Fossilized hominid baby skull from the ferricrete at Odai, Bommayarpalayam, Villupuram District, Tamil Nadu, South India

During a recent geo-archaeological exploration and excavation conducted in October 2001 by the first author at Odai, besides finding Mesolithic and Upper Palaeolithic artifacts from stratified fluvial and aeolian deposits, a well-fossilized human skull was discovered from within the ferricrete. The site is located about 1 km inland from the coast and 2 km south of the Pondicherry border near Bommayarpalayam at an altitude of 15 m above the sea-level (Figure 1). At the site there are aeolian and fluvial deposits from the surface down to 5.7 m. Five layers of aeolian sand and four layers of sand and gravel of varying thickness are seen intermittently. Below 5.7 m depth the ferricrete begins and it continues downward. At about 1.5 m depth in ferricrete cutting, a small part of fossilized material was seen on 14 October 2001 at 12:45 pm. Since the ferricrete at the site is quite hard, it was impossible to extricate the fossil from the matrix. Close examination of the fossil revealed that it would be detrimental to remove the surrounding laterite.

The normal palaeontological approach to this sort of problem is to extract the fossil in its entirety from the matrix. This can be done chemically, by dissolving the matrix away to leave the fossil or by dissolving the fossil away to leave a hole from which a latex cast can be made, or physically, by digging the fossil out with fine needles or drills. In this case, none of these approaches was particularly useful, and therefore, the entombed fossil was dug out along with the surrounding ferricrete for further study.

Thousands of hominid fossils ranging from a few lakhs to over four million years old are known from different parts of the world and most of them have been found in stratified context. Some of the human fossils discovered earlier from different parts of the world include the *Australopithecus afarensis* of 3.3 to 3.6 million years of age from Hadar in Ethiopia by Johanson (see refs 1 and 2); *A. africanus* of 2 to 3 million years of age from Taung by Dart[3], and Clarke from Sterkfoutein in South Africa; *A. robustus* of 1.5 to 2 million years of age from Kromdraai by Terblanche[4] and by Keyser from Drimolen cave in South Africa; *A. boisei* of 1.5 to 2 million years of age from Olduvai Gorge in Tanzania[5,6] and from Congo in Ethiopia by Amzaya.

Homo habilis of 1.5 to 2.4 m years of age was discovered by Leakey and White from Olduvai Gorge in Tanzania[7]; *H. erectus* of 300,000 to 1.8 million years of age by Dubois from Trinil on the Indonesian island of Java and Kimeu from Nariokotome in Kenya[8,9]; and by Sonakia from Narmada valley in India[10,11]. *Homo sapiens* (Archaic) of 2,00,000 to 5,00,000 years of age from Petralona in Greece; *H. sapiens* (Neanderthalensis) of 2,30,000 to 30,000 years of age from Feldhofer in the Neander valley, Germany by Fuhlrotte and by Leveque from Saint-Cesaire in France[12,13]; *H. sapiens sapiens* of about 1,20,000 years of age from Cro-Magnon in France. However, none of them have been found within the ferricrete and, therefore, they could be retrieved without much damage. Now, a human fossil has been found entombed in hard ferricrete of the Pleistocene period.

The next attempt was to explore the methodology in the study of the entombed fossil. Since no precedence was known to study such a specimen, it was decided to image the fossil inside the nodule using technologies developed for medical scanning. Initial attempts were made with X-ray computed tomography (CT) at the Kumar Hospital in Kollam to spot the fossil inside the nodule. CT X-rays were passed into the specimen from 360° and detected by a row of detectors in the opposite side. The difference in the density of the material is reflected as the difference in the intensity of X-rays. This difference is projected as an image by a complicated reconstruction algorithm. Thus an oval structure surrounded by the hard matrix has been well identified and it has confirmed the existence of a human fossil within it.

Then the scanning technique (2D) AP Scanogram slice from above, AP Scanogram with image planes, cross-sectional images, and lateral scanogram viewed from the side were carried out. These analyses have shown several human cranial features on various images.

However, the search continued since several points on its full morphology and orientation remained inconclusive from the 2D images. At that time a piece of recent literature regarding the 3D morphology reconstruction of Herefordshire fossils was obtained from the Internet. According to the literature, theoretically it is possible to image the fossils inside their nodules using technologies developed for medical scanning. Some of these include magnetic resonance imaging (MRI), CT scanning, scanning 2D and 3D, etc., which are expensive. This shows that the medical methodologies such as CT and 2D scanning carried out earlier are correct.

