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CONTACT OF THE BURRO CANYON FORMATION WITH THE DAKOTA SANDSTONE, SLICK ROCK DISTRICT, COLORADO, AND CORRELATION OF THE BURRO CANYON FORMATION*

By

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CONTACT OF THE BURRO CANYON FORMATION WITH THE DAKOTA SANDSTONE, SLICK ROCK DISTRICT, COLORADO, AND CORRELATION OF THE BURRO CANYON FORMATION

By George C. Simmons

ABSTRACT

Weathering of shales in the upper part of the Burro Canyon formation and the lower part of the overlying Dakota sandstone has made recognition of the disconformity between the formations difficult in the Disappointment basin area of the Slick Rock district, San Miguel and Dolores Counties, Colo. In lieu of the basal conglomerate of the Dakota sandstone which marks the contact between the formations in the surrounding region, the presence of abundant carbonaceous material in shales of the Dakota sandstone distinguishes them from the green shales in the Burro Canyon formation. The contact of the two formations, where clearly exposed in Disappointment basin, is conformable, sharp, and not gradational.

Correlation of the Burro Canyon formation of western Colorado with Stokes' Cedar Mountain formation of central and eastern Utah is substantiated by the discovery in the Burro Canyon formation of two pelecypods, Protelliptio douglassi and "Unio" farri with the conifer, Frenelopsis variens. The pelecypods also occur in the Kootenai-Cloverly fauna of Montana and Wyoming. The Kootenai-Cloverly fauna contains the pelecypod Eupera onestae which is found in Stokes' Cedar Mountain formation. The conifer also occurs in the Trinity group of Texas. The Trinity group contains the charophyte Clavator harrisi which is found in the Cedar Mountain formation of Stokes.

INTRODUCTION

During the past two decades Lower Cretaceous sedimentary rocks have been recognized over a large part of the Colorado Plateau. Post-Morrison, pre-Dakota rocks have long been recognized as a distinct lithologic unit in the region (Coffin, 1921, p. 97-118), but for a number of years were believed to be Jurassic or Late Cretaceous in age. Later, mapping and the discovery of fossils led to the assignment of an Early Cretaceous age. The first formation names applied to probable Lower Cretaceous rocks on the Colorado Plateau were Stokes' Buckhorn conglomerate and Cedar Mountain shale (Stokes, 1944, p. 958, 965-67). In 1952, Stokes (p. 1774) revised this to make the Buckhorn conglomerate the lower member of the Cedar Mountain formation. The Cedar Mountain formation occurs in central and eastern Utah. Stokes and Phoenix (1948) applied the name Burro Canyon formation to rocks of the same stratigraphic position in western Colorado.

This paper discusses the contact of the Burro Canyon formation with the Dakota sandstone in the Slick Rock district, western San Miguel and Dolores Counties, Colo. (figs. 1 and 2), with special attention given to its unusual nature in the structural basin underlying the northwest end of Disappointment Valley. In addition, fossil evidence is presented that substantiates the correlation of the Burro Canyon formation with Stokes' Cedar Mountain formation.

For the past 3 years the U. S. Geological Survey, on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission, has been making a detailed study of the geology and uranium deposits in the Slick Rock district. This report is an outgrowth of that study.

