Comment on “Outburst flood at 1920 BCE supports historicity of China’s Great Flood and the Xia dynasty”

Chun Chang Huang,1a Yali Zhou,1 Yuzhu Zhang,2 Yongqiang Guo,3 Jiangli Pang,1 Qiang Zhou,3 Tao Liu,4 Xiao-chun Zha3

Wu et al. (Reports, 5 August 2016, p. 579) reported an enormous flood in the upper Yellow River that destroyed the Lajia Ruins. However, published research shows that the Ruins were destroyed at 3950 years before the present (B.P.) by earthquakes accompanied with mudflows, whereas the landslide-dammed lake terminated about 5650 years B.P. Various kinds of sediments with different ages were taken as evidence to verify an outburst flood.

Wu et al. (1) provided seeming geological verifications of the ancient myths of the Great Yu’s flood. However, this Report fails both to cite and to address the alternative interpretations by geologists and archaeologists. It ignores important studies concerning prehistoric extraordinary floods of the Yellow River; landslides and damned-lake deposits in the Jishi Gorge; and palaeo-earthquakes, flashfloods, and mudflows that occurred at the Lajia Ruins (Fig. 1, A to F). As palaeo-hydrologists (2–4), we are not in a position to say anything about the Great Yu and the Xia dynasty in Chinese prehistory, but we would like to point out some obvious misleading evidence that the authors organized to verify the so-called outburst flood.

First, the Lajia Ruins were destroyed at 3950 years before the present (B.P.) by earthquakes accompanied with mudflows from the hillsides rather than by the Yellow River floods. Archaeological excavations have exposed pictures of the prehistoric catastrophes in the Lajia Ruins. Geophysical investigations show that, at 3950 years B.P., multiple disasters, including major earthquakes, rainfall, flashfloods, and mudflows, occurred over the area. The earthquake-damaged settlement was immediately overtaken by immense mudflows coming along the gullies. Enormous mudflows poured into the dwellings suddenly, and the instinctive reactions of women and children have been preserved in the rigid mudflow deposits (Fig. 1, G to I). The source of the catastrophic mudflows was traced upslope northerly to the gully heads behind the ruins, where palaeo-earthquakes together with rainstorms and flashfloods induced widespread mass wasting on the hillsides composed of the semiconsolidated Tertiary red clay formation (5–8). Similar conclusions were also drawn by other researchers (9).

The thick deposits of red conglomerated mudflows packing human skeletons and the ruins were regarded as the Yellow River flood deposits initially (10, 11). This was negated by other investigators, including Wu et al., because, hydrologically, the Holocene floods of the Yellow River in this reach, with a channel width of 800 to 1000 m, could not rise 25 to 30 m to have the prehistorical settlement inundated. Meanwhile, as is generally known, the suspended sediment load of the Yellow River is always yellowish dispersive silt rather than rigid conglomerated red clay, and also the skeletons of drowned people could not show vivid postures, as in the Lajia Ruins.

Second, the landside-dammed lake in the Jishi Gorge terminated at 5650 years B.P. gradually rather than bursting suddenly, without relation to the catastrophes that ruined the Lajia settlement at 3950 years B.P. Investigations indicate that the damned-lake sediments extend about 33 km and end up at 1915 to 1920 m above sea level (asl) within the Xunhua basin in the upper stream (7). There are no lake sediments found to support the claim that the dammed lake extended 85 km further into the Jianzha Basin and ended up at 2005 m asl (7). Maximum depth of the dammed lake was therefore estimated to be 80 to 85 m rather than 185 to 210 m (7). The top part of the lake sediments contains abundant shallow water plant remains and inset with slope clastics in between the beds, indicating that the dammed lake became shallower and desiccated gradually rather than burst suddenly. Incision of the Yellow River into the dammed-lake deposits has formed well-exposed profiles along the river banks. These deposits profiles provide a natural record of the life span of the dammed lake (Fig. 2, A to D). The bottom sterile clay beds deposited during the last deglaciation of the Tibetan Plateau were dated by optically stimulated luminescence (OSL) to 8250 ± 390 years, whereas the top silt beds containing shallow water plant remains were OSL-dated to 5650 ± 210 years (7). The dammed lake existed for about 2600 years and became shallower gradually and disappeared at 5650 years B.P. because the landslide dam was dissected slowly by the river itself. This is much earlier than the catastrophes that ruined the settlement at Lajia (5–8). Similar conclusions were also drawn by other groups of investigators (13, 14).

