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FROM CREEKOLOGY TO GEOLOGY:
FINDING AND CONSERVING OIL ON THE SOUTHERN PLAINS, 1859-1930

a Dissertation APPROVED FOR THE
DEPARTMENT OF HISTORY

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Introduction

For approximately 200 years leading up to the nineteenth century, the technology Americans used for illumination remained as primitive as that used by the ancient Romans and Greeks. The colonial whaling industry had long hunted right whales to provide for Americans' illumination needs but discovered early in the eighteenth century that the fats and oils of sperm whales proved markedly superior for burning and lubrication. Spermaceti, a sponge-like substance from the heads of sperm whales, provided an unrivaled material for making candles. On the eve of the American Revolution, a fleet of approximately 150 vessels regularly docked at the port of Nantucket Island off the coast of Massachusetts as a base of operations for launching expeditions to hunt and kill sperm whales to provide fuel for lighting Americans' homes. The decreasing number of sperm whales and increasing demand for illumination gave rise to four new alternatives for providing light from 1830 to 1850: distillation of oil from terpentine, expanded production of lard oil, the growth of a domestic manufactured-gas industry, and coal-oil production.[1]

The production of coal-oil proved most important to the development of the petroleum industry within the United States. Coal-oil production began during the mid-1850s and disappeared merely six years later but provided a foundation for the

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[1] Harold F. Williamson and Arnold R. Daum, *The American Petroleum Industry,* vol. 1, *The Age of Illumination, 1859-1899* (Evanston, IL: Northwestern University Press, 1959), 29; 33.

distillation, refining, and commercial patterns the petroleum industry would follow. Chemists in France and Scotland first experimented with applying low temperatures to coal in order to distill oil in the 1830s and 1840s. The process found its way to the U. S. where two separate groups of inventors and investors working out of Boston and New York began producing coal-oil on a commercial basis. The industry boomed throughout 1858-1860 as these and other cities became home to numerous production plants. At the same time, the manufactured-gas industry grew at an even faster rate, but coal oil offered a more attractive source of illumination to the majority of Americans because it was safer and produced a better quality of light. From the outset, coal-oil producers considered using petroleum as the primary raw material for illumination and some applied methods of distilling and treating coal to petroleum in order to extract kerosene which they burned in lamps. For petroleum to supplant coal permanently as the primary raw material for illumination, however, producers had to be sure they could find adequate supplies and that they could produce petroleum less expensively than mining coal and converting it to oil. Until such time, the coal-oil industry's infrastructure continued to expand.[2]

The possibility of inexpensive and plentiful supplies of oil came to fruition in 1859 when Edwin Drake drilled the first commercial oil well in Pennsylvania. Initially, many questioned whether petroleum existed in a sufficient quantity to replace coal oil permanently as a raw material for illumination and lubrication. As a result, transportation, marketing, and refining facilities lagged behind the production of

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[2] Ibid., 43; 37-8; 43-44; 56; 57; 59; 60.

petroleum for two years after Drake's discovery. As producers continued to find oil and pump it from the ground, coal-oil refineries gradually converted their operations to accommodate the new material. By 1861, Pennsylvania drillers realized that they had only scratched the surface of potential oil production when Henry Rouse struck the area's first flowing well, or "gusher." Gushing wells accounted for much of the total output during 1861 and 1862 but a much smaller proportion of Pennsylvania's future production. Once the pressure that pushed petroleum to the surface dissipated, workers extracted oil from the reservoir with pumps. Although gushers lasted a relatively short time in Pennsylvania, their impact was lasting and lay at the heart of many problems the industry faced into the twentieth century.[3]

Overproduction destabilized the oil industry early-on, and producers struggled to balance supply and demand in order to avoid wasting both oil and capital. A cycle of boom and bust plagued the oil industry throughout much of its history. In Pennsylvania, for example, output decreased slightly in 1862 but increased annually thereafter for nine years. Production leveled off again in 1873 but soon began climbing and peaked at thirty million barrels annually in 1882. As inventories rose, prices fell and consternation grew among oil producers. Although they attempted to negotiate shutdown agreements to eliminate glutted markets, the difficulty of convincing thousands of oil men to ignore the opportunity to expand into new fields undermined the success of such efforts. Continued production swamped existing transport and refining facilities and prompted businessmen

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[3] Ibid. 82; 111; 112; 113-14.

to begin thinking about organizing their industry more efficiently.[4]

No one deplored the chaos that prevailed in the industry more than John D. Rockefeller. Vilified as a ruthless monopolist by some and praised as a sagacious businessman by others, no single person did more to shape the structure of the oil industry. His efforts in assembling the Standard Oil trust and vertically integrating the industry have been well documented and need not be retold here. Of significance to this study, however, is how the passion for order and efficiency motivated him. Rockefeller looked with revulsion at the mad scramble among producers who competed to extract oil and blamed them for the industry's overproduction, wild price fluctuations, and waste. Although independent producers understandably resented Rockefeller's ruthless business tactics, his efforts to consolidate control over refining capacity reflected his recognition that unrestrained production destabilized the industry and undermined everyone's long-term interests.[5]

The director of Pennsylvania's state geological survey, J. Peter Lesley, agreed that overproduction destabilized the industry and wasted oil but attributed the industry's problems to oil men's poor understanding of geological principles. Like Rockefeller, Lesley lamented the "utter demoralization of the crowded population which scrambles for

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[4] Ibid., 118; 373; 374.

[5] The most authoritative biography of Rockefeller is Allan Nevins, *John D. Rockefeller: The Heroic Age of American Enterprise*, 2 vols. (New York: Charles Scribner's Sons, 1954). Probably the best single-volume account is Ron Chernow, *Titan: The Life of John D. Rockefeller, Sr.* (New York: Vintage Books, 1998); Daniel Yergin, *The Prize: The Epic Quest for Oil, Money and Power* (New York: Simon and Schuster, 1991), 42.

it [oil] in so unmanly and thriftless a manner." Drilling wells indiscriminately caused gushers to unleash more oil than markets could absorb, but Lesley believed science offered a solution to the problem. From his vantage point as director of the state survey, "violent fluctuations of the market would be impossible but for a still prevalent ignorance of the Geology of Petroleum..." The Pennsylvania geological survey generated voluminous amounts of information about the state's resources but did not significantly influence the oil industry's prospecting or production practices. Oil men easily supplied markets without consulting professional geologists but their inefficiency perpetuated the problems of overproduction, waste, and instability.[6]

The availability of petroleum and the kerosene it produced radically transformed people's lives in America and around the globe. By 1873 kerosene had grown into the leading illuminant in both Europe and America. A Pennsylvania newspaper reporter declared the same year that petroleum had "become of such commercial and social importance to the world that if it were suddenly to cease no other known substance could supply its place, and such an event could not be looked upon in any other light than of a widespread calamity." Previously, the limited supply and poorer burning quality of whale oil prevented people from spending their evenings in activities other than sleeping. Wider availability of kerosene in the U.S. and its better luminescence meant that more people had the option of reading into the night or engaged in other amusements requiring

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[6] J. P. Lesley, "Geological Report on Warren County," *Second Geological Survey of Pennsylvania 1880 to 1883*, IIII, xiv; Quoted in John Ise, *The United States Oil Policy* (New Haven: Yale University Press, 1926), 36.

light. Petroleum transformed people's lives in other countries as well. Only by supplying foreign markets could the American petroleum industry have continued to grow. Throughout the 1870s and 1880s, kerosene was the country's largest manufactured good and Europe provided the largest market.[7]

By the end of the nineteenth century, the electric light all but eliminated the kerosene market. Thomas Edison's invention of the incandescent bulb and efforts to commercialize electric power provided a cleaner and economically competitive alternative. Edison began experimenting with electric illumination in 1877. Eight years later, 250,000 light bulbs were in use and the number mushroomed to 18 million by 1902. Europeans also began to choose electricity for their lighting needs, further diminishing the market for kerosene. In America, only residents in rural locales relied upon kerosene to light their homes.[8]

Just as the need for petroleum as an illuminant diminished, new markets opened that required petroleum as an energy source. From 1899 to 1919, the amount of energy Americans consumed increased by approximately two and one-half times. Coal decreased as a source of energy throughout this period while water power and natural gas increased slightly. Petroleum increased the most, however, from 4.5% to 12% of total

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[7] Williamson and Daum, *American Petroleum Industry,* 371-372; *Titusville Morning Herald*, April 30, 1873; Quoted in Ibid., 371; Daniel Yergin, *The Prize: The Epic Quest for Oil, Money, and Power* (New York: Simon and Schuster, 1991), 50; Ibid, 56.

[8] Ibid. 79; Harold F. Williamson, Ralph L. Andreano, Arnold R. Daum, and Gilbert C. Klose, The *American Petroleum Industry*, vol. 2, *The Age of Energy, 1899-1959* (Evanston, IL: Northwestern University Press, 1963), 171.

energy generated. At the start of the twentieth century, consumers of petroleum included gas manufacturers, commercial companies, and various industries. Each of these consumers converted petroleum to fuel oil to serve its own purposes. Gas manufacturers purchased petroleum to enrich the fuel extracted from coal. A commercial demand for fuel oil emerged when marketers began selling space heating to residences and businesses. Industry needed fuel oil to generate heat for smelting operations, iron and steel production, cement and brick manufacturing, and for boilers which powered steam-driven machinery. The petroleum industry had used crude oil to fire boilers and stills as early as the 1860s and continued to rely on petroleum when the price of coal grew too high. By far the greatest demand for petroleum came from its growing use in marine transportation.[9]

The U.S. Navy began experimenting with petroleum as an energy source as early as the 1860s but did not begin to adopt fuel oil to power its ships until early in the twentieth century. The navy concluded early-on that petroleum provided more control over heat than coal, reduced the weight and space required for storing fuel, and required fewer personnel to stoke ships' boilers. The higher cost of petroleum, however, prevented navies throughout the world from converting their ships' engines to burn fuel oil until the eve of the First World War. The conversion to fuel oil was well underway by 1914 and by the end of the war demand for petroleum by navies and merchant marines

[9] Ibid., 169; 170.

worldwide accounted for approximately twenty percent of total fuel oil sales.[10]

The automotive industry's adoption of the internal combustion engine further increased the demand for gasoline and accelerated transformation of the petroleum industry from a supplier of illuminating oil to a supplier of fuel oil. A German inventor built a four-cycle engine in 1876 that served as the basis for all modern gas engines. Even with an internal combustion engine to model, the high cost of fuel compared to coal throughout the nineteenth century prevented factories, railroads, or marine transportation from abandoning steam engines before 1900. Discovery of vast oil reserves in the Midcontinent states of Kansas, Oklahoma, and Texas facilitated adoption of the internal combustion engine and enabled the automobile industry to expand. Prospectors found oil at Texas' Spindletop field in 1901, at Oklahoma's Glenn Pool field in 1905, Cushing in 1912, and Healdton in 1913, but these were only some of the largest discoveries. As the availability of oil grew, so too did the market for automobiles. The number of gasoline automobiles increased from just under 17,000 in 1904 to nearly 1.7 million in 1919. In a very brief period of time, the future of the automobile had become inextricably linked to the necessity of finding additional supplies of oil.[11]

As the twentieth century began, the federal government facilitated the need to find more oil. As the political battles between Congress and U.S. Geological Survey director John Wesley Powell subsided, economic geology became the survey's primary focus and

[10] Ibid.,183; 184.

[11] Ibid.

geologists visited or investigated mining camps throughout the country. Initially, they focused their efforts on metalliferous ores and later on coal, but as petroleum became more important to the nation's economy and energy supply the survey emphasized locating, mapping, and classifying lands where this resource could be found. The survey began issuing reports focusing specifically on oil and conducting investigations into oil shales. The U.S. Bureau of Mines, created in 1910 to promote conservation and safety, established a Petroleum and Natural Gas Division four years later. In 1918, this division opened a petroleum experiment station in Bartlesville, Oklahoma which conducted some of the first systematic scientific and engineering research related to the oil industry. After World War I, the USGS struggled to retain many of its geologists who quit to take more lucrative positions in private industry. Oil companies integrated geological prospecting into their production process to meet the increasing demand for petroleum and found that they could profit from the surveying and mapping skills geologists learned while working for the survey. By the 1920s, the oil industry had located so much oil that some within the industry began clamoring for federal intervention to regulate production along geological principles as Lesley intimated was necessary when the industry first began.[12]

This dissertation will explore prospectors' encounters with the landscape from 1860 to 1930 and discuss how key individuals' physical interactions with and mental

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[12] Thomas G. Manning, *Government in Science: The U.S. Geological Survey, 1867-1894* (Lexington: University of Kentucky Press, 1967), 218; August W. Giebelhaus, "The Emergence of the Discipline of Petroleum Engineering: An International Comparison," *Journal of the International Committee for the History of Technology*, 2 (1996), 111.

conceptions of the environment shaped the search for oil, the discipline of petroleum geology, and the political debate over the best method for conserving this resource. Throughout this period, some prospectors, commonly referred to as "practical men," demonstrated an uncanny ability to find oil without formal scientific techniques long before the industry began to accept petroleum geology as a legitimate method for finding oil. They derived their prospecting techniques from a vernacular form of knowledge that grew out of local experience rather than a scientific understanding of universal earth processes they could systematically employ in different environments. Petroleum geologists cultivated a somewhat different form of knowledge which prevented them from understanding how practical men's experience within a particular local environment often developed into a hunch, knack, feel, or instinct about where to look for oil.

Geologists participated in the oil industry from its inception in 1859 when practical men drilled the first commercial oil well but would not exert a significant influence until approximately 1915.[13] Even though some geologists made considerable money as consultants, the advice they offered produced minimal results in Pennsylvania and other states throughout the nineteenth century. A speculative boom of the 1860s presented scientific consultants with a flood of monetary and intellectual opportunities.[14] Mining engineers and geologists who worked in the Pennsylvania coal industry found

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[13] Keith Miller, "Petroleum Geology to 1920," in *Sciences of the Earth: An Encyclopedia of Events, People, and Phenomena*, 2 vols., Gregory A. Good, ed.(New York: Garland, 1995), 33, 673; Edgar Owen, *Trek of the Oil Finders, A History of Exploration for Petroleum*, (Tulsa, OK: American Association of Petroleum Geologists, 1975), 66.

[14] Ibid., 442.

employment as consultants in the oil business but mostly suggested methods that oil prospectors who learned by trial and error had already been using.[15] Although they may have supplemented their income, geologists failed to provide the oil industry with a systematic method for finding oil based upon geological knowledge that prospectors could apply on a consistent basis. As a result, practical men generally placed little authority in geologists' advice.

Practical oil men could afford to ignore geologists in the early days of the industry and even into the twentieth century because they needed no assistance finding oil. Even with no rational foundation to their approach, practical men found oil by surface indications alone because untapped reserves of petroleum sat atop the soil, creeks, and streams.[16] Even so-called "creekologists" who divined for oil by employing "witching sticks" or relied upon supposed psychic powers often met with success because oil could be observed, felt, or smelt with the senses. Although sometimes derided as creekologists for rejecting geology in favor of their own methods, practical men found oil by following production "trends" because they believed oil lay in linear, belt-like patterns beneath the ground.[17] As long as they continued to supply the country and much of the world's oil requirements, practical men felt no compulsion to listen to geologists, scorned their

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[15] Owen, *Trek of the Oil Finders*, 68.

[16] In support of this point, it is important to remember that Drake's well was shallow by modern standards. The drillers struck oil at seventy feet. Lucier, "Scientists and Swindlers," 397-98; William Wright, *Oil Regions of Pennsylvania, showing where petroleum I s found, how it is obtained, and at what cost, with hints for whom it may concern* (New York: Haper, 1865).

[17] Owen, *Trek of the Oil Finders*, xiii.

advice, and carried their bias against geologists with them as they migrated westward to explore the Midcontinent region.[18]

My organization of this dissertation and the themes I have chosen to emphasize flow from the idea that oil prospectors were bound to nature through their work. Many environmental histories have explored the idea that human beings are bound to nature in one way or another through the relationships they established with the natural world..[19] This was certainly true of practical men who established a particular kind of relationship with nature as they prospected, but it was also true of petroleum geologists who undertook "scientific" excursions in order to conduct field work. Gould did not make an effective oil prospector because the relationship with nature he valued most enabled him to study geology for the sake of simply *knowing* rather than for its practical application. Doherty's genius lay in recognizing the potential utility of geologists' relationships with nature and systematically organizing their effort to achieve the goal he relished most–finding oil. My thesis, then, is that both practical men and geologists fashioned dialectics with the environment in order to locate and conserve oil but that over time the efforts of large oil companies to rationalize these processes transformed those relationships, shifting control of the natural world to extra-local sources of authority.

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[18] Ibid., 292, xiii.

[19] This is an idea beautifully articulated by Richard White in *The Organic Machine: The Remaking of the Columbia River* (New York: Hill and Wang, 1995), ix-x.

Chapter 1

"Creekologists, Practical Men, and Geologists: Contests for Authority the Oil Field"

Historians often cite the first commercial oil well drilled in 1859 as the event which launched the modern oil industry, but its symbolism extends beyond simply marking the first time Americans tried to profit from oil. The cast of characters involved, particularly a university-trained geologist and a down-and-out director of operations, epitomized the different class and educational backgrounds of geologists and so-called practical oil men which persisted well into the twentieth century. In 1854, two businessmen founded the Pennsylvania Rock Oil Company with the aid of a scientific report authored by the famous Yale University geologist Benjamin Silliman, Jr., who testified to the quality and usefulness of oil bubbling forth from natural springs at Oil Creek, Pennsylvania. After a series of frustrations, the company changed ownership, adopted the new name Seneca Oil Company, and placed Colonel Edwin L. Drake in charge of operations.[1] Prior to his employment with the oil company, Drake had worked as a steamboat night clerk, farm laborer, hotel clerk, and salesman in a dry-goods store. The only time the "colonel" had worn a uniform was at his job as a railroad conductor, but company backers suggested he adopt the title to lend dignity and credibility to their

[1] Edgar Owen, *Trek of the Oil Finders, A History of Exploration for Petroleum*, (Tulsa, OK: American Association of Petroleum Geologists, 1975), 11-12.

venture.[2] On August 28,1859, Drake struck oil at sixty-nine-and-a-half feet below the surface, not because of Silliman's recommendations but from hard work, persistence, and phenomenal determination. In the early days of the oil industry, prospectors did not need geologists' recommendations to find oil.

No systematic method for finding oil existed throughout most of the nineteenth and early-twentieth centuries, and prospectors relied upon a variety of techniques which fell under the rubric of "creekology." Literally, the term referred to the supposed relationship between the flow of a creek and the presence of oil, but it grew to encompass a variety of techniques and acquired a more generic meaning. The different methods of creekology generally fell into one of two categories, those which invoked superstition or the supernatural and those which involved surveying the landscape. Prospectors who considered searching for a creek or other geographical feature adopted a more practical approach to finding oil and thereby earned the name "practical oil men." Rather than laying claim to some vague, obscure "power," they traversed the surface of the earth in search of concrete, verifiable evidence of oil that lay beneath. Whatever the approach, each of these prospectors relied on intuition albeit to varying extents.

Geologists also relied on intuition but competed with both kinds of creekologists as brokers of information who claimed to possess the knowledge many investors and speculators sought. As long as professional geologists could not consistently demonstrate an ability to find oil, people remained skeptical about their "expertise." The possibility of

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[2] Ruth Sheldon Knowles, *The Greatest Gamblers: The Epic of American Oil Exploration*, 2nd ed. (Norman: University of Oklahoma Press, 1959), 3.

locating oil with geological principles remained unproven until 1885. Even though geologists demonstrated the practical application of their knowledge at this time, oil companies did not employ them systematically for approximately another thirty years. Part of the reason for the industry's recalcitrance resulted from the abundant signs of oil apparent to the naked eye.

Searching for oil in the nineteenth century was primarily a sensory experience. Locating oil required prospectors to encounter the landscape physically, by *looking* for it with their eyes, *smelling* it with their noses, and *touching* it with their hands. Finding oil in this manner remained possible for much of the nineteenth century because black liquid still bubbled out of the ground to create "seepages," or seeps, which the eyes, nose, and hands could identify. A seep exuded anywhere from a few drops to a few barrels of oil.[3] The black ooze seeped into creeks and streams, intermixing with the water and impressing the eyes with the rainbow swirls that rotated on the surface. Because the oil seeps and associated natural gas resided close to the surface, they emitted their distinctive smells signalling that gas and oil might be lurking nearby, perhaps even directly beneath the feet.[4] Gas also revealed itself to prospectors' eyes when it bubbled to the surface of a stream or to the ears when it issued forth in a volume large enough to emit a whistling

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[3] Kenneth K. Landes, *Petroleum Geology* (New York: John Wiley and Sons, Inc., 1951), 21-29.

[4] Locating oil by sense of smell was a valuable technique, but the idea of "oil smelling" became a generic term employed for a variety of searching methods. Mody C. Boatright, *Folklore of the Oil Industry*, (Dallas: Southern Methodist University, 1963),16.

noise.[5] Surface indications other than oil and gas seeps included asphalt veins and oil-impregnated outcrops, all phenomena which led prospectors to the first commercial oil fields in America and guided the search for oil throughout the industry's first fifty years.[6]

Locating oil by physically encountering the environment remained particularly necessary during much of the latter-nineteenth century because the knowledge and technology for locating oil remained rudimentary. Searching for oil required grueling physical labor as prospectors ventured onto the landscape, climbed hills and descended into valleys, exploring the banks of streams and creeks. Once found, collecting oil required perhaps an even greater physical encounter with the environment. So rudimentary was the knowledge for extracting oil at the time of Drake's well that once prospectors found oil they gathered it by digging pits or trenches.[7] In instances where it "bubbled up in mid stream," Indians and settlers after them obtained the oil "by throwing a blanket on the water, and, after it became saturated, squeezing the oil into the vessel prepared to receive it."[8] In the early days of most oil regions, prospectors relied almost

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[5] Landes, *Petroleum Geology,* 21.

[6] Owen, *Trek of the Oil Finders*, (Tulsa, OK: American Association of Petroleum Geologists, 1975), 6. For a list and description of the five basic types of surface indications, see A.I. Levorsen, *Geology of Petroleum* (San Francisco: W.H. Freemon and Co. 1959), 15 ; Frederick G. Clapp, "The Occurrence of Petroleum," in *A Handbook of the Petroleum Industry*, David T. Day, ed. (New York: John Wiley and Sons, Inc.), 1922.

[7] Everette DeGolyer, *The Development of the Art of Prospecting*, (Princeton: The Guild of Brackett Lecturers, 1940), 24; Samuel Tait, *The Wildcatters: An Informal History of Oil Hunting in America* (Princeton: Princeton University Press, 1946), 10.

[8] J.H.A. Bone, *Petroleum and Petroleum Wells* (Philadelphia, J.B. Lippincott and Co., 1865), 20.

exclusively upon direct indications they could visually identify to locate oil and required little assistance from professional scientists.[9] They often looked next to creeks for indications of oil.

With only rudimentary knowledge of how and where oil accumulated, early prospectors erroneously believed that creeks and streams sat atop large fissures in the earth's surface and that oil flowed to the surface through these openings. They reasoned that drilling next to creeks could lead them to large cracks, or "fissures," in the earth's surface, through which oil supposedly flowed.[10] The practice of studying creeks in order to find oil encompassed a mix of superstition and very crude geological reasoning.[11] Oil men who considered creeks indicators of oil so readily perpetuated this unsound principle they elevated it to the status of a superstition people wholeheartedly adopted and applied as a fool-proof methodology into the early-twentieth century. Although geologically unsound, the search for a feature of the landscape which correlated with oil reserves beneath the surface constituted the basic principle geologists later developed into a workable strategy for consistently finding oil.

Even though some methods of creekology contained the seeds of geological

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[9] Prospecting for direct indications of oil gave rise to petroleum production in Pennsylvania and throughout the world. DeGolyer, *The Development of the Art of Prospecting*, 24.

[10] Mody C. Boatright and William A. Owens, *Tales from the Derrick Floor: A People's History of the Oil Industry*, (Lincoln and London: University of Nebraska Press, 1970), 15; DeGolyer, "Concepts on the Occurrence of Oil and Gas," 22.

[11] Max Ball, Douglas Ball and Daniel S. Turner, *This Fascinating Oil Business*, (Indianapolis, Kansas City, New York: Bobbs-Merrill Company, Inc.1940), 46-7.

reasoning, prospectors who dogmatically applied this principle decreased the probability of finding oil over time because they limited themselves to a very narrow geographic range. After the completion of Drake's well in 1859, oil men in the Pennsylvania oil fields confined their search to the valleys through which the Allegheny river and its tributaries flowed.[12] prospectors explored creek valleys "on the supposition that the present configuration of surface was related to the strata containing the oil."[13] They supposed correctly that they could find oil by establishing a relationship between surface structures and strata beneath the ground but they erred in believing that creeks constituted such structures. Although creekology originally referred to the supposed relationship between creeks and oil, the term grew into a generic label referring to a variety of other techniques which included superstition and the occult.[14] Unlike the search for creeks, these forms of creekology were less concerned with geographical features of the environment.

As more people realized the potential to profit from oil, there emerged in Pennsylvania a brand of creekologists who claimed they possessed special powers to locate underground resources. One visitor to the oil region noted the increasing presence

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[12] Stephen Farnum Peckham, *Report on the Production, Technology, and Uses of Petroleum and its Products*, (Washington: Government Printing Office, 1885), 11.

[13] Ibid.

[14] The variety of methods for locating oil encompassed by the term "creekology" included following seepages, drilling near "breaks" and "belt-lines," or following a dowser or doodlebug. Owen, *Trek of the Oil Finders*, 1577.

of people "claiming to be gifted with extraordinary powers."[15] Shortly after the discovery of Drake's Well, another contemporary observed that "'a new class of people has sprung into existence under the cognomen of 'oil smellers,' who profess to be able to ascertain the proper spot by smelling the earth." [16] Not all oil-finders who claimed supernatural powers possessed unscrupulous intentions. Many oil prospectors who claimed supernatural abilities held deep convictions about their "powers" as did the individuals who employed them.[17] One contemporary observed that supernatural creekologists exerted "more real power among the operators than the latter are willing to openly concede."[18] Oil companies typically refrained from mentioning in their prospectuses whether they had hired a consultant who employed unorthodox or unscientific methods.[19] Companies justified hiring them, however, because the small fee they charged amounted to "an inconsiderable item in the general expense, seeing we mean to bore any how."[20] As long as no proven, systematic approach for finding oil existed even the most unorthodox methods maintained a degree of legitimacy in the eyes of investors. Whether they called themselves smellers,

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[15] William Wright, *Oil Regions of Pennsylvania, showing where petroleum is found, how it is obtained, and at what cost. With hints for whom it may concern.* (New York: Harper, 1865), 61.

[16] Bone, *Petroleum and Petroleum Wells*, 35.

[17] Paul Lucier, "Scientists and Swindlers: Coal, Oil, and Scientific Consulting in the American Industrial Revolution." (Ph.D. diss.: Princeton University, 1994), 418.

[18] Wright, *Oil Regions of Pennsylvania*, 63.

[19] Lucier, "Scientists and Swindlers," 418-419.

[20] Wright, *Oil Regions of Pennsylvania*, 62-3.

seers, diviners, or clairvoyants, what distinguished this type of creekologist from those who looked for surface structures was the lack of any conscious attempt to correlate surface features with subsurface stratigraphy

Creekologists who claimed the ability to summon spirits or super-human gifts of smell, sight, and intuition attempted to bolster their authority by circumventing the more difficult approach of surveying and traversing the landscape to understand how geography and geology could lead them to oil.[21] An oil "seer" constituted one type of creekologist who claimed the ability to locate oil without having to observe the landscape. An Indian woman named Augusta Del Pio Lougo felt shocks passing from her head to her feet "'causing distinct pain'" when she walked through a field containing oil or water.[22] Although she had to walk over the landscape in order to activate her alleged ability, she made no attempt to correlate specific identifiable land forms or structures with underground reserves. Similarly, when the seer Evelyn Penrose walked over an oil field she felt a "'violent stab in the soles of my feet like a red-hot knife.'"[23] Any indication of where oil reserves might lay rested solely on the seer's advice and bore no relationship to the physical terrain.

Many other seers did not even require close proximity to a potential site in order to

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[21] The use of occult methods for locating oil dates to the earliest days of the industry. Mody C. Boatright, *Folklore of the Oil Industry*, (Dallas: Southern Methodist University Press, 1963), 23.

[22] *New York Times*, 10-8-22, II, 5:1; Quoted in Boatright, *Folklore of the Oil Industry*, 20-21.

[23] Evelyn M. Penrose, "Dowsing," *Blackwood Magazine*, CCXXXII (Sept. 1932), 345-53;Quoted in Boatright, *Folklore of the Oil Industry*, 21.

locate oil.[24] Ruth Bryant of Abilene, Texas (also known as Madame Virginia) claimed to determine whether a farm contained oil simply by talking to its owner.[25] The environment remained so irrelevant to her approach she did not even have to see or walk upon the landscape. In one instance, she intuitively sensed where oil lay when she passed over it while riding a train at night.[26] Not having to identify specific features on the landscape which might lead to oil allowed Madame Virginia to retain a high degree of authority among oil investors. She enhanced her authority further by not identifying the source of her alleged ability. All she conceded about the origin of her power was that she received it early in life, before the age of six.

Like Madame Virginia, surveying the landscape for specific geological or geographical features played no part in the methodology employed by Guy Findley, also known as the x-ray-eyed boy. Findley also received visions of oil from a very early age. In order to be most effective, he preferred to search at night, the darker the better. When a group of oil investors heard of his ability, "they buried a barrel of oil and a barrel of water out where I didn't know where it was, and took me out there."[27] Findley claimed to have

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[24] Boatright, *Folklore of the Oil Industry*, 24

[25] Ruth Bryan, tape-recorded interview, August 2, 1959; Quoted in Boatright, *Folklore of the Oil Industry*, 27. A large portion of the interview is reproduced in Mody C. Boatright and William A. Owens, *Tales from the Derrick Floor: A People's History of the Oil Industry*, (Lincoln and London: University of Nebraska Press, 1970), 23-25.

[26] Ruth Bryant, tape-recorded interview, August 2, 1959; Quoted in Boatright, *Folklore of the Oil Industry*, 28.

[27] Guy Findley, tape-recorded interview, May 5, 1956; Boatright, *Folklore of the Oil Industry*, 19.

located both barrels successfully, but did not elaborate upon his approach. His preference for working in the dark of night revealed that he was not looking for surface structures and probably reflected his concern to shield onlookers from some kind of subterfuge.

By keeping oil investors guessing about their supposed powers, creekologists like Madame Virginia and the x-ray-eyed boy carefully protected the authority some people willingly bestowed upon them. Unlike creekologists who searched for surface structures, seers did not face the difficult task of having to identify specific features on the landscape, even if only a creek, and risk their credibility by stating a probable relationship to oil beneath the ground. Instead, they relied on superstition to the exclusion of any sensory experience informed by physical or visual encounters with the environment. Attributing their power to a vague unidentifiable source enabled seers to protect their status as a class of prospectors who possessed unique abilities to locate oil and to continue selling their expertise. As long as other oil prospectors could not articulate a systematic approach which led to oil more consistently, seers enjoyed a favorable position among investors.

The methods of seers and other creekologists who claimed supernatural abilities remained popular as long as they appeared to produce results, but their success remained greater within the folk tales, stories, and traditions that described them than was actually the case.[28] One example from the Pennsylvania oil region in the 1860s illustrates this point. Another prospecting method under the rubric of supernatural creekology involved people who claimed they could locate oil through dreams. Like seers, clairvoyants and spiritualists, dreamers offered no systematic method for locating oil but their stories

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[28] Boatright, *Folklore of the Oil Industry*, 11.

resonated with many people. For example, a Pennsylvanian clerk named Kepler dreamed in 1864 that he was wandering through the woods with a coquettish young woman when an Indian appeared who threatened to shoot them with a bow and arrow. The woman handed Kepler a rifle which he fired at the Indian who subsequently vanished, but in the spot where he stood a flood of oil gushed. At a later date, Kepler happened to encounter the location he had envisioned in his dream and leased the spot where the Indian had been standing. He drilled a well there, named the Coquette, which produced more than ten thousand barrels and netted him eighty thousand dollars.[29] Dreams like this one located oil with less frequency than the proliferation of such reports suggested.[30]

The success story of the Coquette and those like it reflected a strong folk tradition involving the ability to locate oil with non-scientific techniques, metaphors to which the folk ascribed literal meaning.[31] Less significant than the well's success was the manner in which the story of finding it with a dream resonated with so many people. Because Kepler acquired instant wealth, the well served as a tourist attraction to people visiting the oil region once it ceased producing. The well owners built steps up to it and charged each

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[29] The story of the Coquette well is told in Bone, *Petroleum and Petroleum Wells,* 72-74, and in Herbert Asbury, *The Golden Flood* (New York, 1942), 74.

[30] Boatright reports that the people who dreamed about oil often cannot be found or that acquaintances cannot recall in subsequent years that the person ever talked about finding oil in a dream. He speculates the possibility that one person's experience may have been transferred onto another's or that the dream was "perhaps a metaphor...given literal interpretation," Boatright, *Folklore of the Oil Industry*, 11.

[31] Ibid.

spectator a dime to observe the wonder.[32] Newspapers exacerbated the hysteria and played a significant role in disseminating fantastic stories to audiences both within and outside of the oil industry.[33] Dreamers and clairvoyants' chances for finding oil remained high in untapped oil regions where they could still see seeps or where pools remained close to the surface, but finding oil with metaphors could not last forever. As prospectors identified and extracted easily-recognizable pools of oil, creekologists who relied upon the supernatural had to work harder to retain their credibility.

When clairvoyance and dreams failed to convince speculators to invest their money, creekologists cast their methods as "science" in order to impress, confuse, and deceive. Enticing investors had always required creekologists to engage in a significant degree of theater. Indeed, as one observer noted after the discovery of Drake's Well, "some of them practice considerable mummery in order to mystify their employers.'"[34] The "mummery" necessary to "mystify" investors grew more elaborate over time. As long as oil remained close to the surface and easy to identify by sight, creekologists who employed supernatural techniques could more easily capture the imagination of investors. Surface indications disappeared quickly in new oil regions, however, robbing creekologists of the visual aids necessary to supplement their instincts. Struggling to maintain their credibility, they increasingly invoked science to explain their methodologies but their version of "science" held no rational foundation.

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[32] Bone, *Petroleum and Petroleum Wells*, 72-74.

[33] Boatright, *Folklore of the Oil Industry*, 17.

[34] Bone, *Petroleum and Petroleum Wells*, 35.

Pseudoscientific instruments such as divining rods proliferated as prospectors who relied on superstition tried to bolster their sagging authority. The divining rod and other devices with a more sophisticated appearance acquired the name of "doodlebug," which applied to either the apparatus itself or the person using it. A doodlebug apparatus came in a variety of shapes and designs, but the divining rod served as the most recognizable example of an oil-finding device based on superstition and alleged scientific principles. The divining rod, or "wigglestick," is perhaps the oldest device used for locating minerals, dating back to the Chaldeans.[35] Also known as "dowsing," prospectors throughout history have divined for a variety of reasons which included locating water, buried treasure, and even escaped criminals.[36] The divining rod usually consisted of a Y-shaped tree branch, often from a peach tree but sometimes a hazel or willow.[37] One creekologist, Jonathan Watson, resorted to divining rods only after the advice of spiritualists began to fail, but the witching-stick operators he hired proved no more successful as each well they located came in dry and tempered Watson's faith in the device.[38] Every failed attempt at locating oil with a divining rod cast further doubt upon the credibility of the method and its operator.

Scientists rejected the efficacy of divining rods outright and declared that any

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[35] Roy J. Santschi, *Modern 'Divining Rods': A History and Explanation of Geophysical Prospecting Methods* (By Author, 1928), 53.

[36] Landes, *Petroleum Geology*, 8.

[37] Boatright, *Tales from the Derrick Floor*, 14, 21; Santschi, *Modern 'Divining Rods'*, 53.

[38] Tait, *The Wildcatters*, 73.

successful oil discovery rested entirely on chance.[39] Some oil men agreed with the statement by Professor Benjamin Silliman Jr. who declared that "'the pretensions of diviners are worthless. The art of finding fountains of minerals by a peculiar twig is a cheat upon those who practice it, an offense to reason and common sense, an art abhorrent to the laws of nature, and deserves universal reprobation.'"[40] Silliman's statement stands out as a direct challenge to those who relied upon supernatural methods of finding oil. Silliman staked a claim for scientists as the defenders of reason and declared the superiority of their knowledge regarding the laws of nature. His statement revealed that professional scientists began to challenge the credibility and authority creekologists had for a while enjoyed.

By devising more elaborate devices than divining rods and declaring a unique ability to operate them, doodlebug prospectors sought to bolster their authority against competition presented by scientists such as Silliman. Machines with an exotic appearance supplanted the divining rod as the need intensified to convince people that doodlebugs possessed an explainable rationale beyond mere superstition.[41] One machine consisted of bells, whistles, and dials attached to a large black box which a man operated while seated and covered with a large shroud, as four men carried him and the device over prospective oil fields. When the bells wrang, the operator declared that oil lay below. Allegedly, the shroud prevented discovery of the machine's secrets, but more likely it concealed the

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[39] Santschi, *Modern 'Divining Rods'*, 53.

[40] Source not cited. See Tait, *The Wildcatters*, 72.

[41] Landes, *Petroleum Geology,* 8.

operator's wringing of the bell.[42] As with supernatural creekologists, secrecy allowed doodlebugs to prevent scrutiny of their techniques.

Doodlebug prospectors intended the elaborate appearance of their oil-finding devices to entice speculators and kept the principles on which they supposedly operated a mystery to perpetuate the ruse. Some doodlebugs purportedly operated on an electrical or chemical foundation. In one instance, the mechanism accommodated interchangeable vials which contained a sample of whatever substance the operator hoped to find.[43] A Houston, Texas doodlebug operator, Dr. Griffith, proffered a variation of this approach. Griffith possessed "a contrivance that nobody else could work but he could."[44] The machine contained "little lugs that looked like the size of a silver pencil and it had a plate that would fit the palate, the roof of his mouth. ...He would threadscrew one of these little lugs marked silver, or gold, or iron, or oil, or gas, or sulphur [onto the machine], and then he would walk. ...Sometimes he would start and tremble and you'd see this lug draw down toward the ground. There he'd make a mark."[45] Griffith offered a vague scientific rationale to explain how the device worked. He also attributed its functioning to a mysterious attribute only he possessed. The doctor explained "that it was something in these lugs plus a magnetism of his--in his body--some companion property of chemistry

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[42] Blakey, *Oil On Their Shoes,* 18-22; W. L. Copithorne, "From Doodlebug to Seismography," *The Lamp* 64 (1992), 44.

[43] Boatright, *Folklore of the Oil Industry*, 14.

[44] Ibid., 17.

[45] Ibid.

that made it possible for him to locate these things."[46] Although doodlebugs could not prove their devices operated on scientific principles, the inability to disprove their claims prolonged the credibility they enjoyed.[47]

A doodlebug who could not describe how his device worked was not necessarily trying to swindle the public and sometimes possessed a legitimate knack at finding oil. O.W. Killiam earned a reputation as a doodlebug in the Gulf Coast region of Texas. Killiam could not even characterize a doodlebug device much less explain how it worked. He described it as "a little instrument that goes up and down and around and around" but grew exasperated in his explanation and confessed "there's just no way to describe them."[48] There existed "dozens" of different types and they all "work on the same principle."[49] Although Killiam failed to state that principle explicitly, his description revealed that success had more to do with the operator than with the device itself.

The most successful doodlebug prospectors also surveyed the landscape and this activity cultivated within them an instinct for recognizing changes in topography and vegetation which often indicated the presence of oil. In order to operate the apparatus, Killiam explained that "you've got to have a lot of common sense and some knowledge of oil to get any effective results."[50] Although an avowed believer in these devices, he

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[46] Ibid., 18.

[47] Santschi, *Modern 'Divining Rods',* 61.

[48] O. W. Killiam, in Boatright, ed., *Tales from the Derrick Floor*, 20.

[49] Ibid.

[50] Ibid.

considered the individual's "common sense" and "knowledge" the most important attributes in finding oil. His elaboration suggested that the device itself probably played no part in a successful find, whether he consciously acknowledged this point or not. Killiam subscribed to the "theory that if you knew what to look for you could see an oil field on top of the ground."[51] Instinct provided the prospector's most effective attribute "cause if you'll go to any oil field you'll see that it differs a little bit from the surrounding territory."[52] Although Killiam conceded that prospectors within the industry had not perfected this approach, he knew of Indians who had demonstrated the ability to find oil on the basis of vegetation, how it grew, and the shape of the earth. Professional scientists confirmed that a relationship existed between vegetation and geological formations.[53] What Killiam seemed to be saying was that successful prospectors, whether they used a doodlebug or not, cultivated an intuition or knack for finding oil by surveying the landscape. Of course, in regions where great pools of oil still remained untapped the chances for finding it remained high regardless of the method employed.

Whether creekologists used machines, invoked spirits, or searched for specific features on the land, each estimation of the best site to drill amounted to a "hunch" when no visible signs of oil existed. Luck had always played a large role in finding oil. Especially in untapped regions, the abundance of oil residing at or just below the surface

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[51] Ibid.

[52] Ibid.

[53] Charles N. Gould, "Petroleum and Surface Vegetation," *Proceedings of the Oklahoma Academy of Science* 10 (1930), 110.

increased the probabiliy of finding it and the more holes drilled the higher the chance for success.[54] Killiam conceded that luck played a large role in a doodlebug's ability to find oil. He illustrated this point when he declared that a doodlebug is an instrument "which makes you spend your money drilling holes in the ground" even though "the law of averages will finally hit you a pool of oil."[55] Even into the twentieth century when petroleum geologists had begun to develop their discipline, one of the most influential, Everette L. DeGolyer, noted that "it takes luck to find oil." An ideal oil-finder possessed luck mixed with a large degree of skill, "but don't ask what the proportion should be. In case of doubt, weigh mine with luck."[56] As important a role as luck played, though, some hunches were better informed than others. Creekologists who based their decisions on field work rather than luck alone minimized the financial risk of drilling a dry hole. As obvious surface indications such as seeps grew more scarce, studying a region's geology increasingly provided the most practical prospecting method.

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[54]Boatright, *Tales from the Derrick Floor*, 66

[55] For the high probability of finding oil in the early says of unexploited oil region, see Boatright, *Tales from the Derrick Floor*, 96; Ball says that oil was so abundant in the early days of the Appalachian oil fuels that "hit-and-miss methods found enough of them to glut the market," Ball, *This Fascinating Oil Business*, 46-7; Boatright, *Folklore of the Oil Industry*, 20.

[56] Everette L. DeGolyer; Quoted in Ray Miles, *King of the Wildcatters: The Life and Times of Tom Slick, 1883-1930*, (College Station, TX: Texas A&M University Press, 1969), 68; When DeGolyer questioned his friend and leading petroleum geologist of the early-twentieth century, Wallace Pratt, to what he attributed his success, Pratt replied: "If I were to reply that I had simply been lucky you would charge me with undue modesty; but my 'successes' do appear to me to be largely fortuitious..." Wallace E. Pratt to Everette DeGolyer, February 23, 1945; Box 12, File 1513; Everette DeGolyer Collection, Southern Methodist Universty.

Creekologists who surveyed the landscape earned the name "practical oil men" because they sought-out visible indications of oil and, in the process, developed a crude geological reasoning based upon correlations they established between observations in the field and the possibility of oil beneath the ground. Although not professional geologists, practical oil men in the Petrolia, Pennsylvania field were "nothing if not geological. ...Nearly every operator is ready to discourse learnedly on rocks, formations, strata, shales, sandstones..."[57] While traveling the countryside, they "engaged in a kind of blind man's buff with nature" to decide whether or not to lease a particular tract of land.[58] Any decision to lease involved a significant degree of risk without the visible presence of oil, but "the more capable prospecting was guided by a combination of instinct, experience and rule-of-thumb geology."[59] Drilling oil on the basis of a "hunch" did not necessarily translate into guesswork. The shrewdest wildcatters never allowed chance alone to dictate their search. Rather, their interactions with the natural environment led them to decipher potential correlations with land formations above the ground and oil that lay beneath. That some oil men could better predict where oil lay than others suggests that field experience developed within them a stronger instinct for identifying surface structures that might lead them to oil. In this way, their "rule-of-thumb geology" grew out of visual and physical

[57] William Wright, *The Oil Regions of Pennsylvania* (New York: Harper, 1865), 58.

[58] William Larimer Mellon, *Judge Mellon's Sons* (By Author, 1948), 158.

[59] Ibid.

encounters with the environment.[60]

Field work so significantly influenced prospectors' instincts about where to drill that even when they approved of a location on the basis of a hunch or superstition, their decision often possessed a geological rationale. Only a very fine line separated the superstitious methods of creekology from those which involved the search for surface formations. The manner in which different methods of creekology overlapped was apparent in one prospector's choice for the best site to drill. Surface observations led one man to "a decision that oil was to be found most probably in association with the base of some mountain ridge or creek bed or some other geological feature of the surface..."[61] Even though based on a mistaken notion, the idea that a relationship existed between surface formations and oil beneath the ground at least possessed an inherent logic. The same man easily dismissed such logic, however, and allowed superstition to inform his decision by concluding that "the place that seemed most attractive to me had for many years been used as a burying ground. It was a churchyard cemetery."[62] Some prospectors so vehemently subscribed to the notion that oil resided beneath cemeteries that "when oil was found in some neighborhood, any graveyard there was soon encompassed by a forest

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[60] Ibid., 158; Boatright supports the view that wildcatters relied upon an eclectic mix of oil-finding methods: "...the wildcatter was likely to rely on a strange mixture of surface observation, superstition, the occult, and even the divine." Boatright, *Tales from the Derrick Floor*, 14.

