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EXAMINATION OF METAL PIECE FROM THE BOTTOM OF THE ST. LAWRENCE SEAWAY

by

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PHYSICAL METALLURGY DIVISION

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SUMMARY OF RESULTS

A piece of metal found in the bottom of the St. Lawrence Seaway was submitted with the request to establish its approximate age. The configuration of the piece suggested it may have been a shackle bolt. The sample was heavily corroded, the surface underlying the corrosion products had the markedly fibrous appearance typical of wrought iron. The chemical composition and microstructure were typical of good quality wrought iron. There were no distinctive features which served to indicate the age of the material. Subsequent information having been received that the piece was associated with an anchor, it was suggested the question of establishing the age be pursued through the design aspect by reference to nautical historical establishments.

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INTRODUCTION

A piece of metal "found in the bottom of the St. Lawrence Seaway" was received, via Dr. V. K. Prest of the Geological Survey of Canada Branch, Department of Mines and Technical Surveys, from Mr. J. Hode Keyser, Chief Engineer, Control and Research Laboratory of the City of Montreal, with the request to establish the approximate age of the metal.

VISUAL EXAMINATION

The sample, Figure 1, consisted of a cylindrical piece, approximately $3\frac{1}{2}$ in. by $\frac{3}{4}$ in. diameter, hereinafter referred to as the bolt, with a tapered split wedge driven through a slot near one end of the bolt. The sample had been cut from a longer piece, the cut being at the right of the bolt as shown in Figure 1. The large transverse groove in the bolt had penetrated slightly more than halfway through the bolt. The surface of this groove was smooth and covered with an adherent layer of iron oxide. The light coloured material shown in Figure 1 is an extremely thin layer which cannot be brushed off. It appears to be a layer of clay which has worked into the relatively porous surface of the iron oxide. When the friable corrosion products were brushed from the sample, the surface was found to have a pronounced fibrous or woody texture characteristic of corroded wrought iron.

CHEMICAL COMPOSITION

The chemical composition of the bolt is shown in Table 1 along with compositional ranges of wrought irons from different eras and different areas.

TABLE 1

Chemical Composition

Element	Per Cent of Element in:					
	Sample	British Wrought Iron (1)			North American Wrought Iron (2)	
		Roman Era	Post Roman to 13th Cent.	Modern	1825 - 1910	Modern-Typical
C	0.05	0.02/0.95	Tr/0.097	0.02/0.15	0.007/0.056	0.02
Mn	0.065	Tr/0.17	Tr/0.04	0.02/0.03	0.011/0.141	0.03
Si	0.18	0.04/0.15	Tr/0.16	0.09/0.15	0.030/0.329	0.12
S	0.015	0.003/0.017	Tr/0.046	0.010/0.015	0.010/0.057	0.02
P	0.198	0.008/0.16	Tr/0.95	0.117/0.158	0.126/0.479	0.12
Ni	0.03		0.23	0.17/0.22		
Ti	0.004 (3)					
Co	0.008 (3)					
Cu	0.030 (3)					
Mo	.070 (3)					

(1) History of the British Iron and Steel Industry, H. R. Schubert, pub. Routledge & Kegan Paul Ltd. 1957

(2) Wrought Iron, James Aston & Edward B. Story, pub. A.M. Byers Company, 1939

(3) Spectrographic Analyses.

METALLOGRAPHIC EXAMINATION

Longitudinal and transverse sections of the bolt and a longitudinal section of the wedge were examined. The microstructure consisted of polygonal ferrite grains with a considerable quantity of elongated duplex slag-type inclusions. There were also a considerable number of small round glassy inclusions. No carbides were observed. The microstructure is characteristic of good quality wrought iron. The slag inclusions were not bent around the transverse groove in the bolt, indicating that the groove was not forged.

DISCUSSION

The diameter of the bolt, the split wedge, the gap between the wedge and the transverse groove, and the fact that the groove appears to have been produced by wear are consistent with the hypothesis that the sample submitted is one end of a shackle bolt. This is a standard means of connecting chains to rings, including anchor rings, and provides no information as to age.

Wrought iron has been produced from prehistoric times to the present. The process has gone through three basic changes, i.e., direct, puddled, and finally, Aston-Byers process. There have, of course, been innumerable refinements of technique. Despite time and technological change, the end product has not changed markedly in physical structure. Although the quality of early material varied widely, good quality wrought iron of the Middle Ages does not appear to differ significantly from good quality wrought iron produced in the 20th century. Hence, the structure of this sample is of no value in determining its age.

The situation with regard to chemical composition is similar. It is true that there are slight but detectable trends in average composition for certain eras. Nonetheless, the range of compositions reported - which undoubtedly does not represent the full range produced - is such that the sample could fit any of the listings given in Table 1, although "North American: 1825-1910" provides the best correlation. The presence of certain impurities such as titanium, nickel, cobalt, etc., sometimes serves to pinpoint the area of origin and, indirectly, the age. Unfortunately, such impurities were not detected in this case.

The rate of corrosion can offer some guidance in certain cases. It is known that 0.0003 in. per year is a rough value for the formation of corrosion product on wrought iron exposed to fresh water. Unfortunately, the sample in question appears to have been buried. This alters the chemical environment drastically and the corrosion rate noted above is not applicable.

The examination did not reveal any feature which served to indicate the age of the sample. Information has been received latterly that the sample submitted was removed from an anchor. It is suggested the problem of establishing the age of the artifact should be pursued through the design aspect. Anchors have changed in design details over the centuries and it is highly probable that records of the changes are available. Museums and naval historical establishments are the obvious sources of historical knowledge of matters nautical. Reference to the National Maritime Museum, Greenwich, England; the Maritime Museum of Canada, Halifax; the Naval Historians of the British, French, and Canadian Navies; and to Lloyd's Registry of Shipping, London, England, may be fruitful. Inquiries directed to such bodies should, of course, contain photographs and dimensions of the anchor.

CONCLUSIONS

1. The sample is good quality wrought iron.

2. The sample bore no distinguishing characteristic which served to establish its age.

DRB/gm

Figure 1. Sample as-received.
(Approx. full size)

Figure 2. Longitudinal section of pin.
(X100, etched with 2% nital)