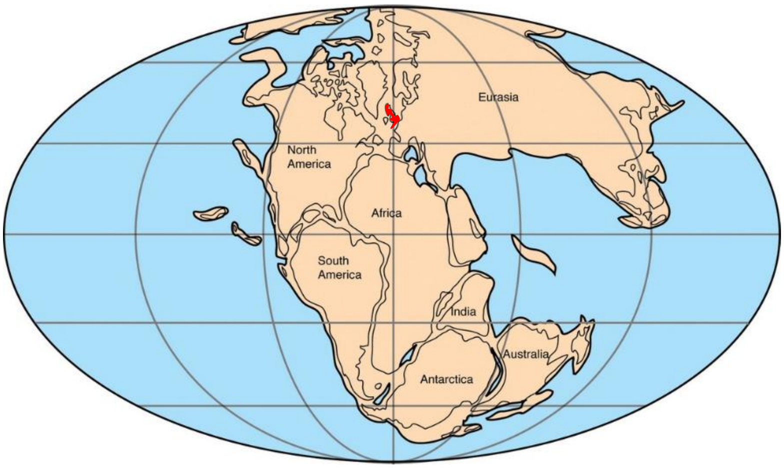
# Our Geological Heritage

1. Ancient landscapes
2. Rocks of the Sandstone Ridge
3. The lost years, and the formation of the Ridge
4. The Ice Ages
5. People and the landscape

## 1. Ancient landscapes

We can begin this story about 250 million years ago, at the start of a period of geological time called the Triassic Period, when the UK was near the centre of a large super-continent called Pangea. As

this landmass began to break up due, it is thought, to east – west extension of the earth's crust, low lying areas formed as the crust was stretched, extended and faulted. The area we now know as Cheshire lay in one such area of extension as a flat, low-lying, hot and arid desert plain, at a similar latitude to where the Sahara Desert is now. As other, similar, low lying areas down western England became connected, a large, north flowing river drainage system developed across this desert, evidence of which is now preserved in the Triassic rocks exposed in Cheshire and southwards in the West Midlands and Worcestershire.




*Position of GB (red) within the Pangea super-continent, about 250 million years ago*

https://historyofevolution10.weebly.com/gondwana.html

Seasonally fast-flowing rivers, laden with gravel, sand and clay, originating from upland areas in what is now northern France, flowed northwards depositing this sediment across the arid landscape, with winds from the east reshaping these sands into dunes.

In detail, this arid landscape would have encompassed a range of features as in modern deserts. These included areas with wind-blown sands and sand dunes, very wide, flat river valleys containing meandering sediment-laden rivers, subject to flash flooding and drying up, and temporary lakes and mud flats.

Desert sands took on a red colour, due to iron oxides, effectively rust, coating individual sediment grains thereby helping to cement the grains together, and in time changing them into the familiar red sandstones that characterise much of the Sandstone Ridge today.

*Similar to the northward flowing river system through the Cheshire Basin in the Early Triassic, this modern example shows a river with seasonally variable flow, depositing sand across a desert plain, sourced from mountain areas, Namibia*

