Metallurgical investigation of an iron plate found in 1837 in the Great Pyramid at Gizeh, Egypt

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Abstract

An ironplate was found by an excavation team in the Great Pyramid at Gizeh, Egypt in 1837. This plate was said to have been found near an air passage high up on the flank of the Pyramid, but located *within* an undisturbed portion of that structure.

The plate was not examined in any detail at the time and it has since been in the safe keeping of the British Museum in London. A small fragment of the plate has now been subjected to detailed examination by modern metallographic techniques.

These techniques have shown, conclusively, that the plate consists of numerous laminates of wrought iron and that these laminates have been inexpertly welded together by hammering. The various layers differ from each other in their grain sizes, carbon contents, the nature of their non-metallic inclusions, and in their thicknesses. Some of the non-metallic inclusions are thought to consist of un-reacted (or incompletely reacted) fragments of the iron ore that was used to produce the iron metal. Other "inclusions" consist of iron oxide "scale" between the inexpertly welded iron laminates, and the sodium-and potassium-rich "ashy" remnants of the charcoal fuel that had been used during the smelting operation.

The iron grains in all the laminates are equi-axial whilst the non-metallic inclusions are invariably markedly elongated. These features suggest that the welding process had been carried out at modest temperatures - temperatures that allowed the iron grains to recrystallise whilst the inclusions retained their elongated forms.

None of the iron layers contains siliceous, slaggy inclusions. Furthermore, none of the other phases within the iron laminates shows any *metallic* copper globules, nor do they show more than small traces of the *element* copper. These features suggest that the Gizeh iron plate had not been produced as a by-product of copper smelting operations.

The outer layers of the iron have been badly corroded and now exist as complex banded iron oxides. small, but significant, proportions of gold were found in one of the oxidised layers and it is thought possible that the plate may, originally, have been goldplated.

The new metallurgical data, coupled with the archaeological information concerning the way, and the place, in which the plate was found, strongly suggest that this plate is contemporaneous with the building of the Pyramid and that it is, therefore, one of the oldest known plates of iron metal.

Background Information

A rectangular iron plate, roughly 26 cm by 8.6 cm in area and ranging in thickness from 0.4 cm to zero, is said to have been found *within* the stonework of the Great Pyramid of Khufu at Gizeh in Egypt during excavations carried out in 1837.[1] The plate has since been in the custody of the British Museum in London.

The age of this plate is important to archaeologists because, if it can be shown to be of the same age as the Pyramid, then it is one of the most ancient pieces of iron yet discovered. On the other hand, if it is merely an artefact that was left on, or in, the Pyramid by some later (possibly *much* later) mutilators of that structure, then it is relatively unimportant.

The great potential value of the iron plate was appreciated by the archaeologists who were working at the site where it was found; therefore, its location within the Pyramid structure was very carefully documented at the time. Day[1] in 1877 states that the iron was "not dug up amongst any rubbish or concreted mass at the foundation of the Pyramid . . . . ., but was obtained out of the solid masonry near the top of the building, as the following passage and certificates quoted from Vyse's original 1840 report *The Pyramids of Gizeh in 1837*[2] testify":

"Mr Hill discovered a piece of Iron in an inner joint, near the mouth of the southern air-channel, which is probably the oldest piece of wrought Iron known. It has been sent to the British Museum, with the following certificates:-"

"This is to certify, that the piece of iron found by me near the mouth of the Air-passage in the southern side of the Great Pyramid at Gizeh, on Friday, May 26th, was taken out by me from an inner joint, after having removed, by blasting, the two outer tiers of the stones of the present surface of the Pyramid; and that no joint or opening of any sort was connected with the above-mentioned joint, by which the iron could have been placed in it after the original building of the Pyramid. I also showed the exact spot to Mr Perring on Saturday, June 24th" . . . . (signed) "J R Hill"
"Cairo, *June 25th,* 1837."

"To the above certificate of Mr Hill I can add, that since I saw the spot at the commencement of the blasting, there have been two tiers of stone removed, and that if the piece of Iron was found in the joint pointed out to me by Mr Hill, and which was covered by a large stone, partly remaining, it is impossible it could have been placed there since the building of the Pyramid. (signed) "J S Perring, CE"
"Cairo, *June 27th,* 1837"