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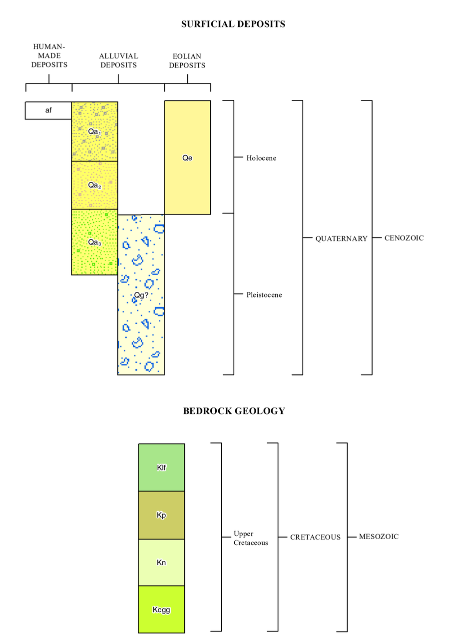
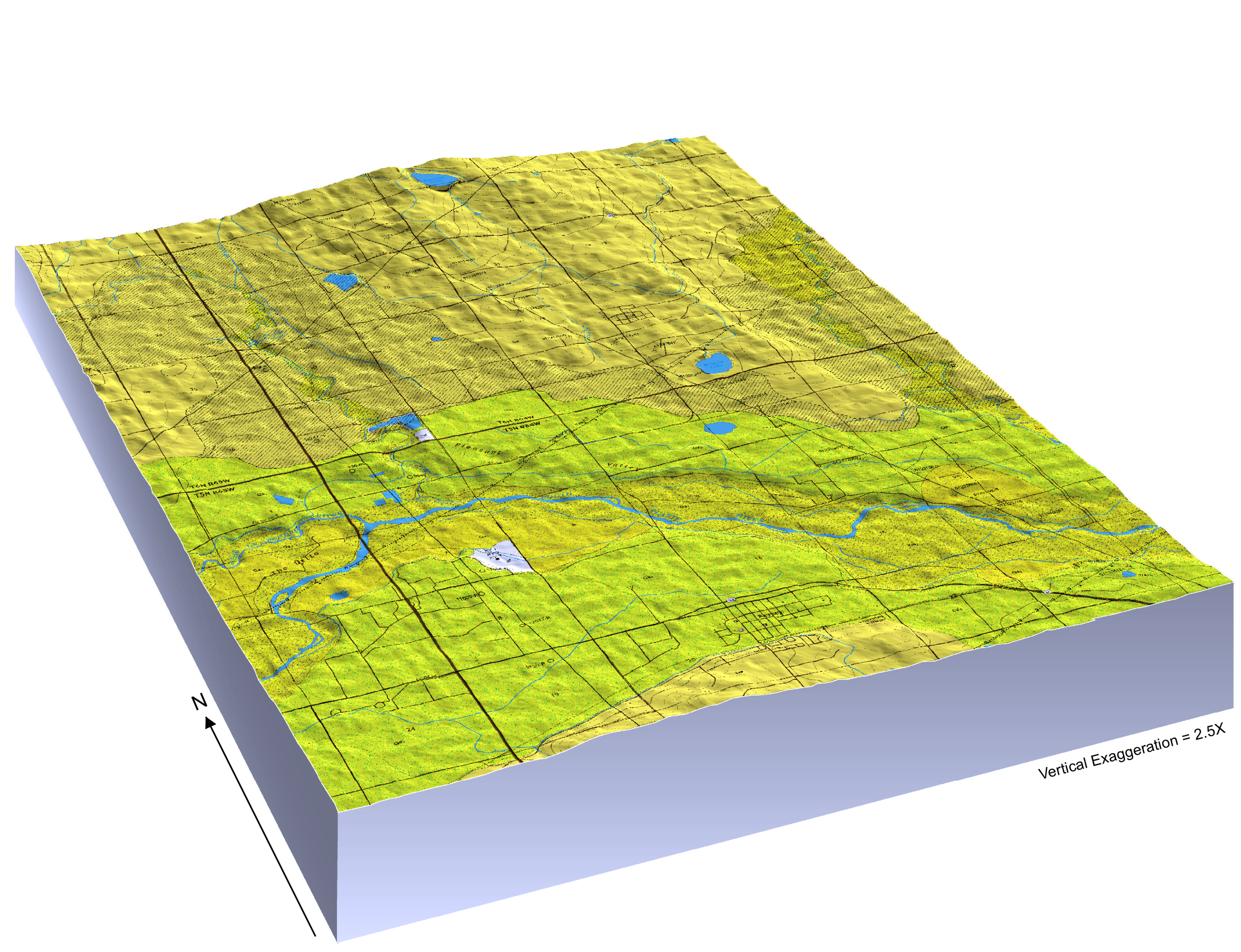
CORRELATION OF MAP UNITS



