The Farga Rossell. An example of catalan forge

Col·lecció Guies del Patrimoni Cultural d'Andorra

FARGA ROSSELL CENTRE D'INTERPRETACIÓ

Govern d'Andorra
Ministeri d'Educació, Cultura, Joventut i Esports
Àrea de Recerca Històrica

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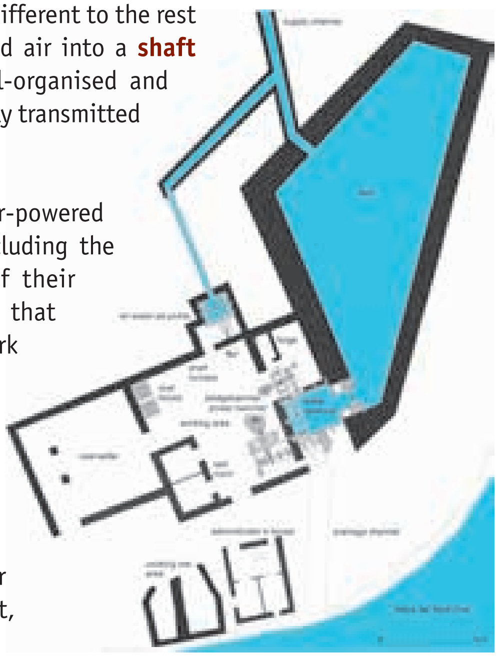
The Farga Rossell. The Centre d'Interpretació del Ferro (AT).

A *farga* or forge is an early workshop for producing raw **iron**, with a highly-organised workforce and a rational management of natural resources (charcoal, **ore** and water). From the earliest manpowered to the later water-powered forges, the structures, organisation and management underwent major changes to meet market requirements.

The Rossell forge (1842-1876) is the last example of a technological form of the **direct process**, which was developed in the eastern Pyrenees between the 18th and 19th centuries. This branch is known as the "Catalan" forge and is characterised by a particular combination of technology and labour. Catalan forges were different to the rest due to an **air-water-jet pump**, that blasted air into a **shaft furnace**. The gang of **forge-men** was well-organised and applied the knowledge that had been jealously transmitted from father to son.

At the end of the 19th century, the water-powered forges closed down, one after another, including the Catalan forges. Therefore, a good part of their knowledge and a way of understanding life that was founded on the importance of team-work was irremissibly lostforever. Those men and their endeavour have left their mark, still to be seen in abundant material remains, numerous written documents and a wide variety of names. This heritage can but win our admiration and gratitude for the men who bore iron in their veins and who were tempered, day in day out, by the effort of their work.

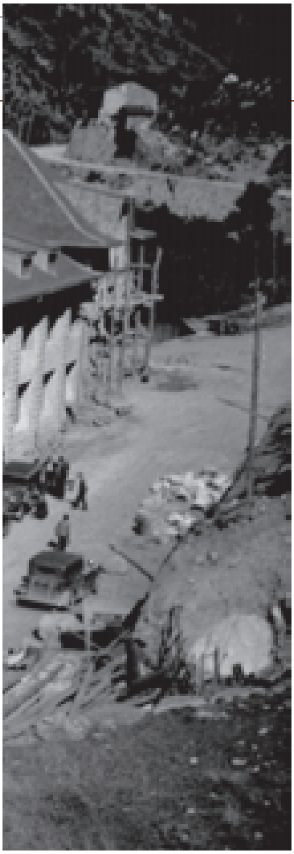


The Rossell forge ground plan (1842-1876) (ARH).

Hydroelectric power station of FEDA (Escaldes) (AHN-FEDA, neg. 35).

IRON

Iron is a material that, (unlike flint for example), can be flexible, resistant, easily cast or magnetic. These properties have ensured its survival along history as one of the main components in tool and machine manufacture. Iron working processes can be divided into the **direct process**, with evidence in Africa that dates back to 2000 BC, and the **indirect process**, with remains in China that dates from 800 BC. In every period of history, communities have met the challenge of working iron and manufacturing objects in different ways; as **soft iron**, **steel** or **cast iron**. So, the term “iron” is imprecise because of the levels of carbon coming from the fuel (charcoal), that will determine its mechanical properties giving it a different name. Moreover, charcoal in forge furnaces plays a decisive role as the generator of **reduction gases,** which make **reduction** possible. The sequence of operations that characterises the iron and steel production process, from charcoal and **ore** to the finished product, is called the **production line**. The work of supplying and preparing the raw materials, the kind of furnace used wherein reduction took place, the machines that simplified the work and lastly, the production sites and markets, have not been immune to change over time.



The direct and indirect processes

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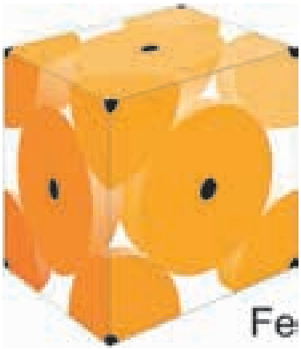
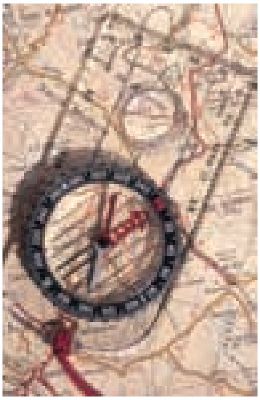
The direct process produces iron in a **shaft furnace**, in one single operation, **reduction**, obtaining a mass of spongy iron, called **bloom,** with low levels of carbon (**steel and wrought iron**). On the other hand, in the indirect process iron production is carried out in a **blast furnace** and by means of two operations (reduction and **decarburation)**. The first one produces molten iron with a high percentage of carbon (**cast iron**), while the second one lowers the levels of carbon to obtain steel. In Europe, the use of the indirect process in blast furnaces was concurrent with the direct process in forges from at least the 12th century onwards. However, at the end of the 19th century, the development of the direct system was abandoned in favour of the indirect system.





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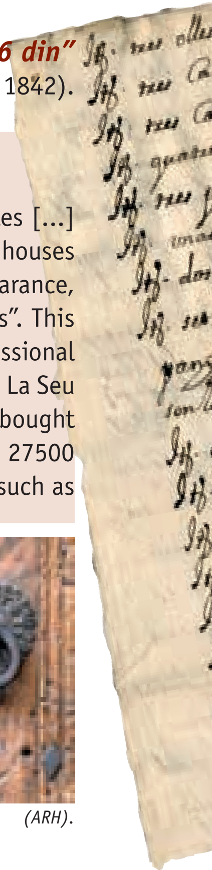
Soft iron, steel and cast iron

© *El transbordador de Bizkaia*.

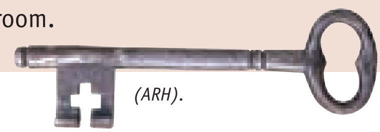
Iron is a generic term that includes soft iron, steel and cast iron. Each of these three types is distinguished by their different percentages of carbon (**carburation** degree), which determine their properties and uses. The soft iron, also called *ferro* moll, has less than 0,02% percentage of carbon and it is typically ductile and malleable. The steel or *hard iron* contains between 0,02% and 1,7% carbon and is typically resistant and hard. Cast iron, also called *casting* contains between 1,7% and 6,67% carbon and is typically brittle and easy to cast. Forge-men and blacksmiths to fit their requirements can modify as they please with chemical treatments carbon levels, as well as the crystalline structure with thermal treatments. The commonest chemical treatments for iron were **cementation** and **nitruration**, while the thermal ones were **tempering***, revingut* and ***recuit***.

"30 hundred tacks for the roof of the house: 7 Ll. 17 s. 6 din"
C. Casanoves (master housebuilder, Ordino, 1842).



IRON IN CONSTRUCTION

In 1835, James Erskine visited Andorra and wrote: "the roofs are covered with slates [...] laid down on the rafters and held down with heavy stones. Only in the best-built houses nails are used for fixing them, in such a fashion that the roofs have an unusual appearance, as if an avalanche had covered the slates with stone fragments from the mountains". This can be explained by the fact that, at that time, nails had to be bought from a professional craftsman, which raised building costs. In Andorra, nails were usually imported from La Seu d'Urgell because there was no nailsmith here. In 1842, for example, 3000 tacks were bought for building the roof of the house of the Rossell forge-master and the following year, 27500 nails and tacks of different sizes were bought for the main building. Other objects, such as window bars and grilles, hinges and railings were made of iron forged by **village blacksmiths** or, less frequently, by the local **forge-men**. Despite being a heavy investment for a family, this iron is hardly ever mentioned in house inventories in the 18th and 19th centuries, the only exception being locks made by locksmiths, because of their particular significance, to lock a room.



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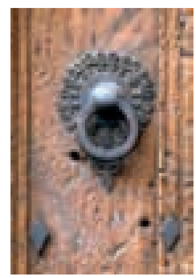
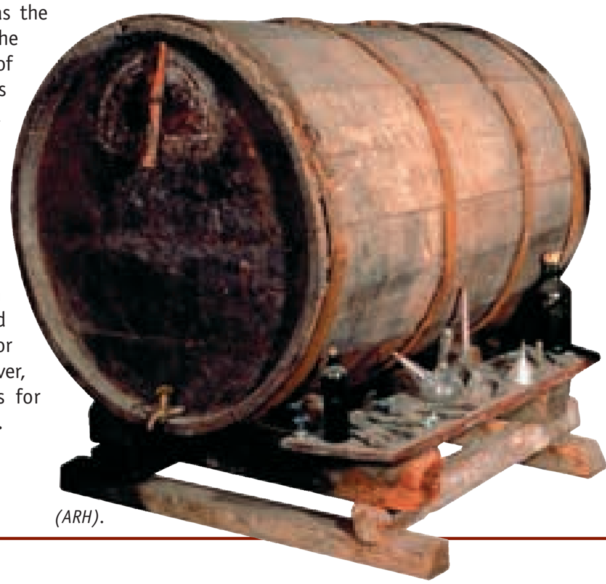


(ARH).

Iron at home

Iron, though was not the only metal, was the most abundant and found everywhere in the house. All about could be found examples of keys, hinges, rings, strips, staples or tools with iron blades. The success of this material was in its flexibility, solidity, incombustibility and thermal conductivity. Objects such as fire-baskets, shovels or cooking-pots did not need a particular quality of iron; on the other hand, tools that might wear, such as ploughs, axes, hoes and sickles, needed treated iron. In such cases, steel was used, for its hard grain and because the blades could be reinstated or sharpened when blunt. The best **steel**, however, was used in making precision elements for watches, or blades for weapons and razors.



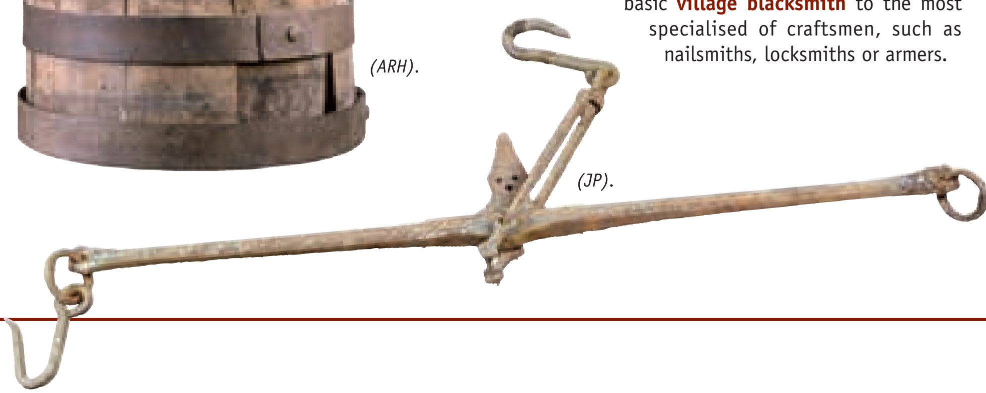
(ARH).

(AHN-NMV, llib.98).

(AT).

