New stratigraphic revelations in the subsurface Susitna basin, south-central Alaska, from geochronology and biostratigraphy

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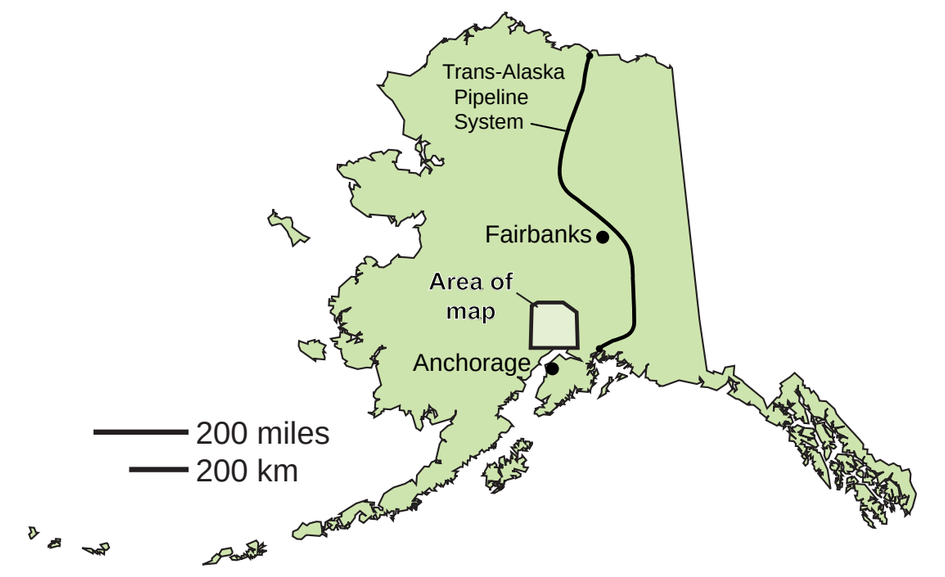

Abstract

New geochronologic and palynologic data from wells in the Susitna basin of south-central Alaska indicate the presence of Paleogene and Neogene nonmarine sedimentary and volcanic strata that provide a record of the tectonic history of the area. The Susitna basin is located north of the Castle Mountain fault and the petroliferous Cook Inlet basin. Seven exploratory wells drilled in the Susitna basin during 1964-2005 found no commercial amounts of oil or gas.

The deepest wells in the Susitna basin are the Trail Ridge Unit 1 (latitude 61.843˚, longitude -151.084˚) and Pure Kahiltna Unit 1 (62.041˚, -150.756˚), which reached measured total depths of 13,708 ft (4,178 m) and 7,265 ft (2,214 m), respectively, and are about 17 miles (27 km) apart. Both wells bottomed in a package of interstratified sedimentary and volcanic rocks of late Paleocene to early Eocene age. The ages are based on late Paleocene palynomorphs and $^{40}Ar/^{39}Ar$ step-heating ages on andesite and basalt of 57.3 ± 0.2 Ma (cuttings), 56.9 ± 0.4 Ma (core), and 54.3 ± 0.4 Ma (core). This package is about the same age as the Arkose Ridge Formation in the Talkeetna Mountains and volcanic rocks on the eastern flank of the Tordrillo Mountains.

The volcanic-bearing package is overlain by a nonmarine sequence of sandstone, siltstone, and coal that has an apparent thickness of about 4,296-4,442 ft (1,309-1,354 m) and contains early to middle Eocene terrestrial palynomorphs. This sequence, in turn, is unconformably overlain by a nonmarine interval of primarily conglomerate and sandstone with apparent thicknesses of about 8,200 ft (2,500) m in the Trail Ridge well and 490 ft (150 m) in the Pure Kahiltna well; this interval contains early to middle Miocene terrestrial palynomorphs in its lower part and Quaternary terrestrial palynomorphs in the upper part. Nonmarine deposition is indicated by the presence of coal and terrestrial palynomorphs and the absence of marine fossils.

We infer that late Paleocene and Eocene strata in the Susitna basin record volcanism, subsidence, and sedimentation that accompanied eastward passage of a slab window related to subduction of the hypothesized Resurrection-Kula spreading ridge. The Miocene-on-Eocene unconformity is not precisely dated but may represent uplift and erosion that accompanied the initiation of Yakutat microplate subduction beneath south-central Alaska. The mechanisms of subsidence that accommodated the thick Miocene to Quaternary deposits are unclear but may have included sediment loading, faulting, and lithospheric flexure associated with subduction of the Yakutat microplate.