https://www.pinterest.co.uk/pin/542754192574579968/

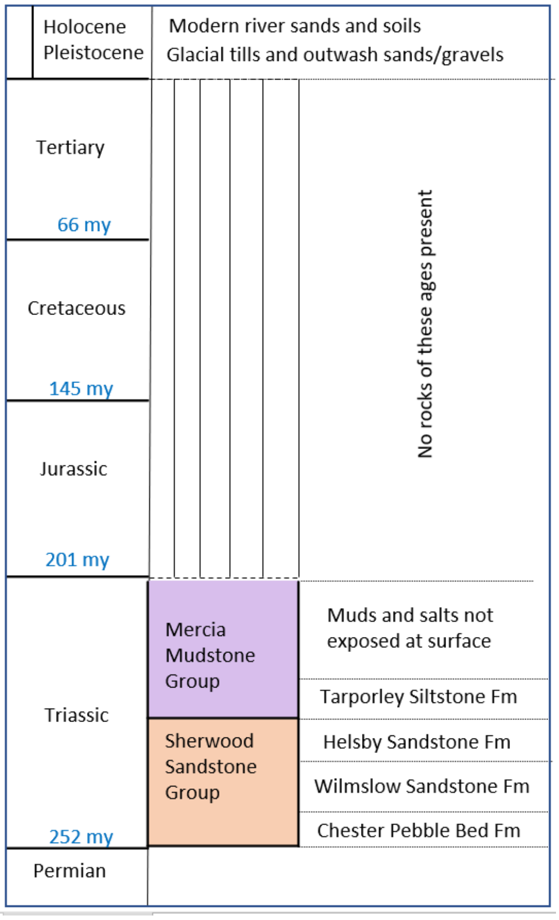
Within the Middle Triassic, slower rivers flowing over broad, flat plains deposited much more fine-grained material, and coarser sediments in times of flood. Wind was an increasingly important factor in the movement, transportation and accumulation of dust-sized particles. At the same time, with fluctuating and often cyclic (repeated) sea level changes, saline water flooded across the intertidal flat landscape depositing expanses of sand, silt and mud along with salty, temporary (playa) lakes. Through the evaporation of these saline waters, salt deposits, for which Cheshire is well known, accumulated.

*Example of a playa lake, showing white salts left by evaporation*

Geologypics.com

## 2. Rocks of the Sandstone Ridge

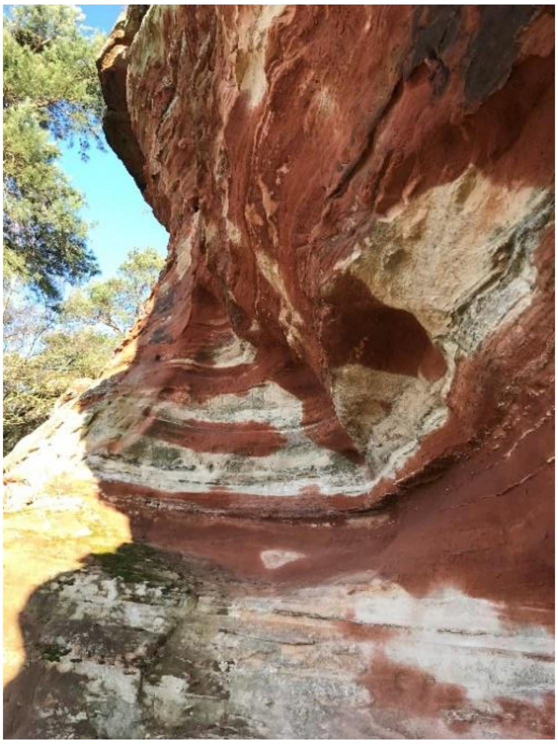
Rocks forming the Sandstone Ridge can be found at outcrop (exposed at the surface) along the full length of the Ridge and are represented by sandstones of the Sherwood Sandstone Group and siltstones of the lowermost part of the overlying Mercia Mudstone Group.




*Geological time scale and relationship to rock units used here for the Sandstone Ridge area, (Fm = Formation)*

Within the lower Triassic sediments of the Sandstone Ridge, deposited around 250 million years ago, are reddish brown, coarse grained sandstones, incorporating rounded quartz-rich pebbles carried in by rivers originating in what is now northern France, forming a sequence of rocks known as the Chester Pebble Bed Formation. It was an important building stone locally, and used, for example, to build St Chad's Church, Farndon.

*Chester Pebble Bed Formation, Rocky Lane, Tattenhall. Detail showing rounded pebbles, coin for scale.*



These rocks are overlain by the Wilmslow Sandstone Formation. This typically reddish-brown sandstone is visible in many of the natural exposures of the escarpments, particularly in the southern half of the Ridge. The formation represents sands deposited from fast flowing rivers (alluvial sands) and sands from wind deposition (aeolian). Sand grains are generally well-rounded, with spherical 'frosted' or 'millet-seed' grains visible in some horizons indicative of rock formed from wind-blown sand. Rock faces often show mottling, or bleaching of the iron oxide cement, forming grey/buff coloured irregular patches. This bleaching, iron reduction or removal, can occur more extensively and such bleached white rocks have been mined at several locations to be used as a scouring or cleaning agent. The Wilmslow Sandstone is also host to deposits of copper, once mined in the Bickerton area.

