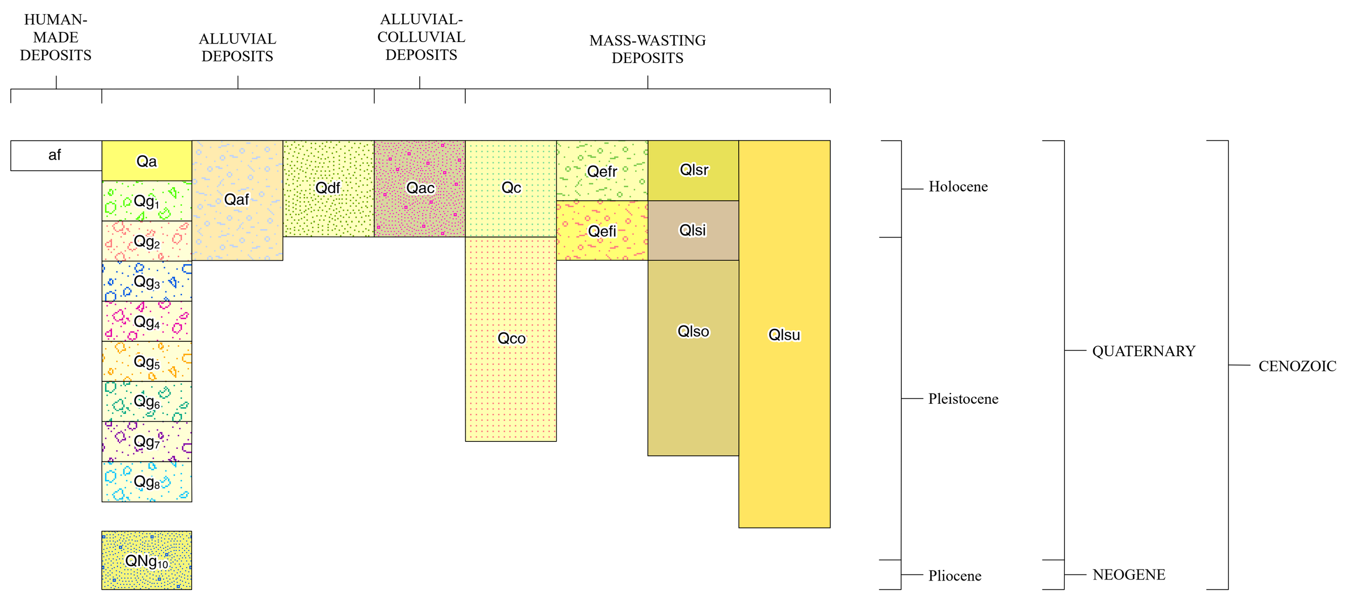
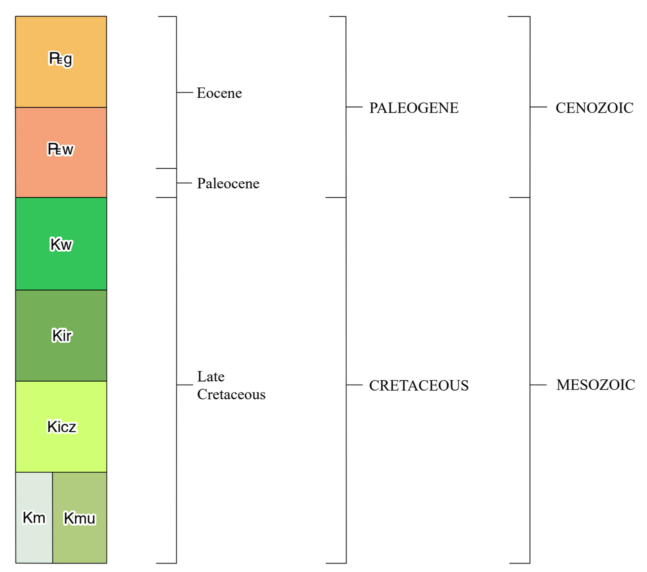
DOI: https://10.58783/cgs.of2103.ovbr9253

