Field Trip to Moon's Hill Quarry SSSI [ST 665 460] April 2019

Beneath the massive beds of Carboniferous limestone [259 – 360 mya] and Devonian sandstone [360 – 416 mya] are the oldest rocks of Mendip, the Silurian volcanics, laid down about 425 mya, far south of the equator, near the edge of the Iapetus Ocean. The beds were laid horizontally then twice uplifted to form the core of the Mendip mountains. Their high peaks have been gradually eroded to such an extent at Moon's Hill that it is one of the exposure!

The site, currently some 150 metres deep, quarried in a series of steps, called benches, meant we could gaze upon the outpourings of an island arc of perhaps six volcanoes, deposited over millions of years in the shrinking Iapetus Ocean. Island arc volcanoes are formed near subduction zones where an oceanic plate collides with a continental one. Tectonic forces mean that the former, which is less dense, goes under the latter, taking with it large amounts of sea water. It is now recognised that water aids the partial melt of the rock and, as steam, along with other volatile gases, is responsible for highly explosive volcanic eruptions. Today oceanic island arcs are to be found near plate margins, for instance, north eastern Japan, the Lesser Antilles, the Aleutian and Mariana Islands. Such places, although quiescent for many years, will be prone to earthquakes and sudden violent eruptions, hurling volcanic bombs and clouds of ash and gas into the atmosphere, as well as producing streams of magma. The viscosity of the lava tends to build a classic steep-sided, cone shaped volcano. This was not visible at Moon's Hill and would have been some distance away. All the rocks we saw were evidence of violent, Andesitic eruptions and had been laid down in the surrounding shallow sea.

Main rock types. The first impression of the quarry face was how varied and steeply-tilted the beds were. Initially folded and uplifted during the Caledonian mountain building period and later in the Variscan, the beds are now at more than 70 degrees from their original horizontal position and some are almost vertical.

Pyroxene Andesite.

Named after the Andes Mountains, where this type of lava is common, it is dark, hard, fine-grained and with a high silicate content – over 60% - which makes it valuable commercially as a roadstone. The distinct lava flows, often more than a metre wide and apparently extending for up to 150 metres, are crushed into small pieces. Half are combined with bitumen and laid as a skid-resistant road surface, the rest as loose chippings. It is the slightly protruding silica crystals that aid grip.

Tuffs.

By contrast, these rocks formed of compacted volcanic ash are poorly consolidated, crumble easily and are of less use commercially. An ash cloud produced at an eruption might drift through the air for many miles before settling, here under water, and sometimes in distinct sedimentary layers. Colours varied, according to the minerals present. The bed widths varied too, often just a few centimetres.

A hand lens showed rock fragments in some samples, making them lithic tuffs.

Agglomerates.

These beds, some more than two metres wide, were the most visually dramatic and intriguing to geologists, who have proposed at least five theories of their origin.

1) The standard description of pyroclastic material shot into the atmosphere by explosive volcanic eruptions. As globules of liquid magma travel through the air, the gases within escape as it solidifies forming volcanic bombs. When split open, tiny holes (vescicles) can be seen, some of which may be filled later with a variety of minerals, such as green chlorites and epidotes. The cavities are then called amygdales.

2) Spheroidal weathering of rock on the sides of the nearby volcano, might account for the rounded clasts that were not volcanic bombs. Gravity, aided by earthquakes would lead to their falling into the sea where they would be consolidated later, if not already engulfed by a lava flow.
3) Pebble beds, rounded by wave and tidal action and, like (2) later consolidated, perhaps incorporated in lava flows.
4) Weathered material, brought from the more distant land mass and consolidated later.
5) Geologists have identified at least one bed of vent agglomerate. After an eruption, lava may harden within a volcano and clog the vents. Later, as gas pressure builds, another eruption would cause the rock to fragment violently. If the clasts are angular it is called a volcanic breccia.

