

Excavation of a Lime Kiln at Knowle Farm, Mellor



A report by Donald Reid and John Roberts of the Mellor Archaeological Trust.



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1. Summary

In September 2009 the Mellor Archaeological Trust carried out an excavation at Knowle Farm in Mellor. The excavation was on the site of an anomaly detected during a magnetometry survey performed by the Trust in 2007. The excavation revealed the substantial remains of what appears to be a Lime Kiln. The remains consisted of a stone built, oval, 'Pot' measuring 2.75 m by 2.50 m and 2.76 m deep. At its base on its west side the Pot had an opening, the Eye, from which ran a 3.5 m stone lined flue. There was no direct dating evidence for the structure however indirect evidence suggests two equally probable dates. High grain prices during the Napoleonic wars and the arrival of the Peak Forest canal at Marple in 1796 point to a construction date around 1800 while the map evidence tends to suggest a date sometime between 1836 and 1886. After recording the kiln was backfilled the ground reinstated and a large 'gate post' stone removed during excavation positioned over the centre of the Pot.

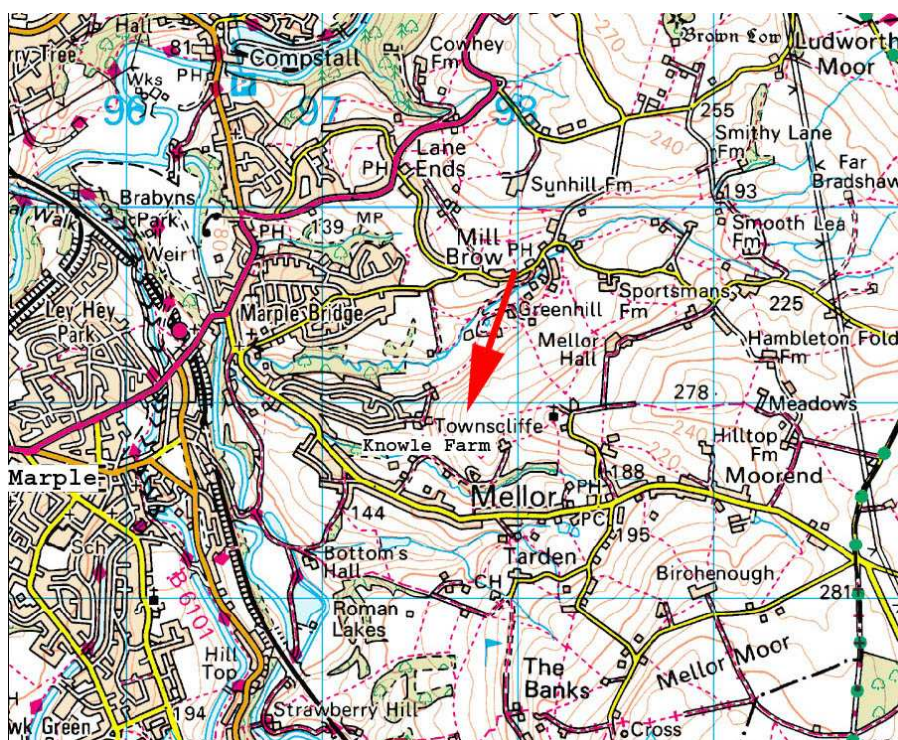


Figure 1. Site Location map.

Acknowledgements; *Thanks are due to Donald Reid for his contributions to this report and to all the volunteers who helped with the excavation; to the Hodgeson family for letting us excavate on their land and keep dry in their barn. Special mention should be made to the contributions of the late Philip Day whose knowledge and enthusiasm were an inspiration to everyone and the late Peter Hodgeson without whose friendliness and helpfulness much of the archaeological work at Mellor would not have been possible.*



Figure 2. Modern aerial photograph with the results of the magnetometry survey superimposed.

2. Background

Why; In August and September 2009 the Mellor Archaeological Trust conducted excavations in a field now known as Top Field belonging to Knowle Farm in Mellor (Grid reference: 397740, 388920). The excavation was part of a programme by the Trust and the Greater Manchester Archaeological Unit which sought to identify possible archaeological sights in the vicinity of the Iron Age remains located in the Old Vicarage garden half a mile to the east. Vital to this programme were the series of geophysical surveys carried out by the late Philip Day. 'Top Field' is the final step in a series of ridges which sees the land descend from the hilltop at the Old Vicarage to Marple Bridge. As such it seemed a likely possible location for prehistoric settlement and was targeted for geophysical survey. It was during the magnetometry survey of the field in July 2007 that an intense magnetic anomaly was detected. Ever the scientist Philip would not be drawn on the source of this anomaly stating '*Could be a large piece of metal buried in the ground, but could be an old pit, well, golf bunker....?*' adding '*All told, very interesting but needs a trench or two to see what we are looking at, if anything.*'

