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New Members of the Gering Formation (Miocene) in Western Nebraska

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A GEOLOGICAL MAP OF WILDCAT RIDGE AND RELATED OUTLIERS

BY

CARL F. VONDRA,[1] C. BERTRAND SCHULTZ,[2] and THOMPSON M. STOUT[2]

ABSTRACT

The Gering Formation is the lower part of the Arikaree Group (Miocene) in western Nebraska and adjacent region, unconformable upon the Brule Formation (Oligocene) but overlain with essential conformity by the Monroe Creek Formation of the Arikaree. Representing the filling of an ancient system of valleys, with channel sands dominant near the center of each main and tributary valley, the Gering contains progressively more silt (much of this reworked from the Brule) toward each valley margin. The valley divides are characterized by very much thinner silts, with soils and volcanic ash beds, known collectively as the Bayard Paleosol Complex. The top of this soil-ash complex, where present, marks the top of the Gering, but elsewhere there may be a volcanic ash bed, the *Wildcat Ridge Ash Bed* (new name), or correlative lime-siltstone at the top.

A more prominent and widespread volcanic ash, the *Carter Canyon Ash Bed* (new name), occurs within the Gering. An unconformity occurs about 60 feet above this bed, which allows division of the Gering in the Wildcat Ridge area of western Nebraska into the *Helvas Canyon Member* (new name), below, and the *Mitchell Pass Member* (new name), above. Both of these members are defined from relations in Helvas Canyon, south-southwest of Gering, Scotts Bluff County, Nebraska, where the Gering reaches its near-maximum thickness of about 200 feet, as noted by Darton in 1899. The primary or type locality of the Gering Formation is at Helvas Canyon. The *Twin Sisters Pumice Conglomerate Bed* (new name) occurs at the base of the upper member there. Two additional reference sections, at Mitchell Pass and Redington Gap, facilitate identification of the two new members throughout much of the Wildcat Ridge of western Nebraska, and an attempt is made to correlate also into the Pine Ridge area of northwestern Nebraska. The recently-proposed "Sharps Formation," named from the Big Badlands of South Dakota, does not appear to be a recognizable stratigraphic unit in Nebraska, being mostly if not wholly a synonym of Gering, and perhaps includes even a part of the Monroe Creek.

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INTRODUCTION

The Gering Formation was named by N. H. Darton (1898; 1899a; 1899b, reprinted 1903a, 1905) and is currently considered as the basal formation of the Arikaree Group (Table 1) in the Central Great Plains of western Nebraska, eastern Wyoming, southwestern South Dakota, and northeastern Colorado. The relation of this Early Miocene formation to the underlying Brule Formation of the White River Group (Oligocene), and to the overlying Monroe Creek Formation (also in Arikaree Group, Miocene), was the subject of a field conference (August 20–23, 1967) of many interested geologists and paleontologists conducted by the authors in western Nebraska. However, the extension of the Gering into southwestern South Dakota, where it has been termed the "Sharps Formation" (Harksen, Macdonald, and Sevon, 1961a, reprinted 1961b; Nicknish and Macdonald, 1962; reprinted 1963; Macdonald, 1963), was not reviewed in the field at that time. It is suggested, however, that the "Sharps" is not a recognizable stratigraphic unit in Nebraska. It is mostly if not wholly a synonym of the Gering and may include in places part of the Monroe Creek.

As one immediate result of the Gering field conference, it seems necessary for clarification of thought and for greater precision in definition of units, to assign formal names to the two members of the Gering Formation and to certain beds within them, as now recognized *at many localities* in the Wildcat Ridge and Pine Ridge of western Nebraska. Elsewhere in western Nebraska and adjacent areas, where division has not been attempted, the Gering must be considered *undifferentiated.* The division of the Gering into two members, by emphasizing certain key beds and horizons, should aid in establishing regional correlations. However, the incautious proliferation of names, in this as in other parts of the geologic column, could result in placing undue emphasis upon local situations, to the neglect of an overall view (Schultz and Stout, 1955, p. 48; 1961, pp. 4–7). It is hoped that this will not be the case here.

GENERAL RELATIONS

A regional picture is surely the most important reconstruction to be expected from the careful plotting of many local relations, especially for such mixed fluviatile, colluvial, and eolian sediments as comprise the Gering Formation in western Nebraska. The formation there is the collective sandy-and-silty fill of an ancient system of valleys cut into pinkish-buff loessic silt (Whitney Member, Brule Formation). Gray channel sands are best developed along the axial trend of each main or tributary valley. Silt, much of it loess-like, and colluvial silt partly reworked from the Whitney, occurs progressively as one approaches the valley walls and main divides.

The *regional unconformity* at the base of the Gering was early recognized by Darton (1898; 1899-a-b; 1903a), and subsequent studies have emphasized it (Schultz and Stout, 1955, 1961; Schultz, Falkenbach, and Vondra, 1967). It is certain that the *regional rejuvenation* of streams at this time involved some tectonism, for the Brule in northwestern Nebraska is very much more faulted and folded than is the overlying Gering. A climatic change, from dominant aridity to dominant humidity, may be inferred to have occurred then as well.

PLIOCENE—Ogallala (Valentine and younger divisions) overlies

Regional Unconformity

MIOCENE

Hemingford Group

Sheep Creek Formation

Upper Member
(= Lower Snake Creek,
= Sand Canyon, *in part*)

Unconformity

Lower Member
(= Sheep Creek, *sensu stricto*,
= Spottedtail, *in part*)

(= "Box Butte"?)

Unconformity

Marsland Formation

Regional Unconformity

Harrison Formation

Unconformity

Arikaree Group

Monroe Creek Formation

Local Unconformity

Gering Formation

Mitchell Pass Member

Unconformity

Helvas Canyon Member

Regional Unconformity

OLIGOCENE—Brule Formation (Whitney Member) underlies

Table 1. Miocene sediments of western Nebraska and adjacent region, showing relative position of the proposed new members of the Gering Formation (*modified from* Schultz and Stout, 1961, fig. 3).

DIVISION OF THE GERING

The approximate trace of the main Gering channels through much of the Wildcat Ridge and its outliers in western Nebraska is shown as Figure 1, and a partial reconstruction across this ancient valley is presented as Figure 2. The detailed relationships of Gering to other Tertiary outcrops throughout this area is illustrated on the Geologic Map of Wildcat Ridge and Related Outliers in Western Nebraska. The Geologic Map was prepared as a part of the University of Nebraska State Museum field program in 1959 by Carl F. Vondra and Arne Aadland, under the direction of C. Bertrand Schultz and Charles H. Falkenbach.

