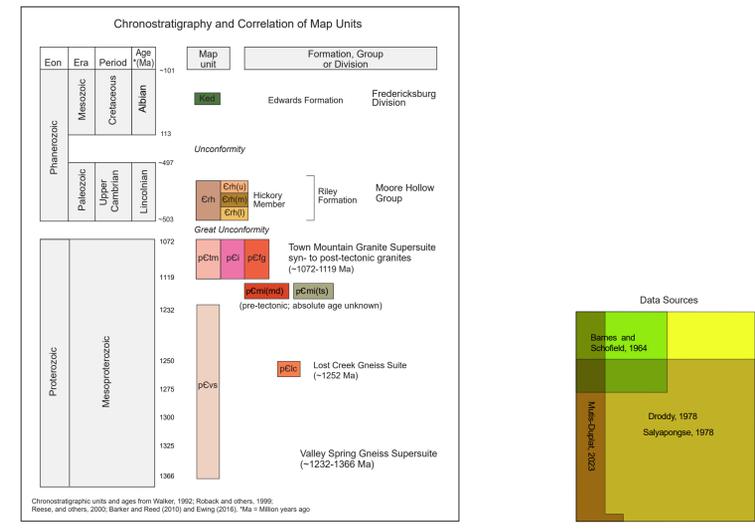


- CRETACEOUS SEDIMENTARY ROCKS**
 - FREDERICKSBURG DIVISION**
 - UNCONFORMITY**
 - PALEOZOIC SEDIMENTARY ROCKS**
 - Moore Hollow Group**
 - Riley Formation**
 - Crh**—Hickory Sandstone Member (Late Cambrian)—Quartz sandstone. From Hunt and Helper (2024). "Subdivided into three informal units (upper, middle, and lower) based upon variations in color, grain size, porosity, bedding thickness, cementation, and topographic expression (Mutis-Duplat, 1962; Becker, 1956). Where not differentiated, the unit generally consists of brown to red quartz sandstones. Diagenetically there is little to no calcite and glauconite. Locally there is a major aquifer in the subformation. The contact with the overlying Cap Mountain is placed at the first resistant calcareous cemented sandstone, which is often expressed as a topographic scarp and heavily vegetated breaks in slope. About 400 ft thick (Becker, 1956)."
 - Crh(u)**—Upper Hickory (Late Cambrian)—Sandstone. Hematitic quartz arenite. From Hunt and Helper (2024). "Massive to thinly bedded, red, medium- to coarse-grained, moderately sorted, friable, hematite and ironstone cement, and glauconitic with calcite cement toward the top. Hematite locally forms oolite-like coatings around quartz grains. Poorly exposed sandstone unit, forms topographically low benches that develop deep red soils often used for cultivation or agricultural purposes. Unit grades into overlying Cap Mountain, marked by calcite-cemented sandstone with increased resistance and red soil landscape. The unit is locally gray and/or blue. About 75 ft thick (Becker, 1956)."
 - Crh(m)**—Middle Hickory (Late Cambrian)—Quartz arenite. From Hunt and Helper (2024). "Thin- to thin-bedded, with laterally continuous beds, quartz and hematite cement (increasing upward), fine- to coarse-grained, rounded to subrounded, poorly sorted, smaller scale trough cross-bedding, light brown to orange brown, and phosphatic brachiopods, and abundant trace fossils. Locally silty laminations and interbeds. Laterally continuous mudstone and siltstone interbeds. This unit is indurated and forms ridges, outcrops and low hills owing to a weathering-produced, near-surface illitization process (Brian Johnson, personal communication). The unit is often thickly vegetated. Little to no agriculture and is considered an equivalent (Brian Johnson, personal communication) to 165 ft thick (Becker, 1956)."
 - Crh(l)**—Lower Hickory (Late Cambrian)—Sandstone. Quartz arenite. From Hunt and Helper (2024). "Massive and discontinuous beds, large amplitude trough cross-bedding, very coarse- to medium-grained, quartz and hematite cement, poorly sorted, rounded to subrounded, light to dark brown, friable, locally conglomeratic with feldspar grains, granitic to metamorphic pebbles and at the base. Vertically described and mapped near the base (Alexander, 1952). Very porous and permeable and locally is a major aquifer unit. A recessive and poorly exposed unit that forms topographically low benches with well-developed soils often in agricultural use. The top of the unit is the first resistant, well-cemented sandstone. Unit rests unconformably on the Precambrian surface and has variable thickness, ranging from 0 to about 55 ft thick (Becker, 1956)."
- UNCONFORMITY**
- MESOPROTEROZOIC IGNEOUS ROCKS (SUPERSUITE)**
 - Syn- to Post-Kinematic Granites (Suite)**
 - pCtm**—Town Mountain Granite (Mesoproterozoic)—From Hunt and Helper (2024). "Physically to equigranular, pink, fine- to coarse-grained granite. Composed of pink microcline (up to 3 cm), vitreous gray quartz, cloudy white plagioclase, biotite and hornblende, and containing subtle pegmatite veins. Locally sparse bearing (White, 1965). Unbedded microcline phenocrysts locally define a flow foliation and/or lineation, especially near pluton margins. Granite occurs in plutons up to 13 miles in size which tend to be circular vertical cylinders with concentric textural variations. Boundaries range from sharp and regular to highly irregular with wide zones of mixed rock. U-Pb zircon ages for these bodies are 1119–1070 Ma (Walker, 1992; Reed, 1999). Weathers to form gus aggregate, where granite is deeply weathered and gus well developed locally underlies areas in cultivation. The large granite body in the south-central portion of the quadrangle is known as the Eckert pluton (Barker and Reed, 2010). Although the Eckert Pluton has not been dated, however the nearby Katerney Pluton located to the northwest is reported to be 1070 ± 2 Ma, based on U-Pb zircon dating (Walker, 1992)."
