Stratigraphy of the State Bridge Formation in the Woody Creek Quadrangle, Pitkin and Eagle Counties, Colorado

By VAL L. FREEMAN

CONTRIBUTIONS TO STRATIGRAPHY

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STRATIGRAPHY OF THE STATE BRIDGE FORMATION IN THE WOODY CREEK QUADRANGLE, PITKIN AND EAGLE COUNTIES, COLORADO

By VAL L. FREEMAN

ABSTRACT

Distinct lithologic units within a 6,300-foot-thick red-bed sequence are of great help in interpreting the history and structure of the Woody Creek quadrangle, west-central Colorado. Three thousand feet of the red beds are assigned to the Maroon Formation; they are overlain in sequence by 2,400 feet of State Bridge Formation and 900 feet of Chinle Formation. The State Bridge is bounded top and bottom by unconformities. Within the State Bridge three mappable units are designated: the sandstone of the Fryingpan River at the base; the Sloane Peak Member—a new, formal name—in the upper part; and the coarse unit of Toner Creek at the top. Only the Sloane Peak is recognized in the State Bridge type locality. The South Canyon Creek Member of the State Bridge is recognizable along the north edge of the Woody Creek quadrangle, but is only 30 inches thick and pinches out about 2 miles to the south.

The State Bridge Formation can be distinguished from the Maroon Formation by its content of well-rounded spherical coarse sand grains, by the presence of parallel symmetrical ripple marks with wavelengths of less than 2 inches, by generally thinner and more even beds, and by better sorting of the beds. The Chinle Formation is readily identified by the presence of the distinctive and continuous mottled member at the base.

INTRODUCTION

The Woody Creek quadrangle in west-central Colorado (figs. 1, 2) contains about 6,300 feet of red beds consisting of parts of the Pennsylvanian and Permian Maroon Formation and the Triassic Chinle Formation and the Permian and Triassic State Bridge Formation. The State Bridge is unusually thick and was divided during mapping as an aid to greater understanding of the structure and geologic history of the area. Three newly recognized members—one formal and two in-

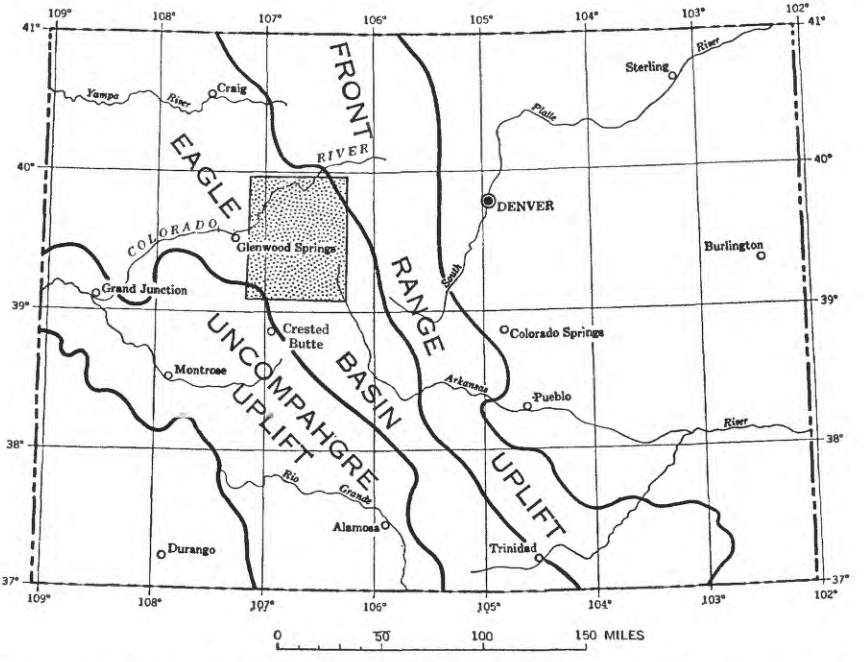

FIGURE 1.—Map of Colorado showing area of figure 2 (stippled) and structural elements during Pennsylvanian time (from Mallory, 1960).

formal—of the State Bridge proved mappable are herein named and described: the sandstone of the Fryingpan River at the base, the Sloane Peak Member in the upper part, and the coarse unit of Toner Creek at the top. These members are separated by unnamed parts of the State Bridge. The State Bridge Formation unconformably overlies the Maroon Formation, within which is recognized an upper unit informally called the siltstone unit. Unconformably overlying the State Bridge is the Chinle Formation, which was recognized a few miles north and south of the quadrangle by Poole and Stewart (1964).

The purpose of this report is to describe three units of the State Bridge Formation. The mapping of these units is essential to the understanding of the geologic history and structure of the Woody Creek and adjacent quadrangles. The lithology of each is distinct and clearly recognizable, and it undoubtedly reflects changes of depositional conditions within the State Bridge. The sandstone of the Fryingpan River and the coarse unit of Toner Creek are probably of local extent within the Eagle basin. The Sloane Peak Member is probably continuous as a lithologic unit across the basin from near Aspen to Kent (fig. 2).

