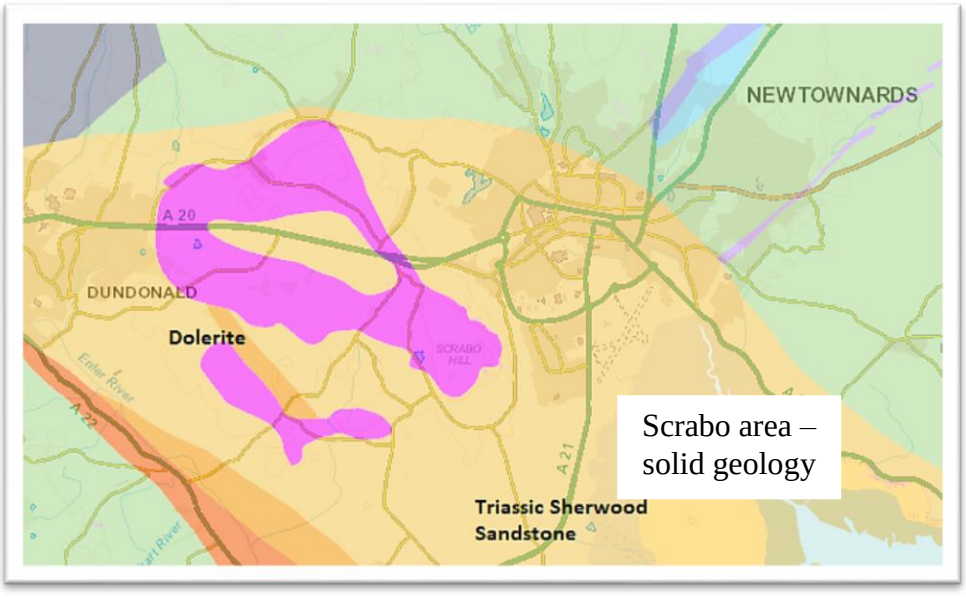
East Antrim U3A geology group report – Scrabo quarry 4th October 2022

Ian Enlander group convenor

Links to all previous excursion reports can be found at https://eau3a.org.uk/geology/ (scroll down web page)

As per 'the plan' we met at the Scrabo car park and then walked up the main path towards Scrabo Tower. A turning took us to the South Quarry floor, giving views of the main quarry face en route. We then retraced our steps and finished the walk up to the Tower – now unfortunately closed to the public. The Tower does hold a small exhibition about the history of the site covering geology, quarrying and construction and history of the Tower itself.

The site geology is dominated by Triassic Period (250 - 201 million years ago) Sherwood Sandstones (named for their 'type locality' around Nottingham and Sherwood Forest). These were formed in a desert environment with episodic (seasonal?) flood events. The area was one of a series of subsiding basins allowing sediment and ultimately the sandstone series to acquire a substantial thickness (> 300m in Lagan valley). As floods receded thin mudstone were deposited (often showing ripple marks demonstrating running water). The damp mud surface 'captured' a range of trace fossils (burrows, footprints and other tracks).

