GEOLOGIC MAP OF THE DEADWOOD SOUTH QUADRANGLE, SOUTH DAKOTA

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State of South Dakota
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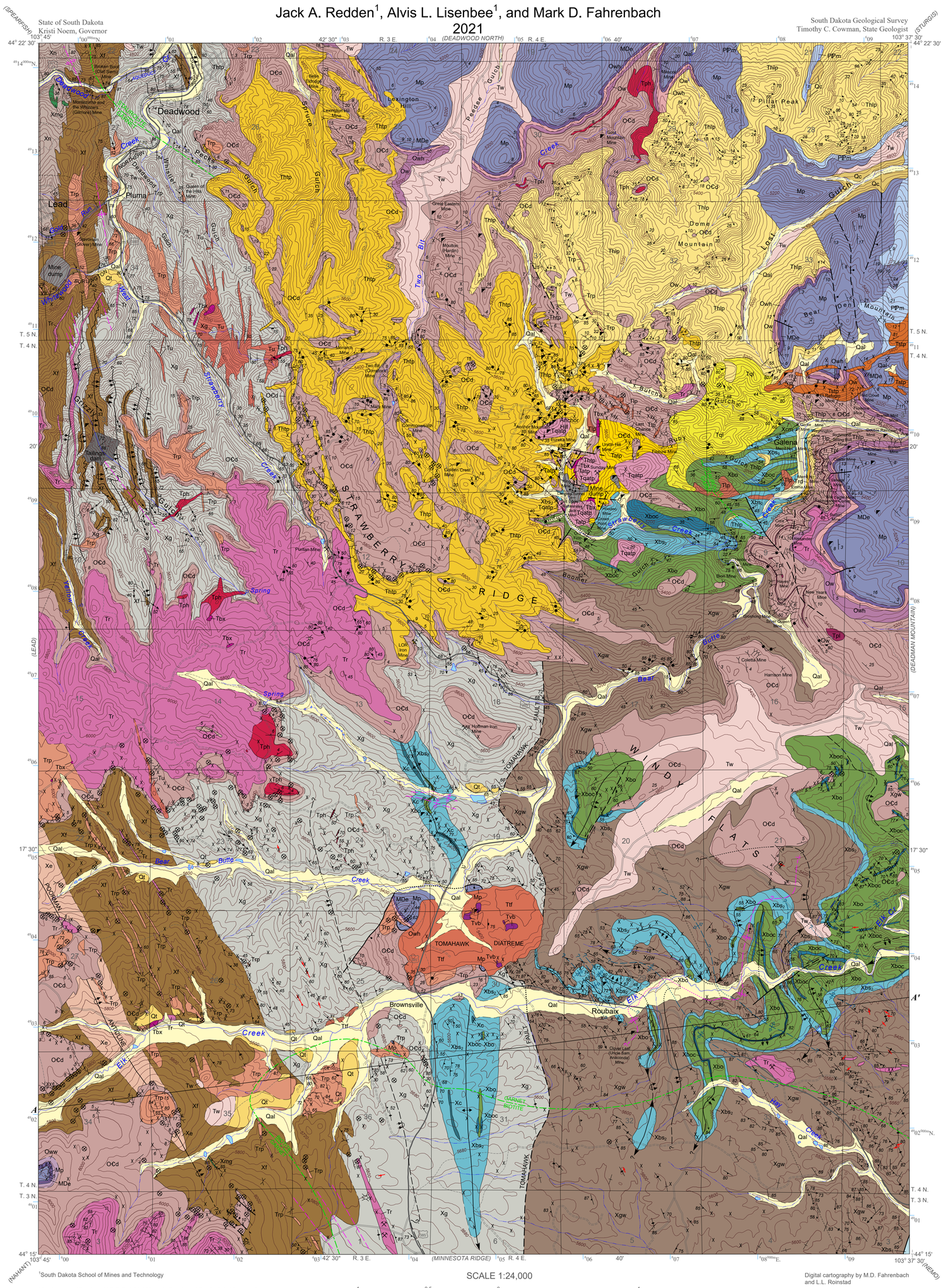
SOUTH DAKOTA DEPARTMENT OF AGRICULTURE AND NATURAL RESOURCES
DIVISION OF FINANCIAL AND TECHNICAL ASSISTANCE
GEOLOGICAL SURVEY PROGRAM
7.5 MINUTE SERIES GEOLOGIC QUADRANGLE MAP 13



