OPEN-FILE REPORT 06-8

Geologic Map of the Russellville Gulch Quadrangle, Douglas and Elbert Counties, Colorado

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by
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Colorado Geological Survey
Department of Natural Resources
Denver, Colorado
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Description of Map Units, Structural Geology, Geologic Hazards,
Mineral Resources, and Ground-Water Resources

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Jon P. Thorson
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This mapping project was funded jointly by the Colorado Geological Survey and the U.S. Geological Survey through the National Geologic Mapping Program under STATEMAP Agreement No. 05HQAG0064.

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FOREWORD

The purpose of Colorado Geological Survey Open File Report 06-8, *Geologic Map of the Russellville Gulch Quadrangle, Douglas and Elbert Counties, Colorado* is to describe the geologic setting, mineral and water resources, and geologic hazards of this 7.5-minute quadrangle located southeast of Denver in central Colorado. Consulting geologist Jon P. Thorson completed the field work on this project during the summer of 2005.

This mapping project was funded jointly by the U.S. Geological Survey through the STATEMAP component of the National Cooperative Geologic Mapping Program, which is authorized by the National Geologic Mapping Act of 1997, award number 05HQAG0064, and the Colorado Geological Survey using the Colorado Department of Natural Resources Severance Tax Operational Funds. The CGS matching funds come from the Severance Tax paid on the production of natural gas, oil, coal, and metals.

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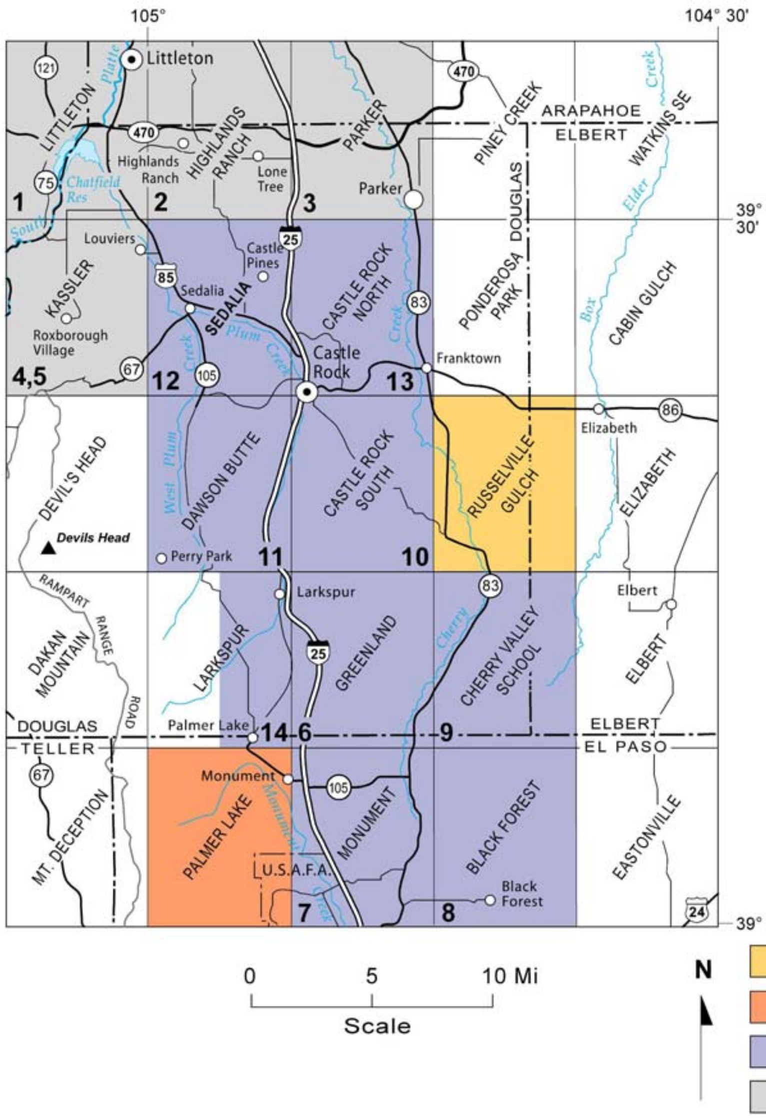
INTRODUCTION

The Russellville Gulch 7.5-minute quadrangle is located east of Castle Rock, Colorado, in the southern part of the Colorado Piedmont section of the Great Plains. The quadrangle is located in the Cherry Creek and Gold Creek drainage basins, which are tributary to the South Platte River. Geologic mapping of the Russellville Gulch quadrangle was undertaken by the Colorado Geological Survey (CGS) as part of the STATEMAP component of the National Cooperative Geologic Mapping Program. Geologic maps produced by the CGS through the STATEMAP program are intended as multi-purpose maps useful for land-use planning, geotechnical engineering, geologic hazards assessment, mineral resource development, and ground-water evaluation. Figure 1 shows the location of the Russellville Gulch quadrangle and the status of geologic mapping of 7.5-minute quadrangles in the Castle Rock area.

This map is based on prior published and unpublished geologic maps and reports, interpretation of aerial photography, and field mapping in 2005. The aerial photographs used are approximately 1:26,600 scale black and white photographs flown in 1971 for the U.S. Geological Survey. The U.S. Geological Survey topographic base map for the Russellville Gulch quadrangle was published in 1966 and updated by photo inspection in 1994. Consequently, some of the more recently constructed roads, buildings, and other human-made modifications of the landscape are not shown on the base map.

Previous geological mapping in the Russellville Gulch area includes the work of Emmons and others (1896) and Richardson (1915). Trimble and Machette (1979a, 1979b) published 1:100,000 scale regional geologic maps of the Front Range urban corridor, one of which includes the Russellville Gulch quadrangle. Bryant and others (1981) compiled a 1:250,000 scale map that includes the Russellville Gulch quadrangle. Maberry and Lindvall (1972, 1977) mapped the Parker and Highlands Ranch quadrangles, located northwest, respectively, of the Russellville Gulch quadrangle. The Colorado Geological Survey has published open-file maps of quadrangles adjacent to the Russellville Gulch quadrangle: Castle Rock South (Thorson, 2004a), Cherry Valley School (Thorson, 2004b), Greenland (Thorson, 2003b) and Castle Rock North (Thorson, 2005b). See figure 1a for locations of these quadrangles.



Completed 1:24,000-scale geologic maps:

Index Map No.	Publication No.	Date
1	USGS Bulletin 1121-L Scott	1962
2	USGS GQ 1413 Maberry and Lindvall	1977
3	USGS I-770-A Maberry and Lindvall	1972
4	USGS PP-421-A Scott	1963
5	USGS PP-421-B Scott	1963
6	CGS OF 03-9 Thorson	2003
7	CGS OF 02-4 Thorson and Madole	2002
8	CGS OF 03-06 Thorson	2003
9	CGS OF 04-06 Thorson	2004
10	CGS OF 04-05 Thorson	2004
11	CGS OF 04-07 Morgan and others	2004
12	CGS OF 05-06 Morgan and others	2005
13	CGS OF 05-02 Thorson	2005
14	CGS OF 05-07 Thorson	2005

Explanation

- This report
- Mapped concurrent with this report
- CGS completed geologic maps
- USGS completed geologic maps

Figure 1a. Index map showing the location of the Russellville Gulch quadrangle and adjacent 1:24,000 scale mapping by the U.S. Geological Survey and Colorado Geological Survey.