CORRELATION OF MAP UNITS

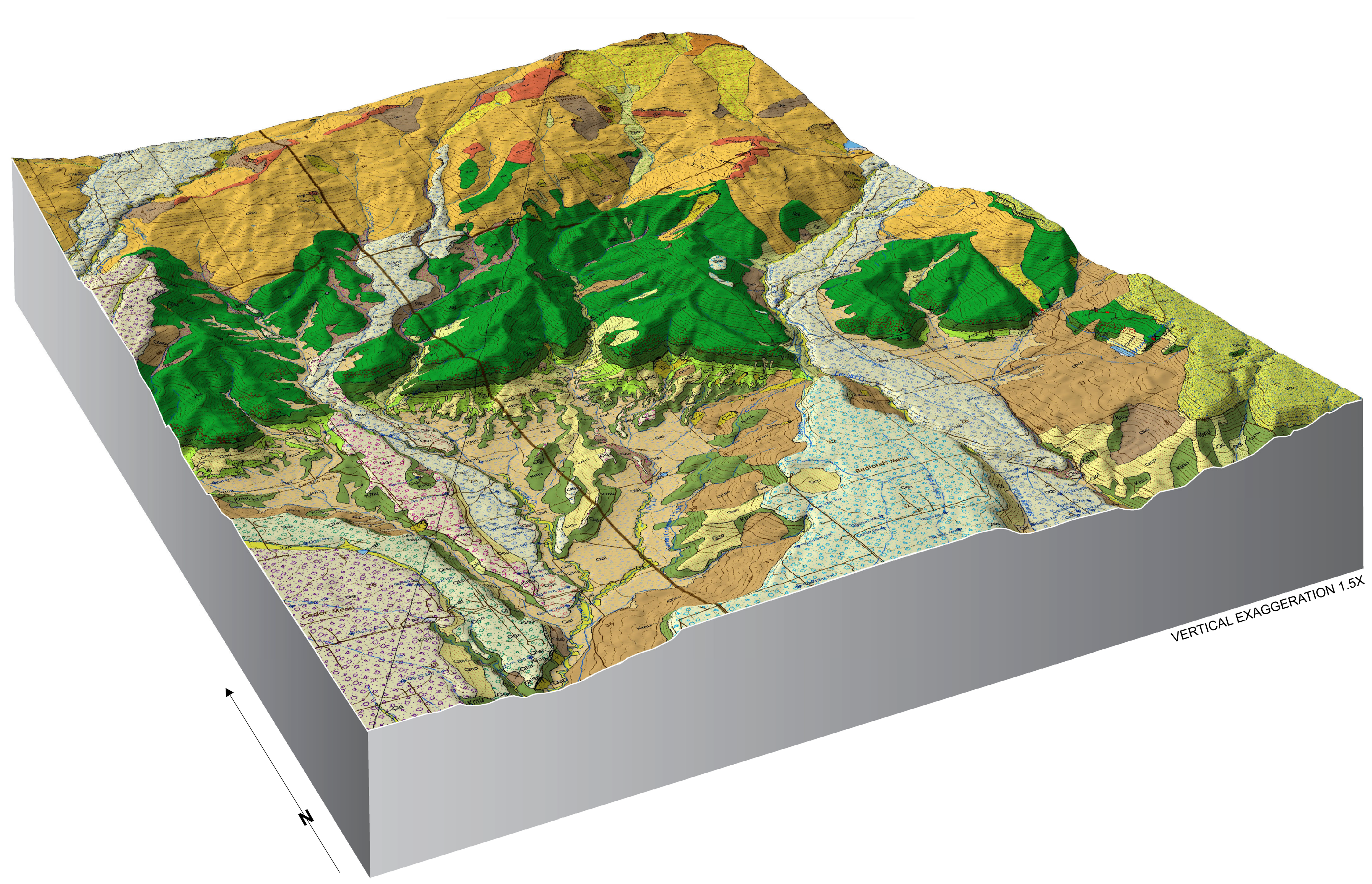
SURFICIAL DEPOSITS



BEDROCK UNITS



3-D OBLIQUE



GEOLOGIC HAZARDS

Potential geologic hazards in the map area are primarily the risk posed by landslides and other ground movements; however, there are also areas susceptible to rockfall, debris-flow flooding, and coal-mine subsidence hazards. The Mancos Shale also contains bentonite and other expansive clay minerals. Clayey surficial sediments derived from the shale may be expansive (and referred to as swelling soils). The marine shale may also be high in sulfates, which can be corrosive to unprotected concrete and steel. Site-specific geotechnical investigations, including boreholes and soil testing, should be conducted for structures planned in the Mancos Shale or clayey soils that are derived from it.

