The development, of the mining, of lead in the Iberian, Peninsula and Britain under the Roman Empire until the end of the Second Century A.D

Elkington, H. D. H.

The Development of the Mining of Lead in the Iberian Peninsula and Britain under the Roman Empire until the end of the Second Century A.D.

UNIVERSITY OF DURHAM

THE DEVELOPMENT OF THE MINING OF LEAD IN THE IBERIAN PENINSULA AND BRITAIN UNDER THE ROMAN EMPIRE UNTIL THE END OF THE SECOND CENTURY A.D.

By

H.D.H.ELKINGTON

St.John's College,Durham

PREFACE

The course of study for this work began in the summer of 1964, and has taken three and a half years to complete. In the course of that time, I have visited many of the pigs in the South of England. I have also paid frequent visitts to the Roman lead mining centre at Charterhouse on Mendip, and would have visited the Shropshire area as well towards the end of my study had not the disastrous epidemic of foot-and-mouth disease struck the area in the autumn and winter of 1967-8.

Throughout the whole of this period of time, I have received continual help and guidance from my supervisor of studies, MR. R. P. Wright, Reader in Epigraphy, and Senior Lecturer in Classics in the University of Durham. It is to him that my great debt of gratitude must be paid for his encouragement and patient counsel. It was most fortunate for me that the first volume of his <u>Roman Inscriptions of Britain</u> (<u>Inscriptions in stone</u>) was published in 1965, for I was able to use this as a guide for my list of pigs at the end of this work.

Whenever I was in doubt about an inscription,Mr.Wright was always ready to supply the solution and to guide me with the presentation and interpretation. I am grateful also for his strictness with regard to the presentation of this theses. His thorough methods and scrutiny are the only ones possible,hard though they are to follow, and such mistakes as exist are due entirely to my own failings in this respect.

A special note of thanks is due too to the Bristol Archaeological Group,to Mr.L.V.Grinsell,Mr.M.Hebditch, and Mr.J.Cross of the City Museum,Bristol,and to Mr.P. Fowler of the University of Bristol,who have shown continual interest in,and helped,my research. In October 1967,they organized a weekend course on 'Lead mining in Mendip' dealing with the geology,and with the history from Roman to modern times,a course which I was honoured to address on 'Roman lead mining'.

I gratefully record also my thanks to Dr.F.S.Wallis, of the Wells Museum,and to Mr.H.W.W.Ashworth for their help with the pigs and site of Green Ore,and to Mr. G.C.Boon,of the National Museum of Wales for his assistance with the pigs and equipment from Wales.

My thanks are due also to the curators of the Castle Museum, Taunton and the Corinium Museum, Cirencester, for permission to examine and photograph their pigs.

I am extremely grateful to the Trustees of the British Museum, and to the Keepers and staff of the Departments of Greek and Roman, and of British and Mediaeval antiquities, for their help in examining and photographing the pigs of lead whose total weight is just short of one ton.

My thanks are also gratefully recorded to my colleagues Mr.B.D.W.Chacksfield, and Mr.R.W.A.Rhodes for their assistance, the former in translating from German texts, and the latter in reading and advising my treatment of the chemical chapter.

Finally, I record my gratitude to the librarian of the Bristol University Library for the facilities granted me there, and to the librarians of the Wellington public library, Somerset for their great assistance.

H.D.H.Elkington

Wellington, Somerset.

Shirehampton, Bristol.

St.David's Day, 1968

✓

CONTENTS

TABLE OF ILLUSTRATIONS

INTRODUCTION

The first chapter of this work discusses the history of lead mining in Spain and Britain during the Roman period, and lists the known sites in the two provinces. I have found it necessary to cover part of the Republican period for this survey, and not merely to restrict it to the Empire as would be suggested by the title.

This chapter is followed by chapters on ownership and labour, Roman mining techniques – dealing with the prospecting methods and extraction of the ore, and then smelting and cupelling, the processes whereby first lead and then silver were extracted from the ore.

I have included the whole text and its translation of the Lex Vipasca and the Aljustrel Tablet, since it is relevant to so much of chapter on organization and ownership, not only in Spain, but also in Britain.

The final chapter deals with the evidence and problems given by the two hundred lead pigs that exist, or are recorded. It soon became evident, when writing this last chapter, that there were so many references to the texts of these pigs, including many that are not recorded in the lists that have been compiled by other authors due to their recent discovery, or to their being from another province,that it would be an advantage to my readers if I appended a comprehensive list. There is only one other such list - that compiled by Maurice Besnier in 1921, which I have used extensively for the Spanish examples. The British pigs will, of course, be covered by the second volume of _Roman Inscriptions of Britain_, which is now in the course of publication. The joint editor, Mr. R.P. Wright, my supervisor of studies, kindly guided my compilation of this list.

The list of Spanish and British pigs, together with relevant examples from Gaul, Germany and Sardinia appears at the end of this volume together with tables of concordance. Doubtful pigs and _falsa_ have been included in this list and are so indicated in the initial notes of their entry.

The list closed on December 31st 1967, shortly after the discovery of the pig I have numbered 159b, which appears in the list of pigs, but which has not been included in the tables of weights, nor are its references complete in the index, since the details reached me in February 1968, just two days before completing this thesis.

The Index contains references to pages numbers 1 to 141.

Thereafter, to avoid confusion, references are to pig numbers, and these are underlined. The references to the list of pigs includes their place of discovery, present location, and their mine of origin. The names of Emperors, lessees, legions, voting-tribes and the marks of origin are included in the index

A separate introduction to the list of pigs can be found below on pages 144 and 145, together with the critical apparatus on page 146.

ABBREVIATIONS AND BIBLIOGRAPHY

A. Abbreviations of Periodical and Serial Works

AA	Archaeologia Aeliana (Society of Antiquaries of Newcastle-upon-Tyne). ser. i. I-IV, 1822, 1832, 1844, 1850. Ser. ii. I - XXV, 1857 - 1903. Ser. iii, I - XXI, 1904 - 24. Ser. iv. I - , 1925 - .
AC	Archaeologia Cambrensis. Ser. i. I-IV, 1846-9. Ser. ii, I-V, 1850-4. Ser. iii, I-XV, 1855-69. Ser. iv, I-XIV, 1870-83. Ser. v. I-XVII, 1884-1900. Ser. vi. I-XX, 1901-20. Ser. vii, I-VIII, 1921-8, and from LXXXIV (1929) adopting consecutive numbering.
AE	Année épigraphique, L'. 1888 - . Also included in Revue Archéologique.
AJ	Archaeological Journal. 1845 - .
AJA	American Journal of Archaeology. (Journal of the Archaeological Institute of America. Ser. ii. I - . 1897 - .
Antiq.	Antiquity. 1927 - .
Ant. J.	Antiquaries Journal, The. 1921 - .
Arch.	Archaeologia. 1770 - ,
Arch. Zeit.	Archäologische Zeitung. 1843 - 85.
BAAJ	British Archaeological Association, Journal of. Ser. i. I-L, 1846-94. Ser. ii, 1895-1936. Ser. iii, I - , 1937 - .
BARG Bull.	Bristol Archaeological Research Group, Bulletin of. 1962 - .
Bull. Ant.	Bulletin des Antiquités de France. 1897

CASJ	Chester Architectural and Archaeological Society, Journal of. Ser.i.I-III,1850 - 1885. Ser.ii,I - ,1887 - .
CIL	Corpus Inscriptionum Latinarum.1863 - .
CW	Cumberland and Westmorland Antiquarian And Archaeological Society, Transactions of. Ser.i.I-XVI,1874-1900.Ser.ii,I- ,1901-
Derbs.AJ or Derbys.ASJ	Derbyshire Archaeological and Natural History Society, Journal of.I- ,1879 - .
Dessau	See ILS
Dorset NHAFCP or Dorset NHASP	Dorset Natural History and Antiquarian Field Club, I-XLIX, 1877-1928.Continued as Dorset Natural History and Antiquarian Society, Proceedings of. I - ,1928.
EE	Ephemeris Epigraphica I-IX,1872-1913.
Flints.Hist. Soc.Publ.	Flintshire Historical Society, Transactions of. 1911 - .
Ill.Lond.News.	Illustrated London News.1842- .
ILS or Dessau ILS	Inscriptiones Latinae Selectae.Ed. H.Dessau. 3 vols. in 5 parts,1892 - 1916.
JRS	Journal of Roman Studies.1911 - .
Metallurgia	British Journal of Metals .I - ,1930- .
Montgom.Coll.	Historical and Archaeological collections relating to Montgomeryshire, issued by the Powys-Land Club, Ser.i.I-XLVII,1868 - 1942.Continued as Montgomeryshire Collections.XLVIII - ,1944 - .
Newcomen Soc.Trans.	Newcomen Society for the Study of the History of Engineering and Technology, Transactions of.I - ,1922- .

Num.Chron.	Numismatic Chronicle. In 6 series, 1836 - .
Phil.Trans.	Philosophical Transactions. 1665 - .
PW	Pauly-Wissowa Realencyclopädie. 1894 - .
RCAM	The Royal Commission on the Ancient and Historical Monuments... in Wales and Monmouthshire (arranged by counties) 1911- .
RCHM	The Royal Commission on Historical Monuments(England)(arranged by counties). 1910 - .
Rev.Arch.	Revue Archéologique . 1884 - .
Salop AST	Shropshire Archaeological and Natural History Society, Transactions of. 1878 - .
Salop News	Shropshire Newsletter
Shropshire AST	see Salop AST
Som.ASP	Somersetshire Archaeological and Natural History Society, Proceedings of. 1851 - .
Som.& Dorset NQ	Somerset and Dorset Notes and Queries 1889 - .
TIMM	Institute of Mining and Metallurgy, Transactions of. I - , 1891 - .
TLL	Thesaurus Linguae Latinae. Leipzig, 1900 - .
VCH	Victoria County History (arranged by counties). 1900 - .
Wells NHASP	Wells Natural History and Archaeological Society, Proceedings of.
YAJ	Yorkshire Archaeological Journal. 1870 - .
Yorks.Phil. Soc.Proc.	Yorkshire Philosophical Society, Proceedings. Ser.i. 1847-1854. Ser.ii. 1855 - .

B. Manuscript Sources

B.M. is the abbreviation used for the British Museum.

Leland, J. B.M.MS. Cotton Julius C.VI

Skinner, J. B.M.MSS.ADD.

C. Separate Works, including important articles in journals.

Bailey *Pliny's Chemicals*	Bailey, K.C. *The Elder Pliny's Chapters on Chemical Subjects.* London, 1929-32.
Besnier *Rev. Arch.*	Besnier, M. in *Rev. Arch.* XII(1920) 211-214, XIII(1921)36-76,98-130. *Le commerce du plomb à l'époque Romaine.*
Brill and Wampler AJA	Brill, R.H. and Wampler, J.M. in *AJA* LXXI(1967)64-77. *The Isotope Studies of Ancient Lead.*
Bruns *Fontes*	Bruns, C.G. *Fontes iuris Romani Antiqui.* Ed.5. Freiburg, 1887
Cagnat. *Cours épig. lat.*	Cagnat, R.L.V. *Cours d'épigraphie latine*, Ed.4. Fontemoing, 1914.
Camden *Britannia*	Camden, W. *Britannia*. 1586; ed.2, 1587; ed.3, 1590; ed.4, 1594; ed.5, 1600; ed.6, 1607.
Camden	Camden, W., ed. Gough, R. *Camden's Britannia* translated by R. Gough. 3 vols., 1789; 4 vols., ed.2, 1806.
Collingwood *Archaeology of Roman Britain*	Collingwood, R.G. *The Archaeology of Roman Britain*, 1930.

Collingwood Britain	Collingwood, R. G. Britain in Tenney Frank ESAR III, Baltimore, 1937
Cox AJ	Cox, J. C. The mining operations and metallurgy of the Romans in England and Wales in AJ LII(1895) 25-42.
Cyprian	Cyprianus, Thascius Caecilius, Saint, Bishop of Carthage, Epistulae
Davies Roman Mines	Davies, O. Roman Mines in Europe. Oxford, 1935.
Dessau	see ILS
Diodorus or Diod. Sic.	Diodorus Siculus, Bibliothecae historicae
Forbes Technology	Forbes, R. J. Studies in ANCIENT Technology vols. VII-VIII, Leiden, 1964.
Gough Camden	See Camden
Gough Mendip	Gough, J. W. The mines of Mendip ed. 2. Newton Abbot, 1967.
Gowland Arch.	Gowland, M. The early metallurgy of silver and lead in Arch. LVII(1901) ii, 359-422.
Grinsell Wessex	Grinsell, L. V. The archaeology of Wessex, London, 1958.
Hill and Sandars JRS	Hill, G. F. and Sandars?H. W. Coins from the neighbourhood of a mine in Southern Spain in JRS I(1911) 100-106.
Holder	Holder, A. Alt-celtischer Sprachschatz Leipzig, 1896- .
Hoppensack Bergbau	Hoppensack, J. H. Über den Bergbau in Spanien, Weimar, 1796.

Hudson Metallurgia Hudson, D.R. Early mining in Spain in Metallurgia XXXIII(1945-6)293-300.

Huebner in Corpus Inscriptionum Latinarum VII

It. Ant. Itineraria Romana, vol. I, Itinerarium Antonini Augusti. Ed. O. Cuntz, Leipsig, 1929.

Justinian Justinianus Flavius Petrus Sabbatus, Codex Theodosianus, canon metallicus

Kubitschek Imp. Rom. trib. discr. Kubitschek, J.W. Imperium Romanum tributim discriptum. Vienna, 1859.

Leland Itinerary Leland, J., ed. Hearne, T. The itinérary of John Leland the antiquary, published from the original manuscript in the Bodleian Library, 9 vols. Oxford, 1710-12; 9 vols, ed. 2, 1745; 9 vols. ed. 3. 1768-9.

Leland Collect. Leland, J. De Rebus Britannicis collectanea.... ed. Hearne. T. 6 vols. Oxford, 1715; 6 vols., ed. 2, London, 1774.

Levy West Roman Vulgar Law Levy, E., West Roman Vulgar Law, the law of property. Memoirs of The American Philosophical Society XXIX, 1951.

Lewis Wales Lewis, W.J., Lead Mining in Wales, 1967

Lysons reliq. Brit. Rom. Lysons, S. Reliquiae Britannico-Romanae. 3 vols. 1801-17

Mason the Mendips Mason, E.J. with Coysh, A.W., and Waite, V. The Mendips, London 1954.

Merlin Mel. Cagnat Merlin, A., Lingots et ancres trouvés en mer près de Mahdia. in Cagnat, R. Mélanges Paris, 1912.

Nash-Williams Roman Wales — Nash-Williams, V.E., The Roman Frontier in Wales, Cardiff, 1954

North, Mining — North, F.J., Mining for metals in Wales Cardiff, 1962

Orth PW — Orth, s.v. Bergbau PW supplbd.IV. vols.120-155.

Palmer TIMM — Palmer, R.E., Notes on ancient mine equipments and systems in TIMM XXXVI (1927) 299-336.

Palmer and Ashworth SASP — Palmer, L.S., and Ashworth, H.W.W., Four lead pigs from Green Ore in SASP CI-CII(1956-7)

Pennant Wales — Pennant, T., A tour in Wales 1781 ed.

Pidal España — Pidal, F.M., Historia de España, Vol.II España Romana, Madrid, 1935.

Pliny NH — Plinius, Gaius Plinius Secundus, Naturalis Historia, libri XXXVII

Polybius — Polybius Historiae

RIB — Collingwood, R.G., and Wright, R.P., The Roman Inscriptions of Britain, vol.I, Inscriptions on stone, Oxford, 1965

Raistrick Newcomen Soc.Trans. — Raistrick, A., Notes on lead mining and smelting in West Yorkshire in Newcomen Soc.Trans.VII (1926) 81-96

Raistrick and Jennings Pennines — Raistrick, A., and Jennings, B. History of Lead Mining in the Pennines, London, 1965

Rav. — Ravennas ANONYMUS, Cosmographia in Richmond and Crawford Arch.XCIII (1949) 'The British section of the Ravenna Cosmography.'

Riccobono	Riccobono,S.,*Fontes Iuris Romani Antejustiniani*,I,*Leges* Florence,1941
Rickard *JRS*	Rickard,T.A., *The mining of the Romans in Spain in JRS* XVIII(1928) 129-143
Rickard *Metals*	Rickard,T.A.,*Man and metals* 2 vols. New York,1932.
Schulze	Schulze,W. *Zur Geschichte Lateinischer Eigennamen* Berlin,1933
Smith *collect.ant.*	Smith,C.Roach. *Collecteanea antiqua* 7 vols.,1848-80
Smythe *Newcomen Soc.Trans.*	Smythe,J.A. *Roman pigs of lead from Brough* in *Newcomen Soc. Trans.*XX(1940) 139-145,with a note by I.A.Richmond.
Strabo	Strabo *Geographica*
Stuart *Caledonia*	Stuart,R., *Caledonia Romana*... Edinburgh 1845; ed.2 revised by Thomson,D.,Edinburgh,1852.
Sutherland *Coinage*	Sutherland,C.H.V., *Coinage and Currency in Roman Britain* ,Oxford,1937
Tacitus *Annales*	Tacitus, Publius Cornelius Tacitus, *Annales*
Täckholm *Bergbau*	Täckholm,U., *Studien uber den Bergbau der Römischen Kaiserzeit.* Uppsala,1937
Tenney Frank *ESAR*	Tenney Frank, *An Economic Survey of Ancient Rome* Baltimore,1937
Theod.cod.de metal.	See Justinian.
Tylecote *Metallurgy*	Tylecote,R.E.,*Metallurgy in Archaeology* London,1962

Tylecote Roman lead Tylecote,R.E., Roman lead working in Britain in British Journal for thé History of Science II.i.no.5 (June 1964) 25-43.

Van Norstrand Spain Van Norstrand,J.J., Spain in Tenney Frank ESAR III Baltimore,1937

Way AJ Way,A., The enumeration of blocks or pigs of lead in AJ XVI(1859) 22-42.

Webster Flints.Hist.Soc.Publ. Webster,G., The lead mining industry in North Wales in Roman times in Flints.Hist.Soc.Publ. XIII(1952-3) 5-53.

West Spain West,L.C.,Imperial Roman Spain ,1929

Wheeler Prehist.Rn.Wales Wheeler,R.E.M., Prehistoric and Roman Wales,1925

Whittick JRS Whittick,G.C.,Notes on some Romano-British pigs of lead in JRS XXI(1931) 256-264

Whittick Newcomen Soc.Trans. Whittick,G.C., Roman mining in Britain in Newcomen Soc.Trans. XII(1932) 57-84

Wright Uriconium Wright,T., Uriconium,a historical account of the ancient city,1872

Throughout this work I have abbreviated the name of my supervisor of studies,following RIB to R.P.W(right), and my own name to H.D.H.E(lkington).

The Development of the Mining of Lead in the Iberian Peninsula and Britain under the Roman Empire until the end of the Second Century A.D.

It is essential in beginning the study of the development of Roman lead-mining to go back to about 100 B.C.,for it was in the first Century before the Christian era and in the two sucessive centuries that Roman lead-mining was most flourishing and succesful. During the first Century A.D. the mining of lead in Spain dwindled as a new field was opened up in the exploitation of the mineral in the newly acquired province of Britain - a place which, according to Pliny, possessed lead in abundance (1).Then in Britain too, the evidence for mining activity decreases towards the end of the second Century, and although numismatic evidence suggests that the mines were still operated until the end of the Roman occupation of the province (c.A.D.410), the exploitation must have been on a small scale.

Our main source of evidence for mining activity are the 200 or so inscriptions which occur on pigs of lead manufactured by the Romans,and which are treated at length in my final chapter.But it will be seen quite easily from a glance at the chronological tables on page

123 that lead mining was at its height in Spain in the 1st Century B.C. These pigs of lead are unfortunately undated, but, from the style of lettering and from the absence of cognomina in the titles of the mining lessees moulded on the faces, the upper surfaces of the pigs, it is at least possible to date most of them to before the abdication of Sulla in 79 B.C.

In Spain the exploitation of the lead mines was most remunerative. The ore was rich, containing approximately twenty to thirty ounces of silver for every ton of lead (0.05 - 0.09 %), which is a high proportion ; and it was from these lead ores that the Romans gleaned much of their silver. Even so, some authorities hold that it was the vast extent of the mining operations in Spain rather than the richness of the ore that led to the success of the Romans in this field.

The labour force was cheap to maintain - slaves and prisoners were used at first at minimal costs. 40,000 slaves were used in one mine, according to Strabo, which ? Ref ? yielded 25,000 drachmae a day. The methods of mining gradually became more proficient. By the time of Hadrian, elaborate laws were enforced to protect the mining rights

The incuse inscription V · ET P · C on pig no.89 of Claudius' reign, which allows us to date the pig to A.D.49. This pig, from Somerset is the earliest extant example from Britain.

and to ensure that the ore was not wasted.The mines were also to be run in as safe a manner as possible.Pains were taken too to ensure the smooth running of the pithead settlements.

The Romans smelted the lead ore in the vicinity of the mine,as is attested by the slag,and by the numerous smelting hearths that have been found in Spain.The Roman methods of cupellation - that is,the de-silverizing of lead- were extremely efficient,and compare favourably with those in use today.

There was little competition for the Spanish mines from those in Gaul and Germany,but in A.D. 43,came the Claudian invasion of Britain,where mineral resources were reputed to be high.We have evidence that within six years of the invasion the lead mines on the Mendip hills in Somerset, which had probably been operating on a small and inefficient scale by the Celts,had been taken over by the Romans who were now producing their own lead there in the forms of pigs bearing the name and titles of the Emperor Claudius.

Thus,as the conquest of Britain continued,so did the acquisition of the lead mines and the exploitation of the lead ores. From Somerset, the Romans mined lead in Wales, Flintshire, Shropshire, Derbyshire, Yorkshire and Cumberland. Throughout the province, and particularly in Derbyshire, the ore was poor in silver, yielding perhaps just two to five ounces of silver for every ton of lead (0.006 - 0.01%), but the ease with which the ore could be gleaned from the earth, - by opencast methods and by simple workings - , compared with the complicated network of shafts, and the honeycombing of hills and mountains with galleries in Spain, naturally led to the decline of the Iberian peninsula as a lead-silver producing province, and to the increase of productivity in Britain. This is borne out again by the evidence shown by the pigs of lead which suddenly almost cease to exist after the conquest of Britain, whereas in this province, lead production appears to have reached its peak by A.D. 69 , and again during the reign of Hadrian, from A.D. 117 to 138.

Such was the concern in Spain over the increased output of lead and silver from Britain, Pliny tells us, that it became necessary for legislation to be enforced, restricting the productivity of the mineral mines, implying that at this time some British mines were in the hands of lessees, and it was at this time too (in the Flavian era) that there was a resurgence of mining in Spain ,for Pliny again informs us of increased revenues from the workings.

Then during the second century A.D. the evidence from the pigs of lead in Britain begins to fade also, and the last datable pig belongs to the last decade of that Century. However, lead continued to be mined and was used amongst other things in the manufacture of pewter.

Let us now examine the literary evidence for the mining of lead in these two provinces, and also the location of the principal mines and mining areas:

Pliny, NH III, 30

metallis plumbi, ferri, aeris, argenti, auri tota ferme Hispania scatet.

' -almost all Spain abounds in mines of lead, iron, tin, silver and gold.'

Our main literary authority for Roman lead mining methods is Pliny, who, having described the Roman methods of sinking shafts, and driving adits (which are discussed later) goes on to describe the methods of acquiring silver:

Pliny, NH XXXIII.95-97

" Our next subject is the mining of silver - a second manifestation of madness. It is found only in shaft mines and there is no previous indication of its presence, for there are no glinting sparks as in the case of gold; the earth is red in places and ash-coloured in others. The method of refining universally employed is heating with lead or lead ore called galena ...

' Silver is found in almost all the provinces, but the best comes from Spain. Like gold, it occurs in barren soil and even among mountains, and wherever one vein is found, another is not hard to seek. This is the case with almost all the other ores, and seems to be the source of the Greek name metalla. It is wonderful that the mines opened by Hannibal in Spain are still productive.

' They are named after the original discoverers, and one, which furnished Hannibal with three hundred pounds daily is called Baebelo unto this day. The excavations now exceed 1500 paces into the mountains and throughout the whole distance, the Aquitanians stand and bale out water in lamp-measured watches night and day until a river is made. The vein of silver that is found nearest the surface is called <u>crudaria</u>.'

On the properties of lead, of <u>plumbum nigrum</u>, as opposed to <u>plumbum album</u>, which is tin, Pliny states:

Pliny, <u>NH</u> XXXIV, 156-158

' Let us now consider the properties of lead, of which there are two species - black lead and white lead. The latter is more valuable ...

' Black lead is not produced in Gallaecia in spite of the fact that the neighbouring Cantabri possess it in abundance. Silver, which is obtained from black lead, is absent in white lead. Black lead cannot be welded without oil, and even two pieces of white lead cannot be united without black lead...'

Concerning the areas in which lead could be found, Pliny writes:

Pliny, <u>NH</u> XXXIV, 164-5

' We make pipes and plates from black lead, which is mined with great toil in Spain and in all the divisions of Gaul, but occurs in Britain in the surface stratum of the ground and in such abundance that the amount refined is actually limited by law. The following names are given to varieties of black lead - Iovetanum - Caprariense - Oleastrense - but there is no difference between them, provided that, in the roasting the slag is carefully separated. A phenomenon peculiar to mines of this metal only is that, if abandoned for a time, they recover their fertility.

' This result is achieved by leaving the air shafts open and allowing the air to stream in to saturation - and may be compared with the fact that some women are rendered more fertile by miscarriage. Such revival is known to have happened recently in the Samarian mine in Baetica, which used to be rented at 200,000 denarii per year, and after a period of neglect was let once more at 45,000 denarii. Similarly the Antonian mine in the same province which had been let for a similar sum, subsequently brought in a rent of 400,000 sesterces.'

Strabo too assists us with his evidence, and when describing the mineral wealth of Spain says:

' Up to the present moment, neither gold, nor silver, nor yet copper, nor iron has been found anywhere in the world in a natural state, either in such quantity or of such good quality.'

-Strabo, III.2.8

A Map of Spain, showing the principal mining sites

Strabo,III.2.3.

' On the North(above Cordova) there are some mountain ridges which extend parallel to the river,approaching it closely,sometimes more so,sometimes less,and they are full of mines.Silver,however,is most plentiful in the region about Ilipa ,and in those about Sisapo.'

Strabo,III.2.10.

'Polybius,in mentioning the silver mines of Carthagena, says they are very large;that they are distant from the city about twenty stades and embrace an area 400 stades in circuit,and that 40,000 workmen stay there who bring unto the Roman exchequer a daily revenue of 25,000 drachmae...

'...the silver mines are still (under Augustus) being worked;they are not state property ,however,either at Carthagena or anywhere else,but have passed over to private ownership.But the majority of gold mines are state-owned.'

If we look now at the map showing the locations of the Roman lead mines in Spain,it can clearly be seen that the greatest concentration of mines is in the South and in the South-East.Significantly,it is from this area that the greatest number of extant pigs originated.

In Lusitania, in the South-west of the Iberian peninsula, a Roman lead mine was located at Santaren (2).

In Baetica and Andalusia, the principal lead mines were at Linares and Alcaracejos, both of which have yielded evidence in the form of lead pigs (3). Lead pigs have also been found at Rio Tinto, but these were all imported from other mines, leading us to suppose that here was a centre for cupellation (4), for tongs used for handling crucibles have also been discovered (5). Rio Tinto may also have been a school for miners (6). The workings at La Carolina have yielded coins dating to the year A.D.383 (7). The ores at the Roman mines at Sierra de Cordoba and at El Centenillo were noted for their rich quality, the latter yielding twenty ounces of silver in each ton of lead (0.06%)(8). The mine at Cerro Muriano, on the other hand, yielded only poor ores, containing but 42.13% lead and no silver (9). There were also mines at Sisapo (10), at Sotiel Coronada(11) and near Castulo(12).

In Huelva there was a mine at Ilipa where much Roman slag has been discovered (13). In Turdetania there was a mine at Orongis (14). Fifty-two furnaces have been recorded by Gowland (15) in Almeria,which has also produced pigs of lead.Here,the main mine was at Cabo de Gata (16) ,and in the Sierra Morena district,pigs have been found at Plumbaria(17),Lorca (18),Mazarron (19),Orihuela (20),and at Carthagena.(21).Plumbaria and Carthagena were obviously the main harbours for exporting lead from the mines in this highly productive area (22).At Coto Fortuna,Roman workings have been found to extend for two kilometers (23), and coins attest to the mine's occupation from the second century A.D. up to the beginning of the fifth (24).

In the East of the province there was a mine at Dianium (25) and in Tarraconensis,amongst the Celtiberi,there were possibly lead mines at Osca,Venasque,Plan,Bietsa,and Lerida (26). Barcelona was probably used,like Rio Tinto, as a cupelling centre (27).

In the North,in Asturias,slag has been found at Pravia (28) and further West,amongst the Artabri,and the Cantabri, Pliny mentions a mine at Ovetum (plumbum Iovetanum). Pliny's plumbum Caprariense and plumbum Oleastrense are from unknown locations.The latter,however,may be from the Oleastrum,near the mouth of the Ebro,but here no mines are known (29).

A Map of Britain, showing the principal mining areas and ports.

Tacitus, <u>Agricola</u> XII,6.

" Britain yields gold, silver, and other minerals - the prize of victory. "

In Britain the areas of mining activity were on the Mendip hills, in Somerset, in Wales, in Flintshire, Shropshire, Derbyshire, Yorkshire, and Cumberland.

The traces of the Roman workings are not always easy to find. In the case of the Mendip mines, activity continued until the nineteenth century, and in most of the mining areas it is almost impossible to distinguish between Roman, on the one hand, and mediaeval and modern workings, on the other. The workings too, being of a much simpler nature than those of Spain, have not been able to produce so much evidence for the archaeologist. Nevertheless, their importance was such that the output was restricted in Pliny's day, as we have seen above.

It is interesting to see also that the pigs were exported to the Continent, and that many of the lead pigs that have been found, were in fact lost <u>en route</u> to the ports. Mendip pigs have been taken from the river Frome in Bristol, and Clausentum (Bitterne) near Southampton must have served as a port for Flintshire and Derbyshire, as well as for Somerset.

Two photographs showing the amphitheatre at Charterhouse-on-Mendip.

Derbyshire, together with Yorkshire, also exported lead pigs through Brough-on-Humber, for there a number of pigs have been found.

From the Mendips, a total of twenty-four pigs have survived showing continued occupation under the Romans from A.D.49 until c.169. There is some evidence that the mines were operated before the Roman arrival by the Celts, but that their output was small (30). Numismatic evidence, together with the remains nearby of a pewter industry show that the Roman occupation of the Mendip lead mines lasted until the end of the fourth Century A.D. (31).

Smelting of the lead ore took place on the site, as is attested by the slag that is still visible, difficult though it is to distinguish between Roman and later slag. It also appears, from hearths that have been found (32) that cupellation took place near the site as well.

The workings on the Mendips centred around Charterhouse. Here, first and second Century coins have been found together with fibulae and pottery showing occupation throughout the first two centuries (33). It was a large settlement with an earthwork which is almost definitely an amphitheatre (34). In the adjacent fields, aerial photo-

The inscription LEG II AVG on pig no.93

graphs reveal ground patterns resembling streets of a Roman town. A coin hoard has been found here, and recent discoveries on the site of a possible fort include pottery dated to the first thirty years of the Roman occupation. (35). The actual workings appear all to have been opencast, but, once again, later exploitation has confused the Roman workings.

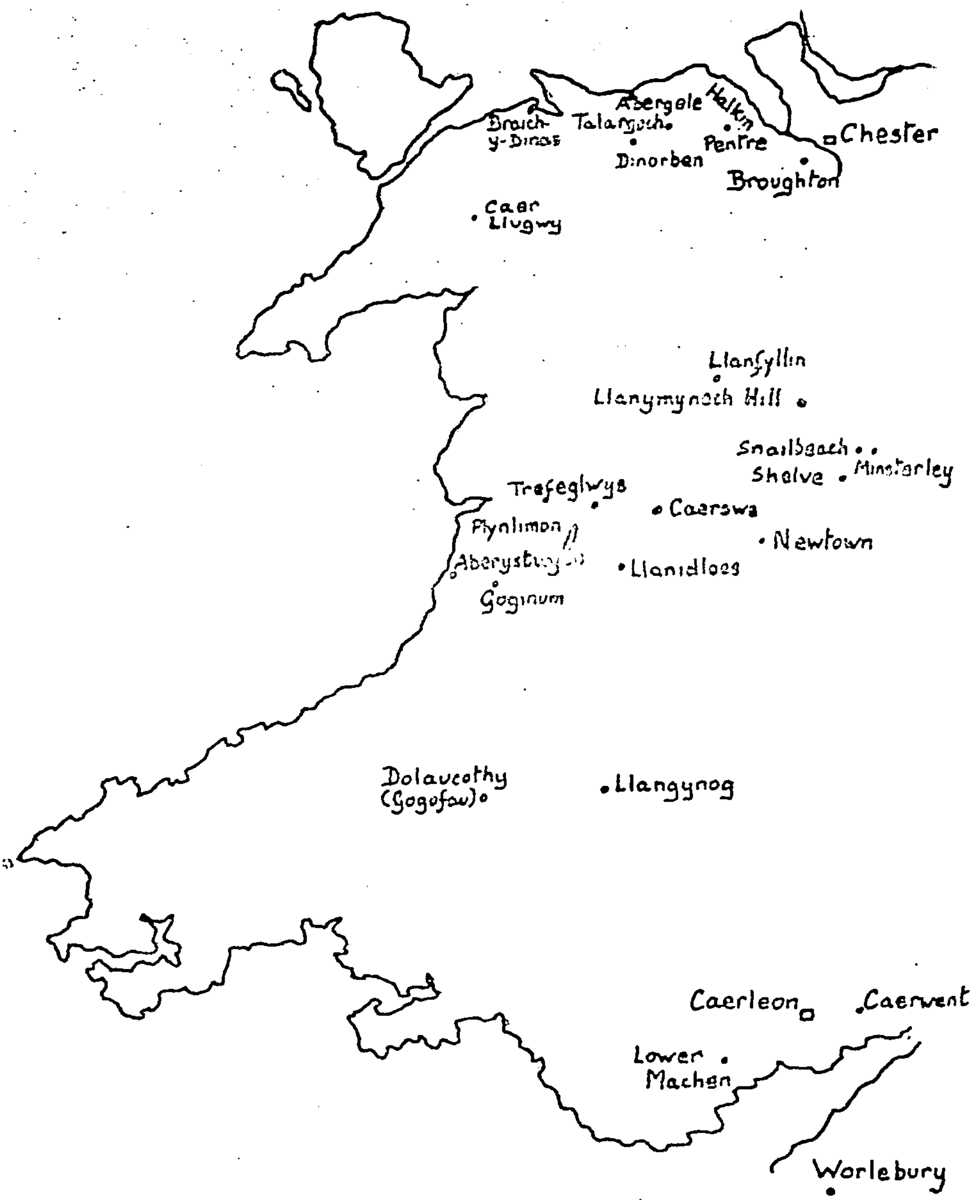
Across the Bristol Channel, in South Wales, there were lead mines at Lower Machen, near Caerleon. These, like those of the Mendips, may well have been controlled by the Second Legion, which had established itself at Caerleon about A.D. 75. (36). Galena ore found at the fort, and containing 0.001% silver, may possibly have been from the same mine (37). Several Roman coins of Domitian's reign have been found here, and other finds indicate its occupation up to the end of the second Century A.D. (38). The pig no. 93 inscribed (L)EG II AVG, from Caerwent is presumably from the Lower Machen mine.

Cerussite found in the Roman villa at Llantwit Major, Glamorgan, contains 170 ounces of silver for each ton of lead (0.52%) one of the richest silver ores in the country (39).

In the North-west of Wales, in Caernarvonshire, there were probably Roman lead workings at Pont-ty-Hyll, one mile to the East of Bryn-y-Gefeilau (Caer Llugwy) by Capel Curig (40).

In Shropshire and Montgomeryshire, the workings were opencast, and use was made also of shafts and galleries (41). The mines were at Shelve, Snailbeach, and Minsterley (42). Here, workings underground can be traced following a 2'6" lode for 200 yards at a depth of twenty to fifty feet. The lead ore has been found as far as Llandidloes and Trefeglwys in the Upper Severn Valley (43). Smelting was carried out here too (44), and pigs of lead span a period of time from the reign of Hadrian right up to the end of the second Century A.D. Numismatic evidence attests to Roman occupation at Llanymynech during the first two Centuries (45), and amongst other finds, a wooden spade of Roman date is recorded, although Prof. Haverfield and Miss M.V. Taylor consider that it may not be Roman (46).

Oliver Davies (47) reported in 1938 that at Newtown there were cave and gallery workings like the Roman ones at Llanymyneoh, but that these were not necessarily as early as, or exclusively, Roman. He does, however, point out that a Roman road passed within half a mile of the mine, and that the slag there is certainly earlier than the sixteenth



A Map of Wales, showing the mining sites century.

There were works for lead and copper near Plynlimon, where workings several hundred yards long are reported (48). At Caersws occur pieces of galena, clay and crucible - the galena containing silver to a proportion that caused Davies to comment that the Romans failed to exploit the lead mines of a very attractive district (49). From Caersws runs a Roman road through an area where a number of Roman remains have been discovered. (50).

Roman workings are said to exist at Nantymwn (51), and Roman and pre-Roman workings at Nant-yr-eira and on the left bank of the Severn (52). Smelting hearths of Roman date have been found on Dol y felin Blwm at Llanfyllin, and mines on the hills surrounding Llangynog (53).

Wheeler also mentions the alleged discovery of a bronze vessel containing Roman remains at the Goginian lead mine near Aberystwyth (54).

The date of the beginning of the lead mines in Flintshire is uncertain, but the earliest lead pigs that can definitely be attributed to these mines are of Vespasianic date. The mines were on the Halkin mountains (55), twelve miles west of Chester, at Pentre, where smelting was carried out, and where furnaces and pottery show Roman occupation until the second Century, and possibly the third (56). There are also remains at the mines of Ffos-y-bleiddiaid near Abergele (57), and Talargoch, where coins prove Roman occupation until the middle of the third century (58), at Dinorben, and Braid y Dinas (59).

