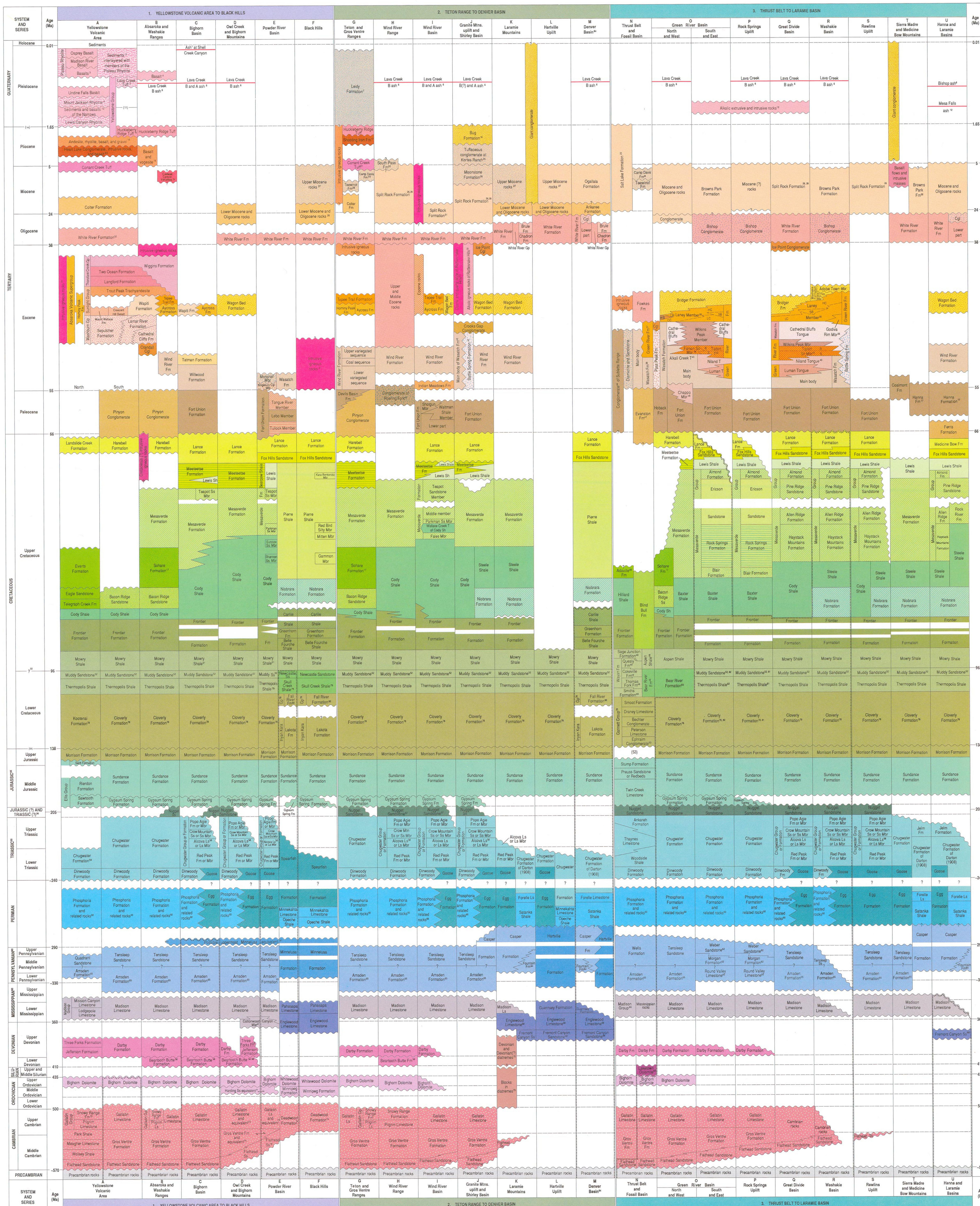
THE GEOLOGICAL SURVEY OF WYOMING
Gary B. Glass, State Geologist



Prepared in cooperation with the U.S. Geological Survey

Cartography by: Joseph M. Huss and Phyllis A. Ranz, Geological Survey of Wyoming and Kenneth T. Oetting, U.S. Geological Survey

STRATIGRAPHIC CHART SHOWING PHANEROZOIC NOMENCLATURE FOR THE STATE OF WYOMING

Compiled by

J.D. Love and Ann Coe Christiansen, U.S. Geological Survey and Alan J. Ver Ploeg, Geological Survey of Wyoming

1993

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DISCUSSION

Stratigraphic units, correlated on this chart along three generally west-east lines crossing mountains and basins (**Figure 1**) and shown on the *Geologic map of Wyoming* (scale 1:500,000; Love and Christiansen, 1985), were compiled for the Wyoming Geological Association (Love and Christiansen, 1980) from individual geologic maps of the 1° x 2°, 1:250,000-scale quadrangles of the State (**Figure 2**). The chart has been revised to agree with the ages and units shown on the 1985 State geologic map and explanation except where necessary to reflect subsequent revisions. Ver Ploeg added the subsurface terminology. Ages, in millions of years (Ma), of system and series boundaries are shown beside the series columns (see footnote 14 for references; also see Obradovich and Sutter, 1984, for age of Tertiary-Cretaceous boundary). **Figure 3** shows North American Land Mammal Ages and radioisotopic chronology for the Paleogene and Neogene.

