1 Introduction

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The Pech de l'Azé Sites

The Middle Paleolithic site of Pech de l'Azé IV (Pech IV) is one of a cluster of four independent Lower and Middle Paleolithic sites located in the Perigord region of southwest France (Figs. 1.1, 1.2 and 1.3). They are situated about 50 m above the floor of a small, usually dry, valley formed by the Enéa, a small tributary of the Dordogne River. Pech I and II are opposite entrances of a single tunnel-like cave that cuts through a promontory in the limestone cliff. Pech III is a small cave in the same cliff located about 30 m west of the opening of Pech II. Pech IV, located roughly 80 m east of the mouth of Pech I, is a collapsed cave situated at the foot of the cliff.

The history of research at this complex of sites extends back to virtually the beginning of the discipline of Paleolithic archaeology. Pech I, or "Pey de l'Azé", as it was then spelled (this translates in English to 'Hill of the Donkey'), was initially excavated early in the nineteenth century by Jouannet and later by the Abbé Audierne (Bordes 1954), and was one of the sites described by Lartet and Christy (1864) in their seminal "Cavernes du Périgord". At some point during the nineteenth century most of the archaeological material inside the cave (identified as the Pech Ia locality; Bordes 1954) was removed by pothunters. However, in 1909, at the base of the cliff on the terrace just outside the cave, Peyrony discovered the cranium of a Neandertal child that had died around age five or six (Bordes 1954; Capitan and Peyrony 1909; Ferembach et al. 1970; Patte 1957; Maureille and Soressi 2000). In 1929–30 Vaufrey (1933) excavated in the terrace outside of the entrance to the cave (Pech Ib) and identified the sequence as containing only assemblages attributable to the Mousterian of Acheulian Tradition. Later, from 1948 until 1951, more excavations were carried out by Bordes (1954) in the same area. Most recently, Soressi excavated deposits in front of the site from 2004–5 (Soressi et al. 2002, 2007, 2008, 2013) (Fig. 1.4). These deposits were recently dated with optically-stimulated luminescence to roughly 51–48 ka (Jacobs et al. 2016).

Pech II was discovered by Bordes in 1948, thanks to the fact that some of the talus of the site had been cut away in the construction of a rail line that ran parallel to the cliff at this point. He excavated there from 1949 to 1951 and again from 1967 to 1969 (Fig. 1.5). Both outside the mouth of the cave (locality Pech IIb) and within the cave itself (Pech IIa), an occupational sequence began with the so-called Meridional Acheulian, followed by a variety of Mousterian industries (Bordes 1972). Schwarcz and Blackwell (1983) published two U-series dates from Pech II and two from Pech I, and Grün et al. (1991) published a series of ESR

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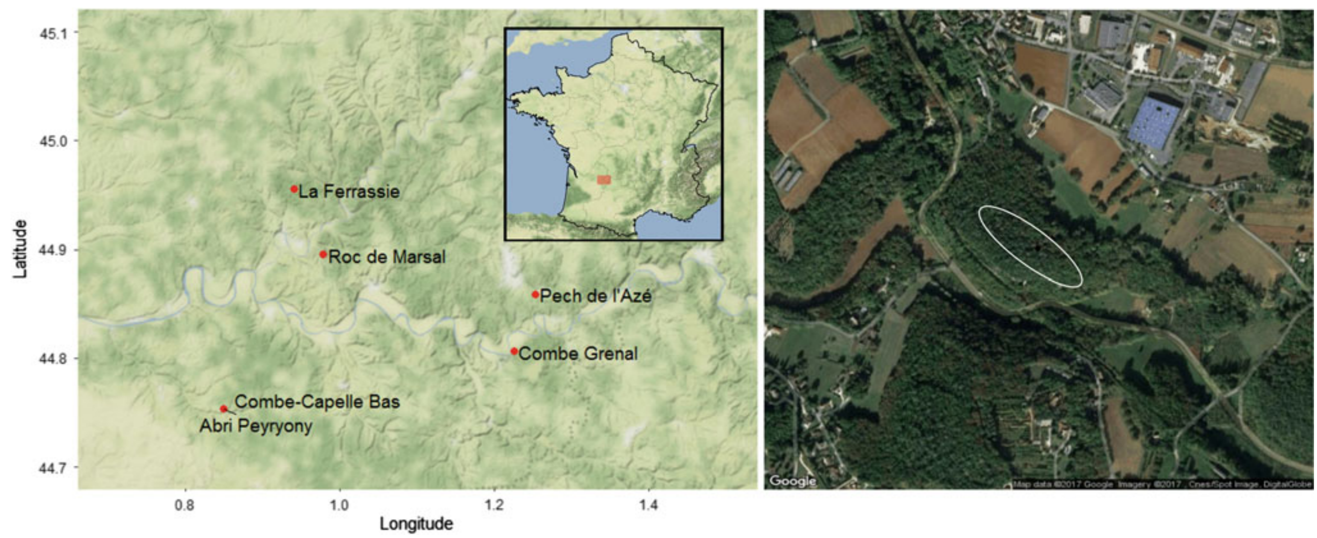
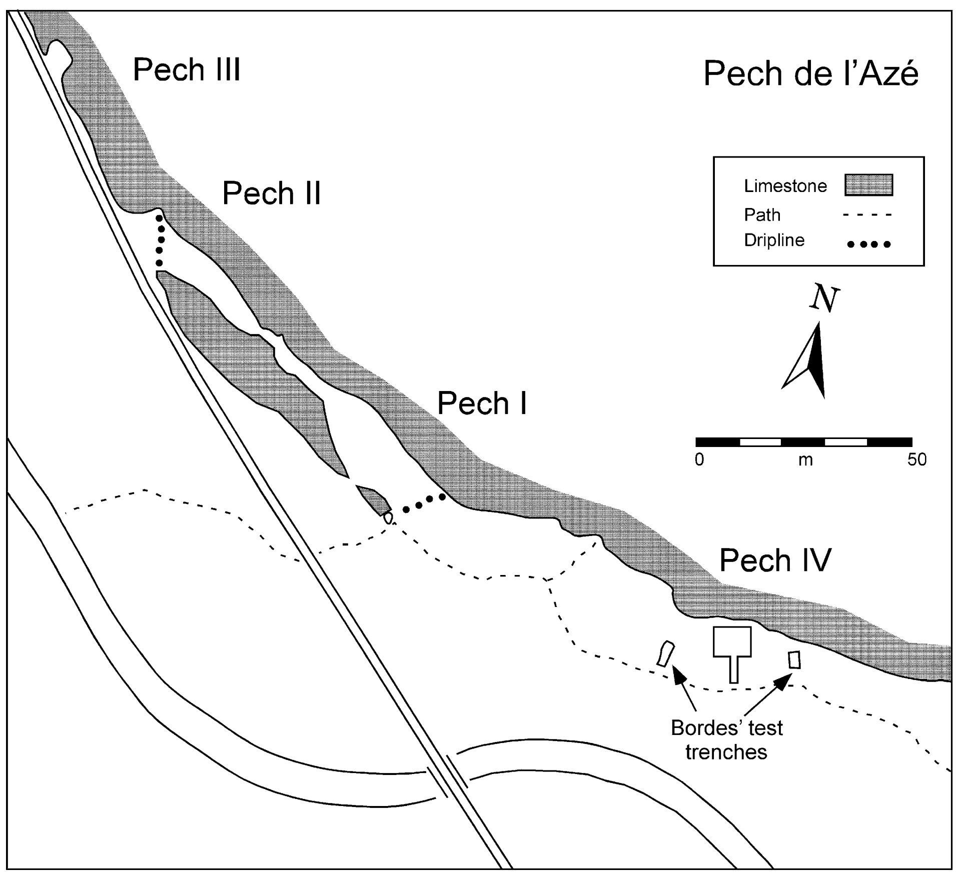


Fig. 1.1 The location of Pech IV in southwest France (*left*) and satellite view of the hill containing the Pech sites (approximate location noted with ellipse)

Fig. 1.2 The Pech de l'Azé sites



dates based on 29 teeth from Pech II. Both sets of dates give a consistent picture, though the ESR dates provide more detail (see also Grün and Stringer 1991). More recently, OSL dates (Jacobs et al. 2016; see Chap. 3) suggest ranges from 100 to 55 ka for the upper ensemble (layers 2G1 to 4D) and roughly 180–140 ka for the lower ensemble (layers 7–9).