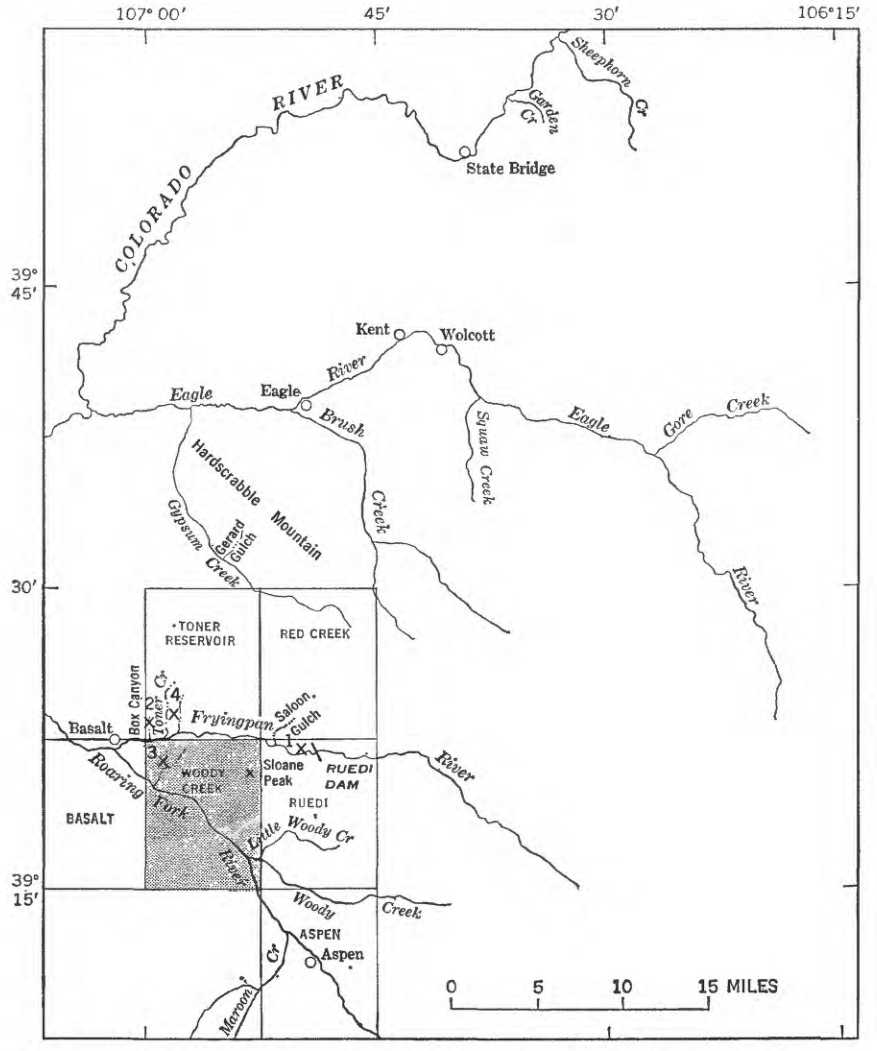

FIGURE 2.—Locations in central Colorado of the stratigraphic sections of the State Bridge Formation and of places discussed in text. 1, Fryingpan River section; 2, Box Canyon section; 3, Bionaz Gulch section (type section of the Sloane Peak Member); 4, Toner Creek section.

PALEOGEOGRAPHY

The Woody Creek quadrangle is near the southwest side of the Eagle basin, an elongated structural basin that lies between the Front Range uplift on the northeast and the Uncompahgre uplift on the southwest (fig. 1). From Middle Pennsylvanian through Early Triassic time, during which the Maroon and State Bridge Formations were deposited,

the basin received a thick sequence of clastic sediments derived from the adjacent highlands. The clastic rocks are dominantly "red beds" that in general increase in grain size toward the basin margins. Limestones and evaporate beds were deposited sporadically near the center of the basin.

NOMENCLATURE

The Maroon Formation, originally the Maroon Conglomerate, was named for typical exposures on Maroon Creek a few miles south of the Woody Creek quadrangle by G. H. Eldridge (in Emmons and others, 1894). In the Crested Butte area, where Eldridge used the name, the Maroon sediments are unconformably overlain by Jurassic sediments; consequently Eldridge did not give criteria for identifying the top of the Maroon where younger red beds are present.

Triassic red beds overlying the Maroon Formation in the Aspen area were recognized by Spurr (1898), but recent mapping by Bruce Bryant (oral commun., 1968) reveals that Spurr's placement of the contact was not consistent. Poole and Stewart (1964) correlated the Triassic beds of the Aspen area with the Chinle Formation and summarized the distinctive characteristics of the Chinle in that area. Their (fig. 3) regional section showed that the Chinle rests on progressively older rocks as it is followed into the Aspen area from the northwest; however, Bryant's recent mapping (1971) shows that at the locality of Poole and Stewart's section, the Chinle rests upon the Sloane Peak Member of the State Bridge Formation.