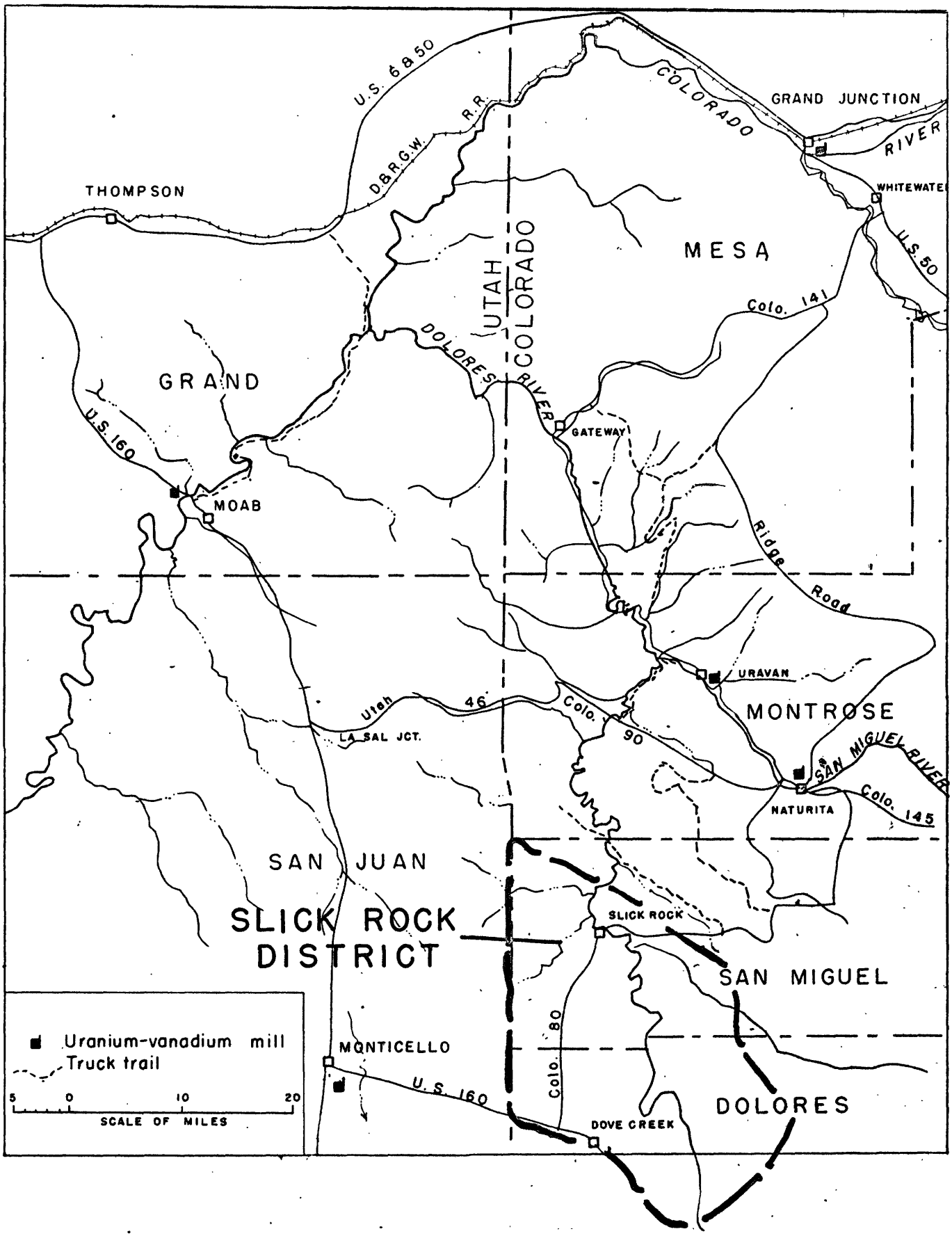

FIGURE 1.--MAP OF PART OF THE COLORADO PLATEAU SHOWING LOCATION OF THE SLICK ROCK DISTRICT, SAN MIGUEL AND DOLORES COUNTIES, COLO.

