Stratigraphic Divisions and Geologic History of the Laney Member of the Green River Formation in the Washakie Basin in Southwestern Wyoming

GEOLOGICAL SURVEY BULLETIN 1372-E

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By HENRY W. ROEHLER

CONTRIBUTIONS TO STRATIGRAPHY

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The Laney Member is divided into the Hartt Cabin, Sand Butte, and LaClede Beds

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CONTENTS

ILLUSTRATIONS

CONTRIBUTIONS TO STRATIGRAPHY

STRATIGRAPHIC DIVISIONS AND GEOLOGIC HISTORY OF THE LANEY MEMBER OF THE GREEN RIVER FORMATION IN THE WASHAKIE BASIN IN SOUTHWESTERN WYOMING

By HENRY W. ROEHLER

ABSTRACT

The Laney Member, formerly the Laney Shale Member, of the Eocene Green River Formation in the Washakie Basin in southwestern Wyoming is herein divided into three new rock-stratigraphic units: a basal oil-shale section named the LaClede Bed; a middle wedge of tuffaceous sandstone and siltstone named the Sand Butte Bed; and an upper sequence mainly of mudstone alternating with sandstone, limestone, and shale named the Hartt Cabin Bed. The fossil and stratigraphic records indicate that the LaClede Bed was deposited in Lake Gosiute in the early middle Eocene during a stage when the lake had great areal extent, that the introduction of air-laid volcanic ash later in the early middle Eocene initiated a southeastward retreat and shallowing of the lake during the deposition of the Sand Butte Bed, and that the lake dried up and disappeared near the end of the middle Eocene during the deposition of the Hartt Cabin Bed. The thickness, areal distribution, stratigraphic relations, age, and geologic histories of the beds are discussed and illustrated in a cross section and by maps, and the lithologies are described in type sections.

INTRODUCTION

Since 1968, I have investigated the Green River Formation in southwestern Wyoming as part of a program by the U.S. Geological Survey to evaluate oil-shale deposits located on federally owned lands. Geologic mapping and stratigraphic studies of oil bearing shales in the Washakie Basin have shown that the Laney Shale Member of the Green River Formation, called in this report

the Laney Member, can be divided into three rock-stratigraphic units: a basal 150- to 500-foot-thick sequence that is mainly oil shale, a middle 0- to 900-foot-thick wedge that is mainly tuffaceous siltstone and sandstone, and an upper 0- to 700-foot-thick heterogeneous sequence that is mainly mudstone, alternating with sandstone, limestone, and shale. In ascending order, these units are herein named the LaClede Bed, the Sand Butte Bed, and the Hartt Cabin Bed. The three beds have dissimilar lithologies, diverse geologic histories, and partly unconformable contacts, and the oil shale in the LaClede Bed is a valuable resource; these facts make it desirable to recognize these units formally and to map each one separately.

NOMENCLATURE

The Laney Member was named the Laney Shale Member by Schultz (1920, p. 27) for exposures of "white and green shale, limestone and sandstone" along Laney Rim, a large ridge that parallels the northern part of the Washakie Basin. (See geologic map, fig. 1.) Schultz (1920, p. 27–28) reported that in the basin the Cathedral Bluffs Tongue of the Green River Formation (now placed in the Wasatch Formation) is overlain nearly everywhere by "fine, fissile Laney shales, 100 to 800 feet thick, which in turn is capped in places, as at Pine Bluffs [Pine Buttes], by reddish or cream-colored coarse-grained sandstone that is probably equivalent to the Tower sandstone." (The fine, fissile shales are now classified "oil shale.") Schultz (1920, p. 25) referred the rocks overlying the Tower Sandstone to the plant beds, a unit that was previously recognized by Powell (1876) along the crest of White Mountain in the Green River Basin about 40 miles west of the Washakie Basin. On a geologic map at the scale of 1:250,000, Schultz (1920, pl. 1) included the Tower Sandstone and plant beds in the Laney Shale Member in the Washakie Basin, but he showed a dashed and queried contact nearly everywhere for the Laney Shale Member with the overlying Bridger Formation. The LaClede Bed, Sand Butte Bed, and Hartt Cabin Bed are believed to correspond, respectively, to the Laney Shale Member, Tower Sandstone, and plant beds of Schultz, as he recognized them in the Washakie Basin; but subsequent stratigraphic revisions make the names as they were applied by him unusable.

Bradley (1945; 1959) made several nomenclatural changes for the Green River Formation in southwestern Wyoming. On a 1945 geologic map of the Washakie Basin at the scale of about 1:200,000, he recognized the Tower Sandstone (fig. 1), but he substituted the name Morrow Creek Member for the combined

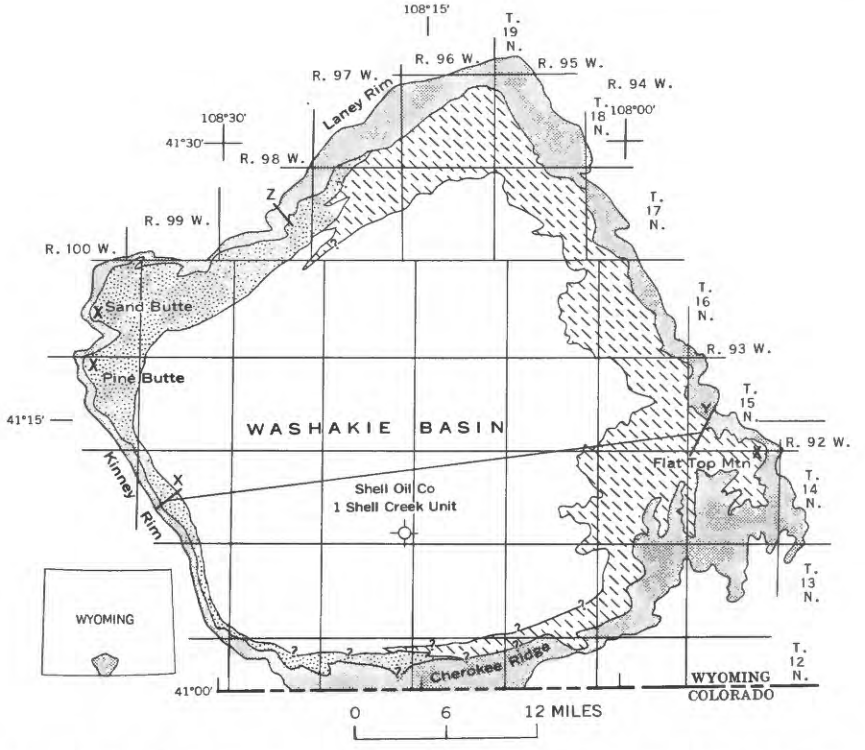

FIGURE 1.—Geologic map showing the areal distribution of the LaClede (shaded), Sand Butte (dotted), and Hartt Cabin (dashed). Beds of the Laney Member in the Washakie Basin. X, type section for the Sand Butte Bed; Y, type section for the Hartt Cabin Bed; and Z, type section for the LaClede Bed. X–Y, line of section shown in figure 3.

plant beds and Tower Sandstone of Schultz (1920); he retained Laney Shale Member for the basal oil-shale beds. On the 1945 map, Bradley explained that "around the Washakie basin the Laney shale member and the overlying Morrow Creek member of the main body of the Green River formation were not mapped separately." In 1959, Bradley (p. 1074) abandoned the name Morrow Creek Member (he believed the Morrow Creek Member in the Green River Basin was the rock-stratigraphic equivalent of the Laney Shale Member in the Washakie Basin), and he placed all the beds lying between the Cathedral Bluffs Tongue and the Bridger Formation (or Washakie Formation in the Washakie Basin) in the Laney Shale Member.

The name Tower Sandstone was abandoned as a formal stratigraphic term by Culbertson (1962, p. C54).

The Laney Shale Member has been divided into three beds in the Washakie Basin in preference to other nomenclatural alternatives because the term Laney Shale Member as it was inclusively applied by Bradley (1959) is now widely accepted for use in the adjacent Green River and Great Divide Basins in southwestern Wyoming and in the Sand Wash Basin in northwestern Colorado. However, inasmuch as the type locality of the Laney Shale Member is in the Washakie Basin and as the rocks to which the name is now applied are not exclusively shale, it is here proposed that the word "shale" be dropped and that the unit be henceforth named the Laney Member of the Green River Formation.

Changes in the nomenclature of the Laney Member in the Washakie Basin are shown in a correlation chart (fig. 2).