Although general age relations are indicated on the chart, subtleties of unit age changes from west to east or from north to south across the State are not shown. Neither relative thicknesses of stratigraphic units nor relative duration of time is implied by the arbitrary vertical dimension of the chart, selected mainly to accommodate space required for lettering.

Most Quaternary surficial and glacial deposits, as well as some Tertiary units such as the Tunp, Angelo, and Fossil Butte Members of the Wasatch Formation, are not shown on the chart although they may be shown on the 1° x 2° geologic quadrangle maps. An arbitrary cutoff between basins and uplifts in adjacent columns was made; it is not the same across the chart.

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EXPLANATION

Unconformity (generally of regional extent) — Hiatus — Rocks in subsurface

Abbreviations used in the columns or figures

Gp	Group	Ss	Sandstone
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Mbr	Member	R	Range
T	Tongue	MTS	Mountains
Ls	Limestone	V	Valley
Cgl	Conglomerate		

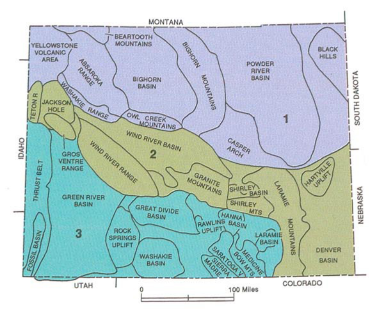

Figure 1. Map of Wyoming showing areas listed in columns A-U. 1, Yellowstone volcanic area to Black Hills; 2, Teton Range to Denver Basin; 3, Thrust Belt to Laramie Basin.

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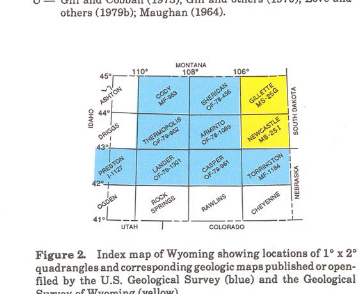

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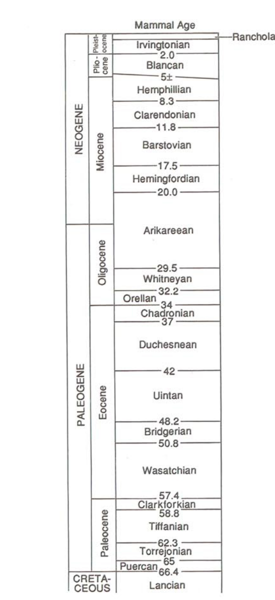

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Stratigraphic Nomenclature Chart of Wyoming

MS-41

FOOTNOTES

[1] Very young age; possibly 0.1 Ma (G.A. Izett, U.S. Geological Survey, oral communication, 1980).

[2] Includes sediments of Potts Hot Springs, till of Bechler Meadows, sediments of Sevenmile Hole, sediments of Upper Falls, sediments of Lower Falls, sediments of Red Rock, and sediments of Inspiration Point (Christiansen and Blank, 1972, p. B6).

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[8] Age 0.73 Ma (Izett and others, 1988).

[9] K-Ar age of sanidine 0.64 Ma and 0.79 Ma (J.D. Obradovich *in* Christiansen and Blank, 1972, p. B12).

[10] K-Ar age 1.1 Ma or less (McDowell, 1971).

[11] Mesa Falls Tuff of Yellowstone Group does not crop out in Wyoming; K-Ar age of sanidine 1.27 Ma (J.D. Obradovich *in* Izett and Wilcox, 1982).

[12] Ash was correlated with source-rock material; age 1.2 Ma (Izett and Wilcox, 1982).

[13] K-Ar age of sanidine 1.6 Ma (Christiansen and Blank, 1972, p. B11).

[14] The boundary used on the State geologic map (Love and Christiansen, 1985) was placed at 2 Ma (Geologic Names Committee, U.S. Geological Survey, "Major geochronologic and chronostratigraphic units [chart]", 1980 edition); the boundary has since been placed at 1.65 Ma (Aguirre and Pasini, 1985).

[15] K-Ar age of sanidine 2.02 Ma (J.D. Obradovich *in* Izett and Wilcox, 1982).

[16] Pleistocene or Pliocene (Love, 1970, p. 100).

[17] Love (1989).

[18] Includes andesite and basalt of Emerald Lake (K-Ar age 2.19 ± 0.08 Ma as reported *in* Love and others, 1976, p. A21), rhyolite of Broad Creek, Junction Butte Basalt, and gravel of Mount Everts.

