The geology of New Mexico as understood in 1912: an essay for the centennial of New Mexico statehood. Part 1

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Celebrating New Mexico's Centennial

The geology of New Mexico as understood in 1912: an essay for the centennial of New Mexico statehood Part 1

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Introduction

New Mexico became the 47th state of the United States on January 6, 1912, some 66 years after American administration was established at the beginning of the Mexican War in 1846. Observations of the geology of New Mexico began to be made as soon as American soldiers entered the territory, mainly by members of the Army Corps of Topographical Engineers traveling with the invading army. Immediately after the war much additional information was recorded by military men (e.g., Simpson 1850) and by geologists attached to exploring expeditions organized by the federal government, two of them to ascertain potential routes for a transcontinental railroad (the Pacific Railroad expeditions led by Whipple in 1853 and by Pope and Parke in 1854–1855). Reports by geologists and paleontologists such as Antisell (1856), Blake (1856), Hall (1856), Marcou (1858), Shumard (1858, 1859), and Newberry (1861) covered large areas of New Mexico in a reconnaissance manner and laid the foundations for initial general understanding of the geology of many parts of the territory (see Kues 1985a, b, 1992, 2006, 2008a, and references therein for detailed accounts of these early studies).

Geologic exploration of New Mexico continued after the Civil War (1861–1865). Of the four great scientific surveys of the West (King, Hayden, Wheeler, Powell) sponsored by the federal government in the 1860s and 1870s, the Wheeler Survey was by far the most important in adding to knowledge of New Mexico geology. Geologists of extraordinary skills, such as G. K. Gilbert, J. J. Stevenson, and the paleontologist E. D. Cope, spent months in various parts of New Mexico while attached to the Wheeler Survey and wrote long scholarly accounts of their observations and interpretations of the territory's geology and paleontology. To these efforts should be added the long-delayed publication (1876) of J. S. Newberry's geologic observations while a member of the Macomb Expedition in 1859 and 1860. These separate surveys were abolished in the late 1870s, and all federal geologic work was united in the new U.S. Geological Survey (USGS) in 1879. Geologists of the USGS would be the primary force in furthering knowledge of New Mexico geology in the late 19th and early 20th centuries.

Three major trends in the development of New Mexico during the last half of the 19th century emphasized the importance of knowledge of the territory's geology. First, beginning in the 1850s but expanding greatly after the Civil War, was the search for economically valuable geologic resources, initially precious metals and later coal (Christiansen 1974). Dozens of important gold and silver strikes brought thousands of miners into the territory, led to the establishment of hundreds of towns (few of which survived more than a few years), and were a major factor in the economy of New Mexico until 1893.

Second, the entry of railroads, beginning late in 1878 with the laying of track across Raton Pass, revolutionized transportation in the territory, provided the means for moving ore from mines to smelters more quickly and cheaply, and themselves generated a great demand for coal from local deposits to fuel steam locomotives. In just three years (by 1881) more than 1,000 miles of railroad track had been constructed across New Mexico (Myrick 1970), from its northern to southern borders. After a lull in the 1890s, an additional 1,200 miles of track were laid from 1901 to 1910, bringing the total in the territory to about 3,000 miles by the time of statehood.

Third, a five-fold increase in New Mexico's population from 1850 to 1910 documents a great influx of people into the territory. Many sought land for farming and ranching. The Homestead Act of 1862 in particular spurred immigration by making it possible for settlers in New Mexico to acquire as much as 1,120 acres (nearly 2 square miles) of land per family (Williams 1986a). During the 1880s and 1890s the expanding railroads opened access to vast areas for homesteader settlement; towns sprang up and grew, and agriculture and commerce expanded. Accompanying this growth in population was a persistent need for information about the natural environment, climate, the nature and quality of soils, and especially the availability of water. The expansion of mining, railroads, and population in the late 19th century all made geologic studies of New Mexico Territory essential.

The aim of this contribution is to survey the state of knowledge of New Mexico geology in 1912, as the territory became a state. An appreciation of the understanding of the geology of New Mexico 100 years ago is useful for several reasons. It provides a vantage point from which to view the impressive accumulation of geologic knowledge since American administration began in 1846, when virtually nothing was known of the geology of New Mexico. In addition, geologic studies in the territory up to 1912 reflect the ideas, paradigms, and methods of investigation and interpretation that were current in the geosciences then, and thus provide perspectives on the advances our discipline has experienced since then. Third, geologic studies up to 1912 were beginning to be applied to large-scale projects, particularly in irrigation, that would benefit the citizens of New Mexico, some of which have endured to the present. And finally, by appreciating what was known about New Mexico geology in 1912, contemporary geoscientists can better understand the great increases in our knowledge that several generations of their predecessors produced over the past century.

Before beginning our survey of New Mexico geology as understood in 1912 we will first examine some general features of the territory as it transitioned into statehood.

Editors' note

In honor of New Mexico's centennial celebration, *New Mexico Geology* has dedicated this volume to the accomplishments of geologists working in New Mexico Territory from 1846 until statehood in 1912. This contribution will be published in four parts, one in each of the four quarterly issues of the 2012 volume of *New Mexico Geology*. References are included for each part, and the numbering of figures is consecutive from part to part.

A Snapshot of New Mexico in 1912

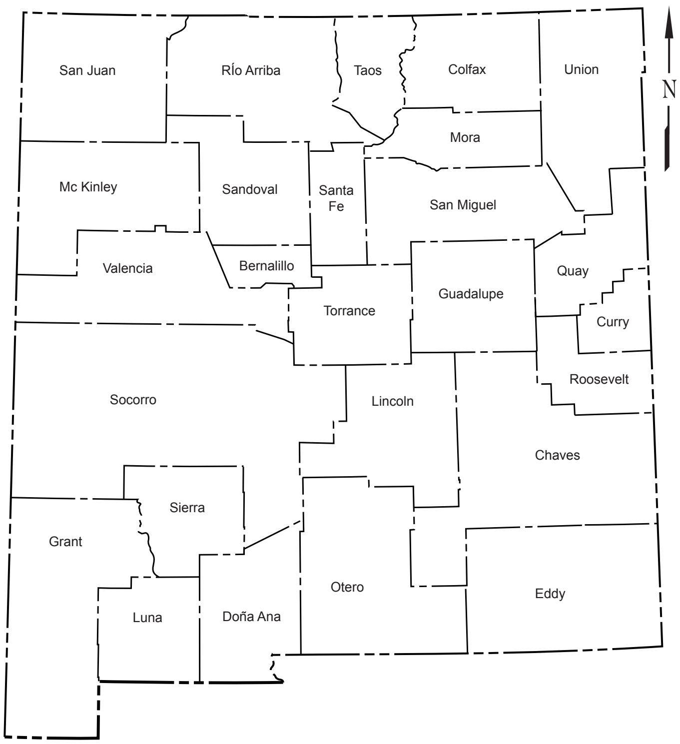

FIGURE 1—New Mexico counties in 1912 (after Beck and Haase 1969).

TABLE 1—Population of New Mexico's 10 largest towns (1910 census). Albuquerque figure includes Albuquerque town (11,020) plus population of contiguous Old Albuquerque precinct. Las Vegas includes the combined population of the separate but contiguous towns of East and West Las Vegas. For comparison the present (2010 census) populations of these towns are shown, and their percent increase over the past century.

	1910	2010	Increase (%)
Albuquerque	13,163	545,862	4,046
Las Vegas	6,934	13,753	98
Roswell	6,172	48,366	684
Santa Fe	5,072	67,947	1,240
Raton	4,539	6,885	52
Las Cruces	3,836	97,618	2,445
Clovis	3,255	37,775	1,061
Silver City	3,217	10,315	221
Tucumcari	2,525	5,363	112
Gallup	2,204	21,678	884

Geography and population

The state of New Mexico, as constituted in 1912, occupied the same area, 121,598 square miles, as it does today, but consisted of 26 instead of the present 33 counties (Fig. 1). De Baca and Lea (1917), Hidalgo (1919), Catron and Harding (1921), Los Alamos (1949), and Cibola (1982) Counties all were created after statehood was attained. About 335,000 people (extrapolated from the 1910 census population of 327,301) lived in the new state in 1912 (0.35% of the approximately 94 million residents of the U.S.), compared to the present population (2010 census) of 2.059 million (0.65% of U.S. population). The population density was 2.75 people per square mile (only Arizona, Nevada, and Wyoming were less densely populated), and the large majority of New Mexico's population lived on farms and ranches and in small communities. Only 14% of New Mexico's population was classified as urban (living in towns and cities with 2,500 or more people) by the Census Bureau; only North and South Dakota, Arkansas, and Mississippi had a lower percentage of urban dwellers, and the U.S. average was 46%. Today, New Mexico's population is about 75% urban.

Then, as now, Albuquerque was the largest city in the state, but it had a population of only 11,000 people (13,000 if the adjacent precinct of Old Albuquerque is included; Table 1), compared to its current population (546,000 in 2010). Viewed another way, the population of Albuquerque in 1910 represented only 4% of New Mexico's total population, whereas the population of Albuquerque in 2010 represented 27% of the state's total population (or more than 35% if the entire Albuquerque urbanized area is considered). In 1912, then, New Mexico was a rural state with few cities and towns, and even the largest of these was hardly a dominant urban center.