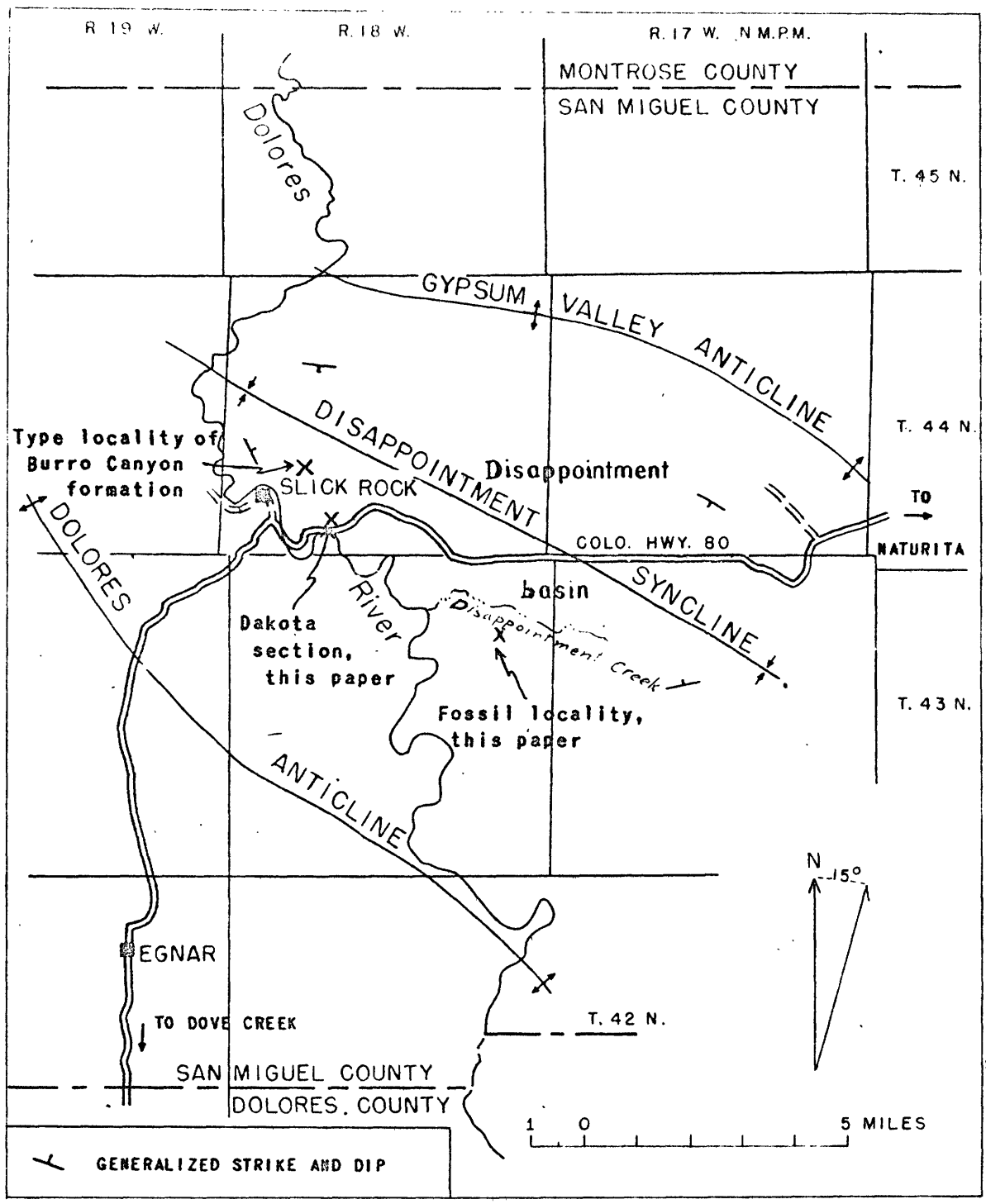

FIGURE 2.--MAP OF PART OF THE SLICK ROCK DISTRICT, SHOWING LOCALITIES REFERRED TO IN TEXT.

GENERAL GEOLOGY

The oldest rock unit exposed in the Slick Rock district is the Cutler formation of Permian age. Rocks of Mesozoic age above the Cutler formation are, in ascending order: the Chinle formation and Wingate sandstone of Triassic age; the Kayenta formation of Jurassic(?) age; the Navajo sandstone of Jurassic and Jurassic(?) age; the Carmel formation, Entrada sandstone, Summerville formation, Junction Creek sandstone and Salt Wash sandstone and Brushy Basin shale members of the Morrison formation of Jurassic age; and the Burro Canyon formation, Dakota sandstone, and Mancos shale of Cretaceous age. The Junction Creek sandstone is recognized in only the southeast portion of the district. The Navajo sandstone is locally absent on the axis of the Dolores anticline. All other rock units are present throughout the district.

The dominant structural features of the district are the northwest-trending Dolores anticline and the parallel Disappointment syncline 6 miles to the northeast. The Disappointment syncline lies between the Dolores anticline and the collapsed Gypsum Valley anticline which is farther northeast, outside of the district (fig. 2). Disappointment Valley coincides with most of the Disappointment syncline. At the northeast end of the valley along the synclinal axis there is a structural basin known as Disappointment basin (fig. 2).

Most of the post-Wingate formations are thicker along the Disappointment syncline than along the Dolores anticline. The thickening is most noticeable in Disappointment basin where the post-Wingate, pre-Mancos

section is twice the thickness of the same section on the Dolores anticline (fig. 3). Within this stratigraphic interval the rock units that thicken most are the Navajo sandstone, both members of the Morrison formation, and the Burro Canyon formation.

