An Analysis of Romano-British Lead Pigs

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Although the importance of the lead industry in Roman Britain has long been appreciated, our understanding of its organisation and operation remains relatively limited. In the absence of reliable documentary sources and intact Roman mine workings, the lead ingots commonly known as "lead pigs" (Fig. 1) constitute the primary evidence for this activity. Less than half of the 102 examples discovered since the sixteenth century are still extant, while the range of published literature on this subject has been found to contain significant errors and variations concerning the details of both these ingots and those which are now lost. By contacting the majority of institutions holding lead pigs in their collections, and by an intensive examination of published sources regarding their details, it has been possible to produce a comprehensive listing of these objects, and to obtain an overview of the industry which produced them and the society within which that industry functioned.

By examination of the inscriptions, weights, compositions and find-spots of all the known Romano-British lead pigs, it has been possible to answer a number of important questions concerning the lead industry during this period. The evidence for the chronology of its operation and the shift between Imperial and commercial operation of the mines will be examined, while the existence of standard policies both for the production of pigs of standard weights and for the desilverisation of argentiferous lead will be considered. On the basis of evidence from finds of lead pigs, patterns of distribution and export from each ore-field will be suggested and the possible use of lead-isotope analysis as a sourcing tool will be considered.

Chronology

Lead ores, primarily in the form of galena (lead sulphide, PbS), occur mainly in hydrothermal deposits in the Carboniferous limestone regions of Britain and it was in these areas that extensive mining occurred during the Roman period (Fig. 2). The Mendips (Somerset) were the earliest to be mined, starting as early as AD 49 on the evidence from inscribed lead pigs found in the area (Elkington 1976). As the Roman conquest proceeded over the next three decades, the ore-fields of Flintshire (north Wales), Shropshire, Derbyshire and Yorkshire were opened for exploitation. In the last of these areas, the earliest lead pig bears an imperial inscription dated to AD 81 (Raistrick 1931). By the use of such inscriptions, it has been possible to propose four phases of exploitation of the Romano-British lead mines, with control shifting according to the military and economic climate of the time.

The first of these, the **Military** phase, is evidenced by the presence in the Mendips of lead pigs bearing the names of known Roman legions (Elkington 1976) while at several mining sites including Prestatyn, Flintshire, forts contemporary with the mine workings have been discovered (Fry 1984). This phase reflects the need of the Army to maintain control of resources in newly conquered territory, lasting for only a few decades until civil rule was established.

