

# **OPEN-FILE REPORT 04-6**

## **Geologic Map of the Cherry Valley School Quadrangle, Elbert, Douglas, and El Paso Counties, Colorado**

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Colorado Geological Survey  
Division of Minerals and Geology  
Department of Natural Resources  
Denver, Colorado

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Elbert, Douglas and El Paso Counties, Colorado

Introduction  
Geological Setting  
Description of Map Units  
Structural Geology  
Mineral Resources  
Water Resources  
Geological Hazards  
and References Cited

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Jon P. Thorson

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. 03HQAG0095

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## FOREWORD

The purpose of Colorado Geological Survey Open File Report 04-6, *Geologic Map of the Cherry Valley School Quadrangle, Elbert, Douglas, and El Paso Counties, Colorado* is to describe the geologic setting, structural geology, mineral resource potential, water resources, and geologic hazards of this 7.5-minute quadrangle located in central Colorado. Consulting Geologist Jon P. Thorson completed the field work on this project during the summer of 2003.

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 03HQAG0095](#), 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 Cherry Valley School 7.5-minute quadrangle is located between Colorado Springs and Castle Rock, Colorado in the southern part of the Colorado Piedmont section of the Great Plains. The Cherry Valley School quadrangle is located in the upper part of the Cherry Creek drainage basin which is tributary to the South Platte River. Geologic mapping of the Cherry Valley School 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 Cherry Valley School quadrangle and the status of geologic mapping of 7.5-minute quadrangles in the Colorado Springs area.

