D. G. BIRD

The Roman Gold Mines of North-West Spain

North-west Spain is uniquely suited to the study of Roman imperial gold-mining techniques. In the first place it seems probable that there was no earlier working in the area, at least not on a large scale, and the mines were only available to the Romans themselves under the Empire [1]. Secondly the various features around the mines have survived the passage of time well, being normally in areas where agriculture is impossible and apparently having been little subject to reworking. Finally, the only comprehensive account of Roman gold-mining which has survived almost certainly describes mining practice as it was known in this area in the first century A. D. This is the relevant section of the Natural History of Pliny [2].

Although it has long been recognised that the area was one of the most important gold fields of the Roman Empire, the mines have been little studied, except by Quiring [3], until very recently. Work by Lewis and Jones [4], Domergue [5], and Jones and Bird [6] has begun to fill the gap, and it is now possible to attempt a more comprehensive survey of Roman mines and mining techniques in the region. Quiring's work was concentrated mainly on a study of what he took to be Pliny's 'arrugiae' in the mines south of Astorga. Domergue follows this interest in arrugiae, working from the philological evidence and using the remains to illustrate this, rather than vice versa. For this reason a study of the remains for themselves is necessary to redress the balance. Lewis and Jones were able to do this to some extent by applying methods learnt from

[1] Florus II 33, suggests that the Romans introduced the working of gold to the area. It seems unlikely that any large scale mining for gold will have been carried out earlier, without the benefit of Roman organisation and knowledge, but there will no doubt have been panning along the major auriferous rivers. Prehistoric copper mines are, however, known in the area. (O. Davies, Roman Mines in Europe [Oxford, 1935] 99).

[2] Pliny, Nat. Hist. XXXIII, 67 ff.; printed by C. Domergue, op. cit., n. 5, but without comment, and by Lewis and Jones, op. cit., n. 4., with an important new translation.

[3] H. Quiring, Die römischen Goldbergwerke bei Astorga und ihre geologische Position. Zeitschr. d. Dt. Geol. Ges. 109, 1957, 361 ff. – Ders., Der römische Goldbergbau in Hispanien und die 'Arrugien' des Plinius. Zeitschr. Berg-, Hütten- und Salinenwesen im Deutsch. Reich, 1939, 270 ff.

[4] P. R. Lewis and G. D. B. Jones, Roman Gold-Mining in North-West Spain. Journ. Rom. Stud., LX, 1970, 169 ff.

[5] C. Domergue, Introduction à l'étude des mines d'or du nord-ouest de la péninsule ibérique dans l'antiquité. Legio VII Gemina (León, 1970) 255 ff.

[6] R. F. J. Jones and D. G. Bird, Roman Gold-Mining in North-West Spain II. Journ. Rom. Stud., LXII, 1972, forthcoming.

study of the Romano-British gold mine at Dolaucothi [7] to the problems of the Spanish sites; they attempted a basic survey of one each of the three main types of gold mine [8], and suggested the underlying principles in the methods used by the Romans to work them. They then re-examined Pliny's work in the light of this study of the surviving remains [9]. Their work was made more difficult, however, by the complicated nature of the remains at two of their chosen sites; Montefurado is a special case and the mine at Las Médulas cannot be regarded as typical if only because of its great size. Jones and Bird followed this work with the first really detailed survey of a Roman gold mine in this area [10], at Los Castellones in the Duerna valley.

The present study is based on this earlier work and on considerable fieldwork carried out by the author in Spain in 1969–70 [11]. The mines of León and the Asturias were examined in detail, as this area has the greatest concentration of mines and also provides examples of each type of mining. The region is split conveniently into two by the Cordillera Cantabrica, with the most important hard rock mines to the north and the alluvial mines to the south. Placer mining is possible along the rivers on both sides of the mountains, but Roman activity is difficult to prove, and attention has therefore been centred on the hard rock and alluvial sites which must have been much more important to the Romans in any case.

Hard rock mines

The most important auriferous region in the north-west of Spain extends along a line drawn from Luarca in the north to the area of Monte Teleno in the south. Hard rock mines are known on both sides of the Cordillera Cantabrica, often high up in the mountains themselves. The most important mines for the purpose of this study, however, are all to be found in the modern region of Asturias, in Roman times the area of the Astures Transmontani. Many of the gold mines here lie along the eastern edge of the quartzite zone which runs north-south across this part of Spain, along a line drawn between Trevias (23) [12] and Braña (15). Others are known west of this line, on the opposite side of the watershed which divides the systems of the rivers Navia and Narcea.

[7] P. R. Lewis and G. D. B. Jones, The Dolaucothi Gold Mines I: the Surface Evidence. Ant. Journ., XLIX, 1969, 244 ff.; see also now Bonner Jahrb. 171, 1971, 288 ff.

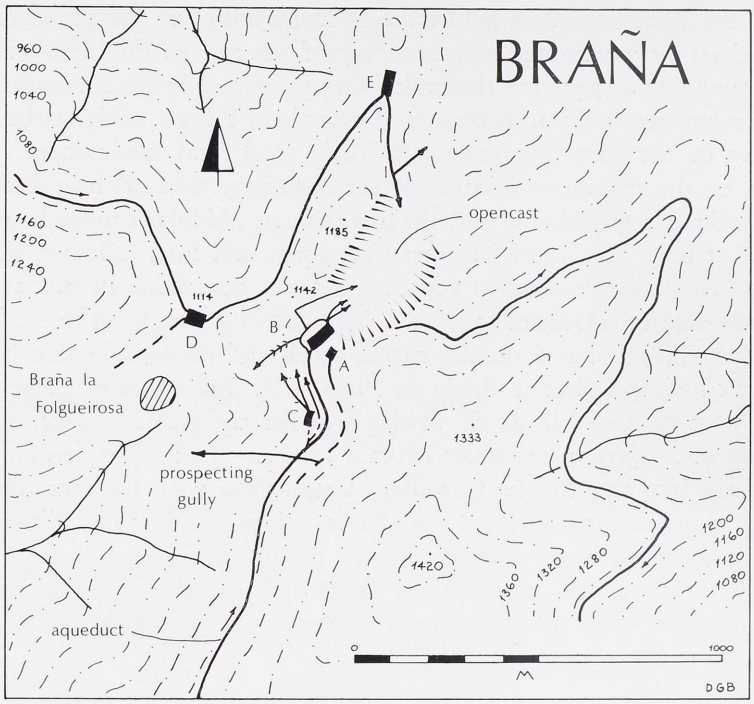
[8] That is hard rock, alluvial, and placer. For a basic dicussion see Lewis and Jones op. cit., n. 7 or Domergue, op. cit., n. 5. A simple geological map of the area is given by Quiring, op. cit., n. 3, (1957) 362, Abb. 1.

[9] The result is incorporated in appendix I, op. cit., n. 4.

[10] With the possible exception of J. M. Luengo, Explotaciones auriferas romanas en Rabanal del Camino (Leon). Archivo Esp. de Arte y Arq., 1935, 287 ff.

[11] A debt of gratitude is owed to the Spanish Government for the grant of a scholarship in 1969/70, and to the Department of Education and Science for making it possible for me to visit Spain again in late 1970. Professor G. D. B. Jones has given freely of time, advice and information; my debt to him is great. I should also like to thank R. F. J. Jones and Joanna Morris for their help. Any opinions expressed remain, of course, my own.

[12] A number in brackets after the name of a site refers to the map fig. 19, and to its key in the appendix.



1 Plan of the mine at Braña la Folgueirosa. – M. 1 : 20 000.

Several of these mines have been examined, and five in particular are of importance for the excellence of the survival of the features which surround the mine. These sites are Braña (15), Iboyo (18), Fresnedo (20), Rio de Oro I (14), and Puerto del Palo (13). All of these mines were worked on the opencast system; the only shafts and adits known in the north-west in gold mines are at Puerto del Palo (the feature traditionally known as La Cueva de Juan Rata) and at Montefurado on the Sil (40) [13]. Even at these two sites the underground features were of little importance. The largest of the five mines studied is that of Puerto del Palo, though it is clear from late nineteenth century references that there were mines as large in other parts of the north-west [14]. The most complete survival of a mining system, that is the system involving the use of aqueducts and tanks, is that of the mine at Braña la Folgueirosa, the furthest south and the highest known site. It will be convenient therefore to examine this mine in some detail (see fig. 1).

The opencast of the mine lies just to the north of the watershed dividing the Rio Arganza and the Rio del Coto, to the north-east of a small collection of huts called Braña la Folgueirosa, apparently no more than a summer grazing settlement. It is cut down into the mountain from a height of about 1200 metres to about 1050 metres above sea level, and about half of the hill now

[13] Lewis and Jones, op. cit., n. 4, 172.
[14] At Carballino (1) for example; Davies, op. cit., n. 1, 103.

2 Braña la Folgueirosa: triple aqueduct section near tank B, which is seen on the skyline. (Photograph by the author.)

represented by spot height 1185 seems to have been removed in the mining operations. The mine is overshadowed by a peak of 1420 metres in height, connected to the main mountain chain running north to Puerto del Palo by a saddle of only 1114 metres. This has naturally conditioned the factors of water supply to the mine anywhere above this height.

Two aqueduct systems survive. The higher of the two is something of a problem in that it starts one side of the opencast and is run round the mountain (spot height 1420) to the other side. It can be seen on both sides in fig. 3. There can be no doubt that the feature in question was an aqueduct; in the first place it ends in a very well preserved water tank which will be discussed below. Secondly it is rock cut in places, and has built up sections (similar to those in fig. 17) in others; and thirdly it preserves a line round the mountain which makes no sense at all as a track, for it has no destination and is cut neatly in two by the opencast. The only reasonable explanation is that the Romans were doing all they could to supply the tank (tank B) with water, collecting all the run-off water from the mountain above the height of the aqueduct, because nothing else was possible under these particular circumstances. This must mean that considerable importance was attached to having the tank in its particular position. It should also be noted that the aqueduct had at one time a triple or quadruple section, probably fed by a tank (C), just before it reaches tank B (see fig. 2). The purpose of this arrangement is not now clear.

