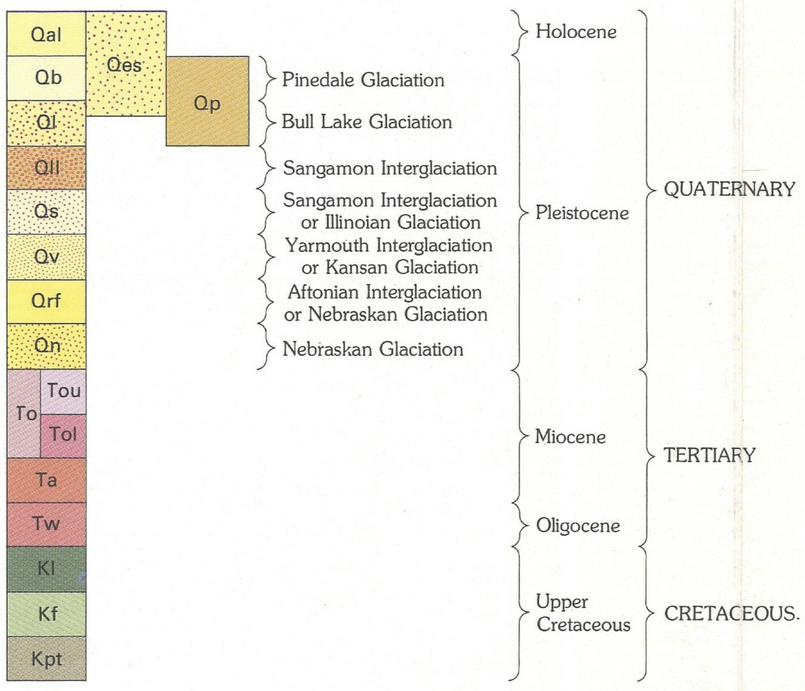
CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

[Vertebrate fossils diagnostic of the ages and stratigraphic positions shown for each formation were identified by Edward Lewis (written commun., 1975 and 1976) and these collections are housed at the Federal Center, Denver, Colorado]

Qal ALLUVIUM (HOLOCENE)—Composed of alluvial deposits of two ages that are not mapped separately

Post-Piney Creek alluvium—Yellowish-gray loose gravel, sand, and silt. Sand from upper 5 ft (1.5 m) is loose and stratified. Underlying sandy gravel generally is free of silt and clay; average grain size is ¼ in. (0.6 cm); maximum size about 4 in. (10 cm). Clasts composed of quartz, feldspar, granite, gneiss, pegmatite, and chert. Forms floodplain and locally a low terrace covered by most floods. Depth of channel cut into bedrock below South Platte River locally is more than 200 ft (61 m); the lower part of the fill in the channel is composed of Louviers and Broadway Alluviums. Post-Piney Creek alluvium contains many vertebrate fossils

Piney Creek Alluvuim—Dark yellowish-brown or grayish-orange clayey to fine sandy well-stratified silt. Has weakly developed Brown soil in upper part. Forms terraced alluvial fill in most valleys, but is mapped in only largest valleys. Along South Platte River forms a terrace of which only the lower part is occasionally flooded. Thickness probably exceeds 30 ft (9 m)

Qes EOLIAN SAND (HOLOCENE AND PLEISTOCENE)—Pale-brown, yellowish-brown, or dark yellowish-brown locally silty well-sorted loose wind-blown sand. Contains calcareous Brown soil in upper part. Forms sheets of sand and widespread dunes many of which are more than 100 ft (30 m) high. Some blowouts still are active

Qb BROADWAY ALLUVIUM (PLEISTOCENE—PINEDALE GLACIATION)—Two members (Gardner, 1967), a lower coarse sand that crops out poorly along the South Platte River near Weldona and in small valleys elsewhere, and an upper silty sand that follows the South Platte River from Bijou Creek to Atwood.

