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LEAD MINING IN SPAIN IN THE 19TH CENTURY: SPANISH INDUSTRY OR BRITISH ADVENTURE?

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Abstract: This article explores whether Spain's attempts to exploit her mineral wealth in the 19th century benefitted the national economy or the foreigners who capitalised and managed the ventures. It summarises the views of Spanish writers, and indicates the methods and plant used for lead smelting, demonstrating that although technology was not limited by national boundaries it was modified by local circumstances. A fictional view is given of the British company community in Spain. In technology and output, Spanish lead mining in the 19th century was successful, but the benefits were seen as going to the foreign-owned companies rather than the Spanish people.

THE SPANISH ECONOMY

In the 18th century, Spain had had a vast American empire which gave stimulus to the production and export of cotton textiles, and had seemed poised for development. The loss of the empire and the vital overseas market in the early years of the 19th century forced her back upon her own poor agricultural resources.

An arid country, with harsh winters in parts, Spain suffered short growing seasons, barely able to support her peasantry and increasing numbers of desperately poor landless labourers, let alone produce surplus wealth to create a market for any kind of manufactured goods. During this period, the population was steadily rising from the 10.5 million of 1800, but agriculture was not encouraged to improve methods because merely by taking in extra land the increasing population could be fed. With declining foreign trade in the first half of the century, and successive civil wars and changes of government up to 1876, Spain offered a poor foundation for economic development.

The government was forced to seek ways of closing the gap between its country's economic development and that of other European countries, but did not really know how to go about it so took little action. Despite having important mineral resources, they had not the wealth to exploit them. They allowed foreign investment in the country after 1850, but this merely created enclaves of activity that hardly rubbed off on the rest of the economy at all.

Communications in Spain were poor, with the road system built under Charles III deteriorating for lack of upkeep, and the rivers not suitable for navigation, being either dried up or steep and fast flowing. Mules remained the major form of transport for the rural population. A national rail network was built, financed by foreign investment, which was actively encouraged from 1855. The network was not planned to exploit areas of natural resources, but rather to link each region to Madrid. As such it was not very successful, indeed may have been positively harmful as it diverted funds from other possible projects. The agricultural slump of 1867 brought the process of industrialisation to a halt and caused foreign investors to be cautious for a while. The industrial history of Spain can be summarised as a long struggle to provide alternative sources of demand from the local agricultural regions with little disposable income, a struggle which was ultimately unsuccessful. Agriculture was a source of fundamental weakness in the Spanish economy, where the level of income remained so low as to prevent all possibility of a balanced economy.

LOCKED-AWAY WEALTH - THE MINERAL INDUSTRY OF SPAIN

Spain's rich mineral resources provided a suitable source for investment, being second in importance only to the textile industry. Mining experienced successive booms, the capital being provided from abroad, and most of the resulting ore was exported. Overall, little ore was processed in Spain. The main ores exploited were lead (with silver), copper, pyrites (sulphur), iron and mercury. The State gradually relaxed its controls over mining rights, culminating in new mining laws in 1868, which helped to encourage foreign capital. By 1900, minerals and processed metals accounted for 30% of Spain's exports.

Lead mining had already become well-established on a large scale before 1868 (Fig.1). Spanish lead had been heavily exploited by the Romans, but the mines were abandoned with the collapse of the Roman Empire in the west. By the 16th century the town of Linares was one of the most important in the province of Jaen because of its lead mines, the development of the mines having a profound effect on the social structure and demography of the town. But Spanish lead mines did not seize the opportunities to expand in the 18th century, and although the indigenous industry continued to produce a respectable amount of lead, with Andalusian lead forming 8% of total exports in the 1830s, the overall output declined in the face of the development of the British mines. In 1838, Britain was producing 40% of world output, half the European output of lead in the 1840s and 1850s, but this supremacy could not be maintained.

In 1852 the English-run Linares Lead Mining Company was set up, followed in 1854 by the Fortuna Company, also English, bringing British mine captains and agents to Spain to supervise their Spanish workforce.

Spain began to produce large quantities of lead, which regularly sold below the British price. By the 1870s this competition, coupled with the declining ore reserves in Britain, produced a depression in British mining and unemployment in all districts, with miners looking abroad for new opportunities. By the 1880s, Britain's share of world output was down to 14%, with Spain being the largest producer from 1868 until the end of the century. Lead was mined and smelted in many areas, around Jaen, Badaioz, Cordoba and Cuidad Real; apart from the British mines, others were sunk and operated by French, Belgian and German capital. These foreign-capitalised mines were on a very different scale from the original Andalusian operations.

The first big copper mines were sunk by a French company near Huelva; the associated pyrites provided sulphur which was in heavy demand by the British chemical industry who required sulphuric acid; this encouraged further copper and sulphur mining. From its setting up in 1866 to 1909, the Glasgow-based company, Tharsis Sulphur and Copper Mines, recorded an annual average return of 20% on its mining operations in Spain. In 1873 the richest of the concessions, the Rio Tinto mines, were leased to an Anglo-German-French consortium; within six years they were the most prolific copper and pyrites mines in the world, paying dividends of an amazing 70%. At the Almaden mines mercury was produced, having effectively a world monopoly. Iron was mined near Bilbao and a useful two-way trade with Welsh coal was established.

Although the exploitation of Spanish minerals was successful, little of the resulting wealth found its way back into the Spanish economy, thus contributing little to the wealth of the country or its industrial progress. According to A. Ramos Oliveira, a very biased writer on modern Spanish history, the government was at fault for allowing these companies to be wholly foreign owned, their success achieving only the sucking of funds out of Spain.