 - pCtg**—Fine-grained granite (Mesoproterozoic)—Fine-grained gray and pink granites, often foliated or migmatitic, thought to be derived from partial melting of Valley Spring Gneiss (Salyapongse, 1978).
 - pCj**—Pegmatite or aplite (Mesoproterozoic)—Small bodies of pegmatite or aplite consisting of quartz and feldspar.
 - pCq**—Quartz vein (Mesoproterozoic)—Vein quartz. Milky white, monomineralic veins of quartz, most too small to map but up to 1.5 m wide, that cut across gneiss foliation or schistosity.
- Maligneous Rocks (Suite)**
 - pCm(ta)**—Tremolite schist (Mesoproterozoic)—Tremolite schist (Droddy, 1978). Slightly foliated, dark green, non-resistant, composed nearly entirely of tremolite with secondary chlorite and opaque oxides (Droddy, 1978).
 - pCm(md)**—Metadiorite (Mesoproterozoic)—Metadiorite. Black and white, fine- to medium-grained, poorly exposed xenolith(?) within Town Mountain Granite of the Eckert Pluton. About 70% zoned and altered plagioclase, 25% amphibole and biotite (replacing amphibole) and 5% quartz and opaque oxides (Droddy, 1978).
 - pCm(mt)**—Metabasalt (Mesoproterozoic)—Metabasalt (Droddy, 1978). Hydrothermally altered basaltic breccia containing dark green chlorite (~50%) and plagioclase (An71)–20% with light green epidote (20%) and quartz veins. Known only from a shaft across the trace of the ESW fault near the eastern edge of the map.
- MESOPROTEROZOIC METAMORPHIC ROCKS**
 - Valley Spring Gneiss (VSG) Supersuite**
 - pCvs(5)**—Unit 5—Calc-silicate-bearing gneiss and quartz-feldspar gneiss (Mesoproterozoic)—Mainly fine-foliated calc-silicate-bearing gneiss and quartz-feldspar gneiss with minor quartzite, biotite and hornblende schist, amphibole and plagioclase-gyroxene rock (Droddy, 1978). Foliated calc-silicate-bearing gneiss has mm-scale green calc-silicate-rich laminae that alternate with light pinkish to grayish feldspar bands. Microcline and plagioclase (predominant) to 10%, oligoclase more abundant than microcline, quartz is highly variable (~20%), commonly 20–40%. Calc-silicates are actinolite (up to 25%), green clinopyroxene (up to 12%), occasional brown andradite garnet (intergrown with clinopyroxene, up to 10%) and epidote (up to 18%), with accessory calcite, staurolite, and Fe oxides. Forms rounded knobs. Lack green calc-silicate patches common to Unit pCvs(4) and is fine-grained. Gradually to pCvs(3) over hundreds of meters by increase in amphibole, with a resultant lighter color. Relative increase in amphibole and epidote marks pCvs(3) contacts. Equivalent to Mutis-Duplat (1962) unit V52 and contains layers of Unit V51(A). Approximately 500 m thick in the SW corner of the map.
 - pCvs(5bhs)**—Unit 5bhs—Biotite-hornblende schist (Mesoproterozoic)—Biotite-hornblende schist (Droddy, 1978). Dark gray, fine-grained, interlayered with quartz-feldspar gneiss. Equivalent to V52(2) of Mutis-Duplat (1962).
 - pCvs(4)**—Unit 4—Quartz-feldspar gneiss (Mesoproterozoic)—Mostly pink quartz-feldspar gneiss with either accessory mica or calc-silicates (Droddy, 1978). Forms prominent NE- to NW-trending ridges. Contact with pCvs(1b) and pCvs(2) is marked by a micaceous or hematitic horizon in the west-central part of the quadrangle, but it is less well defined elsewhere. Contact with pCvs(3) is characterized by an increase in amphibole content and hence a transition from pink to dark green over a few tens of meters. Unit pCvs(2) gneiss is slightly lighter with fewer calc-silicates, and pCvs(2) has parallel feldspar bands that are largely absent or poorly developed in pCvs(4). Equivalent to Unit V51 of Mutis-Duplat (1962) but includes parts of his units V52 and V53. Approximately 1200–1300 m thick (Droddy, 1978).