[19] K-Ar age of intrusive from Pilot Knob 3.40 ± 0.06 Ma (J.D. Obradovich *in* U.S. Geological Survey, 1978, p. 183).

[20] K.M. Flanagan, Southern Illinois University, Carbondale (written communication, 1990).

[21] Age change to Pliocene(?) and Miocene(?), based on stratigraphic position in Idaho between tuff of Kilgore, dated 4.3 Ma, and rhyolite of Kelly Mountain, dated 5.7 Ma (Lisa Morgan, written communication, 1990).

[22] Denson, Zeller, and Stephens (1965, p. A29) considered the South Pass Formation to be "late Miocene to middle Pliocene in age". Recent work by Steidtmann and Middleton (1986) suggests that it may be early Miocene and late Oligocene, and that it intertongues laterally with the Arikaree Formation (Split Rock Formation of this chart). See also Denson and Pipiringos (1974).

[23] Includes Pliocene Gooseberry Member of Fowkes Formation (Oriel and Tracey, 1970).

[24] K-Ar age on obsidian from lag gravels at top of Caldwell Canyon Volcanics at Cougar Pass is reported to be 6.26 Ma (Naeser and others, 1980, p. 19). Subsequent fission-track analyses suggest a much younger age (C.W. Naeser, U.S. Geological Survey, written communication, 1990).

[25] Fission-track ages on zircon from lower part of type section indicate age is 5.0-9.2 Ma (C.W. Naeser, written communication, 1990). May include unnamed red conglomerate in Hoback Canyon area.

[26] For discussion of problems of correlation of Split Rock Formation with Arikaree and Ogallala Formations of Nebraska, see Love (1970, p. 71-73 and Table 8). See Denson (1965) for discussion of Pliocene and Miocene nomenclature in central Wyoming. Mapped as Miocene rocks on State geologic map (Love and Christiansen, 1985).

[27] May include Ogallala Formation or equivalent rocks.

[28] K-Ar age of sanidine 9.2 Ma (Evernden and others, 1964, p. 185).

[29] Ogallala and Arikaree Formations (Denson and Pipiringos, 1974). Mapped as Miocene rocks on State geologic map (Love and Christiansen, 1985).

[30] North Park Formation as shown on State geologic map (Love and Christiansen, 1985) is now considered (Montagne, 1991) to be the upper part of the Browns Park Formation.

[31] Arikaree Formation (Denson, 1965). Mapped as lower Miocene rocks on State geologic map (Love and Christiansen, 1985).

[32] K-Ar age 35.8 ± 0.8 Ma (J.D. Obradovich *in* Love and others, 1976, p. A17).

[33] K-Ar age of quartz latite 44.0 ± 2.6 Ma, of phonolite 43.6 ± 1.0 Ma (Pekarek and others, 1974).

[34] Includes Crater Mountain Dacite and Needle Mountain Granodiorite in Absaroka Range.

[35] WB, Whiskey Butte Bed of Bridger Formation; HC, Hartt Cabin Bed, SB, Sand Butte Bed, LC, LaClede Bed, CH, Cow Hollow Bed, and CC, Craven Creek Bed, all of Laney Member of Green River Formation (Roehler, 1991a).

[36] Of Green River Formation (Roehler, 1991b).

[37] Includes Angelo and Fossil Butte Members.

[38] Divided into (descending order): Bullpen Member, mudstone tongue, sandstone tongue, main body, lower member, and basal conglomerate member; also includes Tunp Member (diamictite), which is equivalent to members above basal member (Oriel and Tracey, 1970).

[39] Of Green River Formation (Roehler, 1991a).

[40] R, Rife Bed; S, Scheggs bed (Roehler, 1991a).

[41] Various fission-track and K-Ar ages ranging from 34 Ma to 55.5 Ma (Bassett, 1961; McDowell, 1971; Hill and others, 1975; Staatz, 1983).

[42] See Love (1970) for discussion of Battle Spring and Wasatch Formations; also see Pipiringos and Denson (1970).

[43] Of Wasatch Formation (Roehler, 1991a).

[44] Lower Eocene or Paleocene (Rubey and others, 1980).

[45] Eocene or Paleocene; older than main part of Wasatch Formation (Love and Christiansen, 1985); shown on State geologic map as conglomerate of Roaring Creek).

[46] Age of Chappo Member of the Wasatch Formation is Eocene and Paleocene. The overlying main body of the Wasatch Formation was called La Barge Member in the preliminary stratigraphic chart (Love and Christiansen, 1980).

[47] Divided into main body, Hams Fork Conglomerate Member, and lower member.

[48] Upper boundary from W.A. Cobban, U.S. Geological Survey (oral communication, 1980).

[49] See Rubey (1973, figure 2) for relations between Aspen Shale, Bear River Formation, and Sage Junction, Quealy, Cokeville, Thomas Fork, and Smiths Formations.