A SPANISH ATTEMPT TO EXPLOIT ITS' OWN LEAD: SIERRA DE GADOR, 1820-1860

An article by Perez de Perceval Verde published in Spain in 1983 is worth quoting in some detail for the light it sheds on the difficulties faced by the Spanish in attempting to exploit their own mineral resources in the face of little capital, technical skill or organisational experience. It gives a useful amount of technical detail which makes for interesting comparison with the developments in Britain, and demonstrates how technical knowledge was being transferred at quite an early stage of foreign involvement in Spanish mineral exploitation. The importance of the San Andres plant in establishing good practice is clearly stated, as are the reasons for the decline of the industry in the area, and the minimal fundamental effect on the long-term economy of the area.

Lead had been known in the Sierra de Gador for a long time, but was not exploited on a large scale until the 19th century, when the government needed funds and tried to promote mineral exploitation, over which at that time they had a monopoly. The monopoly over galena and lead was removed in 1817, but little activity took place until an uprising in 1820. This resulted in a Decree which allowed any Spaniard or foreigner to exploit and profit from the mining of any metal found. This motivated the inhabitants of Sierra de Gador, who had in their region plentiful resources of rich ore, with a metal content between 70% and 80%. The extraction of the lead required little investment or technical resources. Also, the deposits were close to the sea, so transport to the European market was not difficult. There was much demand for lead abroad as a result of industrialisation, so most of the lead from Sierra de Gador was exported. It was not permitted to export ore, so an industry grew up to process and smelt it. This consisted of many small processing plants, as the capital was not available locally for anything more; operations were poorly planned, using outdated methods and having only irregular production. Furnaces were built of sandstone and adobe, using esparto grass and scrub for fuel. They produced 50%-55% lead, leaving slag with a 30% metal content, but they did not resmelt this, being concerned only with immediate profit.

Much of the lead was exported in bar form to Marseilles. There were as many as one hundred small smelting plants, indiscriminately exporting huge quantities of lead to many parts of the world. In 1827 lead was the third most important export, but the market was soon saturated and the price paid in England fell from £25 10s per ton in 1825 to £12 4s per ton in 1830. Production had increased from 9,000 tons in 1820 to 37,000 tons in 1829, when the area was producing ten times more than the Harz region of Germany, and was only exceeded by British production. This crisis precipitated important changes in the Sierra de Gador.

New technology was introduced into the smelting process with the building of the San Andres plant in the coastal town of Adra in 1822. Capital, initiative and experience had to be brought in from Malaga. The plant was very successful both for the quantity and quality of its output. In 1824 it introduced the "English furnace" or reverberatory furnace into Spain, which used coal. By 1827 the plant had a steam engine. The plant set an example and soon stimulated the building of other reverberatory furnaces.

The crisis over lead prices led to the closing down of many small smelting plants, bringing the golden age to an end, but it encouraged technical advances. Slag began to be resmelted, using Spanish furnaces. On the commercial side, there was debate between those who wanted to improve technology and reinvest capital, and those who preferred to respond more directly to the demands of the market even it if meant using outdated techniques. During the 1830s and 40s exports were not as high as in the 1820s, being around 20,000 tons per year, but the exports were concentrated into the hands of fewer trading houses, so that by 1845, six companies exported 90% of the lead from the Sierra de Gador.

Miners and those living near the smelters were at great risk of lead poisoning, which led to death or paralysis, but it was twenty years before action was taken. Towards the end of the 1830s the San Andres plant installed condensation chambers to capture fumes and retrieve vaporised lead, and were soon copied by others.

The fuel used for smelting was of three types - scrub and esparto grass in the small plants [which may have been of the ore-hearth type], olive and oak wood in the Spanish (slag) furnaces, and coal in the English (reverberatory) furnaces. Almeria was rich in esparto grass, but great quantities were uprooted, causing the destruction of the grass supplies and the closure of many small smelting plants. Eventually in 1850 there was a total ban on smelting with scrub. The oak trees which were cut down for fuel were not replaced, so wood had to be imported from the Balearic Isles. The ore-hearths requiring wood for fuel were replaced in the 1840s by reverberatory furnaces which required coal. Supplies of cheap coal were not easy to find - it could be brought from Asturias or imported, but from 1821 to 1832 only the smelters of San Andres and Bonaplata in Barcelona were permitted to import coal. Import restrictions were then lifted but high duty was charged until 1837 when tariffs were lowered. After 1849 tariffs continued to decrease until 1869 and the free trade agreement.

The high price of coal was a real problem for the metallurgical industries. In 1841, San Andres used over

