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Fire as an Artifact—Advances in Paleolithic Combustion Structure Studies: Introduction to the Special Issue

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Abstract

Hearths present sedimentary features, artifacts, and direct evidence for maintained and controlled fire in the past. The use of hearths reflects regular access to fire and its diverse benefits. Among these benefits are cooked food, protection from the cold and from predators, and fire's transformative power regarding raw materials. Hearths may have also served as focal points of activity at Paleolithic campsites and triggered changes in social structures. As sedimentary features, combustion structures function as behavioral as well as paleoenvironmental archives. The papers in this special issue focus on the former aspect, how combustion feature can serve as transmitters of behavior, and with what tools we can explore them. We here briefly present an overview on the range of topics explored in these papers, which include ethnoarchaeological research on fire use among recent hunter-gatherer groups, spatial analysis of burnt lithics, actualistic experiments regarding fire function and fire use in tool production.

Keywords Fire · Combustion structures · Hearths · Pyroarchaeology

Introduction

Fire use and pyrotechnology played a large role in human evolution and prehistory: from the first cooked food to the modification and creation of raw materials, fire enabled our species to transform our environment and ourselves. Pyroarchaeological research in the Pleistocene is often focused on the identification of early evidence for fire use due to its significance for human evolution (Chazan 2017; Sandgathe 2017; Stahlschmidt et al. 2015). The main challenge for such research is to distinguish between combustion materials and features resulting from anthropogenic or natural

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processes (Goldberg et al. 2017). Therefore, pyroarchaeology has often been at the forefront of developing and applying new techniques to the field (Brittingham et al. 2019; Courty et al. 2012; James et al. 1989; Weiner and Bar-Yosef 1990). Combustion materials and features can be regarded and analyzed as artifacts when they result from anthropogenic processes. Combustion features, which preserve focal points of fire activity of either natural processes (e.g. burning tree stumps) or anthropogenic hearth-building, even have the potential to preserve true snapshots of the past (Leierer et al. 2019; Miller et al. 2013). Apart from constituting behavioral archives, combustion features can also retain paleoenvironmental information and thus present a window into human-environment interactions (Vidal-Matutano 2017). (Micro)contextual and multi-analytical approaches can unlock this unique archive. This special issue is a collection of contributions to session IV-4 "Fire as an Artifact: Advances in Paleolithic Combustion Structure Studies" by the UISPP Scientific Commission on Pyroarchaeology held at the XVIII UISPP Congress in Paris, 4–9 June 2018, and compiles research from ethnoarchaeology, experimental archaeology, and studies on Paleolithic hearths and pyrotechnology.

Ethnoarchaeology of Fire Use

The study of fire use among recent hunter-gatherers represents a powerful tool to explore early fire use (Mallol and Henry 2017). One of the most famous examples of this is Binford's study on the Nunamiut with observation of toss and drop zones around hearths (Binford 1978). Despite the impact of this model on spatial analysis in archaeology, directly testing it in the archaeological record has proven difficult. Geoethnoarchaeological studies have revealed that hearths have a low preservation potential in open-air settings and that subsequent maintenance practices can destroy the sedimentary evidence of fire use (Mallol et al. 2007; Mallol and Henry 2017). At the same time, these geoethnoarchaeological studies highlight the variable and multitask nature of combustion features. In this issue, McCauley et al. (2020) report on the variability of fire use by recent hunter-gatherers based on a thorough investigation of the World Cultures Ethnography Database. Based on a search for a of fire-related keywords, McCauley et al. (2020) present an overview on how recent hunter-gatherers use fire and reveal a rich set of hypotheses to test on the archaeological record. They echo observations of multipurpose fires with long duration and repeated use resulting in thick combustion layers. Most surprisingly, they found a strong focus on persevering and transporting fire instead of renewed fire making for several groups when moving camps and found no records of bone fuel use even in arctic contexts.

