

'TREASURE OF THE WORLD, KING OF THE MOUNTAINS, ENVY OF KINGS': THE IMPERIAL SPANISH SILVER MINES OF POTOSI, BOLIVIA

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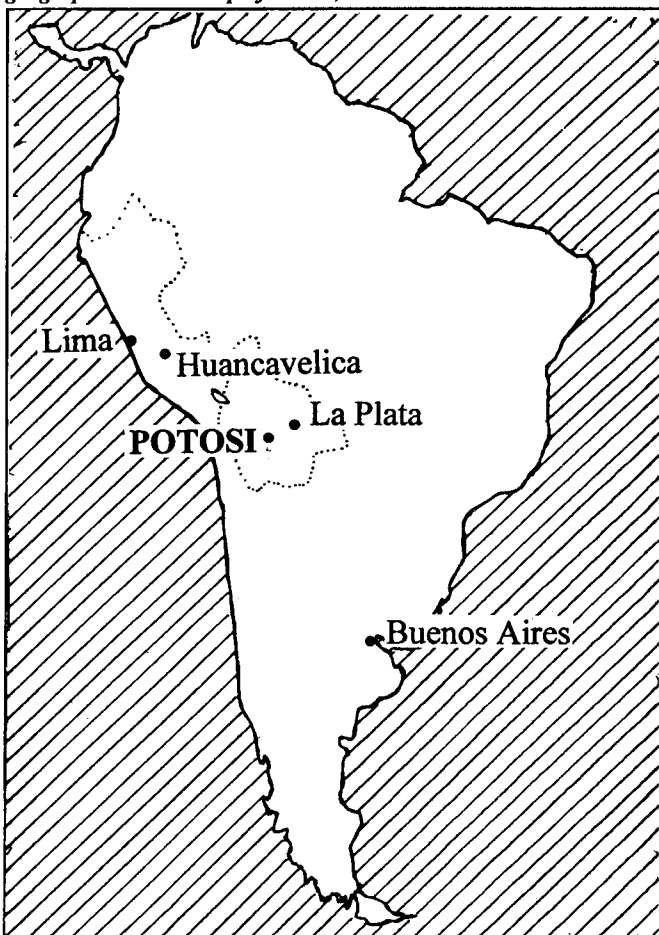
Abstract: Stimulated by the "Welsh Potosi" a visit was made to the original Potosi. Its history is briefly described including the technology and labour system, its decline and the conditions in the 19th Century and today.

INTRODUCTION

The author visited Potosi in September 1985, travelling up into the cordillera from Uyuni on the back of a lorry laden with blocks of salt and cheap Japanese hi-fi's. This rather ignominious entry was nevertheless in the spirit of pilgrimage to this, one of the highest mining towns in the world, and on whose fortunes the Spanish American colonies had once depended.

For me this journey had begun the year before whilst standing on a mine tip at Esgair Hir (William Waller's 'Welsh Potosi') in Cardiganshire one cold winter's day, after having just lost, and found my car keys (and this after an hour's search combing every square metre of monotonous slate spoil!). At the auspicious moment of their discovery, I made a commitment to

Fig. 1. Inset map of South America and Bolivia showing geographic relationship of Potosi, Huancaveca etc.



travel half way across the world for no other reason than to satisfy my curiosity and to pay homage to this place which had captured my imagination. This image of the pyramid shaped Cerro Rico (rich hill) (Figs. 2 and 3 a-c), along with its promise of un-told riches, must have been equally strong within the 17th Century psyche for it to have been able to attract investment upwards of £20,000 which was then sunk and buried forever within this wind-swept and silver-poor stretch of Welsh hillside. The latter being a landscape and mineral deposit to which Potosi bore almost no resemblance whatsoever!

The story of Potosi is one of unbridled richness mixed with poverty and exploitation, of technological innovation alongside backwardness, of squandered wealth, and finally, as its epitaph today, sad-looking crumbling buildings and unemployment, with out of work tin miners scratching a meagre living extracting the last remnants of ore from the miles of old silver workings which now honeycomb the top of the mountain.

GEOLOGY AND MINERALOGY

Although Bolivia now accounts for less than 14% of world tin production, it is still an important world producer of antimony and bismuth, most of which is still deep mined from polymetallic vein deposits (Sn, W, Zn, Pb, Sb, Bi, Au) within the 800 km long Altiplano Tin Belt. This is zoned along its length, being tin/tungsten rich in the north (around La Paz) and tin/silver rich in the south towards Potosi. There is also a clear relationship here between mineralisation and cordillera igneous activity, for example an association with the aureoles which surround the Trias-Jurassic granodiorite plutons of the Cordillera Real to the north, and those linked to isolated porphyry stockworks, dykes and eruptive centres of Miocene age in the south (Hutchison, 1980).

Within the Potosi - Oruru area this mineralisation dates from the Lower Miocene period (23-19 million yrs BP), whilst at Potosi itself this is associated with a high level intrusion of rhyodacite porphyry (the Cerro Rico Stock). Here the accompanying low grade pyrite mineralisation and halo of alteration within the surrounding volcanics and conglomerates have been cut by numerous high grade veins emanating from the centre of the stock, the latter emplaced at shallow depth following the cooling and fracturing of the pluton which then allowed the circulation of hydrothermal solutions. As with many other similar ore bodies, there is also a clear depth/temperature relationship to the mineralisation at Potosi, with the tin-silver-antimony phase (vein growth at temperatures of 400-200°C) giving way to tin (cassiterite) at depth.