Upper member—Yellowish-brown to light olive-brown, wellbedded, silty medium sand. The member contains some pebbles of ash-flow tuff also detrital lignite from the Laramie Formation. Contains fresh-water fossil mollusks. Forms terrace that lies about 90 ft (27 m) above the river near Bijou Creek, but decreases in height to about 15 ft (4.6 m) near Atwood along the South Platte River. Upper member probably was deposited as a result of flash floods along Bijou Creek

Lower member—Light reddish-brown to pale-orange feldspathic well-sorted coarse sand. About 10 percent is well-rounded pebbles. Thickness 20–30 ft (6–9 m)

Qp PEORIA LOESS (PLEISTOCENE—PINEDALE AND BULL LAKE GLACIATIONS)—Moderate yellowish-brown, slightly clayey or fine sandy, blocky, nonstratified wind-blown calcareous silt. Commonly is sandy in lower part. Loess has a columnar structure and stands in vertical cuts or locally in boxlike arroyos. Thickness probably reaches 130 ft (40 m). As mapped, includes some small outcrops of bedrock (mostly Ogallala) and places where bedrock is less than 5 ft (1.5 m) beneath the surface. Thin unmapped loess covers White River Group near Avalo and Ogallala Formation near Clarkville

Ql LOUVIERS ALLUVIUM (PLEISTOCENE—BULL LAKE GLACIATION)—Pale orange, light reddish-brown, or pinkish-brown feldspathic well-stratified moderately well sorted gravel. Contains about 45 percent pebbles and granules, 30 percent sand, and 25 percent silt; median diameter of particles is 1.6 mm (Gardner, 1967, p. 82). The gravel is composed of subangular to rounded clasts of granite pegmatite, gneiss, quartz, and feldspar. The Louviers Alluvium is exposed in few places apparently owing to subsequent erosion and burial beneath younger alluvium. It is inferred to underlie younger alluvium for the full length of the South Platte River in the quadrangle. The thickness possibly is as much as 150 ft (45 m), but is uncertain because the base of the overlying Broadway Alluvium can not be seen

Qll LOVELAND(?) LOESS (PLEISTOCENE—SANGAMON INTERGLACIATION)—Reddish-brown poorly sorted windblown clayey sand or sandy silt. In upper part has strongly developed prismatic or columnar structure, and a nonplastic or sticky slightly plastic consistency when moist. Hard when dry, friable when moist. A very strong Brown soil is developed in the upper part of the loess. Only tentatively correlated with Loveland Loess and considered to be of Sangamon age because it overlies Slocum Alluvium. Thickness quite variable, locally as thick as 15 ft (4.6 m)

Qs SLOCUM ALLUVIUM (PLEISTOCENE—SANGAMON INTERGLACIATION OR ILLINOIAN GLACIATION)—Yellowish-brown to reddish-brown cross-stratified clayey limonitic or calcareous sand and gravel. Alluvium is much coarser along the South Platte River, containing boulders as large as 8 in. (20 cm), than along its tributaries where it locally is silty sand or contains thick clay lenses. Composed of subangular to rounded clasts of quartz, pegmatite, quartzite, granite gneiss, porphyry, chert, and other sedimentary rocks. The unit was mapped only in the northern part of the area, although Gardner (1967), had mapped small patches north of Fort Morgan. The alluvium is as much as 45 ft (14 m) thick along the old channel of the South Platte River as based on well logs. The terrace formed by Slocum Alluvium averages about 60 ft (18 m) above the South Platte River

Qv VERDOS ALLUVIUM (PLEISTOCENE—YARMOUTH INTERGLACIATION OR KANSAN GLACIATION)—Reddish-brown well-stratified coarse gravel containing some sand lenses. Clasts are subangular to rounded and consist of Precambrian pegmatite, quartz, gneiss, quartzite, granite, Tertiary porphyry, Paleozoic chert and locally other sedimentary rocks. Most clasts are fine-grained rocks and few are altered. Some boulders are as large as 10 in (25 cm). The alluvium is loose to firmly consolidated and torrentially cross-stratified; some beds are stained by iron oxide, others by manganese oxide. Contains vertebrate fossils including *Equus* sp. Along Springdale Creek in the NW¼SE¼ sec. 2, T. 8 N., R. 53 W., are conglomerate beds cemented by calcium carbonate and associated with a bed of volcanic ash. This ash bed, which is thought to be type-O Pearlette ash, a marker volcanic ash bed about 600,000 years old with origin in Yellowstone National Park, is also found in the SE1/4 and NE1/4 sec. 23, T. 10 N., R. 52 W. and in the NE/4 NW1/4SW1/4 sec. 14, T. 10 N., R. 51 W. A very strong soil in the upper part of the alluvium contains a reddish-brown clay-enriched B horizon, a calcium carbonate enriched C_{ca} horizon as much as 5 ft (1.5 m) thick and calcium carbonate crusts 1 in. (2.5 cm) thick on the bottoms of clasts. The alluvium is about 30 ft (9 m) thick. Its ancient terrace lies north of the South Platte River and about 160 ft (49 m) above it. Overlying the Ogallala Formation north and west of Wray is reddish-brown sand and gravel apparently reworked from the Ogallala and in the Wray area formerly called the Grand Island Formation (Hill and Tompkin, 1953; Weist, 1964). This sand and gravel deposit is correlated with Verdos Alluvium, but because it is covered by eolian sand and loess and is exposed only in local gravel pits it is not mapped