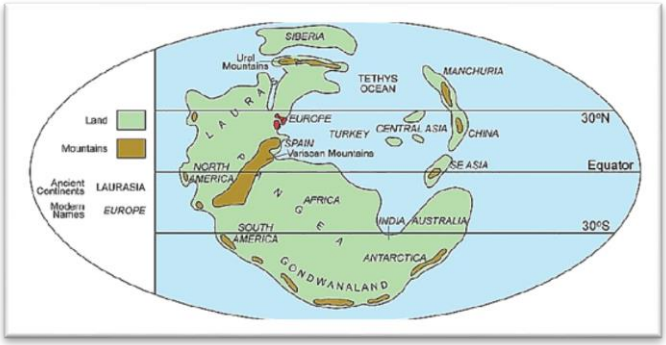


Scrabo area – solid geology

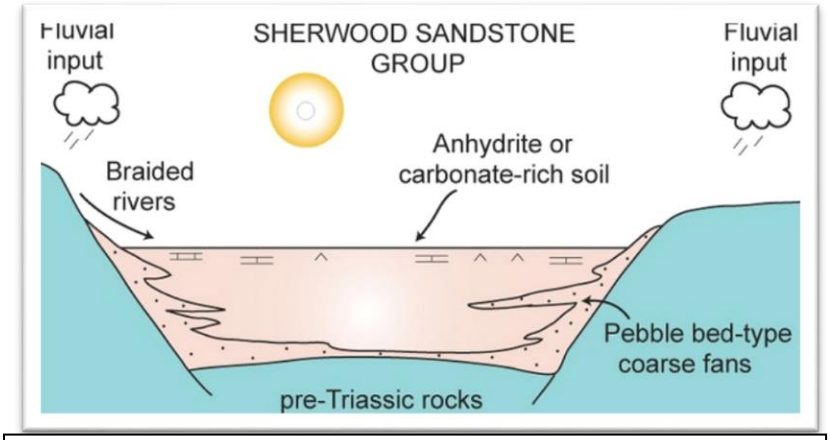
Much more recently in the Palaeogene Period (66 – 23 million years ago) there was intense volcanic activity over much of the north of Ireland - part of more extensive Thulean Volcanic Province stretching from what is now east Greenland to west Scotland.This activity was related to the opening up of the north Atlantic. At Scrabo, an initial explosive episode (forming a vent breccia) was followed by the intrusion of dolerite (horizontal) sills and (vertical) dykes. The main sill, most easily seen in the area around the Tower, is part of a more extensive sill complex including Dundonald, Ballyrainey and Ballyalton. The scale of the sill like intrusion means it is classified as a laccolith – a lens shaped intrusion causing uplift of the rocks into which it has been intruded forming a dome shaped structure. The sill has protected Triassic sandstones from erosion.

Triassic Scrabo

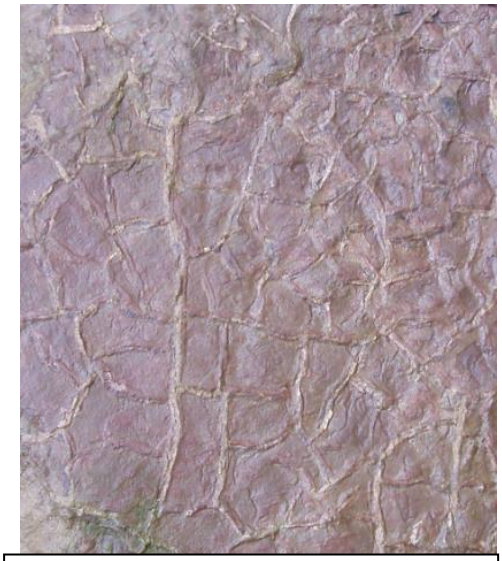
The sandstone was mainly laid down within large (possibly seasonal) streams and lakes. Low angle cross-bedding demonstrates this. The common occurrence of well-rounded (millet seed) sand grains suggests the influence of aeolian (wind) deposition and there is evidence of fossil sand dunes contained in the Scrabo rocks. These grains are rounded by wind action, transporting the grains, rounding them by impact with other grains.



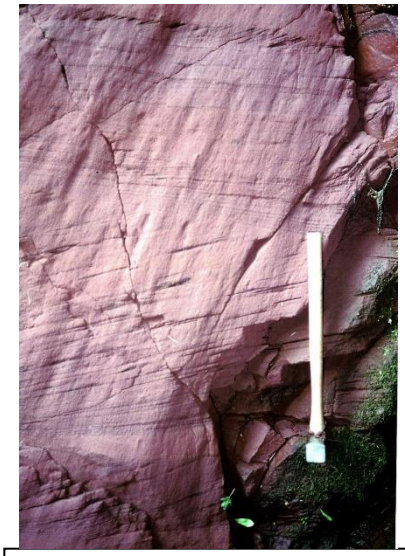
The Triassic world – Ireland approx. where Morocco is today



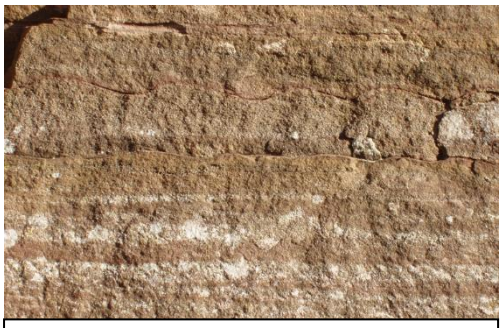
Simplified model for formation of the Sherwood Sandstones



Fossil mud cracks



Cross-bedding in Sherwood Sandstone at Scrabo



Sandstone with thin mudstone layers – note ripple form

Fossil ripple marks

As the floods receded, finer mud grade sediment was able to settle. While still ‘muddy’ these became a canvas to capture the traces of anything that moved across the surface. Trace fossils i.e. preserved marks left by the presence of animals but without any remains of the animas that made them – conditions would not have been suitable for preservation of organic material. Flowing water also produced ripple marks while exposed mud layers gradually dried out, developing mud cracks as the mud dried and contracted. See photos above

