Early American Geologists and the Oil Industry

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Petroleum has been known for centuries in various parts of the world, but it was not until the famous Drake well was drilled in 1859 that it suddenly assumed the proportions of an industry. Petroleum is one form of bitumen which also occurs as asphalt, as a semifluid substance called maltha and the natural gas which is so familiar to Americans of the twentieth century. All forms of bitumen were known to ancient people. The word “slime” as used in Genesis probably refers to the soft bitumen of the Euphrates Valley and some form of semifluid bitumen was used as mortar in the construction of Nineveh and Babylon. Petroleum is mentioned in the early writings of the Arabs and by the historian Herodotus. Pliny described oil that was used in lamps under the name of “Sicilian Oil.” The oil springs of Baku, which frequently burned in spectacular fashion, attracted the attention of early travelers including that imaginative globe-trotter, Marco Polo.¹

In North America it seems evident that the Indians, particularly the Iroquois and their ancestors in the Great Lakes region, were aware of the oil springs at an early date. Undoubtedly, they used the oil as a base for war paint and as medicine. French missionaries noticed traces of petroleum in the Great Lakes country early in the seventeenth century and by the middle of the eighteenth century the famous Oil Creek in Pennsylvania was receiving some attention in travel books.² After the Revolution, American troops guarding the western frontier posts used the oil for tired feet and aching joints.³

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As the hunters and pioneers moved into the Midwest and Upper South, they noticed oil springs and greasy streams in Ohio, Kentucky, and Tennessee. In Ohio and western Virginia pioneer salt-well drillers encountered oil on the Great and Little Kanawha and in the Muskingum Valley. Later, part of this district was known as the White Oak Anticlinal or the so-called West Virginia Oil Break. Early salt wells bored in Kentucky and Tennessee, especially in the valleys of the Big Sandy and the Cumberland, produced oil in sufficient quantities to be troublesome. The Beatty well in Kentucky, bored about 1819, produced more oil than brine and was abandoned as useless for more than thirty years. Sometimes there were startling and unexpected results from well drilling in these early years. In 1828 a driller from Pennsylvania sank a well near Burkesville, Kentucky, which struck oil instead of salt. When the well was finished it became ignited and the driller, who had boasted on starting the well that he would either find salt or bore into hell, was satisfied that he had accomplished the latter.

Oil in the salt wells was a nuisance, but the petroleum had some commercial value even in the early frontier period of the west. At the time of the westward migration at the beginning of the nineteenth century the methods of collecting the oil were very primitive. The most popular procedure consisted in throwing a coarse blanket into the oil spring and allowing the cloth to absorb the oil. The blanket was wrung out into a tub or barrel and the operation repeated. Some frontiersmen collected oil in five-gallon kegs which they exchanged in Pittsburgh for hardware or food staples needed by the family. This method of barter was not dependable since the demand of the local apothecaries was limited and two large barrels of oil would glut the market.

Since the pioneers believed that the oil had almost miraculous medicinal powers, it was inevitable that every quack and pill vendor of the frontier either used it in his practice or sold it wholesale as a miracle drug capable of curing a

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5 Clarence M. Gaines, *A History of the Oil Fields of Western Kentucky District* (Bowling Green, Kentucky, 1922?), 3.

remarkable array of ailments. Among these were fever (all types), dyspepsia, cholera, and tape work. In addition, the settlers along the frontier used the oil as a cough medicine, a laxative, a liniment for rheumatism, saddle bruises, and charley horses. It was considered very effective on minor burns and it was used extensively in fly season to bring some degree of comfort to domestic animals. Some men claimed that the oil made a very good hog dip and others declared that when it was mixed with the proper ingredients, it made an excellent spring tonic for man or beast.'

