gneiss (II.). Here the relation between the granite and gneiss becomes rather puzzling; I have shown its details in a profile (1:10,000) on pl. V. of the map, and described them in a paper ("Ueber das Verhältniss des Granits zum Gneiss am Gotthard") read at the 55th meeting of Deutsche Naturforscher u. Aerzte, held at Eisenach, 1882.

WEISSENSEE, BERLIN, 7 Oct., 1891.

III.—THE FAUNA OF THE OLENELLUS ZONE IN WALES.

By HENRY HICKS, M.D., F.R.S., Sec.G.S.

IN his recently published excellent Memoir on the "Fauna of the Lower Cambrian or *Olenellus* Zone,"¹ Mr. Walcott has referred briefly to the presence of the fauna in Wales. The following additional facts bearing on the question may therefore be of some interest, and they will, I think, show that there is strong evidence in favour of the conclusion arrived at, that the *Olenellus* fauna occurs in the Caerfai Group of St. Davids, and in beds at the same horizon in North Wales.

South Wales.

In the year 1871, in a paper printed in the Q.J.G.S., vol. xxvii. p. 399, I described and figured some fossils which I had discovered near the base of the Lower Cambrian Rocks at St. David's. They were *Lingulella primæva*, *Discina pileolus*?, *Leperditia*? *Cambrensis*, and "part of the head of a Trilobite from a bed at the base of the purple rocks about 3000 feet below the Menevian Group" (i.e. in the beds immediately following the basal Cambrian Conglomerate, which rests unconformably on the Pre-Cambrian rocks). The Trilobite (head) (fig. 18, pl. xv.) was too indistinct for identification, and I refer to it now mainly to note the interesting fact that a Trilobite had been discovered at that time at the very base of the Cambrian at St. David's. What, however, has proved since to be of more importance was the discovery, about the same time, in a highly cleaved red slate near the same horizon, of several small fragments which I recognized to be portions of a Crustacean, but which I then incorrectly associated under one name in my description of *Leperditia*? *Cambrensis*. These fragments and others I have since obtained have now satisfied me that they are portions of heads of a species of *Olenellus*. In referring to them I said that some of the specimens "show a reticulated ornamentation." This form of ornamentation of the surface has now been shown by Professor Schmidt,² Mr. Walcott, and others to be characteristic of *Olenellus*. I am hoping that, ere long, another zone may be discovered, in beds which have suffered less from cleavage, and that it might be possible to give specific identifications, but at present it is only possible to say that the genus does occur there,

¹ Extract from the Tenth Annual Report of the Director of the U.S. Geological Survey, Washington, 1890.

² "Ueber eine Neuentdeckte Untercaembrische Fauna in Estland," St. Pétersbourg, 1888.

and that the horizon of the fauna is very near the base of the series. As this fauna is separated by about 1000 feet of red and purple sandstones and slates from the next overlying fauna (*Plutonia Sedgwickii* and *Conocoryphe Lyellii* zone), it is quite possible that other zones, containing different species, may occur between, for in the higher beds containing *Paradoxides* each important zone is characterized by a new species. In the Cambrian succession at St. David's the most marked changes in the sediments occur almost immediately below the *Plutonia* beds, and at the top of the Menevian, but the greatest palæontological break is undoubtedly at the close of the Menevian. This tempted me in former papers to divide the Cambrian at St. David's into an Upper and a Lower division only, but as, at present, there seems to be a desire to make a threefold division, there can be no serious objection to restricting the terms Lower Cambrian to the Caerfai Group (*Olenellus* fauna), Middle Cambrian to the Solva and Menevian Groups (*Paradoxides* fauna) and Upper Cambrian to the Maentwrog, Ffestiniog, Dolgelly and Tremadoc Groups. I may here mention that the sandstones at the top of the Menevian, which yielded *Orthis Hicksii* and other Brachio-pods, are now known to contain a *Paradoxides*, probably a new species, and a new species of *Conocoryphe* (which I hope to describe shortly). This somewhat extends the range upwards of *Paradoxides*, but the genus is still confined within the limit of the Menevian Group.

North Wales.