Life at Scrabo

Surprisingly, no confirmed signs of ancient life were noted at Scrabo during the 100+ years of pre-WW2 quarrying. In 1938 a young professional photographer and amateur geologist, Hallam Ashley, visited Scrabo and found a fossilized footprint of a reptile on a large block of loose stone too heavy to collect, so he photographed it. Returning after WW2 he revisited the quarry but could find nothing more and enquiries in the Belfast Municipal Museum drew a blank. This wrote up details of the original find in a paper published in the Irish Naturalists’ Journal in 1946 illustrated with a poorly printed photograph. The footprint resembled similar tracks in similar aged rocks common on the Wirral in Cheshire and named Chirotherium so he used the same name for the Scrabo specimen. Over the years without a specimen to support the claim some began to doubt whether the fossil was genuine or simply a chance resemblance to a footprint. 1987 found Ashley’s daughter resident in Northern Ireland in possession of her father’s photographic plates and a small tin box containing the original print which he had prized off for his own collection. The photographic plates and the print are now in the Ulster Museum.

Hallam Ashley original find

Chirotherium footprint

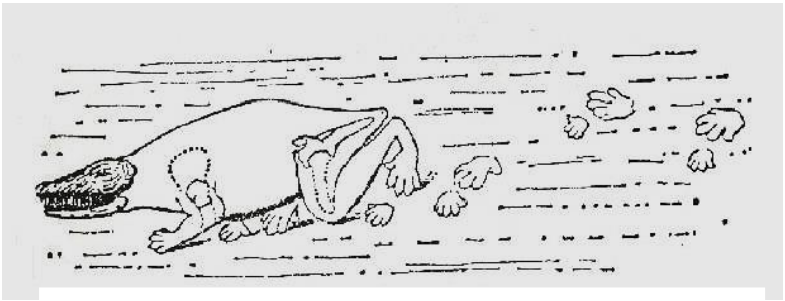
So we have our first reptilian footprint confirmed but no new material was discovered until the 1994 when Andy Jeram, then with the Ulster Museum, accessed new Scrabo material with a wide range of trace fossils including further examples of Chirotherium (which is 5 toed) prints. In addition, footprints made by other three- and four-toed reptiles have been found, with further footprints assigned to the reptile Chelichnus. Finally, scorpion tracks have been identified as those belonging to Paleohelcura making Scrabo one of very few sites internationally yielding evidence of Triassic scorpions. So not a lifeless desert.

Some of the beasts recorded (by footprints) at Scrabo – Chelichnus (left) and Ticinosuchus (right)

Note that in palaeontology (study of fossils) geologists give a name to the fossil tracks/footprints and a separate name to the fossil creatures that made them (if known) as the latter are often not identified and even where they are, may not be 100% linked to the specific tracks/prints. Giving a 'species' name to the tracks allows geologists in different parts of the world to meaningfully compare similar/identical tracks in the same way they would if comparing actual fossils.

Walking cross-legged

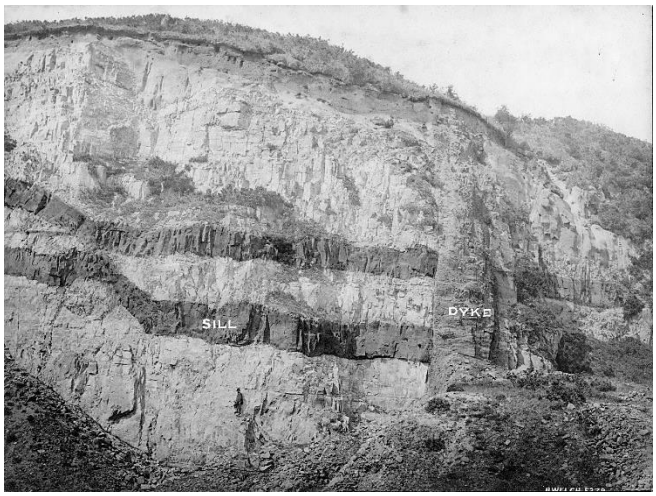
Chirotherium tracks have been known to geologists for some time – first identified in Germany in 1834. When trying to assess the type of creature that made them, people focused on the 5 fingered hand like appearance (Chirotherium means 'hand beast'). The outermost digit was interpreted as a 'thumb' which gave rise to the problem that the thumb was outermost on the hand (innermost in primates). To resolve this 'problem' it was suggested that Chirotherium/Ticinosuchus might have walked with its legs crossed! Of course the digits are not comparable to primate fingers and thumbs. Confirmation of the beast that made the Chirotherium prints came in 1966 when a newly discovered skeleton of a reptile was described from a specimen found it Switzerland. It was named Ticinosuchus (the Ticino crocodile – Ticino being the Swiss canton where it was found) by its finder and proved to be the right size, to have exactly the right foot structure for Chirotherium and was exactly the same age as the Sherwood Sandstone so mystery solved.



