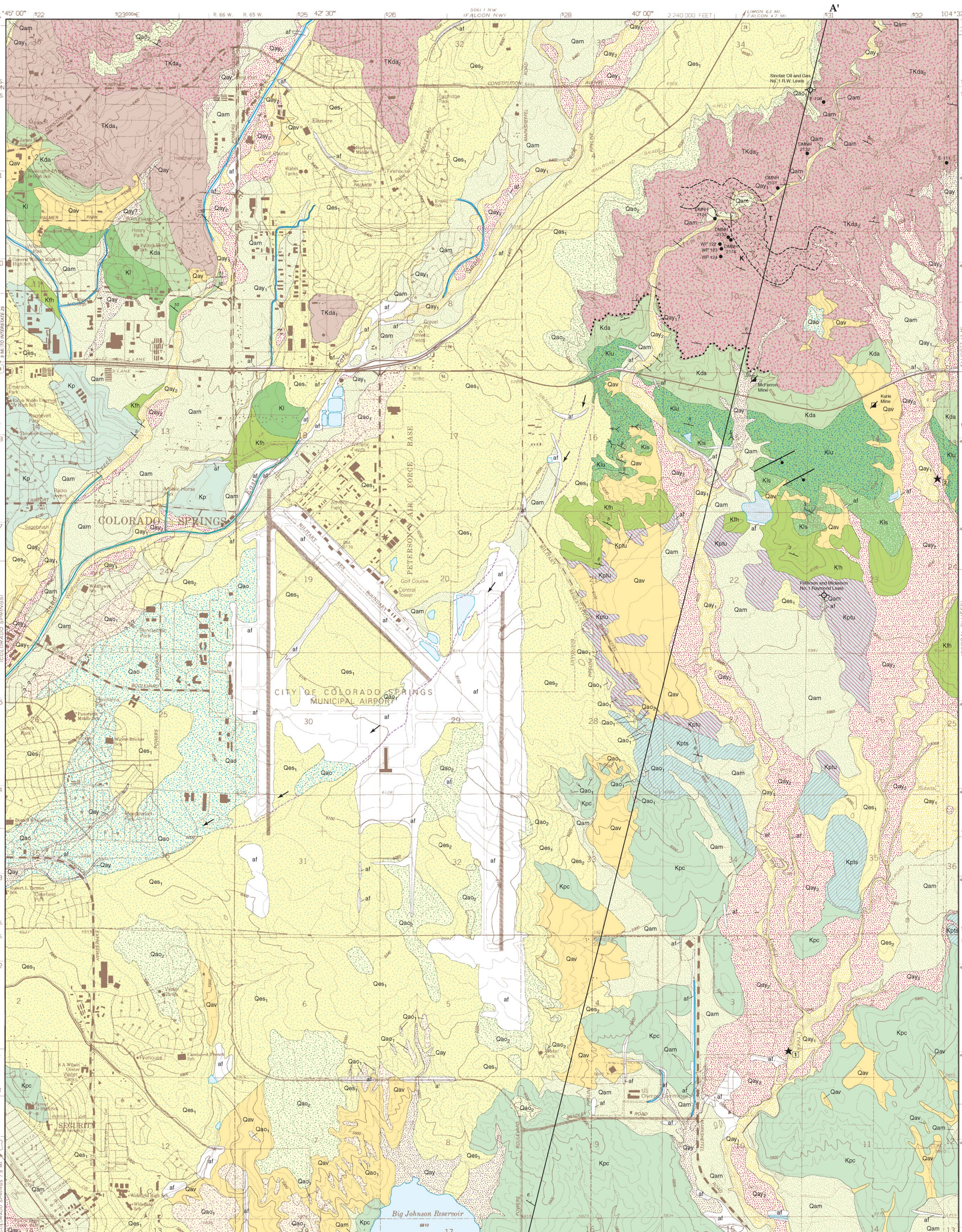
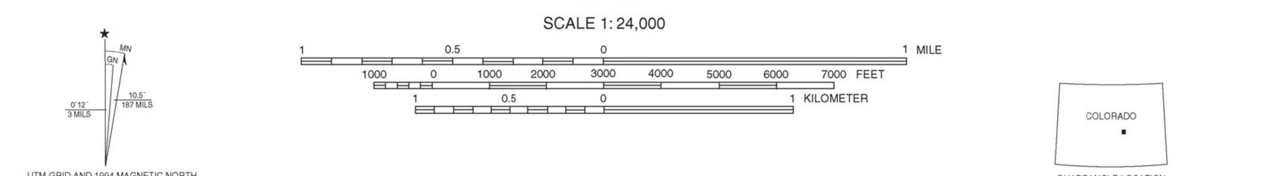
COLORADO GEOLOGICAL SURVEY
DIVISION OF MINERALS AND GEOLOGY
DEPARTMENT OF NATURAL RESOURCES
DENVER, COLORADO