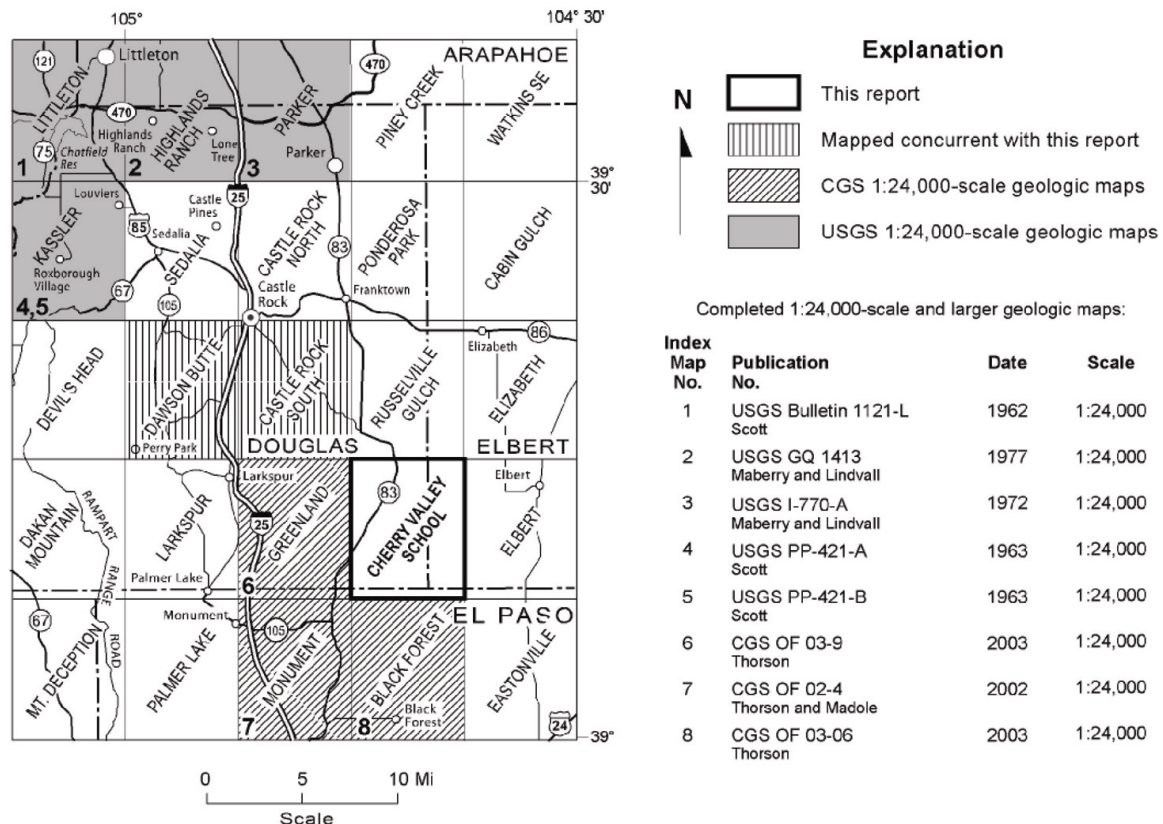


Figure 1. Location of the Cherry Valley School quadrangle and adjacent quadrangles mapped at a scale of 1:24,000.

This map is based on prior published and unpublished geologic maps and reports, interpretation of aerial photography, and field mapping in 2003. The aerial photographs

used are 1:28,000 scale black and white photographs taken in 1969. The topographic base map for the Cherry Valley School quadrangle was published in 1954 and updated by photo inspection in 1969. Consequently, some of the presently existing roads, buildings and other human-made modifications of the landscape are not shown on the base map.

Previous geological mapping in the Cherry Valley School area includes the work of Emmons and others (1896) and Richardson (1915). Trimble and Machette (1979) published a 1:100,000 scale regional geologic map of the Front Range urban corridor which includes the Cherry Valley School quadrangle.

The names and symbols used for geological units in the Cherry Valley School quadrangle conform as much as possible to those employed previously on geologic maps of nearby areas prepared by the Colorado Geological Survey (Fig. 1). 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 ft were not mapped. Also, deposits that are less than 5 ft thick were not mapped unless they are coincident with landforms that can be delineated on aerial photography. Some of the surficial deposits of the Cherry Valley School 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.

## **ACKNOWLEDGMENTS**

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: Vincent Matthews of the Colorado Geological Survey reviewed the map and text. Matt Morgan and Karen Morgan of the Colorado Geological Survey were valuable help in converting notes and field mapping on aerial photos into the geological map. George D. VanSlyke, Colorado Division of Water Resources, provided generous access to his department's files of water-well logs. Special thanks go to the landowners and developers who granted permission to enter their property.

## **GEOLOGICAL SETTING**

The Cherry Valley School quadrangle is located near the western edge of an asymmetrical, oval-shaped, geological structural depression called the Denver Basin (Emmons and others, 1896). This structural basin lies immediately east of the Front Range and covers a large part of eastern Colorado north of Pueblo, southeastern Wyoming, and southwestern Nebraska. The axis of this basin appears to lie beneath the southwestern part of this quadrangle .

Most of the exposed bedrock in the Cherry Valley School 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), 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 the granitic arkosic materials was mostly the Precambrian Pikes Peak Granite located immediately to the west of the Rampart Range mountain-front fault system. Stream flow was generally towards the east (Morse, 1979; Crifasi, 1992). The pebble conglomerate and arkosic sand beds of the Dawson are cross-bedded and fill broad channels generally cut into finer grained deposits of clayey sandstones and sandy claystones. Interbedded with the channel deposits are occasional structureless beds deposited by mudflows. Also 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 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, the conglomerate of Larkspur Butte (Thorson, 2003b) was deposited in a series of channels and broad valleys occupied by streams which 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 southeast.

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 the valleys which contained the conglomerate of Larkspur Butte. Because of its great heat the ash compacted into a viscous plastic which flowed for short distances before it cooled into welded tuff. Erosional remnants of the Wall Mountain Tuff now cap the conglomerate of Larkspur Butte or Dawson Formation on the higher buttes in the Cherry Valley School quadrangle. The Castle Rock Conglomerate was deposited near the end of the Eocene in paleovalleys on an erosion surface that cuts across the upper Dawson, conglomerate of Larkspur Butte, and Wall Mountain Tuff.

Since the deposition of the 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, former flood plains along stream courses, and on various upland erosion surfaces as streams eroded the landscape.