[50] Upper part of Mowry Shale is considered to be early Cenomanian (Late Cretaceous) on the basis of bentonite age determinations (Obradovich and Cobban, 1975) and ammonites (W.A. Cobban, U.S. Geological Survey, written communication, 1989). Odin and Hunziker (1982) indicate the Cenomanian-Albian boundary is within the Mowry Shale. Cobban and Kennedy (1989) place the entire Mowry in the early Cenomanian on the basis of a reassessment of the ammonite zones and their ages.

[51] In local areas of good exposure, black shale directly overlying the Muddy Sandstone Member of the Thermopolis Shale was called Shell Creek Shale by Eicher (1960).

[52] Some classifications show the Muddy Sandstone as the upper member of the Thermopolis Shale. The currently accepted usage in Wyoming considers the Muddy Sandstone to be a formation that is readily mappable in both surface and subsurface areas. This usage restricts the Thermopolis to the lower shale member, designates the Muddy Sandstone a separate formation, and extends the Mowry Shale to the top of the Muddy Sandstone (Love, 1948, p. 106). In the Denver Basin, J sandstone (Colorado terminology) is used in Wyoming only in the subsurface; see Berman and others (1980, p. 119-120).

[53] Eyer (1969, p. 1377) and Furer (1970, p. 2295) reported Upper Jurassic fossils in the lower part of the Ephraim Formation. Caparco (1989) recognized, on the basis of foraminiferal evidence, that a siltstone and claystone sequence below the oldest major conglomerate is of Late Jurassic age. In his unpublished thesis, he named this siltstone and claystone sequence for the Salt River and considered it to be of Oxfordian Age and equivalent to the Redwater Shale Member of the Sundance Formation. He restricted the Ephraim Formation to the overlying conglomeratic Cretaceous part. His interpretation suggests that the Morrison Formation or its lateral equivalent is absent here.

[54] Part of the earliest Cretaceous and latest Jurassic (pre-Kootenai-post-Morrison time) may be missing. See Bralower and others (1990) for age of Cretaceous-Jurassic boundary.

[55] For alternate interpretation of stratigraphic relations, see Pipiringos and O'Sullivan (1978).

[56] Fred Peterson *in* Blakey and others (1988) places the Nugget Sandstone in the Lower Jurassic; Love (1957) considers it to be Triassic.

[57] Intertongues with underlying Popo Agie Formation.

[58] Generally not mappable at 1:24,000 scale.

[59] Mapped as Thaynes(?) and Woodside Formations (U.S. Geological Survey, 1972); therefore restricted to Lower Triassic in this area.

[60] Intertonguing equivalents are Park City Formation, which is primarily cherty dolomite and limestone, and Shedhorn Sandstone, which is primarily sandstone (Sheldon and others, 1967).

[61] Verville (1957), using fusulinid evidence, dated these rocks as Wolfcampian and assigned them to the Tensleep Sandstone. Maughan (1978) does not consider these rocks to be part of the Tensleep Sandstone, but to be an onlapping tongue of the Minnelusa Formation. This sequence may also correlate with a unit recognized at Nowood by McCue (1953) in the lowermost part of the Phosphoria Formation in the Bighorn Basin.

[62] Utah and northwest Colorado terminology; used in Wyoming only in subsurface. See Hansen (1965, p. 42-51).

[63] For alternate interpretations of stratigraphic relations, see Lageson and others (1979), where they discuss the possible unconformable nature of the contact between the Tensleep Sandstone and the Amsden Formation.

[64] Colorado terminology; used in Wyoming only in subsurface. See De Voto (1980, p. 72, figure 1).

[65] E.K. Maughan (U.S. Geological Survey, written communication, 1989; Lageson and others, 1979) believes that there are hiatuses within the Amsden Formation at the top of the Darwin Sandstone Member and at the top of the Ranchester Limestone Member, throughout much of Wyoming. He also considers the Darwin Sandstone Member at the base of the Amsden Formation to be conformable with the underlying Madison Limestone. However, other workers have described the development of widespread karst topography at the top of the Madison. See also Sando and others (1975).

[66] Divisible into Humbug Formation, Mission Canyon Limestone, and Lodgepole Limestone (DeJarnett, 1984).

[67] Sandberg and Klapper (1967).

[68] Sando and Sandberg (1987); Sandberg, Poole, and Johnson (1989, p. 187).

[69] Crops out only in Lincoln County, Wyoming, in Ts.19 and 20 N., Rs.120 and 121 W. C.A. Sandberg, U.S. Geological Survey (oral communication, 1991), considers these outcrops to be the Leigh Dolomite Member of the Bighorn Dolomite.

[70] Devonian and Devonian(?) kimberlite pipes and intrusives. Several diatremes contain diamonds, xenoliths of Silurian and Ordovician limestone and dolomite, fragments of Precambrian crystalline rock, and xenoliths of peridotite, westerite, and eclogite. See Hausel and others (1985).

[71] Kirk (1930).

[72] Upper boundary from Grant (1965).

[73] Boysen Formation of Deiss (1938). Upper boundary from Kurtz (1976).

