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# 5,000 years old Egyptian iron beads made from hammered meteoritic iron☆

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ABSTRACT

The earliest known iron artefacts are nine small beads securely dated to circa 3200 BC, from two burials in Gerzeh, northern Egypt. We show that these beads were made from meteoritic iron, and shaped by careful hammering the metal into thin sheets before rolling them into tubes. The study demonstrates the ability of neutron and X-ray methods to determine the nature of the material even after complete corrosion of the iron metal. The iron beads were strung into a necklace together with other exotic minerals such as lapis lazuli, gold and carnelian, revealing the status of meteoritic iron as a special material on a par with precious metal and gem stones. The results confirm that already in the fourth millennium BC metalworkers had mastered the smithing of meteoritic iron, an iron–nickel alloy much harder and more brittle than the more commonly worked copper. This is of wider significance as it demonstrates that metalworkers had already nearly two millennia of experience to hot-work meteoritic iron when iron smelting was introduced. This knowledge was essential for the development of iron smelting, which produced metal in a solid state process and hence depended on this ability in order to replace copper and bronze as the main utilitarian metals.



## 1. Introduction and archaeological background

The production of iron metal from ore only started in the mid-second millennium BC, but a number of earlier iron artefacts are known to exist (Waldbaum, 1999, and literature therein), or at least have been claimed at various stages to be early iron artefacts. These could either be made from accidental by-products of copper smelting, or represent meteoritic iron, or be younger iron intruded into older archaeological contexts, such as the alleged 6th millennium iron object from Samarra (Herzfeld, 1930), later dismissed by the excavator as an Islamic intrusion (Herzfeld, 1932). Confusion also exists over objects made from minerals such as magnetite, which can be mistaken to be corroded iron and even exhibit exsolution lamellae which appear in the microscope similar to the famous Widmannstaetten texture of meteoritic iron; this seems to be the case for instance with the nodules reported by Ghirshman (1939: 206) from Tepe Sialk II, identified as magnetite ore by Pigott (1984). Microchemical and metallographic criteria clearly distinguish these different materials (Buchwald, 1975, 1977, 2005), but their investigation requires invasive sampling, which is not acceptable for archaeological finds of such importance and rarity. The nature and origin of mankind's earliest iron artefacts have therefore remained a matter of uncertainty and dispute. The same is true for the set of iron beads reported here ever since their excavation in 1911, in a pre-dynastic cemetery near the village of el-Gerzeh in Lower Egypt (Fig. 1), believed to be the earliest known extant iron artefacts.


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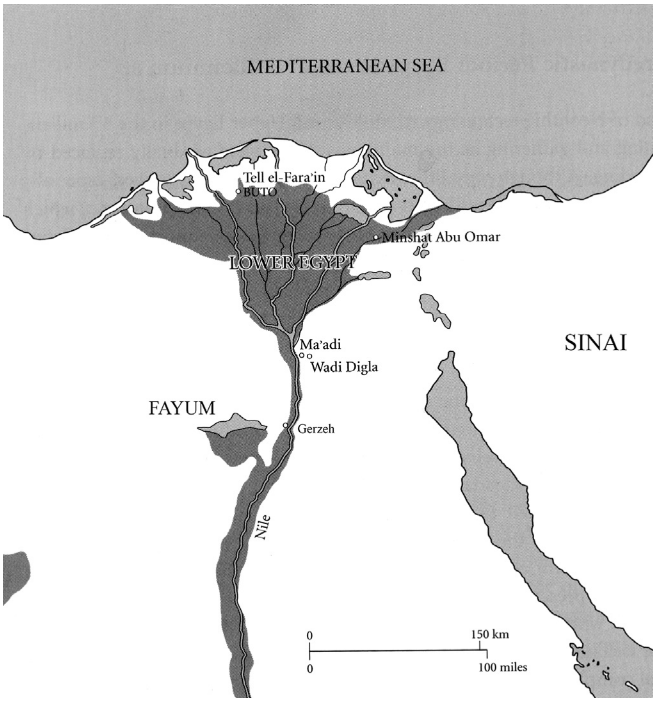


**Fig. 1.** Map of lower Egypt in the 4th millennium BC, with key predynastic sites marked. Gerzeh is near the entrance to the Fayum. Shaded area indicates cultivated land. Map by Gianluca Miniaci, adapted from Bard (2007).