In later years crude petroleum was used for more practical purposes. It proved to be superior to animal oils when used as a machine lubricant and in spite of its stench, it was used for illuminating purposes in certain localities. It was beginning to be popular locally as an illuminant in Ohio by 1850 although its use there as elsewhere was retarded by the introduction of a cheap coal oil.* However, by 1858, largely because of the experimentation of A. C. Ferris of New York with oil and oil lamps, the public was becoming increasingly interested in petroleum as a practical illuminant. It was this potential market that prompted the formation of the first petroleum companies between 1854 and 1858 which in turn began the trend of drilling for oil, using the salt-well technique, in order to secure the “black gold” in large quantities.*

It is pertinent to the theme of this article to notice that the promoters of the early companies saw the practical value of scientists as consultants. At this time it was not the geologist who was employed but the chemist, and the services requested did not include field surveys but laboratory tests of the crude oil from the seepages to determine its commercial value. The most important of the pioneer advisers was Benjamin Silliman, Jr., of Yale College who was recognized as an eminent authority in chemistry. He was also interested in geology but his employers were concerned primarily with

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* For the best account of the early oil companies see Paul H. Giddens, The Birth of the Oil Industry (New York, 1938), especially chapters three and four.
the important chemical report on Pennsylvania crude that he issued from his laboratory. In 1854, Silliman was engaged by Jonathan G. Eveleth and George H. Bissell, who were organizing the Pennsylvania Rock Oil Company of New York, to analyze samples of oil from their Titusville property. In April of 1855, Silliman made his historical report which eventually led to the drilling of the Drake well in 1859.\textsuperscript{10}

Silliman's report was important for several reasons. For the first time it was scientifically demonstrated that the refined oil was not only valuable as an illuminating oil but that it was superior to any of the important means of artificial illumination known at the time with the possible exception of the English Argand gas burner.\textsuperscript{11} To prove the point, Silliman invented an original photometer by means of which he brought the petroleum light into rigid comparison with the illumination of camphene lamps, sperm oil lamps, coal oil and gas burners.\textsuperscript{12} Furthermore, he anticipated and described the early methods of distilling petroleum that were to be adopted by manufacturers. He used the method that became known as "cracking" and suggested the use of steam for distillation, an idea that was to be adopted and exploited by Joshua Merrill, a manufacturing chemist on the staff of the Downer Kerosene Oil Company of Boston.\textsuperscript{13}

Eveleth and Bissell were pleased with Silliman's report. With the hope of securing New England capital they reorganized the company and incorporated the Pennsylvania Rock Oil Company of Connecticut with Benjamin Silliman, Jr., as president. Thus there came about the wedding of science and capital but the honeymoon was of brief duration. Internal dissension among the stockholders plus the disturbing effects of the panic of 1857 quickly terminated the activities of this organization. It was succeeded by the Seneca Oil Company which was incorporated in 1858. This firm was responsible for the drilling of the Drake well at Titusville in 1859.\textsuperscript{14}

\begin{thebibliography}{99}
\bibitem{11} \textit{Ibid.}, 22-23.
\bibitem{12} \textit{Ibid.}
\bibitem{13} \textit{Ibid.}, 401-403; see also, Henry, \textit{Early and Later History of Petroleum}, 38-54; Paul H. Giddens, \textit{Pennsylvania Petroleum, 1750-1872, A Documentary History} (Titusville, Pennsylvania, 1947), 127-129.
\bibitem{14} For the history of the companies see Giddens, \textit{Birth of the Oil Industry}, chapters three and four.
\end{thebibliography}
The Drake well proved that a commercial supply of petroleum could be obtained by drilling directly into the rock or "oil sands," and the successful operation of this well marks the beginning of the petroleum industry. It attracted the attention of geologists, promoters, prospectors, and businessmen and soon additional wells were being drilled mostly on a helter skelter basis since no one had a sound theory relative to petroleum origin and occurrence. Most of the new wells were drilled on the assumption that if Drake could get oil from a hole in the rock, so could other men.

