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Ancient Monuments Laboratory
Report 75/93

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Summary

A "nail" recovered from a pit fill dated to the early/middle Iron Age was examined by metallography. The excellent quality of the structure suggested that both the interpretation and the dating are questionable.

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# THE METALLOGRAPHIC EXAMINATION OF AN IRON OBJECT FROM THE CASTLE HILL RING DITCHES, FOLKESTONE, 1991-92

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## Introduction

The excavation at Castle Hill near Folkestone, Kent was undertaken by The Canterbury Archaeological Trust (C.A.T. site code CTF7291) between October 1991 and March 1992 in advance of the construction of an extension to the A20 linking the Channel Tunnel terminal at Folkestone with Dover Western Docks[1]. The site had been discovered by aerial photography which had shown three circular crop marks. Subsequent trial trenching suggested these three ring ditches to date from the late Neolithic/early Bronze Age Transition. The full excavation of the site confirmed the dating and interpretation of the three ring ditches and also revealed the existence of later features including late Bronze Age terracing and eight pits, dated by ceramic typology to the early/middle Iron Age (c.600-400/300 BC).

The upper fill (Context 225) of one of these pits (Context 300) produced a small, highly corroded iron object (Fig. 1), provisionally identified as a nail (Find No. 251). The presence of a nail in such an early context caused some concern with regard to the integrity of the context's dating. The object was therefore examined metallographically to determine whether the structure was consistent with the technology of the period.

## Visual Examination

The iron object appeared to be of square, reasonably uniform, section without clear evidence of a head or point. It was bent to an "S" shape and had a maximum dimension of 32mm and a weight of 5g. The object was very heavily corroded and was attracted only weakly by a magnet. X-Radiographs supplied with the "nail" (Fig. 2) showed fine striations along its length as well as deep cracks but also the existence of a more solid core of iron at its centre.

