

Stormy Down, near Bridgend, to comprise only one or two bands of compact white limestone, there is no sufficient reason to regard the 30 or 40 feet of White Sutton stone as Rhætic on the ground that it consists of pale beds at the base of the Lias.

At Stormy Down there is a thin conglomeratic band at the base of the Lias Limestones, which there belong to the zone of *Ammonites planorbis*, and this band occurs on top of the beds that are admitted to represent the White Lias. It has been taken to correspond in a feeble way with the Sutton Conglomerate. There is no reason to dispute this, but a conglomeratic band suggesting a local change in conditions should be grouped rather with the overlying than with the underlying beds, and hence we need not hesitate to place it and the Sutton stone also in the Lower Lias. The peculiar characters of the Sutton stone may be due to its being derived largely from islets of Carboniferous Limestone, and to the limestone-mud being mixed to some extent with the *débris* of corals.

NOTE.—Since writing the above (see p. 531), I have had the opportunity of visiting Goldcliff, in Monmouthshire, and of seeing the Bone-bed described by Mr. Lee. (See also his ‘Note-book of an Amateur Geologist,’ 1881, p. 72, and plates 171 and 172. He, however, omitted to point out that the Bone-bed there occurs beneath three feet of the greenish-grey marls, which are thus shown to be intimately linked with the *Avicula-contorta* Shales above.—H. B. W.]

NOTE ON THE SOUTH WALES COAL-FIELD.

By F. W. RUDLER, F.G.S., President.

During the approaching visit of the Association to South Wales exceptional facilities will be offered for making an Excursion into the heart of this coal-field, under the able guidance of Mr. William Galloway, of Cardiff. To those who are about to avail themselves of this opportunity, it may be useful to possess a general sketch of the physical characters and geological structure of the district about to be visited.

While occupying the greater part of Glamorganshire, the coal-field of South Wales stretches to a greater or less extent into the four neighbouring counties of Monmouth, Brecknock, Carmarthen, and Pembroke. As seen on a geological map the Coal-measures

occupy an irregular oval or pear-shaped area, having its longest axis in an east and west direction, and tapering towards the west. The southern margin of the field is deeply indented by Swansea Bay, while further to the west it is so completely cut into by the waters of Carmarthen Bay that the western portion is severed from the main area, and thus forms the isolated coal-field of Pembrokeshire.

The extreme length of the larger portion, measured from Pontypool in the east, to Kidwelly in the west, is about 56 miles; while the greatest length of the Pembrokeshire area is 17 miles. The maximum width of the large field, not far from the meridian of Cardiff, is nearly 20 miles. The total area of the coal-field, though variously estimated, may be set down at about 950 square miles; it is thus, with the exception of the Clyde basin, the largest coal-bearing tract in Britain.

The Coal-measures of South Wales form a true basin, the dip being everywhere from the margin inwards. Along the southern border the dip is greater than along the northern outcrop; but the beds near the southern edge, after plunging inwards, at varying angles up to 30° or 40° , are soon elevated, and fortunately brought within easy reach of the miner by means of a great anticlinal ridge, which traversing the field in an east and west direction, may be traced, more or less continuously, from Risca through Maesteg to near Aberafon. The effect of this elevation is to divide the coal-basin into two elongated troughs; and since the axis of upheaval is much nearer to the southern edge of the field than to the north, it follows that the southern trough is narrower than its northern neighbour. It should be noted that the field is also disturbed by other anticlinals of subordinate magnitude and by numerous faults. The faults run chiefly from north-north-west to south-south-east, and have in some instances a downthrow of as much as 300 yards.

The Coal-field is traversed by a succession of narrow deep valleys, running generally in a north and south direction, and corresponding in many cases with lines of dislocation. Much of the field may be regarded as a plateau of Coal-measures deeply trenched by picturesque valleys, between which are tabular hills and rugged heights of sandstone. The highest ground is Carn-fach, to the south-west of Hirwain, in Glamorganshire, which rises to an altitude of 1,971 feet above sea-level. It is naturally in the valleys that most of the great industrial centres are situated. The principal of these parallel valleys are those of the Nedd, the Afon,

the Ogwr, the Taff, the Rhymney, and the Ebbw, with their tributaries. Rapid streams, flowing into the Bristol Channel, run through most of the valleys. On an alluvial tract, at the mouth of the Taff Vale, Cardiff is situated, and it is up this valley, and its tributary the Rhondda, that the Association will make its Excursion.

These transverse valleys by cutting deep into the Coal-measures offer unusual facilities for winning the mineral, and for effecting its transport by railway and canal. Valuable coal-seams cropping out on the sides of the valleys long ago invited the miner to work them by open quarry, or tempted him to follow them by driving his adit into the hill-side. Documentary evidence exists to show that the coal of this area had attracted attention some three centuries ago, though the resources of the field remained practically undeveloped until pit-coal came to supersede charcoal in iron smelting. The steam-coal trade—an industry of first importance in the district—is a development of the last half-century.

The coal-field of South Wales is almost encircled by a belt of Carboniferous Limestone. On the north this limestone rises into hills upwards of 1,200 feet high, forming mural escarpments overlooking the Old Red Sandstone; while in the south the scenery is less bold and the hills rarely reach an elevation of 500 feet. In the latter region the older rocks are, to a large extent, concealed by coverings of Dolomitic Conglomerate and Lias, and also by Glacial Drift. In the eastern part of the field the Coal-measures rest upon Millstone Grit, but to the west of Swansea Bay this formation disappears, and the lower measures repose on Carboniferous Limestone, while at Haverfordwest this, in turn, is lost, and the Coal-measures are based directly upon Lower Silurian (Ordovician) strata.

