

THE CAMBRIAN AND ORDOVICIAN SYSTEMS
OF SOUTHEASTERN ARIZONA

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INTRODUCTION

Formations of Cambrian and Ordovician systems in southeastern Arizona form a unit of the lower Paleozoic rocks that is separated by hiatuses from the rocks above and below. Cambrian strata rest on a planed surface cut on Precambrian schist, granite, and sedimentary rocks, and Upper Cambrian and Lower Ordovician beds are overlain with apparent conformity by Upper Devonian formations. The interval from Middle Ordovician to Middle Devonian is not presently known to be represented. The following summary reviews the published literature and outlines some of the problems concerning the Cambrian and Ordovician Systems of southeastern Arizona.

CAMBRIAN ROCKS

Bolsa Quartzite

The Bolsa quartzite (Ransome, 1904) forms the basal part of the Cambrian system in southeastern Arizona. It is composed of a basal quartzite conglomerate that grades upward into quartzite. These rocks are rusty brown, commonly cross-bedded, and form high ridges or strong topographic benches. Their thickness (Stoyanow, 1936) ranges from 430 feet at Bisbee to 720 feet in the Picacho de Calera Hills west of Tucson.

The Bolsa quartzite rests on the Precambrian Pinal schist and the related intrusive rocks. The contact is a surface of very low relief that represents either a peneplain or a plain of marine abrasion of remarkable smoothness. The quartzite represents littoral deposits of a transgressing sea (Gilluly, 1956).

In the Peloncillo Mountains in southwestern New Mexico, the Bolsa quartzite rests on Precambrian granite and has been divided into three members (Gillerman, 1958). The lower quartzite is cross-bedded and contains conglomerate lenses; the middle member is composed of fine grained arkose and glauconitic sandstone with some black shale; and the top member is thick-bedded quartzite. The total thickness is about 400 feet.

Ransome (1904) assigned a Middle Cambrian age to the Bolsa quartzite because it grades upward into the overlying fossiliferous Middle Cambrian Abrigo limestone. In the Chiricahua and Dos Cabezas Mountains, Sabins (1957a) and Flower (1958) have reported trilobites from the upper part of the Bolsa quartzite that are of Dresbach age, which is now considered to be latest Middle Cambrian (Flower, 1958).

In the Tucson-Globe area the Troy quartzite of Middle Cambrian age rests unconformably on the Precambrian Apache group. Darton (1925) correlated the Troy beds with the Bolsa-Abrigo beds to the south. Generally in the literature, the term "Troy" has been used for the quartzite that overlaps younger Precambrian Apache beds and "Bolsa" has been used for the quartzite that overlaps older Precambrian Pinal schist and other crystalline rocks (Lance, 4).

Coronado Quartzite

The Coronado quartzite (Lindgren, 1905) overlies Precambrian granite in the Morenci area. It consists of about 200 feet of quartzite sandstone with a quartzite conglomerate up to 50 feet thick at its base. The Coronado quartzite is of probable Middle Cambrian age and is tentatively correlated with the Bolsa quartzite by Darton (1925) and Stoyanow (1936).

Bolsa-Bliss Problem

Overlying the Precambrian rocks in southwestern New Mexico is the Bliss sandstone, which has been considered to be of Upper Cambrian and Lower Ordovician ages at the type locality in the Franklin Mountains near El Paso, Texas. Flower (1958) considers the Bliss sandstone at the type locality to be Early Ordovician in age, but to be both Cambrian and Early Ordovician to the north, and possibly Trempealeuan (Late Cambrian) in the Hatchet Mountains to the west.

Correlation of the Bolsa quartzite of Arizona with the Bliss sandstone of southwestern New Mexico has been suggested by Kelley and Silver (1952) and Sabins (1957a). They consider that the rock unit crosses time lines, and that the Bolsa quartzite was once laterally continuous with the lithologically similar but stratigraphically younger Bliss sandstone.

After this correlation was proposed, Epis and Gilbert (1957) described from the Northern Swisshelm Mountains an unbroken stratigraphic sequence of Cambrian and Ordovician rocks consisting of Bolsa quartzite, Abrigo limestone, Upper Cambrian sandstone and dolomite, and El Paso limestone. Based on the presence of Billingsella spp. (very Late Cambrian, Franconian or Trempealeuan) in the Upper Cambrian dolomite of the Northern Swisshelm Mountains, in the upper sandy dolomite of the Abrigo limestone in the Bisbee area, and in the lower sandy dolomite of the El Paso limestone in the Dos Cabezas and Chiricahua Mountains, Epis and Gilbert (1957) would term the sandstone strata below these dolomite beds "Bliss equivalents". These relationships are shown in figure 3.