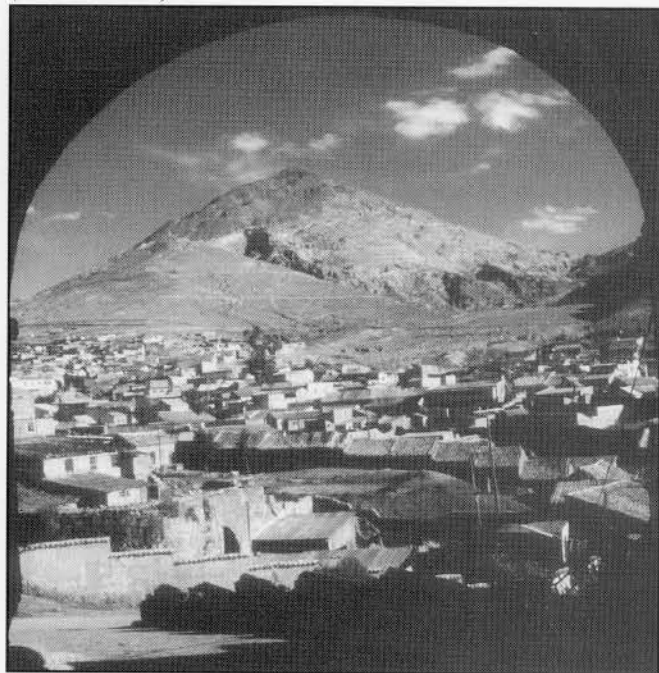
The mineralisation of the Cerro Rico stock has developed over a vertical depth of more than 1000 metres. The top 300 metres of the 4790 metre peak lies almost entirely within the oxidised supergene zone of the ore deposit, and the gossan here must have yielded large amounts of silver (probably as native metal along with chlorargyrite) during the earliest period of working prior to 1560. Beneath this, the upper part of the zone of primary mineralisation, which extends from below the base of the hill up to 4350 m, is dominated by sub-vertical veins (particularly on the central and eastern side of the peak) consisting of the Ag/Sb/As sulphide (fahlerz) ores which include jamesonite ($Pb_4FeSb_6S_{14}$), tetrahedrite ($Cu_{12}Sb_4S_{13}$), freibergite (Ag-bearing tetrahedrite), pyrargyrite (Ag_3SbS_2) and miarygyrite ($Ag_2S.Sb_2S_3$), alongside zinc blende, and a gangue of pyrite plus the phosphate and arsenate minerals apatite and phosphophyllite (zinc arsenate). This zone was effectively worked to exhaustion from the late 16th century up until about 1940, when deep mining commenced from the base of the mountain at the Pallaviri Tin Mine. The latter exploited the lowest zone of primary mineralisation which consists of an earlier phase of Sn/W/Bi oxides and sulphides, in particular cassiterite (SnO_2), stannite ($Cu_2S.FeS.SnS_2$) and bismuthinite (Bi_2S_3).

THE LOCATION OF POTOSI

The town of Potosi is situated at an altitude of about 4000 metres on the eastern side of the Cerro Rico at the foot of the Cordillera Oriental range of the Bolivian Andes, some 500 kms from the coast of Chile and some 3400 kms from Buenos Aires (Fig.1). The climate on the Altiplano here is arid and the landscape almost completely tree-less, whilst winter temperatures can drop to well below freezing for weeks at a time.

The logistical difficulties of transporting fuel, food, metal, people and materials to and from here, and of working and living at this altitude have dominated the history of this place, and places the scale of effort of such a massive undertaking in its rightful context. Three hundred years ago the journey overland from Lima, my entry to the region, and the main administrative centre of Peru, would have taken between two and three months.

Fig. 2. Cerro Rico viewed through an old Spanish doorway in Potosi. From the upper levels of this mountain some 30,000 tons of high grade silver ore were extracted between 1545 and 1600. (Photo ST 1985).



LEGEND AND DISCOVERY

The speed with which the Spanish began to develop the mineral resources of Peru can be gauged by the date of discovery of Potosi and neighbouring mineral deposits.

The conquistadores entered Cusco the Inca capital in 1533, and tempted by tales of silver they pushed south, Pizarro Gonzalo (cousin of Francisco Pizarro) founding Chuquisca and the neighbouring mines of Porco in the Charcas region of the Altiplano (south of Potosi) in 1538. It seems likely that it was from here that the Spaniards first heard of the legend of Potosi.

The stories relating to this discovery vary (Vilar, 1976). In one of these, a local Indian looking for a lost llama on the mountain pulled up a bush to light a fire, to the roots of which were attached globules of silver, another version being that he saw silver by the light of the fire, or else was guided to it. The origin of the name in quechua is either *pputunsi*, meaning 'gushing', a name suggestive of its later bounty of silver, or *potosji*, meaning 'to thunder'. The legend surrounding the latter version concerns the Inca king Huayana Capaj who came to view the reddened mountain in antiquity, and who heard a voice thundering from its depths which said: "this is not for you.... god is keeping the riches for those who come from afar". However, this story could well have been a later Spanish fabrication.

Whatever the truth of the legends, Pizarro had arrived and was exploring the silver veins by 1543, and the mine was registered in 1545. By 1546 this was so rich that all the mines within the surrounding area were abandoned in its favour, and exploitation commenced in earnest on the mountain. The town of Potosi was founded in the same year by the captains Villaroel, Diego de Centeno and Don Pedro Contamito, and shortly afterwards this was awarded the privileged title of Imperial Town, by Charles V of Spain. A year later this was renewed by Philip II, who authorized a shield of arms crowned by the Hapsburg eagle, with the bold and adventurous motto "for the power of Caesar and the prudence of the King, this high mountain will serve towards winning the whole world..". (Vilar, 1976).

The speed and scale of exploitation of the silver veins on the Cerro Rico is best indicated by the rapid growth of the town and its population. In 1545 there were 170 Spaniards and 3000 Indians at the base of the mountain. Two years later there was



a town with a population of 14000 people and 2500 houses, whilst by the early 1560s this had grown to some 30-50 000 Indians living in *ayllus* (ranches) plus 400 Spanish homes (of merchants or mining entrepreneurs). Within the space of 5-6 years it seems likely that Potosi had indeed become the single richest source of silver in the known world.