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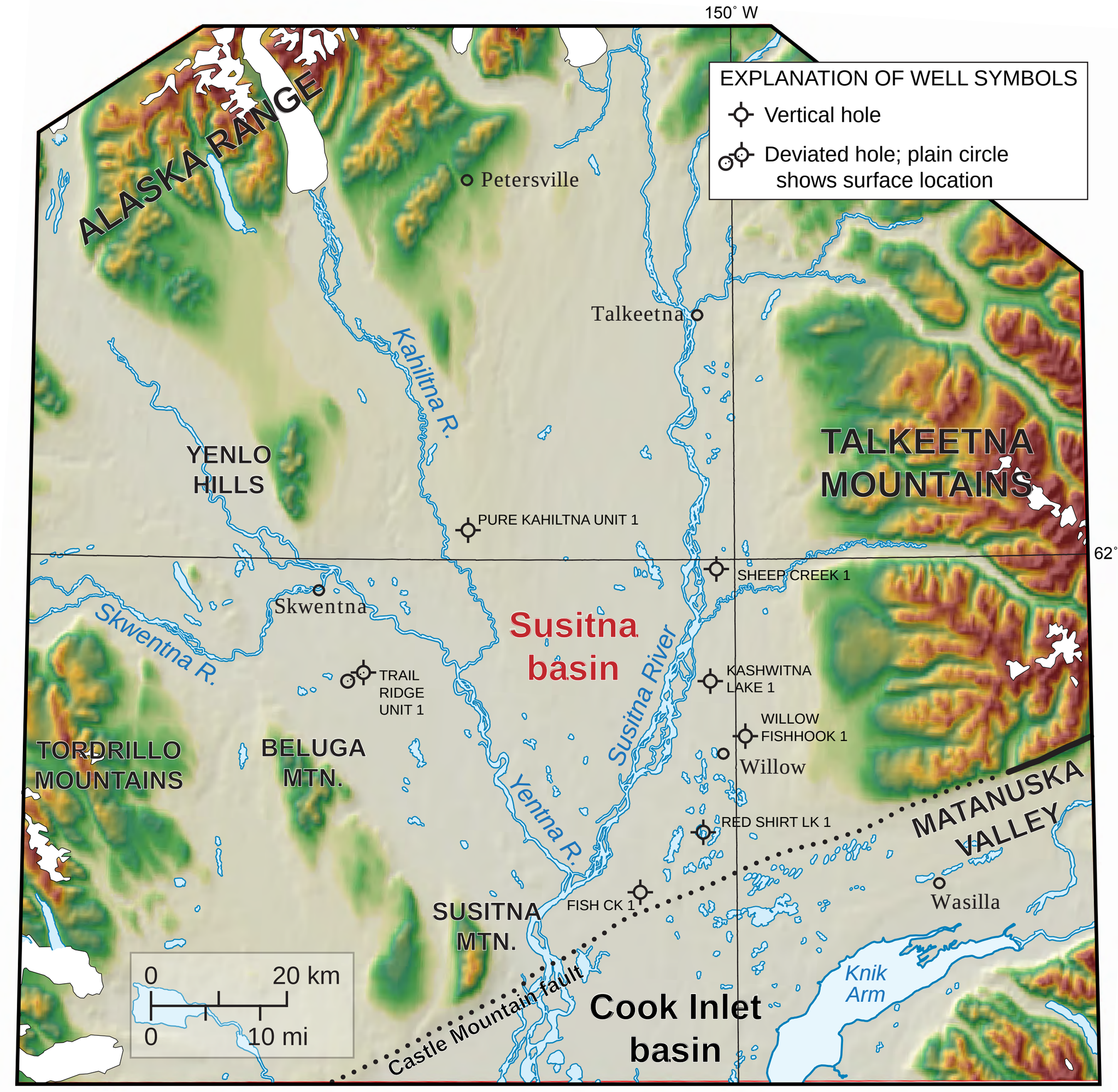
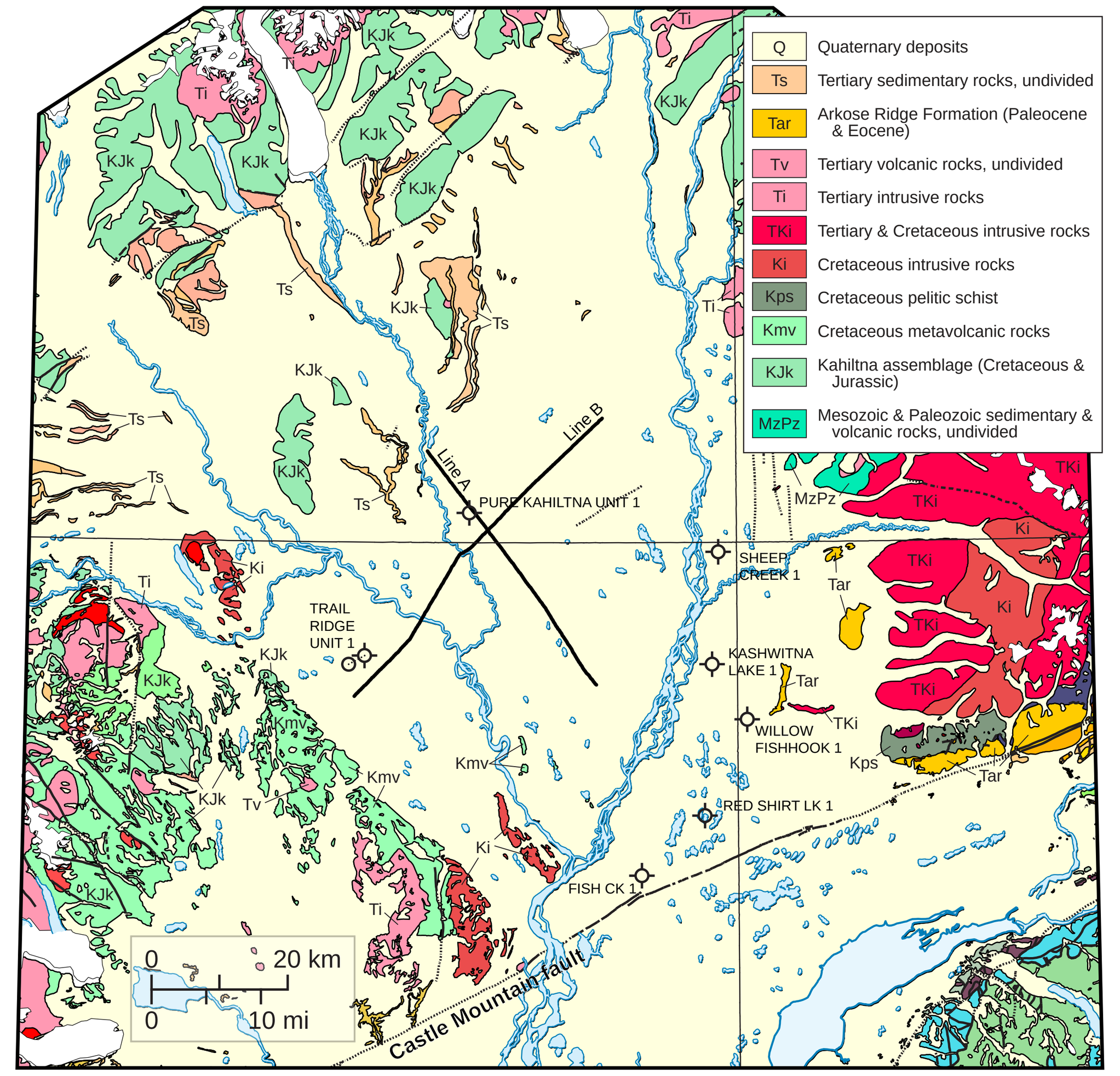
Susitna basin location map


