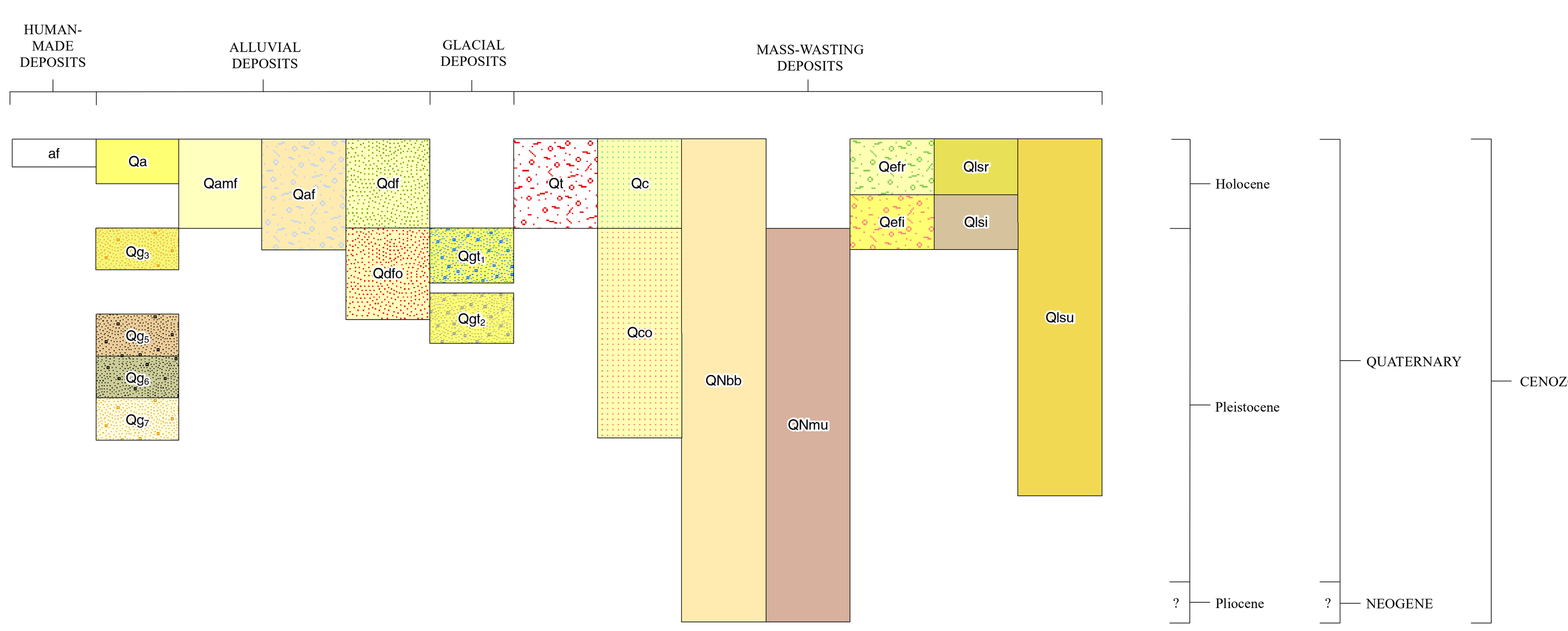
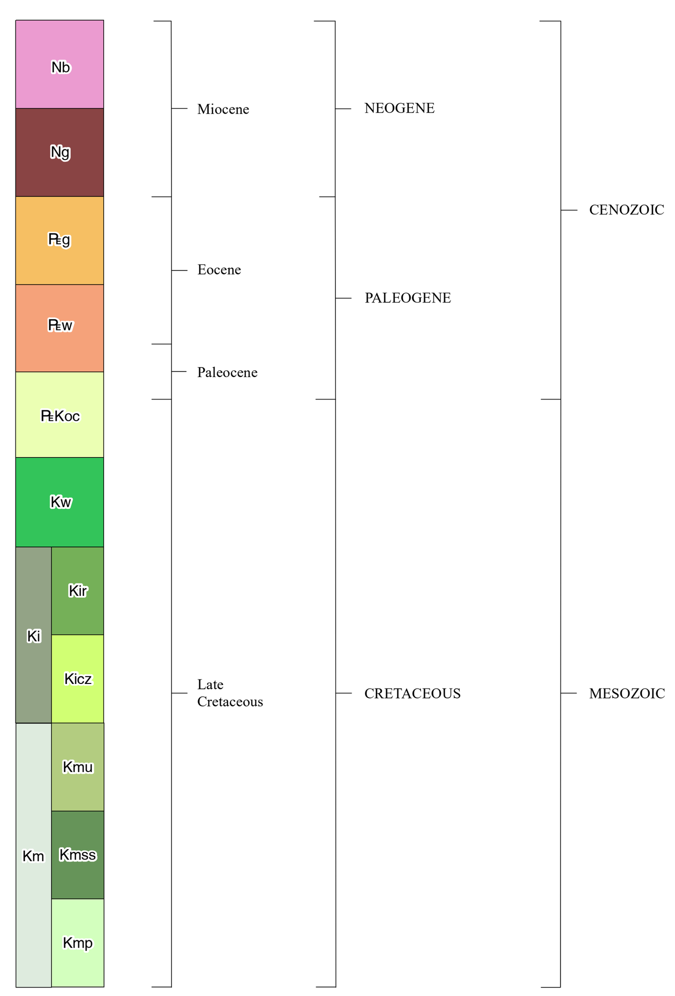
CORRELATION OF MAP UNITS