[61] Mellon, *Judge Mellon's Sons*, 158.

[62] Ibid.

of derricks."[63] The superstition took such a hold that "nearly all the country graveyards in the oil region at one time or another were leased to oil men, and I leased this one."[64] The contention that oil always underlay graveyards places this approach to oil-finding within the realm of superstition or folk tradition. A more rational explanation for drilling in cemeteries existed even if wildcatters only recognized it intuitively.

Even when picking a location based on superstition, geological principles informed the choice more than oil men realized. Cemeteries often yielded oil not for mystical or supernatural reasons but because the hills they sat atop consisted of geologic structures that served as repositories for oil. While a graveyard did not guarantee success, prospectors often found oil there because structures such as "anticlines" or "salt domes" provided high ground which provided ideal burial sites. In fact, most graveyards situated in oil regions contained oil.[65] The 1,000 barrels one man extracted from a cemetery led him to reflect: "I think back on that churchyard drilling as one of the best of my early operations."[66] Although a supernatural belief that the Lord blessed a churchyard cemetery's holy ground by bestowing it with oil motivated some men to drill there, the decision more often resulted because businessmen lacked a systematic method for finding oil and followed a tradition that had proven successful in the past.[67] The notion grew so

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[63] Ibid.

[64] Ibid.

[65] Boatright, *Folklore of the Oil Industry*, 5-6.

[66] Mellon, *Judge Mellon's Sons*, 159.

[67] Boatright, *Folklore of the Oil Industry*, 9.

popular practical oil men over time transformed the idea into a folk tradition.[68] Similarly, just as cemeteries yielded oil because of their elevation, sawmills indicated sites to avoid because builders typically situated them on lower ground, or in geological structures known as synclines, where oil tended not to accumulate.[69] Thus, sound geologic principles explained the existence or absence of oil even when superstitious or supernatural explanations appeared more obvious.

A rational explanation existed for the frequent success of some practical oil men who drilled next to creeks. The downward slope of anticlines often formed valleys through which creeks, streams, and rivers flowed. Drilling next to the water met with success because the anticlinal structure trapped oil inside, not because the water bore a relationship to oil.[70] Oil men unknowingly applied geology even when they subscribed to the "superstition" that they could find oil by drilling next to creeks. Petroleum geologists had not consistently and unanimously articulated principles that prospectors could rely upon as tools for exploration. Nevertheless, oil men began to realize that actively studying the composition of the earth could lead them to oil.[71]

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[68] Boatright cites examples of the folk traditions that led congregations to lease-out their churchyard cemeteries. See Boatright, *Folklore of the Oil Industry*, Chapter 1: "There's Oil Under Them Hills."

[69] Ellen Sue Blakey, *Oil On Their Shoes: Petroleum Geology to 1920*, (Tulsa, OK: American Association of Petroleum Geologists, 1985), 18.

[70] Edward Bloesch, "Early Day Petroleum Geology in Oklahoma," Box 3A, File "Ed Bloesch Letters," Edgar Owen Collection, American Heritage Center, University of Wyoming.

[71] Tait, *The Wildcatters*, 75.

One of the earliest attempts to formulate a systematic method for finding structures that revealed the presence of oil resulted in the mistaken idea that large, underground crevices or fissures provided cavernous reservoirs for oil.[72] This idea constituted oil-country folklore which remained current during the first twenty years of the industry and probably originated with Uncle Billy Smith who drilled Drake's well. Smith vowed that when the hole reached sixty-nine feet, he encountered an opening that caused his tools to drop six inches.[73] The idea so captured the imagination of drillers throughout the Pennsylvania oil region that "it was the popular belief that a fissure must be struck in the oil sand or a well would be a failure."[74] The idea that the quantity of oil bore a direct relationship to the size of an underground crevice possessed no geological validity, but drillers adopted this misconception as truth. If a driller happened to locate a productive well, he suddenly "recalled" that, indeed, his drill had dropped at a certain point. Subsequent production of the well influenced his recollection of how far the drill had dropped.[75] The more prolific the well, the greater the distance he imagined his drill had dropped in order to reflect the size of the supposed crevice. The manner in which practical

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[72] For a more extensive discussion of reservoir rocks, see "The Reservoir Rock," in Robert H. Dott, Sr., and Merrill J. Reynolds, comps., *Sourcebook for Petroleum Geology, Semicentennial Commemorative Volume*, Memoir 5 (Tulsa, OK: American Association of Petroleum Geologists, 1969)

[73] DeGolyer, "Concepts on Occurrence of Oil and Gas," 24; Tait, *The Wildcatters*, 75.

[74] John F. Carll, "The Geology of the Oil Regions of Warren, Venango, Clarion and Butler Counties," in *Pennsylvania 2nd Geological Survey Report*, III, xxiv, 482 and atlas. (1880); Quoted in DeGolyer, "Concepts on Occurrence of Oil and Gas," 22.

[75] DeGolyer, "Concepts on Occurrence of Oil and Gas," 24.

oil men transformed the geologically mistaken notion of crevices into truth resembled the way in which they elevated other oil-finding techniques into folk tradition.

Petroleum geology took a significant step away from folk tradition when C.D. Angell articulated the belt-line theory in 1861. Although practical oil men incorrectly perceived a relationship between creeks and oil, they correctly reasoned that oil often lay in a pattern beneath the surface. A practical operator without any geological training, Angell observed that a number of successful wells tended to occur in a pattern irrespective of flowing water.[76] Based upon his experiments, Angell concluded that oil lay in continuous belts which ran along a straight line in a northeast-southwest direction, at an angle of twenty-two-and-a-half degrees longitude.[77] According to his reasoning, this meant that he could locate a belt and plot its course from the surface and that creeks had no relation to the belt whatsoever.[78] He successfully demonstrated this belt-line theory in 1871 and again in 1873 by locating a productive well after correlating the stratigraphy of a potential site with that of a known producer.[79] Even though some of Angell's assumptions and principles were exaggerated, invalid, or parochial in the manner he applied them, he provided a method of exploration based upon quasi-geological principles in order to

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[76] Ibid., 22; Owen, *Trek of the Oil Finders*, 66.

[77] Fuller, "Appalachian Oil Field," 625.

[78] C.E. Bishop, Letter to Editor, *New York Tribune* (1873), in *Early and Later History of Petroleum*, J.T. Henry, comp. (Philadelphia: Jas. B. Rodgers Co.; Philadelphia, 1873), 486-492.

[79] Frederick Prentice who was briefly associated with Angell first observed the belt pattern in 1861 and deserves partial credit for the theory. Owen, *Trek of the Oil Finders*, 102, 104; Dott, *Sourcebook for Petroleum Geology*, 411.

eliminate the role of chance.[80]

Despite limitations of the belt-line theory, it grew in popularity and displaced many of the methods creekologists employed. Practical oil men had remained so blindly attached to the idea that oil resided along creeks they rarely drilled at higher elevations which looked down into the valleys where water flowed. The belt-line theory changed their conception of how to find oil. Many realized that, regardless of where the creek flowed, if two wells "are alike in depth, and appearance of oil, and of the rocks bored through, I should be inclined to think they are all on one belt."[81] This new way of thinking placed a premium on gathering geological data:

> In nearly all the shanties, or in the enginehouses adjoining the wells, or else in the offices of the owners of the wells, were preserved specimens of the different kinds of rock found in each well. They asked for little specimens of these to compare with similar ones from all other wells.[82]

The belt-line theory widened oil prospectors' perspectives from the confines of a single river valley or creek bed to a much larger region. Gathering and correlating geological "specimens" led them to see that the geology of two locations "six miles apart, separated by a mountain, were almost exactly alike."[83] A broader perspective paid dividends because identifying relationships between two distant sites meant that "that they could find

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[80] Owen, *Trek of the Oil Finders*, 105.

[81] Bishop, Letter to Editor, 488-89.

[82] Ibid.

[83] Ibid.

good wells all along the line, or belt, six miles between these developments."[84] Not all practical oil men, however, consistently applied this new way of thinking.

Well into the twentieth century, many practical oil men ignored the criteria Angell outlined in his hypothesis and followed fortuitous and delusive "belt lines" based on their own idiosyncratic philosophies.[85] Whereas Angell designated the oil line's longitude at twenty-two and a half degrees based upon the geology of the region he examined, additional degree lines grew in popularity among practical men without regard to the geology of a particular locale. Drilling for oil along a line that ran twenty-two and a half degrees in a region where the geology suggested a line of forty-five degrees meant failure from the start.[86] By co-opting Angell's theory as he articulated it and applying it in their own idiosyncratic manner, some practical men disavowed the quasi-geological reasoning which undergirded the theory and proffered in its place a speculative conception of locating oil based more upon hunch and intuition than observable facts. Stripped of its geological principles, the theory held less benefit but proved successful enough to remain the most popular approach among practical men until about 1920.[87]

Practical oil men enjoyed a high probability of finding oil with techniques they had fashioned such as belt-line theory, particularly in unexploited oil regions. In Pennsylvania

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[84] Ibid.

[85] Owen, *Trek of the Oil Finders*, 102; DeGolyer, "Concepts on Occurrence of Oil and Gas," 23; Fuller, "Appalachian Oil Field", 625.

[86] Even one of the largest oil companies in Pennsylvania explored for oil by following lines without a geological justification. Fuller, "Appalachian Oil Field", 626.

[87] Owen, *Trek of the Oil Finders*, 102.

from 1860 to 1863, three years after the discovery of Drake's well, practical men found new oil fields by drilling along the valleys which carried the tributaries of the Allegheny River.[88] Signs presented themselves in the form of oil saturating the soil or swirling on the top of creeks and streams.[89] Marks of disturbance in the topography or in rocks, rugged hills, and sharply defined valleys also indicated good places to drill. They knew that as long as they continued drilling eventually they would find oil.[90] Extracting shallow pools in this manner proved successful for a time, but eventually they had to either drill deeper or move to new regions where they could find oil closer to the surface.[91] Rather than incurring the additional cost of drilling, prospectors followed the traditional surface signs and discovered another major oil-producing belt in Pennsylvania which they worked from 1864 to 1865.[92] The Clarion-Butler trend, or "lower oil belt," eventually rivaled production in the older upper-belt.[93] Field experience provided an opportunity for practical men to cultivate their skill and intuition by learning how to identify geographical

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[88] Ibid., 68; Specifically, the wells were "put down near the junction of the Clarion and Allegheny rivers..." Peckham, *Report on the Production, Technology, and Uses of Petroleum*, 12.

[89] In support of this point, it is important to remember that Drake's well was shallow by modern standards. The drillers struck oil at seventy feet. Lucier, "Scientists and Swindlers," 397-98; Owen, *Trek of the Oil Finders*, 11-12.

[90] Owen, *Trek of the Oil Finders*, 68.

[91] Ibid.

[92] Ibid.; See also Peckham, *Report on the Production, Technology, and Uses of Petroleum,* 12.

[93] Owen, *Trek of the Oil Finders*, 68.

and geological markers which suggested relationships between surface and subsurface conditions.[94] The better prospectors met with success by relying on their instincts and intuition and had no need for the less tangible hypotheses and theories proffered by geologists.[95]

Geologists proposed one hypothesis, the anticlinal theory, repeatedly throughout the nineteenth century but their impact on the oil industry remained slight despite the revolutionary potential of this prospecting guide. Geologists described the theory in published form as early as 1836, but it languished until 1885 when I. C. White demonstrated that he could significantly increase the probability of finding oil with the theory. By demonstrating its practical application, White presented the industry with a reliable prospecting tool based upon definable geological principles rather than instinct and intuition cultivated through field work. Given its potential advantages, the anticlinal theory should have revolutionized oil-finding shortly after White's demonstration but the industry as a whole did not take either the theory nor geology seriously for another thirty years. Historians have not yet explained why the industry responded so slowly, and this study partially attempts to answer that question.[96]

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[94] Ibid.; For a description of many of their "practical" methods, see James Orton, *Underground Treasures: How and Where to Find Them.* (Hartford, Connecticut: Worthington, Dustino and Co., 1872)

[95] Although Owen states that operators adopted some geologists' ideas, they also may have originated others. Many operators knew more about underground conditions than the geoloigsts. Owen, *Trek of the Oil Finders*, 97.

[96] The question of geologists' involvement in the oil industry in the nineteenth century is the subject of historiographic debate. Traditionally, most historians agree that even though professional geologists articulated the anticlinal theory as a workable

Much of the reason for the industry's slow acceptance of geologists and their theories for finding oil stemmed from the longtime antipathy between practical oil men and university-trained geologists. Practical men probably did not read about White's demonstration or simply remained unimpressed and continued exploring on the basis of methods they devised such as belt-line theory.[97] Slightly more surprising, though, is the delay of almost another thirty years after 1885 before companies began to take geologists seriously and consistently hire them. Given practical oil men's ill-feelings toward

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doctrine for finding oil, the industry failed to adopt it. Petroleum geologist and historian J.V. Howell notes that even though some geologists knew about the relationship between oil and anticlines before White's demonstration of the theory, "little effort was made to utilize this information." He notes the "astonishment" of some that between Drake's well in 1859 and White's demonstration in 1885 "little was written by geologists and seemingly they were giving little thought to the subject." Howell, "How Old is Petroleum Geology?", 607; Campbell, "Historical Review of Theories Advanced by American Geologists"; Edgar Owen, another petroleum geologist and historian, contends that from 1860-1870 "most of the major elements of a workable doctrine of petroleum geology were shaped and fitted into place" but that geologists' efforts "failed dismally, partly because of their own deficiencies and partly by the caprice of fortune." Owen, *Trek of the Oil Finders*, 56.

Although concerned primarily with the period 1830 to 1870, Paul Lucier argues that geologists were more important to the nineteenth-century oil business than historians have typically suggested. He reaches this conclusion, however, with rather curious reasoning. He evaluates geologists' importance on the basis of the inroads they made as business consultants rather on than their success at finding oil. Geologists were important to the oil industry, he argues, because "in a broad perspective, success was not the measure of the expertise of scientific consultants. ...Judging by the number and size of petroleum discoveries, the record of consulting geologists in the industry was not astounding. They were not unimportant, however. Several eventually successful companies relied on their services." Lucier, "Scientists and Swindlers," 478, 480.

[97] Myron L. Fuller, "Appalachian Oil Field," *Bulletin of the Geological Society of America* 28 (1917), 626; Paul H. Price, "Anticlinal Theory and Later Developments in West Virginia," *American Association of Petroleum Geologists Bulletin* 22/8 (August 1938), 1097-98.

geologists, it is not surprising that independent oil men so often ignored the theory.[98] One historian of the oil industry remembered that a copy of a report published by the Second Geological Survey of Pennsylvania and written by John F. Carll, one of the most significant petroleum geologists of the nineteenth century, sat untouched in his father's office.[99] His father received geology reports for free but never considered them: "I will wager the price of a string of casing that my Scotch father never spent a dime of his good money for a book by a rockhound."[100] The Survey's publication committee confirmed this point: "There is no doubt that books given away are one-half wasted by falling into the hands of persons who make little use of them."[101] Old attitudes died hard, and geologists struggled for credibility long after White's demonstration. Petroleum geologist and historian, Edgar Owen, attended school in Marietta, Ohio from 1910 to 1912, and "almost all of my classmates belonged to oil producers' families. But I never heard of anybody

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[98] A number of sources make note of the antipathy practical oil men felt for petroleum geologists. See for example: Owen, *Trek of the Oil Finders*, xiii; Ball, *This Fascinating Oil Business*, 46-7. It was not unusual for craftsmen working in the mineral industries to resent an influx of university-trained professionals into their profession. Many of the attitudes that existed among practical oil men toward petroleum geologists were displayed toward college-educated engineers by mining prospectors who followed traditional practices, Clark C. Spence, *Mining Engineers and the American West: The Lace-Boot Brigade, 1849-1933,* (New Haven and London: Yale University Press, 1970

[99] Tait, *The Wildcatters*, 79.

[100] Ibid.

[101] Committee on Publication, August 16, 1877, "Report of Publication Committee," Item 19–Diary Volume 4, 1877-1881, J. P. Lesley Collection, American Philosophical Society.

who had any use for geology."[102] An incident Owen recounted typified the resentment many practical oil men felt when geologists invaded their turf. His grandfather who worked as a practical oil man from 1861 to 1913 went bankrupt when one of the most famous nineteenth-century geologists, E.B. Andrews, issued a statement in a local newspaper which amounted to "an unfavorable geological report on his properties and prevented their sale."[103] Practical oil men had their own ideas about how to find oil and they resented geologists who contradicted opinions they had long held dear.

Practical oil men held on fiercely to prospecting methods they had crafted and relied upon for decades and felt threatened when geologists presented alternatives. Reflecting on the reception petroleum geologists received in the early twentieth century, Wallace Pratt remembered that "we naturally ran into a lot of trouble with the old-timer who had always relied on surface indications for the presence of oil. ...To them a college-trained geologist was the fool of books."[104] Practical men felt particularly threatened when they encountered geologists in the field. When the two crossed paths, practical men sometimes deliberately tried to confuse them by supplying false information or bogus samples from the wells they had drilled.[105] One geologist instantly perceived a practical oil man's temperament when he approached a well and spotted a shallow, mock gravesite

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[102] Edgar Owen to J. V. Howell, May 28, 1964, Box 16, J. V. Howell Collection, American Heritage Center, University of Wyoming.

[103] Ibid.

[104] Copithorne, "From Doodlebug to Seismography," 42.

[105] Blakey, *Oil On Their Shoes,* 52-53.

with boots protruding from the ground at one end at a headstone at the other which read, "He asked too many damned questions."[106] Geologists had to ask questions, however, because they lacked what the practical man possessed in abundance–firsthand experience in the oil fields.

Practical oil men possessed more hands-on field experience searching for oil and drilling promising sites, and they resented geologists who assumed superior knowledge because of their formal education. Perhaps more than any other attribute, the experience of conducting extensive field work contributed the "practical" element to the non-professional oil man's identity and temperament. Unlike the university-trained geologist, the practical man had "begun with nothing, and by hard labor, amid grease and dirt, learned all about putting down wells so as to make them work, or by diligent selection of likely lands have made them known to capitalists..."[107] Finding oil meant labor, grease, and dirt, not effete intellectual theorizing about how to find oil without ever venturing into the field. The famous wildcatter Joseph C. Trees who had earned an engineering degree proved an exception among practical oil men who for the most part never finished high school.[108] Rather than education, they valued hands-on experience which they acquired while roaming the countryside and looking for the best place to drill. Geologists who

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[106] Quoted in Blakey, *Oil On Their Shoes,* 61.

[107] Edmund Morris, *Derrick and Drill, or An Insight into the Discovery, Development and Present Condition and Future Prospects of Petroleum in New York, Pennsylvania, Ohio and West Virginia.* (New York: James Miller, 1865), p. 19; Quoted in Lucier, "Scientists and Swindlers," 422.

[108] Owen, *Trek of the Oil Finders*, 293.

professed to know more about finding oil on the basis of theories learned in the classroom presented an affront to the sweat and toil wildcatters endured while practicing their craft.

Practical men did not have to possess great powers of perception to see that university-trained geologists lacked field experience. Most geologists in Oklahoma had never observed the drilling of a well before graduating from college.[109] Merely a quick glance revealed that the young men fresh from universities who claimed they could find oil with geology had never sunk a well. One oil man refused to let a geologist observe him drill a well when he noticed the "fancy new" wristwatch strapped to his wrist.[110] Starting out his career as a petroleum geologist, J. Elmer Thomas was so unprepared for the physical demands of field work that he was fired when he asked how many pairs of pajamas he should take on an outing.[111] Geologists made matters worse by exerting little effort to ingratiate themselves to the practical oil men.

Although both groups displayed arrogance and believed they possessed superior knowledge, geologists had more to gain by demonstrating humility but instead showed-off with pedantic language and flashy attire. Chief geologist of the U.S.G.S., David White, scolded petroleum geologists at an annual meeting for their complaints about the "unregenerate driller":[112]

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[109] Ibid.

[110] Quoted in Blakey, *Oil On Their Shoes,* 61.

[111] Owen, *Trek of the Oil Finders*, 330-31.

[112] David White, "Discussion," *American Association of Petroleum Geologists, Bulletin* 3 (1919): 79.

> ...is it not possible that after all, your failure to get adequate and accurate well criteria may be due to the fact that you are not in cordial contact and sympathy with the driller? ...His ability and intelligence are not inferior to yours. ...How many of you put aside your high-brow clothes and forego your high-brow language (which is worse than high-brow clothes) and so present the subject of rock characters that he, recognizing them will take pride in good logs and in gathering the samples to serve as vouchers for his identification.[113]

Wildcatters generated valuable information, or "well criteria," from the holes they drilled which offered important clues about subsurface conditions to a geologist who knew how to interpret them. Ascertaining samples of that information, however, required diplomacy on the part of young geologists which they often failed to demonstrate. Rather than encouraging practical oil men to "take pride in good logs" by recording the specific depths at which they encountered various strata, geologists condescendingly adopted the terminology and attire of the college classroom rather than the oil field. What geologists learned from their professors and books could not substitute for the lessons field work taught.

Working on a drilling rig enabled practical oil men to gather important samples as their drills pulled minerals from different strata to the surface, but this information meant less to them than to geologists who could extrapolate from it ideas about subsurface geological conditions. White delivered the above admonition in 1919, but geologists expressed concern for the inadequate attention practical men paid to well records in the 1860s soon after the petroleum boom in Pennsylvania started. The use of well records to map subsurface geology was one of the most important innovations that resulted from

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[113] Ibid.

geologists' participation in the oil industry.[114] J. Peter Lesley was one of the first to advocate increased attention to keeping accurate records and to stress the important role practical oil men played in recording this valuable data. In his view, practical men failed to understand their potential contribution to geological science. He lamented that very few drillers "knew the importance of keeping any other than a contract account for number of feet sunk."[115] Drillers failed to appreciate the necessity of recording facts about the geology they encountered as their drills penetrated deeper stratigraphic layers. The irritation Lesley expressed at this neglect reflected very clearly geologists' condescending attitude toward practical men. He complained that "it is impossible to estimate the loss which geology has suffered during the last six years from this reckless ignorance."[116] Drillers could have generated a great quantity of "priceless information" if only they had kept records from the ten to twenty thousand holes they had drilled, but instead "it was allowed to flow off into the ocean of forgetfulness..."[117] Much of the problem lay in the

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[114] Lucier, "Scientists and Swindlers," 476; A geologist who worked for Lesley on the Second Pennsylvania Geological Survey, John Carll, expressed his frustration at relying on drillers' descriptions of geology because often "they are a delusion and a snare." In attempting to map Venango County, "our personal experience in endeavoring to get a correct idea of the stratification of the oil rocks from published well-records, given promiscuously by different drillers or well owners, and colored by their individual theories or pecuniary interests, discourages us from introducing that kind of record here." John F. Carll, "Report of Progress in the Venango County District," Second Geological Survey of Pennsylvania; Second Geological Survey of Pennsylvania, vol. 1, 1878 ed., p. 23; Quoted in Owen, *Trek of the Oil Finders*, 108.

[115] J. Peter Lesley, [Petroleum in the Eastern Coal-Field of Kentucky] *Proceedings of the American Philosophical Society*, 10 (April 1865), 62.

[116] Ibid.

[117] Ibid.

lack of a repository to deposit the information.

Even if drillers had recorded accurate and abundant data from wells they drilled, no entity existed which could gather, store, and preserve it. Lesley lamented the lack of "any bureau in the State, any society, or any individual" authorized or willing to preserve the few well logs generated by "men of intelligence [who] have waked to the importance" of keeping adequate records.[118] Without a repository for their information, practical men continued drilling on the basis of contracts which made no provisions "for compelling a careful record of the strata."[119] In addition to storing the information, Lesley identified the need for some mechanism "compelling" practical men to deposit their records. In order to organize and systematize the oil industry, geologists needed the power and authority of the state. In Pennsylvania, government involved itself in the oil industry when the legislature appropriated money to fund a geological survey and generate information about the state's resources.

Lesley served as director of the Second Pennsylvania Geological Survey, and according to him the impetus for it originated from oil men who clamored for information about the state's resources. He explained that Pennsylvanians looked to science for answers to their questions about oil because earlier innovations in bessemer iron and metallurgy "exercised an important influence upon the sentiment of the Commonwealth towards geology and applied science."[120] Having witnessed how they could benefit from

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[118] Ibid.

[119] Ibid.

[120] Ibid.

science, "a largely increased geological intelligence in the public mind" spread throughout the state.[121] Naturally, when an oil boom in 1873 threw western Pennsylvania into "a state of the highest excitement," people expected the scientific community to provide them with answers:[122]

> Every one was asking, how long will it last? What is its original source? Where are the limits of the reservoirs? Who can give us a rule to locate a well? How many oil sands are there? Can geology teach us anything? Why does the State Legislature not provide for a scientific examination of the phenomenon?[123]

Pennsylvania lacked immediate answers to these questions because the first geological survey was mostly a reconnaissance and had disbanded in 1842. No state official could provide the public with the information it sought. Businessmen attempted to fill this void themselves by financing "a multitude of private surveys" and generating "a world of fresh data of a specially precise kind..."[124] Private enterprise seemingly solved the problem, but "business refused to give away its valuable secrets."[125] Lesley argued that oil men without capital still lacked information and that the state should supply their needs. Exactly which oil men sought this information and which rejected it, however, remains unclear.

While the Pennsylvania legislature considered whether to fund a second geological

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[121] J. Peter Lesley, "Concerning the State Geological Survey," 303; J. P. Lesley Collection, American Philosophical Society.

[122] Ibid.

[123] Ibid., 305.

[124] Ibid., 303.

[125] Ibid.

survey, one state senator opposed the measure on the principle that practical men did not require it. Senator White from Indiana County could not justify the expenditure for another survey because, he argued, the first had been a failure, was "incorrect," and "fails to give the kind of information" people desired.[126] White wanted Pennsylvanians to derive tangible, demonstrable benefits from the survey, and asked "What will be the practical effect of a geological survey of the State? Will it increase our wealth? I do not see how it will."[127] In addition to not generating more wealth, White felt that geologists knew less about finding oil than practical men who worked in the fields daily:

> Go to the oil regions of the State, and who knows the most about the situation of the ground? Why, the practical men in that region--parties employed by private interests. ...what can a geological survey tell us more than we already know? Who is to be trusted to make a satisfactory report? Men employed by private enterprises.[128]

White felt that the practical oil man "knows the most about the situation of the ground" and not the geologist. His contention that "private enterprise" produced the most "satisfactory" information reflected his belief in a laissez-faire approach to the oil industry. Rather than looking to state government, the practical oil man had always functioned best

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[126] J. P. Lesley, Notebook Miscellaneous #16, Diary Volume 1, 1874, J. Peter Lesley Collection, American Philosophical Society. Lesley's own statements confirm White's opinion: "Yet the first survey was essentially a reconnaissance ...Their views were broad, their isolated observations numerous and exact, but their districts were never accurately surveyed by them..." J.P. Lesley, "Early Observations of the Geology of Pennsylvania," in *Historical Sketch of Geological Explorations in Pennsylvania and other States*, Second Geological Survey of Pennsylvania. (Harrisburg, PA: Board of Commissioners for the Second Geological Survey, 1876), viii-ix.

[127] J. P. Lesley, Notebook Miscellaneous #16, Diary Volume 1, 1874, J. Peter Lesley Collection, American Philosophical Society.

[128] Ibid.

when left to his own devices. Among Pennsylvania legislators, White stood alone in his opposition to the survey.

Three senators from other counties disagreed with White, contending that the state should fund a survey and that geologists had played a pivotal role in finding oil. Senators Dill, Maclay, and Cooper all favored the bill to fund a second geological survey. Dill felt White was mistaken "to say that the people do not desire a survey."[129] Even people "who do not aspire to scientific knowledge" seemed to crave geology and expressed "a very great interest" in the subject.[130] Maclay, who claimed "to have had some experience in the matter" of oil production, felt that White particularly erred in his statement about geologists' inadequate store of knowledge: "The great oil districts of the State have been discovered and their development commenced through the recommendation of geologists."[131] Senator Cooper expressed his constituents' desire for a survey and, like Maclay, explained that "not only scientific men, but gentlemen who interest themselves in geology are earnestly appealing for a measure of this kind." As the senators asserted, many of their constituents desired a survey but they never indicated specifically where practical men stood on the issue. In fact, most practical men probably did not want a geological survey.

Once Lesley became director of the Second Pennsylvania Geological Survey, he too expressed doubts about exactly who desired the geological survey and the information

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[129] Ibid.

[130] Ibid.

[131] Ibid.

it produced. On one hand, Lesley concurred with the state senators who believed that the "oil interest" in the state demanded a survey and that "it was supported by intelligent men from all parts of the state..."[132] Exactly who belonged to this homogenous group, the "oil interest," Lesley never specified except to say that they were "intelligent men." Further, he appeared to have some doubt about exactly who wanted geological information, speculating that "the immediate motive for the survey was probably, but not certainly, the clamour [sic] of the oil men in 1873 for a survey of the oil regions."[133] Most likely, the demand from "all parts of the state" that the senators and Lesley described originated from people not employed in the oil industry and who hoped that geologists would find valuable minerals on their property. Lesley confirmed this when he indicated that people in counties where prospectors failed to find resources particularly argued that "their mineral poverty was merely a mistake or oversight chargeable to the inadequacy of the old survey."[134] Although many Pennsylvania residents may have wanted the survey, practical men had less need for it because they had been successfully finding oil without the assistance of professional geologists.

Just as the label "oil interest" inaccurately homogenized a diverse array of oil industry participants, not all "practical men" fit neatly into a single group who opposed geology as a prospecting tool and some may have even supported the geological survey.

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[132] J. Peter Lesley, "Concerning the State Geological 305, J. P. Lesley Collection, American Philosophical Society.

[133] Ibid.

[134] Ibid., 306

One faction of alleged "practical men" who professed to speak for all within their group proclaimed in a newspaper article that "the time has gone by when the advisability of such a survey can be questioned."[135] Whether practical men or scheming politicians authored this article, even this group of survey supporters acknowledged that "there is probably one class" of Pennsylvanians who opposed the survey, but they are a group to whom the state "owes nothing but a quiet burial place–they are the people who have opposed canals and railroads, and telegraphs and gas companies–the representatives of old fogyism, and prejudice and illiberality."[136] The logic of this statement was clear: Supporters of the survey were enlightened and progressive thinkers, but those who opposed it held prejudiced and illiberal views of a bygone era and teetered on the brink of death. Clearly, some Pennsylvanians wanted the geological survey as evidenced by the sentiments expressed in this article. The caricature of those who opposed it, however, underscores the markedly contrasting worldview of those who favored it. Proponents of the survey wanted to harness the power and authority of the state in order to improve their fortune and chose Lesley to speak for their cause.

Lesley had no qualms claiming authority which he felt his position as a geologist warranted and which the state had bestowed upon him as director of the geological survey.

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[135] Although this article was signed "Practical Men," it is highly likely that politicians who favored the survey wrote it. The article attacks the biggest opponent to the geological survey, Senator White from Indiana County, and refutes his opposition point by point and describes him as "ignorant of the character and merits of the bill"; J. P. Lesley, Notebook Miscellaneous #16, Diary Volume 1, 1874. [p. 20]; J. Peter Lesley Collection, American Philosophical Society.

[136] Ibid.

When editorials in the Pittsburgh newspaper criticized his actions as director, he contended that they "only go to show how completely the average business man misunderstands and, necessarily misunderstands, the real objects, drift and necessary methods of a state geological survey."[137] Criticism did not shake Lesley's convictions of how he thought the survey should function, especially because he had the endorsement of the state behind him. Without apology, he declared "I have my own ideas of what a geological survey ought to be, and they are approved by the board."[138] Lesley felt a responsibility to perform the kind of work desired by the board of commissioners who appointed him, the scientific community, and the taxpaying public.[139] In his opinion, the best way to satisfy these constituents involved the hiring and training of competent assistants he could deploy as field geologists throughout Pennsylvania.

The key to conducting an effective survey lay in hiring well-trained geological experts, and Lesley had a very clear idea of the kind of men he wanted. When the citizens of Pittsburgh expressed concern that geologists spent too little time surveying the western half of the state, he explained that budget constraints prevented him from hiring and training more assistants. He informed his critics that "geology is a special science, and requires trained experts."[140] Any man who has "not been engaged for years in practical

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[137] J. P. Lesley, Letter from Professor Leslie, reprinted in Monogahela City *Republican*, August 21, Item 19–Diary Volume 4, 1877-1881; J. Peter Lesley Collection, American Philosophical Society.

[138] Ibid.

[139] Ibid.

[140] Ibid.

geological field work" could ever understand "how few such experts there are" qualified to perform the work given the small appropriation at his dispense.[141] Sure, Lesley conceded, with the money at his disposal he "could obtain for such compensation a hundred men in all parts of the State who think themselves and are judged by their friends and neighbors to be quite competent to make a geological survey," but they would lack the necessary qualifications.[142] In addition to deflecting criticism for not employing more assistants, Lesley appeared concerned to make a case for the specialized skills of professional geologists and to delineate their expertise from the methods of amateur prospectors. The authority for determining an assistant's expertise lay not in not in the "hundreds" of people who "think themselves" qualified to perform field work nor in the judgments of their "friends and neighbors" but in his discretion as the survey's director. Given his criteria, the knowledge practical men produced had no place on the survey.

Lesley saw a clear distinction between the quality of knowledge trained scientific experts and practical oil men produced, and he exhibited little tolerance for what he deemed amateur geology. He received extensive practice as a field geologist on Pennsylvania's first geological survey, and "experience has taught me that good geological work can only be done by men long trained to it..."[143] Given his emphasis on extensive training, Lesley never considered the possibility of relying on information provided by practical oil men. An amateur geologist, "however good a man" he might be and

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[141] Ibid.

[142] Ibid.

[143] Ibid.

"however enthusiastic his so-called love for geology," amounted to merely a "raw hand" who Lesley refused to take seriously.[144] For a practical oil man to meet Lesley's standards, he "would have to be put through such a course of training, for at least a year, before his work as geological work could begin to be reliable."[145] Even if he had taken a chance and hired amateur geologists, their reports "would be good for nothing" and not fit to publish unless he "entirely" rewrote them, "and even then would be of little or no value."[146] The knowledge they produced failed to pass muster because they lacked the necessary qualifications.

Lesley disagreed with the concepts practical men devised for finding oil and saw the survey as a way to combat their ill-conceived views. Many practical men believed that oil gathered in linear "belts" beneath the surface and that they could find these belts next to creeks or by drilling along an imaginary line between two productive wells. Even though some prospectors found oil in this manner, Lesley argued, their success resulted more from luck than the geological credibility of their methods and he set out to demonstrate this point. He rejected belt-line theory outright: "There are no 'belts of oil,' as some imagine, distinguishable on the surface."[147] He went even further, declaring that "all straight-edge locations of wells upon a map are mere charlantry."[148] He explained that

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[144] Ibid.

[145] Ibid.

[146] Ibid.

[147] Everette DeGolyer, Notes on J. P. Lesley, Box 8, File 1038; Everette DeGolyer Collection, Southern Methodist University.

[148] Ibid.

productive wells only appeared to fall in a linear pattern because of geological factors which practical oil men failed to understand. Lesley reasoned that "belts of wells have been caused by the fact that they are sunk in valleys" along the banks of creeks.[149] Practical men avoided drilling on the hillsides looking down upon the valleys, where they would have also found oil, "in order to avoid the need of going down to inconvenient depths" and incurring additional costs.[150] As a result, their wells "clustered along certain outcrops" in a somewhat linear pattern..[151] They found oil because they unknowingly drilled atop outcrops, not because they followed an imaginary line. Whether Lesley thought advocates of belt-line theory truly practiced "charlantry" or simply misunderstood reasons for their success, he considered it his job as director of the survey to replace their bogus ideas with geologically sound information.

As conceived by Lesley, the geological survey represented a triumph of reason and intelligence over superstition and ignorance, and this philosophical orientation placed him at odds with the methods practical oil men employed. He felt strongly that a survey should possess the "power to stimulate the intellect of the State."[152] The state must behave rationally in order "to sweep away costly superstitions respecting the mineral resources of the Commonwealth."[153] He expressed an almost missionary zeal to eliminate superstition

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[149] Ibid.

[150] Ibid.

[151] Ibid.

[152] Lesley, "Early Observations of the Geology of Pennsylvania," ix-x.

[153] Ibid.

and saw attempts by the first and second surveys as a forty-year, "manly struggle" of science against "the powers of darkness of the Underworld, the stubborn instinct for concealment in Nature, and the prejudices and falsifications of half-educated men."[154] While he never specifically mentioned practical oil men, he drew a clear line between men who possessed an education and employed science to locate resources and those who relied on superstition. He charged the survey with the mission of enlightening the "half-educated men" who kept nature concealed with their darkness and "stubborn instinct" rather than yielding to the light of science.

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[154] Ibid.

Chapter 2:

"J. Peter Lesley and the Search for a Prospecting Method"

Historians who write about the relationship between science and industry tend to focus on either the late-eighteenth century or the latter-nineteenth to early-twentieth centuries, often neglecting the years in-between. At least one historian recently attempted to fill this void by examining the first generation of scientific consultants who lent their skills to the coal and oil industries from the 1830s to the 1860s.[1] The study concluded that the practical and theoretical aspects of geology at mid-century complimented one another and laid the foundation for a successful partnership between business and science. Indeed, nineteenth-century scientists drew no sharp distinction between their work's economic utility and its intellectual contributions, often contending that the two went hand-in-hand.[2] Not all geologists, however, easily reconciled practical and theoretical science at this time. Although he was an accomplished scientist, J. Peter Lesley's personal eccentricities prevented him from accepting the possibility that practical and theoretical science could co-exist and reinforce one another. Lesley's personal eccentricities coupled with a disinclination toward theorizing resulted in his failure to provide prospectors with a reliable method for consistently finding oil because he disavowed the anticlinal theory which eventually

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[1] Paul Lucier, "Scientists and Swindlers: Coal, Oil, and Scientific Consulting in the American Industrial Revolution, 1830-1870." (Ph.D. diss., Princeton University, June 1994); Lucier, "Commercial Interests and Scientific Disinterestedness: Consulting Geologists in Antebellum America," *Isis* 86 (1996): 245-67.

[2] Anne Marie Millbrooke, "State Geological Surveys of the Nineteenth Century," (Ph.D. diss., University of Pennsylvania, 1981)

revolutionized the oil industry.

In the nineteenth century, Lesley probably knew more about the geology of Pennsylvania than any other person.[3] Born in 1819, he spent approximately sixty years of his eighty-four-year life working as a geologist. Immediately after graduating from the University of Pennsylvania, he began working as a map-maker on the Pennsylvania Geological Survey under H.D. Rogers. Lesley suspended his geological work temporarily in 1841 when he entered the Princeton Theological Seminary to train as a minister. For approximately the next fifteen years, he worked in various capacities, including as a pastor at a Congregational church, a consultant for private and corporate geological surveys, and sporadically resuming his work as a map-maker for the geological survey. At the age of forty, Lesley began working as a professor of mining at the University of Pennsylvania. When he was not teaching, he stayed so busy as a private consultant for iron, coal, and oil companies that this work provided him with his chief source of income until 1874 when he accepted the position as Pennsylvania's state geologist and focused his energies entirely on directing the Second Pennsylvania Geological Survey. No other person could have been more qualified or better situated to provide practical men with a systematic method for finding oil, yet Lesley opposed the theory other prominent geologists suggested could fill that role.

To begin understanding why Lesley so vociferously opposed the anticlinal theory, it is necessary to understand what the theory stated. Defined most simply, an anticline

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[3] Edgar Owen, *Trek of the Oil Finders, A History of Exploration for Petroleum*, (Tulsa, OK: American Association of Petroleum Geologists, 1975), 78-79.

consists of an upfold in strata which creates an elevated point but does not break the stratigraphical layers.[4] As underground pressure forces oil to the surface, the elevation, or anticline, serves as a trap into which gravity drives the oil. Because of their different weights, gas, oil, and water separate into different layers instead of remaining mixed together. Although geologists have modified and expanded this idea over time, its fundamental role as a structure trapping oil inside remains sound and credible.[5] Some of the most prominent geologists in North America either hinted at, described, or postulated that anticlines served as habitats for oil for at least fifty years before the industry took the idea seriously.[6] In 1836, S. P. Hildreth provided a detailed description of his observations while travelling in the Ohio valley and implied that oil accumulated in anticlines but did not layout a clearly-delineated hypothesis.[7] Sir William E. Logan of Canada associated oil with anticlines in an 1844. Not until 1861 did a geologist, T. Sterry Hunt, fully articulate the

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[4] Max Ball, Douglas Ball and Daniel S. Turner, *This Fascinating Oil Business*, (Indianapolis: Bobbs-Merrill Co., Inc., 1940), 49.

[5] Ibid., 139

[6] There are many sources that describe each of the several geologists who postulated the anticlinal theory, revised it, or played a part in formulating it. For the most comprehensive accounts, see Robert H. Dott, Sr. and Merrill J. Reynolds, comp., *Sourcebook for Petroleum Geology* Semicentennial Commemorative Volume, Memoir 5 (Tulsa, OK: American Association of Petroleum Geologists, 1969), 399-410; Owen, *Trek of the Oil Finders*; Howell, "Historical Development of the Structural Theory," in *Problems of Petroleum Geology*, W.E. Wrather and F.H. Lahee, eds. (Tulsa, OK: American Association of Petroleum Geologists, 1934), 2-5; DeGolyer, "Concepts on Occurrence of Oil and Gas," in *History of Petroleum Engineering* (New York: American Petroleum Institute, 1961), 17-18.

[7] Dott, *Sourcebook for Petroleum Geology*, 400; Owen, *Trek of the Oil Finders*, 40-41.

hypothesis and describe how oil accumulated in anticlines.[8] Within fifteen years after Hunt's statement, a number of other prominent geologists in North America and Europe endorsed the anticlinal theory and referred to it in their publications.[9] Despite its acceptance by numerous geologists, a few within the oil industry began to take the idea seriously after 1885 when I.C. White wrote a now-famous paper in which he demonstrated how he had located oil and natural gas by applying the theory.[10] Oil men probably did not read about it or simply remained unimpressed with geology and continued exploring on the basis of methods they devised.[11] Still, however, the industry as a whole failed to adopt it. Like many practical oil men, Lesley also disavowed the anticlinal theory and part of the explanation for his rejection of it lay in the politics surrounding the creation of a state survey.

The director of a state geological survey in the first half of the nineteenth century

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[8] Dott, *Sourcebook for Petroleum Geology*, 401.

[9] The geologists include: Charles Hitchcock, H.D. Rogers, E.W. Evans, E.B. Andrews, Alexander Winchell, Henry Hind, and Hans Hoefer. Howell, "Historical Development of the Structural Theory," 13; Galey lists John S. Newberry as a contributor. Although he did not receive formal training as a geologist, F.W. Minshall significantly contributed to the theory as well. John T. Galey, "The Anticlinal Theory of Oil and Gas Accumulation: Its Role in the Inception of the Natural Gas and Modern Oil Industries in North America," in *Geologists and Ideas: A History of North America* (Boulder, CO: Geological Society of America, 1985), 428-29; "The completeness of its acceptance may be judged by the fact that a great majority of the papers on petroleum, written by geologists between 1861 and 1880, refer to the work of either Hunt or Andrews, both advocates of the anticlinal theory." Howell, "Historical Development of the Structural Theory," 6.

[10] M.R. Campbell, "Historical Review of Theories Advanced by American Geologists to Account for the Origin and Accumulation of Oil," *Economic Geology* 6 (1911), 363-395.

[11] Myron L. Fuller, "Appalachian Oil Field," *Bulletin of the Geological Society of America* 28 (1917), 626; Paul H. Price, "Anticlinal Theory and Later Developments in West Virginia," *American Association of Petroleum Geologists Bulletin* 22 (August 1938), 1097-98.

often found himself in a very politically tense position. State surveys started in the South in the 1820s, quickly spread throughout the rest of the country, and within two decades had grown into important institutions for geological research.[12] Legislators appropriated money to establish surveys with the intention of disseminating information to all social levels in society.[13] Particularly in the Jacksonian era, lawmakers hoped to democratize education, in particular, by requiring surveys to make scientific information available to common men rather than just an educated elite.[14] More than its educational value, however, a survey's ability to generate "practical" information which potentially improved an individual's material well-being or enhanced the state's economy determined whether the legislature appropriated the necessary funds.[15] Some geologists perfected the art of balancing the practical and purely scientific results of their work when speaking to lawmakers, while others saw the survey as an opportunity to pursue a purely scientific agenda while paying lip serve to legislators' demands for utility.[16] Whatever the approach, success required the geologist

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[12] Aldrich, "American State Geological Surveys, 1820-1845," 133.

[13] Walter B. Hendrickson, "Nineteenth-Century State Geological Surveys: Early Governmental Support of Science," *Isis* (September 1961), 363; M.W.P. to James Hall, June 19, 1847 in Rachel Laudan, *From Mineralogy to Geology: The Foundations of a Science, 1650-1830,* (Chicago and London: University of Chicago Press, 1987), 295. This letter offers a classic example of the politics involved in funding a survey.