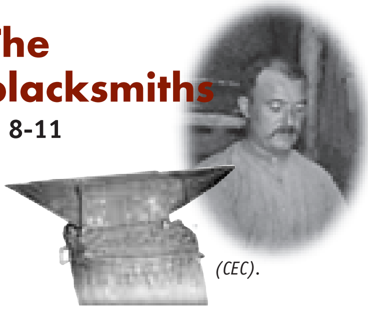
(ARH).

The precision and range of knowledge needed to manufacture iron led to growing specialisation among smiths. For the one material, raw iron, there was anything from the basic **village blacksmith** to the most specialised of craftsmen, such as nailsmiths, locksmiths or armers.



(JP).

SUMARI



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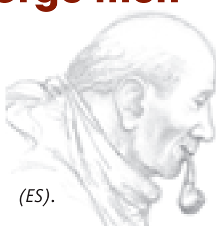

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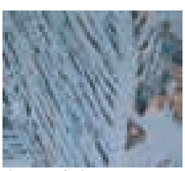


(From PhF).

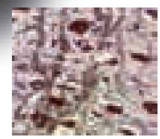
(AT).

Grid from the church of Sant Martí de la Cortinada

The charcoal-burners

P. 20-23

(FP).

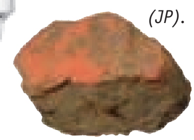


(ARH).

The miners

P. 24-27

(ES).



(JP).

The carriers

P. 28-31

(ES).

(ARH).

The Itinerari Homes de Ferro

P. 34-35

(One point of the Itinerari Homes de Ferro)

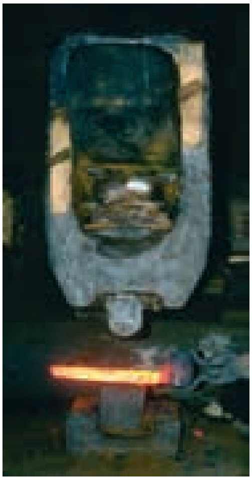
"In the store there is little more than a ton of iron left, we will not be able to deliver Telivet's order"

J. de Riba (owner of the Rossell forge, 1858).

IRON TRADESMEN AND MANUFACTURING

In the second half of the 18th century, markets were filled with blacksmiths, who bought large amounts of raw iron. These wholesale tradesmen owned workshops that specialised in specific types of forging. La Seu d'Urgell, for example, was a centre for workshops making agricultural tools, Ripoll for nails and fire-arms, and Solsona for knives. These manufacturing centres consumed a good part of the raw iron produced by the forges of the Pyrenees. The workshops had one or more **sledgehammers**, for producing either half-finished or quality objects. In the case of half-finished objects such as hoes, the *martinetaire*s only forged a blade with a hole, leaving the **village blacksmiths** to finish the tool, to suit the client. For quality products (sickles, knives, firearms), however, the *martinetaires* relied on their high standard to sell them on the open market. Specialization influenced forge production, which no longer produced standardised objects but met precise requirements, relating to ingot shape, size and finishes.

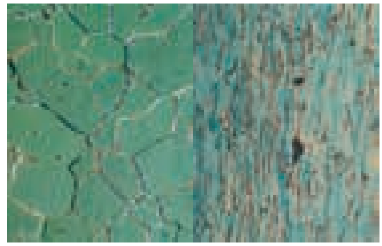
Forge in Arles sur Tech (ARH).



Head of a sledgehammer (FP).

The sledgehammer

The sledgehammer is a water-driven hammer. Compared with the **power hammer**, it is smaller, faster and has a different head. It was not exclusive to forges, but was adopted by them when requirements for raw iron became more specific. In the 19th century, sledgehammer such as the one at the Rossell forge had a heavier head than those belonging to blacksmiths or *martinetaires*, for forging iron bars or larger objects. This head had an interchangeable **tap** on the end to obtain different finishes and ingot shapes. A blacksmith's sledgehammer complemented this piece with a ***demet***, which was also interchangeable, so that two faces of one sheet could be simultaneously forged with different finishes and shapes. This versatility was fundamental to blacksmiths, who depended on small local markets, where specialization was impossible but which required a wide range of products.



Pig iron and wrought iron (from PhF).

The quality of the iron

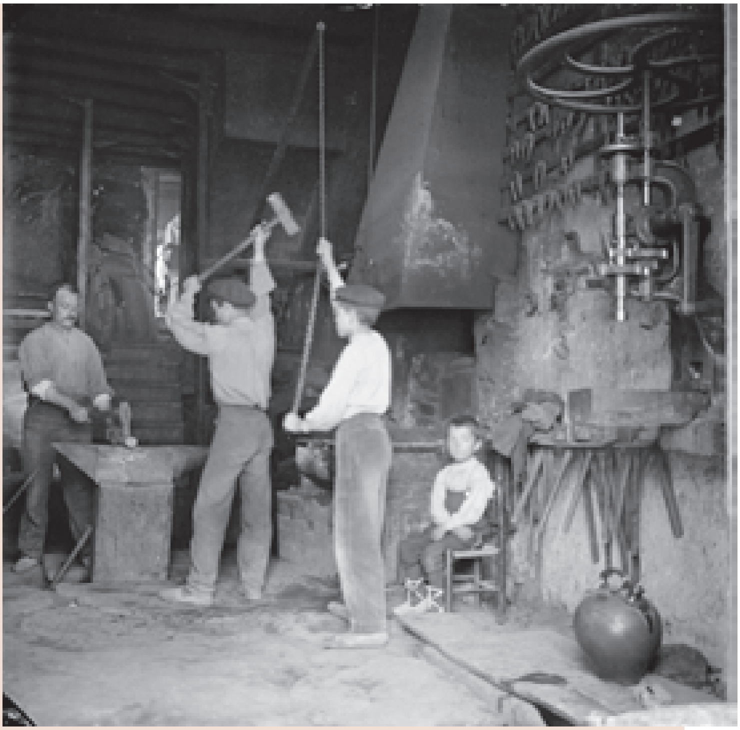
The **bloom** that came out of the **shaft furnace** was a mixture of **soft iron** and **steel,** that were also called *ferro moll* and hard iron.**.** Through **bloom cutting**, they aimed to produce bars that were as much homogenous as possible. During the 18th and 19th centuries, the Catalan **direct process** managed to increase the levels of steel to achieve a high quality that was easily marketed. Not ignoring the fact that part of the iron sold were simply ingots or bars, the **tradesmen** progressively imposed their standards on the quality, finishes and exact shapes, which could only be obtained during refining and post-reduction work. In the Forge Rossell, for example, they produced a whole range of products (*vergues, verguelines, rondills, plates, galetes, barres vigatanes, barres lleidatanes*) which were sent to Osona, Bages or Urgell. As for the supposed quality of the raw iron obtained from the Catalan direct process, this has still not been proven. It is difficult to compare **steel** from a shaft furnace or a **blast furnace** without taking the differences in the **production line** into account. Moreover, we should not forget that at the time, direct processing of steel was not exclusive to Catalan forges.

Sales zone of iron from Areny and Rossell forges (1845-1876) (ARH).

Sickles factory in Rufié
(Voyage pittoresque dans les Pyrénées-MC-AD09).

"three sous for the ploughs which need iron"
Comú d'Encamp (forge contract, 1412).

THE VILLAGE BLACK-SMITH



Blacksmith's of Sant Julià de Vilatorta (CEC).

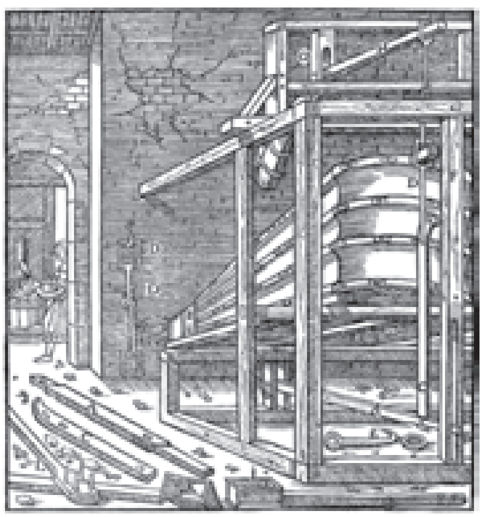
Generally speaking, the village blacksmith forged iron by hand, not with a **sledgehammer** but using a forge with bellows, an anvil and a hand-held hammer. Agricultural tools were repaired in their small workshops, but they also shoed horses and cured wounds in their hooves. The work of the blacksmith was important and reflected village life. For repairing tools, he mostly needed to know how to reinstate a blade (***llossar***) or weld hot new iron on to a worn piece (***calçar***), which required raising the temperature of the forge with iron **ore** to avoid **oxidation**. Other major jobs were strengthening the surface of a blade through **tempering** and **cementation**, then called **steeling (*serrar*)**, and rebuilding the tips of tools (***puntar***) such as ploughs, hoes or mill hammers. For welding jobs, he used old iron brought by the client or chippings from work with the **power hammer** that it was denominated iron into loose pounds or *granatalla*. Rebuilding the tips of tools was the most expensive job, probably because it used **steel** and needed more precise cementation. The development of production of half-finished objects by the *martinetaires*, allowed village blacksmiths to expand still more his range of services.

Blacksmiths tools (AT).

Sales zone of iron and mentioned blacksmiths from Areny and Rossell forges (1845-1876) (ARH).

Communal blacksmith

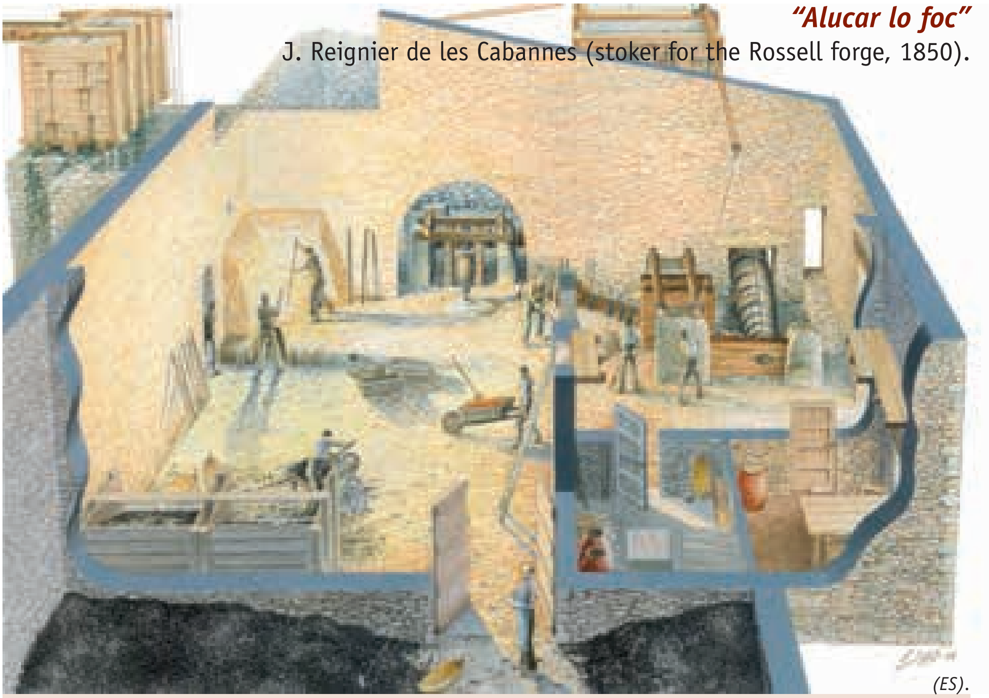
In Andorra, from at least the 15th century until the 19th century, when the municipality (Comú) owned a blacksmith shop used to rent it leaving the rent unspecified, and it was the smith who committed himself to follow the prices fixes in the ***taba***, in return for exclusive rights within the community. Only if the smith (*faure* or *fabre* in 15th century documentation) was an outsider the right to charcoal-burning in the communal woods was specified. During the 18th and 19th centuries, local blacksmiths who were members of the community used this right to sell surplus charcoal to the forges at the end of the year. In order to protect the clients' right to bring their own iron, the ***taba*** always specified separate prices for labour and a supplement for added iron. In 1412, for example, 30% of the total cost of welding ***(calçar)*** a new piece on a plough was the added iron; in 1671 it was 23% and in the 18th century, 20%. This change was the result of the falling price of raw iron from the forge and the rising value of post-reductive work by the smith in his shop.



