Pieces of Old Iron unearthed in South Manchuria and Chosen.

By

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I. INTRODUCTION.

Several years ago Professor Dr. K. Hamada of the College of Literature of this University, and eminent as an archealogist in Japan, presented to the author two pieces of iron unearthed at P'i-tsuo-wo in South Manchuria and at Keishu in Chosen to investigate their nature. The former is said to belong to the early decades of the Han Period (漢時代), so it is about 1900 years old now; and the latter belongs to the 6th century, so it is about 1400 years old. From their fractures we can at once observe that they both consist of white cast iron. Now, before we consider their archeaological value, it is reasonable to discuss briefly the general history of cast iron in the world.

II. BRIEF SKETCH OF THE HISTORY OF CAST IRON.

It is generally recognized, from the newly discovered relics in Egypt[1], and many records in the West as well as in the East, for example the chih-nan-che (指南車) or "magnet-using-South-pointing-waggon" in ancient China, that the use of iron by mankind is far older than that of bronze. But the iron in those far-off ages was what is called "wrought iron" directly smelted from its ores; and there is no trustworthy record telling in what age cast iron was first used.

F. Freise[2] of Germany states in his paper, that the first record of cast iron is that made by Aristotle (384–322 B. C.), and a Greek Pausanias, who lived in the first century, informs us that Theodoros had cast an iron

1) Beck—Geschichte des Eisens Bd. I, S. 85.
2) Stahl und Eisen 1907, S. 1692.

statue as early as 600 B. C. A cast iron ring unearthed at Maehlem in Germany in 1878 is believed by some one to belong to some prehistoric age.

But an eminent authority on the history of iron in Germany, Ludwig Beck[1], rejects these opinions and insists that the use of iron castings begins in the 14th century, at least in Europe. He explains the reasons from the metallurgical point of view, but it is out of place to enter here into the details.

Let us now turn our eyes to the Orient. The fact that the iron-making art of the ancient Indians far surpassed that of the Europeans is clearly to be recognized from the huge wrought iron monument[4] in Delhi, 24 feet high and 6.5 tons in weight, erected as early as 300 A. D.; but even now nothing has been heard of any remains or records of cast iron from that country. As regards China, the Frenchmen, Pauthier and Bazin state in their book that General Lan built a chain-bridge over a deep valley in the Province of Yun-nang during the years 58–76 A. D., and that its supporting columns were of cast iron, but we doubt if this was a fact. F. von Richthofen, the most renowned explorer of China, states in his book that in the Province Shansi the people use an iron smelting furnace, 8 feet long, 5 feet wide and 4 feet high, in which there are about 150 crucibles, 15 inches high and 6 inches in diameter, and these are filled with a mixture of ground iron ore and anthracite, and the furnace is continuously fired by a blast for two days. From the crucibles, masses of cast iron are obtained, these are used for the manufacture of wrought iron and it is said that this method has been used in those districts for several hundred years.

In such a method of manufacture, since the reduced iron in the crucible is heated for a long time in contact with an excess of carbon, it absorbs the latter abundantly; and as a result cast iron with a low melting point is obtained. And since in China the art of bronze casting had

1) Geiger—Handb. der Eisen- und Stahl-Giesserei Bd. I, S. 2.
2) R. Hadfield—Metallurgy and its Influence to modern Progress p. 41.

already made great progress 4000–5000 years ago, it is probable that in that country the art was applied to cast iron from a fairly early period.

III. PIECE OF IRON FROM P'I-TSU-WO IN SOUTH MANCHURIA.

As was said before, this piece of iron belongs to the first century. and it is all covered with a thick layer of brown iron rust. But as it is a kind of white cast iron which is comparatively less corrodible than other kinds, we were able to find a fresh part in the centre and conduct some investigations.

1) FORM OF THE PIECE.

From its outside appearance it can be recognized as being the blade of a hoe. Fig. 1 is a photograph of its upper surface, the faint white curved line abc showing the dividing line between the blade A and the part B in which a wooden stem was inserted. Fig. 2 is a more detailed view from different directions and gives the dimensions of the piece.

