

Investigating the Possible Use of Fire at Zhoukoudian, China

S. Weiner *et al.* (1) reexamined “evidence in Layer 10, the earliest archaeological horizon” at Zhoukoudian, China (Peking Man Site), and concluded that “although indirect evidence for burning is present, there is no direct evidence for in situ burning.” I disagree. Weiner *et al.* do not fully address the wealth of data collected at the entire site since the 1930s, and they do not adequately account for problems of material transport by water that apply to the particular sample they studied.

In 1931, D. Black authored a study, “Evidences of the use of fire by *Sinanthropus*” (2), on the basis of the chemical analyses carried out by Baubert of the Laboratory of Mineralogy of the Paris Museum and Read of the Department of Pharmacology of the Peking Union Medical College. Black stated (2, p. 107),

These two experiments are considered to demonstrate conclusively the presence of a good amount of carbon in the soil examined. Further, since the original material did not effervesce with acid, it is to be concluded also that its carbon content was of the nature of free carbon, i.e., charcoal debris. . . . It is thus clear beyond reasonable doubt that *Sinanthropus* knew the use of fire.

L. Jia, who joined the excavation at Zhoukoudian in 1931, wrote (3, p. 54),

Carbon particles have frequently been seen in the black ash layer (at Locality of Zhoukoudian). Pieces of carbon made of the tree of Chinese redbud (*Cercis chinensis*) have been found in the black substance of Quartz Horizon II in the Getzetang cave. . . . Some pieces of limestone buried in the ash became lime.

W. Pei, who discovered the first skull of the Peking Man and had led the excavation of Zhoukoudian for a long time, wrote, with S. S. Zhang (4, p. 21),

On the big block of limestone beneath the third layer of the deposits west to Getzetang two big piles of ash had been found, these are undoubtedly the hearth. . . . Pieces of limestone sometimes were burned and became lime. . . . In part of the floor of the cave the earth became hardened, the color of the earth became red and reddish brown. . . . There were woody plants used for fuel among which Chinese redbud and hackberry (*C. sinensis*) have been identified.

They also wrote (4, p. 148),

Specimen P.2500 (plate XXXIV, 12, figure 62) is the only chopper with one side. It had been burned by the fire with fissures on the mottled surface looking like that of the surface of a tortoise plastron. This flake is 47 mm thick, as shown in the following figure.

This chopper is about 12 cm long and 7 cm wide as measured on figure 62 of that paper.

If this stone artifact was burned outside the cave, it would be difficult for it to have been transported into the cave.

In 1991, S. Guo *et al.* made fission track dating for Locality 1 of Zhoukoudian using ashes sampled from Layer 4 of this site (5). The result, 0.306 ± 0.056 Ma, corresponds to the ages worked out by other researchers with different methods and implied that the sphene in the sample had been burned in the cave at the time of Peking Man. If the minerals had not been burned at the time of Peking Man, the fission track detected would be about 370 to 1500 times that observed by Guo *et al.*, or the resulting age from these experiments would be much earlier. Guo *et al.* applied the same technique to date the sphene sampled from Layer 10 of Getzetang of the same site and got the age 0.462 ± 0.045 Ma. These studies show that fire was used in this site.

According to Weiner *et al.* (1), the percentages of microfaunal and macrofaunal burned bones found in the sample examined by them from Layer 10 of this site “are roughly similar to those obtained in much younger caves where the fire was undoubtedly used by humans,” but Weiner *et al.* do not give an explanation for this concordance and coincidence before they asserted that the burned bones sampled from the western part of Layer 10 of this site “were probably brought into the cave” by water runoff or mudflow. The places where Weiner *et al.* collected their samples are deep in the cave, far away from the possible entrance. It seems a long way for water to carry bones and artifacts from the outside to this deep interior. If the bones were burned outside of the cave, the situation is probably that “only 2.5% of the microfaunal bones were burned, as compared to 12% of the macrofaunal bones” at the original hearth. Such transport would have made the proportion of the macrofaunal bones in the sample much smaller because they are much heavier. “Water in a low-energy environment” has more difficulty moving the heavier macrofaunal bones and the stone artifacts. So the ratio 2.5:12 found by Weiner *et al.* in their sample does not favor (or even is contradictory to) their conclusion. Also, they do not give a reasonable explanation for the maintenance of the ratio of the microfaunal to the macrofaunal bones in their sample.