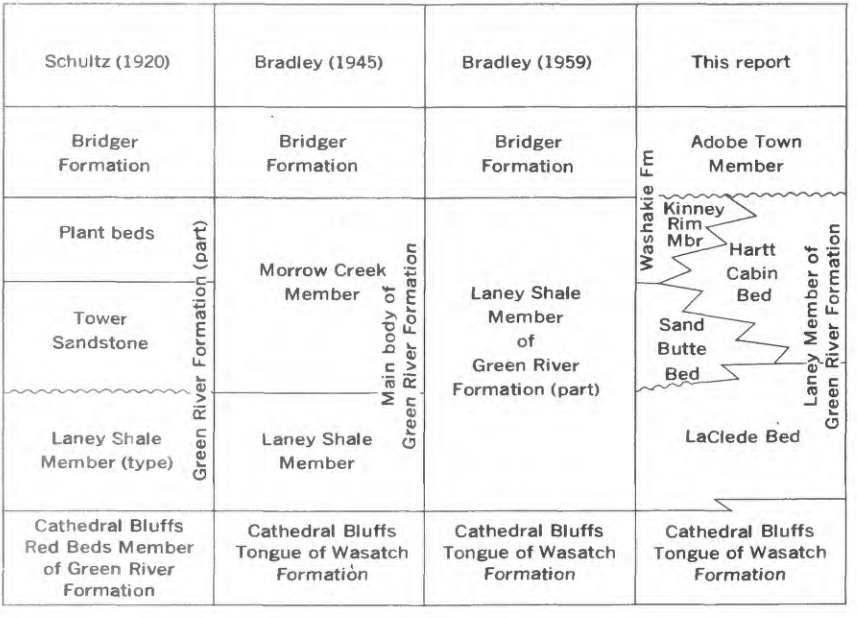

FIGURE 2.—Nomenclatural correlation chart for the Laney Member of the Green River Formation and adjacent formations in the Washakie Basin.

LANEY MEMBER OF THE GREEN RIVER FORMATION

Outcrops of the Laney Member encircle the Washakie Basin in a band of brown-, gray-, and tan-weathering ridges and valleys that is 3–10 miles wide. The outer boundary of the outcrop band describes an unevenly circular area nearly 40 miles in diameter. In most places the outer beds, the basal part of the member, weather

to drab rims above red beds of the upper part of the Cathedral Bluffs Tongue of the Wasatch Formation. The largest of these rims, Laney Rim, in the northern part of the basin, and its counterpart, Kinney Rim, in the western part of the basin, stand several hundred feet high. They slope gently basinward across minor ridges and valleys to the contact of the upper part of the Laney with the overlying Washakie Formation in the interior of the basin. The Laney Member varies in thickness from 900 to 1,200 feet in the western part of the basin, where the LaClede and Sand Butte Beds are present, and from 500 to 900 feet in the eastern part of the basin, where the LaClede and Hartt Cabin Beds are present. The member has a maximum known thickness of about 1,800 feet in the vicinity of the Shell Oil Co. 1 Shell Creek Unit dry hole located in the south-central part of the basin. The location of this dry hole and the areal distribution of the named beds composing the Laney Member are shown in figure 1. Intertonguing, thickness, and lithologic relations of the LaClede, Sand Butte, and Hartt Cabin Beds of the Laney Member are shown in a west-east section across the basin (fig. 3).

LACLEDE BED

The name LaClede Bed of the Laney Member is here proposed for a sequence 145–455 feet thick, mainly of oil shale, that overlies the Cathedral Bluffs Tongue of the Wasatch Formation in the Washakie Basin. The LaClede Bed is typically exposed along Laney Rim north of the ruins of LaClede Stage Station on the Overland Trail, which are located in the NE¼ sec. 26, T. 17 N., R. 98 W. The LaClede Bed is generally well exposed in a band of outcrops that varies in width from less than 1 mile to more than 5 miles; this band encircles the Washakie basin (fig. 1). The bed characteristically weathers to tan and drab brown sparsely vegetated ridges that have gentle dipslopes on the basin side and steep, commonly cliff-forming slopes on the outward-facing side.

The LaClede Bed is composed of at least 70 percent tan to dark-brown finely varved oil shale. Interbedded with the oil shale are beds of tan tuffaceous siltstone and sandstone and minor thin beds of tan oolite, algal limestone, and ostracodal limestone. Laminae of gray coarsely crystalline analcime and gray acicular calcite are common along the west margin of the basin. The oil shale is classified as marlstone by some geologists; however, the term "shale" seems more appropriate inasmuch as the rock is generally fissile to papery; the composition of most of it is no more than 20 percent calcite and dolomite, and it does not readily effervesce in cold dilute hydrochloric acid. Oil yields of weathered

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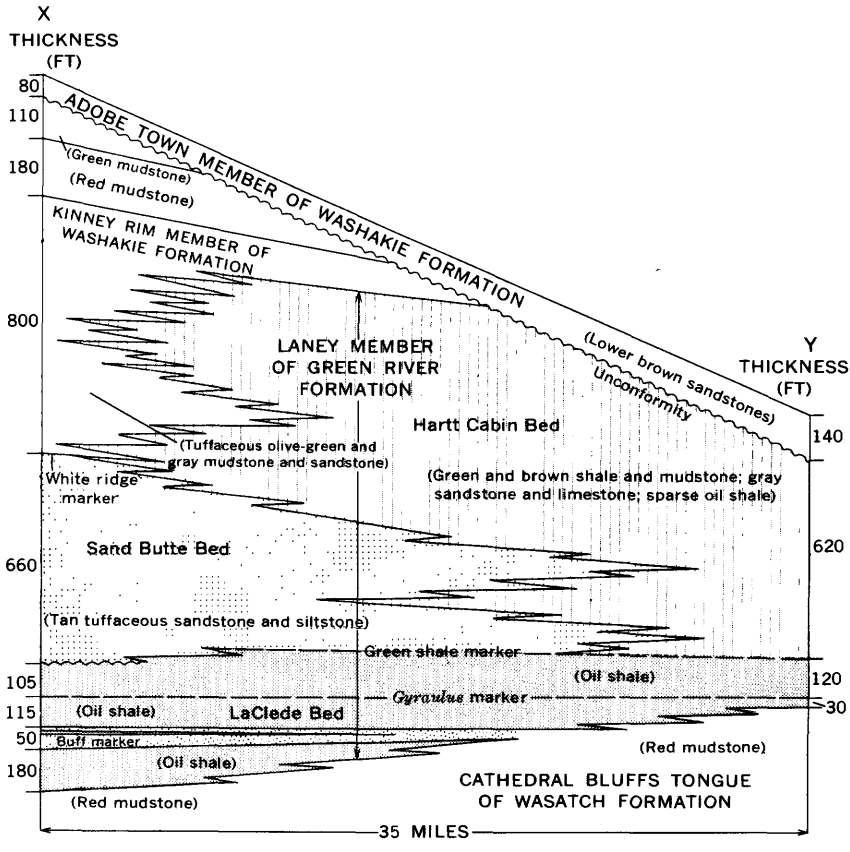

FIGURE 3.—Generalized west-east restored section of the Laney Member of the Green River Formation across the Washakie Basin showing thickness, intertonguing, and unconformable relations of the LaClede, Sand Butte, and Hartt Cabin Beds. The section was constructed from stratigraphic sections X and Y, measured on the west and east edges of the Washakie Basin, respectively, and from subsurface data not shown. The line of section X–Y is shown on the geologic map, figure 1.

oil-shale samples from the rocks called here the LaClede Bed in sec. 18, T. 14 N., R. 99 W., in the southwestern part of the basin, were listed and discussed by me previously (Roehler, 1969, fig. 5, p. 205–206). Facies distributions of montmorillonite and zeolites in the LaClede Bed that were believed to relate to the paleogeography and paleosalinity of Lake Gosiute were also previously described (Roehler, 1972a).

Oil shale and other lacustrine rocks in the lower 350 feet of the LaClede Bed intertongue eastward across the basin with fluviatile red, green, and gray mudstone and gray sandstone that

compose the upper part of the Cathedral Bluffs Tongue of the Wasatch Formation (fig. 3). As here defined, the contact of the LaClede Bed and the Cathedral Bluffs Tongue is the base of the lowermost oil shale in the LaClede Bed. When the contact is thus positioned, thin lacustrine algal limestone and oolite that normally characterize the basal part of the LaClede Bed may at a few places be included in the upper part of the Cathedral Bluffs Tongue.

