ART. IX.—*The Primordial Sandstone of the Rocky Mountains in the Northwestern Territories of the United States;* by Dr. F. V. HAYDEN.

WE have attempted in this paper to present as clear and connected an account, as the known facts will permit, of the Primordial rocks west of the Mississippi, more especially those of the northwest, west of longitude 96°. The Potsdam sandstone of the New York series is the division of the Primordial zone of Barrande, mainly represented in the Rocky Mountain district and is that part alluded to unless otherwise mentioned.

In speaking of the geographical distribution of the Potsdam sandstone reference will be made to localities to the eastward where it has furnished most abundant and satisfactory testimony in regard to its age. We will in the first place, present more in detail, such facts as we have been able to obtain by personal observation in the field, and by the aid of these and the statements of reliable explorers we hope to give some idea of the geographical extension of this wide spread formation in the West.

Our first knowledge of Primordial rocks west of the Missouri river, was obtained in the summer of 1857, during the exploration of the Black Hills of Nebraska, by an expedition under the command of Lieut. G. K. Warren, Top. Eng. The more important facts with the determination of the fossils, were published by Mr. Meek and the writer in March, 1858.*

By reference to the general map of the country west of the Mississippi, recently published under the auspices of the War Department, we find that the Black Hills lie between the 43d and 45th degrees of latitude, and the 103d and 104th degrees of longitude, and occupy an area about 80 miles in length, and from 30 to 50 in width. According to Lieut. Warren the shape of the mass is elliptical and the major axis trends about 20° west of north. The base of these Hills is about 2,500 to 3,000 feet, and the highest peaks 6,700 feet above the ocean. The entire range is clasped, as it were, by the north and south branches

* Proceedings of the Academy Nat. Sci. Pa., March, 1858.

of the Shyenne river, the most important stream in this region. The north branch passes along the north side of the range, receiving most of its waters from it, but taking its rise far to the westward near the sources of Powder river, in the 'divide' between the waters of the Yellow Stone and those of the Missouri. The south branch also rises in the same 'divide,' flows along the southern base of this range, receiving the waters of numerous tributaries which have their sources in it.

Again, by referring to the map above alluded to, we ascertain that the Black Hills form the most eastern outlier of the great Rocky Mountain range as well as the first point where rocks older than the Carboniferous are exposed to the eye after leaving the Missouri westward. These Hills would seem to constitute an independent elevation, so far are they removed from other ranges, were it not for a low anticlinal which may be traced across the plain country southward connecting them with the Laramie Mountains near Laramie Peak. The central portion is composed of red feldspathic granite and stratified Azoic rocks, and resting unconformably upon, and forming a zone or belt around, the ellipsoidal nucleus, are a series of variable, reddish ferruginous sandstones which by their organic remains, furnish the most reliable evidence that they belong to the Potsdam period.

As observed in and around the Black Hills, the Potsdam sandstone presents a great variety of lithological characters. In many localities it is composed of a conglomerate of more or less water worn pebbles, mostly whitish crystalline quartz, but representing to a greater or less extent, the different varieties of the changed rocks beneath. The pebbles vary in size from an eighth of an inch to four inches in diameter cemented together with a silicious paste. Some of the pebbles are scarcely worn, while others are quite smooth. At the locality where the following section was taken, the sandstone is of a gray color tinged with red at the base, but ascending it becomes more ferruginous until its color is a dark dull red, and its texture, a coarse grained friable sandstone with many quartzose and micaceous particles and some calcareous matter. Seams two to four inches in thickness are very nearly composed of shells of the genera *Lingula*, *Obolella*, &c., which, though quite fragile in their nature, are so well preserved as to be easily identified. The following section taken near the central portion of the Black Hills exhibits Carboniferous rocks and the Potsdam sandstone conforming to each other, but the latter resting discordantly upon the Azoic stratified and granitic rocks.

1. A hard, compact fine grained yellowish limestone of an excellent quality; passing down into a yellow calcareous sandstone, quite friable. Fossils: *Spirifer Rockymontana*, Marcou, an *Athyris*, like *A. subtilita*, *Cytoceras*, &c. - - - 50 ft.