THE BURRO CANYON FORMATION

The name, Burro Canyon formation, was proposed by Stokes and Phoenix (1948) for:

> ". . . a relatively thin sequence of rocks of probable Lower Cretaceous age lying between the Morrison formation and the Dakota sandstone. It includes essentially the same rocks as those designated 'Post-McElmo' by Coffin (1921).. The type locality is in Burro Canyon, sec. 29, T. 44 N., R. 18 W. The formation consists of alternating conglomerate, sandstone, shale, limestone and chert ranging from 150 to 260 feet in thickness. The sandstones and conglomerates are gray, yellow, and brown, and the shales are varicolored, mainly purple and green. Assignment to the Lower Cretaceous is mainly by analogy with surrounding regions and is tentative pending study of fossil evidence. The lower contact is at the base of the lowest, resistant, light-colored, conglomeratic sandstone above the varicolored Brushy Basin shale member of the Morrison; the upper boundary is placed above the highest varicolored beds so as to exclude any carbonaceous shales or sandstones in which plant fragments are abundant. This contact has no topographic expression but is remarkably persistent and usable over a wide

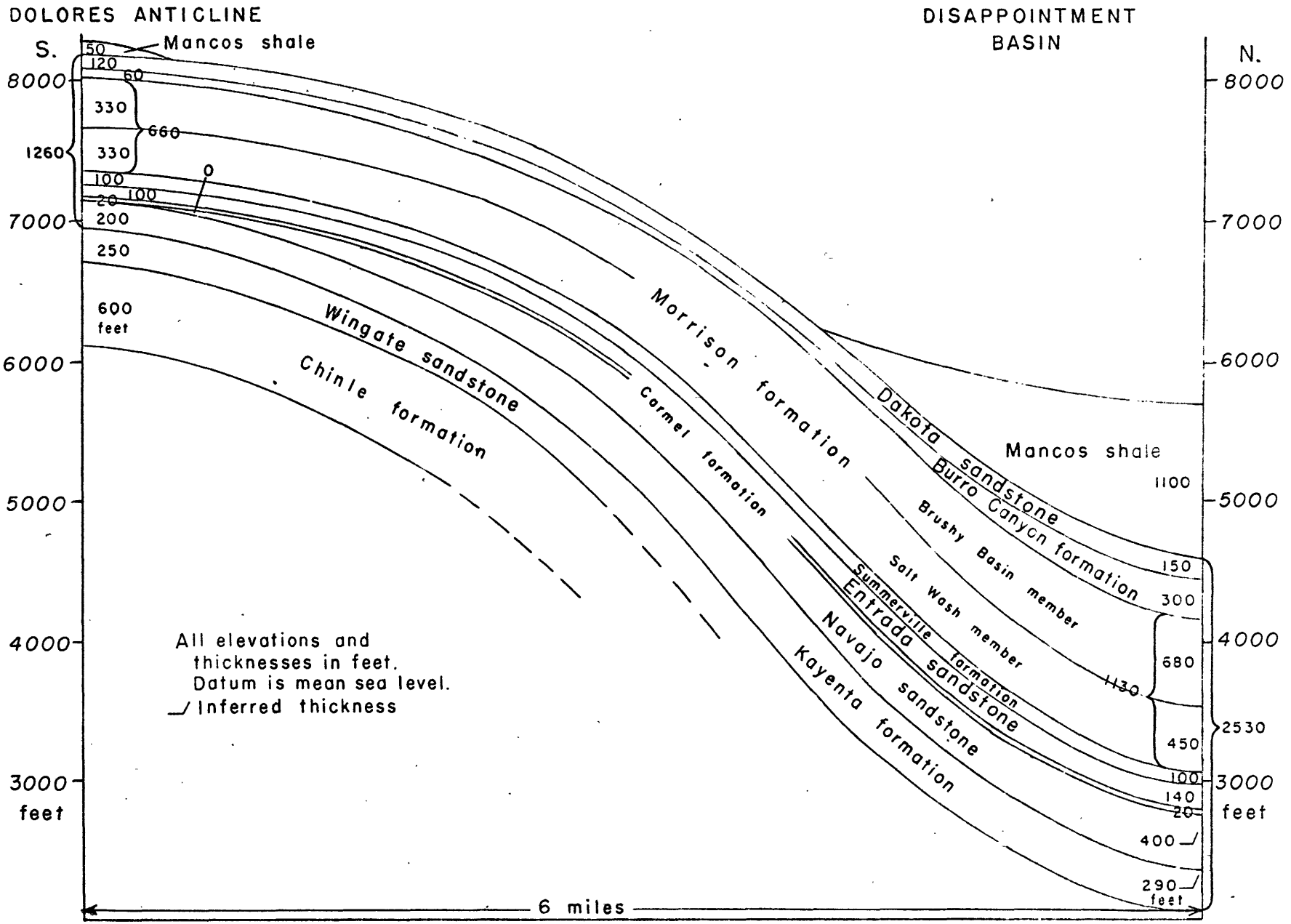

FIGURE 3.--DIAGRAMMATIC SECTION SHOWING THE RELATION OF FORMATION THICKNESSES TO THE DOLORES ANTICLINE AND DISAPPOINTMENT BASIN.

area in and adjoining Gypsum Valley. The Burro Canyon formation shows a slight thinning in passing over the crests of the Dolores anticline and the Gypsum Valley anticline; this may indicate a slight upgrowth of these structures during the early Cretaceous."