It was not until the summer excavations at the Old Vicarage in August 2009 that the resources were finally available to evaluate the nature of the anomaly. A small team of volunteers under the supervision of John Roberts of the Trust opened a 4m x 4m trench over the anomaly. At around 0.30m below ground level a line of stones running east to west was exposed to be the source of the magnetic anomaly. To the north of these stones a spread of stone rubble was discovered. At first it was thought this stone line and rubble represented the remnants of a field boundary shown on a map of 1836. Further excavation of the rubble however revealed that it was at least 1.20 m deep. Partial removal of the rubble confirmed that the line of stones was indeed a wall however rather than being a straight, vertical field boundary the exposed section curved to the north and sloped inwards as it descended. The wall was roughly coursed using stones of varying sizes. No bonding material could be discerned either between individual stones or the different courses. At this point at the end of the 2 week evaluation the function of what was now interpreted as a circular stone walled pit or shaft was still a mystery. Theories included a possible mine shaft, some form of kiln or a world war two observation post. It was clear that in order to establish the function of the feature further excavation would be required. This would involve using a mechanical excavator to enlarge the trench so that the full extent of the wall could be ascertained and to remove the stone rubble which ground penetrating radar suggested was perhaps a further 1.50m below the level reached by the evaluation. To this end the Trust commissioned a two week full excavation of the site which was undertaken between the 14th and 25th of September 2009.

3. Results

Initial machining extended the evaluation to reveal that the curved section of wall exposed during the evaluation continued to form an oval measuring, at the top, 2.75 m east to west and 2.50 m north to south. The level of the top of the wall was at the same height as the natural bedrock and its survival reflected the slope of the rock being about 1.0 m higher on the south side. The machining showed that the top of the wall at its most westerly point was formed by a single stone 1.25 m long by 0.75 m wide by 0.25 m deep. Behind this, outside the circumference of the curved wall, and at a slightly higher level, the top of an even larger stone was exposed. Attention now focused on removing the stone rubble infill. This proved difficult due to the nature of the material and the confined space which was exacerbated by the fact that the inward slope to the curving wall noted during the evaluation continued. Nevertheless by lowering the machine bucket into the feature and hand filling it the base was of the structure was finally revealed. This task was made easier by the fact that for the final c 0.30 m the fill changed from being totally rubble to the occasional fragment found contained within a layer of ash. This gave a height for the wall on the south side of 2.75 m and on the north side of 1.75 m. The base of the structure measured 1.37 m north to south and 2.10 m east to west. For the most part it was formed by the natural sandstone bedrock however in certain places it did appear that silty clay had been laid onto the stepped bedrock and flat pieces of sandstone placed on top of this to produce an even surface. The west side of the structure contained 0.20 m step above which was a rectangular opening 1.50 m high by 1.0 m wide. To the south of this opening was a 0.60 m wide section of flat, vertical wall which separates the opening from the south section of curving wall. This straight section is itself divided into two different sections. Immediately alongside the opening is a two course wide section which appears to be the east end of the southernmost of two walls which run parallel and west from the opening. The top of this wall sits below the lintel but also 'dog legs' south to bond with the curving wall. Below this dog leg was a distinctive course of stonework, two vertical blocks form the top of this section which then steps out to the east and runs to the base of the structure. To the north of the opening the situation is different; the east end of the northern of the two parallel walls is behind the curving wall and bonded into it. The lintel itself was cracked into three pieces and in danger of collapsing which meant it had to be supported in order that the remains could be recorded. It was unclear as to whether the lintel had cracked during use or infilling or if it had been damaged during machining. The construction of the two parallel walls was the same as the curving wall with local stone laid in rough courses with no apparent bonding material. In some areas of the walls the natural bedrock was visible and the walls had been built onto and against it. The walls ran west for 3.50 m. Beyond the flue was a 1.50 m flat area of bedrock, presumably this had been deliberately levelled as to the west of it the bedrock tipped downwards to follow the contour of the hillside.



Figure 3. Initial machine excavation revealed the kiln 'Eye'.



Figure 4 Overhead photograph showing the excavated structure and the lines of the drawn profile and elevation.

