**Mining and metallurgy in medieval Europe**

During the [Middle Ages](https://en.wikipedia.org/wiki/Middle_Ages) from the 5th century AD to the 16th century, Western Europe saw a blooming period for the mining industry. The first important mines here were those at [Goslar](https://en.wikipedia.org/wiki/Goslar) in the [Harz](https://en.wikipedia.org/wiki/Harz) mountains, taken into commission in the tenth century. Another famous mining town is [Falun](https://en.wikipedia.org/wiki/Falun%22%20%5Co%20%22Falun) in Sweden where copper has been mined since the thirteenth century.

The rise of Western European mining industry depended, of course, closely on the increasing weight of Western Europe on the stage of world history. Although the subject has sometimes been overlooked by historians, advances in medieval mining and metallurgy enabled to a large extent the flourishing of Western European civilization.

Metallurgical activities were also encouraged by the central political powers, regional authorities, [monastic orders](https://en.wikipedia.org/wiki/Monastic_orders) and ecclesiastical overlords, who tried to claim royal rights over the mines and a share in the output, both in private lands and regions belonging to the Crown. They were particularly interested in the extraction of the precious metal [ores](https://en.wikipedia.org/wiki/Ore), and for this reason the mines in their territories were open to all miners.

**Early Middle Ages, 500-1000 AD**

The social, political, economic stagnation and decline that followed the Roman World affected Europe throughout the early medieval period, leaving a critical impact upon technological progress, trade and social organization. Technological developments that affected the course of metal production were only feasible within a stable political environment, and this was not the case until the 9th century.

During the first medieval centuries, the output of metal was in a steady decline and constraint in small scale activities. Miners adopted methods much less efficient than those of the [Roman times](https://en.wikipedia.org/wiki/Roman_metallurgy). Ores were extracted only from shallow depths or from remnants of former abandoned mines. The vicinity of the mine to villages or towns was also a determinant factor when deciding about working on site due to the high cost of material transportation. Only the output of [iron](https://en.wikipedia.org/wiki/Iron) diminished less in relation to the other base and precious metals until the 8th century. This fact, correlated with the dramatic decrease in [copper](https://en.wikipedia.org/wiki/Copper) production, may indicate a possible displacement of copper and [bronze](https://en.wikipedia.org/wiki/Bronze) artifacts by iron ones.

By the end of the 9th century, economic, and social conditions dictated a greater need of metal for agriculture, arms, [stirrups](https://en.wikipedia.org/wiki/Stirrup), and decoration. Consequently, conditions began to favor metallurgy and a slow but steady general progress developed. Starting from the reign of the emperor [Otto I](https://en.wikipedia.org/wiki/Otto_I%2C_Holy_Roman_Emperor) in the 960s, smelting sites were multiplied. New mines were discovered and exploited, like the well-known [Mines of Rammelsberg](https://en.wikipedia.org/wiki/Mines_of_Rammelsberg), close to the town of Goslar in the Harz Mountains. [Open-cast mining](https://en.wikipedia.org/wiki/Open-cast_mining) and metallurgical activities were mostly concentrated in the Eastern Alps, Saxony, Bohemia, Tuscany, the Rhineland, Gaul, and Spain. It was mainly German miners and metallurgists who were the generators of metal production, but the French and Flemish made contributions to the developments.

**High Middle Ages, 11th to 13th centuries**

The period just after the 10th century marks the widespread application of several innovations in the field of mining and ore treatment. It marks a shift to large scale and better quality production. Medieval miners, and metallurgists, had to find solutions for the practical problems that limited former metal production, in order to meet the market demands for metals. The increased demand for metal was due to the remarkable population growth from the 11th to the 13th centuries. This growth had impact on agriculture, trade, and building construction, including the great Gothic churches.

The main problem was the inefficient means for draining water out of shafts and [tunnels](https://en.wikipedia.org/wiki/Adit) in [underground mining](https://en.wikipedia.org/wiki/Underground_mining). This resulted in the flooding of mines which limited the extraction of ore to shallow depths close to the surface. The secondary problem was the separation of the metal bearing minerals from the [worthless material](https://en.wikipedia.org/wiki/Gangue) that surrounds it, or is closely mixed with it. There was also the difficulty of the transportation of the ore, which resulted in additional high costs.