The LaClede Bed has within it three important stratigraphic markers. Two of these, called informally the buff marker and the green shale marker, are easily recognized in outcrops by their distinctive colors. The buff marker (figs. 3, 4) varies in thickness from about 6 to 66 feet in outcrops along the western part of the Laney Rim and along Kinney Rim (fig. 1). Composed of tan tuffaceous siltstone, the buff marker commonly weathers to a light-buff band within darker weathering oil-shale strata. The buff marker thins eastward across the basin and grades into the Cathedral Bluffs Tongue of the Wasatch Formation, losing its distinctiveness as a lithologic unit. The green shale marker, 7–20 feet thick, is composed of dark-green fissile to flaky clay shale or, locally, dark-green blocky mudstone. A yellow-brown silty dolomite less than 1 foot thick is commonly present near its center. The green shale marker constitutes the uppermost bed in the LaClede Bed in the eastern part of the Washakie basin. The third marker is a 3-inch to nearly 1-foot-thick bed of light-tan-gray limy siltstone that contains a small, low-spired gastropod, *Gyraulus militarus*, and sparse unidentified ostracodes. Small pebbles of the *Gyraulus* marker are found in talus that commonly covers slopes on weathered surfaces of the upper part of the LaClede Bed. The *Gyraulus* marker has been identified in outcrops everywhere in the basin, except in the poorly exposed rocks in northeastern part.

SAND BUTTE BED

The name Sand Butte Bed is proposed in this report for tuffaceous sandstone and siltstone that cap Kinney Rim in the western part of the Washakie Basin. The lower part of the bed is particularly well exposed on Sand Butte, a part of Kinney Rim, and from this feature in sec. 21, T. 16 N., R. 100 W., the bed takes its name.

The Sand Butte Bed has a maximum thickness of nearly 900 feet along Antelope Creek in Tps. 16 and 17 N., R. 99 W., in the northwestern part of the basin, but it thins and wedges out southeastward across the basin, partly by stratigraphic thinning and

partly by intertonguing with the LaClede and Hartt Cabin Beds (fig. 3). A pronounced eastward thinning and wedging out of the bed is apparent on aerial photographs of the northern part of the basin in Tps. 17 and 18 N., R. 97 W.

The Sand Butte Bed is composed of at least 90 percent gray to brown tuffaceous sandstone and siltstone along Kinney Rim and along the western part of Laney Rim. The remaining parts of the bed are composed of thin beds of gray coquinal siltstone and coquinal sandstone, gray partly coquinal limestone, tan and gray algal limestone, light-gray to tan-gray tuff, gray to brown shale, brown oil shale, and gray and green mudstone. The Sand Butte Bed weathers overall to tan brown.

The contact between the Sand Butte Bed and the underlying LaClede Bed is unconformable in the outcrops on the west side of the basin (Schultz, 1920, p. 26 and pl. IV–B) ; as much as 350 feet of the LaClede Bed was eroded before the deposition of the Sand Butte Bed. Maximum erosion on this surface is in sec. 31, T. 17 N., R. 99 W., where thick tuffaceous sandstone and siltstone beds occupy channels scoured into the buff marker in the LaClede Bed. The unconformity apparently dies out eastward across the basin; no discordance has been noted in laterally equivalent beds that crop out along the east side of the basin.

The contact of the Sand Butte Bed and the Hartt Cabin Bed changes stratigraphic position across the basin because the beds are intertongued; it is arbitrarily located where dominantly tuffaceous sandstone and siltstone that compose the Sand Butte Bed change to dominant shale, mudstone, sandstone, and limestone that compose the Hartt Cabin Bed. Vertical cutoffs are used at the wedging out of the major tongues.

Where the Sand Butte Bed is overlain by the Kinney Rim Member of the Washakie Formation, the two units are transitional through an interval 100–300 feet thick in which fluvial olive-green mudstone and gray crossbedded sandstone characteristic of the Kinney Rim Member are interbedded with beds of lacustrine gray sandstone and gray limestone characteristic of the Sand Butte Bed. The contact is arbitrarily placed within the transitional sequence at the base of a persistent and easily recognized bed of light-gray limy tuff informally called the white ridge marker. This tuff bed weathers chalky white and caps ridges on the lower east slopes of Kinney Rim and along the south slopes of Laney Rim.

HARTT CABIN BED

The name Hartt Cabin Bed is proposed for a sequence of interbedded sandstone, siltstone, mudstone, shale, oil shale, tuff, lime-

stone, and dolomite that compose the uppermost stratigraphic unit of the Laney Member in the Washakie Basin. The Hartt Cabin Bed is well exposed and is 625 feet thick near the head of Hartt Cabin Draw in the northwestern part of T. 14 N., R. 93 W., and from there eastward to the slopes of Flat Top Mountain in T. 14 N., R. 93 W., and T. 15 N., R. 93 W. In most other places in the Washakie Basin, the Hartt Cabin Bed is not well exposed. Along the northern and eastern parts of the basin it weathers to flat plains that are generally covered by sand dunes and alluvial deposits interrupted locally by low sandstone ridges and small areas of badlands. Along Cherokee Ridge in the southern part of the basin the bed is poorly exposed in fault blocks that place it in juxtaposition with either the Washakie Formation or the Browns Park Formation. The bed is laterally equivalent to the Kinney Rim Member of the Washakie Formation and the Sand Butte Bed of the Laney Member (figs. 1, 3).

The Hartt Cabin Bed rests conformably upon the LaClede Bed in the eastern part of the basin. In that area, the contact of the two units is placed at the top of the green shale marker. At this horizon, underlying strata in the LaClede Bed weather drab brown, and overlying strata in the Hartt Cabin Bed weather chalky gray brown. The contact of the Hartt Cabin Bed with the overlying Adobe Town Member of the Washakie Formation is unconformable along the eastern edge of the basin, where 300–500 feet of the Hartt Cabin Bed was eroded before the Adobe Town was deposited (fig. 3).

Where the upper part of the Hartt Cabin Bed intertongues with the laterally equivalent Kinney Rim Member in a north-south band across the basin (figs. 1, 3), the contact of these units is arbitrarily placed at stratigraphic levels where the rocks change from fluvial olive-green and gray mudstone and sandstone (the Kinney Rim Member) to lacustrine green and brown shale and mudstone and gray sandstone and limestone (the Hartt Cabin Bed). Vertical cutoffs are used at the wedging out of major tongues, but in local areas where the intertonguing is complex and unmappable, minor thin tongues of one or the other unit are included within the unit that has the dominant lithology.

AGE

The Laney Member is of middle Eocene age, as determined by dating of fossil mammals. Although I have found fossil mammals at only one locality within the member, in a black chert layer near the base of the Hartt Cabin Bed in the northeastern part of the basin in the SE¼ sec. 36, T. 18 N., R. 95 W. (USGS

Fossil Vertebrate Catalog No. D777), fossils are abundant in the overlying Washakie Formation (Roehler, 1972b), and they are occasionally found in the underlying Cathedral Bluffs Tongue of the Wasatach Formation (Morris, 1954). The fossils indicate that the Laney Member in the Washakie Basin is Bridger A–B (Wood and others, 1941) in the lower part and Bridger C-D (Wood and others, 1941) in the upper part. The fossil dating, moreover, indicates that Lake Gosiute, in which the Laney Member was deposited, dried up in the Washakie Basin area, and probably throughout southwestern Wyoming, in the late middle Eocene.

ELECTRIC-LOG CORRELATIONS

Electric-log correlations of beds within the Laney Member in the Washakie Basin are difficult to make, partly because oil and gas test wells are sparse and widely spaced and partly because of abrupt thickness changes and intertonguing of units. An electric log that illustrates resistivity curves generally typical of the member was recorded in the Shell Oil Co. 1 Shell Creek Unit well (fig. 4). Oil shale and tuff composing the LaClede Bed are consistently the most easily recognized and correlated strata in the Laney Member. The oil shale exhibits high resistivity; the tuffs show low resistivity. The buff marker, the stratigraphic interval that includes the *Gyraulus* marker, and the green shale marker can be identified on the logs of most wells by their distinctive resistivity curves. The Sand Butte Bed is characterized by moderately strong resistivity in logs of wells located along the west side of the basin, but as the bed thins and wedges out southeastward, the curve flattens and loses its distinctive character. The Hartt Cabin Bed is composed of many lenticular strata, and the bed intertongues extensively with the Kinney Rim Member of the Washakie Formation and with the Sand Butte Bed, a relation that commonly makes consistent correlations impossible in that part of the section. In the 1 Shell Creek Unit well (fig. 4), the contact of the Hartt Cabin Bed with the overlying Kinney Rim Member is marked by a change from high to low resistivities, but in other wells in the basin the contact is impossible to locate consistently without supporting lithologic data from drill samples.

GEOLOGIC HISTORY

The deposition of the LaClede, Sand Butte, and Hartt Cabin Beds of the Laney Member in Lake Gosiute most likely began when the lake reached its maximum size and continued during the period when the lake began to shrink and withdraw southeastward across southwestern Wyoming, and finally ended when the lake dried up and disappeared.