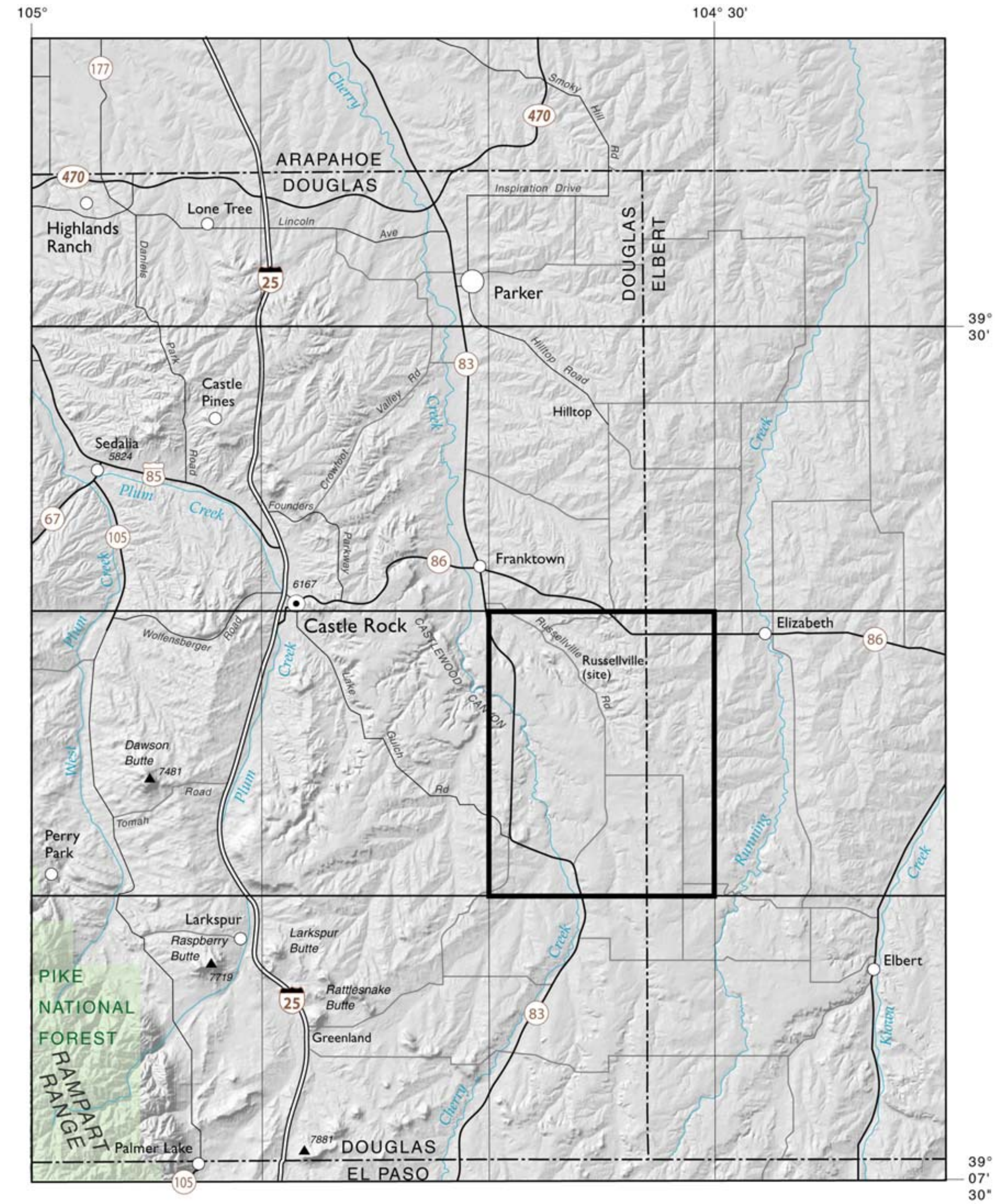


Figure 1b. Physiographic index map for the Russellville Gulch quadrangle; shown with the bold outline.

The geological unit names and symbols used for geological units in the Russellville Gulch quadrangle conform as much as possible to those employed previously on geologic maps of nearby areas prepared by the Colorado Geological Survey (CGS). The names and symbols for many of the surficial and bedrock units used by Maberry and Lindvall (1972, 1977) do not conform to the geologic formations currently used by CGS. The approximate correlations with earlier geological units are described in the "Description of Map Units" section of this text. The scale of the base map and aerial photographs governed the minimum size of the deposits shown. With few exceptions, deposits that have minimum dimensions of less than 150 feet were not mapped. Also, deposits that are less than 5 feet thick were not mapped unless they are coincident with land forms that can be delineated on aerial photography. Some of the surficial deposits of the Russellville Gulch quadrangle are not well exposed. Consequently, the thickness of most units is estimated and descriptions of physical characteristics such as texture, stratification, and composition are based on observations at a limited number of localities.

ACKNOWLEDGEMENTS

This mapping project was funded jointly by the Colorado Geological Survey and the U.S. Geological Survey through the National Geological Mapping Program. Many people have earned my thanks: John Keller and Vincent Matthews reviewed the map and text. Matt Morgan and Karen Morgan of the Colorado Geological Survey provided valuable help in converting notes and field mapping on aerial photographs into the geological map. Karen Morgan assembled the final cartography and booklet. Jane Ciener was technical editor. Special thanks go to the landowners and developers who granted permission to enter their property, particularly Mr. and Mrs. Richard Ludwig, who kindly let me dig holes in their back yard.

GEOLOGICAL SETTING

The Russellville Gulch quadrangle is located near the western edge of the Denver Basin, an asymmetrical, oval-shaped, geological structural depression (Emmons and others, 1896). This structural basin lies directly east of the Front Range and covers a large part of eastern Colorado north of Pueblo, southeastern Wyoming, and southwestern Nebraska.

Much of the exposed bedrock in the Russellville Gulch quadrangle is the assemblage of lithologies shown on the geologic map as the upper part of the Dawson Formation (TKda). At the time of deposition of this unit, during the Paleocene and Eocene Epochs (about 65 to 50 million years ago, figure 2), the uplift of the Front Range was well underway. Braided streams were delivering to the basin a mixture of gravel, sand, silt and clay derived from weathering and erosion of that uplifted area. The source of those granitic arkosic materials was mostly the Precambrian Pikes Peak Granite, located directly west of the Rampart Range mountain-front fault system. The Rampart Range fault is about 12 miles west of the quadrangle. Stream flow was generally towards the east (Morse, 1979; Crifasi, 1992). The pebble conglomerate and arkosic sand beds of the Dawson Formation are cross bedded and fill broad channels generally cut into finer-grained deposits of clayey sandstones and sandy claystones. Interbedded between the coarse-grained beds are finer-grained and thinner-bedded strata of light-gray to gray-green clayey sandstone and brown or brownish-gray sandy claystone occasionally containing fragments of organic material and plant fossils. The fine-grained parts of the upper Dawson were deposited by gentler currents in areas between the braided stream channels and probably were covered with vegetation.

Following the erosion of some of the upper part of the Dawson Formation, probably during the middle of the Eocene Epoch, the conglomerate of Larkspur Butte (Thorson, 2003b) was deposited in a series of channels and broad valleys occupied by streams that drained the newly rejuvenated mountains. In the western part of the Greenland quadrangle, the conglomerate of Larkspur Butte was deposited in narrowly confined, steep-walled stream valleys. These valleys became broader towards the east as in the Cherry Valley School and Castle Rock South quadrangles (Thorson, 2004a, 2004b). The same eastward widening is apparent in the Castle Rock North (Thorson, 2005b) and Russellville Gulch quadrangles.