An important and widespread unconformity occurs in the Wildcat Ridge region in the upper part of the Gering, about 60 feet above an equally-significant ash and marl bed (here named the *Carter Canyon Ash Bed*[1]). This unconformity allows easy separation of the Gering into two new members: the *Helvas Canyon Member* (below) and the *Mitchell Pass Member* (above). Both are defined at the Helvas Canyon, near Gering, Scotts Bluff County, Nebraska (*see* Figures 2–7, and the description of the Primary Geologic Section). The disconformity within the Gering was first noted by Darton (1899, pp. 736, 748, 751–753, fig. 218; reprinted 1903a, pp. 18, 30, 33–35, fig. 33). Throughout much of the Wildcat Ridge and adjoining butte remnants, there is a prominent bench, often talus-mantled, that may be easily traced at this horizon. A pumice-pebble conglomerate, here designated the *Twin Sisters Pumice Conglomerate Bed*,[1] occurs extensively in this region upon the surface of disconformity and at the base of the Mitchell Pass Member. At Twin Sisters, the pumice conglomerate is only 6.5 feet thick, but the 46-foot bed above contains occasional lenses of pumice pebbles, especially near the base. At Helvas Canyon, the primary or type locality of the Gering Formation which is located approximately 11 miles west and 3 miles north of Twin Sisters, a 30.5-foot thick conglomerate and sandstone unit correlates in part with the Twin Sisters Pumice Conglomerate.

The relation of the entire Gering to the Brule in this same region is illustrated by two restored geologic cross sections presented by Schultz, Falkenbach and Vondra (1967, fig. 6A and B), and reproduced here as Figure 4. In each of these cross sections there are three easily recognized horizons: the Upper and Lower Ash Beds of the underlying Whitney Member of the Brule Formation (Schultz and Stout, 1955; 1961), and the near-horizontal base of the overlying Monroe Creek Formation. The deep incision of the Gering, even probably below the Lower Ash Bed at Helvas Canyon, may be noted in the illustrations.

The near-maximum depth of cutting of the Gering valley, with the corresponding greatest thickness of about 200 feet for the Gering, occurs at about six miles south-southwest of Gering (Fig. 3). To the authors, this site serves best as a type locality for the Gering

[1] The type locality is in the Helvas Canyon, east of Carter Canyon, south-southwest of Gering, Scotts Bluff County, Nebraska (*see* Primary Geologic Section and Figure 5). Although the geographic term Helvas Canyon does not appear on recent maps of the region, it is an old and established term of historical importance (LeRoy, 1960).

[1] The type locality is at the Twin Sisters, an erosional remnant well known by the discussion and illustrations of Darton (1899b, pp. 750–751, pls. 80-A, 96-B; reprinted 1903a, pp. 32–33, pls. 7-A, 23-B). It is situated in the SW. ¼, SW. ¼, sec. 19, T. 20 N., R. 53 W. in Banner County, Nebraska (*see* illustration of Twin Sisters graphic section in Figure 2).

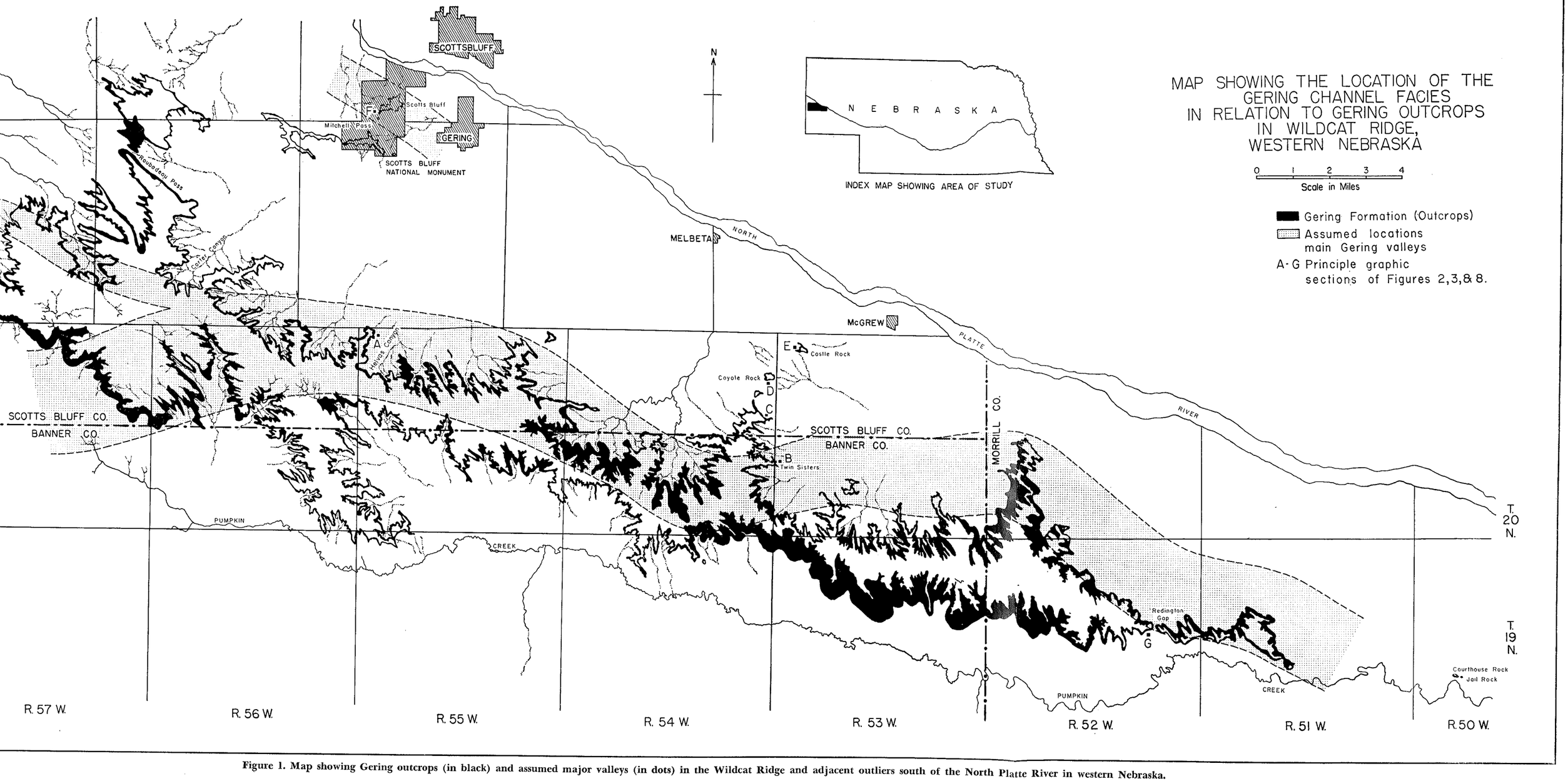

Figure 1. Map showing Gering outcrops (in black) and assumed major valleys (in dots) in the Wildcat Ridge and adjacent outliers south of the North Platte River in western Nebraska.

and its members because, as Darton (1899b, pp. 736, 747, 751, fig. 218; reprinted 1903a, pp. 18, 29, 33, fig. 33) remarks, the "greatest development" of the Gering Formation in the Platte Valley "is south-southwest of Gering, where 200 feet are exposed." Nowhere else in that area, and certainly not at the Scotts Bluff National Monument (Fig. 3; also Darton, 1899, fig. 225; reprinted 1903a, fig. 18; Schultz and Stout, 1955, figs. 9–10), does this thickness, which is emphasized repeatedly by Darton, occur. However, the relations between these two localities, both near Gering, are very clear (Fig. 3), and the two divisions of the Gering recognized in the present paper occur also at the Scotts Bluff National Monument. In any case, manipulation of sections and definitions, advocated by some, cannot justify the insertion of another formation between the Gering and the Brule.