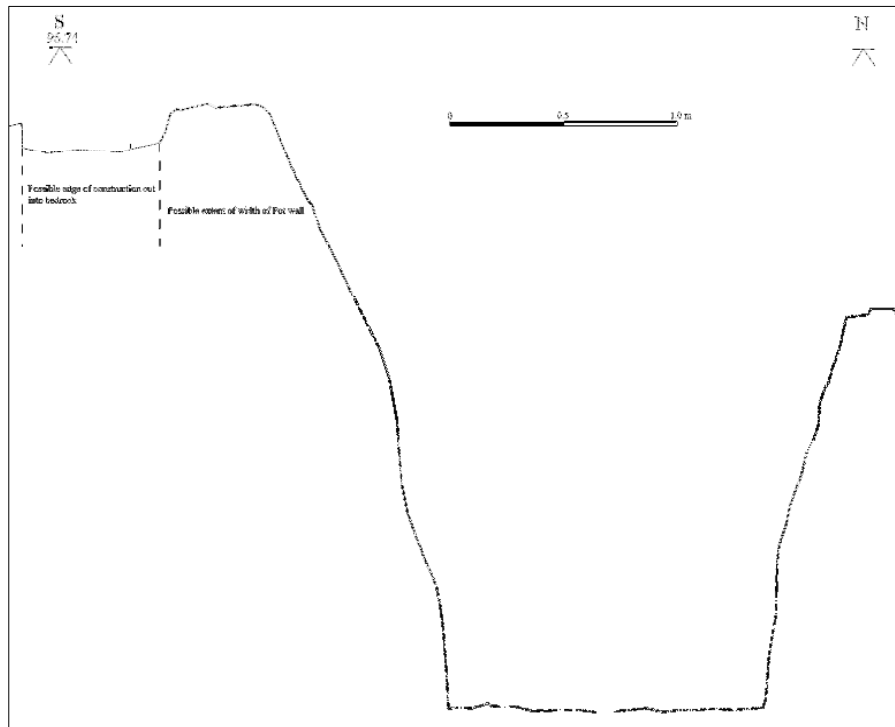


Figure 5. South to north profile of the Pot. N.B due to the remote location of the site the value of the temporary bench mark used for all readings was not tied in to an Ordnance Survey benchmark. All site readings are accurate relative to each other, the TBM is part of a solid wall and should it prove essential its Ordnance Datum height can be surveyed in.

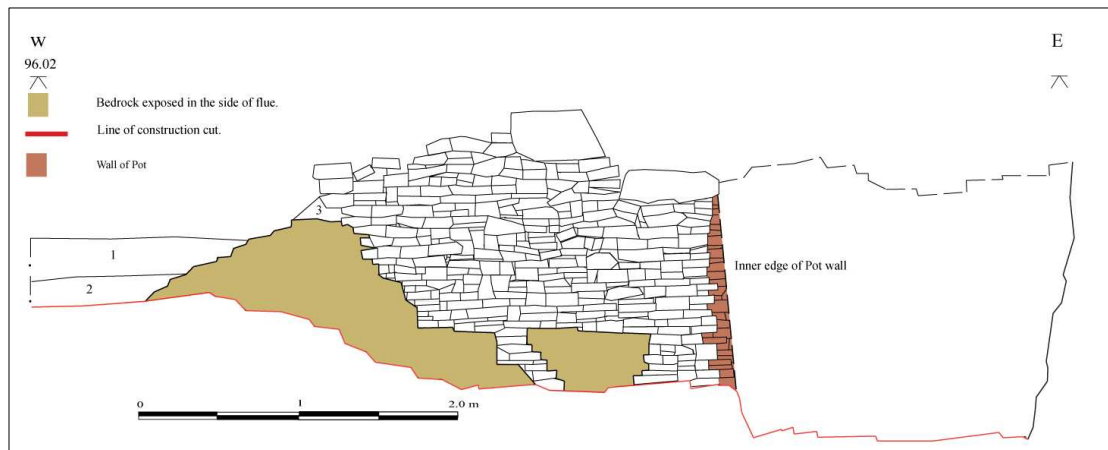


Figure 5. West to East elevation through the kiln.

4. Discussion

4.1 Interpretation

The most likely interpretation of the structure is that it is a lime kiln. This is based on two pieces of evidence.

Firstly an analysis by Philip Day of a sample of the deposit on the wall of the structure which 'looks like clinker or slag; heterogeneous nature of material; rounded nature of edges (probably due to melting); blowholes from escaping gas; the fact that parts of this deposit react with acid, indicating a carbonate'. The combination of heat and a possible residue of limestone are a compelling argument for the structure being a lime kiln.