OPEN FILE MAP 02-2
GEOLOGIC MAP OF THE ELSMERE
QUADRANGLE, EL PASO COUNTY, COLORADO
Booklet accompanies map



Base from U.S. Geological Survey, 1994
Polyconic projection, 1927 North American datum 1983
10,000-foot grid based on Colorado coordinate system, central zone



SCALE 1: 24,000

Geology mapped in 2001
Digital cartography by Cheryl Brchan

CONDENSED DESCRIPTION OF MAP UNITS

Condensed map-unit descriptions focus primarily on lithology, location, and thickness. More complete descriptions of the units, their ages and stratigraphic relations, and references to relevant publications are in the accompanying booklet.

SURFICIAL DEPOSITS

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

af — **Artificial fill (late Holocene)**—Sand, silt, clay, and rock debris emplaced for roadbeds, railroads, parking lots, dikes, embankments, earthen dams, and construction sites for residential and commercial buildings. Thickness is estimated to be 3–30 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

Qay_1 — **Young alluvium one (late Holocene)**—Chiefly light-brownish-gray, grayish-brown, and dark-grayish-brown, poorly sorted sand, silty sand, and minor pebble gravel. Qay_1 exists on narrow flood plains and the floors of stream channels, most of which are incised, and it blankets Qay_2 in areas adjacent to incised channels and over a broad fan-shaped area along the east edge of the quadrangle. Much of Qay_1 lacks soil development, but some has existed long enough for a 2- to 8-in.-thick A horizon to form (see Fig. 4 and Table 3 in booklet for explanation of soil terminology). Areas of Qay_1 are subject to frequent flooding. Exposed thickness generally is 2–8 ft

Qay_2 — **Young alluvium two (late and middle? Holocene)**—Sediment is similar to that of Qay_1, except that it includes several thin beds and lenses of dark-grayish-brown to very dark-grayish-brown sediment. Qay_2 blankets large areas on broad valley floors. It is overlain by Qay_1 near present-day stream channels and, in places, it overlaps Qam. In other words, Qay_1, Qay_2, and Qam may exist side by side at nearly the same level. The upper surface of Qay_2 is generally 10–15 ft higher than stream channels in the northern part of the quadrangle and 15–20 ft higher in the southern part of the area. A very weak, 6- to 18-in.-thick soil is developed in Qay_2.Unit is subject to infrequent large floods. Estimated thickness is 10–20 ft

Qay — **Young alluvium, undivided (Holocene)**—Unit consists of Qay_1 and Qay_2 undivided because exposures are poor or deposits of the two units are too small to show separately at the map scale. Estimated thickness is 10–20 ft

Qam — **Middle alluvium (late Pleistocene)**—Chiefly light-brownish-gray, pale-brown, light-yellowish-brown, and grayish-brown, poorly sorted sand and subordinate amounts of gravel. Unit underlies a terrace that, except along Fountain Creek (southwestern part of area), is only slightly higher (3–5 ft) than Qay_2. Along Fountain Creek, the upper surface of Qam is 40–50 ft higher than the creek and 30–40 ft higher than Qay_2. Moderately developed soil profiles consisting of A/Bw/BC/C, A/BA/Bt/BC/C, and A/AB/Bt /Bk/C horizon sequences are developed in unit Qam (see Fig. 4 and Table 3 in booklet for explanation of soil nomenclature). Estimated thickness is 20–50 ft

