Chapter SN

A SUMMARY OF COAL IN THE COALMONT FORMATION (TERTIARY), NORTH PARK BASIN, COLORADO

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INTRODUCTION

North Park Basin is an intermontane structural basin occupying an area of about 2,250 mi^2 in north-central Colorado (fig. SN-1). The basin is bounded on the east and west by the Front and Park Ranges, respectively, and on the north by Independence Mountain (fig. SN-2). The southern margin of the basin is delimited by volcanic rocks of the Rabbit Ears Range, which separate the North and Middle Park topographic basins. North Park Basin is the northern end of the larger North-Middle Park structural basin (Tweto, 1975; Wellborn, 1977), which formed after uplift and erosion of the Front and Park Ranges in latest Cretaceous or earliest Tertiary time (Tweto, 1975; Maughan, 1989). As a result of the erosion, lower Tertiary rocks in the structural basin unconformably overlie deposits ranging in age from Late Cretaceous to Precambrian (Tweto, 1975).

Sedimentary rocks in North Park Basin are Permian to Quaternary in age, and the maximum cumulative thickness of pre-Quaternary units is about 17,000 ft (Hail, 1965); the oldest Tertiary rocks are included in the Paleocene-Eocene Coalmont Formation (Beekly, 1915; Hail and Leopold, 1960). The Coalmont Formation unconformably overlies Upper Cretaceous marine deposits of the Pierre Shale throughout most of the basin. In the central part of North Park Basin, the formation is unconformably overlain by post-Laramide alluvial strata of the White River (Oligocene) and North Park (Miocene-Pliocene) Formations (Hail, 1965) (fig. SN-3). The Coalmont Formation is composed of conglomerate, sandstone, siltstone, shale, carbonaceous shale and coal beds. Two of the coal beds (the Sudduth and Riach coal beds) locally exceed 50 ft in thickness. Because of erosion prior to deposition of the White River and North Park Formations, the original thickness of the Coalmont Formation cannot be determined. Tweto (1975) suggested that the preserved thickness of the formation may approach 11,000 ft; Hail (1968) estimated a possible aggregate thickness of about 12,000 ft .

This report presents a brief summary of the coal geology, coal quality, and production history of Tertiary coal deposits in the Coalmont Formation in North Park Basin. Significant coal deposits are present in areas surrounding the small community of Coalmont in the southwestern part of the basin, and in areas near the North and South McCallum anticlines, east of the town of Walden (Beekly, 1915) (fig. SN-4). In the Coalmont area, historic production focused on the Riach coal bed, although small wagon mines were developed on local, unnamed coal beds (Beekly, 1915). Erdmann (1941) estimated original coal reserves in parts of T. 7 N, Rs. 80 and 81 W., in the Coalmont district to be on the order of 177,450,000 tons. Historic production in the McCallum anticline district primarily targeted the Sudduth coal bed and Beekly (1915) estimated that the total Sudduth coal resources in a 60 mi^2 area adjacent to the south McCallum anticline were on the order of 2,073,600,000 short tons, with about 1,152,000,000 tons of that total considered as recoverable under prevailing mining conditions at that time.

Within the framework of the National Coal Resource Assessment (NCRA) project of the U.S. Geological Survey, Coalmont Formation coal is considered as “low priority” in terms of its viability as a significant production target in the near future. This low prioritization is not intended to preclude all possibility of future coal production within the basin. However, in the context of the NCRA project the concept of “low priority” suggests a degree of skepticism with regard to any large-scale upswing or significant rejuvenation of coal mining in the area during the next couple of decades.

COAL GEOLOGIC FRAMEWORK

Hail (1968) subdivided the Coalmont Formation in southwestern North Park basin into the following three members (ascending order): the Middle Park Member, middle member, and upper member (fig. SN-5). The Middle Park Member and the middle member are Paleocene in age, whereas the upper member is considered to be Eocene in age (Hail and Leopold, 1960). The Middle Park Member consists of conglomerate, conglomeratic and arkosic sandstone, sandy claystone, and rare carbonaceous shale and coal beds; this member is only present in the extreme southwest area of the basin. The overlying middle member consists primarily of arkosic and conglomeratic sandstone interbedded with sandy claystone, carbonaceous shale, and thin coal beds. In much of the area surrounding Coalmont and to the south, the middle member is in unconformable contact with the underlying Cretaceous Pierre Shale. In outcrops north of Coalmont and in drill holes to the east, Hail (1968) recognized three units in the middle member (fig. SN-5): a lower unit (as much as 1,130 ft thick) composed of interbedded conglomerate, sandstone, and sandy mudstone beds; a middle unit (about 630 ft thick) of gray to brownish-gray silty shale; and an upper unit (as thick as 435 ft) of interbedded conglomerate, conglomeratic sandstone, and olive-green, brown, or gray mudstone beds. The thickness of these individual units is highly variable throughout the Coalmont area. The upper member of the Coalmont Formation is characterized by interbedded sandstone, mudstone, carbonaceous shale, and locally thick coal beds; conglomerate is rare. The lower part of the upper member primarily consists of carbonaceous shale that varies in thickness from 775 ft just southwest of Coalmont to as much as 1,000 ft in exposures along Chedsey Creek, north of Coalmont (Hail, 1968). Overlying the carbonaceous shale is an 800-ft-thick interval of interbedded micaceous sandstone, shale, carbonaceous shale, and coal; the Riach coal bed, as well as coal included in the Pole Mountain-Mexican Creek coal zone are within this interval. The uppermost part of the upper member includes beds of arkosic sandstone, mudstone, and only sparse carbonaceous shale and coal. Hail (1968) interpreted the contact between the Middle and upper members to be unconformable.