Abrigo Limestone

The Abrigo limestone (Ransome, 1904) of Middle and Late Cambrian age overlies the Bolsa and Troy quartzites in southeastern Arizona. In the Bisbee area, where the Abrigo formation was originally defined, the Bolsa quartzite grades upward through thin sandy micaceous shale layers to a limestone with conspicuous edgewise conglomerate. This thin-bedded limestone is bluish gray and in places is mottled by irregularly scattered yellow inclusions of silty or micaceous material. The limestone becomes increasingly sandy upward, and the upper part of most sections consists of sandstone or quartzite. The Abrigo limestone ranges in thickness from 770 feet (Ransome, 1904) in the Bisbee area to 844 feet in the Tombstone Hills (Gilluly, 1956). It is disconformably overlain by Devonian beds throughout most of southeastern Arizona. The Abrigo limestone contains several faunal zones.

Stoyanow (1936) locally subdivided the Abrigo on the basis of faunal zones and changes in lithology. At Bisbee, he restricted the "Abrigo formation" to 420 feet of the middle part of the Abrigo limestone defined by Ransome. Stoyanow named the underlying 290 feet of shale the "Cochise formation" and he gave the name "Copper Queen limestone" to the 81 feet of limestone overlying the restricted Abrigo. The Cochise formation is Middle Cambrian and the Abrigo and Copper Queen formations

are Late Cambrian. In the Santa Catalina Mountains, Stoyanow restricted the Abrigo formation to 288 feet of limestone of Late Cambrian age and named the 21 feet of sandstone overlying his restricted Abrigo formation the "Peppersauce Canyon sandstone." The bottom 415 feet of the Middle Cambrian rocks underlying the restricted Abrigo formation was named the "Santa Catalina formation" and the upper 26 feet, the "Southern Belle quartzite". Stoyanow also restricted the Abrigo limestone in the Whetstone Mountains and the underlying Middle Cambrian beds were termed "Cochise formation". Four feet of hard sandstone at the base of the Cochise in this locality was named the "Pima sandstone". These subdivisions are only locally mappable and for regional purposes recent workers (Bryant, 1955; Gilluly, 1956; Epis and Gilbert, 1957; McClymonds, 1957) have continued to use Abrigo according to its original definition.

The Abrigo limestone of Ransome is restricted to beds of Cambrian age, and the Ordovician and Cambrian beds at Dos Cabezas termed "Abrigo limestone unrestricted" by Jones and Bacheller (1953) are now called El Paso limestone.

CAMBRIAN AND ORDOVICIAN ROCKS

El Paso Limestone

The name El Paso limestone was first applied in Arizona to strata above the Bolsa quartzite in the Chiricahua Mountains (Sabins, 1957a). Epis and Gilbert (1957) recognized El Paso limestone in the northern and southern Swisshelm Mountains and in the Pedregosa Mountains. The term "El Paso limestone" was originally applied to Lower Ordovician strata in the Franklin Mountains, Texas, by Richardson (1908).

