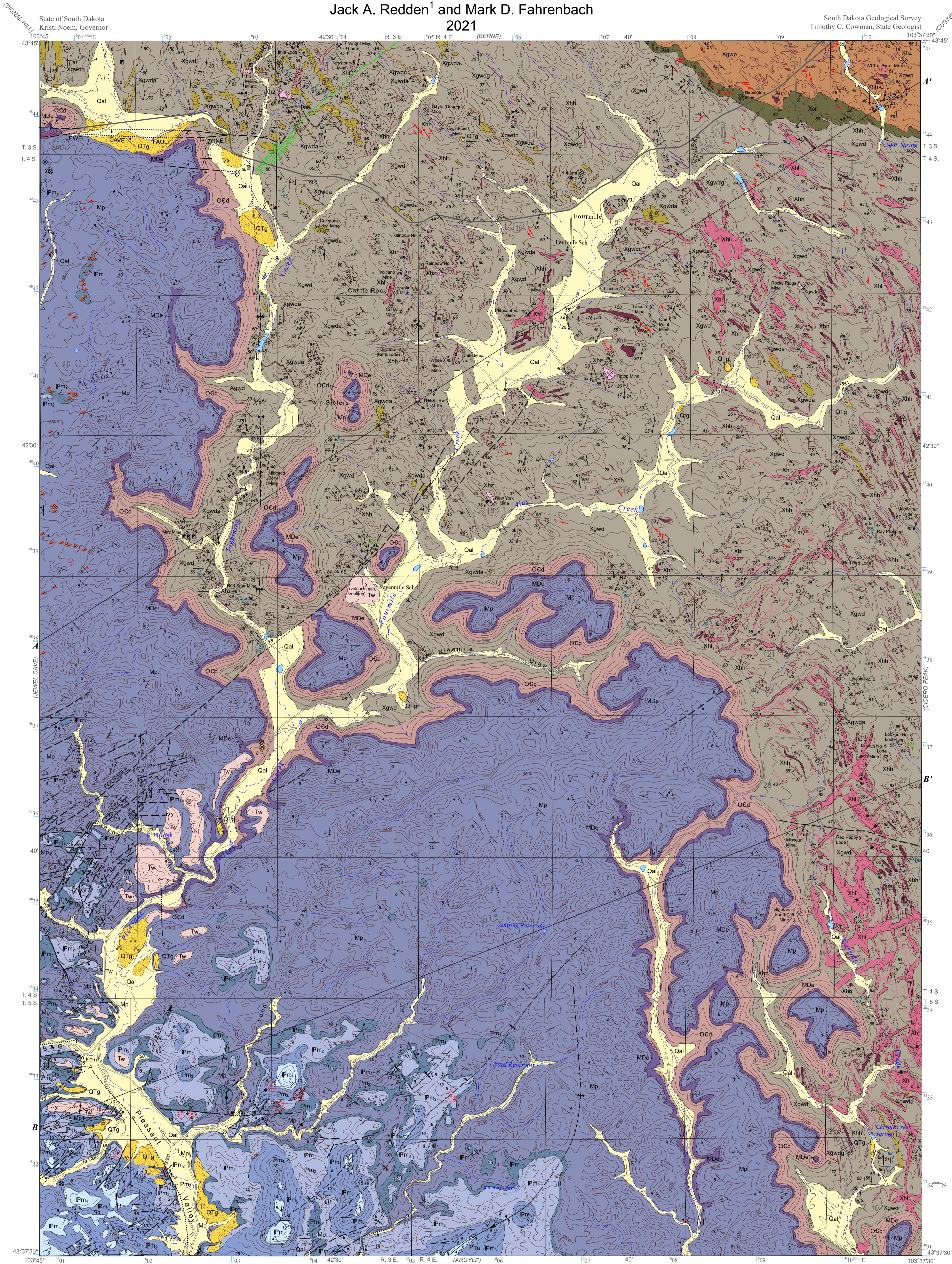


GEOLOGIC MAP OF THE FOURMILE QUADRANGLE, SOUTH DAKOTA

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EXPLANATION

QUATERNARY	Qal Alluvium - Clay- to boulder-size clasts, unconsolidated to loosely consolidated. Deposited in present day stream drainages.	QTg Gravel deposit - Clay- to boulder-size clasts dominantly of vein quartz, granite, calc-silicate nodules, and minor schist and Paleozoic rocks. Unconsolidated to loosely consolidated, sub-rounded to well-rounded. Some blocks and boulders of Paleozoic rocks along upper Hay Creek are over 4 ft (1.2 m) in diameter, are several miles from present outcrops of Paleozoic rocks, and may be residual deposits modified by later erosion. Likely includes reworked White River Group deposits. Occurs as much as 80 ft (24.4 m) above present-day streams. Thickness approximately 20 ft (6.1 m).		
TERTIARY	Tw White River Group - Dominantly gravel and boulders up to 3 ft (0.9 m) across, sub- to well-rounded, with white to tan, medium-grained, subrounded, very well-sorted sand and minor pinkish to grayish-white bentonitic clay. Clasts are locally derived and typically quartzite, granite, amphibolite, calc-silicate concretions, and rarely Pahasapa Limestone. Placer minerals include gold, cassiterite, and columbite-tantalite. Most deposits occur on the west side of Pleasant Valley in an old channel about 100 ft (30.5 m) to as much as 100 ft (30.5 m) above the present valley that apparently followed a solution zone in the Pahasapa Limestone. Deposits are typically poorly exposed (Redden, 1963). Equated with the White River Group based on similar lithology, mineralogy, and elevation of occurrences. Some deposits designated as White River Group may be younger terrace deposits consisting mainly of reworked White River material. Thickness several feet to as much as 140 ft (42.7 m).			
PENNSYLVANIAN	Pm1 Minnelusa Formation unit 4 - Dolomite, yellowish-tan to brownish-yellow, very finely crystalline, laminated to medium-bedded. Contains ripple marks, sparse striae and structures, and mud cracks. Blue-gray to white chert nodules up to 1 ft (30 cm) across occur near the top of the unit. Thickness approximately 120 ft (36.6 m).	Pm2 Minnelusa Formation unit 3 - Sandstone interbedded with shale, brownish-yellow, tan, to reddish-brown. The sandstone is typically very fine to fine-grained and siliceous. Approximately 30 ft (9.1 m) of brownish-yellow to gray limestone containing silicified fossils of <i>Chaetetes miltoschous</i> and striae structures occur near the top of the unit. Thickness approximately 120 ft (36.6 m).	Pm3 Minnelusa Formation unit 2 - Limestone, grayish-white to gray, having a pinkish hue. Finely to medium crystalline, thin- to medium-bedded, becoming shaly near the base. Contains variegated red and white chert lenses and nodules that mainly occur at the top of the unit. Thickness approximately 40-60 ft (12.2-18.3 m).	Pm4 Minnelusa Formation unit 1 - Sandstone and orthoquartzite, medium- to coarse-grained, typically siliceous, tan, beige, to reddish-brown. May be overlain by up to 30 ft (9.1 m) of red shale and siltstone. Thickness approximately 5-40 ft (1.5-12.2 m).
MISSISSIPPIAN	Mp Pahasapa Limestone - Limestone to dolomitic limestone, grayish-white to gray. Finely to medium crystalline, thin- to thick-bedded in the lower portion, thick, argillite, and garnet. Occurs as sills, dikes, and dominantly in the upper third of the formation. Forms prominent cliffs. Contains rugose corals and spirifer brachiopods, especially near the top. Thickness approximately 420 ft (131.1 m).	MDe Englewood Formation - Limestone, dolomitic limestone, and shale, pink, purple-gray, to gray. Finely to very finely crystalline, thinly laminated to thin-bedded with abundant stylonite surfaces. Limestones are typically argillaceous. Sparingly fossiliferous, typically scabrous. Thickness 40-55 ft (12.2-16.8 m).		