*Mottled sandstone of the Wilmslow Sandstone Formation, near Raw Head*

The Wilmslow Sandstone Formation comprises generally soft, friable or loosely cemented, fine to medium-grained, foxy red and reddish-brown coloured sandstones which are extensively and characteristically mottled with buff and grey patches, blotches and bands. Although the Wilmslow Sandstone has an extensive outcrop within mid Cheshire, the normally 'soft' or friable rock is not very resistant to weathering and is readily worn into characteristic wind-blown holes, hollows and shallow 'caves'. It is generally too soft and easily weathered and eroded to have been used as a building stone.

The succeeding Middle Triassic Helsby Sandstone Formation is by contrast represented by harder sandstones where the individual sand grains are cemented strongly together. They are more resistant to weathering and therefore form much of the high ground, capping the hill crests along the Ridge. The lower part of the formation represents a range of rock types, typically a hard reddish brown to grey, coarse-grained sandstone, sometimes containing small pebbles and clay pieces (usually weathered out leaving small irregular-shaped cavities). Silt and mudstones are also present. These sandstones were mainly deposited from rivers and are generally overlain within the Helsby Sandstone Formation by finer, softer, redder sandstones, deposited predominantly by wind (aeolian) processes. This type of rock is particularly evident above Frodsham.

*Helsby Cliff, Helsby Sandstone Formation*

Thicker, more uniform bedded or layered sequences of Helsby Sandstone can be seen in the numerous quarry faces along the ridge, with the Helsby cliffs being the finest natural exposure. Important quarries include Helsby quarry, which supplied stone to build the Liverpool docks, and Manley quarry, which supplied stone for Grosvenor Bridge and Chester Cathedral.

Only small areas of the ridge are formed from other rocks, notably the Tarporley Siltstone Formation which forms the summits of some of the higher hills (such as Eddisbury and the Old Pale) and is a part of the younger Mercia Mudstone Group. The Tarporley Siltstone Formation consists of red mudstones and thin-bedded, flaggy, fine-grained sandstone and siltstone interpreted as the deposits of an inter-tidal environment. The combination of pervious and porous layers with interbedded impervious layers gives rise to seepage of water at the surface (springs), and which may have given rise to the rock unit's original name of 'Waterstones'.

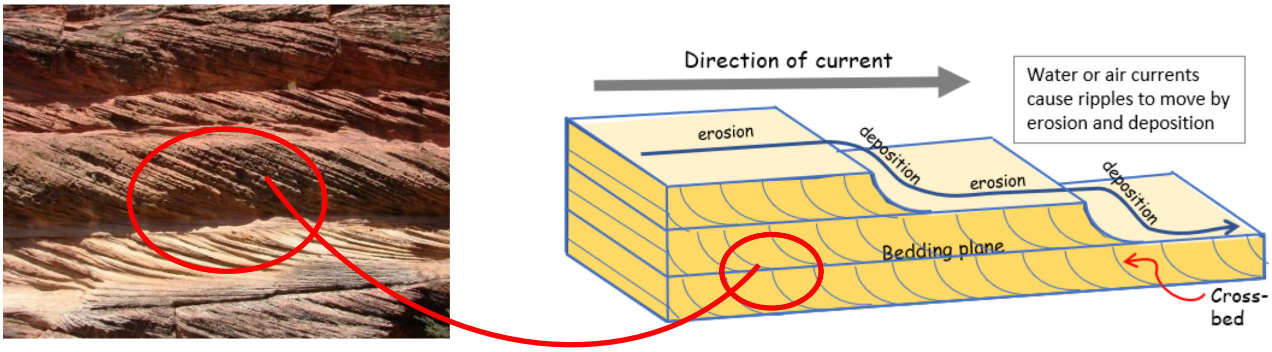
These fine-grained sandstones, which tend to split along mica (a plate-like mineral) -rich layers forming 'flaggy' slabs or flagstones, were much used for hearth-stones, doorsteps and window sills. One quarry producing such flagstones was at Luddington Hill, near Tarporley itself.

