Cave Development and Patterns of Caves and Cave Systems in the Eogenetic Coastal Karst of Southern Mallorca (Balearic Islands, Spain)

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Abstract

Coastal cave patterns can be studied in exceptional conditions along the southern and eastern coast of Mallorca Island owing to the widespread outcrop of the Upper Miocene calcarenites, in which the development of eogenetic karst features started approximately 6 Ma ago, at the end of Messinian period. Some remarkable coastal-karst caves are today accurately surveyed, including among others the labyrinthine Cova des Pas de Vallgornera (more than 73 km in length), the celebrated Coves del Drac (explored by E.A. Martel in 1896 and visited each year by about one million of tourists) and the impressive submerged passages of Cova de sa Gleda cave-system (exceeding in its current state of exploration a length of 13.5 km, as shown by detailed scuba-diving surveys). A three-fold approach to studying the cave patterns characterizing this complex island CIKM-type karst is presented here on the basis of morphometric analysis of cave-segments, individual caves and cave-systems. At every one of these three levels of observation, the most outstanding feature that can be generalized for the vast majority of caves turns out to be the presence of large breakdown chambers, wider than 20 m along their minor axes, that are partially or totally submerged by sea level fluctuation and the rise of the water table in Holocene times.

11.1 Introduction

Interest in coastal karst and coastal caves has increased during the last few decades because of the particular hydrogeological and speleogenetic characteristics, which differ from karst and caves that develop in continental settings. Karst caves developed in coastal areas have been explained as the result of dissolution from the mixing of waters with different chemical compositions, and it is

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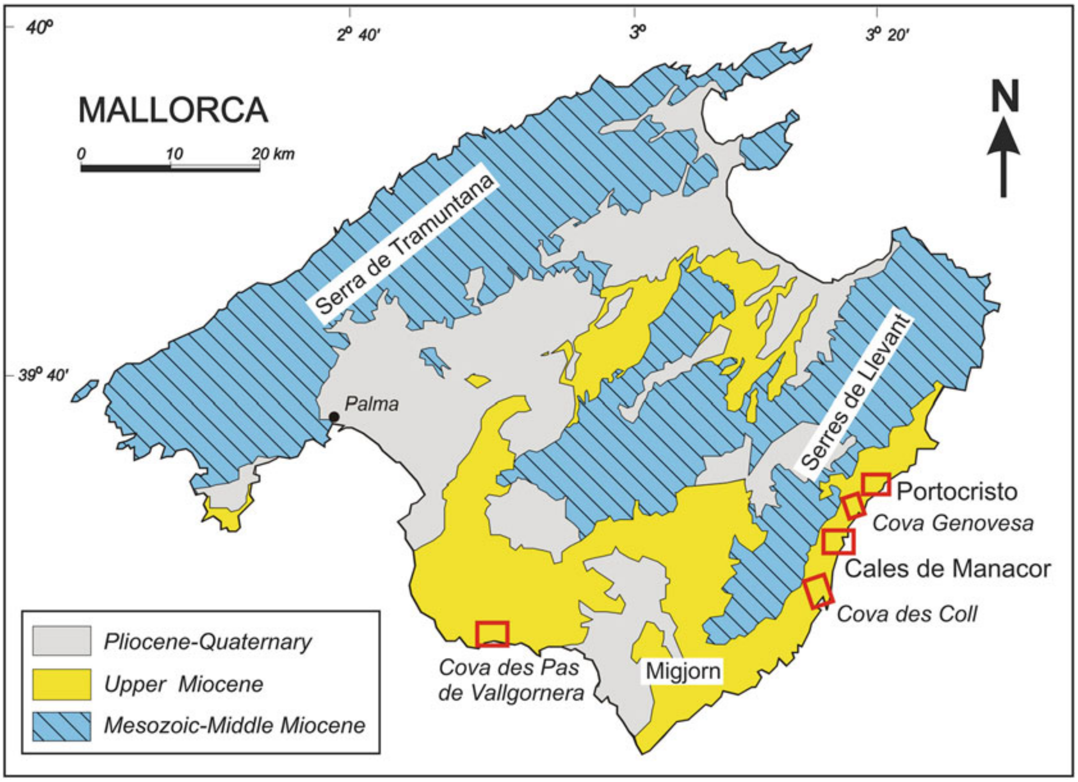


Fig. 11.1 Simplified geological map of Mallorca Island showing the location of the caves and the cave-areas discussed in the text. The Migjorn area is in the *lower right* of the figure

assumed that distinctive cave patterns could be expected in such special geochemical and hydrodynamical environment. These caves commonly exhibit spongework and ramiform development believed to reflect geochemical processes including the mixing of fresh and saline water and hydrodynamics of the freshwater lens.

Knowledge of caves depends on the availability of accurate cave maps. Surveying of caves located in the immediate vicinity of the sea is frequently hampered by the closeness of the water table. Many coastal caves appear drowned in most of their real sections by the postglacial sea-level rise and the consequent rise of the water table. For this reason, cave mapping in these partially-submerged karst systems requires accurate and detailed survey tasks to account not only for the air-filled rooms and passages, but also the water-filled extensions of the caves.

One of the main goals in cave surveying is the disclosure and subsequent explanation of cave patterns. This is especially true for coastal karst because comparisons between cave patterns may reflect different speleogenetic processes, such as the relationship between cave development and glacio-eustasy, the role of breakdown in the evolution of the caves or the bioclimatic, geochemical and structural constraints involved. Since significant information can be obtained using detailed cave maps, a discussion on surveying criteria and standardization of coastal cave maps seems worthwhile (Mylroie 2007; Ginés et al. 2009a).

Cave surveying in the Migjorn region (Fig. 11.1), a coastal karst area located in the southern part of Mallorca Island (western Mediterranean), has a long history of exploration, mapping, and scientific debate on the mechanisms driving cave development, starting in the second half of the nineteenth century. In short, three main periods can be distinguished: (1) the pioneer descriptions of a few celebrated

Migjorn caves (including the Martel map of Coves del Drac, performed in 1896); (2) the conventional-caver mapping of many caves of the region (produced during the 70s to 90s of the twentieth century) that suggested a typical and repetitive pattern made up of apparently isolated collapse chambers that coalesce randomly; and (3) recent detailed mapping by cave divers (from 1995 till present) demonstrating underwater connections between caves and in some cases even with the sea.