Pech III, discovered in 1951, is a very small cave that contained a sequence thought to correspond to the earlier

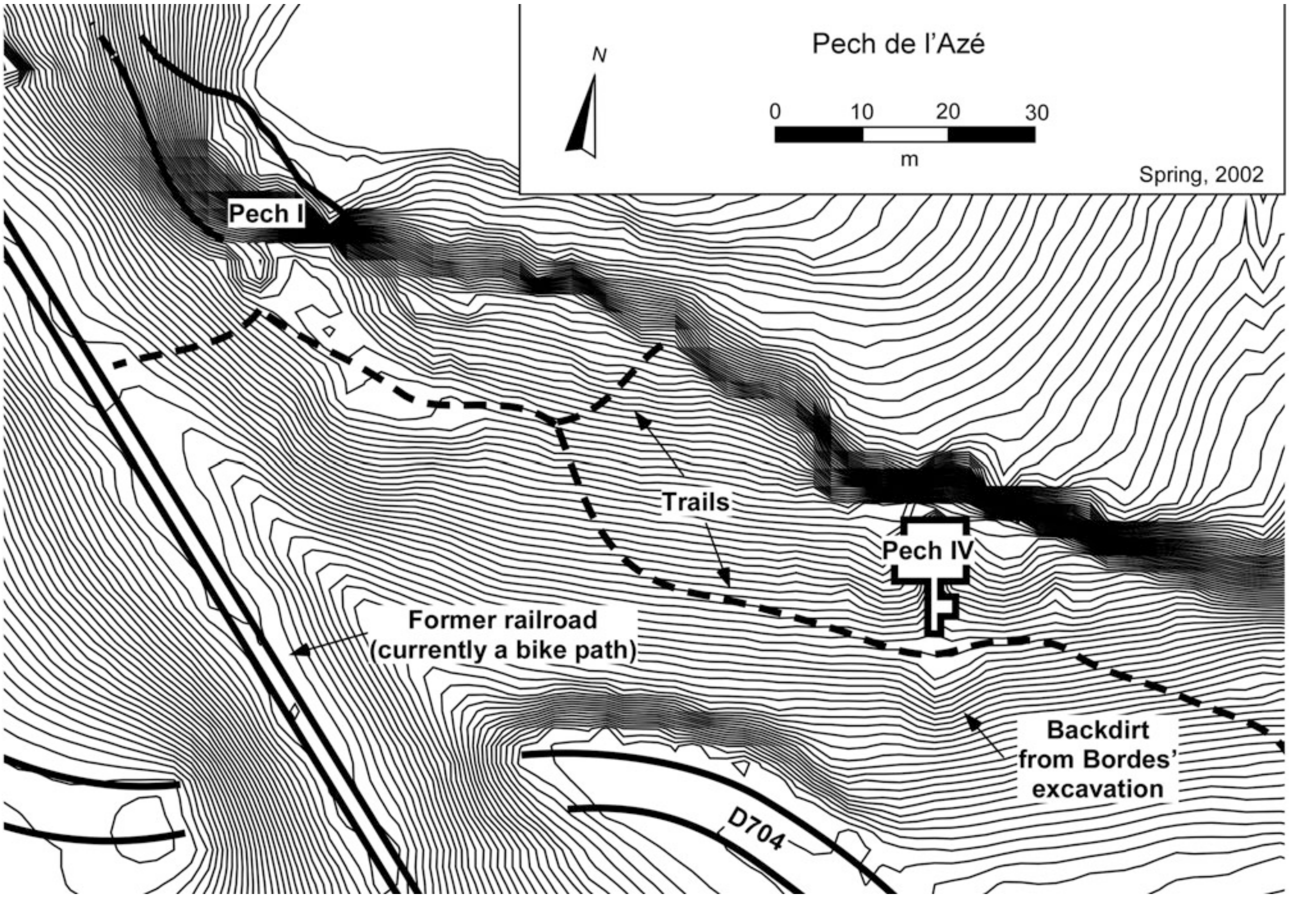


Fig. 1.3 Topographic map between Pech I and IV

part of the Pech II sequence (Bordes and Bourgon 1951) (Figs. 1.5 and 1.6). The cave is now completely empty.

Pech IV was discovered and tested by Bordes in the spring of 1952 (Bordes 1954). In the following 4 years, 1953–1956, Mortureux, a dentist from the nearby town of Sarlat, excavated a larger trench, 1 by 9 m, into the site. He was stopped, however, by large blocks of roof fall and the demands of his practice. Because of Bordes' continued excavations at Pech I and II, among other sites, it was not until 1970 that he again began excavating Pech IV. He spent eight field seasons there, through 1977, and opened 52 m^2 (Figs. 1.7 and 1.8). In the first year, Bordes expanded Mortureux's trench into the site making it approximately 2 m wide and 11 m long through the slope deposits in front of the limestone cliff. In the following years, he opened a rectangular grid of 7 by 6 m against the cliff. Most of these squares were excavated to bedrock. At its maximum, against the cliff face, this meant a depth of roughly 4.5 m below surface, though a block of squares on the western side of the grid (C12–I13 and G14–H14) was only partially excavated leaving a series of steps (Fig. 1.6). Altogether he excavated just under 115 m^3. It is interesting to note that in terms of the investment of his time and amount of material that he recovered, Pech IV represents one of the largest excavations undertaken by Bordes during his career, second only to his work at Combe Grenal (McPherron et al. 2012; see Fig. 1.7). It was, however, the last site he excavated in France.

Unfortunately, the archaeological material Bordes excavated was never fully published. A preliminary note describing the stratigraphy, lithic industries, and fauna was published by him in 1975, based on analysis of material recovered through the 1973 season, and some of his interpretations of the industries were included in a later paper (Bordes 1981). The Mousterian industries included several examples of the named "facies": Typical Mousterian, Mousterian of Acheulian Tradition, and a new variant Bordes called the Asinipodian. Apart from these brief publications by Bordes himself, a dissertation was written on the fauna (Laquay 1981), and an early attempt at TL dating was made (Bowman et al. 1982). No other studies were made of these collections until the late 1990s when we started our project.

Fig. 1.4 The site of Pech I. The area excavated most recently by Soressi is in the *lower left*

Fig. 1.5 *Left* View of Pech II facing northwest. *Right* Entrance to Pech III

Fig. 1.6 Former railroad bed that cuts in front of the Pech sites. Dibble (shown here surveying) is standing roughly opposite Pech I. Pech II is further along this roadbed, followed by Pech III

Bordes' Excavations at Pech IV

There is relatively little documentation of Bordes' excavation methods at Pech IV. However, one of us (HLD) excavated there with Bordes in 1976 and 1977, and it is also possible to gain some insights into his methods through analysis of his field notebooks and of the archaeological materials themselves. There is no doubt that Bordes, during the course of his excavations at many sites, helped to usher in a new era of archaeological methods, including three-dimensional point proveniencing of most of the recovered objects and assigning unique numbers to them (see McPherron et al. 2005, 2012), along with careful attention paid to the geologic context of the finds. However, in other respects, his methods were lacking.

Bordes set up a 1 m grid system for the site, with east–west rows designated by letters and the north–south rows designated by numbers, much like a modern spreadsheet. Thus, each square meter, defined as the intersection of the two rows, was named by the combination of the letter and number, e.g., G12 or D18. Artifacts recovered from each square were given unique identifiers formed by the combination of the square name (or excavation Unit) and a sequential ID number, with the ID numbers going from 1 (the first object recovered from the square) to the last object recovered. So, the fifth artifact recovered from square G12 would be given the identifier G12–5, and so on through subsequent seasons until excavation in that unit stopped.

Typically, each meter square was excavated as a separate unit, in part to facilitate the recording of the *X* (east–west) and *Y* (north–south) coordinates of the objects. As each object was exposed, the *X* coordinate was measured from the western edge of the square to the middle of the object and the *Y* coordinate from southern edge. However, because the exposed walls at the periphery of each square were not often maintained to be truly vertical (due simply to human error typical of excavations carried out prior to the use of total stations), the actual surface area of a square varied as excavation descended. This of course introduced error in both the *X* and *Y* measurements, as illustrated in Fig. 1.9.

Although not as systematic, there were also problems with the measurement of the depth of objects or the

Fig. 1.7 Looking grid west on Bordes' excavations in 1976. This portion of the site was not excavated completely to bedrock

Z coordinate. Bordes utilized a technique of positioning two horizontal strings at a known depth below datum, and to measure the depth of a particular object, the excavator would place a meter stick vertically on the object, line-up the strings visually (to solve the problem of parallax), and record the depth as read from the meter stick at the point where the two strings line-up. The actual *Z* coordinate would then be the sum of the vertical distance from the object to the strings and the vertical distance of the strings from the site datum. Although, in theory, this is an accurate system for recording Z, in practice the reliability of the measurement suffered from a number of problems, including not holding the meter stick vertically and the tendency for sagging in the strings due to fluctuations in humidity. As discussed in McPherron et al. (2005), the effects of all these problems resulted in the blurring of discrete zones of differing artifact densities that were much clearer when objects were provenienced with more reliable and precise methods (Fig. 1.10).

