

CATALOG OF PRINCIPAL SEDIMENTARY FORMATION NAMES IN
SOUTHERN ARIZONA AND NORTHERN SONORA

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The following list of sedimentary formation names is restricted to those that are currently used in southeastern Arizona or have occurred frequently in geological literature. Some of this data is also shown in the nomenclature chart, table 1.

The terms applied to stratigraphic units in Sonora are in flux, and age determinations, boundaries, and correlations change rapidly as additional work is done. Names identical to those used in Arizona have been omitted. In some cases the original references have not been available and information has been derived from other sources, particularly the 1937 issue of the U. S. Geological Survey Lexicon of Geologic Names and its 1957 supplement. Special acknowledgment is due to Dr. Carl Fries, Jr., for his assistance with the Sonoran units both here and in the nomenclature chart. The presence of unnamed stratigraphic sequences of different ages is indicated in the correlation chart.

Some igneous rock names in current use in southern Arizona are shown in table 6 (Tittley, 17).

- Abrigo formation (770 feet) Upper Cambrian
Type Area: Bisbee, Arizona. Ref.: Abrigo limestone, Ransome, 1904; Abrigo formation, Stoyanow, 1936.
Lith.: Limestone, cherty limestone to calcareous shale.
Underlain conformably by Bolsa quartzite; overlain disconformably by Devonian strata.
Remarks: Subdivided by Stoyanow, 1936, from top down into Copper Queen limestone, Abrigo formation (restricted), Southern Belle quartzite, Santa Catalina formation, and various equivalents (Peppersauce Canyon sandstone, Rincon limestone, Cochise formation, Pima sandstone); unrestricted, Jones and Bachellor, 1953; current use follows original definition as modified by Gilluly, 1956.
- Amole arkose (2,000 feet +) Upper Cretaceous
Type Area: Tucson Mts., Arizona. Ref.: Brown, 1939.
Lith.: Arkose and siltstone.
Underlain conformably by Recreation red beds; overlain disconformably by Tertiary rocks.
Remarks: Distribution south-central Arizona—variable unit, continental fluvial deposition; suggested redefinition by Kinnison, 1958 and 12.
- Andrada formation Pennsylvanian and Permian:
Virgil to Leonard
Type Area: Empire Mts., Arizona. Ref.: Wilson, 1951; Bryant, 1955.
Correlations: Undifferentiated equivalent of Pennsylvanian and Permian Earp, Colina, and Epitaph formations.
Remarks: Local use.
- Apache group (800-1,000 feet) Younger Precambrian
Type Area: Globe, Arizona. Ref.: Ransome, 1903; redefined by Ransome, 1915; redefined by Darton, 1932.
Lith.: Arkosic quartzite; siliceous mudstone; conglomerate; limestone. Intruded by diabase in many places.
Underlain unconformably by Pinal schist; overlain unconformably by Middle Cambrian quartzite.
Remarks: Subdivided from top down into Mescal limestone, Dripping Spring quartzite, Barnes conglomerate, Pioneer shale, Scanlan conglomerate. Locally basalt overlies the Mescal.
- Barnes conglomerate (10-15 feet) Younger Precambrian
Type Area: Globe, Arizona. Ref.: Ransome, 1903.
Lith.: Well-rounded pebbles of hard white or pink quartzite with some reddish jasper and white vein quartz.
Underlain conformably by Pioneer shale; overlain conformably by Dripping Spring quartzite.
Remarks: Part of the Apache group.
- Bisbee formation (variable) Lower Cretaceous
Type Area: Southeastern Arizona. Ref.: Gilluly, 1956.
Lith.: Arkose, sandstone, mudstone, conglomerate, some thin-bedded limestone.
Underlain unconformably by all older rocks; overlain unconformably by Tertiary rocks.
Remarks: Near-shore marine deposits; equivalent to Morita and Cintura formations, where Mural limestone is absent.
- Bisbee group (4,600 feet at Bisbee) Lower Cretaceous
Type Area: Southeastern Arizona. Ref.: Dumble, 1902; designated as group by Ransome, 1904; revised by Stoyanow, 1949.
Lith.: Coarse basal conglomerate, mudstone, sandstone, arkosic sandstone, and limestone.
Underlain unconformably by all older rocks; overlain unconformably by Cenozoic rocks.
Remarks: Subdivided in descending order into: Cintura formation; Mural limestone; Lowell formation; Morita formation; Glance conglomerate. Basal conglomerate may be continental; other formations are marine.
- Black Prince limestone Upper Mississippian to lower Pennsylvanian(?)
Type Area: Central Cochise County, Arizona. Ref.: Romslo, 1949, USBM; Gilluly, Cooper, and Williams, 1954.
Lith.: Limestone, with basal pebbly mudstone.
Underlain disconformably by Escabrosa; overlain disconformably by Horquilla limestone.
Correlations: Paradise formation in part.
Remarks: Localized distribution.
- Bliss sandstone (250 feet) Upper Cambrian
Type Area: Fort Bliss, El Paso, Texas. Ref.: Richardson, 1904.
Lith.: Brownish crossbedded sandstone.
Underlain unconformably by granite; overlain unconformably by El Paso limestone.
Correlations: Bolsa, Troy quartzites.