Economy

The economy of New Mexico in 1912 was miniscule by present standards, even adjusted on a per capita basis, and for the decrease in the value of a dollar over the past century. Agriculture, manufacturing, and mining were the main pillars of the small economy; tourism and employment by governmental entities were much less significant than they are today. Agriculture, rapidly increasing as a result of major irrigation projects and the cultivation of new dryland crops, produced products valued at more than $8 million (much of the data in this section are from the Statistical Abstracts of the U.S. and the World Almanac for years around 1912, and Coan 1925). Hay, corn, wheat, and oats were the major plant products, with smaller amounts of barley, cotton, sorghum, sugar beets, and various fruits. Livestock included 1.1 million cattle, 3.8 million sheep (the annual wool clip was valued at $2.8 million), 133,000 horses, as well as smaller numbers of swine, milk cows, and chickens. The number of sheep ranked third in the U.S., after Montana and Wyoming. The number of cattle in New Mexico has increased slightly in the past century, but the number of sheep has declined precipitously to less than a half million (ranked 6th today). About 15% of New Mexico's total area (11.3 million acres) was devoted to farming in 1912, compared with 43 million acres of farms and ranches today, which yield a total annual value of about $2.5 billion for all agricultural products.

In 1912 about 14% (10.9 million acres) of New Mexico's area had recently (by 1909) been set aside in national forests. The state had begun to receive some of the income generated by the national forests (primarily lumbering) from the federal government; the total for 1906–1911 was $134,000. Of much greater economic importance, however, was the transfer of 13.4 million acres of federal land to the new state, to be held in trust for education and other public institutions. Revenue from this land, mainly from geologic resources, is managed by the State Land Office and has added billions of dollars to the New Mexico economy during the past century.

A modest beginning to a tourism industry, in the form of several new national monuments created by the federal government, was in place by 1912. El Morro (1906), Chaco Canyon (1907), Gila Cliff Dwellings (1907), and Gran Quivira (1909) had all been established by the time of statehood. These were managed individually by the Department of Interior, as the National Park Service did not yet exist (it was formed in 1916). The first state parks were not created until the 1930s. Of greater economic importance was the influx of people seeking a cure for tuberculosis in the high, dry climate of New Mexico. Several thousand had moved to the new state by 1912, and many remained after their health improved.

TABLE 2—Value of geologic resources produced in New Mexico in 1911 and 1912 (U.S. Bureau of Mines Yearbooks).

	1911	1912
copper	$507,000	$5,615,000
coal	4,526,000	5,037,000
silver	718,000	945,000
zinc	564,000	936,000
gold	763,000	786,000
stone (granite, sandstone, limestone, marble)	406,000	336,000
lead	133,000	247,000
clays	187,000	190,000
iron	146,000	145,000
sand, gravel	19,000	30,000
lime	13,000	9,000
fluorspar	23,000	1,000
gemstone	27,000	1,000
mineral waters	42,000	small
Total	**$8,176,000**	**$14,931,000**

Manufacturing also contributed significantly to the state's economy, although it represented far less than 1% of the total U.S. manufacturing effort in 1912. The total annual value of manufactured products was about $8 million, of which nearly half was devoted to the construction and repair of railroad facilities and equipment. Next in importance were lumbering and flour and grist milling, with a smaller contribution from wool mills and cement plants. By 1908 the Albuquerque Lumber Co. was the largest manufacturing firm in the Southwest, processing massive amounts of lumber from the Zuni Mountains, and its payroll for more than 1,000 employees exceeded even that of the Santa Fe Railroad (Simmons 1982, p. 332). Some 9,200 barrels of "fermented liquors" were also produced in the state in 1912. In all, about 310 manufacturing establishments provided employment for some 4,800 New Mexicans.

The most important economic activity in New Mexico in 1912 was mining, which produced a total of about $14 million from a variety of resources (Table 2). Copper and coal were by far the most important minerals produced. Copper production increased rapidly from 1911 to 1912 and surpassed the value of coal produced for the first time, owing to the beginning of large-scale open-pit mining at Santa Rita in 1910 and the milling of low-grade ore at Hurley the following year. Production of many of New Mexico's most valuable geologic resources, such as potash, uranium, molybdenum, and especially oil and natural gas, lay in the future. New Mexico's $14 million in mineral production in 1912, even when converted into 2010 dollars (multiply by 22), was small compared to the total annual value of around $10 billion today. In terms of total value of geologic resources produced, New Mexico ranked 34th among the states and territories in 1911 and 29th in 1912. Today, New Mexico's rank is typically among the top seven each year.

Travel

In 1912 New Mexico had nearly 17,000 miles of public roads, which was relatively small for the area of the state (0.14 mile per square mile of area). Only the areas of Arizona, Utah, Wyoming, and Nevada were less accessible to roads. New Mexico's improved roads in 1912 were primarily gravel or a sand-clay mixture, but only the major thoroughfares were graded, drained with culverts, and utilized bridges where necessary. The first New Mexico State Legislature established a highway commission with funds allocated for state roads; counties and towns also subsidized local road construction and maintenance. Road building was accomplished mainly by convict labor. According to Twitchell (1917, p. 249), the best of New Mexico's roads had "mile after mile…where forty miles an hour in a touring car is comfortable riding—if one cares to ride too fast to get the beauties of the scenery." Even in 1912 the speed of autos was of great interest and increasing rapidly; the winner of the 1912 Indianapolis 500 race averaged an amazing (for the time) 79 mph.

The growth of automobile traffic undoubtedly influenced the road building plans of the new state. Auto production had been increasing rapidly (to more than 200,000 cars per year in the U.S. in 1912). Most of these were Model T Fords, produced in Henry Ford's efficient assembly lines; by 1914 the number of Fords produced exceeded the combined total of all other auto manufacturers, and their low price ($850) put them in reach of many middle-class families. However, few autos were present in New Mexico at statehood; only 904 license plates were issued during 1912 (Johnston 2011). Simmons (1982, p. 336) estimated that there were probably no more than 32 cars in all of Albuquerque in 1910, the year the city police department acquired its first auto. Photos of various city and town main streets around 1912 typically show more horse-drawn buggies, carriages, and delivery vans than autos, but business directories of this period do list firms involved in the sale and repair of autos, together with larger numbers of blacksmiths and livery feed and sale stables. Some livery establishments hedged their bets by taking care of autos as well as horses. Auto traffic in 1912 was mainly limited to the cities and towns, some of which had paved roads. Horse-drawn carriages were far more important in town-to-town travel and in rural areas, and most towns were served by stage lines.

The first tentative steps toward a "coast-to-coast highway" (actually a series of connected roads of variable quality) was made in 1910, when the National Highways Association laid out an auto route across the nation. A. L. Westgard was employed to scout a route, and part of it went through New Mexico, along the old Santa Fe Trail to Santa Fe, then south to Los Lunas, and west to Grants, Zuni, and Springerville, Arizona. Westgard made a second trip in 1911, using a somewhat different route (south from Santa Fe along the Rio Grande to Socorro and then west to Magdalena, Datil, Quemado, and Springerville). His auto carried rolls of canvas and wooden planks to allow passage across difficult terrain (see Smith et al. 1983, pp. 3–4, for more details of this "coast-to-coast highway"). Few motorists attempted to drive across the country until the late 1920s, when the national highway system was established and more of the roads were paved. Paving most New Mexico highways took decades. According to the official state highway map of 1930, only a few significant stretches of highways were paved: Roswell to Carlsbad; El Paso to Las Cruces and Lordsburg; Santa Fe to Las Vegas; and Algodones to Albuquerque, Los Lunas, and the Rio Puerco.

"Service stations" for autos did not exist in 1912, although rudimentary gas pumps (invented in 1905) were beginning to appear for curbside fueling and clustered in city lots as "filling stations" in the larger eastern, midwestern, and Pacific Coast towns by then (Vieyra 1979). Few if any such facilities were available for motorists in New Mexico, however. The proliferation of dozens of different gasoline brands and stations providing more service than just fuel did not develop until the late 'teens and 'twenties. Bicycles, however, were common in the streets of cities and towns, and the larger New Mexico cities had trolley systems for mass transit. In Albuquerque, horse-drawn trolleys transitioned to electric street cars in 1904 (Johnson and Dauner 1981).

At statehood, railroads were the primary form of medium- and long-distance transportation in New Mexico. In 1912 about 3,000 miles of track stretched across the state, which amounted to 2.49 miles per 100 square miles of area (compared with the U.S. average of 8.30). However, if measured against population, New Mexico's tracks amounted to 86 miles per 10,000 people, far higher than the U.S. average of 26. Nearly every town of a few hundred inhabitants was situated on a rail line, and many spur lines connected to mining and lumbering camps (Myrick 1970). Since about 1914 New Mexico railroad track mileage has declined, to less than 2,000 miles today. However, the mileage of high-quality paved public roads has multiplied many times with the rise of automobile and truck traffic, and this, together with air traffic, has largely replaced railways in passengers and freight transported.

Airplanes, first flown by the Wright brothers in 1903, were still curiosities in 1912, capable of inspiring excitement and even awe in people in remote places like New Mexico. The first airplane to take flight from New Mexico ascended from the grounds of the territorial fair in Albuquerque in October 1911. The first aerial photos from an airplane followed 2 years later, again over Albuquerque (Johnson and Dauner 1981). Probably no one watching these early flights could foresee the tremendous development of air travel and transport that would follow in the 1920s and 1930s.

Communication

Instantaneous (albeit indirect) person-to-person communication, accomplished by telegraphy since before the Civil War, had arrived in New Mexico in the 1860s, as lines were extended from Denver and Kansas City. Telegraph communication expanded rapidly through the territory, and by making available large amounts of information the telegraph helped to stimulate the growth of local newspapers. By 1912, 126 daily to weekly papers were being published in the new state, compared to less than one-half that total today. By 1912, then, New Mexicans were well integrated into the nation's communications grid and learned quickly of important events happening throughout the country and around the world.

Telegraph and newspaper communication was being augmented rapidly by use of telephones in 1912 New Mexico. In that year there were about 7.7 million telephones in the U.S., mostly in the East, about one telephone for every 12 persons. In 1912 New Mexico 10,349 telephones were in use, about one for every 32 residents (McAllister and Putman 1986). This was four times the number in 1902. By 1912 some of the larger towns had their own telephone companies, but most of the phones were concentrated in hotels, business establishments, and government offices and required the assistance of an operator to make the connection with the intended recipient of a call. Few homes in the new state possessed a telephone, and even by the early 1940s there was only one telephone for every 10 New Mexico residents.