Using outcrop and subsurface data, Hendricks (1977; 1978) developed a palynostratigraphic framework for the middle and upper members of the Coalmont Formation in the Coalmont district. He identified 3 "process-controlled genetic units" (units 1-3, ascending order; fig. SN-5) in the middle member, which are essentially correlative to the 3 informal units identified by Hail (1968). An important aspect of this study was the identification of lower Eocene palynomorphs in the upper part of the middle member (unit 3), below the Paleocene-Eocene unconformity proposed by Hail (1968). Based on this evidence, Hendricks (1977) suggested that the contact between the middle and upper members is best interpreted as a diastem rather than an unconformity. Additionally, Hendricks (1977) assigned strata of the middle member below unit 3 to the upper Paleocene.

Stands (1992), in studies of the Coalmont Formation in the McCallum anticline area, identified palynomorphs of middle Paleocene age in the Sudduth coal bed, which is within 100-200 ft of the sub-Coalmont unconformity along the flanks of the south McCallum anticline (Roberts, unpublished data, 1993). He also recognized upper Paleocene palynomorphs in the Capron coal zone, some 2,000 ft stratigraphically above the Sudduth coal bed (Beekly, 1915), which established a relative age equivalency to the middle member deposits in the Coalmont area. Based on these criteria, Stands (1992) included the Sudduth coal bed, the Capron coal zone, and all intervening strata in eastern North Park Basin in the middle member of the

Coalmont Formation (fig. SN-5). The upper member of the Coalmont Formation (or its age equivalent) is not present in the McCallum anticline district.

Based on these studies, and the identification of alternating alluvial and lacustrine successions in the Coalmont Formation (Roberts and Flores, 1996), a generalized stratigraphic framework for the formation in North Park Basin (fig. SN-6) suggests that development of peat-forming mires in the McCallum anticline district was associated with alluvial deposition (river and floodplain environments) that predominated during the middle Paleocene and early part of the late Paleocene. Peat-forming environments in the Coalmont district were closely associated with thick lake successions that prevailed in North Park Basin in the later Paleocene and the early Eocene.

COAL BEDS AND COAL ZONES

The discussion that follows is taken primarily from Beekly (1915), and unless otherwise noted, his report should be considered as the primary source for this compilation.

MCCALLUM ANTICLINE DISTRICT

Sudduth coal bed

The Sudduth coal bed is present in outcrops along the flanks of the south McCallum anticline and in some places, has burned naturally to form resistant deposits of clinker. Along the eastern flank of the south McCallum anticline, coal bed dips are commonly on the order of 60°-70° to the east and locally approach a vertical orientation. The coal bed ranges from about 25-30 ft thick in areas near the abandoned Bourg surface mine (fig. SN-4), and increases to more than 50 ft in areas in and north of the site of the Marr strip mine. At the southern end of the south McCallum anticline, the Sudduth coal bed thins to less than 20 ft.

Hoyle coal bed

The Hoyle coal bed has only been identified in highwall exposures in the abandoned Bourg strip mine, and likely is present only in the mine area (Walden coal company, unpublished field data, 1987). The coal bed is about 18 ft thick, and is about 90-95 ft stratigraphically above the Sudduth coal bed.

Capron coal zone

The Capron coal zone is about 2,000 ft stratigraphically above the Sudduth coal bed, and includes two coal beds separated by as much as 300 ft of strata. The upper bed attains a thickness of 11-12 ft in the abandoned Capron mine. The lower bed typically comprises a 6-ft-thick interval of thin coal stringers and carbonaceous shale partings.