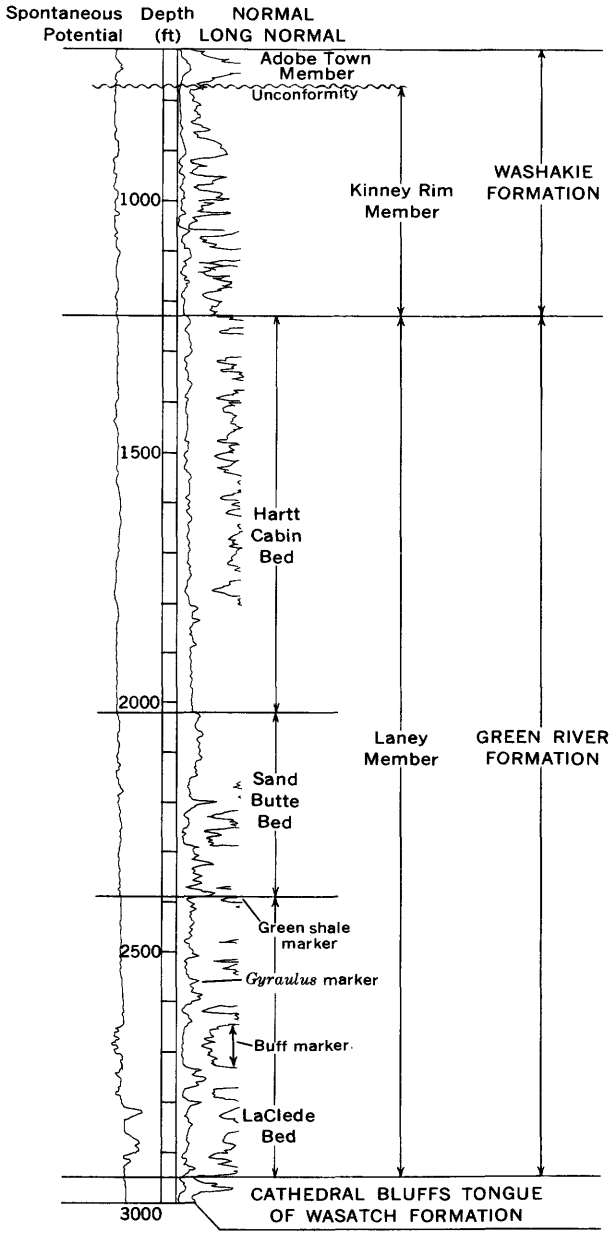

FIGURE 4.—Electric log of the Shell Oil Co. 1 Shell Creek Unit well in the Washakie Basin illustrating resistivity curves of the Hartt Cabin, Sand Butte, and LaClede Beds. The geographic location of the well is shown in figure 1.

During the late early and very early middle Eocene the climate in southwestern Wyoming was hot and dry; the saline rocks that

compose the Wilkins Peak Member of the Green River Formation were deposited in the Green River Basin to the west and the fluvial rocks that compose the Cathedral Bluffs Tongue of the Wasatch Formation were deposited upon the flood plains that encircled the lake. The depositional center of the lake at this time was in the southern part of the Green River Basin. At a later time during the middle Eocene the climate changed from hot and dry to hot and humid, as shown by unpublished fossil-plant data, and Lake Gosiute expanded to an area of more than 10,000 square miles. Moderately saline lake waters inundated most of the Green River, Great Divide, Washakie, and Sand Wash Basins and all of the Rock Springs uplift (fig. 5). Lake Gosiute at this time probably reached its maximum size and depth, although it competes for this distinction with its stage during the period of deposition of the Tipton Shale Member of the Green River Formation. The thick beds of varved oil shale and the few beds of air-laid tuff that were deposited in the expanded lake are preserved now as the LaClede Bed. If the thickest strata were deposited in the deepest parts of the lake, the depositional axis must have been situated toward the south shore, north of and generally parallel to the Uinta Mountains (see fig. 5), near the southwest edge of the Washakie Basin.

Minor thin tuffs were deposited in early Eocene time in the Washakie basin, but during the early middle Eocene a volcanic disturbance of major proportions abruptly introduced large quantities of air-laid volcanic ash that dramatically changed the basin landscape. The large lake in which the LaClede Bed was deposited rapidly began to fill with the volcanic sediments that now compose the Sand Butte Bed. Although the volcanic ash was originally air-laid, much of it was later reworked and water deposited, as evidenced by the thin interbedded mollusk-bearing limestone and algal limestone and by the sedimentary structural features typical of shallow-water and shoreline deposits. The center of the distant volcanic activity is unknown, but a northwest-source direction is indicated by the abrupt thinning and wedging out of the Sand Butte Bed in a southeasterly direction across the Washakie Basin (figs. 1, 3, 6); possibly the center of activity was in the Absaroka Range in northwestern Wyoming.

The unconformable contact of the LaClede Bed and the Sand Butte Bed in outcrops along the western part of the basin indicates a gentle uplift and erosion of the western part of the basin near the end of the period of deposition of the LaClede Bed in the early middle Eocene, and a penecontemporaneous southeast-

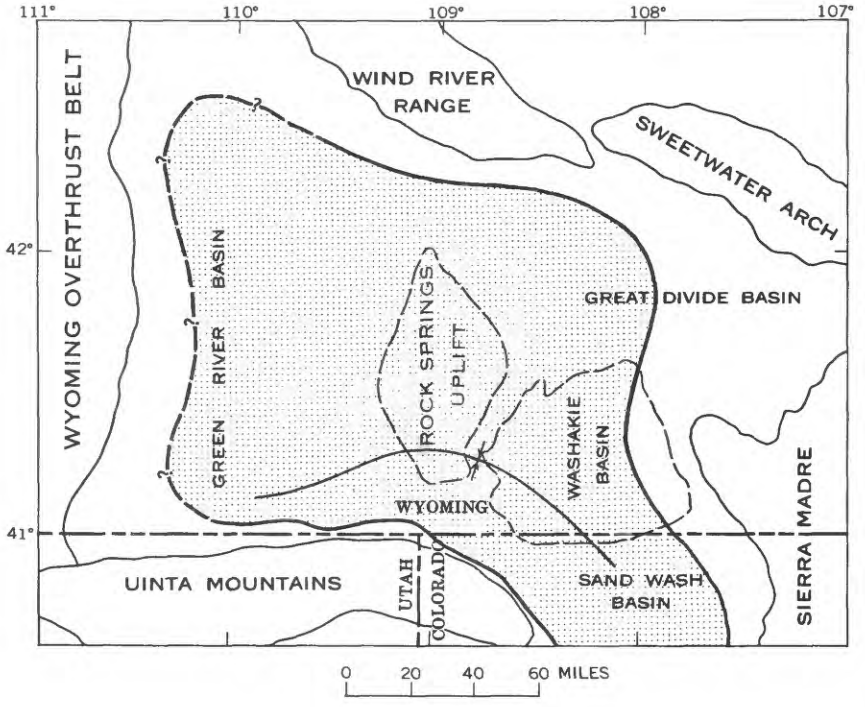

FIGURE 5.—Paleogeographic map of the Washakie Basin area and adjacent areas in southwestern Wyoming and northwestern Colorado showing the areal extent of Lake Gosiute during the deposition of the LaClede Bed of the Laney Member of the Green River Formation. Areas of lacustrine deposition are patterned; the approximate depositional center of the lake is shown by a line and arrows.

ward shift of the center of deposition in the basin. The two events probably were brought on (1) by a change in the topography of the lake floor resulting from rapid deposition of volcanic sediments in the northwestern part of the basin and slower deposition of fluvial clastic sediments in the southeastern part and (2) by isostatic adjustment to the accumulation of low-density volcanic sediments in the northwestern part of the basin as compared to higher density clastic sediments in the southeastern part of the basin. Climatic changes, possibly resulting from volcanic activity, may also have helped shrink the lake. Air-laid volcanic ash accumulation and basin tilting must be considered as the primary factors involved in the drying up and withdrawal of Lake Gosiute from southwestern Wyoming.