A most interesting compressed section of the Gering, and a corresponding preservation of the uppermost portion of the Whitney Member of the Brule Formation, occur at the Castle Rock, Scotts Bluff County, Nebraska (Fig. 2). The highest point preserved on the ancient drainage divide of Gering time is apparently at the north side of Castle Rock, where the upper surface of the Whitney and overlying six feet of ashy marls and soils have been considered to represent not only the terminal weathering of the Whitney, but the entire Gering as well; it has been termed the Bayard Paleosol Complex (Schultz and Stout, 1955, p. 46, fig. 10, column 6 and inset). The capping soil of this complex, which was about one foot thick as formerly exposed, surely must be taken as the top of the Gering there, since it is overlain directly by the pipy concretions of the Monroe Creek Formation. At the southwest corner of Castle Rock (Scotts Bluff County), and on south to beyond the Twin Sisters, the Gering thickens progressively toward the valley axis (Fig. 2), and the basal sand channels of the Gering seem to have occupied a very restricted inner valley near the Twin Sisters (Figs. 1–2 and 4; *also* Schultz, Falkenbach, and Vondra, 1967, fig. 6B). It has been assumed that Gering sediments gradually filled this valley form, up to the level of the capping soil at the north face of the Castle Rock, so much of the Gering along this rising valley wall must represent the upper part of the Gering. Darton (1899b, p. 751, pl. 100-D; reprinted 1903a, p. 33, pl. 27-D) seems also to have realized this, but the possibility must be considered of some colluvial movement, or even loessic additions even in the early part of Gering time along higher slopes. Also, the Bayard Paleosol Complex, as discussed above, must represent at the summit divide most, if not all, of the Gering.

At the top of the Gering along the east side of the Redington Gap (southeast of Castle Rock and Chimney Rock, in Morrill County, Nebraska), there is a prominent volcanic ash bed and marl, here named the *Wildcat Ridge Ash Bed*[1] (see Fig. 8). The ash correlates with the lime-siltstone which caps the Gering in the vicinity of Roubadeau Pass, Scotts Bluff County, and with at least the upper part of the Bayard Paleosol Complex.

In northwestern Nebraska, particularly in the nearly-vertical exposures below Round Top northwest of Crawford in Sioux County (Schultz and Stout, 1955, figs. 2–3, 8; 1961), the Brule-Gering contact is best placed at nearly 100 feet above the base of the Upper Ash Bed of the Whitney Member of the Brule Formation. Laterally,

[1] The type locality is at Redington Gap, located in the W. ½, SE. ¼, sec. 14, T. 19 N., R. 52 W., in Morrill County, Nebraska (*see* description, Reference Section No. 3).

along the old road just below and northwest of Round Top, there was formerly exposed the characteristic gray channel sand of the basal Gering, with the Whitney in place below. Some traces of this sand may be seen even now, despite much talus and vegetative cover.[1] A less-significant break occurs about 40–56 feet above the base of the Gering in the Round Top exposures (Schultz and Stout, 1955, fig. 3, column 8), and it is suggested that this may divide the Gering of the Pine Ridge area into two parts corresponding to those in the Wildcat Ridge area. At several localities in the Pine Ridge area a prominent volcanic ash bed, the "Gering Second Ash" of Wellman (MS., 1964) occurs above this break and may mark the base of the Mitchell Pass Member.

The Gering Formation of the entire Pine Ridge, from eastern Wyoming through northwestern Nebraska to near White Clay (at the Nebraska-South Dakota boundary), is also lithologically similar and displays the same range in thickness and general relations to beds below and above. It is surely the same formation as in the Wildcat Ridge. Even in Darton's (1899b; 1903a) work, this was assumed as evident.

[1] Just west of Fort Robinson, near the mouth of Smiley Canyon, there is a prominent volcanic ash bed at the base of the Gering. This elsewhere may be a silicified thin ashy ledge (Schultz and Stout, 1955, fig. 3, column 9).

PRIMARY AND REFERENCE SECTIONS

Primary (or Type) Geologic Section (Helvas Canyon)—Considered as the most representative geologic section for the Gering Formation (Darton, 1899b, pp. 736, 747, 751, fig. 218; reprinted 1903a, pp. 18, 29, 33, fig. 33), and selected here as the type locality also for the proposed new members. Additionally, the *Carter Canyon Ash Bed* is defined here. Illustrated in figures 2, 3, 5, 6, and 7. Situated in Helvas Canyon, just east of Carter Canyon and south of Mitchell Pass, Scotts Bluff County, Nebraska, 2.7 miles west and 5.6 miles south of Gering, in the NW. ¼, NE. ¼, NW. ¼ sec. 6, T. 20 N., R. 55 W. (15 minute Scottsbluff Quadrangle).

Bed	Description	Thickness (feet)
	MIOCENE, ARIKAREE GROUP MONROE CREEK FORMATION 183 feet	
12	Sandstone, buff to grayish-buff, very fine-grained, very silty, well sorted, consisting of angular to subrounded quartz and feldspar grains; very slightly calcareous, poorly indurated, massive, containing numerous very calcareous "pipy" concretions	183
	GERING FORMATION *Mitchell Pass Member* 63.5 feet	
11	Sandstone, buff, very fine-grained, very silty, well sorted, consisting of angular to subrounded quartz and feldspar grains; slightly calcareous, moderately indurated, massive, containing numerous very calcareous "pseudo-pipy" concretions	33
10	Conglomerate and sandstone, gray, consisting of well rounded pebbles to cobbles of gray pumice in a matrix of slightly calcareous, well sorted, silty sandstone; sandstone matrix fine-grained, consisting of angular to subrounded quartz and feldspar grains; moderately indurated, massive, crossbedded; correlates in part with the *Twin Sisters Pumice Conglomerate Bed*	30.5
	DISCONFORMITY *Helvas Canyon Member* 187–205 feet	
9	Claystone, green, silty, moderately indurated, flaky fracture	0–1
8	Sandstone, pinkish-buff, very fine-grained, silty, consisting of well sorted, angular to subrounded quartz and feldspar grains, moderately calcareous, somewhat indurated, massively bedded, blocky fracture	14.5
7	Siltstone, buff to grayish-buff, sandy, very slightly calcareous, moderately indurated to friable, thickly bedded, containing numerous thin siltstone partings, slightly crossbedded and containing thin bands of heavy minerals along foresets in the lower portion	29
6	Siltstone, grayish-buff, very sandy, slightly calcareous, massive, moderately indurated	15.5
5	Volcanic ash, white, consisting of silt-sized, angular fragments of volcanic glass, very slightly calcareous, poorly indurated to friable: *Carter Canyon Ash Bed*	4
4	Sandstone, buff to grayish-buff, very fine to coarse-grained, conglomeratic, consisting of angular to subrounded quartz and feldspar grains, very poorly sorted at the base grading into well sorted, very fine-grained sandstone above, containing lenses of well rounded siltstone and crystalline pebbles and cobbles throughout, and numerous well rounded armored boulders of pink, argillaceous siltstone, moderately indurated, crossbedded	34–38
	LOCAL DISCONFORMITY (cut-and-fill relationship with underlying strata)	
3	Siltstone, gray to buff, sandy, very calcareous, well indurated, thickly bedded to massive, containing several local, lenticular, bluish-gray to buff, channel sandstones, consisting of crossbedded, well indurated, calcareous, very fine to medium, angular to subangular quartz and feldspar grains with occasional laminae of dark-colored heavy mineral grains	62–75

