GEOLOGICAL SITES of the Bristol Region

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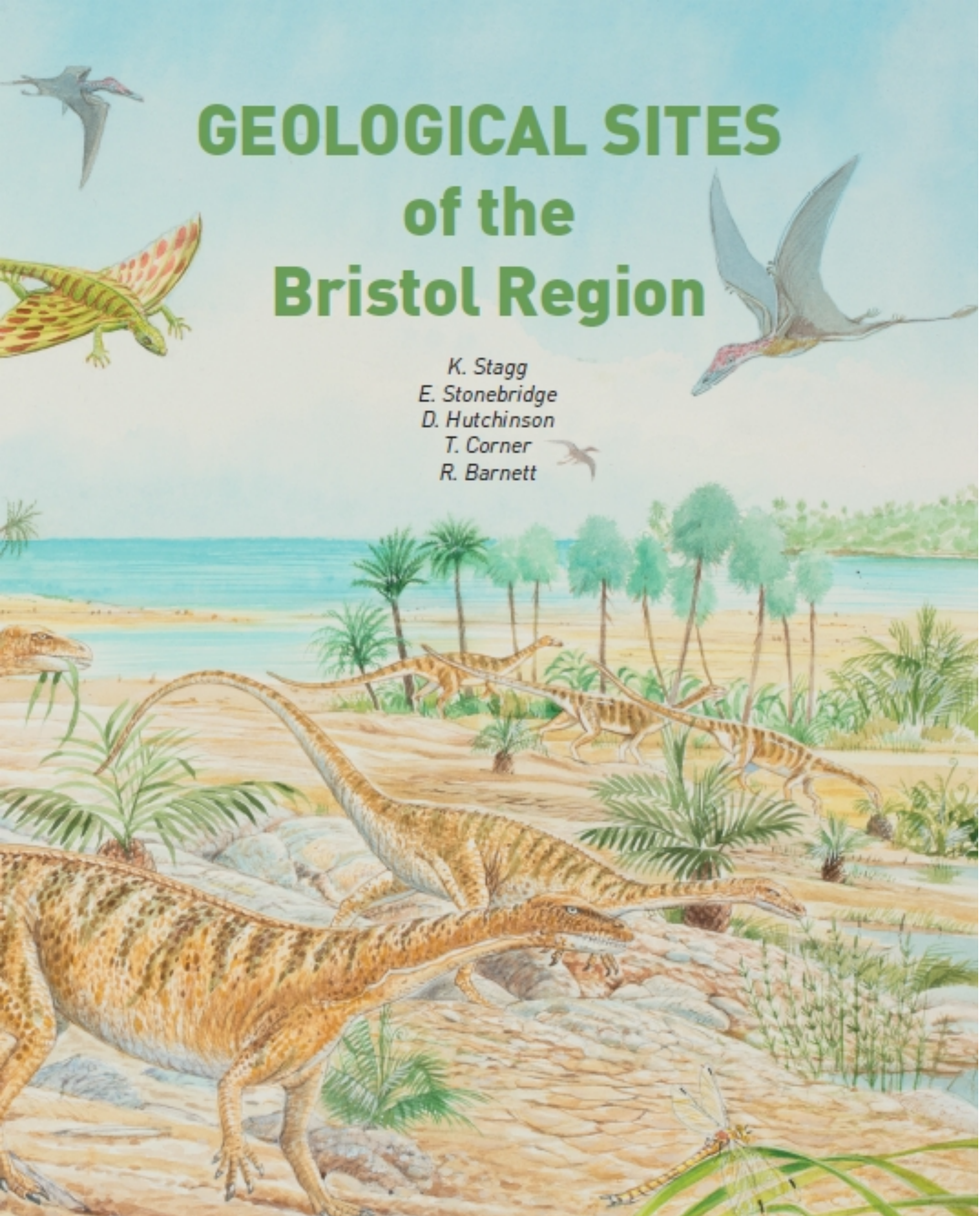


