



## A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE

*"To the solid ground  
Of Nature trusts the mind which builds for aye."*—WORDSWORTH

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### AMERICAN GEOLOGICAL SURVEYS \*

THE volumes which record the progress of the United States Geological Survey of the Territories since its commencement in 1867 contain much information of great value to geologists, as well as to those who watch with intelligent interest the advance of the wave of human civilisation into the far West. Each of them is full of fresh illustrations of the principles of geology, such as the dependence of scenery upon rocky structure, the order of succession of formations, the plication of mountain-chains, the phenomena of volcanic action, the functions of rivers and glaciers as geological agents—illustrations which have already to some extent found their way into general text-books and are no doubt destined ere long to be made in that way familiar even to tyros in the science all over the world. In each of them too we have such information as could be gathered as to the agricultural value of the countries, the practicable routes for roads and railways, the mineral resources to be looked for, the facilities for general commerce—information which will probably serve as the basis for the future development of the regions into settled States.

During the years 1871 and 1872 Dr. Hayden's parties were at work about the sources of the Missouri and Yellowstone Rivers. They had gradually pushed on into that wild region, stimulated by the variety and interest of its scenery and geology, but they had got far from any civilised base-line, including railroads and other conveniences of transport and subsistence. Beyond them lay the lands of the Indians, who manifested no disposition to treat the peaceful work of the Survey in another light than as some insidious part of the designs of the grasping central power at Washington. It seemed desirable therefore in the meantime to discontinue the further prosecution of the Survey in the north-west until by the establishment of railroad communication it could be resumed with much less labour and cost. This delay, however, will probably not be of long continuance, when

\* See vol. xii. p. 267.

we consider with what marvellous rapidity the tide of American energy is travelling towards the Pacific.

The region recommended by Dr. Hayden and approved of by the Government as the scene to which the operations of the Survey should be transferred was that portion of the Rocky Mountain range which runs through Colorado and New Mexico—a region as yet unsurveyed and likely in a few years to be rapidly developed by some of the most important railroads of the West. The survey of the fortieth parallel by Mr. Clarence King, to which allusion has been already made, and of which some account will be given in a subsequent paper, had done good service in making known the physical features and geology of a belt of country stretching across the northern limits of the tract which Dr. Hayden now proposed to examine. That survey would form the starting-point of the new explorations which it was arranged should sweep westward across the watershed of the continent to the left bank of the Green and Colorado Rivers, eastward across the sources and higher course of the Platte, Arkansas, and other tributaries of the Mississippi, and southwards to the boundary-line between the United States and Mexico.

The first instalment of results from this transference of area has appeared in the Annual Report of the Geological Survey of the Territories for 1873—a thick volume of 718 pages, with numerous and excellent sections, maps, and views. This Report is divided into four parts, devoted respectively to—I. Geology, Mineralogy, and Mining Industry; II. Palæontology; III. Zoology; IV. Geography and Topography. An appendix contains papers on some mineral fields, while detailed descriptions of a large number of new species of fossil plants and animals are given in Part II. Taking the general supervision of the whole operations of the Survey, Dr. Hayden furnishes some chapters in reference to the geological features of part of the eastern slope of the Rocky Mountains, and introductory to those of the officers placed by him in charge of the three subdivisions into which, as already remarked, the work of the year was arranged. It appears that the first division, under the charge of Mr. A. R. Marvine, surveyed, topo-

graphically and geologically, an area of 5,600 square miles during the period between the end of May and the latter part of October; the third division, under Dr. F. M. Endlich, accomplished the survey of nearly 7,600 square miles, "particular attention being paid to the agricultural and mineralogical resources of the country traversed." Allowing 130 full working days for the period during which these two parties were at work, we find that on an average 100 square miles were surveyed topographically and geologically each day, and that this was performed by some seven or eight observers! And if it be further noted that only half of that number were geologists, and that in the case of the San Luis, or third division, the geological work appears to have been done by one man, we shall form some notion of the rate at which scientific surveys advance in the far West. We have not the same precise statements of the area actually surveyed by the second or South Park division, under Dr. A. C. Peale; but it seems to have been on the same extensive scale.