EXPLANATION OF WELL SYMBOLS
Vertical hole
Deviated hole; plain circle shows surface location
ALASKA RANGE
Petersville
Talkeetna
YENLO HILLS
TALKEETNA MOUNTAINS
PURE KAHILTNA UNIT 1
SHEEP CREEK 1
Skwentna
Susitna basin
TRAIL RIDGE UNIT 1
KASHWITNA LAKE 1
WILLOW FISHHOOK 1
Willow
TORDRILLO MOUNTAINS
BELUGA MTN
RED SHIRT LK 1
MATANUSKA VALLEY
SUSITNA MTN.
FISH CK 1
Wasilla
Knik Arm
Cook Inlet basin
Castle Mountain fault
0 20 km
0 10 mi
150˚ W
62˚ N

Susitna basin surface geology (modified from Wilson and others, 2012)


Q Quaternary deposits
Ts Tertiary sedimentary rocks, undivided
Tar Arkose Ridge Formation (Paleocene & Eocene)
Tv Tertiary volcanic rocks, undivided
Ti Tertiary intrusive rocks
Tertiary & Cretaceous intrusive rocks
Ki Cretaceous intrusive rocks
Kps Cretaceous pelitic schist
Kmv Cretaceous metavolcanic rocks
KJk Kahiltna assemblage (Cretaceous & Jurassic)
MzPz Mesozoic & Paleozoic sedimentary & volcanic rocks, undivided
PURE KAHILTNA UNIT 1
TRAIL RIDGE UNIT 1
SHEEP CREEK 1
KASHWITNA LAKE 1
WILLOW FISHHOOK 1
RED SHIRT LK 1
FISH CK 1
Castle Mountain fault
0 20 km
0 10 mi

