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A new approach to study the fuel used in hearths by hunter-gatherers at the Upper Palaeolithic site of Abri Pataud (Dordogne, France)

L. Marquer [a,*], T. Otto [b], R. Nespoulet [a], L. Chiotti [a]

[a] Département de Préhistoire du, Muséum national d'histoire naturelle, UMR-CNRS 7194, USM-103, 1 rue René Panhard, 75013 Paris, France
[b] ECOLAB – Laboratoire d'Ecologie Fonctionnelle, UMR 5245 CNRS-UPS-INPT, Université Paul Sabatier-Toulouse 3, 29 rue Jeanne Marvig, 31055 Toulouse, France

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ABSTRACT

The fuel used in hearths in the Upper Palaeolithic period and the management of this fuel have long given rise to questions on intentional or opportunistic human comportment. To understand how fuel was managed during the Aurignacian and Gravettian cultures, hearth samples from the French site of Abri Pataud (ca. 34–20 kyr BP) were collected. An image analysis method for the automated quantification of burnt particles from macroscopic-to-microscopic sediment fractions was developed, and the results obtained using this method were compared with the palaeoenvironmental data available close to the site. At Abri Pataud, the use of bones was dominant during the Pleniglacial, suggesting an intentional practice. However, environmental pressures could have influenced the fuel management practices of the hunter-gatherers, even if the dualistic relationship between the availability of firewood and the use of bone in hearths must be considered. Thus, burnt particle quantification provides more than just an observation of burnt macroremains in hearths: it relates to fundamental information on human behavior.

1. Introduction

Upper Palaeolithic populations continued to subsist as hunter-gatherers, relying on various combinations of plant and animal foods mainly cooked in hearths. Plant and animal remains preserved in hearths are key factors from the viewpoint of understanding the interactive processes between human subsistence and the potential role of environmental pressures. In prehistoric caves and rock-shelters, hearths contain various combustion residues resulting from an intentional or an accidental presence. The main fuels used are wood, grass, lignite, bones and probably dung. Grasses can be used in Palaeolithic hearths at the beginning of the combustion processes at the same time as others types of fuels. Lignite might have been intentionally blended with the wood supply in the fireplace (Théry et al., 1995). Nevertheless, burned lignite is rarely found in Palaeolithic sites. The two burnt remains more frequently recovered from archaeological sites are wood charcoals and burnt bones. In Europe, from the end of MIS 3 (ca. 28 kyr BP) to the Late-Glacial, wood charcoals were sometimes rarely found in hearths or were absent altogether, while other combustion residues were abundant such as burnt bones (Perlès, 1977; Théry-Parisot, 2002b). Bone used as fuel appears to be the most likely hypothesis to explain these facts, raising the questions of cultural and/or economic practices specific to these periods (Costamagno et al., 2005; Perlès, 1977; Théry-Parisot, 2002a,b; Théry-Parisot et al., 2005; Villa et al., 2002).

The European Pleniglacial landscapes (ca. 75–15 kyr BP), except for the Mediterranean area, were defined as steppe or wooded-steppe regions with very few trees (mainly *Pinus*) (Beaudouin et al., 2007; Beaulieu and Reille, 1984, 1992; Reille and Beaulieu, 1988, 1990). Burnt bones are thus abundant in Upper Palaeolithic sites when the climate was more dry and cold with a scarcity of wood in the environment. The bones used in hearths might be due to the lack of supply of wood at the gathering by the prehistorics and can thus be connected to an environmental impact. A debate is in process on the possible use of bone in hearths in i) an "intentional" way for specific activities such as providing light, drying, and curing or in ii) an "opportunistic" form derived from environmental stress during the Pleniglacial. Recent works (Costamagno et al., 2005; Théry-Parisot et al., 2005) have highlighted the complexity of this topic. It is necessary to integrate the use of fuels into a complex system, which takes into account a large number of variables, such as the function of the hearth site, the energy requirements of the period, the combustible properties of the bone, the origin of the burned bones and the change of the environmental context.