DEVONIAN	OCd Deadwood Formation - Conglomerate, sandstone, glauconitic sandstone, and orthoquartzite, brown to reddish-brown. General sequence from bottom to top is a basal conglomerate of angular to moderately rounded pebbles as much as 1 in (2.5 cm) in diameter derived from local quartz veins and pegmatites, conglomeratic sandstone, sandstone, orthoquartzite, glauconitic sandstone, siltstone and shale overlain by a thick-bedded coarse-grained sandstone. Thin greenish shale and siltstone occurs near the middle and top of the formation. The uppermost unit is orthoquartzite about 5 ft (1.5 m) thick, composed of extremely well-rounded quartz grains. Thickness of formation is 90 ft (27.4 m) near the southeast corner to 170 ft (51.8 m) in the northwest corner of the quadrangle.			
ORDOVICIAN	Xh Harney Peak Granite - Granite, peraluminous, S-type. Pink to beige, finely to coarsely crystalline, locally pegmatitic. Includes albite, perthite, microcline, oligoclase, muscovite, and quartz with accessory tourmaline, biotite, apatite, and garnet. Occurs as sills, dikes, and large irregular bodies. Age of 1.715 ± 0.3 Ma based on ²⁰⁷ Pb- ²³⁵ U (Redden and others, 1990). Xh1 - Layered granite with compositional layering generally parallel to the fault contact. May be lenticular to tabular in form. Xh2 - Homogeneous granite having the same texture and composition throughout. Typically has a thin, finely crystalline border phase. Xh3 - Zoned granite, having distinct zones of differing composition and texture around a central core.			
CAMBRIAN	Xgwd Mayo Formation - Quartz-mica-feldspar schist, gray to dark-gray, and variegated schist containing garnet, staurolite, and sillimanite. Protholith is distal graywacke deposits. Xgwd1 - Calc-silicate gneiss. Discontinuous 2-15 ft (0.6-4.6 m) thick beds in the lower part of the Mayo Formation. Xgwd2 - Metasandstone and metagrit with pebbles of quartz and feldspar up to 2 in (5.1 cm) across in a fine-grained quartz-rich matrix, brownish-gray. Occurs as one to several adjacent beds having a total thickness of 5-25 ft (1.5-7.6 m). Xgwd3 - Amphibolite, medium to coarsely crystalline, massive to weakly foliated, dark-green to black. Occurs as small sills, dikes, and irregular discordant bodies.	Xcr Crow Formation - Interbedded hornblende-plagioclase rock, actinolite-tremolite, plagioclase-calcite gneiss, diopside-hornblende-plagioclase gneiss, and minor biotite-microcline schist (Lincoln and Lincoln, 2017). Variegated dark-gray, dark-green, to black, poorly exposed. Has accessory cordierite. A thick unit of amphibole-bearing schist occurs at the base of the formation. Upper contact is placed at the top of a 3-8 ft (0.9-2.4 m) thick resistant, laminated quartzite bed having streaks and lenses of graphite, hematite, or ironite. Appears to be conformable with schist of the Mayo Formation. Weathering of the Crow Formation produces characteristic dark, noncohesive soil. Protholith is likely submarine volcanic flows, tuff, and pyroclastic deposits. Thickness approximately 100-200 ft (30.5-61.0 m), variable due to deformation (Redden, 1963).		
PRECAMBRIAN	Xgwp Bugtown Formation - Quartz-mica schist, gray, with rare sillimanite and garnet. Interbedded with thin-bedded, dark micaceous schist rarely having garnet or sillimanite. Ellipsoidal masses and lenticular beds of calc-silicate rock are common, mainly occurring in the middle portion of quartz-rich beds. Moderately resistant, forming large outcrops. Protholith is proximal graywacke deposits. About 1,500 ft (457.2 m) is exposed on the quadrangle. Total thickness approximately 4,000 ft (1219.3 m).			