3-D OBLIQUE



GEOLOGIC HISTORY

The Kersey quadrangle is located approximately 80 km northeast of Denver and 40 km east of Fort Collins, Colorado. The map area lies within the Colorado Piedmont section of the Great Plains physiographic province. In eastern Colorado, Upper Cretaceous rocks are the predominant bedrock units and were deposited during the transgressive and regressive stages of the Western Interior Seaway (WIS). The Laramide orogeny began at around 70 Ma and corresponds with the final stages of the WIS in eastern Colorado (Weimer, 1996). It was during this time that the sediments forming the major bedrock units, identified in oil and gas well logs within the map area were deposited: Carlile Shale, Greenhorn Limestone, and Codell Sandstone (collectively known as the Colorado Group, unit Kcgg), Niobrara Formation (unit Kn), and Pierre Shale (unit Kp). However, bedrock units are not exposed within the Kersey quadrangle because they are mantled by surficial deposits. As the Laramide orogeny progressed, the Denver Basin was created with steeply dipping bedrock on the western margin, and dip angles decrease significantly toward the east.

Units deposited during the Cretaceous and early Cenozoic are valuable reservoirs for groundwater and oil and gas resources within the Denver Basin. The mapped area is located within the Wattenberg Field, a world-class oil and gas-producing area that is part of the larger Denver-Julesburg Basin. The field has produced over 4 trillion cubic feet of gas and 210 million barrels of oil. Faulting and related structures have contributed to the trapping of hydrocarbons in the Wattenberg Field (Higley and Cox, 2007; Weimer, 1996). The Johnstown (JWFZ) and Longmont (LWFZ) wrench fault zones are associated with hydrocarbon production (Weimer, 1996). The LWFZ, is mapped in the subsurface and traverses near the southeast corner of the quadrangle. The LWFZ is considered to be a normal oblique left-lateral fault. Fault angles are unknown, but Weimer (1996) reports they are likely either listric or nearly vertical, depending on their relation to bedrock. Offsets ranging from 6 to 30 m or more are indicated in oil and gas well logs and shown on cross section C-C'. The Wattenberg Field also contains important groundwater resources.

During the Pleistocene, streams likely experienced significant aggradation during deglaciation when large volumes of meltwater carried a considerable amount of sediment to the plains east of the foothills (Church and Ryder, 1972). Between periods of aggradation, streams eroded the underlying sediment leaving behind gravelly terrace deposits. A water-well log (well ID 2848-F) in the northern part of the mapped area indicates gravel as shallow as 1.2 m below ground surface. The top of the gravel-capped surface at this location is 77 m above the modern South Platte River channel. By virtue of its height above modern stream channels and its relationship with other alluvial deposits within the mapped area, the gravel is likely to be the oldest gravel in the quadrangle. This gravel is not exposed on the quadrangle and was only identified on water-well logs. Aggradation during the Late Pleistocene and Early Holocene is recorded by younger, inset terraces and their underlying deposits: Qa_3 (Late Pleistocene and Early Holocene) and unit Qa_2 (Holocene). The youngest alluvial unit is Qa_1 and it underlies modern channels and low (1 to 2 m high) terraces.