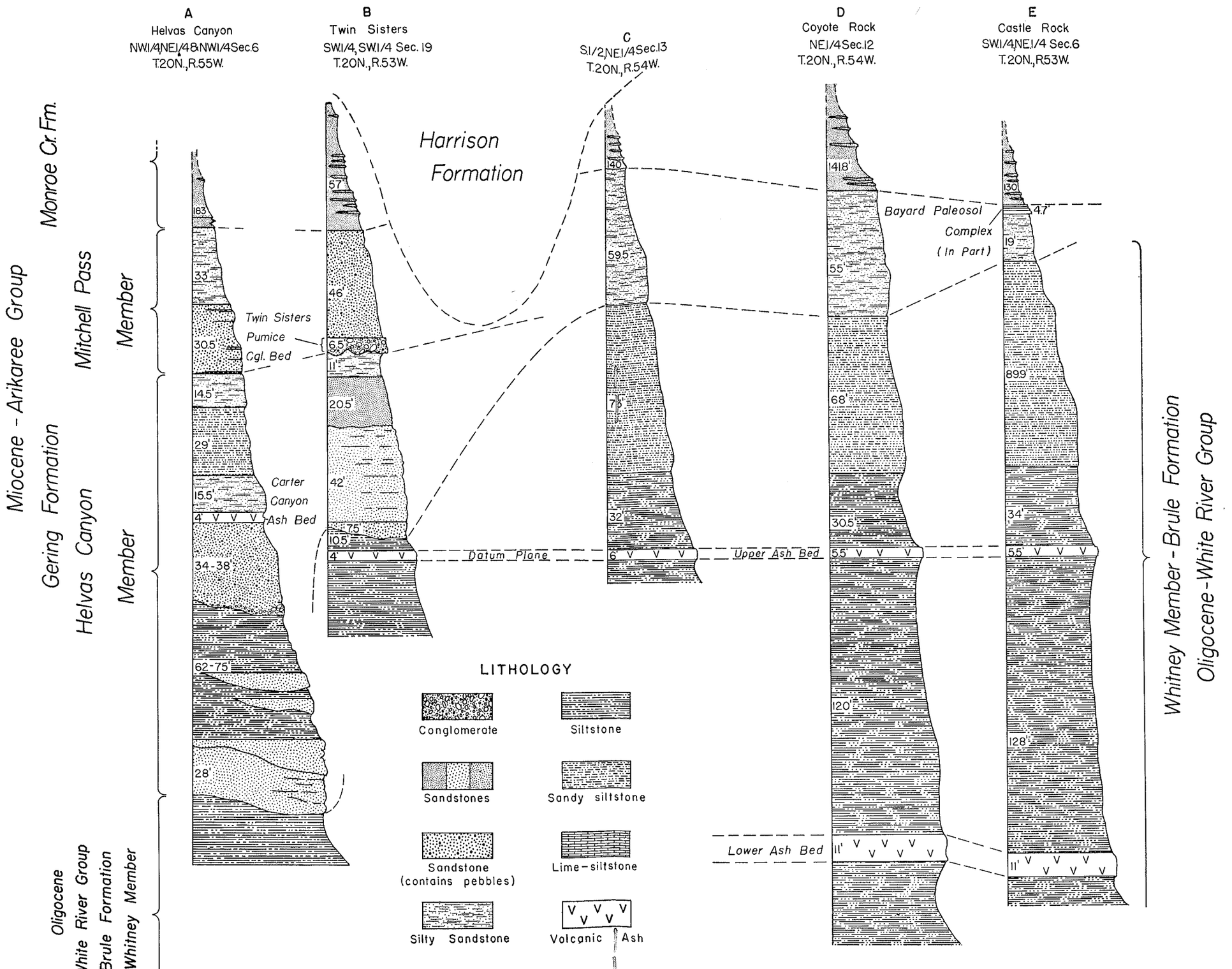

Figure 2. Stratigraphic cross section of the ancient Gering valley shown in Figure 1 with principal geologic sections from Twin Sisters (B) to Castle Rock (E) in relation to Helvas Canyon (A), the primary geologic section. The "inner valley," consisting of sediments of the Helvas Canyon Member of the Gering Formation, is capped by the Mitchell Pass Member of the same formation, with the Twin Sisters Pumice Conglomerate Bed at its base.

Bed	Description	Thickness (feet)
	LOCAL DISCONFORMITY (cut-and-fill relationship with underlying strata)	
2	Sandstone, bluish-gray to pinkish-buff, very fine- to medium-grained, very silty, moderately sorted, consisting of angular to subrounded quartz and feldspar grains, calcareous, well indurated, crossbedded, thickly bedded and interbedded with pink argillaceous siltstone, thus producing a weak ledge	28
	REGIONAL DISCONFORMITY Oligocene, White River Group Brule Formation Whitney Member	
1	Siltstone, pinkish-buff, argillaceous, calcareous, well indurated, massive, blocky to platy fracture	20 (measured)

Reference Geologic Section No. 1 (Mitchell Pass-Scotts Bluff)—Illustrated in Figure 3 (*see* also Darton, 1899b, pp. 747, 756, fig. 225, pl. 102; reprinted 1903a, pp. 18, 38, fig. 18; Schultz and Stout, 1955, figs. 9–10). Situated at Mitchell Pass and the west to north sides of the Scotts Bluff National Monument, Scotts Bluff County, Nebraska, 2.2 miles west and 0.8 mile north of Gering, in the SW. ¼ and NE. ¼, sec. 33, T. 22 N., R. 55 W. (Scottsbluff South and Scotts Bluff National Monument Quadrangles).

Bed	Description	Thickness (feet)
	MIOCENE, ARIKAREE GROUP Monroe Creek Formation 200 feet	
17	Sandstone, grayish-buff, fine- to medium-grained, very silty, moderately sorted, consists of angular to subrounded quartz and feldspar grains, poorly indurated to friable, massive; contains numerous "pipy" concretions	200
	GERING FORMATION *Mitchell Pass Member* 48 feet	
16	Sandstone, buff, very fine-grained, very silty, well sorted; consists of angular to subrounded quartz and feldspar grains, slightly calcareous, moderately indurated, thinly bedded, containing some thin, resistant calcareous ledges in the upper portion	48
	Helvas Canyon Member 39.8 feet	
15	Lime-siltstone, white, sandy and ashy, massive, blocky fracture; contains a three-inch layer of very calcareous, grayish-white fine-grained sandstone at the base	2.7
14	Sandstone, yellowish-brown, very fine- to fine-grained, very silty consisting of angular to subrounded quartz and feldspar grains, limonitic, moderately well indurated to friable, massive	3
13	Sandstone, gray, very fine- to fine-grained, friable, massive	3
12	Sandstone, greenish-gray, fine-grained, friable	0.4
11	Lime-siltstone, white	0.2
10	Sandstone, grayish-buff, very fine- to fine-grained, very silty, consisting of angular to subrounded quartz and feldspar grains; moderately indurated to friable; poorly bedded to massive, slightly crossbedded; contains thin bands of heavy minerals	16.5
	DISCONFORMITY	
9	Siltstone, pinkish-buff, grading into a very fine-grained sandstone, well indurated, massive	14
	REGIONAL DISCONFORMITY Oligocene, White River Group BRULE FORMATION Whitney Member 171.5 feet	
8	Siltstone, pinkish-buff, clayey, well indurated, massive, blocky to platy fracture	27
7	Volcanic ash, whitish-buff, silty, moderately indurated, massive; blocky fracture; correlated as the Upper Ash Bed (see Schultz and Stout, 1955, 1961)	9.5
6	Siltstone, pinkish-buff, clayey, well indurated, massive, blocky to platy fracture	91.5
5	Siltstone, buff, very ashy, well indurated, massive	3

