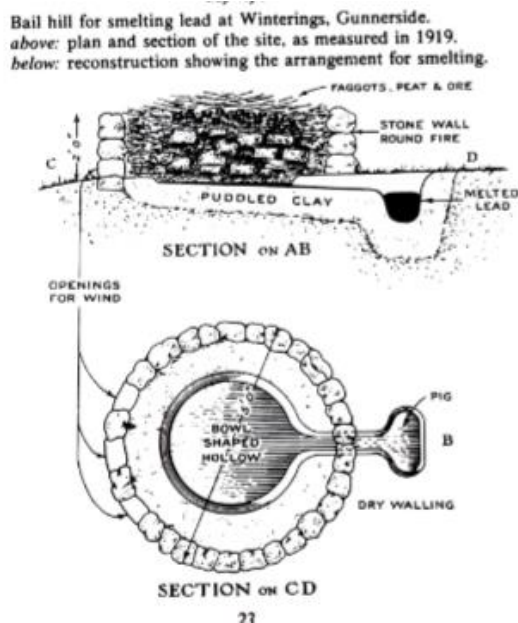


Smelting the Ore

Bale (Bail) Hills

In medieval times smelting was carried out in bales; these were simple wind-blown hearths situated on the side of exposed hillsides. They were shallow depressions in the ground between three and six feet diameter, with a low stone wall built around and lined with clay, inside alternative layers of ore and fuel were built.



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The wall had holes allowing air to be pulled in to help burn off the sulphur; they typically reached temperatures of 600 – 800 C which allowed the first stage of smelting to occur; creating the conditions required for the formation of molten lead, which was drained off via a channel in the bottom of the fire and set into a block. Although this method was effective, the residual slag still held significant levels of lead. Bales were commonly used until the 1570's when they were replaced by ore hearths in smelt mills.

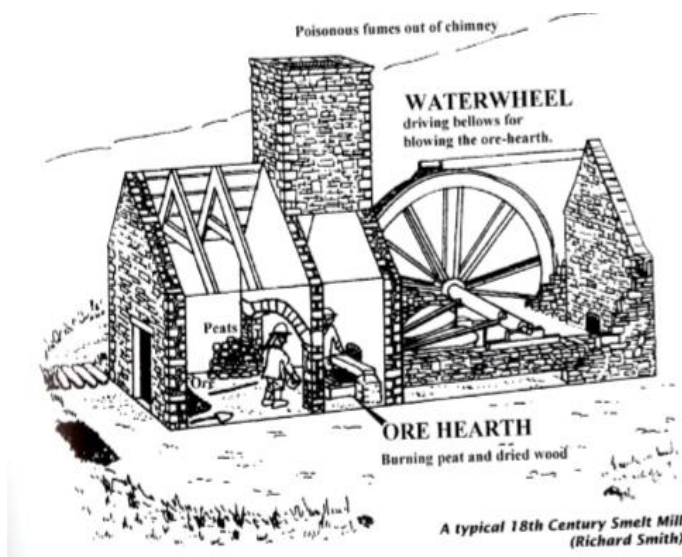
Ore Hearths

These were small, bellows-blown hearths in which the ore and fuel were mixed. Waterwheels were used to power the bellows which meant less reliance on wind, and so the smelting process could be completed under more controlled settings in purpose built smelt mills. The mills relied on a constant supply of water and so were built near a river or beck, uphill streams were dammed and water was directed to the wheels by channels known as *leats*. Many sections of these water courses can still be seen today.

Fuel was still predominantly wood, but the earlier bale smelting had used up the majority of woodland in Upper Swaledale. By the 18th century peat was cut on local moors and stored in peat houses close to the mills, coal was also increasingly used and brought in from the Tan Hill coal mines. These hearths were cheap to build and stood in stone arched recesses which allowed the smelters room to rake and work the ore and fuel, and also ensured the poisonous fumes were taken away via the flue system. The hearths were in constant use, with smelters working shift systems and a typical annual output would be 300 - 400 tons of lead per hearth.

The smelting process was skilled work. At the end of each shift the hearth was left partly full of lead ready for the next smelter. All through the shift the blast from the bellows had to be regulated, the hearth contents stirred up every five minutes bringing the ore onto the work stone for inspection, and the smelter then repositioning the contents as required. As the process continued, lead began to flow into a sumpter pot which was heated by its own fire. From this pot the lead would be ladled into the pig moulds.

Two men worked each shift and would alternate the fire and casting jobs. At the end of the shift, the fire would be shut down, the hearth cleaned and the amount of lead replaced ready for the next shift.



The process produced a grey slag, which still contained some lead oxides so this was then re-smelted in special slag hearths that could produce the very high temperatures required. This process could recover as much as 15 to 20% additional lead and so often slag from earlier bale sites was re-smelted.

Early smelt mills had small vertical chimneys, but the fumes contained large amounts of sulphur dioxide which fell on

nearby pasture land and killed grazing animals. Despite this, it was not until the 1840's that the long horizontal flues were built, running up the moor from the mills so taking the fumes far away from the mills and pastureland. The long flues also allowed the gases to cool and deposit lead oxide or 'fume' on the flue walls. These deposits were valuable as they still contained lead; so men worked inside the flue, brushing the fume off the walls which was then smelted again in a slag hearth.

Reverberatory furnaces were also used, but rare in Swaledale. These differed to the standard ore hearths as the fuel and ore were positioned in separate chambers. The heat was reflected onto the ore and so a temperature of 1100 – 1200 degrees was required. These furnaces were designed to run continuously and were capable of smelting on an industrial scale.

The earliest known smelt mill in Swaledale was built at Marrick in 1575. In total there have been 36 smelt mills in Swaledale and Arkengarthdale.