Chirotherium footprints (left) and Ticinosuchus going for a walk cross-legged (above)

Palaeogene Scrabo

The South Quarry hosts a range of features associated with igneous and volcanic activity dating to approx. 65 million years ago. The series of dolerite sill (horizontal) and dyke (vertical) intrusions are seen well in the RJ Welch photo below left – this shows the value of black and white photography + having a working quarry face with no 'bleeping' vegetation getting in the way.



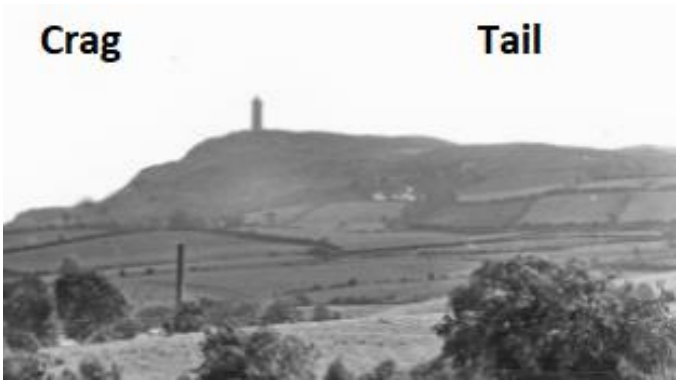
Preceding the intrusion of the sills and dyke, there was a phase of explosive volcanic activity. The evidence for this is the (now vegetated) depression shown below. When examined close up it is seen to consist of angular blocks of sandstone set in an ash matrix. Such 'dry' explosive activity is typical of phreatomagmatic eruptions caused by magma rising through cracks in the existing rock and coming in contact with water at is progresses

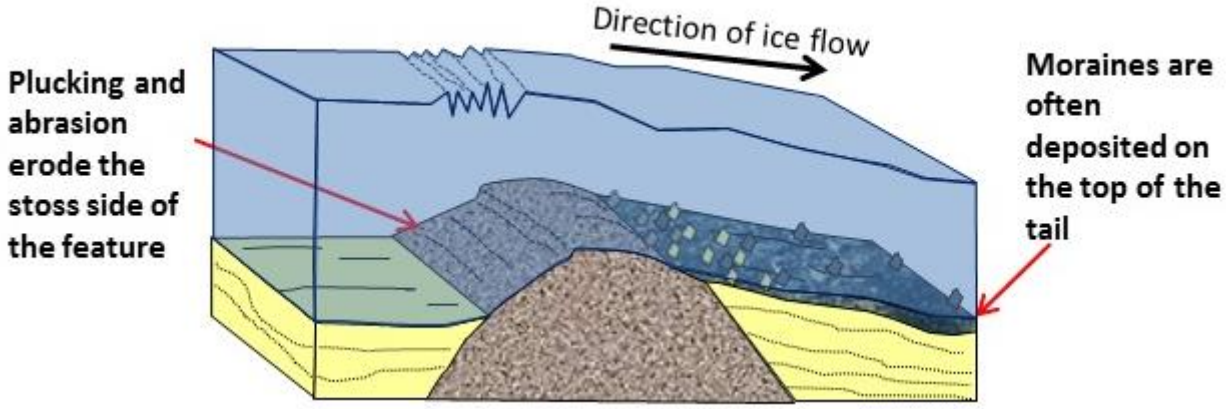
upwards close to the surface. The magma will have been at temperatures above 1000^0C and of course water vaporises at boiling point. The instantaneous conversion (and expansion) of water to steam causes the explosions, shattering the surrounding rock. The impact of the explosion can be seen some distance from the vent feature. Finely ground dust was also forced into cracks in the sandstone. The varying degrees of thermal alteration of the sandstone, often reflected in colour changes, is of importance when we come to look at the history of quarrying.

The vent is marked by the depression as the shattered rock is more easily eroded. Sections of shattered sandstone can be seen in the quarry face.

Pleistocene Scrabo

Some interesting features can be found at Scrabo relating to periods of glaciation in the area. These likely date to the last phase of glaciation in the north of Ireland (known as the Late Midlandian) starting some 25000 years ago. Glacial striations can be seen on the dolerite sill surface around the Tower. These are formed by rock, embedded in the base of the ice, scratching/gouging grooves in the rock surface as they are dragged along by the ice movement. At a larger scale, ice moving approx. south westwards over Scrabo Hill, left a trail of glacial material behind the hill forming a ‘crag and tail’. The image below is part of the Welch collection.