Although Bordes spent most of the excavation season on-site along with his student participants, he spent little effort in explaining various excavation protocols. At the beginning of each season, students were briefly instructed on how to measure the coordinates of the objects and to record certain observations in the field notebooks: the artifact ID number, its *X*, *Y*, and *Z* coordinates, the layer in which the object was found (occasionally these were later changed by Bordes himself based on the altitude of the object), a descriptive term for the object (scraper, bone, tooth, etc.), and a comment about the nature of the sediment (using the student's own system of description). Some excavators made hand-drawn maps as they worked, though many did not. He instructed students to record (i.e., provenience and number) most lithics (though without any particular attention to size cutoffs or other technological or typological criteria) and to provenience only "identifiable" pieces of bone (such as articular ends or teeth). Objects that were not provenienced or numbered were put in bags, which were in turn labeled by square, level, and the beginning and ending depths of the excavated volume of sediment. Thus, the decision of which objects were recorded, which ones were put into a bag labeled

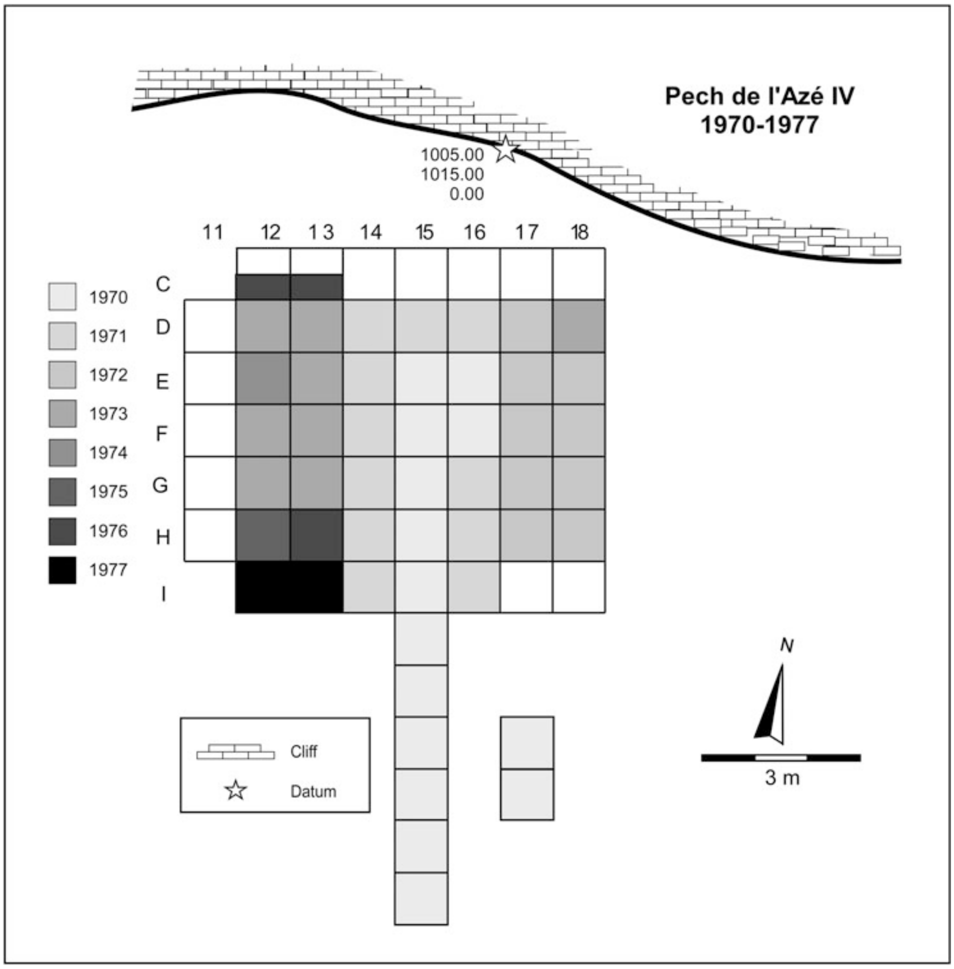


Fig. 1.8 Bordes' excavation year by year

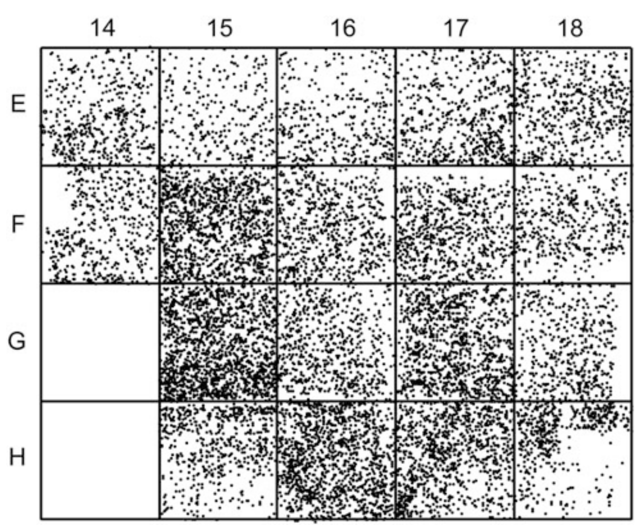


Fig. 1.9 Plan view showing provenienced artifacts from Bordes' Layers X, Y, and Z in the central part of the excavation. Each grid cell is 1 m^2. Grid north is at the *top*. Gaps between squares are due to errors introduced by measuring from the edges of the unevenly excavated squares, while varying densities in adjacent squares reflect inter-excavator variation in deciding which objects to provenience

only by layer and depth, and which ones to be discarded was left primarily to the individual excavators, who, of course, had varying levels of background and training. Buckets that contained the excavated sediment and objects to be discarded were simply tossed downslope without screening. During the course of the new excavations we sampled Bordes' back dirt and analyzed the resulting lithics and fauna in a study designed to evaluate the nature of excavator bias during his excavation (Dibble et al. 2005).

A lack of clear standards on what to record led to a great deal of inter-personal variation. Some enthusiastic excavators had a tendency to record and number lithic objects quite literally as small as 2 mm in maximum size, whereas most others would either put such pieces in the small finds bags or simply discard them. Although most retouched pieces were provenienced, unretouched flakes were much more likely to be either retained in the bags or discarded. Few section drawings were made, and those that were are inconsistent in terms of terminology and description. Fortunately, as described below, it was possible to correct many of these deficiencies during our first phase of work with his collection.

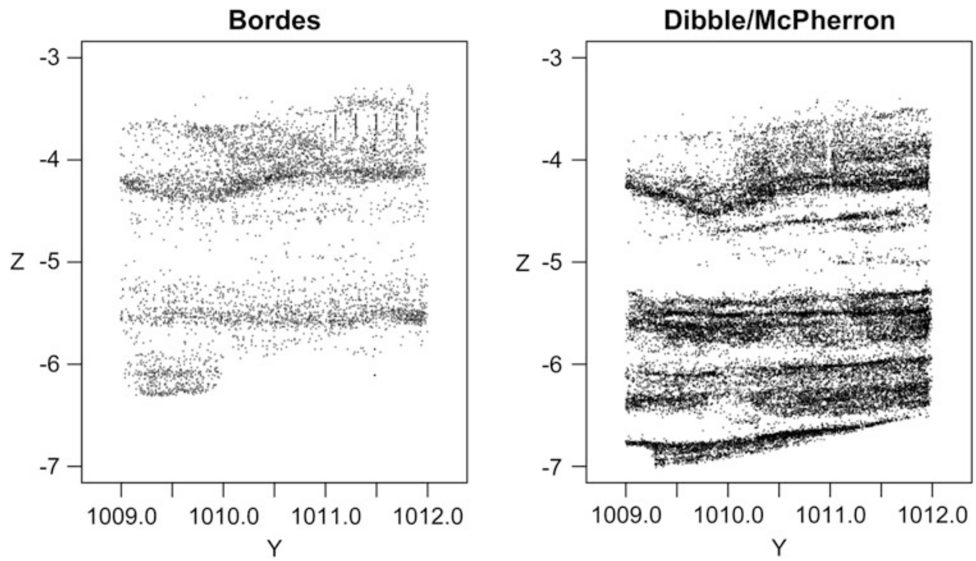


Fig. 1.10 Comparison between Bordes' hand recording of artifact proveniences and those done with a total station. Note especially how the latter clarifies horizons of different artifact densities. Both projections represent artifact distributions through 1 m

The Pech IV Sequence Based on the 1970–1977 Excavations

For the most part, Bordes' stratigraphic units (Fig. 1.11) were based on sedimentological variation, although in some cases he would also subdivide them either arbitrarily by depth or on the basis of changes in the composition of the assemblages. In his two preliminary reports on the Pech IV excavations (Bordes 1975, 1981), he provided the following descriptions of his stratigraphic succession and the Middle Paleolithic industries associated with each layer. In Chap. 2 we will discuss in greater detail the geological sequence as interpreted on the basis of the 2000–2003 excavations (as well as the correlation between his sequence and ours).

