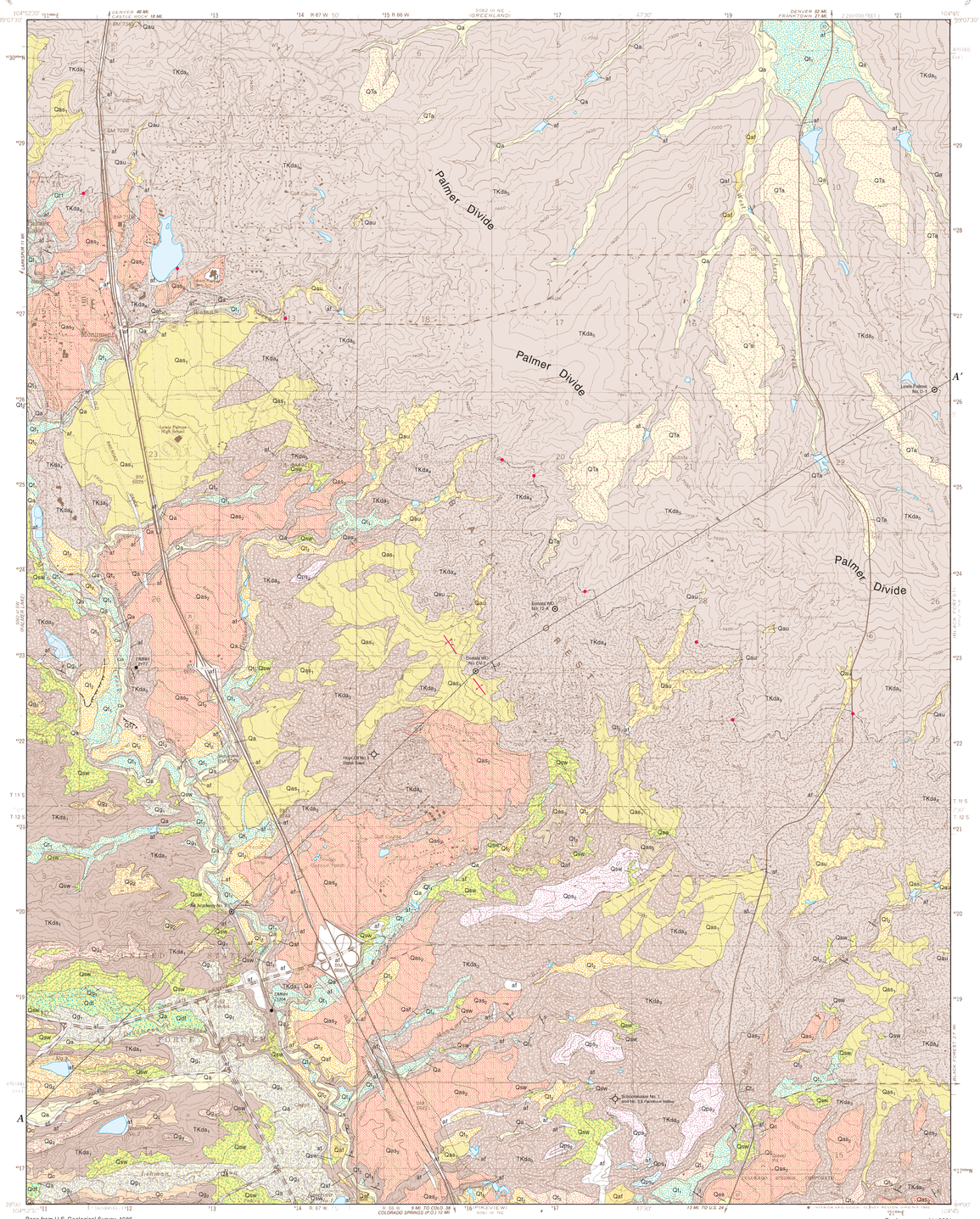
COLORADO GEOLOGICAL SURVEY
DIVISION OF MINERALS AND GEOLOGY
DEPARTMENT OF NATURAL RESOURCES
DENVER, COLORADO

OPEN FILE MAP 02-4
GEOLOGIC MAP OF THE MONUMENT
QUADRANGLE, EL PASO COUNTY, COLORADO
Booklet accompanies map



CONDENSED DESCRIPTION OF MAP UNITS

The complete description of map units and references are in the accompanying booklet.

