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

Compiled and mapped by Susan M. Vuke, Edith M. Wilde,
Roger B. Colton, and Robert N. Bergantino

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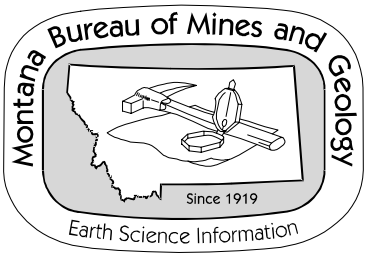

This report has been reviewed for conformity with Montana Bureau of Mines and Geology's technical and editorial standards.

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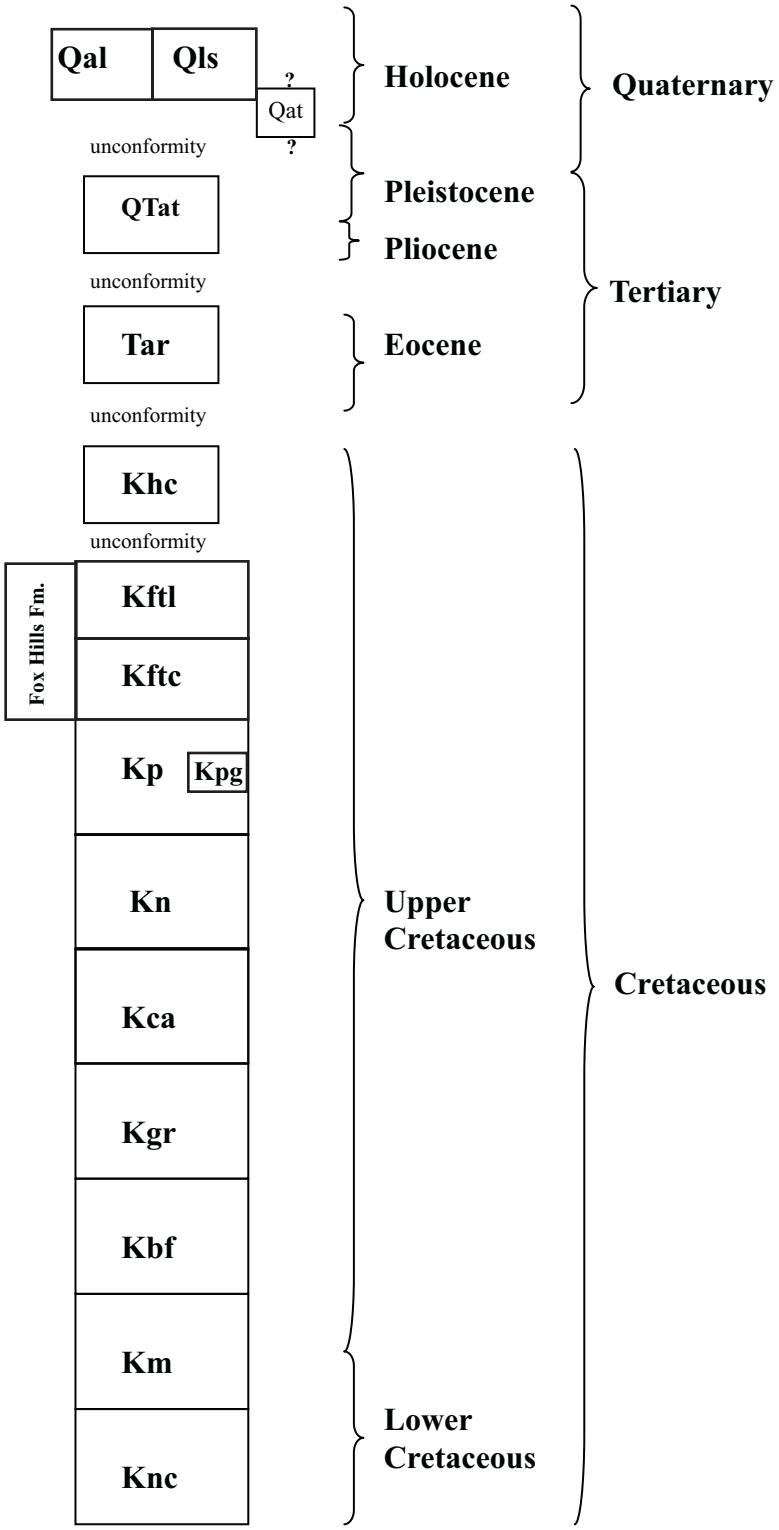
CORRELATION DIAGRAM
ALZADA 30' x 60' QUADRANGLE



DESCRIPTION OF MAP UNITS
ALZADA 30' x 60' QUADRANGLE

Note: Thicknesses are given in feet because original field maps were on 7.5’ quadrangles with contour intervals in feet. To convert feet to meters (the contour interval unit on this map), multiply feet x 0.3048.