11.2 Cave Surveying: A Matter of Accessibility

Producing accurate and detailed cave maps requires overcoming technical problems associated with physical exploration involved with each cave and most importantly traversing the minimum penetrable-size of all cave passages. The availability of cave maps remains a function of exploration, which increases with time. Direct observation, and consequently cave surveying, is limited in some cases by the presence of fluids (e.g. high concentrations of carbon dioxide or, more commonly, water) which require specific exploration equipment. Nonetheless, the most obvious limit for cave surveying is the minimum size of the cavity to explore, whereby many sections of a cave are out of the access of cavers and can only be interpreted through indirect observations.

Inaccessibility accounts for most of the unsatisfactory knowledge of coastal caves and coastal cave-systems in all littoral karst areas as the Holocene rise in sea level flooded these low-lying caves. Furthermore, eogenetic karst is not prone to promote the development of well-structured cave conduits, in spite of its inherent great hydraulic conductivity, impeding the direct observation and mapping of the myriads of tiny interconnected voids that transmit the water toward the sea (the touching vug permeability of Vacher and Mylroie 2002). On the other hand, it is still hard to lay down solid generalizations, because only a small number of locations around the world form the base of the current theoretical approach to coastal karst systems (e.g. Bahamas, Bermuda, Marianas, Mallorca, Puerto Rico, Florida or Yucatan – see accompanying case studies within this volume) and comparison between these coastal locations is still a task to develop in the near future.

11.3 Cave Surveying: A Matter of Methodology and Sampling Strategy

Cave surveying and cave mapping are more than a descriptive task. Although some cave features are striking, many significant features are frequently ignored in the most common cave maps. Selective criteria are applied implicitly when the cavers choose what shape better describes the perimeter of a cave, or when they plot the inside of such a wall-perimeter the most relevant features to enclose in the drawing. Cave maps are the only way to study the pattern of the caves, but these maps can be far from objective representations.

An alternative approach is to assume these facts as the uncertainty bias of a particular "sampling method", thereby avoiding unexpected "graphic artifacts" that would introduce misleading information through the mapping practices. In this way, cave surveying becomes a specific sampling method for collecting accurate field data. For instance, in the case of the Migjorn karst of Mallorca (Fig. 11.1), our current analysis of coastal cave patterns relies on a three-level approach based on the following scale of increasing size and complexity: cave-segments, individual caves and cave-systems.

11.4 Maps of Cave-Segments in the Karst of Southern Mallorca

Detailed analysis of particular cave-segments may make it possible to identify diagnostic features that relate to specific geochemical environments. For example, some irregular chambers may relate to dissolution voids that develop similar to flank margin caves, or definite cave passages may reflect active flow and dissolution processes similar to conduits that develop in telogenetic settings. Additionally, it is important to report significant assemblages of solutional forms, as well as to measure their size and frequency of appearance. Cave maps provide little information about small-scale solution features (e.g. presence or absence of solution notches, scallops, etc.). On larger scales, however, some significant data can be obtained by analyzing chambers and passages in plan view. Cross sections are especially informative because their shapes commonly provide insight on passage genesis. In addition, the cave floor of rooms and passages requires detailed attention when trying to recognize the presence of sediments, speleothem pavements, collapse boulders or *in situ* rock.

In the eogenetic karst of Migjorn, cavers have traditionally focused on the richness in speleothems, the widespread occurrence of breakdown features (boulder heaps and collapsing vaults), and the scarcity of former solutional evidence (that become progressively dismantled by breakdown). This condition is easy to recognize within the whole background of cave surveys produced by Majorcan cavers till present. The vast majority of available maps depict, in detail, the recurrent collapse chambers floored with fallen blocks and speleothems, even below the water table (Fig. 11.2). More recently, however, mapping by cave divers has incorporated specific symbols in order to indicate the presence of conspicuous solutional features (Fig. 11.3), such as certain assemblages of corrosion forms including spongework morphology and single solutional-conduit passages (Gràcia et al. 2005, 2006, 2007, 2009). This information has an additional value because solutional voids appear structured in horizons that are currently located between 1 and 30 m below the water table; being therefore inaccessible for conventional cave exploration.

11.5 Maps of Individual Caves in the Karst of Southern Mallorca

Maps of individual caves in southern Mallorca commonly fail to reflect entire cave systems as new discoveries by cave divers have substantially expanded the old maps. Since most cave maps reflect an “artifact of the current stage of exploration” of the real cave, the new discoveries by cave divers allow the old surveys to be substantially modified. This “expansion” of previous cave maps is especially evident in light of the coastal caves drowned as a result of the Holocene sea-level rise.

In the eogenetic karst of southern Mallorca, excellent examples of caves illustrating the “artificial changes in cave pattern” result from new exploration techniques. For example, the caves surrounding Portocristo harbour (Fig. 11.4) and Cova Genovesa (Fig. 11.5) were previously explored by conventional cavers who produced detailed cave maps that stopped at sea-level pools.

The karstic area around Portocristo encloses two celebrated show caves, Coves dels Hams and Coves del Drac (Fig. 11.4), that reflect the typical trends of caves from the Migjorn karst region (Ginés and Ginés 1989; Ginés 2000a, b). These caves exhibit wandering sets of large breakdown-vault units, 30–50 m in width, connected randomly by local collapses and surrounded by peripheral brackish pools. This pattern is easy to recognize throughout the maps published on these caves over the last century (Martel 1896; Maheu 1912; Faura y Sans 1926; Ginés and Ginés 1992; Ginés et al. 2007). The updated cave surveys (Fig. 11.4) highlight the remarkably non-directional path of Coves del Drac, in spite of its location between the incised creek of Torrent de ses Talaioles and the small bight of Cala Murta. Until now, only some sporadic cave-diver explorations added significant underwater extensions in Coves del Drac (Clarke 1991), although additional passages are expected if underwater surveying continues.