Red beds between the Maroon Formation and the Chinle Formation are recognized as a mappable formation in the area near State Bridge, Colo., about 50 miles northeast of the Woody Creek quadrangle (fig. 2). The name State Bridge Siltstone Member of the Maroon Formation was applied to these beds by Donner (1936, 1949). The State Bridge was raised to formation rank by Brill (1942) in the Gore Creek area. The State Bridge in these papers is considered to be conformable on coarser clastic sediments now called Maroon Formation and to be unconformably overlain by conglomerate now recognized as a basal unit of the Chinle Formation. The State Bridge was recognized throughout a larger area to the west and south (Sheridan, 1950); there it overlies the Schoolhouse Sandstone of Thompson (1949) or overlies Pennsylvanian arkoses (now Maroon Formation according to Brill, 1952) where the Schoolhouse Sandstone (now Weber Sandstone according to Brill, 1952) is not present. Murray (1958, p. 56) demonstrated that an unconformity is present at the base of the State Bridge Formation east of State Bridge and that the Weber is cut out beneath the conformity nearer to the Front Range uplift.

Three units within the State Bridge Formation (fig. 3) have proved mappable in the Woody Creek quadrangle and are called herein: the sandstone of the Fryingpan River (at the base), the Sloane Peak Member (in the upper part), and the coarse unit of Toner Creek (at the top). The upper part of the Maroon Formation is distinct from the underlying parts and is informally called the siltstone unit, although it is not a mappable unit.

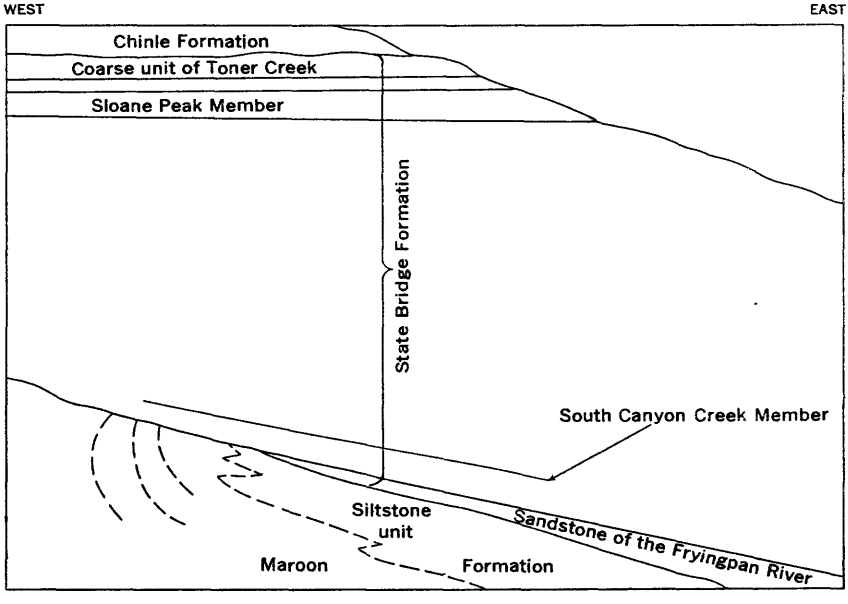

FIGURE 3.—Schematic section showing relations of red-bed units across Woody Creek and western part of Ruedi quadrangles. Not to scale.

MAROON FORMATION

In the Woody Creek quadrangle only parts of the Maroon Formation are exposed. A complete section of Maroon, however, crops out along Woody Creek and Little Woody Creek in the Ruedi and Aspen quadrangles east and south of the Woody Creek quadrangle. The Maroon in this section is about 15,000 feet thick. The base of the Maroon is placed at the gradational contact between the interbedded greenish-gray and grayish red beds of the Eagle Valley Formation and the dominantly red beds of the Maroon (Bruce Bryant, oral commun., 1968). The Maroon is composed mostly of silty and clayey sandstone, clayey siltstone, and silty claystone with lesser amounts of conglomeratic sandstone, limestone, and limestone chip conglomerate. The clastic beds are arkosic, micaceous, and calcareous. The colors are mostly shades of grayish red in the lower part and mostly shades of

reddish brown in the upper part. Beds of sandstone and conglomeratic sandstone are less abundant toward the top and are absent in an uppermost unit 2,000 feet thick. This upper unit is dominantly composed of slightly clayey moderate-reddish-orange siltstone with films and thin beds of somewhat darker silty claystone.

In the Woody Creek quadrangle only about 3,000 feet of the Maroon Formation is exposed. Of this total, the upper 1,000 feet is composed of siltstone very similar to the siltstone unit at the Woody Creek–Little Woody Creek section. Here the siltstone is slightly clayey and occurs as thick to very thick beds, some of which show a few parallel laminae. Bedding-plane features include a peculiar small-scale lumpy feature resembling the *Rivularites* of White (1929, pls. 6, 7, 8), mud cracks, and poorly preserved trails or twig imprints. The remaining 2,000 feet of Maroon in the Woody Creek quadrangle is in isolated exposures but is probably older. It is generally coarser grained than the Maroon in the Woody Creek–Little Woody Creek section and consists of thin- to thick-bedded sandstone, conglomeratic sandstone, conglomerate, clayey siltstone, silty claystone, and limestone. The clastic beds are commonly poorly sorted, micaceous, arkosic, and calcareous. Pebbles are commonly rounded or subrounded, but the sand grains are angular. The debris appears to have been derived mostly from Precambrian crystalline terranes nearby. Sedimentary structures are crossbedding and scour of fluvial aspect, cusp or asymmetrical parallel ripple marks with wavelengths more than 2½ inches, flute casts, clay chips, mud cracks, and raindrop impressions. Limestone beds in the Maroon are thin, clayey, and mostly unfossiliferous. One limestone near the base of the exposures contains poorly preserved Foraminifera and ostracodes. The Maroon in the Woody Creek quadrangle consists mostly of first-cycle sediments deposited from fresh water. The main part was deposited as channel and overbank stream deposits, and the siltstone unit was deposited as ephemeral lake or playa deposits.