The water system at the end of the higher aqueduct with tank B at its centre can be seen quite clearly in fig. 3 and in fig. 4 which has been drawn from the photograph to make understanding of the various features easier. Just before the aqueduct enters the tank it is tapped by a leat (1) which first runs downhill for a short distance then turns to the east to feed a feature (5) parallel with the

tank and just below its massive outer bank. This feature (5) has a strongly built outer bank similar to the tank but on a smaller scale, so that it is like a small thin tank itself. It is also fed by a leat (4) which itself taps another leat (3) running from the eastern end of the tank to the opencast. It seems thus to have been fed from both ends of the tank, though presumably not at the same time. Feature (5) is itself tapped twice; first by a gully containing a number of steps (7) running down across the hill to the west, and then by a steeply falling gully (6) which drops straight down the hillside for some 30 metres until it is about the same height as the lowest point of the ridge between the opencast and the head of the valley to the north (the valley of the Arroyo de las Corradas; the point is about 1142 metres above sea level). Here it turns sharply through a right angle to run across the slope and onto spot height 1142, whence it feeds into the opencast. There is a much more vague line (8) running into this last part of the gully along the hillside from the west, which suggests that the feed from above may have been secondary to an original feed across the slope from the west, below the main aqueduct, and perhaps therefore coming from tank C.

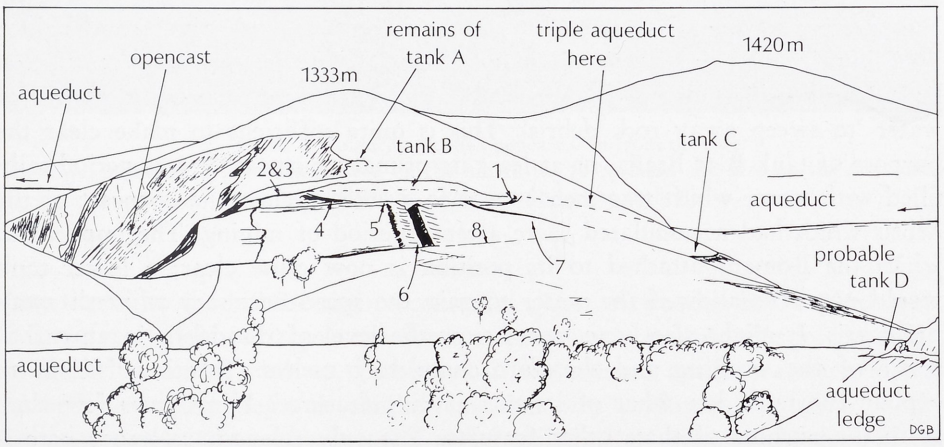
Tank B is the centre of this whole system, and is the main surviving tank on the site. As can be clearly seen in the photograph, it is situated very near the top of the opencast. What was the purpose of this tank? Pliny provides the clue: 'On the ridge above the minehead reservoirs are built measuring 200 feet each way and ten feet deep. Five sluices about a yard across occur in the walls. When the reservoir is full, the sluices are knocked open so that the violent downrush is sufficient to sweep away rock debris [15].' He is, of course, being too precise; it will be obvious, for example, that the exact size of a reservoir, or tank, is unimportant, and similarly the number of sluices. In fact, tanks of all shapes and sizes are known, with a varying number of sluices. But this is not important; what is, is that Pliny describes the positioning and purpose of these tanks. He makes it clear that they were placed at the top of the mine and used in the process known as 'hushing', that is the use of a rush of water to clear away debris, or, although Pliny does not mention this (perhaps because by this time the major sites were all known and there was little prospecting) to strip off the topsoil covering the rock so as to determine the exact position on the ground of the outcropping of an auriferous vein [16].

Tank B at Braña is a perfect example of such a tank. Its position has dictated its shape; clearly the situation calls for a long narrow tank, with a very strong outer bank, and this is what the Romans have constructed. Excavation of the tank was not possible, but it is clear from the visible remains and also from other examples which have been sectioned by accident, that the tank was constructed by digging a platform back into the hillside and using the upcast

[15] Pliny, Nat. hist. XXXIII, 75. The translations of Pliny given here are taken from Lewis and Jones, op. cit., n. 4, app. I.

[16] For the use of the term 'hushing' in this sense see W. Forster, A Treatise on a section of the strata from Newcastle-upon-Tyne to Cross Fell (3. edit. Newcastle 1883) 161 ff. The relevant passage is given by Lewis and Jones, op. cit., n. 4, 183–4; see also the discussion of prospecting below.

3 Braña la Folgueirosa: the system around tank B seen from the north. (Photograph by the author.)



4 Explanatory drawing of fig. 3.

for the outer bank [17]. This bank was probably constructed of earth and stone with an inner stone wall to serve as a steadying core. The general effect is that of a rampart and ditch, except that here the 'ditch', that is the part which actually held the water, is uphill from the 'rampart', the tank's bank.

The tank measured approximately 61 metres by 10 metres, and survives to a height of over 2 metres; its original capacity must have been about 1 300 000 litres when full. The outer bank is well preserved throughout its length, and it is clear that there cannot have been the five sluices suggested by Pliny. This is in any case unlikely as the whole purpose of the exercise is to produce

[17] C. f. the construction of tanks at Dolaucothi; Lewis and Jones, op. cit., n. 7, 258.

as strong a rush of water as possible, and clearly this could be best achieved by using only one sluice. A large number of tanks are known on Roman sites on both sides of the mountains and only rarely can they be shown to have had more than one sluice; when this is so it is usually because they have been used for ground sluicing (see below, p. 52). No examples of tanks which are known to have been used only for hushing can be shown to have had more than one sluice. Tank B at Braña conforms to the pattern common to the tanks of Asturias, with one narrow sluice set at the far end of the tank from the entrance of the aqueduct. Careful excavation here and at Puerto del Palo tank A should locate the position of the setting for the sluice gate, even if nothing else survives. The sluice at Braña fed into a leat (2) which led directly to the opencast. This leat was tapped twice; by another channel (3) which also led directly to the opencast at a slightly lower level, and from the same place by the leat (4) which runs into the eastern end of the feature (5) below the tank as described above. This leat (4) is now blocked at the top, and there is a second block in the system, where the feature (5) is blocked just to the east of the point where it feeds the gully (6) leading straight down the hill.

These features are difficult to interpret in detail and it is necessary to seek comparative material from the other sites and also to ask what help can be given by Pliny. The latter first. He is in no doubt about the purpose of the tanks built 'on the ridge above the minehead'. They are used to provide a rush of water 'to sweep away rock debris'. This is quite sufficient to make clear the purpose of tank B at Braña, or at least its primary purpose; it was periodically filled with water which was then let out in a rush to clear the opencast of the debris which had accumulated there after a period of mining. The importance which the Romans attached to its position is now quite clear; a lower tank would not have allowed the water to gain the speed necessary to wash away the debris. It might also have been below the level of the debris in an earlier phase of the working and therefore completely useless. This is sufficient to explain the tank, but what of its surrounding features? Pliny gives few clues as to the purpose of these other features. The only relevant reference here is when, describing the washing process, he says: 'Water conduits, the Greek name for which means 'leads', are cut in steps and floored with gorse, a plant resembling rosemary, that collects gold particles. The conduits are boarded with planks and carried over steep pitches [18].'

Lewis and Jones in their recent articles on gold mining in Wales at Dolaucothi explain these 'steps' as 'stepped washing tables cut in the ground, preferably rock', suggesting that Pliny has confused two different washing systems, in that his reference to 'conduits boarded with planks' should refer to sluice boxes of a type similar to those in use in nineteenth century California [19]. As they themselves note, however, the two systems are by no means mutually exclusive and there is no need to assume that Pliny has conflated two different systems. Rather he seems to suggest that it was normal practice to cut a series of descen-

[18] Pliny, Nat. hist. XXXIII, 76.

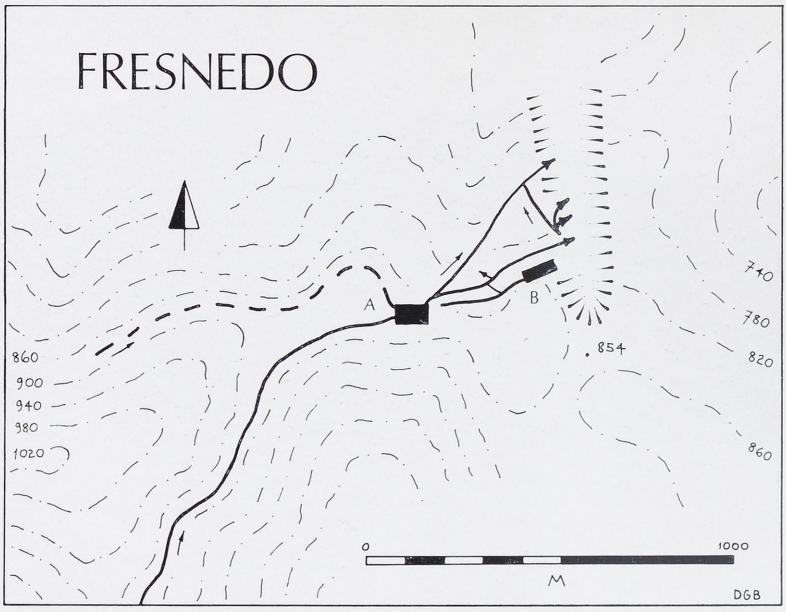
[19] Lewis and Jones, op. cit., n. 4, 184, and R. W. Paul, California Gold: the Beginning of Mining in the Far West (University of Nebraska 1947)

5 Braña la Folgueirosa: the opencast seen from the east.
The lower aqueduct system can be seen on the hill in the foreground and also on the mountains in the background. (Photograph by the author.)

ding steps into the hillside and to construct a sort of wooden box on each step. Strips of gorse laid out across the floors of these boxes trapped the gold particles which, being denser, sank to the bottom as the crushed auriferous material was washed down the steps. A similar function was performed in some of the Californian sluice boxes by strips of wood nailed at an angle to the floor of the boxes. It may be worthy of note that there is a growth of gorse in the area around the mine at Braña.

