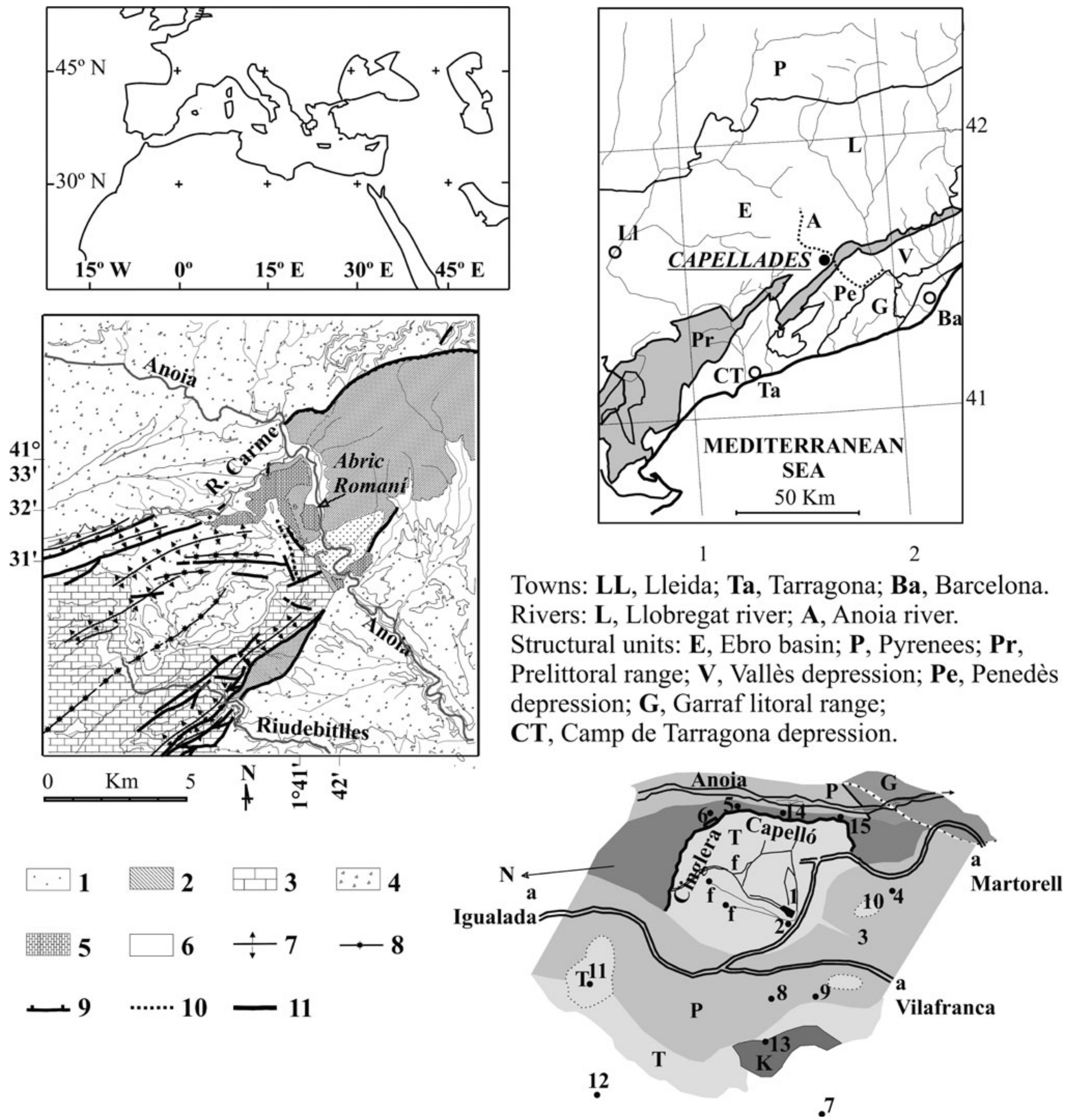


Fig. 2.1 Geographical location and main geochronological units of the Capellades region. Legend (IGME 1975): *1* Plutonic intrusions. *2* Paleozoic. *3* Mesozoic. *4* Cenozoic. *5* Quaternary travertines. *6* Quaternary. *7* Anticline. *8* Syncline. *9* Normal fault. *10* Inverse (thrust) fault. *11* Fault. At the bottom right, geological outline and water sources in the vicinity of Capellades (Vidal 1911, p. 111): *G* granites; *P* slates; *T* tuff; *K* travertines; *1* Bassa or Font Gran; *2* Font Petita; *3* Font Cuitora; *4* Font del Llargandaix; *5* Font de la Reina; *6* Abric Romaní; *7* Font de Riudacost; *8* Pou del Cardús; *9* Mina del Artigues; *10* Travertí del Cementeri; *11* Turó de Torre Nova; *12* Font de Frígols; *13* Terreres de la Garca; *14* Agut Station; *15* Barret del Capelló; *f* public springs

(1) The Ebro Basin
(2) The Prelitoral Range
(3) The Prelitoral Depression
(4) The travertine Capellades-Carme area

The Ebro Basin is an extensive triangular unit, bordered by the Pyrenees and the Basque-Cantabrian Ranges to the north, by the Iberian Ranges to the south and by the Catalan Coastal Ranges to the east (Fig. 2.2). This depression is

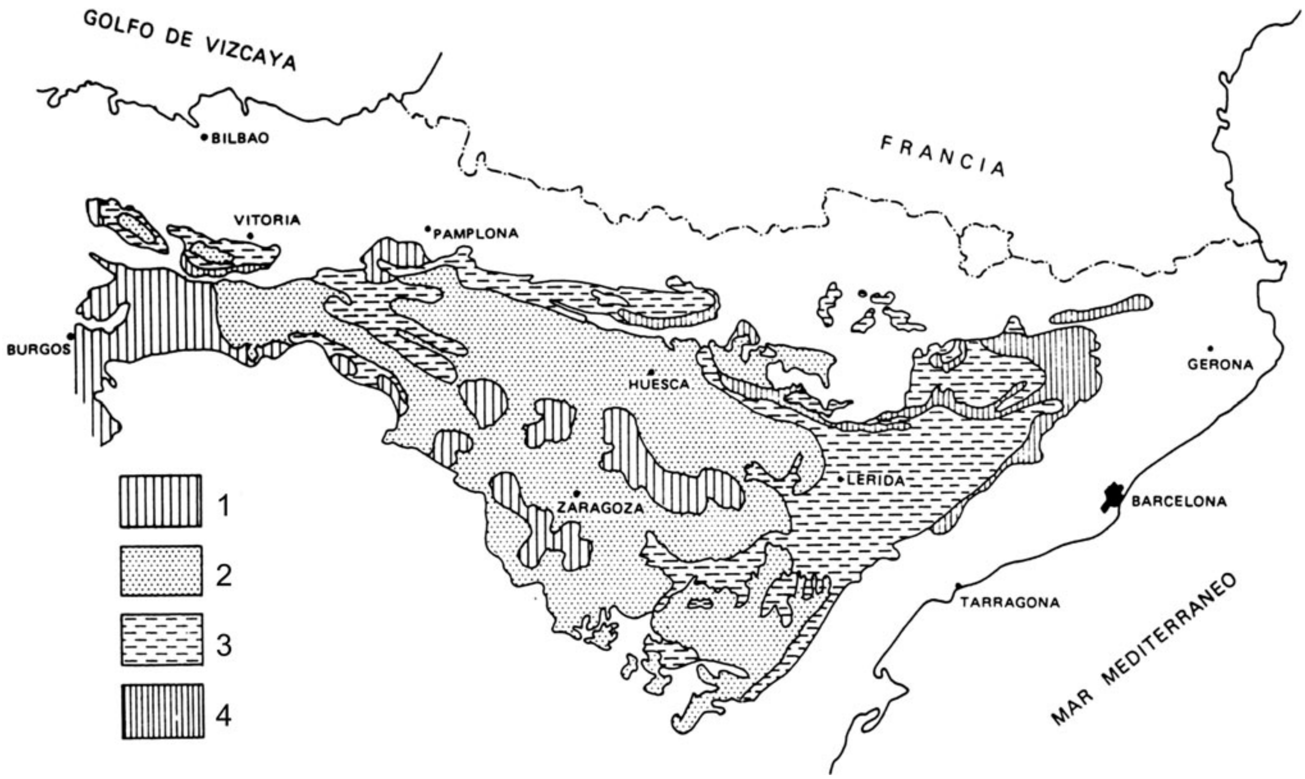


Fig. 2.2 Ebro Basin. From Riba et al. 1983. Legend: *1* Upper Miocene. *2* Lower Miocene. *3* Oligocene. *4* Eocene

mainly drained by the Ebro River and corresponds to a tertiary sedimentary basin with Eocene deposits formed by erosive processes affecting the bordering ranges (Solé Sabarís 1958–1964).

Two marine sedimentary cycles dominated the development of the Ebro Basin. The first marine transgression took place during the Ilerdian (Lower Eocene) and deposited platforms of neritic limestone and marls. The second cycle began in Catalonia during the Lutetian (Middle Eocene), reaching the Igualada area in the Bartonian (*Fm. Collbàs*, *Fm. Igualada* and *Fm. Tossa* from Upper Eocene) (Riba et al. 1983). A regression subsequently took place, causing the formation of conglomerates in the margins of the Catalan Coastal Ranges (Montserrat, St. Llorenç de Munt, etc.). During the transition between the Eocene and Oligocene, the basin was not covered by the sea and, therefore an endorheic system was established, forming a large interior lake by continuous continental contributions. This sedimentation was characterized by alluvial fans in the Oligocene. During the Neogene, sedimentation ended in the Catalan area (Gutiérrez and Peña 1994). This endorheic system concluded at the end of the Tertiary due to the elevation of the Iberian Peninsula and the sinking of the Mediterranean. Tertiary materials were subjected to great erosion and the basin was partially cast towards the sea by the river Ebro.

The Prelitoral Ranges are part of the Catalan Coastal Ranges. This name designates the reliefs extending along the Catalan coast between l'Empordà and the Iberian Range, which correspond to the Mediterranean System as defined by Solé Sabarís (1958–1964). It is range stretching north-east to south-west over 250 km that connects to the Pyrenees in the north. This system is formed by two parallel coastal ranges separated by an intermediate depression (Fig. 2.3).

One of the most outstanding features of the central part of the Prelitoral Range is the Capellades Strait, formed by the Anoia River. In the Capellades area, the Anoia divides the Prelitoral Range into two different lithological areas: the Paleozoic materials to the east and the Triassic materials to the west. The Paleozoic formations are composed of gray–blue Silurian slates, which are dark and glossy, and crossed by quartz ledges and some porphyry dikes (García Rodrigo 1957). Between Capellades and Cabrera d'Igualada, there is a plutonic outcrop formed by intrusive granitic materials, which has given rise to a phenomenon of regional metamorphism in contact with the Paleozoic. The Triassic formations west of the Anoia begin with the Bundsandstein materials of essentially fluvial origin (Anadón et al. 1979). The Muschelkalk is formed by dolomitic limestones separated by red clays. Finally, the Keuper is formed by yellowish clayish dolomites, gray marls, with occasional gypsum strata at the top of the formation (García Rodrigo 1957).

Fig. 2.3 Tectonic map of the Mediterranean system. Modified from Anadon et al. 1979 in Sala 1994. Legend: *1* Faults. *2* Folds. *3* Neogene from inner depressions. *4* Volcanic rocks from Neogene and Quaternary origin. *5* Paleogene from the Ebro basin and the Mora depression. *6* Mesozoic cover. *7* Paleozoic basement

The Prelitoral Depression, also known as the Vallès-Penedès rift, was formed by the sinking of a large block during the last movements in the Alpine orogeny. It is approximately 200 km long and 12 km wide, although its width tends to decrease in the north. During the Neogene, a group of normal faults related to distensive phenomena affected the western Mediterranean. The Llobregat fault divided the depression into two large rifts: the Vallès rift to the north-east and the Penedès rift to the south-west.

The Penedès rift has a sedimentary depth of 2,000 m and was filled by Triassic materials from the Prelitoral Range, marine Paleogene materials from the Ebro Basin and fluvial Quaternary sediments. At the end of the Lower Miocene, the sea penetrated through the Penedès Depression to the Llobregat valley when the fault became active and the rifts sank. During the Upper Miocene, a regression gave rise to a significant erosive phase. In the Pliocene, a transgressive phase fossilized the paleotopography developed during the previous phase (Sala 1994). According to Gallart (1981), the occurrence of more than one marine phase has not been proven and, with the exception of the first such phase during the Burdigalian–Serravallian age, the Pliocene deposits correspond to continental formations (Gallart 1981).