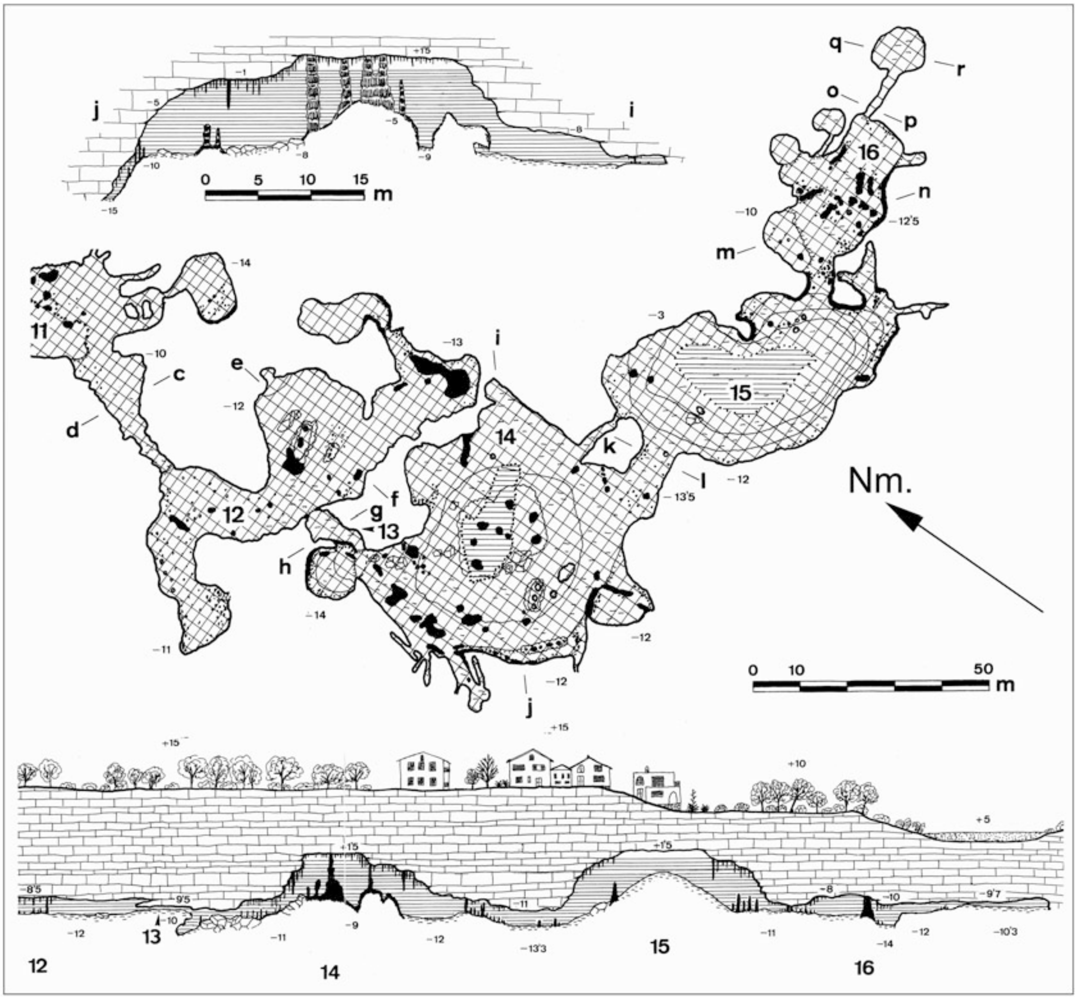
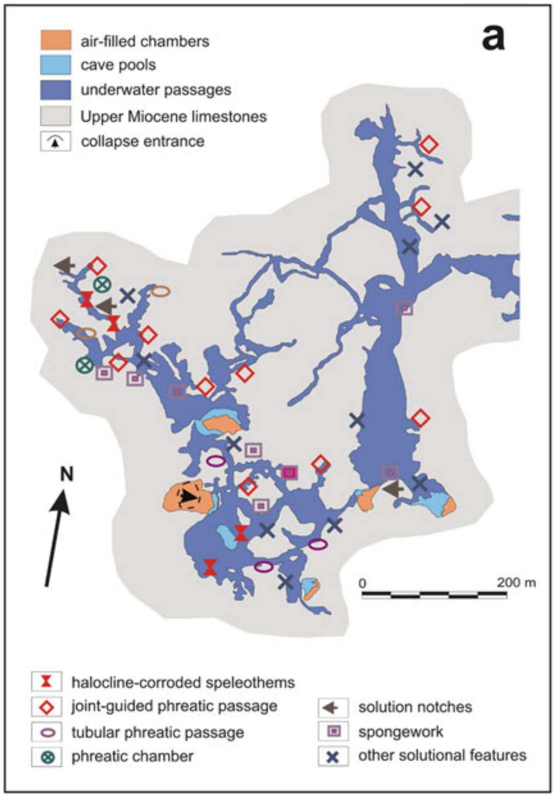


Fig. 11.2 Detailed scuba-diver survey of a sector from Cova Genovesa. The presence of breakdown features and speleothems is easy to recognize with the aid of this kind of underwater mapping (Adapted from Gràcia et al. 2003a)

In addition to the foreseeable discoveries in Portocristo, Cova Genovesa also provides a good example of the striking changes in its plan-view map resulting from underwater exploration and careful mapping (Fig. 11.5). Twenty years ago, the known cave included only two typical collapse chambers near the entrance. Nevertheless, recent mapping has demonstrated a wandering path running toward the Cala Anguila bight, hidden from the "conventional-cavers" below the modern water table (Gràcia et al. 2003a). Such discoveries suggest the previously known caves, namely those accessible without scuba equipment, can be interpreted as just the topmost part of extensive systems of coalescing chambers, whose "solutional roots" are mainly located more than 10 m below the present sea level.

11.6 Maps of Cave Systems in the Karst of Southern Mallorca

The cave systems can be defined as "a collection of caves interconnected by enterable passages or linked hydrologically" or as "a cave with an extensive complex of chambers and passages" (Gillieson 1996). As could be expected, only few of the surveyed caves fit within this



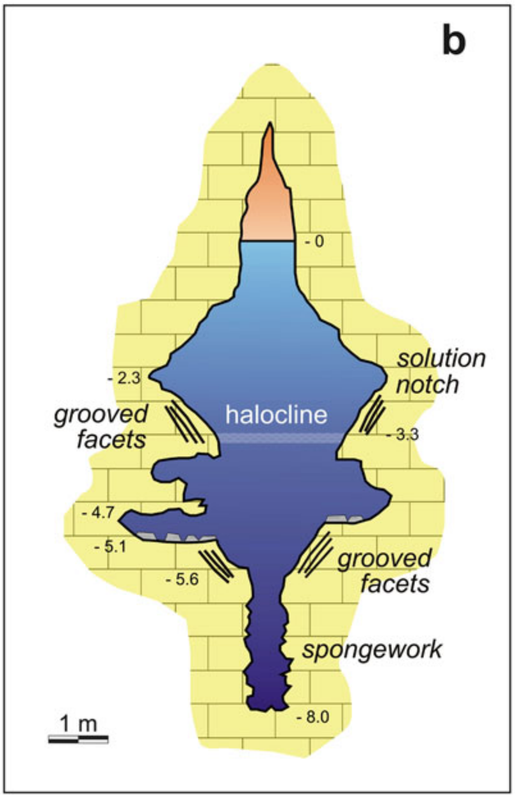


Fig. 11.3 Two examples showing the useful incorporation of specific symbols that indicate the presence of solutional features in underwater cave maps: (**a**) on a plan view survey of a sector from Cova de sa Gleda (Adapted from Gràcia et al. 2007); (**b**) on a cross-section from Galeria Miquel Àngel Barceló, Cova des Pas de Vallgornera (Adapted from Gràcia et al. 2009)

third scale-level of standardized interpretation. Namely, Cova des Coll, Cova dets Ases, Coves de Cala Varques, Cova de sa Gleda and Pirata-Pont-Piqueta system have several connected entrances, and the extensive cave complex of Cova des Pas de Vallgornera that has only one known artificial entrance.