"Wireless telephones," later to be called radio (the term was coined in 1910), were in their infancy. Radio communication was mainly used for ship-to-ship and ship-to-shore messages, although amateur ham radio operators communicated with each other using primitive crystal sets. Commercial radio stations, broadcasting scheduled programs to a wide audience, would not arrive until the early 1920s. New Mexico's first radio station, KOB in Albuquerque, was established in 1922 (Williams 1986b).

The bulk of person-to-person communication in 1912 was done by hand-written letters and postcards delivered by the U.S. mail, a practice that is fast fading today with the explosion of electronic communication. There were far more post offices in New Mexico 100 years ago than there are today; virtually every town that existed for more than one or two years and had a few dozen residents boasted a post office (see Julyan 1996). Mail was carried long distances by railroads to major towns and then distributed by hundreds of local delivery routes to small town post offices, and into rural areas, no matter how remote. Rural free delivery service, initiated in 1902, brought mail to those who lived far from post offices, and the mail was delivered by horse and buggy until 1914, when the service motorized. A postcard cost one cent to send, whereas letters required a two-cent stamp (about the same in terms of actual value as today's 45-cent cost to mail a letter). The postal service not only allowed reasonably rapid communication (generally one to a few days depending on distance) between individuals anywhere in the country, but it also delivered mail-order catalogs and the purchases made from them to people in rural communities, allowing them to order items that might not otherwise be available to them within 100 miles or more distance to the nearest large town.

Politics

Before becoming a state New Mexico had elected a senate of 24 members (17 Republicans or Progressive Republicans) and a house of 49 members (33 Republicans/Progressive Republicans), but a governor, William C. McDonald, who was a Democrat. One of the first items of business for the new state legislature was to select New Mexico's first U.S. senators (direct election of senators by the people—Amendment 17—was not ratified until 1913). Thomas B. Catron (5 year term) and Albert B. Fall (1 year term), both Republicans, were selected. Fall was re-elected in 1913 and 1919 but resigned from the Senate in 1921 to become secretary of the Department of the Interior in the Harding administration. He was subsequently (1929) convicted of taking $200,000 in bribes in the Teapot Dome scandal. In essence, while secretary, he leased petroleum from public lands in Wyoming and California that was allocated by the U.S. Navy to two oil men, Sinclair and Doheny, without competitive bidding, and he received large kickbacks in return. Fall was disgraced, paid a large fine, and spent a year in prison—an unfortunate end to the career of a man who had been the first of only four New Mexicans in the cabinet of a president (the others being Clinton Anderson, Agriculture Department, 1945–1948; Manuel Lujan, Interior Department, 1989–1993; and Bill Richardson, Energy Department, 1998–2001). Harvey Fergusson, a Democrat, and George Curry, a Republican, were elected New Mexico's first congressmen.

Women did not vote in these elections, nor did they serve in the first state legislature. In 1912 women could vote in state elections in only 10 states (none of which was New Mexico), and universal voting rights for women only came with the passage of the Nineteenth Amendment in 1920. Native Americans could not vote at all anywhere in the U.S. in 1912, as they did not become American citizens until 1924.

Late in 1912 New Mexicans participated in their first presidential election, one of the most complex in American history (Chace 2004). Four major candidates ran for president: William H. Taft (the Republican incumbent), Woodrow Wilson (Democrat), Teddy Roosevelt (Progressive, and former president), and Eugene Debs (Socialist). New Mexico voted for the winner, Wilson, who received 43% of the vote. This was somewhat of a surprise, as Republicans dominated the state legislature, and Taft had been an enthusiastic supporter of statehood and had signed the legislation that had made New Mexico a state.

Education

Education in the state in 1912 was rudimentary by present standards but was probably not unusual for the time. Of an estimated school-age (5 to 21 years) population of 100,000, only about 40,000 regularly attended public and private schools. There they were taught by a statewide total of about 1,600 teachers, most of them women, who earned an average annual salary of $390 (Twitchell 1917, p. 130). Teacher training was limited; most public school teachers lacked even a high school education, and Twitchell (1917, p. 174) thought it praiseworthy that most New Mexico schools employed at least one teacher who had two to four years of high school education. The average length of the school term was 125 days, and state regulations mandated that schools must be open for at least five months of the year. One of the acts of the first New Mexico state legislature was to establish at least one high school in each county; 14 high schools existed by the end of 1912. Given the state of public education in New Mexico it is probably surprising that only 20% of the adult population was illiterate.

During the first few years of statehood, New Mexico's institutions of higher education were in their infancy, and included courses that today would be considered at the level of high schools. About 1,000 students were attending the state's nine institutions of higher education in 1912. These were University of New Mexico (Albuquerque); New Mexico College of Agriculture and Mechanical Arts (Las Cruces, now New Mexico State University); New Mexico School of Mines (Socorro, now New

Mexico Institute of Mining and Technology); New Mexico Normal University (Las Vegas, now New Mexico Highlands University); New Mexico Normal School (Silver City, now Western New Mexico University); Spanish-American Normal School (El Rito, now Northern New Mexico College); New Mexico Military Institute (Roswell); New Mexico Institute for the Blind (Alamogordo); and New Mexico School for the Deaf and Dumb (Santa Fe). Of these institutions the largest was the Las Cruces college, with 42 professors and 370 students (Statesman's Yearbook 1913); UNM employed 22 professors to teach 137 students, and the New Mexico School of Mines eight professors for 34 students. No graduate programs existed at any New Mexico institution. Presently, by contrast, at least 25 institutions of higher education exist in New Mexico, with a total enrollment of about 200,000 (Vigil-Giron 2005).

In 1912 some $954,000 was expended for public schools and $381,000 for higher education (Twitchell 1917, p. 130). Education expenditures were the single largest item of the state budget and represented more than a third of the state's total expenditures of about $3 million. Today, education remains the single largest area of expenditures for New Mexico, but has risen to more than one-half of the total budget of about $5.5 billion.

Daily life

The first decade of the 20th century witnessed many innovations that were becoming, or would grow to become, basic elements of modern American society; the advent of autos, airplanes, telephones, and early forms of radio was noted above. People living in New Mexico, and indeed throughout the U.S. in 1912, experienced more rapid scientific and technological change, and therefore societal changes, than had any previous generation. The pace of change would only increase through the 20th century, driven in part by bursts in technological advances accompanying two horrendous world wars and dozens of smaller conflicts. Looking back 100 years, to the fabric of the lives and culture of New Mexicans in 1912, we see much that is recognizable (the more so the older we are and the farther back our memories extend), but much that seems completely archaic in the context of our own late 20th and early 21st century experiences. Here, I sketch a few selected aspects of the daily lives of New Mexicans as statehood was attained.

First, people lived considerably shorter lives. The average life span at birth in the U.S. in 1912 was 51.5 years for men and 55.9 years for women (average = 53.5 years), compared with 75.7 years (men), 80.7 years (women) and 78.1 years (average) in 2009 (U.S. Census Bureau). Tuberculosis and pneumonia were the leading causes of death 100 years ago; now it is heart disease and cancer. Medical knowledge and practice, and access to it by the public, have increased tremendously. In 1912, although the bacterial causes of some diseases were known, and anesthesia was used in surgery, knowledge of viruses and antibiotics, the use of X-rays, and myriads of advances in understanding and treating the biologic, genetic, and environmental causes of diseases, as well as in surgical practices, organ replacement, and so on lay in the future. The realization that inadequate diet could cause debilitating diseases, such as scurvy, beriberi, pellagra, and rickets, was just beginning to be understood in 1912. Certain organic molecules (amines) were first identified as necessary dietary constituents in 1912 by the Polish biochemist Casimir Funk, who coined the term vitamin for the first one he discovered (B1, or thiamine) (Bryson 2011, pp. 197–198). As New Mexico became a state, however, the relationship between vitamins and diseases had not become widely accepted. More than 90% of babies were born at home, and most people died in their homes. Small hospitals were present only in the larger New Mexico towns, and these were operated mainly by churches.

In addition, because the causes and treatments of many diseases were unknown, people turned to hundreds of widely advertised "patent medicines," which claimed to cure any disease or ailment, but which contained a large variety of ineffective or dangerous ingredients, generally mixed in alcohol. The health hazards of these "medicines," as well as the widespread adulteration of food products, was just beginning to be recognized (e.g., Sinclair 1906) and curtailed in the early 20th century. For example, laudanum (a highly addictive mixture of 10% powdered opium in alcohol) and similar elixirs were widely used to reduce pain, induce sleep, and relieve everything from colds to cardiac diseases and menstrual cramps (Wikipedia, "Laudanum"; "Patent Medicines"). Passage of the Pure Food and Drug Act of 1906 helped, but it required only that the ingredients of any product be listed on the label; laudanum and many other harmful "medicines" continued to be sold over the counter. Strong regulation and testing of food and drugs came only in 1938, with passage of the Food, Drug, and Cosmetics Act. One medicine of indisputable value, however, was available to late-territorial New Mexicans; aspirin was first marketed in 1899.

Life in 1912 was considerably more labor intensive than it is today. The use of electricity in lighting and power generation was well established and expanding rapidly; most towns had light and power companies, and electric street lights as well as lighting in hotels, businesses, and in some residences were becoming common. However, smaller towns and rural areas often lacked electricity; this changed only with the great expansion of rural electrification programs in the 1930s. Even so, consumer products run by electricity were becoming available to the middle class. From 1891 to 1910 electric fans, vacuum cleaners, washing machines, irons, and toasters began to appear in the homes of those who could afford them (Bryson 2011, p. 158). Other equally useful but more inconspicuous implements invented in the late 19th century (e.g., mousetraps, paper clips, the zipper, safety pins) were also becoming available to late-territorial New Mexicans.