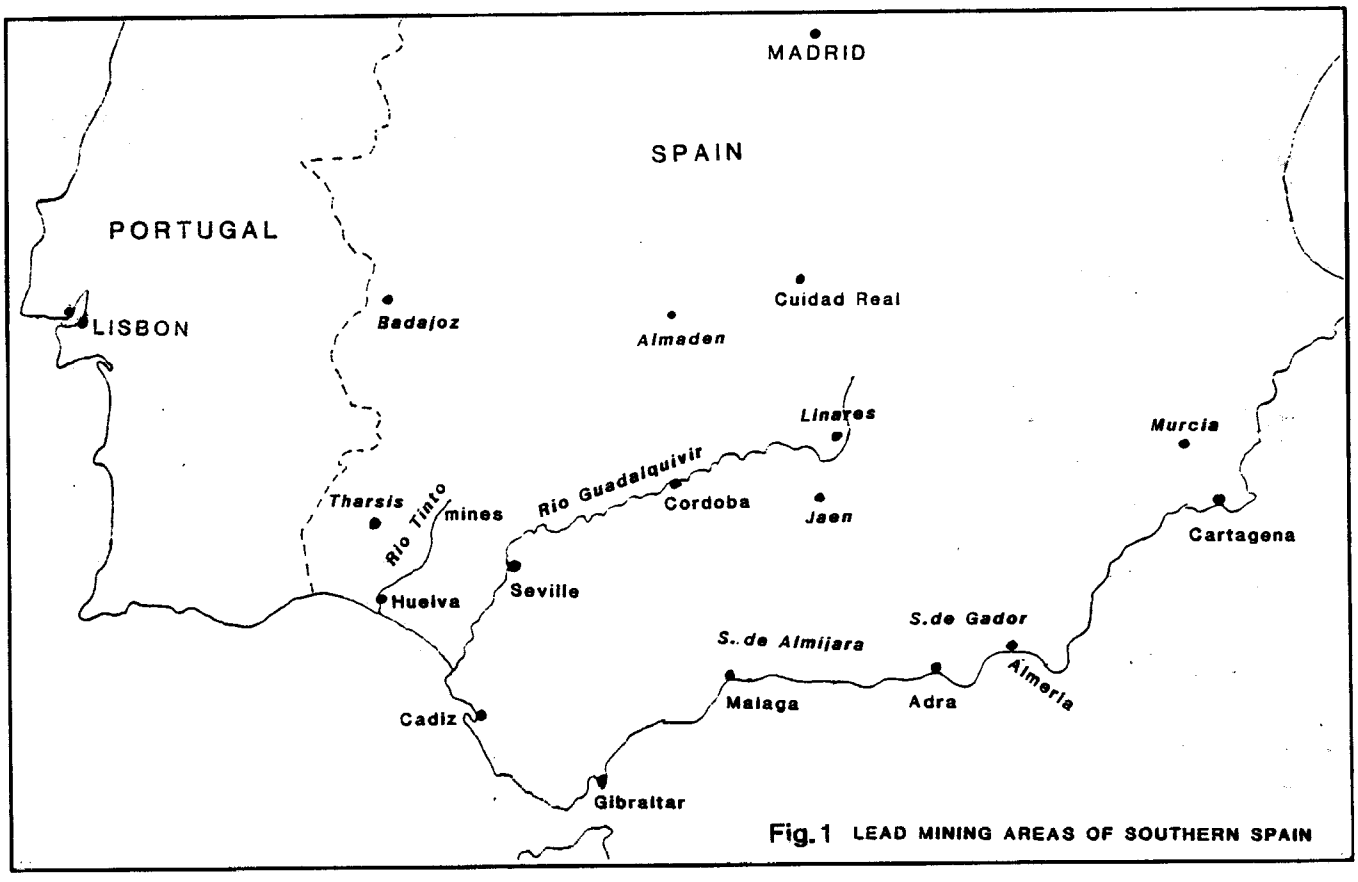

Fig. 1 LEAD MINING AREAS OF SOUTHERN SPAIN

9,000 tons of coal. The lead industry needed to reduce costs in order to compete with foreign goods. In the 1830s there was conflict between the miners and the merchant-smelters. The crisis over the price of lead caused moves to restrict output by having the mines worked for only five months of the year, but this plan was soon abandoned. The ore was mined indiscriminately in an attempt to achieve as much ore as possible in the least amount of time. The mines were crudely and uneconomically worked, and many mines invaded neighbouring properties, causing regular disputes. The businessmen had learned from the lead crisis that it made better sense to agree amongst themselves to preserve the market. The sale of lead was to be controlled, and all sold at the same price. Improved unity, greater wealth and a clearer understanding of the market enabled the businessmen and manufacturers to exercise some control over production and price. They bought from the miners when the price was low, and occasionally forced the price down by not buying all of one year's production of ore. In 1837 the miners began to form associations to combat these pressures by doing their own smelting.

The San Andres de Adra smelting plant was established in 1822 by Rein and Co. and was the most important plant in the region, introducing English furnaces in 1824 and a steam engine in 1827. In 1833 it went bankrupt and was sold to Josiah Lambert who formed the Collman and Lambert Co. Business was not good as the plant was working below capacity; in 1835 it went to Scholt Bros & Grund, and was sold again in 1837 to Manuel Augustin Heredia from Malaga, one of the most important industrialists of the day. Under him San Andres achieved technical developments and good profits. It was the leading plant in Spain and one of the most important in Europe, having eventually ten reverberatory furnaces.

One of San Andres' most outstanding improvements was in making use of waste heat from the furnaces to heat the steam boilers. They used "hornos de manga" [ore hearths] for resmelting, which were replaced in the 1840s by "hornos atmosfericos" [draught furnaces?] - by 1852 they had four of these. They also had purification furnaces to refine their own lead and also lead brought in from Carthagena; they had furnaces for the treatment of litharge, or lead carbonate. There was also a laboratory for assaying all types of ore.