The lithology of the Burro Canyon formation at the type locality is not typical of the formation throughout the Slick Rock district. In most places in the district the Burro Canyon formation consists of one conglomeratic sandstone bed, as much as 80 feet thick but in most places about 60 feet thick, which contains a few thin greenish-gray mudstone "splits." Locally a few feet of greenish-gray mudstone occurs above the sandstone.

In and about Disappointment basin, the lithology of the Burro Canyon formation is similar to the lithology at the type locality (fig. 2). The sandstones are more numerous and thicker than they are away from the basin, and the formation includes green shale and green and gray limestone and chert. The lower part of the formation is dominantly gray to light-brown conglomeratic sandstone with some shale, and grades upward into a dominantly argillaceous sequence containing limestone, chert, and sandstone. The upper sixth of the formation is almost entirely green shale. A 240-foot thick section was measured by Stokes (1952, p. 1773) near the type locality. The maximum thickness of the Burro Canyon formation in Disappointment basin is in excess of 300 feet, as indicated by exploratory diamond drilling for the U. S. Geological Survey.

Most sandstones in the Burro Canyon formation in the Slick Rock district are conglomeratic, but particles larger than small pebbles are rare. In a few places thin layers of "basal conglomerate" in sandstone beds contain cobbles and small boulders of sandstone, mudstone, limestone, and quartzite. Sandstone units in the Burro Canyon formation are commonly 60 feet or more thick. Weathering of sparse pyrite to limonite imparts a light-buff color to sandstones of the Burro Canyon in most places.

The contact of the Burro Canyon formation with the underlying Brushy Basin shale member of the Morrison formation is mapped, in the Slick Rock district, at the base of a prominent sandstone unit which generally is in contact with shale units of the Brushy Basin member. Although the contact is commonly a disconformity marked by scours and sandstone-filled channels, the contact in many other places is gradational, marked by intertonguing of Burro Canyon sandstone with Brushy Basin shale. Also, in many places, thicker sandstones near the base of the Brushy Basin member resemble sandstones of the underlying Salt Wash member whereas thicker sandstones near the top of the Brushy Basin resemble sandstones of the overlying Burro Canyon formation. These relations indicate that in the Slick Rock district deposition was essentially continuous from Morrison (Late Jurassic) into Burro Canyon (Early Cretaceous) time.

THE DAKOTA SANDSTONE

The term Dakota sandstone has been applied to rocks on the Colorado Plateau that are similar in lithology and stratigraphic position to rocks of the Dakota sandstone in the western Great Plains. The Dakota sandstone

in much of the Slick Rock district is like that of the surrounding region: a lower sandstone unit with a basal conglomerate, intermediate carbonaceous shale unit, and an upper sandstone unit.

The poorly exposed contact of the Dakota sandstone with the overlying Mancos shale seems sharp, but carbonaceous "Dakota-like" sandstones occur near the base of the Mancos formation, and the two formations may interfinger. As shown in drill core, the contact of the Mancos and Dakota formations in Disappointment Valley is gradational within a few feet.

Except for the basal conglomerate in the Dakota sandstone, conglomerates are rare in the formation in the Slick Rock district. Carbonaceous material is abundant throughout most of the Dakota sandstone, though locally it is absent, particularly in the lower sandstone unit. However, limonitic and siliceous plant molds are common in the basal conglomerate. Sandstone units in the Dakota are generally less than 40 feet thick. Weathering of abundant pyrite in the Dakota has imparted a yellowish-brown color to the sandstones in most places.

In Disappointment basin the Dakota sandstone lacks the lower sandstone unit. A section of Dakota sandstone measured in Joe Davis Canyon and in adjacent Diasppointment Valley ($SW\frac{1}{4}$, sec. 28, T. 44 N., R. 18 W., Hamm Canyon quadrangle, Colo.), is typical of the Dakota sandstone in Disappointment basin:

