Foreword: The Evolution of Oil and Gas Conservation Law and the Rise of Unconventional Hydrocarbon Production

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I. INTRODUCTION

In 2014, the Arkansas Oil and Gas Commission celebrated its seventy-fifth anniversary. Arkansas has long been a leader in conservation law. Indeed, the state's conservation laws and practices have served as a model for others, including my home state of North Dakota, where I served as counsel to the conservation commission in the late 1970s and early 1980s. In this Foreword, I first provide a brief history of oil and gas conservation laws and regulations. Thereafter, I briefly discuss current trends in conservation law. Finally, it is my honor to introduce the various symposium articles included in this issue of the *Arkansas Law Review*.

II. PRE-REGULATION AND EARLY REGULATORY LAWS AND PRACTICES

Oil and gas conservation regulation arose late in the game, but this is no surprise. The oil industry grew rapidly during the industrial revolution, a time of laissez-faire political philosophy. Even during the regulatory awakening of the early 1900s, the upstream oil industry was largely unregulated.[1] Notwithstanding the dearth of regulatory law in the oil industry's formative years, which commenced in 1859 with the

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[1] Of course, this cannot be said of the oil and gas downstream, as the giant Standard Oil Trust was broken up into thirty-three different companies by the federal government pursuant to the Sherman Antitrust Act. *See* Sherman Anti-Trust Act, ch. 647, 26 Stat. 209 (1890). The United States Supreme Court ultimately blessed the break-up. *See* Standard Oil Co. of N.J. v. United States, 221 U.S. 1 (1911).

drilling of the Drake well near Titusville, Pennsylvania,[2] the development of petroleum fortuitously provided major environmental benefits.

First, developers were able to refine crude oil into relatively clean-burning kerosene[3] for use in lamps. The oil industry thus saved the sperm whale from almost certain extinction, as wealthy Americans had used whale oil for lighting because it burned clean. The poor, however, had been forced to use coal oil, which burned dirty and left black soot residue anywhere it was used, contributing to respiratory ailments in those who came in close contact with it. As more oil was produced, kerosene became much cheaper than whale oil and was widely used for lighting.

Second, the invention of the internal combustion engine, used to power machinery and passenger vehicles such as the Ford Model T, made automobiles affordable for the general population and solved the growing problem of horse manure in cities. The internal combustion engine, which was powered by refined crude oil and natural gasoline, also fortuitously saved the oil industry from Edison's electric light.

Third, a more recent environmental benefit involves increased natural gas production. Natural gas has gradually displaced coal for the generation of electricity, as it burns cleaner and is safer to produce.

Today, we are accustomed to conservation regulations governing the upstream oil and gas industry. Comprehensive regulation did not occur, however, until the late 1930s, when states like Arkansas passed oil and gas conservation acts.[4] Prior to this time, most oil fields developed on the basis of the common law rule of capture.[5] The rule allowed developers to

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[2] *See* HERBERT CHARLES BELL, HISTORY OF VENANGO COUNTY, PENNSYLVANIA: ITS PAST AND PRESENT 310-11 (Chicago, Brown, Runk & Co. 1890).

[3] The ability to refine crude oil into kerosene was developed by Yale chemist Benjamin Silliman for investors George Bissell and Jonathan Eveleth, who also financed the drilling for oil near Titusville. *See* CHARLES A. WHITESHOT, THE OIL-WELL DRILLER: A HISTORY OF THE WORLD'S GREATEST ENTERPRISE, THE OIL INDUSTRY 50 (1905). Bissell, Eveleth, and James Townsend employed Edwin Drake to secure the land and arrange for drilling, giving him the bogus title of "Colonel" so that the Titusville community might be more welcoming. *See id.* at 47-50.

[4] *See* Act 105, 1939 Ark. Acts 219 (codified as amended at ARK. CODE ANN. §§ 15-72-101 to -407 (Repl. 2009 & Supp. 2013)).

[5] For the leading history on the rule of capture, see TERENCE DAINTITH, FINDERS KEEPERS? HOW THE LAW OF CAPTURE SHAPED THE WORLD OIL INDUSTRY (2010).

drill as many wells as they wished within the confines of their surface and subsurface rights to real property and to claim exclusive ownership of petroleum produced therefrom. Those who drilled within their own boundaries were not liable for drainage, and the remedy for a drained party was one of self-help—drill a well to prevent drainage. The rule of capture encouraged developers to drill as many wells as possible within their respective tracts and to produce the wells as rapidly as possible to capture as much petroleum as possible from the subsurface. This rapid drilling and production occurred for two primary reasons.

First, drillers understood the concept of drainage—that a driller must drill and produce rapidly or risk losing oil to drainage by neighboring drillers. Transactional costs, particularly strategic "holdout" bargainers, prevented agreements to limit drilling.

Second, many drillers—and some courts[6]—believed that oil and gas behaved much like a wild animal beneath the subsurface—constantly on the move. Thus, the trick was to drill many wells to capture as much oil as possible as it passed beneath the driller's surface. If the driller delayed, the oil might move on to other property.

Thus, for more than forty years after the drilling of the Drake well, neither drillers nor government officials saw a real need for oil conservation as we know it today. For example, in 1890, oil was discovered just north of what is now downtown Los Angeles.[7] Two years later, Edward Doheny—who would later become a pioneer driller in Mexico[8] and still later become ensnared in the infamous Teapot Dome scandal[9]—drilled the

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[6] *See, e.g.*, Kelly v. Ohio Oil Co., 49 N.E. 399, 401 (Ohio 1897) ("Petroleum oil is a mineral, and while in the earth it is part of the realty, and, should it move from place to place by percolation or otherwise, it forms part of that tract of land in which it tarries for the time being, and, if it moves to the next adjoining tract, it becomes part and parcel of that tract; and it forms part of some tract until it reaches a well, and is raised to the surface, and then for the first time it becomes the subject of distinct ownership, separate from the realty, and becomes personal property,—the property of the person into whose well it came.").

[7] *See* Stephen M. Testa, *The Los Angeles City Oil Field: California's First Oil Boom During the Revitalization Period (1875-1900)*, 6 OIL-INDUSTRY HIST. 79, 80 (2005).

[8] *See* JONATHAN C. BROWN, OIL AND REVOLUTION IN MEXICO 25-46 (1993) (detailing Doheny's experiences in the oil industry).

[9] In the 1910s, federal oil reserves had been established in Wyoming and California to "conserve" oil supplies for the United States Navy. DAVID H. STRATTON, TEMPEST

first commercially successful well in what would become the Los Angeles City Oil Field.[10] The field came to encompass about 700 acres.[11] By 1897, over 500 wells had been drilled in the field—a drilling density of about one well per 1.5 acres.[12] Ultimately, approximately 1250 wells were drilled.[13] By 2008, only a single producing well remained, reportedly producing about 3.5 barrels of oil per day.[14]

OVER TEAPOT DOME: THE STORY OF ALBERT B. FALL 6-7 (1998). During the administration of President Warren G. Harding, management of these reserves was transferred from the Navy Department to the Department of the Interior. *See id.* at 214. Doheny and Harry Sinclair, a fellow oilman, were accused of bribing then-Secretary of the Interior Albert B. Fall to secure oil and gas leases to portions of these oil reserves. *Id.* at 5-6. The scandal was called the Teapot Dome Scandal because of a teapot-shaped rock formation on the surface above the reserves. *Id.* at 6. The scandal soon became a national symbol for government corruption in the United States. Although Doheny was acquitted of bribery, a jury found Fall guilty, and Sinclair was jailed for contempt. *See id.* at 301-42 (discussing the scandal's fallout).