WILDLIFE AND GEOLOGY OF THE BRISTOL REGION: 5

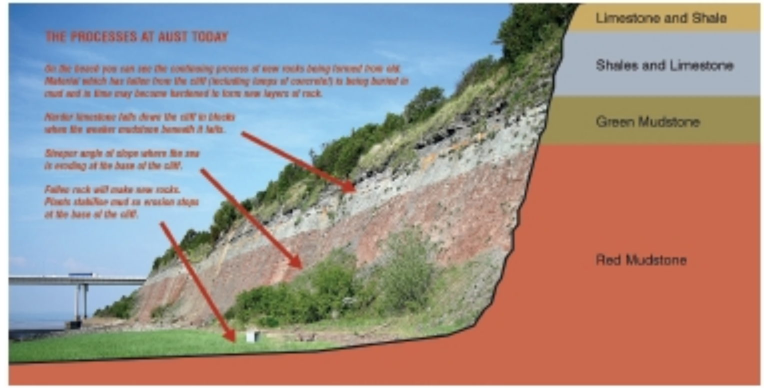
Severn Estuary mudflats at Littleton Warth.
South Gloucestershire 'A Forgotten Landscape' project (James Flynn)

The Bone Bed of the Westbury Formation
At the base of the Westbury Formation is the famous Westbury bone bed. It consists of 15cm-thick blocks of a conglomerate, mainly of small lumps of green-grey siltstone and quartz pebbles, with a concentration and a diversity of well-preserved vertebrate fragments all cemented into a sandy matrix. Larger fossils include pieces of bone, now identified as part of a basal sauropod (Redelstorff *et al.*, 2014). Smaller fossils include ichthyosaur bone fragments and plesiosaur teeth and coprolites (fossilised excrement). Pieces of the bone bed and the moulds and casts of bivalves can be found in rocks that have fallen from the cliff onto the foreshore. There is also a good display in the Bristol Museum & Art Gallery.

The Cotham Member
The Cotham Member, named after Cotham House in Bristol, has provided specimens of flora and fauna distinct from the Westbury Formation. These species, including the well-known algal-derived Cotham Marble from the uppermost horizon, indicate fluctuating water levels in a lagoon. There is an ongoing lively debate based on geological and geochemical evidence from the Cotham Member both in the Aust area and from St. Audrie's Bay and Lavernock Point of seismic, volcanic and meteor impact events, and their association with an end-Triassic mass extinction (Simms, 2007; Deenen *et al.*, 2010).

The top of the cliff at Aust is mostly overgrown, but the Blue Lias, which consists of clays interbedded with limestones are visible in places, lying disconformably above the Cotham Member. The fossil record, which includes ammonites of Hettangian age, indicates a marine environment.

There is a prominent fault in the cliff face before the bridge footings. It helps with identifying the strata from the foreshore as the beds can



The processes which can be observed at Aust Cliff today.
John Graham; based on the original from the Avon RIGS Group

be visually traced until a disjuncture at the fault. There are several other normal faults in the cliff, some of which give rise to springs on the foreshore. At the concrete causeway for example, there is a faulted section which has a promontory at the base where spring water, rich in dissolved calcium carbonate, is precipitating a type of limestone called travertine, forming mounds and domes of tufa. Geological and geochemical processes are continuing today.

Geomorphology
This site demonstrates the dynamic processes acting on this river cliff. Occasionally there are rock falls and landslips, particularly after wet and stormy weather. On a smaller scale, the sound of small particles of falling debris can be heard on a still day. Rainfall seeping into the cliff weakens the face and gravity pulls material to the ground. In winter, water freezes in the cracks and joints forcing a thin layer of debris to split off. Strong winds and currents at high tide cause the base of the cliff to be undermined causing more rock to fall. It is a truly dynamic site.

Many years ago a much longer length of the cliff could be seen. However, the dynamics of the currents moving the estuarine mud caused it to build up, protecting the base of the cliff. Since the building of the Severn Bridge and the second Severn crossing, even more material has built up on the foreshore. Colonisation by the Common Reed has helped to stabilise the sediments, thus forming new land. An indication of the amount of new land can be seen from looking at the old ferry landing stage which last operated in 1966: no boat could get there now.

Where erosion has occurred at the base of the cliff, it has degraded into a slope which has become colonised by terrestrial vegetation. This has obscured the solid geology in places.