*Tarporley Siltstone Formation, showing characteristic thin, uniform bedding. Forest Road, Tarporley*

Younger Triassic sediments of the Mercia Mudstone Group, represented by mudstones and salt deposits, are not locally exposed. They occur on the eastern side of the ridge but are buried under several metres of glacially derived sediment.

**Structure within the rocks**

When looking in a little more detail at the sandstone rocks exposed in cliff faces along the Ridge, one can often see inclined lines within near horizontal beds of sandstone (be careful not to confuse these with chisel marks where the sandstone has been quarried). In geology, cross-bedding, also known as cross-stratification, refers to this layering within a bed of sediment, at an angle to the main bedding plane.




Cross-bedding forms through deposition on the inclined surfaces of ripples and dunes, and it indicates that the sediment was deposited by water or air. Sand grains are carried up the gentle, up-current slope, and deposited in the steep, inclined, down-current slope. The direction of these cross beds indicate the direction of sediment transport, and can therefore be a good guide as to the direction of water or wind currents.

Where the cross-bedding dips in one direction and then in another in large scale, the feature forms trough cross-bedding and is typical of aeolian, or wind-blown sands. This layered pattern is very distinctive and in dune-bedded sandstones, given enough surfaces in three dimensions to calculate the orientation of the cross-bedding, geologists can deduce the prevailing wind direction that existed many millions of years ago. It turns out that during the early Triassic Period the wind direction was predominantly from the east!

# 3. The lost years, and the formation of the Ridge

The youngest rocks found in the Cheshire Basin, but to the south of the mid-Cheshire Sandstone Ridge, occur right at the top of the red Triassic siltstones and mudstone, and have been located in boreholes around Prees and Wem in North Shropshire. There then follows a large gap in the geological record lasting some 200 million years, where no rock records remain in our area. The next ‘rocks’ were deposited a mere few 10’s of thousands of years ago when an entirely different environment existed and Britain was in the grip of the last Ice Age.

But all was not quiet during this period of time from the end of the Triassic Period. As the old continent of Pangea began to break into two continents the geography changed and the area we now know as Cheshire became covered by seas in the Jurassic and Cretaceous periods and what had been a desert became largely a shallow sea. While dinosaurs roamed the land elsewhere during the Jurassic and

Cretaceous our region became submerged below the sea, with thick sedimentary layers gradually accumulating.