Winscom coal zone

Like the Capron coal zone, the Winscom coal zone contains two coal beds separated by several hundred feet of rock. The coal beds are generally on the order of 5-6 ft thick, and commonly consist of carbonaceous shale with thin coal interbeds. It is likely that this coal zone is correlative to the Capron coal zone, but discontinuous exposures hamper an understanding of the exact stratigraphic relation.

Hill coal bed

This coal bed was identified in one abandoned adit on the east side of the Michigan River in the southwest 1/4 of T. 10 N., R. 79 W. (fig. SN-4). No thickness is reported and its stratigraphic position is uncertain, although it may be roughly equivalent (in part) to the Capron and Winscom coal zones.

COALMONT DISTRICT

Pole Mountain-Mexican Creek coal zone

The Pole Mountain-Mexican Creek coal zone is the designation for coal beds that outcrop in the Pole Mountain and Mexican Creek areas as described by Hail (1968); we interpret the coal at both localities to be stratigraphically equivalent. The coal zone is immediately above the uppermost thick succession of lacustrine deposits (fig. SN-6) in the upper member of the Coalmont Formation on Pole Mountain, and is below the Riach coal bed, although the exact thickness of the intervening interval is not well established. Coal beds in this zone are lenticular, and locally contain abundant carbonaceous shale partings. The coal beds are typically a few ft thick or less, although some shaley coal beds may attain a thickness of about 9 ft (see, for example, Hail, 1968).

Riach coal bed

This coal bed is prevalent in the vicinity of Coalmont (fig. SN-4), and has been correlated in drill holes to an area 4-5 miles east and southeast of Coalmont (see, for example, Madden 1977). The thickness of the coal bed is quite variable, and can range from less than 5 ft to more than 66 ft in the area of the abandoned Riach mine at Coalmont. Based on studies of Erdmann (1941), Hail (1968) reports a maximum Riach coal bed thickness of as much as 80 ft. However, based on correlation of subsurface data from coal exploratory drill holes (see, for example, Madden, 1977), the Riach coal bed or its interpreted equivalent more commonly ranges in thickness from 20-40 ft. Additionally, the coal bed can include abundant carbonaceous shale partings, although locally the bed consists of clean, hard coal throughout.

Additional, unnamed coal beds are also present within the middle member of the Coalmont Formation at horizons well below the Riach coal bed and the Pole Mountain-Mexican Creek coal zone. The thickness of these coal beds generally ranges from 2 ft or less to as much as 6 ft locally. Most of the thick coal beds in the Coalmont district are restricted to the upper member of the formation.

COAL PRODUCTION

There is currently no coal mining in North Park Basin, and most of the historic mines have been completely abandoned and mostly reclaimed. Little or nothing is published on the amount of coal produced from the numerous small wagon mines that ranchers and local citizens developed in both the McCallum and Coalmont districts during the late 1800's and the early 1900's. One can probably assume that production totals from these mines were negligible compared to subsequent commercial ventures, and that most of the coal produced was for local domestic use.

Mining of the Riach coal bed (Coalmont district) began in the late 1800's in the Riach mine near Coalmont. By 1915, this mine was operated by the Northern Colorado Coal Company and approached a capacity of 800 tons per day. The first commercial mining in this area began in 1909, and continued until the end of World War II (Hail, 1968). A new surface mine began in 1959, although production ceased a few years later (Hail, 1968). Erdmann (1941), as reported in Hail (1968), estimated that total production in the Coalmont district was on the order of 1,438,355 tons as of 1941. At the time of this writing, no additional data on production in subsequent years could be located.

More recent surface mining of coal in North Park took place in the McCallum anticline district where, for a period of years in the early 1980's, as many as three surface mines (the Bourg, Marr, and Canadian surface mines; fig. SN-4) produced coal from the Sudduth coal bed along the flanks of the south McCallum anticline. The Marr mine was the first to open in 1974, followed by the Canadian mine in 1975, and the Bourg mine in 1980 (Kelso and others, 1981). Cumulative production totals as of 1981 were 3,021,404 tons from the Marr strip mine; 600,567 tons from the Canadian strip mine; and 48,796 tons from the newly developed Bourg mine (Kelso and others, 1981). Production totals in years subsequent to 1981 are somewhat incomplete, but based on data in the Keystone Coal Industry Manual (years 1982-95), we estimate that additional production was on the order of 1,066,000 tons from the Marr mine and 243,000 tons from the Bourg mine. No additional production reports for the Canadian mine could be found at the time of this writing. The Canadian strip mine was listed as inactive by 1985 and the Bourg mine by 1987 (Keystone Coal Industry Manual, 1985, 1987). The Marr mine ceased mining coal subsequent to 1993, and was fully reclaimed by spring of 1995.

