GEOLOGICAL MAP OF THE UNITED STATES AND TERRITORIES.

BY CHAS. H. HITCHCOCK AND WM. P. BLAKE.

A GEOLOGICAL Map giving a broad general view of the extent of the various geological formations of the country has long been an acknowledged desideratum. The materials have been accumulating from year to year, one government expedition after another has returned bringing new facts, and State after State has instituted geological surveys. But all these results have been published independently, and at different times, without concert or system. The attempts to combine and generalize these disconnected data have been few, and, in general, unsatisfactory, though, no doubt, each effort has been of great service to the science, and economically.

The preparation of such a map is one of the most difficult and thankless labors a geologist can undertake. It is not a work of mere compilation. To a general knowledge of the whole region must be added critical skill and discrimination, for the data are so disconnected, diverse, and often conflicting that they must be compared, harmonized, and resolved into a common expression. There are also blanks, for which the facts are scanty or wanting, and these must be filled in order to complete the general picture.

Under such adverse conditions, with diverse, and in some regions, only partial materials, notably in the great and but partly explored areas of the West, the result must necessarily be imperfect. It will fail to satisfy many who have made special studies of limited areas in detail, and will afford an inviting field for critics.

Yet such maps, confessedly imperfect, serve a most excellent purpose—they give broader and more comprehensive views of the geological structure of the country, of the relative position and extent of the mineral and agricultural regions and of the bases of indigenous industries. They are important in all discussions of the distribution of plants and animals and even of population. Further, as regards the progress of geology, they stimulate investigation and publication, they provoke criticism and corrections and thus advance knowledge.

It is hardly necessary, however, to explain the reasons for the publication of a general geological map. Such a map has long been an acknowledged need. At the meeting of the American Association for the Advancement of Science, in 1872, a Committee was appointed to memorialize Congress upon the preparation and publication of a geological map of the United States, and it is hoped that suitable provision will ere long be made for one on a scale commensurate with the importance of the subject to the country.

Of the map now presented two editions have already been issued, one for the volume on "Industry and Wealth" at the Ninth Census, the other for the Report of the U. S. Commissioner of Mining Statistics. The third edition now presented contains many additions and corrections, but it is still claimed to be only approximately correct and to a great extent hypothetical, particularly west of the Mississippi River, as all maps of the kind must necessarily be, until accurate measured surveys of the surface and of the outcrops of the formations have been made.

The topographical or geographical basis of the map is the well-known Engineer's map, which has been carefully prepared in the office of the Chief of Engineers at Washington from the results of official explorations, having been added to from time to time, as the accumulation of data justified it. The scale of the map is about one hundred miles to the inch. Upon the parallel of 37° an inch extends over two degrees of longitude. An area of 25 square miles may be covered by the head of a pin. On such a scale detail must, of course, be sacrificed, and give place to general representation. The same is true of the topography. And the topographical features, essential guides in plotting the geology, are, over a great part of the country, and particularly on the western half of the map, very defective, and in some extended districts are entirely wanting. Yet for many of these districts a general knowledge of the geology permits them to be colored with tolerable accuracy. But the difficulty of successfully representing the geology in the absence of the usual topographical guides will be readily appreciated. It may be stated, as a general rule, that in regions where the topography is not known, the representation of the geology is to be considered as typical, or hypothetical and suggestive, rather than accurate.

For convenience of representation and of printing in colors, the formations are delineated in nine groups. The arrangement is not in every respect the most natural, but it best accords with the materials in existence, It is as follows:

EOZOIC	Eozoic and Metamorphic.
PALEOZOIC	Cambrian and Silurian.
	Devonian.
	Carboniferous.
MESOZOIC	Triassic and Jurassic.
	Cretaceous.
CENOZOIC	Tertiary.
	Alluvium.
	Volcanic.

We have traced out and separately indicated each of these divisions as far as possible in the existing state of our knowledge, but no attempt has been made to trace the dividing lines of the Paleozoic over the western area, as will be presently explained.

The first group, the Eozoic and Metamorphic, includes the Laurentian, Atlantic, Labradorian, and Huronian, together with the granites and metamorphic rocks. The few metamorphic rocks of later age, whether Paleozoic or Mesozoic, in the Appalachian and Rocky Mountain regions, have been separated from the Eozoic as far as possible.

GENERAL OBSERVATIONS UPON THE REPRESENTATION OF THE GEOLOGY OF THE EASTERN PORTION OF THE UNITED STATES.

