BUILDINGS AT RISK

How use of limekilns and lime has evolved

Buildings at Risk looks at our built heritage – buildings and structures, how they have evolved, and their place and role in the landscape. In this instalment, **Dave Martin** of the Isle of Man Natural History and Antiquarian Society looks at how mankind's production of lime from limestone has evolved, contributing to the limekilns we find all around the island.

A limekiln, drawn in England about 1805 by WH Pyne. Limestone, broken with the tools in the foreground, and fuel would have been carried up the spiral steps to be loaded in layers into the kiln through the charging hole at the top. The fire would be started from the bottom, and the lime would be raked out from the same opening once the burn was completed. The customer arriving on horseback is bringing his empty barrels to collect quicklime. Note: the free-standing (but vegetation cloaked) limekiln on the Ayres below Ballagarret is of similar construction, but has a ramp to facilitate loading

Two weeks ago, we looked at opencast mining for clay to marl the fields, and the increasing use of 'lime' on the land. Why was there such a demand? How was it satisfied? And what else was lime used for?

Soil productivity is affected by both the underlying landscape topography, and by the nature of the surface soil itself.

On the macro/landscape scale, factors include the fields' orientation, underlying drainage, shelter, amount of rainfall, exposure to sunlight/warmth from the sun, how 'stony' the soil is etc.

Topography can be changed on a garden scale, and by very localised use of 'lazy beds', but otherwise - for the types of agriculture practised in the island – the only real minor improvements are by laying field drains if needed, or arranging irrigation.

Within the surface soil, productivity is affected by the amount of organic matter present; appropriate levels of trace nutrients / minerals; and appropriate amounts of moisture at the right time.

These 'micro' scale soil conditions are factors that mankind can influence by adding things to the soil. Probably best known is adding organic matter - agriculture is one of, if not the oldest, example of recycling (middens, slurry, compost etc.). We also saw last time how marl was used to increase water retention, which not only helps plants grow, but slows the rate at which organic and inorganic nutrients are leached out and washed away.

Soil pH can have a very significant effect on plant growth.

pH is a measure of acidity or alkalinity on a scale from 0 to 14. pH 7 is neutral; pH below 7 are increasingly acidic; pH values between 7 and 14 are increasingly alkaline. Generalising, the optimum for European agricultural crops is between pH 5.5 and 7.5; but some plants have evolved to tolerate pH outside that range.

Amongst its other uses, limestone, and its derivative, lime, can assist with rectifying over-acidic soils – and this has helps explain the proliferation of limekilns around the island.

Clamp limekilns. Left – all that can be seen of this early example on Lismore is a shallow depression. Right – a later, larger clamp kiln in Derbyshire, showing air vent

Photos: Historic Scotland and David Kitching

LIMESTONE

Limestone is principally formed on the seabed by accumulation of organic remains (such as shells or coral), and we are lucky to have modest-sized beds of limestone in the island, which run from Scarlett and Turkeyland on the coast inland to the vicinity of Silverdale.

It is commonly composed of tiny fossils, shell fragments and other fossilized debris. These fossils are frequently visible to the unaided eye on close examination of the stone surface, but many who have visited the flags at Scarlett will have seen really prominent seabed fossils such as corals and ammonites which unequivocally proclaim the seabed origin of those limestone flags.

Limestone is usually grey, but it may also be white, yellow or brown. Grain size varies - some varieties have an extremely fine grain and are valued for carving; the finest have been engraved to form stable printing-plates, especially for maps and charts.

Limestone is a soft rock and is easily scratched; but the heat and pressure of major geological events can result in limestone recrystallizing as marble.

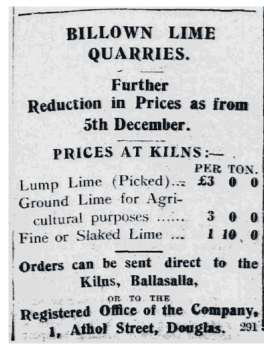
Limestone is not soluble with the rapidity we see, say, salt or sugar dissolving; however in geological timeframes limestone is relatively easily eroded or dissolved by water. This erosion can be seen on the surface in locations like Cheddar Gorge; and underground in the honeycomb of potholes and caverns under the Yorkshire Dales.

Pure water can erode but doesn't dissolve limestone; but any rain that falls will have absorbed some carbon dioxide from the atmosphere, giving rise to carbonic acid, which can dissolve limestone.

A number of mineral-rich solutions can give rise to sta-

Close-up of 'View of Port Le Mare' by John 'Warwick' Smith in 1795, with Port St Mary limekilns smoking away in the background Manx Museum Art Collection

Draw eyes, Glen Trunk limekiln Photo: Rory McCann



BILLOWN LIME QUARRIES.

Further Reduction in Prices as from 5th December.

PRICES AT KILNS:—

	PER TON.
Lump Lime (Picked)...	£3 0 0
Ground Lime for Agricultural purposes	3 0 0
Fine or Slaked Lime ...	1 10 0

Orders can be sent direct to the Kilns, Ballasalla, OR TO THE Registered Office of the Company, 1, Athol Street, Douglas. 291

From the IOM Weekly Times 4 Feb 1922 (iMuseum)

Scarlett limekilns c. 1930 Canon EH Stenning via iMuseum

lactites and stalagmites as a result of relatively long-term drips in a fairly still atmosphere; most commonly these are from limestone dissolving and re-precipitating out, but the rate at which this happens is indicative of the relative insolubility of limestone in the short term.