Qal **Alluvium (Holocene)—**Light-gray to tan gravel, sand, silt, and clay deposited in stream and river channels and on flood plains. Clasts are subangular to well rounded. Deposits are poorly to well stratified and poorly to well sorted. Thickness generally less than 20 ft but as much as 30 ft.

Qls **Landslide deposit (Holocene and Pleistocene?)—**Mass-wasting deposit of stable to unstable, unsorted mixtures of sediment. Deposit primarily as rotated or slumped blocks of bedrock and surficial sediment. Color and lithology reflect that of parent rock and transported surficial deposits. Thickness as much as 70 ft.

Qat **Alluvial terrace deposit (Holocene and/or Pleistocene)—-**Light-gray to light-brown gravel, sand, silt, and clay in terrace remnants. Clasts are generally locally derived, and subround.. Thickness 10–30 ft.

QTat **Alluvial terrace deposit (Pleistocene and/or Pliocene)—**Light-brown to light-grayish orange, coarse sand with lenses of gravel, and lenses and beds of clay, silt, and fine-grained sand in terrace remnants generally more than 100 ft above modern flood plains. Clasts are generally well sorted, and most are well rounded. Deposits are generally well stratified. Dominant clast lithology is pale-yellow quartzite. Other clast compositions are quartz, ferruginous rocks, chert, igneous rocks and sandstone. Thickness generally less than 10 ft, but locally as much as 35 ft.

Tar **Arikaree Formation (Miocene)—**Greenish gray to light-gray, crossbedded or massive sandstone that is tuffaceous or calcareous and may contain tubular or round concretions. Sandstone is interbedded with a few laminated ash beds as much as 12 ft thick. Formation also includes subordinate rip-up clast conglomerates, dolomite, siltstone, and shale, and is generally capped by several feet of resistant, greenish orthoquartzite with a few scattered small quartz pebbles and granules. In the Finger Buttes area, the Arikaree rests unconformably on a Tertiary landslide deposit of Chadron and Brule Formations that also rest unconformably on the Pierre Shale (Denson and Gill, 1965). In the A-Bar-A Buttes area, the Arikaree Formation rests unconformably on the Hell Creek Formation, the Fox Hills Formation, and the Pierre Shale.

White River Group (Oligocene)(Outcrop pattern too narrow to show at scale of this map.)

Brule Formation—May only be present in the quadrangle at Finger Buttes in a pre-Arikaree landslide deposit beneath the unconformable base of the Arikaree Formation. Massive pinkish gray, calcareous, clayey siltstone; tuffaceous siltstone; nodular claystone; and channel sandstone (Denson and Gill, 1965). Contains abundant vertebrate fossils. Thickness 0–30 ft.

Chadron Formation—Preserved as erosional remnants in pre-Arikaree landslide deposits beneath the unconformable base of the Arikaree Formation in the Finger Buttes area (Denson and Gill, 1965). Basal conglomeratic sandstone overlain by beds 10 to 15 ft thick of dark-gray bentonite and cream-colored tuffaceous siltstone (Denson and Gill, 1965). Rests unconformably on the Pierre Shale. Thickness 0–100 ft.

Khc **Hell Creek Formation (Upper Cretaceous)—**Gray and greenish gray, structureless, smectitic, silty mudstone with "popcorn" weathering. Grayish yellow to moderate-yellowish brown crossbedded and ripple-laminated, micaceous, fine- to medium-grained channel sandstone. Only present in northern part of quadrangle at B-Bar-B Buttes. Southward it has been thinned and removed by pre-Arikaree erosion. Upper contact not exposed in map area. Maximum exposed thickness 75 ft.

Fox Hills Formation (Upper Cretaceous)

Kftl Timber Lake Member—Brownish gray siltstone, and fine- to medium-grained, coarsening-upward sandstone that weather to moderate-brown. Hummocky beds and trough crossbeds are characteristic of member, and locally it contains *Ophiomorpha* burrows and selenite crystals, and may have a sulfurous odor. Thickness of member 70 –250 ft.

Kftc Trail City Member—Interbedded light-gray siltstone that coarsens upward to fine-grained sandstone, and dark-gray shale. Member is a transitional zone between the underlying Pierre Shale and the sandy Timber Lake Member. Thickness of member 80 ft.

Kp **Pierre Shale (Upper Cretaceous)—**Dark-gray to brownish black bentonitic claystone and shale that contain large fossiliferous limestone concretions and bentonite beds that range from less than an inch to 2 ft thick. Includes Groat Sandstone Bed described below. Thickness of formation 500–700 ft.

