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This volume is dedicated to Dr. Rainer Zangerl

The Mammalian Faunas of the Washakie Formation, Eocene Age, of Southern Wyoming

Part I Introduction: The Geology, History, and Setting

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INTRODUCTION

This report is the first of a series planned to document the faunas of each of the members of the Washakie Formation. The series is based upon the materials at Field Museum that have resulted from my systematic collecting during 13 of the past 20 years and from Rainer Zangerl's work in the late 1940's and early 1950's. Also included are the large collections from the Washakie Formation at the American Museum of Natural History, the Carnegie Museum, Princeton University, Yale Peabody Museum, the University of California (Berkeley), and the University of Wyoming. These are often crucial and historically important.

To document this extensive record properly, it is obviously necessary to understand the stratigraphy and geology of this large area in detail. No adequate mapping at a useful scale for any part of the Washakie Formation was available when I began work in 1956; to create a detailed map, I assembled an aerial photo mosaic[1] upon

[1] I am indebted to M. McKenna for the loan of the air photo coverage.

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which I could pinpoint localities and trace formations and key beds. To this montage map I added some of the road and track network, the Range-Township grid, and for a decade recorded the progress of my systematic collecting. I expected to publish this in lieu of any available geologic map. About 1967 a decision was reached by the United States Geological Survey to map the entire Washakie Basin area, both topographically and geologically.

Delighted at the prospect of soon having available fine quality maps, I abandoned plans to publish the air photo map and began an informal and productive period of co-operation with Mr. Henry Roehler, the Survey geologist assigned the geologic mapping project. For recording stratigraphic and collecting locality information, I continued to use my air photo mosaic map during the uncertain interval until the new maps appeared. By 1974 the Survey's topographic mapping was complete, but circumstances had altered. It now appears unlikely that a significant part, if any more, of the planned Geologic Quadrangle sheets covering the Washakie Formation outcrop area will be completed within the forseeable future. Hence to provide a map it has again become necessary to publish the air photo mosaic.

The map, including its quadrant enlargements, and the introduction to the geology, history, and setting together comprise this first section of the series. Subsequent sections will not follow any systematic, geochronologic, or stratigraphic order, except that the second of the series will cover the very fragmentary materials recovered from the Kinney Rim Member to document their morphology and to give evidence of the faunal age stage represented. Beyond this, additional numbers will appear as they are readied, and I will try to heed the priorities of other workers whenever possible.

GEOGRAPHIC AND GEOLOGIC SETTING

The Washakie Basin is usually defined as a high, structural, and topographic Tertiary intermontane basin (Bradley, 1945; Love, 1961; Roehler, 1972). It covers over 2,500 sq. miles (6,400 km.^{2}) of southern Wyoming, from the Colorado boundary north for 45-50 miles (72-80 km.), largely south of the line between Rock Springs and Rawlins. Major mountain ranges surround it, and have contributed their erosional sediment to it: the Sierra Madre in the east; the Wind Rivers in the northwest; and the Uintas in the southwest. Lesser structural features also serve to confine it: the Rock Springs uplift to

the west; the Wamsutter arch to the northeast; and the Cherokee Ridge to the south.

This last feature separates the Washakie Formation from its equivalent beds within the Sand Wash Basin of Colorado (McKay, 1974; McKay and Bergin, 1974; West and Dawson, 1975), the structurally attached, smaller twin of the Washakie Basin. The Cherokee Ridge is partly capped by the Late Tertiary Browns Park Formation. Most of the strata of the Green River Formation and the deeper, older Early Tertiary formations are draped over the Cherokee structure in a continuous manner from the one basin to the other.

The structure of the Washakie Basin is simple. Successively younger formations are piled one upon the other, like a stack of plates. Yet the large size of the outcrop, the widespread erosion, and the cover by dune and alluvium all tend to obscure relationships, and in the southeast part of the basin a series of faults create an even greater degree of complexity. A thin veneer of Pleistocene and/or Recent alluvial deposits and sand dunes covers much of the surface of the basin, with the more resistant beds forming more or less continuous cuestas or rims in concentric arcs with dip-slopes that consistently are inclined toward the center of the basin.

Most fossil collecting has naturally been along the exposures associated with these rims. A few landmark features provide guideposts to this otherwise confusing repetition of similar-appearing, usually low ridges and sand- or clay- or dune-covered valleys. Most noteworthy of these landmarks are Pine and Sand Buttes on the Kinney Rim (and the Rim itself — pl. 3) in the western portion of the basin, the Laney Rim (pl. 2) to the north, Flat Top and Haystack Mountains (pl. 4) in the eastern and north-central regions respectively, and Powder Butte (pl. 5) on the Cherokee Ridge in the south. Lesser, usually more local, features also serve as landmarks: the Man and the Boy, the Seven Sisters, Court House Butte (all pl. 4), Adobe Town (pl. 3), the notch in the Kinney Rim, the northwest flank of Haystack (pl. 4), Wild Horse Spring, etc.

Land use is mainly for sheep (Rife Ranch, Rock Springs Grazing Assn.) and cattle grazing (The Eversole Ranch survives deep within the basin, and several others operate toward the periphery). During the past 20 years there has been much oil and gas exploration activity. The Patrick Draw and related fields have been major developments. Rainfall is only about 10 in. (25.4 cm.) or slightly more per year, and vegetation is accordingly sparse: a few trees, mostly aspen

and cedar (on the major ridges only), sagebrush, cactus, greasewood, soft sage, rabbit bush, desert flowers, and grasses.

Drainages are all intermittent, but abundant water for field work is always available at Kinney Spring, at Antelope Springs, and at a few others, as well as from wells at the Eversole and other ranches. Elevations vary between a low of about 6,100 ft. (1,860 m.) in the southeast where the major drainage (Sand Creek) leaves the basin, to 8,700 ft. (2,650 m.) at Pine Butte. Sand Butte, Haystack Mountain, and similar high features including the higher parts of the major rims approach these upper elevations, and the other important drainage exits in the northwest (Bitter Creek) and southwest (Shell Creek) are nearly as low as that of Sand Creek.

The early Tertiary sedimentary formations of the Washakie Basin which overlie Cretaceous and older rocks are (from bottom to top): Fort Union, Wasatch, Green River, and Washakie. Late Tertiary Bishop Conglomerate and Browns Park Formation, and a thin veneer of Pleistocene—Recent deposits overlie them in places. Plate 1 shows the relationships of the outcrop areas of: 1) the two members of the Washakie Formation, including the subdivisions of the thicker, upper one; 2) part of the underlying Wasatch-Green River Formation complex of intertongued beds; and 3) part of the main Browns Park outlier. Some of the road and track network is also shown, but much has been omitted for clarity since it is available in the new topographic maps published within the last five to six years.

A township and range grid of sorts is also given, but this must be used with the understanding that it is only approximate in as much as the survey work was quite incomplete when the map was made, and there was little ground control. Also, to avoid having any portion of the terrain obscured by the overlap zones of distorted adjacent air photos, I systematically erred by slight outward shifting of the offending segment when necessary. This results in a creeping expansion of the mosaic from its center outward, with occasional duplicated adjacent slivers of the same terrain. In spite of these deficiencies the map and the larger scaled quadrants of it (plates 2, 3, 4, 5) serve adequately to locate both specific key beds and all of my collecting localities. The errors have necessitated some dual locality designations. When needed the first of a pair will apply to my mosaic map, and the second will appear in brackets for the new topographic maps (Appendix). Rarely the difference can amount to as much as one-quarter mile (.4 km.).

