OPEN-FILE REPORT 08-16

Authors' Notes

Geologic Map of the Dakan Mountain Quadrangle, Douglas, Teller, and El Paso Counties, Colorado

By

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Description of Map Units, Structural Geology, Geologic Hazards,
Mineral Resources, and Ground-Water Resources

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Outcrops of the Pikes Peak Granite in the Dakan Mountain quadrangle. [UTM83 491982, 4339497]

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. 07HQAG0083

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FOREWORD

The purpose of Colorado Geological Survey Open File Report 08-16, *Geologic Map of the Dakan Mountain Quadrangle, Douglas, Teller, and El Paso Counties, Colorado* is to describe the geologic setting, mineral and water resources, and geologic hazards of this 7.5-minute quadrangle located in the Front Range, north of Woodland Park, Colorado. Consulting geologists Jay Temple, Alan Busacca and field assistants David Mendel and Karri Sicard completed the field work on this project during the summer of 2007. The sedimentary bedrock unit descriptions, structural geology, and water resource sections of this report were written by Mr. Temple. Dr. Busacca completed the sections on surficial deposits and geologic hazards. Mr. Mendel and Miss Sicard contributed the crystalline bedrock unit descriptions and mineral resources section.

This mapping project was funded jointly by the U.S. Geological Survey and the Colorado Geological Survey. U.S. Geological Survey funds were received under STATEMAP award number 07HQAG0083. STATEMAP is a component of the National Cooperative Geologic Mapping Program, which is authorized by the National Geologic Mapping Act of 1997. The Colorado Geological Survey matching funds are drawn from the Colorado Department of Natural Resources Severance Tax Operational Funds, which are obtained from the Severance Tax paid on the production of natural gas, oil, coal, and metals in Colorado.

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State Geologist and Director

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LOCATION AND GENERAL GEOLOGY

The Dakan Mountain 7.5-minute quadrangle is located in Douglas, Teller, and El Paso Counties, Colorado, in the southern part of the Colorado Front Range (fig. 1). The mapped area is predominantly mountainous terrain and a part of the Rampart Range. The city of Colorado Springs (Census 2000 population of 360,890) is located approximately 20 miles southeast of the quadrangle. The town of Woodland Park (Census 2000 population of 6,515) is located 8 miles to the south of the quadrangle. State Highway 67 transects the southwest quarter of the Dakan Mountain quadrangle and connects Woodland Park with the towns of Deckers, Buffalo Creek, and Pine Junction. Rampart Range Road (Forest Service Road 300) runs northwest-southeast through the quadrangle along the drainage divide between streams draining to the east and streams draining to the west. Trout Creek, the major drainage throughout the southwestern part of the Dakan Mountain quadrangle, flows northward to join the South Platte River near the town of Deckers. The South Platte watershed supplies a large share of water consumed by Denver and other cities to the north and east along the foothills of the Front Range. Several creeks and streams that originate in the mountains in the eastern part of the Dakan Mountain quadrangle flow into Trout Creek. The highest point in the mapped area is Storm Peak, located in the extreme east-central part of the quadrangle in sec. 9 of T. 10 S., R. 68 W. (elevation 9,199 feet). The lowest point (elevation 7,440 feet) is in the southwestern part of the quadrangle in the Trout Creek bottom north of Rainbow Falls Park.

The quadrangle can generally be described as consisting almost entirely of north-south trending mountainous terrain and flanked by the low lying areas of Manitou Park to the southwest (fig. 2). The mountainous terrain is part of the Rampart Range, which trends north-south for over forty miles from Colorado Springs to Kassler. Most of this mountainous region is rugged, forested land administered by the U.S. Forest Service (Pikes Peak and South Platte Ranger Districts, Pike National Forest). A significant portion of this Forest is comprised of the Manitou Experimental Forest, which was established by the U.S. Forest Service in 1936 to study problems of land use and its relation to the management of natural resources in the Front Range ponderosa pine zone (Gary, 1985). The ponderosa pines are accompanied by lodgepole pine, Douglas-fir, Engelmann spruce, and aspen. Average precipitation is 16 inches near Rainbow Falls Lake, with seventy percent accounted for by rain from April through August and the remaining thirty percent from snow during the winter months.

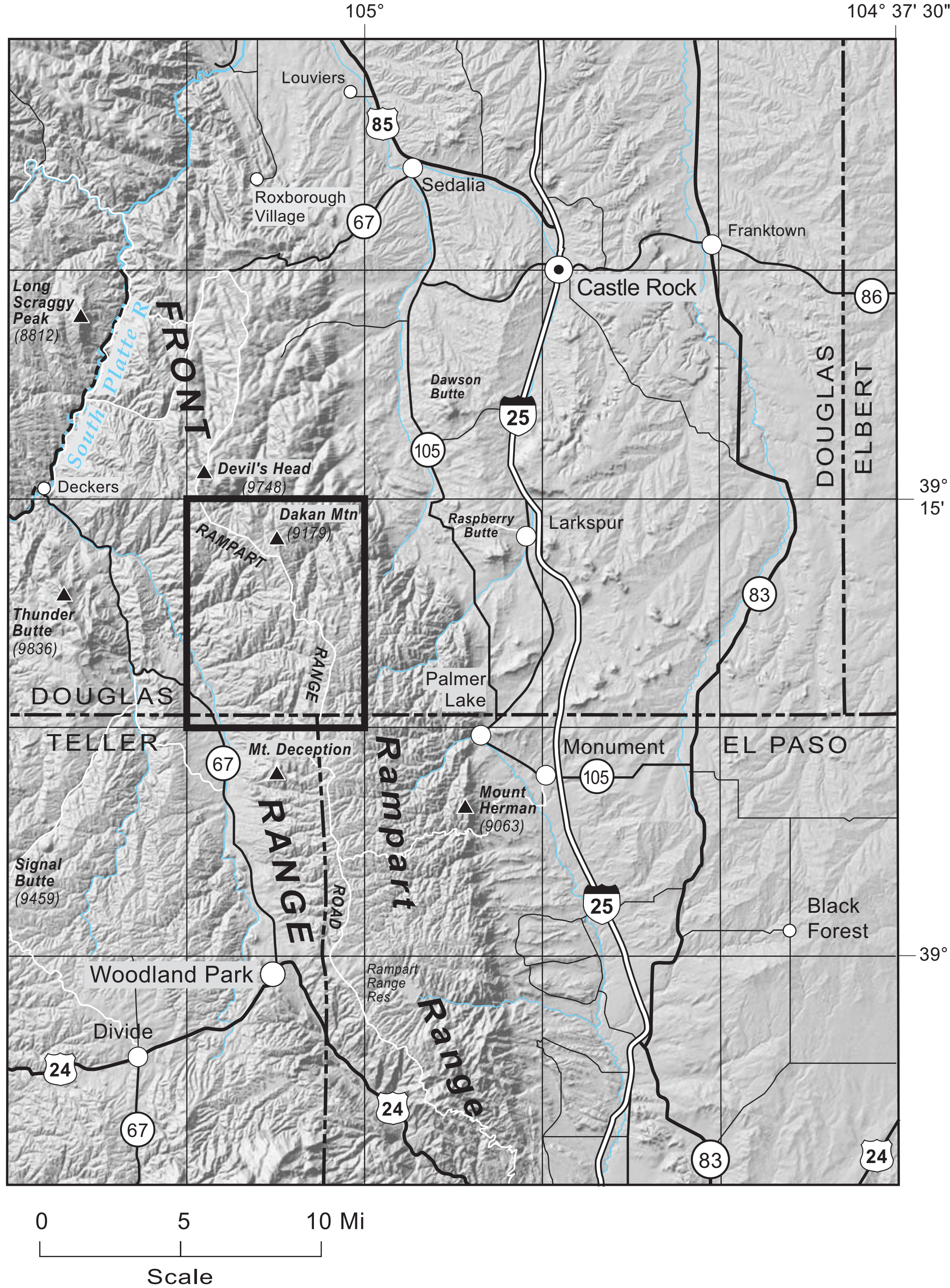


Figure 1. Shaded relief map of the region surrounding the Dakan Mountain quadrangle (bold black outline) showing cities and towns, major roads, and other geographic features.

The range-core rocks in the map area and surrounding region are typically of granitic composition and are part of the Neoproterozoic Pikes Peak batholith. High-angle faults generally striking north-south are common throughout the granitic core. Paleozoic sedimentary rocks crop out in the southwestern part of the quadrangle and a veneer of Quaternary surficial materials flank the granitic core. The “Great Unconformity”, a nonconformity where the Cambrian Sawatch Sandstone lies directly upon the Precambrian granitic basement, is spectacularly exposed in the Rainbow Falls Park area in the southwest part of the quadrangle. Faulting in the southwestern part of the quadrangle consists of a significant northwest-southeast striking fault that defines Trout Creek and a few minor east-west trending faults within the Lower Paleozoic rocks. The extreme southwestern part of the quadrangle is the location of the north-south striking, high-angle reverse, Ute Pass fault.

Figure 2. Photograph looking south from Rainbow Falls Park towards Pikes Peak. View in the foreground shows the lower topography of the Trout Creek drainage basin which is part of the Woodland Park or Manitou Park graben.

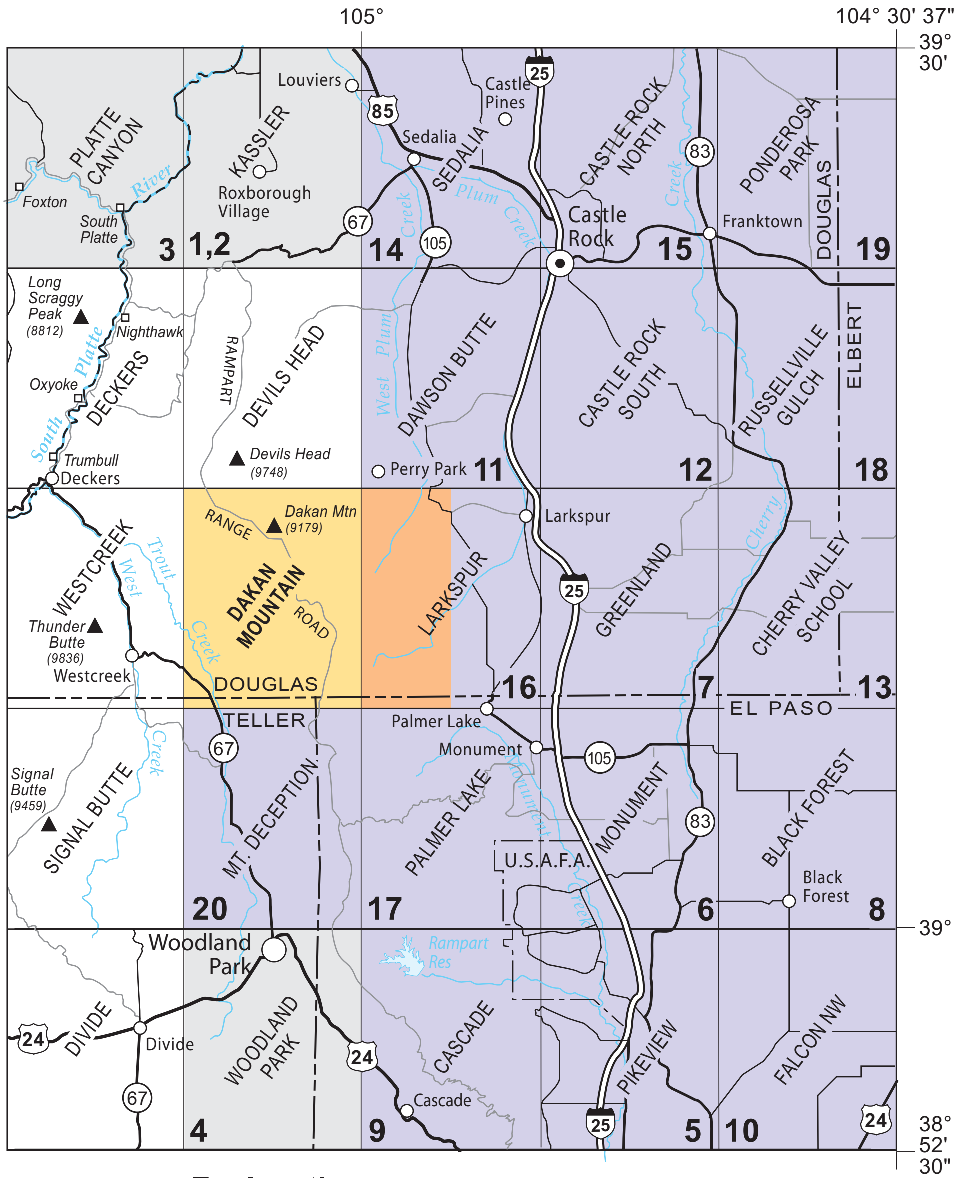
SCOPE OF WORK

Geologic mapping of the Dakan Mountain 7.5-minute quadrangle was undertaken by the Colorado Geological Survey (CGS) as part of the STATEMAP component of the National Cooperative Geologic Mapping Act, which is administered by the U.S. Geological Survey. 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 groundwater exploration. Figure 3 shows the status of geologic maps of 7.5-minute quadrangles in the Colorado Springs area. This is the twenty-fifth quadrangle in this area to be mapped by the CGS.