As a result of systematic cave-diver explorations carried out during the last two decades in the sea-level pools of many formerly "well-known" caves from the southern karst of Mallorca, several groups of caves were successfully connected underwater. The exploration of two of them (Cova des Coll and Cova dels Ases) led to a direct opening to the sea, demonstrating a hydrological connection between the caves and the brackish water outlets existing along the coastal line via conduits negotiable by cave-divers. Cova des Coll has today more than 7 km of surveyed passages, of which 5.5 km are submerged (Gràcia et al. 2005), and is distinguished by its rather directional trend (Fig. 11.6). The pattern of the cave includes not only several collapse chambers, but also remarkable joint-guided solutional passages that locally generate mazes of conduits. Cova dets Ases is an array of typical collapse chambers connected with the sea through a shallow underwater passage (Gràcia et al. 1997; Ginés 2000a).

Around the Cales de Manacor karst area (Fig. 11.7) successful explorations provided insight on the pattern of coastal cave-systems of this part of Mallorca. Three cave systems that developed not far from the coast showed no direct drainage toward the sea. Cova de sa Gleda has more than 13 km of submerged chambers and large passages (Gràcia et al.

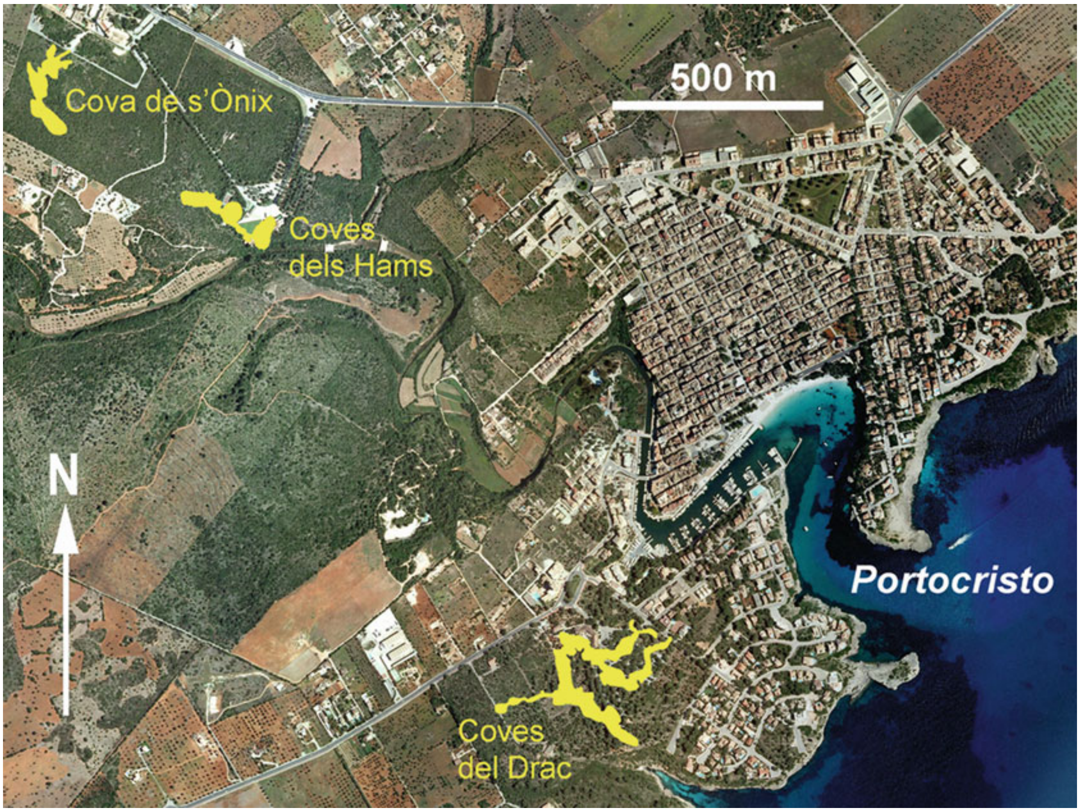


Fig. 11.4 Plotting of the main caves located around Portocristo harbour. Note the wandering trend and the remarkably non-directional path of the Coves del Drac cavern, placed just between the incised creek of Torrent de ses Talaioles and the small bight of Cala Murta visible at the *southern side* of the figure

2007, 2010). Coves de Cala Varques consists of three connected collapse caves that surround the homonymous bight (Gràcia et al. 2000). Pirata-Pont-Piqueta system shows wandering and chaotic paths (longer than 3 km) characterized by the coalescence of nine major collapse chambers (Fig. 11.8), without efficient hydrological connectivity between them, and opened to the surface through three cave entrances (Gràcia et al. 2006). Ramiform patterns are dominant in these three neighboring cave systems (Fig. 11.7).

11.7 Cave-Pattern Statistics: A Matter of Map Availability

Morphometry of caves is a crucial topic trying to explore differences between cave-patterns. Qualitative observations are basic, but they depend excessively on subjective appraisals and rarely could substantiate a statistical approach with enough solid data. Specific measurements of significant features are difficult and tedious to make inside the caves and require too much time. On the other hand, cave maps are the most suitable tool for analyzing the structure of the caves: certainly they are not quite objective representations, but are produced upon measures obtained *in situ* and generally are carried out by authors, not necessarily biased toward any speleogenetic theory, that simply want to describe the path and geometrical development of the caves. For these reasons, we suggest that the most useful criteria in order to implement cave-pattern statistics would be to lay down some general and simple procedures, which being open to comparison between different caves would be based in practice on measures easily to obtain from ordinary cave maps,