Landslides are ubiquitous throughout the northern part of the map area. Lands within the northern mapped landslide areas, underlain by the weak clay-rich Neogene and Paleogene rocks, are predominantly undeveloped and unoccupied public lands or private ranch land. Several areas in this terrain are actively moving down slope. In the lower terrain, most mesa flanks or risers underlain by Mancos Shale are also susceptible to landsliding. The mesa tops are irrigated, and where the gravel is underlain by shale, irrigation water percolates down to the water table and moves laterally along the contact between the permeable gravel and the underlying impermeable shale. Many ancient to recent landslides are mapped along the flanks of high mesas where wet ground conditions previously occurred on the steeper slopes as stream downcutting continued through the Pleistocene into the Holocene. The near-vertical scarps of fresh landslides expose gravel, and underlying weak shale may also be exposed. At older landslides, the scarp is covered by old colluvial deposits. Areas of mapped landslides and earthflows should be considered susceptible to future ground movements. Careful geological and geotechnical investigations should be completed for any site within mapped landslide areas if land-use changes and critical, permanent, and (or) occupied structures are planned. Those investigations would also be warranted for prospective buyers of real estate within mapped landslides, especially if residential structures exist or are being planned. Earth flows and debris flow/flash flooding can have long runouts (as much as 2.5 km). Careful planning and siting of structures are also important in the vicinity of creek floors and drainage swales. This map only shows existing landslides and earthflows, and does not reflect future risk or recurrence intervals for ground movements. Future landsliding could occur in any susceptible area along the flanks of Grand Mesa and hillsides adjacent to gravel-mantled mesas in the map area. Those ground movements can range from slow, nearly imperceptible, creep to movements that destroy structures to dangerous, potentially catastrophic rock avalanche-type flows.

Rockfall hazards occur along the base of high, near-vertical sandstone cliffs (e.g., Rollins Sandstone) or any cliffy slope with a steep grade (slope) that exceeds the angle of repose. Debris flow and hyperconcentrated flash flooding may also be hazards where drainage channels lie within steep terrain and outlet onto alluvial or debris-flow fans.

Several small historic underground coal mines exist in the map area. Coal-mine subsidence should be considered prior to future construction above underground workings.

PREVIOUS GEOLOGIC MAPPING

The preparation of this map was aided by the review of previous geologic mapping conducted in the area. The geology of the Dry Creek quadrangle was previously mapped at limited, small-scale extents by Lee (1912) in a 1:125,000-scale plate that accompanied his report on the Grand Mesa coal field; at 1:250,000 scale by Williams (1964); and at 1:50,000 scale by Dunrud (1989) who mapped coal-bearing rocks. Hail (1972) mapped a 15-minute quadrangle (scale 1:48,000) that includes the Dry Creek area. Quaternary surficial units were previously mapped at a small scale within the map area by Cole and Sexton (1981). Geology has been mapped on adjacent 1:24,000-scale quadrangles as part of this multi-year mapping program by the Colorado Geological Survey. These maps include portions of Grand Mesa and include the Lands End (White and Palkovic, 2018), Mesa Lakes (Chesnutt and others, 2019), Hells Kitchen (White and Palkovic, 2019), and Cedaredge (White, 2020) quadrangles. To the south of the map area along the Gunnison River Valley are geologic maps of the North Delta (Noe and others, 2015a), Orchard Mesa (Noe and Zawaski, 2013), Lazear (Noe and others, 2015b), and Hotchkiss (Noe and Rodgers, 2014) quadrangles. These 1:24,000-scale quadrangles are shown on the Plate 1 index map.

ACKNOWLEDGMENTS

The author thanks the following property owners for allowing or facilitating access to critical land parcels for the mapping of Dry Creek quadrangle: U.S. Forest Service - Grand Mesa National Forest; U.S. Bureau of Land Management; Laura and William Vaughn, Vaughn Ranch; Paul Smith, manager of ST Ranches; Mike Ludlow, manager of Bear Ranch; Dennis Durmas, manager for Carlson Ranch; Overland Ditch Co. board members; the Girling family; Hank and Charlie Warren; and Justin Heiber at Cactus Park Ranch. Carrie Derco, the Delta County GIS Coordinator, provided digital 9-inch (23 cm) pixel orthorectified aerial photography and tax assessor land parcel datasets. Pangaea Geospatial produced the map plates and GIS files for this publication. This map publication benefited from reviews by Ralph Shroba and Matthew Morgan of the Colorado Geological Survey.