We will return to look at the use of limestone as a building material in the island, but in agricultural applications, even when finely crushed to sand-size grit to maximise surface area, limestone is slow to dissolve; and despite vastly higher cost 'lime' became the favoured or dominant dressing, possibly sometimes helped by the drama of its production!

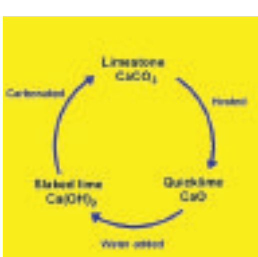
LIMEKILNS

When limestone is heated to temperatures of 900 to 1,000 °C (1,650 to 1,800 °F), the calcium carbonate ($CaCo_3$) will dissociate into carbon dioxide (CO_2) and calcium oxide (CaO) which we know as quicklime, or just 'lime'.

No extra chemicals are needed for this process – it is just a case of heating the limestone – but it has to be thoroughly and uniformly heated to get consistent results.

It has to be heated in a kiln – enough to drive off the CO_2 from the middle of each lump – but only just enough. To get even heating of all the limestone in the kiln, it is best to have all the lumps of similar size, just like getting all the potatoes in the pan the same size.

However, whereas the heat is conducted to each lump of potato by the water in which they're being boiled, and you can adjust the heat going in, and you can stir the pot – you can't do that in a limekiln. In pre-industrial limekilns, the only way to get the fierce heat to



The Lime Cycle (Peter Bell, CC-BY)

convert a worthwhile mass of limestone was to have the fuel (often coal) in close contact with the limestone, in a closed environment.

When lime was first deliberately made is lost in prehistory; but around the Mediterranean lime plaster and mortar has been found dating back perhaps even before 5000 BC; the Egyptians used lime plaster in the pyramids; and further East some of the earliest parts of the Great Wall of China used lime mortar.

To paraphrase a 1979 film which asked 'What the Romans ever do for us?' yes, they introduced a whole range of institutions – but almost anything the Romans built that was a storey or more higher was very often bonded with lime mortar; frequently lime-plastered, and tesserae floor mosaics were bedded in lime mortar. They developed early lime-based concrete, and discovered/developed 'hydraulic' lime mortars that would set in damp conditions or under water – so the Romans played a major role in developing lime production.

After the Romans left Britain, lime consumption vastly diminished with regression to timber as the main building material, but the eventual return to masonry brought fresh demands for lime.

HOW DID LIMEKILNS EVOLVE?

Millennia ago, lime was made for specific building projects, and would be made on-site, much as farmers made lime-on farm a few centuries ago.

Just having limestone in an open fire may give rise to a tiny surface layer of lime, so most developments were around keeping the fuel/heat in close contact with the limestone, and keeping cooling draughts out.

Some of the first dedicated 'kilns' were pits in the ground, with layers of limestone and fuel, which were covered with turf – somewhat like a charcoal-makers' clamp.

It was then realised that more, thinner layers gave better results, and that as the kiln had to be left to cool down and then at least partly dismantled each time to empty it, it made sense to do as much as possible each firing.

Capacity was increased by raising the sides of the pit with stone walls, sometimes themselves sealed with lime mortar or clay, and strengthened on the outside by banks of earth which also provided shelter and insulation. To allow air to enter the base of the kiln to help combustion, a hole would be left in the wall, or a primitive early tuyere (air pipe) constructed to allow the fire to draw air. This principle really underlies all fired limekilns.

As time went on, they became bigger and bigger. Rather than try and scoop the lime out from the top after each burn, apertures or 'eyes' were left at the bottom through which lime could be raked out. Methods were developed to allow continuous operation; extra layers of limestone and fuel were periodically added through the charging-hole at the top and lime which had dropped through a grate was raked out from the bottom. This near-continuous process was more efficient – not only did it avoid down-time whilst kilns cooled down and heated up again; it also used less fuel, as every time you start from cold it uses a lot of fuel to get the kiln up to working temperature; this is also one of the reason later kilns were built in rows 'snuggling up" to each other.

When the 'lump lime' is drawn from a kiln, it is usually mechanically milled and sorted to produce grains of uniform size for mortar, or rolled finer to a powder.

That mechanically powdered lime is known as 'quicklime'; when water is added – 'slaking' the lime – a chemical reaction occurs and heat is released as the quicklime and water combine to form 'slaked lime' or 'hydrated lime' (calcium hydroxide).

When exposed to the air, that calcium hydroxide absorbs carbon dioxide from the air and effectively turns back into limestone, thus completing the 'lime cycle' – so lime plaster for example is really a thin coat of limestone on the wall.

In the island, limestone was quarried for building, aggregate and burning. The sophistication of the kilns tended to reflect the intensity of their use; those used by individual or groups of farmers to make coarse lime for their fields were 'just good enough', whereas those operated commercially such as Scarlett, Derbyhaven, Port St Mary and Glen Trunk (Orrisdale) were of significantly better and more robust construction. The last major lime producers were Knivetons (at Oatlands) and the Billown quarry; but lime is currently not being burnt in the island on a commercial scale.

● Next time we will look at the multitude of uses for quicklime in building including lime mortar, lime render, lime plaster and lime-wash; and some other purposes, and its perils.