The Wall Mountain Tuff, an ignimbrite, or glowing hot volcanic ash flow, was erupted in the late Eocene and poured across the landscape. This ash flow blanketed the eroded surface of the Dawson Formation and valleys that contained the conglomerate of Larkspur Butte. Because of its great heat, the ash compacted into a viscous plastic that flowed for short distances before it cooled into welded tuff. Erosional remnants of the Wall Mountain Tuff overlie the Dawson Formation or conglomerate of Larkspur Butte in a broad east-northeast-trending zone across the central part of the quadrangle.

The Castle Rock Conglomerate was deposited near the end of the Eocene as a broad sheet following a northwest trending paleo-valley in the Russellville Gulch quadrangle, which had been eroded across the upper Dawson Formation, conglomerate of Larkspur Butte, and Wall Mountain Tuff. Erosional remnants of the conglomerate of Larkspur Butte and Wall Mountain Tuff stand at higher elevations above that paleovalley on its eastern and western flanks (see the cross section diagram included with the geologic map).

Since the deposition of the late Eocene rocks, the area experienced continued periods of erosion and deposition. During the Miocene, the Ogallala Formation was deposited across much of eastern Colorado and probably once covered the quadrangle but has since been removed by erosion. During the Quaternary, deposits of unconsolidated sands and gravels were left in paleochannels, flood plains along stream courses, and on various upland erosion surfaces as streams eroded the landscape.

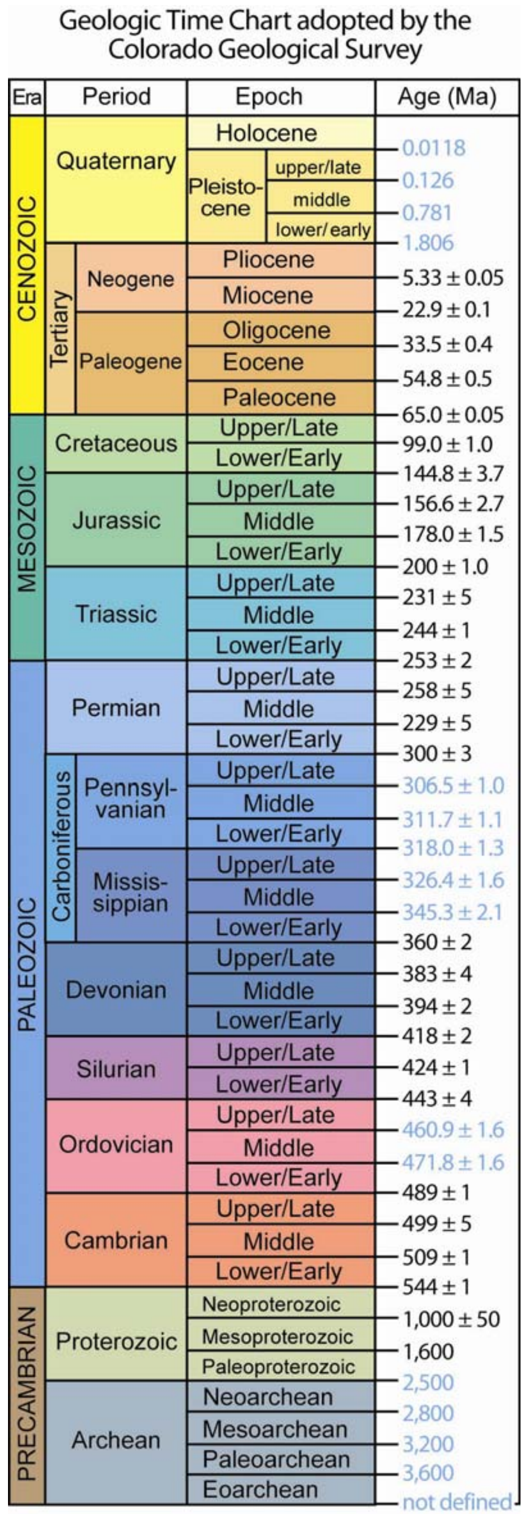


Figure 2. Geologic time chart used for this report. Numerical ages shown in black are from the Geological Survey of Canada (Okulitch, 2002); ages shown in blue are from the International Commission on Stratigraphy, (2005).

AGE OF FORMATIONS

Dawson Formation. The lower part of the upper Dawson Formation spans the Cretaceous-Paleogene (K-P) boundary, but the exact location of the time boundary in most of the basin has not been identified. Kluth and Nelson (1988) reconfirmed the Late Cretaceous (late Maastrichtian) age for part of the Dawson Formation on the U.S. Air Force Academy. In the Elsmere quadrangle, the K-P boundary has been approximately located about 370 feet above the base of the upper part of the Dawson Formation (Benson, 1998; Benson and Johnson, 1998; Johnson and Raynolds, 2001; Madole and Thorson, 2002; Johnson and others, 2003). Fossil leaf localities in the Monument quadrangle are Paleocene in age: Scotty's Palm, Denver Museum of Nature & Science, DMNH-1204, NE 1/4 SW 1/4 sec. 12, T. 12 S., R. 67 W., (Johnson, 2001, Johnson and others, 2003); and Baptist Road, Denver Museum of Nature & Science, DMNH-2177, NW 1/4 sec. 35. T. 11 S., R. 67 W., Johnson and Raynolds, 1998, Johnson and others, 2003). An important early Paleocene rain-forest fossil-leaf locality, estimated to be 63.8 ± 0.3 mybp (million years before present), is located in the NE 1/4, SW 1/4, sec. 2, T. 8 S., R. 67 W. of the Castle Rock North quadrangle (Johnson and Ellis, 2002; Ellis and others, 2003; Johnson and others, 2003). This site is estimated to be 284 m above the K-P boundary on the basis of correlations with the Castle Pines cored well located in the adjacent Sedalia quadrangle (Ellis and others, 2003, figure 2).

The rain-forest fossil locality is estimated to lie just below the Denver Basin paleosol, a regional paleosol traced around the basin by Soister and Tschudy (1978) and proposed to mark the Paleocene-Eocene boundary. Recent work on this paleosol has recognized that it separates early Paleocene pollen zone P3 from late Paleocene pollen zone P6 (Nichols and Fleming, 2002) and lies just below the Paleocene-Eocene boundary. A prominent paleosol thought to be the Denver Basin paleosol was used as the boundary between Dawson facies units four and five in the Monument quadrangle (Thorson and Madole, 2002). Mapping of the Castle Rock South (Thorson, 2004a) and Castle Rock North quadrangles has shown that most of the local Dawson Formation lies above a well developed paleosol thought to be the Denver Basin paleosol and is therefore correlated with the Eocene TKda5 facies unit of the Monument quadrangle. However, Morgan and others (2004) have confirmed the observation that there are multiple paleosols developed in the Dawson Formation along the western edge of the Denver Basin (Thorson and Madole, 2002; Thorson, 2003a), so appropriate caution is advised in using the relation of a stratigraphic unit to any particular paleosol as an indication of age. Nonetheless, the topography and generally flat dips of the upper part of the Dawson Formation in the Castle Rock area confirm that the Dawson unit mapped in the Russellville Gulch quadrangle lies above the Paleocene rain-forest strata and is accepted to be Eocene in age.