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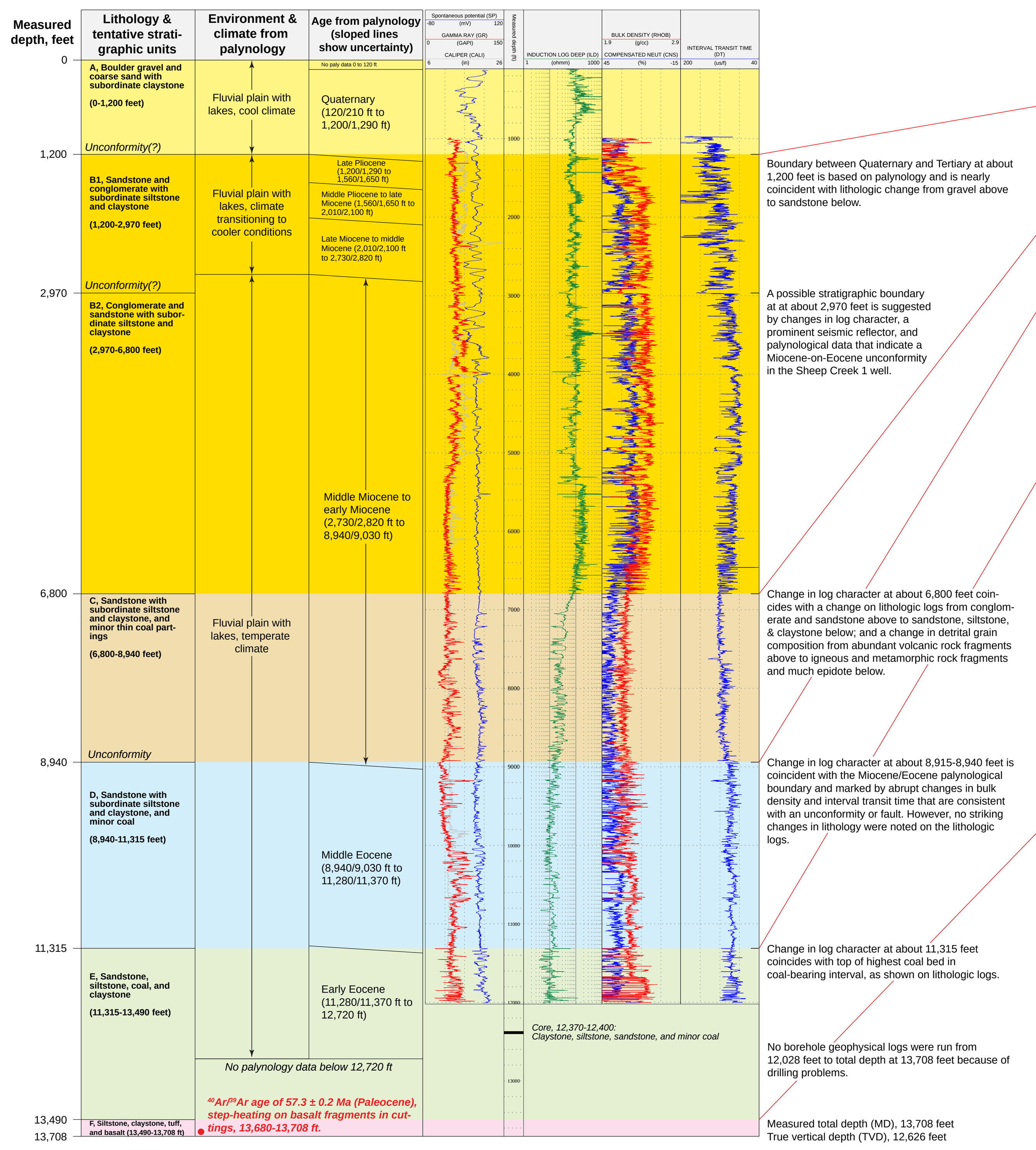