At the base of the sequence, resting on bedrock, Bordes distinguished three layers named, respectively, from bottom to top, Z, Y, and X, which consisted of multiple lenses that were sometimes difficult to distinguish from one another. They contained abundant traces of burning and apparently discrete fire features; in Layer Z, the burning appeared directly on the bedrock. Bordes considered the industries of these layers to be examples of Typical Mousterian.

Overlying Layers X, Y, and Z and separated from it by a layer of roof fall, Layer J was subdivided into several layers (from bottom to top J3–J1). All of the J layers were described as fairly pliable sand with rare *éboulis* (pieces of limestone from the cave roof or walls), a rich lithic industry, abundant fauna, and macroscopic evidence of fire. In terms of color, J3 was black toward its base, then grayer, and finally redder at the top.

At the bottom of the J layer, Layers J3C–J3A were thought by Bordes to represent an entirely new facies of Mousterian, what he termed the "Asinipodian." Indeed, there were many features of these assemblages that stand out. In particular, they contained a high number of truncated-faceted pieces (though Bordes did not recognize this type—see Debénath and Dibble 1994), Kombewa flakes and cores, and very small Levallois flakes and cores. Although the overall average size of Asinipodian tools and flakes was more or less similar to what was seen throughout the Pech IV sequence, the small size of some of the Levallois flakes led Bordes (1975: 298) initially to consider the term "Micro-mousterian" to describe this industry; he later coined the eponymous term Asinipodian (a rough Latin translation of Pech de l'Azé) to emphasize that Pech IV was the first site where it was recognized. Later studies have shown that these types co-occur in relatively high frequencies at a number of Paleolithic sites throughout western Eurasia (Dibble and McPherron 2006, 2007).

Layer J2, immediately above the J3 layers, was described by Bordes as having been affected by cryoturbation, with rounded limestone blocks (*éboulis*) and damaged flints in a sandy matrix. The effects of cryoturbation seemed to be more pronounced in the front of the site than in the rear. Above it, Layer J1 consisted of light red-brown sands with large blocks of limestone representing another partial collapse of the shelter. Both of these levels contained Mousterian artifacts.

Within Layer I, the stratigraphic distinction between Layers I1 and I2 is not well-marked. Layer I2 is characterized by numerous small limestone blocks, while I1 has fewer limestone blocks and fewer stone tools. Both layers are at times highly concreted. In Bordes' own words (1975: 298), the assemblages from I1 and I2 are "esthétiquement parlant, la plus belle [industrie] du site," and presented a very different kind of industry from the underlying Asinipodian. Here scrapers were the dominant tool, Levallois production was moderate, and the flakes and tools had the largest dimensions of any in the Pech IV sequence. Among the scrapers, there was a higher frequency of the more reduced

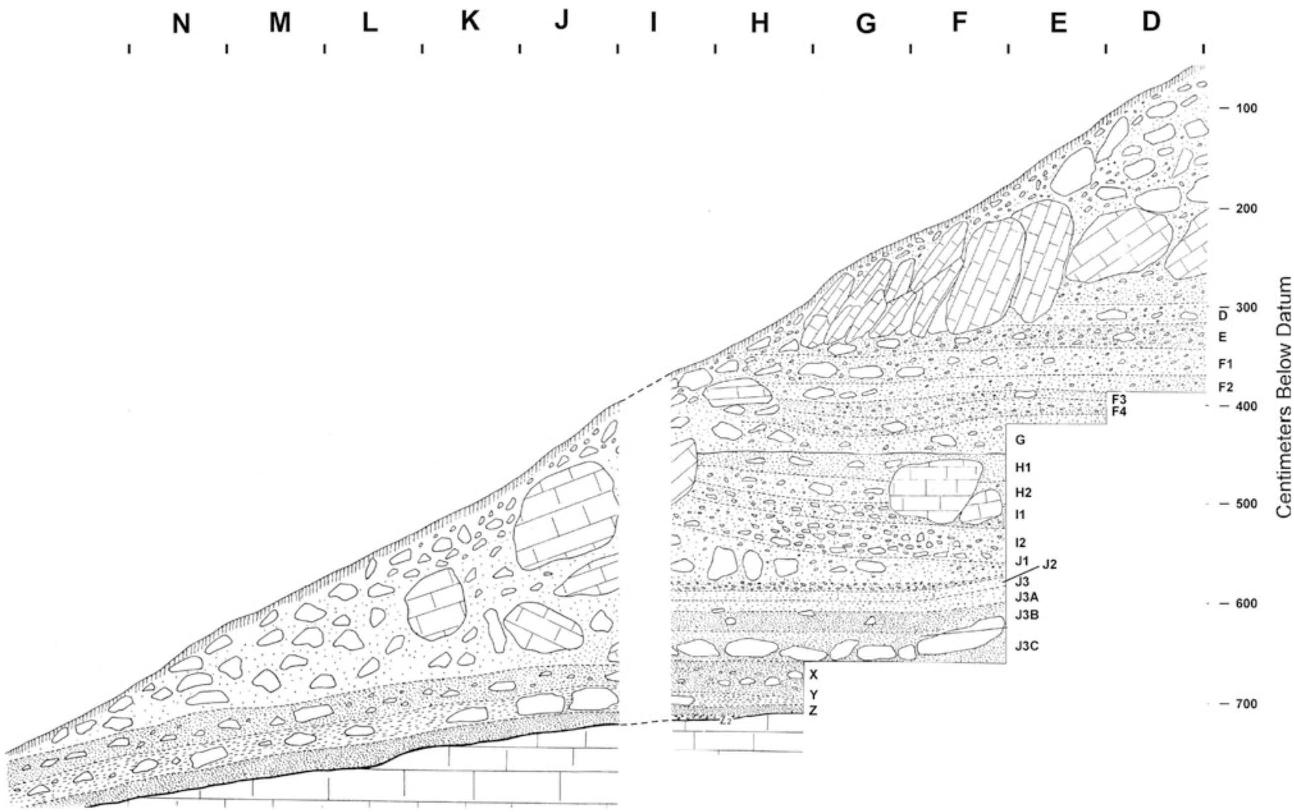


Fig. 1.11 West profile of Pech IV, probably along the 14–15 square boundary (taken from Bordes' notes)

convergent and transverse types than in other assemblages of the site. Although the hiatus between the upper J layers and Layer I suggests some length of time between the deposition of these two units, the fact remains that it represents an extreme shift in tool production relative to flake production and in terms of artifact dimension.

Levels H1 and H2, described as sandy with scattered limestone blocks, contained very few lithics, though Bordes classified them as Typical Mousterian. Likewise, Layer G was nearly sterile. Bordes felt that some of the tools identified from this layer more likely represent pockets of material derived from Level F4 above, though our own analysis of the full assemblage suggests closer affinities, both typologically and technologically, to the underlying Layer I, and our new excavations suggest a shift at the top of Layer H toward a more Quina-type technology.

Layer F, again more or less arbitrarily subdivided by Bordes into four layers so that change through time in this thick deposit could be more easily detected (see McPherron et al. 2005), is the last substantial Mousterian deposit at Pech IV, though the assemblages, particularly Layer F4, were the richest at the site. All of the F layers were assigned to the Mousterian of Acheulian Tradition (MTA) industry with Bordes noting a shift from Type A MTA at the base to Type B MTA at the top of the sequence.

Overview of the New Pech IV Project

The new research at Pech IV consisted of two distinct stages. The first, which took place between 1996 and 1999, is focused on the existing data and collections recovered by Bordes during his excavation. The second stage, from 2000 through 2003, was a renewed excavation at the site (McPherron and Dibble 2000; Dibble and McPherron 2007).