Conglomerate of Larkspur Butte. The conglomerate of Larkspur Butte (Tlc) is a newly recognized unit that underlies the late Eocene Wall Mountain Tuff on Larkspur Butte and on many of the high buttes in the Greenland (Thorson, 2004b), Black Forest (Thorson, 2003a), Cherry Valley School (Thorson, 2004b), Castle Rock South (Thorson, 2004a), and Castle Rock North (Thorson, 2005b) quadrangles. This conglomerate is clearly of

Eocene age; it lies between Eocene upper Dawson Formation and late Eocene Wall Mountain Tuff. It is of probable late Eocene age because a significant part of the Eocene epoch probably passed during the deposition, alteration, and erosion of the upper Dawson. A late Eocene age is indicated because the conglomerate of Larkspur Butte fills, or partially fills, paleovalleys that were present in the late Eocene and appear to have influenced the deposition of the late Eocene Wall Mountain Tuff.

Wall Mountain Tuff. The ignimbrite eruption that deposited the Wall Mountain Tuff has been considered in the past to be an Oligocene event (for example, see Trimble and Machette, 1979a). Recent radiometric dates on its eruption are about 36.7 mybp (Mcintosh and others, 1992; Mcintosh and Chapin, 1994). However, the age for the end of the Eocene is now recognized to be 33.5 mybp (figure 2), so the Wall Mountain Tuff should now be considered to be late Eocene.

Castle Rock Conglomerate. The Castle Rock Conglomerate post-dates the Wall Mountain Tuff because the conglomerate contains clasts of the tuff. The Castle Rock Conglomerate also contains bones of Chadronian (late Eocene) titanotheres (K.R. Johnson, Denver Museum of Nature and Science, written commun., 2002) and so must be late Eocene in age, between 36.7 and 33.5 mybp.

DESCRIPTION OF MAP UNITS

SURFICIAL DEPOSITS

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

af **Artificial fill (latest Holocene) —** Gravel, sand, silt, clay, and rock or concrete debris emplaced for constructing highways and dams. Thickness generally is between 5 and 50 feet.

ALLUVIAL DEPOSITS — Sand, silt, gravel, and clay transported and deposited by flowing water in channels or as unconfined runoff. The alluvial deposits in the Russellville Gulch quadrangle are predominantly composed of quartz, feldspar, and granite fragments derived mostly from arkosic source materials in the Dawson Formation. Most of the fragments in the channel and flood-plain (Qa) and terrace (Qt_1, Qt_2, Qt_3) deposits are subround coarse pebbles (less than 1.25 inches) or smaller grains. Occasional larger pebbles and small cobbles (up to about 4 inches) of well rounded light-colored quartz and subangular to subround yellow-brown chert, and rare larger cobbles and small boulders of round to subround dark-pink to light-red Pikes Peak Granite, found in the channel, flood-plain, and terrace deposits cannot have been derived from the

Dawson. These clasts appear to be recycled from either the older surficial deposits, the conglomerate of Larkspur Butte, or from the Castle Rock Conglomerate. Large cobbles and small boulders of subround Dawson Formation arkose or angular to subangular brownish-gray welded tuff in the alluvial deposits were derived from local sources.

Part of the Russellville Gulch quadrangle is mantled by older alluvial deposits of probable Pleistocene age (Qp_1). The relative age of these deposits has been interpreted from their slope, base level, and position in the landscape. These deposits have been named "older alluvium" because they represent deposition at higher elevations compared to the present drainage system. The map symbol Qp_1 is retained, rather than simply Qp, since Qp_1 deposits are continuous with similar deposits in the adjacent quadrangles to the south and west where there are multiple older alluvium deposits, and where the symbol Qp_1 was used for the youngest of these deposits.

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 generally coarser, lighter in color, and more poorly sorted than unit Qt_1. In many places, the unit is so young that plant roots have scarcely disturbed or destroyed stratification that extends nearly to the ground surface. Typically, soil has not developed. Unit is subject to frequent flooding. Estimated thickness is 3-7 feet.

Qt_1 **Terrace alluvium one (Holocene and late Pleistocene)** — Pale-brown and brown to grayish-brown beds of sand, silty fine sand, sandy silt, clayey silt, and gravel. Generally, stratification is weakly expressed, and texture and composition vary along the valley axis. The upper surface of the unit is 3-10 feet higher than some of the larger streams but is only about 2-5 feet higher than the smaller streams of the area. Infrequent large floods may inundate Qt_1 in places. The unit correlates with the Post-Piney Creek Alluvium of Maberry and Lindvall (1972). Thickness is estimated to be 5-15 feet.

Qt_2 **Terrace alluvium two (late Pleistocene) —** Very pale-brown to dark-grayish-brown, very poorly sorted sand and subordinate amounts of gravel. The unit correlates with the Piney Creek Alluvium of Maberry and Lindvall (1972). The upper surface of the unit is typically 5-15 feet higher than the larger streams. Thickness is 5-20 feet.

Qt_3 **Terrace alluvium three (late middle Pleistocene) —** Chiefly pale-brown to light-grayish-brown, extremely poorly sorted sand, gravel, and cobbly or bouldery gravel that underlies terrace remnants along the larger streams of the area. The upper surface of the unit is 10 to 30 feet higher than the drainages. The unit may correspond to Broadway Alluvium of Maberry and Lindvall (1972). Estimated thickness is 5-30 feet.

Qsw **Sheetwash (Holocene and late Pleistocene) —** Typically, light-grayish-brown, pale-brown, to brown, extremely poorly sorted sand, silty and clayey sand, and minor amounts of gravel including some cobbles and small boulders. Unit consists chiefly of material transported on moderate slopes by sheet flow but also includes some sediment delivered by runoff in rills and minor gullies. The abundance of sand-size grains and pebbles in this unit make it a grüs-like deposit. The unit has been largely derived from disintegration of the Dawson Formation, but a smaller amount may have been derived from the older alluvial deposits. Estimated thickness is 3-20 feet.

Qp_1 **Older alluvium one (late Pleistocene) —** Chiefly light-brown to light-reddish-brown, extremely poorly sorted sand and gravel, which, in places, includes boulders as well as pebbles and cobbles. The unit may have cobbly and bouldery layers with angular to subround fragments of Wall Mountain Tuff, subrounded clasts of Dawson Formation arkose, and in places abundant well rounded cobbles and small bounders of granite, gneiss, and quartzite weathered out of the conglomerate of Larkspur Butte or Castle Rock Conglomerate. This unit appears to correlate with the Slocum Alluvium of Maberry and Lindvall (1972) but may include some material that they would have mapped as Louviers Alluvium at lower elevations. Unit Qp_1 is poorly exposed; estimated thickness may be a great as 60 feet.

Qau **Alluvium, undivided (Holocene and Pleistocene) —** Chiefly pale-brown to brown, poorly sorted sand and fine gravel in valley heads in the upper parts of drainages. The unit includes sheetwash and stream-deposited alluvium that are undivided. These alluvium-filled valley heads are not exhumed or deeply incised. The unit may include sediment that is correlative with units Qa, Qt_1, and possible Qt_2. Estimated thickness is 3-10 feet.

MASS-WASTING DEPOSITS — Earth materials that were translocated downslope under the influence of gravity. Colluvium deposits are the principal products of mass wasting in the Castle Rock North quadrangle. Colluvium, as used here, adheres in most respects to Hilgard's (1892) definition. According to Hilgard, the principal attributes of colluvium are that it (1) was derived locally and transported only short distances, (2) may contain clasts of any size, (3) has no structures indicative of sedimentation or stratification by water flowing in channels, and (4) has an areal distribution that bears no relation to channelized flow of water (Madole and Streufert, 2001). Hilgard's definition allows colluvium to include a minor amount of sheetwash alluvium.