* Corresponding author. Tel.: +33 6 07 48 77 21.
E-mail address: marquer@mnhn.fr (L. Marquer).

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Experimental approaches in the laboratory were developed to test some of these variables, such as the combustion properties of bone (Costamagno et al., 2005; Théry-Parisot, 2002a,b; Théry-Parisot et al., 2005). These experiments were designed to assess the potential use of bone as fuel for some specific activities, for which the use of bone seemed preferable to that of wood alone. Nevertheless, the abundance of bones in hearths remains difficult to explain directly from archaeological levels which are subjected to taphonomic processes.

A taphonomic approach to burnt residues could also be taken into account to explain the absence and scarcity of charcoal. Wood is essential to ignite a fire (Costamagno et al., 2005; Théry-parisot et al., 2005) and residual woody combustion material may still be enclosed at some archaeological levels. Thus far, archaeological excavations have rarely considered <0.5-mm-sized wood charcoals. Micromorphological investigations on archaeological sites are widely used to observe the microscopic remains. They permit direct observation of particle properties, including size, geometry, and orientation, from undisturbed sediments. The thin micromorphological components appear as 2-D sections that consider only a small area of sediment. If we consider a volume of sediment with scarce, scattered micro-particles of charcoal, we have a lower probability to find these particles there. The smallest wood charcoal particles produced by combustion processes and intense fragmentation processes have not been examined, suggesting that some of the information on the presence of wood charcoal might have been lost.

Macroscopic-to-microscopic quantification of wood charcoal particles and burnt bones from sediment volumes of ^{14}C-dated hearths and sedimentary levels at Abri Pataud allows us to investigate the presence and proportions of each type of fuel employed and to discuss the use of wood and/or bone in hearths during the Pleniglacial. The Abri Pataud archaeological sequence covers the entire Upper Palaeolithic, from the Aurignacian to the Solutrean periods (ca. 34–20 kyr BP). Therefore, it is an important topic from the standpoint of understanding the issue of human subsistence in the glacial steppe landscapes.

2. The prehistoric site of Abri Pataud

The Abri Pataud rock-shelter (44°56′N, 1°0′E, 75 m a.s.l.) is located at the West of the Massif Central (Fig. 1), in a limestone cliff overhanging the Vezère valley. It belongs to a series of well-known Upper Palaeolithic sites, including Cro-Magnon, Laugerie, La Micoque, La Madeleine, La Ferrassie, Le Moustier, and Lascaux.

2.1. Stratigraphy and archaeological remains

The stratigraphy over a total depth of 9.25 m represents a series of 14 major occupations alternated regularly with archaeologically poor or sterile 'Eboulis' accumulations (Fig. 2) (Bricker, 1995; Movius, 1975, 1977). The site was excavated by Professor H. L. Movius (Peabody Museum, Harvard University) between 1958 and 1964. The archaeological levels contain many artefacts and fossil bones. The manufactured tools represent a complete early Upper Palaeolithic succession from the basal Aurignacian to the Solutrean (Movius, 1977). More than 300 remains of *Homo sapiens*, including a complete skull and mandible, teeth, and bones were discovered in the Gravettian levels (Movius, 1977; Movius and Vallois, 1959; Nespoulet et al., 2008). The site also encloses different works of art, including paintings, mobile art objects, rock engravings, and beads, along with a high diversity of bone industries (Brooks, 1979; David, 1985; Delluc and Delluc, 1986, 2004; Movius, 1977; Movius and Vallois, 1959; Vercoutère, 2004). The lithic industry corresponds to stone tools from the Aurignacian and Gravettian period (Brooks, 1979; Chiotti, 2005; David, 1985; Kong-Cho, 1997; Leoz, 2007; Nespoulet, 1996; Pottier, 2005). Faunal assemblages (mammals, rodents, and birds) were also recorded (Bouchud, 1975; Brooks, 1979; Chiotti et al., 2003; Cho, 1998; David, 1985; Sekhr, 1998; Vannoorenberghe, 2004). The faunal remains are mainly reindeer; other species such as horse, bovines, mammoth, chamois, red deer, boar, roe deer, bear, and some carnivores are also present. Palaeoenvironmental reconstructions (palynology, anthracology, and sedimentology) suggest cold and more or less humid conditions, with a wooded-steppe (*Artemisia*, Chenopodiaceae, Poaceae, *Pinus sylvestris*, *Juniperus*, *Salix*, and *Betula*).