Rock-cut washing tables of this sort are known at Dolaucothi [20], and they form the best known parallel to the series of steps in the gully (7) which runs downhill to the west from feature (5) at Braña. If this were so it would explain at least part of the system around the tank; leat (1) which taps the aqueduct just before it enters the tank was presumably designed to by-pass the tank and provide water for the washing process when this was needed. It must be assumed that these washing tables belong to an early stage in the life of the mine as they are now very much higher than the floor of the opencast; there were probably others at the head of the valley north of spot height 1142, and no doubt the lower aqueduct system (see below) was used to provide water for washing purposes in the later mining work.

[20] Lewis and Jones, op. cit., n. 7, 256–258.



6 Plan of the mine at Fresnedo. – 1 : 20 000.

Water power may well have had one further use at Braña. An important feature of the area below tank B is the well built downhill gully (6). This feature was carefully and strongly built, and water allowed to flow down it will have reached a considerable velocity by the time it reached the bottom, represented by the sharp right angle turn towards the opencast. Yet it is quite clear that the gully did not continue downhill from this point. The force of the water must therefore have been broken in some way. Pliny gives no clue as to its purpose, but it is possible that it was designed to drive some sort of crushing mill to prepare auriferous material for the washing process.

The description of the main features at Braña is completed by the lower aqueduct system. This seems to have had two short branches feeding a probable tank (D) on the saddle at spot height 1114 and thence another probable saddle tank (E), designed to control the passage of water around the hill of spot height 1185 to the northern edge of the opencast, where there was probably yet another tank of which no trace has survived. It may have suffered the same fate as tank A (see below). The whole system was presumably designed for use when the opencast had reached a considerable depth (see fig. 5) and could no longer be effectively worked from the upper aqueduct. The downhill gully (6) may represent an intermediate stage between the two aqueduct systems where water from the upper system was channelled lower, perhaps to another lost tank.

Examination of the other four sites mentioned above makes it clear that Braña is merely the best example of a mine working system as it survives; at least part of such a system survives at each of the other sites. Each site has an aqueduct

7 Puerto del Palo: the 'hush gullies' below tank C can be clearly seen in the centre of the photograph. The foot of the main opencast of the mine is seen in the right foreground. (Photograph by G. D. B. Jones.)

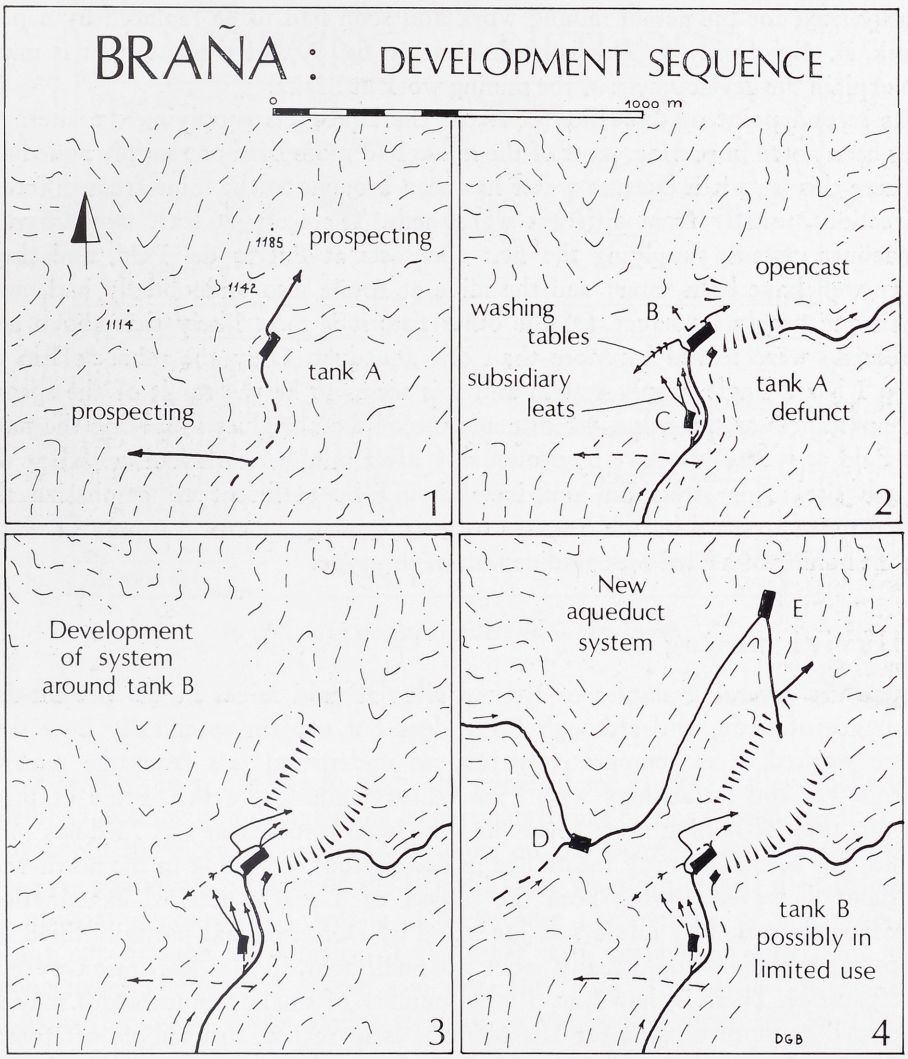
system (most have two), at the end of which is set a tank or series of tanks. Every one of the four other sites has a tank exactly similar in shape to tank B at Braña; tank A at Puerto del Palo, tank C at Iboyo, tank A at Rio de Oro I, and tank B at Fresnedo. Except at Iboyo the tank is always situated at one side of the opencast, very near the top. The exception is instructive. There is in fact a tank at the top of the opencast at Iboyo, tank A. This tank is very nearly square in shape and it is set across the top of a small saddle between two hills, not on the hillslope as are all the other tanks mentioned above. Yet it must surely have been designed to perform the same function as the other tanks at the top of their respective opencasts, and this theory is supported by the features below the tank which are similar to the features below tank B at Braña. A second point is that although tank C at Iboyo is of the same pattern as the 'hushing' tanks elsewhere, it does not seem to have been intended to be used in this way, as it is situated some distance from the edge of the opencast and is only connected to it by a horizontal leat; it is therefore impossible for it to have been used for hushing into the opencast. It is thus clear that the shape of a tank is determined by its position and not by its purpose. It is also clear from the surviving examples that there was no standard size for a tank.

The water systems at Palo, Iboyo, Fresnedo and Rio de Oro I all preserve in some form a leat running below the main hushing tank and then feeding a gully running straight down the hillslope like feature (5) and gully (6) at Braña. At Fresnedo (see fig. 6) and Iboyo, where it is possible to see what happens to the end of the gully, it eventually runs into another leat running across the hill into the opencast, as at Braña. The best interpretation remains that suggested above, that is that the gullies were intended to drive machinery of some sort.

8 Great Dunfell, England: nineteenth century 'hush gully'. (Photograph by G. D. B. Jones.)

Two more important points remain to be made about the Roman methods of mining on hard rock sites. The first is a method of prospecting already mentioned above, in the discussion of Pliny's description of hushing. The significant sites in this respect are Puerto del Palo and Braña. At the latter mine, some distance to the east of tank A, there is a sharply defined downhill gully which bears no resemblance to natural water-made features in the area. Its purpose and its artificiality are made clear when it is compared to a similar feature at Palo (fig. 7) and another in the 19th century mining work on Great Dunfell in England (fig. 8). At Palo the gully is clearly related to a part of the water control system, fed from tank C [21]. The position of the gully is especially significant in that it lies immediately opposite the main opencast on the other side of the valley, where it might be thought possible that a further outcrop of the gold-bearing strata should occur. Its purpose is explained by its position and by comparison with the gully on Alston Moor which was described by Forster in his discussion of the process of hushing [22], used here to strip away from the hillside its covering of topsoil and loose rock so that the hidden rock beneath could be examined for any signs of ore. The fact that none were found is made

[21] See Lewis and Jones op. cit., n. 4, fig. 26, 178, for a plan of this site.
[22] Forster, op. cit., n. 16.



9 Suggested development scheme for the mine at Braña la Folgueirosa. – M. 1 : 20 000.

obvious by the survival of the 'hush gully', and this raises the point that only unsuccessful prospecting gullies could survive, as obviously those which were successful would be obliterated by later mining work. Other examples are known in the alluvial mining areas to the south; at Los Castellones on the Duerna (53) and at Castropodame (47) for example (see below). The hush gully at Braña was probably connected with the remains of a tank (A), higher than tank B, most of which has collapsed into the opencast. A few traces of the aqueduct supplying this tank survive and it would have been at the right height to be used to create the hush gully. It is most likely that these are the only surviving traces of the earliest activity at the mine, when the Romans made use of water power to expose the auriferous rock. Tank A must have been

badly sited for the actual mining work and soon had to be replaced by a new tank, B, slightly lower. This is made clear on fig. 9, where an attempt is made to explain the development of the mining work at Braña.