COAL QUALITY

Most of the reported chemical analyses of coal from North Park Basin relate to the Sudduth and Riach coal beds, which by far were the primary coal beds of commercial interest. The Sudduth coal bed apparent rank varies from subbituminous B to subbituminous A, whereas the apparent rank of the Riach coal bed ranges from subbituminous C to subbituminous B (Hatch and others, 1979).

Proximate analyses (on an as-received basis) of 3 samples of the Sudduth coal bed, collected from small underground mines by Beekly (1915), indicate moisture ranging from 16.7 to 20.0 percent, ash yield ranging from 3.59 to 6.29 percent, total sulfur content varying from 0.16 to 0.59 percent, and heat-of-combustion values ranging from 9,640 to 10,360 Btu/lb. Chemical analyses (on an as-received basis) of an isolated sample from the Winscom mine (Winscom coal zone) yielded moisture of 18.1 percent, an ash yield of 12.13 percent, total sulfur content of 0.08 percent, and a calorific value of 9,280 Btu/lb.

As-received analyses of five samples from the Sudduth coal bed in the Canadian strip mine (Colorado Geological Survey, 1981) indicate moisture ranging from 14.5 to 16.1 percent (arithmetic mean of 15.0 percent), ash yield ranging from 3.2 to 19.2 percent (arithmetic mean of 8.4 percent), total sulfur content consistently at 0.2 percent for all samples, and heat-of-combustion values ranging from 8,580 to 10,990 Btu/lb (arithmetic mean of 10,218 Btu/lb). As-received analyses of seven bench samples of the Sudduth coal bed in the Marr strip mine (Colorado Geological

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Survey, 1981) show moisture ranging from 11.0 to 14.4 percent (arithmetic mean of 12.71 percent), ash yield ranging from 2.1 to 10.8 percent (arithmetic mean of 5.9 percent), total sulfur content ranging from 0.2 to 0.3 percent (arithmetic mean of 0.25 percent), and calorific values ranging from 10,040 to 11,280 Btu/lb (arithmetic mean of 10,755 Btu/lb).

Chemical analyses (on an as-received basis) from 21 samples of the Sudduth coal bed (Hatch and others, 1979) indicate moisture ranging from 11.0 to 20.7 percent (arithmetic mean of 15.0 percent), ash yield varying from 2.1 to 19.2 percent (arithmetic mean of 8.0 percent), total sulfur content ranging from 0.2 to 0.6 percent (arithmetic mean of 0.3 percent), and heat-of-combustion values ranging from 8,580 to 11,280 Btu/lb (arithmetic mean of 10,135 Btu/lb).

As-received analyses of the Riach coal bed in the Coalmont district, based on 12 samples, indicate moisture ranging from 14.5 to 20.2 percent (arithmetic mean of 17.59 percent), ash yield ranging from 5.1 to 37.0 percent (arithmetic mean of 16.6 percent), total sulfur content varying from 0.3 to 1.4 percent (arithmetic mean of 0.7 percent), and heat-of-combustion values ranging from 6,520 to 9,570 Btu/lb (arithmetic mean of 8,200 Btu/lb) (Colorado Geological Survey and U.S. Geological Survey, 1981).

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Figure SN-1. Map showing North Park Basin and associated coal basins in the Northern Rocky Mountains and Great Plains region.