Qrf ROCKY FLATS ALLUVIUM (PLEISTOCENE—AFTONIAN INTERGLACIATION OR NEBRASKAN GLACIATION)—Reddish-brown or yellowish-brown well-stratified coarse gravel, sand, and silt. Clasts are rounded pegmatite, quartz, granite, quartzite, gneiss, porphyry, chert, and other sedimentary rocks. Contains boulders as large as 12 in. (30 cm). Loose to firmly consolidated; some layers torrentially cross-stratified. Layers stained by iron and manganese oxide. Contains vertebrate fossils including *Equus (Dolichohippus)* sp. A very strong soil in the upper part of the alluvium locally shows a reddish-brown clay enriched B horizon and generally a thick concentration of calcium carbonate including nodules in the C_{ca} horizon. Thickness locally exceeds 30 ft (9 m). The upper surface of its terrace lies 210–270 ft (64–82 m) above the South Platte River

Qn NUSSBAUM ALLUVIUM (PLEISTOCENE—NEBRASKAN GLACIATION)—Reddish-brown, yellowish-brown, or grayish-pink coarse well-stratified gravel. Clasts are chiefly granitic detritus including pegmatite, quartz, granite, but also are gneiss, quartzite, porphyry, chert, petrified wood, and other sedimentary rocks. Boulders as large as 4 in. (10 cm) were seen. Gardner (1967) reported that the alluvium was 50 percent pebbles and larger rocks, 14 percent granules, 21 percent sand, and 15 percent silt and clay. Locally contains lower and upper gravel layers separated by thick calcareous reddish-brown silt and light-gray coarse sand layers. Caliche locally cements the alluvium. A well developed soil of pre-Bull Lake age is preserved on the Nussbaum; the clay-enriched B horizon generally is lacking, but the calcareous C_{ca} horizon is present everywhere. Contains vertebrate fossils. Thickness of the alluvium is about 40 ft (12 m). Its terrace lies 390–450 ft (119–137 m) above the South Platte River

To OGALLALA FORMATION (MIOCENE)—A fluvial deposit locally mapped as upper and lower parts. Deposits south of South Platte River not differentiated but resemble upper part. Miocene age based on upper boundary of Miocene being placed at 5 m.y.

Tou Upper part—Equivalent to the Ash Hollow Member of Condra and Reed (1959) of the Ogallala Formation. In upper part contains a pale-red or very pale orange dense pisolitic caliche layer or limestone, locally brecciated and recemented which forms a bench-forming caprock that is about 2 ft (0.6 m) thick. In Nebraska, this and possibly some underlying beds are assigned to the Kimball Member of the Ogallala Formation by Condra and Reed (1959). The characteristic feature of the Ash Hollow Member is the mortar beds; grayish-orange-pink pebbly sand and silt firmly cemented by calcium carbonate or locally opal and forming many resistant ledges. Nonconsolidated gravel is abundant, clasts are rounded and consist of granitic, sedimentary, and volcanic rocks. Layers of light-brown and yellowish-gray silt lie in the upper part. Contains beds of silver-gray and of biotite-rich volcanic ash and fairly abundant vertebrate fossils. Thickness ranges from 40 to 450 ft (12–137 m)

Tol Lower part—Equivalent in age to the Valentine Member of Condra and Reed (1959) and the lower Snake Creek Beds of McKenna (1965); beds equivalent in age to the underlying Sheep Creek Formation of McKenna (1965) have not been recognized. Includes beds containing the Sand Canyon local fauna of Wood and others (1941), and the Vim-Peetz, Kennesaw, and Eubanks local faunas of Galbreath (1953). Composed of gray to brown semiconsolidated ashy sand and silt beds and volcanic ash beds. Recognized north of Pawnee Buttes and as far east as T. 11 N., R. 53 W., but could be present elsewhere. Thickness almost 150 ft (46 m)