By C. H. Hitchcock.

The rocks of the first group form a continuous belt from the northeastern boundary southwesterly to Alabama. From their broadest expansion at the north, they gradually narrow southward through New England to New York and then expand southward through the Southern States. They form the mountain region of the Eastern States, and, together with the broad development of the same formations in Canada, skirting the Great Lake region and considerable areas about Lake Superior, form the margin or rim of the great interior region of comparatively horizontal Paleozoic formations, holding the vast coal areas of the continent. The natural geological and geographical outlets of this interior basin, with its stores of wealth in coal, iron, and fertile lands, are on the southwest, through the open valley of the Mississippi to the Gulf, and on the east, across the narrowest portion of the Eozoic at New York.

These Eozoic and Metamorphic rocks constitute what is generally known as the granitic region. It is the nucleus of the later rocks, of the Paleozoic on the west, and the Mesozoic and Cenozoic on the east. Of the principal divisions, the Laurentian is developed along the valley of the St. Lawrence, the Huronian in the west, and the Atlantic in the White Mountains of New Hampshire.

The Atlantic system is first carefully distinguished from the others in the first volume of the geological report of New Hampshire (1874). It is the same as the so-called White Mountain series, and has a large development along the Atlantic border. A considerable portion of the New England metamorphic rocks, particularly in Maine, is now referred to the Huronian system.

The Silurian and Cambrian systems are made to extend from the Paradoxides beds to the Lower Helderberg inclusive; in accordance with the general usage of American geologists. The Calciferous mica schists of Vermont, the Coös group and certain mica schists of New Hampshire, are provisionally included in this division. Certain schists in North and South Carolina, largely those called Taconic by Professor Emmons, are excluded, and referred to the Huronian upon the authority of Professor Kerr. A large area of quartzites in Minnesota and Dakota, consisting chiefly of the *Plateau du Coteau des Prairies*, are now for the first time ranked with this division. Heretofore opinion has been divided in respect to them, whether they should be called Huronian or Cretaceous.

The Devonian system is now separated from the Lower Carboniferous, and is chiefly developed over the interior of the continent.

The Coal measures are not separated from the Carboniferous, because a map representing them and other subdivisions is included in this publication. The representation of the entire Carboniferous system by itself enables one much better to understand the geological structure of the country. The Permo-Carboniferous strata are not separated from this division.

The Triassic and Jurassic formations are represented together. They constitute long lines of sandstone in the east, and Gypsiferous beds west of the Mississippi.

The Cretaceous formation may be traced almost continuously from the northeast end of Long Island through the Carolinas to Alabama; thence northerly along the Mississippi valley to the mouth of the Ohio River; thence southwesterly into Mexico, and northerly to the British Possessions, covering immense areas in the Territories and in the States of the Pacific coast. The formation is perhaps the most extensive of any in the country. With the approval of Prof. Kerr we have represented a continuous area of Cretaceous, nearly 200 miles long, from the Neuse River in North Carolina to the farther side of the Great Pedee basin in South Carolina. This area is usually covered by Tertiary or Alluvium, but displays Cretaceous sections along all the great transverse river valleys. Large Cretaceous areas in Minnesota cover Eozoic and Silurian deposits, and are therefore only partially represented on the map.

The Tertiary rocks lie outside of the Cretaceous along the whole Atlantic coast south of Cape Cod; and are immensely developed over the western portion of the country.

The Alluvium lies outside of the Tertiary along the coast, composing the peninsula of Florida and the Mississippi delta.

No volcanic rocks, properly so called, occur east of 103° west longitude Greenwich

This edition of the map differs in some portions from the first issue for the following reasons:

A small area of Cambrian has recently been described by the writer as occupying a part of the Saco River valley in Maine. The granite in northeastern Vermont, and near Montpelier, may be partly of Devonian age. Three small outliers of the Catskill formation are represented in New York upon the authority of Logan's map. This formation is everywhere included with the Carboniferous upon the authority of Chancellor Winchell The Long Island rocks are still considered as Cretaceous. The ragged edges of the Carboniferous rocks in northeastern Pennsylvania are not preserved. In North Carolina the Eozoic system is expanded to include several isolated patches of gneiss in the low country. This expansion causes the eastern boundary of this system to harmonize with that in Virginia, as delineated by Prof. W. B. Rogers.