Bordes' Collections

Bordes' collections, which consisted of the numbered objects (lithics and fauna) and several hundred bags of small finds, were initially stored at the Institut de Préhistoire et de Géologie du Quaternaire (IPGQ), Université de Bordeaux I, in Talence, France. In 2007 the material was transferred to the Musée National de Préhistoire (MNP) in Les Eyzies, France, where it is currently curated. Before this transfer, the collections and associated documents were in various states of curation. First, a portion of the lithic collection (approximately one-half) was washed, labeled (with the site name ["PA IV"], square, and sequential ID number) and organized by Bordes into layers and typological classes. For the material that had not been studied by Bordes (primarily the material excavated between 1973 and 1977), a portion was washed and labeled but was left unsorted either by layer or category.

There was also a significant portion of both the lithic and faunal collections, primarily from the last 2 years of excavations, that was not washed. The principal issue we encountered with this material was the deterioration of the artifact labels. At the time of excavation, each artifact was wrapped in foil and the ID number for the piece was written in pencil on masking tape that was then wrapped around the foil. This system was never intended to be permanent, and with the passage of time the tape sometimes lost its adhesive properties and became separated from the artifact. This had already happened with a small number of pieces (fewer than 50).

The small finds, lithics and fauna together, were stored in plastic bags labeled by square (or portion of square) and a depth range. For the most part, these bags and their contents had never been inventoried. By cross-checking the depth with the notebook data we were able to associate these finds with the numbered artifacts and thereby assign the proper stratigraphic unit to them. All of these materials were washed, put into new bags with permanent labels, and analyzed.

All of the basic provenience data, drawings and notes recorded during Bordes' excavation were retained at the Musée d'Aquitaine, Bordeaux, by D. de Sonneville-Bordes. Altogether, there are some 2500 pages of field notes and various plan and sections views. Over a period of 4 years the raw data contained in the field notebooks were entered into a computer database. These data consist of square, id number, *X* (relative to west edge of square), *Y* (relative to south edge of square), and *Z* (relative to the daily reference datum) coordinates, a code indicating type of artifact (retouched tool, flake, core, tooth, etc.), sediment description as recorded by the excavator, layer assignment, excavator name, and date of excavation. We modified the coordinate data to create a global grid system for the site as a whole relative to the original site datum (which we eventually located on the cliff above the site). In addition, each notebook page was scanned and saved in a high-resolution format, as a means both to archive the notebook information and to facilitate editing of the entered notebook data.

Altogether, approximately 92,000 lithic artifacts from Bordes' excavations were inventoried and analyzed. For complete flakes, tools, and cores a full set of descriptive and analytical observations were made, building on the system described in Dibble and Lenoir (1995; see also; Debénath and Dibble 1994; Chase et al. 2009). These include detailed observations of technology, typology, morphology, and raw material. For broken lithic artifacts, a more restricted set of observations was made depending on the nature of the object. The goal of this analysis was to provide a thorough typological and technological description of the industries.

The entry of both the notebook data and the analytical data for the lithic artifacts resulted in the creation of a large database, and a large part of our efforts focused on the organization and maintenance of it. Some of the problems we faced were those inherent in any large database, but many were also due to the fact that this collection had not been systematically processed and adequately curated. Some problems were simply the result of the fact that the material was excavated and processed before computers were in common use.

One issue that became apparent during our analysis is that there is a relatively high number of duplicate ID numbers in the Pech IV collection. This is a problem that is much more serious in archaeological work than is commonly realized and, in fact, it becomes apparent only with computerized inventorying of the entire collection (which allows for quick and accurate verification of identification numbers). Artifact labeling is often considered a trivial aspect of archaeological fieldwork, but it is fundamentally important since the only way to link a particular object with other data (such as its original provenience) is through the identifying number written on the object itself. In our system, which we developed during the course of work at several sites (Dibble and McPherron 1988; Dibble and Lenoir 1995; Chase et al. 2009; Dibble et al. 2006), each time an artifact is picked up and analyzed; its identifying number is the first thing entered in the computer. The computer then checks to see that (a) the number is a valid number in our system and (b) that it has not already been analyzed. In making these checks during the course of analysis of the Pech IV material, it became clear that there were a number of errors related to artifact labeling, and unfortunately we had no way to correct this problem after the fact (i.e., work out which artifact was correctly labeled and which had a duplicate label). Since duplicate ID numbers make it impossible to relate external data to a specific artifact, these cases were set aside (though not permanently deleted) in the main database.

As noted above, another problem in the Pech IV collections is the tremendous amount of inter-excavator variability in the minimum sizes of numbered and provenienced artifacts. The issue is not that small artifacts are not important, but for comparative studies it is essential to be consistent in terms of how different materials are collected and analyzed. Inter-excavator variability in terms of minimum size cutoffs can grossly affect a number of measures, including artifact densities, basic counts, artifact size calculations, and artifact class ratios. For this reason, we coded all lithic artifacts less than 2.5 cm in maximum dimension as such and, again, set them aside (though not permanently deleted) in the main database. This not only helps to minimize intra-excavator variability at Pech IV itself, but it also makes the remaining data sample more comparable to other sites we have excavated with the same controls.

Finally, we had to determine or verify the layer from which each of the artifacts came. There were three sources of information regarding the proper layer assignments of the excavated artifacts: Bordes' own assignments (whereby artifacts were stored together and the layer indicated on their container), notebook entries by the individual excavators (including Bordes) indicating the layer, and the artifacts' position in three-dimensional space. Only about one-half of the existing collection had been assigned by Bordes into layers, and there were clear problems even with these. Some such problems were relatively easy to spot and correct, thanks to our ability to plot the points on the computer, and by doing this (Fig. 1.12) we determined that at least two drawers of material had incorrect layer labels. Thus, it became clear that the storage of the existing collection by layer had serious errors and that any prior use of the collection without verification with the notebook data would lead to significant problems of interpretation. However, by utilizing all of these sources of information, the overwhelming bulk of the material has been assigned to their proper stratigraphic provenience. As discussed in Dibble et al. (2009), a similar problem exists with Bordes' collection from his excavation at Combe Grenal, though in this case, because only half of the objects were individually labeled, it is impossible to verify the original provenience for the entire collection.

During the analysis of the lithic materials from Bordes' collection, approximately ten percent of the objects were digitally photographed.

The New Excavation

Following an initial topographic mapping of the site in 1998 (see Fig. 1.3), the renewed excavations at Pech IV began in 2000, co-directed by Dibble and McPherron. The excavation itself continued through 2003.

Deciding where to dig involved choosing among the three main, intact sections left by Bordes (see Fig. 1.8). Any further excavation along the north wall would have quickly removed sediment immediately adjacent to the cliff face, which in turn would have effectively destroyed the connection between the east and west stratigraphic profiles. Compared to the east wall, the deposits on the west side of the site were thicker, contained more abundant artifacts, had far fewer large rocks, and appeared to be closer to the center of the site. Furthermore, the west section was closer to the stratigraphic section that Bordes illustrated in his description of the site stratigraphy (see Fig. 1.11), making it easier for us to understand his interpretation of each layer as work proceeded. Therefore, we decided to excavate to bedrock the entire western wall, squares D11, E11, F11, G11, and H11, as well as adjacent squares (D12, D13, E12, E13, F12, and F13, as well as a thin edge of the 14 column through rows D to F) that he had partially excavated. The area thus excavated is shown in Fig. 1.13. Most of our squares were excavated to bedrock, with two exceptions: (1) the row of squares H11–H14 and the southern half of G11–G14, both of which stop within a layer of thick limestone blocks, and (2) the northern half of G11–G14, which is an untouched bench of sediment

