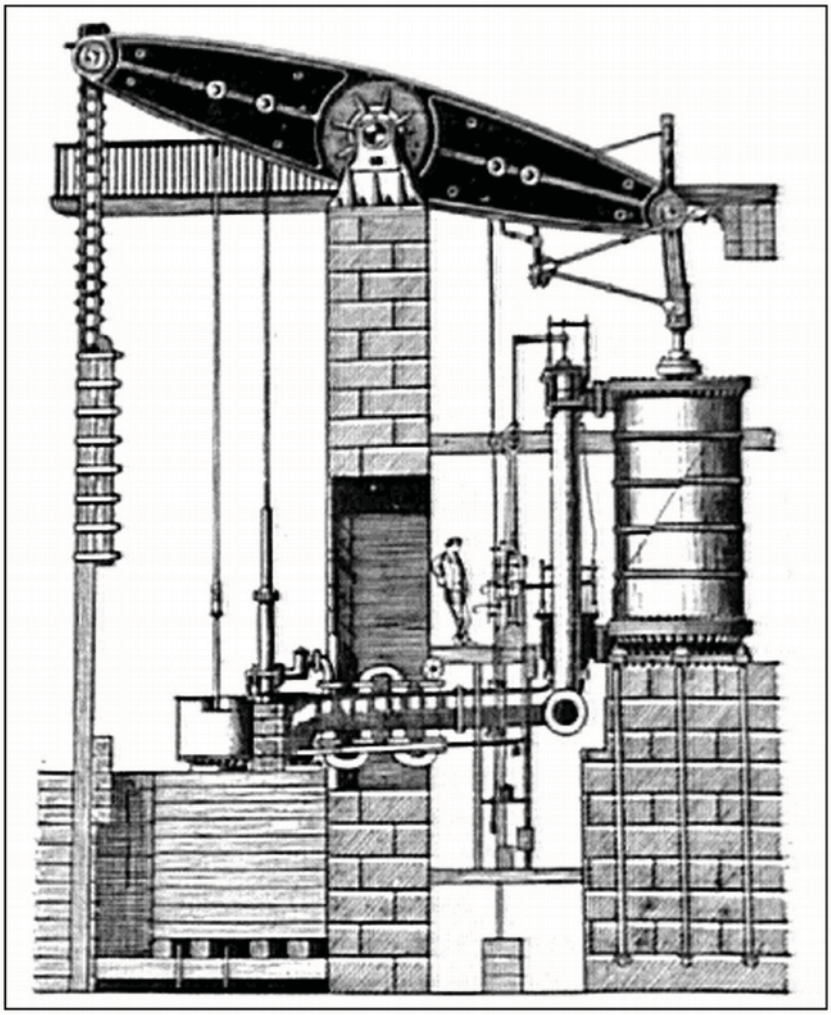
Chapter 4. The Enemy Below

4.1. The Desagüe del Jaroso.
4.2. The Desagüe del Francés.
4.3. The Desagüe del Arteal.



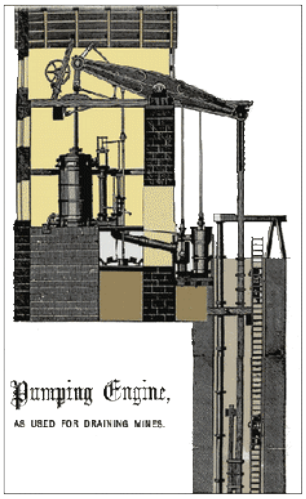
4.1. The Desagüe del Jaroso.

Rodrigo.

What really sparked my interest in the mines was the puzzle of the “lost village” of San Juan lying abandoned like a ghost town in the mountains. Everybody who has walked through it forms a picture of what life was like there, with its row of houses, its church etc., etc., What I found out came as a great surprise but I had to go back to the early days of exploitation for the explanation.

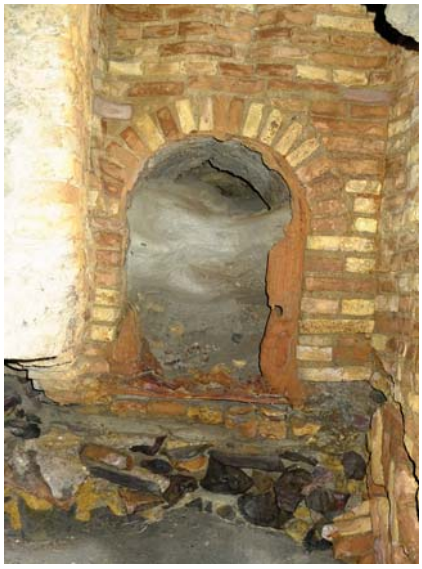
In 1845, in the Barranco del Jaroso, workings in the mine Ánimas had reached a depth of 150 metres when they encountered a problem. Small trickles of water started to appear. These were contained initially by primitive bailing methods, gates and dykes. As they mined deeper, following a productive vein, alarming amounts of water appeared. The same thing then happened in neighbouring mines.

The Sierra Almagrera is arid and yet there was this problem with water. Initially, the water was presumed to be sea water, but measurements showed that the water level in the mines was 30 metres below sea level, in addition, analysis of the water proved that this was not the case. What they discovered was a large hot spring, which was located at the base of the mountain. This was erroneously visualized as a large underground basin, that in time, and with sufficient drainage, could be eliminated. The presence of such water was not surprising since the rock formations and minerals present indicate a geothermal system. In fact, Ezquerra del Bayo predicted it a few years before the water was reached.



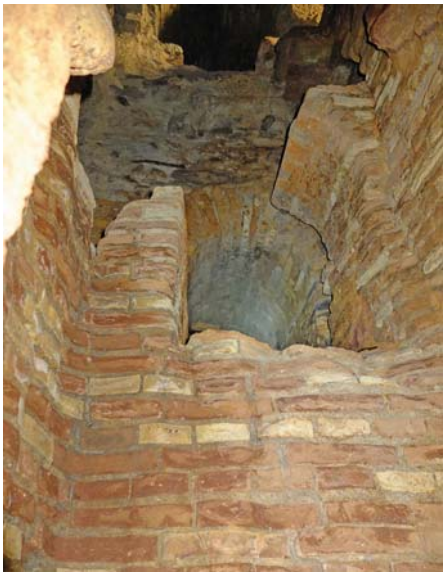
There appeared to be two possible solutions. One, draining by pumping or two, opening a sloping tunnel to discharge the water into either, the Rambla de Muleria, or, into the sea, depending on the position of the mine. The point of maximum depth was the mine Constancia which was closer to the rambla than to the sea. Using the lie of the land, and existing mine shafts for ventilation the construction of a socavón, or tunnel, was proposed. It was to have run from Ánimas and would have discharged into the rambla at la Boca de Mairena near Los Lobos. Work was due to start in 1843 and be finished in 1846. However, due to a lack of agreement between the mine owners, this logical and relatively inexpensive project never got off the ground.

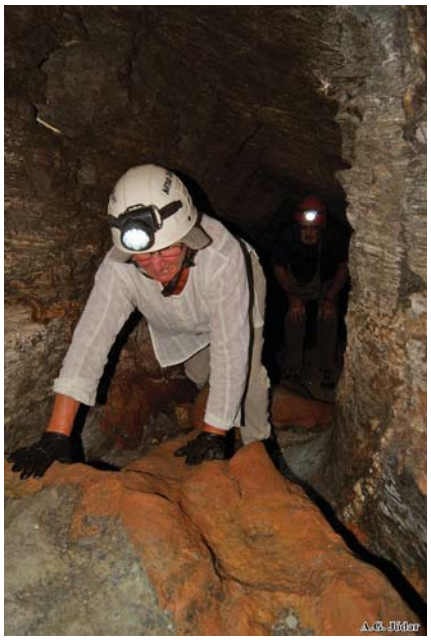
Flooding became a serious problem. In 1846 a consensus was reached and a new-fangled steam engine, to drain the mines was purchased. The parts for which were laboriously hauled up the mountain by a great team of oxen. As soon as it entered service it was realized that there was more water than previously thought. In addition, the salts and minerals in the water encrusted the pipes causing frequent breakdowns. The water was pumped up to the surface and discharged into a short tunnel which links the pumping station to the Jaroso rainwater culvert, (There are several apertures, one above the other, below the pumping station and I assume that the outflow was through the lowest one.) the water was then used in the lavaderos that were situated on the valley floor. An idea of the magnitude of the encrustations that caused so much trouble for the pumps can be seen on the floor of this tunnel.