[14] Hendrickson, "Nineteenth-Century State Geological Surveys," 363.

[15] Ibid., 363-64; "State Geological Surveys and Economic Geology," *Economic Geology* 20 (June-July 1925), 376; in Everette DeGolyer Collection, Box 16, File 2245, DeGolyer Library, Southern Methodist University.

[16] Hendrickson, "Nineteenth-Century State Geological Surveys," 366-7.

to possess a broader vision than legislators of the survey's scope and less myopic views of how research might result in economically useful information.[17]

Scientists and legislators sometimes disagreed over what constituted practical information because the matter presented a subjective question open to interpretation. Some state geologists found themselves unemployed or under-funded when legislatures deemed their work to lack any apparent educational or economic value. James Hall directed the New York State Survey and contributed to Iowa and Wisconsin's surveys and provided the classic example of a geologist who subordinated his work's practical application to its scientific relevance.[18] Rather than perform the humdrum work of locating and testing building stones or other natural resources, Hall published reports with detailed descriptions of fossil shells accompanied by expensive reproductions of steel-engraved plates.[19] Uncertain how his work might translate into economic gains, the Iowa legislature discontinued its survey, Wisconsin refused to reimburse him for engravings to illustrate his reports, and both legislatures objected to funds for expensive and arcane books which benefitted only a small group of

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[17] "State Geological Surveys and Economic Geology," *Economic Geology* 20 (June-July 1925), 377; in Everette DeGolyer Collection, Box 16, File 2245, Everette DeGolyer Library, Southern Methodist Universty.

[18] Despite his bad luck with Iowa and Wisconsin, Hall had better luck with other attempts to acquire appropriations for purely scientific work. See "State Geological Surveys and Economic Geology," *Economic Geology* 20/4 (June-July 1925), 376; in DeGolyer Collection, Box 16, File 2245. Hendrickson, "Nineteenth-Century State Geological Surveys," 367.

[19] Hendrickson, "Nineteenth-Century State Geological Surveys," 367.

scientists.[20] What Hall considered "practical" legislators viewed as science for the sake of science, without apparent benefit to taxpayers.

Henry D. Rogers encountered similar opposition from the Pennsylvania legislature. Rogers directed the first Pennsylvania geological survey from 1836 to 1842[21] Between he and his brother, William B. Rogers, the two men directed three state surveys and often complained to each other about the obstacles each legislature presented to their work. Henry considered the Pennsylvania state legislature a "tribunal to which I have to bow" for money and complained about one senator who refused to vote for a bill funding the survey because it unfairly neglected other sciences, making "'no provision for phrenology, animal magnetism, and the highly important science of *water-smelling...*'"[22] The senator's statement made clear that determining what constituted "practical" knowledge presented a very politically-charged debate neither geologists nor legislators could easily resolve.[23] The *kind* of science mattered as much as the cost involved. A political fight to fund fringe sciences such as animal magnetism and water-smelling at the expense of geology revealed that the senator held an entirely different conception of "practical" knowledge than Rogers. If legislators mirrored the views of their constituents, the senator's position revealed that the public and its representatives conceived of science and its utility very differently than

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[20] Ibid., 368.

[21] Rogers was reinstated as director in 1851.

[22] Henry D. Rogers to William B. Rogers, May 1, 1841, *Life and Letters of William B. Rogers*, I, 190; in Hendrickson, "Nineteenth-Century State Geological Surveys," 370.

[23] Hendrickson, "Nineteenth-Century State Geological Surveys," 365.

geologists.

Unlike James Hall, Henry Rogers understood that the public and politicians wanted state geologists to produce results, but this pressure presented no problem because he considered pure and applied science compatible and mutually reinforcing. Rogers recognized that in the discipline of geology, "whose aims are eminently practical, it frequently happens that useful results connected with the arts are involved in the higher generalizations of the science..."[24] To ensure that the legislature and its constituents remained content, he published annual reports which recounted the survey's activities and documented its progress.[25] He also included glossaries with geological terms in many of these reports, a common tactic by state geologists to avoid alienating the public with arcane scientific terms.[26] He targeted a different constituency, however, with his three-volume *Final Report* which addressed the scientific community and discussed more theoretical matters. Rogers and other notable geologists such as David Dale Owen and Edward Hitchcock proved adept at highlighting both the practical and theoretical results of their work because they recognized that no clear distinction existed between pure and applied science.[27]

As an assistant to Rogers on the first geological survey, Lesley learned perhaps too well that in order to prosper a state geologist must emphasize the practical application of a

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[24] H.D. Rogers, *First Annual Report of the State Geologist*, (Harrisburg: Emanuel Guyer, 1836), 22; Quoted in Anne Millbrooke, "Henry Darwin Rogers and the First State Geological Survey of Pennsylvania," *Northeastern Geology* 3 (1981), 72.

[25] Ibid.

[26] Ibid.; Hendrickson, "Nineteenth-Century State Geological Surveys," 365-66.

[27] Hendrickson, "Nineteenth-Century State Geological Surveys," 365-6.

survey's work. If James Hall presented an example of a scientist who subordinated the practical application of his work to its theoretical relevance, Lesley fell at the other end of the spectrum because he strived to produce practical information devoid of theoretical statements and speculation. Even though Rogers understood the necessity of justifying the survey's existence by producing annual reports informing the legislature and public of his progress, he exhibited some administrative ineptitude and had to ask the legislature for additional funding on two occasions which delayed the *Final Report* for approximately sixteen years after the survey had disbanded. Lesley strove to avoid similar mistakes throughout his tenure as director of the Second Pennsylvania Geological Survey. Whereas Rogers waited to publish a definitive final report after amassing multiple drafts, maps, and cross-sections from his assistants, Lesley published material from individual districts or projects as soon as he received them.[28] This approach ensured that business interests received helpful information as quickly as possible and offered tangible evidence of the survey's work to the legislature. Rogers' rather vague conclusions on the first survey also influenced Lesley to adopt an anti-theoretical orientation. Lesley determined to improve upon the first geological survey by reducing generalizations and theories to precise statements verified by direct observation in order to provide mineral prospectors with a systematic method for locating coal and oil.

Rogers' *Final Report* provided mostly generalizations and speculations because inadequate funding prevented him from surveying and mapping the state in detail, and Lesley

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[28] Frederick G. Clapp, "The Occurrence of Petroleum," in *A Handbook of the Petroleum Industry* (New York: John Wiley and Sons, Inc., 1922), 376.

committed himself to offering more concrete results devoid of uncertainty. Lesley did not blame Rogers for the character or quality of his work and recognized that the first survey was "essentially a reconnoissance" performed without "instruments of precision and under the greatest inconvenience."[29] Despite these limitations, he observed that many still considered the *Final Report* a "matter of frequent remark and admiration..."[30] The assistants Rogers employed worked diligently, but their "views were broad, their isolated observations numerous" and the lack of adequate instrumentation prevented them from accurately surveying their districts.[31] Lesley considered it his mission to accomplish all the first survey had not:

> The second survey is intended to supply this lack to take up their work where they left off; to reduce their general statements to precision; to measure, where they could only estimate; to define, what they could only indicate; to demonstrate what they could see to be true, but which they could not prove and show in all its truth.[32]

He rejected outright any statement that lacked verifiable proof and considered any "general" idea or "estimate" devoid of the rigorous standards he committed himself to upholding as state geologist and as a scientist. Lesley felt so strongly about achieving these objectives that he sought to ensure that "precision" and sharp definitions always prevailed over speculation, and this approach formed the guiding principle he instituted as director and imposed upon

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[29] J.P. Lesley, "Early Observations of the Geology of Pennsylvania," in *Historical Sketch of Geological Explorations in Pennsylvania and other States*, Second Geological Survey of Pennsylvania. (Harrisburg, PA: Board of Commissioners for the Second Geological Survey, 1876), viii.

[30] Lesley, "Early Observations of the Geology of Pennsylvania," viii.

[31] Ibid.

[32] Ibid.

his assistants.

The political pressure to produce practical results which Rogers encountered as director of the first geological survey established a context which influenced Lesley's actions as director of the second geological survey. When a ten-member board of commissioners named Lesley director, he heard loud and clear the mandate to produce only economically useful information. He recalled that "when the geological survey of Pennsylvania was first ordered, its first business was well understood to be not scientific, but practical."[33] Lesley took seriously his role to uncover information that helped coal, gas, and oil companies earn a profit by locating Pennsylvania's natural resources. Distinguishing between practical objectives on the one hand and scientific objectives on the other, Lesley refused to allow theoretical science to undermine the survey's utilitarian function. This meant that he must "direct the State survey almost exclusively in an economic direction, so as to make the whole of every appropriation bring as much fruit to the business community as possible, neglecting, in what systematic geologists may possibly or probably consider a shameful manner, strictly scientific researches."[34] In order to make every dollar count, he specifically disavowed

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[33] Benjamin Smith Lyman, "Biographical Notice of J. Peter Lesley," *Transactions of the American Institute of Engineers* 34 (1903), 734. Lyman was Lesley's nephew and worked for him on the survey. Lyman said: "The practical character of the Survey was always kept in view, and the constant aim was to gather knowledge that would have a useful bearing upon the working of coal, iron, gas and other minerals of the State. ...He not only aimed to have the Survey work and investigations of an entirely practical character, but to have the results reported in language that would be simple, clear and readily understood." Ibid., 735-6.

[34] "From the inception of the work it therefore was essential that reports be made each year, that these reports consist of great accumulations of facts describing the occurrence of ores, oils, coals and other valuable deposits in a form useful to the practical miner, and

theoretical, or "strictly scientific," research. Unlike other geologists, including his mentor Rogers, Lesley failed to realize that applied and theoretical science complemented one another. Whatever his peers in the scientific community might think, he felt no shame making clear that theoretical science played no role in the survey's objectives: "Even when I have ordered long and extensive scientific researches...it has been, not in the spirit of transcendental science, but with the express intention to use the results directly as applied science to the economical demands of the State."[35] Although Lesley's objectives for the survey grew out of the political pressure to appease the legislature, they also reflected his personal philosophy about how to conduct science. He approached science as an either/or proposition, as a method of inquiry that either served practical and economic purposes or as a purely theoretical exercise.

In attempting to divorce applied and theoretical science, Lesley demonstrated a naive and unsophisticated philosophical orientation. Geologists formulated the conceptual foundations of their science roughly during the half century which spanned from 1780 to 1830.[36] Although they used a spectrum of methods in their investigations, most or all of them relied upon theories in their work as long as they could point to observable evidence

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that the deduction of general laws, correlation of geological names, elaboration of geological structure, investigations of deposits of obscure origin and paleontological studies all must be deferred until the survey had been in progress for several years." Henry M. Chance, "A Biographical Notice of J. Peter Lesley," *Proceedings of the American Philosophical Society* 45 (1906), 903.

[35] George P. Merrill, *The First One Hundred Years of American Geology* (New Have: Yale University Press, 1924), 496.

[36] Laudan, *From Mineralogy to Geology,* 8.

to substantiate their claims. When geologists disagreed about methodology, they did not argue over whether to rely solely upon theory or fact-gathering but, rather, over the proper relationship between theory and facts in order to justify a hypothesis.[37] Drawing a sharp distinction between "speculation" on the one hand and "empirical observation" on the other to characterize a methodology failed to consider that the two approaches went hand-in-hand, like building blocks in support of an idea.[38] Like other geologists of his time, Lesley employed both theory and observation in his work but exhibited difficulty seeing how the two complemented one another.

Lesley particularly objected to the tenuous relationship between theory and observation practical oil men displayed in the methods they used for locating oil. He realized that both geologists and practical men relied on theories to find oil and had no problem with theories per se, as long as "they are supported by a great multitude of harmonized facts."[39] According to Lesley, practical men were too theoretical. He explained that "practical men, so-called, are just as theoretical, and much more theoretical, than men of science."[40] Geologists produced more reliable information because they "base their theories on a wide range of well connected facts" whereas practical men "establish theoretical prejudices upon the basis of a comparatively narrow circle of the facts..."[41] Practical men developed theories

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[37] Ibid.

[38] Ibid.

[39] G.P.M., "Peter Lesley," *Dictionary of American Biography* vol. 6, viii.

[40] Ibid.

[41] Ibid.

that led them to oil in particular locales, but when they applied the same theories in areas where the geology differed they met with failure. Lesley correctly pointed out that, in many instances, practical men formulated theories and applied them dogmatically. Like practical men, however, he too struggled to establish the appropriate balance between theory and observation.

As much as he criticized practical men for their wild speculations, he too demonstrated the capacity to indulge a theoretical bent. Henry M. Chance worked for Lesley on the survey and witnessed that his boss often displayed a great fondness for theoretical science. According to Chance, Lesley was "intensely interested in abstract science, loving it for itself alone..."[42] He witnessed Lesley "dreamily looking back through the ages, reconstructing mentally the conditions and forces at work, which have given us the earth as we now have it, and perhaps looking forward to foretell the future..."[43] Despite such reveries, Chance described Lesley as "eminently practical, a man of affairs, an engineer." He noticed that Lesley's mind often shifted abruptly from the theoretical to the practical. Lesley contemplated geological processes that took place over thousands of years, but "in a moment, divorcing these poetic dreams, he became a utilitarian, a conservative mining engineer, accepting and weighing only those facts and agencies having direct bearing upon the extent, quality and value of the minerals with which as a master of the art he continually

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[42] Henry M. Chance, "A Biographical Notice of J. Peter Lesley," v.

[43] Ibid.

had to deal."[44] Chance's description suggests that Lesley recognized the value of both practical and theoretical science but that they seemed at odds within his mind. He appeared unable to reconcile these differing conceptions of science, and as an eminently utilitarian and conservative engineer he determined to prevent unsubstantiated theories from undermining the survey's practical contributions.

His commitment to producing practical results led him to administer the survey on the basis of a policy which called for fact-gathering alone and specifically avoided larger questions which fell within the realm of theoretical, and therefore impractical, science. Lesley consciously strove to produce reports which contained only "simple descriptions of work done, records of facts observed, and explanations of the local geology of each district within the limits of what is *known* by geologists."[45] This approach left no room for speculation about larger ideas unless they logically followed from assistants' observations while in the field.[46] He mandated that assistants collect data only while "avoiding the discussion of abstruse questions, which do not concern the inhabitants, and are still subjects of speculation among geologists."[47] Again, Lesley demonstrated a provincial orientation that pure and applied science served different purposes and could never complement one another. He interpreted theoretical statements by his assistants as showboating and he wanted the record to reflect that should any of them pose open-ended questions "they are made under

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[44] Ibid.

[45] Lesley, "Early Observations of the Geology of Pennsylvania," xxii.

[46] Ibid.

[47] Ibid.

protest..."[48] In his mind, publishing theories would have undermined his mandate to generate information that helped prospectors locate resources.

As an assistant to Rogers on the first geological survey, Lesley could not have found himself better paired with a mentor who understood the futility of separating pure and applied science but he failed to learn this lesson due, in part, to difficulties in their friendship and business relationship. Lesley began surveying for the first geological survey of Pennsylvania in 1839 and performed field work during each of the following three summers until the survey disbanded when a shortage of funds caused the legislature to cease appropriations.[49] The survey temporarily recommenced in 1851, but only a short time elapsed until Lesley realized he could no longer work with Rogers. Although the two felt a strong affection for one another, their friendship often suffered when they disagreed over business matters. Lesley viewed Rogers as more than just a boss and perhaps even considered him a father figure. He told Rogers that he felt "as strong an affection for you, as one man can for another..."[50] As early as 1851, however, relations between the two men began to deteriorate. Lesley's daughter Mary speculated that her father and Rogers were "temperamentally antagonistic" because both possessed irritable, "extremely nervous"

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[48] Ibid.

[49] W. M. Davis, "Biographical Memoir of J. Peter Lesley, 1819-1903," *Biographical Memoirs* (1915), 159; Clapp, "The Occurrence of Petroleum," 373.

[50] J.P. Lesley to H.D. Rogers, July 25, 1851, J. P. Lesley Collection, American Philosophical Society.

personalities, but more than personality differences effected their relationship.[51] When the two began working together after the survey recommenced, they squabbled about the length of employment, salary, and other work-related matters. Lesley complained that Rogers was "a most uncomfortable partner in any work...," particularly when he extended the length of employment without providing additional compensation.[52] When he complained about these matters, Rogers responded to these complaints with an earnest desire to retain the services of a valued assistant.

Lesley probably had legitimate gripes about the terms of employment, but most of his resentment resulted from his perception that Rogers took him for granted and placed the objectives of the survey above his struggle to establish himself within the scientific community. At times, Rogers sounded like an unsympathetic boss who randomly altered the terms of employment, informing Lesley that "a much larger part of your work demands your presence in the field than was at first imagined."[53] Such whimsy did not sit well with Lesley who made his feelings known: "You seem to have allowed my ten years devotion to your wishes to induce you to forget that I have affairs of my own sometimes to attend to, which

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[51] Mary Lesley Ames, ed. *Life and Letters of Peter and Susan Lesley*, 2 vols. (New York and London: G.P. Putnam's Sons, 1909), 284.

[52] J. Peter Lesley to Susan Lesley, June 15, 1851, in Mary Lesley Ames, *Life and Letters of Peter and Susan Lesley*, 284.

[53] H.D. Rogers to J.P. Lesley, July 20, 1851, J. P. Lesley Collection, American Philosophical Society.

are not so wholly unimportant..."[54] In addition to feeling neglected, Lesley complained that he had "ruined my eyes" making a map, work he would not have accepted "but for your solicitation."[55] Rogers took advantage of their close relationship, leading Lesley to object "that when I have to [do] something it must be done with business punctuality and exactness but when you have to do something it may be left to the loose convenience and kindly constructions of friendship."[56] The only solution in Lesley's mind was to base their relationship on either business or on friendship. By December 1851, he appeared to have reached a breaking point, and he tried as diplomatically as possible to extricate himself from continued professional involvement with Rogers and to preserve amicable relations. Lesley spoke clearly and to the point: "...In order to save the feelings of both in future, I wish to repeat what I did not perhaps put before beyond all doubt--that we cannot work together upon this survey..."[57] As much as they argued throughout 1851, their relationship continued for seven more years.

When Rogers published a geological report and failed to credit his assistants' for their work, Lesley lashed out at his former boss in print and the two never spoke again. Over the years, he expressed resentment for Rogers for a number of issues and took every opportunity to make his feelings known. Lesley spent the winters of 1846 and 1847 in Boston working

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[54] J.P. Lesley to H.D. Rogers, July 25, 1851, J. P. Lesley Collection, American Philosophical Society.

[55] Ibid.

[56] Ibid.

[57] J. P. Lesley to H.D. Rogers, December 3, 1851; "Correspondence"; J. Peter Lesley Collection, American Philosophical Society.

as a draftsman, duplicating a map that he had previously drawn for Rogers to reproduce in the survey's final report. He grew enraged when Rogers published the map twelve years later and only mentioned Lesley briefly in the preface and failed to credit other assistants for their work.[58] The following year, Lesley published a work on iron manufacturing and took the opportunity in his preface to attack Rogers personally, calling the "so-called" author of the report an "imposture," and accusing him of failing to acknowledge the apprentices' contributions on the survey.[59] To make-up for Rogers' neglect, he listed each member of the survey and their efforts. This incident initiated a serious rift between the two men which lasted the rest of their lives.[60] According to Lesley's daughter, Mary, the conflict was "the most painful episode of my father's life."[61] Because of their disagreement, Lesley resigned from the survey in 1852.

As the years passed and Lesley matured, the anger he once harbored toward Rogers had begun to subside. When Lesley began working on the survey, he was a "young fellow of twenty" and felt "full of enthusiasm for his leader."[62] This excitement waned, however, as Lesley entered the next phase of his life. Twenty years later, the pressure to make a name for himself within the scientific community compelled him to step out from his mentors'

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[58] Owen, *Trek of the Oil Finders*, 47.

[59] J. Peter Lesley, *The Iron Manufacturers' Guide* (1859), in Martha B. Kendall, "J. Peter Lesley," *Dictionary of Scientific Biography* vol. 8, 260.

[60] Davis, "Biographical Memoir of J. Peter Lesely," 167.

[61] Mary Lesley Ames, *Life and Letters of Peter and Susan Lesley*, 283.

[62] Davis, "Biographical Memoir of J. Peter Lesely," 194.

shadow even if doing so required a verbal attack. He had grown into "a striving man of nearly forty when he excitedly" lashed out at Rogers in print.[63] Having established himself professionally seemed to have cooled the passions of youth. By the time "he had gained secure position and was well towards sixty," he had matured enough to praise his former boss' work.[64] In critiquing Rogers' *Final Report* of the first geological survey, he observed that "there can be no sentiment but one of admiration for the breadth of his views, and the clearness, force and elegance of his delineations."[65] It had taken twenty years, but the ambitious, driven young scientist had mellowed.

Lesley's attitude had changed because his experience as director of the second geological survey gave him a new appreciation for the administrative responsibilities that accompanied the position. Lesley's administrative style pervaded all aspects of the survey and developed in large part from the rift between he and Rogers.[66] One historian of state geological surveys felt that Lesley overestimated his value as an assistant and underestimated Rogers' burden as director. He described Lesley's conflict with Rogers as "another illustration of the experiences of every executive who has planned, directed, and rendered possible the work of subordinates, only to find in the end that the value of his instrumentality

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[63] Ibid.

[64] Ibid.

[65] Second Geological Survey of Pennsylvania, Vol. A., 1876, p. 122, 127; in Davis, "Biographical Memoir of J. Peter Lesely," 194.

[66] Clapp, "The Occurrence of Petroleum," 376.

is quite underestimated, and all credit claimed by him to whom opportunity was given."[67] Directing the survey taught Lesley very quickly how instrumental Rogers had been to the first survey's functioning.

As director of the Second Pennsylvania Geological Survey, Lesley experienced firsthand the difficulty his former boss faced adhering to a budget when assistants demanded higher salaries. When I.C. White asked for more money, Lesley replied in a manner reminiscent of Rogers' response to him when he had inquired about monetary issues. Lesley explained that his remaining funds had "to be shared among the corps, offices, equipment, and expenses of all kinds."[68] At the same time, he assured White "that no one is more aware of the inadequacy of all new stipends than I am."[69] Like Rogers, Lesley faced the difficulty of maintaining a staff large enough to perform the necessary work and finding the money to pay them. He could not offer White an increase because "this year the survey is overloaded" and he doubted whether his funds would hold out until the end of the year.[70] Rather than lose an employee, however, he struck a compromise and paid White an extra $25 after stumbling upon some "unexpected savings."[71] As director, Lesley acquired a new appreciation for stretching the budget. The burdens of administering the survey also influenced his

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[67] Laudan, *From Mineralogy to Geology,* 343.

[68] J. Peter Lesley to I. C. White, June 1, 1877, Series I–Correspondence, J. P. Lesley Collection, American Philosophical Society.

[69] Ibid.

[70] Ibid.

[71] Ibid.

philosophy in dealing with assistants.

The falling-out with Rogers taught him to exhibit patience toward the assistants he employed, but the open and flexible interpersonal style Lesley possessed prior to accepting the directorship of the Second Pennsylvania Geological Survey did not last long. Nine years before Lesley accepted the position as director, he gave advice to his nephew, Benjamin Lyman, who also directed a geological survey, about how to deal with subordinates. Lesley encouraged Lyman to display understanding and cooperation. After years of working on geological surveys, Lesley had supervised "a number of men young and old" and had learned "to exercise a great deal of patience."[72] A director and his assistants, Lesley advised, "must make the best of each other," and he urged Lyman to consider that "there is more good in every young fellow than appears at first..."[73] Lesley could not claim perfection, however, and conceded that "many a harsh word I have said which I was sorry for" and that he had at times behaved in an "unjust and despotic" manner.[74] He qualified this behavior, though, claiming that altruism and not selfishness motivated his despotism, for his "chief desire was to advance their interests and consult their comfort rather than my own..."[75] The conflict with Rogers proved so pivotal an event in his life it tempered his anger in dealing with assistants. The relationship could never be an easy one, but as long as subordinates recognized that the

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[72] J. P. Lesley to Benjamin Lyman, September 25, 185, J. P. Lesley Collection, American Philosophical Society.

[73] Ibid.

[74] Ibid.

[75] Ibid.

director possessed a "warm and generous heart, you will find your intercourse with your assistants, not always satisfactory, but at all events not intolerable."[76] He had learned that the demands of directing a survey pushed even the most cool-headed director to the brink of frustration.

Lesley's patience grew so short when assistants violated his injunction against making theoretical statements in their reports that he limited their freedom to reach independent conclusions. As with Lesley's administrative style, his scientific methodology also pervaded the second geological survey and grew out of his rift with Rogers.[77] In addition to feeling angry toward Rogers because of his failure to credit assistants for their contributions, Lesley also resented his unwillingness to grant them independence in their work.[78] As a result, he vowed to take a different approach.[79] As early as 1856, he insisted that "no primary report should receive the touch of any hand but that of the first observer."[80] The demands of producing timely and accurate results prevented him from practicing what he preached. Rather than granting his assistants the freedom to reach independent

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[76] Ibid.

[77] Clapp, "The Occurrence of Petroleum," 376.

[78] Davis, "Biographical Memoir of J. Peter Lesely," 216.

[79] Lesley willingness to grant assistants more autonomy "was an evident reaction from the opposite policy of the First Survey under Rogers, which he had so violently condemned, and like most reactions, it was carried to an extreme." Davis, "Biographical Memoir of J. Peter Lesely," 215.

[80] J. P. Lesley, *Manual of Coal and its Topography, illustrated by original drawings chiefly of facts in the Geology of the Appalachian Region of the United States of North America.* (Philadelphia, 1856), 212; Quoted in Davis, "Biographical Memoir of J. Peter Lesely," 216.

conclusions after conducting field work, he constantly edited their reports to eliminate statements he considered too speculative or theoretical.

Although Lesley's practice of eliminating theoretical statements from assistants' reports occurred, in part, as a by-product of the demands placed upon him to produce accurate information quickly, his excessive editing more accurately reflected a compulsive tendency to micro-manage the survey's findings. Lesley felt committed to the policy of "publishing results as fast as obtained" in order to appease the board of commissioners who appointed him, and he agreed that "there can be no question about the propriety of this policy."[81] The most pragmatic method of dealing with the demands he faced would have been to place more trust in the conclusions his assistants reached or to trust that their training qualified them to meet the survey's objectives. Instead, he interpreted the policy as necessarily imposing upon him "unceasing labor as an editor, every day of the entire year. Every sentence of every report must be revised..."[82] Lesley failed to discuss opposing points of view with assistants or to reconcile disagreements before simply eliminating their conclusions on the basis that they sounded too theoretical.[83] In Lesley's defense, many of his assistants lacked field experience and this understandably increased his caution, but his temperament also prevented him from relinquishing control over the survey's published reports. He exercised so much control over his assistants' reports that they grew to resent

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[81] Lesley, "Early Observations of the Geology of Pennsylvania," xx.

[82] Ibid.

[83] Curiously, Davis makes this point but simultaneously argues that the blame should lay with the principle itself rather than on Lesley's shoulders. Davis, "Biographical Memoir of J. Peter Lesely," 217.

any changes he made.

As director of the survey, Lesley scrutinized the work of young men he hired so closely that they exhibited the same impetuous attitude toward him he had displayed toward Rogers approximately twenty years earlier. One of his assistants, John J. Stevenson, acknowledged that only three or four of the men who worked for Lesley had any field work experience. While their inexperience legitimately necessitated careful review their work, he suggested that Lesley often criticized them in an overbearing manner. Lesley could "never forget...that his assistants were inexperienced, and his constant anxiety was to prevent that lack of experience from doing injury either to them or to the state."[84] Whether altruistic or not, his feedback seemed picayune and aroused confusion among many of his assistants. Stevenson remembered that "the time of proofreading was often a time of perplexity to authors of reports, who frequently discovered parenthetical comments or argumentative foot-notes which were not in every case edifying."[85] When Lesley detected an error or even a statement with which he disagreed, he "relieved himself in a communication which was a model of terseness and clearness" and "his criticisms were none too mild."[86] Assistants usually responded in kind and these disagreements endured only briefly, but Lesley walked a fine line between providing feedback and censoring his assistants' ideas.

Assistants who addressed the scientific community in their reports rather than the

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[84] John J. Stevenson, "Memoir of J. Peter Lesley," *Bulletin of the Geological Society of America* 15 (1904), 535.

[85] Ibid.

[86] Ibid.

narrow economic interests of the Pennsylvania taxpayers also caused Lesley to censor their findings. In one instance, Lesley chastised White for taking too long to produce a report on Crawford and Erie counties, but his irritation stemmed from more than just tardiness. Lesley expressed annoyance with White for discussing issues which appeared to concern only the scientific community rather than the Pennsylvania taxpayers. In addition to objecting to White's delay, Lesley reminded him that "the treatment of general geological subjects is not called for. I care nothing at all about the 'geologists of the country.'"[87] Ever mindful of the need to prove the Survey's practical orientation, Lesley admonished him that they published reports "not at all for the geologists of the country, but for the citizens of the counties and the state, who pay for the Survey." Not only did he struggle to maintian equilibrium between pure and applied science, but he mistrusted his assistants' abilities to formulate accurate theories based upon what they observed in the field. In short, he questioned the relationships they established between theory and observation.

If assistants failed to eliminate statements which sounded too theoretical, Lesley simply rewrote their reports. He spent much of his time trying to prevent one assistant in particular, I.C. White, from making theoretical statements. He chastised White on many occasions for using language that sounded too speculative and re-wrote large sections of his reports. In one case, he rewrote eighty-two pages of what White had written, "condensing it and making it easily readable."[88] Lesley experienced difficulty deciding whether he

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[87] J.P. Lesley to I.C. White, August 11, 1879, J. P. Lesley Collection, American Philosophical Association.

[88] J.P. Lesley, August 16, 1879, Item 19–Diary, volume 4, 1877-1881; J. P. Lesley Collection, American Philosophical Society.

objected most to White's writing style or the content of his reports. He commented that White's "style is so verbose and inverted that I will not accept it. He makes assertions and generalizations which I will not allow."[89] Lesley's criticism suggests that as an editor he elided matters of style and content. Rather than identifying a particular issue and presenting an opposing point of view, he objected to the verbose style because he could not trust that White sufficiently based his "assertions and generalizations" upon observations while in the field. Unwilling to place too much trust in White's judgment, he chose to rewrite the report.

While Lesley understandably felt obligated to review what his assistants wrote and even to influence the results of their work, he constrained their conclusions by imposing upon them his overly rigid commitment to practical science. In some cases Lesley refused to publish the results of an assistant's work he deemed too theoretical. When I.C. White proposed researching a particular geological question, Lesley disapprovingly stated that "your plan of Lake Shore work won't do."[90] He lacked confidence in White's ability to handle too theoretical an issue, and told him that he "can't risk having you slash away" at the question because "it is a fearfully big thing."[91] Time constraints militated against the work as well. Answering the question involved so much effort that "three or four weeks work won't settle it."[92] Behind his objections to White's qualifications and the time involved lay

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[89] Ibid.

[90] J. P. Lesley to I. C. White, August 5, 1879; J. P. Lesley Collection, American Philosophical Society.

[91] Ibid.

[92] Ibid.

Lesley's personal bias against expending effort "merely for a theoretical (scientific) question of nomenclature of no importance whatever."[93] He refused to consider that time spent answering a theoretical issue could have produced any practical benefit. Should White have decided to shirk his boss' admonition, Lesley warned that "I shall not publish anything you write upon it if you discuss it in large in your report."[94] Even the most innovative theoretical statements faced a small chance of finding their way to print because Lesley would have eliminated them.

On occasion Lesley published some statements even though he considered them too speculative, but he made sure to present them as the assistant's views and not those of the survey. Lesley demanded such an unrealistic standard of proof to verify every statement published it is no wonder he so frequently objected to what his assistants wrote. In one instance, he initially told White that he would "not permit a confident expression of a general character to go into type, where I know of current doubts."[95] Anything less than absolute certainty from his assistants failed to pass muster. Because White could not support his statements with "ample and indisputable" evidence, Lesley refused to present them as "absolute authority."[96] Rather than eliminate White's statements entirely, however, Lesley conceded to changing "your general assertion into a personal assertion, and let the statement

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[93] Ibid.

[94] Ibid.

[95] J.P. Lesley to I.C. White, November 23, 1880, J. P. Lesley Collection, American Philosophical Society.

[96] Ibid.

go on your authority alone."[97] Field work could not always produce "indisputable" evidence or "absolute authority" to explain geological processes taking place underground, but this is the standard Lesley demanded.

Even when Lesley praised White, he could not resist the urge to remind him that good work resulted only from firsthand observations garnered through careful geological field work and not from speculation. White had "done nobly" to identify a relationship between "the Ohio rocks and our oil belt," but Lesley harangued that this good work "has been done by sticking to your county work, and doing it minutely and locally."[98] Only by gathering facts in a slow and prodding manner could geologists construct theories because field work provided the only method for making a discovery, a point Lesley wanted to reinforce: "So are made all our advances in science."[99] He had always questioned the relationship his assistants established between theory and observation but in this case he approved. Nevertheless, he still felt compelled to remind White that "prediction and speculation on insuffic[ient] data have been and still are the curses of our science, and when you are 60 years old as I am next month you will feel this keenly."[100] Lesley's desire for sufficient data to support a theory constituted a perfectly reasonable standard, but field work did not always reveal the evidence scientists needed to answer complex questions or to verify their theories.

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[97] Ibid.

[98] J. P. Lesley to I.C. White, August 5, 1879; J. P. Lesley Collection, American Philosophical Society.

[99] Ibid.

[100] Ibid.

Lesley interpreted so many of his assistants' statements as too theoretical because his overly-rigid commitment to a methodology that emphasized fact-gathering to the exclusion of theorizing required him to observe every geological phenomenon firsthand before he could endorse it. According to one of his assistants, Lesley displayed an entirely open mind in writing his *Final Report for the Second Geological Survey*. He tackled controversial issues head-on, made "no attempt to evade anything, no inclination to undervalue the work of those disagreeing with him."[101] The same assistant qualified this statement to a significant degree. While the geological phenomena assistants observed "receive full discussion," Lesley considered them only "from the standpoints of his broad reading and his own field work."[102] To the end, he remained suspicious of the relationships his assistants established between theory and observation and evaluated their ideas not upon the weight of their own merit but upon *his* reading and upon *his* field work.

Lesley's unwillingness to endorse the existence of any geological phenomenon he had not observed with his own eyes presented the biggest obstacle to his acceptance of the anticlinal theory. By the early eighteenth century, geologists had recognized that surface geological features resulted from subterranean processes.[103] Throughout the eighteenth century, geologists accepted laboratory experimentation as a legitimate method of overcoming their inability to observe these processes at work.[104] From the late-eighteenth

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[101]Stevenson, "Memoir of J. Peter Lesley," 537.

[102] Ibid.

[103] Laudan, *From Mineralogy to Geology,* 9.

[104] Ibid.

century on, however, some geologists began to argue that laboratory experiments failed to replicate adequately conditions in the natural world and often produced serious misconceptions about processes they hoped to understand.[105] Lesley's refusal to endorse the anticlinal theory was influenced by his unwillingness to accept the legitimacy of laboratory experiments which reproduced the geological processes occurring beneath anticlines.

Although geologists who believed oil accumulated beneath anticlines showed that gravity stratified gas, water, and oil into different layers within a bottle, Lesley refused to accept the experiment's legitimacy because he contended that the phenomenon operated differently within the earth. Lesley accepted that gravity separated gas, oil, and water according to their weights, but he refused to believe this phenomenon occurred beneath anticlines.[106] He argued that "if the application of this theory was confined to bottles no one would dispute it...but the earth is not a bottle."[107] A laboratory experiment could never replicate the conditions within the earth. The experiment lacked validity because, unlike the space inside a bottle, the earth "has no great caverns in it."[108] In addition, in a laboratory "the arrangement takes place naturally under the pressure of only one atmosphere; while any arrangement of water, gas, and oil made at depths of a thousand or two thousand feet, must

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[105] Ibid.

[106] Lesley believed that gravity separated gas, oil, and water in underground cavities known as "fissures" but not in anticlines. J. Peter Lesley, Private Report, April 6, 1865; Quoted in Everette DeGolyer's Notes on J. Peter Lesley, File 1038, Box 8, Everette DeGolyer Collection; DeGolyer Collection, Southern Methodist Univeristy.

[107] J. P. Lesley, "The Geology of the Pittsburgh Coal Region," *Transactions of the American Institute of Mining Engineers* XIV(June 1885 to May 1886), 655.

[108] Ibid.

be made under pressures of from 100 to 400 pounds to the square inch."[109] Because of underground pressure, Lesley believed that "the water, oil, and gas at great depths, if they could exist at all, would remain practically mixed like the carbonic-acid in a soda-water fountain."[110] The earth did not resemble a bottle, but Lesley was wrong and his refusal to accept gravitational stratification beneath anticlines constituted his chief reason for dismissing the anticlinal theory's utility for finding oil.

His refusal to extrapolate conclusions about processes within the earth from a laboratory experiment placed him among mainstream European and American scientists, but the fault in his methodology lay in his overly insistent demand for a direct cause and effect relationship. No single methodology offered geologists a foolproof approach to understanding how the earth worked.[111] Since early in the eighteenth century most acknowledged that their inability to observe subterranean processes which produced geological phenomena at the surface limited what they could legitimately claim.[112] To overcome these limitations, all geologists accepted that any methodology must consist of both theory and fact-gathering.[113] Each faced the challenge, then, of how best to establish

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[109] Ibid.

[110] Lesley, "The Geology of the Pittsburgh Coal Region," 655; DeGolyer stated that "this was an error in which he persisted throughout his professional life..." Notes on J. P. Lesley, Box 8; File 1038, Everette DeGolyer Collection, DeGolyer Library, Southern Methodist University.

[111] Laudan, *From Mineralogy to Geology,* 8.

[112] Ibid.

[113] Ibid.

a relationship between these two activities, not of choosing between them. All too often, Lesley dismissed theoretical statements outright in an effort to present facts alone. His tendency to mistrust his assistants' observations coupled with his insistence that they produce verifiable proof of even the smallest claims in their reports limited the utility of the survey for the Pennsylvania taxpayers Lesley so dutifully sought to serve.

For all his commitment to generating practical information, the Second Pennsylvania Geological Survey failed to produce a reliable method for locating oil. Lesley so cautiously guarded against speculative statements by his assistants that he issued an injunction that they refrain from theorizing and, in doing so, single-handedly suppressed the anticlinal theory.[114] Many of the geologists who worked for Lesley recognized the existence of anticlinal structures in various fields throughout Pennsylvania but carefully avoided investigating them too zealously.[115] Knowing that their boss edited every word they wrote and that he disavowed the anticlinal theory, most assistants refrained from making any statement which supported it. They knew that even if they had referred to the theory, Lesley would have eliminated it.[116] One assistant, John F. Carll, had acknowledged the significance of the theory in a trade journal as early as 1876 but avoided it in his official reports for the

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[114] Owen, *Trek of the Oil Finders*, 116; "Lesley continued to oppose the theory throughout his life, and it seems to have been his attitude that in large measure caused it to decline in popularity between 1875 and 1885." Howell, "Historical Development of the Structural Theory," 11.

[115] Owen, *Trek of the Oil Finders*, 102-103.

[116] Ibid., 106.

survey.[117]

It would be unfair to contend that Lesley single-handedly delayed the oil industry's adoption of the anticlinal theory without also noting that he reached his position after correctly observing that anticlines in eastern Pennsylvania did not contain oil. Indeed, not all anticlines contained oil but by extrapolating from his observations in this one locale a theory he applied to all regions Lesley committed the error he constantly warned his assistants to avoid–speculating on the basis of insufficient evidence. To the end, he insisted that scientists formulate theories only after observing them firsthand, but he demanded an unrealistic standard of proof that, in the end, even he could not achieve. Even veteran scientists make mistakes, but Lesley's error resulted from personality quirks which prevented him from accepting the intuitive and often indefinable dialectic between practical and theoretical science.

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[117] Ibid. 122.

Chapter 3:

"When Oil Moved West:

Geologists, Practical Men, and the Search for Structure on the Southern Plains"

Roswell Johnson set-up shop as a petroleum geologist in the northeast corner of Oklahoma in 1908 and began advertising his services as an independent consultant. After arriving in the small town of Bartlesville, he began dutifully running ads and occasionally even published articles in the pages of the petroleum industry bible, the *Oil and Gas Journal*, as part of a campaign to convince oil men of the practical advantages his services could provide.[1] Prospectors had been pouring into the Midcontinent region from the Appalachian oil fields, and Johnson perceived an untapped market for his consulting skills if only he could demonstrate that geology offered a better prospecting method than the belt-line theory. He explained that even though practical men had successfully found oil in Pennsylvania by drilling along lines that ran at forty-five degree angles, "many operators had accordingly come to believe that there was some mystic power in this particular direction" and that they could find oil in Oklahoma by applying the theory.[2] When this approach failed to produce oil in the Midcontinent fields, "those mystically inclined" adopted a new faith that drilling along a line of twenty-two and a half degrees

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[1] Roswell H. Johnson to James A. Veasey, February 24, 1941, "Belt-line theory," Box 23, James A. Veasey Collection, American Heritage Center, University of Wyoming. (Hereafter cited as Veasey Collection.)

[2] Ibid.

would yield oil.[3] Johnson contended that geology and particularly the anticlinal theory offered a better prospecting tool than the belt-line theory. Although his advertisement sat prominently on the corner of the same page where his article appeared, he had attracted so few clients by 1912 that he accepted a position teaching geology at the University of Pittsburgh and quit the oil business.

Sensing that he championed a losing cause, Johnson left Oklahoma but his timing could not have been worse because within a year after his departure the oil industry began seeking geologists' advice on an unprecedented scale. Some practical oil men accepted petroleum geology earlier than others, but 1913 proved a pivotal year in the history of the oil industry because many who had resisted geology began to take it more seriously.[4] It was during this year that geologists mapped an anticline in Cushing, Oklahoma and demonstrated with a visual representation that they could find oil by applying geological principles. Because geologists could never say with absolute certainty whether drilling in a particular place would strike oil, their techniques seemed like practical men's educated guesses. Unlike practical men, however, geologists had more specific information about the physical conditions beneath the surface of the earth which they used to create a visual image of the strata, thereby eliminating much of the guesswork involved.

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[3] Ibid.

[4] One of the most reliable sources for the history of Oklahoma petroleum geology dates the year of acceptance at 1913. Sidney Powers, "Petroleum Geology in Oklahoma," *Oil and Gas in Oklahoma*, Oklahoma Geological Survey Bulletin 40, vol. 1 (Norman: Oklahoma Geological Survey, 1928), 5; DeGolyer also sees 1913 as a pivotal year to date geology's acceptance by the industry. See Everette DeGolyer, *The Development of the Art of Prospecting* (Princeton: The Guild of Brackett Lecturers, 1940), 28.

As pivotal as the mapping of the Cushing anticline was to petroleum geology's acceptance, to suggest that the oil industry suddenly embraced a more "scientific" approach greatly understates and misrepresents practical men's contributions to the knowledge necessary for finding oil. Many practical men still resisted geology even after production began at Cushing because they continued to find oil with traditional methods such as the belt-line theory. Their knowledge represented a stochastic mode of reasoning better characterized as experienced intuition rather than haphazard guessing uninformed by scientific principles.[5] Most felt no need to adopt geology because they had long crafted novel solutions to solve practical problems amidst daunting uncertainties the search for oil presented.[6] Geologists strove to reduce the level of uncertainty by gleaning important data from practical men's drilling logs and using it to formulate "geological" theories about where to find oil. Although maps of the Cushing field proved pivotal in convincing many within the industry of geology's utility, no clear line demarcated the traditional, pre-scientific knowledge prospectors used to find oil from the geological principles the industry began to adopt in 1913 and which eventually revolutionized the search for oil.

The knowledge which guided oil prospecting in the Midcontinent region during the early-twentieth century grew out of a context with roots further to the east as the oil industry had been migrating westward since approximately 1890. The modern oil industry began in Pennsylvania when Captain Drake drilled the first commercial well in

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[5] James Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed*, (New Haven and London: Yale University Press, 1998) 326-7.

[6] Ibid., 327.

1859. Pennsylvania led United States oil production every year after Drake's well until 1895 when Ohio produced approximately one million barrels more for the year. Ohio's production climbed steadily throughout the 1880s and 1890s, as did West Virginia and New York's.[7] Production continued moving west, as Illinois' production climbed steadily from 1898 to 1908.[8] At the turn of the century, Ohio topped all states at just over twenty-two million barrels. About this time, though, the total annual yield in states east of the Mississippi River began to decline. As production decreased in the Appalachian and upper Midwestern regions, it accelerated in states further to the west.

For at least the first two decades of the twentieth century either California or Oklahoma headed the list of the nation's top oil-producing states. The best indication that the industry had shifted to the west was California's ranking as the top oil-producing state in 1903. California out-produced all other states until 1921 except for two periods when it placed second to Oklahoma, from 1907-1908 and 1914-1918.[9] Despite California's annual ranking as the top oil-producing state for much of the early-twentieth century, no state exceeded Oklahoma's cumulative production for the period 1903 to

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[7] David T. Day, *A Handbook of the Petroleum Industry*, 2 vols. (New York: John Wiley and Sons, Inc., 1922), 332-333. New York's production actually began to decline in 1907, but its output was so small as to be negligible by comparison. For statistics on oil production, also see *Derrick's Hand-Book of Petroleum. A Complete Chronological and Statistical Review of Petroleum Developments during 1859 to 1898*, vol. 2 (Oil City, Pennsylvania: Derrick Publishing Company, 1898), 35-6.

