THE MISSISSIPPIAN SYSTEM IN SOUTHERN ARIZONA

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INTRODUCTION

Strata of Mississippian age occur throughout southeastern Arizona wherever Paleozoic rocks are extensively exposed. They are composed principally of limestone, with minor amounts of clastic material, and generally occur in massive beds that form prominent cliffs. The Mississippian strata range in age from Kinderhookian through Chesterian. They are everywhere conformably underlain by beds of Upper Devonian age and disconformably overlain by the Pennsylvanian Horquilla or Naco limestones. The principal Mississippian formation in southeastern Arizona is the cliff-forming Escabrosa limestone of Lower Mississippian age. Beds of Upper Mississippian age occur as the Paradise formation in the southeasternmost part of the State and as the Black Prince formation in northwestern Cochise County.

LOWER MISSISSIPPIAN FORMATIONS

Escabrosa Limestone

The Escabrosa limestone was named by Ransome (1904) for exposures in the Bisbee district. The Escabrosa limestone is a thickly bedded, commonly white but locally dark gray, granular, nonmagnesian limestone composed largely of fragments of crinoid stems. Irregular continuous bands and nodules of chert occur at many horizons and dolomite occurs in the lower part of the Escabrosa limestone in many places.

The Escabrosa limestone has been subdivided in only two areas. Harshman (in Short, and others, 1943) subdivided the 380 feet of Escabrosa in the Superior region into four members which are, in ascending order: (1) Dark gray limestone; (2) massive cliff-forming limestone; (3) thin-bedded dark limestone; and (4) cherty shale and limestone. The fourth member has since been shown to be of Pennsylvanian age (Huddle and Dobrovolny, 1950). In the Peloncillo Mountains of New Mexico, Gillerman (1958) subdivided about 450 feet of Escabrosa limestone, in ascending order, into: (1) Lower gray member; (2) middle black member; and (3) upper gray member.

In the southeastern part of the State, the Escabrosa limestone is about 700 feet thick and the formation thins to about 100 feet in the central part of the State. The thinning is due either to onlap, erosion, or both.

The Escabrosa limestone is of Early to middle Late Mississippian age. The basal units are Kinderhookian (Girty, in Ransome, 1904), to post-Osage or pre-Chester in central Cochise County (Gilluly, Cooper, and Williams, 1954), and to Meramec (St. Louisian) in the Chiricahua Mountains (Hernon, 1935).

The name Tornado limestone was proposed by Ransome (1916) for a sequence of Lower Mississippian and Lower Pennsylvanian limestone beds in the Ray and Globe areas. The basal 145 feet of this formation, of Mississippian age, were assigned by Stoyanow (1936) to the Escabrosa limestone. The name Tornado limestone is no longer used.

The small amount of clastic material in the Escabrosa distinguishes it from the underlying Devonian formations. The paucity of clastic material, white color and thick bedding distinguish the Escabrosa in the field from the pink-tinted, thin-bedded, shaly Horquilla and Naco limestones.

Modoc and Tule Springs Limestones

In the Clifton-Morenci area, there are two sections of Mississippian rocks, the Modoc and Tule Springs limestones (Lindgren, 1905a; 1905b). The Modoc limestone (Lindgren, 1905a) crops out in the southern part of the Clifton-Morenci area and consists of about 170 feet of blue and gray limestone, light-brown dolomitic limestone, and calcareous quartzite. A bed of cross-bedded calcareous quartzite in the Escabrosa limestone is also reported in the Galiuro Mountains, about 60 miles southwest of Morenci (Thomssen and Barker, 1958). The Modoc limestone rests conformably on Devonian Morenci shale and is Lower Mississippian in age. It is probably equivalent to part of the Escabrosa limestone.

The Tule Springs limestone (Lindgren, 1905b) crops out in the northern part of the area and consists of about 200 feet of limestone of Lower Mississippian age, disconformably overlain by about 300 feet of limestone of Lower Pennsylvanian age. No Upper Mississippian fossils are known to occur. The total thickness of Mississippian strata in this area is not known because there is no faunal or stratigraphic tie between the Modoc and Tule Springs limestones.