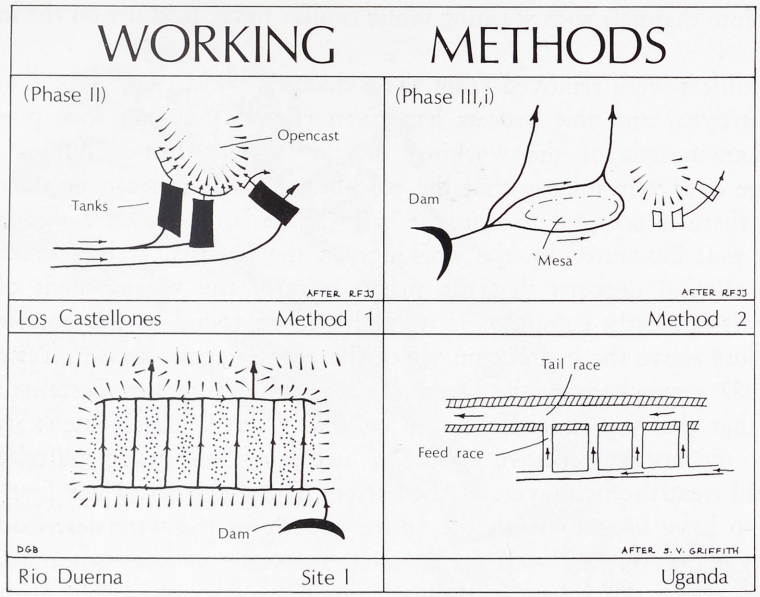
The second point of discussion concerns the aqueducts supplying the sites. As has been noted in passing, most of the mines had more than one supply aqueduct. Where this is so it is because water has been brought to the mine from different directions, usually from different watersheds. There are at least two different aqueduct systems supplying the two opencasts at Puerto del Palo, and there may well have been three; and the mine at Braña also undoubtedly had more than one supply aqueduct. Of the other sites it is most likely that Iboyo and Fresnedo were served by more than one aqueduct. Only the mine at Rio de Oro I has a single supply system and this seems to be the result of the special circumstances at this mine, which made use of the aqueduct supplying the mine at Palo as it passed above it, presumably after mining work had ceased at the latter site. This stress on aqueducts should be sufficient to emphasize the importance attached by the Romans to the need for a plentiful supply of water in the mining of a hard rock gold deposit of this type.

Alluvial mining

There are several examples of Roman alluvial gold mines in the present-day province of León, and although Pliny does not explain specifically how they were worked, it is comparatively easy to understand this from the remains themselves and by analogy with 19th century mining practice. Pride of place in this type of mining must go to the vast mine complex at Las Médulas (43), which has been frequently mentioned in descriptions of mining in the north-west without, however, having been the subject of a really detailed examination. Recent publication by Lewis and Jones and by Domergue has partially filled the gap, but the mine would really require a small book if any description were to do it justice. There is, however, a large number of smaller mines which may be regarded as more typical, for Las Médulas is in reality an example of Roman methods taken to extremes. For this reason it will be more profitable first to examine these smaller mines in detail, and then see if the mine at Médulas has anything to add other than a mere increase in scale.

The most important alluvial mines in the north-west are in the valleys of the rivers Eria, Duerna, Turienzo, Cabrera, Burbia and Cua. These can be divided into two groups. The first four rivers all rise or have major tributaries rising very near one another in the Montes de León. The Eria, Duerna and Turienzo all run east from the watershed, into the Esla basin, while the Cabrera flows west to join the Sil at Puente de Domingo Flórez. The last two mentioned rivers also join the Sil, draining south from the Cordillera Cantabrica. Hard rock gold mines are known in the mountains at their head [23]. There are thus two main groups of alluvial deposits, one around the Burbia and the Cua, the other, more important, around the Montes de León. To this latter group may be added a number of scattered mines including that at Castropodame.

[23] At Burbia (33) and Menival (32).



10 Working methods on different alluvial sites.

It has recently been possible to study the mines of the Duerna valley, including a detailed examination of one mine in particular, that of Los Castellones [24]. This is probably the most important single mine on the Duerna, and it fortunately preserves considerable traces of the two different ways water was used to mine the alluvial deposits here (see fig. 10). Because the remains of one type of mining cut through the remains of the other it is possible to understand the chronological relationship of the two different types. The earlier of the two involved the use of tanks similar to those in use in the north; at Castellones they are broad rectangles, like tank A at Iboyo. Like the tanks in the north, however, the shape seems to have been adapted freely to suit the ground; there are examples of long narrow tanks at sites on the Duerna and on other alluvial sites, notably that of Castropodame. At Castellones the tanks were used to work opencasts of a sort, cutting back gradually into the ridge at the end of which the mine is set. The alluvial deposits of the area are here about 50 metres deep fronting onto the river, and they have been cut into a series of ridges by a number of small streams (or 'arroyos') draining the mass of Monte Teleno to the south. The system of working in the earlier phase seems to have been to let the water flow out of the tanks and over the working face in a number of streams, cutting channels in it and thus collapsing parts of the cliff. The water and the debris it had collected in its progress across the soft alluvial and down over the cliff was then guided into large collecting pools, from which it was

[24] Jones and Bird, op. cit., n. 6.

directed into channels with washing tables similar to those in use on the hard rock sites [25].

Large boulders were removed from these channels which they would otherwise have destroyed, and this process has given rise to the long rock piles which are a characteristic of the workings on this river. Alluvial mining has the advantage over vein mining that the gold-bearing material can be immediately washed; there is no need to crush it first. There is, however, a disadvantage, which is well illustrated by the workings on the Duerna. It is a characteristic of these alluvial deposits that the richest part of the various beds of gravel of which it is mostly composed is normally to be found at the bottom of the deposit, just above the bedrock on which the entire deposit rests [26]. Tests carried out in 1887 somewhere on the Duerna, very probably at Los Castellones itself, showed that this was indeed the case on that river [27]. The Romans were thus faced by the need to remove about 50 metres of low grade material before they could treat the rich layers at the bottom of the deposit. Their first reaction appears to have been to wash the entire deposit in the way described above. This may have worked well for a time, especially at the beginning of the operations when the ridges still sloped down to the river. The method will have been much less effective, however, once this area had been treated and the full depth of 50 metres had to be worked. It is tempting to argue that about this point the mines were abandoned for a time, as being no longer worth the cost of working them, and they remained this way until the new methods of the second type of working came to be applied in the second half of the 2nd century A. D. [28]. This would allow for the mines being worked almost immediately after the conquest of the area [29], for it is extremely unlikely that they will have been worked continuously over the course of two centuries, as this would require that the area was worked very slowly indeed. There is no proof at all, however, and it must remain merely an attractive theory until proper archaeological excavation can be carried out on settlement sites connected with the mining operations.

The second method of working is clearly later than the first at Los Castellones, and the position of the other sites where it is used in the Duerna vallery also suggests that it was a later method, in that at least two of them would not have been worked until other sites, easier to work, had been given up. The

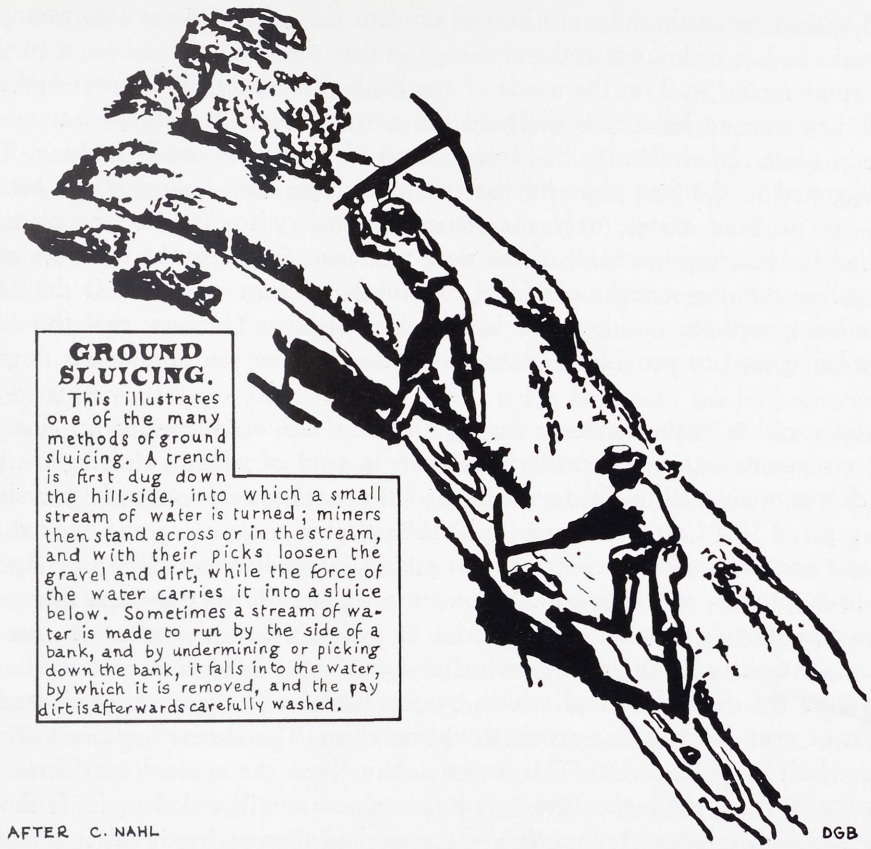
[25] A similar method is suggested by S. V. Griffith, Alluvial Prospecting and Mining (2. revised edit. London, 1960) 121.

[26] J. M. Maclaren, Gold: its Geological Occurrence and Geographical Distribution (London 1908) 89.

