

Lime Burning and the Uses of Lime in the Historic County of Westmorland and Along the Pennine Edge of Cumberland

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Lime kilns are a common feature in the Cumbrian landscape but not one that has received detailed examination. Lime was an indispensable commodity in Cumbria for many centuries until the 1960s, in agriculture, building work and local craft industries. This article presents the results of a detailed field survey across the entire historic county of Westmorland and along the Pennine fringe of Cumberland, and of comprehensive archival research into the production and uses of lime. It makes comparisons – and contrasts – with the results of a similar survey in the Central Pennines. The article begins by placing lime burning within a historical context, then briefly outlines the historic use of lime across the rest of what is now Cumbria, and considers the constraints which held back large-scale lime production in the county, before going on to discuss a range of variables that help to explain the distribution and details of lime kilns in the survey area.

Introduction

UNTIL relatively recently lime kilns, and the uses of lime, were a neglected aspect of our heritage and most published work undertaken elsewhere in the country tended to focus on compiling gazetteers of lime kiln sites with less emphasis on historical, archaeological or architectural detail.¹ English Heritage's Monuments Protection Programme was conceived to undertake a detailed assessment of surviving industrial sites across England, with the limestone industry having been bracketed with cement and plaster.² Within Cumbria only six lime kiln sites were assessed in the field, out of a national total of 171 which, while being a reflection of the inevitable logistical constraints inherent in the Programme, illustrates the limitations of the process given that there are many thousands of sites in the country.³

A full field survey of lime kiln sites across (and beyond) the Yorkshire Dales National Park (YDNP) was achieved by this writer between 1996 and 2009, building on the earlier work of other surveyors in specific areas of the Park.⁴ All this writer's results were submitted to the YDNP Authority or North Yorkshire County Historic Environment Records (HER), and to the Cumbria County HER for sites in south-east Westmorland.

In addition to carrying out ground surveys across the YDNP and contiguous areas, this writer has also undertaken comprehensive archival research into lime burning and the multi-varied historical uses of lime as well as industrial-scale limestone quarrying in those areas;⁵ and into the key role that lime played in agricultural improvement.⁶ No similar studies, at the same level of detail and spatial extent, have been located for any other part of the country.

This paper builds on the writer's work across the Central Pennines by extending areal coverage to the historic county of Westmorland: lime kiln sites across the entire county

have been surveyed in the field, with follow-up archival research. As that part of East Cumberland fringing the Pennine chain contained a wealth of major lime burning sites, the bounds of the survey were extended to include the six parishes between the border with Westmorland and Cumrew Fell, namely Ainstable, Culgaith, Cumrew, Glassonby, Kirkoswald and Ousby.

The results of this survey should be seen in the context of the larger Central Pennines survey and of site-specific industrial-scale lime producing studies in the North such as Mealbank Quarry and Limeworks at Ingleton, the Craven Limeworks near Settle, Toft Gate lime kiln above Nidderdale, and Marsden lime kilns near South Shields.⁷

Lime burning in its historical context

Lime has been produced in Britain since at least Roman times, though there appear to be some hints of its use prior to that.⁸ Incontrovertible evidence, derived from excavation by the writer of a sow, or clamp, kiln in the Forest of Bowland confirms lime burning there from the thirteenth century and, given that the site in question was in a very remote agricultural situation, the lime was probably destined for use on the land.⁹ There are references to lime kilns as boundary markers in monastic records in Upper Wharfedale and Lunesdale, and within the Central Pennines manor court records for Lothersdale date the use of agricultural lime to before 1600.¹⁰ Speed's hand-annotated map of Yorkshire, published in 1610, described the quarrying of limestone to the east of the Pennines and transportation of the burnt lime (*calce viva*) to other colder and mountainous parts which must refer to the Dales.¹¹ Increasingly widespread use of agricultural lime can be demonstrated for the Yorkshire Dales from the seventeenth century, though it goes without saying that every stone-built structure – church, monastery, bridge, manorial hall – would have needed lime even in Anglo-Saxon times and it was common practice to construct a simple kiln at the place where lime mortar was needed. Kilns prior to the very late seventeenth century were not the masonry-fronted kilns surviving in the landscape today but sub-surface bowls dug into a natural bank: they now either lie buried and invisible or appear as the penannular grass-covered hollow of a sow kiln. Agricultural lime was in use, at least in the north of England, until the late 1960s and lime mortar was only gradually replaced by cement during the twentieth century: until then lime had been an indispensable product, as will be discussed later.

As far as can be discerned from the documentary record, the widespread use of agricultural lime in Westmorland and Cumberland had a later genesis than in the former West Riding, though the corollary concerning early use of lime mortar still applies. Shap and Furness Abbey precincts will probably have sow kilns hidden somewhere as will the various castles and halls with medieval origins. Pendragon Castle in Mallerstang has a well-preserved earthwork that has not been excavated but looks suspiciously like a sow kiln; given its fine state of preservation, it is more likely to date from Lady Anne's renovation of the castle in 1661-62 rather than from its initial medieval construction in stone. Whether or not the dearth of early archival sources for liming truly reflects a relatively late take-up of the practice remains to be proven, though the smaller number of landed estates in Westmorland compared to the North

and West Ridings does provide one reason for late adoption. It was frequently the steward, charged with looking after the estate on behalf of the often-absentee landlord, who was instrumental in writing husbandry and liming clauses into farm leases.¹² Furthermore, the proportion of land under monastic control in Westmorland was also far less than in Yorkshire: much early improvement of existing farmland, and organised incursions onto the so-called waste, were undertaken by monastic foundations. Again, Westmorland, along with the northernmost parts of the West Riding, was typified by independent but small-scale yeoman farmers – the statesmen – who, it could be argued, lacked the financial wherewithal to invest in improvements such as liming. They had other priorities.

A major constraint holding back lime burning in Westmorland was access to affordable fuel supplies. Early kilns normally relied on fuelwood but this presupposes that sufficient quantities of suitable smallwood were available close at hand to minimise transport costs. Where timber supplies were at a premium peat and even gorse were used as kiln fuel. Both had their innate disadvantages: peat burns with a slow, smoky and low heat meaning that each firing event was a drawn-out process, whereas gorse burns with a high intensity flame which could lead to too quick a firing having a negative effect on the quality of the lime produced.

Sometimes dual fuels were used, presumably to balance temperature and burning time. The Levens Hall estate steward wrote to his master in 1694 to the effect that he was ‘now leading peats for another lime kilne’ and that he also intended to ‘get coals for it’.¹³ In 1805 a farmer from east Cumberland, called Dodgson, wrote to the Board of Agriculture with a detailed description of how to successfully burn lime using peat. Peat was available nearby, at a much lower cost than coal, and he extolled the virtues of peat over coal, claiming it to be more fuel-efficient producing better quality lime.¹⁴ It is hard to accept his assertion, given their relative thermal efficiencies, but that is how he felt.

