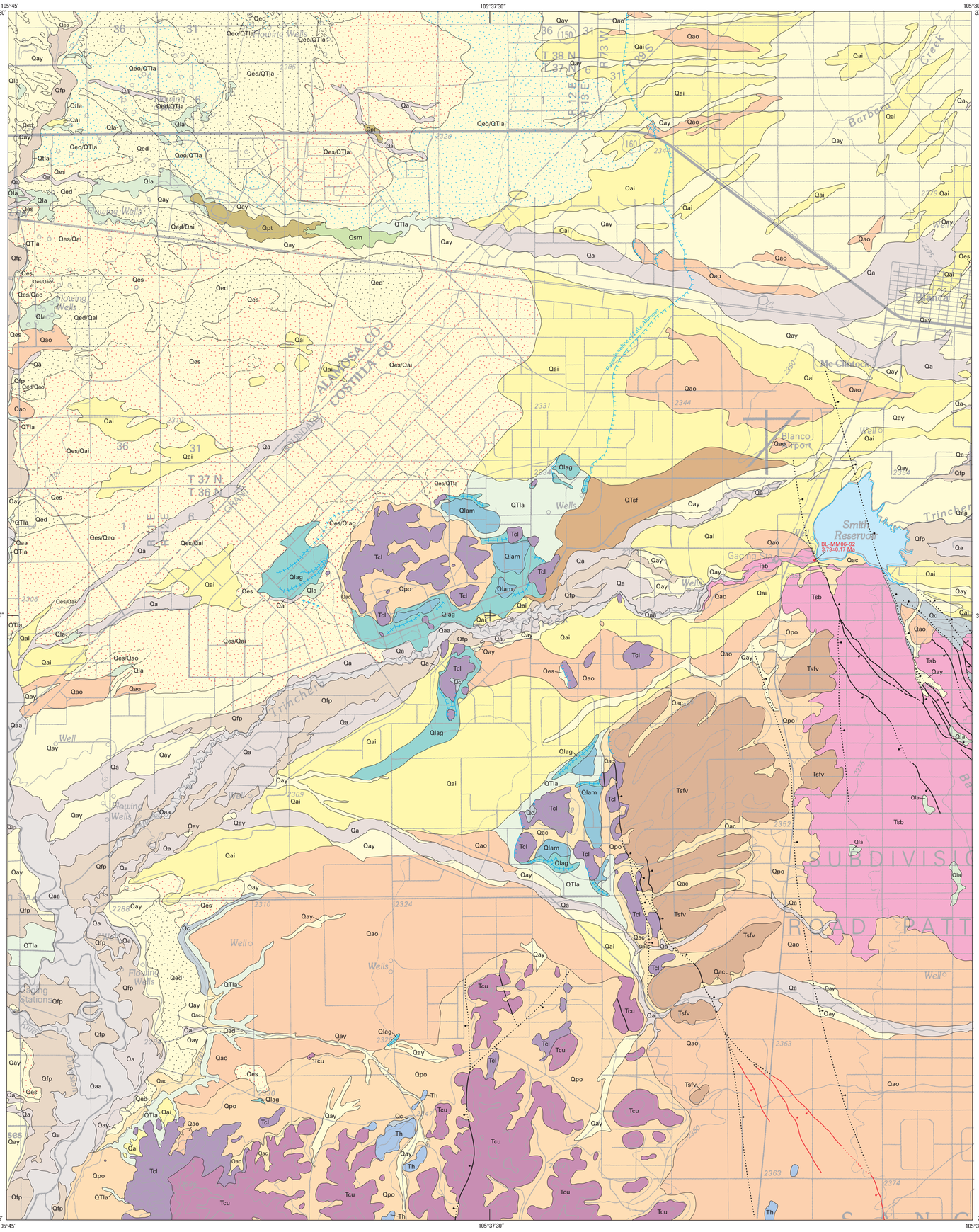
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

OPEN-FILE REPORT 2008–1124
Version 1.0



Base enlarged from U.S. Geological Survey 1:100,000-scale metric topographic map (30- × 60-minute sheet) of Alamosa, Colorado, 1983

Universal Transverse Mercator projection, 1927 North American datum.

