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HISTORY OF GEOLOGY IN THE STATE OF WASHINGTON*

The first explorers to what is now the State of Washington naturally came by the sea, and in the logs of their journeys there are occasional references in a meager way to the geology of the region. They found the shores so heavily wooded and so difficult to penetrate that they did practically nothing on land that today we would designate as field-work. For that matter the science of geology was so little developed in those days that the ablest man of his time, if he were aboard one of the ships, could have made but little contribution to the general knowledge of the subject.

Early in the eighteen hundreds exploring parties made the long journey overland and entered Washington from the East. In the printed accounts left by these men, a student of geology may find statements and hints which give him a clue to various geological phenomena which caught the eyes of the keen observers. Southeastern Washington was mentioned as a lava country, and the source of the flows was assumed to be in Mount Adams, Mount Hood, and other undoubted volcanoes of the Cascades. The great gorge of the Columbia was believed to be due to a gigantic fault which cleft the mountains and thereby made a passageway for the river. Naturally the conclusions of these early men have been frequently modified by more extended observations and by the general growth of the science itself.

After a time, when the more formidable surveys and exploring expeditions were sent out from the East, it was the rule to assign to the parties from one to several geologists. Thus it happened that when the Pacific Railway Surveys were undertaken, from 1853 to 1856, one of the geologists, William P. Blake, while in San Francisco, obtained reliable information regarding the occurrence of coal on Bellingham Bay, which he

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mentions on pages 285-7, pt. 2 Vol. V, of the *Pacific Railway Reports.*

The geologist attached to the United States Northwest Boundary Commission (1857-1861) was George Gibbs. As results of his work, glaciers and perpetual snow-fields were discovered in the northern Cascades, and the age of the coal strata around Bellingham Bay was determined from the fossil plants that he collected.

The Geological Exploration of the 40th Parallel (1862-72) had several well known geologists on its staff, notably Clarence King, the leader, Arnold Hague, James D. Hague, and S. F. Emmons. In the summer of 1870 they studied the volcanoes and glaciers in northern California, Oregon, and Washington, and several papers were published.

The Geographical Surveys west of the One Hundredth Meridian, under Wheeler, (1869-79) published some information regarding the Indian tribes, the elevations at several localities, and the latitude and longitude at a few points, but nothing of any consequence regarding the geology.

In the matter of the early explorations mention should be made of the Wilkes Exploring Expedition (1838-42) which touched at several places on our shores. The geologist of this expedition was James D. Dana, who had an opportunity to study the geology along the lower Columbia River. From his collection of fossil shells, the Tertiary age of the rocks at the mouth of the stream was made known.

The various explorations into the West all ceased by 1879, and that year saw the establishment of the United States Geological Survey that has had the major part in working out the complicated geology of Washington. The Canadians have carried on two notable surveys along the 49th parallel, whereby the geology of our extreme northern margin has been worked out in much detail. The men in charge of these surveys were Hilary Bauerman, who did his field-work in 1859-61, and R. A. Daly, who made his studies in 1901-6.

As to subject matter of geological investigations, it was but natural that there should have been an early start along economic lines. The people of the East were curious as to the mineral wealth that might be hidden away in the somber forests of the new Territory or lying ready for the hardy miner in the forbidding mountains. Coal was discovered on Bellingham Bay in

1852 and became at once an article of export to San Francisco. At a later date coal mines were opened near Seattle and in the foothills of the Cascades, east of Tacoma. Reliable reports were called for and survey parties from time to time were sent into the field. The principal Federal publications have been made by Bailey Willis and George Otis Smith, and the State reports by George W. Evans, Edwin J. Saunders, Joseph Daniels, H. E. Culver and Henry Landes.

The structural materials of the State have received attention, because as the population grew there was a demand for detailed knowledge as to the quantity and quality of our building stone, clay and cement resources. The chief publication in these fields have been made by Solon Shedd, Hewitt Wilson, M. M. Leighton and Henry Landes.

The early discovery of the precious and useful metals in the states south of us, as well as in British Columbia, led to much prospecting in the mountains of Washington. Our State has not developed any great mines of the metals, but reports on our metalliferous resources have been demanded from time to time. The government geologists who have made reports upon different areas at different times have been Waldemar Lindgren, Howland Bancroft and George Otis Smith. For the State Geological Survey, investigations and publications have been made by Charles E. Weaver, Joseph B. Umpleby, Ernest N. Patty and Olaf P. Jenkins.

The early settlers who came to the State noted at once that Western Washington had a very humid climate but that on the east side of the Cascades the rainfall was so slight that desert conditions prevailed in all the lowlands. These same plains had an excellent soil, an abundance of sunshine, a long growing season, and if supplied with water would develop great agricultural communities. Hence there followed a demand for a careful investigation of all water supplies. The United States Geological Survey began its measurements of the run-off of the streams in order to know how much water could be depended upon for irrigation or any other use. Stream measurements were begun on the Columbia River, at The Dalles, in 1878; on the Spokane River, at Spokane, in 1891; on the Yakima River, at Union Gap, in 1893; on the Naches, near North Yakima, in 1894; and so on until the annual and seasonal flow of every stream in the State has been measured with close accuracy.

The measurement of the mountain streams, especially those on the western slope of the Cascades, and their gradients or profiles have been scured more for water power determinations than for other uses. The Federal and State surveys, under cooperation, have published three volumes dealing with the water-power resources of the State and have other reports in preparation.