The second body of evidence comes from a comparison of the remains with other sites. Typologically the remains excavated at Knowle Farm bare a striking resemblance to limekilns excavated elsewhere, particularly the solitary kilns of the northern uplands which utilise local stone and whenever possible are built into slopes.

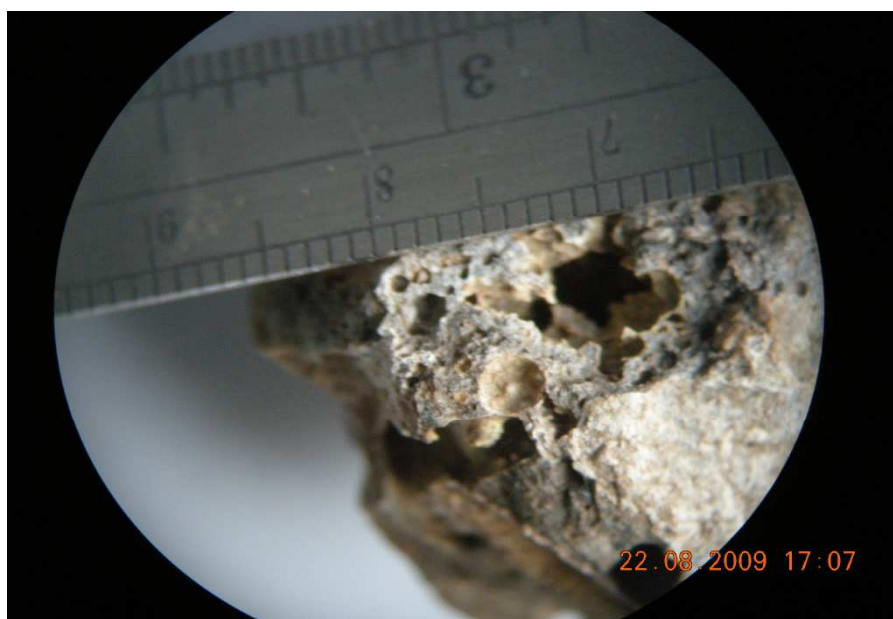


Figure 6. Photomicrograph of a small piece of the "white deposit on the south wall (cm scale). Note: looks like clinker or slag; heterogeneous nature of material; rounded nature of edges (probably due to melting); blowholes from escaping gas; the fact that parts of this deposit react with acid, indicating a carbonate.



Figure 7. Field kiln at Ravenstonedale in Cumbria. Typically of these kilns it is constructed into the side of a slope.



Figure 8. Photograph of the excavated kiln looking west, downhill, towards Townescliffe.



Figure 9. Partly infilled Pot of a field kiln in Monyash Derbyshire.



Figure 10. Partly excavated Pot during the evaluation. Looking South.



Figure 11. Minninglow Derbyshire.



Figure 12. A view looking west giving an indication of the slope into which the structure was built.



Figure 13. Errwood in Derbyshire.

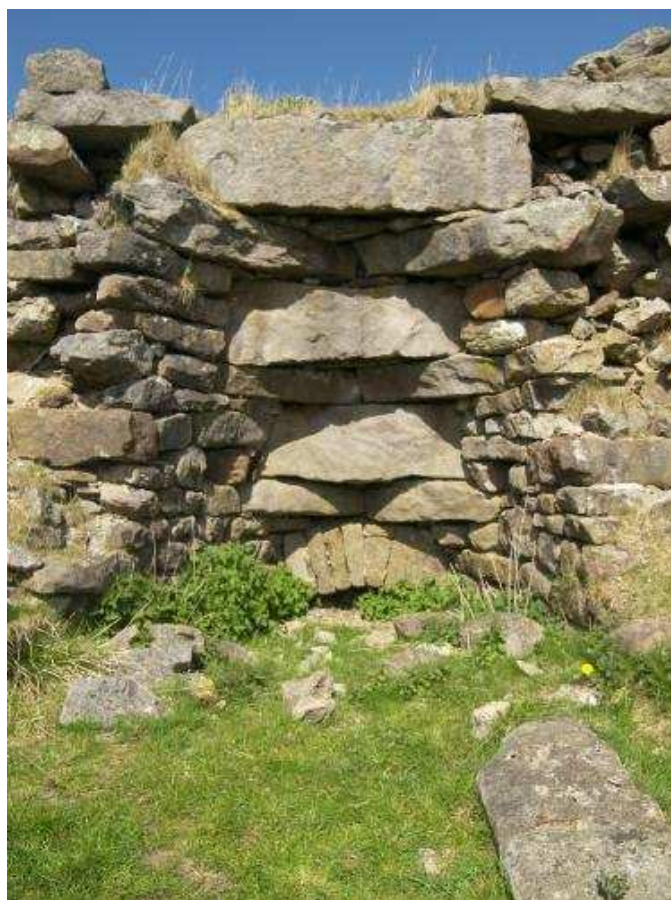


Figure 12. Field kiln in South Bowland showing staggered lintels above the arch of the flue.