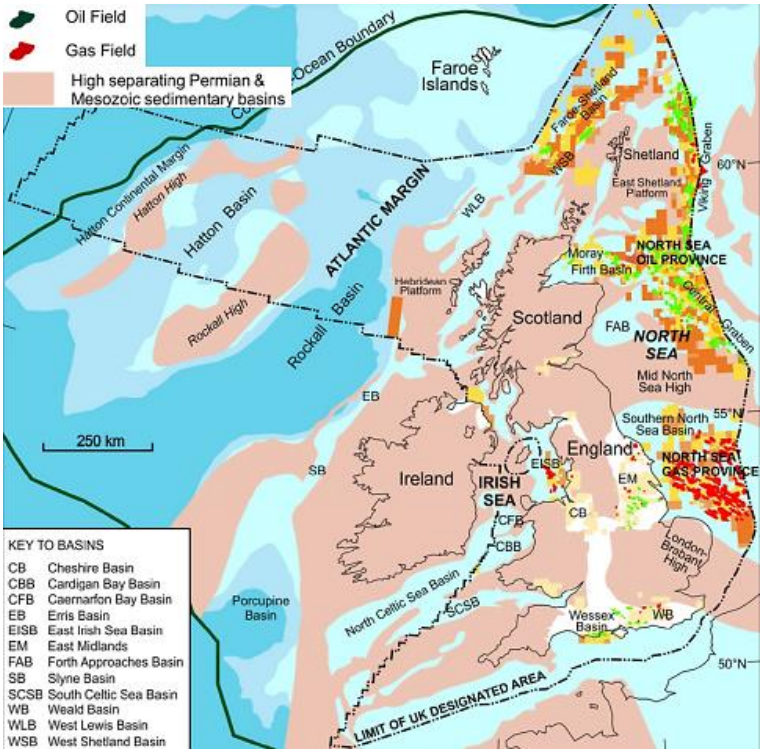


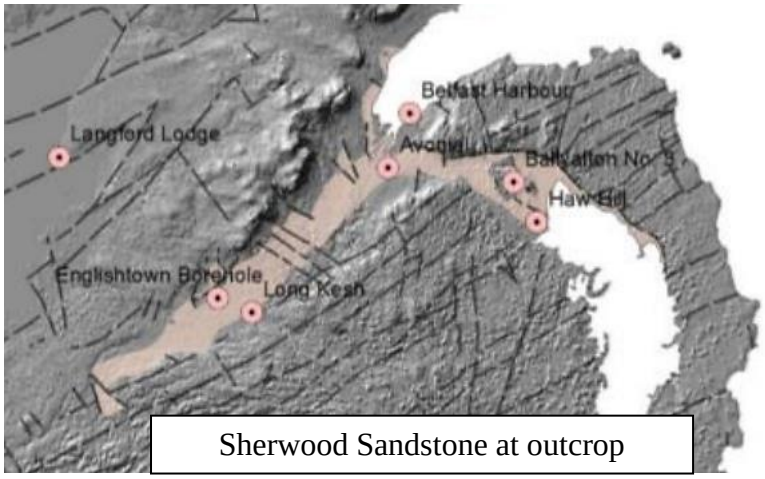


Formation of the crag and tail – geological detail not relevant to Scrabo

Economic importance of Scrabo
Hydrocarbons

The Sherwood Sandstone is an important reservoir rock i.e. it has good porosity (space between the individual sand grains from which it is composed) and so can host and store a range of fluids and gases. Elsewhere Permian and Triassic geology is very important for its hydrocarbon potential. Older organic materials are 'matured' (organic content in deeper Carboniferous rocks are particularly important) and can migrate (due to lower relative density) upwards. These Permian and Triassic sandstones can host gas and liquid hydrocarbons, provided the host rock is capped by impermeable rocks, stopping the valuable hydrocarbons from 'leaking' away. While Sherwood Sandstone has proven to be a productive hydrocarbon source in Morecambe Bay gasfield, no commercial scale targets have been identified to date around Northern Ireland.