Indoor plumbing was a luxury, even in towns. The better hotels proudly proclaimed the availability of "hot and cold running water" (together with telephones and electric lights). However, even as late as 1940, 41% of dwellings in New Mexico lacked running water (Vigil-Giron 2005). Sewer systems were being constructed in the larger towns, but generally sewage was little treated. Albuquerque's sewer system, for example, simply routed the wastes into the Rio Grande (Johnson and Dauner 1981).

Such labor-saving devices as refrigerators were available on an industrial scale, but were not yet in homes. Most towns had ice plants, the largest of which (in Albuquerque) could produce as much as 45 tons per day (Simmons 1982). Ice was delivered to homes regularly from the plants, at a cost of 50–75 cents per pound. Food spoilage and its health risks were a constant problem. Most homes were heated either by wood or coal; mines near Gallup and Madrid provided most of the coal needed in Albuquerque.

The standard of living for most New Mexicans was considerably lower in 1912 than today. According to one study (Klein 2009), the per capita income for the U.S. in 1910 was only about $300. A wage earner in manufacturing or other industry averaged about $720 per year in income, with some specialized positions paying considerably more than $1,000 per year (for these and following monetary figures, remember that one dollar in 1912 had the purchasing power of about $22 in 2010). The average wage earner was paid about 20–25 cents per hour, and worked 50 or more hours per week (Fisk 2003).

The per-capita income of New Mexico in 1910 was $201 (Klein 2009), considerably less than the national average and ranking 38th of the (then) 48 states and territories. This amounts to about $4,400 in 2010 dollars, compared with a 2009 per-capita income of $32,992 (U.S. Census Bureau). New Mexico's current low ranking among the states (42nd of 50) has changed little in the past century. It is also important to keep in mind that New Mexico wage earners in 1912 included children (no child labor laws, although the problem was much worse in the industrial cities of the East and Midwest), and no social safety nets, such as unemployment benefits, social security, pensions, or health care plans existed at the time. The life of an average New Mexican working man at statehood was considerably more precarious than it is today.

Income earned by New Mexicans in 1912 was used, as today, for the necessities of life, and for some people (a much smaller proportion than today) luxuries were also possible. Prices of common items (1911 wholesale prices, from World Almanac 1912) provide an insight into the expenses of living a century ago (again, multiply by 22 to obtain comparable 2010 prices): loaf of bread, 4 cents; eggs, 35 cents per dozen; bacon, 9 cents per pound; milk, 5 cents per quart; coffee, 15 cents per pound; beef, 12 cents per pound; print cloth, 3 cents per yard. A barrel of crude oil cost $1.30, and bituminous coal went for $3.15 per ton. A good horse might cost $195. January 1912 issues of the *Albuquerque Morning Journal* advertised men's overcoats for $15–$20; hats for $1.95; dress shirt, 90 cents; women's cloth skirts, $3. A four-room house and lot in town cost $1,900–$2,300, but one would have had to pay $4,500 for a more luxurious seven-room house. When traveling, a room in a good hotel would cost $1–$2.50 a night; and 25 cents to $1 would buy a large dinner.

Payment for many purchases was made with silver (10, 25, 50 cent, and dollar) and gold (2 ½, 5, 10, 20 dollar) coins, although copper and copper-nickel coins (1, 5 cent) and bills also circulated widely. The price of silver in January 1912 was 55 cents per ounce, less than half of its inflation-adjusted value today (ca. $30 per ounce), and gold was $20.67 per ounce, about one-third of its present inflation-adjusted value of around $1,600 per ounce. If one had the means in 1912 he could take 30 to 40 $20 gold coins and purchase a deluxe Ford Model T touring car. Today, 20 to 30 $20 gold coins (when converted into modern paper currency) will buy an equally luxurious auto. The purchasing power of gold and silver, unlike that of the dollar, has actually increased through the past century.

When the work was done, a middle-class New Mexican in 1912 had many entertainment options—orchestral concerts in a park, silent movies (tickets cost 5 or 10 cents) or vaudeville shows (in the larger towns), amusement parks, a traveling circus, picnics. If in Santa Fe, a visit to the newly founded Museum of New Mexico, in the Palace of the Governors, was a possibility, and county fairs during the summer attracted many people. Baseball was without doubt "the national pastime"; many towns formed local teams, and professional baseball leagues covered much of the country. Professional football and basketball did not exist (college teams, especially in the East and Midwest, attracted many fans), and hockey was limited to Canada, but boxing, wrestling, and tennis were popular sports.

Photography was an increasingly popular pastime. Dry-plate cameras, in which a glass plate coated with gelatinized light-sensitive chemicals was exposed, and the plate then developed in a bath of chemicals, was still the choice of professional photographers in the early 1900s. However, their use involved unwieldy equipment and time spent with messy chemicals in order to develop an image. George Eastman had invented a camera using a roll of celluloid film in 1889, and in 1900 introduced and mass-marketed an inexpensive box camera called the "Brownie." These could be carried easily, used a six-snapshot film cartridge that could be sent to the Kodak lab for developing and printing, allowed a person to instantly photograph an ephemeral scene, and were so simple to operate (essentially point-and-shoot) that a child could take photographs. The earliest Brownies sold for a dollar, plus 15 cents for a film cartridge. By 1912 one could still buy the cheapest model for a dollar (or spend as much as $12 for a deluxe folding camera with a better lens and shutter), and a developing box was available for those who wished to make their own prints. Millions of Brownies had been sold by 1912, and their use revolutionized the preservation of photographic records of daily life.

At home, the wealthy family might have a phonograph machine to play music recorded on either a cylinder with a grooved surface, initially of hard wax but by 1912 of celluloid plastic, or a gramophone disk (record) composed of shellac (vinyl appeared in the 1920s). Records were finding greater favor with the public in 1912 (because of more recording time and easier storage), and cylinders eventually became extinct in the 1920s, but there was little difference in sound quality (Wikipedia, "Phonograph Cylinders"). More commonly a member of a family, often a daughter, played a musical instrument for the entertainment of family and friends.

Public libraries were considered important, and most of the larger towns in 1912 New Mexico had one, since the first was established in Cimarron in 1881. Many were established through fund-raising efforts by civic-minded women, and in the early years of the 20th century, Albuquerque's public library was considered to be the largest and best in the Southwest (Rex 1986). The building of libraries in towns across the U.S. was considerably enhanced by grants made by Andrew Carnegie, a Scottish-born steel magnate. From 1889 to 1929 Carnegie's foundation subsidized the construction of nearly 1,700 libraries in the U.S. Three were built in New Mexico (in Raton, Las Vegas, and Roswell) from 1902 to 1911 at a total cost of $32,000 (Wikipedia, "Carnegie libraries").

The shelves of many of these libraries (in New Mexico and across the U.S.) undoubtedly held books about New Mexico. Most of the dozens that had been published were the accounts of explorers, military men, and scientists who had visited the territory since the time it had passed to American administration. Many of these also contained art, ranging from simple sketches to fully realized watercolor paintings, which gave readers a visual appreciation of the people, towns, and natural landscapes of the territory. Books of fiction set in the territory, however, were few. The earliest and best known New Mexico novel is *The Delight Makers* (1890) by the anthropologist Adolph Bandelier, but only a few others had been published by 1912 (Cohen 1986). Use of New Mexico as a locale, or in some cases a protagonist, in novels would accelerate in the 1920s, and today of course the state has been portrayed in hundreds of novels.

By the time New Mexico became a state, its unique cultural and environmental qualities, as well as its wonderful natural light, were also coming to be recognized by early film makers. Thomas Edison experimented with the process near Cerrillos before the end of the 19th century, and the first actual (experimental) movie shot in the territory, *Indian Day School*, only a few minutes long, was filmed in 1898 in Isleta Pueblo. By 1912 several silent movies starring such noted actresses as Mary Pickford and Mabel Normand had been filmed in New Mexico (Williams 1986c).

And, beginning in 1898, when two eastern artists (Bert G. Phillips and Ernest Blumenschein) on their way to Mexico stopped in Taos to have a broken wagon wheel fixed, a group of artists gradually began to live or spend summers in Taos. Entranced by the landscape and light and native cultures, they painted local subjects with a palette of vibrant colors, and became internationally known. They called themselves the "Taos artists colony," and in 1915 formalized their association as the Taos Society of Artists. Their work represents the pinnacle of late territorial/early statehood artistic expression in New Mexico.

Geology in New Mexico around 1912

During the decade before statehood, New Mexico geology was being studied to a degree that far exceeded that of any previous decade. Geologists were actively engaged in field studies in many parts of the territory, both in order to fill in the many blank spots in geologic knowledge of areas, and to gain a better understanding of rocks in which important deposits of minerals, and other resources such as coal and water, were found. The large majority of geologists active in New Mexico during this time worked for the USGS.

By its 25th anniversary in 1904, the USGS was the pre-eminent geologic institution in the country. The survey had attracted an outstanding staff of geologists, many of them from academia but some, such as N. H. Darton, who were largely self taught and lacked college degrees, and they in turn trained younger men recently graduated from academic geology programs. The survey's work encompassed a broad spectrum of disciplines and ranged from practical to theoretical. Fundamental research on rock composition and structure, including experimental and theoretical studies, was conducted together with broad programs of field and regional geology involving stratigraphy, paleontology, volcanology, and structural geology. Study of the geology of mining districts and of water resources, both on the surface (involving hundreds of gaging stations along rivers) and within the ground, were within the survey's purview, as was the classification of forested and irrigable lands (Frazier and Heckler 1972; Rabbitt 1989).