EXPLANATION

QUATERNARY

- Qal — **Alluvium -** Unconsolidated to poorly consolidated, clasts to boulder-size. Deposited in present-day stream drainages. Estimated maximum thickness 40 ft (12.2 m)
- Qc — **Colluvium -** Unconsolidated, poorly sorted, randomly oriented angular rocks and soil locally deposited along steep slopes
- Qt — **Terrace deposit -** Unconsolidated to poorly consolidated, clasts to boulder-size. Deposited as much as 40 ft (12.2 m) above present stream drainages. Estimated maximum thickness 20 ft (6.1 m)

Unconformity

Oligocene - Eocene

- Tw — **White River Group -** Unconsolidated to loosely consolidated, clasts to boulder-size dominantly of Precambrian rock types but also with Paleozoic sedimentary and Tertiary igneous rocks in a fine-grained matrix. Bentonitic clay content variable. Typically stained pinkish to reddish. Includes gravels of the Mountain Meadow terrace of Plumley (1948). Estimated maximum thickness 40 ft (12.2 m)

Unconformity

TERTIARY

Eocene - Paleocene

- Tph — **Phonolite -** Sills, dikes, and small stocks, gray to greenish-gray. Composition varies from alkali trachyte to phonolite. Contains up to 45% phenocrysts of andesine, nepheline, or sanidine in a finely crystalline to aphanitic plagioclase, biotite, nepheline, and leucite groundmass. Typically has a trachytic texture from aligned feldspar laths. May have flow layering, especially along contacts. An age of 58.2 +/- 1.7 Ma was obtained from a dike on the Lead quadrangle (McDowell, 1971)
- Tvb — **Vent breccia -** Clast-supported breccia of angular, pebble- to cobble-size clasts of rhyolite, flow-banded rhyolite, rhyolite porphyry, pitchstone, and Precambrian schist in a groundmass of ash- to lapilli-size clasts of rhyolitic composition. Pink to tan (Drake, 1967). The pitchstone has a K-Ar age of 55.8 +/- 1.4 Ma (Redden and others, 1983)
- Ttf — **Tuff -** Lapilli tuff with clasts of rhyolite, flow-banded rhyolite, rhyolite porphyry, and Precambrian schist in a clay matrix. Tan to brown. Graded beds range from 0.8 in (20 mm) to 6 ft (1.8 m) thick. Locally contains well-rounded xenoliths up to 3.9 in (10 cm) of Precambrian metamorphic and Phanerozoic rocks up to the Late Cretaceous Carlile Shale (Drake, 1967)
- Tbx — **Breccia -** Small dikes of clast- to porphyry-supported breccia composed of angular to sub-rounded, lapilli- to bomb-size clasts of Tertiary igneous and Precambrian metamorphic rocks. Matrix contains 5-10% iron oxide, quartz, and clay where oxidized. Pyrite, fluorite, and calcite is present where unoxidized. Typically occurs along margins of larger Tertiary igneous bodies. Contacts are gradational (MacLeod, 1986)
- Tql — **Quartz latite -** Aphanitic, with 0.1 mm biotite crystals, aggregates of lath-like plagioclase and sanidine crystals, and rare quartz fragments. Light-gray to yellowish-gray. Contains minor magnetite and clinopyroxene (Grunwald, 1970)
- Thlp — **Hornblende latite porphyry -** Composed of 40% euhedral plagioclase, 1-10% aligned hornblende, and 1-5% sanidine phenocrysts up to 0.2 in (5 mm) in an aphanitic to glassy groundmass of orthoclase with as much as 3% quartz. Light-gray to dark greenish-gray. Small intrusives contain calcite- and quartz-filled amygdules up to 0.16 in (4 mm). Has trace pyroxene, magnetite, ilmenite, pyrite, and calcite, and local propylitic alteration (Beck, 1976). Has a K-Ar date of 60.5 +/- 3 Ma (Mukherjee, 1968)