The geology of Georgia is very little known; the Cretaceous outliers are given upon the authority of Sir Chas. Lyell. The Silurian areas of Ohio and northern Illinois are

probably connected together across Indiana; the boundaries between the Silurian and Devonian, as given, being based upon Sir William Logan's map. The northwest part of Iowa, here colored as Cretaceous, is said by Prof. White in his Iowa report to be so deeply covered by drift that no rocks appear *in situ*. The Devonian along the Red River, in Minnesota, is given upon the authority of Dr. Winchell's Map. In Texas a few changes are made upon the authority of a manuscript map furnished by A. B. Roessler. The coal area of Northern Texas is separated from that of the Indian Territory by the overlying Cretaceous along the valley of Red River. The Tertiary area of the Cross Timbers region is retained in accordance with the results of this summer's explorations (1874), specially communicated by Prof. S. B. Buckley. Improvements will doubtless be made hereafter in the representation of the copper rocks about Lake Superior. We have not altered their delineation from that of the first edition.

A few general statements are suggested by even a casual inspection of the map. First, there is a wide contrast in color between the east and the west; indicating that the former, with its enormous supplies of coal and iron, is adapted by nature to be the manufacturing region, while the latter, with its immense plains and its veins of the precious metals, is more properly an agricultural and mining country. Second, the gradual thinning out of the Tertiary rocks on the Atlantic, suggests the probability of a considerable submergence off the coast of New England and the British Provinces in very recent times, so that the later rocks are entirely concealed. Third, the arrangement of the formations along the lower Mississippi valley indicates a submergence commencing at the close of the Paleozoic and continuing down to the present era—the sinking of large tracts of land in southeastern Missouri in conjunction with the earthquake of 1812, shows that the line is still weak. The successive development of the several divisions of the Cretaceous and Tertiary below the mouth of the Ohio, proves that the valley has been gradually reclaimed from the Gulf of Mexico. Quite recently, also, the western water-shed followed the Cretaceous outliers from southeastern Arkansas to the "Five Islands" near the mouth of Bayou Teche. Fourth, the overflows of lava are confined to the Rocky Mountain region and westward. There are no evidences of igneous overflows in the east later than the Jurassic. Fifth, the great plains west of the Mississippi, occupying more than a fourth part of the country, belong to nearly horizontal deposits of the Cretaceous and Tertiary. Sixth, the central portion of the main Rocky Mountain range seems to belong to the Eozoic system; but not to have been elevated extensively so early as the same formation along the Atlantic border. The principal epoch of Rocky Mountain elevation seems to have been in the later Tertiary.

GENERAL VIEW OF THE GEOLOGY OF THE WESTERN PORTION OF THE UNITED STATES.

By William P. Blake.

The following brief notices of the salient geological features of that portion of the United States west of the 100th meridian are designed to supplement and explain the Map and to assist in giving a general idea of the geographical range of the principal formations and their relation to each other. Some of the difficulties of the task of delineating the geology over such an extended region, as yet but imperfectly known, are stated in the foregoing joint article by Prof. Hitchcock and the writer, to which reference is made.

Eozoic and Paleozoic.

Paleozoic formations have been traced to the shores of the Pacific, and their representation forms a conspicuous feature of the Map from the Rocky Mountains westward throughout the whole area, and especially in the great interior basin-region where there are numerous parallel mountain ranges trending from north to south. Over this western portion of the Map the divisions of the Paleozoic are not indicated by different colors as they are on the eastern portion. The single blue color represents the whole or any single member of the Paleozoic, either the Silurian, the Devonian, or the Carboniferous, or all of them. The divisions have not yet been traced out except in a few limited areas.