The vertical thickness of the Coal-measures varies in the different valleys, but the maximum has been estimated at from 7,000 to 10,000 feet. At the base of the Coal-measures is the "Farewell Rock," a marine sandstone, associated by some writers with the Millstone Grit. The Lower Coal-Measures—known sometimes as the "White Ash series" and the "Lower Shale series"—contain not only the most valuable seams of steam-coal, but the principal bands of clay-ironstone. Seams of workable coal, reaching in some cases a thickness of upwards of nine feet, and extending with remarkable persistence over a wide area, are so numerous as to form an aggregate of about 50 feet.

Above the lower division of the Coal-measures is the "Pennant series," a group of beds containing steam-coal of fair quality, with black-band ironstone, but on the whole less remarkable for its mineral wealth. The inferior beds of the Pennant series, immediately overlying the Lower Shale group, are sandstones passing into a siliceous conglomerate known locally as the "Cockshoot rock." The upper series of Coal-measures has suffered great denudation, but valuable relics have been preserved, and the famous Mynyddysllwyn seam, which yielded a household coal of great value, now almost exhausted, occurs low down in this series.

One of the most noteworthy features in the coals of South Wales is the change which they suffer with respect to their bituminous character in passing across the field from east to west. Speaking in broad terms, it may be said that coal of normal character may be found in the south-east, this bituminous fuel being suitable for household purposes, and yielding "smalls" that readily coke. Towards the centre of the field the coal becomes less bituminous, passing into a "dry" or non-coking coal, free burning yet practically smokeless, and known as semi-bituminous or "steam-coal." Finally this merges in the north and west into true anthracite or "stone-coal."*

It has often been supposed that this change is due to the proximity of some igneous rock, which has effected a kind of natural distillation of the neighbouring coal. In Pembrokeshire, where the seams are much contorted and faulted, coal is occasionally found "burnt" in the vicinity of the trappean intrusions. But by far the larger part of the South Wales coal-field is remarkably free from such disturbances; nor is there reason to believe that any large masses of igneous rock are concealed at moderate distances below. Mr. Galloway, our Director, has suggested, with much

* George Owen, of Henllys, who wrote a description of the South Wales coal-field in the latter part of the sixteenth century, quaintly describes the Welsh anthracite as a coal which "being once kindled giveth a greater heat than light, and delighteth to burn in dark places." Moreover, it "is not noysome for the smoake nor nothing soe lothsome for the smell as the ring cole is, whose smoake annoyeth all things neare it, as fyne linen, men's handes that warm themselves by it; but this stone cole yeldeth in a manner noe smoake after it is kindled, and is soe pure that fine camericke and laune is usually dried by it without any stayne or blemish, and is a most proved good dryer of malt—therein passing wood, ferne, or straw." This essay by George Owen was described by Buckland and Conybeare as "a work of the highest interest, as being the earliest example extant in any language of what can properly be called geological investigation."—*'Trans. Geol. Soc.,' Ser. ii, Vol. i, p. 312.*

probability, that the change may have been brought about by a gradual rise of temperature towards the north-west, connected with the thickening of the strata in that direction. He assumes that originally the coal-seams in the north-west of the field were covered by a much greater thickness of beds than in the south-east, and being thus buried deeper beneath the surface they must have been exposed to a higher temperature, which would tend to induce more or less complete de-bituminization of the coal.

EXCURSION TO THE FOREST OF DEAN, WYE VALLEY, AND SOUTH WALES.

MONDAY, AUGUST 6TH, TO SATURDAY, AUGUST 11TH.

Directors: THE PRESIDENT; WILLIAM GALLOWAY, of Cardiff; W. F. GWINNELL, F.R.Met. S.; J. STORRIE, Curator of the Cardiff Museum; T. H. THOMAS, R.C.A., President of the Cardiff Naturalists' Society; DR. C. T. VACHELL, of Cardiff; and E. WETHERED, F.G.S., F.C.S., F.R.M.S., Hon. Sec. Cotteswold Naturalists' Field Club and Cheltenham Nat. Hist. Soc.

(*Report by THE DIRECTORS.*)

Monday.—Gloucester had been chosen as a convenient centre for the work to be undertaken on Monday and Tuesday, and here the party was met, early on Monday morning, by Mr. Wethered, who acted as Director during the day. From Gloucester the train was taken, on the Ross and Hereford line, to Mitcheldean Road, at the extreme north-eastern corner of the Forest of Dean. A move was at once made in the direction of Baily Hill, and on the way thither an exposure of Old Red Conglomerate was seen. The Director here called a halt for the purpose of explaining the structure of the surrounding country. He pointed out the features of the Old Red Conglomerate, which, he remarked, pointed to an alteration of the conditions which had allowed of the deposition of the Old Red Sandstone beneath, and to a coming change which brought in the Carboniferous rocks. For this reason he asked them to mark well this Conglomerate, as he regarded it as the upper limit of the Old Red and Devonian rocks of the west of England. The beds which intervened between it and the true Carboniferous strata were, in his opinion, transitional, and should be so regarded.