2) CHEMICAL COMPOSITION OF THE PIECE.

The white cast iron of which this piece consists has the following chemical composition :

Carbon	4.25%	Silicon	0.53%
Manganese	0.92	Phosphorus	0.144
Sulphur	0.01	Copper	0.007

It is very interesting to see that the carbon content of the iron just corresponds to that of the eutectic cast iron ; and since, as the cast iron of that early period its carbon, silicon, and manganese contents are pretty high, it is known that it was smelted at a fairly high temperature.

3) MICROSCOPIC STRUCTURE OF THE PIECE.

Fig. 3 is a macro-photograph of the fresh part H of the piece magnified 5 times. The casting is very well and thoroughly done, and no

blowholes are to be found in it. It is peculiar that the big iron crystals are well-developed normally to the outer surface of the casting, as is seen in the fig. 3; this shows that the outer mould was made of metal, or other heat-conducting materials of excellent quality.

The iron of this composition with 4.25% of carbon has the lowest melting point in the series of iron-carbon alloys; it is metallographically called "eutectic cast iron" and it is very easy to cast. Fig. 4 is a micro-photograph of the fresh part magnified 100 times. It has the structure of "Ledeburite", peculiar to the eutectic cast iron quickly cooled in a metallic mould. Fig. 5 shows the manner of the progress of corrosion of the piece, the white part being fresh and dark part corroded; and the white lines in the latter are the skeletons of cementite not yet eaten up.

IV. IRON FROM KEISHU IN CHOSEN.

These pieces of iron were found in the renowned tomb called Kinkwantsuka (Gold Crown Tomb) unearthed in Keishu in Southern Chosen in 1925, in which a brilliant gold crown and many other valuable relics were found. The pieces of iron here described were found arranged in good order along the walls of the tomb, about 60 pairs in number.

1) FORM OF THE PIECE.

Fig. 6 is a photograph of a pair of the pieces put over each other; figs. 7, 8 and 9 are sketches of them in perspective and viewed from above with details of their respective dimensions. As is seen in the figures, the individual pieces are wedge-shaped and hollow, and the insides are filled with red clay. Figs. 10 and 11 show the cross sectional views of the broken pieces, in which a is the oxidized iron part, b is the core clay and c is the still fresh iron part.

From the explanations given, it can be at once recognized that the central red clay part is the moulding core to make the hollow casting, which has not been taken out. Althogh these pieces are mostly transformed into brown iron rust at their outer and inner surfaces, yet the solid end part maintains its perfectly fresh metallic condition, in spite of their

being exposed for a very long time to the damp atomosphere in the tomb. It was therefore fortunately possible to ascertain their nature chemically and metallographically.

It is not obvious for what purpose these pieces of iron were prepared; but from their sharp edges and their very hard nature and moreover from the fact that they were regularly arranged in the tomb of an ancient noble, probably a king of that time, it is most probable that they were used as weapons, wooden shafts being inserted in their hollow parts.

According to Dr. K. Hamada, the tomb can be traced to the first half of the 6th century, so they are about 1400 years old, and so about 500 years younger than the former.

2) CHEMICAL COMPOSITION OF THE PIECE.

From their fractures we could at once notice that the metal is also clearly white cast iron. Its chemical composition is as follows:

Carbon	3.73%	Silicon	0.09%
Manganese	0.019	Phosphorus	0.228
Sulphur	0.005	Copper	0.035

It shows that this cast iron is much poorer in silicon and manganese than the former, and we know that it was smelted at a much lower temperature.

The composition of the clay is as follows:

Silica (SiO_2)	47.35%	Ferric Oxide (Fe_2O_3)	25.71%
Alumina (Al_2O_3)	15.79	Lime (CaO)	2.40
Magnesia (MgO)	1.44	Manganese Oxide (Mn_2O_3)	0.30
Loss by Ignition	6.60		

It is very poor in alumina and quite rich in ferric oxide as ordinary clay, the latter coming from the corroded iron around it.

3) MICRO-STRUCTURE OF THE PIECE.