Some coal was mined, dominantly along the Pennine fringe, for example on Barbon and Casterton Fells, on the eastern slopes of Mallerstang and on the hills east of Hartley in Westmorland; and, notably, on Haresceugh, Renwick, Scarrowmanwick and Croglin Fells in Cumberland.¹⁵ However, much of the coal was of low quality and fit only for use in lime kilns.¹⁶ A letter written by Edenhall estate steward, Christopher Dobson, to Sir Philip Musgrave at his main seat at Kempton Park in 1776, reported that he had ‘a poor fellow trying to get Coals on Hartley Fell’ but that he had ‘little hopes of his making anything out however if he can only procure Limekiln Coals’ it would prove of value for the estate’s own kilns and soil improvement programme.¹⁷ This ‘poor fellow’ may have been working the myriad of shallow shafts and adits that are strung along the foot of Low Greenside at what was called Greyrigg Pits, centred on NY815 075, where the sheer number of infilled pits and the presence of a much overgrown cart or sled track leading up to them emphasise the scale of operations there.

Coal was carted in from considerable distances, at great expense, from Stainmore and Burton in Lonsdale, localities where high-quality coal was mined on a commercial

scale.¹⁸ It was the excessive cost of carting coal, for example for over 25km from Stainmore to Orton or from Burton to the eastern parishes of Westmorland, and even further from the Lancashire collieries to Kendal, that militated against the widespread take-up of lime burning. Essentially, it was the coming of the Lancaster Canal in 1819 that brought cheap and plentiful supplies of coal into Westmorland acting as a catalyst for vastly increased lime production, for both building and agriculture.¹⁹

Lime burning elsewhere in Cumbria

This article focuses on specific parts of modern Cumbria but lime burning was widespread across the county, with both agricultural and constructional end-uses. One of the earliest detailed accounts of its production and usage dates from the closing decades of the seventeenth century, commissioned by the 1st Viscount Lonsdale.²⁰ Thomas Denton, the lawyer charged with its compilation, noted that limestone was found in many parts of Cumberland to ‘exceedingly’ help enrich farmland thereby enabling those farmers who spread lime to ‘fill their barns with abundance of corne’, specifically naming Papcastle and Broughton, near Cockermouth, and Warnell, near Sebergham south of Carlisle, as townships where limestone was widely quarried and burned.

Andrew Huddleston, of Hutton John (NY439 269), was keen to gain an insight into building and operating a lime kiln successfully and a letter written to him in 1845 described in great detail what were described as ‘a few hints as to (a kiln’s) management’.²¹ A short distance south of Hutton John was the small estate of Mellfell and at the start of the nineteenth century the diary of the occupant, Tom Rumney, has frequent entries concerning farm operations and improvements carried out with the occasional mention of lime being applied to specific fields, the lime having been sourced from Risdale.²²

In an essay on farming in West Cumberland William Dickinson described agricultural liming in the mid-nineteenth century but referred to it as an ‘ancient practice’.²³ However he defined ‘ancient’, liming was presumably something that had been entrenched in local memory from previous generations. It was certainly not ‘new’ in Furness if contemporary accounts from the Napoleonic era are to be taken at face value.²⁴ One landowner in particular, the Ironmaster John Wilkinson who lived at Castlehead near Grange (at SD421 797), was lauded in his own time and in ours as an Improver of note, investing much of the profit from his industrial ventures in winning farmland from coastal marshes and in inspiring his brother, at Flookburgh, to do the same.²⁵ Sir John Sinclair, one of the most prominent and important disciples of Improvement in Britain, praised Wilkinson’s efforts and successes – which involved lime as an integral element – claiming he had ‘hardly ... a parallel’ in the nation and should be ‘ranked among the best friends’ of agricultural interests.²⁶

Perhaps, though, he should share his pedestal with Robert Graham who inherited the Netherby Estate, on the River Esk north of Longtown in 1757, taking in and improving *c.* 400 ha of farmland and increasing his annual rental income from £2000

in 1757 to £13,000 by 1782.²⁷ As with Wilkinson, liming was an essential part of his strategy.

Vernacular uses of lime

One could readily compile a long list of uses that lime had up to *c.* 1960, many of them in industrial contexts, but it still had a plethora of purposes in rural situations from at least medieval times. The use of lime as mortar has already been mentioned and there is ample evidence from across Westmorland, from estate and farm accounts, of purchases of lime – along with building stone and hair – for use in repairs or new build. Horse hair was often mixed with lime to bind the mortar together as a stronger mix. Building accounts at New Hall in Nether Staveley (SD463 972) for 1762 provide useful detail of constructional methods, in this case on a barn or cowhouse.²⁸ Payment of 10s. was made for leading (carting) 20 bushels of lime, a further 12s. for purchase of the lime at the kiln, and 6d. for ‘leading five stone of haire’. This consignment was used over two days for ‘liming the inside of the barn’, meaning that the interior walls were given a coating of plaster rather than of lime- or whitewash.

In the 1780s the locally-based bailiff for the Dalemain Estate itemised payments made to various workmen on its Mallerstang properties, including purchases of lime, leading lime, walling and hair.²⁹ This lime seems to have been sourced from a kiln owned by the estate as other items in the accounts include payments to stone breakers, cutting and leading peat and limestone to the kiln, and burning lime. As was common practice, Robert Shaw was paid 6d. a pint for ale consumed at the kiln: lime burning could be a hot and unpleasant job.

A century earlier a new barn had been built at Sir John Lowther’s Sockbridge Hall (NY503 270) and, out of a total expenditure of £212, £57 was allocated for lime, sand and water in addition to 9s. 6d. paid to the local tanner for ‘19 Stone of Hare’.³⁰ The huge scale of this project is made manifest by the consumption of 859 cart loads of lime in 1699 and 1700; as are the logistical realities of carrying out maintenance on his far-flung properties when repairs to Hartsop Hall in Patterdale, in 1702, required 20 loads of lime to be brought in. There are no limestone outcrops in that valley but there were lime kilns on the lake shore at Blowick and Glenridding burning limestone brought by boat down Ullswater. This trade is under-recorded but one – tragic – entry in the Rydal Hall Estate accounts, dated 14 September 1697, recounts the sinking of a vessel called the ‘Great Boat’ and the drowning of its four-man crew during stormy weather on Windermere.³¹ The boat, ‘loaded with Limestones’ was, sadly, overloaded.