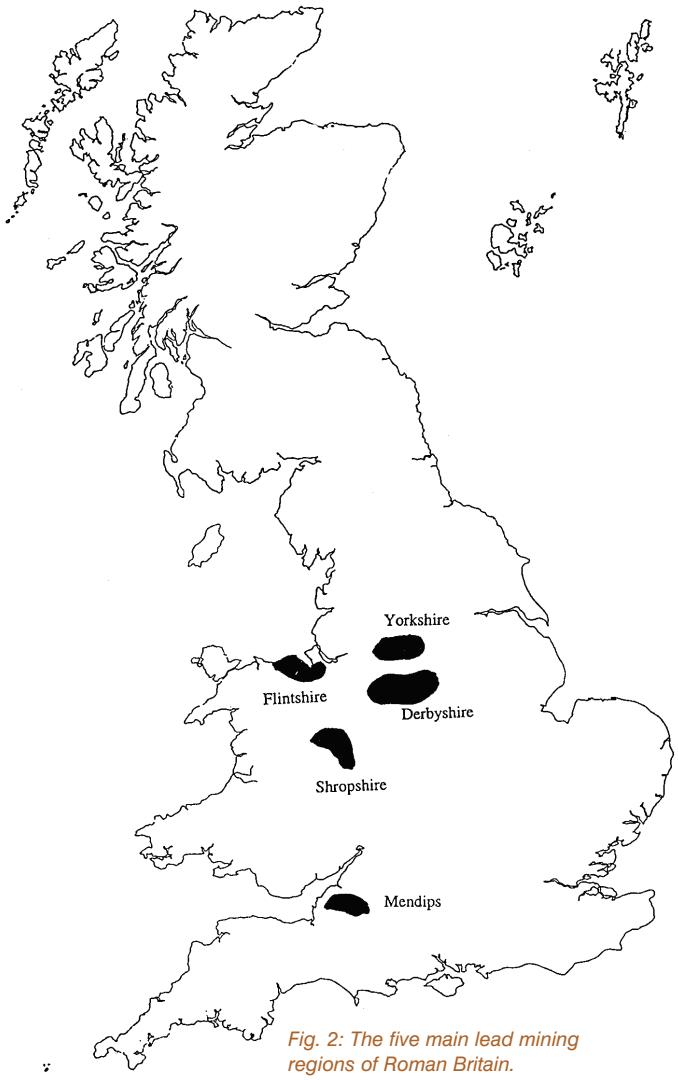
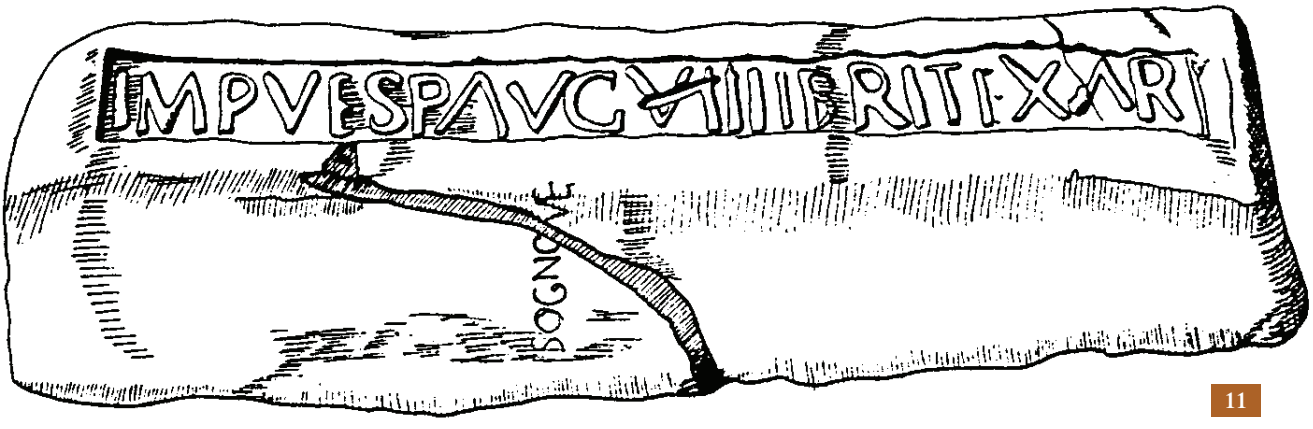


Fig. 2: The five main lead mining regions of Roman Britain.

The **Early Commercial** phase covers the late first and early second centuries AD, and reflects the increasing stability of the new province, with private companies (societates) and individuals (conductores) being granted mining rights by a

Fig. 1: A lead pig from the Mendip mining region found at Syde, Gloucestershire. Its inscription dates it to AD 79 while the SOCNOVEC marking identifies the company which produced it. Length 58.4 cm, weight 78.9 kg (de la Bedoyere 1989).