Kpg Groat Sandstone Bed—Grayish brown, fine-grained, glauconitic, rusty-weathering sandstone or poorly resistant grayish brown, fine-grained argillaceous sandstone. Basal brownish-gray sandy shale with calcareous concretions that average 10 inches in diameter. Thickness 100 ft. (Knechtel and Patterson, 1962)

Kn **Niobrara Formation (Upper Cretaceous)—**Yellowish gray, soft marl, and dark-gray, fissile, noncalcareous shale that contain light-gray bentonite beds, septarian limestone concretions veined with brown or light-gray calcite that range from 6 inches to 1½ ft in diameter, and *Inoceramus* fossils. Thickness 150–215 ft. (Knechtel and Patterson, 1962)

Kca **Carlile Shale (Upper Cretaceous)—**Gray shale with abundant concretionary nodules of calcareous, ferruginous, and phosphatic materials, and a few very thin beds of bentonite. Middle of formation contains many limestone concretions and lenses of light-gray sandstone and sandy shale. Thickness 600–640 ft. (Knechtel and Patterson, 1962)

Kgr **Greenhorn Formation (Upper Cretaceous)—**Brownish gray, calcareous shale and marl with a few thin beds, lenses and concretions of limestone, and some bentonite beds, the most prominent of which is in the lower part of the formation and ranges from 3 to 6 ft thick. Thickness of formation 365 ft. (Knechtel and Patterson, 1962)

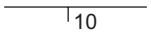
Kbf **Belle Fourche Formation (Upper Cretaceous)—**Upper part dark-gray, fissile, soft shale with a few zones of calcareous concretions, and some bentonite beds, including a prominent reddish gray bed in the middle of the formation that pinches out locally but is as much as 4 ft thick in places. Lower part dark-gray shale that is harder and less fissile than upper part, contains several bentonite beds, and many purplish red-weathering, oblate spheroidal concretions of hard, gray, finely crystalline siderite that weather dark, and range from 1 to 5 ft at their greatest diameter, but seldom more than 1 ft at their least diameter and weather dark. South of Alzada, the lowermost 25 ft of strata also contain yellowish brown ovoid calcareous concretions with an average diameter of 1½ ft that display cone-in-cone structures. Middle of lower part is sandy shale intercalated with many beds and lenses of soft gray sandstone, generally less than 2 inches thick. Thickness 365–850 ft. (Knechtel and Patterson, 1962)

Km **Mowry Shale (Upper and Lower Cretaceous)—**Brownish gray, hard, siliceous shale interbedded with subordinate amounts of brown silty mudstone and white bentonite. Clay Spur bentonite at top. Thickness 200 ft. (Knechtel and Patterson, 1962).

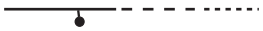
Knc **Newcastle Sandstone (Lower Cretaceous)—**Light-gray, cross-bedded or ripple-laminated sandstone interbedded with subordinate amounts of siltstone, sandy shale, carbonaceous shale, bentonite, and lignitic carbonaceous shale. Base not exposed in map area. Exposed thickness 50 ft.

MAP SYMBOLS
ALZADA 30’ x 60’ QUADRANGLE

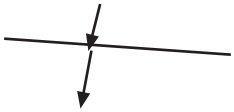
Contact—Dotted where concealed.



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



Fault—Ball and bar on downthrown side, dashed where approximately located, dotted where concealed



Monocline—Showing axial trace of anticlinal flexure.

GEOLOGIC MAP SOURCES AND INDEX OF 7.5' QUADRANGLES
ALZADA 30' x 60' QUADRANGLE

105° 104°
45°30' 45°

Pentecost Reser-voir 5	Knud-son Draw 5	White-tail Creek 5	Ridg-way 5	Prairie Dog Creek 1, 5	Lone Tree Creek 1, 5	Capitol NW 1, 5	Capitol 1, 5
Knud-son Draw 5	Knud-son Draw NE 5	Tip Top Butte 2, 5	Potato Buttes 2, 5	Finger Buttes West 5	Finger Buttes East 5	Cactus Creek West 5	Cactus Creek East 5
Ham-mond 4, 5	Greasy Hill 4, 5	Black Point 4	Black Point NE 4	Alzada NW 4	Albion 4	Elkhorn Creek West 4	Elkhorn Creek East
Stack Rocks 4, 5	Ham-mond SE 3, 4, 5	Cochran Reser-voir 3, 4	Gomer Draw 3, 4	Alzada 3, 4	Seven-mile Creek 3, 4	Elkhorn Creek SW 4	Elkhorn Creek SE 4

Numbers below correspond to numbers on index map above.