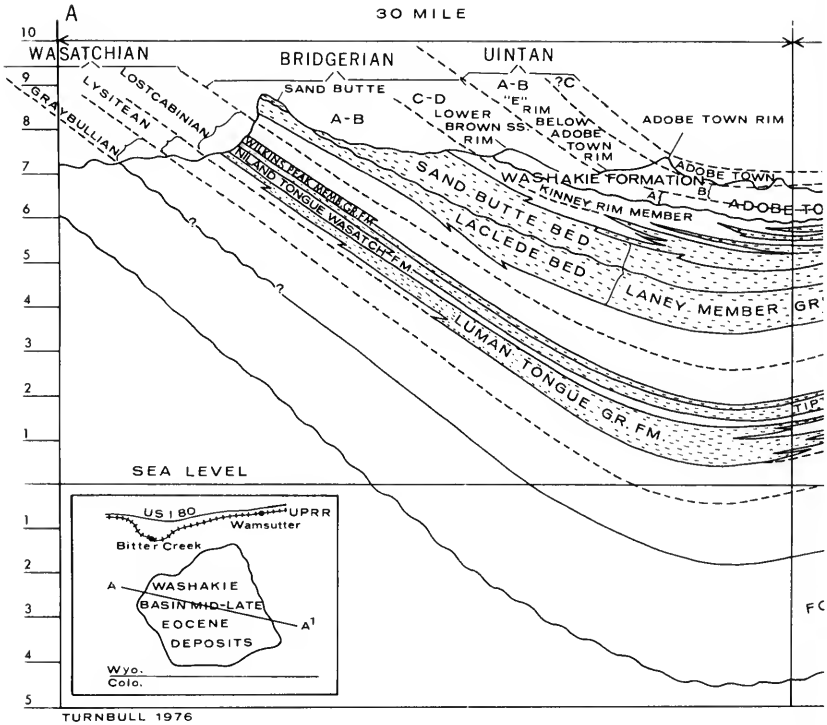
STRATIGRAPHIC DETAIL

The most comprehensive recent published studies of the geology and stratigraphy of the Tertiary deposits of the Washakie Basin are those of Roehler (1969, 1970, 1972, 1973a, b). Roehler has recorded the history of discovery, summarized the earlier works, and given the modern geological interpretation. The reader is referred to his works for detail not given here. Three of the reports which are of particular importance for paleontological investigation of the Washakie Formation are reviewed here.

Roehler's 1969 work on the Green River oil shale deposits goes beyond that formation to provide a useful composite (measured) columnar section of 49 units for the 8,000 ft. (2,438 m.) thick Eocene sequence. Included within this section and designated as "Fluviatile rocks of Bridger and Uinta Age," is the 3,345 ft. (1,019.8 m.) thick Washakie Formation. Further, Roehler (1969) provides the first detailed restored cross-section of the Basin (as fig. 3 of that work) and he gives (p. 201) the first published information on subsurface detail when he states, "isopach maps (not shown) indicate a possible maximum thickness of about 12,300 ft. near T14N, R98W."

Later, in his review of the Eocene stratigraphy, Roehler (1972) performed two other useful services. He provided a regional correlation chart that includes Green River, Washakie, Sand Wash, Piceance Creek, and Uinta Basins, and that summarizes his interpretations of the many inter-relationships.[1] Second, he expanded the restored cross-section of the 1969 work to include 1) surface conformation features, 2) the Paleocene Fort Union Formation, and 3) greater details of thickness, age, and intertonguing relationships. I find this a most useful synopsis for the Early Tertiary deposits, and I repeat it here in modified form (fig. 1) to emphasize the interrelationships between the two members of the Washakie Formation, and the divisions within the upper one. Further, it shows how they relate to the underlying Green River Formation, and the buried subsurface extent of the section.

[1] An Eocene Correlation Committee of the Society of Vertebrate Paleontology is dealing with stratigraphy and North American mammalian age stage revisions. The report which is tentatively titled "Eocene Biochronology of North America" is to be published as a chapter in a book being edited by M. O. Woodburne for the University of California Press with the title *Vertebrate Paleontology as a Discipline in Geochronology*. Authors of this chapter are R. M. West, M. C. McKenna, C. C. Black, M. R. Dawson, J. A. Lillegraven, D. E. Savage, and W. D. Turnbull. For the present purpose Roehler's correlation chart serves admirably.


A
30 MILE
WASATCHIAN
BRIDGERIAN
UINTAN
GRAYBULLIAN
LYSITEAN
LOSTCABINIAN
SAND BUTTE
A-B
C-D
LOWER BROWN SS
A-B "E" RIM
?C
BELOW ADOBE TOWN RIM
ADOBE TOWN RIM
ADOBE TOWN
WASHAKIE FORMATION
KINNEY RIM MEMBER
A1
B
ADOBE TO
WILKINS PEAK MBR OF THE
KNIGHT TONGUE WASATCH FM
SAND BUTTE BED
LACLEDE BED
LANEY MEMBER GR
LUMAN TONGUE G.R. FM
TIP
SEA LEVEL
US 180
UPRR
Wamsutter
Bitter Creek
A
WASHAKIE
BASIN MID-LATE
EOCENE
DEPOSITS
A1
Wyo.
Colo.
TURNBULL 1976

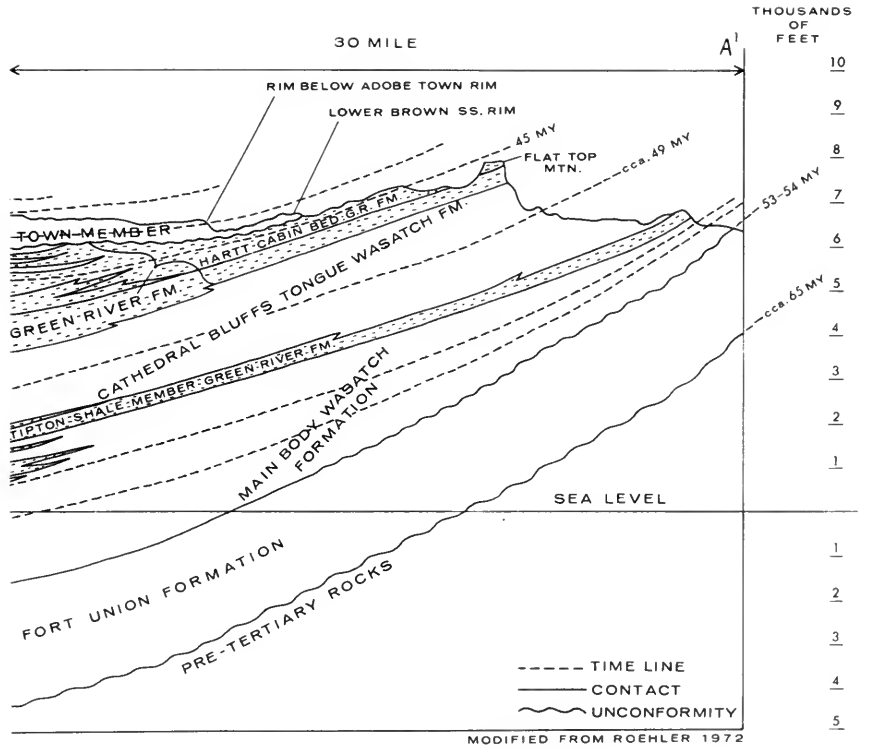


FIG. 1. West to east cross-section of the Tertiary strata in the Washakie Basin showing thickness, age (with radiometric correlations based upon Evernden et al. (1964), and Mauger (1974, unpublished)), intertongueing relationships, and surface conformation.