CONTACTS

- Long dashed where approximately located; dotted where concealed.
- Arrow indicates contact dip direction and amount. Double arrow indicates a vertical contact.

FAULTS

- Long dashed where approximately located; short dashed where inferred; dotted where concealed; queried where uncertain. Bar and ball on downthrown side. Tic indicates dip direction and amount. The Fourmile fault is Laramide in age, while faults in the Minnelusa Formation, especially along Pleasant Valley, are likely due to Tertiary dissolution.

FOLDS (Laramide)

- Folds in the Minnelusa Formation, especially along Pleasant Valley, are likely due to Tertiary dissolution.
- Anticline: Location of trace of axial plane. Long dashed where approximately located; dotted where concealed; queried where uncertain in cross section.
- Syncline: Location of trace of axial plane and direction of plunge. Long dashed where approximately located; dotted where concealed; queried where uncertain in cross section.

FOLDS (Early Proterozoic) D1 FOLDS

- Syncline: Location of trace of axial plane. Long dashed where approximately located; dotted where concealed.

BEDDING

- Inclined: /
- Vertical: |
- Horizontal: —

FOLIATION

- Inclined: /
- Vertical: |
- Medial age: Typically parallel to bedding and axial planes of folds. Striking north-northwest, dipping southwest.
- Medial age: Parallel to bedding and axial planes of folds. Striking north-northwest, dipping southwest.
- Vertical: |
- Medial age: Typically parallel to bedding and axial planes of folds. Striking north-northwest, dipping southwest.
- Inclined: /
- Youngest: Crosscut bedding except in northeast-trending limbs of some folds. Striking northeast, dipping southwest.

FRACTURES

- Inclined: /
- Vertical: |

LINEAR STRUCTURES

- Lineation: —
- Showing bearing and plunge: —/
- Elongate pebble: —/
- Calc-silicate ellipsoid: —/
- Minor fold: —
- Showing bearing and plunge: —/

QUARTZ VEIN

- First appearance of index mineral noted on side of isograd.

METAMORPHIC ISOGRAD

- STAUROLITE
- SILLIMANITE

BRECCIA

- Angular to rounded schist fragments cemented by hematite or albite in zones a few feet thick concordant with the surrounding schist. Occurs 1 mi (1.6 km) northeast of Fourmile, South Dakota.

KARST FEATURE

- Area of collapse: Indicated by chaotically oriented bedding. Occurs in the Minnelusa Formation in the southwest portion of the quadrangle. Likely due to Tertiary dissolution.
- Breccia pipe: ▲
- Sinkhole: ●
- Cave: ○

CARBONATE CONCRETION

- Round to ellipsoidal, up to 2 ft (0.6 m) across. Weathers reddish-brown, tan to beige where fresh. May be partly silicified. Has a mottled texture from dissolved invertebrate fossil fragments. Typically associated with the Pahasapa-Minnelusa contact. Symbol may indicate more than one occurrence.

OTHER FEATURES

- Open pit mine or glory hole: x
- Placer pit: x
- Mine shaft: P
- Mine adit: >
- Trench: <
- Group of prospect pits: ⊕
- Prospect pit: x