2. Loose layers of very hard yellow arenaceous limestone with a reddish tinge, underlaid by a bed, six to eight feet in thickness of very hard blue limestone; the whole contains great quantities of broken crinoidal remains with cyathophylloid corals and several species of brachiopoda. - - - - 40 ft.
3. Variegated sandstone, of a gray and ferruginous red color, composed chiefly of grains of quartz and particles of mica cemented with calcareous matter. Some portions of the bed are very hard, compact, silicious; others a coarse friable grit, others a conglomerate. Fossils: *Lingula prima*, *L. antiqua*, *Obolella nana*, and fragments of a trilobite, *Arionellus? Oweni*. 50 to 80 ft.
4. Stratified azoic rocks standing in a vertical position for the most part.

Leaving the Black Hills in a direction, a little west of south, we follow an anticlinal valley to the Laramie Mountains with which the Black Hills seem thus obscurely connected. The evidence, so far as it goes, appears to indicate that the same force which elevated the one raised the other, and that the events were synchronous. We do not observe the lower rocks after leaving the Black Hills until we reach the source of the Niobrara river, where we find a series of horizontal strata resting upon the vertical edges of Azoic clay slates and schists, which from their lithological characters and position, doubtless belong to the age of the Potsdam sandstone, though no organic remains could be found. The following section shows the descending order of the beds.

1. Quartzose sandstone, some parts filled with pebbles, - - 22 ft.
2. Red argillaceous slate, - - - - - - - 5 "
3. Sandstone, dull reddish ferruginous, like bed 1, above, - - 37 "
4. A series of strata more or less inclined, composed of gneiss with silvery mica in large plates, micacous and talcose slates, white quartz, &c.

We have no doubt that the Potsdam sandstone occurs in the form of an outcropping belt all along the Laramie range of mountains, though, after a thorough search we were unable to discover any organic remains. Having once fixed the position and age of a formation, as the Potsdam sandstone is established in the Black Hills, we may rely with considerable confidence upon the physical characters and stratigraphical position to determine the age of rocks in the same district of country. We have on these grounds regarded certain rocks along the Laramie range as of this age. In the first ridge of elevation west of the trading post on La Prele creek, about sixty miles northwest of Fort Laramie, is a series of rocky layers, fifty feet in thickness, reposing unconformably upon red feldspathic granites, mica schists and clay slates. The lower portion is a fine grained subcrystalline quartzose rock, partially metamorphosed, passing up

into a friable sandstone arranged in thin layers, with the laminæ quite oblique, overlaid by a considerable thickness of conglomerate. The dip is about 20° east. Resting upon these supposed Potsdam rocks at this point and inclining at about the same angle are layers of limestone, containing numerous fossils which prove them to belong to the Carboniferous age.

Again, farther southward along the same range, near the source of the Chugwater river we find the same limestones, well developed, containing some Carboniferous fossils, and underneath them and inclining in the same direction is a group of strata of a brick red color, more or less changed by heat, holding the position of the Potsdam sandstone in other localities. In some places these rocks are so metamorphosed by heat from beneath as to appear like a red feldspathic granite, and in others, like a reddened granular sandstone containing numerous unchanged masses of quartz.

At the Shyenne Pass, we observe the well known Carboniferous rocks, inclining about 13°. Beneath them is a considerable thickness of red marls and laminated sandstone, and still farther down and inclining 26° is a quartzose sandstone, full of water-worn pebbles, passing down into layers which at a distance look like indurated clay, but which, on a closer examination, proved to be an aggregation of quartz and feldspar crystals cemented with an aluminous paste. At another locality we have the following characters: 1st, a greyish quartzose sandstone, 12 inches; then descending, 2d, laminated granitoid rock, 2 feet; 3d, compact reddish ferruginous granitoid material, 8 feet; 4th, a considerable thickness, perhaps 50 feet of feldspar crystals cemented with an aluminous paste, inclining 13°. Though we could find no organic remains in these supposed Potsdam rocks along the Laramie range of mountains, yet their stratigraphical position and physical characters leave very little room for doubt as to their age.

Although we think that the known facts justify the inference that the Potsdam sandstone is revealed in an outcropping belt all along the margins of the Big Horn range, resting unconformably upon the Azoic rocks beneath, yet we were unable to make a careful examination except in a few localities. We could see, however, in the loose material scattered along the foot of the mountains, washed down by the streams, masses of sandstone closely resembling the rock under consideration. Near the sources of Powder river we penetrated to the nucleus of the mountains and found a series of sandstones underlying the Carboniferous limestone and resting unconformably upon the schistose and clay slates of the Azoic series, in very nearly the same manner as in the Black Hills before described. The Potsdam sandstone in this region is quite well developed, attaining a thickness of 200 feet, and exhibiting its usual variable lithologi-