PRE-LATE MISSISSIPPIAN DISCONFORMITY

In central Cochise County, there is a probable disconformity between the Escabrosa and Black Prince limestones that is marked by a pebbly shale. Gilluly, Cooper, and Williams (1954) suggest that "the relative thinness of the Escabrosa sections measured in the Little Dragoon Mountains and Johnny Lyon Hills is due primarily to pre-Black Prince erosion because very little if any regional thinning of (Escabrosa) beds is indicated. . . ."

In the Chiricahua Mountains, the Upper Mississippian Paradise formation lies conformably on the Escabrosa limestone and the contact is marked by limy shale and fragmental limestone at the base of the Paradise formation.

UPPER MISSISSIPPIAN FORMATIONS

Paradise Formation

The Paradise formation (Stoyanow, 1926) is exposed in the Chiricahua Mountains and consists of eight members (Hernon, 1935): (1) Limy shale and gray fragmental limestone; (2) thin- to medium-bedded gray limestone capped by a massive, coarsely crystalline bed of limestone bearing great numbers of Dielasmoidi bisenatus; (3) shaly strata overlain by a gray sandy limestone and shale which are capped by a black limestone containing abundant mollusc fragments; (4) highly fossiliferous shale with a massive black bed in the middle; (5) black massive oolitic limestone; (6) shale and limestone; (7) dark fossiliferous shale; and (8) shale with gray granular limestone. The preponderant color of the formation is yellow and it is 195 feet thick. The Paradise formation lies conformably on the Escabrosa limestone and is overlain by the Horquilla limestone.

The Paradise formation also crops out in the Peloncillo Mountains of south-

western New Mexico where it ranges from about 150 to 200 feet in thickness. Gillerman (1958) described the Paradise formation as consisting of "alternating beds of fine-grained black, brown, and gray limestones; black calcareous siltstone; brown oolitic limestone; calcarenite; gray and green calcareous shale; quartzitic sandstone and conglomerate." Here also the formation weathers to a characteristic yellow-brown color. The Paradise formation is Upper Mississippian, ranging in age from Meramec to Chester (Hernon, 1935). One of the most abundant fossils is Archimedes, an Upper Mississippian guide fossil.

Black Prince Formation

The Black Prince formation (Gilluly, Cooper, and Williams, 1954) is exposed in the Little Dragoon Mountains and the Johnny Lyon and Gunnison Hills in northwestern Cochise County. It was at first considered to be an upper member of the Escabrosa limestone and locally it may occur in the upper part of the Escabrosa, as mapped (Gilluly, 1956). The basal beds consist of about 10 to 20 feet of pebbly red to purple shale with scattered chert pebbles and local beds of conglomerate. Above the shale is about 140 feet of pure, medium-to coarse-grained, light-gray to pink, slope-forming limestone with some chert nodules. The thickness of the formation ranges from about 120 to 170 feet, thickening to the northwest. The faunal assemblage in the Black Prince is limited and its age is tentatively considered to range from late Osage to early Meramec. Locally some Early Pennsylvanian strata may be included in the Black Prince.

MISSISSIPPIAN AND PENNSYLVANIAN UNCONFORMITY

Where the Paradise and Black Prince formations are absent, the hiatus between the Escabrosa and Horquilla limestones represents at least all of Mississippian Chester and possibly all of Pennsylvanian Morrow time. Nonetheless, there is little or no evidence of either erosional or angular discordance between the two formations in central Cochise County (Gilluly, Cooper, and Williams, 1954). Farther to the west, the contact is in many places marked by local limestone conglomerate, shaly beds, weakly developed karst topography and red to purple cherty siltstone, similar to that at the base of the Black Prince formation.

CORRELATION

The Escabrosa limestone is correlated with the Mississippian Redwall limestone of northern Arizona, the Madison limestone of Colorado, and Caballero and Lake Valley limestones of New Mexico (Weller, and others, 1948). Cooper and Arellano (1946) correlate the Escabrosa with the Represo beds of Sonora, Mexico. Huddle and Dobrovolny (1950) regard the Escabrosa and Redwall limestones as regional names for a single unit.

The Upper Mississippian Paradise formation correlates with the Helms formation of west Texas and New Mexico. The Black Prince limestone is probably equivalent to the lower part of the Paradise formation, although it may be slightly older.

Huddle and Dobrovolny (1950) suggest that the red cherty mudstone between the Mississippian and Pennsylvanian strata may represent the Pennsylvanian Molas formation of Colorado.