- Bolsa quartzite (450 feet) Middle Cambrian
Type Area: Bisbee, Arizona. Ref.: Ransome, 1904.
Lith.: Quartzite, coarse grained, resistant, crossbedded; locally conglomeratic; purple to brown.
Underlain unconformably by Pinal schist; overlain conformably by Abrigo formation.
Correlations: Troy and Bliss formations.
Remarks: Troy is used if sandstone lies on Apache group. Bolsa is used if sandstone lies on Pinal schist.
- Canelo red beds (1,360 feet) Lower Cretaceous
Type Area: Canelo Hills, southern Arizona. Ref.: Feth, 1948.
Lith.: Red clastics and a few thin limestone beds.
Underlain unconformably by Paleozoic rocks; overlain unconformably by Cenozoic rocks.
Correlations: Bisbee formation(?).
Remarks: Local usage.
- Cintura formation (1,400 feet) Lower Cretaceous
Type Area: Cintura Hills, Bisbee, Arizona. Ref.: Ransome, 1904.
Lith.: Bottom up: Quartzite; red shale and sandstone, nodular limestone; nodular shale and flaggy crossbedded sandstone.
Underlain conformably by Mural limestone; overlain unconformably by Quaternary.
Remarks: Top formation of Bisbee group.
- Cochise formation (311 feet) Middle Cambrian
Type Area: Whetstone Mts., Arizona. Ref.: Stoyanow, 1936.
Lith.: Blue to brown mottled limestone, alternating with shale; overlying yellow to red shale; basal reddish sandstone.
Underlain conformably by Bolsa quartzite; overlain conformably by Abrigo (restricted of Stoyanow).
Correlations: Southern Belle quartzite and Santa Catalina formation, in part.
Remarks: Local usage; part of Abrigo formation as subdivided by Stoyanow.
- Colina limestone (600 feet +) Permian: Wolfcamp-Leonard(?)
Type Area: Gunnison Hills, Arizona. Ref.: Gilluly, Cooper, and Williams, 1954.
Lith.: Black, thick- to medium-bedded limestone with a few clastic beds near base.
Underlain conformably by Earp formation; overlain conformably by Epitaph dolomite.
Remarks: Part of Naco group.
- Concha formation Permian: Leonard(?)
Type Area: Gunnison Hills, Arizona. Ref.: Gilluly, Cooper, and Williams, 1954; Bryant, 1955.
Lith.: Limestone, light gray, cherty, fossiliferous, with some sand layers at base.
Underlain conformably by Scherrer formation; overlain unconformably by Glance conglomerate.
Remarks: Part of Naco group.
- Copper Queen limestone (81 feet) Upper Cambrian
Type Area: Bisbee, Arizona. Ref.: Stoyanow, 1936.
Lith.: White to gray cliff-forming algal limestone.
Underlain conformably by Abrigo formation as restricted by Stoyanow, 1936; overlain disconformably by Martin limestone.
Correlations: Rincon limestone, Peppersauce Canyon sandstone.
Remarks: Faunal zone of Abrigo formation.
- Coronado quartzite (100-250 feet) Upper Cambrian
Type Area: Clifton-Morenci area, Arizona. Ref.: Lindgren, 1905a; age discussed by Stoyanow, 1936.
Lith.: Heavy-bedded quartzitic sandstone; locally includes thick basal conglomerate.
Underlain unconformably by granite; overlain unconformably by Longfellow limestone.
Correlations: Probably correlates with Bolsa, Troy, and Bliss formations.
- Earp formation (600 feet +) Pennsylvanian: Virgilian and Permian: Wolfcamp
Type Area: Tombstone Hills, Arizona. Ref.: Gilluly, Cooper, and Williams, 1954.
Lith.: Limestone with shale, some sandstone; in upper part orange-weathering dolomite.
Underlain conformably by Horquilla limestone; overlain conformably by Colina limestone.
Remarks: Part of Naco group. Basal part is upper Pennsylvanian and upper part is lower Permian in age; no lithologic break between them.
- El Paso limestone (750-1,600 feet) Lower Ordovician
Type Area: Franklin and Hueco Mts., Texas. Ref.: Richardson, 1904.
Lith.: Massive dolomitic limestone with sandy zones, especially near base.
Underlain unconformably by Bliss sandstone or Precambrian; overlain conformably by Upper Ordovician Montoya limestone.
Remarks: Originally included all Ordovician limestone between Cambrian and Silurian; restricted (Richardson, 1908) to Lower Ordovician; redesignated El Paso formation (Sabins, 1957a). See discussion by Dickenson (6).
- Epitaph dolomite (800 feet) Permian: Leonard
Type Area: Tombstone Hills, Arizona. Ref.: Gilluly, Cooper, and Williams, 1954.
Lith.: Dolomite, red and maroon shale, limy sandstone and red sandstone.
Underlain conformably by Colina limestone; overlain conformably by Scherrer quartzite.
Remarks: Restricted in extent; possibly in part equivalent to Colina; see discussion by Bryant (10).
- Escabrosa limestone (50-700 feet) Lower Mississippian: Kinderhook and Osage
Type Area: Bisbee, Arizona. Ref.: Ransome, 1904.
Lith.: Light-gray limestone, thick bedded, some fossils, generally non-magnesian but locally dolomitic; cliff former.
Underlain conformably by Martin limestone; overlain disconformably by Horquilla, Black Prince, and Paradise.
- Fort Buchanan formation (2,000 feet) Upper Cretaceous
Type Area: East side Santa Rita Mts. Ref.: Stoyanow, 1937 and 1949.
Lith.: Basal conglomerate with alternating gray sandstone and red shale.
Underlain conformably by andesitic lavas; overlain conformably by Fort Crittenden formation.
Remarks: Lower part of Sonoita group (Stoyanow, 1937). Contains fossil plants and dinosaurs.
- Fort Crittenden formation (2,500 feet +) Upper Cretaceous
Type Area: East side Santa Rita Mts., Arizona. Ref.: Stoyanow, 1937 and 1949.
Lith.: Conglomerate, alternating yellow shale and limestone, shale and sandstone.
Underlain conformably by Fort Buchanan formation; top faulted off or overlain unconformably by alluvium.
Remarks: Upper part of Sonoita group (Stoyanow, 1937); top of unit may be in part early Tertiary.
- Fusselman limestone (1,000 feet) Lower and Middle Silurian
Type Area: Franklin Mts., El Paso, Texas. Ref.: Richardson, 1908; Kelley and Silver, 1952; Pray, 1953.
Lith.: Massive dolomitic limestone.
Underlain disconformably by Montoya limestone or Cutter formation; overlain unconformably by Hueco limestone (Permian) at type locality.
Remarks: Fusselman dolomite (Dunham, 1935).