[10] *See* Testa, *supra* note 7, at 83-84. This field was discovered as a result of oil seeps at the surface, reminiscent of the beginning of an old sitcom, *The Beverly Hillbillies*. The introductory song to that series, performed by Lester Flatt and Earl Scruggs, told of Jed Clampett "shootin' at some food, and up from the ground come a bubblin' crude." FLATT AND SCRUGGS, *The Ballad of Jed Clampett*, *on* HARD TRAVELIN' FEATURING THE BALLAD OF JED CLAMPETT (Columbia Records 1962). In the show, Clampett made his oil discovery in middle America and then, after becoming a millionaire, moved his family, which included nephew Jethro, daughter Elly May, and mother-in-law Granny, to Los Angeles. These fictional characters should not be confused with Edward A. Clampitt, who became one of the principal operators in the Los Angeles City Oil Field during the first decade of the twentieth century. *See* Bob Pool, *Capping an Era of L.A. Oil Exploration*, L.A. TIMES (Jan. 9, 2012), http://articles.latimes.com/2012/jan/09/local/la-me-old-wells-20120109.

[11] *Los Angeles Oil Field*, S. F. CALL, Jan. 24, 1896, at 3.

[12] William Rintoul, *The Los Angeles Basin: Oil in an Urban Setting*, *in* ACTIVE MARGIN BASINS 25, 25 (Kevin T. Biddle ed. 1991).

[13] *See* Pool, *supra* note 10.

[14] *See* DIV. OF OIL, GAS & GEOTHERMAL RES., CAL. DEP'T OF CONSERVATION, 2008 ANNUAL REPORT OF THE STATE OIL & GAS SUPERVISOR 94 (2009), *available at* ftp://ftp.consrv.ca.gov/pub/oil/annual_reports/2008/PR06_Annual_2008.pdf. About 400,000 marginal, or "stripper," wells—those that produce fifteen or less barrels of oil per day—still operate in the United States. *Stripper Well Facts*, NAT'L STRIPPER WELL ASS'N, https://nswa.us/custom/showpage.php?id=25 (last visited Mar. 13, 2015). Prior to the shale boom of the last six years, marginal wells accounted for over 10% of United States onshore production—an astonishing figure when one considers that our country is the third-largest producer of conventional oil in the world. *Id.* A major goal of oil and gas conservation law has been to maintain stripper-well production—a daunting task when oil prices are low, such as when prices for crude oil fell below $10 per barrel in late 1999 and early 2000. Although maintaining stripper-well production may not result in the highest or best use of land in some places, the strategic importance of America's total stripper-well production cannot be ignored.

Thus, the generally accepted modus operandi for drillers was "more wells, more oil"—that is, the more wells that were drilled, the more oil that would be captured. A few drillers questioned this approach after the Spindletop Field was developed near Beaumont, Texas. The discovery well, drilled in 1901, was the first true "gusher," spewing an estimated 70,000 to 100,000 barrels per day for several days before being brought under control.[15] A couple of years later, wells were so densely drilled in the field's heart that a person could walk from derrick to derrick without stepping on the ground.[16] Unfortunately, the field dried up by 1908, not because there was no oil left in the ground, but because the reservoir energy—something drillers were just beginning to understand—was inefficiently dissipated by the rapid rate of production.[17] Still, the fiercely independent drillers did not call for regulation, even though the early 1900s marked the beginning of a regulatory era, part of the progressive movement symbolized by the presidency of Theodore Roosevelt.

Nevertheless, in the 1910s, the Standard Oil Trust was broken up into over thirty separate companies, but this break-up largely affected only the downstream oil industry. The only real upstream concern during this decade was a fear that the United States was running out of oil. This fear occurred at a time when products from refined oil were becoming important consumer commodities, vital sources of energy and lubricants for industry, and strategically important resources for warfare.

Around this time, both the British Empire, at the behest of then-First Lord of the Admiralty Winston Churchill, and the United States Navy decided to convert their naval fleets from coal to oil.[18] Oil proved far superior, as it is a denser form of

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[15] JOHN STRICKLIN SPRATT, THE ROAD TO SPINDLETOP: ECONOMIC CHANGE IN TEXAS, 1875–1901, at 274 (1955). A discovery so huge, along with the many others that would follow, justified breaking out champagne in celebration. My, how times have changed. Today, a blowout like the discovery at Spindletop would quickly prompt costly well-control efforts to minimize environmental damage, and a host of lawyers would be engaged to deal with the resulting legal consequences.

[16] This is depicted photographically in WALTER RUNDELL, JR., EARLY TEXAS OIL: A PHOTOGRAPHIC HISTORY, 1866–1936, at 43 (1977).

[17] Robert Wooster & Christine Moore Sanders, *Spindletop Oilfield*, TEX. STATE HIST. ASS'N (June 15, 2010), https://tshaonline.org/handbook/online/articles/dos03.

[18] *See* Erik J. Dahl, *Naval Innovation: From Coal to Oil*, JOINT FORCE Q., Winter 2000–01, at 50, 54.

energy and easier to transport for refueling on the high seas.[19] In other words, oil-burning naval vessels did not have to return to port for refueling.[20] Oil-fueled naval fleets provided an important speed advantage during World War I against a German fleet that continued to rely on coal.[21]

The strategic importance of oil was also recognized when Mexico nationalized its oil industry in 1917. Before this event, the country allowed drillers to develop oil resources on a private ownership model similar to that of the United States.[22] In addition, the 1917 Bolshevik Revolution signaled that Russia might develop its oil resources as a government enterprise.[23] Even Winston Churchill convinced the British government, which had no oil production within the British Isles, to take a controlling stake in the Anglo-Persian Oil Company in order to protect British strategic oil interests in the Middle East.[24]

In 1912, President Taft withdrew federal acreage from use by private developers. Prior to this withdrawal, drillers could assert placer mining claims to oil resources, thereby allowing them to acquire title to the claim and to any oil produced therefrom.[25] After the United States Supreme Court upheld such use of executive authority to withdraw federal acreage from placer claims,[26] Congress passed the Mineral Leasing Act of 1920, making oil, gas, and a few other substances—so-called "leasable minerals"—subject to royalty.[27]

In addition, some limited state and local laws began to regulate discrete aspects of oil drilling during the 1910s. In 1915, California passed a law requiring drillers to run surface casing below freshwater zones to isolate oil from the groundwater.[28] This was done as much to protect oil from water

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[19] *Id.* at 51.

[20] *Id.*

[21] *See id.* at 55.

[22] *See* BROWN, *supra* note 8, at 224-26.

[23] FRED HALLIDAY, ARABIA WITHOUT SULTANS 396 (1974).

[24] *See* WINSTON S. CHURCHILL, THE WORLD CRISIS: 1911–1918, at 76-77 (First Free Press trade paperback ed. 2005).

[25] *See* Northcutt Ely, *The Government in the Capacity of Land Owner*, *in* CONSERVATION OF OIL & GAS: A LEGAL HISTORY, 1948, at 599, 623-24 (Blakely M. Murphy ed., 1949).

[26] *See* United States v. Midwest Oil Co., 236 U.S. 459, 483 (1915).

[27] Mineral Leasing Act of 1920, ch. 85, 41 Stat. 437 (1920); *see also* 30 U.S.C. § 181 (2012) (preeminent current statute).

[28] *See* 1915 Cal. Stat. 1404, 1408.

as it was to protect water from oil. Today, the running of well casing and associated cementing below known freshwater resources is a basic feature of oil and gas conservation regulation.

In 1928, developers discovered the Oklahoma City Oil Field.[29] Drilling occurred within city limits by 1930,[30] which prompted the passage of local ordinances that regulated the location of wells within the city.[31] These rules are still in place today and are administered by a special local body.[32] Well-density and spacing regulations are now a mainstay of state oil and gas conservation laws.[33] Tension between local and state regulation has become a major issue in New York,[34] Pennsylvania,[35] and Colorado,[36] where state conservation laws have not fully preempted regulatory law. In many states, local zoning laws may regulate the location of wells, but other local regulation is largely preempted. For example, voters in Denton, Texas voted to ban hydraulic fracturing within city limits in November 2014.[37] The validity of this regulation is presently under challenge.[38] The current Model Conservation Act, promulgated by the Interstate Oil and Gas Compact Commission (IOGCC), recognizes this tension with alternative versions of the section that governs the Act's scope. One version preempts

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[29] OKLAHOMA: A GUIDE TO THE SOONER STATE 170 (1941).