The lowest part of the Maroon Formation exposed in the Woody Creek quadrangle is in fault contact with the Eagle Valley Formation. The top of the Maroon Formation is at an angular unconformity. The difference in dip across this unconformity is so low as to be indiscernible in parts of the Woody Creek quadrangle, but it exceeds 60° locally. The angle of unconformity decreases northeastward from the center of the quadrangle, but an angle of 20° was noted at Gerard Gulch just east of its confluence with Gypsum Creek (about 10 miles to the north).

STATE BRIDGE FORMATION

The State Bridge Formation in the Woody Creek quadrangle ranges in thickness from about 650 feet to about 2,400 feet. The Weber Sand-

stone that separates the State Bridge from the Maroon Formation to the north is not recognized here. Recognized only along the north edge of the Woody Creek quadrangle is the South Canyon Creek Member (termed the Yarmony Limestone Member by Sheridan, 1950) that serves to divide the State Bridge into lower and upper units in the Glenwood Springs and State Bridge areas. Three new members are recognized and mapped in the Woody Creek quadrangle: the sandstone of the Fryingpan River, the Sloane Peak Member, and the coarse unit of Toner Creek (fig. 3).

The Permian age of the South Canyon Creek Member of the State Bridge Formation is based on the determination of its fossils (Bass and Northrop, 1950) and its regional correlations. Consequently the lower unit and the sandstone of the Fryingpan River are Permian, and the lower unit is a correlative of the Park City Formation (McKee and others, 1967, table 1). The upper unit is assigned to the Early Triassic (M. E. MacLachlan in McKee and others, 1959, p. 8) and considered to be a correlative of the Moenkopi Formation (McKee and others, 1959, table 1). The Sloane Peak Member and the coarse unit of Toner Creek are therefore of Early Triassic age. No unconformities have been recognized within the State Bridge and the Permian-Triassic boundary is not evident. M. E. MacLachlan (in McKee and others, 1959, p. 3) stated that the boundary is placed arbitrarily 100 feet above the limestone now recognized as the South Canyon Creek Member.

The bulk of the State Bridge Formation between the Maroon Formation—or the sandstone of the Fryingpan River where present (fig. 3)—and the newly named Sloane Peak Member consists of fine clastic sediments and is mainly moderate reddish brown. This part of the formation thins abruptly to the west, and coarser clastic beds become more abundant in that direction, that is, toward the Uncompahgre uplift. The most common rock type is clayey siltstone containing scattered coarse sand grains that are characteristically rounded and highly spherical. Some thin short lenses of the coarse grains occur in the clayey siltstone. Other rocks are medium-grained sandstones, commonly slightly silty and clayey; claystones, commonly silty; clean medium- to coarse-grained sandstones; and at the north edge of the quadrangle at least one thin discontinuous limestone, the South Canyon Creek Member. The fine clastic sedimentary rocks are micaceous, arkosic, and calcareous, but seemingly to a lesser degree than the sedimentary rocks of the Maroon. Bedding in the State Bridge is thin to thick, and crossbedding is present, especially in the western part of the quadrangle. The rocks of the State Bridge are less resistant to weathering than are those of the Maroon, probably owing to a lesser degree

of compaction of the sediments. Sedimentary structures characteristic of the State Bridge are parallel ripple marks mostly symmetrical with wavelengths less than 2 inches, mud cracks and associated clay chips, and rare markings such as rain prints and salt crystal casts. In general, the bedding in the State Bridge is more even and regular and thinner than that in the Maroon. The rounded spherical sand grains of the State Bridge are nearly omnipresent, though rarely abundant, and are diagnostic in differentiating the State Bridge from the Maroon. Also diagnostic is the type of ripple marks.

The clastic material composing the State Bridge Formation appears to have been derived partly from preexisting sedimentary rocks of the Maroon Formation and to have been transported farther and reworked to a greater degree than Maroon material. Deposition of the State Bridge sediments was in widespread bodies of standing water that often dried up. A marginal marine environment is postulated.