[74] Upper boundary from Lochman-Balk and Wilson (1967).

[75] Depass Formation of Miller (1936).

[76] Cambrian rocks are transgressive from west to east across Wyoming. The Flathead is assigned a Middle Cambrian age at most localities; however, it may be as young as Late Cambrian where it intertongues with the Deadwood Formation of Late Cambrian and Early Ordovician age.

[77] According to J.A. Lillegraven (written communication, 1992), vertebrate fossils of early Eocene age occur in the upper 1,500 feet of the Hanna Formation in the northeastern corner of the Hanna Basin.

[78] Beginning in 1862, the terms "Dakota Sandstone" or "Dakota Formation" have been used in many ways for stratigraphic units between marine Jurassic and Lower Cretaceous rocks from Oklahoma to the Rocky Mountains and from New Mexico to Montana. Some of the stratigraphic problems are discussed in Keroher and others (1966), Moberly (1960), Ostrom (1970), and Ryer and others (1987), and in references cited by them.

[79] The base of this unit is sometimes referred to locally as the "Dakota silt" (Wyoming Geological Association, 1969).

[80] Formerly called the "Dakota Sandstone" (Darton, 1904), the name was abandoned by Russell (1928) in favor of the present terminology.

[81] The Cloverly Formation, Thermopolis Shale, and Muddy Sandstone are often combined as the "Dakota Sandstone Group" in the subsurface; the Muddy Sandstone under this classification is called the "Dakota Sandstone" (Rocky Mountain Association of Geologists, 1972).

[82] The Cloverly Formation, Thermopolis Shale, and Muddy Sandstone are often combined as the "Dakota Sandstone" in the subsurface in the area north of the Uinta Mountains (Hansen, 1965).

[83] This interval is also called the "Dakota Sandstone" in the subsurface along the Moxa arch (Ryer and others, 1987). The lowermost part of the Bear River Formation, below what is called the Thermopolis Shale to the east and north, and above what is called the Gannett Group to the west, is also called the "Dakota" (Wyoming Geological Association, 1969).

[84] Also known as the Denver-Julesburg Basin, Denver-Cheyenne Basin, and Cheyenne Basin.

[85] Love and Keefer (1969).

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Wyoming State Geological Survey Map Series MS-41

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(Discussion, data sources, footnotes, and selected references)

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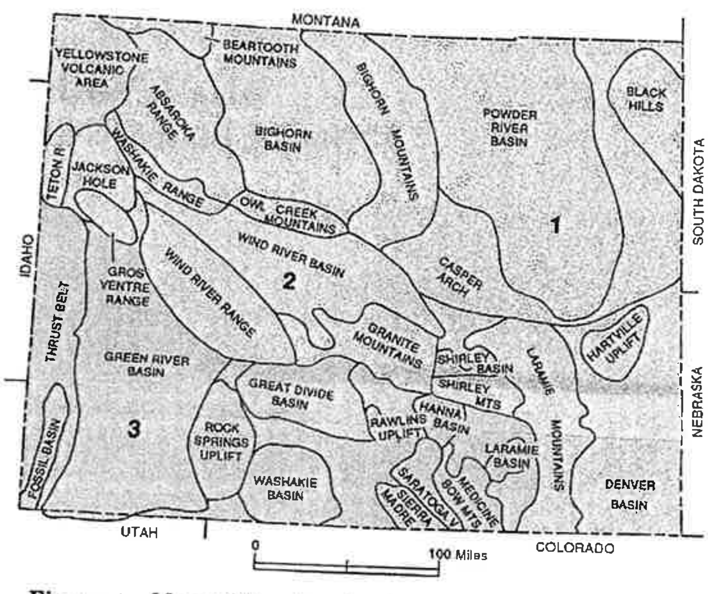

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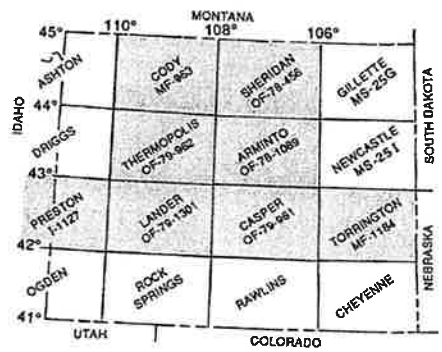