The pigs from the Derbyshire mines cause a problem, since it is not easy to date them to an exact period before or after the reign of Hadrian, but this problem is discussed later. Certainly Roman finds in the area suggest occupation from Hadrian's reign until the fourth Century (60). Here, opencast workings are found together with the primitive pits (61). The area was known as Lutudaron (62), and mines existed at Matlock, Wirksworth, and Dovedale (63), though traces of them are hard to find. More workings were discovered by engineers at Starkholmes which were thought to be Roman. This consisted of a vertical shaft, 1'6" wide with neatly squared corners (64). The lead content of the ore in Derbyshire is very high - almost the maximum, whereas the silver content is extremely poor (65).

In Yorkshire, there were a number of lead mines. From Nidderdale, two pigs show that the mines there were in operation during Agricola's governorship in A.D.81 (nos. 118-119).

In Swaledale, the "Hurst" mine has yielded evidence of Roman occupation (66).

At Greenhow Hill, West of Pateley Bridge (67), there is evidence of "hushing", a process of washing the ore from the ground, and which is discussed in the chapter on mining technique, and of adits and surface workings (68). Here, pottery was said to have been found, but none was kept (69).

At Grassington, in Wharfedale, there are sherds of Roman pottery to be found (70), which Dr. Raistrick says were dumped there from a nearby Romano-British site, but these should not be connected with the mine (71). There is no definite evidence of occupation after Hadrian's reign, and yet coins suggest that mining was continued for some time afterwards (72).

The possibility of Roman lead mining on Alston Moor, in Cumberland, has been discussed on various occasions (73). Certainly, lead ore, very rich in silver content from Alston Moor has appeared at Corstopitum (74), and lead ore and slag, found in Whitley Castle, a fort on the Maiden Way, near Alston, seem to prove that there was some activity there (75). The fort at Braboniacum, Kirkby Thore, is thought to have served as a control point for lead passing South from the various mines (76).

The ladle ,said to be Roman,and for pouring lead,which was found on Wolsingham South Moor,together with slag, charcoal and furnace clay is now considered to be post-Roman (77).

References

1.Pliny NH XXIV,164.

2.West Spain 45.

Hoppensack Bergbau 2.

see too Besnier Rev.Arch.XII(1920)224.

3.Gowland Arch.LVII(1901)ii,377.

Davies Roman Mines 115

Rickard Metals 446-7.

Van Nostrand Spain in Tenney Frank ESAR III 140.

West Spain 43.

4.Gowland Arch.LVII(1901)ii,378.

Rickard Metals 428-9.

5.Davies Roman Mines 22.

6.Davies Roman Mines 10,130.

see too Rickard JRS XVIII(1928) 132.

7.Gowland Arch.LVII(1901)ii,377.

Besnier Rev.Arch.XII(1920) 229-230.

West Spain 44.

8.Hill and Sandars JRS I(1911) 100.

Besnier Rev.Arch.XII(1920) 229.

Davies Roman Mines 137.

Rickard JRS XVIII(1928) 140f.

9,Davies Roman Mines 133 fn.

10.Orth P-W Supplbd.IV col.121.

Besnier Rev.Arch.XII(1920) 226.

Strabo III 2,3.

11.Davies Roman Mines 10.

12.Gowland,Arch.LVII(1901)ii,377.

Besnier Rev.Arch.XII(1920) 229.

Rickard JRS XVIII(1928) 139. Metals 447.

West Spain 43-45.

13.Davies Roman Mines 111.

Besnier Rev.Arch.XII(1920) 226.

Rickard Metals 428.

14.Davies Roman Mines 108

Besnier Rev.Arch.XII(1920) 226.

15.Gowland Arch.LVII(1901)ii,377.

16.Gowland Arch.LVII(1901)ii,377.

Davies Roman Mines 110.

Besnier Rev.Arch.XII(1920) 229.

Hoppensack Bergbau 15.

Rickard JRS XVIII(1928) 141.

West Spain 45.

17.Rickard JRS XVIII(1928) 140. Metals 446.

18.Van Norstrand Spain in Tenney Frank ESAR III 140.

19.Besnier Rev.Arch.XII(1920) 228.

Davies Roman Mines 9,107,109.

Van Norstrand Spain in Tenney Frank ESAR III 140.

Rickard JRS XVIII(1928) 140. Metals 446.

20.Gowland Arch.LVII(1901)ii,378.

Besnier Rev.Arch.XII(1920) 228.

Van Norstrand Spain in Tenney Frank ESAR III 140.

Rickard JRS XVIII(1928) 140,142. Metals 446.

21.Gowland Arch.LVII(1901)ii,377.

Besnier <u>Rev.Arch.</u>XII(1920) 228.

Davies <u>Roman Mines</u> 9,107f.

Rickard <u>JRS</u> XVIII(1928)140, <u>Metals</u> 446.

22\. Gowland <u>Arch.</u>LVII(1901)ii,377.
   Besnier <u>Rev.Arch.</u>XII(1920) 224-5.
   Davies <u>Roman Mines</u> 107.
   Van Norstrand <u>Spain</u> in Tenney Frank <u>ESAR</u> III 140.
   Rickard <u>JRS</u> XVIII(1928) 140.
   West <u>Spain</u> 45.

23\. <u>Rev.Arch.</u>ser.iv. IX(1907) 60.
   Besnier <u>Rev.Arch.</u>XII(1920) 23.
   Van Norstrand <u>Spain</u> in Tenney Frank <u>ESAR</u> III 157.
   Rickard <u>JRS</u> XVIII(1928) 140. <u>Metals</u> 446.

24\. Davies <u>Roman Mines</u> 109.
   Rickard <u>JRS</u> XVIII(1928) 140. <u>Metals</u> 446.

25\. Besnier <u>Rev.Arch.</u>XII(1920) 225.

26\. Davies <u>Roman Mines</u> 97.
   Hoppensack <u>Bergbau</u> 14.

27\. <u>Rev.Arch.</u>I(1868) 299.
   Gowland <u>Arch.</u>LVII(1901)ii,378.
   Davies <u>Roman Mines</u> 97.
   West <u>Spain</u> 45.

28\. Davies <u>Roman Mines</u> 98.
   Hoppensack <u>Bergbau</u> 17.

29\. Davies <u>Roman Mines</u> 115.
   see too Besnier <u>Rev.Arch.</u>XII(1920)224-225.

30\. <u>VCH Som.</u>i.338
   A.Bulleid and H.St.G.Gray <u>Glastonbury Lake Village</u> I (1911)241-253.
   H.St.G.Gray and A.Bulleid <u>Meare Lake Village</u> II (1948) 249-252

D.P.Dobson Archaeology of Somerset (1930) 130.
Grinsell Wessex 237f.

31.VCH Som.i.334-341,354-355.
Gough Mendip 31.
Evans Num. Chron.ser.iv.XV(1915) 499.
Collingwood Britain in Tenney Frank ESAR III 42.
Sutherland Coinage 90f.

32.JRS XLIV(1954) 99.
Ashworth Wells NHASP XLVIII-XLIX(1957-8) 10ff.

33.VCH Som.i.334-341.
Sutherland Coinage 90f.
see too Mason The Mendips 45-46.

34.VCH Som.i.336.
Collingwood Archaeology of Roman Britain 105,fig.26.
Collingwood Britain in Tenney Frank ESAR III 42.
Whittick Newcomen Soc.Trans.XII(1932) 68.
Som.ASP LV(1909) 118-137.

35.VCH Som.i.338.
BARG Bull.December 1967 132.
Brill and Wampler AJA LXXI(1967) 70.

36.Randall AC C(1949) 95.
Nash-Williams Roman Wales 105.

37.Brill and Wampler AJA LXXI(1967) 74,sample 82.

38.Nash-Williams AC XCI(1936) 379.
AC XCIV(1939) 108.

39.Nash-Williams AC CII(1952-5)89-163.

40.Randall AC C(1949) 100.
Nash-Williams Roman Wales 42.

41.VCH Salop i,263.
Collingwood Britain in Tenney Frank ESAR III 43.

42.Cox AJ LII(1895) 31.
Gowland Arch.LVII(1901)ii,383.
VCH Salop i,263.
Collingwood Britain in Tenney Frank ESAR III 43.
Whittick Newcomen Soc.Trans.XII(1932) 72.
43.Montgom.Coll.V(1872) 24ff.
Collingwood Britain in Tenney Frank ESAR III 43.
44.Collingwood Britain in Tenney Frank ESAR III 43.
45.Pennant Wales II 381-2.
Montgom.Coll.XLII(1932) 99f.

Collingwood Britain in Tenney Frank ESAR III 43.
Davies Roman Mines 160.
Wheeler Prehist.Rn.Wales 270.
Salop News.July 1966.
46.Cox AJ LII(1895) 31.
VCH Salop i,263.
Whittick Newcomen Soc.Trans.XII(1932) 59.
47.Montgom.Coll.XLV(1938) 154.
see too Lewis Wales 25.
48.Montgom.Coll.III(1870) 289.
Davies Roman Mines 155.
Nash-Williams Roman Wales 57.
North Mining 28.
49.AC (1857) 172.
Montgom.Coll.XLV(1938) 157.
50.Montgom.Coll.XXXVII(1915) 24.
Nash-Williams Roman Wales 48,54.
51.Montgom.Coll.VI(1873) 339.
52.Montgom.Coll.III(1870) 289,429f. V(1872) 24.
53.Montgom.Coll.XVIII(1885) 38.
54.Wheeler Prehist.Rn.Wales 270.
55.Collingwood Britain in Tenney Frank ESAR III 43.

Flints.Hist.Soc.Publ.IX(1922)10.
North Mining 27.
56.CollingwoodBritain in Tenney Frank ESAR III 43-4.
RCAM Wales and Flints XCV 31.
Whittick Newcomen Soc.Trans.XII(1932) 70.
Atkinson and Taylor Flints.Hist.Soc.Publ. IX(1922) 10, X,i.(1923) 5ff. X,ii.(1924) 6ff.
Webster Flints.Hist.Soc.Publ.XIII(1952-3) 14-16.
57.Wheeler Prehist.Rn.Wales 270.
Webster Flints.Hist.Soc.Publ.XIII(1952-3) 15.
AC LXXXVII(1932) 34.
Lewis Wales 24.
North Mining 12,26.
58.Wheeler Prehist.Rn.Wales 270.
Taylor Flints Hist.Soc.PublIX(1922) 10.
but see North Mining 26.
see also Nash-Williams Roman Wales 21.
Chester AHSP new ser.I(1887) 136-138.
59.Roman Mines 155.
Collingwood Britain in Tenney Frank ESAR III 44.
60.Davies Roman Mines 155.
Collingwood Britain in Tenney Frank ESAR III 44.
61.Davies Roman Mines 155.
62.Collingwood Britain in Tenney Frank ESAR III 45.
Richmond Newcomen Soc.Trans.XX(1940) 144.
Richmond and Crawford Arch.XCIII(1949) 38.
63.Collingwood Britain in Tenney Frank ESAR III 44.
64.Derbys.ASJ LXXII(1952)106-7.
see too Tylecote Roman Lead 28.
65.Derbys.ASJ LIX(1938) 61.
66.Whittick Newcomen Soc.Trans.XII(1932) 72.

Raistrick and Jennings *Pennines* 3,7.

67.Collingwood *Britain* in Tenney Frank *ESAR* III 45.

R.Clough *The Lead Smelting Mills of the Yorkshire Dales* (1962) 10.

68.Way *AJ* XVI(1859) 22-40.

YAJ XXX(1931) 181f.

Whittick *Newcomen Soc.Trans.*XII(1932) 72.

69.Raistrick and Jennings *Pennines* 7.

70.Whittick *Newcomen Soc.Trans.*XII(1932) 72.

Collingwood *Britain* in Tenney Frank *ESAR* III 45.

71.Raistrick and Jennings *Pennines* 7.

72.Whittick *Newcomen Soc.Trans.*XII(1932) 72.

73.Gowland *Arch.*LVII(1901)ii,382.

74.*AA* i,IV(1850)36.

Richmond *CW* ii,XXXVI(1936) 109.

Collingwood *Britain* in Tenney Frank *ESAR* III 45.

74.Raistrick and Jennings *Pennines* 10.

75.Raistrick and Jennings *Pennines* 10.

76.Collingwood *Britain* in Tenney Frank *ESAR* III 45.

CW ii,XXXVI(1936) 104. ii,LXIV(1964) 64.

77.Wooler *YAJ* XXVIII(1926) 93.

The Ownership and Organization of the Mines

The ownership and the organization of the mines underwent considerable changes during our period.

During the republic and at the beginning of the Empire, the mines in Spain were privately owned, and the owner of the land or the local ruler was _ipso facto_ the owner of the subsoil, and the mining resources. The mines could be worked by the owners themselves, or by others who had arranged to do so with the consent of the owners. Later this agreement was not required.

During the Republic, the mines could be leased to _publicani_ for tenures of five years. The leasing method saved Rome the need for a large staff of officials of whom there is no trace (1). The _publicani_ then endeavoured to exploit the ore as much as possible during their five - year tenancy, a habit which continued under the early Empire, by extracting only the richest ore, with little regard either for the efficiency of the operation or for the health and safety of the workers of whom they employed an enormous number. Profits were increased by rejecting ore up to a higher percentage than was required to pay the costs of mining and smelting (2).At Laurion,in Attica, ore containing less than ten per cent lead was thrown away or left in the supporting pillars.(3).

The mines could be worked by individuals or,by the first Century A.D.,by *socii*.Pigs of lead from Spain (nos. 81-86) tell us of the *Societas Montis Ilucronensis*, though more usually in Spain,mines were run by one ,two or three individuals ,whose names and voting-tribes suggest that they were of Italian origin rather than Spanish.

This system was an improvement on the former where considerable waste had been allowed with little revenue to the state,but Augustus began the system,continued by Tiberius and subsequent Emperors,whereby all mines came under Imperial control irrespective of whether the province in question was Imperial or Senatorial.(4)

Strabo,III.2.10.

ἔστι δὲ καὶ νῦν τὰ ἀργυρεῖα, οὐ μέντοι δημόσια,
οὔτε ἐνταῦθα οὔτε ἐν τοις ἄλλοις τόποις, ἀλλ'
εἰς ἰδιωτικὰς μετέστασαν κτήσεις τὰ δὲ
χρυσεῖα δημοσιεύεται τὰ πλείω.

• The silver mines are still being worked at the present time (under Augustus);they are not state property,however either at Carthagena or anywhere else,but have passed over to private ownership. But the majority of the gold mines are state property."

Under this system mining concessions were leased out to conductores (lessees) again for periods of five years, and the latter were to find it much harder to become profiteers.

By the time of Polybius (c.145 b.c.), the right to grant mining concessions had gone to a committee of censores (5). According to Justinian (6), they received from the conductor a tithe for the fiscus, the Imperial treasury, and a tithe for the dominus, the owner of the land if the mine was on private land.

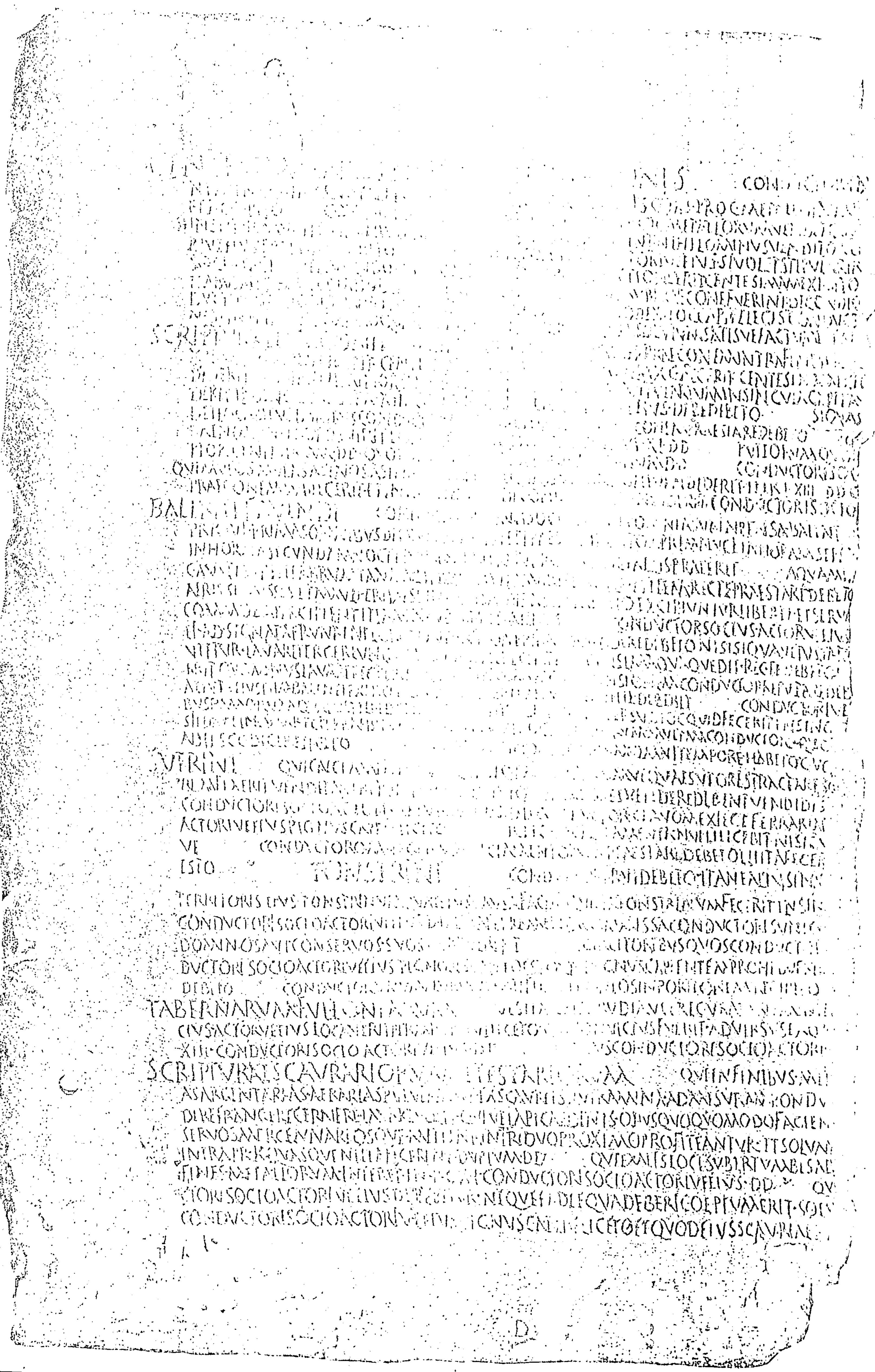
Mines were gradually acquired from their former owners by one of several means - usually by purchase or default (7). Some were confiscated, as were the mining possessions of Sextus Marius by the Emperor Tiberius after the former's execution (8).

The head Imperial officials first appointed by Augustus were procuratores, who were either equites or, more rarely, Imperial freedmen, and these were responsible personally to the Emperor for all the mines in their province, or even in two provinces (9), again regardless of whether the province was Imperial or Senatorial.

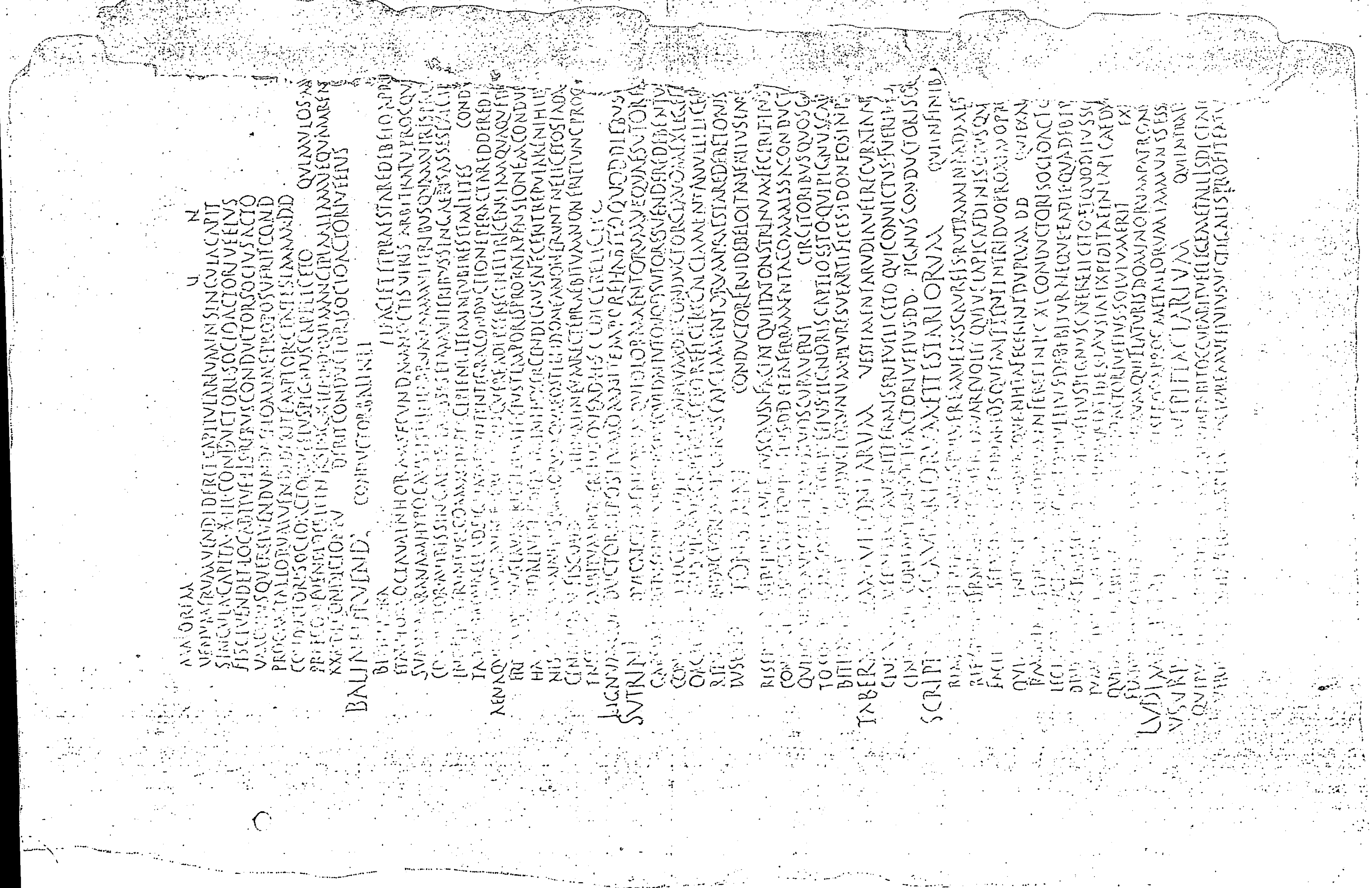
The procurators had under them a staff of slaves who were _commentarienses_ and _tabularii_ - registrars and book-keepers; γραμματεῖς - secretaries; _dispensatores_ - treasurers; _arcarii_ - public revenue controllers; _probatores_ examiners of mines, together with a staff of technicians to supervise the workings of the mines (10). If he was an _eques_, the procurator would also have under him certain officers (11). He had supreme powers over people in the mining area except those of life and death. The mining staff under him was so numerous that in provinces where the ore was poor and was not able to be mined profitably, the ore was abandoned. Provinces thus became known as mining - and non-mining - provinces.

The procurator farmed out the mines to the _conductores_, lessees, who were usually _equites_, and these either supervised the workings themselves or sub-let them to individuals or to companies. The procurator would enforce the collection of revenue for the _fiscus_.

Concession boundaries were vertical, and private citizens had to pay a levy for the use of the ground to the lessee. The lessee could sell his portion of the mine for as great a profit as he could acquire, provided that



A facsimile of the Lex Vipasca (first side)



A facsimile of the <u>Lex</u> <u>Vipasca</u> (second side) his own debt to the _fiscus_ was fully paid up (12). An _occupator_ had the right to choose a place for prospecting, to erect a tablet in order to 'stake his claim', and then had to inform the lessee within two days. At Rio Tinto the vast size of the area and the unity of design suggest a centralized control, but elsewhere in Spain, sub-letting is more obvious.

We are fortunate in having extant two bronze tablets found in 1906 and 1876, approximately the same size :
0.72 m. high ; 0.52 m. wide ; 10.12 mm. thick:
These are called the _Lex Metallis Dicta_, or ,more usually, the Aljustrel tablet (13), and the _Lex Territorio Metalli Vipascensis Dicta_, or, more usually, the _Lex Metalli Vipascensis_ ,or ,the _Lex Vipasca_ (14). The full text of these in Latin, together with their translation into English can be found at the end of this chapter. The Aljustrel tablet is inscribed on both sides, the second side being a duplicate of the first. The _Lex Metalli Vipascensis_ is inscribed on one side only. They are dated to Hadrian's reign. The _Lex Metalli Vipascensis_ was originally thought to be of Vespasianic date, but the reference in line fifty-nine to the _lex metallis dicta_, which in turn refers in line five

to the Emperor Hadrian dates this to Hadrians' reign also.

The two _leges_ deal with the organization of the mines and the mining areas, and lay down strict laws for the levying of taxes and the conditions under which mines were to be leased, and so on.

The whole of the mining settlement, not merely the mine came under the control of the _fiscus_. The lessee paid for his lease of the mine, thereby accepting strict control under the procuratorial administration both of the shaft and of the pithead settlement. The costs of the administration were met by the rents which the lessee paid. The _fiscus_ then claimed, as duty, one-half of the ore extracted in addition to the rent which had already been paid on the mine. So long as production at the mine continued, the lessee was secure in his tenure of the mine, but if the mine was left idle for six consecutive months, then he lost it.

Under the _lex metallis dicta_ the lessee could have associates, and it was under this heading that _societates_ began to spring up. Six Spanish pigs, as we have seen, bear the names of a _societas_. These _societates_ can be dated to the first Century A.D. while Spain retained a monopoly in the lead industry. _Societates_ are also known in Britain (15). The _lex_ also states that each _socius_ had to undertake expense in proportion to the amount of his share. If a _socius_ wished to leave the _societas_ he was entitled to a refund of the value of his portion of the equipment. The procurator enforced this. If, on the other hand, a _socius_ was unable to meet his commitments, after publication of the accounts in the forum for three days, his share would be withdrawn and the mine would belong to the remaining _socius_ or _socii_.

Revenues were derived in the mining areas partly from taxes and partly from monopolies. Auctioneers, cobblers bakers and the like had to pay the _fiscus_ for the right to carry on their trade at the pithead settlement.

Whoever made a claim to start work in a mine had first to pay the price of occupation and within twenty-five days amass a working capital and begin work immediately. If he failed to do so, or began work immediately and then subsequently abandoned it soon afterwards for a period of ten consecutive days, then the occupancy of the mine was forfeit.

Once paid for, the mine was held by the lessee so long as it was worked in accordance with the regulations laid down above and so long as it was worked without respite of more than six months consecutively. Mines abandoned in this manner could be occupied or confiscated by the state. Anyone had the right of occupation. Just as the right to the mine was forfeited if working was discontinued for six months, so it was forfeited if the renewal fee for the right of occupation was not paid. Any new occupator who seized the mine had to inform the lessee of his seizure within two days. Likewise a lessee who sold his mining rights had to inform the procurator.(16)

The occupator obtained just half the shaft, and could then start extracting the ore. The other half, which belonged to the fiscus was set aside for him as soon as he paid the requisite sum, which he had to do before he smelted any of the ore. If he did smelt the ore before having paid the purchase price, then his tenure of the mine was confiscated and the whole mine sold by the procurator, one-quarter of the proceeds going to the person who informed about the misdemeanour.

It seems likely that the procurator would have reserved the right to assess each mine on its own merits before naming the purchase price. The 4,000 sesterces mentioned in the lex metalli Vipascensis would presumably have applied to that mine alone.

The law laid down that five shafts had to be sunk in each mine, and that once the first was sunk, then the other four had to be sunk likewise and worked. (This accounts in part for the large numbers of shafts sunk on some sites.).

As reckless exploitation had previously done serious harm to the mines in Spain there were strict rules drawn up controlling the workings and laws enforced against the theft of ore. For example, no ore was allowed to be moved from the mine between the hours of sunset and sunrise. Defaulters were fined 1,000 sesteroes, slaves were beaten and thereafter kept in chains, and freemen had their property confiscated and were banished from the mining area. Ore-bearing rock from other mines could be imported into a mining area for smelting or cupelling or other processing on payment of one denarius for one hundred librae. Defaulters were liable to have their ore confiscated.

With regard to mine safety, strict measures were enforced, for under the law, the props of the mines were to remain untouched, old ones were to be replaced by new structures and were not to be interfered with, nor was ore to be extracted from within sixty feet of the drainage adits.

As far as Britain is concerned little evidence survives to tell us exactly how the mines were run. We know that at Charterhouse on Mendip, Somerset, a pithead settlement existed, but for the most part we have to rely on the evidence from Spain to supply us with this information.

When the mines in Britain opened, which was certainly by A.D. 49 if not before, Spain began her decline as the main lead-producing province in the Empire, and as a result of this, presumably after complaints or requests from Spanish officials, by Vespasian's time a law was passed restricting the output of lead from Britain (17).

It is probable that in Britain too the mines were, in the earlier stages, under State control with private leases which may be Flavian if the TR on the pigs nos. 144-148 q.v. from Derbyshire is to be taken as Trifernaon five of the pigs, no. 90 of Nero's reign, and nos. 108, 114, 116, 117 of Vespasian's reign, all from Somerset, the name of Imperial officials have been stamped, and on the faces of the majority of the pigs from Derbyshire are moulded the names of lessees who were probably freedmen (18). Societates are found in the reign of Vespasian (nos. 108 - 110) yet, by Hadrian's

The incuse inscriptions EX ARGENT C · NIPI ASCANI and XXX on pig no.90

The moulded inscription C · NIPI · ASCANI on pig 91 reign,some mines were again under Imperial control.It would appear that the leasing of lead mines in Britain to societates if not to private lessees was practised before the end of the first Century A.D.,and was resumed towards the end of Hadrian's reign after a period when the State had taken control of at least some mines. The late Prof.I.A.Richmond,discussing the evidence for the leasing of mines before Hadrian,says that conclusive evidence for the leasing cannot be based on the fact that nomina and praenomina of lessees mentioned on pig inscriptions refer to Emperors earlier than Hadrian.(19).Since the date of this statement by Prof.Richmond,however,pigs nos.91.108.114.116.117 have been discovered.Pig no.91 bears the name of the lessee C.Nipius Ascanius,the same name as the mining official from Somerset mentioned on pig no.90.,which can be dated to A.D.60.It would not be possible for a mining official of A.D.60 to become a lessee after the reign of Hadrian,and it would be unlikely that he could do so even during Hadrian's reign.Likewise pigs nos.114.116 and 117 bear the name of the Imperial official Tiberius Claudius Triferna and are dated to between A.D. 69 and 79. The name of the lessee on pigs nos.144 - 148 has been abbreviated to TI.CL.TR .Positive

The incuse inscription TI•CL•TRIF on pig 116 identification of the lessee as Tiberius Claudius Triferna is not possible because the abbreviation is too great, but it is attractive to think, and not unreasonable, that the two inscriptions refer to the same man.

The evidence for military control of the mines in this province is again small. The inscription LEG II AVG appears on pig no.93 from South Wales, and L II on pig no.92 from Somerset. LEG XX occurs on pig no.175, discovered in France and attributed to Shropshire or possibly Flintshire - from a mine that was within easy reach of Chester. Dr. Graham Webster has suggested that these pigs were merely the property of the legions in question, and that the mines were not under military control, but Mr. R. P. Wright contends that the legionary stamp shows that the mines were under military control (20).

In Spain during the Republic, slaves were used to do the work in the mines - slaves who had been brought there as prisoners of war and who provided a cheap labour force. Later on, when these became scarce through lack of border wars, the *damnatio ad metalla* secured for the mines workers in the persons of prisoners condemned by the courts for such crimes as robbery with violence, transgression of boundaries, highway robbery, and the like (21).

These were less efficient than the slaves.The owners of the mines had compensated for the work of the slaves which had frequently been poor and lacking in technique by employing large numbers of them.Now,with the criminals, they found their mines full of men who had been turned off the streets in Rome and whose physique was not as strong as that of their predecessors.These miners,unused to hard labour,were more inclined to try to escape,and eventually the smallness of the numbers of workers forced the Romans to give up state exploitation of the mines (22).

In Britain too slaves were forced to work in the mines. Tacitus in the Agricola describes the scene before the battle of Mons Graupius when Calgagus one of the Britons' "many leaders" exhorts his troops against the Romans with the alleged words :

'...Before us is their general,here his army;behind are the tribute,the mines and all the other whips to scourge slaves.Whether you are to endure these for ever or take summary vengeance,this field must decide.'
(23)

The lessees employed <u>mercenarii</u> as well and when more than one lessee was operating in one area, legislation was introduced to prevent competition in the employment of workers who lived in the district.The total number of workers employed in the mine was also restricted.

The moulded inscription BRIT · EX ARG · VEB

on pig no;115

The authorities required that they should be informed of the numbers of these workers in a mine that was being started up or re-started after a period of unoccupation, and a fixed sum had to be paid for each of the workers. Within two days, the occupator had to inform the procurator of the number of slaves used in all the processes of the mines.

Provincials were employed in Spain and in Britain. Davies(24), and Orth (25) take the inscription BRIG and DECEANGL found on pigs of lead from Britain to mean that local miners were forced to work in the mines of Yorkshire and Flintshire, but as with the inscription VEB from Somerset, this should merely define the area from which the lead came, and not the identity of the miners.

Later , the local inhabitants were obliged to work in the mines. In Spain, after Trajan's reign, the inhabitants of Gallaecia were kept there to work in the mines (26) and elsewhere whole populations of efficient miners were transported to other parts of the Empire for this purpose. Miners from Salona in Dalmatia, for example, were taken to Dacia to work in the gold mines there (27).

To ensure continuity in the mines, half the children of each miner had to work in the mines as well. This was later increased to include all the children of the miners.This was not a popular move,but an even more unpopular one came when the soldiers were forced to work in the mines - as ? we learn from the complaints made by the legionaries to Claudius that they had to subject themselves to prospecting and inspection work (28).

Great capital was required to run the mines.Strabo (29) says that 40,000 slaves worked at Carthagena. Pidal (30) and others calculate that 120 million sesterces would be needed to buy these slaves and an extra 60 million for the equipment.Expenses on food and the upkeep of the slaves amounted to 10 million sesterces.There was a death rate of twelve per cent,and with liquid assets of 127½ million sesterces,the state is reckoned to have had a seven per cent revenue,since daily production was in the order of 25,000 denarii, or 36½ million sesterces a year.

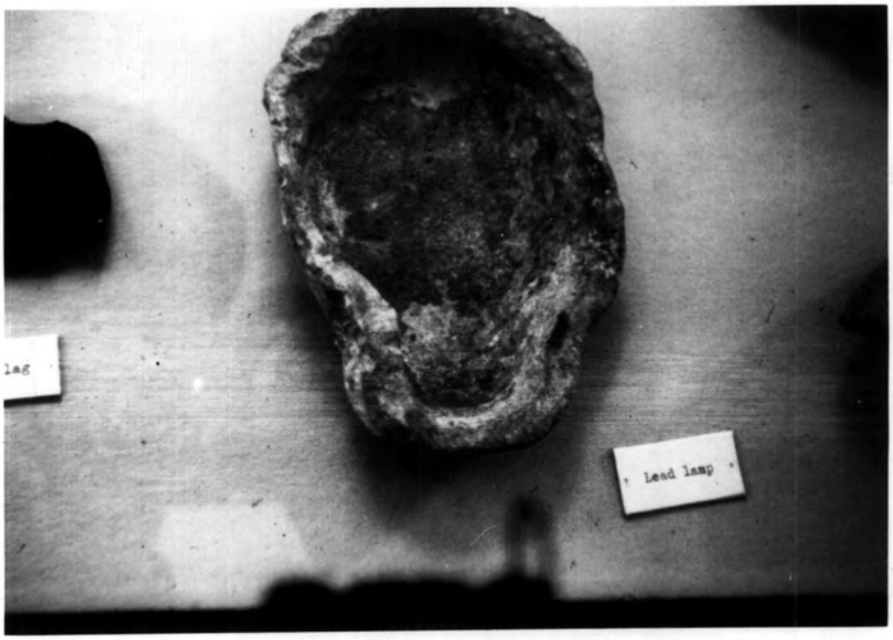
The workers themselves lived under varying conditions. The Aljustrel tablet gives us some idea of the life led by the slaves and mineworkers in the second Century A.D., but at the beginning of our period,things were very different.Diodorus Siculus (31) says that life was no different than that of the gold workers of ancient Egypt :

' The mineworkers create for their masters unbelievable riches.They themselves however have to suffer unspeakable things since they have to work day and night below the surface.Recuperation and rest is unknown. Rather they are forced with blows to bend themselves to this work.Many take their own lives,preferring death to their sad fate.Only a few,possessing strong wills and bodies survive standing this hard labour.'

Most of the labour was unskilled,and expert guidance was needed.The workings at Rio Tinto were so uniform that they may well have been a school for mining engineers. The only skilled labour was that supplied by those who had worked the mines before the Roman conquest and who were now forced to return.Later skilled labour was provided by those who,being experienced in mining work, were transferred to another province.

Slaves were forced to spend their time below the ground.Various devices were employed to keep them there - caves below the mouths of the shafts , rocks with rings attached to them - these held the prisoners who were fettered at the waist and ankles.Cyprian,referring to the lot of the slaves in the third Century A.D.says:(32)

' Their feet lie in fetters which not a smith,but God alone will take off them.Their bodies lack a place to



A lamp-holder from Charterhouse on Mendip rest, and they have to lie on the bare ground. The condemned receive no water to wash off the thick dust with which they are covered. Bread is distributed meagrely as are the clothes to protect them. Their heads are half shaved, and what hair remains is stuck together with dirt.' The slaves were branded on their foreheads (33), but by the time of Constantine they were branded on their arms and on the calves of their legs as well. They were guarded by soldiers, and garrisons were set up to take charge of them/and of the mining settlement.

A square earthwork surrounded by a double vallum, which may well be one such garrison has been observed at Charterhouse on Mendip, Somerset, where chains, though possibly later than the Roman period, have also been found.