During this time the USGS also was producing an ever-increasing number of topographic maps (by 1904 for more than a quarter of the U.S.), and the number of geologic maps for portions of the U.S. was increasing rapidly. Survey research was published almost continuously in a mounting series of bulletins, professional papers, and water-supply papers. An ambitious program to create a geologic atlas of the country, via separately issued folios of large quadrangles or other areas, had begun in the 1890s. Each folio included a topographic and geologic map of an area, and comprised a mini-treatise on its geology. However, although more than 150 folios had been published by 1912, none covered any part of New Mexico, although the field work leading eventually to the first two New Mexico folios (Silver City, Paige 1916; Luna County, Darton 1917b) had begun by 1910.

By 1912, the USGS was in a state of transition. Much work on forested lands was transferred to a newly established Forest Service in 1905; the Reclamation Service, charged with evaluating and improving access to water, became independent in 1907 (Frazier and Heckler 1972); and the Bureau of Mines was detached as a separate agency in 1910. Some noted that more of the survey's activities involved "practical" endeavors, such as topographic mapping and water and mineral resource evaluation, more than geologic research (Rabbitt 1989). In New Mexico in the years just before statehood, USGS geologists were mainly involved in programs studying ore deposits, the occurrence of coal, and water resource evaluation. However, field geologic studies were essential to such projects, and a considerable number of fundamental, outstanding geologic studies were published.

Several main lines of USGS field research in New Mexico had developed by 1905, and these would broaden and diversify as time went on. The first was an effort to better understand the geology of west Texas and especially the putatively Permian sequence in the Guadalupe Mountains and neighboring areas, by G. H. Girty and G. B. Richardson. These studies led inevitably across the border into southern New Mexico as individual units and facies were traced northward. Second, in 1905 the USGS initiated a program of detailed studies of New Mexico's metallic resources and their geological contexts, which resulted in the publication of one of the classic works of New Mexico geology, *The ore deposits of New Mexico*, by Lindgren et al. (1910) (see below). Third, another major USGS program initiated in 1905 was the study of the territory's coal resources, which necessarily involved much work on Cretaceous stratigraphy. Fourth, in response to the need for better control of Rio Grande and Pecos River flow, for flood control and irrigation, the survey initiated large-scale engineering projects on both rivers, which required a good deal of additional expertise in water resources, agriculture, and local geology.

The survey geologists sent to study these various aspects of New Mexico geology were an extraordinarily talented group, and many of their studies were not limited to a single research area but cross-fertilized each other. Two of the *Ore deposits* authors, Graton and Gordon, also examined sedimentary strata in the areas where they worked, and they began to develop a regional stratigraphic framework for the Paleozoic. Willis Lee, originally assigned to study the water resources along the Rio Grande, soon moved extensively into Paleozoic stratigraphy, and then was the major contributor to studies of New Mexico's Cretaceous stratigraphy as part of the survey's coal studies program. Finally, after these efforts were underway, the mapping, field, and regional geologic studies of N. H. Darton had begun by 1912. Darton's contributions mostly postdated the attainment of statehood, and they would culminate in 1928 with the first great synthesis of New Mexico geology, together with the first modern geologic map of the state.

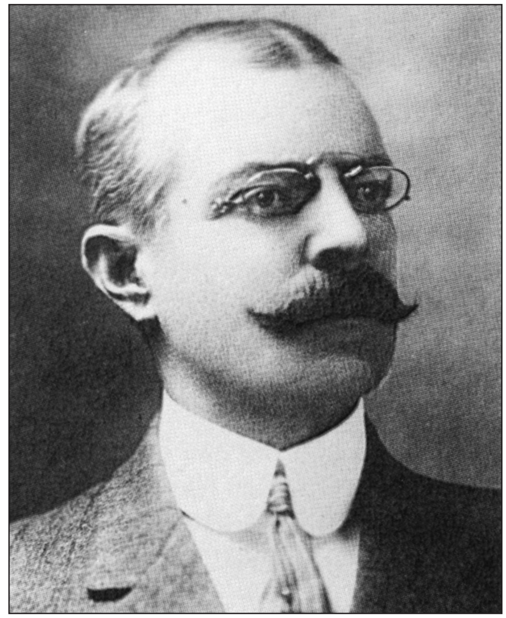

FIGURE 2—Waldemar Lindgren, USGS (Robertson 1993).

Of many important studies published by survey geologists around the time New Mexico became a state, probably the finest single publication on New Mexico geology to appear in the years leading up to statehood was *The ore deposits of New Mexico*, Professional Paper 68, by Lindgren, Graton, and Gordon (1910). This is far more than a comprehensive description of ore deposits; it includes detailed information on stratigraphy, structure, volcanic and intrusive rocks, and a synthesis of the geologic history of the territory, which makes it the closest approximation to a book on the geology of New Mexico as existed in 1912. This work will be referenced many times in the following narrative. Its authors exemplify the high caliber of geologists employed by the USGS during this time, and the excellent standards of scholarship by the survey in the first decade of the 20th century.

Waldemar Lindgren (1860–1939; Fig. 2) was born in Sweden and came to the U.S. with a degree in mining engineering (1882) from the University of Freiburg, Germany. He was hired by the USGS in 1884 and spent the next 25 years studying and publishing prodigiously on the geology of mining districts in California and other western states, and establishing himself as one of the leading theorists on the origin of ore deposits. He became chief of the metals branch of the survey in 1907 and chief geologist in 1911. The following year he moved to M.I.T. as chairman of its geology department and in 1913 published the first edition of his encyclopedic textbook *Mineral Deposits*. He continued at M.I.T. until his retirement in 1933.

Louis C. Graton (1880–1970) graduated from Cornell University in 1900 and completed doctoral work (except for the dissertation) there in 1903. In that year he joined Lindgren with the USGS in studying the gold-bearing rocks of the Cripple Creek (Colorado) mining district and then moved with Lindgren to study New Mexico's ore deposits. During his six years with the survey Graton became an expert on copper deposits. In 1909 he joined the faculty of Harvard University in mining geology, and he remained at Harvard through a long and distinguished career that involved wide participation as a consultant and member of the boards of directors of many mining companies (Hurlbut 1972).

C. H. Gordon (1857–1934) received his doctorate from the University of Chicago (1895) and then embarked upon a series of teaching positions, spending the 1904–05 academic year as a professor of geology and mineralogy at the New Mexico School of Mines in Socorro, just as the survey was beginning its multifaceted studies of the territory. He joined the USGS in 1905, stayed until 1913, and from 1907 on also served as a professor at the University of Tennessee.

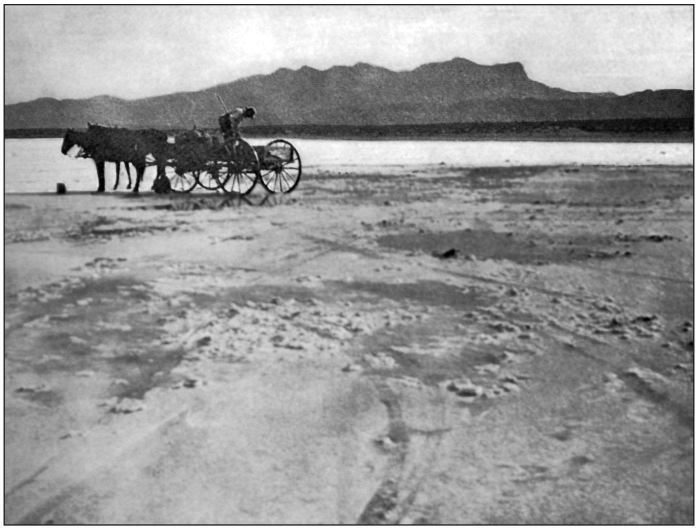

FIGURE 3—Field transportation in the early 1900s, west of the Guadalupe Mountains (Richardson 1904).

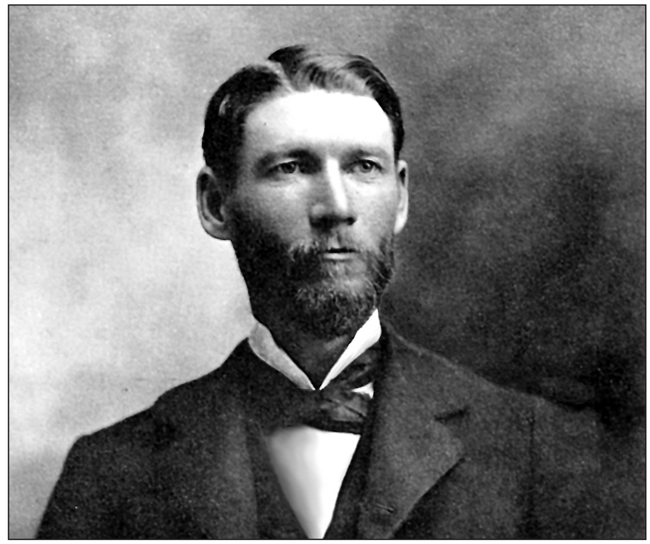

FIGURE 4—C. L. Herrick, University of New Mexico (Northrop 1966).

Other geologists who contributed significantly to understanding the geology of New Mexico as the territory transitioned into statehood will be introduced as this narrative proceeds.

A typical USGS geologist would arrive in New Mexico in late spring or early summer by railroad, a journey of four or five days from Washington, D.C., the location of USGS headquarters. According to contemporary accounts (e.g., Morgan and Lucas 2002), meals along the way each cost from $0.60 to $1.25 and a hotel room $2.50 a night. Upon disembarking at a town closest to his field area, the geologist would need to purchase food and water sufficient for several days to a week or two in the field. Transportation, by horse or horse-drawn wagon or buggy (Fig. 3), would be rented or purchased. Wagons could be used for access to areas in which at least rudimentary roads existed, but travel by horse and pack train might be required for excursions to remote or topographically difficult regions. If the field work was lengthy, a local man with a wagon and saddle horse might be hired as cook and camp hand for $150 per month. Motorized vehicles were not used in survey field work until 1917 (Rabbitt 1989). Some geologists, like N. H. Darton, who were working in other areas of the West, would head south to the warmer climates of Arizona or New Mexico for a few weeks of field work in early fall before returning to Washington (King 1949).

