Field Excursion to Portishead, led by Professor Maurice Tucker on Saturday 15th October 2016

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We met on a bright, warm October day close to the Royal Hotel at Portishead and, after a brief introduction, walked down the steps to the new Portishead lifeboat station. The new station had been completed in 2015 and incorporated a new ramp to the sea across the foreshore. It was on the ramp that Professor Tucker explained the plans for the day, to look at the Devonian, Carboniferous and Triassic sedimentary rocks and structures along the coast from the Lifeboat Station to Woodhill Bay, approximately half a mile to the south of the end of the Esplanade. The traverse would cover a period from 400 mya in the Devonian Lower Old Red Sandstone to 200 mya in the Triassic Dolomitic Conglomerate. During the Devonian, rivers flowed to the south to the Rheic Ocean while in the Triassic all the rivers flowed from south to north as a result of closure of the Rheic Ocean and uplift in the south. The ocean was gradually closing to produce shallowing seas, deposition of Lower Carboniferous limestone eventually progressing to swamps which produced forests which were periodically flooded in the Upper Carboniferous Coal Measures and Westphalian Pennant Sandstones. At the end of the Carboniferous, the Rheic Ocean had closed and new compressional forces came from the south, causing faulting and folding. Eventually, the continents would coalesce to form the huge continent of Pangaea, causing the desert conditions found in the Triassic. The first exposure we were to examine is now under the ramp from the Lifeboat Station, and although much had been obscured by the construction, we were able to examine the Lower Carboniferous Black Rock Dolomite (Fig 3). Unusually, the rock was seen to be red caused by staining from the once overlying Triassic and there were also a few fossils indicating that the dolomitisation had not been complete. From the ramp we

SYSTEM		STAGE	FORMATION	THICKNESS (metres)	GENERAL LITHOLOGY
CARBONIFEROUS	UPPER	WESTPHALIAN	PENNANT SANDSTONE	18–20	Coarse to medium-grained, green-brown lithic sandstones displaying much trough cross bedding. Erosion surfaces overlain by intraformational conglomerates comprising clay ironstone pebbles and plant debris. Mudstone horizons are rare.
	LOWER	TOURNAISIAN	BLACK ROCK DOLOMITE	155*	Fine-grained, grey dolomitic limestones with chert horizons. Occasional bioclastic limestones with shelly faunas.
			LOWER LIMESTONE SHALE	100*	Alternating lenticular limestones and calcareous siltstones. Limestones contain skeletal debris and well preserved fossils whereas siltstones are intensely bioturbated. Dolomitized and red stained throughout.
DEVONIAN	UPPER OLD RED SANDSTONE	FARLOVIAN	PORTISHEAD BEDS	194	Variable sequence of red and green coarse pebbly sandstones, coarse to fine-grained sandstones and siltstones. Fossil fish locally abundant. Prominent green sandstone unit in middle of sequence. Fining-upward sequences present with much cross bedding and associated depositional sedimentary structures.
			WOODHILL BAY CONGLOMERATE	4	Polymictic roundstone conglomerate of extraformational origin.
	LOWER OLD RED SANDSTONE	?BRECONIAN	BLACK NORE SANDSTONE	292 (min.)	Dominantly red, fine to medium grained quartzitic sandstones internally flat and cross bedded. Intra-formational conglomerates common, siltstones rare. Many pedogenic limestone horizons in the sequence.

Fig 1, *Devonian and Carboniferous stratigraphy in the Portishead area (Savage 1977)*