The geologic interpretations shown on the map were based on (1) field investigations in 2007, (2) prior published and unpublished geologic maps and reports, (3) orthorectified 1-meter resolution National Agriculture Imagery Project (NAIP) photography flown in 2005, (4) high-resolution aerial stereo photography from the U.S. Department of Agriculture, and (5) other high-resolution orthorectified aerial photography. Bedrock geology and surficial deposits were mapped in the field on topographic maps of the quadrangle and on aerial photographs. The photos and maps were scanned, georeferenced, and imported into ESRI ArcGIS software where line work was traced and digitized as ESRI feature classes. Universal Transverse Mercator (UTM; North American Datum 1983, Zone 13) coordinates are provided for key geologic areas and photographs.

PREVIOUS GEOLOGIC MAPPING

Geologic mapping in the late nineteenth and early twentieth centuries targeted areas to the north, south, and east of the Dakan Mountain quadrangle but did not include it as part of a compilation for the Geologic Atlas of the United States by the U.S. Geological Survey. The region northeast of the quadrangle was mapped at a scale of 1:48,000 for the Castle Rock Folio by Richardson (1915); to the east for the Colorado Springs Folio by Finlay (1916); and to the south for the Pueblo Folio by Gilbert (1897). Descriptions of the rock units, chemical analyses of some of the Proterozoic igneous rocks, and structural interpretations were parts of these folios. Several graduate theses were completed near the quadrangle by students from the University of Colorado and the University of Iowa (Bennett, 1940, Fowler, 1952, and Sweet, 1952). The Front Range, including the Dakan Mountain area, was also mapped and described as to structure and stratigraphy in a tectonic synthesis by Boos and Boos (1957). The Denver 1:250,000 scale geologic map by Bryant and others (1981) included the area of this quadrangle. Recent detailed geologic mapping in the Colorado Springs area at a scale of 1:24,000 has been conducted by the Colorado Geological Survey (fig. 3).



Explanation

- This report
- Mapped concurrently with this report
- Completed CGS geologic maps
- Completed USGS geologic maps

N

Completed 1:24,000-scale geologic maps:

Index Map No.	Publication No.	Date
1	USGS PP-421-A Scott	1963
2	USGS PP-421-B Scott	1963
3	USGS B-1181C Peterson	1964
4	USGS MF-842 Wobus and Scott	1977
5	CGS OF 01-3 Thorson and others	2001
6	CGS OF 02-4 Thorson and Madole	2002
7	CGS OF 03-9 Thorson	2003
8	CGS OF 03-6 Thorson	2003
9	CGS OF 03-18 Morgan and others	2003
10	CGS OF 03-8 Madole	2003
11	CGS OF 04-7 Morgan and others	2004
12	CGS OF 04-5 Thorson	2004
13	CGS OF 04-6 Thorson	2004
14	CGS OF 05-6 Morgan and others	2005
15	CGS OF 05-2 Thorson	2005
16	CGS OF 05-7 Thorson	2005
17	CGS OF 06-6 Keller and others	2006
18	CGS OF 06-8 Thorson	2006
19	CGS OF 07-4 Thorson	2007
20	CGS OF 07-7 Temple and others	2007

0 5 10 Mi

Scale

Figure 3. Location map and index of selected published 1:24,000-scale geologic maps in the vicinity of the Dakan Mountain quadrangle.

ACKNOWLEDGEMENTS

The authors are grateful to the landowners of the Dakan Mountain region for their permission to access the areas necessary to complete this map. The dominant land administrator in the region is the U.S. Forest Service, and the Pikes Peak Ranger District's Jeff Hovermale provided key support for access to these lands. The Manitou Park Experimental Forest staff, consisting of Steve Tapia and Richard Oakes, was also very supportive of our efforts. Key support during the digitizing of maps and compiling of figures was provided by Colorado Geological Survey personnel Matt Morgan, Nick Watterson, and Larry Scott. Field checks and suggestions for the manuscript were provided by Vince Matthews, Matt Morgan, and Dave Noe, also from the Colorado Geological Survey. Discussions with Paul Myrow and Christine Siddoway of Colorado College were extremely helpful to better understand the stratigraphy and structure of the area.

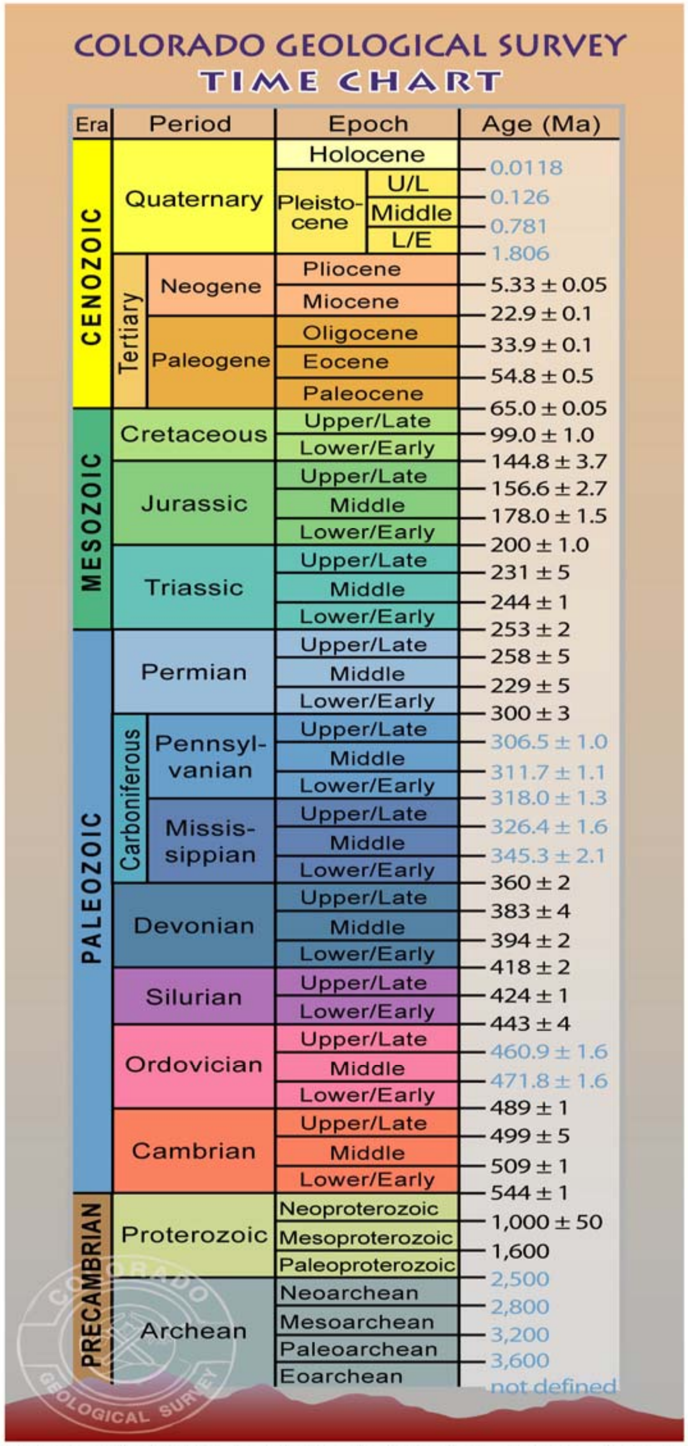
DESCRIPTION OF MAP UNITS

Geologic time divisions used in this report are shown in Table 1. Numerical ages were taken from the Geological Survey of Canada (Okulitch, 2002) and the International Commission on Stratigraphy (2005).

SURFICIAL DEPOSITS

Unit Descriptions. The area of surficial deposits in the Dakan Mountain quadrangle is small, less than ten percent of the quadrangle. Most of the surficial sedimentary units are located along and adjacent to Trout Creek in the southwestern corner of the map.

Trout Creek flows northward along the Manitou Park graben at a low gradient, then over a knickpoint in hard crystalline bedrock at Rainbow Falls along the west-central edge of the map, and from there it joins West Creek, which flows into the South Platte River. Trout Creek has a low gradient in the mapped area, which is south and upstream of the knickpoint at Rainbow Falls, effectively isolating this area from the influence of major base level changes to the major trunk drainage, the South Platte River. Additionally, the Ute Pass and Mount Deception fault zones may have been reactivated in the late Cenozoic, creating an additional, local influence on the history of surficial sediments.



COLORADO GEOLOGICAL SURVEY
TIME CHART

Era	Period		Epoch		Age (Ma)
CENOZOIC	Quaternary		Holocene		0.0118
			Pleistocene	U/L	0.126
				Middle	0.781
				L/E	1.806
	Tertiary	Neogene	Pliocene		5.33 ± 0.05
			Miocene		22.9 ± 0.1
		Paleogene	Oligocene		33.9 ± 0.1
			Eocene		54.8 ± 0.5
			Paleocene		65.0 ± 0.05
MESOZOIC	Cretaceous		Upper/Late		99.0 ± 1.0
			Lower/Early		144.8 ± 3.7
	Jurassic		Upper/Late		156.6 ± 2.7
			Middle		178.0 ± 1.5
			Lower/Early		200 ± 1.0
	Triassic		Upper/Late		231 ± 5
			Middle		244 ± 1
			Lower/Early		253 ± 2
PALEOZOIC	Permian		Upper/Late		258 ± 5
			Middle		229 ± 5
			Lower/Early		300 ± 3
	Carboniferous	Pennsylvanian	Upper/Late		306.5 ± 1.0
			Middle		311.7 ± 1.1
			Lower/Early		318.0 ± 1.3
		Mississippian	Upper/Late		326.4 ± 1.6
			Middle		345.3 ± 2.1
			Lower/Early		360 ± 2
	Devonian		Upper/Late		383 ± 4
			Middle		394 ± 2
			Lower/Early		418 ± 2
	Silurian		Upper/Late		424 ± 1
			Lower/Early		443 ± 4
	Ordovician		Upper/Late		460.9 ± 1.6
			Middle		471.8 ± 1.6
			Lower/Early		489 ± 1
	Cambrian		Upper/Late		499 ± 5
			Middle		509 ± 1
			Lower/Early		544 ± 1
PRECAMBRIAN	Proterozoic		Neoproterozoic		1,000 ± 50
			Mesoproterozoic		1,600
			Paleoproterozoic		2,500
	Archean		Neoarchean		2,800
			Mesoarchean		3,200
			Paleoarchean		3,600
			Eoarchean		not defined

Okulitch, A.V., 2002, Geological time chart: Geological Survey of Canada, Open File 3040 (National Earth Science Series, Geological Atlas) –BLACK DATES.

International Commission on Stratigraphy, 2005, International stratigraphic chart: downloaded January 2006 from the International Commission on Stratigraphy website, www.stratigraphy.org/chus.pdf–BLUE DATES.

Table 1. Geologic time chart used by the Colorado Geological Survey.

Taken together, the isolation from major trunk streams such as the South Platte River and local tectonic influences militate against attempting to correlate the surficial deposits in the map area to surficial deposits along the Front Range. We therefore have purposely not used names of formally recognized rock stratigraphic units from the Front Range area. We instead have based our descriptions on physical characteristics such as texture, stratification, composition, and mode of deposition. The thicknesses of most units are not known with any certainty because they are poorly exposed, which also means that our descriptions of the surficial deposits are based on observations at a small number of localities.