For this area García Rodrigo (1957) established three Miocene facies: the Piera Series, the Vallbona Series and the Guixera Series. However, Gallart (1981) later attributed the Guixera Series to the Pliocene. The Piera Series is of fluvial origin and can be found to the east of Piera creek. It extends to the south and south-west, forming the Badorc massif. It is a reddish-yellow formation composed of alternating conglomerate banks, silt and sandstones. The Vallbona Series is of local origin related to the erosion of the borders of the basin. It is located in the triangle formed by the Badorc massif and Piera creek, the Paleozoic of the Prelitoral Range to the north and north-west and Vallbona to the south-west. The Guixera Series is a detrital continental formation (Gallart, *Op. cit*), located in the triangle formed by the Anoia River to the north-east, the Riudebitlles River to the south-west, the confluence of these two rivers to the south-east and the Paleozoic materials of the Prelitoral Range to the north-west. In general, it is made up of alternating pudding stone banks, sandstones and clays. Chert nodules appear in the conglomerates of this formation.

The structural unit of the travertines of the *Cinglera del Capelló* cliff overlies the Paleozoic slates of the Prelitoral Range. In the Capellades Gorge the Anoia River runs along a tectonic fracture, often called the Anoia fault, which lies roughly perpendicular to the Vallès Penedès fault. The tectonic movements of these two faults produced the horst of the Prelitoral Range. Cenozoic materials from the Ebro Basin can also be found on the block near Carme. The post-Alpine subsidence of this block led to the lateral erosion of Paleozoic, Mesozoic and Cenozoic-aged materials and promoted springs and travertine formation in the fault of the Capellades and Carme region (Vidal 1911). These travertines fossilized the Anoia fault and therefore mark the end of its tectonic activity. However, the fault is laterally active through a small satellite fault which fractures the travertine deposits and forms the *Pla de Capellades* mesa (IGME 1973, 1975). This satellite fault runs parallel to the Anoia fault and caused this small part of the block to sink, resulting in a flat travertine surface, on which the town of Capellades has been built (Solé Sabaris et al. 1957).

The travertine platform, at a height of nearly 22 m above the river, is flooded by the multilayer aquifer of Carme and Capellades. Its hydrological model is described by Vidal (1911). This aquifer forms travertine deposits that outcrop at the Òdena and Penedès basins (García Rodrigo 1957). Springs originating from lithological discontinuities between fractured Paleozoic, Mesozoic, and Cenozoic sedimentary materials have led to differing aquifer elevations. In the area of Capellades, Romani and Vidal found different sedimentary ages for lacustrine and karstic spring travertine deposits, such as Pla de la Torre and the Pla de Capellades and the above-mentioned *Cinglera del Capelló* and the Abric Romaní lacustrine gorge (Muro et al. 1987; Bartrolí et al. 1995).

Quaternary Geology

Capellades is located on the the border between the Penedès and Òdena basins. Studies on the Quaternary of the Anoia valley unite these two regions as a single area (García Rodrigo 1957; Gallart 1980, p. 372; Josa 1985). Travertines from the Capellades area have been recognized as a stratigraphic marker, widely cited in regional studies on Quaternary-Neogene geology. García Rodrigo (1957) mentions two river terraces (+20 and +1) and interfluves near the town of Badorc, covered by two types of slope deposits composed of gravel and silt. The upper slope deposits are considerably widespread, while the reddish lower slope deposits are limited to the areas near escarpments. The position of these materials provides insight into some Quaternary erosional processes. The reddish sediments would have formed a ramp where they were deposited, probably synchronously to the Villafranquian travertine formation of Capellades, Cabrera and Badorc (García Rodrigo 1957). This deposition was then followed by a period of erosion, removing part of the reddish sedimentary material and reducing its extension to the current area. This new erosional relief hosts a second slope deposit, which in the Conca d'Òdena correlates with glacis 2 (G2), which laterally adjoins the +25 m Anoia terrace (T2) (Gallart 1991). The reddish slope deposits correspond to glacis 3 (G3) (Gallart 1991).

The geomorphology of the Anoia terraces in the Òdena basin is as follows (Gallart 1991):

Upper terrace (T4): 380 m high and 80 m above the level of the Anoia River. It locally contains bedded Eocene marine materials identical to those that constitute the G3 glacis. Furthermore, its elevation suggests a connection with the travertines of Capellades and Carme and, consequently, a Lower Pleistocene age.

High terrace (T3): 55 m above the level of the Anoia River. It contains a lot of lacustrine limestone and has a cemented relief, eroded/dissected into a discontinuous surface.

Middle terrace (T2): 25 m above the level of the Anoia River. This terrace is very extensive and contains two subunits: the more elevated T2b (+30 m) with coarser deposits and T2a, which is lower and more abundant. The lower T2a seems to link to glacis G2 and contains dark argillic soil.

Lower terrace (T1): 8–14 m above the level of the Anoia River. It consists of silt, gravel and sand deposits, with carbonate nodules and grey-colored soil on top.

Lower terrace (T0): 1–2 m above the level of the Anoia River. It consists of alluvial flood deposits.

In the area of the Penedès basin, Gallart indicates five Pleistocene levels between the Anoia and Riudebitlles fluvial valleys (Gallart 1981) (Fig. 2.4):

Level 5 (early Quaternary): Similar to conglomerates of Riudebitlles outcrops (Gallart 1985), though more torrential in character, this level is made up of deposits called *rañas* or *sasos* in other regions of the Iberian Peninsula. The morphometry of the distal segments of these deposits is

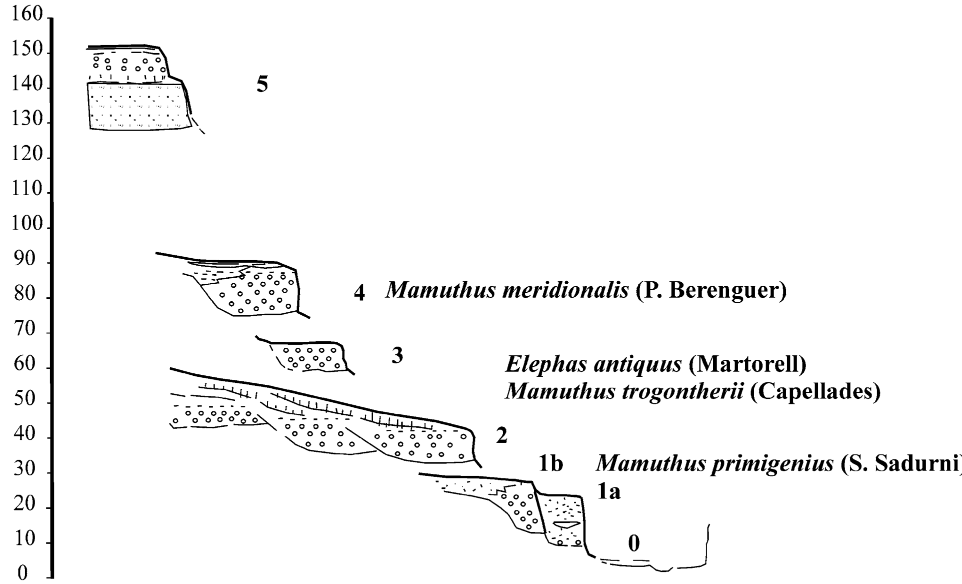


Fig. 2.4 Fluvial and slope surfaces with the proboscidean Quaternary biostratigraphy in the Llobregat and Anoia valleys (Gallart 1981)

similar to that of those located on the Anoia terraces. The possibility of two stages in these torrential deposits is suggested by the presence of a thick interbedded (1 m) fersialitic soil. This level may be related to Anoia River deposits measuring 140 m whose terrace morphology has not been preserved.

Level 4: This level is made up of accumulations of material and some alluvial fan deposits with poor morphological preservation, with an elevation of 90 m and a thickness of up to 15 m. The lower boundary surface of these accumulations is usually cemented and pedological processes mark the upper boundary surface capped with a caliche horizon. This level can be correlated to the 85–90-m Llobregat terrace (Manresa, Puig Berenguer), prior to the Cromer-Galerian biozone.

Level 3: A level comprised of cemented alluvial deposits, poorly preserved, at an elevation of 65 m.

Level 2: The most characteristic geomorphological forms in this level are the glacis, which formed in three phases, separated by periods of dissection. The fluvial deposits show the existence of two incision stages separating three morphological units. Their morphological preservation is poor due to colluvial and eolian erosion, which has limited the differentiation of forms. This level corresponds to deposits of the Barcelona city and Llobregat River terraces (Virgili 1960). The soils and paleosoils of these deposits contain argillic and carbonate-rich horizons.

Level 1: This level consists of well-preserved glacis-terraces with a relative height of 30 m. Soil forming processes produced brown soils (7.5 YR 5/4), with partial leaching of carbonates in the upper horizon. Pseudomicelia have accumulated in the lower horizons. In Sant Sadurní, *Elephas primigenius* remains suggest a Middle Pleistocene age for the lower Anoia terrace complex (Calzada 1975). A small level over 22 m is composed of silt and sulfates.

Level 0: This level consists of the Anoia floodplains and contains an incised and meandriform stream.

Morphogenetic periods in the Penedès Basin are characterized by stream efficiency, storm erosion, physical weathering and eolian erosion and sedimentation. This morphogenesis points to a relationship with cold Quaternary periods, but in the Penedès area no clear periglacial record below 800 m exists. There were no extremely cold periods because soil formation processes on colluvial slopes and in eolian silts were synchronous with their deposition (Gallart 1981).

One of the narrower sections of the Capellades Gorge is in the travertine cliff called the *Cinglera del Capelló*. Travertine stratigraphy shows facies associations originating from lacustrine and spring paleoenvironments. In Badorc, travertines are 20–50 m thick and are located on the hilltop. Below the travertines, a river terrace (+20 m) contains *Paraelephas trogontherii nesti* POHLIG (Solé Sabaris et al. 1957). Travertine U-series dating taken, from the Bofia sample of basal travertine units indicates an age of over 350 ka (Bischoff et al. 1988). Neotectonic activity caused faulting of the travertine complex between Pla de la Torre and Pla de Capellades during the Lower Pleistocene.

History of Excavations

The Abric Romaní has a long history of research. It was the first Middle Paleolithic site known in Catalonia and was excavated in different periods throughout the

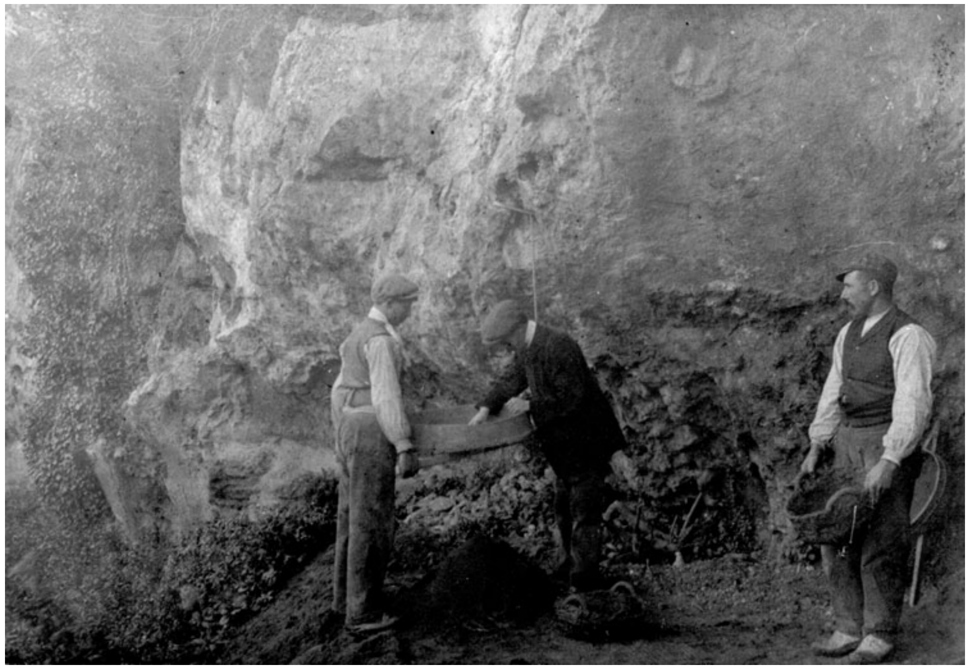


Fig. 2.5 Amador Romaní (in the middle of the photograph) during the excavation of the Abric Romaní in 1909 (Photo: Arxiu Museu Molí Paperer de Capellades)

Fig. 2.6 Amador Romaní watching the excavation works. This image corresponds to the beginning of the excavation in the middle part of the shelter in 1909 (Photo: Arxiu Museu Molí Paperer de Capellades)

twentieth century. It has undergone three major periods of excavation: the Amador Romaní excavations (1909–1930), the Eduard Ripoll excavations (1956–1962) and the current excavations (1983–2009). This long research history pays testimony to the various different theoretical and methodological paradigms that have been dominant in the archeological thinking of this century. The Amador Romaní excavations exhibit the construction of the basic scientific procedures that have characterized Paleolithic archeology up to the present. The second period of excavations represents the dominance of the historic and cultural paradigm that marked the development of European archeology. Finally, the current period corresponds to the crisis of this paradigm and the spreading of the assumptions linked to processual archeology. In this sense, the history of the Abric Romaní is the history of the emergence, consolidation and transformation of archeological science.

