The use of coal in ”la chaine opératoire du fer” to late Middle Ages in the north of France

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The use of coal in “la chaine opératoire du fer” to late Middle Ages in the north of France

Introduction
This document presents the PhD research that I have been conducting since September 2014 - under the supervision of Anne Nissen and with tutor support from Danielle Arribet - at the Sorbonne University (Université Paris I Panthéon-Sorbonne). This academic research is informed by analysis of preventive archaeology operations conducted since 2008 at five sites in the region of France currently known as Nord-Pas-de-Calais. These sites all yielded evidence of antique and medieval ironworking facilities that used coal as a fuel (fig.1). These finds led to numerous initiatives aimed at shedding new light on the coal economy, both from a supply chain perspective and in terms of the use of coal in the iron production and working chain.

First results
Inspired by the aforementioned British research, we began by reviewing medieval written sources. We looked for coal-related records in various book-keeping, legal and tax documents (including «tonlieu» market tax and toll records). A similar analysis of the available archaeological resources was performed, with the aim of identifying any discoveries other than those already reported in our research corpus. To date, we have identified 102 written mentions of coal and 43 archaeological discoveries, 23 of which involve evidence of metalworking activity (fig.2). Antiquity
In detail, nine antique sites from around the 3rd century have been recorded. Three of these five sites contained metalworking remains.

Middle Ages
The earliest written records of coal use and trading date back to the Higher Middle Ages, 12th-13th century
Between the 12th and 13th centuries, most records still relate to the Hainaut region, particularly the area around Mons. There are references to mining in coal outcrops around Mons, as well as evidence of coal movements along the river Haine and then along the Escaut and Scarpe. Together, these records document the export and use of carbon in forges in Douai and as far away as Ghent. The first records of English coal being imported by Flemish trading towns also date from this period. The most interesting archaeological finds from the 12th and 13th centuries were also made in the Mons area, and more specifically in the Borinage, where two preventive archaeology operations revealed a number of 11th-century coal mineshafts. These finds support the idea that outcrops were being mined – or rather, that mining had resumed – by the 13th century at the latest. 14th-16th century
A radical shift in the coal economy occurred during this period. The literature contains far fewer references to the transportation and use of coal from the Mons region. There are also fewer records of coal movements along the Haine, Escaut and Scarpe. Conversely, there was an upswing in the number of records describing imports of British coal to Flemish towns. Coal (mainly from Newcastle) was one of the many commodities traded between Flemish and English merchants. Furthermore, as explained previously, while Calais was under English control, the town became a mandatory stopping place for coal shipped from England to mainland Europe. From an archaeological perspective, this fuel was being used increasingly in smithing activities. In Flanders, during this period, wood became somewhat scarce and prices spiked. The counts of Flanders asked the biggest craft users of wood and charcoal (mainly smiths, lime producers and potters) to switch to alternative fuels. It would appear that the lime and iron craft industries turned to coal, whereas potters opted for turf, which was abundant in Flanders.

The slag of coal metallurgy
These sites all yielded evidence of an atypical forging slag morphology. The slag was more jagged and lighter than usual (fig.3). Some forge slag was observed under a metallographic microscope at the Laboratoire Métallurgie et Culture (metalworking and culture laboratory) in Belfort. Initial analyses revealed coal remnants trapped inside the slag formations (fig.4), evidence of the use of coal to fire the forge. Also, macroscopic observation of the iron-making scrap revealed a powdery yellow substance filling several cavities in the slag. This substance was analysed using a spectrometer, enabling it to be identified as jarosite, a hydrous sulphate of iron produced when sulphur is released by coal burning in the forge’s fire pit (fig.5). This powdery yellow substance is one of the exterior elements for recognizing the slag of coal metallurgy (fig.6).

Research outlook
The next stage of our research is to analyse the information arising out of this review of a large part of the relevant written sources. We intend to analyse the various archaeological coal fragments, to identify where they were mined and confirm or refute the source and trading route of this fuel indicated by the written sources. This will be achieved in a joint effort with Dr. Jean-Marc Baele of the Geology department at the University of Mons. Several specimens will be analysed by laser spectroscopy (LIB) to determine the composition and sources of the archaeological coal finds, furthering our understanding of the historical use of coal. Similarly, further analyses of slag from coal-burning workshops will be conducted, to more accurately ascertain the impact of this fuel on the iron production and working chain.

Agenda
- Metalworking activity with coal discoveries
  - 11th - 12th discoveries
  - Early Middle Ages discoveries
  - Middle Ages discoveries
  - Late Middle Ages discoveries
  - 14th-16th century
  - Within mining of coal

Fig. 1 : Fragments of coal - 12th century
Fig. 2 : First result.
Fig. 3 : Slag of coal metallurgy - 14th century
Fig. 4 : Coal remnants trapped inside the slag
Fig. 5 : Spectrometer analysis
Fig. 6 : Exterior elements for recognizing the slag of coal metallurgy.