

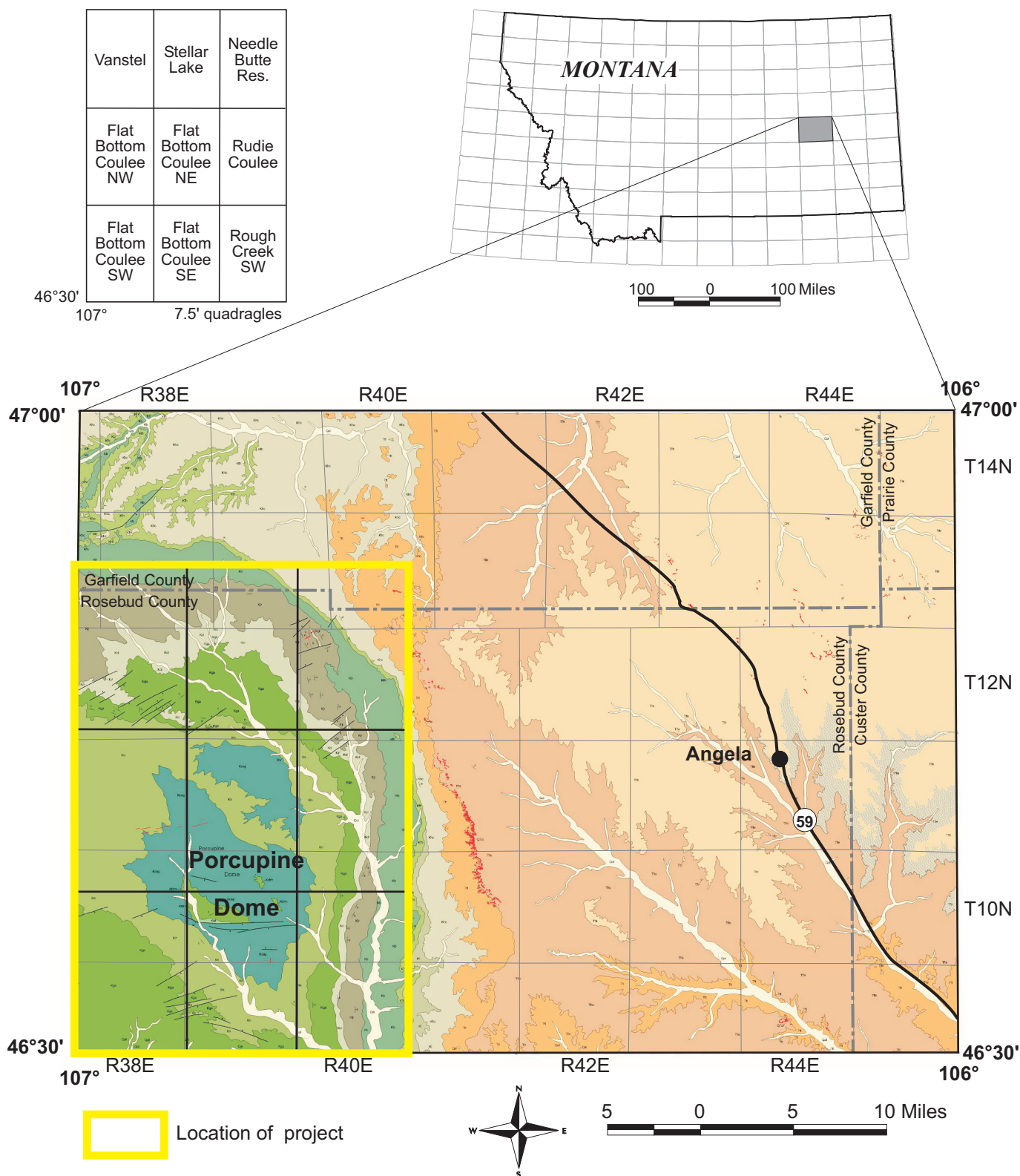
# **GEOLOGIC MAP OF THE PORCUPINE DOME AREA ROSEBUD AND GARFIELD COUNTIES, MONTANA**

