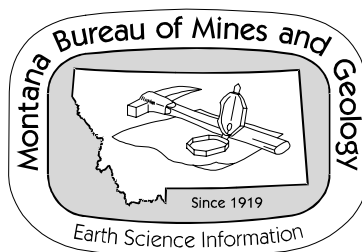


GEOLOGIC MAP OF THE SAND SPRINGS 30' x 60' QUADRANGLE, EASTERN MONTANA

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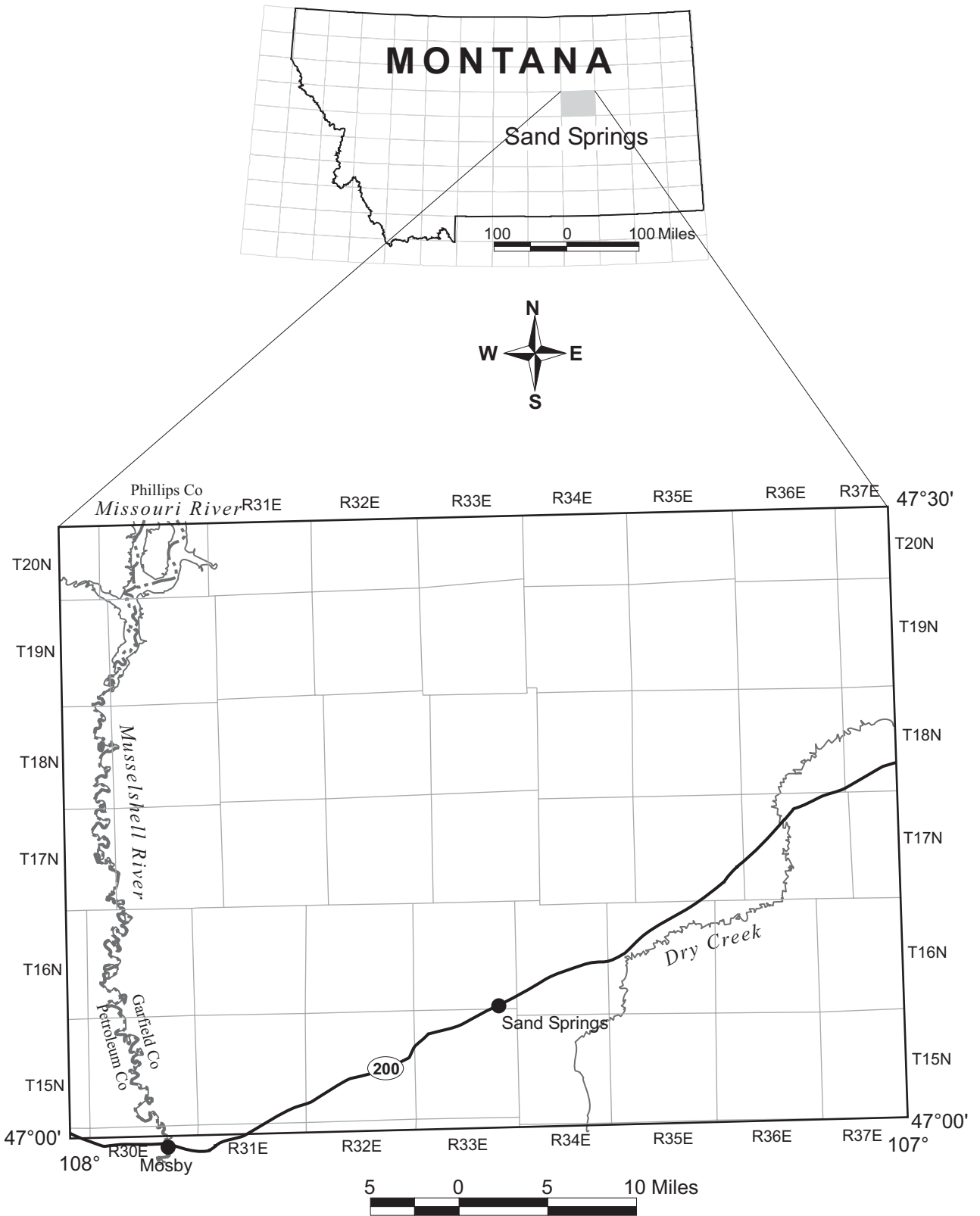
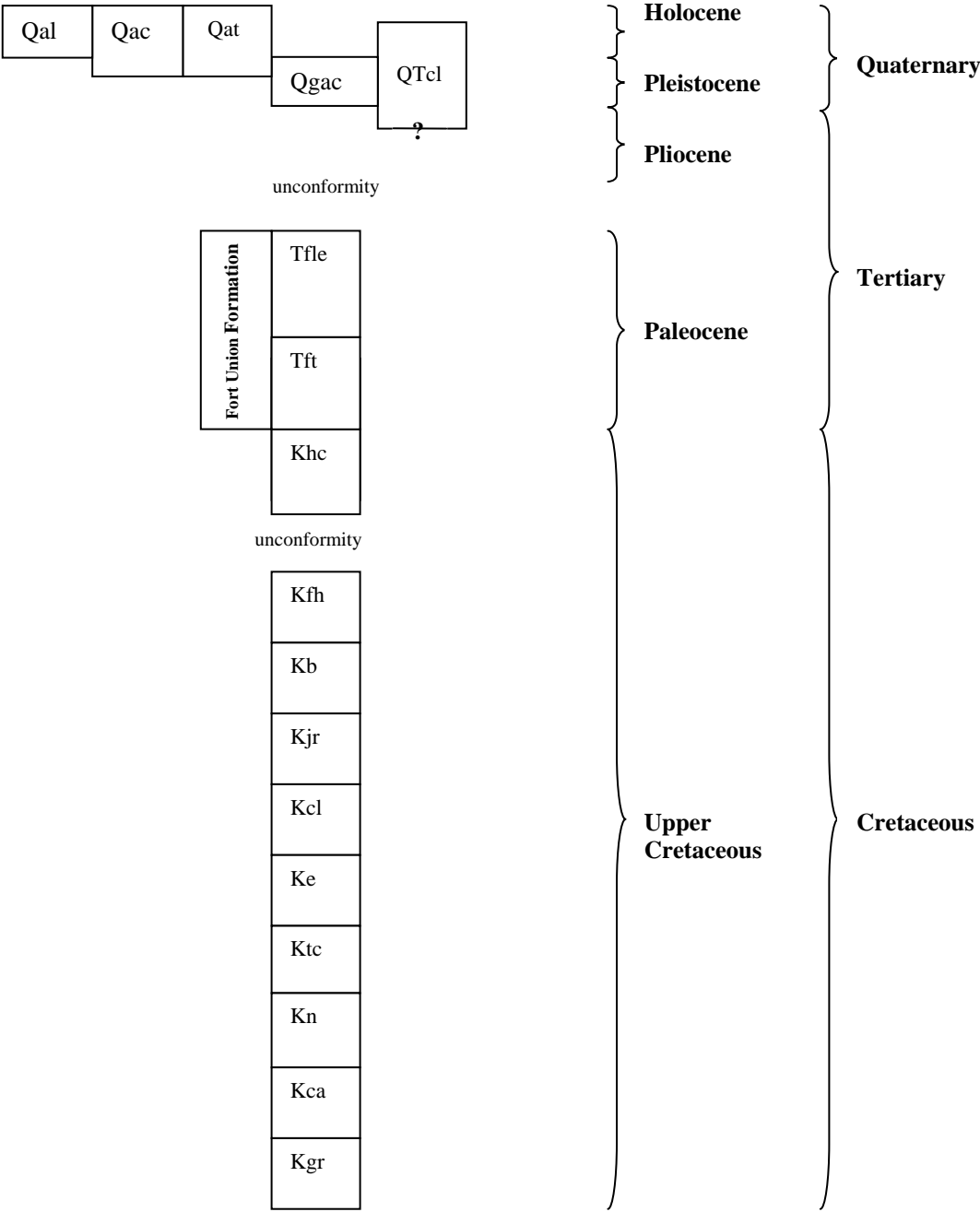


Figure 1. Location of Sand Springs 30'x60' quadrangle, eastern Montana.