(DRM).

"Alucar lo foc"

J. Reignier de les Cabannes (stoker for the Rossell forge, 1850).



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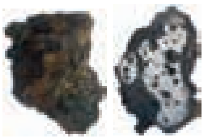
THE PRODUCTION LINE IN THE FORGE

Within the process of iron production, the gang of **forge-men** was responsible for reducing the **ore** to obtain pig-iron and then refining it to obtain a marketable product. For each **reduction**, the forge-men received a certain amount of treated ore ***(recuit)*** and charcoal. First, the ore crusher broke up the ore and kept the powder to make the ***grillada***. Once the **bloom** had been removed after the last reduction, the furnace was recharged before it could cool down. At first, the furnace-operator and his assistant kept the fire going gently, to avoid creating an excessive flow of air or heat, which would alter the *massoques* of the previous bloom that had been left in the furnace to keep warm during forging. Once this operation was complete, the furnace-operator pumped air into the fire and was left alone in charge. Periodically, the furnace-operator bled the furnace of slag and, at the right moment, stirred the bloom with a bar, in an operation called the ***balejada***. The men worked together to extract the bloom, of some 200 kg, and drag it to the **power hammer** where it was refined and **cut**. Finally, it was stretched by the **sledgehammer** to make 4 primary bars ***(estirar cues)***. Each sequence of **reduction** and refining lasted some 6 hours and the same jobs were carried out 4 times a day from Monday to Saturday. This production line is characteristic of the Catalan **direct process**, used by the Rossell forge.

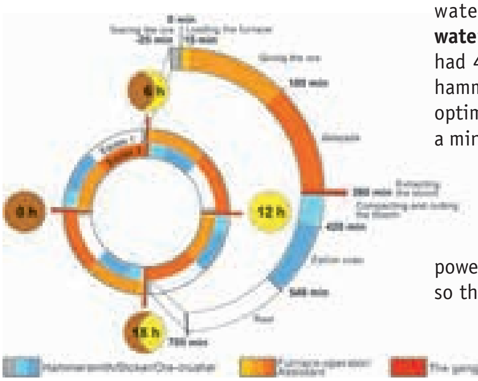
Drained slag (AT).

Bottom slag of the furnace from the Areny forge (AT).



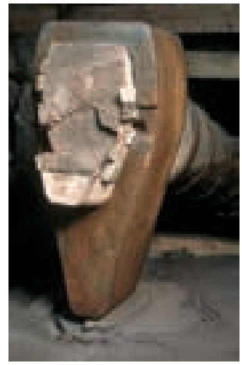
Gromp (AT).

Hammerscales crust from the sledgehammer (AT).



Daily work plan (ARH).

The power hammer

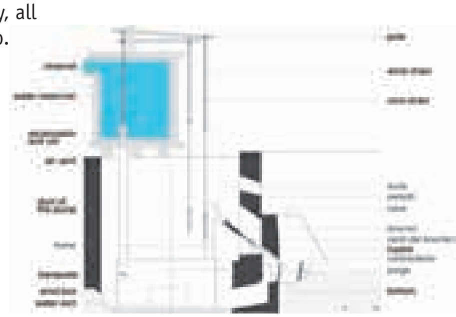


Head of the power hammer (AT).

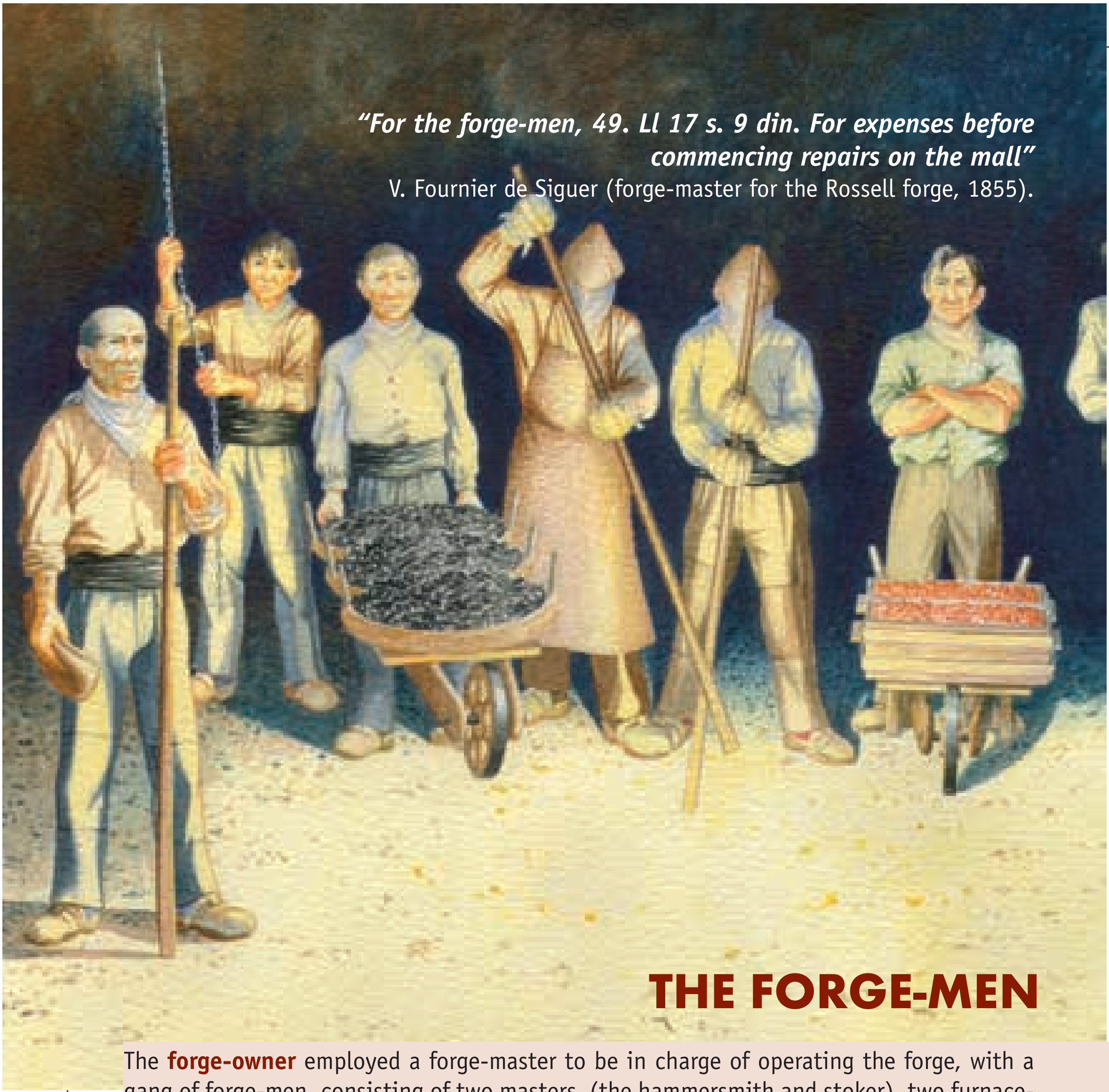
The power hammer is a water-driven hammer that held pride of place in the forge until the **sledgehammer** was adopted in the 18th century. The layout of the workshop in the Rossell forge in the middle of the 19th century, where the power hammer was separated from the furnace by the sledgehammer, is an example of the final stage of this process. To activate the power hammer, water was released from the **water reservoir** on to the wheel, which turned an **axle** that had 4 **cams** at the opposite end. The cams hit the tail of the hammer's **handle** successively, tilting it on its pivot (***boga***). In optimal conditions the hammerhead could strike up to 90 blows a minute. As a result of the weight of the **bloom** was increased, doubling in little less than a century, the head of the power hammer became progressively heavier. In the Rossell forge, for example, blooms of some 200 kg were compacted with a head of some 600 kgs. This change in size made the power hammer useless for making neater finishes or ingot shapes so that it was reserved for compacting and refining.

The air-water-jet pump and the shaft furnace

The air-water-jet pump and shaft furnace, together with the **production line**, are particular to the Catalan **direct process**. The air-water-jet pump is a water-powered bellows: as water is released down pipes (***duct of the pump***) into a large box (**wind box**), it causes air to be sucked in through small holes (***espiralls***). The mixture of water and air inside the wind box crashes into a barrier and is violently separated. Pressure inside the wind box pushes the air towards the upper vent and through the ***home, bourrec, canó del bourrec*** and **tuyere** into the furnace, while gravity lets the water out through a lower vent. The flow of water could be adjusted with ***cors***, so altering the flow of air into the furnace. At the beginning of the 18th century, all forges in the eastern Pyrenees adopted the air-water-jet pump. The shaft furnace is a very simple furnace: it had a trunked cone crucible framed by three walls of iron (*contravent, lleiterol* and *porgues*) and one of clay (*cava*). In the Rossell forge, the base of the crucible was a thick layer of clay. When the large hammer parts needed repairing (the head and ***boga***), the furnace was easily dismantled and the **forge-men** could use a large crucible in the blast of the tuyere.



Air-water-jet pump and shaft furnace section (ARH).

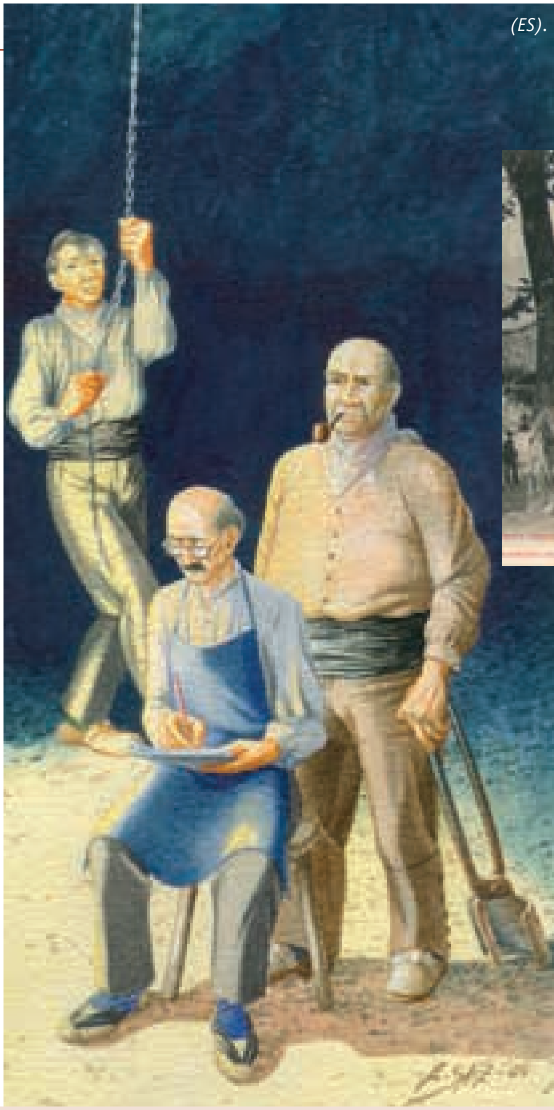


"For the forge-men, 49. Ll 17 s. 9 din. For expenses before commencing repairs on the mall"
V. Fournier de Siguer (forge-master for the Rossell forge, 1855).