Left, water was probably pumped out through the lower aperture into the tunnel under the present course of the Jaroso rambla.

Right, the higher aperture may have been for ventilation.





Left, the encrustations formed by the salts and minerals in the water can clearly be seen on the tunnel floor

Right, the tunnel leading to the desagüe is a classic coffin adit.

The entrance to the combined rain and pumped water tunnel is on the right.

In 1849 work started on a tunnel, the socavón Riqueza Positiva, to drain the water to the sea.

The line of the tunnel under the Sierra.

400 metres had been drilled when there was a change of mind. A board was set up consisting of 2 members from each affected mine and two new boilers were purchased and pumping recommenced.

Breakdowns caused by corrosion continued. In December 1854 a group of workmen were down the main shaft clearing encrustations early in the morning when, because they were cold or to improve ventilation, they lit a fire! 30 sections of wooden platforms and ladders went up in flames. The ventilation shafts of the neighbouring mines had to be closed and it was not until the afternoon of the next day that the fire was extinguished. The fire-setters were not only fired but imprisoned.

Work recommenced on the Riqueza Positiva.

The socavón started 177m below Constancia and passed through the old workings in adjacent mines, going under San Cayetano to the seaward side of the Sierra. This 2 metre high and 2.5 metre wide tunnel maintains a gradient of 1 in 1000, its outfall is 2 metres above sea level in the Cala del Peñón Cortado. The water flowed through wooden trunking set in the floor. There are several lumbrera or ventilation shafts along its length, the first situated just a few metres from the exit.

Looking up through the first lumbrera. *Mti.blog*

The interior of the tunnel looking towards the exit. *Mtiblog.*

The brick kiln.

On the coast side is it reinforced by brick arches. The bricks were made in the specially constructed, nearby, brick oven. It was hoped to use the gallery as a corridor for moving minerals from adjacent mines to the coast, but economic difficulties and changes of ownership meant that this never happened. It is possible to walk for quite a way into the tunnel before it is blocked by a fall.

The Cala del Peñón Cortado seen from above.

Entrance to the tunnel from the beach.

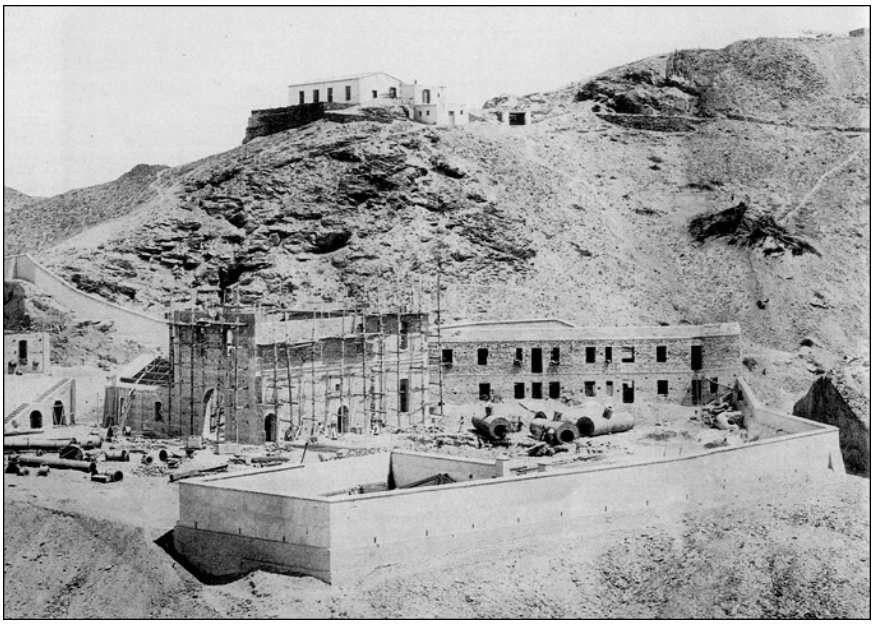
The cove is named after the "Peñón", or crag, that was "cortado, or cut through, to give access to the socavón.

Over the years, work continued on the desagüe, pumping engines were modified and replaced. A new shaft was sunk. A larger condenser installed. Drainage was slow, breakdowns were frequent It was money down the drain. The mine owners refused to pay the 10% levy imposed by the drain operators and in 1879 it closed.

Two years later it was reopened by La Compañia de Águilas who made some improvements but in 1886 it was abandoned for the final time.

All that remains of the Desagüe del Jaroso today.

4.2. The Desagüe del Francés.



San Juan under construction. *Tiempos de Plata y Plomo. (Bolea et al.)*

So to the “lost village” of San Juan, situated at the heart of the Barranco del Francés. With its row of terraced houses and the remains of a large house, one can be forgiven for imagining it as a village, peopled by miners and their families. It was, of course, nothing of the sort. It was the second of the pumping stations in the Sierra, trying to prevent the mines from flooding.

In the 1880’s, the centre of exploitation was shifting from the Jaroso to other areas. The most important of these was the Barranco del Francés, where the Compañia de Águilas was working several of the concessions.

San Juan is their legacy. They blasted out the wide flat area around the San Juan shaft, where they built the pumping station’s pump and engine house, together with a large boiler room, water collection and storage tanks. Above and behind this plaza, they created a second tier to accommodate the plant director’s house and offices, accessed by a flight of steps.

San Juan, as it is today. The director's house is on the raised second tier.

The workers lodgings and canteen were constructed on the side of the roadway which they cut through to the Barranco Chico de Torre.

The accommodation block as it looks today.

An interesting feature of both desagües is the sloping condensation channels from the boilers. The Jaroso one is stepped, while that of San Juan is straight. Both had a chimney at the top and, presumably, the San Juan one had a covering. Sloping condensation tunnels from boilers are a feature in the Sierra and I suspect there was a water recuperation element to them. There is a second, sloping channel, leading up towards the mine Isabelita. This one, however, was to increase the updraught from the ventilation shaft in the area by the curtain wall.

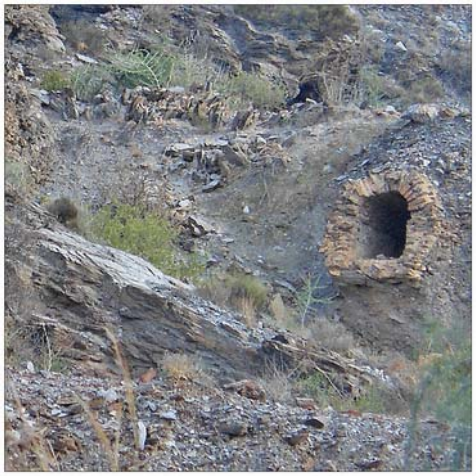
Left, the condensation channel from the boilers and,
right, the ventilation channel running up towards Isabelita.

The San Juan shaft, part of the Crescencia concession was extended to a depth of 220 metres and widened to 3.30 metres by 2.10 metres. It was twinned with the ventilation shaft sunk over by the curtain wall.

The San Juan shaft and the remains of the engine room

The water at the bottom is 35^{O} C. and is red.

The rough sides of the secondary shaft.



The water was pumped out through here.

Water for the boilers proved to be a problem for the Compañía de Águilas. The cost of the water brought up on the backs of mules was exorbitant and there was often insufficient rainfall to meet the demand. The solution was to make as much use as possible of condensed water which they supplemented with 5% seawater. This was pumped up from the same cove as the exit for the socavón Riqueza Positiva. The pipe can still be seen after certain sea conditions. I have no idea what line the pipe took: part way through the socavón and then through existing mine workings is one theory. It could also have passed through the brick arch visible in the photograph below and then taken a completely different route. Pie y Allué in, an article he wrote for 'La Revista Minería y Metalúrgica 1883', tells how a 10hp locomóvil (a steam engine on wheels similar to those used to power agricultural machinery) was used to power the pump. The locomóvil or the pump could have been housed in the edifice in the photo below.

Possible remains of the pump house in Cala del Peñón Cortada.

The pipe which carried seawater to the desagües is occasionally exposed. *A G Jódar.*

Using seawater seems to have been a short-term solution because the publication 'Minero de Almagrera' of 26th November 1884, printed an article about La Compagnie de Águilas sinking a well on the bank of the Almanzora and laying a pipe to the desagüe in order to fill the water cisterns. I have not been able to extablish the location of the well or the line of the pipe.

The pit parallel to the shaft

Another view of the engine house.