Top (feet)	Base (feet)	Thickness (feet)	
000	025	25	Sandstone, light-brown, medium fine-grained; 10 percent interstitial clay; trace limonite stain; thin-bedded; cross-bedded; top of Dakota sandstone; overlain by Mancos shale.
025	042	17	Shale, dark-gray; 15 percent carbonaceous material; abundant limonite stain; few thin sandstone and siltstone lenses.
042	061	19	Sandstone, light greenish-brown, medium- to medium fine-grained; 10 percent interstitial clay; abundant carbonaceous material in a few thin layers, trace limonite stain; thin-bedded; crossbedded.
061	065	4	Shale, dark-gray; 10 percent carbonaceous material; trace limonite stain.
065	071	6	Sandstone, light-brown and light- and dark-gray, medium- to fine-grained; moderate limonite stain; sparse carbonaceous material; thin-bedded; crossbedded.
071	082	11	Shale, dark-gray; few thin sandstone lenses; poorly exposed.
082	089	7	Sandstone, light greenish-gray, fine-grained; 10 percent interstitial clay; trace mica; trace limonite stain; crossbedded.

Top (feet)	Base (feet)	Thickness (feet)	
089	102	13	Mudstone, shale, coal, and claystone, dark- and light-gray; sparse limonite stain; trace hematite stain; few thin sandstone lenses.
102	108	6	Sandstone, light-brown, very fine grained; 15 percent interstitial clay; sparse carbonaceous seams and flakes.
108	118	10	Thin alternating layers of sandstone, light greenish-gray, fine-grained, with dark-gray shale; abundant carbonaceous material; trace limonite stain; trace pyrite in twig fragments; thin coatings of gypsum on a few fractures.
118	120	2	Coal, dark-brown to black; 20 percent mudstone; trace limonite stain.
120	123	3	Sandstone, gray to light yellowish-brown; fine-grained; 10 percent carbonaceous material; 10 percent interstitial clay.
123	125	2	Shale, dark-gray; abundant carbonaceous material; abundant limonite stain; base of Dakota sandstone; underlain by shales of the Burro Canyon formation.

Total thickness of Dakota sandstone is 125 feet.

CONTACT OF THE BURRO CANYON FORMATION WITH THE DAKOTA SANDSTONE

Several of the better criteria used to distinguish the Burro Canyon formation from the Dakota sandstone in the Slick Rock district are: 1) Fossil plants and carbonaceous material are rare in the Burro Canyon formation and abundant in the Dakota sandstone. 2) Pyrite is more abundant in the Dakota sandstone than in the Burro Canyon formation. Oxidation of the pyrite has imparted a yellowish-brown color to both formations, but the color is more intense in the Dakota sandstone. 3) Shales of the Dakota sandstone are carbonaceous, and hence some shade of gray. The shales of the Burro Canyon formation are greenish gray except for minor occurrences of reddish-brown shale and rare occurrences of gray carbonaceous shales. 4) Conglomerates are common in the Burro Canyon formation, less common in the Dakota sandstone. 5) Because of their greater thickness, Burro Canyon sandstones generally form more prominent cliffs and hogbacks than the thinner Dakota sandstones.

The contact between the Burro Canyon formation and the overlying Dakota sandstone, as described by Stokes, is marked by a disconformity. In tracing the contact into New Mexico and Arizona, Craig and others (1955, p. 161) have noted that the disconformity between the Burro Canyon and Dakota becomes an angular unconformity and pre-Dakota warping and erosion have removed Lower Cretaceous and Upper and Lower Jurassic formations.

The contact between the two formations has been described by Carter (1957) in the nearby Mt. Peale No. 1 quadrangle, Utah and Colorado, as " . . . extremely undulatory in nature . . . Broad channels filled with Dakota conglomerate have been observed in contact with light-green mudstone, limestone, chert, and in many places, the thick sandstone with conglomerate lenses which comprises the basal unit of the Burro Canyon. Included in the basal unit of the Dakota are angular and subangular fragments of rock from the beds through which the channels are scoured."

Over most of the Slick Rock district too, the Burro Canyon formation and Dakota sandstone are separated by a disconformity; that is, the contact is slightly irregular and is marked by channel scours. In the scours the basal conglomerate of the Dakota contains cobbles and slabs of sandstone of the Burro Canyon. The sandstone of the Burro Canyon in places is bleached to as much as 3 feet below the disconformity; this may represent pre-Dakota weathering on a surface of the Burro Canyon formation.

Towards Disappointment basin the contact becomes more conformable with relatively few and shallow scours. In this peripheral area the Burro Canyon formation thickens and the lower arenaceous unit of the Dakota sandstone becomes shaly and loses its identity.

In Disappointment basin the contact of the Burro Canyon with the Dakota is apparently conformable. The lower sandstone unit of the Dakota sandstone is absent, and the contact must be determined by the presence of carbonaceous material in the shale of the Dakota sandstone and by a silty chert marker bed near the top of the Burro Canyon formation.