**Fig. 2.** Collection of stone and faience beads from Tomb 67. UC10741, modern re-stringing, without the iron beads.

The excavation of these beads was supervised by G.A. Wainwright and J.P. Bushe-Fox as part of investigations in the district of Riqqeh for the Flinders Petrie British School of Archaeology in Egypt (Petrie et al., 1912). Wainwright recorded about 277 burials, securely dated by ceramic and other finds to Naqada Period phases IIC to IIIA, or in terms of absolute chronology about 3400–3100 BC (Stevenson, 2009: 11–31,10: 25).

A total of nine tubular iron beads were retrieved from the cemetery, all from two closed archaeological contexts, and so of secure date. Seven were recorded in tomb 67: three from the waist of the deceased, and four as part of a necklace placed round his neck (Petrie et al., 1912: 15–16). The necklace beads were found in their original order as strung with tubular lapis lazuli, carnelian, agate, and gold beads. Petrie et al. (1912: pl. IV.2) present the necklace beads in order as found; UC10742 is the modern restringing in a different order and excluding the iron beads (Fig. 2). In addition to the beads, tomb 67 contained also a limestone mace-head, a copper harpoon, and a small ivory vessel, a mudstone fish-shaped palette, an ivory spoon, a flint bladelet, two stone vessels, and twelve ceramic vessels (Petrie et al., 1912; Gerzeh tomb card no. 67 in Petrie Museum archive PMA WFP1/103/1/1; Stevenson, 2009: 198, Appendix E under ms 67).

One of the beads had been analysed in the 1920s and found to contain about 7.5 wt% nickel (Desch, 1929; Wainwright, 1932); another analysed later did not yield any nickel (Gowland and Bannister, 1927). More recent analyses of surface samples of three beads by electron microprobe revealed a fully oxidised structure incorporating sand grains (i.e. analysing most likely a secondary corrosion crust rather than the original metal body), with a nickel content below 0.2 wt% (El Gayar, 1995).

The other two iron beads come from grave 133, and according to the report they were placed at the hands of the deceased, but not such that the original order could be determined (Petrie et al., 1912: 16). This tomb contained the largest number of beads and of the most diverse materials in the entire cemetery: lapis lazuli, obsidian, gold, carnelian, calcite, chalcedony, steatite, faience, garnet, and serpentine. In addition the burial equipment included an extraordinary heterogeneous assemblage of artefacts and unworked materials: a porphyry bowl, a miniature pink limestone jar, a bird scutiform-shaped palette, an ivory spoon, a flint flake, an ivory comb (?), shells, a jackal canine tooth, 16 stones of carnelian, green jasper, and quartz, a lump of red resin, and nine pottery vessels (Petrie et al., 1912: 16; Stevenson, 2009: 195–196, Appendix E under ms 133).

The report places particular emphasis on the absence of any signs of plundering or later intrusion in both tombs (Petrie et al., 1912: 16–17): criteria for both tombs include the presence of valuable and unbroken objects; for tomb 67, there is also the preservation of the body in original position, and for tomb 133, where the bones were not well preserved, there was an intact mud coating, two inches thick, over the burial equipment and the body.

The gender of the deceased is not documented: the individual buried in grave 67 is said to belong to a “fair-sized boy” (Petrie et al., 1912: 5) with “a small body” (tomb card) but no more detail can be obtained either from the published report or from the tomb cards. However, both tombs present the widest range of object types in the cemetery, with unusually rich burial equipment and including a number of exotic materials, notably the iron beads. Both the material diversity and the wealth indicate marked social and economic distinction (status and wealth), and perhaps also a specific link to some particular role in specialised networks of exchange relations (Stevenson, 2009: 192–199). As such, the el-Gerzeh beads support the idea that the initial use of a metal, (e.g., iron, copper, gold), is less about exploiting characteristic material properties for functional uses, and more impelled by “the desire for new materials to serve as aesthetic visual displays of identity, whether of a social, cultural or ideological nature” (Roberts et al., 2009: 1019).

Since both tombs are securely dated to Naqada IIC–IIIA, c 3400–3100 BC (Adams, 1990: 25; Stevenson, 2009: 11–31), the beads predate the emergence of iron smelting by nearly 2000 years, and other known meteoritic iron artefacts by 500 years or more (Yalçın 1999), giving them an exceptional position in the history of metal use. Their early date makes it reasonable to assume that they were made from meteoritic iron; however, while the tombs were undisturbed, the intrusion into the tomb of man-made iron through taphonomic processes or contamination during excavation cannot be a priori entirely excluded. Here we present positive proof