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# Critique: Geological Errors in Walter Prescott Webb's *The Great Plains*

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# CRITIQUE: GEOLOGICAL ERRORS IN WALTER PRESCOTT WEBB'S *THE GREAT PLAINS*

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**ABSTRACT**—The comprehensive nature of Walter Prescott Webb's (1931) text, *The Great Plains*, has made this book a classic reference. However, the scientific errors and omissions, as well as the availability of more current research on the geology, hydrology, and physical geography of the region, suggest that the information presented should be viewed with more skepticism.

## Introduction

The breadth and seeming depth of *The Great Plains*, by University of Texas historian Walter Prescott Webb (1931), make this text required reading in many college courses concerning the plains, even today. Yet, how good is the science represented? Webb's book has always been hard to define. Professor Frederick L. Paxson (1932) reviewed Webb's text and noted that "Whether it is to be described as history or sociology, or as that new form of geography that embraces the human occupant . . . is not quite clear." Although ostensibly writing about all of the Great Plains, Webb concentrated on Texas. The local bias is not surprising since Webb was born, raised, and lived virtually nowhere else before writing his most famous book. Of more concern than his local bias, however, are numerous scientific errors in Webb's enduring text. He makes serious errors in geology, groundwater hydrology, and physical geography (physiography), clearly illustrating his ignorance of science.

First, the book's geological and geographical information is seriously outdated, and it was outdated even at the time *The Great Plains* was published. For example, Webb relied on a single, 30-year-old reference for all of his discussions of the groundwater geology of the Great Plains, the 1901 article on the "The High Plains and their Utilization," from the *21st Annual Report of the U.S. Geological Survey* (Johnson 1901).Yet, geological and geohydrological understanding progressed significantly between 1901 and 1931. For example, Meinzer (1923) published a more definitive work, *The*

*Occurrence of Ground Water in the United States, with Discussion of Principles*, eight years before Webb published his book, and it was published by the same agency (US Geological Services) that published Webb's 1901 reference (Johnson 1901). Meinzer's (1923) book has been called the "Bible" of modern ground water hydrology (Fetter 1988: 310). In addition, the "father" of American physiography, Nevin M. Fenneman, had published the *third edition* of his seminal work, *Physiographic Divisions of the United States* (Fenneman 1928), three years before Webb published his book. These books updated the geological and geographical understanding of the plains significantly; yet, they were not used by Webb. It is now obvious, as one of Webb's biographers has stated, that, "If Webb's career had followed a conventional pattern from 1906 on, he might well have been attracted to the study of geography . . . But his interest remained potential, and his education from that point on deferred any contact with current trends in Geography" (Tobin 1976: 23).

Second, why would a scholar of Webb's stature rely on a single geologic reference for all his information on groundwater in the Great Plains? The use of a single primary, or secondary, source to fully characterize the role of John Wesley Powell in the formation of cooperative irrigation projects in the West, for example, or to detail the effects of Soil Conservation Service programs on ending the Dust Bowl would be unthinkable to any conscientious scholar. Webb's use of one source for his geologic and groundwater data is akin to a geologist today discussing the formation of Rocky Mountains as the result of "geosynclinal downwarp" and "isostasy," the prevalent geological theories in 1969, instead of "continental drift," the current theory. In the past 30 years, geologists have progressed from disbelieving the radical theory proposed by Canadian professor J. Tuzo Wilson to finding undeniable scientific evidence of drift with "sea-floor spreading," "plate tectonics," and "mid-oceanic ridges." However, even the scientific references that were available at the time Webb wrote his book dispute many of his conclusions.

Third, Webb's discussion of groundwater on the plains demonstrates a lack of geological understanding. For example, in his discussion of the "water plane," he claims that wells should strike groundwater "anywhere" because "'ground water at a greater or less depth is a universal phenomenon'" (Webb 1931: 328). On the contrary, ground water is restricted by geological substrate. In addition, he distinguished between "artesian water and ground water proper" (Webb 1931: 326), when no such distinction exists since artesian systems are ground water systems. Webb's (1931) conception of groundwater was either generally incorrect or oversimplified throughout, despite the availability of Messner's (1923) detailed, precise descriptions. The prominance of some of the concepts Webb used helps explain why 19th century Great Plains agricultural boosters, like Colorado governor William Gilpin, could predict that farming was feasible anywhere in the Great Plains and that "rain follows the plow" (Benson 1988: xv-xix; Opie 1993: 65-70).