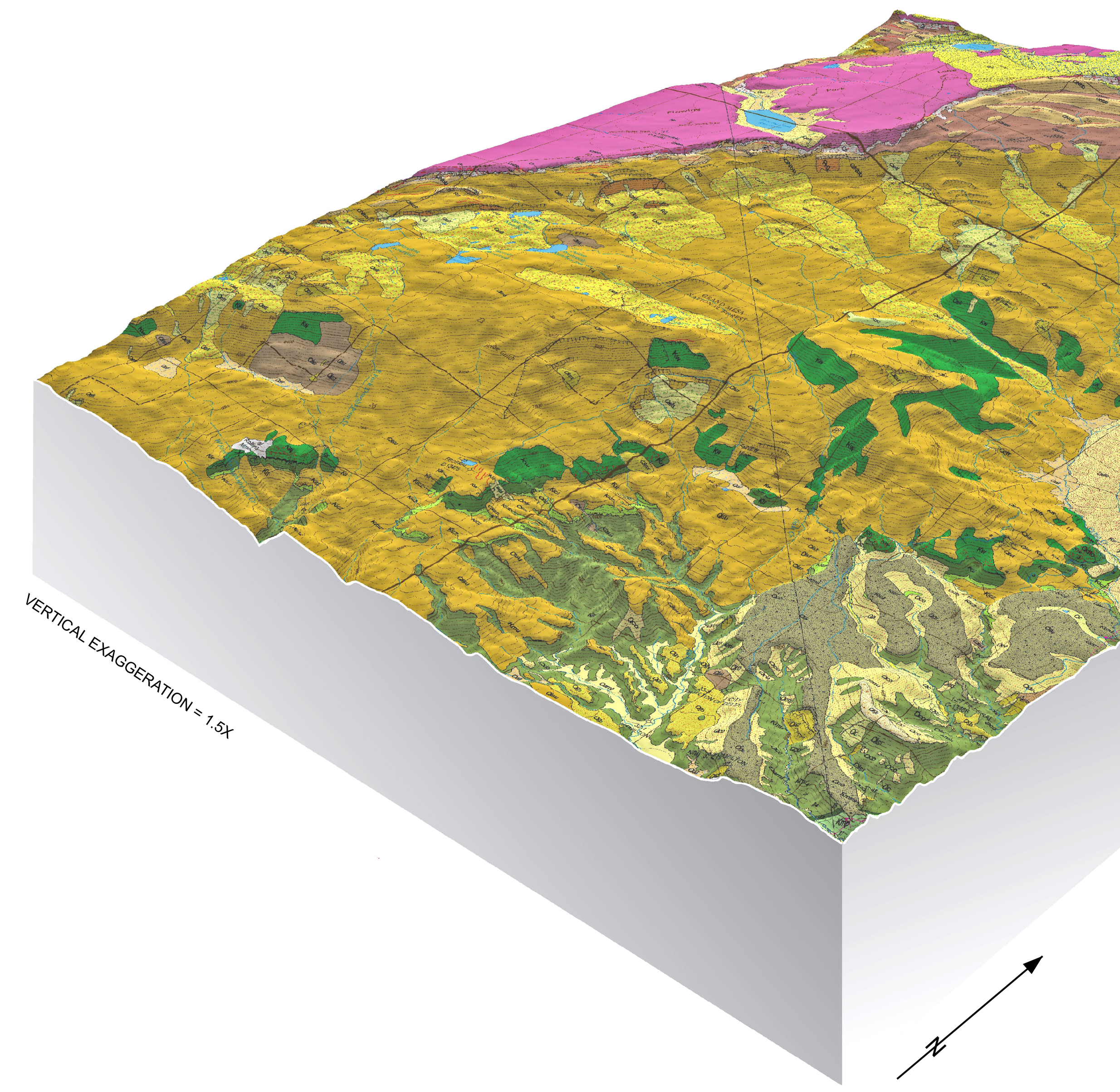
SURFICIAL DEPOSITS



BEDROCK UNITS



3-D OBLIQUE VIEW



PHYSIOGRAPHIC AND GEOLOGIC SETTING

The Hells Kitchen quadrangle lies in Mesa and Delta Counties, Colorado, approximately 13 mi (21 km) north of Delta. The landscape of the map area is characterized by a high mesa (Grand Mesa) formed by the Miocene eruption of the Grand Mesa Volcanic Field (GMVF), epeirogenic uplift, and topographic inversion. The lava flows of the GMVF formed two westward lobes divided by the Kannah Creek Basin: the Palisade Lobe (PL) resulted from lava flows to the west, and the Flowing Park Lobe (FPL) formed from flows to the southwest. The Hells Kitchen quadrangle includes the northeastern half of the FPL to Kannah Creek and a small portion of the PL rim north of Carson Lake, near where the two lobes diverge. Grand Mesa rises a mile (1.6 km) in elevation above the confluence of the Gunnison and Colorado rivers in Grand Junction and is a major physiographic feature and landmark of western Colorado. In the map area, the annual precipitation ranges from 36 inches (91 cm) on Grand Mesa where alpine forest is predominant, to 12 inches (31 cm) at the lowermost flank of the map area where semi-arid pinyon-juniper woodlands and arid sparsely vegetated adobe badlands occur.