Qc **Colluvium (Holocene to Pleistocene) —** Unit comprises slope deposits that consist chiefly of very pale-brown to brown sand and fine gravel plus cobbles and boulders of Dawson Formation arkose, Wall Mountain Tuff, conglomerate of Larkspur Butte, or Castle Rock Conglomerate. Deposits typically are massive and very poorly sorted. Although primarily the product of mass wasting, the unit may include minor amounts of sheetwash. Unit is estimated to be 2-50 feet thick.

EOLIAN DEPOSITS — Wind-deposited sediment.

Qpe **Eolian sand (middle and lower Holocene and Pleistocene) —** Very pale-brown, pale-brown, and light-reddish-brown sand and silt. Unit is predominantly coarse to fine sand sand that appears to have been deposited as sand sheets or low-relief, dune-like forms that lack distinct slip faces. However, in the southeastern part of the quadrangle, particularly along the drainage divide between the East Cherry Creek and Gold Creek drainages (sec 34, T. 8 S., R. 65 W. to sec. 23, T. 8 S., R. 65 W.), the topographic form suggests steep slip faces on the eastern side. Low-angle dune stratification is well exposed in an artificial cut in the Elbert County Road Department maintenance yard in NW 1/4, sec. 10, T. 8 S., R. 65 W. Thickness of the unit is estimated to be up to 100 feet.

In the lower elevation parts of the rolling topography of this unit, the wind blown deposits are interbedded with a variable amount of beds that appear, from their landforms, to have been deposited by sheetwash or other alluvial processes that redistributed the eolian sand. In some places the eolian strata grade into undifferentiated alluvium (Qau) along the stream courses; in most instances the contact is very gradational. Rather than map numerous artificial contacts, the unit is mapped as a whole as an eolian unit since both its topography and lithology are dominated by eolian processes.

The map symbol Qpe has been used to register the similarity of this unit to contiguous units in the quadrangle to the south (Cherry Valley School, Thorson, 2004b) that were designated as older alluviums Qp_1 and Qp_3. This change in designation from alluvial to eolian deposits may be a real, but very gradational, change, or it may just be a function of more distinct eolian topography in the Russellville Gulch quadrangle and a few fortuitous exposures.

BEDROCK DEPOSITS

Tcr **Castle Rock Conglomerate (late Eocene) —** The Castle Rock Conglomerate is a pebble, cobble, and boulder arkosic conglomerate composed predominantly of subround to round fragments of pink and gray granite and quartz with subordinate amounts of gneissic metamorphic rocks, quartzite, red sandstone, welded tuff, and chert in a coarse to very coarse sand matrix of quartz and feldspar grains. The distinguishing characteristic of this unit is the presence of angular to subangular cobble- to boulder-size blocks of gray, brownish-gray, maroon, or lavender-gray welded tuff that have been eroded from deposits of the Wall Mountain Tuff (figure 3). The Castle Rock Conglomerate is younger than the Wall Mountain Tuff, which has been dated at about 36.7 my (Mcintosh and others, 1992; Mcintosh and Chapin, 1994). It must be older than the end of the Eocene (33.5 my; figure 2) since it contains bones of titanotheres (late Eocene, K.R. Johnson, Denver Museum of Nature and Science, written commun. 2002). Fossilized bone fragments from large animals were found in, on, or near outcrops of this unit in SE 1/4 sec. 35, T. 8 S., R. 66 W., SE 1/4 sec. 12, T. 9 S. R. 65 W., and NW 1/4 sec. 5, T. 9 S. R. 65 W. The Castle Rock Conglomerate reaches a thickness of at least 120 feet in parts of the quadrangle. Morse (1985) has reported greater thickness of the unit, up to 230 feet, but does not cite a location for this thick section. The thickness of the sections published by Morse (1985, figure 12, p. 284; up to 135 feet) agree well with observations in the Russellville Gulch quadrangle. Since Morse lumped the conglomerate of Larkspur Butte together with the Castle Rock Conglomerate, as did the previous published work (for example, Trimble and Machette, 1979a, 1979b; and Bryant and others, 1981), it is possible that his thick sections include both conglomerate units.

Figure 3. Road-cut exposure of Castle Rock Conglomerate showing angular to subangular clasts of Wall Mountain Tuff in a matrix of pebble conglomerate composed mostly of well-rounded quartz and feldspar grains from the Pikes Peak Granite. Exposure located in NW 1/4 sec. 25, T. 8 S., R. 66 W., between the Highway 83 bridge over Cherry Creek and the entrance road to Castlewood Canyon State Park. Hammer is 16 inches long.

The Castle Rock Conglomerate was deposited as a large sheet that filled a paleovalley on an erosion surface cut across the top of the upper Dawson Formation, conglomerate of Larkspur Butte, and Wall Mountain Tuff (figure 4). This surface slopes gently to the north and northwest from elevations between 6800 and 6850 feet in the southern part of the quadrangle to below 6470 feet in the northwest part.

The map that accompanies this booklet shows the distribution of Castle Rock Conglomerate to be much less than shown by previous authors. Trimble and Machette (1979a) and Bryant and others (1981) show the Castle Rock Conglomerate to cap the ridge between the drainage of East Cherry Creek and Gold Creek (between the towns of Franktown and Elizabeth). I, too, have mapped a conglomerate unit there but have assigned the ridge-capping conglomerate to the conglomerate of Larkspur Butte for the following reasons. First, it stands higher in the topography by about 150 feet. Second, on buttes in sec. 17, 20, and 21, T. 8 S., R. 65 W. and sec. 22, 27, and 34, T. 8 S., R. 65 W. this ridge-capping conglomerate was found to lie beneath the Wall Mountain Tuff. And, third, the ridge-capping conglomerate, although very coarse and bouldery, was not found to contain any clasts of Wall Mountain Tuff. Thus the Castle Rock Conglomerate, as mapped in the Russellville Gulch quadrangle, is the remains of a deposit that filled an ancient paleo-valley, which trended north-northwest roughly paralleling the present Cherry Creek valley. The unit does not extend across the drainage divide into the Gold Creek drainage.

The Castle Rock Conglomerate is variably permeable, in some places well drained and in others supporting local ephemeral ponds. It has good foundation characteristics. Excavation may be difficult, even though the unit is friable and easily eroded on weathered outcrops. Rock fall from cliffs at the edges of plateaus of this unit poses a possible slope-stability hazard in some areas, especially where the unit rests on easily erodable sandstone or sandy mudstone beds in the Dawson Formation.

Figure 4. Castle Rock Conglomerate deposited on the erosional unconformity at the top of the Dawson Formation; road-cut exposure in SW 1/4 sec. 13, T. 8 S., R. 66 W. along Highway 83. Hammer (just left of center) is 16 inches long.

Twm **Wall Mountain Tuff (late Eocene) —** The Wall Mountain Tuff is a moderately to densely welded tuff of rhyolitic composition (Izett and others, 1969; Epis and Chapin, 1974). It is generally light to medium-brown when fresh but is locally medium gray in a few of the more densely welded outcrops. On weathering the tuff may be light brown, lavender, pink, reddish brown, or maroon. The fine-grained groundmass usually contains small phenocrysts of biotite and sanidine, and occasionally near the base may contain quartz grains and small arkose fragments ripped up from the underlying strata. The Wall Mountain Tuff was emplaced in the Castle Rock area as an ash-flow that was hot enough that the ash compacted and welded into a viscous plastic-like consistency after emplacement. In places, the welded ash flowed and developed flow banding before cooling and solidifying. The Wall Mountain Tuff has been dated as about 36.7 million years in age by McIntosh and others (1992) and McIntosh and Chapin (1994). The Wall Mountain ash flow was erupted from an unidentified location west of the upper Arkansas River valley between Salida and Buena Vista (Epis and Chapin, 1974; McIntosh and Chapin, 2006, in press).