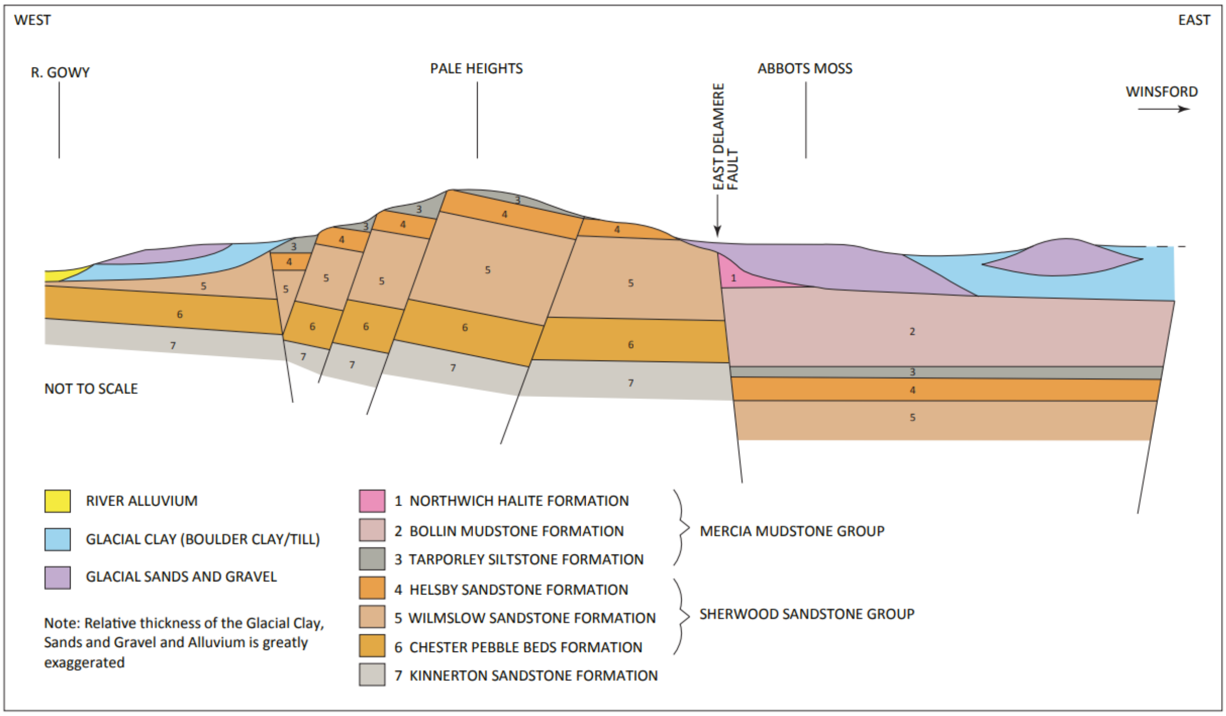
The rocks of the Sandstone Ridge were subjected to compression and extension as the continents moved to their present positions, and the rock sequences were bent and folded, fractured and faulted. They were also moved around upwards, downwards and sideways. These deep-seated earth movements took place along fracture systems or faults, with rock masses being moved one against the other by fault movements creating earthquakes.

These large faults, many of which have been traced running generally north-south through Cheshire, are the sites of major movements of the Triassic bedrocks, with blocks of land having been both elevated and lowered. In the last 65 million years or so, from the end of the Cretaceous Period, uplift and erosion has removed over 2kms of the overlying rocks and revealed the red Triassic rocks. The folding and faulting has formed a large, Cheshire-wide saucer-shaped fold with the youngest Triassic rocks towards the centre of the structure, and progressively older rocks around the periphery.

For these reasons the harder, older Triassic sandstones occur in a wide arc from Alderley Edge in the north-east, then westwards through Frodsham and Helsby and then south through the hills of Delamere and the whole length of the Sandstone Ridge to reappear in north Shropshire, for example, at Hawkstone Park. Where these harder sandstones became exposed, particularly the Helsby Sandstone Formation, erosion was relatively slow, leaving these rocks as an elevated landscape feature: the Sandstone Ridge.

The softer and younger mudrocks, containing the salt beds, rest above the sandstones but now lie hidden under the much younger glacial sediments in mid Cheshire, especially around Northwich and Winsford.

All of these rocks are cut by faults and have been moved by them. But faults have also acted as channel ways for fluids and some of these have deposited exotic minerals within the sandstones, chiefly with copper. **Mining for copper** has been done in the Sandstone Ridge at Gallantry Bank, Bickerton, but the largest mines are at Alderley Edge.



Geological cross section west – east across Pale Heights and looking north, illustrating how faulting has elevated harder sandstones relative to softer mudstones in the east, *Redrawn from Hydrogeology Workshop, David Joyce, Sandstone Ridge Trust*

The faulted blocks forming the ridge, shown in the cross section above, are largely responsible for the prominent west facing escarpments, so characteristic of the Sandstone Ridge. The photograph below illustrates the influence of these faults on the landscape. Here, this time looking southwards towards Burwardsley Hill (from near the Shady Oak pub), evidence of tilted and faulted blocks can be seen in the steep westward-facing scarp slopes and the eastward facing, gently inclined dip slopes. These escarpments are shaped through the relative resistance to weathering and erosion of the harder Helsby Sandstone, which overlies softer, more friable Wilmslow Sandstone.


