THE GEOLOGY OF MALHAM

The Basement Rocks

The piece of the earth's crust on which Malham sits has changed dramatically in the last 400 million years - the time for which we have local evidence. A 1960s study showed the National Park area to be underlain by granite. A deep borehole, drilled in the 1970s near Semerwater proved its existence. All of the surface Dales rocks are of 'sedimentary' origin, deposited by water, mostly under the sea.

The oldest rocks surface in the area around Malham Tarn, where they are mostly covered by younger 'Ice Age' deposits. These siltstones were deposited about 400 million years ago during the 'Silurian Period', on a sea bottom near the southern shore of the Iapetus Ocean. We know their age from the Silurian fossils they contain - long spidery fronds called graptolites. Similar rocks are quarried around Horton in Ribblesdale, they include 'Horton Flags', used as paving stones and for lining sheep troughs.

After deposition of the Horton Flags, the Iapetus Ocean, which divided land areas of what are now Scotland and England, was squeezed out of existence by the drift of these land masses towards each other. For the next 50 million years (the 'Devonian Period'), this part of the earth's crust was a desert.

Carboniferous Limestone

About 350 million years ago at the beginning of the Carboniferous Period, sea levels rose worldwide flooding many Devonian deserts. What is now northern England was flooded by warm, tropical seas. We know from magnetic orientation in the rocks, that this part of the earth's crust was then about 10 degrees south of the equator. The Malham area lay near the southern edge of the 'Askrigg Block', approximately the area of the present-day National Park. This was a stable submarine plateau, underlain by granite, overlain by shallow, clear, marine lagoons. Surrounding areas, especially to the south had deeper water and a subsiding sea-floor. The lagoons provided ideal conditions for limestone deposition (as today in the Red Sea and around the Bahamas). On the Askrigg Block, beds of pure, pale grey 'shelf' limestone were deposited, almost as horizontal today as when first laid down. In the Malham area this limestone is generally known as the 'Great Scar Limestone' and can be seen at Malham Cove, Gordale Scar and on the plateau to the north. The distinct horizontal lines between the beds of limestone (bedding planes) indicate pauses in deposition. The bedded limestones contain many fossil corals, crinoids (sea-lilies) and shells; the latter are mostly brachiopods, a rare group of animals now, but probably more common than any other in Carboniferous seas.

The boundary between the 'block' and the deeper basin to the south was marked by reef growth. Reefs provided a habitat for many sea-shells, mostly brachiopods, and were made from a framework of calcareous algae, sponges and bryozoa (sea-mats) - rather than the later corals. Reef limestone is visible at Burns, just west of Malham village, and Cawden Hill, to the north-east. The limestone is pale grey like that of the bedded limestone to the north but without the clear horizontal bedding planes.

South of the Askrigg Block in the area between Malham and Gargrave, Carboniferous rocks are very different in character. Deposited in a deeper, dirtier sea, they are mostly dark grey shales and limestones, rarely visible on the surface, except in the local dry-stone walls.

Limestone deposition ended gradually with sediment brought from the north by huge rivers, deposited in a Mississippi-like delta. During early delta growth, intermittent sea-level rises brought clear water intervals and further limestone deposition, these thinner limestone beds were separated by sand and shale from the river-delta waters. The cycle of repeated limestone, shale and sandstone - seen on Fountains Fell - are called 'Yoredale Beds' (best seen along the sides of 'Yoredale', Wensleydale). South of the Askrigg Block limestone deposition had ended, rocks of the same age as the Yoredale Beds are the dark 'Bowland Shales', seen in the Bowland Fells to the south-west.

Millstone Grit
The clear seas of limestone deposition disappeared about 325 million years ago as the deltas grew. Alternating sandstones, deposited by the rivers, and shales laid down in the quiet waters between channels and during marine incursions, are characteristic of these times. The sandstones, known as grits, are made of coarse sand with quartz pebbles. Stones quarried from them and shaped circular have been used for grinding corn. In the marine shales the squashed remains of mussel-like shells and coiled shells called goniatites can be found. The latter evolved rapidly during this period and have proved invaluable in dating the strata. Hard gritstones cap all the highest hills in the area: Fountains Fell, the 'Three Peaks' to the west, Simon's Seat and Barden Moor to the east.

Millstone Grit to the Ice Age
Towards the end of Carboniferous times, earth movements began producing great cracks and folds in the rocks of the area. While strata remained more or less horizontal in the Askrigg Block area, in the Craven Basin to the south, they were folded into east to west aligned domes and troughs. Close to the boundary between the two areas are several major fractures, two of which, the North and Middle Craven faults displaced the rocks to the south downwards. This helped create the great fault scarp, of which Malham Cove and Gordale Scar are two major features and helped bring to the surface the base of impervious rocks under Malham Tarn.

As sedimentary rocks dry out after deposition they develop vertical cracks or joints. Jointing and faulting created a plumbing system for the movement of hot richly mineralised fluids during the Permian period. These liquids rose, evaporated and deposited the minerals within them. Metallic and other minerals of this age occur in many parts of the Pennines: in the Malham area zinc, lead and copper ores were mined north-west of the village during the eighteenth and nineteenth centuries.

Little trace remains of events in the Malham area during the 250 million years from the end of Permian Period, up to two million years ago. Evidence suggests that the surface rose and fell several times, perhaps falling below sea-level again. About sixty million years ago, along with much of Britain, the surface rose to form the land upon which the main features of the present-day have been modelled.

The Ice Age and After
'THE Ice Age,' is only the latest of several very cold periods throughout geological time. Ice-cap advances in northern Europe in the last two million years have completely re-shaped the scenery. It was the last of four ice advances within the last sixty thousand years, which had most significant effects. Eroding ice scoured the limestone plateau north of Malham to create the bare limestone pavements. Alternate freezing and thawing of rocky outcrops helped create huge limestone cliffs like Malham Cove. Moving ice scoured huge amounts of clay and boulders (glacial till) from the land, carrying it and dumping it as featureless sheets, or moulding it into egg-shaped hills, or drumlins. These indicate, by the orientation of their long axes, the glacial flow direction. Large boulders were dumped as 'glacial erratics,' miles from their origin. Rushing torrents created by thawing ice gouged out the valleys of Watlowes and Gordale Scar and spread sheets of sand around Malham Tarn. The last ice sheet in the area melted about ten thousand years ago, since when the quieter processes which moulded the pre-glacial landscape have resumed.

People have lived in the Malham area since the Ice Age, quarrying rock to build field boundaries, barns and dwellings, using the rocks nearest to hand, so that constructions tell us about the immediate local geology. Where needs were particular, as in the quoins and lintels of important buildings, the regularly bedded 'sandstones were preferred to limestone. In general, however, the villages, farms and walls blend into the natural landscape because they are made from the same materials.