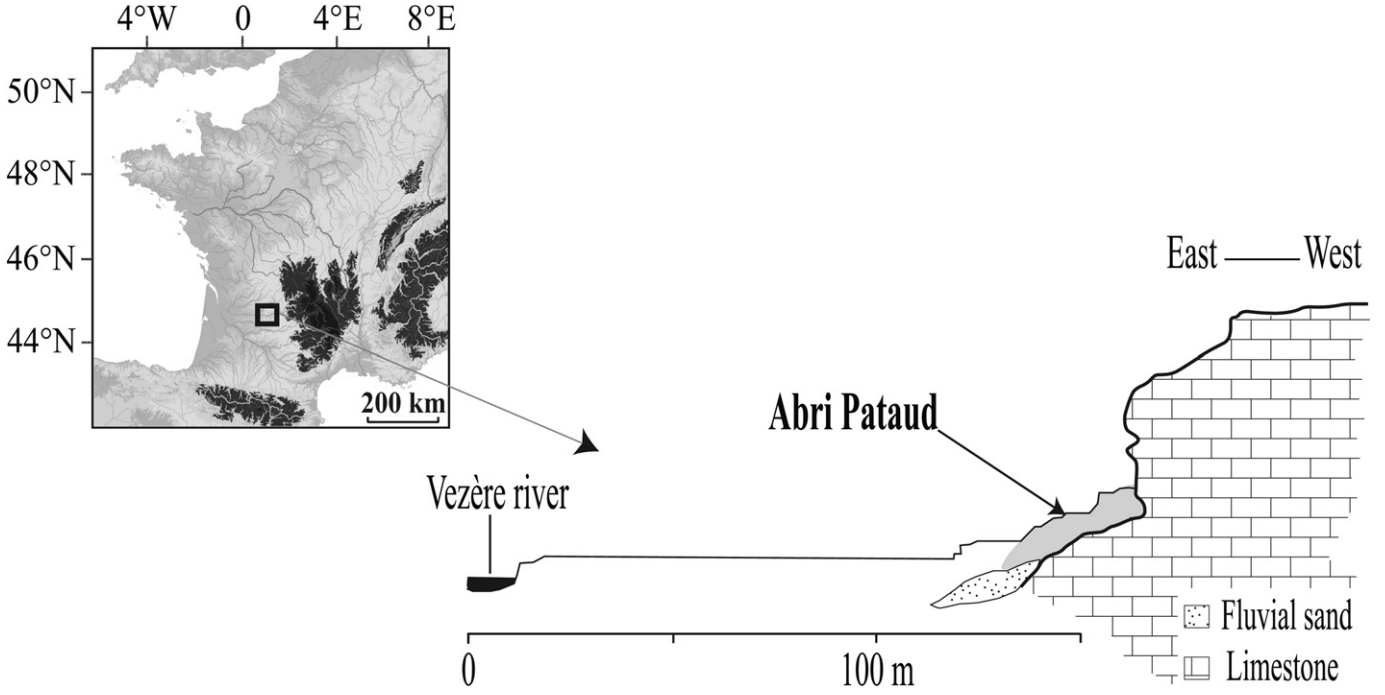

Fig. 1. Location of Abri Pataud in France and cross-sections of the Vezère river valley.