SANDSTONE OF THE FRYINGPAN RIVER

The distinctive sandstone here called the sandstone of the Fryingpan River occurs at the base of the State Bridge Formation in the northeastern part of the Woody Creek quadrangle and in the adjacent Ruedi, Toner Reservoir, and Red Creek quadrangles. A stratigraphic section (section 1) measured on the Fryingpan River 1 mile west of the Ruedi Dam shows the unit to be about 400 feet thick there. The unit thins to a pinchout about 3 miles to the south and southwest, about 4 miles to the west, and about 7 miles to the northwest. To the east and northeast of the measured section it is missing, because of erosion. The contact with the underlying siltstone unit of the Maroon Formation is sharp and is probably an angular unconformity of very low angle. The contact with the overlying clayey siltstone of the State Bridge is sharp and seemingly concordant.

The sandstone of the Fryingpan River is composed of moderate-reddish-orange clay-free sandstone which is fairly well sorted. The constituent grains range from silt size to medium sand size and were originally mostly rounded but are now irregular in shape, owing to intergrowth of the grains during compaction. Pore space is now filled by secondary quartz and minor calcite. Bedding in the unit consists mostly of large-scale sweeping crossbeds with laminae of differing grain size and with rare black-sand concentrations. A few parallel partings of clay-rich beds are present. The dominant dip direction of the crossbeds is to the southwest. The unit is believed to be of eolian origin.

The sandstone of the Fryingpan River is resistant to erosion and typically forms vertical cliffs or underlies large dip-slope areas. The

sandstone has, in the past, been quarried and marketed as building stone and is still used locally as flagstone.

SLOANE PEAK MEMBER

The Sloane Peak Member of the State Bridge Formation is here named for typical exposures capping Sloane Peak in the northeast corner of the Woody Creek quadrangle. The top of the member is not present on Sloane Peak, but full thicknesses occur to the west and southwest in the quadrangle. The type section (section 3) is 5 miles west of Sloane Peak in Bionaz Gulch. The member also occurs in the Toner Reservoir quadrangle to the north and in the Aspen quadrangle to the south. The Sloane Peak may prove to be the most widespread member of the State Bridge Formation.

The Sloane Peak Member of the State Bridge Formation is a homogeneous very fine grained sandstone that ranges in thickness from about 130 feet in the northwestern part of the quadrangle to about 250 feet in the northeastern part. The sandstone is very well sorted and marked by medium-scale crossbedding throughout its thickness. In most of the Woody Creek quadrangle a 10-foot-thick clayey siltstone above the basal 10 feet of sandstone appears as a darker band. In the easternmost exposures in the Woody Creek quadrangle this clayey siltstone grades laterally into a very fine grained sandstone that is like the rest of the member. Both the upper and lower contacts of the member are sharp but seemingly conformable.

This member is slightly more resistant than the overlying and underlying beds and tends to form cliffs or the capping unit on ridges. In many exposures it weathers to subhorizontal slabs that obscure the crossbedding.

Every place where it has been observed, the Sloane Peak Member lies near the top of the State Bridge not more than 300 feet below the unconformity at the base of the overlying Chinle Formation. In the northwest corner of the Woody Creek quadrangle, the Sloane Peak is about 900 feet above the base of the State Bridge. In the northeast corner of the quadrangle the member is about 2,100 feet above the base of the State Bridge. Similar sandstones near the top of the State Bridge Formation in the Kent, Squaw Creek, and Brush Creek areas are believed to correlate with the Sloane Peak. The sandstone at Kent that is considered to be the Sloane Peak is about 10 feet thick and lies about 20 feet below the base of the Chinle and about 470 feet above the base of the State Bridge. In lower Squaw Creek, about 4 miles southeast of Kent, the Sloane Peak is 30 feet thick, about 35 feet beneath the Chinle Formation. On Hardscrabble Mountain, between the Kent area and the Woody Creek quadrangle, the Sloane Peak has not been measured but is well developed and resistant. It is tentatively suggested that the Sloane Peak Member formed as an offshore bar.

COARSE UNIT OF TONER CREEK

The coarse unit of Toner Creek of the State Bridge Formation crops out in the western part of the Woody Creek quadrangle, in the Toner Reservoir quadrangle, and in a few places in the Basalt quadrangle. A stratigraphic section of this unit was measured (section 4) near Toner Creek. The unit is probably a tongue-shaped body of sediment derived from the southwest that never extended much farther northeast than its present known extent. The maximum measured thickness, near the center of the Woody Creek quadrangle, is 388 feet. This unit consists of clastic rocks coarser than those in any other beds in the formation and probably reflects a renewed uplift of the Uncompahgre uplift. In gross aspect the sediments of the Toner Creek resemble sediments of equivalent grain size in the Maroon Formation, but a close examination of Toner Creek sediments always reveals the spherical coarse sand grains typical of the State Bridge and absent in the Maroon.

The sedimentary rocks of the coarse unit of Toner Creek are poorly to moderately sorted sandstones, pebbly sandstones, conglomerates with pebbles as much as 6 inches across, and silty and sandy claystones. They are micaceous and arkosic in thin to thick beds. Crossbedding and scour fills are common. The unit may represent deposition in a fluvial environment.