- Gila conglomerate (0-1,000 feet) Pliocene and Pleistocene, in part
Type Area: Southeastern Arizona and southwestern New Mexico, in four separate valleys along Gila River east of Safford, Arizona. Ref.: Gilbert, 1875; Heindl, 1954 and 1958.
Lith.: Conglomerate, sandstone, siltstone, local limestone, and local tuffs, basalt flows and volcanic sediments.
Remarks: Generally unconformable on older consolidated rocks. Used as a non-specific synonym for valley fill, which is the preferable term. See Whitetail conglomerate.
- Glance conglomerate (0-6,000 feet) Lower Cretaceous(?)
Type Area: Bisbee, Arizona. Ref.: Ransome, 1904; Gilluly, 1956.
Lith.: Brown, bedded conglomerate.
Underlain unconformably by all older rocks; overlain conformably by Morita formation.
Remarks: Basal member Bisbee group (Ransome, 1904).
- Horquilla limestone (1,000 feet +) Pennsylvanian; DesMoines, or possibly earlier, and Missourian
Type Area: Tombstone Hills, Arizona. Ref.: Gilluly, Cooper, and Williams, 1954.
Lith.: Gray limestone with shaley limestone.
Underlain disconformably by Escabrosa limestone; overlain conformably by Earp formation.
Remarks: Includes most of earlier Naco limestone (Ransome, 1904). In extreme eastern Arizona may be as early as Morrowan or Atokan.
- Longfellow limestone (400 feet +) Lower Ordovician; Beekmantown and Upper Cambrian(?)
Type Area: Clifton-Morenci area, Arizona. Ref.: Lindgren, 1905a.
Lith.: Limestone, siliceous and shaley at base; dolomitic and cliff forming at top.
Underlain disconformably by Coronado quartzite; overlain conformably by Morenci shale.
- Lowell formation Lower Cretaceous
Type Area: Vicinity of Bisbee, Arizona. Ref.: Stoyanow, 1949.
Lith.: Alternating sandstone and limestone.
Underlain conformably by Morita formation; overlain conformably by Mural limestone, as restricted by Stoyanow, 1949.
Remarks: Local unit (Gilluly, 1956).
- Lower Ouray formation (150 feet) Upper Devonian
Type Area: Santa Catalina Mts., Arizona. Ref.: Stoyanow, 1936.
Lith.: Thin-bedded limestone, sandstone and calcareous shale.
Underlain conformably by Martin limestone, as restricted by Stoyanow, 1936; overlain conformably by Escabrosa limestone.
Remarks: Faunal zone of Martin limestone.
- Martin limestone (50-350 feet) Middle and Upper Devonian
Type Area: Mt. Martin, Bisbee, Arizona. Ref.: Ransome, 1904.
Lith.: Hard, dark-gray limestone and some calcareous shale.
Underlain unconformably by Abrigo limestone; overlain conformably by Escabrosa limestone.
Correlations: Morenci shale, Percha formation.
Remarks: Locally subdivided by Stoyanow, 1936; locally called Martin formation, Huddle and Dobrovolny, 1952.
- Mescal limestone (250 feet) Younger Precambrian
Type Area: Globe area, Arizona. Ref.: Ransome, 1915.
Lith.: Cherty limestone.
Underlain conformably by Dripping Spring quartzite; overlain disconformably by Troy quartzite or basalt flows.
Remarks: Part of Apache group.
- Mineta formation (3,000 feet +) Lower Miocene
Type Area: Vicinity of Redington, Arizona. Ref.: Chew, 1952a and 1952b.
Lith.: Conglomerate, mudstone, siltstone, algal limestone.
Lower and upper contacts faulted in type area.
Correlations: Pantano formation (Brennan, 1957).
Remarks: Contains fossil jaw of Diceratherium sp. in upper part of sequence.
- Modoc limestone (170 feet +) Lower Mississippian
Type Area: Clifton-Morenci, Arizona. Ref.: Lindgren, 1905a.
Lith.: Coarse blue-gray limestone.
Underlain conformably by Morenci shale; overlain unconformably by Pinkard formation.
Correlations: Escabrosa limestone.
Remarks: Local name.
- Molly Gibson formation (1,000 feet +) Lower Cretaceous
Type Area: Patagonia Mts., Arizona. Ref.: Stoyanow, 1937 and 1949.
Lith.: Shale and blue to gray limestone.
Correlations: Underlain by shales of the Patagonia group and overlain by hornstone and siliceous shale.
Remarks: Part of Patagonia group (Stoyanow, 1949); contains Stolicskaia, Aptian guide fossil.
- Morenci shale (175 feet +) Upper Devonian
Type Area: Clifton-Morenci, Arizona. Ref.: Lindgren, 1905a.
Lith.: Clay, shale, and argillaceous limestone.
Underlain unconformably by Longfellow limestone; overlain conformably by Modoc limestone.
Correlations: Martin limestone, Percha formation.
Remarks: Local name.
- Morita formation (1,800 feet) Lower Cretaceous
Type Area: Bisbee, Arizona. Ref.: Ransome, 1904.
Lith.: Alternating red and yellow shale, sandstone, and limestone; shale red and more calcareous at top.
Underlain conformably by Glance conglomerate; overlain conformably by Mural limestone.
Correlations: Part of Bisbee group.
- Mural limestone (675 feet +) Lower Cretaceous
Type Area: Bisbee, Arizona. Ref.: Ransome, 1904; Stoyanow, 1949; Gilluly, 1956.
Lith.: Thick-bedded sandstone overlying thin-bedded impure sandstone.
Underlain conformably by Morita formation; overlain conformably by Cintura formation.
Correlations: Part of Bisbee group.
- Naco limestone (2,000 feet +) Upper Pennsylvanian and Permian
Type Area: Naco Hills, Bisbee, Arizona. Ref.: Ransome, 1904 (Naco limestone); Gilluly, Cooper, and Williams, 1954 (Naco group); Bryant, 1955.
Underlain disconformably by Escabrosa; overlain unconformably by Mesozoic and younger deposits.
Remarks: "Naco" previously was used for the Pennsylvanian and Permian beds in southeastern Arizona; Naco limestone, sensu stricto (Stoyanow, 1936) restricted Naco to Pennsylvanian beds; Gilluly, Cooper, and Williams (1954) raised to group status and subdivided it from bottom up into Pennsylvanian Horquilla limestone; Pennsylvanian and Permian Earp formation; and Permian Colina limestone, Epitaph dolomite, Scherrer formation, and Concha limestone. Bryant (1955) distinguishes the Rain-valley formation as forming the uppermost unit of his Naco group.