THE FORGE-MEN

The **forge-owner** employed a forge-master to be in charge of operating the forge, with a gang of forge-men, consisting of two masters, (the hammersmith and stoker), two furnace-operators, two ore-crushers and two assistants, all of them coming from the Ariège. Each of the two masters was responsible for a team of workmen, each consisting of a ore crusher, an furnace-operator and his assistant. The two teams took turns at the furnace all day long, to keep production going. In charge of **reduction** were the furnace-operator and his assistant, and for **bloom cutting**, the master and the ore crusher. The hammersmith was responsible for keeping the hammers working and the stoker for keeping the **shaft furnace** in good condition, taks for which they each earned a bonus. The greater the amount of iron obtained

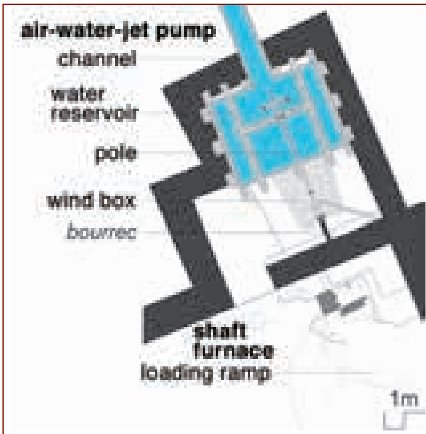
(ES).



Tarascon fair. Workers contracting place (AD09-2Fi1026).

Fontargent col, Aston valley towards the Cabannes and Tarascon.

from the **bloom**, the higher the **wage**. Therefore the masters did not take on workers without references or experience. The forge-men's guild selected workmen from their own community, favouring skilled workers for major tasks and their own relatives for subordinate work. This system prevented outsiders from entering the guild and retained control over all knowledge. The assistants' and ore crushers' contracts allowed for their children to enter forge work, enabling the forge-men of Ariège to export their technique to all points of the Pyrenees: to Bearn and Aragon in the west and Cerdanya and Roussillon in the east. North of the Ariège valley, the forge-men worked in the forges of the Montagne Noire.



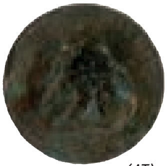
Ground plan of the shaft furnace and the air-water-jet pump from the Rossell forge (ARH).

Origin of the workers from the Areny and Rossell forges (1845-1876) (ARH).

Cup tong (AT).

Wages

Forge-men received a fixed wage according to their work and category. In the Rossell forge, the team earnt a wage of 225 Barcelona diners (d) per quintar (41kg) of iron produced. From this sum, the hammersmith, the stoker and furnace-operators received 40 d each and the ore crushers 22 d. A fixed wage was added for the assistants, amounting to little more than 8.5 d per quintar. The gang received a bonus, called a ***fargada***, according to the week's production. If less than 80 quintars (3328 kg), they received no bonus; between 80 and 89 quintars, they shared 814 d and so on, in rises of 10 quintars, so they could gain up to 1.620 d if weekly production was over 4160 kg. The **forge-owner** also gave them a fixed amount of wine for some operations; for example, half a litre of wine was given to the hammersmith for cutting the bloom or the ore crusher for shaping the bars (***estirar cues***). In one week, the gang could consume 26 litres of wine. The daily wage of a forge-man was some 650 d, four times more than that of a labourer and double that of a professional carpenter or blacksmith. This difference in wages highlights their comparatively high level of specialization, and helps to explain their attitude of corporatism and exclusiveness.



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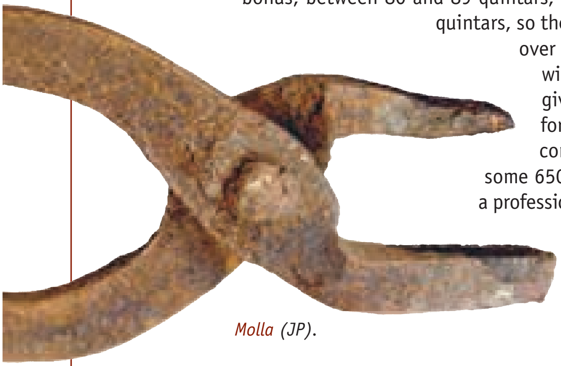

Molla (JP).

The village of Vicdessos (AD09-2Fi1774).

Ground plan of the power hammer and th sledgehammer from the Rossell forge (ARH).

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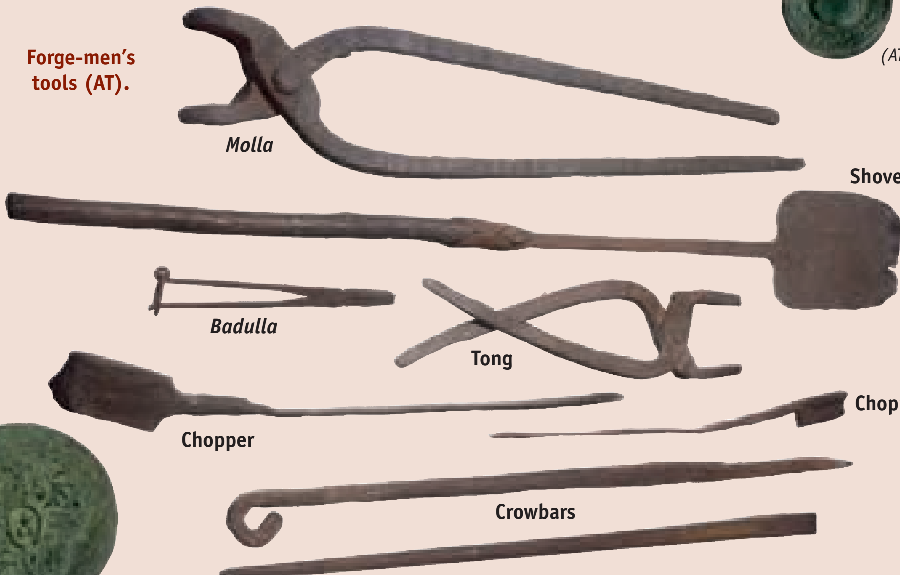
Forge-men's tools (AT).



(AT).

Crowbars point

(JP).

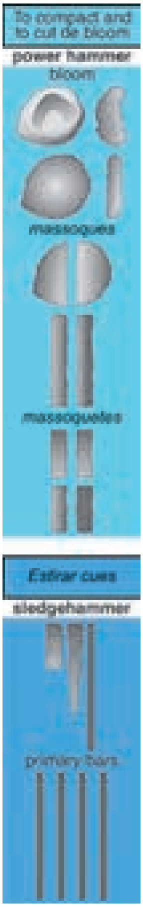
"Secure the bloom"
P. Jerome de Chateau-Verdun, alias Esquirol (furnace-operators of the Rossell forge, 1856).

THE SENSES, EXPERIENCE AND INTELLIGENCE

Inside the forge, in the middle of the shadows and heat, the smoke and dust, the crash of the water as it fell through the **air-water-jet pump** and on to the wheels, and the **power hammer**, the furnace-operator approached the furnace and poked the fire with a bar. Guided by his senses, he could evaluate the progress of **reduction**. By sight, he could gauge the temperature from the colour and height of the flame. The appearance of the crucible walls; the quantity and state of the slag; the appearance of the **tuyere**, and the shape and colour of the **bloom** as it came out of the furnace completed these informations. Using his sense of touch, he probed the fire with the bar. He could gauge the phase of reduction from the toughness of the bloom, and feel for the quantity of slag. By working the bloom with the bar, he could toughen it, making it compact and regular. Despite the din in the forge, he could capture other details through his ears, such as the sound of **ore** being attacked by fire and bursting loudly. A characteristic sound told the furnace-operator if there was enough slag to push towards the tuyere and he could also recognise slag that was too greases because it burst violently when water was thrown on to quench it. Thanks to the data that he gathered with his senses and analysed with his experience and intelligence, the furnace-operator could balance the progress of the fire with the operation of the air-water-jet pump, according to the behaviour of the ore and the charcoal. He developed a series of gestures, such as "giving **ore**" or opening the ***chio***, based on his knowledge. If the reduction went well, the furnace-operator might say that the fire was "eating the ore well" and therefore the bloom would be a success.

(ES).

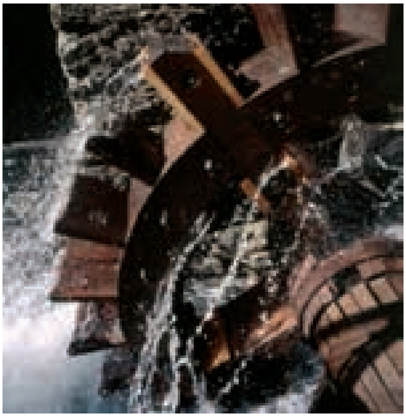
The bloom cutting (ARH).



Cutting the bloom

Some 6 hours after starting the fire, the **forge-men** uncovered the **bloom** with a shovel. The stoker poked a bar through the ***chio*** and, climbing on top of it, used it as a lever to prise off the bloom from below, with strong jerks. Once the bloom came unstuck, the furnace-operator and the two assistants used bars and picks to turn it "bottom up" and pull it out of the crucible. They rocked and rolled it over to the **power hammer**. When the bloom was placed on the anvil, the hammersmith gave the order for water to be released on to the wheel, and began to hammer it with the power hammer until a cylindrical mass was obtained. The hammersmith divided this into two equal parts called *massoques*. While one of these was kept warm in the furnace, the other was refined. The hammersmith, sitting on a bench, divided each again into two *massoquetes*, which were stretched under the **sledgehammer**. Once the work of the power hammer was finished, the workers threw water on it, to cool the head and anvil. This process lasted about 3 hours and 45 minutes, but the power hammer only worked for one and a half hours, during which losses in iron reached 13% of the weight of the *massoquetes*.

Good management of the foge



(AT).

In 1874, the owner of the Rossell forge, Joaquim Riba Fiter (of Ordino), drew up basic rules for "good management of the forge", to avoid losses and improve production. Sunday night, the **forge-men** had to heat the furnace and, so as not to spoil the **ore** with a too cool furnace, they could not "begin to make the first **bloom** until daylight". They should always have "a supply of holm oak for making ***reinetes***" to avoid losing the bloom through a technical hitch in the **power hammer**. During reduction, they should wait until the ore had begun to agglomerate before throwing on ***grillada*** for, if not, "it precipitated to the bottom" and did not disperse correctly. If "the flame of the fire was green" this was a sign that the air flow had dropped and that the **tuyere** was melting. When the slag coming out of the ***chio*** was light and could be "easily flattened", the furnace was burning well; if not, the slag was heavy and formed "a spongy mass, of leaden hue" with a high iron content. If, at the end, a "soft" bloom was obtained, which, when compacted, "bled **clinker**", this was a sign that the furnace temperature was too low when the ore was tipped in. At the end of each session, the forge-men had to clean the crucible "else the clinker remained as a deposit on the base of the furnace" and its capacity would diminish with time.

Tuyere from the Rossell forge (JP).

(AT).

"Which sale we make you only for the wood or logs which exist today and not what will be"

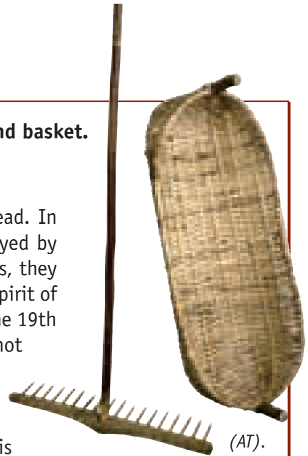
Commune of Andorra la Vella (sale of woods for charcoal-burning, 1842).

WOODLAND MANAGEMENT

In Andorra, the woods were mostly the property of the Comunne or *Quart*. Each house in the village had the right to make charcoal from dead wood for private use and, if previously authorised by the Comunne, could also obtain wood for building. Sales of woods only included adult trees and not the rights to hunting, fishing or pasturing animals. At the end of the 18th century and especially during the 19th century, after revaluation and a change in forest management by the Comunne*s* the price of charcoal sold to the forges was raised and there was a tendency towards over-exploitation. Before being able to make charcoal from a certain sector again, it was necessary to wait between 19 and 35 years, depending on the orientation of the land, or twice this for total regeneration. **Communal protection** and respect for the regenerative cycle were the tools for maintaining woods over the long term. The **charcoal-burners** and the **forge-owners** were those most interested in protecting the woods long-term. The right to make charcoal did not always imply logging but simply clearing up the wood. In the 19th century, exports of wood for construction and the expansion of pastureland led to extensive logging, which did not distinguish between types of wood or the age of trees, resulting in major negative effects. The shrinking woods were not just a result of iron production but also depended on the co-existence or confrontation of various activities in one space (shepherds, charcoal-burners, miners), all after the same natural resource.

