Cultural Heritage Agency
Ministry of Education, Culture and Science

17th century bronze cannon: How can they be magnetic?

Bertil van Os, Hans Huisman, Arent Vos, Lucas van Dijk, Janneke Nienhuis, Ineke Joosten

Cultural Heritage Agency of the Netherlands
b.van.os@cultureelerfgoed.nl

Introduction

Salvaged bronze cannon from Dutch 17th century vessels were found to be magnetic: A magnet would stick at the surface. This is remarkable, since bronze in itself is not magnetic. Magnetism in 17th century Dutch cannon has been described also by Guilmartin (1983). Recently, researchers at the Western Australian museum in Fremantle (Au) have confirmed that some of the bronze cannon form the Batavia also have magnetic properties (Vicky Richards, *pers. comm.*). The phenomenon may therefore be much more widespread.

Possible causes

This phenomenon could have several causes:

1 During casting, the mold for the cannon is commonly held in place with iron reinformcements. Iron bars from these reinforcements ("crown irons" or "cruzeta"; figure 1) could be the magnetic parts of the cannon (Fig 1 and Guilmartin 1983).

2 Magnetic iron minerals like magnetite (Fe_3O_4) or greigite (Fe_3S_4) may have been formed during corosion when the cannon were on the seafloor.

3 Iron particles or scrap iron could be included in the bronze melt, maybe as a result of melting and re-use of old bronze cannon.

In order to test these hypothesis, we investigated the composition of six 17th century cannon from the collections of RCE and bataviawerf in Lelystad with hand held XRF. (table 1; figure 2). Multiple measurements were done different parts of each cannon and on corroded and non-corroded areas.

Results

The composition of the canon appeared to vary between the different makers: (Fig 3a) Some had tin-contents that were much lower (less that half) than the 10% that was prescribed (fig 3b). Magnetic cannon showed systematically higher iron contents than non-magnetic cannon. The higher iron contents were not only restricted to the outer (corrosion) layer, but were also found on locations where the corrosion layer was removed (fig 3c). Moreover, the iron contents varied between the makers (fig 3d).

Preliminary results from a study of the iron in the bronze melt (figure 2) show many very fine iron inclusions in the bronze melt. Their small size and their shape indicates that the iron was included in the melt as a fine powder (filings?) and on purpose.

This indicates that the magnetism is the result of iron particles that were included in the melt used for cannon casting. The reason for this is unknown; maybe some iron was added to the melt in order to disguise a deficiency in tin contents?

Literature

Guilmartin, J.F. (1983) *The Guns of the Santissimo Sacramento*, Technology & Culture, 24-4, 559 - 601.

Table 1 Investigated canon

Maker	Year	Weight	Origin	Magnetic?
Arent van der Put	1623	1638 kg	S. North Sea c. 1988	+
Cornelis Ouwerogge	1631	4200 lbs	Euro-Maasgeul 1996	+
Cornelis Ouwerogge	1631	4275 lbs	Euro-Maasgeul 2008	+
Everhardus Splinter	1632	3480 lbs	Eurogeul	+/-
Wouter Wegewaert	1652	1875 lbs	Eurogeul	-
Coenraet Wegewaert	1654	2200 kg	Euro-Maasgeul 1999	-