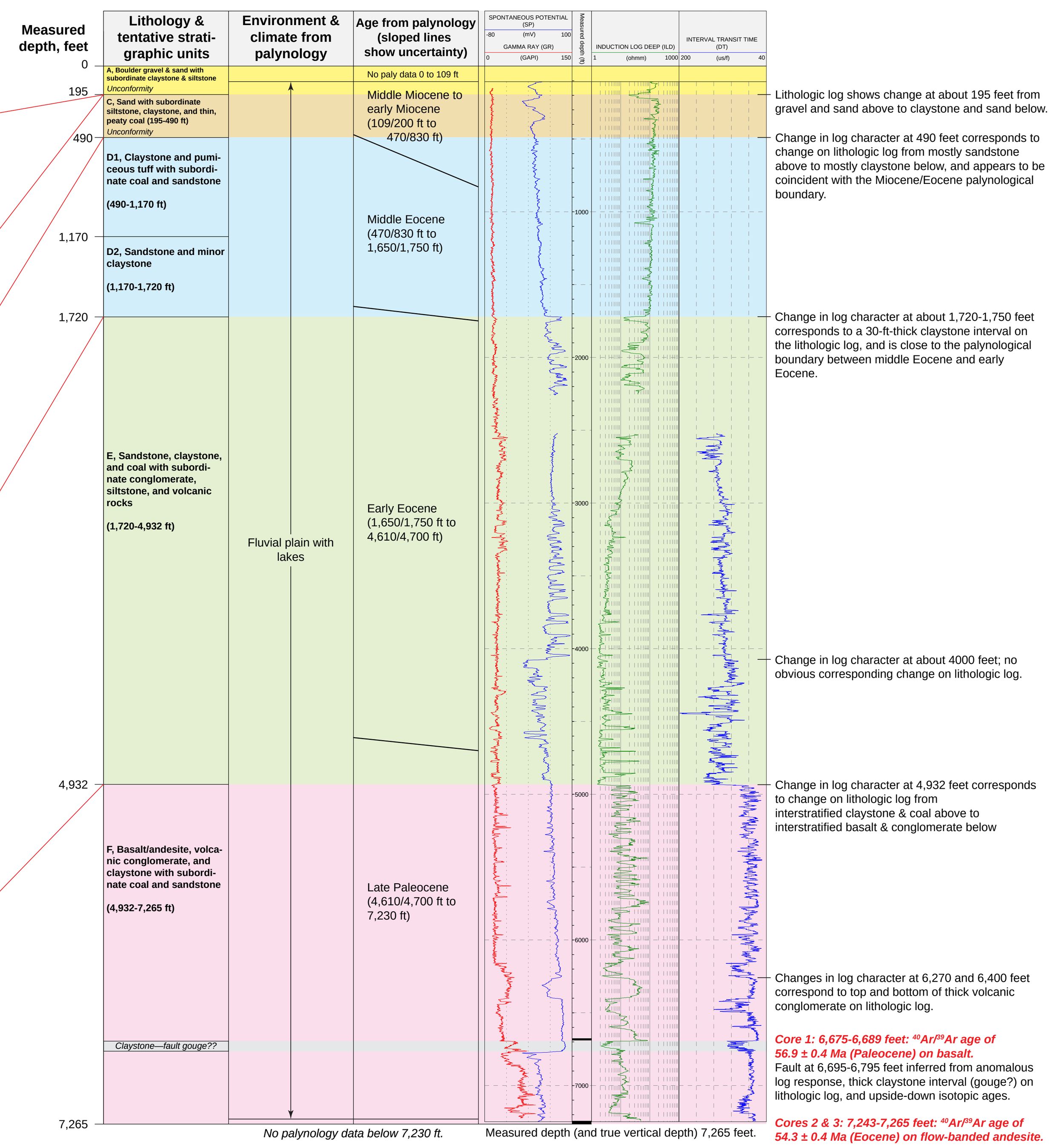
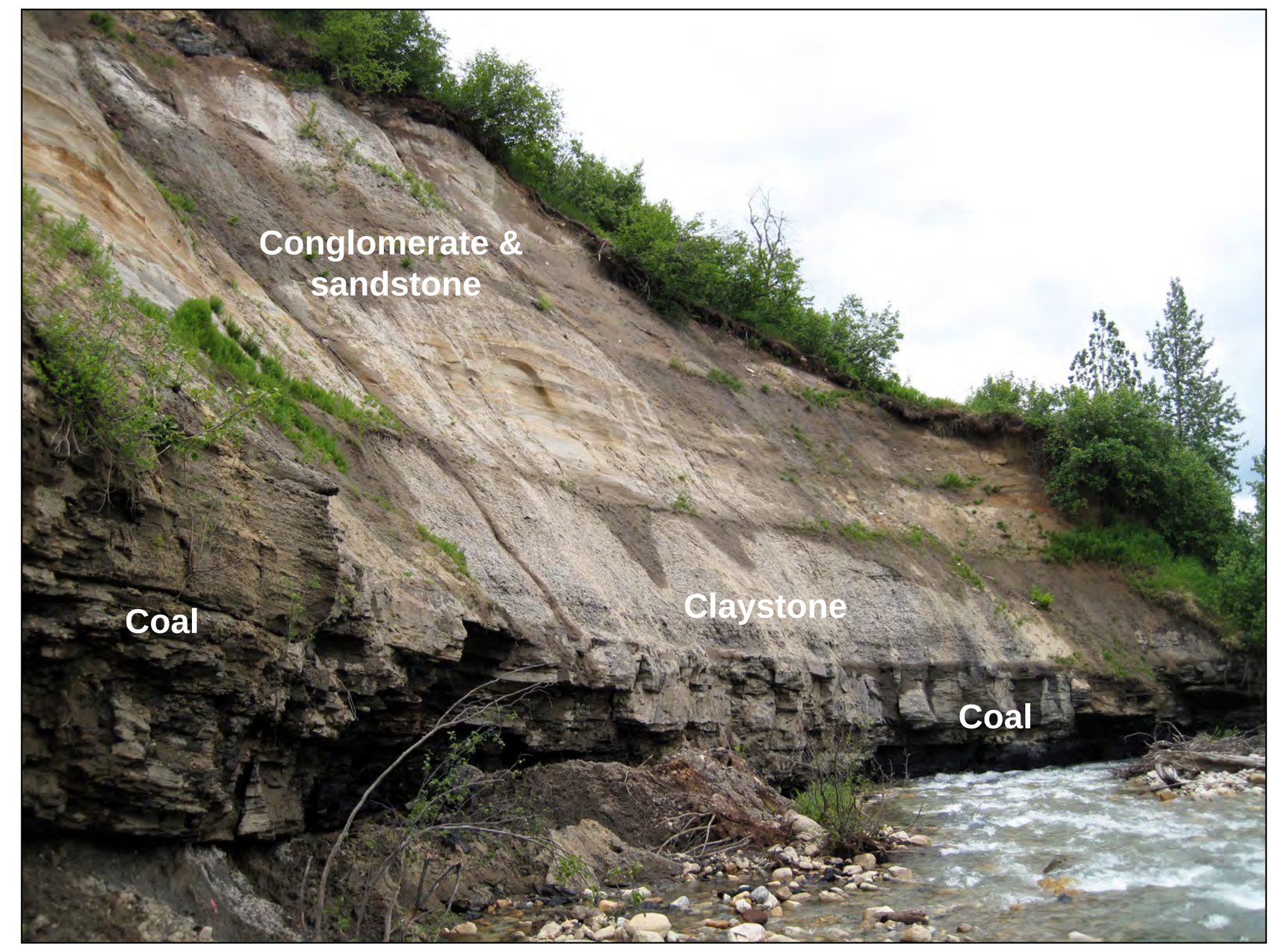
Stratigraphy of Trail Ridge Unit 1 well