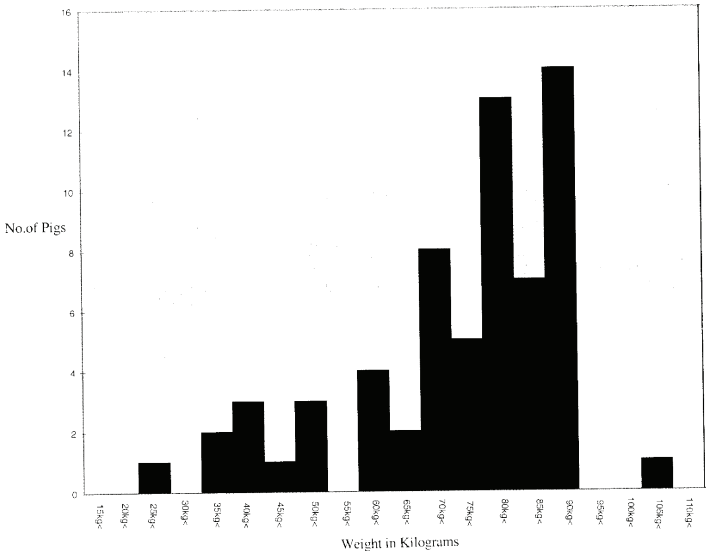


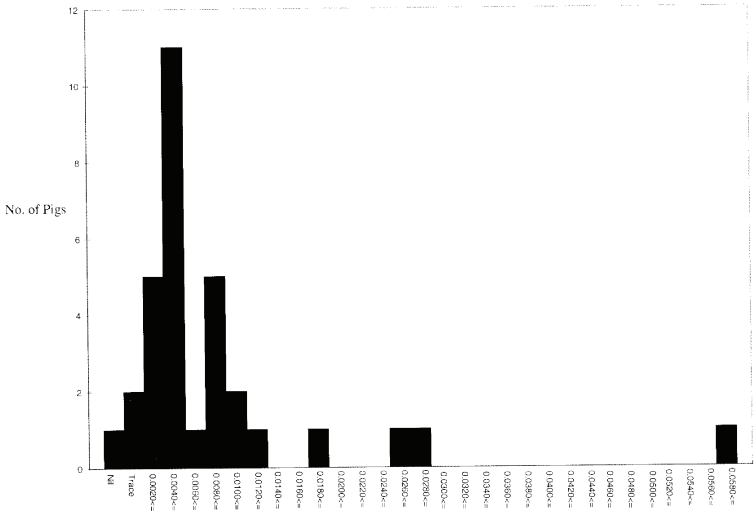
Fig. 3: Chart of weight distribution for Romano-British lead pigs.

Procurator Metallorum in exchange for a proportion of the revenue going to the state. Numerous lead pigs bearing company markings such as SOC LVT or the names of conductores such as G NIP[IVS] ASCAN[IVS] have been found indicating commercial exploitation in areas previously controlled by the army.

The period of **Hadrianic Construction** occurs at the start of the second quarter of the second century AD, with the construction of the massive frontier works in the north of Britain, and it seems likely that large quantities of lead would have been required for pipes, cisterns, bath linings and roofing in these new installations. From this period onwards, the names of societates and conductores are almost entirely absent and all the datable pigs from this period bear imperial markings.

The **Later Commercial** phase occurs in the second half of the second century and continues until the end of Roman Britain. Although a few lead pigs with imperial markings are known from this period onwards, it seems likely that the industry was allowed to fall more and more into private hands and was no longer producing large inscribed ingots (Frere 1987). The few late examples rarely bear any markings, but testify to the continued exploitation of this resource.

Fig. 4: Chart of silver distribution for Romano-British lead pigs



Weights

In addition to their use for dating the phases of exploitation, detailed examination of these lead pigs can show the extent to which standardisation of weights was practised within the industry. The presence of numeric markings on some examples has led to suggestions that a "standard weight" of 195 Roman librae (63.85 kg) existed and pigs which varied from that were marked to indicate the excess (Palmer & Ashworth 1956). Although this appears to have been the case with three of the four lead pigs found at Green Ore, Somerset, (Table 1) there is little evidence for its use in other parts of the country. Similarly, although numeric markings were found on a lead pig from Strageath Roman Fort, Perthshire which corresponded closely to its weight in librae - it was marked with CCX (210) and weighed 209.19 librae (Frere & Wilkes 1989) - only one other example found in Britain has any comparable relationship between its weight and the inscriptions on its surface.

Table 1: Relationships between Lead Pig weights and numeric inscription.