*Series of escarpments, looking south towards Burwardsley Hill*

*Resistant rock forming a protective cap over softer, less resistant sandstone, near Raw Head*

# 4. The Ice Ages

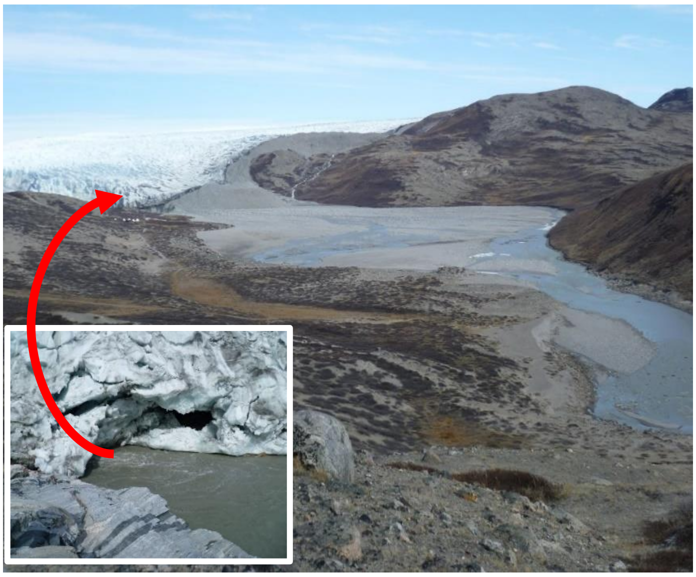
Following the long time gap since the Triassic rocks were deposited, the story of the Ridge landscape jumps much nearer to the present, where over the last 2.5 million years the UK has been subject to periodic cold phases where glacial (ice age) conditions prevailed, interspersed with warmer inter-glacial periods. Although there have been several 'ice ages' in this time, it is the last glacial event, the Devensian (which reached its peak about 18000 years ago, with the glaciers retreating from our area about 12,000 years ago) that has left the greatest impact on the mid Cheshire landscape. The name Devensian is derived from the Latin *Dēvenses;* the people living by the Dee (*Dēva* in Latin), and is a recognition of the national importance of glacial features from our area.

At its maximum, the ice sheet was up to 400m thick, and therefore buried the ridge deep below ice. Glaciation left many erosional and depositional features that are so important to the local landscape.

*Urchin's Kitchen, Delamere Forest,*
Photo from sandstonetrail.co.uk

Ice, as it moved against any prominent ground may well have over-steepened the ridge flanks, particularly where softer rock below harder rock was encountered, creating or enhancing many of the steep cliffs seen along the Ridge. Glacial meltwater channels carrying an erosive cocktail of mud, sand and rocks, and sometimes running underneath the ice, carved numerous steep-sided valleys. These glacial meltwater channels occur throughout the length of the ridge. One of the best examples being Urchin's Kitchen.