[8] Day, *Handbook of the Petroleum Industry*, 344.

[9] Ibid., 342; *Derrick's Hand-Book of Petroleum*, 35-6. Although the number for total production in each state varies somewhat between these two sources, they basically tell the same story.

1922.[10] States comprising the Midcontinent region produced 240 million barrels by 1920 whereas California produced only 95 million.[11] Oil men defined the Midcontinent region as Kansas, Oklahoma, north and central Texas, and small portions of New Mexico, Arkansas, and Louisiana. As a region, the Midcontinent out-produced California by nearly 150 percent.[12]

Throughout the early 1900s, geologists played little or no role in the large volume of oil produced in the states of Kansas, Oklahoma, and Texas. In 1891, Kansas and Oklahoma produced only 1000 barrels of oil but by 1910 they put-out 53 million barrels annually.[13] Oklahoma out-produced all other states in 1907 and 1908 and supplied twenty-five percent of the nation's total output from 1907 to 1910, but geologists discovered none of this oil.[14] Practical men who ignored geology bore responsibility for most of the oil discoveries throughout the Midcontinent region and ignored the advice of geological "experts." In California, however, the oil industry embraced geologists.

California prospectors adopted petroleum geology before oil men working in any

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[10] Ralph Arnold, "Two Decades of Petroleum Geology, 1903-1922," *American Association of Petroleum Geologists Bulletin* 8 (November-December 1923), 605.

[11]Day, *Handbook of the Oil Industry*, 327.

[12] For some great description of the oil industry in Oklahoma from 1905-1929, see Samuel Tait, *The Wildcatters: An Informal History of Oil Hunting in America* (Princeton: Princeton University Press, 1946), 129.

[13] Edgar Wesley Owen, *Trek of the Oil Finders: A History of Exploration for Petroleum* (Tulsa: American Association of Petroleum Geologists, 1975), 230.

[14] Ibid.

other region of the country.[15] Approximately forty professional geologists and geological engineers worked in the California oil industry between 1900 and 1911, a figure probably not exceeded by the total number of petroleum geologists working in the rest of the nation at that time.[16] Petroleum geology met with acceptance in California for several reasons. Stanford University and the University of California had long trained students to work in the mining industry, and the skills graduates acquired in reconnaissance, subsurface investigation, and evaluating untested prospects adapted easily to the oil business and provided companies with a plentiful source of geologists and engineers to employ.[17] Technical expertise originally intended for the mining industry lent itself to petroleum development, but the greatest reason for the early adoption of petroleum geology stemmed from the land itself.

Anticlines appeared so prominently on the California landscape that they caught the attention of geologists who encouraged oil men to begin drilling at these sites.[18] Geologists frequently noted the prominent appearance of anticlines in California. They more easily observed these geological structures there because "in the eastern states the slopes of the domes frequently do not exceed 20 feet to a mile, whereas in California the

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[15] Ibid., 161.

[16] Ibid., 188.

[17] Ibid., 188; Jesse. V. Howell, "History of Petroleum Geology," pp. 3-4, Box 16, Edgar Owen Collection, American Heritage Center, University of Wyoming. (Hereafter cited as Owen Collection)

[18] Owen, *Trek of the Oil Finders*, 188.

strata stand at a very steep angle with the horizon, frequently being overturned."[19] Even with this recognition, however, California practical operators resisted geological advice prior to 1900.[20] One geologist recalled that he and his colleagues knew about "several of the more obvious of the California structures...for a number of years before any attempt was made to develop them."[21] Geologists continued to suggest drilling near anticlines, but "sometimes these recommendations were followed and sometimes they were not."[22] The initial reluctance did not last long, however, as the presence of numerous anticlines dotting the landscape led some oil men as well as larger companies to take an interest in geology.[23] The Union Oil Company of California organized a geological department in 1899 and the Kern Trading and Oil Company followed suit in 1903.[24] California's topography played a role in the early acceptance of petroleum geology because the state's scientists posessed a unique relationship with the environment which had originated in the nineteenth century.

The unique qualities of California's natural environment and the state's isolation from scientific intelligentsia on the east coast conjoined to fashion a distinct social

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[19] A.S. Cooper, "The Genesis of Petroleum and Asphaltum in California," *Mining and Scientific Press* 78/8 (February 25, 1899), 205.

[20] Robert B. Moran, "The Role of the Geologist in the Development of the California Oil Fields," American Association of Petroleum Geologists Bulletin 8 (January-February 1924), 77-78; Tait, The *Wildcatters*, 115.

[21] Moran, "The Role of the Geologist," 77.

[22] Ibid., 78.

[23] Owen, *Trek of the Oil Finders*, 188.

[24] Moran, "The Role of the Geologist," 73-4.

climate for the state's scientists throughout the nineteenth century.[25] California's scientific community began to take shape when geologists, surveyors, botanists, and naturalists arrived during the gold rush of 1849.[26] A unique subculture soon emerged as the state's geology and vegetation inspired scientists to appreciate the natural world for its aesthetic rather than utilitarian attributes.[27] Instead of viewing nature with detached objectivity, California scientists perceived the natural world holisitically and themselves as integral parts of it. The environment figured prominently in their view of science, of themselves as scientists, and of society itself.[28] The oil industry may have been more inclined to embrace geology in California because scientists showed by example how fashioning intimate ties to the environment held practical applications. Whatever the case, environment influenced the adoption of petroleum geology in California while oil prospectors in other parts of the country continued to resist it.

Although practical men experienced significant success with the prospecting methods they had crafted at the oil industry's inception, production eventually began to taper off east of the Mississippi River and they headed for the Midcontinent states of Kansas, Oklahoma, and Texas. In the 1890s and early 1900s, oil men from Pennsylvania,

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[25] Michael L. Smith, *Pacific Visions: California Scientists and the Environment, 1850-1915* (New Haven and London: Yale University Press, 1987)

[26] Smith, *Pacific Visions*, 2.

[27] Their aesthetic appreciation for nature began to diminish by the second decade of the twentieth century, at which time California's scientific community followed the pattern evident in the rest of the country by adopting a managerial ethos which emphasized the conservation of natural resources. See chapter eight in Smith.

[28] Smith, *Pacific Visions*, 4.

West Virginia, Ohio, Indiana, and Illinois transplanted themselves onto the Southern Plains in significant numbers.[29] The population influx rapidly transformed the small town of Bartlesville, Oklahoma into the oil industry's unofficial capitol just a short time after Roswell Johnson left for the University of Pittsburgh.[30] James Veasey, a lawyer who specialized in oil and gas leases, remembered "that town was literally flooded with old-time producers who had operated in all of the eastern fields."[31] He recalled that "the older operators from the east were flocking there in droves," men steeped in oil-field practices which had originated in Pennsylvania's most famous oil sites, places such as Pithole, Pleasantville, Butler and Clarion counties, and the Bradford and McDonald fields.[32] Some of the prospectors who migrated to the Midcontinent region had been drilling along the prolific Oil Creek in Pennsylvania as early as the 1860s. J. S. Sidwell began working for the South Penn Oil Company in Pennsylvania beginning in 1896 and followed the industry westward, working in West Virginia, Ohio, and Kentucky before settling in Oklahoma in 1916.[33] Veasey listed several of the men by name and "could

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[29] Tait, *The Wildcatters,* 127.

[30] The Bartlesville discovery well was drilled in 1897. For a full account, see C. B. Glasscock, *Then Came Oil: The Story of the Last Frontier* (New York: Bobbs-Merrill, 1938).

[31] James A. Veasey to Alf M. Landon, June 12, 1941, Belt-Line Theory, Box 23, Veasey Collection

[32] James A. Veasey to George Otis Smith, October 24, 1941, Belt-Line Theory, Box 23, Veasey Collection

[33] J. S. Sidwell to James A. Veasey, July 14, 1941. Belt-Line Theory, Box 23, Veasey Collection

mention at least 100 others."[34] Oil men who "were of the same class" as those moving to Bartlesville also settled in eastern Kansas.[35] As men like Sidwell migrated to the Midcontinent region, they carried their prospecting methods with them.

While oil men in California embraced petroleum geology, prospectors who moved into the Midcontinent region continued to rely on traditions and practices for finding oil they had cultivated since the industry began. Despite I. C. White's 1883 demonstration of the anticlinal theory in West Virginia and his articulation of it in print in 1885, practical oil men continued prospecting on the basis of the belt-line theory or trendology as they moved into Kansas and Oklahoma. Veasey's work in oil and gas leases brought him into contact with many prospectors, and he remembered "very definitely" that "operators who came there represented every old field in the east, and they brought with them their settled notions regarding oil and gas occurrences."[36] In describing practical men's "settled notions," Veasey recalled that "they would have no part of geology, but on the contrary were still taking leases and drilling their properties under the old belt-line or trend theory, that is, northeast or southwest production."[37] Alf Landon began working in the oil business in 1912 and never made a decision to lease or drill by making "any reference to

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[34] James A. Veasey to George Otis Smith, October 24, 1941, Belt-Line Theory, Box 23, Veasey Collection

[35] J. S. Sidwell to James A. Veasey, July 14, 1941, Belt-Line Theory, Box 23, Veasey Collection

[36] James A. Veasey to W. E. Wrather, June 26, 1941, Belt-Line Theory, Box 23, Veasey Collection

[37] Ibid.; Veasey explained to Alf M. Landon that oil men who came from the east "brought the belt-line theory with them." Veasey to Landon, June 12, 1941.

the guidance of geologists."[38] Other oil men who worked alongside Landon shared this experience, as he recalled that "the operators in the field with which I was connected were not at that time following the guidance of geologists in their leasing and drilling activities."[39] Instead of geology, "the old trend theory of northeast-southwest" guided exploration "and the theory had considerable following for many years."[40] Writing in 1941, Landon contended that "its psychological effect is still in evidence in selling acreage in a block around a wildcat drilling well."[41] Practical men continued prospecting with the belt-line theory because it produced results, but their contempt for geologists also reinforced their loyalty to traditional prospecting methods.

As practical men carried their theories for finding oil westward, so followed their contempt for geologists.[42] Everette DeGolyer recalled that geologists' "intrusion into the industry was generally resented, often with intense bitterness" by practical oil men.[43] Writing in 1923, one petroleum geologist recalled that "twenty years ago a geologist was just as welcome in a drilling rig as a 'hornet at a garden party.' The oil men were prejudiced against us."[44] The speaker understood their animosity, however, because he

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[38] Landon to Veasey, June 18, 1941, Belt-Line Theory, Box 23, Veasey Collection.

[39] Ibid.

[40] Ibid.

[41] Ibid.

[42] Owen, *Trek of the Oil Finders*, 293.

[43] DeGolyer, *The Development of the Art of Prospecting*, 27.

[44] Ralph Arnold, "Two Decades of Petroleum Geology, 1903-1922," *American Association of Petroleum Geologists Bulletin* 8 (November-December 1923), 613.

recognized that many practical men had experienced the sting of fraud perpetrated by some creekologists who claimed to possess supernatural powers or unique gifts for locating oil. The possibility that oil men suffered financial loss after investing in one of the many fraudulent schemes prompted him to ask, "When one sizes up some of the freaks and impostors who have posed as geologists, can we blame the oil men?"[45] As the twentieth century dawned, geologists faced a credibility problem. Practical men who had successfully found oil had maintained confidence in their approach and had no reason to consider geology as an alternative, especially since many had been burned by confidence men hawking the next sure-fire method for finding oil.

Tom Slick offers an excellent example of a Pennsylvania practical oil man who followed the industry westward to Oklahoma and like his contemporaries disavowed geology in favor of methods he had crafted. After finishing high school, Slick began working for his father who owned drilling rigs in various Pennsylvania fields.[46] Slick suggested that his birth in the heart of oil country and to a father who worked as a driller instilled within him an innate, sensory relationship to oil: "I came west from Clarion, Pa., where I was born among the oil derricks. The first sniff of air I ever breathed into my nostrils was laden with the odor of oil."[47] One early historian of the oil industry seemed to accept Slick's suggestion that he possessed an extra-sensory power and could literally

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[45] Ibid.

[46] Ray Miles, *"King of the Wildcatters": The Life and Times of Tom Slick, 1883-1930* (College Station: Texas A&M University Press, 1996), 15-16.

[47] *Kansas City Star*, May 5, 1929; Glasscock, *Then Came Oil*, 218.

smell oil as deep as two thousand feet below the surface.[48] Like a bee drawn to a flower, "the smell of oil sands was perfume to his nostrils" and this allegedly innate gift explained Slick's success.[49] By 1903 production in Pennsylvania and other fields east of the Mississippi River began to decline, and Slick, his brother, and their father migrated to Chanute, Kansas. Like others who headed west in search of oil, the Slick family carried their non-scientific methods of finding oil with them to the Midcontinent region. While prospecting in Kansas, Oklahoma, and Texas, Tom occasionally scoffed at geologists who claimed that they could find oil with science, but he could not ignore geologists forever.[50]

For the first two decades of the twentieth century, petroleum geologists and their ideas for finding oil gradually gained more credibility in the eyes of some practical men. Even Slick eventually proved more willing to listen to geologists' advice, but he never invested more authority in their opinions than in his own judgment. He occasionally hired geologists as consultants but ignored their advice when it contradicted his own personal hunches.[51] For example, in 1922 he hired three geologists to survey a tract of land on Laura Endicott's farm in Oklahoma's Kay and Noble counties before investing the money to drill a well.[52] Even though none of the geologists recommended the site,

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[48] Glasscock, *Then Came Oil*, 218.

[49] Ibid.

[50] Miles, *"King of the Wildcatters"*, 6-7.

[51] Ibid., 7.

[52] Ibid., 74-5.

Slick decided to ignore their advice, follow his instincts, and sink a well.[53] The well he drilled eventually produced 4,560 barrels per day and along with the production from neighboring wells initiated the Tonkawa oil boom, a notable chapter in the history of the oil industry.[54] Slick's decision to rely on instinct underscored how successful oil strikes at times resulted from subjective evaluations despite geologists' objective evidence to the contrary. Discoveries like Slick's undermined geologists' claims that they had crafted a scientific approach to oil prospecting. Yet, as demonstrated in Pennsylvania cemeteries, no clear line separated creekology and geology and neither practical men nor geologists realized that their methods often complimented one another's.

Petroleum geologist Everette DeGolyer frequently thought and wrote about the early history of oil prospecting, and he struggled to understand how practical men found so much oil even though they had not formally studied geology and sometimes even refused to acknowledge its validity.[55] In contemplating how wildcatters discovered some of the most productive and significant oil fields in the United States, from Pennsylvania to California, DeGolyer observed that "some of the early day prospectors must have really had a nose for oil" but he could not more clearly articulate the reasons for their success.[56]

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[53] Ibid.

[54] Ibid.; There is a relationship between Tonkawa, Slick, and deep sands such the Wilcox. See Owen, *Trek of the Oil Finders*, 540.

[55] Among the list of greats, he included John H. Galey, Mike Benedum, Edward L. Doheney, and Tom Slick.

[56] Everette DeGolyer to Wallace E. Pratt, December 16, 1954, File 1513, Box 12, Everette DeGolyer Collection, Clements Library, Southern Methodist University. (Hereafter cited as DeGolyer Collection.)

Their ability to find oil without systematically employing geology prompted him to acknowledge perhaps somewhat self-consciously that "their prospecting was done without the benefit of geological clergy."[57] Despite such a self-effacing comment, he refused to dismiss geology outright. He considered oil exploration fundamentally "a geological enterprise" but also felt "that prospecting was more than just geology and it is this 'more' that I am interested in."[58] His training as a petroleum geologist taught him to look for systematic, scientific principles that consistently led to oil, but this orientation prevented him from understanding how practical men succeeded with an entirely different approach.

In his quest to understand how their methods comprised "more than just geology," DeGolyer consulted his friend Wallace Pratt, a notable petroleum geologist in his own right, and the two agreed that practical men's perseverance bore much of the responsibility for their success. Pratt considered oil prospectors quintessential American pioneers. He felt that "the prime requisite to success in oil-finding is freedom to explore" which American culture offered in abundance.[59] Any successful prospector exhibited "the adventurous, chance-taking spirit of the pioneer which pervades America and has impelled Americans to drill thousands of wells every year in search for oil."[60] With this conception in mind, Pratt replied to DeGolyer that persistence was an "attribute of the

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[57] Ibid.

[58] Ibid.

[59] Wallace E. Pratt, *Oil in the Earth* (Lawrence, Kansas: University Press of Kansas, 1942), 58.

[60] Ibid., 57.

successful oil-finder that few of us [petroleum geologists] possess."[61] DeGolyer concurred, observing that all "any of these men really possessed was a great willingness to venture..."[62] Most wildcatters felt compelled to persevere in their searches for oil to demonstrate the validity of their hunches. They possessed the instincts of an explorer, an unrelenting desire to confirm their suspicions that oil lay in a particular place. Biographers of famous oil men such as E. W. Marland, H. L. Hunt, and Tom Slick all attributed their subjects' success in part to the willingness to trust their instincts and persevere in their searches. Such accounts characterized wildcatters as tough-minded optimists who continued "to hang on, keep on going, and never give up. Slick was of that kind."[63] Perseverance certainly increased practical oil men's chances for success, but without a "hunch" they had no idea where to begin searching. As important as persistence may have been, a hunch more than any other factor guided and motivated their search. DeGolyer and Pratt did not consider how hunches originated, few practical men could answer this difficult question.

Although many successful prospectors developed great trust in their instincts, they could not explain why their hunches consistently proved correct. Edward R. Wilson, a practical oil man based in Oklahoma City, offers another example "of that kind" of prospector who found oil because of the compelling desire to demonstrate the veracity of

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[61] Wallace E. Pratt to Everette DeGolyer, January 24, 1955, File 1513, Box 12, DeGolyer Collection.

[62] DeGolyer to Pratt, December 16, 1954, File 1513, Box 12, DeGolyer Collection.

[63] *Literary Digest* 48 (March 14, 1914), 568.

his hunch. He discovered the Pioneer field in Texas even after others abandoned it "due to his unfailing belief in his own intuition and his 'sticktoitiveness.'"[64] When he solicited financial backing from an oil company in Tulsa, "they waved him aside."[65] Wilson's discovery of the field only after "larger companies and big operators were pulling out of the territory" seemed only to confirm the legitimacy of his technique.[66] Although Wilson believed that his instincts led him to oil, he could not articulate any more clearly than DeGolyer why or how this approach worked. On one hand he exuded confidence in his approach, declaring emphatically that "'I never lost when I played a hunch.'"[67] However, he also admitted that even though "'my hunch was compelling, almost over-powering, I had no idea that it would lead me to a 15,000-bbl. gusher.'"[68] Neither practical men nor petroleum geologists understood what constituted a hunch because this prospecting method defied rationalization.

Practical men derived their prospecting techniques from a vernacular form of knowledge that grew out of local experience rather than a scientific understanding of universal earth processes they could systematically employ in different environments. Loosely interpreted as "cunning intelligence," the Greek concept "*metis*" refers more broadly to an array of practical skills and a specific type of intelligence cultivated in

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[64] "Hunch, Backed by Unfailing Courage and Fiath esulted in Discovery of Pioneer Field," *Oil and Gas Journal 21/2* (June 8, 1922), p. 32

[65] Ibid.

[66] Ibid.

[67] Ibid.

[68] Ibid.

response to social and environmental change.[69] For example, when *The Farmer's Almanac* suggested planting corn after a specified date, the most "cunning" farmer adjusted this advice to suit the unique circumstances of his immediate surroundings. The date to plant varied for crops growing at different altitudes and latitudes, in valleys and on hills, and near the coast or inland.[70] The shrewdest farmers adapted the *Almanac*'s universal advice to suit local conditions. Practitioners of *metis* did not seek a universal principle based upon rational thought but, instead, applied rules of thumb in their endeavors and invoked a strategy based upon feel, knack, or common sense.[71] Similarly, practical men did not reduce their prospecting methods to deductive principles or codify them into a formal set of procedures based upon rational decisions. Intuition comprised such a significant portion of *metis* that its practitioners often could not characterize their methods.[72] This explains Edward Wilson's difficulty justifying the great trust he placed in his instincts or how they led him to oil. Like Wilson, other practical men remained confused over their methodology.

Both DeGolyer and Pratt noticed that most practical men struggled to explain why their methods worked. DeGoyler suggested that many wildcatters denied that luck enabled them to find oil and that they offered a rationale for their success even when none existed. To present himself as an authority, a wildcatter was "likely to rationalize his

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[69] Scott, *Seeing Like a State*, 313.

[70] Ibid., 312.

[71] Ibid., 316.

[72] "Metis knowledge is often so implicit and automatic that its bearer is at a loss to explain it," Ibid., 329.

motives" after finding oil particularly when "the reasons for drilling somewhat vague or mistaken."[73] He did not consciously lie when explaining his methodology but "honestly believes his revised and entirely fictitious reasoning."[74] To claim authority as an oil-finding expert, the wildcatter offered an explanation that either "fit with then current methods of prospecting" or insisted "mysteriously on a superior knowledge which he does not reveal."[75] Pratt reached a similar conclusion after conducting a study of oil-discovery methods prior to 1911, finding that "ambiguity shrouds records of methods of discoveries. I am convinced that even the fellow who drills a well is sometimes unable to state accurately what his reasons were!"[76] Practical men encountered difficulty articulating their methods because of *metis*' implicit, experiential nature.[77] Like any experienced practitioner of a particular skill or craft, practical men developed a repertoire of visual judgements and sensations for assessing their work born out of experience that defied articulation.[78] It may have appeared to layman and petroleum geologists that luck explained their success, but *metis* played the greater role.

Many of Tom Slick's contemporaries considered him one of the luckiest oil-finders of his day, but he developed his hunches for locating oil from observations he

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[73] Everette DeGoyler, "Foreward," in Carl Coke Rister, *Oil! Titan of the Southwest* (Norman: University of Oklahoma Press, 1949), x.

[74] Ibid.

[75] Ibid.

[76] Pratt to DeGolyer, June 20, 1941, File 1513, Box 12, DeGolyer Collection.

[77] Scott, *Seeing Like a State*, 329.

[78] Ibid.

made of a region's surface and subsurface geology. Like other practitioners of *metis*, Slick developed a knack or feel for finding oil that grew out of his experiences surveying the topography of Kansas, Oklahoma, and northern Texas.[79] As he explained it, "I know all this country, every foot of it. As a leaser I drove and walked over all of it, studied it, have learned to sort of sense, by intuition, where there ought to be oil."[80] Like Edward Wilson, he could not quite explain this knack, believing that he could "sort of sense, by intuition" where to drill. Slick's technique did not rely upon superstition or magic but on his ability to translate experiences traversing local environments into a vernacular knowledge and to apply that know-how successfully.[81] While he did not use the term "geological" to describe the knowledge he acquired at each potential site, he sought information through firsthand observations in order to develop an educated guess about the best possible place to drill. Slick admitted that he never knew with certainty whether he would find oil, "but I have been at it so long, have studied the lay of the land and the underlying formations so persistently, have drilled so many wells, dry and wet, that I often get a hunch..."[82] What Slick considered a hunch, in fact, grew out of "persistently" studying "the lay of the land" and from trial-and-error drilling which yielded important

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[79] Miles, *"King of the Wildcatters"*, 80.

[80] *Kansas City Star*, May 5, 1929.

[81] Another wildcatter expressed clearly how people instinctively attributed the successful application of the belt-line theory to "magic" before geologists began offering scientific rationales: "From some unknown reason there was a belief that there was some magic in the 96th meridian... At that time anything east of Dewey was taboo, but not for any geological reasons." John H. Kane to James A. Veasey, May 17, 1941, "Belt-line theory," Box 23, Veasey Collection.

[82] *Kansas City Star*, May 5, 1929.

information about the "underlying formations." Only after such extensive preparation could he "sort of feel that there's oil in a certain spot..."[83] Slick argued somewhat defensively that his success resulted from a tested methodology rather than good fortune, explaining that "if I strike oil everyone calls it Tom Slick's luck, but do you call that luck? I call it largely judgment based upon experience."[84] Observations of the environment imbued the judgement of many practical men with authority in the early days of the Midcontinent oil booms. As petroleum geologists came onto the scene, they too eventually acquired authority and threatened to displace practical men as oil-finding experts.

Petroleum geologists set-out to replace what they considered guesswork in oil-finding with a systematic methodology a prospector could apply in a variety of different environments. Investors who equated a "hunch" to a mere guess worried about the high costs of drilling a dry well and wanted more definitive evidence before investing in a speculative venture. Relying on rational thought rather than intuition, petroleum geologists contended that "there's a reason why oil and gas occur and accumulate in certain rocks and regions" and considered it their job to explain why.[85] By conducting "scientific study," they tried "to eliminate the expensive drilling of dry holes and promote the testing of 'reasonable' looking areas–these men are Oil Geologists."[86] Unlike

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[83] Ibid.

[84] Ibid.

[85] Forest Rees, Circular letter mailed to oil men, General Correspondence 1919, Charles Decker Collection, Western History Collection, University of Oklahoma.

[86] Ibid.

practical men, geologists strove to provide a rationale for drilling at a particular site which they believed offered more security to investors. A geologist's reason for thinking a region might produce oil "amounts to more than a 'hunch,' and when he completes a Detailed Survey his opinion is worth big financial backing."[87] Petroleum geologists prospected for oil in a more systematic fashion than practical men and articulated a rationale for drilling at a particular site, but the attributes of different environments at times resisted the application of their generic rules.

Petroleum geologists cultivated a form of knowledge distinctly different than *metis* which prevented them from understanding how a practical man's experience within a particular local environment often bore a relationship to his hunch about where to look for oil. Another concept of Greek origin, *techne*, or technical knowledge, referred to a type of learning that consisted of hard-and-fast rules, principles, and propositions.[88] Whereas *metis* depended upon a local context and was intuitive, *techne* was universal and could be organized into explicit, logical steps.[89] The universal quality of *techne* meant that it could be taught as a formal discipline, like geology for instance, whereas practitioners of *metis* acquired their knowledge through local practice and hands-on experience.[90] The different kinds of knowledge a riverboat pilot relies upon to navigate a

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[87] Ibid.

[88] Scott, *Seeing Like a State*, 319.

[89] Ibid., 320.

[90] Ibid.

river illustrates the differences between *metis* and *techne*.[91] Every riverboat pilot possesses universal knowledge about rivers and the methods for negotiating their currents, shallows, and turns. He also acquires more specific knowledge, however, from his experience on a particular river. Although he can anticipate that seasonal changes will similarly alter water levels in all rivers, only through extended experience can he gain an understanding of how depths will vary at different times of the year on particular stretches of a given river or in certain harbors. The pilot's local knowledge is more practical and therefore superior to the universal rules of navigation. As with riverboat pilots, extended experience in a particular environment often served as better preparation for oil prospectors than did universal rules or principles.

Although a university-trained petroleum geologist inculcated with the technical expertise of a formal discipline, DeGolyer understood that arbitrary factors often undermined universal learning. His undying faith in geology led him to repeat Pratt's often-quoted remark that "the enterprise of winning oil from the earth is essentially a geological venture."[92] Although convinced of his discipline's utility for finding oil, he also believed "that geology is not the whole of prospecting."[93] After conducting a study of past oil discoveries, he concluded that they had often been "controlled by arbitraries."[94]

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[91] Ibid., 317.

[92] DeGolyer, *The Development of the Art of Prospecting*, 25; For other examples, see DeGolyer to Pratt, February 16, 1955; Box 12, File 1513, DeGolyer Collection; DeGolyer to Pratt, December 16, 1954, Box 12, File 1513, DeGolyer Collection.

[93] DeGolyer to Pratt, December 16, 1954, Box 12, File 1513, DeGolyer Collection.

[94] Ibid.

Unexpected contingencies such as an unconformity in the environment potentially undermined the application of generic prospecting methods. In the case of oil prospectors, *metis* at times offered practical advantages over technical, generic knowledge because intuition aided oil prospectors in anticipating "arbitraries" like those DeGolyer uncovered. The application of *metis* often appeared so unsystematic to those who witnessed it that they confused it with sheer luck.

Whether a geologist or a wildcatter, all oil prospectors relied upon luck to some degree but applying the term too loosely potentially obscured a much more complicated process. DeGolyer believed that "success in exploration depends upon luck and skill" but he hastened to add that "what the proper proportion of each may be, I do not know."[95] Given a choice between the two, he preferred luck over skill. Well sites "selected by the most refined and exact of techniques" could result in failure, and a well drilled "at random for mistaken reasons or no reason at all may result in the discovery of a new and important field."[96] Good fortune improved one's chances for success in any endeavor, but he cautioned that in oil prospecting "one must recognize luck but not overemphasize it" and warned that the term "is merely a convenient catchall."[97] When petroleum geologists accounted for a successful oil find solely on the basis of luck, "we ascribe to chance the favorable outcome of a complex of conditions, all of which we have not yet

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[95] DeGoyler, "Foreward," viii.

[96] Ibid.

[97] Ibid., ix.

been able to analyze, much less understand."[98] DeGolyer's inability to grasp the "complex of conditions" that enabled practical men to find oil underscores the contingent, highly variable quality of the knowledge they produced and his appreciation for geology's limitations.

As much as he strove to evaluate practical men's methods objectively, he felt strongly enough about their inadequacy to distinguish them from those of petroleum geologists. DeGolyer recalled that geologists' "intrustion into the industry was generally resented, often with intense bitterness" because they "were regarded by most so-called practical oil men as being highly theoretical."[99] Practical men felt that their prospecting methods provided more tangible benefits, were more "practical," than the arcane theories geologists proposed. He reacted defensively to this suggestion and set the record straight by indicating that "the truth is that the practical men were just as theoretical as the geologists and less soundly so."[100] He argued that geologists conducted field work more systematically, and therefore more reliably, than practical men. Practical men encountered the environment haphazardly because they had no formal training in geological theories or how to observe them at work in the field. They arrived at generalizations based upon a rather "narrow range of facts which had happened to come within their experience and which were not studied systematically..."[101] Unlike petroleum

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[98] Ibid.

[99] DeGolyer, *The Development of the Art of Prospecting*, 27.

[100] Ibid.

[101] Ibid.

geologists who formulated theories consistent with knowledge they had learned in the classroom and with what they observed outdoors, "their theorizing was uncurbed by any knowledge of the laws governing earth processes."[102] DeGolyer's contention that finding oil was "more than just geology" suggested sympathy with practical men's methods, but as a professionally trained petroleum geologist he could never entirely shed his orientation that "the winning of petroleum is a geological enterprise." This dichotomy in his thinking prevented him from fully appreciating the significance of *metis* to practical men's prospecting methods.

Petroleum geologists failed to comprehend *metis* as a legitimate form of knowledge because of their indoctrination in an empirical science which strove to establish universal laws applicable in all locations rather than an intuitive knowledge contingent upon local experience. Even though geologists and practical men both conducted field work, their approaches differed significantly. Geologists typically gathered information in a regimented and structured fashion. While in the field, the geologist calculated and measured his observations because he "was a trained observer, and subjected his theorizing to the limitations of the laws of stratigraphic and structural processes."[103] Unlike practical men, the geologist "based his generalizations on a systematic study of a much wider range of facts..."[104] What geologists perceived as flaws in the prospecting methods of practical men, in fact, marked the very reasons for their

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[102] Ibid.

[103] Ibid.

[104] Ibid.

success.

Although DeGolyer criticized practical men for basing their theories on too narrow a range of facts, their experiences in a particular locality marked the strength to their approach and not its weakness. Scientists often denigrated *metis* because its practical and highly-contextual character did not lend itself to generalizations or integration into scientific discourse. DeGolyer echoed this criticism when he called practical men unsystematic, less theoretically sound, and alleged that they sampled facts endemic to a particular locale. What he and fellow scientists missed, however, was that *metis*' power lay in its variable and contextual character. Practitioners of *metis* attempted to solve concrete problems in local environments and did not concern themselves with contributing to a wider body of knowledge.[105] Their search for practical knowledge to solve problems of immediate concern led them to study a "narrow range of facts" because *metis* required close and astute observations of the environment.[106] The conclusions that riverboat pilots, peasant farmers, or practical oil men reached bore greatly on their material well-being and, therefore, led them to scrutinize the environment more closely and pay greater attention to local conditions than research scientists.[107] Scientific researchers did not necessarily bear the consequences of their own advice, but the marginal economic status many practitioners of *metis* held provided an even greater impetus to close, careful observation. Living in the field throughout the seasons gave

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[105] Scott, *Seeing Like a State*, 324.

[106] Ibid.

[107] Ibid.

them an advantage in conducting field work because they could observe changing conditions a research scientist might never notice.

Tom Slick put his close and astute observations into practice in 1912 when he located a favorable site in northeast Oklahoma and drilled the discovery well for the Cushing oil field. Shortly after arriving in the Midcontinent region, Slick departed for Illinois where he went to work leasing land for Charles B. Shaffer who had previously become a millionaire in western Pennsylvania's oil fields. Slick prospected for Shaffer in Kentucky and Canada before the two decided to try Oklahoma. From 1907 to 1911, Slick drilled as many as ten dry holes on land he had leased for Shaffer.[108] Steeped in the tradition of Pennsylvania's practical oil men, Slick relied upon intuition but also actively and consciously evaluated surface and subsurface geological phenomena when deciding where to sink a well. Just prior to his discovery of the Cushing field, he drilled the Tiger well three miles to the east which, although dry, provided him with valuable information that buoyed his confidence in finding oil nearby. The Tiger well failed to yield commercial quantities of oil, but his drill pulled-up positive indications from 2,000 feet below the surface and he studied the dips and slopes of the region's surface geology and these observations led him to Frank Wheeler's farm where he drilled the Cushing well.[109] Slick considered his decision to drill a hunch, but observable and objective data also influenced his choice. Shaffer and Slick's "luck" changed in March 1912 when a well they had been drilling for almost two months came in as a gusher and marked the

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[108] Ray Miles, *'King of the Wildcatters': The Life and Times of Tom Slick, 1883-1930* (College Station: Texas A & M University Press, 1996), 24.

[109] *Literary Digest* 48 (March 14, 1914), 568.

discovery of the Cushing oil field.[110] Although Shaffer, Slick, and their business partners had leased much of the land surrounding the site, news of Cushing's production brought prospectors and speculators from numerous other states pouring into the surrounding area to repeat Slick's success.

A pivotal moment in the history of the oil industry occurred when Cushing operators began drilling to depths beyond which most practical men believed oil existed.[111] For nine months after Slick and Shaffer drilled the discovery well, "drilling of the shallow sands proceeded rapidly" but they only realized the field's giant size "when production was found in the Bartlesville sand at 2500 feet."[112] Development of the field proceeded apace and by August 1913 the total geographic area encompassed an expanse nine miles long and three miles wide.[113] In addition to expanding horizontally, the field

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[110] For a more detailed description of the events leading up to the discovery of Cushing and all the major figures involved, see Carl N. Tyson, et. al, *The McMan: The Lives of Robert M. McFarlin and James A. Champman*, (Norman: University of Oklahoma Press, 1977); Ruth Sheldon Knowles, *The Greatest Gamblers*: The Epic of American Oil Exploration (New York: McGraw-Hill Book Co., 1959); Glasscock, *Then Came Oil*, 217-225; Tait, *The Wildcatters*, 129; Owen, *Trek of the Oil Finders*, 294; Rister, *Oil! Titan of the Southwest*, 119-124; Kenny Franks, *Oklahoma Petroleum Industry*, (Oklahoma City: Oklahoma Heritage Association, 1980), 68-78.

[111] Tait, The *Wildcatters*, 129.

[112] J.V. Howell Collection,"History of Petroleum Geology," 14; Eventually, oil men would continue drilling even deeper. Homer F. Wilcox missed the shallow sands entirely when in 1914 he sank a well southeast of Tulsa. This layer soon became the state's primary producing layer of sand and was forever known as the "Wilcox sands." See Tait, The *Wildcatters*, 129.

[113] Sidney Powers, "Petroleum Geology in Oklahoma," *Oil and Gas in Oklahoma*, Oklahoma Geological Survey Bulletin 40, vol. 1 (Norman: Oklahoma Geological Survey, 1928), 8.

also grew vertically as drillers continued finding oil the deeper they went.[114] Eventually, six successive layers of sand yielded oil, ranging in depth from 1,000 to 3,000 feet.[115] The significance of deeper wells lay only partially in the fact that they yielded more oil. The greater depth of Cushing's wells provided geologists with important information they built upon to map the subsurface geology and eventually find even more oil.

By using the information drillers generated, geologists mapped Cushing's subsurface geology and illustrated in vivid form the principle that I. C. White demonstrated in West Virginia almost thirty years before, that a relationship existed between the accumulation of oil and geological structures. Slick found oil at Cushing because he unknowingly drilled into a giant anticline which ran fifteen miles north-south and two to five miles east-west.[116] Similarly, when the Gypsy Oil Company sank a well to the north, it "was found to have been located by chance on a surface anticline."[117] These anticlines located inadvertently formed merely the tip of a much larger iceberg. The Cushing field produced significant amounts of oil because it consisted of a number of anticlines clustered together rather just than a single geologic structure.[118] Geologists scored a major victory when they illustrated the relationship between these structures and the location of oil.

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[114] Ibid.; Tait, The *Wildcatters*, 129.

[115] Carl Coke Rister, *Oil! Titan of the Southwest* (Norman: University of Oklahoma Press, 1949), 124.

[116] Owen, *Trek of the Oil Finders*, 294.

[117] Powers, "Petroleum Geology in Oklahoma," 8.

[118] Ibid.

Even though Slick drilled the initial well, geologists played a pivotal role in the huge amount of oil the field eventually yielded. Although steeped in the prospecting traditions of practical men, Slick had proven more willing to consider geologists' recommendations shortly after arriving in the Midcontinent region. Once drilling began on the Cushing discovery well, he hired geological consultant L. L. Hutchison to report on the prospect.[119] Hutchison soon performed additional consulting work on the Cushing field for another customer, the McMan Oil Company, and in February 1913 located a structure geologically related to Cushing known as the Dropright dome.[120] The location of this prospect resulted in some of McMan's most valuable production.[121] Everette DeGolyer considered Hutchinson's work pivotal: "I am inclined to think that the first real useful geological work done was the location by L.L. Hutchinson of the Dropright dome at Cushing."[122] Several other geologists played important roles in various oil ventures on or near the Cushing anticline and their work collectively caused many practical men who had once viewed geology with contempt to alter their opinions.[123] With the help of geologists, practical men recognized that they had a new and fairly reliable prospecting method.

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[119] Howell, "History of Petroleum Geology," 20-21; Owen, *Trek of the Oil Finders*, 294.

[120] Howell, "History of Petroleum Geology," 21.

[121] Ibid.

[122] DeGolyer to Veasey, June 10, 1941, "Belt-line theory," Box 23, Veasey Collection.

[123] Owen, *Trek of the Oil Finders*, 294.

Discovery and development of the Cushing field proved a pivotal moment in the history of the oil industry because geologists demonstrated how practical men could reliably and consistently find oil through the application of petroleum geology and specifically the anticlinal theory. Although identifying a single date or reason practical men accepted petroleum geology risks oversimplifying a much longer and complicated process, most geologists agreed that their profession gained much credibility because of the events at Cushing. The work they performed made the development of this oil field "one of the most important chapters in the history of petroleum geology."[124] By mapping the extent of the anticline and the subsidiary traps where oil accumulated, petroleum geologists demonstrated that the search for geological structures offered a useful method for finding oil. As James O. Lewis recalled, "geology was first generally accepted in the Mid-Continent when extensions were successfully predicted by geologists for the Cushing pool..."[125] In addition to mapping the outer limits of the anticline, geologists "predicted" the location of subsidiary traps, or "extensions," by applying the anticlinal theory and located additional oil with a greater degree of reliability. DeGolyer agreed that even though "Cushing was discovered in 1912 without benefit of geologic clergy... it is my opinion that this was probably one of the most important steps toward reduction of the theory to actual working practice. I know of no earlier clean cut application of the anticlinal theory."[126] After demonstrating that they could find oil by applying the theory,

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[124] J. V. Howell, "History of Petroleum Geology," 8.

[125] James O. Lewis to Veasey, September 10, 1941, Veasey Collection.

[126] DeGolyer felt that although Cushing was important development of Augusta and Eldorado was "the greatest impulse" toward acceptance of the anticlinal theory.

geologists had proven their utility to many within the oil industry.

Geologists' entry into the oil industry did not mean that practical men simply abandoned methods that had served them well in the past. Many prospectors continued to ignore geologists and remained skeptical of this emerging, new science. The most skilled oil men had no reason to consider geology because they continued finding oil with methods that had always proven successful, long before geologists came onto the scene. Practical men knew, even if only intuitively, that they encountered the environment in a fundamentally different way, as had their fathers before them, and trusted themselves to follow the landscape's lead. Although the strongest hunch or intuition could sometimes result in a dry hole, practical men grew even more confident in their own methods when a geologist's prediction failed to produce oil. Every mistake by a geologist only confirmed to skeptics that geology was merely the latest form of quackery or, worse, another oil-finding scam. When geologists began to prove that their methods worked, they often failed to bolster their credibility by behaving arrogantly and condescendingly toward lifelong oil men who possessed little knowledge of scientific prospecting. Some practical men took notice when university boys with scientific methods produced results, but a geologist who failed to find oil after charging a consulting fee remained just another college-educated know-it-all.

Everette DeGolyer to James A. Veasey, June 10, 1941, "Belt-line theory," Box 23, American Heritage Center, University of Wyoming. Petroleum geologist and one-time director of the U.S.G.S. agreed that Cushing played a significant role in demonstrating "that oil accumulation is governed by structure" and he agreed that Augusta and Eldorado illustrated the same point. I will cover these fields in a subsequent chapter. W.E. Wrather to Veasey, November 3, 1941, "Belt-line theory," Box 23, Veasey Collection.

Chapter 4:

"Charles N. Gould: Petroleum Geology Arrives on the Southern Plains"

Scientists conducting field work do not encounter the environment free of preconceptions, values, or theories about the land they observe, and Gould N. Gould was no exception.[1] He arrived at the University of Oklahoma in 1900 where he founded the geology department and served as the first director of the state's geological survey. Gould loved his job as a geology professor and survey director because both positions afforded him numerous opportunities to enjoy nature by conducting field work where he taught his students by showing them firsthand the geological phenomena they talked about in the classroom. He held a great fondness for the Oklahoma landscape and often expressed its beauty in prose and poetry.

Gould encountered the environment in a manner fundamentally different than the practical oil men who combed Oklahoma's hills and valleys in search of oil. At the time of his arrival, the oil industry had not embraced petroleum geology and practical men had discovered most of the oil in the state. Although he eventually resigned his positions as university professor and survey director to work as an independent oil consultant, he never acquired significant wealth and eventually returned to the university where he resumed teaching and directing the survey. Many of his students, however, also entered

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[1] Richard White, "Discovering Nature in North America," *Journal of American History* 79 (1992), 874. White's observation has been particularly true of field scientists whose conceptions of nature often reflect visual and literary conventions depicted in nature writing and landscape painting, Henrika Kuklik and Robert E. Kohler, eds., "Introduction," *Osiris* 11 (1996), 5-6.

the oil business as petroleum geologists, discovered some of the most significant oil fields in the Midcontinent region, and acquired great wealth. Gould left his greatest mark on the oil industry by training this cadre of students who parlayed the knowledge he had taught them into valuable prospecting skills that oil companies increasingly desired, placing petroleum geology on a solid foundation within the industry.

Gould interacted with nature frequently as a child, and these experiences fostered his interest in geology. He was born July 1868 in the small farming community of Duck Creek in the southeastern corner of Ohio.[2] Although Gould "thoroughly disliked farm work," he eagerly took advantage of the opportunities rural life presented for abundant and diverse outdoor activities.[3] He enjoyed hunting and fishing, and in the autumn helped his sister gather walnuts, butternuts, chestnuts, and hickory nuts.[4] Wild fruit grew so plentifully around the family's home that pawpaws, persimmons, black haws, mulberries, May apples, wild grapes, and June berries offered a cornucopia during the summer.[5] Geology too attracted Gould at an early age. In addition to helping his father dig for coal, he filled window ledges in the family's home with collections of smooth pebbles and rock specimens.[6] He must have found many of these items while indulging in his favorite

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[2] Charles N. Gould, *Travels Through Oklahoma* (Oklahoma City: Harlow Publishing Company, 1928), 9-10.

[3] Ibid., 20.

[4] Ibid., 11, 19.

[5] Ibid., 17.

[6] Charles Gould, *Covered Wagon Geologist* (Norman: University of Oklahoma Press, 1959) 11, 20.

activities which included digging in the dirt banks along streams and rivers and exploring caves and ravines.[7] In 1887, the Gould family headed west and left the Ohio landscape behind but the natural world continued to intrigue young Charles as he grew to adulthood.[8]

When they settled sixty miles west of Wichita in the small town of Ninnescah, Kansas, the Goulds encountered a distinctly different environment than in Ohio. The new landscape made an immediate impression on young Charles: "What a contrast to the old home in Ohio with its timbered hills, narrow valleys, swiftly flowing streams, little hillside fields, and big farmhouses and barns!"[9] The familiar Ohio landmarks lingering in Gould's mind starkly conrasted with the new images he encountered on the Kansas prairie. He was overwhelmed trying to orient himself amidst a circular horizon "stretching away in all directions for unnumbered miles" and the treeless topography which offered "nothing to meet the eye but grass-covered plains."[10] Instead of large farmhouses and barns, he saw dugouts, sod houses, and claim shanties.[11] The weather in this new environment also disoriented him. When the spring rain gave way to summer heat, "the words will convey little meaning. Day after day of burning, blistering wind from the southwest; wind that scorched the skin like a blast from a furnace; hot wind that

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[7] Ibid., 20.