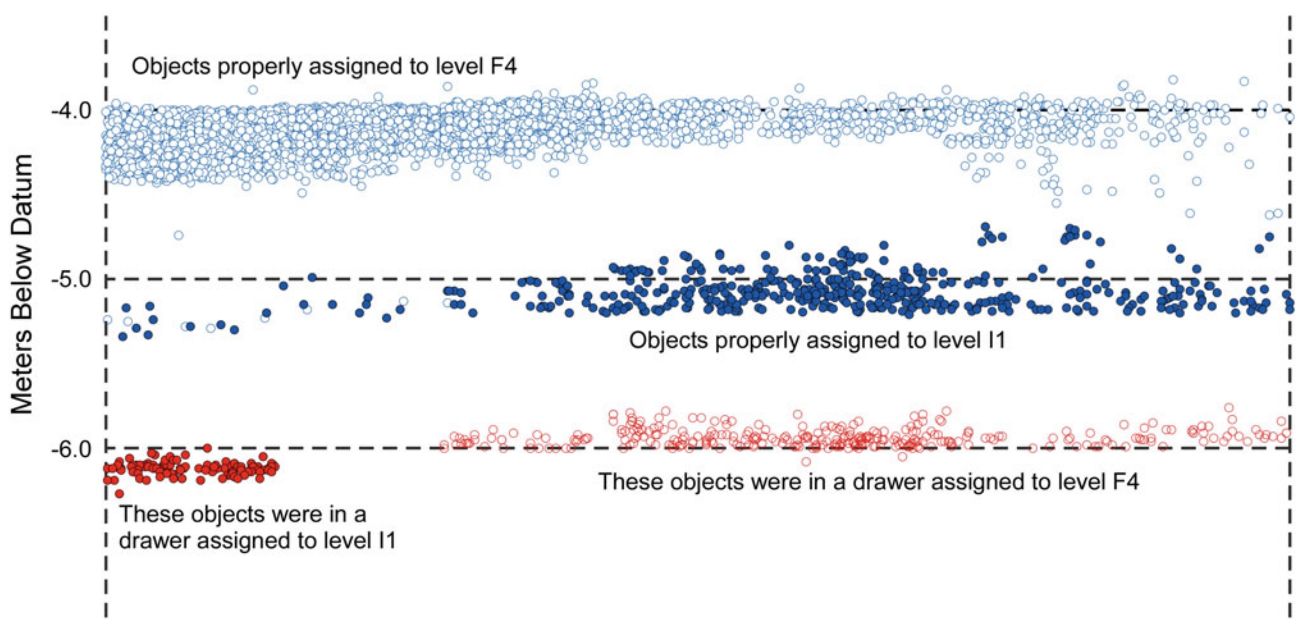


Fig. 1.12 A profile view demonstrating some of the curation problems in Bordes' Pech IV collection. The coordinates used to draw the profile come from the square notebooks. The layer designations come from labels on the drawers containing the stone tools. In several instances, labels had apparently been inadvertently switched

from our Layer 8. Layer 8 proved very difficult to excavate because of its many combustion features, and so the decision was made to reserve a small portion of it for a future time when better methods could be developed and used. Altogether, based on the number of 7-L buckets of sediment collected, we removed just over 15 m^3 of deposit during the new excavations, which yielded approximately 19,500 provenienced lithics, around 23,000 faunal remains, and one hominin tooth (see Table 1.1).

At some point in the 1980s, following Bordes' death, the exposed Pech IV sections were protected with cement blocks and/or poured concrete (Fig. 1.14). Although it initially appeared to be a thin covering of concrete that could be removed fairly quickly, it turned out to be so difficult that only parts of the west and north walls could be removed in the first season (Figs. 1.13, 1.14 and 1.15). The rest of the walls were removed over the next two seasons. Because removal of the walls left the site exposed, a fence was erected around the site. Ultimately, a more permanent structure was erected to protect the site.

Fortunately, we were able to find Bordes' original site datum in the cliff overlooking the site. This datum enabled us to continue with the same grid he defined for his excavations. Bordes gave this datum a *Z* of 0, which means that all of the *Z* coordinates in the excavation are negative values. In order to avoid any negative numbers in the *X* (east–west) and *Y* (north–south) axes during our excavation, the *X* and *Y* coordinates for the datum were arbitrarily given large values. Because Bordes used a tape measure to layout his site grid, some error in defining square boundaries was inevitable and with this method errors accumulate in the placement of individual unit boundaries. Because of this, and perhaps also due to some post-excavation erosion, there is a 10–15 cm gap between the eastern most extent of the new excavations compared with the western most extension of Bordes' (Fig. 1.16).

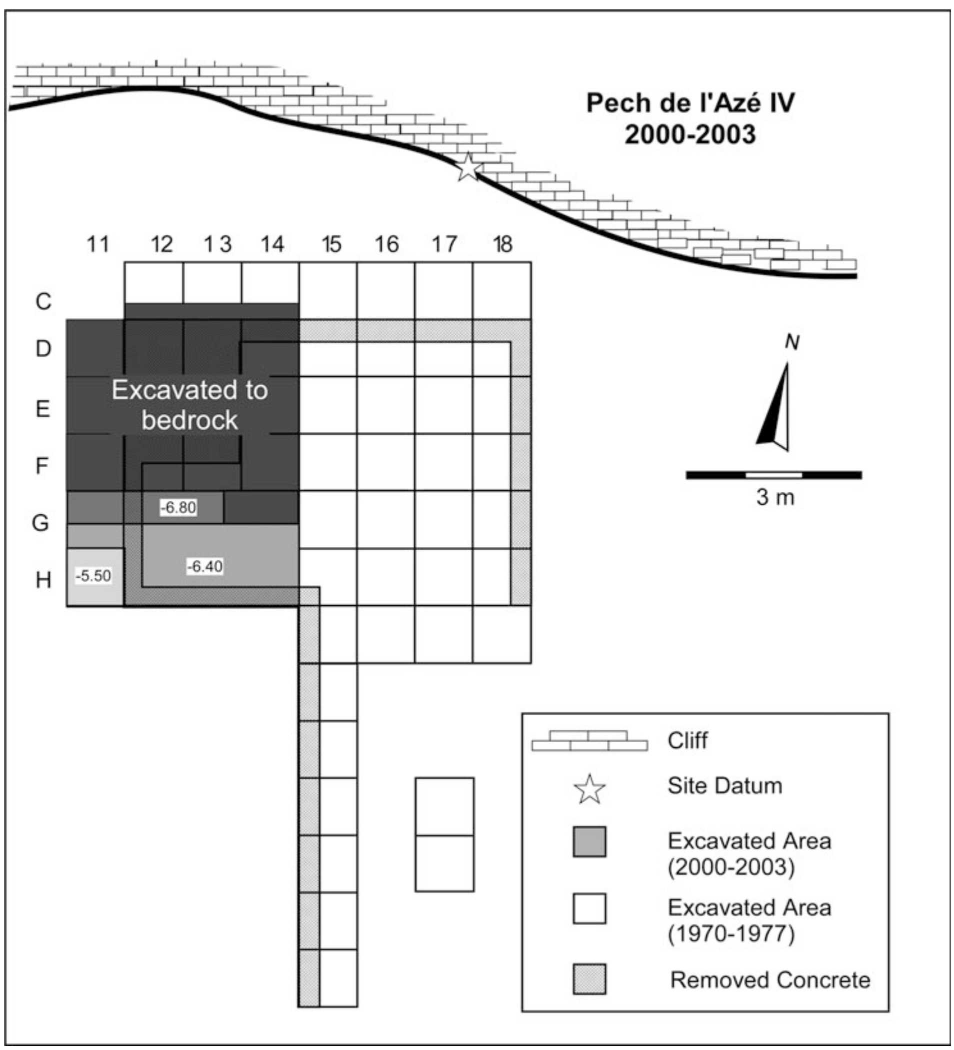


Fig. 1.13 The extent and depth of the new excavations

Table 1.1 Counts of provenienced faunal and lithic remains, and volume excavated, from each layer

Layer	Fauna	Lithics	m^3
3A	746	1638	1.15
3B	956	2938	0.79
4A	1078	275	2.44
4B	412	49	0.74
4C	3827	652	0.74
5A	2640	1453	0.71
5B	1034	715	1.44
6A	4895	2500	2.16
6B	5346	2532	2.53
7	341	4214	0.79
8	1736	2597	1.86
Total	23,011	19,563	15.34

Fig. 1.14 (*left*) Pech IV looking west prior to the demolition of the cement wall and (*right*) after partial removal of the wall. For reference, the flat bench on the *left* is the same as the flat bench still partially intact on the *right*

Methods Used During the 2000–2003 Excavations

The excavation methodology and techniques employed at Pech IV were based on those developed in the course of work on several other French Paleolithic sites including La Quina, Combe-Capelle Bas, Cagny l'Epinette, and Fontéchevade (Dibble and Lenoir 1995; Chase et al. 2009) and subsequently employed in the course of work at the French Paleolithic sites of Roc de Marsal, and La Ferrassie (Dibble et al. 2006, 2008, 2012; Goldberg et al. 2012; Turq et al. 2008). The backbone of this methodology is the use of a total station connected to a small, hand-held computer (Dibble 1987; Dibble and McPherron 1988). The computer ran self-authored software designed to allow for rapid and accurate proveniencing of excavated items and greatly reduced error in the three-dimensional proveniences. Data collected from the field were then transferred to a central database.