After referring to the fossils found in the Lower Cambrian rocks of St. David's, Mr. Walcott says (p. 580): "These, with the species from North Wales, described by Dr. Henry Woodward¹ as *Conocoryphe viola*, do not prove the presence of the *Olenellus* zone; but the weight of stratigraphic evidence is so strongly in favour of including them in its fauna that I shall do so. In the summer of 1888 I visited the locality of *Conocoryphe viola*, and found fragments of it associated with a species of *Hyalolithes*." Mr. Walcott's visit was made during the excursion of the International Geological Congress, which I conducted to the Penrhyn Slate Quarries, in 1888. The position of this fossil is given in the "Explication des Excursions," p. 38, as near the horizon of the *Plutonia* and *Conocoryphe Lyellii* zone at St. David's; but it is quite possible that it might be somewhat lower than that horizon, though evidently higher than the *Lingulella primava* zone. Most of the red and purple slates occur below the *C. viola* zone, and there are evidences of fossils in these beds. The succession in the Cambrian rocks at Penrhyn, Llanberis and in the Harlech Mountains, so nearly resembles that at St. David's that it has been possible to indicate the position in those areas of all the main zones found at St. David's, and at present it only remains for them to be worked out.

The following section contains the chief fossiliferous zones which are now known to occur in the Cambrian rocks of Wales, and by its side I place a section which was given for Wales in my paper

¹ Quart. Journ. Geol. Soc. vol. xliv. p. 74.

Chief fossiliferous zones now (1891) known to occur in the Cambrian rocks of Wales, compared with those known in 1875.

"On the Physical Conditions under which the Cambrian and Lower Silurian Rocks were probably deposited over the European Area," in the Q.J.G.S. for 1875, which has been reproduced by Mr. Walcott, along with the map and sections for other European areas, in his monograph. The main lines of division and zones remain as given in that section, but it has since been possible to make several important sub-divisions and to add new zones.¹

The information obtained since the Map was published has confirmed the view I expressed in the paper that wherever the base line of the Cambrian is seen throughout the European area, it is almost invariably found to "rest unconformably upon an earlier series of rocks," and that the beds varied in thickness and character in accordance with the unevenness of the old pre-Cambrian floor and along fairly well-marked lines of depression. It is not, of course, to be expected that there should be an unconformable break between the Cambrian and Pre-Cambrian in all parts over a very large area, and Mr. Walcott shows that there is conformity at that horizon in several districts in America. In future the faunas must determine the position where there is any doubt as to the presence of a physical break. In Britain fortunately there is evidence of a very marked break at the base of the Cambrian in all the areas examined.

IV.—READE'S THEORY OF MOUNTAIN-BUILDING.

By A. J. JUKES-BROWNE, B.A., F.G.S.

MR. MELLARD READE'S book on the "Origin of Mountain Ranges" has now been before the geological public for five years; it has been reviewed in this MAGAZINE and elsewhere, and several more or less weighty objections to the theory have been put forward; but no very complete examination of it has been attempted. This may be partly due to the manner in which Mr. Reade has presented his theory, for he has certainly been too diffuse over points which require very slight illustration and not nearly explanatory enough on other points of great physical difficulty.

Having had occasion to pay some attention to the subject, it has seemed to me that some of the difficulties raised by some of his critics are not so great as they imagine, while there are other difficulties which neither Mr. Reade nor his critics have sufficiently considered. It may seem rather presumptuous on my part to enter a field of controversy where such men as O. Fisher, C. Davison, and M. Reade, are the debaters, and where the chief weapons used—physics and mechanics—are such as I have small acquaintance with. But some of the questions dealt with can be handled without more than an elementary knowledge of these subjects, and I fancy there are many geologists who wish to know exactly how far Mr. Reade's theory can be accepted as a *vera causa*. In what follows, therefore, I am only endeavouring to assist in forming a conclusion on this point.

¹ See "The Classification of the Eozoic and Lower Palæozoic Rocks," Popular Sci. Rev. 1881, and "Recent Researches among Lower Palæozoic Rocks," Proceed. Geol. Assoc. vol. vii.