The sheer abundance of silver at this time can be gauged by the comments of the contemporary chronicler Garcilaso: "...an iron horseshoe in that quarter came to be worth nearly its weight in silver" (Prescott, 1874). How much one can believe such a story, in literal terms, is a matter for debate, yet it seems credible nevertheless, since all metal other than silver would have had to have been brought in from Lima or La Plata, possibly even imported from abroad.

THE EARLY ORGANIZATION OF MINING AND SILVER PRODUCTION (1545-1565)

Although controlled economically by the Spaniards, prior to 1570 the Indians were still free miners. They bought concessions on the mountain, and also worked for the Spanish (*peninsulares*) miners and mining entrepreneurs on a contract basis as tribute workers, known as "yard Indians". These tributes varied from

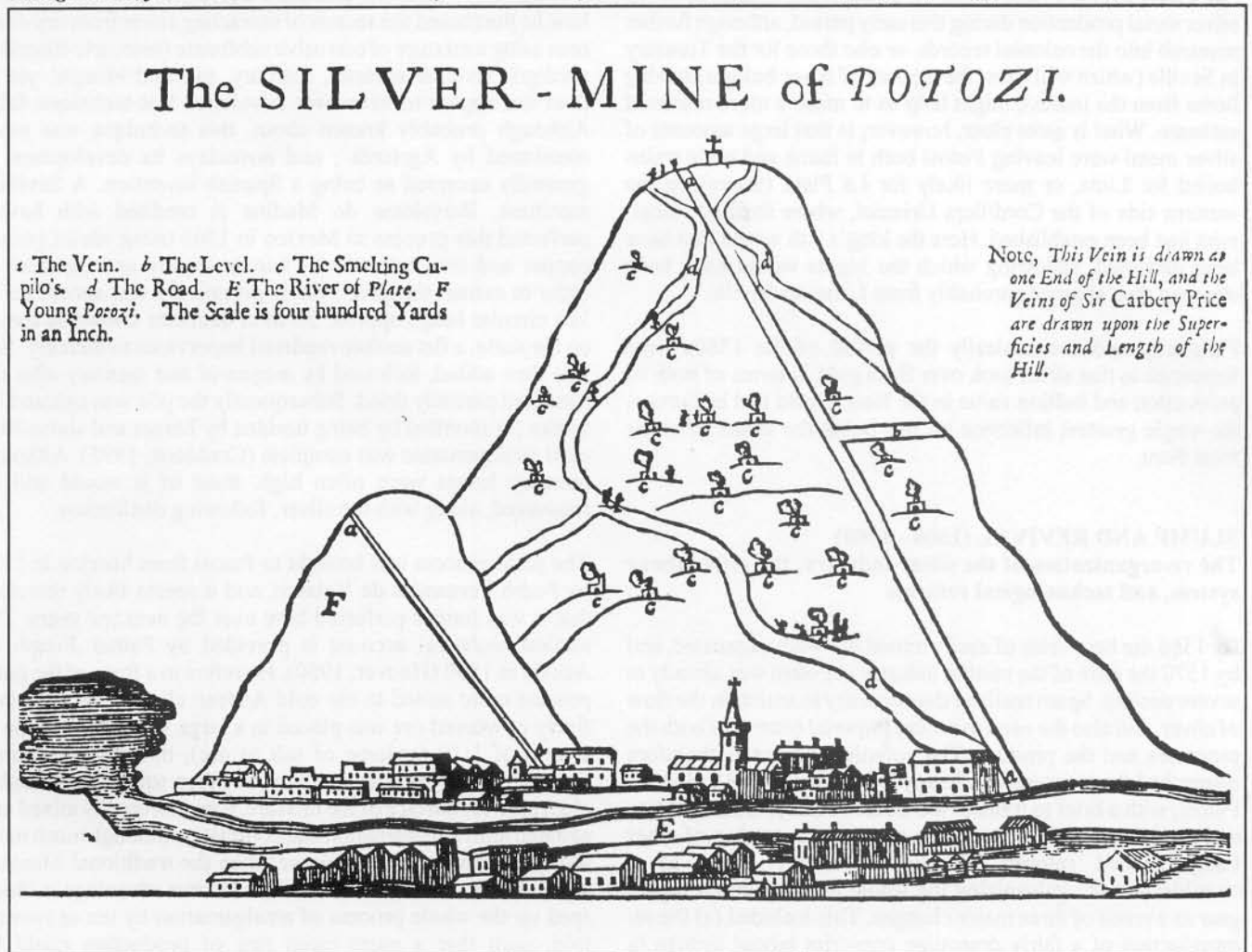


Fig. 3. The iconography of the silver ore mountain.

3a (above). The sanctification of the Cerro Rico in a painting by Melchor Perez de Holguin, in the Museum of the Potosi Mint (ST 1985).

3b (opposite page). A Potosi silver token of 1808 to commemorate the accession of Ferdinand VII, showing the mountain surmounted by the Hapsburg eagles and framed between the Pillars of Hercules. Note the mine levels and pack trains of llamas carrying down ore (reproduced courtesy of the Department of Coins and Medals, British Museum).

3c (below). The "Silver Mine of Potozi" illustrated for the purpose of comparison with the Esgair Hir (Welsh Potosi) mine of Cardiganshire, from William Waller's 'An essay on the value of the mines late of Sir Carbery Pryse' (1698) [Palmer 1983].



between 12 *vairas* (yards distance) on a rich vein, to 30.5 *vairas* on a poor vein. The mining entrepreneurs (*mineros*) ranged from the King of Spain downwards to local Potosi merchants. By decree, the Indian miners were allowed to work for themselves on Sundays. At the height of its working between 1550 and 1560, some 94 veins were being worked simultaneously by both Indian and Spanish miners. Little is known of the technology of mining at this time, but in all probability the shafts were driven by hand using hammers and wedges, quite possibly in a manner which would have been considered antiquated in Europe. There is also a vague, but rather interesting reference to fire setting having been 'introduced' to Potosi in 1550 by a 'gentleman from London' (Vilar, 1976). However, the innovation appears to have died with him since he was attempting this using coal and unfortunately suffocated himself during the course of his experiments!