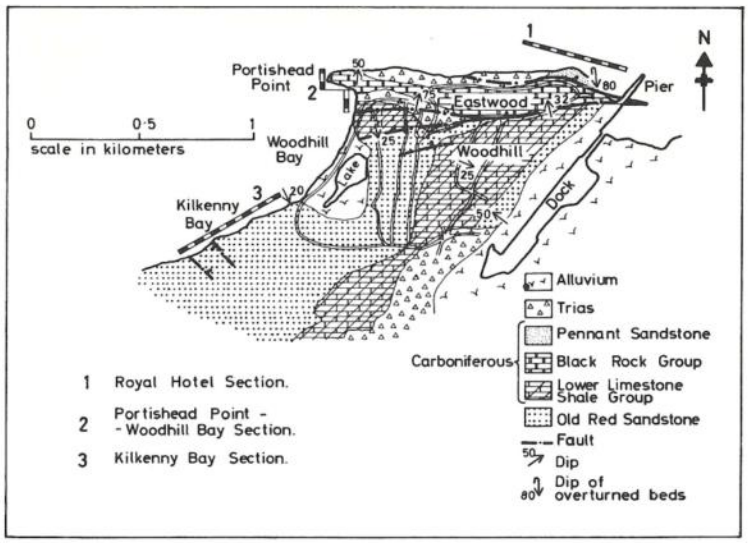

Fig 2, *Geology of the Portishead area (Savage 1977)*

Fig 3 *Black Rock Dolomite*

walked west, past the exposure of Triassic Dolomitic Conglomerate which lies unconformably on the Carboniferous and contains large clasts of Carboniferous Limestone enclosed in a brownish sandy matrix within which small vugs of galena were found, to the only exposure of the Upper Carboniferous Pennant Sandstone in

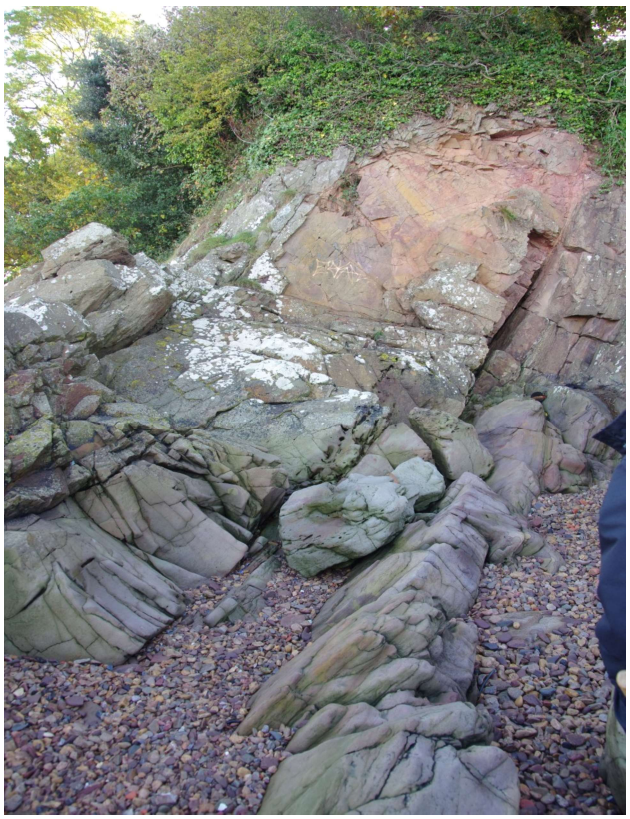

Fig 4, *overturned Pennant Sandstone*

the Portishead area. At one place at the back of the beach, a stone wall built to stabilise the cliff lies just in front of the north dipping normal strike-slip fault which brings the Pennant down to the beach. At this point it was explained that the rocks were younger to the north. Farther along, we were to see the steeply dipping beds of over-turned Pennant Sandstone in the cliff and extending across the beach (Fig 4). On the left side of the view, a thick 2 metre bed of coarse sandstone marked a sand channel in which plant debris could be seen. Holes in the rock marked sites where the plant remains had carbonised and then been eroded out while a loose block showed plant material in situ (Fig 5). Close by we were able to see moulds of

Fig 5, *plant fossils in Pennant Sandstone*

Fig 6, *Stigmaria in Pennant Sandstone*

the fossil *Stigmaria* (Fig 6) and *Calamites* (Fig 7). In the centre of the view a narrow cleft could be seen where mudstone had been eroded out, while to the right, thin bedded sandstone layers extended for a metre or two, indicating that the channel had overtopped in flood events, depositing the finer sediments. The

Fig 7. Calamites in Pennant Sandstone

sediments had been transported from a landmass located to the south, possibly now marked by the Devonian Hangman Grits of north Devon. On the beach the beds of Pennant Sandstone display cross bedding (Fig 7), soft sediment deformation and channel structures.

We returned to the cars by climbing steps from the beach and then drove to the Esplanade, meeting outside the Lido Cafe from where we walked to Portishead Point, also known as Battery Point because it has been the site of gun and cannon emplacements over many conflicts. The Point projects into the Bristol Channel, the consequence of the E – W faulting that produces the high ground of the Black Rock Dolomite from the lifeboat station westwards to the Point. On the north side of the Point, the Black Rock Dolomite is