[30] *Id.* at 170-71.

[31] *See id.*

[32] *See* OKLA. CITY, OKLA., CODE § 37-15 (2010) (outlining the duties of the city's Oil and Gas Inspector).

[33] *See, e.g.*, MODEL OIL & GAS CONSERVATION ACT § 10 (Interstate Oil & Gas Compact Comm'n 2004) (governing well spacing).

[34] *See* Anschutz Exploration Corp. v. Town of Dryden, 940 N.Y.S.2d 458, 470-71 (Sup. Ct. 2012) (holding state law did not preempt a local zoning law prohibiting oil and gas exploration).

[35] *Compare* Range Res.-Appalachia, LLC v. Salem Twp., 964 A.2d 869, 877 (Pa. 2009) (ruling state oil and gas conservation act preempted local ordinance), *with* Huntley & Huntley, Inc. v. Borough Council of Borough of Oakmont, 964 A.2d 855, 869 (Pa. 2009) (reaching opposite conclusion).

[36] *Compare* Bd. of Cnty. Comm'rs, La Plata Cnty. v. Bowen/Edwards Assocs., 830 P.2d 1045, 1060 (Colo. 1992) (en banc) (holding state oil and gas conservation act did not preempt local land-use regulations), *with* Voss v. Lundvall Bros., 830 P.2d 1061, 1069 (Colo. 1992) (en banc) (reaching opposite conclusion).

[37] *Denton's Fracking Ban Challenged in Court on Wednesday*, FOX4NEWS.COM, http://www.fox4news.com/story/27272660/denton-residents-could-ban-fracking-in-historic-vote (last updated Nov. 5, 2014, 2:25 PM).

[38] *Id.*

all local laws except zoning, and an alternative recognizes the possibility of additional local regulation.[39]

In the 1920s, various new oil discoveries, both in the United States and abroad, eased the concerns over oil shortages.[40] In fact, by the late 1920s, the major oil companies conspired to conserve oil supplies by cartel.

Following a major discovery in Iraq, Calouste Gulbenkian, a principal stockholder in the Turkish National Bank, brokered an agreement to organize the Turkish Petroleum Company.[41] The agreement included a partnership between Royal Dutch Shell; Compagnie Française des Pétroles (Total); Anglo-Persian (BP); and the Near East Development Corporation, a consortium of the five largest American oil companies—Jersey (Exxon), Socony (Mobil), Gulf (which later merged with Chevron), Pan American Petroleum & Transport (which later sold its shares in the consortium to Jersey and Socony), and Atlantic Richfield (which was later acquired by BP).[42] As part of this agreement, Gulbenkian kept a 5% interest for himself (hence the nickname "Mr. 5%") and devised a secret "Red Line Agreement" that no party to the consortium would independently develop oil within the boundaries of the former Ottoman Empire without the consent of the others.[43] The goal was to avoid bringing large, new oil supplies to market, which would lead to even lower prices.

Also in 1928, leaders from three of the major oil companies—Royal Dutch Shell, Jersey, and Anglo-Persian—met at Achnacarry Castle in Scotland.[44] At this secret meeting, the companies sought to limit competition among them by

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[39] *See* MODEL OIL & GAS CONSERVATION ACT § 3 (Interstate Oil & Gas Compact Comm'n 2004).

[40] During this time, modern seamless steel pipe was developed, which allowed for more widespread use of natural gas. Apart from extracting natural gasoline from casinghead gas, natural gas was rarely used beyond the immediate locality of production. Seamless steel pipe brought about more regional use and ultimately nationwide distribution after World War II.

[41] STEPHEN PELLETIÈRE, IRAQ AND THE INTERNATIONAL OIL SYSTEM: WHY AMERICA WENT TO WAR IN THE GULF 26 (2001).

[42] *See id.* at 56; *see also* DANIEL YERGIN, THE PRIZE: THE EPIC QUEST FOR OIL, MONEY & POWER 185-89 (First Free Press trade paperback ed. 2009) (recounting the story of this agreement).

[43] *See* PELLETIÈRE, *supra* note 41, at 56.

[44] 2 JAMES BAMBERG, THE HISTORY OF THE BRITISH PETROLEUM COMPANY: THE ANGLO-IRANIAN YEARS, 1928–1954, at 110 (1994).

agreeing to lock in their respective market shares and to fix prices.[45] The agreement came to be called the "As Is" Agreement.[46]

Together, the "Red Line" and "As Is" Agreements discouraged new production and reduced competition in much of the Middle East, thereby stabilizing prices. However, the discovery of the giant East Texas Field in 1930 dumped so much oil into the market that prices plummeted to unprecedented lows.

At the time, the East Texas Field was the largest field ever discovered.[47] It was not eclipsed until 1948, when the giant Ghawar Field was discovered in Saudi Arabia.[48] As production from the East Texas Field flooded the market, oil prices fell below $0.05 per barrel,[49] or about $0.70 in 2015 dollars. Some producers and politicians advocated for mechanisms to control production and stabilize prices, but regulation was difficult because of the large number of small producers.[50]

Although the Texas Railroad Commission had authority to limit production to prevent the physical waste of oil, it lacked the authority to regulate production in order to support prices.[51] The Oklahoma Corporation Commission had authority to regulate production to support prices, but the legality of its authority was dubious.[52]

An oil states advisory committee was formed in 1931, and several meetings were held among its participants.[53] Oklahoma, which had been regulating production, threatened to flood the market if the other major producing states refused to cooperate.[54] Some cooperation resulted, but rogue producers exceeded their allowables, taking much of the excess production

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[45] *See id.* at 109-10.

[46] *Id.* at 110.

[47] *See* VAN CRADDOCK, JR., HISTORIC GREGG COUNTY: AN ILLUSTRATED HISTORY 27-28 (2006).

[48] ALBERT MARRIN, BLACK GOLD: THE STORY OF OIL IN OUR LIVES 92 (2012).

[49] *See* YERGIN, *supra* note 42, at 230.

[50] *See id.* at 232.

[51] *Id.*

[52] *See* Michael L. Decker, *Natural Resources and Public Utilities Regulation in Oklahoma: The Corporation Commission in Crisis*, 19 OKLA. CITY U. L. REV. 353, 359-60 (1994).

[53] *See* Blakely M. Murphy, *The Oil States Advisory Committee, a Predecessor of the Compact*, *in* CONSERVATION OF OIL & GAS: A LEGAL HISTORY, 1948, *supra* note 25, at 545, 545.

[54] *Id.* at 549.

across state lines to refineries that assisted in thwarting this cooperative effort.[55] The advisory committee proposed an Interstate Compact shortly after President Franklin Roosevelt took office.[56]

Infighting on the question of regulating production to support prices nearly led to federal regulation. The Independent Petroleum Association of America (IPAA) briefly supported federal intervention until Secretary of the Interior Harold L. Ickes advocated in favor of declaring the oil industry a public utility.[57] Oklahoma Governor "Alfalfa Bill" Murray declared martial law, calling out the "state militia" to enforce production regulations.[58] Texas Governor Ross Sterling sent the National Guard and the Texas Rangers into the East Texas Field to enforce regulations against waste.[59] These efforts proved unsuccessful, and the flood of production into the market led prices to fall to $0.04 per barrel in 1933.[60] Thereafter, the IPAA promoted regulation, but many small producers remained hostile.[61]

The oversupply crisis was finally addressed through the formation of the Interstate Oil Compact Commission (IOCC) in 1935.[62] This formal arrangement was supported by the Connally Hot Oil Act,[63] the successor to a law overturned by the United States Supreme Court in 1933.[64] The Act prohibited "[t]he shipment or transportation in interstate commerce from any State of contraband oil produced in such State . . . . or withdrawn from storage in excess of the amount[] permitted . . . under the laws of such State."[65] Congressional action, pursuant to the Compact Clause of the United States Constitution, authorized producing states to form an interstate compact for the purpose of establishing production quotas to meet reasonable

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[55] YERGIN, *supra* note 42, at 234.

