

ravines, leaving many elevated peaks denuded of their most prominent features. Mr. Scott, engineer, then employed at Achozumio, about 14,500 feet high, describes the shocks there as terrific, and the noise, as if an immense mass of porcelain had, after being raised in the air, been then let fall and dashed to pieces. By his telescope, he saw the masses falling from the mountains, one of them leaving a space as large as St. Enoch's Square, Glasgow. On the 20th of January 1834, a terrible earthquake occurred in New Granada, by which the large towns of Popayan and Pasto, were entirely demolished, and many thousands perished. On the 21st of September 1834, Mr. Hamilton experienced a most severe shock, in which the movements of the earth were entirely vertical, and seemed to take place twice every second. He mentions also, the terrible earthquake on the coast of Chile, the 5th of February 1835, by which, the sea-port of Concepcion, and Talcahuano, the capital of the province, were totally destroyed. The sea then retired several times to a great distance, and returned in immense billows. It is believed, that new banks were then thrown up from its bottom, and that it was on one of these, that the *Challenger*, ship of war, a few months after, was wrecked.

#### MONDAY.

'On the Stratified Deposits which constitute the Northern and Central Regions of Russia,' by Mr. Murchison and M. E. de Verneuil, Membre de la Société Géologique de France.

Mr. Murchison, accompanied by M. E. de Verneuil, having just completed a tour of considerable extent in the northern and central districts of Russia, with a view to determine the general relations of the older stratified deposits of that empire, took this first public opportunity of giving a brief outline of some of the chief results at which his friend and himself had arrived, in anticipation of an extended memoir, which they purpose to prepare in the ensuing winter. The geologist who has been accustomed to the diversified outlines of physical feature which invariably characterize all those other countries of Europe in which the older sedimentary rocks exist, and has often had the utmost difficulty in working out their succession and classification, in consequence of the great disturbances and alterations to which deposits of this age have been subjected,—who has seen their frequent breaks, and sometimes even their entire reversal over limited areas, is delighted to find in so wide a portion of the earth's surface as northern Russia these strata spread in horizontal unbroken sheets; each great formation trending for distances of 1,000 miles, with few or no changes in its mineral characters or organic remains. Two great difficulties are opposed to the examination of this region: the slight altitude of the masses above the sea, which debars the chance of natural escarpments; and the vast quantity of drift or superficial detritus which obscures the fundamental rocks. To conquer these difficulties, the authors examined in succession, and as far as their time permitted, all the river banks between the longitude of St. Petersburg and that of Archangel, which, trending from north-north-east to south-south-west, might be expected here and there to offer the evidences they required, and, having ascended the great Dwina from the White Sea to Ousting Veliki, they afterwards extended their researches to the south of Nijny Novogorod, and the edges of the province of Tambof, to determine the relations of the secondary rocks to those older deposits with which they had become familiar.

The formations succeed each other in the following ascending order:—

**Silurian Rocks.**—The oldest stratified deposits of Russia (those on which the metropolis, St. Petersburg, is situated) are clays, sandstone, limestone, &c., which, from the organic remains they contain, are clearly the equivalents of the Silurian system of the British Isles. The detailed order of these beds was long ago accurately given by Strangways, but at the early day when he wrote, the study of organic remains was not sufficiently advanced to enable him to determine their place in the geological series, nor to point out their relations to the superior masses. Many of the organic remains have recently been described by a native author, Pander, and also by Eichwald, and some very characteristic forms by M. de Buch, from specimens sent to him by Colonel Helmersen. These Silurian deposits occupy the

islands of Oeland, Gothland, &c. in the Baltic, also the shores of Courland, and they trend thence in a broad bank from west-north-west to east-north-east, till they are lost under vast heaps of granite detritus, between the Lakes Ladoga and Onega. At the northern extremity of the latter lake, these deposits are deflected to the north, and there meet with great ridges of trappean rocks, which run from north-north-east to south-south-west. In that region all the deposits are in a highly altered state, and the limestones present few distinct traces of fossils; and the authors, having satisfied themselves that there was no chance of observing any further evidence of a descending order between such rocks and the great primary granitic chain of Scandinavia and Russian Lapland, the edges of which they coasted, afterwards confined their attention to the ascending order of the strata.