Two paleovalleys, interpreted from high-resolution (1 m) hillshaded lidar imagery, extend from adjacent quadrangles to the west and east. The aerial extent of these paleovalleys is indicated by the hachured pattern on the geologic map. In the western part of the mapped area, Lone Tree Creek occupies one of these valleys. Lone Tree Creek has experienced at least three major episodes of aggradation and erosion. At least two older terrace levels mantled by unit Qe are evident on hillshaded lidar on the eastern side of the drainage, in addition to Holocene alluvium underlying the modern channel. The two terraces and modern channel are identified on cross section B-B'. Between the deposition of the lower terrace and the establishment of the modern channel, eolian sediments were deposited over the terraces. Alluvium associated with the Lone Tree Creek paleovalley is locally as much as 10 m thick and at least 1 to 2 m of eolian sediment mantles the underlying alluvium in most areas. Crow Creek, on the eastern side of the mapped area, is incised into a paleovalley extending from the east. As much as 6 m of eolian sediment mantle the underlying alluvium in this paleovalley. Alluvial packages are predominantly 6 to 9 m thick, and one DWR borehole indicates the alluvium may be as much as 12 m thick. There is at least one higher level terrace, underlain by unit Qa_2, along Crow Creek that is locally mantled by a very thin layer (<1 m) of eolian sediments in places. The modern channel of Crow Creek is underlain by unit Qa_1.

Eolian sediments were episodically deposited along the Front Range throughout the Pleistocene and Holocene, as indicated by radiocarbon ages and varying degrees of soil development. Major dune fields are present on both sides of the South Platte River and dune crests directions indicate prevailing winds are from the northwest and have been for much of the Holocene (Aleinikoff and Muhs, 2006). Regional sand dunes and sand sheets are currently stable; however, local sand bodies may mobilize during high winds in areas where vegetation is sparse or has been removed and broad areas could be destabilized in the future from human development or changes in the local climate (Muhs and others, 1995). Eolian sediment mantles much of the Late Pleistocene aged units in the mapped area indicating that eolian sediment within the mapped area is likely all Holocene in age. Lone Tree and Crow creeks are underlain by unit Qa_1 and have eroded into eolian deposits. Many archaeological sites were identified within and near the mapped area (Haynes and others, 1998; Meyer, 2019). Artifacts made by Clovis Paleoindians at these sites were found in eolian sediments that mantle terraces. These sediments yielded radiocarbon ages ranging from approximately 9,500 to 11,500 yrs BP (Haynes and Haas, 1974).

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Table 1. OSL analysis for Quaternary deposits in the Kersey quadrangle.

Field Number	Laboratory Number	Map unit	Material	UTM Easting [a]	UTM Northing [a]	Latitude	Longitude	Depth Below Ground Surface (m)	Aliquots	Equivalent Dose (De) (Gy)[c]	Over dispersion (%)[d]	U (ppm)[e]	Th (ppm)[e]	K2O (%)[e]	H20 (%)	Cosmic dose rate (mGray/yr)[f]	Dose Rate (mGray/yr)	SAR-OSL age (yr)[g]
KY 1		Qa?	Alluvium	535046	4473403	40.411	-104.587	25.3	30/35	309.26 ± 12.99	20 ± 3	1.72 ± 0.01	8.94 ± 0.01	3.91 ± 0.01	10 ± 2	0.04 ± 0.004	3.56 ± 0.09	86,980 ± 4090
KY 2		Qa?	Alluvium	535046	4473403	40.411	-104.587	21	28/35	272.17 ± 13.36	22 ± 3	2.04 ± 0.01	7.58 ± 0.01	3.70 ± 0.01	10 ± 2	0.05 ± 0.005	3.65 ± 0.09	75,540 ± 4020
KY 3		Qa3	Alluvium	535046	4473403	40.411	-104.587	16.5	37/46	54.26 ± 5.24	26 ± 3	1.52 ± 0.01	6.64 ± 0.01	4.71 ± 0.01	10 ± 2	0.06 ± 0.006	4.01 ± 0.10	13,510 ± 1375