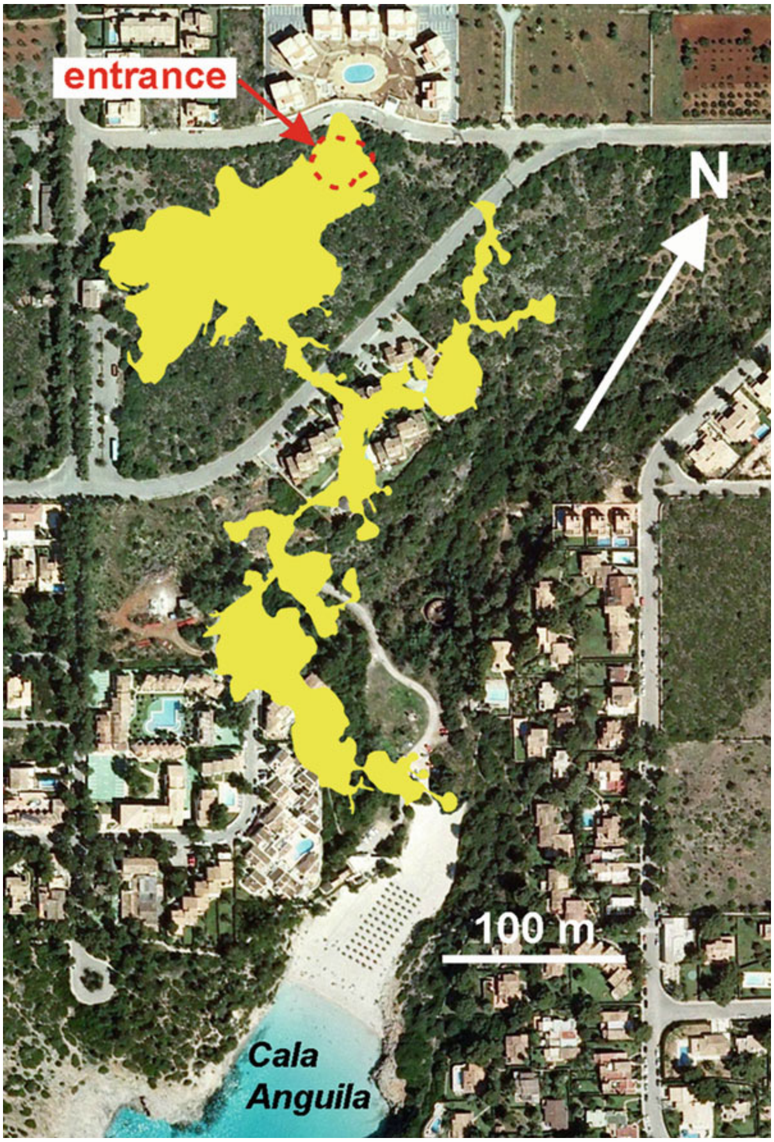


Fig. 11.5 Map of Cova Genovesa plotted over an aerial photograph of Cala Anguila bight (After Gràcia et al. 2003b)

preferably if they are performed with enough detail and accuracy (Fig. 11.2). Let us show some examples of these morphometrical procedures taking as case-studies the cave surveys of Cova Genovesa and Cova des Pas de Vallgornera.

11.7.1 Passage Cross-Section Statistics

Surely one of the most conspicuous features that can be appreciated in the plan view of whatever cave map is the width of the passages and chambers that constitute the entire cave. The breadth of the different sectors of a cave is very easy to measure with the aid of the scale that are plotted on the survey, and at the same time it is quite simple to collect series of width measurements along the imaginary center line that follows the complete pathway of the cave. A good option would be to measure how wide are, in statistical terms, a significant set of transverse cave sections taken at right angles with respect to the main center line route. Furthermore,

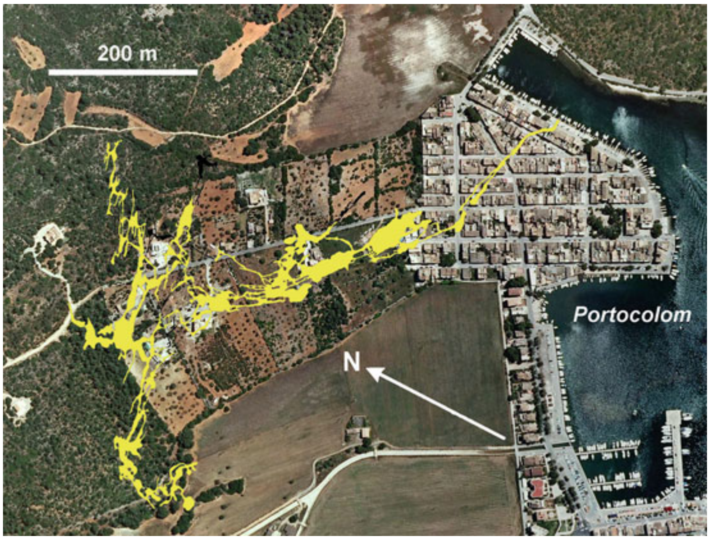


Fig. 11.6 Map of Cova des Coll plotted over an aerial photograph of Portocolom harbour (After Gràcia et al. 2005). The cave connects to the sea in the *upper right*

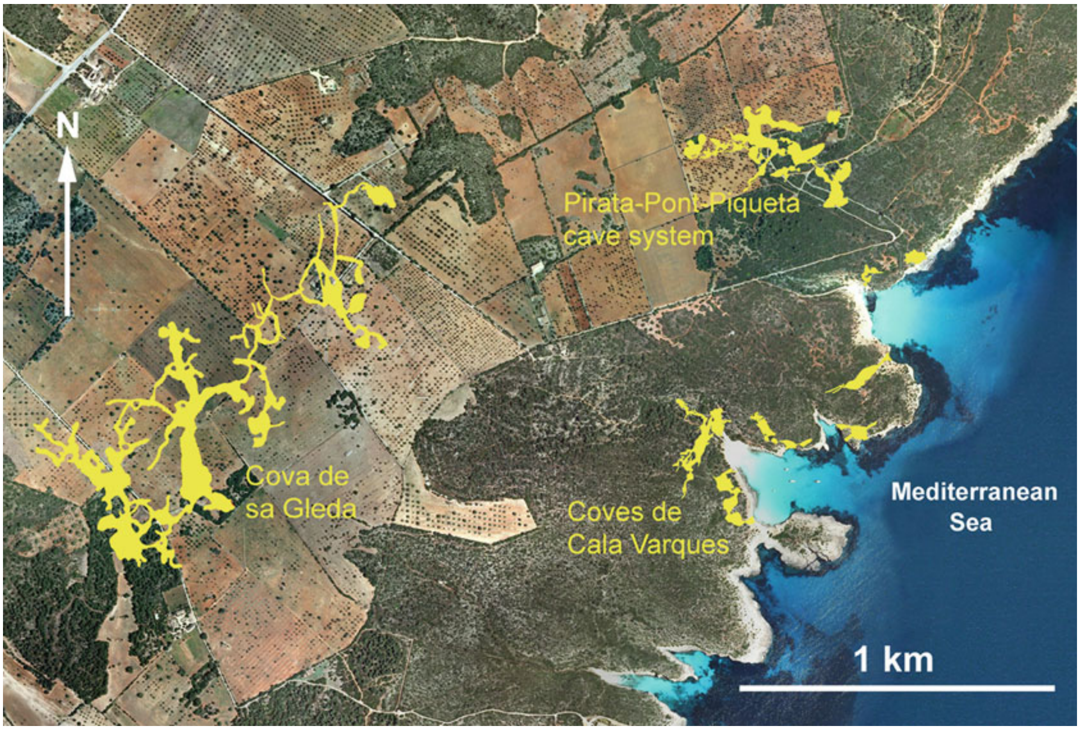


Fig. 11.7 Plotting of the main caves located in Cales de Manacor area. Ramiform patterns are dominant, lacking apparent direct drainage toward the sea (updated after the current explorations performed by the cave-divers of Grup Nord de Mallorca)

