What's new is old: Comments on (more) archaeological evidence of one-million-year-old fire from South Africa

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The essential roles of fire in human evolution and in humanity's technological mastery of the natural world are disproportional to our understanding of its earliest domestication. Archaeologists researching relatively recent occurrences of fire, only after ~0.4 Ma and mostly in Europe, are particularly critical of earlier archaeological claims of fire from African sites older than 1.0 million years old.[1] The problem is that the initial harnessing of fire was such an extraordinary accomplishment that any claim of that achievement requires extraordinary evidence for its acceptance. Unfortunately, ancient fire lacks the tangibility of prehistoric stone tools, the oldest of which are 2.6 million years old[2] but that are also still readily accessible to us by sight and by touch. Fire – even when employed in the most evolutionarily important of ways (e.g. to cook food, provide nocturnal illumination and ward off carnivores) – is ephemeral; it burns itself out. Thus, the occurrence of fire in the deep past left only trace evidence, if any at all.

So instead of being based on easily identifiable, well-developed hearths, the very earliest claims of hominin-controlled fire from Africa are based on more dubious evidence, like patches of heated sediment or burned clumps of clay found in association with simple stone tools at some archaeological sites in Kenya which are 1.5-1.4 million years old.[3,4] Sceptics want to know if wildfires, rather than hominins, actually created these prehistoric indications of burning, and if their associations with bona fide archaeological remains are coincidental instead of behavioural. Even the ballyhooed reports of charred plants and heated flint from the ~0.8-million-year-old Gesher Benot Ya'aqov site (Israel)[5,6] encounter some resistance, as the site was formed in the open and thus may have been susceptible to burning by wildfires.

Using micromorphological and Fourier transform infrared microspectroscopy techniques to analyse intact sediments from the South African cave site of Wonderwerk, Francesco Berna and his colleagues have just demonstrated the presence of *in situ* fire in the cave's 1.0-million-year-old Acheulean stratum 10; in doing so, they have also shown what newly applied rigor in archaeological recovery adds to the quest for the world's earliest controlled fire.[7] Berna et al.'s[7] analyses revealed that the stratum 10 sediment contains inclusions of ashed plants and burned bone fragments. The plant remains are well preserved and the bone fragments are still sharp-edged, indicating that both were burned at the locus of recovery, and not blown or washed in from outside the cave. Additionally, the cave entrance is ~30 m from the excavation area, and was even further away 1.0 Ma, when the archaeological evidence accumulated. By noting the absence of bat guano in the Acheulean level, Berna et al.[7] neutralise anticipated criticisms that self-ignition of that fuel caused the burning in stratum 10. Putting a point on their thesis, the authors also describe larger pieces of charred and calcined bones, as well as banded ironstone tools and manuports (i.e. non-worked, non-local stones transported to the cave by hominins) with heat-generated pot-lid fractures. In sum, the research at Wonderwerk was exacting, the data are powerful and the conclusions compelling.

Even so, the notion of hominin control of fire by 1.0 Ma does not surprise me, having directed research at Swartkrans Cave (South Africa) for the last several years. One of the most important discoveries at Swartkrans by my predecessor, Bob Brain, was the presence of 270 burned bone fragments in Member 3, a depositional unit of the Swartkrans Formation that dates ~1.5 Ma – 1.0 Ma.[8]

Like the Wonderwerk sediments and bones,[7] most of the Swartkrans bones were burned in fires reaching temperatures around or in excess of 400 °C – 500 °C.[9,10] Within a fire, temperatures vary at different heights, but small campfires rarely exceed 700 °C and have an average overall temperature of ~400 °C, whereas wildfire temperatures can near 800 °C aboveground, but are dramatically cooler at the ground subsurface.[11,12] Thus, determining the origin of a fire based on proxy indications of its heat is tricky; for example, a bone burned at low temperatures for a long time can assume heat-altered chemistry and histology similar to that of one burned at high temperatures for a short time.

Complicating matters, the Swartkrans burned bones, unlike those from Wonderwerk, were probably transported short distances from their loci of combustion. To sceptics this means that wildfires probably ignited flammable detritus, including bones, which was lying jumbled on the floor of the cave mouth, and was then eventually washed deeper into the gully in which the Member 3 deposit formed. In contrast, Brain[13] contends that hominins regularly tended fires in the mouth of the gully, with bony debris from those fires, as well as other cultural materials, washing deeper into the cave over time.

The strength of Brain's interpretation is contextual. Firstly, only two other burned bone fragments have been found in the entire Swartkrans Formation, which includes four other early Pleistocene depositional units, each yielding thousands to tens of thousands of macrovertebrate fossils; so why would wildfires not have affected each assemblage similarly? Secondly, burned bones were excavated from much of the entire 6-m thickness of Member 3, suggesting that fires were maintained repeatedly over the thousands of years that it took the deposit to accumulate. Lastly, four of the burned bones are also scarred by defleshing butchery marks,[13] so the sample is linked functionally to a spatially associated assemblage of Early Acheulean stone cutting tools.[14] The possibility exists, of course, that uncooked bones were defleshed by hungry hominins, dropped in or near the cave entrance, burned in a wildfire and then washed deeper into the Member 3 gully. It is, however, just as likely that uncooked butchered bones were dropped into fires tended by hominins for purposes other than cooking meat; Brain[13], for one, believes that hominins employed fires initially to fend off carnivores.

Indeed, even though much is made of Richard Wrangham's[15,16] hypothesis that early *Homo* was biologically adapted to eating cooked food, the vast majority of butchered bones in Swartkrans Member 3,[17] in addition to all of them at other early Pleistocene African sites, are not burned.[18] Further work on the taphonomy of the Wonderwerk fauna might, in the future, elucidate the issue of meat cooking. And, our own work at Swartkrans is now focused on this question.

As it now stands, the new evidence of fire at Wonderwerk also does nothing to resolve the question of whether early African *Homo* cooked plant foods. The burned plant matter is only identified to broad taxonomic categories, and the statement that 'data suggest that the fuel used in Wonderwerk was composed mainly of 'light' plant materials such as grasses, brushes and leaves'[7] could indicate that Wonderwerk hominins used those plants primarily for fuel rather than for food.

None of this parsing of the data is meant to impugn the revelations from Wonderwerk, but is instead to demonstrate the importance of considering the new evidence in the broadest reasonable context. We ought to resist the temptation to simply cast aside previous claims of early hominin fire management in the wake of newer, fancier analytical techniques. Combining all scientifically sound observations of ancient archaeological fire provides a much richer picture of the possibilities of its domestication and uses, and will also allow us to build more comprehensive hypotheses to be tested against the next new claim.

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