The Wall Mountain Tuff is about 40 to 60 feet thick in the large erosional remnants in the western part of the quadrangle, where it rests on older deposits of conglomerate of Larkspur Butte or Dawson Formation at about 6700 ft elevation. The smaller remnants in the northeast part of the quadrangle rest on conglomerate of Larkspur Butte at about the same elevation.

The Wall Mountain Tuff breaks into angular blocks and slabs as it weathers, and makes poor outcrops. Below the weathered zone, however, the unit should be expected to be fractured into larger blocks, generally 3 to 4 feet in size, and may be difficult to excavate. Small pits dug in some outcrops indicate that these outcrops have been tested for use as building stone, as is common in the Castle Rock area. A small quarry on the eastern edge of the outcrop in NW 1/4, sec. 1, T. 9 S., R. 66 W. indicates either limited quarrying of the unit for local use, or a failed attempt at commercial quarrying.

Tlc **Conglomerate of Larkspur Butte (late? Eocene) —** The conglomerate of Larkspur Butte is a brown, pinkish-brown, or pink arkosic conglomerate composed predominantly of pebbles and cobbles of pink granite or pink feldspar in a coarse sand-size to small-pebble matrix of quartz and pink feldspar. In the Russellville Gulch quadrangle the clasts of gray or white quartz and a distinctive dark-gray to dark-bluish-gray quartzite are common (figure 5, 6); less abundant are clasts of red or pink Pikes Peak Granite, gneissic metamorphic rocks, brown or yellowish-brown quartzite, red sandstone, and chert; clasts are subround to round. The conglomerate of Larkspur Butte is up to 60 feet thick in the quadrangle.

In the quadrangle this unit does not make good natural outcrops as it is not well cemented, but the resistant rounded cobbles and boulders litter the surface where the unit is present. A poor artificial outcrop can be found along Highway 83 in W 1/2 sec. 1, T. 9 S., R. 66 W.; better artificial outcrops were found near a concrete batch plant near the NE corner, sec. 16, T. 8 S., R. 65 W. Boulders of 10 to 12 inches are common in this unit, and occasional larger boulders, up to 24 inches, have been found in sec. 16 and 21, T. 8 S., R. 65 W.

The conglomerate of Larkspur Butte is distinguished from the underlying Dawson Formation by its coarser grain size, pinkish color tones, common pink granite and unbleached pink feldspar grains in the gravel-size fraction, and lack of clay in the matrix material. The uppermost strata of the Dawson are generally very light colored (white, cream, light greenish-gray) because most of the feldspar in the Dawson Formation is bleached and essentially all of the macroscopic pores of the Dawson beds are filled with light-colored clay. The bleaching and clay-filling in the Dawson suggests a prolonged period of weathering and/or diagenetic alteration of the Dawson before deposition of the conglomerate of Larkspur Butte. The conglomerate of Larkspur Butte is similar in appearance to the Castle Rock Conglomerate although the latter generally lacks pink tones and is light brown or light brownish-gray in color. The principal distinguishing characteristic is the fragments of Wall Mountain Tuff in the Castle Rock Conglomerate. In the absence of tuff fragments, the two late-Eocene conglomerates may be very hard to distinguish.

Figure 5. Conglomerate of Larkspur Butte exposed at the edge of an excavation in NE corner sec. 16, T. 8 S., R. 65 W. near the south side of Highway 86; detailed view shown in Figure 6. Hammer is 16 inches long.

Figure 6. Detailed view of conglomerate of Larkspur Butte exposure in Figure 5 showing well rounded clasts of granite, metamorphic rocks, quartz, and distinctive dark bluish-gray quartzite.

In the western part of the quadrangle the outcrops, or subcrops, of this unit have been preserved by a capping layer of Wall Mountain Tuff. In the northeastern part of the quadrangle the same relationship (Tlc preserved under a layer of Twm) remains at the small remnants of Wall Mountain Tuff. Here, the base level of the conglomerate of Larkspur Butte deposits is higher in the landscape than the top of the Castle Rock Conglomerate (figure 7, 8). Thus, the Castle Rock Conglomerate filled a younger paleovalley eroded through older paleovalleys once filled with conglomerate of Larkspur Butte. The clast size and regional distribution of the conglomerate of Larkspur Butte suggests that the unit was deposited by streams that were generally eastward flowing.

The conglomerate of Larkspur Butte is generally permeable, well drained, and has good foundation characteristics. Excavation may be difficult, even though some of the conglomerate is friable and easily eroded on weathered outcrops.

Figure 7. Geomorphology of the conglomerate of Larkspur Butte and Wall Mountain Tuff; view NE across sec. 20, T. 8 S., R. 65 W. from Russellville Road. The flat surface in the foreground is the erosion surface on the Dawson Formation into which the Castle Rock Conglomerate is incised (behind the observation point); the flat topped hill on the skyline, about 140 feet higher than the view point, is capped by Wall Mountain Tuff overlying a preserved remnant of conglomerate of Larkspur Butte (see figure 8 for more detailed view).

Figure 8. Hill capped by Wall Mountain Tuff (5 to 15 feet) overlying a preserved remnant of conglomerate of Larkspur Butte (5 to 20 feet) resting on the erosion surface at the top of the Dawson Formation; view is the south end of the hill shown in figure 7.

Dawson Formation (Upper Cretaceous to Eocene) — The Dawson Formation is divided into upper and lower parts in the Colorado Springs area (Thorson and others, 2001, Thorson and Madole, 2002). The lower part is entirely Upper Cretaceous in age and composed almost exclusively of andesitic debris. The upper part of the Dawson Formation is a mixture of andesitic and arkosic material deposited during the Late Cretaceous and early Tertiary. 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 ($TKda_5$). A sixth facies unit has been recognized locally in the Cherry Valley School (Thorson, 2004b) and Larkspur quadrangles (Thorson, 2005a). These facies units are 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 versus coarser-grained beds of sandstone, arkose, pebbly arkose, and pebble conglomerate. Only facies unit five ($TKda_5$) is present in the Russellville Gulch quadrangle.

In the Denver area the nomenclature for the comparable Upper Cretaceous to Eocene strata mapped as Dawson Formation in the Colorado Springs area is quite variable. Maberry and Lindvall (1972, 1977) used Dawson Arkose and Denver Formation, with the Dawson Arkose younger than, and stratigraphically above, the Denver Formation. Trimble and Machette (1979b) changed terminology and used “Dawson and Arapahoe Formations” and “Denver Formation” of comparable Paleocene to Upper Cretaceous age. Bryant and others (1981) used Arapahoe Formation and restricted this unit to Upper Cretaceous age, while Dawson Arkose and Denver Formation were retained. On the map of Bryant and others (1981), the Dawson Arkose is designated as Eocene, Paleocene, and Upper Cretaceous, the Denver Formation is described as Paleocene and Upper Cretaceous, and the formations are shown as interfingering lateral equivalents of each other.

In an attempt to simplify the nomenclature confusion, Raynolds (2002) defined two unconformity-bounded sequences, D1 and D2. The D2 sequence contains Maberry and Linbdvall’s (1972, 1977) Dawson Arkose, above the regional Denver Basin paleosol, but only part of Bryant and others’ (1981) Dawson Arkose. All the rest of the Upper Cretaceous through Paleocene strata of the Denver Basin are included within the D1 sequence. The recognition of the D1 and D2 sequences is a very useful addition to the understanding of the depositional sequence of Upper Cretaceous through Eocene strata in the Denver Basin and has been widely adopted (Raynolds and Johnson, 2002; Raynolds, 2002; Nichols and Fleming, 2002; Obradovich, 2002; Wilson, 2002; Kelley, 2002; Farnham and Kraus, 2002; Kelley and Blackwell, 2002; Woodward and others, 2002; Carpenter and Young, 2002; Hicks and others, 2003; Wheeler and Michalski, 2003; Barclay and others, 2003; Ellis and others 2003; Johnson and others, 2003; Hutchinson and Holroyd, 2003; Eberle, 2003; Raynolds and Johnson, 2003).