The best known member of the system is the Carboniferous limestone, believed in general to be the Sub-carboniferous, which has a wide extension, having been identified as far west as the seaward slopes of the Sierra Nevada, in the Humboldt Mountains, the Wahsatch, and in the Rocky Mountain system of elevation from Mexico to the northern boundary. It forms the summits of ranges about the Great Salt Lake, and is the prominent rock of many parallel ranges extending northward into Montana and beyond into British America. It is believed to constitute an important feature of the Salmon River ranges of mountains, comparatively unexplored, and of the Blue Mountains in southeastern Oregon. The formation is, in general, much uplifted, and forms the crest or highest portions of many mountain ranges up to an elevation of 13,000 feet or more. But in the broad region drained by the Colorado and its tributaries, the Carboniferous, together with older divisions of the Paleozoic, and the later formations of Mesozoic time, are comparatively undisturbed, and form a broad plateau region of nearly horizontal strata through which the streams have cut their way and expose unbroken sections of the whole series of rocks from the early Silurian, resting upon the Eozoic, to the Tertiary surmounted by volcanic outflows. The Mogollon Mountains of Arizona mark the southern limits of the plateau region, beyond which the formations are uplifted and extend in parallel ranges southeastward into Mexico. Thus a deep Carboniferous sea appears to have extended over the greater portion of the United States. A period of elevation succeeded with the deposition at the west as well as in the eastern portion of the country of sandy and clayey deposits, the foundation for the growth of plants and the formation of coal-beds. Coal measures and thin seams of coal are found in the Rocky Mountains at Santa Fé, and recently they have been shown to exist as far west as the Pancake range of mountains in Nevada (Lon. 115°) with workable beds of coal. So far as yet observed, coal-seams do not exist in the Carboniferous in the northwest.

Devonian beds have been recognized in the White Pine Mining District in Nevada and probably occur far to the north and south of that point in the same and other parallel ranges. They have also been identified in the Wahsatch, southeast of Salt Lake City, and no doubt have a very considerable geographical extension in connection with the Sub-carboniferous limestone. Devonian sandstones are reported in the Calitro Mountains, Arizona; but in a section near El Paso, from the Potsdam upwards, there is a notable absence of Devonian beds. This section is believed by Mr. Tenney to exhibit the equivalents of the Potsdam sandstone, the Trenton limestone and the Oneida conglomerates with the Carboniferous resting unconformably upon them. An absence of Upper Silurian and Devonian beds has also been noted by Hayden in sections about the Black Hills and the Laramie range. But according to Comstock, the whole Paleozoic series, from the Lower Silurian to the Carboniferous, inclusive, is found upon the eastern slope of the Wind River Mountains dipping away from the metamorphic rocks.

Limestones of the Quebec group have been identified by Bradley, near Malade City, Idaho. The equivalent of the Potsdam sandstone is described by Hayden and others as existing in the Black Hills and northern ranges of the Rocky Mountains, especially in the Big Horn Mountains at the head of Powder River and in the range known as the Tetons. A quartzite underlying the limestones of the Wahsatch and resting unconformably upon the upturned edges of Eozoic rocks, is referred by the writer to the Lower Silurian. The Primordial has also been observed by Clayton in southern Nevada (Lon. 116°), and on Schell Creek, seventy-five miles northeast of White Pine.

It may be said, in general, that the prevailing formations in the silver-mining districts throughout Nevada are made up of limestones and sandstones of Paleozoic age, either Carboniferous, Devonian, or older, in connection with Eozoic, granitic, syenitic, porphyritic, trachytic, and volcanic rocks. Dikes of porphyry and dioritic rocks are numerous, but, in general, are too narrow and limited in their breadth to be satisfactorily delineated on the Map.

The phenomena of uplift and plication of the strata are exhibited on a broad scale in the Rocky Mountains and westward in all the mountain systems, though, in general, the folding is not abrupt and steep, and monoclinal ridges are most common. The principal area of folding lies to the westward of the Wahsatch range in the Great Basin, where the parallel mountain ranges are numerous and inclose long and narrow valleys partially filled by the debris and wash from the adjoining ridges, so that the rocks are covered from view. The region of the greatest lateral compression is the Sierra Nevada, where most of the strata stand on edge. The Cretaceous and Tertiary formations of the Coast Mountains are also plicated.

The rifts and fissures of the rocks giving rise to veins and mineral deposits follow, in general, the lines of easiest fracture presented by the upraised strata, parallel to the general axes of uplift. A general longitudinal arrangement results, and determines to a great extent the distribution of population, lines of communication, settlement, and occupation of the country.

There are evidences in several places of considerable dislocations and breaks in the strata for great distances; as, for example, along the eastern base of the Sierra Nevada, and in the Colorado plateau, where Powell has observed a succession of vertical displacements extending in a northwesterly and southeasterly direction, one of these lines of break being nearly under the extinct volcano of San Francisco Mountain and coincident with the edge of the mesa terminating the plateau on the south.