One thing which puzzled me about the site was the remains of the engine and pump room house. The pit where the fly wheel rotated is positioned parallel to the shaft and not at 90 degrees to it as one would expect.

On further research, I found out why it was arranged in this way. The pump that was installed in 1884 was a Kley Pumping Engine, which, as can be seen from the diagram, needs to be positioned alongside the shaft.

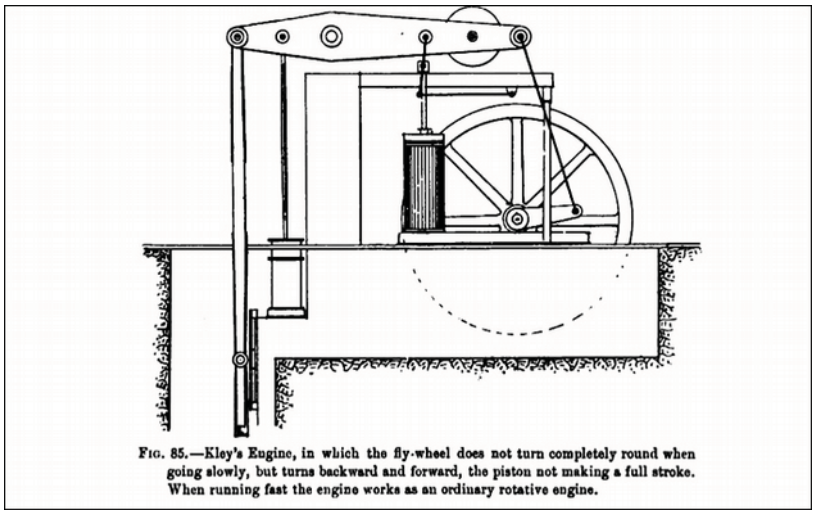


FIG. 85.—Kley's Engine, in which the fly-wheel does not turn completely round when going slowly, but turns backward and forward, the piston not making a full stroke. When running fast the engine works as an ordinary rotative engine.

Diagram of Kley pump
Henry Davey. 1900

Restored Kley steam pump at the Idrija Museum.

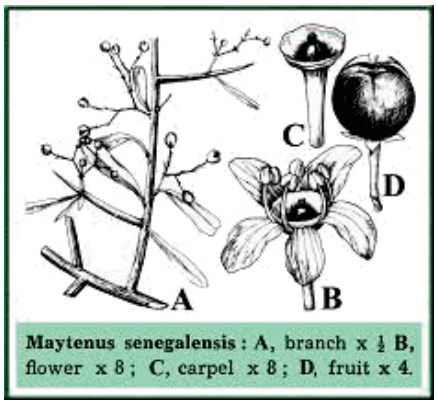
A Kley pump has been restored in Idrija, Slovenia. It began service in 1895 and was last operated in 1948. The one at San Juan operated for a mere 13 months, closing 3 days before the desagüe in the Jaroso. It was designed to lift water to a maximum of 221 metres, so was working at the limits of its capability in a 220 metre shaft. There was talk of pumping the water out through a drain lower down in the Barranco de Sima. However, in 1886, La Compañia de Águilas pulled the plug. In the case of both desagües, it was the mine owners refusal to pay for the very infrastructure they needed that sealed their fate. The mines were inundated and once more the industry was in crisis.

Two separate types of water caused problems in the Sierra Almagrera. The first was that encountered is common to virtually all mining activity after reaching a certain depth. In this area it was referred to as 'las aguas frias', or cold waters. In other words, rainwater. This filters through fractures in the rock, the mine workings and, where it is porous, through the rock itself. For the most part, this cold water can be drained by gravity, or raised to the surface or a combination of both. In the Sierra it was the other type, the thermal waters as hot as 50ºC that caused far more trouble. This water accumulates in fissures in the veins, filling the space previously occupied by gases given off during the mountain's formation. Such spaces, where they are between the body of the ore and the next strata can be relatively small. These were known as 'huecos', or hollows by the miners. Larger spaces, which contained considerable amounts of water were known as 'soplandos', or blow-holes. In places there is a mixture of the two types.

The method adopted by both the Jaroso and Francés pumping stations was to sink shafts until the water level was reached and then to extend the pipes as the level dropped. When they tried to drive levels to tap into the thermal waters they ran into problems. Once they encountered a fissure, the heat and corrosive nature of the water made it virtually impossible to continue with the drive. This resulted in only those mines in close proximity to the pumping stations benefiting from its efforts. Those further away saw little return on the levy they were expected to pay.

4.4 The Desagüe del Arteal.

The only sign that indicates the presence of one of the most important sites in the Sierra Almagrera is the one that reads ‘EL ARTEAL poblado minero’ (El Arteal mining complex). There used to be signs on both sides of the road but the one in the photo on the right was knocked down and lay in the undergrowth for a while before it was ‘collected’ for scrap. The name El Arteal comes from Arto, the Spanish name for the evil, thorny shrub, Maytenus Senegalensi, which grows abundantly on the site.



Above and right, Maytenus Senegalensis.

The closure, in 1886, of the two previous pumping stations had meant that the level of the water in the mines had been rising at the rate of 1cm. every day, having a serious impact on both the mines and the foundries. In 1890 a commission was set up to investigate the possibility of draining and re-activating the mines. One of its first steps was to petition the Government to to enact a law making it compulsory for every individual, or company, working in the Sierra to contribute to the cost of de-watering the mines. With the commission’s success resulting in a contribution of 16% of the gross output of the mines it then looked at the likely amount of water that had to be dealt with. They concluded that 3000 litres a day would be the target. They wanted the level to be dropped by 80 metres initially and then down to 100 metres within four years.


Acción núm. 116 mitad

Los Imperios

Sociedad minera para explorar y beneficiar las minas "BRANDT Y BRANDAU, Y "SIRET" cuyos títulos he propiedad fueron expedidos por el Sr. Gobernador civil de esta provincia en 21 de Septiembre de 1888.

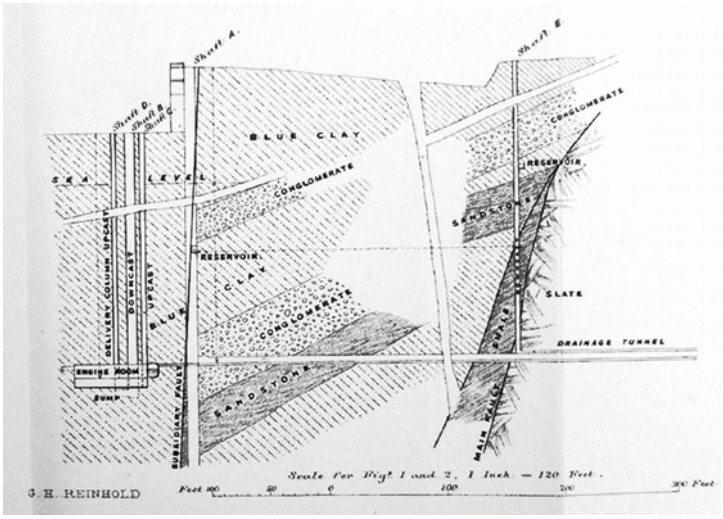
The project was put out to tender and various companies submitted bids, proposing a variety of schemes, most of which involved raising the water to the level of the Riqueza Positva and creating new socavóns linking to it. In the event the contract was awarded to Alfredo Brandt and Karl Brandau, whose company would also build the 19.8 kilometres Simplon Tunnel linking Switzerland and Italy. On winning the contract Brandt and Brandau in association with Luis Siret, formed a company called Los Imperios.

Hastial Vol 2 2012.

Brandt adopted a radical approach to the problem. He looked to place his pumps underground and channel the water to them. After a careful survey of the area he chose El Arteal as the place to site the new pumping station. There were several reasons for his choice. Firstly, it was at the base of the Sierra rather than half-way up it. Secondly, a 1.5 metre fault had dislocated the slate at the base of the mountain. The dislocated section was overlaid with clay, similar to London Clay, and was impervious apart from some thin ribbons of conglomerate close to the surface. Water in the conglomerate was not thermal water, although it did smell of hydrogen sulphide. Thirdly, there was a wide ribbon of conglomerate on the other side of the section which had itself been dislocated by a small fault. The new installations were sited at the end of this ribbon. The shaft of the mine Puente Luchana was chosen as an auxiliary shaft as it extended 20 metres below the level of the standing water in the mines.