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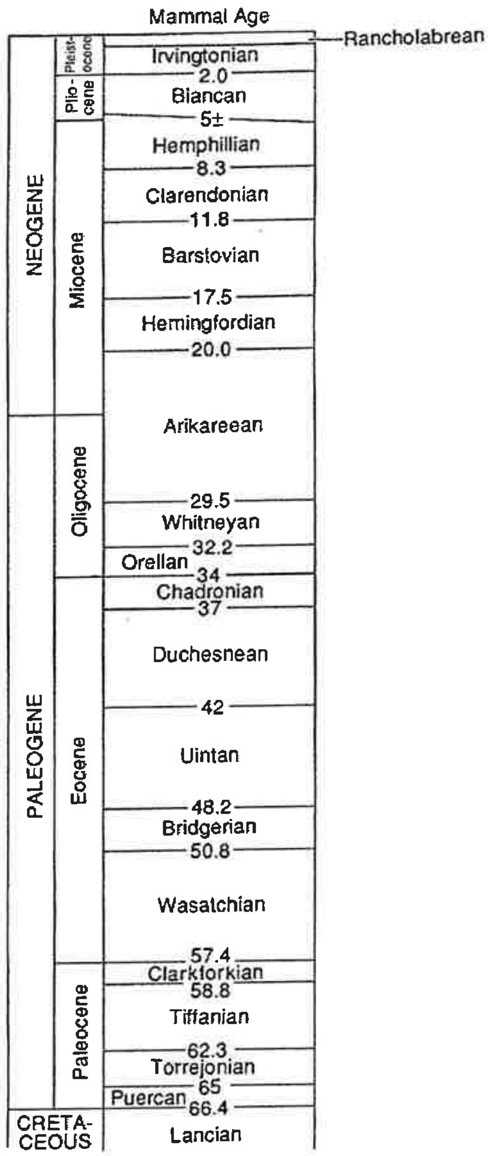

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[7] Lacustrine-fluviatile-glacial sequence along Gros Ventre River (Love, in press).

[8] Age 0.73 Ma (Izett and others, 1988).

[9] K-Ar age of sanidine 0.64 Ma and 0.79 Ma (J.D. Obradovich in Christiansen and Blank, 1972, p. B12).

[10] K-AR age 1.1 Ma or less (McDowell, 1971).

[11] Mesa Falls Tuff of Yellowstone Group does not crop out in Wyoming; K-Ar age of sanidine 1.27 Ma (J.D. Obradovich in Izett and Wilcox, 1982).

[12] Ash was correlated with source-rock material; age 1.2 Ma (Izett and Wilcox, 1982).

[13] K-Ar age of sanidine 1.6 Ma (Christiansen and Blank, 1972, p. Bll).

[14] The boundary used on the State geologic map (Love and Christiansen, 1985) was placed at 2 Ma (Geologic Names Committee, U.S. Geological Survey, "Major geochronologic and chronostratigraphic units [chart]", 1980 edition); the boundary has since been placed at 1.65 Me (Aguirre and Pasini, 1985).

[15] K-Ar age of sanidine 2.02Ma(J.D. Obradovich in lzettand Wilcox, 1982).

[16] Pleistocene or Pliocene (Love, 1970, p. 100).

[17] Love (1989).

[18] Includes andesite and basalt of Emerald Lake (K-Ar age 2.19 ± 0.08 Ma as reported in Love and others, 1976, p. A21), rhyolite of Broad Creek, Junction Butte Basalt, and gravel of Mount Everts.

[19] K-Ar age of intrusive from Pilot Knob 3.40 ± 0.06 Ma (J.D. Obradovich in U.S. Geological Survey, 1978, p. 183).

[20] K.M. Flanagan, Southern Illinois University, Carbondale (written communication, 1990).

[21] Age change to Pliocene(?) and Miocene(?), based on stratigraphic position in Idaho between tuff of Kilgore, dated 4.3 Ma, and rhyolite of Kelly Mountain, dated 5.7 Me (Lisa Morgan, written communication, 1990).

[22] Denson, Zeller, and Stephens (1965, p. A29) considered the South Pass Formation to be 'late Miocene to middle Pliocene in age". Recent work by Steidtmann and Middleton (1986) suggests that it may be early Miocene and late Oligocene, and that it intertongues laterally with the Arikaree Formation (Split Rock Formation of this chart). See also Denson and Pipiringos (1974).

[23] Includes Pliocene Gooseberry Member of Fowkes Formation (Oriel and Tracey, 1970).

[24] K-Ar age on obsidian from lag gravels at top of Caldwell Canyon Volcanics at Cougar Pass is reported to be 6.26 Ma (Naeser and others, 1980, p. 19). Subsequent fission-track analyses suggest a much younger age (C.W. Naeser, U.S. Geological Survey, written communication, 1990).

[25] Fission-track ages on zircon from lower part of type section indicate age is 5.0-9.2 Ma (C.W. Naeser, written communication, 1990). May include unnamed red conglomerate in Hoback Canyon area.

[26] For discussion of problems of correlation of Split Rock Formation with Arikaree and Ogallala Formations of Nebraska, see Love (1970, p. 71-73 and Table 8). See Denson (1965) for discussion of Pliocene and Miocene nomenclature in central Wyoming. Mapped as Miocene rocks on State geologic map (Love and Christiansen, 1985).

[27] May include Ogallala Formation or equivalent rocks.

[28] K-Ar age of sanidine 9.2 Ma (Evernden and others, 1964, p. 185).

[29] Ogallala and Arikaree Formations (Denson and Pipiringos, 1974). Mapped as Miocene rocks on State geologic map (Love and Christiansen, 1985).