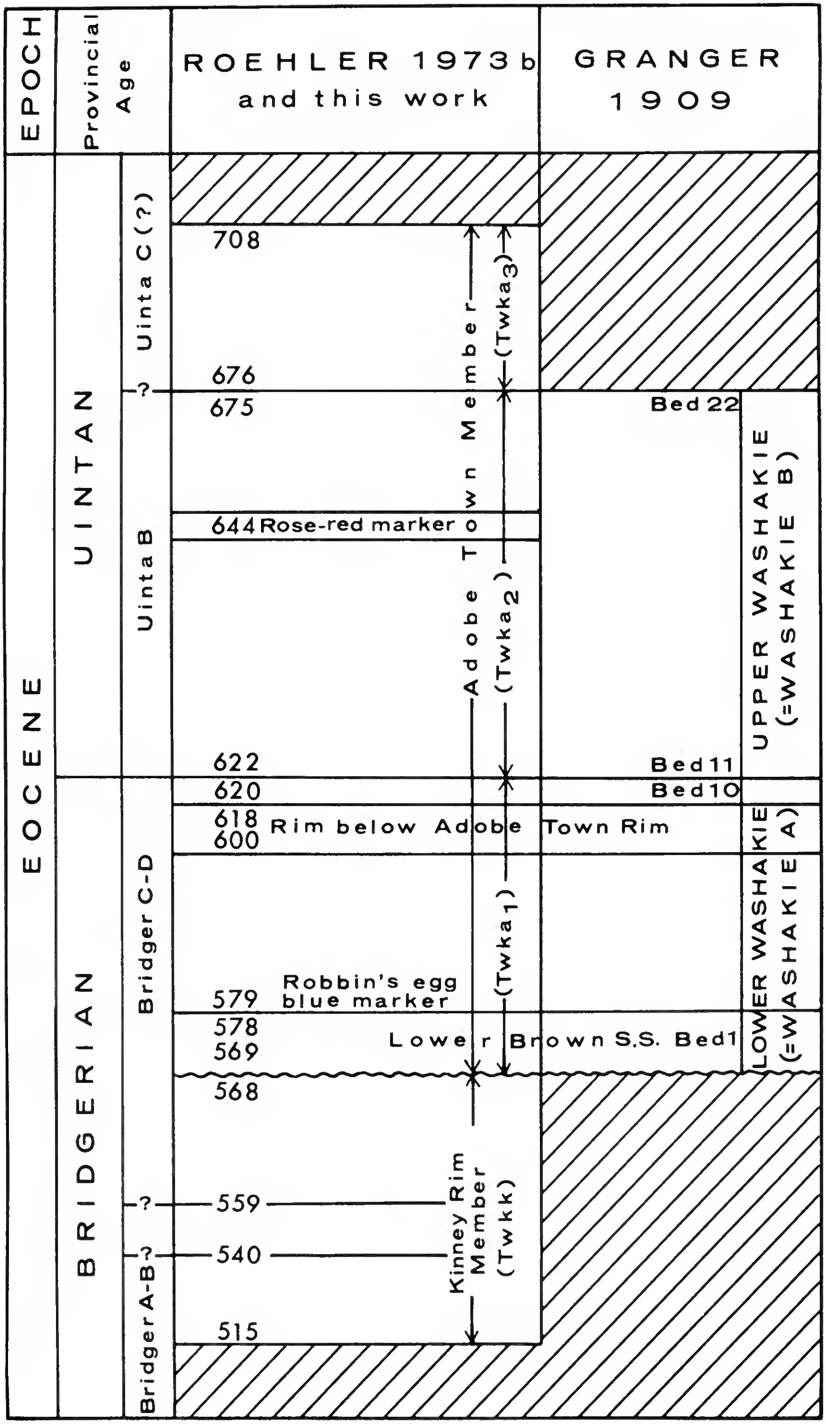
The last of the three Roehler reports (1973b) is the most important in that it deals directly with the Washakie Formation. It provides electric log data for four wells and relates these logs to the measured sections. It is augmented by the only two published Geological Quadrangle maps which cover areas of outcrop of the Washakie Formation (Roehler,1973c, 1975). In each the stratigraphy is set forth in detail so that scaled, measured columnar sections are given, with the lithology of each unit designated. That given in Bulletin 1369 (Roehler, 1973b) covers beds 515-708, and represents 3,213.4 ft. (979.7 m.) of measured Washakie sediments as follows: Twkk, 893.9 ft. (272.5 m.) for the type section of the Kinney Rim Member (beds 515-568); $Twka_1$, 877.8 ft. (267.6 m.) for a principal reference section for the lowest part of the Adobe Town Member (beds 569-628), the equivalent of Granger's Lower Washakie plus about 110 ft. (33.5 m.), of the base of Granger's Upper Washakie (see below); $Twka_2$, 1,100.7 ft. (335.6 m.) for the type section of the Adobe Town Member (beds 629-675), the equivalent of most of Granger's Upper Washakie; and $Twka_3$, 341.0 ft. (104.0 m.) for a principal reference section for the uppermost part of the Adobe Town Member (beds 676-708). The section given in Geological Quadrangle 1128 (Roehler, 1973c) covers 983 ft. (300 m.) of the Kinney Rim Member and 1,439 ft. (439 m.) of the base of the Adobe Town Member in addition to much of the Wasatch and Green River Formations. That in Map G.Q. 1231 (Roehler, 1975) covers 724 ft. (221 m.) of Kinney Rim Member and 206 ft. (63 m.) of the base of the Adobe Town Member, as well as much of the Green River Formation. Figure 2 shows the historic and modern correlations of the various units of the Washakie Formation.

All this comprises a far more thorough documentation of the lithology, and is a record of much more section than I could have possibly managed to record and measure, and still have found time for prospecting and collecting. I therefore follow it here.

Vertebrate paleontologists have long used the term Washakie Formation to designate the stratigraphically highest Eocene sediments of largely fluviatile rocks that outcrop in the central part of the Washakie Basin, following Granger (1909) and others before him. Granger had designated two units: Washakie A, or Lower Washakie, beginning with his bed 1, the Lower Brown SS, at the base, and going

Opposite:

FIG. 2. Correlation of Granger's 1909 Washakie Formation with that of Roehler, 1973.


EPOCH
Provincial Age
ROEHLER 1973b and this work
GRANGER 1909
EOCENE
UINTAN
BRIDGERIAN
Uinta C(?)
Uinta B
Bridger C-D
Bridger A-B?
708
676
675
644 Rose-red marker
622
620
618
600
Rim below Adobe Town Rim
579
Robbin's egg blue marker
578
569
Lower Brown S.S. Bed1
568
559
540
515
Adobe Town Member
(Twka3)
(Twka2)
(Twka1)
Kinney Rim Member (Twkk)
Bed 22
Bed11
Bed10
UPPER WASHAKIE (=WASHAKIE B)
LOWER WASHAKIE (=WASHAKIE A)

up to his bed 10 capping the rim below the Adobe Town Rim; and Washakie B, Upper Washakie, Granger's bed 11 up through the sandstones that cap Haystack Mountain, bed 22. Washakie A has come to be recognized as a Bridger C-D faunal equivalent, and Washakie B as a Uinta A-B equivalent (Granger, 1909; Osborn, 1929; Simpson, 1933; H. E. Wood et al., 1941; McGrew, 1951; Gazin, 1959; Wheeler, 1961; A. Wood, 1962; Turnbull, 1972; Roehler, 1972, 1973b, and many others). These floodplain, stream, pond, and lake deposits directly overlie the Laney Member of the Green River Formation (Sand Butte Bed in the west and southwest, Hartt Cabin Bed in the north, east, and southeast). The contact is further complicated by irregular development of the Washakie Formation.

In his 1973b study, Roehler re-established the name Washakie Formation in terms acceptable to the U.S. Geological Survey, and he named two subdivisions, the Kinney Rim and Adobe Town Members. This is fortunate for Granger's Washakie Formation had never received U.S.G.S. acceptance. However, vertebrate paleontologists (Wood et al., 1941, Robinson, 1957) had used it and nearly all of the fossil vertebrate remains from these deposits in the major collections in the United States bear that designation. Attention should be called to the fact that the Washakie Formation as Roehler has designated it is more inclusive than it had been in Granger's concept.