- Tr — **Rhyolite -** Finely crystalline to aphanitic groundmass of potassium feldspar. White, tan, to pinkish where fresh, weathering gray to yellowish-brown. Iron- and manganese-stained. Locally prominently flow banded. May have sericitic or argillic alteration (Grunwald, 1970)
- Trp — **Rhyolite porphyry -** Aphanitic sanidine groundmass containing as much as 10% anhedral to euhedral quartz phenocrysts up to 0.24 in (6 mm) and 1-5% clinopyroxene. May have sericitic or argillic alteration. Light-tan, white, to pinkish where fresh, weathering gray to yellowish-brown (Grunwald, 1970)
- Tpl — **Pyroxene lamprophyre -** Sills with phenocrysts of pyroxene and garnet up to 0.08 in (2 mm) in an aphanitic groundmass of glass and aligned sanidine, clinopyroxene, nepheline, pigeonite, garnet, and traces of calcite, titanite, oxyhornblende, and apatite. Hypocrystalline, dark-gray. Has local intense propylitic alteration (Grunwald, 1970)
- Tstp — **Sanidine trachyte porphyry -** Composed of as much as 75% euhedral sanidine phenocrysts up to 1.4 in (3.6 cm), up to 10% rounded and embayed quartz grains, and 1-5% clinopyroxene in an aphanitic groundmass. Tan, pink, to reddish-brown. Has minor titanite, pyrite, magnetite, and ilmenite. Locally altered to sericite and clay (Grunwald, 1970)
- Tqatp — **Quartz alkai trachyte porphyry -** Composed of 45-55% phenocrysts of subhedral to euhedral sanidine and perthite as much as 1.0 in (2.5 cm) across, subhedral plagioclase up to 0.2 in (5 mm), and oval to embayed anhedral quartz up to 0.2 in (5 mm) in a tan to light greenish-gray aphantic, K-feldspar groundmass. Finer-grained zones up to 50 ft (15.2 m) thick along stock margins have sharp contacts with country rock but are transitional to a coarser interior. Contains less than 2% secondary calcite, clay, magnetite, pyrite, sericite, siderite, and fluorite (MacLeod, 1986)
- Tatp — **Akali trachyte porphyry -** Composed of 45-70% subhedral to euhedral K-feldspar phenocrysts up to 2.0 in (5 cm) in an aphanitic, K-feldspar and quartz groundmass. Medium to coarsely crystalline. Fractured and brecciated, altered to quartz and clay in outcrop. Medium-gray to chalk-white, stained orange-brown to deep red-brown by iron oxide. Contains secondary pyrite, calcite, fluorite, and sericite (MacLeod, 1986)
- Tlp — **Latite porphyry -** Composed of anhedral to subhedral phenocrysts of sanidine up to 1.2 in (3 cm) and plagioclase up to 0.2 in (5 mm) in an aphanitic K-feldspar groundmass having over 5% rounded and embayed quartz fragments up to several millimeters across. Porphyritic to aphanitic, yellowish-gray. Has minor apatite, calcite, magnetite, and pyrite. With local propylitic alteration (Grunwald, 1970)
- Trd — **Rhyodacite porphyry -** Composed of phenocrysts of plagioclase up to 0.16 in (4 mm) and sanidine up to 0.39 in (10 mm) in an aphanitic plagioclase groundmass. Highly altered and sericitic. White to yellowish-gray. Only one exposure is shown and is located just east of the town of Galena (Grunwald, 1970)
- Thtp — **Hornblende trachyte porphyry -** Sill-like massses having as much as 50% subhedral to euhedral phenocrysts of plagioclase up to 0.47 in (12 mm), hornblende up to 0.2 in (5 mm), and 4-8% pyroxene in an aphanitic, K-feldspar groundmass. Local propylitic alteration. Medium- to dark greenish-gray (MacLeod, 1986)
- Tu — **Undifferentiated Tertiary igneous rocks -** Leucocratic to mesocratic, aphanitic to porphyritic, hypabyssal intrusive rocks. Includes phonolitic, rhyolitic, trachytic, and latitic rocks