The soldiers of the garrison were responsible also for restoring order in cases of mutiny by the mineworkers, or when attacks were made on the settlement by hostile tribes (34). The mortality rate in the mines was high, and the correctness of this is borne out by the number of skeletons belonging to men who had died before the age of thirty.

The shifts which the mineworkers worked were regulated by oil-lamps secured in niches along the mining galleries (35).

The slaves formed themselves into guilds and fraternities under the Imperial aegis. By the time of Hadrian, the interests of the miners were looked after, as we see in the *Lex Metalli Vipascensis*. The laws laid down here were not merely for the running of the mine, but were also for the organization of the mining settlement. Leases were granted to shoemakers, bakers and fullers, and no other person was allowed to undertake this sort of work except for the benefit of himself, his master, or his fellow-slave. Pit-head baths were provided and strict laws were enforced concerning their efficiency and cleanliness. Opening times were controlled by law as were the prices of admission. Freedmen and slaves, minors and soldiers were admitted without charge.

The only example of a pithead bath known in Britain was at the Dolaucothi gold mine in Wales.

The inclusion of adequate educational facilities for the children of the settlement was ensured by exempting schoolmasters from taxation.

LEX METALLIS DICTA

From Riccobono, Fontes Iuris Romani Antejustiniani.
Florence (1941) I. Leges . 499 ff.

.... Ulpio Aeliano suo salutem,

(1) ...] Aug.praesens numerato.Qui ita non fecerit et convictus erit prius coxisse venam quam pretium,sicut | supra scriptum est,soluisse pars occupatoris commissa esto et puteum universum proc(urator) metallorum| vendito. Is,qui probauerit ante colonum venam coxisse quam pretium partis dimidiae ad fiscum pertinen|tis numerasse,partem quartam accipito.

(2) Putei argentari ex form[a] exerceri debent quae| hac lege continetur; quorum pretia secundum liberalitatem sacratissimi imp(eratoris) Hadriani Avg.obser|vabuntur, it[a]ut ad eum pertineat proprietas partis,quae ad fiscum pertinebit,qui primus pretium puteo fecerit | et sestertia quatuor milia nummum fisco intulerit.

(3) Qui ex numero puteorum quinque unum | ad uenam perduxerit,in ceteris,sicut supra scribtum est,opus sine intermissione Facito ; ni ita fecerit, [alii] occupandi [ius] esto. Qui post dies XXV praeparationi impensarum datas opus quidem| statim facere coeperit,diebus autem

continuis decem postea in opere cessauerit,alii occupandi | ius esto. Puteum a fisco venditum continuis sex mensibus intermissum alii occupandi ius | [es]to,ita, ut ,cum uenae ex eo proferentur,ex more pars dimidia fisco salua sit.

(4) O[ccu| pa]tori puteorum socios quos uolet habere liceto,ita ut, pro ea parte ,qua quis socius erit,impensas | conferat. Qui ita non fecerit,tum is qui impensas fecerit rationem impensarum factarum a se | continuo triduo in foro frequentissimo loco propositam habeto et per praeconem denuntiato | sociis ut pro sua quisque portione impensas conferat. Qui non ita contulerit,quiue quid dolo | malo fecerit quominus conferat,quoue quem quosue ex sociis fallat,is eius putei partem ne | habeto,eaque pars socii sociorum ut qui impensas fecerit esto.| Et ii[s] coloni[s] qui impensam fecerint in eo puteo,in quo pluris socii fuerint,repetendi a sociis quod bona fide erogatum apparuerit ius esto.Colonis inter se eas quoque partes puteorum,quas | a fisco emerint et pretium soluerint, vendere quanti quis potuerit liceto.Qui uendere suam partem | quiue emere uolet,aput proc(uratorem),qui metallis praeerit,professionem dato;aliter emere aut uendere | ne liceto.Ei qui debito[r] fisci erit,donare partem suam | ne liceto.

(5) Venas, quae ad puteos prolatae| [i]acebunt ab ortu solis in occasum, ii quorum erunt in officinas uehere debebunt; qui post occa | sum sollis [us]q(ue) in o[r]tu[m] uenas a puteis sustulisse conuictus erit, HS ∞ nummos fisco inferre debeto. | Venae furem, si servos erit, procurator flagellis caedito et ea conditione vendito, ut in perpetuis/ uinculis sit neue in ullis metallis territorisue metallorum moretur; pretium serui ad dominum| pertineto; liberum procurator confiscato et finibus metallorum in perpetu[u]m prohibeto.|

(6) Putei omnes diligenter fulti destinatique sunto, proque putri materia colonus cuiusque putei no/uam ad editionem sub[i]cito. Pilas aut fulturas firmamenti causa relictas attingere aut | uiolare doloue malo quid facere quominus eae pilae fulturaeue firmae et [peruiae] sint ne liceto. / Qui puteum uitiasse labefactasse decapitasse aliutue quid dolo malo fecisse quominus is puteus | firmus sit conuictus erit, si seruos erit, flagellis arbitratu proc(uratoris) caesus ea conditione a dom[i] | no ueneat, ne in ullis metallis moretur; liberi bona proc(urator) in fiscum cogito et finibus ei metal/ lorum in perpetuum interdicito.

(7) Qui puteos aerarios aget a cuniculo qui aquam metallis| subducet recedito,et non minus quam quinos denos pedes utroque latere relinquito.[Cu]|niculum uiolare ne liceto.Proc(urator) explorandi noui metalli causa ternagum a cuniculo agere|permittito,ita ut ternagus non plures latitudinis et altitudinis quam quaternos pedes habeat.|[V]enam infra quinos denos pedes ex utroque latere a cuniculo quaerere caedereue ne liceto. |[Q]ui aliter quit in ternagis fecisse conuictus erit, servos flagellis arbitrato proc(uratoris) caesus ea condi|tione [a] domino ueniet,ne in ullis metallis moretur; liberi bona proc(urator) in fiscum cogito et fini|bus ei metallorum in perpetuum interdicito.

(8) Qui puteos argentarios [aget] a cuniculo,qui| aquam metallis subducet,recedito et non minus quam sexagenos pedes utroque latere relin quito|,et eos puteos quos occupauerit adsignatosue acceperit in opere uti determinati erunt| habeto nec ultra procedito neue ecbolas colligito neue ternagos ita agito extra fines putei adsignati,[ut] ....

Translation of the Lex Metallis Dicta from Van Norstrand, Roman Spain, in Tenney Frank, An Economic Survey of Ancient Rome III p.171 ff.

To Ulpianus Aelianus, greeting.

In accordance with the will of the liberal and most sacred Imperator Hadrianus Augustus, he shall make immediate payment. He who shall not have done this and who shall be convicted of having smelted ore before the purchase price has been paid in the manner indicated above shall be deprived of the share due to him as occupier, and the entire mine shall be sold by the procurator of mines. He who shall prove that the colonus has smelted ore before he has paid the price for the half share belonging to the fiscus shall receive the fourth part.

Mines of silver shall be exploited in conformity with the regulation which is contained in this law. The price of these mines shall be maintained in accordance with the will of the liberal and most sacred Imperator Hadrianus Augustus; namely, that the usufruct of that portion which belongs to the fiscus shall belong to him who first shall put up the price for the mine and who shall present to the fiscus four thousand sesterces.

As has been stated above, he who shall have reached ore in only one of five shafts shall continue work in the others without intermission. If he shall not do this, the right of occupancy shall go to another.

If anyone after the twenty-five days granted for the collection of working capital shall begin to work at once, but shall afterwards cease working for ten consecutive days, the right of occupancy shall revert to another.

If a mine sold by the fiscus shall lie unworked for six consecutive months, the right of occupying it shall be open to anyone, provided that when the ore shall be extracted therefrom, one-half shall be reserved to the fiscus, according to custom.

It is permitted that the occupier of mines shall have such partners as he wishes, provided that each one shall undertake the expense in proportion to the amount of his share. If a partner shall not do this, then he who has undertaken the expense shall make out a statement of the expenses undertaken by himself, shall place this statement for three consecutive days in the most frequented spot of the forum, and shall announce through the public crier that each partner must bear his share. The partner who shall not contribute, or who shall wilfully do anything to avoid his share, or who shall deceive one or more of his partners, that man shall not retain his share in the mine, and his share shall belong to the partner, or partners, in proportion to their payment of the expenses.

And to those coloni who have undertaken an expense in a mine in which many partners are interested, there shall be the right, in law, of regaining from their partners that which shall appear to have been asked for in good faith.

The coloni may sell among themselves, at as great a price as possible, those shares of mines which they have bought from the fiscus and for which they have paid the full price. He who wishes to sell his share, or who wishes to purchase, shall make a declaration before the procurator who is in charge of the mines. In no other way may purchase and sale be effected. It is not permitted him who is indebted to the fiscus to give away his share.

Those to whom the ore belongs shall convey to the smelter from sunrise to sunset that which lies extracted at the mine head. He who shall be convicted of having carried ore from the mines after sunset and before sunrise shall pay to the fiscus one thousand sesterces. If an ore thief be a slave, the procurator shall beat him and shall sell him with the condition that he be kept perpetually in chains and shall not reside in any mining camp or district. The price of the slave shall go to the owner. If the thief be a free man, the procurator shall confiscate his property and banish him forever from the mining districts.

All mines shall be carefully propped and supported, and in place of old material the colonus of each mine shall substitute a new structure.

No one shall touch or injure the pillars or props left for the purpose of strengthening (walls and ceilings), nor shall he wilfully do anything as a result of which these pillars or props shall be less firm and passable. He who shall be convicted of having injured, weakened, ... or having done anything wilfully which shall render the mine unsafe, if he be a slave shall be beaten with rods at the discretion of the procurator and sold from his master under the condition that he shall not reside in any mining district. The procurator shall seize the property of a freeman for the fiscus and banish him forever from the mining district.

The person who works a copper mine shall avoid the ditch which carries water from the shaft and leave untouched a space not less than fifteen feet on either side. He shall not be allowed to harm the ditch in any way. The procurator shall permit, for the purpose of discovering new deposits, a drift from the ditch, provided that the drift be not greater in depth and in width than four feet. It is not permitted to prospect for or to extract ore within fifteen feet on either side of the ditch. He who shall be convicted of having violated the regulations concerning the drifts, if he be a slave, shall at the discretion of the procurator be beaten with rods and sold from his master under the condition that he shall not reside in any mining district. If a freeman transgress, his property shall be taken by the procurator for the fiscus and he shall be banished forever from mining districts.

He who works silver mines shall avoid the tunnel which carries water from the mines and shall leave untouched not less than sixty feet on either side, and he shall exploit the mines which he has occupied or received in assignment in accordance with the regulations; nor shall he go beyond the boundaries, nor pile up crude ore, nor extend his drifts beyond the limits of the mines assigned......'

LEX TERRITORIO METALLI VIPASCENSIS DICTA

vulgo LEX METALLI VIPASCENSIS

from Riccobono, Fontes Iuris Romani Antejustiniani

Florence (1941) I, Leges, p.503 ff.

C e n t e s i m a e a r g e n t a r i a e s t i p u l a t i o n i s. Conductor ea[rum stipulationum, quae ob auctio]| nem intra fines metalli Vipascensis fient, exceptis iis, quas proc(urator) metallorum iu[ssu imp(eratoris) faciet, centesimam a vendito]|re accipito. Conductor ex pretio puteorum, quos proc(urator) metallorum uendet, cen[tesimam ne exigito].| Si instituta auctione uniuersaliter omnia addicta fuerint, nihilo minus uenditor ce[ntesimam conductori socio acto]|riue eius praestare debeto. Conductori socio actoriue eius, si uolet stipulari a u[enditore, is promittito. Conductor]| socius actorue eius <eius> quoque summae, quae excepta in auctione erit, centesimam exigito. [Qui res sub praecone]| habuerit, si eas non addixerit et intra dies decem, quam sub praecone fuerint, de condici[one vendiderit, nihilo minus con]| ductori socio actoriue eius centesimam d(are) d(ebeto). Quod ex hoc capite legis conduct[ori socio actoriue eius debebitur],| nisi in triduo proximo, quam debere coeptum erit, datum solutum satisue factum erit,du[plum d(are) d(ebeto)].|

S c r i p t u r a e p r a e c o n i i. Qui praeconium conduxerit,praeconem intra fines praebe[to.Pro mercede ab eo qui uenditionem]| X L minoremue fecerit, centesimas duas,ab eo qui maiorem X C fecerit, centesimam exi[gito.Qui mancipia sub praecone venum]|-dederit,si quinque minoremue numerum uendiderit, capitularium in singula capita [X...,si maiorem numerum uendi]|derit,in singula capita XIII conductori socio actoriue eius dare debeto.Si quas[res proc(urator) metallorum nomine] fisci uen|det locabitue,iis rebus conductor socius actorue eius praeconem praestare debeto. Q[ui inuentari]um cuiusque rei uendundae nomine proposuerit,conductori socio actoriueeius X I d(are) d(ebeto).Puteorum,quos proc(urator) metallorum uendiderit,em|ptor centesimam d(are) d(ebeto).Quod si in triduo non dederit,duplum d(are) d(ebeto).Conductori socioactoriue eius pignus cape<re> liceto.| Qui mulos mulas asinos asinas caballos equas sub praecone uendiderit in k(apita) sing(ula) X III d(are) d(ebeto). Qui mancipium aliumue quam re[m sub]| praeconem subiecerit et intra dies XXX de condicione uendiderit,conductori socio actoriue eius [idem d(are) d(ebeto)].|

B a l i n e i   f r u e ndi . Conductor balinei sociusue eius omnia sua inpensa balineum,[quod ita conductum habe]bit in | pr(idie) k(alendas) Iul(ias) primas omnibus diebus calfacere et praestare debeto a prima luce in horam septim[am diei mulieribus] et ab hora octava| in horam secundam noctis uiris arbitratu proc(uratoris) qui metallis praeerit.Aquam in [alueum usque ad] summam ranam hypo/caustis et in labrum tam mulieribus quam uiris profluentem recte praestare debeto.Conductor a uiris sing(ulis)| aeris semisses et a mulieribus singulis aeris asses exigito.Excipiuntur liberti et serui [Caes(aris),qui proc(uratori)] in officis erunt uel| commoda percipient,item inpuberes et milites.Conductor socius actorue eius [instrumentum balinei et e] a omnia quae / ei adsignata erunt integra conductione peracta reddere debeto nisi si qua uetustate c[orrupta erunt]. Aena quibus | utetur lauare tergere ungereque adipe e recenti tricensima quaque die recte debeto.[Si qua necessaria refectio inpedi]|erit,quo minus lauare recte possit,eius temporis pro rata pensionem conductor reputare debe[to . Praeter] haec et siquid|aliut eiusdem balinei exercendi causa fecerit,reputare nihil debebit. Conductori ue[ndere ligna] nisi ex recisamini|bus ramorum quae ostili idonea non erunt ne liceto.Si adversus hoc quid fecerit,in singul[as venditiones HS]centenos N(ummos) fisco d(are) d(ebeto).|Si id balineum recte praebitum non erit,tum proc(uratori) metallorum multam conductori quo[ti]ens recte praebitum non erit usque| ad HS CC dicere liceto.Lignum conductor repositum omni tempore habeto,quod diebus ......[satis sit].

S u t r i n i. Qui calciamentorum quid loramentorumue quae sutores tractare so[lent,fecerit clauomue cali] ga|rem fixerit uenditaueritue siue quid aliut,quod sutores uendere debent,uendidis[se intra fines conuictus erit,is]| conductori socio actoriue duplum d(are)d(ebeto). Conductor clauom ex lege ferrariar[um uendito.Conductori soci]o |actoriue eius pignus capere liceto.Reficere calciamenta nulli licebit nisi cu[m sua dominiue quis curauerit refece]rit|ue. Conductor omne genus calciamentorum praestare debeto: ni ita fecer[it, unicuique ubi volet emendi]ius|esto.|

T o n s t r i n i. Conductor frui debeto ita,ne alius in u[ico metalli Vipascensis inue]|territoris eius tonstrinum quaestus causa faciat .Qui ita tonstrinum fecerit,in sin[gulos ferramentorum usus ....]| conductori socio actoriue eius d(are) d(ebeto),et ea ferramenta commissa conductori sunto.[Excipiuntur serui] qui| dominos aut conseruos suos curauerint.Circitoribus quos conductor[non miserit,tondendi ius ne es]to. Con| ductori socio actoriue eius pignoris captio esto. Qui pignus capientem prohibuerit,[in singulas prohi] bitiones X V d(are)| debeto.Conductor unum pluresue artifices idoneos in portionem recipito. |

T a b e r n a r u m f u l l o n i a r u m.Vestimenta rudia uel recurata nemini m[ercede polire nisi cui conductor so]|cius actorue eius locauerit permiseritue liceto.Qui conuictus fuerit aduersus ea qui[d fecisse, in singulas la] cinias| XIII conductori socio actoriue eius d(are) d(ebeto). Pignus conductori socio actoriu[e eius capere liceto].|

S c r i p t u r a e s c a u r a r i o r u m e t t e s t a r i o r u m. Qui in finibus met[alli Vipascensis .... scau]ri/as argentarias aerarias pulueremue ex scaureis rutramina ad mesuram pondu[sue purgare tundere ure]re expe|dire frangere cernere lauare uolet quiue lapicaedinis opus quoquo modo facien[dum suscipiet[quos ad id]faciendum|seruos mercannariosque mittent,in triduo proxmio profiteantur et soluan[t..... conductori quo]que mense| intra pr(idie) k(alendas) quasque:ni ita fecerint,duplum d(are) d(ebeto).Qui ex alislocis ubertumbis ae[ris argentiue ru]tramina in | fines metallorum inferet,in p(ondo) CXI conductori socio actoriue eius d(are) d(ebeto).Qu[od ex hoc capite]legis conduc|tori socio actoriue eius debebitur neque ea die,qua deberi coeptum erit, solu[tum satisue factum erit], d(uplum) d(are) d(ebeto).| Conductori socio actoriue eius pignus capere liceto et quod eius scauriae pu[rgatum tunsum ustum expeditum frac]|tum cretum lauatumque erit quiue lapides lausiae expeditae in lapicaedi[nis erunt,commissa ei sunto,nisi quid]|quid debitum erit conductori socio actoriue eius solutum erit: ex[cipiuntur serui et liberti]|flatorum argentariorum aerariorum qui flaturis dominorum patron[orumque operam dant].|

L u d i   m a g i s t r i.Ludi magistros a proc(uratore) metallorum immunes es[se placet].|

U s u r p a t i o n e s   p u t e o r u m   s i u e   p i t t a c i a r i u m.Qui intra fi[nes metalli Vipascensis puteum locum]| que putei iuris retinendi causa usurpabit occupabitue e lege metallis dicta,b[iduo proximo quod usurpauerit occupa]|uerit apud conductorem socium actoremue huiusce vectigalis profiteatu[r.......

Translation of the Lex Territorio Metalli Vipascensis Dicta

From Van Norstrand, Roman Spain, in Tenney Frank, An Economic Survey of Ancient Rome, III, 167 ff.

"Of the one per cent sales tax"

The lessee of these sdes by auction within the boundaries of the mining district of Vipasca shall receive one per cent from the seller, exception being made to those sales made by the procurator of mines at the command of the Emperor. The lessee shall receive from the purchaser one per cent of the price of mines which the procurator of mines shall sell.

If, after the auction has begun, everything shall be purchased with one bid, the seller shall nevertheless pay one per cent to the lessee, his partner, or his agent. The seller shall announce beforehand to the lessee, his partner, or his agent if he wishes any articles witheld from auction.

The lessee, his partner, or his agent shall exact also one per cent of the value of that which has been withdrawn during the auction.

With reference to him who shall have placed goods in the hands of a crier: if the crier shall not have sold them at the price agreed upon, the owner shall nevertheless give one per cent to the lessee,his partner ,or his agent.

Unless that which ,in accordance with this section of the law,is due the lessee,his partner of his agent is paid,settled or secured,within three days after the debt shall have been contracted,the seller shall pay double.

Of the auctioneer's fee

He who has leased the auctioneering concession shall furnish an auctioneer within the boundaries of this district.From him for whom sale of one hundred denarii or less is completed,the lessee shall receive two per cent; for a sale of over one hundred denarii,one per cent.

He who shall have given slaves to the auctioneer for sale shall give to the lessee,his partner,or his agent, if five,or a smaller number be sold,three denarii for each slave;if a greater number be sold,three denarii for each slave.

If the procurator of mines shall sell,or lease,any property in the name of the fiscus,for this property the lessee,his partner ,or his agent shall furnish an an auctioneer.

He who shall have published a list with the name of each thing to be sold shall give to the lessee, his partner or his agent one denarius.

Of the mines which the procurator of mines shall have sold, the purchaser shall pay to the lessee one per cent of the price. If he shall not have paid this within three days, he shall pay double. The lessee, his partner of his agent shall have the right to take security for this.

He who shall have sold through an auctioneer mules, asses, or horses of either sex shall pay for each animal three denarii.

He who shall have offered for sale through an auctioneer slaves, or any other property, and the latter shall have sold them at the price agreed upon within thirty days, the seller shall pay the regular fee to the lessee, his partner, or his agent.

Of the bath management

The lessee of the baths, or his partner, shall entirely at his own expense warm and keep open the baths, which he shall thereby hold in lease until the following June 30, from sunrise until noon for women, and from one P.M. to eight P.M. for men, subject to the approval of the procurator who will be in charge of the mines. He shall properly furnish water running into the tank over the heating chambers, up to the highest mark, and in the plunge, for the women as well as for the men. The lessee shall charge each man half an as, and each woman an as. Freedmen and slaves of the emperor who shall be in the service of the procurator, or receiving pay from him, shall be exempted; likewise minors and soldiers. The lessee, his partner or his agent, at the termination of the lease, shall hand over in good repair the equipment of the bath and everything which was assigned to him, except that which has been worn away by age. The bronze articles which he shall use he shall properly wash, dry, and coat with fresh grease atleast once every thirty days. If any necessary repairs should make impossible adequate use of the bath, the lessee shall deduct (from his contract price) an amount in proportion to the loss of time. Aside from this, if he does anything else in the course of administering the bath, he shall deduct nothing. The lessee shall not be permitted to sell wood except the ends of branches which are not suitable for burning. If he violates this rule, he shall pay one hundred sesterces to the fiscus for the sale. If this bath shall not be properly open for service, the lessee shall pay to the procurator of the mines a fine of not more than two hundred sesteroes for each time it shall not be open for service. The lessee shall have wood in reserve at all times to last (?) days.

Of the shoemaker

He who shall have made any shoes, or thongs which shoemakers are wont to make, or who shall have nailed in shoemaker's nails, or who shall have sold them or who shall have been convicted of having sold within the boundaries anything else which shoemakers are wont to sell, shall pay to the lessee, his partner, or his agent double the amount of the sale. The lessee shall sell nails in accordance with the law of iron mines. The lessee, shall his partner, or his agent may take security (from other shoemakers). Nonone may repair shoes save when he mends or repairs his own or those of his master. The lessee shall offer for sale ALL varieties of shoes. If he shall not have done this, anyone may have the right to purchase where he wishes.

Of the barber

The lessee shall have this privilege, that no one in the village of the mining district of Vipasce, or within the district, shall practice barbering for profit. He who shall have practiced barbering in this manner shall pay to the lessee,his partner ,or his agent,for each use of his razors (?) denarii,and his razors shall be forfeited to the lessee.Slaves who shall have served their masters, or their fellow-slaves,shall be exempted.Travelling barbers, whom the lessee shall not have sent,have not the right to practice barbering.The lessee,his partner,or his agent may take security from them.He who shall have refused the giving of security,for each refusal shall pay five denarii .The lessee shall furnish one or more workers in proportion to the demand.

Of the fullers

No one shall have the right to clean and press,for pay,unworn or soiled garments save him to whom the lessee, his partner,or his agent shall have leased or granted this privilege.He who shall have been convicted of having acted contrary to this regulation shall pay to the lessee,his partner,or his agent three denarii for each garment.The lessee,his partner,or his agent may take security.

Of the tax on mining dumps and rock piles

He who within the boundaries of the mining district of Vipasca shall wish to clean,crush,smelt,prepare,break up,separate,or wash silver,or copper dumps,or dust from dumps,or rock fragments purchased by measure,or by weight, or who shall undertake work of any nature in the quarries, shall declare within a period of three days the number of slaves and free laborers whom he is sending for this work,and shall pay to the lessee on or before the last day of each month (?).If they shall not do this,they shall make double payment.He who shall bring within the boundaries of the mines copper- or silver-bearing rock from other mineral workings shall pay to the lessee,his partner,or his agent one denarius per hundred pounds. For whatever amount,in accordance with this section of the law,he shall owe to the lessee,his partner,or his agent,and shall not have paid,or have given security for payment on the day on which payment shall have been due,he shall make double payment.The lessee,his partner, or his agent may take security ,and whatever part of this dump (or dross) shall have been cleaned,crushed smelted,prepared,broken up,separated,and washed,and whatever prepared stones and slabs shall have been worked up in the quarries may be confiscated unless he shall have paid what he shall owe to the lessee,his partner, or his agent.Slaves and freedmen of operators engaged in smelting silver or copper, who are working in the smelters of their masters or patrons, shall be exempted from this charge,

School masters

School masters shall be untaxed by the procurator of mines.

Seizure of mines or of claims

He who within the boundaries of the mining district of Vipasca shall seize or hold a mine in order to establish legal possession under the terms of the law of mines, shall within two days of his seizure or occupancy report to the lessee of this tax, his partner or his agent. "

References

1.Davies Roman Mines 8.
Rickard Metals 415.

2.Davies Roman Mines 5.

3.Davies Roman Mines 5.

4.Rickard Metals 405,417.
see too CIL II 956 and 1179.

5.Polybius VI,7.
Rickard Metals 407,415.

6.Justinian Theod.cod.de metal.XI,vi,leg.6.

7.Lex Metallis Dicta,see below p.50ff.
Rickard Metals 406.

8.Tacitus Annales VI,19.
Rickard Metals 417.

9.CIL II 956 and 1179.
Rickard Metals 416.

10.Orth P-W Supplbd.IV col.153
Rickard Metals 416.

11.Orth P-w Supplbd.IV col.153.

12.Lex Metallis Dicta,see below,p.52.

13.Brnns Fontes 293.
Riccobono Fontes Iuris Romani 498,no.104.
Van Norstrand Spain in Tenney Frank ESAR III 171.
see above p.46-54.

14.CIL II 5181.
ILS 6891.
Bruns Fontes 289
Riccobono Fontes Iuris Romani 502,no.105.
Van Norstrand Spain in Tenney Frank ESAR III 167.
see above p.55-68.

15.see below p.136.

16.Levy West Roman Vulgar Law 112-114.

17. 'Sed in Britannia summo terrae corio adeo large, ut lex ultro dicatur, ne plus certo modo fiat.'
Pliny NH XXXIV 164.

18. R.P.W. JRS XLI(1951) 142 no.8.
R.P.W. to H.D.H.E. January 1967.

19. Richmond Newcomen Soc.Trans. XX(1940) 145.

20. Webster Flints.Hist.Soc.Publ.XIII(1952-3) 10ff.
R.P.W. to H.D.H.E. April 1967.

21. Justinian Theod.cod.de metal.XV
Orth P-W Supplbd.IV col.146.
Rickard Metals 491.

22. Forbes Technology VII 155.

23. Tacitus Agricola XXXIII, see also XXX and XXXI.

24. Davies Roman Mines 14-15 fn.

25. Orth P-W Supplbd.IV col.147.

26. Orth P-w Supplbd.IV col.147.

27. Orth P-W Supplbd, IV col.147.

28. Orth. P-W Supplbd.IV col.147.
Tacitus Annales XI 20,4.

29. Strabo III, 2,10.

30. Pidal España II 340
Orth P-W Supplbd.IV col.146.

31. Diodorus Siculus V 36-38.

32. Cyprian Epistulae 77.

33. Orth P-W Supplbd.IV col.145. quotes Suetonius Caligula XXII which must be incorrect.

34. Orth P-W Supplbd.IV col.147.

35. Pliny NH XXXIII 97.

Roman Mining Technique

There were a number of mining techniques known to the Romans which they used at some time in Spain and Britain. Wherever possible they employed the open-cast method which was in use in the ancient world, since this was the cheapest and easiest way of obtaining the ore. Where this method was not possible, then the driving of shafts downwards and adits horizontally into the ore-bearing rock was tried, and this came to be the method most commonly used in Spain. Two other techniques were also adopted - hushing and fire-setting. Neither was common in Spain, but there is some evidence of their use in Britain, as we see below.

The open-cast system of mining lead was the easiest way of gleaning the ore. Capital outlay was small and the mine owner would employ a large number of men to handle the ore. They would break it and pass it back by hand along a human chain to the point where it was gathered into sacks or buckets to be conveyed to the smelting ovens. It paid the mine owner to have a large number of workers, for these saved him time. The machinery he used was extremely primitive, which had the distinct advantage of enabling small workings to be exploited without much loss, whereas it would obviously not be worth the owner's while to set up large and expensive machinery to extract a meagre amount of ore. In fact many of the mines in Spain can have yielded little.

When all the ore had been taken from the surface, the Romans had to excavate and drive shafts and adits into the mountain or ore-bearing rock. This necessitated the use of equipment for hoisting the ore, and for drainage, and a larger capital outlay, but the Romans used this system extensively for all types of mining. In fact they soon began to prefer the excavating methods to the open-cast method even though it was more expensive. It has been reckoned that for every hundred feet that the mine increased in depth, the output of the shift was halved, and the price thereby doubled (1). As the mine left the surface, steps had to be cut or spiral paths were constructed enabling the workers to make an easier descent. If the mine entrance was in the side of a hill, and the adit or gallery rose rather than descended, then any hollows formed were filled in with waste, or even the poorer ore-bearing rock to prevent a collapse (2). Props were occasionally used, possibly consisting again of the poorer ore, left untouched as pillars whilst the rock around them was removed (3).

The main enemy of the Roman miners was hard rock and water, and especially water below sea-level. Hard rock was attacked with picks and hammers. At El Centenillo, we can see how the Romans progressed. First, they sank small shafts in the outcrop. They then constructed an adit from the side of the hill to intercept the lode at a depth of fifty metres. The adit in this case stretched for 1,000 m. Thirdly another adit, also 1,000 m. long was dug 60 m. lower down, and finally a fourth adit was constructed, though at El Centenillo, this was never finished(4). This was a particularly late working, and really falls outside the scope of the present study, nevertheless, we can use it as an example of the ways in which the Romans set out to exploit the lead ore. Near Valencia it can clearly be seen that the mine was constructed by two sets of workers using different techniques, though whether they are both of Roman period, or whether one was pre-Roman is not quite certain(5).

The Roman methods of mining were firstly open-cast stoping, that is excavating horizontally layer after layer and extracting the ore by this process, then stoping by subterranean excavation, and then stoping by overhead excavation, where the ore-body had to be taken from the roof of the adit rather than from the walls or side. The land in which the ore was found was sometimes totally undermined. The process could take several months to complete, and in one case Pliny describes the scene when the land above the mining area was allowed to collapse. (Pliny, NH XXXIII 72-73.)

' When the operation is finished, they cut the supports close to the roof beginning with the one that is farthest from the mouth. The subsidence of the earth gives a signal, seen only by a watcher stationed on a peak of the same mountain.

By shouts and signals, he bids them call out the miners while he too rushes down. Its own weight brings the shattered mountain down in widespread destruction with a roar that can scarce be imagined by the mind of men, and causing a rush of air powerful beyond belief. Nature lies in ruins before the eyes of the conquerors.'

(6)

In Britain, the Romans concerned themselves mainly with deposits on or near the surface. The mining tended to be nearly all open-cast and adits or levels are rare. Few traces have survived of lead workings which are undoubtedly

Roman,and certainly nothing to compare with the multitude of galleries still to be found in Spain.

Where the ore was plentiful excavations were extensive and sometimes veins were followed by digging deep trenches.At Shelve,in Shropshire,where the width at the base is scarcely wide enough for a man to work in,the trench reaches a depth of forty metres.In other places caverns have been built or shafts sunk from which galleries ran in varying directions.(7)

Prospecting

Diodorus,V.36.

" They make openings in various places and go deep into the earth to search for the silver- and gold-bearing strata.By means of pits which they sink they penetrate for several furlongs not only horizontally but also in depth;and,extending their subterranean galleries in different directions,sometimes transverse sometimes oblique,from the bowels of the earth they raise the ore which yields their gain.If one compares these mines with those of Attica,one notices a great difference.Those who work in the latter,in spite of the large outlay,often fail to make a profit and even lose their capital... but those who exploit the mines of Spain find their hopes fulfilled and pile up enormous wealth from their operations. For, succesful as were their first attempts, thanks to the mineral richness of the ground, veins even more dazzling, which teem with silver and gold are constantly being discovered: the whole of the surrounding soil is riddled in every direction with a network of metal. "

(8)

The Romans had little geological knowledge, but the rules and methods which they learned at one mine they passed on to the next, and so their prospecting technique from "looking for shiny white pebbles on the surface" to the sinking of numerous shafts and the making of prospecting adits in the hillside. Frequently the adits would follow the direction of the valley, or link up a line of shafts which were sunk at regular intervals at anything from ten to thirty metres apart (9). Alternatively a shaft was excavated and served to link a sequence of galleries made at regular intervals (10). Adits were driven into the hillside at fifteen to twenty-five metre intervals, the highest being a short way below the mouth of the shaft - such was the system adopted at Linares (11). Elsewhere, the system known as "squaring" was used. By this method, a shaft would be sunk, from which a gallery would be led for a number of yards, perhaps ten, as at Sotiel Coronada, in one direction, and then for an equal number of yards at right angles to it. Then it would meet another shaft sunk from the surface and calculated to coincide(12). In this way an area could be exploited by a network of shafts.

There were two main advantages in this process of squaring. First, it was much easier to cut along or across the line of the ore, than to cross it diagonally, and secondly, whereas the Romans had surveyors who were capable of making accurate measurements on the surface, the same was not true with underground calculations. Besides, the contractors were not so skilful, and the squaring made subterranean calculations less likely to be false.

<u>Shafts</u>

One of the most common methods of gleaning ore adopted by the Romans was to sink shafts. These shafts varied considerably in construction, depth, size and shape. The earlier shafts were square and rectangular and it was only towards the end of our period that round or even elliptical shafts were known. The mouths of these shafts

An exposed shaft at Rio Tinto, Spain, showing the footholds.

were strengthened by wooden beams in the case of the square or rectangular shafts. Stone casing was used for the round and elliptical varieties, which, by reason of their shape were safer (13). At Sotiel Coronada, there is no trace of a lining of any kind at the shaft mouth, and the walls there have, in places, caved in (14).

The shafts, whatever their shape, were all narrow in the early mines, varying from 0.8 m. to 1.5 m. In the later mines, the shafts became a little wider, and at Coto Fortuna, many shafts were three metres wide, and examples of as much as ten metres in width are recorded in the Pyrenees(15). This, however, is unusually large. Men often descended into the pit by means of a rope and windlass, but in the earlier mines, holes were cut in the walls of the shaft at intervals of 0.6 m. on the way down. These served either as hand- or foot-holds for the miners as they climbed up and down the shaft, or else, as is more likely, where the holes appear on opposite walls, these served as mortices into which were inserted beams of wood which served as a ladder. The holes are usually set to one side of the shaft, thereby making it easier for the raising and lowering of buckets. In some places there are just foot-holds, as at

Rio Tinto,where the miners used ropes to climb out of the shaft,whereas in other places,trunks of trees were placed at the mouth suitably notched to form ladders. Later,a more sophisticated type of ladder constructed from two long spars and with connecting rungs was introduced(16).

The shafts were by no means completely vertical.Twists of 10 degrees occur in twenty-one metres at Rio Tinto, where the shaft also diverges from the vertical (17). At Linares,slopes occur at a depth of eighteen metres, and by the time the shaft has reached sixty metres,a twist of twenty degrees has occurred (18).At Sotiel Coronada,the twist is twenty degrees in twenty-five metres(19),and other twists in square shafts of ninety degrees are known.This corkscrew effect,which was common in the deeper Greek and Roman mines could easily have been obtained by miners picking with one hand. Oliver Davies even suggests that the Romans may have found it easier to steady buckets when the shaft twisted.

Shafts are found to have become constricted when they reached a depth greater than ten metres(20).When the shafts became too deep,then adits were driven in to meet them.These occurred in the first place a little way below the surface, then another would have to be driven in, as at El Centenillo, 140 m. below, and another fifty metres below that, but here adits of 1,000 m. in length were needed to reach the ore (21).

It is interesting to note that the shaft, 210 m. deep at La Carolina, and the galleries 1,000 m. long were still in use in 1929(22).

A large number of shafts were sunk in the mining areas, as we have already seen. These may have been built to comply with legal requirements, for many of them had been left undeveloped. Their frequency can also be accounted for by the need for adequate ventilation in the mines. R.J.Forbes holds that the Romans seem to have preferred to sink extra vertical shafts to reduce the length of the galleries, which would otherwise require props(23).

At the bottom of the shaft, a hall or cavern, such as that found at Sotiel Coronada was usually constructed to house ore or rock waiting to be taken to the surface. In addition, at the base of the shaft there would be a sump from which water was baled out to the ground level(24).

The miners seem to have extracted the ore from the shaft wall to adepth of only about 0.5 m. and did not seem concerned in gleaning any that was beyond their reach (25).

In Britain, where shafts occur, they were again square or rectangular, and few round ones are found. In all cases they were small. Again there were ladders or notched tree trunks and in some places there were even steps. In the Shropshire mines a very deep square shaft followed the line of the ore down into the earth, but like the other British examples and the majority of the Spanish ones, the dimensions were very small. They were dug by miners using pick, hammer, wedge and chisel (26).

Elliptical shafts were rare and have only been found in Lusitania, and in Portugal.

Adits

Pliny, NH XXXIII, 70.

" The third way will be found to have surpassed the achievements of the Giants, for mountains are excavated by lamplight by driving galleries far into their flanks. Lamps also serve to measure the spells of work and for many months together the toilers are without the light of day. These mines are called arrugiae. Miners are sometimes swallowed up by fissures that open suddenly beneath their feet, so that it seems less foolhardy now to seek pearls and purple-fish in the depths of the sea -

so much more dangerous have we made the land. On account of this danger, arched supports are left at frequent intervals to bear the weight of the mountain.'