Problems of a very different nature were described in enormous detail in a series of letters from Hugh James, steward on the Levens Hall estate to James Grahme at Bagshot Park, between 1692 and 1695.³² The south wing of the hall was being built and James had contracted a number of limeburners to provide the required quantities of lime from the estate’s own kiln in Kitching Flatt (SD5012 8487). They were clearly less than co-operative and, week after week, he moaned about their failure to fulfil their obligations and the way they disported themselves: ‘truly the Limes men deales very basely with me’, he wrote on 5 June 1693, expressing his utter frustration in a

letter dated 1 October that year with the cri de coeur ‘they are the Greatest villanes upon Earth’!

Various rural trades relied on a regular supply of lime: tanning and tawing of leather, craft-scale soap and paper making, and bleaching and dyeing yarn, being just a few. As far as farmers were concerned lime had a multitude of uses, and not just for sweetening acidic pastures, especially on newly taken-in moorland, or for replenishing the calcium content of soil on arable ground.³³ Several stock diseases were treated (with direct lime mixtures or by top dressing pastures), such as red water,³⁴ lactation tetany and the degenerative bone disease *Cochexia ossifraga*. There was also a practice common to Westmorland and contiguous areas of Yorkshire, known as ‘need fire’, whereby cattle were driven through the smoke of a specially-lit fire slowly enough for them to breathe in the fumes.³⁵ Whether it was employed to treat cattle murrain – which may have been foot and mouth – or in a superstitious attempt to keep ‘evil infections’ at bay is immaterial: those who used it believed in it.

Field survey methodology

The starting point for the field survey was a complete examination of all Ordnance Survey (OS) First Edition six inch maps as they depict the majority of kilns, either as ‘Limekiln’ or ‘Old Limekiln’, the latter indicating that those kilns were still recognisable as such but had clearly gone out of use. Alongside this resource, records from the Lake District National Park Authority (LDNPA) and Cumbria County HERs were obtained to identify which sites are still extant and known. All enclosure awards and maps for Westmorland and the six East Cumberland townships were examined together with farm and estate maps and selected tithe apportionment maps. Though the vast majority of sites surveyed were sourced from OS mapping and the HERs, some were either found by accident while visiting other sites in the field or were pointed out by farmers and landowners.

TABLE 1. Number of kiln sites by parish

Area	No. of parishes with kiln sites	No. of kiln sites
Westmorland Barony	43	461
Kendal Barony	33	192
Cumberland Pennine Edge	6	58
TOTAL	82	711

Within Westmorland 76 parishes had lime kilns,³⁶ with a total of 653 discrete kiln sites having been located on the ground, 461 in Westmorland Barony and 192 in Kendal Barony (Table 1 and Fig. 1). The six parishes along the Pennine edge of Cumberland have 58 kiln sites in total. Field surveying was implemented on a parish-by-parish basis, between 2005 and 2012, utilising the template of this writer’s similar survey across the Central Pennines which, in turn, was based on methodology drawn up by Robert White of the YDNP Authority. All survey results were submitted to the respective LDNPA and County HERs. Apart from offering ease of use, this approach

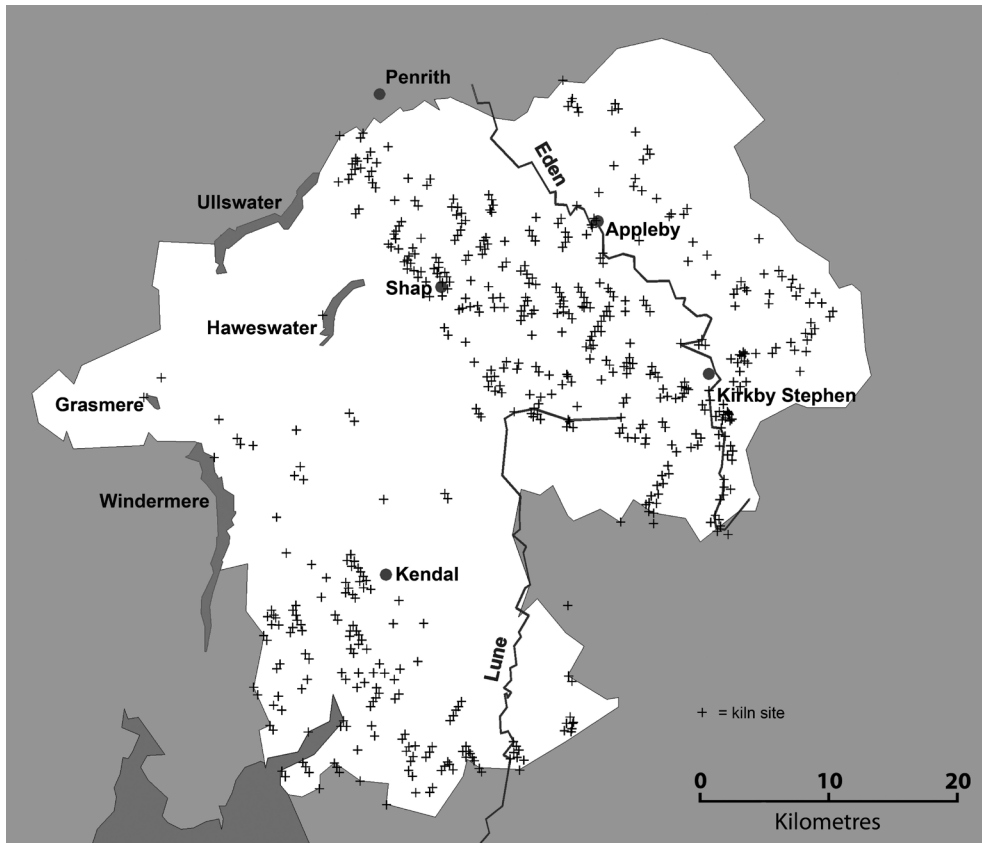


FIG.1. Lime kiln distribution: Westmorland (each cross represents a kiln site).

also enables direct comparisons to be made between the results of the two surveys, as will be shown below.

At each site locational details were noted (grid reference, altitude, aspect, land use) as well as bedrock geology. The source of stone for the kilns was also recorded, whether from an adjacent or nearby quarry or – in a significant number of sites – from elsewhere. Detailed measurements were taken, a photographic record was compiled, and any particular structural or architectural features were noted, including the aesthetic embellishments found on a number of kilns. The present condition of each site was recorded, using five categories: complete, semi-ruinous, ruined, site only or no trace. ‘Complete’ indicates that a kiln is in a sound condition with all or almost all of its structural integrity intact (Fig. 2); ‘semi-ruinous’ that a kiln displays structural failure or even partial collapse but with form and design still essentially clear (Fig. 3); a ‘ruined’ kiln has totally collapsed – or been robbed of stone for use elsewhere – so that it is no longer possible accurately to describe what it had looked like (Fig. 4); if all building stone has been robbed and only the tell-tale hollow or cutting, or charging ramp, mark a kiln’s location it was described as ‘site only’ (Fig. 5); and if absolutely no trace remains on the ground to show there had been a kiln, it was recorded as ‘no trace’.