San Andres produced lead sheet and tube using steam-powered machines, and in 1851 could make continuous tube of any length. They had a shot tower 50 metres high for making bullets and shot, and in 1853 installed a machine to make bullets without heat. Once the condensation chambers were built they were able to adopt a Dutch technique for making white lead. Red lead was produced with two reverberatory furnaces. Most operations were mechanised, using three steam engines, that installed in 1827 was 14 h.p.; 1841 - 25 h.p.; 1851 - 8 h.p.

Another important part of the work at San Andres was the separation of silver. In 1838, silver-bearing lead ore was discovered to the east of the province of Almeria, and in 1841 the first separation of silver took place. Until 1843 San Andres was Spain's major silver producer. Later on, factories in the Almagrera Range took over silver production, and Heredia concentrated on the processing of lead ore with a low silver content, using the Pattinson method. In 1851, the 5% of silver obtained from this "poor lead" was exempted from duty, which encouraged Heredia's specialisation. But in 1852, it was permitted to export all silver-bearing lead, so factories in the Sierra Almagrera only exported lead bars with their silver content intact.

The San Andres plant was always the leader, introducing new techniques and influencing the future of lead

production. Everything in the factory was of the best and most modern, with all processes mechanised, and the workers did not have to exert themselves too much!

1840 saw the beginning of a gradual exhaustion of the ore mined in the Sierra de Gador. The mining ground spread further east but the ore was of poorer quality. The number of smelting plants decreased, from 56 in 1837 to only 19 in 1845. The first to close were the small ones, facing both lack of income and scarcity of fuel. Adra became the smelting centre for the region, with the number of plants there increasing in the 1840s.

Revolutionary activity in France ended trade with Marseilles in 1848, and mines and processing plants were at a standstill for several months. The crisis in lead prices beginning in 1847 continued, and prices fell to 1820 levels. Trade with Britain reopened in 1850, and prices gradually improved through the decade. In the latter part of the century Britain imported a large proportion of Spain's lead.

As the resources of the Sierra de Gador were exhausted, processing plants, especially San Anares, were buying in lead from other parts of the coast and inland, most of it for later export.

By the end of the 19th century the metallurgical industry of the region had almost disappeared. The factors contributing to this included lack of an internal market and dependence upon an external market; lack of an industrial class in the province; mining laws and taxes which from 1868 favoured foreign rather than native initiative; and problems with obtaining fuel from either vegetable or mineral sources.

The modern exploitation of Spain's mineral resources can be said to have started with mining and metallurgical processing in the Sierra de Gador. Its success awoke government interest but Spain's economic backwardness meant the country did not benefit as it should. Two schools of mining were established, and students went to Frieberg in Germany to study techniques in use there. The Mining Law of 1825 enabled ordinary people to exploit the ore, but this led to the international crisis in the price of lead.

Little study has been done of the impact of the industry on a local scale, but it is clear that the Sierra de Gador attracted people from Granada and other nearby provinces. In 1839 more than 30,000 people in the area were engaged in mining, smelting and transport. Huge profits could be made without the need for huge investments. The 1820s saw the greatest production and the greatest immigration, the influx of people leading to the development of the areas close to the mines and smelters, for example, Adra and Dalias. When it became clear around 1840 that the mines were becoming exhausted, emigration from the area began, people moving to Sierra Almagrera, and to the mining areas in the province of Murcia, especially Linares. Some moved abroad in search of work. Agriculture in the Alpujarras had been very backward at the beginning of the 19th century, but the mining industry helped encourage agriculture, so that by 1840 it was one of the best cultivated areas in Spain. Mining profits were being invested in the improvement of the land, and demand arose for export crops, particularly grapes and sugar. The wealth of the mining industry created high consumption in the region, but it was not reinvested in other areas, so apart from the textile and sugar industries the general economy of the Alpujarra region remained backward.

Lead processing had reached a level which was technically advanced for its time, and the modern methods in use at San Andres encouraged other plants to follow its lead. Enterprising industrialists were able to raise lead processing to the level of that of other European countries.

SPANISH MINING FROM 1868-1875

A very detailed article by Donezar de Ulzurrun, published in Spanish in 1975, demonstrates statistically the development of all kinds of Spanish mining as a result of the Mining Law of 1868 and the lowering of tariffs on exported minerals in 1870. The statistics are drawn from figures published by the General Direction [sic] of Public Works, Agriculture, Industry and Commerce. They are far too detailed to be summarised easily here, but the original article, being largely composed of tables, is reasonably accessible to readers with a little Spanish. For present purposes, a few useful facts can be gleaned about conditions, operations and output of Spanish mines during this period of intense activity.

The range of minerals found in Spain is wide, although output varies enormously. The list includes iron, lead, argentiferous lead, silver, silver pyrites, copper, silver copper, tin, zinc, mercury, antimony, cobalt, manganese, soda, alum, sulphur, phosphorus, asphalt, coal, lignite, peat, bituminous slate [shale?], auriferous quartz, nickel, anthracite, common salt, barytes and topaz.

The workforce included men, women and children. Men (that is over 16 years old) worked underground; women were paid at half the men's rate and worked above ground, helping to transport the minerals. Children under 16 worked above ground carrying and washing minerals. All worked in poor conditions, and those underground particularly suffered work-related diseases respiratory problems, anaemia etc. There was little change in wages, conditions or hours of work between 1868 and 1878.