The early methods of well drilling would seem simple and inexpensive today but they certainly marked a revolutionary advance over the frontier "soaked blanket" technique. In Pennsylvania, New York, and Ohio the well was drilled with iron or wooden rods, or both combined. If the rock was covered with a layer of soil or quicksand, a cast-iron pipe was driven down to the oil level. The drill hole and the pipe varied from three to six inches in diameter. Great care was taken to drill the hole perpendicular otherwise the pump would never set properly. Small mirrors were used to reflect the sun's rays into the well so that its condition could be determined and errors corrected before the pump was set in place. If the borehole filled with water at a short distance from the surface, it was more difficult, if not impossible, to examine the well accurately.18

The pump was of copper or iron and operated by a five-horse power engine. Barren water veins above the oil pool were stopped by a "seed bag." This was a leather jacket filled with dry flaxseed and placed around the pump. When in place, the water expanded the seed and the jacket swelled into a water tight packing. Since most of the oil came with water, it was run off into a series of large vats of varying depth which separated the oil from the water. From the last vat the pure oil was drawn off into casks and shipped to market.19

The cost of well construction varied from place to place depending on the depth of the boring, hardness of the rock, and the price of labor and supplies. In eastern Ohio a six-inch boring one hundred feet deep cost two hundred and fifty

19 Ibid., 615.
dollars in labor. The pump and frame cost an additional one hundred and sixty dollars. A four-horse power engine was worth about five hundred dollars and three run-off vats could be purchased for ninety dollars. About five hundred dollars was allowed for operating expenses during the boring process bringing the total cost of the well to fifteen hundred dollars. Daily operating expenses for a moderately productive well were estimated at twenty-five or thirty dollars per day. Such a well, producing at least ten barrels\(^{17}\) per day produced a daily profit of eighty-three dollars when oil was quoted at twenty-five cents per gallon at the well.\(^{18}\)

During the years following the development of the Drake well men pursued the smell of petroleum with the same feverish determination that had characterized the gold prospector in the rush of forty-nine. According to Alexander Winchell, one of the early oil geologists, the wildcatters could not be convinced "that mineral oil is a geological product, fixed in its relations to the earth and to the strata, as unchangeably and as intelligibly as iron or salt. They would not listen to the counsel of science. Every man was confident in his self-wisdom, and never inquired on what grounds he believed and acted as he did."\(^{19}\) Of course, in the 1860's geologists themselves did not know very much about the subject and they made many mistakes in their efforts to locate oil. These errors in judgment caused promoters and businessmen to look askance at geologists and the science was given a stigma which, while unjust, was difficult to eradicate. The profession was discredited still more by unscrupulous quacks who advertised themselves as trained and reputable geologists. By 1880 it was a common saying among oilmen that if they wanted to make sure of a dry hole, they would employ a geologist to select the location.\(^{20}\)

Slowly but surely the geologists developed sound theories pertaining to oil occurrence and eventually these ideas were

\(^{17}\) In 1859 a barrel contained forty gallons of oil.

\(^{18}\) Ibid., 616.

\(^{19}\) Alexander Winchell, Walks and Talks in the Geological Field (New York, 1890), 135.

accepted by scientists and oilmen alike. Among the early writers on this subject were T. Sterry Hunt, E. B. Andrews, and Alexander Winchell. Hunt (1826-1892) had been a student in the chemistry course taught by Benjamin Silliman, Jr., at Yale, and in 1847 he was appointed chemist and mineralogist of the geological survey of Canada. While performing his duties in this connection, he observed that Canadian oil occurred "along the line of a low, broad anticlinal axis." This seems to be the first time that the anticlinal fold was associated with oil accumulation. Hunt published his views in an article in the Canadian Naturalist for August, 1861, and modern authorities claim that had he backed up his anticlinal reservoir theory with additional factual evidence based on actual field observation, he would have become an outstanding petroleum authority.