Silver ores were either crushed and ground by hand, or else by "water engines", supplied by long lines of leats from the nearest source of supply such as small lakes (probably seasonal), or by "blood engines" (referred to in this way within contemporary accounts since the mills were turned by animals or Indians in harness). However, the smelting of ore was still carried out by the Indians in the traditional pre-Columbian fashion, using small wind-draught furnaces called *guayras* fuelled by *ichu* grass (Vilar, 1976). Contemporary accounts record the Cerro lit up at night by the light of thousands of such tiny furnaces. However, by the end of this period there must at least have been some economic and technological control of this process by the Spanish, since it is recorded that in 1550 considerable improvements to the furnace design and process was carried out by a man from Seville.

No references have been found which show the volume of ore or silver metal production during this early period, although further research into the colonial records, or else those for the Treasury in Seville (which will show the amount of silver bullion arriving home from the Indies), might help us to make a more reasoned estimate. What is quite clear, however, is that large amounts of silver metal were leaving Potosi both in llama and mule trains bound for Lima, or more likely for La Plata (Sucre) on the western side of the Cordillera Oriental, where the first 'local' mint had been established. Here the king's 1/5th would first have been deducted, following which the ingots would have been stamped then shipped (probably from Lima) to Seville.

Politically and economically the period of the 1560s were important in that silver took over from gold in terms of both its production and bullion value in the New World and in Europe, the single greatest influence on this being the influx of silver from Peru.

SLUMP AND REVIVAL (1566 - 1600)

The re-organization of the silver industry, the mita labour system, and technological reforms

By 1566 the best veins of easily mined ore were exhausted, and by 1570 the state of the mining industry at Potosi was already in severe decline. Spain realized the necessity to maintain the flow of silver, and also the need to secure Imperial control of both the processes and the product. The colonial authorities therefore dispatched the progressive Viceroy Don Francisco de Toledo to Potosi, with a brief to transfer the Court of Silver from La Plata and establish a new mint, and to carry out a number of other badly needed reforms. Toledo effectively acted as a 'troubleshooter', galvanizing the whole industry into a higher gear as a result of three major changes. This included (a) the re-introduction of a fairly draconian conscript labour system (a

form of the old *mita* labour tax first imposed on local peoples by the Incas); (b) the establishment of an Imperial Mint and furnaces within the town itself; and (c) the introduction of new techniques for ore separation and recovery. The most prominent of the latter was the mercury amalgam patio process, a technique which would enable poorer grade ores to be worked.

THE MERCURY AMALGAM PATIO PROCESS AND LOCAL INNOVATIONS

The most immediate effect of the introduction of the patio process to Potosi in 1571 was that it broke the only remaining Indian control over production. Within the space of a few months 6000 native smelters were replaced by a few hundred refining workshops. The process also enabled the mining of much lower grade ores, such as the fahlerz minerals which contained large amounts of arsenic, antimony, copper and lead, and from which the silver had previously proved difficult to extract and refine. The timing of the introduction of this process was also important, since it was linked to the discovery of the mercury deposit at Huancavelica (1500 kilometres north of Potosi) in 1566. Shortly afterwards mercury production came under the sway of Imperial control, a situation that was soon to benefit the production of silver elsewhere in Peru.

The history of the discovery and development of the mercury amalgamation technique for the extraction of silver, and ultimately of the patio process itself, is described more fully by Hoover & Hoover (1912) (within a footnote to their translation of Agricola's *De Re Metallica* (1556)), and more recently by Craddock (1995).

Biringuccio within his treatise *Pirotechnia* (1540) describes how he purchased the secrets of extracting silver from dry silver ores using a mixture of corrosive sublimate (mercuric chloride), verdigris (copper acetate), mercury, salt and vinegar, yet he does not appear to have ever developed this technique fully. Although probably known about, this technique was never mentioned by Agricola, and nowadays its development is generally accepted as being a Spanish invention. A Sevillian merchant, Bartolome de Medina is credited with having perfected this process in Mexico in 1566 using *vitriol* (mixed copper and iron sulphates) - known locally as *magistral*. In order to extract the silver, finely-ground ore was spread out in low circular heaps approx. 20 m in diameter known as *tortas*, on the *patio*, a flat surface rendered impervious to mercury. Salt was then added, followed by *magistral* and mercury after the *torta* had partially dried. Subsequently the pile was agitated for weeks (or months) by being trodden by horses and shovelling, until amalgamation was complete (Craddock, 1995). Although mercury losses were often high, most of it would still be recovered, along with the silver, following distillation.

The patio process was brought to Potosi from Mexico in 1571 by Pedro Fernandes de Velasco, and it seems likely therefore that it was further perfected here over the next ten years. The earliest technical account is provided by Father Joseph de Acosta in 1590 (Hoover, 1950). He refers to a form of the patio process more suited to the cold Andean climate. In the latter, finely powdered ore was placed in a large vessel with brine in a ratio of 1:10 (volume of salt to ore), then heated upon a furnace. Following this, mercury was then squeezed through a cloth onto the surface of the mixture, then thoroughly mixed and agitated until amalgamation was complete. Although much more costly in terms of fuel resources than the traditional Mexican method, this technique did have the distinct advantage in that it sped up the whole process of amalgamation by ten or twenty-fold, such that a more rapid rate of production could be

achieved, and a much larger volume of ore treated. Nevertheless, there are a number of different descriptions of the Potosi patio process, some of which describe a process altogether much closer to that brought by Velasco from Mexico. The latter involved the filling of stone-lined flat-bottomed tanks with a mixture of ground ore, mercury, impure vitriol (copper sulphate), salt and hot water, and allowing this to set for a few days. Acosta talks of a similar method:

...before the invention of these furnaces of fire, they did often mingle their metal with quicksilver in great troughs, letting it settle some daies, and then did mix it and stirre it again, until they thought all the quicksilver were well incorporate with silver, the which continued twenty daies and more, and at least nine daies..