Figures were kept of causes of death, serious and slight injury, and noted such causes as subsidence, blasting accidents, asphyxiation, smelting, breakage of machinery, falling rods etc, falling down shafts, and "unclassified". Apart from the latter, which is always the most numerous, the largest cause of death and serious injury was subsidence, and of minor injury the breaking of machinery. Over 3,000 injuries are recorded, out of a workforce for all mines ranging from a total of 40,000 in 1868 to 50,000 in 1872. Spanish labour was cheap, the daily wage being half that of the English equivalent; the twelve hour working day was standard into the 20th century. People gradually began to live closer to the mines so that they could return home each day rather than staying at the mines.

Steam-Powered machinery introduced after 1870 replaced older less powerful equipment - the number of machines fell whilst the total horse power increased. Much of the labour and machinery was concentrated in the lead mining industry, as lead was the major source of mineral wealth in Spain.

Hydraulic engines were in use through this period, their numbers decreasing from 208 in 1868 to 123 in 1874. [We have been unable to translate this more precisely. Is the writer referring to waterwheels? Was there sufficient water for this? Or does he mean something else?] Steam engines remained fairly stable in number and horsepower at around

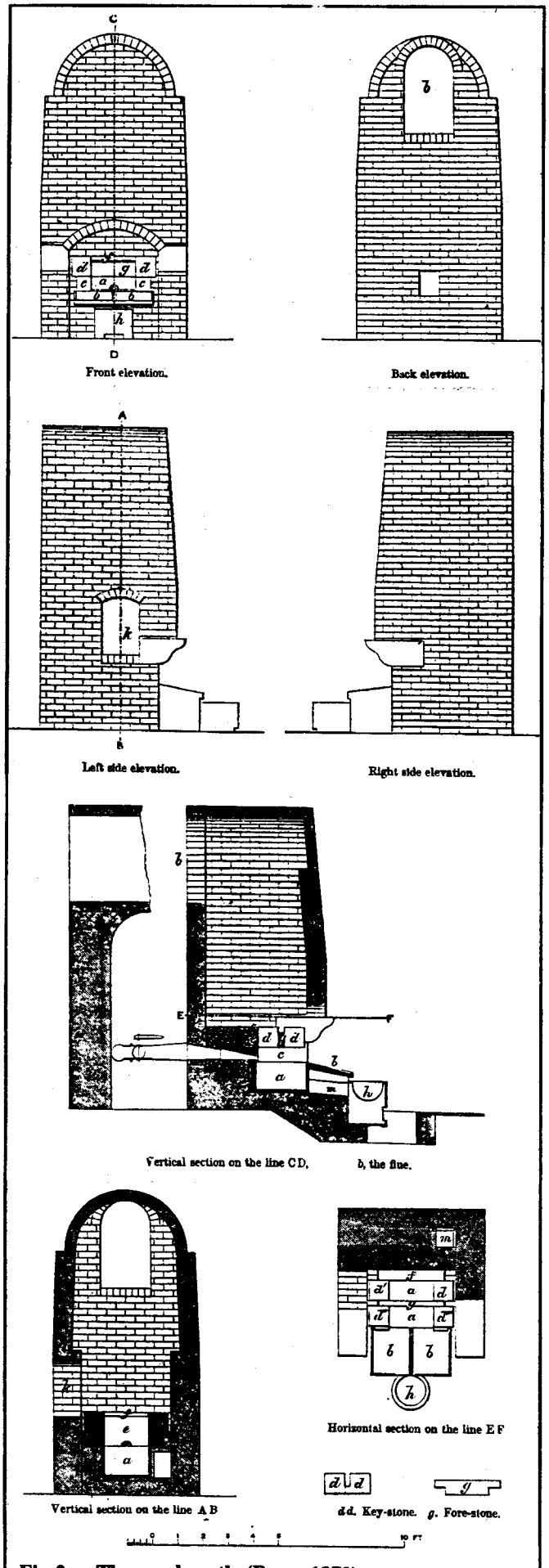

Fig 2. The ore hearth (Percy 1870).

180 engines and 3,300 h.p. Spain was technically 50 years behind the rest of Europe. The lead industry accounted for only a small proportion of these:

	Hydraulic engines	h.p.	Steam Engines	h.p.
1868	1	8	31	284
1869	1	8	40	406
1870	2	18	32	318
1871	1	4	35	443
1872	1	4	33	427
1873	-	-	36	350
1874	1	4	34	399

In 1872, the lead industry employed three kinds of furnaces:

	Active	Inactive
Ore hearths	171	59
Reverberatory furnaces	78	70
Refining furnaces	9	1

These figures indicate the number of separate smelting operations, although the vast majority of the output would have come from the reverberatory furnaces.

Between 1868 and 1875, ferrous metals represented 41% of Spain's total mineral yield, and lead and silver 46%. In terms of exports, lead achieved the greatest importance because it was the only mineral which was exported already processed, as lead bars, representing upwards of 84% of the processed ores exported in this period. However, exports achieved little of benefit for the Spanish economy because, apart from iron, the minerals were mined by foreigners, so exports from Spain enriched the investing country. After 1877, lead and copper was overtaken in importance by increased foreign demand for iron and steel, which did benefit the indigenous Basque iron mining industry.

LEAD SMELTING TECHNIQUES: A SHARED TECHNOLOGY

Percy's Metallurgy of lead, published in 1870, describes, inter alia, contemporary processes in use all around the world for smelting lead and extracting silver. He describes the main types of furnace and their variations in different places, and in so doing demonstrates how techniques were utilised in places far away from their origins. He describes the operation of a number of specific furnaces, including those at Linares and Carthagena.