While Hunt was developing his theory in Canada, E. B. Andrews of Marietta College came to a similar conclusion after a study of the oil regions of Ohio and Pennsylvania. Andrews published his conclusions in December, 1861, but neither his report nor Hunt's stimulated the comment that they deserved. Nothing more of importance to the oil prospector was advanced by the geological profession until 1865. In that year, Alexander Winchell (1824-1892), who had been surveying the bituminized shales of Michigan, called attention to the very essential need of an impervious rock covering for the oil sands in order to prevent spontaneous distillation. He was the first to point out that wherever the oil producing shales were exposed to the atmosphere or were covered with a porous medium, the oil and gas slowly escaped and were lost. On the other hand, where the oil rock was covered by an impenetrable layer of rock or heavy clay the oil and gas were retained, gradually forcing out the water and saturating whatever porous strata there was in the formation. The saturated porous strata then became a tightly capped oil reservoir.

21 Quoted in George P. Merrill, The First One Hundred Years of American Geology (New Haven, Connecticut, 1924), 400.
Winchell also accepted the anticlinal theory although he used the word arch instead of anticline.  

Although these theories were fundamentally sound they were given little publicity at this time and several decades went by before a practical working hypothesis for oil prospecting was worked out, successfully demonstrated and generally accepted. Meanwhile, geological field work continued, and the state surveys in Pennsylvania and Ohio were especially valuable to the growing oil industry and to the geologists who were interested in petroleum. From time to time geologists demonstrated that their scientific knowledge was expanding and that this knowledge when properly applied to a given problem possessed a practical value. A striking example was the successful drilling of a well at Brady’s Bend, Pennsylvania, in 1865. The Brady’s Bend Iron Works Company consulted the well-known geologist J. P. Lesley (1819-1903) for an opinion on the probable depth at which oil could be reached on their property. Lesley, who had made a thorough study of the formations in the vicinity, promptly made his computations and predicted that oil should be found at a depth of eleven hundred feet. Acting on his advice the company drilled the well and struck oil at eleven hundred and twenty feet.  

Perhaps Lesley was lucky because few geologists made predictions as accurate as this at this time. Generally speaking, in the 1860's and 70's wells were still being drilled merely because the hills or ledges seemed to resemble other topographical features where petroleum had been discovered. In Pennsylvania, it was noted that the oil pools tended to be elongated, with a nearly straight axis of a fixed magnetic bearing. This caused the development of the “degree lines” or “oil belt” school of thought. When founded on fact, such lines proved to be helpful in drilling in certain cases, but frequently the idea was carried to extremes and applied to districts far removed from those where the original basic data had been gathered. One “oil belt” expert ran a line for sixty-five miles through the woods and terminated his survey,  

24 Ibid.  
by coincidence, at a productive well. This incident was proof to many that all the lands through which the line had been run contained valuable oil deposits.29

John Franklin Carll (1828-1904), who was in charge of the petroleum department of the Pennsylvania survey under Lesley from 1874 to 1885 considered the belt-line theory the best of the old methods, but he was among the first to demonstrate that it was not infallible. He described the belt method of oil prospecting as "an attempt, by means of compass lines, to keep on the axis of the sand deposit," as shown by previous experience and oil well development. It was unfortunate that the oil sands had been directed by the very unstable agent, water, and consequently had not been laid down on a straight and continuous line. This natural condition, he pointed out, was the fallacy in the oil belt theory. Unexpected breaks and curves in the oil sands and gravels made the application of a dogmatic formula of this type a risk and not a certainty in the search for new wells.28

According to Carll, the best guides for the oil prossector were the rocks themselves and while he did not condemn the anticlinal theory, he was very critical of it and thought that it should be used with caution. He agreed with Winchell that there should be a reservoir to hold the oil and a good impervious cover to prevent its escape.29 Carll was the first geologist to thoroughly describe the structure of the Pennsylvania oil formations and at least one student of his career asserts that he created the geology of petroleum.30 However, the fact remains that he failed to see the correlation between the oil and gas wells already in operation and the anticlinal folds that were plainly indicated on his own maps.31 It remained for I. C. White of West Virginia and Edward Orton of Ohio to