[56] Murphy, *supra* note 53, at 554-55.

[57] *See* YERGIN, *supra* note 42, at 237.

[58] *Id.* at 233.

[59] *Id.*

[60] *Id.* at 237.

[61] *See id.*

[62] *See* YERGIN, *supra* note 42, at 239-40.

[63] Connally Hot Oil Act, ch. 18, 49 Stat. 30 (1935).

[64] *See* A.L.A. Schechter Poultry Corp. v. United States, 295 U.S. 495, 541-42 (1935); *see also* National Industrial Recovery Act, ch. 90, 48 Stat. 195 (1933) (overturned by the decision).

[65] Connally Hot Oil Act, ch. 18, § 3, 49 Stat. 30, 31 (1935).

market demand based upon federally supplied data.[66] Before its creation, Oklahoma Governor Ernest W. Marland vigorously supported the Compact.[67]

This practice, market-demand prorationing, was effectively used along with tariffs on imported oil in the 1960s to manage supply and demand in the United States until the Arab oil embargo in the 1970s. By then, domestic production in the United States had fallen to the point where it had little influence on global oil prices.[68] Starting in the 1970s, production quotas were used by members of the Organization of Petroleum Exporting Countries (OPEC) to support high prices.[69]

III. THE DEVELOPMENT OF COMPREHENSIVE CONSERVATION LAWS AND REGULATIONS

Besides implementing market-demand prorationing, the IOCC supported other regulatory measures designed to prevent waste. Led by Arkansas and New Mexico, states began passing comprehensive oil and gas conservation acts that required drilling permits, managed the drilling and location of wells, regulated well spacing and density, permitted exception locations to prevent waste or to protect correlative rights, authorized regulatory forced pooling, and later allowed compulsory unitization. With respect to drilling, regulations came to include strict permitting, casing, cementing, plugging, and abandonment requirements.

Although Texas and Oklahoma still go through the process, most states no longer meaningfully regulate production to meet market demand, but state conservation agencies still regulate production to prevent physical waste and to protect correlative rights. Most also regulate drilling and production to prevent economic waste, such as by preventing the drilling of more wells than are necessary to effectively and efficiently drain a field. When natural gas became a valuable product that could be

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[66] *See* YERGIN, *supra* note 42, at 240 (discussing the establishment of the Interstate Oil Compact).

[67] Blakely M. Murphy, *The Formation of the Interstate Compact to Conserve Oil and Gas*, *in* CONSERVATION OF OIL & GAS: A LEGAL HISTORY, 1948, *supra* note 25, at 556, 559.

[68] *See* MOHAMMED E. AHRARI, OPEC: THE FAILING GIANT 130 (1986) (discussing the considerable damage that the Arab oil embargo caused on the United States economy).

[69] *Id.* at 26.

transported long distances thanks to the invention of seamless steel pipe, states began to restrict the flaring or venting of gas. Today, conservation agencies also regulate drilling and production to protect the surface of land and fresh water from hydrocarbon pollution.

New Mexico[70] and Oklahoma[71] were the first states to enact comprehensive compulsory pooling laws in 1935. Arkansas[72] was not far behind, passing its law in 1939. Today, New Mexico requires consenting parties to carry non-consenting parties, but the state subjects non-consenting working interests to a risk premium of up to 200%.[73] Oklahoma allows consenting parties to acquire the working interests of non-consenting parties at an appraised price consisting of a combination of up-front cash and overriding royalty (or royalty in the case of a non-consenting, unleased mineral-interest owner).[74] Texas first adopted the practice of granting small-tract, exception-location wells, coupled with a "living allowable," to prevent confiscation, but the state eventually enacted a limited pooling act that is seldom utilized.[75] Kansas, which lacks a compulsory pooling law, adopted the practice of granting small-tract, exception-location wells without a disproportionate increase in allowables, but the state does permit the owners of small tracts to pool voluntarily, including pooling non-contiguous acreage overlying the common reservoir, in order to gain an increased allowable.[76]

Comprehensive compulsory pooling laws are superior to the Texas and Kansas approach. However, the Oklahoma or New Mexico approach to dealing with non-consenting parties may not be preferable. The New Mexico risk-premium approach is simple, and because the parties can generally predict the terms of the pooling order, they may more readily agree to voluntary pooling that reflects the likely provisions of the order. The Oklahoma approach is costly in terms of both time and money, as an administrative hearing is necessary to establish

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[70] *See* 1935 N.M. Laws 137.

[71] *See* 1935 Okla. Sess. Laws 232.

[72] *See* Act 105, 1939 Ark. Acts 219.

[73] *See* N.M. STAT. ANN. § 70-2-17(C) (West 2014).

[74] *See* OKLA. STAT. ANN. tit. 52, § 87.1(e) (West 2014).

[75] *See* 1977 Tex. Gen. Laws 2570.

[76] *See* Bruce M. Kramer, *Compulsory Pooling and Unitization: State Options in Dealing with Uncooperative Owners*, 7 J. ENERGY L. & POL'Y 255, 255-56 n.2 (1986).

values; however, the approach encourages participation and is thus very effective in getting wells drilled.

Although Harold L. Ickes, Secretary of the Interior under President Franklin Roosevelt, strongly advocated unitization during the 1930s, Oklahoma was the first state to enact a compulsory unitization law, doing so in 1945.[77] Other states, including Arkansas, followed suit in the 1950s and 1960s,[78] but Texas has declined to adopt compulsory unitization.[79] Curiously, Kansas has a compulsory unitization act[80] but no compulsory pooling law.

A weakness in compulsory unitization acts is that they require a certain level of voluntary agreement, generally representing at least 60% of the production-share entitlement, before the conservation agency may force non-consenting parties into the unit.[81] This makes unitization difficult and also invites those favoring unitization to game the production allocations in a manner that benefits them at the expense of non-consenting parties. Because conservation agencies are primarily concerned with preventing waste, especially the underground waste of leaving hydrocarbons unrecovered, they are likely to approve any unitization that achieves the required level of voluntary approval.

Conservation regulation in the twentieth century evolved around what is now called "conventional" oil and gas operations. During the nineteenth and twentieth centuries, oil and gas were largely produced from naturally porous and permeable traps or reservoirs. Petroleum formed from dead plant and animal matter buried in source rock as a result of pressure from overlying strata that had gradually accumulated through erosion. If conditions were right, the resulting high temperatures and chemical changes caused some of this dead plant and animal matter to transform into oil and gas. Geologists sometimes call this source rock the "petroleum kitchen." As a result of further overlying pressure, some of the petroleum that was "cooked" in the petroleum kitchen was

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[77] *See* 1945 Okla. Sess. Laws 162.

[78] Act 536, 1963 Ark. Acts 1648.

[79] *See* Kramer, *supra* note 76, at 259 n.16.

[80] *See* KAN. STAT. ANN. §§ 55-1301 to -1317 (West 2015).

[81] In Alaska, however, the conservation agency may order compulsory unitization without any level of voluntary agreement. *See* ALASKA STAT. ANN. § 31.05.110(q) (West 2014).

squeezed out of the source rock into overlying formations that were more porous and permeable. This petroleum then migrated until it was confined to geologic traps, where it remained over time until a drilling bit penetrated the trap or reservoir.