Leaving aside primitive methods, the two main types of smelting hearths for lead were the ore-hearth and the reverberatory furnace. The ore-hearth, or blast furnace, was a relatively simple device, commonly used in the Yorkshire Dales, in which the ore and the fuel were mixed (Fig.2). It required an artificial blast of air for its efficient operation. A variation of the ore-hearth was employed for the further refining of slag. The reverberatory furnace was generally a much larger affair, where fuel and ores were kept separate and the heat was transmitted by the flow of gases, thus not requiring any form of blowing engine. Percy debated the arguments for choosing either form of furnace, and reviewed the various theories put forward. The choice was by no means an easy one, and depended upon such factors as the fuel available, the type of impurities found in the ore, the amount of ore to be dealt with. In practice the

ore-hearth tended to be used where vegetable fuels were to hand - peat in the case of the Dales - and the reverberatory furnace where supplies of cheap coal were to be had.

In Southern Spain, where coal had to be imported, the "boliche", a small version of the reverberatory furnace, was designed to burn brushwood. The ore hearth was also used in Spain, which would also have used brushwood.

Percy stated that the Spanish smelting works using fragrant shrubs as fuel have been described as giving off a delicious and aromatic odour, contrasting with the "rankest compound of villainous smells" at an English smelting works using coal. It is hard to believe that the fragrances could outweigh the poisonous fumes from the lead, but it is tempting to try to imagine the smell of fuels such as broom, rosemary, juniper, lavender, citrus, thyme and jasmine.

Percy described the Carthagena furnaces, ore-hearths, known variously as hornos de gran tiro, hornos economicos, pavos, or, in other sources, hornos de manga (Fig.3). They were first installed at the Santa Lucia works at Carthagena in 1847. They were specially designed for smelting the poor and impure white-lead or carbonated ores of the Carthagena region, which contain only 6% to 15% of lead, plus iron pyrites and arsenical pyrites, which make smelting difficult. The characteristic of these furnaces is that the air enters the tuyeres by means of a chimney draught, and is not forced by blowing engines as in a blast furnace. The fuel used is coke and the furnace is well-suited to resmelting slags.

The Spanish reverberatory furnace (horno reverbero), a variation on the Flintshire furnace, is described (Fig.4), based on Percy's communications with Mr. Joseph Lee Thomas, who was the local mining engineer at Linares, and the observation of Monsieur Petitgand. The Spanish use the term "boliche" for a smaller furnace, but M. Petitgand detected no difference. The furnaces are built of thick rubble, with clay for mortar. They are lined with refractory bricks. The original furnaces were fired with underwood cut from ilex and gum-cistus. Long condensing flues were introduced in the Linares district, replacing the original 30 foot chimneys. A particular feature was the absence of a grate in the firebox, which seems to be the special merit of the Spanish furnaces. Percy questions the theory of the particular design, and whilst not denying the great value of experience in metallurgy, he warns that experience can be a powerful obstruction to improvement. Similarly, the theorists should not be dogmatic, and should listen to the teachings of experience.

The Spanish slag hearth (Fig.5) was a blast furnace invented specifically for the resmelting of Roman lead slags. It had been tested in recent years at various smelting works in England and Wales, but was abandoned by experienced smelters "who have expressed to me their opinion of it in language far from respectful. Thus one smelter friend calls it a 'beastly thing'". It seems that it allowed considerable volatilisation of lead, and although it was deemed useful for smelting poor slags it was not suitable for rich slags.This description suggests that the resmelting of Roman slags was being carried on profitably in Spain, despite the questionable efficiency of the slag-hearth.

Percy gives a table of the production of lead in foreign countries, which shows that Britain was still marginally ahead of Spain in the late 1860s:

Country	Year	Tons
Great Britain	1868	71,017
Spain	1866	66,803
German States	1867	49,337
Isle of Sardinia	1867	23,255
France	1864	16,692
Belgium	1867	10,352
Greece	1869	8,483
Austro-Hungarian Empire	1867	7,637
Sweden	1868	284

These few extracts demonstrate some of the wealth of information to be found in Percy, and his work repays detailed study. It is noticeable that he took an international view in his researches, and although he inevitably has more British than foreign material, he was at pains to discover as much detail as possible about other parts of the world. In presenting his material, he by no means presumed that British was best, and conveyed the attitude that scientific and technological knowledge should be shared by all in the interests of development.

THE BRITISH COMMUNITY IN SPAIN

Thomas Armstrong's novel of Skewdale (Swaledale) lead mining, *"Adam Brunskill"*, opens in 1879 with a description of the community in Spain in which Adam was born and grows to manhood. This gives a very clear picture of the involvement of a foreign company and its servants in Spanish leadmining. He talks of the London and Andajoz Lead and Silver Mining Company, which may well be based on the Linares Lead Mining Company founded in 1852.