[30] North Park Formation as shown on State geologic map (Love and Christiansen, 1985) is now considered (Montagne, 1991) to be the upper part of the Browns Park Formation.

[31] Arikaree Formation (Denson, 1965). Mapped as lower Miocene rocks on State geologic map (Love and Christiansen, 1985).

[32] K-Ar age 35.8 ± 0.8 Ma (J.D. Obradovich in Love and others, 1976, p. A17).

[33] K-Ar age of quartz latite 44.0 ± 2.6 Ma, of phonolite 43.6 1.0 Ma (Pekarek and others, 1974).

[34] Includes Crater Mountain Dacite and Needle Mountain Granodiorite in Absaroka Range.

[35] WB, Whiskey Butte Bed of Bridger Formation; HC, Hartt Cabin Bed, SB, Sand Butte Bed, LC, LaClede Bed, CH, Cow Hollow Bed, and CC, Craven Creek Bed, all of Laney Member of Green River Formation (Roehler, 1991a).

[36] Of Green River Formation (Roehler, 199lb).

[37] Includes Angelo and Fossil Butte Members.

[38] Divided into (descending order): Bullpen Member, mudstone tongue, sandstone tongue, main body, lower member, and basal conglomerate member; also includes Tunp Member (diamictite), which is equivalent to members above basal member (Oriel and Tracey, 1970).

[39] Of Green River Formation (Roehler, 199la).

[40] R, Rife Bed; S, Scheggs bed (Roehler, 1991a).

[41] Various fission-track and K-Ar ages ranging from 34 Ma to 55.5 Me (Bassett, 1961; McDowell, 1971; Hill and others, 1975; Staatz, 1983).

[42] See Love (1970) for discussion of Battle Spring and Wasatch Formations; also see Pipiringos and Denson (1970).

[43] Of Wasatch Formation (Roehler, 1991a).

[44] Lower Eocene or Paleocene (Rubey and others, 1980).

[45] Eocene or Paleocene; older than main part of Wasatch Formation (Love and Christiansen, 1985); shown on State geologic map as conglomerate of Roaring Creek).

[46] Age of Chappo Member of the Wasatch Formation is Eocene and Paleocene. The overlying main body of the Wasatch Formation was called La Barge Member in the preliminary stratigraphic chart (Love and Christiansen, 1980).

[47] Divided into main body, Hams Fork Conglomerate Member, and lower member.

[48] Upper boundary from W.A. Cobban, U.S. Geological Survey (oral communication, 1980).

[49] See Rubey (1973, figure 2) for relations between Aspen Shale, Bear River Formation, and Sage Junction, Quealy, Cokeville, Thomas Fork, and Smiths Formations.

[50] Upper part of Mowry Shale is considered to be early Cenomanian (Late Cretaceous) on the basis of bentonite age determinations (Obradovich and Cobban, 1975) and ammonites (W.A. Cobban, U.S. Geological Survey, written communication, 1989). Odin and Hunziker (1982) indicate the Cenomanian-Albian boundary is within the Mowry Shale. Cobban and Kennedy (1989) place the entire Mowry in the early Cenomanian on the basis of a reassessment of the ammonite zones and their ages.

[51] In local areas of good exposure, black shale directly overlying the Muddy Sandstone Member of the Thermopolis Shale was called Shell Creek Shale by Eicher (1960).

[52] Some classifications show the Muddy Sandstone as the upper member of the Thermopolis Shale. The currently accepted usage in Wyoming considers the Muddy Sandstone to be a formation that is readily mappable in both surface and subsurface areas. This usage restricts the Thermopolis to the lower shale member, designates the Muddy Sandstone a separate formation, and extends the Mowry Shale to the top of the Muddy Sandstone (Love, 1948, p. 106). In the Denver Basin, J sandstone (Colorado terminology) is used in Wyoming only in the subsurface; see Berman and others (1980, p. 119-120).

[53] Eyer (1969, p. 1377) and Furer (1970, p. 2295) reported Upper Jurassic fossils in the lower part of the Ephraim Formation. Caparco (1989) recognized, on the basis of foraminiferal evidence, that a siltstone and claystone sequence below the oldest major conglomerate is of Late Jurassic age. In his unpublished thesis, he named this siltstone and claystone sequence for the Salt River and considered it to be of Oxfordian Age and equivalent to the Redwater Shale Member of the Sundance Formation. He restricted the Ephraim Formation to the overlying conglomeratic Cretaceous part. His interpretation suggests that the Morrison Formation or its lateral equivalent is absent here.

[54] Part of the earliest Cretaceous and latest Jurassic (preKootenai-post-Morrison time) may be missing. See Bralower and others (1990) for age of Cretaceous-Jurassic boundary.

[55] For alternate interpretation of stratigraphic relations, see Pipiringos and O'Sullivan (1978).

[56] Fred Peterson in Blakey and others (1988) places the Nugget Sandstone in the Lower Jurassic; Love (1957) considers it to be Triassic.