Compiled and mapped by  
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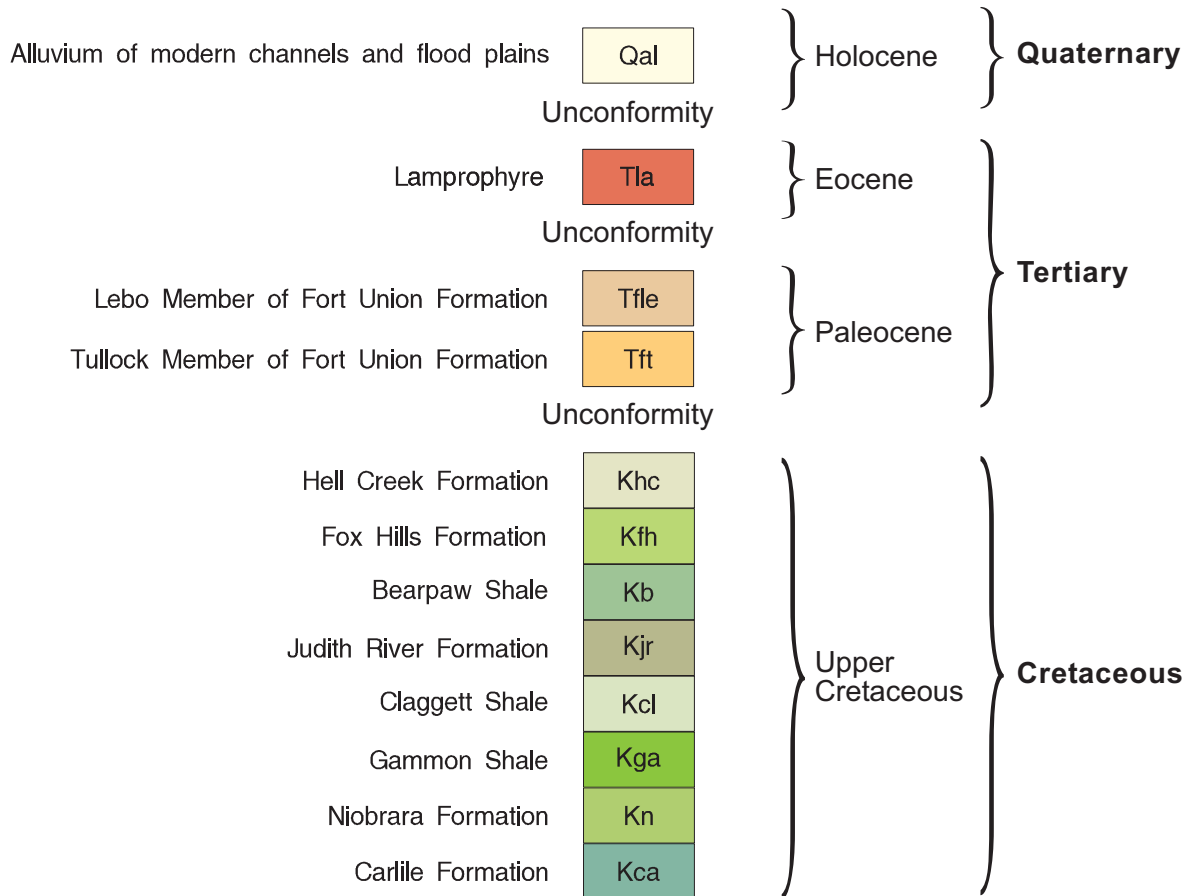
This report has been reviewed for conformity with technical and editorial standards of the Montana Bureau of Mines and Geology.

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**Figure 1.** Location of Porcupine Dome Project which includes nine 7.5' quadrangles across the crest of Porcupine Dome in eastern Montana. Sources of previous geologic mapping for entire map area: Schulte, 1959; and Vuke and others, 2003.