Intrusive Contact

PENNSYLVANIAN

Upper Pennsylvanian

- PPm — **Minnelusa Formation -** Sandstone, shale, limestone, and dolomite, red, brown, yellow, to beige. Red shale and siltstone terra rossa occurs along the lower contact. Exposed thickness approximately 50 ft (15.2 m)

Disconformity

MISSISSIPPIAN

Lower Mississippian

- Mp — **Pahasapa Limestone -** Limestone and dolomite, white, beige to gray. Contains thin lenses and beds of gray to brown chert and local solution breccia. Karstic, with caves occurring mainly in the upper third of the formation. Forms prominent cliffs. Thickness approximately 450 ft (137.2 m)

DEVONIAN

Upper Devonian

- MDe — **Englewood Formation -** Argillaceous limestone, dolomite, and shale, pink, gray to purple-gray. Laminated to medium-bedded, finely to medium crystalline; bioturbated. Thickness 30-50 ft (9.1-15.2 m)

Disconformity

ORDOVICIAN

Upper Ordovician

- Oww — **Whitewood Limestone - Winnipeg Formation (undifferentiated)**
- Owh — **Whitewood Limestone -** Dolomitic limestone and dolomite, variegated yellowish-brown, brownish-orange, to gray. Thin- to thick-bedded with thin shale partings; bioturbated. Thickness approximately 20-40 ft (6.1-12.2 m)
- Ow — **Winnipeg Formation -** Includes the Ice Box Shale Member of greenish-gray fissle shale, and the Roughlock Siltstone Member of tan to yellowish-gray, calcareous siltstone. Combined thickness 20-60 ft (6.1-18.3 m)

CAMBRIAN

Lower Ordovician Upper Cambrian

- O€d — **Deadwood Formation -** Glauconitic sandstone, shale, limestone, intraformational conglomerate, and local basal conglomerate. Laminated to thick-bedded. Greenish- to reddish-brown. Thickness 240-423 ft (73.2-128.9 m)

Unconformity

PRECAMBRIAN

Lower Proterozoic

- Xcm — **Crook Mountain Granite -** Peraluminous pegmatitic granite composed of quartz, muscovite, sodic plagioclase, and perthite. Occurs as very thin light-colored dikes with mineral grains up to 0.79 in (2 cm) across in Butcher Gulch north of the town of Galena (Grunwald, 1970). Has a Pb^{206}/Pb^{207} age of 1,718 +/- 22 Ma (Ghosh, 2009) to 1,713 +/- 10 Ma (Frei and others, 2009), and is likely equivalent to the Harney Peak Granite of the southern Black Hills
- Xmg — **Metagabbro -** Amphibolite and chloritic amphibole schist. Occurs as finely to coarsely crystalline dikes and sills composed of plagioclase, hornblende, biotite, and calcite. Locally foliated and schistose. Grayish-green, greenish-black, to brown. A sill on the Pactola Dam quadrangle has a Pb^{206}/Pb^{207} zircon age of 1,883 +/- 5 Ma (Redden and others, 1990). It is uncertain that all bodies of metagabbro (Xmg) are of the same age. Protolith is gabbro
- Xg — **Grizzly Formation -** Phyllite, slate, mica schist, and minor metagraywacke. Gray, bluish-gray, to dark-gray. Some beds are carbonaceous. Gradational into the Swede Gulch Formation to the south. Protolith is dominantly shale and siltstone
- Xf — **Flag Rock Formation -** Mica schist and laminated carbonaceous and pyritic phyllite, light-gray to greenish-gray. Contains pillowed metabasalt and amphibolite, streaked graphitic quartzite, metachert, and metamorphosed carbonate-facies iron-formation with cummingtonite, biotite, and chlorite similar in appearance to the Homestake Formation. A quartz-pyrite replaced graphitic bed locally known as the "iron dike" extends from the Broken Boot (Olaf Seim) mine south to the Montezuma and the Whizzers and Slavonian (Glover) mines, to near the town of Kirk on the Lead quadrangle (U.S. Bureau of Mines, 1954). Occurs only at higher elevations and is interpreted to have been formed from White River age weathering of iron-rich beds similar to the Homestake Formation. The Flag Rock Formation is gradational into the Poverty Gulch Slate to the south. Protolith is pillow basalt with interflow deposits of siltstone, carbonaceous shale, chert, and iron carbonate