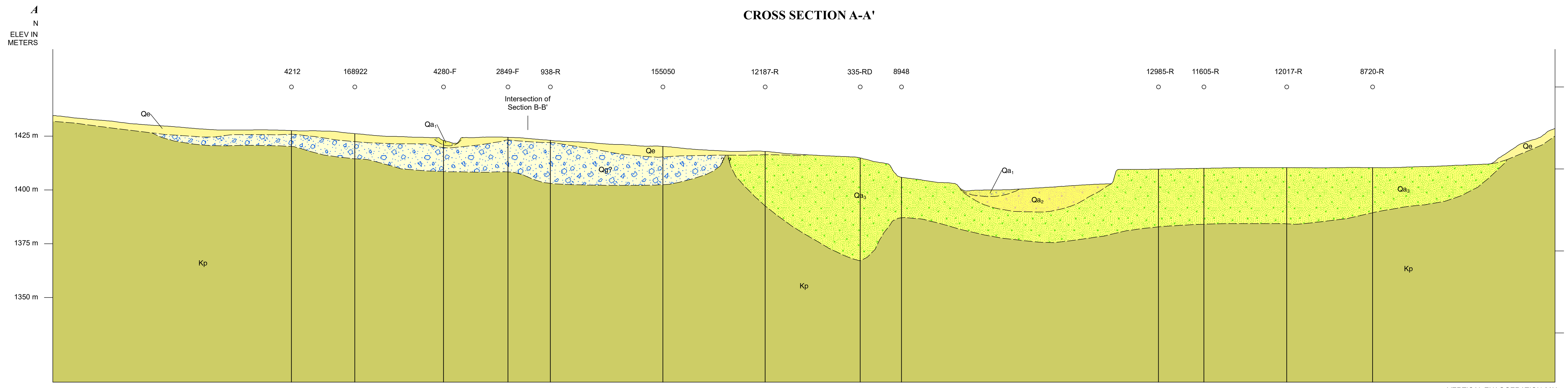
[a]North American Datum (NAD) 1983, zone 13N
[b]Aliquots measured, used to define De population by Central or Minimum age models (Galbraith and Roberst, 2012)
[c]Equivalent dose calculated on a pure quartz fraction with ultra-small aliquots with 20-80 grains/aliquot and analyzed under blue-light excitation (470 ± 20 nm) by Single Aliquot Regeneration protocols (SAR; Murray and Wintle, 2003; Wintle and Murray, 2006). Equivalent dose (De) was calculated by Central or Minimum age models (Galbraith and Roberts, 2012)
[d]Overdispersion values reflects precision beyond instrumental errors; values of ≤ 20% (at 1 sigma limit) indicate low dispersion in equivalent dose values and defines a unimodal distribution. Values > 20% are associated with mixed equivalent dose signature reflecting multiple grain populations or partial solar resetting.
[e]U, Th, Rb and K content analyzed by inductively-coupled plasma-mass spectrometry by ALS Laboratories, Reno, NV; and includes dose contribution from Rb.
[f]Includes also a cosmic dose rate calculated from parameters in Prescott and Hutton (1994) and includes soft components.
[g]Systematic and random errors calculated in a quadrature at one standard deviation by the Luminescence Dating and Age Calculator (LDAC) at https://www.baylor.edu/geosciences/index.php?id=962356. Datum year is AD 2010.

Table 2. Carbon-14 analysis for Quaternary depsoits in the Kersey quadrangle.
Radiocarbon dating by Beta Analytic, Inc., Miami, Florida