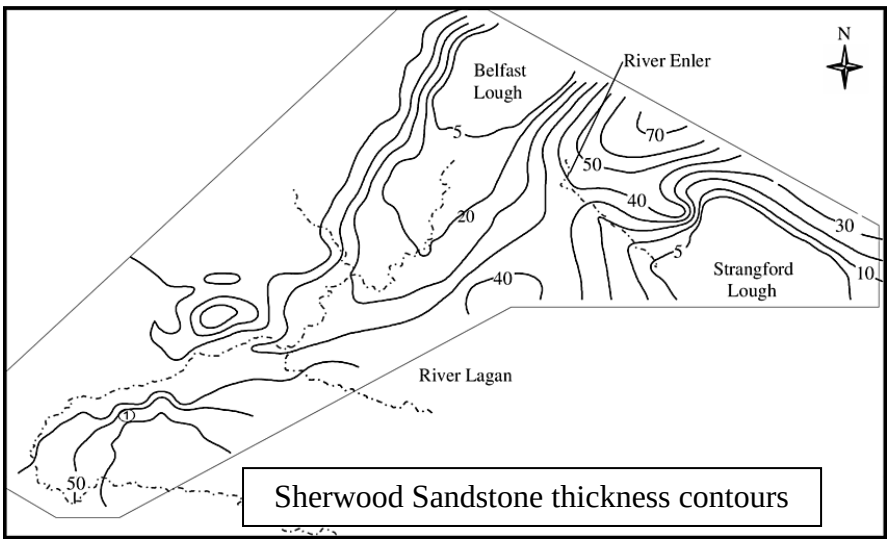




Sherwood Sandstone at outcrop

Water

The characteristics that make the Sherwood Sandstone an important reservoir rock for hydrocarbons also serve to make it important an aquifer for water. Water actively moves through the rock meaning that it is a renewable source. Historically this was also an important source of clean water which had a bearing on some of the uses it was put to. The water is usually accessed by drilling wells into the sandstone and then pumping water out. The occurrence of the Sherwood Sandstone under the Lagan Valley and Newtownards, meant that, once this resource was identified, it became especially important in the Belfast and Newtownards area with it being used by private industry for more than 120 years. Peak abstraction was of the order of 31 000 m^3/day (31 million litres, 7 million gallons).



Sherwood Sandstone thickness contours

The first public water supply to originate from groundwater via artificial means was for the town of Newtownards. Prior to the first borehole being drilled in 1922, Newtownards was already supplied by two tunnels drilled through the Sherwood Sandstone extending over 1 km in length.

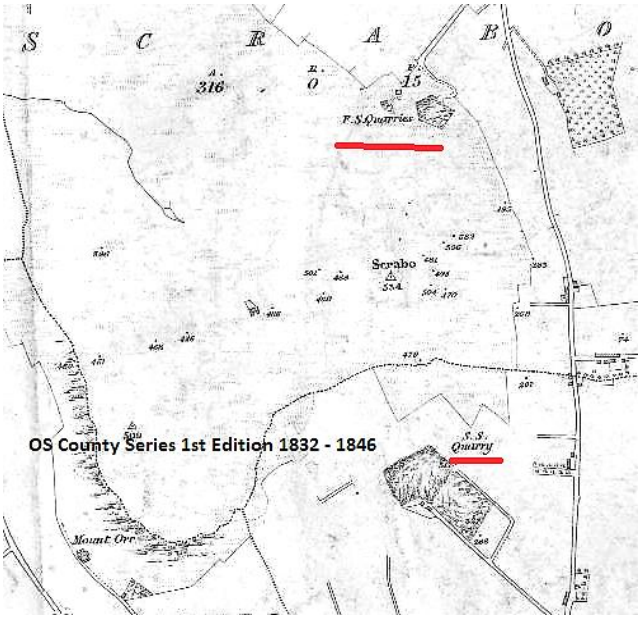
In Belfast, by 1913, almost 30 manufacturers of carbonated water had drilled boreholes into the Triassic sandstone. This industry exported more than 14 million bottles annually making it the largest exporter of carbonated water in the world. Currently Queen's University, Belfast's hospitals and the Coca Cola bottling plant near Lisburn all use the aquifer as their water source.