Further improvements to the patio process were carried out over the next 50 years. These are described by the priest Alonso Barba, a native of Andalucia who took up a number of postings in Peru between 1600-1630, and who at one time held the Curacy of the Iglesia St. Bernard in Potosi. In 1640 he published in Madrid a series of five books *Arte de los Metales*, within which a number of these variants of the mercury-silver amalgam method are described. The type described by Acosta, and perhaps also by Barba at Potosi, was referred to as the *buytron* process (Craddock, 1995).

Further mechanization at Potosi was required following the demands of the patio process for a plentiful supply of very finely crushed ore. At the height of activity and production in 1574 there were some 150 *ingenios* or water powered crushing mills at work, supplied by some 20 reservoirs, accompanying dams and leats. The cost of maintaining this hydraulic system was said to be some 2 million pesos a year (yet this needs to be put in context with the current level of expenditure and squandering of money then taking place in Potosi, for example it was recorded that some 8 million pesos were expended on Philip II's coronation alone!).

DEEPER MINES AND WORSENING CONDITIONS

By 1582 there were 612 separate mining claims registered on the Cerro Rico. As part of the drastic reforms instituted by Toledo a much more organized system of registering mining claims was introduced, along with a mining code. This helped to provide some sort of legislation and protection for the mining entrepreneurs, but needless to say, very little for the Indians.

In spite of the introduction of the *mita* system of forced labour, shaft mining by this time was becoming expensive. The cost of maintaining a deep shaft on the Cerro was considered equivalent to the cost of building a cathedral (Vilar, 1976), whilst some one fifth of these production costs, on average, were expended on its sinking. All this begins to make more sense when one realizes that (by the late 1570s) some of these shafts were already 250 metres deep. Most were regularly climbed by the Indian miners using wooden ladders with leather rungs, and as recorded, sharing one candle between several workers. Each Indian *mitayo* miner was required to carry out two 45 kg bags (90 kg) in one go, with a minimum of 25 sacks per day (Vilar, 1976), an exertion which now seems barely credible (within a level let alone a shaft). Not surprisingly, the recorded death rate from disease (most probably pneumonia, silicosis and mercury poisoning), cave-ins, and sheer physical exhaustion was impossibly high, a fact which exerted tremendous pressure on the *mita* supply system, and thus on the de-population of surrounding areas. Even so, at the expense of maintaining the opulent lifestyle of the European population of Potosi, the cost of extraction within the mines themselves was becoming

exorbitant, and thus it was claimed that only the removal of vast quantities of ore would continue to make it pay.

THE MITA LABOUR SCHEME

The re-introduction of the pre-Columbian type corvee system of conscript labour was one of the principle 'reforms' instigated by Toledo in 1574. It soon became apparent that a workforce of at least 20-30 000 miners would be necessary in order to maintain output at the mines (in fact a great many more would be needed to boost it). Unfortunately, the rate of depletion within the existing mining population, largely as a result of the death toll within the workforce, local epidemic and the un-sustainable agriculture within surrounding areas, meant that the local depopulated hinterland could no longer supply the necessary quota of free labour. Furthermore, the cost of paid labour to the *mineros*, in such a labour intensive market as mining had now become, often meant that there was barely enough capital remaining at the end of the day for investment in new shafts, levels and equipment.

The organization of the *mita* supply system was a massive administrative undertaking. In a similar fashion to the old Inca tribute system, sixteen supply districts (*corregimientos*) were established as far north as Cusco, 700 kms distant (Cook, 1981). Within these districts, one seventh of all adult males were obliged to give one year's service every six years at the mines of Potosi. This was the equivalent of 13500 men per year (divided into groups of 4000+). Luis Capoche (1585) a contemporary chronicler, records that at Potosi, all of the *mitayo* miners worked on a three week on, three week off rota. Each *mitayo* would receive 3.5 reales per day for their labour (compared to 4 reales for the *mingados* (free miners)), but in addition the *mitayo* communities within each of the *corregimientos* were also obliged to provide all of the food requirements for their workers whilst in service, maintain the families of absent *mitayo*, and pay for the transportation costs of men to Potosi (this often involved a several month trek with animals).

All of the mining concessionaires working on the Cerro Rico were entitled to receive *mitayo* workers, thus the smaller concerns, particularly if the mine was struggling, would often sell on their workers at a profit to the larger ones. In fact, there was a clear discrepancy between the numbers of *mitayos* allotted to each vein by the colonial authorities, and the numbers of miners working. For example, in 1603 it was said that less than one in ten of the miners working on the Cerro were *mitayos*. Nevertheless, *mitayo* workers were still required to do the work that most of the others refused. Some of the Potosi *mineros* did keep negro slaves, but apparently these were never put to work underground, since their death rate was far too high.

From the study of contemporary census returns it has been estimated that a third of all *mitayos* working at Potosi never returned to their home districts. It is an almost impossible task now to try and calculate how many thousands of these workers perished in the mines, and how many thousands of others joined the growing population around Potosi. There was undoubtedly fear amongst the communities to the *mita* system, and on some occasions there was resistance to the conscription. However, it was said that the mercury mines of Huancavelica were far worse than those of Potosi. Of Huancavelica, Capoche says drily "...six months in the mine and a man was useless"(1585)

ESTABLISHMENT OF THE IMPERIAL MINT AT POTOSI

Following the transfer of the Court of Silver from La Plata (Sucre), an Imperial Mint was set up within the town of Potosi which minted its first coinage in 1574 during the reign of Philip II. Both the tools (cutters, stamps and dies) and machinery (silver rolling mills) for this were transferred from the rather precarious establishment at La Plata, which in turn (prior to 1561) had been brought from the first mint at Lima - thus most were already outdated when they began service in Potosi. The original location of the mint was in the Cajas Reales near to the Cathedral, and to this building were then added three furnaces (cupolas), and some months later a fourth, for the purposes of silver refining. The silver arrived at the mint in the form of the un-refined *pastas* (literally 'dough'), almost certainly the silver concentrate extracted from the amalgam product of the patio process, after the re-distillation of mercury.