SURFICIAL DEPOSITS

(The modified Wentworth scale is used to describe sediment particle sizes, and except for unit QTa, colors of surficial deposits are from Munsell Soil Color charts.)

ANTHROPOGENIC DEPOSITS—Earth materials emplaced or modified by human beings or deposited as a consequence of human activities

af — **Artificial fill (late Holocene)**—Gravel, sand, silt, clay, and rock debris emplaced for constructing highways, railroads, dams, and commercial and residential structures. Thickness generally is between 5 and 30 ft

ALLUVIAL DEPOSITS—Sand, silt, gravel, and clay transported and deposited by flowing water in channels or as unconfined runoff or sheet flow. Deposits resulting from sheet flow are referred to as sheetwash alluvium. Stream alluvium is the principal deposit underlying flood plains and stream terraces

Qa — **Channel and flood-plain alluvium (late Holocene)**—Pale-brown to brown sand, gravel, silt, and minor clay underlying narrow flood plains, stream channels, and, locally, low terraces flanking flood plains. Unit is subject to frequent flooding. Estimated thickness is 3–7 ft

Qt_1 — **Terrace alluvium one (Holocene and late Pleistocene)**—Pale-brown and brown to grayish-brown and dark-grayish-brown beds of sand, silty fine sand, sandy silt, clayey silt, and gravel. Stratification generally is weakly expressed. Qt_1 includes both the Husted Alluvium and Monument Creek Alluvium of Varnes and Scott (1967). The upper surface of the unit is 5–25 ft higher than Monument, Black Squirrel, and Kettle Creeks, but is only about 3–10 ft higher than the smaller streams of the area. Infrequent large floods may inundate Qt_1 in places. Thickness is estimated to be 5–35 ft.

Qt_2 — **Terrace alluvium two (late-middle Pleistocene)**—Very pale-brown to brown, extremely poorly sorted sand and subordinate amounts of gravel. In places along Monument Creek, Qt_2 contains large cobbles and small boulders, mostly of Pikes Peak Granite. Along streams draining from the upland east of Monument Creek, the unit consists chiefly of sand and sandy fine pebble gravel (mostly 0.08–0.32 in. in size) that reflect the dominant grain sizes of the Dawson Formation from which they were derived. The upper surface of the unit is typically 35–40 ft higher than Monument Creek. The unit corresponds to the Kettle Creek Alluvium of Varnes and Scott (1967). Thickness is 5–20 ft

Qt_3 — **Terrace alluvium three (late-middle Pleistocene)**—Chiefly pale-brown to strong brown, extremely poorly sorted sand and gravel that underlie terrace remnants along the larger streams of the area. In the upper reaches of Monument Creek, the unit consists of sand, pebbles, cobbles, and boulders that were derived primarily from granitic rocks of the Rampart Range. Similar large clasts of granitic rock are not present in deposits of Qt_3 in valleys that originate in the Black Forest. The upper surface of the unit is 50–60 ft higher than Monument, Black Squirrel, and Kettle Creeks, but only about 30 ft higher than lesser streams such as Monument Branch. Estimated thickness is 5–30 ft

Qg_1 — **Old gravel one (late-middle Pleistocene)**—Chiefly brown to reddish-brown, extremely poorly sorted sand and fine gravel. Boulders and cobbles are common and widespread but make up only a small part of the unit. Most clasts are Pikes Peak Granite. The unit underlies a surface that is 80–120 ft higher than Monument Creek. The unit includes the type locality of Pine Valley Gravel of Varnes and Scott (1967). Estimated thickness is 5–30 ft

Qg_2 — **Old gravel two (middle Pleistocene)**—Similar to unit Qg_1, but it is less extensive and higher in the landscape. Unit composition and texture are inferred from landforms and clasts on the ground surface and descriptions provided by Varnes and Scott (1967) who named the unit Douglass Mesa Gravel. The upper surface of unit Qg_2 is about 100 ft higher than adjacent valley floors and 200 ft higher than Monument Creek. Estimated thickness is 5–50 ft

Qg_3 — **Old gravel three (early Pleistocene)**—Similar to units Qg_1 and Qg_2. Unit Qg_3 is the Lehman Ridge Gravel of Varnes and Scott (1967). The upper surface of unit Qg_3 is about 160–220 ft higher than adjacent valley floors and 380 ft higher than Monument Creek. Thickness may exceed 65 ft