in order to improve the validity (even the exhaustiveness) of the set of measurements, each section could follow a definite spatial sequence through the whole center line, for example at a fixed interval. The frequency distribution of the width values would provide a characteristic signature for different caves, probably related to different cave-patterns.

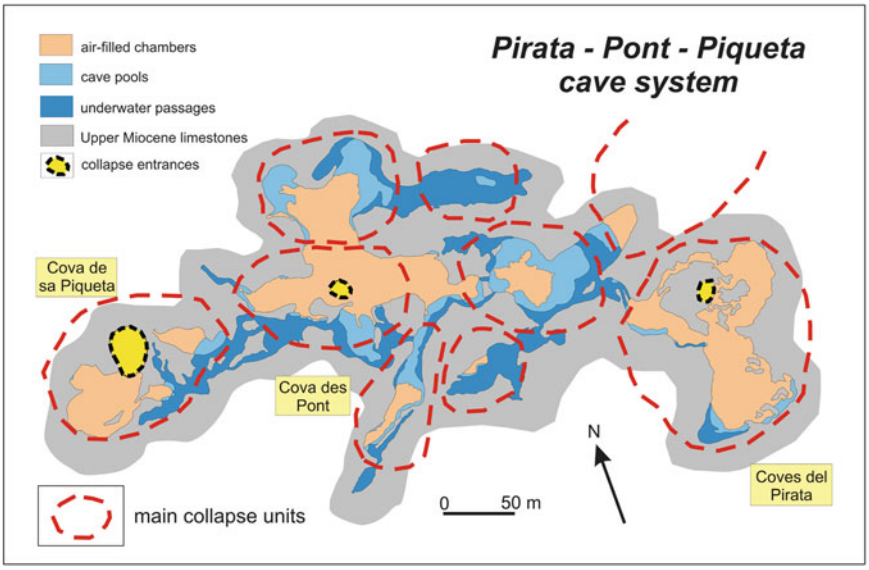


Fig. 11.8 The whole pattern of Pirata-Pont-Piqueta cave system, about 3 km in development, is easily explained as the result of coalescence of nine major breakdown units (Slightly modified from Gràcia et al. 2006)

In the case of Cova Genovesa (see a simplified survey in Fig. 11.5) such a methodology has been applied thoroughly all along the total length of the cave, in the form of 237 cross-sectional measurements spaced between them approximately each 5 m. The results obtained demonstrate that 68 % of the cave is wider than 5 m, and more than 27 % exceed 20 m in breadth. The frequency distribution (Fig. 11.9) points out two significant peaks for the width-classes 20–25 m and 35–40 m, which are clearly related to the extensive collapse breakdown affecting the main part of the cave. This assumption is corroborated by the detailed description of the cave published by Gràcia et al. (2003a, b), that points out the presence of breakdown features over 90 % of the total cave development.

11.7.2 Inferences on Major Cave-Level Development

A rough estimation of the major speleogenetical horizons involved in the evolution of a particular cave can be easily obtained by evaluating the total amount of cave-void that, after the information supplied by its own cave-map, appears distributed at different elevations. For this purpose, a useful method consists simply in drawing a set of horizontal, parallel and equidistant lines across the whole extended profile of the cave (as well as over additional cross-sections if necessary), and measure how much passage length has been intercepted by each leveled line. The most noticeable peaks, that stands out when plotted the frequency distribution corresponding to the amount of void space intercepted within each level, would indicate presumably the location of preferential horizons where karstic erosion have generated more cave.

In the case of Cova Genovesa (Figs. 11.2 and 11.5) two complementary frequency distribution analyses were performed. The first one (Fig. 11.10a) was the simpler result of measuring on the profiles published by Gràcia et al. (2003a) the total amount of cave intercepted at elevation intervals of 2 m. The obtained results show an outstanding maximum of cave-voids placed at 10 m below sea level, as well as several subdued peaks at 18, 8 and −18 m a.s.l.; at the same time, it demonstrates that approximately 40 % of the total surveyed passages and chambers are comprised between 6 and 10 m below the current sea level. On the other hand, the second statistics

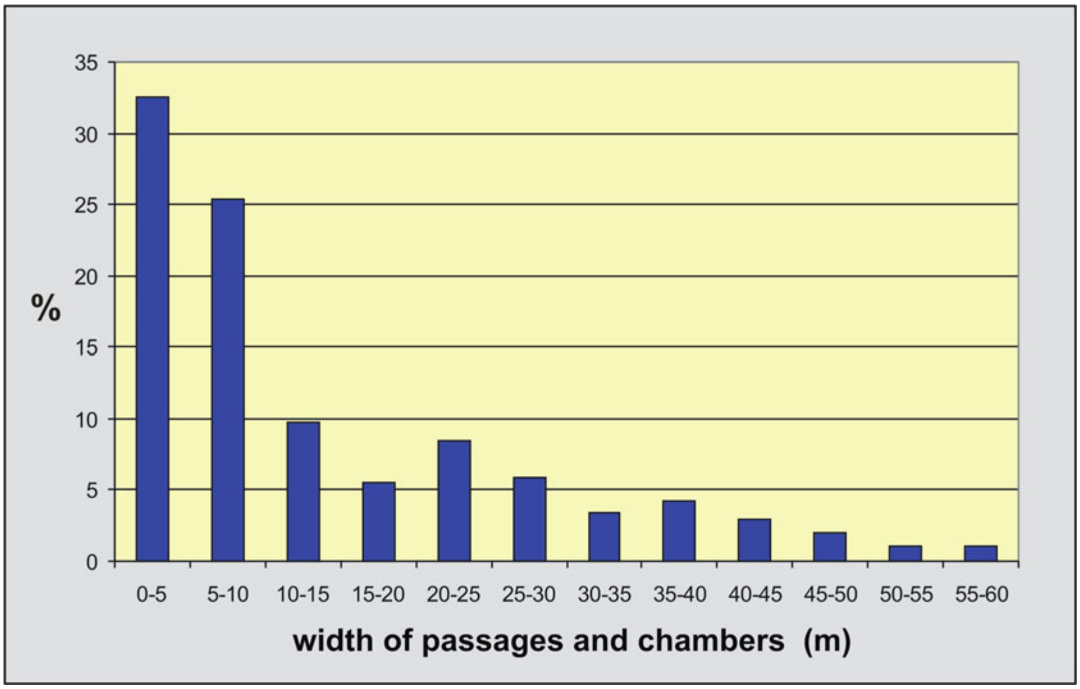


Fig. 11.9 Frequency distribution of cave passage widths from Cova Genovesa. It is worth noting that more than 27 % of the 237 measured cross-sections are wider than 20 m

