Footprints, lake sediments and replaced evaporites from the Triassic of South Wales: fieldtrip 23 April 2016

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On a bright sunny day with clear blue skies (23 April 2016) 32 members of the Bath Geological Society and other local societies met at Swanbridge on the Glamorgan coast of South Wales between Penarth and Barry Island to examine the Triassic deposits nearby.

The Triassic rocks exposed in south Glamorgan were deposited around the edge of an enormous lake or inland sea in which the Mercia Mudstone (formerly Keuper Marl) was deposited. The mudstone is mostly a red-purple silty dolomitic clay with nodules of pink-white gypsum (alabaster); it is exposed in a small bay on Barry Island, and also in the cliffs close to Penarth. In the subsurface of the Bristol Channel, there is a thick salt unit (the Somerset Halite) within the Mercia Mudstone, that was deposited in the lake when the water level was very low and very saline, and the climate was hyper-arid. The Triassic sediments in south Glamorgan overlie the Carboniferous limestone which locally created hills and cliffs around the Mercia Mudstone lake (Fig. 1). Wave-cut shore-platforms and wave-notches were cut into the limestone cliffs, and screes of Carboniferous Limestone debris were formed, locally reworked into beach gravel breccias where they

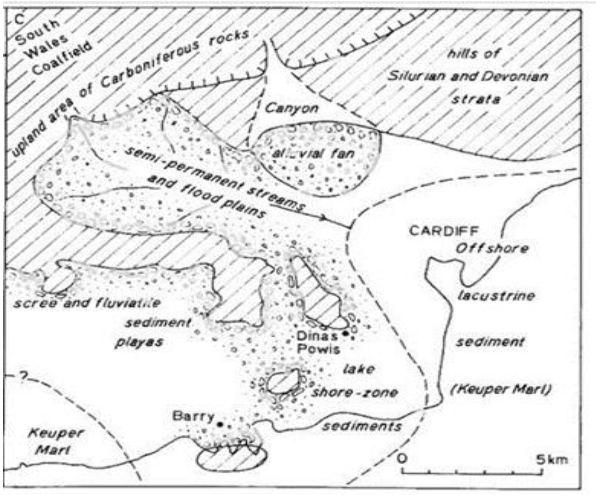

Fig. 1. Palaeogeography during Triassic times in South Glamorgan, South Wales (from Tucker 1978).

reached the shoreline of the lake. These features are well-developed and very accessible on Barry Island (see Tucker 1977, 1978).

After coffee and bacon sandwiches in the convenient café at Swanbridge for those arriving early, the group visited the exposures at Bendrick Rock and Hayes Point (Grid Ref: ST 140672). Here the unconformity with the Carboniferous Limestone is very clear and is extremely interesting since the upper surface of the limestone has split into very thin sheets. This exfoliation is a typical weathering feature of deserts, where the temperature change between day and night causes the rocks at the surface to split. There are also pebbles of limestone on the unconformity surface which have split in an onion-skin fashion (see Tucker 1974). The Carboniferous limestone here is full of fossils: mostly crinoids, with a few brachiopods and corals. The overlying Triassic consists of lenticular conglomerates and cross-bedded sandstones, some with a channel form, deposited by rivers in flood (Fig. 2).
There are also thin, finer grained sandstones with

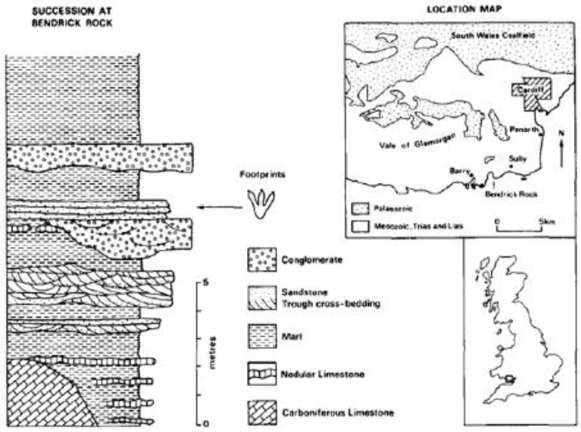

Fig. 2. Triassic succession at Bendrick Rock (Tucker & Burchette

ripples and mudcracks which were deposited by sheet floods coming from overflowing river channels, when there were flash floods. In actual fact, most of the deposits here are limestones (strictly calc-lithites) since most of the grains (sand to pebble size) are fragments (clasts) of Carboniferous limestone.