Fig. 2.7 Sieving of sediments during the 1909 excavation. Amador Romaní is on the left (Photo: Arxiu Museu Molí Paperer de Capellades)

The Amador Romaní Excavations (1909–1930)

The site was discovered and the first archeological excavations were conducted by Amador Romaní i Guerra, an industrialist from Capellades who began prospecting in the *Cinglera del Capelló* in 1905 (Muro et al. 1989). Over several years, Romaní brought to light many rockshelters containing archeological deposits. Most of these were recent prehistory sites, but some of them yielded Pleistocene layers. Among these, the most significant was the Abric Romaní, previously known as the *Balma del Fossar Vell* (Old Grave Rockshelter), because it was used as a cemetery during the nineteenth century. After the discovery of the site, on 9th August 1909, the first excavations were immediately undertaken under the sponsorship of the Institute for Catalan Studies (IEC) (Figs. 2.5, 2.6, 2.7, 2.8). These works were nominally directed by Norbert Font i Sagué—who named the site Abric Romaní—and, after his sudden death in 1910, by Lluís Marià Vidal. However, in the field direction was effectively given by Amador Romaní. Vidal published the first results a short time after he took charge of the project (Vidal 1911–1912). That paper, along with Romaní's diary (the *Atlas*), are the primary sources of information about this first period of excavation (Bartrolí et al. 1995). Excavations continued until 1911 when IEC sponsorship came to an end, but Amador Romaní kept working intermittently in the *Cinglera del Capelló* almost until his death in 1930.

These excavations affected the upper part of the stratigraphy, from the top to level J. The uppermost layers, from A to D, were almost entirely removed, although these levels were severely damaged by the nineteenth century burials. The first works focused on the western part of the shelter, where a 4.5 m trench was dug perpendicular to the wall. This trench was subsequently enlarged, forming a 6 × 6 m pit, which is currently known as Pit 2. This pit was deepened to layer 12 of Romaní's stratigraphy, except in the area near the shelter wall, where it went down to layers 13–14 (level J of the current stratigraphy). In the middle of this pit a circular well, 1.6 m in diameter, was excavated with the aim of reaching the bottom of the deposit. This sounding—the Romaní well—did not reach the bottom of the sequence, but permitted the documentation of eight additional meters of the stratigraphy. At the base of the well, Romaní excavated a gallery 4 m in length that reached the shelter wall.

Romaní then extended the excavation towards the eastern part of the shelter, bringing the area affected by excavations to nearly 80 m^2. Nevertheless, east of Pit 2 Romaní's excavation only reached the top of layer 9—level E of the current excavations. The maps included in his *Atlas* indicate that the surface area Romaní excavated roughly corresponds to rows M–V and columns 43–60 of the current grid. However, he only occasionally touched the shelter wall and left several sedimentary remnants at the rear of the site. It should be stressed that the travertine layers forming the bulk of the sequence are considerably harder close to wall.

The first stratigraphic description was published by Vidal (1911–1912), although it was slightly different from that presented by Romaní in *Atlas*. Both Romaní and Vidal describe the sequence as a 12 m thick deposit of calcareous sand, interbedded with thin layers of black sediment—the archeological levels—and thick travertine strata. The stratigraphic sequence described by Romaní was made up of 31 layers, 12 of them containing evidence of human

Fig. 2.8 Amador Romaní sitting in the middle of the rockshelter in 1924 (Photo: Arxiu Museu Molí Paperer de Capellades)

occupation. However, the fourteen lowermost layers were only identified in the Romaní well, and Romaní provided very little information about them. The layers from the uppermost six meters, documented over a more or less extended surface, were thoroughly described from a geological and archeological point of view. This was the sequence used as a reference in subsequent works and basically corresponds to the profile described in Pit 2 (Fig. 2.9). From top to bottom, this sequence was as follows (Bartrolí et al. 1995, p. 118).

Layer 0: This was a disturbed layer containing some lithic implements and many human remains from the nineteenth century burials. This layer was the top of the sequence in most of the site, except near the shelter wall, where layer 1 was still present.

Layer 1: This was originally the top of the deposit, but was only preserved at the back of the shelter when Romaní started his excavations. It was between 0.5 and 2 m thick and completely filled the shelter. This layer was formed by red silts, characterized by Romaní and Vidal as *diluvium roig*, or red flood, and was archeologically virtually sterile.

Layer 2: This was an archeological layer of between 5 and 50 cm thick (Vidal 1911–1912) which corresponded to the only Upper Paleolithic assemblage documented in the Abric Romaní sequence. It was only preserved in three relatively small areas close to the shelter wall. It is called level A in the current excavations.

Layer 3: This was a travertine layer with an irregular thickness of between 15 and 40 cm. Amador Romaní designated this kind of hard travertine layer using different names such as *bancal estalagmític* (stalagmitic terrace), *bancal caliç* (calcareous terrace) or *calissa estalagmítica* (stalagmitic limestone), in order to differentiate it from the softer travertine deposits, which were called *terra sabulosa caliça* (calcareous sandy soil).

Layer 4: This was formed by black sediment with many charcoals and contained evidence of Mousterian industry. Thickness was also highly variable—between 20 and 50 cm. According to Romaní, this was the first archeological level preserved in the entire site and provided the richest assemblage. Vidal (1911–1912, p. 281) and Romaní mention the recovery of two human teeth, but they are intrusions from the modern burials. Layer 4 corresponds to level B of the current excavations.

Layer 5: This was a travertine layer with a maximum thickness of 10 cm.

Layer 6: This was a 10 cm thick archeological layer that was made up of black sediment with charcoals and Mousterian artifacts. In addition to the recovery of lithic and bone remains, Amador Romaní also documented a carbonized wood artifact. This is the first reference to the presence of wooden implements in the archeological levels of the Abric Romaní. This layer corresponds to level C of the current excavations.

Layer 7: This was a 10–15 cm thick deposit of white sediment found only in a small area near the shelter wall. It was absent in the rest of the site, in which layer 6 lay directly over layer 8.

Layer 8: This corresponds to a travertine layer.

Layer 9: This is a Mousterian archeological layer made up of red silts similar to those of layer 1. These characteristics have made this layer a point of reference in the stratigraphy and it has served to correlate the Amador Romaní sequence with those of subsequent works. It corresponds to level E of the current excavations.

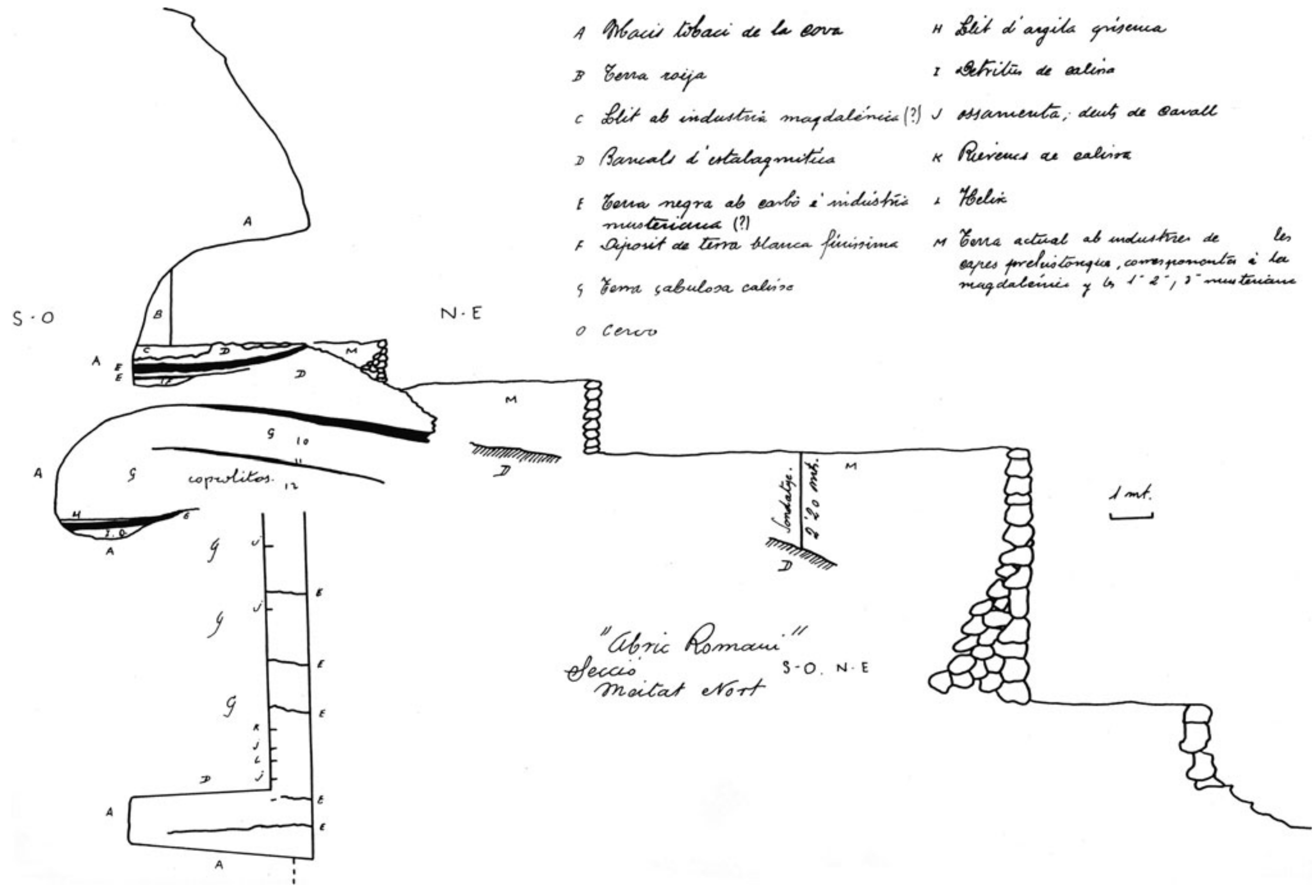


Fig. 2.9 Stratigraphic sequence documented by Amador Romaní at Pit 2 and the Romaní Well. Modified from the *Atlas* of Amador Romaní

Layer 10: This layer, with a thickness of 0.5–1.5 m, was characterized as a deposit of calcareous sandy sediment without archeological remains, but included many hyena coprolites.

Layer 11: This was an archeological layer with Mousterian artifacts. It appears in the profiles as a very thin and discontinuous layer. It can be correlated with level I of the current excavations.

Layer 12: This layer was also described by Romaní as a deposit of calcareous sand with many coprolites and malacological remains, but lacking other archeological evidence.

Layer 13: This was a 20 cm thick archeological layer formed by black sediment with Mousterian artifacts.

Layer 14: This layer was described by Amador Romaní as a deposit of *calissa estalagmítica en lámines*—blades of stalagmitic limestone. It seems clear that this corresponds to a layer of travertine blocks and clasts. Only charcoal and bone remains were found. Layers 13 and 14 can be correlated to level J of the current excavations. This layer and the one above it were only documented in the deepest area of Pit 1.

Layer 15: This travertine layer was the lowermost layer documented in Pit 1.

The rest of the sequence corresponds to the Romaní well, in which between five and nine additional archeological horizons were identified. This was the stratigraphic sequence depicted by Amador Romaní in the *Atlas*, although it was slightly different from that published by Lluís M. Vidal. The sequence presented by Vidal was made up of only 12 layers, as Romaní's layers 7, 14 and 15 were excluded. Due to the absence of layer 7, there was a change in the name of the units underlying layer 6; Romaní's layer 8 was Vidal's layer 7 and so on (Table 2.1). At any rate, this was the valid sequence used for the entire shelter, excepting the stratigraphic succession identified inside a small cavity located in the north-western end of the site, the *Coveta Nord* (Northern Small Cave). Due to the absence of travertine layers in this cavity, the archeological levels above layer 8 overlapped to form a thick palimpsest. The main features of Romaní's stratigraphy were confirmed in subsequent works, although the current excavations have shown that some archeological levels, like levels D, H and F–G, were Romaní. They were very thin and low-density levels that

Table 2.1 Correspondence between the different systems used to designate the archeological levels

Amador Romani	Vidal (1911–1912)	Lumley and Ripoll (1962)	C.R.P.E.S. (1983–1989)	Current name
Layer 2	Layer 2	Hearth 2	C.II 1.0.1	Level A
Layer 4	Layer 4	Hearth 4	C.II 1.1.0	Level B
Layer 6	Layer 6	Hearth 7	–	Level C
Layer 8A?	–	Hearth 8	C.II 1.4	Level D
Layer 9	Layer 8	Hearth 9	C.III 1.0.0	Level E
–	–	–	C.III 2.1.6	Level F
–	–	–	C.III 2.1.8	Level G
–	–	Layer 10	C.III 2.2.5	Level H
Layer 11	Layer 10	Hearth 11	C.III 2.2.7	Level I
Layer 13	Layer 12	Hearth 12	C.III 19.0	Sublevel Ja
Layer 14	–	Layer 13	–	Sublevel Jb

went unnoticed due to the excavation methods used at that time. Moreover, the Romaní excavations allowed the archeological layers to be characterized from the chrono-cultural point of view. At first, layer 2 was attributed to the Magdalenian, although its Aurignacian character was soon recognized. The remaining layers were assigned to the Mousterian. These Mousterian layers were considered as a whole, and no differences between levels were pointed out.