FIG. 2. 'complete' kiln, with Romanesque arch at Great Asby.



FIG. 3. semi-ruinous kiln, with segmental arch, at Well Head, North Stainmore.



FIG. 4. ruined kiln at Swindale Brow, Murton.



FIG. 5. The site of a kiln at Helsington Barrows, surviving as a tell-tale mound with rubble.

Results

The key attributes of surveyed sites are discussed in this section, namely geology, altitude, orientation, kiln size and methods of operation, kiln design features, present condition, land use, and dating evidence.

Geology

The production of lime clearly requires limestone and once the raw stone has been through the firing – or calcining – process carbon dioxide and moisture are driven off leaving the resultant product, the quicklime, looking much as it did prior to calcining but *c.* 50 per cent lighter in weight. Thus, logic might dictate that a lime kiln would be sited as close as possible to where the stone was sourced. Indeed, it has been said that the siting of a kiln ‘relates very closely indeed’ to outcrops of limestone.³⁷ However, it is not as clear cut as that. The Central Pennines survey found that 21 per cent of all kilns were not found in association with such outcrops, as other locational factors had come into play.³⁸ In some cases kilns were sited at the source of fuel, usually coal, or at the point of end use whether that was at a building complex or within or adjacent to a tract of moorland being newly enclosed and improved. These same factors came into play in Cumbria, too, but the relative number of kilns not closely linked to the stone is smaller than in the Pennines, being *c.* 12 per cent (Table 2).

TABLE 2. Relationship between the number of kiln sites and geology

Geology	No. of kiln sites	Per cent of total sites
limestone	615	88
sandstone	36	5
Silurian and volcanics	38	6
glacial deposits	7	1
TOTAL	696	100

Where limestone is the dominant surface geology, as across much of the central plateau of Westmorland, or in one particular altitudinal zone along the Pennine fringe, there is a very close correlation between stone sourcing and kiln location, though even in the six Cumberland parishes three kilns had been sited nowhere near limestone bedrock. Close comparison of Figure 1, which shows kiln distribution, and the geology map (Fig. 6) illustrates that the areas with a negative correlation tend to be within the main Lakeland upland massif and in the South Lakes or in those townships where access to coal supplies was deemed more important, as in Mallerstang and Stainmore and to a lesser extent in Ravenstonedale and at three kiln sites on the lower slopes of Cross Fell in Culgaith and Ousby parishes. In a number of instances those who had commissioned a new kiln had gone to extraordinary lengths to find small limestone outcrops within areas of different geology, and the logistics of leading the burnt lime to where it was required, across rough moorland, must have been daunting.

Within the Pennine survey sample (of 1446 kilns) 43 per cent of all sites were not associated with a quarry, even if limestone was locally found – crags, scree slopes, stream beds, pits dug into moraine deposits, and hushes were all exploited for stone.³⁹

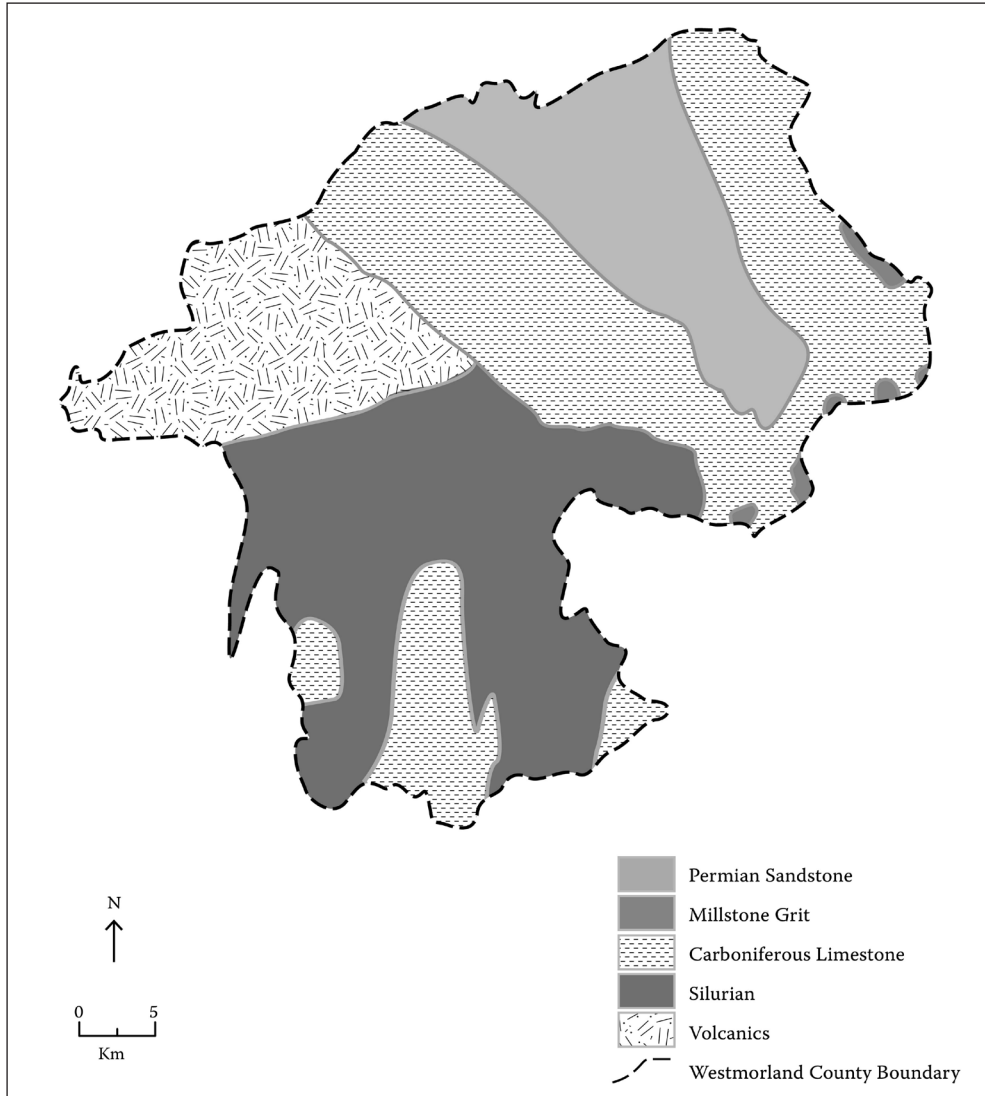


FIG. 6. Geological map.

