

# Early Methods: The Extraction of Ore and Rock Breaking Techniques

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## Extraction systems

Once the lodes had been reached, the methods of ore extraction were similar for both shaft and adit mines. Two systems were used; one for rake or hading veins (narrow but continuous lodes) and the other for pipe and flat works (large but irregular masses of ore). A.H. Stokes described rake veins as ore-filled fissures and crevices that are generally vertical, or highly inclined, and run through a series of rocks, or beds of limestone; pipe veins were irregular ore-filled cavities or hollow spaces parallel to the bedding of the rocks in which they occur, often nearly horizontal; flat works were very similar to pipe veins, and may be termed an irregular horizontal cavity filled with minerals where the roof and floor are only a few feet apart, but whereas the pipe vein is accompanied with many branches and leaders, one from another, the flat work has none, and is often a lonely chamber without leaders or stem. Since both types of deposit might be encountered in the same mine, both extraction techniques were often in use together.

## Rock-breaking techniques

Unlike coal miners, metal miners were rarely able to cut their way with picks alone and from an early date artificial techniques were used for softening and breaking rock. These techniques improved considerably during the eighteenth and nineteenth centuries and greatly increased the speed and efficiency of driving shafts and adits as well as the extraction of ore.

## Early methods

At the beginning of the eighteenth century many mines still relied on the ancient practices of firing or fire-setting; plug and feathering; or perhaps splitting with

quick lime. The use of fire to soften rock was described as early as the second century B.C. by Agatharchides and was still in use in parts of Germany down to the end of the nineteenth century. The technique involved building a small fire against the ore face, the heat softening and cracking the rock. It was well suited to mines where the ore was carried in quartz gangue rock, as in parts of Cumberland, but was little used where the ore was a soft sulphide of lead and the gangue was principally calcite, as in Swaledale. Firing was slow and relatively inefficient but its main drawbacks were the dangers which it created for the miners, through fire, explosion, or suffocation, and the time needed to clear badly ventilated workings of smoke. These difficulties meant that firing could only be used under carefully controlled conditions in relatively shallow workings. In Derbyshire the mineral customs of the High and Low Peaks contained regulations to control the general practice of firing and to prevent operations in ore mines from unduly affecting neighbouring and sometimes interconnecting workings. Article 40, for example, of the code drawn up in 1665 for the Peak read:

*'We say that any miner in an open rake may kindle or light his fire four of the clock in the afternoon, giving his neighbours lawful warning thereof'.*

The only alternative to firing before the late seventeenth century were the equally ancient practices of plug and feathering or the similar technique of liming. The latter technique was probably uncommon in metal mines though 'blast holes' charged with lime were discovered in 'old mines' in the Vale of Towy, Caernarvonshire. For plug and feathering -sometimes known as 'wedging'- the miner drilled a series of holes, inserted wedges with circular backs into each hole, and then drove plugs between them. By hammering along the line of plugs the rock was gradually split. Although safer than firing, presenting no ventilation problems and more efficient for some purposes, plug and feathering had the disadvantages of requiring more labour and producing broken rock and ore which was generally too large for easy dressing. The technique possibly survived in some metal mines into the late nineteenth century but was more commonly used in slate mines, collieries and quarries where the shattering effect of gunpowder blasting and later dynamite was often undesirable.