# AGE OF THE TOADS IN THE A. H. HOLLOMAN SAND PIT AT FREDERICK, OKLAHOMA

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The sand and gravel deposit at Frederick, Oklahoma, has elicited nation-wide interest not alone because of the human artifacts found in the deposit with parts of Pleistocene mammals, but also because of the live toads found inside the balls in the sand and gravel. These animals have been called frogs, but Dr. A. I. Ortenburger, of the department of Zoology, University of Oklahoma, has identified them as the common toad *Bufo* and the Spadefoot toad *Scaphiopus*—two species which he says are common in the Frederick region at the present time.

The age of the deposit has been placed as Pleistocene because of the included fossils, the only suggestion noted that the deposit may be much younger having been made by Professor O. F. Evans. He has thought that it may represent a reworked deposit in which the Pleistocene fossils have been carried from older ones to the north and west in comparatively recent times. This suggestion is thought-provoking, and is worthy of being thoroughly tested. However, some of the evidence seems to indicate that the deposit is Pleistocene, and that it has not been reworked in recent times; namely, its isolation from larger streams, its elevation above all of the present stream channels, indicating a vast amount of erosion since it was made, the presence of the Glyptodon carapace high up in the deposit, which would not have withstood reworking without being completely demolished, and the thorough induration of much of the lower part of the deposit.

If the deposit is Pleistocene, as is thought by most who have studied it, the question next arises as to whether the live toads which have been found inside of clay balls in the deposit necessarily are of the same age. One of these toads which was sent to Washington, D. C. for inspection, is still alive, being transparent and having a much abbreviated and darkened digestive system. He has been christened "Pleistie," suggesting that he originated in the Pleistocene.

*But did he?* This question might lead us to inquire how the balls were formed, and how the toads got inside of them. As to the origin of the clay balls, a few years ago, in the southern edge of Kansas a few miles northwest of Winchester, Woods County, Oklahoma, along a northern tributary of Salt Fork, the writer found some recently formed clay balls in the channel of the stream. In high water the stream had impinged against and undercut a clay bank. Masses of clay being let down into the current were carried forward and rounded up by abrasion. These clay balls were carried forward and scattered in a linear deposit between one-eighth and one-fourth mile and deposited in the depressions between cobble stones and on the sand. If the Pleistocene clay bank above Frederick was undercut by a stream at that time, were toads hibernating in the clay and left rolled up in the balls since that time? Such a method has been suggested, but my mind is very skeptical of the possibility of the formation of clay balls in streams by accretion. If it were possible for them to be formed in that way, did the toads lose their balance in the water, and did the clay adhere to their wet, slimy bodies as they were rolled over and over in the current until they were included and finally formed the nuclei of the clay balls?

It seems improbable that the toads got into the balls in either of these ways. To account for their presence it is here suggested that the balls in the deposit originated by two very distinct methods. The types of origin suggested are: first, that part of the balls were formed and included as clay balls in the deposit made by the stream during the Pleistocene, and later that some of these clay balls were increased in size from a calcareous solution carrying some pink clay. Many of the balls have a red clay center covered by a highly calcareous pink deposit on the outside, some showing gravel and sand cemented on the exterior portion of the ball. The second method of origin suggested is, that some of the balls represent deposition from solution alone, and hence were formed later than the rest of the deposit.

This second type of ball, then, may represent any time from that early one in the Pleistocene nearly to the present, depending on the relations of the materials in solution to the changes in the level of ground water. Some of the balls, then, may be Pleistocene in age, some may represent any time from the Pleistocene to very recent, and it is thought that the toads have been included in those of the more recent type.

How then did the toads get inside the balls? It is suggested that in the normal course of hibernation some of them burrowed down to the level of ground-water, and that those which happened to be favorably (or unfavorably) situated with reference to descending solutions early found the little space in which they were hibernating becoming locked in by a calcareous deposit, but were too sleepy to attempt to break through the thin wall as it was first forming around them. Later, when they were completely tired of hibernating, the stored fat having been consumed and the pangs of hunger began to prod, they tried to break out of their hibernat-

ing nest, but found the walls too strong to penetrate. Then, as the smooth interior walls of the chambers gave evidence of repeated struggles to escape, the walls were constantly being thickened and strengthened by additional deposits, so that apparently they were locked in forever, or until released by the friendly hand of Mr. A. H. Holloman.

In examining the walls of the balls in which the toads were found, they are seen to consist chiefly of calcium carbonate with a minor amount of fine pink clay, such as is found in concretions of various sorts and shapes in the pit and in the superficial coating on some of the regular clay balls. Further evidence of effective solution and deposition is seen by the thorough induration of the sand and gravel in the lower part of the deposit by a calcium carbonate cement. That these solutions were carried more effectively in certain channels than in others is indicated by the irregular distribution of the indurated deposits.

To go back to the question with which we started, the age of the toads, how long have they been inside the balls? The answer is, some for a longer period and others for a shorter, as evidenced by the condition in which Mr. Holloman found them. Some were dead or died instantly when he opened the balls, others lived for several days, while "Pleistie," with small transparent body and abbreviated digestive system has lived for more than a year. One large common toad, *Bufo.* is of normal size and color and looks as though he had been only slightly affected by his imprisonment, while a small turtle which Mr. Holloman says was enclosed in a ball with a very thin wall seems little the worse for his period of imprisonment. How long, then, have the toads been inside the balls? Certainly not for 200,000 years, nor for 50,000, probably not 1,000, and some of them possibly considerably less than 100 years, and it seems probable that the large Bufo and the turtle were imprisoned for only a very few years. Possibly an experiment could be devised to determine the rapidity with which calcium carbonate would be precipitated under conditions similar to those prevailing in the sand pit. It is possible that excretions from the animals may accelerate precipitation. According to the experiments made by Dr. W. H. Emig* in the Arbuckle Mountains in 1917, with conditions prevailing at the surface of the water along the streams, the toads could easily have been enclosed in one or at least two hibernating seasons. He found that at the end of three days a very distinct deposit occurred on cotton rope, felt cloth, and copper wire screen, and at the end of three weeks these articles were covered by a hard calcareous coat. While the rate of precipitation from solution would normally be less beneath the surface than at it, due to decreased evaporation, other causes may have functioned locally to accelerate the rate of precipation, and excretions from the toads and the turtle may have been one of the contributing causes.

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*Emig, W. H., Okla. Geol. Surv. Bull. 29, pp. 70, 71, 1917.