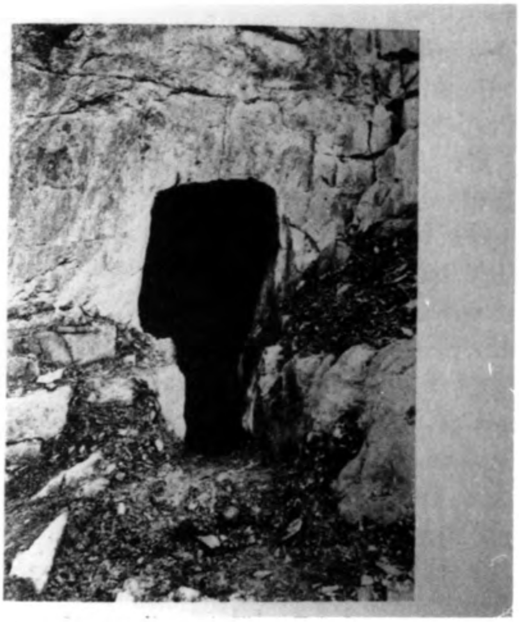
(27)

It is interesting to note that in pre-Roman mines in Spain, entrance was made by means of cave-adits (28) as at Rio Tinto, roughly hewn into the side of the hill, whence passages led inside it; the Romans improved on these cave-adits and used this method in a very few mines, at Llanymynech for example, when they came to Britain (29). The pre-Roman mines in Spain were made by using picks of horn, stone and wood. The Romans had slightly more sophisticated tools of stone and iron, which they used both in Spain and in Britain, in conjunction with wooden wedges to split the rock, and the advancement of their mining technique in the driving of adits can clearly be seen.

The Romans adopted the adit method in the late Republic and progressed from driving one adit to working from a number of galleries all running from a main adit, as can be seen at Sotiel Coronada, just as they worked from galleries running from a central shaft, as at Carthagena. A number of Roman adits are straight, but a great many are confused and frequently become maze-like in their construction.When tackling the barren rock, the adit was straight,but as soon as the ore was contacted,then the adit would follow the course of the ore.At El Centenillo,adits meet the vein at depths of 150,210, and 250 m. (30).

At the beginning of the Roman period,the adits were very narrow and constricted,though their length could be considerable.One early adit found at El Centenillo, and 135 m. below the mouth of the shaft,was 1,000 m. long.It was constructed at about 100 B.C. and was used until the end of the second Century A.D. Frequently the width of the adit was not more than 0.6 m. and the height in some places,where again Rio Tinto can be quoted as an example was only 1 to 1.3 m. Driving-galleries were low,for the Romans found it cheaper to use a lot of slaves and to keep the roof low.Later,higher galleries became the custom,and a 2.5 m. gallery is to be found in Wales (31).At Linares,one adit is vaulted, and reaches a height of 2.3 m. for here the ore was to be found overhead.(32).

An interesting feature of these early adits was their shape.Their greatest width,often at a point two-thirds



The entrance to an adit at Rio Tinto.

of the way up the height,was designed to coincide with the miners' shoulders,and in some mines where the height was particularly small,it has been suggested that boys were used to convey the ore out of the mines in baskets placed on their shoulders (33).Boys would have had to crawl on all fours in some places.The cross-section of the adit was mainly rectangular,as at Sotiel Coronada, from 2 x 0.7 m. to 1 x 0.6 m. ,but some of trapezoidal shape are found.These were usually narrower at the top than at the bottom,as at Linares where an adit is 2 x 0.6 m. with 2 x 0.7 m. R.J.Forbes mentions that 1.1 m. x 2.2 m. sections are common in trapezoidal galleries (34).

Just as the shape of the adit varied,so did its length. Adits of up to 2,000 m. have been found at Rio Tinto (35).Every metre along the adit would be a small niche in which,fastened by clay,was placed a lamp.These lamps played a dual rôle,as Pliny mentions above, for besides provideing light,they were used to determine the length of the miners' shifts below the ground.

The entrances to the mines were nearly always steep or vertical (36).For the drainage passages,this was so that the water could be gathered below the mouth before being baled out.

As I have mentioned above, shafts were sunk at frequent intervals to meet the adits, thus doing away with the need for too many props. Timbering was used in preference, and this was well constructed with brushwood lagging (37). Where props were inserted, they were made with two uprights, and with a cross-beam placed on top of them, examples of which occur at Rio Tinto. (38). In other places props were made of the ore-rock which had been left uncut.

Drainage adits were common and were built with sloping floors at Sotiel Coronada, and Linares, and with near-level ones at Rio Tinto. They were constructed to run parallel with the main adit and were joined to it by frequent cross-passages. Water then could run from the main adit into the drainage adit and out to the mouth (39). Drainage adits of over 1,000 m. were common (40).

As with the shafts, caverns were sometimes built up to ten metres wide near the mouth of the adit where the ore-rock was stored before transportation.

Hushing

Another method of gleaning the lead ore from the ground was that of hushing. This method appears to have been used in Britain in Yorkshire, and possibly in Derbyshire (41), but its use in Spain seems to have been confined mainly to gold mines (42). The hushing method was of use only for the ore that lay on the surface. A huge cistern was built on the hill-top and allowed to fill with water. From the cistern, which was dammed, channels were dug in the direction of the ore-field. When enough water had been collected, the dam was broken and the water flowed over the hillside stripping the soil from the face of the rock. This was an expensive way of gleaning the ore, since it required many workers and was regarded as dangerous (43).

Fire-setting

Pliny, NH XXXIII, 71.

" In both kinds of mine the miners meet with flinty rocks which they break up by heating them and pouring vinegar on them, or more often (for the steam and smoke make the air in the galleries unbreathable) they hew them out with shattering machines fitted with iron rams, weighing 150 lb., and they bear out the debris on their shoulders, night and day, passing it on in the darkness to their neighbours, of whom only the last see the daylight. If the outcrop of flint seems too thick, the miner skirts the edge of it and circumvents it. Yet it is sometimes less difficult to work through the flint.'

(44)

The method of fire-setting was not a common one in Spain.It consisted of heating the rock by fire,and then pouring cold water on top of it,causing it to crack. Its uses were known very early on (45),but during this period traces of its use are hard to find,though it appears to have been used in Britain,at Charterhouse on Mendip (46) and in other areas where few signs of pick marks remain,fire-setting seems likely to have been employed.

Livy describes the fire-setting method of breaking rock when Hannibal,during his crossing of the Alps,finds his way barred by a huge rock.This he heats and pours vinegar on top.The effect of vinegar on limestone putrefies the rock and makes it easier to chip away. Heat was also used in conjunction with wedges.Wedges of wood were heated in fire and then placed quickly in fissures in the rock.Cold water was then poured on top, and the wedges,having swollen,cracked the rock rendering it easy to split.

Below the ground picks of iron were used to break down the rock, and tongs have been found which were used to pull the hot rock away. The method needed a great deal of fuel however, and was unsatisfactory since it created a lot of smoke, which below ground caused ventilation problems.

Lighting and Ventilation

Light was arranged, as mentioned above, by means of lamps of oil. These lamps were placed in niches 5 cm. deep every metre along the passage. The lamps had one or two spouts, and in some places, pieces of fatty skin or twigs were used. Many examples of these lamps have been found in the mines in Spain, and in Britain lamps from Charterhouse can be seen at the Castle Museum, Taunton, Somerset.

Pliny states that the lamps were used also to determine the length of the miners' shifts, and a reconstruction has shown that the shift was of approximately ten hours duration.

Ventilation was a more difficult problem. The problem became more acute the deeper the mine went, and as we have seen, a particular problem existed where fire-setting was used.

To test whether a mine was safe or not, a lamp was lowered down into it; if the air was foul and the lamp went out, then a descent was not attempted.

The frequency of the shafts in Roman mines is partly explained by the need for ventilation. The air was either allowed to circulate by means of these shafts on its own, or else it was assisted by various means. Where shafts were sunk in pairs, then a fire was often placed on a ledge at the base of one to ensure a good circulation, as can be seen at Rio Tinto. In other shafts, grooves have been found into which were slotted boards which were so placed to create a draught, and in other mines, adequate ventilation was achieved by the 'flapping of cloths'.

Adits were also used to help ventilation. Passages, parallel to the main adits with frequent cut-outs, as with the drainage adits, made a change of air possible. In Asia Minor, in the arsenic mines of Sandarakurgion, at Pompeiopolis, evidence has been found of aromatic smoke containers, which also occur at Laurion in Attica, which were used to purify the air after thousands had died (47).

Lucretius (48) also mentions the dangers of bad ventilation :

' Do you not see ... when men are following up the veins of gold and silver, probing with picks deep into the hidden parts of the earth, what stenches Scaptensula breathes out underground? And what poisons gold-mines may exhale ! How strange they make men's faces, how they change their colour ! Have you not seen or heard how they are wont to die in a short time and how the powers of life fail those whom the strong force of necessity imprisons in such work ?'

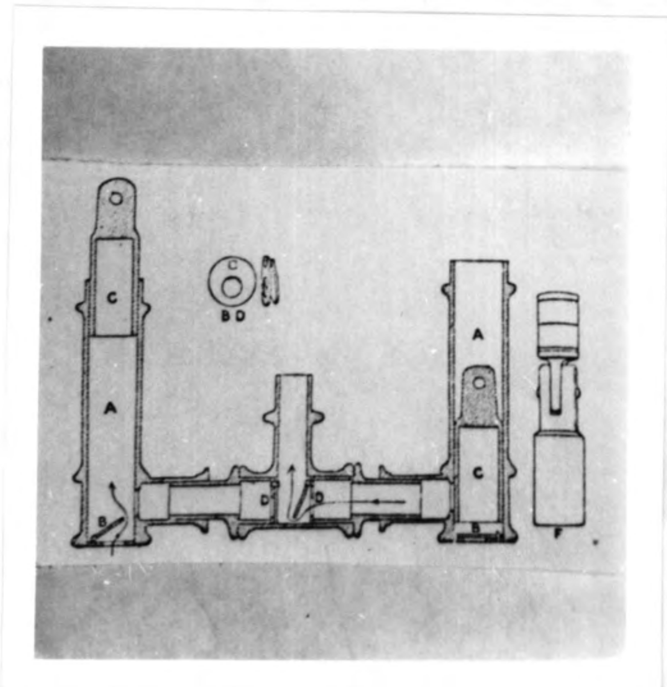
(49)

Drainage

Another acute problem in any mine is that of drainage. In Britain, however, there appears to have been less difficulty than in Spain, since little in the way of machinery for drainage purposes has been found. In Spain, however, where the level of the mine was sometimes below that of the sea, the problem was more urgent. We have already noted the employment of drainage adits in hill-sides and from shafts, into which the water would drain prior to its being removed. The simplest way of removal, yet at the same time, the most expensive, was by baling it by hand. This was done in buckets of various metals,

Above:The pump from Bolsena,in the British Museum.

Below:The same in diagrammatic form.



bronze,copper,or leather or even of esparto grass, treated with pitch and set in a wooden frame.The buckets were laage and hauled out of the mouth of the shaft by rope.Where this method was employed,the buckets could contain up to 150 litres,and were of various shapes - with pointed bases or ovoid - to allow easy filling.

Drainage adits were cut parallel to the main mining adit and were slightly below their level.The Roman government repaired and made large adits for the concessionaires who were not allowed to touch them.

The other mechanical methods of raising watter were by the pump,cochlea,water wheel and kaduff.

The kaduff was a high vertical pole,forked at the top into which was fitted another pole horizontally.At one end of the horigontal pole was a rope which held the bucket,and at the other end stood the operator.This method can be seen in use today in parts of Africa and Europe.

The pump,of which there is an example from Bolsena,in Etruria,in the British Museum,was a remarkable piece of equipment.It was made of bronze and it was constructed on a principle invented by Ktesibios of Alexandria,who probably lived in the third Century B.C. It was worked by alternating plungers raised and lowered by a rocking beam. As the plunger was raised, the water, drawn by the vacuum created, forced the valve open and rushed in. When the plunger was pushed down, the valve fell back into place, and the water was driven out through another valve into the central discharge pipe.

The third method of mechanical drainage was by means of the cochlea, or Egyptian screw, or Archimedian screw. This is the method mentioned by Diodorus:

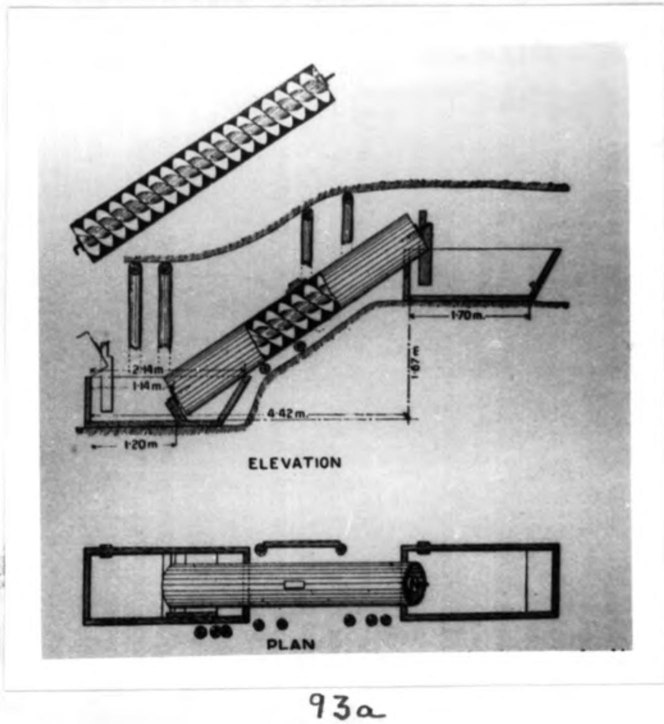
Diodorus, V.37.3.

" They make openings in various places and go deep into the earth ... when the workings penetrate deeply, they encounter streams of water that flow underground;
c but the force of these they overcome by diverting the flow through transverse drains. Certainty of profit breeds a determination to carry through their various plans to completion. Most striking of all is the way in which they drain off the streams of water by using the so-called Egyptian screws - an invention made by Archimedes of Syracuse when visiting Egypt. The water is raised by a succession of screws to the outlet of the gallery, and thus the bottom of the mine is dried and the conduct of the operation made easy. This machine,

Above:The terracotta of the slave working the cochlea,

from the British Museum.

Below:The cochlea,in diagrammatic form.



which is a masterpiece of ingenuity, with the application of moderate effort can lift an astonishing mass of water and will easily discharge on the surface the whole volume of such streams as these. '

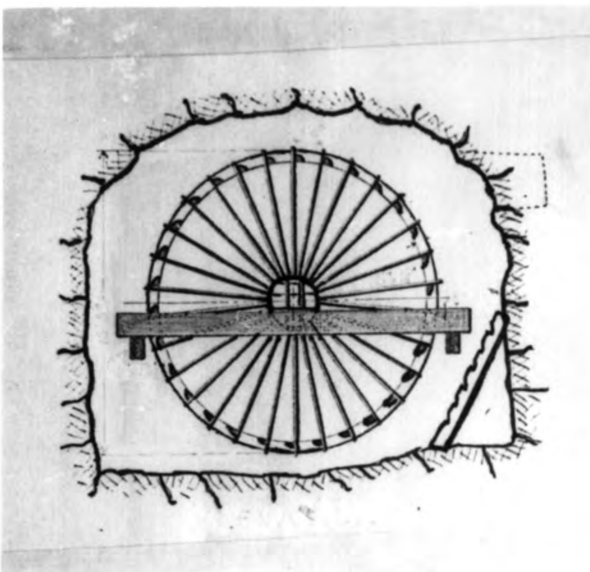
(50)

The cochlea is still used in Egypt. It consists of a core or hub of wood, 20 cm. in diameter around which was placed in a spiral, in screw formation, vanes of metal 2 mm. thick attached by copper lugs and rivets. The whole was enclosed in a wooden cylinder 4 m. long and 0.5 m. in diameter. At the end of the cylinder an iron point was inserted into the core, the other end of the point rotating in a timber socket. The screw was laid at an angle and a slave rotated it by walking round the outer casing of the cylinder. Water was thereby drawn up into the cylinder by the vanes and delivered at the upper end.

The angle of the screws varied and this obviously affected the efficiency of the machine. It has been estimated that each cochlea lifted the water a distance of two metres vertically, or in effect 1.6 m. due to loss of water, and so it can be assumed that twenty were needed for a lift of forty metres.

Right:The fragment of water-wheel from Dolaucothi, Wales; in the National Museum of Wales.

Below:A diagram showing a water-wheel in Rio Tinto, Spain.

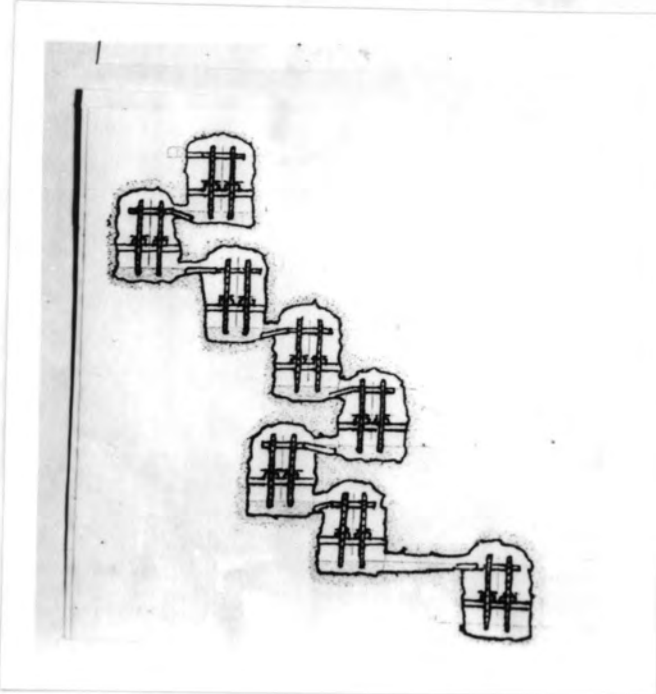


The cochlea was also workable by means of an iron crank, but this was harder and less efficient.

The cochlea was more economical than water-wheels because they needed only one man to operate them instead of two or three. They were arranged in series, and with one man on each a steady flow of water could be produced.

The fourth method of water-raising by mechanical means was by the water-wheel. Here again an excellent example is to be seen in the British Museum. This wheel was one of a nest of eight pairs of wheels found at the Rio Tinto mine in Spain(51). A fragment of such a wheel, this time from a British mine, the gold workings at Dolaucothi in Wales, can be seen in the National Museum of Wales, Cardiff. (52). The wheels of the Spanish mine are made of wood and are 4.5 m. in diameter. The axle is of bronze 0.9 m. x 6 cm. x 6 cm. ,and the hubs and bearings are of oak. Around the periphery are fastened twenty-four boxes, made of pine, as are the spokes and rim of the wheel, and measuring 38 cm. x 18 cm. x 13 cm., and fastened by wooden dowels. Larger wheels are known with thirty boxes. Operated by a pull of 150 lb., they can raise 13½ lb. of water each minute through a

Right: The nest of eight water-wheels at Rio Tinto, Spain.



Below. The water-wheel from Rio Tinto, in the British Museum.

distance of 3.6 m. and have been found to be efficient to sixty-one per cent.(53)

The wheels were arranged in pairs, and to ensure that the flow of water was even, they were rotated in opposite directions. The water was then carried to the top of the wheels where it left the boxes, falling into a launder which transported it to the sump of the next wheel. The total lift of eight pairs of wheels at Rio Tinto was thirty metres.

There appears to be some doubt as to whether the rotation of the wheels was achieved by slaves treading downwards in treadmill fashion on the cleats which are attached to each of the twenty-four boxes, and parallel to the axle, or whether they sat by the side of the wheels and pulled in an upwards direction on short lengths of rope which are again to be found intact by the same cleats. It seems to me however that if the slaves had to pull upwards on the lengths of rope then the effort involved would be considerably greater. There would be need for far fewer slaves if the wheels were worked in the treadmill fashion and if the ropes were used to assist them to pull the wheel round in a downwards direction. Palmer, saying that this seems impossible, first put forward the view of lifting the wheel in 1926 (54), though drawing notice to the fact that the cleats were worn on the uppermost surface. To support this view, he says that the chambers on which the wheels were found were all larger on the side where the water was being raised, and he therefore thinks that the workers stood on that side. Palmer admits that if this method was used, then a rachet would have been necessary, and none has been found.

Tools

Numerous examples of the tools used in mines in Spain and Britain have been found, and we are able to judge accurately their mining methods (55).

We have already mentioned the picks of stone, wood and horn which were used in pre-Roman times. On their arrival, the Romans took over the mines and excavated normally with iron tools. At first the picks had single blades and were straight, and then they became curved and some had double ends. The majority were twenty to twenty-four centimetres long, although some examples of up to thirty-six centimetres occur. In North Wales, stone tools were used and elsewhere in Britain, picks of all types were used to split the rock after the

The spade from Charterhouse on Mendip, now in the City Museum, Bristol.

fire-setting process, besides their more general use in the cutting of shafts and adits. The picks had holes near the head where the wooden handle would have been inserted.

Besides using the pick, the Romans soon turned to using hammers and gads. The hammers, like the picks, had sockets for short wooden handles. They weighed five to ten pounds and were designed with either a double flat head, or with a flat head at one end and a pointed end at the other. The gads in cross-section are square, whereas in long section they are V-shaped.

Rilled stones were used in Spain until the end of the first Century A.D. Hammers and gads were still being used in the third and fourth century. Pliny also mentions a sort of battering ram weighing 150 lb. (56).

Spades were used to shovel the ore into a dust-pan-like object. Two spades of cleft oak were found at Shelve in Shropshire, others at Greenhow Hill and Hurst in Yorkshire (57) and yet another, though of doubtful date at Charterhouse on Mendip (58).

The wedges which were used extensively in Britain for the fire-setting process were made of wood.

Hoes were also used to gather in the ore. These were first made of horn, and later this material gave place to wood and iron. A number of these hoes survive. They have shanks bent over at angles of 120 degrees and were attached to long handles.

The ore was gathered into flat trays of wood and wickerwork. At Carthagena, the ore was carried in bronze buckets to the bottom of the shaft and then hoisted to the surface by means of a windlass and a hempen rope. Buckets woven from Esparto grass twenty centimetres in diameter and seventeen centimetres high were used too, and elsewhere bags of leather, and goatskin, held open by bronze rings were in use. These would be passed from hand to hand along the mine passages, as happens in the Siberian silver mines today.

Before taking the lead ore to the smelting furnace, the workers would sieve it on sieves of hazel-wood, and then wash it. This was a most efficient process because of the high specific gravity of lead. Ore was washed as much as five times (59).

We are fortunate in having a contemporary illustration of a group of miners. At Linares a bas-relief was found depicting five miners. The leader, obviously the foreman is holding an object which is variously interpreted as

The Linares bas-relief.

being a bell,lantern or an oil-can.He also holds a pair of double tongs,which would have been used for raking in the ore,or else for tackling the hot rock in the fire-setting process.Another member of the group carries a pick which is blunt at one end and pointed at the other. A third carries a lamp.All the miners have sandalled feet and are naked except for a leather strap and tunica around their waists.Helmets appear not to have been worn,although one,of doubtful date,has been found at Cordoba.

References

1. Forbes *Technology* VII,208.
2. Davies *Roman Mines* 29.
   Orth *P-W Supplbd.*IV col.127.
3. Davies *Roman Mines* 29.
   Orth P-W *Supplbd.*IV col.127.
4. Rickard *Metals* 448.
   Hudson *Metallurgia* XXXIII(1945-6) 294.
5. Hudson *Metallurgia* XXXIII(1945-6) 294.
6. Translation from Bailey *Pliny's Chemicals* I.
7. Whittick *Newcomen Soc.Trans.*XII(1932) 72.
   Cox *AJ* LII(1895) 31.
   North *Mining* 20.
8. Translation from *JRS* XVIII(1928) 130.
9. Davies *Roman Mines* 31.
10. Forbes *Technology* VII,196.
11. Davies *Roman Mines* 137.
12. Davies *Roman Mines* 122.
13. Davies *Roman Mines* 23.
14. Davies *Roman Mines* 120.
15. Orth *P-W Supplbd.*IV col.126.Rickard *Metals* 446.
16. Forbes *Technology* VII 207.
17. Davies *Roman Mines* 126.
    see too Rickard *Metals* 427.
18. Davies *Roman Mines* 126.
19. Davies *Roman Mines* 120.
20. Davies *Roman Mines* 121.
21. Rickard *JRS* XVIII(1928) 142.
22. West *Spain* 44.
23. Forbes *Technology* VII 194f.
24. Davies *Roman Mines* 20.

25. Davies Roman Mines 137.
26. Whittick Newcomen Soc. Trans. XII(1932) 60 .
Cox AJ LII(1895) 31.
T. Wright Ill. Lond. News October 4th 1856, 351-2.
27. Translation from Bailey Pliny's Chemicals I, 95.
28. Rickard Metals 427.
Forbes Technology VII 196.
29. Davies Roman Mines 160.
30. Davies Roman Mines 24.
Rickard Metals 448.
Forbes Technology VII 212.
31. Orth P-W Supplbd. IV col. 126.
32. Davies Roman Mines 137.
33. Hudson Metallurgia XXXIII(1945-6) 298.
34. Forbes Technology VII 195.
see too Davies Roman Mines 20.
35. Forbes Technology VII 196.
36. Davies Roman Mines 20.
Forbes Technology VII 196
37. Hudson Metallurgia XXXIII(1945-6) 298.
see too North Mining 14.
38. Davies Roman Mines 28.
Palmer TIMM XXXVI(1926-7) 299.
39. Davies Roman Mines 20.
Rickard Metals 447.
Forbes Technology VII 196.
40. Forbes Technology VII 212.
41. Raistrick Newcomen Soc. Trans. VII(1926) 82.
Whittick Newcomen Soc. Trans. XII(1932) 72.
42. Orth P-W Supplbd. IV 127.
43. Orth P-W Supplbd. IV 127.

44. Translation from Bailey *Pliny's Chemicals* I 97.

45. Livy *Ab Urbe Condita* XXI 37.
For its use at Rio Tinto see Rickard *Metals* 426.

46. B.M.MS.add.33651 f.160.
see too North *Mining* 14,16.

47. Orth *P-W Supplbd.* IV col.133.
after *S.- Ber der Archaeologischer Geselschaft der Berlin* (1887).

48. Lucretius *De Rerum Natura* VI,806.

49. Translation from C.Bailey *De Rerum Natura* Oxford (1947) 555.

50. See Egyptian figurine of a slave working the cochlea at the British Museum, Cat.No.37563.

51. Davies *Roman Mines* 26.
Forbes *Technology* VII 216.
Palmer *TIMM* XXXVI(1926-7)299.

52. Boon and Williams *JRS* LVI(1966) 122ff.

53. Palmer *TIMM* XXXVI(1926-7)304.

54. Palmer *TIMM* XXXVI(1926-7)302, from Mr. F. Bodenham, superintendent of the work.

55. Davies *Roman Mines* 32f.
Forbes *Technology* VII 192f.
Palmer *TIMM* XXXVI(1926-7)304.
Hudson *Metallurgia* XXXIII(1945-6)296.
Lewis *Wales* 22.

56. Pliny *NH* XXXIII 71.

57. Whittick *Newcomen Soc.Trans.*XII(1932) 59.

58. *VCH Som.* i,337.

59. Strabo III,2,10.

Smelting and Cupelling

Once the ore-bearing rock had been brought to the surface, it was treated in two main processes - smelting and cupelling. Smelting and cupelling. Smelting produced the lead from the ore-rock, and cupelling produced the silver from the lead. The two processes require the material to be heated - the former to a little over 300 degrees Centigrade, and the latter to over 900 degrees Centigrade. Because of the different heats, the cupelling hearths or furnaces differed from those that smelted the ore, being required to withstand a far greater heat. It is possible that the two processes were linked in some places, since we read the following passage from Pliny:

Pliny, <u>NH</u> XXXIII, 106-107.

' Chrysitis is made from the original ore, argyritis from silver, and molybditis from the smelting of lead itself. Molybditis is made at Puteoli - whence the name. All varieties however are made in the same way. The raw material is melted and the 'silver scum' flows down from the upper vat into the one placed below, from which it is removed with iron spikes, each spike-load being revolved in the flame to make it less dense.' (1)

Other passages referring to the processes of smelting and cupelling follow:

Pliny, <u>NH</u> XXXIV, 159

' There are two sources of blank lead; in the one case the ore is pure and gives rise to no other substance, in the other, lead and silver occur together and the metal is smelted from the double mineral. In the case of the latter ore, the first material to enter into fusion in the furnace is called <u>stagnum</u>, and the second <u>argentum</u>. The residue, about one-third of the original ore, is called <u>galena</u>, which after another smelting, gives black lead, with a loss of two parts in every nine.' (2)

Pliny, <u>NH</u> XXXIII, 95

' It is impossible to melt it (sc. silver), except in combustion with lead or with <u>galena</u> - this last being the name given to the vein of lead that is mostly found running near the veins of silver ore. In this smelting operation part of the ore separates into the lead, but the silver floats on top like oil on water.' (3)

Strabo, III.2.10.

' The alluvial soil is first broken up and sifted in sieves held in water. The deposit is again broken up and

and being again filtered with running water, is broken up a third time. This is done five times, the fifth deposit is smelted and the lead (lead oxide) being run off, pure silver remains.'

(4)

Ulf Täckholm (5) suggests that in the upper vat, (catinus) mentioned in the first passage from Pliny on page 105, crude lead was taken from the ore, which then flowed down to the lower vat, where refinement took place in the form of cupellation.

R.J.Forbes (6) concludes that by stagnum and argentum mentioned in the second Pliny passage, on page 106, crude lead is meant, and that by galena, purified lead is meant.

Galena is, in fact, lead ore. It has the appearance of coal and clings to the rock in cubes. However, unlike coal which has a specific gravity of 1.3, galena has a specific gravity of 7.5. Before smelting began, the ore was repeatedly washed, to remove the excess gravel, like panning for gold, as is attested by Strabo's commentary above. In Cornwall today, tin ore is subjected to this same continuous washing.

Having been washed and then pounded and crushed, the ore was then smelted. Of the three methods of smelting used today, R.J. Forbes (7) suggests that the two known to the Romans were the following:

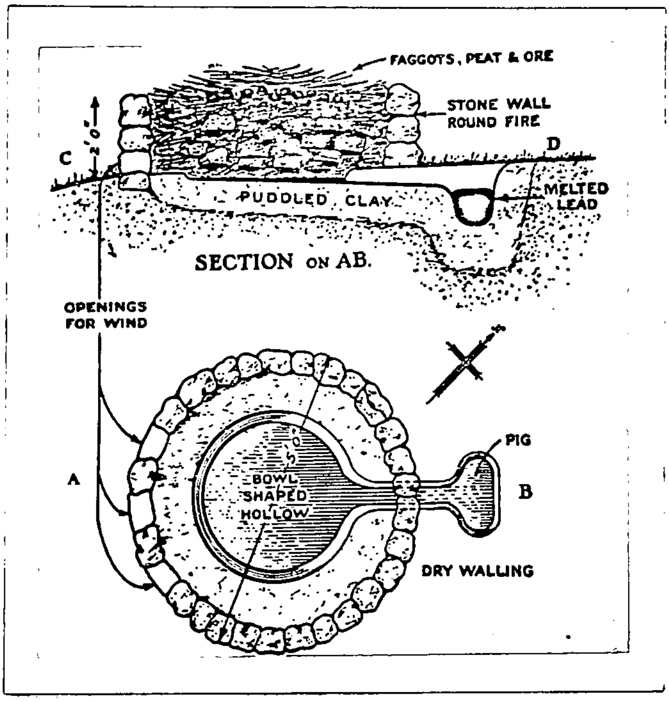
In the first, the galena, lead sulphide, <u>PbS</u>, having to be converted to lead oxide, <u>PbO</u>, was heated in a furnace and subjected to a blast of air. The lead content of the furnace charge depends on the method of mining and concentrating the ore. In the Derbyshire mines, furnace charges of 100 per cent galena were probably used (8). The sulphur lead compound, being roasted, decomposed, and the sulphur escaped as sulphur dioxide gas, $\underline{SO_2}$. Some, however, is left in the form of lead sulphate, and some galena remains intact, but most of the lead is oxidised to lead oxide litharge. When the correct stage of desulphurisation is reached, the litharge, lead sulphate and the galena interact to form lead.

$$2PbO + PbS = 3Pb + SO_2$$

The lead formed falls to the bottom of the fire.

The other reduction process which R.J. Forbes considers was known to the Romans entailed the roasting of the galena until almost all the galena was litharge, which was then reduced by charcoal, coke and wood to lead.

A reconstruction (by Raistrick) of a Roman smelting hearth.



The lead obtained by smelting galena was called crude lead, the German <u>Werkblei</u>, and contained 45 to 180 ounces of silver for every ton of lead (0.12 - 0.54 %).

The Romans used primitive equipment which contained a number of cracks through which a great deal of lead was lost. Experiments have been conducted, however, which show that it is possible to smelt lead galena in a brick-surrounded fire under these primitive conditions (9). Troughs and trenches were also used on hillsides where the ore and fuel were mixed together and fired by the wind for blast.

Archaeological evidence is not very helpful with regard to the appearance of these lead-smelting hearths. This is because a lower temperature is required to smelt the lead, and the hearths and furnaces built were not as robust as those for smelting copper and iron, nor as those for cupelling the lead. They may have been similar to the mediaeval hearths, the wells of which held 168 lb., which corresponds closely with the weights of Romano-British pigs of lead (10).

An open hearth containing unsmelted and part-smelted lead galena has been found at Heriot's Bridge on the

Mendips (11), and at Pentre in Flintshire, remains of Roman smelting furnaces of the first Century A.D. have been discovered (12).

On the Mendips, lead mining continued up until the end of the nineteenth century and it is difficult now to distinguish between Roman and later slag, but during the nineteenth Century, Roman slag found to contain as much as twenty to twenty-six per cent of lead still, was re-smelted(13). At Carthagena, in Spain, slag has been found containing eight to seventeen per cent of lead. This compares unfavourably with the one per cent of lead that is left in modern slag after more efficient smelting processes. This vast wastage could have been caused by smelting the ore at too high a temperature. Overheating in this manner would cause the lead to form a vapour and some would escape completely, whilst some would be trapped in the layer of slag on top. In general, however, the simple nature of the smelting operation provided an almost pure metal, the Romano-British pigs that have been analysed showing a very high lead content in the order of 99.9% Pb. (14).

Once the lead had been desilvered, it was used for making pipes, lining baths and cisterns etc., but was never further refined.

Oliver Davies describes the development of the furnace from the hearth (15).The bowl furnace was a clay-lined hole,conical or hemispherical, 1 m. deep and 1½ m.wide ,in the ground. In time,this increased in height,and,being built of stones,developed into the shaft furnace.In the bottom of the pit,heat - resisting materials were placed: ten to twenty centimetres of fire-proof clay,or clinkers mixed with lime,and then kindling wood,coal,charcoal and ore were placed in layers alternately on top and ignited. The necessary draught was achieved by positioning the hearths on mountain slopes,where too the poisonous fumes could be blown clear of the smelters,and on beaches,and an arched wind tunnel,covered with stone was dug sideways into the ground to the furnace.Bellows were also used - these were probably a skin,with a hole in it,closed at the heel,and with a cord,which when pulled opened the bellows to inflate them.Some Roman furnaces found at Carthagena have a conical blast-hole,where the wind was used instead of bellows to provide the blast.Where possible,the hearths were placed near forests where fuel was readily available.

In Central Europe the neck of the furnace was contracted to conserve the heat, and a tapping-hole had to be built near the base. Its height did not come above the ground.

M. Gowland (16) says that in Britain too the hearths were below the ground, and lined with a refractory material, but without an outer wall. Mr. Whittick (17) disagrees, calling attention to the subsequent discovery of the hearths in Flintshire, where the furnace was made of solid stone blocks, laid in and lined (though not entirely) with clay, which was also packed between the stone (18).

Shaft furnaces appear not to have been used in Britain, but they are known at Carthagena, in Spain (19) and at Tharsis (20), and are mentioned by Strabo:

Strabo, III 2.8

'They build their silver-smelting furnaces with high chimneys so that the gas from the ore may be carried high into the air, for it is heavy and deadly.'

(21)

With the shaft furnace, ore and fuel could be added by dropping it down the chimney, thereby enabling a continuous process, whereas the bowl furnace with the contracted neck had to be demolished to reach the lead.

Smelting in the shaft furnace was a longer process than in the hearth, and a larger amount of material could be collected in the bottom.

The slag was usually removed by means of tongs through the same hole that had been used for the bellows to provide their blast.

The tapping-hole through which the molten metal flowed into the well was set at the base.

The recovery of the silver from the smelted lead was by cupellation, which involved the oxidation of lead to litharge (PbO). The process known as liquation was not used. Melted lead, when exposed to air, oxidises freely and forms litharge. When argentiferous lead oxidises completely, silver is left behind in the hearth; the litharge was absorbed by the bone-ash hearth, or else was skimmed off, where clay cupels were used (22). The saturated cupel could then be resmelted, and the lead recovered from the litharge by reduction with charcoal, yielding practically pure lead.

R.J. Forbes (23) believes that the 'Pattinson' process was used by the Romans. Here, if the lead is melted and cooled again, the first crystals formed consist of pure lead,and the remaining solution is therefore richer in silver.The formation of pure lead crystals goes on until the remaining lead contains 2.4 % of silver when the remaining metal sets all at once,but by pouring off the molten metal before this happens,the silver is concentrated as far as possible,and the lead is enriched and can be de-silvered by the very old cupellation process.

The cupellation hearth had to be very shallow so that the maximum amount of lead could be exposed to the oxidising blast of air,which was again supplied by bellows through the side of the hearth.Charcoal and wood provided a heat of 1,000 to 1,100 degrees Centigrade,and were held in a dish-like cavity in the bone-ash at the base of the hearth.The hearths were lined with the bone-ash,which is refractory,porous and readily absorbs the oxides produced in the process.The furnace was walled and roofed with clay as well.At Green Ore,near Charterhouse on Mendip,in 1956 over 1,000 pieces of charcoal were found together with a saucer-shaped depression in the ground , 25.4 cm. in diameter,which had probably housed a cupellation hearth (24).Remains of these hearths have been found at Silchester,Wroxeter,and Hengitsbury Head (25).