Lead mining in Skewdale had become so depressed in mid-century that anyone who could do so left the area, to work in the Durham coalmines, or the textile mills of Lancashire and Yorkshire. Those left behind were close to starvation if they did not have a cow to help them eke out a living, unless they had had the foresight to invest in land when times were good. Adam's father Jim left Skewdale in the early 1850s, running away with Mary, his bride, to be

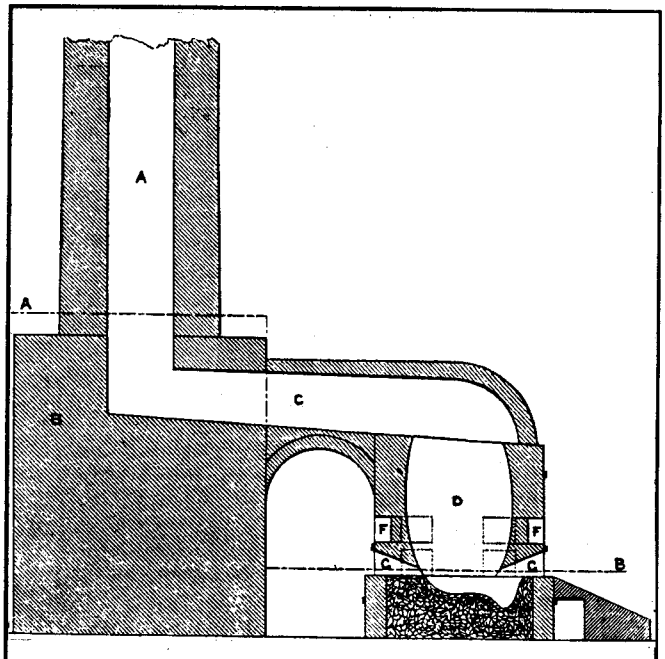

Fig 3. The Carthagena furnace (Percy 1870).

taken on by the Company to go and work in Spain. They took a steamer for the 5-day journey to Spain, then travelled by mule and cart to the mine.

The village is in the foothills of mountains which rise to 6,000 or 7,000 feet. The view from the village is not beautiful - the land is scarred by the crumbling headgear of disused mine-shafts; lead and silver extraction plants are not renowned for their beauty. A vast area has been poisoned by fumes from the smelt-mill chimneys, forming a wilderness with sickly herbage that could kill or maim straying livestock. Nevertheless it is a happy place, and although the older people remember their origins with nostalgia, they are aware of the poverty they left behind.

The Company village has at its centre a main thoroughfare, where the company offices are housed, with a counting-house, a bar-room for the British workers where beer is served, and a separate common room for the Spaniards where food and wine are available. The company provides a minister (there is a stone-built Wesleyan chapel) and a doctor for their staff, and the London office has charge of Jim Brunskill's will and £600 savings.

The British community lives in a separate part of the village, with cottages set around a green - where no decent grass could be persuaded to grow - looking for all the world like a Yorkshire green village, but a closer inspection reveals differences of detail. A roof pitch here, a style of door-latch there, a massive squat chimney, all reflecting connections with the various lead mining areas of Britain - Leadhills in Scotland, Derbyshire, the Mendips - and the faithfully characteristic cottages where the Yorkshire Dales folk live.

British people provide all the company's managers at this site - the general manager, the head agent and his four assistants (of whom Adam is one), a cashier, clerks, and the skilled men - Adam's friend Simon is head smelter at one of the mills. Their families are with them - Simon's wife, baby daughter and mother-in-law live with him. Rivalry exists between the different groups of British - Adam and a Cornishman spar in a contest of strength.

Jim Brunskill is dying, probably from lead poisoning, at the age of about 50, having worked in Spain for nearly thirty years and had buried his wife there when Adam was a baby. At Jim's funeral, the Wesleyan chapel is full, with men from the lead-mines of Durham, Northumberland, the Isle of Man, Alston Moor in Cumberland, Cornwall, Derbyshire, Wanlockhead in Dumfriesshire, the once-famous Leadhills of Lanarkshire, from the western dales of Yorkshire - "Skewdale", Swaledale, Arkengarthdale, Wensleydale, Wharfedale and Nidderdale. The Spanish miners are also present, the southerners more demonstrative in their grief than the grave men of the Asturias in the north. Despite this touching display of community feeling, the funeral tea is given only for those with Skewdale connections. The old links are the strongest.

Adam decides to leave Spain to travel to Skewdale, where he knows times are hard and lead mining is in a poor way. He is given greetings to carry to all manner of friends and relations who live along the Dale, and the Head Agent is surprised to remember that Adam and his friends have never seen Skewdale but know it only through the conversations of their elders.

Adam travels from the mine with the mule teams hauling

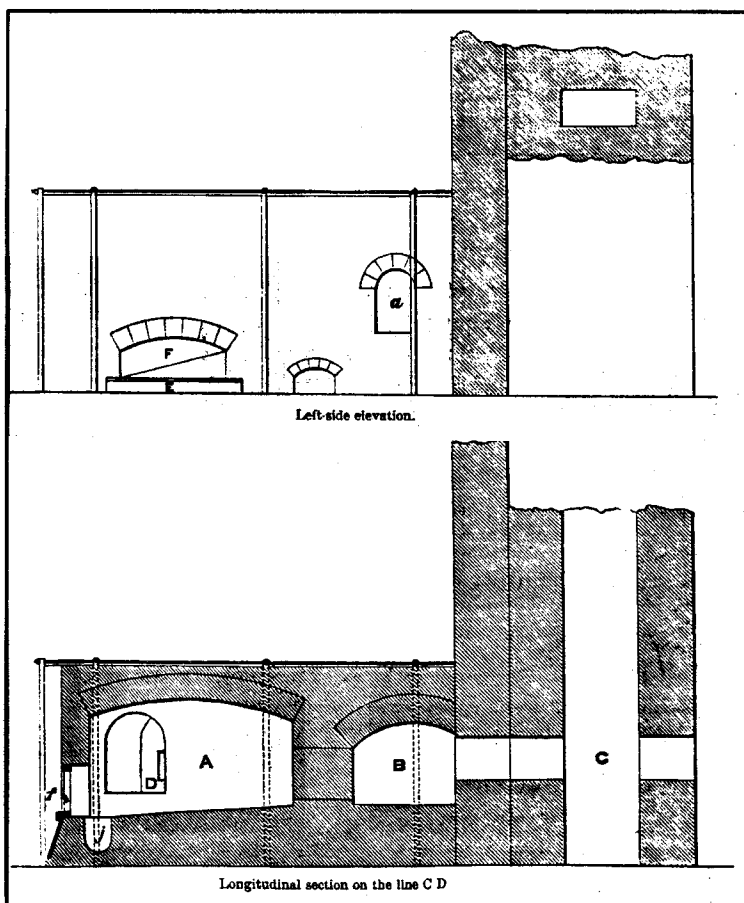

Fig 4. The Spanish reverberatory furnace.

