

corresponding to Barrande's *third* series of Trilobites in Bohemia. About 20 miles N.E. of Cordova, the upper Silurian is represented by beds of calcareous concretions, containing *Cardiola* and *Orthocera*. Devonian strata occur both N. and S. of Almadon, including the quartzites and schists of the mercury mines*; fossils of the genera *Productus*, *Leptaena*, *Spirifer*, &c. were enumerated. Carboniferous deposits are found further south, consisting of masses of limestone with *Productus semi-reticulatus*, and true coal-measures, of great value, but little worked for want of roads. The Sierra Cantabrica has an axis of Devonian rocks with fossils; and on its southern flank is the richest coalfield in Spain; the beds are vertical, but can be worked in the mountains 1,200 feet or 1,300 feet above the level of the streams; there are more than eighty workable beds, and the total thickness of the system must be 10,000 feet or 10,200 feet. The red magnesian limestone and gypsiferous marls of Montiel have been doubtfully referred to the *Permian* system. In this formation are the caves of Montesinos, explored by Don Quixote. The *Trias* has been traced from the Pyrenees to Santander, Asturias, and Leon, on both sides of the Cantabrian chain; it also occurs east of Madrid. *Jurassic* and *Cretaceous* formations extend over much of eastern and southern Spain, lying on the *Trias*, and constituting most of the high land east of Madrid. In Portugal, according to Mr. Sharpe, they are confined to the coast. In the south of Spain (Malaga and Ronda), these rocks have become so metamorphic that it is difficult to distinguish one from the other. Most of the *Jurassic* beds belong to the upper *lias*, characterized by *Ammonites Walcottii* and *Spirifer verrucosus*. The *cretaceous* system of Spain consists of the Hippurite limestone, or equivalent of the lower chalk, and of the equivalent of the green-sand, well developed in Santander and Biscay. Above the chalk is the *nummulitic rock*, now considered *Eocene*, seen at Santander, and containing *Conoclypus conoides* and *Serpula spirulea*. Nummulites are also found at Malaga, Motril, Tarragone, Olot, &c. The *Miocene tertiary strata*, chiefly of freshwater origin, are generally horizontal, extending as vast plains over Old and New Castile, from the Cantabrian chain to the Guadarrama, and from this to the Sierra Morena, sometimes reaching an altitude of 2,500 feet. The most recent beds contain living freshwater shells and bones of the elephant, near Madrid.†

'Notes on the Geology of the Southern Extremity of Cantyre, Argyleshire,' by Prof. NICOL.—The peninsula of Cantyre is connected with the mainland by an isthmus only a mile broad, and a depression of a few feet would convert it into several islands. The fundamental rock is an arenaceous mica slate, which runs nearly N. and S., and dips about 30° E. The red sandstone and conglomerates rest upon it almost conformably; the conglomerate attains an immense thickness, and consists of sand, pebbles, and rounded blocks, sometimes three feet or more in diameter; the blocks consist of porphyry, sandstone, hornstone, quartz, and trap, all of local origin. The red sandstone above is often almost a tufa of re-composed claystone-porphry. West of Campbeltown some beds of coal are wrought; it contains *Stigmariæ*, *Sigillariæ*, and *Lepidodendra*; with the coal are beds of porphyry and green-stone, by which it is singularly altered. In the cliffs south of Tosset some splendid veins of trap are seen, rising up through the mica slate, sandstone, limestone, and shale, and spreading out in the overlying beds. On the shore at Kilhousland is a mass of trap like a miniature Giant's Causeway; the vertical columns are divided by veins of calc spar, hæmatite and malachite. No *lias* or oolitic coal was seen, as represented by Dr. McCulloch, but there is a large mass of ordinary red till or boulder clay, with shingle beds above, often forming terraces. In the hollows of this drift are masses of peat, of great antiquity, and still increasing; leaves of the alder and other trees, nuts, &c. occur in the peat, whilst roots of birch and oak are found in the red clay beneath. All round the shore are cliffs and caves above the present level of the sea. Two caves in the hard porphyry of Davar

Island are 130 feet long, meeting in the interior. Regarding the mica slate of the Grampians as altered Silurian rocks, the author suggests that the arenaceous mica slate of Cantyre may be newer Silurian or Devonian rock in a similarly metamorphosed condition. The discovery of the large mass of trap (coloured as mica slate by McCulloch) brings Cantyre into parallelism with the south of Arran, and completes the band of igneous rock, commencing near Montrose, ranging across Scotland, and reappearing on the north of Ireland.