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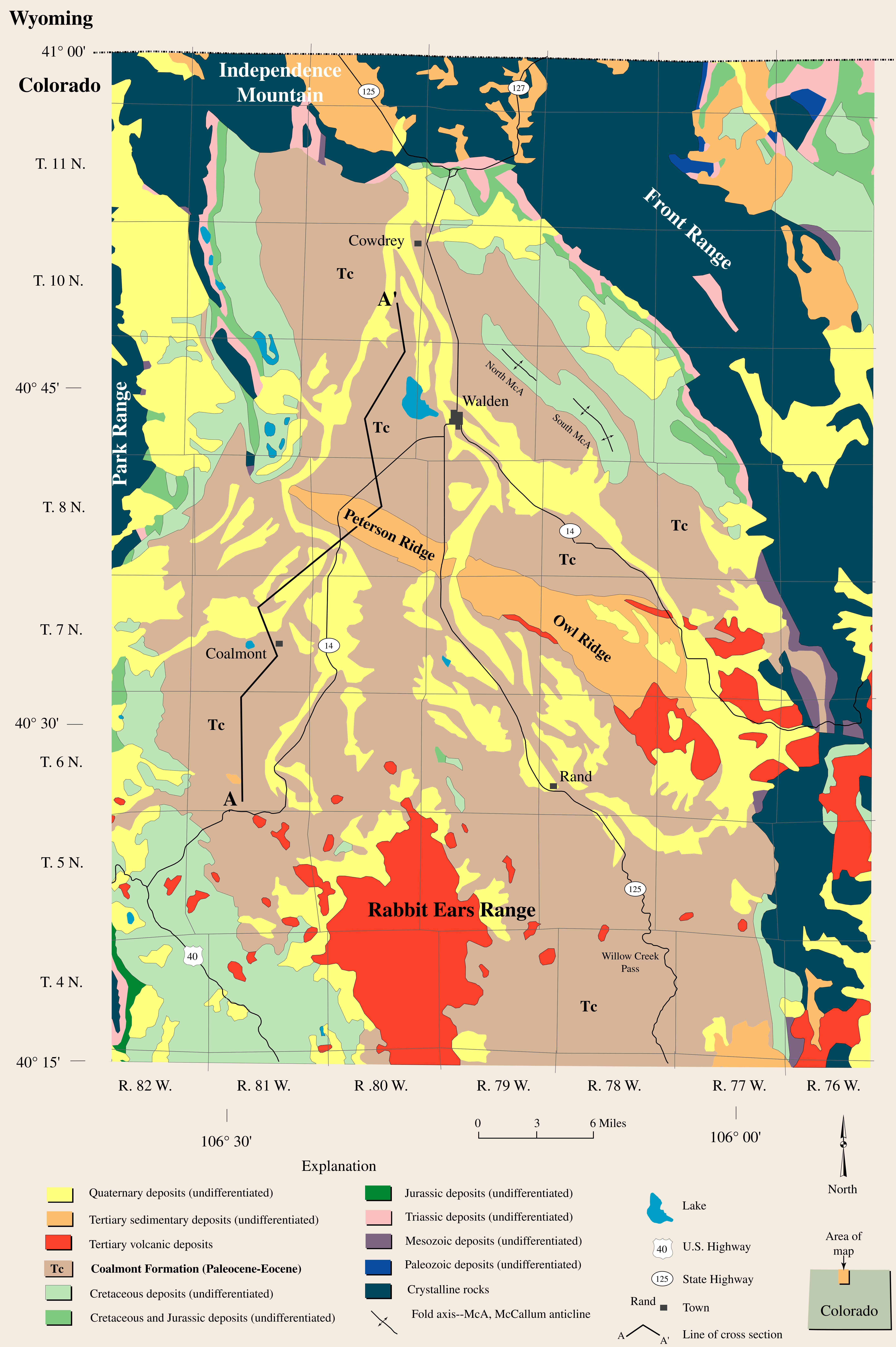

Figure SN-2. Generalized geologic map of the North Park Basin and vicinity, Colorado. Geology modified from Green (1992).

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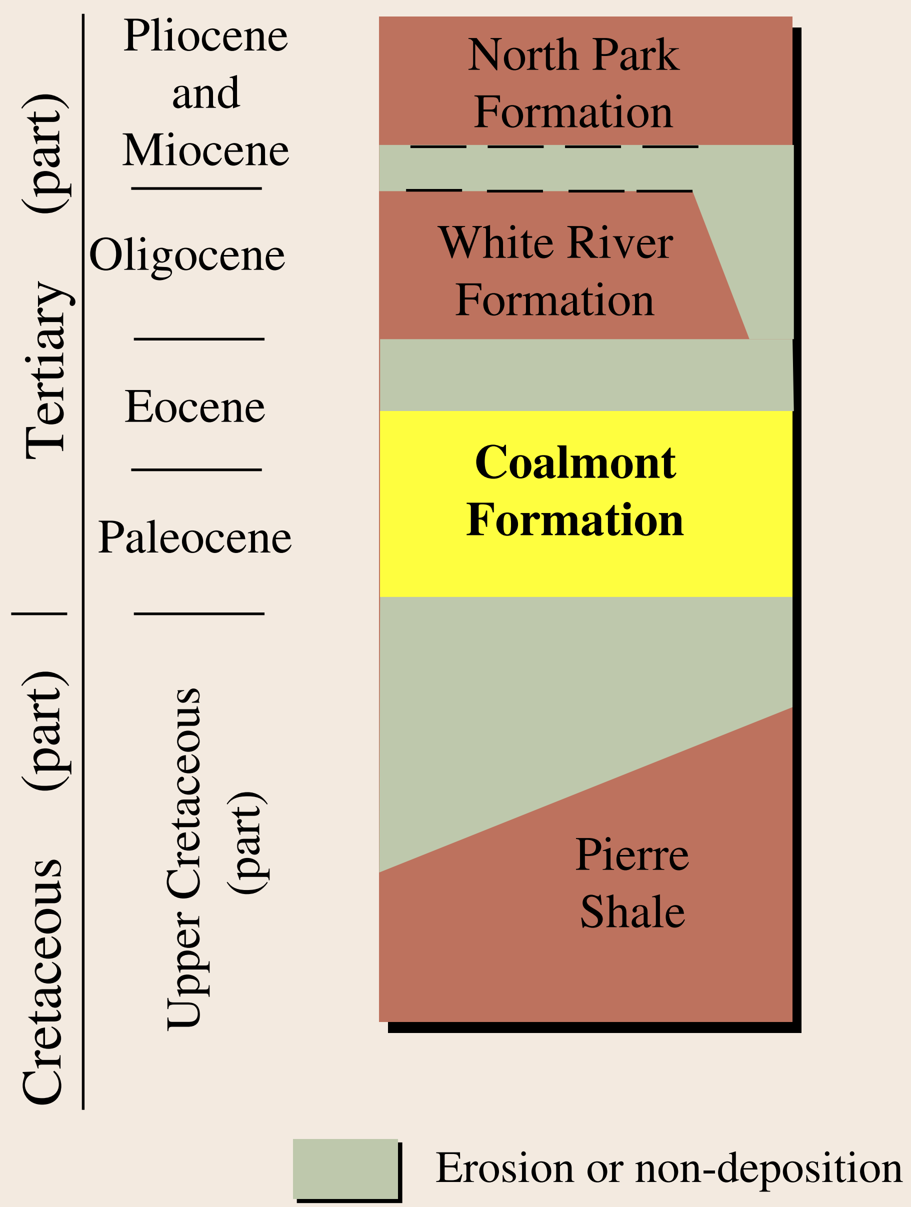