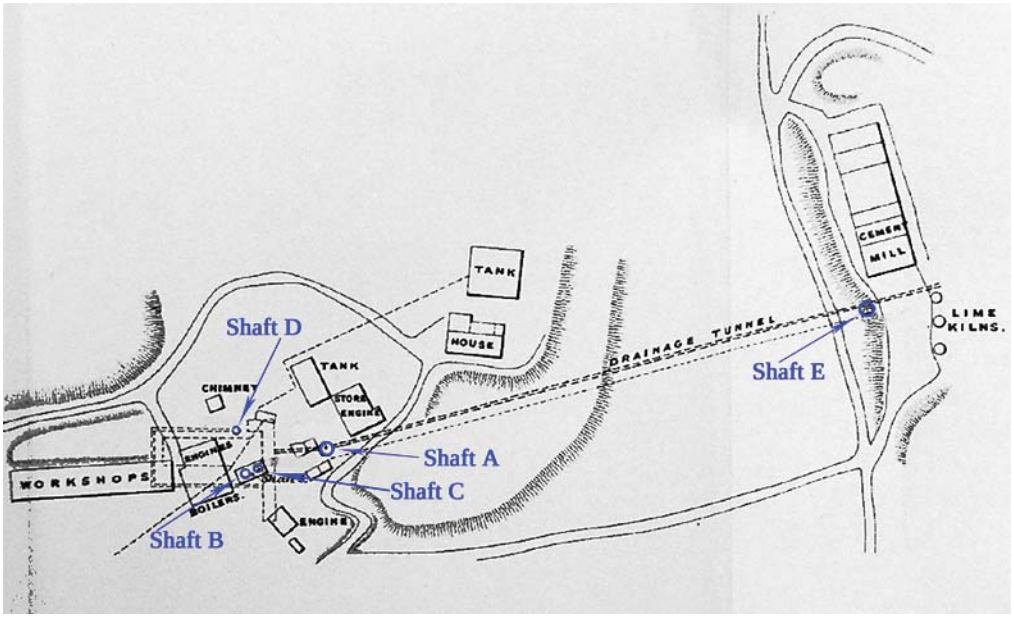
The Puente Luchana mine is at the bottom right.

The Puente Luchana's shaft.



Cross-section showing the geology and positions of the 1st phase shafts and tunnels. *Reinhold*

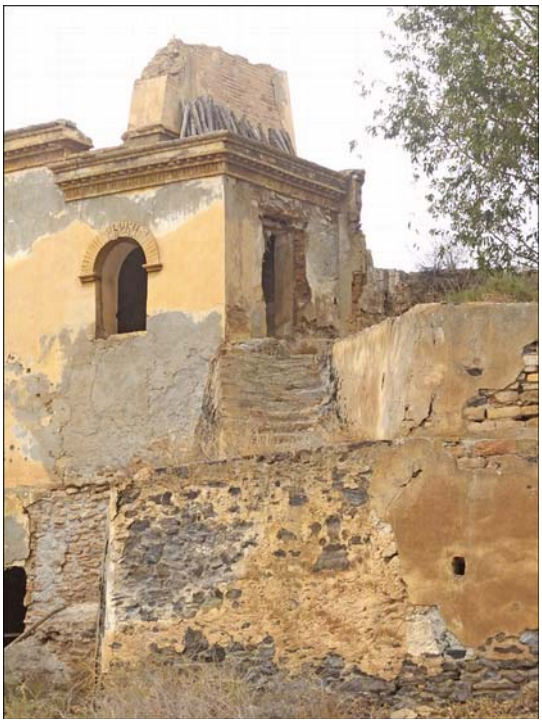
El Arteal was developed in three stages as the magnitude of the problems they faced became clear. The first phase was the sinking of the five necessary shafts and the driving of a tunnel to collect and channel the cold water to the underground pumps.



Ground plan of the 1st phase. *Reinhold.*

The first shaft, Shaft A on the plan, was named Pozo Encarnación after Encarnación Garcia de Cuélo, who gave the land to the company. The beautiful building was erected around and above the shaft and winding pulleys were installed.

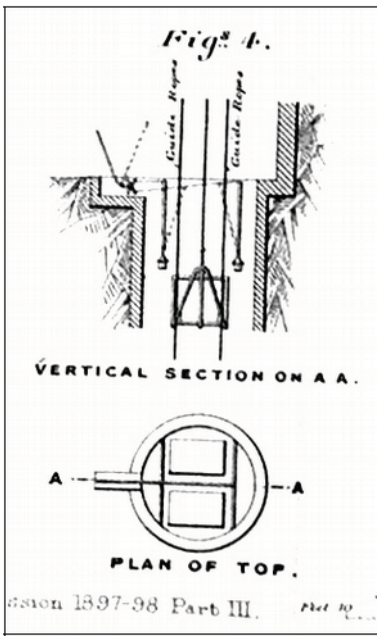
All that remains of the beautiful building that housed Pozo Encarnación.



The downcast shaft, B, and the upcast shaft, C, were then excavated simultaneously. Because of their close proximity it was possible to ventilate one by means of the other, using ‘holings’ at intervals, then closing these openings later. The elliptical upcast shaft was named Pozo Ana and was sunk to a depth of 117 metres and served as the main ventilation shaft for Encarnación and the engine room. The circular, 120 metre downcast shaft, was known as Pozo Juala meaning cage shaft, because it was fitted with cages capable of bringing spopil wagons to the surface. The delivery shaft, D, up which the water was raised to the surface, was fitted with ladders in case of any failure of the winding gear in Encarnación or Juala.

Left, Pozo Ana. The chimney above the shaft was added at a later date.

Right, diagram of the guide cables for Juala's cages. Reinhold.

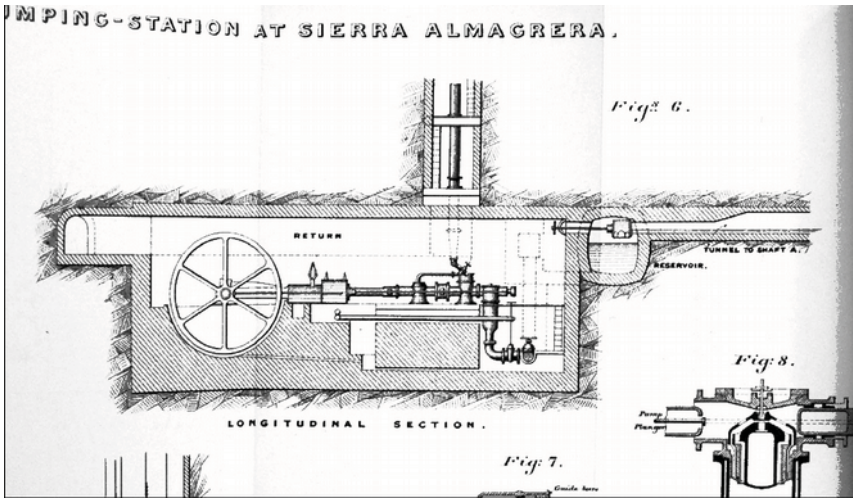


Left, back wall of Pozo Juala. This shaft has been remodelled many times over the years and is now completely sealed. Above, The top of the delivery shaft up which the water was piped to the surface.

Above, the delivery shaft seen from below.

Above, all four shafts. The boiler room is on the left, the delivery shaft is above left, the remaining wall of Juala is in the centre with Encarnación above it and Ana on the right.

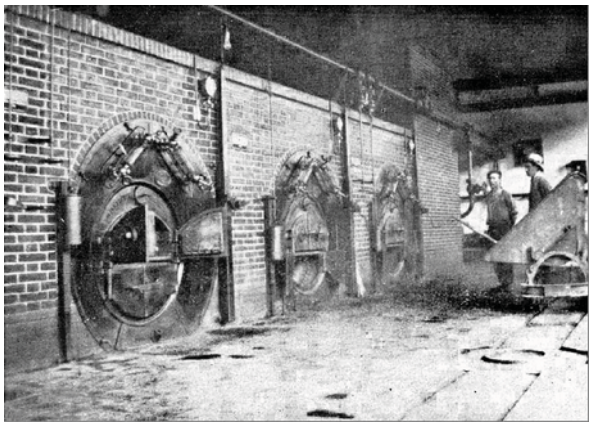
Once work was completed on Pozo Juala the steam pipes were fed down to the engine room which had been constructed below and the pump was installed.