La Massana and the Arinsal valley (AHN-121-HP).

Rake and basket.

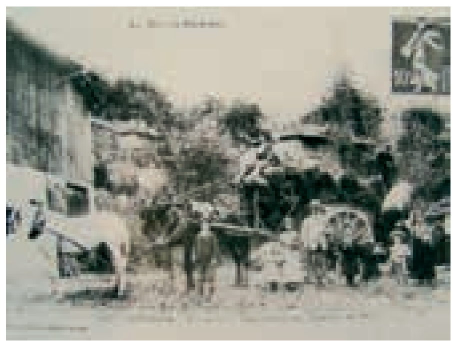


(AT).

The effects of charcoal-burning

At the end of the 18th century, the idea that forges preyed on woods was widespread. In 1790, Francisco de Zamora wrote that "all these forests are being continually destroyed by forges, set up without order or rule and leading them to their death... within 30 years, they will be closed for lack of wood". In 1843, Jules François blamed the situation on "the spirit of devastation of mountain people". By the end of the 19th century, however, these apocalyptic omens had not been fulfilled. In 1888, fifty years after the closure of the Andorra forge, Antoni Guash described the fir woods of the Madriu as "one of the few that remain in this part of the Pyrenees, it is extremely magnificent and majestuous, both for the height of its trees and its extensiveness". **Communal protection** of the woods was limited to the effects of deforestation. The bad omens were only impressions from a certain time and place, of a landscape affected not only by the forges but also by many other activities. Despite his romantic views, Jacint Verdaguer would not have sung to the "dense Andorran woods" if he had not seen them.

The charcoal-burner's tools (AT).



(AD09-2FI248).

Communal protection

When selling sectors of woodland, Comunne and *Quart* required **charcoal-burners** to follow the rules for regeneration. To guarantee best use, they were obliged to cut down all kinds of tree and make charcoal with all the wood, not only trunks and thick branches but also less productive branches, which were harder to work with. To avoid a forest fire, fires could only be lit in a special clearing (*plaza carbonera*), and the Comunne reserved the right to site these in areas of low risk, which also ensured a more balanced distribution of charcoal fires over the terrain. To encourage the use of more distant sites, the Comunne might pay part of the expenses for cutting the paths needed for transporting wood, and to ensure forest regeneration, it was forbidden to log young trees, trees marked for producing new shoots or areas reserved for sheltering flocks or supplying brushwood for folds. To ensure more or less continuous exploitation, the decennial contracts stipulated that only adult trees existing at the time of sale could be logged; young trees were reserved for the next contract.

(AHN-CR, 2.2.1, 6/6/1842).

"Charcoal costs 10 French sous a load"

J. B. Blasy de Saurat, alias Grasset (master charcoal-burner for the Rossell forge, 1863).

THE CHARCOAL-BURNERS

As with the **forge-men** and **miners**, most charcoal-burners working for the Andorran forges came from the Ariège, from the valley of Saurat or Barguillère. Charcoal-burning aimed to reduce the volume and weight and increase the calorific properties of wood. A good knowledge of the profession enabled a charcoal-burner to obtain yields of 15% to 18% of the carbon in the wood, almost half the total (38%).Between spring and autumn, the charcoal-burners lived in the wood. First, if they could not re-use an old site, they would condition the clearing, then clean the *cabanada* (logging site) to make it easier to haul wood and, if the site was remote, they cut paths for the **carriers**. Once the wood was cut, it was prepared as firewood (wooden plugs) and placed in concentric circles of a decreasing diameter around a structure of logs (cage). Once the pile was finished, it was covered in earth and branches to exclude air, which would cause the wood to burn instead of turning into charcoal. At this point, burning logs were introduced through the hole in the top and the pile was stoked by opening or closing different holes in the sides, depending on the prevailing wind. This process of controlled combustion lasted at least 5 days for the smallest charcoal piles. Depending on the size of the clearing, the capacity of the piles varied from 10 to 40 steres, producing between 500 and 2000 kg of pine charcoal.

The *cabanada* and charcoal-burning

The woods that were sold by Comunne and *Quart* were subdivided into lots. Each lot, depending on its size, was sub-divided again into a number of *cabanades*. Each *cabanada* had a logging area and a clearing, which acted as a fire break and site for building piles. The size of a *cabanada* was proportionate to the number of **charcoal-burners** needed to exploit it. Although this depended on the relief, this was usually calculated on the basis of 250 loads of charcoal per person. The clearing lay below the logging sector to make it easier to haul the logs. In setting out and distributing *cabanades*, the interests of the charcoal-burner and Comunne were met. The former wanted an easy exploitation that was accessible from the forge, while the latter tried to spread exploitation to avoid intensive use of the best areas of woodland. Up in the mountains, a lack of useful space forced them to cut 3 or 4 times more clearings than on the valley floor or plains. The multiplication of sites and transportation requirements complicated the charcoal-burners' work. As often as not, the best sites, such as those between two slopes, were used on a more regular basis.

(Pau Fort-AEG).

(Pau Fort-AEG).

(Pau Fort-AEG).

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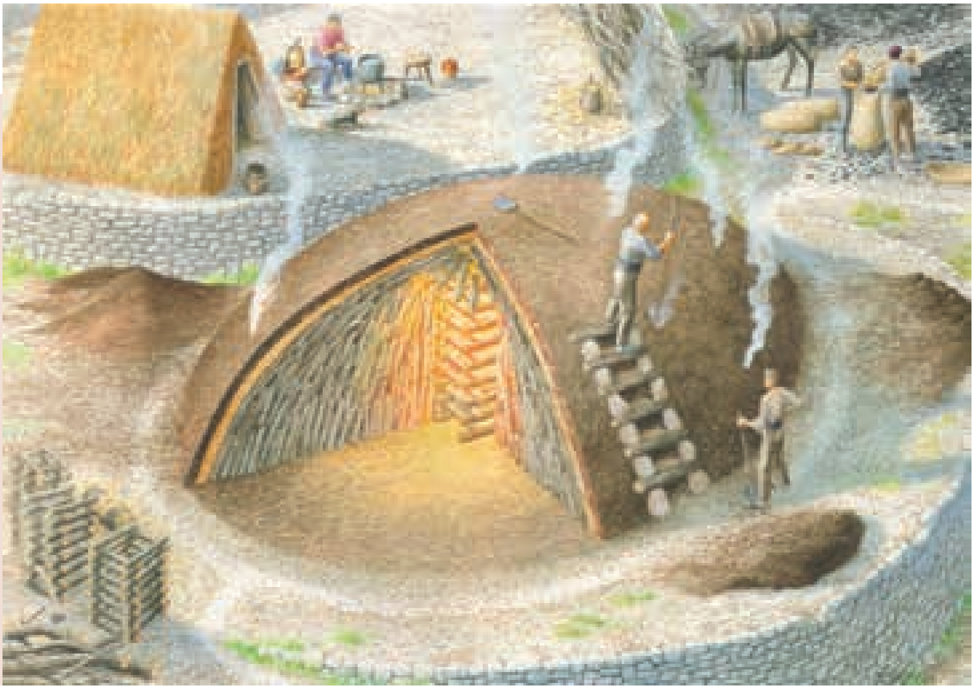
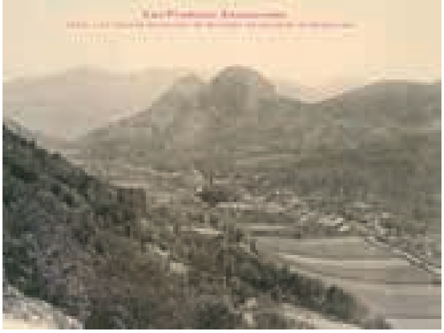


(ES).

Measures of charcoal

Depending on the luxuriance of the woods and size of the trees, the valuers from the Comunne estimated the quantity of loads of charcoal that the **charcoal-burners** could obtain. Although the common measure was 12 *arroves* (124,8kg), in Andorra, the load used by the forges was 2 sackfuls, weighing about 80 kg. The sacks were used to transport charcoal and also to set the wages for the charcoal-burners and **carriers** and to predict future requirements. Once inside the forge store, the charcoal was emptied out of the sacks into piles for storage. The measure of charcoal needed for **reduction** was the *parsó*, a large wooden box, there were 2 of which, placed in a corner of the workshop and which held 3m^3 of charcoal. If more charcoal was needed in the furnace, a basket measure was used, the equivalent of about a quarter sack. Apart from human error or technical faults, the reason for rising consumption of charcoal during reduction could be the type of wood. Weight and calorific values varied according to the species: for example, 1 m^3 of charcoal made from oak weighed about 235 kg, while 1 m^3 of pine or fir weighed between 152 and 173 kg. In Andorra, most charcoal was made from resinous trees: fir, Scotch or black pine.



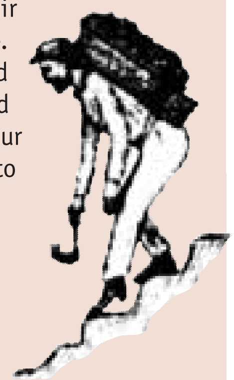
Saurat (AD09-2Fi1437).

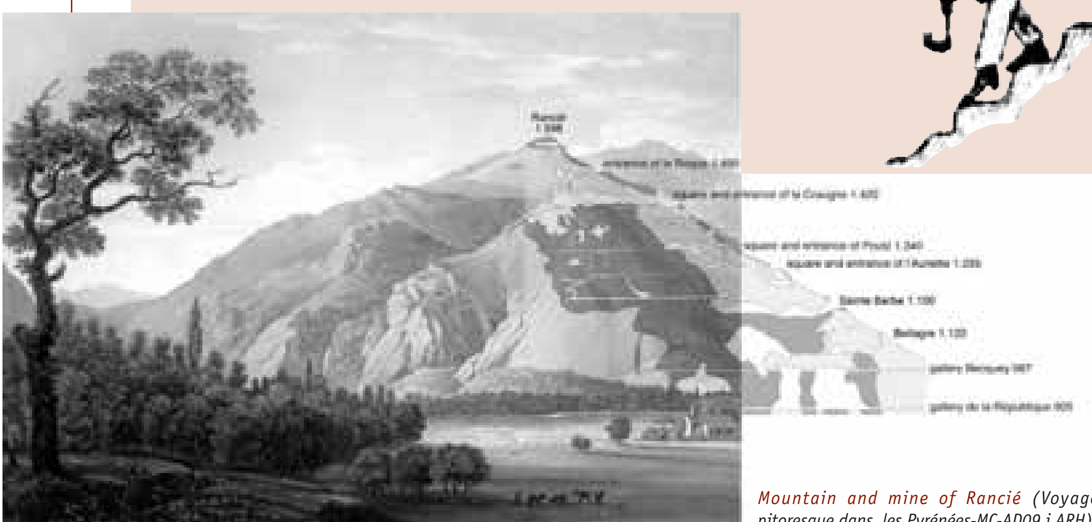
Rabat (AD09-2Fi869).

“Foreigners cannot be admitted under any pretext”
(Rancié regulation, 1731).

THE MINERS

The mine at **Rancié** (Ariège) and those at Somorrostro (Basque Country) and Canigó (Roussillon) were among the most important in the Pyrenees. Every morning, the miners met at the Rancié mine and the gangs were split up according to their work, with picks and wedges and a little gunpowder. The gangs might number 20 and worked in pairs at the **mine face.** The more experienced of the two mined the **ore** while the other (*gorbatier*) carried it out in a basket (a *volta*) loaded on his back. One *volta* took a load of about 60 kg, which was used for calculating wages. The season, about 250 working days, began on 1st March and ended on 1st November. In summer, the working day lasted 11 hours (8.00-19.00) and in winter, 7 (9.00-16.00). Among the miners, it was usual to find children who carried ore in baskets, half the weight of a *volta*. However, in 1813, it was prohibited for children under 10 to work. In the 19th century, miners’ women and children did most of the carrying to the stores of the ore vendors. Low wages and debt forced families to carry out complementary farming work but, despite these conditions, their corporate spirit encouraged them to exclude outsiders from the mine. Their attitude and the antiquated working system gave them a bad reputation among mine engineers, who accused them of ignorance and living in the past. The methods of exploitation and organisation of labour at Rancié was exported to Andorran mines and, more specifically, to **Collada dels Meners**.