Unconformity

- Xn — **Northwestern Formation -** Phyllite, slate, and biotite-sericite schist, gray to dark-gray. Thin- to medium-bedded, locally with laminations and identifiable bedding. May contain minor tourmaline and titanite. Protolith is shale, carbonaceous shale, and siltstone
- Xe — **Ellison Formation -** Sericite-quartz phyllite, banded, well foliated, tan, light-gray, to black; biotite-quartz phyllite, thick-bedded; quartz-mica schist, light-gray to pale-brown; fine-grained quartzite and metachert, thick-bedded, gray to black; and minor amphibolite. Conglomerate beds rare; locally with minor carbonate. Protolith is sandstone with siltstone and shale. A metatuff in the lowermost Ellison Formation at the Homestake Mine on the Lead quadrangle has an age of 1,974 +/- 8 Ma (Redden and others, 1990)
- Xgw — **Metagraywacke -** Quartz-mica schist and phyllite, and quartzose schist, gray to brownish- and reddish-gray. Fine- to very fine-grained, thin- to thick-bedded. May be equivalent in part to metagraywacke units Xgw_1, Xgw_2, and Xgw_3. Protolith is distal to proximal turbidite deposits
- Xbs_2 / Xc Xboc / Xbo — **Phyllite and schist - Xbs_2 -** Laminated to thin-bedded, gray to black. Correlation of units across the Tomahawk fault is uncertain. Protolith is carbonaceous shale with interbedded chert, iron carbonate, and sulfides.
  Metachert - Xc - Light- and dark-banded, finely to medium crystalline, with minor grunerite and carbonaceous schist. Typically iron-stained. Similar in appearance to unit Xboc. Protolith is likely submarine thermal spring deposits
  Hay Creek Greenstone - Xbo - Tholeiitic metabasalt and amphibolite. Grayish-green, pale olive-green, moderate yellowish-green, to black. Very finely to coarsely crystalline, often having a speckled appearance. May have a moldic texture from dissolved amphibole laths. Contains pillow structures. Typically highly fractured. Age of 2,020-1,970 Ma (Frei and others, 2008) to 1,974-1,964 Ma (Redden and others, 1990). Protolith is pillowed tholeiitic basalt flows with interflow deposits of volcanic tuff, carbonaceous shale, and chert. **Xboc -** Metachert with minor grunerite and carbonaceous schist. White to tan, gray to reddish-brown, with thin light and dark banding. Occurs as thin lenses, to thick-bedded and massive. Medium to finely crystalline, having a sugary texture. Typically iron-stained from oxidized sulfides, locally forming a gossan. Some beds are brecciated. Thickness typically 5-30 ft (1.5-9.1 m), thickening in fold noses. One bed reaches 98 ft (30 m). Beds are similar in appearance to unit Xc and occur at several stratigraphic levels. Resistant, often forming prominent outcrops. Protolith is likely chert from submarine thermal spring deposits