Pump. *Reinhold*

A fifth shaft, E, was sunk 200 metres from the others, near to the mountain, to serve as a ventilation shaft for the tunnel that would bring the water to the pumps in the engine room. As this ventilation shaft was being sunk they encountered a layer of conglomerate which, despite being close to the surface, was water bearing. As soon as the shaft cleared the band of conglomerate a reservoir was built to contain the water. This was then tapped off and raised to the surface in kibbles (buckets) alongside the spoil from the sinking.

The power for all these works was provided by two Cornish style boilers, which were a temporary measure as the boiler house had been built to accommodate three larger boilers which were installed when the plant was ready to enter service.

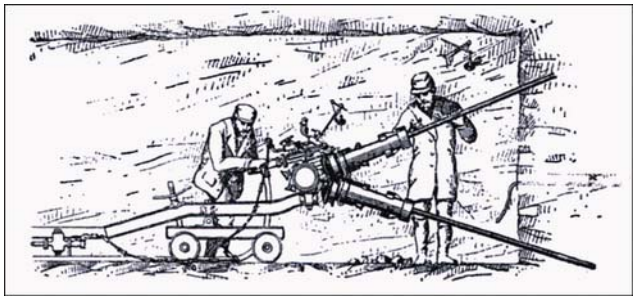


Above, the three larger boilers.
The steam-pipes can be seen running into Pozo Juala. *Hastial Vol 2 2012.*

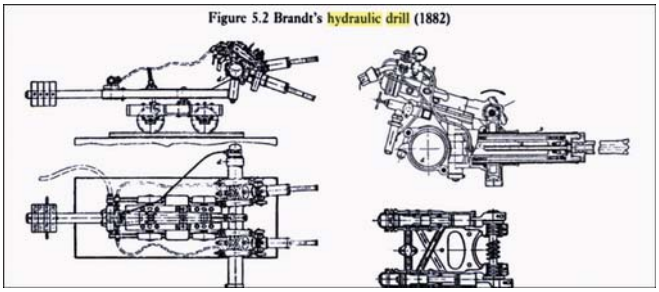
Above right, the remains of the boiler house today.

Right, the traces of the turntable for the coal wagons.

The water collection tunnel, or conduit, was driven at a depth of 85 metres below sea-level. Both the bricks and the mortar used to line the tunnel were made on-site. Flagstones were laid along the tunnel's length on which the wagon tracks were laid for the removal of spoil. Refuges and passing places were created at intervals to allow the passage of full and empty wagons and to provide shelter when explosives were used. On reaching the slate of the mountain temperatures rose considerably and the water from the layer of conglomerate in the ventilation shaft was allowed to fall as a cooling spray. As work progressed a proper water jet was used and set up about 10 metres from the work face, then as temperatures rose even further, the water was allowed to play on the faces of the workers. At 50 metres into the slate a fissure containing thermal water was encountered and drained lowering – slightly – the water level in the mines. The rate of progress through the slate, using traditional methods, was 1.30 metres a day. The inclination of the strata was unfavourable, and likely to slow the rate even more, so the decision was made to use rock drills. As far as I can ascertain, this was the first time they had been used in the Sierra. Certainly, the men operating them had never done so before although it seems they soon became quite skilled spurred on by generous bonuses. Naturally, Brandt Hydraulic Rock Drills were used since he had invented them and had used them in other tunnelling ventures. Their use speeded up the rate of progress to 3 metres a day.



Brandt Rock Drill



Drill diagram

From 'Innovation and the Rise of Tunnelling'. Graham West

A deep well was sunk on the banks of the Almanzora river and a pumping station built, fitted with a Worthington pump and boiler. 2,000 metres of Mannesmann pipes carries the water to El Arteal, where it was used to power the hydraulic drills.

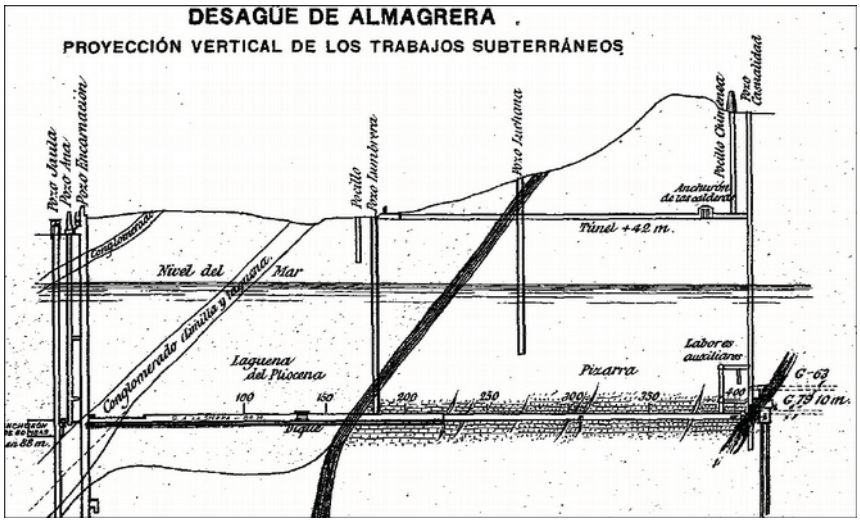
Although a new well had been sunk adjacent to the Portillo electricity substation in Las Rozas, the original well was only properly capped a few years ago after a tractor got a wheel stuck in it during ploughing.

Below left, the capped, old well and, right, the new well by the substation.

The drainage of the cold water was successful and everyone was pleased with the rate at which the water level was dropping. Then, there were problems. A collapse in a gallery at around 450 metres brought things to a halt.

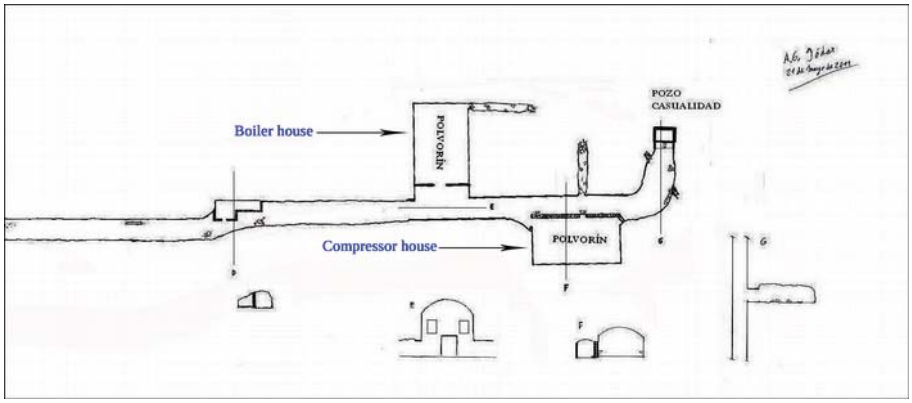
A costly stage two was about to begin.

In order to open a second gallery, at a slightly different angle, major works were required. A tunnel, 42 metres long, was driven from a point close to the original ventilation shaft, E, to link up with the shaft at Casualidad. At its end, two chambers were excavated, one to house boilers, the other, the compressors. A shaft was sunk to ventilate the area and Casualidad's shaft was extended down to the drainage gallery, where a further equipment chamber was excavated. Then, in order to deal with the increased volume of water flowing through this second gallery, a new pump needed to be installed in Encarnación.



Plan of the underground working.
Estadistica Minero 1908.

Plan of Casualidad's tunnel showing the Boiler and Compressor houses.
Drawing A G Jódar.



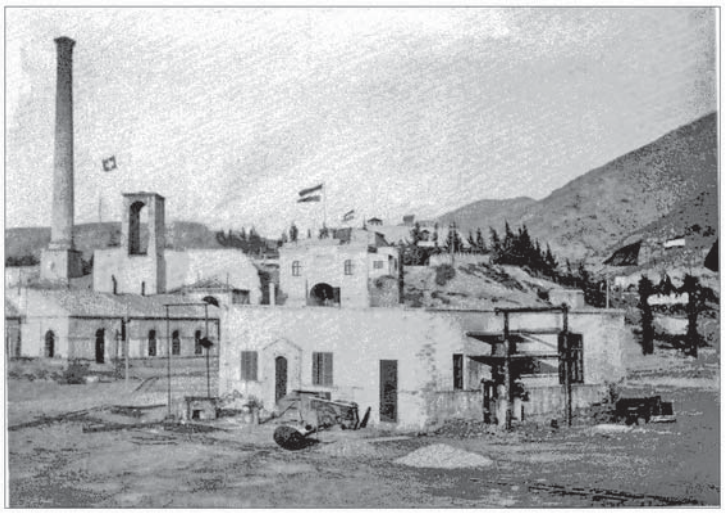
Left, Casualidad's main shaft.