Qau — **Alluvium, undivided (Holocene and Pleistocene)**—Chiefly pale brown to brown, poorly sorted sand and fine gravel in valley heads. The unit includes sheetwash and stream-deposited alluvium that are undivided for various reasons. Reasons include 1) different ages of alluvium are superposed, 2) exposures are poor, and 3) two or more units are present but are too small to show separately at the map scale. Qau probably includes sediment that is correlative with units Qsw, Qa, Qt_1, and possible Qt_2. Estimated thickness is 3–30 ft

Qps_1 — **Younger paleochannel sand (middle-middle Pleistocene)**—Unit is similar in form, origin, and presumably character to Qps_2. Deposits are about 80 ft higher than Black Squirrel Creek. Unit may be correlative with Qg_1. Estimated thickness 5–25 ft

Qps_2 — **Older paleochannel sand (early-middle Pleistocene)**—Chiefly very pale-brown, conspicuously stratified, medium to very coarse sand and thin beds and lenses of fine pebble gravel. These paleochannel deposits are inverted and now cap some of the higher bedrock surfaces in the landscape. Qps_2 is better sorted and stratified than terrace alluvium along Monument Creek. Deposits are 120–150 ft higher than Black Squirrel Creek and Monument Branch. The unit may be correlative with Qg_2. Thickness may exceed 55 ft

Qsw — **Sheetwash (Holocene and upper Pleistocene)**—Typically, pale-brown to brown, extremely poorly sorted sand, silty and clayey sand, and minor amounts of gravel. Unit consists chiefly of material transported from the upper parts of valley-side slopes by sheet flow, but also includes some sediment delivered by runoff from rills and minor gullies. Qsw exists principally in sheets and wedges along valley sides and footslopes. Estimated thickness is 3–15 ft

Qaf — **Alluvial-fan deposits (Holocene and latePleistocene)**—Pale-brown to brown, very poorly sorted sand, silt, and minor gravel deposited on fans at the edges of valley floors by ephemeral tributary streams. Estimated thickness 5–20 ft

Qas_1 — **Younger alluvial-slope deposits (Holocene and late Pleistocene)**—Unit is similar in form and origin to Qas_2, but is poorly exposed and less extensive. It includes deposits of both sheet flow and fluvial origin, which collectively form general broad, thin alluvial veneers on slopes that were graded westward toward Monument Creek. Estimated thickness is 5–15 ft

Qas_2 — **Middle alluvial-slope deposits (middle Pleistocene)**—Unit consists of thin beds of very pale-brown to brown, poorly sorted sand and sandy fine pebble gravel (mostly 0.08–0.3 in. in size) that are similar to those of Qps_2. Unit comprises sheetwash and stream-deposited alluvium that span a broad range of time and include deposits of more than one age. Some deposits are probably correlative with terrace deposits and older gravels along the larger streams of the area, but others owe their existence to non-synchronous channel avulsions and stream piracies. Estimated thickness 5–40 ft

Qas_3 — **Older alluvial-slope deposits (early Pleistocene)**— Unit is similar in form, and presumably character and origin, to Qas_2. The largest remnant of Qas_3 in the area is at the upper end of the interfluve between Smith Creek and Monument Branch. No sedimentological information is available for the unit. Estimated thickness 5–15 ft

QTa — **Alluvium of Palmer Divide (early Pleistocene or Pliocene?)**—Unit is chiefly very pale-brown, pale-brown, and pinkish-brown fine to coarse sand interbedded with pinkish-gray to light-brownish-gray pebble gravel. Sands are poorly sorted, medium to thin bedded, laminated, and composed largely of quartz grains. Pebble gravels consist primarily of white and light-gray quartz, light-pink to light-red and reddish-brown feldspar, and pink to light-red to reddish-brown granite in a sandy matrix. Strata range from massive to thinly bedded and include lamina and small lenses of pebble gravel. Weathered and eroded surfaces on QTa are covered with a pebble lag in which white quartz is prominent. On the Palmer Divide (E1/2 sec. 20, T. 11 S., R. 77 W.) sand and pebble gravel are interbedded with cobble and boulder gravel. The coarse gravel consists of pink to reddish-brown Pikes Peak Granite, buff to light-brown weathered arkose, white and light-gray quartz, and gray and light-brownish-gray welded tuff in a matrix of gray sand. Lag deposits of cobbles and boulders of these lithologies also are present on weathered bedrock