[27] J. A. Jones, Trans. Fed. Instit. Mining Eng., XX, 1900/01, 426.

[28] Working in the area in the second half of the 2nd century is attested by the presence of a number of imperial freedmen procurators whose sphere of activity is made clear by the specific reference to one of them, Aurelius Firmus, as 'Aug. Lib. Met.'. See Jones and Bird, op. cit., n. 6.

[29] Early working in the area is suggested by Florus, op. cit., n. 1: 'Thus the Astures digging deep into the ground in search of riches for others gained their first knowledge of their own resources and wealth.' The context implies that this was soon after the conquest, and in the region of Astorga.



11 Ground sluicing in nineteenth century California.

characteristic feature of this method seems to be the presence of a feature which was christened the 'mesa' on the Los Castellones survey of 1970. This term was rather inaccurately used to describe a very large mound of unworked alluvial which had been made free-standing by the action of the various gullies which surrounded it (see fig. 10). These gullies ran round each side of the 'mesa' through a semi-circle to meet in the front. The gullies were fed with water from a dam, which seems to be the second distinctive feature of this method. There were two dams at Los Castellones, one of which was simply a replacement a little further back on the ridge for the other which had been wrecked by the water from one of its sluices cutting back into the alluvial and eventually undermining the dam itself, always a danger on these sites. The dams were crescent-shaped, with (as represented by the later dam, which has naturally survived much better than the earlier) strongly built downhill banks and two sluices. They were apparently built in a similar fashion to the long narrow tanks in the Asturias, by excavating a crescent-shaped ditch and piling the material into a bank on the downhill side. Proper archaeological excavation is necessary, but examination on the ground, as for example at Morla de Lavaderia (54), suggests again that the centre of the dam wall was formed by a stone and earth

wall with more earth and stone heaped on each side of it. One or two examples of tanks and dams known in the area suggest that there may have been a further dry stone facing wall on the inside of the bank. The dams differ from tanks in that they seem to have been designed for controlling the supply of water to a certain place rather than to build up a head of water for use in hushing. This is suggested in the first place by the lack of a large area hollowed out behind the dam to hold water; only the trenches necessary to provide the material needed for building the bank of the dam were cut. Secondly there are no clear cut gullies running straight out from the sluices, as there would be if the dams were being used for hushing. The implications of these facts are that the dams were being used to provide a relatively gentle, more or less continuous flow of water.

Taken together with the long deep gullies the use of a continuous flow of water suggests that the Romans were using a kind of ground sluicing method which was much used in California in the 19th century on poor grade gravels of the type at Los Castellones (see fig. 11)[30]. Water was led to the top of the deposit and channelled over its edge as a kind of small waterfall which rapidly cut back into the soft alluvial. As it wore a channel down the slope men with picks and shovels loosened the material on either side and pushed it into the water. In California the miner trusted to nature to provide obstructions in the course of the channel behind which, over a period of time to be measured in weeks or even months, fine debris would build up. This debris contained all the gold which had been saved. This seems to have been the method considered the best for working the higher poor grade gravels of an alluvial deposit. It should be remembered, however, that this was a method of working involving usually only a few men, and these were free men. The Romans will undoubtedly have been able to make use of a considerable number of slaves if the occasion warranted. With a large number of men it would have been possible to work several gullies at once, and by passing the debris-carrying water through a system of sluice boxes rather more of the gold could have been saved than was possible in California. In time it would be possible to work down to the rich levels at the bottom of the deposit, and these could then be treated very carefully, by shovelling the material into a series of sluice boxes. Pliny's reference, discussed above, to steps floored with gorse and with boarded sides, makes it quite clear that the Romans understood the simple principle behind the sluice box and it is therefore very reasonable to assume that they were in use in the Roman period.

Granted that this was the method which was used to create the gullies which still survive today, it is still necessary to explain the purpose of the 'mesa'. This feature can best be understood by assuming that it was the intention of the Romans to work the whole of the area in front of the dams down to the bedrock. The idea in this case would be that the working of the gullies surrounding the 'mesa' would gradually reduce it to nothing, and thus a large area would have

[30] See R. W. Paul, op. cit., n. 19, 151–2. Fig. 11 is taken from D. E. Fehrenbacher and N. E. Tutorow, California: an Illustrated History (London, etc., 1968) 50.

been available for intensive treatment of the rich layer just above the bedrock. This must, of course, remain a theory, which best fits the known facts, as there is no literary evidence; Pliny fails us here.

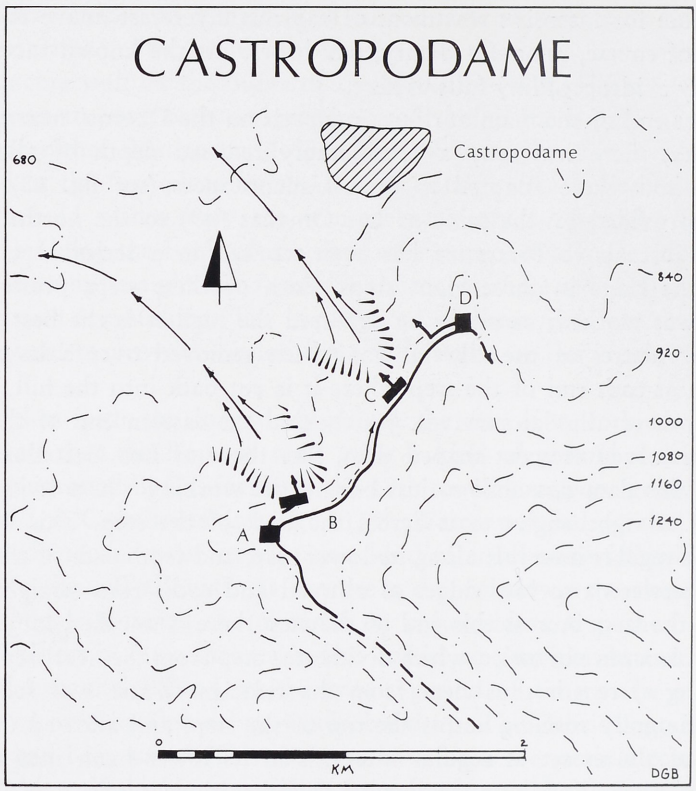
At the lower end of the main auriferous deposit on the Duerna, near the village of Priaranza, there was only a considerably reduced depth of alluvial, and Roman methods were adapted to these circumstances (see fig. 10). A useful parallel is provided by the mine at Las Omañas (49) to the north. The ridge of alluvial just above Priaranza has been worked in a series of terraces cut back into the ridge in three giant steps. Each of these steps preserves traces of how it was worked; as might be expected the highest is the best preserved. Here a few metres of the alluvial have been removed over a large area, as can be seen at each end of the step where it is cut back into the hill, where the original depth of alluvial survives. Just behind the eastern end of the working is a well-preserved crescent-shaped dam, like those at Los Castellones. A leat leads from this dam downhill to just behind the working where it joins a gully which runs at right angles to it across the back of the step. This latter gully is broken at regular intervals along its lower side, and from each of these breaks, a channel between two low ridges of alluvial and rocks runs straight down to the end of the step. Across this end of the step there is another, larger ridge of alluvial, broken once or twice, which divides the step from the next step down.

The working system is thus clear from the remains. Water was fed from the dam into the gully running across the top of the step, and allowed out through a number of sluices set at regular intervals in its lower bank into a series of downhill channels. Each one was probably fed with water in turn. The water and debris was controlled at the lower end of the step by a second cross gully, and most of the gold will have been deposited here. This is similar to a method of ground sluicing used in Uganda (see fig. 10), where the gravel was excavated and dumped into the downhill 'feed races', the gold being trapped along the gravel banks of the 'tail race', which were subsequently dug up and treated in sluice boxes [31]. It will be clear that this method will only have been effective when used, as here, when it is not necessary to remove a large amount of material to work the richer part of the deposit.

Most of the alluvial mines known conform to one or other of the patterns described above. Some of the other sites, however, have elements of special interest which are worthy of note, as variations in the type of deposit were naturally met by variations in the particular method employed to win the gold. One mine on the Duerna seems to have been worked by undercutting the alluvial by directing a continuous stream of water along the base of the working face. This was a special case which has been described in some detail by Jones and Bird [32] and therefore need not be further discussed here. At at least two mines, Castropodame (47), and Morla de Lavaderia on the Eria (54), the alluvial seems to have been a relatively shallow covering down the side of a mountain. It is

[31] See S. V. Griffith, op. cit., n. 25, 121.

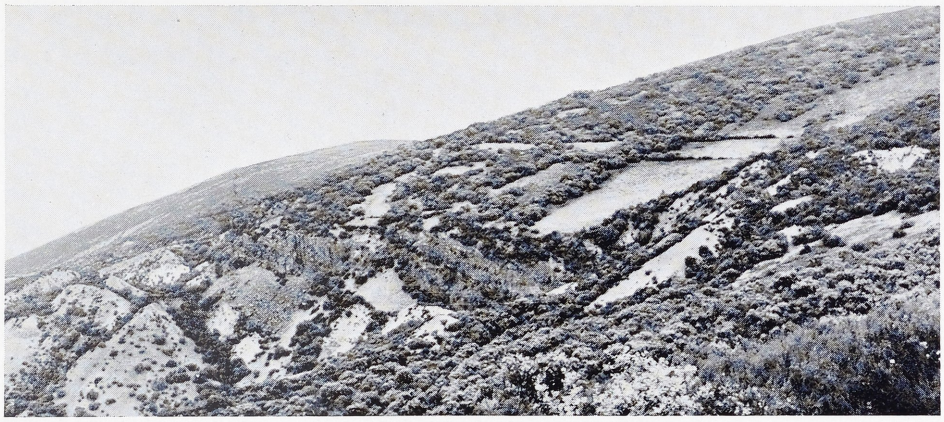
[32] The mine of Fucochicos, Jones and Bird, op. cit., n. 6; the method is hinted at by Griffith, op. cit., n. 25, 120.