MRI can work only with fluids and is thus of no use for the investigation of material like solid fossils. In this case, CT and 2D scanning have already been carried out. Now only 3D scanning remains to be applied, which is best suited for reconstructing the full morphology of the entombed fossil. Even though the resolution of the current medical CT machine is relatively low, CT works by passing X-rays through the sample from many different angles, using different densities, and helps in locating the fossil inside the nodule. Two- and three-dimensional scanning of the specimen is the best for reconstructing the full morphology of the entombed fossil. Though these techniques are very expensive, the morphological information obtained through the 3D image is much more when compared to a 2D one.

At a 3D scanning facility in the Upasana Hospital at Kollam, in order to extract all the cranial features of the fossil, the scanning in thin helical runs (3 mm × 4.5 mm) of the entire specimen on different planes was carried out and reconstructed at 2 mm interval.

The scanogram has revealed a hemispherical solid object with a spherical object within it having a few lucent areas. Serial axial section shows the

Figure 1. Panoramic view of the site at Odai.

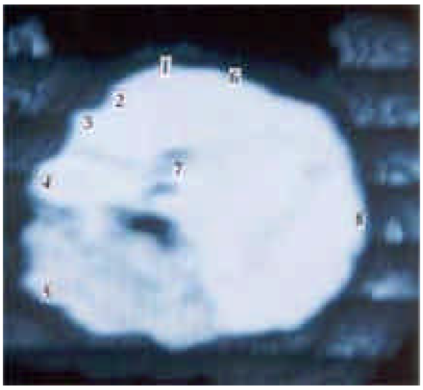

Figure 2. Three-dimensional minimum intensity projection image of skull. (1) Frontal bone, (2) Orbital cavity, (3) Nasal bone, (4) Maxilla, (5) Mandible, (6) Parietal bone, (7) Sphenoidal fontanella and (8) Occipital bone.

Figure 3. Three-dimensional minimum intensity projection image of face. (1) Eye orbit and (2) Nasal bone.

same hemispherical solid object with a central, slightly hypodense ovoid–spherical object having air-containing clefts within. The spherical object is covered by a fossilized structure measuring 1–2 mm, which has been identified as the fossilized part of the cranial bone having CT attenuation of 1192 HU (Hounsfield Unit). The CT attenuation of the ovoid–spherical object – the brain – ranges from 1137 to 1765 HU, which is lower than the outer hard matrix (ferricrete) having CT attenuation ranging from 1628 to 2383 HU. The CT attenuation of the teeth ranges from 1322 to 1984 HU. The length and breadth of the cranium were measured to be 10.1 and 8.6 cm respectively and its capacity has been calculated, based on the ellipsoid formula, to be 312 cc. Studies have been repeated on many planes at different angles and hundreds of images have been reconstructed, thereby identifying various morphological features of the human skull besides its orientation, state of preservation, etc.

Images of the skull include 3D minimum intensity projection image showing the frontal bone, orbital cavity, nasal bone, maxilla, mandible, parietal bone, sphenoidal fontanella and occipital bone (Figure 2) and 3D the projection image showing the eye orbit, and nasal bone (Figure 3). Some of the other important images of the skull include axial 3D maximum intensity projection image revealing ferricrete, cranial bone, and brain tissue; basal image having nasal bone, posterior nasal aperture, foramen ovale, zygomatic arch, carotid canal, foramen magnum, and foramen lacerum; 3D minimum intensity projection of the cerebral axial image showing frontal pole, and longitudinal fissure; axial 3D maximum intensity projection image indicating the cranial bone, brain tissue and teeth within the maxilla and mandible; and plane axial section showing the coronal suture, anterior fontanella and sagittal suture, etc.