Depending on the terrain and location, other measures were necessary. Dave Love (pers. comm., 2010) recounted additional practices from the field notes of Oscar Meinzer, who began water-supply studies of the Tularosa Valley in 1911, resulting in one of the classic works of New Mexico geology (Meinzer and Hare 1915). “Each notebook starts with Meinzer calibrating his buggy-wheel revolution counter with known mileages between Alamogordo and Tularosa. Then he records the number of revolutions at various places during his field work and calculates the number of miles he has gone in that feature-challenged landscape of the central Tularosa Basin. He also sights stars and lights of ranch houses at night to figure out where he is.” The prudent geologist would inquire locally concerning roads and springs and other sources of water. He would have brought the relevant topographic maps for his field area, but in New Mexico topographic maps did not exist yet for most of the territory, and so reliance on local maps and information was important.

Although such accounts doubtless exist in unpublished field notes, I have not discovered many published records of field supplies and equipment typically used by a field geologist in New Mexico in the early 1900s. In many respects the methods of making and recording observations in the field have not changed much in the past 100 years. The early 20th century geologist would walk outcrop, observe rock formations and structural features, measure stratigraphic sections, take strike and dip measurements, do plane table/alidade work, and collect rock and fossil samples (which, if voluminous, would be packed up back in town and shipped by rail back East). Binoculars were probably used to trace formation outcrops in distant or inaccessible areas and to observe large-scale structures. Brunton compasses, patented by the Colorado geologist D. W. Brunton in 1894 and soon after manufactured by the William Ainsworth Co. of Denver (Wikipedia, “Brunton compass”), may well have been part of the field geologist’s tool kit before 1912.

Photographs of field areas, outcrops, and specific geologic features began to appear in USGS publications in the 1890s and are present in fair abundance in many publications relating to New Mexico geology before statehood. The camera equipment used was probably dry-plate cameras, judging from the quality and dimensions of many of the published photos, a few of which are reproduced in this paper. By 1900 such cameras had become much less bulky and could carry many prepared plates. King (1949, p. 153), in a fine memorial to N. H. Darton, noted that he “made a fine art of his geological photography,” and that it “was accomplished with equipment that would seem cumbersome and inferior today—with glass plates and a heavy box camera that had to be carried by hand over mountain peaks and through canyons.” It would not be surprising though, if some geologists also carried a roll-film Brownie camera in the field to document important details as a supplement to field notes.

In the years leading up to statehood two New Mexico institutions employed geologists—the University of New Mexico (UNM) and the New Mexico School of Mines (now New Mexico Institute of Mining and Technology). Both had been established in 1889, and both took several years to organize and begin instruction of students, most of whom were college-preparatory (high school) students. At UNM, its second president (1897–1901) was the gifted young geologist Clarence L. Herrick (1858–1904). Herrick (Fig. 4) had been a professor at Denison and Cincinnati universities before arriving in New Mexico in 1894 to take the cure for tuberculosis, contracted the previous year. Trained as a geologist and paleontologist, Herrick was versatile and brilliant, publishing more than 150 papers in such fields as zoology, neurology, and psychobiology in addition to his contributions to the earth sciences (Northrop 1966). After a year as a geologic consultant in Socorro he was named in 1897 as president (and first geology professor) of UNM. Herrick lost no time in constructing a science building at the fledgling university (Hadley Climatological Laboratory, which burned to the ground in 1910) and establishing a bulletin for the publication of scientific research papers (the first in New Mexico), which lasted until the 1960s. He also began a program of geologic field studies that took him to many parts of the territory and resulted in a steady stream of publications describing details of the regional geology (structure, tectonics, igneous geology, geomorphology, in addition to stratigraphy and paleontology) of the large areas he surveyed before his untimely death in 1904. These papers are filled with perceptive observations and ideas, many of which were mentioned only in passing and were later more fully developed by others. Several of them also included the first real geologic maps made of areas of the territory. Herrick mentored one brilliant student (Douglas Johnson, who received the first bachelor's degree in geology awarded in New Mexico); we will encounter both men again later in this paper.

Herrick was succeeded at UNM as geology professor by William G. Tight (1865–1910), who was also the third president (1901–1909) of the university (see Northrop 1966). Tight matriculated at Denison University in Ohio and received his doctorate from the University of Chicago. Tight did little geologic research while at UNM, publishing only one paper involving New Mexico geology. His main contributions to New Mexico geology were twofold. He mentored another outstanding undergraduate student, Kirk Bryan, a native of Albuquerque who would go on to become a professor at Harvard, and return to New Mexico for groundbreaking geomorphic and hydrogeologic studies. And, somehow, Tight persuaded the Geological Society of America to hold its 20th annual winter meeting at UNM in December 1907. A total of 33 geologists, plus several students made the trip to what must have seemed to some (especially the three Canadian attendees) as a small town in the middle of nowhere. Some 42 papers were presented in the Hadley Science Hall at UNM, and Tight led a field trip to the Sandia and Manzanita Mountains, providing an unpublished sketch map of the geology of the area. The USGS was represented by N. H. Darton, who presented three papers, only one of them having to do with New Mexico geology. Charles Rollin Keyes, former president of the New Mexico School of Mines (see below), also presented three papers.

Meanwhile in Socorro, the New Mexico School of Mines had opened in 1893 and awarded its first baccalaureate degrees, in chemistry and mining engineering, in 1896 (much information in the following paragraphs is from Christiansen 1964). By 1912 a few degrees had been awarded also in metallurgical engineering, civil engineering, and general science. Geology courses (but not degrees) also were offered, but the focus of the school was clearly engineering. The school had begun commercial analyses (assaying, water and fuel analysis) in 1907 as a service to the mining industry.

Two early presidents, Fayette Jones (1898–1902) and Charles R. Keyes (1902–1905), were active in matters involving New Mexico geology. Jones (1859–1936) was trained as a mining engineer and pursued a variety of mostly mining-related professions during his life (see Holts 1979, for a short biography). Probably his main contributions in New Mexico occurred after he had left the presidency of the School of Mines and was living in Albuquerque as a consultant and field assistant for the USGS. Governor Otero appointed him to the board preparing the territory's contribution to the 1904 World's Fair in St. Louis. New Mexico's exhibit, organized by the School of Mines with Jones' assistance, focused on mining and geology, and by contemporary accounts was one of the most memorable at the fair. According to Christiansen (1964, p. 17) the exhibit required a full train car to ship. "In the center was a huge relief map of New Mexico twenty feet square. All the mineral products and natural resources in the [territory] were represented in different colors. With this was a large display in color showing the geologic formations in New Mexico. There were several pyramids (eight feet high) of zinc, lead, and copper ores from the Magdalena mining district, as well as four large cases displaying the various minerals found in New Mexico, and a number of pictures of New Mexico emphasizing mines, minerals, and natural resources."

To accompany the exhibit, Jones (1904) wrote a book, *New Mexico Mines and Minerals*, which was an attempt to provide a comprehensive record of New Mexico's mineral resources and the history of their development. It is a fascinating book, with much information derived from correspondence and conversations with mining men throughout the territory, many of whom had lived through the boom times of the 1880s and early 1890s. As Holts (1979, p. 54) noted, the accuracy of some information is questionable in places, and, being published by the New Mexico Bureau of Immigration, it served as promotional tourist and immigrant literature as well as a record of New Mexico's geologic resources.

That Jones included much accurate information in the book is indicated by the fact that Lindgren et al. (1910), in their monograph on New Mexico ore deposits, made much use of it, stating (p. 16) that in Jones' book "for the first time a resume was given of the historical, geologic, and mining features of the various camps of the Territory. This book of reference is quoted frequently in the following pages; it contains a great amount of valuable material, including a list of minerals which forms the base of a similar table in this report. The geologic features are not always adequately treated and are in places erroneously stated, but the work is not claimed to be a geologic treatise."

Jones lived in New Mexico for much of the rest of his life, primarily as a mining consultant but also serving the state in various capacities, including a second term as president of the New Mexico School of Mines (1913–1917). There, in 1915, he established a "New Mexico Mineral Resources Survey" but without any designated state funding, and it published three bulletins between 1915 and 1919. These were ideas ahead of their time; it was not until 1927 that the state established the New Mexico Bureau of Mines and Mineral Resources as a department of the School of Mines, and the bureau began a vigorous publication program, which continues to this day. The School of Mines became the New Mexico Institute of Mining and Technology in 1951.

Charles Rollin Keyes (1864–1942) followed Jones as president of the School of Mines (1902–1905). He received his Ph.D. from Johns Hopkins University in 1892, and by the time of his arrival in Socorro, Keyes had served as chief geologist and paleontologist of the Missouri State Geological Survey, assistant state geologist of Iowa, and director of the Missouri Geological Survey. He had also published extensively on the stratigraphy, paleontology, and economic geology of the Midwest. Keyes' career deserves extended study, for it is unique in the annals of American geology, but only a few comments are made here.