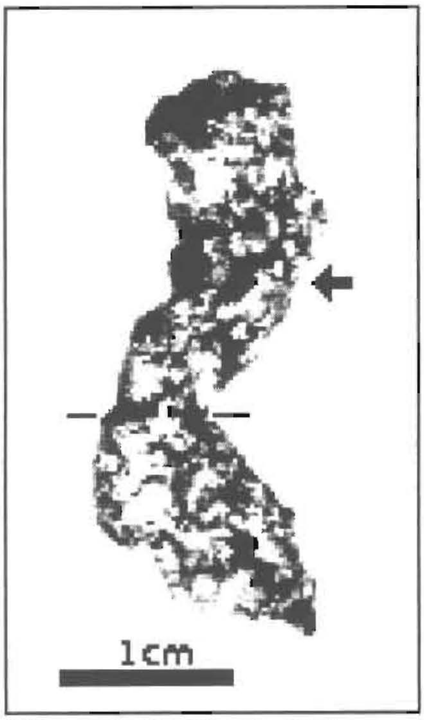


*Figure 1 The Castle Hill "nail" showing location of sample*

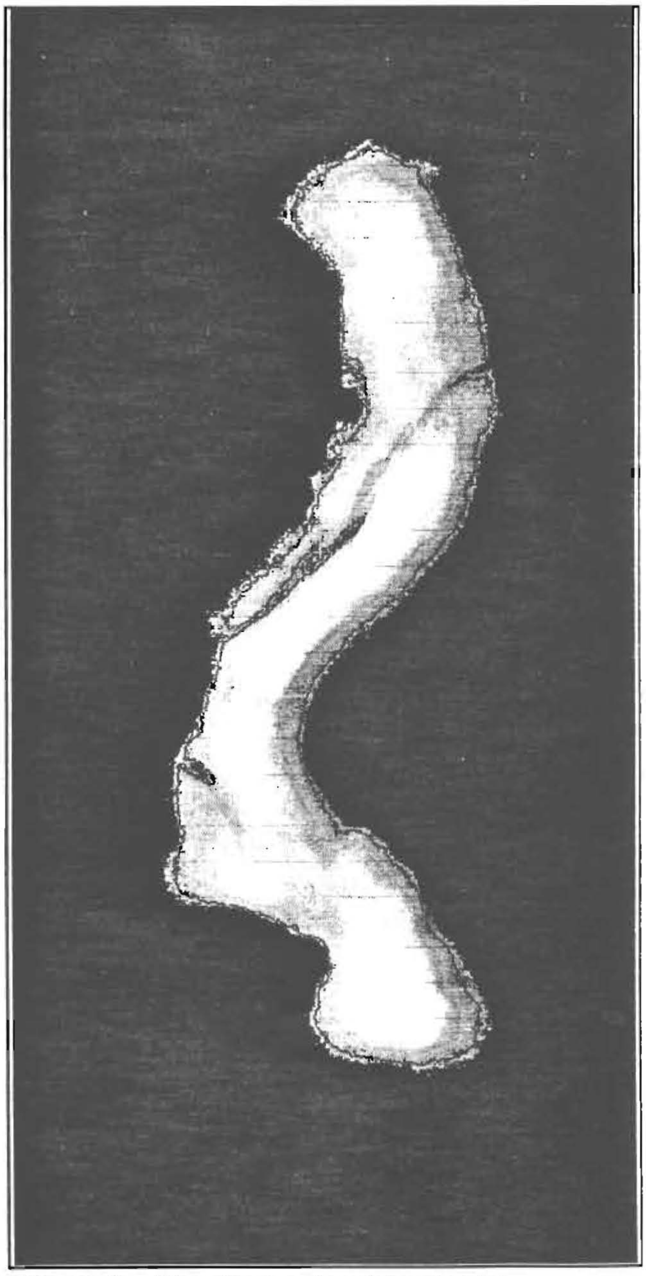

*Figure 2 X-radiograph of the "nail"*

## Metallographic Preparation

Half of the object was mounted in thermosetting Bakelite and ground down along its long axis until the cross section revealed the surviving metallic core (Fig. 3). The specimen was prepared using standard metallographic techniques; grinding on successively finer abrasive papers then polishing with diamond impregnated cloths. The specimen was examined on a metallurgical microscope in both the "as polished", i.e., unetched condition and after etching in 2% nital (nitric acid in alcohol).

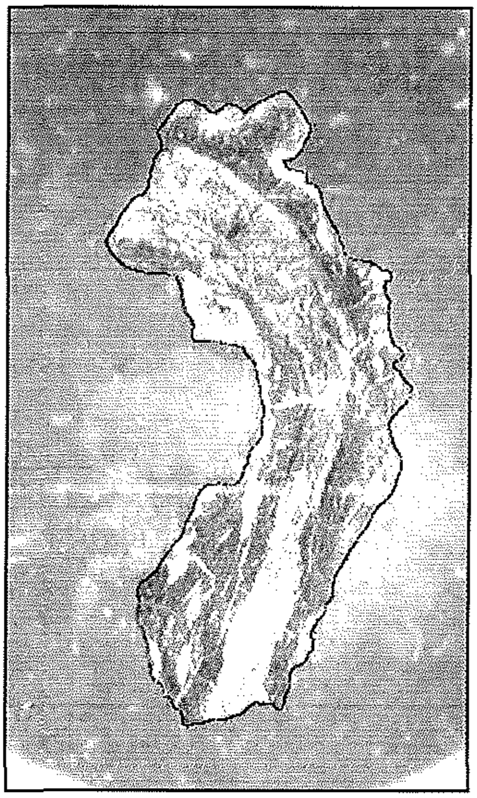

***Figure 3*** *Metallographic sample showing residual iron core towards bottom.*

## Description of the Metallographic Structure

Viewed in the **unetched** condition (Fig. 4) the surviving iron core was found to be remarkably free of slag inclusions. The few inclusions observed comprised considerably less than 1% of the structure, tended to be elongated with an orientation along the long axis of the object and contained a single, mid grey coloured phase.

**Etching** in 2% Nital revealed the grain structure of the metallic phases to be predominantly ferrite (60%) and degenerate pearlite (40%), although towards the centre of the core a localised region showed a slightly higher proportion of pearlite (Fig. 5). The grain size of the sample was below ASTM 8. This is unusually small for an ancient iron artefact and prevented microhardness tests being targeted onto individual grains. Microhardness tests on the ferrite+pearlite and pearlite-rich regions showed some variation:

| | ferrite + pearlite | pearlite-rich |
|---|---|---|
| | 181 | 193 |
| | 176 | 199 |
| | 157 | 228 |
| | 193 | 193 |
| average | 177 | 203 |

## Interpretation of the Metallographic Structure

The small surviving metallic core of the object consisted of a high quality, low slag, homogenous medium carbon steel. It had probably been cold worked and annealed, which resulted in the recrystallisation of ferrite grains and the agglomeration of the pearlite lamellae. No attempt had been made to quench the object from heat in order to increase its hardness, on the contrary it appears to have been "overheated" in such a way as to detrimentally affect its mechanical properties. However, it is possible that this last heating occurred after the fabrication of the object, perhaps during its use.

