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The age of three Middle Palaeolithic sites: Single-grain optically stimulated luminescence chronologies for Pech de l'Azé I, II and IV in France

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ABSTRACT

Optically stimulated luminescence (OSL) measurements were made on individual, sand-sized grains of quartz from Middle Palaeolithic deposits at three sites (Pech de l'Azé I, II and IV) located close to one another in the Dordogne region of southwest France. We were able to calculate OSL ages for 69 samples collected from these three sites. These ages reveal periods of occupation between about 180 and 50 thousand years ago. Our single-grain OSL chronologies largely support previous age estimates obtained by thermoluminescence dating of burnt flints at Pech IV, electron spin resonance dating of tooth enamel at Pech I, II and IV and radiocarbon dating of bone at Pech I and IV, but provide a more complete picture due to the ubiquitous presence of sand-sized quartz grains used in OSL dating. These complete chronologies for the three sites have allowed us to compare the single-grain ages for similar lithic assemblages among the three sites, to test the correlations among them previously proposed by Bordes in the 1970s, and to construct our own correlative chronological framework for the three sites. This shows that similar lithic assemblages occur at around the same time, and that where a lithic assemblage is unique to one or found at two of the Pech sites, there are no deposits of chronologically equivalent age at the other Pech site(s). We interpret this to mean that, at least for these Pech de l'Azé sites, the Mousterian variants show temporal ordering. Whether or not this conclusion applies to the wider region and beyond, the hypothesis that Mousterian industrial variation is temporally ordered cannot be refuted at this time.

1. Introduction

As one of the sites presented in the seminal work of Lartet and Christy (1864) in the mid-19th century, Pech de l'Azé I has earned its place in the development of the field of Palaeolithic archaeology. Around 150 years have now elapsed since that publication, and during this time many other sites in and around the Dordogne valley have been excavated, including three other Lower and Middle Palaeolithic locales in the immediate area of Pech de l'Azé I (Pech de l'Azé II–IV; Bordes, 1971; Soressi et al., 2007; Turq et al., 2011). Together, the Pech sites contain examples of most of the classic Mousterian "facies", or industrial variants as defined by Bordes (1961) and others (Peyrony, 1925), and thus continue to play a vital role in debates concerning the nature and interpretation of Mousterian assemblage variability (e.g., Mellars, 1965, 1969; Binford, 1973; Bordes, 1977; Rolland and Dibble, 1990; Delagnes and Rendu, 2011; Discamps et al., 2011). With the advent of new dating techniques over the past several decades, numerical ages have been obtained from a large number of sites in southwest France, including the Pech sites, by a variety of methods (e.g., Vogel and Waterbolk, 1967; Bowman and Sieveking, 1983; Valladas et al., 1986, 1987, 1999, 2003; Mellars and Grün, 1991; Falguères et al.,

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1997; Guibert et al., 1997, 1999, 2008; Lahaye, 2005; Guerin et al., 2012). Given the time-depth represented by the Pech archaeological deposits, which together are comparable to those of the classic, but still undated, reference site of Combe Grenal, and the size and variety of the archaeological assemblages, which together are far larger than those of Combe Grenal (Bordes' Pech IV collection exceeded his Combe Grenal collection [McPherron et al., 2012a]), it is not surprising that some of the earliest numerical ages for the French Mousterian have been obtained at these sites (e.g., Schwarcz and Blackwell, 1983; Grün et al., 1991) or that these sequences are a continuing focus of attention for both archaeologists and geochronologists (e.g., McPherron and Dibble, 2000; McPherron et al., 2001, 2012b; Dibble et al., 2005, 2009; Soressi et al., 2007, 2013; Texier, 2009; Turq et al., 2011; Richter et al., 2013).

Prior to the present study, a number of dating studies were undertaken at the Pech sites, including electron spin resonance (ESR) dating of tooth enamel on teeth collected from Pech I, II and IV (Grün et al., 1991, 1999; Soressi et al., 2007; Turq et al., 2011), thermoluminescence (TL) dating of burnt flint from Pech IV (Bowman et al., 1982; Richter et al., 2013), radiocarbon (^{14}C) dating of charcoal and bone from Pech I and IV (Soressi et al., 2007; McPherron et al., 2012b) and uranium-series dating of flowstones in the cave connecting Pech I and II and in deposits at Pech II (Schwarcz and Blackwell, 1983). Only three optically stimulated luminescence (OSL) ages have been reported for the Pech sites and that was for one level at Pech I in Soressi et al. (2013) as part of the study fully presented here. At Pech I and II a single technique (ESR dating of tooth enamel) has been used to date the entire sequence. At Pech IV, no single technique was applied to the entire sequence; instead, different techniques have been used to date different portions of the deposit, with only a small amount of overlap. This is because animal teeth (for ESR dating) are not present in abundance in every layer, burnt flints (for TL dating) are available only in those layers where burning is evident, flowstones are rarely preserved in archaeological sections and may be too dirty for uranium-series dating, and most of the deposit is beyond the range of radiocarbon (^{14}C) dating.