Oil and gas exploration in the nineteenth and twentieth centuries was largely a search for these traps.[82] Production occurred when a vertical well penetrated a trap. Although not well understood until the 1930s, drainage was facilitated by sources of reservoir energy, such as natural reservoir pressure in the form of water, gas in solution with oil, or gas caps. This energy pushed oil through the permeable trap into wellbores, where it could be further forced to the surface, or as pressure declined, be pumped to the surface. A major objective of conservation agencies was to conserve reservoir energy to maximize oil production. If reservoir energy was not conserved, debacles like Spindletop[83] might occur, leaving huge volumes of oil unrecovered, a classic example of so-called underground waste.

Although state conservation agencies addressed economic waste—the drilling of more wells than necessary to drain a trap effectively and efficiently—and surface waste—the waste of oil through surface leaks and spills—they were most concerned with underground waste. The chief means of preventing waste came in the form of regulations that limited the number of wells that could be drilled into a reservoir trap. Production could be directly curtailed on a well-by-well basis, such as by limiting extraction from wells that produced proportionately large ratios of gas or water (reservoir energy) compared to oil production. Ideally, all reservoirs should have been unitized, but unitization was often hard to achieve.

Conservation practices that limited the number of wells were largely an effort to overcome the "more wells, more oil" development practices that were commonplace under the unregulated rule of capture. Well-spacing and density regulations limited the rule by capping the number of wells that

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[82] Coalbed methane, an unconventional resource, was produced in the latter part of the twentieth century, but the mechanics of coalbed methane recovery did not require major changes in conservation practices.

[83] *See supra* notes 15-17 and accompanying text; *see also* Sharon O. Flanery & Ryan J. Morgan, *Overview of Pooling and Unitization Affecting Appalachian Shale Development*, 32 ENERGY & MIN. L. INST. 457, 460-61 (2011) (discussing the "frenzied production" at Spindletop).

could be drilled in order to conserve reservoir energy. This led to "fewer wells, more oil" development practices.

IV. TRENDS IN CONSERVATION LAWS AND REGULATIONS

Although conventional operations remain an important part of the American oil and gas industry, "unconventional" operations, especially in shale formations, have become more important in terms of increasing domestic reserves and production. Conservation practices have been forced to adjust to new drilling and completion techniques and to the fact that shale is relatively impermeable—that is, petroleum does not readily flow through shale compared to conventional formations such as sandstone.

While there is no established definition of "unconventional petroleum," some use the term to describe any petroleum that is substantially more difficult and expensive to recover.[84] Shale oil

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[84] *See* IHS, INC., AMERICA'S NEW ENERGY FUTURE: THE UNCONVENTIONAL OIL AND GAS REVOLUTION AND THE US ECONOMY 2 (2012), *available at* http://www.energyxxi.org/sites/default/files/pdf/americas_new_energy_future-unconventional_oil_and_gas.pdf ("'Unconventional' oil and natural gas is exactly the same commodity as 'conventional' oil and natural gas. The word 'unconventional' is typically applied to major new advances in extraction technology, in the oil and natural gas industry, that allow access to resources not technically or economically recoverable."). The *Schlumberger Oilfield Glossary* defines "unconventional resource" as follows:

> An umbrella term for oil and natural gas that is produced by means that do not meet the criteria for conventional production. What has qualified as unconventional at any particular time is a complex function of resource characteristics, the available exploration and production technologies, the economic environment, and the scale, frequency and duration of production from the resource. Perceptions of these factors inevitably change over time and often differ among users of the term. At present, the term is used in reference to oil and gas resources whose porosity, permeability, fluid trapping mechanism, or other characteristics differ from conventional sandstone and carbonate reservoirs. Coalbed methane, gas hydrates, shale gas, fractured reservoirs, and tight gas sands are considered unconventional resources.

Unconventional Resource, SCHLUMBERGER, http://glossary.oilfield.slb.com/en/Terms/u/unconventional_resource.aspx (last visited Mar. 13, 2015). Phil Chan, a prominent petroleum engineer, offers the following distinction between conventional and unconventional resources:

> Conventional resources exist in discrete petroleum accumulations related to a localized geological structural feature and/or stratigraphic condition (typically with each accumulation bounded by a down-dip contact with an aquifer) that is significantly affected by hydrodynamic influences such as the buoyancy of petroleum in water. The petroleum is recovered through

and shale gas meet these criteria because of shale's comparatively impermeable nature.[85] Shale is porous and thus can hold large quantities of oil, gas, or both, but it is not sufficiently permeable—that is, shale pore spaces are not sufficiently interconnected—to allow fluids to readily flow.[86] For decades, drill cuttings of many shales revealed the presence of petroleum, but these fluids have not been technically and economically recoverable in sufficient quantities until recently.[87] Three twentieth century innovations were independently developed, gradually improved, and then combined to allow for the recovery of large volumes of oil and gas from shale source rock: (1) hydraulic fracturing; (2) horizontal drilling; and (3) microseismic monitoring.[88]

A. Hydraulic Fracturing

The *Schlumberger Oilfield Glossary* defines "hydraulic fracturing" as follows:

> A stimulation treatment routinely performed on oil and gas wells in low-permeability reservoirs. Specially engineered fluids are pumped at high pressure and rate into the

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> wellbores and typically requires minimal processing prior to sale. Unconventional resources exist in hydrocarbon accumulations that are pervasive throughout a large area and that are generally not significantly affected by hydrodynamic influences (also called "continuous-type deposits"). Such accumulations require specialized extraction technology, and the raw production may require significant processing prior to sale.

Phil Chan, *Unconventional Resources Estimation*, *in* GUIDELINES FOR APPLICATION OF THE PETROLEUM RESOURCES MANAGEMENT SYSTEM 128, 128 (2011), *available at* http://www.spe.org/industry/docs/PRMS_Guidelines_Nov2011.pdf.

[85] ALEX TREMBATH ET AL., BREAKTHROUGH INST. ENERGY & CLIMATE PROGRAM, WHERE THE SHALE GAS REVOLUTION CAME FROM: GOVERNMENT'S ROLE IN THE DEVELOPMENT OF HYDRAULIC FRACTURING IN SHALE 5 (2012), *available at* http://thebreakthrough.org/blog/Where_the_Shale_Gas_Revolution_ Came_From.pdf.

[86] *Id.* True hydrocarbon "reservoirs" are not found in shale because its permeability is 1,000,000 times lower than "conventional reservoir rock." *See* José Martínez de Hoz et al., *Shale We Dance an Unconventional Tango?*, 6 J. WORLD ENERGY L. & BUS. 179, 180 n.5 (2013).

[87] *See* TREMBATH ET AL., *supra* note 85, at 5 ("Engineers had neither the technology nor the knowledge base to cost effectively map shale expanses, drill horizontally in the formations, initiate fractures that were productive and predictable, and recover the gas resources locked in the formations.").

[88] For a detailed discussion about the development of hydraulic fracturing, horizontal drilling, and three-dimensional seismic, see Owen L. Anderson, *Shale Revolution or Evolution: Opportunities and Challenges for Europe*, 4 GLOBAL BUS. L. REV. 1 (2013). The discussion that follows is an updated adaptation of Part I of that article.