The wide extension of the Eozoic rocks as the foundation of the western part of the Continent is well established. They underlie the Paleozoic unconformably, and are in general crystalline and uplifted at high angles. In the Rocky Mountain system, particularly near Santa Fé in New Mexico, in Colorado, and in Wyoming, gneissic strata are traversed by veins and dykes of flesh-red granite. Farther west this granite disappears and gray granite prevails, especially in the Wahsatch, the Humboldt, and the Sierra Nevada. In the Wahsatch the Paleozoic series rests upon the upturned edges of older formations now in the condition of compact granite but retaining distinct traces of the original layers of deposition. This granite is flanked by gneissic beds, and it closely resembles the granite of the Humboldt range, and of the Sierra Nevada, which two great ranges may also be regarded as prominent lines of exposure of the most ancient rocks. The Eozoic is also exposed at many points in the ridges of the Great Basin, at the bottom of the cañon of the Colorado, and southward through Arizona into Mexico. In Montana Territory the rocks are gneissic, and are traversed by gold-bearing quartz veins.

Mesozoic.

The most widely distributed and recognized member of the Mesozoic series is the Cretaceous, which underlies the Great Plains westward from the Missouri, forms the table-lands of Texas known as the Llano Estacado, and appears all along the eastern base of the Rocky Mountains. Beyond this chain it is spread over the great plateau region of the Colorado River, finding its principal limit on the north and west in the Wind River, the Uintah, and the Wahsatch Mountains. Farther west it reappears east of the Cascades in Oregon, is heavily developed about Puget's Sound and Vancouver's Island, and, together with uplifted Tertiary beds, forms the bulk of the ranges of the Coast Mountains in California.

In southwestern Texas the lower members of the formation consist of thick beds of compact limestone, forming cliffs hundreds of feet in height along Devil's River and the Rio Grande, while the higher members forming the Llano become more clayey and sandy. Coarser materials also prevail in the formation upon the western coast, where sandstones and shales prevail and pass upwards conformably into the Eocene and Miocene Tertiary.

East of the Rocky Mountains the Cretaceous is underlaid by Jurassic and Triassic strata, the latter being largely developed and exposed at the surface in northern Texas, the Indian Territory and Kansas. This member of the Mesozoic consists chiefly of red shales, marls and sandstones, with an abundance of gypsum. The Triassic beds are also found throughout the Colorado Basin and extend west of the Virgen. They have been identified in several of the uplifts of the Great Basin area, particularly in the Virginia and Pine Nut ranges near the eastern base of the Sierra Nevada, associated with syenitic and other

plutonic rocks, and also in the west ranges of the Humboldt Mountains, notably at Star Mountain, rising to a height of 9000 feet and largely made up of Triassic strata.

Jurassic, and probably Triassic beds, highly folded, form a part of the western slope of the Sierra Nevada of California, and are the chief repositories of the gold-bearing veins and of the copper ores. With these beds the Cretaceous formations are not conformable. Thus the great uplift of the Sierra Nevada, and of many parallel ranges in the Great Basin, appear to have taken place at the close of the Jurassic period, introducing a great change in the topographical and physical conditions of the Continent.

The relations of the Mesozoic, in the Sierra Nevada, to the Paleozoic, have not been satisfactorily shown. The Carboniferous has been identified near Fort Reading by Trask, and in the Map the limestones of the range to the southward have been considered as belonging to that system. But of whatever age, they as well as other and apparently older strata, in a metamorphosed condition, are all conformable with the Mesozoic.

Cenozoic.

Tertiary deposits over the western part of the Continent are found, in general, nearly coincident in geographical distribution with the Cretaceous, there being no break in the continuity of the deposits from below upwards. Along the Pacific border, the Eocene, Miocene, and Pliocene divisions have been recognized and are all of marine origin and attain a great thickness. They partake, in the Coast Mountains, of the plications of the Cretaceous, but are, in general, nearly horizontal along the base of the Sierra Nevada.

Between the Rocky Mountains and the Missouri River, on the Great Plains, extensive areas are covered with Tertiary beds through which the rivers have cut their way to the underlying Cretaceous. So also in the Green River basin, north of the Colorado plateau in Wyoming, there is a wide area covered with horizontal Tertiary deposits eroded by streams to a great depth. These are not only of marine origin but are mingled with brackish and fresh-water deposits which, as well as extended basins in the Tertiary of the Upper Missouri region, were deposited in shallow lakes partially or wholly shut off from the sea. These deposits in Wyoming overlie unconformably an earlier series of Eocene beds, characterized at the base by the general presence of workable seams of lignitic coal, found not only along the Rocky Mountains and in the Green River basin but in California and Oregon; thus showing that at the close of the Cretaceous epoch the greater part of this western area had emerged from the sea and was covered with a wide-spread luxuriant vegetation.