Fig. 12 shows the macro-structure of a section of the fresh part of the piece, 3.7 times magnified. The casting is not sound and the metal is

full of blowholes; it was probably cast directly from the smelting furnace and the casting temperature must have been very low. Fig. 13 is the micro-photograph of its fresh part, 100 times magnified; columnar cementite and pearlite (partly Ledeburite), peculiar to white cast iron slowly cooled, are seen to be well developed. Fig. 14 shows the boundary of the fresh and corroded parts, the dark area being the oxidized portion with skeletons of some remnant cementite left in it.

V. CONCLUSIONS.

From the facts above cited, it is clear that while the art of making cast iron was introduced into Europe about 600 years ago, according to Beck, but in China, or at least in Manchuria, it was being skillfully made 1900 years ago, and used even for such common agricultural tools as hoes; and we believe that the piece of iron from P'i-tsu-wo is certainly one of the oldest cast iron ever found in the world.

The mode of manufacture was probably by the crucible process as described by Richthofen; and the innumerable remains of crucibles in the districts of Pen-hsi-hu in South Manchuria tell us, that the old method of those far away ages developed and flourished in these regions.

The wedge-shaped piece from Kinkwantsuka at Keishu in Chosen is also the same kind of iron, but judging from its structure, its smelting temperature was far lower and the art of casting was still poorly developed. Since it is about 500 years younger than that of P'i-tsu-wo, we think that the iron casting art developed in South Manchuria, gradually tended southwards and eventually was transmitted to the people in southern Chosen in those dim and distant ages.

Finally, we are reminded of the huge cast iron statues of Mahavariroscana-tatatha-gata (大日如来) 3.72 feet high and of Sa'kya (釋迦) 9.5 feet high, in the Keijo-museum in Chosen. They are said to belong to the Silla-age (新羅時代) (1150–1400 years ago), about 200–300 years later than the iron from the old tomb in Keishu. It is very astonishing that such big and delicate castings should have been so skilfully accomplished in

this district in such remote times. We can imagine, therefore, that the iron making and casting arts made great progress in the above mentioned age in the southern part of Chosen; and it is most probable that these arts were finally transmitted more than 100 years ago over the narrowest part of the Japan-sea to our Sanindo district, where they have made their own development.

(THE END.)

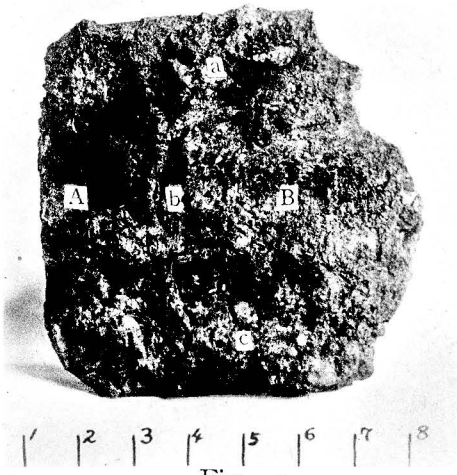


Fig. 1.

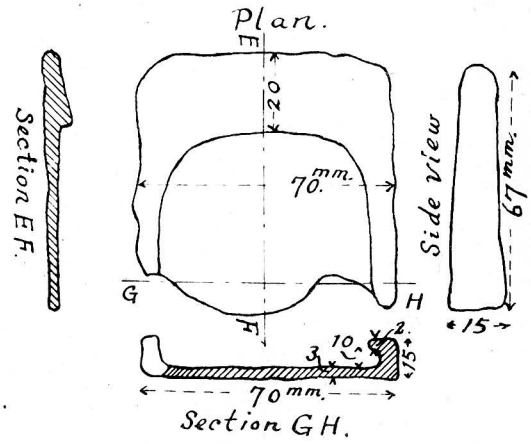


Fig. 2.

A.