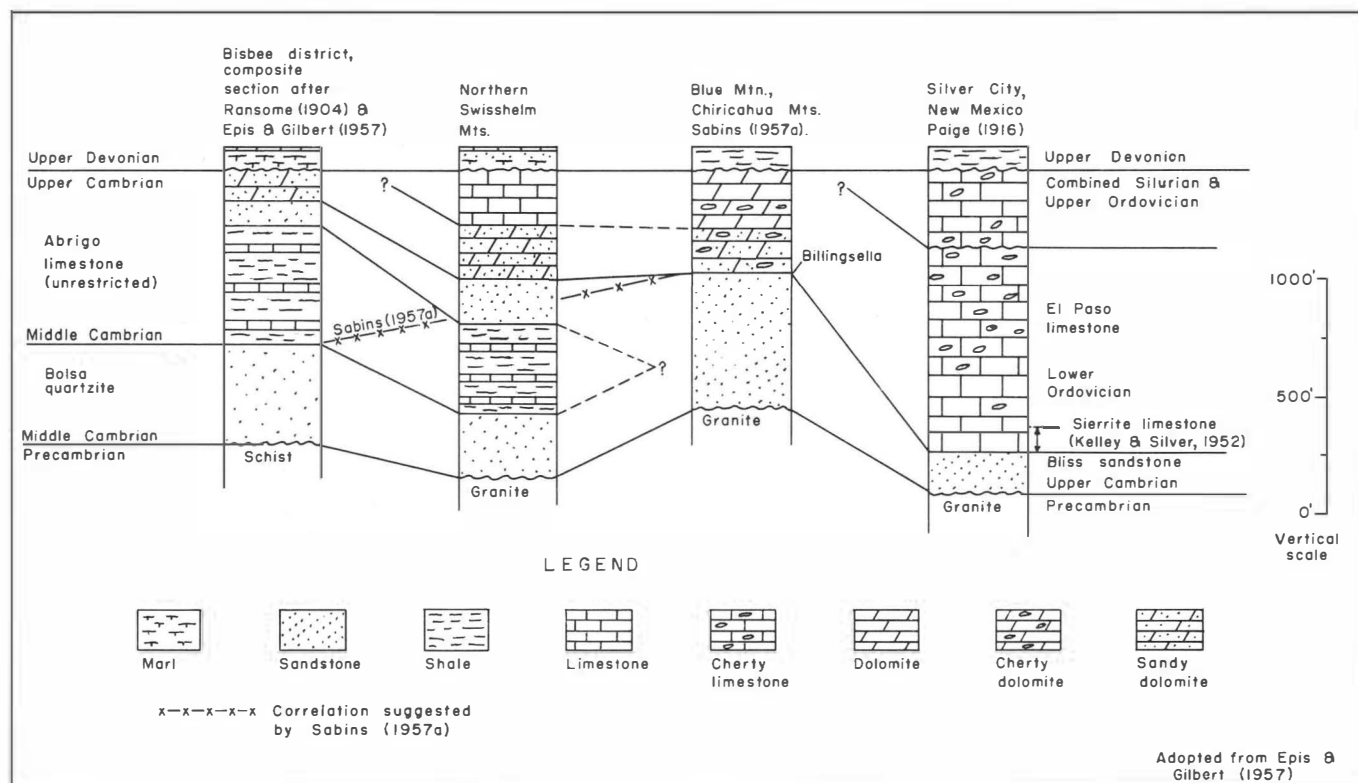


FIGURE 3. Suggested correlations and relationships of Cambrian and Ordovician strata between Bisbee, Arizona and Silver City, New Mexico.

Rocks of Ordovician age had earlier been recognized in the Dos Cabezas Mountains by Darton (1925), Stoyanow (1936), and Jones and Bacheller (1953). Sabins (1957a) and Epis and Gilbert (1957) have suggested that El Paso limestone is a more suitable designation for these beds than "Abrigo limestone unrestricted" (Jones and Bacheller, 1953), although the lower part of the beds may be Cambrian in age.

In the Chiricahua Mountains, the Ordovician beds are predominantly dolomite instead of limestone, and in that locality Sabins (1957a) used the term "El Paso formation". At Apache Pass the formation consists of gray dolomite and dolomitic limestone with thin interbedded limestone, sandstone, and shale at the base. In that area the El Paso formation overlies the Bolsa quartzite with a sharp conformable contact and is overlain disconformably by weak calcareous shale of the Upper Devonian Portal formation.

In the Swisshelm Mountains, the El Paso beds are limestone or dolomite. The slabby gray strata contain intraformational conglomerate which is composed of a fine-grained calcite matrix and angular to subrounded fragments of limestone. This clastic texture is clearly shown on weathered surfaces. The El Paso limestone in the Peloncillo Mountains in southwestern New Mexico consists of about 550 feet of dolomite and cherty limestone (Gillerman, 1958).

The El Paso limestone in the Chiricahua Mountains (Sabins, 1957a) is both Late Cambrian and Early Ordovician in age, and Sabins concurs with Kelley and Silver (1952) in suggesting the likelihood of a west-to-east marine transgression from an expanding Sonoran seaway in southeast Arizona during Middle Cambrian-Lower Ordovician time. Sabins (1957a, p. 475) states, "according to this concept, the Abrigo formation (Upper Cambrian) of southeast Arizona, the El Paso formation (Cambrian-Ordovician) of the Chiricahua-Dos Cabezas Mountains and the El Paso formation (Lower Ordovician) of New Mexico and West Texas represent parts of a continuous sheet of carbonate sediments deposited offshore in the transgressing sea and becoming progressively younger from west to east."

In contrast, Epis and Gilbert (1957) contend, on the basis of the Northern Swisshelm Mountains section, that the Abrigo limestone of Ransome (1904) pinches out in Arizona under the Chiricahua Mountains (fig. 3) and is not to be correlated on biostratigraphic or lithogenetic grounds with the El Paso limestone in New Mexico.

ORDOVICIAN ROCKS

Longfellow Limestone

The Longfellow limestone (Lindgren, 1905) crops out in the vicinity of Morenci, Ariz. It consists of about 400 feet of strata conformably covering the Coronado quartzite. The lower 250 feet contain shaly limestone with a few sandstone and quartzite beds and the upper 150 feet is composed of dolomitic limestone. Correlation of the Longfellow limestone with Ordovician beds in the Dos Cabezas Mountains has been suggested by Darton (1925), Jones and Bacheller (1953), and Epis and Gilbert (1957).

Additional note: Epis (1958) describes the Cambrian and Ordovician section in the Pedregosa Mountains, east of the Swisshelm and Chiricahua Mountains, as consisting, in ascending order, of at least 520 feet of Bolsa quartzite, about 400 feet of Abrigo limestone, 380 feet of an unnamed Cambrian sandstone, 168 feet of dolomite and 35 feet of El Paso limestone. Epis (1958) states: "The thickening of the upper Cambrian sandstone in the southern Pedregosa Mountains is consistent with the hypothesis that this unit continues northeastward and eastward from the Sulphur Spring Valley in Arizona to form most (perhaps all but the lowermost part) of the Bliss sandstone of southwestern New Mexico." He concludes that the Pedregosa Mountains section validates the relationships of the Bolsa, Abrigo, Bliss and El Paso formations presented by Epis and Gilbert (1957).