Independently, Roehler and I had reached the conclusion that there are 341 ft. at the top of the Adobe Town Member, outcropping along the Adobe Town rim 15 miles SSW of Haystack, that are younger than the uppermost beds on Haystack itself, long considered to be the top of the section. These beds appeared to extend farther south for an undetermined distance. Both of us (Turnbull, 1972; Roehler, 1973b) have recorded this previously, and Roehler has speculated that because of striking lithic differences, these beds may be a Uinta C equivalent not heretofore recognized in the Washakie Basin. I have spent much effort attempting to collect from these units so as to be able to settle the matter, but to date no sufficiently diagnostic materials have been recovered. Nor is there a satisfactory key bed that can be readily traced which might serve as a marker for the base of the unit. However I have been able to make some progress in defining the extent of the unit by tracing weakly discernable outcrop patterns on the air photos. The result is the area designated $Twka_3$ on the maps (pls. 1, 3).

Roehler (1973b) also recognized that as much as 900 ft. (275 m.) of sediments capping the Kinney Rim on much of its dip-slope side (eastern), which Bradley (1945, 1964) had previously mapped as belonging to the upper part of the Laney Member of the Green River Formation, were largely non-lacustrine, and that they were almost entirely fluviatile, flood plain, and channel deposits. Accordingly, he switched their assignment from the Laney to the basal part of the Washakie as a new unit, the Kinney Rim Member, Twkk (figs. 1, 2). This unit is a wedge of sediment, thickest in the west and southwest, and thinning so rapidly eastward that it is missing in the northeast and east areas where it would otherwise be expected. At depth it intertongues with, but mostly lies upon the Sand Butte Member of the Green River Formation in its more western reaches, and intertongues more extensively farther east with the Hartt Cabin Member. Still farther east it is wedged out. The overlying Adobe Town Member rests unconformably upon the Kinney Rim Member in the west, and upon the Hartt Cabin bed of the Laney in the east. Thus a basin-wide discontinuity which terminated with the beginning of deposition of the Lower Brown SS of Granger (=Bed 569) separates the overlying Adobe Town Member from the underlying beds.

As rapidly as possible Roehler has published Geological Quadrangle Maps for the western side of the basin (Roehler 1973c; 1974a,b,c; 1975), but only two of them cover areas of Washakie Formation outcrops (1973c, 1975). The need to have the Green River Formation (with its oil potential) well understood, has given a priority status to those deposits. There has not been time to complete the detailed geologic mapping for quadrangles covering areas that have only outcroppings of the Washakie Formation, or other non-Green River deposits. To make matters worse from the standpoint of production of more Geologic Quadrangle maps of the Washakie Formation, priorities have shifted again and Roehler's attention is now focused on precise documentation of the Cretaceous coals in the Rock Springs uplift.

HISTORY OF EXPLORATION AND COLLECTING

Few Western areas received the attention of trained paleontologists earlier than did the Washakie Basin. Following the opening of the West, there was a period of investigation of the Western Territories by agencies of the U.S. Government. Among the earliest of these were the Hayden Surveys (1867–1878). Twelve Annual Re-

ports resulted from this work as well as a number of papers in "Miscellaneous Publications," "Bulletins," and a "Quarto Series." Seven of the Annual Reports (Preliminary Reports of Progress) contain some mention of the fossils or the geology of the area (Hayden, 1868, 1869, 1871, 1872, 1873, 1874, 1876). E. D. Cope was the paleontologist for these surveys. Volume III of the "Quarto Series" (Cope, 1884) was the first work to deal with the entire vertebrate fauna of the Washakie Formation, and it is still the most comprehensive treatment of the mammals. Earlier, in addition to his sections within the Hayden Reports of 1872 and 1873, Cope had published a number of short descriptive accounts of various elements of the fauna. For a time Cope was also affiliated with the Wheeler Survey. Most of Cope's extensive collections are now at the American Museum of Natural History.

Beginning early in the 1870's O. C. Marsh (1872a, b) also made a number of contributions based upon specimens from the Green River Basin. The chief work was his uintathere monograph, which includes Washakie Formation specimens. It was published in 1884 (but with U.S. Government Printing office dates of 1885 and 1886 on various copies — Field Museum copy bears 1886; Simpson (1945, p. 292) states that 1885 is probably correct). Unfortunately, a study of this fauna involves one with the Cope-Marsh feud. Aside from the disgraceful feud itself (see Wheeler, 1960, 1961; Romer, 1964), a number of undesirable results related to the rivalry ensued. Most troublesome are resultant problems of taxonomic priority (see Wheeler, 1961). Clearly, both men were guilty of bad publication practices, even for their day.

Marsh made collections for Yale during each year from 1872 through 1876 with a follow up in 1882. He was affiliated with the King and later Powell surveys. The extensive collections at Yale have been published upon by Earle, Matthew, Osborn, Troxell, Wheeler, and others besides Marsh, and the collections were supplemented by G. E. Lewis in 1938, W. Wheeler and P. Robinson in the mid- to late 1950's.

In 1875 Powell worked briefly at Salt Wells and Bitter Creek. In his report on the stratigraphy in 1876, he considered the beds which had been given the name Wasatch Group to be equivalent to the Bitter Creek Beds, and that the Washakie Group constituted the upper part of the Bitter Creek series. From his (p. 65) statements quoting Cope, it seems clear that the term Washakie Group referred to those beds currently designated as the Cathedral Bluffs tongue of

the Wasatch Formation for they are described as notable for their colors (especially brilliant cherry-reds), and as being overlain by the Green River beds. In any case, the term Bitter Creek group (or beds or series) has been considered outmoded since the work of Schultz (1920) and Sears (1924) and is no longer in use.

The King surveys studied the area of the 40th parallel during the late 1860's and early 1870's between the 104° and 120° meridians. In the report of this work (King, 1878) the Tertiary deposits are discussed at considerable length with the main emphasis on the Green River beds. Discussion of the Bridger (including Washakie) beds is restricted to 12 pages of text, most of which consist of descriptions of the development of badlands topography in both Green River and Washakie basins. The faunal lists appear to be referrable to the Green River Basin itself. Unfortunately, the map does not differentiate between the various Eocene strata as the text indicates was intended. Roehler (1973b), in commenting on King's work notes its accuracy and detail, and goes on to make an observation that because it has been overlooked, needs added emphasis. "In locating Bridger outcrops, King made two important observations that were missed by many geologists: (1) the beds composing the top of Haystack Mountain are not the uppermost Bridger (Washakie) strata in the basin; and (2) Bridger (Washakie) beds are present in the east slopes of the Kinney Rim." Hopefully between us, Roehler (1973b) and I will have put to rest the misconception, and will have shown the correctness of King's observations. A final comment on King's contribution has to do with one of the now antiquated locality names used by him: Washakie Mountain (p. 382). This I believe to be the equivalent of Cope's Mammoth Buttes, which in current usage (and for the past 70 years) has been termed Haystack Mountain. Cope considered Haystack Mountain to be the large terminal, eroded butte, haystack-like in appearance (fig. 3A) at the eastern end of the 7 mile arc of his Mammoth Buttes (fig. 3B—currently referred to as Haystack Mountain). Nothing would be gained by reviving either Cope's original or the King terms in the face of the fixed, long-established precedent; to do so would risk adding to the confusion.

In 1877 Princeton College began sending field parties (faculty and students) into the field in Colorado and Wyoming. Two of these student participants, H. F. Osborn and W. B. Scott, were destined to become famous paleontologists. In the 1878 season, and in a number of subsequent years, the Washakie Basin was explored, so that

FIG. 3. **A,** View (looking southeast) toward the terminal butte at the eastern end of Cope's "Mammoth Buttes" which he called Haystack Mountain or Butte.