To correct some of the misconceptions in Webb's (1931) Chapter 8, the level of ground water is known as the "water table," not the "water plane." Artesian water is defined as "ground water that is under sufficient pressure to rise above the level at which it is encountered by a well, but which does not necessarily rise to or above the surface of the ground," and is also called "confined groundwater" (American Geological Institute 1976: 21). Unconfined groundwater does not always follow topography and the flow of confined groundwater is completely unrelated to topography (Fetter 1988: 101-5). Additionally, unconfined groundwater does not always "flow to the sea," as Webb (1931: 328) stated, but to a base level created by local stream systems. This unconfined groundwater may even continue to migrate as subsurface "base flow" in stream valley alluvium when the surface stream is dry, due to seasonal/climatic conditions. Finally, groundwater is not available "everywhere." Water can be found "floating" on top of denser sea water within inches of sea level on islands or peninsulas such as Florida, but it may be too deep to drill due to either technical or economic factors (Meinzer 1923: 309; Darton 1905: 194). Incidentally, Webb (1931: 328) gave no source for his quote on the "universal phenomenon" of groundwater.

Fourth, Webb overgeneralized, by extrapolating the geologic data for a limited area of the High Plains to the entire Great Plains region, as he defined it. He stated (1931: 324), ". . . Willard D. Johnson's study, which, though devoted to the High Plains, the central portion of the Great Plains, will serve to illustrate the problem for the entire region." Webb (1931: 330) then stated that "The presence of ground water in great quantity in certain sections of the High Plains and the Great Plains has led to the belief, and the hope, that it might be used as a means of reclamation on a large scale. . . . but such utilization over a broad area would call for a re-supply "'beyond the possibilities of even the most humid climate.'" Webb apparently did not know about the advances in well-drilling technology between 1901 and 1931. New drilling technologies developed for the oil industry had allowed the completion of many new wells into the Ogallala aquifer (Darton 1905: 286-90). In addition, since Webb's book, the extraction of groundwater has accelerated dramatically with the invention of the center-pivot sprinkler (Opie 1993:

146). The area underlain by the Ogallala aquifer now forms the largest continuous area of center-pivot sprinkler irrigation in North America (Opie 1993: 2-4). More than 93,000 irrigation wells were in operation in the Texas portion of the High Plains alone in the early 1980s (Driscoll 1986: 130), with more than 150,000 covering the entire High Plains (Opie 1993: 4). Current use of Webb's book without extensive correction is thus highly misleading on water resource availability and use in the plains.

Fifth, Webb also erred in describing the geological processes by which the Great Plains were formed. For example, he stated (1931: 329) that "Since arid lands are formed by aggradation. . . . The High Plains . . . are only the remnants of the old aggraded plain built up by the desert rivers." He did not understand, as he should have, that when the sediments forming the High Plains were being deposited, the region was not a desert, but actually was even wetter than in his time (Meinzer 1923: 277-78). In addition, he failed to realize that an "aggraded plain" may be formed by a change in velocity of a river. Decreased velocity is likely to occur at any point where a mountain or piedmont stream flows onto a flatter erosional or depositional surface (Lahee 1961: 343-44). He also omitted the important geologic role of Pleistocene-age continental glaciation, known to have created much of the geomorphology and many of the rivers and aquifers of the northern and central Great Plains (Fenneman 1928: 322). The current locations and flow directions of the Missouri River and its tributary, the Platte River, and the Red River of the North are derived from these continental glaciers (Fenneman 1931: 72). The Pleistocene glacial cycles in North America—Nebraskan, Kansan, Illinoian, Iowan, Wisconsin—were even named by geologists for the advances of the continental glaciers into, and retreats from, some of the states of Webb's "Great Plains" (Coleman 1926: 21).