12 Plan of the mine at Castropodame. – M. 1 : 40 000.

possible that the process of hushing was used at these sites to wash the alluvial away from the rock on which it was set. In this respect the mine at Castropodame is very instructive.

This mine has a very interesting set of water control features which have mostly survived the passage of time well (fig. 12). At least one aqueduct fed water to the mine from the west to supply four tanks. The site is set on the butt end of the mountains of the Alto de la Matoña, between two spurs which each have a slight saddle where the contours turn sharply back round the spur at about 930 metres above sea level. These saddles have been used for the first and last tanks of the mine's water system. The first tank, A, was clearly designed to act as a water control tank where the aqueduct reaches the site; distribution across the site could thus be controlled. (In this respect the tank is very similar to tank A at Fresnedo, which also occupies a slight saddle between two small hills and controls the further distribution of the site's water supply between three separate leats). From A a leat ran straight across the site to the final tank, D. Between these two tanks there are two more, of a similar type to the long narrow tanks of the Asturian mountainsides. Both of these tanks, B and C, lie a little below the line of the cross-site leat that connects tanks A and D. Tank B must have been fed with water by a second leat from tank A, although this cannot now

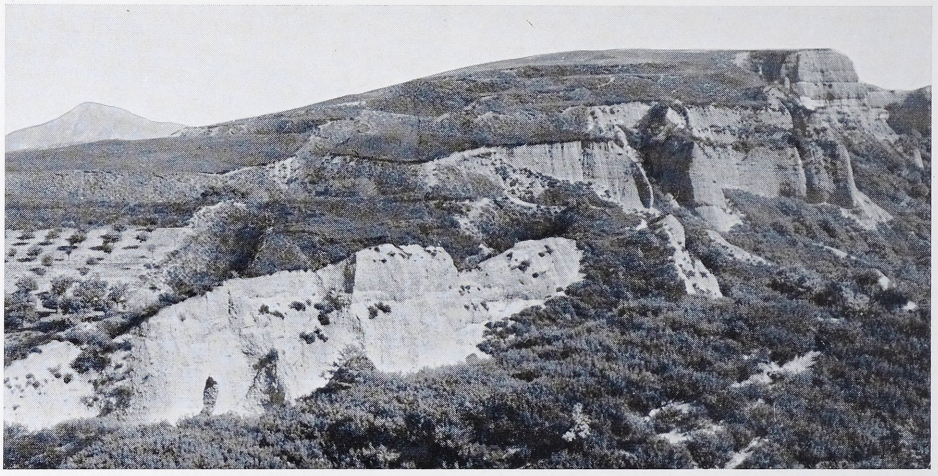


13 Castropodame: the western opencast from the west. Tank B is hidden in the undergrowth in the right foreground. Two leats can be clearly seen in the centre of the photograph; the higher is the main cross-site leat but the purpose of the other is not now clear. (Photograph by the author.)

be traced in the thick undergrowth in the area. The tank lies in exactly the same position in relationship to the opencast which forms the western end of the mine as the hushing tanks of the Asturias, that is, at one side and very near the top (see fig. 13). Tank C seems to have been supplied with water by a simple cut-off leat from the main leat which passes directly overhead, and it is also right at the top of its opencast, in this case at the eastern end of the mine. Thus the mine is more or less symmetrical, with a tank at each end, and two more in the middle each serving an opencast. Below each opencast there is a wide valley running down to the Rio Boeza in the plain. These valleys were obviously cut by the action of water, but they are not now very wet and are much larger than nearby gullies taking the same amount of water. Their position below the opencasts must therefore be significant, and taken in conjunction with the presence of hushing tanks above each opencast they make it clear that the main working method in use at the site was a kind of hushing [33]. No doubt the debris-laden water was channelled into sluices at the bottom of the mine, and this will have created the valleys running down to the Boeza when it was allowed to drain away.

One further feature of the mine at Castropodame is worthy of note. Looking up at the eastern end of the site from below it is possible to see the line of a leat running round the spur from the east and feeding a gully which runs straight down the slope. It is clear from comparison with the similar features at mines in the Asturias, noted above, that this gully was a 'hush gully' which was presumably used to examine the hillside a little to the east of the eastern opencast to see if it would be worth working the hill in this area; the obvious conclusion was that it was not. This gully derived its water supply ultimately

[33] Griffith, op. cit., n. 25, 121–2, makes it clear that hushing can be used in the mining of alluvial deposits (though the reason for its use at Castropodame is unlikely to have been lack of water.).

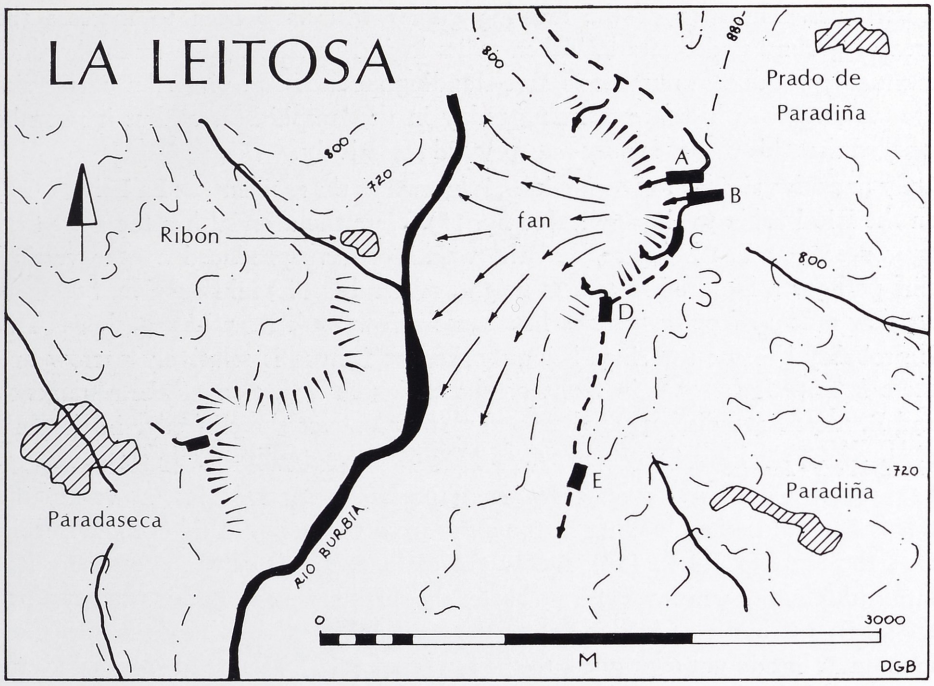


14 Las Médulas: the system of gullies below tank B. The 'amphitheatre' is to the right. (Photograph by the author.)

from tank D, and it seems probable that the purpose of this tank was to prospect for further working areas in the immediate vicinity of the mine. There may indeed have been working further to the east in the area around Turienzo Castañero, perhaps first discovered in this way.

It is now possible to return to the mine of Las Médulas. As Lewis and Jones have noted, the greatest problem with respect to any understanding of this site is the question of the appearance of the area in its pre-mining stage, that is, how much of the alluvial has been eroded by purely natural processes. Negative evidence, the absence of any features connected with the use of water on the site on the many isolated pinnacles and mounds of alluvial in the amphitheatre-shaped bowl at the centre of the mine, would seem to suggest that a large part of this latter feature is the work of nature. The question must remain an open one however. Certainly the number of aqueducts supplying the mine argue that a massive undertaking was carried out, and the recent discovery of a new tank and its connected gully system at the end of the western ridge, higher by several metres than the surrounding land and thus cut off from the water supply system for a distance of over 500 metres, suggests strongly that at least a considerable portion of the alluvial of the 'amphitheatre' was removed by Roman activity. The amount removed would in any case look to have been much more than it was if there had been a pre-existing valley or valleys where now there is the 'amphitheatre', as indeed the heights and general shapes of the free-standing pinnacles seem to show.

Several tanks are known on this site; the most interesting is one of the largest (both here and in the north-west in general), tank B. The surviving remains make it quite clear that the water from the tank was led into two different but complementary gully systems. The first zigzags down the slope below the tank and then cuts into the 'amphitheatre'; it cuts across the other system which



15 Plan of the mine at La Leitosa. – M. 1 : 40 000.

16 La Leitosa. The mine from the west. Note the 'fan' in the foreground. (Photograph by the author.)

seems to have run straight down the hillside from below the tank (see fig. 14). The latter gully must have been the earlier on the site as it is cut and its various sections left as a kind of hanging valley by the first. The working method in use here thus seems to have been a system of crossing gullies presumably worked by the ground sluicing method suggested above as the second method in use at Los

Castellones. The idea of the crossing gullies will have been to increase the area of ground under attack. Taken to its logical conclusion the method would eventually produce a number of free-standing mounds and pinnacles of alluvial similar to those which are standing today in the 'amphitheatre', but it must be stressed that this theory is only put forward tentatively.

Only one mine similar to Las Médulas is known at the moment, at La Leitosa (37) on the Rio Burbia to the north (see fig. 15). Here the alluvial has the same firm structure as at Las Médulas, and the workings have produced a near vertical cliff perhaps a hundred metres in height. A number of tanks survive, but there are few traces of gully systems like those below tank B at Las Médulas. This is probably because the ridge being worked at Leitosa is relatively narrow and there is not much room in front of the tanks; indeed, two of these, tanks A and B, must have discharged their water straight over the cliff edge in the final phase of the working. Only tanks C and D now have a gully system attached.