Spatial Studies of Burnt Lithics

Unfortunately, hearths often do not preserve, especially in open-air settings, where various translocation and transformation processes affect the combustion residues. Heated rocks present the most durable category of heated materials, and studies of diachronic and synchronic patterns of heated rocks at archaeological sites have been used to explore patterns of fire use (see e.g. (Shimelmitz et al. 2014)) and to reconstruct

hearth localities (see e.g. (Sergant et al. 2006)). Here, Sobkowiak-Tabaka and Diachenko (2019) and Plavšić et al. (2020) present spatial distribution studies on burnt lithics for the reconstruction of fire features and use. Sobkowiak-Tabaka and Diachenko (2019) use macroscopic identification of burnt flint and explore their spatial clustering using variable statistical methods at two small Late Paleolithic open-air sites, Osno Lubuskie 7 and Lubrza 10, in Western Poland. They conclude that nearest neighbor statistics on burnt lithics present the best approach to infer hearth locations in the absence of sedimentary evidence. Plavšić et al. (2020) investigate fire use in Aurignacian populations at the cave site Šalitrena pećina, Serbia. They similarly employ macroscopic identification of burnt flint combined with spatial analysis but use the quadrant count method to detect and evaluate concentrations of burnt lithics and to reconstruct hearth localities. In addition, Plavšić et al. (2020) combine this with technological analyses of the lithic assemblage in zones adjacent and removed from the inferred hearth localities and conclude that Aurignacian life was centered around hearths.

Hearth Function and Fuel

While ethnographic studies point to a rich variability in the use of hearth features, to detect this use variability in the archaeological record presents its own challenge. Mallol and Henry (2017) point out that there is still a dearth of information on hearth function, which could includes light, warmth, and heat for cooking or to transform raw materials. Fuel is one important proxy to address the function of a hearth, and research on combustion feature function often centers on wood fuel. Such anthracological studies are concerned with wood fuel management strategies (Théry-Parisot and Henry 2012; Vidal-Matutano et al. 2017), but the use of bone fuel has also been suggested for Paleolithic contexts (Schiegl et al. 2003; Théry-Parisot 2002). Here, Hoare (2020) addresses the different possible functions of hearths by looking at the two crucial fire characteristics, heat and light. In this actualistic study, Hoare (2020) explores the luminosity and radiative heat output of different wood species and bone and observes that fuel types result in fires of variable intensity, radiation, and duration, suggesting possible functional differentiation of ancient hearths. However, for prehistoric hunter-gatherers, resource availability and wood preservation state may have limited fuel choice.

Fire Use in the Production Sequence

Heating temperature and duration of combustion features are crucial for transforming raw materials, such as in birch tar production (Kozowyk et al. 2017; Schmidt et al. 2019) or for heat treatment of lithic raw materials to increase their knapping quality (Brown et al. 2009; Domanski and Webb 2007). Such early transformative pyrotechniques have been interpreted to reflect advanced cognitive capabilities (Wadley and Prinsloo 2014) and have been used to explore potential cognitive gaps between Neanderthal and *Homo sapiens* populations (see e.g. (Roebroeks and Soressi 2016)). One important question here is how pyrotechnologies tie into other technologies. For silcrete heat treatment in the Middle Stone Age of South Africa, Delagnes

et al. (2016) propose that heat treatment occurred early in the *chaine opertaire*, during core exploitation, influencing all following production stages and preserving in all ensuing products. Here, Revedin et al. (2019) explore the role of fire in the manufacture of wooden tools and present actualistic experiments for wooden tools such as have been found in the Middle Paleolithic deposits at Poggetti Vecchi, Italy (Aranguren et al. 2018). At Poggetti Vecchi, the researchers observed that some of these wooden tools preserved superficial charring and hypothesized that these traces result from implementing fire in the tool production process. Based on their experimental study, Revedin et al. (2019) suggest that such traces could result from controlled burning in a hearth and that this extra step would have helped to speed up the processing regarding the surface preparation as well as for the final shaping of the pointed tip.

Conclusion

Altogether, the papers in this special issue illustrate some of the ways in which anthropogenic combustion structures or hearths contain a wealth of behavioral information. As true artifacts, the study of combustion features and materials from different methodological perspectives and disciplines informs us on technology, subsistence, domestic activities, and other cultural behaviors, from the Pleistocene to the present.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict interest.

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