- Pantano formation (13,000 feet +) Miocene(?)
 Type Area: Vicinity of Tucson, Arizona. Ref.: Brennan, 1957.
 Lith.: Gray, lavender to maroon conglomerate, some sandstone, mudstone, and intercalated volcanic rocks, particularly a coarsely porphyritic andesite.
 Upper and lower contacts faulted.
 Correlations: Possibly Mineta formation, San Xavier conglomerate bed, Helmet fanglomerate beds.
 Remarks: Continental deposits of alluvial, lake, and flood-plain origin.
- Paradise formation (134 feet) Upper Mississippian:
 Chester
 Type Area: Chiricahua Mts., Arizona. Ref.: Stoyanow, 1926; Hernon, 1935.
 Lith.: Black and gray crystalline limestone with sandstone and shale.
 Underlain disconformably by Escabrosa limestone; overlain conformably by Naco limestone.
 Correlations: Black Prince limestone in part.
 Remarks: Local extent.
- Patagonia group (5,850 feet) Lower Cretaceous
 Type Area: Patagonia and southern Santa Rita Mountains. Ref.: Stoyanow, 1937 and 1949.
 Lith.: Predominantly continental near-shore shale and sandstone; several sequences of volcanic rocks are not included in the thickness listed above.
 Base unknown, includes Molly Gibson formation and overlying Cretaceous beds; relationships to Sonoita group unknown.
 Correlations: Possibly Bisbee formation, in part.
- Peppersauce Canyon sandstone (21 feet) Upper Cambrian
 Type Area: Santa Catalina Mts., Arizona. Ref.: Stoyanow, 1936.
 Lith.: Siliceous sandstone and pink quartzite.
 Correlation: Rincon limestone, Copper Queen limestone.
 Remarks: Part of Abrigo formation, local use.
- Percha shale (200 feet +) Middle and Upper Devonian
 Type Area: Sierra County, New Mexico. Ref.: Gordon, 1907.
 Lith.: Calcareous and non-calcareous black shales with limestone nodules.
 Underlain disconformably by Fusselman or El Paso or Abrigo formations; overlain conformably by Escabrosa or Lake Valley limestone.
 Correlations: Martin limestone; Morenci shale.
 Remarks: Restricted to uppermost formation of Percha (Stevenson, 1942 and 1945); subdivided into Box Canyon and Ready Pay members (Stevenson, 1945); subdivided into Canutillo (now the Onate), Sly Gap, Contadero and Percha (Stevenson, 1942 and 1945); given formation status (Kelley and Silver, 1952).
- Picacho de Calera formation (73 feet) Upper Devonian
 Type Area: Tucson area, Arizona. Ref.: Stoyanow, 1936.
 Lith.: Sandstone and limestone.
 Underlain disconformably by Abrigo (Rincon) formation; faunal zone in Martin formation.
- Pima sandstone (4 feet) Middle Cambrian
 Type Area: Tucson area, Arizona. Ref.: Stoyanow, 1936.
 Lith.: Hard, buff sandstone.
 Underlain conformably by Bolsa quartzite; part of Abrigo formation?
 Remarks: Obsolete.
- Pinal schist (20,000 feet +) Older Precambrian
 Type Area: Pinal Mts., Arizona. Ref.: Ransome, 1903; Cooper and Silver, 1954.
 Lith.: Quartz-sericite and quartz-muscovite schist, intruded by granites and other igneous rocks.
 Overlain unconformably by Apache group, Bolsa quartzite or younger rocks.
 Correlations: In part equivalent to Yavapai and Vishnu schists in central and northern Arizona; may be equivalent to Altar schist in Sonora, Mexico.
- Pinkard formation (500 feet) Upper Cretaceous
 Type Area: Clifton-Morenci, Arizona. Ref.: Lindgren, 1905a; Pike, 1947.
 Lith.: Black shales and yellowish-gray sandstone; locally calcareous; some conglomerate; near-shore marine.
 Underlain unconformably by Modoc limestone; overlain with angular disconformity by all younger rocks.
 Correlations: May be equivalent to Upper Cretaceous deposit along Deer Creek (Ross, 1925).
 Remarks: Local name.
- Pioneer shale (200 feet +) Younger Precambrian
 Type Area: Globe area, Arizona. Ref.: Ransome, 1903.
 Lith.: Red-brown arenaceous shales.
 Underlain conformably by Scanlan conglomerate; overlain conformably by Barnes conglomerate.
 Remarks: Part of Apache group.
- Portal formation (342 feet) Upper Devonian
 Type Area: Portal, Arizona. Ref.: Sabins, 1957a.
 Lith.: Siliceous and calcareous black shale, fine silt and nodular limestone.
 Underlain unconformably by El Paso formation; overlain conformably by Escabrosa limestone.
 Remarks: Local facies of Percha formation.
- Rainvalley formation (400 feet) Permian: Guadalupe
 Type Area: Mustang Mts., Arizona. Ref.: Bryant, 1955.
 Lith.: Gray, brown, red and black limestone and dolomite with some sandstone.
 Underlain conformably by Concha formation; overlain unconformably by Cretaceous or Cenozoic rocks.
 Remarks: Limestone and dolomite in Waterman Mountains probably equivalent to Rainvalley; absent due to erosion in many places.
- Recreation red beds (2,300 feet) Upper(?) Cretaceous
 Type Area: Tucson Mts., Arizona. Ref.: Brown, 1939.
 Lith.: Red non-marine sandstone and silt with some conglomerates and volcanic rocks.
 Underlain conformably by volcanic rocks; overlain conformably by Amole arkose.
- Rincon limestone (15-90 feet) Upper Cambrian
 Type Area: Rincon and Whetstone Mts., Arizona. Ref.: Stoyanow, 1936.
 Lith.: Pink, coarsely crystalline limestone.
 Underlain conformably by restricted Abrigo formation of Stoyanow; overlain disconformably by Martin limestone.
 Correlations: Copper Queen and Peppersauce Canyon units.
 Remarks: Faunal zone of Abrigo formation.
- Santa Catalina formation (400 feet) Middle Cambrian
 Type Area: Santa Catalina Mts. Ref.: Stoyanow, 1936.
 Lith.: Thin-bedded mudstone and shale.
 Underlain conformably by Troy quartzite; overlain conformably by Southern Belle quartzite.
 Correlations: Cochise formation, in part.
 Remarks: Part of Abrigo formation.
- Scanlan conglomerate (0-20 feet) Younger Precambrian
 Type Area: Globe area, Arizona. Ref.: Ransome, 1903.
 Lith.: Quartz-pebble conglomerate.
 Underlain unconformably by Pinal schist; overlain conformably by Pioneer shale.
 Remarks: Basal formation of Apache group.
- Scherrer formation (680 feet) Permian: Leonard
 Type Area: Gunnison Hills, Arizona. Ref.: Gilluly, Cooper, and Williams, 1954.
 Lith.: Two massive white sandstone units, separated by dolomitic limestone; basal red siltstone.
 Underlain conformably by Epitaph dolomite; overlain conformably by Concha limestone.
- Snyder Hill formation (1,200 feet) Permian: Leonard
 Type Area: Snyder Hill, Tucson, Arizona. Ref.: Stoyanow, 1936.
 Lith.: Gray to black limestone, fine sandstone in lower part, dolomite in upper part.
 Remarks: Replaced by upper Permian units of Naco group; obsolete.