APPROXIMATE MEAN DECLINATION, 2007

SCALE 1:50 000

CONTOUR INTERVAL 50 METERS

SUPPLEMENTAL CONTOUR INTERVAL 25 METERS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

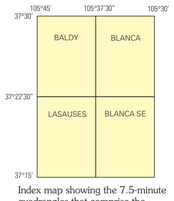
COLORADO
MAP LOCATION

Geology mapped in 2004–2007 using aerial photographs, U.S. Department of Agriculture county soil-survey maps, and field reconnaissance. Geology compiled on 1:24,000-scale topographic base maps (see index map at far left), using a Kern PG–2 photogrammetric plotter.

GIS database by T.R. Brandt

Edited by L.J. Binder
Denver Publishing Service Center

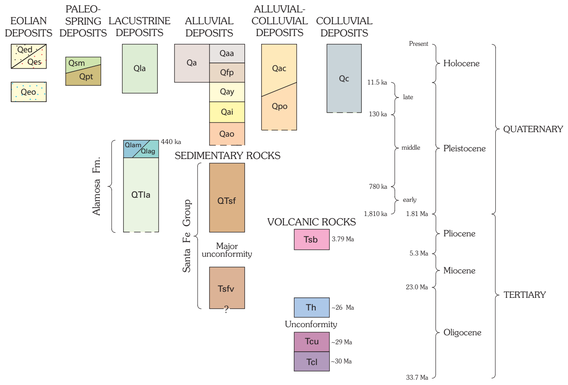
Manuscript approved for publication May 28, 2008



Index map showing the 7.5-minute quadrangles that comprise the north-central part of the Alamosa 30′ × 60′ quadrangle depicted on this map.

MAP LOCATION

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

[Map-unit names and stratigraphic associations are based on mapping over the entire Alamosa 30′ × 60′ quadrangle, which contains many more units. Thin units (such as **Qes**) that cover widespread older units (such as **Qai**) are shown as **Qes/Qai**. Where **Qes** covers older units, red stipple is used; **Qed**, black stipple; **Qeo**, cyan stipple. The following thin units are described: **Qed/QTla**, eolian dune sand over Alamosa Formation of Siebenthal; **Qed/Qai**, eolian dune sand over intermediate alluvium; **Qed/Qao**, eolian dune sand over older alluvium; **Qeo/QTla**, older eolian sand over Alamosa Formation of Siebenthal; **Qes/QTla**, eolian cover sand over Alamosa Formation of Siebenthal; **Qes/Qai**, eolian cover sand over intermediate alluvium; **Qes/Qao**, eolian cover sand over older alluvium; **Qes/Qlag**, eolian cover sand over shoreline deposits of Lake Alamosa. See Birkeland (1999) and Machette (1985) for soil horizon nomenclature and stages of carbonate morphology, respectively. Radiocarbon ages with 1 sigma errors were determined by the Woods Hole Oceanographic Institute (WHOI) Laboratory]

EOLIAN DEPOSITS

Qed — **Eolian dune sand (Holocene)**—Eolian sand in small pronounced dunes as much as 5 m high; mapped with interdune playas that are composed of silt and clay. Some dunes are active, others have weak buried soils (A horizons). Radiocarbon ages of charcoal in buried soils are 2,802±42, 3,904±71, and 5,541±61 cal. yrs B.P., indicating at least four episodes of landscape stability and redeposition of sand in the past 5,500 yrs (Machette and Puseman, 2007)

Qes — **Eolian cover sand (Holocene)**—Eolian sand in thin sheets and small coppice (plant-anchored) dunes. Thickness commonly 1–3 m

Qeo — **Older eolian sand (upper Pleistocene)**—Eolian sand in thin stable sheets that have weak argillic (Bt) and calcic (Bk) soil horizons. Thickness commonly 1–3 m

PALEOSPRING DEPOSITS

Qsm — **Spring-mound deposits (Holocene)**—Tufa mounds associated with paleosprings in the north-central part of the map area are <1 m thick and 10-20 m in diameter and overlie peat deposits (**Qpt**). Radiocarbon age of snail shells in the tufa is 3,875±40 cal. yrs B.P. (see Schumann and Machette, 2007)