cal characters. Near the base, the rock is of a reddish flesh color, very compact, composed of an aggregation of quartz pebbles, varying in size from a minute grain of quartz to masses half an inch in diameter, cemented with silicious matter. Portions of the rock contain many pebbles of jasper which appear to have been slightly worn before being enclosed in the silicious paste. Passing up we find the rock to be arranged in thin ferruginous layers, slightly calcareous but mostly silicious, with many small particles of mica. These thin layers are also charged with fossils, as *Lingula antiqua*, *Obolella nana*, *Theca gregarea* and *Arionellus? Oweni*. Many of the slabs were covered with fucoidal markings and what appear to be tracks or trails of worms. The upper part of this formation as seen in the Big Horn mountains, is a rust colored granular sandstone, the small silicious grains being held together by a calcareous cement which causes the rock to effervesce briskly on the application of an acid. In tracing the different fossiliferous rocks, at this locality, from the nucleus outward, we can see a good illustration of the strict conformability of all the formations from the Potsdam sandstone to the summit of the Lignite Tertiary. We see here the evidences of only two great periods of disturbance, the one occurring prior to the deposition of the Primordial sandstones which inclined the Azoic rocks, and the other at the close of the accumulation of the true Lignite Tertiary deposits when the mountain nuclei began their elevation above the surrounding country.

Along the Wind-river mountains which extend far northward and form the dividing crest of the great Rocky range, the Potsdam sandstone is quite thinly represented and yielded no organic remains to a somewhat hasty examination. Near the junction of the three forks of the Missouri, alternate strata of clay, limestone, and compact silicious rock, occur beneath well marked Carboniferous beds. These rocks are evidently of ancient date, and were deposited in quite shallow water, as is shown by numerous thin layers of rock covered with trails of worms and fucoidal plants. These facts thus enumerated would seem to indicate with considerable certainty that this rock once spread over the area occupied by the central range of the Rocky Mountains, doubtless extending far north beyond the limits of the territories of the United States. The predominance of eruptive rocks as we pass northward along the main range of the Rocky Mountains greatly increase the difficulty in tracing out the lower fossiliferous beds.

The following list of fossils from the Primordial rocks of the Rocky Mountains, with the accompanying remarks is taken from a paper by F. B. Meek and the writer published in the Proceedings of the Acad. Nat. Sci. Pa.

Lingula prima, Conrad.

Our specimens are generally more or less exfoliated, but as near as can be determined, they seem to agree with the well known New York species in every respect. Quite abundant in the Primordial sandstone of the Black Hills, lat. 44°, lon. 104°.

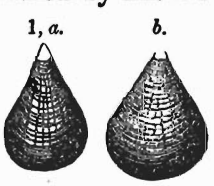
Lingula antiqua, Hall.

There are amongst our specimens several varieties of forms, some being much more elongated and more attenuate towards the beaks than others. Some of the latter agree quite nearly with Dr. Owen's figures of *Lingula pinnaformis*, which is generally regarded as a variety of *L. antiqua* (though it may be distinct) while others are in all respects like the typical forms of *L. antiqua* from New York.

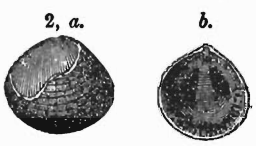
Locality.—Black Hills and Big Horn Mountains.

Obolella nana, Meek and Hayden, Proc. Acad. Nat. Sci. Phila., Dec. 1861.

The genus *Obolella* has been recently established by Mr. Billings, the able Palæontologist of the Canadian Geological Survey. It consists of a group of small shells allied to *Obolus* of Echwald, but presents fundamental diffferences in the form and arrangement of its muscular impressions. The type of the genus is closely allied to the form here figured, though specifically distinct.



The figures here given are enlarged three diameters. No. 1, *a*, represents the outside of the dorsal valve, and No. 1, *b*, the inside of the ventral valve, showing the muscular scars. There are also some appearances of another small scar on each side between those represented and the margins of the valve. The radiating striæ represented on the exfoliated portion of fig. 2, *a*, are too numerous and crowded in the cut.

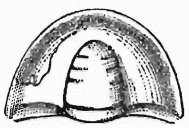


Theca (*Pugiunculus*) *gregarea*, (M. and H.) Proc. Acad. Nat. Sci. Philad.

This species resembles in form *Pugiunculus striatulus* of Barrande (Neues Jahrb., pl. 9,) but differs in being very much smaller, and much more convex on the ventral side, as well as in being destitute of striæ. This little shell must have existed in vast numbers, since on a single slab not more than six by eight inches across, we have counted nearly two hundred individuals. Occurs in rocks equivalent to the Potsdam sandstone of the New York series, in the Big Horn Mountains, near lat. 43°, lon. 107°.