If the hearth was in the cave not far away from the sampling place, the ratio of microfaunal to macrofaunal bones could have been

more easily maintained, even if the bones were transported by “low-energy water” for a short distance.

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References

1. S. Weiner, Q. Xu, P. Goldberg, J. Liu, O. Bar-Yosef, *Science* **281**, 251 (1998).
2. D. Black, *Bull. Geol. Soc. China* **11**, 107 (1931).
3. L. Jia and W. Huang, *Excavation at Zhoukoudian* (Tianjin Publisher of Science and Technology, Tianjin, China, 1984), p. 54 (in Chinese).
4. W. Pei and S. Zhang, *Palaeontologia Sinica*, whole no. 168, new series D, no. 12 (Science Press, Beijing, 1985) (in Chinese), pp. 21 and 148.
5. S. L. Guo *et al.*, *Nucl. Tracks Radiat. Meas.* **19**, 719 (1991).

21 September 1998; accepted 3 December 1998

Response: Our report showed that the black bones in Layer 10 were burned. Because the bones were located in close association with the quartzite tools, this finding is “suggestive of a cultural association” (1, p. 253), but in the absence of in situ hearth features, it cannot be regarded as conclusive, direct evidence for the use of fire by *Homo erectus*.

1) We cited the frequencies of burned bones in much younger caves in order to illustrate that the findings in Layer 10 are consistent with fire use by *H. erectus*. We were not able to demonstrate that the burned bones and the artifacts were in situ.

2) The demonstration of free carbon does not necessarily imply that the organic matter was burned. Assuming that the material analyzed by Baubert and Read [as discussed by Black (2)] was in fact burned carbon, it is most likely not the same material from the same locality that we studied. Moreover, the presence of such carbon would not show conclusively that fires were present in the cave; some of the carbon identified could have washed in. Our micromorphological analyses, which examine the in situ constituents of the sediments, showed unequivocally that the organic matter found in Layer 10 was not from an in situ burning event, and that the organic materials had settled in water along with mineral matter. We did not observe charcoal. The presence of burned carbon also does not mean that fire was necessarily made by humans. Fires are commonly started by lightning strikes or can be produced in a cave by the spontaneous combustion of guano, as mentioned by Binford and Ho (3).

3) We made no attempt to confirm or refute the observations of earlier investigators in other parts of the cave. We would have cited any well-documented evidence

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of the use of fire. We did not find any objects that looked like burned lime in the extant section, but there is an interesting rock-like object on display in the Zhoukoudian museum at the site that could be the material that Jia and Huang (4) observed. It has the distinct turquoise color that we referred to in our report as resulting from the heating of fossil material. Where and under what circumstances such heating occurred is not known. This observation, like many others, is circumstantial at best.

4) The implications of the fission track dating in the study by Guo *et al.* (5) are most intriguing, and we had not given them sufficient thought. The data Guo *et al.* reported referred to Layer 4, where they found that 29 spherical grains out of several hundred were annealed by fire. They also reported (without accompanying data) a fission track age for Layer 10, indicating that some of the spheres in this layer were also annealed by fire. The question here again is whether or not they are in situ. We should have cited this study (5), along

with our finding burned bones, as evidence in support of fire use. Neither study is conclusive.

We agree with Wu that there are many open questions, some of which can be addressed using the materials in collections and the extant section at the site. We are still analyzing a vast amount of data to better understand the site formation processes such as the issue of the cave's configuration during the different occupations. We conclude that there is evidence consistent with fire use by *H. erectus*, including our own contribution concerning the burned bones. To date, however, the evidence is not direct or unequivocal.

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References and Notes

1. S. Weiner, Q. Xu, P. Goldberg, J. Liu, O. Bar-Yosef, *Science* **281**, 251 (1998).
2. D. Black, *Bull. Geol. Soc. China* **11**, 107 (1931).
3. R. L. Binford and C. K. Ho, *Curr. Anthropol.* **26**, 413 (1985).
4. L. Jia and W. Huang, *Excavation at Zhoukoudian* (Tianjin Publisher of Science and Technology, Tianjin, China, 1984), p. 54 (in Chinese).
5. S. L. Guo *et al.*, *Nucl. Tracks Radiat. Meas.* **19**, 719 (1991).

10 November 1998; accepted 3 December 1998

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Science **283** (5400), 299.

DOI: 10.1126/science.283.5400.299a

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