In New Mexico, Keyes began publishing articles on the geology of the territory as soon as he arrived, and Burks and Schilling's (1955) *Bibliography of New Mexico Geology and Mineral Technology through 1950* lists 52 publications from 1903 to 1912, mostly short notes, on a wide variety of subjects, including stratigraphy, coal fields, mineral deposits, structure and tectonics, surface processes, geomorphology, volcanic craters, and ground water. Although he apparently returned to his home state of Iowa a few years after his School of Mines service (even running a losing race for senator from that state in 1918), he continued to publish papers on the geology of New Mexico until the year of his death. His list of publications on the geology of the state is by far the longest of any author cited by Burks and Schilling (1955), yet he had relatively little influence on the development of geologic knowledge of New Mexico. Many of his publications were short, derivative, superficial, and idiosyncratic, and many mainly featured criticism and arguments against mainstream views of the local geology, especially the work of the USGS. He coined dozens of stratigraphic names within a grand but inconsistent concept of New Mexico's geologic history, but these units were little supported by actual field description or establishment of type sections. He preferred the short-lived International Geological Congress convention of ending period names with "-ic" (e.g., Devonic, Cretacic, etc.) to the more familiar USGS forms, and apparently enjoyed publishing his own unorthodox views.

In 1922, Keyes bought the defunct journal *The American Geologist*, renamed it *The Pan-American Geologist*, and thereafter, as publisher and editor, published whatever he wanted, unfettered by peer review, exclusively in that journal. Most of his subsequent articles on New Mexico geology involved little more than opinions, assertions, and criticisms of the well-established views of other geologists, often rehashing arguments that had been settled to everyone else's satisfaction decades ago. Although his early writings on New Mexico stratigraphy and other subjects were referenced and discussed by other workers (e.g., Lindgren et al. 1910), by 1912 much of his work had been dismissed and was ignored as study of New Mexico geology proceeded.

Geologists working in New Mexico (and everywhere else) in the early 20th century were almost exclusively men. The culture of the time discouraged, if not actually prohibited, women from pursuing geology degrees and working as geologists. A few pioneering women obtained graduate degrees in geology in the late 19th century. Mary E. Holmes was the first woman in the U.S. to be awarded a doctoral degree (from the University of Michigan, 1888) and the first to be elected a Fellow of the Geological Society of America. Florence Bascom received her doctorate from Johns Hopkins (1893), was the first woman hired as a geologist by the USGS (1896), and later founded and taught in the geology department of Bryn Mawr College, Pennsylvania. However, these early women geologists were trained in eastern and midwestern universities and worked mainly in those regions. Very few ever found their way to wild and remote New Mexico.

The Burks and Schilling (1955) bibliography of New Mexico geology through 1950 lists only three women who published (a total of five papers) on the geology of New Mexico through 1912. Three of these papers were by Ida H. Ogilvie. She was a student of Bascom's at Bryn Mawr and then received her doctoral degree at Columbia University in 1903 (Wood 1964). She founded and for several decades taught in the geology department at Barnard College in New York City. In 1899, she was part of a field party led by R. D. Salisbury (University of Chicago), which passed through New Mexico on its way to the Grand Canyon. An unusual igneous intrusion through Cretaceous strata near Las Vegas caught her attention, and she published (Ogilvie 1902) a short paper on the composition of these rocks, a camptonite or plagioclase lamprophyre. In the winter of 1904 she studied the geology of the Ortiz Mountains and surrounding area, proposing the term *conoplain* (Ogilvie 1905) for the partly erosional and partly constructional plain that slopes away in all directions from the intrusive core of the mountains—one of the first descriptions of what has come to be called the Ortiz pediment surface. This paper features detailed analyses of erosional processes and stream action in a high-elevation, arid region, and it is one of the earliest important contributions to the study of New Mexico geomorphology. Her third publication (Ogilvie 1908) was a chemical-petrographic analysis of the igneous rocks (mostly andesite, dacite, and diorite) that compose the Ortiz range.

The other two women's contributions were less substantial. Ada Springer, a daughter of the noted Las Vegas lawyer and crinoid specialist Frank Springer, published (1902) a short report on Pleistocene and modern snails around Las Vegas. Mildred Blodgett, about whom little is known, apparently spent a week in the field around Mt. Taylor and produced a B.S. thesis on the Cretaceous stratigraphy for M.I.T., which was later published, with the addition of paleontological information, by Shimer and Blodgett (1908).

This unfortunate underrepresentation of women in geology continued long past 1912. The first woman geologist to obtain a position at any of New Mexico's academic institutions was the noted paleontologist-stratigrapher Christina Lochman Balk, who joined New Mexico Institute of Mining and Technology and the New Mexico Bureau of Mines and Mineral Resources in the 1950s (Love 2006). It would not be until the 1970s and 1980s when significant numbers of women pursued graduate studies and were hired as geology professors in the state's academic institutions.

Geologic processes, of course, can strongly influence human societies and this was true of late territorial New Mexico. During the 25 years before statehood New Mexico experienced an unusually high frequency of earthquakes strong enough to frighten its residents. On May 3, 1887, an estimated 7.5 magnitude quake originating near Bavispe, Sonora, Mexico (about 190 miles southeast of Tucson, Arizona) was felt through much of New Mexico as far north as Las Vegas (DuBois and Smith 1980). Structural damage to buildings was reported in El Paso, but the effect in New Mexico was limited to shaking, which caused alarmed people to rush out into the streets in Las Cruces and Albuquerque. Clocks stopped, crockery fell from shelves, and a few windows were broken, but no injuries to New Mexicans resulted.

In April 1893, a series of shocks produced minor damage and much alarm in Belen, followed in July by several shocks to Albuquerque, and in September by temblors that collapsed some adobe buildings in Las Lunas and Sabinal (Northrop 1982). Two years later four quakes hit the Sabinal–Jarales area within 12 hours, causing houses to rock and household items to tumble from shelves.

Seismic activity hit a high point early in the 20th century, when the territory was struck by two separate lengthy episodes of strong earthquake swarms, centered around Socorro. The first, from January to September 1904, produced 34 shocks strong enough to be felt, although they caused no significant damage to structures or injuries to people. The second and stronger swarm occurred from July 1906 to early in 1907. The three strongest shocks averaged an estimated 6.0 in magnitude. Accurate measurement of earthquake magnitude was not possible then; it wasn't until 1960 that the first permanent seismograph station providing exact magnitudes and epicenters for New Mexico quakes was installed in the state (Northrop 1982). The 1906–1907 shocks caused substantial damage to buildings and sent frightened Socorro residents rushing into yards and streets for safety. Although no serious injuries were reported, tremors were felt nearly every day for months (see Sanford, 1963, for details). These 1906–1907 quakes were the strongest, and most numerous and sustained, shocks ever to have originated in New Mexico in its recorded history, and no earthquakes even approaching the severity of these quakes have occurred during the time New Mexico has been a state. At the time no reasonable explanation for these quakes was offered; some believed that they were somehow related to the great San Francisco quake that had occurred earlier in 1906. It was not until the 1970s, with the discovery of an ascending subsurface magma body beneath Socorro, that the high seismicity of the Socorro area was explained (e.g., Sanford 1983).

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References

Antisell, T., 1856, Report of explorations for railroad routes, San Francisco Bay to Los Angeles, west of the Coast Range, and from the Pimas villages on the Gila to the Rio Grande, near the 32nd parallel of north latitude: geological report; *in* Reports of explorations and surveys to ascertain the most practicable and economical route for a railroad from the Mississippi River to the Pacific Ocean, v. 7, pt. 2: U.S. 33rd Congress, 2nd Session, Senate Executive Document 78, 204 pp.

Bandelier, A., 1890, The delight makers: Dodd, Mead & Co., New York, 490 pp.

Beck, W. A., and Haase, Y. D., 1969, Historical atlas of New Mexico: University of Oklahoma Press, Norman, not paginated.

Blake, W. P., 1856, Report on the geology of the route, no. 1—General report on the geological collections; *in* Whipple, A. W., Reports of explorations and surveys to ascertain the most practicable and economical route for a railroad from the Mississippi River to the Pacific Ocean, v. 3, pt. 4: U.S. 33rd Congress, 2nd Session, Senate Executive Document 76 and House Executive Document 91, pp. 1–91, 106–119.

Bryson, B., 2011, At home: Anchor Books, New York, 577 pp.

Burks, M. R., and Schilling, J. H., 1955, Bibliography of New Mexico geology and mineral technology through 1950: New Mexico Bureau of Mines and Mineral Resources, Bulletin 43, 198 pp.

Chace, J., 2004, 1912: Simon and Shuster, New York, 323 pp.

Christiansen, P. W., 1964, Of earth and sky: New Mexico Institute of Mining and Technology, Socorro, 107 pp.

Christiansen, P. W., 1974, The story of mining in New Mexico: New Mexico Bureau of Mines and Mineral Resources, Scenic Trips to the Geologic Past, no. 12, 112 pp.

Coan, C. F., 1925, A history of New Mexico, vol. 1: American Historical Society, Inc., Chicago and New York, 586 pp.

Cohen, S., 1986, Novels of New Mexico; *in* Williams, J. L., New Mexico in maps, 2nd edition: University of New Mexico Press, Albuquerque, pp. 353–356.

Darton, N. H., 1917b, Description of the Deming quadrangle: U.S. Geological Survey, Geologic Atlas, Deming Folio, no. 207, 15 pp.

DuBois, S. M., and Smith, A. W., 1980, The 1887 earthquake in San Bernardino Valley, Sonora: historic accounts and intensity patterns in Arizona: Arizona Bureau of Geology and Mineral Technology, Special Paper no. 3, 112 pp.

Fisk, D. M., 2003, American labor in the 20th century: U.S. Dept. of Labor web site.

Frazier, A. H., and Heckler, W., 1972, Embudo, New Mexico, birthplace of systematic stream gaging: U.S. Geological Survey, Professional Paper 778, 23 pp.

Hall, J., 1856, Descriptions and notices of fossils collected upon the route; *in* Whipple, A. W., Report on explorations and surveys to ascertain the most practicable and economical route for a railroad from the Mississippi River to the Pacific Ocean, v. 3, pt. 4: U.S. 33rd Congress, 2nd Session, Senate Executive Document 78 and House Executive Document 91, pp. 99–105.