## **AGE OF FORMATIONS**

**Dawson Formation** - the upper part of the Dawson Formation spans the Cretaceous-Paleogene (K-P) boundary, but the exact location of the time boundary near the southwestern edge of the basin has not been located. Kluth and Nelson (1988) reconfirmed the Late Cretaceous (late Maastrichtian) age for the upper 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). Fossil leaf localities in the Monument quadrangle (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; 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) are Paleocene in age. Therefore much of the upper part of the Dawson in the Monument quadrangle is suspected to be Paleocene in age. A well-developed paleosol found at several localities in the Monument quadrangle may be the regional paleosol traced around the basin by Soister and Tschudy (1978) and proposed to mark the Paleocene-Eocene boundary. This paleosol was used as the boundary between Dawson facies units four and five in the Monument quadrangle. 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).

No direct or indirect dating of the Dawson Formation has been done in the Cherry Valley School quadrangle, but the structural attitudes of the Dawson outcrops, and locations of paleosol occurrences in adjacent quadrangles indicate that the Dawson in this quadrangle are entirely Eocene. Paleosols that are believed to be near the Paleocene-Eocene time boundary have been found in the Black Forest quadrangle (Thorson, 2003a), Dawson Butte quadrangle (Raynolds, 2002, personal commun; Farnham, 2002, personal commun.; Morgan and others, 2004), and Castle Rock South quadrangle (Thorson, 2003b; Johnson, personal commun, 2002). All of these paleosol localities occur in strata that are structurally lower and older than the Dawson in the Cherry Valley School quadrangle.

**Conglomerate of Larkspur Butte** - The conglomerate of Larkspur Butte (Tlc) is a newly recognized unit that underlies the late-Eocene-age Wall Mountain Tuff on Larkspur Butte, and on most of the other high buttes, in the Greenland quadrangle (Thorson, 2004b) and extends eastward into the Black Forest quadrangle (Thorson, 2003a) and into the Cherry Valley School quadrangle. This conglomerate is clearly of Eocene age; it lies between Eocene upper Dawson Formation and late Eocene-age 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. And, 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 Wall Mountain Tuff.

**Wall Mountain Tuff** - The ignimbrite eruption which deposited the Wall Mountain Tuff has been considered in the past to be an Oligocene event, for example see Trimble and Machette, 1979. Recent radiometric dates on its eruption are about 36.7 mybp (million years before present; McIntosh and others, 1992; McIntosh and Chapin, 1994). However, the age for the end of the Eocene is now recognized to be 33.7 mybp (Remane and others, 2002), 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 since 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 35.7 and 33.7 mybp. One large fossil bone was found in outcrops of Castle Rock Conglomerate in Sec. 30, T. 10 S., R. 65 W.; from inspection of photographs of this fossil K. R. Johnson speculated that it may be another titanotheres bone (personal commun., 2003).

## 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 (late Holocene)** — Gravel, sand, silt, clay, and rock or concrete debris emplaced for constructing highways, railroads, and dams. 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. The alluvial deposits in the Cherry Valley School quadrangle are dominantly 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 Qau), and terrace (Qt1, Qt2, Qt3) 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 can not 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 arkose or angular to subangular brownish-gray welded tuff in the alluvial deposits were derived from local sources.

A large part of the Cherry Valley School quadrangle is mantled by older alluvial deposits of probable Pleistocene age (Qp1, Qp2, Qp3, Qp4). In many places the upper surface of these older alluvial deposits is preserved as a gently sloping planar surface from which the original base level for the deposit can be interpreted. The relative age of these deposits has been interpreted from the slope, base level, and position in the landscape. These deposits have been grouped together as “older alluvium” since they represent either higher elevations of the present drainage system (Qp1, and Qp2 or deposits which can be related to an older drainage system, Qp3. In either case their form is being modified by erosion over wide areas.

The youngest of these older alluvial deposits, Qp1, has surfaces which mimic the present drainage system but represent material deposited during a higher base level of the drainage than present. Unit Qp2 is the remnants of a paleochannel in the western half of sec. 5, T. 10 S., R 67 W. that sloped towards West Cherry Creek. Qp2 is intermediate in position in the landscape between Qp1 and Qp3. The position of the oldest alluvial deposits, Qp3, at higher elevation positions in the landscape than Qp2, suggests that these deposits may be the remnants of older drainage systems which flowed northeastward and mantled much of the area in the Pleistocene. In some places the lower elevation edges of the older deposit, Qp3 grades imperceptibly into the upper part of Qp1; in others Qp3 was clearly deposited at a higher elevation than Qp1, and is therefore older.

