

Tektites and the Age Paradox in Mid-Pleistocene China

The article by Hou Yamei *et al.* (1), if correct, demonstrates that 800 thousand years ago (ka) people in southern China were making stone tools as sophisticated as any being made in Africa at that time. The basis for that claim is the assumed age of the artifacts found in the sediments of a terrace 25 to 100 m above the present-day Youjiang River, in the Bose basin in the Guangxi Zhuang Autonomous Region of China. The age cited for the artifacts was based on new high-quality $^{40}\text{Ar}/^{39}\text{Ar}$ age dates for tektites found with the artifacts.

The assumption is that the tektites found in association with the artifacts were found in situ, at the place where they originally landed after the impact that produced them. The authors produce no evidence to support that assumption—and, if true, such an outcome would be highly unusual. Tektites are not commonly found in situ, but instead generally are found in deposits younger than their isotopic ages, a fact that has led to the so-called age paradox (2–4). Numerous authors have documented that tektites were often used by primitive humans to make stone implements or as talismans (5). In the case of the tektites found in Australia (australites), it has been suggested that transport by aborigines might even be at least partly responsible for the age paradox (6). As Fiske *et al.* (3) state, “[a]s it is sometimes difficult to establish the *in situ* nature of tektites with certainty, caution should be applied to their use as a stratigraphic marker.”

It will be difficult to demonstrate that the tektites found in the Bose basin were in situ at the time of discovery, as proposed by Yamei *et al.* One way to do so would be to find unmelted impact ejecta, such as coesite or shocked quartz exhibiting planar deformation features, in the same sediments in which the tektites and artifacts were found. Also, if Yamei *et al.* are correct and the tektites were actually found in situ, then one can calculate an average rate of uplift in this region of the Qinghai-Tibetan Plateau: 100 m of uplift in 803 thousand years (ky) gives an average uplift rate of 0.012 cm per year or 124 m per million years over the last 803 ky. Does that agree with other estimates of the uplift rate in this area?

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Tektites found in association with stone artifacts at several Bose river terrace localities in southern China have been dated at 732 ± 39 ka (1) and at 803 ± 3 ka (2). It is appropriate, however, to be very cautious about associating tektites with archaeological materials found in the same location in river deposits. In island Southeast Asia, it has been repeatedly demonstrated—for example, at the Sangiran hominid locality, central Java—that tektites have been redeposited and that the isotopic ages do not date the deposits in which the tektites were found, let alone the archaeological materials, but only the tektites themselves (3–6). The Bose tektites all show fluvial abrasion, whereas the stone artifacts are in fresh condition.

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Response: In the comments of Koeberl and Glass and of Keates, three principal issues are at stake: First, do the Bose tektites occur in situ and exclusively associated with the stone tools, as described by Hou Yamei *et al.* (1)? Second, were the tektites largely transported

by fluvial processes? And, third, does the context of the tektites reflect their original chronostratigraphic position? Observations of sedimentary and stratigraphic context, tektite form, and geomorphological distribution all indicate a firm in situ and original association and a sound basis for assigning the tektite age to the tools.

There are seven recognized river terraces in the Bose basin (Fig. 1), including three younger than terrace 4 (T4), in which the stone tools and tektites were found. The tektites are dispersed throughout the basin exclusively at the artifact level, with no evidence of concentration by stream processes or by humans. They were found consistently near the top of T4 in a silt or clay matrix, with no evidence of the gravels that typify the lower unit of T4. The absence of gravels at the tektite level cannot easily be explained if water transport were responsible for tektite deposition. Furthermore, the tektites were well preserved both at loci where stone tools were present and at loci where they were absent, and none of the macroscopic tektites exhibited any evidence of human modification.