B

FIG. 3. **B,** View (looking west) toward the 7 mile arc of the Mammoth Buttes of Cope. The entire elevated mass, including that shown in A, constitutes Haystack Mountain by modern usage.

Princeton, too, has a significant Washakie collection. As a result of this early introduction, Osborn and Scott, in addition to growing interests in other areas, continued to publish upon Washakie materials throughout most of their long careers (Osborn and Speir, 1879; Osborn and McMaster, 1881; Osborn, 1883, 1890, 1895, 1902, 1907, 1908, 1909, 1913, 1921, 1929; Scott and Osborn 1882, 1883; Scott, 1883, 1888, 1890, 1937). The Princeton tradition of field projects continued under Jepsen, but mainly in Big Horn and Wind River Basins, and one work (Morris, 1954) was concerned with the Cathedral Bluffs Tongue of the Wasatch Formation in the Washakie Basin.

Osborn's infectious interest and influence carried over, especially at the American Museum, where J. Wortman, W. Granger, and W. D. Matthew took up the cause with field assistance from P. Miller, G. Olsen, O. A. Peterson, J. W. Sinclair, and A. Johannsen, and others (Wortman & Matthew, 1899; Matthew, 1899, 1909a, b; Wortman, 1901; Granger 1909; Sinclair, 1909; Johannsen, 1914). World War I interrupted the effort and no definitive faunal report resulted, but by then the American Museum had amassed the most representative series of mammalian remains from the Washakie Formation within any one institution.

Peterson moved to the Carnegie Museum where he concentrated his efforts on the Uinta Basin, but he introduced J. L. Kay to the Bridger and Washakie Basins. Kay and his assistants collected extensively in both basins, beginning in the mid 1920's and continuing through the 1930's and into the mid 1940's. Carnegie's largest Washakie collections were made in 1941 (J. L. Kay, J. Clark, A. and R. Zangerl, A. Lewis, and H. Stoll), 1942 (Kay, Lewis, J. S. Swauger, and H. J. Clement), and 1946 (Clark, T. Harrison, and Lewis). Thus far only Wetmore (1944) and Zangerl (1944) have published on these materials, but this fine collection deserves further attention.

Workers at the U.S. Geological Survey have contributed greatly to our knowledge of the geology and stratigraphy of the basin's sediment deposits. Roehler (1973b) has covered the topic from the pre-survey days to the present. Since the pre-survey days, reports have not dealt primarily with fossils or collecting. A few basic works are: Bradley (1945, 1964), Sears (1924), and Schultz (1920). Bradley, perhaps more than anyone else, studied and knew the Green River Formation and adjacent deposits in the greatest detail. All three contributed greatly to form the modern understanding of the regional stratigraphic and geologic framework. Roehler and others of

this generation of workers are building upon that broad base of understanding.

At the U.S. National Museum, Gazin (1955, 1958, 1959, 1962, 1968, 1976) has been very actively documenting various Wasatchian and Bridgerian aged faunas, but he has not been extensively involved with many from the Washakie Basin. He did work the poorly productive Cathedral Bluffs Tongue in 1958, but did not work higher up in the section within the basin as far as I am aware.

Two other fine Washakie collections are those of the Universities of California (Berkeley) and Wyoming. The California materials were collected by M. McKenna in the early 1950's as a diversion from his major effort on the Four Mile, Wasatchian Fauna. Several of his helpers took part, but L. Kent is credited with the discovery and collection of many of the specimens, which are mostly from the Upper Washakie, from the south slopes of Haystack Mountain. The Berkeley collection, with its many titanothere specimens, nicely augments the other collections. The University of Wyoming materials have been accumulated over the past several decades as a result of the efforts of P. O. McGrew and his students, including Roehler. While not extensive, they too help to broaden the basis for our knowledge of the faunas.

Efforts in the Washakie Formation by parties from Field Museum began in 1947 and 1949 with R. Zangerl's collecting and study of the turtles and other reptiles, and it has continued with my work from 1956 to date. As a result, these collections are now among the most extensive, and they cover the entire range from sediments within the formation.

A primary aim during all of my work has been to collect systematically, in order to sample the full range of the stratigraphic sequence of beds of the Washakie Formation, and to cover as great and representative a portion of its spatial extent as possible. I have thus far avoided the faulted region in the southeast part of the basin. The long-known Washakie A and B levels ($Twka_{1,2}$, the greater part of the Adobe Town Member) have been by far the most productive. Included are three microfaunal localities among the 70 designated productive ones. The record from the six localities in the uppermost unit of the Adobe Town Member ($Twka_3$) is poor and thus far lacks taxa that are good time indicators. That from the Kinney Rim Member (Twkk) is also poor, but nevertheless the eight localities have yielded materials suggesting an Early Bridger assemblage.

The full locality listing is given in the Appendix.

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PLATES 1-5, pp. 588-592

A key to symbols is given for Plate 1. For Plates 2-5 the symbols for the units of the Washakie Formation and for the Browns Park Formation are the same as in Plate 1; the other formations and units are keyed as follows:

Tgl=Tertiary, Green River Group, Laney Fm. (undifferentiated)

Tglh=Tertiary, Green River Group, Laney Fm., Hartt Cabin Member

Tgls=Tertiary, Green River Group, Laney Fm., Sand Butte Member

Tgll=Tertiary, Green River Group, Laney Fm., LaClede Shale Member

Twc=Tertiary, Wasatch Fm., Cathedral Bluffs Tongue

Tgw=Tertiary, Green River Group, Wilkins Peak Fm.

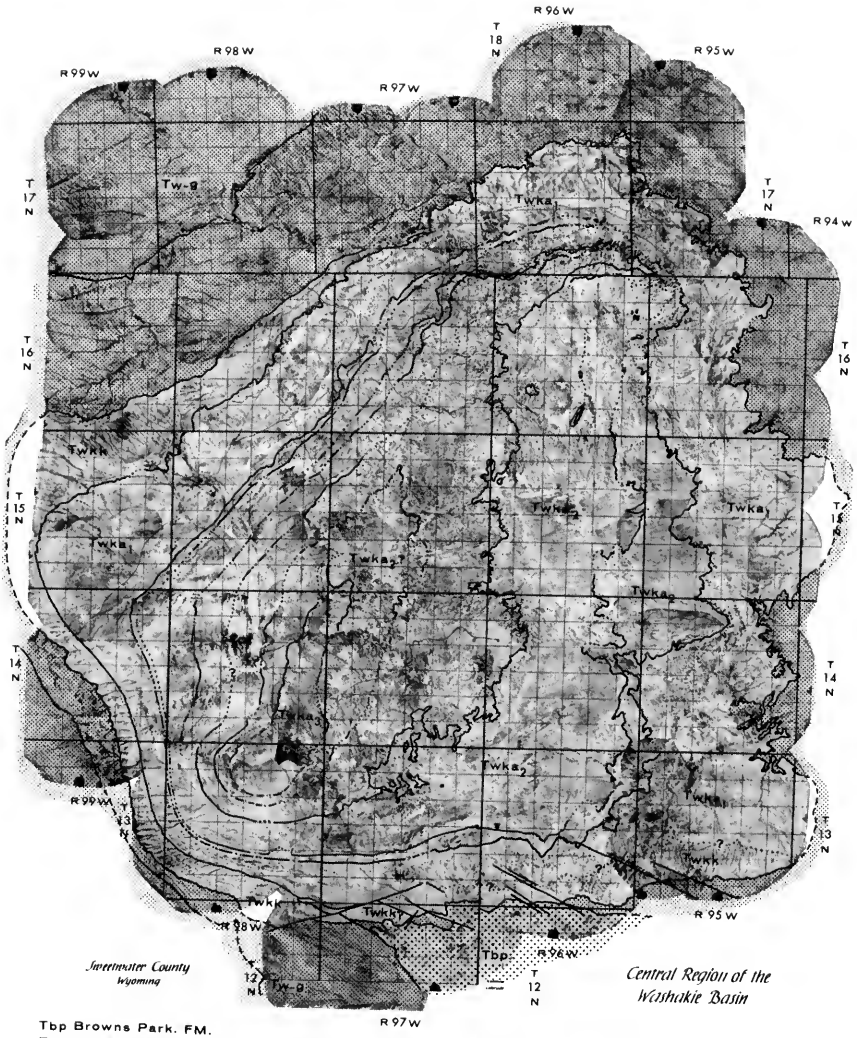
Tgt=Tertiary, Green River Group, Tipton Shale Fm.