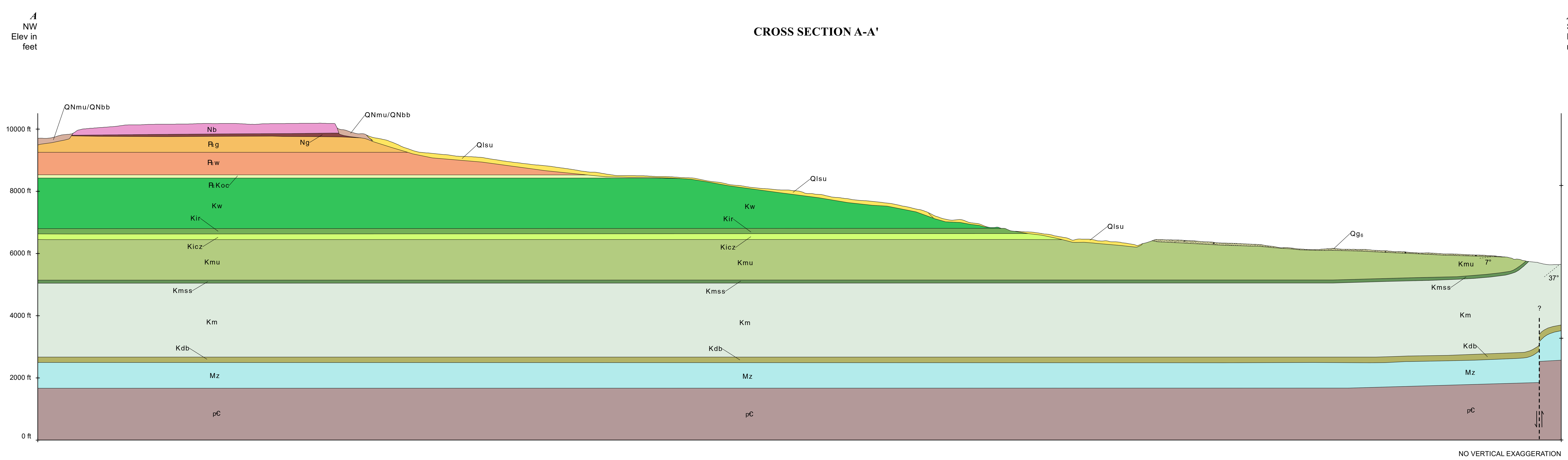
The highest elevation of Hells Kitchen quadrangle is 10,605 ft (3,232 m) at the northeast edge of the GMVF basalt rim at the northern boundary of the quadrangle. The lowest is 5,615 ft (1,712 m) where the Oak Creek channel exits the quad at its southern boundary to adobe badlands where the Mancos Shale is exposed. The surface elevation of the FPL in the map area averages about 10,000 ft (3,048 m) Above Mean Sea Level (AMSL) and, including glacial and other surficial deposits overlying the GMVF basalt (Nb), covers 7.2 mi^2 (18.6 km^2), or 12% of the map area. The majority of the map area (67.5%) is mapped surficial mass-movement and landslide deposits that cover 39.2 mi^2 (101.5 km^2) along the flank of Grand Mesa below the FPL rim. Exposed bedrock, predominantly Cretaceous rocks in the southeastern part of the map area, covers 5.2 mi^2 (13.5 km^2); only 9% of the map area. The remaining 11.5% of the map area, below the FPL rim, was mapped with other unconsolidated surficial units (e.g., glacial and alluvial deposits).