The basal contact of the coarse unit of Toner Creek at the measured section is at the base of the lowest conglomerate. This contact is easily found and is sharp. A few coarse grained sandstones in the upper part of the underlying State Bridge, however, are probably thin wedges of the coarse unit that likely intertongue with the underlying beds. During mapping of the Woody Creek quadrangle, I used for the base of the coarse unit of Toner Creek a sandstone that is considerably finer grained than the basal conglomerate in the measured section. The upper contact of the Toner Creek is the regional unconformity at the base of the Chinle Formation. The beds above and below this contact are seemingly without angular discordance in the Woody Creek quadrangle.

COMPARISON WITH ITS OCCURRENCE IN OTHER AREAS

The State Bridge Formation in the Woody Creek quadrangle is distinctly different from the type State Bridge, yet correlation is not in doubt. In both areas the State Bridge unconformably underlies the Chinle Formation and unconformably overlies the Maroon Formation. The South Canyon Creek Member of the State Bridge area is present in the northern part of the Woody Creek quadrangle, and the Sloane Peak Member of the Woody Creek quadrangle extends as far

as Kent (fig. 2). A section at Kent was correlated with the type locality by Sheridan (1950). The main difference in the formation between the two areas is the thickness: about 500 feet in the type locality and about 2,400 feet in the northeastern part of the Woody Creek quadrangle. Other differences result chiefly from the fact that the two areas are on opposite sides of the Eagle basin and received debris from different source areas. Wedges of coarse debris are present in both areas: the coarse unit of Toner Creek, derived from the Uncompahgre uplift, at the top of the formation in the Woody Creek quadrangle area; and the Sheephorn graywacke, a local unit used by Sheridan (1950, p. 132), derived from the Front Range uplift, at the base of the formation east of the type locality.

Between State Bridge and the Woody Creek quadrangle, the State Bridge Formation is exposed east of Gypsum Creek on the slope of Hardscrabble Mountain. This area is near the center of the Eagle basin, and the State Bridge Formation is thicker than known elsewhere. The Sloane Peak Member is well developed and locally caps Hardscrabble Mountain. The formation rests with noticeable angular unconformity upon the Maroon Formation and very locally upon pre-Maroon strata.

The State Bridge Formation in the Glenwood Springs area is little changed from the type locality, except that it rests conformably upon a tongue of the Weber Sandstone, which in this area is certainly a water-laid deposit. In the Woody Creek quadrangle the sandstone of the Fryingpan River may be about the same age as the tongue of the Weber Sandstone; however, it is of eolian origin and must have formed as a group of dunes in no way connected with eolian parts of the Weber.

CHINLE FORMATION

The Chinle Formation is easily separable from older red beds in the Woody Creek quadrangle. This formation, 900 feet thick, consists mostly of red siltstone that is very thin bedded, although the bedding is generally obscured on weathered slopes. A continuous unit, but less than 50 feet thick, of red and purple mottled siltstone and sandstone and lenses of gray quartzose sandstone makes up the base of the Chinle. This unit, the mottled member of Poole and Stewart (1964), contrasts with the underlying State Bridge Formation.

SELECTED STRATIGRAPHIC SECTIONS

Stratigraphic sections were measured by hand leveling with a Brunton compass. Color descriptions and numbers are from the Rock-color Chart (Goddard and others, 1948).

1. FRYINGPAN RIVER SECTION, RUEDI QUADRANGLE

[Composite section of the sandstone of the Fryingpan River, State Bridge Formation. Measured on the north side of the Fryingpan River. The tendency of this sandstone to occur as a very steep cliff or as broad dip slopes precluded measurement of a single complete section. The thickness of this section, present on the north side of the river, 5,000 ft due west of the Ruedi Dam, was calculated from mapped contacts and is 400 feet; the lower 150 ft was examined and is described below. The top 85 ft of the sandstone is described from exposures at the easternmost of the three quarries of the Western Slope Stone Co., on the north side of the river 2,600 ft east of the mouth of Saloon Gulch. The central part was examined in low outcrops on the dip slope north of the section where the lower 150 ft was examined. Measured June 1968]

	Thickness (feet)
State Bridge Formation (part):	
Siltstone and sandstone, moderate-reddish-brown (10*R* 4/6); sandstone very fine to medium grained; siltstone contains scattered spherical coarse grains; all beds more or less clayey, calcareous, and friable. Unit is much more easily weathered and eroded than underlying sandstone of the Fryingpan River. Contact sharp	Not measured
Sandstone of the Fryingpan River:	
Sandstone, pale-red to reddish-orange (10*R* 6/2, 5*R* 6/2, 10*R* 6/4 10*R* 7/4), mainly fine- to medium-fine-grained, some medium- and medium-coarse-grained; different grain sizes form distinct laminae; a few laminae have slight clay content or concentration of opaque grains, but most are very free of clay and are dominantly composed of quartz grains tightly packed, with interlocking grain boundaries and secondary outgrowths of quartz; sand grains originally rounded. Bedding in large-scale sets of sweeping thin crossbeds internally laminated that approach underlying bed tangentially	85
Sandstone like unit below, in outcrops on dip slope. No internal break above or below unit	165
Sandstone, between light-brown (5*YR* 6/6) and moderate-reddish-orange (10*R* 6/6); moderate reddish brown (10*R* 4/6) at base; fine and medium-fine grained; a few laminae of rounded, well-sorted medium and medium-coarse grains; sandstone free of clay except in basal few feet. Sandstone is hard with siliceous cement except at base where sandstone is friable at surface and has calcite cement. Bedding thin in crossbedded sets, most thicker than 20 ft but some 2–3 ft thick; one bed 18 in. thick about 50 ft above base is probably parallel to base and is composed of very fine grained sandstone that is not laminated. Crossbeds mostly with internal laminae, crossbeds tangential at base. Base not exposed but probably not more than basal 4 ft of unit is covered	150
Total sandstone of the Fryingpan River	400
Maroon Formation, siltstone unit (part):	
Siltstone, reddish-brown (10*R* 4/4), clayey; faint streaks of increased clay content; thickly bedded with thin to thick interbeds of silty claystone of slightly darker color	Not measured