Measured depth, feet
Lithology & tentative stratigraphic units
Environment & climate from palynology
Age from palynology (sloped lines show uncertainty)
Unconformity(?)
Unconformity
Fluvial plain with lakes, cool climate
Quaternary
Middle Miocene to early Miocene
Middle Eocene
Early Eocene
Measured total depth (MD), 13,708 feet
True vertical depth (TVD), 12,626 feet

Stratigraphy of Pure Kahiltna Unit 1 well


Measured depth, feet
Lithology & tentative stratigraphic units
Environment & climate from palynology
Age from palynology (sloped lines show uncertainty)
Middle Miocene to early Miocene
Middle Eocene
Early Eocene
Late Paleocene
Fluvial plain with lakes
No palynology data below 7,230 ft
Measured depth (and true vertical depth) 7,265 feet

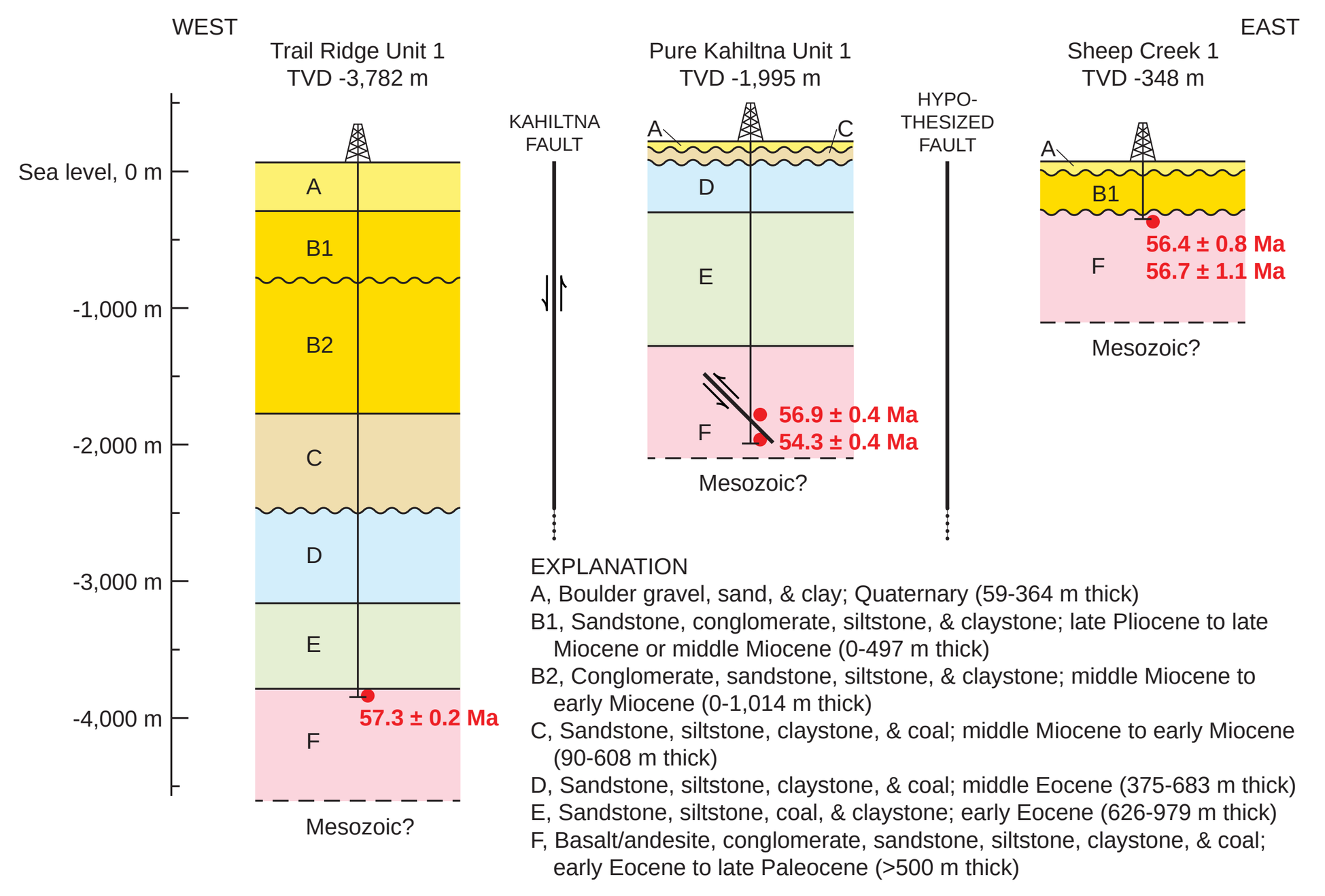
Outcrop located along Lake Creek about 50 km southwest of Talkeetna (Gillis and others, 2013) showing steeply-dipping layers of conglomerate with clasts of granitic rock up to 1 meter in diameter that were derived from an unknown source. Strata of similar lithology and stratigraphic position are present in units B1 and B2 in the Trail Ridge Unit 1 well.