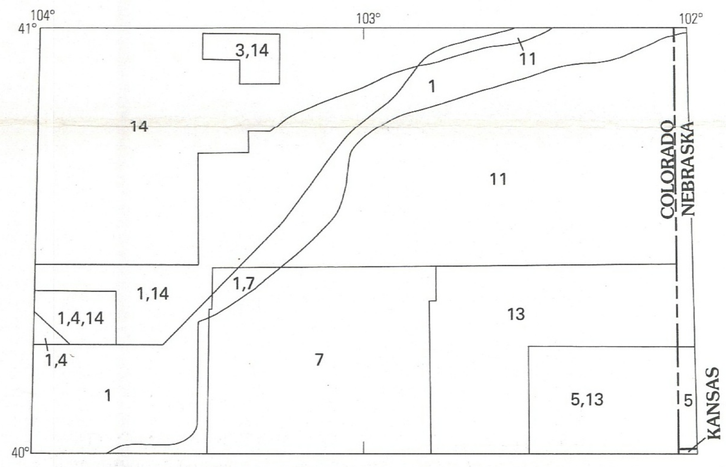
Ta ARIKAREE FORMATION (LOWER MIOCENE)—A fluvial deposit equivalent in age to the Marsland Formation of Schultz (1938) and to the Arikaree Formation as described by Wilson (1960, fig. 7). Only beds containing the Martin Canyon local fauna of the Pawnee Creek Formation of Galbreath (1953) are here included in the Arikaree Formation. The Arikaree consists of gray to brown moderately well consolidated conglomerate, sandstone, siltstone, and claystone, but also contains some gravel and sand. It is characterized by rubble composed of biotite-rich ashy calcareous siltstone nodules that generally are ovoid, but may assume many shapes. The rubble is best developed at the top, but occurs locally throughout the Arikaree. The gravel is cross-stratified and contains clasts of siltstone, quartz, feldspar, and plutonic and volcanic rocks as large as 10 in. (25 cm). The sand is fine to coarse, loose to friable, cross-stratified and commonly occupies channels cut into a next lower bed or into Oligocene beds. Contains vertebrate fossils. Forms badlands. Thickness ranges from 20 to 150 ft (6–46 m)

Tw WHITE RIVER GROUP (OLIGOCENE)—Contains upper and middle Oligocene Brule Formation (needlessly named the Vista Member and Cedar Creek Beds of White River Formation by Galbreath, 1953, and Matthew, 1901, respectively) and underlying lower Oligocene Chadron Formation (also needlessly named the Horsetail Creek Beds by Matthew, 1901) of the White River Formation. Both the Brule and Chadron are fluvial in origin. The Brule is predominantly gray to pale-brown or reddish-brown sandy to slightly clayey ashy mica-bearing siltstone. The siltstone ranges from soft and plastic to hard and blocky. According to Wenzel, Cady, and Waite (1946, p. 67) a sample of siltstone was composed of 26.6 percent sand, 69.4 percent silt, and 3.9 percent clay-size particles. The upper part, equivalent to the Whitney Member of Schultz and Stout (1938) of the Brule Formation, contains small calcareous nodules; a little bit lower in the upper part is a white calcareous marker band that is conspicuous on the scarp at the south edge of the Peetz Table. In the lower part is a thick lenticular pale-red or reddish-brown crossbedded friable, pebbly, cobbly, hard, micaceous channel sandstone and siltstone containing siltstone clasts and granitic gravel; it is equivalent to the Orella Member of Schultz and Stout (1938) of the Brule Formation. Stout (1960) has proposed that use of the Whitney and Orella Member names be extended into northeastern Colorado from Nebraska. The author approves of this proposal and has mapped at one inch equals a mile Brule, and its basal member, the Orella, and the Chadron in much of the Sterling quadrangle, but the contacts are not shown on this small-scale map. The channel sandstone of the Orella Member is a minor wedgelike part of a characteristic gray to pale-brown ashy siltstone unit that shows no stratification. These siltstone beds contain blue barite crystals, calcite "sand crystals", and thin clastic dikes. Forms badlands. Contains vertebrate fossils. Thickness ranges from 200 to 500 ft (61–152 m). The Chadron is mainly light-gray, greenish-gray, light olive-gray, pale-brown, or dark yellowish-brown clayey blocky ashy siltstone and montmorillonitic clay. It contains channels filled by pale yellowish-brown, olive-gray, or yellowish-gray hard silica-cemented crossbedded coarse- to medium-grained sandstone or conglomerate that forms resistant ledges and sinuous channels. The sandstone is composed mostly of quartz and feldspar and contains clay balls and bones and teeth of fossil vertebrates. Locally the sand is uncemented and loose. Grayish-green dense resistant freshwater limestone beds lie in the upper part of the formation. Formation contains altered volcanic ash beds. Thickness ranges from 100 to 250 ft (30–75 m)