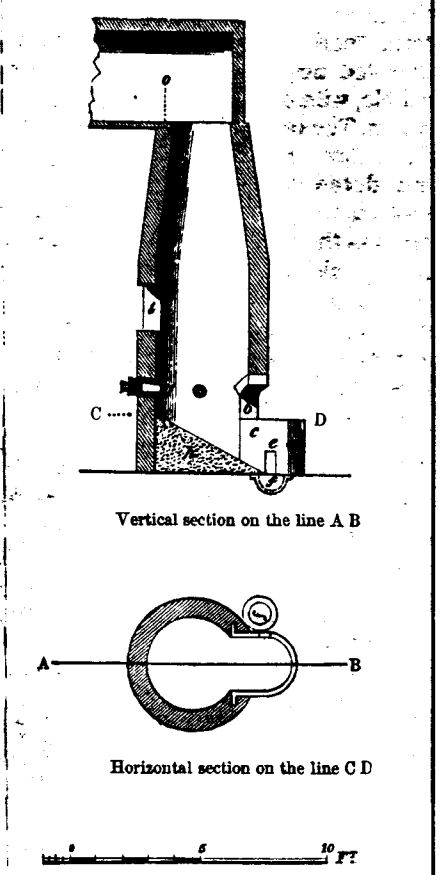

Fig 5. The Spanish slag hearth. (Percy 1870).

waggons laden with pigs of lead and bars of silver. The cheapest way home from Seville would be to take passage in a grimy coal ship going to Newcastle carrying part-treated ore for reduction, but he chooses to travel to London, then by rail to Yorkshire.

Armstrong's fictionalised account bears all the hallmarks of a true picture. The rest of the book, set in "Skewdale", has as its background a very accurate depiction of the mines and mills of Swaledale, and one has no reason to dispute that his view of a Spanish lead mining community is any less faithful.

S.G. Checkland's book, *The Mines of Tharsis*, describes life in the copper mining villages set up by the Tharsis Sulphur and Copper Company, and it supports and expands Armstrong's picture. The villages were self-contained communities of foreign managers and Spanish workers and their families, representing all the tasks and activities associated with the mine. Many local people retained a connection with their original village and went home to help with the harvest. The may have come from the immediate area or travelled across Spain to take work. Cornishmen were brought in to operate and maintain engines. All were strangers in a strange land. The development of family life served to strengthen the bonds of the community, making it more responsive to the discipline of the Church and encouraging school attendance.

Originally workers provided their own shelters of stone and mud, but later on the company provided simple dwellings - this paints a different picture from Armstrong's, where the British at least had built their own decent houses. At Tharsis few facilities were provided until the company was forced to give consideration to water supply, hospital, replacement housing, a market for produce. At Tharsis the company owned a large area of surrounding land, so they could control who lived and worked on the site, and supervise drinking. At Rio Tinto, the company did not have this control, and had to cope with all manner of bad behaviour and general mayhem.

Much of the management at Tharsis was Scottish, the company being Glasgow based. They brought with them a strong Presbyterian tradition of self-help, in striking contrast to the Andalusian Catholic workmen. The Scots and Spanish remained segregated, the Scotsmen acting in a way reminiscent of the Raj, maintaining a very Scottish existence in these foreign hills. In contrast, Armstrong describes respect and goodwill between the groups, even if not integration.

The descriptions of life in the mining communities emphasise yet again that it was the investors, the foreigners, who stood to gain from the activities of the companies, not the indigenous people who provided not capital, technical or managerial skill but were merely the hired workforce.

CONCLUSION

As a technological venture, Spanish lead mining was a great success during the 19th century, especially in the latter part when its production had the effect of depressing British output. However, as a contributor to the development of the Spanish economy it had small effect. This was largely due to difficulties within Spain herself - no agricultural development or wealth, poor leadership from the government, and no entrepreneurial skill on the part of the people. A brave attempt was made by the people to open up the mineral resources of the Sierra de Gador, but the venture was not successful until the British intervened as organisers - and, of course, profit takers. As the century progressed, all initiatives were being taken by foreigners. Foreign companies set up operations and brought in their own people to manage the sites, creating separate communities on foreign soil. The Spaniards were the workforce, and did not develop as managers or owners. Ramos Oliveira, in his grudging way, sums up the situation with regard to the copper mining areas, and his words can equally be taken as a description of British involvement with Spanish lead mining:

"Around the copper mines the British have accumulated a wealth of property that cannot be estimated - railways, buildings of all kinds, residences for the British personnel, and acres and acres of forest land, which virtually make these alert colonisers an economic power on Spanish soil and turn the province of Huelva into an English province in the Roman style, a sovereign enclave."

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