(Fig. 11.10b) is the result of considering also as measurable voids the space occupied presumably by the great boulder chokes that constitute the floor of the collapse chambers, which are so significant regarding the whole pattern of the cave. The processing of such total cave-void space (real cave plus presumed void occupied by fallen blocks) shows a more smoothed frequency distribution, but the maximum remains clearly the same, at about 10 m below sea level, and indicating only two minor peaks at −2 and −18 m a.s.l. In this way, the statistical data obtained by means of both procedures suggest −10 m a.s.l. as the major horizon of speleogenesis in Cova Genovesa, as well as indicate the existence of a second horizon at −18 m a.s.l., in good agreement with the qualitative observations reported by Gràcia et al. (2003b). The subdued peaks in Fig. 11.10a and the −2 peak from Fig. 11.10b could be caused by the presence of more resistant bedding planes, which probably correspond to the top of the main domes that form some of the greater collapse chambers.

11.7.3 Selection of a Suitable Scale and Grid Size for Comparison Between Cave-Patterns

Whatever comparison between caves is strongly conditioned by the scale of the available surveys, which in turn is tightly dependent on the development and dimensions of the caves or cave-systems. This is particularly true for Cova Genovesa and Cova des Pas de Vallgornera, both located inside the Upper Miocene reef, where they form part of the eogenetic karst of southern Mallorca. In fact, as could be expected for the vast majority of caves developed in the Migjorn coastal karst, they share the same kind of great collapse chambers partially drowned by the current water table, a comparable richness in speleothem abundance and diversity, as well as the presence of several similar features produced by phreatic corrosion. But the difference in their total development is quite significant (2.4 km against 73 km, respectively), and this fact is reflected on the general pattern of both caves

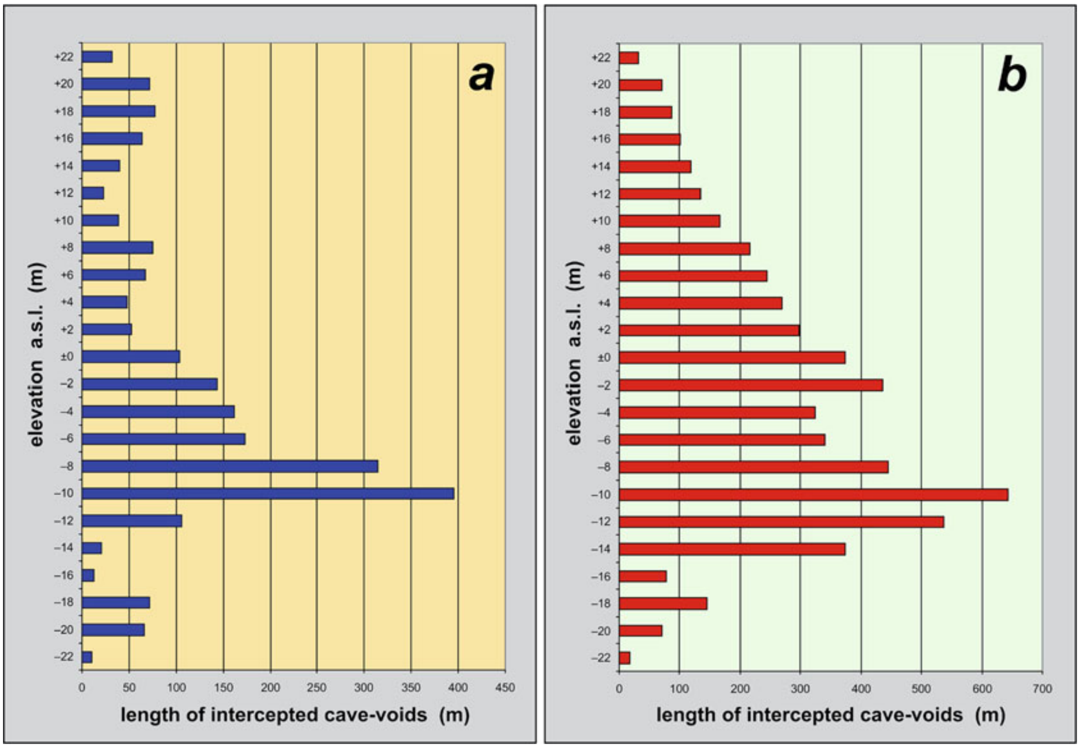


Fig. 11.10 Inference of the main speleogenetic levels in Cova Genovesa as deduced from passage elevation statistics: (**a**) total amount of real cave passages intercepted at elevation intervals of 2 m; (**b**) estimated amount of cave passages at elevation intervals of 2 m including the space occupied presumably by boulder chokes at the floor of the great collapse chambers. Note the outstanding maximum horizon of cave development placed at −10 m a.s.l

as shown by their corresponding plan view. For instance, the map of Cova Genovesa fits better with the ramiform and wandering pattern of Coves del Drac (2.3 km in length), rather than with the complex labyrinthine pattern shown in the complete plan view of Cova des Pas de Vallgornera (Fig. 11.11).

In the case of Cova des Pas de Vallgornera the scale factor illustrates the major reason for the complexity of its pattern, since the cave is huge enough to become conditioned by the different facies characterizing the architecture of the reef inside which the cavern is developed. Namely, whereas in the reef front, being plentiful of coral constructions, a ramiform pattern including collapse chambers and spongework mazes are dominant, in the back reef facies a parallel set of straight joint guided passages is the ruling trend and generates a rather elongated network (Ginés et al. 2009b, c). Conversely, the smaller Cova Genovesa is merely limited to the reef front facies, showing a much simpler ramiform pattern. When the caves to contrast are so different in size, a good option is to observe the maps through a grid and compare, and maybe even measure with the aid of specific descriptors, the enclosed features between significant squares, better than between the entire plan views. A suitable grid size, at least for the caves of the coastal karst of Mallorca, could be formed by squares measuring 200 × 200 m, which means a surface of 4 ha (40,000 m^2, or approximately 10 acres). An example of the fairly diverse perception of several parts of Cova des Pas de Vallgornera as being observed through such a grid is presented in Fig. 11.11, where at least three different cave-patterns related to lithological conditionings are easy to recognize.