Right, the ventilation shaft. The chimney was added C1903.

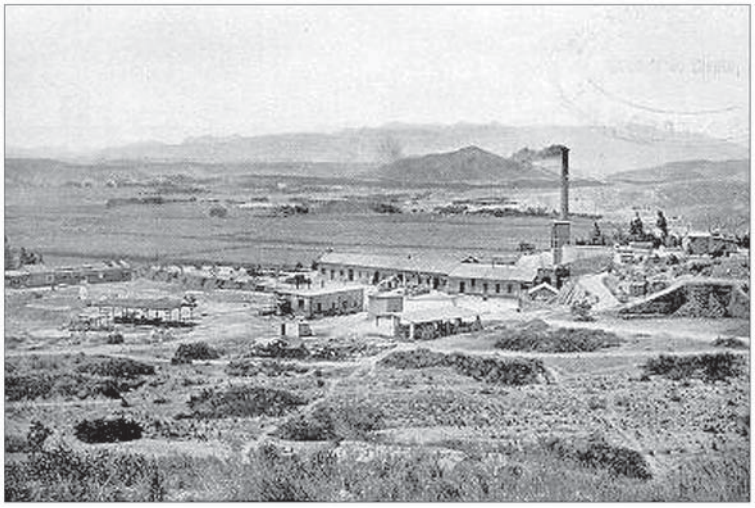
The tunnel entrance to Casualidad. The sloping wall on the right of the arch is the remains of one of the lime-kilns shown on Reinhold's plan on page 70.

These works were costly: the company was losing 15,000Pts a month and they tried, unsuccessfully, to raise more capital. They then tried to re-negotiate the terms of their contract and raise the levy from 16% to 25% but the mine-owners refused to agree to those demands. The upshot of all this was that, in 1903, the desagüe was taken over by a new company, the Compañia Minera é Industrial para España, with the mine-owners levy set at 21%.

So started the even more costly stage three of El Arteal's development.



El Arteal in the early days. The building in the centre under the Spanish flag is recognisable as Encarnación.
Un Siglo de Historia Minera. Bolea.



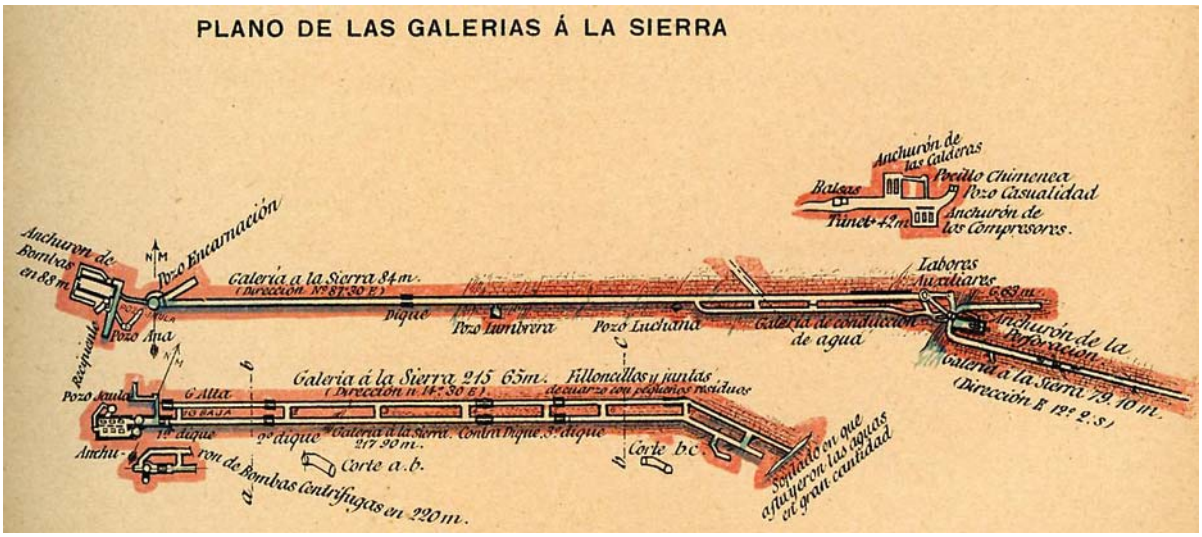
Another view.
Editions Martin.

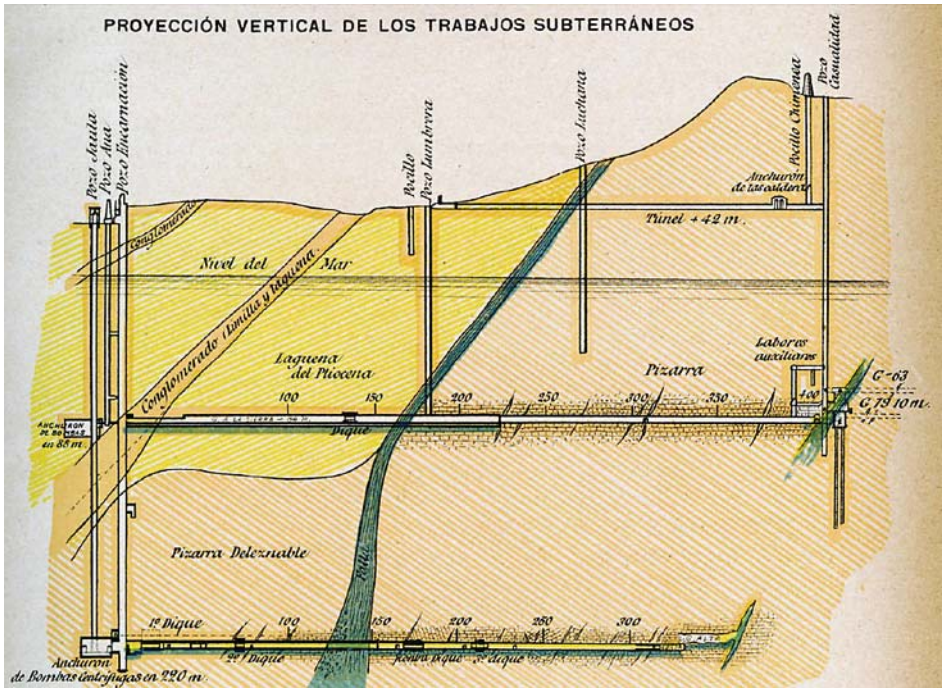
With the water level holding at 95 metres below sea level, and their contract requiring it to be lowered to 120 metres, this new company undertook a massive amplification of the installations.

The shafts, Encarnación, Jaula and Ana were taken down to 250m, 130m, and 132m respectively, below sea level and a chimney built over Ana to improve ventilation. A new plant room was excavated in the slate at 220 metres below sea level which comprised of an engine room and a pump house, both 18.60 metres long. Three vertical compound steam engines powered the three centrifugal pumps which operated at 1500 rpm. The inner parts of the pumps were coated with phosphor-bronze to protect them, as far as possible, from the corrosive nature of the thermal waters. The water deposit for the pumps had a capacity of 46,300 cubic metres.

Leading from Encarnación were two brick-lined water collection galleries, one above and slightly to the side of the other and at a vertical distance of 2.50 metres and a horizontal distance of 8 metres. The higher of the two was 300 metres long and the lower 332 metres. These two galleries were connected at intervals by incline shafts and both conduits were fitted with sluice gates. This arrangement allowed for the balancing of the flow of water into the reservoir and the pumps.

The 16th of March 1906 was a red-letter day, when the actual thermal waters were encountered as opposed to water which had accumulated in fissures.





Above. Plan of the galleries. The lower gallery met with the thermal waters of the Sierra at a depth of 220 metres and a distance of 332 metres from the pumping station.

Right. Cross section of the underground workings in 1906.

Both: Hastial Vol 2 2012.