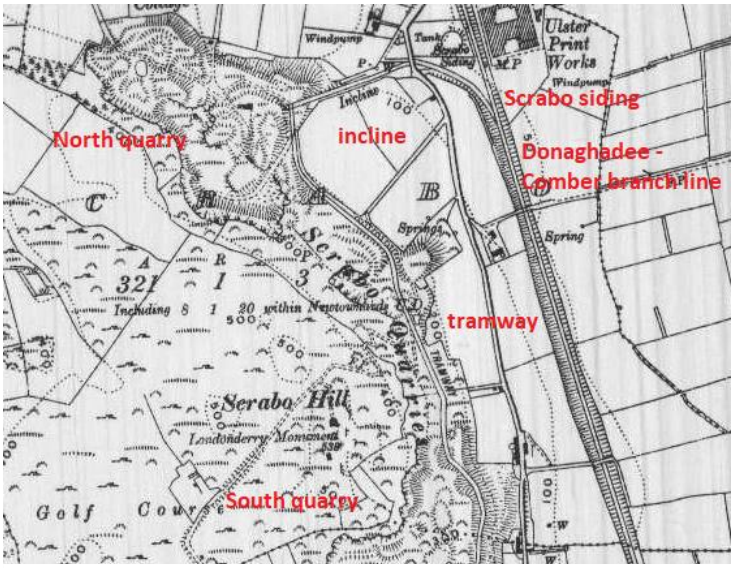
Stone

While quarrying in the Scrabo area was well established by 1744 when several quarries were in operation, the sandstone was clearly worked at an earlier date as the Market Cross in Newtownards, made of Scrabo stone, dates from 1636. In 1826 large scale commercial quarrying was commenced by Robert Corry who wanted to make Scrabo stone widely available and by the 1840's quarrying was active at a number of sites in the area. The extension of the Belfast and Co Down Railway to Newtownards in 1850 brought cheap and convenient transport and tonnages expanded rapidly to meet the demands of boomtown Belfast. Corrie's was the principal quarry at the time working the northern end of the hill employing cranes and a tramway to the railway but others were in operation including Duggan's, Dalzell's and Scrabo & Dufferin (Ritchie and Jackson), the last with a stone yard by the railway at Ballymacarrett. It was this company that supplied stone for the Albert Clock. The stone was also used for paving, kerbs, rubble and pitching.

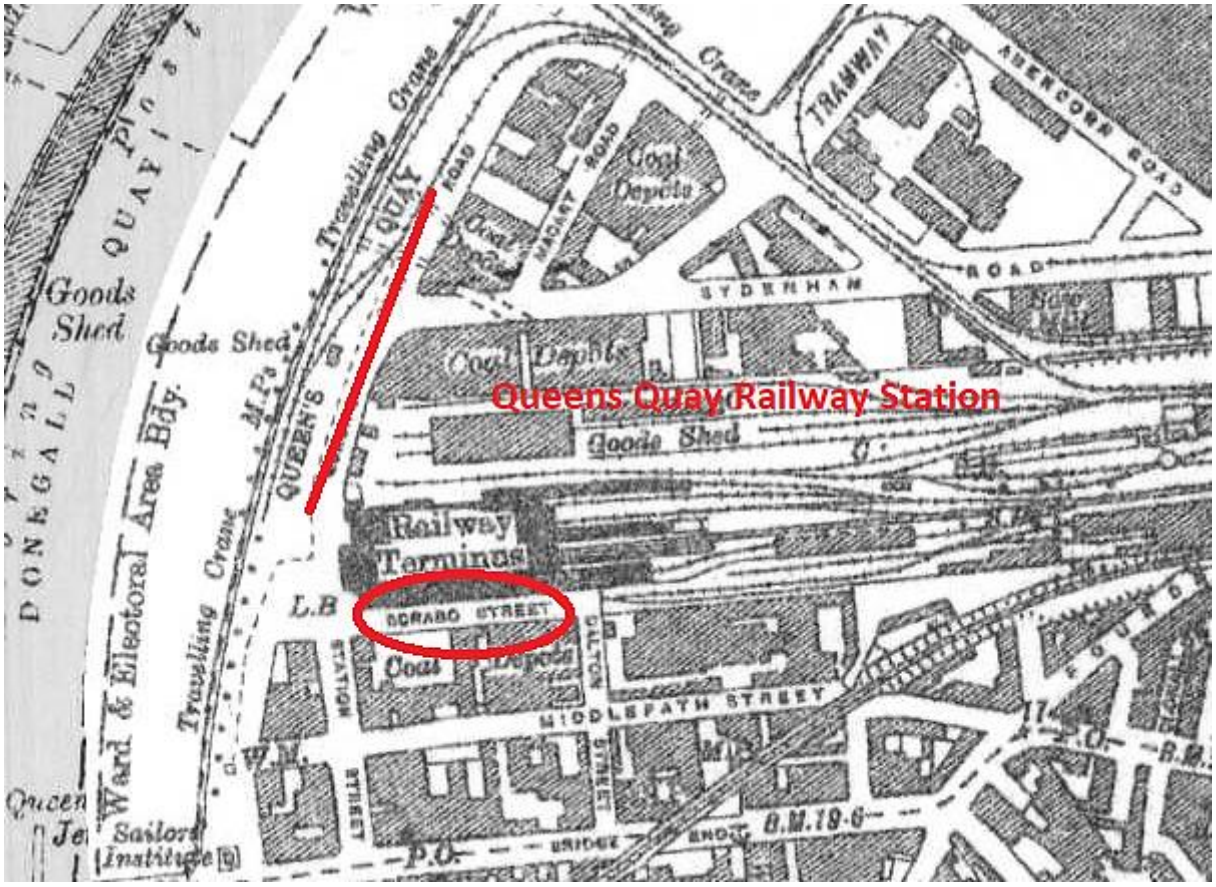
Smith's Book of Prices for 1863 quotes plain worked stone from Scrabo at four pence ha'penny per foot and ten pence to a shilling per foot cube for delivery in Belfast. Early Belfast examples of poor