Dr. FLEMING remarked, that the interval between columns of basalt, amounting sometimes to six inches, indicated a remarkable degree of contraction on cooling.

'On the Representatives of the Mountain Limestone as they occur on the south and east of Dumfries-shire,' by Mr. R. HARKNESS.—This stratum was described as consisting of three divisions:—1. The lowest beds, hard white grits, 350 yards thick; 2. White and red sandstone, flagstone, limestone, ironstone, and thin seams of coal and slate, above 300 yards; 3. Variegated grits and conglomerates, from 150 to 200 yards. The hills formed by these strata are low and flat-topped, and the grit beds are exceedingly sterile, producing only gorse and heather, contrasting with the fine pasture of the sheep-walks on the tracts occupied by the altered Silurian strata.

Mr. HARKNESS exhibited a drawing of the foot-prints of a biped from the new red sandstone of Western Point, Dumfries;—and Sir W. JARDINE gave an account of the foot-prints in the same formation at Corncockle Mines, in the vale of the Annan, first noticed by Dr. Duncan, and described and figured by Dr. Buckland in the *Bridgewater Treatise*, where he compares them to the foot-prints of tortoises. The tracks run mostly in an east and west direction, as if the creature had made periodical journeys across the sands at low water.

TUESDAY.

'On the Geological Position of the Black Slates of the Menai Straits,' by Prof. RAMSAY.—The Professor exhibited a map of North Wales geologically coloured, and explained his reasons for regarding these black slates of the Menai as the equivalents of the "*Lingula* beds" of Prof. Sedgwick. He stated that the purple slates and sandstones of Llanberris were 3,000 or 4,000 feet thick, and overlaid by beds containing *Lingula*, interstratified with "volcanic ash" and feldspar porphyries, the whole being 10,000 or 12,000 feet thick. Near Bala there were small beds of this volcanic ash, two or three feet thick, overlaid by the Bala limestone; but these beds became more important westward, until they attained a thickness of several thousand feet. The summit of Snowdon was formed of them. He then pointed out that the trap-rocks of North Wales were of three dates:—1st, contemporaneous traps; 2nd, greenstones, at first appearing as if interstratified but in reality injected along lines of bedding; 3rd, great ruptive masses, such as those in the Horn of Caernarvon. The chlorite and mica slate of Caernarvon were probably altered Cambrian rocks. Their metamorphic condition had been induced at a very early period, since pebbles of them were found in the lower old red sandstone and pebbles of the trap rock in the carboniferous limestone.

Prof. SEDGWICK said that he had explored North Wales before the labours of the Survey commenced, and had arrived at and published most of these results; however, he was glad that what he had sketched out was being now done in detail, and that points of which he was doubtful were now being rendered certain. He objected to the term "volcanic ash," as being already in use for sub-aerial deposits, whilst these were plutonic.

'On the Parallel between the Superficial Deposits of the Basin of Switzerland and those of the Valley of the Po, in Piedmont,' by MM. MARTINS and GASTALDI.—1. *Ancient moraines*. In proceeding from the higher to the lower ground in both basins they met with numerous ridges, formed of erratic blocks, striated pebbles from the Alps, sand, gravel and clay mixed together, without any trace of stratification, indicating the long existence of glaciers. In Switzerland, Berne, Sursee, and other towns are built on moraines; and examples were seen in the great moraine of Mont Sion, between Geneva and Annecy, and that of the ancient glacier of the Rhone,