- Sonoita group (4,000 feet) Late Upper Cretaceous
Type Area: Sonoita area, Patagonia, Arizona. Ref.: Stoyanow, 1937 and 1949.
Lith.: Conglomerate, sandstones, red and yellow shales; volcanics(?).
Remarks: Subdivided into Fort Crittenden and Fort Buchanan formations.
- Southern Belle quartzite (26 feet) Middle Cambrian
Type Area: Santa Catalina Mts., Arizona. Ref.: Stoyanow, 1936.
Lith.: Massive white quartzite.
Underlain conformably by Santa Catalina formation; overlain conformably by restricted Abrigo formation of Stoyanow.
Correlations: Cochise formation, in part.
Remarks: Part of Abrigo formation.
- Swisshelm formation (615 feet) Upper Devonian
Type Area: Swisshelm, Arizona. Ref.: Epis, Gilbert, and Logenheim, 1957.
Lith.: Sandstone, calcarenite and siltstone with impure limestone and shale.
Underlain unconformably by El Paso formation; overlain conformably by Escabrosa limestone.
Remarks: Grades laterally into Percha and Martin formations.
- Tornado limestone (1,000 feet +) Early Mississippian and Early Pennsylvanian
Type Area: Dripping Springs Mts., Arizona. Ref.: Ransome, 1915.
Lith.: Gray limestone with shale.
Underlain unconformably by Devonian.
Remarks: Subdivided into Escabrosa and Horquilla formations; obsolete.
- Troy quartzite (400 feet) Middle and Upper Cambrian
Type Area: Ray area, Arizona. Ref.: Ransome, 1915.
Lith.: Pink to brown, medium- to coarse-grained quartzite; crossbedded in part.
Underlain disconformably by Mescal limestone; overlain conformably by Abrigo formation.
Correlations: Bolsa quartzite(?).
Remarks: Basal quartzite of Paleozoic section where it overlies Apache group.
- Tule Springs formation (500 feet) Mississippian and Pennsylvanian
Type Area: Clifton-Morenci, Arizona. Ref.: Lindgren, 1905a and 1905b.
Lith.: Heavy-bedded gray limestone.
Underlain conformably by Morenci shale or Longfellow limestone; overlain disconformably by Pinkard formation.
Correlations: May be equivalent to parts of Escabrosa and Horquilla limestones.
Remarks: Local name.
- Whitetail conglomerate (1,000 feet) Tertiary
Type Area: Globe area, Arizona. Ref.: Ransome, 1903 and 1919; Heindl, 1958.
Lith.: Alluvial conglomerate, composed principally of diabase and limestone fragments.
Underlain unconformably by all older rocks; overlain by dacite flow.
Correlations: Older than upper part of Gila conglomerate and probably equivalent, in part, to lower units of Gila conglomerate.

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in Northern Sonora

- Altar schist (3,000 feet +) Lower Precambrian
Type Area: Altar district, northwestern Sonora. Ref.: Baker, 1925, in Schuchert, 1935; Stoyanow, 1942; Cooper and Arellano, 1946.
Lith.: Fine-grained schist, limestone lenses, gneissic quartzite, gneissic granite.
Overlain unconformably by Gamuza beds(?).
Correlations: Pinal schist(?).
Remarks: Considered to be "Older Paleozoic" by Baker (1925); considered to be Older Precambrian by Stoyanow (1942); described by Cooper and Arellano (1946) as Precambrian. Probably Lower Precambrian, but possibly Upper Precambrian.
- Arrojos formation (1,012 feet +) Middle Cambrian
Type Area: Caborca area, northwestern Sonora. Ref.: Stoyanow, 1942; Cooper and Arellano in Cooper et al., 1952.
Lith.: Limestone with interbedded shale.
Underlain conformably by Cerro Prieto formation; overlain conformably by Tren formation.
- Atil sandstone Lower Paleozoic(?) or Cretaceous(?)
Type Area: Altar district, northwestern Sonora. Ref.: Baker, 1925, in Schuchert, 1935; Maldonado-Koerdell, 1954.
Lith.: Sandstone and conglomerate.
Remarks: Baker (1925) considered it to be "Older Paleozoic;" Maldonado-Koerdell (1954) considers it to be uppermost Precambrian and lowermost Cambrian. Regional evidence suggests an Early Cretaceous age.
- Barranca formation (4,900 feet +) Middle and Upper Triassic and Lower Jurassic
Type Area: Yaqui River basin, east-central Sonora. Ref.: Dumble, 1900; King, 1934 and 1939.
Lith.: Shale, sandstone, conglomerate, minor limestone, coal and graphite; partly marine and partly continental.
Underlain disconformably by Permian or older rocks; overlain unconformably by Lista Blanca formation, Tarahumara formation.
Remarks: Dumble (1900) assigned an Upper Triassic age; King (1934 and 1939) assigned an Upper Triassic and Lower Jurassic age; basal part is probably Middle Triassic in type area. Subdivided by Wilson and Rocha (1946).
- Báucari division = Baucarit formation
Ref.: Dumble, 1900.
Remarks: Redefined.
- Báucarit formation (500 feet +) Upper Tertiary
Type Area: Cedros River basin, central Sonora. Ref.: Dumble, 1900; King, 1934 and 1939.
Lith.: Clay, sand, conglomerate, breccia, volcanic interbeds. Continental beds in intermontane valleys.
Underlain by earlier Tertiary rocks, Mesozoic or Paleozoic rocks; overlain by Pleistocene clastic beds.
Correlations: Equivalent in a broad way to the so-called Gila conglomerate.
Remarks: Originally called Báucari division by Dumble (1900) and thought to be underlain by the Nogales division, also of Tertiary age. Name was corrected to Báucarit formation by King (1934 and 1939). Poorly defined and probably includes rocks of different Tertiary ages locally.