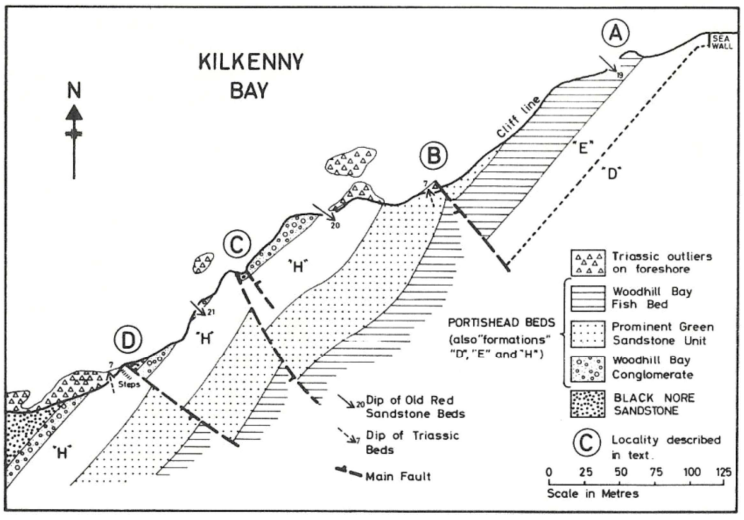

Fig 8, *The Old Red Sandstone in Kilkenny Bat (savage 1977)*

faulted and folded; the thin to moderate bedding dips north with tight easterly plunging Z folds and extensive fractures related to the northerly thrust which runs E-W under the headland (Fig 9). On the south side of the Point, the Black Rock Dolomite shows intense S-folding and lamination which may mark the location of microbial mats and cavities (vugs) that were formed as dolomitisation progressed and limestone replacement occurred. The chemical process of dolomitisation can cause a volume reduction within the rock, forming cracks and cavities in the bedding. The Carboniferous Lower Limestone Shale underlies the Black Rock Dolomite and is exposed at the edge of the beach. However, a more accessible exposure of the Shale lies about 100 metres farther to the south. Between the point and this exposure, the beach exposes gently dipping beds of the Triassic Dolomitic

Fig 9, *Folding and thrusting, Portishead Point*

Conglomerate with pebbles of Carboniferous limestone overlying the Lower Limestone Shale, marking the site of a shallow valley or wadi in the Carboniferous landscape. Moving to the exposure of the Lower Limestone Shale, we were able to see boulders on the beach in which the horizontal branching trace fossil *Chondrites* was evident (Fig 10). Also well displayed on a boulder face was a continuous crinoid stem about

Fig 10, Chondrites *in Lower Limestone Shale*

20cm long with two smaller branches (Fig 11). It was agreed that this specimen was unusual as crinoids normally break up into short sections or even single ossicles, so this had probably been buried very quickly. The other fine feature on the beach, projecting from the low cliff, was the tight

Fig 11, *Branching Crinoid in Lower Limestone Shale*

fold in the cliff which was seen to be folded back on itself, forming a flattened Z with the axis marked by a longitudinal crack (Fig 12). The Shale is formed from comminuted crinoid and brachiopod debris, sand and silt, reddened due to the hematitic content of the beds. It was decided that lunch was best taken at this point, after which we met along the Esplanade to where steps drop to the beach to walk southwards to Kilkenny Bay until the cliff was reached where the Devonian Upper Old Red Sandstone is exposed. The rocks are non-marine sediments of the Portishead Beds, in which the well known Woodhill Bay Fish Bed outcrops, comprising about 1000 metres thickness. At the first stop the Old

Fig 12, *Z Fold in Lower Limestone Shale*

Red Sandstone was composed of flat beds where the rock was pale red due to the hematite content but where other beds were pale green, being a secondary event due to ground water converting the iron from the ferric to ferrous form. The beds were fluvial, laid down in braided flash rivers flowing north to south in arid conditions into the Rheic Ocean. (The Devonian marine sediments of South Devon, in the Torquay area, mark the position of the Rheic Ocean). The beds show 'grain' lineations caused by fast flowing water moving grains of sand and gravel over the sediment surfaces. Cross bedding is common with fining upward sequences indicative of migrating channel systems, with slower currents leaving migratory submarine dunes, and

Fig 13, *Sun dried cracks in Portishead Beds*

slow currents producing ripples. In two loose blocks at the base of the cliff were seen fossil sun-dried cracks (Fig 13) indicating that the terrain dried out at intervals.