Third, palaeo-earthquake sand boils over the Lajia Ruins and various sediments of different ages were taken as the evidence to verify the so-called outburst flood. Over the Lajia Ruins, several great earthquakes occurred during the Holocene. The ground composed of eolian loess soils of the late Pleistocene-Holocene was badly broken and deformed by the impact force of the palaeo-earthquakes. These are common conclusions published by both archaeologists and geologists (5, 10, 15). Numerous earthquake fissures with a width up to 60 cm interweave over the prehistoric ground. Some of the fissures are infilled with the red mudflow lumps dropping down from the ground of the ruins. The others are infilled with sand boils because of the underground liquefaction and impact force during the earthquakes. The sand boils settle on the prehistoric ground have formed sand lenses sandwiched in the loess-soil stratigraphy (Fig. 1, A to F). However, these mixed gray-red-brown-colored clastic sands were regarded as the outburst flood deposits from the dammed lake in the Jishi Gorge (7). The fact is that these sands originated from the tributary gully flashflood deposits beneath the stratigraphy of eolian loess soils. They have nothing to do with the landslide dam and the dammed-lake deposits. A green schist clastic in the sand boils was especially stressed as the most reliable evidence of an outburst flood from the Jishi Gorge (7). However, the Yellow River cuts into the fractured green schist bedrock forming a part of the gorge. The clastics always drop into the river and are brought downstream by the river at all times. It is not necessarily related to the so-called outburst flood.

Along the Yellow River banks and the feet of the cliffs and slopes, various kinds of sediments with different ages were also regarded as the deposits of the so-called outburst flood (7). These include the widely distributed slope clastics and landslide/landslip deposits along the Jishi Gorge, the flashflood deposits along, or at the mouth of, the tributary gullies, the Yellow River floodplain gravels, and the river terrace deposits under the eolian loess-soil stratigraphy of different thickness within the Guanting Basin (Fig. 2, E to G).

In conclusion, the hypothesis of an enormous outburst flood associated with the myths of the Great Yu has been argued by ignoring numerous published studies that present alternative interpretations.
Fig. 1. Evidence of the great earthquakes and rigid mudflow deposits over the Lajia Ruin of the Qijia Culture (4200 to 3950 years B.P.). (A) Prehistorical ground of the Lajia Ruins covered with the conglomerated red mudflow deposits and the tensional earthquake fissures infilled with the dense blocks of the red mudflow. (B) A close-shot photo of the rigid red mudflow deposits. (C and D) Mudflow infill pressed into a slab in the compressional earthquake fissures. (E) Earthquake sand boils deposited on the prehistorical ground and now sandwiched in the loess-soil stratigraphy. (F) Cultural layer of the Lajia Ruins covered with rigid red mudflow deposits, sand boils coming up along the earthquake fissures. (G to I) Different postures of the victims sinking into the red mudflow in the Lajia Ruins. The sand boils in (E) and (F) and the rigid mudflow deposits in (G), (H), and (I) were regarded as the so-called outburst flood deposits [e.g., figure 1 and figures S1, S5, and S6 in (1)]: OFS at P13 and the Lajia site.
Fig. 2. Evidence of the landslide dam and the dammed-lake sediments in the Jishi Gorge and sediments of different origins in the downstream regarded as the so-called outburst flood deposits. (A) Remains of the landslide dam dissected by the Yellow River. (B) The dammed-lake deposits with a thickness up to 37 m forming the banks of the Yellow River. (C) The bottom part of the dammed-lake deposits consisting of greenish sterile silt and clay deposited during the deglaciation over the Tibetan Plateau. (D) The top part of the dammed-lake deposits containing the remains of the shallow water plants inserted with slope clastics in between the beds. (E) Slope clastic deposits on the riverbank immediately in the downstream of the landslide dam; note the yellowish floodwater of the Yellow River on 31 July 2013. (F) Yellow River floodplain deposits. (G) Tributary flashflood deposits settled on the Tertiary red clay formation and covered with the Holocene eolian loess soil. (E), (F), and (G) were regarded as the so-called outburst flood deposits [e.g., figure 1 and figures S1, S4, and S6 in (1): OFS at P8, P11, P12].
REFERENCES AND NOTES


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