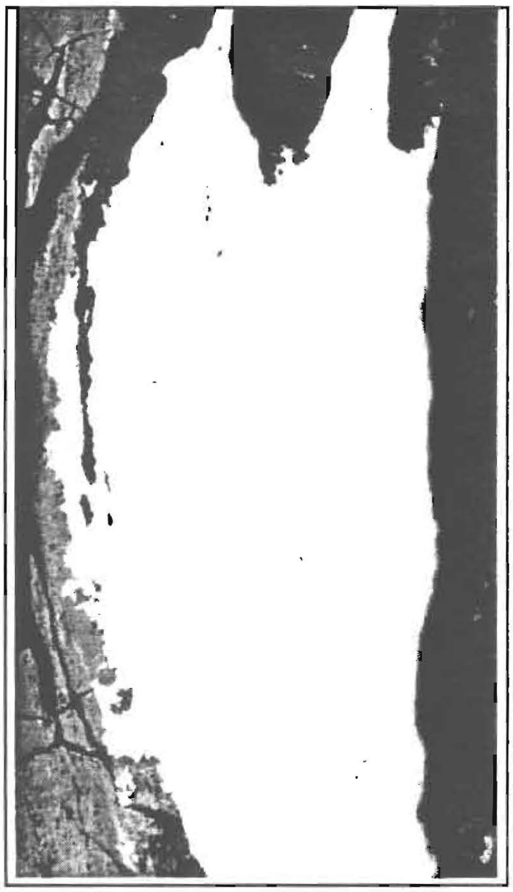

***Figure 4** Unetched sample x150*

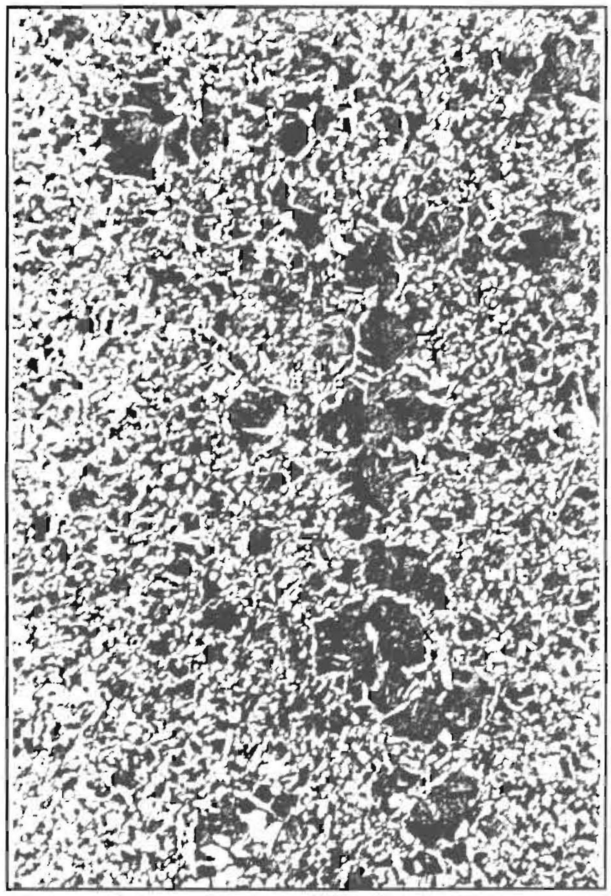

***Figure 5** Sample etched in 2% nital x35*

## Discussion

Until the late Medieval period iron production in Europe utilised the bloomery, or "direct" smelting process. Because, in this process, the smelt takes place below the melting temperature of pure iron or steel, the metal is produced as a solid bloom with large quantities of iron silicate slag entrapped within its mass. During the primary "bloom smithing" most of the slag is expelled and the iron is consolidated into a billet.

Further hot working will continue to reduce the slag content as the billet is worked to a bar and the bar to an artefact. However, very extensive hot working, which might reduce the slag levels considerably, would have been avoided because it would result in considerable losses of iron by surface oxidation[2]. Ancient iron therefore typically contains considerable quantities of slag. Two further characteristics of bloomery iron are the uneven distribution of carbon, where this element is present, and a relatively large grain size caused by the extensive high temperature smithing operations required to consolidate the bloom and form the artefact. On these three criteria the object from Castle Hill, with its paucity of included slag, relatively homogenous carbon content and very fine grain size, would not appear to be the product of a primitive iron production technique. However, the structure does not match modern (post Bessemer) ferrous alloys either and a Medieval/post Medieval origin with large scale production and mechanised working would seem most likely.

A further point that can be made is that ancient nails studied metallographically have been found to be of poor metallurgical quality in comparison with other contemporary objects, reflecting the limited mechanical properties required of these effectively disposable items. By the standards of pre-eighteenth century metalworking, the iron in the Castle Hill object could be considered of superior quality, which would have been wasted in such a mundane object as a nail. Visually, it should also be noted that although the object does appear to taper slightly, there is no clear head or point which would confirm the original interpretation of the object as a nail.

## Conclusion

The heterogeneity of iron in ancient artefacts must necessarily limit the conclusions that can be reached by the examination of a single iron object particularly when, as with this sample, very little iron remains in the uncorroded state. However, the metallographic structure of the Castle Hill nail is sufficiently unusual for it to throw considerable doubt on both its interpretation as a nail, and of its contemporaneity with early/middle Iron Age pottery within the same context. It was not possible to shed further light on the function of this object for which a good quality steel was chosen. However, it is suggested that the date of the object is considerably later, perhaps late Medieval or post-Medieval, and that the object is intrusive within its archaeological context.

## References


1. Canterbury Archaeological Trust, *Castle Hill Ring Ditches (F72): Assessment and Post Excavation Research Design*, December 1992.

2. P. Crew and C. Salter, Comparative Data from Iron Smelting and Smithing Experiments, *Materiały Archeologiczne* XXXVI, 1991, 15-23.