Bed	Description	Thickness (feet)
4	Siltstone, pinkish-buff, clayey, well indurated, massive, blocky to platy fracture	13
3	Volcanic ash, grayish-white, silty, moderately dense, massive; blocky fracture; correlated as the Lower Ash Bed (see Schultz and Stout, 1955, 1961)	11
2	Siltstone, interbedded with fine sandstone, pinkish-buff, well indurated, bedded, with weak ledges	16.5
1	Siltstone, pinkish-buff, clayey, well indurated, massive, blocky to platy fracture	not measured

Reference Geologic Section No. 2 (Redington Gap)—Illustrated in figure 8 (*see also* Darton 1899b, pl. 99-C; reprinted 1903a, pl. 26-C) situated at Redington Gap, Morrill County, Nebraska, 9.2 miles west and 3.7 miles south of Bridgeport in the W. ½, SE. ¼, sec. 14, T. 19 N., R. 52 W.

MIOCENE, ARIKAREE GROUP
Monroe Creek Formation
151.7 feet

Bed	Description	Thickness (feet)
11	Sandstone, light-gray to buff, fine-grained, silty, well sorted, consisting of angular to subrounded quartz and feldspar grains, slightly calcareous, moderately indurated to friable, massive, containing numerous "pipy" concretions	151.7

GERING FORMATION
Mitchell Pass Member
47 feet

Bed	Description	Thickness (feet)
10	Volcanic ash, white, very silty, sandy, consisting of silt-sized volcanic glass, friable, massive: *Wildcat Ridge Ash Bed*	5
9	Sandstone, gray to buff, very fine- to fine-grained, silty, poorly sorted, consisting of angular to subrounded quartz and feldspar grains, moderately indurated to friable, containing thin bands of heavy minerals and thick lenses of conglomerate consisting of well rounded pebbles and cobbles of gray pumice and pink siltstones in matrix of fine- to coarse-grained sandstone; numerous pseudo-pipy concretions occur near the top; correlates in part with the *Twin Sisters Pumice Conglomerate Bed*	42

Bed	Description	Thickness (feet)
	DISCONFORMITY	
	Helvas Canyon Member	
	53.6 to 57.7 feet	
8	Siltstone, pinkish-buff, very sandy, well indurated, massive	12
7	Sandstone, buff, fine-grained, well sorted, consisting of angular to subrounded quartz and feldspar grains, moderately calcareous, thinly bedded to massively, friable, containing thin layers of pink, silty claystone and a ten-inch lenticular layer of white, slightly silty volcanic ash, correlated as the *Carter Canyon Ash Bed*	7
6	Sandstone, grayish-buff, fine-grained, silty, well sorted, consisting of angular to subrounded quartz and feldspar grains, moderately indurated to friable, crossbedded, containing thin bands of heavy minerals and pebbles and cobbles of claystone	5–9.1
	LOCAL DISCONFORMITY	
	(cut-and-fill relationship with underlying strata)	
5	Sandstone, buff, very fine-grained, very silty, well sorted, grading into a very sandy siltstone, well indurated, massive, resistant	29.6
	DISCONFORMITY	
	Oligocene, White River Group	
	Brule Formation	
	Whitney Member	
	65.3 feet	
4	Siltstone, pinkish-buff to grayish-white, argillaceous, sandy, moderately calcareous, well indurated, massive, blocky to platy fracture, weathers as smooth, rounded knobs; contains three distinct ashy layers	45
3	Siltstone, pinkish-buff, argillaceous, moderately calcareous, well indurated, massive; blocky fracture	27
2	Volcanic ash, grayish-white, slightly calcareous, moderately indurated, massive, blocky fracture; correlates with the Upper Ash Bed (*see* Schultz and Stout, 1955, 1961)	2.3
1	Siltstone, pinkish-buff, argillaceous, moderately calcareous, well indurated, massive; blocky fracture	not measured