**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 Qt1. 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 ft.

**Qt1 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 5-15 ft higher than some of the larger streams, but is only about 3-10 ft higher than the smaller streams of the area. Infrequent large floods may inundate Qt1 in places. Thickness is estimated to be 5-35 ft.

**Qt2 Terrace alluvium two (upper Pleistocene)** — Very pale-brown to dark grayish-brown, extremely poorly sorted sand and subordinate amounts of gravel. The unit may correspond to the Kettle Creek Alluvium of Varnes and Scott (1967). The upper surface of the unit is typically 10-20 ft higher than the larger streams. Thickness is 5-20 ft.

**Qt3 Terrace alluvium three (upper middle Pleistocene)** — Chiefly pale-brown to light grayish-brown, extremely poorly sorted sand and gravel that underlies terrace remnants along the larger streams of the area. The upper surface of the unit is 20-40 ft higher than West Cherry Creek. Estimated thickness is 5-30 ft.

**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 probably includes sediment that is correlative with units Qa, Qt1, and possible Qt2. Estimated thickness is 3-10 ft.

**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 gruss-like deposit. The unit has been largely derived from disintegration of the Dawson, but a smaller amount may have been derived from the older alluvial deposits. Estimated thickness is 3-20 ft.

**Qaf Alluvial-fan deposits (Holocene and late Pleistocene)** - Typically, light grayish-brown, pale-brown, to brown very poorly sorted sand, silt, and minor gravel deposited by ephemeral tributary streams on fans at the edges of valley floors. The unit is composed of material that is essentially the same as the sheet-wash deposits (Qsw), and was probably largely deposited by sheet-flow processes, although it may contain also some material transported by debris flow and mud flow processes. The geomorphic form of these alluvial fan deposits allows them to be mapped separately. Estimated thickness is 3-20 ft.

**Qp1 Older alluvium one (late Pleistocene)** — Chiefly light-brown to reddish-brown, extremely poorly sorted sand and coarse gravel, which, in places, includes boulders as well as pebbles and cobbles. The unit may have cobbly and bouldery layers with angular to sub-round fragments of Wall Mountain Tuff up to 12 inches and subrounded clasts of Dawson arkose up to 2 ft in size. It is unusual to find clasts of either conglomerate of Larkspur Butte or pink to red Pikes Peak Granite in this unit. Some of older alluvium Qp1 was mapped by Trimble and Machette (1979) as Slocum Alluvium, to which it may be equivalent, but they greatly underestimated the distribution of this unit. Unit Qp1 is poorly exposed in places; estimated thickness may be as great as 60 ft.

The slope of the Qp1 older alluvium deposits, and of the upper surface where preserved, indicates that this is the youngest of the older alluvial deposits. Gently sloping surfaces that appear to be the original depositional surface can be seen in many areas. The slope of these surfaces, toward a drainage in approximately the same position as the present drainage but representing a higher base level, acknowledges the presence of an older drainage system that resembled the present drainage system. The older alluvial deposits that are older than Qp1 indicate drainages that have less similarities to the present system.

**Qp2 Older alluvium two (middle Pleistocene)** — Brown to reddish-brown, extremely-poorly-sorted sand and coarse gravel which includes cobbles and boulders as well as pebbles exposed on the western part of Sec 5, T. 10 S., R. 65 W., as remnants of a paleochannel. Subangular cobbles and boulders of Wall Mountain Tuff up to 8 inches in size are predominant, but subround to round cobbles of quartz and quartzite up to 5 inches in size are common. Estimated thickness is 5-10 ft.

**Qp3 Older alluvium four (early ? to middle ? Pleistocene)** This deposit is composed of light-brown sand and fine gravel that appears to be derived from the

Dawson Formation, plus cobbles and small boulders of Dawson arkose up to 1 ft, cobbles of Wall Mountain Tuff up to about 8 inches, and lesser amounts of well rounded cobbles of white quartz and pink or reddish-brown Pikes Peak Granite up to 6 inches in diameter. Qp3 is the highest alluvial deposit in the Greenland quadrangle and therefore, probably the oldest. The highest parts of this unit in the southern part of the quadrangle are located at elevations above 7200 ft. Qp3 slopes generally toward the north. Unit is about 45 to 60 ft thick.