The first year's production of the mint (1575) can be roughly calculated from the annual cut of approx. 72 000 marks of silver assayed and stamped, each of 67 reales, giving a value of 4,824,000 reales, or \$603,000. By 1597 the value of this production had risen to some \$1,340,000 (Burzio, 1941)

SOCIAL CONDITIONS IN POTOSI - POVERTY, WEALTH AND TURMOIL (1573-1650)

In 1573 Potosi boasted a population already larger than that of London. By 1611 a census revealed that the population had grown by almost a third to 160,000, now consisting of some 76,000 Indians, 6000 blacks, 35,000 criollos and 3000 *peninsulares* (mostly Spaniards). However, amongst the mix of ethnic groups there is little doubt that life was harshest for the Indians. Communities were periodically decimated by European introduced epidemics (particularly measles), and both disease and poverty, in particular lack of food and sufficient fuel, left many vulnerable to the winter climate at this altitude. In 1577 a 4-day snowstorm left many frozen in the streets, whilst on other occasions it is recorded that freak storms rained hailstones the size of pigeons eggs, sometimes killing and maiming those caught in the open. Heavy rains also led to the bursting of the mine dams on the Cerro, the resultant floods inundating surrounding miners' settlements, drowning many.

In addition to bearing the brunt of natural disasters and exploitation within the mines, discrimination and exploitation continued through all walks of life. The Indian miners and labourers depended upon the chewing of coca leaves to continue working in the mines. These, as well as many other essential Indian commodities were dealt in by European merchants, who oftentimes charged inflationary prices, whilst there was further pressure upon the very same people to consume products when these were in excess. In theory, at least, there was some legal protection for the Indians from the extremes of exploitation by the *mineros* and merchants (Capoche, 1585), and a number of minor reforms were introduced at about this time, most of which had little or no effect. Contemporary observers wonder at the Indians' passivity to their lot, although some theologians were genuinely concerned about the official negligence shown over the Indians' wellbeing: "... what is being sent to Spain is not silver, but the blood and sweat of the Indians".

Life for the *peninsulares* could not have been more contrasting, but even so, it was not without hazards of its own, and one type of mortality was peculiar to the Spanish settlers.

On account of the altitude, Spanish infants usually died within a

few hours of birth, the first boy to survive being born in 1584 (Cook, 1981). However, for much of the adult population life was lived in opulence and in a style to which they would not have been unaccustomed to in Spain. Yet Potosi was definitely not a city of the nobility - most of the European inhabitants were either merchants or *mineros*, or else the families of these, who had made it rich at the mines. All the same, these were the people who dressed as if they were at court 'in silver stockings, gold brocade and velvet' and who spent lavishly on everything. In 1579 the Royal Judge Matienzo commented: "...there is never a shortage of novelty, scandal, and wantonness at Potosi". Silver was everywhere. Even at the mines silver wire was substituted for iron in the crushing griddles when the latter was in short supply. Everybody had money, all the currency was of silver, and all purchases were in currency. Being a centre of silver production and of currency, the money: commodity relationship here was unusual i.e. merchants sold unrefined silver for silver currency produced by their own silver, whilst the extreme inflation resulting from the availability of money attracted outside merchants and speculators who could sell imported items at vastly inflated prices.

At the beginning of the 17th century in Potosi one could buy anything: silk and fabrics from Granada, Flanders and Calabria; hats from Paris and London; diamonds from Ceylon; precious stones from India; pearls from Penang; stockings from Naples; crystal from Venice; carpets from Persia; porcelain from China; perfumes from Arabia; plus plenty of fine Castillian wines! Within the boundaries of the mining town there were 36 magnificently decorated churches, 36 gambling houses, 14 dance academies, plus many fine salons and theatres. Artists were patronised by the wealthy, and by the 1650's there was a flourishing school of religious painters led by the artist Melachor Perez de Holguin. However, culture was commonly at a rather more grosser level, for it is recorded that Potosi had 800 professional gamblers and 120 of the most famous white prostitutes in South America.

During the 16th-17th centuries, at a time when prosperity was at its peak, Potosi was also gaining a reputation as one of the most hazardous cities in the Indies in which to live. Continual strife amongst warring factions of the *peninsulares* strikes a comparison with some of the North American frontier towns of the Wild West during the 1850s. The Castillians fought with the Andalusians, the Portugese with the Extramadurans, the Basques against the Navarrese and Gallegos. Every year the death toll from duels and gang warfare was considerable. In 1622 this violence reached an unprecedented level, and Potosi was in a state of virtual Civil War. The focus of the violence on this occasion was between the Basques and the Criollos (the former with their long history of mining expertise in Spain had begun to dominate economic life here). Some 381 Europeans and over 1000 Indians and mestizos perished in the violence, whilst a further 1600 Europeans were killed in the following year. Street fighting had an element of sheer wantonness and sport-gangs blocked streets to test each other with the sword. Such violence was not just confined to secular disputes - it is recorded that Augustinian monks also took to the streets, sword in hand, to fight over petty privileges!

THE SILVER ROUTE FROM THE AMERICAS

Even at the height of silver production in Potosi there was a noted inequality of distribution of this metal within South America. Whilst silver was plentiful and iron rare (and possibly as valuable) at Potosi, the situation was the reverse elsewhere. In fact, most of the silver being produced in the Americas was leaving for Spain, as a result of which in 1599, in Buenos Aires,

there was such a shortage of (silver) coinage that old iron nails and spoons were being used as a money substitute. Almost one fifth of all the silver produced at Potosi automatically ended up as royalties within the coffers of the Treasury in Seville, whilst a great deal more was also being bought by the House of Trade (Seville). Indeed this “royal fifth” was also the source of much embezzlement, fortune and loss en route, principally through fraud perpetuated during dockings in Lisbon or other ports before reaching Spain.