Based on the anatomical inferences drawn from the several scanned images of the Odai specimen, it is now clear that it is a well-preserved, fossilized, intact pediatric skull. Even the fossilized brain is seen in full inside the brain case of 312 cc, and the cranial bone measures 1–2 mm in thickness. Milk teeth have been noted both within the maxilla and mandible. These characteristics along with the nature of the fontanella indicate the age of the baby to be below five months. The extraordinary state of preservation of the complete skull with the fossilized brain inside the cranium is probably due to its getting sealed in the non-airy deposit immediately after the death of the child. Studies elsewhere by Hatcher *et al.*[14], De Leeuw and Largeau[15], Knicker *et al.*[16] and Hedges *et al.*[17] on the preservation of organic matter in terrestrial and marine contexts may help further to understand more about the nature of preservation of the Odai human fossil. In this context the remaining part of the child is likely to be there *in situ*, and the presence of adult hominid fossils within the ferricrete at Odai cannot be ruled out. Hence this is one of the most potential hominid sites in India which requires further scientific study.

The skull rests on its side and is entombed in the fully ferricretized alluvial matrix. A similar type of ferricrete on Kerala coast has been dated by electron spin resonance to 0.187 million years[18]. Therefore, more or less the same age can be assigned to the ferricrete at Odai and to the infant baby skull found within it. In the hominid evolutionary stage this may belong to the *Homo erectus* or *Homo sapiens* (Archaic) which had existed during the late Middle Pleistocene or in the early Upper Pleistocene age. Interdisciplinary studies, including DNA analysis, are still in progress to find out the absolute chronology and the exact genus and species of the 'laterite baby'.

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ACKNOWLEDGEMENTS. We acknowledge the observations and suggestions made by Dr G. Sujathan and Dr V. M. Kurshid, Thiruvananthapuram Medical College and the excavation permission given by the Archaeological Survey of India. Our thanks are due to Dr K. K. Kusuman, History Department, Kerala University; Dr K. S. Mathew, History Department, Pondicherry University, and the Director and Staff, Directorate of Archaeology, Tamil Nadu. We thank Mrs Thomas Kunnikal and George Kutty for successfully conducting the excavation. We also thank the radiographers M. Sajeey, S. Geetha and Johnson Thundil Varghese.

Received 6 May 2002; revised accepted 6 January 2003

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FROM THE ARCHIVES

Vol. X] FEBRUARY 1941 [NO. 2

The First All-India Pharmaceutical Conference

The first session of the All-India Pharmaceutical Conference was held in the Benares Hindu University on the 3rd and 4th of January 1941, Mr S. N. Bal, Ph.C., M.S., Curator, Industrial Section Indian Museum, presiding. Prominent scientists and representatives of pharmaceutical concerns from all over India attended the session.

Sir Sarvapalli Radhakrishnan, inaugurating the Conference, said that along with the social and political awakening in our country we are passing through a phase of industrial renaissance. He observed that India hitherto used to export raw materials and import manufactured drugs resulting in a great loss to the country's wealth.

Besides a number of scientific papers read, two symposia were held, the first of which was on the organization of the chemical and pharmaceutical profession in India with Prof. J. C. Ghosh, Director, Indian Institute of Science, as Chairman, and the second was on the manufacture of drugs from indigenous resources with Prof. T. R. Seshadri of the Andhra University as Chairman. In the course of his address Prof. Ghosh remarked, 'The war is an ill wind, but it has blown at least one good thing – the public are now keenly anxious for the proper development of a pharmaceutical industry and the proper organization of pharmaceutical studies in the country. In olden days the apothecary used to make in a shop all the pills, tinctures and extracts which the physicians prescribed, but the base of most of these pharmaceutical operations has now been transferred from the apothecary's stores to the factor of the drug manufacturer; it is here that the chemist and the pharmacist meet'. He then referred to the Drugs Act and the proposed Pharmacy Act and pointed out how they would create a continual demand for highly trained pharmaceutical chemists.

Introducing the symposium on the manufacture of drugs from indigenous sources, Prof. Seshadri pointed out that though the present time may be said to be the most propitious for the rapid development of a drug industry in India, the response from industrialists including capitalists and technologists has been comparatively poor. A guarantee that the present demand by the Government and the public for drugs manufactured in India will continue and that legitimate protection against outside competition will be given after the war, is needed for providing the necessary stimulus for large-scale drug production in the country. A protected drug supply is as important to the health of a community as a protected water or food supply. No famine in these essential requisites or blockades can be allowed. He then discussed how the Government, the industrialists, the scientists, the universities, the politicians and the public can play their part for the rapid development of the drug industry.