

Southern Arizona
Guidebook II
Arizona Geological Society



1959

ARIZONA GEOLOGICAL SOCIETY

SOUTHERN ARIZONA GUIDEBOOK II

*Combined with the
2nd Annual Arizona Geological Society Digest*

Edited by L. A. Heindl

Prepared for Field Trips held in connection with
Geological Society of America
Cordilleran Section 55th Annual Meeting

*April 2-6, 1959
Tucson, Arizona*

SILURIAN AND DEVONIAN STRATIGRAPHY
SOUTHEASTERN ARIZONA AND SOUTHWESTERN NEW MEXICO

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INTRODUCTION

No representatives of the Silurian system are known in southeastern Arizona, but they are present in southwestern New Mexico. Middle and Upper Devonian rocks are present within southeastern Arizona but the Lower Devonian section is missing. The Devonian beds can be broadly classified as a western facies of carbonate rocks and an eastern facies of fine clastic rocks, with the division occurring a short distance west of the Arizona-New Mexico State line.

The writer is indebted to a manuscript by Mr. D. V. LeMone for much of the material on the Devonian system that is summarized here.

SILURIAN SYSTEM

No rocks of proved Silurian age have been recognized in southeastern Arizona. In southwestern New Mexico the Silurian system is represented by the Fusselman limestone (Richardson, 1908) or Fusselman dolomite (Dunham, 1935); Kelley and Silver (1952) and Pray (1953) restricted the Fusselman dolomite to include only rocks of Silurian age. They designated the lower part which carried Upper Ordovician fossils as the Cutter formation. The Fusselman dolomite is Niagaran and Alexandrian in age (Flower, 1955).

In New Mexico, beds of Silurian age rest disconformably upon either the Cutter formation, which is of uppermost Ordovician age, or upon the El Paso limestone, which is Lower Ordovician in age.

Beds overlying the Silurian section are Middle to Upper Devonian in age. Although a hiatus of some magnitude exists, the strata are conformable. There is no evidence of significant topographic relief having developed on the Fusselman dolomite before the Devonian beds were laid down.

The Silurian beds thin westward and northward from Luna and Sierra Counties, New Mexico, and probably wedge out before the Arizona-New Mexico State line is reached. Beds of Silurian age have not yet been recognized around Cananea, Mexico, although a thick section of Paleozoic rocks is present in that area.

DEVONIAN SYSTEM

Beds of Devonian age are present throughout Arizona, southwestern New Mexico and northern Sonora. A wide variety of names has been applied to these beds, or to faunal zones and facies. Table 4 lists names applied to Devonian strata discussed in this paper.

Throughout southeastern Arizona, the basal beds of the Devonian system are considered generally to be of Upper Devonian age. In southwestern New Mexico and central Arizona beds of Middle Devonian age are present. Lower Devonian beds are found in northwestern Arizona.

Table 4. Selected Devonian unit names in central and southeastern Arizona and southwestern and south-central New Mexico

Central Arizona	Southeastern Arizona	Southwestern and south-central New Mexico
Martin formation *Crook formation *Island Mesa beds *Jerome fm. **Lower Ouray fm.	Martin formation Calcareous facies Dolomitic facies ***Picacho de Calera fm. ***Restricted Martin fm. ***Lower Ouray fm. **Santa Rita limestone Swisshelm formation (transitional facies) Percha formation *Portal fm. = Percha fm. *Morenci shale = Percha fm.	(<u>Southwestern N. Mex.</u>): Percha formation Box Canyon member Ready Pay member (<u>South-central N. Mex.</u>): Percha formation Percha shale Contadero formation Sly Gap formation Ocate formation **Chloride formation **Perchian series **Bella shale
*Local usage. **Abandoned formation name. ***Local faunal zone or facies.		

These basal beds of the Devonian system rest upon rocks ranging in age from Precambrian to Silurian. The hiatus decreases eastward from central Arizona to southwestern New Mexico as wedges of younger beds successively appear below the Devonian section.

In southeastern Arizona the Upper Devonian Martin formation usually rests disconformably on beds of Middle to Upper Cambrian age, although locally it rests on Precambrian rocks. The Swisshelm, Percha and Portal formations of southeastern Arizona rest disconformably on the El Paso formation of Upper Cambrian to Lower Ordovician age or its equivalents. In New Mexico, the Percha formation rests disconformably on El Paso beds of Lower Ordovician age to the west, and on Fusselman beds of Middle Silurian age to the east.

The Devonian sequence throughout the area is everywhere conformably overlain by the Lower Mississippian Escabrosa or Lake Valley formations, both of which are of Kinderhookian age in their lower parts.