In the current survey 18 per cent of kilns were sited within large commercially-operated quarries, mainly along the Pennine edge, but 26 per cent (183 kilns) were not in any way associated with a nearby quarry. It is possible that some quarry holes have been infilled and levelled since abandonment but still the overall proportion is larger than one might have anticipated: this statistic quite categorically belies the oft-quoted direct and inevitable spatial link between kiln and source of stone.

Altitude

Given the topographical and geological nature of the area encompassed by this survey, there is clearly an enormous altitudinal range, from sea level on the shores of

Morecambe Bay to the upland massifs. It must follow that the innate quality of soil and vegetation will show marked variations with increased altitude, reflecting rock type, angle of slope and climatic nuances. Further, in very general terms, from the medieval period those areas offering the best opportunities for settlement and farming would have been settled first with marginal upland tracts being left until later.⁴⁰ In the case of Westmorland and to a lesser degree Cumberland this came much later. In 1800 no less than 79 per cent and 50 per cent respectively of the land area of each county was classed as unproductive ‘waste’ compared to a national average of 21 per cent; by 1873 a third of all land in Westmorland was still regarded as unenclosed and unproductive.⁴¹

With these facts in mind, it should perhaps follow that there will be a direct link between the distribution of lime kilns and altitude if one accepts that enclosure and improvement came later than elsewhere, as those areas subjected to late enclosure tend to be on higher ground, and that liming and therefore lime kilns were associated with this late improvement. In other words, following this train of thought, there should be a positive correlation between the number of kilns and altitude. Figure 7 shows the reality within the survey area.

The greatest proportion of kilns (47 per cent) occurs between 190m and 310m, comparatively few are found above 340m (10 per cent), but 94 sites – nearly 15 per cent – occur below 100m. Out of a randomly-selected sample of 19 enclosure awards post-dating 1840, ten range between 190m and 310m, five are below 190m and four above 340m. Statistically there is an albeit rather weak positive correlation, except that few of the kilns in the lowest altitudinal band were associated with a formal enclosure award. There are acute contrasts between the situation in this survey and that in the Central Pennines: in the former 26 per cent of sites are found above 309m (more or less Natural England’s dividing line between uplands and lowlands) compared to 42 per cent in the latter, while less than 3 per cent of the former’s sites exceed 460m, compared to 7 per cent in the Pennines.

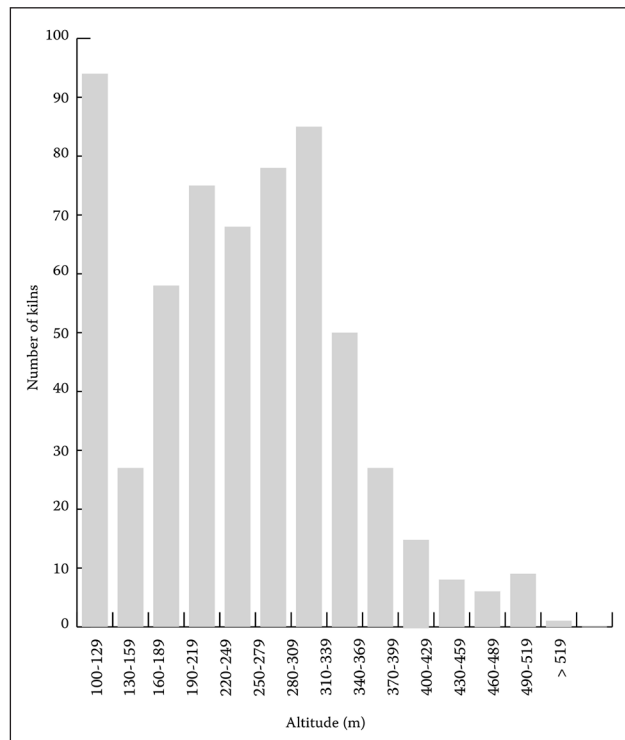


FIG. 7. Altitude.

These discrepancies could be due to geological differences, the Pennines having much more limestone than the Lake District with its volcanic and Silurian dominance, or to the possibility that by the time the later enclosures were implemented the application of lime had been replaced by artificial alternatives. It may also be that the driving forces behind the later enclosures did not have improvement in mind.

Orientation

It was important to commercial limeburners that their end product was of sufficient quality to attract regular customers, and to farm- and estate-based limeburners that tenants would be happy with what they were supplied with. To ensure high quality they had to contend with a number of variables such as the carbon content of the limestone and the quality of coal added to the mix. Seasonal variations in temperature and moisture helped determine how readily the fuel would burn and the limestone calcine – if both were cold and wet, the process was slowed down. Wind strength, too, was a crucial factor. Over-exposure to a strong wind brought about a quick burn often resulting in over-burned and clinkered lime; a complete lack of wind starved the fire of oxygen preventing it from drawing and causing the lime to lump together with a high proportion of ‘dead-burned’ (under-fired) lime. The limeburner faced with either of these situations would indeed have been dismayed.

What he therefore had to do was to control the flow of air into the kiln, making sure there was sufficient to allow it to draw but not too rapidly. Kiln tops were very rarely



FIG. 8. A kiln with twin eyes, each with surviving framework for cast-iron doors, at Thrimby Out Scar.

capped so airflow could not be controlled from the top, and only the larger and later kilns had cast-iron doors on the drawing eyes at the base of the bowl to control inflow from there (Fig. 8). It was essentially a matter of the limeburner using his empirical knowledge to maintain optimum conditions.

However, the way a kiln had been laid out on the ground could make his job easier or well-nigh impossible. The orientation of a kiln determined which way the draw arch and eyes faced, so account had to be taken of prevailing wind direction when siting a kiln. In this part of the country dominant winds averaged out through the year come from between north-west and south. Winds from the north east tend to be less frequent. Thus, ideally, kilns should have been built facing between north west and south. Not surprisingly, as Fig. 9 shows, it is beyond question that this ideal was well known as 65 per cent of all kilns for which it was possible to determine orientation faced between 180 and 315 degrees with almost one in five facing south west. Only one of the 58 sites along the Pennine edge in Cumberland faced between north west and ESE which is hardly surprising considering that the edge faces west: topography was on their side. Where a kiln faces between north and east one can only assume that its builders had no real choice and they were using whatever topography offered. It is perhaps of interest to note that in the Central Pennines the overall conclusions are very similar.⁴²

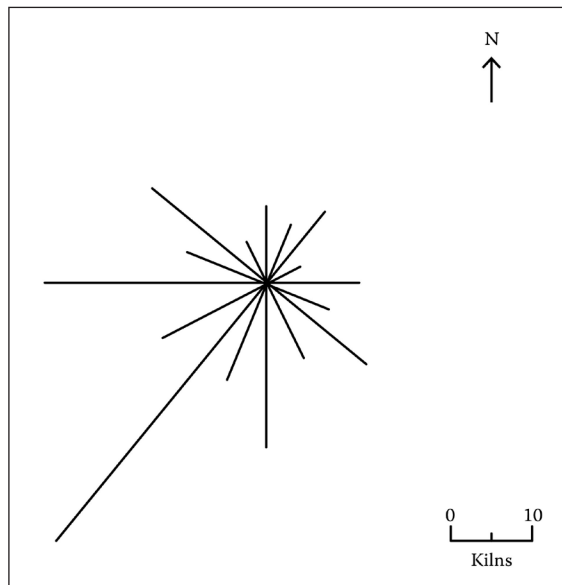


FIG. 9. Orientation.