> reservoir interval to be treated, causing a vertical fracture to open. The wings of the fracture extend away from the wellbore in opposing directions according to the natural stresses within the formation. Proppant, such as grains of sand of a particular size, is mixed with the treatment fluid to keep the fracture open when the treatment is complete. Hydraulic fracturing creates high-conductivity communication with a large area of formation and bypasses any damage that may exist in the near-wellbore area.[89]

Used with horizontal drilling, which serves to expose more reservoir rock to the wellbore, hydraulic fracturing of the horizontal lateral allows a greater portion of the reservoir rock to be fractured, thus facilitating a greater recovery of hydrocarbons. Engineers have long used hydraulic fracturing to further stimulate production from conventional reservoirs. It was first used in 1947 to extract natural gas from limestone[90] and was widely used by 1949 to complete vertical wells.[91] In total, more than 1,000,000 wells have been hydraulically fractured in the United States to date.[92] Over 60% of the wells drilled in the United States in 2010 were hydraulically fractured.[93]

Prior to hydraulic fracturing, drillers used other techniques to stimulate production. In 1864, Colonel Edward Roberts patented a torpedo that he detonated at the bottom of wellbores to increase the permeability of the oil-bearing formation.[94] Later, "shooters" began to use nitroglycerin. Owing to the volatility of "nitro," oil companies logically preferred to employ shooters who were unmarried and without dependents!

The federal government played a major role in the development of shale gas, conducting experiments to stimulate

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[89] *Hydraulic Fracturing*, SCHLUMBERGER, http://glossary.oilfield.slb.com/en/Terms/h/hydraulic_fracturing.aspx (last visited Mar. 13, 2015).

[90] TREMBATH ET AL., *supra* note 85, at 3.

[91] *See* Carl T. Montgomery & Michael B. Smith, *Hydraulic Fracturing: History of an Enduring Technology*, J. PETROLEUM TECH., Dec. 2010, at 26, 27. After obtaining a patent and an exclusive license, the Halliburton Oil Well Cementing Company (Howco) performed the first two commercial fracturing treatments. *Id.* The company treated 332 wells in the first year, which increased production by an average of 75%. *Id.*

[92] *See Hydraulic Fracturing Q & A's*, AM. PETROLEUM INST., http://www.api.org/oil-and-natural-gas-overview/exploration-and-production/hydraulic-fracturing/hydraulic-fracturing-qa.aspx (last visited Mar. 13, 2015).

[93] *Id.*

[94] *See* WHITESHOT, *supra* note 3, at 754-55.

gas production by detonating nuclear bombs in shale formations between 1961 and 1973.[95] President Gerald Ford also sought funding for unconventional gas development research.[96] The Crude Oil Windfall Profit Tax Act of 1980[97] included so-called "Section 29" tax credits to encourage unconventional gas development.[98]

Beginning in 1982, the United States government funded the Gas Technology Institute to study the recovery of oil and gas from low-permeability formations.[99] The Energy Research and Development Administration, created after a reorganization of the Atomic Energy Commission, funded the Morgantown Energy Research Center,[100] which conducted pioneering research in association with private industry and the federal government to demonstrate and improve shale-fracturing and horizontal-drilling technologies.[101] In 1986, the Department of Energy, together with several private companies, drilled a demonstration shale well and hydraulically fractured it.[102] The Gas Research Institute subsidized Mitchell Energy and Development Corporation's first successful horizontal well in the Texas Barnett Shale in 1991.[103] George Mitchell, then the

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[95] *See "Gasbuggy" Tests Nuclear Fracking*, AM. OIL & GAS HIST. SOC'Y, http://aoghs.org/technology/project-gasbuggy/ (last visited Mar. 13, 2015).

[96] TREMBATH ET AL., *supra* note 85, at 6. In response to the shortages that followed the oil crisis of the 1970s, the Ford administration "began a concerted federal effort to seek unconventional natural gas." *Id.* In the 1970s, several experimental shale gas wells were drilled with federal participation. *Id.* at 6-7.

[97] *See* Crude Oil Windfall Profit Tax Act of 1980, Pub. L. No. 96-223, 94 Stat. 229 (1980).

[98] *See* TREMBATH ET AL., *supra* note 85, at 7. These Section 29 tax credits "provid[ed] an incentive of $0.50 per thousand cubic feet (Mcf) of natural gas produced from unconventional resources." *Id.*

[99] PAUL STEVENS, THE 'SHALE GAS REVOLUTION': DEVELOPMENTS AND CHANGES 9 (2012), *available at* http://www.chathamhouse.org/sites/files/chathamhouse/public/Research/Energy%2C%20Environment%20and%20Development/bp0812_stevens.pdf.

[100] This organization later became the National Energy Technology Laboratory. *See* SHERIE MERSHON & TIM PALUCKA, U.S. DEP'T OF ENERGY, NATIONAL ENERGY TECHNOLOGY LABORATORY: A CENTURY OF INNOVATION 330 (2010), *available at* www.netl.doe.gov/File%20Library/NewsRoom/NETL-A_ Century_of_Innovation.pdf.

[101] Alex Trembath, *Interview with Alex Crawley*, *Former Program Director for the Energy Research and Development*, BREAKTHROUGH INST. (May 21, 2012), http://thebreakthrough.org/archive/interview_with_alex_crawley_fo.

[102] *Hearing Before the S. Comm. on Energy & Natural Res.*, 112th Cong. 22-23 (2012) (statement of Jesse D. Jenkins, Director of Energy and Climate Policy, Breakthrough Institute).

[103] TREMBATH ET AL., *supra* note 85, at 23.

owner of Mitchell Energy, is considered the father of hydraulic fracturing.[104] Mitchell spent nearly two decades developing a successful hydraulic fracturing technique for use in shale.[105] His company's first economically viable shale gas well was drilled in 1998 in the Barnett Shale.[106]

Hydraulic fracturing has become very controversial. Environmental groups attack it on multiple fronts, but their underlying concern is that the technique has increased oil and gas reserves—fossil fuels the environmental movement hoped were being depleted. Proponents and opponents cannot even agree on how to spell the colloquial term for hydraulic fracturing—"fracing" or "fracking." Scientists have generally used fracing, while the mass media seems to have adopted fracking. I take the coward's way out by using the more formal name, hydraulic fracturing!

B. Horizontal Drilling

The *Schlumberger Oilfield Glossary* defines "horizontal drilling" as follows:

> A subset of the more general term "directional drilling," used where the departure of the wellbore from vertical exceeds about 80 degrees. Note that some horizontal wells are designed such that after reaching true 90-degree horizontal, the wellbore may actually start drilling upward. In such cases, the angle past 90 degrees is continued, as in 95 degrees, rather than reporting it as deviation from vertical, which would then be 85 degrees. Because a horizontal well typically penetrates a greater length of the reservoir, it can offer significant production improvement over a vertical well.
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> The intentional deviation of a wellbore from the path it would naturally take to a horizontal trajectory. Horizontal lateral sections can be designed to intersect natural fractures

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[104] *See* Michael Graczyk, *Texas Oilman, Hydraulic Fracking Pioneer George P. Mitchell Dead at 94*, DALL. MORNING NEWS (July 26, 2013, 3:44 PM), http://www.dallasnews.com/obituary-headlines/20130726-texas-oilman-hydraulic-fracking-pioneer-george-p.-mitchell-dead-at-94.ece Devon Energy Corporation acquired Mitchell Energy in 2002. *See* Ryan Dezember et al., *Devon Energy Nears Deal for GeoSouthern Energy*, WALL ST. J., http://www.wsj.com/articles/SB10001424052702303985504579208141141137528 (last updated Nov. 20, 2013, 11:19 AM).

[105] *See* Graczyk, *supra* note 104.

[106] *See* TREMBATH ET AL., *supra* note 85, at 2.