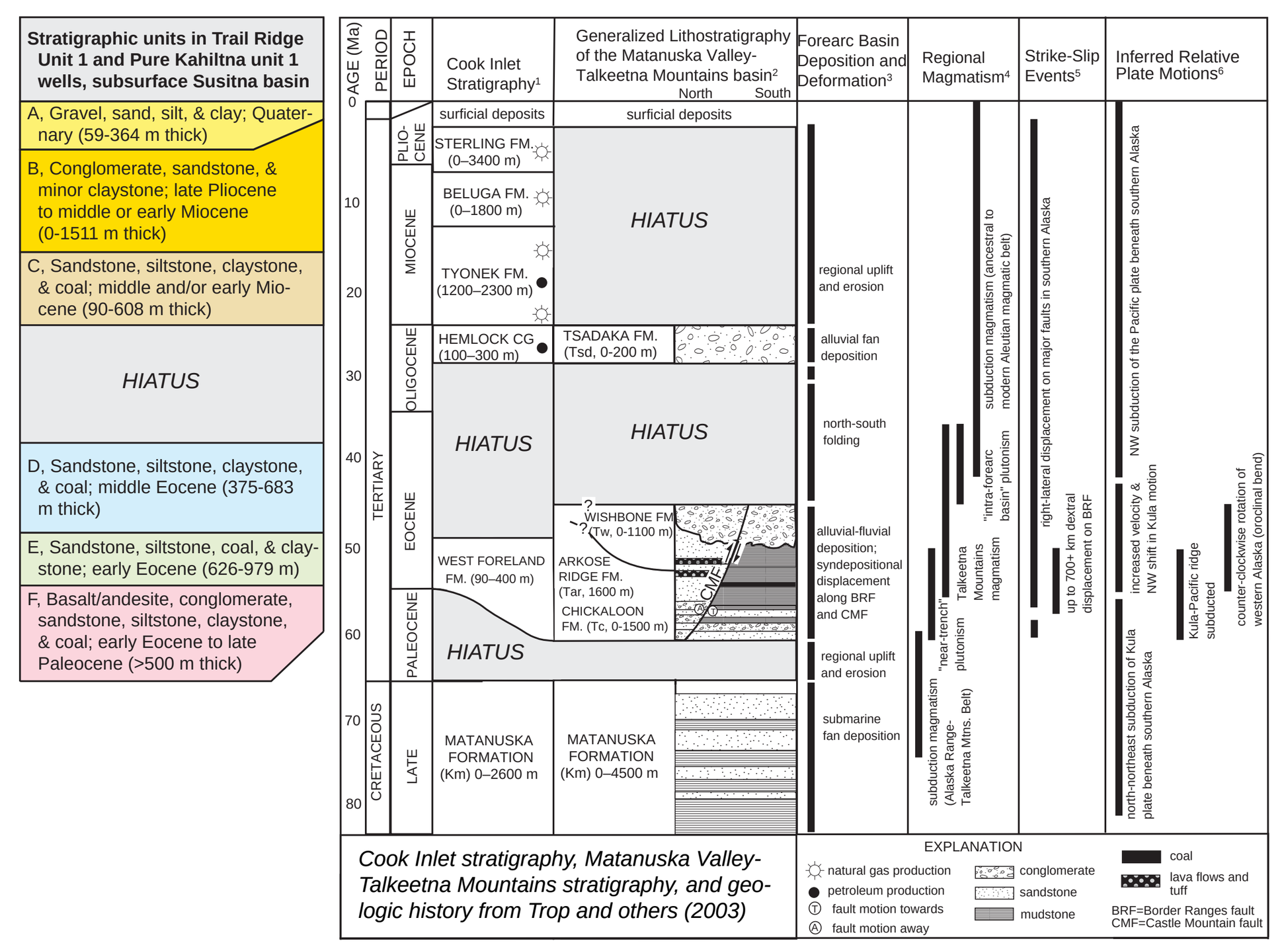
Outcrop of Miocene conglomerate, sandstone, claystone, and coal along Contact Creek, about 100 km southwest of Talkeetna. The gray claystone horizon is about 3 meters thick (Gillis and others, 2013). Strata of similar lithology and age are present in unit C in the Trail Ridge Unit 1 and Pure Kahiltna Unit 1 wells.

Andesitic(?) tuff with near-vertical flow banding, from core in unit F in the Pure Kahiltna 1 well at 7,243-7,265 ft (2,208-2,214 m) depth, dated at 54.3 ± 0.4 Ma. Volcanic rocks of similar age occur in the Trail Ridge Unit 1 and Sheep Creek 1 wells, and in outcrops of the Arkose Ridge Formation in the Talkeetna Mountains.