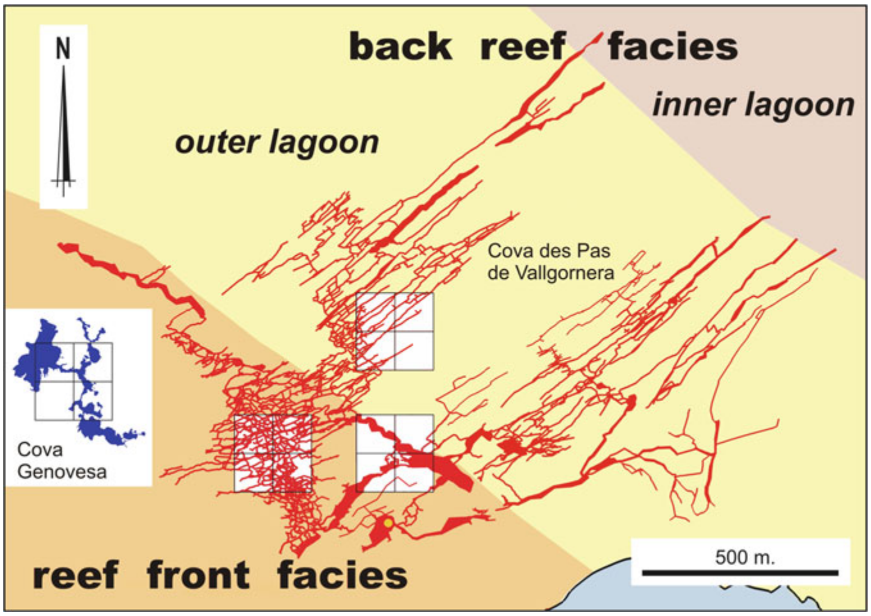


Fig. 11.11 Because cave patterns are strongly conditioned by the scale of observation, they can only be compared through a suitable sized grid. The different facies characterizing the architecture of the Upper Miocene reef of southern Mallorca are reflected in the diverse plan patterns observable in Cova des Pas de Vallgornera (Adapted from Ginés et al. 2009c), whereas the smaller Cova Genovesa (*left-side inset*) only shows the ramiform pattern related to the reef front facies

11.8 Conclusions

Accurate cave maps are essential for the analysis of cave patterns and suggest relevant information such as detailed surveys and complementary data should be included in these maps. This is particularly true in many coastal karst areas, like Yucatan (Mexico) (see Chap. 16), the Gambier Karst (southeastern South Australia) and southern Mallorca (Spain), where specific constraints (e.g. drowned extensions of many cave systems) restrict conventional cavers from access to the lower passages of many caves. The presence of sea-level pools, disrupting the connectivity between caves and hampering the perception of its real pattern, is a general rule in these caves.

Morphometrical approaches to cave patterns are obviously conditioned by speleogenetic hypothesis and at the same time the presence or absence of diagnostic features, as well as the eventual statistical data based on cave surveys, can introduce significant improvements in our perception of the real processes involved in coastal speleogenesis, as well as in computer modeling attempts (Labourdette et al. 2007, see also Chap. 4). For instance, simple statistical measurements on passage cross-sections show that large voids, produced mainly by breakdown collapse, must account for not less than 60 % of the wandering cave development surveyed in Cova Genovesa (Fig. 11.9). The assumption that breakdown is the responsible for the great amount of wide voids in the Majorcan coastal caves is supported by *in situ* observation of boulders occupying the floor of many passages and chambers, as depicted in the subaquatic maps from Gràcia et al. (2003a, 2006, 2010) and sustained furthermore by the conventional-caver knowledge available for the majority of caves in the region, namely about the celebrated Coves del Drac (Ginés 2000a; Ginés and Ginés 2007). The role of vault-collapse in the development of many coastal caves was also documented in Bermuda (Palmer et al. 1977), Yucatan (Beddows 2004) and southeastern South Australia (Grimes 2007).

Fig. 11.12 Tubular phreatic passages are well developed in the less permeable outer lagoon facies of the back reef along the Sector Subaquàtic de Gregal, at Cova des Pas de Vallgornera (Photo Antoni Cirer, Grup Nord de Mallorca)

Recently Mylroie and Mylroie (2007) considered the coastal caves of Bermuda as a particular case in the frame of the CIKM-model: the so-called carbonate-cover island. After our experience in the karst of southern Mallorca, we suggest that, both the composite island and the complex island categories of the CIKM-model could present usually significant breakdown processes along their caves and cave-systems.

The coastal karst caves of Balearic Islands would yield significant contributions to the validation of current successful models concerning development of karst and caves in island environments, namely the eogenetic karst model (Vacher and Mylroie 2002) and the CIKM-model (Mylroie and Mylroie 2007) respectively. Recent studies have demonstrated to what extent typical karst conduits (Fig. 11.12) can grow in eogenetic karsts, as a response to changes in permeability through the complex architecture of the Upper Miocene reef in southern Mallorca; this is the case of the straight passages of Cova des Pas de Vallgornera developed on the inside of the outer lagoon facies. On the other hand, not only southern Mallorca constitutes the higher degree of complexity in the frame of the CIKM-model, as a good example of the complex island category. The Upper Miocene reef in the Balearics is indeed characterized by a good example of simple carbonate island (the smaller island of Formentera) and another typical example of composite island, the karst of southern Menorca.

Our experience in the karst of southern Mallorca (the so called Migjorn region) demonstrates the importance of accurate and detailed cave mapping. Such standards can provide a major significance in the studies of coastal caves. For example, the cave surveys of Coves del Drac (Faura y Sans 1926), Cova Genovesa (Gràcia et al. 2003b) or Cova des Pas de Vallgornera (Gràcia et al. 2009; Merino et al. 2011) are much more than simple description-tools, but instead support inference of speleogenesis (Ginés and Ginés 2007; Ginés et al. 2008, 2009b). In this way, we are suggesting that detailed underwater surveys must to be encouraged, in spite of the incumbent difficulties, with the aim of improving our knowledge on coastal cave morphogenesis (Ginés et al. 2009a). Furthermore, we introduce an open discussion about what data standards could be more advisable regarding future comparisons between coastal cave maps from different coastal settings of the world.

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