**CORRELATION DIAGRAM
SAND SPRINGS 30' x 60' QUADRANGLE**



MAP SOURCES AND INDEX OF 7.5' QUADRANGLES .
SAND SPRINGS 30' x 60' QUADRANGLE

108°	107°	47° 30'					
Germaine Coulee W	Germaine Coulee E	Cap Rock Butte	Spring Creek School	Blackfoot School	Brusett	Moon- light Creek	Biscuit Butte
2, 4	2, 4	4	4				
Nelson Coulee	Seventy- nine Coulee	Benzien	Hay Coulee	Steve Forks SW	Steve Forks	Smoky Butte Creek	Smoky Butte
2, 4	4	4	4				
Bridge Coulee	Lelig Coulee	Searl Coulee	Coffin Butte	Twin Butte	Edwards	Big Dry School	Ziegele Coulee
1, 3, 4	1, 3, 4	1, 3, 4					
Fail Ranch	Barney Pinnacle	Froelich Butte	Cox Butte	Sand Spring	Robert- son School	Van Dusen Spring	Fig Moun- tain
1, 3, 5	1, 3, 5	1, 3, 5					
							47°

Numbers below correspond to numbers on index map above.

1. Bowen, C.F., 1919, Plate 4, scale 1:250,000.
2. Frahme, C.W., 1979, Plate 1, scale 1:48,000.
3. Johnson, W.D., Jr., and Smith, H.R., 1964, Plate 1, scale 1:63,360.
4. Osterkamp, W.R., 1970, scale 1:250,000.
5. Reeves, Frank, 1927, Plate 3, scale 1:125,000 and 1:63,360.

Entire map east of Musselshell River:

Stoner, J.D., and Lewis, B.L., 1980, scale 1:500,000.

SAND SPRINGS 30' x 60' QUADRANGLE
DESCRIPTIONS OF MAP UNITS

- Qal Alluvium (Holocene)**—Light-brown and gray gravel, sand, silt, and clay deposited in stream and river channels and on flood plains. Clasts are well rounded to sub-rounded. Deposits are poorly to well stratified. Thickness probably less than 15 ft.
- Qat Alluvial terrace deposit (Holocene and Pleistocene)**—(from Johnson and Smith, 1964) Gravel composed of subangular to rounded clasts of dominantly pebbles with subordinate cobbles. Composition primarily igneous rocks and limestone with some sandstone, chert, ironstone, quartzite, and shale. Generally unconsolidated, but locally cemented by calcium carbonate. Several terrace levels range from about 50 to 525 ft above the Musselshell River. Thickness generally about 8 ft, but ranges from a veneer to more than 60 ft.
- Qac Alluvium and colluvium, undivided (Holocene and Pleistocene)**—Brown, yellowish-brown, grayish-brown, and light- to dark-gray sand, silt, and clay that overlies broad, generally flat-lying valley bottoms along underfit modern stream channels. Thickness probably less than 10 ft.
- Qls Landslide deposits**—Deposits resulting from mass movement of bedrock and surficial deposits, primarily by slide and flow processes. The southern part of a large, extensive landslide complex along Fort Peck Lake to the north extends into the present map area along the Musselshell River. Numerous small landslide deposits dominantly on slopes along drainages, not shown on map. Exposed thickness of mapped landslides approximately 20-50 ft.
- Qgac Gravelly sheet-wash alluvium and colluvium (Pleistocene)**—Gray, brown, brownish-gray or yellowish-gray, fine to coarse gravel, fine to coarse sand, and silt. Unit located on upland benches in patchy deposits covering bedrock units. May have originated as till. Thickness about 20 ft.
- QTcl Clinker (Holocene, Pleistocene, and Pliocene?)**—Red, pink, orange, black, and yellow, very resistant metamorphosed sandstone, siltstone, and shale of the lower Lebo Member of the Fort Union Formation. Rock was baked by natural burning of underlying coal, and locally collapsed into voids created by burning. Thickness as much as 50 ft.
- Tlam Lamproite (Eocene)**—(from Irving and Hearn, 2003) Dikes, plugs, and breccia pipes of the Smoky Butte Lamproite Complex. Some dike margins show ropy pahoe-hoe texture. Welded agglutinates are locally interlayered with bedded tuffs.
- Fort Union Formation (Paleocene)**
- Tfle Lebo Member**—Gray, greenish-gray, smectitic shale and mudstone. Shale and mudstone contain 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. About 180 ft exposed in map area, close to the entire thickness of the member.