[8] Ibid.

[9] Ibid., 27.

[10] Ibid., 26.

[11] Ibid.

dried up the vegetation till the green leaves of the corn turned white, then rattled and blew away."[12] Despite the drastic differences between Ohio and Kansas, Gould eventually oriented himself to his new locale and acquired a deep appreciation for its landscapes and people. He grew so fond of his new surroundings that his experiences there significantly shaped the career path he followed.

If the Ohio landscape sparked Gould's initial interest in geology, the Kansas plains cultivated his curiosity and prompted him to choose geology as a profession. One day while picnicing north of Ashland, he began to walk over the nearby low-lying hills where he encountered several distinct geological formations: red beds along the valleys, black shale on the slopes, and white shales covering the uplands.[13] Gould found fossil shells and two femurs of an animal buried within the shales, and this find "revived my desire to learn something about geology.[14] He spent almost every subsequent weekend combing the hills twenty miles north and northwest of Ashland until he found a row of vertebrae, a few leg bones, and skull fragments protruding from the shale.[15] He shipped the bones to University of Kansas professor S.W. Williston who notified Gould he had discovered a new species of reptile. Gould's interest in geology blossomed. He cultivated a relationship with Williston and they began hunting fossils together. Williston tried to prevent him from becoming a geologist, warning that "'It's a dog's life, Gould,

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[12] Ibid., 28.

[13] Ibid., 45.

[14] Ibid..

[15] Ibid., 46.

and there is nothing in it. A geologist never makes any money, he works hard all his days, he is called a fool and a crank by nine-tenths of the people he meets, and he lives and usually dies unappreciated.'" Undeterred, Gould pursued his passion despite Williston's warning. While field work provided Gould the means for indulging his love of nature, it also directly influenced his decision to study geology.[16] Throughout the spring and summer of 1894, he collaborated with Robert T. Hill, a prominent University of Texas geologist and member of the U.S.G.S., on field work in southwestern Kansas, and "from that time on there never was a shadow of a doubt as to what my life's work should be. I knew I must be a geologist, and could never be anything else."[17] Gould continued practicing fieldwork each summer for nearly the next two decades, often on horseback and in a covered wagon, to catch a firsthand glimpse of the geology in Kansas, Oklahoma, Texas and New Mexico.[18]

When Gould arrived at the University of Oklahoma in 1900, students held little esteem for the discipline of geology because they believed had no practical application. Upon his arrival, the university was only eight years old, had only sixty college students, and no geology department.[19] Gould painted a bleak picture of his first days on campus.

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[16] Kuklik and Kohler, "Introduction," 6.

[17] Gould, *Covered Wagon Geologist*, 51.

[18]Rachel Laudan, *From Mineralogy to Geology: The Foundations of a Science, 1650-1830* (Chicago and London: University of Chicago, 1987), 7.

[19] Charles N. Gould, "Beginning of the Geological Work in Oklahoma," *Chronicles of Oklahoma* 10 (1932), 199. Total student enrollment was somewhat higher than sixty because the university functioned as a preparatory school for a number of years and counted highschool students among its population.

When he showed up to teach, "there was no geological equipment whatever, no laboratories, no collections, no books, no students, not even a class room."[20] Students did not enroll in geology classes because they did not feel the discipline prepared them for future employment: "As I remember now, there was no mad rush among the student body to avail themselves of the opportunities offered to secure a first-class geological education."[21] He explained students' apathy with the observation that working as a geologist failed to make the list of "legitimate and recognized methods of securing a permanent meal ticket."[22] Students avoided the discipline because "in those far-off days of 1900, geology was one of the so-called cultural subjects taught in college. It was a pure science, meaning one that had no known practical application."[23] The perception that geology could not secure a young man's future changed drastically during the course of Gould's tenure at the university and in subsequent years.

The best measure of how opportunities for geology students had changed was Gould's recollection in 1931 of how differently the public and private industry had perceived geologists in 1900 when he arrived at the university. He cautioned that when considering geologists' image at the turn of the century, "it should be remembered that

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[20] Ibid., 200.

[21] Ibid.

[22] Ibid.

[23] Ibid.; Charles N. Gould, "Pioneer Geology in Oklahoma," *Tulsa Geological Society Digest* 14 (1945-1946), 56.

these were the old days."[24] Since that time, the notion that geologists' work did not merit substantial financial rewards had entirely changed. Recalling the public's expectations of geologists nearly thirty years before, he remembered that "at that time geologists were not supposed to become opulent."[25] In the three decades that had elapsed, geology students had not only begun to find jobs but struggled to stay in school by refusing large amounts of money offered by companies trying to lure them away. Such lucrative opportunities had not always existed for Gould's students. When he first began teaching, "the persuasive promoter had not yet begun to comb the universities and inveigle reluctant sophomores from their studies, holding out as inducements fabulous salaries, an interest in the business, and an opportunity to marry the blonde daughter."[26] His discipline had become so popular that there emerged a "Sears Roebuck, mail-order variety of geologist" who had never attended college but hoped to profit from claiming that he had.[27] Geology began to warrant more authority among oil speculators and invoking science to justify investing in a venture gained acceptance. Thus, the "mail-order" geologist was a type of "fellow who always found the anticline crossing the block of leases held by the promoter, and whose reports, like a certain brand of soap were 99.98 percent favorable."[28] University-trained geologists would eventually protect their turf from invasion by these

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[24] Gould, "Beginning of the Geological Work in Oklahoma," 200.

[25] Ibid.

[26] Ibid.

[27] Ibid.

[28] Ibid.

unscrupulous hucksters who threatened to usurp their authority. The changing perception of geologists that Gould had witnessed in Oklahoma was part of a larger national trend.

At the turn of the century American geologists who worked solely on economic, or "applied," geology began publishing a journal as part of an attempt to assert their professional identity and stake a claim to legitimacy within the scientific community. In the inaugural issue of *Economic Geology*, the author of the opening article believed that nineteenth-century distinctions between theoretical and practical research had disappeared and boldly declared that "all geology is applied geology."[29] American geologists began to conform to scientists in other cultures who had never created this false distinction. For example, German scientists possessed a long and prestigious tradition of regarding economic geology equivalent to other branches of the earth sciences.[30] Americans, on the other hand, inherited from the British a tendency to conceive of geology as either a pure science which appealed to the human imagination or as an applied science which offered practical and potentially economic advantages.[31] British geologists viewed research into the occurrence of natural resources on a lower plane than more grandiose, theoretical topics such as the principles of stratigraphy, erosion, or volcanism.[32] Until the end of the nineteenth century, famous American geologists repeated this tendency to emphasize

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[29] Frederick L. Ransome, "The Present Standing of Applied Geology," *Economic Geology* 1 (October-November 1905), 1-2.

[30] Ibid.

[31] Ibid.

[32] Ibid.

theoretically interesting topics. Works such as Grove Karl Gilbert's "Henry Mountains" or Clarence Dutton's "Grand Canyon of the Colorado" strongly appealed to the imagination because they were "pursued amidst such attractive surroundings [rather] than investigations requiring frequent descent into the gloom and grime of mines dealing with processes many of which we can never hope to see in operation."[33] Like many nineteenth American scientists, Gould's enthusiasm for geology emerged from an interest in pure scientific research.

Although he spent much of his life demonstrating how geology facilitated economic growth, Gould's affinity for pure scientific research endured until the end of his career. When asked why he had not emphasized in his autobiography the significant impact of his pure scientific research on the economic development of the state's mineral resources, Gould replied "I hate oil geology."[34] One possible explanation for his disdain may have been that wealth eluded him throughout his life while clients who hired him as an independent consultant grew rich.[35] Once the oil industry began to boom and students poured into his classes, many of them also earned fortunes by parlaying their studies into expertise the oil industry valued. Struggling as a university professor while students acquired wealth may have embittered Gould later in life, but he never hinted that the

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[33] Ibid.

[34] Quoted in B. W. Beebe, "Introduction," *Covered Wagon Geologist,* viii. Gould wrote his memoirs in 1946 and died three years later. Thus, he was perhaps seventy-eight years old when he made this statement.

[35] Ibid., viii. Beebe states clearly that he is merely guessing that Gould's statement was motivated out of resentment over not becoming wealthy.

acquisition of wealth motivated him. As stated in his memoirs, he grew excited by pursuing knowledge for its own sake or else by making an intellectual contribution to his field.[36]

Teaching and researching at the University of Oklahoma afforded him plenty of opportunities to indulge his love of pure science, but throughout his tenure he grew to appreciate the advantages of applied geology as well. In his position as director of the Oklahoma Geological Survey, Gould had to approach geology in a manner different than he had as a university professor. As director of the survey, Gould became one of the most vocal boosters to advertise the mineral wealth that lay untapped within the state. He complained that the people "who pose as pure scientists" frequently overlook the value of Oklahoma's economic geology, which, after all, is the basis of a large part of our material prosperity as a State." [37] With the exception of gas and oil, the majority of the state's other minerals lay dormant in the ground, failing to "increase the revenues of the State..."[38] At the time he made this argument, Gould had been serving as director and had learned how his skills as a scientist could play a central role in locating the state's resources. He asked, "What better object might be sought, what more potent tasks might be accomplished, how can we as scientists better serve our State and our generation...?"[39] He knew just where to begin looking for resources too because he had witnessed them on

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[36] Gould, *Covered Wagon Geologist.*

[37] Charles N. Gould, "Beginning of the Geological Work in Oklahoma," 12.

[38] Ibid., 15.

[39] Ibid.

many excursions undertaken within the state since his arrival.

Upon arriving at the University of Oklahoma, he wasted no time organizing a field party to survey the state's terrain and natural resources. The university's first official field party departed June 1900 from Norman in a covered wagon and consisted of Gould, botanist Paul J. White, biologist A.H. Van Vleet, and cook Roy Hadsell.[40] Heading north from Norman, they set-out to explore central and northwestern Oklahoma. While they hoped to gather information pertaining to the state's geology, plants, and animals, "especial attention will be paid to the probabilities of gas, oil and coal in certain portions of the territory."[41] Gould and Hadsell took turns driving the wagon while the "gentlemen of leisure rode on the rear seat."[42] Despite Gould's sarcasm, covered wagon travelers on the Plains enjoyed anything but leisure. While camping near Orlando, "a prairie storm out of the northwest struck camp about two o'clock in the morning, and the four of us hung onto tent poles for an hour to keep the tent from blowing down."[43] The next day they picked up their tin plates, dishpans, and a stew kettle which the wind had blown as far as a quarter mile down the trail. Their journey took them approximately five to six-hundred miles around the state and lasted for much of the summer.[44] Twenty-eight

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[40] "Its Geological Survey: The Party from The University is Now in Logan and Noble Counties," *Kansas City Star*, June 19, 1900, p. 5, col. 4, in Collection, Folder 11, Box 1, Sardis Roy Hadsell Western History Collection, University of Oklahoma.

[41] Ibid.

[42] Charles N. Gould, "Beginning of the Geological Work in Oklahoma," 198.

[43] Ibid., 199.

[44] Ibid.

years later, Gould and Hadsell (who had become a literature professor at the university) made the same trip by automobile in one week.[45] Traversing Oklahoma in a covered wagon only reinforced the lesson Gould had been learning as a child in Ohio and as a young man in Kansas--that field work was a great method for teaching human beings about nature. As a university professor, he conveyed this lesson to his students.

Convinced that encounters with the natural world offered unique learning opportunities that could not be replicated in the classroom or laboratory, Gould instituted field work as a core component to his geology classes.[46] He contended that geologists could not afford to rely solely on classroom lectures because they practiced what was fundamentally an "outdoor science."[47] Unlike other scientists who conducted their work within a laboratory enclosed by four walls, "the geologist's laboratory lies out of doors."[48] Nature taught valuable lessons and without proper field work students simply failed to learn their subject adequately. Gould reminded his colleagues that "it is the common thing not the unusual thing, for young men to go out from four years of

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[45] Ibid.

[46] Historians have recognized that field science differed qualitatively from the closed workplace of the laboratory. The difficulty of screening-out the "cultural conventions of ordinary conduct" makes for a less closed and controlled workplace than in the laboratory. Kuklik and Kohler, "Introduction," 2.

[47] Charles N. Gould, *Oklahoma, The Geologists' Laboratory*, Oklahoma Geological Survey Circular No. 16 (Norman: Oklahoma Geological Survey, 1927), 3.

[48] Gould, *Covered Wagon Geologist*, 115.

laboratory and class room experience with but a hazy notion of what it is all about..."[49] The same young men who left the class room with a hazy notion of the forces that shape the earth "wake up to the importance of the whole subject" after observing geological processes and structures firsthand.[50] Despite the requirement by California and east coast universities that geology curricula include field work, conventional instructors in some parts of the country continued to teach without ever leaving the classroom and Gould hoped to change this tradition.

Although careful not to offend colleagues who taught standing in front of a blackboard, Gould advocated field work with a sense of mission. He and other geologists "who have been in the thick of the fight for some years" remained convinced that "the only practical geological laboratory is the field."[51] He asked readers to pardon him for expressing the opinion "that neither text-book illustrations, blackboard diagrams, high-priced charts, models of wood or of plaster, nor any other makeshifts, ever taught a student, however earnest, to recognize a fault in the field."[52] Although he attempted to deliver his message delicately, he did not mince words in stating that no teacher, however brilliant, could "build up indoor laboratories, and devise methods of work that would in a measure bring home to the student of geology something of what it is all about." [53] He

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[49] Gould, *Oklahoma, The Geologists' Laboratory*, 4.

[50] Ibid., 3.

[51] Ibid.

[52] Ibid.

[53] Ibid.

even doubted the success of the geological masters, "giants though they were," who taught students without introducing them to outdoor study. Thirty years as a geologist led Gould to conclude that "only by means of field work are geologists made, and that unless one wears out shoe leather on the rocks, vain is the help of man."[54] Throughout his professional life, he practiced his preachments about the necessity of field work.

As a university instructor, Gould trained his students by taking them on field trips to various locations and particularly to the Arbuckle Mountains in south-central Oklahoma. Gould began conducting field work in the Arbuckles while working part-time with members of a U.S.G.S. surveying party. One evening while sitting around a campfire after a day's work, he and his co-workers related to one another that they "had all been impressed with the unusual geology we had seen" and the members of the party "agreed that they knew of nothing quite like it in America."[55] Gould did not originate the idea of using the Arbuckles as a location for students to conduct field work. A member of the party "turned to me and said, 'Gould, you are starting a department of geology in a young university. Here at your back door is a magnificent geological laboratory. You will make a great mistake if you don't bring young men and women in your classes to the Arbuckle Mountains to learn geology first hand.'"[56] This was all the encouragement he needed and in 1901 arrived in the mountains with a wagon carrying his first group of

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[54] Ibid.

[55] Gould, *Covered Wagon Geologist*,112-13.

[56] Ibid., 113.

students.[57] He and three young men took two days to make the sixty-mile trek. As his mentor had guided him in the hills of Kansas, Gould and his students "spent several days scouting over the country and picking up fossils."[58] The next year the number of students grew by one, but by the third year a dozen students made the trip including Gould's sister and another female.[59] Within a few years, more than one hundred students had undertaken the pilgrimage.[60] As the department grew, ten to twenty women and three times as many men made the trip annually.[61] Eventually, the department took two trips per year.[62] Field trips to the Arbuckles continued long after Gould left the university, and he estimated that toward the end of his life as many as 5,000 students had visited the mountains.[63] Even students from universities in Texas and Kansas took advantage of the opportunity to learn from the site, and several leading geologists conducted field trips and conferences in the mountains.[64]

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[57] George Garrett Huffman, *History of the School of Geology and Geophysics, the University of Oklahoma.* (Norman: Alumni Advisory Council of the School of Geology and Geophysics, University of Oklahoma, 1990), 37-8.

[58] Gould, *Covered Wagon Geologist,*113.

[59] Ibid.

[60] Charles N. Gould, "Pioneer Geology in Oklahoma," *Tulsa Geological Society Digest* 14 (1945-1946), 56.

[61] Gould, *Covered Wagon Geologist,*113.

[62] Ibid., 114-15.

[63] Ibid., 115.

[64] Gould, *Covered Wagon Geologist,*115; Huffman, *History of the School of Geology and Geophysics,* 37.

The Arbuckle Mountains provided students unique opportunities to see and touch geological formations their teachers could merely describe and to collect a great number and variety of fossils their textbooks only pictured. Gould considered the Arbuckles "one of the best places in the United States to study rocks first hand" because it possessed "all sorts and conditions of geological phenomena."[65] Contained within the mountains were rocks of numerous geological eras and a great variety of minerals. The scenery presented a stimulating and exciting vision for those who witnessed it. The mountains offered several sites "where one may stand on a hill and see spread out before him in panorama a series of anticlines and synclines–Appalachian-type structure in miniature."[66] Visitors could witness how dynamic forces turned rocks on their edges, formed crevices and faults, resulting in "great upheavals of the earth's crust."[67] Nature's forces continued to transform the landscape before students' eyes, as they witnessed the Washita River wind through the mountains, cutting into various formations, "and many of its tributaries are now eating their way back into the rocks, illustrating stream piracy."[68] Gould lapsed into rapture when he described the opportunities the mountains presented: "And the fossils! Where can the American paleontologist find better collecting than here?"[69] White

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[65] Gould, *Covered Wagon Geologist*,112-13.

[66] Gould, *Oklahoma, The Geologists' Laboratory*, 11.

[67] Gould, *Covered Wagon Geologist*,112.

[68] Ibid., 112-113.

[69] G. T. White, "Oil Industry," in *The Reader's Encyclopedia of the American West*, Howard Lamar, ed. (New York: Harper and Row, 1977), 1047.

Mound, a famous collecting site composed of white shale and approximately twenty feet high, "stands out on the prairie, and its surface is literally covered with small fossils. One might collect for a year on an area not much larger than a city block and still not pick it clean, for each rain washes out more new forms."[70] The mountains offered the ideal geological laboratory and often influenced students to study geology full time.

The Arbuckle Mountains presented such an effective teaching device that they inspired students to choose geology as their major or occupation. A field trip to the Arbuckles often inspired students who had enrolled in an introductory geology class to pursue the discipline as their primary field of study. Just as fieldwork in southeastern Kansas convinced Gould to become a geologist, his students "received their first geological inspiration on these trips."[71] Many of his students who distinguished themselves as geologists, teachers, and businessmen later in life pointed to their field work as a defining moment in their professional development. They told Gould that "the Arbuckle Mountain trip was an eye-opener. They date their geological zeal to the camping trip in these mountains."[72] Gould witnessed and attested to the transforming experience students underwent as a result of their field work. He could name at least one hundred prominent geologists who, had it not been for their field experience in the Arbuckles, "would in all probability today have been shoe salesmen or automobile

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[70] Gould, *Covered Wagon Geologist*,112-13; For an excellent photo of women collecting at White Mound, see Huffman, *History of the School of Geology and Geophysics*, 37.

[71] Gould, *Covered Wagon Geologist*, 115.

[72] Ibid.

mechanics."[73] Field work impacted students at other universities in a similar manner.

Geology students at the University of Missouri also believed that field work provided a formative experience which shaped their careers and personal lives. Like Gould, other university professors hoped to get their students out of the classroom and into the field. Professor W. A. Tarr taught the first summer field work course at the University of Missouri in 1915 at a site near Breckenridge, Colorado. The following summer Professor E. B. Branson took the university's geology students to conduct field work near Wind River, Wyoming. Many of the students on these trips eventually worked as chief geologists or exploration managers for major oil companies, such as The Houston Company, Carter Oil, and Sinclair. They considered these encounters with nature "rugged work and valuable experience" and acknowledged their importance as professional preparation because it "changed some of us from students to practical geologists."[74] The field trips taught students to translate their experience into private industry, but they also effected students on a deeper, more personal level.

Traveling to a new locale to perform field work had much in common with the tradition of a religious pilgrimage because the excursion potentially offered geologists intense emotional experiences and opportunities for new insight into their lives.[75] As

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[73] Gould, *Oklahoma, The Geologists' Laboratory*, 4.

[74] Horace L. Griley, "General Information," Horace L. Griley Letters, Box 3A, Edgar Wesley Owen Collection, American Heritage Center, University of Wyoming.

[75] Martin Rudwick, "Geological Travel and Theoretical Innovation: The Role of 'Liminal'," *Social Studies of Science Experience* 26 (1996), 145; Related to the idea of nature as the source of spiritual renewal is the Victorian notion of nature as the source of personal growth. See Kuklik and Kohler, "Introduction," 5.

with a pilgrimage, taking a field trip isolated students both geographically and intellectually. Students left behind familiar landscapes and the controlled environment of the classroom or laboratory where professors remained on-hand to guide and assist them.[76] Especially in pre-modern periods when transportation was slow, expensive, and uncomfortable, long arduous journeys offered time for reflection and introspection as geologists visually surveyed the landscapes they traversed. Upon reaching their destination, they encountered an unfamiliar environment which demanded new ways of thinking in order to understand the geological forces that produced a landscape much different than the one to which they had grown accustomed. Removed from familiar surroundings and confronting an alien environment paved the way for a liminal experience which often led to introspection and contemplation of one's life.[77] Visiting the Arbuckles provided Gould's students with just such an experience. After arriving at the University of Oklahoma "with no definite purpose in life," his students "had their feet set in the right path, and their goings established, on field trips into the Arbuckle Mountains."[78] Gould understood nature's formative impact on his students because roaming the hills of Ohio and the plains of Kansas influenced him in a similar manner. The intimate ties to nature he fashioned as a student only grew stronger in his later years.

Gould performed field work partly to meet the requirements of his job as a professional geologist, but the natural world he encountered brought so much enjoyment

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[76]Rudwick, "Geological Travel and Theoretical Innovation," 145.

[77] Kuklik and Kohler, "Introduction," 149-50.

[78] Gould, *Oklahoma, The Geologists' Laboratory*, 4.

he celebrated what he saw in poetry.[79] He exhibited literary aspirations at an early age. While attending the Normal School at Southwest Kansas College, he met Hadsell who had accompanied him on his first field expedition. While the two were boys, they "belonged to what we considered the best literary society. ...Gould got me into several scrapes in the regular program of songs, debates, etc."[80] Gould's love of geology only fanned the flames of his literary passion, and he wrote poems which revealed a deep love of the Oklahoma landscape.[81] In "The Red Buds," the western half of the state's brilliant color manifested in the "red soils, red fields, red canyons cut in shale and sandstone; Brick red water in the streams."[82] Even as he tried to wax romantic about Oklahoma's natural beauty, his poems belied a geological sensibility. The Wichita Mountains impressed him as both "a silhouette of jagged granite peaks against the sky" and as "remnants of once larger mountains, upheaved in olden times, worn down by erosion..."[83] He also celebrated the region known as Black Mesa with the same odd mix of geological observations and romantic lyrics. Black Mesa struck Gould as a "product of earth's internal fires; Reminiscent of the time when hot and seething lavas; Belched forth from

[79] Field scientists experienced natural places through their work, but the lines between work and leisure remained more ambiguous for them than in other social arenas. See Kuklik and Kohler, "Introduction," 14.

[80] S. R. Hadsell, "Gould the Pioneer," Folder 11, Box 1, Sardis Roy Hadsell Collection, Western History Collection, University of Oklahoma.

[81] David W. Levy, "Scientist and Bard: The Poetry of Charles N. Gould," *Sooner Magazine* 17/1 (Fall 1996), 29.

[82] Gould, "The Red Buds"; cited in Levy, "Scientist and Bard," 30.

[83] Gould, "The Wichita Mountains," cited in Ibid., 31.

crater mouths; A hot and viscous flood; Upon the land..."[84] Even the state's coal deposits inspired him to write a poem: "Seventy-five billion tons of bottled sunlight; Priceless stores of carbon; Power for untold generations; Stored in the hills of Oklahoma."[85] The mandate of his profession required him to look for the practical benefits and economic potential of the state's resources, but his gaze focused upon the beauty and grandeur of the ancient geological processes that had shaped the land.[86]

In addition to writing poetry, Gould found the perfect forum for conjoining his appreciation of Oklahoma's aesthetic and utilitarian attributes in his role as director of the state's geological survey. Upon receiving a Bachelor of Science degree in 1899, he determined to become a state geologist and achieved this objective four years later when the governor of Oklahoma appointed him director of the state's geological survey.[87] Like J. Peter Lesley, Josiah Dwight Whitney, and other directors of geological surveys, Gould faced the difficult task of finding an appropriate balance between pure and applied science but unlike his nineteenth-century predecessors proved more adept at achieving this goal. Conducting field work enabled him to survey the state and inventory its natural resources so that taxpayers might reap an economic gain, but his excursions into the Oklahoma hinterlands also provided opportunities to observe the scenic landscapes which might serve as inspiration for future poems. Gould's strong desire to conduct field work

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[84] Gould, "Black Mesa," cited in Ibid., 29.

[85] Gould, "Oklahoma Coal," cited in Ibid., 30.

[86] Levy, "Scientist and Bard," 29.

[87] Gould, *Covered Wagon Geologist*, 68.

partly explains why he succeeded as director the survey but so too did his recognition that a state geologist must perform as a politician as well as a scientist.

Gould almost single-handedly brought about the creation of the Oklahoma Geological Survey Due to his ambition, foresight, and shrewd political instincts. When the territorial legislature met in 1906 to discuss the possibility of statehood, he instantly identified an opportunity to realize his long-held professional goal of becoming a state geologist.[88] Gould must have felt as though the perfect moment had arrived, for he "long had in mind the establishment of a geological survey in the new state."[89] In addition to calculating the right time to broach the idea, he drew upon personal ties to ensure that the survey came to fruition. Because he knew several members of the convention, "I had little difficulty in having appointed a committee on a geological survey."[90] Once they agreed to consider the idea, Gould found his way into their discussions and personally guided the debate. Although not an official delegate to the convention, "I met with the committee several times and aided them in formulating plans for the establishment of a survey."[91] Due in large part to his lobbying and guidance, Oklahoma became the only state with a provision in its constitution mandating that the legislature establish a geological survey.

Not satisfied with merely a constitutional mandate, Gould took the liberty of

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[88] Ibid., 141.

[89] Ibid.

[90] Ibid.

[91] Ibid.

drafting a law to ensure that the state organized and implemented a survey in the manner he had envisioned. As soon as the delegates adopted the constitution, he wasted no time formulating a law "for carrying out the plans I had in mind for so many years."[92]. He wrote to various states and countries to obtain copies of the laws governing their surveys and sought advice from other state geologists.[93] He aimed at writing a law which was both concise and "flexible," not burdened "with too many provisions."[94] He hoped this approach would keep the survey free from political entanglements. The law that Gould drafted avoided the "danger" of a large governing board unable to compromise when faced with difficult decisions.[95] He refused to leave the appointment of the state geologist in the hands of any single individual, "not even the governor of the state," because he hoped to keep the director free from the pressure of partisan politics.[96]

The final version of the law he drafted codified the University of Oklahoma's influence over the survey and left the state geologist unencumbered by any legal restrictions. Gould's bill called for the creation of a Geological Survey Commission which consisted of the governor, the state superintendent of public instruction, and the president of the University of Oklahoma.[97] These three officials appointed the director of

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92 Gould, *Travels Through Oklahoma*,142.

93 Gould, *Covered Wagon Geologist*,141.

94 Ibid., 142.

95 Ibid.

96 Ibid.

97 Ibid., 143.

the survey who, because of Gould's careful wording, "can do almost anything he desires."[98] Once again Gould relied upon personal suasion to ensure that the legislature passed his bill. Content that he had written "the kind of law I wanted," he campaigned for its passage and "again my acquaintance over the state stood me in good stead."[99] Because he knew personally almost half of the state legislature and many of the constituents of those legislators with whom he was not familiar, the bill faced little opposition and the governor signed it into law in 1908. In his memoirs Gould admitted no pretensions to serving as director of the survey, but he should not have been too surprised when the governor asked him to fill the position since he had so visibly and aggressively lobbied for its creation.[100]

Because of Gould's dual role as founder of the university's geology department and the state's geological survey, the line between the two entities often blurred and at times no line appeared to exist at all. The draft of the bill he presented to the legislature helped to codify institutional ties between the university and the survey. In addition to vesting the university president with authority to select the director, Gould further blurred distinctions between the two institutions by stating in his bill that the University of Oklahoma should furnish rooms and equipment until the survey could provide its own.[101] Just before the legislature passed the bill, however, a campus fire eliminated extra space

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[98] Ibid.

[99] Ibid.

[100] Ibid., 75.

[101] Ibid., 149.

at the university and Gould rented four rooms near his home to house the survey.[102] Located so close to his home, Gould had nearly unlimited oversight. Just as the close proximity blurred lines between the survey and geology department, so too did the activities each undertook. For example, the university catalogue for 1913 included more than four pages detailing the nature of survey's work, publications produced, and explained to curious students the advantages of studying at an institution which housed the state's geological research headquarters.[103] The geology department and survey's activities continued to overlap even after Gould resigned to work in the private sector. D. W. Ohern assumed the directorship and, like Gould before him, chaired the geology department which gave him access to students.[104] Geology students benefitted from the survey's affiliation with the university because it afforded summer employment that provided valuable experience conducting field work.[105]

The students Gould and Ohern hired conducted field work for the survey and in the process gained experience which prepared them to make significant contributions to the discipline of petroleum geology as private consultants and as employees of major oil companies. In the opinion of one petroleum geologist, "the Oklahoma Geological Survey

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[102] Ibid.

[103] *The University of Oklahoma General Catalogue, 1913-14*, 52-55, Located in the Western Heritage Center, University of Oklahoma.

[104] Gould, *Covered Wagon Geologist*, 148.

[105] State surveys often functioned as informal graduate schools and/or first jobs for students. In Europe, surveys inventoried natural resources in order to determine their uses by colonizing powers. This applied to all types of surveys--geological, topographic, social, and public health surveys. Kuklik and Kohler, "Introduction," 8-9.

had a decisive part in the sudden progress of petroleum geology during and immediately following the Cushing boom, not so much by its publications as by the professional work of the geologists whom it trained."[106] The combination of coursework taken at the university, field trips to locations around the state, and field experience working for the survey taught students how to prospect for oil in a manner dramatically different than the methods practical men employed. The joint efforts of the geology department and geological survey trained a generation of geologists whose efforts began to transform how prospectors searched for oil.

Experience had taught Gould the importance of field work and consciously made field work the centerpiece of the survey's activities. Although he feigned ignorance when stating that he had merely "an inkling of what was to be done" to organize a survey, his decisive action indicated otherwise: "Within an hour after my appointment I had long distance telephone calls to five men in different parts of Oklahoma, directing them to begin field work."[107] By the end of the summer, he had arranged for nine different field parties to conduct work throughout Oklahoma.[108] Gould found a ready supply of

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[106] J. V. Howell, "History of Petroleum Geology," Box 16, Edgar Owen Collection, American Heritage Center, University of Wyoming. (Hereafter cited as Owen Collection) Howell names approximately twenty men who worked for the survey, many of whom went on to distinguished careers and are mentioned throughout my study. For information similar to Howell's, also see Edgar Wesley Owen, *Trek of the Oil Finders: A History of Exploration for Petroleum* (Tulsa: American Association of Petroleum Geologists, 1975), 278. Note that Owen almost certainly derived his information from the Howell document.

[107] Gould, *Covered Wagon Geologist*,147.

[108] Ibid.,

assistants to hire in the geology classes he taught at the university. L. L. Hutchison studied at the University of Oklahoma and parlayed the knowledge he gained into a profitable business as an independent consultant before most oil companies proved willing to hire petroleum geologists. While at the university, he enrolled in classes such as economic geology, paleontology, and mineralogy.[109] After graduating, he attended Yale University where he received a Master of Science degree.[110] In addition to his academic training in geology, he also gained experience observing firsthand the principles he had learned in the classroom. While attending college in Oklahoma, he worked for the Oklahoma Geological Survey and studied the stratigraphy of oil fields while traveling in a covered wagon in the northeastern corner of the state.[111] His astute ability to observe geological structures and processes in the field prompted Gould to comment that Hutchison was "one of the best men I have ever taken out. He has a keen eye, correlates accurately and is able to express intelligently what he has observed."[112] After graduating from Yale in 1908, he returned to Oklahoma where he accepted a position as assistant director of the geological survey under Gould and headed a field party that surveyed the

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[109] Charles N. Gould to Charles W. Brown, June 1, 1908, File 1-1, Box M2179, L.L. Hutchison Collection., Western History Collection, University of Oklahoma. (Hereafter cited as Hutchison Collection)

[110] Charles N. Gould, "Memorial–Lon Lewis Hutchison," *American Association of Petroleum Geologists Bulletin* 31 (March 1947), 650-51.

[111] Ibid., 650-51.

[112] Gould to Brown, June 1, 1908, Hutchison Collection

northeastern counties he had traveled as a student.[113] Hutchison quit the Oklahoma Geological Survey after two years and moved to Tulsa where he opened an office as a geological consultant. Fifty miles to the north in the smaller town of Bartlesville, Roswell Johnson continued to struggle as a geological consultant and grew so discouraged he left Oklahoma in 1912. Many practical men remained unconvinced of geology's utility, but others began to believe that they could not ignore this emerging new science.

Starting in 1913, the demand for petroleum geologists greatly increased as both practical men and oil companies sought geologists' services.[114] While Johnson struggled to make a living, Hutchison found his services in such high demand that he became "the first man in the state to devote his entire time to petroleum geology," suggesting that a new era in the history of the oil industry and geologists' place within it was about to begin.[115] The knowledge Hutchison acquired at the university as well as his experience traveling the state as assistant director of the Oklahoma Geological Survey enabled him to increase the probability of finding oil before investors incurred the expense of drilling. His consulting fees increased so much that by 1911 he realized he could afford to resign from the survey because "my private affair matters bring me a living."[116] Although

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[113] Gould, "Memorial–Lon Lewis Hutchison," 650-51.

[114] Owen, *Trek of the Oil Finders*, 293.

[115] Charles N. Gould, "Memorial–Lon Lewis Hutchison," *American Association of Petroleum Geologists Bulletin* 31 (March 1947), 651.

[116] L. L. Hutchison to Tom Wall, February 14, 1911, File 2 "Correspondence Regarding Hutchison's Work as a Consulting Geologist," Box 2, L. L. Hutchison

careful never to charge for advice he gave while working for the Survey, Hutchison had written a number of reports for individuals and companies including the practical oil man Tom Slick. Even though Tom Slick drilled the initial well at Cushing, Hutchison played a pivotal role in the huge amount of oil this field eventually produced. Several other geologists played important roles in various oil ventures on or near the Cushing anticline and their work collectively caused many practical men who had once viewed geology with contempt to begin viewing it favorably.[117]

Like Hutchison, Frank Buttram took geology classes at the University of Oklahoma and worked for the Oklahoma Geological Survey, and his work on the Cushing field further convinced practical men to take petroleum geology seriously. In addition to employing different methods for finding oil, geologists and practical men typically did not enter the oil industry in the same manner. Whereas Slick was "born among the oil derricks" in Pennsylvania and smelled oil upon taking his first breath of air, Buttram was born in 1886 to a poor farming family who had migrated to Indian Territory from Missouri.[118] He worked his way through the Teachers' Institute at Tecumseh, Oklahoma, received high grades, and earned a certificate to teach school. After finding

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Collection, Western History Collection, University of Oklahoma.

[117] Owen, *Trek of th Oil Finders*, 294.

[118] C. B. Glasscock, *Then Came Oil: The Story of the Last Frontier* (New York: Bobbs-Merrill, 1938), 315. Buttram's daughter wrote a very filiopietistic biography of her father, but it it is useful for factual details. Merle Buttram, *One Man's Footprints: The Story of Frank Buttram* (Muskogee: Western Heritage Books, 1985); C. C. B., "Frank Buttram, 1886-1966," in Huffman, *History of the School of Geology and Geophysics*, 220.

employment as a teacher, he continued taking college classes at the Normal School in Edmond until 1909 when he acquired enough credits to enter the University of Oklahoma as a junior where he received a bachelor's degree in chemistry.[119] Buttram continued his education and while pursuing a master's degree caught the attention of Gould who hired him to work as a chemist for the survey.[120] This position familiarized Buttram with the state's geology and initiated his entrance into the oil business.[121] He authored three bulletins while working for the survey, and one entitled "The Cushing Oil Field" served as a key turning point in the way Midcontinent prospectors found oil and in the history of the oil industry.[122]

Buttram's bulletin and the accompanying maps demonstrated to practical operators that a relationship existed between anticlines and the accumulation of oil. Slick drilled the Cushing discovery well in March 1913, and approximately four months later Buttram led a team of geologists in an effort to survey and map the oil field.[123] The survey devoted most of its resources that year to surveying and mapping the Cushing field.[124] In December 1914, the Oklahoma Geological Survey published bulletin number

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119 Glasscock, *Then Came Oil*, 315-316.

120 Ibid., 317.

121 Ibid.

122 Ibid.

123 C. C. B., "Frank Buttram," in Huffman, *History of the School of Geology and Geophysics,* 220.

124 J. V. Howell, "History of Petroleum Geology," Owen Collection.

eighteen, a report written by Buttram which was the "best description of any mid-continent oil field which had ever been published."[125] Beyond just describing the field, though, Buttram's real accomplishment lay in demonstrating that Cushing's subsurface geology bore a direct relationship to the location of oil. By mapping the area's surface and subsurface geology, he convinced practical men that "geologists were able to predict the limits of production of Cushing."[126] His ability to articulate and illustrate geology's relationship to oil made his work "the first important oil publication in Oklahoma..."[127] When practical men found oil on the basis of Buttram's maps, geologists "gained the confidence of the oil operators" because they had provided a predictable method for locating oil.[128] With geologists' maps to assist them, "the structure of these fields was taken as the type to be sought elsewhere," and practical men expanded out from the initial well to find additional domes or anticlines in each direction.[129] The more success practical men scored on the basis of information gleaned from Buttram's maps, the more they believed that geology, and particularly the anticlinal theory, could lead them to oil.

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[125] Ibid., p. 8; Frank Buttram, *The Cushing Oil and Gas Field, Oklahoma*, Oklahoma Geological Survey Bulletin No. 18 (Norman: Oklahoma Geological Survey, 1914)

[126] Sidney Powers, "Petroleum Geology in Oklahoma," *Oil and Gas in Oklahoma*. Oklahoma Geological Survey Bulletin 40, Volume 1 (Norman: Oklahoma Geological Survey, 1928), 8; Merle, *One Man's Footprints*, 35.

[127] Edward Bloesch, "Early Day Petroleum Geology in Oklahoma," File: Ed Bloesch letters, Box 3A, Owen Collection.

[128] Powers, "Petroleum Geology in Oklahoma," 8.

[129] Ibid.

As they encountered additional oil throughout 1914 by drilling into deeper sands, "the proof by drilling that geological maps of surface outcrops delimited oil accumulation gave further impetus to geological reconnaissance."[130]

Buttram's work at Cushing placed petroleum geology on a firm foundation and provided impetus to the formation of the Fortuna Oil Company, a venture he started with D. W. Ohern and a group of New York investors. Buttram's report on the Cushing field caught the attention of executives for the Metropolitan Life Insurance Company who met with him in their New York offices to ask, "'How can you get us into the oil business in Oklahoma?'"[131] He left the meeting with a $40,000 advance to finance the Fortuna Oil Company, a venture in which he collaborated with Ohern. Both men received stock in the company and quit their jobs at the survey to devote their full attention to building the company. Over the next few years, Fortuna demonstrated "an outstanding record of success" based solely upon the recommendations of Buttram and Ohern.[132] Employing their geological expertise, the first seven out of eight wells they drilled resulted in good production.[133] They achieved these successes by "the discovery of surface structures," demonstrating the validity of the ideas Buttram and other geologists had been

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[130] Ibid.

[131] Quoted in Buttram, *One Man's Footprints*, 41.

[132] Jerry B. Newby, "Daniel Webster Ohern," Memorial, *American Association of Petroleum Geologists Bulletin* 38/5 (May 1954), 963.

[133] Buttram, *One Man's Footprints*, 13; For a more complete description of the location of the wells they discovered, see Newby, "Daniel Webster Ohern," 963.

articulating.[134] The company quickly gained a reputation because of its geologists' successful track record in locating oil.[135] As the industry began to take notice of Fortuna's success, the company sold a 48-acre lease to the Roxana Petroleum Company in 1915 for one million dollars.[136] In less than four years, Fortuna acquired and developed a significant number of oil fields, and the original investors sold-out to the Magnolia Oil Company in 1918 for $8 million.[137] At the age of 32, Buttram was a millionaire. Subsequent to the sale of Fortuna, he started his own oil company and in the early 1920s began acquiring large leases near the Corsicana field in east Texas and in Oklahoma's Wewoka-Seminole field.[138] In exchanging their positions as state employees for more remunerative possibilities in the private sector, Buttram and Ohern followed the lead of Gould who had also quit the survey in order to make more money working for the oil industry.

The oil industry in Oklahoma had just begun to boom when Gould resigned from the university and geological survey to work as an independent geological consultant in

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[134] Newby, "Daniel Webster Ohern," 963.

[135] Buttram, *One Man's Footprints*, 15.

[136] Howell "History of Petroleum Geology," 8-9; Buttram, *One Man's Footprints*, 15.

[137] Jerry B. Newby, "George Franklin Buttram and Fortuna Oil Company," in George Garrett Huffman, *History of the School of Geology and Geophysics* (Norman: Alumni Advisory Council of the School of Geology and Geophysics, University of Oklahoma, 1990), 245. Buttram's daughter says that Fortuna was sold for $6 million. Buttram, *One Man's Footprints*, 13.

[138] Buttram, *One Man's Footprints*, 43.

1908, but he was never able to profit as much as some of his students had. When he embarked upon his career in private industry, prospectors in the Midcontinent region generally did not recognize the relationship between anticlines and the presence of oil. Gould had not actively taught the idea to his students and even discouraged many from entering the oil business. Perhaps his most famous student, Everette DeGolyer, remembered that "during this period of 1904 to 1908 when I was exposed, so to speak, to geologic influences, Gould used to take the attitude with us students that 'if we had taken up geology at an earlier date, there might have been an opportunity for us in oil geology but that the future did not look very bright as the big fields, such as Spindletop, Glenn Pool, and Caddo, had already been discovered.'"[139] Fortunately, DeGolyer did not follow Gould's advice. Shortly after hearing this discouraging news he defied his mentor by taking a job for an oil company and discovered huge reserves of oil in Mexico. Although still in his early twenties, DeGolyer's income quickly eclipsed the university professor's salary.

Other students who studied under Gould would also prove their mentor wrong by playing a pivotal role in discovering much of the oil in Oklahoma. Although he had not trained them as oil prospectors, he indirectly gained acceptance for geologists within the industry by taking his students onto Oklahoma's landscapes and teaching them how to conduct field work both in his classes and as members of the geological survey. They built upon these experiences and parlayed what they had learned into knowledge oil

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[139] Everette DeGolyer to James A. Veasey, June 10, 1941, Belt-line theory, James A. Veasey collection, American Heritage Center, University of Wyoming.

companies desired for mapping and rationalizing nature in order to reap a profit. Gould also attempted to profit from his geological expertise by working as an oil industry consultant but could never entirely escape his affinity for pure scientific research and his appreciation for nature's aesthetic rather than utilitarian value.

Chapter 5

"Henry L. Doherty:

From Independent Consulting to Corporate Geological Research"

After leaving the University of Oklahoma and the state geological survey to work as an independent consultant, Charles Gould reaffirmed his legacy as a superb instructor of field geology but merely a mediocre oil-finding expert when he acquired a contract with the Empire Gas and Fuel Company to locate natural gas. Empire was one of approximately 150 companies within the Cities Service Holding Company, a conglomerate presided over by Henry L. Doherty. Empire was one of the first oil companies to train and recruit petroleum geologists and to establish a permanent geological research department as part of its corporate structure. Doherty committed himself to utilizing the knowledge of university-trained employees to ensure that his companies remained at the forefront of the oil and gas industry. Empire hired Gould as an independent consultant when it first began considering the idea of utilizing geological expertise, but it was Gould's student, Everett Carpenter, who discovered two of the largest oil and gas fields in the state of Kansas. Doherty departed from standard oil industry practice by embracing this emerging new science and revealed to other large oil companies the benefits of hiring and retaining geologists as part of the production process. The manner in which Doherty mobilized his companies to locate oil and gas provides another significant episode in the history of petroleum geology.

Doherty fit the image of Horatio Alger so perfectly and the story of his success so captivated those who heard it that they often attributed Cities Service's accomplishments to him alone, but many other employees also deserved credit for the company's innovations. One senior-level employee expressed awe at his boss's remarkable rise to success: "The story of Henry L. Doherty is a Horatio Alger story that outshines all the Horatio Alger stories at their best."[2] Although the rise of Cities Service owed much to Doherty's engineering genius, he exhibited perhaps even greater brilliance in devising programs to train and educate his workforce. He hoped to cultivate innovators like himself who could craft technical solutions to problems the company encountered. Doherty declared, "If I am ever known for anything I would prefer to be known as a man who could develop men rather than a man who could pick men."[3] This image remained fixed in the minds of other Cities Service personnel.