## **BEDROCK DEPOSITS**

**Tcr                      Castle Rock Conglomerate (late Eocene)** - The Castle Rock Conglomerate is a pebble, cobble, and boulder arkosic conglomerate composed dominantly of subround to round fragments of pink and gray granite and quartz with subordinate amounts of gneissic metamorphic rocks, quartzite, red sandstone, and chert. The distinguishing characteristic of this unit is the presence of angular to subangular cobble to boulder-size clasts of gray, brownish-gray, maroon, or lavender-gray welded tuff which have been eroded from deposits of the Wall Mountain Tuff. The Castle Rock Conglomerate was deposited on an erosion surface cut across the top of the upper Dawson Formation, conglomerate of Larkspur Butte, and Wall Mountain Tuff. In places the Castle Rock Conglomerate has been reported to overly the Wall Mountain Tuff (Morse, 1979, 1985), but this relationship was not observed in the Cherry Valley School quadrangle. 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 (33.7 my; Remane and others, 2002) since it contains bones of titanotheres (late Eocene, K. R. Johnson, written commun. 2002).

The Castle Rock Conglomerate outcrops in two areas in the Cherry Valley School quadrangle. In the northeastern part of the quadrangle it appears to be part of a series of large sheets of conglomerate that filled the lowest part of the Denver Basin in the late Eocene. Mapping by Trimble and Machette (1979), reconnaissance of the Russellville Gulch and Castle Rock North quadrangles, and mapping in the Castle Rock South quadrangle (Thorson, 2004) indicates that these sheets of conglomerate were deposited over a large area. The outcrops of Castle Rock Conglomerate in the southern part of the Cherry Valley School quadrangle occur as the remnants of an eastward sloping paleochannel that crossed the quadrangle following an older paleovalley and paleochannel that influenced the deposition of the conglomerate of Larkspur Butte and Wall Mountain Tuff (figure 2).