We walked a short distance south to a sequence of mudstone, fine-grained sandstone and fine conglomerate that are superbly displayed in the cliff where a down cutting river channel had overflowed the banks to deposit the finer material on the flood plain (Fig 12). A little farther along, a thick mudstone lay at the base of the

Fig 12, *Sequence in Portishead Beds*

cliff, formed on a flood plain with ephemeral lakes from which the muds were deposited. The lakes were populated by fish, the evidence being their scales which can be found in the cliff. We found two examples although in the past more complete specimens have been found (Fig 13). Fish are important for the correlation of the Old Red Sandstone, the species found at Portishead (*Holoptychius s)* being similar to those in the Fammennian of Greenland. There were also examples of vertical trace fossils, possibly *Skolithos* or *Monocraterion*, passing up through a series of red and greenish beds, suggesting that the organisms had formed escape burrows as they were buried (Fig 16). Continuing along the beach

Fig 15, *Fish scales, Woodhill Bay Fish Bed*

past coarse sandstones we came on the major post Triassic fault in the cliff which brings down the Triassic Dolomitic Conglomerate to sit unconformably on the Old Red Sandstone. The Conglomerate is a scree deposit, containing clasts of Carboniferous limestone in a yellow sandy matrix denoting shallow-water deposits of a Triassic lake (Fig 18).

Fig 16, *Trace Fossils in Portishead Beds*

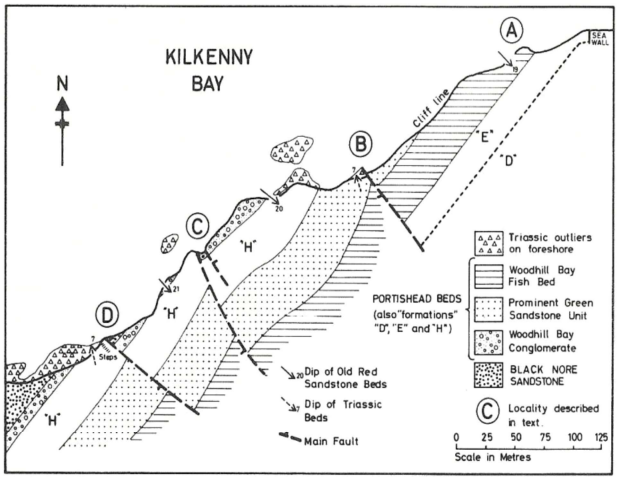

Fig 17, *The Old Red Sandstone in Kilkenny Bay*

Some distance south, the distinctive Woodhill Bay Conglomerate outcrops in the cliff, displaying well rounded pebbles of quartz and schist, lying on a flat-bedded sandstone of the Lower Old Red Sandstone Black Nore Sandstone. The pebbles are thought to have been brought by large rivers from the Mona Complex of Angl North Wales (Fig 19). The sharp contact of the Woodhill Bay Conglomerate on the Black Nore Sandstone marks the unconformity between the Lower and Upper Old Red Sandstones. It was at this point in the excursion that the threatened rain started so we moved a little farther south to where

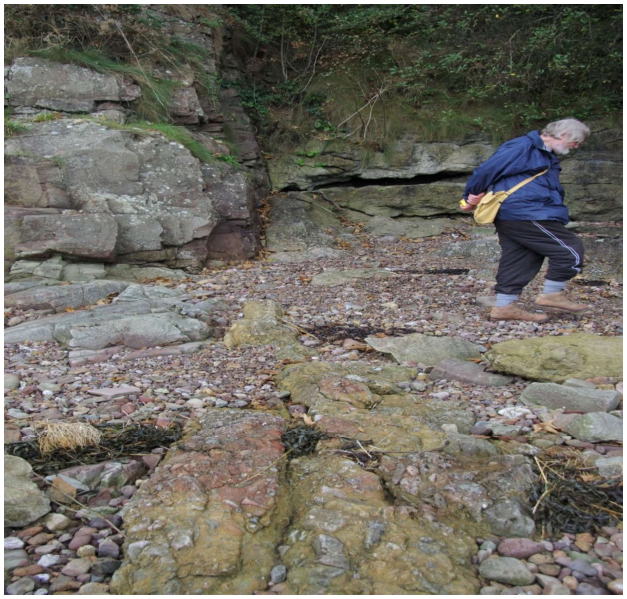

Fig 18 *Fault downthrowing Triassic*

calcrete nodules in the Lower Old Red Sandstone in the cliff indicate arid conditions with ground water evaporating at the surface (Fig 20).

Fig 19, *Woodhill Bay Conglomerate*

Fig 20, *Calcrete in Lower Old Red Sandstone*

It was decided that, as the rain had set in and time was short we would leave our last intended locality at Ladye Bay, Clevedon until another occasion. After thanking Professor Tucker for an excellent trip, we made our way home.

Ref – R.J.G.Savage (edit) 1977 ''Geological Excursions in the Bristol District'' Pub. University of Bristol.