1. Bauer, C.M., 1924, plate 3, 1:125,000
2. Denson, N.M., and Gill, J.R., 1965, plate 15, scale 1:48,000, and plate 16, scale 1:63,360.
3. Knechtel, M.M., and Patterson, S.H., 1956, scale 1:48,000.
   Knechtel, M.M., and Patterson, S.H., 1962, plate 60, scale 1:48,000.
4. Robinson, C.S., Mapel, W.J., and Bergandahl, M.H., 1964, plate 11, scale 1:96,000.
5. Stoner, J.D., and Lewis, B.D., 1980, scale 1:500,000.

Entire quadrangle

Bergantino, R.N., 1980, scale 1:250,000.

Colton, R.B., Whitaker, S.T., Ehler, W.C., Holligan, J., and Bowles, C.G., 1978, scale 1:250,000.

Ellis, M.S., and Colton, R.B., 1994, scale 1:500,000.

Wilde, E.M, Vuke, S.M., Bergantino, R.N., Colton, R.B, 1989, scale 1:100,000.

REFERENCES
ALZADA 30' x 60' QUADRANGLE

Bauer, C.M., 1924, The Ekalaka lignite field southeastern Montana: U.S. Geological Survey Bulletin 751-F, 267 p., 5 pls.

Bergantino, R.N., 1980, Geologic map of the Ekalaka 1^o x 2^o quadrangle, southeastern Montana: Montana Bureau of Mines and Geology Montana Atlas Map MA 1-A, scale 1:250,000.

Colton, R.B., Whitaker, S.T., Ehler, W.C., Holligan, J., and Bowles, C.G., 1978, Preliminary geologic map of the Ekalaka 1^o x 2^o quadrangle, southeastern Montana and western North and South Dakota: U.S. Geological Survey Open-File Report 78-493, scale 1:250,000.

Denson, N.M., and Gill, J.R., 1965, Uranium-bearing lignite and carbonaceous shale in the southwestern part of the Williston Basin—A regional study: U.S. Geological Survey Professional Paper 463, 75 p., 19 pls.

Ellis, M.S., and Colton, R.B., 1994, Geologic map of the Powder River Basin and surrounding area, Wyoming, Montana, South Dakota, North Dakota, and Nebraska: U.S. Geological Survey Miscellaneous Investigations Map I-2298, scale 1:500,000.

Gill, J.R., 1959, Reconnaissance for uranium in the Ekalaka lignite field, Carter County, Montana: U.S. Geological Survey Bulletin 1055-F, p. 167–179.

Knechtel, M.M., and Patterson, S.H., 1956, Bentonite deposits of the northern Black Hills district, Montana, Wyoming, and South Dakota: U.S. Geological Survey Mineral Investigations Field Studies Map MF-36, scale 1:48,000.

Knechtel, M.M., and Patterson, S.H., 1962, Bentonite deposits of the northern Black Hills district, Wyoming, Montana, and South Dakota: U.S. Geological Survey Bulletin 1082-M, 6 pls., p. 893–1030.

Lisenbee, A.L. and DeWitt, E., 1993, Laramide evolution of the Black Hills uplift, *in* Snoke, A.W., Steidtmann, J.R., and Roberts, S.M., eds., Geology of Wyoming: Geological Survey of Wyoming Memoir 5, p. 374–412.

Mapel, W.J, Robinson, C.S., and Theobald, P.K., 1959, Geologic and structure contour map of the northern and western flanks of the Black Hills district, Wyoming, Montana, and South Dakota: U.S. Geological Survey Oil and Gas Investigations map OM-191, scale 1:96,000.

Merewether, E.A., 1996, Stratigraphy and tectonic implications of Upper Cretaceous rocks in the Powder River Basin, northeastern Wyoming and southeastern Montana: U.S. Geological Survey Bulletin 1917-T, 92 p.

Miller, W.R., 1981, Water resources of the southern Powder River area, southeastern Montana: Montana Bureau of Mines and Geology Memoir 47, 53 p. 4 sheets.

Robbins, S.L., 1994, Gravity and aeromagnetic studies of the Powder River Basin and surrounding areas, southeastern Montana, northeastern Wyoming, and western South Dakota: U.S. Geological Survey Bulletin 1917, 17 p., 4 pls.

Robinson, C.S., Mapel, W.J., and Bergandahl, M.H., 1964, Stratigraphy and structure of the northern and western flank of the Black Hills Uplift, Wyoming, Montana, and South Dakota: U.S. Geological Survey Professional Paper 404, 134 p.

Stoner, J.D., and Lewis, B.D., 1980, Hydrogeology of the Fort Union coal region, eastern Montana: U.S. Geological Survey Miscellaneous Investigations Series Map I-1236, scale 1:500,000.

Wilde, E.M, Vuke, S.M., Bergantino, R.N., Colton, R.B, 1989, Preliminary geologic map of the Alzada 30x60-minute quadrangle: Montana Bureau of Mines and Geology Open File Report MBMG 279, scale 1:100,000 (superseded by this report).