Mountain and mine of Rancié (Voyage pitoresque dans les Pyrénées-MC-AD09 i ARH).

Rancié

The date when mining began here is unknown. The first regulation dates back to 1293, when the count of Foix gave the rights to extract **ore** to the inhabitants of the valley. From the 16th century on, the mining rights were held by the inhabitants of the communities of Goulier, Sem and Olbier. This "mountain of iron", located in Sabartès, outside the village of Sem, was crossed by three large parallel seams that stretched from the peak (1598 m) to the valley floor (994 m). In the mid-19th century, the longest access galleries were over 300 m and the mine employed about 400 miners, who produced more than 20000 tons of ore per year, enough to meet theoretical consumption at the Rossell forge for 60 years. The ore was sold to all the forges in the Ariège. From 1347, a treaty allowed for ore to be exchanged with charcoal produced at Coserans. Rancié ore reached the central Pyrenees: Aude, Tarn and Haute Garonne. In the 19th century, confronted with regulations that were formulated by mine engineers, appointed by the Government, "the mine for the **miners**" became the battle-cry, until a myth about miners' independence evolved. Thanks to the engineers, however, we now have a lot of data about the Catalan forges.

Gestiès (AD09-2Fi1297).

Olbier (AD09-2Fi1636).

Goulier (AD09-2Fi554).

(FP).

The attraction of Andorra

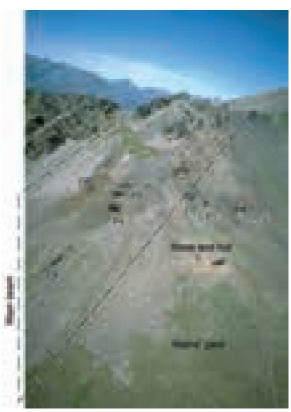
The **miners** who worked during the season at **Collada dels Meners** came from the same villages of the Ariège as those who worked the'**Rancié** mine. In Andorra, the season only lasted the spring and summer months, the gangs rarely numbered more than 5 miners and the wage, although the same (18 French *sous*), was based on a load of 10 *arroves* (104 kg). These advantages made the journey very attractive to many families. Oil for lamps and tools were also paid for by the forge-owner. Compared with Rancié, this already meant a saving of one-fifth of their yearly salary. Moreover, in Andorra they were paid for the upkeep of the galleries, while at Rancié this was unpaid labour they were obliged to do. Above all, underlying written tradition, the absence of labour laws offered full freedom to control the number of contracts and ensure higher wages without fear of competition from other workers. At the end of each season, the mine masters evaluated the amount of **ore** remaining in the **mine face** and the potential of uncovered seams. On this basis, they employed workers and formed gangs the following spring.

(AT).

"Artxe has found the gang at Sem, they will come for St Peter's Day"
A. Fournier from Siguer (forge-master for the Rossell forge, 1874).

Collada dels Meners

At the beginning of the 17th century, the first mines were open-cast. In the 18th century, however, there was already a reference to the existence of galleries in the upper, more easily accessible sector of the seam (Ransol side). These galleries always worked downwards. When the **ore** ran out, or the height difference between the mouth and the **mine face** was excessive, a new gallery was opened below. To cross the waste rock (***esteril***) and reach the ore, the miners made an opening, little more than 1 m wide and 2 m high which was shored up with wood and stone walls, depending on rock conditions. Once the seam was located, the mining itself created large, irregular chambers of 3 to 4 m wide by 2 to 3 m high, held up by columns of ore. In time, the existence of different levels of galleries and empty spaces caused certain stability problems. In the 19th century, mining became progressively more complicated and the miners were forced to open new, upper galleries and dig out a new one from the opposite side (Sorteny side) with the aim of finding new angles for extraction.



Collada dels Meners (ARH).

A entrance from the Collada dels Meners (ARH).

THE SEASON IN ANDORRA

Expansion of iron production in Andorra was, to a large extent, made possible by the major deposit of iron **ore** at **Collada dels Meners** (Canillo). The main seam lay in the area of the tips at Embolcat, between 2500 and 2730 m. Around 1750, there were 7 mining companies exploiting this seam in the name of 5 forges, each with a monthly consumption of 250 tons of ore. At the beginning of each season, the best **miners,** with a master at the fore, were put in charge of cutting and conditioning the galleries. The main gang arrived between May and June and took over the mining, selection and transport of ore to the yard. Once in the yard, the ore was weighed to calculate wages and to share it between concessionaries, if an opening belonged to more than one company. Usually, by August, the gangs had already extracted the agreed amounts

(AT).

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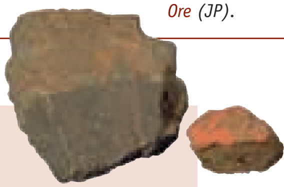


Ore (JP).

and returned to their home towns. Before winter set in, the **carriers** transported the ore to the stores and forges. At this point, some miners continued to work on a daily basis and the mine masters prospected in the area to find new seams. From the middle of the 19th century, for fear of exhausting the deposit, new sites were sought. The prospecting galleries at Llorts or Sedornet (Ordino) are an example of that period. In any case, Andorran forges never closed for lack of ore, as some of them closed and productive seasons were reduced.

The ore

In the natural world, pure iron is very rare; it is only found in small amounts in some volcanic areas. On the west coast of Greenland, for example, there are fragments of iron, at most 1 cm wide, which the eskimos have used to fashion objects. More or less everywhere, however, it is easy to find iron in chemical combination with other elements. Rock with exceptionally high levels of iron, if mined at any time, is called ore. For example, in the area of Morvan-Auxois (Côte d'Or), Roman and mediaeval workshops had 5 major types of mineral at their disposal, only 2 of which, with a minimum weight in iron of 36,05%, were viable. On the other hand, the part of the ore that was useless or had too low a level of iron for extraction with the technology of the time was called gangue. The ore that was most used in forges contained iron oxides (haematites, oligist, magnetite, limonite) or iron carbonates (siderite).

(*ES*).

"For carrying a quintar of iron to Castellciutat, he is owed 6 sous"
D. Camarlot (owner of the Rossell forge, 1873).

THE CARRIERS

In the era of forges, the transportation of goods on the back or by mule was vital as it was the only way. The carriers, called *traginers*, were one of the collectives that kept the Andorran valleys open and in communication throughout the year. The difference between a part-time or professional carrier lay in their dedication. Part-time carriers had their own mules for work in the fields, and they used these to carry goods for short distances, supplementing their income from farming and livestock. The inhabitants of Ransol and Llorts, for example, often transported **ore** from the mine of the **Collada** and charcoal to the forges. Among the professionals were the *traginers*, who were self-employed, and

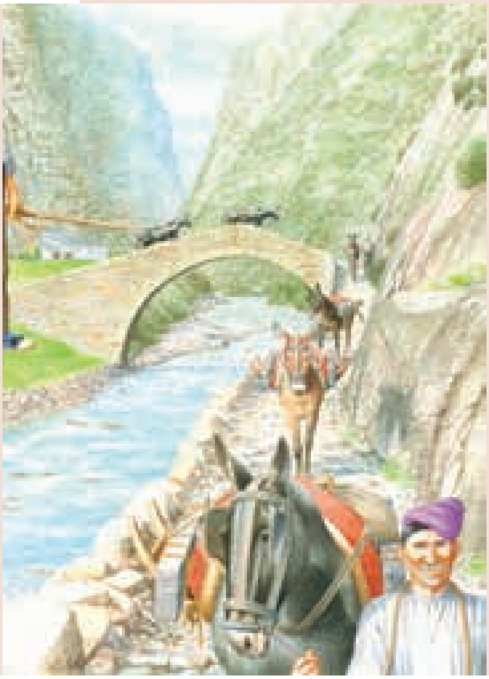
(ES).

Mule smuggling

In the 19th century, customs privileges caused political conflict between the Spanish government and Andorra. The trade in mules and horses, tobacco and, to a lesser extent, French manufactures, escaped the control of the Spanish customs. In 1848, Colonel Bonifacio Ulrich considered that the volume of exports of mules and horses could only be explained by "prodigious fecundity" among the 400 mares existing in the country. Two years later, the official, Juan Miguel Sanchez de la Campa wrote that tobacco smuggling was serious but that livestock smuggling was not far behind. The system used by Andorran herders was simple: they imported French animals, processed a certificate of Andorran origin and benefited from the ancient privilege of freely attending fairs and markets with their products. The undercover aspect of this trade and economic interests caused these figures to be exaggerated or minimised. In 1864, the *Sindic* Bonaventura Riba claimed that the 4 main smugglers boasted of gaining 4500 pounds per year and trafficking 800 heads, when in reality they only sold about eighty. This conflict had a negative effect on the iron trade, causing the cost price to rise 16% on paying customs duties.

(AHN-15T21).

those who worked for a wage. The former were real tradesmen who had enough capital to keep animals and buy goods. They usually covered the longer **routes**, always using the return journey to import other consumer goods and, as far as possible, trying to do business on three fronts. For example, they carried iron from Andorra to the markets on the plain of Urgell, then loaded oil and wine there for Tarascon, where they bought cloth and trinkets for the return to Andorra. The waged carriers, on the other hand, despite owning their own mules, were paid according to the load and route. In some cases, they received a day-wage from the **forge-owners** who also paid for the animals' upkeep.



(Pau Fort-AEG).

Routes and products

During the 19th century, iron from the forges was introduced into Catalonia through the valleys of the Segre and Cardener rivers, to the markets of the Urgell plain, the Central plateau and the Bages plain, and from there to Lleida, the area of Montblanc and Valls or even Barcelona. Part of the sales was paid in consumer goods for the Andorran markets. From the area of Lleida, the **carriers** brought wine, oil and chocolate on their return journey. From the Anoia basin, they brought local or Tarragonese oil and malvasia from the area of Sitges. At Cardona, they loaded salt, hemp and, to a lesser extent, cloth and manufactures from the area of Solsona and Barcelona. A small amount of iron was also distributed in the Ariège via the Tarascon route, along which cloth, haberdashery and trinkets were imported for resale to the shops in Andorra or at Catalan markets.

(AHN-15T34).

(AHN, neg13FAM).

"The forges will never work again, only the livestock will remain as work"
J. de Riba (the Andorran *Sindic*, 1864).

THE CATALAN FORGE CRISIS

When the Rossell forge was built in 1842, the market for iron production had just recovered from the effects of the First Carlist War. Until 1857, demand for iron was stable and yearly production increased progressively. From 1858, however, demand fell. Merchants stopped paying for purchased goods in the same year and, for the **forge-owners**, even though they slightly raised the price of iron, this meant that their capital was tied up longer and liquidity suffered. This situation forced the forges to cut operational costs and, in some cases, to close. Equally, the creation of Asturian iron production sites and rising imports through the port of Barcelona made the situation worse. Pyrenean iron, despite being cheaper, stopped being attractive to markets in the coastal zone due to the cost of transport. The commercial network of the forges was limited to inland areas, where iron from **blast furnaces** could also reach but was not competitive due to inadequate communications. Finally, the crisis was accentuated by improvements in the road system and construction of the railway between Barcelona and Lleida which, from 1860, brought imported iron closer to inland areas. The effects of the Third Carlist War (1872-1876) drew out the agony of the forges by reviving the demand from Pyrenean **village blacksmiths**, so that the Rossell forge managed to achieve an overall positive financial balance from just the profits made during the 4 years of conflict.

Joaquim de Riba (AHN-CR).