The extraction of silver was expensive, costing approximately three times the cost of producing lead, and in Roman times it was economic to cupel lead containing 0.06% of silver as compared with the 0.0003% of the present day (26). The processes must have been extremely efficient since the silver content of some of the Roman lead which has been cupelled is only 0.01 or 0.002% which is very low, even by today's standards. In 1955, a small amount of lead carbonate, cerussite $PbCO_3$ was found at Llantwit Major, Glamorgan, in a Roman villa. This contained 0.52% of silver - from one of the richest ores in the province (27). At Rio Tinto, in Spain, some mineral yielding 0.55% silver, which is 200 ounces in every ton of lead, has been mined. A lead ore entirely devoid of silver is not known. A table showing the silver content of lead from recently mined lead ores from sources in Britain follows on page 116.

Once cupelled, the lead was recovered by re-smelting the litharge in a similar way to that of smelting the original lead (28).

When the lead had been smelted and cupelled, it was cast into moulds of the right size for their intended weight. Dr. Smythe (29), having examined the pigs of lead

TABLE A

to show the silver content from recently mined lead ores - from Tylecote Roman lead 26. (adapted)

	1847	1923
Yorkshire	-	0.003 - 0.006%
Salop	0	0.006 - 0.009%
Derbys.	0.007-0.018	0.003 - 0.006%
Montgom.	0.018	0.009 - 0.012%
Flints.	0.021	0.009 - 0.018%
Scotland	0.024	0.009 - 0.015%
Cumberland	0.027	0.018%
Ireland	0.030	-
Northumb.	0.036	0.018%
Carmarth.	0.045	0.009 - 0.012%
Isle of Man	-	0.090 - 0.120%
Mendips	0.411	

found together at Brough-on-Humber, says that it is probable that three of these and two others were cast in the same mould. No moulds have survived, but they were probably made of clay, which would withstand the five impressions, in the base of which, and on the sides of some, was the inscription, reversed and recessed, that was to appear on the face, or along the sides of the pigs. It is possible that separate letters were used to make the die for the mould, which would obviate the necessity of having to cut a new panel each year.

Professor Palmer (30) has suggested that the pigs were filled by ladling the lead out of the well by the furnace and into the mould, suggesting that the striations which can be seen on all the pigs are the results of the different pourings. This theory is refuted by most authorities (31) who show that the striations are the natural result of cooling lead, due to surface tension effects between the metal and the mould. Dr. J. A. Smythe conducted some research into this question before his death, and Mr. G. Clement Whittick expounds his explanation in JRS LI (1961) 105 ff. with photographs of modern pigs.

Both Professor Palmer and Dr. Smythe have attempted to interprett the different weights of the pigs, and their theories are discussed in the following chapter.

The pig with the highest silver content is no.117 from the Mendips. This contains 0.056% silver, and it appears that this pig must have escaped the cupelling process, since its content far exceeds that of any other pig.

References

1. Translation from Bailey _Pliny's Chemicals_ I,127.
2. Translation from Bailey _Pliny's Chemicals_ II,65.
3. Translation from Bailey _Pliny's Chemicals_ I,111(adapted).
4. Translation from Van Norstrand _Spain_ in Tenney Frank _ESAR_ III,157.
5. Täckholm _Bergbau_ 34.
6. Forbes _Technology_ VIII,231.
7. Forbes _Technology_ VIII 227ff.
8. Tylecote _Roman Lead_ 26.
9. Tylecote _Metallurgy_ 76, _Roman Lead_ 28-9.
10. Tylecote _Metallurgy_ 77.
11. _JRS_ XLIV(1954) 99.
12. Atkinson and Taylor _Flints.Hist.Soc.Publ_.X(1923)i, 7.
13. Täckholm _Bergbau_ 44.
14. Tylecote _Roman Lead_ 36.
15. Davies _Roman Mines_ 42f.
16. Gowland _Arch_.LVII(1901)i,119. ii.398.
17. Whittick _Newcomen Soc.Trans_.XII(1932) 62.
18. Atkinson and Taylor _Flints.Hist.Soc.Publ_.X,i(1923) 7.
    Petch and Taylor _Flints.Hist.Soc.Publ_. X,ii(1924) 6.
    see too Cox _AJ_ LII(1895) 34.
19. Monasterio _Anales de minas_ IV(1846) 28.
20. Schönicken _Berg- und hüttenmännische Zeitung_(1863) 200.
21. Translation from Van Norstrand _Spain_ in Tenney Frank _ESAR_ III,157.
22. Tylecote _Roman Lead_ 31-32.
23. Forbes _Technology_ VIII 23.
24. Ashworth and Palmer _Wells NHASP_ LXIX-LXX(1957-8) 12.
    see too Gowland _Arch_.LVII(1901)i,113-124.

25.Gowland Arch.LVII(1901)i,113-124.

J.R.Bushe-Fox Excavations at Wroxeter ,Report 2 Soc.Ant.London (1914) 65.

J.R.Bushe-Fox Excavations at Hengitsbury Head,1911, Report 3 Soc.Ant.London (1915) 72ff.

26.Tylecote Metallurgy 82.

27.Nash-Williams AC CII(1952-5) 89-163.

Tylecote Roman Lead 28.

28.Tylecote Roman Lead 32.

29.Smythe Newcomen Soc.Trans.XX(1940) 139ff.

30.Palmer and Ashworth Som.ASP CI-CII(1956-7) 71.

31.Whittick JRS LI(1961) 105f.

Tylecote Metallurgy 89.

The pigs of lead

from Roman mines

in Spain and Britain

Almost two hundred pigs of lead, made by the Romans, have been found which can be attributed to mines in Spain and Britain. The circumstances in which they were found vary, but the majority were found either near the mines from which the lead was extracted, or else by the sides of roads or rivers along which they were obviously being transported. Some pigs have been found in holes in the ground, or under cairns, such as the group from Green Ore, in Somerset (nos. 114 - 117), where they had been placed intentionally. The large number of pigs found at Carthagena shows that this was probably the principal lead-handling port for the many mines in the South-East of the Iberian peninsula. In Britain, Clausentum on Southampton Water, Brough-on-Humber, and Runcorn on the river Mersey, appear to have been the major lead-exporting harbours.

Table B on page 123 shows the numbers of pigs recorded which were produced by mines in Spain and Britain in the later Republic and in the Empire. It is easy to see how the production of lead from Spanish mines dropped considerably once the Romans had reached

TABLE B
to show the dates of the lead pigs

SPAIN: Unknown mine	Spain or Attica	Orihuela	Carthagena	Sierra Morena	Coto Fortuna	Castillejos	Alcaracejos	Almeria	TOTAL	BRITAIN: unknown	Somerset	S-Wales	Flints.	Salop.	Derbyshire	Yorks.	TOTAL	DATE
2	3	30	5						40									Early C 1 b.c.
1	24								25									Late republ.
12			2	3	1	2		2	22									Early Empire
					5		1		6									C 1 A.D.
1																		unknown
											2						2	Claudius 41-54
											2	1	1				4	Nero 54 - 68
											10		4 10/10				24	Vespasian 69 - 79
													10/10			2	12	Domitian 81 - 96
Prov. not known		GAUL		SP.		SARD.				1							1	Nerva 96 - 98
																1	1	Trajan 98 - 117
						1			1		2			3	2	1	8	Hadrian 117 - 138
				1		2			3				1		20		21	pre 138 ?
											3						3	Ant. Pius 138 - 161
											4						4	M. Aurelius 164 - 169
		1								1			1/1 1				3	Sept. Severus 193 - 211
													2/2				2	late C 2.
1		3								5	3				3		11	unknown

TABLE C

to show weights of pigs from Gaul, Spain and Sardinia to the nearest kilogram.

Unknown Province	GAUL or GERMANY	Unknown Spanish mine	SPAIN or ATTICA	Orihuela	Carthagena	Sierra Morena	Coto Fortuna	Castillejos	Alcaragecos	Almeria	SARDINIA	Total	Weight kg.
		1										1	5
						1						1	11
			2				5					7	31
			6	3								9	32
		1	12	4								17	33
		4	1	3	1						1	10	34
		2	2				1					5	35
											1	1	36
	1											1	43
									1			1	57
	1											1	61
	1											1	66
								1+				1+	92
	1 or	1										1	145
1												1	275

Fragments of pigs have not been included in this table.

TABLE D

to show weights of British pigs to the nearest kg.

Unknown	Som.	S.Wales	Flint.	Salop	Derby.	York.	Total	weight
1							1	33
	1						1	34
					1		1	37
					1	1	2	38
	1						1	40
1	1							45
					2		2	51
					1		1	58
					1		1	60
			1				1	61
					1		1	65
	1		1				2	68
	1						1	69
	1		1			2	4	70
	2						2	73
	2						2	75
			1				1	76
						1	1	77
	1				2		3	78
	2				2		4	79
			1				1	81
1	1						2	82
					3		3	83
	1						1	84
	1				1		2	85
	1		2 or	2,2	1		6	86
			1	2	1		4	87
	1				1		2	88
					1		1	89
	1						1	90
	1						1	102

Fragments of pigs have not been included in this table.

Britain.Numismatic evidence,however,shows that the mines in Spain were operating at a later date (1),and so production there did not stop completely.It is also interesting to note how the opening of the mines in Britain corresponds with the Roman advance into the province.Again numismatic evidence shows that the British mines were in use up to the fourth Century A.D.,which, together with the evidence of later lead and pewter objects shows that mines did not cease production at the end of the second Century,as one might be led to believe by looking at this table (2).

The virtual absence of pigs during the reigns of Nerva and Trajan may be due to the fact that in Vespasian's reign the law restricting output from the lead mines was passed.This regulation implies that some mines were in the hands of lessees at this stage,supporting the evidence from some of the pigs discussed on page 38 above. Hadrian,on the other hand,promoted mining activity in his policy of provincial consolidation(3), and evidence of this can be seen in the large numbers of pigs recorded that are of Hadrianic date,and which make a marked contrast with the sparse evidence of activity during the reigns of his two predecessors.The pigs of later date that bear Imperial inscriptions show that at some mines,notably those on the Mendips,the output of lead continued for some time under Imperial control.

The weights of the lead pigs

Pigs were cast in moulds of the right size for a certain weight and Dr.Smythe has shown that it was possible to cast at least five pigs from the same mould.(4).The average range of weight of the pigs from Spain is thirty-two to thirty-five kilogrammes,with a few exceptions at either end of the scale. (32.74 kg. = 100 librae). The average range of weight of the British specimens is much greater - from fifty-eight to ninety-one kilogrammes,with lighter pigs weighing as little as thirty-three kilogrammes,and larger ones of as much as 102 kg. Table C gives the weights to the nearest kilogramme of the lead pigs from Spain,and from this it would appear that the pigs were cast in moulds to give a weight of 100 librae.

The weights of most of the British pigs are known,and it is easier to attribute them to their mines of origin by means of their inscriptions,marks of origin,etc., than is the case with the specimens from Spain.The range of weights (Table D) of these pigs is so great that it is almost impossible to say that in Britain in general, or in any particular mine in the province, lead was cast in moulds to give a standard weight, the majority weighing between seventy and ninety kg. Dr. Smythe(5) has suggested that the pigs can be grouped in weights that are multiples of twenty-two pounds. Mr. Raistrick(6) suggests that the pigs were cast in accordance with a fixed scale that was probably the precursor of one-sixteenth of a fodder ($176\frac{1}{4}$ lb. = 240 librae). Smythe admits, however, that the figures are only very approximate, with variations of up to eight pounds, and can offer no explanation for the pigs that vary by eleven pounds each.

On fourteen pigs numerals have been stamped or incised. On five of these the stamped number corresponds closely with the actual weight of the pig in Roman librae.

(1 libra = 327.45 grammes = 0.721 pounds)

Pig no.	Mine.	Weight: kg.	Weight: librae	Inscription
161	Sardinia	35.6	108	CVII
164	Salop(?)	61.5	188	CLXXV
180	Derby	65.3	200	CCX
181	Britain(?)	274.6	840	DCCCLXX
189	Gaul/Spain	145.0	443	P CCCCL

On a further nine pigs the stamped numerals seem to bear no relation to the actual weight in librae:

The incuse numerals LXXIIX and the stamp LRΛD on pig.116.

Pig no.	Mine.	Weight: kg.	Weight: librae	Inscription
115	Somerset	89.35	273	LXXIIX
116	Somerset	85.72	262	LXIIX
114	Somerset	84.81	259	LXV
109	Somerset	78.9	240	IIVI
90	Somerset	75.28	230	XXX
110	Somerset	c.73	223	VIII
190	Gaul(?)	66	200	XLVII
192	Britain	'about 100 lb.'	138	P CCCCL or P CCLXX or CCXX
191	Britain	33.1	100	CXXXXII

Professor Palmer in his paper on the four pigs of lead from Green Ore, Somerset (nos.114-117)(7) suggested that the numerals on nos.114-116 denoted the excess weight in librae over a supposed standard weight of 141 lb.(70 kg.) which was probably the precursor of one-sixteenth of a fodder, a weight used for lead pigs at the present time. Prof. Palmer is following here Raistrick's suggestion cited above, but in order to support his theory, Palmer suggests altering the texts of the inscriptions of pigs nos.180 and 109 (8), a practice which we should on no account follow, and which has been described by Mr.R.P.Wright (9) as 'epigraphically unsound'.

When I first attempted to discover a relationship between the numerals and the weights of the pigs, I deduced that if 200 (CC) were added to the numerals the number resulting would almost correspond with the weight in librae. I re-examined the pigs, but it is quite clear that the two letters CC were never on the pigs, and it seems to me that they must have been intended to be taken as read.

The amended numbers for Somerset pigs would then read:

Pig no.	Weight: librae	Inscription	Amended
115	273	LXXIIX	CCLXXIIX
116	262	LXIIX	CCLXIIX
114	258	LXV	CCLXV
109	241	IIVI	CCIIVI
90	230	XXX	CCXXX
110	223	VIII	CCVIII

It will be seen that the amended numeral corresponds closely or exactly in most cases, the notable exception being no. 109 from Bitterne, and to a lesser extent no. 110, also from Bitterne.

The shapes and sizes of the lead pigs

The shape of the Spanish pigs of lead was usually

Pig no.3. A typical semi-cylindrical example from Spain.

semi-cylindrical, whereas the pigs from Britain were in the form of truncated pyramids. It is not possible to attribute the vast difference in weight between the Spanish pigs and the British pigs to their shape however, for truncated pyramids have also been found in Spain, and their weight corresponds to that of the other Spanish pigs rather than to the British examples.

The semi-cylindrical pigs are $7\frac{1}{2}$ - 9 cm. in height on average, and 43 cm. long by 9 cm. wide in general.

The Spanish truncated pyramids are approximately 11 cm. high, with a length and breadth of 47 x 10 cm. at the base, and 43 x 4 cm. at the face. In some cases, both the Spanish and the British pigs appear to have been filled in moulds which were not level, since the height at one end of the pig differs greatly from that at the other.

The British examples of the truncated pyramids vary in size. No. 150, which weighs 61.2 kg. is 11.4 cm. high, and measures 50.1 x 9.5 on the face, and 55.9 x 13.3 at the base. No. 155, weighing 89.2 kg. is 13 cm. high, and 50 x 9.52 on the face and 59 x 14.2 cm. at the base.

<u>Marks of origin</u>

On more than eighteen pigs, all Spanish, marks have been moulded on the face of the pig which have been presumed to denote the mine of origin. On nine pigs, nos. 33, 55-60, 61 and 71, the mark is a dolphin. On three more, nos 35, 66-67 + , it is a caduceus. Aswan is depicted on no. 62, and a rudder on no. 71. On nos. 51 and 52, there is a dragon-serpent, and on nos 53 and 54 an anchor. On no. 71, the dolphin and the rudder appear together.

In addition to the eleven inscribed pigs discovered in 1910 - 1912 in a shipwreck off Mahdia, Tunisia (nos. 37 - 39, 53-54, 55 - 60), five uninscribed lead pigs were found. Three of these pigs bore the dolphin mark in a centre panel between two other panels which had been left blank(10). It has been suggested that all these pigs may have come from mines in Attica (11), since the ship had been loaded at Athens, and it is unlikely that lead would have travelled to Mahdia from Spain via Athens. Moreover the Laurion mine in Attica had regained activity in the middle of the second century B.C. after the victory of Rome over Macedon in 168 b.c. The slaves at Laurion had massacred their guardians at the beginning of the Century, and it is possible that the pigs date to the Sullan period. Nevertheless, Merlin admits that they are unlike all Laurion pigs which weigh only fifteen kilogrammes, nor do the Laurion pigs bear any inscriptions, but just marks. He argues, however, that all the Laurion pigs with which he is making comparisons are pre- Roman, whereas these are Roman pigs, and there is no reason why the Romans could not have standardised the products from Laurion to match those from Spain. It must be pointed out however that the dolphin on pigs nos. 55 - 60, and on the three uninscribed pigs, also appear on pig 33 found at Carthagena, and on no. 71, from Castulo, and that the Lucius Planius Russinus (with anchor) on pigs 53 - 54 from Mahdia also occurs (with dragon-serpent) on pigs 51 - 52 from Picenum, Italy, and the same praenomen and nomen and filiation, but without cognomen or further mark appear on pigs 41 - 50.

The picture is a confused one and it does not seem possible yet to attribute these pigs definitely to a mine in Spain, but their shape, size, and inscriptions indicate a Spanish origin, and absence of further examples of their type from Laurion would indicate that they are not from Attica.

It is not possible to attribute a mark to any particular mine in Spain. It appears that different lessees sometimes used the same mark. For example, the dolphin is used by Publius Turvilius, son of Marcus (no.33), by Marcus Planius Russinus (nos.55 - 60), by Publius Turvilius Arcon (no.61), and by Titus Iuventius (no.71). The caduceus is used with the letters FER or FERM by Lucius Aetilius (no,35) and by Marcus Raius

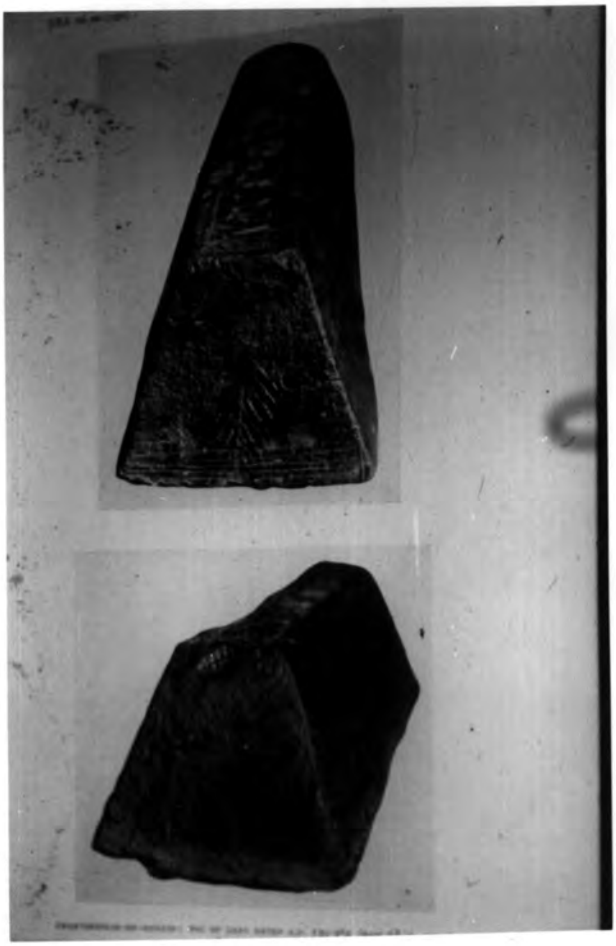
Pig no.137, showing the palm branch.

Rufus (no.66-67).On no.71, besides using the dolphin mark, Titus Iuventius also uses a rudder. Pig no.33, bearing the dolphin was found at Carthagena, and is attributed to a mine there. No.71, bearing the dolphin and the rudder was found near Linares, and is attributed to a mine in the Sierra Merena district. (12)

The recurrence of these 'marks of origin' produces a complicated pattern and shows that they were not restricted to a particular mine. From pig no.71 it appears that one mine could use two different marks, and this would also be the likely explanation for nos.51-54, where Lucius Planius Russinus uses both the serpent-dragon and an anchor as his mark.

These marks, the dolphin, serpent, anchor, rudder and swan, being connected with the sea, cause me to speculate whether they indicate that the pigs were for transport by sea, and do not denote the place of origin. The caduceus is the odd mark, but if taken as being the staff of Mercury, an inveterate traveller, the transport idea is not entirely lost.

On no British pig can be found the mark of a dolphin, an anchor, or any other mark similar to those found on the Spanish pigs. On four examples, however, nos.137, 138, 139, and 166, the first three being from Shropshire and



Left:Pig no.166, showing the palm-branch, and below, the hammer mark, and the circle.

Below:Pig no.117, showing the incuse IMP inscription.

the last from Somerset, there can be seen moulded on the surface of the pig - a palm branch, the significance of which is uncertain, although it could be the mark of an Imperial official(13). On two of these pigs, nos. 138 and 166 there is also a reticulated pattern, as though applied by a hammer (presumably by an inspecting agent) and on the latter, a circle (14).

On one of the pigs from the Mendips (no. 117) is found the stamp IMP, which must indicate the Imperial check(15).

Names of voting-tribes and places of origin

The name of the producer's voting-tribe occurs on thirty-seven Spanish pigs.

Mai(cia tribu) on no. 33

Maic(ia tribu) on nos. 3-32.
Fab(ia tribu) on no. 34A.
Mene(nia tribu) on nos. 37-39

Menen(ia tribu) on nos. 36

Ae(milia tribu)(?) on no. 68

Aim(ilia tribu) on no. 79

The place of origin occurs on seven pigs:

Mont(is) Ilucr(onensis) on nos. 81, 82-86

M(etalli) Lu(...) on no. 71

And on three other inscriptions are the abbreviations FER and FERM which may indicate the name of the mine.

Pig no.115,showing the inscription BRIT·EX ARG·VEB

Below:Pig no.119,showing the G of BRIG on the front.

Many British pigs indicate their place of origin. The least specific of the British pigs is merely inscribed BRITAN? '(plumbum) Britan(nicum).' Nos.87 bears the inscription De Britan(nicis argentariis), and comes from the Mendip mines. Nos.94-96, and 120-129 from the Flintshire mining area are inscribed Deceangl(icum plumbum), 'Deceanglic (lead)' from that tribal area, now part of Flintshire (16).

A number of the Somerset pigs bear the letters VEB , Whittick suggests that it may be the abbreviation of an unknown tribal district, or place-name, as does R.G.Collingwood(17). The suggestion has also been made that VEB. was a contraction for a name that has come to be UBley, the name of the parish adjoining Charterhouse (18).

On nos.118 and 119, the abbreviation BRIG is used. This is clearly the inscription used by the Yorkshire mines, the area being the home of the Brigantes.

The inscriptions of the Derbyshire pigs are:

Met(alli) Lut(udarensis) on no.141

Metalli Lutudare(nsi)s on no.142

Metal(li) Lutud(arensis) on no.143

Lut(udarense plumbum) Br(itannicum) on nos.144-148, 150,151,153-155.

The first of these inscriptions is used with the name of the Emperor Hadrian, the others together with the names of the lessees. The place-name Lutudaron is known from the Ravennas Cosmography (19). Its precise location is unknown.

No mention of the locality is made on any pig attributed to the Shropshire mining area.

It is interesting to note that a pig (no.186) found at Avignon, France, bears the inscription SEGVSIAVIC , a reference to the Segusia tribe who inhabited the central area of Gaul, and that another (no.190) from Gaul is inscribed Sociorum Plumb(ariorum) Ger(manicorum).

Lessees and Societates

The names of lessees appear on seventy-eight of the early Spanish pigs, and the name of a societas is on seven. The fact that there are no cognomina used in the inscriptions on many of the former, and the archaic spelling of certain words like Maic(ia) for Maec(ia) show that they were made in the early first Century B.C.

In Britain, the name of the Emperor is featured on most, and shows that the mines were under Imperial control. On some pigs, like those from Green Ore, Somerset, (nos.114-117) another name, presumably that of an official, has been

Above: Pig no.142

Below:Pig no.143

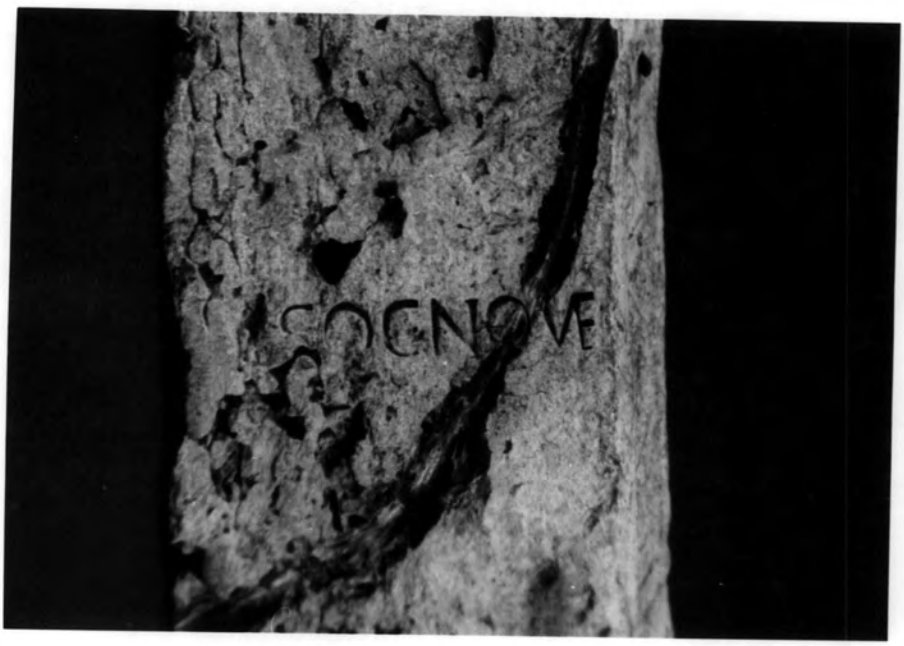
stamped: Ti(berius) Cl(audius) Trif(erna). (20)

When leasing was first started is not known, but it appears from pigs nos.90 and 91, where we find Gaius Nipius Ascanius first as an official in Somerset, and then as lessee in Flintshire, that the practice must have been in operation a long time before the reign of Hadrian (see above p.38).

The pigs from Derbyshire bear the names of a number of lessees - Lucius Aruconius Verecundus (no.143), Publius Rubrius Abascantus (no.142) and Gaius Iulius Protus (150-151, 153 -155), the forms of whose names suggest that they had been promoted from the status of freedmen. On nos.144-148 the lessee is named as Ti(berius) Cl(audius) Tr(...), a name very similar to that of Tiberius Claudius Triferna, whose name appears on pigs from Somerset, mentioned above. Perhaps Tiberius Claudius Triferna was formerly an official on the Mendips and then became lessee in Derbyshire. However, the Derbyshire inscriptions are so abbreviated that a positive identification with the Somerset official is not possible(21).

References to societates appear on seven British pigs of lead. Soc(iorum) Lut(udarensium)(nos.156-7); socior(um)

Pig no.108, showing the incuse stamp of the Novaec. societas.



Lut(udarensium plumbum) Br(itannicum) on no.159 ; and socior(um) Lut(udarensium) on no.159a.; these all refer to the Lutudarensian partners who controlled the mines in the Derbyshire area. Pigs nos.108 - 110 bear the inscriptioms of a societas which operated mines on the Mendips: the Novaec(...) Company.

Oliver Davies has suggested(22) that the Derbyshire mines were never run by the government directly since they were so poor in silver. He also suggests that since these were the only important mines in the province that have not yielded a legionary stamp, then they may not have been under military control, and were leased instead. Nevertheless, only three pigs out of more than eighty exist with the legionary stamp, and this is a view which I would hesitate to adopt.

The legionary stamps

The three pigs on which legionary stamps appear are no.93 from South Wales, a fragment bearing the inscription LEG II ; no.92 from Somerset with L II ; and no.175 from the Shropshire, or Flintshire area, which bears the stamp of the Twentieth Legion.

The letters LVICVC appear on pig.no.174, also from

Pig no.109, showing the moulded inscription

BRIT ? EX ARG · VEB

on the front.

the Shropshire area, and this has been interpreted to mean Legio VI, however, since the legionary titles are not given, and since the letters CVC are used in conjunction with LVI , and which are unknown with Leg VI, Mr.R.P.Wright concludes that L(egionis) VI is not the correct transcription.

EX ARGENTARIIS

A number of the pigs from Britain bear the inscription EX AR ; EX ARG ; or EX ARGENT . This has frequently been interpreted as meaning that the pigs in question had been de-silverised (23).This however is incorrect. Gowland himself noted that one of the pigs so inscribed had a silver co ntent that was the second highest of any British pig found to date (1901), and higher than many pigs not so inscribed. Dr.Smythe did much work on this particular question (24), and showed that of elv v eleven Derbyshire pigs, those with the inscription EX ARG contain a greater proportion of silver than those without. He suggests that in Derbyshire the ores are poor in silver content, and the Romans would have decided not to de-silver the lead.R.E.Tylecote (25) concludes that no attempt was made to desilver the ores of Derbyshire, nor probably those of Yorkshire and Shropshire. Of the seven EX ARG pigs in Dr. Smythe's analysis the mean silver content is 0.0068% and those without the inscription contain 0.005%. This theory is borne out too by the pigs from Derbyshire that have been discovered since Smythe delivered his paper. In addition, two pigs, nos. 153 and 155, still have lumps of galena clinging to them. Whereas lumps of galena could have survived the smelting process, they could not possibly have survived the heat of at least 900 degrees Centigrade of the cupelling process, so powerful is the action of molten litharge on galena (26). Tests conducted on the lumps of galena show that their lead content is 81.2 and 74.8% in the case of the first pig, which has two such lumps, and 69.7% in the case of the second pig. (The maximum possible lead in galena is 86.6%). The silver content is respectively 0.0022%, 0.0025% and 0.0025%, whereas the silver content of the pigs themselves is 0.01% and 0.005%.

EX ARG must therefore mean 'from the lead-silver works' and must not be interpreted as meaning that the silver had been taken from them.

There now follows a list of all the lead pigs recorded from Spain and Britain, together with certain relevant pigs from Gaul and Sardinia. These have been arranged, as far as is possible, in chronological order.

References

1. Besnier Rev.Arch.XII(1920) 230.
   Davies Roman Mines 109.
   Rickard JRS XVIII(1928) 140.
2. VCH Som.i,334-341,354-355.
   Pennant Wales 218.
   Atkinson and Taylor Flints.Hist.Soc.Publ.IX(1922) 101,
   X,i(1923) 5f. X,ii(1924) 6f.
   Collingwood Britain in Tenney Frank ESAR III 42.
   Davies Roman Mines 160.
   Wheeler Rn.Wales 270.
   Nash-Williams AC XCI(1936) 379. XCIV(1939) 108.
   Gough Mendip 24.
   Evans Num.Chron.ser.iv,XV,499.
   Sutherland Coinage 90f.
   Webster Flints.Hist.Soc.Publ.XIII(1952-3) 14-16.
3. Whittick Newcomen Soc.Trans.XII(1932) 71.
4. Smythe Newcomen Soc.Trans.XX(1940) 139.
5. Smythe Newcomen Soc.Trans.XX(1940) 142.
6. Raistrick Newcomen Soc.Trans.VII(1926) 82.
7. Palmer and Ashworth Som ASP CI-CII(1956-7) 52-88.
8. Palmer and Ashowrth Som ASP CI-CII(1956-7) 84-87.
9. R.P.W. to H.D.H.E. (December 1966).
10. Merlin Mél.Cagnat 383-391.
    Besnier Rev.Arch.XIII(1921) 100.
11. Merlin Mél.Cagnat 388.
12. Besnier Rev.Arch.XII(1920) 239-240.
13. JRS XXI(1931) 264.
14. JRS XXI(1931) 262.
15. JRS XLVII(1957) 231,no.20 d.

16. _CASJ_ IV(1890-1) 68,77.

Flints.Hist.Soc.Publ. IX(1922) 10f.

17. Collingwood _Britain_ in Tenney Frank _ESAR_ III 43.

18. Palmer and Hunt _Som.& Dorset NQ_ XXVII(Aug.1958)197-8.

19. Richmond and Crawford _Arch._ XCIII(1949) 38.

20. R.P.W. _JRS_ LII(1962) 195.

21. R.P.W. _Som.ASP_ CI-CII(1956-7) 82.

22. Davies _Roman Mines_ 11.

23. Gowland _Arch._ LVII(1901)ii,399.

Davies _Roman Mines_ 12.

24. Smythe _Newcomen Soc.Trans._ XX(1940) 142ff.

25. Tylecote _Roman Lead_ 38.

26. Smythe _Newcomen Soc.Trans._ XX(1940) 143ff.

Introduction to the list of pigs

There follows now a list of pigs from Britain,Spain, Sardinia,Gaul and Germany.Where possible these have been arranged in chronological order.

Each entry begins with the details of the pig's discovery and its present location.Most of the information for the 'present locations' of the pigs from Spain has come from Rev.Arch.XII and XIII,which were published in 1920 and 1921.Consequently these locations must be regarded as suspect. In general,the Spanish pigs were semi-cylindrical in shape,and the British pigs were truncated pyramids. Variations from this pattern are noted in the first paragraph of each entry.Likewise doubtful pigs and inscribed fragments of lead are so described here too.

The weight of the pig in kilogrammes is then given.This is followed by its measurements in centimetres,in the order - height,base,face.

The height is the distance between the base and the face. The base is the part of the pig that lay uppermost in the mould when being made,but which,when turned out of the mould lies on the ground.The face,conversely,is the narrowest part of the pig that lay on the ground when being made, but which,when turned out,lies uppermost,and bears the main inscription.The front,the back,the right and the left are the terms used to describe those parts of the pig in relation to the inscription on the face.

Where known, the silver content of the pig follows the dimensions, and this in turn is followed by the name of the mine or area of its origin.

A short bibliography for each pig is then given. This includes references to CIL, ILS, EE, JRS, VCH and to the articles cited by Way, Gowland, Besnier, Webster, and Tylecote, as well as to other important notes.

The text of the inscriptions, their expansion and translation are then given. The inscriptions were either:

moulded - where the lead has been poured into a mould containing a die on which were carved in reverse the inscriptions to appear in relief on the pig,

incuse - letters or numerals stamped onto the cold pig,

impressed - letters, in relief, impressed onto the pig after its removal from the mould,

or

applied - letters cut from strips of lead and applied to the surface of the pig.

The last notes of each entry give the date and additional information.

References in the Index are made to pig numbers, and not page numbers, and are underlined.

CRITICAL SIGNS

(abc)	omitted in the original by abbreviation
[...]	(three) letters missing in the original through damage
[abc]	letters missing through damage, but restorable with certainty
[...	lacuna of unknown length at the end of a line
...]	lacuna of unknown length at the beginning of a line
|	division between lines on the original
ạḅc̣	subscript dots mark doubtful letters, but not defective letters which can be restored with certainty
ABC	capitals, other than initial letters, in the transcript mark a word or passage that cannot be interpreted
abc	italic is used to represent a maker's mark in the inscription and transcript. e.g. *delphinus*

1. Found in 1829 at Savignano, Italy. Now at Rimini, in the Gambalunga collection.

Weight and measurements: unknown.

Mine of origin: (?) Spanish.

<u>CIL</u> XI 6722.13. Besnier Rev.arch.XIII(1921) 109, no.61

Face (moulded) ⇨ C • MESSI • L • F

C(ai) Messi L(uci) f(ili)

'(product) of Gaius Messius, son of Lucius.'

The nomen Messius occurs in Baetica.

Date: the absence of a <u>cognomen</u> suggests that this pig dates from the early 1st Century B.C.

2. Found in the river Tiber, Rome, Italy, and now in the Diocletian Baths Museum, Rome.

Weight: 34.8 kg.   Shape: truncated pyramid

Height: 11 cm. Base: 44 x 9.5 cm. Face: 40 x 4 cm.

Mine of origin: (?) Spanish

<u>CIL</u> XV 7918 Besnier <u>Rev.arch.</u>XIV(1922) 110, no.63

Face (moulded) T POPILLI • N F • GALEN

Side (incuse) APM

T(iti) Popilli N(umeri) f(ili) galen(a)

'the lead (product) of Titus Popillius, son of Numerius.'

' ' (not interpreted)

galena is also mentioned on pigs nos.79 and 81

Date:early 1st Century B.C.

3-32. Thirty examples found in 1846 at Orihuela, Spain. Two are now at the Madrid school of mines, two in the Madrid Academy museum, one is in the Louvre, Paris, and one is in the Bibliothèque Nationale de Paris. One is in the British Museum, London, and one is at Newcastle-upon-Tyne, having formerly been in the Geological Museum, London.

Weights:(Madrid school of mines) 32kg. and 32.5 kg. (Louvre) 34.5 kg.

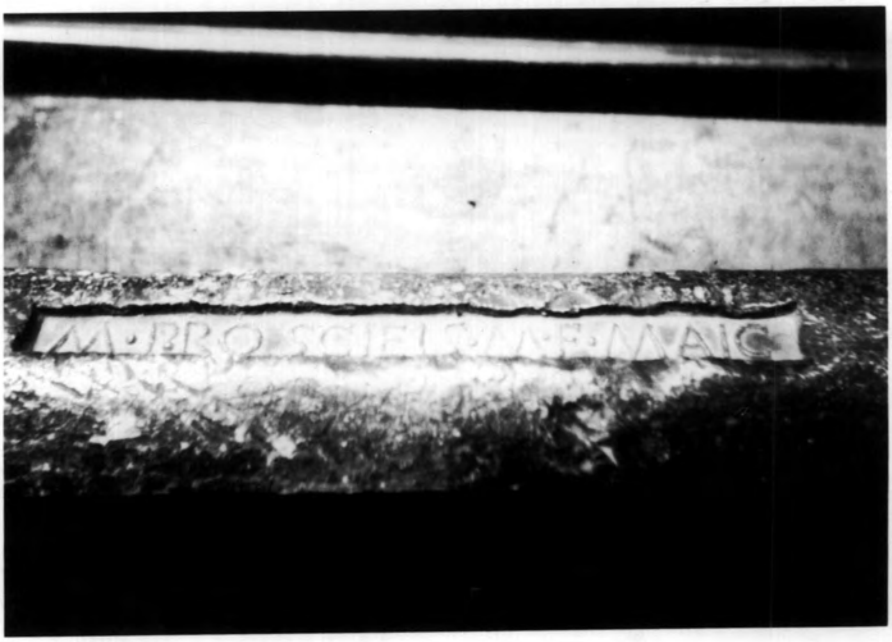
Heights:8cm. with the exception of the Louvre example, which is 9 cm.