In coloring the Map no effort has been made to discriminate between these Tertiary formations of different periods. The yellow coloring is comprehensive, including all the sedimentary formations later than the Cretaceous, excepting, only, certain areas of alluvium and modern lacustrine deposits. It is to be particularly noted that in the region of the Great Basin, and in a portion of Montana, Idaho, and Oregon, this color represents not only the Tertiary but the most recent deposits washed down by rains and streams from the adjoining mountains, and spread out in gentle slopes.

The modern lacustrine deposits, to which reference has been made, constitute one of the most interesting records presented to us in the whole series of formations. They show the former extent of immense fresh-water lakes, now either wholly or partially dried up, leaving behind them floor-like beds of fine clay and well-marked terraces and water-lines. The largest of these ancient lakes may be designated as the Humboldt, the Timpanogos (of which the present Great Salt Lake is the remnant), the Tulare, and the Coahuilla, the last having occupied the long valley at the head of the Gulf of California now a desert.

Volcanic.

Lofty extinct volcanoes with enormous outpourings of lava form a striking feature of the geology of the western portion of the United States. The extent of the igneous outbursts is shown approximately by the vermilion coloring. The broadest area covered by lava is in the valley of the Columbia River, and of the Snake River in Oregon. The principal field extends in a nearly unbroken plain over five degrees of longitude and three of latitude. There is a continuous line of extinct cones and lava outflows along the Sierra Nevada of California, and the Cascade Range of Oregon, from latitude 36° to the northern boundary. A large part of the Cascade Range is made up of the outpourings of volcanoes, and at the gorge of the Columbia the superimposed lava beds attain a thickness of between 3000 and 4000 feet, resting upon horizontal Miocene or Pliocene deposits.

The interior region east of the Sierra Nevada is studded at intervals with extinct cones and lava streams, many of them looking as fresh as if they were now cooling. Some of the more important of the extinct volcanoes of the interior have poured floods of lava out over the Cretaceous and more recent formations of the Colorado plateau. Lava plains of great length and breadth are found along the Gila River and in New Mexico. Another great center of igneous action exists upon the head-waters of the Yellowstone and the Snake River, from which lava appears to have flowed throughout the whole length of the Snake River valley, joining the lava fields of the Columbia. The great geysers of the Yellowstone region show that thermal action has not yet wholly ceased, and similar evidences of volcanic heat are exhibited at intervals along the eastern base of the Sierra Nevada, and in the Coast Mountains of California.

Glaciers and Erosion.

There is no extensive drift formation corresponding to the great northern drift of the Eastern States, nor has there been such a wide-spread and deep erosion of the whole surface as that which scooped out the valleys of the great lakes and swept away a large portion of the Paleozoic strata from Maine to Alabama. The erosion of the western area has been comparatively local, being confined chiefly to river valleys, but is exhibited on a stupendous scale in all the mountain ranges, especially on the western slope of the Sierra Nevada, where transverse valleys have been cut out of the rocks to a depth of 3000 feet or more. Farther in the interior the Great Cañon of the Colorado is the grandest example known of river erosion, this stream having cut out a channel a mile or more in depth through the horizontal strata of all ages.

Enormous accumulations of bowlders and gravel deposited by streams are found upon the flanks of the Sierra Nevada, and are the chief repositories of the placer gold. The deposits appear to be in part the result of ancient systems of drainage, and in part to be due to glacial action. The Sierra Nevada, the Cascades, and the high ranges of the Rocky Mountains have all been the theatre of enormous glaciation by local and wide-spread glaciers. These glaciers have left lateral and terminal moraines of great extent, particularly in the region above the Yosemite Valley, California, where the ice-sheet must have been of unusual thickness, and at the head-waters of Kern River about Mount Williamson. The effects of glaciers have been traced as far south as latitude 35°, and remnants of glaciers are still to be found in the deep and protected valleys of the higher mountains in California and Oregon, increasing in magnitude to the northward until, in Alaska, they are of magnificent proportions, filling broad valleys and descending to the sea-level.