Don Guillem (ARH).

The forge-owners

The families of Areny-Plandolit of Ordino, Rossell of Ordino, Picart of Encamp and Moles of Andorra, among others, were the principal owners of Andorran forges. In 1836, the Andorra forge, the last Comunne-owned forge in Andorra, closed its doors, and only 5 private forges remained open. The owners of these workshops, as a result of their need to minimise operational costs, were obliged to accept partners, work less, and close or renovate infrastructures. In the Encamp forge, for example, Josep Picart went into partnership with Policarpe Benansi from Les Cabannes, Antoni Rossell and Tomàs Palmitjavila from Encamp. In the Areny forge, after sharing costs, the profits from one quarter of production went to Seferino Riba of Ordino and the rest to Guillem Areny. The Os forge (1815) and the Rossell (1845) are two examples of the attempt by forge-owners to adopt the latest technology, improve yields and cut costs; in contrast, the Serrat forge became obsolete and closed in 1845.

Dolors de Riba Camarlot (AHN-CR).

Josep de Riba (AHN-CR).

(AHN-CAP).

Tarascon blast furnace (AD09-2Fi2219).

Chronology of the crisis in Andorra

1863 - Faced with the serious economic situation, Joaquim de Riba, owner of the Rossell forge, decided to expand his investments outside Andorra.

1864 - The *Sindic* considers that, without an agreement with the Spanish government, iron from the Andorran forges will be more expensive than the one arriving to Barcelona's harbour. Joaquim de Riba, faced with this prospect, refuses a load of charcoal offered by the *Quart* (neighbouring) of Sispony at a good price.

1865 - Abolition of privileges and the first stoppage of Andorran forges. Guillem Areny-Plandolit tries to get rid of the Areny forge but the asking price is too high and he finds no investor.

1867 - Second stoppage of the Andorran forges. Antoine Fournier, manager of the Rossell forge, accepts employment from a forge in the Ariège because he fears that the Rossell forge will not re-open.

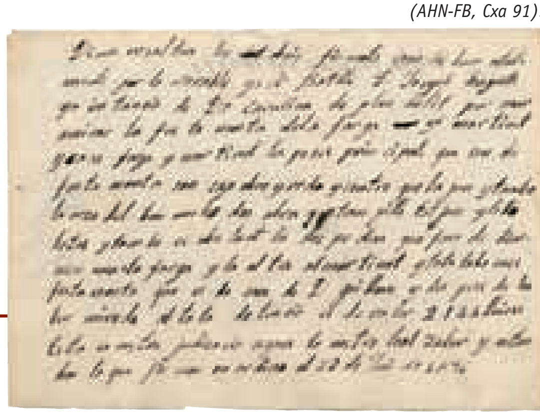
1869-1871 - Third stoppage of the Andorran forges.

1872 - The Areny and Rossell forges re-open due to the effect of the Third Carlist War on markets.

1876 - The end of the Third Carlist War returns markets to normal and the Areny and Rossell forges close their doors permanently. The direct process disappears from Andorra.

1877 - In the stores of the Rossell forge, there are still 261 tons of charcoal, 83 tons of **ore** and 3 tons of raw **iron**, waiting to be sold.

(AHN-FB, Cxa 91).



RESTORATION OF THE BUILDING

When, in December 2002, the *Farga Rossell* was officially opened, this was the culmination of a whole restoration process, aimed at transforming a private asset into a collective asset. In this case, because it was the last forge to be built in Andorra and because it had had a short working life, the building reached us in a good state of conservation in 1996; the roofs had collapsed and only the tops of some walls had crumbled. Data obtained during the period of historical research helped us to understand and evaluate the treatment needed to adapt the ruins to the requirements of the new building, intended for a ***"Centre d'Interpretació"***. Given the possibility of restoring the original unity of the forge, the works were envisaged as a reconstruction, built with modern techniques and materials. **Written documentation** and archaeology allowed for **reconstruction of the machinery** and the **shaft furnace**, while interior lighting was adapted for the museography, so that the charcoal store was left in the dark while the workshop receives filtered light through roofs of dark glass. These roofs solve the climate problems presented by the original open-air structures. The aim of the architect, Pedro Maria Basáñez Billelabeitia, beyond creating a solitary public area, is to convert the forge into an urban green space. This can be best appreciated in the section of walkway built along the river bank, with the intention of continuing it on into the centre of La Massana.

The Rossell forge before excavation (ARH).

Wooden floor of the air-water-jet pump from the Rossell forge (ARH).

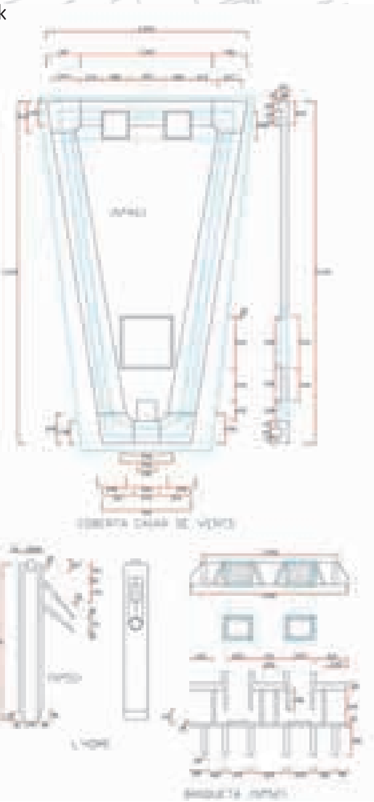
Written documentation

The main documentary sources about the Andorran forges came, essentially, from the family archives of the Areny-Plandolit and Rossell families of Ordino. A good part of these documents were written by the respective forge-masters and show, more or less systematically, the operation of the forge and commercialisation of the iron. In these archives there is, for example, a series of account books relating to charcoal-burning, **ore** extraction, iron production and working, and the books where sales and payments for iron were recorded. The value of this resource, despite the lack of a complete series in many cases, lies in the opportunity to trace the development of the forges from the end of the 16th century until the end of the 19th century. The combination of this resource and the Comunne archives allows us, moreover, to trace how the forges fitted into the economic structure of the Andorran valleys at any moment in time, and the influence of the iron men on Andorran society. The documentation shows how progress in the iron market allowed for significant economic growth in these high mountain lands.

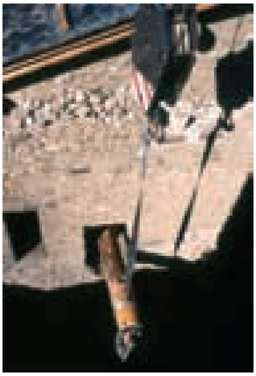
(ARH).

Reconstruction of the machinery

The quality of data from written documentation and archaeology about the Rossell forge allowed a rigorous and realistic project for machinery and tools reconstruction. Next to the real risk of deceiving the eye and senses, reconstruction was seen as necessary, when faced with a total lack of references to Catalan forges. Unable to reconstruct the original water circuit, it was necessary to install two pumps (626 m^3/h) to guarantee a minimum of water in the mill-pond, with its capacity of 450 m^3. To fill the tank of the air-water-jet pump (24 m^3) and wheel (48 m^3) as quickly and as independently as possible, three pumps were installed on the gate of the mill-pond. This new circuit was designed for a maximum consumption of 1.000 l/s. The water consumption of the **power hammer**, with its head of about 500 kg and a wheel diameter of 3 m, is fixed at 675 l/s, while in the **sledgehammer**, with a head of 350 kg and a wheel diameter of 2,66 m is fixed at 425 l/s. This reconstructed mechanism, together with the **air-water-jet pump** and **shaft furnace**, are examples of final developments in machines that had been in evolution from at least the beginning of the 12th century.



Air-water-jet pump planimetry (Tetra-ARH).



(ARH).

(ARH).

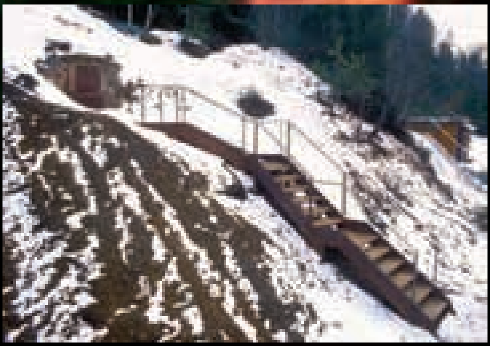
Shaft furnace from the Rossell forge (ARH).

Background: forge planimetry (PNB).

THE *"CENTRE D'INTERPRETACIÓ"* AT THE FARGA ROSELL

From 1971, Andorran students and historians have vindicated the value to our heritage of the remains of iron production in the valleys. It was not until 1996, with the presentation of the programme "*Homes de Ferro*" (Iron Men), that the concept of making these ruins part of our heritage and outlining its importance with an itinerary, was proposed. Among the main initiatives of this programme was, notably, the plan to convert the *Farga Rossell* into the neural centre for depicting the iron industry in Andorra. The museographic project saw this as a unique opportunity to teach about Catalan forges and proposed using this space to explain the operation of the machinery, the process of transforming iron **ore** into ingots and the commercialisation of iron on the Catalan markets. For this reason, it is called a "***Centre d'Interpretació***", which is more of an educational centre than a museum, to reflect the importance of this resource and the possibilities of **reconstructing the machinery** and tools. The tour consists of a multimedia show about the history of iron, in the charcoal store; a demonstration of the **air-water-jet pump** and **sledgehammer** in operation, in the workshop, and educational workshops. The aim is to arouse interest in the machines, tools and labour, about which, unfortunately, much knowledge has been lost.

Sant Martí de la Cortinada (*ARH*).



The mine of Llorts (*AT*).

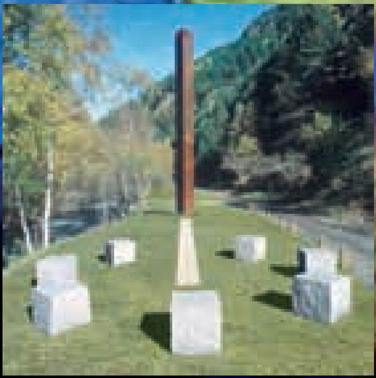
The Iron Men trail

This itinerary is a project by the "*Homes de Ferro*" (Iron Men) programme, to inform about the iron industry in Andorra and the Pyrenees and, equally, link up with other itinerary about industrial archaeology. The entrance to the itinerary lies at *Farga Rossell*, where the visitor is invited to discover the most representative remains and works relating to this activity, between the 17th and 19th centuries. This project has already taken shape in the valley of Ordino, where we can follow a good section of the old supply path (*Camí Ral*), along which the **carriers** and their mule trains supplied the forges with **ore** and charcoal and carried ingots to the southern markets. Along the path, one can visit the Museum of *Casa Areny-Plandolit*, the home of the former forge-owner; the church of *St. Martí* at La Cortinada, where windows bars that were forged by local smiths are kept, and finally, the *Mina de Llorts*, which was a prospecting for ore in the 19th century. It is planned to extend this itinerary to new points, such as the *Farga of Areny* and the *Farga of Andorra*. Also, with the intention od creating a transfrontereer itinerary, for which we are building formal relations with the Ariège (*forges de Pyrène*), the Basque country (*ferrerías de Mirandaola* and *Agorregui*, and *Puente Colgante de Bizkaia*), Aquitaine (*Forge d'Arthez-d'Asson*) and Catalonia (*farga Palau* and *Mines de Cercs*).

Museum-House of Areny-Plandolit (ARH).

The sculptures of the Iron Men

The contemporary sculpture trail is a project within the framework of the programme "Homes de Ferro" (Iron Men), and policies for sustainable, cultural tourism in the valley. Presently, the works stand alongside a section of the old supply path, between *Farga Rossell* and the *Mina de Llorts*, which is the main artery of the trail. In 2002, for the 1st Symposium of Contemporary Sculpture, four artists, Mark Brusse (Netherlands), Alberto Carneiro (Portugal), Guy de Rougemont (France) and Satoru Sato (Japan), took part in a creative exercise, taking the iron industry as their source of inspiration. The construction of spaces, the solidity of materials, the sculpted forms and their relationship with the environment are the medium, while schist, granite, **ore** and **iron** are the materials for reviving the memory and meaning of the path. This initiative, once completed with further symposiums, will join the contemporary art that already overlooks many of our landscapes.