Surficial deposits in the Dakan Mountain quadrangle are poorly sorted, most contain a broad range of particle sizes from clay to pebbles. The modified Wentworth scale (Ingram, 1989) is used to describe particle size, and Pettijohn's (1949) classification of roundness is used to describe particle shape. In the modified Wentworth scale, gravel includes pebbles, cobbles, and boulders. Also, because gravel has the connotation of rounded rock fragments (Bates and Jackson, 1995), angular rock fragments larger than 1/12 inch (2 mm) are referred to as pebble size or cobble size, as the case may be. Clast, as used here, is limited to rock fragments (rounded or angular) that are larger than 1/12 inches (2 mm) in maximum dimension, and matrix refers to fragments that are smaller than 1/12 inches (in other words, sand-, silt-, and clay-size particles). The colors of surficial map units were determined using Munsell Soil Color charts (Munsell Washable Soil Color Charts, 2000 Version; X-Rite Corporation; accessed at: http://www.xrite.com/product_overview.aspx?ID=872 on February 17, 2008) and are for the dry state of the materials.

Age Assignments. The age limits of divisions of Pleistocene time (Table 1) are U.S. Geological Survey Geologic Names Committee (2007). The 11,500-year date for the Pleistocene-Holocene boundary is the approximate calibrated equivalent of 10,000 radiocarbon years. No formal divisions of Holocene time have been agreed upon, so sediment referred to here as upper Holocene was deposited during the interval between 4,000 years ago and the present.

None of the surficial deposits in the Dakan Mountain quadrangle have been dated directly by any radiometric method, such as radiocarbon, cosmogenic, or luminescence dating. Thus, the unit ages listed here are estimated on the basis of relative-dating methods. These include stratigraphic relationships (superposition, unconformities, etc.), position in the landscape (mainly height above stream level), differences in degree of weathering and soil development, and best possible inferred correlations with deposits elsewhere whose ages have been determined by numerical-dating methods.

HUMAN-MADE DEPOSITS — Earth materials emplaced by human beings.

af **Artificial fill (upper Holocene) —** Earth materials (sand, silt, clay, and rock debris) emplaced mainly to construct roads and earthen dams. Unit is 6-50 feet thick.

ALLUVIAL DEPOSITS — Gravel, sand, silt, and clay transported and deposited by flowing water, either in channels (fluvial deposits) or as unconfined runoff (sheet flow). Alluvium deposited from confined channel flow is the principal sediment underlying streams, flood plains and terraces. Alluvium resulting from sheet flow, referred to as sheetwash alluvium, blankets the lower parts of most slopes but was mapped only where especially prominent.

Qa_1 **Channel and flood-plain alluvium (upper Holocene) —** Unit consists mainly of pale-brown to brown, poorly sorted, angular to subrounded pebble gravel and sand underlying stream channels and flood plains. Deposits of Qa_1 wide enough to show on the map are present only in the valley of Trout Creek. Flood plain is used here in the geomorphologic sense and refers only to flat areas adjacent to streams and that are flooded frequently. Areas flooded only by 100- or 50-year floods are not included in the flood plain. Unit Qa_1 probably was deposited mostly during historic time. Deposits of Qa_1 are thin and overlap or are inset into unit Qa_2 in many places. Estimated thickness is 2-10 ft.

Qa_2 **Valley-floor alluvium (upper Holocene) —** Unit consists of interbedded pale-brown to brown, poorly sorted, angular to subrounded pebble gravel, sand, and silty sand. It underlies a low terrace on the valley floor of Trout Creek that is about 5 to as much as 10 ft higher than stream level. A weakly developed soil (A/C horizon sequence) has formed in Qa_2. Infrequent large floods may inundate areas of this unit. Estimated thickness is 5-15 ft.

Qa_3 **Valley-floor and terrace alluvium (lower Holocene and upper Pleistocene) —** Unit consists mainly of pale-brown to brown, poorly sorted subangular to subrounded sand and fine pebble gravel at the mouths of tributaries to Trout Creek. In places such as the mouth of Missouri Gulch it underlies a terrace that is as much as 10 ft higher than stream level. The unit is of limited extent and exposure is especially poor, but a soil profile apparently bearing an A/B/C horizon sequence is developed in unit Qa_3. Very infrequent very large floods may inundate unit Qa_3 in places. Estimated thickness is 5-20 ft.

Qau **Alluvium, undivided (Holocene and Pleistocene)** — Unit is mainly pale-brown to brown, poorly sorted sand and pebble gravel. Qau was mapped where it consists of deposits of different kinds of alluvium (sheetwash and fluvial) or different ages of alluvium (Qa_1, Qa_2, and Qa_3) that are either too small or too poorly exposed to map separately at the scale of this map. On the floors of deep, narrow valleys cut in Proterozoic rocks in the eastern and central parts of the map, the unit may consist of units Qa_1, Qa_2, and Qa_3 undivided, but includes sheetwash alluvium and colluvium locally. Estimated thickness is 1-20 ft.

Qsw **Sheetwash (Holocene and Pleistocene)** — Pale-brown, brown, or reddish to reddish-brown, thinly bedded, poorly sorted sand, matrix-supported sandy pebble gravel and angular to subrounded sandy fine-pebble gravel that was deposited mainly by unconfined water flow. Unit exists principally in sheets and wedges along valley sides and footslopes. In some places, it grades upslope into unit Qac, and locally Qsw includes colluvium such as debris-flow deposits. A blanket of Qsw commonly conceals bedrock along the lower parts of escarpments capped by gravel units (Qg_1, Qg_2, and Qg_3). Some deposits of Qsw are at least partly correlative with units Qg_1, Qg_2, and Qg_3. Estimated thickness is 1-40 ft.

Qg_1 **Gravel one (upper middle Pleistocene?) —** Reddish-brown, crudely stratified, poorly sorted sand and angular to subrounded pebble gravel in a sandy matrix. Gravel is composed mainly of fragments of Pikes Peak Granite, but it also includes clasts of Paleozoic sedimentary rocks in some places. Most of the unit was eroded from older fan gravel (Qg_2 and Qg_3) as gullies cut headward from Trout Creek. In some places there is up to 30 feet of relief separating the upper surfaces of units Qg_1 and Qg_2 but in other places, such as to the west of the intersection of Highway 67 and the road into Rainbow Falls Park, the upper surfaces are at nearly the same elevation. Relict soil profiles consisting of A/Bt/Btk/ Bk/C horizon sequences are present in some places. Bt denotes accumulation of clay in the subsoil and Bk denotes accumulation of white coatings of lime (calcium carbonate) deep in the soil profile. Carbonate in the Btk and Bk horizons is present mainly as coatings on sand grains but it also coats pebbles. Height above Trout Creek is variable and not a consistent indicator of Qg_1, but the upper surface of Qg_1 is generally 20-50 ft higher than stream level. Unit thickness is probably 30-50 ft.

Qg_2 **Gravel two (middle Pleistocene?)** — Qg_2 has similar characteristics to those of unit Qg_1, except that the Bt horizon developed in it appears to be thicker and to contain more clay and the Btk and Bk horizons probably contain more $CaCO_3$. It is difficult to compare the soils developed in Qg_1 and Qg_2; however, because relict soils (complete and intact soil profiles) are not preserved everywhere and unit Qg_2 is poorly exposed. Unit Qg_2 appears to have been deposited in small valleys that were cut into unit Qg_3. Unit Qg_2 filled the valleys nearly to the level of the upper surface of unit Qg_3. Unit Qg_2 apparently was part of a broad alluvial slope that extended into the Manitou graben but in the mapped area it consists of isolated hillocks with relict deposits of cobbles and larger but highly dissected remnants of the unit. Unit Qg_2 was derived chiefly from erosion of Pikes Peak Granite but also includes clasts of Paleozoic sedimentary rocks in some places; some sediment in unit Qg_2 also was eroded from unit Qg_3. Thickness of the unit appears to be up to about 40 ft.

Qg_3 **Gravel three (lower Pleistocene?)** — Deposits of Qg_3 are comparable in setting and nature to those of unit Qg_2. West of Trout Creek, the upper surfaces of eroded remnants of Qg_3 are commonly 60 feet or more higher than remnants of Qg_2. Deposits of Qg_3 appear to be redder than deposits of Qg_2 and possibly contain soils that are more developed than those in Qg_2, but exposures are few. Unit thickness is variable, but it is probably between 30 and 50 ft in most places.

ALLUVIAL AND COLLUVIAL DEPOSITS — These units contain material of both alluvial and colluvial origin that are mapped as a single unit due to poor exposure that makes differentiation impossible or due to limitations of map scale. Colluvium is a general term for earth materials transported by mass wasting; that is, mainly under the force of gravity and not transported by a medium such as wind, flowing water, or glacier ice. 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.

Qdf **Debris-fan deposits (Holocene and Pleistocene)** — Fan-shaped bodies of pale-brown, brown, and reddish-brown, extremely poorly sorted sand, silt, and gravel deposited mainly during intense thunderstorms, times of heavy snowmelt runoff, and by debris flows (mixtures of sediment and lesser amounts of water and air that move as a mass). Units of Qdf along the margins of Trout Creek are mostly alluvial-fan deposits that formed during the Holocene, some during historic time. This unit may be flooded frequently, and in some places, it may be subject to infrequent debris flows and rock fall. Deposits of Qdf are mostly 20-40 ft thick.

Qac **Alluvium and colluvium, undivided (Holocene and Pleistocene) —** Sheet or wedge-shaped masses of pebble- to boulder-size rock fragments, sand, silt, clay that are present mostly just below steep slopes. The material was transported and deposited mainly by rock fall and slide, debris flows, sheet flow, and thunderstorm-generated floods. Unit is estimated to be 3-30 ft thick.

BEDROCK UNITS

IPPf **Fountain Formation (Lower Permian and Pennsylvanian) —** The Fountain Formation is primarily a light-red to pink, fine- to coarse-grained, poorly sorted, arkosic sandstone and pebble conglomerate. Clasts are subangular to rounded and consist of quartz and coarse-grained intrusive rocks ranging in size from less than an inch to several inches in size. Cross bedding and graded bedding are common. Locally, the formation contains beds of dark-red to red to reddish-brown, thinly bedded shales and mudstones. The formation is generally soft and friable due to intense weathering throughout the mapped area with the exception of locations east of Trout Creek in the southwest part of the quadrangle. At these locations the formation is well indurated, resistant, and is exposed in topographic "hoodoo" features reaching several tens of feet in elevation from ground to top. The depositional environment for the arkosic sandstones and conglomerates of the Fountain Formation was one of fluvial channels, overbank deposits, and alluvial fans. The source is material from the uplift of the Ancestral Rocky Mountains, a series of roughly north-trending, basement-involved highlands that formed in the western part of North America during the Pennsylvanian-Permian periods (Hoy and Ridgway, 2002). The formation thickness was not measured in the map area due to Quaternary deposits which limit the formation's exposure. However, it is over 4,000 feet thick twenty miles to the south in the Cascade quadrangle (Morgan and others, 2003). The Fountain Formation unconformably overlies the Leadville Limestone.