MASS-WASTING DEPOSITS—Earth materials translocated downslope under the influence of gravity. Although creep is a form of mass wasting, material translocated by creep is not mapped as a separate unit because it exists to some degree on most slopes. Furthermore, it is slow and its contribution to surficial deposits such as colluvium generally cannot be discerned in the field or on aerial photography

Qc — **Colluvium (Holocene and late Pleistocene)**—Unit comprises slope deposits that consist chiefly of very pale-brown to brown sand and fine gravel. Deposits typically are massive and very poorly sorted to extremely poorly sorted. Unit may include minor amounts of sheetwash locally. Unit is estimated to be 2–10 ft thick

Qdf — **Debris-flow deposits (Holocene? and late-middle Pleistocene)**—Extremely poorly sorted matrix-supported gravel in small drainage basins in the southwestern part of the quadrangle. No sedimentological information is available for the deposits, other than that inferred from landforms and materials on the ground surface. Clasts are chiefly Pikes Peak Granite. Unit postdates Qg_1, and may include deposits that are late Pleistocene. Estimated thickness is 5–20 ft

EOLIAN DEPOSITS—Wind-deposited sediment

Qes — **Eolian sand (middle and early Holocene and late Pleistocene)**—Very pale-brown, pale-brown, and light-yellowish-brown sand. Unit is predominantly very coarse sand and coarse sand that apparently was deposited as sand sheets or low-relief dunes that lack distinct slip faces. Thickness is estimated to be 3–15 ft

BEDROCK DEPOSITS

Dawson Formation (Upper Cretaceous to Eocene)—Divided into upper and lower parts

Upper Part of the Dawson Formation (Upper Cretaceous to Eocene)—The upper part of the Dawson Formation is divided into facies unit one ($TKda_1$), facies unit two ($TKda_2$), facies unit three ($TKda_3$) facies unit four ($TKda_4$), and facies unit five ($TKda_5$); differentiated on the relative proportions of andesitic and arkosic material, on the thickness and style of coarse-grained bedding units, and on the relative proportion of fine-grained claystone and siltstone, compared to coarser-grained sandstone, arkose, pebbly arkose, and pebble conglomerate

$TKda_1$ — **Facies unit one (Upper Cretaceous to Paleocene)**—Unit composed of white to light-gray, cross-bedded or massive, very coarse arkosic sandstone, pebbly arkose, or arkosic pebble conglomerate; contains occasional interbeds of thin- to very thin-bedded gray claystone and sandy claystone; or dark-brown to brownish-gray, organic-rich siltstone to coarse sandstone containing abundant plant fragments. May also contain massive, light-gray to light-brownish-gray, thick to very thick, homogeneous beds with little internal structure except poorly developed crude grading of coarser fragments, disseminated small dark flakes of carbonaceous organic material (often charcoal), and a few wispy dark laminae; interpreted to be mud flow deposits. Occasional interbeds of dark-brown to brownish-gray organic-rich siltstone to coarse sandstone with abundant plant fragments; may grade downward into coarse pebbly arkose or mudflow beds; tops are generally sharp; load deformation structures where overlain by thick arkosic conglomerate or mudflow beds; interpreted as the deposits of ephemeral swamps or swampy soil horizons. Unit also contains numerous interbeds of 1- to 3-ft-thick, pink, yellow-brown, and red weakly developed oxidized paleosols. In the Monument quadrangle facies unit one is 700 to 900 ft thick

$TKda_2$ — **Facies unit two (Upper Cretaceous to Paleocene)**—Not exposed in the Monument quadrangle but shown on cross section; 400 to 500 ft thick. See booklet for description

$TKda_3$ — **Facies unit three (Paleocene)**—Unit consists of subequal amounts of thick and very thick-bedded, massive and cross-bedded, white, tan, and light-gray arkose and pebbly arkose; thin to thick beds of light-green to olive-gray clay-rich, fine- to medium-grained micaceous and feldspathic sand-stone; and thin to thick beds of dark-gray to greenish-gray sandy claystone. Very thick-bedded, massive or cross-bedded, light-colored arkose beds in facies unit three resemble those in facies unit one but are finer grained and generally thinner; lithologies of coarse grains more varied than facies unit one, with quartz, white feldspar, pink feldspar, white granite, pink granite, and small amounts of tan vuggy dolomite and red, black, or orange-brown chert, rare altered volcanics. The light-green to olive-gray, clay-rich, fine- to medium-grained micaceous and feldspathic sandstone and dark-gray to greenish-gray sandy claystone resemble lithologies in the lower part of facies unit two in the Pikeview and Elsmere quadrangles (Thorson and others, 2001; Madole and Thorson, 2002); may have occasional thin, poorly developed, paleosols; reported coaly strata are not exposed at surface. Unit 500 to 600 ft thick in southeast; thins toward northwest as it interfingers with facies unit one and facies unit four