> or simply to contact more of the productive formation. Horizontal drilling is accomplished through the use of whipstocks, bottomhole assembly (BHA) configurations, instruments to measure the path of the wellbore in three-dimensional space, data links to communicate measurements taken downhole to the surface, mud motors and special BHA components, including rotary steerable systems and drill bits. While many techniques can accomplish this, the general concept is simple: Direct the bit in the direction that one wants to drill. By placing a bend near the bit in a downhole steerable mud motor, the bend points the bit in a direction different from the axis of the wellbore when the entire drillstring is not rotating. By pumping mud through the mud motor, the bit turns while the drillstring does not rotate, allowing the bit to drill in the direction it points. When a particular wellbore direction is achieved, that direction may be maintained by rotating the entire drillstring (including the bent section) such that the bit does not drill in a single direction off the wellbore axis. Instead, the bit sweeps around and its net direction coincides with the existing wellbore. Rotary steerable tools allow steering while rotating, usually with higher rates of penetration and ultimately smoother boreholes. Horizontal drilling is common in shale reservoirs because it allows drillers to place the borehole in contact with the most productive reservoir rock.[107]

Intentional drilling of directional or slant wells occurred as early as the 1920s, often for the purpose of trespassing.[108] In the 1930s, directional or slant wells were drilled into existing vertical wells to redirect hydrocarbons to fight well fires and blowouts.[109] Modern horizontal drilling is a relatively recent innovation, developed in the late 1980s.[110] Hydraulically powered downhole motors are used to turn drill bits while the drill pipe remains stationary in the hole. And "measurement-while-drilling" tools can send directional drilling data to the

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[107] *Horizontal Drilling*, SCHLUMBERGER, http://glossary.oilfield.slb.com/en/Terms/h/horizontal_drilling.aspx (last visited Mar. 13, 2015).

[108] Kate Mantle, *The Art of Controlling Wellbore Trajectory*, OILFIELD REV., Winter 2013/2014, at 54, 54.

[109] *See id.*

[110] *See* ENERGY INFO. ADMIN., DRILLING SIDEWAYS—A REVIEW OF HORIZONTAL WELL TECHNOLOGY AND ITS DOMESTIC APPLICATION, at vii (1993), *available at* http://www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/drilling_sideways_well_technology/pdf/tr0565.pdf.

surface as drilling proceeds, enabling the drill bit to be directed in a particular direction.[111] In the 1980s and 1990s, horizontal drilling was used extensively to develop the Austin Chalk oil play in south-central Texas.[112] The Austin Chalk Formation contained intermittent vertical columns, or lenses, of oil-bearing rock. Hence, a vertical well may or may not have encountered a lens, but a horizontal-lateral borehole could encounter multiple lenses. More recently developed rotary steering system tools now allow for more accurate control of the drilling bit. Today, horizontal laterals can be steered precisely into the most promising portions of a target formation.[113]

C. Microseismic Monitoring

The *Schlumberger Oilfield Glossary* defines "microseismic monitoring" as follows:

> A technique to track the propagation of a hydraulic fracture as it advances through a formation. Microseisms are detected, located, and displayed in time for scientists and engineers to approximate the location and propagation of the hydraulic fracture. Software provides modeling, survey design, microseismic detection and location, uncertainty analysis, data integration, and visualization for interpretation. Computer imagery is used to monitor the activity in 3D space relative to the location of the fracturing treatment. The monitored activities are animated to show progressive fracture growth and the subsurface response to pumping variations. When displayed in real time, the microseismic activity allows one to make changes to the stimulation design to ensure optimal reservoir contact. Also known as hydraulic fracture monitoring, this technique delivers information about the effectiveness of

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[111] With respect to this development, "little practical application occurred until the early 1980's, by which time the advent of improved downhole drilling motors and the invention of other necessary supporting equipment, materials, and technologies, particularly downhole telemetry equipment, had brought some kinds of applications within the imaginable realm of commercial viability." *Id.* at 7.

[112] In 1990, roughly 850 horizontal wells were drilled in this formation alone. *Id.* at 8.

[113] For example, in the Giddings Field of the Austin Chalk, "a lateral displacement of about 300 feet was used to reach a comparatively small area of faulted and fractured rock, with the small horizontal reach in the target formation being little beyond that achievable with a vertical well." *Id.* at 14.

> the stimulation of a reservoir that can be used to enhance reservoir development in shale gas completions.[114]

Seismology dates to World War I, when armed forces measured the speed of sound through the air to locate enemy artillery positions.[115] The generation of sound and the use of listening and timing devices were adapted to find petroleum traps in Oklahoma during the 1920s.[116] Historically, geophysical information was gathered only along a narrow line of the subsurface. While this is still done, and is often called conventional, or two-dimensional, seismic, the development of modern computers capable of processing large amounts of data in a short amount of time allows geophysical information to be gathered over a grid, called three-dimensional seismic. And thanks to the development of more sophisticated geophones, or listening devices, processed seismic data can even reveal the probable presence of hydrocarbons.[117]

Additional seismic data can be gathered through monitoring wellbores. Microseismic devices can measure the effectiveness and location of fractures created by hydraulic fracturing, which allows for changes in the hydraulic-fracturing operation. Moreover, the behavior of a reservoir over its productive time can be monitored—four-dimensional seismic—

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[114] *Microseismic Monitoring*, SCHLUMBERGER, http://glossary.oilfield.slb.com/en/Terms/m/microseismic_monitoring.aspx (last visited Mar. 13, 2015).

[115] *The First 100 Years (1845–1945)*, 208 GEOLOGICAL SOC'Y AM. MEMOIRS 47, 48 (2012) ("During World War I, seismic waves from large guns were detected at arrays of seismic stations and used to pinpoint gun emplacement sites.").

[116] In 1920, John Clarence Karcher and William P. Haseman "organized the Geological Engineering Company and[,] . . . . [t]he first field tests were conducted near Oklahoma City, Oklahoma, in 1921." *Id.* at 52. Although a drop in oil prices quickly caused the company to close, Karcher went on to help establish Geophysical Service Incorporated (GSI), "one of the most successful seismic contracting companies for the following 50 years and . . . the parent of an even more successful company, Texas Instruments." *Id.*

[117] Geophones have become extremely sensitive. *See Bob Hardage: Using Seismic Technologies in Oil and Gas Exploration*, EARTHSKY (June 12, 2013), http://earthsky.org/earth/bob-hardage-using-seismic-technologies-in-oil-and-gas-exploration ("To give you an idea of the sensitivity, we have to stop seismic recording if winds get up to, say, 20 miles an hour or higher. The reason is the wind shakes the grass and affects the signal. It just builds up background noise in the geophones that is undesirable. A small insect, even an ant, can crawl across the top of a geophone, and it'll generate noise in that geophone. So they're really extremely sensitive devices.").

to determine the need for additional drilling or fracturing to increase ultimate recovery.[118]

D. Modern Conservation Practices

The combined use of hydraulic fracturing, horizontal drilling, and microseismic monitoring have facilitated the development of shale oil and shale gas. Because shale is relatively impermeable, conservation practices have had to adapt. In a sense, conservation practices have evolved "back to the future" from "less wells, more oil" to "more wells, more oil." Due to the impermeable nature of shale, drillers prefer to expose as much of the formation to the wellbore as possible, hence the need for laterals and more wellbores. In essence, some shale plays are developed on roughly the equivalent of forty-acre well density to as much as ten-acre well density. In other words, sixteen or more—up to sixty-four—vertical wells would have to be drilled on a 640-acre section of land to roughly achieve the equivalence of the four to eight horizontal wellbores that might be drilled on that same section. Horizontal laterals routinely extend nearly a mile and can commonly extend to nearly two miles. Two-mile laterals are commonly developed using 1280-acre units that allow multiple wellbores. The equivalent number of vertical wells needed to roughly equal the horizontal wellbores would range from 32 to 128. The North Dakota Industrial Commission has 5120-acre units that overlap existing units to facilitate the drilling of horizontal wells along section lines. Moreover, laterals may extend in opposite directions from the well pad, so a single well pad may be used to develop two or more stacked units.