In the more arid portions of the State there have been several investigations of the water resources, whether the water came from streams, ordinary wells, artesian basins, or any other source of supply. Along these lines reports have been made by Israel C. Russell, on Southeastern Washington; George Otis Smith, on a portion of Yakima County; Frank C. Calkins, on a portion of East-Central Washington; G. A. Waring on a portion of South-Central Washington; Schwennesen and Meinzer, on Ground Water in Quincy Valley; and Henry Landes, on the underground waters of Washington.

The character of the soils of the State and their adaptability for particular crops were topics of early inquiry. These investigations were called for in Western Washington when the acreage of cut-over or logged-off lands began to run into hundreds of thousands of acres. In order to help solve the problem of these "loafing acres" extensive soil surveys have been made of the deforested areas of Western Washington, the costs of the field-work being divided between the United States Bureau of Soils and the State Geological Survey. Soil surveys have also been made of Stevens and Spokane Counties, and of the arid regions about Pasco, Walla Walla, Yakima, and Quincy Valley.

The topographic mapping of the State has been largely in the hands of the United States Geological Survey, with the exception of certain areas which in later years were mapped jointly by the Federal and State surveys. The field-work for the first topographic map was done in 1893, and involved the country about Seattle. The surveys have proceeded slowly, but something has been accomplished each season, and today almost one-half of the State has been covered by topographic maps.

The geologic mapping has proceeded with great slowness, largely because of the heavy expense involved. The Federal Survey has mapped the geology of four of the topographic quadrangles and published these in the form of folios, with colored maps and text. The folios thus far published are known as the Tacoma, Ellensburg, Mount Stuart, and Snoqualmie, and each

includes an area of about 825 square miles.

The Federal Survey has published several other areal geological maps, upon which the outcrops of the various formations are shown. One of these maps, with descriptive text, was published in 1918 and was called "Geology and Mineral Deposits of the Colville Indian Reservation," by J. T. Pardee.

The State Geological Survey has also published several geological maps, embracing a total of several thousand square miles. They are all accompanied by texts of descriptive matter, and emphasize particular areas or formations of unusual significance. One very important report was made by C. E. Weaver in 1916 and was entitled "The Tertiary Formations of Western Washington." In 1920 Dr. Weaver also published another bulletin which was called "The Mineral Resources of Stevens County."

The University of Washington, in 1927, printed and distributed a book, with a geological map, on the "Geology of the San Juan Islands." This report was made by Roy D. McLellan as a part of his work for his doctorate in geology.

The high Cascades and the Olympics have always served as a lure for the mountain lovers and the many expeditions into their more inaccessible parts, made by individuals and parties, have brought us much geological information about these Alpine areas. The more formidable groups of mountain climbers that have made notable additions to our mountain knowledge have been The Mountaineers of Seattle, the Mazamas of Portland, and the Sierra Club of San Francisco.

Chronologically it may be of interest to note that the first ascent of one of our high snow caps was made by Thomas J. Dryer and three companions who ascended mount Saint Helens in 1853 and published an account of it in *The Oregonian* of September 3, 1853; the second was by E. T. Coleman, who climbed Mount Baker in 1868, and who published an account of his trip in volume 39 of *Harper's Magazine.* Mount Rainier was first ascended in the summer of 1870 by Hazard Stevens and P. B. Van Trump. The former wrote the story of the climb for the *Atlantic Monthly,* and this appeared in volume 38, p. 513, 1876.

The leading student of the glacial history of Washington has been J. Harlen Bretz. The glaciation of the Puget Sound region was first studied in detail by Dr. Bretz and several important publications were made by him. The most conspicuous of his early reports was the one entitled "Glaciation of the Puget

Sound Region," which appeared in 1913. In recent field seasons Dr. Bretz has been working out the story of the ice invasions of Northeastern Washington and already he has written a number of papers setting forth his observations and conclusions.

Several reports have been printed which tell the story of the geography and an outline of the geology along some of our railway lines in the State. The first of these was a part of MacFarlane's *American Geological Railway Guide,* which was published by the Appletons in 1890. In 1915 two valuable bulletins of this kind appeared, published by the United States Geological Survey. One was prepared by M. R. Campbell and was entitled *Guidebook of the Western United States, Part A, The Northern Pacific Route.* The second bulletin had for its author, J. S. Diller, and it was labelled *Guidebook of the Western United States, Part D, The Shasta Route and Coast Line.*

Many paleontologists, seeking out both animal and plant remains, have made their contributions to our knowledge of the geological ages represented in the State. These ardent men and women, after much zealous endeavor, have worked out in a satisfactory way the major facts and incidents of the Mesozoic and Cenozoic ages, but their researches regarding the earlier periods of time have been but slightly rewarded.

As far as sequence of investigations in paleontology is concerned, the earliest work was probably done by Dana, already mentioned. In 1857, 1861 and 1876, F. B. Meek published several reports, with figures, on Cretaceous fossils from Vancouver and Sucia Islands. Between 1885 and 1891 C. A. White prepared a number of reports on the occurrence of Tertiary fossils in the formations about Puget Sound.

The principal paleobotanist who has studied the plant fossils of the Washington rocks has been Frank H. Knowlton. Through his researches the geological ages of the formations around Bellingham, Ellensburg, Winthrop and a number of other localities were determined.

In the limited space at the command of the writer he has been able to give only a skeleton account of the progress of the science of geology in this State. Many important contributions have passed unnoted and the work of many geologists has not been mentioned. In a bibliography of Washington geology which the writer has prepared and has on file in his office there are

about seven hundred titles listed. It would require a great many pages of print to give even a summary of the results of the researches that have been made during the last few decades on the geology of Washington.

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