The contact between the systems is frequently covered because debris from the massive cliffs of the Mississippian rocks cover the uppermost beds of the underlying, slope-forming Devonian beds. There is no evidence of a disconformity between the systems and in many areas the contact appears to be gradational.

LeMone (1958) shows that within southeastern Arizona and southwestern New

Mexico the Devonian section is fine- to medium-grained, dark-gray to buff, dolomitic or silty limestone with crinoid columnellas absent or small. In contrast, the Mississippian rocks above the contact are coarsely crystalline, light-gray to white limestone with crinoid columnellas abundant and large.

Southeastern Arizona

The Devonian rocks of southeastern Arizona may be separated into: (1) the Martin formation, which LeMone (1958) has subdivided into (a) a calcareous facies and (b) a dolomitic facies; (2) the Swisshelm and Portal transitional formations or facies; and (3) the Percha formation.

Martin Formation

Throughout most of southeastern Arizona the Devonian system is represented by the Martin formation (Huddle and Dobrovolsky, 1950). The term "Martin formation" is preferred to "Martin limestone" (Ransome, 1904) because the strata referred to range in composition from calcareous in southeastern Arizona to calcarenaceous in central Arizona. At the type locality at Mount Martin near Bisbee, the "Martin limestone" (Ransome, 1904) is composed of 340 feet of calcareous beds which locally may be dolomitic. Beds of dark-gray, compact limestone, averaging about 4 feet thick, alternate with limestone of lighter color and calcareous shale of pinkish tint. The lower half of the formation is more shaly than the upper half. Topographically the formation forms slopes and tends to be inconspicuous.

The calcareous facies may be somewhat dolomitic. The facies extends southward from the vicinity of the type locality near Bisbee to include the Devonian limestone at Cananea, Mexico. Typically, this facies is thinly bedded and may range in color from pink to dark gray and carry shale of similar colors. The upper part is predominantly limestone and the lower part is predominantly shale.

The limestone facies interfingers with the dolomitic facies in the vicinity of the Tombstone Hills. In the Dragoon Mountains the dolomitic facies is well represented. The dolomitic facies typically contains 20 to 30 units of thin-bedded dolomitic limestone and dolomite beds of yellow, red, brown, and gray colors. The carbonate rocks have a high percentage of silt and clay and are usually fine- to medium-grained in texture. Chert zones may be present and may form excellent correlation markers (LeMone, 1958). Limestone beds are few in number and are usually medium-grained. Locally, shale predominates in the section and sandstone and calcarenite are present. The sand grains may be well rounded and frosted and are scattered throughout the section or concentrated in thin beds and stringers. Fossils of Upper Devonian age are common in both facies of the Martin formation.

Stoyanow (1936) subdivided the Martin formation in the Tucson area into a lower member, 73 feet thick, called the Picacho de Calera formation, a restricted Martin formation, and an upper member 150 feet thick called the Lower Ouray formation. These are now considered to be faunal zones rather than mappable formations.

The Santa Rita limestone (Stauffer, 1928) was proposed for a section in the Santa Rita Mountains but the term is not used by other geologists (Reid, 1928; Stoyanow, 1936).

Swisshelm Formation

The Swisshelm formation (Epis and Gilbert, 1957) is exposed in the Swisshelm and Pedrogosa Mountains of southeastern Arizona. At its type locality it is 615 feet thick. It forms a brown to yellowish slope which contrasts with the cliffs of the overlying Escabrosa limestone and the step-and-slope topography of the underlying El Paso formation. The upper part of the Swisshelm formation consists of impure carbonate, which may grade laterally into typical Martin lithology, and the lower half is chiefly siltstone and sandstone. The Swisshelm formation represents a sandy facies lying between a western carbonate Martin formation and an eastern fine clastic Percha formation.

The Swisshelm formation is Upper Devonian (Senecan) in age. The upper part carries fossils similar to the Martin formation and the Contradero and Sly Gap formations of New Mexico. The lower part contains fauna similar to the Sly Gap and Onate formations of New Mexico.

"Portal Formation"

The name "Portal formation" was given by Sabins (1937a) to a sequence of 342 feet of calcareous and siliceous, gray to black shale alternating with argillaceous, nodular limestone near Portal, Arizona. Sabins subdivided the formation, from the base up, into: (1) very thin-bedded limestone and calcareous shale resting disconformably on the El Paso formation; (2) black siliceous shale; (3) beds similar to unit 1 and grading down into unit 2; and (4) a member similar to members 1 and 3, except for thicker units of limestone and shale. This "formation" has been separated largely on a faunal basis; lithologically it is similar to the Percha formation of New Mexico.

The "Portal formation" is lower Upper Devonian (Senecan or Chemung) in age (Sabins, 1957a) and may be considered to be a correlative facies of the Percha formation. It is suggested that on the basis of age and lithology, the strata forming the "Portal formation" could be included in the Percha formation and that the term "Portal" could be retained for faunal or facies use.