Pig No.	Date	Weight (librae)	Marking	Different between weight and 195 librae "standard"
M11	**AD69-79**	**258.97**	**LXV (65)**	**+63.97**
M12	**AD69-79**	**273.63**	**LXXIX (79)**	**+78.63**
M13	**AD69-79**	**262.33**	**LXIIX (68)**	**+67.33**

(Data from Palmer & Ashworth 1956. Pig Numbers from Gardiner 1999).
All weights are given in Roman librae. 1 libra = 327.45 g

As only 10% of all the known pigs bear such markings, and only half of the markings have any correlation with the weights of these objects, it is reasonable to conclude that there was no precise standardisation of weights, although some localised exceptions may have existed. Similarly, when the weights of the 64 lead pigs for which this information is known are plotted (Fig. 3), three modal peaks are visible, at 65-70 kg, 75-80 kg and 85-90 kg, although the exact meaning of these observed peaks is still uncertain. During the later periods of exploitation a broader range of weights are observed - particularly within individual mining regions - which may reflect a relaxation of state control but at no stage does there appear to be an enforced policy of standard weights.

Silver Content

Similarly, the question of whether a standard policy for the desilverisation of argentiferous lead existed can be explored through the analysis of Romano-British lead pigs. Thirty lead pigs from the Mendip and Derbyshire mining regions bear the inscription EX ARG, and it has long been a matter of debate whether these examples contained desilvered lead or whether the inscription simply - and perhaps optimistically - identified the object as "a product of the lead/silver works". Evidence from the 13 EX ARG marked examples for which analyses exist showed considerable variation in silver content, ranging from nil to 0.0564% (18oz 12dwt/ton), with the majority falling within the range of 0.002 - 0.01%. Of the 32 lead pigs - both with and without EX ARG - for which analyses are available (Fig. 4), 75% contained between nil and 0.012% (4oz/ton) silver. No appreciable variations were detected between those bearing EX ARG markings and those without, strongly suggesting that EX ARG is not indicative of desilverisation and that there is no clear pattern regarding this activity.

Transport and Origin

Examination of the find-spots of lead pigs has helped to identify the distribution patterns of these objects, and the routes along which they were transported. Of the pigs for which exact find-spots are known, 37% were found in or near navigable rivers while only 24% were in close proximity to known Roman roads. The benefits of water transport for

goods in the ancient world is already well known (Finlay 1985) while the presence in France of four lead pigs of probable Romano-British origin is a clear indication of cross-channel trade in these materials.

When the find-spots of lead pigs from each mining region are plotted on a map, it is possible to suggest a pattern of distribution from each (Fig. 5), although these must always be tentative given the very small sample of material on which they are based. However, it is reasonable to propose the following: The Mendip region mainly supplied the south-west of Britain from Gloucestershire, Hampshire and south Wales down to Cornwall, although finds of Mendip pigs from London (Hassall & Tomlin 1996) suggests that some other areas may also have been supplied, and some material may have been exported to the continent through Clausentum (Bitterne, Hants.). The Derbyshire ore-fields certainly supplied central and north-eastern Britain, probably the south-east and possibly East Anglia, while the presence of numerous lead pigs around the port of Petuaria (Brough-on-Humber) suggests that this was a probable point from which they were exported or transported by sea to other parts of the province.

Yorkshire, for which only four lead pigs are known, probably supplied northern Britain and - because of its location - may have provided much of the material used during the Hadrianic phase of exploitation, although its distribution to other areas remains uncertain. The Shropshire region - which has only three known lead pigs - probably supplied central Wales and the West Midlands, but this cannot be confirmed due to the absence of archaeological evidence. The Flintshire region appears to have supplied north Wales, Cheshire, Staffordshire and Merseyside, while a cargo of some 20 pigs found on a shipwreck in the River Mersey suggest that some seaborne distribution was undertaken from this ore-field although again the precise distribution is uncertain.