The latter is 1 to 5 feet thick and is overlain by as much as 12 feet of greenish-gray, carbon-free shale of the Burro Canyon formation. Exposures of the contact in Disappointment basin are not common due to the weathering of shales above and below the contact. However, at all exposures found, the contact of carbonaceous shales of the Dakota with green shales of the Burro Canyon is conformable, sharp, and not gradational.

FOSSIL EVIDENCE FOR THE AGE OF THE BURRO CANYON FORMATION

Fossils were collected from the Burro Canyon formation by Stokes in T. 43 N., R. 18 W., about half a mile east-southeast of the junction of Disappointment Creek with the Dolores River, in the Slick Rock district (fig. 2). The collection includes ganoid fish scales, fresh water ostracods, and plant fragments. The plant fragments were identified by Brown (Stokes, 1952, p. 1767) as Frenelopsis variens. Brown (1950, p. 50) regards Frenelopsis variens as an early Cretaceous index fossil because neither it nor any of its close relatives have been found outside strata of Early Cretaceous age.

In November 1955, the writer and D. R. Shawe, while looking for Stokes' locality, found a new fossil locality at approximately the same horizon. A few days later the site was revisited with L. C. Craig and others, and a large collection of fossils was made. The locality (fig. 2) is in the NE¼, NW¼, NE¼, sec. 11, T. 43 N., R. 18 W., San Miguel County, Colo., in the Hamm Canyon quadrangle, 1,000 feet south of Disappointment Creek in a wash indicated as an intermittent stream on the quadrangle map. The wash enters Disappointment Creek on its south side, and the mouth of the wash is 6,000 feet from the junction of Disappointment Creek with the Dolores River.

The fossils occur in a 10-foot zone of interbedded black to green shale, green siltstone, and fine-grained sandstone. The top of the interval is 18 feet below the top of the Burro Canyon formation. The following fossils have been identified: Protelliptio douglassi Stanton; "Unio" farri Stanton; Nippononaia asinaria Reeside[1]; Nippononaia sp.[1]; Viviparid gastropod;

[1] New pelecypod species described in a paper being prepared by J. B. Reeside, Jr.

Cypridea ?; Darwinula ?; Ganoid fish scales; Frenelopsis variens Fontaine; Pinus susquaensis Dawson; and Fern pinnules.

The mollusca were identified by J. B. Reeside, Jr. (written communication, 1956), who states: "This assemblage, like most nonmarine faunas, contains many individuals of a few species. It is only moderately well preserved, but can be determined with considerable confidence. The new species is unlike anything I have seen in the older faunas."

According to J. B. Reeside, Jr. (written communication, 1956), the pelecypods are all unioid types. Protelliptio douglassi and "Unio" farri are well known and widespread Early Cretaceous (Aptian) species in the faunas of the Kootenai and Cloverly formations in Montana and Wyoming (Henderson, 1935, p. 25, 76; Yen, 1949, p. 466; Yen, 1951, p. 1-3). The new species belongs to Nippononaia, a Lower Cretaceous genus of Japan (written communication from J. B. Reeside, Jr., 1956).

The ostracods, Cypridea ? and Darwinula ? were examined by I. G. Sohn (written communication, 1956) who states: "The ostracods are fairly common, but unfortunately, the preservation is such that they cannot be identified

with any degree of certainty. Gross form suggests the general to which they are referred with a great deal of uncertainty."

The plant material was examined by R. W. Brown who found Frenelopsis variens to be abundant. Frenelopsis variens has been described from the Trinity group of Texas (Fontaine, 1893, p. 273). Only one specimen of Pinus susquaensis was found.

The age of both Stokes' collection and the present collection is most certainly Early Cretaceous. However, no fossil evidence has been found to determine the age of the sandstone beds which form the lower part of the Burro Canyon formation in Disappointment basin and most of the formation away from the basin. The sandstone beds may be of Late Jurassic age and/or of Early Cretaceous age.

FOSSIL EVIDENCE FOR AGE OF STOKES' CEDAR MOUNTAIN FORMATION

Stokes (1944, p. 967) was the first to report fossils from his Cedar Mountain formation. The fossils were nondiagnostic dinosaur bone fragments from the upper or shale member of the formation. More recently collections have been made from two localities in the shale member, both yielding Early Cretaceous fossils.