The Excavations of Dr. Eduard Ripoll (1956–1962)

Unfortunately, the line of research started by Amador Romaní and the Institute for Catalan Studies had no continuity. The Spanish Civil War (1936–1939) imposed a profound break in archeological activities. This "dark period" persisted until the mid-1950s, when the end of the international isolation of Franco's regime favored a reactivation of archeological works, frequently associated with the collaboration of foreign scholars. In this context, a new stage of excavations at the Abric Romaní began. The V INQUA Congress held in Spain in 1957 included a visit to the Abric Romaní leading the Archeological Research Service of the Barcelona Provincial Council to promote these excavations, which started in 1956 under the direction of Dr. Eduard Ripoll Perelló. The primary goal was to verify the stratigraphic sequence outlined by Amador Romaní (Ripoll 1958, p. 14). The fieldwork was undertaken in part by French researchers like Georges Laplace, who studied and published the description of the Upper Paleolithic assemblage recovered by Romaní in layer 2 (Laplace 1962), and Henry de Lumley.

Compared to the work led by Amador Romaní, relatively little is known about the excavations carried out between 1956 and 1962, especially in terms of fieldwork processes. We do not know whether there were field diaries, and the papers published as a result of these excavations (Ripoll 1958, 1959; Laplace 1962; Lumley and Ripoll 1962; Ripoll and Lumley 1964–1965) provide little information about the excavation methods used or the areas affected by these works. Apart from these publications, the only sources that give some insight into Ripoll's excavations are some imprecise and often contradictory oral accounts, short notes published by other authors (Pericot 1960–1961, 1964; Maluquer 1969) and occasional references accompanying the archeological remains recovered during that period and stored in the Capellades Museum. Methodology was essentially guided by stratigraphic criteria and consisted of digging various trenches and pits in different areas of the site. It is important to mention that the attribution of some of these actions to Ripoll's excavation is hypothetical and is based on the archeological methods used at the time in combination with the absence of references in Amador Romaní's works. Therefore, to the best of our knowledge, the actions carried out during this period seem to have been the following:

- A 4 × 4 m pit was dug in the central part of the site, corresponding to squares N–Q/52–55 of the current grid (Pit 1). The excavation of this area started at the level at which Amador Romaní (layer 9) stopped and continued to layer 14. At the bottom, the pit was smaller (3 × 3 m) and had a more irregular outline.
- A 4.5 × 3.5 m pit was excavated at the easternmost end of the site (Pit 3), in the area corresponding to squares G–J/67–71 of the current grid. This pit was 3.25 m deep and affected the upper part of the stratigraphic sequence to the lower part of layer 8.
- A 1-m wide L-shaped trench was also excavated in the middle of the site, starting from the south-eastern corner of Pit 1. At 3.5 m in length, the trench turned to the east at a right angle and extended three additional meters.

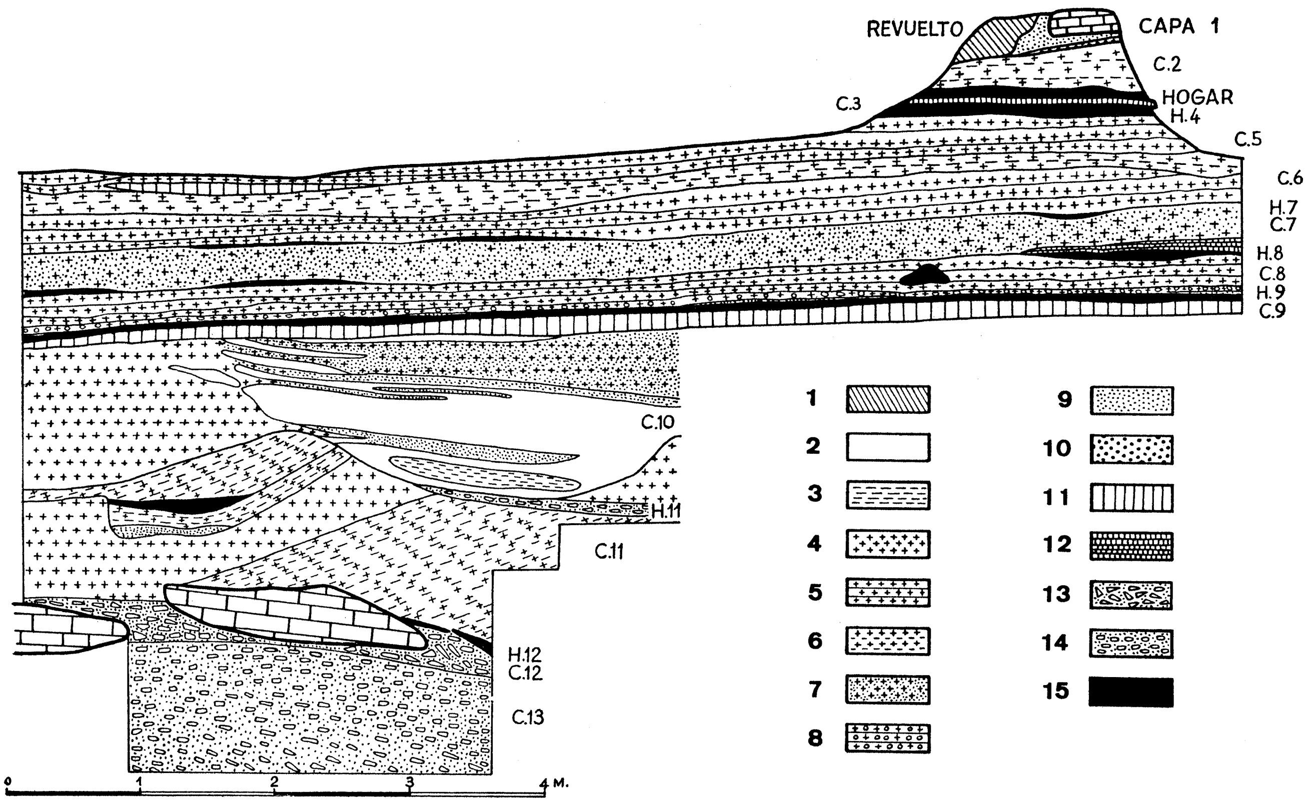


Fig. 2.10 Stratigraphic sequence documented during the Ripoll excavations. From Ripoll and Lumley 1965. Legend: *1* disturbed; *2* chalk; *3* lumpy chalk; *4* hardened tufa; *5* hardened and bedded tufa; *6* chalky bedded tufa; *7* hardened bedded sandy tufa; *8* tufa rich in plant remains; *9* silty sand; *10* calcareous spherical nodules; *11* sandy silts; *12* calcareous crust; *13* medium-sized clasts in yellow sandy matrix; *14* small clasts in yellow sandy matrix; *15* hearth

It had a maximum depth of 2 m and reached layer 12 of Romaní's sequence.

- It is possible that the *Coveta Ripoll,* or Ripoll's Small Cave, was also partially excavated during these years. This small cavity was formed in the middle of the shelter due to the growth of a stalagmitic column in the area of squares R–T/46–51. However, this excavation affected only the sequence made up of layers 9–12. Due to the hardness of the travertine layers above layer 9, the excavators penetrated the cavity leaving the travertine of layer 8 as a false roof. To prevent it from collapsing, this roof was supported by two vertical props that rested on two small planks. These planks were placed into two hollows excavated in layer 13.

Ripoll and de Lumley published the stratigraphic study derived from these excavations (Lumley and Ripoll 1962, p. 4–5). It describes only the six uppermost meters of the sequence because they were unaware of the existence of the Romaní well. This sequence was very similar to that described by Amador Romaní, although there are a few differences (Fig. 2.10). To refer to the archeological units they used the term *foyer* (hearth). From top to bottom, the stratigraphic sequence was described as follows:

Layer 1: Sandy silts.

Layer 2: Stratified calcareous travertine.

Hearth 2: Archeological level. Amador Romaní's layer 2.

Layer 3: Calcareous crust.

Hearth 4: Archeological level. Amador Romaní's layer 4.

Layer 5: Hardened stratified travertine that becomes calcareous travertine towards the bottom.

Layer 6: Hardened stratified travertine.

Hearth 7: Archeological level.

Layer 7: Hardened and stratified sandy travertine.

Hearth 8: Archeological level.

Layer 8: Hardened stratified travertine, rich in plant remains at the bottom.

Hearth 9: Archeological level. Amador Romaní's layer 9. Lumley and Ripoll highlighted the great abundance of faunal and lithic remains in hearth 9. This was the only level that yielded a statistically significant number of remains and was therefore presented separately.

Layer 9: Sandy silts.

Layer 10: This was a very complex unit formed by different depositional facies. At the western end of the section, there was a *gour* deposit basically formed by "calcareous dust", but also including some lenses of "lumpy clay" and

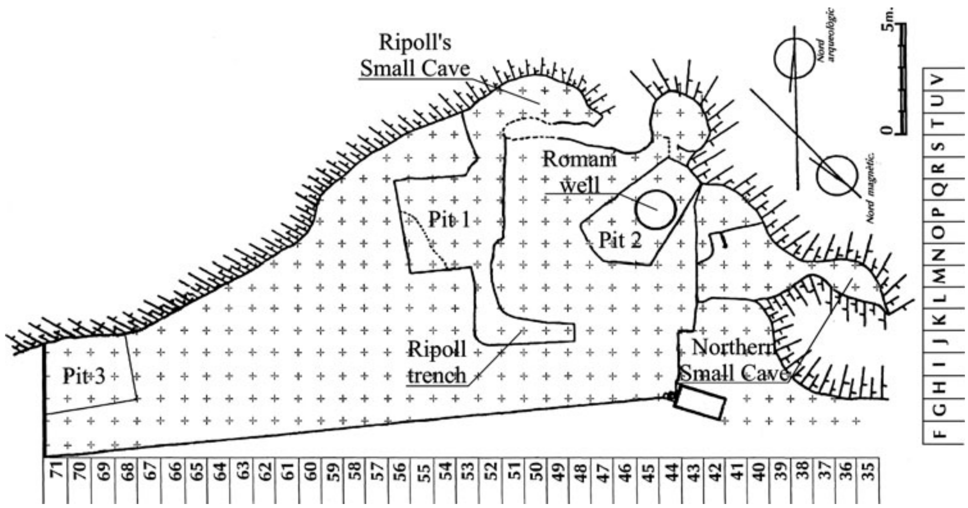


Fig. 2.11 Abric Romaní plan made in the beginning of the last excavation phase. The different pits and trenches from previous excavations are indicated (Drawing: Josep Maria Prats)

silty sand. There was a deposit of hardened and stratified sandy travertine at the top. To the east of the section, this layer was formed by a homogeneous hardened travertine. Although Lumley and Ripoll did not mention the recovery of archeological remains, some artifacts labeled as layer 10 have been found in the Capellades Museum.

Layer 11: This layer was formed by different travertine facies with some lenses of silty clays. A discontinuous archeological unit (hearth 11) was included in this layer. It can be correlated with layers 11 and 12 of the Amador Romaní sequence.

Hearth 12: Archeological level corresponding to layer 13 of Romaní's sequence.

Layer 12: This was a clastic deposit formed by medium-sized travertine fragments in a sandy matrix. Some large blocks from the roof collapse were also present.

Layer 13: Small clasts in a yellow sandy matrix. Layers 12 and 13 can be correlated to layer 14 of the Amador Romaní stratigraphy. This clastic deposit was considerably thicker in Pit 2 than in Pit 1, where it was excavated by Romaní. Like layer 10, this layer was not considered an archeological unit by Lumley and Ripoll, although remains labeled as coming from the level have been found in the Capellades Museum.

Lumley and Ripoll (1962, p. 3–7) organized this sequence into three stratigraphical sets that were interpreted in environmental terms.

1. Levels of fallen blocks of cryoclastic origin. This set was 1.5 m thick and was subdivided into two units. The upper unit (layer 12) was formed by large travertine blocks, while the lower one (layer 13) consisted of small angular clasts in a sandy matrix. The layer formed by small fragments was attributed to periods characterized by daily freeze–thaw cycles. Otherwise, the falling of large blocks would occur as the result of seasonal cycles. These deposits would indicate the cold and humid conditions associated with the end of Würm II.
2. Travertine layers (layers 11–2). This 4 m thick set was mainly formed by travertine of different facies with silt and sand lenses. It suggested the very wet conditions of the Würm II–III interstadial, although hearth 2 was attributed to the beginning of Würm III due to the presence of an Upper Paleolithic assemblage.
3. This set was comprised of the red silty sands of layer 1.

The principal outcome of Ripoll's excavation was the integration of the Abric Romaní into the framework of western prehistory, which was characterized at the time by the dominance of the historical-cultural paradigm. The lithic assemblage from layer 2 was studied by Laplace (1962), who attributed most of the artifacts to the *synthétotype aurignaco-gravettien* and highlighted its resemblance to a group of assemblages that were later included in the Protoaurignacian. The assemblages from the Mousterian layers were characterized by Lumley and Ripoll (1962) within the framework of Mousterian facies defined by Bordes. The artifacts were classified according to the Bordes type-list and all the Mousterian layers were attributed to the Denticulate Mousterian. This made it possible to compare the Abric Romaní assemblages with other European Mousterian sites. Similarly, correlating the stratigraphy with paleoenvironmental stages provided the first relative chronologies for the sedimentary deposit. The collaboration of foreign researchers and publications in international journals (Laplace 1962; Lumley and Ripoll 1962) made the site known among the European scientific community. As a result, references to the Abric Romaní appeared in many studies about the Middle Paleolithic of south-west Europe (Escalon de Fonton 1963; Lumley and Berard 1964; Freeman and González Echegaray 1967; Altuna 1972).