It is within the thin-bedded sheet-flood sandstones that dinosaur footprints were discovered in 1974 by Trevor Burchette and Maurice Tucker, then at the Geology Department, University College Cardiff.

Fig. 3a . Dinosaur footprints of Anchisauripus type from Bendrick Rock, now in the National Museum of Wales, Cardiff

Fig. 3b. Dinosaur footprint of Anchisauripus type from Bendrick Rock, now in the National Museum of Wales, Cardiff.

There are two sizes of footprint, one about 10 cm in length and the other up to 20 cm in length; both have 3 toes (Fig. 3 a and b).

There were many trackways composed of the smaller footprints on the top surface of a sandstone which had mudcracks and ripples. This surface, covering an area of some 25 square metres, is on display in the National Museum of Wales in Cardiff. Both sizes of footprint were assigned to the ichnogenus *Anchisauripus* by Tucker & Burchette (1977). Sadly, many of the footprints at Bendrick have been removed over the years by collectors and they have appeared for sale in rock-shops. The site is actually protected, being an SSSI, so it is illegal to take specimens from there. However, the party was lucky to find a good number of convincing footprints still visible on the bedding planes.

Along the coast at Bendrick there are palaeosoils developed within the succession and these show polygonal patterns of dolomite ridges, and nodules of dolomite. There are also numerous geodes ('potato-stones') composed of calcite in nodular dolomitic mudstone which were originally nodules of gypsum-anhydrite. The depositional environment was probably a saline sabkha which endured long periods of subaerial exposure, developed in the supra-littoral zone around the margin of the Mercia Mudstone lake. There are collapse features and disturbances too within the strata, which are likely the result of dissolution of evaporites (gypsum and/or halite) precipitated in the mud. Some of the dolomites could be dolocretes, precipitates forming close to the groundwater table, or in the capillary zone above.

After lunch, the group moved to Sully Island (Grid Ref: ST 169669) which can be reached at low tide by a rocky path across the foreshore (but only cross when the tide is falling!) from Swanbridge. On the cliff along the southern side of the island there is a spectacular outcrop of the marginal Triassic resting on Carboniferous limestone (Fig. 4).

Fig. 4. The cliff at the SE corner of Sully Island showing the marginal Triassic lacustrine facies resting unconformably upon, and onlapping, the Carboniferous limestone. The section is faulted, with the down-throw to the right / east. Lacustrine limestone occurs at the top of the cliff with nodular dolomitic mudstone below, much of which once contained evaporites (gypsum-anhydrite, possibly halite too). More clastic, shoreline facies occurs directly upon the Carboniferous bedrock, which formed an island at the time.

A well-developed lacustrine limestone is exposed at the top of the cliff, which was deposited in shallow-water in the marginal part of the lake, as shown by a range of sedimentary structures. Much of the red limestone is fenestral – that is containing small cavities (a few mm across) filled with calcite spar, called bird's eyes. This is the typical facies of a tidal flat or in this case, since the lake would not have had tides, a littoral flat – a planar area around the margin of the lake, at times covered by water and at other times subaerially exposed. The bird's eyes are cavities formed by the sediment drying out and the trapping of gas there. In addition, there are stromatolites, formed by microbial mats, and tepee structures resulting from cementation of the sediment surface and its expansion and buckling to form pseudoanticlinal features. Within the lacustrine limestone there are also palaeosoils, in the form of vertical calcite nodules – a type of calcrete, and below, layers of hematite-dolomite which represent a ferricrete (laterite). There are also local travertine-spring deposits, laminated calcite flowstone and large crystal pisolites, the result of freshwater, possibly warm, emerging from the Carboniferous limestone bedrock along faults (Leslie et al. 1992). Also of note and occurring below the limestone in nodular dolomite (probably a dolocrete), are numerous nodules of quartz, some with well-formed crystals inside. These are similar to the 'Bristol diamonds', geodes which are common in the Triassic of the Bristol area, and formed through replacement of anhydrite (Tucker 1976).