The economic value of mining resulted in investment in the development of solutions to these problems, which had a distinct positive impact on medieval metal output. This included innovations such as [water-power](https://en.wikipedia.org/wiki/Water_power) using [water-wheels](https://en.wikipedia.org/wiki/Waterwheel) for powering draining engines, [bellows](https://en.wikipedia.org/wiki/Bellows), [hammers](https://en.wikipedia.org/wiki/Hammers); or the introduction of advanced types of [furnaces](https://en.wikipedia.org/wiki/Furnace). These innovations were not adopted at once, or applied to all mines and smelting sites. Throughout the medieval period these technical innovations, and the traditional techniques, coexisted. Their application depended on the time period, and geographical region. Water power in medieval mining and metallurgy was introduced well before the 11th century, but it was only in the 11th century that it was widely applied. The introduction of the [blast furnace](https://en.wikipedia.org/wiki/Blast_furnace), mostly for iron smelting, in all the established centres of metallurgy contributed to quantitative and qualitative improvement of the metal output, making metallic iron available at a lower price.

In addition, [cupellation](https://en.wikipedia.org/wiki/Cupellation), developed in the 8th century, was more often used. It is used for the refinement of lead-silver ores, to separate the silver from the lead. Parallel production with more than one technical method, and different treatment of ores would occur wherever multiple ores were present at one site.

Although limited in depth, underground work in [shafts](https://en.wikipedia.org/wiki/Ventilation_shaft), was accomplished either by [fire-setting](https://en.wikipedia.org/wiki/Fire-setting) for massive ore-bodies or with iron tools for smaller scale extraction of limited veins. The sorting of base and precious metal ores was completed underground and they were transferred separately.

Permanent mining in [Sweden proper](https://en.wikipedia.org/wiki/Sweden_proper) begun in the [High Middle Ages](https://en.wikipedia.org/wiki/High_Middle_Ages) and did not spread to Finland until 1530 when the first iron mine was begun operations there.

**Late Middle Ages, 14th to 16th centuries**

By the 14th century, the majority of the more easily accessible ore deposits were exhausted. Thus, more advanced technological achievements were introduced in order to keep up with the demand in metal. The alchemical laboratory, separating precious metals from the baser ones they are typically found with, was an essential feature of the metallurgical enterprise. However, a significant hiatus in underground mining was noted during the 14th and the early 15th century because of a series of historical events with severe social and economic impacts. The [Great Famine](https://en.wikipedia.org/wiki/Great_Famine_of_1315%E2%80%931317) (1315–1317), the [Black Death](https://en.wikipedia.org/wiki/Black_Death) (1347–1353), which diminished the European population by one third to one half, and the [Hundred Years War](https://en.wikipedia.org/wiki/Hundred_Years_War) (1337–1453) between England and France, that amongst others caused severe deforestation, had also dramatic influences in metallurgical industry and trade. Lead mining, for example, ground to a halt due to the Black Death pandemic, when atmospheric lead pollution from smelting dropped to natural levels (zero) for the first and only time in the last 2000 years. The great demand of metals, e.g. for armour, could not be met due to the lack of manpower and capital investment.

It was only by the end of the 13th century that great capital expenditures were invested and more sophisticated machinery was installed in underground mining, which resulted in reaching greater depths. The wider application of water- and horse-power was necessary for draining water out of these deep shafts. Also, [acid parting](https://en.wikipedia.org/wiki/Gold_parting#Acid_parting) in separating gold from silver was introduced in the 14th century. However, notable signs of recovery were present only after the mid-15th century, when the improved methods were widely adopted.

Nevertheless, determinant for the European metal production and trade was the discovery of the [New World](https://en.wikipedia.org/wiki/New_World), which has affected world economy ever since. New rich ore deposits found in Central Europe during the 15th century were dwarfed by the large amounts of precious metal imports from the Americas.

**Smiths and miners within medieval society**

Metallurgists throughout medieval Europe were generally free to move within different regions. German metallurgists in search of rich precious metal ores, for instance, took the leading part in mining and affected the course of metal production, not only in East and South Germany but in almost all Central Europe and the Eastern Alps. As mining gradually became a task for specialized craftsmen, miners moved in large groups and formed settlements with their own customs close to mines. They were always welcomed by the regional authorities, since the latter were interested in increasing the revenue and the exploitation of the mineral-rich subsurface was quite profitable. These authorities claimed a part of the output, and smiths and miners were provided with land for cottages, mills, [forges](https://en.wikipedia.org/wiki/Forge), farming, and pasture, and they were allowed to use streams and lumber.

Progressing to the high and late Middle Ages, as smelting sites became geographically independent from mines, metalworking was separated from ore smelting. The urban expansion from the 10th century onwards and the dominant role of towns provided metallurgists with the right environment to develop and improve their technology. Metallurgists got organized in [guilds](https://en.wikipedia.org/wiki/Guilds) and, usually, their workshops were concentrated in town peripheries.

In medieval societies, liberal and mechanical arts were considered to be totally different disciplines. Metallurgists, as all craftsmen and artisans, almost always lacked the formal education that would inform a methodical intellectual background. However, they were the pioneers of causal thinking based on empirical observation and experimentation.