Twn=Tertiary, Wasatch Fm., Niland Tongue

Tglu=Tertiary, Green River Group, Lumen Fm.

Twm=Tertiary, Wasatch Fm., main body

Bed number designations 257 through 644 correspond to those of Roehler 1973b, 1973c, and 1975.



Tbp Browns Park. FM.
$Twka_3$ Washakie FM., Adobe Town Mamb. (Uinta C-D equivalent)
$Twka_2$ Washakie FM., Adobe Town Memb. (Old Upper Washakie)-Uinta A-B
$Twka_1$ Washakie FM., Adobe Town Memb. (Old Lower Washakie)-Brider C-D)
Twkk Washakie FM., Kinney Rim Memb. (Bridger A-B)
Tw-g Wasatch & Green River FMS.

PLATE 1.

NW QUADRANT

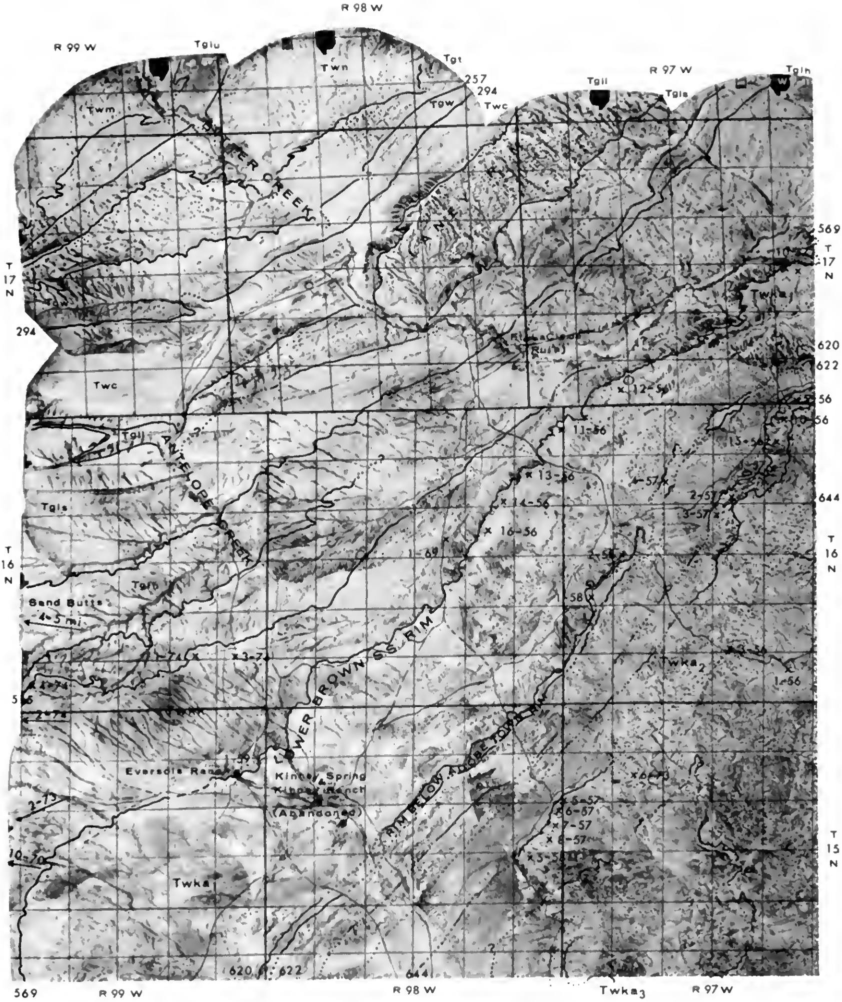


PLATE 2.

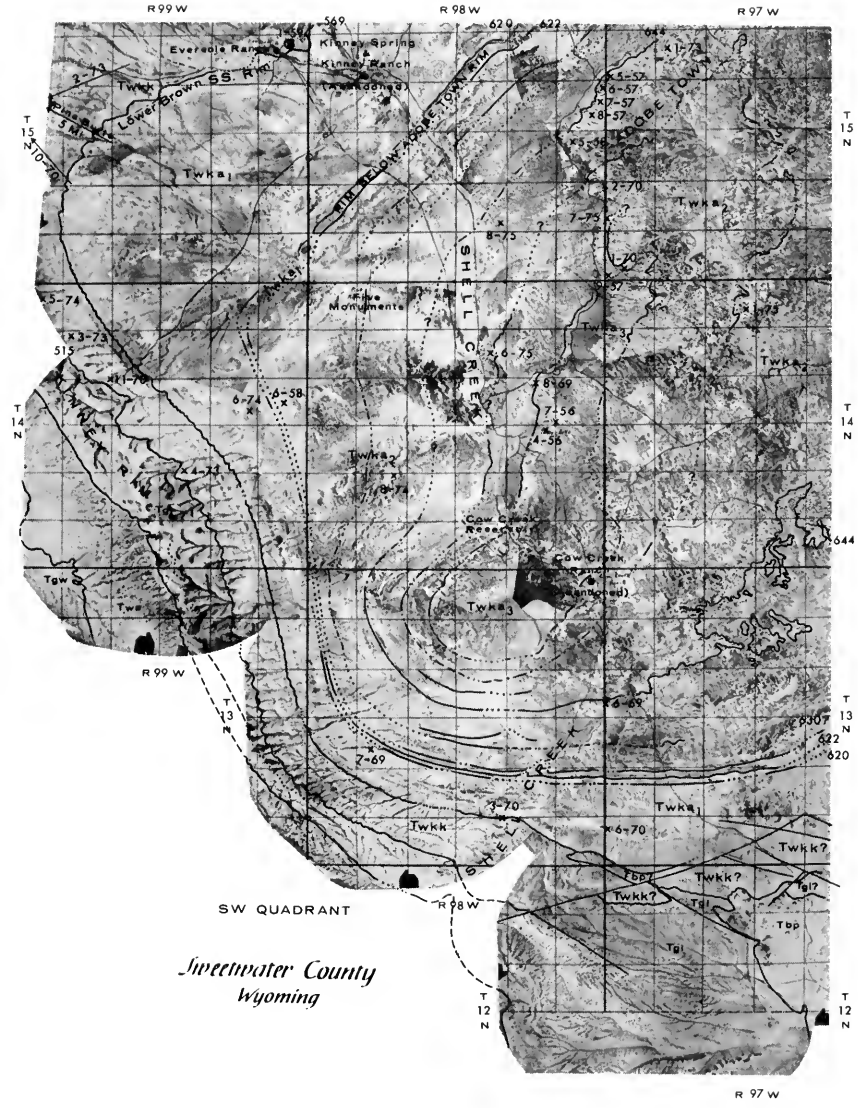

R 99 W
R 98 W
R 97 W
T 15 N
T 14 N
T 13 N
T 12 N
Everette Ranch
Kinney Spring
Kinney Ranch
(abandoned)
Lower Brown SS. Rd.
Twkk
Twka1
Twka2
Twka3
Twkk?
Tbp
Tgl
Tgl?
Twe
Tgw
Fire Monuments
Cow Creek Reservoir
Cow Creek Ranch
(abandoned)
SHELL CREEK
SW QUADRANT
Sweetwater County
Wyoming

PLATE 3.