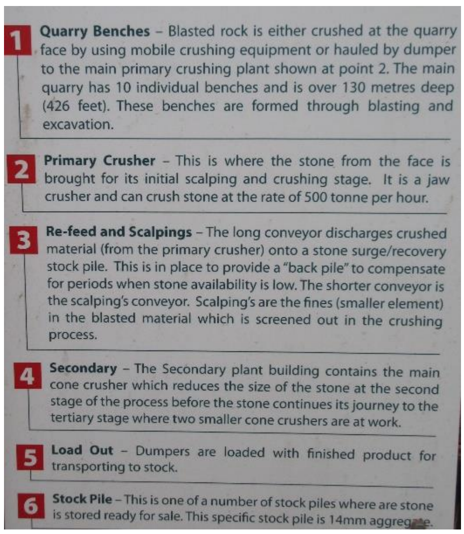
Mudstones.

In the quarry face was much evidence of volcanic activity, but there were also signs of quieter periods of erosion and weathering. Discolouration of some of the rocks suggested they had been exposed to the air for a while. Material would have been washed down, deposited on the sea bed and later lithified.

The earliest mudstones contain fossil bivalves and brachiopods – not seen by us. Once volcanoes developed, sea life was much reduced. However, fragments of the zone fossil, eocoelia angelini, prove that the beds at Moon's Hill belong to the Upper Silurian. Later mudstones contain ash particles making them less well consolidated than andesite and of lower value commercially.

The Quarry.

The volcanic rocks of Moon's Hill were discovered in the 1860s by geologist, Charles Moore. A quarry was in operation by 1877 and now covers 240 acres on both sides of the road. It is excavated in a series of benches, wide platforms into which holes are drilled vertically and packed with 250 kg of explosives at a time blasting up to 3,000 tons of rock. This is then crushed to produce stone of various grades, the most valuable being the pyroxene andesite, ironically traded as basalt. The "scalpings" from the top of the quarry and tuffs are used to cover waste tips.



1 **Quarry Benches** – Blasted rock is either crushed at the quarry face by using mobile crushing equipment or hauled by dumper to the main primary crushing plant shown at point 2. The main quarry has 10 individual benches and is over 130 metres deep (426 feet). These benches are formed through blasting and excavation.

2 **Primary Crusher** – This is where the stone from the face is brought for its initial scalping and crushing stage. It is a jaw crusher and can crush stone at the rate of 500 tonne per hour.

3 **Re-feed and Scalpings** – The long conveyor discharges crushed material (from the primary crusher) onto a stone surge/recovery stock pile. This is in place to provide a "back pile" to compensate for periods when stone availability is low. The shorter conveyor is the scalping's conveyor. Scalping's are the fines (smaller element) in the blasted material which is screened out in the crushing process.

4 **Secondary** – The Secondary plant building contains the main cone crusher which reduces the size of the stone at the second stage of the process before the stone continues its journey to the tertiary stage where two smaller cone crushers are at work.

5 **Load Out** – Dumpers are loaded with finished product for transporting to stock.

6 **Stock Pile** – This is one of a number of stock piles where are stone is stored ready for sale. This specific stock pile is 14mm aggregate.

As part of a designated "sacrifice area", there are no plans to limit quarrying in this part of Mendip. Stephen's photographs are a record of the rock face today. It will soon be gone.

Summary.

Stephen and I have tried to imagine what it would have been like in the quarry in Silurian times. During quiescent periods, would there have been a picturesque view of snow-covered volcanoes across a tranquil sea?

Perhaps, but his take is the more vivid: "Had we been there at the time of eruption, we would have been in trouble. The ocean probably would have been a lot rougher than we see today as tides were higher and more often. The flows of lava would have been faster than we saw in Doug's video [filmed in Hawaii] and with the evidence we saw of the number of volcanic bombs, hard hats would have been useless. Add to that, the atmosphere was not the breathable standard we know today especially as the volcano would have been pumping out vast amounts of poisonous gases."

More like Hokusai's famous print, The Wave, perhaps, with the view of Mt Fuji obscured by a hail of volcanic bombs and a fog of choking gas?

Thank you again, Susan, for arranging the trip, checking this report and adding Stephen's photographs. We're also grateful for the warm welcome at the study centre. What a wonderful facility and an Aladdin's cave of rocks and fossils. Thank you, Gill and Adel, for showing us round in such a relaxed, friendly way.

As ever on our field trips there is a mystery and the story of this rock was one to investigate on our return visit!

Report by Linda