Sixth, Webb's (1931) lack of physiographic evidence for his definition of the area constituting the Great Plains is disturbing. He defined the "Great Plains" as a geographic area with three characteristics (1931: 2-8): a semi-arid climate, a lack of trees, and a nearly level surface. By this definition, the Great Plains extended from western Indiana on the east to Southern California on the west and from the Gulf Coast of Texas on the south to central Canada on the north (1931: 8). Part of his reasoning was that "It is only on the Pacific Slope—in Washington, Oregon, and northern California—that the forest covers any appreciable area in the West" (Webb 1931: 6). However, millions of acres in the Rocky Mountains had been designated as national forest before 1909 (Morison and Commager 1962: 489-90). Furthermore, the first "wilderness" forest (Gila Wilderness Area), located in the

Southern Rockies of western New Mexico, was designated three years before Webb's book was published (Nash 1977: 19-22). This error is not surprising, however, since Webb (1931: 6) dismissed the Rocky Mountains as mere "islands" in the plains. Specifically, the "arid" and "level" Colorado Plateau and Great Basin were Webb's westward continuation of the "level" plains of the central United States (Webb 1931: 4-5). Thus, Utah, Nevada, and Arizona were part of his Great Plains province. Webb equated "The Great Plains" with "The West"—physiographically, geologically, and geohydrologically. Continued, unskeptical use of this text perpetrates these errors.

Webb's belief that the Rockies were only "islands" in the Great Plains is groundless. The Rocky Mountains represent a geologic and physiographic province stretching from Alaska to Central America, a distance twice as long in a north-south direction as Webb's "Great Plains." Based on years of in-depth study of North American geology and topography, Fenneman (1928: 8) had already defined a more restricted Great Plains Physiographic Province. Fenneman (1928) stated that the characteristic feature of the Great Plains ". . . consists in its plateau character" and ". . . is sharply distinguished from the mountains on the west and . . . the low plains on the east." Geologists and geographers today agree with Fenneman's definition of the Great Plains. Fenneman (1928: 319) also recognized the Great Plains Physiographic Province as a complex region with 600 million years of sedimentary deposition, including several hundred million years of deposition in a shallow, inland sea. He recognized that these sedimentary rocks were covered by alluvial (water-deposited) and glacial (ice-deposited) silts, sands, and gravels, lacustrine (lake-deposited) clays, aeolian (wind-deposited) silts and sands, air-fall (air-deposited) volcanic ash, and colluvial (gravity-deposited) wedges of broken rock, sand, silt, and clay. Some of these bedrock and surficial deposits contain groundwater and some do not (Meinzer 1923: 277-78). Some of this groundwater is confined and some unconfined; some is economical to pump and some is too deep or too saline to produce usable water (Darton 1905: 286-90). Some of the bedrock units contain oil, some gas, some coal, some salt, and some no mineral resource of value (Darton 1905: 372-407). In sum, the Great Plains environment was recognized as geologically, hydrologically, and physiographically distinct prior to Webb's (1931) book. Unfortunately, these facts make it clear that Webb was ignorant of contemporary scientific work.

*The Great Plains* (Webb 1931), therefore, provides an example of the dangers of a non-scientist with an incomplete understanding of the physical sciences attempting to define the relationship between physiography, geology, and groundwater hydrology for a region encompassing "63 per cent" of the land area of the United States (Webb 1931: 323). If today's students are to understand the roles played by aridity and scarce water resources in the settlement of the West, they should avoid relying on Walter Prescott Webb's *The Great Plains*. They will be much better prepared by using the scientific data presented in many more recent books on the Great Plains by historians and scientists. For example, books by Dunbar (1983), Pisani (1992 and 1996), Opie (1993), Hurt (1981), Worster (1985), or Reisner (1993) would be more useful than *The Great Plains*.

Perhaps some enterprising soul should consider rewriting *The Great Plains* (Webb 1931), especially to update its science. However, the author of such a revision will need to carefully consider the problems presented here. If a non-geologist uses geologic, geohydrologic, or physiographic data to define an entire geographic region, and to draw broad inferences about the influence of these factors from such data, he or she had better be thorough in checking those scientific facts!

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