Arionellus? Oweni, (M. and H.) Proc. Acad. Nat. Sci. Philad.

4.



The only specimen of this species we have seen is a cast, retaining none of the shell, and of course giving no idea of the nature of the external markings if there are any. Nor is it in a condition to enable us to determine whether or not the posterior lateral extremities of the buckler are pointed though they appear to be. At a point nearly opposite the middle of the glabella, there is on each cheek less than half way down the slope from the furrow between the check and the glabella, what appears to be some remains of small eyes, though the specimen being unfortunately a little defective here on both sides, the nature of these prominences cannot be clearly made out.

As near as can be determined from a shadowy medal ruled figure of an imperfect specimen, this *Trilobite* seems to be nearly related to a form represented by Dr. Owen on plate 1, A (fig. 13) of his Report on the Geology of Wisconsin, Iowa and Minnesota under the name *Crepicephalus;* though the anterior margin of its head is more narrowly rounded, and its glabella less tapering. Until specimens showing its facial sutures can be obtained, its generic relations will have to remain somewhat doubtful.

Near the central portion of the Black Hills, and at the Big Horn Mountains.*

We have now described this member of the Primordial zone as far as it has occurred within the limits of our own observations. It now becomes an interesting point to determine its geographical extension in the West, and for that purpose we propose to summon all the evidence at our command. The proof will not, however, be as satisfactory as could be desired owing to the general absence of organic remains.

If we now extend our examinations far north into the Hudson's Bay territory we find that much interesting information has been obtained in regard to the Silurian rocks of that region, but not accompanied by the evidence which gives to the knowledge acquired that definiteness which is desirable. It is probable, however, that when not eroded away or concealed by more recent deposits, the Potsdam sandstone and perhaps rocks of more recent Silurian age occur all along the margins of the Rocky Mountains to the Arctic Sea. To what extent still more recent or Upper Silurian occur over this vast region, our present knowledge will not enable us to determine, but the few fossils which have been collected indicate that the great Silurian Sea extended over much of the northwest. Sir John Richardson

* The fossils referred to in the present paper are to be found in the Museum of the Smithsonian Institution.

mentions the existence of conglomerates and sandstones to which succeed limestones and clay slates probably of Silurian age, and granite. We know that in many localities in the mountains, about the sources of the Missouri, the rocks of the Potsdam period are composed of sandstones and more or less coarse conglomerates. Underneath are clay slates and very hard limestones of Azoic age and to these succeed granite. As we proceed northward, the evidence of true Lower Silurian rocks, gives place to those of Upper Silurian age which have furnished a good supply of organic remains. According to Mr. Isbister these rocks are well developed around Hudson's Bay, Great Slave Lake and River, Lake Winnepeg, &c. He cites numerous fossils as belonging to Silurian types, but the species are too numerous to mention here. We may simply state that so far as our knowledge extends, there is no evidence which renders it certain that any portion of the Primodial zone of Barrande occurs north of lat. 49° though it is quite probable that when carefully sought after, it will be found revealed along the margins of the mountain elevations to the Arctic Sea.

As we proceed southward along the line of the mountain ranges toward New Mexico, though no fossils have been found, we feel safe, acting upon our previous knowledge, in regarding the evidence as quite clear, that this sandstone occurs in numerous localities. In our investigations of the geology of the West, we have relied on three tests of evidence, viz.: 1st, Palæontological evidence, which is the most important, and in most instances the only conclusive proof; 2d, Stratigraphical position; 3d, Lithological resemblance. The last two tests are all we have to rely upon to determine the extension of the Lower Silurian rocks as we proceed southward from the Black Hills. Having traced rocks which we regard of this age south to a point on a parallel with the Salt Lake district, we present the following resemblances in lithological characters as probable evidence of their existence in Utah territory.