Back in Triassic times, some 200 million years ago, the Bristol Channel area was basically part of an extremely large lake extending down to Dorset with a shoreline in South Wales and the Bristol District where sabkhas and littoral flats existed and the various sedimentary rocks seen on this fieldtrip were deposited. There were hills around (now the South Wales coalfield and Mendips) composed of Carboniferous rocks, which supplied debris to the shoreline through flash floods descending down wadis and channels. The Middle East today has a similar climate, and many of the marginal lacustrine sediments are similar to those now being deposited along the Trucial coast of Abu Dhabi.

With clouds gathering and a cool wind blowing off the sea, the fieldtrip came to an end.

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Why is flint found in Islay?

by Isabel Buckingham

In 1979 an archaeological dig at a Bronze Age site on the island of Islay unexpectedly found a flint assemblage from a location where flint had been worked. As Ireland is the nearest land, they assumed that was where the flint and possibly the people had come from. Over the years a mix of random chance, observant crofters and deliberate searches has revealed more sites and information well summarised in ScARF South Hebrides Mesolithic Project.

While there was some contact with Ireland there are stylistic differences in the microliths and it is now known that the Mesolithic was found not only on the west and east coast of Scotland but inland in the Tweed valley, Aberdeenshire and to Orkney and Shetland. In Scotland stones are used locally and apart from an occasional high status object they are worked and used where found.

In Islay the sites are only in the Rinns on or near the west coast. Some sites show recurrent use and charcoal has given dates of 7250 +_45 BP, 7930 +-59 BP. These sites are near where flint is found in *diamictons* a convenient word that avoids stating whether this is till, or ice drop deposit. These deposits are only found on the Rinns which is part of the puzzle. High level glacial deposits to a height of <60m OD have yielded dates by Thermoluminescence of 53.9ka BP to 41.4 ka BP while those lower at Kilcairn gave >150ka BP. These flint and chalk erratics are totally absent from the more recent fluvo glacial deposits to the east on the Rinns or the low area joining Loch Indaal and Loch Gruinard which only became land about 2ka BP.

These are four possibilities:

Chalk exists in N Ireland but is largely covered by extensive Tertiary Basalt flows. It is only exposed along the coast. Did people transport this to Islay? That was the earlier assumption but the sea is stormy with strong tidal currents and the stylistic differences and other evidence make this unlikely.

Could chalk with flint have been plucked from N Ireland and moved north? Conventional thinking has the Irish and Scottish ice sheets joining and flowing to the edge of the continental shelf. The Donegal-Barra fan is interpreted as debris flowing from the ice. As the distinctive Ailsa Craig granite is found in the South West of England it is assumed the flow was southwards. However there is one possibility that this may have happened once.

Some chalk is still found in a tiny area of Skye. All striations show an east to west movement. Doubtless there were several cycles of erosion and deposition. Flint gravels are found near Buchan, and SW of Peterhead on hill tops up to 100m above sea level. They were worked in the Mesolithic, and suggest a widespread now remover Cretaceous cover.

Further east? Chalk fragments in a volcanic vent in Arran are well attested. There is the large Loch Gruinard fault on the east side of the Rinns which is a branch of the Glen More fault. It may be a half graben. There is a down throw to the east. Could Cretaceous rocks be found in the bed of Loch Indaal?

Fig. 1: Kilchairan storm beach