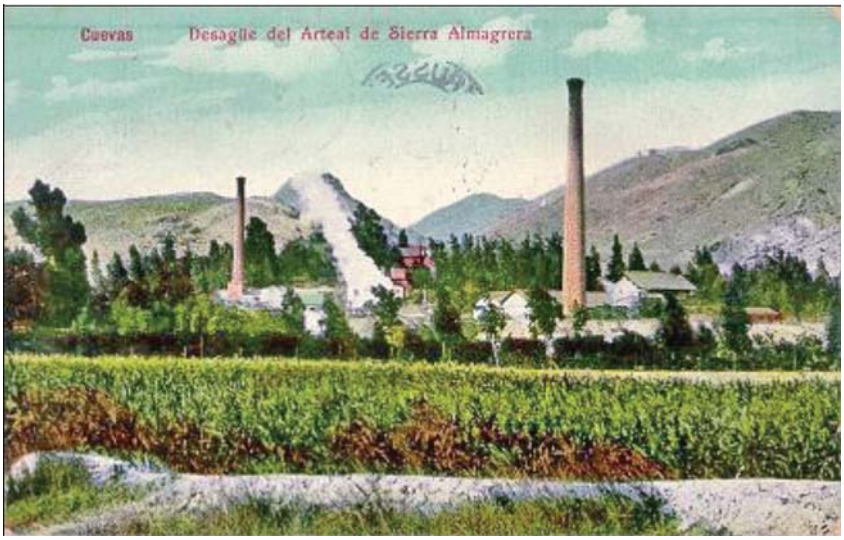
This plan, for some reason, does not show the delivery shaft up which the water was pumped from the original conduit and pumps. ‘Estadística Minero 1908’ details how the other three shafts were lengthened, but makes no reference to the delivery shaft. In fact it states that the water was pumped to the surface via Pozo Jaula. This would mean that Jaula had cages, steam pipes and a rising water pipe, which seems rather odd. The other problem is that, without the delivery shaft and its ladder, the evacuation of the pump room in an emergency would have been difficult. The delivery shaft is still open and while Jaula has been capped and/or filled, and all that remains of it is the back wall. Another mystery! Wherever the water was pumped from, it ran down between the two walls at the back of the courtyard by the abandoned new-build and out through a grille set in the far wall. From here it was channelled along the top line of the field below, then behind the new pump house, along the line of the field wall and into the Rambla del Arteal. At some point, a flow metre measured the volume of water extracted. This was probably placed in the channel between the two walls.

Above. The water left the courtyard through the grille (highlighted).

Left. The pumped water flowed through the channel between the walls.

A new power plant was built in order to run the new machinery. Sited 80 metres from the old one, it was three times the size. The boiler room had two banks of four condensing boilers from which the superheated steam was channelled through triple insulated pipes, over to and then down, Pozo Jaula to the machines underground. The feed water for the boilers went through a very complicated purification process (of which more in Volume 3) and the draw was provided by a 45 metres high chimney. Luis Siret’s railway was extended to El Arteal in order to bring coke, from the port at Villaricos. The line was carried, from the Rambla de Muleria to the site, along a raised pier and an embankment, and then crossed a bridge over the road to the Sierra. The bridge supports are still, just about, standing. The coke was stored in a huge, covered purpose built store next to the boiler-house.

The remains of the bridge supports over the original track to the Sierra.



El Arteal after the new power plant was constructed.
F de Blain.

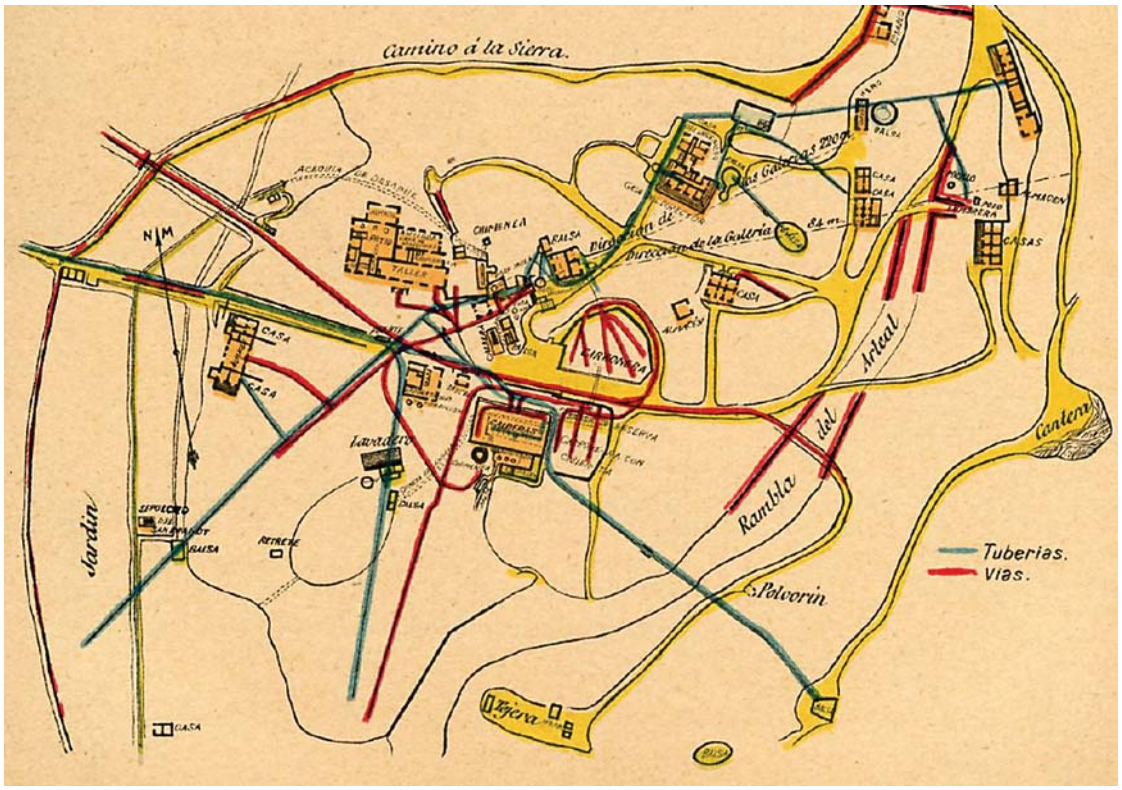
Above, general view of the power plant. The base of the chimney on the left is highlighted and the boiler room wall is behind the water tower.

Right, the base of the chimney, in front of the water tower.

The remains of the water tower. Tanks were situated on top of the tower.

Inside the water tower.

As well as these major works they installed a 10 horsepower motor to power a Schuckert dynamo to provide lighting for the site. Encarnación had lift cages fitted, and new motors were fitted for Jaula's lift cages. The forge, machine, and metal work shops were fully equipped with modern machinery, and there were two overhead cranes, one underground and the other on the surface.



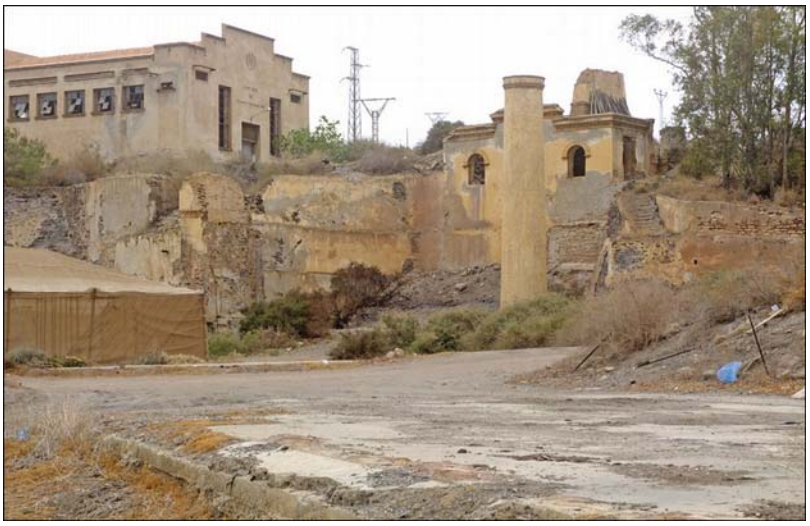
Surface plan of el arteal in 1908. *Hastial 2012 after Estadística Minera 1908*

This detailed plan of El Arteal gives a very clear picture of how it was in 1908 and much of it remains to be seen today. However, everything that was in the area south of the power plant has disappeared apart from the balsas, or, water storage cisterns. The drain from the boilers of the new plant ran down to a lavadero, or ore washing shed, indicating that El Arteal was also the site of at least one working mine. The drain was then channelled past the retrete, or lavatories. Nearby, surrounded by a garden, was Alfredo Brandt's sepulchre. He had died in 1900 and, while his son Gustavo took over the business, it was his son-in-law Rafael Souvirón who, as the engineering director, was the company's driving force. On the south eastern side of the complex, was a tejera, or brick kiln, where the bricks used in the construction of the site were made, alongside the kiln were two ore furnaces. Of the polvorín, or dynamite store, there is no trace, but the cantera, or quarry can still be seen beside the top track.