The early Cenozoic and Late Cretaceous evolution of western Colorado is recorded in the terrestrial formations exposed in the map area. The basal bedrock unit exposed in the map area is an upper member of the Late Cretaceous Mancos Shale. This very thick, marine shale was deposited during the transgression of the Cretaceous Western Interior Seaway (WIS). Regressive and transgressive sequences of the western shoreline of the WIS formed the sediments of the Iles Formation in shoreface and nearshore environments. Of note is the 100-ft (30-m) high gray-white cliffs of the Rollins Sandstone Member that is a prominent stratigraphic marker bed. As the paleoshoreline regressed to the east, broad floodplain environments were created. Sand, mud, and 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. The resultant erosion from the highlands of the orogenic belt shed a thin unit of sandstone with coarse pebble-to-cobble gravel that would become the conglomerate of the Ohio Creek Formation, followed during the Paleogene by thick packages of clastic sediments, deposited westward to become the Paleogene Wasatch Formation. Differential uplift during the Laramide orogeny created large, closed, structural basins where freshwater lakes formed. The Wasatch Formation sediments were buried by a thick package of lacustrine and lake-shoreface sediments would develop into the Paleogene Green River Formation (Franczyk and others, 1992). After some continuing but limited terrestrial sedimentation that buried the Green River Formation during the late Miocene, there was an eventual integration and establishment of the westward drainage network of the paleo Colorado River Basin on a topographically subdued landscape. Basaltic lava of the Neogene GMVF eruption flowed onto this surface. Later Neogene epeirogenic uplift of the Colorado Plateau, concurrent to Early Quaternary river incision by the Colorado River and its Gunnison River tributary, resulted in several thousand feet of regional topographic lowering, possible erosional-isostatic rebound, and topographic inversion of the more resistant GMVF basalt to form Grand Mesa. Later Quaternary events include Pleistocene glaciation on the mesa and mass wasting of the flanks of Grand Mesa that continues until today.

The GMVF is important in the ongoing understanding of the timing of Neogene river incision and tectonic uplift rates for the establishment of the Upper Colorado River Basin (Aslan and others, 2008; Aslan and others, 2010; Aslan and others, 2019). Supporting this understanding is the radiometric dating of the GMVF basalt, and those lava flows becoming a baseline for a 10 Ma paleotopographic surface. The presence of ancestral Colorado River gravel directly below the basalt flows at the PL rim on the adjacent Lands End quadrangle (Aslan and others, 2012; White and Palkovic, 2018) and detrital sanidine dating results (Aslan and others, 2019) helps constrain the Miocene establishment of the westward flow of the paleo Colorado River drainage network. Evidence of an alluvial interbed within the GMVF basalt suggests an ancestral middle Miocene river briefly flowed across the FLP during a lull in volcanic activity (Buckhorn Geotech, 1981). Additional evidence may be the now-abandoned shallow valley across the FPL mesa top, currently occupied by the Flowing Park Reservoir. While no exotic pebbles were observed as were noted on the PL (Yeend, 1969; White and Palkovic, 2018), this shallow east-to-west topographic valley crosses the FPL with a drainage divide and apparent inlet and outlet. While timing is uncertain, this shallow valley was likely abandoned during late Miocene or Pliocene time when a tributary stream migrated southward into the Gunnison River basin, probably by stream capture around the more resistant basaltic rocks of the GMVF.