## CORRELATION OF MAP UNITS



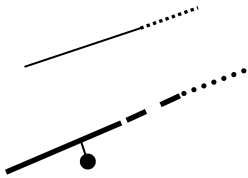
## PORCUPINE DOME AREA EXPLANATION

- Qal    **Alluvium (Holocene)**—Light-brown and gray, sand, silt, and clay deposited in stream and river channels and on flood plains. Sediment is mostly clay because it is derived largely from erosion of local Cretaceous shales. Deposits are poorly to well stratified. Thickness about 3-10 m (10-30 ft).
- Tla    **Lamprophyre dikes and small plugs (Eocene)**—Fine grained, porphyritic, calcareous, with only phlogopite visible in hand specimen (Doden, 1997). Much of material in plugs and dikes is breccia containing wide variety of clasts mainly derived from Cretaceous shale country rocks and other sedimentary rocks that are present at depth. Mostly medium gray brown and weathering yellowish brown. Dikes are commonly composed of several parallel, closely spaced, very thin sheets injected into the sedimentary rocks. Two small plugs are present, one at Gold Butte and one approximately 1.6 km (1 mi.) east in an unnamed butte. Dikes extend east and west from Gold Butte. Dikes parallel the predominant fault trends in the area, suggesting injection along pre-existing faults and fractures.
- Fort Union Formation (Paleocene)**
- Tfle    **Lebo Member**—Gray, greenish-gray, smectitic shale and mudstone that contains lenses and interbeds of gray and yellow, very fine to medium-grained, poorly resistant sandstone. The Big Dirty coal bed and associated dark gray or grayish brown carbonaceous shales are at or near the base of the member. Thickness of member about 68 m (225 ft) (Vuke and others, 2003).
- Tft    **Tullock Member**—Light yellow and light brown, planar-bedded, very fine to medium-grained sandstone and subordinate gray shale with thin beds of dark brown to black carbonaceous shale and coal. Thickness of member about 45 meters (150 ft)(Vuke and others, 2003).
- Khc    **Hell Creek Formation (Upper Cretaceous)**—Dominantly gray, grayish brown, and dusky yellow, fine- to medium-grained, locally cross-bedded, locally calcium carbonate-cemented sandstone with subordinate orangish brown sandstone, smectitic, silty, greenish brown or gray shale and mudstone, and a few thin beds of carbonaceous shale. Brown calcium carbonate-cemented concretions with round, irregular, or cylindrical shapes are typical in the fine-grained sandstone. Ferruginous clay pebbles are present locally. Thickness 53-84 m (175-275 ft.) (Vuke and others, 2003).

- Kfh **Fox Hills Formation (Upper Cretaceous)**—Light brown or light yellowish gray, thin- to thick-bedded, micaceous, fine- to medium-grained sandstone with ferruginous concretions in the upper part and thin-bedded siltstone and silty shale in the lower part. Thickness 8-15 m (25-50 ft) (Vuke and others, 2003).
- Kb **Bearpaw Formation (Upper Cretaceous)**—Dark gray and dark brownish gray, bentonitic, fissile shale, and mudstone, with numerous thin bentonite beds and zones of calcareous, and less commonly ferruginous concretions. Several intervals contain fossiliferous gray limestone concretions (Gill and others, 1972; Vuke and others, 2003). Thickness 245-305 m (800-1,000 ft).
- Kjr **Judith River Formation (Upper Cretaceous)**—Upper: very fossiliferous, light brown, to light gray, thin- to thick-bedded, fine- to medium-grained, crossbedded sandstone that weathers tan, gray, and brown and contains lenses of resistant calcium carbonate-cemented sandstone. Lower: interbedded gray to tan micaceous, non-calcareous, locally crossbedded sandstone, olive-gray shale, and silty shale. Local invertebrate fossil zones and trace fossils including *Ophiomorpha*. Local gray limestone concretions and brown ferruginous limestone concretions. Thin layer of black phosphate nodules and rounded bone fragments at base (Gill and others, 1972; Vuke and others, 2003). Thickness 75-120 meters (250-400 ft); thickest in the western part of the map area and much thinner with much less sandstone on the eastern side of Porcupine Dome.
- Kcl **Claggett Formation (Upper Cretaceous)**—Dark-gray, thinly bedded, poorly resistant and poorly exposed shale with calcareous concretions, numerous bentonite beds and some thin, lenticular, fine-grained sandstone beds. Shale bedding planes and fracture surfaces coated with jarosite and limonite. Numerous closely spaced dark-gray, brown-weathering, septarian limestone concretions, about 1.5 meters (5 ft.) in diameter near top. Ardmore bentonite (Gill and others, 1972) near the base. Thickness 60-70 meters (200-225 ft) (Vuke and others, 2003).
- Kga **Gammon Formation (Upper Cretaceous)**—Light gray non-calcareous shale, silty shale, and lesser siltstone and fine-grained sandstone lenses, with thin beds of calcareous concretions, ferruginous concretions, and bentonite scattered throughout the formation. Sandstone and shale more abundant near the top of the formation. Outcrops commonly littered with abundant, 1.5 cm (½ in) or smaller, reddish brown chips derived from concretions (modified after Vuke and others, 2003). Thickness about 230 m (750 ft) (Rice, 1976, Sheet 2, Texaco, State1-F, sec. 32, T. 7 N., R. 39 E.) .