$TKda_4$ — **Facies unit four (Paleocene)**—Similar to facies unit one ($TKda_1$); dominated by very thick bedded to massive, cross-bedded, light colored arkoses, pebbly arkoses and arkosic pebble conglomerate; contains common white to light-tan, fine- to medium grained feldspathic cross-bedded friable sandstone, poorly sorted with high clay content, thin or medium bedded; wavy bedding and ripple cross-laminations common. Unit contains massive structureless mudflow beds that occasionally have dark-colored swampy soil zone tops. Contains rare interbeds of thin- to very thin-bedded gray claystone and sandy claystone; or dark-brown to brownish-gray, organic-rich siltstone to coarse sandstone containing plant fragments. Facies four is about 500 ft thick in the center of the quadrangle; it may thin towards the northwest and thicken towards the southeast.

The top of facies unit four is a regional paleosol developed at the boundary between the Paleocene and Eocene epochs. Makes very poor natural exposures, but man-made exposures of this well-developed paleosol are multiple zones of bright-maroon to dark-red, very clayey coarse sandstone and fine pebble conglomerate mottled with yellow-brown and greenish-gray patches and cut by root structures; very clayey, has very coarse sand-size grains or fine pebbles of clear and light- to dark-gray quartz floating in a matrix of red, maroon, yellow-brown, or greenish-gray sandy structureless claystone; up to about 40 ft thick

$TKda_5$ — **Facies unit five (early to middle(?) Eocene)**—Similar to facies units one and four ($TKda_1$, $TKda_4$); dominated by thick-bedded to massive, cross-bedded, light-colored arkoses and pebbly arkoses, but the individual grains of feldspar or granite are often pink instead of light gray to white; contains common white to light-tan, fine- to medium grained feldspathic cross-bedded friable sandstone, poorly sorted with high clay content, thin or medium bedded; wavy bedding and ripple cross-laminations common. Contains rare interbeds of thin- to very thin-bedded gray claystone and sandy claystone, or dark-brown to brownish-gray, organic-rich siltstone to coarse sandstone containing plant fragments. In the northwestern part of the quadrangle unit $TKda_5$ contains thin, poorly developed, red, pink, and yellow-brown oxidized paleosol zones interbedded with, or developed within, thick arkoses. Facies five is about 500 feet thick in the northwest part of the quadrangle; its top has been eroded

Kda — **Lower part of Dawson Formation (Upper Cretaceous)**—Yellowish-green and greenish-gray to olive-brown sandstone interbeded with grayish-green to dark-green and brown to brownish-gray siltstone and sandy claystone; composed almost exclusively of andesitic debris. About 300 ft thick; shown only on cross section

Kl — **Laramie Formation (Upper Cretaceous)**—Yellowish-gray, olive-gray and brownish-gray sandy shale and thick- to very thick-bedded, white, light-gray, or light-orange sandstone. About 600 ft thick; shown only on cross section

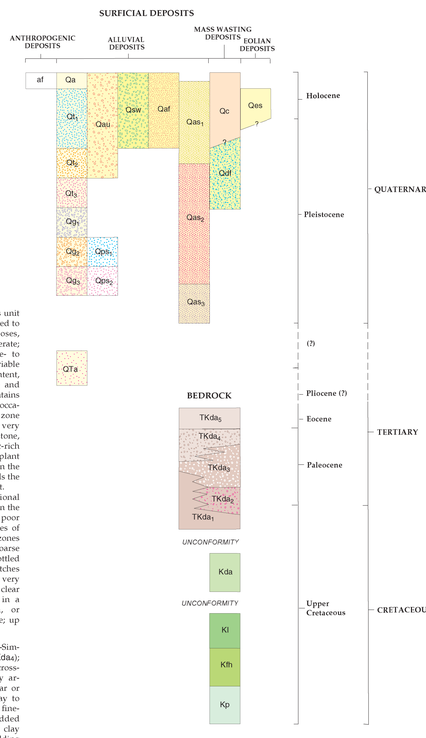
Kfh — **Fox Hills Sandstone (Upper Cretaceous)**—Greenish-gray to yellowish-brown micaceous sandstone. About 150 ft thick; shown only on cross section