However, paleontological control is necessary for the recognition and application of the D1-D2 nomenclature. Recent mapping along the west side of the Denver Basin (Thorson and Madole, 2002; Thorson, 2003a, 2005a; Morgan and others, 2004) has shown that there are multiple paleosol horizons in the Dawson Formation, and that no single paleosol exposure clearly defines the D1-D2 boundary without age confirmation. Nonetheless, facies unit TKda5 of this report appears to be consistently equivalent to Raynolds’ D2 sequence.

Logs and samples from the Dawson Formation in the abandoned petroleum test well in the Greenland quadrangle (sec 17, T. 10 S., R. 66 W.; F.G. Holl et al., #1 Greenland Cattle Co.), plus the thickness of Dawson exposed on the adjacent buttes above the collar of the well, indicate that the Dawson Formation is about 2750 feet thick. The formation should is expected to be about the same thickness inn the Russellville Gulch quadrangle.

TKda$_5$ **Facies unit five (early to middle? Eocene) —** Unit TKda$_5$ is dominated by very thick-bedded to massive, cross-bedded, light-colored arkoses and pebbly arkoses, but the unit also contains common beds of white to light-tan, fine- to medium-grained feldspathic, cross-bedded friable sandstone. These sandstones are poorly sorted, have high clay contents, and are often thin or medium bedded; wavy bedding and ripple cross-laminations are common in the finer-grained parts. Facies unit five may also contain a few massive, structureless beds interpreted to be mudflows. Eastward from the mountain front, facies unit five becomes progressively finer grained and loses much of its distinctive thick-bedded character and conglomeratic lithologies. In the Russellville Gulch quadrangle the unit is predominantly coarse to very coarse arkosic sandstone and finer-grained lithologies and contains common beds of greenish-gray to olive-green sandy claystone.

Unit $TKda_5$ locally contains thin, poorly developed, red, pink, and yellow-brown oxidized zones interbedded with, or developed within, the thick arkoses. Some of these oxidized zones have preserved mottling, burrows, and root structures that indicate their origin as paleosols; others are probably just the result of oxidation by groundwater. $TKda_5$ is at least 200 feet thick in the quadrangle but the base is not exposed and the upper part of the unit has been removed by erosion. Mapping in adjacent quadrangles suggests that the unit is probably about 400 feet thick. TKda5 appears to correlate with Raynolds' (2002) D2 sequence and with the Dawson Arkose of Mayberry and Lindvall (1972, 1977), but the unit does not correlate specifically with any of the units used by Bryant (1981). In hydrologic studies, facies unit five appears to be equivalent to the Dawson Arkose and/or Dawson aquifer in the Denver area (George VanSlyke, 2001, oral commun.).

$TKda_5$ is generally permeable, well drained, and has good foundation characteristics. Excavation may be difficult even though the arkoses are friable and easily eroded on weathered outcrops. The clay content of the finer-grained parts of the facies unit suggests that soils developed from the Dawson may have high swell factors. Rock fall from cliffs in facies unit five poses a possible slope-stability hazard in some areas.

TKdu **Dawson Formation, undivided (Upper Cretaceous to Eocene) —** undivided Dawson Formation possibly including facies units one through facies unit four of the upper Dawson plus the exposed facies unit five; shown only on cross section.

STRUCTURAL GEOLOGY

The structural geology of the Russellville Gulch quadrangle is not complex. Most of the Dawson strata are flat lying or very gently dipping. Few strike and dip symbols are shown on the map. Measurement of strike and dip in the Dawson Formation is difficult and questionable because of the coarse-grained, lenticular and cross-bedded character of most of the beds and because of poor exposures. Bedding surfaces and cross-bed orientation from these beds were inclined at deposition and are unlikely to be representative of the strike and dip of the whole unit. Strike and dip measurements shown on the map were made on thin-bedded, fine-grained strata that were more likely deposited in a horizontal orientation.

MINERAL RESOURCES

Sand, gravel, and building stone are the most significant potential mineral resources in the Russellville Gulch quadrangle. One test well for oil and gas has been drilled. No radioactive mineral resources are known in the quadrangle (Nelson-Moore and others, 1978). Two areas have been exploited for placer gold.

SAND AND GRAVEL

Sand and gravel are widely available in the quadrangle from surficial deposits derived mostly from erosion of the Dawson Formation, but there is little indication that these resources are currently being exploited from the quadrangle.

BUILDING STONE

The Wall Mountain Tuff has been extensively quarried for building stone in the Castle Rock area for over a century. A small quarry was started in NE 1/4, NW 1/4, sec. 1, T. 9 S., R. 65 W. but appears to be inactive. On several outcrops of the Wall Mountain Tuff small pits have been excavated, apparently to test potential quarry sites. The Wall Mountain Tuff is actively being quarried in the adjacent Castle Rock North quadrangle.

OIL AND GAS

The Colorado Oil and Gas Conservation Commission has completion records for one petroleum test well in the Russellville Gulch quadrangle. In 1974 Norsk Hydro Petroleum Company drilled the Winkler State #1 well (SW 1/4 SW 1/4, sec. 36, T. 8 S., R. 66 W.) to a depth of 9577 feet. It was declared dry and abandoned. Formation tops from the completion records and well logs are shown in Table 1. The nearest oil production is about 15 miles northeast of the quadrangle, northwest of Kiowa in Elbert County.

TABLE 1.
Formation tops (depth in feet below surface) from the Norsk Hydro Petroleum Company Winkler State #1 oil and gas test well (SW 1/4 SW 1/4, sec. 36, T. 8 S., R. 66 W.);

Surface (elevation 6732)	0
Laramie Formation	2360
Fox Hills Sandstone	2735
Pierre Shale	3065
Niobrara Formation	8470
Fort Hays member	8850
D sand	9244
J sand	9270

Skull Creek Shale	9420
Dakota Formation	9468
Morrison Formation	9568
Total depth	9577

GOLD

Two areas in the Russellville Quadrangle have had recorded production of small amounts of placer gold. In 1858 a party of prospectors lead by John Beck and William Green Russell followed placer gold occurrences from where gold had been discovered in 1849 or 1850, in what is now Denver, upstream along Cherry Creek and discovered placer diggings that are credited with sparking the Pikes Peak Gold Rush (Parker, 1974). The diggings, the stream (Russellville Gulch), and the resulting village bare Russell's name. The discovery site is reported to be located in NW 1/4 sec. 20, T 8 S., R. 65 W., where an explanatory plaque has been erected along Tomichi Drive. Vanderwilt (1947) reports that the Russellville Gulch placers extended along Russellville Gulch for a distance of three miles and merged with the Cherry Creek placers at the confluence of the streams about one mile upstream from Franktown. Little physical evidence can be seen of the placer workings; the area has been modified either by subsequent development or by flooding, and in places is overgrown by willow brush. Placer gold production has also been reported from the Elizabeth area, from Ronk Gulch and Gold Creek (Gold Run; Parker, 1974). From the local topography, Gold Creek in SW 1/4 sec. 23 and NW 1/4 sec. 27, T. 8 S., R. 65 W. appears to be one of those locations. The gold from the Cherry Creek placers, including Russellville Gulch and Gold Creek, has very unique trace metal proportions and very high fineness, up to 990 fine (Desbrough and others, 1970; Parker, 1974).