The geology on the whole is much more intricate and complicated than at the east. The transitions from one formation to another are rapid and sudden. It is a region of great disturbance, of broken, irregular topography, of high mountains, deep valleys, and of great variety in climate, soil, and productions. The coast is precipitous and the good harbors are few. The chief geographical outlets from the interior are the Columbia River in the northwest, the Golden Gate at San Francisco, and the Colorado Valley on the south, leading to the Gulf of California; but this drains a comparatively inaccessible and barren region. Practically the outlet of the interior basin is by railway to San Francisco, all the longitudinal valleys north and south being tributary to one great east and west line. For the Rocky Mountain region, the Rio Grande and the valleys tributary to the Mississippi excavated in the later and yielding formations of the Secondary and Tertiary period, give the most direct and advantageous means of communication.

Geological Maps and Publications.

The sources of information from which we have drawn in the preparation of the Map are very various. The numerous reports of State Geological surveys have been freely used. Space does not permit a presentation of the full list of geological reports and other publications upon the geology of the Eastern States. As might be expected, the materials accessible have been found to be of very unequal value. In some of the States very satisfactory work has been done, and this has been properly recorded without difficulty; but the adjoining territory perhaps has not been examined, and it has been very difficult to continue the representations into the unknown region. Different authorities have not used the same classification, and it has been necessary to make divisions where the author has given a single color.

In the extreme west it has repeatedly been found impossible to locate recorded observations, from the fact that rivers or natural boundaries mentioned are not to be found on the maps. Again, the extent of formations is seldom so described as to permit of accuracy in plotting except at a single point. It would be well if our explorers should keep constantly in view the importance of so tracing out the boundaries of formations, and recording them on maps or sketches on a large scale, that they can be used in the preparation of reduced maps. Some of the exploring parties of late have been more interested in the science of palæontology than in structural geology, and while collecting fossils have failed to obtain information of the extent and distribution of formations.

The great work of geological exploration of the west (west of the 100th meridian), may be said to have fairly commenced in 1853, when geologists were appointed to accompany each of the Pacific Railroad explorations and the survey of the Mexican boundary. The results thus obtained form the basis of that portion of the map.

For the Upper Missouri and the Rocky Mountain region we are chiefly indebted to the labors of Prof. Hayden; for the northwestern boundary region, to the map of Prof. Bell; for the White Pine region in Nevada, to the Survey of the 40th parallel; for the Cañon of the Colorado, to Prof. Newberry and to J. W. Powell; and for the Uintah Mountains, to Prof. Marsh of the Yale Exploring Expeditions. These more recent contributions to our knowledge of the geology of the West have been supplemented by personal explorations.

The earliest publication of a general Geological Map of the United States was by Maclure in 1809, in a Memoir before the American Philosophical Society. It was separately published in a small volume in Philadelphia in 1817. The coloring does not extend westward beyond the mouth of the Kansas in the Missouri. He adopted the Wernerian classification—the Primitive, Transition, Secondary, and Alluvial.

Featherstonhaugh, in 1835, gave a colored geological section extending from the Atlantic Ocean across New Jersey, Delaware, Maryland and Virginia, through the Western States to Missouri, and thence southwestward to Texas.

Sir Charles Lyell, in 1845, published a Geological Map of the United States and Canada, compiled chiefly from the results of the State surveys. The coloring did not extend much beyond the meridian of 95°.

In 1853, Prof. Jules Marcou published a Geological Map of the United States and British Provinces of North America, with an explanatory text, geological sections, etc., and in October of the same year Prof. Edward Hitchcock published a Geological Map of the United States and Canada accompanying an "Outline of the Geology of the Globe and of the United States in particular."

Another map by Prof. Marcou appeared in Peterman's Journal in July 1855. It was presented at the May meeting of the Geological Society of France and was published in March 1856, and again in the Geology of North America in 1858.

Prof. W. B. Rogers, in 1855, compiled a map for A. Keith Johnston's Physical Atlas, published in 1856.

After the return of the Pacific Railway exploring expeditions in 1854–'55 a map of the region west of the 100th meridian was prepared by one of the writers. It was compiled in the Engineer's office, War Department, from the results of various surveys, and it was exhibited with explanations at the Albany meeting of the American Association in 1856, but it was never published. Shortly after, the map illustrating the General Geological Features of the country west of the Mississippi River, compiled from the surveys of W. H. Emory and from the Pacific Railroad Surveys and other sources, by Prof. James Hall assisted by J. P. Lesley, Esq., was published in the Report of the United States and Mexican Boundary Survey, 1857.

1806.—Abstracts of Public Documents relative to the late discoveries in exploring the Missouri, Red, and Washita Rivers. 8vo. Washington.
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