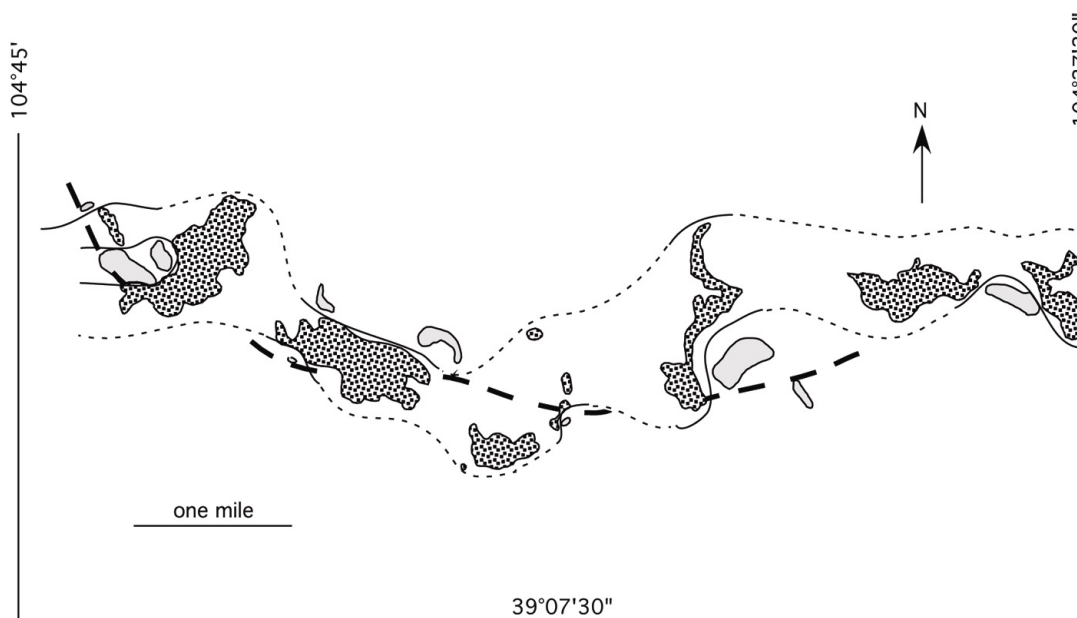


Figure 2. East-trending paleochannels in the southern part of the Cherry Valley School quadrangle; map outline shown by border of diagram. Outcrops of Wall Mountain Tuff (Twm) shown in light shaded pattern; interpreted axis of Wall Mountain paleochannel, where tuff was deposited on conglomerate of Larkspur Butte, shown with bold long-dash line. Outcrops of Castle Rock Conglomerate (Tcr) shown with heavy stippled pattern; mapped edges of Castle Rock Conglomerate paleochannel shown with solid thin line, interpreted edges shown with short-dash thin line.

**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 occasionally medium-gray in a few of the more densely welded outcrops. On weathering it 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 Cherry Valley School quadrangle as an ash-flow that was hot enough that the ash compacted and welded into viscous plastic 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; McIntosh and Chapin, 1994. The ash was erupted from the Thirtynine Mile volcanic field (Epis and Chapin, 1974).

In the Cherry Valley School quadrangle the Wall Mountain Tuff is up to about five to 40 feet thick. On most outcrops the welded tuff is fractured horizontally into hackly plates generally about 4 to 8 inches thick. It caps many of the higher buttes in the quadrangle as a flat or very gently sloping deposit resting either on the conglomerate of Larkspur Butte or on the Dawson Formation. In the northwestern part of the quadrangle the Twm appears to be remnants of a northeast dipping sheet of welded tuff that was once continuous with the outcrops in the Greenland quadrangle (Thorson, 2003b). The

remnants of this welded tuff sheet in the Cherry Valley School quadrangle indicate a dip towards the northeast at about 100 ft per mile. The outcrops of Twm in the southern part of the quadrangle appear to follow an east-trending paleovalley that slopes from about 7400 ft on Bucks Mountain to about 7200 ft near the eastern edge of the quadrangle. This valley contains a small paleochannel filled with conglomerate of Larkspur Butte, and appears to have persisted to influence the deposition of the Castle Rock Conglomerate.

The outcrops of Wall Mountain tuff in the Cherry Valley School quadrangle appear to be the remains of two separate deposits of tuff. The outcrops in the northwestern part of the quadrangle are the distal, lowest elevation, edge of a northeast-dipping sheet of welded tuff probably once continuous with the sheet of tuff whose remnants are widely distributed in the Greenland quadrangle (Thorson, 2003b). The outcrops of Wall Mountain Tuff occurring across the southern part of the quadrangle are the remnants of a tuff flow that filled an east-trending paleochannel (figure 2). The elevation of these welded tuff remnants decreases from about 7400 feet on Bucks Mountain (SE 1/4 sec. 23, T. 10 S., R. 66 W.) to below 7200 feet at the eastern edge of the quadrangle. The presence of small remnants of conglomerate of Larkspur Butte beneath the tuff along this trend of outcrops confirms that the welded tuff was emplaced along a pre-existing drainage partially filled with the conglomerate. This paleo-drainage was reoccupied by the stream which deposited the Castle Rock Conglomerate.

**Tlc Conglomerate of Larkspur Butte (late ? Eocene) -** The conglomerate of Larkspur Butte is a brown, pinkish-brown, or pink arkosic conglomerate dominantly composed of pebbles and cobbles of pink granite or pink feldspar in a coarse sand-size to small-pebble matrix composed of quartz and pink feldspar. Clasts of gray or white quartz are common; less abundant are clasts of gneissic metamorphic rocks, quartzite, red sandstone, and chert; clasts are subround to round. Clasts of eroded Dawson Formation arkose are common near the base of the unit. The conglomerate of Larkspur Butte rests on an erosional unconformity on the top of the Dawson Formation that has up to 50 to 60 feet of relief where well exposed on Larkspur Butte in the Greenland quadrangle (Thorson, 2003b). Similar channel-edge geometry relationships can be seen on in the exposures in the southern part of the Cherry Valley School quadrangle. On Larkspur Butte in the northwest corner of the Greenland quadrangle the unit contains granite clasts up to 8 inches in diameter, but clast size decreases regularly towards the southeast. This decrease in clast size continues in the southern part of the Cherry Valley School quadrangle where the clasts are seldom greater than 3 inches in diameter.