PHYSIOGRAPHIC SETTING

The Dry Creek quadrangle lies in Delta County in western Colorado. The map center lies approximately 10 km northeast to east of the town of Cedaredge. The steeper slopes in the upper third of the map area are part of the southern flank of Grand Mesa and are characterized by high elevations and hummocky, south-facing slopes underlain by landslide deposits. The upper hummocky terrain transitions southward to cliffy mid-elevation sandstone outcrops of the Williams Fork and Iles Formations of the Mesa Verde Group. In the lower valleys and south part of the map area, bouldery gravel underlies low gradient mesa and river terrace surfaces. The highest elevation of the Dry Creek quadrangle is 3,097.0 m (10,160.8 ft) above mean sea level (AMSL) at the northeast map corner within high elevation landslide terrain in the Grand Mesa National Forest. The lowest elevation is 1,850.3 m (6,070.5 ft) AMSL near the southwestern corner of the map area where Current Creek exits the quadrangle, 1.3 km below its confluence with Dry Creek. The annual precipitation in the map area (National Centers for Environmental Information) ranges from about 100 cm along the northern map area where alpine forests are predominant, through a mid-elevation semi-arid Gambel oak, pinyon-juniper, woodland climate of the high alluvial mesas, and to a low of about 33 cm at lower elevations shrublands on the southwest flank of the map area. A winter snowpack occurs in the high country of the map area, and average temperatures are cooler than those along the Gunnison River Valley and in the Grand Junction-Grand Valley area below the confluence with the Colorado River.

GEOLOGIC SETTING

The early Cenozoic and Late Cretaceous evolution of western Colorado is recorded in the transition from marine to terrestrial rocks exposed in the map area. The basal bedrock unit exposed in the map area is the upper member of the Late Cretaceous Mancos Shale. This marine shale was deposited during the Cretaceous Western Interior Seaway (WIS) transgression into west-central North America. Regressive and transgressive sequences of the western shoreline of the WIS formed the sediments of the Iles Formation in shoreface and nearshore environments (Roberts and Kirschbaum, 1995). Of note is the 30-m high gray-white cliffs of the Rollins Sandstone Member that is a prominent stratigraphic marker bed in the area. As the paleoshoreline regressed to the east, broad floodplain environments were created. Sand, mud, and organic-rich swamp sediments, transported from west to southwest sources, formed the Late Cretaceous Williams Fork Formation. Commercial coal deposits in the Cameo-Wheeler coal zone were formed. Uplifts during the Laramide orogeny (of Late Cretaceous and Paleogene ages) occurred along the Southern Rocky Mountain orogenic belt in central Colorado. Concurrently, structural intermountain basins such as the Piceance Basin developed. The resultant erosion of the highlands of the orogenic belt shed deposits of sand, mud, and coarse pebble to cobble gravel that become the sandstone and conglomerate of the Ohio Creek Formation. Later, beginning in the Paleocene, thick packages of terrestrial clastic sediments accumulated to form the Wasatch Formation. Differential uplift during the Laramide orogeny created closed, structural basins where freshwater lakes formed. The Wasatch Formation sediments were buried by a package of lacustrine and lake-shoreface sediments that formed the Green River Formation of Eocene age (Franczyk and others, 1992). After limited deposition of terrestrial sediments that buried the Green River Formation during the late Miocene, drainage integration led to the establishment of the paleo Colorado River drainage basin on a subdued landscape. Basaltic lava of the Grand Mesa Volcanic Field (GMVF) flowed into this drainage basin during the Miocene (Cole and others, 2017). The GMVF is composed of very hard basaltic bedrock that is resistant to erosion compared to the underlying softer Neogene and Paleogene bedrock (Green River and Wasatch Formations). During late Neogene time, epeirogenic uplift of the Colorado Plateau occurred, possibly coupled by mantle buoyancy and subsequent erosional-isostatic rebound driven in part by regional denudation from river incision by the Colorado River and its Gunnison River tributary. About 1.5 km of regional, late Neogene to Quaternary downcutting by the Colorado River and its tributaries, accompanied by topographic inversion of the resistant GMVF basalt, formed Grand Mesa and nearby Battlement Mesa (Aslan and others, 2019).

Major Quaternary events included continuing incision and regional lowering of the landscape, Pleistocene glaciation on Grand Mesa, and mass wasting. The latter continued through the Holocene to the present day. The primary mechanism of topographic lowering is continual ground instability and mass-wasting processes on the flanks of Grand Mesa. Slump blocks, scarps, disturbed and broken ground, heave and pressure ridge features, and linear earth-flow pathways are typical of the upper slopes that surround the Grand Mesa rim (Baum and Odom, 1996; White and Palkovic, 2018; Chesnutt and others, 2018; White and Palkovic, 2019; and White, 2023). The source materials for much of the landslide deposits are GMVR basaltic rocks from blockfields, glacial till, and glacio-fluvial outwash, and the underlying weak clay-rich Neogene and Paleogene sedimentary rocks.