Mlw **Leadville Limestone and Williams Canyon Member of the Leadville Limestone, undivided (Mississippian) —** The Mississippian rocks mapped in the southwestern part of the Dakan Mountain quadrangle include the Leadville Limestone and the Williams Canyon Member of the Leadville Limestone. The Williams Canyon Member is exposed along Missouri Gulch (E 1/2, sec.34, T. 10 S., R. 69 W.). Here, the member consists of calcitic sandstones, lime mudstones, and dolomitic mudstones that unconformably overlie the Manitou Formation. The basal part of the member is composed of a thin (< 1 foot) quartz sandstone that is medium to coarse grained, well rounded, and moderately sorted. The sandstone grades upwards into approximately 30 feet of lime mudstones and dolomitic mudstones that are a light gray to greenish gray, mottled, and locally contain vugs filled with calcite crystals. Scattered lenses of rounded and frosted quartz grains are common throughout the mudstones. The Leadville Limestone conformably overlies and may even interfinger with the

Williams Canyon Member as reported by Hill (1983). The Leadville Limestone consists of a light-gray to tan, very fine-grained limestone that is typically massive and contains pitted surfaces and vugs from dissolution. The formation was measured in White Spruce Gulch in the northern part of the Mount Deception quadrangle to be near 50 feet in thickness, with outcrops forming cliffs up to 40 feet above the valley floor. At this location, the formation is brecciated and contains abundant fractures, frequently filled with calcite. Our classification of the Leadville Limestone and Williams Canyon Member of the Leadville Limestone as an undifferentiated mapped unit in the Dakan Mountain quadrangle deviates from the same rock unit mapped in the Manitou Springs quadrangle (Keller and others, 2005) and the Cascade quadrangle (Morgan and others, 2003). In these earlier mapped quadrangles, the Leadville Limestone was mapped undifferentiated as MDlh-the Hardscabble Member of the Leadville Limestone (Mississippian) and the Williams Canyon Formation (Devonian). On the basis of detailed stratigraphic correlations and conodont identification by Hill (1983) throughout south-central Colorado, we have adopted the age and classification of the Williams Canyon Member as Mississippian and as a member of the Leadville Limestone. The depositional environment of the Williams Canyon Member was most likely an intertidal-supratidal zone as suggested by thin parallel beds, a lack of fossils, and abundant rounded and frosted quartz grains originating from windblown sands. The Leadville Limestone facies would represent a nearshore marine environment as suggested by micritic carbonates, dolomite mudstones, and fossil assemblages containing brachiopods, bryozoans, ostracodes, and conodonts (Hill, 1983).

Om **Manitou Formation (Lower Ordovician) —** The Manitou Formation consists of resistant, fine-grained limestone and dolomitic limestone. The formation is easily recognized by pink to pinkish-gray carbonates that weather to a fine, reddish-colored soil. The formation in the mapped area is composed of two slightly different and informal members. The lower member rests on the Sawatch Formation on a surface described as the Mid-Rossodus unconformity based on extensive biostratigraphic investigations by Myrow and others (2003). The lower member is a pink to light-red to maroon, fine-grained limestone and dolomitic limestone. Beds average 4 to 6 inches in thickness with occasional 1 to 2 foot beds. The thickness of this member is about 55 feet. The upper member is composed of thicker beds (1-3 feet) of more coarsely crystalline light-pink to light-gray limestone and dolomitic limestone, with thin, resistant, gray chert layers occurring near the top. This member was measured to be 65 feet thick. The combined thickness of the two members is 120 feet. This is in close agreement with the measured thickness in Missouri Gulch (sec. 34, T. 10 S., R. 69 W.), as reported by Myrow and others (2003). The Manitou Formation is locally fossiliferous, represented primarily by Lower Ordovician conondonts. However, incomplete and poorly preserved parts of trilobites were described by Berg and Ross (1959). The trilobites of the Manitou Formation have been the focus of recent collection activities in the Rainbow Falls State

Park area in the southwestern part of the Dakan Mountain quadrangle. The collecting was coordinated by the Denver Museum of Nature and Science (Jeff Hovermale, oral commun., 2006). Descriptions of wave-rippled grainstones, thin-bedded and bioturbated micrites, and fossil assemblages of trilobites and gastropods described by Myrow (1998) are indicative of a shallow marine environment of deposition for the Manitou Formation.

Ꞓs **Sawatch Formation (Upper Cambrian) —** The Sawatch Formation is composed of a medium- to coarse-grained, quartz-rich sandstone that overlies the Mesoproterozoic crystalline basement rocks in a nonconformable contact. This dramatic contact is referred to as the "Great Unconformity", and is spectacularly exposed in the southwestern parts of the Dakan Mountain quadrangle east of Trout Creek. The Sawatch Formation was described and measured as four informal members at a location in the Mount Deception quadrangle just one-half mile south of the Dakan Mountain quadrangle. At and above the contact with the crystalline rocks, the basal member is a light-gray to light-yellow, coarse- to medium-grained quartz pebble conglomerate averaging about 4 feet in thickness. Clasts are composed primarily of rounded to sub-rounded quartz grains up to ¼ inch in size with local cross-bedding prevalent in the finer matrix. The basal conglomerate grades upwards into a resistant, gray to tan, medium-grained, locally cross-bedded, quartz sandstone. This member was measured to be 33 feet in thickness. Characteristics of this member are massive, resistant layers, intermittent zones of glauconite, and maroon-colored, weathered surfaces, suggestive of higher iron content. The third informal member consists of light- brown to tan, fine- to medium-grained, quartz-rich sandstone characterized by thin beds ranging from 3 to12 inches in thickness. Grains are rounded to sub-rounded and locally cross bedded. This member is 10 feet in thickness. The uppermost member is a distinctly darker, red to maroon, medium- to coarse-grained, quartz-rich sandstone that is less resistant and highly porous. Local cross bedding is also common. This member was measured to be 9 feet thick. Total thickness for the four informal members of the Sawatch Formation at this location is 56 feet. The Sawatch Formation has been interpreted in the area near Manitou Springs by Myrow (1998) to be transgressive deposits that include subaqueous, tidally influenced dune deposits suggestive of shallow marine deposition.

NEOPROTEROZOIC IGNEOUS ROCKS OF THE PIKES PEAK BATHOLITH

Late Neoproterozoic granitic rocks of the Pikes Peak batholith are the oldest rocks exposed in the Mount Deception quadrangle. The Pikes Peak batholith is exposed over an area of 1,200 square miles in the southern Front Range (Tweto, 1987). Numerous studies have been conducted on the batholith, which was emplaced 1090 to 1020 Ma (Aldrich and others, 1957; Bickford and others, 1989; Unruh and others, 1995; Smith and others, 1999a). Cross (1894) first mapped the geology of the Pikes Peak region and in 1894 applied the formal name Pikes Peak Granite (Ypp) to the most common rock type in the batholith. Hutchinson (1972, 1976) studied the granite tectonics and modes of intrusion of the batholith and showed that the batholith is composite in nature. Barker and others (1975) produced a comprehensive petrologic and geochemical description of the rocks that comprise the batholith and noted that the batholith is composed of granites that have two distinct chemical trends, or series: the dominant potassic series and a sodic series. Wobus (1976) provided petrologic and major-element chemical data for smaller plutons of both the potassic and sodic series.

Smith and others (1999b) studied the petrology and geochemistry of late-stage intrusions of the batholith and showed that both fractionation of mantle-derived magmas and melting of preexisting crustal rocks (anatexis) were involved in the petrogenesis of the batholith. The potassic series granites, including the Pikes Peak Granite, are interpreted to be derived from crustal anatexis. Smith and others (1999a) provide a review of the chemistry and genesis of the Pikes Peak batholith and note that the batholith is an example of A-type granitic magmatism. Pegmatites and veins in the Pikes Peak batholith have locally produced an abundance of specimen-quality minerals. Foord and Martin (1979) and Muntyan and Muntyan (1985), among others, describe the mineralogy of the pegmatites in the Pikes Peak batholith.

Ypeg **Pegmatite (Neoproterozoic) —** Very coarse grained pink and white veins and masses consisting chiefly of feldspar and quartz (fig. 4). Elongated, lath-like or bladed crystals of black to weathered bronze-green biotite are present in some areas within the large pegmatites. Most pegmatites in the quadrangle are small, less than 5 feet thick and 50 feet in length, and thus were not mapped separately. Nine large pegmatites, all of which have been mined in the past for feldspar and/or quartz, are mapped in the south-central through north-central parts of the quadrangle. All of these mines are accessed from Rampart Range Road (Forest Road 300).

Figure 4. Very coarse-grained crystals of biotite (black) enclosed in feldspar (light pink) and quartz (white to very light gray) in a pegmatite dike exposed in an abandoned surface mine in the south-central part of the Dakan Mountain quadrangle (note the dime for scale) (UTM83 495053, 4334021).

Ypb **Porphyritic granite of the Pikes Peak batholith (Neoproterozoic) —** Pink, fine- to medium-grained porphyritic biotite granite with phenocrysts of equidimensional gray quartz, and subhedral microcline and oligoclase. This unit is prevalent in the south-central part of the quadrangle. The contact of this unit with the Pikes Peak Granite was not observed, however, field relations suggest the transition occurs over a few tens of feet. The unit is mapped as younger than the Pikes Peak Granite.

Ypp **Pikes Peak Granite (Neoproterozoic) —** Pikes Peak Granite is the most abundant rock type in the Dakan Mountain quadrangle. This hornblende-bearing biotite granite is the main constituent of the potassic series of intrusives that constitute more than 90 percent of the Pikes Peak batholith (Wobus, 1976; Smith and others, 1999b). Pikes Peak Granite is pink to light gray, coarse grained, and usually equigranular. It weathers to form rounded, bouldery outcrops. Weathering of Pikes Peak Granite usually produces deposits of grüs (loose, disaggregated mass of constituent minerals). Grüs is best developed on north-facing slopes and can accumulate to thicknesses as much as 150 feet

(Blair, 1976). Grüs develops first along joints in the granite. More resistant rock between joints may remain intact as rounded “corestones” (Blair, 1976).

Gross and Heinrich (1965) described the petrology of the Pikes Peak Granite in detail. The constituent minerals of Pikes Peak Granite are perthitic microcline (35-50 percent), quartz (20-35 percent), plagioclase (oligoclase; 10-20 percent), biotite (2-7 percent), and hornblende (<0.5 – 2 percent). Accessory minerals include zircon, apatite, magnetite, and fluorite, plus rare allanite and bastnaesite. Major and trace element analyses of the Pikes Peak Granite were reported by Smith and others (1999b). Fine- to medium-grained aplite dikes, typically 0.5 to 2.0 feet in width, are widely scattered in the Pikes Peak Granite but were not mapped separately. Small pegmatite dikes and quartz veins are locally common and also were not mapped separately.

STRUCTURAL GEOLOGY

The type of deformation in the Dakan Mountain quadrangle is dominated by the brittle behavior of rocks in the form of regional and local faulting, fault imbricates, slickensides near the fault zones, and intense fracturing. One regional fault system, the Ute Pass fault, transects the quadrangle in the extreme southwestern part. The fault has field relations that are suggestive of a high-angle reverse fault with the hanging wall block composed of Proterozoic crystalline rocks and the footwall block composed of sedimentary rocks of the Pennsylvanian-Permian Fountain Formation. To the south in the Mount Deception quadrangle, the fault is largely responsible for the western boundary of the downthrown, north-south-trending, Woodland Park or Manitou Park graben. A second fault transects the southwestern part of the quadrangle along Trout Creek and partially serves as the eastern boundary of the graben. This fault is referred to as the Trout Creek fault. The rocks in the graben area along State Highway 67 are primarily represented by outcrops of the Fountain Formation and Tertiary to Quaternary alluvial fans and surficial deposits. Numerous faults throughout the Proterozoic crystalline rocks are present in the mountainous region of the quadrangle and primarily strike north to northeast and are accompanied by intense fracture sets.

Ute Pass Fault Zone

The Ute Pass fault zone consists of at least two north- to northwest-striking faults that transect the extreme southwestern part of the quadrangle. Each of these faults is easterly-directed and places either granitic basement over Lower Paleozoic sedimentary rocks or Lower Paleozoic strata over Upper Paleozoic strata. The Ute Pass fault zone is interpreted as a Laramide (Late Cretaceous-Tertiary) fault system that was reactivated from an Ancestral Rockies (Pennsylvanian) structure (Kluth, 1997, Keller and others, 2005). This fault system is well documented in the Mount Deception quadrangle to the south, and the reader is referred to the author's notes accompanying that quadrangle map for more information (Temple and others, 2007).

Trout Creek Fault

The Trout Creek fault is the name we have given to the concealed fault that strikes northwest-southeast through the Trout Creek stream bottom in the southwestern part of the quadrangle. Field relations in the hanging wall and footwall blocks are inconclusive as to the geometry of the fault. The fault is on trend with the Mount Deception fault to the south and similarly defines the eastern boundary of the Manitou Park graben. The Mount Deception fault has field relations suggestive of a reverse fault directed to the west (Temple and others, 2007). Therefore, the Trout Creek fault is interpreted as a westerly directed reverse fault on the cross section.