Fig. 2.12 Excavation of level J during the 1994 field season

Fig. 2.13 Excavation of level J during the 1994 field season

After the end of this second period of excavations, the Abric Romaní remained under the control of the Barcelona Provincial Council, but scientific activity was practically nonexistent. In the second half of the 1970s, there was a brief reactivation of archeological research in the *Cinglera del Capelló*. In 1976, Ripoll and Freeman conducted excavations at the nearby site of Abric Agut. However, these works scarcely affected the Abric Romaní. In 1978, the profile of Pit 2 was rejuvenated in order to take samples for several types of analyses, although in the end, only the pollen analyses were performed (Metter 1978; Deguillaume 1987). This lack of continuity in the excavations also gave rise to some negative consequences. Due to the absence of effective protective measures, the site was affected by the activity of amateur excavators who severely damaged the stratigraphic testimonies left at the back of the shelter. This plundering of the site persisted practically until the beginning of the third excavation period in 1983.

The Current Excavations (1983–2009)

Archeological excavations in the Abric Romaní restarted in 1983 under the direction of Eudald Carbonell, Artur Cebrià and Rafael Mora. The excavations were carried out by the Centre de Recerques Paleo-Eco-Socials (CRPES) of Girona between 1983 and 1988, and Rovira i Virgili University (URV) from 1989 to the present. Since 1989, Eudald Carbonell has been the only fieldwork director. These excavations have been conducted in the framework of a research project focusing on the entire *Cinglera del Capelló*, including works at other sites such as Abric Agut, Balma dels Pinyons and Balma de la Costa de Can Manel.

The first three years (1983–1985) were devoted to preparing the rockshelter for the excavation of a large surface. The site was protected with a roof and a 1-m grid system was set up. One of the primary undertakings was to delimit the old pits and trenches, and remove the sediments that filled them (Fig. 2.11) This revealed the Romaní

Fig. 2.14 Excavation of level J during the 1994 field season

well, which was deepened several times—in 1997 and 1992—adding four additional meters to the stratigraphic sequence originally documented by Romaní. However, the bedrock has not yet been reached. It was evident from the beginning that most of the uppermost levels had been removed in former excavations and a significant surface was preserved only from layer 9 downwards. At first, a numerical code was adopted to name the stratigraphic units, but this system was abandoned in 1990. Since then we have used an alphabetical system for the archeological levels. The correlation between this system and previous denomination systems can be seen in Table 2.1.

Apart from the excavation of the small remains of the uppermost levels (A–D) mainly preserved all along the shelter wall, our work has mostly been devoted to extensively excavating the Middle Paleolithic layers over large surfaces. Levels E to J were still significantly altered by the old pits and trenches, but from level K downwards the archeological units were virtually intact. The area affected by the excavations was progressively enlarged, reaching a maximum surface of 315 m^2, which represents most of the area occupied by prehistoric humans. Between 1983 and 1986, a first excavation area was defined, which was delimited by columns 43–60 and rows H–V. This area was enlarged in 1989–1990 to include the area defined by squares H–G/43–60. Finally, the excavation was extended to column 70 in 1991 and to column 40 in 1995.

The theoretical background of this research project was largely influenced by the principles of Processual Archeology. The excavation strategy has been directed towards achieving a paleoethnographical interpretation of the archeological record. Special attention has been paid to the spatial distribution of the remains. All artifacts and bones were three-dimensionally recorded and spatial structures were carefully documented. It was fairly clear from the beginning that the hearths constituted a basic feature in understanding the organization of the humans who occupied this site. Moreover, research has been conducted from an interdisciplinary perspective in order to approach a large array of behavioral, chronostratigraphical and paleoenvironmental questions. Great effort has been devoted to establishing the sedimentary dynamics and chronology of the deposit (Bischoff et al. 1988, 1994; Mora et al. 1988b; Giralt and Julià 1996; Arteaga et al. 2001b; Vallverdú et al. 2005b), as well as the paleoenvironmental sequence

Fig. 2.15 The Abric Romaní during the 1994 field season. The surface shown in the image corresponds to sublevel Ja. Some of the combustion structures found in this sublevel and the *Coveta Ripoll* in the back of the shelter can be seen

(Burjachs and Julià 1994, 1996). Behavioral issues have been approached from the perspective of different disciplines: bone taphonomy and zooarcheology (Aimene et al. 1996; Aimene 1998; Anconetani and Rosell 1998; Cáceres 1998, 2002; Cáceres et al. 1998; Saladié and Aimene 2000; Rosell 2001), the study of plant remains (Carbonell and Castro-Curel 1992; Castro-Curel and Carbonell 1995; Allué 2002; Cabanes et al. 2007), lithic technology (Mora 1988; Carbonell et al. 1997; Vaquero 1997, 1999b; Morant and García-Antón 2000; Martínez Molina 2002, 2005), and spatial organization (Vaquero et al. 1997, 1998, 2001a, 2004; Vaquero 1999a, 2005, 2008; Vaquero and Pastó 2001; Martínez Molina and Rando 2000; Pastó et al. 2000; Arteaga et al. 2001a). In addition, several general papers have been published throughout these years (Mora et al. 1988; Carbonell et al. 1994, 1996a, b; Vaquero et al. 2001b; Martínez Molina et al. 2005), as well as interdisciplinary studies of specific archeological levels (Carbonell 1992, 2002; Vallverdú et al. 2005a).

Level J was primarily excavated between 1993 and 1996, except for at the westernmost part of the site (columns 40–42), which was excavated between 1998 and 1999 (Figs. 2.12, 2.13, 2.14, 2.15). The excavated area was comprised of the space between columns 40–65 and rows G–V, which represents a total surface area of 250 m^2. As we have seen, level J was the last archeological unit significantly affected by the previous excavations, although less so than the overlying levels. The Ripoll trench did not reach level J and the surface affected by Pits 1 and 2 was smaller than in the upper levels. Pit 2 was only deepened to level J in a relatively small area (squares Q43–44, R43–44, S42–43, and T42–44). The main sector damaged by these previous works was that of Pit 1, corresponding to an irregular area of 10 m^2 (O–R/52–55). As described earlier, the *Coveta Ripoll* deposit was minimally damaged by the props used to sustain the travertine roof. Finally, a small circular pit located in K52 was also documented measuring a little more than 1 m in diameter. Although the authorship of this pit is unknown, its characteristics are reminiscent of those of the Romaní well.

The profiles of Pit 1 provided the first stratigraphic guidance for the excavation of level J. The examination of these sections revealed that there were two archeological units in level J, which were separated by a sterile layer. These units were designated sublevels Ja and Jb. The ongoing fieldwork was carried out taking into account

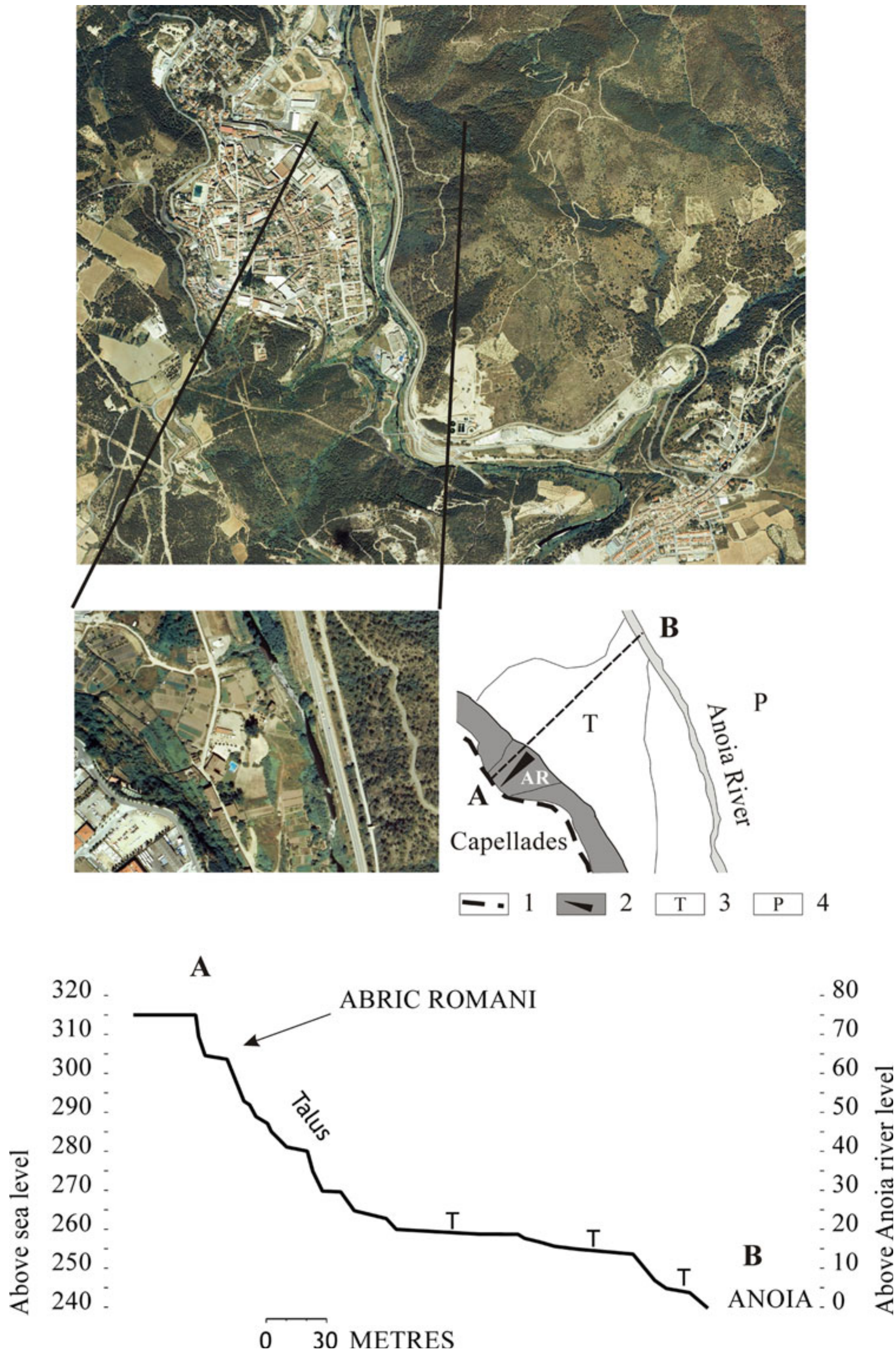


Fig. 2.16 Location of the Abric Romaní, Capellades. Orthophotomap of Capellades and the *Cinglera del Capelló*. Detail of the orthophotomap of the north-west section of the *Cinglera del Capelló* with the cartography of the lower terraces of the Anoia valley, the slope taluses, and the escarpment of the Capellades travertine mesa where the Abric Romaní is located. Topographic profile. Legend: *1* cliff escarpment; *2* talus slope; *3* Quaternary fluvial terraces; *4* Paleozoic slope; *AR* Abric Romaní; *A* and *B*, topographic transect

this archeostratigraphic pattern, although it was soon evident that it was not possible to document this sequence throughout the shelter. Only one archeological unit was recognized in many areas. In fact, sublevels Ja and Jb were clearly identified only in the middle of the shelter, in the area defined by columns 40–54 and rows L–O.

Stratigraphy and Sedimentary Processes

The stratigraphy of the Abric Romaní is considered within the talus sedimentary processes of the *Cinglera del Capelló* cliff (Fig. 2.16). The talus of the Abric Romaní occupies an NNE convex-shaped area exposed on the north side of the

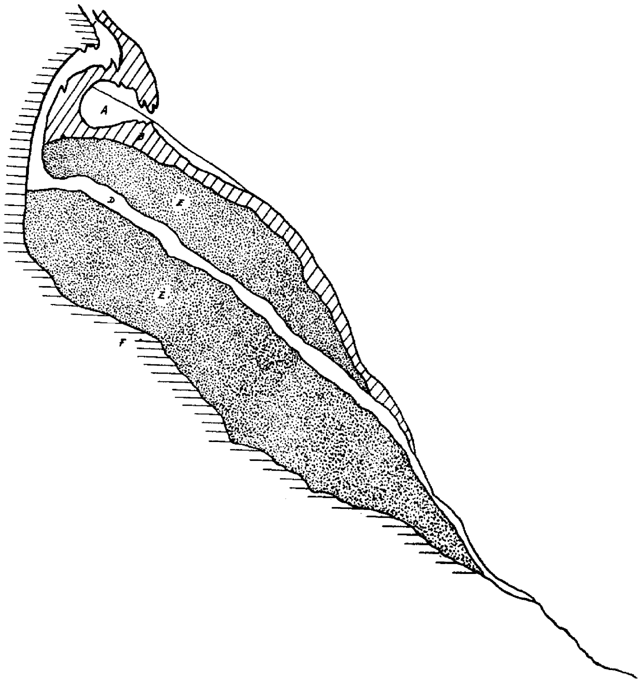


Fig. 2.17 Hypothesis-diagram of the formation of the Abric Romaní into stalagmitic terraces and sandy terraces (Solé Sabaris et al. 1957, from the *Atlas* of Amador Romaní)

travertine mesa of Capellades. The lithostratigraphy of the talus rock is described mainly by the stratigraphical outcrops at the uppermost part of the rockshelter. The abundance of travertines in this part of the sequence was described as a "stalagmitic strata" (Fig. 2.17) (Vidal 1911). These strata are in fact travertines formed by the carbonated incrustation of either vegetation or clastic materials, and speleothems. Although vegetation-travertines can even incrust trees, the most common organisms are algae, mosses and lichens (Julià 1983). One of the common vegetation communities is the *Adiantetea*, which is found in dripping water environments such as cliffs and springs (Folch 1981). Further stratigraphical observations also record clastic deposits in the lithostratigraphy of Pit 1 (Ripoll 1959). The research of the CRPES determined four block-drops, which were used to distinguish 'boundaries' in the stratigraphical succession (Muro et al. 1987).