31 Carll's work was defended by Charles A. Ashburner and other Pennsylvania geologists at this time (1885). See for example, Science (Cambridge, Massachusetts, and New York, 1883- ), VI (1885), 42-43; also Peckham, "Report on the Production, Technology, and Uses of Petroleum and Its Products," in House Miscellaneous Documents, 47 Cong., 2 Sess., no. 42, p. 52.
demonstrate and popularize the anticlinal theory.\textsuperscript{82} White in particular was a prominent figure in the movement to convince oilmen that geological knowledge was indispensable to the economy of the industry. The field work that he started in 1883 and the publicity that he gave to it during the next two decades revolutionized the field techniques of the petroleum industry.\textsuperscript{88}

Israel Charles White was born in Monongalia County, Virginia (later West Virginia) in 1848. He attended the local public schools and graduated from the University of West Virginia in 1872. For a time he studied geology in the graduate school of Columbia University but he gave up graduate work in 1877 in order to accept a position as professor of geology at his Alma Mater. He taught at the University of West Virginia until 1892, devoting his vacation periods to field work in Pennsylvania where he was attached to Lesley's survey. From 1884 to 1888 he was also an assistant geologist on the United States Geological Survey, devoting most of his attention to the stratigraphy of the bituminous coal field of Pennsylvania, Ohio, and West Virginia.

He advocated the establishment of a geological survey for his native state, West Virginia, and when the survey was actually organized in 1897, he was appointed to the office of superintendent. He spent the rest of his life in this position. During his administration of the survey, he personally supervised the preparation of a complete set of topographical maps covering the entire state and published thirty-four geological reports. Five of the reports, including two on petroleum, he wrote himself.\textsuperscript{84}

When he accepted the position of chief of staff on the West Virginia survey, White was already foremost among petroleum geologists in the United States and his reputation was beginning to spread to Latin America and Europe. His reputation was built on his careful field work and on his clear

\textsuperscript{82} In the early 1880's, F. W. Minshall, an experienced geologist and oilman, after a special study of the West Virginia "Oil Break" published some interesting observations on the nature of anticlines but his ideas were almost unnoticed at the time. Report of the Geological Survey of Ohio (Columbus, 1873-1888), VI (1888), 90.

\textsuperscript{83} Fuller, "Appalachian Oil Fields," in Bulletin of the Geological Society of America, XXVIII, 626.

Early American Geologists and the Oil Industry

exposition and actual demonstration of the anticlinal theory. He made the first of these revolutionary field tests in 1883 and the results convinced him that the anticlinal theory was valid and should be generally adopted.

White possessed some of the characteristics of the typical crusader. He was anxious to prevent the waste of man power and the waste of capital in the fruitless drilling for oil and gas in areas where it could not exist. He was also concerned over the stigma that had been placed on the geological profession by skeptical and prejudiced oilmen. Since he believed sincerely that the anticlinal theory was the best guide to petroleum deposits, he was determined to win the support of geologists and oilmen alike and with this objective in mind he began what he called the battle against prejudice by publishing several articles in 1885 that were based on his successful field demonstrations. New demonstrations were followed by additional reports and articles. Then in 1892 he republished his most important articles because he was certain that many geologists had not seen them before and he was determined that they should.

Undoubtedly there were many geologists who did not read his articles and some of those who did flatly refused to accept his general thesis. However, it was impossible to overlook his remarkable success in locating oil and gas in commercial quantities. For example, during the 1880's he located in Pennsylvania the Washington gas and oil field, the Grapeville gas pool, and the Belle Vernon field. The celebrated Taylortown oil horizon had been located and mapped by White long before the actual drilling proved that his con-

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37 White, "The Mannington Oil Field and the History of Its Development," in Bulletin of the Geological Society of America, III, 204ff; Fuller, "Appalachian Oil Field," in ibid., XXVIII, 626-627. At this time White was employed by the Forest Oil Company whose president, J. J. Vandergrift, had more faith in geologists than the majority of his contemporaries. Vandergrift had been influenced by William Earsman, a successful oilman who had made a special study of Carll's stratigraphic reports. All three men should be given some credit for White's subsequent success.
clinations had been accurate once more. The crucial test of his theory, however, was made in 1889 on the Mannington field in West Virginia.