Now by those who take interest in the progress of topographical and geological surveying some explanation will naturally be required as to the almost incredibly large area examined in one season by Dr. Hayden's corps. Compared with his rate of progress, our Ordnance and Geological Surveys creep on at a snail's pace. His geologists, for instance, get over in a single day an amount of ground which the most hard-working and experienced members of the Geological Survey of Great Britain could hardly accomplish in a year's campaign. Evidently the two kinds of work cannot properly be compared with each other. That of the British Surveys is minutely detailed, and meant to be, for the time, exhaustive. The American Survey of the Territories, on the other hand, cannot be regarded as, and does not pretend to be, more than a rapid but intelligent reconnaissance, wherein the positions of the leading landmarks are correctly determined, and those of the intermediate features are fixed as nearly as may be; while, acting in concert with the topographer, and availing himself of the same points of observation, the geologist ascertains the nature and order of the rocks in a few traverses from which he infers what must be the structure of the surrounding districts. It is no disparagement to this work to say that it must in the end be superseded by more accurate and detailed surveys. It is in the meanwhile doing a notable service by pioneering in vast and unknown or little known regions, and giving the world a first outline of the main features of their geography and geology. In the territory of Central Colorado investigated in 1873, the geologists had the advantage of comparatively simple structure to deal with. So clearly does the skeleton of the continent protrude in that region through the surface, that from each main hill-top it was not difficult to follow for many miles on successive ridges and spurs the crags and hollows marking the lines of outcrop of particular strata. The extent to which this peculiarity and simplicity of geological physiography has been useful, may be inferred from the numerous diagram-sections of the belt of country surveyed, showing the relation of the surface-contour to the arrangement of the underlying rocks.

Space cannot be given here for a detailed account of this Report, but reference may be made to some of its

features which have a general interest. Mountain-structure, especially in relation to the plications of the crust of the earth, receives much notice from the various members of the Survey. They have followed the gradual swelling of the flat formations of the plains, first into gentle ridges or "hog backs," then into more marked and crested ranges, until they have traced them in vertical or even inverted masses reposing against the central core of granite. Crossing this latter they have caught up again the same formations on the other side, and followed them in like order and position from the disrupted and highly-inclined central mass down to their gradual subsidence into the flat plains. The rocks next to the granite are metamorphosed, and, what must strike European geologists as curious, have huge intercalated sheets and dykes or veins of trachyte associated with them. The elevation of the mountain ranges has upraised cretaceous rocks, and even some parts of later geological formations.

The length of time, however, which has passed since the upheaval of the Rocky Mountains and their subsidiary spurs has allowed a vast amount of work to be done upon their slopes and crests by the weather, rain, torrents, frost, snow, and glaciers. It would seem hardly possible indeed to find a region where it would be more easy to appraise exactly the amount of waste from a given area due to this cause. The geological structure of the anticlinal and synclinal folds is so simple, the rocks are so well exposed, and the limits of sub-aërial erosion seem so sharply marked off from those of subterranean movement, that the flanks of the Rocky Mountains might be selected as a typical region for the study of this branch of physiographical geology. Sometimes the corries or cirques ("gulches" is their American name) have been cut back so as to leave a steep hardly-traversable crest between them, while now and then a valley has been cut completely across the watershed, so as to draw its first waters from the other side. In some places the rocks have been so weathered as to stand up in extraordinary pillars and capped statuesque masses like those for which Saxon Switzerland has been so long famous.

The former presence of extensive glaciers descending from the mountains of Colorado has been proved by the evidence of huge moraine mounds, admirable ice-worn domes of granite, and scattered glacier-lakes. It would seem, indeed, that no very great diminution of temperature might suffice to restore glaciers to these valleys. Dr. Hayden describes vast masses of snow and ice, which, melting in summer on the steep slopes and saturating the rocks and soil, slide down like glaciers and cumber the declivities and valleys with piles of rubbish.

The now well-known geysers of the Yellowstone region have made known the extent and comparative recentness of volcanic action in that region. We learn some further facts of interest on this subject from the present report. Dykes and streams of basalt have been found in proximity to their parent cones. In some cases the lava beds form the cappings of isolated hills, or project as terraced bars from the sides of the slopes. In other instances they occur in the bottoms of the valleys, and even appear to have sometimes crossed the present river-courses and formed lakes. Recent, therefore, though these lava-eruptions must be, they were evidently continued during a period of time long enough for deep and wide valleys to be cut



out of the older flows, while *coulées* were poured down the excavated hollows. In these respects the history of this late North American volcanic action recalls the succession of events so long ago and so admirably described by Mr. Poulett Scrope as traceable among the volcanic masses of Central France.

The mines now in operation, as well as indications of probable positions for new ones, are carefully noted in the Report. The geologists, indeed, have constantly had before them the consciousness that the future development of these territories would not be helped so much by their making out all geological details at present as by their ascertaining what practicable places could be found for the establishment of mining industry. At the same time, they deserve great credit for keeping the thoroughly scientific character of their duty so conspicuous in their reports; for undoubtedly the only way to make an exploration which shall be of real value as a guide in mining operations is to do it in the strictest sense geologically. With the area and relations of the different rock-formations mapped out for him, the mining prospector may save much time and money by learning what tracts to avoid as well as which to explore.