Episodes of erosion and alluvial deposition, likely related chiefly to glacial and interglacial events during the Pleistocene, shed rocky alluvial sediments from the highland terrain. This material was mainly deposited in large aprons of bouldery alluvial-fan gravel and very rocky debris-flow deposits at and near the base of the landslide terrain. Water-well logs suggest that basaltic gravel filled paleovalleys. For example, the maximum recorded thickness of the gravel on Cedar Mesa was 66 m (White, 2023), and one water well on Redlands Mesa exceeded 80 m, far thicker than measured exposures along the mesa perimeters. Subsequent erosion and ground-surface lowering have resulted in the formation of gravel-capped mesas. The most distinctive, from the highest and oldest gravel in the map area, caps Oak Mesa, Redlands Mesa, and Cedar Mesa, which all display alluvial-fan morphology on topographic maps and lidar hillshade imagery. Younger terrace gravel treads occur within stream valleys whose basins extend to the highlands. All the mesas, mesa remnants, and river terraces have longitudinal profiles that slope southward towards the Gunnison River Valley.

The structural geology of the Dry Creek quadrangle reflects the regional development of Late Cenozoic basins. Formations generally dip at a gentle grade away from the Uncompahgre Plateau Uplift towards the Piceance Basin to the north. Structural data, such as bedding attitudes, was difficult to obtain because of extensive Quaternary surficial deposits that cover the underlying bedrock and (or) subsidence and collapse deformation near clinker zones in exposed Williams Fork strata resulting from coal seam fires in the Cameo coal zone.

The only structural feature observed by the author in the map area is a normal fault that offsets the Rollins Sandstone, which trends northwestward and crosses LeRoux Creek, where the valley broadens and is underlain by Mancos Shale. No other surface expressions of other faults, no strata offsets, nor deformation-band damage zones typically seen in faulted sandstone were observed. However, Hail (1972) shows a short fault that offsets Wasatch and Williams Fork formations high on the slopes north of Leroux Creek, which this author could not discern within the landslide deposits in that area. Dunrud (1989) mapped several inferred faults in his study of the coal-bearing strata exposed in the Dry Creek quadrangle area, mostly along river valleys and canyons that cut into the Rollins Sandstone and Williams Fork Formation. Structure-contour offsets drawn by Dunrud (1989) at the top of the Rollins Sandstone (Kir) are in areas covered by thick surficial deposits; so were likely inferred from coal exploration well logs. Regionally, the map area lies upon the trend of the ancestral Pennsylvanian-Permian Uncompahgre Uplift where the entire package of Paleozoic rocks was removed by erosion before the deposition of Mesozoic and Cenozoic sediments. An oil and gas well log (API No. 05-029-05030) shown in the southeast quadrant of the map area near Leroux Creek logged the nonconformity between the Mesozoic rocks and Precambrian crystalline rocks at a depth of 1,484 m (560 m AMSL).

WATER RESOURCES

The southern flank of Grand Mesa just north of the Dry Creek quadrangle contains major watersheds that flow southward into the map area. The upper watersheds along the high flanks (about 3,200 m AMSL) receive high (about 125 cm) annual precipitation, much of which is stored in winter snowpack. The watersheds are a critical water resource for domestic and agricultural use, recognized by Delta County Board of County Commissioners (Kolm and van der Heijde, 2014). Almost all pastures, orchards, vineyards, and crop farmland are irrigated. Surface Creek and Leroux Creek provide water to public water systems (PWS), and current rules (Colorado Energy and Carbon Management Commission (ECMC) rule 411.a) have buffered creek areas from oil and gas activity in the map area to protect water quality. Almost all privately owned completed water wells draw water from thick unconsolidated deposits, some are landslide deposits, but most are gravelly alluvium on the mesas or along terraces treads in incised valleys. Selected water wells from the DWR water-well database are shown on the map to indicate gravel thickness. The underlying rock units do not produce much water. Seasonal recharge of groundwater in the gravel mesas occurs from watersheds that extend north of the map area.