Kp — **Pierre Shale (Upper Cretaceous)**—Dominantly gray to dark-gray shale. About 4,500 ft thick; shown only on cross section

MAP SYMBOLS

- **Contact**—Dashed where approximately located; dotted where concealed
- **Anticline**
- **Terrace scarp**—Separates contiguous deposits of same map unit; tick marks are on side of lower surface
- **Strike and dip of inclined beds**—Angle of dip shown in degrees
- **Man-made exposures of well developed paleosol**—May be the regional paleosol at the Paleocene–Eocene boundary; projections of the paleosol shown by dashed line
- **Oil and gas test well**—plugged an abandoned
- **Water well shown on cross section**
- **Fossil locality**—With Denver Museum of Nature and Science collection number
- **Alignment of cross section**

CORRELATION OF MAP UNITS



QUATERNARY TIME CHART

FORMAL TIME DIVISIONS		INFORMAL TIME DIVISIONS	AGE[1] (Sidereal Years)
Quaternary Period	Holocene Epoch		~11,500
	Pleistocene Epoch	late Pleistocene	~127,000
		middle Pleistocene	~778,000
		early Pleistocene	~1,806,000
Tertiary Period (part)	Pliocene Epoch		

[1] See section on chronology in booklet for explanation sidereal-year ages shown here.

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State of Colorado
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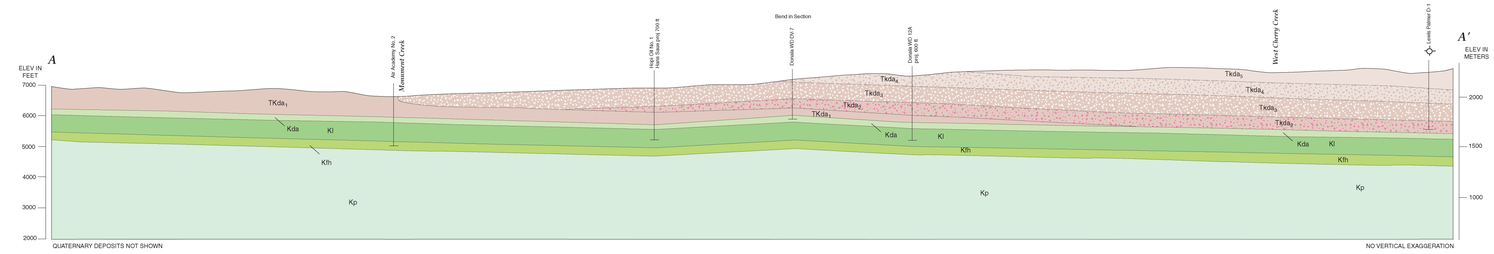
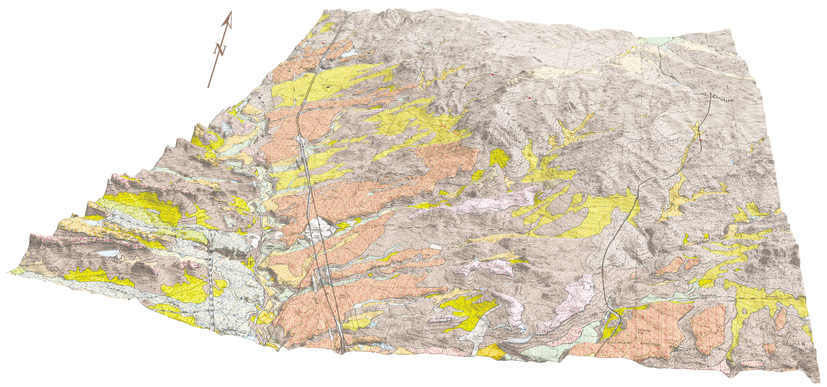


SHADED-RELIEF MAP OF THE MONUMENT QUADRANGLE WITH GEOLOGY AND TOPOGRAPHY OVERLAY, OBLIQUE VIEW LOOKING NORTH NORTHWEST



GEOLOGIC MAP OF THE MONUMENT QUADRANGLE, EL PASO COUNTY, COLORADO

By Jon P. Thorson and Richard F. Madole

2003