Morenci Shale and Limestone

The Morenci shale was named by Lindgren (1905a) for 175 feet of Upper Devonian rocks exposed in the Clifton-Morenci area, Arizona. The upper 100 feet of the section is a clay shale called the Morenci shale; the lower 75 feet is a compact and fine-grained argillaceous limestone named the Morenci limestone. The limestone may be missing locally. The formation rests conformably on the Ordovician Longfellow limestone and is conformably overlain by the Mississippian Modoc limestone. The fauna in the Morenci shale are Upper Devonian in age and correlate with the "Portal" and Percha formations.

Southwestern New Mexico

In southwestern New Mexico the Devonian sequence is predominantly one of shale with minor amounts of limestone, calcarenite and siltstone. The term Percha shale (Gordon, 1907) was applied to the shaly sequence of Devonian beds which underlie the Mississippian Lake Valley limestone and overlie the Mimbres limestone, whose upper part is the equivalent of the Silurian Fusselman dolomite. Thus the original term "Percha shale" represented the entire sequence of Devonian rocks in southwestern New Mexico. No type locality was named and the thickness was given as

200 feet at Percha Creek in Sierra County, New Mexico.

In southwestern New Mexico, Kelley and Silver (1952) proposed the term Percha "formation" rather than "shale" because of the lithologic variation within the unit. These terms include all Devonian beds, or include that part of the Devonian shale which cannot be assigned to other Devonian formations. The Percha shale was subdivided by Stevenson (1945) into 1) an upper Box Canyon member, consisting of about 50 feet of yellowish and greenish shale with lime nodules and shaly limestone, and 2) a lower Ready Pay member, consisting of about 140 feet of black, fissile, carbonaceous, non-fossiliferous shale. The contact between the two members appears gradational. These strata are similar to the "Portal" and Morenci formations in southeastern Arizona.

The upper, Box Canyon, member of the Percha shale has been considered of latest Devonian age (Stevenson, 1945). However, Ellison (1950) assigned an Upper Devonian (?) and Kinderhookian age (Woodford or Chattanooga shale) to the Ready Pay member which underlies the Box Canyon member. Stainbrook (1947) considered the upper part of the Percha shale to be of Mississippian age.

Farther east in New Mexico, in the mountains north of El Paso, Kelley (1937 ; 1940) and Stevenson (1941; 1942; 1945) subdivided the Percha shale of Gordon, from the base up, into the Onate, Sly Gap, and the Contadero formations and restricted the term Percha shale to those beds of the upper part of the original Percha shale which lay above the Contadero formation. The Onate is Middle Devonian; the Sly Gap is Upper Devonian, or Middle Cassadogan (Kottlowski, and others, 1956); and the Contadero is Upper Devonian (Chemung). The Sly Gap, and possibly the upper part of the Onate, correlate with the Ready Pay member of the Percha formation (Stevenson, 1945).

Other terms for Devonian strata in southwestern New Mexico that are no longer used include the Chloride formation (Keyes, 1904), Perchian series (Keyes, 1922), and Bella shale (Keyes, 1908).

Northern Sonora, Mexico

At Cananea, Sonora, the Lower Crystalline limestone of Mulchay and Velasco (1954) is 200 to 250 feet thick. It rests disconformably on older limestone. The beds contain some dolomite. These beds are equivalent to the calcareous facies of the Martin limestone.

A lower Upper Devonian sequence of more than 900 feet of limestone and dolomite has been described by Copper and Arellana (1946) from northwest of Caborca, Sonora. These beds crop out in isolated hills and neither the bottom nor top of the Devonian sequence is exposed. These beds may be equivalent to the Martin formation but younger and older beds may be present.

Central Arizona

The Martin formation becomes increasingly sandy and dolomitic from southeastern to central Arizona. The section thins and rests upon Cambrian and Precambrian beds. Locally, parts of the lower part of the section are missing because of nondeposition, and elsewhere the basal Devonian deposits fill channels cut into underlying rocks. The age of the Devonian beds in central Arizona is Middle to Upper Devonian (Huddle and Dobrovolsky, 1950). Locally the Devonian section may be

entirely absent.

Numerous names have been assigned to the Devonian rocks in central Arizona. Among them are the Crook formation (Short, and others, 1943), Lower Ouray formation (Stoyanow, 1936), Island Mesa beds (Stoyanow, 1936), and Jerome formation (Stoyanow, 1930). These names for the most part seem to apply to local faunal or facies zones and Huddle and Dobrovolny (1950) did not think it advisable to recognize these units as formal subdivisions of the Martin formation.