In 1600, at the height of Spanish silver imports from Potosi, some 36 million pesos (\$30,257,463) worth of silver arrived back in Seville. Of this, the Master of Silver at Seville took 11% under direct control, with ingots bought up by middlemen. Even despite piracy by Dutch and British merchantmen (such as Frobisher and Drake), approx. 85% of all silver leaving Peru reached its destination. Unfortunately, the greatest loss from the Spanish coffers was subsequent to this, in the repayment of debts at interest to the English, Flemish and Genoese banks. Thus unbridled borrowing to pay for Spain’s lavish domestic expenditure and European military campaigns in fact meant that much of the silver from Potosi was now legally ending up in the hands of Spain’s enemies or competitors. The irony of the situation was summed by Louis Ortez, Treasurer of Castille when he commented: “. . . Spain has become the foreigner’s Indies..”(Vilar, 1969).

THE START OF THE DECLINE (1649-1800)

Loss of confidence in Potosi coinage following exposure of widespread fraud at the mint in 1649 heralded a period of gradual decline in silver output over the next century and a half. There were certainly remissions from this decline at various times throughout the 18th Century, but these mini-booms were short-lived, and ultimately un-sustainable.

Fraud in coin minting at Potosi was relatively easy to perpetuate before the introduction of machined coinage (*moneda bustedo*) in 1772. In 1649 during the reign of Philip IV a fraud conspiracy was uncovered at Potosi linked to the increasingly irregular shape of the *moneda macuquina* (hand minted coinage), a situation which helped to disguise further cuts to the edges of a high proportion of these, and the subsequent theft of silver by the officers of the mint. Following discovery, the silver merchant Fransisco Gomez de la Rocha and the assayer of the mint Felipe Ramirez de Arellano were both condemned to death by the court of the Audiencia de Charcas, whilst the remaining guilty were imprisoned or else heavily fined. Yet confidence in the Potosi coinage did not return for a long while, and even after the introduction of a completely new type and die of *macuquina* money in 1651, the

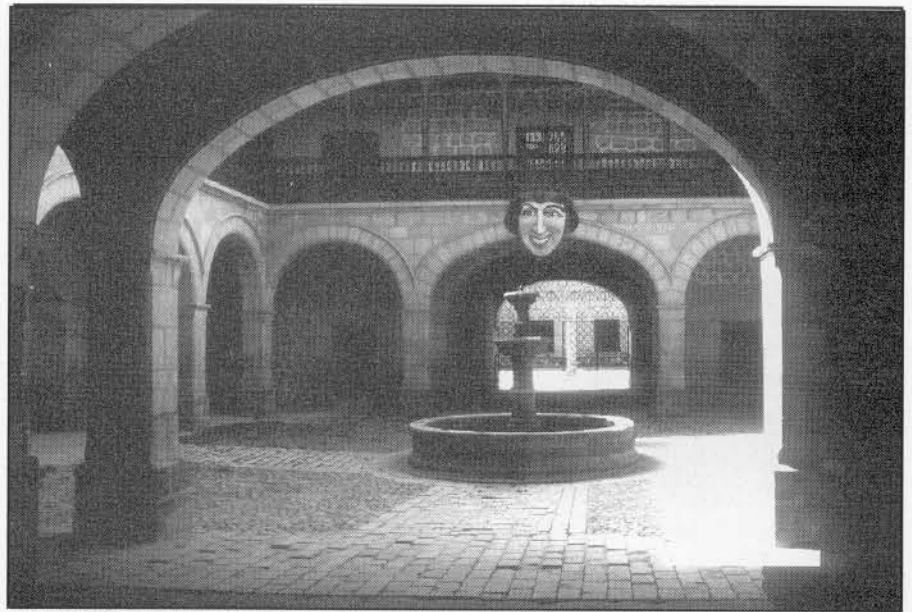


Fig. 4 (above). The entrance courtyard of the 18th Century mint (Casa del Moneda) in Potosi (ST 1985).

Fig.5 (below). Silver-rolling machinery in the Potosi mint, c. 1700. The mill was turned by conscript/penal labour (ST 1985).

prohibition upon the introduction of this coinage into Brazil was not lifted until July 1655. The decline in circulation of silver originating within the Americas must have been considerable from this date after, for it was recorded that by the late 1650s, some 80% of the coinage in circulation within Spain was de-based (mostly copper). Spain was in debt, and its silver was in foreign banks.

Meanwhile, in Potosi, mining on the Cerro Rico was also in severe decline from 1650 onwards. Water shortages at surface restricted the use of hydraulic machinery, whilst water drainage problems underground grew as the mines got deeper and reserves of rich ore became harder to find. However, deprecation of the labour supply, following epidemics amongst the Indian workforce at Potosi and the continuing low birth rate and de-population within the *corregimientos* supply areas, had the single greatest effect on production. This decline in mining activity can be seen within the number of individual concessions at work on the mountain, as well as in the number of ‘engines’ or crushing mills still in operation. The latter had dropped from 150 in 1574, to only 57 in 1692.



THE 19th. CENTURY - MORE DECLINE, POLITICAL TROUBLES, AND RE-CAPITALISATION OF MINING

The opening two decades of the 19th century coincided with an all time low in silver production at the Potosi mint, amounting to some 150,000 marks per annum in 1820. The drop in production in part reflected the exhaustion of some of the richest veins on the Cerro Rico (such as the old Socabon Mine (Simpich, 1933)), alongside continuing water and labour supply problems. The *mita* labour scheme was still in operation within the mines (but only just), although some 90% of the workforce was now composed of free miners. However, almost all of the stages in the process of winning silver were as labour intensive as they were at the start of the 18th Century, and the industry was becoming heavily undercapitalised.

By 1818 the price of silver had dropped considerably, both inside and outside the

Americas-Mexican market, as a result of important new discoveries elsewhere, such as the rich Comstock Lode in Nevada, from which silver was now beginning to flood the world market. Problems in silver production at Potosi coincided with a contracted period of political instability which was just beginning to sweep the Spanish colonies of the Americas, associated with the rise in nationalism and the fight for independence. From 1818 onwards Lima's hold on the area was tenuous. By 1823 the Potosi mint had already been emptied several times by Republican forces from Buenos Aires, and when independence came in 1825, both the mint and some of the mines were still functioning, but at an exceedingly low ebb.