Base:23 cm. x 9 cm. The Bibliothèque Nationale example measures 43 x 9 cm. The Louvre example is 45.5 x 10 cm. The Madrid school examples measure 44 x 9 cm. and the Madrid Academy pig is 45 x 10 cm. The pig in the British Museum measures 45 x 11.4 cm.

Silver contents: Bibliothèque Nationale 0.002%, Louvre 0,003%, British Museum 0.003%, Newcastle 0.0029%. The weights and measurements of the other pigs in this group have not been recorded.

Mine of origin: Orihuela

Pig no.3



The British Museum example was examined by H.D.H.E. in 1966.

6247,4

CIL II 3439. ILS 8706. Gowland Arch.LVII(1901) ii 400.
Besnier Rev.Arch.XII(1920) 236 no.14

Face(moulded) M · P . ROSCIEIS · M · F · MAIC

M(arcus et) P(ublius) Roscieis M(arci) f(ilieis) Maic(ia tribu)

'Marcus and Publius Roscius,sons of Marcus,from the Maecian tribe (produced this).'

Date;probably early 1st Century B.C. The abbreviation MAIC for MAEC is the archaic spelling for the Maecian voting tribe,and the archaic Roscieis for Roscii is also Republican.For further examples of the archaic spellings see CIL II 3433 ,hisceis,and Plautus,Rudens Act II Sc.1. 10, hisce hami instead of hice.

The Roscii: Dessau conjectures that mention of this tribe made it likely that the two Roscii came from Lanuvium. P-W s.v. Lanuvium ,says that it is not certain that Lanuvium belonged to the Maecian tribe.cf.CIL XIV 2104

The Maecian tribe is one of the Italian voting-tribes, listed in Kubitschek,Imp.Rom.trib.discr.as follows:

In Italy,reg.I Neapolis,reg.II Bruddisium,reg.III Paestum, reg.V Hadria, reg.IX Liberna. In Macedonia: Palagonia.

33. Found at Carthagena, and now in the Guirao collection, Murcia. Weight and measurements: unknown.

Mine of origin: Carthagena.

EE IX 428,3. Besnier Rev.Arch.XII(1920) 234.no.9

Face(moulded) P • TVRVILI • M • F | MAI delphinus

P(ubli) Turvili M(arci) f(ili) | Mai(cia tribu) delphinus

'(product) of Publius Turvilius, son of Marcus.'

'from the Maecian tribe' 'dolphin'

Date: probably early 1st Century B.C. For the early spelling of Maicia, and for the Maecian tribe, see no.3-32 above. For the nomen Turvilius see nos.61-62.

Hübner (EE IX 428,3) thinks that this pig, and no.62 are identical, but this is obviously incorrect, since no.62 bears a swan in place of the dolphin, and Publius Turvilius has the cognomen Labeo on no.62.

The dolphin also appears on pigs.nos.55-61,71. For a comment on the dolphin see p.131 ff.

34. Found at Carthagena, and now in the Guirao collection, Murcia. Weight and measurements: unknown.

Mine of origin:Carthagena

EE IX 428,2. Besnier Rev.Arch.XII(1920)235,no.11.

Face(moulded) C • PONTICIENVS M • F

G(aius) Ponticienus M(arci) f(ilius)

'Gaius Ponticienus,son of Marcus (produced this)'

Date:probably early 1st.Century B.C. Schulze gives the nomen Pontinienus from CIL IX,but EE is emphatic the Ponticienus is the correct reading,as is borne out by comparison with the following example.

34A.Found at Volubilis.Its weight,measurements and present location are not known.

mine of origin:Carthagena.

Rev.Arch.XXXII(1930)348,no.38.

Face(moulded) C • PONTICIENI M F FAB

G(ai) Ponticieni M(arci) f(ili) Fab(ia tribu)

'(product) of Gaius Ponticienus,son of Marcus,from the Fabian tribe.'

Date:probably early 1st.Century B.C. Carthagena belonged to the Sergia tribus.Gaius Ponticienus must have come from one of the towns assigned to the Fabia Tribus:

Ancyra, Aradus, Aventicum, Brixia, Falerio, Heliopolis Syriae, Heraclea, Luca, Patavium, Rudii, Trebula Mutuescae, Volturnum. (from ILS)

35. Found near Carthagena ,and now at the College of the Four Saints, Carthagena. Weight and height unknown. Base: 38 cm. in lnegth.

Mine of origin: Carthagena district.

EE VIII 254,1. IX p.181 Besnier, Rev. Arch. XII(1920) 236, no.13.

Face (moulded) L • AETILI • FERM | caduceus

L(uci) Aetili Ferm(...) / caduceus

'(product) of Lucius Aetilius, Ferm( )'? 'caduceus'

Date: probably early 1st Century B.C. The nomen Aetilius occurs in CIL VI 11192. The nomen Laetilius occurs at Carthagena, cf. CIL II 3473, 3474, 5959. Ferm. may be the name of the mine, or even the town from which Aetilius came. It occurs also on pigs 66 - 67. It does not appear to be a cognomen, nor is it the name of a voting-tribe. *Fierm.* is an incorrect reading (R.P.W. in private conversation April 1967).

The caduceus appears also on pigs nos.66-67. For comment on this mark see page 131 ff.

36. Found at Carthagena, and now in the Guirao collection, Murcia. Weight and measurements: unknown.

Mine of origin: Carthagena.

EE IX 428,1 Besnier *Rev.Arch.* XII(1920) 235, no.10

Face(moulded) C • VTI • C • F • MENEN

G(ai) Uti G(ai) f(ili) Menen(ia tribu)

"(product) of Gaius Utius, son of Gaius, from the Menenian tribe."

Date: probably early 1st. Century B.C. Carthagena belonged to the Sergia *tribus*. No town outside Italy belonged to the Menenian tribe. This producer and Gnaeus Atellius of no.37 must have come from one of the towns in Italy assigned to this tribe - *reg.* I *Herculaneum, Nuceria, Alfaterna, Pompeii, Praeneste, Stabiae, Surrentum*. *reg.* X *Feltria, Vicetia* (from Kubitschek, *Imp. Rom. trib. discr.*)

37-39. Three examples found in 1912 in a shipwreck off

Mahdia, Tunisia, and now in the museum at Bardo.

weights: 32.18 , c.32 , and c.32 kg.

measurements: unrecorded.

Mine of origin: (?) a mine in Attica or in Spain.

AE 1913 no.147 Merlin Mél.Cagnat 385. Besnier Rev.Arch. XIII(1921) 100 no.55

Face(moulded) CN · ATELLI · T · F · MENÊ

Gn(aei) Atelli T(iti) f(ili) Mene(nia tribu)

'(product) of Gnaeus Atellius, son of Titus, from the Menenian tribe.'

Date: probably early 1st Century B.C. For the Menenian tribe, see no.36

40. Found at Castagneto (Livourne). This is merely a fragment of inscribed lead that may not be part of a pig.

CIL XI 6722,15-16. Besnier Rev.Arch.XIII(1921) 108 no.60

(moulded) C · PLAN

G(ai) Plan[i

'(product) of Gaius Planius.'

Date: it is difficult to date this piece of lead, since only part of the inscription survives. The nomen Planius also occurs on pigs nos.41-60, the last ten of which also bear *cognomina*. The *nomen* Planius occurs in Macedonia cf. *CIL* III, S.1, Fas.I-III 7352

41-50. Ten examples were found in 1873 in Sicily, and are now in the museum at Palerma.

Weight: 33 - 33.5 kg. Measurements: unknown.

Mine of origin: (?) a mine in Attica or Spain

CIL X 8073,3. and p.1002. Besnier *Rev. Arch.* XIII(1921) 108 no.59

Face (moulded) L • PLANI • L • F

L(uci) Plani L(uci) f(ili)

'(product) of Lucius Planius, son of Lucius.'

Date: probably late Republican.

51-52. Two examples found in 1880 at Picenum, Italy, and now in the Ripatransone museum.

weight: 35 kg. Measurements: unknown.

Mine of origin: (?) a mine in Attica or Spain

CIL IX 6091, 8073.3. Besnier *Rev. Arch.* XIII(1921) 108 no. 58

Face (moulded) L • PLANI • L • F | *draco* | RVSSINI

L(uci) Plani L(uci) f(ili) | *draco* | Russini

'(product) of Lucius Planius Russinus, son of Lucius.'
' <u>dragon</u> '

Date: late Republican. The same <u>praenomen</u>, <u>nomen</u> and filiation appear on pigs.nos.41-50, but here the <u>cognomen</u> Russinus is given. This also appears on nos.53-54 where the dragon has been replaced by an anchor, which does not separate the <u>nomen</u> from the <u>cognomen</u> as does the position, in these examples, of the dragon.

53-54. Two examples found in 1912 in the shipwreck off Mahdia, Tunisia, and now in the museum at Bardo.
weight: 32 and 32.73 kg. measurements: unknown.
Mine of origin: (?) a mine in Attica or Spain

Merlin <u>Mél. Cagnat</u> 385. Besnier <u>Rev. Arch.</u> XIII(1921) 101 no.56.

Face(moulded) L • PLANI • L • F • RVSSINI | <u>ancora</u>
L(uci) Plani L(uci) f(ili) Russini | <u>ancora</u>
'(product) of Lucius Planius Russinus, son of Lucius.'
'<u>anchor</u>'

Date: late Republican. For notes, see nos. 51-52 above.

55-60. six examples found in 1912 in the shipwreck off Mahdia, Tunisia, and now in the museum at Bardo.

weights: 33.3, 34.37, 31.38, 32.09, 32.32 kg.

measurements: unknown.

mine of origin: (?) a mine in Attica or Spain.

AE 1913 no.146. Merlin Mél.Cagnat 384. Cagnat Cours épig.lat. plate XXV i. Besnier Rev.Arch.XIII(1921) 102 no.57.

Face(moulded) M · PLANI · L · F | delphinus | RVSSINI

M(arci) Plani L(uci) f(ili) | delphinus | Russini

'(product) of Marcus Planius Russinus, son of Lucius'

'dolphin'

On three examples the two letters SS of Russini are inverted, and on another example, the dolphin is upside down.

Date: late Republican. The dolphin also appears on pigs nos. 33, 61 and 71, besides being on five lead pigs found in the same shipwreck and now also in the museum at Bardo. The details of these are as follows:

Three are in lozenge form, weighing 1.316, 1.357 and 1.383 g.

One is in the form of a truncated cone 17.2 kg. in weight. 11 cm. high, 19 cm. wide at the base, and 10.5 cm. at the top.

One is in semi-cylindrical form, 31.3 kg. in weight, 9 cm. high. 45 cm. long at the base, and 41 cm. long at the top. These five examples have three panels, in the centre one of which is moulded a dolphin, as on these pigs, 55-60, but the outer two panels have been left blank.

61. Origin unknown. Now in the museum at Madrid.
weight: c. 34 kg.
height: 9 cm. base: 44 x 10.5 cm.
mine of origin: (?) a mine in Spain.

Madrid Mus. Cat. no. 308. Besnier Rev. Arch. XII (1920) 232 no. 4

Face (moulded) P TVRVILII ARCON | delphinus
P(ubli) Turvilii Arcon(is) | delphinus
'(product) of Publius Turvilius Arcon' 'dolphin'

Date: early Empire. The cognomen Arcon appears frequently in Lusitania, and it is also possible that the Publius Turvilius on pig no. 33 is of the same family, but this is by no means certain. Schulze has a nomen Turullius, but has no example of a nomen Turvil. It is possible that this inscription is obscure and should read TVRVLLI and not TVRVILI . Holder has no example of the _nomen_, but says that the _nomen_ Turullius occurs in Carthagena, _CIL_ II 3508, Cn. Turullio, and also at Rome, CIL VI 27838 P. Turullius, and 27839 Cn. Turulli. The dolphin also appears on nos. 33, 55-60, 71.

62. Found in the harbour at Carthagena. Weight and measurements and present location unknown.

mine of origin: (?) a mine in the South-East of Spain.

_EE_ VIII 254, 2. Besnier _Rev. Arch._ XII (1920) 234, no. 8.

Face (moulded) P • TVRLLI LABEONI

cycnus

P(ubli) Tur(e)lli Labeoni(s) | _cycnus_

'(product) of Publius Turellius Labeo' '_swan_'

Date: early Empire. _CIL_ II 3103, 3104 inform us that Turellii are known in the region, and it is possible that further examination of the pig would reveal an _E_ ligatured on to the first _L_ to read TVRƎLLI. Holder indexes this name as Turellius.

The swan occurs on this pig alone.

63. Details of origin unknown, but now in the museum at Madrid.

weight: c. 34 kg.

height:7.5 cm. base:45 x 10 cm.

mine of origin:(?) a mine in Spain

CIL II 6247,1. Besnier Rev.Arch.XII(1920) 232 no.3.

Face(moulded) T • AVRVNC •| L|[V]C[A]NI

T(iti) Aurunc(ulei) L[u]c[a]ni (?)

'(product) of Titus Aurunculeius Lucanus (?)'

Besnier reads T • AVRVNC • L C ▨ Λ I

but this is not mentioned in CIL,and it seems likely that the second panel should be linked with the first, as in my text above (R.P.W. TO H.D.H.E. April 1967)

Date:early Empire.

64.A fragment of lead,the origin of which is unknown, but which is now in the museum at Tarraco.

7 cm.long ,and 15 cm.wide.

mine of origin:(?) a mine in Spain.

EE IX 428.4. Paris Bull.Ant.379. TLL ..Tomd fasc.I s.v.Callonius. Besnier Rev.Arch.XII(1920)233 no.5.

(moulded) TCALLONI[Q]VINT

T(iti) Galloni [Q]uint(i)

'(product) of Titus Gallonius Quintus'

Date:early Empire. This fragment of lead seems to be part of a pig, as does no.65, bu the text is difficult, since EE, and subsequently Besnier, give

T • CALLONIOVINT. TLL suggests that Callonius is possible. It seems wise to interpret this as

T.CALLONI QVINT(i)

65. Another fragment of lead, whose origin is unknown, but now with no.64 in the museum at Tarraco. The dimensions are the same as no.64:

7 cm. long x 15 cm. wide.

Mine of origin: ? a mine in Spain.

EE IX 428,5. Paris Bull.Ant.379. Besnier, Rev.Arch. XII(1920) 233, no.6.

(moulded) VIII I

This is a broken portion of a moulded panel resembling closley no.64. This may then be a poor moulding of the same Quint(i) and is less likely to be the numeral '9'. Following this suggestion by R.P.W.(to H.D.H.E. April 1967), I prefer to read:

(moulded) Q]VINT

Q]uint(i)

'(product) of (?) Quintus'

Date:early Empire.

66-67.An unspecified number of pigs were found in the harbour at Carthagena.One of these is now in the museum of the Society of Economics,Carthagena,and another in the museum at Berlin.The pigs all bear the same inscriptions and marks.The details of the Carthagena museum example are as follows:

weight:unknown. height:83 mm. base 50.3 x 4.6 cm.

mine of origin:(?) a mine in the South-East of Spain.

CIL II 6247,3 Besnier Rev.Arch.XII(1920) 234,no.7

Face(moulded) M • RAI • RVFI •| caduceus | FER

M(arci) Rai Rufi | caduceus | Fer(...)

'(product) of Marcus Raius Rufus' 'caduceus' 'Fer(...)'

Date:early Empire.Raius does occur as a nomen elsewhere. The caduceus is found also on pig no.35 which reads L·AETILI FERM . It is not clear whether FER is an abbreviation of another name,or it may indicate the name of the mine.It is not to be taken as an inference that Marcus Raius Rufus came from Firmum,in North Italy. By analogy with no.35,it is probably the name of the mine or the mining area.

68. Origin unknown, but now in the museum of the Society of Economics, Carthagena.

weight: c.34 kg. (Besnier)

height: 8.9 cm. base: 47.4 x 10.3 cm.

mine of origin: a mine near Carthagena.

CIL II 6247,6. EE IX p.181 n. Besnier Rev. Arch. XII(1920) 235, no.12.

Face (moulded) P • NON • AE • T • F • NVC

P(ubli) Non(i) Ae(milia tribu (?)) T(iti) f(ili) Nuc(erini)

'(product) of Publius Nonius Nucerinus, son of Titus, from the Aemilian tribe (?).'

Date: early Empire. In most cases where the tribe is mentioned, it is placed after the groups of names, as in nos.36, and the like; the AE which is taken by Besnier, following A.Engel in EE to be Ae(milia tribu (?)) comes after the nomen in this example, and before the filiation and cognomen. The transcription in CIL should be disregarded. Kubitschek, Imp. Rom. trib. discr., lists the towns belonging to the Aemilian tribe in Italy, reg. I Formiae, Fundi, Suessa, Aurunca. reg. III Copia Thurii, Vibo Valentia. reg. VI Mevania . In Macedonia, Dobiros, Dyrrhachium, Stobi. The Aemilian tribe is also mentioned on no. 79.

69-70. Several pigs and a fragment of a pig were found in 1821 at Canjajar in North-West Almeria, Spain, all of which appear now to be lost. Their weights and measurements are unknown.
Mine of origin: Almeria.
CIL II 4964, 1, 6247, 5, Besnier Rev. Arch. XII(1920) 239, no. 16.

Face (moulded) L • S • REX

L(ucius) S(....) Rex

'Lucius S(....) Rex (produced this)'

Date: early Empire. Hübner, CIL 4964, 1, expands S as S(ergius) which is reasonable, but there are many nomina beginning with the letter S.

71. Found at Castulo, near Linares, and now in the Loring collection, Malaga museum. This pig is of irregular shape, in the form of a wedge.

weight: 11.15 kg.

height: 11 cm. tapering to 5 cm. at the other end.

length: 30 cm. at the base. 26 cm. on the face.

mine of origin: a mine in the Sierra Morena district.

CIL II 3280a., 6247,2. Besnier Rev.Arch.XII(1920) 239, no.18.

Face(moulded) T · IV̂EN̂TI | delphinus gubernaculum | M · LV[

T(iti) Iuventi | delphinus gubernaculum | M(etalli) Lu[...

'(product) of Titus Iuventius' 'dolphin rudder' '(lead) of the Lu[...] mine.'

Date: early Empire. The dolphin appears on nos.33, and 55-61. This is the only known example of the rudder mark, and the only pig which bears two marks, and these of different design. It is this difference which leads me to conjecture that the mark on the pig can not denote the mine of origin, since it is hard to explain why one pig should have two different marks. It is similarly hard to explain why on pigs 51-54 Lucius Planius Russinus, the son of Lucius, should have two different marks, a dragon and an anchor, unless of course he changed his tenure of mine. I prefer to think that the mark was intended to deonte that the pig was to be transported, possibly by water, in view of the links that the marks have with the sea.

The Lu(....) mine is unknown. Besnier rightly rejects the theory that the pig was a British one from the Derbyshire (Lutudaron) mines, on the grounds that Spain, herself a great lead-producing province would hardly import lead from such a distance. The shape and weight do not correspond with other British pigs moreover, nor do the dolphin and rudder appear on British pigs, as does the former on Spanish pigs.

72. Found in the Terrenas mine at Alcaracejos, on the road from Sisapo to Cordoba, in the form of a truncated pyramid.

weight: 56.75 kg.

base: 51.5 x 15 cm. face: 44 x 5 cm.

silver content: 0.031 %.

mine of origin: Alcaracejos

<u>AE</u> 1914 no. 23. Besnier Rev. Arch. XII(1920) 240, no. 19

Face(moulded) C · P · T · T · CAENICORVM

G(ai) P(....) (et) T(iti) T(....) Caenicorum

'(product) of Gaius P(...) and Titus T(...) Caenicus.'

Date: 1st. Century A.D. As with the two Roscii of pigs nos. 3 - 32 ,we have here the two Caenici working as associates,but their <u>nomina</u> are so contracted that they cannot be expanded with any certainty.The <u>cognomen</u> Caenicus also appears in Lusitania. <u>ILS</u> 4506.

72a.Several pigs were found in 1842 in the Cerro de los Castillejos,but without inscriptions.
weights:c.92 kg. other measurements unknown.
<u>CIL</u> II 4964,2 Besnier Rev.Arch.XII(1920) 241.

73.Found in 1910 near Heppen,Westphalia,Germany,and now in the Dörrenberg collection at Soest.The form is a truncated pyramid,of which only a fragment remains.
weight: c.13 kg.
height:11 cm. base:11.5 x 13 cm. face:9.5 x 7.5 cm.
mine of origin:(?) a mine in Spain.

A.Schulten,<u>Bonner Jahrbücher</u> CXXIV (1917) 88 . Besnier <u>Rev.Arch.</u>XIII(1921) 72 ,no.50.

Face(moulded) L • FLA

side(incuse) L • F • VE

L(uci) Fla(vi)

L(ucius) F(...) Ve(...)

'(product) of Lucius Flavius' 'Lucius F(...) Ve(...)'

Date:early Empire. Schulten estimates that the pig would originally have measured 50 cm. and have weighed c.32.5 kg. which would bring it into the Spanish pig category and indicate its origin in that province rather than in Gaul which he favours. Schulten's transcription (Lucius Flavius Vetus) are difficult to uphold since the <u>nomen</u> and the <u>cognomen</u> in the second inscription are so abbreviated.

74-77.Found in 1858 in the harbour at Cherchel,Algeria, and now in the museum at Cherchel.They are truncated pyramids.

weight: 34.5 kg.

height:9 cm. base:47 x 10 cm. face: 43 cm. long.

mine of origin:a mine in Spain.

<u>CIL</u> VIII 10484 . Besnier <u>Rev</u>.<u>Arch</u>.XIII(1921) 99,no.53.

Face(moulded) Q Vari Hiberi

Q(uinti) Vari Hiberi

'(product) of Quintus Varius Hiberus!

Date:early Empire. The weight of the pig and its shape indicate that it came from the Spanish mines.

78.Found in 1881,at Pompeii,Italy,and now in the museum at Naples. It is a truncated pyramid.

Weight: 35 kg.

Height: 10 cm. base: 48 x 11 cm.

mine of origin: a mine in Spain.

<u>CIL</u> X 8339 . Besnier <u>Rev.Arch.</u>XIII(1921) 109, no. 62

Face (moulded) P · AEMILI · GALLICI

P(ubli) Aemili Gallici

'(product) of Publius Aemilius Gallicus.'

Date: early Empire.

79. Found in the river Tiber, Rome, and now in the municipal museum on the Capitol.

weight: 5.3 kg.

height: 2.5 cm. base: 43.5 x 7 cm.

mine of origin: a mine in Spain

<u>CIL</u> XV 7917 . Besnier <u>Rev.Arch.</u>XIII(1921) 111, no. 64

Face (moulded) P · CORNEL L F AIM POLLION FORMAN | GAL

P(ubli) Cornel(i) L(uci) f(ili) Aim(ilia tribu)

Pollion(is) Form(i)an(i) gal(ena)

'lead, (product) of Publius Cornelius Pollio, son of Lucius, a Formian, from the Aemilian tribe.'

Date: early Empire. The Aemilian tribe is also mentioned on pig no.68,where the towns belonging to the Aemilian tribe,which include Formii,are listed. Galena is also mentioned on pigs no.2 and 81.

80.Found in 1653,in two halves,at Basle,Switzerland,and now in the museum at Basle.

weight: 33kg.

height:7.5 cm. base: 52 x 9.5 cm.

mine of origin:(?) a mine in Spain.

<u>CIL</u> XIII 10029,26. <u>ILS</u> 8707 . Gowland <u>Arch</u>.LVII(1901) ii. 380. Besnier <u>Rev</u>.<u>Arch</u>.XIII(1921) 74,no.52.

Face(moulded) SOCIETAT // S · T · LVC · RET

Societat(is) S(exti et) T(iti) Lucret(iorum)

"(product) of the company of Sextus and Titus Lucretius."

Date:early Empire. Here the two Lucretii,working together as the Roscii (3-32) and the Caenici(72) had formed a <u>societas</u> ,the first that we have met.<u>Societates</u> are found on the following pigs from Spain also (81 - 86). The pig,from its shape and weight,would have presumably come from Spain,as Besnier argues.

81.Found in 1887,in the river Tiber at Rome,and now in the Diocletian Baths museum. It is a truncated pyramid.

weight: 34.8 kg.

height: 20 cm. base: 46 x 10 cm. face: 43.5 x 4 cm.

mine of origin: Coto Fortuna, Spain.

CIL XV 7916 ILS 8708 Besnier Rev. Arch. XIII (1921) 111 no. 65.

Face (moulded) SOCIET · ARGENT FOD · MONT · ILVCR | GALENA

right end (incuse) P · DR · N

Societ(atis) argent(ariarum) fod(inarum) mont(is) Iluor(onensis) | galena

P(ublius) Dr(...) N(...)

'lead, (product) of the company of the lead-silver mines of the Ilucronensian range.'

'Publius Dr(...) N(...)'

Date: early Empire. Again, as with pig no180, a societas is recorded, and like nos. 82 - 86, it is the societas which operated the lead-silver works of the Ilucronensian range.

It is not possible to expand Publius Dr(...) N(...) with any certainty, and his significance is doubtful. He may have been an imperial official, like Tiberius Claudius Triferna (?) on pigs from the Mendips in Britain (114-7).

82 - 86. Five identical pigs were found near a cupellation hearth in the mining district of Coto Fortuna, not far from the port of Mazarron. One example is in the Louvre, Paris. It is a truncated pyramid.

weight: 30.8 kg.

height: 8 cm. base: 47 x 10.5 cm. face: 43.5 x 5.5 cm.

silver content: 0.42%

Mine of origin: Coto Fortuna

AE 1907 no.135. Besnier Rev.Arch. XII(1920) 238, no.15

Face (moulded) SOCIET | MONT · ARGENT | ILVCRO

Societ(atis) mont(is) argent(ariarum) Ilucro(nensis)

'(product) of the company of the lead-silver works of the Ilucronensian range.'

Date: 1st Century A.D.

87. Found in 1544, at Wookey Hole, near Wells, Somerset, but now lost. Weight and measurements unknown.

mine of origin: Mendip mines, Somerset.

<u>CIL</u> VII 1201 . <u>EE</u> IX p.642 . Way, <u>AJ</u> XVI(1859) 24. <u>VCH Som</u> i ,340 . Gowland <u>Arch</u>.LVII(1901)ii,402.no.17, Besnier, <u>Rev.Arch</u>.XIII(1921) 40,no.21 . Webster, <u>Flints. Hist.Soc.Publ</u>.XIII(1952-3) 24,no.27. Tylecote, <u>Metallurgy</u> Table 34,no.25.

Face(moulded) TI • CLAVD • CAESAR AVG • P . M • TRIB • P • VIIII • IMP • XVI DE BRITAN

Ti(beri) Claud(i) Caesar(is) Aug(usti) P(ontificis) M(aximi) trib(unicia) p(otestate) VIIII Imp(eratoris) XVI de Britan(nicis argentariis)

'(product) of Tiberius Claudius Caesar Augustus, Pontifex Maximus, in the ninth year of his tribunician power, and sixteen times acclaimed Imperator, from the British lead-silver works.'

Date: A.D.49. This pig is the earliest extant example from Britain, and proof that by A.D.49, to which this pig can be dated, by reason of the Imperial titles of Claudius, the Romans were working the lead mines of the Mendips - just six years after the invasion . When a man was hailed

Imperator, he really held the Empire, and then counted his reign as having started as this point. It is interesting to note that both Leland V(ed.II,1774)45, and Camden (ed.I,1589)105, thought that the 'plate of lead' was a commemorative trophy.

88A,B,C. Three pigs of lead found in 1822 by Farmer Stephens when ploughing in Raynes Batch, Charterhouse on Mendip, Somerset. They were melted down almost immediately. Their measurements were not recorded.

weights: 'one upwards of 200 lb., one less, and one half as much.'
mine of origin: Mendips, Somerset.

Skinner B.M.MSS.Add.33673 f.103,105,117. 33717 f.166.
Webster Flints.Hist.Soc.Publ.(1952-3)26,nos.40,41,42.
Tylecote Metallurgy Table 34,nos.57,58,59.

Face(moulded) said to be DB or OB
DB or OB
'(?)' not interpreted.

Date: ? .The Revd. Skinner unfortunately was slow in visiting farmer Stephens after the latter had reported his finds, and so did not see the pigs, which had been sent to the plumber to be melted down. In Ms.33673, f.105, Skinner says that they were without inscription, but in f.117 he records that the farmer's son mentioned that they bore the letters OB (Skinner has altered his Ms. from DB). He draws the pigs on f.103 as weighing 150,200,100 lb. and puts the letters OB on the 100 lb. pig.

89. Found in 1853, near Blagdon, Somerset, Now in the British Museum.
Weight: 73 kg.

height:9.2 cm. Base:60.9 x 14.6 cm. face:52 x 6.98 cm.

Silver content:0.025%

mine of origin:Mendips,Somerset.

CIL VII 1202 . EE IX p.642 . Way,AJ XVI(1859) 23.

VCH Som.i.341 . Gowland,Arch.LVII(1901)ii,402,no.14 .

Besnier,Rev.Arch.XIII(1921) 40,no.22 . Webster,Flints.

Hist.Soc.Publ.XIII (1952-3) 24,no.28. Tylecote,Metallurgy,

Table 33,no.17.

Examined in 1966 by H.D.H.E.

Face(moulded) BRITANNIC[I] AVG FI

front(incuse) V · ET P ·C

Britannic[i] Aug(usti) fi(li)

V(eranio) et P(ompeio) c(onsulibus)

'(product) of Britannicus,true son of Augustus'

'in the consulship of Veranius and Pompeius.'

Date:A.D.49. Q.Veranius and C.Pompeius were consuls in A.D.49.Haverfield,VCH loc.cit. also dates the pig to this year basing his reckoning on the marriage that year of Claudius to Agrippina,for it was thereafter that Nero,the son,was in the ascendancy.

90.Found in 1783,at Bossington,Stockbridge,Hants,and

Pig no.90

now in the British Museum.

weight:75.3 kg.

height:12.5 cm. base:58.1 x 14.6 cm. face:53.1 x 8.25 cm.

silver content:0.002 %.

mine of origin:Mendips,Somerset.

CIL VII 1203 . EE VII 1120 .Way,AJ XVI(1859) 26.

VCH Hants.i.323 . Gowland,Arch.LVII(1901)ii,402,no.27.

Besnier,Rev.Arch.XIII(1921)44,no.26 .Webster,Flints.

Hist.Soc.Publ.XIII(1952-3)24,no.29 .Tylecote,Metallurgy

Table 33,no.21.

Examined in 1966 by H.D.H.E.

Face(moulded) NERONIS AVG.EX K IAN.IIII COS • BRIT

Front(moulded) [E]X K IVL P • M • COS

Back(incuse) EX ARGENT • C •N[I]PI ASCA[NI] | XXX

Neronis Aug(usti) ex k(alendis) ian(uariis) quartum

co(n)s(ulis plumbum) Brit(annicum)

Ex k(alendis) Iul(iis) p(ontificis) m(aximi),co(n)s(ulis)

Ex argent(ariis) G(ai) N[i]pi Asca[ni] XXX

'(product) of Nero Augustus from the 1st January in his fourth consulship,British (lead)' 'From the first of July Pontifex Maximus,consul.' 'From the lead-silver works of Gaius Nipius Ascanius.' '30'

Date:A.D.60. The Imperial titles of Nero date this pig to A.D.60.He entered his fourth consulship on 1st January, The 1st July in the second line refers to the year 60, and not A.D.59 which Hübner favours. Gaius Nipius Ascanius would appear to have been a mining official in Somerset (see also nos.108,114,116-7).He later appears (no.91) as the lessee of a mine in Flintshire, for the pig bears his name on the face. The significance of the numeral 30, I believe to be the number of librae in excess of a standard weight of 200 librae. 230 librae are the equivalent of 75.3 kg., which corresponds exactly with the present weight of this pig. (see above p.127 ff.)

The weight of the pig is 166 lb. and not 156 lb. as stated by Gowland.

91. Found in 1950, at Carmel, Flints. and now in the National Museum of Wales, Cardiff.

weight: 61 kg.

height: 9.52 cm. base: 59.6 x 13.9 cm. face: 52.3 x 8.25 cm.

silver content: 0.00375%

mine of origin: Flints.

JRS XLI(1951) 142 no.8 . Webster, Flints. Hist. Soc. Publ. XIII(1952-3) 24, no.26. *Tylecote Metallurgy Table 34, no.70.*

Face(moulded) C • NIPI Ↄ ASCANI

G(ai) Nipi Ascani

'(product) of Gaius Nipius Ascanius.'

Date:(?) The Flints.mines were under direct Imperial control in the 1st Century A.D.,and the lessee here is a private individual,who,in A.D.60 was supposedly an Imperial official in the Somerset mines(pig.90). The date of this pig is therefore probably late 1st.Century rather than second Century,as was first favoured (<u>JRS loc.cit.</u>). It also seems likely that leasing was in operation some time before the reign of Hadrian.

Nipius is a rare <u>nomen</u>,as is the <u>cognomen</u> <u>Ascanius</u>. As in the case of Gaius Iulius Protus,a lessee from the Lutudaron mines(nos.150-155) hehad probably been elevated to the status of freedman.

92.Found in 1883,at Saint Valéry sur Somme,Boulogne, France,and now in the museum at Saint Germain en Laye, near Paris.

weight:75 kg.

height:10 cm. base:61 x 17 cm.

mine of origin:Mendips,Somerset.

<u>CIL</u> XIII 3491 . <u>ILS</u> 8709 . Besnier,<u>Rev</u>.<u>Arch</u>.XIII(1921) 67,no.45.

Face(moulded) NERONIS AVG · BRITAN L · II

Neronis Aug(usti)(plumbum) Britan(nicum) L(egio) II

'(product) of Nero Augustus, British (lead): the Second Legion (produced it).'

Date: A.D. 54-68. This pig is one of the few examples which bear a legionary stamp, and signify that at some time during Nero's reign, the mines on the Mendips were under military control. No. 93, from South Wales, also bears the military stamp of the Second Legion (see above p. 138 f.)

93. Fragment of a pig, found in 1947, at Caerwent, and now in the National Museum of Wales, Cardiff.

weight: 16.8 kg.

height: 13.3 cm. base: 11.4 (the rest being cut away) x 13.3 cm. face: 10.1 (the rest being cut away) x 8.9 cm.

mine of origin: South Wales.

JRS XXXVIII (1948) 101. Webster, Flints. Hist. Soc. Publ. XIII (1952-3) 28, no. 57. Tylecote, Metallurgy, Table 34, no. 80.

face (transverse) (~~moulded~~ in) L] EG II AVG

L] eg(ionis) II Aug(ustae)

'(product) of the Second Legion Augusta.'

Date: (?). This is only part of a pig, the main inscription of which has been lost. The Legionary stamp signifies that at some stage, the mines of South Wales were, like the Somerset ones, under military control of the Second Legion AUGUSTA.

94. Found in 1838 at Broughton, near Chester, and now in the Grosvenor Museum, Chester.

weight: 81.2 kg.

height: 10.8 cm. base: 58.1 x 13.9 cm. face: 57.1 x 7.6 cm.

silver content: 0.0026%

mine of origin: Flintshire.

<u>CIL</u> VII 1204 . <u>EE</u> IX p.642-3. Way, <u>AJ</u> XVI(1859) 27. Gowland, <u>Arch.</u> LVII(1901)ii, 402, no.28. Besnier, <u>Rev. Arch.</u> XIII(1921)49. no.28. Webster, <u>Flints. Hist. Soc. Publ.</u> XIII (1952-3)22, no.19. Tylecote, <u>Metallurgy</u>, Table. 34, no. 33

Face(moulded) IMP · VESP · V · T · IMP · III COS

(moulded) DE CEANGI

Imp(eratore) Vesp(asiano) V T(ito) Imp(eratore) III co(n)s(ulibus)

Deceangl(icum plumbum)

'(cast) while the Emperor Vespasian was consul for the fifth time, and Titus Imperator for the third time.'

'Deceanglic (lead)'

Date:A.D.74. 'Deceanglic lead'identifies this pig as a product of Flintshire,which was inhabited by the Deceangli."

95.Found in 1886,at Roodeye,Chester,and now in the Grosvenor Museum,Chester.

weight:87 kg.

height:11.4 cm. base:59.7 x 13.9 cm. face:57.1 x 7.6 cm.

silver content:0.0027%

mine of origin:Flintshire.

<u>EE</u> VII 1121 . <u>ILS</u> 8710 . <u>JRS</u> XII(1922) 283. Gowland, <u>Arch</u>.LVII(1901)ii.402,no.29. Besnier,<u>Rev.Arch</u>.XIII(1921) 50,no.29. Webster,<u>Flints.Hist.Soc.Publ</u>.XIII(1952-3) 22, no.20. Tylecote,<u>Metallurgy</u>,Table 34,no.34.

Face(moulded) IMP • VESP • AVG • V • T • IMP • III

Front(*moulded*) DE CEANGI

Imp(eratore) Vesp(asiano) Aug(usto) V (et) T(ito)

Imp(eratore) III

Deceangl(icum plumbum)

Date:A.D.74. '(cast) while the Emperor Vespasian Augustus (was consul) for the fifth time,and Titus Imperator for the third time.'

'Deceanglic (lead).'

Date:A.D.74.

No.96.Found in 1772,on Hints Common, Staffs. and now in the British Museum.

weight:68.9 kg.

height:10 cm. base:56 x 13 cm. face:

silver content:0.0022%

mine of origin:Flintshire.

CIL VII 1205 . EE IX 1264 .Way,AJ XVI(1859) 28.
Gowland,Arch.LVII(1901)ii,402,no.50.Besnier,Rev.Arch.
XIII(1921)51,no.32a. Webster,Flints.Hist.Soc.Publ.XIII
(1952-3)22,no.21. Tylecote,Metallurgy Table 33,no.22.

Face(moulded) IMP · VESP · VII T· IMP · V COS

Front( ) DECEA G

Imp(eratore) Vesp(asiano) VII (et) T(ito) Imp(eratore)
V co(n)s(ulibus)

Deceanglicum plumbum)

'(cast) while the Emperor Vespasian was consul for the seventh time,and Titus Imperator for the fifth time.'