Kiln size and operation

Inevitably there is a significant difference in the overall size of kilns, partly reflecting their purpose and ownership. A kiln producing lime for use on a single farm or for taking in a new enclosure from the waste did not need to have a large bowl volume, and individual farmers would have baulked at the expense of constructing something larger than was needed. On the other hand, an estate kiln supplying all its tenants with agricultural – or building – lime or a commercial ‘selling’ kiln turning out lime more or less throughout the year would necessarily have been much larger in every dimension.

Small ‘field’ kilns tended to be worked only when lime was required. This may have been for the initial improvement of taken-in moorland and such kilns may have had a very short life; on existing farmland lime was applied either as top dressing of pastures or for treating land lying fallow but only at intervals of anything from ten to 20 years. In both scenarios a kiln would have been fired up and kept running on a continuous basis but only for as many weeks as were needed to complete this initial or cyclic

process. For most of the time these kilns lay idle and in their total life span they were only worked on an intermittent basis.

An estate or selling kiln, however, was kept running day and night, month on month. If a commercial or estate limeburner was operating with only one single-bowl kiln, he may have worked it on a batch basis filling the bowl to the rim, firing it all as one event and drawing all the lime in one go meaning such kilns were worked on a short-cycle intermittent basis; or on a continuous basis filling fresh stone and fuel at the top and drawing burnt lime at the base. One aspect of estate and selling kilns in this survey area, which distinguishes it from the Central Pennines, is the large number of kilns with multiple drawing eyes (60 extant kilns have twin eyes and three have triple eyes); or twin bowls (16 kilns); and/or large oval bowls with multiple eyes (75 kilns). This is especially evident along the Pennine edge in both counties under review where there were massive kilns in extensive quarries (Table 3).

TABLE 3. Former major commercial quarries along the Pennine edge.

Parish/township	Location	Quarry name	No. of kilns
Ainstable/Croglin	Croglin Fell	Croglin Quarry	5
Kirkoswald	Scarrowmanwick Fell	Clint Quarries	9
Kirkoswald	Whity Knots		4
Kirkoswald	Green Rigg		4
Kirkoswald/Renwick	Haresceugh Fell	Cocklake Quarries	3
Glassonby	Hartside	Green Fell Quarries	7
Glassonby/Gamblesby	Gamblesby Fell	Sailrigg Quarry	5
Glassonby/Melmerby	Melmerby Low Scar	Long Bottom Quarry	2
Milburn	Windy Hall	Thrushgill Quarries	8
Long Marton/Knock	The Fell	Knock Quarries	7
Stainmore/Stainmore South	Bleathgill Edge	Bleathgill Quarries	4
Hartley	Out Wood	Hartley Quarries	2

Within the survey area 17 kilns have survived with the bowl open to full depth: in the vast majority of extant kilns the bowl was infilled with rubble and levelled off as a livestock safety measure. It is possible to determine bowl volume if fully open using the mathematical formula:

$$V = 0.75[(d^2h \div 4)^{4/3}]$$

where V = volume, d = bowl diameter at the rim, and h = total bowl height (or depth).

Within the sample, volumes range from 6m³ to 34m³ with average volume being 15m³ but, if one exceptionally large kiln is excluded, 12m³. Ten of the sample have a volume larger than the mean, of which seven were selling kilns, one was set aside for public use and two were estate kilns. Of the smallest volumes two were definitely field kilns.

Kiln design

There was no ‘best’ way of designing a kiln’s front face and two basic styles cover all extant kilns in Cumbria and the Central Pennines: they are either squared or rounded. Within the Pennine area numbers of each type are equally balanced; in the current survey the squared form is dominant having 82 per cent of all sites (Table 4). One

TABLE 4. Structural form.

Form	No. of kilns
rounded	40
squared	187
TOTAL	227
with lintel	48
corbelled	12
Romanesque arch	58
segmental arch	87
TOTAL	205

familiar element of the east Cumbrian fieldscape is the square lime kiln, and it is considered valid to speak of a regional style here. There is more variation in the style of draw arches (see Table 4). In this survey 70 per cent of all extant kilns have an arch with flattened segmental arches outnumbering rounded Romanesque arches. Within the Central Pennines it is relatively uncommon to find kilns with a slab lintel rather than a voussoir arch (16 per cent of the total) whereas in this survey area this form accounts for 23 per cent. In both areas kilns with a corbelled structure are rare, and it is likely many such kilns are older than the arched form.

As mentioned in the previous section, there are considerable variations in kiln size reflected in the number and plan form of the firing bowl and draw eyes (Table 5). There is a marked contrast in bowl number between Westmorland and the Cumberland Pennine edge: in the former less than 2 per cent had twin bowls but the latter had 12 per cent which points up the later and more commercially-orientated nature of lime burning in those townships. This commercial focus is also emphasised by the fact that the proportion of kilns with an oval bowl (supporting twin or triple eyes) is significant in both Westmorland and Cumberland.

TABLE 5. Design features

Feature	No. of kilns, Westmorland	No. of kilns, Cumberland
round bowl	61	9
oval bowl	58	17
TOTAL	119	26
single bowl	468	46
twin bowls	9	7
TOTAL	477	53
twin draw arches	8	5
opposing draw arches	1	0
TOTAL	9	5
two eyes per draw arch	49	11
three eyes per draw arch	1	2
TOTAL	50	13

It is further emphasised by the number of kilns, across the entire survey area, with firebrick- rather than sandstone-lined bowls. Firebrick normally had to be brought in from specialist brickworks elsewhere so was much more expensive than locally-sourced heat-resistant sandstone. Hence, it was not used in field or small selling kilns, or in early kilns, as the technology was only perfected *c.* 1820. Within the much larger Central Pennines sample only eight extant kilns have visible firebrick: in the Cumbrian sample there are 36 and, of these, the majority have legible manufacturer's marks.⁴⁴

Present condition

As stated earlier, Westmorland has well over 600 kiln sites and the Cumberland Pennine edge 58. Of the combined total, 158 (23 per cent) survive more or less intact and structurally stable, with a further 39 classified as semi-ruinous showing some collapse but a still recognisable form (Table 6). These totals compare favourably with the Central Pennines which have only 16 per cent standing complete. A further 15 per cent have been classified in this survey as ruined (*cf* 16 per cent in the Central Pennines). Of the balance 35 per cent are classified as 'site only' (*cf* 36 per cent), while 22 per cent have left no trace whatsoever on the ground (*cf* 24 per cent). All three latter sets of data are remarkably similar.