Qao_1 — **Old alluvium one (middle Pleistocene)**—Chiefly pale-brown to strong-brown, extremely poorly sorted, fine to very coarse sand, silty and clayey sand, and gravel. Unit occupies positions in the landscape that are higher than those of Qam, but are lower than Qao_2. Deposits of Qao_2 are 20–160 ft higher than the channels of major streams. Estimated thickness is 3–30 ft

Qao_2 — **Old alluvium two (middle and early? Pleistocene)**—Sediment is similar to that of Qao_1 and is distinguished from it solely on the basis of position in the landscape and height above stream level. Qao_2 underlies the highest surfaces in the landscape. Most deposits are about 200 ft higher than the channels of major streams. Estimated thickness 10–80 ft

Qao — **Old alluvium, undivided (middle and early? Pleistocene)**—Unit may include deposits of more than one age that are undivided because exposures are poor and relative-age dating techniques generally are not useful for differentiating them. Over much of the area, a thick cover of eolian sand prevents comparison of the weathering profiles developed in this unit. Unit thickness is unknown, but could be as much as 80 ft

Qav — **Valley-side alluvium, undivided (Holocene and late Pleistocene)**—Chiefly brown to light-yellowish-brown, extremely poorly sorted sand, silty and clayey sand, and minor amounts of mostly pebble-size gravel. Unit exists primarily on valley-side slopes and alluvial fans and consists of sheetwash and reworked wind-deposited sediment. Estimated thickness is 3–25 ft

EOLIAN DEPOSITS—Wind-deposited sediment

Qes_1 — **Younger eolian sand (middle and early Holocene and late? Pleistocene)**—Very pale-brown, pale-brown, and light-yellowish-brown sand. Unit is chiefly very coarse and coarse sand that appears to have been deposited as sand sheets. Unit typically has thin soils consisting of A/C or A/AC/C horizon sequences. Unit thickness is estimated to be 3–20 ft

Qes_2 — **Older eolian sand (late Pleistocene)**—Unit is similar in most respects to Qes_1, except it contains more fine sediment (chiefly silt) and a thicker more complex soil profile (A/Bt/Bk/C horizon sequence). Unit thickness is estimated to be 3–15 ft

BEDROCK

Dawson Formation (Upper Cretaceous, Paleocene, and Eocene)—Consists of an upper part that is upper Cretaceous, Paleocene, and Eocene in age, and a lower part that is of upper Cretaceous age. The lower part and the lower portion of the upper part are present in the quadrangle

Upper part (Upper Cretaceous and Paleocene)—Divided into four informal members or lithofacies units (see Figure 5 in the accompanying booklet). Only facies units one and two crop out in the Elsmere quadrangle. Facies unit one occurs as a very thick "basin-edge" deposit closer to the mountain front and as a basal unit, below finer grained facies, in the Elsmere quadrangle. The finer grained basinal facies unit two interfingers with the coarser facies; contacts between facies are gradational

$TKda_2$ — **Facies unit two**—Brownish-gray, yellowish-gray, and light-yellow-brown, pebbly sandstone interbedded with yellowish-gray to grayish-green, fine- to coarse-grained micaceous sandstone and sandy claystone and with dark-gray, greenish-gray, and dark-brown sandy claystones with variable amounts of organic material. Sandstones and pebble conglomerates are generally poorly sorted, micaceous, and commonly massive or cross bedded and make discontinuous lenses which appear to be channel fillings. Pebbles in some conglomerate beds are 30 to 40 percent volcanic fragments mixed with quartz and feldspar. Occasional beds of light-gray arkosic sandstone and pebble conglomerate, similar to facies unit $TKda_1$, occur in smaller discontinuous channels. Sandstone and pebble conglomerate beds commonly contain large clasts of claystone and occasionally contain petrified logs and large fragments of coalified wood. Heavy dotted line at the base of $TKda_2$, in Jimmy Camp Creek, is a thin layer of $TKda_1$ about 10 to 30 ft thick. Stippled zone in $TKda_2$ across Jimmy Camp Creek is the approximate position of the Cretaceous-Tertiary boundary. Only about 1,000 ft of unit is preserved in quadrangle