High-Angle Faults in Proterozoic Rocks

High-angle, north-south striking faults transect the Proterozoic crystalline rocks throughout exposures in the quadrangle as identified from the topographic map, DEM, aerial photographs, and observations of outcrops with significant increases in fracture occurrence. These high-angle faults are interpreted to generally be up-to-the-east in the western half of the quadrangle progressing towards the Rampart Range ridge crest. East of the ridge crest, the faults remain high-angle but become dominantly down-to-the-east. These faults are interpreted to be Laramide in age; however, the absence of Phanerozoic sedimentary rocks makes the determination of the relative timing of fault initiation or any later rejuvenation difficult, if not impossible.

Fracture and joint data measured from the Proterozoic rocks for the Dakan Mountain quadrangle are depicted on the map (plate 1). These data and the fracture and joint data for the Proterozoic rocks in the easterly adjoining Larkspur quadrangle are cumulatively plotted on a stereonet diagram (fig. 5). These data do not show a preferred strike direction; however, moderate-to-steep inclinations are dominant throughout the quadrangles. It should be noted that multiple fracture and joint sets were often taken at a single outcrop. For map display purposes the symbols for these data had to be moved slightly to allow the data to become legible. The exact UTM locations for these data can be found in Appendix A, a Microsoft Excel file on the CD ROM that accompanies the map.

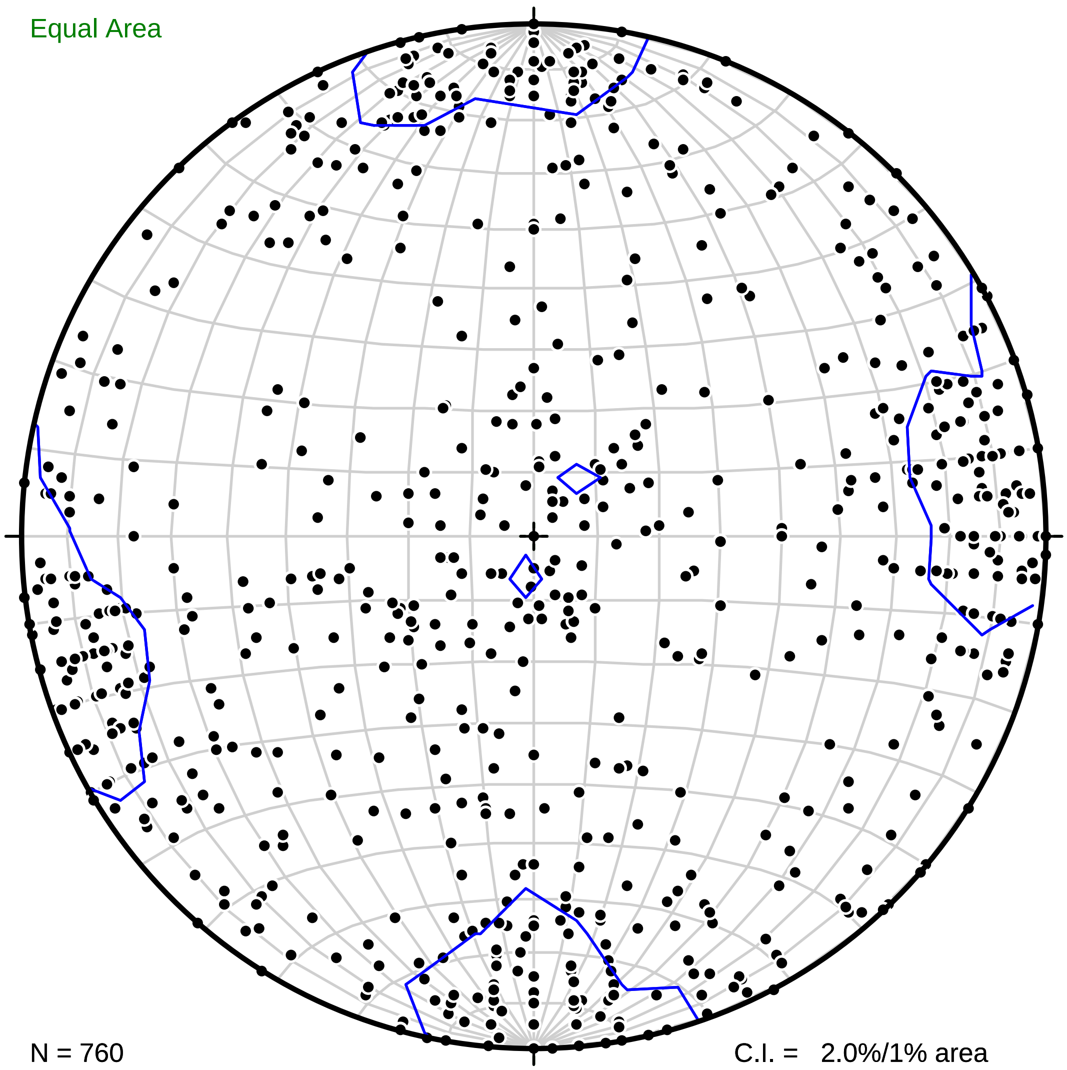


Figure 5. Stereonet diagram of poles to fracture and joint planes for 760 points in the Proterozoic crystalline rocks in the Dakan Mountain and Larkspur quadrangles. Lower hemisphere projection.

MINERAL AND ENERGY RESOURCES

Pegmatites

Quartz and feldspar were mined in the past from open cuts on nine different pegmatite bodies (unit Ypeg) from the south central to the north central parts of the Dakan Mountain quadrangle. All of the mined pegmatites are enclosed within Pikes Peak Granite (unit Ypp). Bladed biotite crystals up to 6 inches long are common in some parts of the pegmatite, and specular hematite is present locally. One of the largest of the pegmatite mines was operated by Colorado Quarries, Inc. and was permitted by the Colorado Division of Reclamation, Mining, and Safety in the late 1970s under the name Skeleton No. 1 and 2. It is located west of Rampart Range Road in Section 1 of T. 10 S., R. 69 W. in the north-central part of the map area. There has been no recent mining at the site but the permit is listed as active. Clean, white, crystalline quartz and pink microcline feldspar were mined from parts of the Lone Pine pegmatite in Section 25 of T. 10 S., R. 69 W. This pit is about two hundred feet long and 50 feet wide (fig. 6).

Figure 6. A large open-cut at an abandoned pegmatite mine (Lone Pine Mine), south-central part of the Dakan Mountain quadrangle (UTM83 499503, 4334021).

Building Stone

The Belvedere Stone Quarry is the only recently active mining operation in the quadrangle (Colorado Division of Reclamation, Mining, and Safety; mining permit database). The small operation is located one mile east of Trout Creek in the NE¼ of sec. 34, T. 10 S., R. 69 W. The quarry produced beautiful slabs of pink to rose-colored Ordovician Manitou limestone. Production at the site recently terminated.

Grüs (decomposed granite)

Grüs is formed from the weathering of coarse-grained granite into fragments consisting mainly of individual component mineral grains, principally feldspar and quartz. Grüs is common in areas of Pikes Peak Granite and is thickest on north-facing slopes (Blair, 1976). Elsewhere in the Pikes Peak region, grüs is mined for use as fill material or aggregate. It is a potential resource in the Dakan Mountain quadrangle but is not presently being mined.

Metals

No metal mining operations are present in the Dakan Mountain quadrangle. Several gold occurrences are reported in the U.S. Geological Survey's Mineral Resource Data System (MRDS) in the Signal Butte quadrangle to the west (Wilson, 2003). These appear to be small mines or prospects and the database refers to them as part of the West Creek district. Some are reported to be placer deposits.

Oil and Gas

No hydrocarbons have been produced in the Dakan Mountain quadrangle. No potential hydrocarbon source or reservoir rocks are known to exist in the quadrangle. The nearest productive oil and gas fields to the quadrangle are the Hoy Gulch, Wallbanger, and Caledonia fields about 35 miles to the northeast in Elbert County (Wray and others, 2002). Production from these fields is from the Lower Cretaceous Dakota Sandstone. Two new wildcat exploration wells are proposed in the nearby Palmer Lake quadrangle to the southeast (Keller and others, 2006), but drilling has not begun as of this writing. Dyad Petroleum Company of Midland, Texas plans to drill these wildcat wells near Mt. Herman in the Rampart Range. One of the wells is proposed to be spudded in Pikes Peak Granite.

Soil-gas samples collected in the Rampart Range indicate that hydrocarbons, derived from Mesozoic and Paleozoic strata that are projected to underlie Pikes Peak Granite below the Rampart Range Fault, may be migrating upward through Pikes Peak Granite along fractures and faults (Jacob and Fisher, 1985). Samples collected over north-south-trending fractures and faults inferred from aerial photographs contained anomalous concentrations of methane, ethane, propane, and butane. Additionally, oil seeps were reported in the past at Saylor Park in the northeast part of the Mount Deception quadrangle and at Leo Lake in the Palmer Lake quadrangle (Jacob and Fisher, 1985).

GEOLOGIC HAZARDS

Floods

Floods are the most serious hazard in the map area because they occur more frequently than other hazards, and they affect larger areas and impact areas of higher risk. Risk as used here refers to the potential for loss of life and property should a hazardous event occur rather than to the likelihood that a hazardous event will occur. In the Dakan Mountain quadrangle, floods may be triggered by heavy snowmelt runoff, but, as along the east side of the Rampart Range, prolonged or intense rainstorms are likely to produce the most serious flooding. Areas underlain by map units Qa1 and Qa2 will flood frequently, and large, but infrequent (once per 50 to 100 years) floods will inundate many, if not most, areas underlain by Qa3. The network of small, chiefly ephemeral streams in narrow valleys and gullies in the high-relief terrain in the eastern and southwestern parts of the map area contain deposits of Qa that are too small to show at the scale of this map. These valleys can be expected to flood frequently, and the floods will impact roads or other structures that cross them. Given the abundance of granitic detritus in the residuum and surficial deposits in the map area, small floods may erode and deposit surprisingly large quantities of sediment, especially where construction has disturbed the ground surface or impounded or redirected runoff.

Rock Fall

Rock fall is used here as a generic term for a range of mass movement that begins when a rock falls or topples, and then continues to move downslope by bouncing and rolling. Rock fall areas in the Dakan Mountain quadrangle are widespread but small. Most areas are in high-relief terrain of the Rampart Range. Rock fall generally occurs where rock crops out along drainage divides or on the upper parts of slopes that are steeper than 24°. Talus deposits that are too small or thin to show at the scale of this map are present downslope from outcrops that are sources of rock fall. Rock-fall hazards can be identified on aerial photography and by inspection on the ground. Where rocks fall frequently, they pile up or litter the ground surface. Many boulders in deposits of Qac on steep slopes in the southern part of the map area may have originated as rock fall. However, some of these rock-fall deposits may be relicts of Pleistocene glacial and periglacial climates. During glaciations, alpine tundra may have expanded downward in this area to levels that were several hundred feet lower than the highest parts of the Rampart Range.

Debris flows

Debris flows are dense mixtures of sand, silt, clay, rock debris, and lesser amounts of water and air that move as a fluid mass. Debris flows commonly resemble wet concrete that varies in degree of fluidity depending on the proportions of debris and water present. The amount of debris (material larger than 2 mm) in debris flows may range from as little as 20 percent to as much as 80 percent (Cruden and Varnes, 1996). Flows in which less than 20 percent of the material is debris are called mudflows in some mass-movement classifications (Selby, 1993). Debris in flow deposits in the Dakan Mountain quadrangle tends to be in the lower half of the 20-80 percent range. Debris flows originate in the upper reaches of many gullies and small valleys that drain into the Manitou graben from highlands on either side. Soils in the highland areas, which consist chiefly of the Legault, Pendant, and Sphinx soil series (Moore, 1992), are thin (less than 2 ft), coarse, and highly permeable. Thus, they quickly become saturated during intense thunderstorms, and then surface runoff is high and the resulting erosion of soil and surficial material is severe. Debris-flow deposits make up parts of unit Qfy and Qfo, particularly in the high-relief terrain in the southwestern part of the map area that is dissected by Trout Creek and its major tributaries and also in the small alluvial fans in the Rampart Range. Construction projects on and adjacent to units Qfy and Qfo should be cognizant of the potential for flooding and debris flows in these areas.