4.2 Construction

The rural 'Field Kiln's' which proliferated in the late 18th and 19th centuries all followed similar design principles. Where possible they were built into a slope which would allow the Pot to be filled from the top at ground level and down slope provided a natural level for the construction of the Eye. To a greater or lesser extent this would have required terracing and excavation into the slope. The nature of this would partially be dictated by the local geology. Externally, many Field Kiln structures have the Pot completely encased and supported by a square structure. This would have been necessary in a soft geology, at Knowle Farm with the sandstone bedrock so close to the surface it appears that such a supporting structure was not needed. Without removing any of the pot wall to confirm the theory it does seem that in this instance a trench c 1.50 m wide (the width of the flue plus its walls) was excavated c 4.50 m laterally and slightly downwards into the slope. The slight drop would have accentuated the natural slope of the hill allowing the necessary depth of the Pot to have been realised in a shorter distance and would have meant less of the lower, west, side would have to be built above the level of the natural bedrock. The most westerly end was flat presumably to facilitate the bagging and transport of the quicklime, the central c 2.20 m inclined down slightly this section would have acted as a flue allowing air to fuel the burning but preventing the wind from blowing directly into the Pot. The stepped nature of the bedrock forming the floor of this section might appear to be an awkward surface to rake ash and quicklime on however as the excavation showed these steps quickly became smoothed out by compacted material from the burning. The excavators discovered that the flue was full of stone rubble presumably from collapsed walls but it is possible that the flue was arched or at the very least had some form of covering, wood or canvas to offer some protection to the workers and to reduce the danger of accidental slaking as the quicklime was raked out. Behind the sandstone lintel which formed the top of the Eye was an even larger stone which spanned the flue. This was not local stone and had clearly been worked into what appears to be a large gatepost. It had clearly been deliberately set into the flue walls. It may be that this was an attempt to cover the flue or it could be that the damage to the Eye lintel had occurred during the lifetime of the kiln and that this stone represents an ad hoc attempt at repair. The final c 1.50 m of the trench would have formed the flat base of the Pot. This end was then presumably expanded to the form the traditional 'truncated cone' shape. It is unknown whether this expansion involved shaping the bedrock to a cone shape and then lining this with a wall or if a square box was excavated and a circular wedge shaped wall wider at the base than the top was built to form the shape. At the top, on the surface, the circular wall appears to be two courses thick. This seems true both at the higher southern section and the lower north section suggesting that it is a uniform width all the way down. On the surface it was clear that the north east quadrant of the wall was built tight against the natural bedrock however on the southern side there appears to be an earth packed gap between the wall and the bedrock. This may simply be the result of a dip in the bedrock but it could be that in places packing had to be placed between the wall and the bedrock. The excavation into the bedrock of the hillside would have provided much of the stone to construct a wall against the exposed bedrock to form the shape of the Pot. As the bedrock sloped downhill, to keep the top of the Pot level, the top courses of the southern part of the pot wall, including the section built on the lintel above the Eye, would have been built above the level of the supporting bedrock by about 1.0m. This would have required some method of retaining given the pressure

it would have been under when the Pot was loaded and the heat it would have been subjected to during firing. This may have taken the form of a stone wall buttress although no evidence of one was found during the excavation. If there was a wall then it is possible, even likely that it was used to infill the Pot when the site was levelled but even so it might be expected that some indication of a foundation cut might have been seen. It is also possible that instead of a wall an earth and stone glacis was formed around the pot wall to secure it. If there was a wall or bank encasing the 'down slope' half of the Pot then it would have covered the flue. In this case the top of the flue would have required a series of ascending lintel's to cover it and carry the wall. This could possibly be the function of the large 'gate post' stone found behind and above the pot wall lintel. Inside the Pot, immediately to the south of the Eye, a section of stonework projected from the main wall of the Pot. It is possible that this is the remnant of a more extensive ledge or series of jetties that would have supported grate bars onto which the limestone and fuel would have been loaded and through which the quicklime and ash would have fallen to be raked out. This theory seems to be supported by the fact that during excavation the fill of the Pot below this outcrop contained a large amount of ash and very few of the large stone fragments typical of the upper fill.