Figure SN-3. Generalized chart (not to scale) showing Upper Cretaceous (part) and Tertiary stratigraphic nomenclature for North Park Basin, Colorado. Modified from Rocky Mountain Association of Geologists (1980).

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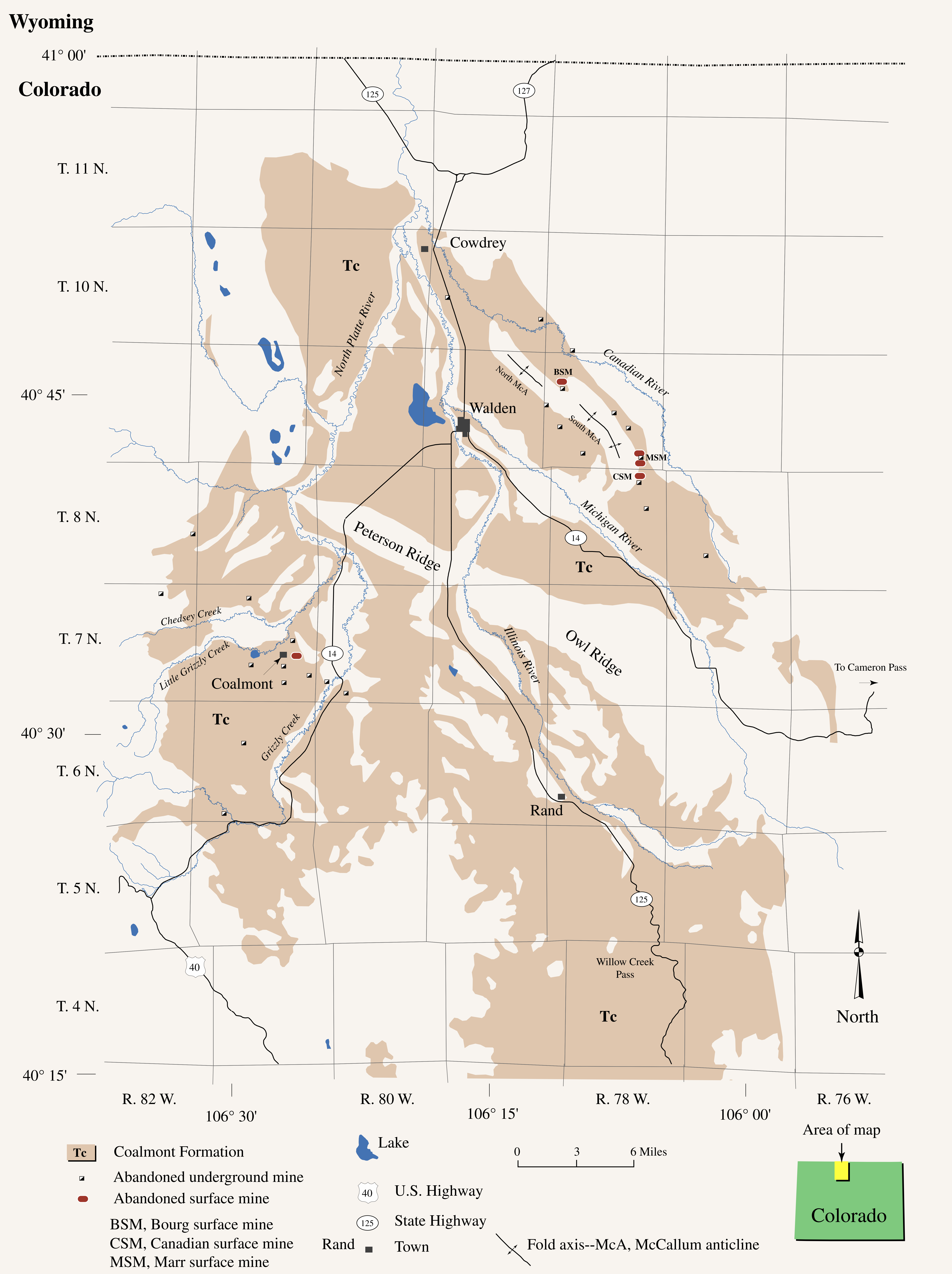