$TKda_1$ — **Facies unit one**—White to light-gray, cross-bedded or massive, very coarse arkosic sandstone, pebbly arkose, or pebble conglomerate and lesser amounts of white to light-tan, crossbedded, poorly-sorted, fine- to medium-grained feldspathic sandstone. 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 plant fragments. Thickness varies from about 200 ft in the northeastern part of the quadrangle to about 25 ft in Jimmy Camp Creek; pinches out further southeast. Heavy dotted line at the base of $TKda_2$, in Jimmy Camp Creek, is a thin layer of $TKda_1$ about 10 to 30 ft thick

Kda — **Lower part (Upper Cretaceous)**—Orange-weathering, yel-lowish-green and greenish-gray to olive-brown sandstone almost exclusively composed of andesitic material, interbedded with grayish-green to dark-green and brown to brownish-gray siltstone and sandy claystone. Sandstones thick to very thick bedded, massive or crossbedded, and grade up to finer grain size material in most beds; very poorly sorted and contain abundant greenish-gray clayey matrix. Finer grained beds are mostly greenish-gray clayey material mixed with a variable proportion of organic material; occasional thin beds of coal and dark-brown coaly shale, greenish-gray tuff, and light-gray clastic dikes. Locally at the base of the member there are lenticular beds of light-gray, medium- to coarse-grained, crossbedded, quartzose pebbly sandstone or yellowish-gray to orange chert-pebble conglomerate. Unit is about 300 ft thick in the Elsmere quadrangle

Kl — **Laramie Formation, undivided (Upper Cretaceous)**—Divided into two members: upper member and sandstone member. Areas of probable Laramie Formation that were mapped by previous studies, but now obscured by urbanization are shown as undivided Laramie Formation on map

Klu — **Upper member**—Yellowish-gray, olive-gray, and brownish- gray sandy shale that makes poor natural outcrops, thin coal beds, and channel fillings of fine- to medium-grained, light-colored sandstone. Sandstone beds often cemented with limonitic iron oxides which form discontinuous lenticular layers of resistant ironstone. Two or three thin coal beds 1 to 10 ft thick; local bright-red or orange sandstone or shale beds oxidized and baked by burning coal. About 400 ft thick

Kls — **Sandstone member**—Thick- to very thick-bedded, white, light-gray, or light-orange, crossbedded sandstone with small amounts of gray and brown sandy shale and fine-grained sandstone interbeds. Sandstones are fine to medium grained and subangular to subround; uppermost beds may be coarse grained. Small amounts mica and dark grains of sand-size chert are characteristic. Outcrops are often littered with small spherical concretions of iron-oxide-cemented sandstone 2 to 3 inches in diameter. Common burrows including *Ophiomorpha*. Small clastic dikes of light-colored sandstone that cut overlying coal or shale may weather in relief on upper bedding plane. Basal unit of light-gray to light-brownish-gray, very fine-grained sandstone intebedded with gray sandy shale and minor brown organic-rich shale is seldom exposed. About 150 ft thick

Kfh — **Fox Hills Sandstone (Upper Cretaceous)**—Thin to thick beds of very fine- to medium-grained, yellowish-gray to yellowish-brown sandstone, micaceous and in part ferruginous; contains large brown calcareous concretions up to 5 ft in diameter; thin layers of gray sandy limestone in the base. Thin layers or ledges of iron-oxide-cemented sandstone commonly contain smooth polished pebbles of white to dark-brown phosphate and rare shark teeth. *Pelecypod* fossils in the middle and lower parts; *Ophiomorpha* burrows are common in sandstone beds and large concretions. The shales interbedded with the sandstone are olive-gray and sandy. About 150 ft thick

Kp — **Pierre Shale (Upper Cretaceous)**—Gray to dark-gray shale that weathers to brown and olive-green clay; lesser amounts of yellowish-gray, medium- to coarse-grained sandstone. Thickness in the quadrangle is about 5,000 ft, but the base of the formation is not exposed. Subdivided into three map units following Scott and Cobban (1986)

Kptu — **Upper part of upper transition member**—Gray to yellowish- gray sandy shale and siltstone with scattered thin beds of fine- to very fine-grained sandstone and occasional thin beds of gray sandy limestone

Kpts — **Lower part of upper transition member**—Yellowish-gray, medium- to coarse-grained crossbedded sandstone with thin shale interbeds