Kl LARAMIE FORMATION (UPPER CRETACEOUS)—Yellowish-brown cross-stratified to massive friable "salt and pepper" sandstone, red and brown claystone, and dark-gray to reddish-gray sandy shale of fresh or brackish water origin. Contains platy limonitic concretions and lignitic coal. Contains oyster beds two ft (0.6 m) thick. Fossil burrows of *Ophiomorpha* normally lacking in the Laramie were not found; this serves to differentiate it from the Fox Hills. Probably less than 100 ft (30 m) thick

Kf FOX HILLS SANDSTONE (UPPER CRETACEOUS)—Yellowish-brown, yellowish-orange, or yellowish-gray thin hard or thick soft friable marine sandstone that is in part crossbedded. Contains some thin beds of olive-gray sandy shale; however the boundary between the Fox Hills and the Pierre Shale was picked where the overlying beds were chiefly sandstone and the underlying beds were chiefly shale. The Fox Hills is lighter gray and softer in the upper part than in the lower part. It contains many large gray to brown hard calcareous sandstone concretions as large as 8 ft (2.4 m). The concretions are quite resistant to erosion and cause the Fox Hills to form rough steep valley walls north of Fort Morgan. Contains *Ophiomorpha*. The Fox Hills probably is a little more than 150 ft (45 m) thick

Kpt UPPER TRANSITION MEMBER OF PIERRE SHALE (UPPER CRETACEOUS)—Dark-gray marine calcareous silty shale or claystone, shaly sandstone, and sandy shale comprising the upper transition member of the Pierre Shale, the only member observed in the area. Member weathers grayish-orange, olive-gray, yellowish-gray, or dark yellowish-orange. The yellowish-brown sandstone occurs as hard to soft layers several feet thick or as lenses a fraction of an inch thick that contain trace fossils and fecal pellets. Contains large (6 ft, 1.8 m) and small calcareous sandy or nonsandy concretions, some of which are fossiliferous. Fossils include *Sphenodiscus (Coahuilites)* sp. and *Baculites clinolobatus*, which are diagnostic of the upper transition member of the Pierre Shale in northeastern Colorado. Also contains nearly continuous concretionary limestone beds, some as long as 50 ft (15 m) and several feet in thickness, and thin gypsum layers. Pierre Shale ranges from nearly 6,000 ft (1,828 m) thick in western part to a little more than 1,000 ft (305 m) thick in the eastern part of the area



INDEX SHOWING SOURCES OF GEOLOGIC DATA

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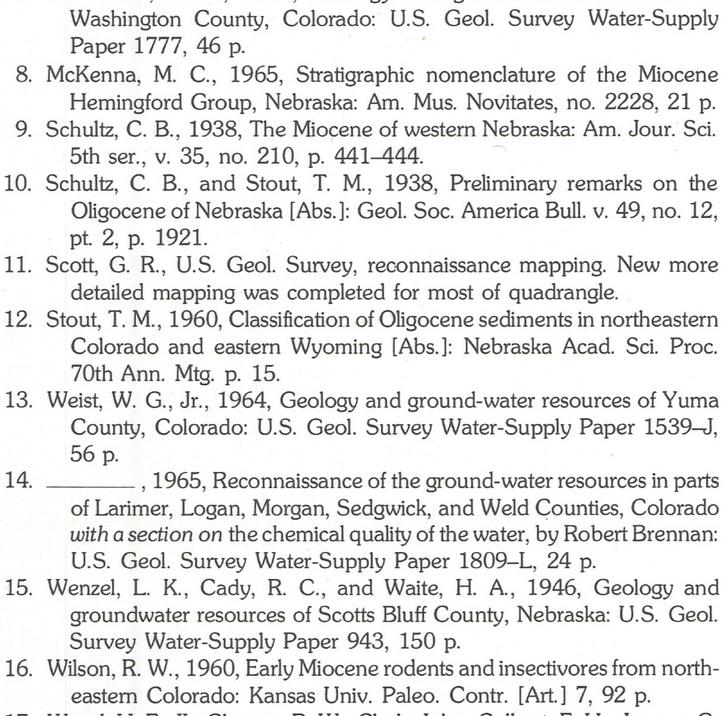

INDEX MAP SHOWING AREA OF STERLING QUADRANGLE AND OTHER PUBLISHED 1°×2° QUADRANGLE MAPS

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