×3

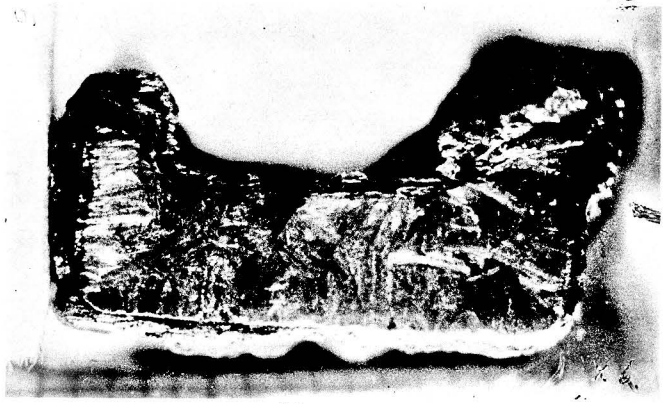


Fig. 3.

×100

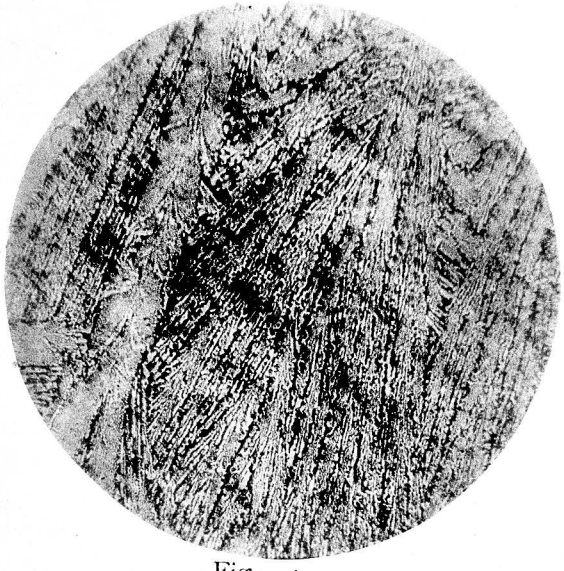


Fig. 4

×100

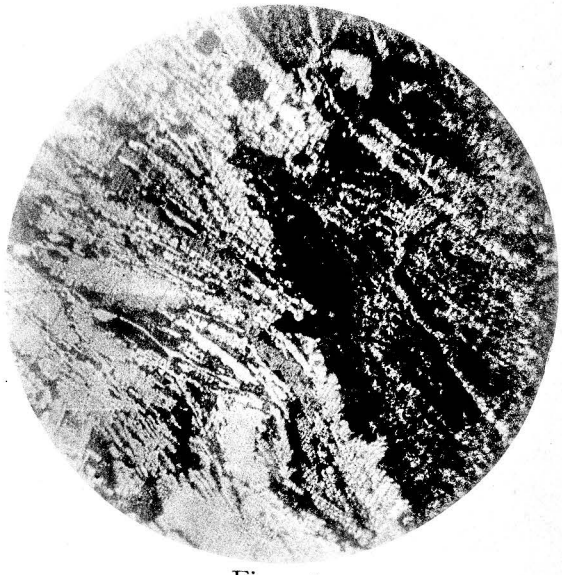


Fig. 5.

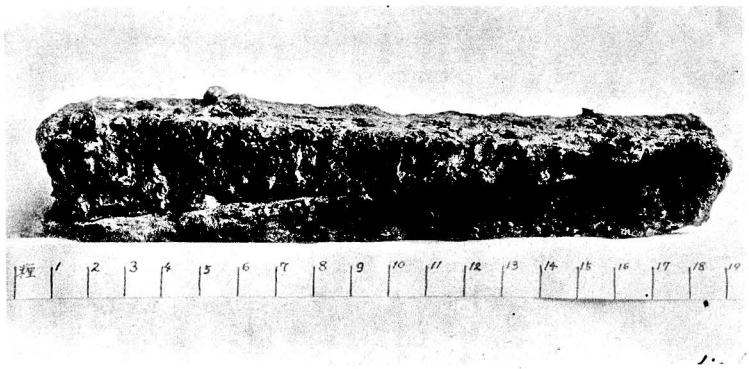
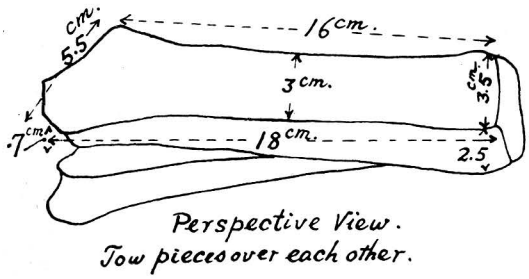


Fig. 6.