Kpc — **Cone-in-cone zone of Lavington (1933)**—Dark-gray clayey or silty shale containing reddish-brown siderite ironstone concretions, gray iron-stained limestone concretions, thin bentonite beds, and concretions with cone-in-cone structure

MAP SYMBOLS

Contact—Dashed where approximately located, queried where uncertain

Fault—Dashed where approximately located; ball and bar on downthrown side

Strike and dip of inclined beds—Direction of dip shown by crossbar, angle of dip shown in degrees where measurable

Abandoned and collapsed or reclaimed coal mine adit

Abandoned and collapsed or reclaimed coal mine shaft

Plugged and abandoned oil and gas test well

DMNH 2132 — **Fossil locality**—DMNH, Denver Museum of Nature and Science; E and WP, field locations discussed in booklet

2 — **Radiocarbon sample locality**

T K — **Approximate location of the Cretaceous–Tertiary boundary**

Limits of inferred buried paleovalley; arrows point downvalley

Channelized streambeds and canals for drainage and flood control

A——A′ **Alignment of cross section**

ACKNOWLEDGMENTS

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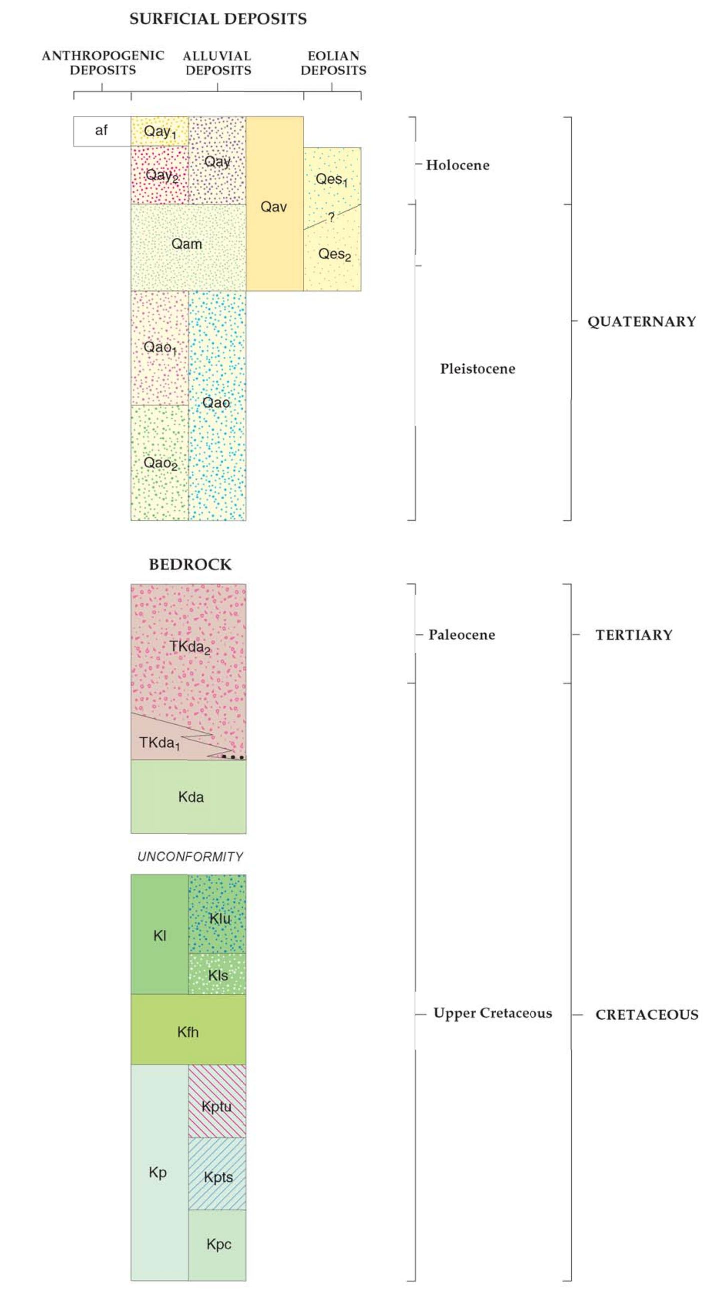
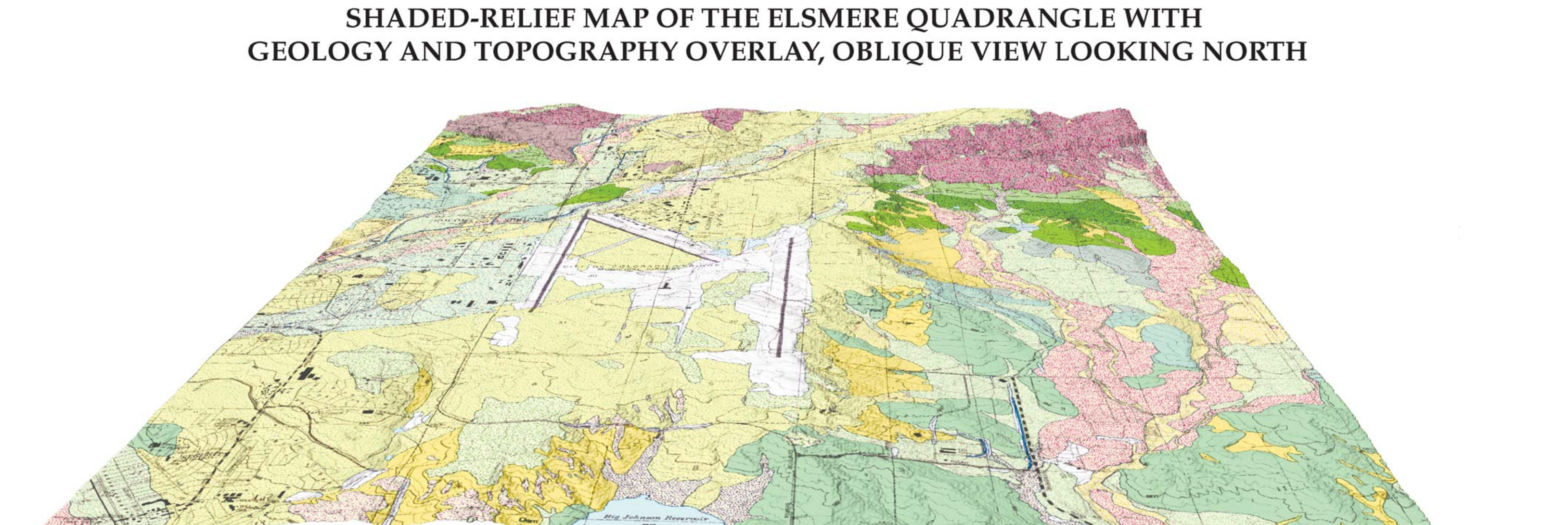
CORRELATION OF MAP UNITS