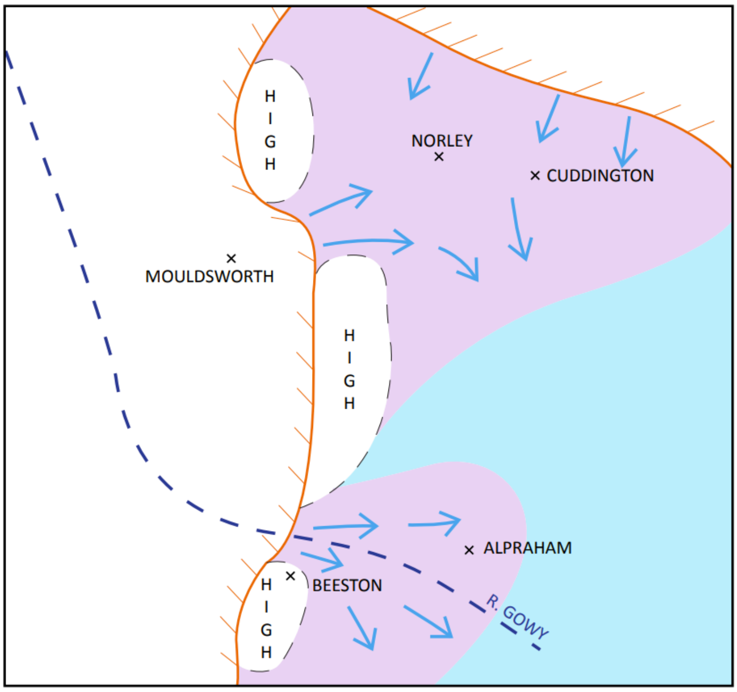
It is easy to think of the effects of glaciation mainly in terms of erosion in mountainous areas, the familiar u-shaped valleys, sharp ridges and mountain tarns of the Lake District for example. But much of our landscape away from the mountains has been modified by the deposition of glacial material. Glacial ice sheets act like giant conveyor belts, carrying vast quantities of weathered rock debris on their icy surface, inside them and beneath them, and as ice melts, either as a mass or at the margins of glaciers, this material is released and deposited.



Modern example of outwash, Greenland. Insert shows sediment-laden water issuing from base of the edge of the ice cap. Main picture, foreground shows extensive deposition of sands and gravels.

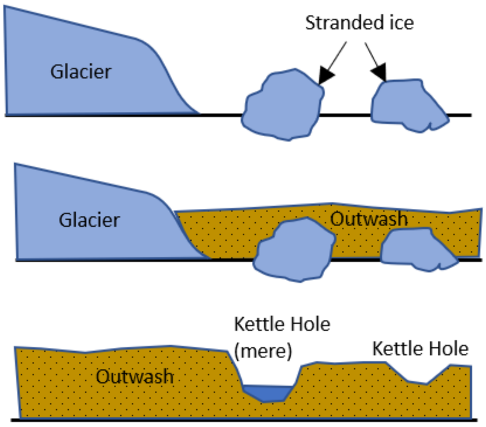
Glacial outwash is the sand and gravel deposited by running meltwater leaving a glacier. The Sandstone Ridge acted as something of a barrier to the passage of ice during the last ice age, and where water flowed out from the front of glaciers, extensive deposits of sand and gravel were left, mainly on the east side of the Ridge.

The area through Delamere (Mouldsworth to Sandiway) is noted for the extensive deposits of sand and gravel. As the ice front retreated north, deposits of till (or boulder clay, blue) were left behind (see diagram). A temporary halt in the retreat of the ice front west of the Ridge may have occurred because of pressure exerted by ice flow building west of the Ridge. Rivers flowing from the ice front from Norley/Cuddington and through gaps in the Ridge then left deposits of sand and gravel (outwash, purple).



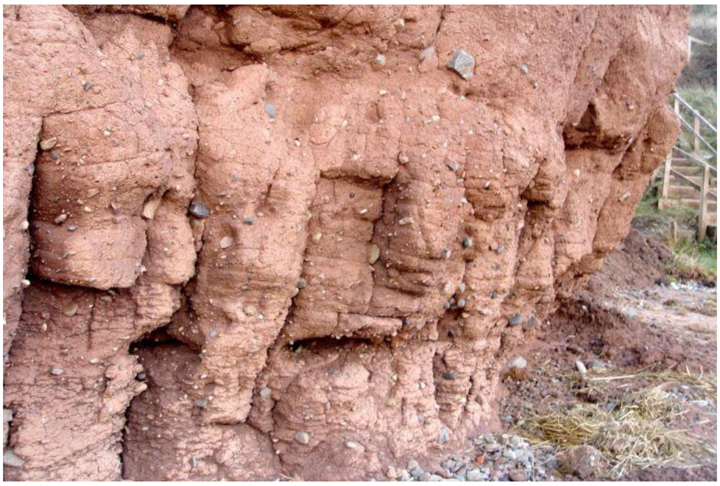

A schematic view of how the Glacial outwash was deposited on the eastern side of the Sandstone Ridge. *Hydrogeology Workshop, Sandstone Ridge Trust*

As the main body of ice retreated (where ice was melting faster than the glacier could replace it), stranded blocks of ice that temporarily remained were subsequently buried as sand and gravel outwash was deposited around and possibly above them. In time these blocks melted, leaving behind water-filled basins known as kettle holes. The meres are the deepest of these, surviving even today as open bodies of water. The mosses formed in shallower basins where peat formation led to the creation of lowland raised bogs.