Qpt — **Peat deposits (lower Holocene and upper Pleistocene)**—Wetland peats associated with paleospring discharge. Peat is composed of organic-rich humic layers; underlain by fluvial deposits and overlain, locally, by spring-mound deposits (**Qsm**). Found in shallow valley about 15 km west of Blanca and 2–3 km south of Highway 160; extensively mined in the Mr. Peat Pit. Radiocarbon age of organic carbon near base of peat is 6,700±50 cal. yrs B.P. (see Schumann and Machette, 2007)

LACUSTRINE DEPOSITS

Qla — **Lake and pond deposits (Holocene and upper Pleistocene)**— Lacustrine-like deposits of fine-grained alluvium and colluvium in small lakes and ponds, commonly impounded by eolian sand (units **Qes** and **Qed**) or filling closed depressions on basalt (**Tsb**). Thickness commonly 2–5 m

Alamosa Formation

Qlam — **Lagoonal deposits of Lake Alamosa (middle Pleistocene)**— Fine-grained sand and silt that fill lagoons and ponds impounded by barrier bars and spits. Comprises the uppermost part of Siebenthal's (1910) Alamosa Formation. Commonly 2–5 m thick, poorly exposed and base covered

Qlag — **Shoreline deposits of Lake Alamosa (middle Pleistocene)**—Locally derived sandy fine- to coarse-grained gravel that forms barrier bars, spits, and shorelines of ancient Lake Alamosa. Commonly has strongly developed calcic soil (Bk and stage III–IV K horizons) as much as 1 m thick. Preserved at elevations of 2,332–2,338 m (7,650–7,670 ft) on the northern margin of the San Luis Hills, in the central part of map area. Shoreline projected to the north at these elevations corresponds with terminations of older alluvium (unit **Qao**). Comprises the uppermost part of Siebenthal's (1910) Alamosa Formation, as in previous description (**Qlam**). Reworked basalt (Th) in spit has ^{3}He surface-exposure age of 439±6 ka (Machette, Marchetti, and Thompson, 2007). Commonly 2–10 m thick; base covered

QTla — **Alamosa Formation of Siebenthal (1910) (middle Pleistocene to Pliocene)**—Closed-basin lacustrine deposits (mainly clay, silt, and sand) and near-shore deposits (sand and fine gravel) related to alternating, climatically(?) driven shallow- and deep-water phases of ancient Lake Alamosa. Time equivalent to the upper part of the Santa Fe Group. Best exposed section of Alamosa Formation is along Hansen Bluff (west margin of map area), where Rogers and others (1985, 1992) collected fossils (flora and fauna) and volcanic ash and analyzed the paleomagnetic record of the fluvial and lacustrine sediments (see Stop B7 in Machette and others, 2007). The maximum elevation of the lake was about 2,330–2,340 m (7,640–7,677 ft). Strong calcic soils (stage III morphology) on the shoreline deposits and surface exposure age of basalt in a lake spit suggest the lake overflowed at about 440 ka (Machette, Marchetti, and Thompson, 2007) and cut an outlet channel through the San Luis Hills. Base covered, but maximum thickness reported to be 350–400 m in the Alamosa area (Siebenthal, 1910); much thinner along margins of ancient Lake Alamosa

ALLUVIAL DEPOSITS

[Grain size and lithology variable depending on distance transported and type of material being eroded. Gravel clasts generally <3–6 cm in maximum diameter, slightly coarser (6–10 cm) along streams heading in Sangre de Cristo Mountains]

Qa — **Undivided alluvium (Holocene)**—Fluvial silt and clay (overbank) to sand and gravel (main stem) that underlie stream channels and floodplains, or underlie areas too small to map separately as either unit **Qaa** or unit **Qfp**

Qaa — **Channel alluvium (upper Holocene)**—Fluvial sand and gravel in active stream channels or beneath landforms that retain fresh geomorphic expression such as meander scars, oxbow lakes, or abrupt terrrace escarpments. Comprises younger part of unit **Qa** where it is not differentiated