Landslides

Landslide classifications include most forms of mass movement. Consequently, landslide has become a generic term for all but the slowest forms of movement regardless of whether it was by fall, flow, or slide. Landslide deposits large enough to show at the scale of this map are present in only a few places, and those that were identified are probably relicts of the Pleistocene. In other words, they formed under different conditions of climate and vegetation than exist today and probably are stable under present conditions. However, stable slopes, whether underlain by surficial deposits or bedrock, can be destabilized by human activities that replicate the wetter conditions that prevailed at times during the Pleistocene. The natural events that trigger landslides are well known. Worldwide, they include intense rainfall, rapid snowmelt, water-level changes, and strong ground shaking during earthquakes (Wieczorek, 1996). Unfortunately, humans also trigger landslides because simple fundamentals that have been well understood for decades (Brunsden, 1993) are neglected. Humans generally trigger landslides either by adding weight to the natural slope, which increases the shear stress in the area where the weight was added, or they remove support by excavating material, which reduces shear strength (the force that resists downslope movement of material). Excavations on slopes, particularly at or near the toe of a slope, are especially troublesome. The weight of earth material commonly is overlooked when material is being rearranged by excavation and filling during construction. A layer of earth fill one-foot thick is equivalent in weight to that of a single-story home of equal area (Erly and

Kockelman, 1981). Also, activities that cause water—either ground water or surface water—to be concentrated in localities that previously had not been heavily soaked can cause slopes to fail. The added weight of the water increases shear stress and increases pore-water pressure, which reduces shear strength. Human activities known to have triggered landslides include (1) excavating, or cutting benches into hillsides for construction of roads or buildings, (2) emplacement of artificial fill, (3) diversion of surface runoff by roads, ditches, and various other land-surface modifications, (4) irrigation of crops and lawns, and (5) installation of septic tanks and leach fields. The areas most vulnerable to human-caused slope failures are in the high-relief terrain in the southwestern parts of the Dakan Mountain quadrangle.

Earthquakes

The Ute Pass fault zone strikes north–south through the Mount Deception quadrangle to the south and northwest-southeast through the extreme southwest part of the Dakan Mountain quadrangle. Movement may have occurred on this fault some time after the beginning of the middle Pleistocene, but before Holocene time (Widmann and others, 1998). A similar structure (Rampart Range fault) bounds the east flank of the Rampart Range north of Colorado Springs. The Colorado Geological Survey considers both the Ute Pass fault zone and the Rampart Range fault to be potentially active (Dickson and others, 1986). The epicenter of a magnitude 4 earthquake that occurred on December 25, 1994, was determined to be on the east side of the Rampart Range about 2.5 miles north of Perry Park (MicroGeophysics Corporation, 1995). The focus of this earthquake was at a depth of 14.6 miles. Seismic risk should be included in the design of all major construction in the map area. For more details on earthquake hazards see Widmann and others (1998, 2002) and the geologic hazards section of the Colorado Geological Survey website at http://geosurvey.state.co.us.

WATER RESOURCES

Surface Water Resources

The Dakan Mountain quadrangle lies almost entirely within the drainage area of Trout Creek, which originates in the West Creek Range just to the southwest of the quadrangle. Numerous tributaries originate in the West Creek Range and Rampart Range and flow towards the topographically lower Manitou Park area and into Trout Creek. Trout Creek continues to the north and flows into the South Platte near the town of Deckers.

The U.S. Geological Survey Water Resources Data website (http://co.water.usgs.gov/Website/projects/viewer.htm) indicates that stream gauge data are available only for one station (10190002) on Trout Creek at a location two miles west of the quadrangle. Data collected from this location represent surface water flow conditions from an area covering 106 square miles that includes most of the Dakan Mountain quadrangle. Data were collected only from April through September for the years 2003 through 2006. Average discharge peaked in the month of May at 16 cubic feet per second and decreased to an average low of 3.0 cubic feet per second in the month of September.

Rainbow Falls Lake, located in the southwest part of the quadrangle, is the only reservoir. This lake, man-made for water storage from Trout Creek, covers about 15 acres and is now used primarily for recreational purposes.

Ground Water Resources

Ground water provides a primary resource for municipal and domestic water use throughout the Dakan Mountain quadrangle. Ground water can be found in one, or a combination of two hydrogeologic units: (1) consolidated bedrock aquifers of Paleozoic age sedimentary deposits, and (2) fractured crystalline rock aquifers of the Neoproterozoic Pikes Peak batholith.

Bedrock aquifers of Paleozoic age sedimentary deposits are primarily confined to the Pennsylvanian-Permian Fountain Formation in the southwestern part of the quadrangle. The Fountain Formation has been estimated to be about 2,000 feet in thickness in the central regions of the Mount Deception quadrangle where it is the primary reservoir. The porosity of the sandstone and conglomerate beds ranges from 3 to 12% and averages approximately 7% (Robson and Banta, 1987). Permeability varies considerably based on cementation and fracture conduits. Water level data for the Fountain aquifer can be obtained from the Division of Water Resources (DWR) well permit files. Water levels in the Fountain aquifer vary considerably throughout the region and are based on location, elevation, porosity, and permeability.

The Proterozoic crystalline rock aquifer system underlies the main part of the quadrangle. Since these are igneous rocks, primary porosity is effectively zero, and the water is produced from fractures and fault zones. Locally, it is possible to complete a well in highly weathered granite if the depth of weathering is substantial and the site is close to perennial surface water. Finding productive fractures and fracture zones is unpredictable and yields can be quite low. The fracture data from figure 10 document the high angles of fractures measured in the quadrangle; these fractures would enhance the infiltration of precipitation and snowmelt recharge. Information obtained from a ground-water filing for the Ridgewood Subdivision in the north-central part of the Mount Deception quadrangle indicates that most wells in this area are completed between 100 and 400 feet in depth and yield from 1 to 10 gallons per minute. Landowners with wells near the Ute Pass or Mount Deception fault systems report higher flow rates due to the increase in fracture occurrence.

Water-quality data for the Fountain and Proterozoic crystalline aquifer systems within the quadrangle are non-existent. However, the water quality is adequate for domestic use except in areas of mineralization where metallic or acidic waters may be present (Topper and others, 2003). Ground water from both of these reservoirs is considered “tributary” and is thus subject to the State of Colorado surface water appropriations system.

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Appendix A: OFR 08-16, Dakan Mountain Fracture Data

UTM_X_NAD83	UTM_Y_NAD83	Strike	Dip	Type	Notes
491453	4332802	250	89	Fracture	Mlw
491467	4333468	8	22	Fault plane	Fault surface, Cs
491142	4333938	290	33	Fracture	Mlw
490419	4334233	145	73	Fracture	Cs
490419	4334233	220	90	Fracture	Cs
490046	4336822	78	77	Fracture	Cs
490046	4336822	327	87	Fracture	Cs
490928	4335159	128	90	Fracture	Cs
490928	4335159	164	90	Fracture	Cs
496770	4330704	84	82	Fracture	Ypp
496770	4330704	21	9	Fracture	Ypp
496770	4330704	194	71	Fracture	Ypp
496770	4330704	148	69	Fracture	Ypp
496770	4330704	284	78	Fracture	Ypp
496770	4330704	95	74	Fracture	Ypp
496770	4330704	194	85	Fracture	Ypp
496770	4330704	60	73	Fracture	Ypp
496770	4330704	97	31	Fracture	Ypp
496770	4330704	19	0	Fracture	Ypp
496770	4330704	341	68	Fracture	Ypp
495704	4337913	284	11	Fracture	Ypp
495704	4337913	6	90	Fracture	Ypp
495704	4337913	95	12	Fracture	Ypp
495704	4337913	306	85	Fracture	Ypp
496178	4338332	349	90	Fracture	Ypp
496178	4338332	346	14	Fracture	Ypp
496328	4339068	275	71	Fracture	Ypp
496328	4339068	268	44	Fracture	Ypp
496328	4339068	344	72	Fracture	Ypp
496490	4339314	214	79	Fracture	Ypp
496490	4339314	145	81	Fracture	Ypp
496490	4339314	323	24	Fracture	Ypp
496490	4339314	205	76	Fracture	Ypp
496490	4339314	100	90	Fracture	Ypp
497086	4339598	112	90	Fracture	Ypp
497086	4339598	347	77	Fracture	Ypp
497086	4339598	280	81	Fracture	Ypp
497121	4339555	113	8	Fracture	Ypp
497121	4339555	181	75	Fracture	Ypp
497468	4339492	117	65	Fracture	Ypp
497468	4339492	178	40	Fracture	Ypp
497493	4339445	72	64	Fracture	Ypp
497493	4339445	300	58	Fracture	Ypp
497649	4339350	311	81	Fracture	Aplite dikes prevalent
497649	4339350	311	8	Fracture	Aplite dikes prevalent
497649	4339350	200	50	Fracture	Aplite dikes prevalent

497797	4339230	52	71	Fracture	Ypp
497797	4339230	307	77	Fracture	Ypp
497797	4339230	212	9	Fracture	Ypp
497826	4338763	335	43	Fracture	Aplite
497826	4338763	272	70	Fracture	Aplite
497768	4338531	308	54	Fracture	Aplite
497768	4338531	50	18	Fracture	Aplite
497768	4338531	92	37	Fracture	Aplite
497709	4338149	77	70	Fracture	Aplite
497709	4338149	248	40	Fracture	Aplite
497709	4338149	304	35	Fracture	Aplite
497709	4338149	319	70	Fracture	Aplite
497141	4338005	282	65	Fracture	Aplite
497141	4338005	6	15	Fracture	Aplite
497141	4338005	225	81	Fracture	Aplite
497087	4337956	90	27	Fracture	Aplite
497087	4337956	226	90	Fracture	Aplite
497135	4337842	131	31	Fracture	Ypp
497135	4337842	300	75	Fracture	Ypp
494777	4341932	226	60	Fracture	Ypp
494777	4341932	111	83	Fracture	Ypp
494777	4341932	260	73	Fracture	Ypp
495357	4341685	230	12	Fracture	Ypp
495357	4341685	275	80	Fracture	Ypp
495357	4341685	355	76	Fracture	Ypp
495474	4341158	351	48	Fracture	Ypp
495474	4341158	263	63	Fracture	Ypp
495474	4341158	320	45	Fracture	Ypp
495774	4340839	98	75	Fracture	Ypp
495774	4340839	197	56	Fracture	Ypp
495774	4340839	318	9	Fracture	Ypp
496044	4340877	148	82	Fracture	Ypp
496044	4340877	333	36	Fracture	Ypp
496044	4340877	96	81	Fracture	Ypp
496636	4340873	311	69	Fracture	Ypp
496636	4340873	195	78	Fracture	Ypp
496658	4340328	270	78	Fracture	Ypp
496658	4340328	348	32	Fracture	Ypp
496658	4340328	334	75	Fracture	Ypp
496706	4340025	350	58	Fracture	Ypp
496706	4340025	88	80	Fracture	Ypp
496595	4339946	353	90	Fracture	Ypp
496595	4339946	70	34	Fracture	Ypp
495516	4338467	185	86	Fracture	Ypp
495516	4338467	205	46	Fracture	Ypp
490690	4342962	264	80	Fracture	Ypp
490690	4342962	352	84	Fracture	Ypp
490690	4342962	91	18	Fracture	Ypp
490511	4342597	265	90	Fracture	Ypp
490511	4342597	163	78	Fracture	Ypp