Fault Contact

- Xbs_1 — **Reausaw Slate -** Biotite phyllite, garnet schist, quartz-mica schist, and graphitic slate and schist. Gray, brownish- and reddish-gray, dark-gray, to black. Laminated to thin-bedded, fissile, very fine grained, carbonaceous. Contains sulfides, iron carbonate, and thin veinlets of milky quartz. Protolith is black shale with minor siltstone and thin chert beds

CONTACTS

Long dashed where approximately located; dotted where projected above ground surface and queried where uncertain in cross section. Arrow indicates contact dip direction and amount

FAULTS

Long dashed where approximately located; dotted where concealed; queried where uncertain. Bar and ball on downthrown side. Arrows indicate lateral movement

FOLDS (Early Proterozoic)

D_1 FOLDS

Generalized interpretation of earliest northwest trending folds having low plunges. Smaller D_1 folds are generally not shown, especially where coinciding with younger folds and modified by later shearing. Trends and plunges are different on opposite sides of the Tomahawk fault, having low north-northwest plunges east of the fault, and steep southeast plunges west of the fault

- Anticline — Location of trace of axial plane and direction of plunge. Dotted where concealed; queried where uncertain
- Overturned anticline — Location of trace of axial plane, dip direction of limbs, and direction of plunge. Long dashed where approximately located; dotted where concealed; queried where uncertain
- Overturned syncline — Location of trace of axial plane, dip direction of limbs, and direction of plunge. Long dashed where approximately located; dotted where concealed; queried where uncertain

D_2 FOLDS

Includes smaller folds formed during development of major D_2 structures and younger folds developed largely by localized shear zones. Only generalized traces of axial planes are shown. Plunges commonly vary, even in individual folds. Small sheath folds probably modify some structures. Trends and plunges are different on opposite sides of the Tomahawk fault, having low north-northeast plunges east of the fault, and steep southeast plunges west of the fault. Most minor D_2 folds are not shown at this map scale

- Antiform — Location of trace of axial plane. Long dashed where approximately located; dotted where concealed; queried where uncertain
- Synform — Location of trace of axial plane. Long dashed where approximately located; dotted where concealed; queried where uncertain
- Undifferentiated — Location of trace of axial plane. Long dashed where approximately located; queried where uncertain
- Minor fold (55) — Showing bearing and plunge

D_3 FOLDS

Northwest trending superposed structures on D_1 and D_2 folds located east of the Tomahawk fault near Roubaix

- Antiform — Location of trace of axial plane. Long dashed where approximately located; dotted where concealed; queried where uncertain
- Synform — Location of trace of axial plane. Long dashed where approximately located; dotted where concealed; queried where uncertain

BEDDING

- Inclined (33)
- Inclined with top — Ball indicates top direction of beds known to be in dip direction
- Vertical
- Overturned (75) — Where direction of younging is known. Top direction of beds is opposite dip direction
- Top of bed — Direction of younging shown by sedimentary structures

FOLIATION

- Inclined (33)
- Inclined, parallel to bedding (75)
- Vertical

IGNEOUS FLOW FOLIATION

- Inclined (33)
- Vertical

FRACTURES

- Inclined (33)
- Vertical

LINEATION

- Lineation (33) — Mineral lineation, showing bearing and plunge

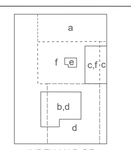
QUARTZ VEIN

METAMORPHIC ISOGRAD

- BIOTITE / GARNET — First appearance of index mineral noted on side of isograd

OTHER FEATURES

- Mine dump
- Tailings dam
- Open pit mine or quarry
- Mine shaft
- Mine adit
- Trench
- Group of prospect pits
- x — Prospect pit



INDEX MAP OF SELECTED REFERENCES

REFERENCES

a. Beck, J.A., Jr., 1976, *Geology of the Lexington Hill-Pillar Peak area, Lawrence County, South Dakota*: Rapid City, South Dakota School of Mines and Technology, M.S. thesis, 102 p.