Qfp — **Floodplain alluvium (Holocene)**—Fine-grained silt and clay to sandy pebble gravel that form floodplains adjacent to stream channels. Flood plains commonly have muted depositional morphology such as infilled meander scars and oxbow lakes or subtle terrrace margins

Qay — **Younger alluvium (upper Pleistocene)**—Fluvial sand and gravel in former flood plains that are now 1–2 m above stream level. Commonly has a weak soil with Bw and(or) Bk horizons of stage I-II carbonate morphology

Qai — **Intermediate alluvium (upper to middle Pleistocene)**—Fluvial sand and gravel in former flood plains that are now at intermediate height (2–5 m) above stream level. Many of the elongate, northeast-trending deposits fill alluvial channels that were incised into lake deposits (**QTla**) following draining of Lake Alamosa (see description of **Qlag** and **QTla**). These channels are now topographically high as a result of erosion of the much softer lake deposits (that is, topographic inversion). The relict surface of the intermediate alluvium has a moderately developed soil (Bt and stage II–III morphology Bk horizons). Locally, thin deposits of map unit **Qay** overlie unit **Qai**

Qao — **Older alluvium (middle Pleistocene)**—Fluvial sand and gravel beneath surfaces that project 10–15 m higher than adjacent streams. Forms extensive surfaces east of and 20 m above the Rio Grande, such as on Hansen Bluff (west margin of map area). Commonly has a strongly developed calcic soil (Bk and stage III–IV morphology K horizons) as much as 1–1.5 m thick. Mapped as an undifferentiated unit; it probably pre-dates and post-dates final stage of Lake Alamosa, which overflowed at about 440 ka (Machette, Marchetti, and Thompson, 2007)

ALLUVIAL-COLLUVIAL DEPOSITS

Qac — **Alluvium and colluvium, undivided (Holocene and upper Pleistocene)**—Fine- to coarse-grained alluvium and colluvium on gentle to moderately sloping surfaces adjacent to bedrock-cored hills (San Luis Hills for this map). Material is typically silty sand to pebbly sand, coarser grained near source hills. Contains weakly developed zonal soils with A, Bw, and(or) Bk horizons. Surface of deposits typically not dissected

Qpo — **Undivided piedmont-slope deposits (upper and middle Pleistocene)**—Fine- to coarse-grained alluvium and locally sourced colluvium that form moderately to steeply sloping piedmont surfaces adjacent to bedrock-cored hills (such as the San Luis Hills). Deposits are typically silty sand to pebbly or cobbly sand, coarser grained near source hills. Locally includes debris-flow deposits. Deposits have zonal soils with A, Bw or Bt, and Bk horizons, the latter of which have stage II–III morphologies. Depositional surfaces are typically dissected

COLLUVIAL DEPOSITS

Qc — **Colluvium, undivided (Holocene to upper Pleistocene)**—Poorly sorted, nonstratified, sandy to gravelly deposits; typically on moderate to steep slopes of resistant volcanic rocks around San Luis Hills in the south-central part of the map area. Gravitationally driven, locally derived deposits; commonly includes some debris-flow deposits and locally derived alluvium

SEDIMENTARY ROCKS

Santa Fe Group

QTsf — **Upper part (middle Pleistocene to Pliocene)**— Light brown to reddish brown, poorly consolidated sandstone, siltstone, and conglomerate that lie above the Pliocene Servilleta Basalt (**Tsb**). Lower part of group only preserved in subsurface. Thickness unknown; probably 100 m to <200 m where exposed west of Smith Reservoir and north of Trinchera Creek

Tsfv — **Volcaniclastic facies (Miocene and upper? Oligocene)**— Coarse conglomerate comprised exclusively of subangular to subrounded clasts derived from Oligocene volcanic rocks in San Luis Hills (**Th** and **Tcl**). Poorly exposed, but preserved as elongate, rounded hills southwest of Smith Reservoir. Thickness at least 100 m