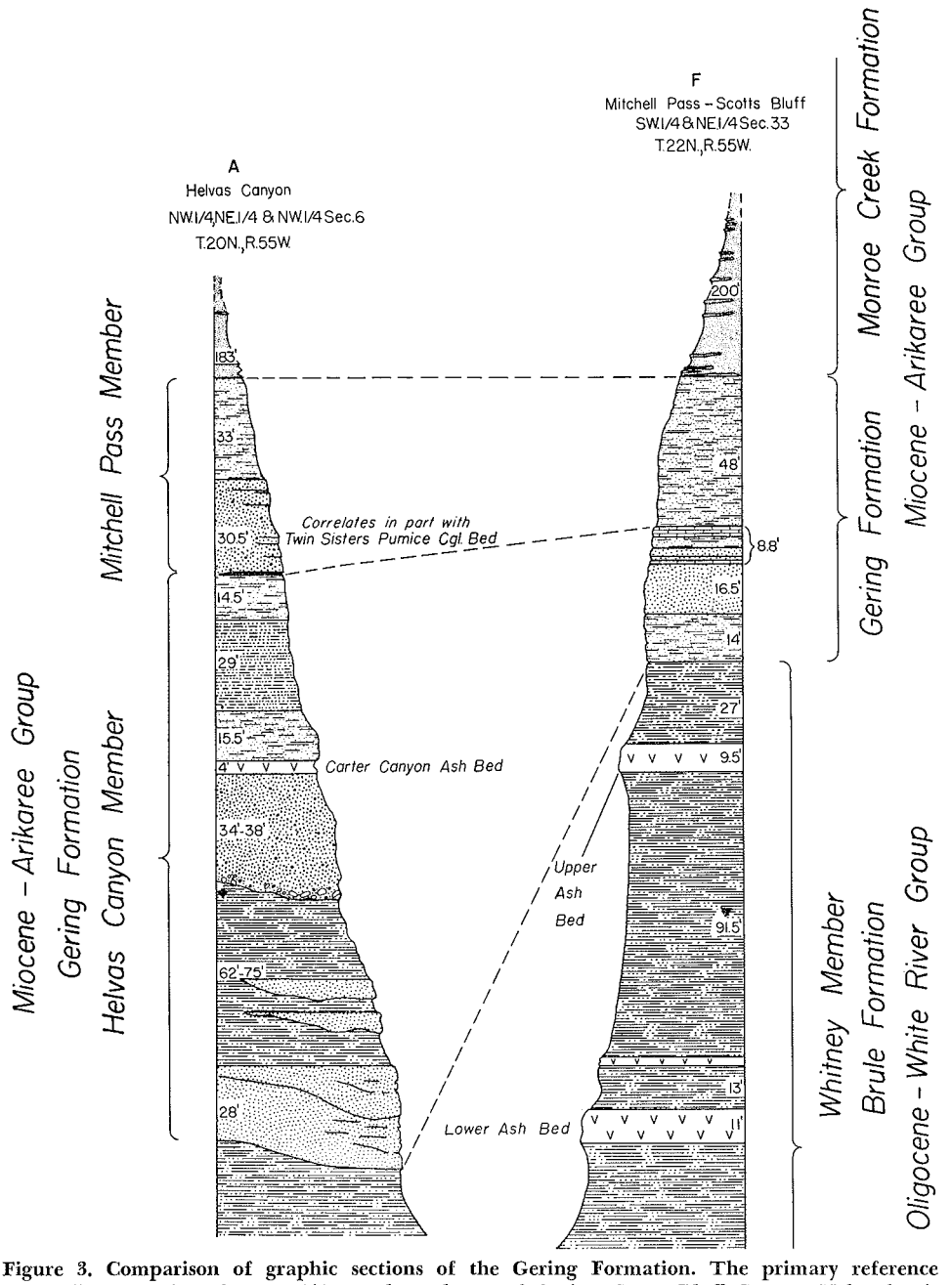

Figure 3. Comparison of graphic sections of the Gering Formation. The primary reference locality at Helvas Canyon (A), south-southwest of Gering, Scotts Bluff County, Nebraska, is shown at left. Section at right (F) is to the north, at Mitchell Pass and Scotts Bluff National Monument, just west of Gering. Note again the "inner valley" of the Gering Formation, shown in Figure 2, and the overlap of the upper part of the Gering onto the Brule. Lithology is same as for Figure 2. From Schultz, Falkebnach, and Vondra (1967, fig. 4).

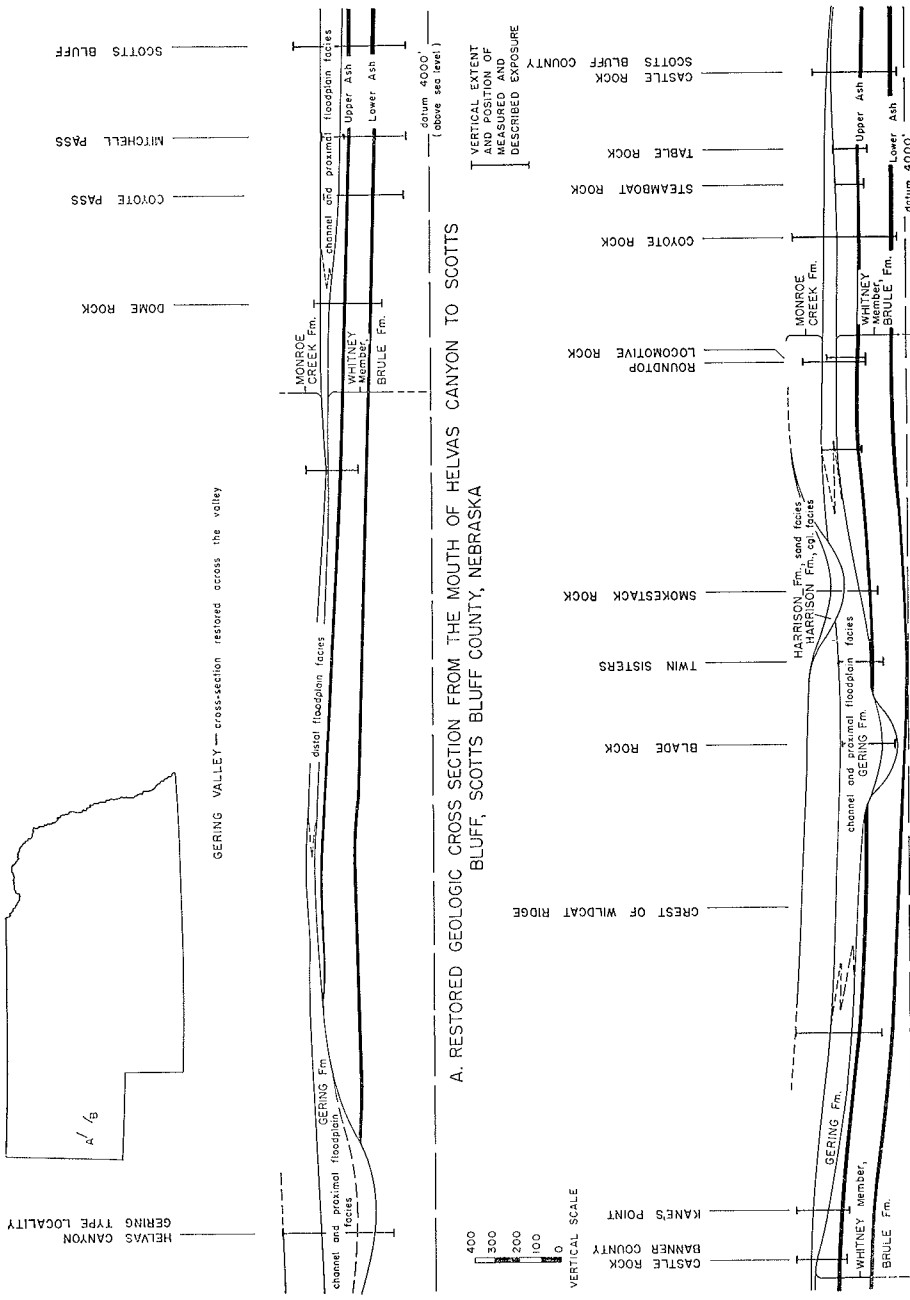

Figure 4. Restored geologic cross sections of the Wildcat Ridge in western Nebraska from the mouth of Helvas Canyon to Scotts Bluff, Scotts Bluff County, and from Castle Rock, Banner County, to Castle Rock in Scotts Bluff County, showing the lateral relationships of the several Gering facies. From Schultz, Falkenbach, and Vondra (1967, fig. 6).