Comparison of the modern cliff face with that drawn by Reynolds in 1912, gives an indication as to how much has been obscured. However, a considerable length of cliff is available for study — though only from a distance as the cliffs are unscalable and unstable. A much better source of information are the fallen blocks which litter the beach and it is from these that our knowledge of the geology has been obtained.

This account was in part based on John Byles' blog for the Avon RIGS Group.

View of the Avon Gorge from a hot air balloon.
Bob Griffin

(1793–1861) and Samuel Jackson (1794–1869).

The Avon Gorge is a classic geological site which has a long history of scientific research. Two important early geologists, William Buckland (1784–1856) and W.D. Conybeare (1787–1857), published on the site as long ago as 1824 (only a year after the Bristol Institution was officially founded), highlighting the main features of the geology as understood at the time.

In 1905, Arthur Vaughan (1868–1915) published important work based on careful fieldwork and study of the Avon Gorge sequences. The papers he published which detailed the geology of the Avon Gorge, were instrumental in the development of the discipline of stratigraphy. His work carefully identified and described the changing rock types found in the sequence seen in the Avon Gorge, based on the fossils in each layer, creating 'biozones'. This led to the Avon Gorge being recognised as the standard for the Avonian stage of the Lower Carboniferous because the section shows a complete local succession of Lower Carboniferous Limestone.

However, more recent research has shown there to be an unconformity in the middle section of the sequence (not easily seen in the rock face in the Avon Gorge), making the succession incomplete. Carboniferous rock successions from elsewhere in the country were later discovered to show the sequences that are absent in the Avon Gorge. Vaughan's work was revised in 1936 by S.H Reynolds, and further work by Kellaway and Welch (1993) in the later 20th century has led to other classifications of the Avon Gorge rocks based on lithology.

Geology

Late Devonian

The oldest rocks in the Avon Gorge are from the **Old Red Sandstone.** These rocks are best seen from the west bank close to Leigh Woods, downstream from the Black Rock Quarry. Cropping out in the Avon Gorge at the top of the Old Red Sandstone is the Sneyd Park Fish Bed, comprised of conglomerates, sandstones and mudstones deposited by meandering river systems in an arid environment. They are iron-rich giving them their beautiful red colour, and as the name suggests, these beds contain fossil fish material.

Fossils are not common in the Old Red Sandstone, but important and very rare plant fossils of early ferns from the Avon Gorge have been described as being instrumental in the study of early plants. The site presents perhaps the best Late Devonian plant fossils in the UK in terms of their diversity and preservation.

Lower Carboniferous

The deltaic flat and arid land of the Devonian Old Red Sandstone was eventually submerged by the incoming sea in the Early Carboniferous. The Bristol area became covered in shallow tropical waters which stretched from modern day Belgium into west Wales. The Late Devonian sandstones transition into the marine deposits of the Shirehampton Beds, which are composed of sandstones, limestones and mudstones. Above this, are the thick, well-bedded sequences of fossil-rich Carboniferous limestones. These deposits make up the main exposures of geology on display in the Avon Gorge cliffs and consist of many easily observed individual beds and bedding planes. Tectonic faulting has also influenced the exposures, so it is not always easy to trace individual beds across the face of sections of the Gorge.

Some of the best exposed rock units are to be seen on the east bank of the Avon Gorge next to the A4 Portway. In the descriptions that follow the names used for the different lithological units are as given in Kellaway and Welch (1993); some of these names are now technically obsolete but are retained here due to widespread use in the existing literature.

Devonian early ferns.
Courtesy of the National Museum of Wales

- Lower Limestone Shale Group

The oldest rocks seen in this section are the **Lower Limestone Shale Group**, where the **Shirehampton Beds** can be seen. These sediments represent the transition from a terrestrial environment to the fully marine conditions of the main Carboniferous rocks that follow after them. The Shirehampton Beds are comprised of limestones, shales, calcareous sandstones and crinoidal limestones. The top of the beds are marked by the **Bryozoa Bed**, a sequence of pink and grey limestone about

Strata of the east side of the Avon Gorge. *Richard Arthur*