ABSTRACT: The Walloon method of refining pig (cast) iron is one of the first extensions of the blast furnace process, which appears between the 14th and 16th centuries in northern Europe. This study investigates the production capacity of Walloon refining and in particular its handling of high-phosphorus pig iron through a series of experiments. A Walloon hearth was built to refine high-phosphorus pig iron, using data on the refining process found in archaeological sources and historical documents from the 18th century onwards. The chemical composition and the structure of the metals and slag produced during refining have been determined. A similar yield to those mentioned in historical sources has been obtained. These experiments suggest specific techniques enabling high-phosphorus pig iron to be refined efficiently. Finally, the results point out the importance of the metal-slag reaction phase in obtaining a carbon-free and phosphorus-free material.

Introduction

Between the 14th and 16th centuries, the blast furnace process, also referred to as indirect reduction, appeared and spread in northern Europe, gradually supplanting the earlier bloomery. In contrast with the latter, indirect reduction is a two-step process. Iron ore is first reduced in a blast furnace, producing molten pig iron, an iron alloy containing several percent carbon, silicon and phosphorus. The pig iron is then refined in a finery forge, transformed through the oxidation of carbon and silicon into either iron or steel. The bloom thus obtained is then compacted using a water-powered hammer. One of the first variants of this operation is the Walloon method. Emerging in Wallonia early in the 14th century (Awty 2006; 2007), it spread southward to the French regions of Champagne and Nivernais (Belhoste and Leon 1996) late in the 14th century and into numerous parts of Normandy from 1450 onwards (Belhoste 2001), before crossing the Channel into southern England (Belhoste et al 1991).

The aim of the present paper, however, is not to revisit in detail either the history or the chronology of indirect reduction and refining, but to examine what will henceforth be referred to as the 'stabilized' Walloon method: a blast furnace, two hearths – the finery and the chafery – and a water-powered hammer. A number of researchers have published articles presenting interesting data on the construction and the spatial organization of the work areas associated with the early blast furnace. Excavations of blast furnaces and a finery forge were conducted in the Weald, in England, by Crossley and Bedwin (Crossley 1972; 1975a; Bedwin 1978; 1980); a Welsh blast furnace, dating from the 16th century was uncovered by Peter Crew (Crew and Williams 1985) and the Marsonille blast furnace in Belgium has been the subject of a number of studies (Weber 1997). Yet in spite of this work, concrete information on the operation of the finery forge remains scanty.

Over the past 15 years, Danielle Arribet-Deroin has conducted excavations at the Glinet blast furnace and finery, located in Normandy and active during the 15th and 16th centuries (Arribet-Deroin 2001; 2010; Dillmann et al 2007). Within the site the finery, the water-powered hammer, the anvil block and a likely chafery hearth have been located. While the finery hearth has yet to be entirely excavated, numerous refining-furnace-bottom cakes clearly linked to the refining process have been