(NOTE: Other bodies of water have formed from the sub-surface collapse and subsidence of the salt beds, typical know as 'flashes').

As the last of the ice melted, about 12,000 years ago, all the rock material that the ice was carrying, from clay, through sand to large boulders, was left behind forming a blanket of till (boulder clay) and outwash sands over all but the highest points along and around the ridge.



*Till left by the melting of glaciers, sand and muds contain erratic rocks, some derived from the Lake district*

The erosion at Thurstaston – A Sense of Place

Much of this till has been reshaped by overlying ice and water into a rounded, hummocky landscape, typical of many areas flanking the higher ridge. Over much of the Cheshire Basin, these superficial deposits have largely (but not completely) buried the Triassic bedrock.

Erratics are pebble to boulder-sized rocks that have been transported by glacial ice from one region to another, so that as a consequence, they differ in composition to the bedrock they reside on. For our area, they can often be seen around the fringes of the Sandstone Ridge, so look out for large, often rounded boulders that, having usually been dug up and cleared from nearby fields are often placed at entrances to farms or other boundary positions. Many are of a granite rock type originating from the

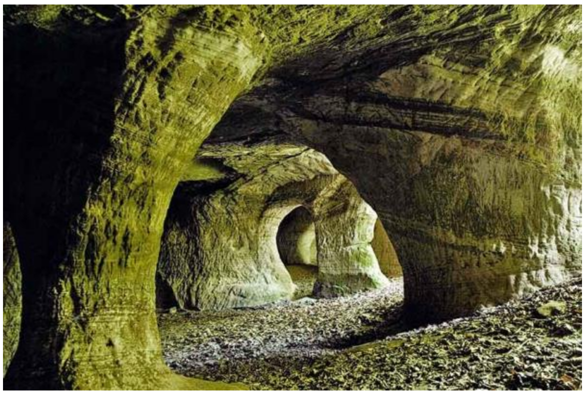
Lake District, but many other rock types can be found. One such erratic can be seen by the pond at the entrance to the NT carpark, Bickerton Hill.

In the last few thousand years, a variety of soils formed, from sandy (loam) soils to heavy clay soils, as well as peat; their characteristics strongly dependant on the character of the underlying glacial deposits.

*Glacial erratic, NT carpark, Bickerton Hill*

## 5. People and the landscape

The final chapter of this story reflects how humans, through the exploitation of the geology, have shaped and affected the Sandstone Ridge landscape. From the extensive quarrying of sandstone from which many of the iconic Cheshire buildings are constructed, to the creation of caves through the mining of white sand for scouring and cleaning. Through the digging of sand pits and copper mines, and the hundreds of field pits to extract marl (a type of lime-rich clay) to condition the soil for agriculture. To the digging and drilling of wells for the extraction and supply of underground water. We have clearly made our mark on this landscape.



*Beresford's cave, Beeston, a large white sand mine showing pillar & stall mining techniques. (The extensive white sandstone is this cave is in part now covered by green algae)*

Of course the Ridge itself has been hugely influential in how the region has been occupied by humans, from Neolithic times when shelters provided points to observe the movements of large mammals and later to influence early settlements and provide defensive sites. As a prominent feature for **viewing the wider landscape**, this has continued right up to WWII, where points along the ridge were used for a variety of observation roles.

The geological diversity of the Sandstone Ridge has therefore provided us with a rich heritage. This **geoheritage** reflects the value to the economy, education, recreation, culture and history that our local geology has provided.

*Acknowledgment: The author would like to thank Dr Chris Carlon for his very valuable comments in finalising this manuscript.*