490066	4342206	77	81	Fracture	Ypp
490066	4342206	227	90	Fracture	Ypp
490066	4342206	243	6	Fracture	Ypp
490066	4342206	177	83	Fracture	Ypp
489853	4341921	162	70	Fracture	Ypp
489853	4341921	87	78	Fracture	Ypp
489756	4341286	307	74	Fracture	Ypp
489756	4341286	354	87	Fracture	Ypp
489756	4341286	62	71	Fracture	Ypp
489496	4340744	8	85	Fracture	Ypp
489496	4340744	46	90	Fracture	Ypp
489496	4340744	138	84	Fracture	Ypp
489948	4341086	248	81	Fracture	Ypp
489948	4341086	118	6	Fracture	Ypp
489948	4341086	166	70	Fracture	Ypp
490228	4340693	162	85	Fracture	Ypp
490228	4340693	81	23	Fracture	Ypp
490228	4340693	7	82	Fracture	Ypp
490409	4340164	174	77	Fracture	Ypp
490409	4340164	50	64	Fracture	Ypp
490409	4340164	277	65	Fracture	Ypp
490409	4340164	95	11	Fracture	Ypp
490261	4339949	232	72	Fracture	Ypp
490261	4339949	111	65	Fracture	Ypp
490261	4339949	265	74	Fracture	Ypp
490261	4339949	301	20	Fracture	Ypp
490005	4339569	229	87	Fracture	Ypp
490005	4339569	68	57	Fracture	Ypp
489741	4339286	162	80	Fracture	Ypp
489741	4339286	108	84	Fracture	Ypp
489653	4338532	221	90	Fracture	Ypp
489653	4338532	150	44	Fracture	Ypp
489552	4337858	165	80	Fracture	Ypp
489552	4337858	265	62	Fracture	Ypp
489450	4337714	85	85	Fracture	Ypp
489450	4337714	305	17	Fracture	Ypp
489450	4337714	165	83	Fracture	Ypp
489228	4337138	71	75	Fracture	Ypp
489228	4337138	346	36	Fracture	Ypp
492985	4342333	163	31	Fracture	Aplite
492985	4342333	80	72	Fracture	Aplite
493221	4342579	133	15	Fracture	Ypp
493221	4342579	347	15	Fracture	Ypp
493221	4342579	62	82	Fracture	Ypp
493179	4342739	334	85	Fracture	Ypp
493179	4342739	274	65	Fracture	Ypp
493454	4342887	354	79	Fracture	Aplite
493454	4342887	160	73	Fracture	Aplite
493454	4342887	274	13	Fracture	Aplite
493495	4342858	162	64	Fracture	Ypp

493495	4342858	274	8	Fracture	Ypp
493362	4343344	219	27	Fracture	Aplite
493362	4343344	87	75	Fracture	Aplite
493362	4343344	262	90	Fracture	Aplite
493598	4343532	84	70	Fracture	Ypp/Aplite
493598	4343532	346	44	Fracture	Ypp/Aplite
493647	4343824	179	69	Fracture	Ypp
493647	4343824	107	69	Fracture	Ypp
493647	4343824	277	25	Fracture	Ypp
493443	4344158	95	78	Fracture	Ypp
493443	4344158	323	84	Fracture	Ypp
493443	4344158	82	8	Fracture	Ypp
493158	4343795	200	40	Fracture	Ypp
493158	4343795	172	64	Fracture	Ypp
493158	4343795	168	8	Fracture	Ypp
492959	4343636	309	67	Fracture	Ypp/Aplite
492959	4343636	75	90	Fracture	Ypp/Aplite
492959	4343636	350	36	Fracture	Ypp/Aplite
493125	4343317	74	81	Fracture	Ypp
493125	4343317	160	90	Fracture	Ypp
493125	4343317	153	17	Fracture	Ypp
492822	4342745	79	18	Fracture	Ypp
492822	4342745	180	40	Fracture	Ypp
492822	4342745	335	79	Fracture	Ypp
492550	4342627	271	67	Fracture	Aplite
492550	4342627	155	20	Fracture	Aplite
492200	4342535	197	82	Fracture	Ypp
492200	4342535	260	73	Fracture	Ypp
491466	4332853	245	85	Fracture	Mlw
497528	4331197	245	42	Fracture	Ypp
497528	4331197	90	50	Fracture	Ypp
497528	4331197	217	33	Fracture	Ypp
497528	4331197	265	85	Fracture	Ypp
497528	4331197	335	59	Fracture	Ypp
497528	4331197	100	74	Fracture	Ypp
497528	4331197	345	60	Fracture	Ypp
492589	4334564	245	84	Fracture	Ypp
492589	4334564	255	60	Fracture	Ypp
492589	4334564	150	59	Fracture	Ypp
492589	4334564	257	90	Fracture	Ypp
492542	4335265	335	75	Fracture	Ypp
492542	4335265	330	90	Fracture	Ypp
492542	4335265	56	25	Fracture	Ypp
493095	4336708	185	75	Fracture	Ypp
493095	4336708	58	78	Fracture	Ypp
494018	4337078	311	90	Fracture	Ypp
494018	4337078	79	87	Fracture	Ypp
494018	4337078	345	90	Fracture	Ypp
494018	4337078	23	17	Fracture	Ypp
492877	4336638	329	90	Fracture	Ypp

492877	4336638	261	81	Fracture	Ypp
493009	4336265	75	78	Fracture	Ypp
493009	4336265	115	38	Fracture	Ypp
493009	4336265	135	75	Fracture	Ypp
493009	4336265	230	85	Fracture	Ypp
493009	4336265	6	20	Fracture	Ypp
493009	4336265	256	51	Fracture	Ypp
493009	4336265	184	85	Fracture	Ypp
492600	4335459	349	78	Fracture	Ypp
492600	4335459	325	61	Fracture	Ypp
492600	4335459	157	12	Fracture	Ypp
492600	4335459	111	84	Fracture	Ypp
493081	4334898	126	48	Fracture	Ypp
493081	4334898	24	78	Fracture	Ypp
493081	4334898	172	52	Fracture	Ypp
493081	4334898	322	75	Fracture	Ypp
493081	4334898	311	27	Fracture	Ypp
493879	4335271	76	86	Fracture	Ypp
493879	4335271	132	19	Fracture	Ypp
493879	4335271	101	80	Fracture	Ypp
493879	4335271	49	72	Fracture	Ypp
493879	4335271	192	26	Fracture	Ypp
493879	4335271	180	75	Fracture	Ypp
494706	4335385	139	22	Fracture	Ypp
494706	4335385	270	54	Fracture	Ypp
494706	4335385	14	26	Fracture	Ypp
494706	4335385	196	85	Fracture	Ypp
494706	4335385	265	67	Fracture	Ypp
491735	4334377	77	90	Fracture	Ypp
491735	4334377	324	83	Fracture	Ypp
491735	4334377	232	63	Fracture	Ypp
491735	4334377	175	58	Fracture	Ypp
497525	4335962	82	90	Fracture	Ypp
497525	4335962	340	84	Fracture	Ypp
497392	4336177	345	74	Fracture	Ypp
497392	4336177	262	84	Fracture	Ypp
497392	4336177	100	19	Fracture	Ypp
497392	4336177	170	53	Fracture	Ypp
497591	4336436	170	57	Fracture	Ypp
497591	4336436	175	85	Fracture	Ypp
497591	4336436	58	12	Fracture	Ypp
497591	4336436	265	90	Fracture	Ypp
498065	4336696	330	69	Fracture	Ypp
498065	4336696	110	44	Fracture	Ypp
498065	4336696	250	65	Fracture	Ypp
498065	4336696	120	55	Fracture	Ypp
498110	4336855	85	35	Fracture	Ypp
498110	4336855	65	52	Fracture	Ypp
498110	4336855	265	11	Fracture	Ypp
498110	4336855	340	48	Fracture	Ypp

498110	4336855	260	65	Fracture	Ypp
498396	4337040	270	80	Fracture	Ypp
498396	4337040	335	90	Fracture	Ypp
498396	4337040	45	75	Fracture	Ypp
498448	4337213	85	80	Fracture	Ypp
498448	4337213	345	75	Fracture	Ypp
498547	4337428	290	85	Fracture	Ypp
498547	4337428	170	85	Fracture	Ypp
498790	4338167	155	86	Fracture	Ypp
498790	4338167	250	15	Fracture	Ypp
498790	4338167	80	74	Fracture	Ypp
498790	4338167	305	32	Fracture	Ypp
498494	4337585	145	85	Fracture	Ypp
498494	4337585	30	48	Fracture	Ypp
498494	4337585	275	73	Fracture	Ypp
498356	4337746	35	10	Fracture	Ypp
498356	4337746	245	15	Fracture	Ypp
498356	4337746	170	65	Fracture	Ypp
498356	4337746	80	78	Fracture	Ypp
497611	4337306	265	82	Fracture	Ypp
497611	4337306	90	27	Fracture	Ypp
497611	4337306	130	53	Fracture	Ypp
497611	4337306	350	84	Fracture	Ypp
494397	4340430	332	59	Fracture	Ypp
494397	4340430	5	60	Fracture	Ypp
494397	4340430	285	45	Fracture	Ypp
493881	4340700	285	52	Fracture	Ypp
493881	4340700	195	85	Fracture	Ypp
493812	4340693	185	68	Fracture	Ypp
493812	4340693	285	75	Fracture	Ypp
493812	4340693	190	46	Fracture	Ypp
493329	4340602	170	74	Fracture	Ypp
492970	4340060	165	75	Fracture	Ypp
492970	4340060	240	80	Fracture	Ypp
492970	4340060	340	89	Fracture	Ypp
493097	4339565	270	64	Fracture	Ypp
493097	4339565	175	87	Fracture	Ypp
493482	4339953	240	48	Fracture	Ypp
493482	4339953	343	76	Fracture	Ypp
494041	4339994	340	80	Fracture	Ypp
494041	4339994	245	68	Fracture	Ypp
494108	4339156	125	85	Fracture	Ypp
494108	4339156	250	17	Fracture	Ypp
493902	4338602	270	80	Fracture	Ypp
493902	4338602	350	90	Fracture	Ypp
491718	4342205	72	80	Fracture	Ypp
491718	4342205	305	83	Fracture	Ypp
491718	4342205	320	55	Fracture	Ypp
491436	4342001	285	15	Fracture	Ypp
491436	4342001	295	80	Fracture	Ypp

491436	4342001	165	76	Fracture	Ypp
491169	4341663	330	85	Fracture	Ypp
491169	4341663	60	85	Fracture	Ypp
491169	4341663	270	5	Fracture	Ypp
491021	4341458	343	85	Fracture	Ypp
491021	4341458	230	5	Fracture	Ypp
491021	4341458	270	65	Fracture	Ypp
490761	4341278	345	78	Fracture	Ypp
490761	4341278	130	15	Fracture	Ypp
490761	4341278	245	72	Fracture	Ypp
490628	4340906	345	71	Fracture	Ypp
490628	4340906	225	65	Fracture	Ypp
490738	4340389	275	45	Fracture	Ypp
490738	4340389	170	78	Fracture	Ypp
490476	4339747	212	90	Fracture	Ypp
490476	4339747	315	83	Fracture	Ypp
490352	4338775	265	76	Fracture	Ypp
490352	4338775	55	13	Fracture	Ypp
490352	4338775	215	60	Fracture	Ypp
490225	4338475	335	86	Fracture	Ypp
490225	4338475	292	75	Fracture	Ypp
490225	4338475	240	11	Fracture	Ypp
490505	4338281	255	90	Fracture	Ypp
490505	4338281	185	70	Fracture	Ypp
490505	4338281	5	35	Fracture	Ypp
493941	4331814	240	86	Fracture	Ypp
494102	4331686	75	71	Fracture	Ypp
494102	4331686	315	60	Fracture	Ypp
494979	4343600	335	88	Fracture	Ypp
494979	4343600	235	72	Fracture	Ypp
494979	4343600	135	15	Fracture	Ypp
495014	4343506	250	10	Fracture	Ypp
495014	4343506	185	71	Fracture	Ypp
495014	4343506	230	82	Fracture	Ypp
494870	4343546	275	20	Fracture	Ypp
494870	4343546	175	72	Fracture	Ypp
494870	4343546	260	90	Fracture	Ypp
494701	4343489	185	85	Fracture	Ypp
494701	4343489	265	81	Fracture	Ypp
494701	4343489	285	32	Fracture	Ypp
494554	4343029	330	22	Fracture	Ypp
494554	4343029	185	85	Fracture	Ypp
494329	4343025	65	87	Fracture	Ypp
494329	4343025	170	80	Fracture	Ypp
494329	4343025	265	13	Fracture	Ypp
494304	4343093	330	86	Fracture	Ypp
494304	4343093	255	82	Fracture	Ypp
494304	4343093	210	70	Fracture	Ypp
494304	4343093	15	74	Fracture	Ypp
494304	4343093	280	38	Fracture	Ypp