The Mannington oil field in Marion County, West Virginia, was developed by White and his associates and its location was made from purely scientific deductions in which the anticlinal theory was of paramount importance. When White was surveying the field and predicting that oil would be found there, oilmen and geologists were skeptical. The test of his knowledge and of his theories came with the drilling. It was a long and tedious process and even White became discouraged when rocks thickened where they should have thinned and when the intervals between strata were not what the calculations had indicated they should be. Day after day the drill cut deeper into the rock. The geologists became anxious; the scoffers continued to smile knowingly to themselves. And then suddenly, success! On October 11, 1889, the drill struck saturated oil sand and the black gold began to flow in large quantities.

White's successful demonstration on the Mannington field was a very important episode in the history of petroleum geology. As White himself said, "It taught the practical oil men once for all that they could not afford to disregard geological truths in their search for oil deposit." The fight against the old prejudices was beginning to be won and White deserves a great deal of credit for his role in the struggle. Certainly he did more than any other geologist to popularize the anticlinal theory. The importance of the accomplishment was clearly summarized by Edward Orton (1829-1899), Ohio's state geologist (1882-1899), when he asserted that while there was "no element of the theory as stated by Professor White that differs from the theory as stated before," his applications of it are bold and, best of all, successful, marking a new period in our study of the geology of oil and gas.

Orton, too, applied rather boldly the principles of the

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88 Ibid., 195.
89 Ibid., 198-199.
90 Ibid., 199.
anticlinal theory to the gas and oil fields of Ohio and Indiana. After he had examined the Findlay and Kokomo-Muncie gas and oil regions, he found that some modifications of the basic theory were necessary. For example, the heart of the Indiana gas field was not a true anticline but a high lying formation that resembled a terrace, which may be described as a flattened arch or roll, so constructed that the oil and gas could be arranged within the rocks in order of their specific gravity much as they would do in a perfect anticline. Orton's "terrace principle," which was defined about 1886, became an important and practical corollary of the anticlinal theory.44

Orton's administration of the Ohio survey was very efficient and productive. His reports on coal, oil, and gas were scholarly and thorough and they became the basic authorities for the state, ranking in importance with the publications of Carll and White. It was Orton and his associates who discovered that the main street of Findlay, Ohio, was above an anticlinal dip in the oil producing Trenton Limestone of that area. Gas had been discovered there more or less by accident in November, 1884, and before long geologists, oil, and gas men were on the scene. Almost immediately the so-called practical prospectors began to lay their belt lines in all directions but especially north forty-five degrees east, which had become the most popular line in the Pennsylvania fields. Advice from the geologists was ignored and numerous wells were drilled on the basis of the belt theory with the expected results from the scientific point of view: most of the wells were failures. This effort, however, was not entirely wasted as the geologists were able to secure valuable information from the drilling without any expense or effort on their part. According to Orton, this wildcat drilling proved again the worthlessness of lines or belts as guides to productive horizons.45 More scientific prospecting helped to develop the Findlay field and by 1886 the town was experiencing a typical boom complete with industrial and real estate promoters. The city government bought out the local gas com-


pany and reduced the gas rates for fuel and illumination to a ridiculously low figure. Under the circumstances the use of gas was lavish and wasteful and Orton, who had made a special study of oil and gas accumulation, warned of the probability of the exhaustion of the supply. He was the first geologist to promote conservation practices where petroleum products were concerned.