- Kn    **Niobrara Formation (Upper Cretaceous)**—Upper: interbedded, dominantly calcareous and subordinately non-calcareous, poorly resistant, fissile, dark-gray shale, that contains siltstone beds, thin bentonite beds, and gray or orangish brown, calcareous or ferruginous concretions. Lower: non-calcareous, poorly resistant, fissile, dark gray shale with a few thin bentonite beds (Vuke and others, 2003). Base mapped at base of ledge-forming zone of gray septarian concretions with brown calcite veins. Thickness about 75 m (250 ft) (Rice, 1976, Sheet 2, Texaco, State1-F, sec. 32, T. 7 N., R. 39 E.).
- Kca    **Carlile Formation (Upper Cretaceous)**—Dark gray to medium gray weathering, non-calcareous shale, generally well exposed in the axial area of Porcupine Dome and recognized by a characteristic sequence of concretion types. Lower unit contains characteristic horizons of oval, dark red ironstone concretions that weather to small, angular, red-brown, “chippy” fragments that form rubbly patches in blue-gray fissile shale; a barren, blue-gray weathering shale about 15 m (50 ft) thick is exposed below this more resistant concretion-bearing shale. At the top of this basal shale is a 15-60 cm thick (6 in-2 ft) bed of medium dark gray, ledge-forming, sandy, concretionary limestone. The basal shale and capping sandy limestone were mapped by Schulte (1959) as the Belle Fourche Shale and Mosby Sandstone, respectively. Rice (1976) shows, in the subsurface of Porcupine Dome, about 15 m (50 ft) of Mosby Sandstone overlain by about 15 m (50 ft) of Greenhorn Shale, which supports the map interpretation that the Mosby and Belle Fourche are not exposed at the surface. The middle unit of the Carlile contains a characteristic zone of large, sandy, dull orange weathering concretions that are commonly highly fractured and contain cone-in-cone structures. The upper unit contains common to locally abundant white-gray weathering, rounded, football-size concretions. The upper contact of the Carlile is mapped at the base of the ledge-forming, gray concretion zone described in Kn above. (Description modified from Porter and Wilde, 1999). Thickness about 105 m (350 feet) (Rice, 1976, Sheet 2, Texaco, State1-F, sec. 32, T. 7 N., R. 39 E.).

## MAP SYMBOLS



**Contact**--Dotted where concealed.

**Fault**--Dashed where approximately located, dotted where concealed, queried where uncertain. Bar and ball on down-thrown side.



**Anticline**--Showing trace of axial plane and direction of plunge; dotted where concealed.



**Syncline**--Showing trace of axial plane and direction of plunge; dashed where approximately located, dotted where concealed.



**Dike**



**Strike and Dip of Beds**

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