494363	4342892	340	88	Fracture	Ypp
494363	4342892	262	55	Fracture	Ypp
494393	4342509	290	68	Fracture	Ypp
494393	4342509	160	60	Fracture	Ypp
494393	4342509	355	80	Fracture	Ypp
494551	4342297	345	75	Fracture	Ypp
494490	4341963	340	84	Fracture	Ypp
494490	4341963	290	42	Fracture	Ypp
494490	4341963	230	15	Fracture	Ypp
494158	4342063	345	84	Fracture	Quartz
494158	4342063	115	83	Fracture	Quartz
494158	4342063	195	25	Fracture	Quartz
494087	4342291	335	80	Fracture	Ypp
494087	4342291	270	35	Fracture	Ypp
495006	4334228	185	85	Fracture	Peg mine
497506	4331165	100	78	Fracture	Ypp
497506	4331165	65	72	Fracture	Ypp
497521	4331206	215	33	Fracture	Ypp
497521	4331206	90	51	Fracture	Ypp
497529	4331265	215	33	Fracture	Ypp
497529	4331265	265	85	Fracture	Ypp
497515	4331299	250	40	Fracture	Ypp
497515	4331299	268	90	Fracture	Ypp
497697	4332411	96	80	Fracture	Ypp
497697	4332411	55	25	Fracture	Ypp
497697	4332411	280	90	Fracture	Ypp
497697	4332449	100	74	Fracture	Ypp
497697	4332449	335	59	Fracture	Ypp
497836	4332978	349	68	Fracture	Ypp
497836	4332978	345	60	Fracture	Ypp
497836	4332978	24	86	Fracture	Ypp
499195	4334061	322	71	Fracture	Ypp
499195	4334061	340	80	Fracture	Ypp
499195	4334061	274	61	Fracture	Ypp
499195	4334061	69	63	Fracture	Ypp
498589	4334823	155	82	Fracture	Ypp
498589	4334823	275	90	Fracture	Ypp
498589	4334823	204	75	Fracture	Ypp
496895	4333903	94	84	Fracture	Ypp
496895	4333903	270	75	Fracture	Ypp
496895	4333903	357	86	Fracture	Ypp
496895	4333903	105	59	Fracture	Ypp
496755	4333596	272	74	Fracture	Ypp
496755	4333596	335	80	Fracture	Ypp
496755	4333596	98	59	Fracture	Ypp
496755	4333596	312	48	Fracture	Ypp
496636	4333586	295	38	Fracture	Ypp
496636	4333586	218	67	Fracture	Ypp
496636	4333586	110	48	Fracture	Ypp
496636	4333586	344	83	Fracture	Ypp

496636	4333586	135	25	Fracture	Ypp
496636	4333586	100	75	Fracture	Ypp
496548	4333718	330	25	Fracture	Ypp
496548	4333718	221	70	Fracture	Ypp
496548	4333718	93	61	Fracture	Ypp
496548	4333718	280	45	Fracture	Ypp
496548	4333718	20	75	Fracture	Ypp
489164	4336006	202	72	Fracture	Ypp
489164	4336006	325	24	Fracture	Ypp
496265	4333092	310	23	Fracture	Ypp
496265	4333092	20	78	Fracture	Ypp
496265	4333092	111	70	Fracture	Ypp
495202	4333475	322	58	Fracture	Ypp
495202	4333475	60	79	Fracture	Ypp
495202	4333475	349	85	Fracture	Ypp
495202	4333475	318	21	Fracture	Ypp
496922	4330909	245	55	Fracture	Ypp
496922	4330909	350	73	Fracture	Ypp
496922	4330909	70	74	Fracture	Ypp
496922	4330909	280	46	Fracture	Ypp
496740	4330793	260	50	Fracture	Ypp
496740	4330793	350	70	Fracture	Ypp
496474	4330873	280	68	Fracture	Ypp
496474	4330873	160	78	Fracture	Ypp
496474	4330873	135	4	Fracture	Ypp
496474	4330873	290	47	Fracture	Ypp
496366	4330983	266	64	Fracture	Ypp
496366	4330983	110	30	Fracture	Ypp
496366	4330983	328	63	Fracture	Ypp
496366	4330983	180	85	Fracture	Ypp
496362	4331353	339	74	Fracture	Ypp
496362	4331353	275	81	Fracture	Ypp
496362	4331353	137	71	Fracture	Ypp
496295	4331695	265	80	Fracture	Ypp
496295	4331695	95	80	Fracture	Ypp
496295	4331695	185	70	Fracture	Ypp
496295	4331695	19	21	Fracture	Ypp
497324	4331493	30	20	Fracture	Ypp
497324	4331493	192	54	Fracture	Ypp
497324	4331493	97	63	Fracture	Ypp
497324	4331493	340	85	Fracture	Ypp
497324	4331493	183	80	Fracture	Ypp
497324	4331493	140	18	Fracture	Ypp
497946	4334978	182	90	Fracture	Ypp
497946	4334978	330	75	Fracture	Ypp
497946	4334978	215	33	Fracture	Ypp
498224	4335314	307	79	Fracture	Ypp
498224	4335314	170	90	Fracture	Ypp
498224	4335314	95	75	Fracture	Ypp
498224	4335314	15	34	Fracture	Ypp

498224	4335314	273	56	Fracture	Ypp
498224	4335314	120	62	Fracture	Ypp
498224	4335314	56	55	Fracture	Ypp
498224	4335314	335	25	Fracture	Ypp
498693	4335146	182	47	Fracture	Ypp
498693	4335146	55	60	Fracture	Ypp
498693	4335146	68	41	Fracture	Ypp
498693	4335146	340	79	Fracture	Ypp
499151	4336462	260	78	Fracture	Ypp
499151	4336462	350	35	Fracture	Ypp
499151	4336462	84	82	Fracture	Ypp
499151	4336462	21	9	Fracture	Ypp
499732	4336442	194	71	Fracture	Ypp
499732	4336442	290	83	Fracture	Ypp
498407	4335966	194	85	Fracture	Ypp
498407	4335966	60	73	Fracture	Ypp
498407	4335966	30	32	Fracture	Ypp
498407	4335966	19	5	Fracture	Ypp
498407	4335966	125	77	Fracture	Ypp
498407	4335966	341	68	Fracture	Ypp
497674	4335904	190	90	Fracture	Ypp
497674	4335904	55	65	Fracture	Ypp
496686	4334941	155	68	Fracture	Ypp
496686	4334941	85	24	Fracture	Ypp
496686	4334941	290	78	Fracture	Ypp
496384	4335019	190	74	Fracture	Ypp
496384	4335019	255	38	Fracture	Ypp
496158	4335097	290	20	Fracture	Ypp
496158	4335097	205	85	Fracture	Ypp
495992	4335148	330	80	Fracture	Ypp
495992	4335148	265	60	Fracture	Ypp
496502	4334436	95	62	Fracture	Qtz mine
496502	4334436	180	88	Fracture	Qtz mine
496502	4334436	10	68	Fracture	Qtz mine
497342	4335812	85	84	Fracture	Ypp
497342	4335812	185	88	Fracture	Ypp
497296	4336415	155	84	Fracture	Ypp
496819	4337125	95	70	Fracture	Ypp
496819	4337125	305	44	Fracture	Ypp
496021	4337286	85	80	Fracture	Ypp
496021	4337286	260	42	Fracture	Ypp
496021	4337286	185	60	Fracture	Ypp
496709	4336712	165	72	Fracture	Ypp
496709	4336712	300	52	Fracture	Ypp
496730	4336319	85	44	Fracture	Ypp
496730	4336319	185	65	Fracture	Ypp
495547	4335318	280	80	Fracture	Ypp
495547	4335318	190	84	Fracture	Ypp
495024	4335869	285	90	Fracture	Ypp
495024	4335869	165	62	Fracture	Ypp

495082	4336050	5	80	Fracture	Ypp
495082	4336050	275	80	Fracture	Ypp
495082	4336050	80	85	Fracture	Ypp
495087	4337148	180	88	Fracture	Ypp
495087	4337148	270	90	Fracture	Ypp
495087	4337148	320	26	Fracture	Ypp
495792	4336879	80	72	Fracture	Ypp
495854	4336593	125	72	Fracture	Ypp
495854	4336593	190	82	Fracture	Ypp
495820	4337323	100	84	Fracture	Ypp
495820	4337323	5	74	Fracture	Ypp
495744	4337453	190	76	Fracture	Ypp
495744	4337453	295	50	Fracture	Ypp
495368	4337698	5	85	Fracture	Ypp
495368	4337698	260	80	Fracture	Ypp
495368	4337698	200	32	Fracture	Ypp
491894	4340079	260	70	Fracture	Ypp
491894	4340079	175	78	Fracture	Ypp
491577	4340176	325	80	Fracture	Ypp
491577	4340176	230	84	Fracture	Ypp
491232	4339412	135	82	Fracture	Ypp
491232	4339412	350	84	Fracture	Ypp
491232	4339412	55	88	Fracture	Ypp
491273	4339108	325	70	Fracture	Ypp
491273	4339108	125	70	Fracture	Ypp
491337	4338813	250	70	Fracture	Ypp
491337	4338813	260	75	Fracture	Ypp
491337	4338813	170	80	Fracture	Ypp
491314	4338578	250	50	Fracture	Ypp
491314	4338578	140	36	Fracture	Ypp
491314	4338578	20	78	Fracture	Ypp
494642	4331540	180	84	Fracture	Ypp
494642	4331540	95	76	Fracture	Ypp
494359	4331494	310	65	Fracture	Ypp
494359	4331494	5	84	Fracture	Ypp
495251	4344455	250	80	Fracture	Ypp
495251	4344455	165	75	Fracture	Ypp
495185	4344204	265	85	Fracture	Ypp
495185	4344204	185	80	Fracture	Ypp
495364	4343899	345	76	Fracture	Ypp
495364	4343899	150	55	Fracture	Ypp
495364	4343899	115	32	Fracture	Ypp
496010	4343866	175	76	Fracture	Ypp
496010	4343866	260	86	Fracture	Ypp
496467	4343574	90	88	Fracture	Ypp
496467	4343574	355	85	Fracture	Ypp
496467	4343574	15	46	Fracture	Ypp
496568	4343221	90	90	Fracture	Ypp
496568	4343221	355	84	Fracture	Ypp
496538	4342890	280	84	Fracture	Ypp

496538	4342890	185	80	Fracture	Ypp
496538	4342890	80	52	Fracture	Ypp
496260	4342728	280	82	Fracture	Ypp
496306	4342517	140	72	Fracture	Ypp
496306	4342517	350	40	Fracture	Ypp
496306	4342517	220	80	Fracture	Ypp
496191	4342272	75	85	Fracture	Ypp
496191	4342272	170	85	Fracture	Ypp
495769	4342878	125	70	Fracture	Ypp
495769	4342878	170	90	Fracture	Ypp
489837	4344331	265	73	Fracture	Ypp
489837	4344331	160	75	Fracture	Ypp
489837	4344331	144	10	Fracture	Ypp
491401	4342904	171	25	Fracture	Ypp
491401	4342904	260	87	Fracture	Ypp
492143	4344481	160	90	Fracture	Ypp
492143	4344481	60	82	Fracture	Ypp
492143	4344481	182	30	Fracture	Ypp
492143	4344481	245	70	Fracture	Ypp
492143	4344481	319	32	Fracture	Ypp
491897	4342445	195	76	Fracture	Ypp
491897	4342445	175	20	Fracture	Ypp
491897	4342445	245	32	Fracture	Ypp
491897	4342445	282	73	Fracture	Ypp
492717	4342263	72	19	Fracture	Ypp
492717	4342263	91	81	Fracture	Ypp
492717	4342263	275	65	Fracture	Ypp
492717	4342263	170	86	Fracture	Ypp
494895	4341146	355	79	Fracture	Ypp
494895	4341146	245	13	Fracture	Ypp
494895	4341146	100	90	Fracture	Ypp
494960	4340670	104	83	Fracture	Ypp
494960	4340670	135	23	Fracture	Ypp
494960	4340670	355	60	Fracture	Ypp
495431	4339542	90	50	Fracture	Ypp
495431	4339542	176	81	Fracture	Ypp
495431	4339542	282	82	Fracture	Ypp