extending from Fort Ecluse to Soleure, along the eastern declivity of Jura. In Piedmont, the moraine of Rivoli, at the opening of the valley of Susa, that of Ivrea formed by the ancient glacier descending from Mont Blanc, Mont Rose, and Mont Coque, filling the valley of Aoste and extending over the plains as far as Calasso. 2. *Scattered erratic formation*, composed of gigantic angular blocks from the Alps, gravel with striated angular pebbles, and mud, brought down by the glaciers at the period of their greatest extension. In Piedmont it forms a band round the moraine, and is seen on the hill of Superga. In Switzerland it covers all the plain, from the lake of Geneva to the lake of Constance and penetrates the valley of Jura. 3. *Glacier diluvium*, formed of rolled and rounded pebbles from the Alps, which are never striated; it is sometimes stratified, but without fossils. It covers a great part of the basin of Switzerland, and is very deep round Geneva and Berne. The authors attributed its origin to the fusion of glaciers at the period of their oscillations. 4. *Ancient alluvium*, with small rolled pebbles, not derived from the Alps, and bones of pachyderms, *Elephas primigenius*, *Rhinoceros tichorhinus*, *Bos priscus*, *Cervus euryceros*, &c. In Switzerland it rests on *miocene* molasse, and in Piedmont on marine *pliocene* beds. Northern Europe and America having been submerged at this period, many marine deposits were accumulated of the same age with these glacier formations.

'On recent Changes of Sea Level,' by Mr. R. AUSTEN.—After remarking that many phenomena formerly classed as "raised marine beds or beaches" are now referred to distinct periods of time, the author proceeds to describe evidences of a former line of sea level on the headland west of Falmouth harbour. This "raised beach" is only eight or ten feet above the existing beach, and therefore partly within the influence of the present tides, which rise eighteen feet above low-water mark.

'Additional Observations on the Temperature of Mines in Ireland,' by Prof. OLDHAM.—Alluding to the former report, the deepest mine in Ireland was only 800 feet, and the increase of temperature, making all requisite allowances, amounted to only 1° for every 85 feet below the level of no variation; whilst in England and on the Continent the average increase was 1° for every 45 feet. Since then the same mine has been deepened to 1,200 feet and new observations have been made, but the results were the same. In another and older part of the same mine, 300 yards distant and 50 fathoms deep, the increase of temperature was ascertained to be 1° for every 52 feet.

A paper was communicated by the Rev. P. B. BRODIE, 'On the Inferior Oolite near Grantham.' (Not read, but recommended to be transferred to the Geological Society.)

'On certain extraordinary Peculiarities of Structure in the more ancient Ganoids,' by Mr. H. MILLER.—The fishes exhibited and described were obtained from the lower part of the old red sandstone in Scotland; they were in a very complete state of preservation and some of them entirely new or but imperfectly known from Russian specimens.

'On the Palæozoic Rocks of the South of Scotland,' by Prof. SEDGWICK.—After describing the development of the Silurian rocks in Cumberland, the Professor pointed out their parallels in the great chain of graywacke, of which the Lammermuir forms part; in the central part, or axis of the chain, the rocks consisted of coarser materials, and were more contorted, as at St. Abb's Head, whilst the newer rocks, both on the north and south, had a generally lower inclination.

Sir R. I. MURCHISON announced to the Meeting that M. Barrande was preparing a work on the Silurian rocks of Bohemia, and explained that in Bohemia they formed but a small basin, about 25 miles across, but abounding in fossils, and exhibiting an older series of organic remains than any known in England. Thus, although M. Barrande was no species-maker, but had united many which his precursors had considered distinct, he still possessed 250 species of trilobites alone; and amongst these he had discovered sexual differences and changes in the course of growth.

Dr. ANDERSON exhibited a collection of fishes from the yellow sandstone of Dura Den, and pointed out

* The mercury is not in veins, but dispersed through vertical strata of sandstone and carbonaceous slates; in the Asturias it occurs in coal-measure strata.

† There are three districts of extinct volcanoes in the Peninsula,—one at the Cape of Gata, one near Ciudad Real, and the third near Olot, in Catalonia.