VOLCANIC ROCKS OF THE BASALTIC HILLS

Tsb — **Servilleta Basalt (Pliocene)**—Olivine-tholeiite flood basalts of the Basaltic Hills (eastern part of map area) erupted from sources to the south and east. Tholeiites contain plagioclase feldspar, clinopyroxene, magnetite, and ilemite and are typically fine grained and glassy. They rarely contain olivine, hence the Servilleta basalts are atypical. Basalt (sample BL–MM06–92) from the north abutment of Smith Reservoir yielded an Ar^{40}/Ar^{39} date of 3.79±0.17 Ma (D.P. Miggins, U.S.Geological Survey, written commun., 2007). These basalts may have flowed northward around the east side of the San Luis Hills, closed off the Alamosa portion of San Luis Basin and allowed Lake Alamosa to form north of San Luis Hills (Machette, Marchetti, and Thompson, 2007). Basin closure may have also occurred west of San Luis Hills, near Antonito, Colorado. Commonly has a cover of eolian sand or loess less than 1 m thick.

VOLCANIC ROCKS OF THE SAN LUIS HILLS

[Geology and contacts slightly modified from Thompson and Machette (1989)]

Th — **Hinsdale Formation (Oligocene)**—Basaltic lava flows, associated breccia, and near-vent pyroclastic deposits. Typically caps flat-topped mesas of the San Luis Hills in southwestern part of map area. Previously dated at about 26 Ma by whole-rock K/Ar methods (Thompson and Machette, 1989)

Conejos Formation (Oligocene)—Includes 29–30 Ma mafic- to intermediate-composition lava flows, flow breccias, lahar or mudflow breccias, and vent-facies pyroclastic rocks erupted or derived from local sources. Separated into an upper and lower sequence based on observed stratigraphy and predominant lithology and mineralogy. Locally includes andesite and dacite porphyry dikes. See Thompson and Machette (1989) for details

Tcu — **Upper part (Oligocene)**—Dark-brown to reddish-brown, moderately porphyritic andesite flows and flow breccias containing plagioclase, clinopyroxene, iron-titanium oxides, and, in places, minor olivine phenocrysts. Flows thicken and are more abundant in southwest part of map area

Tcl — **Lower part (Oligocene)**—Gray to light gray, moderately to coarsely porphyritic, dacite flows containing plagioclase, variably altered biotite and (or) hornblende, clinopyroxene and iron-titanium oxide phenocrysts in glassy to pilotaxitic groundmass. May locally include minor thin flows and breccias of more andesitic composition

Contact—Solid where well located; dashed where approximately located or inferred

Quaternary fault—Bar and ball on downdropped side; solid where well located; dotted where concealed

Fault—Bar and ball on downdropped side; solid where well located; dashed where approximately located; dotted where concealed

Crest of lacustrine spit or barrier bar—Solid where identity and existence certain; dashed where buried by younger deposits

Paleoshoreline of Lake Alamosa—Solid where identity and existence certain; dashed where approximately located. Highest shorelines are at 2,330–2,340 m (7,640–7,677 ft) elevation along north margin of San Luis Hills in central part of map area. Shorelines north of Trinchera Creek are projected (dashed) based on above mentioned elevations. Shorelines represent the final stage of Lake Alamosa, about 440 ka (Machette, Marchetti, and Thompson, 2007)

BL–MM06–92 3.79±0.17 Ma — **Sample locality for $^{40}Ar/^{39}Ar$ age determination**

REFERENCES CITED

Birkeland, P.W., 1999, Soils and Geomorphology, 3rd edition: New York, Oxford University Press, 430 p.

Machette, M.N., 1985, Calcic soils of the southwestern United States, *in* Weide, D.L., ed., Soils and Quaternary geology of the southwestern United States: Geological Society of America Special Paper 203, p. 1–21.

Machette, M.N., Marchetti, D.W., and Thompson, R.A., 2007, Chapter G—Ancient Lake Alamosa and the Pliocene to middle Pleistocene evolution of the Rio Grande, *in* Machette, M.N., Coates, M.-M., and Johnson, M.J., eds., 2007 Rocky Mountain section friends of the Pleistocene field trip—Quaternary geology of the San Luis Basin of Colorado and New Mexico, September 7–9, 2007: U.S. Geological Survey Open-File Report 2007–1193, p. 157–168.

