

the "jubilee number." O. Bergstrand writes on the effective wave-lengths of the galactic stars; A. S. Eddington on the dynamical equilibrium of the stellar system; P. Guthnick and A. A. Nijland on the Cepheid problem; J. G. Hagen on dark nebulae;

H. Shapley on the galactic distribution of the B stars; and H. v. Zeipel on the masses of stars in clusters. The list is not exhaustive, but will serve to give an idea of the varied contents of this memorable publication.

Geology of the South Wales Coalfield.¹

AS is pointed out by the Director in the preface to the memoir under notice, the district, though not containing many deposits of economic importance, includes a very extensive series of rocks, ranging from the Ordovician to the New Red, and the hope is expressed that the district will be recognised as a typical area for the study of the formations represented, as developed in S.W. Wales.

The area shows considerable physical diversity. The highest ground is formed by remnants of a plateau mainly consisting of Lower Old Red Sandstone. The remnants are separated from one another by erosion-valleys and by level tracts chiefly composed of Carboniferous Limestone. The latter are referred to as the limestone flats, and considered to be probably the work of the Pliocene sea. The remarkably level character of these flats is shown in the frontispiece. The coast is deeply indented by partly drowned valleys (rias), of which the chief is Milford Haven. Many of the valleys are independent of the geological structure, and afford examples of superimposed drainage.

The oldest rocks occurring in the district are shales and sandstones belonging to the Llanvirn series exposed in the anticlines of Freshwater East and Castle-martin Corse. Here, too, are seen Silurian rocks, which both lithologically and in fossil-contents are of the Welsh-borderland type.

The Old Red Sandstone is specially interesting from the intercalation in the upper beds of bands containing a marine Devonian fauna. These bands, which were originally noted by de la Beche, and afterwards referred to by Salter, have yielded more than fifty species of fossils, by far the greater number coming from Freshwater West. The author considers that apart from these marine intercalations in the highest beds, the Old Red Sandstone represents an aqueous deposit formed under "continental" conditions. He does not believe that any of the rocks are directly æolian, the sandstones being too well bedded and conglomeratic to represent sand-dunes, and though the marls may be formed of wind-borne dust, it probably settled in water.

The Old Red Limestones "probably represent precipitates thrown down as the fresh, tributary waters carrying the calcium carbonate in solution mingled with the more saline water of the basin of deposition." The breccias and conglomerates of the Upper Old Red contain much igneous material, chiefly acid lavas, which, Dr. H. H. Thomas points out, "show a general resemblance to the pre-Cambrian and lowest Palæozoic rocks of Pembrokeshire, more particularly of the part north of St. Bride's Bay." In the Ridge-way conglomerate of the Lower Old Red Sandstone the pebbles are chiefly quartzite, igneous material being almost unrepresented.

The Carboniferous Limestone Series (Avonian) is perhaps the most interesting formation in the area, and the full account now available will be most acceptable to all students of these rocks. The author, like all other workers on the Carboniferous Limestone, has been deeply influenced by the work of the late Dr. Vaughan, to whom he "cannot adequately express his indebtedness." The faunal subdivisions

recognised are in the main those of Vaughan's original paper, but the author draws the line between the Upper and Lower Avonian at the top of the C₁ beds, where a marked transgression occurs in the northern part of the South Wales area, instead of at the top of C₂, where Vaughan originally drew it.

The study of the rock-types of the Carboniferous Limestone Series is one which the author has made peculiarly his own, but he has already treated the subject so fully in describing the rocks of Gower that there is comparatively little of a novel character in the present memoir. A description is given of the interesting reef dolomites, and of the characters which lead the author to compare them with the reef or knoll limestones of Clitheroe and the Belgian Waulsortian. They occur in the C beds of the extreme south-west corner of the district, and appear to be essentially bryozoan reefs. Oolites have been recognised at an exceptionally large number of levels in the Lower Avonian. In very numerous respects mentioned by the author the rock-types are identical with those of the Bristol district. The term "Zaphrentid-phase," which was introduced by Vaughan, but not defined, is employed by the author, who defines his use of the term. A very lengthy fossil list is included.

The "Millstone Grit"—the term used to include the sandstones and shales intervening between the Carboniferous Limestone and the Coal Measures—though well exposed, is greatly disturbed, and the strata are difficult to correlate. The lower beds are shown to contain radiolarian chert and fossils of Pendleside type, while the presence of certain plants in the upper beds appears to indicate an horizon as high as the Middle Coal Measures of the Midlands.

Certain deposits of a peculiar character preserved in fissures or cavities of the Carboniferous Limestone are the only ones referred to the New Red (Trias). The most remarkable of these are the gash-breccias, which are fully described, and illustrated by an admirable plate. The author considers that they are probably due to the collapse of the roof and sides of cavities formed by the underground solution of the limestone.

A particularly full and interesting account is given of the earth-movements which have affected the district, and while by far the most important are the post-Carboniferous (Armorican) movements, others occurred between the Llanvirn and Wenlock periods, between the Ludlow and the Lower Old Red Sandstone, between the Upper and Lower Old Red Sandstone, between the Upper and Lower Avonian, and between the Carboniferous Limestone and Millstone Grit. All the chief strike-faults are overthrusts of Armorican date, while the cross-faults, which are tabulated, also appear to belong in the main to the same period of disturbance.

The district differs from Gower and some other parts of South Wales in that glacial deposits are nowhere seen resting in clear sequence on undoubted raised-beach.

The memoir is illustrated by five fine plates and an admirable series of sketch-maps. It everywhere bears evidence of the minute observation and thoroughness which are so characteristic of the author's work.

¹ Memoirs of the Geological Survey: England and Wales. "The Geology of the South Wales Coalfield." Part 13: "The Country around Pembroke and Tenby." By E. E. L. Dixon. (Southampton: Ordnance Survey Office; London: E. Stanford, Ltd., 1921.) 8s. net.