Macroscopically identified tektites ≤ 5 mm in diameter commonly exhibit delicate forms, with elongate, plate-like, or shard-like shapes; the thin, angular features of these tektites would not have survived transportation and redeposition by water. Tektites ≥ 10 mm in diameter are spherical to ellipsoidal and typical of original splashform shapes (2). These larger forms are also generally uneroded; the margins preserve flow-like features and bubbles that are absent only a few millimeters into the body of the tektite (only black, dense, uniform glass was observed in the body of the tektites). The completeness of this outer shell implies that no erosion has taken place. In representative large tektites from Bose (Fig. 2), sharp-edged pits and other features commonly are present on one side, with smooth, melt-like features on the opposing side. In addition to macroscopic forms, microscopic specks of sharp, delicate tektites pervade the Bose T4 sediments in which the artifacts were found. Thus, we found no evidence of size sorting, which also argues against fluvial transport.

Finally, the tektites occur in a stratigraphic position that can be traced laterally over several tens of kilometers and that includes the basin center. The presence of tektites and stone tools away from high-gradient highlands means that there is no geomorphological basis for suspecting redeposition of either tools or tektites.

The combined evidence suggests that Keates's claim that all Bose tektites show fluvial abrasion is without basis and that fluvial transport and redeposition to younger beds can be discounted. We do acknowledge, however, the age paradox noted by Koeberl and Glass, in

TECHNICAL COMMENTS

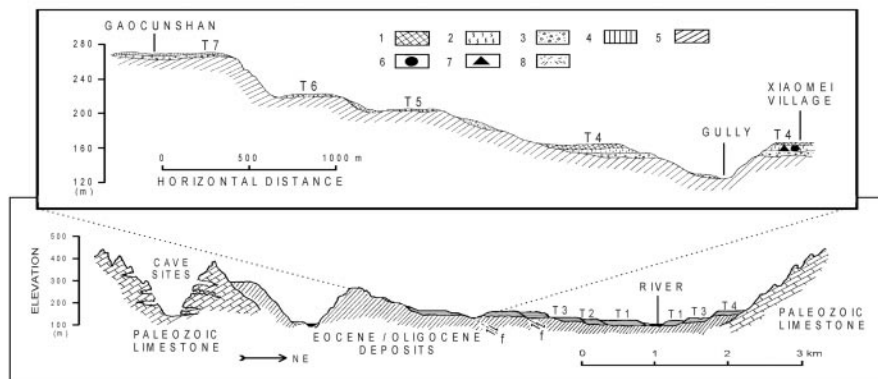


Fig. 1. Stratigraphy of the Bose Basin. River terraces and highlands are indicated on a composite profile, part of which (between Xiaomei and Gaocunshan) shows the stratigraphic position of associated stone artifacts and tektites on T4. Sediments: 1, latosols; 2, reticular mottled brick-red clay; 3, sand and gravel; 4, loessic soil; 5, basal rock; 6, tektites; 7, Paleolithic artifacts; and 8, slopewash (colluvium).



Fig. 2. Tektites from T4. Scale bar is divided into 1-cm units.

which tektites commonly are associated with younger sediments. In response, we note that at Bose, Paleolithic stone tools and tektites were observed to occur exclusively in T4, were found in excavation, and, thus, are in situ. The apparent absence of either tools or tektites in the three terraces that formed after T4 argues

against the idea that the Bose tektites form a disconformable horizon between younger and older deposits. That the Bose tektites were somehow displaced into significantly younger sediments requires special pleading as to how the tektites avoid the three younger terraces and came to have an exclusive association with the stone tools in a discrete excavated horizon.

In response to the final point of Koeberl and Glass, although river downcutting and terrace formation were related to uplift of the Tibetan Plateau (located to the northwest), the Bose basin is not located on the Plateau; thus, the elevation of Bose T4 above the river provides no direct measure of the rate of Plateau uplift.

We conclude that the tektites are conformable in T4 and that their association with the Acheulean-like artifacts provides the basis for a

precise age date of the tools. We will continue to test this conclusion with analyses of the type suggested by Koeberl and Glass and with further analysis of the charcoal fragments, which also appear to have an exclusive association with the tektites and the stone tools in T4.

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