DeWitt, E., Buscher, D., Wilson, A.B., and Johnson, T., 1988, *Map showing locations of mines, prospects, and patented mining claims, and classification of mineral deposits in the Deadwood South 71/2-minute quadrangle and part of the Deadman Mountain 71/2-minute quadrangle, Black Hills, South Dakota*: U.S. Geological Survey Miscellaneous Field Studies Map MF-1978-F.

b. Drake, B., 1967, *Structure and origin of the Tomahawk volcanics, central Black Hills, South Dakota*: Minneapolis, University of Minnesota, M.S. thesis, 271 p.

Frei, R., Dahl, P.S., Duke, E.F., Frei, K.M., Hansen, T.R., Frandsson, M.M., and Jensen, L.A., 2008, *Trace element and isotopic characterization of Neoarchean and Paleoproterozoic iron formations in the Black Hills (South Dakota, USA): Assessment of chemical change during 2.9-1.9 Ga deposition bracketing the 2.4-2.2 Ga first rise of atmospheric oxygen*: Precambrian Research, v. 162, p. 441-474.

Frei, R., Dahl, P.S., Frandsson, M.M., Jensen, L.A., and Frei, K.M., 2009, *Lead-isotope and trace-element geochemistry of Paleoproterozoic metasedimentary rocks in the Lead and Rochford basins (Black Hills, South Dakota, USA): Implications for genetic models, mineralization ages, and sources of leads in the Homestake gold deposit*: Precambrian Research, v. 172, n. 1-2, p. 1-24.

Ghosh, A.K., 2009, *Reconnaissance U-Pb geochronology of Precambrian crystalline rocks from the northern Black Hills, South Dakota: Implications for regional thermotectonic history*: Kent, Kent State University, M.S. thesis, 131 p.

c. Grunwald, R.R., 1970, *Geology and mineral deposits of the Galena mining district, Black Hills, South Dakota*: Rapid City, South Dakota School of Mines and Technology, Ph.D. dissertation, 323 p.

d. Krahulec, K.A., 1981, *Precambrian geology of the Roubaix district, Black Hills, South Dakota*: Rapid City, South Dakota School of Mines and Technology, M.S. thesis, 46 p.

e. MacLeod, R.J., 1986, *The geology of the Gilt Edge area, northern Black Hills of South Dakota*: Rapid City, South Dakota School of Mines and Technology, M.S. thesis, 146 p.

McDowell, F.W., 1971, K-Ar dates of igneous rocks from the western United States: Isochron/West, v. 2, p. 1-16.

f. Mukherjee, N.S., 1968, *Geology and mineral deposits of the Galena-Gilt Edge area, northern Black Hills, South Dakota*: Golden, Colorado School of Mines, Ph.D. dissertation, 288 p.

Plumley, W.J., 1948, *Black Hills terrace gravels: A study in sediment transport*: Journal of Geology, v. 56, p. 526-577.

Redden, J.A., Obradovich, J.D., Naeser, C.W., Zartman, R.E., and Norton, J.J., 1983, *Early Tertiary age of pitchstone in the northern Black Hills, South Dakota*: Science, v. 220, p. 1153-1154.

Redden, J.A., Peterman, Z.E., Zartman, R.E., and DeWitt, E., 1990, *U-Th-Pb Geochronology and preliminary interpretation of Precambrian tectonic events in the Black Hills, South Dakota*: in Lewry, J.F. and Stauffer, M.R., eds., The Early Proterozoic Trans-Hudson orogen of North America, Geological Association of Canada Special Paper 37, p. 229-251.

U.S. Bureau of Mines, 1954, *Black Hills mineral atlas: Part 1*: U.S. Bureau of Mines Information Circular 7688, 123 p.

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[1]South Dakota School of Mines and Technology

Map base modified from U.S.G.S. 1:24,000-scale Deadwood South digital line graph.
Projection is Universal Transverse Mercator, Zone 13N.
Datum is 1983 North American.
UTM grid information generated from the ArcMap™ layout grid function.