The Eocene climate became cooler and drier after the deposition of the Sand Butte Bed (unpub. fossil plant data); and Lake

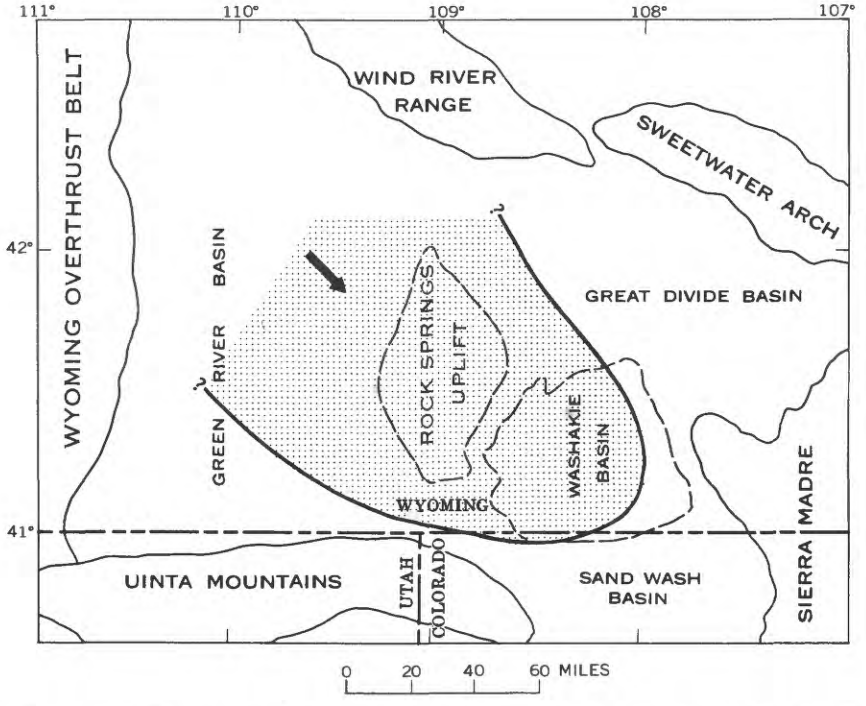

FIGURE 6.—Paleogeographic map showing the areal distribution of the Sand Butte Bed of the Laney Member of the Green River Formation in the Washakie Basin area and adjacent areas in southwestern Wyoming and northwestern Colorado. The area of Sand Butte deposition is patterned; a suggested source direction for air-laid volcanic ash that composes most of the bed is shown by the arrow.

Gosiute was reduced in size until it occupied only the Washakie Basin area in southwestern Wyoming and parts of the Sand Wash Basin area of northwestern Colorado (fig. 7). The terminal stages of Lake Gosiute are recorded in the stratigraphic sequence composing the Hartt Cabin Bed. Interbedded fluvial and lacustrine rocks attest to intermittent flooding and drying up of large areas. Volcanic sediments continued to enter the basin from the northwest, but they intermixed with clastic sediments derived mainly from the plutonic core of the Sierra Madre. Fluvial sediments that encroached upon the withdrawing lake are preserved in the Kinney Rim Member of the Washakie Formation (fig. 3). In the final stages, the lake was characterized by scattered freshwater ponds and small interconnected shallow lakes that supported prolific populations of mollusks. In many ways the terminal stages of Lake Gosiute recapitulated in reverse the embry-

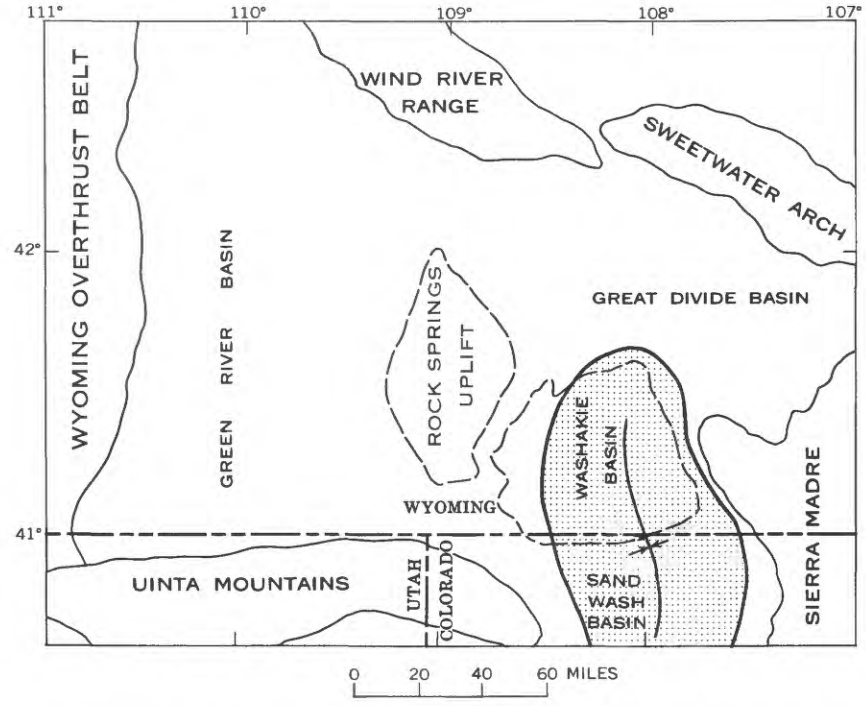

FIGURE 7.—Paleogeographic map of the Washakie Basin area and adjacent areas in southwestern Wyoming and northwestern Colorado showing the areal extent of Lake Gosiute during the deposition of the Hartt Cabin Bed of the Laney Member of the Green River Formation. Areas of lacustrine deposition are patterned; the approximate depositional center of the lake is shown by a line and arrow.

onic stages of Lake Gosiute described for the southwestern part of the Rock Springs uplift (Roehler, 1965, p. 145).

STRATIGRAPHIC SECTIONS

Type section for the LaClede Bed of the Laney Member, Green River Formation

[The section was measured on Laney Rim in secs. 14, 15, and 23, T. 17 N., R. 98 W. The LaClede Bed is overlain at this locality by several hundred feet of gray tuffaceous siltstone and sandstone that compose the Sand Butte Bed of the Laney Member]

Green River Formation (part):
Laney Member (part):
Sand Butte Bed.
Unconformity.
LaClede Bed:

		Thickness (ft)
55.	Oil shale, brown, silty, blocky; a few thin beds of gray blocky limy hard siltstone; not well exposed	30.0
54.	Tuff, light-gray, silty, firm; scattered plant and leaf fragments; weathers to light-gray band in outcrops	4.5

Type section for the LaClede Bed of the Laney Member, Green River Formation—Continued

Green River Formation (part)—Continued
Laney Member (part)—Continued
LaClede Bed—Continued

		Thickness (ft)
53.	Oil shale, brown, flaky, soft; poorly exposed	11.2
52.	Calcite, gray, hard; a persistent bed of vertical acicular crystals; exhibits some cone-in-cone structure	.05
51.	Oil shale, brown, flaky, soft; poorly exposed	1.4
50.	Siltstone, tan-gray, limy, hard; scattered ostracodes and sparse *Gyraulus militaris*. The *Gyraulus* marker	.9
49.	Oil shale, brown, papery, soft; some silty laminae	73.0
48.	Algal limestone, tan, gray; onionskin type	1.8
47.	Oil shale, brown, flaky, soft; poorly exposed	9.0
46.	Siltstone, tan, hard, limy, platy, and thin interbeds of tan algal limestone; wavy-banded colonies	1.3
45.	Oil shale, brown, flaky, soft; poorly exposed	7.8
44.	Tuff, light-gray, blocky, hard	.3
43.	Oil shale, brown, flaky, soft; poorly exposed	2.8
42.	Algal limestone, gray; rounded brain-type colonies	.4
41.	Ostracodal limestone, light-brown, silty, hard	.2
40.	Siltstone, tan, very tuffaceous, finely bedded, hard	5.3
39.	Oil shale, brown, papery, soft; some flaky and brittle	12.5
38.	Siltstone, tan, limy, hard	.7
37.	Oil shale, black, flaky, hard, brittle	2.7
36.	Siltstone, tan, very tuffaceous, finely bedded, platy; weathers to prominent buff band in outcrop. The "buff marker" bed	36.0
35.	Algal limestone, tan, silty, very hard; the upper part is mainly algal fragments in a coarse-grained sandstone matrix; the lower part is thin beds of algal colonies	3.6
34.	Oil shale, brown, papery, firm	15.0
33.	Siltstone, tan, very tuffaceous, blocky, firm	2.9
32.	Ostracodal limestone, tan, very hard; weathers rust brown	.1
31.	Oil shale, brown, papery, soft	4.7
30.	Analcimized tuff	.2
29.	Oil shale, brown, papery, soft	11.0
28.	Oolitic limestone, tan, siliceous, hard; weathers to spongy texture	.3
27.	Oil shale, brown, flaky, silty, firm; scattered carbonaceous plant fragments	1.8
26.	Pisolite, tan, silty, hard; caps distinct ledge in outcrops; top 0.2 ft exhibits algal banding	1.1
25.	Oil shale, brown, papery to flaky, firm; some thin laminae very dolomitic; sparse thin laminae of tan firm siltstone	12.3