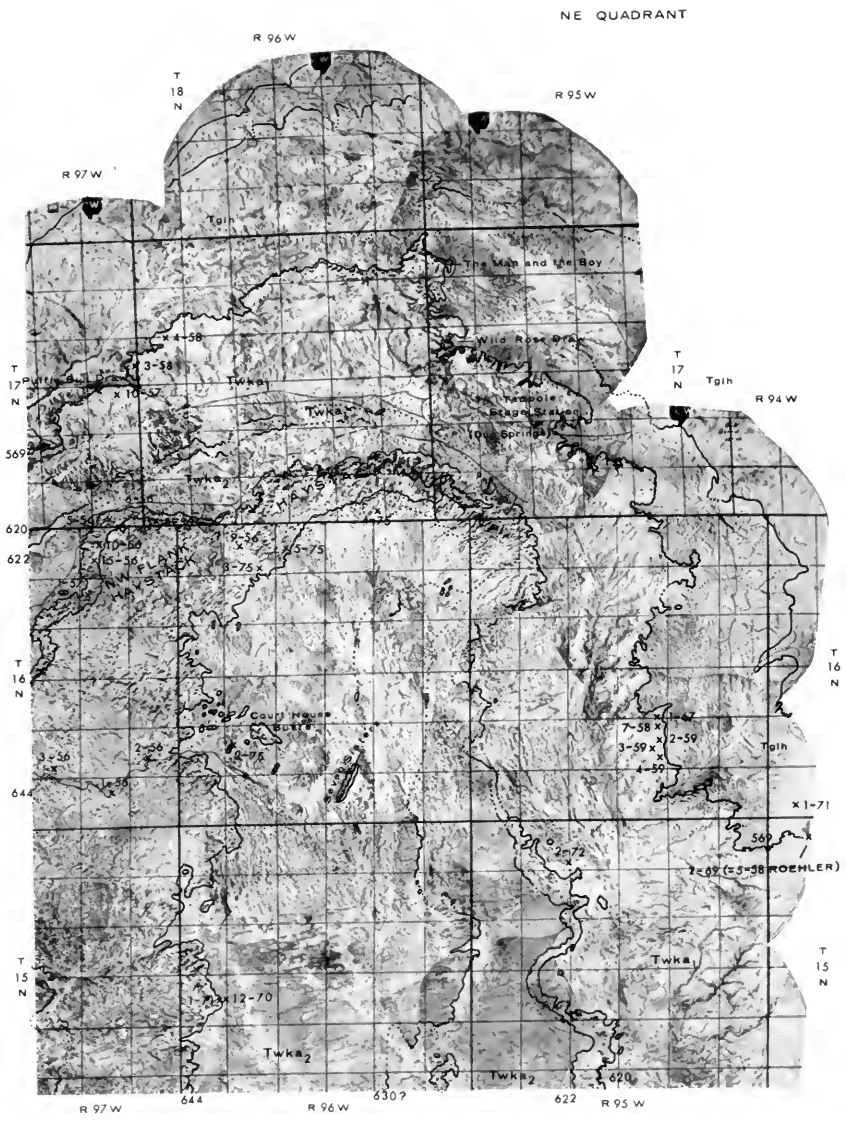
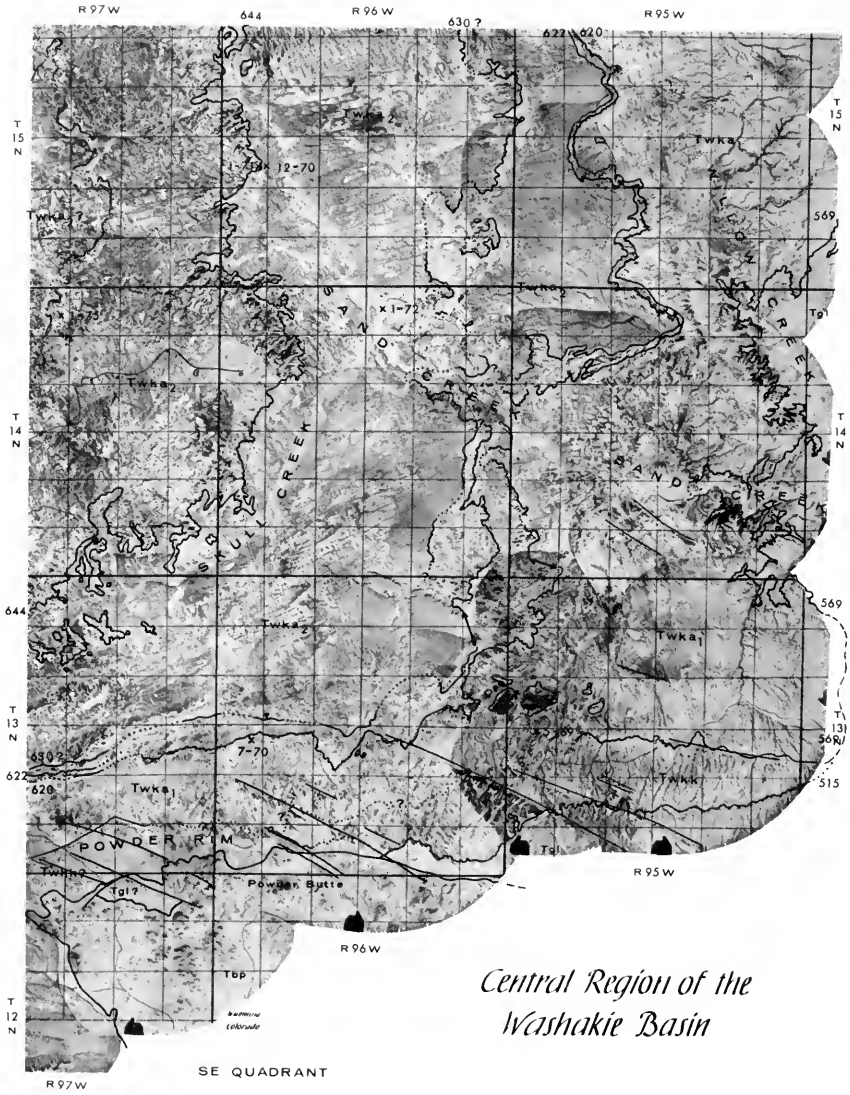

NE QUADRANT
R 96 W
R 95 W
R 97 W
R 94 W
T 18 N
T 17 N
T 16 N
T 15 N
Tglh
The Man and the Boy
Wild Rose Draw
Trapole Stage Station
Twka1
Twka2
Court House Butte
Twka1
Twka2
Twka2
Tglh
ROEHLER
644
630?
622
620
569
R 97 W
R 96 W
R 95 W

PLATE 4.



Central Region of the Washakie Basin

PLATE 5.

APPENDIX

Field Museum, Washakie Formation localities.
(Bracketed descriptions pertain to USGS topographic sheets. These are used when there is a difference from my air photo reference. Most post-1970 localities are so designated.)

Adobe Town Member, upper unit (beds 676-708) $Twka_3$:

FM – 4-56 – WDT NE¼, NE¼, sec. 23, T14N, R98W.

FM – 7-56 – WDT Within 150 yards of section corner between sections 13, 14, 23, and 24, T14N, R98W.

FM – 9-57 – WDT SW¼, sec. 31, T15N, R97W and SE¼, sec. 36, T15N, R98W.

FM – 8-69 – WDT E½, sec. 14, T14N, R98W.

FM – 1-70 – WDT SE 2/3 of S½, sec. 31, T15N, R97W.