Machette, M.N., and Puseman, Kathy, 2007, Chapter E—Dating and stratigraphy of middle to late Holocene eolian sand deposits in the San Luis Basin, east of Alamosa, Colorado, *in* Machette, M.N., Coates, M.-M., and Johnson, M.J., eds., 2007 Rocky Mountain section friends of the Pleistocene field trip—Quaternary geology of the San Luis Basin of Colorado and New Mexico, September 7–9, 2007: U.S. Geological Survey Open-File Report 2007–1193, p. 138–146.

Machette, M.N., and Thompson, R.A., 2006, Preliminary geologic map of the northwestern part of the Alamosa 30 × 60 minute quadrangle, Alamosa and Conejos Counties, Colorado: U.S. Geological Survey Open-File Report 2005–1392, 1 sheet, 1:50,000 scale.

Machette, M.N., Thompson, R.A., Marchetti, D.W., and Kirkham, R.M., 2007, Chapter B—Field Trip Day 2 Quaternary Geology of Lake Alamosa and the Costilla Plain, Southern Colorado, *in* Machette, M.N., Coates, M.-M., and Johnson, M.J., eds., 2007 Rocky Mountain section friends of the Pleistocene field trip—Quaternary geology of the the San Luis Basin of Colorado and New Mexico, September 7–9, 2007: U.S. Geological Survey Open-File Report 2007–1193, p. 157-168.

Rogers, K.L., and Larson, E.E., 1992, Pliocene and Pleistocene sedimentation in south-central Colorado—Opportunity for climate studies: Quaternary International, v. 13/14, p. 15–18.

Rogers, K.L., Repenning, C.A., Forester, R.M., Larson, E.E., Hall, S.A., Smith, G.A., Anderson, Elaine, and Browen, T.J., 1985, Middle Pleistocene (Late Irvingtonion: Nebraskan) climatic changes in south-central Colorado: National Geographic Research, v. 1, no. 4, p. 535–563.

Schumann, R.R., and Machette, M.N., 2007a, Chapter F—Late Pleistocene to early Holocene paleoecology of the Mr. Peat wetland deposit, Alamosa County, Colorado, *in* Machette, M.N., Coates, M.-M., and Johnson, M.J., eds., 2007 Rocky Mountain section friends of the Pleistocene field trip—Quaternary geology of the San Luis Basin of Colorado and New Mexico, September 7–9, 2007: U.S. Geological Survey Open-File Report 2007–1193, p. 147–156.

Siebenthal, C.E.,1910, Geology and water resources of the San Luis Valley, Colorado: U.S. Geological Survey Water Supply Paper 240, 128 p.

Thompson, R.A., and Machette, M.N., 1989, Geologic map of the San Luis Hills area, Conejos and Costilla Counties, Colorado: U.S. Geological Survey Miscellaneous Investigations Series Map I–1906, 1 sheet, scale 1:50,000.

PRELIMINARY GEOLOGIC MAP OF THE NORTH-CENTRAL PART OF THE ALAMOSA 30′ × 60′ QUADRANGLE, ALAMOSA, CONEJOS, AND COSTILLA COUNTIES, COLORADO

By
Michael N. Machette, Ren A. Thompson, and Theodore R. Brandt

2008

Suggested citation:
Machette, M.N., Thompson, R.A., and Brandt, T.R., 2008, Preliminary geologic map of the north-central part of the Alamosa 30′ × 60′ quadrangle, Alamosa, Conejos, and Costilla Counties, Colorado: U.S. Geological Survey Open-File Report 2008–1124, scale 1:50,000.

Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Although this information product, for the most part, is in the public domain, it also contains copyrighted materials as noted in the text. Permission to reproduce copyrighted items for other than personal use must be secured from the copyright owner.

For sale by U.S. Geological Survey Information Services
Box 25286, Federal Center, Denver, CO 80225
1-888-ASK-USGS

A PDF of this report is available at:
http://pubs.usgs.gov/of/2008/1124