Type section for the LaClede Bed of the Laney Member, Green River Formation—Continued

Green River Formation (part)—Continued

Laney Member (part)—Continued

LaClede Bed—Continued

		Thickness (ft)
24.	Algal limestone, gray; onionskin type	.3
23.	Oil shale, dark-brown, papery, firm; thin dolomitic laminae; sparse thin laminae of analcime	11.3
22.	Algal limestone, tan, silty; mostly algal fragmented limestone at the base, grading upward into wavy-banded colonies at the top; weathers to a small ledge	1.0
21.	Oil shale, brown, papery to flaky, hard; thin laminae of dolomitic shale; a few thin laminae of calcite and analcime	5.6
20.	Sandstone, gray, very fine grained, soft, very biotitic; appears analcimitic	.2
19.	Siltstone, tan, gray, tuffaceous, firm; some claystone inclusions; weathers to a groove in cliff face	1.7
18.	Oil shale, brown, papery, firm	4.5
17.	Algal limestone, tan; brain and onionskin types; weathers to small, persistent ledge	.7
16.	Oil shale, brown, papery, soft	5.2
15.	Oolite, tan, silty, hard; evenly bedded; sparse ostracodes	.15
14.	Oil shale, brown, papery, soft	2.4
13.	Algal limestone, tan, hard, and interlaminated ostracodal tan hard limestone	.6
12.	Oil shale, brown, papery, soft; several thin laminae of gray coarsely crystalline analcime	4.5
11.	Oolite, tan, hard; evenly bedded	.3
10.	Mudstone, green, sandy, blocky, firm at the base, and gray limy hard finely laminated to varved siltstone at the top; a few thin laminae and flattened colonies of algae	2.7
9.	Algal limestone, tan, oolitic at the base; fragmented algal limestone in the middle; wavy-banded algal limestone at the top	1.2
8.	Mudstone, gray, fissile to blocky, silty, firm; very finely bedded at the top; weathers brown	3.5
7.	Oil shale, brown, flaky, firm	1.3
6.	Ostracodal limestone, tan, silty, hard	.3
5.	Oil shale, brown, papery to flaky, firm; abundant ostracodes	8.2
4.	Algal limestone, tan; persistent even beds of fragmented brain-type colonies at the top; thin interbedded algal limestone and tan limy siltstone at the base	.7
3.	Oil shale, brown, papery, soft	5.4

Type section for the LaClede Bed of the Laney Member, Green River Formation—Continued

Green River Formation (part)—Continued

Laney Member (part)—Continued

LaClede Bed—Continued

	Thickness (ft)
2. Algal limestone, tan, silty, hard, siliceous in part; persistent beds of brain-type algae at the base, with fine wavy laminated bedding at the top	1.1
1. Oil shale, brown, papery, soft	4.0
Total thickness LaClede Bed (rounded)	320

Cathedral Bluffs Tongue of the Wasatch Formation.

Type section for the Sand Butte Bed of the Laney Member, Green River Formation

[Measured on Kinney Rim in the NE¼ sec. 19, N½ sec. 20, and NW¼ sec. 21, T. 14 N., R. 99 W. The Sand Butte Bed is overlain at this locality by the mostly olive-green mudstone and gray crossbedded brown-weathering sandstone that compose the Kinney Rim Member of the Washakie Formation]

Washakie Formation (part):

Kinney Rim Member (part): Bed 5 ft thick of light-gray limy tuff (white ridge marker).

Green River Formation (part):

Laney Member (part):

Sand Butte Bed:

	Thickness (ft)
62. Algal limestone—gray, silty, hard, rounded colonies of brain type as much as 1.5 ft in diameter—and gray, very finely crystalline, silty, platy, hard limestone between the algal colonies	4.1
61. Mudstone, dark-olive-green and gray, silty to sandy, blocky, firm	17.8
60. Sandstone, gray, very fine grained, some fine-grained, poorly sorted, subangular; very calcareous in part; soft to hard	16.7
59. Mudstone, gray-brown, silty to very sandy, blocky, firm	4.0
58. Limestone, tan-gray, very finely crystalline, silty, platy, hard	1.1
57. Sandstone, light-gray, very fine grained, very argillaceous biotitic, calcareous, hard	4.0
56. Sandstone, gray, fine to very coarse grained, poorly sorted, subangular, biotitic, calcareous, firm; scattered pebbles and lenses of conglomerate—pebbles are rounded and somewhat flattened gray mudstone and gray siltstone; unit is crossbedded	41.9
55. Conglomerate—subrounded gray sandy mudstone galls as much as 0.2 ft in diameter in a matrix of gray, coarse-grained, poorly sorted, biotitic, very calcareous, hard sandstone; abundant poorly preserved fossil wood fragments	3.0
54. Sandstone, medium-gray, very fine grained, fairly well sorted, subangular; colored grains; very calcareous; crossbedded; nonresistant to weathering	5.0

Type section for the Sand Butte Bed of the Laney Member, River Formation—Continued

Green River Formation (part)—Continued
Laney Member (part)—Continued
Sand Butte Bed—Continued

	Thickness (ft)
53. Mudstone, medium-gray, silty to sandy, blocky, firm; becomes very sandy at the top	2.5
52. Sandstone, medium-gray, very fine grained, fairly well sorted, subangular; colored grains; very calcareous; hard; weathers to ledge	2.5
51. Sandstone, gray, very fine to fine-grained, fairly well sorted, micaceous; abundant colored grains; firm; friable; nonresistant to weathering; and thin interbedded, dark-gray-green, silty to sandy, blocky, firm mudstone	28.0
50. Limestone, light-gray, very finely crystalline, hard, dense; weathers to peculiar spongy texture and forms a distinct gray ledge; large talus blocks from a distance appear to be a flock of sheep	4.9
49. Sandstone, light-gray, very fine to very coarse grained, poorly sorted, subangular; abundant colored grains; soft; friable; crossbedded; conglomerate lens near the base has clay galls as much as ½ in. in diameter; abundant fossil wood fragments	56.0
48. Sandstone—light-gray, mostly very fine grained, some fine-grained, calcareous, firm— and interbedded dark-gray-green, sandy, soft mudstone	20.0
47. Siltstone, light-gray, calcareous, argillaceous, hard	1.0
46. Limestone, gray, sandy, hard; sparse fish bones and a few mollusk shell fragments including those of *Goniobasis* sp	.3
45. Algal limestone, tan, platy; small rounded heads as much as 1.0 ft in diameter	.4
44. Sandstone, gray, very fine grained, soft, friable; nonresistant to weathering	7.8
43. Sandstone, gray, fine- to coarse-grained, poorly sorted, subangular; abundant colored grains; soft; friable; becomes calcareous the top 3.0 ft; weathers gold brown	18.5
42. Limestone, medium-gray, silty, hard; weathers to ledge	1.5
41. Sandstone, gray-brown, fine- to medium-grained, subangular, soft, friable, tuffaceous; some calcareous streaks; abundant colored grains; weathers to nonresistant slopes	23.8
40. Tuff, tan-gray, silty, hard	1.5
39. Siltstone, tan, gray, tuffaceous, calcareous, firm, and sparse interbedded gray, very fine grained, calcareous tuffaceous, hard sandstone	49.3
38. Mudstone, gray-green, silty, blocky, soft to firm	2.8

Type section for the Sand Butte Bed of the Laney Member, River Formation—Continued

Green River Formation (part)—Continued
Laney Member (part)—Continued
Sand Butte Bed—Continued

	Thickness (ft)
37. Sandstone, gray, very fine to fine-grained, poorly sorted, subangular; colored grains; soft; friable; calcareous; becomes very silty in the top 1 ft	9.1
36. Sandstone, gray, very fine grained, poorly sorted, tuffaceous, calcareous; colored grains; hard	1.0
35. Mudstone, gray-brown, blocky, firm; possible low kerogen content	10.5
34. Tuff, white, hard	.4
33. Sandstone, gray, very fine grained, slightly calcareous, fairly well sorted, firm; and interbedded gray, calcareous, tuffaceous, firm siltstone	14.5
32. Sandstone, gray, very fine grained, very limy, very hard; weathers gray brown	1.3
31. Siltstone, tan-gray, tuffaceous, calcareous, hard, and occasional thin beds of light-gray, very fine to fine-grained, tuffaceous, calcareous, hard sandstone	21.6
30. Oil shale, brown, flaky, firm; some silty; some very limy; estimated oil yield 5 gallons per ton	5.0
29. Siltstone, gray, hard, tuffaceous, calcareous; abundant clay galls; weathered blocks form talus slope	7.5
28. Sandstone, light-gray, very fine grained, poorly sorted, silty, tuffaceous, hard; weathers rust brown	6.5
27. Siltstone, light-gray, tuffaceous, calcareous, hard; scattered plant impressions; and thin interbedded, light-gray, very fine grained, tuffaceous, calcareous, hard sandstone	38.0
26. Coquinal sandstone, gray, fine- to medium-grained, very limy, very hard; contains *Goniobasis* sp. and *Lampsilis* sp	1.0
25. Siltstone, pink to maroon, calcareous, tuffaceous, firm	2.5
24. Siltstone, gray, maroon, brown, tuffaceous, calcareous, hard; interlaminated and interbedded with light-gray, tan, very fine to medium-grained, poorly sorted, subangular, tuffaceous, calcareous, firm sandstone	35.5
23. Coquinal limestone, gray, shaly, hard; contains poorly preserved shell fragments of *Goniobasis* sp., *Lampsilis* sp., and *Viviparus*, sp	.4
22. Limestone, tan, brown, silty, ostracodal, hard; and finely interlaminated to interbedded brown, silty, blocky, hard oil shale; estimated oil yield 5 gallons per ton	9.8