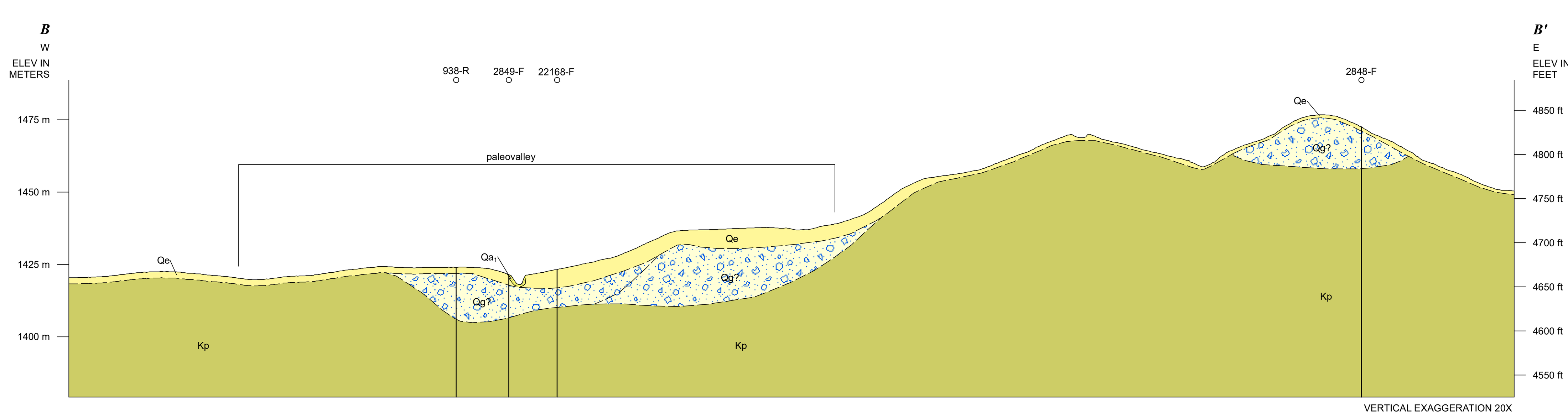
Field Number	Laboratory Number	Map unit	Material	UTM Easting[a]	UTM Northing[a]	Latitude	Longitude	Depth Below Ground Surface (m)	Conventional 14C age (yr BP)	δ13C(‰)	14C age (14C yr BP)[b]	Calibrated Age (cal yr BP)[c]
KY 4	Beta - 562631	Qa2	Alluvium	542106	4475342	40.427649	-104.50361	2	3560 ± 30	-18.4	1980 - 1868	3929 - 3817
KY 5	Beta - 562632	Qa2	Alluvium	542106	4475342	40.427649	-104.50361	0.9	1740 ± 30	-14.7	236 - 385	1714 - 1565

[a]North American Datum (NAD) 1983, zone 13N
[b]Conventional radiocarbon age, normalized to -25‰, based on 5,568 year half life; uncertainty ± 1 σ
[c]Calibrated age calculated using INTCAL13 (Reimer and others, 2013); 0 yr B.P. = 1950 A.D.

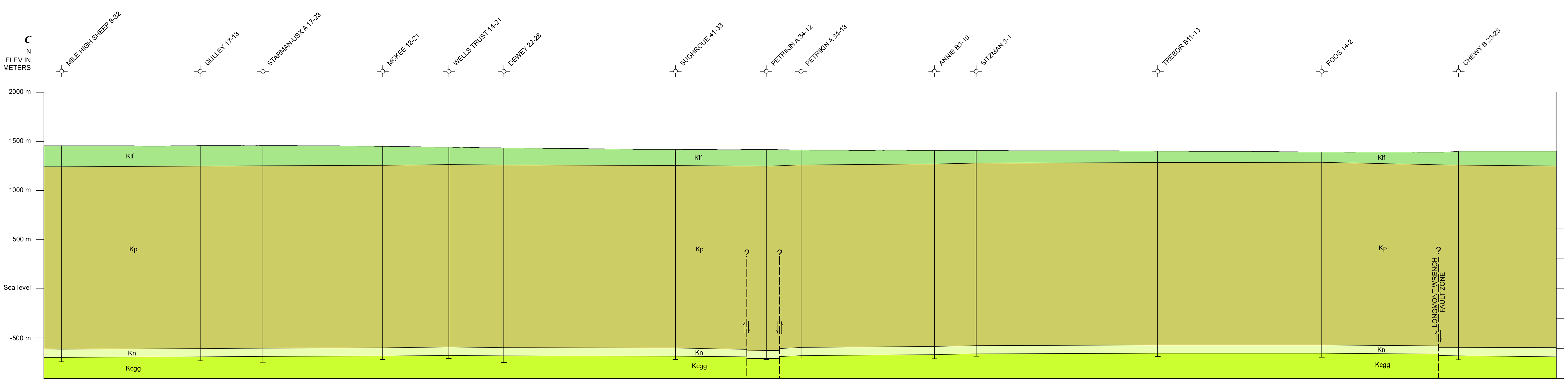
CROSS SECTION A-A'



CROSS SECTION B-B'



CROSS SECTION C-C'



GEOLOGIC MAP OF THE KERSEY QUADRANGLE, WELD COUNTY, COLORADO
CORRELATION OF MAP UNITS, 3-D OBLIQUE, GEOLOGIC HISTORY, AND CROSS SECTIONS

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2020

COLORADO GEOLOGICAL SURVEY
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