W. Alton Jones, Doherty's successor, remembered him as a man dedicated to recruiting highly-educated personnel and working aggressively to inculcate employees who lacked an education with knowledge that would benefit the company. Jones conceded that Doherty's charismatic and towering persona often overshadowed contributions of other key personnel in observing that "Mr. Doherty's eminence was such that many gained an impression of Cities Service as a one-man organization. Nothing

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[2] Everett Carpenter, "Reminiscences of Everett Carpenter," *Shale Shaker* (September 1965) in *Digest V: A Compilation of Unaltered Geologic Papers from Shale Shaker*, Volumes 15-17, 1964-1967 (Oklahoma City: Times-Journal Publishing Company, 1968), 431.

[3] Henry L. Doherty, *Principles and Ideas for Doherty Men*, vol. 2, comp. Glenn Marston (Printed for the use of Members of the Doherty Organization, 1923), 143.

could be further from the truth."[4] Far from denigrating Doherty's contributions, however, Jones hailed him as an innovator, particularly because he "devoted his principal attention to the development of men."[5] Doherty pioneered "in the recruitment of engineering talent from the schools and universities" and when the workers he hired lacked sufficient training he developed "special training schools to instruct these recruits in applying their specialties to the requirements of Cities Service and of the business world."[6] His commitment to recruiting and sustaining a highly-educated and well-trained workforce guided his efforts to build Cities Service into a dominant holding company of gas and electric utilities.

Doherty grew convinced of the need for university-trained engineers while managing Denver Light and Electric. He felt that the existing workforce lacked the kind of knowledge necessary for preparing the company to adapt to changes about to transform the industry. Hands-on experience provided the best training for workers to learn their jobs since the gas industry began. Self-educated workers continued to dominate the industry into the twentieth century, a point Doherty confirmed in 1904 when he suggested that the majority of employees in the gas utility business one "might classify under the greatly abused term of 'practical men.'"[7] Although lacking a technical background, these

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[4] W. Alton Jones, *The Cities Service Story: A Case of American Enterprise* (New York, San Francisco, and Montreal: The Newcomen Society in North America, 1955), 22.

[5] Jones, *The Cities Service Story,* 22.

[6] Ibid., 22.

[7] Doherty, *Principles and Ideas for Doherty Men*, vol. 2, 104.

workers possessed "valuable practical experience" and were "the kind of men that can never be entirely eliminated and there is no desire to do so..."[8] Practical men contributed significantly to the industry throughout the nineteenth century, but the necessity of providing gas for new markets in growing cities increasingly required skills they did not possess. To make this point, Doherty cited two examples of superintendents he had known who could neither read nor write but secured "better than average results of all gas companies throughout the country at that time."[9] Although they were "remarkable men in their way," he contended that they "would be entirely out of place with our present methods," not to mention that "the gas business already possesses a preponderance of this class of men..."[10] Of course, workers who lacked technical training could always educate themselves by reading company manuals in their spare time as Doherty had done, but most chose not to exercise this option.

Even though Doherty reached a position of eminence within the gas utility business by educating himself, he believed a gradual but drastic transformation had been taking place within the industry that would eventually make all but the most brilliant self-educated workmen obsolete. As America's cities grew, companies looked for technologically sophisticated solutions to the problems of locating and supplying gas to expanding markets. Organizational changes necessary to accommodate new ways of conducting business required skills and knowledge many workers did not possess.

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[8] Ibid., 106.

[9] Ibid., 105.

[10] Ibid., 105, 106-107.

Doherty observed that "the gas business was formerly carried on as a craft, but is gradually undergoing a change and will eventually be carried on as a science."[11] He placed practical men who made-up the bulk of the workforce squarely within the "craft" tradition because "they were not scientists, their education was limited, and they were at least indifferent to scientific methods and technical training."[12] Far from remaining "indifferent," Doherty embraced science and technology and this orientation set him apart from the typical practical man.

What bothered him more than practical men's aversion to new ideas was their outright contempt for university-educated engineers who initiated many of the changes he believed the gas industry required. Reflecting upon his statement about practical men's indifference toward science and technology, Doherty observed that "indifference is hardly the word to use" because many expressed outright "opposition to technically trained men and to scientific and exact methods."[13] In fact, he observed, "it is not hard to find men in the gas business who have an outspoken contempt for a college education."[14] Even though he too lacked a formal education, he embraced the university as a training ground for prospective employees. He hoped to recruit a new type of employee, one "thoroughly

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[11] Ibid., 104.

[12] Ibid.

[13] Ibid.

[14] Ibid., 107. This was not an uncommon feeling, as "field" engineers in other professions typically resented coworkers who had received "theoretical" training. David Noble, *America By Design: Science, Technology, and the Rise of Corporate Capitalism* (New York: Alfred A. Knopf, 1977), 27.

educated and possessing all the necessary fundamental knowledge to enable them to take up the special problems of the gas business. This, to the writer's mind, means a college educated man..."[15] Doherty's commitment to hiring engineers grew so strong that he equated opposition to this idea as an impediment to the industry's growth.

Practical men had grown so entrenched in their beliefs about how to conduct their jobs that they blocked the entry of new ideas which might invigorate the industry. In stubbornly refusing to acknowledge when their methods had grown obsolete, practical men "insist in spite of increased knowledge and changed conditions, on following what was considered good practice twenty years ago."[16] They failed to recognize that "conditions are changing and we must change to meet them."[17] Doherty believed many practical men remained provincially wedded to traditions which had served them in the past and unwilling to consider new ways of conducting their work: "They do not take kindly to proposed changes and prefer to see the business conducted along the lines of traditions of doubtful origin."[18] Clinging to outdated work habits even as the industry changed, "the man who may have been a leader in the gas fraternity twenty years ago may be an obstacle to progress today."[19] Slowly but surely, however, "these obstacles are

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[15] Doherty, *Principles and Ideas for Doherty Men*, vol. 2, 106-107.

[16] Ibid., 105.

[17] Ibid.

[18] Ibid.

[19] Ibid.

being overcome..."[20] Within recent years, the example of college educated men who had made "remarkable progress" served as "an incentive for others to endure the direct opposition, and sometimes ridicule, to which they have been compelled to subject themselves."[21] Throughout the first decade of the twentieth century and increasingly thereafter, Doherty hired those engineering graduates bold enough to run the gauntlet of ridicule dished-out by the industry's practical men.

Even though some universities began engineering programs throughout the last two decades of the nineteenth century, Doherty initially could not find graduates with specific knowledge of the gas and electric industry which prompted him to create a training school designed to supplement their theoretical knowledge with practical experience. Due to the shortage of engineers, he initially hired graduates of Denver's technological high school, gave them the title of "apprentice," and insisted that they attend an informal instructional program designed to provide on-the-job training.[22] He encouraged the apprentices to continue acquiring theoretical knowledge by enrolling in correspondence schools, offering to pay up to 100 percent of their tuition.[23] In approximately 1905, he began hiring graduates of engineering colleges from throughout

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[20] Ibid., 104.

[21] Ibid., 104.

[22] Mark H. Rose, *Cities of Light and Heat: Domesticating Gas and Electricity in Urban America* (University Park, Pennsylvania: Pennsylvania State University, 1995), 74. Doherty's inability to find suitably-trained engineers was a common problem for other industries as well, and his solution of establishing an in-house training problem was also a common solution. Noble, *America By Design*, 29.

[23] Rose, *Cities of Light and Heat,* 74.

the nation and added a more formal cast to the training program, dubbing it the "Doherty School of Practice," and granting new recruits the title "Cadet Engineer.[24] Even though instructors instituted a prescribed curriculum and taught in a more formal classroom setting, the school maintained its goal of providing cadets with a forum where they "could obtain practical experience to supplement their theoretical education."[25] From 1904 to 1932, the Doherty training school admitted 1,059 engineers, almost half of whom remained with the company at the end of that period.[26] Although the school successfully infused the company with new ideas to prepare for sweeping changes Doherty believed would soon transform the gas and electric utility industries, the company never lost sight of the need to strike a delicate balance between theoretical information and practical experience.

Although company executives welcomed the opportunity to integrate the latest technological ideas into a workforce which had been dominated by practical men, they saw the school as a vehicle to ensure that engineers not get lost in a theoretical haze and learn how to apply their knowledge in order to enhance efficiency and streamline production. Jones described the training program as a forum "to develop men who can

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[24] Ibid.

[25] Ibid., 75; W. Alton Jones, "Services of Henry L. Doherty and Company to Subsidiaries of Cities Service Company," p. 1, vol. II, chapter 6, Box 14, Cities Service Collection, Western History Collection, University of Oklahoma. (Hereafter cited as Cities Service Collection)

[26] Jones, "Services of Henry L. Doherty and Company," Cities Service Collection

apply their technical training with good sense and good judgment."[27] Instructors at the school echoed this sentiment. They strove to indoctrinate engineers with a perspective wide enough to understand how the company functioned but critical enough to identify problems without getting lost in the details of day-to-day operations. Given this orientation, personality played a significant role in the type of men admitted: "The kind of men we need are men with large enough vision to see the problem as a whole and separate the essential object to be achieved from the details now in vogue for achieving these essentials."[28] To ensure that students received every opportunity to acquire practical experience, instructors required them to spend a limited amount of time in each department. This approach worked well, particularly because "the men being fresh from school absorb information rapidly and eagerly grasp the opportunity to supplement their theoretical training with a wide range of practical knowledge."[29] Doherty's School of Practice proved such a success for training young men in the utility industry that he applied the same philosophy to the engineers he hired after acquiring several oil and natural gas companies.

Already convinced that university-educated engineers would play a vital role in the gas and electric utility industries, Doherty acted quickly to hire similar recruits and train them at his School of Practice when he purchased more than fifty oil and gas companies. In 1912, Doherty organized Empire Gas and Fuel to serve as the parent

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[27] Ibid., 6.

[28] Ibid.

[29] Ibid., 9.

company of several gas and oil properties he purchased throughout Kansas, Oklahoma, and Arkansas. Just as he had trained engineers to work in his utility companies, he employed the same strategy to fill the ranks of his oil and gas companies with employees who possessed a mix of technological knowledge and hands-on experience. As the oil and natural gas industries boomed during the first two decades of the twentieth century, "the demand for trained men in this work became urgent" to Empire executives.[30] They responded by opening an additional training program in Bartlesville, Oklahoma "to train technical graduates in the oil and gas business."[31] In addition to engineers, the Bartlesville program recruited university geology graduates.[32] The program accepted eight recruits in 1916 and twenty-five the following year.[33] Although no students entered the program in 1918, the number skyrocketed to 100 in 1919.[34] Numbers tapered off thereafter, probably a reflection of the oil industry's boom and bust cycle.

As with the public utility training course, Doherty's school in oil and gas production required engineers to spend time in all departments in order to gain as much practical experience as possible. Students at the Bartlesville branch participated in tasks as diverse as accounting, scouting, auto service, and warehouse work. Of course, they

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[30] Ibid., 7.

[31] Ibid.

[32] Charles A. Warner, "Sources of Men," in *History of Petroleum Engineering* (New York: American Petroleum Institute, 1961), 55.

[33] Jones, "Services of Henry L. Doherty and Company," 8.

[34] Ibid. The total number of students who received training in the oil and gas business alone equaled 352 from 1916 to 1931.

also spent time in the oil and gas fields where "they learn production at first hand, as roustabouts on the leases and clerks in the field offices. They are thus brought in direct contact with field problems, both production and engineering."[35] As much as Doherty pinned his hopes on young engineers to lead Empire Gas and Fuel into the future, the training program aimed to maximize their exposure to practical men such as "roustabouts" and "clerks in the field offices" who could provide a perspective engineers would never have received either in a classroom or an office. As Americans consumed more oil and Empire expanded its operations to include gasoline manufacturing plants and oil refineries, students spent time in these facilities too and learned "by actual experience how the various products of crude oil are made and prepared for the market."[36] Practical men demonstrated by example how to perform specific tasks engineers had never encountered, and in this respect contributed as much to the learning process as did the instructors. The Doherty School of Practice drew upon a wealth of experience by exposing its engineers at every turn to practical men working in the field at tasks many had been performing all their lives.

Even before Empire established the Bartleville training program, the work traditions of practical men influenced Empire's approach to oil production because the previous owner of the subsidiaries which made-up this parent company built them from a lifetime of experiences as a Pennsylvania oil man. Doherty purchased the fifty-six oil and gas companies which became Empire Gas and Fuel Company in 1912 from Theodore N.

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[35] Ibid., 11.

[36] Ibid.

Barnsdall, a Pittsburgh-based practical oil man. Empire's three most important subsidiaries were the Wichita Natural Gas Company, the Quapaw Gas Company, and a large interest in the Indian Territory Illuminating Company (I. T. I. O.).[37] By acquiring these companies, Doherty marked his entrance into the Midcontinent oil and gas industry but also inherited the problem of locating new natural gas reserves to supply their customers which had been running dangerously low. The men Doherty's company assembled provided a solution to the problem of diminishing natural gas reserves which placed petroleum geology on a firm foundation within the oil and gas industry. One of the men who contributed to this effort included Barnsdall himself who retained a minority interest in each property and continued to play a role in management-level decisions.[38]

Barnsdall was a second-generation Pennsylvania practical oil man who had achieved great success and wealth by the time he and Doherty came into contact. The success of Drake's well in 1859 inspired Barnsdall's father, William, to undertake his own search for oil and he drilled the nation's second commercial well in a nearby location

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[37] William Donohue Ellis, *On the Oil Lands with Cities Service*. (Cities Service Oil and Gas Corporation, 1983), 40, 55. According to Ellis, Doherty acquired a total of eighteen companies on July 1, 1912. See Ellis pg. 56n8 for a list of all but two of these. However, Everett Carpenter who worked for Empire reported that Doherty acquired from Barnsdall "about fifty-six separate oil properties and two gas companies..." Everett Carpenter, "As I Remember It," *Shale Shaker* (June 1957), 40, in folder entitled, "Everett Carpenter–Company's 1st Full-time Geologist," Box 5, Cities Service Collection.

[38] Edgar Wesley Owen, *Trek of the Oil Finders: A History of Exploration for Petroleum* (Tulsa: American Association of Petroleum Geologists, 1975), 298; Although Doherty acquired Barnsdall's shares in ITIO, he did not became the majority shareholder until later.

on his brother-in-law's farm.[39] As Pennsylvania's oil boomed, William soon acquired the wealth to send his second son, Theodore, to a preparatory school but after a brief stint realized that a job in Barnsdall Oil Company rather than a scholar's life better suited the rebellious lad.[40] Theodore thrived in the atmosphere of a booming oil town and seemed at play among the confidence men, wildcatters, speculators, and gamblers.[41] He quickly earned the reputation of a savvy businessman who instinctively recognized a good deal, and at the age of sixteen successfully brought-in his own well.[42] Theodore extended his holdings to Oklahoma and Kansas by 1912 when his western-most companies caught the attention of Doherty. Barnsdall's aversion to academic life and instinctive business acumen enabled him to blend well among practical oil men but did not prevent him from hiring a prospector who systematically studied geology to find oil rather than relying upon hunch or intuition.

Shortly after 1903 when William B. Pine arrived in Indian Territory, he began studying geology and eventually gained employment finding new oil reserves for Barnsdall. Prior to accepting this position, Pine spent approximately three years working for an oil-well equipment distributor and in his spare time supplemented his income as a

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[39] Norman M. and Dorothy K. Karasick, *The Oilman's Daughter: A Biography of Aline Barnsdall* (Encino, California: Carleston Publishing, Inc., 1993), 5; *The Derrick's Hand-Book of Petroleum. A Complete Chronological and Statistical Review of Petroleum Developments during 1859 to 1898.* Vol. 1 (Oil City, PA: Derrick Publishing Company, 1898), 870.

[40] Karasick, *The Oilman's Daughter,* 6.

[41] Ibid.

[42] Ibid.

creek skimmer.[43] This activity involved skimming the surface of creeks to collect oil that leaked into the water from natural reserves beneath the ground. His work experiences taught him many of the most rudimentary aspects of the early oil industry's production and prospecting techniques. Finding oil through the application of geology did not qualify as accepted practice during his informal apprenticeship, but Pine began studying the subject through a correspondence course.[44] In 1906, he parlayed what he had learned into a job scouting oil reserves for Barnsdall.[45] Over the course of three years, Pine worked with Barnsdall's general manager, F. M. Robinson, to acquire 40,000 acres of oil leases.[46] When Barnsdall decided to relinquish control of the leases, Pine and Robinson took them over. Pine earned enough money to initiate wildcat prospects of his own and achieved significant success as an independent operator.[47] He believed that the application of geology lay behind his prosperity and differentiated him from other independent oil men who continued to rely on intuition, dowsing, and other less scientific methods.[48] Whether Pine's geological prospecting method by itself won him Barnsdall's favor remains unclear. What is clear, however, is that Barnsdall showed no fear in hiring

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[43] Maynard J. Hanson, "Senator William B. Pine and His Times," (M. A. Thesis–University of South Dakota–1983), 6.

[44] Ibid.

[45] Ibid.

[46] Ibid., 9.

[47] Ibid., 10.

[48] Ibid.

men who used this emerging, new science.

Although motivated primarily to help a friend in need, Barnsdall bucked the traditional antipathy practical men felt for geologists when he hired Herbert R. Straight who possessed a degree in geology from Stanford University. Other than Straight's university education, the two men had much in common. Straight's father was also among Pennsylvania's early oil pioneers, following on the heels of Drake and William Barnsdall by drilling the nation's third commercial well.[49] Like many practical men who relied on intuition rather than science for finding oil, the elder Straight "was imaginative and creative in his approach to drilling and to prospecting for oil."[50] This expertise directly benefitted his son because "during summer vacations, it was customary for Herbert to work on his fathers [sic] leases near Bradford Penna, hwere [sic] his father lived."[51] Herbert took leave from helping his father for three and a half years prior to 1896 to attend Stanford where he graduated with a degree in geology in 1896.[52] After school, he returned to Pennsylvania and worked for his father's oil company until either 1911 when the elder Straight "suffered financial reverses" and could no longer employ his

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[49] Lois Straight Johnson, "Bartlesville Historical Society," April 16, 1975, H. R. Straight, Box 14, Cities Service Collection.

[50] Ibid.

[51] Ibid.

[52] Ibid; Straight's reasons for attending college are not entirely clear, but one latter-day biographer offered the vague statement that he "began to realize the importance and need for academic background" and thus enrolled at Stanford. "Biographical Sketch–Herbert R. Straight," October 8, 1954, H. R. Straight, Box 14, Cities Service Collection. This file contains numerous but brief biographies of Straight which mostly take the form of press releases.

son.[53] Herbert soon found employment when his friend, T. N. Barnsdall, offered him a job overseeing oil and gas properties in Oklahoma. When Doherty acquired Barnsdall's holdings, his decision to retain Straight as general manager of the oil and gas division revealed an affinity for scientifically-trained experts that was ahead of its time within the oil and gas industries but consistent with the philosophy he had employed since his earliest days in business.[54] Straight's degree in geology qualified him as the new breed of university-educated employee Empire increasingly sought to hire, but in assembling the company Doherty chose executives and managers who complemented each other with a mix of practical experience and theoretical knowledge. As president of the new properties he chose a longtime Pennsylvania oil man, J. C. McDowell, who had worked as general manager of the famous J. M. Guffey Petroleum Company which had played a significant role in Spindletop and later grew into the Gulf Oil Company.[55] Guffey and his partner

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[53] Johnson, "Bartlesville Historical Society," Cities Service Collection; Herbert Straight to James A. Veasey, May 17, 1941, Belt-line theory, Box 23, James A. Veasey collection, American Heritage Center, University of Wyoming. (Hereafter cited as Veasey Collection)

[54] Although a practical oil man, Barnsdall probably had no aversion to geology and it may have even appealed to him and motived him to hire both Pine and Straight. Petroleum geology was accepted by oil companies outside the United States at a much earlier date. The first company to employ geology in Oklahoma was the Union des Pétroles d'Oklahoma in 1911, originating out of Holland and Paris. Straight worked for this company at some point but I have been unable to determine the beginning date of his employment. It is highly possible that this position drew him to Oklahoma and the geology he practiced there made him an even more attractive candidate to Barnsdall and eventually to Doherty. Owen, *Trek of the Oil Finders*, 291-92; Samuel P. Ellison, Jr., Joseph J. Jones, and Mirva Owen, eds., *The Flavor of Ed Owen: A Geologists Looks Back* (Austin: Geology Foundation, University of Texas at Austin, 1987), 11.

[55] Everett Carpenter to Edgar W. Owen, July 31, 1963, Folder 88, Box 1, Everett Carpenter Collection, Western History Collection, University of Oklahoma, (Hereafter

John H. Galey earned a reputation as two of the oil industry's most famous wildcatters and two of the earliest to hire geologists.[56] They bucked the industry's anti-geologist sentiments in 1885 when they hired I. C. White who performed the now-famous location of oil by applying the anticlinal theory.[57] Although Guffey and Galey's refusal to eschew technical knowledge outright remained the exception among practical men, they almost certainly would have demanded that McDowell as their general manager demonstrate a similar tolerance. The man beneath McDowell in Empire's executive hierarchy exhibited an even greater orientation toward technical knowledge.

Alfred J. Deischer served as Empire's vice-president and, like Doherty, had little formal education but acquired technical expertise as a self-taught engineer and produced a number of innovations which benefitted the company.[58] The Diescher family was of German descent but Alfred's father, Samuel, emigrated from Hungary after studying at Carlsruhe Polytechnic College and the University of Zurich and working as a mechanical designer for various industrial enterprises throughout Europe.[59] In America, the senior

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cited as Carpenter Collection). This letter is reprinted in its entirety as "Reminiscences of Everett Carpenter," *Shale Shaker* (September 1965) in *Digest V: A Compilation of Unaltered Geologic Papers from Shale Shaker*, Volumes 15-17, 1964-1967 (Oklahoma City: Times-Journal Publishing Company, 1968), 431.

[56] They hired petroleum geologists Lee Hager in 1901. Lee Hager to James A. Veasey, June 5, 1941, Belt-line theory, Box 23, Veasey Collection.

[57] Owen, *Trek of the Oil Finders*, 298.

[58] Ibid.

[59] Arthur B. Fox, "The Incline Builders: Forgotten Engineers of Pittsburgh," *Pittsburgh Tribune-Review*, June 1, 1997.

Deischer built a successful engineering firm and designed and constructed projects such as steel bridges, incline planes, pipelines, oil pumping stations, and gas compressor stations.[60] Alfred quit high school during his first semester to begin working in his father's Pittsburgh engineering practice and eventually became a full-member of the firm.[61] The lack of formal education did not deter Alfred from working in his spare time to prepare himself as an engineer. A subordinate of Diescher's at Empire, Everett Carpenter, recalled that his boss "mastered Trigonometry, Analytical Geometry, Differential and Integral Calculus all on his own."[62] Although Carpenter had received a geology degree from the University of Oklahoma, his formal education did not diminish the esteem he held for the self-educated Diescher whom he considered a "clear thinking and far seeing individual with a keenly analytical mind."[63] Similarly, Diescher showed none of the traditional disdain for geologists exhibited by many practical men. According to one account, "Diescher was paying much attention to geology for some time before 1913," which is the year he hired Carpenter to employ the skills he had acquired .[64]

Diescher placed enough faith in geology to hire Carpenter who he hoped could find additional reserves of natural gas to supply the subsidiaries Doherty had purchased

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[60] Ibid.; Carpenter to Owen, July 31, 1963, Everett Carpenter Collection.

[61] Carpenter to Owen, July 31, 1963, Everett Carpenter Collection.

[62] Ibid.

[63] Ibid.

[64] John H. Kane to James A. Veasey, July 15, 1941, Belt-line theory, Box 23, Veasey Collection.

from Barnsdall. The field work Carpenter practiced as a student at the University of Oklahoma and later at the U.S.G.S. facilitated his ability to locate and map the anticlines which held the gas Diescher desired. Carpenter began exploring near Augusta, Kansas because "some small showings had been found in some wildcat wells."[65] Nothing particularly "geological" led him to the site other than the "small showings," and like some practical men he merely looked for oil by following the success of others.[66] After arriving in the immediate vicinity, however, his approach changed significantly. He began surveying the area to acquaint himself with the surface geology and identified two stratigraphic layers of limestone which he then "mapped by pacing the distances from numerous points on the outcrops to Section lines and corners."[67] Carpenter drew upon skills he had learned at the U.S.G.S. to depict in visual form the geology he had observed. After carefully traversing the area, he documented the surface geology so that "the outcrops were appropriately indicated and colored on a map."[68] Rather than merely drawing pictures of what he had observed, "the inclination or dip of the rocks was shown by the conventional dip and strike symbols then in use."[69] With his work completed, he expressed satisfaction that "it was a noble map–one that would warm the heart of the

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[65] Ibid.

[66] Ibid.

[67] Ibid.

[68] Ibid.

[69] Ibid.

most cold blooded."[70] With map in hand, he set-out to convince his boss how they would find natural gas with this visual representation as their guide.

Carpenter encountered a problem when he returned to Empire's Bartlesville office because company executives, although not averse to geologists, could not entirely understand their methods. Despite the great pleasure Carpenter took in his map, he lamented that "there was just one thing wrong with it–the general manager could not understand what was meant to be shown."[71] Both Diescher and Barnsdall proved willing to hire geologists, but they retained an understanding of the oil business based upon the traditions of practical men. Both men initially failed to comprehend the significance of the anticline Carpenter depicted because they could not read his map. Carpenter included different perspectives of the structure, explaining that "cross sections were tried but without absolute elevations it was difficult to give them the rosy appearance that graces the modern reports."[72] Diescher could not make sense of the map's graphic symbols, but "still a good enough picture was made to enable me to convince him that a detailed survey with a telescopic alidade was necessary."[73] Although Diescher supported the request to perform additional work, he refused to approve funds for equipment Carpenter considered necessary to complete the task.

Even though Diescher proved willing to hire geologists, their methods remained

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[70] Ibid.

[71] Ibid.

[72] Ibid.

[73] Ibid.

so unproven at the time that he could not justify extravagant expenditures on equipment that only a few years later every geologist would possess. Carpenter began exploring at Augusta with "none of the tools so necessary to a geologist such as a compass, aneroid, hand level, etc.,....and for transportation I had my own two legs."[74] Although he eventually acquired a compass and hand level, "it was still forbidden to spend any money even for an alidade" and he "did not get permission to buy one" even though Diescher agreed to additional field work.[75] Carpenter "finally succeeded" in overcoming his boss's intransigence but admitted that "it took considerable scheming and a lot of nerve to get around that hurdle."[76] He waited until company officials left the office for a two-week period so he could place an order for the alidade and receive it before they returned. They eventually uncovered his scheme and "I was called on the carpet for a rather severe lecture..."[77] Carpenter received a tongue-lashing but had acquired the tool he needed and initiated the field work necessary for creating an even more detailed map.

The second survey produced such a superior map that it convinced Empire executives to lease acreage and begin drilling on the Augusta anticline. Carpenter solicited the services of another University of Oklahoma graduate, J. Russel Crabtree, to carry out the field work. Although Crabtree studied engineering rather than geology, his education may have better equipped him to survey and map the area because "he became

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[74] Ibid.

[75] Ibid.

[76] Ibid.

[77] Ibid.

one of our best men in geological mapping. His maps were works of art..."[78] The use of an alidade enabled Crabtree to measure geological structures with more precision and represent them more clearly on the map through the use of contour lines. Crabtree's work greatly impressed Empire executives because "the structure was portrayed by means of contours which the management could visualize and understand at a glance."[79] Carpenter met with Barnsdall and Diescher to show them the map and "to explain the geology of the Augusta field."[80] At the end of their meeting, "Barnsdall asked if it was our contention and belief that simply because the contour lines ran around in complete circles that that made this a good place to drill."[81] Carpenter assured him that this was his position and on that basis Barnsdall "gave his consent to whatever it was that was desired."[82] The use of contour lines on the new map showed more clearly the anticline's elevation and convinced Empire executives to invest in drilling at the site.

Perhaps more than any other single event, Carpenter's discovery of the Augusta and El Dorado fields won acceptance for petroleum geology within the oil industry. Petroleum geologists working at the time of the discovery remembered it as a pivotal moment for their discipline. One declared, albeit inaccurately, that "Empire invented Oil

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[78] Ibid.

[79] Ibid.

[80] Ibid.

[81] Ibid.

[82] Ibid.

Company geology, based on experiences in Augusta and El Dorado, Kansas."[83] Other companies had previously used geologists but mostly as consultants and in a much less systematic way than Empire. Edgar Owen, one of the first geologists Carpenter hired, expressed clearly and succinctly how Empire's approach to geological exploration differed from any previous attempt. The company's discovery of these two fields "was most influential in popularizing the application of geology at a time when the Mid-Continent was becoming the most important districts in the world."[84] Empire's achievement lay not in originating any new exploration techniques but in demonstrating "the economic utility of a program consisting of geological reconnaissance followed by detailed mapping of surface anticlines and promptly leasing and drilling of large blocks on the favorable structures."[85] After the success at Augusta and Eldorado, Empire executives no longer needed convincing of the utility in Carpenter's methods and reasoned that if one geologist could find oil then many geologists could find a lot more.

Confidence in Carpenter's methods ran so high among Empire's top-level managers that they ordered him to hire as many geologists as he could find and in doing so created the largest geological exploration department the oil industry had ever witnessed. Empire committed significant resources to acquiring a staff that could

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[83] Horace L. Griley to Mr. Jenkins, March 4, 1973, Horace L. Griley Letters, Box 3A, Owen Collection. A clear consensus exists among geologists at the time that Empire's discovery of Augusta and Eldorado marked a turning point in their profession. For examples, see the following: William N. Davis to James Veasey, June 5, 1941, Belt-Line theory, Box 23, Veasey Collection.

[84] Ellison, et al., *The Flavor of Ed Owen,* 21.

[85] Ibid.

conduct field work on a large scale and translate observations into high-quality contour maps which outlined the structural characteristics of anticlines. After receiving the order "to increase the personnel of the department greatly before the Standard group and other large companies gathered up all the geologists," Carpenter acted swiftly and began combing the geology departments of nearby universities for as many students and faculty as he could find.[86] He particularly drew upon his close ties at the University of Oklahoma to build his staff. As an instructor there recalled, "Mr. Carpenter employed six or eight of the graduating class from Oklahoma University in June 1914; in fact, practically every man that had majored in geology."[87] A geologist working for the company remembered how swiftly the number of his coworkers grew, as "Empire expanded its geological staff from practically nothing at the beginning of 1915 to more than 100 men early in 1916."[88] By the summer of 1917, the company had hired "about 250" geologists and placed them "just about everywhere" throughout the United States, including New York, Kentucky, Texas, Ohio, and Wyoming.[89] Accounts vary as to exactly how many geologists Empire

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[86] Carpenter to Owen, July 31, 1963, Carpenter Collection.

[87] Alex W. McCoy to James A. Veasey, June 20, 1941, Belt-Line Theory, Box 23, Veasey Collection.

[88] L. Murray Nuemann to James Veasey, May 20, 1941, Belt-line theory, Box 23, Veasey Collection.

[89] Horace L. Griley to Edgar W. Owen, September 14, 1965, Empire Gas and Fuel Co. (Cities Service), Box 3A, Owen Collection. Elsewhere, Griley states that the number was closer to 200. See Griley to Jenkins, March 4, 1973, Owen Collection.

employed, but the number certainly exceeded 200 and may have approached 250.[90] No longer content to invest in drilling on the basis of a hunch, Empire committed itself to geologists who could identify and map anticlinal surface structures and increased the probability of finding oil.

A problem quickly surfaced in this plan, however, because the students and faculty Carpenter hired from universities understood geological theories and principles but did not know how to construct contour maps or operate the necessary surveying equipment. Even though professors like Charles Gould ensured that their students experienced field work first hand, these excursions tended to focus on examining geological processes rather than practical tasks the oil industry required such as mapping the formations they had observed. The nature of field work students practiced to fulfill university degree requirements particularly differed from that performed by employees of the U.S.G.S. Geologists like Carpenter who had worked for the U.S.G.S. prior to joining Empire learned how to make maps and isolate resources while conducting field work. Although Empire and other oil companies that followed its lead initially "were raiding the

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[90] Carpenter reported that "I am unable to arrive at so large a figure" as 250. He continued, "I have been unable to arrive at a number greater than a hundred, but there may have been several whose names have been overlooked." Carpenter to Owen, July 31, 1963, Carpenter Collection. Owen attempted to document every geologist Empire employed from 1916 to 1919 and he compiled 212 names plus eight "probables" for a total of 220, although they probably were not all employed at the same time. "Empire Gas and Fuel Co. Geology Department Personnel," Empire Gas and Fuel Co. (Cities Service), Box 3A, Owen Collection. John Steiger, claimed that the geological staff grew "to almost 250 by 1917..." John Steiger, Untitled Document, June 8, 1968, Miscellaneous Text Documents, Box 11, Cities Service Collection. Perhaps the most definitive source is that which says "some records which we have found indicate a total of 149 geologists were on the pay roll during the summer of 1917." Herbert Straight to James A. Veasey, May 17, 1941; Belt-line theory, Box 23, Veasey Collection.

faculties" of universities, they eventually began to recruit geologists from the U.S.G.S. instead. Johnson explained that "the reason that the companies preferred survey men to faculty men was that the latter were on the whole less good field men."[91] Following the lead of Doherty, Empire executives believed that they could teach university geologists the practical skills their company required.

The Bartlesville branch of Doherty's School of Practice aimed at teaching university educated geologists how to operate surveying equipment in order to make contour maps which depicted anticlinal structures. The methods of detailed structure mapping developed piecemeal over a number of years.[92] Through field work, geologists hoped to identify control points by measuring the elevations of identifiable stratigraphic layers which outcropped at the surface.[93] Although the preferred instruments varied with the nature of terrain and structure in question, geologists most often adopted the telescopic alidade and plane table.[94] This devise consisted of a tri-pod with telescope-like instrument attached as well as a flat surface where the geologist recorded coordinates

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[91] Roswell Johnson to James A. Veasey, February 24, 1941, Veasey Collection.

[92] Owen, *Trek of the Oil Finders*, 225. For a more detailed description of the instruments and techniques employed at the time, see Owen 225-27, 241-42, 295-97 and the following sources: C. W. Hayes, *Handbook for Field Geologists* (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Limited, 1913) and *Field Mapping for The Oil Geologist* (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Limited, 1921); Frederic H. Lahee, *Field Geology*, 2nd ed. (New York and London: McGraw-Hill Book Company, Inc., 1923); Walter A. English, "Some Planetable Methods," *American Association of Petroleum Geologists Bulletin* 8 (January-December 1924), 47-54.

[93] Owen, *Trek of the Oil Finders*, 225.

[94] Ibid., 225-26.

which served as the basis for contour lines depicting the structure. To ascertain the coordinates, the geologist looked through the alidade to follow an assistant who walked over the structure with a "stadia rod," which resembled a large ruler, stopping at various points for the viewer to plot measurements marked on the rod. Teaching young geology students meant showing them how to operate these instruments and to perform this procedure, so Carpenter hired an associate from the University of Oklahoma, Luther C. Snider, to train new recruits. Learning this process required time, "at least a full year's practice...," but time was not a luxury Empire could afford.[95] After experiencing significant success by mapping and drilling anticlines at Augusta and Eldorado, the company so zealously committed its resources to expanding this approach that it acquired "an enormous amount of acreage in the MidContinent region, particularly in Kansas and Oklahoma."[96] The pressing need to return a profit on an "enormous" investment prevented new geologists from getting the practice necessary to learn the art of map-making.

Numerous accounts confirm that Empire dramatically decreased the amount of time new geologists received to practice making maps and that the company's unprecedented commitment to field work failed to meet its expectations. The urgency with which Empire and its subsidiaries searched for geologists resonated in a letter J. W. George, head geologist at I. T. I. O., sent to the University of Missouri's geology

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[95] Carpenter to Owen, July 31, 1963, Carpenter Collection.

[96] "Scientific Methods of Exploration for Oil Help Industry Meet Its Demands," *Oil and Gas Journal* 34/31 (December 19, 1935), 14.

department. He explained that he was "much in need of some men that can do plain [sic] table with telescopic alidade." Even students who could not operate this equipment qualified for employment, as he had "been starting men who have not had previous experience at seventy five dollars per month and expenses while in the field."[97] Executives at Empire, I.T.I.O.'s parent company, felt the same sense of urgency to hire and train geologists, pushing them through the training process with utmost speed. Johnson related that "Diescher had a scheme that flopped of quickly training in a few weeks youth to do anticline hunting. That was about 1914."[98] The training program "flopped" because simple "anticline hunting" did not directly translate into new discoveries of oil.

Empire's massive undertaking to find surface structures started out with much promise and proved successful for a time but quickly grew into a dogmatic formula that failed to produce results. Despite considerable resources and personnel, Empire "mapped many anticlines which yielded some commercial discoveries but none of great significance."[99] As a result, the "crash program" of hiring and training geologists which lasted until 1917 "did not fulfill expectations..."[100] After drilling a number of dry wells, "the large geological department then was reduced and it was realized detailed and

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[97] J. W. George to W. A. Tarr, October 30, 1917, Oklahoma Notes and Extracts, Pre-1921, Box 1C, Owen Collection.

[98] Johnson to Veasey, February 24, 1941, Veasey Collection.

[99] Ellison, et. al., *The Flavor of Ed Owen,* 21.

[100] Ibid.

careful field work was more important than mass production of field maps by inexperienced men, many of whom had been taken from the college class rooms before completing their regular course of study."[101] Empire had learned an important lesson that would not occur to the management of other companies who mimicked their approach for a number of years, that no substitute existed for "detailed and careful field work." By reducing the search for oil to mere "anticline hunting," Empire overestimated the anticlinal theory's suitability for explaining all occurrences of oil and failed to consider alternative explanations.

Once oil industry geologists and executives accepted the utility of the anticlinal theory, they employed it so dogmatically that it failed to yield results and the creativity of many petroleum geologists diminished as they ceased to think of other geological explanations for the accumulation of oil. The anticlinal theory appealed to prospectors because it offered visual clues which guided them to potential new pools.[102] Although every hole drilled next to an anticline did not always yield oil, most geologists' faith in the theory endured because success at places like Cushing, Augusta, and Eldorado seemed to verify its validity.[103] Over time, however, perfunctory application of the theory

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[101] "Scientific Methods of Exploration for Oil Help Industry Meet Its Demands," 14.

[102] Everett DeGolyer, "Concepts on Occurrence of Oil and Gas," in *History of Petroleum Engineering*, American Petroleum Institute (New York: American Petroleum Institute, 1961), 24.

[103] Ibid.

retarded the rate of discovery.[104] As one of the most prominent and successful petroleum geologists of the time put it, "this beautiful conception, perfectly valid in principle, has often actually led us astray in the practical search for oil."[105] Geologists soon learned that in addition to structural traps such as anticlines which they could observe at the surface other geological phenomena deep within the subsurface of the earth could also trap oil beyond their purview. Although hunting anticlines served geologists well for a time, they eventually located the most prominent ones and needed to devise new methods for finding oil.

Like most who had heard of the anticlinal theory, Carpenter initially conceived of it as a prospecting method with universal application and never considered how other geological phenomena might also trap oil beneath the ground. As a college student studying at the University of Oklahoma, he became "very much intrigued with Dr. I. C. White's anticlinal theory of oil and gas accumulation and bent my best efforts" to some day work as a petroleum geologist.[106] His view of this theory that prompted him to enter the profession changed dramatically over the years. In 1924, he reflected that "it never occurred to me during my university days that there was any limitation to the theory of anticlinal accumulation."[107] Thirteen years of experience in the oil industry gave him a

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[104] Wallace Pratt, *Oil in the Earth,* (Lawrence, Kansas: University of Kansas Press, 1942, 1944) 23.

[105] Pratt, *Oil in the Earth*, 23.

[106] Carpenter to Owen, July 31, 1963, Carpenter Collection.

[107] Ibid.

different perspective which he expressed in a letter to Gould, stating that "I do not regard anticlines as the only controlling factor in the accumulation of oil. There are other factors equally important."[108] He had ceased believing that the theory offered a panacea for finding oil, a notion some geologists would not accept until a much later date.[109] Partly as a result of the initial successes Empire scored searching for anticlines, other companies followed suit and also applied the theory perfunctorily. Some geologists had ceased to think creatively in their search for oil or to consider "other factors" trapping oil beneath the ground. Convinced that "anticlines furnish only one condition under which oil and gas may accumulate," Carpenter determined to identify alternative explanations for the occurrence of oil.[110]

By the mid-1920s, Carpenter's recognition of limitations in the anticlinal theory led him to postulate other geological features associated with the presence of oil. While he did not dismiss the validity of the anticlinal theory, he expressed to Gould that "other conditions equally important are furnished by Sand Lenses, Faults, Shoe-string Sands, etc."[111] A contemporary of theirs considered "this view-point years ahead of its time." Management at some companies so "slavishly worships the anticlinal theory" that a

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[108] Everett Carpenter to Charles N. Gould, December 19, 1924; quoted in Carl Branson, "Petroleum Notes from the Twenties," *Oklahoma Geology Notes* 17 (October 1957), 94.

[109] Ibid.

[110] Ibid.

[111] Ibid. For further explanation of shoe-string and lense traps, see A. I. Levorsen, *Geology of Petroleum* 2nd ed. (San Francisco: W. H. Freeman and Company, 1967), 293-305 and 305-318.

geologist "has to sell an anticline to get a stratigraphic trap drilled."[112] Geologists found it necessary to justify drilling at a site by "selling" an anticline because this structure, unlike a stratigraphic trap or the other geological phenomena Carpenter described, manifested at the surface which easily lent itself to mapping and, therefore, offered tangible evidence that they could find oil nearby.

A major advance in the discipline of petroleum geology and in the oil industry occurred when geologists articulated the principle that stratigraphy, like structures, also trapped oil but far below the surface beyond human purview. By definition, a stratigraphic trap consisted of a discontinuity, or open space, missing from a layer of stratigraphy providing a reservoir for oil to pool. The missing space resulted from one of several different processes.[113] For example, the reservoir may have been formed from a cessation in deposition or by erosive forces which broke away a section of the stratum many years in the past.[114] A. I. Levorsen, the petroleum geologist who most clearly articulated the concept and argued for its acceptance, defined a stratigraphic trap "as one in which a variation in the stratigraphy is the chief confining element in the reservoir

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[112] Branson, "Petroleum Notes from the Twenties," 94.

[113] Max Ball, Douglas Ball and Daniel S. Tuner, *This Fascinating Oil Business* (Indianapolis, Kansas City, New York: The Bobbs-Merrill Company, Inc., 1965, 1940), 37. For further elaboration on stratigraphic traps, see Kenneth K. Landes, *Petroleum Geology*, 2nd ed., (New York: John Wiley and Sons.; London: Chapman and Hall, Ltd., 1959), 276-279, 388-391, and A. I. Levorsen, *Geology of Petroleum* 2nd ed. (San Francisco: W. H. Freeman and Company, 1967), 287-339.

[114] Ball, et. al., *This Fascinating Oil Business*, 39-40.

which traps the oil."[115] Regardless of how stratigraphic traps formed, geologists could not observe them from the surface and relied primarily on drillers' logs to conceptualize subsurface conditions which provided for the accumulation of oil.

Long before geologists and engineers began to identify limitations in the anticlinal theory, they recognized and attempted to understand how subsurface conditions trapped oil beneath the surface and influenced its production. Subsurface geology consists of a variety of techniques geologists used to gather information about underground conditions in order to construct a map depicting the relationship of oil reservoirs to successive layers of stratigraphy. Many geologists considered John Carll, who worked under J. Peter Lesley on the Second Pennsylvania Geological Survey, a candidate for the title "father of petroleum engineering" because he compiled one of the first subsurface maps detailing the location of oil.[116] Although Carll had no university education, he drew upon well-log data compiled by civil engineers to reconstruct the stratigraphy underlying Pennsylvania's Venango oil district and published these findings in 1875. Carll's report included maps which depicted cross-sections of twenty layers of stratigraphy and their position in relation to three different levels of oil reservoirs.[117] In addition to identifying the relative position of the strata, he included descriptions of distinctive beds and of fossils

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[115] A.I. Levorsen, "Stratigraphic Versus Structural Accumulation," *American Association of Petroleum Geologists Bulletin* 20 (May 1936), 524.

[116] Warner, "Sources of Men," 38; An equally, if not more, viable candidate is Edwin T. Dumble who ran the geological department for the Southern Pacific Railroad in California, but this debate is beyond the scope of my present purpose. See Dorsey Hager to James A. Veasey, June 18, 1941, Veasey Collection.

[117] Owen, *Trek of the Oil Finders*, 107.

characteristic of certain depths as a guide to drillers. Carll's practice of creating a subsurface structure map was far ahead of its time, but his greatest contribution lay in illustrating the fallacy that a relationship always existed between surface topography and the presence of oil.[118] Other geologists and engineers subsequently illustrated and articulated how subsurface conditions governed oil production, but their ideas for the most part fell upon deaf ears.[119] Many practical men and geologists so ardently desired a single, comprehensible prospecting method that they held tenaciously to ideas such as the belt-line theory and later the anticlinal theory because they could employ them on the basis of surface observations alone. Once these methods failed to produce results, though, Empire Gas and Fuel Company took an unprecedented step by exploring the subsurface in a systematic and comprehensive way.