In this study, we applied a single dating method to the sedimentary deposits at each of the Pech sites to provide a coherent chronology on a common time scale. We used single-grain OSL dating of quartz because quartz is ubiquitous in geological and archaeological deposits and has an OSL time range that can extend from a few years to a few hundreds of millennia. Because OSL dating can be applied to geological and archaeological sediments, it was also feasible to obtain a complete chronological sequence for these sites – even for those layers that do not contain any archaeological traces. By applying single-grain OSL dating to each and every layer, it is thus possible to discern the history of site formation at a temporal resolution that might allow periods of occupation to be distinguished from periods of site abandonment.

There is also an archaeological imperative to link these sites using a common chronological yardstick. The three Pech sites have lithic assemblages that vary significantly within each site (Pech II and IV), that show some similarities between sites (e.g., Pech I and the top of Pech IV), and that occur at only one of the sites (e.g., small flake production in the so-called Asinipodian at Pech IV; Bordes, 1975). The question thus arises: does the assemblage variability both within and between the Pech sites represent different/similar periods in time or is it because the caves were used for different/similar purposes at the same time? This basic question concerning Mousterian variability remains unresolved with, on the one hand, some stratigraphic and palaeoenvironmental data suggesting that the Mousterian variants represent chronological phases (Mellars, 1970, 1989, 1992; Jaubert, 2012; Discamps, 2014) while on the other, an increasingly large set of numerical ages have failed to support a chronological succession (e.g., Valladas et al., 1999; Guibert et al., 2008; Vieillevigne et al., 2008; Richter et al., 2013). Although many numerical ages have been obtained for the Pech sites over the past few decades, the differing precisions and possible systematic biases in age determinations make it difficult to correlate the deposits with sufficient resolution based on previous dating evidence alone. A coherent and consistent chronology is required, therefore, to reliably compare the timing of the different artefact assemblages at each of the Pech sites and to overcome any distortion inevitably introduced by different dating methods.

Our goal in this paper is to develop an OSL chronology for the three Pech sites that will reveal when the lithic sequences for the three sites are broadly contemporaneous and when they are not. The three sites are located very closely within the same collapsed cave setting, where the same raw materials were also used for tool manufacture. This may increase the probability of similar behaviours being recorded at similar times. Though three sites are not enough to demonstrate that Mousterian variability is chronologically structured, they can falsify the hypothesis. If similar Pech industries are not broadly contemporary or if, in a given time slot, there is significant lithic variability, it suggests that the chronological phase argument for Mousterian variability cannot be supported. In doing this study, we will also test previous correlations of the sites, made by Bordes (1975) on the basis of faunal and sedimentological evidence, linked to the Riss-Würm climatic phase scheme.

2. Site background and stratigraphy

The hill of Pech de l'Azé contains a complex of four separate late Middle Palaeolithic collapsed cave sites (Fig. 1c), located in the department of the Dordogne in southwest France, situated about 5 km southeast of the city of Sarlat (44°50′N, 1°14′E) (Fig. 1a and b). The sites are positioned at the base of an Upper Cretaceous, Coniacian limestone cliff face (Goldberg et al., 2012), ~50 m above the valley floor of the Enéa River, a small tributary of the Dordogne River (Fig. 1c). Pech I and II are on either side of a still existing karstic tunnel, and Pech IV is thought to be part of the same karst system, though not the same karstic tunnel (Turq et al., 2011) (note that Pech III is a small cave not far to the west of Pech II that is now empty of sediment). All three sites had a complex morphological evolution, including periods of cliff retreat and intense roof collapse that significantly changed their configuration over time (Texier, 2009; Turq et al., 2011). Understanding the sedimentology and the site formation processes at each of these sites is important for OSL dating, as this directly impacts on what we are dating – the last time sedimentary grains of quartz were exposed to sunlight. The sedimentology and site formation of all three sites have been documented thoroughly in Bordes (1972), Laville (1973), Goldberg (1979), Texier (2009), Turq et al. (2011) and Soressi et al. (2013). A summary of the stratigraphy, associated archaeological industries and the main sedimentological features of each layer and for each site are provided in Tables 1a, 1b and 1c.

2.1. Pech I

Pech I was originally excavated in the early 19th century by Jouannet and later by the Abbé Audierne, followed by excavations in 1909 by Capitan and Peyrony, in 1929 to 1930 by Vaufrey and from 1948 to 1951, and again from 1970 to 1971, by Bordes. In 2004 and 2005 limited excavations were conducted by Soressi on the witness section left by Vaufrey in 1930, which has been used as the reference sequence for the site since then. A schematic of the site, location of each of the excavations and the witness section are provided in Figure 2a.