La Leitosa provides one very important parallel with Médulas, however, and this is best seen when looking at the mine from the opposite side of the Burbia, near the mine of Ribón (34). Below the main opencast of the mine there is a large alluvial fan which was formed after the surrounding mountains had attained their present shape, as is made clear the way gullies and valleys cut into those mountains but do not continue into the fan (see fig. 16). The point from which the material of the fan spreads out is the central point at the foot of the opencast and this makes it obvious that the fan was created in the course of the mining operations as the vast quantities of debris-laden water were allowed to run down to the river after they had been treated for the gold they were carrying in suspension. When Las Médulas is re-examined in the light of this knowledge it becomes obvious that there are similar features below the various parts of the mine. This is especially clear in the area around the ermita de San Juan de Vilarello, an isolated building on a small island of rock standing out above a nearly flat plain which slopes gradually and evenly down to the narrow valley from the Lago de Carucedo to the Sil. Here the Arroyo del Balén, the little stream which drains the lake, has cut a section through the plain and revealed that it is at least thirty metres deep at this the lower end, composed of evenly laid beds of gravel which become finer at the top. Again it is clear that this gravel plain was laid down after the main drainage pattern had been imposed. If it is accepted that the plain was the result of the workings at the mine then the scale of work implied is a further very strong argument in favour of the theory that the 'amphitheatre' is largely the creation of Roman mining. Further support comes from the valleys below the workings on the southern spur at Médulas. These valleys are all steep-sided and v-shaped except for one, and that is the valley immediately below the opencasts, the one into which the effluent will have drained.

Some mention should be made here of the aqueducts which supplied the hard rock and alluvial mines with the large quantities of water they required. There are substantial traces of such aqueducts throughout the Roman mining areas and the mines themselves can often be traced by following an aqueduct down to its destination. Pliny was obviously impressed by this aspect of the work of

17 Cabrera valley: rock cut and built up aqueduct supplying the mine at Las Médulas. (Photograph by the author.)

the mining engineers; he talks of the 'problem of running aqueducts mile after mile along mountain ridges to wash away mining debris ... the incline must be steep to produce a surge rather than a trickle of water; consequently high-level sources are required. Gorges and crevasses are bridged by viaducts. Elsewhere protruding rocks are cut away to allow the placing of flumes' [34].

This description can be shown from the remains to be substantially accurate. The longest aqueducts serving the mine of Las Médulas, for instance, may have been over 50 kilometres in length. The need for a high-level source will be apparent when it is considered that most of the mines are themselves more than a thousand metres above sea level. Pliny must have been confused, however, to write that the aqueducts should have a steep incline. The surviving examples are all so carefully levelled that it is impossible to tell which way they are inclined simply by walking along them. The need for a rush of water comes later in the mining process (see above, p. 40). An example of the rock cutting made necessary by protruding rocks is shown in fig. 17, of one of the aqueducts supplying Las Médulas. This view is particularly interesting because it shows something which Pliny does not mention; that is, how the Romans overcame the problem of running the aqueduct along a loose slope. Earth and stone banks were built up with carefully constructed dry stone revetment walls to hold them in place. The success of this system is often demonstrated in the Asturias by the survival of the line of an aqueduct as a vegetation covered

[34] Pliny, Nat. hist. XXXIII, 74.

ledge running across a fairly steep scree slope. No examples are known of viaducts; the remains suggest that such bridges were usually avoided. They will presumably have been constructed of wood when they were necessary.

Placer mining

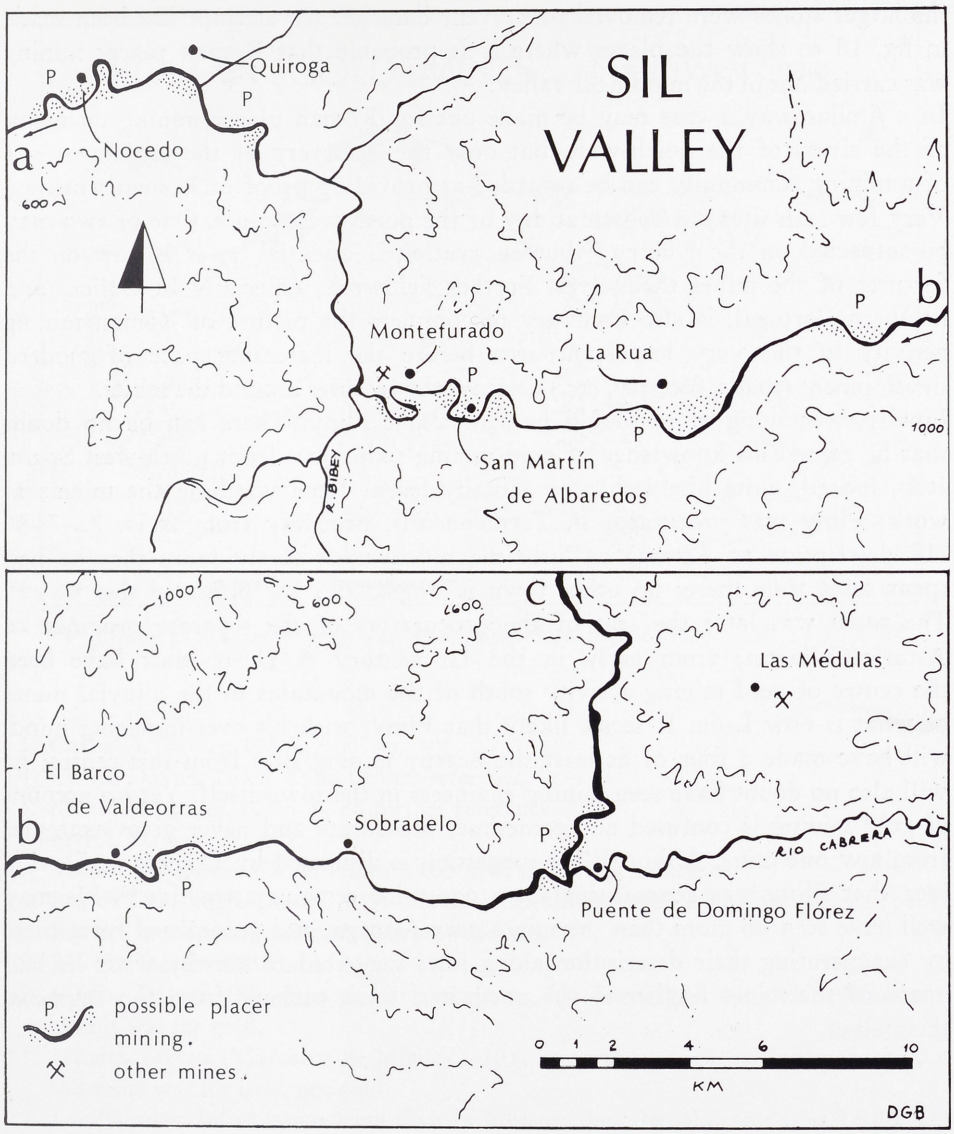
This is the most difficult of all mining operations to discuss with regard to the Romans because of lack of evidence. In hard rock and alluvial mining the Romans had methods which were clearly their own, but this was not the case with placers. This means that it is extremely difficult to date placer mining activity in any particular place. Only at one mine, Montefurado on the Rio Sil (40), is there sufficient evidence for a strong case to be made out for placer mining carried out by the Romans. Here Lewis and Jones have suggested the presence of a hard rock mine which was eventually turned into a rock cut tunnel through a spur around which the river at one time made a very sharp turn [35]. The Romans led the river through this tunnel and in this way cut off the loop in the river so that they were able to treat the whole of the river bed thus exposed. This was a highly elaborate way of making it possible to work part of the bed of the river, and presumably only occurred because it was possible at the same time to cut the necessary tunnel at least partly through gold-bearing rock.

Normally placer mining is carried out by exposing part of the river bed either by diverting the river for a short distance or by constructing a dam across part of its bed and working this part, and then moving the dam, and so on. These operations are carried out in summer when the river is low and after the torrents of winter and spring have (it is hoped) brought down more gold from the mountains. The kinds of construction in use are not designed to last for more than the one season in which they are used; they are usually destroyed by the force of the river in winter and would certainly not survive for many years. Montefurado is a freak circumstance in this respect, and even there it can only be said that the Romans made it possible to mine the placers of the river bed; there is no actual proof. The situation there is obscured by the presence of considerable 19th century workings. Other Roman placer mining sites must be a matter for conjecture.

The valley of the Rio Sil below Montefurado is one of the most likely areas for the Romans to have mined placers. The Sil is a noted auriferous river and there was a considerable Roman mining presence in the valley already, at Las Médulas and Montefurado. The river flows in a wide valley in several channels spread across banks of gravel in the area of Puente de Domingo Flórez (42); from Sobradelo, above el Barco de Valdeorras, down to La Rua, that is the area known as the Valdeorras (41) [36]; and around Quiroga, especially opposite

[35] Lewis and Jones op. cit., n. 4; but see also Domergue for an alternative and perhaps even more complicated explanation, op. cit., n. 5.

[36] The name does not seem to be concerned with gold; one suggestion is that it comes originally from the name of the tribe which lived in the area in Roman times, the Gigurri, via the me-



18 Probable sites of Roman placer mining in the middle Sil valley. – M. 1 : 200 000.

Nocedo (39). The river also meanders frequently in these areas, and they are thus suitable for placer mining, since gold in suspension in a river is most likely to be deposited on the inside bends of its meanders, where the current is at its slowest. In several places there are rock piles along the banks of the river implying the treatment of the material from the river bed in sluices from which

diaeval name of Val de Guirrez. See A. Schulten, Los Cantabros y Astures y su guerra con Roma (Madrid, 1943). Domergue, op. cit., n. 5, 257, n. 7, suggests a connection with the Spanish 'orres' or 'orras', land broken up and cut by valleys.

the larger stones were removed to prevent damage. An attempt has been made in fig. 18 to show the places where it is probable that Roman placer mining was carried out in the middle Sil valley.