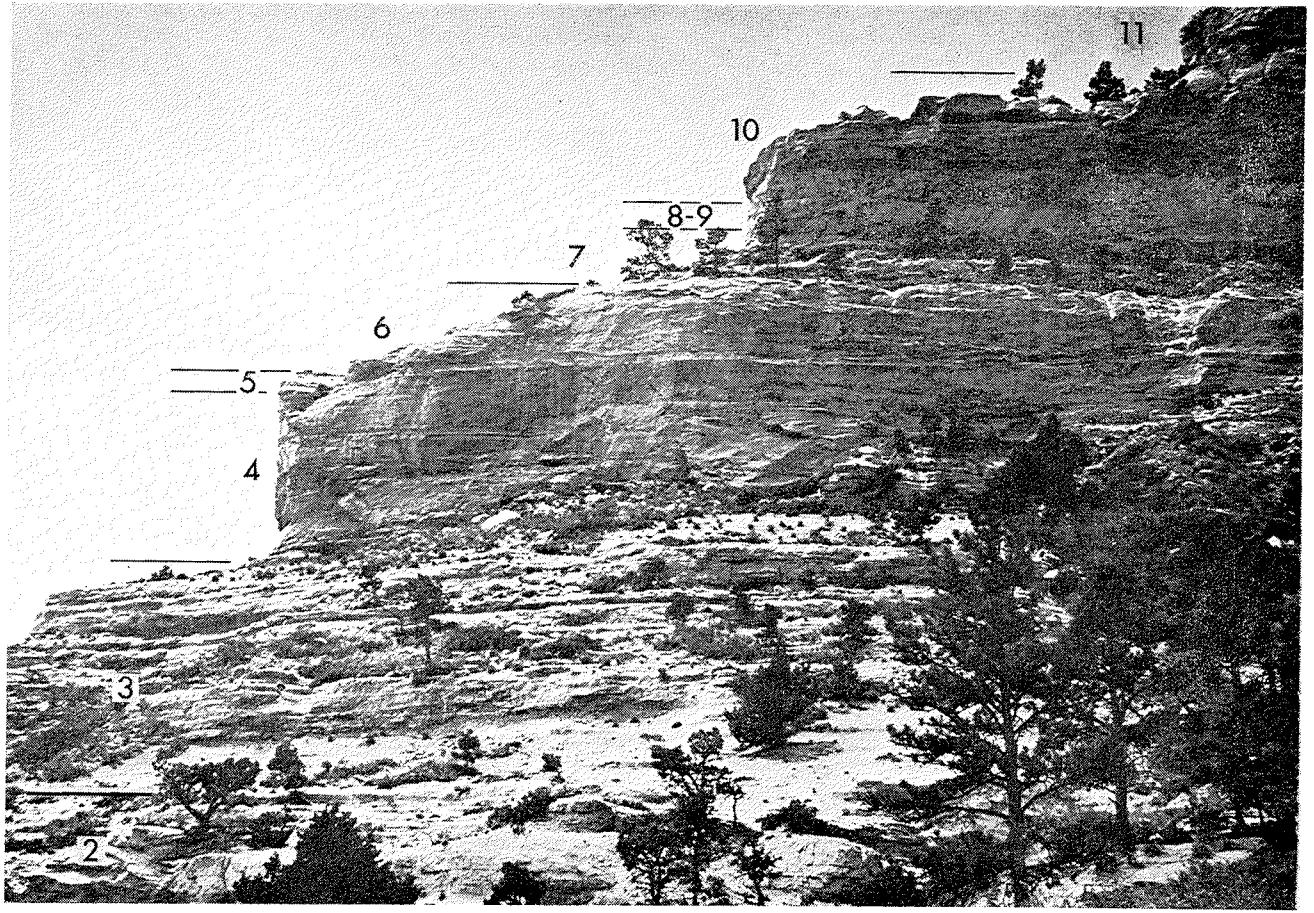

Figure 5. Primary Geologic Section for the Gering Formation and for the Helvas Canyon Member and Carter Canyon Ash Bed, at Helvas Canyon, south-southwest of Gering, Scotts Bluff County, Nebraska. The numbers refer to the beds as described in the Primary Geologic Section. This is taken to be the best choice of a type section as well as the most representative locality to demonstrate both the maximum thickness and lithologic divisions of the Gering Formation.

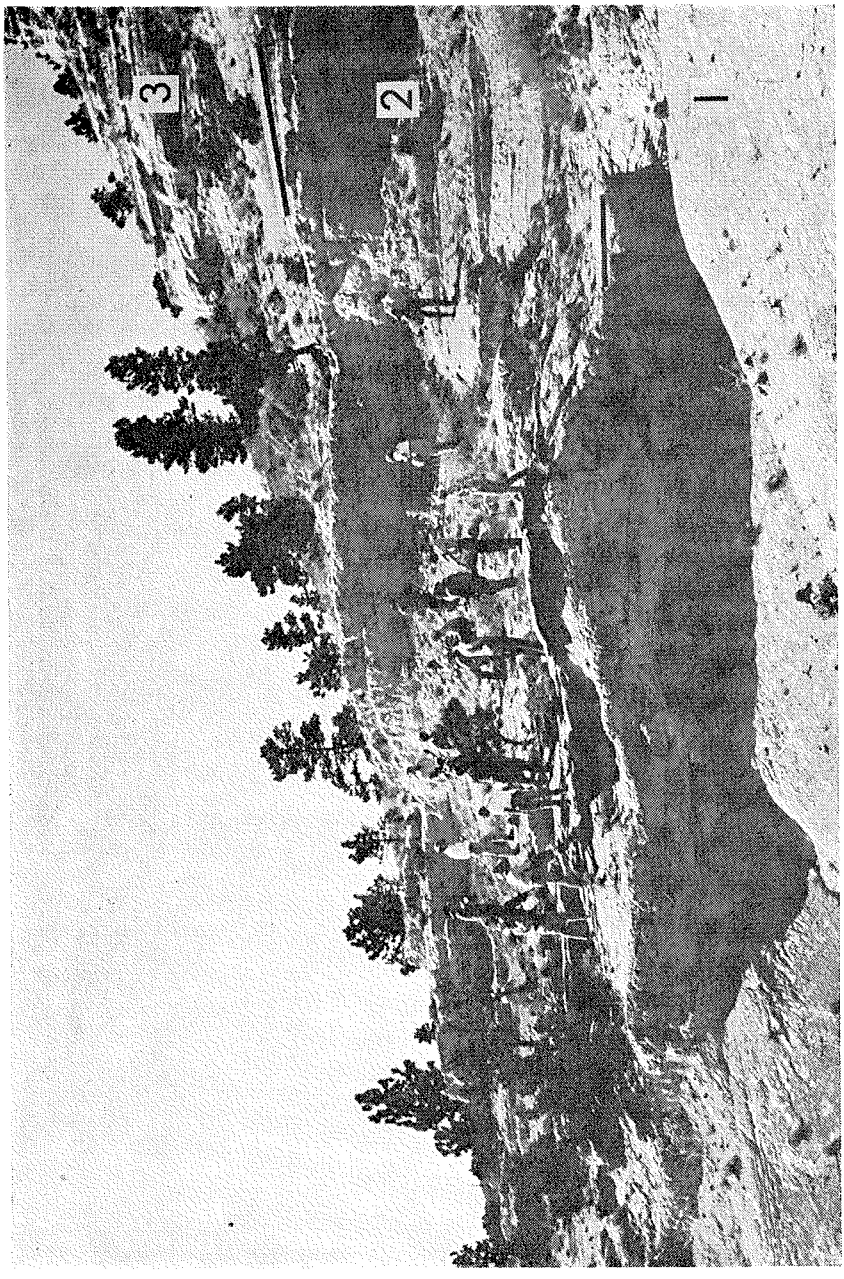

Figure 6. Same locality as shown in Figure 5, but downslope and to left of that photograph. Members of the 1967 field conference are shown standing on projection just above the unconformity between the Whitney Member of the Brule Formation and the overlying Helvas Canyon Member of the Gering Formation. Numbers refer to beds described in the Primary Geologic Section.