Figure 14 Photograph of the completed excavation looking north.



Figure 16. Photograph showing the southern half of the pot wall.



Figure 17. Photograph looking west showing the different levels to which the pot wall survives.



Figure 18. Picture showing the southern half of the pot wall.



Figure 19. Photograph of the base of the Pot and what might be the remnants of a ledge used to support a grill.



Figure 20. A picture of the internal opening of the Eye.



Figure 21. A view from inside the Pot looking through the Eye and along the flue.



Figure 22. The opposite view; looking through the outside opening of the Eye, along the flue, into the Pot.



Figure 23. Aerial view of the flue and its flanking walls and two 'lintel' stones.



Figure 24. A view of the west end of the flue.



Figure 15 a view of the end of the flue looking north. The junction of the north flue wall and the natural, sloping bedrock can be seen. Immediately below the ranging rod is a layer of rubble presumably from the collapsed/demolition of the kiln. Below the rubble is what appears to be natural subsoil.

4.3 Usage

Field kilns such as the one at Knowle Farm fall into two basic types; flare kilns and draw or running kilns. The two have similar construction, generally a broad chimney, often set into the side of a hill. The kiln is loaded from the top (the hill side) and fired from the bottom, from whence the lime is also removed. Flare kilns are loaded with a single charge of limestone. Firstly a vault of limestone blocks is built over the furnace, above which the rest of the limestone is stacked. The fire is lit and kept stoked for several days until all the limestone has been calcined. The kiln is then unloaded, the lime sent to the slaking pits, and the process repeated with the next batch of limestone. In contrast, draw kilns have a permanent grate fixed over the furnace and the limestone is stacked above this in layers alternating with layers of fuel. As the fuel burns the limestone is calcined and the lime drops through the grate from where it is removed through the stoke hole. As the fuel/lime layers drop through the grate, further layers can be added at the top, allowing for a continuous process to be operated.

The purpose of the kiln was to produce quicklime by the calcination of limestone. This reaction takes place at 900 degrees c but proceeds more quickly at around 1000 degrees c. In these types of kilns at that time temperature control was a case of trial and error as was duration of the burn. Large variations in temperature between the centre of the charge and the material against the wall of the kiln meant that not all the lime produced was useable. If it had not been heated enough the reactive process would not start, while excessive temperatures produced 'dead burned' unreactive lime. Limestone was crushed into manageable lumps and successive layers of fuel and limestone were loaded into the Pot from the top onto grate bars set above the level of an opening in the side of the kiln at its base. This was known as the kiln Eye it allowed air to feed the fire, prevented the hot quicklime from being blown around and protected it from the rain. As a fuel coal is readily available from a number of seams in the area. The slow burning coal mined from the yard seam is particularly suited to use in lime kilns. When loading was complete the kiln was fired as the quicklime, dropped through the grate it was raked out through the Eye. Further layers of fuel and limestone could be added from the top to allow for continuous burning. The hillside setting of the structure at Knowle farm is typical of rural kilns. Using the natural contours allowed the top of the Pot to be easily accessed for filling. The flue or draw tunnel at Knowle Farm sloped downwards into the hillside this design has been noted at other farmer's kilns and may suggest that the kiln was unloaded from the top.

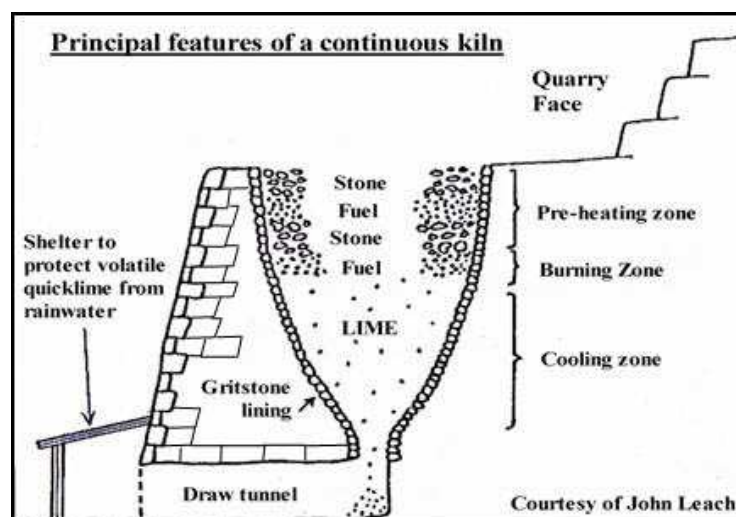


Figure 16 A schematic of a typical Field Kiln.