Unfortunately, although the workings of the mint are well documented for the period 1799-1825, there are few contemporary accounts which refer either to the working of the mine(s), or to the conditions of the miners, although the memory of one old (anonymous) Indian miner was passed down and recorded for posterity by Nash (1979):

During the time of the Spaniards, when a man died, he was buried right there where he was, inside the mine like an animal, a beast of burden. When people got sick, they died without the mass. They had poor food - charki, toasted beans, maiz mote (stewed corn), flour and water....Many went to Potosi; some died on the way. In Potosi they lived in very cold houses without any facilities, called choquia. These were round houses made of adobe and with a straw roof. Some were made of stone. In this land there was a better living. My grandfather earned 2 reales a day, but things weren't cheap . . . My grandmother worked at the mouth of the mine and helped with the expenses . . . In those days men crawled into the mine. They had patches of cow-hide on the seat of their pants, at their knees, at their elbows. they wore sheepskin in hats and fur in shoes. It was very deep inside the Potosi mine - four hundred to five hundred metres, like a challado (offering place). There was boiling water down there . . .

Potosi benefited less than other mines thereabout from the investment of foreign money and mining expertise. In 1816 Richard Trevithick, the Cornish mining engineer arrived at the Cerro de Pasco Mines, and thereafter became involved in a number of Peruvian



Fig. 6 (above). Bolivian miners re-working the old Spanish mines on the Cerro Rico in 1985 (ST 1985).

Fig. 7 (below). Underground view by carbide lamp on the Cerro Rico showing a windlass and leather bag currently being used for draining a winze in 1985. The method is essentially Medieval, and more or less identical to that described and illustrated in Agricola's 'De Re Metallica'(1546) (ST 1985).

In 1773, 795,000 kilos of silver arrived in Spain from the Americas. However, by this time the output of the Mexican mines (573, 000 kilos) had more than doubled that of Peru (250,000 kilos), whilst the Peruvian production also included that of a number of other successful mines, such as the recently exploited Cerro de Pasco. Meanwhile, the mint at Potosi had been modernised, with new standards of silver purity, new coinage, and new rolling/stamping machinery. Direct control of production passed from the hands of the Crown to the colonial administration (Real Hacienda) in 1750, and in 1772 the mint was re-built on its present site (facing the Plaza del Regocijo) as the Casa del Moneda (Fig. 5). Potosi silver was now leaving the Americas via Buenos Aires.



mining ventures. It is likely that he was asked to come and inspect the mines at Potosi, although it seems rather doubtful whether he had any further involvement here. Production at the mine did however receive a boost much later in the 1860s following the investment of European capital. This resulted in an upsurge in silver production in the 1870s (unfortunately no details of this period of working have been found).

MINING IN THE 20TH CENTURY

The mining industry at Potosi went into further decline at the beginning of the 20th. Century, and did not recover until the advent of deep mining for tin beneath the Cerro Rico in the 1940s, centring upon the Pallaviri Mine. Following the collapse of the tin market in the mid 1980s production here has been erratic, and as of now, it is still uncertain whether or not official mining on the Cerro Rico has ceased after more than 450 years of continuous activity.

POSTSCRIPT

The end of industrial scale mining, however, does not necessarily imply the end of any mining interest. At the time of my visit in 1985, somewhere in the region of 50-100 miners were at work within small groups of 2-4 men each, re-processing old mine spoil, and in some cases re-working some of the old Spanish levels. Most of these partnerships appeared to be composed of unemployed tin miners, together with family members, and affiliated to a co-operative which would collect, mill and concentrate ore for the miners, and deliver this product to the one smelter still willing to process the remaining Ag-poor ores (an intermix of cassiterite, blende and fahlerz minerals). These ores were being worked as much for the antimony, arsenic, zinc and bismuth which they contained, as their tin and silver content.

I visited one of the old Spanish workings underground (Figs. 6 and 7). This was being re-worked by a father and son team, without the use of explosives, using only picks and shovels and a wheelbarrow. The condition of the old workings were appalling. So much rock had been removed that many of the tunnels were in the process of collapse, and throughout the mine a 'creaking' was audible as the rocks thereabout continued to move and settle. The miners were using carbide for lighting, whilst both drainage (using leather bags or tins instead of buckets) and haulage were by hand, using wooden windlasses over short winzes (Fig.7). The windlasses were virtually identical to other disused examples of these found lying thereabouts and which, according to the miners, dated from the time of the Spanish working of the mine.

In 1985 these unofficial mining claims seem to have been chosen by agreement amongst the miners themselves, their squatter status here (there were indeed some miners living here in shacks outside of the level entrances), probably giving them no certain rights to the mineral, nor protection from eviction. Under these conditions children, occasionally as young as nine or ten were found working underground alongside their fathers.

Today, Potosi is a sad, almost forgotten place, still gripped in the throes of post-mining depression common to many of the former mining towns of the Bolivian Tin Belt. However, this was once one of the most important towns in the whole of the Americas, and the intensity of its history - from the wealth and privilege of the Spanish settlers to the misery and exploitation of the Indian miners, whose only epitaph now are the hundreds of kilometres of collapsing mine tunnels and a collective memory kept alive in

Andean folk song - can be seen and felt everywhere. Nevertheless, by 1985 (this situation may since have changed) there had been little or no attempt to develop the heritage aspects of this world class mining site, with the greater part of its history still remaining un-researched, with no proper recording or conservation of remains. Crumbling colonial architecture survived anonymously all over the town whilst on the Cerro Rico itself there were few who could point to the sites of the crushing mills or those of the revolutionary patio process.

It is hoped that the publication of this paper may in some small way encourage further research, and ultimately, conservation of this immensely important site.

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