stone selection and working include the Presbyterian College (1852), the Albert Clock (1865) and Victoria College (1873) all of which have needed extensive patching and repair. Carefully selected stone, properly bedded has a much better record as in Robinson and Cleaver's (1886), Elmwood Presbyterian (1850), St Thomas's Church of Ireland (1869) and Cooke Centenary Church (1890) all in Belfast. The last years of the 19th and the first two decades of the 20th century saw a change in stone fashion in central Belfast with the extensive use of Scottish sandstones. Much of 19th and early 20th century Newtownards is constructed in Scrabo stone. Quarrying diminished in the mid 20th century and post-WW2 reconstruction required cheap, mass-produced materials. Now, although still widely seen, only salvaged Scrabo stone is available.
More information on the Scrabo railway system can be found at the following link – unfortunately the images are not accessible. http://occurs.lineum.org.uk/public/2016/01/31//Scrabo-Funicular-Railway



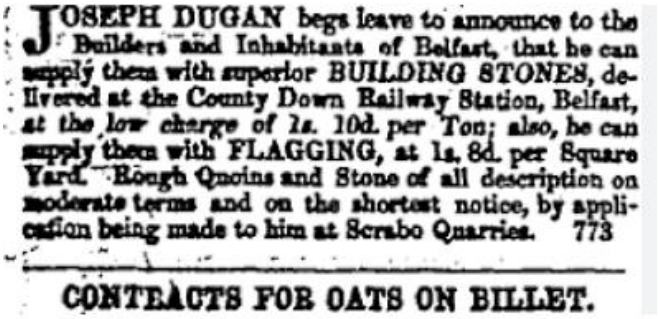


OS map c1905 Scrabo quarries, tramway and rail link to Comber/Belfast & Co Down Railway



Stone yard by Queens Quay railway station at Ballymacarrett (linked to the Scrabo railway siding via Comber) gave rise to Scrabo Street which is still present.

Many of the quarries were able to offer a variety of stone colours from pinks to browns, white to red. The colour variation is partly due to differences in the mineral composition of the stone but also due to the stones proximity to the intrusive igneous dykes and sills – the closer the rock was, the more affected by ‘baking’.



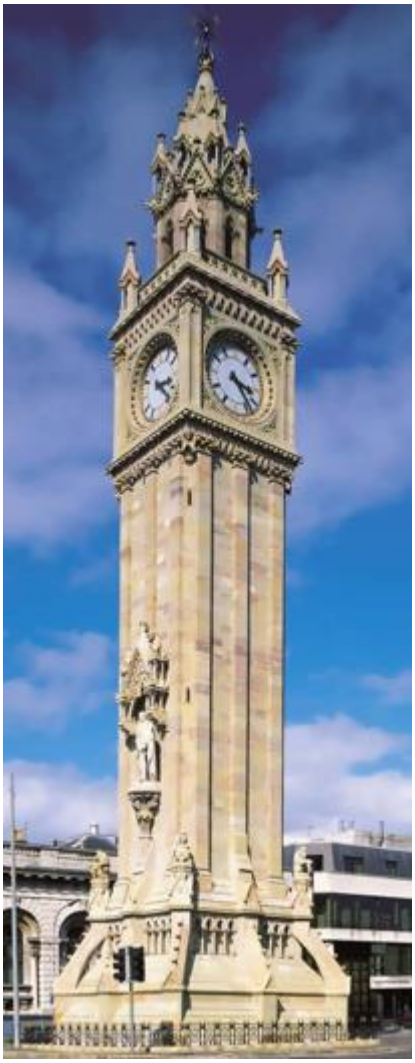
JOSEPH DUGAN begs leave to announce to the Builders and Inhabitants of Belfast, that he can supply them with superior BUILDING STONES, delivered at the County Down Railway Station, Belfast, at the low charge of 1s. 10d. per Ton; also, he can supply them with FLAGGING, at 1s. 8d. per Square Yard. Rough Quoins and Stone of all description on moderate terms and on the shortest notice, by application being made to him at Scrabo Quarries. 773

CONTRACTS FOR OATS ON BILLET.

An ad for Scrabo stone

The Albert Clock

Crescent Arts Centre



Made it to the top