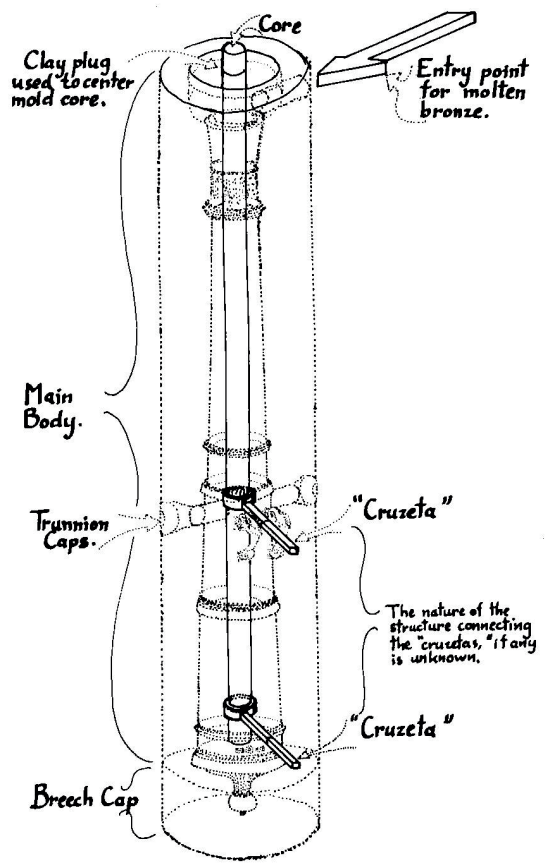

Figure 1 Cannon-mold schematic, with estimated position of "Cruzetta" or "Crown irons" indicated. From Guilmartin (1983).

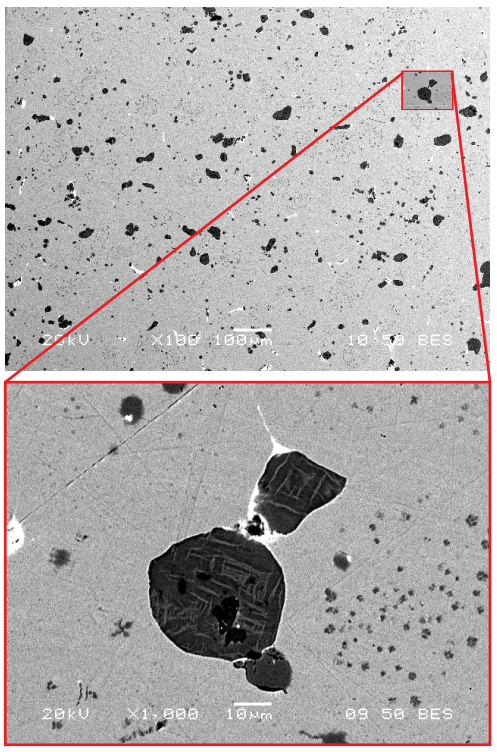

Figure 2 SEM Backscatter images of polished sample from the Ouwerogge 1631/4275 cannon showing many finely distributed iron - rich inclusion (darkgrey) with internal structure in the bronze groundmass (lightgrey).

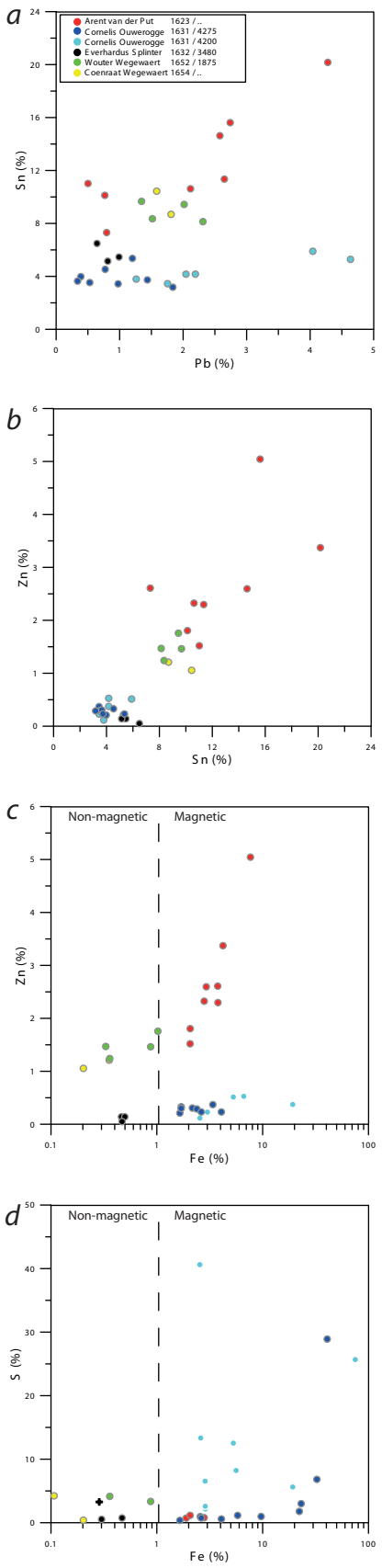

Figure 3 Results of XRF-analyses a -c uncorroded spot measurements only; d including corrosion layers to show S-contents in corrosion layers.