In a similar way a case may be made out for Roman placer mining on many of the rivers of the north-west, but only the discovery of the settlement site of a mining community can be regarded as providing proof of Roman working. Very few such sites are known at any of the north-west mines. One or two may be suspected on the Duerna [37] but excavation is essential, as it is now on the features of the mines themselves. Further fieldwork, especially in Galicia and northern Portugal, is also necessary to complete the picture of Roman mining activity in this very important area before the increasing pace of modern development (roads, forestry, etc.) destroys the features around the mines.

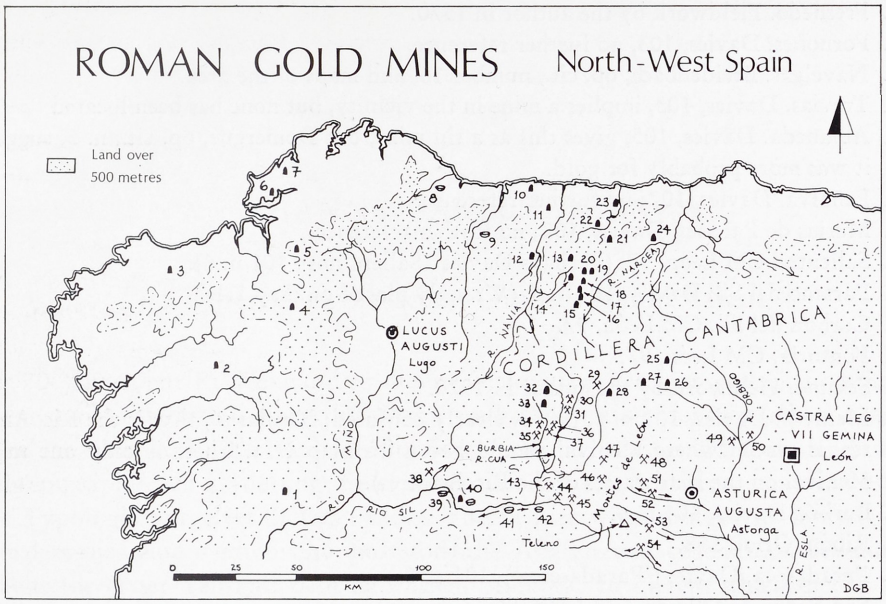
Finally, something more should be said about Pliny. There can be no doubt that he gained his knowledge of gold mining techniques from north-west Spain. It is, indeed, quite likely that he actually learnt from watching the miners at work: Pliny was procurator in Tarraconensis, probably from A. D. 72–74 [38]. His description of Astorga as 'urbs magnifica' must surely mean that he had spent some time there; no other town is singled out for praise in this way [39]. The town was later the seat of the procurators of the separate province of Asturia/Callaecia; from early in the 1st century A. D. it must have been the centre of gold mining activity south of the mountains in the alluvial mines of what is now León. It seems likely that Pliny, with his ever-inquiring mind, will have made a tour of at least the nearby mining sites from this centre; he will also no doubt have seen mining engineers in the town itself. Yet his account of gold mining is confused and sometimes inaccurate and never gives examples from any one mine. Although the suggestion is dismissed by Domergue, Davies' idea that Pliny was generalising from one mine remains attractive [40]. He may well have seen no more than the mines near Astorga, and generalised from these by exaggerating their description along lines suggested to him by what he had heard of the mines further to the north and west, perhaps from the engineers themselves.

Appendix

Key to map, fig. 19. The following symbols have been used on the map for the different types of mines: ▲ for hard rock; ⚒ for alluvial; and ⊕ for placer mines. The following abbreviations are used in the brief notes on the sites: Davies, for O. Davies, Roman Mines in Europe (Oxford 1935); CM León, for Gomez Moreno, Catálogo Monumental de León (1925); and Oriol, for R. Oriol, Minas de Oro del Duerna en la Provincia de León. Revista Minera, Metalurgica y de Ingenieria, XLVII, 1896, 197 ff. References are normally given to Davies, who gives further references; where he does not this is noted.

1. Carballino. Davies, 103; no further reference.
2. Fornos. Davies, 103 and n. 9.

[37] See Jones and Bird, op. cit., n. 6.
[38] R. Syme, Pliny the Procurator. Harv. Stud. Class. Phil. LXXVIII, 1969, 201–236, esp. 215–227.
[39] Pliny, Nat. hist. III, 28. [40] Davies, op. cit., n. 1, 101.



19 Roman gold mines in north-west Spain, general site location map. – M. 1 : 3 000 000.

3. Carballo. Davies, 103 n. 7.
4. Curtis. Davies, 103 n. 8; no further reference.
5. Monfero. Davies, 103 n. 8; no further reference.
6. Ferrol. Davies, 103 n. 7.
7. Valdoviño. Davies ('Valdoviños'), 103 n. 8; no further reference.
8. Rio de Oro, Lugo. Davies, 103: 'the name speaks for itself'; but this does not prove R o m a n working, and none has been located.
9. Rio Eo. Davies, 103 and n. 6.
10. Salabe. Davies, 105, gives this as a tin mine, but Domergue, op. cit., n. 5, suggests that it was for gold.
11. Miudes. Davies ('Carcobas de Miudes'), 103; no further reference. It is possible that this mine was for iron, not gold.
12. Las Furadas. Information from Oviedo Museum, but the mine was not located and it may have been for some metal other than gold.
13. Puerto del Palo. Davies ('Cueva de Juan Rata'), 103; no further reference but see the references given for number 14. It is also probable that Davies' reference to 'Lago', 103, refers to this mine.
14. Rio de Oro I (Asturias). Mining Journal for 8, 2, 1896, 171 and 24, 2, 1894, 199. There are said to be seven sites; only one was located but it has been numbered in case there should be others.
15. Braña la Folgueirosa. Davies ('Vegalagar'), 102 and n. 3.
16. San Felix de las Montañas. Breidenbach, Das Goldvorkommen im nördlichen Spanien, Zeitschr. f. Prakt. Geologie, 49, 1893, 16 ff.
17. Faidiel. Breidenbach, op. cit., number 16.
18. Iboyo. Mining Journ. for 24, 2, 1894, 199.
19. Figueras. Mining Journ. for 24, 2, 1894, 199; but the mine could not be located in 1969/70 despite careful search.

20. Fresnedo. Fieldwork by the author in 1970.
21. Fornones. Davies, 103, no further reference.
22. Navelgas. Breidenbach, op. cit., number 16, and maps of the area.
23. Trevias. Davies, 103, implies a mine in the vicinity, but none has been located.
24. Ablaneda. Davies, 105, gives this as a tin mine, but Domergue, op. cit., n. 5, suggests it was more probably for gold.
25. Peñalva. Davies, 102; no further reference.
26. Murias de Paredes. Davies, 102; no further reference.
27. Salientes. CM Leon, 97. (Perhaps Davies' 'Salientinos', 101 n. 6).
28. Paramo del Sil. Davies, 101 n. 6. (Wrongly placed on map IIIa).
29. Corbon del Sil. CM León, 97.
30. Fontoria. CM León, 97.
31. Sesamo. Fieldwork by the author in 1970.
32. Menival. Davies, 101 n. 6. (He is clearly confused; 'Anclares', that is the Rio Ancares, is placed where Menival should be on his map IIIa. There is only one mine: Menival on the headwaters of the Rio Ancares).
33. Burbia. Davies, 101 n. 6.
34. Ribón. Oriol, 198.
35. Paradaseca. Davies ('Paradasesca'), 101 n. 6.
36. San Pedro de Olleros. CM León, 96.
37. La Leitosa. Oriol, 198.
38. San Pedro (Rio Lor). Fieldwork by the author in 1970.
39. Nocedo. Fieldwork by the author in 1970, and c. f. Domergue, op. cit. n. 5, 257.
40. Montefurado. Davies, 102 and n. 1; but he clearly confuses Montefurado on the Sil and Monte Furado in Asturias (an aqueduct channel connected with the workings at Puerto del Palo), following O'Reilly, Proc. Royal Irish Acad., ser III VI, 1901/02, 65. See also Lewis and Jones, op. cit., n. 4, and Domergue, op. cit., n. 5.
41. The Valdeorras. Fieldwork by the author in 1970, and c. f. Domergue, op. cit., n. 5, 257.
42. Puente de Domingo Flórez. Fieldwork by the author in 1970, and c. f. Domergue, op. cit., n. 5, 257.
43. Las Médulas. Davies, 102 and n. 2. See also Lewis and Jones, op. cit., n. 4, and Domergue, op. cit., n. 5, app. I, 280 ff.
44. Castroquilame. CM León, 96.
45. Pombriego. CM León, 96.
46. Espinoso/Compludo. Three mines. CM León, 96.
47. Castropodame. CM León, 96.
48. Santa Cruz de Montes. CM León, 96.
49. Las Omañas. Fieldwork by the author in 1970.
50. Rio Braña. Davies, 102 n. 3.
51. Rabanal del Camino. J. M. Luengo, Explotaciones auriferas romanas en Rabanal del Camino (Leon), Archivo Esp. de Arte y Arq. 1935, 287–291.
52. Rio Turienzo. H. Quiring, op. cit., n. 3, 1957.
53. Rio Duerna. Twenty-three mines; Los Castellones is marked. Davies, 102 f. See also Jones and Bird, op. cit., n. 6.
54. Rio Eria. Three mines (but probably more to be located). Davies, 103; no further reference, and fieldwork by the author in 1970.