In 1917 Empire became the first company in the history of the oil industry to create a department devoted exclusively to understanding how subsurface geological conditions effected oil exploration and production when Carpenter hired Alex W. McCoy to oversee this new effort. McCoy received his degree in civil engineering from the University of Missouri and in 1914 graduated with a master's degree in geology.[120] He had been teaching in the geology department at the University of Oklahoma when

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[118] Ibid.,108.

[119] The history of subsurface geology unfolded over a number of years and involves a number of geologists. For the best source for identifying the geologists who made the greatest contributions and describing their work, see Ibid., 106-116, 127-133, and 166-173.

[120] Executive Committee, "Memorial: Alexander Watts McCoy," *American Association of Petroleum Geologists Bulletin* 30 (February 1946), 293.

Carpenter hired him to work for Empire. The study of subsurface geology utilized all available data in order to create three-dimensional models that represented underground structures and processes and their relationship to oil.[121] Researchers obtained data from as many sources as possible, including surface exploration, drillers' core samples, and fossils to name a few. In the 1920s, geophysical exploration revolutionized the kind and quantity of data available to conduct subsurface explorations.[122] McCoy started Empire's subsurface department just before that revolution took place, however, and during his tenure there initiated innovative research which would shift the industry's focus from relying solely upon geology to locate and produce oil to utilizing engineering principles as well.

Although other candidates legitimately deserve the title "father" of petroleum engineering, McCoy brought recognition to this field in much the same way Carpenter had for mapping surface structures. Just as Carll's report and maps charted the subsurface of Pennsylvania's oil fields, McCoy's "group of geologists constructed subsurface structure maps, made a detailed investigation of stratigraphic problems throughout the MidContinent district, and served generally as a research group for the Empire Companies."[123] Apparently unaware of contributions by previous geologists and engineers, McCoy never doubted that "the first attempts at petroleum engineering work, as we know it today, were made by the Empire Gas and Fuel Company in 1917," the year

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[121] Landes, *Petroleum Geology*, 84.

[122] Ibid.

[123] McCoy to Veasey, June 20, 1941, Veasey Collection.

he began employment.[124] Although he may have somewhat overstated the case, the subsurface work he directed popularized and won acceptance for the application of engineering principles to oil exploration and production. Initially, his department focused on maximizing production at sites Carpenter had already located, as "all wells in the El Dorado and Augusta fields were drilled in, pipe and cementing recommendations submitted, and the responsibility of measuring up wells was turned over directly to this department."[125] In addition to creating and implementing more efficient procedures for extracting oil already located, McCoy's work also shifted prospectors' focus from surface to subsurface exploration.

To geologists like Carpenter who recognized the anticlinal theory's limitations, McCoy offered promising alternatives to surface exploration by conducting research into methods that illustrated how they could find oil by shifting their focus from surface traps to stratigraphic traps. What most differentiated principles of "engineering" from those of "geology" was the less prominent role field work played in generating information. Prior to the creation of Empire's subsurface department, "the geologic evidence for guidance of operators had been predominately, if not entirely, a study of surface structure."[126] McCoy's hiring marked a turning point in this approach because it "began a period where

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[124] McCoy to Veasey, July 15, 1941, Belt-line theory, Box 23, Veasey Collection. For another example of McCoy's belief that his efforts constituted "the beginning in the Midcontient of petroleum engineering as it is known today," see the same file for McCoy to Veasey, June 20, 1941.

[125] McCoy to Veasey, June 20, 1941, Veasey Collection.

[126] McCoy to Veasey, July 15, 1941, Veasey Collection.

scientific evidence used by engineers and geologists was not limited to the study of surface outcrops."[127] Instead of relying solely on field surveys, the subsurface branch of the geological department "carried on a number of experiments regarding production problems, estimates of reserves, underground stratigraphic studies, and originated many of the general practices which have been greatly improved and are now in vogue by all of the departments of geology."[128] McCoy saw his approach to exploration as a significant departure from the traditional field surveys of the kind Carpenter and other university-trained geologists conducted. He characterized his work as the starting point for a new type of exploration. McCoy differentiated "between the period when geology first became prominent throughout the Midcontinent, since it was primarily a field science of an exploratory nature, limited to the study of surface outcrops" and the period beginning in 1917 when "various phases of scientific endeavor were commenced which later have developed into the intricate phases of petroleum engineering."[129] In the first period he described, finding and producing oil had been a geological enterprise but in the later period engineering knowledge and technical expertise determined how efficiently companies could extract oil that lay trapped beneath the ground.

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[127] Ibid.

[128] Ibid.

[129] Ibid.

Chapter 6:

"Practical Oil Men and the Oklahoma Oil Conservation Statute, 1915"

Oklahoma's practical oil men devised and implemented an oil conservation plan in 1915 that successfully limited overproduction and curbed the ability of integrated companies' to use pipelines in order to control particular oil fields within the state. The success of their conservation plan contradicts historian Samuel Hays' argument that professional scientists working in the federal government established the conservation agenda during the Progressive era. Hays argued that conservation sentiment did not spring from a grassroots public railing against "the interests" but from professional scientists working for the federal government whose "ideals and practices" set the tone for the movement to conserve natural resources.[1] Practical men in Oklahoma found oil consistently on the basis of methods they had crafted and devised their own solutions to overproduction, challenging Hays' contention that "conservation, above all, was a scientific movement, and its role in history arises from the implications of science and technology."[2] On the contrary, the movement to conserve oil on the Southern Plains began as a grassroots political struggle led by practical men who consciously avoided

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[1] Samuel Hays, *Conservation and the Gospel of Efficiency: The Progressive Conservation Movement, 1890-1920*, (Pittsburgh: University of Pittsburgh Press, 1999; Originally published: Cambridge : Harvard University Press, 1959), 1-2.

[2] Ibid., 2. For a critique of Hays which influenced some of the following points I make, see Donald J. Pisani, *Water and American Government: The Reclamation Bureau, National Water Policy, and the West, 1902-1935* (Berekely, Los Angeles, and London: University of California Press, 2002), 287-288.

science and technology devised by professional scientists like Gould. The situation in Oklahoma revises Hays' argument on another count.

Considering how practical men consistently identified Standard Oil affiliates or subsidiaries as the culprits responsible for overproduction, Hays' contention that conservation advocates did not center their "fire primarily upon the private corporation" fails to characterize the attitude of Oklahoma's independent producers.[3] The 1911 Supreme Court which broke-up the Standard Oil trust occurred only ten years after the discovery of Texas' highly productive Spindletop oil field opened the way for new companies to begin integrating their operations.[4] The pattern was repeated throughout the region as additional oil was discovered in Texas, Oklahoma, and Kansas for approximately the next thirty years, providing companies with significant incentive to perfect integration. Pipelines proved key to their strategy because companies who owned them supplied the only effective means of transportation, enabling them to dictate the price paid to independent producers for oil. Integrated companies often induced independent oil men to produce as much oil as possible with the promise of purchasing it all, leading to frenzied competition, a glut of oil, and power in the hands of pipeline companies. Independent producers moved to remedy the situation when they organized into producers' associations, crafted an oil conservation statute, and lobbied the

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[3] Hays, *Conservation and the Gospel of Efficiency,* 1.

[4] Joseph A. Pratt, "The Petroleum Industry in Transition: Antitrust and the Decline of Monopoly Control in Oil," *Journal of Economic History* 40 (December 1980), 817.

legislature for reform. Variations of the movement which coalesced in Oklahoma surfaced in other Southern Plains' states, and independent oil men, not professional scientists in the federal government, continued to dominate the issue until the latter-1920s.

Shortly after 1859 when Edwin T. Drake drilled the first commercial oil well in Pennsylvania, the question of who owned this resource grew into a hotly contested issue. Oil men possessed only rudimentary knowledge of how to extract petroleum from the ground, but they recognized very soon the conflict of interest between themselves and others who rushed-in to drill next to their productive wells.[5] Derricks sprouted overnight and the race began among multiple drillers to drain as much oil as possible before their neighbors could do the same. The migratory nature of oil after drilling had begun complicated matters of ownership. In an undisturbed state, oil remained in one place but when a well released pressure by puncturing the boundaries of a reservoir, it moved toward that point and crossed property lines designated at the surface.[6] Owners of adjoining tracts who felt cheated by their neighbors looked to the courts for a determination of ownership.

Judges could not easily decide who owned the oil because no legal precedents existed prior to the mid-nineteenth century. Operating within this legal vacuum, the

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[5] *History of Petroleum Engineering*, (New York and Dallas: American Petroleum Institute, 1961), 1124.

[6] Max W. Ball, *This Fascinating Oil Business* (Indianapolis and New York: Bobbs-Merrrill Company, 1940), 92-3; Nicholas George Malavis, *Bless the Pure and Humble: Texas Lawyers and Oil Regulation, 1919-1936*, (College Station: Texas A&M University Press, 1996), 12.

Pennsylvania Supreme Court drew upon English common law rules of property and issued three rulings which collectively established "the rule of capture," a precedent which provided the predominant rationale for determining ownership of oil and gas rights until approximately 1935. Just as a property owner acquired title to a wild animal if "captured" on his land, title to oil or gas devolved upon the person who "captured" them even if they migrated to his land from beneath an adjoining tract. Without the knowledge that petroleum geologists would later develop explaining how and where oil pooled, the court offered the rule of capture as the most reasonable method for resolving ownership conflicts.

The Pennsylvania court acknowledged that its ruling originated from an inadequate understanding of underground conditions. As one justice explained, "exact knowledge on this subject is not at present attainable, but the vagrant character of the mineral" justified the decision.[7] Oil's "vagrant character" complicated the court's task of formulating an effective law because "there is no certain way of ascertaining how much of the oil and gas that comes out of the well was when in situ under this farm and how much under that."[8] The only resolution the court could offer to aggrieved litigants who complained that neighbors siphoned oil from beneath their land was to "go thou and do

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[7] Barnard vs. Monongahela Gas Company 216 PA. 362, 65 Atl. 801 (1907); as cited in Robert E. Hardwicke, "Rule of Capture as Applied to Oil and Gas," An Address Delivered Before the American Bar Association Section of Mineral Law, at the Annual Meeting in Los Angeles, California, July 15, and 16, 1935, p. 9; James Veasey collection, Folder 4, Rule of Capture, Box 33, American Heritage Center, University of Wyoming.

[8] Ibid. *In situ* means in an original place or location, such as oil in its natural underground state.

likewise."[9] Every owner had to protect himself by extracting as much oil and gas as possible, for "he knows it is wild and will run away if it finds an opening and it is his business to keep it at home. This may not be the best rule; but neither the Legislature nor our highest court has given us any better."[10] The rule of capture amounted to no rule at all. The court codified a climate which led to unremitting production and caused waste because the market could not absorb this surplus oil.

Unabated production empowered large, integrated companies like Standard Oil to dictate the price per barrel when purchasing supplies from independent producers in Kansas. Standard purchased significant amounts oil in the state from 1902 to 1905, but independent producers began to resent the company in early 1904 when it announced a series of price cuts.[11] They accused Standard of price-fixing but, prompted by the rule of capture, independent producers contributed to the declining price by continuing to produce oil. Production more than quadrupled from 932,000 barrels in 1903 to 4,250,000 in 1904, causing prices to continue dropping.[12] The more independent men produced, the more their dependency on Standard grew. Surplus production benefitted Standard because the company's integrated structure allowed it to control the state's refineries, pipelines, and storage tanks, providing independent producers the only market to sell

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[9] Malavis, *Bless the Pure and Humble*, 14.

[10] Barnard vs. Monongahela Gas Company; cited in Hardwicke, "Rule of Capture as Applied to Oil and Gas," p. 9.

[11] Francis W. Schruben, *From Wea Creek to El Dorado* (Columbia: University of Missouri Press, 1972) 57, 67.

[12] Ibid.,100.

their oil.[13] Independent producers felt exploited by the Standard Oil "octopus" and organized the Kansas Oil Producers Association in order to resist control.[14] Their vulnerability intensified when Standard bypassed independents and purchased from its own production subsidiaries.

The Prairie Oil and Gas Company began functioning as Standard's primary Midcontinent supplier of oil in 1901 and continued for many years thereafter selling oil to subsidiaries formed as a result of the 1911 antitrust ruling. Prairie dominated the Midcontinent crude oil markets for approximately a decade starting 1910.[15] The company learned quickly that the rule of capture worked to its advantage. Prairie purchased oil when overproduction pushed prices down, stored what it had purchased in huge tank farms, and sold when prices increased.[16] The company's ability to invest in pipelines and tank farms allowed it to exploit the advantages of its integrated structure. Independents who made-up the ranks of the Kansas Oil Producers association focused their wrath on Prairie just as they had on Standard.[17] Among their efforts, independents lobbied the Kansas legislature for a law deeming all pipelines within the state common carriers.[18]

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[13] Ibid., 35,

[14] Ibid., 57.

[15] Edgar W. Owen, *Trek of the Oil Finders: A History of Exploration for Petroleum* (Tulsa: American Association of Petroleum Geologists, 1975), 333.

[16] Ibid., 333.

[17] Schruben, *From Wea Creek to El Dorado*, 101.

[18] Ibid.

When the Prairie Oil and Gas Company extended a pipeline into Oklahoma in 1905, independent producers in that state inherited Kansas' problem.[19]

Oil men in Oklahoma struggled to deal with problems of overproduction upon discovering the state's first major oil field at Glenn Pool in 1905.[20] Prospectors from eastern states located oil and gas in southeastern Kansas in 1882 and continued exploring southward where they discovered additional accumulations in Indian Territory.[21] They found Glenn Pool in December 1905 which at the time lay within the Creek Nation. Initially, much of the oil they found lay at shallow depths which they retrieved without pumps because gas pressure drove it to the surface.[22] Upon the completion of each well, oil flowed relatively easily and abundantly to the surface. By 1907, independent operators had drilled 102 wells which produced approximately 100,000 barrels a day. Although oil flowed in vast quantities from numerous wells, it bottle-necked on its way to market because inadequate railroad facilities could not transport the field's voluminous production. A more efficient mode of transportation arrived when pipelines entered the field.

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[19] Blue Clark, "The Beginning of Oil and Gas Conservation in Oklahoma, 1907-1931," *Chronicles of Oklahoma* 55 (1977-1978), 377.

[20] Kenny Franks, *The Rush Begins: A History of the Red Fork Cleveland, and Glenn Pool Oil Fields* (Oklahoma City: Western Heritage Books, 1984); Frank Galbreath, *Glenn Pool, A Little Town of Yesteryear* (Tulsa: By Author, 1978)

[21] Ibid.

[22] Carl N. Tyson, James H. Thomas, and Odie B. Faulk, *The McMan: The Lives of Robert M. McFarlin and James A. Chapman* (Norman: University of Oklahoma Press, 1977), 19.

Three major oil companies built pipelines to Glenn Pool by 1907 and in the process placed independent operators without an easily accessible market at their mercy. The Gulf and Texas companies constructed pipelines from southern Texas to Glenn Pool in 1907.[23] The principal purchaser of oil in the field, however, was the Standard subsidiary and supplier, Prairie Oil and Gas Company.[24] These companies purchased the oil independent operators produced and transported it to refineries. After acquiring their own leases, integrated companies produced and transported their own oil and purchased from independent producers only enough oil to fill the space remaining in their pipelines. When pipeline companies integrated the production end of the business into their operations, independent men's market instantly diminished but most continued extracting oil even though they could not immediately sell it. If they ceased producing altogether, the rule of capture ensured that pipeline companies who owned the means of transport would continue to drain whatever oil remained in the field. No easy solution presented itself, and in February 1909 at Glenn Pool "the principal topic of discussion among oil men has been a shut-down, general or in part."[25] Most expressed unease at shutting down production entirely, and "a larger number favor the cessation of all new drilling including

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[23] W. P. Z. German, "Legal History of Conservation of Oil and Gas in Oklahoma," in *Legal History of Conservation of Oil and Gas* (Chicago: American Bar Association, 1939), 111.

[24] Ibid.

[25] "Oklahoma Operators Talk of a Shut Down," *Oil and Gas Journal* 7 (February 6, 1909), 73.

wildcatting."[26] Confronted with this dilemma, independent men chose to continue producing oil and to store what they could not sell. The question of how and where to store large quantities of oil efficiently soon presented another vexing problem.

Feeling helpless against integrated companies, many small producers built earthen storage ponds to house surplus oil hoping eventually to find a purchaser. One early Glenn Pool independent , Charles Colcord, recounted the dilemma he and other oil men often faced when pipeline companies ceased purchasing their oil. Colcord and his partners leased a tract of land and agreed to drill ten holes by a certain date, but they produced so much oil after the first six wells that "our storage was brimful."[27] They could not sell what they had stored because "pipelines were taking only about ten or twenty percent of the production" which meant "we had to let up on our drilling to avoid wasting the oil."[28] When notified that their lessor would hold them to the terms of the contract, Colcord and partners drilled around the clock to complete the agreed upon ten wells. Meanwhile, they hired "all the teams in that part of Oklahoma" to begin building an earthen storage pond by "damming up a big hollow."[29] After completion of this additional storage site, all that they produced from the ten wells "filled this great lake and I believe that the greater part

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[26] Ibid.

[27] Charles Francis Colcord, *The Autobiography of Charles Francis Colcord* (Tulsa, OK: C. C. Helmerich, 1970), 199. .

[28] Ibid., 200.

[29] Ibid.

of all this oil was wasted."[30] Ruptured storage reservoirs wasted oil but also caused serious environmental damage.

Inadequate storage facilities heightened the need for conservation because escaping oil polluted nearby streams and killed water fowl. Oil stored in earthen reservoirs failed quickly evaporated, seeped back into the ground, or washed-out retaining walls.[31] One observer noted that "'more oil has run down the creeks from the famous Glenn Pool than was ever produced in Illinois."[32] Colcord recounted how the production from another operator's wells flowed into "the biggest lake of oil I ever saw."[33] Each day anywhere from 250 to 500 barrels flowed from the wells, creating lakes of oil "so large that thousands of wild ducks alighted on them never to rise again."[34] Although the producer had taken great pains to store what he could not sell, "the greater part of this oil was also wasted."[35] Harming the environment did not concern independent men as much as the economic loss they suffered.

Failed storage facilities caused independent men to lose the oil they had worked so hard to produce, and resulted in wasted effort and the loss of potential profits.

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[30] Ibid.

[31] German, "Legal History of Conservation of Oil and Gas in Oklahoma," 112.

[32] Order No. 937, *Eight and Ninth Annual reports of the Corporation Commission of the State of Oklahoma.* (Oklahoma City, 1914); cited in German, "Legal History of Conservation of Oil and Gas in Oklahoma," 112.

[33] Colcord, *Autobiography,* 200.

[34] Ibid.

[35] Ibid.

Integrated companies could afford steel tanks to store surplus production but this additional expense placed a financial burden on many independents. Insufficient capital dictated that small producers like Colcord pursue the cheaper alternative of constructing earthen reservoirs, but pools of oil sitting uncovered quickly evaporated and seeped back into the ground.[36] Even at the risk of losing all they had produced, the rule of capture prompted independents to continue this inefficient practice at a dizzying pace. Colcord recounted how producers at Glenn Pool who owned abutting property often engaged in a "line fight" to extract oil which sat beneath both parcels of land. Bob Galbreath and Dave Connally owned eight acres of land next to one another, and "they each started a line of wells three hundred feet apart, the full half-mile length of their eighty acres."[37] Connally "had the same kind of line fight" with Bill Milligan who owned eighty acres on the other side of his property.[38] Milligan pumped his oil into "a large draw running the full length of his eighty acres."[39] After he created one lake of oil, Milligan "had number two lake ready and it was filled, then number three was filled–a monument to the folly of both men."[40] Colcord considered their actions "folly" because he had experienced firsthand how waste resulted from inefficient storage facilities. Independent men also displayed folly because they competed amongst themselves while integrated companies with

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[36] German, "Legal History of Conservation of Oil and Gas in Oklahoma," 112.

[37] Colcord, *Autobiography,* 200.

[38] Ibid.

[39] Ibid.

[40] Ibid.

pipelines continued transporting oil.

Prior to Oklahoma statehood, the Secretary of the Interior held the only governmental authority to address wasteful oil field practices and prescribed a set of rules governing reservoir construction and use but not the competitive advantage pipelines gave to integrated companies. On June 11, 1907, the secretary issued regulations which established fifteen feet as the minimum height for reservoir walls.[41] He also required producers to gauge accurately a tank's holding capacity before filling it with oil in order to avoid spillage.[42] These regulations, however, only impacted independent men because companies that owned pipelines did not have the added burden of having to store their oil. The Secretary did not issue any rules which addressed the issue of competition, thereby perpetuating "staggering physical surface wastes of oil and economic losses to practically all except the few strong companies."[43] Although the federal government did not provide independent men with any legislative relief, the state legislature enacted laws intended to remedy the situation once Oklahoma entered the union.

The Oklahoma legislature passed a law in 1909 what was probably the first statute by any state addressing problems within the oil industry resulting from competition between integrated companies and independent producers.[44] To ensure an equal opportunity for all independent operators to sell their oil, the law deemed pipeline

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[41] German, "Legal History of Conservation of Oil and Gas in Oklahoma," 112.

[42] Ibid.

[43] Ibid.

[44] Ibid., 113-114.

companies "common purchasers" and stipulated they must buy oil "without discrimination in favor of one producer or one person as against another...."[45] In addition to preventing pipeline companies from bestowing preferential treatment on a particular operator, the law went further by specifying that "in the event such purchaser is likewise a producer, it is hereby prohibited from discriminating in favor of its own production..."[46] To prevent pipeline companies from giving priority to their own oil and purchasing from independent producers as an afterthought, the law deemed that they "shall purchase and transport petroleum from each person and producer ratably, in proportion to the average daily production."[47] Another section of the law directly addressed the competitive advantage integrated companies possessed over independent producers by declaring it illegal for the owner of a pipeline "to own or operate, directly or indirectly, any oil well, oil leases or oil holdings or interests..."[48] Companies already in possession of oil properties "shall divest themselves" of such holdings.[49] The 1909 common purchaser statute worked well for a while, but the threat to independents from integrated companies reemerged with additional discoveries of oil throughout the state.

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[45] Section 4307, *Revised Laws of Oklahoma, 1910*, vol. 1, (St. Paul, Minnesota: The Pioneer Co., 1912), 1112. See section 4309 of the law deemed all pipeline companies "common carriers" to ensure that even if the company had not purchased the oil it could not discriminate in whose oil it chose to transport.

[46] Ibid.

[47] Ibid.

[48] Section 4310, *Revised Laws of Oklahoma, 1910*, 1113.

[49] Ibid.

Discovery of two very productive Oklahoma fields in 1912 and 1913 reintroduced many of the problems between independent operators and integrated companies that had plagued Glenn Pool. Oklahoma led the country in production at this time, and most of the state's oil came from the Cushing and Healdton fields. Together, they produced so much oil that many operators could not find a market regardless of the 1909 common purchaser statute.[50] As at Glenn Pool, oil men at Cushing and Healdton believed pipelines would solve the problem of overproduction by providing them with the means to sell their oil. Magnolia Petroleum Company was a fully integrated organization and moved aggressively to build pipelines from its refineries on the Gulf Coast to Cushing and Healdton.[51] Formed in 1911 with Standard Oil assets, Magnolia competed with the Prairie Oil and Gas Company to buy oil cheaply throughout the Midcontinent region. Magnolia built its first pipeline from refineries in Beaumont and Corsicana to north Texas and continued building north to Healdton in 1913-1914.[52] Within a year, the company paid $35,000,000 for leases and an existing pipeline to the Cushing field.[53] Even though other companies built pipelines to Cushing, together they could not purchase all the oil produced. Tank farms sprouted overnight in order to store the surplus oil. One operator recalled that "this is the first time in the history of the business that so many different

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[50] German, "Legal History of Conservation of Oil and Gas in Oklahoma," 117, 119.

[51] Owen, *Trek of the Oil Finders*, 333-334.

[52] Ibid.

[53] Ibid.

individuals have built the large number of tanks that are being completed at Cushing."[54] Similar problems occurred at the Healdton field.

Wirt Franklin remembered how his discovery of oil precipitated a rush of like-minded prospectors seeking fortune and that they produced so much oil the market eventually disappeared. He recounted that "after discovery of Healdton, there was a great influx of oil operators, who leased everything they could get for miles around the discovery well in all directions."[55] So many oil men flocked to the area "there was a wild scramble for leases" as they attempted to secure land and drill their own wells.[56] Eventually, prospectors discovered the Hewitt field ten miles to the west and another "wild scramble" ensued. After the Hewitt discovery well had been drilled, "everything that was open and unleased was quickly gobbled up at high prices by the operators of this area in all directions from the well."[57] At both Healdton and neighboring Hewitt, oil men acquired leases and sank wells which eventually yielded large amounts of oil. As long as they could sell the oil they produced, independent operators' prospects at Healdton appeared bright. Their situation appeared to brighten even more when Magnolia finished its pipeline.

Representatives from Magnolia encouraged independent operators to produce as

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[54] "Building Storage Tanks," *Oil and Gas Journal* 13 (August 13, 1914), 14.

[55] Wirt Franklin to James Veasey, June 28, 1941, James A. Veasey collection, American Heritage Center, University of Wyoming. (Hereafter cited as Veasey collection)

[56] Ibid.

[57] Ibid.

much oil as possible in order to fill the pipeline it was constructing from Ft. Worth, Texas to the Healdton field. Franklin recalled that Magnolia president, Dave Stewart arrived at nearby Ardmore and "called on everybody who had a lease in the Healdton field."[58] Gathering independent producers around him, Stewart "urged them to drill as many wells as possible and get them on production because his company, the Magnolia, was building a pipe line to the field and they wanted enough oil to fill the line by the time it could be completed, in 60 or 90 days."[59] Oil men willingly complied with Stewart's request because he promised that his company "would buy all the oil that we could produce, and would pay us therefore the posted price then in effect in other parts of Oklahoma, which was $1.03 a barrel."[60] Franklin remembered that he "urged me to put at least ten strings of tools to work drilling up our leases..."[61] Franklin and his partners complied too because "we believed him, took him at his word," and contracted with drillers to sink wells on their leases.[62] Prompted by the promise of an easily-accessible market once the pipeline arrived, they extracted as much oil as possible so that "by the time the pipe line was completed, there was a very large production."[63] Oil men produced so much oil that

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[58] Ibid.

[59] Ibid.

[60] Ibid. Magnolia offered to pay 70 cents a barrel "for oil under 32 gravity and $1.03 for that above 32 gravity." *Oil and Gas Journal* 12 (March 12, 1914), 8-10.

[61] Franklin to Veasey, June 28, 1941, Veasey collection.

[62] Ibid.

[63] Ibid.

"we had 1600 barrel wooden tanks in large numbers around each producing well and later on earthen storage on nearly every lease."[64] Having produced such a bountiful supply of oil, the producers had only to await the pipeline's arrival which would provide them with a market for their product. Ostensibly, the situation served the needs of both the pipeline company and independent producers.

Completion of the pipeline spelled disaster for independent oil men who had produced and stockpiled enormous amounts of oil because Magnolia lowered the price it promised to pay once construction completed. Franklin recounted, "it was not long until there was a wild orgy of drilling and there was no market for the oil."[65] They had dutifully complied with Stewart's request to produce as much oil as possible, but "when the pipe line finally reached the field, the Magnolia cut the price from $1.03 a barrel to 70 cents a barrel and a short time later by successive cuts until the price was reduced to 30 cents a barrel."[66] To make matters worse, "Magnolia had acquired a few leases and drilled wells thereon."[67] Acquiring its own oil-rich land enabled the company to transport what it produced and avoid purchasing from independent men. This strategy proved so successful that the company increased its holdings from "a few leases" and became "the

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[64] Ibid.

[65] Ibid.

[66] Ibid.

[67] Ibid.

largest buyer and checkerboarded the area for twenty miles around."[68] In the event that its properties did not yield sufficient quantities of oil, Magnolia ensured that its pipeline remained full by negotiating a contract to purchase the McMann Oil Company's production. Independent oil men realized that Stewart had them in a vulnerable position. As Franklin explained it, "even at 30 cents we could not sell any oil for the reason that the Magnolia was filling their pipe line with oil from their own properties and the properties of the McMann Oil."[69] The company created a situation that enabled it to purchase from independent operators only as a last resort, and even then dictated the price. Despite the low price independents received, they had no incentive to cease producing oil.

In a situation very reminiscent of Glenn Pool, independent men at Healdton continued producing oil even though they had no market resulting in waste and significant environmental damage.[70] Recalling how he and other producers competed to extract as much oil as possible, Franklin said that "the Healdton field was in a state of indescribable chaos."[71] The rule of capture dictated they either extract oil as quickly as possible or lose any opportunity of every acquiring it. Because of this mindset, "oil was being put into earthen tanks and in some cases into ravines, which had been dammed for the purpose to prevent properties being drained by the Magnolia and McMann companies

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[68] The term "checkerboarded" refers to the system of acquiring large amounts of land in a checkerboard pattern in anticipation of finding oil. Owen, *Trek of the Oil Finders*, 313.

[69] Franklin to Veasey, June 28, 1941, Veasey collection.

[70] German, "Legal History of Conservation of Oil and Gas in Oklahoma," 115.

[71] Franklin to Veasey, June 28, 1941, Veasey collection.

through wells on their property."[72] Nature seemed to undermine their efforts when "heavy rains came and washed out the oil which had been impounded in ravines and hundreds of thousands of barrels went down the creek."[73] Their situation worsened when "in these same storms lightning struck the stored oil and other tens of thousands of barrels went up in flames."[74] In addition to the environmental damaged caused by polluting nearby creeks, independent men wasted natural resources and impaired the long-term prospects for the field's productivity by allowing huge stores of natural gas to escape into the atmosphere. At the time, producers did not widely recognize the utility of preserving natural gas in order to maximize underground pressure and drive oil more forcefully to the surface which would have increased the total yield. Franklin lamented that wells producing as much as 30,000,000 cubic feet of gas per day "were allowed to blow wide open in order to bring them into oil producers."[75] Without a market to sell their oil and nature undermining their efforts at every turn, Healdton oil men sought redress by taking their complaints to executives at Magnolia.

Independent oil men organized themselves into the Ardmore Oil Producers Association and appointed Franklin as their president in order to present their grievances Magnolia officials. Members of the producers' association traveled to Dallas to conduct a meeting at the company's headquarters, but when they arrived and expressed their

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[72] Ibid.

[73] Ibid.

[74] Ibid.

[75] Ibid.

intention to a secretary "the young lady came back and informed us that they had nothing to discuss with us. They refused to see us."[76] Employing another tactic, "we tried also to discuss the matter with C. R. Stewart then in charge of the Magnolia pump station in the Healdton field, and he likewise told us there was nothing to discuss."[77] Only when independent producers took their complaints to state officials did Magnolia executives express a willingness to discuss the matter.

The Oklahoma constitution provided for a three-member Corporation Commission and charged it with establishing rates and operating standards for transportation and utility companies within the state, and the commissioners listened to Healdton producers' complaints. The commission had significant investigative and administrative authority and only the state supreme court could overturn its decisions.[78] Rebuffed by Magnolia, the producers' association filed a grievance with the Corporation Commission which held a hearing on the matter. Franklin recounted that "when the hearing was about half over and we were proving discrimination in the taking of oil, George C. Greer, Counsel for Magnolia, asked that the hearing be continued until the following day and that a committee of producers be appointed to negotiate with the Magnolia officials..."[79] As a result of these negotiations, the company and producers

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[76] Ibid.

[77] Ibid.

[78] James R. Scales and Danney Goble, *Oklahoma Politics: A History* (Norman: University of Oklahoma Press, 1980), 24-5.

[79] Franklin to Veasey, June 28, 1941, Veasey collection.

agreed to a contract in which Magnolia would buy all oil in earthen storage at thirty cents a barrel and make subsequent purchases from all oil men in the field based upon a percentage of what each produced. When the First World War broke out in 1914, "they forgot the contract and commenced all over again the same old and a second case was brought before the Corporation Commission which resulted in a compromise and a new contract."[80] Feeling emboldened after finding an ally within the ranks of state government, independent producers moved to consolidate even more power behind their cause by approaching the Oklahoma legislature.

Oil men throughout Oklahoma realized by 1914 that the common purchaser law passed four years earlier ceased to protect their interests and looked for a new solution to the problem of physical and economic waste incurred when pipelines entered a field. After experiencing Magnolia's perfunctory attempts to negotiate, independent producers "were not satisfied with the treatment they had received under these contracts and decided to take the matter to the legislature."[81] Problems of overproduction and waste plagued other Oklahoma fields, "and the market for oil throughout the state was sadly demoralized."[82] Amidst these conditions, independent operators at four other Oklahoma fields followed Healdton's lead and organized themselves into producers' associations. Together these five groups lobbied the legislature for redress. Two men from each producer's association met in Oklahoma City and "decided to ask the legislature to pass

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[80] Ibid.

[81] Ibid.

[82] Ibid.

an oil and gas conservation law to stop the terrible waste that was going on in the state, and to force ratable taking of oil from a common pool when the entire production could not be taken."[83] This ten-member advisory board next selected three men to draft a conservation law and chose Franklin to push the law through the legislature.

The Oklahoma legislature convened it January 1915 and passed legislation which addressed practical oil men's concerns about waste and the monopoly that integrated companies exerted throughout the state. Commonly referred to as the Oil Conservation Act, the legislature enacted House Bill No. 168 on February 11, 1915. The law declared that extracting oil "in such manner and under such conditions as to constitute waste, is hereby prohibited."[84] More importantly, the law expanded the definition of what constituted "waste." In addition to the term's "ordinary meaning," the legislature deemed that it "shall include economic waste, underground waste, surface waste, and waste incident to the production of crude oil or petroleum in excess of transportation or marketing facilities or reasonable market demands."[85] This statement enumerated the multiple ways in which the rule of capture wasted oil. Economic waste resulted when overproduction required producers to spend capital constructing storage facilities. Underground waste occurred when producers allowed large stores of natural gas to escape, disregarding its utility in maximizing recovery of oil deep within a reservoir.

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[83] Ibid.

[84] *State of Oklahoma Session Laws of 1915*, Passed at the Regular Session of the Fifth Legislature of the State of Oklahoma, January 1915 (Oklahoma City: State Printing and Publishing Co., 1915), 35.

[85] Ibid., 36.

Evaporation and broken dikes caused surface waste. Frenzied competition among producers to capture oil before competitors led to production "in excess of transportation or marketing facilities or reasonable market demands." By expanding the definition of the term "waste," the Oklahoma legislature moved to conserve oil but also to address the competitive advantage pipelines gave to integrated companies.

To ensure that all producers enjoyed access to the Healdton field, the Conservation Act deemed oil beneath the ground a common resource and stipulated that the quantity each producer could extract must correspond to the number of productive wells he owned. The law took for granted the inability to determine property rights of oil still in the ground, stating that each producer drilling into a "common source of supply may take therefrom only such proportion" as his well or wells bore to the total production of the field.[86] By classifying oil as a "common" resource, the law empowered the Corporation Commission to regulate production "to prevent the inequitable or unfair taking...by any person, firm, or corporation, and to prevent unreasonable discrimination in favor of any one such common source of supply as against another."[87] To ensure that integrated companies with pipelines could not dictate the price of oil, the law further stipulated that "the actual value of such crude oil or petroleum at any time shall be the average value as near as may be ascertained in the United States..."[88] The Conservation Act vested the Corporation Commission with full authority to enforce all these

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[86] Ibid.

[87] Ibid., 37.

[88] Ibid., 36.

provisions. Never before had any state enacted an oil conservation law which simultaneously addressed the problems of wasting oil and monopoly control created by the rule of capture.[89]

Franklin wasted little time putting the law to a test when less than two months after its passage he filed a complaint on behalf of the Ardmore Oil Producers' Association with the Corporation Commission, alleging violations at Healdton of all major provisions in the Oil Conservation Act. The complaint argued that a number of companies wasted oil by producing more than their apportioned share, exceeding pipeline capacity, and stored this surplus oil in above-ground tanks.[90] In addition to the physical waste resulting from overproduction, independent producers incurred economic waste because they had to expend capital continuing to produce what they could not sell and build tanks to store the oil rather than leave it in the ground for others to extract. Independent producers had drafted the Oil Conservation Act to address these very issues, and the Corporation Commission enforced the law as they had written it.

One of the three commissioners, George Henshaw, understood clearly the mandate the law bestowed upon he and his colleagues. According to Henshaw, "the legislature had in mind mainly two objects" when it passed the Oil Conservation Act.[91]

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[89] German, "Legal History of Conservation of Oil and Gas in Oklahoma," 127.

[90] Defendants in the case included: W and F Oil Company, 1911 and Bayou Company, Corsicana Petroleum Company, and Ardmore Refining Co. *Eight and Ninth Annual Reports of the Corporation Commission of the State of Oklahoma*, For the Years Ending June 30, 1915 and June 30, 1916. (Oklahoma City, 1916), 252.

[91] Ibid., 261.

First, lawmakers intended the commission "to regulate the production of oil by the operators so that the weaker or small producers would be guaranteed his pro rata part of the oil."[92] Second, the legislature charged commissioners with ensuring that oil was "produced and preserved in such manner that the public would enjoy the full benefits thereof at reasonable prices..."[93] Henshaw defined "the public" broadly to include average citizens who consumed the oil, independent producers like Franklin who initiated the complaint, and even integrated oil companies whose headquarters may have resided outside the state but who invested capital in Oklahoma oil fields.

Henshaw strove to render a judgment which took all these interests into consideration. He acknowledged that "some of the producers in the Healdton field have gone to great expense in establishing pipe lines and refineries" and that others "have contracted to furnish a certain amount of oil within a given time."[94] Despite significant investments and binding agreements, he reasoned that these conditions did not bestow upon integrated companies greater access to the common supply of oil than independent producers possessed. For example, the Magnolia Pipe Line Company built a pipe line to the field as well as three refineries throughout Texas in order to process the oil it transported. In addition, the Corsicana Petroleum Company incurred costs acquiring

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[92]Ibid.

[93]Ibid.

[94] Order No. 937, *Eight and Ninth Annual reports of the Corporation Commission of the State of Oklahoma.* (Oklahoma City, 1914); cited in German, "Legal History of Conservation of Oil and Gas in Oklahoma," 257.

"extensive marketing facilities" throughout Texas, Oklahoma, and other states.[95] Henshaw could not accept, however, that these companies "have a right to extract from the common source of supply" all the oil necessary "to supply all of their market demands and the contracts entered into."[96] Without some authority to regulate production, large integrated companies "would have the other producers absolutely at their mercy."[97] Unsettled at this prospect, Henshaw posed the question, "Must the field be turned over entirely to the Magnolia Petroleum Company, the other pipe line companies and the individual that makes his private contract, and the state be powerless to protect a citizen who has an equal right to take oil from the field?"[98] Although a hypothetical question, he made clear that only the authority of the state could ensure all operators–large and small–enjoyed equal access.

The Corporation Commission identified the rule of capture as the source of the problem among producers in the Healdton field and unequivocally asserted its authority as a representative of state power to determine fair production practices. As proof of its authority, the Commission invoked the Oil Conservation Act and reiterated that it was "authorized to prescribe rules and regulations for the taking of oil under certain

[95] Ibid.

[96] Ibid.

[97] Ibid.

[98] Ibid.

conditions so as to prevent inequitable or unfair operations by the producers."[99] Since the law did not delineate how much each producer could extract, the Commission authorized itself "to ascertain from day to day and from time to time the pro rata part of the oil that each producer may take from the ground without constituting waste as defined by the law."[100] The commission enumerated ten rules and regulations including a provision appointing an umpire to ensure that whether each producer extracted only his "pro rata part" of the field and nothing more. The commissioners designated A. L. Walker their agent and empowered him to "make a gauge of each well" in order to determine its potential production and apply this measurement as "a basis for the fair and equitable taking of oil from the common source..."[101] Once he had measured each well's production capacity, Walker calculated the maximum potential for the entire field. The last step in determining how much each producer could extract required Walker to measure pipeline capacity in order to "ascertain the amount of oil necessary to meet the daily market demands."[102] This oversight at the local level provided the key component to an effective conservation plan and prevented overproduction at Healdton and all oil fields throughout the state until approximately 1930.

The best testament to the effectiveness of the 1915 oil conservation statute came

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[99] Order No. 920, *Eight and Ninth Annual reports of the Corporation Commission of the State of Oklahoma.* (Oklahoma City, 1914), 255

[100] Ibid.

[101]Ibid., 261.

[102] Ibid.

from Franklin himself. Nearly fifteen years after he achieved passage of the law, he hoped to avert federal regulation when representatives of integrated oil interests began lobbying for federal oil conservation legislation. He spoke at a 1929 conference of industry representatives and government officials and took the opportunity to make clear that conservation conceived at the local level worked best. Franklin made a point to "remind this conference that the original conservationalists [sic] in the oil industry were the small producers of Oklahoma."[103] He recounted that the legislation he and other producers wrote and lobbied into passage had prove effective. The oil industry did not need federal authority to conserve oil and he wanted jurisdiction to remain within the statel. He also took the opportunity to tell conferees that integrated oil companies originally opposed conservation, stating that "at the time these laws were presented to the legislature they met with the concerted and determined opposition of the major pipeline and purchasing companies, the very interests which, during the past two years, have claimed to be the originators of conservation."[104] The fact that integrated companies had reversed their position on conservation by 1929 and sought a federal solution testified to the effectiveness of Franklin's plan. The lobbying effort of integrated companies was part of an attempt to eliminate the control over oil production at the local level, but this was a battle Franklin eventually lost.

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[103] Wirt Franklin, "The Colorado Springs Speech"; reprinted in George Elliott Sweet, *Gentleman in Oil* (Los Angeles: Science Press, 1966), 52.

[104] Ibid.

Chapter 7:

"Contesting the Oil Field: Engineers and Technocrats Co-opt Conservation"

Oklahoma Governor William H. Murray, or Alfalfa Bill as he is popularly known, declared martial law in 1931 to take control of the oil industry in his state. The price per barrel had been declining and additional production continued to glut the market. Oklahoma had passed a law mandating prorationing, which restricted the amount of oil each producer could extract from a single reservoir as part of an attempt to halt the free-falling price. When oil men ignored this law and continued producing as much as they desired, Murray, who in four years as governor issued thirty-four proclamations of martial law, did not hesitate to exercise full authority of the state and ordered the National Guard to prevent oil from flowing in Oklahoma.[1] Conditions only worsened when that same year the discovery of the massive East Texas field unleashed an additional flood of oil, further destabilizing the price. When producers in Texas refused to obey prorationing orders, Governor Ross Sterling followed Murray's lead and also declared martial law shutting down production in four counties.[2] What had gone wrong within the industry that both governors felt only state power could address the situation?

A small group of oil men believed that the answer to that question lay in the inefficient production techniques which led to overproduction and waste and that

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[1] Keith L. Bryant, *Alfalfa Bill Murray* (Norman: University of Oklahoma Press, 1968), 198, 245.

[2] David F. Prindle, *Petroleum Politics and the Texas Railroad Commission.* (Austin: University of Texas Press, 1981).

government cooperation with their industry was necessary in order to craft an effective conservation plan. Henry L. Doherty, Earl Oliver, and Mark L. Requa called upon the federal government for assistance in implementing an oil conservation plan based upon geological and engineering principles which they contended would eliminate overproduction, reduce waste, and stabilize the fluctuating price of oil. They faced opposition, however, from many oil men who had only recently begun to accept geology and engineering as practical aids to production. Lacking a depth of understanding as to how they might benefit from these emerging fields, most oil men preferred traditional methods of exploration and production that they felt had served their industry well since its inception. As a result, both independent oil producers as well as the heads of integrated firms opposed a conservation plan which relied upon a cadre of efficiency experts to implement. More importantly, though, they resisted any attempt at conservation that would have required federal intervention in order to implement. Although Doherty, Oliver, and Requa preached the gospel of efficiency, they faced a political battle mobilizing the authority of the state behind their plan but eventually succeeded and, in the process, transformed the oil industry by demonstrating how geology and engineering served its longterm interests by conserving oil.

Henry L. Doherty led the charge in outlining a plan for extracting oil based upon scientific principles which he contended would eliminate overproduction waste, and he called upon the federal government to require that the oil industry implement his plan. Referred to as "unitization," Doherty's plan conceived of an oil field as a geological unit under the control of a single person, company, or other entity.[3] Rather than granting access to an oil field on the basis of surface property rights, Doherty's approach called for determining a reservoir's boundaries on the basis of geological principles. The manner in which strata had formed beneath and trapped oil beneath the ground should influence decisions regarding the number and location of wells at the surface. Limiting the number of wells drilled into each reservoir and positioning them strategically enabled producers to preserve stored natural gas which they could release as desired in order to expel oil when they needed it.

Unitization conserved oil because it utilized energy stored within the reservoir to maximize production. Doherty recognized that pressurized gas and water represented forms of kinetic energy which, if retained within the reservoir, could force greater amounts of oil to the surface in a shorter period of time than if multiple producers drilled numerous wells simultaneously.[4] Minimizing the number of wells decreased the likelihood that fluids migrated because a withdrawal from one area affected fluids throughout the reservoir.[5] Engineering production in this way prevented waste because it

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[3] Note that the derivative term "unitization" sometimes referred to the process by which "the owner of the oil or gas rights in an individual tract or tracts of land surrenders his exclusive ownership thereof in return for an assignment to him of an undivided interest in the oil and gas rights of the pool as a whole." Leonard M. Logan, *The Stabilization of the Petroleum Industry*, Oklahoma Geological Survey Bulletin No. 54 (Norman: University of Oklahoma Press, 1930), 171n1.