4.4 Purpose

The two principle uses for lime are in construction and agriculture. Lime kilns have been identified in Britain from Roman times when they provided lime for the mortar and cement required for their extensive building projects. After the Roman period there was little demand for lime although the Saxons are known to have used it when building their churches and as a wash on wattle and daub walls. It was not until the Norman's ambitious building programme of the great churches and castles that lime was again in considerable demand. In the medieval period the construction of abbeys, monasteries, town walls and bridges continued this need. In the seventeenth century the large scale use of bricks increased the demand for lime and while the invention of Portland cement in 1824 to an extent reduced the requirement of lime in construction work it has never fully replaced it. The possibility exists therefore that the lime kiln at Knowle Farm was built to meet the needs of either a specific construction project or a group of contemporary projects, in the immediate vicinity. The kiln lies roughly equidistant from the buildings at Heathy Bank, Townscliffe and Knowle Farm. A survey of Townscliffe Farmhouse carried out by the Mellor Archaeological Trust found evidence of extensive 16th 17th and 18th century phases of construction all of which would have required considerable amounts of lime.

Most of the quicklime produced until the late 19th century was used in agriculture. The spreading of lime on fields 'Liming' increases their productivity as it neutralises soil acidity and breaks down heavy clay soils. The Agricultural revolution of the 18th century and enclosures acts created a huge demand for lime. This was exacerbated during the Napoleonic Wars when increasing grain prices led to an estimated 2 million acres of land being brought into cultivation between 1790 and 1810. Areas of moorland were "taken in" to cultivation and because the peaty moorland soil was acidic, the addition of lime was required to sweeten the soil and make it suitable for cultivation. For example, some two miles to the north of the Mellor site is "Intakes Farm", located on former moorland. During this period farmers in marginal grain growing areas either built their own lime kilns or had access to one. If the owners of Middle Field Head were to maximise the benefits of high grain prices then the liming of their fields would be an obvious and crucial first step. Exact calculations on the amount of lime needed for the initial correction of a field vary depending on the soil; modern authorities suggest 1 – 2 tons per acre. Again the amount of quicklime one of these rural kilns would produce per day would depend on a number of factors but nineteenth century sources quote between 300 – 400 bushels per day. Converting this measurement of volume would roughly give 10 – 15 tons per day. A ratio of 2 – 1 limestone to quicklime is generally accepted. These rough calculations mean that it would take 3 days continuous burning just to produce enough quicklime to initially treat the 7.744 acres of Middle Field Head as it is depicted on the 1892 Ordnance Survey map.¹

4.5 Date

The few finds of pottery sherds appear to confirm a date of closure in the 19th Century. When considering this question it is worth taking into account the availability of limestone. The source of which would probably be the Doveholes Quarries in Derbyshire. Availability of limestone from these quarries was transformed by the construction of the Peak Forest Canal. The upper section of the canal, between Bugsworth and Marple, was completed in the summer of 1796. A major shareholder in the company was local businessman Samuel Oldknow who sought to capitalize on his investment by building lime kilns next to the canal in Marple. Although the principles were the same as the rural kilns these were on a massive industrial scale. The first consignment of limestone arrived at Marple in July 1797 and the kilns began processing later that year. In 1780 74,000 horse loads (106,804 cubic metres) of lime were produced. The question is would the availability of limestone at the canal in Marple be an incentive for the owner of Middle Field Head to build their own lime kiln, post 1797, or would the availability of ready processed quicklime from the Oldknow's kilns mean that local farmers were less likely to build their own kilns after 1797? Perhaps an answer to the question can be found in what happened to the lime once it left the kiln. The quicklime raked from the Pot after burning was lump lime similar to the unburnt lime in shape and appearance but a lot softer. In order to produce a powder suitable for spreading on fields or to mix as a mortar it had to be slaked by moistening it. The lump lime would be dispersed in small heaps over a field; these were sometimes covered in earth to retain the heat of the reaction. Rain would produce a furious reaction turning the lump lime reducing the lump lime to a powder which could be ploughed in. Even moisture in the air could be enough to start the slaking process. This made it dangerous to handle and transport quicklime as the heat generated when it started to slake was enough to set fire to carts and containers. Given the hazards of transporting quicklime even the short distances to fields adjacent to the kilns it would be understandable if local farmers thought it prudent to process limestone in their own kilns rather than transporting than taking the risk of transporting quicklime from the Oldknow's kilns. It would seem likely then that the kiln was constructed in an attempt to make the surrounding fields profitable for grain growing and so take advantage of the high grain prices during the Napoleonic Wars and that it was probably prompted by the availability of Derbyshire limestone after the construction of the Peak Forest Canal in 1796.