- Buelna formation (398 feet) Lower Cambrian
 Type Area: Caborca area, northwestern Sonora. Ref.:
 Lochman, 1948; Cooper and Arellano, 1952.
 Lith.: Limestone.
 Underlain conformably by Proveedora formation; overlain
 conformably by Cerro Prieto formation.
 Remarks: Near top of Lower Cambrian.
- Caborca division = Monos formation + Gamuza beds
 Type Area: Caborca area, northwestern Sonora. Ref.:
 Keller, 1928.
 Remarks: Obsolete. Named by Keller (1928) who included
 the Monos beds at the top and the Gamuza beds below.
 Cooper (in Cooper, et al., 1952) shows Monos beds to be
 Middle Permian and Gamuza beds to be Upper Precam-
 brian.
- Caborca series = Caborca division = Monos formation +
 Gamuza beds.
 Ref.: Baker, 1925, in Schuchert, 1935.
 Remarks: Obsolete.
- Cabullona group (8,000 feet +) Upper Cretaceous
 Type Area: Cabullona area, northeastern Sonora. Ref.:
 Talliaferro, 1933.
 Lith.: Sandstone, shale, carbonaceous beds, limestone,
 conglomerate, and tuffaceous beds.
 Underlain disconformably by Lower Cretaceous Bisbee
 group; overlain unconformably by Tertiary volcanic and
 clastic rocks.
 Correlations: Sonoita group.
 Remarks: Subdivided in descending order into rhyolite tuff,
 upper red beds, Packard shale, Camas sandstone, and
 Snake Ridge formation; faulted at base.
- Camas sandstone (1,220 feet) Upper Cretaceous
 Type Area: Cabullona area, northeastern Sonora. Ref.:
 Talliaferro, 1933.
 Lith.: Crossbedded, tuffaceous sandstone with some red
 and green shale.
 Underlain conformably by Snake Ridge formation; overlain
 conformably by Packard shale.
 Remarks: Part of Cabullona group; silicified tree trunks
 are common.
- Capote limestone = Lower Crystalline limestone
 Devonian(?)
 Ref: Blake, 1904; Mulchay and Velasco, 1954.
 Remarks: Obsolete.
- Capote quartzite (several hundred feet) Middle Cambrian
 Type Area: Cananea district, northeastern Sonora. Ref.:
 Emmons, 1910; Mulchay and Velasco, 1954.
 Lith.: Arkosic, conglomeratic quartzite.
 Underlain unconformably by Lower Precambrian Pinal
 schist; overlain conformably by Esperanza limestone.
 Correlations: Bolsa quartzite, Troy quartzite.
 Remarks: Capote quartzite and overlying Esperanza lime-
 stone total 700 feet in thickness. Emmons assigned Pre-
 cambrian age.
- Cedros River division = Baucarit formation Upper
 Tertiary
 Type Area: Cedros River valley, central Sonora. Ref.:
 Dumble, 1900.
 Remarks: Obsolete.
- Chivaterra zone Pennsylvanian
 Type Area: Cananea district, northeastern Sonora. Ref.:
 Mulchay and Velasco, 1954.
 Lith.: Limestone.
 Underlain disconformably by Upper Crystalline limestone;
 overlain conformably by Puertecitos limestone.
 Correlations: Naco limestone, Nacozeni limestone.
 Remarks: Lower part of Puertecitos limestone.
- Elenita formation (6,000 feet) Lower Tertiary(?)
 or Upper Cretaceous(?)
 Type Area: Cananea district, northeastern Sonora. Ref.:
 Valentine, 1936; Mulchay and Velasco, 1954.
 Lith.: Trachyte, rhyolite flows, agglomerate with some
 interbedded waterlaid clastics.
 Underlain by or equivalent to top of Cabullona group; over-
 lain unconformably by Henrietta formation.
 Correlations: May correlate with top of Cabullona group.
 Remarks: In fault contact with Henrietta group, but prob-
 ably older (Velasco, 1956). Earlier was assigned an
 early and middle Mesozoic age and mapped as part of
 LaMesa formation.
- Esperanza limestone (300 feet +) Upper Cambrian
 Type Area: Cananea district, northeastern Sonora. Ref.:
 Mulchay and Velasco, 1954; Ordonez and Ulloa, 1956.
 Lith.: Limestone.
 Underlain conformably by Capote quartzite; overlain dis-
 conformably by Lower Crystalline limestone.
 Correlations: Abrigo limestone.
 Remarks: Thought formerly to be of Devonian age (Mulchay
 and Velasco, 1954).
- Gamuza beds (5,500 feet +) Upper Precambrian
 Type Area: Altar district, northwestern Sonora. Ref.:
 Baker, 1925, in Schuchert, 1935; Keller, 1928; Cooper
 and Arellano, 1946; Cooper and Arellano in Cooper et al.,
 1952; Cooper in Cooper et al., 1953.
 Lith.: Shale, limestone, sandstone, quartzite, dolomite.
 Underlain unconformably by Altar schist(?); overlain un-
 conformably by Puerto Blanco formation.
 Correlations: Apache group.
 Remarks: Name was used by Baker (1925) for supposed
 Pennsylvanian beds now called Proveedora, Buelna, and
 Cerro Prieto formations by Cooper and Arellano (in
 Cooper et al., 1952), of Lower Cambrian age. Name is
 restricted by Cooper to Precambrian rocks (in Cooper
 et al., 1953), which were described by Cooper and
 Arellano (1946). Also spelled "Gamusa."
- Henrietta formation (5,500 feet +) Lower Tertiary
 Type Area: Cananea district, northeastern Sonora. Ref.:
 Valentine, 1936; Mulchay and Velasco, 1954; Velasco,
 1956.
 Lith.: Fine-grained tuffs, agglomerate, rhyolite, dacite
 and andesite flows.
 Underlain unconformably by Elenita formation; overlain un-
 conformably by LaMesa formation.
 Remarks: In fault contact with Elenita formation, but prob-
 ably younger (Velasco, 1956) and probably lower Tertiary.
 Earlier assigned a middle or upper Mesozoic age.
- Jojoba formation = Cerro Prieto formation
 Ref.: Stoyanow, 1942, and in Cooper et al., 1952.
 Remarks: Obsolete.
- LaMesa formation (5,000 feet +) Lower Tertiary
 Type Area: Cananea district, northeastern Sonora. Ref.:
 Valentine, 1936; Mulchay and Velasco, 1954; Velasco,
 1956.
 Lith.: Mostly tuffs and agglomerates; near base several
 interbedded lenticular flows of rhyolite, dacite and andes-
 ite; higher is a thick flow called San Pedro andesite.
 Underlain unconformably by Henrietta; overlain unconform-
 ably by upper Tertiary clastic deposits.
 Remarks: Age is not proven, and although thought to be
 lower Tertiary, it may be younger or older; earlier was
 assigned an upper Mesozoic or lower Tertiary age.
 Also referred to as Mesa formation.