[4] Blakely M. Murphy discusses the "engineering basis for conservation" in *Conservation of Oil and Gas* (Chicago: Section of Mineral Law, American Bar Association, 1949), 13-14.

[5] Ibid., 14.

maximized a reservoir's longterm yield. Doherty explained that "to allow an oil well to flow as a gusher" meant that "we often leave huge islands of oil in the sand practically untouched."[6] He reasoned that "if gas is not allowed to escape I think in most cases practically all the oil in the pool can be raised without pumping."[7] Doherty's conception of oil production offered a rational alternative to unregulated drilling.

Doherty hoped his ideas for oil production would replace the rule of capture which he considered the cause of overproduction and help conserve this valuable natural resource in which he was heavily invested. Doherty explained that the oil industry had been "under laws that are different from those that pertain to any other property or product from property, except those pertaining to wild birds and to wild animals."[8] Relatively simple steps had been taken to conserve wild game such as the closing of hunting season, "but no one as yet has advocated even 'closed seasons' for petroleum."[9]

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[6] Henry L. Doherty to George Otis Smith, August 28, 1924, File: Correspondence 1924, Box 1, George Otis Smith Collection, American Heritage Center, University of Wyoming.

[7] Ibid. In addition to the propulsive force of gas, Doherty's researchers learned that they could further maximize recovery by leaving gas in the reservoir because it intermixed with and decreased the viscosity of oil, thereby facilitating its flow to the surface. For more details about this aspect of his research, see in L. E. Elkins, "Research," in *History of Petroleum Engineering*, (New York and Dallas: American Petroleum Institute, 1961), 1095; Leonard Fanning, *The Story of the American Petroleum Institute*. (By Author, 1959), 108.

[8] Henry L. Doherty, "Suggestions for the Conservation of Petroleum by Control of Production," *Production of Petroleum in 1924*, Papers Presented at the Symposium on Petroleum and Natural Gas, at the New York Meeting of the American Institute of Mining and Metallurgical Engineers, February 1925. (AIMME, 1925), 9.

[9] Ibid.

To avoid totally depleting the nation's oil resources, "we must get away from the law of capture."[10] He arrived at an alternative method to oil production by drawing upon years of business experience during which he systematically employed science and technology to rationalize production processes.

Doherty campaigned to eliminate the rule of capture because he believed that it unnecessarily introduced the role of chance and created an atmosphere resembled a lottery more than an organized industry built upon rational, scientific procedures and techniques. In addition to reducing the oil business to a game of luck, the rule of capture required producers to expend capital needlessly by drilling wells with no guarantee of reaping even a minimal profit: "Everybody knows that more money goes into a lottery than comes out of it, yet the instinct for gambling is so widespread and so easily excited that lotteries are forbidden by law. The hope of winning the grand prize is what lures men on. The search for and production of oil has become a more frenzied game than the search for gold ever was."[11] The necessity to gamble when operating under the rule of capture offended him because he had devoted his life to eliminating chance. Just as lotteries were "forbidden by law," he called for a federal law to forbid the lottery oil exploration had become. As a businessman interested in a return on his investment, Doherty showed no interest in playing a "frenzied game." The necessity to gamble when operating under the rule of capture offended him because he had devoted his life to eliminating chance by developing rational and systematic processes for oil production. Out of his commitment to the

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[10] Ibid.

[11] Doherty, "Suggestions for the Conservation of Petroleum," 7.

application of science and technology sprang his ideas for conservation.

Although the unit plan of oil development rationalized production techniques, it did not simplify nature but, rather, allowed its complexities to influence how the industry should operate.[12] Geological and engineering principles facilitated oil producers by enabling them to work in concert with earth processes. In Doherty's view, the primary "evil" effecting the oil industry stemmed from "the bad practices that are forced upon us by laws," especially when they are "in violent conflict with natural economic and physical laws."[13] Better that nature dictate how oil production proceed than laws conceived by human beings based solely upon economic gain. Doherty recognized that his consideration of nature as an active force in the process of oil extraction accounted for the strength of his conservation plan. As he described it, "In trying to make a different plan for the development of oil, I have merely tried to get in harmony with nature."[14] Property rights may have proved useful in determining ownership at the surface, but "a petroleum pool is by nature incapable of being divided up and operated according to the surface

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[12] James C. Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed*, (New Haven and London: Yale University Press, 1998), ??.

[13] Henry L. Doherty, "The Petroleum Problem As I See It," February 10, 1926, A Statement before the Federal Oil Conservation Board, pp. 6-7, File: "Addresses," Box 1, George Otis Smith Collection, American Heritage Center, University of Wyoming.

[14] Henry L. Doherty, "Discussion of Unitization," *Transactions of the American Institute of Mining and Metallurgical Engineers*, Petroleum Development and Technology 1930. Papers Presented Before the Division at Tulsa, October 3-4 and Los Angeles, October 4-5, 1919, and New York, February 18-20, 1930, (New York: The Institute, 1930), 91

divisions that have been arbitrarily created."[15] Unfortunately for him, many within the oil industry disagreed.

Doherty faced significant opposition from many different constituents within the oil industry when he called for a conservation plan based upon cooperation between industry and government. No relationship existed between the oil industry and the federal government from 1859 when Drake drilled the first commercial oil well until 1911 when the Supreme Court dissolved the Standard Oil trust.[16] Throughout this period, the rule of capture and the fierce individualism it fostered governed the oil industry. Even though the rule of capture at times led to overproduction and destabilized the industry, most oil men preferred to maintain their autonomy rather than look to the federal government for solutions.[17] Expanding markets reinforced this attitude as the developing automotive industry and the outbreak of the First World War in Europe stimulated the demand for

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[15] Doherty, "The Petroleum Problem As I See It," p. 7.

[16] Logan, *Stabilization of the Petroleum Industry*, 209, 210.

[17] One historian has noted that the motives for oil men's opposition to conservation were as "intertwined with the exceedingly complex montage that was the petroleum scene in the 1920s," Gene Gressley, "GOS, Petroleum, Politics and the West," *The Twentieth Century American West, A Potpourri* (Columbia and London: University of Missouri Press, 1977), 108. Indeed, the reasons for their resistance to conservation were numerous and at times overlapped. One contemporary of the conservation debate presented a list of reasons for oil men's opposition, which included: the need to recoup investments quickly, promoters who sought new fields only to sell them quickly for profit, small refiners who did not have a certain supply of oil, opposition to royalty owners, and intransigent oil lawyers overly concerned with protecting their clients' interests rather than long-term planning. Logan, *Stabilization of the Petroleum Industry,* 212. For another view by a contemporary, see James A. Veasey, "May the American Petroleum Industry, Through Voluntary Action, Meet Its Problems of Overproduction," *Mining and Metallurgy* (April 1929), 190.

petroleum.[18] Competition remained fierce, but most oil men believed the demand for oil great enough for all to survive.[19] When Doherty began lobbying for federally-mandated unitization in 1925, he met with resistance from small, independent operators as well as executives who presided over large, integrated companies. Independent oil men had experienced how integrated firms like Standard Oil consolidated power through monopolies, greatly limiting the ability of smaller producers to compete, and viewed any plan proposed by the head of a large oil company with skepticism and caution. Many executives of large oil companies started out as independents and earned their way through the ranks, retaining this fierce individualism. Even though they had begun to integrate their companies, they resisted any plan that called for them to relinquish autonomy they had fought so hard to win. Believing he could not overcome such entrenched attitudes, Doherty solicited help from the president.

In a 1924 letter to Calvin Coolidge, Doherty sounded an alarm by warning the president that inefficient production methods were rapidly depleting the nation's oil reserves and that the country would eventually face a shortage which would jeopardize national security unless the federal government addressed the situation. Doherty explained that innovations in the field of geological prospecting greatly facilitated prospectors looking for oil and that their success led to overproduction. He told Coolidge that ever since discovering "that many, and probably most, of our oil pools could be located and mapped out by surface observations without putting a drill into the ground, I

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[18] Logan, *Stabilization of the Petroleum Industry,* 209-210.

[19] Ibid.

realized that this might mean the early and premature exhaustion of our American oil reserves."[20] The industry was in the midst of rapid change due to innovations in geological prospecting, but the problem resulted from "the fact that under our present unfortunate laws each pool as discovered must be immediately devastated."[21] The rule of capture caused the industry to overproduce and "only through the efforts of our Federal Government can the oil problem be solved..."[22] Doherty warned Coolidge of the resistance he would face in convincing the oil industry to change its ways.

As his commitment to developing new methods of prospecting and reservoir engineering indicated, Doherty was an innovator within the oil industry and his embrace of change set him apart from many of his colleagues. He explained to Coolidge that "every business and industry is controlled largely by its conservative and standpat element" and the oil industry was no different.[23] He cited the banking industry's long-time resistance to federal reform legislation and warned that "the attitude of the men in the oil business will be no different than the attitude of the bankers except in degree, and that for the worse rather than for the better."[24] He had learned over the years that "you need only recommend to a group of oil men that they should themselves seek legislation

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[20] Henry L. Doherty to Calvin Coolidge, August 11, 1924; reprinted in Robert E. Hardwicke, *Antitrust Laws, et al. v. Unit Operation of Oil or Gas Pools* (Dallas: Society of Petroleum Engineers of AIME, 1961), 179.

[21] Ibid., 180.

[22] Ibid.

[23] Ibid., 187.

[24] Ibid., 188.

and the mere suggestions will throw them into a panic" because they in general are "afraid of our government."[25] He cautioned Coolidge, therefore, that any federal attempt to solve the problem would be met "without much help from the men in the oil industry, and with the determined opposition of some..."[26] Doherty's lobbying effort paid off when Coolidge organized several cabinet members to investigate the matter.

Coolidge responded to Doherty's plea within the year by establishing the Federal Oil Conservation Board (FOCB). From 1924 until 1932, the FOCB served as the primary forum for government officials to discuss with members of the oil industry any number of issues concerning the future of United States oil policy, such as the quantity of untapped oil reserves, the necessity of restricting production, and whether federal or state laws could address industry problems.[27] Coolidge accepted Doherty's argument in favor of conservation and expressed to the newly-appointed board members that "the present method of capturing our oil deposits is wasteful to an alarming degree."[28] Heeding Doherty's warning, however, Coolidge moved carefully and diplomatically by instructing FOCB members "to enlist the full cooperation of representatives of the oil industry in the

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[25] Ibid.

[26] Ibid., 189.

[27] Ibid., 85, 87. At the time it was created, the FOCB consisted of the following four cabinet members: Hubert Work, Secretary of the Interior; Dwight F. Davis, Secretary of War; Curtis D. Wilbur, Secretary of the Navy, and Herbert Hoover, Secretary of Commerce.

[28] Calvin Coolidge to the Secretaries of War, Navy, Commerce, and the Interior, December 19, 1924; reprinted in Samuel B. Pettengill, *Hot Oil: The Problem of Petroleum* (New York: Economic Forum Co., 1936)

investigation" to assuage oil men's fears of government intervention.[29] Coolidge's approach appeared to pay-off because oil men initially demonstrated a willingness to cooperate with the FOCB's efforts to remedy the industry's problems.

The honeymoon between the board and the industry ended quickly when oil men reacted defensively to a series of questionnaires the FOCB distributed to gather information on all aspects of the industry, including the reasons for waste. Although they remained guarded, many oil men responded to ensure that board members understood their views. George Otis Smith, director of the U.S. Geological Survey and chairman of the board's technical advisory committee, digested the responses and noted that "in most of the replies, physical waste of oil is termed negligible or practically nil."[30] Smith further observed that "the common attitude of those leaders of the oil industry who replied to the Board's inquiry toward any proposal for the elimination of waste in oil production, is frankly defensive, as such a proposal, in their opinion, would seem to imply that remedial action can come only through Governmental intervention."[31] Oil men became so "defensive" at the prospect of intervention that they closed their minds to any proposal that might alter production practices they had been employing throughout their lives. As one respondent explained, "there is fear that stabilization would take away from

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[29] Calvin Coolidge to the Secretaries of War, Navy, Commerce, and the Interior; Reprinted in Pettengill, 210-211.

[30] George Otis Smith, Digest of Responses to Letter Entitled "Waste in Production," p. 5, File: "FOCB Letters," Box 4, George Otis Smith Collection, American Heritage Center, University of Wyoming.

[31] Ibid.

the business the 'haphazard, sentimental, and gambling viewpoint' still dominant."[32] Of course, eliminating this "viewpoint" and replacing it with more rational production processes that employed geological and engineering principles is exactly what Doherty hoped to accomplish but industry traditionalists less comfortable with innovation opposed him at every turn.

J. Edgar Pew offers one example of a long-time oil man who initially resisted innovation and refused to accept the advantages geologists had to offer. He entered the industry when the techniques and methods of practical men dominated and this orientation prevented him from taking university-trained geologists seriously. Pew began overseeing Carter Oil Company, a Standard Oil subsidiary, in 1915 and like many industry executives at the time could not ignore geologists once their methods began to prove successful. He eventually relented and hired C. L. Severy but explained that "'I don't think you will do us any good and I will damn well see that you don't do us any harm.'"[33] Severy recalled that Pew "meant it, too" and refused to buy him geological surveying equipment.[34] Only after persuading the company's treasurer did Severy receive an aneroid barometer and plain table, but "it wasn't that they were stingy or did not have the money. It was simply that they could not see spending good money on a crazy idea of

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[32] Smith, Digest of Responses, 2.

[33] "C.L. Severy, 1963, Random notes in Edgar Owen Collection, American Heritage Center, University of Wyoming; Cited in Edgar W. Owen, *Trek of the Oil Finders: A History of Exploration for Petroleum* (Tulsa: American Association of Petroleum Geologists, 1975), 311.

[34] Ibid.

a geologist."[35] He still had to prove himself, however, and "when the wild scramble was on for leases in the El Dorado" field of Kansas Pew and other company executives eventually acquired land there but only "because I pestered them so much."[36] The company made millions on Severy's advice and "finally Mr. Pew was convinced that geology was doing him some good and from then on he went all out with no strings attached."[37] Pew's unwillingness to take geology seriously in 1915 placed him within the mainstream of oil company executives. Like other oil men tutored in the practical tradition, Pew resisted change. He exhibited a similar intransigence ten years later when Doherty proposed that engineering principles should guide any oil conservation plan.

As president of the oil industry's first national trade association, the American Petroleum Institute (API), Pew used his position to oppose Doherty's proposal for a federally-mandated conservation plan based upon the latest engineering research. Incorporated in 1919, the API was the industry's first national trade association and included among its members the heads of most major oil companies, including Doherty.[38] Pew represented a contingent within the API who opposed Doherty and denied any need for conservation. Although he never mentioned Doherty by name, Pew argued that "there

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[35] Ibid.

[36] Ibid.

[37] Ibid.; For additional support of Pew's initial reluctance to use geology and eventual acceptance, see J. J. Conry to James Veasey, June 11, 1941, James Veasey Collection, American Heritage Center, University of Wyoming.

[38] Leonard Fanning, *The Story of the American Petroleum Institute* (By Author, 1959), 1.

is not the waste a few visionary theorists would have us believe there is."[39] He conceded that waste had existed in the past but that "improved methods of operating have largely done away with this."[40] Pew rejected the possibility that unit production might prove beneficial to the industry in any capacity: "I know of no unit leasing plan that is either practicable of operation or that would yield better results in the production of the greatest quantity of oil from any given area."[41] About the time he made these comments, the FOCB planned to hold public hearings on the issue of oil conservation. Rather than rely upon the federal government to publicize the opinions of oil industry executives, however, the API initiated its own investigation to determine whether the industry wasted oil and the need for conservation.

Pew served on a committee of eleven API members convened to investigate allegations that the industry overproduced and wasted oil. Popularly referred to as the "API report," the Committee of Eleven's published findings declared that "there is no imminent danger of the exhaustion of the petroleum reserves of the United States" and that "waste in the production, transportation, refining and distribution of petroleum and its products is negligible."[42] Despite the highly technical nature of these issues and the

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[39] The questions and Pew's responses are replicated in their entirety in "No Preventable Waste in Oil Production, Opinion of J. Edgar Pew," *National Petroleum News* 17 (August 19, 1925), 91.

[40] Ibid.

[41] Ibid. 91-2.

[42] *American Petroleum, Supply and Demand.* A Report to the Board of Directors of the American Petroleum Institute by a Committee of Eleven Members of the Board, (New York and London: McGraw-Hill Book Company, Inc., 1925), 3, 5. These are the

arcane knowledge required to address them, none of the committee members possessed qualifications as either a geologist or engineer. Ten members served as either president, director, or chairman of an oil company and the eleventh as general secretary of the API.[43] Although all API members did not uniformly ignore the benefits of technology or innovation, the committee's refusal to address Doherty's plan directly suggests that a political agenda other than determining efficient production methods motivated them in formulating their conclusions. Probably the most learned and prolific oil and gas lawyer at the time characterized the report as "a self-satisfied and ultraconservative viewpoint."[44] The same lawyer, perhaps somewhat naively, observed that "it seems odd, however, that the report did not discuss or even mention unit operations."[45] The committee's failure to mention either Doherty or his conservation plan revealed that the API's primary motivation lay in preventing government regulation rather than candidly addressing the

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two major conclusions and also the one's most pertinent to my argument. For the full list of thirteen separate points the committee agreed upon, see pp. 3-5 of the report.

[43] See Ibid., 5 for a full list of each committee member and his company affiliation.

[44] Hardwicke, *Antitrust Laws,* 23-24. Despite his negative assessment of the API report, Hardwicke was in no respect anti-oil industry. In fact, he apparently sought and was recommended for employment with the API. For a thorough description of his background and an extensive bibliography of his work, see Robert E. Hardwicke, "General Nature of Work," File: "Hardwicke, Robert E.," Box 52, Series 3, Sun Oil Company Records, Hagley Museum and Library. For the recommendation, see in the folder Robert E. Goodrich to E. L. DeGolyer, May 5, 1937. Nash also considered the report as "hastily drawn." See Gerald D. Nash, *United States Oil Policy, 1890-1964: Business and Government in the Twentieth Century* (Pittsburgh: University of Pittsburgh Press, 1968), 88.

[45] Hardwicke, *Antitrust Laws,* 23-24.

problem of waste and devising the most efficient solution.

In order to compensate for the lack of scientific credentials among its members, the Committee of Eleven established a technical advisory subcommittee but only to bolster conclusions it had already reached. One of the most prominent petroleum geologists of the period, Wallace Pratt, chaired this subcommittee which generated statistics the Committee of Eleven used to draft its report. Pratt expressed regret and embarrassment when recalling his complicity in providing data that supported the Committee of Eleven's anti-conservation stance. He recalled that "it is not a story to be proud of" and confessed that "I blush at my recollection."[46] According to Pratt, "lawyers dominated the API and the industry" and, as a result, the report's "viewpoint was legalistic."[47] He explained that subcommittee members purposely reached conclusions in order to justify the rule of capture, casting conservation as an issue of states' rights, and declaring compulsory unitization unconstitutional. Remembering his actions at the time made Pratt "blush," but thirty years after the fact he wanted to set the record straight and declared that "these shibboleths the industry nourished. We wanted to maintain them. ...We preserved the status quo." The Committee of Eleven drew upon scientific experts but only perfunctorily and even proved willing to alter geologists' conclusions before printing them in the API report.

In addition to conceding that he downplayed the need for conservation, Pratt

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[46] Wallace Pratt to Edgar Owen, December 15, 1969; cited it Owen, *Trek of the Oil Finders*, 476.

[47] Ibid.

alleged that committee members changed some of the conclusions he and other geologists reached. He explained that "the text our sub-committee submitted was re-written."[48] The revised report declared that the country contained a "billion-barrel reserve" and that "no physical waste" existed, but such phrases "were the language of the Committee itself."[49] Throughout the report, "the legalistic doctrine and the fear of putting too much control in Washington prevailed."[50] The Committee of Eleven hoped to legitimize its findings by soliciting the endorsement of a trained geologist like Pratt, but as he made clear politics influenced the report's conclusions. Ironically, the report's biggest critic was an oil man tutored in the practical methods of traditionalists like Pew who rejected Doherty's scientific conception of conservation.

Earl Oliver could not suppress his sarcasm when responding to the Committee of Eleven's findings in a publication he entitled "The So-Called A.P.I. Report–An Analysis." Oliver was born in 1878 "on an oil lease" in Butler County, Pennsylvania and spent his life working in the oil industry.[51] He recounted that "as a boy I began as a pumper and roustabout" and eventually passed through "the various stages of tool-dresser, driller, drilling contractor, production superintendent and appraisal engineer in

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[48] Ibid.

[49] Ibid.

[50] Ibid.

[51] Earl Oliver, "Autobiography," 1931, Earl Oliver biography file #B-OL4-C, American Heritage Center, University of Wyoming.

the oil fields of Pennsylvania, West Virginia, and Kentucky."[52] Experience in a variety of positions provided a firsthand perspective on the oil industry's wasteful production practices. In particular, his "oil field and appraisal experience disclosed the extremely wasteful methods of the oil industry..."[53] Oliver's observation of inefficient production methods prompted him to draft a rebuttal to the Committee of Eleven as a "protest against the so-called A.P.I. report being accepted as representing the sentiment of the oil industry."[54] He objected to the report's contention that the industry did not waste oil, that no danger of an oil shortage existed, and to its negative appraisal of the Federal Government's efforts to address overproduction.[55] In addition to disagreeing with the report's conclusions, Oliver expressed concern over the motivations behind those who composed it.

He alleged that the authors of the API report consciously and surreptitiously attempted to downplay the existence of waste within the industry. He argued that the committee "did not approach its problem with the mental attitude of the analyst impartially attempting to find the truth, but rather as a propagandist influencing public opinion."[56] He reached this conclusion because the study "was conducted under the

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[52] Ibid.

[53] Ibid.

[54] Earl Oliver, "The So-Called A.P.I. Report–An Analysis," 1, 1925, J. V. Howell collection, Box 2, American Heritage Center, University of Wyoming. (Hereafter cited as Howell collection).

[55] Ibid.

[56] Ibid.

strictest injunctions of secrecy on all parties engaged therein," an approach he felt "conducive neither to the creation of public confidence nor to impartial analysis."[57] He conceded that although it contained "many excellently written scientific discussions" the report's "general conclusions have no relationship" to the scientists' contributions.[58] As a result, the report "represents only the personal attitude of four or five individuals who were prompted to their effort and attitude by partisan zeal..."[59] One of these partisan zealots included API president and committee member Pew to whom Oliver complained that the report presented a "misleading picture of the American oil situation..."[60] Oliver rejected the report's conclusions because in his experience oil men had acknowledge the existence of waste since the industry began. Galvanized by what he considered a propaganda campaign, Oliver joined Doherty throughout the latter-1920s and early-1930s to convince API members of the need for conservation guided by geological and engineering principles.

Like Doherty, Oliver understood that to effect conservation production practices had to conform more closely to the physical attributes of oil and the geological forces trapping it beneath the ground. At the first meeting of the FOCB, Oliver delivered an

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[57] Ibid.

[58] Ibid.

[59] Ibid.

[60] Earl Oliver to J. Edgar Pew, October 24, 1925, Howell collection.Oliver expressed the same sentiment to the FOCB, arguing that "this report does not reflect a true picture, but it must be conceded that it is having a very considerable influence on pubic thought." Earl Oliver to Federal Oil Conservation Board, October 16, 1925, Howell collection, Box 2.

address in which he argued that the rule of capture led to overproduction and instability within the industry. The rule of capture may have worked well to determine ownership of wild animals who wandered unpredictably from one privately-owned parcel of land to another, but it failed to account for the complex geological phenomena governing the pooling and migration of oil. Because the industry had applied this inadequate rule throughout its history, "evils have developed and become perpetuated because we have attempted to apply to petroleum principles of law and practices unfitted to the nature of the product."[61] The rule of capture had been conceived by taking into account the "nature" of wild animals but not the "nature" of oil. Rather than continuing to extract oil in this laissez-fare manner, Oliver suggested that "it might be well now for a time to forget what we want and study what petroleum must have according to its peculiar characteristics in order that it may be conserved and utilized efficiently."[62] The key to conservation, Oliver contended, lay in acknowledging and respecting the physical properties of oil and allowing them to determine production practices.

Like Doherty, Oliver proposed conserving oil through the application of engineering principles. Although not formally trained as an engineer, extensive work experience in oil fields throughout the United States taught him to think about extracting oil in a more conceptual manner than producers who followed the rule of capture. To edify oil men at the hearings who did not share his perspective, Oliver explained that "we

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[61] Earl Oliver, "Supply and Waste in the Petroleum Industry," *Federal Oil Conservation Board, Complete Record of Public Hearings*, February 10 and 11, 1926 (Washington: G.P.O., 1926), 102.

[62] Ibid.

must first visualize the fact that this is a highly mobile product confined under great pressure in very large containers frequently miles in extent with right on the part of many individuals to puncture those containers and draw off the product."[63] Each oil man should further "visualize" that each time he punctured one of these underground containers "he immediately modifies in a large way the fortunes and values of every other individual with a like right."[64] Oliver argued that the industry could solve the problem of overproduction if oil men thought more like engineers: "Progress will be made if we regard the emptying of that container as one big engineering problem, determining how this peculiar product contained and confined as it is under high pressure can be removed as needed and retained until needed."[65] Conservation meant leaving oil in the ground until the market could absorb it. Temporarily ceasing to extract oil offered longterm benefits that quick extraction did not.

Government would have to play a role, Oliver believed, in order to convince oil men how they benefitted from a conservation plan which called upon them to refrain from extracting oil. He had witnessed his colleagues waste oil throughout his career but felt that this admission "should cause no embarrassment to the petroleum industry."[66] Rather, "if embarrassment exists anywhere it should be that of Government, not industry," because legislators had not actively attempted to remedy overproduction

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[63] Ibid.

[64] Ibid.

[65] Ibid.

[66] Ibid., 96.

codified by the rule of capture.[67] His solution required more government involvement, not less, but he did not believe that legislators should act alone. Past errors could be addressed only through "cooperation of Government and industry, and this Federal Oil Board is a most fitting tribunal to determine the way Government in its several branches, State and Federal, can best function in cooperating with the industry to bring about a correction of those errors."[68] Oil men could not escape blame, however, and their persistent failure to appreciate how engineering could solve industry problems convinced Oliver that government could also teach them how they might benefit from this discipline.

Government inaction codified overproduction and inadvertently perpetuated a laissez-fare mentality among oil men, but it could redress its past failure by teaching oil men to appreciate the utility of a conservation plan informed by engineers. The rule of capture established a precedent by which "certain practices and usages of the industry" had grown entrenched and "remain as an aftergrowth that is difficult to break through."[69] Oil men had followed these "practices and usages" for so long "they now claim them as vested rights notwithstanding they are entirely inconsistent with underlying principles..."[70] Oliver knew that "these errors die hard" and that oil men have defended them "by bold and baseless assertions," but he believed that new laws could change oil

[67] Ibid.

[68] Ibid.

[69] Ibid.

[70] Ibid.

field practice.[71] Longstanding customs "now give promise of becoming the subject of parliamentary compromise and I have no doubt they will at last be swept away and repudiated."[72] Government could effet change through legislation and by educating oil men about the benefits of engineering. Oliver contended that "the Federal Government can, and I have no doubt will assist materially in this necessary education" and demonstrate to the oil industry "the value of applying sane engineering principles to the extraction of oil and gas from these great containers in which nature placed them."[73] Oliver did not easily win converts at the hearings but received support in his call for government intervention.

Mark L. Requa also spoke at the hearings and shared Oliver's faith in the ability of government and industry to cooperate in fashioning an oil conservation plan. Requa's family moved to California during the Gold Rush and later to Virginia City, Nevada where his father took a job as a mine superintendent.[74] Following his father's lead, Requa entered the mining industry and eventually opened his own mine engineering firm in San Francisco before branching out to start an oil company before the First World War.[75] His profession brought him into contact with another mining engineer, Hebert Hoover, who

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[71] Ibid.

[72] Ibid.

[73] Ibid.,103.

[74] Edgar Eugene Robinson, "Mark Lawrence Requa," *Dictionary of American Biography*, Robert Livingston Schuyler and Edward T. James, eds., Vol. 11, supplement two, (New York: Charles Scribner and Sons, 1958), 552-3.

[75] Ibid.; Nash, *United States Oil Policy*, 30.

had been serving as U.S. Food Administrator during the war when he hired Requa as a staff member. Under Hoover's tutelage, Requa absorbed his boss's vision of industry/government cooperation. Hoover conceived of a new socioeconomic order which grafted corporatist and technocratic values onto the energy and creativity of nineteenth-century individualism.[76] Requa carried his mentor's philosophy into the U.S. Fuel Administration's oil division when President Garfield appointed him director in 1918. Oil industry spokesmen applauded Requa's appointment and pledged to support him.[77] Throughout his tenure as director of the oil division which lasted only a year and a half, Hoover's associationalism guided Requa as he worked to strengthen ties between the oil industry and government.

Requa adopted Hoover's notion that trade associations functioned as ideal forums to foster cooperation between industry and government and facilitated creation of the American Petroleum Institute. Trade associations, professional societies, and other cooperative institutions, Hoover believed, could function as a type of "private government" to reform business, stabilize industries, and expand markets.[78] According to Hoover, these institutions would avoid the abuses of earlier trusts because of their members' enlightened leadership and commitment to service, efficiency, and ethical

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[76] Ellis W. Hawley, "Herbert Hoover, The Commerce Secretariat, and the Vision of an 'Associative State,'" *Journal of American History* 61 (1974), 117.

[77] Nash, *United Staes Oil Policy*, 30.

[78] Hawley, "Herbert Hoover, The Commerce Secretariat, and the Vision of an 'Associative State,'" 117.

behavior.[79] Requa led the effort within the oil industry to create a trade association which could function as a "private government" to organize efforts at scientific rationalization without extinguishing the individual's energy and creative spirit.[80]

As the conflict in Europe subsided, he met with oil men to discuss plans for establishing a permanent trade association to perpetuate the industry's cooperative relationship forged with government during the war. Requa explained that "we can not hope for commercial success .... without Government help."[81] The oil industry could not afford to let self-interest, or individualism, dictate its course because "we need for the future an efficiency, a co-ordination, a synchronizing of individual and Government effort such as never before has been attained. "[82] Rather than "unrestricted competition, we must substantiate the doctrine of co-operation."[83] Oil men at the conference made plans to meet three months later in order to announce the creation of a trade association to act as a bridge between their industry and government. Requa was the principal speaker at the conference which gave birth to the American Petroleum Institute and in his speech, entitled "Cooperation," made clear his vision for the direction the new trade association

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[79] Ibid., 117-18.

[80] Ibid.; Kendrick A. Clements, *Hoover, Conservation, and Consumerism: Engineering the Good Life* (Lawrence: Universtiy Press of Kansas, 2000), 72.

[81] Mark L. Requa, "Peace–Not the End but the Beginning," An Address Delivered at Atlantic City, December 5, 1918, p. 8. Biographical File #B-R299-ML, American Heritage Center, University of Wyoming.

[82] Ibid., 8.

[83] Ibid., 12.

should take.

Requa retained his commitment to cooperation when the FOCB held convened in the mid-1920s to address overproduction of oil and the need for conservation. Nor surprisingly, he believed any conservation plan must involve both government and the oil industry. He rejected the argument put forth by some oil men that "it is practically imossible to remedy existing unsatisfactory conditons relative to production because of our governmental structure."[84] Requa did not consider government a hindrance and commended the FOCB for initiating hearings which he considered "the first foundation stone in the new structure of cooperative relationship between Government and industry as related to mineral raw materials."[85] Although no easy solution to overproduction presented itself, he remained optimistic and saw "in the future a solidarity of effort and continuing progress in place of discord, and the sporadic and unorganized efforts of the past."[86] Although steadfastly contending that government should play a role in addressing the problem, he contended that any solution start with oil men themselves: "What the industry must do is to develop that program and present it to the Government."[87] Requa did not outline a specific plan for cooperation at the hearings, but

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[84] Mark L. Requa, "The Oil Industry's Opportunity," *Federal Oil Conservation Board, Complete Record of Public Hearings*, February 10 and 11, 1926, (Washington: G.P.O., 1926), 131.

[85] Ibid., 134.

[86] Ibid.

[87] Ibid., 133. Requa repeatedly stated that the solution for conservation should come from the industry and not government. See also, Mark L. Requa to James A. Veasey, September 24, 1917, Folder "Correspondence 1927-1929," Box 1, James A.

another California oil man who had been his subordinate at the Fuel Administration did.

In an address entitled "How Neighbors Should Cooperate," Thomas O'Donnell presented a conservation plan which called for a cadre of industry experts to work collectively at identifying wasteful production practices and devising solutions. As Requa's director of production in the Fuel Administration, O'Donnell envisioned cooperation in a manner very similar to his former boss.[88] He called for "a nation-wide, organized, cooperative effort" to pevent waste and improve recovery methods which "would be of tremendous importance to the industry and to the public at large" so long as it had "the proper leadership."[89] His plan would "call into action a united effort of the best talent in the Nation to solve the problems invovled."[90] O'Donnell's idea of who constituted the "proper leadership" and "best talent" consisted of personnel drawn from within the ranks of industry. Specifically, he proposed the creation of a permanent conservation board comprised not of government officials but "the heads of the most active operating companies."[91] Board members would appoint committees for each oil pool or district by selecting "among those actually residing in the district and in daily

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Veasey collection, American Heritage Center, University of Wyoming.

[88] O'Donnell had been affiliated with the interests of California oil man E.L. Doheny. Nash, *United States Oil Policy*, 41.

[89] Thomas A. O'Donnell, "How Neighbors Should Cooperate," *Federal Oil Conservation Board, Complete Record of Public Hearings*, February 10 and 11, 1926, (Washington: G.P.O., 1926), 139.

[90] Ibid.

[91] Ibid.

contact with the work under their supervision."[92] As he envisioned the plan, "it would be the duty of these local committees to make periodic inspections, study and recommend improvements" and request that producers "install the improved methods."[93] Like Requa, O'Donnell believed that oil industry personnel should bear primary responsibility for conceiving a conservation plan. When Hoover won the presidency in 1928, Requa would have the opportunity to implement his conception of a cooperative oil conservation plan.

Requa acted quickly and advised Hoover a month after his inauguration to call a conference of industry experts and government officials to begin discussing plans for an interstate oil compact based upon voluntary participation. He had begun recommending to Hoover the merits of an interstate agreement for implementing unit operation as early as 1925.[94] Hoover liked the idea because he prided himself on efforts as Secretary of Commerce to facilitate passage of the Colorado River Compact and felt a similar plan which vested authority in the states could better resolve the oil industry's problems than federal regulation.[95] In July 1929, he authorized Requa to organize and chair the Federal and States Petroleum Conservation Conference in Colorado Springs and to invite

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[92] Ibid.

[93] Ibid.

[94] Kendrick A. Clements, "Herbert Hoover and Conservation, 1921-1933," *American Historical Review* 89 (February 1984), 78.

[95] Hoover did not originate the idea of conservation through interstate agreements but made the approach "peculiarly his own." Clements, "Herbert Hoover and Conservation," 74, 75. Hoover cited the agreement as proof that voluntary efforts between state and local governments could succeed. Kendrick A. Clements, *Hoover, Conservation, and Consumerism*, 85.

government and industry representatives from oil-producing states to discuss the feasibility of an interstate compact. The conference revealed a significant rift between independent oil men and integrated companies which undermined Requa's attempt to fashion a consensus in favor of a compact.

Large integrated companies generally supported the idea of a compact, but small independents believed a tariff on imports would solve the problem of overproduction by creating more demand and higher prices for oil produced within the U.S.[96] Independent producers believed integrated oil companies benefitted from the lack of a protective tariff. One independent producer explained that "major companies have not suffered to any appreciable extent because of the low price of crude oil..."[97] On the contrary, inexpensive oil benefitted integrated firms because they purchased much of their supplies from small producers. Major companies enjoyed significant profits for the year 1928 which were "occasioned by the fact that they have been able to buy cheap crude oil in Oklahoma and Texas..."[98] Requa rejected a tariff as the solution to overproduction and pointed out that the United States exported more oil than it imported. He reasoned that a tariff would only push integrated companies to build refineries overseas and result in a loss of American jobs.[99] Unable to resolve this deadlock, he grew frustrated at conference attendees whom

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[96] Nash, *United States Oil Policy*, 104-105.

[97] Wirt Franklin, "The Colorado Springs Speech"; reprinted in George Elliott Sweet, *Gentleman in Oil* (Los Angeles: Science Press, 1966), 55.

[98] Ibid.

[99] Requa also faced opposition from westerners at the conference who resented Hoover's recent withdrawal of federal lands from drilling. Clements, *Hoover,*

considered "'unattached enthusiasts, cranks, etc.'"[100] The independent operator who made this argument, Wirt Franklin, Requa must have particularly considered a crank.

Franklin addressed the Colorado Springs conference and voiced strong opposition to a compact which lacked safeguards to prevent larger, integrated companies from using the agreement as a means to eliminate smaller producers from the industry. Introducing himself as the representative of Oklahoma's small oil producers, Franklin explained that he and his colleagues were "sometimes erroneously referred to as independent producers, a misnomer, because there is no class engaged in productive enterprise more dependent than the small producer."[101] The small producer's "dependency" resulted not from the rule of capture *per se* but "because he must of necessity drill his wells to prevent his land from drainage and sell his oil at the posted price, what ever it may be at the time, whether remunerative or not, to the major purchasing agencies."[102] After listening to proposals for an interstate agreement, Franklin explained that "we are fearful that in the name of conservation a compact may be initiated and presented for adoption vesting such absolute authority in a commission, which might fall under the domination of the major factors of the industry..."[103] A corrupt commission, he postulated, "could restrict domestic

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Conservation, and Consumerism, 137.

[100] Quoted in Ibid., 136.

[101] Franklin, "Colorado Springs Speech"; reprinted in Sweet, 51.

[102] Ibid.

[103] Ibid., 53. This is a highly biased biography which supports the view of Franklin as a of the free enterprise system. Sweet calls the Colorado Springs conference a "little scheme" which "smacked of the same muddled thinking and hazy governmental

production to any extent it might desire" in the name of conservation or national defense while meeting domestic demand with imports from abroad.[104] Such a scenario "would mean the annihilation and destruction of the small producer of crude oil."[105] Franklin's nightmare did not become a reality until 1935 when Congress passed legislation authorizing an interstate oil compact.

Although Hoover failed to achieve passage of the compact during his administration, he laid important groundwork in getting the industry eventually to accept the idea through his work on the oil conservation board as Secretary of Commerce and philosophically in outlining his vision for cooperation between government and industry. More important to convincing the oil industry to accept this new conservation plan were the efforts of Doherty, Oliver, and Requa. These men shared a conception of industry/government cooperation that was a departure from the decentralized state-based approach to conservation advocated by Franklin. According to political scientist James C. Scott, state efforts to impose an "administrative ordering of nature and society" have been guided by an "imperialist ideology" but frequently failed by excluding "the necessary role of local knowledge and know-how."[106] Capitalist entrepreneurs guided by this ideology recognized that they required state action to implement their plans and

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awareness that spawned the Great Depression." Sweet, *Gentleman in Oil*, 49-50.

[104] Ibid., 53.

[105] Ibid.

[106] Scott, *Seeing Like a State*, 4-7.

relied upon highly-trained experts, planners, engineers, scientists, and technicians to implement their goals of rationalizing the state and its resources.[107] Despite local resistance, oil industry technocrats successfully employed their professional expertise and coopted the issue of conservation by implementing rationalized and efficient production methods which ultimately enabled integrated companies to exert more control over oil production than independent oil men.

[107] Ibid., 4-5.

Conclusion

The oil industry underwent dramatic changes from 1859 to 1930. Throughout most of the nineteenth century, practical men successfully found oil with methods they had crafted. Most prospectors probably possessed a good understanding of "geology" even though they may not have identified their methods with this term. Whether they consciously realized it at the time, a geological principle often explained their success. Most oil prospectors had not studied geology at universities or read about scientific principles but possessed an acute understanding of the geological formations they encountered on a daily basis. Because of their frequent success, they had little patience for university-educated geologists who presumed to educate them with esoteric knowledge and tell them how and where to look for oil. Their attitude would eventually change as the twentieth century began.

Although geologists entered the scene and generated significant amounts of information relevant to the oil industry throughout the late-nineteenth century, their influence remained minimal until the early-twentieth century. State geological surveys provided opportunities for directors and their assistants to gain valuable experience conducting field work in order to meet taxpayers' demands about where to find natural resources. Men like J. Peter Lesley and Charles N. Gould understood the political fallout if they failed to deliver the kind of information residents in their states desired and employed a cadre of assistants to conduct field work and map the location of resources that might generate a profit. Situated in two of the country's most prolific oil-producing states, both men were well situated to revolutionize the oil industry with the information their surveys generated. Oil-industry intransigence proved too great a barrier for either Lesley or Gould by himself to convey the utility of their findings in the search for oil.

Henry Doherty did not need to be convinced of geologists' utility and probably more than any other single figure paved the way for their acceptance in the oil industry. Like "transitional" figures in other industries, he bridged a gap in the oil business between the era of "heroic independent invention" in the late 1800s and the period of organized industrial research which coalesced in the early-twentieth century .[1] Although John D. Rockefeller had assembled an integrated oil company before Doherty entered the industry, Standard Oil focused its efforts on refining, transportation, and marketing and purchased the oil it acquired from large and small prospectors throughout the country. Doherty recognized that prospecting for oil and its extraction from the ground remained unsystematic, decentralized endeavors and moved to organize and rationalize these activities. This meant hiring university-educated geologists and engineers whose knowledge seemed more tangible, predictable, and therefore reliable than the intuitive approach practical men employed. He committed more resources than any oil company ever had to searching for oil through the application of geological principles. Other companies followed suit, and throughout the 1920s the industry located so much oil that overproduction which had been a problem since Drake's well in 1859 returned with a

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[1] The seminal "transitional" figure is Elmer Sperry who concentrated his work on the electrical industry but worked with mining machinery, automobiles, streetcars and other technology. Doherty too began his inventing career in the electric industry but I am more concerned with how he applied ideas he learned in that field to the oil industry. Thomas P. Hughes, *Elmer Sperry, Inventor and Engineer* (Baltimore and London: Johns Hopkins Press, 1971), xiv.

vengeance.

Overproduction destabilized the industry to such an extent that from 1930 to 1935 most oil producers agreed on the need for governmental regulation to prevent waste and implement a conservation plan but they disagreed about how best to achieve these goals. Doherty believed that the answer to the question of overproduction lay in fashioning more efficient production techniques, and he led a crusade for a federal law mandating oil conservation. He outlined a plan for extracting oil based upon scientific principles which he contended would eliminate overproduction and waste, and he called upon the federal government to require that the oil industry implement his plan. He faced opposition, however, from most oil men who had only recently begun to accept geology and engineering as practical aids to oil production.[2] More importantly, though, they resisted Doherty's plan because it would have required federal regulation. Conservation advocates of Doherty's ilk preached the gospel of efficiency, but they faced a political battle mobilizing federal authority behind their plan and eventually convinced the oil industry to adopt geological and engineering principles as part of its production

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[2] Nordhauser recounts many of the events surrounding Doherty's attempt to implement conservation and speculates that "perhaps historians have overemphasized the triumph of technocracy" in the history of conservation. However, he concluded that "Doherty's original conservation proposals, and the industry's counter-proposals, were directly related to current prices and profits." While my argument certainly supports the view that Doherty's experiences do not represent the unqualified "triumph of technocracy," I attempt to show that the oil industry ultimately could not ignore the influence of technology in streamlining production and implementing a conservation plan. See Norman Nordhauser, "Origins of Federal Oil Regulation in the 1920s," *Business History Review* 47 (Spring 1973), 71; and *The Quest for Stability: Domestic Oil Regulation, 1917-1935* (New York and London: Garland Publishing, Inc., 1979); Hays, *Conservation and the Gospel of Efficiency.*

processes.

Doherty ultimately lost the fight for a federal law but won the battle for conservation to proceed along geological and engineering principles when Congress approved a resolution in 1935 approving the Interstate Oil Compact. Six states agreed to enter the compact, which included Oklahoma, Kansas, Texas, New Mexico, Colorado, and Illinois. The agreement provided no formal mechanism for regulation but urged each state to pass laws necessary to prevent the waste of oil and gas.[3] Language in the compact declared that its purpose originated out of the need to promote conservation and was not an attempt to control the industry by creating a monopoly. Supporters of the compact considered its strength to lay in the absence of authority to compel member states to do anything. Rather than a coercive tool, the compact functioned as a forum for discussion where state representatives could exchange ideas and valuable technical information in the form of books, articles, and reports. As part of the agreement, an Interstate Compact Commission was created to serve as an administrative agency which held meetings open to the public. During approximately seven years after its passage, the compact effectively answered many of the questions regarding the best methods and techniques to regulate production and unified state statutes which had hitherto conflicted and prevented formulation of a uniform approach to oil and gas conservation.[4]

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[3] Rex G. Baker and Robert Hardwicke, "Conservation," in *History of Petroleum Engineering*, ed. D. V. Carter (New York: American Petroleum Institute, 1961), 1143.

[4] Ibid.

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