The map evidence, although ambiguous, is also relevant to dating the kiln. It does not appear on the 1836 Measure and Valuation maps although it should be noted that for the purposes of this map the inclusion of a kiln may not have been required. Neither is it shown on the Ordnance Survey map of the 1880's or any subsequent ones. If it had been operating at the time of the survey in the 1880's it would have been included in the survey. So while the absence of the kiln on the earlier map does not conclusively mean it was not in use at that time its absence from the later one means that it had definitely been abandoned. It is possible that it was constructed after the survey for the 1836 map and had fallen out of use and did not warrant inclusion on the survey undertaken in the 1880's. However if the theory of it being built in the decade after the arrival of the canal at Marple is correct then its absence from the 1836 map might suggest it had fallen out of use by that time.

The 1836 map shows a field wall running east to west immediately to the south of the kiln site. Sometime before the Ordnance Survey map this wall has been removed in such a thorough manner that no trace of it showed up on the magnetometry survey. If the kiln was operating before 1836 then it was probably doing so in very close proximity to this dry stone wall. This is possible and stone from the wall during its demolition could have been used to help completely infill the kiln explaining why there was no tell tale depression in the modern landscape. However it is hard to conceive what the advantages would have been building the kiln so close to the wall while its presence must surely have hindered access to the kiln and the distribution of quicklime to the surrounding fields. It is possible that stone from the dismantling of the wall was used to supplement excavated rock in the construction of the kiln. The presence of what appears to be a stone gate post as part of the flue seems to support this idea. This would mean that the kiln operated sometime between 1836 and the 1880's.



Figure 27. 1836 Measures and Values (Tithe) map.



Figure 28. 1836 Measures and Values (Tithe) map turned through 90 degrees to orientate it with the Ordnance Survey map. The wall dividing Middle Field Head and Great Field has been highlighted in blue.

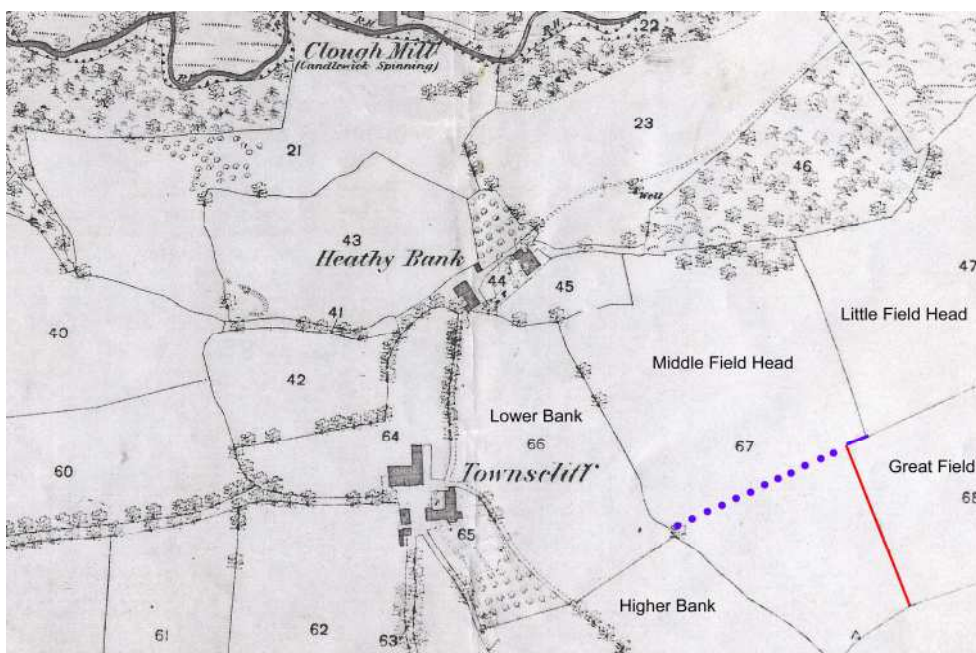


Figure 29. 1886 Ordnance Survey map. The old wall dividing Middle Field Head and Great Field has disappeared (its line marked with blue dots) and a new dividing wall built marked in red.