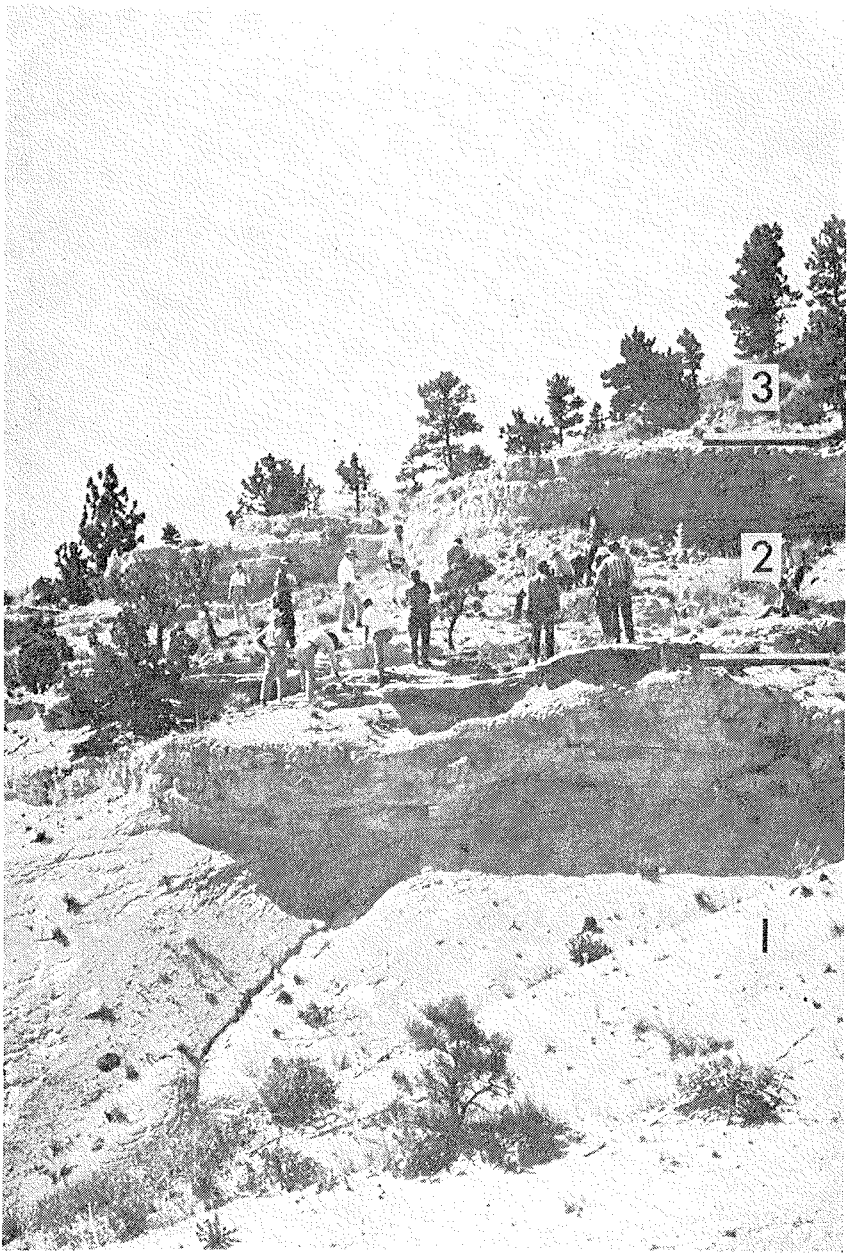

Figure 7. Closeup view of the unconformity between the Gering (*above*; Bed 2) and the Brule (*below*; Bed 1) at the same site as shown in Figures 5 and 6.

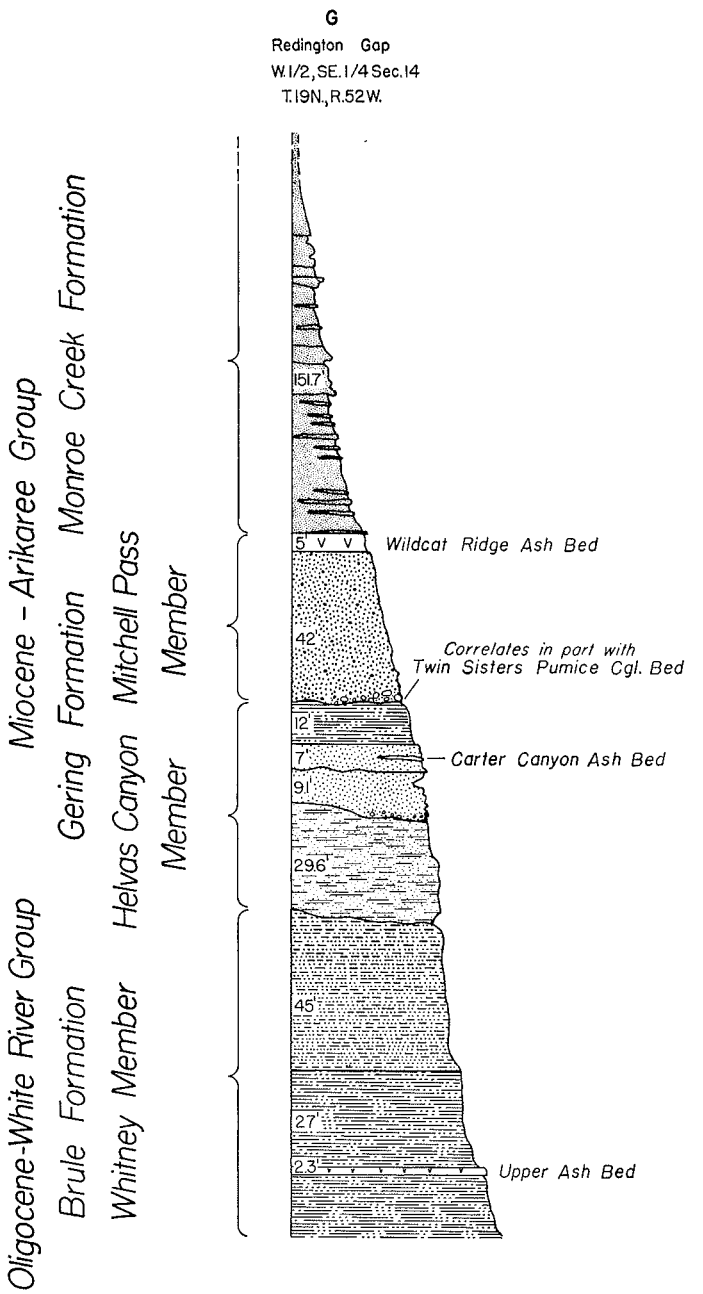

Figure 8. Graphic section of the Gering Formation at the type locality of the Wildcat Ridge Ash Bed, Redington Gap, southwest of Bridgeport, Morrill County Nebraska. *See* Reference Geologic Section No. 3. Lithology is the same as for Figure 2. The type specimen of *Mesocyon geringensis* Barbour and Schultz (1935), together with many other fossil mammals, was collected from the Gering about ten feet above the disconformity between the Gering and the Brule (Whitney Member) at this locality.

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