2. BOX CANYON SECTION, TONER RESERVOIR QUADRANGLE

[Traverse from NE¼NE¼ sec. 9, T. 8 S., R. 86 W., to SE¼NE¼ sec. 4, T. 8 S., R. 86 W. Base of section in Box Canyon 250 ft south of powerline; section proceeds east-northeast to top of the ridge east of Box Canyon and then up ridge to north. Measured June 1968]

	Thickness (feet)
Top of section.	
State Bridge Formation (part):	
Siltstone, sandstone, and claystone, pale-reddish-brown (10*R* 5/4, 10*R* 6/4); mostly clayey siltstone, minor amount of very fine grained sandstone that is silty and clayey, very minor amount of coarse-grained sandstone with clay chips and rounded grains of moderate sphericity; all beds calcareous and micaceous. Near base is claystone which is almost free of silt grains	Not measured
Sandstone (Sloane Peak Member), light-brown (5*YR* 6/4), very fine grained, well-sorted; essentially free of clay matrix; homogeneous throughout; calcareous. Very thin crossbeds in sets averaging 3–4 ft thick. On ridge forms a moderate slope, but in canyon wall forms a rough-faced cliff in which abundant partings subparallel to base cut through crossbeds	135
Poorly exposed but abundant float pieces. Siltstone and minor silty claystone, reddish-brown (10*YR* 4/4, 10*R* 5/4); siltstone is generally clayey, micaceous, and calcareous; rare claystone is dark reddish brown (10*R* 3/4). Probably most of the rocks in the interval are very thin bedded with some laminae that contain sparse clay. Unit is easily weathered and forms bench and slope above unit below. Top contact picked on float	290
Poorly exposed but abundant float on ridge, well exposed in canyon wall to west. Mostly siltstone, moderate-reddish-brown (10*R* 4/6) to dark-reddish-brown (10*R* 3/4); common very thin to thin beds of sandstone, fine or medium grain size, with some very coarse grains; medium grains rounded and moderately spherical, very coarse grains rounded and highly spherical; abundant clay and mica on bedding surfaces; most sandstone beds clayey, but some nearly free of clay; siltstone is calcareous and in very thin beds. Some float chips of claystone contain coarse sand grains. Two sandstone beds about 1 ft thick are crossbedded, with crossbed dips to the west. Sedimentary structures are symmetrical parallel ripple marks with wavelengths 1–2 in., some poorly developed cusp ripple marks, and rare marks like small raindrop imprints which may be bubble or foam marks. Ripple marks strike in two directions, north to N. 30° E. and at right angles to this. Top of this unit at break in slope at topographic map elevation 7,674 ft	412
Limestone (South Canyon Creek Member), very clayey, pale-red-purple (5*RP* 6/2) and light-olive-gray (5*Y* 6/1), very fine grained; no textures visible except faint lines of higher clay content	0.5
Poorly exposed, but abundant float. Siltstone and sandstone, reddish-brown (10*R* 4/4). Siltstone is slightly clayey with clay films on some bedding surfaces. Sandstone is fine grained but has floating grains medium to medium coarse in size that are rounded and spherical; slightly clayey, moderately sorted. Siltstone and sandstone are calcareous and micaceous but mica mostly on some bedding surfaces. Some parting lineation on bedding	160

	Thickness (feet)
State Bridge Formation—Continued	
Poor exposure of pebbly sandstone in old roadcut; pebbles as much as 1 in. in diameter, mostly of rusty quartz, also of very fine to fine-grained metamorphic rocks. Some sandstone grains are medium coarse, rounded, and moderately spherical. Some blotches of pale-red-purple (5*RP* 6/2) color. No pebbles above this unit. Unit probably marks an unconformity	2
Total State Bridge Formation (part)	999.5
Maroon Formation (part):	
Covered	23
Arkose, moderate-red (5*R* 5/4), like bottom unit in measured section but more granules and fewer pebbles, one disk-shaped pebble of mica schist 2 in. long. Forms ledge	7.5
Siltstone and sandstone, moderate-reddish-brown (10*R* 4/6, 10*R* 4/4). Mostly clayey siltstone, well sorted, micaceous and calcareous. Sandstone is very fine grained, poorly sorted, clayey; grains as large as coarse, angular to rounded, mostly subangular, low to moderate sphericity, micaceous and calcareous. Unit thinly bedded, forms slope with thin ledges outcropping	32
Arkose, conglomeratic, moderate-red (5*R* 5/4) to moderate-pink (5*R* 7/4), poorly sorted, medium-grained; mostly angular grains with some subrounded; conspicuous cleavage faces on feldspar grains; clay matrix and streaks of greater than average clay content. Pebbles as large as 3 in., rounded, consist of vein quartz, fine- to coarse-grained igneous rocks with common pink feldspar, and dark schist, probably all from Precambrian rocks. Beds are calcareous but friable at surface. Bedding not clear, but some crossbedding cut off sharply at top of sets; no scour channels visible. Bedding sets thin to thick. Unit mostly forms rounded ledges with rough surfaces, some benches, one bench 17 ft thick covered	101
Total Maroon Formation (part)	163.5