Type section for the Sand Butte Bed of the Laney Member, River Formation—Continued

Green River Formation (part)—Continued
Laney Member (part)—Continued
Sand Butte Bed—Continued

	Thickness (ft)
21. Siltstone, tan, gray, some maroon tinted, tuffaceous, calcareous, hard; with shale partings; and interlaminated to interbedded gray, red-tinted, very fine grained, tuffaceous, calcareous, hard sandstone; some mud cracks	19.0
20. Sandstone, tan-gray, very fine to medium grained, poorly sorted, subangular; abundant colored grains; calcareous; firm; weathers to ledge	4.8
19. Siltstone, gray, some maroon-tinted, calcareous, tuffaceous, hard, thin-bedded, platy; some green shale partings, and a few thin beds of gray, very fine grained sandstone; scattered aquatic plant impressions	8.0
18. Oil shale, dark-brown, silty, ostracodal, hard; becomes very silty the top 1.5 ft; oil yield of weathered surface sample 11.6 gallons per ton	5.4
17. Sandstone, gray, red, brown, very fine to fine-grained, fairly well sorted, subangular, very calcareous, hard; abundant green shale partings, and some interbedded brown, gray, tuffaceous, calcareous, hard siltstone	10.0
16. Sandstone, gray, green, very fine grained, poorly sorted, tuffaceous, calcareous, hard; a few shaly streaks; abundant worm borings; weathers to ledge	3.0
15. Sandstone, light-gray, brown, some red tinted, fine- to coarse-grained, poorly sorted, subangular, tuffaceous; abundant colored grains; crossbedded; and some interbedded gray, very tuffaceous, calcareous, firm siltstone; weathers to a series of rust-brown ledges	131.0
14. Siltstone, tan, argillaceous, tuffaceous, firm, and interlaminated, light-gray, very fine grained, tuffaceous; and calcareous firm sandstone	9.0
13. Oil shale, brown, flaky, ostracodal, soft; estimated oil yield 10 gallons per ton	7.5
12. Siltstone, gray, tan, some red-tinted, argillaceous, tuffaceous, some shaly streaks, and interlaminated to interbedded light-gray, very fine grained, calcareous, tuffaceous, firm, finely bedded sandstone; not well exposed	65.5
11. Oil shale, tan-brown, fissile, some flaky, ostracodal, soft; estimated oil yield 3 gallons per ton	13.3
10. Sandstone, light-gray, fine- to coarse-grained, poorly sorted, subangular, tuffaceous, calcareous, hard; weathers to nearly flat slope; sparse very	

Type section for the Sand Butte Bed of the Laney Member, River Formation—Continued

Green River Formation (part)—Continued
Laney Member (part)—Continued
Sand Butte Bed—Continued

	Thickness (ft)
poorly preserved twigs and wood, mostly replaced by limonite	2.0
9. Sandstone, light-gray, very fine grained, subangular, tuffaceous, hard; and interbedded light-gray, tuffaceous, firm siltstone; 2 ft dark-gray, fissile, soft shale, about 5 ft from the top	18.4
8. Sandstone, light-gray, very fine grained, subangular, poorly sorted, calcareous, tuffaceous, firm	3.2
7. Siltstone, light-gray, tuffaceous, hard; and sparse thin laminae of gray very fine grained sandstone. Some outcrops of this unit are, very locally, oxidized red. Cinder fragments suggest that oil shales in the underlying LaClede Bed may have burned	9.6
6. Sandstone, light-gray, fine-to coarse-grained, subangular, poorly sorted; abundant colored grains; calcareous; tuffaceous, broadly crossbedded; weathers to rust brown and caps ridge	4.5
5. Siltstone light-gray, argillaceous, tuffaceous, firm; disseminated plant impressions	1.9
4. Sandstone, light-gray, fine- to coarse-grained, poorly sorted, subangular to subrounded; abundant colored grains; calcareous; limonitic; weathers to smooth rust-brown slope; top of unit contains abundant *Goniobasis* sp	4.2
3. Siltstone, light-gray, argillaceous, tuffaceous, firm; and sparse thin laminae of light-gray, very fine grained, tuffaceous, firm sandstone; surface of unit contains casts of *Goniobasis* sp	7.7
2. Sandstone, light-gray, fine- to coarse-grained, poorly sorted, subangular to subrounded; abundant colored grains; calcareous; firm; weathers rust brown	19.2
1. Silstone, gray, tuffaceous, firm, finely bedded; platy in part; and finely interlaminated to interbedded, light-gray, very fine grained, tuffaceous, firm, friable sandstone; scattered small plant fragments	19.8
Total thickness Sand Butte Bed (rounded)	850

Unconformity.
LaClede Bed.

Type section for the Hartt Cabin Bed of the Laney Member, Green River Formation

[Units 1–42 were measured in secs. 30, 31, and 32, T. 15 N., R. 93 W., and units 43–82 were measured in sec. 6, T. 14N. , R. 93 W.]

Washakie Formation.
Adobe Town Member.
Unconformity.
Green River Formation (part):
Laney Member (part):
Hartt Cabin Bed:

		Thickness (ft)
82.	Sandstone, gray, very fine grained, fairly well sorted, tuffaceous, firm; and interbedded gray, finely bedded, hard siltstone	13.0
81.	Siltstone, gray, tuffaceous, calcareous, finely bedded; and interbedded medium-brown, very silty, firm oil shale	19.0
80.	Shale, gray-brown, flaky, soft	2.5
79.	Siltstone, gray-brown, tuffaceous, firm; scattered ostracodes	2.7
78.	Siltstone, light-gray, calcareous, very tuffaceous, hard, massively bedded; weathers to small ledge	1.5
77.	Mudstone, dark-gray-green, silty, blocky, firm	5.2
76.	Tuff, light-gray, sandy, hard	.8
75.	Siltstone, gray, calcareous, tuffaceous, finely bedded, firm; weathers to a small ledge	7.4
74.	Mudstone, dark-gray, dark-gray-green, silty, blocky, firm; and a few beds of gray, very fine grained, argillaceous sandstone; soft at the base	15.3
73.	Sandstone, gray, fine-grained, fairly well sorted, subangular; abundant black grains; calcareous; hard; crossbedded	1.6
72.	Mudstone, dark-gray-green, silty, blocky, firm; and interbedded dark-gray-brown, fissile to flaky, firm, shale; a few thin beds of tan, calcareous, platy siltstone; one thin bed of brown, carbonaceous shale about 8 ft below the top	24.0
71.	Shale, medium-brown, fissile, carbonaceous, very soft	2.5
70.	Mudstone, dark-gray, dark-gray-green; black at the top; silty; blocky; firm	32.7
69.	Siltstone, gray-brown, limy, finely bedded, platy; abundant ostracodes. Laterally the base of this unit grades into a siliceous coquina containing the gastropod *Goniobasis tenera*	8.6
68.	Sandstone, gray, very fine to fine-grained, poorly sorted, subangular; abundant colored grains; abundant biotite; argillaceous, becoming tuffaceous and calcareous in the top 3 ft; the upper part weathers to a gray ledge; the lower part weathers brown	6.8
67.	Oil shale, brown, fissile, flaky, firm; sparse ostracodes	4.4

Type section for the Hartt Cabin Bed of the Laney Member, Green River Formation—Continued

Green River Formation (part)—Continued
Laney Member (part)—Continued
Hartt Cabin Bed—Continued