It is possible that a more accurate pattern of distribution could be constructed if a large-scale programme of lead-isotope analysis was undertaken, using samples from all the extant Romano-British lead pigs and relating the results to the analyses of lead ore from Britain and Ireland compiled by B.M. Rohl in 1996. (The ratios of different isotopes within the metal vary according to the area in which it originated, and this can be detected and assessed using Mass Spectrometry). If successful, such a study would enable the extant pigs to be assigned to one of the known ore fields and improve our knowledge of the distribution patterns of these objects.

One lead-isotope analysis which can be compared to this list was conducted by N.H. Gale on a lead pig from Strageath, Perthshire (Frere & Wilkes 1989). The analysis was as follows:

Ratio of Pb^{208} to Pb^{206} :	2.09109
Ratio of Pb^{207} to Pb^{206} :	0.85350
Ratio of Pb^{206} to Pb^{204} :	18.233

When this is compared to Rohl's listing of British and Irish galena ores, the closest match is from Wanlockhead in the Southern Uplands of Scotland :

Ratio of Pb^{208} to Pb^{206} :	2.09176 (+0.00067)
Ratio of Pb^{207} to Pb^{206} :	0.85350 (Exact Match)
Ratio of Pb^{206} to Pb^{204} :	18.230 (-0.003)

Although unexpected (having no evidence of Roman mining) and lying some 110 km south of Strageath, Wanlockhead is only 5 km from the main Roman road into Scotland (Margary road 77). It is also close to the Flavian/Antonine fort of Crawford, suggesting that if mining was carried out there, the Roman infrastructure to supervise the operation and transport the product north was easily accessible.

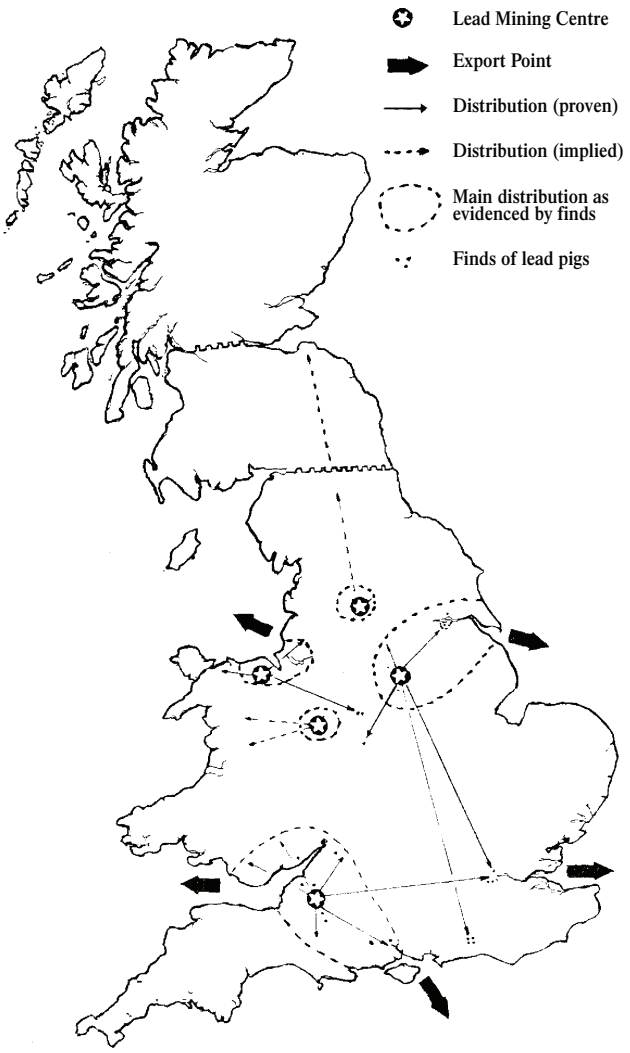


Fig. 5: A map of proposed distribution patterns of the main lead mining regions of Roman Britain.

It is hoped that, with appropriate funding and co-operation from museums and collections, a sampling programme for lead-isotope analysis may be undertaken in order to further elucidate the sources of supply and patterns of distribution of this material in Roman Britain.

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