Metallographic Studies on an Ancient Roman Nail

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Abstract

The article deals with an ancient nail dated back to 87 A.D., found at Inchtuthil, Perthshire UK among the ruins of a Roman Legionary fortress.
Detailed metallographic studies have been performed to shed light on the manufacturing techniques used by the ancient Roman blacksmiths.
The analyses confirmed the high level of skill reached by these craftsmen in the large scale production of ordinary tools.
On the whole, the nail is of sound manufacture, devoid of macrodefects and of regular geometrical shape. The steel is made up of layers of distinct structures presumably obtained by repetitively fattening and folding of the blank with an anvil and hammer.

Riassunto

L'articolo tratta un antico chiodo risalente all'anno 87 d.C., rinvenuto ad Inchtuthil, Perthshire UK tra le rovine di una fortezza legionaria Romana.
Dettagliati studi metallografici sono stati condotti per fare luce sulle tecniche di costruzione adottate dagli antichi fabbri romani. Le analisi confermano l'alto livello di sviluppo raggiunto da questi artigiani per la costruzione su larga scala di oggetti metallici.
In complesso il chiodo è di sana manifattura, privo di difetti macroscopici e con geometria regolare. L'acciaio è costituito da strati di distinte strutture ottenute presumibilmente attraverso il ripetuto schiacciamento e ripiegatura del prodotto con incudine e martello.

Preface

The Hittites were the first population to learn how to work iron. The first notable archaeological metallic implements in fact, have been found in Anatolia and in Palestine and can be dated to the period 1300-1200 B.C. [Ref. 1]. The contemporary written sources also depict thriving activities. The letters of El Amarna (Egypt, 14th century B.C.) describe some of the presents made by the Mesopotamian ruler and given to the Egyptian pharaoh Amenophis III (1405-1367 B.C.); amongst these, stood out an iron dagger plentifully decorated. In a more recent period, (about 1280 B.C.) it is possible to notice in the correspondence of the Hittite king Hattusilis III, the following passage of a letter probably addressed to an Assyrian king: "Regarding the good iron that you are writing about — good iron is not available in my house of the seal of Kizzuwatana (the Hittite kingdom) for the moment — good iron is being produced here, but so far the production has not been carried out — when this will be done, I will send you the iron — Today I will hand you over a blade of a sword" [Ref. 2, 3]. Subsequently, the metalworking of iron was diffused throughout the Orient and then, in the Mediterranean area. It has been ascertained that, from the 8th century B.C. on, the populations of Greece, Spain, and of the pre-Roman Italy were completely aware of the techniques of iron extraction from its ores and of its hot forging procedures [Ref. 4, 5]. It is in this period (8th-6th century B.C.) that in the mediterranean basin the iron metallurgy overwhelms the production of bronze. The latter, still remaining in use above all for decorative objects, coins, plates and pots [Ref. 5]. Several hypotheses have been arisen to account for this transformation: from the technical standpoint, it can be said that the discoveries of carburizing and quenching allowed the fast development and diffusion of the iron technology [Ref. 1].

By means of the diffusion of carbon into the metallic matrix through a thermochemical route, it was possible to attain higher superficial hardness, toughness and mechanical strength in the iron-base products with respect to the corresponding bronze objects. These features soon became extremely interesting for the manufacture of several kinds of devices such as: ploughs, tools, axes and swords. Various examples of this technology can be dated to the period of classical Greece [Ref. 6] and of Etrurian Italy [Ref. 7].

Also the quenching treatment was well known, as Homer writes in the Odyssey: "It was as when a smith plunges an axe or adze into cold water, and it hisses loudly at the tempering, though this is what makes the strength of iron; so his eye hissed now with the olive-stake penetrating it". Significant examples of the techniques used in ancient Greece are given by scenes of blacksmiths' workshops painted on vases of that period [Ref. 8].

However, it is with Rome, first during the late Republic and then throughout the imperial Roman age, that the manufacturing of metals underwent a real definitive expansion and diffusion at any social

level [Ref. 9]. Although this period is not labelled by particular technological discoveries, the age when Rome was the leader city of the known world indicates the high level reached by metallurgy, both from an economical and organizational side and as far as its specialization is concerned. The demand for ferrous and non-ferrous metals for civil and military employments was increasing steadily. Above all coining underwent a significant development together with the manufacture of copper and its alloys. Moreover, the general improvement of life conditions in the empire supported the production of large amounts of jewels and of metallic ornaments.

The production of iron was subjected to an important development with the introduction of shaft furnaces and the new air furnaces with increased mass rates with respect to the devices used in the pre-Roman age [Ref. 10].

Of particular significance is the fact that each Roman legion had in its staff a certain number of blacksmiths and hand workers with their own field workshops, inferred from the implements recovered from the remains of the Roman military camps [Ref. 11, 12, 13].

From the "Notitia Dignitatum" (4th-5th century A.D.) it is known that at that time there were at least 32 independent workshops for the supply of goods and weapons to the Roman army. Each of them specialized in the manufacture of a particular kind of iron component. A particular role in the Roman society was held by blacksmiths. There were powerful corporations of iron blacksmiths in Milan, Brescia, and all along the Po valley [Ref. 8]. In this period the first encyclopaedic texts dealing with metallurgy were written. The Younger Plinio (1st century A.D.) in his "Naturalis Historia" tackles the issues of gold, silver, copper, lead, bronze and iron with interesting references to ore mining and to metal manufacturing [Ref. 14].

Introduction

A remarkable archaeological discovery of metallic articles dating from the Roman age was found at the beginning of the sixties and consisted of some 900,000 iron nails in the ruins of the Roman legionary fortress in Inchtuthil, Perthshire U.K. Although this finding does not constitute an outstanding discovery, it highlights the notable technical and organizational progresses made by the Roman military structure [Ref. 15].

The building of the fortress was begun in 83 A.D. but, in 87 A.D., was abandoned owing to the reduction of the Roman garrison in that region. Therefore, a large stock of nails, which was supposed to be used for other secondary buildings, was left there, buried in deep pits and covered with earth. The reason for the concealment of the iron was to prevent it from falling into the hands of the Scot tribes who could convert it into weapons.

The recovered nails were examined and classified into six groups according to their shape, weight and dimensions by N.S. Angus et al. [Ref. 16]. The same authors also described the particular forging process probably adopted to manufacture the nails.

The implement examined in the present paper is a sample of the nails of the Inchtuthil fortress on which detailed structural analyses were performed with the aim of investigating in depth the material used and the manufacturing methods of the Roman blacksmiths.

Experimental

The nail was first measured and weighed in order to state its features with respect to the classification described by N.S. Angus and co-workers. The main geometrical data are summarized in Table 1.