The Geological Survey Program, South Dakota Department of Agriculture and Natural Resources, engages in an ongoing data collection and interpretation process. An outcome of that process is to reflect those interpretations on maps such as this one. Reasonable efforts have been made to ensure that this map accurately reflects the source data used in its preparation. As additional data becomes available, geologic interpretations may be revised and the map may be updated by the Geological Survey Program. This map should not be enlarged or otherwise used in an attempt to interpret more detail than can be seen at a scale of 1:24,000

SCALE 1:24,000

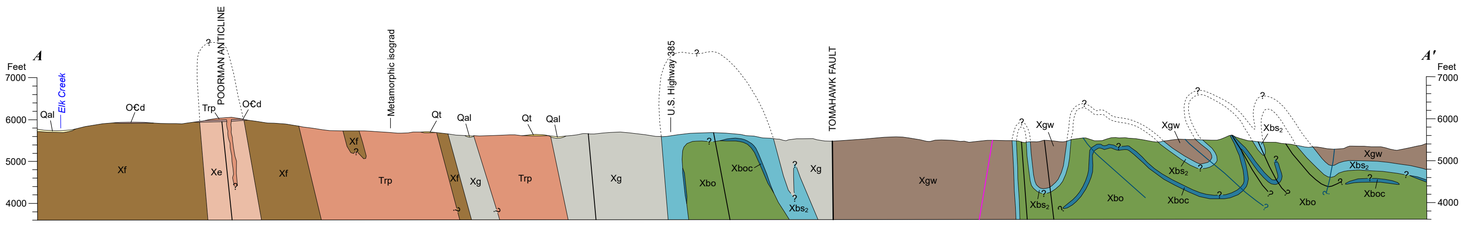
1 Mile
1,000 0 1,000 2,000 3,000 4,000 5,000 6,000 7,000 Feet
1 Kilometer

CONTOUR INTERVAL 40 FEET

UTM GRID AND 2021 MAGNETIC NORTH DECLINATION AT CENTER OF MAP
MN GN 7° 38' 136 MILS 0° 55' 16 MILS

SOUTH DAKOTA
QUADRANGLE LOCATION

Digital cartography by M.D. Fahrenbach and L.L. Roinstad



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Complex folding in the Grizzly Formation (Xg) along U.S. 385. Plunges range from horizontal to nearly vertical within a few feet. Dark layers contain abundant almandite garnets. Hammer is 16 in (40.6 cm) long andparallel to the main axial plane.


Timbered adit in massive metachert (Xboc) in the Hay Creek Greenstone (Xbo). Bedding is nearly vertical and cut by low angle fractures. Prospects typically followed brecciated iron-stained beds.


Boulder of quartz and taconite pebble conglomerate from the basal Deadwood Formation (O€d) below a highwall of the abandoned LOR Iron mine. 4000 tons was produced in 1948 for use as pigment and in cement (U.S. Bureau of Mines, 1954). Hammer is 16 in (40.6 cm) long.


Rhyolite (Tr) along U.S. 385 having columnar jointing. Limonite staining is from oxidized sulfides. This roadcut is at the eastern edge of a laccolith that intruded the lower Deadwood Formation (O€d).


Manganese oxide-stained folds in the Northwestern Formation (Xn) along U.S. 85. These small-scale folds have an amplitude of 6-8 in (15-20 cm) and plunge to the southeast.


Contact of light-colored rhyolite porphyry (Trp) with foliated schist of the Grizzly Formation (Xg) along U.S. 385. Flow layering produces a folded appearance plunging to the right.


Quartz veins up to 18 in (46 cm) wide parallel to foliation in schist of the Flag Rock Formation (Xf) along U.S. 14A near the Broken Boot (Olaf Seim) mine. The mine supplied pyrite from the "iron dike" for use in local smelters.