- 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 300 ft.
- 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 subordinant 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 300 ft.
- 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 60 ft.
- Kb Bearpaw Shale (Upper Cretaceous)**—Dark-gray and dark-brownish-gray, bentonitic, fissile shale, and mudstone, with numerous thin bentonite beds and zones of calcareous and less common ferruginous concretions. Several intervals contain fossiliferous gray limestone concretions. Thickness 1100 ft.
- Kjr Judith River Formation (Upper Cretaceous)**—Upper: Very fossiliferous, light-brown to light-gray, thin- to thick-bedded, fine- to medium-grained, cross-bedded sandstone that weathers tan, gray, and brown and contains lenses of resistant calcium carbonate-cemented sandstone. Lower: Interbedded gray to tan micaceous, noncalcareous, locally cross-bedded sandstone and olive-gray shale and silty shale. Local invertebrate fossil zones and trace fossils include *Ophiomorpha*. Local gray limestone concretions and brown ferruginous limestone concretions. Thin layer of black phosphate nodules and rounded bone fragments at base. Thickness 215 ft.
- Kcl Claggett Shale (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 5 ft in diameter near top. Ardmore bentonite near the base. Thickness 350 ft.
- Ke Eagle Sandstone (Upper Cretaceous)**—Yellowish-gray sandy shale with some thin yellowish-gray sandstone beds. Thickness 200 ft.

- Ktc** **Telegraph Creek Formation (Upper Cretaceous)**—Light-olive-gray to yellowish-gray sandy shale and sandstone with ironstone concretions in the lower part. Thickness 130 ft.
- Kn** **Niobrara Shale (Upper Cretaceous)**—Upper: Interbedded dominantly calcareous and subordinately noncalcareous, poorly resistant, fissile, dark-gray shale, that contains siltstone beds, thin bentonite beds, and gray or orangish-brown calcareous or ferruginous concretions. Lower: Noncalcareous, poorly resistant, fissile, dark-gray shale with a few thin bentonite beds. Thickness 250 ft.
- Kca** **Carlile Shale**—(from Smith and Johnson, 1964) Dark-gray, sandy shale. Upper two-thirds contains abundant limestone concretions that weather light gray and yellowish orange. Zone of abundant ironstone concretions in the lower part. Thickness 310 ft.
- Kgr** **Greenhorn Formation**—Dark-gray, calcareous shale that weathers very light gray. A thin, persistent bed of gray septarian limestone concretions occurs at the top of the formation. Base not exposed in map area. Exposed thickness 20 ft.

MAP SYMBOLS



Contact—Dotted where concealed.



Strike and dip of bedding—Number indicates degree of dip.



Fault—Ball and bar on downthrown side. Dashed where inferred, dotted where concealed.

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