- Lista Blanca formation (3, 250 feet) Upper Cretaceous
Type Area: San Marcial area, central Sonora. Ref.:
Dumble, 1900; King, 1934 and 1939.
Lith.: Andesitic tuff, breccia, flows; some sandstone,
conglomerate, rare limestone.
Underlain unconformably by Barranca formation and Pale-
ozoic rocks; overlain by Tertiary volcanic and clastic
rocks.
Correlations: Cabullona group; Tarahumara formation.
Remarks: Dumble (1900) named the Lista Blanca division
and thought it to be Upper Triassic; King (1934 and 1939)
considered the Lista Blanca formation to be Upper
Cretaceous.
- Lower Crystalline limestone Middle(?) and Upper
Devonian
Type Area: Cananea district, northeastern Sonora. Ref.:
Mulchay and Velasco, 1954.
Lith.: Limestone.
Underlain disconformably by Esperanza limestone; over-
lain disconformably by Upper Crystalline limestone.
Correlations: Martin limestone
Remarks: The Capote limestone of Blake (1904) is probably
a part of the Lower Crystalline limestone.
- Monos formation (2, 200 feet +) Permian: Guadalupe
Type Area: El Antimonio district, northwestern Sonora.
Ref.: Baker, 1925, in Schuchert, 1935; Keller, 1928;
Stoyanow, 1942; Cooper in Cooper et al., 1953.
Lith.: Marine limestone, shale, sandstone, chert.
Underlain by ?; overlain unconformably by Upper Triassic
marine rocks.
Correlations: Scherrer formation.
Remarks: Baker (1925) originally called this formation the
Monos beds and thought it to be Upper Pennsylvanian.
Keller (1928) called it the upper part of the Caborca
division and also Pennsylvanian. Stoyanow (1942) assign-
ed a Permian age to fossils from the formation. The
Middle Permian (Word) age of the whole formation was
confirmed by Cooper et al. (1953).
- Nabosaigame conglomerate (3, 000 feet +) Lower Tertiary
Type Area: Eastern Sonora and west-central Chihuahua.
Ref.: Hovey and Hill, 1905; King, 1939.
Lith.: Conglomerate and sandstone, mostly of andesitic
composition.
Underlain with angular unconformity by ?; overlain with
angular unconformity by Late Tertiary volcanic and clastic
rocks.
Correlations: Elenita, Henrietta, and LaMesa formations(?)
Remarks: No fossils have been found in the formation.
Whether it includes Cretaceous rocks is uncertain.
- Nacozari limestone (1, 000 feet +) Upper Pennsylvanian(?)
and Lower Permian
Type Area: Nacozari district, northeastern Sonora. Ref.:
Wade and Wandke, 1920; Imlay, 1939.
Lith.: Limestone.
Underlain unconformably by ?; overlain conformably by
Permian limestone.
Correlations: Naco limestone.
Remarks: Originally assigned Late Pennsylvanian age;
probably includes Pennsylvanian and Permian beds through
Guadalupian age.
- Nogales formation (1, 000 feet +) Middle Tertiary
Type Area: Nogales area, north-central Sonora. Ref.:
Dumble, 1900; King, 1934 and 1939.
Lith.: Rhyolitic lavas, agglomerates, conglomerates, some
andesitic lavas and tuffs.
Underlain unconformably by Trincheras formation; overlain
unconformably by Baucarit formation.
Remarks: Originally called Nogales division by Dumble
(1900) and assigned "Late Tertiary" age. U. S. Geolog-
ical Survey Lexicon (1937) indicates Cretaceous or
Tertiary.
- Packard shale (1, 800-2, 500 feet) Upper Cretaceous
Type Area: Cabullona area, northeastern Sonora. Ref.:
Taliaferro, 1933.
Lith.: Dark to black marine shale; thin sandstone and
bentonite beds.
Underlain conformably by Camas sandstone; overlain con-
formably by Upper Red beds.
Correlations: Sonoita group.
Remarks: Part of Cabullona group.
- Palmar formation (4, 000 feet +) Lower Cretaceous
Type Area: East-central Sonora. Ref.: King, 1939.
Lith.: Coarse conglomerate at base; alternating limestone,
shale and sandstone followed by massive limestone with
interbedded quartzite.
Overlain conformably by Potrero formation.
Correlations: Bisbee group.
Remarks: Formerly considered Triassic in age.
- Potrero formation (5, 200 feet) Lower Cretaceous
Type Area: Ranch El Potrero east of Cerro el Palmar,
east-central Sonora. Ref.: King, 1939.
Lith.: Shale, locally fossiliferous; thin-bedded brown lime-
stone, sandstone and conglomerate, with contemporaneous
flows of andesite.
Underlain conformably by Palmar formation.
Correlations: Bisbee group.
Remarks: Formerly considered to be Triassic.
- Provedora formation (732 feet) Lower Cambrian
Type Area: Caborca area, northwestern Sonora. Ref.:
Cooper and Arellano in Cooper et al., 1952.
Lith.: White quartzite and dark slaty shale.
Underlain conformably by Puerto Blanco formation; over-
lain conformably by Buelna formation.
- Puertecitos limestone (2, 650 feet +) Upper Pennsylvanian
and Lower Permian
Type Area: Cananea district, northeastern Sonora. Ref.:
Emmons, 1910; Lee, 1912; Mitchell, 1928; Mulchay and
Velasco, 1954; Velasco, 1956.
Lith.: Dense, black, thin bedded, cherty; marmorized and
may look like an argillite.
Underlain disconformably by Upper Crystalline limestone;
overlain unconformably by Cretaceous and Tertiary
rocks.
Correlations: Naco formation, Nacozari limestone.
Remarks: Originally thought to be Cambrian and equivalent
to Abrigo. Mitchell (1928) found upper Carboniferous
fossils.
- Puerto Blanco limestone (961 feet +) Lower Cambrian
Type Area: Caborca area, northwestern Sonora. Ref.:
Cooper and Arellano in Cooper et al., 1952.
Lith.: Slate, limestone, shale, quartzite, marble.
Underlain by Upper Precambrian beds; overlain conform-
ably by Proveedora formation.
Remarks: Actual base of the formation has not been seen
and full thickness is thus greater.
- Represo beds (124 feet +) Mississippian: Kinderhook-
Osage
Type Area: Caborca area, northwestern Sonora. Ref.:
Arellano in Weller et al., 1948; Easton et al., 1958.
Lith.: Limestone, much chert.
Underlain disconformably(?) by Devonian limestone; over-
lain conformably by Venada beds.
Correlations: Escabrosa limestone.
Remarks: Lower contact is covered.
- Rhyolite tuff (800 feet) Upper Cretaceous
Type Area: Cabullona area, northeastern Sonora. Ref.:
Taliaferro, 1933.
Lith.: Crystalline vitric rhyolite tuff.
Underlain conformably by Upper Red beds; overlain discon-
formably by Elenita formation.
Remarks: Top part of Cabullona group.