CROSS SECTION A-A'



WATER RESOURCES, MINERAL RESOURCES, AND GEOLOGIC HAZARDS

The Hells Kitchen quadrangle includes a portion of the FPL of Grand Mesa. The upper watersheds along its high-elevation flanks receive high annual (up to 42 in (102 cm)) precipitation stored in winter snowpack, which is an important water resources. Many small reservoirs (e.g., Granby Reservoirs) and agricultural diversions (ditches and aqueducts) in the map area are administered by the Grand Mesa Water Users Association. The underlying rock formations do not produce much water, and the few water wells within the map all appear to produce from unconsolidated surficial deposits.

Oil and gas, coal, coalbed methane, and landscape stone are potential mineral resources on the Hells Kitchen quadrangle. Coal resources exist in the basal Williams Fork Formation within the Cameo-Wheeler coal zone. The Palisade coal seam pinches out eastward and is not present in the map area (Gill and Hail, Jr., 1975). The Cameo coal zone, and related red clinker beds, outcrop in a band directly above the Rollins Sandstone that trends northeast from the southwest corner of the map area to where Dirty George Creek exits the map area. The Cameo coal zone was actively prospected in this area. Dunrud (1989) reports deep coal-resource test borings identifying multiple coal seams. Five coal mines operated on the quadrangle since the late 1880s (Lee, 1912): the Kuhnley mine (mine opening is just off the map area (SE ¼ SE ¼ S34, T. 13 S., R. 96 W.) but underground workings extend into the map area), the Rollins mine, Fairview mine, Winton mine (precise location is unknown), and the Tomahawk strip mine. All have been closed and the mined land reclaimed. Within the map boundary there has been some oil and gas drilling activity and well completions in Cretaceous rocks but there is currently no production. The map area lies upon the trend of the ancestral Pennsylvanian-Permian Uncompahgre Mountains and oil and gas well logs indicate the nonconformity of the Triassic Chinle Formation with Precambrian crystalline rocks occurs at approximately 2,900 ft (884 m) AMSL at the southeast corner of the map area. Within the Mancos Shale, the Niobrara Member may have oil and gas potential. Aggregate resources are of limited value because of the high percentages of clay and silt that exists in unconsolidated gravel and clast-supported debris-flow deposits. Opportunities may exist for the quarrying of lichen-covered and pock-weathered landscaping stone from the many basaltic boulder fields in the map area.

Potential geologic hazards in the map area are primarily due to the risk of ground movements. Landslides are ubiquitous throughout the map area below the GMVF basalt rim. Most lands within mapped landslide areas are unoccupied public lands or private ranch land. However, some residential areas occur along the east map margin near Cedaredge, Colorado. 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 there are land-use changes and permanent and/or occupied structures are planned. Those investigations would also be warranted for prospective buyers of real estate within mapped landslides, especially if there are existing residential structures. Earth flows and debris flow/flash flooding can have long runouts (over 2 mi (3.2 km)) so careful planning and siting of structures is 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. Future landsliding could occur in any susceptible area along the flanks of Grand Mesa. Those ground movements can range from slow near-imperceptible creep to dangerous, potentially catastrophic, very high velocity, rock avalanche-type flows.

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 Hells Kitchen was previously mapped at smaller scales by: Lee (1912) at a limited extent for a 1:125,000-scale plate that accompanied his report on the Grand Mesa coal field, 1:250,000 scale by Williams (1964), 1:100,000 scale by Ellis and Gabaldo (1989), 1:50,000 scale by Dunrud (1989) in the southeastern part of the quadrangle along the exposed band of coal-bearing rocks, and at the 1:48,000 scale of the adjacent 15-minute Cedaredge quadrangle (Hail, 1972). Quaternary surficial units were previously mapped at a small scale by Cole and Sexton (1981). Geology has been mapped on adjacent 7.5 minute (1:24,000-scale) quadrangles. To the north on Grand Mesa is Lands End (White and Palkovic, 2018) and Mesa Lakes (Chesnutt and others, 2019). To the south and east are the North Delta quadrangle (Noe and others, 2015) and Orchard Mesa (Noe and Zawaski, 2013). 7.5-minute quadrangle locations are shown on the Plate 1 index map.

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GEOLOGIC MAP OF THE HELLS KITCHEN QUADRANGLE, MESA AND DELTA COUNTIES, COLORADO
CORRELATION OF MAP UNITS, 3-D OBLIQUE VIEW, GEOLOGIC SETTING, AND CROSS SECTION

By Jonathan L. White and Martin J. Palkovic

2019

COLORADO GEOLOGICAL SURVEY
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