TABLE 6. Current condition of lime kilns

Status	Per cent of total, Westmorland	Per cent of total, Cumberland
complete	20.5	2
semi-ruinous	4	1
ruinous	13	2
site only	32	2.4
no trace	22	0.4
earthwork	0.5	0.2

Many kilns have simply collapsed as age has taken its toll, but easily accessible disused kilns were a ready source of building stone to be recycled elsewhere. The majority of farmers and landowners spoken to during the survey expressed interest in their extant kilns and some would like to see unstable ones consolidated but, given the current economic climate, it seems inevitable that others will slowly succumb to old age.

Land use

There are understandable contrasts in the category of land that kilns are located on between the two county areas: along the Cumberland Pennine edge 64 per cent of all sites are found within a large (long-disused) commercial quarry while the balance are on open moorland or fell sides, in both situations exploiting a limestone band at high altitude. Across Westmorland 26 per cent are on open moorland or commons, and only 13 per cent within a large quarry, while the greatest proportion (47 per cent) are within or on the edge of enclosed improved grassland or arable land. Many of these sites are on land taken in and improved during the era of parliamentary enclosure but there are significant numbers on what enclosure maps mark as 'ancient enclosures'.

This is particularly apparent in the South Lakes and close to township centres in certain parishes in the Barony of Westmorland such as the Meaburns and Appleby. By way of comparison, in the Central Pennines 72 per cent of all sites are within enclosed improved grassland and a mere 7 per cent on moorland or commons.

The fact that a kiln is located on moorland does not equate with use of lime on nearby ground. It is obvious, for example, that the enormous scale of lime burning along the Pennine edge in Cumberland emphasises that lime was being produced in large quantities for despatch to lower ground, either in the Eden valley or on newly taken-in enclosures on the western slopes.

Dating evidence

Whereas farm leases confirm that agricultural liming was practised, they do not give any indication as to when such provisions became commonplace, but various contemporary sources do provide hints that can tie down the period of use of certain kilns or, perhaps, wider lime burning localities. Trade directories list significant occupations in each township, including limeburners, though they tend to be conspicuous by their absence as lime burning was not necessarily a full-time occupation. Rarely, there are indications concerning the use of lime: for example, a directory published in 1829 noted that lime was 'first used ... as manure about forty years ago' putting its use back to the 1780s; while one from 1849 claimed that lime was 'now pretty generally burned' for use in farming.⁴⁵ If these comments can be taken at face value, they confirm the assertion made earlier that liming in Westmorland had a later genesis than in the Yorkshire Ridings.

Enclosure awards are a useful source of dating detail. Out of the 93 Westmorland awards examined by this writer, 13 set aside public limestone quarries without specifying what the stone was to be used for, and 41 areas covered by these awards have lime kiln sites on the ground. Of course, it is impossible to know how many of these kilns resulted from formal enclosure. For a further five awards it is possible to draw meaningful conclusions as they spelled out that limestone could be worked and burned in public quarries either for repairs, building or for agricultural improvement.⁴⁶ In four of these cases it has been possible to relate actual kilns to these awards.

Estate papers and maps, and early OS mapping, occasionally marked kilns by name, either naming them after the quarry they were part of, such as Cocklock Limekiln and Green Fell Limekiln in Kirkoswald parish or Croglin Limekiln in Ainstable; or after their location, such as Waitby Limekiln or Knock Lime Kiln or as 'belonging to Smardale Hall'. What can be drawn from these depictions is that those kilns were still in use at the time the maps were surveyed, or papers drawn up, but they do not indicate how old the kilns were.

Farm sale or letting notices can be equally vague in providing firm dates. Aikbank Farm (SD549 810) in Farleton was advertised for sale in 1824 with two lots coming with rights to get limestone and to build a kiln in addition to a half-interest in a kiln on the north side of Farleton Knott.⁴⁷ On the fellside opposite Aikbank (SD549 810), alongside Puddlemire Lane, there are remains of five kilns with a further three on

the northern snout end of the Fell. Which kilns were within this sale is not known. Catholes Farm, near Pellsyeat west of Kirkby Lonsdale, was up for re-letting in 1835 with a 'LIMESTONE QUARRY and LIME-KILNS thereon'.⁴⁸ Close by there is a kiln and a small quarry but the use of the plural form would suggest that the kilns in question were at Tearnside just to the west where five kilns are known. Again, the wording on this notice just confirms that those kilns were fully operational at that time.

Kilns were certainly being worked at Tearnside before and after the 1835 transaction. James Harrison, a local yeoman farmer, took on three parcels of land there in 1809 specifically for the 'use and purpose of building a lime kiln or lime kilns thereon';⁴⁹ in 1842 his widow conveyed back to the estate the same land 'on part of which a lime kiln hath been erected'. This dates at least one of the Tearnside kilns to that 33-year period. Interestingly, an Irishman known as Paddy O'Reilly was said to have been a limeburner there in the run up to the Great War which puts lime burning at Tearnside very late indeed.⁵⁰

Crag House Farm (SD557 765) in Burton-in-Kendal was up for re-letting in 1843 along with 'an excellent and well-accustomed LIME KILN'.⁵¹ It is, perhaps, indicative of the value attached to liming that in these two latter instances the term 'lime kiln' was in upper case: to be able to offer a farm with its own supply of stone and its own functioning kiln was seen as positive spin by the selling agents. Much later than these notices, and at a time when farming across the country was mired in depression and tenancies were being given up by tenants who could not make ends meet, two properties in South Stainmore were put on the market.⁵² Barras, or maybe Barras Farm, on the now dismantled South Durham and Lancashire Union Railway, and Duckintree, were advertised as having a private kiln and access to the nearby 'Public Lime Works' alongside the railway, at NY8439 1167, with its massive twin kiln. This reference is of importance in confirming that lime was still being produced in that part of Westmorland, as well as in Tearnside, towards the end of the nineteenth century when the industry had gone into terminal decline in many other areas.