Holts, C. L., 1979, Fayette Jones, mining engineer—a profile in diversity: New Mexico Geology, v. 1, pp. 53–54, 63.

Johnson, B. A., and Dauner, R. K. (eds.), 1981, Early Albuquerque: Albuquerque Journal, 270 pp.

Johnston, B., 2011, History drive: Albuquerque Journal, Nov. 27, 2011, pp. E1, E5.

Jones, F. A., 1904, New Mexico mines and minerals: The New Mexico Printing Co., Santa Fe, 349 pp.

Julyan, R., 1996, The place names of New Mexico: University of New Mexico Press, Albuquerque, 385 pp.

King, P. B., 1949, Memorial to Nelson Horatio Darton: Geological Society of America, Annual Report for 1948, Proceedings Volume, pp. 146–170.

Klein, A., 2009, Personal income of U.S. states: estimates for the period 1880–1910: Warwick Economic Research papers, no. 916, 61 pp.

Kues, B. S., 1985a, Early geological explorations in northeastern and east-central New Mexico; *in* Lucas, S. G., and Zidek, J. (eds.), Santa Rosa–Tucumcari region: New Mexico Geological Society, Guidebook 36, pp. 103–118.

Kues, B. S., 1985b, Stratigraphy of the Tucumcari area: a historical account; *in* Lucas, S. G., and Zidek, J. (eds.), Santa Rosa–Tucumcari region: New Mexico Geological Society, Guidebook 36, pp. 119–140.

Kues, B. S., 1992, James Hervey Simpson and the first record of San Juan Basin geology; *in* Lucas, S. G., Kues, B. S., Williamson, T. E., and Hunt, A. P. (eds.), San Juan Basin IV: New Mexico Geological Society, Guidebook 43, pp. 83–101.

Kues, B. S., 2006, Geological studies of the Guadalupe Mountains area, New Mexico and west Texas, to 1928; *in* Land, L., Lueth, V. W., Raatz, W., Boston, P., and Love, D. W. (eds.), Caves and karst of southeastern New Mexico: New Mexico Geological Society, Guidebook 57, pp. 127–144.

Kues, B. S., 2008a, Early geological studies in southwestern and south-central New Mexico; *in* Mack, G., Witcher, J., and Lueth, V. W. (eds.), Geology of the Gila Wilderness–Silver City area: New Mexico Geological Society, Guidebook 59, pp. 77–106.

Lindgren, W., Graton, L. C., and Gordon, C. H., 1910, The ore deposits of New Mexico: U.S. Geological Survey, Professional Paper 68, 361 pp.

Love, J. C., 2006, In memory of Christina Lochman-Balk, 1907–2006: New Mexico Geology, v. 28, pp. 88–90.

Marcou, J., 1858, Geology of North America, with two reports on the prairies of Arkansas and Texas, the Rocky Mountains of New Mexico, and the Sierra Nevada of California, originally made for the United States government: Zurich, Zurcher and Furrer, 144 pp.

McAllister, P. E., and Putman, M. L., 1986, Communications: telephone; *in* Williams, J. L. (ed.), New Mexico in maps, 2nd edition: University of New Mexico Press, Albuquerque, pp. 304–306.

Meinzer, O. E., and Hare, R. F., 1915, Geology and water resources of the Tularosa Basin, New Mexico: U.S. Geological Survey, Water-Supply Paper 343, 317 pp.

Morgan, V. L., and Lucas, S. G., 2002, Walter Granger, 1872–1941, paleontologist: New Mexico Museum of Natural History and Science, Bulletin 19, 58 pp.

Myrick, D. F., 1970, New Mexico railroads—an historical survey: Colorado Railroad Museum, Golden, 205 pp.

Newberry, J. S., 1861, Geological report; *in* Ives, J. C., Report upon the Colorado River of the West: U.S. 36th Congress, First Session, Senate Executive Document 77 and House Executive Document 90, 154 pp.

Newberry, J. S., 1876, Geological report; *in* Macomb, J. N., Report of the exploring expedition from Santa Fe, New Mexico, to the junction of the Grand and Green Rivers of the great Colorado of the West in 1859: Washington, D.C., Engineer Dept., U. S. Army, 118 pp.

Northrop, S. A., 1966, University of New Mexico contributions in geology, 1898–1964: University of New Mexico, Publications in Geology, no. 7, 152 pp.

Northrop, S. A., 1982, Earthquakes of Albuquerque country; *in* Grambling, J. A., and Wells, S. G. (eds.), Albuquerque country II: New Mexico Geological Society, Guidebook 33, pp. 171–178.

Ogilvie, I. H., 1902, An analcite-bearing camptonite from New Mexico: Journal of Geology, v. 10, pp. 500–507.

Ogilvie, I. H., 1905, The high-altitude conoplain: a topographic form illustrated in the Ortiz Mountains: American Geologist, v. 36, pp. 27–34.

Ogilvie, I. H., 1908, Some igneous rocks from the Ortiz Mountains, New Mexico: Journal of Geology, v. 16, pp. 230–238.

Paige, S., 1916, Description of the Silver City quadrangle, New Mexico: U.S. Geological Survey, Geologic Atlas, Silver City Folio, no. 199, 19 pp.

Rabbitt, M. C., 1989, The United States Geological Survey, 1879–1989: U.S. Geological Survey, Circular 1050, 52 pp.

Rex, H., 1986, Library collections; *in* Williams, J. L. (ed.), New Mexico in maps, 2nd edition: University of New Mexico Press, Albuquerque, pp. 360–362.

Richardson, G. B., 1904, Report of a reconnaissance in trans-Pecos Texas, north of the Texas and Pacific Railway: Texas University Mineral Survey, Bulletin 9, 119 pp.

Robertson, E. C., (ed.), 1993, Centennial history of the Geological Society of Washington, 1893–1993: Geological Society of Washington, Washington, D.C., 165 pp.

Sanford, A. R., 1963, Seismic activity near Socorro; *in* Kuellmer, F. J. (ed.), Guidebook of the Socorro region, New Mexico: New Mexico Geological Society, Guidebook 14, pp. 146–151.

Sanford, A. R., 1983, Magma bodies in the Rio Grande rift in central New Mexico; *in* Chapin, C. E., and Callender, J. F. (eds.), Socorro region II: New Mexico Geological Society, Guidebook 34, pp. 123–125.

Shimer, H. W., and Blodgett, M. E., 1908, The stratigraphy of the Mt. Taylor region, New Mexico: American Journal of Science, 4th series, v. 25, pp. 53–67.

Shumard, G. G., 1858, Observations on the geological formations of the country between the Rio Pecos and Rio Grande, near the line of the 32nd parallel: St. Louis Academy of Sciences, Transactions, v. 1, pp. 273–289.

Shumard, G. G., 1859, The geological structure of the "Jornada del Muerto," New Mexico: St. Louis Academy of Sciences, Transactions, v. 1, pp. 341–355.

Simmons, M., 1982, Albuquerque, a narrative history: University of New Mexico Press, Albuquerque, 443 pp.

Simpson, J. H., 1850, Report from the Secretary of War communicating the report of Lieutenant J. H. Simpson of an expedition into the Navajo country in 1849, and, also, the report of Captain S. G. French relative to the road opened between San Antonio and El Paso del Norte: U.S. 31st Congress, First Session, Senate Executive Document 64, pp. 55–138, 146–148.

Sinclair, U., 1906, The jungle: Doubleday, Page & Co., New York, 475 pp.

Smith, C. T., Osburn, G. R., Chapin, C. E., Hawley, J. W., Osburn, J. C., Anderson, O. J., Rosen, S. D., Eggleston, T. L., and Cather, S. M., 1983, First day road log from Socorro to Mesa del Yeso, Joyita Hills, Johnson Hill, Cerros de Amado, Lomas de las Canas, Jornada del Muerto, Carthage, and return to Socorro; *in* Chapin, C. E., and Callender, J. F. (eds.), Socorro region II: New Mexico Geological Society, Guidebook 34, pp. 1–28.

Springer, A., 1902, On some living and fossil snails of the genus *Physa*, found at Las Vegas, New Mexico: Philadelphia Academy of Natural Sciences Proceedings, v. 54, pp. 513–516.

Statesman's Yearbook, 1913, MacMillan & Co., London, 1536 pp.

Statistical Abstracts of the United States, 1913, U.S. Government Printing Office, Washington, 720 pp.

Twitchell, R. E., 1917, The leading facts of New Mexico history, vol. V: The Torch Press, Cedar Rapids, 505 pp.

Vieyra, D. I., 1979, Fill'er up, an architectural history of America's gas stations: Collier Books, New York, 111 pp.

Vigil-Giron, R., 2005, New Mexico bluebook, 2005–2006: Office of the Secretary of State, Santa Fe, 372 pp.

Williams, J. L., 1986a, Surveyors and homesteaders, 1880–1940; *in* Williams, J. L. (ed.), New Mexico in maps, 2nd edition: University of New Mexico Press, Albuquerque, pp. 126–128.

Williams, J. L., 1986b, Communications: radio; *in* Williams, J. L. (ed.), New Mexico in maps, 2nd edition: University of New Mexico Press, Albuquerque, pp. 298–300.

Williams, J. L., 1986c, Movies made in New Mexico; *in* Williams, J. L., (ed.), New Mexico in maps, 2nd edition: University of New Mexico Press, Albuquerque, pp. 350–352.

Wood, E. A., 1964, Memorial to Ida Helen Ogilvie (1874–1963): Geological Society of America, Bulletin, v. 75, p. 35–40.

World Almanac and Encyclopedia, 1912, The Press Publishing Co., New York, 800 pp.