Figure SN-4. Map showing the location of abandoned underground and surface coal mines, North Park basin, Colorado. Locations of coal mines adapted from Beekly (1915) and Jones and others (1978).

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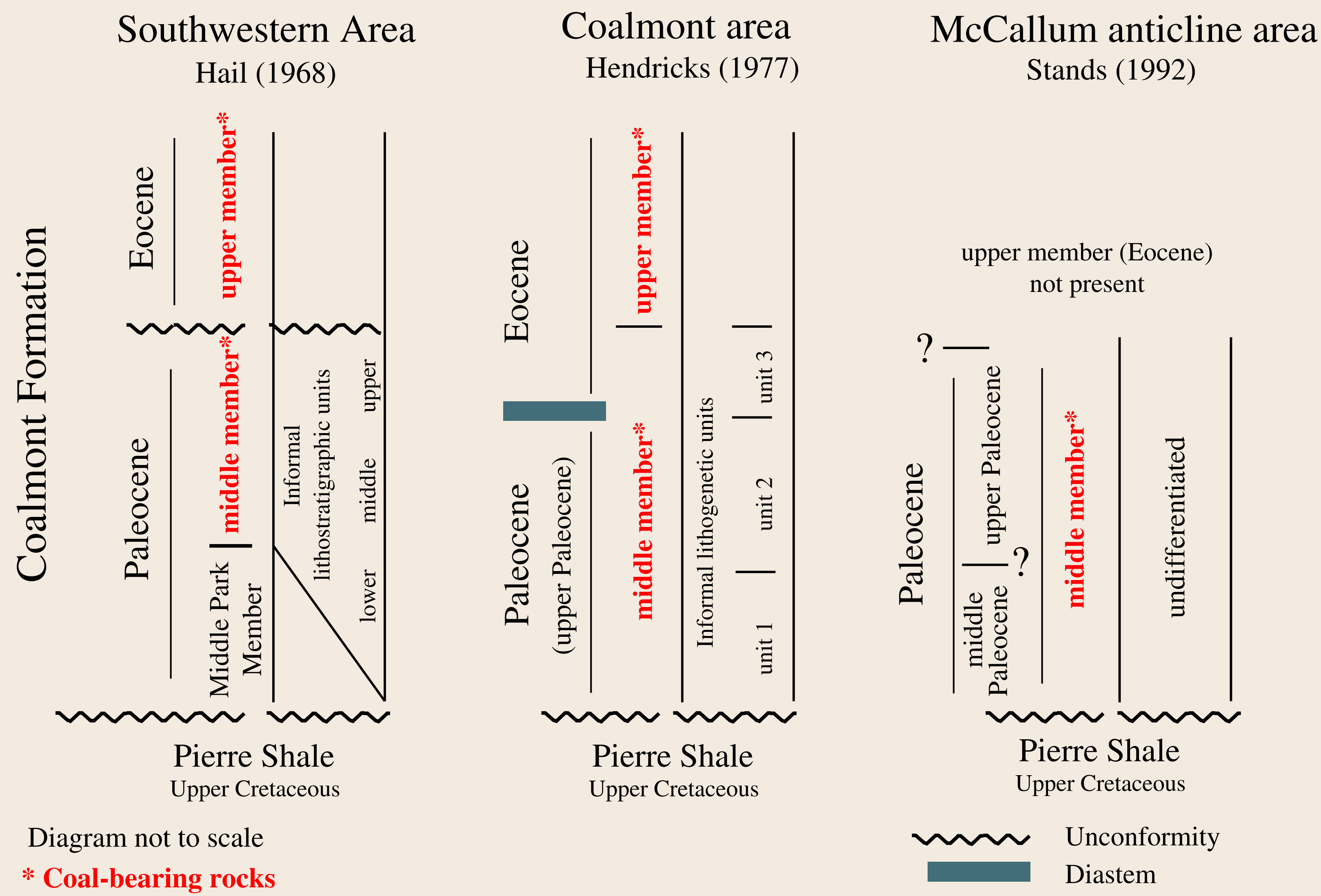

Figure SN-5. Chart showing stratigraphic nomenclature for Paleocene-Eocene deposits in the Coalmont Formation, North Park Basin, Colorado. Nomenclature modified from Hail (1968), Hendricks (1977), and Stands (1992).