[57] Intertongues with underlying Pope Agie Formation.

[58] Generally not mappable at 1:24,000 scale.

[59] Mapped as Thaynes(?) and Woodside Formations (U.S. Geological Survey, 1972); therefore restricted to Lower Triassic in this area.

[60] Intertonguing equivalents are Park City Formation, which is primarily cherty dolomite and limestone, and Shedhorn Sandstone, which is primarily sandstone (Sheldon and others, 1967).

[61] Verville (1957), using fusulinid evidence, dated these rocks as Wolfcampian and assigned them to the Tensleep Sandstone. Maughan (1978) does not consider these rocks to be part of the Tensleep Sandstone, but to be an onlapping tongue of the Minnelusa Formation. This sequence may also correlate with a unit recognized at Nowood by McCue (1953) in the lowermost part of the Phosphoria Formation in the Bighorn Basin.

[62] Utah and northwest Colorado terminology; used in Wyoming only in subsurface. See Hansen (1965, p. 42-51).

[63] For alternate interpretations of stratigraphic relations, see Lageson and others (1979), where they discuss the possible unconformable nature of the contact between the Tensleep Sandstone and the Amsden Formation.

[64] Colorado terminology; used in Wyoming only in subsurface. See De Veto (1980, p. 72, figure 1).

[65] E.K. Maughan (U.S. Geological Survey, written communication, 1989; Lageson and others, 1979) believes that there are hiatuses within the Amsden Formation at the top of the Darwin Sandstone Member and at the top of the Ranchester Limestone Member, throughout much of Wyoming. He also considers the Darwin Sandstone Member at the base of the Amsden Formation to be conformable with the underlying Madison Limestone. However, other workers have described the development of widespread karat topography at the top of the Madison. See also Sando and others (1975).

[66] Divisible into Humbug Formation, Mission Canyon Limestone, and Lodgepole Limestone (DeJarnett, 1984).

[67] Sandberg and Klapper (1967).

[68] Sando and Sandberg (1987); Sandberg, Poole, and Johnson (1989, p. 187).

[69] Crops out only in Lincoln County, Wyoming, in Ts. 19 and 20 N., Rs. 120 and 121 W. C.A. Sandberg, U.S. Geological Survey (oral communication, 1991), considers these outcrops to be the Leigh Dolomite Member of the Bighorn Dolomite.

[70] Devonian and Devonian(?) kimberlite pipes and intrusives. Several diatremes contain diamonds, xenoliths of Silurian and Ordovician limestone and dolomite, fragments of Precambrian crystalline rock, and xenoliths of peridotite, westerite, and eclogite. See Hausel and others (1985).

[71] Kirk (1930).

[72] Upper boundary from Grant (1965).

[73] Boysen Formation of Deiss (1938). Upper boundary from Kurtz (1976).

[74] Upper boundary from Lochman-Balk and Wilson (1967).

[75] Depass Formation of Miller (1936).

[76] Cambrian rocks are transgressive from west to east across Wyoming. The Flathead is assigned a Middle Cambrian age at most localities; however, it may be as young as Late Cambrian where it intertongues with the Deadwood Formation of Late Cambrian and Early Ordovician age.

[77] According to J.A. Lillegraven (written communication, 1992), vertebrate fossils of early Eocene age occur in the upper 1,500 feet of the Hanna Formation in the northeastern corner of the Hanna Basin.

[78] Beginning in 1862, the terms "Dakota Sandstone' or 'Dakota Formation' have been used in many ways for stratigraphic units between marine Jurassic and Lower Cretaceous rocks from Oklahoma to the Rocky Mountains and from New Mexico to Montana. Some of the stratigraphic problems are discussed in Keroher and others (1966), Moberly (1960), Ostrom (1970), and Ryer and others (1987), and in references cited by them.

[79] The base of this unit is sometimes referred to locally as the "Dakota silt' (Wyoming Geological Association, 1969).

[80] Formerly called the 'Dakota Sandstone' (Darton, 1904), the name was abandoned by Russell (1928) in favor of the present terminology.

[81] The Cloverly Formation, Thermopolis Shale, and Muddy Sandstone are often combined as the "Dakota Sandstone Group' in the subsurface; the Muddy Sandstone under this classification is called the 'Dakota Sandstone' (Rocky Mountain Association of Geologists, 1972).

[82] The Cleverly Formation, Thermopolis Shale, and Muddy Sandstone are often combined as the "Dakota Sandstone" in the subsurface in the area north of the Uinta Mountains (Hansen, 1965).

[83] This interval is also called the "Dakota Sandstone' in the subsurface along the Moxa arch (Ryer and others, 1987). The lowermost part of the Bear River Formation, below what is called the Thermopolis Shale to the east and north, and above what is called the Gannett Group to the west, is also called the "Dakota' (Wyoming Geological Association, 1969).

[84] Also known as the Denver-Julesburg Basin, Denver-Cheyenne Basin, and Cheyenne Basin.

[85] Love and Keefer (1969).

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