The first of the two localities is about 16 miles southeast of Castle Dale, Utah, and is in sec. 20, T. 19 S., R. 9 E. The collection, made by Katich (1951), included the fresh water pelecypod, Eupera onestae (McLearn); the fern, Tempskya sp.; and abundant unidentified ostracods. Cobban (in Katich, 1951, p. 2094) notes Eupera onestae (Aptian age) as common in the Kootenai formation of northern Montana and southern Alberta. Stokes later collected from the same locality, adding ganoid fish scales to the list

of fossils. Stokes also collected specimens of Tempskya sp. which were tentatively identified by Andrews (in Stokes, 1952, p. 1769) as Tempskya minor Read and Brown. Tempskya minor is known from the Aspen formation of Wyoming and equivalent parts of the Wayan formation in Idaho.

The second locality is in sec. 22, T. 22 S., R. 20 E., on the southwest flank of the Salt Valley anticline, Grand County, Utah. The site was discovered by Stokes who collected gastropods, pelecypods, and microfossil material. Stokes referred the microfossil material to Peck (Stokes, 1952, p. 1768) who identified three ostracod species: Metacypris angularis, Cypridea cf C. brevicornis, Cypredea wyomingensis; and the charophyte, Clavator harrisi. In regard to these fossils Peck states: "All of these are common fossils in the Gannett group, the Cloverly of northwestern Wyoming, and the limestones in the upper Kootenai of Montana. Clavator harrisi is common in the Trinity of the Gulf coast. None of these species occurs in the Morrison of the Front Range in Colorado, in eastern Wyoming, or in the Black Hills. Their occurrence is an excellent indication of the Lower Cretaceous age of the formation."

In view of the identifications, an Early Cretaceous age seems assured for the shale member of Stokes' Cedar Mountain formation. No fossil evidence has been found to establish the age of the Buckhorn conglomerate member of the formation. Like the age of the thick sandstone units of the Burro Canyon formation, the age of the Buckhorn conglomerate may be Late Jurassic and/or Early Cretaceous.

CORRELATION OF THE BURRO CANYON FORMATION WITH STOKES' CEDAR MOUNTAIN FORMATION

Collections of fossils from the upper part of the Burro Canyon formation in Disappointment basin and from the shale member of Stokes' Cedar Mountain formation have been determined to be of Early Cretaceous age. As yet, collections have not shown any species common to both formations. However, both formations have species found together in other Lower Cretaceous rock units. The accompanying table (table 1) lists the index fossils used to correlate the Burro Canyon formation with Stokes' Cedar Mountain formation and also lists the rock units in which the fossils occur.

SUMMARY

Throughout most of the Slick Rock district the Burro Canyon formation is composed of a conglomeratic sandstone about 60 feet thick, locally with a few feet of overlying green shale. In the same area the Dakota sandstone is composed of three units: an upper sandstone unit, a middle carbonaceous shale unit, and a lower sandstone unit with a basal conglomerate. The disconformable contact between the formations is most readily recognized by the presence of the basal Dakota conglomerate.

In Disappointment basin the upper part of the Burro Canyon formation is composed largely of shale. In the same area the lower part of the Dakota sandstone is also composed largely of shale. Weathering of the shales in the two formations has resulted in a poorly exposed contact. However, at favorable exposures the contact is conformable, sharp, and not gradational.

Table 1.--Fossils and rock units used to correlate the Burro Canyon formation with Stokes' Cedar Mountain formation.

Fossils	Rock units and regions			
	Burro Canyon formation western Colorado	Cloverly formation, Wyoming; Kootenai formation, Montana	Trinity group, Texas	Stokes' Cedar Mountain formation central and eastern Utah
Protelliptio douglassi	x	x		
"Unio" farri	x	x		
Eupera onestae		x		x
Clavator harrisi			x	x
Frenelopsis variens	x		x	

This determination is made possible by the presence of carbonaceous material in the gray shales of the Dakota sandstone and the absence of carbonaceous material in the greenish-gray shales of the Burro Canyon formation.

The correlation of the Burro Canyon formation with the Cedar Mountain formation of Stokes was confirmed through two analogies; 1) The Burro Canyon formation was correlated with the Kootenai and Cloverly formations of Montana and Wyoming by the pelecypods Protelliptio douglassi and "Unio" farri. The Kootenai and Cloverly formations contain the pelecypod Eupera onestae which is found in the Cedar Mountain formation of Stokes. 2) The Burro Canyon formation was correlated with the Trinity group of Texas by the plant Frenelopsis variens. The Trinity group contains the charophyte Clavator harrisi which is also found in the Cedar Mountain formation of Stokes.

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