'Deceanglic(lead).'

Date:A.D.76

97.Found in 1838,at Tamworth,and now in Tamworth Castle museum.

weight:68 kg.

height:10.1 cm. base:57.1 x 14.6 cm. face:52 x 7.6 cm.

mine of origin:Flintshire.

EE IV 1264 . Besnier,Rev.Arch.XIII(1921)52,no.32b.

Webster,Flints.Hist.Soc.Publ.XIII(1952-3)22,no.22.

Tylecote,Metallurgy,

Face(moulded) IMP · VESP · VII T · IMP · V · COS

Imp(eratore) Vesp(asiano) VII (et) T(ito) Imp(eratore)

V co(n)s(ulibus)

'(cast) while the Emperor Vespasian was consul for the seventh time,and Titus Imperator for the fifth time.'

Date:A.D.76.

98-107.Twenty pigs were found in the River Mersey at Runcorn,bearing either this inscription or that recorded for pigs.120-129.All twenty pigs have since been lost.Their weights and measurements were not recorded.

Mine of origin: Flintshire.

Camden,Britannia (1590)470. Webster,Flints.Hist.Soc.Publ. XIII(1952-3)22,no.24. Tylecote,Metallurgy,Table 34,no.35f.

Inscription,transcription and translation as for no.97

Date:A.D.76

Pig no.108, showing the

inscription C • P • Ↄ

108. Found in 1952 at Syde, Gloucestershire, and now in the Corinium museum, Cirencester.

weight: 78.9 kg.

height: 10.1 cm. base: 58.1 x 16.8 cm. face: 52 x 7.6 cm.

mine of origin: Mendips, Somerset.

<u>JRS</u> LIII(1963) 162

Face(moulded) IMP • VESP • AVG • VIIII BRIT • EX AR

Left end(impressed) C•P•Ɔ C•P•Ɔ C•P•Ɔ C•P•Ɔ C•P•Ɔ

front(incuse) SOCNOVE.

Imp(eratore) Vesp(asiano) Aug(usto) VIIII (plumbum)

Brit(annicum) ex ar(gentariis)

G(aius) P(ublius) C(...)

Soc(ietatis) Nov(a)ec( )

'(cast while) the Emperor Vespasian Augustus was consul for the ninth time: British (lead) from the lead-silver works.'

'Gaius Publius C(...) (produced this)'

'(product) of the Novaec. Company.'

Date: A.D. 79. Gaius Publius C(....) was probably an official like Gaius Nipius Ascanius on pig. 90, and Tiberius Claudius Triferna on pigs 114, 116 and 117 - also from Somerset. The Novaec. company is the earliest company of which we have evidence in Britain. Companies had operated lead mines in Spain,cf.pigs nos.80-86. The Novaec. Company operated the lead mines in Somerset, producing also pigs nos.109 and 110.

109.Found together with pig 110 at Clausentum,Bitterne, Southampton,and formerly in private ownership,but now presumably lost.

weight:78.9 kg.(in 1951,when last weighed by R.P.W.)

height:11.4 cm. base:59.7 x 14.6 cm. face:49.6 x 7.7 cm.

silver content:0.0005%

mine of origin:Mendips,Somerset.

Besnier,<u>Rev.Arch.</u>XIV(1922) 119,no.70.Webster,<u>Flints.Hist.Soc.Publ.</u>XIII(1952-3)28,no.55. Tylecote,<u>Metallurgy</u> Table 34,no.64.

Face(moulded) IMP • VESPASIAN • AVG

Front(moulded) BRIT • EX ARG • VEB

(incuse) NOVEC.SOC.NO IIVI

Imp(eratoris) Vespasian(i) Aug(usti)

(plumbum) Brit(annicum) ex arg(entariis) Veb.

Nov(a)ec.Soc(ietatis) No(vaec.) IIVI

'(product) of the Emperor Vespasian Augustus'

'British (lead) from the Veb.lead-silver works.'

'(product) of the Novaec.Company.' '8'

Date:A.D.69-79. The absence of the Imperial titles makes the exact dating of this pig impossible. This pig is again the product of the Novaec. Company, and for the first time we have a pig which is inscribed with the word Veb., which must be the abbreviation for the name of the Mendip mining area. The significance of the numeral IIVI is obscure. If one takes it as '8' being the number of librae in excess of a standard weight of 200 librae, as I have suggested above, p.127ff., then this pig, and no.110 fall short by a long way. For this pig weighs 78.9 kg. or 240 librae. This pig had presumably been brought to Clausentum for export to Gaul.

110. Found with no.109 in 1918, at Clausentum, Bitterne, Southampton. It was formerly in private ownership, but is now presumably lost.

weight: in 1918, this pig was said to weigh 75.3 kg. but no.109, then said to weigh 80.7 kg. was subsequently (1951) found to weigh 78.9 kg. We would therefore be justified in assuming that the weight of this pig would also be discrepant, making it c.73 kg.

height: 10.5 cm. base: 58.1 x 13.9 cm. face: 49.6 x 7.7 cm.

mine of origin: Mendips, Somerset.

Besnier, Rev.Arch.XIV(1922)119,no.70. Webster, Flints. Hist.Soc.Publ.XIII(1952-3) 28,no.56.Tylecote, Metallurgy, Table 34,no.65

Face(moulded) IMP • VESPASIAN • AVG

Front(moulded) BRIT • EX ARG • VEB

Front(incuse) SOCNO.... | SOCNO....

Back(incuse) VIII

Imp(eratoris) Vespasian(i) Aug(usti)

(plumbum) Brit(annicum) ex arg(entariis) Veb.

soc(ietatis) No(vaec....)

VIII

'(product) of the Emperor Vespasian Augustus.

'British (lead) from the Veb.lead-silver works'

'(product) of the Novaec.company.'

'8'

Date:A.D.69-79. The significance of the numeral VIII is again obscure, the pig weighing 223 librae (cf.pig 109).

111.Found in 1876, at Charterhouse on Mendip, Somerset, and now in the City Museum, Bristol.

weight:82.5 kg.

height:12.7 cm. base:60.9 x 15.2 cm. face:50.8 x 8.2 cm.

silver content:0.0021%

mine of origin;Mendips,Somerset.
EE III 121b. VCH Som.i.341 .Besnier,Rev.Arch.XIII(1921)
41,no.23b. Webster,Flints.Hist.Soc.Publ.XIII(1952-3)
24,no.31. Tylecote,Metallurgy Table 34,no.74

Face(moulded) IMP · VESPASIANI · AVG
Imp(eratoris) Vespasiani Aug(usti)
'(product) of the Emperor Vespasian Augustus.'

Date:A.D.69-79.

112.Found in 1874,at Charterhouse on Mendip,Somerset,
but now lost.Its weight was not recorded.
approximately 38 cm.long,9 cm.wide and 5 cm.thick.
mine of origin: Mendips,Somerset
EE III 121c. VCH Som.i.341. Besnier,Rev.Arch.XIII(1921)
41,no.23c. Webster,Flints.Hist.Soc.Publ.XIII(1952-3)
24,no.32. Tylecote,Metallurgy Table 34,no.75.

Face(moulded) IMP · VESPASIA[...
Imp(eratoris) Vespasia[ni Aug(usti)]
'(product) of the Emperor Vespasian Augustus .'

Date:A.D.69-79

113.Found in 1875 at Charterhouse on Mendip,Somerset,and
now at the Priory,Roehampton.

weight:78.1 kg.

height:13.9 cm. base:60 x 15.8 cm. face:50.8 x 8.2 cm.

silver content:trace.

EE III 121a. JRS XXI(1931) 256. VCH.Som.i.341.Gowland, Arch.LVII(1901)ii.402,no.18. Besnier,Rev.Arch.XIII(1921) 41,no.23a. Webster,Flints.Hist.Soc.Publ.XIII(1952-3) 24,no.30.Tylecote,Metallurgy Table 34,no.26.

Face(moulded) IMP • VESPASIAN • AVG

Front(moulded) BRIT • EX ARG • VEB

Imp(eratoris) Vespasian(i) Aug(usti)

(plumbum) Brit(annicum) ex arg(entariis) Veb.

'(product) of the Emperor Vespasian Augustus.'

'British (lead) from the Veb.lead-silver works.'

Date:A.D.69-79

Nos.114 - 117 .Four pigs were discovered in 1956 on Rookery Farm,Green Ore,Somerset (ST 55 576511), approximately five miles east of the Charterhouse mining centre.

mine of origin:Mendips,Somerset.

Som.Dorset NQ XXVII(Dec.1956)110-111.Som.ASP CI-CII (1957)52-88. JRS XLVII(1957) 230 , LII(1962) 195.

114.

weight:84.8 kg.

height:12.7 cm. base:59.7 x 15.2 cm. face:51.4 x 8.9 cm.

silver content:nil.

Som.ASP CI-CII(1956-7)52-88, a. Tylecote,Metallurgy Table 34,no.60.

Face(moulded) IMP • VESPASIAN • AVG

Front(moulded) BRIT • EX [ARG • VEB]

Back(applied) Λ

Left end scored by plough on discovery

Right end(incuse) LXV (incuse and inverted) TI•CL•TRIF

Imp(eratoris) Vespasian(i) Aug(usti)

(plumbum) Brit(annicum) ex [arg(entariis) Veb.]

Λ

LXV Ti(berius) Cl(audius) Trif(erna)

'(product) of the Emperor Vespasian Augustus.'

'British (lead) from the Veb. lead-silver works.'

'(?)'

'65' 'Tiberius Claudius Triferna (produced this).'

Date:A.D.69-79. The applied strip Λ occurs on this pig, and as V on pig no.116.Its significance is unknown,and it does not occur elsewhere. The numeral LXV probably denotes the weight of the pig.Numerals occur also on on nos.115 and 116.Together these read'65'(114),'78' (115) and '68'(116).Their respective weights are 84.8, 89.3 and 84.7 kg.,and in Roman librae,259,273,and 262. Palmer(Sem.ASP loc.cit.)proposed that the stamped numerals represented the weight of the pig in excess of a standard weight of 141 lb.,(70 kg.) or 195 librae. To support his argument he proposed that the <<X on pig.180 (65.3 kg. or 200 librae) should be read not as CCX (210,which would correspond closely with the present weight of the pig),but as IIX, '8' , This re-arrangement however is untenable,and quite unsound epigraphically, as indicated to me by R.P.W.(December,1966). It seems to me that the numerals stamped on these present pigs indicate the weight in librae in excess of a standard weight of 200 librae,and on these examples the inscription CC was intended to be taken as read.The numerals then correspond closely with the present weight of the pigs.

Tiberius Claudius Triferna (R.P.W.,JRS LII(1962) 195. cf.CIL XV 2467) was no doubt an Imperial official,whose stamp had to appear on the finished pig.It is interesting to note that a Tiberius Claudius Tr(...),whose cognomen is abbreviated too greatly to allow a confident translation,was later the lessee of a mine in Derbyshire (pigs nos.144-148).It is attractive to think that Tiberius Claudius Triferna moved from his post as an official in Somerset to being a lessee in Derbyshire, just as Gaius Nipius Ascanius moved from Somerset(90) to Flintshire(91).The names of these lessees, together with Gaius Publius C(...) on pig 108 suggest their promotion to the status of freedmen.

115.

weight:69.35 kg.

height:12.7 cm. base:60.9 x 15.2 cm. face:51.4 x 8.9 cm.

silver content:trace

Som.<u>ASP</u> CI-CII(1956-7)52-88, b. Tylecote, <u>Metallurgy</u> Table 34, no.62.

Face(moulded from same die as 114)

IMP • VESPASIAN • AVG

Front(moulded) BRIT • EX ARG • VEB

Right end(incuse) LXXIIX (incuse and inverted) LRΛD

Imp(eratoris) Vespasian(i) Aug(usti)

(plumbum) Brit(annicum) ex arg(entariis) Veb.

LXXIIX LRΛD

'(product) of the Emperor Vespasian Augustus.'

'British (lead) from the Veb. lead-silver works.'

'78' '(?)'

Date:A.D.69-79. LRΛD has not been interpreted.

116.

weight:85.7 kg.

height:12.7 cm. base:60.9 x 15.2 cm. Face:51.3 x 8.9 cm.

silver content: trace

<u>Som.ASP</u> CI-CII(1956-7) 52-88, c. Tylecote,<u>Metallurgy</u>

Table 34,no.61

Face(moulded) IMP • VESPASIAN • AVG

Back(moulded) BRIT • EX ARG • VEB

(applied) V (overlaying the A of ARG)

(incuse,transversely) TI•CL•TRIF

right end(incuse) TI•C[L]•TRIFER[NA] { ligatures ?

left end(incuse) LXIIX

Imp(eratoris) Vespasian(i) Aug(usti)

(plumbum) Brit(annicum) ex arg(entariis) Veb.

V

Ti(berius) Cl(audius) Trif(erna)

Ti(berius) Cl(audius) Trifer(na)

LXIIX

'(product) of the Emperor Vespasian Augustus'

'British (lead) from the Veb. lead-silver works'

Pig no.117

'(?)'

'Tiberius Claudius Triferna(produced this).'

'68'

Date:A.D.69-79. Two dies were used for stamping the name of Tiberius Claudius Triferna.One,reading TI·CL·TRIF,as on no.114 and on the back of this pig, and of no.117; and the second,reading TI·C[L]·TRIFER(NA) was used on the right end of this pig,and on the left end of no.117.

117.

weight:84.8 kg.

height:12.7 cm. base:60.9 x 15.2 cm. face:50.8 x 8.9 cm.

silver content:0.056%

Som.ASP CI-CII(1957-8) 52-88, d. Tylecote,Metallurgy, Table 34,no.63

Face(moulded) IMP • VESPASIAN • AVG

Front(incuse and inverted) IMP

Back(incuse) TI·CL·TRIF TI·CL·TRIF

left end(incuse and inverted) TI·C[L]·TRIFER(NA) TI·C[L·TRIFER(NA)

Imp(eratoris) Vespasian(i) Aug(usti)

Imp

Ti(berius) Cl(audius) Trif(erna)

Ti(berius) Cl(audius) Trifer(na)

'(product) of the Emperor Vespasian Augustus.'

'Imp'

'Tiberius Claudius Triferna(produced this).' (twice)

Date:A.D.69-79. The stamp IMP is presumably an Imperial checking stamp.The large silver content of this pig compared with that of its neighbours,which contain only a trace or no silver at all,probably indicates that it escaped the cupelling process somehow. It is not likely to have been on the way to the cupelling hearth,since it was found together with three others which had already been cupelled, and it was already made up into an inscribed pig.

The four pigs 114-117 are on permanent loan to Wells museum.

118.Found in 1734,on Heyshaw Moor,Nidderdale,Yorks., and now in Ripley Castle,Yorks.

weight:70.3 kg.

height:10.2 cm. base:59 x 13.9 cm. face:50.8 x 7.7 cm.

mine of origin:Yorkshire.

<u>CIL</u> VII 1207. <u>EE</u> IX p.643. Way,<u>AJ</u> XVI(1859) 29.

Gowland,<u>Arch</u>.LVII(1901)ii,402,no.13. Besnier,<u>Rev.Arch</u>.

XIII(1921)59,no.41. Webster,Flints.Hist.Soc.Publ.XIII (1952-3)28,no.49. Tylecote,Metallurgy Table 33,no.15.

Face(moulded) IMP • CAES • DOMITIANO • AVG • COS • VII

Front(moulded) BRIG

Imp(eratore) Caes(are) Domitiano Aug(usto) co(n)s(ule) VII | (plumbum) Brig(anticum)

'(cast) during the seventh consulship of the Emperor Domitian Augustus.' | 'Brigantic lead.'

Date:A.D.81. The BRIG on the front of the pig identifies it as having come from a mine in Yorkshire,which was inhabited by the Brigantes.

119. Found in 1735 on Heyshaw Moor,Nidderdale,and now in the British Museum.

weight: 69.8 kg.

height: 10 cm. base:58 x 13.3 cm. face:51.4 x 8.9 cm.

silver content: 0.0066%

Mine of origin: Yorkshire.

CIL VII,1207. EE IX p.643. Way,AJ XVI(1859)29. Gowland Arch.LVII(1901)ii,402,no.12. Besnier Rev.Arch.XIII (1921)59,no.41. Webster Flints.Hist.Soc.Publ.XIII(1952-3) 28,no.48. Tylecote Metallurgy,Table 33,no.16

Inscription,expansion and translation as for no.118

Date: A.D.~~118~~ 81

120-129. Twenty pigs were found in the river Mersey, at Runcorn, bearing either this inscription or that recorded for pigs 98-107. All twenty pigs have been lost. Their weights and measurements were not recorded.

mine of origin: Flintshire.

CIL VII, 1206. Camden ed.3(1590)488. Gowland Arch. LVII (1901)ii, 402, no.30-49. Webster, Flints. Hist. Soc. Publ. XIII(1952-3)22, no.23. Besnier Rev. Arch. XIII(1921)50, no.23. Tylecote Metallurgy table 34, nos.35-54.

Face(moulded) IMP • DOMIT • AVG • GER

Front(moulded) DECEANG

Imp(eratoris) Domit(iani) Aug(usti) Ger(manici)

(plumbum) Deceang(licum)

'(product) of the Emperor Domitian Augustus Germanicus.'

'Deceanglic (lead).'

Date: A.D.81

130. Found in 1849, at Common Hall St., Chester, and now in the Grosvenor Museum, Chester.

weight: 76.2 kg.

height: 11.4 cm. base: 58 x 13.9 cm. face: 52 x 8.9 cm.

silver content: 0.002%

mine of origin: Flintshire,

CIL VII, 1212. EE III p.141. Gowland Arch. LVII(1901)ii, 402, no.51. Besnier Rev. Arch. XIII(1921)51, no.31. Webster

Flints.Hist.Soc.Publ.XIII(1952-3)22,no.25. Tylecote, Metallurgy,Table 34,no.55.

Face(moulded) CAESARI[S...] NIVADON

Caesari[s...] NIVADON

'(product) of Caesar (?).'

Date: ? . The transcription and translation of this pig are obscure.

131. Found,cut in half,in 1922 or 1923,at Richborough, and now in Richborough museum.Its weight is not recorded.

height:11.4 cm. base:35.4 cm.(cut) x 15.2 cm.

face:30.4 cm.(cut) x 9.5 cm.

mine of origin: (?)

JRS XI(1921) 239, XII(1922) 283. Webster,Flints.Hist. Soc.Publ.XIII(1952-3)28,no.54.Tylecote,Metallurgy Table 34,no.79.

Face(moulded) IMP • NERVAE CA[...]

Imp(eratoris) Nervae Ca[es(aris)]

'(product) of the Emperor Nerva Caesar.'

Date:A.D.96-98. This is the one example of a pig produced during the reign of Nerva.

132.Found near Grassington,in the West Riding of Yorkshire, but now lost.

weight: c.38 kg. Measurements unrecorded.

mine of origin:Yorkshire.

JRS XXI(1931)264,n.5. Webster *Flints.Hist.Soc.Publ.* XIII(1952-3) 28,no.51.Tylecote,*Metallurgy* Table 34,no.68

The inscription was said to be a Trajanic one.

Date:A.D.98-117.

133. Said to have been found in about 1819 near the road over Claverton Hill from Bathwick,Somerset.Now presumed lost.Its measurements are not known.Weight:68-72 kg. origin:the Mendips,Somerset.

Skinner B.M.Ms.Add.33673 f.105.

Face(moulded) IMP HADRIANVS AVG

Imp(erator) Hadrianus Aug(ustus)

'The Emperor Hadrian Augustus (produced this)'

Date:A.D.117-138. The only reference we have to this pig is in the Skinner manuscript cited.An inscription in the nominative on a pig of lead is not otherwise known during Hadrian's reign,and it is possible that Skinner is referring to pig no.135 which was found in 1822 in Bath.That his descriptions were not always accurate can be shown by referring to pig no.192.Skinner records this pig in B.M. Ms.Add.33686 f.55 as reading PCCCCL,and on f.58 as CCXX.

134.Found at the Hurst mines,Swaledale, Yorks. but since lost.

weight:c.77 kg. measurements:unrecorded.

mine of origin:Yorkshire.

Webster,Flints.Hist.Soc.Publ.XIII(1952-3)28,no.50.

Tylecote,Metallurgy Table 34,no.56

The inscription was said to be a Hadrianic one.

Date:A.D.117 - 138.

135.Found in 1822 at Sidney Place,Bath,Somerset,and now in the Roman Baths Museum,Bath.

weight:88kg.

height:11.4 cm. base:59.6 x 15.2 cm. face:52 x 8.2 cm.

silver content:0.002%

mine of origin:Mendips,Somerset.

CIL VII 1209d. EE IX p.643. Way,AJ XVI(1859)32.

VCH Som.i.342.Gowland,Arch.LVII(1901)ii.402,no.21

Besnier,Rev.Arch.XIII(1921)48,no.27d. Tylecote,

Metallurgy Table 34,no.29. Webster Flints. Hist. Soc. Publ. XIII(1952-3) 28, no.52.

Face(moulded) IMP • HADRIANI • AVG

Imp(eratoris) Hadriani Aug(usti)

'(product) of the Emperor Hadrian Augustus.'

Date:A.D.117 - 138.

Pig no.137

136. This pig is really the same as no.137, but since the details of its discovery and its weight were different, it was accepted as a different pig by Way, AJ XXIII(1866) 279.n.5. and by others. The pig was said by Bagshaw, History of Shropshire 678, to have been found at Minsterley, Salop, eight miles North of the spot where 137 was discovered. Its weight was said to be 173 lb. instead of the 193 lb. of no.137. It was said to be twenty inches in length, and twenty in girth. Haverfield, VCH Salop i.265, suspected the error, and this was followed by others. (R.P.W. to H.D.H.E. April, 1967)
CIL VII 1209f. EE IX p.643. Gowland, Arch. LVII(1901)ii, 402, no.26. Besnier, Rev. Arch. XIII(1921)47, no.27b. JRS XXI(1931) 264. Webster, Flints. Hist. Soc. Publ. XIII(1952-3)26, no.47. Tylecote, Metallurgy Table 34, no.32

137. Found in 1795 on Snailbeach Farm, Minsterley, Salop, and now in the British Museum.
weight: 86.6 kg.
height: 11.4 cm. base: 55.9 x 17.7 cm. face: 49.6 x 8.9 cm.
silver content: 0.007%
mine of origin: Shropshire.
CIL VII 1209c. EE IX. p.643. Way, AJ XVI(1859) 32. JRS XXI (1931)264. VCH Salop. i. 265. Gowland, Arch. LVII(1901)ii.

402,no.22. Besnier,<u>Rev.Arch</u>.XIII(1921)48,no.27c.

Webster,<u>Flints.Hist.Soc.Publ</u>.XIII(1952-3)26,no.45.

Tylecote,<u>Metallurgy</u> Table 33,no.20.

Face(moulded) IMP HADRIANI AVG

Back(moulded) <u>palm branch</u>

right end(incuse) NSI

Imp(eratoris) Hadriani Aug(usti)

<u>palm branch</u>

NSI

'(product) of the Emperor Hadrian Augustus.'

<u>palm branch</u>

'(?)' stamp of an official not interpreted.

Date:A.D.117-138. The significance of the palm branch is not known.It occurs also on nos.138 and 139,and 166. It was moulded on the pig and was not subsequently added. It is possible that this was the mark of a mint official Whittick,<u>JRS</u> XXI(1931)262. The palm branch cannot be a mark to denote the mine of origin,since no.166,on which it also occurs was found at Charterhouse on Mendip. NSI must be the stamp of an official,which it is not possible to interpret.

138.Found in 1767,near Aston farm-house in Aston parish, Montgomeryshire, three miles North-West of Bishop's Castle, Shropshire. Once on loan to Birmingham Geological Museum, but now in the possession of Mr. Jasper, Linley Hall, Lydham, Salop.

weight: 86.7 kg.

height: 10.7 cm. base: 55.2 x 17.7 cm. face: 48.9 x 8.9 cm.

mine of origin: Salop

CIL VII 1209a. EE IX p.643. Way, AJ XVI(1859) 32. JRS XXI(1931) 263. VCH Salop. i. 265. Gowland, Arch. LVII(1901) ii 402, no. 23-4. Besnier, Rev. Arch. XIII(1921) 47, no. 27a, b. Webster, Flints. Hist. Soc. Publ. XIII(1952-3) 26, no. 43.-44. Tylecote, Metallurgy Table 34, no. 30.

Face(moulded) IMP • HADRIANI • AVG

lower rim of face(incuse) MINB MINB

front(moulded) palm branch ; (incuse) hammer-mark

back(moulded) palm branch

Imp(eratoris) Hadriani Aug(usti)

Minb Minb

palm branch ; hammer mark

palm branch

'(product) of the Emperor Hadrian Augustus.'

'(?)' stamp of an official - not interpreted.

Date: A.D. 117 - 138. The MINB stamp is minute, and led one observer to read LEG XX . This has been rightly rejected by Whittick(<u>Shropshire AST</u> XLVI(1931-2)134.). The true significance of the stamp remains obscure. The hammer-mark seems to have been made by the blow of a reticulated hammer,but again its significance is obscure. It was presumably the stamp of an official.

139. Found in 1851,near an earthwork called 'The Roveries', Snead,two miles North of Bishop's Castle,Salop.Now in the City Museum,Liverpool.

weight:86.2 kg.

height:11.4 cm. base:55.2 x 17.7 cm. face:48.9 x 8.9 cm.

mine of origin:Salop.

<u>CIL</u> VII 1209e <u>EE</u> IX p.643 .Way,<u>AJ</u> XVI(1859)34.

<u>JRS</u> XXI(1931)264. <u>VCH</u> <u>Salop</u>.i.265.Gowland,<u>Arch</u>.LVII (1901)ii.402.no.25. Besnier,<u>Rev.Arch</u>.XIII(1921)48,no.27e. Webster,<u>Flints.Hist.Soc.Publ</u>.XIII(1952-3)26,no.46. Tylecote,<u>Metallurgy</u> Table 34,no.31.

Face(moulded) IMP · HADRIANI · AVG

Back(moulded) <u>palm branch</u>

Imp(eratoris) Hadriani Aug(usti)

<u>palm branch</u>

'(product) of the Emperor Hadrian Augustus.'

'(?)' official mark not interpreted.

Date:A.D.117 - 138.

140.Found at Cheshunt,Hertfordshire,and now in the British Museum.

weight:84.6 kg. height:13 cm.

base:59 x 17 cm. face:52 x 8 cm.

mine of origin:(?) Derbyshire.

EE IX.1264a. Besnier,Rev.Arch.XIII(1921)56,no.40.

Webster,Flints.Hist.Soc.Publ.XIII(1952-3)28,no.53.

Tylecote,Metallurgy Table 34,no.67.

Face(moulded) IMP • CAES • HADRIANI • AVG

Imp(eratoris) Caes(aris) Hadriani Aug(usti)

'(product) of the Emperor Hadrian Augustus.'

Date:A.D.117-138.

141.Found in 1777 on Cromford Moor,Wirksworth,near Matlock,Derbyshire,and now in the British Museum.

weight:57.6 kg.

height:9.5 cm. base:56.5 x 13.7 cm. face:48.2 x 8 cm.

mine of origin:Derbyshire.

silver content:0.006%

Pig no.141

CIL VII 1208. EE III p.141. IX p.643. ILS 8711a.
Way,AJ XVI(1859)31. VCH DERBS.i.230. Gowland,Arch.LVII (1901)ii.402,no.1. Besnier,Rev.Arch.XIII(1921)54,no.36. Webster,Flints.Hist.Soc.Publ.XIII(1952-3)20,no.14. Tylecote,Metallurgy Table 33,no.14.

Face(moulded) IMP • CAES • HADRIANI • AVG • MET • LVT

Imp(eratoris) Caes(aris) Hadriani Aug(usti) met(alli) Lut(udarensis)

'(product) of the Emperor Caesar Hadrian Augustus,from the Lutudaron mine.'

Date:A.D.117-138. This is the earliest pig bearing the name Lutudaron,the Roman place-name for the Derbyshire area.This pig is one of the few from Derbyshire which bears an Imperial inscription.The majority carry the name of lessees on the face.This pig shows that for some time during Hadrian's reign,the Derbyshire mines were under Imperial control.

142.Found in 1894,on Tansley Moor,Matlock,Derbyshire,and now in the British Museum.

weight:79.3 kg.

height:10.5 cm. base:55.7 x 11 cm. face:49.2 x 8.7 cm.

silver content:0.0025%

mine of origin:Derbyshire.

EE IX 1266. ILS 8711e. VCH Derbs.i.232. Gowland, Arch. LVII(1901)ii.402,no.3. Besnier, Rev.Arch.XIII(1921)53, no.33.Webster, Flints.Hist.Soc.Publ.XIII(1952-3)20,no.1. Tylecote, Metallurgy no.12.

Face(moulded) P • RVBRI • ABASCANTI METALLI LVTVDARES

P(ubli) Rubri Abascanti metalli Lutudare(n)s(is)

'(product) of Publius Rubrius Abascantus, from the Lutudaron mine.'

Date:(?)2nd Century A.D. Publius Rubrius Abascantus was the lessee of theDerbyshire mine from which this pig came.The majority of the Derbyshire pigs bear the names of lessees.Little is known of them, but their names suggest that they had been promoted to the status of freedmen. The nomen Rubrius is unknown elsewhere in Britain, but is found in Spain.The cognomen Abascantus has been suggested as the expansion of C.VALAB, G(aius) Val(erius) Ab(ascantus) for CIL 1336 (1145), a patella from Camulodunum, by C.R.Smith, collect.ant.2.(1852)40. This cognomen is also found in Spain.

143.Found before 1783, at Matlock Bank, Derbyshire, and now in the British Museum.

weight:37.6 kg.

height:7 cm. base:51.5 x 11.7 cm. face:47.7 x 8.7 cm.

silver content:0.0039%

mine of origin:Derbyshire.

CIL VII 1214. ILS 8711b. Gowland,Arch.LVII(1901)ii.402, no.2. Besnier,Rev.Arch.XIII(1921)54,no.34. Webster,Flints. Hist.Soc.Publ.XIII(1952-3)20,no.2. Tylecote,Metallurgy Table 33,no.13.

Face(moulded) L · ARVCONI · VERECVNDI · METAL · LVTVD

L(uci) Aruconi Verecundi metal(li) Lutud(arensis)

'(product) of Lucius Aruconus Verecundus,from the Lutudaron mine.'

Date:second Century A.D. The nomen Aruconus is not found elsewhere in Britain.The cognomen is found thrice in Britain,once being on the tombstone of a centurion found at Colchester,CIL VII 90. RIB i.200.

144.Found in 1777,at Matlock,Derbyshire,but since lost.

weight:78.5 kg.

height:11.7 cm. base:50 x 16 cm. face:42.7 x 7.5 cm.

mine of origin:Derbyshire.

CIL VII 1215a. Way,AJ XVI(1859)25. Gowland,Arch.LVII

(1901)ii.402,no.10. Besnier, Rev. Arch. XIII(1921)54,no.35a.
Webster, Flints. Hist. Soc. Publ. XIII (1952-3)20,no.3.
Tylecote, Metallurgy Table 33,no.23.

Face(moulded) TI·CL · TR · LVT · BR · EX ARG

Ti(beri) Cl(audi) Tr(ophimi) Lut(udarense plumbum)
Tr(ifernae)
Br(itannicum) ex arg(entariis).

'(product) of Tiberius Claudius Trophimus(or Triferna) British lead, from the Lutudaron (mine), from the lead-silver works.'

Date: late 1st Century, or early 2nd Century A.D.) It is attractive to think that the Tiberius Claudius Tr(...) on this and on the next four pigs is the Triferna from Somerset, pigs.nos.114,116,117, who, having been an official in Somerset, has moved to Derbyshire as lessee. However, the abbreviation of the cognomen to TR makes the positive identification impossible. The cognomen Trophimus occurs on an amphora from London (CIL VII 1331,115).

145-148. Four pigs were found in 1824 at Pulborough, Sussex. One is in the British Museum, two are lost and one, formerly at Parham Hall, Pulborough, is now apparently lost.

The details of the British Museum example are:

weight:82.9 kg.

height:12 cm. base:58 x 15 cm. face:44.4 x 7.6 cm.

silver content:0.0034%
Mine of origin: Derbyshire.
CIL VII 1215b. ILS 8711c. Way, AJ XVI(1859)26.

Gowland, Arch. LVII(1901)ii.402, no.6-9. Besnier, Rev. Arch.

XIII(1921)57, no.35b. Webster, Flints. Hist. Soc. Publ. XIII

(1952-3)20, nos.4-7. Tylecote, Metallurgy Table 33, nos.8-11.

Face(moulded) INSCRIPTION, transcription and Translation

as for no.144.

Date: late 1st Century, or early 2nd Century A.D.

149. Found in the river Tiber, at Rome, and now in the

Diocletian Baths Museum.

weight:83.8 kg.

height:10.5 cm. base:60 x 15 cm. face:51 x 8 cm.

mine of origin:(?)Derbyshire

CIL XV 7919 . Besnier, Rev. Arch. XIV(1922)113, no.67.

(incuse) [T · IVLI]

TR[

T(iti) Iuli Tr[....

Date:?. Positive identification of this pig as a

Derbyshire one is not yet possible. Tiberius Claudius

Triferna, on pigs from Green Ore, nos. 114-117, and Tiberius Claudius Tr(....) on pigs 144-148 cannot be identical with this man. We cannot know how to expand the Tr. here.

150. Found in 1848, at Hexgrave Park, Nottinghamshire, and now in the British Museum.

weight: 82.6 kg.

height: 12 cm. base: 57.7 x 13.9 cm. face: 50.2 x 9.5 cm.

silver content: 0.0082%

mine of origin: Derbyshire

CIL VII 1216. EE IX 1265. ILS 8711d. Way, AJ XVI(1859) 36. Gowland, Arch. LVII(1901) ii. 402, no. 4. Besnier, Rev. Arch. XIII(1921) 55, no. 38a. Webster, Flints. Hist. Soc. Publ. XIII (1952-3) 20, no. 8. Tylecote, Metallurgy Table 33, no. 1.

Face (moulded) C • IVL • PROTI • BRIT • LVT • EX ARG

C(ai) Iul(i) Proti (plumbum) Brit(annicum) Lut(udarense) ex arg(entariis)

'(product) of Gaius Iulius Protus, British lead from the Lutudaron mine, from the lead-silver works.'

Date: (?) 2nd Century A.D. The cognomen Protus is not known elsewhere in Britain.

151. Found in 1890 with no. 152 at South Cave, Brough-on- 7

Humber, Yorkshire, and now in the museum at Hull.

weight: 60.2 kg.

height: 11.4 cm. base: 55.5 x 13.3 cm. face: 50.2 x 9.5 cm.

silver content: 0.0082%

mine of origin: Derbyshire

Gowland Arch. LVII (1901) ii, 402, no. 5.

EE IX 1265. Besnier, Rev. Arch. XIII (1921) 55, no. 38b. Webster, Flints. Hist. Soc. Publ. XIII (1952-3) 20, no. 9. Tylecote, Metallurgy Table 33, no. 2.

Inscription, Transcription and Translation as for no. 150

Date: ? 2nd Century A.D.

152. A lead plate, 17.7 x 8.8 cm., presumably the face of a pig was found in 1890 at South Cave, Brough-on-Humber, Yorkshire, but is now lost. ?

mine of origin: Derbyshire

CIL VII 1217. Besnier, Rev. Arch. XIII (1921) 56, no. 39

Face (moulded) [C · IVL · PROTI] | BR[IT · LVT] EX ARG ??

Expansion and translation as for no. 150

Date: ? 2nd Century A.D.

153-156. Four pigs of lead, together with the rough casting no. 158, were found in 1940, at Brough-on-Humber, Yorkshire.

They are now in the museum at Hull.

mine of origin:Derbyshire.

JRS XXXI(1941) 146.

153.

weight:86.2 kg.

height:13 cm. base:59 x 14.3 cm. face:50.1 x 9.5 cm.

silver content:0.0104%

Webster,Flints.Hist.Soc.Publ.XIII(1952-3)20,no.10.

Tylecote,Metallurgy Table 33,no.3.

Inscription,expansion and translation as for no.150

Date:? 2nd Century A.D. On the base of this pig there are adhering two lumps of galena,approximately 2.5 x 1.5 cm. and 2.5 x 2.5 cm. There is also one lump of galena adhering to the base of pig.155. It was these lumps of galena which lead Smythe (Newcomen Soc.Trans. XX (1939-40)139ff.)to conclude that the inscription EX ARG on lead pigs could not mean that the pigs had been de-silverised.For,as he points out,no galena could survive the cupellation temperature of at least 900 degrees Centigrade,whereas it could survive the smelting temperature of 327 degrees.

154.

weight:86.9 kg.

height:13 cm. base:59 x 14.3 cm. face:50.1 x 9.5 cm.

silver content:0.0066%

Webster, <u>Flints.Hist.Soc.Publ</u>.XIII(1952-3)20,no.11.

Tylecote, <u>Metallurgy</u> Table 33,no.4.

Inscription, expansion and translation as for no.150.

Date:? 2nd Century A.D.

155.

weight:89.2 kg.

height:13 cm. base:59 x 14.3 cm. face:50.1 x 9.5 cm.

silver content:0.0056%

Webster, <u>Flints.Hist.Soc.Publ</u>.XIII(1952-3)20,no.12.

Tylecote, <u>Metallurgy</u> Table 33,no.5.

Inscription, expansion and translation as for no.150

Date:? 2nd Century A.D. There is a lump of galena adhering to the base of this pig, approximately 3.8 cm. in diameter. (see note on pig 153).

156.

weight:87.8 kg.

height:12.3 cm. base:59 x 13.9 cm. face:50.1 x 8.8 cm.
silver content:0.0068%
mine of origin:Derbyshire
Webster,Flints.Hist.Soc.Publ.XIII(1952-3)20,no.13.
Tylecote,Metallurgy Table 33,no.6.

Face(moulded) SOC • LVT • BRIT • EX ARG
Soc(iorum) Lut(udarensium)(plumbum) Brit(annicum)
ex arg(entariis)
'(product) of the Lutudarensian partners,British lead from the lead-silver works.'

Date:? 2nd Century A.D. This is the first product from a Derbyshire mine of a mining company.