The morphological evolution of the *Cinglera del Capelló* is characterized by the formation of alveoles and carbonate curtains (the *Capelló*). Most of the sedimentary materials deposited in the talus rock originated from the wall and roof of the Abric Romaní. Only in the upper section of the Abric Romaní is there evidence of a morphological change towards a cave-microenvironment where allochthonous aeolian sediment is trapped. The sedimentary processes in the alveoles, at the foot of the wall, are formed by clastic rhythms of gravel sand calcarenites more or less cemented by carbonate precipitation on dripping domes and flat surfaces. Dripping water close to alveoles can develop stalagmites and stalactites, such as the *covetas*. The alveoles are microforms of rock walls very similar to weathering forms in tafoni, abundant in coastal, arid and semiarid settings (Salomon 1997) (Fig. 2.18). These microforms are the product of several physical weathering processes that are concatenated by water: cryoclasty, haloclasty (salt crystal growth), insolation, wetting and drying. Underneath the carbonate cornice, the sedimentary processes are related to talus cone deposits. These sedimentary processes are characterized by a cyclic repetition of: (1) decimetric to metric biochemical deposits of tuffas and speleothem; (2) decimetric to metric fluvial deposit; (3) rockfall deposits originating from granular disaggregation, block fall and megablock fracture.

The variety of carbonate materials in the lithostratigraphy of the Abric Romaní illustrates the autochthonous character of the sedimentation. At first glance, the mineralogical homogeneity of the calcite makes granulometric estimations difficult, as do the abundant carbonated cementation processes, which can erase the discontinuity surfaces such as those found in dripping dome deposits. The highly stratified and cyclic nature of the stratigraphical sequence indicates numerous paleoenvironmental changes (Fig. 2.19). The outcrop of the *Coveta Nord* section will be discussed in order to highlight the allostratigraphical units or sequences and to identify the distribution and hierarchy of the stratigraphical discontinuities. The sequential analysis of the stratigraphy presented in the following paragraphs (1) indicates timelines for correlation; and (2) suggests the climato-geological implications of the carbonate and siliciclastic sedimentary facies in different time-scales of environmental change. But before describing the sequences of the Abric Romaní, we will provide a summary of the lithostratigraphical research that has been carried out in the field of sedimentary facies.

The stratigraphical sequence of the Abric Romaní has been the subject of a large volume of quality research. The extensive study of the stratigraphical sequence has been helped along by the archeological intervention of Romaní, who was responsible for the excavation of the Romaní well (Bartrolí et al. 1995) (Fig. 2.20). Subsequently, Lumley and Ripoll (1962) developed the first climatic interpretations. At this stage in the research, only the definition of the lithological character of the stratigraphical units was discussed.

The pioneering works of Romaní deal primarily with the top section of the rockshelter. Layers 1 to 13–14 (level J of the current stratigraphy) were described in detail (Bartrolí et al. 1995). In his *Atlas*, A. Romaní goes into the reconstruction of the shelter and its relationship to the cliff

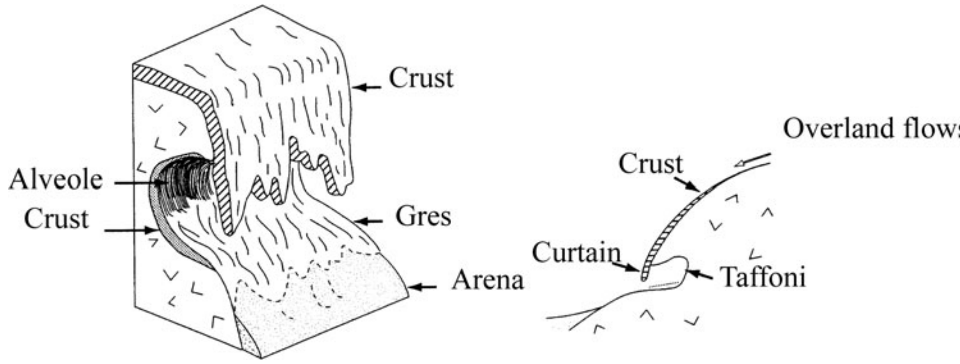


Fig. 2.18 Taffoni, a weathering microform typical of arid zones (Salomon 1997)

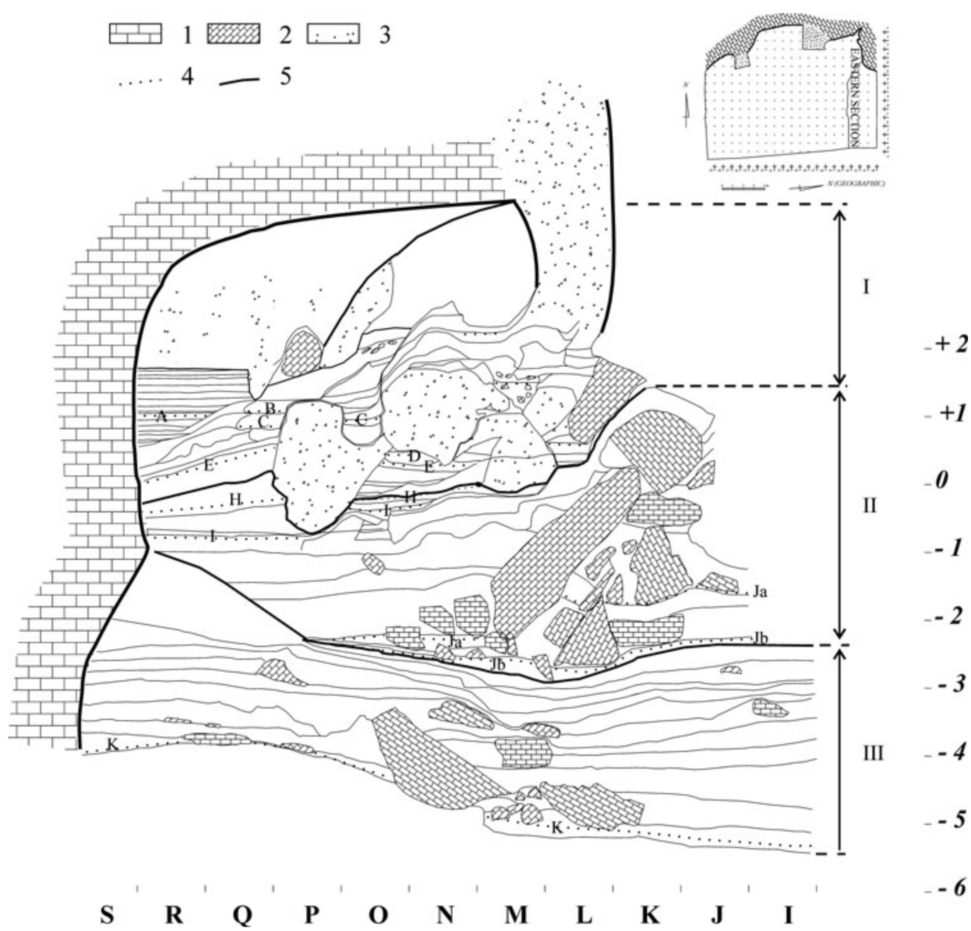


Fig. 2.19 Stratigraphy of the *Coveta Nord* section (SCN). Legend: *1 Cinglera del Capelló*, Abric Romaní wall; *2* blocks fallen form the cornice; *3* stalagmites and stalactites; *4* archeological levels; *5* major discontinuities

(Bartrolí et al. 1995). He also puts forward the hypothesis of three stalagmitic deposits stratified with sandy deposits (Fig. 2.17). Vidal also described the lithological character of the layers, following the outline established by Romaní (Vidal 1911; Vaquero 1992).

In 1957, the Abric Romaní was visited by the V INQUA International Conference (Solé Sabarís et al. 1957), although a detailed lithostratigraphical description and interpretation did not appear until some time later (Ripoll et al. 1965, p. 107). This publication deals with the Ripoll works in Pit 1 (Fig. 2.10), which was six meters deep and and describes the layers in Pit 1 that lay beneath Romaní's layer 13 (Level J in the current stratigraphy). Ripoll and Lumley (1965) divided and described these six meters as comprised of 1, basal cryoclastic gravel; 2, travertine stratum; and 3, superficial red silty sand. The basal cryoclastic gravels comprising strata 12 and 13 correspond to level J of the current stratigraphy. The proposed interpretation for this section of the sequence is characterized by a rapid rate of sedimentation and its correspondence to a cold, wet climate.

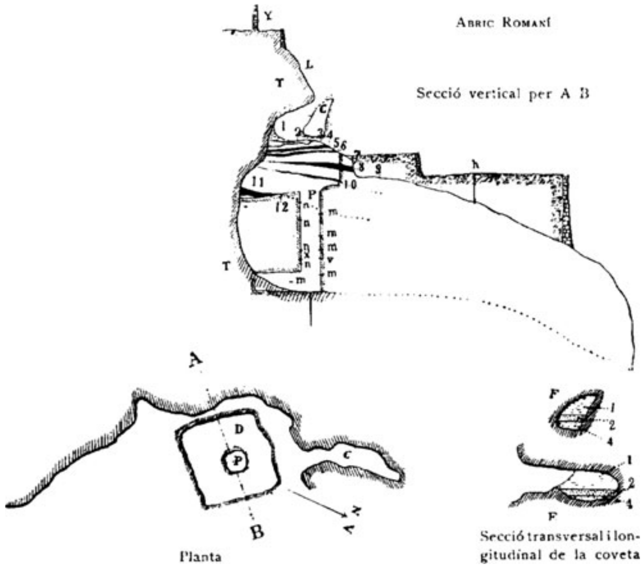


Fig. 2.20 Abric Romani stratigraphy and plan maps made by Amador Romaní. Stratigraphic profiles showing Romani Well and *Coveta Nord* archeological layers, published in the *Història de Catalunya* by Rovira i Virgili (1922–1924) (Canal and Carbonell 1989). Level J plan map showing archeological excavations of Romaní and Ripoll

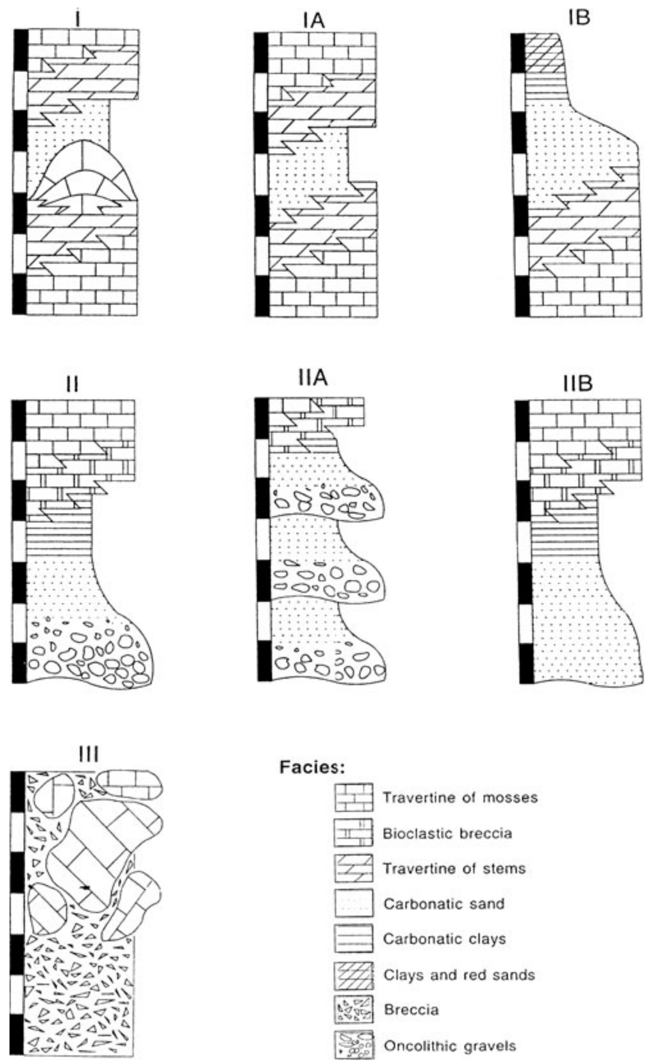


Fig. 2.21 Three facies associations established by Giralt and Julià for the Abric Romaní and for the Abric de la Consagració, Cinglera del Capelló, Capellades (Giralt and Julià 1996, p. 115)

A first study on the lithostratigraphy and the sedimentary facies of the site was published in 1987 (Muro et al. 1987). Muro and his colleagues drew up an exhaustive description of the succession, which they divided into sets separated by block-fall episodes and archeological levels (Mora et al. 1988b). The research was supported by comprehensive documentation of the sections in the form of drawings, and U/Th absolute dating. With the start of the CRPES excavations, the stratigraphy took on more relevance when absolute dating, lithofacies and the pollen spectrum were further specified. The materials analyzed were derived from the sequence of the Romaní well and the sections drawn up by Ripoll (Muro et al. 1987; Bischoff et al. 1988; Burjachs and Julià 1994). During the 1990s, the URV team deepened the well and published a detailed description of the lithostratigraphical column (Carbonell et al. 1994).