Base of section.

3. BIONAZ GULCH SECTION, WOODY CREEK QUADRANGLE

[Type section of the Sloane Peak Member, State Bridge Formation. SE¼SW¼ sec. 15, T. 8 S., R. 86 W. Measured July 1968]

Top of section.

	Thickness (feet)
State Bridge Formation (part):	
Coarse unit of Toner Creek:	
Base is coarse-grained sandstone	Not measured
Unnamed unit:	
Siltstone, silty claystone, and sandy siltstone, pale-reddish-brown (10*R* 5/4), claystone slightly darker; thinly bedded; some mica flakes concentrated in bedding, some parallel ripple marks with wavelengths from ¾ to 2 in	46

State Bridge Formation—Continued	Thickness (feet)
Unnamed unit—Continued	
Siltstone, pale-reddish-brown (10*R* 5/4); has coarse spherical sand grains, otherwise is well sorted; tightly cemented with clay and calcite. Beds 3 in. thick or less. Forms stepped moderate slope	10
Total unnamed unit	56
Sloane Peak Member:	
Sandstone, moderate-orange-pink (10*R* 7/4), very fine grained, very well sorted; tightly compacted with some calcite cement. Beds 2 in. to 4 ft thick; generally beds parallel to base are thin, and cross-laminated beds are thicker. Cross-laminations are planar and simple, low angle, medium size, tangential to underlying surface. Near base are some laminations darker in color, probably indicating higher clay content. Forms a cliff with rubble at bottom. Rubble covers basal contact	150

Base of section.

4. TONER CREEK SECTION, TONER RESERVOIR QUADRANGLE

[Traverse along ridge east of creek, from NE¼NE¼ sec. 3, T. 8 S., R. 86 W., to SW¼SW¼ sec. 35, T. 7 S., R. 86 W. Measured June 1968]

Top of section.

Chinle Formation:

Not measured or described; lower part covered.

Regional unconformity not exposed.

State Bridge Formation (part):	Thickness (feet)
Coarse unit of Toner Creek:	
Covered with debris from above. Upper contact picked at break in slope	11
Siltstone, very poorly exposed, reddish-brown (10*R* 4/4), clayey, micaceous, seems homogeneous. Probably very thin bedded or laminated	40.5
Sandstone, arkosic, grayish-pink (5*R* 8/2); coarse grained and pebbles to 1 in.; abundant clay chips, grayish-red (10*R* 4/2) to moderate-reddish-brown (10*R* 4/6); seems loosely packed with clay matrix and calcite cement; appears speckled, owing to white grains which may be kaolinite after feldspar; fresh feldspar present, also light-greenish-gray (5*GY* 8/1) clay grains(?). Sand grains are angular to rounded, mostly subangular, some spherical quartz grains. Twenty feet along strike unit is 7.5 ft. thick	4
Covered, in part sandstone like that at base of unit; pebbles in float not more than ¾ in. in maximum diameter	23
Covered; float indicates interval is continuation of sandstone unit below, maybe with siltstone interbed	28
Sandstone, very conglomeratic, like sandstone at base of unit; cobbles as large as 5 in. across, many of dark-gray and grayish-red fine-grained igneous rock, some as large as 4 in. across of quartz or quartzite. Crossbedded	31

State Bridge Formation—Continued	*Thickness (feet)*
Coarse unit of Toner Creek—Continued	
Covered, at top some siltstone chips in float	20
Sandstone, conglomeratic, like sandstone at base of unit	3
Covered; float chips of siltstone, clayey to very clayey; mica on bedding surfaces	21
Sandstone, conglomeratic, slightly arkosic, grayish-pink (5*R* 8/2), poorly sorted; mostly medium-coarse grains that are angular to rounded and of low to moderate sphericity. Friable but some clay-coating grains, and calcareous. Pebbles as much as 1½ in. long of metamorphic and pegmatitic rock, feldspar granules, clay chips probably from underlying beds. Low outcrops, bedding not apparent	4.5
Total coarse unit of Toner Creek	186.0
Unnamed unit:	
Not described in detail. Interval is mostly siltstone and very fine grained sandstone. At 46 ft above base is a coarse sandstone; other coarse sandstone beds occur higher in unit and become more common upward, and unit becomes more like coarse unit of Toner Creek in appearance	70
Sloane Peak Member:	
Not described	170
Base of section.	

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