 - pCvs(3)**—Unit 3—Actinolite-rich gneiss (Mesoproterozoic)—Actinolite-rich gneiss (Droddy, 1978). Calcium-rich, slightly foliated, fine- to medium-grained, pink and green, with abundant green amphibole, albite, microcline and lesser quartz (10%). Comprises discontinuous outcrops not confined to a stratigraphic horizon—most lie near or at the top of pCvs(2), but biggest at the pCvs(4)/pCvs(5) contact. In both cases, it is always found near pCvs(1b). Diagnostic for abundance of green amphibole (21–38%), tremolite-hornblende (10%), plagioclase (An71) is more abundant than microcline; quartz about 10%; it contains rare pale green clinopyroxene. Locally overlain by unit pCvs(3).
 - pCvs(2)**—Unit 2—Calc-silicate-bearing gneiss and quartz-feldspar gneiss (Mesoproterozoic)—Well-foliated, pink, fine-grained quartz-feldspar gneiss, with or without foliation-parallel calc-silicate (actinolite, epidote) (Droddy, 1978). Forms broad ridges over 120 m high. Locally overlain by Unit pCvs(1b) in direct contact with pCvs(4) or pCvs(1b). Contact with pCvs(1b) is gradational and poorly exposed. Pink, resistant, gneiss bands up to 2 cm thick are composed of quartz and microcline alternating with less resistant light pink to white bands of quartz and plagioclase. Biotite, muscovite, and opaque oxides are common at levels up to a few percent. Calc-silicate-bearing gneiss, most common near the base, contains abundant, distinctive greenish patches of elongate brown andradite, actinolite, and epidote (replacing plagioclase and actinolite) with accessory titanite and opaque oxides. Calc-silicates comprise 15–25% in these gneisses that otherwise contain 25–40% quartz, 12–25% microcline and 24–40% albite (An2).
 - pCvs(1c)**—Unit 1c—Chlorite-rich gneiss (Mesoproterozoic)—Chlorite-rich gneiss (Droddy, 1978). Lenses of fine-grained greenish gneiss containing chlorite (replacing amphibole), quartz, and albite. No potassium feldspar. Lenses are localized to pCvs(1b).
 - pCvs(1b)**—Unit 1b—Biotite gneiss, migmatite, muscovite schist or hematite schist (Mesoproterozoic)—Biotite gneiss, migmatite, muscovite schist or hematite schist (Droddy, 1978). Abundant biotite and Fe-Ti oxides, commonly interlayered with pCvs(1c) contacts, gradational with unit pCvs(2). Gneiss forms rounded ridges and knobs, schist, and migmatites weather to fatter terrain. This unit is not restricted to a single stratigraphic horizon but is within, or in contact with, units pCvs(1a), pCvs(2), pCvs(3), pCvs(4) and pCvs(5). Heterotitic, coarse-grained and more mica-rich than pCvs(1a). Microcline 30–50%, quartz 30–40%, plagioclase 10–20%, mica 10–20%, Fe-Ti oxides 5%. Granoblastic gray to red and black biotite gneiss is the most common subtype containing quartz (up to 80%, commonly 40–60%), microcline (up to 60%, commonly 30–40%), plagioclase (up to 44%, commonly 10–20%), biotite (up to 25%), muscovite (to 5%, replacing albite) and Fe-Ti oxides (to 5%), with both magnetite and ironite present. More foliated gneiss of this variety contains ovoid quartz-muscovite-illite-micas that weather out in relief. These are microcline-deficient, a few contain almost-undifferentiated garnet.
 - pCvs(1a)**—Unit 1a—Muscovite-rich gneiss (Mesoproterozoic)—Muscovite-rich gneiss (Droddy, 1978). Pink, fine-grained, weakly foliated with an appearance that resembles fine-grained granite. 60–70% microcline, 25–30% quartz, 10% opaque, with minor albite and biotite. Two varieties: 1) a moderately foliated, compositionally layered fine-grained gneiss with abundant microcline porphyroblasts up to 1–2 mm in size; 2) poorly foliated, relatively quartz-rich (to 40%) gneiss with elongate quartz up to several mm long.
- Lost Creek Gneiss Suite**
 - pCic**—Lost Creek Gneiss augen gneiss (Mesoproterozoic)—Granitic augen gneiss (Droddy, 1978; Hunt and Helper, 2024). Medium- to coarse-grained, pink, slightly foliated with elongate microcline (up to 30 m) and subparallel biotite-rich bands (up to 1 mm thick) that wrap augen. Sharp but intertonguing contact with pCvs(5). Poorly exposed. A single sample contains 50% feldspar (subequal albite and microcline), 50% quartz, 4% biotite and <1% magnetite. Microcline augen are perthitic, banded and contain albite inclusions. Albite (An4–13) is also present in myrmecite around microcline, and as anhedral grains.