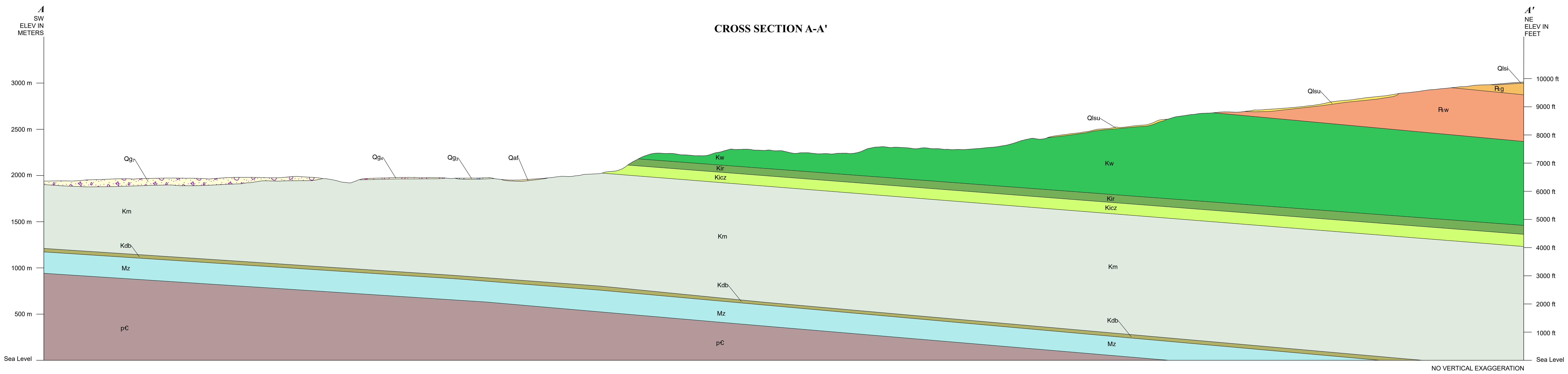
MINERAL RESOURCES

Oil and gas, coal, coal-bed methane, and clinker shale are potential and current mineral resources in the Dry Creek quadrangle. Coal resources exist in the basal part of the Williams Fork Formation (Cameo-Wheeler coal zone) within the map area (Lee, 1912), which were developed in the early- to mid-1900s. The coal zone and related red clinker beds outcrop in a band directly above the Rollins Sandstone. The outcrop trends west to east near the lower middle of the map area where the high Rollins Sandstone cuesta is prominently exposed above Cactus Park and in the valleys of Currant, Dry Creek, and Leroux creeks before the valleys broaden where underlain by the more easily eroded Mancos Shale. At the east boundary of the map area, the outcrop follows the riser of Oak Mesa and ends where the high gravel surface buries bedrock strata. Coal beds up to 4-m thick have been reported (Lee, 1912). Dunrud (1989) reported deep coal-resource test borings identifying multiple coal seams. Some of those boring locations are shown on the map (Eager, 1978 and 1979). Several small coal mines that historically operated in the map area are now closed and the mined land has been reclaimed. Within the coal-mining district, there are small quarries where red clinker rock was mined.

There has been some oil and gas drilling activity within the map area. In the northwest corner of the map area, wells were completed in Cretaceous rocks at a small gas field near Surface Creek. During the preparation of this map, these wells were either plugged and abandoned or shut-in (ECMC). Coal-bed methane within the Williams Fork Formation and the Mancos Shale Niobrara Member may have gas potential using horizontal well drilling and hydraulic fracturing completion techniques. The coal-bearing units dip northward. Oil and gas well logs (COGCC COGIS) place the top of the Cameo coal zone about 850 m deep (1,750 m AMSL) at the northwestern corner of the map area.

Except for the red clinker quarry mentioned earlier, the aggregate resource value of the extensive gravel deposits is limited because they commonly have layers of mud and poorly sorted debris-flow gravel that contain weak sedimentary clasts as well as high percentages of clay and silt. There are a few borrow pits in the map area. Opportunities may exist for the collection of weathered and pitted boulders suitable for landscaping stone that are common in the map area, particularly within the main drainage basins in the map area. Boulders are commonly moved to the sides of agricultural fields and removed from foundation and borrow-area excavations.

CROSS SECTION A-A'



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GEOLOGIC MAP OF THE DRY CREEK QUADRANGLE, DELTA COUNTY, COLORADO
CORRELATION OF MAP UNITS, 3-D OBLIQUE, GEOLOGIC SETTING, AND CROSS SECTION

By Jonathan L. White
2024