Our methodology was based on a number of goals. First, it was designed to maximize the accuracy and reliability of the recording of the positions of objects and samples. The use of a total station itself had a precision of 1 mm, and the correct positioning of the instrument was verified continuously. Excavators were trained extensively on how to position the prism on the objects or samples being collected,

Fig. 1.15 View of Pech IV at the end of excavation in 2003. The *black*, rectangular bench is Layer 8

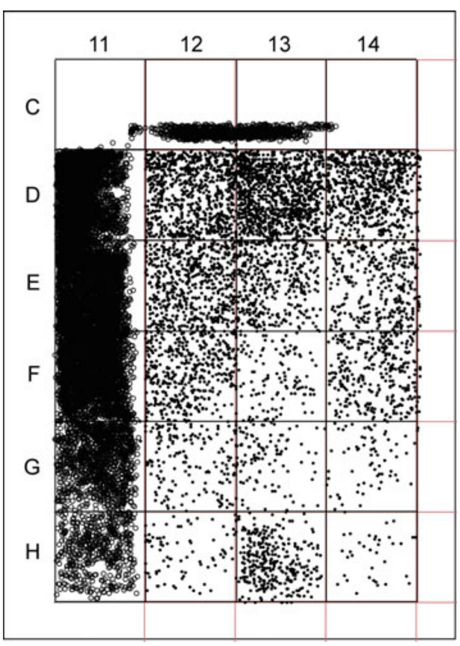


Fig. 1.16 Lateral contact between Bordes' excavations (levels G, H, I1, and I2 in columns 12–14) and our excavations (Layers 4a–c, 5a in column 11)

which helped to minimize reliability issues. The second goal was to increase the efficiency of the recording process. By having the total station connected directly to a field computer, data were transferred quickly and without the error that can happen with hand entry of data. The same was true for entry of analytical data (see McPherron and Dibble 2002). The third goal was to maintain strict standards or protocols on what kinds and what size objects to be point-provenienced, and when objects should be placed in the buckets of sediment for later recovery after wet screening. This greatly reduced the degree of inter-excavator variability.

During excavation, all lithic artifacts and faunal remains equal to or greater than 2.5 cm in maximum dimension were point-provenienced. What this means is that such objects were given a unique identification number (following the same system of Square-ID as used by Bordes, or what is termed now Unit-ID) and their three-dimensional coordinates were recorded by the total station (in squares that were originally excavated by Bordes, our ID numbers picked up where his left off). Other relevant variables were also recorded at this time, including the layer in which the object was found, the name of the excavator, the date, and a general code indicating the kind of object (lithic, bone, mineral, etc.). Other objects, such as minerals (e.g., pieces of manganese oxide) and teeth (though not microfauna), were provenienced regardless of size. Objects smaller than the minimum cutoff were bulk provenienced with the sediments and recovered during the wet screening at the lab.

Most provenienced objects were recorded with a single *X*, *Y*, and *Z* coordinate at the center, base of the object (i.e., the surface the object rests on). There are, however, some important exceptions. For elongated objects that showed a clear orientation, two points were recorded, i.e., one at each of its ends (McPherron et al. 2005). These two points provide both the horizontal (bearing) and vertical orientation (plunge) of the object, which, as described in Chap. 2, are useful for inferring site formation processes. For rocks that were 30 cm or larger in maximum dimension, multiple shots were taken. Typically, one point was recorded at the center of its upper surface, and then 3–5 more points were recorded around the outline at its base. This provided some indication of the size, shape, volume, and orientation of each rock. Although these rocks were not saved, their recorded coordinates were assigned an identification number that consisted of the name of the excavation unit (i.e., square) and five random letters as the ID (e.g., D11–XIGFE). Smaller rocks (10–30 cm in maximum dimension) were provenienced with only a single point and also assigned a random 5-letter designation. All rocks less than 10 cm in maximum dimension went into the bucket of sediment and were thus counted as part of the volume of each bucket.

All lithic and faunal objects were processed in a similar manner. After they were point-provenienced, objects were placed in reclosable plastic bags with an affixed label and barcode (Dibble et al. 2007) indicating the identification number. Any fragile items, such as bone fragments, or items that may exhibit fragile cultural modification, like pieces of mineral, were wrapped in tinfoil before they were placed in their plastic, reclosable bags. In the lab, the durable objects were washed in water (without detergent), using only fingers or a soft brush to remove adhering sediments; some lithics with concretions were also soaked for several minutes in white vinegar. Almost all objects were large enough to be labeled with indelible ink, with the site name ("PA IV") and the Unit-ID. To prevent the kinds of labeling mistakes that plagued Bordes' collections, a system for artifact labeling was followed in which one person labels the artifact and a *second* person then reads the number from the artifact and verifies that it corresponds to the number on the accompanying tag. In this way, virtually all of the labeling errors were eliminated. Once washed and labeled, all objects were put into fresh plastic bags, with a new barcode label indicating the object ID number and type of object. Ultimately, all of the objects were organized into various boxes by class of object (for the lithics) or by ID number (for the fauna), and the boxes were grouped together by layer and put into plastic trays. Each box and each tray also had a unique identifier and has a barcode label. In this way, each curated object was put into a specific box and each box into a specific tray, and these locations were all put into the final database. Thus, by knowing the Unit-ID of a particular object, it is possible to find in which tray, and which box within that tray, the object is stored.

Excavators were instructed to work within a relatively small area, usually within an area of approximately a quarter-square. As they worked, they put all sediments and rocks smaller than 10 cm into a bucket along with all unprovenienced objects. When the bucket was filled with 7 L of sediment, or when a new layer was encountered, the excavator recorded with the total station a point on the excavation surface at the center of the area in which they worked, and thereby assigned a new Unit-ID for the bucket of sediment. The buckets of sediment were then wet screened through two mesh sizes (6 and 2 mm), and the objects recovered in this manner were sorted into lithics or fauna (and, where appropriate, other categories, such as minerals), and these aggregated bags of material were given the same Unit-ID and coordinates as the bucket itself. In this way it is possible to compute an accurate measure of the quantity of sediment removed from each layer and across the excavated area. Furthermore, any lithics or fauna found in a bucket that were greater than 2.5 cm in maximum dimension, which should have been point-provenienced during excavation, were assigned a new ID number with the coordinates of the bucket itself. In order to mark these records as having approximate coordinates, a special code of "LAB" was entered as the value for excavator.

Sample Collection

In addition to artifacts, many kinds of samples were taken during the excavation and virtually all were point-provenienced in the manner described above.

Various kinds of materials were collected to be used specifically for dating purposes, including charcoal, sediment samples, burned flint, and large mammal teeth. When charcoal was encountered in potentially datable quantities (a few grams), it was provenienced, collected, and wrapped in foil to avoid any contamination. For burned flints and large teeth suitable for thermoluminescence and electron spin resonance the object was wrapped in foil, along with any sediments still adhering to it, and placed in a small plastic bag. This bag was then placed in a larger plastic bag along with a larger sample of sediments from within a 10 cm radius of the object. This provided the dating lab a means of recording the background radiation in the immediate vicinity of the objects. In addition, each object was also photographed in situ along with a small tag indicating the identification number (following the same convention of Unit-ID as described above) and the type of sample (e.g., TL or ESR). These photographs were to provide further information for the dating lab about the nature of the surrounding sediments and their potential concentration of background radiation. All of these samples were given normal object identifiers (Unit-ID) and special codes ("RC14", "TL", "ESR", "OSL"; see Chap. 3 for descriptions of these dating methods). In 2014, 30 OSL samples were collected at night under red light (see Jacobs et al. 2016); three more unconsolidated samples were collected as blocks and stabilized with plaster bandage. The positions of all samples were recorded with the total station, and all samples were sealed in black plastic bags to prevent light exposure.

Because many of the numerical chronological techniques require accurate measurements of background radiation, dosimeters were placed at least 30 cm into the unexcavated sediment and left for a minimum period of time (usually one year) (see Richter et al. 2013). While the exact position of the opening in which the dosimeter was placed was provenienced at the time the dosimeter was inserted, our normal practice was to position them in sediment that would be excavated in the following season; this allowed us to record the exact *X*, *Y*, and *Z* coordinates of the dosimeter when it was eventually recovered during subsequent excavation. Dosimeters were identified by a special Unit designation ("DOSIM") and numbered sequentially.