157.Found in 1957 at Ellerker,in the East Riding of Yorkshire,and now in the museum at Hull.
weight:79.2 kg.
height:11.4 cm. base:58.4 x 13.9 cm. face:50.8 x 8.9 cm.
mine of origin:Derbyshire.
JRS XLVIII(1958)152. Tylecote,Metallurgy Table 34,no.69.
Inscription,expansion and translation as for no.156.
Date:? 2nd Century A.D.

158.A rough casting was found in 1940 at Brough-on-Humber, Yorkshire, together with the four pigs 153-156.

weight: 36.6 kg.

silver content: 0.0068%.

mine of origin: Derbyshire.

JRS XXXI(1941)146. Tylecote, Metallurgy Table 33, no.7.

No inscription.

It is possible that this was lead which had been run off into a bed of sand.

159.Found in 1910, at Belby, Yorkshire, but sold for scrap.

weight: (?) 51 kg. measurements: unknown.

mine of origin: Derbyshire.

Webster Flints. Hist. Soc. Publ. XIII (1952-3) no. 18.

JRS XXXI(1941)146. Tylecote, Metallurgy Table 34, no.72.

Face(moulded) SOCIORLFBR EX ARG

Socior(um) L[ut(udarensium] plumbum) Br(itannicum) ex arg(entariis)

'(product) of the Lutudarensian partners, British(lead) from the lead-silver works.'

Date: ? 2nd Century A.D.

ADDENDUM

159B. Found in 1967 on a Roman site, North-East of Weighton Lock, Broomfleet, in the East Riding of Yorkshire, on the North bank of the Humber, four miles West of Brough.

weight: 79.4 kg.

height: 11.4 cm. Base: 60 x 16.5 cm. face: 22.1 x 8.4 cm.

mine of origin: Derbyshire

R.P.W. to H.D.H.E. 26.2.1968

Face (moulded) SOCIOR LVT BR • EX ARG

Socior(um) Lut(udarensium plumbum) Br(itannicum)

ex arg(entariis)

*(product) of the Lutudarensian partners, British (lead) from the lead silver works.

Date: ? second Century A.D. R.P.W. states that this tallies with my 159a in lay-out and letter-heights, and in four flaws in the mould. It clearly came from the same mould, but has suffered much more wear.

The details of this pig reached me a few days before the thesis was sent to the binders. Consequently the full details are not included in tables or indexes.

159a. Found in 1966, in a garden at Churchover, Caves Inn (Tripontium) Warwicks, and now stored by Dr. J. A. Reynolds at the Associated Engineering Ltd., Group Research Centre, Cawston, Rugby.

weight: 78.2 kg.

height: 12.1 cm. base: 58 x 16.1 cm. face: 44.4 x 7.6 cm.

mine of origin: Derbyshire.

JRS LVII(1967)206.

Face(moulded) SOCIOR · LVT · BR · EX ARG

Socior(um) Lut(udarensium plumbum) Br(itannicum) ex arg(entariis)

'(product) of the Lutudarensian partners, British (lead) from the lead-silver works.'

Date: ? 2nd Century A.D.

160. Found in 1860 at San Nicolo in Sardinia, and now in the museum at Cagliari. In the form of a truncated pyramid.

weight: 34 kg.

height: 7 cm. base: 37 x 15.5 cm. face: 34 x 10 cm.

mine of origin: Sardinia

CIL X 8073,2. Besnier, Rev. Arch. XII(1920)222, no. 1

Face(moulded) IMP CAES HADR AVG

Imp(eratoris) Caes(aris) Hadr(iani) Aug(usti)

'(product) of the Emperor Hadrian Augustus.'

Date:A.D.117-138. This pig is the earliest and one of the few examples of lead mining activity in Sardinia.

161.Found in 1870 at San Nicolo,Sardinia,and now in Berlin museum.It is a truncated pyramid.

weight:35.6 kg.

height:9 cm. base:42 x 11 cm.

silver content:0.004%

mine of origin:Sardinia

CIL X 8073,1. and p.1002. Besnier,Rev.Arch.XII(1920) 222,no.2.

Face(moulded) CAESARIS • AVG

front(incuse) CVII

Caesaris Aug(usti)

CVII

'(product) of Caesar Augustus.'

'107'

Date:? The numerals 107 correspond almost exactly with the present weight of the pig in librae - 108.It would appear that pigs in Sardinia,like Spain,were cast in moulds to produce specimens of 100 librae.

162. A piece of lead which may be from a pig of lead , found in Italy.

mine of origin:? Spain.

CIL II 6247,8. Besnier, Rev. Arch. XII(1920)241, no.20

IMP

Imp(eratoris)

'(product) of the Emperor.'

Date:? 1st or 2nd Century A.D.

163. Found in Rome, but now lost with no record of its weight and measurements.

mine of origin: Sardinia.

CIL XV 7914. Besnier, Rev. Arch. XIII(1921)113, no.66

Face(moulded) CAESARIS AVG

front(incuse) CCCCXXI XCVIII

Caesaris Aug(usti)

CCCCXXXI XCVIII

'(product) of Caesar Augustus.'

'431' '98'

Date:? The significance of the numeral 431 is unknown. 98 is presumably the weight of the pig in librae.

164.Found in 1885 at Worms, Germany, and now in the museum at Worms.

weight: 61.5 kg. length: 50 cm.

mine of origin: ? probably a mine in Gaul or Germany.

CIL XIII 10029,25. Besnier Rev.Arch.XIII(1921)73,no.51.

side(): DDD NNN | CLXXI | PCLXXV

D(ominorum) n(ostrorum trium) | CLXX[V] | P CLXXV

'(product) of our three Emperors.'

'175' 'by weight 175 librae.'

Date: A.D.198 - 211. 175 is presumably the weight of the pig, its present weight being 188 librae. There were three Emperors from 198 - 211, from 283 - 284, and from 337 - 340. We have evidence of Severan pigs(nos.173-175) and it seems likely that this inscription refers to Severus, Caracalla and Geta.

165.FALSUM. Said to have been discovered before 1802, at Castleton, Derbyshire.

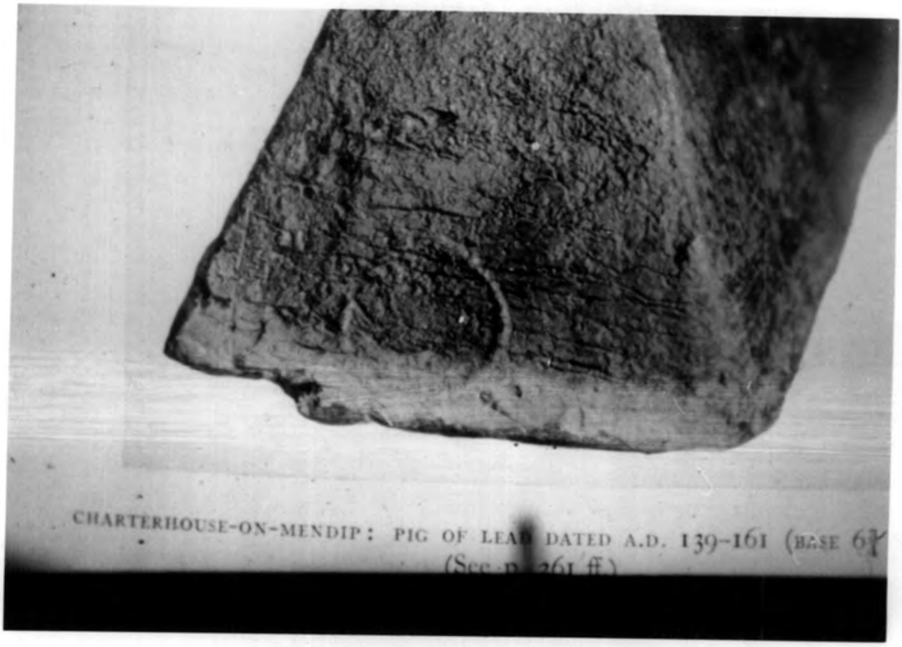
CIL VII 1213. EE IX p.642. Way AJ XVI(1859)36. VCH Derbys. i.232. Gowland Arch.LVII(1901)ii,402,no.11. Besnier Rev. Arch.XIII(1921)55,no.37. Webster Flints.Hist.Soc.Publ. XIII(1952-3)20,no.15. Tylecote Metallurgy Table 34,no.24.

IMP

Imp(eratoris)

'(product) of the Emperor'

J.Mawe, Mineralogy of Derbyshire (1807)6, claimed that 'a bar of lead' had been found in Derbyshire, 'marked with the name of one of the Emperors'. This was stated to be

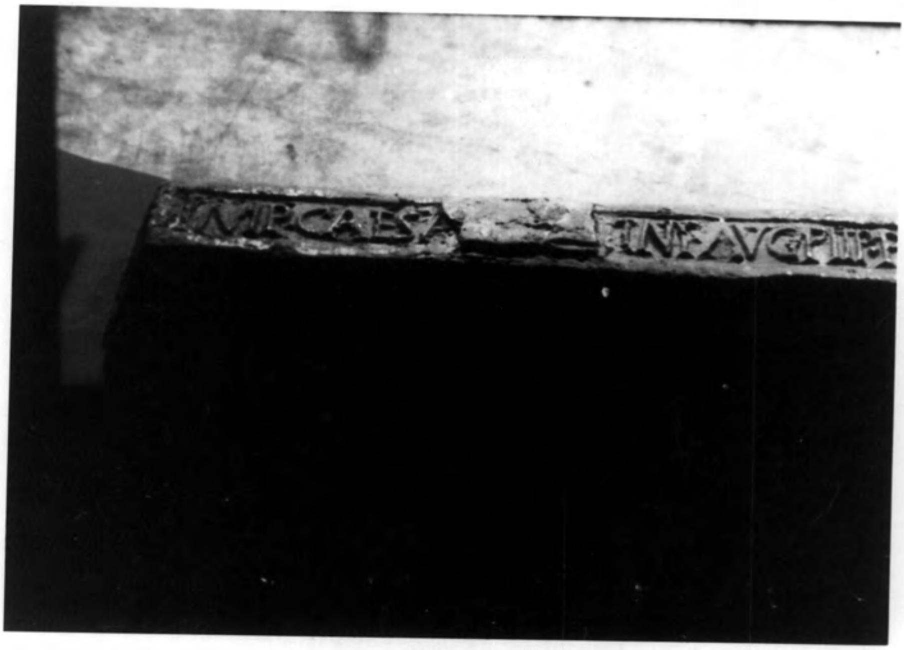


Pig no.166

in the museum of a Mr.Greene,At Lichfield. Phillips, Yorks.Phil.Soc.Proc.I(1849) 89 said that a pig had been found at Castleton,on which only the letters IMP could be read distinctly. Haverfield VCH,loc.cit. rejects the pig,and there is good reason to support this.

166.Found in 1873,at Charterhouse on Mendip,Somerset,and now at the Priory ,Roehampton.
weight:101.6 kg.
height:12.3 cm. base:59.7 x 17.1 cm. face:49.5 x 7 cm.
silver content:0.0029%
mine of origin:Mendips,Somerset.
EE III 121d. JRS XXI(1931)259. VCH Som.i.342. Gowland, Arch.LVII(1901)ii.402,no.19. Besnier,Rev.Arch.XIII(1921) 42,no.24a. Webster,Flints.Hist.Soc.Publ.XIII(1952-3) 24,no.33. Tylecote,Metallurgy Table 34,no.27.

Face(moulded) IMP • CAES • ANTONINI • AVG • P[II] P • P
right end(moulded) a circle
left end(moulded) a palm branch ; (incuse) a hammer-mark
Imp(eratoris) Caes(aris) Antonini Aug(usti) P[ii] P(atris) P(atriae)
circle
palm branch ; hammer-mark



Pig no.167

219 a

'(product) of the Emperor Caesar Antoninus Augustus Pius _pater patriae_.'

'(?)' official marks not interpreted.

Date:138 - 161. Official marks appear also on nos. 137-139 _q.v._ This pig is the heaviest pig recorded of truncated pyramid shape.

167.Found in 1865,in the river Frome,at Bristol,and now at the City Museum,Bristol.

weight:40.4 kg.

height:7.6 tapering to 6.3 cm.

base:54.6 x 13.9 cm. face:48.3 x 6.9 cm.

silver content:0.002%

mine of origin:Mendips,Somerset.

CIL VII 1210b. _VCH_ _Som_.i.342. Gowland,_Arch_.LVII(1901)ii. 402,no.16. Besnier,_Rev_._Arch_.XIII(1921)42,no.24b. Webster,_Flints_._Hist_._Soc_._Publ_.XIII(1952-3)26,no.35. Tylecote,_Metallurgy_ Table 33,no.19.

Face(moulded) IMP • CAES • A[NTO]NINI • AVG • PII P • P

Imp(eratoris) Caes(aris) [A]nt[o]nini Aug(usti) Pii p(atris) patriae.

'(product) of the Emperor Caesar Antoninus Augustus Pius _pater patriae_.'

Pig no.168

Date:A.D.138 - 161. It would appear that this pig was filled in a mould that was standing on uneven ground.

168.Found in 1865,in the river Frome,at Bristol,and now in the British Museum.

weight:34.5 kg.

height:6.3 cm. base:52.7 x 12.7 cm. face:49.6 x 6.9 cm.

silver content:0.0034%

mine of origin:Mendips,Somerset.

CIL VII 1210a. VCH Som.i.342. Gowland,Arch.LVII(1901)ii.402,no.15. Besnier,Rev.Arch.XIII(1921)42,no.24b. Webster,Flints.Hist.Soc.Publ.XIII(1952-3)24,no.34. Tylecote,Metallurgy Table 33,no.18.

Inscription,expansion and translation as for 167.

Date:A.D.138 - 161.

169.A fragment of lead found in the eighteenth Century, at Bruton,Somerset,but since lost.

weight:c.23 kg.

c.2 cm.thick, 50 cm.long and 8 cm.wide.

mine of origin:Mendips,Somerset.

CIL VII 1211. Way,AJ XVI(1859)35. VCH Som.i.342. JRS XLI(1951) Gowland,Arch.LVII(1901)ii.402,no.20

Besnier, <u>Rev. Arch.</u> XIII(1921)42, no. 25a. Webster, <u>Flints. Hist. Soc. Publ.</u> XIII(1952-3)26, no. 36. Tylecote, <u>Metallurgy</u> Table 34, no. 28.

Face(moulded) IMP • DVOR • AVG • ANTONINI |
ET VERI ARMENIACORVM

Imp(eratorum) duor(um) Aug(ustorum) Antonini |
et Veri Armeniacorum
'(product) of the two Emperors Augustus, Armeniacus, Antoninus and Verus.'

Date: A.D. 164 - 169. Verus took the title Armeniacus in 163, but Marcus Aurelius took the same title in the following year. The pig must then be dated to between 164 and the death of Verus in 169.

170. Found in about 1530, at Wells, Somerset, but since lost. Its weight and measurements were not recorded.
mine of origin: Mendips, Somerset.
Leland, B.M. MS. Cotton Julius C.VI f.37. <u>JRS</u> XLI(1951)141.
Webster, <u>Flints. Hist. Soc. Publ.</u> XIII(1952-3)26, no. 37.
Tylecote, <u>Metallurgy</u> Table 34, no. 76.

By analogy, the inscription, expansion and translation are as for no. 169.

Date: A.D. 164-169.

Pigs nos.171-172

171-2. Two fragments of lead found in 1874, at Charterhouse on Mendip, Somerset, and now in the Castle Museum, Taunton. They were originally thought to be from the same pig, but Whittick has shown that the metal for these two fragments was poured in from opposite sides of the mould, showing that they are not from the same pig.

Mine of origin: Mendips, Somerset.

EE III 121e, IV p.206. VCH Som. i, 342-3. Besnier, Rev. Arch. XIII(1921) 43, nos. 25b-c. Webster, Flints. Hist. Soc. Publ. XIII(1952-3) 26, nos. 38-9. Tylecote, Metallurgy, Table 34, nos. 77-8. Whittick, JRS LI(1961) 108.

171.

weight:

20 cm. long x 9.5 cm. wide, x 2 cm. thick.

Face (moulded) A]NTONINI

]CORVM

Imp(eratorum) duor(um) Aug(ustorum) A]ntonini |
et Veri Armenia]corum

'(product) of the two Emperors Augustus Armeniacus, Antoninus and Verus.'

172.

14 cm. long x 5.7 cm. wide x 0.6 cm. thick.

Face (moulded) AV]G[

AR]MENIA[CORUM

Imp(eratorum) duor(um) Au]g[(ustorum) Antonini |

et Veri Ar]menia[corum

'(product) of the two Emperors Augustus Armeniacus, Antoninus and Verus.'

Date:A.D.164 - 169

173.Fragment of a lead pig found in 1840,at Lillebonne, North France,and now in Rouen Museum.

weight:43.5 kg.

height:13 cm. base: 29 cm.long. face:25 cm. long.

mine of origin: ? presumably British from its location.

CIL XIII 3222. Besnier,Rev.Arch.XIII(1921)68,no.46.

Face(moulded) I[...] L[...]

NACIS • AVG • PA

I[mp(eratoris) Caes(aris)] L[uci Septimi Severi] |

(Perti]nacis Aug(usti) Pa(rthici Adiabenici)

'(product) of the Emperor Caesar Lucius Septimius Severus Pertinzx Augustus Parthicus Adiabenicus.'

Date:A.D.195 - 211. Septimius Severus took the title Parthicus Adiabenicus in A.D.195,dating this pig to between then and his death in 211.

173A. Found at Chamilly and Alugi. Its present location is unknown.

weight: 86 kg. measurements: unrecorded.

mine of origin: Flintshire or Shropshire ?.

<u>Rev. Arch.</u> (1941) no. 28.

Face (moulded)   P
                NACIS • AVG PARTICI ADIABENICI
    (   ) DL'P   LVICVC
                CCXL

Imp(eratoris) Caes(aris) L(uci) Se]p (timi)[Severi (Perti)nacis Aug(usti) Part(h)ici Adiabenici

'(product) of the Emperor Caesar Lucius Septimius Severus Pertinax Augustus Parthicus Adiabenicus.'

'(?)' not interpreted.

'240'

Date: A.D. 195 - 221. See notes for pig 174. This pig weighs 262 librae, twenty-two librae in excess of the stamped numerals.

174.Found in 1855,at Sassenay, near Châlon-sur-Saône,France,and now in the Museum at Chalon.

weight:86.3 kg.

height:12 cm. base:58 x 13 cm.

mine of origin: ? Shropshire

CIL XIII 2612a. Besnier,Rev.Arch.XIII(1921)69,no.47.

Front(moulded) AUG PARTICI ADIABENICI

Back(incuse) DL'P LVICVC VICVC

[Imp(eratoris) Caes(aris) L(uci) Septimi Severi Pertinacis]
Aug(usti) Part(h)ici Adiabenici

DL'P LVICVC VICVC

'(product) of the Emperor Caesar Lucius Septimius Severus Pertinax Augustus Parthicus Adiabenicus.'

'(?)' not interpreted.

Date:A.D.195 - 211. LVICVC have been taken by some to be the stamp of the Sixth Legion.However,since the Legionary titles are not given,and the letters CVC are used in conjunction with LVI ,which are completely unknown with Leg.VI ,R.P.W.concludes that this is not the correct interpretation (R.P.W.to H.D.H.EL)(December 1966).

175.Found in 1864 at Chatenoy-le-Royal, near Chalon-sur-Saône,France,and now in the museum at Chalon.

weight:86.3 kg.

height: 12 cm. base: 58 x 13 cm.

mine of origin: possibly Flintshire or Shropshire.

CIL XIII 2612b. Besnier Rev.Arch.XIII(1921)70,no.48.

Front(moulded) LEG XX

BFLIDOC

DOC

BFLIDOC

LEG XX

Leg(ionis) XX

B(ene)f(iciarius) LI Doc(cius)

Doc(cius)

'(product) of the Twentieth Legion.'

'The Beneficiarius Doccius (produced this).'

'Doccius (produced this)'

Date:Late second Century A.D.?The Twentieth Legion was based during the second and third Centuries at Chester. We should consider therefore that this was a product from the mines of Flintshire,or perhaps Shropshire,- mines within easy reach of Chester.Some interpreters expand the stamp BFLIDOC as Beneficiarius Legionis I Doc(....).It is hard to see why Leg.I should be mentioned on the same pig as Leg.XX,and why,if this is the Legion, it carries the title DOC and not MINERVAE.Besides the

First Legion was stationed in Germany, and it is hard to understand why an official from that Legion was detached for lead mining duties in Britain. It is unusual for rank to come <u>before</u> the abbreviated name of an official, however. <u>CIL</u> believes that 174 and 175 are two parts of the same pig, but Besnier is insistent that the second pig is a whole one and is not fractured, and that the two are different pigs. Certainly their combined weights and measurements would be unusual.

175A. A fragment of lead found at Lidney Park, Gloucestershire, but now perished. Its weight and measurements are not recorded.

mine of origin: ?

<u>CIL</u> VII 1218. *EE* IX, 643. Webster <u>Flints.Hist.Soc.Publ.</u> XIII (1952-3) 30, no.59

DOCCIVSI   DOCCIVSI

Doccius

'Doccius (produced this).'

Date: ? . This is first recorded in Lysons <u>reliq.Brit.</u> <u>Rom.</u> 2. tab.29. Way <u>AJ</u> XVI(1859) does not record it, and it may not be part of a lead pig.

176. Found in 1896, at Bradwell, Matlock, Derbyshire, and now in Sheffield Museum.

weight: 50.7 kg.

HEIGHT:7.5 cm. base:50 x 13.7 cm.

silver content: 0.0034 %

mine of origin:Derbyshire.

VCH Derbys.i,232.Besnier Rev.Arch.XIII(1921)ii,55.

Webster Flints.Hist.Soc.Publ.XIII(1952-3)22,no.16.

Tylecote Metallurgy Table 34,no.71.

The inscription has perished.

177.Found in 1846,at Coker Hill,two miles North of Matlock, Derbyshire,but now apparently lost.Its weight and measurements are not recorded.

mine of origin:Derbyshire.

VCH Derbys.i,232. Besnier Rev.Arch.XIII(1921)ii,55.

Webster,Flints.Hist.Soc.Publ.XIII(1951-2)22,no.17.

Tylecote Metallurgy Table 34,no.73.

There is no record of the inscription.

178.Found in the river Tiber at Rome,and attributed to Britain by reason of its shape and weight.

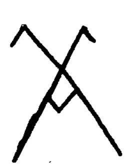
weight:82.1 kg.

height:12 cm. base: 59 x 15 cm. face:50 x 8 cm.

mine of origin: ? Britain.

CIL XV 7920. Besnier Rev.Arch.XIII(1921)ii,114,no.68.

(moulded)



"(?)" not interpreted.

Date: ?.

179A,B,C,D. Four pigs were said to have been found (before 1822) at Hove Abbey, in Sussex. Their weights, measurements and location were not recorded.

mine of origin: ?

SkinnerBM.Ms.Add.33673 f.105.

No inscription is recorded.

Date:? . Skinner, recording these pigs is merely reporting what he has heard. There is no further evidence of the existence of these pigs, which must be treated with suspicion.

180.Found in 1946,at Carsington,Derbyshire,and now at Owslow farm in Carsington.Museum.

weight:65.3 kg.

height:8.9 cm. base:58.4 x 13.9 cm. face:51.4 x 10.1 cm.

mine of origin:Derbyshire.

JRS XLIII(1953)129. Tylecote,Metallurgy Table 34,no.66.
Derbys.AJ LXXIII(1953)110.
(incised) <<X

CCX

'210'

Date: ? . The numerals 210 presumably denote the weight of the pig in librae.This would correspond closely with the present weightof the pig,200 librae.Palmer's conjecture (see pig no.114) that the numerals should read IIX or '8',was agreed with by Mr.Cockerton, Derbys.AJ LXXIX(1959)90.This,however is refuted by R.P.W. JRS XLVII(1957)231.The conjecture must be regarded as incorrect,and epigraphically unsound.

181.Found in the river Tiber at Rome,and now in the Diocletian Baths Museum.It is in the form of a very large truncated pyramid.

weight:274.6 kg.

height:17.5 cm. base:64 x 23 cm. face:47 x 17 cm.

CIL XV 7915. Besnier *Rev.Arch.*XIII(1921)ii,114,no.69.

Basé(incuse) M · ARI | M · ARI

CCETM ADA CCETM

TRDAVG · N

DCCCLXX Ↄ XX ↃↃↃC·

M(arci) Ari

C(....orum) G(ai) et M(arci)

Ada(....)

t(essera) r(ationis) d(ominicae) Aug(usti) n(ostri)

DCCCLXX Ↄ XX ↃↃↃC·

'(product) of Marcus Arius.'

'(product) of Gaius and Marcus C(....).'

'ADA(....)' not interpreted.

'tablet of imperial accounts of our Emperor Augustus.'

'870' '(?)' not interpreted.

Date: ? .The *nomen* Arius occurs in *ILS* 3153. Besnier, *loc.cit.* attributes this pig to Britain suggesting that ADA is a place-name in Britain that Adansa is near Camulodunum (It.Ant.480).There is no eveidence for mining activity near Camulodunum,however,and if this does refer to a place-name,it was *not* Adansa.The pig is twice the size of the average British specimen.It is the only one which has an inscription on the base . I am not inclined to believe that this is a British pig.

182.A fragment of lead found at Achlum,North Holland, and now in the museum at Leeuwardem.

weight:13 kg. length:15 cm.

CIL XIII 10029.27, Besnier,Rev.Arch.XIII(1921)72,no.49

end(incuse) P XXX

P(ondo) XXX

'by weight 30'

Date: ? . This being only a fragment of lead,it is not possible to know its true weight. It is attributed to Britain,because of its location near the coast of Holland.

183.A bar of lead found at Carthage,but now apparently lost.

weight:2.27 gr. measurements: 11 x 8 x 3 cm.

CIL VIII 22656,3. Besnier,Rev.Arch.XIII(1921)99,no.54.

▭ EX

Ex

'from'

Date: ? .

184. A round bun of lead, found at Fréjus, France. Its present location is not known, nor are its measurements.

CIL XII 5700,2b. Besnier, Rev. Arch. XIII(1921)66, no. 44.

Mine of origin: Gaul.

IIIIII

'6'

Date: ?

185. A rectangular bar of lead found at Fréjus, France. Its present location is not known, nor are its measurements.

Mine of origin: Gaul.

CIL 5700, 2a. Besnier, Rev. Arch. XIII(1921)66, no. 43.

IIIII

'5'

Date: ?

186. Found in 1848 at Barry, Vaucluse, France, and now in Avignon Museum. It is a truncated pyramid.

weight: 43 kg.

height: 12.5 cm. base: 47 x 11 cm. face: 43 x 6.5 cm.

mine of origin: a mine in Central Gaul.

CIL XII 5700,1. Besnier, Rev. Arch. XIII(1921)65, no. 42.

Face(moulded) SEGVSIAVIC

(plumbum) Segusiavic(um)

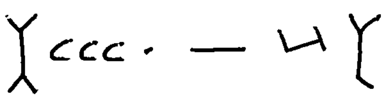
'Segusiavic (lead).'

Date: ? .The Segusiavi were a tribe who inhabited a region in Central Gaul, with their capital at Lugdunum, the modern Lyons.

187. error

188. A fragment of lead, but possibly part of a pig found at Lomas de la Urraca, Spain. Its present location and measurements are unknown.

CIL II 6247,7. Besnier Rev.Arch. XII(1920) 239,no.17.



CCC(?)

"300" "(?)" not interpreted.

Date: ? .

189. Found at Arbon , Switaerland, and now in the museum at Arbon.

weight: 145 kg.

measurements:unknown.

mine of origin:a mine in Spain or Gaul.

AE 1954,225. Rev.Arch.LIV 51-53.

VAL POSTVME

PCCCCL

Val(eri) Postume(i)

P(ondo) CCCCL

'(product) of Valerius Postumus.'

'by weight 450'

Date: ? . The weight of this pig is exactly 450 librae.

190.Found at Fos, L L

weight:66 kg.

mine of origin:a mine in Gaul.

UR.Schweiz.XVI(1952) .Gallia XVI(1958)36. L Tr/to prev. pig

Face(moulded) SOCIORVM PLVMB GER

XLVII

Sociorum Plumb(ariorum) Ger(manicorum)

XLVII

'(product) of the Germanic lead partners.'

'47'

Date: ? .The weight of the pig is 200 librae, the significance of '47' is not known.

191. An oblong bar of lead, found in 1774, on the North bank of the river Almond, near its confluence with the river Tay, Perthshire, Scotland, and to the West of the site of a Roman camp. It is now lost.

weight: 33.1 kg. measurements: unknown.

mine of origin ?

CIL VII 1220. EE IX p.643. Way, AJ XVI(1859) 37.

-CXJ.$\frac{11}{XXX}$

CXXXXII

'142'

Date: ?. The significance of the numerals is obscure. The alleged weight of the pig is 100 librae (see above p.128f) The inscription is that given by D. Wilson, Prehist. Ann. Ed.1(1851)392, ed.2(1863)64. In 1845, Stuart, Caledonia (1845)203, ed.2(1852)206, could not trace it. Haverfield rejects it as Roman saying that numerals are not known on Roman pigs. This we now know to be inaccurate, and may accept this as genuine.

192. Found in 1826 at Kirkintilloch, Scotland. Its present location is unknown. Said to be cut in half.

weight: 'nearly 100 pounds'

60.9 cm x 15.2 cm.

mine of origin ?.

CIL VII 1219 EE IX 643 Stuart Caledonia 323.

Skinner B.M.Ms.Add.33686 f.55,f.58.Way AJ XVI(1859) 37.

face(moulded) PCCCCL or PCCLXX or CCXX

P(ondo)CCCCL or CCLXX or CCXX

'by weight 450 or 270 or 220 librae.'

Date: ? .Haverfield rejects this pig(EE loc.cit.)on the same grounds as no.191,but more pigs have been found bearing numerals and it seems fair not to accept his rejection of the pig.

CONCORDANCES.

1. <u>CIL</u> : H.D.H.E.

2. <u>EE</u> : H.D.H.E.

3. <u>ILS</u> : H.D.H.E.

4. <u>JRS</u> : H.D.H.E.

5. <u>Arch</u>.LVII(1901)ii : H.D.H.E.

6. <u>Rev</u>.<u>Arch</u>.XII-XIII(1920-1921) : H.D.H.E.

7. <u>Flints</u>.<u>Hist</u>.<u>Soc</u>.<u>Publn</u>.XIII(1952-3) : H.D.H.E.

8. <u>Metallurgy</u> Tables 33 & 34 :H.D.H.E.

CONCORDANCE TABLES

1. CIL : H.D.H.E.

CIL II	HDHE	CIL VII	HDHE	CIL VIII	HDHE
3280a	71	1201	87	10484	74-77
3439	3-32	1202	89	22656,3	183
4964,1	69-70	1203	90		
4964,2	72a	1204	94		
6247,1	63	1205	96		
6247,2	71	1206	120-129		
6247,3	66-67	1207	118-119		
6247,5	69-70	1208	141		
6247,6	68	1209b,a.	138		
6247,7	188	1209c	137		
6247,8	162	1209d	135		
		1209e	139		
		1209f	136		
		1210	167-168		
		1211	169		
		1212	130		
		1213	165		
		1214	143		
		1215a	144		
		1215b	145-148		
		1216	150		
		1217	152		
		1218	175a		
		1219	192		
		1220	191		

CONCORDANCE TABLES

CIL IX	HDHE	CIL X	HDHE	CIL XI	HDHE
6091	51-52	8073,1	169	6722,13	1
		8073,2	160	6722,15-16	40
		8073,3	51-52 and 41-50		
		8339	78		
		p.1002	41-50		

CIL XII	HDHE	CIL XIII	HDHE	CIL XV	HDHE
5700,1	186	2612a	174	7914	163
5700,2a	185	2612b	175	7915	181
5700,2b	184	3222	173	7916	81
		3491	92	7917	79
		10029,25	164	7918	2
		10029,26	80	7919	149
		10029,27	182	7920	178

2. EE : H.D.H.E.

EE III	HDHE
121a	113
121b	111
121c	112
121d	166
121e	171
121e	169
p.141	130
p.141	141

EE IV	HDHE
p.201	169
p.206	172

EE VII	HDHE
1120	90
1121	95

EE VIII	HDHE
254,1	35
254,2	62

CONCORDANCE TABLES

EE IX	HDHE	EE IX	HDHE
428,1	36	p.642	87
428,2	34	p.642	89
428,3	33	p.642-3	94
428,4	64	p.643	118
428,5	65	p.643	119
1264	96	p.643	135
1264	97	p.643	136
1264a	140	p.643	137
1265	150	p.643	138
1265	151	p.643	139
1266	142	p.643	141
p.181	3-32	p.643	165
p.181	35	p.643	175a
p.181	66-67	p.643	191
p.181	68	p.643	192

3. ILS : H.D.H.E.

ILS	HDHE
8706	3-32
8707	80
8708	81
8709	92
8710	95
8711a	141
8711b	143
8711c	145-148
8711d	150
8711e	142

4. JRS : H.D.H.E.

JRS	HDHE	JRS	HDHE
XI(1921)239	131	XXXVIII(1948)101	93
XII(1922)283	94	XLI(1951)141	169
	95		170
	131	142	91
XXI(1931)256	113	XLIII(1953)129	180
259	166	XLVII(1957)230	114
263	138		115
264 n.5	132		116
264	136		117
	137	XLVIII(1958)	157
	139	LII(1962)195	114
XXXI(1941)146	153		115
	154		116
	155		117
	156	LIII(1963)162	108
	158	LVII(1967)206	159a
	159	LVIII(1968)	159b
		(as yet unpublished)	

5. *Arch.* LVII(1901)ii,340 : H.D.H.E.

Arch. LVII	HDHE
1	141
2	143
3	142
4	150
5	151
6-9	145-148
10	144
11	165
12	119
13	118
14	89
15	168
16	167
17	87
18	113
19	166
20	169
21	135
22	137
23-24	138
25	139
26	136
27	90
28	94
29	95
30-49	120-129
50	96
51	130

CONCORDANCE TABLES

Rev.Arch.XII -- XIII (1920 - 1921) : H.D.H.E.

Rev. Arch.	HDHE	Rev. Arch.	HDHE	Rev. Arch.	HDHE	Rev. Arch.	HDHE
1	160	23b	111	34	143	53	74-77
2	161	23c	112	35a	144	54	183
3	63	24a	166	35b	145-148	55	37-39
4	61	24b	167	36	141	56	53-54
5	64		168	37	165	57	55-60
6	65	25a	169	38a	150	58	51-52
7	66-67	25b	171	38b	151	59	41-50
8	62	25c	172	39	152	60	40
9	33	26	90	40	140	61	1
10	36	27a	138	41	118	62	78
11	34	27b	138		119	63	2
12	68	27c	137	42	186	64	79
13	35	27d	135	43	185	65	81
14	3-32	27e	139	44	184	66	163
15	82-86	27f	136	45	92	67	149
16	69-70	28	94	46	173	68	178
17	188	29	95	47	174	69	181
18	71	30	120-129	48	175	70	109
19	72	31	130	49	182		110
20	162	32a	96	50	73	XII(1920) p.241	72a
21	87	32b	97	51	164	XIII(1921) p.55	176
22	89	33	142	52	80		177
23a	113						

CONCORDANCE TABLES

7. Flints. Hist. Soc. Publ. XIII (1952-3) : H.D.H.E.

Flints.	HDHE	Flints.	HDHE	Flints.	HDHE
1	142	24	98-107	44	138
2	143	25	130	45	137
3	144	26	91	46	139
4-7	145-148	27	87	47	136
8	150	28	89	48	119
9	151	29	90	49	118
10	153	30	113	50	134
11	154	31	111	51	132
12	155	32	112	52	135
13	156	33	166	53	140
14	141	34	168	54	131
15	165	35	167	55	109
16	176	36	169	56	110
17	177	37	170	57	93
18	159	38	171	58	not included
19	94	39	172	59	175a
20	95	40	88c	60	192
21	96	41	88b	61	191
22	97	42	88a	62	not included
23	120-129	43	138		

CONCORDANCE TABLES

R.E. Tylecote <u>Metallurgy</u> Tables 33 & 34 : H.D.H.E.

R.E.T.	HDHE	R.E.T.	HDHE	R.E.T.	HDHE
1	150	23	144	61	116
2	151	24	165	62	115
3	153	25	87	63	117
4	154	26	113	64	109
5	155	27	166	65	110
6	156	28	169	66	180
7	158	29	135	67	140
8–11	145–148	30	138	68	132
12	142	31	139	69	157
13	143	32	136	70	91
14	141	33	94	71	176
15	118	34	95	72	159
16	119	35–54	120–129	73	177
17	89		98–107	74	111
18	168	55	130	75	112
19	167	56	134	76	170
20	137	57	88c	77	171
21	90	58	88b	78	172
22	96	59	88a	79	131
22a	97	60	114	80	93

A Glossary of terms found in this volume

adit: a horizontal working made from the surface

arcarius: a public revenue controller

argentum: silver, but see p.107

arrugia: a shaft or pit

beneficiarius: a soldier seconded for special duty

bole: a place where lead ores were smelted

catinus: a vat

censor: a censor, a Roman magistrate

cerussite: lead carbonate

cognomen: the third, family, name - Tiberius Claudius TRIFERNA

colonus: the tenant

commentariensis: the registrar

conductor: a contractor who rented the right to collect taxes

damnatio ad metalla: the sentence to hard labour in mines

dispensator: the treasurer

dominus: the proprietor, owner

drift: a passage driven horizontally

eques: a member of the equester ordo, the second rank of nobility in Rome

fibula: a clasp

fiscus: the Imperial treasury

fodina: the mine

fossor: the miner

galena: lead ore

lode: a vein of metal ore

machinator: an engineer

mercenarius: a hired miner

metallum: the mine

nomen: the second name, that of the gens - Tiberius CLAUDIUS Triferna occupator: the occupier

outcrop: the emergence of a vein at the surface

praenomen: the first name,- TIBERIUS Claudius Triferna

praeses fodinae: the foreman

probator: the examiner, or superintendent of mines

procurator: the Imperial agent

publicanus: the collector of taxes

scoria: dross, slag

societas: a company of two or more persons

socius: a member of a societas

stagnum: crude lead, see p.107

stope: to excavate horizontally, layer by layer

tabularius: a book-keeper

tunica: a short-sleeved body-garment

werkblei: crude lead.

A list of the texts and translations to be found in this volume

INDEX

Index

Index

Index