

## Timing of the appearance of habitual fire use

Using a number of Middle and Late Pleistocene sites with good evidence for fire, Roebroeks and Villa (1) argued that the habitual use of fire did not become part of hominin technological repertoires until the latter half of the Middle Pleistocene. We are pleased to see other researchers taking a more critical view of the nature and quality of the available evidence for early fire use and questioning what seems to be a long-held assumption that the earliest evidence for fire use marks the point at which it becomes inextricably part of hominin adaptations (2, 3). We agree that the evidence indicates that fire was not a requisite technology that allowed Early Pleistocene hominins to expand into more northerly latitudes. However, we argue that the available evidence better supports a significantly later appearance for the habitual use of fire (sometime near the end of the Late Pleistocene) and that before this fire, use was always sporadic and opportunistic. Roebroeks and Villa (1) supported their argument by showing, in figure 1 and table 1 in ref. 1, significant increases in the numbers of sites with good evidence for fire in the more recent Marine Isotope Stages (MIS), and they adjusted these data to show numbers of sites with good evidence for fire per 10,000-y increment within each MIS. A potential problem with these data is that they may simply be reflecting the overall frequency of sites per time period. We can expect that, because of ongoing taphonomic processes, there will necessarily be fewer sites the farther back in time we look. It would be more meaningful if we look at the number of site occupations with good evidence for fire relative to the total number of site occupations known for that specific time period. This finding would provide a much better indication of any changes in the frequency of fire use during the Pleistocene and perhaps indicate when fire use stopped being sporadic and became habitual. Our own work (4, 5), which includes a strong control on taphonomic factors in the visibility of fire use, clearly indicates that, as late as mid-MIS 3, Neandertals were rarely using fire during main occupations of (at least some) cave sites in Southwestern France. Specifically, at Pech de l'Azé

IV and Roc de Marsal (Dordogne, France), well-preserved hearths are evident in levels associated with warm climatic conditions, but in levels associated with cold environments (MIS 4 and 3), evidence for fire is almost nonexistent, although concentrations of lithics and butchered faunal remains are high. The fact that this finding reflects a lack of fire use is best supported by frequencies of burned flints throughout the site sequences, although these data are directly paralleled by frequencies of more ephemeral fire residues (burned bone, charcoal, and ash). We would argue that, if Neandertals had the ability to make fire at will, then evidence for it should occur with much greater frequency in Middle Paleolithic sites and occupations and especially, those sites associated with such cold stages.

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