Geologic Points	Contacts and Faults	Geologic Lines	Basemap Symbols
Strike and dip of bedding	Contact	Axial trace of antiform	Topographic contour (20 ft interval)
Horizontal bedding	Contact, inferred	Axial trace of antiform-approximate	Intermittent stream
Strike and dip of foliation, undifferentiated	Fault, dip and slip sense unknown	Axial trace of overturned antiform	County road
Vertical foliation, undifferentiated	Fault, inferred, dip and slip sense unknown	Axial trace of overturned antiform-approximate	Local road
Horizontal foliation, undifferentiated	Fault, ball and bar on down side	Axial trace of synform	Mine Shaft
Trend and plunge of lineation, undifferentiated	Fault, inferred, ball and bar on down side	Axial trace of synform-approximate	Quarry
Trend and plunge of minor fold, undifferentiated	Oblique slip fault, ball and bar on down side, arrow showing lateral motion	Axial trace of overturned synform	
Orientation of minor fault	Oblique slip fault, inferred, ball and bar on down side, arrow showing lateral motion	Axial trace of overturned synform-approximate	
	Foliation trace		



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UNIVERSAL TRANSVERSE MERCATOR PROJECTION, ZONE 14N NAD 83
CONTour INTERVAL: 20 FT
DATUM IS MEAN SEA LEVEL

BEDROCK GEOLOGIC MAP OF THE FLY GAP QUADRANGLE, MASON COUNTY, TEXAS

Mark A. Helper, Brian B. Hunt, and Marvin J. Droddy, Jr.
2025

Acknowledgments

This map compiles previously unpublished and published geologic mapping from the listed sources, augmented by limited new mapping. New mapping employed in 2022, 0.6 m per pixel natural color digital aerial imagery from the National Agriculture Imagery Program distributed through the Texas Geographic Information Office Texas Imagery Service, a 0.7 m per pixel digital terrain model derived from 2019 USGS Lidar data and three short field visits. Mapping was supported by the STATEMAP program of the U.S. Geological Survey (award No. G24AC00508, 2024; Jeffrey G. Paine, Principal Investigator) and by Bureau of Economic Geology STARR funds for geologic mapping and geologic hazards. The topographic base was created from U.S. Geological Survey digital files of the Fly Gap 7.5' quadrangle. Place names and other base map labels are from the Environmental Systems Research Institute, Inc. World Terrain Reference layer (Esn, 2024). Map symbology conforms to the Federal Geographic Data Committee cartographic standard for geologic map symbology (FGDC, 2006). Digital geologic data are contained within a GeMS-compliant database (USGS, 2020) created by M. Helper. We express our sincere gratitude to Mason County landowners who provided access for mapping, including Hal Zesch, Harry W. Greene, John Thomas, and David Hills. We also acknowledge the important work of Droddy (1978), our students and the many researchers whose efforts have collectively advanced the understanding of Llano Uplift geology, particularly to Virgil Barnes for his numerous geologic contributions to the region.

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