FM – 7-75 – WDT SE¼, NE¼, sec. 25, T15N, R98W, and SW¼, NW¼, sec. 30, T15N, R97W.

Adobe Town Member, middle unit (beds 622 - 675) $Twka_2$ (old upper Washakie or Washakie B)

FM – 1-56 – WDT N½, sec. 35, T16N, R97W.

FM – 2-56 – WDT SW¼, sec. 25, T16N, R97W.

FM – 3-56 – WDT S½, sec. 27, and N½, sec. 34, T16N, R97W.

FM – 4-56 – WDT NE¼, NE¼, sec. 23, T14N, R98W.

FM – 5-56 – WDT SW¼, sec. 36, T17N, R97W.

FM – 6-56 – WDT SE¼, sec. 36, T17N, R97W.

FM – 7-56 – WDT Area within 150 yd. of section corner between sections 13, 14, 23, and 24, T14N, R98W.

FM – 8-56 – WDT S½, SW¼, sec. 31, T17N, R96W, and SE¼, SE¼, sec. 36, T17N, R97W.

FM – 9-56 – WDT NE¼, sec. 5, T16N, R96W, and SW¼, sec. 33, and W½, sec. 34, T17N, R96W.

FM – 10-56 – WDT N½, sec. 2, T16N, R97W.

FM – 15-56 – WDT SW¼, sec. 2, T16N, R97W.

FM – 1-57 – WDT W½, sec. 11 and NE¼, sec. 10, T16N, R97W.

FM – 2-57 – WDT S½, sec. 10, T16N, R97W.

FM – 3-57 – WDT N½, sec. 15, T16N, R97W.

FM – 5-57 – WDT SE¼, sec. 12, T15N, R98W, and S½, sec. 7, T15N, R97W.

FM – 6-57 – WDT N½, NE¼, sec. 13, T15N, R98W.

FM – 7-57 – WDT S½, NE¼, sec. 13, T15N, R98W.

FM – 8-57 – WDT S½, sec. 13, T15N, R98W, and SW¼, sec. 18, T15N, R97W.

FM – 5-58 – WDT S¼, sec. 13 and N½, sec. 24, T15N, R98W.

FM – 6-58 – WDT NW¼, sec. 18, T14N, R98W.

FM – 6-69 – WDT S½, sec. 18, T13N, R97W.

FM – 8-69 – WDT E½, sec. 14, T14N, R98W.

FM – 2-70 – WDT SE¼, sec. 24 and NE¼, sec. 25, T15N, R98W, and N½, sec. 30, T15N, R97W.

FM – 12-70 – WDT center of E¼, sec. 19, T15N, R96W.

FM – 1-71 – WDT center of sec. 19, T15N, R96W.

FM – 1-72 – WDT W½, sec. 3, T14N, R96W.

FM – 6-73 – WDT center of sec. 8, T15N, R97W.

FM – 6-74 – WDT [center SE¼, sec. 14, T14N, R99W].

FM – 8-74 – WDT [area near corner between sections 20, 21, 28, and 29, T14N, R98W].

FM – 1-75 – WDT [N½, SE¼, sec. 4, T14N, R97W].

FM – 2-75 – WDT [SW¼, NW¼, sec. 29, T16N, R96W].

FM – 3-75 – WDT [S½, sec. 5, T16N, R96W].

FM – 4-75 – WDT [near (½ mile N of) junction of sections 35, 36 in T17N, R96W, and secs. 2 and 3 of T16N, R96W].

FM – 5-75 – WDT [W½, NW¼, sec. 4, T16N, R96W].

FM – 6-75 – WDT [E½, sec. 10, T14N, R98W].

FM – 8-75 – WDT [SE¼, sec. 27, SW¼, sec. 26, T15N, R98W].

Adobe Town Member, lower unit (beds 569-621) $Twka_1$ (old lower Washakie or Washakie A):

FM – 11-56 – WDT N½, sec. 6, T16N, R97W, and N½, sec. 1, T16N, R98W, [SE 1/3, sec. 1, T16N, R98W, and NW½, sec. 6, T16N, R97W].

FM – 12-56 – WDT SE½, sec. 32, and NW½, sec. 33, T17N, R97W.

FM – 13-56 – WDT NW½, sec. 12, T16N, R98W.

FM – 14-56 – WDT SE½, sec. 11, T16N, R98W.

FM – 16-56 – WDT most of sec. 14, T16N, R98W.

FM – 4-57 – WDT E½, sec. 8, and W½, sec. 9, T16N, R97W.

FM – 10-57 – WDT N½, sec. 24, and E½, sec. 23, T17N, R97W, and NW¼, sec. 19, T17N, R96W.

FM – 1-58 – WDT S½ and NE¼, sec. 19, T16N, R97W.

FM – 2-58 – WDT NE¼, sec. 19, NW¼, sec. 20, and SW¼, sec. 17, T16N, R97W.

FM – 3-58 – WDT E½, sec. 13, T17N, R97W and most of sec. 18, T17N, R96W.

FM – 4-58 – WDT SE½, sec. 7, and N¼, sec. 18, T17N, R96W.

FM – 7-58 – WDT NE¼, sec. 7, T16N, R95W.

FM – 1-59 – WDT NW¼, sec. 12, T15N, R99W.

FM – 2-59 – WDT SE¼, NE¼, sec. 27, T16N, R95W.

FM – 3-59 – WDT W½, E½, sec. 27, T16N, R95W.

FM – 4-59 – WDT E½, SE¼, sec. 27 and edge of SW¼, sec. 26, T16N, R95W.

FM – 1-67 – WDT SE¼, sec. 22, T16N, R95W.

FM – 2-69 – WDT NE¼, sec. 6, T15N, R94W.

FM – 5-69 – WDT S½, sec. 18 and N½, sec. 19, T13N, R95W.

FM – 7-69 – WDT SW½, sec. 20, NW¼, sec. 29, NE¼, sec. 30, T13N, R98W.

FM – 3-70 – WDT SW¼, sec. 26, SE¼, sec. 27, NE¼, sec. 34 and NW¼, sec. 35, T13N, R98W.

FM – 6-70 – WDT NW¼, sec. 31, [SW¼, sec. 31] T13N, R97W.

FM – 7-70 – WDT NE¼, sec. 19, T13N, R96W.

FM – 2-72 – WDT ? sec. 5, T15N, R95W.

Kinney Rim Member (beds 515-568) Twkk

FM – 1-69 – WDT SE¼, sec. 15, T16N, R98W [N central part of sec. 22 and extreme S. central part of sec. 15].

FM – 10-70 – WDT [SW¼, sec. 18, NW¼, sec. 19, T15N, R99W].

FM – 11-70 – WDT [SE¼, sec. 8, NW¼, sec. 16, NE¼, sec. 17, T14N, R99W].

FM – 2-73 – WDT [W½, sec. 18 and SW¼, sec. 7, T15N, R99W].

FM – 3-73 – WDT [area around corner between secs. 5, 6, 7, and 8 and extending into center of sec. 8, T14N, R99W].

FM – 4-73 – WDT [NE¼, center, and SE¼, sec. 16 and NE¼, sec. 21 and NW¼, sec. 22, T14N, R99W].

FM – 1-74 – WDT [S½, sec. 26, T16N, R99W].

FM – 2-74 – WDT [about on section line between 36, T16N, R100W, and sec. 1, T15N, R100W, several hundred yards E of quarter section corner at head of Carr Creek].

FM – 3-74 – WDT [S½, sec. 25, T16N, R99W].

FM– 4-74 – WDT [NW¼, NW¼, sec. 32, and SE¼. SE¼, sec. 29, T16N, R99W].

FM – 5-74 – WDT [SW¼, SE¼, sec. 6 and NW¼, sec. 6, T14N, R99W].

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