As a further source of data on background radiation in the site sediments, small (tablespoon-sized) samples were taken each morning from the surface of each of the excavation squares, usually at the center of each 50 × 50 cm quadrant. These were identified as normal objects (i.e., Unit-ID) with a code of "RINKDOSE" (named after Jack Rink, who originally suggested taking such samples). Nearly 1500 of such samples were collected during the course of excavation, representing a collection of relatively evenly distributed sediment samples for the entire volume of excavated sediment.

Nearly one hundred blocks of sediment for micromorphological analyses were taken, both from the western part of the site and from the east section left by Bordes. Each sample was recorded with two points: one at the upper extent of the sample and one at the lower. These samples were also identified by a special unit designation ("PDA4") and then numbered sequentially.

Casts

With the assistance of Alain Dalis, a mold was made of northern and eastern faces of the Layer 8 deposits. The resulting cast is currently on display in the Musée National de Préhistoire, in Les Eyzies.

Photography

A photographic record of the site during the course of the excavation was considered to be a very important component of the project methodology. The first task every morning was to take photos of each excavation square to record the nature of the deposits encountered and the progress of the excavation. These photos were generally taken looking directly down on each square with a photo board and north indicator (usually a trowel) in the square. Often camera settings were adjusted so as to have several different exposures as needed. General site photos were also frequently taken and included specific excavation areas as they changed with the removal of the deposits, stratigraphic sections, people at work at various tasks in the course of excavating, and visitors to the site. Many photos were also taken of special tasks, such as the removal of the brick and concrete walls, the placement of the dosimeters, and the collection of the sediment cores used for attempted DNA analysis. A series of time-lapse photos (that is, one photo taken every five minutes from one location throughout the working day) were also recorded.

In addition, all lithic objects were photographed in the lab during processing, usually of the exterior surface but sometimes of both surfaces. Though the exact procedure changed some over the course of the excavation, generally artifacts were photographed on a copy stand with a digital camera. A centimeter scale was placed to one side. In post-processing, we attempted to automatically replace the background with a solid shade of blue, to crop the photograph, and to write the Unit-ID into the photograph.

Yearly Progress of the Excavations

For the most part, excavations took place over 6-week seasons during the summer.

2000: The first year of excavation was mostly confined to squares F11, G11, and H11 with some limited excavation in the lower bench left by Bordes. Unfortunately, the time available for excavation was severely reduced due to the need to remove a portion of the concrete walls and erect scaffolding. Thus, only the very top of the Mousterian deposits was exposed in the "11" squares before the season ended.

2001: In the second season most of the rest of the concrete walls were removed and excavation continued on the squares along the top of the west section (we also opened two new squares, D11 and E11) and on the lower bench. By the end of the season, all five of the "11" squares had been excavated to a depth between 2 and 3 m below datum. In addition, the six squares of the bench were taken down approximately 0.75–1 m to a thick, site-wide layer of roof fall, which in turn overlaid the basal Layers 7 and 8 (see Fig. 1.17).

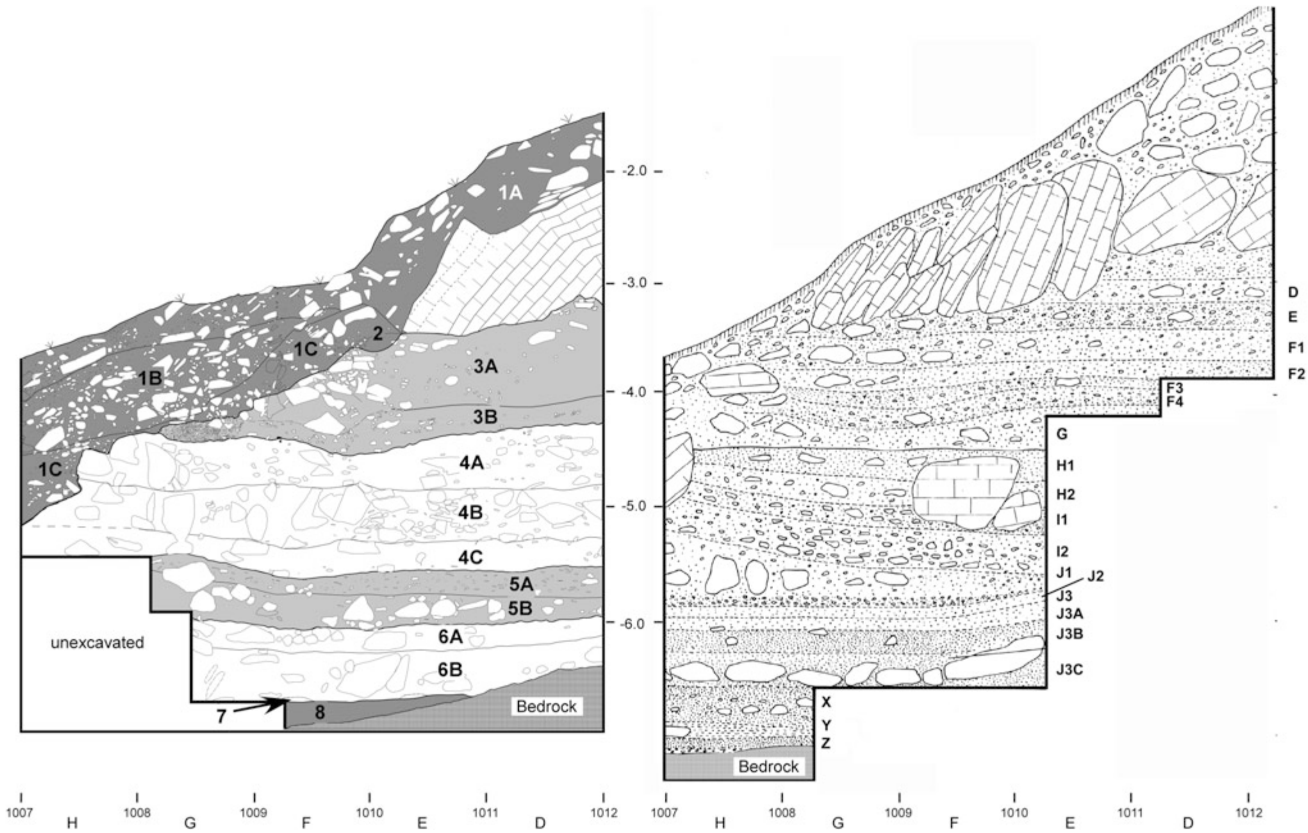


Fig. 1.17 Comparison of Bordes' stratigraphic section at *right* (at the 14–15 column boundary) and that of the recent excavation at *left* (10–11 column boundary)

2002: Work was focused on squares D11, E11, and F11 where the cultural material concentrations were highest. By the end of the season, squares D11, E11, and F11 were taken down to a level between about 0.5 and 0.75 m above bedrock, square G11 to about 1.5 m above bedrock, and H11 about 2 m above bedrock. In addition, the entirety of the bench left by Bordes was excavated to bedrock.

2003: In this year all of the squares D11–F14 were excavated to bedrock. A small bench of the lowermost layer (Layer 8) was left in the northern half of squares G11–G13, and a higher bench left in the southern portion of squares G11–G13 and H11–H14. These benches were left primarily to preserve the deposits of Layer 8, which contained numerous combustion features. Although we had attempted to excavate this layer in such a way as to expose individual features—through the use of both *décapage* (gradually exposing the surface) and advancing from the side section, taking small (25 cm wide) slices—neither technique was entirely successful. Thus, the decision was made to preserve them for future excavations. Beyond this small bench (roughly 2.6 m by 70 cm), probably 20–30 m^2 of this layer remains.

2009: In the winter of 2009 a relatively large mass of limestone blocks and sediments had collapsed from the face of the north section, likely as a result of large tree roots growing into the Holocene deposits that cap the site. The slump included a significant quantity of large limestone blocks and poorly consolidated silts that included Pleistocene and Holocene components. Salvage work and clean up were carried out in July of 2009. Materials recovered included ≈100 lithics, 60 faunal pieces, and 11 ceramic sherds.

The Current Status of the Pech IV Collections and the Site

In 2007, all of Bordes' collection from Pech IV was accessioned by the Musée National de Préhistoire in Les Eyzies, France, and all of the materials excavated during the new excavation were similarly transferred there after the end of the excavations. For Bordes' lithic material, a complete inventory was made of the contents of each box at the time it was analyzed by us. For the recent excavations, there is a similar inventory for all of the material. Aside from the objects themselves, all of the data collected during the first stage of this project, including scans of the field notebooks, all analytical data (lithic observations and measurements), and digital photos of approximately ten percent of Bordes' collection has been made available online. Our data and all of our artifact photographs have also been made available online.

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