**Old Red or Devonian System.**—That the inferior strata are the true equivalents of the Silurian system was determined not only by their aspect and fossil contents, but by their passing into other overlying rocks which are completely identical with the "old red system" of the British Isles, as defined by Mr. Murchison. This system is of enormous extent in Russia, ranging from the borders of Poland; Lithuania is chiefly composed of it, and Dörpat is in its centre. It thence ranges by the lakes of Ilmen, and the Waldai Hills, and is extended over an enormous region to the west-north-west, where it constitutes much of the shores of the White Sea. This vast system consists of flagstone, clays, marls, concretionary stones, and sandstones, the whole bearing a striking resemblance to the deposits of the same age in our Isles; from which, however, they differ in containing copious salt springs, and much gypsum. It was the occurrence of so much salt and gypsum, which led previous writers to place these deposits on an equivalent with our new red system, which, from containing exclusively these minerals in our own parts of Europe, had been termed the saliferous system. That these red deposits (red and green) are, however, the true equivalents of our "old red" system, is accurately demonstrated, not only by order of superposition, but also by the many evidences of organic remains which they offer. Fishes are the distinguishing fossils of this great Russian system, and among these are species (notably the *Holoptychus nobilissimus*, Murchison) which have been described from deposits of the same age in Scotland. These fishes are in abundance, and a beautiful work in illustration of them is now preparing, by Professor Asmus, of Dörpat. The authors have traced these fish beds for many hundred miles, occupying several stages in the system.\* The zoological contents of this system are also of peculiar value in illustrating the classification proposed by Messrs. Sedgwick and Murchison, or, in other words, the evidences now found in Russia leave not a possibility of doubt as to the old red and Devonian systems of rocks being identical. Terebratulæ, spiriferæ, euomphali, bellerophonæ, and other shells quite distinct from those of the carboniferous system, but similar to those which occur in Devonshire, Belgium, the Eifel, and other places, in deposits which have been considered by these authors to be of the age of the old red sandstone, but had never yet been found as they are shown to be in Russia, absolutely associated with the same fishes, and in rocks of the same red and green characters, in which these fishes occur in the British Isles. As, therefore, the Russian red system is recumbent on Silurian rocks, and is immediately covered by unquestionable carboniferous or mountain limestone, this question is for ever set at rest.

**Carboniferous System.**—In the northern and central regions of Russia, the lower or calcareous part only of the carboniferous system exists. The inferior beds consist of incoherent sandstones and bituminous shale, which sometimes contain thin beds of impure pyritous coal, and impressions of several plants well known in the coal measures of our own islands. These are overlaid by various bands of limestone, only the lower of which have some mineralogical resem-

blance to the mountain limestone of western Europe; other beds being undistinguishable from the magnesian limestone of England, others from a pisolite; while a third great and very prevalent band of considerable thickness, is milk-white and not more compact than the *calcaire grossier* of Paris. This white Producta limestone was observed by the authors from the neighbourhood of Moscow to beyond Archangel (and they ascertained that it ranged far into the country of the Samoeses), a district of not less than 1,000 miles. This formation has also another mineral resemblance to chalk, in being loaded with thin bands of flints, which are sometimes concretions invested with corals. It is in parts undistinguishable from the *calcaire grossier* of Paris, and by some observers has been called chalk. Associated with this formation, on the banks of the Dwina, about two hundred wersts above Archangel, and south of Süsskaia, are splendid bedded masses of white gypsum, which for many miles present at a little distance all the appearance of white limestone.\* With these grand deposits of alabaster, inclosing occasionally large concretions, alternate two or three thin bands of limestone, in one of which the authors detected a fossil avicula, and several shells new to them. This and other peculiar fossiliferous bands near West Vaga will be described hereafter when the fossils shall have been examined. The carboniferous limestone of Russia is highly fossiliferous, and from the normal and unaltered condition of the beds the specimens are generally in an excellent state of preservation. Among them are very many well-known British species, the lower beds being distinguished by the same large *Producta hemispherica* so abundant in the Isle of Arran, and various parts of Scotland, and the white beds being loaded (among some new forms described by Fisher) with many of the species published by Prof. Phillips and by Sowerby, as well as by chaetites and other characteristic corals. Owing to its mineral aspect, this rock has also been, till within the last year, much misunderstood by foreign authors, but Col. Helmersen having observed its position in the Waldai Hills, also its association with coal, and having forwarded the fossils to M. de Buch, he first gave out that it must be considered the true mountain limestone. The authors have completely confirmed this view by ascending and descending sections, and have largely extended it.

**Oolite Series.**—When the authors visited Russia, it was still a great problem, even with those who had just recognized the mountain limestone,† whether there was or was not a series of strata to connect the lower carboniferous beds above described, with certain rocks of the oolitic system, which have been long known to exist in the south of Russia, and some of the fossils of which were sent to England by Mr. Strangways. Certain of these beds which rest at once on the great red formation along the banks of the Volga, between Kostrowa and Nijny Novogorod, belong unquestionably to the middle oolite, as they contain ammonites and belemnites identical in species with those of the "Kelloway's rock" of Smith; other shells, found near Jelatima and Kacimof and Moscow, appear rather to resemble forms of the lias; but on this point Mr. Murchison reserves his opinion till the examination and comparison of the organic remains has taken place in London. These shales of the oolite rest at once on the white carboniferous limestone of Moscow, without the intervention of any other strata,—a fact of great theoretical interest to geologists, and of great practical importance to the Russian empire. To the former it seems to suggest the inference that equably as that great region has been elevated (so as scarcely ever to derange the perfect horizontality of the strata), the tracts in question must have undergone considerable oscillations, sufficient, first, to raise them above the sea, during that long period when the new red system was accumulated, and afterwards to depress them to admit of the deposition of shales of the oolite series. To Russia it affords a clear proof that, however productive coal fields may exist (Donetz is a fine example) in southern Russia, they are not to be looked for either in the tracts around Moscow, or in any country north of that city.

\* Prof. Agassiz, having visited the meeting of the Association, confirmed the views of the authors. In the junction beds of old red which immediately underlie the carboniferous strata, a remarkable bone bed contains scales of *Mugilichthys* and of an undescribed fish which characterize our coal deposits, while the other, and far the most striking remains, are those of *Holoptychus* and *Cocconeus*, so characteristic of the old red sandstone of Scotland.

† See note and observations on the recent memoir of M. Eugene Robert, next page.

† Colonel Helmersen.