Each of the geologists in command of a division under Dr. Hayden furnishes a report, which appears in the present volume. These are remarkably well done, that of Mr. Marvin being specially interesting from the variety of phenomena with which he had to deal and the clearness with which he tells his story. Besides the geological reports, Prof. Lesquereux supplies one of great value on the Lignitic formation and its fossil flora, in which he enters anew into the vexed question of the true age of that formation. As the result of his long study of its large and well-marked flora, he concludes that the formation is of Tertiary date, a conclusion which agrees also with that to which Dr. Hayden has been led. A large list of new species of fossil plants from the Lignitic strata is described by him in his report. Under the head of Zoology are gathered a number of communications on insects, crustacea, mollusca, and other invertebrata, collected or observed during the progress of the Survey. The part devoted to Geography and Topography contains the reports of the geographer and his colleagues on the system of triangulation employed, the heights of various places, the practicable routes, and other matters. The book is well printed and well illustrated. It deserves the heartiest commendations both for the Government which supports such good work and for the men by whom it is practically done.

ARCH. GEIKIE

#### ALIX ON THE LOCOMOTION OF BIRDS

*Essai sur l'Appareil Locomoteur des Oiseaux.* By Edmond Alix, M.D. (Paris: G. Masson.)

THIS considerable volume, the first independent work of any pretensions on the osteology and myology of birds, is a valuable addition both to zoological and to ornithological literature. As far as the latter is concerned it would have been more distinctly useful if the author had been better acquainted practically with birds' skins, as well as with the binomial nomenclature and the importance of specific distinctions. If he had, such a sentence as the following

would have been modified in a manner which would have made it of greater value to future investigators, at the same time that the precision would have added weight to the points brought forward. We are told with reference to the accessory femoro-caudal muscle that "this fasciculus, represented in the Cormorant by an aponeurotic band, is found uncomplicated in the Grebe, Flamingo, Heron, Bustard, and Secretary Bird," in which remark the fact that what are there termed Grebe, Bustard, &c., are general terms, seems to be entirely ignored; as is therefore the possibility of there being structural differences among the members of the included groups. It may even be mentioned that respecting the very point referred to in the above quotation, the statement therein made does not generally apply, being correct as far as the Little Grebe (*Podiceps minor*) and the Common Heron (*Ardea cinerea*) are concerned, but being inaccurate when said of the Eared Grebe (*Podiceps cristatus*) and the Giant Heron (*Ardea goliath*). Most works on the anatomy of birds suffer from the same imperfection; the importance of specific and even generic distinctions being generally disregarded, by all but pure ornithologists.

The work is divided into three sections—the three in which the consideration of the locomotive apparatus of birds most naturally falls; namely, the consideration of birds firstly as vertebrated animals (zoologically); secondly, as a special organised type (anatomically); and thirdly, as flying animals (physiologically). An excellent *résumé* of previous investigations on the several subjects prefaces each section, in which due credit is on nearly all occasions given to foreign workers.

Under the first heading, following the teaching of De Blainville and Gratiolet, Dr. Alix describes the typical skull on the hypothesis of its vertebral origin; of the fourth or nasal vertebra, considering the perpendicular plate of the ethmoidal as the centrum, the lateral masses of that bone as the laminae, and the nasals as the spinous element.

In the treatment of the osteology of birds, most of the important subjects which have of late attracted most considerable attention are fully discussed. We are rather surprised to find no reference to the point so forcibly put forward by Prof. Parker, and laid stress on by Prof. Huxley, with regard to the anchylosis of the palatine bones with the vomer in the Tinamous. The vomer as a separate bone is also rather neglected. As to the light thrown by a study of the skull on the classification of birds, we read that "the examination of the head of birds confirms the major divisions established originally from a consideration of the beak and the feet. It proves that Raptores, Passeres, Gallinae, &c., exist in reality: but it also renders it evident that there are divisions beyond these not capable of being included among these primary forms. For instance, the Parrots form a well-marked group of themselves . . . the Raptores Nocturnae are clearly distinct from the Raptores Diurnae, the Pigeons can in no way be confounded either with the Passeres or with the Fowls." As to the sternum, "the results arrived at by De Blainville and confirmed by subsequent authors (are said to) prove that Cuvier has narrowed the question too much in affirming that the indications afforded by the sternum cannot serve for more than generic distinctions. But it must be admitted that, with the exception of the cha-