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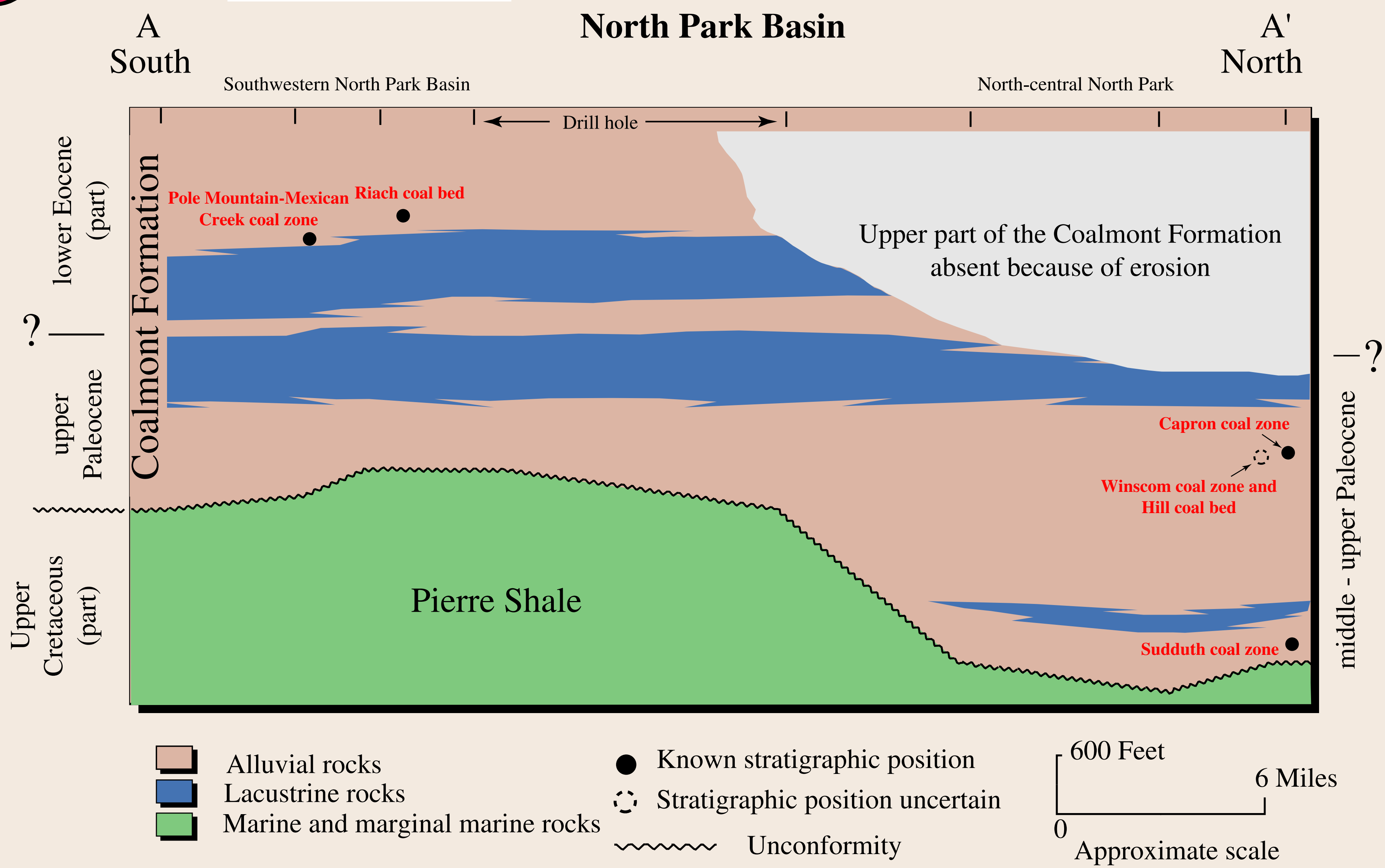

Figure SN-6. Diagrammatic cross section showing the distribution of alluvial and lacustrine successions, and the stratigraphic position of major coal beds or zones, Coalmont Formation, North Park Basin, Colorado. Cross section location shown in figure SN-2.