The source of the gold in the Cherry Creek placers, including Russellville Gulch and several other local occurrences, is judged by Parker (1974) and Desbrough and others (1970) to be reconcentrations from the Castle Rock Conglomerate. There is little doubt that this is true as the concept has reportedly been tested many times (see the discussions and references in Parker, 1974, p. 45-56). However, the gold from the Elizabeth area, including Gold Creek, which Desbrough and others (1970) found to be similar in fineness and trace-metal content to Cherry Creek gold, is unlikely to have come from the Castle Rock Conglomerate since that unit did not cross the drainage divide between Russellville Gulch and Gold Creek. The conglomerate of Larkspur Butte does cross the divide; in fact, it holds up that divide as a resistant cap and may be the original source of the gold in the Cherry Creek placer. From the topography and slope of the Castle Rock Conglomerate in the Russellville Gulch quadrangle it is clear that the Castle Rock Conglomerate paleovalley cuts across and eroded older deposits of the conglomerate of Larkspur Butte. Similar relationships have been found in the Castle Rock South and Castle Rock North quadrangles (Thorson, 2004a, 2005b). This suggests that placer gold coming from the Castle Rock Conglomerate could have been reconcentrated from the older conglomerate of Larkspur Butte. To test this theory I panned several pans of gravel from the conglomerate of Larkspur Butte (sec. 20, T. 8 S., R. 65 W.) and found one flake of relatively coarse gold in each pan (figure 9). Thus, the origin of the gold in the Cherry Creek placers, the gold that figures so largely in Colorado history, may be integrally related to the origin and history of the conglomerate of Larkspur Butte.

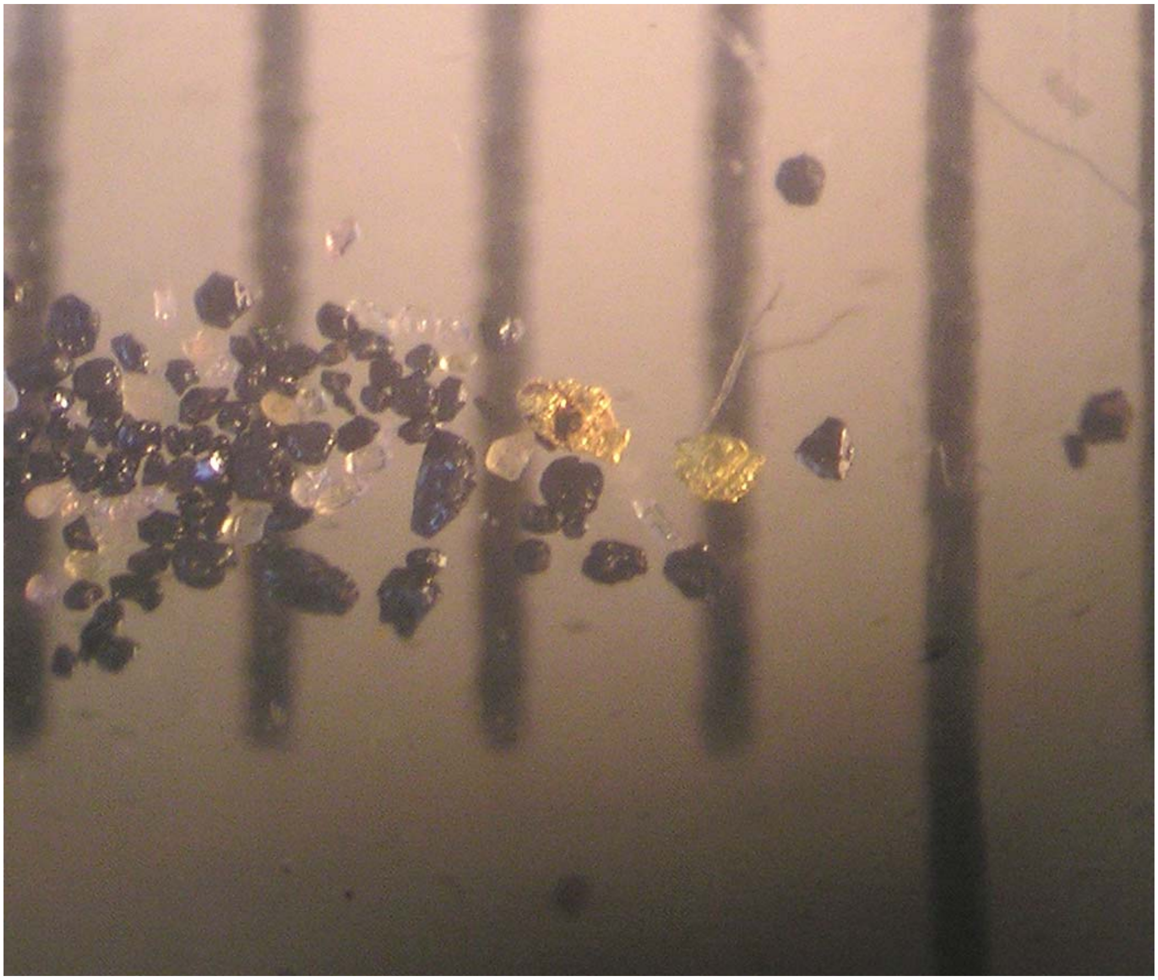


Figure 9. Gold grains recovered from the conglomerate of Larkspur Butte in sec. 20, T. 8 S., R. 65 W.   The heavy mineral concentrate grains with the gold appear to be mostly magnetite and zircon. Scale beneath the gold grains is divided in millimeters.

WATER RESOURCES

Water resources in the Russellville Gulch quadrangle are contained either in shallow groundwater aquifers in surficial alluvial deposits along the major stream drainages, largely the terrace deposits Qt1, Qt2, and Qt3, or in deeper groundwater aquifers of the Denver Basin (Robson, 1987, 1989). This basin contains four major aquifers: the Dawson, Denver, Arapahoe, and Laramie-Fox Hills, listed from the top down. Drill depths anticipated to completely test the four deep aquifers in the Russellville Gulch quadrangle are approximately 500, 1500, 2000, and 3000 feet, respectively (Robson, 1987). A comprehensive review of the geology and issues associated with ground water supply in the Russellville Gulch quadrangle is beyond the scope of this report. The interested reader is referred to Topper and others (2003) and Raynolds and Reynolds (2004) for recent reviews of the subject.

GEOLOGIC HAZARDS

Several geologic processes may effect planning and ultimate development within those portions of the Russellville Gulch quadrangle likely to be developed. In some of the steeper slope areas, particularly below the steep cliffs composed of Dawson Formation, conglomerate of Larkspur Butte, Wall Mountain Tuff, or Castle Rock Conglomerate, the potential for debris flows and rock falls presents significant threats to developed structures. Rock stability along the upper edges of cliffs and outcrops of the same units may be tentative as large blocks of well lithified bedrock begin to creep away as they are undermined by erosion of softer underlying strata. Slope instability and swelling soils associated with clay-rich portions of the Dawson Formation are potential problems where this unit is exposed. Over most of the quadrangle flooding probably represents the greatest geological threat, however. Most of the quadrangle contains broad open slopes with thin to moderate density grassland cover that offer little impediment to runoff. This area is subjected to occasional short but intense periods of torrential rain associated with summer thunderstorms. Flooding following these storms can be dramatic and dangerous.

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