The picture below shows the water tower and the wall of the boiler house, but as can be seen from the plan, the building which housed the calderas, or boilers was a considerable size. The adjacent covered carbonera, or coal bunker, was large, but the one over the road from it was even larger. The former was used as settlement tanks in later years, while the latter is currently covered by greenhouses.

The view of the plant looking over the site of the covered coal yard.

The forge and metal shop were to the right of the boiler house along with the bascule, or weighbridge. The foundations of the workshop are still there, possibly because they are too substantial to be worth the bother of digging them out. Nearby is a large concrete block which I think was part of the weighbridge.

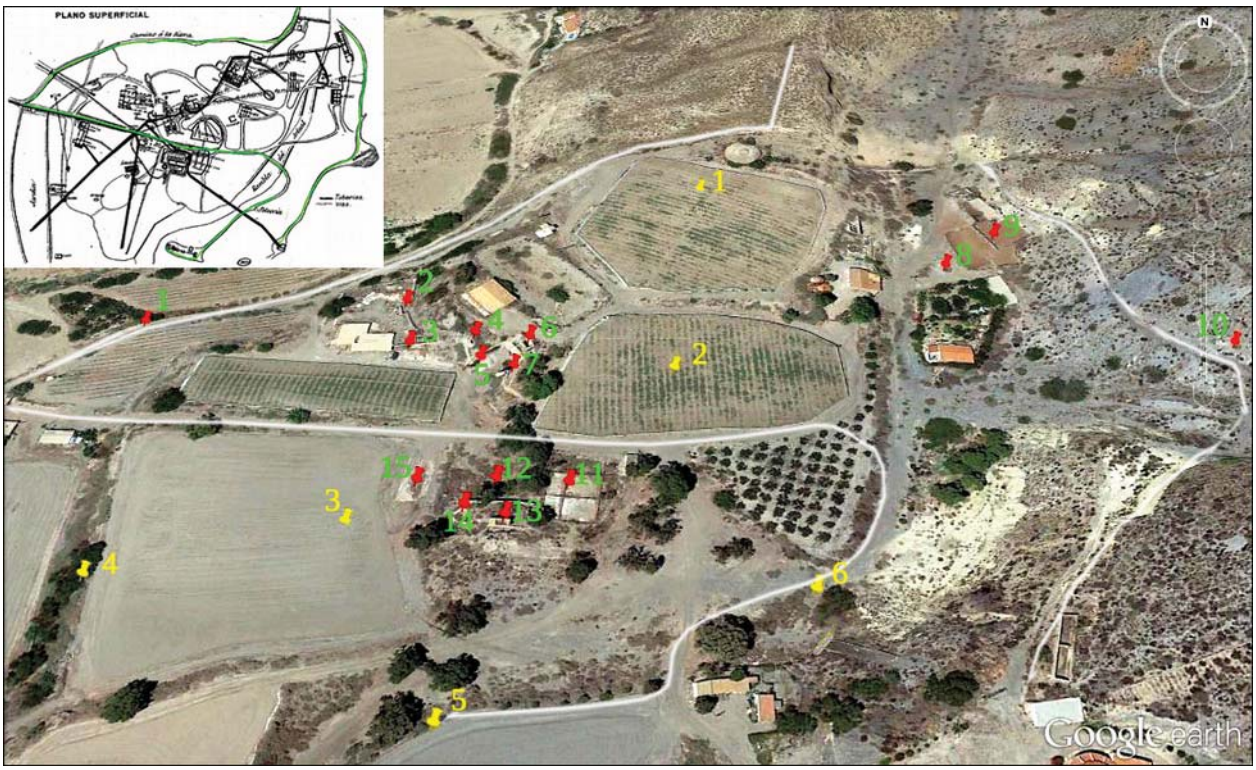


Looking out over the workshops.

The foundations of the workshops are in the foreground, then the chimney over Pozo Ana, with the building hosing Pozo Encarnación behind that. To the left can be seen the back wall of the arched building which housed Pozo Jaula. The base of the delivery shaft is to the left, and slightly above, Pozo Jaula. Originally, the delivery shaft had a tall open-sided tower over it. Of the original chimney there is no trace, I suspect that the Central de Transformación was built over it. The old boiler house is situated behind the greenhouse on the left. As can be seen in the 1908 plan, to the original boiler house was added a carpenter's workshop, a machine shop, a patio, or open work area, and a store room. An abandoned, unlicensed, half-built house stands where the patio and storeroom were.

The plant director and the engineer occupied chalets on the highest part of the site, the area is now covered by greenhouses. Luis Siret lived at El Arteal for a time. When his wife died, he moved with his children, into one of the two villas.

The director's and engineer's villas.
Un Siglo de Historia Minera Bolea.



El Arteal today showing the key locations from the 1908 plan.

Key.

Yellow Pins represent the 'Site of ...'

1. Director's and Engineer's houses
2. Coal bunkers.
3. Ore washing sheds.
4. Brandt's Sepulchre.
5. Ovens and brick kiln.
6. Dynamite store.

Red Pins represent the 'Remains of ...'

1. Railway bridge..
2. Drain.
3. Old boiler house and workshops.
4. Delivery shaft.
5. Jaula shaft.
6. Encarnación shaft.
7. Ana shaft.
8. Well shaft.
9. Ventilation shaft.
10. Quarry.
11. Covered coal store.
12. New boiler house.
13. Water tower.
14. Chimney.
15. Metalwork shop.

All of these improvements to the infrastructure were very successful. The water level was reduced to 127 m below sea level, even in the Barranco del Jaroso. New mining companies were formed and exploitation recommenced. The whole area was revitalized, however, the new boom was short lived. El Arteal was the largest civil works ever seen in Spain, but it was also the most costly. The fall in the value of the extracted minerals meant a fall in income in real terms for the project. This, coupled with increasingly high maintenance costs, forced the Compagnie Minière et Industrielle pour L'Espagne to shut the machines down in 1912. The old story of money down the drain and inundated mines.

After 1912, the Desagüe had a rather chequered history. In 1916 a company by the name of Desagüe de Almagrera S.A. took it on and decided to use coal rather than coke as fuel for the boilers. Needless to say, that was a disaster, since the boilers were designed to be run on coke. They then tried to negotiate a contract with a hydroelectric company in Júcar, but that came to nothing. Finally, they installed a diesel generator to pump water out of the flooded pump room, and then managed to get one of the centrifugal pumps operational. This was not enough to prevent the water level from rising and pumping ceased in 1921.

The situation in the Sierra was poor, the lead and silver mines were dying a slow death. Meanwhile however, in Las Rozas, the extraction of iron ore was booming. Luis Siret and his Société Minière d'Almagrera was a dominant player. He was also extracting iron ore in the Sierra from República Romana, Boletín and Remedios, so he had an interest in maintaining de-watering. In 1924 he took over the running of the desagüe. He improved the electricity supply to the main engines with 26,000 volt hydroelectric power, supplied from Bayarque 80km away. As this supply tended to be erratic he built the Central de Transformación which housed a 535 horsepower German diesel engine. To the three pumps already installed, he added a fourth, two of which were powered by the power generated on site, and the other two by the power from Bayarque. With a constant source of power the de-watering was successful. For the mine owners the benefits did not last, as, in 1929, the Société Minière d'Almagrera moved their operations to North Africa and the running of El Arteal again changed hands.

The Consorcio de Almagrera S.A. then took over the running until 1933. They broke their contract with the company supplying them with hydroelectric power and built a generating plant in Villaricos, powered by a diesel engine. This proved to be inadequate and the mines were again flooded.

Next up were Empresas Eléctricas e Industriales who used both the plant at El Arteal and that at Villaricos, enabling some of the mines to recommence activities. They improved the Villaricos generating plant by installing a new alternator, a 1200 horse-power MAN engine and improved the cooling system by piping in filtered sea water. The future of the remaining mines seemed to have been secured, but then the storm clouds gathered and the whole country was engulfed in conflict. The upheaval and uncertainty of the civil war made the efficient operating of the plant impossible. Fuel shortages meant that the electricity supply from Villaricos was erratic and, eventually, pumping and all other activity ceased.

Once again the mines were flooded.

The end of an Era!