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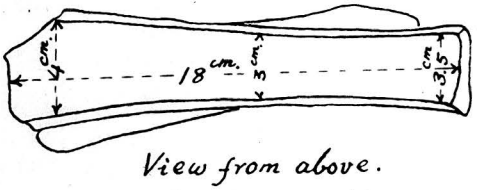

Fig. 8.

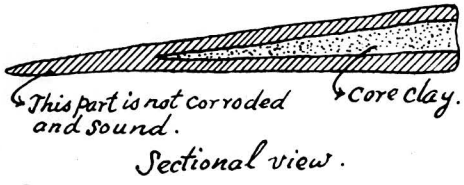

Fig. 9.

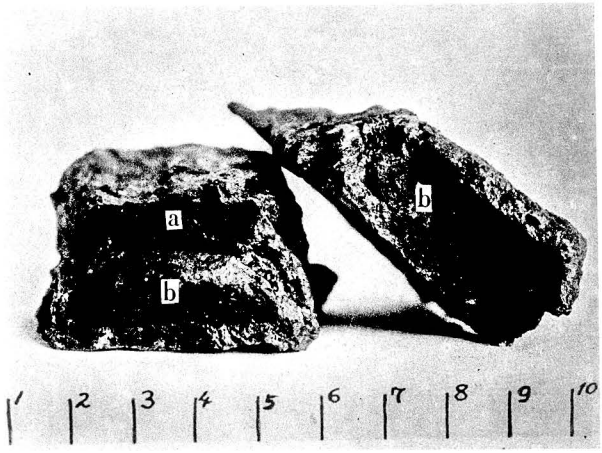

Fig. 10.

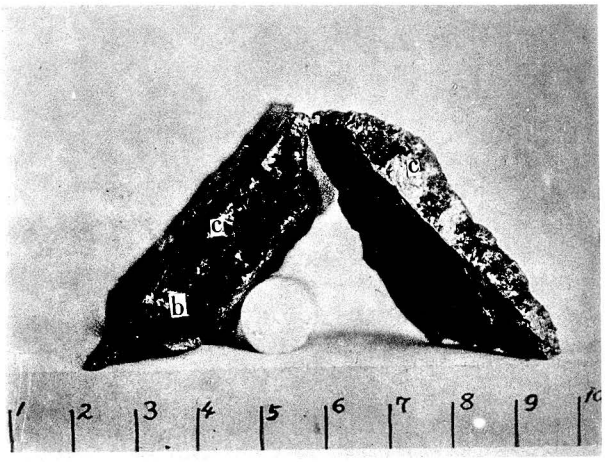

Fig. 11.

Fig. 12.

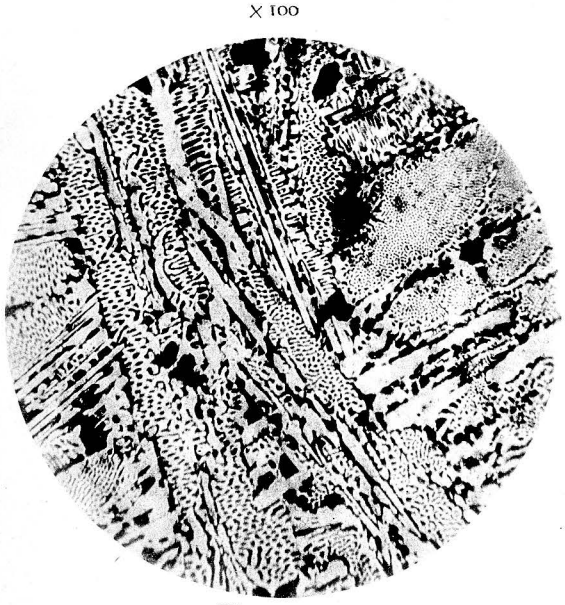

Fig. 13.

Fig. 14.