The stratigraphical sequence of the Romaní well was later deepened to 16.30 m (Carbonell et al. 1994). The U/Th dating of the bottom facies fixed a date of 70 ka BP (Burjachs and Julià 1994; Giralt et al. 1996). The most detailed lithostratigraphical sequence was obtained during the first years of archeological research conducted by Rovira i Virgili University. In 1994, Santiago Giralt (Carbonell et al. 1994) completed the *Cinglera del Capelló* lithostratigraphy and established four sedimentary series or facies associations. Later, Giralt (Giralt et al. 1996) established three facies associations through lithostratigraphy at the Abric de la Consagració and the Abric Romaní (Fig. 2.21).

During the second half of the 1990s, the surface excavation of the Abric Romaní rapidly transformed the site. The extensive scope of excavated surface improved the quality of the sections available for stratigraphical studies. Below we describe the sedimentary geology of the *Coveta Nord* section (SCN) (Fig. 2.22).

Coveta Nord Lithofacies

Bioconstructions (boundstones) and speleothems. The main sediments are tufa (moss-generated travertines) and stromatolites (calcareous microbial laminae) in laminar sets (Viles and Goudie 1990). Water dripping from the rockshelter roof formed the dome-like beds.

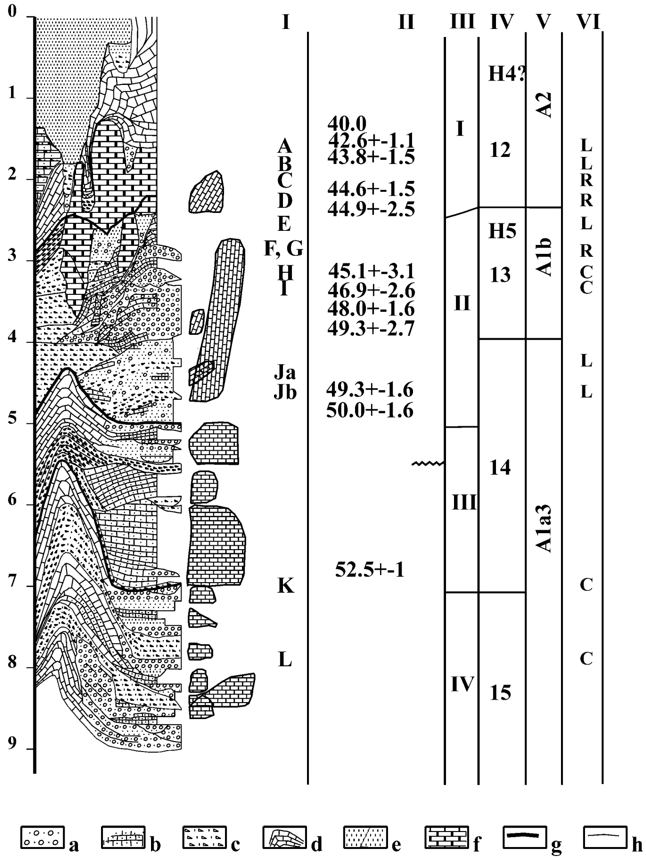


Fig. 2.22 Abric Romaní lithostratigraphy and sequence units in the *Coveta Nord* section. Lithology: **a** travertine and calcarenite conglomerates; **b** moss bioconstruction; **c** angular platy travertine gravels; **d** cemented and laminated algal bioconstructions; **e** siliciclastic calcarenite and calcilutite; **f** stalagmitic dome; **g** sequence limits; **h** boundary surfaces. Comments: *I* archaeological levels; *II* U/Th dates (Bischoff et al. 1988; Mora 1988); *III* sequence numbers; *IV* Groenland stadial and interstadial isotopic stages and Heinrich events within the GISP-2 age-model (Stuiver et al. 2000; Blunier et al. 2001); *V* polinic phases and zones; *VI* short (S) and long (L) time span of human occupation estimated for the archeological levels; *R* indication of relict archeological levels

Gravels, blocs and megablocks. Travertine megablocks, blocks, slabs and gravels found in poorly stratified wedge-shaped beds. Open-structure platy gravels show a typical fine-paired rhythm of scree or talus slope deposits formed by cryoclastism. Color change of the fine fraction from lithochromic grey (10 YR 7/2) to brown indicates decalcification, as can be seen in level J.

Conglomerates, calcarenites and tufas. Round to angular, gravel-sized porous or coated (pisoliths, oncoliths), calcarenites and calcilutites are well stratified beds of horizontal and graded discontinuous (stoneline) sedimentary structures. Conglomerates, sands and tufas fill ribbon-like channel and tabular bedforms. Calcarenite and calcilutite color is yellow to brownish (10 YR 6/4–10 YR 7/4).

Siliciclastic calcarenites and calcilutites. Silt and fine sand silicate minerals (quartz, feldspars, etc.), calcarenites and calcilutites make up irregular and massive to stratified beds. Commonly, this lithofacies has gradational lower contacts and abrupt upper contacts in massive beds of aeolian origin, but laminated and graded beds are also found, mixed with clast to matrix-supported platy gravels and nodules. Thin sections of siliciclastic calcarenite and calcilutite samples taken from the top of the Abric Romaní sequence show a platy microstructure caused by ice segregation (Arteaga et al. 2001b).

Abric Romaní Sequences

Two main lithological units characterize the 20 m thick stratigraphic section. The uppermost unit, composed of three meters of brown siliciclastic calcilutites, was interpreted as an aeolian deposit (Bartroli et al. 1995; Bischoff et al. 1988). The excavation carried out by Amador Romaní removed the greater part of this uppermost unit that originally covered the entire rockshelter. At present, only some small pockets remain adhered to the shelter wall. Below this unit, with a minimum thickness of 17 m, lies the base unit, composed of travertine gravels and blocks, calcarenites and calcilutites, with archeological levels interbedded throughout the entire column (Mora et al. 1988b; Carbonell et al. 1994; Giralt et al. 1996).

The *Coveta Nord* is the profile that has been used to define the stratigraphy of the Abric Romaní (Fig. 2.22). We describe the synthetic stratigraphy of the *Coveta Nord* beginning at the bottom in order to separate cycles of retreat and downward accretion of the carbonate curtain and sediment supply.

In sequence IV, close to the shelter wall, the facies are wedges of gravel alternating with domal bioconstructions. Below the cornice and outside the dripline, facies change to tabular conglomerates and sands, alternating with wedges of gravel.

The basal beds of sequence III onlap towards the shelter wall and consist of moss-generated tufa interbedded with very thin wedges of truncated gravels and blocks. A disconformity in the upper third part of the succession represents a period of erosion.

The bottom of sequence II consists of two wedge-shaped beds of calcarenite and moss-generated tufa interbedded with gravel and megablocks. Close to the shelter wall two dome-like relief forms are present, composed of cemented to open-structure platy fine gravels and calcarenites. A dripline in front the central alveole forms a long speleothemic dome. The upper succession, fining upward below

Table 2.2 U/Th dates of travertine samples from Abric Romani (Bischoff et al. 1988, 1994; Mora 1988)

Archeological location	USGS lab number	Depth	Uppm	$230_{Th}/232_{Th}$	U/Th date, kyrs
Above level A	87-88	30	0.98	26	40.8 ± 1.3[a]
Above level A	87-36f	−10	1.24	7	39.4 ± 1.5
Above level A	87-35f	−20	1.3	11	42.9 ± 1.6
Above level A	87-44	−30	0.76	8.5	39.1 ± 1.5
Above level A	90-AR4	−50			41.8 ± 0.8[a]
Below level A	90-AR3	−70			42.7 ± 1.3[a]
Below level A	87-37f	−60	1.99	25	43.8 ± 1.5
Below level B	87-52	−110	0.73	9	43.4 ± 1.5
Below level B	87-32f	−120	0.88	21	48.1 ± 3
Below level B	87-107	−120	0.60	19	43.1 ± 1.5
Below level B	86-33f	−100	0.71	24	44.0 ± 1.3
Below level B	86-35f	−100	0.65	35	42.4 ± 7.5
Below level C	87-41f	−150	0.69	52	44.2 ± 1.5
Below level C	87-133	−150	0.33	>1,000	44.6 ± 1.5
Below level C	87-126	−180	1.01	11	44.9 ± 2.5
Above level E[b]	03-64	−200	1.0	18	38.1 ± 0.9
Above level E[b]	02-18	−200	0.88	53	36.4 ± 1.4
Above level H[b]	02-22	−290	0.74	15	49.0 ± 1.5
Above level H[b]	03-65	−290	0.58	16	46.5 ± 1.1
Above level I	87-55	−340	0.75	20	45.1 ± 3.1
Above level I[b]	02-21	−340	0.86	26	48.3 ± 1.5
Below level I	87-54	−360	0.92	70	45.3 ± 1.5
Below level I	87-129	−360	0.79	105	47.7 ± 1.6
Below level I	87-66	−360			48.6 ± 2.3
Below level I	87-64	−360			46.9 ± 2.6
Below level I	87-56	−360			46.3 ± 2.4
Below level I	87-60	−380			49.2 ± 3.3
Below level I	87-123	−370	0.96	86	48.0 ± 1.6
Below level I	87-59	−380			47.4 ± 2.5
Below level I	87-57	−390			49.3 ± 2.7
Above level J	87-61	−480	0.55	>1,000	49.3 ± 1.6
Above level J	87-58	−490			49.2 ± 2.9
Above level J[b]	02-19	−500	0.80	34	46.6 ± 1.7
Below level J	87-3	−520	1.82	>1,000	50.0 ± 1.6
Below level J	87-16	−520	1.80	>1,000	50.8 ± 0.8
Above level K[b]	02-24	−600	0.45	13	50.0 ± 2.2
Above level K[b]	07-19	−600	0.68	>1,000	51.6 ± 0.3
Above level L	86-58f	−650	2.00	>1,000	52.0 ± 1.26
Above level L	87-10f	−650	1.84	>1,000	53.0 ± 0.8
Above level L	87-128	−650	1.00	>1,000	51.9 ± 1.6
Above level L	87-4f	−685	0.65	>1,000	52.2 ± 1.6
Above level L[b]	02-20	−700	0.77	146	50.6 ± 2.0
Above level M[b]	02-23	−800	0.98	79	51.8 ± 1.4
Above level M[b]	03-67	−800	0.64	164	61.7 ± 2.2
Above level N	87-17f	−820	1.34	27.5	54.9 ± 1.7
Above level N	87-5f	−820	1.22	27	54.1 ± 1.6

(continued)

Table 2.2 (continued)

Archeological location	USGS lab number	Depth	Uppm	$230_{Th}/232_{Th}$	U/Th date, kyrs
Above level N[b]	02-17	−850	0.82	50	55.8 ± 2.3
Above level O[b]	07-9	−950	0.71	330	54.6 ± 0.4
Above level P[b]	07-10	−980	0.76	149	54.24 ± 0.42
Romaní well	86-65f	−1010	1.56	13	55.0 ± 2.6
Romaní well	87-131	−1010	0.80	30	53.4 ± 1.6
Romaní well	87-129	−1155	0.92	29.5	54.5 ± 1.7
Romaní well	87-11f	−1155	1.46	26	55.5 ± 1.7
Romaní well	86-57f	−1155	1.60	32	60.6 ± 1.7
Romaní well	86-51f	−1180	1.93	40	57.2 ± 0.8
Romaní well	87-12f	−1180	1.79	29	59.6 ± 1.7
Romaní well	87-130	−1180	0.97	27.5	59.0 ± 1.7
Romaní well	86-67f	−1240	1.73	23	63.2 ± 0.9
Romaní well	87-132	−1240	0.91	43	59.0 ± 1.7
Romaní well	86-63f	−1240	1.75	14	60.1 ± 1.8
Romaní well	87-62	−1240	0.93	15	58.0 ± 2.6
Romaní well	87-63	−1240	0.89	16	59.6 ± 2.6
Romaní well[b]	93-12	−1425	0.85	8	60.0 ± 2.0
Romaní well[b]	93-13	−1480	0.65	20	57.0 ± 2.0
Romaní well[b]	93-14	−1580	1.10	121	61.0 ± 2.0
Romaní well[b]	93-15	−1640	0.98	18	70.0 ± 2.0

[a] Mean of several dates
[b] Previously unpublished dates

Table 2.3 ^{14}C (AMS) dates from the Abric Romaní (Bischoff et al. 1994; Carbonell et al. 1994). 2σ calibration has been made using Stuiver et al. (2000)

Level	Lab. Ref.	Radiocarbon age	Cal BP age	Material
A	AA-7395	37290 ± 990	43610–41250	Charcoal
A	AA-8037A	35400 ± 810	42690–38810	Charcoal
A	AA-8037B	37900 ± 1000	44180–41500	Charcoal
A	NZA-1817	28440 ± 650	35330–31010	Charcoal
A	NZA-1818	23160 ± 490	29030–26870	Charcoal
B	NZA-2312	43500 ± 1200	49630–44150	Charcoal
B	AA-7396	29230 ± 530	35760–32680	Charcoal
D	NZA-2313	40680 ± 940	46000–42720	Charcoal
E	NZA-2314	43200 ± 1100	49190–44070	Charcoal
H	NZA-2315	44500 ± 1200	50570–44770	Charcoal
H	NZA-3138	44140 ± 5930	59120 -37840	Charcoal
J	NZA-2316	47100 ± 2100	55910–45350	Charcoal

a second dripline in the shelter wall, shows conglomerates and sands interbedded with channelized calcarenites, stem bioconstructions and stromatolithic crust dipping towards the shelter wall in a talus cone asymmetrical form. These deposits are interbedded with fine beds of open-structure to partially filled platy gravels. The sequence II upper boundary surface contains the first occurrence of siliciclastic calcilutites in the Abric Romani.