Prof. Hall in Stansbury's Report, in several places describes a bed of sandstone, corresponding in its lithological characters and geological position to the Potsdam sandstone in the Black Hills. Stansbury Island, (Great Salt Lake) the summit of which is three thousand feet in height, is capped with Carboniferous limestones which rest upon a coarse sandstone or conglomerate. Again, north of Great Salt Lake City, the limestone overlies a coarse sandstone or conglomerate which almost invariably accompanies it. In several localities as at Promontory Point and near Mud Island, the metamorphic strata appear to be overlaid by a coarse conglomerate or coarse sandstone which is partially altered and assumes the character of a quartz rock. Marcou in the third volume of Pacific R. R. Reports, page 156, mentions

a sandstone occurring near the Aztec Mountains. He says: "We traveled seven miles upon the granite, then a bed of red sandstone. Above this the beds of limestone and grey sandstone, belonging to the mountain limestone." The following day "we traveled three miles on the granite, the remainder on the Old Red Sandstone." An excellent diagram illustrating a section of the rocks near the mountains above alluded to, accompanies Mr. Marcou's remarks, which would apply equally well to similar beds in the Black Hills. The great uniformity in the physical characters of the different formations over large areas which have been examined with care and definite knowledge obtained leads us to place some degree of confidence in the above statements. From lat. 49° to 40° south and east of the dividing crest, we have the Potsdam sandstone, then immediately above it with remarkable uniformity, a series of beds of limestones, containing true Carboniferous fossils. We infer, therefore, that both northward and southward the same uniformity of geological structure continued unless we have evidence to the contrary.

The observations of Dr. J. S. Newberry render it quite probable that rocks of Lower Silurian age occur along the valley of the Colorado. The following paragraphs from a letter addressed to the writer by Dr. N., are extracted by permission. "I have never collected any unmistakable Silurian fossils in the far west. I am perfectly satisfied that the lower stratified rocks of the Colorado section are Silurian, but the only fossils they contain are too much changed to be satisfactorily identified.

The lower rocks above the granite are coarse red sandstones—lithologically and stratigraphically corresponding to your Potsdam of the Black Hills. Above these, a great thickness, over 300 feet of shales, limestones and sandstones and then the first Carboniferous fossils.

Just above the Potsdam (?) is a limestone filled with corals, apparently *Chætetes lycoperdon* or rather the same with that so common in the Trenton with branching stems, formerly included in *C. lycoperdon*, but evidently distinct. On the mountains bounding the Colorado basin the Carboniferous rocks rest directly upon the granite."

We have now considered the Potsdam sandstone in its geographical extension over the West as far as we are acquainted with its existence, and have pointed out the localities where it is revealed. Along the Mississippi Valley and eastward, most important discoveries are made annually, which show it to be developed every where, when the conditions are favorable for its exhibition. It is true that in some localities beds of more recent age repose directly upon Azoic rocks, but in these cases may not the Primordial sandstones lie concealed or be eroded away? The researches of Dr. B. F. Shumard in Texas, have shown that the

Primordial zone attains a considerable thickness in the southwest, and is charged with an interesting group of its peculiar fossil forms. The examination of others proved its existence all along the Atlantic coast extending westward from Canada to Wisconsin, Iowa and Minnesota, and thus a great period in the world's geological history formerly supposed to possess but a meagre fauna, the first representatives of life on our globe, has already yielded very abundant and varied forms. The following is a summary of the principal facts and conclusions from our knowledge of the Potsdam sandstone in the far West.

1. We have the most undoubted evidence of the existence of that division of the Primordial Zone which is the equivalent of the Potsdam sandstone of the New York series, in two important ranges of mountains, outliers of the great Rocky Mountain chain. All the fossils are well known Primordial types and at least two species are identical with forms occurring at the typical localities of this period in the Eastern States. The others are forms closely allied to species found in the equivalent rocks both in this country and in Europe.

2. This division of the Primordial Zone, as a rule, appears as an underlying formation when the conditions are such as to expose it to view, from the Atlantic coast to the crest of the Rocky Mountains, and probably farther. Localities doubtless do occur where rocks of more recent age than the Potsdam sandstone rest directly upon the Azoic or granitic rocks below, but these facts do not militate against the general rule. Having proved its existence in two important ranges of mountains from its organic remains, by means of lithological resemblance and stratigraphical position, we have with considerable confidence, traced it by personal observations throughout the mountainous district comprised within lat. 40° and 49°, and lon. 103° and 112°. From these facts and the observations of reliable explorers in different parts of the West, we think we are warranted in the belief that this rock is exposed all along the margins of the Rocky Mountain range when not eroded away or concealed by overlying formations. How far westward of the dividing crest of the Rocky Mountains it extended we have no data for determining, nor can we hope to have where eruptive rocks seem to predominate. As yet we have not known the Potsdam sandstone to be exposed except along mountains with a true granite nucleus.