	Thickness (ft)
66. Shale, tan-gray, very fissile, flaky, soft	1.4
65. Oil shale, medium-brown, very silty, flaky, firm; some interlaminated medium-brown, shaly, very finely bedded siltstone; abundant ostracodes	7.6
64. Sandstone, gray-brown, very fine to fine-grained, poorly sorted, subangular, calcareous in part, argillaceous, soft	2.5
63. Coquinal sandstone, gray, very fine grained, limy, hard; abundant specimens of *Goniobasis* sp	.9
62. Sandstone, gray-brown, very fine to fine-grained, argillaceous, subangular, poorly sorted; abundant colored grains; abundant biotite; weathers to steep slope	17.5
61. Mudstone, dark-gray-brown, silty, blocky, firm; and thin interbedded gray, very fine grained, calcareous, firm sandstone	9.0
60. Tuff, white, silty, firm, finely bedded; weathers to a chalky ledge. The "flat top white layer"	2.7
59. Sandstone, gray-brown, very fine to fine-grained, argillaceous, firm; banded calcareous zones; a few tuffaceous layers; weathers dark brown near the center; forms a nearly vertical cliff; abundant ostracodes in the upper 2 ft; most of a turtle carapace near the center	30.4
58. Sandstone, gray, very fine grained, fairly well sorted, finely bedded, tuffaceous, firm; scattered small plant fragments	3.4
57. Siltstone, gray, sandy, calcareous, finely bedded; abundant small plant fragments	.9
56. Mudstone, gray, gray-brown, silty, calcareous, firm; some very small plant fragments along partings	5.3
55. Algal limestone, gray, silty, hard; slightly undulating brain-type colonies	.6
54. Shale, medium-gray-brown, flaky, soft	3.2
53. Mudstone, gray-green, silty, blocky, firm; grades upward into firm, gray, calcareous, argillaceous siltstone	3.5
52. Siltstone, gray, sandy, finely bedded, very calcareous; weathers to small, thin plates	.8
51. Shale, gray-green, flaky, firm	.9
50. Sandstone, gray, very fine grained, calcareous, firm, crossbedded; forms ledge; weathers dark brown	2.1
49. Sandstone, gray-brown, very fine to medium-grained, poorly sorted, subangular; abundant colored grains; biotitic; argillaceous; firm; and interbedded gray, very sandy, argillaceous, firm	

Type section for the Hartt Cabin Bed of the Laney Member, Green River Formation—Continued

Green River Formation (part)—Continued

Laney Member (part)—Continued

Hartt Cabin Bed—Continued

		Thickness (ft)
	mudstone; the interval is at least 75 percent argillaceous sandstone; weathers to steep gray-brown slope	28.7
48.	Sandstone, gray-brown, very fine to medium-grained, poorly sorted, subangular; abundant colored grains; abundant biotite; argillaceous; friable; crossbedded; most of unit nonresistant	18.3
47.	Mudstone, gray, sandy, soft, and thin interbedded gray, very fine grained, very argillaceous, soft sandstone and gray, argillaceous, calcareous, firm siltstone	10.0
46.	Oil shale, dark-green-brown, flaky, firm	3.2
45.	Ostracodal limestone, gray, finely bedded, platy, silty, firm	.4
44.	Mudstone, green, very sandy, firm; and interbedded gray-brown, some green-tinted, very fine grained, fairly well sorted, very argillaceous, colored-grained, firm sandstone	8.3
43.	Sandstone, gray-brown, some green tinted; very fine grained, fairly well sorted, very argillaceous; abundant colored grains; firm; a few very shaly streaks	24.9
42.	Siltstone, gray, argillaceous, tuffaceous, calcareous, firm; weathers to ledge	6.2
41.	Mudstone, dark-gray-green, silty to sandy, blocky, firm; and interbedded gray, argillaceous, tuffaceous, firm siltstone	14.3
40.	Siltstone, gray, very argillaceous, tuffaceous, platy, calcareous; weathers to ledge	2.1
39.	Shale, gray-brown, very fissile to flaky, firm; very low kerogen content	6.5
38.	Sandstone, gray, very fine grained, argillaceous, soft; and interbedded gray, calcareous, firm siltstone; grades upward into gray-green firm mudstone	12.5
37.	Siltstone, gray, calcareous, platy, hard	.8
36.	Shale, dark-gray, very fissile to flaky, firm	6.3
35.	Dolomite, tan, finely crystalline, very silty, finely bedded, platy, hard	.6
34.	Mudstone, dark-green, silty, flaky, firm; and interbedded gray, argillaceous, platy, calcareous siltstone	20.3
33.	Siltstone, gray, argillaceous, platy, firm; weathers to small ledge	1.8
32.	Siltstone, gray, argillaceous, calcareous, hard, finely bedded; grades upward into gray, very silty, flaky, firm shale	3.4

Type section for the Hartt Cabin Bed of the Laney Member, Green River Formation—Continued

Green River Formation (part)—Continued

Laney Member (part)—Continued

Hartt Cabin Bed—Continued

	Thickness (ft)
31. Mudstone, green, sandy, blocky, firm	5.9
30. Sandstone, gray-green, very fine grained, fairly well sorted, calcareous, firm; abundant *Goniobasis* sp.; some *Australorbis* sp., and *Lampsilis* sp	.7
29. Mudstone, dark-green, silty, blocky, firm	6.3
28. Dolomite, gray, finely crystalline, very silty, finely bedded, platy, hard	.5
27. Shale, gray, very silty, flaky; and thin, finely interbedded gray, calcareous, finely bedded, platy, hard siltstone	5.3
26. Siltstone, gray, calcareous, finely bedded, platy, hard; abundant syneresis cracks	1.3
25. Shale, dark-gray-green, flaky, clayey, firm	4.1
24. Shale, gray; very silty at the base, grading upward into gray, very fine grained, argillaceous, limonitic, soft sandstone	7.5
23. Siltstone, gray, very calcareous, argillaceous; sparse plant fragments	1.2
22. Sandstone ,gray, very fine grained, very argillaceous; sparse small, carbonaceous plant fragments	1.3
21. Sandstone, gray, fine-grained, fairly well sorted, argillaceous, soft, limonitic, nonresistant	6.5
20. Sandstone, gray, fine-grained, fairly well sorted, angular to subangular, calcareous; abundant colored grains; abundant biotite; crossbedded	1.6
19. Sandstone, gray, very fine to fine-grained, fairly well sorted, argillaceous, soft, friable, nonresistant; and interbedded gray-green, gray, flaky to blocky, firm mudstone; two very thin carbonaceous layers in the lower part	51.9
18. Mudstone, dark-gray, silty, carbonaceous, firm, becoming shaly the top 0.4 ft	1.1
17. Shale, brown, flaky, soft	6.0
16. Mudstone, dark-gray-green, silty to sandy, blocky, soft; deeply weathered; not well exposed	15.0
15. Sandstone, gray, very fine to fine-grained, fairly well sorted; abundant colored grains; soft; friable; argillaceous; weathers distinctive orange brown	5.2
14. Mudstone, dark-gray-green, partly very silty to very sandy deeply weathered	20.4
13. Dolomite, tan, silty, platy, very hard	1.4
12. Shale, gray, fissile, silty; firm at the base, grading upward into dark gray-green, clayey, soft mudstone; deeply weathered	14.0
11. Oil shale, medium- brown, very silty, calcareous; firm, grading upward into medium brown, very	

Type section for the Hartt Cabin Bed of the Laney Member, Green River Formation—Continued

Green River Formation (part)—Continued

Laney Member (part)—Continued

Hartt Cabin Bed—Continued

		Thickness (ft)
	shaly, hard, platy siltstone; abundant ostracodes and fish bones; unidentified gastropod shell fragments	6.1
10.	Siltstone, medium-brown, calcareous, platy, hard; abundant ostracodes; weathers to large white plates	4.0
9.	Shale, medium-brown, very silty, flaky, brittle, tuffaceous; very low kerogen content	10.2
8.	Oil shale, dark-brown, papery, soft	5.4
7.	Oil shale, dark-brown, slightly silty, firm; and interbedded medium-brown, shaly, flaky to platy, tuffaceous siltstone; unit weathers very light gray	12.5
6.	Siltstone, brown, shaly, platy, tuffaceous, calcareous, firm; sparse ostracodes; very sparse *Musculium* sp	3.3
5.	Oil shale, medium-brown, very silty, firm	5.3
4.	Siltstone, medium-brown, limy, hard; and interbedded brown, very silty, firm oil shale; abundant ostracodes	5.0
3.	Siltstone, medium-brown, limy, hard, tuffaceous, very platy; weathers white	3.0
2.	Oil shale, brown, flaky, soft	3.8
1.	Dolomite, gray, finely crystalline, silty, hard; weathers yellow brown	.8
	Total thickness Hartt Cabin Bed (rounded)	625

LaClede Bed (part): Bed 7 ft thick of dark-green flaky shale (green shale marker).

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