The contributions of White and Orton helped convince the oilmen that geologists could be assets to their business. Additional prestige was brought to the profession by the publications of the federal survey which were based on extensive field work in the Midwest, Texas, and California. There were many capable geologists attached to the survey at the end of the nineteenth and beginning of the twentieth century and they brought to light knowledge of numerous oil bearing areas, usually as the result of the application of principles developed by White. At the turn of the century, White was regarded as the pioneer and the guide of the profession of petroleum geologists. It would seem that his popularity was deserved because the new oil discoveries gave additional proof of the general soundness of his fundamental hypothesis. In 1905 oil was discovered in Illinois at the end of the La Salle Anticline, and in 1911 boom conditions developed at Carlyle when productive wells were drilled in the Carlyle Anticline. Similar developments took place in Kentucky, Texas, California, and Oklahoma, and in each new oil field the relationship between the productive sands and definite types of rock formations was obvious to geologists. Writing in 1915, Carroll W. Wegemann of the United States Geological Survey summed up the anticlinal theory as it was understood at that time. "In a large proportion of the oil fields of the world," he wrote, "the accumulation of the oil is controlled principally by the structure of the rocks in which it is contained. In Northern Texas and Oklahoma the structure is unquestionably one of the controlling factors, the oil in all the fields explored having accumulated along the axes or on

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the flanks of anticlines, domes, or monoclines. Even the accumulations that apparently lie in synclines . . . are probably controlled by the monoclinal structure on which the shallow synclines are superimposed." A quarter of a century earlier, White of West Virginia and Orton in Indiana and Ohio had arrived at a similar conclusion.

In the twentieth century the continued success of the application of geological principles to oil prospecting brought about closer co-operation between oilmen and petroleum geologists. By 1920, although quack geologists and "unwashed" wildcatters were still in evidence, big business fully recognized the value of the trained scientist. Even before the turn of the century, Carll was on the payroll of Standard Oil. E. T. Dumble was appointed consulting geologist to the Southern Pacific Railroad, and W. W. Orcutt organized and headed the geological department of the Union Oil Company of California. After 1900 other oil companies began to employ geologists either as consultants or as full time employees. One of the most enthusiastic pioneer supporters of geology as the handmaiden of the oil industry was Frank Adair Leovy of the Gulf Corporation. Leovy was also a pioneer in using applied seismology and geophysics as an aid to the oil prospector. In later years he established at Gulf a complete research department charged with the responsibility of developing improved methods of locating oil fields.

Modern oil companies know the value of trained petroleum geologists and the role played by geology increases in importance year by year. Since modern wells may cost from seventy-five to five hundred thousand dollars, random drilling is a luxury that few companies can afford. The philosophy of modern oilmen was expressed in 1922 when Robert S. Ellison, Vice-President of the Midwest Refining Company


50 The author is indebted to Dr. Ralph W. Hidy, Business History Foundation, for this information.


52 Memorial delivered at the dedication of the Leovy Geophysical Laboratory, 1949 (typed MS); K. C. Heald to the author, Pittsburgh, October 31, 1949.
of Denver, wrote, "I would hesitate to undertake to pilot any concern, however, without loyal, competent, experienced geologists." He could have mentioned the fact that by the 1920's capital for development could be secured in most cases only on a favorable report of a reputable geologist.

In following the main theme of this paper considerable attention has been given to the role of the geologist in the history and development of the oil industry. In closing, it seems appropriate to summarize the distinct contributions made by the industry to the science of geology. These contributions may be grouped under six headings:

1—A large per cent of the geological work that was carried on in the United States after 1917 was financed by the petroleum industry. This work contributed in no small way to the progress of the science.

2—The oil industry has given considerable impulse to the study of geology in colleges and universities.

3—The industry helped to prove the usefulness of applied geology and in doing so, made the science respectable among laymen.

4—This in turn made it possible for the state and federal surveys to secure the necessary appropriations from hard-headed legislators in order to continue their own research.

5—The industry helped develop to near perfection field methods for structural mapping.

6—The geology of thousands of square miles of the earth's surface in the United States, Mexico, Central and South America, the West Indies, Africa, and the Near East has been studied by experienced geologists, paleontologists, and physicists and the results have added materially to the stockpile of scientific knowledge.

It seems obvious that not only has the geology profession been of great service to the oil industry, but the industry in turn has been instrumental in developing the science. The two have become interdependent, but members of the industry would be the first to admit that any balance sheet would indicate a large credit figure in favor of the petroleum geologists.

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