Contemporary records at the other end of the date spectrum confirm the production of lime and the construction of kilns within the eighteenth century. Two examples will suffice: the manor court book for Crosby Garrett bears an entry, from 1741, reaffirming that all customary tenants enjoyed the liberty of getting limestone on the common fell for building and for 'improving their ... lands'.⁵³ There are two kilns on the higher part of the common, one at Bents Hill and one above Hazzler Brow Scar, as well as three just south of the village, so which of them relate to this ruling cannot now be determined.

Two decades later Gilpin Gorst, of Appleby Castle, took on a 21-year lease from the earl of Thanet of all coal pits in Stainmore, Mallerstang and Knock.⁵⁴ The lease included the liberty to 'Gett Limestones and erect Limekiln or Limekilns for the burning of lime'. As discussed earlier, there was a close link between coal mining and lime burning in Westmorland so it is highly likely that Gorst did erect kilns but there are so many kiln sites in all three areas that their location cannot be known.

Conclusion

For many centuries, until it was phased out very abruptly in the 1960s, lime was an essential product across the country, for vernacular and high-status building, in a range of rural trades and in farming. Agricultural liming was practised widely and enjoyed a pre-eminent position – along with draining and paring and burning – in the improvement of acidic soil on existing farm land and in the winning of new land from the ‘waste’. Wherever limestone outcropped it was quarried and burned in lime kilns ranging in size and complexity from small-scale sow kilns through small masonry field kilns to large estate and commercial selling kilns. As in the Central Pennines, limestone or burnt lime was transported over considerable distances in Cumbria to where it was needed, and this article has demonstrated its use here from at least the seventeenth century. Lime was produced in most parts of Westmorland, apart from in the high fells of the Lake District, and on a major scale along the Pennine edge of Cumberland. This survey has provided the first comprehensive field survey of lime kilns and lime burning across the whole of Westmorland, and has drawn together a variety of archival sources to back up the field survey results. Unlike several other surveys elsewhere, this has not merely taken the form of a gazetteer but has sourced and collated data from farm and estate records, manor court books, early mapping, and contemporary accounts and records. Ideally this survey, and its precursor by the writer in the Central Pennines, will act as a catalyst for similar research programmes elsewhere: the rest of Cumberland and Furness are two obvious suggestions.

In our own time lime is only produced in Cumbria at Tata Steel’s battery of four kilns at Shapfell, and quicklime on the land has been completely replaced by chemical alternatives or by pulverised limestone dust. Apart from a small resurgence of lime mortar in the renovation of traditional buildings, cement has fully taken its place. Lime burning is almost a defunct industry now and this writer, at least, feels it is important to record its past extent and significance.

Acknowledgements

To undertake a field survey of this size depended on the co-operation and consent of many landowners and farmers and to them all I extend a blanket vote of thanks. I am also grateful to the staff of the LDNPA and Cumbria County HERs, especially Eleanor Kingston and Jo Mackintosh respectively, for so readily providing me with existing HER data. Staff of the Cumbria Record Offices in Kendal and Carlisle are duly thanked, and I wish to record receipt of a research grant from the Friends of the Cumbria Archive Service (FoCAS). I also wish to recognise the input of Alex Barbour for his field surveys in the Shap area. This paper has also benefitted from the comments of an anonymous referee, though this writer takes full responsibility for any errors of fact or interpretation.

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10. K. Wilson, *The History of Lothersdale* (Lothersdale, 1972, 28)
11. J. Speed, *Eboracensis comitatus descriptio*. (1610). This particular map is in a private collection
12. See, for example, NYCRO, ZAW 138. Title deeds: Agreement between Wingate Pulleine of Carlton Hall, Co. York and Henry Sayer of Ladymires, Bowes, 12 September 1754, by which Pulleine allowed Sayer £2 per year for laying 180 loads of lime and 60 loads of coal for burning the lime; a similar agreement, dated 1 January 1762, required Sayer to burn and lay a specified quantity of lime with his being granted free access to coal at the Tanhill Pits. In a later tenancy agreement for the same farm – Old Spittle – William Atkinson was required to 'manure with at least 300 bushels of Lime or other manure', 28 February 1842.
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21. CRO (C) D/Hud/3/66/2. Andrew Huddleston (1734 - 1822) of Hutton John. Correspondence, 'Letter sent to Andrew Huddleston of Hutton John from Robert Lucock of Broughton Moor Firebrick Works concerning Mr Dyke's Kilns', 1845
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33. This writer has been researching agricultural improvement in Westmorland, including with the use of lime, and it is hoped this will be published in due course. Examples of agricultural liming include CRO (K), WDRY/1/8/4/25, Box 107/33, le Fleming Archive, Receipts for Manure, Ashes and Lime, 1762-64; CRO (K), WDX/94/acc. 463/63, Lease, Hall Intack, Ravenstonedale, 11 February 1779; CRO (K), WD/Hoth/Box 26 (unecat.), Miscellaneous Westmorland leases, eg 1767 to 1791; CRO (K), WD/Cat/Mus. A2173 Edenhall, Letters 1764-89; CRO (K), D/Lons/L8/50, A Valuation of the Estates in Westmorland, 1810
34. William Fleming of Pennington noted in his diary for 12 June 1809 that many cows had died 'of the Redwater' in Furness, suggesting that it was a scourge to cattle farmers, CRO (B), BDX 584
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40. It should be borne in mind, of course, that many upland areas were occupied, based on permanent farmsteads or seasonally-occupied shielings during the medieval warm period (see, for example, J. Quartermaine and R.H. Leech, *Cairns, Fields and Cultivation: Archaeological Landscapes of the Lake District Uplands* (Lancaster: Oxford Archaeology North, 2012, 120-21, 134-9, 273-4). As climatic conditions deteriorated, from the early fourteenth century, many upland settlements became unsustainable leading to a retreat from what quite quickly became the margins
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44. Maker's marks include *Cindrils A* in Kendal, *NB* in Levens and Whinfell, *H. Joseph* in Askham, *Brandon* in Dufton, *FRYER* in Winton, *Cower M*, *Douglas M* and *LILY* in Ainstable. Identifying the various manufacturers has not been undertaken by this writer but would make a worthwhile research exercise
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47. *The Westmoreland (sic) Advertiser and Kendal Chronicle*, 4 September 1824
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49. CRO (K), WD/U/30/6, Articles of Agreement, 2 October 1809
50. W.R. Mitchell, *A Cumbrian Blacksmith. Jonty Wilson of Kirkby Lonsdale* (Clapham: Dalesman, 1978, 14)
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53. CRO (K), WD/HH/82, Crosby Garrett Manor Court Book, 10 December 1741
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