The conglomerate of Larkspur Butte is distinguished from the underlying Dawson by its coarser grain size, pinkish color tones, dominance of pink granite and unbleached pink feldspar grains, 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 arkose is bleached and essentially all of the macroscopic porosity of the Dawson beds is 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 remarkably free of clay filling in the matrix porosity. The outcrops of the conglomerate of Larkspur Butte in the Cherry Valley School quadrangle is restricted to the southern part of the quadrangle and appear almost exclusively as small outcrops under the Wall Mountain Tuff along the course of a paleochannel that controlled the deposition of the welded tuff (Twm).

The conglomerate of Larkspur Butte is similar in appearance to the Castle Rock Conglomerate although the latter generally lacks pink tones and is light-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.

**Tlccru Conglomerate of Larkspur Butte and Castle Rock Conglomerate, undivided (late ? Eocene)** - This unit exposed along the east side of East Cherry Creek in the northern part of the Cherry Valley School quadrangle is a pinkish-gray to light gray conglomerate composed of cobbles and small boulders (up to 8 inches) mostly of granite and quartz with lesser amounts of gneissic metamorphic rocks and quartzite in an arkosic pebble conglomerate and pebbly very coarse arkosic sandstone matrix. It is distinctly coarser grained than the adjacent outcrops of Castle Rock Conglomerate which it appears to underlie, and resembles the conglomerate of Larkspur Butte on the higher hills in the Greenland quadrangle. A diligent search of the outcrops in several areas failed to discover fragments of Wall Mountain Tuff in this unit so it may be correlative with the conglomerate of Larkspur Butte. There are no outcrops of Wall Mountain Tuff in the area which, were they present, should lie above this unit if the correlation is correct. It is possible, although considered at this time less likely, that this unit is a part of the Castle Rock Conglomerate which escaped incorporating fragments of Wall Mountain Tuff. The unit is about 80 to 100 feet thick.

**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 (TKda1), facies unit two (TKda2), facies unit three (TKda3), facies unit four (TKda4), and facies unit five (TKda5). 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.

Mapping in the Greenland, Monument and Black Forest quadrangles (Thorson and Madole, 2002; Thorson, 2003a, 2003b), indicates that most of the Dawson Formation in the Cherry Valley School quadrangle must be TKda5. Locally in the Cherry Valley School quadrangle another facies unit (TKda6) can be recognized above facies unit five.

Logs and samples from the Dawson 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, indicates that the Dawson Formation is about 2750 feet thick.

**TKda6            Facies unit six (early to middle ? Eocene)** - This unit is composed predominantly of coarse to very-coarse grained sandstone and pebble or cobble conglomerate, similar to the underlying TKda5, but distinctly coarser in grain size. The sandstones are white to very light gray clayey sandstone, generally cross bedded, and characteristic of the upper Dawson Formation. The conglomerate is very light brown to white and composed mostly of pebbles 1/4 to 1/2 inch in size, less commonly 3/4 inch, and rarely up to 2 inches. Pebble lithologies are mostly white feldspar and gray quartz with minor amounts of pink granite, pink feldspar, and reddish-brown quartzite. Where the base is well exposed, common large rip-up clasts of TKda5 arkose and mudstone are included in this unit and the base rests on an erosional unconformity cut into the underlying unit. The deposits of TKda6 appear to fill broad channels eroded in the underlying TKda5. The material that filled these channels appears to be a mixture eroded altered arkose with the addition of minor amounts of newly eroded granitic debris. TKda6 is 20 to 50 feet thick.

**TKda5            Facies unit five (early to middle ? Eocene)**  
The TKda5 unit is dominated by very thick-bedded to massive, cross-bedded, light-colored arkoses, pebbly arkoses, and arkosic pebble conglomerate, but 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 also contains massive structureless beds interpreted to be mudflows. Occasionally in the Cherry Valley School quadrangle, TKda5 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 which indicate their origin as paleosols; others are probably just the result of oxidation by groundwater. TKda5 is at least 800 ft thick in the quadrangle; the base is not exposed and the top of the unit has been removed by erosion.