Traditionally, a drilling unit comprised the acreage that could be effectively and efficiently drained by a single well, although as a field matured, conservation agencies might permit "infill" drilling—the drilling of an additional well or wells within an established drilling unit. Today, horizontal-drilling units established in shale plays anticipate multiple wellbores,

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[118] Fiber-optic monitoring technology and wireless wellbore monitoring are used to gather more data and maximize recovery. *See* Garth Naldrett, *Downhole Monitoring, Control Using Digital Distributed Sensing*, OFFSHORE (Mar. 1, 2010), http://www.offshore-mag.com/articles/print/volume-70/issue-3/production-operations/downhole-monitoring-control-using-digital-distributed-sensing.html.

and perhaps a monitoring wellbore used to gather microseismic information.

In the latter half of the twentieth century, the "more wells, more oil" mantra of the rule of capture gave way to a "fewer wells, more oil" philosophy of comprehensive conservation laws and regulations. Today's unconventional plays harken back to the old days, as they are now often developed on the basis of "more wells, more oil."

V. THIS SYMPOSIUM

This symposium is timely because it not only commemorates the seventy-fifth anniversary of the Arkansas Oil and Gas Commission, but it also provides an opportunity to honor the past and to address the future of conservation policies, laws, and practices. As shale oil and shale gas drilling, completion, and production techniques are further refined, conservation policies, laws, and practices will need to adapt. The authors in this symposium issue of the *Arkansas Law Review* address this challenge head on.

Professor David Pierce has written extensively on the doctrine of correlative rights. Like the doctrine of waste, the correlative rights doctrine has common law origins, but both have largely been over-shadowed by two statutory objectives embodied in oil and gas conservation laws and regulations—the prevention of waste and the protection of correlative rights. The regulatory correlative rights doctrine has been little more than a stepchild of the regulatory waste-prevention doctrine, but Professor Pierce believes the correlative rights doctrine is due for some resuscitation. In his article, he discusses the doctrine of correlative rights in the context of Arkansas regulatory and case law. He argues the doctrine is more suitable to resolving disputes involving circumstances where a particular subsurface use or activity intrudes into a neighbor's subsurface, which many courts frame in terms of trespass. Professor Pierce convincingly argues that the trespass doctrine is poorly suited to resolving subsurface uses that inevitably result in intrusions across subsurface boundary lines.

Professor Patrick Martin addresses the need for regulatory and case law, especially trespass law, to adapt to new drilling and production technologies and practices. He argues that the law must adapt to these new technologies and practices, not vice versa. He also reviews the evolution of conservation law, often referencing Arkansas conservation laws and regulations, and discusses how conservation law and regulatory practices have adjusted to the new world of unconventional production, such as the creation of drilling units that allow multiple wells. He discusses various strategies used by working-interest owners, especially non-operators, to take advantage of these new types of units. He compares the Louisiana and Arkansas regulatory practices concerning what he calls "cross units"[119] to address the drilling of wells located close to existing unit boundaries in order to prevent underground waste. He also summarizes the allocation practices of Texas and Pennsylvania, which allocate production from horizontal wells without the necessity of pooling. Due to statutory and judicial restrictions, different states will need to adjust to unconventional drilling and production in different ways.

Professor Phillip Norvell addresses the heart of this symposium—the history of oil and gas conservation law and practices in Arkansas. Arkansas has been a consistent leader in adopting conservation regulations that reflect current best practices and that keep up with new innovations and technologies. Professor Norvell's article provides a comprehensive discussion of this history and will likely become the "go-to" reference for those who practice before the Arkansas Oil and Gas Commission. Oftentimes, to understand current and proposed conservation practices, it is necessary to study the past.

G. Alan Perkins explores one of the most volatile issues facing the upstream oil and gas industry—the conflict between mineral and surface owners. Unfortunately, surface owners who own no mineral rights are an increasingly important consideration in areas where petroleum and mining operations have commenced. Louisiana has long followed its own path of liberative prescription to minimize severed mineral ownership by basically allowing severances of oil and gas rights for a period of ten years and so long thereafter as oil and gas production or operations are conducted. Common law jurisdictions allow mineral severances of unlimited duration. While many states have dormant mineral acts, only a few have legislation that operates automatically and efficiently to vest

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[119] These are called overlapping units in some states.

long-dormant severed minerals in the surface owner. Most require the surface owner to provide notice to the severed mineral owner, giving the severed owner an opportunity to claim the minerals before title passes to the surface owner. This notice requirement largely spoils the utility of the acts. Moreover, several major petroleum- and mineral-producing states do not have dormant mineral acts, and government-owned severed minerals are not subject to such laws. Thus, in most states, petroleum and mining companies have to deal with hostile surface owners who hold no mineral rights.

Although most companies try to be good neighbors by offering compensation for the use of such lands, hard-to-please surface owners can make production extremely difficult. Mineral developers can usually fall back on the common law of reasonable use, which gives them the right to make reasonable use of the surface in order to exploit underlying minerals. A few states have imposed on this right a statutory duty to compensate the surface owner for damages. However, surface owners can still prove difficult. For example, a surface owner can generally deny the use of the surface to a mineral developer who needs to use the land in connection with development of nearby lands, as the scope of a mineral owner's right to use the surface is generally confined to the exploitation of minerals beneath the particular surface or drilling unit that encompasses that surface. Perkins addresses the evolution of Arkansas case law with respect to the scope of the mineral owner's right of reasonable use.

Professor Bruce Kramer and Marvin Rogers, writing separately, remind us that the ultimate conservation tool is unitization. Although available for use in shale plays, unitization has rarely been so used. The North Dakota Industrial Commission recently approved one 30,000-acre unit for shale oil development. This was done in part to lessen the impact of development that would otherwise occur on state park lands. Not surprisingly, this unit has proved controversial. Professor Kramer discusses state unitization laws, the benefits of unitization, the history of how unitization laws came to be included in oil and gas conservation acts, unitization case law, and unitization production allocations. Rogers discusses several unitization acts, including the unitization provisions of the IOGCC Model Act. He also reviews several reported cases addressing unitization in Alabama and other jurisdictions. In my opinion, the greatest failing of oil and gas conservation law is the fact that unitization does not occur early in the life of every oil and gas field.

Thomas Daily discusses the evolution of the Arkansas Oil and Gas Commission's rules on horizontal drilling, with particular emphasis on General Rule B-43. His article provides a history of horizontal-drilling regulations in Arkansas and offers an explanation of current practices from an experienced Arkansas oil and gas lawyer. Anyone engaged in horizontal drilling in Arkansas will find Daily's article to be most helpful and instructive.

VI. CONCLUSION

The seventy-fifth anniversary of the Arkansas Oil and Gas Commission is certainly one worthy of great celebration. This symposium issue of the *Arkansas Law Review* honors the significance of this historic milestone. The articles in this issue are timely and important for several fundamental reasons.

First, the symposium implicitly pays tribute to the rule of capture—a rule that has been limited, but not eliminated, by conservation laws and regulations. Indeed, without the underlying rule of capture, oil and gas conservation acts would prove difficult to administer. Because the rule still applies to the extent that it has not been limited, conservation laws need not be precise. They must only provide a *fair opportunity* for all owners to acquire a fair share of production.

Second, state practices vary. A principal advantage of state conservation regulation is that each state can adapt laws to address its particular needs and circumstances. The IOGCC, as it is now called, encourages states to adopt best conservation practices but recognizes that each state has unique characteristics that present discrete regulatory challenges.

Third, unconventional shale plays require new and non-traditional regulatory practices and careful application of appropriate common law doctrines. Conservation regulations and practices must adapt to the new combined use of the techniques of hydraulic fracturing, horizontal drilling, and microseismic monitoring, and appropriate regulation must not inadvertently lead to waste, especially economic and underground waste. And common law doctrines, especially trespass, must adapt to modern-day correlative uses of the subsurface, including hydraulic fracturing and subsurface storage and disposal operations.

Finally, oil and gas law commentators often ignore conservation law. This symposium helps fill this gap in oil and gas law literature. Again, congratulations to the Arkansas Oil and Gas Commission on its seventy-fifth anniversary. I am honored to play a small role in this celebration.