3. Wherever this rock occurs we are struck not only with the singularity of the organic remains, but also with the remarkable uniformity in the nature of the sediments and the general lithological appearance, compared with its equivalents in more eastern localities. We do not believe this to be due to currents of water bearing the materials from far eastern lands, but that the

sediments were obtained from the vicinity and that the uniformity in their character arises from the nature of underlying rocks from which they were derived.

The Potsdam sandstone is everywhere composed of calcareous and silicious matter, granular quartz, ferruginous material in great quantities, also pebbles of various kinds worn and unworn, with now and then seams and layers of argillaceous material. We find in the Azoic rocks below an abundance of limestone, clay slates, mica schists, seams of white quartz, granite composed largely of feldspar and we can readily detect the source of the fragmentary masses which form the conglomerates. We also know that while nuclei of certain mountain ranges on the eastern slope are composed of a massive feldspathic granite, a great thickness of more recent or overlying rock, forming the lower and smaller ridges are composed of a kind of "rotten granite" which is so full of the hydrated oxyd of iron that it readily decomposes on exposure to the atmosphere. We therefore believe that the source of all the sediments composing the Primordial rocks in the west can be traced to the underlying rocks in the vicinity.

4. There are no indications of long continued deep water in the Primordial sea so far as the West is concerned. If we examine the lower part of the Potsdam sandstone we find that the physical conditions which ushered in this period were quite violent, as is shown by the conglomerate character of the rock. Passing upward this conglomerate graduates into a rock composed of granules of quartz and small plates of mica cemented with calcareous matter, and about midway in the formation we have a fine, very ferruginous calcareous sandstone, in thin layers, filled with fossils in a very good state of preservation. The condition of the organic remains, the fineness of the sediment and the perfect horizontality of the laminæ of deposition indicate a short period at least, of quiet water. As we continue upward the rocks begin to show the shifting nature of the currents, shallow water and perhaps a proximity to land, by oblique laminæ of deposit, ripple markings and fucoidal remains. The upper portion of this rock contains no fossils, nor were the physical conditions such as to have preserved them even if they had existed.

5. There seem to be evidences of a gradual thining out of the Primordial sandstone in its far western extension, as also of all the Palæozoic formations. According to Dr. Owen the Protozoic sandstones in Minnesota are at least 500 to 600 feet in thickness, and in Iowa, Professor Whitney estimates them at from 250 to 400 feet. In Tennessee Prof. Safford finds several thousand feet of rocks, which he refers to this age, and in Texas where they seem to be quite well exhibited and to yield a large number of

fossils, Dr. Shumard gives them as only about 500 feet. In the Rocky Mountain district they are seldom more than 80 feet and never over 200 feet. Indeed all the Primary fossiliferous rocks are but thinly represented there, while the lower Secondary formations begin gradually to increase in force until all along the eastern slope we have an enormous development of the upper Secondary and Tertiary with an aggregate thickness of from 8000 to 10,000 feet.

6. So far as we yet know there is no unconformability in any of the fossiliferous sedimentary rocks of the northwest from the Potsdam sandstone to the summits of the true Lignite Tertiary. There are proofs of two great periods of disturbance which had a marked influence upon the physical geography of the West. The one occurred prior to the deposition of the Potsdam sandstone when the Azoic or granitic rocks were elevated into a more or less inclined position and the other and most important period took place at the close of the accumulation of the great Lignite Tertiary deposits when the great lines of fracture were produced and the massive nuclei of the mountain ranges were raised above the surrounding country.

7. What changes took place in the physical geography of the West during the long period which must have elapsed after the deposition of the Potsdam sandstone until the commencement of the Carboniferous age, we have very few data to determine. We are inclined to think that this portion of the West at least was elevated above the water level during the greater part of that period; the numerous indications of shallow water during the accumulation of the Potsdam sandstone, and the almost entire absence of rocks of intermediate age over so large an area further strengthens that opinion. It is true that in the far Northwest we have proofs that the hiatus is partially filled, but in the South and Southwest the evidence is still more meagre. Near the Humboldt mountains in Utah Messrs. Meek and Engelmann have detected proofs of Devonian rocks but they are not known to be largely developed, and on the western declivity of the El Paso mountains Dr. G. Shumard found "well marked strata of the inferior Silurian system corresponding in age to the Blue Limestone of Cincinnati and the Hudson River group of the New York series."* But so far as our present knowledge extends, rocks of intermediate ages do not form a prominent feature in the geology of the west.

Smithsonian Institution, Washington, Nov., 1861.

* Transactions of the Academy of Sciences, St. Louis, vol. i, No. 2, page 288.