Sequence I contains a basal wedge of blocks and megablocks, capped by two domic biochemical deposits, one of which is rekarstified and the other consisting of stromatolithic laminations in cosets, dipping towards the

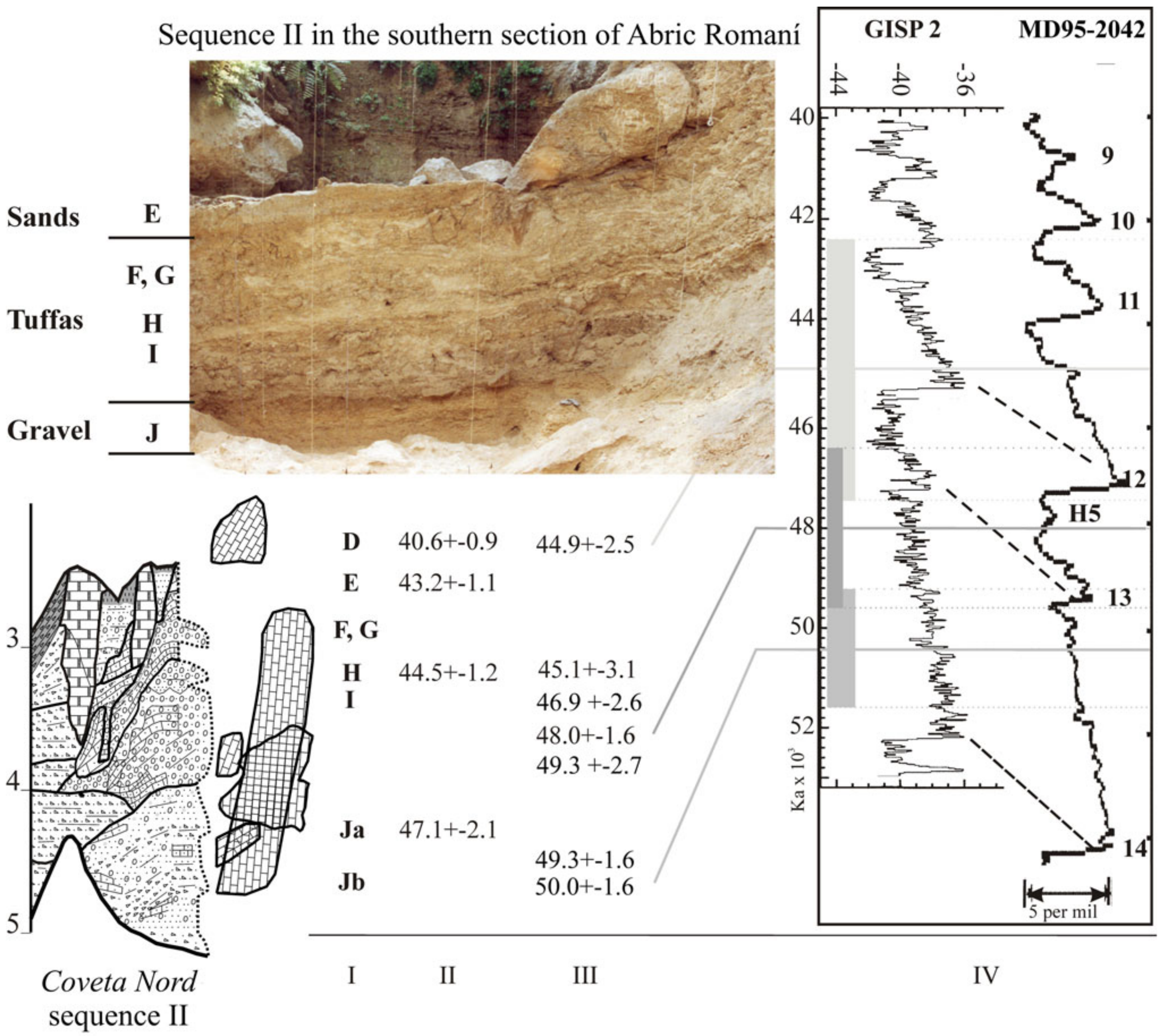


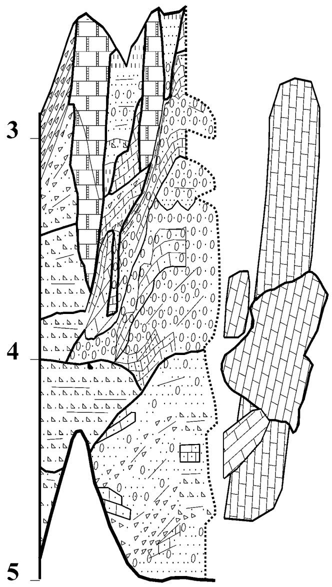
Fig. 2.23 *Coveta Nord* sequence II and level J complex in the radiometric and paleoclimatic time models of environmental change (Stuiver et al. 2000; Shackleton et al. 2004). Legend: *I* archeological levels; *II* radiocarbon (ka); *III* U-series calendar dates; *IV* Dansgaard–Oeschger 9–14 events (D–O) and Heinrich event 5 (HE) chronology in GISP2 and MD95-2042 time ages

shelter wall. Two superimposed channel fills are interstratified with the domic deposits. The upper half of the sequence consists of well stratified and cemented fine gravels, calcarenites and moss-generated tufa in horizontal beds. This sequence is capped by a second layer of siliciclastic calcilutites at the top of the stratigraphy.

Level J Chronology

The moss-generated tufa was found to be an excellent medium for coherent uranium-series dating (Bischoff et al. 1988). An ambitious program of dating has been carried out in the Abric Romaní in close collaboration with the US Geological Survey. Radiometric analysis yielded 66 dates in correct stratigraphic order that define the chronology of the sequence (Table 2.2). The dates indicate that the Romaní sequence covers the period between 70 and 40 ka BP. In addition, a series of ^{14}C AMS dates from the upper archeological levels (A to J) has been also obtained (Table 2.3).

The base of level J has been dated with samples USGS87-3 and USGS87-16 of the Romaní well at 50,000 ± 1600 to 50,800 ± 800 BP respectively (Bischoff et al. 1988). These samples, which come from below the cemented platy wall gravels, were found to significantly predate the fall of the large blocks.



Archeological layers	Sedimentary process	Deposits	Stacking pattern	Sediment supply
E	Rock fragmentation Aeolian	Irregular setbed		Hiatus
F, G H I	Rock fragmentation Dripping	Biochemical Channel fills Crioclast	Vertical accretion Progradation	Carbonate curtain growing
Ja Jb	Rock fragmentation and nivation	Soil forming Crioclast Rock fall	Retrogradation	Carbonate curtain retreat

Fig. 2.24 Sedimentological summary of Abric Romaní sequence II. Lithology: **a** conglomerates of travertines and calcarenites; **b** moss bioconstruction; **c** angular, platy travertine gravels and granules; **d** cemented and laminated algal bioconstructions; **e** siliciclastic (*grey hacht*) calcarenite and calcilutite; **f** stalagmitic dome; **g** sequence limits; **h** boundary surfaces

The level J deposits are located underneath a thick dome-like structure of travertine tufa, which has an extended lateral continuity and is U/Th-dated at the base at around 49,300 ± 1600 BP (Fig. 2.23) (Bischoff et al. 1988). This talus cone contains gours (rimstone dams) and conglomerates, and sand tufa beds where archeological levels F–G, H and I have been excavated. Table 2.2 indicates the dates obtained from the first tufa bed of the talus cone, which has been dated at various points. Considerable horizontal coherence was found within the group of dates, indicating the strong reliability of the sampled and dated carbonated materials. Almost all of the dated samples are described as filiform tufa with ramifications (Mora 1988). Their U/Th age indicates a range of between 49,300 ± 1600 BP in the USGS87-61 sample, the only sample described by Mora as ‘travertine over blocks’ in section PM56, and 49,200 ± 2900 BP in the ‘filiform with ramifications’ sample (USGS87-58 in the M53-55 section). The sample of travertine over blocks (45a in the PM56 section by Mora) allows us to place this date at the tufa bed that separates Ja and Jb. The USGS87-57 sample, also in section PM56, seals two archeological levels, which can be interpreted as level Ja and level Jsup, dated at 49,300 ± 2700 BP (Mora 1988).

Radiocarbon dating of sublevel Ja has been published at 47,100 ± 210 ^{14}C BP (Carbonell et al. 1994). Archeological levels H and E have been radiocarbon-dated at 44,500 ± 1200 and 43,200 ± 1100 ^{14}C BP respectively (Fig. 2.23) (Table 2.3).

The chronostratigraphy of sublevels Ja, Jb and Jsup illustrates the statistical uncertainty of the calendar dates for correlation with the ice and marine age records (Blunier et al. 2001; Shackleton et al. 2004). A short span of Dansgaard–Oeschger (D–O) interstadials and Heinrich events makes it difficult to use lithofacies as a record of climatic change. Long-term cooling and Bond cycles seem to provide a more adequate time scale for age precision of level J and sequence II calendar dates (Fig. 2.23). Sequence II has a chronostratigraphy that is correlated with the paleoclimatic age models close to the Bond cycle of D–O 14 to Heinrich event 5. However, the sedimentary lithofacies of the Abric Romaní can guide the climato-geological correlation and provide dates that are more constrained. Thus, the information collected on travertines and speleothems has been largely assigned to interstadials and interglacials (Henning et al. 1983). Furthermore, the siliciclastic calcilutite facies indicate periods of aeolian sedimentation, which are characteristic for arid and semiarid seasonal humidity systems. These facies are located for the first time in the Abric Romaní at the top of sequence II, between 45,100 ± 3100 and 44,900 ± 2500 BP, very close to the GISP-2 chronology of Heinrich event 5 despite the range error in the dates (Blunier et al. 2001).

The climato-geologic units of sequence II have been established by means of calendar dating from numerous U-series and radiocarbon ages. The discussion concerning constraining calendar ages, in agreement with stratigraphic discontinuities and sequences or allostratigraphic units, can provide timelines for correlations of temporal transgressive lithological units. The sequences established for the Abric Romaní sedimentary record are discussed in order to examine abrupt environmental changes (Broecker 1994; Bond and Lotti 1995).

The chronostratigraphy of level J ranges between 50,000 ± 1600 and 49,300 ± 2700 BP (Fig. 2.23). The association of planar fine gravels, blocks and megablocks interbedded with sandy, less stony facies indicate debris fall episodes (Fig. 2.24). Level J deposits show evidence of effective cryoclasty. However, the dates of the deposits place this level between the interstadials D–O 14 and 13 in the GISP-2 chronology. Screes are numerous in the Central Pyrenean ranges and developed mostly at an elevation of 600–800 m in Tardiglacial times (Chueca et al. 1994). Decarbonation processes in the upper deposits of level J suggest environmental change, as well as the posterior travertine talus cone deposits in the upper half of sequence II (Fig. 2.22). The similarity to the last generation of taluses of the Central Pyrenees might suggest a climate change of a magnitude of stadial and interstadial scale. This climatic change in sequence II can be correlated, due to its proximity in time, to the D–O 13 chronostratigraphy, which is established between 48 and 50 ka with the MD95-2042 age model (Fig. 2.23). Our provisional conclusion is therefore that the deposits of level J lie within the central part of the Bond cycle made up of D–O 16 and Heinrich event 5, with climatic change similar to that which separates isotopic events 14 and 13 in Greenland stadial-interstadials (Walker et al. 1999).

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