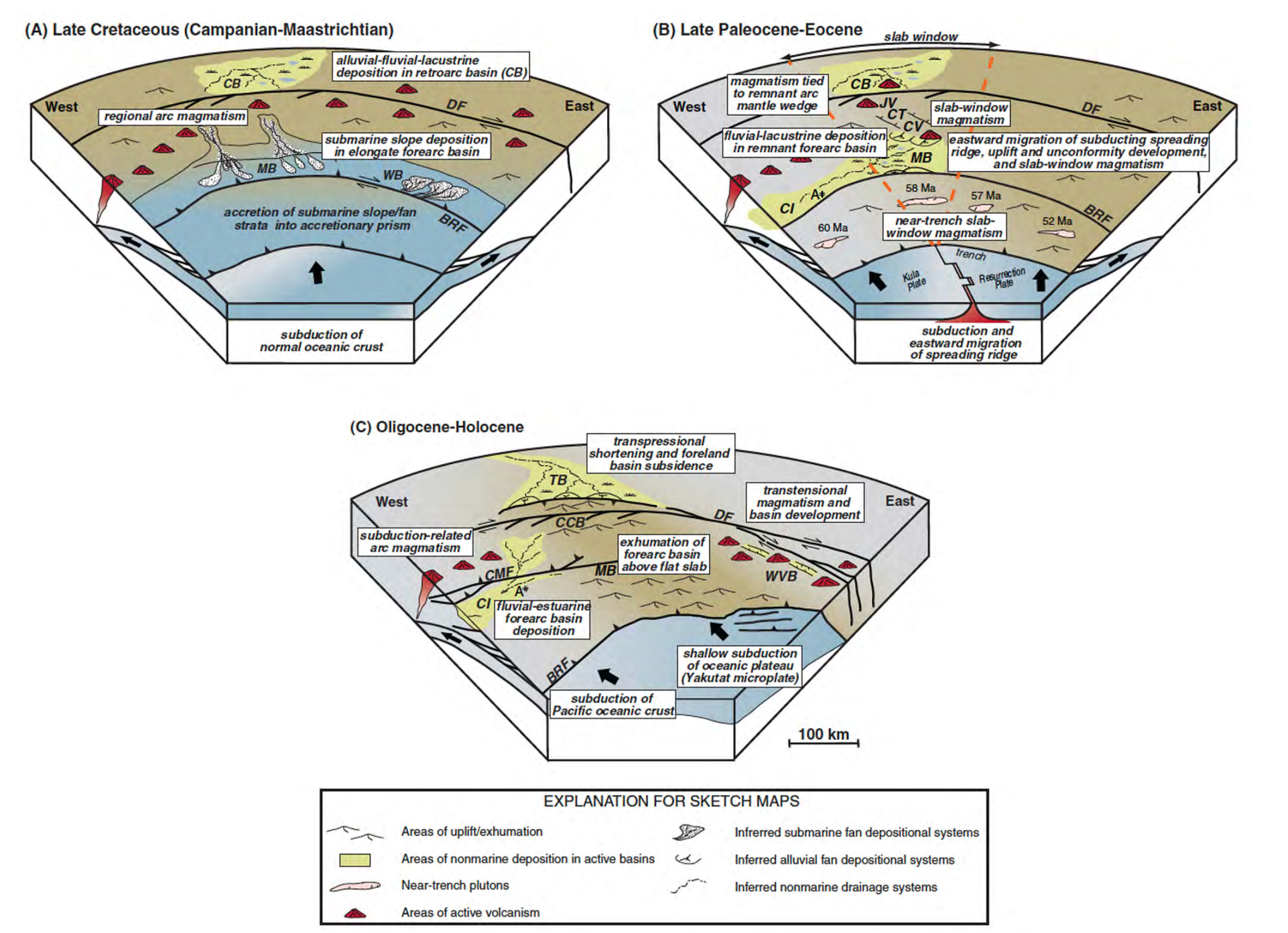
Correlation of Susitna basin wells



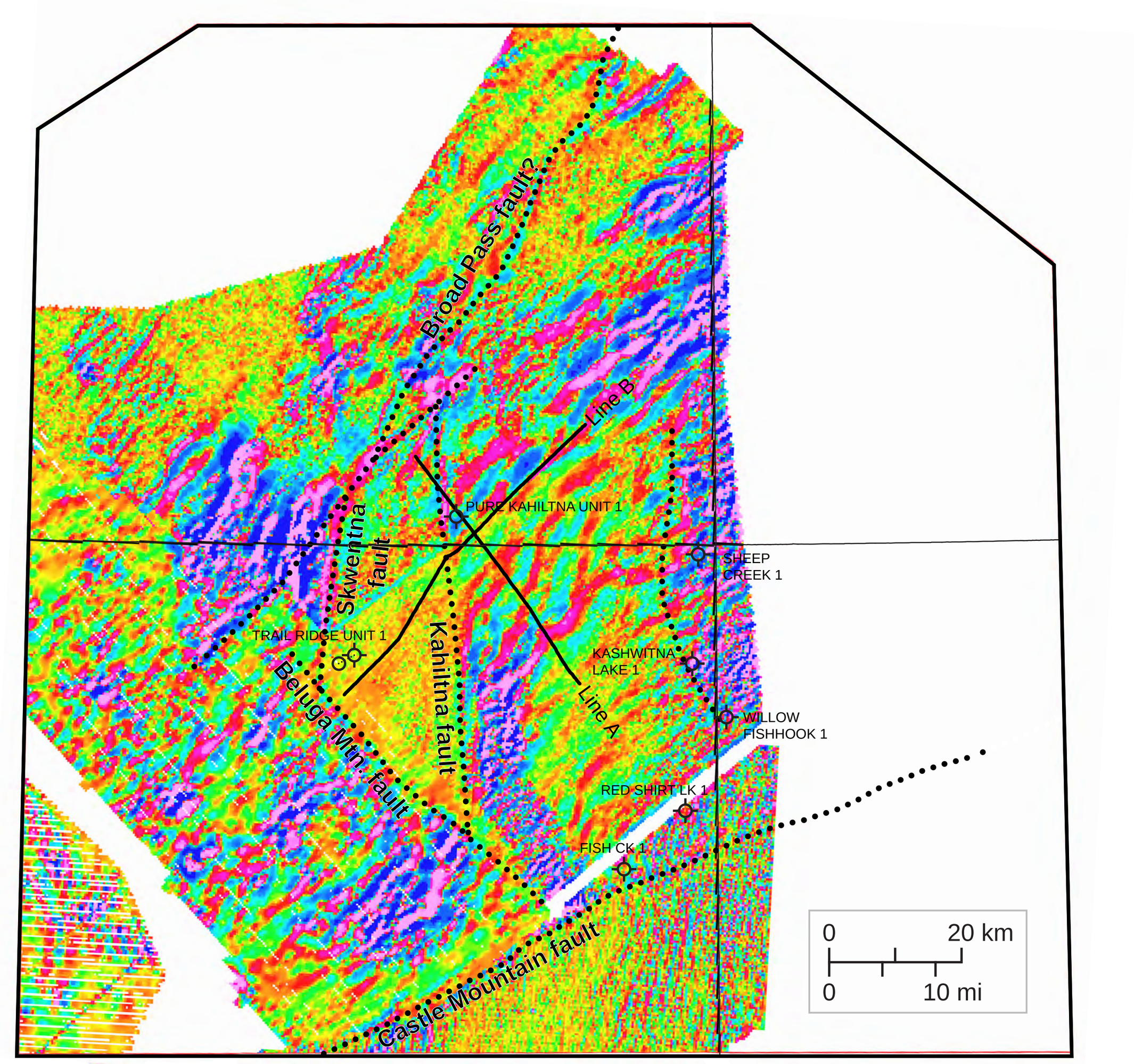
Stratigraphic sequences in the Susitna basin, Cook Inlet basin, and Matanuska Valley are similar but not identical



Tectonic model of Ridgway and others (2012)



Residual aeromagnetic anomaly map, inferred faults (dotted), and seismic lines (solid)



Seismic reflection lines (see locations on geologic and aeromagnetic maps)