TKda5 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 massive mudflow beds can be well indurated and may require considerable effort to excavate. The clay content of the finer grained parts of the facies unit suggest that soils developed from the Dawson may have high swell factors. Facies unit five appears to be equivalent to the Dawson Arkose and/or Dawson aquifer in the Denver area (George VanSlyke, 2001, oral commun.).

**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 undivided on cross sections on the geologic map.

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

**Kf Fox Hills Sandstone (Upper Cretaceous)** - Greenish-gray to yellowish-brown micaceous sandstone. About 300 feet thick; shown only on cross section A-A' that accompanies the geologic map.

**Kp Pierre Shale (Upper Cretaceous)** – Dominantly gray to dark-gray shale. About 5000 ft thick; shown only on cross section A-A' that accompanies the geologic map.

**Ku Older Cretaceous undivided (lowermost Upper Cretaceous and Lower Cretaceous)** - Niobrara Formation, Carlile Shale and Greenhorn Limestone, shown only on cross section A-A' on the geologic map.

**Kd Dakota Group undivided (Lower Cretaceous)** -sandstones and shales including the Dakota, Skull Creek and Lakota formations; shown only on cross section A-A' on the geologic map.

**Jm Morrison Formation (Jurassic)** - variegated shales and sandstones; shown only on cross section A-A' on the geologic map.

## **STRUCTURAL GEOLOGY**

The structural geology of the Cherry Valley School quadrangle is not complex. Most of the Dawson strata are flat lying although a few very gentle northeast dips were found. Strike and dip symbols are not abundant on the map because of poor outcrop exposures. 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. 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 which were more likely deposited in a horizontal orientation. Cross section A-A' shows this gentle structural dip in a northwest-southeast direction. The structure of the younger bedrock deposits is similarly gentle; the Wall Mountain Tuff was deposited on a surface that sloped to the NE at about 100 feet per mile.

## **MINERAL RESOURCES**

Sand, gravel, and stone are the most significant potential mineral resources in the Cherry Valley School quadrangle. Test wells for oil and gas reported no shows and were abandoned. No metallic or radioactive mineral resources are known in the quadrangle.

## **SAND AND GRAVEL**

Sand and gravel are widely available in the quadrangle from surficial deposits derived mostly by 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 few of the outcrops of this unit in the Cherry Valley School quadrangle have been tested as potential quarry sites. These locations were apparently reached by foot or pack trails, and abandoned after small pits were excavated.

## **OIL AND GAS**

The Colorado Oil and Gas Commission has completion records for two petroleum test wells drilled in or near the Cherry Valley School quadrangle. Both of these wells were unsuccessful and abandoned. The nearest oil production is about 30 miles northeast of the quadrangle, north of Kiowa in Elbert County.

In 1952, National Associated Petroleum drilled the #1 State well from a location in SE 1/4, NE 1/4 sec. 36, T. 9 S., R. 66 W. This well tested the Lower Cretaceous Dakota Group sandstone beds and terminated at 9670 ft in the Jurassic Morrison Formation.

In 1971, the Clark Canadian Exploration Company drilled the Beardsley #1. well in SE 1/4 SW 1/4 sec. 34, T. 10 S., R. 65 W and tested the Dakota Group sandstone beds. This well also terminated in the Dakota at 9250 ft.

## **WATER RESOURCES**

Water resources in the Cherry valley School 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 Cherry Valley School quadrangle are approximately 1000, 2000, 2500, and 3000 ft., respectively (Robson, 1987). Records of the Colorado Division of Water Resources indicate that there has been very little evaluation of the aquifers below the Dawson in this part of the Denver Basin.

## **GEOLOGIC HAZARDS**

Several geologic processes may effect planning and ultimate development within those portions of the Greenland quadrangle likely to be developed. In some of the steeper slope areas, particularly around some of the higher hills in the southern part of the quadrangle, the potential for debris flows, and rock falls present significant threats to developed structures. Slope instability and swelling soils problems associated with the more 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 is broad open slopes with thin to moderate density grassland cover which offers 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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