Snake Ridge formation (2,000 feet +) Upper Cretaceous
Type Area: Cabullona area, northeastern Sonora. Ref.:
Taliaferro, 1933.
Lith.: Brackish and continental limestone, conglomerate,
sandstone and carbonaceous shale.
Underlain unconformably by Bisbee group; overlain con-
formably by Camas sandstone.
Correlations: Sonoita group.
Remarks: Lowest formation of Cabullona group; faulted at
base; duck-billed dinosaurs.

Tarahumara formation (650 feet +) Upper Cretaceous
Type Area: Yaqui River basin, east-central Sonora. Ref.:
Wilson and Rocha, 1946.
Lith.: Andesitic to latitic tuff, breccia, and flows.
Underlain unconformably by Barranca formation; overlain
unconformably by Tertiary volcanic and clastic rocks.
Correlations: Lista Blanca formation = Cabullona group, in
part.
Remarks: Top of formation is eroded.

Tigre formation Permian; Leonard(?)
Type Area: Nacozari district, northeastern Sonora. Ref.:
Imlay, 1939; Alvarez, 1949.
Lith.: Limestone.
Underlain conformably by Nacozari limestone.
Remarks: Not included in a recent list of Mexican forma-
tions. Although Imlay (1939) described this formation,
the name was first given by Alvarez (1949).

Tren formation (1,600 feet +) Middle Cambrian
Type Area: Caborca area, northwestern Sonora. Ref.:
Cooper and Arellano in Cooper et al., 1952.
Lith.: Dark dolomite.
Underlain conformably by Arrojos formation.
Correlations: Abrigo formation.
Remarks: Top of section covered.

Trincheras formation (2,600 feet +) Lower Tertiary
Type Area: Trincheras Creek, north-central and northeast-
ern Sonora. Ref.: Dumble, 1900.
Lith.: Conglomerate, sandstone and andesitic flows.
Underlain unconformably by Cretaceous rocks; overlain un-
conformably by Nogales formation.
Remarks: Dumble assigns it a "Late Tertiary" age; U. S.
Geological Survey Lexicon (1937) indicates Cretaceous or
Tertiary age.

Upper Crystalline limestone (Several hundred feet) Lower
Mississippian: Kinderhook and Osage
Type Area: Cananea district, northeastern Sonora. Ref.:
Mulchay and Velasco, 1954.
Lith.: Limestone.
Underlain conformably(?) by Lower Crystalline limestone;
overlain disconformably by Chivaterra zone of Puertecitos
limestone.
Correlations: Escabrosa limestone.

Upper Red beds (2,000 feet) Upper Cretaceous
Type Area: Cabullona area, northeastern Sonora. Ref.:
Taliaferro, 1933.
Lith.: Red shale and white sandstone.
Underlain conformably by Packard shale; overlain conform-
ably by Rhyolite tuff.
Correlations: Sonoita group.
Remarks: Part of Cabullona group; capped by 800 feet of
Rhyolite tuff of Cabullona group.

Venada beds (40 feet +) Mississippian: Meramec
Type Area: Caborca area, northwestern Sonora. Ref.:
Arellano in Weller et al., 1948; Easton et al., 1958.
Lith.: Limestone, a little chert.
Underlain conformably by Represo beds; overlain uncon-
formably by Permian(?).
Correlations: Escabrosa limestone.
Remarks: Upper contact is covered.