Storu Sato's sculpture (AT).

Guy Rougemont's sculpture (AT).

KEY WORDS

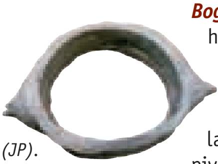
Air Vent (Cat. espirall, Fr. aspiraux) One of a series of small vents at the top of the ducts of the pump, through which air enters when water passes into the wind box.

Axle (Basq. ardatz, Cat. Calaibre, Fr. arbre, Oc. cadaibre, Sp.
árbol) The carved walnut or chestnut trunk, reinforced with iron rings and plates, into which the wheel shafts slot at one end and the cams at the other, acting as an axle.

Balejada (Cat. balejada, Oc. balejade) Process of agglutinating and shaping the bloom inside the crucible using a bar, at the end of reduction.

Blast furnace (Basq. goiko labea, Cat. alt forn, Fr. haut fourneau, Sp. alto horno) Furnace for smelting iron, producing molten iron and slag.

Bloom (Basq. agoa, Cat. Masser, Fr. Loupe, Sp. masa de hierro) Spongy, incandescent mass of iron extracted from the lower furnace, ready for compacting and transforming into four primary bars.



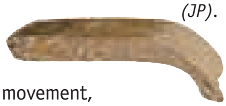
(JP).

Boga (Basq. boga, Cat. boga, Fr. hurasse, Oc. Bogue, Sp. boga) A large iron ring, gripping two thirds of the power hammer handle, with two lateral pins, acting as the pivot for tilting the mall.

Bourrec (Cat. bourrec, Oc. bourrec) A leather bag with an opening on either side, that conducts air from the wind box to the canó del bourrec.

Calçar (Cat. Calçar) To weld new iron to the blade of a worn tool without weakening the structure of the metal.

Cam (Basq. Mazuco, Cat. palma, Fr. Came, Sp. Leva) In the power hammer 4, in the sledgehammer 6, pieces of iron at one end of the axle that change its circular movement into a curvilinear movement, alternating with the hammer-handle.



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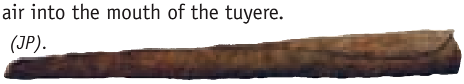
Canó del bourrec (Basq. kanoia, Cat. canó del bourrec, Oc. canon de bourrec, Sp. cañón) Iron pipe that carries air into the mouth of the tuyere.



(JP).

Carburation (Basq. karburazio, Cat. carburació, Fr. Carburation, Sp. carburación) Process for raising carbon levels in iron.

Cementation (Basq. zementazio, Cat. cementació, Fr. Cémentation, Sp. cementación) Process for obtaining surface carburization, by heating iron in a susceptible medium to create an iron and carbon compound, with a maximum level of 6,67% carbon.

Chio (Cat. chio, Basq. ziarzulo, Oc. chio) Hole in the working face of the furnace, in the wall just above the base of the crucible, through which the slag was made to pour out during reduction.

Cors (Cat. cors, Oc. cors) Wooden wedges fixed to the plates of the choke, which could be moved at will to increase or decrease the amount of air and water passing through the ducts of the pump.

Demet (Cat. demet, Oc. demet) Removeable piece of iron with different reliefs, according to the type of hammer, which fits into the anvil where the head strikes.

Decarburation (Basq. deskarburazio, Cat. descarburació, Fr. Décarburation, Sp. descarburación) Process for reducing carbon levels in iron.

Duct of the pump (Cat. arbre, Basq. guzuraska, Fr. Arbre, Sp. cañón) In the air-water-jet pump, two closed wooden pipes through which water from the mill-pond passed, sucking air through the espiralls air vents into the wind box.

Estèril (Cat. estèril, Fr. stérile) Waste rock with a very low or nil concentration of useful ore, which the miners extract to reach the seam.

Estirar cues (Cat. Estirar cues, Oc. Traire quoues) To stretch the respective ends of the iron bars to obtain 4 bars for commercial use.

Fargada (Cat. Fargada) Productivity bonus, usually received by the stoker, the hammersmith, the furnace-operators, and the ore crushers for surplus iron produced in any one week.

Grillada (Cat. Grillada, Oc. greillade) A mixture of powdered ore, charcoal and water that is applied to the ore and prevents reduction gases from escaping from the crucible.

Handle (Basq. gabigun, Cat. mànec, Fr. Manche, Sp. mango) A carved beech or ash trunk, reinforced with a bar or rings. At one end, it is square, to fit the hammer-head. Works as a first-grade lever.

Home (Cat. home, Fr. homme) A wooden tube with a square section, opposite to the arbres, carrying the air from the water through to the bourrec.

Llossar (Cat. Llossar) To flatten and sharpen hot iron to obtain a blade for a tool.

Mine face (Cat. front de talla, Fr. front de taille) Area of direct extraction of ore from a mine.

Nitruration (Cat. Nitruració, Fr. Nitruration, Sp. Nitruración) process for superficially hardening hot iron (at about 500º) by causing a chemical reaction with a nitrogenous compound.

Ore (Basq. mea, Cat. mena, Fr. Mineral, Sp. mineral) 1. Rock with an unusually high concentration of useful minerals, economically and technically exploitable according to conditions of the time. 2. Mineral broken by the ore crushers into fragments, about 2cms in diameter, used to load the furnace.

Oxidation (Basq. oxidazioa, Cat. oxidació, Fr. Oxidation, Sp. oxidación,) Process that increases levels of oxygen in iron by lowering levels of carbon.

Puntar (Cat. puntar) To weld steel on the tip of a tool by cementation.

Recuit (Cat. recuit, Fr. Recuit, Oc. recuit) A process for homogenising the structure of iron by heating it above 721º, keeping it hot for a time, then letting it cool slowly.

Reduction (Basq. erredukzioa, Cat. reducció, Fr. Réduction, Sp. reducción) Process that eliminates oxygen from ferrous oxides to obtain metallic iron.

Reduction gases (Basq. gas erreduktoreak, Cat. gasos reductors, Fr. gaz reducteurs, Sp. gases reductores) Chemical agents that transform ferrous oxides in the ore into metallic iron.

Reineta (Cat. reineta, Oc. rainette) A piece of wood on which the pins of the axles rest and turn.

Revingut (Cat. revingut, Fr. Revenu, Sp. revenido) A process for normalising the brittleness of tempered iron by heating it between 180º and 721º, keeping it hot for a time, then letting it cool slowly.

to Steel (Basq. altzairatu, Cat. acerar, Fr. Aciérer, Sp. acerar) To increase levels of carbon in the iron to make steel.

Taba (Cat. taba) In a lease, the form that contains the rates and regulations that bind the tenant.

Tap (Cat. frapa, Fr. frappe) Piece of iron with different reliefs that is fixed on the nose of the hammer-head, interchangeable according to the desired shape and finish for the ingots and bars.

Tuyere (Basq. Tobera, Cat. tovera, Fr. tuyère, Sp. tobera.) Tubular piece of copper, with a conical profile and a circular or rectangular mouth, through which air is pumped into the crucible.

to Temper (Cat. tremp, Fr. Trempe, Sp. temple) To strengthen iron by heating it and then quench it in cold water.

Water reservoir (Cat. Peixeró, Fr. Paicherou, Sp. depósito de aguas) The water deposit for the air-water-jet pump, set at a specific height above the water through.

Water through (Basq. aizearca, Cat.caixa de vent, Fr. caisse à vent, Sp. caja de aire,) Circular or trapezoidal wooden box where the mixture of air and water coming from the arbres is separated.

CHRONOLOGY

1100-600 AD The end of the Bronze age and beginning of the first Iron age in western Europe.

12th century The appearance of the first water-powered *malls*.

12th-13th centuries Technological stage when the blast furnace is developed in northern Europe.

13th-15th centuries New technological stage in the eastern Pyrenees with the implantation of the first water-powered forges, called mills.

1283 First known reference to a mill: the forge at Escoussens in the Montagne Noire.

Mid-13th-14th centuries The county of Foix becomes an important area for the production and export of iron.

1289 Reference to an iron trade route through the valley of Andorra, between the production area in the county of Foix and markets in Catalonia.

15th-16th centuries Technological innovation in the eastern Pyrenees, with the construction of Genoese and Biscay mills.

17th-19th centuries Stage of technological development in the eastern Pyrenees, the Catalan water-powered forge. Andorra becomes an iron producing area.

1643 First known reference to the air-water-jet pump in Andorra, in a work contract from the Canillo forge.

1726 Reference to the **blast furnace** in the town of Júzcar de la Serranía in Ronda, Malaga.

13th-19th centuries Publication in France of numerous articles and books about the technological stage, the Catalan forge: Tronson du Coudray (1775), Philippe Picot de Lapeirouse (1786), Jean Marie Muthuon (1808), Tom Richard (1838) and Jules François (1876).

1842 Construction begun on the Rossell forge.

1845 First season of production at the Rossell forge.

1866 The owner of the forges at Sanchico and Navas (Burgos) writes that his forges are not producing anything because "the iron industry is not making any profit".

1874 The direct process disappears from Cantabria.

1876 The Rossell forge closes its doors permanently, unable to compete with iron produced by blast furnaces.

1878 The Casanoves forge at Campdevànol closes its doors.
1880-1890 Business at the Catalan forges in the eastern Pyrenees sees a sharp downturn, resulting in the disappearance of this technological stage.
1914 Antoni Gallardo and Santiago Rubio visit the Rossell forge, which will later (1930) become the model for the reconstruction of a Catalan forge at the Universal Exhibition in Barcelona.
1970 First archaeological excavation of a blast furnace in Europe: the site at Lapphyttan in Sweden.
1996-1999 First archaeological excavation of a Catalan forge: the Rossell forge.
2002 Official opening of the "*Centre d'Interpretació*" at the Rossell forge, about the world of iron.

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La Farga Rossell. Centre d'Interpretació del Ferro
(The Rossell Forge. The Interpretation Center of Iron)
Adress: Av del Través, s/n, La Massana, Tel +(376) 835852, Fax +(376) 835857, fargarossell@andorra.ad, www.fargarossell.ad

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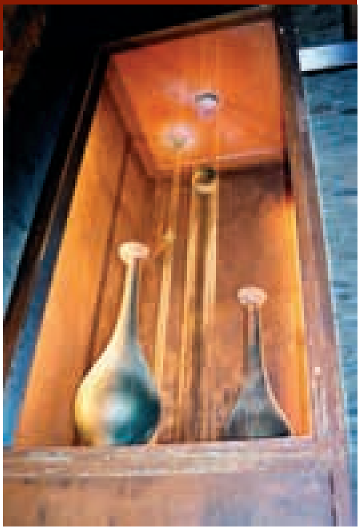

Authors: Josep Maria Bosch, Jean Cantelaube, Olivier Codina, Xavier Llovera, Antoni Vila, Cristina Yàñez.

Abbreviations of figures: AD09: Archives Départementales de l'Ariège, AEG: Agrupació Excursionista de Granollers, AHN: Arxiu Històric Nacional d'Andorra, ARH: Àrea de Recerca Històrica, AT: MIRA audio visual - Àlex Tena, CAP: Fons Patrimonials, Casa Areny-Plandolit, CEC: Centre Excursionista de Catalunya, CR: Fons Patrimonials, Casa Rossell, DRM: De Re Metallica, ES: Eduardo Sáiz, FAM: Fons Fotogràfic, Arxiu Mas, FB: Fons Batllia, FEDA: Forces Elèctriques d'Andorra, FP: Forges de Pyrène, JP: Jordi Pantebre, MC: de Melling i Cervini, NMV: Fons Notarials, Notaria Marc Vila, PhF: Philippe Fluzin, PMB: Pedro Maria Basáñez, TETRA: TETRA Enginyers S.L.

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