QUATERNARY TIME CHART

Formal Time Divisions		Informal Time Divisions	Age (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		

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



CORRELATION OF PRINCIPAL ALLUVIAL UNITS

Time Divisions		Sidereal Years (ka)	Colorado Piedmont (Madole, 1991)	Elsmere Elsmere Quadrangle	Air Force Academy (Varnes and Scott, 1967)	Colorado Springs Quadrangle (Carroll and Crawford, 2000)
Holocene			Holocene alluvial deposits	Qay_1	Flood-plain alluvium Husted Alluvium	Qt_1
				Qay_2		
		11.5				
Late Pleistocene			Broadway alluvium	Qam	Monument Creek Alluvium	Qt_2
		127				
Middle Pleistocene	late		Louviers Alluvium	(alluvium of this age possibly underlies Qam)	Kettle Creek Alluvium [late Pleistocene][1]	Qt_3
			Slocum Alluvium		Pine Valley Gravel [late Pleistocene]	Qg_1
		~302				
	middle			Qao_1	Douglas Mesa Gravel	
		~640				
	early		Verdos Alluvium	Qao_2		Qg_2
		778		?		
Early Pleistocene			Rocky Flats Alluvium		Lehman Ridge Gravel	Qg_3
		1806				

[1] Time terms in brackets for the Kettle Creek Alluvium and Pine Valley Gravel are the ages initially assigned by Varnes and Scott (1967).

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

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2002